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REPORT ON THE MEASUREMENT RESULTS FOR THE EURAMET 658 EXTENSION: PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION (CCT WG-KC VERSION FOR PUBLICATION ON BIPM DATABASE)

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EURAMET 658 Extension: Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Main Comparison Measurement Report
(CCT WG-KC Version for Publication on BIPM Database)

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ABSTRACT

This report describes the measurement procedures and participant results for the EURAMET project 658 extension – 'Project to examine underlying parameters in radiance temperature scale realisation from 156 °C to 1000 °C', with particular emphasis on the results of the variable temperature and fixed point blackbody measurements for the justification of radiation thermometry CMCs.

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Approved on behalf of NPLML by
Dr Stephanie Bell, Science Area Leader.

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1 INTRODUCTION

This project is an extension to the EUROMET project 658 – 'The examination of base parameters for ITS-90 scale realisation in radiation thermometry' [1], which was a comparison of measurements of parameters underpinning ITS-90 scale realisation above 962 °C such as spectral response, size-of-source effect, linearity and calculation of the emissivity of a number of different blackbody sources.

The purpose of the extension project was to undertake a comparison of measurements of parameters necessary for radiation thermometers for the medium temperature range (from 156 °C to 1000 °C). The parameters to be measured were the size-of-source effect, gain (range) ratios, calibration using fixed-point blackbody sources, measurements using variable temperature blackbody calibration sources, and an assessment of the effect on the results of changes in the ambient temperature and humidity. Participants were asked to carry out as many of the measurements as possible.

Two InGaAs-based radiation thermometers, operating at a wavelength of nominally 1.6 μm, were used for the comparison. One of the thermometers was supplied by INRiM (Istituto Nazionale di Ricerca Metrologica); the other was an IKE (Institut für Kernenergetik und Energie) LP5 (Linear Pyrometer 5) supplied by IKE, Stuttgart. These were circulated around the participants. A zinc fixed-point blackbody source, also supplied by INRiM, was also circulated. This was used for checking the thermometers before the start (and sometimes also at the end) of the measurements at each institute to confirm the correct performance of the transfer thermometers and to determine any drift in the thermometer output. The technical specifications for the two radiation thermometers are given in the protocol in Appendix 1. The instructions for operating the zinc freezing-point blackbody source are given in Appendix 2.

This report describes the results of the measurements at each laboratory, and compares the results obtained at different laboratories. Further details of the results, as well as the measurement procedures and equipment used by each participant, are given in the measurement reports (see Appendices 7 to 13). For the purpose of CMC verification it should be emphasised that the results are only applicable for radiation thermometers operating at a wavelength near 1.6 microns and do not ensure equivalence at other wavelengths.

1.1 THE PARTICIPANTS

The participant institutes were: NPL (National Physical Laboratory, United Kingdom), PTB (Physikalisch-Technische Bundesanstalt, Germany), TÜBITAK – UME (Türkiye Bilimsel ve Teknolojik Araştirma Kurumu, Turkey), INRiM (Italy), CEM (Centro Español de Metrología, Spain), METAS (Metrology and Accreditation Switzerland, Switzerland) and LNE (Laboratoire National de Métrologie d'Essais, France).

1.2 THE TWO RADIATION THERMOMETERS

A summary of the technical specifications of the INRiM thermometer and the IKE LP5 are given in the Table 1. More information is given in the technical protocol in Appendix 1.

Parameter	Radiation thermometer	
	IKE LP5 serial no. 80-51	INRiM identification TS1
Operating wavelength/ nm	1568 (36 nm bandwidth)	1500 to 1700
Target size at working distance/ mm	2 at 750	5 at 470
Temperature range/ °C	~230 to ~1085	150 to 1000

Table 1: summary of the specification of the thermometers used in the comparison

1.3 THE SCHEDULE FOR THE CIRCULATION

The original timescale for the circulation of the thermometers was as follows:

Institute	Time periods
PTB	1 August 2007 to 30 September 2007
NPL	1 October 2007 to 30 November 2007
CEM	1 December 2007 to 29 February 2008
UME	1 March 2008 to 30 April 2008
METAS	1 May 2008 to 30 June 2008
LNE	1 July 2008 to 30 September 2008
INRiM	1 October 2008 to 30 November 2008

The comparison schedule was delayed, with the final measurements being carried out, and the final participant report being received, during the summer of 2009. Information about the different measurements is given in the sections below and in the Appendices along with the results.

1.4 STABILITY CHECK OF THE RADIATION THERMOMETERS AT THE ZINC POINT

Prior to the start of the measurements at each institute (and also, sometimes, at the end of the measurements) both transfer thermometers were checked using the INRiM-supplied zinc freezing point blackbody source. The instructions for using source were supplied and are given in Appendix 2. The melt was used to ensure that the thermometer was aligned correctly on the source; the freeze was used for the check measurements. The results of all the checks made by the participants are given in the following Tables. (Note that CEM performed measurements twice at the start). The LP5 was not checked again after the end of the comparison since the Zn fixed-point remained at INRiM and the LP5 was returned to IKE (the supplier of the instrument).

Institute	Background/ A	Thermometer output/ A	Output corrected for background / A	Internal temp. /°C	Ambient temp. / °C	Ambient relative humidity / %rh
PTB	1.15 E-14	4.13801 E-10	4.13790 E-10	29.22	22.7	65
NPL	-5 E-15	4.13818 E-10	4.13823 E-10	29.21	22.0	45
CEM (start 1)	6.55 E-14	4.1362 E-10	4.13555 E-10	29.1	22.7	30.4
CEM (start 2)	5.13 E-14	4.1519 E-10	4.15139 E-10	29.23	23.7	20.6
CEM (end)	7.16 E-14	4.1180 E-10	4.11728 E-10	29.22	22.7	53
UME	1.55 E-12	4.13557 E-10	4.12012 E-10	29.21	22.8	38.3
METAS	1.08 E-13	4.1038 E-10	4.1027 E-10	29.21	21.9	44.9
LNE	0.12 E-12	409.57 E-12	409.45 E-12	29.18	22.8	58.2
INRiM	-	-	409.63 E-12	29.2	-	31

Table 2: results of the zinc point checks for the LP5 thermometer

The results of the stability check measurements are plotted below (Figure 1). The differences in signal level compared to the start of the comparison (the PTB measurements) were converted to an equivalent temperature difference for clarity, and these values are plotted too, and are also given in Table 3 for ease of reference. It can be seen that the signal at the Zn point drifted downwards over the course of the comparison by the equivalent of over 0.5 °C. The results of

these measurements were used to help correct the thermometer signal for the variable temperature and fixed-point blackbody measurements in each of the laboratories to try and compensate for the observed drift.

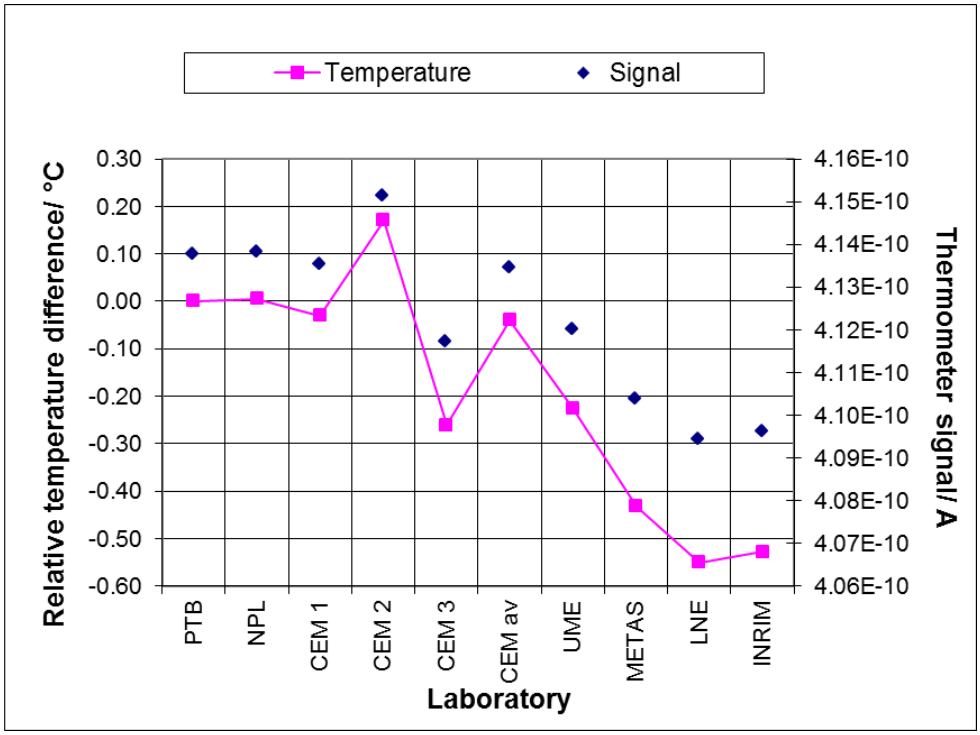


Figure 1: results of the check measurement at the Zn freezing point for the LP5

Laboratory	Difference from PTB/ °C
PTB	0.00
NPL	0.01
CEM 1	-0.03
CEM 2	0.17
CEM 3	-0.26
CEM av	-0.04
UME	-0.22
METAS	-0.43
LNE	-0.55
INRIM	-0.53

Table 3 – the difference, in terms of temperature, of the LP5 Zn point check measurements, compared to the initial (PTB) measurement

Institute	Background / V	Thermometer output/ V	Output corrected for background / V	Internal temp. / °C	Ambient temp. / °C	Ambient relative humidity / %rh
INRiM 1*	-	-	1.98285	-	-	-
PTB	-4.89×10^{-4}	1.98125	1.98174	24.87	22.9	65
NPL	-5.08×10^{-4}	1.98369	1.98420	23.40	21.9	45.5
CEM (start)	-5.14×10^{-4}	1.98058	1.98109	24.64	23.6	19.8
CEM (end)	-5.04×10^{-4}	1.98013	1.98063	24.64	23.6	19.8
UME†	$(-)5.11 \times 10^{-4}$	1.98275	1.98326	23.43	22.8	38.4
METAS	-5.00×10^{-4}	1.98108	1.98158	24.70	21.9	44.3
LNE	-4.83×10^{-4}	1.98142	1.98190	24.09	23.1	47.6
INRiM 2	-	-	1.98204	24.17	-	-

Table 4: results of the zinc point checks for the INRiM thermometer

* Measured before the thermometer was sent to PTB.
† N.B. the background value reported by UME was positive in sign, but it was assumed that this was a typographical error as all the other measured background values were negative.

The results of the stability check measurements are plotted below (Figure 2). The differences in signal level compared to the start of the comparison (the initial measurements made at INRiM before the thermometer was circulated) were converted to an equivalent temperature for clarity, and these values are also plotted in Figure 2 and are also given in Table 5 for ease of reference. It can be seen that there are some small fluctuations but no significant overall drift. Although it would have been adequate to include an uncertainty component for the drift and not apply any corrections to the thermometer signals for the laboratory measurements of the variable temperature and fixed-point blackbody sources, it was decided to apply a correction for completeness and improved uncertainty.

Laboratory	Difference from INRiM 1/ °C	Difference from PTB/ °C
(INRiM 1	0.000)	--
PTB	-0.030	0.000
NPL	0.036	0.066
CEM 1	-0.047	-0.017
CEM 2	-0.060	-0.030
CEM av	-0.053	-0.024
UME	0.011	0.041
METAS	-0.034	-0.004
LNE	-0.026	0.004
INRiM 2	-0.022	0.008

Table 5 – the difference, in terms of temperature, of the INRiM thermometer Zn point check measurements, compared to the initial (INRiM 1) measurement and the PTB measurement (the start of the comparison)

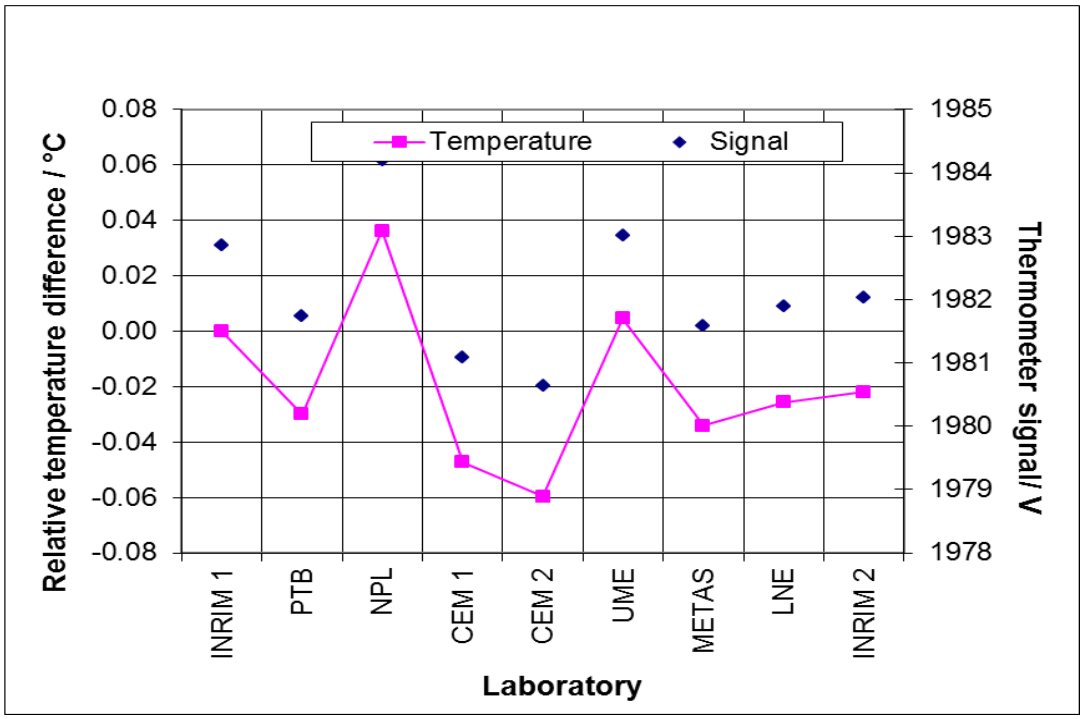


Figure 2: Results of the check measurement at the Zn freezing point for the INRiM thermometer

MEASUREMENT METHODS, RESULTS AND DISCUSSION

2 SIZE-OF-SOURCE EFFECT MEASUREMENTS

A summary of the apparatus used at each institute for the size-of-source effect measurements, the results, analysis and discussion are given in Appendix 3.

3 GAIN AND RANGE RATIO MEASUREMENTS

A summary of the methodology used for the gain ratio measurements, the results, analysis and discussion are given in Appendix 3. (Note that LNE measured the range ratio of the LP5 using the analogue output rather than the photocurrent. The results were not consistent with the rest and have been excluded from the subsequent analysis. This only applies to the LNE measurements of the range ratios; for the all the other measurements LNE used the photocurrent.)

4 EFFECT OF AMBIENT TEMPERATURE AND RELATIVE HUMIDITY

The results of the measurements of the effect of changing ambient temperature and relative humidity, the analysis of the results, the discussion and conclusions are given in Appendix 3.

5 MEASUREMENTS USING THE FIXED POINT AND VARIABLE TEMPERATURE SOURCES

Four laboratories (NPL, UME, CEM and INRiM) carried out measurements using fixed-point (FP) blackbody sources. All the laboratories apart from INRiM carried out measurements using

variable temperature blackbody (VTBB) sources from 156 °C to 1000 °C. For the FP blackbodies the freezing transition of the metal was assumed to occur at the ITS-90 defined temperature; for the VTBB sources the temperature of the source was determined using a calibrated sensor (platinum resistance thermometer or thermocouple) inserted in the source which gave traceability to the ITS-90. Descriptions of the sources are given in the laboratory measurement reports in Appendices 7 to 13, along with full details of the measurement methods and results. Laboratory uncertainty budgets are given in Section 9.

5.1 ANALYSIS OF THE RESULTS

The data was analysed in two ways: (a) a direct comparison of results and (b) a comparison by applying a calibration fit to the results. Both methods are described below.

5.1.1 Direct comparison of measurement results

The direct comparison of the results was carried out using the following steps:

1) For each thermometer the range, or gain, most commonly used by the participants was identified for each temperature. Where this range, or gain, had not been used by a particular laboratory the results were corrected to the common gain/ range setting using the results of the gain or range ratio measured at that laboratory. In the event that the laboratory had not itself measured that particular gain/ range ratio, the average of the values measured by the other laboratories (see Section 2.3.1 and 2.3.2 of Appendix 3) was used.

An uncertainty in the thermometer signal resulting from any gain ratio correction was required. This was calculated using the gain ratio uncertainty ($k = 1$) given by the laboratory (or the standard deviation of the average of all the laboratory values, if the gain ratio had not been measured by that particular laboratory) to determine the maximum uncertainty in the corrected signal value. It was assumed that this uncertainty would have a rectangular probability distribution and so it was divided by √3. The resultant uncertainty in terms of thermometer signal was converted to an equivalent temperature uncertainty and combined with the laboratory measurement uncertainty.

2) The drift of each of the thermometers was calculated for each participant, in terms of equivalent temperature from the start of the comparison (i.e. from PTB), using the results of the zinc point check measurements (see Section 1). For temperatures other than the zinc point, the correction was scaled using the ratio $(t_{source})^2/(t_{zinc})^2$. This temperature correction could be converted to an equivalent signal correction using Equation 1. This correction was applied to the signal values.

$$\Delta S = \Delta T \frac{c_2}{\lambda T^2} S \qquad \textbf{Equation 1}$$

where ΔS is the correction to the thermometer signal S for a temperature correction ΔT, T is the source temperature in K, and λ is the operational wavelength, taken to be 1.57 μm and 1.60 μm respectively for the LP5 and the INRiM thermometer, as given in the technical specifications for the thermometers (Appendix 1 of the comparison protocol).

An additional uncertainty to allow for the drift of the thermometers during the comparison was calculated and combined with the laboratory measurement uncertainty. This additional uncertainty was estimated from the results of the check measurements using the zinc transfer reference source. For the INRiM thermometer, which showed no significant drift, the additional uncertainty was taken to be the maximum observed difference in thermometer output from the start of the comparison (taken to be from INRiM 1 to CEM), treated as a type B uncertainty; i.e. 0.06 °C/√3. For the LP5 thermometer the additional uncertainty was taken to be half the

maximum drift observed between consecutive laboratories, again treated as a type B uncertainty (equivalent to ±0.1 °C/ √3). The uncertainty was scaled using the ratio $(t_{source})^2/(t_{zinc})^2$ to give the uncertainty at all the measurement temperatures.

During the measurements at CEM, it appeared that the LP5 output suddenly shifted mid-way through the measurements, as shown by the results of the zinc point checks carried out at the beginning and end of the measurements, and also observed as an inconsistency in the measurements using the CEM fixed-points. A further additional component was included in the CEM measurement uncertainties to take this shift into account.

3) For the VTBB measurements the thermometer signals were additionally corrected to allow for the difference between the actual temperature of the blackbody, t_{BB} and required comparison temperature, t_{nom}, (500 °C, 961.78 °C etc.). This correction was calculated using Equation 1. (This was not necessary for the FP measurements since the freezing transitions for all the cells were assumed to occur at the ITS-90 defined temperatures).

The results of the direct comparison of all the measurements are given in Sections 6 and 7 Tables 7 to 18 and 22 to 33 for the VTBB results and Section 8 Tables 37 to 41 and 43 to 48 for the FP results. For the purposes of an initial comparison, the results of the fixed-point measurements were kept separate from those of the variable temperature blackbody sources.

For each temperature the average, median and weighted mean thermometer signal was calculated using the results from all the participants. (The weighted mean was weighted with respect to the laboratory measurement uncertainties, which included components for the thermometer drift and gain ratios). The difference between the participant result and the average, median and weighted mean was also calculated. This difference was converted into an equivalent temperature difference, to give clearer information about the performance of each participant with respect to the others. The means and differences from the mean are given in Sections 6 and 7 in Tables 19 to 21 and 34 to 36 for the VTBB results and Section 8 Tables 42 to 43 and 49 to 52 for the FP results. Where a laboratory had used more than one source at a particular temperature, results are given both for the combined data and for each source separately.

The degrees of equivalence (DOE) and quantified demonstrated equivalence (QDE_{95}[1]) values were then calculated for each thermometer at each comparison temperature. The QDE_{95} values for each pair of labs (i,j) were calculated from the equation:

$$QDE_{95(i,j)} \cong |\Delta t|_{(i,j)} + \left\{1.645 + 0.3295 exp\left(\frac{-4.05|\Delta t|_{(i,j)}}{u_{(i,j)}}\right)\right\} u_{(i,j)} \qquad \textbf{Equation 2}$$

where $|\Delta t|_{(i,j)}$ is the absolute difference between the temperature values of the two laboratories and $u_{(i,j)}$ is the combined $k = 1$ uncertainty.

Since there was quite a large spread of values for the measurements with the VTBBs at some of the temperatures, the differences of each participant from the median values were used for the DOE and QDE_{95} calculations. For the fixed-point blackbody results, where the results were more consistent, the differences of the participants from the mean were used in the calculation of the DOE and QDE_{95}. The DOE and QDE_{95} results for the LP5 are given in Appendix 4; those for the INRiM thermometer [see 5.3] are given in Tables 113 to 134 in Section 10. It should be emphasised that the results are only applicable for a wavelength near 1.6 microns and do not ensure equivalence at other wavelengths. It should also be emphasised that for the purposes of CMC justification the results of the VTBB comparison should be used to support VTBB CMCs

1 For example, Wood, B. M., Douglas, R. J., *Metrologia*, 1998, **35**, pp 187-196

and the results of the FP comparison should be used to support FP CMCs.

Additionally, for the measurements at the fixed-point temperatures, in order to provide additional information, the results using the FP and the VTBB sources were combined and compared in a similar way to that described above. This is of benefit since it highlights any systematic issues with the results from the VTBB measurements. Again, the median, mean and weighted mean values were calculated, along with the difference of the laboratory result from the mean or median. Due to the spread of the results the differences from the median were again used to calculate the DOE and QDE_{95} values. The tables of the results and the DOE and QDE_{95} values are given in Appendix 4.

5.1.2 Comparison of results using the calibration fits

As a different comparison method the results were also compared using a calibration fit. The coefficients of the fit were determined i) using the median of all the laboratory measurements, and ii) using the NPL and the INRiM fixed-point measurements. These approaches are described in more detail in Appendices 5 and 6 respectively, where the results and analysis can also be found.

5.2 DISCUSSION OF THE RESULTS

1) The results of the INRiM and NPL fixed-point calibration fits are in very good agreement for the INRiM thermometer, and also for the LP5 once the results have been corrected to allow for the drift of the thermometer during the comparison. It can be seen that calculating a correction based on the zinc point check is sufficient to adequately compensate for the thermometer drift even up to 1000 °C.

2) For both thermometers the results of the fixed-point measurements made in all the laboratories agree with each other within the laboratories' measurement uncertainties.

2) For the VTBB measurements, the results at lower temperatures agree within the measurement uncertainties. However, as the temperature increases the dispersion of the results increases, for both thermometers, with the results from two of the laboratories (UME and METAS) deviating from the others. The deviation occurs with both thermometers. It should be noted that METAS were aware of some issues with the measurements made using a thermocouple in the blackbody source, but submitted the results anyway out of interest to see how they compared to the results of the other laboratories. UME has suggested that their results above 750 °C could be due to the poorer quality of the blackbody calibration source that was used at these temperatures.

5.3 COMPARISON REFERENCE VALUE FOR THE VTBB AND FP MEASUREMENTS

The results of the VTBB and FP measurements have been analysed in several different ways to provide maximum information. However, one comparison reference value needs to be chosen for each comparison temperature. This value needs to include as many of the measurements as possible from all the different laboratories.

The analysis of the results using the 'direct comparison' approach, looking at the differences of each laboratory from the median value, seems to be the most straightforward method. The laboratory differences using the INRiM thermometer and the LP5 were broadly in agreement. However, the INRiM thermometer did not suffer from drift like the LP5 and, furthermore, covered the full temperature range of the comparison (156.6 °C to 1000 °C). The 'direct comparison' results for the INRiM thermometer have therefore been used to determine the

comparison reference value at each of the different temperatures. These results are as given in Tables 6 to 17 (for the VTBB) results and Tables 37 to 41 (for the FP results). The DOE and QDE_{95} values are given in Tables 113 to 156.

The uncertainty of the comparison reference values at each temperature for the INRIM thermometer VTBB measurements and the FP measurements were calculated.

For the VTBB reference values, which were the median values of the measurement results, the uncertainty, *u* (ref value), was calculated using the 'median of absolute deviations' (or 'MAD') method [2]:

$$u(ref\ value) \cong \frac{1.9}{\sqrt{(n-1)}} MAD$$

Where *n* is the number of results and

$$MAD = median\{|x_i - med|\}$$

With x_i being the result of laboratory *i* and *med* the median value (in this case the comparison reference value).

For the FP reference values, which were the average of the measurement results, the uncertainty was taken to be the semi-range of the maximum deviation between laboratory results (difference between the two results which had maximum dispersion from the mean), and treated as a Type B uncertainty, i.e. divided √3. Table 6 shows the calculated uncertainties in the reference values for the VTBB and FP results respectively.

The uncertainties in the reference values were combined in quadrature with the other uncertainty components for each laboratory. Tables 13 to 18 (for the VTBB measurements) and Tables 37 to 40 (for the FP measurements) give the final calculated uncertainty for each laboratory at each temperature.

VTBB results		FP results	
Nominal Temperature/ °C	Calculated $U_{ref\ value}$ (k = 2)/ °C	Temperature/ °C	Calculated $U_{ref\ value}$ (k = 2)/ °C
156.6	0.082	156.599	0.05
200	0.083	231.928	0.01
231.93	0.095	419.527	0.01
250	0.059	660.323	0.01
300	0.180	961.78	0.04
400	0.031		
419.53	0.160		
500	0.064		
600	0.100		
660.32	0.382		
700	0.390		
800	0.609		
900	0.606		
961.78	0.857		
1000	3.432		

Table 6 - calculated uncertainties in the reference values for the INRIM thermometer

Finally the DOE and QDE_{95} values were calculated for each temperature and for each calibration scheme (VTBB and FP) using the final uncertainties (i.e. those also including the uncertainty in the comparison reference values). These are given in Tables 135 to 156 in Section 10.

As stated above the DOE and QDE_{95} values for the LP5 VTBB measurements only and FP measurements only are given in Appendix 4 in Tables 1 to 20. Analysis of the combined VTBB and FP measurements for the LP5 are in Appendix 4 Tables 21 to 38, with the corresponding DOE and QDE_{95} values in Tables 67 to 74. Appendix 4 also gives the results and the DOE and QDE_{95} values for the combined INRiM FP and VTBB results (Tables 39 to 66).

References

1. EUROMET.T-S1, Metrologia 2008, **45**, Tech. Suppl. 03002
2. 'Possible Advantages of a Robust Evaluation of Comparisons' by J. W Muller, J. Res. Natl. Inst. Stand. Technol. **105**, 551, (2000)

6 RESULTS OF THE VTBB MEASUREMENTS FOR THE INRIM THERMOMETER

t_{nom} / °C	Gain used	t_{BB} /°C	Bgrd corrected signal / V	Required gain	Signal at required range/ V	Zn point check drift‡ / °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom} / V	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with gain ratio uncertainty* / °C	u (k=1) plus drift uncertainty† / °C	U (k=2) / °C
156.60	10^10	156.57	0.776219	10^10	0.776219	0.009	0.776568	0.03	0.777703	0.45	0.22	0.22	0.22	0.45
200.00	10^10	200.00	5.135394	10^10	5.135394	0.011	5.137704	0.00	5.137704	0.31	0.15	0.15	0.15	0.31
231.93	10^9	231.88	1.838722	10^9	1.838722	0.013	1.839550	0.05	1.842792	0.30	0.15	0.15	0.15	0.30
250.00	10^9	250.04	3.381156	10^9	3.381156	0.014	3.382676	-0.04	3.378231	0.30	0.15	0.15	0.15	0.30
300.00	10^8	300.02	1.370938	10^8	1.370938	0.016	1.371555	-0.02	1.370804	0.30	0.15	0.15	0.15	0.30
400.00	10^7	399.89	1.362019	10^7	1.362019	0.023	1.362631	0.11	1.365607	0.30	0.15	0.15	0.15	0.31
419.53	10^7	419.49	1.983845	10^7	1.983845	0.024	1.984738	0.04	1.986226	0.30	0.15	0.15	0.16	0.31
500.00	10^7	499.89	7.547499	10^7	7.547499	0.030	7.550894	0.11	7.563392	0.31	0.15	0.15	0.16	0.32
600.00	10^6	600.03	2.837789	10^6	2.837789	0.038	2.839066	-0.03	2.838061	0.27	0.14	0.14	0.15	0.29
660.32	10^6	660.29	5.480883	10^6	5.480883	0.044	5.483348	0.03	5.485046	0.28	0.14	0.14	0.15	0.31
700.00	10^6	700.03	8.093755	10^6	8.093755	0.047	8.097395	-0.03	8.095089	0.29	0.14	0.14	0.16	0.32
800.00	10^5	799.87	1.899449	10^5	1.899449	0.058	1.900303	0.13	1.902232	0.31	0.15	0.15	0.17	0.35
900.00	10^5	899.98	3.858663	10^5	3.858663	0.069	3.860399	0.02	3.860904	0.33	0.17	0.17	0.19	0.39
231.93	10^9	232.02	1.842625	10^9	1.842625	0.013	1.843454	-0.09	1.837608	0.30	0.15	0.15	0.15	0.30
300.00	10^8	300.08	1.375069	10^8	1.375069	0.016	1.375688	-0.08	1.372676	0.30	0.15	0.15	0.15	0.30
500.00	10^7	500.03	7.566450	10^7	7.566450	0.030	7.569853	-0.03	7.566437	0.31	0.15	0.15	0.16	0.32
700.00	10^6	699.99	8.094334	10^6	8.094334	0.047	8.097975	0.01	8.098744	0.29	0.14	0.14	0.16	0.32
900.00	10^5	899.88	3.856424	10^5	3.856424	0.069	3.858159	0.12	3.861185	0.33	0.17	0.17	0.19	0.39

Table 7 - results of the CEM variable temperature blackbody measurements for analysis by direct comparison

‡ Compared to the PTB value at the start of the comparison (see Table 5).

* These uncertainty values include a contribution for the uncertainty of the gain ratio value, as given by the laboratory, where appropriate (i.e. where the signal values have been corrected to a different gain setting).

† These uncertainty values include an additional component to allow for the drift of the thermometer during the comparison, as determined from the measurements using the transfer zinc fixed-point blackbody source (see Section 5.1.1).

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal / V	Required gain	Signal at required range/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with gain ratio uncertainty*/ °C	u (k=1) plus drift uncertainty/ °C	U (k=2) / °C
156.60	10^10	156.566	0.771526	10^10	0.771526	0.00	0.771526	0.034	0.772810	0.064	0.03	0.03	0.03	0.07
200	10^10	200.035	5.165212	10^10	5.165212	0.00	5.165212	-0.035	5.158014	0.064	0.03	0.03	0.04	0.07
231.93	10^9	231.947	1.837326	10^9	1.837326	0.00	1.837326	-0.017	1.836253	0.066	0.03	0.03	0.04	0.08
250	10^9	250.039	3.377719	10^9	3.377719	0.00	3.377719	-0.039	3.373403	0.069	0.03	0.03	0.04	0.08
300	10^8	300.023	1.366982	10^8	1.366982	0.00	1.366982	-0.023	1.366133	0.096	0.05	0.05	0.05	0.11
400	10^7	400.021	1.366276	10^7	1.366276	0.00	1.366276	-0.021	1.365717	0.035	0.02	0.02	0.04	0.07
419.53	10^7	419.519	1.983355	10^7	1.983355	0.00	1.983355	0.011	1.983756	0.036	0.02	0.02	0.04	0.08
500	10^6	500.020	0.757357	10^7	7.569622	0.00	7.569622	-0.020	7.567390	0.039	0.02	0.02	0.05	0.10
600	10^6	600.019	2.835811	10^6	2.835811	0.00	2.835811	-0.019	2.835165	0.044	0.02	0.02	0.06	0.12
660.32	10^6	660.328	5.483683	10^6	5.483683	0.00	5.483683	-0.008	5.483208	0.073	0.04	0.04	0.07	0.15
700	10^6	700.032	8.097138	10^6	8.097138	0.00	8.097138	-0.032	8.094686	0.075	0.04	0.04	0.08	0.16
800	10^5	800.017	1.900651	10^5	1.900651	0.00	1.900651	-0.017	1.900399	0.081	0.04	0.04	0.09	0.19
900	10^5	900.026	3.861526	10^5	3.861526	0.00	3.861526	-0.026	3.860880	0.088	0.04	0.04	0.11	0.22
961.78	10^5	961.728	5.647521	10^5	5.647521	0.00	5.647521	0.052	5.649249	0.094	0.05	0.05	0.12	0.24
156.6	10^10	156.623	0.773692	10^10	0.773692	0.00	0.773692	-0.023	0.772833	0.064	0.03	0.03	0.03	0.07
250	10^9	250.087	3.382039	10^9	3.382039	0.00	3.382039	-0.087	3.372386	0.067	0.03	0.03	0.04	0.08
419.53	10^7	419.516	1.983341	10^7	1.983341	0.00	1.983341	0.014	1.983862	0.036	0.02	0.02	0.04	0.08
500	10^6	500.042	0.757390	10^7	7.569952	0.00	7.569952	-0.042	7.565203	0.039	0.02	0.02	0.05	0.10
700	10^5	700.048	0.809186	10^6	8.098807	0.00	8.098807	-0.048	8.095101	0.075	0.04	0.04	0.08	0.16
961.78	10^5	961.693	5.646728	10^5	5.646728	0.00	5.646728	0.087	5.649622	0.094	0.05	0.05	0.12	0.24

Table 8 - results of the PTB variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Required gain	Signal at required range/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with gain ratio uncertainty*/ V	u (k=1) plus drift uncertainty/ °C	U (k=2) / °C
156.60	10^8	156.53	0.007810	10^10	0.784061	-0.002	0.784002	0.071	0.786711	0.21	0.10	0.10	0.10	0.21
200	10^7	199.90	0.004967	10^10	5.017998	-0.002	5.017622	0.104	5.038499	0.25	0.12	0.12	0.13	0.25
200	10^7	199.89	0.005054	10^10	5.105802	-0.002	5.105420	0.107	5.127274	0.25	0.12	0.12	0.13	0.25
200	10^8	199.90	0.051248	10^10	5.145000	-0.002	5.144614	0.100	5.165303	0.25	0.12	0.12	0.13	0.25
231.93	10^7	231.76	0.016235	10^9	1.779335	-0.002	1.779202	0.174	1.790126	0.28	0.14	0.14	0.14	0.28
231.93	10^8	231.76	0.167536	10^9	1.824540	-0.002	1.824403	0.170	1.835372	0.28	0.14	0.14	0.14	0.28
250	10^7	249.83	0.030599	10^9	3.353591	-0.002	3.353340	0.171	3.372161	0.30	0.15	0.15	0.15	0.30
250	10^8	249.83	0.307849	10^9	3.352601	-0.002	3.352350	0.171	3.371241	0.29	0.15	0.15	0.15	0.30
300	10^7	300.17	0.136254	10^8	1.371208	-0.003	1.371105	-0.175	1.364548	0.32	0.16	0.16	0.16	0.32
300	10^8	300.08	1.366253	10^8	1.366253	-0.003	1.366151	-0.084	1.362999	0.33	0.17	0.17	0.17	0.33
400	10^7	399.91	1.356838	10^7	1.356838	-0.004	1.356736	0.095	1.359292	0.37	0.18	0.18	0.19	0.37
400	10^7	400.12	1.365849	10^7	1.365849	-0.004	1.365746	-0.124	1.362396	0.33	0.17	0.17	0.17	0.34
419.53	10^7	419.68	1.984168	10^7	1.984168	-0.004	1.984019	-0.151	1.978393	0.34	0.17	0.17	0.18	0.35
500	10^7	500.11	7.564966	10^7	7.564966	-0.005	7.564399	-0.108	7.552125	0.36	0.18	0.18	0.18	0.37
600	10^6	600.11	2.833294	10^6	2.833294	-0.006	2.833082	-0.112	2.829329	0.38	0.19	0.19	0.20	0.39
600	10^6	600.02	2.828271	10^6	2.828271	-0.006	2.828059	-0.020	2.827406	0.39	0.19	0.19	0.20	0.40
600	10^6	600.01	2.824760	10^6	2.824760	-0.006	2.824548	-0.014	2.824068	1.09	0.54	0.54	0.55	1.09
660.32	10^6	660.02	5.447661	10^6	5.447661	-0.007	5.447253	0.297	5.463960	1.08	0.54	0.54	0.55	1.09
700	10^6	699.85	8.043894	10^6	8.043894	-0.008	8.043291	0.149	8.054704	1.11	0.55	0.55	0.56	1.12
700	10^6	700.11	8.060855	10^6	8.060855	-0.008	8.060251	-0.112	8.051669	1.11	0.55	0.55	0.56	1.11
800	10^5	800.20	1.893828	10^5	1.893828	-0.010	1.893686	-0.203	1.890692	1.40	0.70	0.70	0.71	1.41
900	10^5	899.89	3.844127	10^5	3.844127	-0.011	3.843839	0.112	3.846649	1.24	0.62	0.62	0.63	1.26
900	10^5	899.92	3.841956	10^5	3.841956	-0.011	3.841668	0.084	3.843779	1.25	0.63	0.63	0.63	1.27
961.78	10^5	961.62	5.618921	10^5	5.618921	-0.013	5.618499	0.160	5.623788	1.54	0.77	0.77	0.78	1.55

Table 9 - results of the LNE variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C)	Gain used	t_{BB} / °C	Bgrd corrected signal / mV	Bgrd corrected signal / V	Required gain	Signal at required range/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	lab u (*k*=1) / °C	u (*k*=1) with gain ratio uncertainty* / °C	u (*k*=1) plus drift uncertainty / °C	U (*k*=2) / °C
156.60	10^10	156.604	777.185	0.777185	10^10	0.777185	0.00	0.777243	-0.004	0.777100	0.22	0.22	0.22	0.43
231.93	10^9	231.915	1833.114	1.833114	10^9	1.833114	0.00	1.833251	0.015	1.834219	0.22	0.22	0.22	0.45
419.53	10^7	419.485	1980.357	1.980357	10^7	1.980357	0.00	1.980506	0.045	1.982182	0.05	0.05	0.06	0.12
660.32	10^6	660.174	5508.215	5.508215	10^6	5.508215	0.01	5.508628	0.146	5.516949	0.09	0.09	0.11	0.22
961.78	10^5	961.861	5705.270	5.705270	10^5	5.705270	0.01	5.705697	-0.081	5.702984	0.39	0.39	0.40	0.81
200	10^10	199.995	5154.564	5.154564	10^10	5.154564	0.00	5.154950	0.005	5.156070	0.22	0.22	0.22	0.44
250	10^9	249.986	3368.463	3.368463	10^9	3.368463	0.00	3.368716	0.014	3.370250	0.18	0.18	0.18	0.36
300	10^8	300.010	1367.415	1.367415	10^8	1.367415	0.00	1.367518	-0.010	1.367135	0.11	0.11	0.11	0.23
400	10^7	400.063	1366.687	1.366687	10^7	1.366687	0.00	1.366790	-0.063	1.365086	0.05	0.05	0.06	0.12
500[1]	10^7	499.953	7560.209	7.560209	10^7	7.560209	0.00	7.560775	0.047	7.566075	0.06	0.06	0.07	0.14
500[2]	10^7	499.976	7563.477	7.563477	10^7	7.563477	0.00	7.564044	0.024	7.566813	0.07	0.07	0.08	0.16
600[1]	10^6	600.015	2835.845	2.835845	10^6	2.835845	0.01	2.836057	-0.015	2.835560	0.06	0.06	0.08	0.16
600[2]	10^6	599.731	2825.946	2.825946	10^6	2.825946	0.01	2.826157	0.269	2.835120	0.08	0.08	0.10	0.19
300[1]	10^8	300.040	1369.291	1.369291	10^8	1.369291	0.00	1.369394	-0.040	1.367893	0.11	0.11	0.11	0.23
400[1]	10^7	400.058	1366.927	1.366927	10^7	1.366927	0.00	1.367030	-0.058	1.365458	0.05	0.05	0.06	0.12
600[1]	10^6	599.988	2834.872	2.834872	10^6	2.834872	0.01	2.835085	0.012	2.835491	0.06	0.06	0.08	0.16
500[3]	10^7	499.820	7563.477	7.563477	10^7	7.563477	0.00	7.564044	0.180	7.584536	0.24	0.24	0.24	0.48
600[3]	10^6	599.280	2825.946	2.825946	10^6	2.825946	0.01	2.826157	0.720	2.850198	0.25	0.25	0.26	0.52
700[3]	10^6	699.941	8125.120	8.125120	10^6	8.125120	0.01	8.125729	0.059	8.130282	0.27	0.27	0.28	0.55
800[3]	10^5	799.917	1908.946	1.908946	10^5	1.908946	0.01	1.909089	0.083	1.910321	0.31	0.31	0.32	0.64
900[3]	10^5	899.924	3882.634	3.882634	10^5	3.882634	0.01	3.882925	0.076	3.884845	0.36	0.36	0.37	0.75
1000[3]	10^5	1000.048	7070.470	7.070470	10^5	7.070470	0.01	7.071000	-0.048	7.069131	0.42	0.42	0.43	0.87
800[3]	10^5	799.950	1909.781	1.909781	10^5	1.909781	0.01	1.909925	0.050	1.910665	0.31	0.31	0.32	0.64
1000[3]	10^5	1000.095	7071.588	7.071588	10^5	7.071588	0.01	7.072118	-0.095	7.068404	0.42	0.42	0.43	0.87

Table 10 - results of the METAS variable temperature blackbody measurements for analysis by direct comparison

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using a Na heatpipe with PRT;
[3] values obtained using a Na heatpipe with thermocouple.

t_{nom} / °C)	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Required gain	Signal at required range/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with gain ratio uncertainty* / °C	u (k=1) plus drift uncertainty / °C	U (k=2) / °C
200	10^9	201.26	0.587914	10^10	5.418297	-0.019	5.414134	-1.261	5.141382	0.955	0.478	0.478	0.480	0.960
250	10^9	250.78	3.470968	10^9	3.470968	-0.023	3.468301	-0.783	3.379299	0.808	0.404	0.404	0.405	0.809
300	10^8	299.80	1.365282	10^8	1.365282	-0.028	1.364233	0.200	1.371707	0.822	0.411	0.411	0.412	0.824
419.53	10^7	417.73	1.923257	10^7	1.923257	-0.041	1.921779	1.796	1.986788	0.860	0.430	0.430	0.431	0.862
500	10^7	497.10	7.285188	10^7	7.285188	-0.051	7.279590	2.896	7.599125	0.810	0.405	0.405	0.407	0.814
600	10^6	596.25	2.739827	10^6	2.739827	-0.065	2.737722	3.750	2.859868	0.850	0.425	0.425	0.429	0.857
660.32	10^6	655.68	5.281204	10^6	5.281204	-0.074	5.277146	4.640	5.532395	0.822	0.411	0.411	0.416	0.832
700	10^6	695.58	7.833208	10^6	7.833208	-0.080	7.827189	4.421	8.158800	0.824	0.412	0.412	0.418	0.835
800	10^5	797.27	1.910186	10^5	1.910186	-0.098	1.908718	2.730	1.949607	1.196	0.598	0.598	0.604	1.208
900	10^5	897.37	3.894053	10^5	3.894053	-0.117	3.891061	2.628	3.958163	1.193	0.596	0.596	0.605	1.209
1000	10^5	1000.09	7.221856	10^5	7.221856	-0.139	7.216306	-0.087	7.212824	1.084	0.542	0.542	0.555	1.110

Table 11 - results of the UME variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Required Gain	Signal at required range/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with gain ratio uncertainty* / °C	u (k=1) plus drift uncertainty/ °C	U (k=2) / °C
156.60	10^10	156.63	0.777632	10^10	0.777632	-0.025	0.776670	-0.032	0.775467	0.20	0.10	0.10	0.10	0.20
200	10^10	200.02	5.186709	10^10	5.186709	-0.031	5.180293	-0.020	5.176180	0.20	0.10	0.10	0.10	0.20
231.93	10^9	232.05	1.841034	10^9	1.841034	-0.035	1.838757	-0.120	1.830977	0.20	0.10	0.10	0.10	0.20
250	10^9	250.01	3.372291	10^9	3.372291	-0.038	3.368120	-0.012	3.366837	0.20	0.10	0.10	0.10	0.20
250	10^9	250.05	3.376714	10^9	3.376714	-0.038	3.372537	-0.054	3.366591	0.20	0.10	0.10	0.10	0.20
300	10^8	300.06	1.365190	10^8	1.365190	-0.045	1.363501	-0.057	1.361375	0.21	0.11	0.11	0.11	0.22
300	10^8	300.02	1.363646	10^8	1.363646	-0.045	1.361959	-0.023	1.361095	0.21	0.11	0.11	0.11	0.22
400	10^7	400.22	1.369248	10^7	1.369248	-0.062	1.367555	-0.223	1.361506	0.20	0.10	0.10	0.11	0.21
400	10^7	400.00	1.363649	10^7	1.363649	-0.062	1.361962	-0.004	1.361856	0.20	0.10	0.10	0.11	0.21
419.53	10^7	419.43	1.976805	10^7	1.976805	-0.066	1.974360	0.100	1.978075	0.20	0.10	0.10	0.11	0.21
500[1]	10^7	499.89	7.546142	10^7	7.546142	-0.082	7.536808	0.112	7.549547	0.20	0.10	0.10	0.11	0.22
500[2]	10^7	500.22	7.612328	10^7	7.612328	-0.082	7.602911	-0.215	7.578334	0.48	0.24	0.24	0.24	0.49
600	10^6	600.05	2.842331	10^6	2.842331	-0.105	2.838815	-0.051	2.837102	0.47	0.24	0.24	0.24	0.48
660.32	10^6	660.03	5.477611	10^6	5.477611	-0.120	5.470836	0.295	5.487479	0.48	0.24	0.24	0.25	0.50
700	10^6	699.95	8.105329	10^6	8.105329	-0.130	8.095303	0.051	8.099225	0.48	0.24	0.24	0.25	0.50
700	10^6	700.00	8.111707	10^6	8.111707	-0.130	8.101673	0.000	8.101673	0.48	0.24	0.24	0.25	0.50
800	10^5	799.81	1.899315	10^5	1.899315	-0.158	1.896965	0.193	1.899818	0.49	0.25	0.25	0.26	0.52
900	10^5	900.19	3.867533	10^5	3.867533	-0.189	3.862749	-0.188	3.858018	0.49	0.25	0.25	0.26	0.53
900	10^5	900.03	3.865023	10^5	3.865023	-0.189	3.860242	-0.028	3.859531	0.49	0.25	0.25	0.26	0.53
961.78	10^5	961.78	5.656693	10^5	5.656693	-0.210	5.649696	0.000	5.649696	0.49	0.25	0.25	0.27	0.54
1000	10^5	1000.00	7.025350	10^5	7.025350	-0.223	7.016660	0.000	7.016660	0.49	0.25	0.25	0.27	0.54
1000	10^5	1000.12	7.034740	10^5	7.034740	-0.223	7.026038	-0.119	7.021394	0.49	0.25	0.25	0.27	0.54

Table 12 - results of the NPL variable temperature blackbody measurements for analysis by direct comparison

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using the NPL wide range cavity (WRC);

6.1 AVERAGE LABORATORY RESULTS FOR VTBB MEASUREMENTS WITH THE INRIM THERMOMETER

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C	U* (*k*=2)/ °C
156.6	0.777703	0.45	0.46
200	5.137704	0.31	0.32
231.93	1.840200	0.30	0.32
250	3.378231	0.30	0.31
300	1.371740	0.30	0.35
400	1.365607	0.31	0.31
419.53	1.986226	0.31	0.35
500	7.564915	0.32	0.33
600	2.838061	0.29	0.31
660.32	5.485046	0.31	0.49
700	8.096916	0.32	0.50
800	1.902232	0.35	0.70
900	3.861044	0.39	0.72

Table 13 – CEM results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C	U* (*k*=2)/ °C
156.6	0.772821	0.07	0.11
200	5.158014	0.07	0.11
231.93	1.836253	0.08	0.12
250	3.372894	0.08	0.10
300	1.366133	0.11	0.21
400	1.365717	0.07	0.08
419.53	1.983809	0.08	0.18
500	7.566297	0.10	0.11
600	2.835165	0.12	0.16
660.32	5.483208	0.15	0.41
700	8.094893	0.16	0.42
800	1.900399	0.19	0.64
900	3.860880	0.22	0.64
961.78	5.649436	0.24	0.89

Table 14 - PTB results

t_{nom}/ °C	Average signal/ V	U (*k*=2) / °C	U* (*k*=2)/ °C
156.6	0.786711	0.21	0.22
200	5.110359	0.25	0.26
231.93	1.812749	0.28	0.30
250	3.371701	0.30	0.30
300	1.363774	0.33	0.37
400	1.360844	0.36	0.36
419.53	1.978393	0.35	0.39
500	7.552125	0.37	0.37
600	2.826935	0.75	0.75
660.32	5.463960	1.09	1.16
700	8.053186	1.12	1.18
800	1.890692	1.41	1.54
900	3.845214	1.27	1.40
961.78	5.623788	1.55	1.77
600 Cs	2.828368	0.40	0.41
600 Na	2.824068	1.09	1.10

Table 15 - LNE results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C	U* (*k*=2)/ °C
200	5.141382	0.96	0.96
250	3.379299	0.81	0.81
300	1.371707	0.82	0.84
419.53	1.986788	0.86	0.88
500	7.599125	0.81	0.82
600	2.859868	0.86	0.86
660.32	5.532395	0.83	0.92
700	8.158800	0.84	0.92
800	1.949607	1.21	1.35
900	3.958163	1.21	1.35
1000	7.212824	1.11	3.61

Table 16 – UME results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C	U* (*k*=2)/ °C
156.6	0.777100	0.43	0.44
200	5.156070	0.44	0.45
231.93	1.834219	0.45	0.46
250	3.370250	0.36	0.37
300	1.367514	0.23	0.29
400	1.365272	0.12	0.13
419.53	1.982182	0.12	0.20
500	7.572475	0.32	0.33
600	2.839092	0.35	0.37
660.32	5.516949	0.22	0.44
700	8.130282	0.55	0.68
800	1.910493	0.64	0.88
900	3.884845	0.75	0.96
961.78	5.702984	0.81	1.18
1000	7.068768	0.87	3.54
Cs at 500	7.566075	0.14	0.44
Na at 500 1	7.566813	0.16	0.15
Na at 500 2	7.584536	0.48	0.17
Cs at 600	2.835526	0.16	0.49
Na at 600 1	2.835120	0.19	0.19
Na at 600 2	2.850198	0.52	0.22

Table 17 - METAS results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C	U* (k=2)/ °C
156.6	0.775467	0.20	0.22
200	5.176180	0.20	0.22
231.93	1.830977	0.20	0.22
250	3.366714	0.20	0.21
300	1.361235	0.22	0.28
400	1.361681	0.21	0.21
419.53	1.978075	0.21	0.27
500	7.563941	0.36	0.36
600	2.837102	0.48	0.49
660.32	5.487479	0.50	0.63
700	8.100449	0.50	0.63
800	1.899818	0.52	0.80
900	3.858774	0.53	0.80
961.78	5.649696	0.54	1.01
1000	7.019027	0.54	3.48
Cs at 500	7.549547	0.22	0.23
WRC at 500	7.578334	0.49	0.49

Table 18 - NPL results

Note:

U is the total combined uncertainty including the laboratory uncertainty and components for the thermometer drift and gain ratios.

U* is the total combined uncertainty including also the uncertainty in the reference value (uncertainty in the median)

t_{nom}/ °C	Mean signal/ V	Median signal/ V	Weighted signal/ V
156.6	0.777960	0.777100	0.774444
200	5.146618	5.148726	5.155781
231.93	1.830879	1.834219	1.834511
250	3.373182	3.372298	3.372364
300	1.367017	1.366823	1.365928
400	1.363824	1.365272	1.365161
419.53	1.982579	1.982995	1.982871
500	7.569813	7.565606	7.566122
600	2.839371	2.837582	2.836128
660.32	5.494840	5.486262	5.492596
700	8.105754	8.098683	8.098531
800	1.908874	1.901316	1.901897
900	3.878153	3.860962	3.863612
961.78	5.656476	5.649566	5.652625
1000	7.100206	7.068768	7.059511

Table 19 – mean, median and weighted mean values for all the INRiM thermometer measurements with the variable temperature blackbody sources. The weighted mean is calculated using only the laboratory uncertainty, *u*, in the third column of the tables, i.e. not including the uncertainty in the reference value

t_{nom}/ °C	NPL – mean/ V	NPL-median/ V	equiv dT* from median/ °C	NPL-wghted mean/ V	UME – mean/ V	UME-median/ V	equiv dT* from median/ °C	UME-wghted mean/ V	METAS – mean/ V	METAS-median/ V	equiv dT* from median/ °C	METAS – wghted mean/ V
156.6	-0.002493	-0.001632	-0.04	0.001024					-0.000861	0.000000	0.00	0.002656
200	0.029562	0.027454	0.13	0.020399	-0.005236	-0.007344	-0.04	-0.014399	0.009452	0.007344	0.04	0.000289
231.93	0.000097	-0.003242	-0.05	-0.003535	-	-	-	--	0.003339	0.000000	0.00	-0.000292
250	-0.006468	-0.005584	-0.05	-0.005650	0.006118	0.007002	0.06	0.006936	-0.002932	-0.002048	-0.02	-0.002114
300	-0.005782	-0.005588	-0.15	-0.004693	0.004690	0.004883	0.13	0.005779	0.000497	0.000690	0.02	0.001586
400	-0.002143	-0.003591	-0.13	-0.003480	-	-	-	-	0.001448	0.000000	0.00	0.000111
419.53	-0.004504	-0.004921	-0.13	-0.004796	0.004209	0.003792	0.10	0.003917	-0.000397	-0.000814	-0.02	-0.000689
500	-0.005872	-0.001665	-0.01	-0.002182	0.029312	0.033519	0.29	0.033002	0.002662	0.006869	0.06	0.006352
600	-0.002268	-0.000479	-0.01	0.000974	0.020498	0.022287	0.66	0.023740	-0.000278	0.001511	0.05	0.002964
660.32	-0.007361	0.001216	0.02	-0.005117	0.037556	0.046133	0.81	0.039799	0.022110	0.030687	0.54	0.024353
700	-0.005305	0.001766	0.02	0.001918	0.053046	0.060118	0.78	0.060270	0.024527	0.031599	0.41	0.031751
800	-0.009056	-0.001498	-0.10	-0.002079	0.040734	0.048292	3.17	0.047711	0.001620	0.009178	0.62	0.008597
900	-0.019379	-0.002188	-0.09	-0.004838	0.080010	0.097201	3.76	0.094551	0.006692	0.023883	0.94	0.021233
961.78	-0.006780	0.000130	0.00	-0.002929	-	-	-	-	0.046508	0.053418	1.59	0.050358
1000	-0.081179	-0.049740	-1.28	-0.040484	0.112618	0.144057	3.60	0.153313	-0.031439	0.000000	0.00	0.009256
Cs at 500	-0.020266	-0.016059	-0.14	-0.016575	-	-	-	-	-0.003737	0.000470	0.00	-0.000047
Na/WRC‡ at 500 1	0.008521	0.012728	0.11	0.012212	-	-	-	-	-0.003000	0.001207	0.01	0.000690
Na at 500 2	-	-	-	-	-	-	-	-	0.014724	0.018931	0.17	0.018414
Cs at 600	-	-	-	-	-	-	-	-	-0.003845	-0.002056	-0.06	-0.000602
Na at 600 1	-	-	-	-	-	-	-	-	-0.004251	-0.002461	-0.07	-0.001008
Na at 600 2	-	-	-	-	-	-	-	-	0.010828	0.012617	0.38	0.014070

Table 20 – differences of the laboratory results from the mean, median and weighted mean values – table 1 of 2

‡ At 500 °C NPL used a Cs heatpipe blackbody and the wide range cavity (WRC); METAS used a Cs and a Na heatpipe blackbody.

* The equivalent temperature difference, ΔT, from the median value was calculated using the following function, where S is the thermometer signal, ΔS is the difference of the laboratory signal from the median value, T is the source temperature and λ is the thermometer wavelength:

$$\Delta T = \frac{\Delta S}{S}\frac{\lambda T^2}{c_2}$$

t_{nom}/ °C	LNE – mean/ V	LNE-median/ V	equiv dT from median/ °C	LNE-wghted mean/ V	PTB – mean/ V	PTB-median/ V	equiv dT from median/ °C	PTB-wghted mean/ V	CEM – mean/ V	CEM-median/ V	equiv dT from median/ °C	CEM-wghted mean/ V
156.6	0.008751	0.009611	0.25	0.012267	-0.005139	-0.004278	-0.11	-0.001622	-0.000257	0.000603	0.02	0.003259
200	-0.036259	-0.038367	-0.19	-0.045422	0.011396	0.009288	0.04	0.002234	-0.008914	-0.011022	-0.05	-0.018076
231.93	-0.018131	-0.021470	-0.34	-0.021762	0.005373	0.002034	0.03	0.001741	0.009321	0.005982	0.09	0.005689
250	-0.001480	-0.000596	-0.01	-0.000663	-0.000287	0.000596	0.01	0.000530	0.005050	0.005934	0.05	0.005868
300	-0.003243	-0.003050	-0.08	-0.002154	-0.000884	-0.000690	-0.02	0.000205	0.004723	0.004917	0.13	0.005812
400	-0.002980	-0.004428	-0.16	-0.004317	0.001893	0.000445	0.02	0.000556	0.001783	0.000335	0.01	0.000446
419.53	-0.004185	-0.004602	-0.12	-0.004478	0.001230	0.000814	0.02	0.000938	0.003647	0.003230	0.09	0.003355
500	-0.017687	-0.013480	-0.12	-0.013997	-0.003516	0.000691	0.01	0.000174	-0.004898	-0.000691	-0.01	-0.001208
600	-0.012436	-0.010647	-0.32	-0.009193	-0.004206	-0.002417	-0.07	-0.000963	-0.001310	0.000479	0.01	0.001933
660.32	-0.030880	-0.022302	-0.40	-0.028636	-0.011631	-0.003054	-0.05	-0.009388	-0.009793	-0.001216	-0.02	-0.007550
700	-0.052568	-0.045496	-0.59	-0.045344	-0.010861	-0.003789	-0.05	-0.003637	-0.008838	-0.001766	-0.02	-0.001614
800	-0.018182	-0.010624	-0.72	-0.011205	-0.008475	-0.000917	-0.06	-0.001498	-0.006641	0.000917	0.06	0.000336
900	-0.032939	-0.015748	-0.63	-0.018398	-0.017273	-0.000082	0.00	-0.002732	-0.017109	0.000082	0.00	-0.002568
961.78	-0.032688	-0.025777	-0.78	-0.028837	-0.007040	-0.000130	0.00	-0.003190	-	-	-	-
1000	-	-	-	-	-	-	-	-	-	-	-	-
Cs at 600	-0.011003	-0.009214	-0.28	-0.007760	-	-	-	-	-	-	-	-
Na at 600 1	-0.015302	-0.013513	-0.41	-0.012060	-	-	-	-	-	-	-	-

Table 21 - differences of the laboratory results from the mean, median and weighted mean values – table 2 of 2

7 RESULTS OF THE VTBB MEASUREMENTS FOR THE LP5 THERMOMETER

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Required range	Signal at required range/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
231.93	R1	231.91	3.02262E-12	R1	3.02262E-12	0.02	3.02522E-12	0.02	3.02740E-12	0.41	0.21	0.22	0.43
250.00	R1	250.11	5.72417E-12	R1	5.72417E-12	0.03	5.72909E-12	-0.11	5.70800E-12	0.32	0.16	0.18	0.36
300.00	R1	300.09	2.62564E-11	R1	2.62564E-11	0.03	2.62789E-11	-0.09	2.62130E-11	0.31	0.16	0.18	0.36
400.00	R1	399.94	2.81427E-10	R1	2.81427E-10	0.04	2.81669E-10	0.06	2.82010E-10	0.31	0.15	0.20	0.40
419.53	R1	419.55	4.14299E-10	R1	4.14299E-10	0.05	4.14655E-10	-0.02	4.14497E-10	0.31	0.15	0.20	0.41
500.00	R1	499.98	1.63872E-09	R1	1.63872E-09	0.06	1.64013E-09	0.02	1.64063E-09	0.31	0.15	0.23	0.45
600.00	R2	600.09	6.40066E-09	R2	6.40066E-09	0.07	6.40616E-09	-0.09	6.39923E-09	0.26	0.13	0.25	0.50
660.32	R2	660.35	1.25941E-08	R2	1.25941E-08	0.08	1.26049E-08	-0.03	1.26010E-08	0.26	0.13	0.28	0.55
700.00	R2	700.10	1.88022E-08	R2	1.88022E-08	0.09	1.88184E-08	-0.10	1.88002E-08	0.26	0.13	0.30	0.59
800.00	R2	799.91	4.51797E-08	R2	4.51797E-08	0.11	4.52185E-08	0.09	4.52509E-08	0.26	0.13	0.35	0.70
900.00	R2	900.01	9.36263E-08	R2	9.36263E-08	0.13	9.37068E-08	-0.01	9.37006E-08	0.26	0.13	0.41	0.81
231.93	R1	232.07	3.05435E-12	R2	3.05435E-12	0.02	3.05698E-12	-0.14	3.04161E-12	0.39	0.19	0.21	0.41
300.00	R1	300.14	2.63234E-11	R2	2.63234E-11	0.03	2.63460E-11	-0.14	2.62432E-11	0.31	0.15	0.18	0.36
500.00	R1	500.09	1.64322E-09	R2	1.64322E-09	0.06	1.64463E-09	-0.09	1.64236E-09	0.31	0.15	0.23	0.45
700.00	R2	700.04	1.87879E-08	R2	1.87879E-08	0.09	1.88041E-08	-0.04	1.87968E-08	0.26	0.13	0.30	0.59
900.00	R2	899.92	9.36075E-08	R2	9.36075E-08	0.13	9.36880E-08	0.08	9.37379E-08	0.26	0.13	0.41	0.81

Table 22- results of the CEM variable temperature blackbody measurements for analysis by direct comparison

‡ Compared to the PTB value at the start of the comparison (see Table 5).

* These uncertainty values include components for the uncertainty due to the range ratio, as given by the laboratory as appropriate (i.e. where the signal values have been corrected to a different range setting), and a component to allow for the drift in the radiation thermometer during the comparison, as determined from the measurements with the transfer zinc fixed-point blackbody source.

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Required range	Signal at required range/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
231.93	R1	231.946	3.03946E-12	R1	3.03946E-12	0.00	3.03946E-12	-0.016	3.03774E-12	0.111	0.055	0.064	0.128
250	R1	250.089	5.70504E-12	R1	5.70504E-12	0.00	5.70504E-12	-0.089	5.68802E-12	0.085	0.042	0.055	0.109
300	R1	300.020	2.62226E-11	R1	2.62226E-11	0.00	2.62226E-11	-0.020	2.62081E-11	0.097	0.049	0.064	0.127
400	R1	400.021	2.82049E-10	R1	2.82049E-10	0.00	2.82049E-10	-0.021	2.81932E-10	0.035	0.018	0.059	0.119
419.53	R1	419.530	4.14019E-10	R1	4.14019E-10	0.00	4.14019E-10	0.000	4.14019E-10	0.036	0.018	0.063	0.125
500	R1	500.015	1.64206E-09	R1	1.64206E-09	0.00	1.64206E-09	-0.015	1.64169E-09	0.039	0.020	0.077	0.155
600	R1	600.017	6.38577E-09	R2	6.38515E-09	0.00	6.38515E-09	-0.017	6.38381E-09	0.044	0.022	0.098	0.196
660.32	R2	660.312	1.25796E-08	R2	1.25796E-08	0.00	1.25796E-08	0.008	1.25806E-08	0.073	0.037	0.115	0.230
700	R2	700.031	1.87788E-08	R2	1.87788E-08	0.00	1.87788E-08	-0.031	1.87731E-08	0.075	0.038	0.124	0.248
800	R2	800.012	4.52005E-08	R2	4.52005E-08	0.00	4.52005E-08	-0.011	4.51963E-08	0.081	0.041	0.150	0.299
900	R2	900.011	9.37001E-08	R2	9.37001E-08	0.00	9.37001E-08	-0.011	9.36930E-08	0.088	0.044	0.178	0.355
961.78	R2	961.748	1.38461E-07	R2	1.38461E-07	0.00	1.38461E-07	0.032	1.38488E-07	0.094	0.047	0.196	0.393
231.93	R1	231.947	3.03869E-12	R1	3.03869E-12	0.00	3.03869E-12	-0.017	3.03689E-12	0.132	0.066	0.073	0.147
300	R1	300.027	2.62522E-11	R1	2.62522E-11	0.00	2.62522E-11	-0.027	2.62324E-11	0.184	0.092	0.101	0.201
419.53	R1	419.512	4.13968E-10	R1	4.13968E-10	0.00	4.13968E-10	0.018	4.14109E-10	0.036	0.018	0.063	0.125
500	R1	500.049	1.64205E-09	R1	1.64205E-09	0.00	1.64205E-09	-0.048	1.64083E-09	0.039	0.020	0.077	0.155
700	R2	700.028	1.87822E-08	R2	1.87822E-08	0.00	1.87822E-08	-0.028	1.87770E-08	0.075	0.038	0.124	0.248
961.78	R2	961.696	1.38400E-07	R2	1.38400E-07	0.00	1.38400E-07	0.084	1.38470E-07	0.094	0.047	0.196	0.393

Table 23 - results of the PTB variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Required range	Signal at required range/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
231.93	R1	231.76	2.99090E-12	R1	2.99090E-12	0.293	3.02238E-12	0.17	3.04049E-12	0.60	0.30	0.30	0.60
250	R1	249.83	5.59107E-12	R1	5.59107E-12	0.314	5.64991E-12	0.17	5.68220E-12	0.43	0.22	0.22	0.44
250	R1	249.84	5.30973E-12	R1	5.30973E-12	0.314	5.36561E-12	0.16	5.39469E-12	0.47	0.24	0.24	0.48
250	R1	249.83	5.59853E-12	R1	5.59853E-12	0.314	5.65745E-12	0.17	5.68993E-12	0.44	0.22	0.22	0.44
300	R1	300.19	2.60880E-11	R1	2.60880E-11	0.378	2.63625E-11	-0.19	2.62212E-11	0.35	0.17	0.18	0.36
400	R1	399.93	2.77908E-10	R1	2.77908E-10	0.520	2.80832E-10	0.07	2.81211E-10	0.31	0.16	0.17	0.33
400	R1	400.14	2.79379E-10	R1	2.79379E-10	0.521	2.82319E-10	-0.14	2.81531E-10	0.32	0.16	0.17	0.34
419.53	R1	419.63	4.09805E-10	R1	4.09805E-10	0.551	4.14118E-10	-0.10	4.13359E-10	0.32	0.16	0.17	0.34
500	R1	500.11	1.62441E-09	R1	1.62441E-09	0.687	1.64150E-09	-0.11	1.63862E-09	0.34	0.17	0.18	0.37
600	R2	600.16	6.32775E-09	R2	6.32775E-09	0.876	6.39434E-09	-0.16	6.38240E-09	0.41	0.20	0.22	0.45
600	R2	600.13	6.32566E-09	R2	6.32566E-09	0.876	6.39223E-09	-0.13	6.38234E-09	0.42	0.21	0.23	0.47
660.32	R2	660.06	1.23955E-08	R2	1.23955E-08	1.000	1.25259E-08	0.26	1.25605E-08	1.04	0.52	0.53	1.06
700	R2	699.83	1.84743E-08	R2	1.84743E-08	1.087	1.86687E-08	0.17	1.86988E-08	1.03	0.52	0.53	1.06
700	R2	700.11	1.85300E-08	R2	1.85300E-08	1.088	1.87250E-08	-0.11	1.87048E-08	1.05	0.52	0.54	1.08
800	R2	800.07	4.45481E-08	R2	4.45481E-08	1.323	4.50169E-08	-0.07	4.49915E-08	1.14	0.57	0.59	1.17
900	R2	899.88	9.22973E-08	R2	9.22973E-08	1.580	9.32687E-08	0.12	9.33424E-08	1.17	0.58	0.61	1.22
900	R2	899.94	9.23564E-08	R2	9.23564E-08	1.580	9.33284E-08	0.06	9.33637E-08	1.19	0.60	0.62	1.24
961.78	R2	961.63	1.36561E-07	R2	1.36561E-07	1.751	1.37998E-07	0.15	1.38124E-07	1.24	0.62	0.65	1.30

Table 24- results of the LNE variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Required range	Signal at required range/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
231.93	R1	231.913	3.0206E-12	R1	3.0206E-12	0.237	3.04632E-12	0.02	3.04820E-12	0.445	0.223	0.225	0.450
419.53	R1	419.500	4.1029E-10	R1	4.1029E-10	0.446	4.13790E-10	0.03	4.14031E-10	0.102	0.051	0.079	0.158
660.32	R2	660.335	1.2502E-08	R2	1.2502E-08	0.810	1.26081E-08	-0.02	1.26061E-08	0.174	0.087	0.139	0.278
961.78	R2	961.678	1.3834E-07	R2	1.3834E-07	1.417	1.39516E-07	0.10	1.39601E-07	0.776	0.388	0.432	0.865
250	R1	249.986	5.6051E-12	R1	5.6051E-12	0.254	5.65281E-12	0.01	5.65552E-12	0.358	0.179	0.182	0.365
300	R1	300.011	2.6007E-11	R1	2.6007E-11	0.305	2.62282E-11	-0.01	2.62202E-11	0.224	0.112	0.119	0.239
400	R1	400.063	2.8005E-10	R1	2.8005E-10	0.421	2.82436E-10	-0.06	2.82077E-10	0.102	0.051	0.076	0.153
500[1]	R1	499.955	1.6277E-09	R1	1.6277E-09	0.556	1.64162E-09	0.05	1.64276E-09	0.110	0.055	0.093	0.186
500[2]	R1	499.963	1.6276E-09	R1	1.6276E-09	0.556	1.64151E-09	0.04	1.64244E-09	0.135	0.067	0.101	0.201
600[1]	R1	600.014	6.3365E-09	R2	6.3400E-09	0.709	6.39403E-09	-0.01	6.39292E-09	0.119	0.060	0.113	0.225
600[2]	R1	599.728	6.3123E-09	R2	6.3158E-09	0.708	6.36961E-09	0.27	6.39046E-09	0.158	0.079	0.124	0.247
300	R1	300.040	2.6079E-11	R1	2.6079E-11	0.305	2.63016E-11	-0.04	2.62724E-11	0.224	0.112	0.119	0.239
400	R1	400.060	2.8016E-10	R1	2.8016E-10	0.421	2.82550E-10	-0.06	2.82208E-10	0.102	0.051	0.076	0.153
600[1]	R1	599.988	6.3348E-09	R2	6.3383E-09	0.709	6.39231E-09	0.01	6.39321E-09	0.119	0.060	0.113	0.225
500[3]	R1	499.803	1.6276E-09	R1	1.6276E-09	0.555	1.64151E-09	0.20	1.64646E-09	0.477	0.238	0.250	0.500
600[3]	R1	599.237	6.3123E-09	R2	6.3158E-09	0.707	6.36961E-09	0.76	6.42816E-09	0.507	0.253	0.271	0.541
700[3]	R2	699.935	1.8713E-08	R2	1.8713E-08	0.880	1.88726E-08	0.07	1.88845E-08	0.534	0.267	0.292	0.584
800[3]	R2	799.890	4.5069E-08	R2	4.5069E-08	1.070	4.54527E-08	0.11	4.54926E-08	0.619	0.309	0.341	0.682
900[3]	R2	899.923	9.3482E-08	R2	9.3482E-08	1.279	9.42779E-08	0.08	9.43265E-08	0.719	0.359	0.398	0.797
1000[3]	R2	1000.039	1.7303E-07	R2	1.7303E-07	1.507	1.74506E-07	-0.04	1.74467E-07	0.833	0.416	0.463	0.926
800[3]	R2	799.949	4.5097E-08	R2	4.5097E-08	1.070	4.54812E-08	0.05	4.54995E-08	0.619	0.309	0.341	0.682
1000[3]	R2	1000.080	1.7314E-07	R2	1.7314E-07	1.507	1.74615E-07	-0.08	1.74535E-07	0.833	0.416	0.463	0.926

Table 25- results of the METAS variable temperature blackbody measurements for analysis by direct comparison

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using a Na heatpipe with PRT;
[3] values obtained using a Na heatpipe with thermocouple.

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Required range	Signal at required range/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
250	R1	250.78	5.76788E-12	R1	5.76788E-12	0.129	5.79267E-12	-0.78	5.64118E-12	0.953	0.477	0.478	0.96
300	R2	299.80	2.60561E-11	R1	2.63989E-11	0.154	2.65124E-11	0.20	2.66604E-11	0.894	0.447	0.634	1.27
419.53	R2	417.73	3.98655E-10	R1	4.03899E-10	0.224	4.05635E-10	1.80	4.19619E-10	0.805	0.402	0.771	1.54
500	R2	497.10	1.56268E-09	R1	1.58323E-09	0.278	1.59004E-09	2.90	1.66117E-09	0.831	0.416	0.917	1.83
600	R2	596.25	6.07226E-09	R2	6.07226E-09	0.354	6.09835E-09	3.75	6.37564E-09	0.830	0.415	0.426	0.85
660.32	R2	655.68	1.19562E-08	R2	1.19562E-08	0.405	1.20076E-08	4.64	1.25996E-08	0.969	0.485	0.497	0.99
700	R2	695.58	1.80514E-08	R2	1.80514E-08	0.440	1.81290E-08	4.42	1.89117E-08	0.921	0.460	0.475	0.95
800	R2	797.27	4.40370E-08	R2	4.40370E-08	0.537	4.42263E-08	2.73	4.51918E-08	1.106	0.553	0.572	1.14
900	R2	897.37	9.18374E-08	R2	9.18374E-08	0.643	9.22321E-08	2.63	9.38530E-08	1.214	0.607	0.631	1.26
1000	R2	1000.09	1.72885E-07	R2	1.72885E-07	0.760	1.73628E-07	-0.09	1.73542E-07	1.179	0.590	0.623	1.25

Table 26- results of the UME variable temperature blackbody measurements for analysis by direct comparison

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/)	Required range	Signal at required range/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	lab U (k=2) / °C	lab u (k=1) / °C	u (k=1) with range ratio & drift uncertainty* / °C	U (k=2) / °C
231.93	R1	232.03	3.06186E-12	R1	3.06186E-12	-0.003	3.06156E-12	-0.10	3.05057E-12	0.26	0.13	0.13	0.27
250	R1	249.99	5.67265E-12	R1	5.67265E-12	-0.003	5.67210E-12	0.01	5.67400E-12	0.25	0.13	0.13	0.26
250	R1	249.99	5.68143E-12	R1	5.68143E-12	-0.003	5.68089E-12	0.01	5.68374E-12	0.25	0.13	0.13	0.26
250	R1	250.06	5.69507E-12	R1	5.69507E-12	-0.003	5.69453E-12	-0.06	5.68404E-12	0.25	0.13	0.13	0.26
300	R1	300.06	2.61833E-11	R1	2.61833E-11	-0.003	2.61808E-11	-0.06	2.61406E-11	0.25	0.13	0.13	0.26
400	R1	400.00	2.81754E-10	R1	2.81754E-10	-0.005	2.81727E-10	0.00	2.81755E-10	0.25	0.13	0.14	0.27
400	R1	400.06	2.82162E-10	R1	2.82162E-10	-0.005	2.82135E-10	-0.06	2.81792E-10	0.25	0.13	0.14	0.27
419.53	R1	419.42	4.12869E-10	R1	4.12869E-10	-0.005	4.12830E-10	0.11	4.13661E-10	0.25	0.13	0.14	0.28
500[1]	R2	499.89	1.63906E-09	R1	1.63849E-09	-0.006	1.63833E-09	0.11	1.64103E-09	0.25	0.13	0.15	0.29
500[1]	R1	499.89	1.63849E-09	R1	1.63849E-09	-0.006	1.63833E-09	0.11	1.64101E-09	0.25	0.13	0.15	0.29
500[2]	R1	500.22	1.65219E-09	R1	1.65219E-09	-0.006	1.65203E-09	-0.22	1.64647E-09	0.50	0.25	0.26	0.52
600	R1	600.04	6.39823E-09	R2	6.40048E-09	-0.008	6.39987E-09	-0.04	6.39660E-09	0.50	0.25	0.27	0.54
660.32	R2	660.04	1.25680E-08	R2	1.25680E-08	-0.009	1.25668E-08	0.28	1.26042E-08	0.51	0.26	0.28	0.55
700	R2	700.00	1.88151E-08	R2	1.88151E-08	-0.010	1.88133E-08	0.00	1.88133E-08	0.51	0.26	0.28	0.56
700	R2	700.00	1.88482E-08	R2	1.88482E-08	-0.010	1.88464E-08	0.00	1.88464E-08	0.51	0.26	0.28	0.56
800	R2	799.80	4.51596E-08	R2	4.51596E-08	-0.012	4.51553E-08	0.20	4.52282E-08	0.51	0.26	0.29	0.58
900	R2	900.19	9.38009E-08	R2	9.38009E-08	-0.014	9.37920E-08	-0.19	9.36745E-08	0.51	0.26	0.31	0.61
900	R2	900.01	9.38529E-08	R2	9.38529E-08	-0.014	9.38439E-08	-0.01	9.38354E-08	0.51	0.26	0.31	0.61
961.78	R2	961.78	1.38637E-07	R2	1.38637E-07	-0.016	1.38624E-07	0.00	1.38624E-07	0.51	0.26	0.32	0.64
1000	R2	1000.00	1.73311E-07	R2	1.73311E-07	-0.017	1.73295E-07	0.00	1.73295E-07	0.52	0.26	0.33	0.66
1000	R2	1000.17	1.73490E-07	R2	1.73490E-07	-0.017	1.73473E-07	-0.17	1.73302E-07	0.52	0.26	0.33	0.66

Table 27- results of the NPL variable temperature blackbody measurements for analysis by direct comparison

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using the NPL wide range cavity (WRC).

7.1 AVERAGE LABORATORY RESULTS FOR VTBB MEASUREMENTS WITH THE LP5

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.03450E-12	0.43
250	5.70800E-12	0.36
300	2.62281E-11	0.36
400	2.82010E-10	0.40
419.53	4.14497E-10	0.41
500	1.64150E-09	0.45
600	6.39923E-09	0.50
660.32	1.26010E-08	0.55
700	1.87985E-08	0.59
800	4.52509E-08	0.70
900	9.37192E-08	0.81

Table 28 – CEM results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C
231.93	3.03731E-12	0.147
250	5.68802E-12	0.109
300	2.62203E-11	0.201
400	2.81932E-10	0.119
419.53	4.14064E-10	0.125
500	1.64126E-09	0.155
600	6.38381E-09	0.196
660.32	1.25806E-08	0.230
700	1.87751E-08	0.248
800	4.51963E-08	0.299
900	9.36930E-08	0.355
961.78	1.38479E-07	0.393

Table 29 - PTB results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C
231.93	3.040492E-12	0.60
250	5.588942E-12	0.48
300	2.622117E-11	0.36
400	2.813707E-10	0.34
419.53	4.133589E-10	0.34
500	1.638618E-09	0.37
600	6.382367E-09	0.47
660.32	1.256055E-08	1.06
700	1.870179E-08	1.08
800	4.499146E-08	1.17
900	9.335301E-08	1.24
961.78	1.381241E-07	1.30

Table 30 - LNE results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C
250	5.64118E-12	0.96
300	2.66604E-11	1.27
419.53	4.19619E-10	1.54
500	1.66117E-09	1.83
600	6.37564E-09	0.85
660.32	1.25996E-08	0.99
700	1.89117E-08	0.95
800	4.51918E-08	1.14
900	9.38530E-08	1.26
1000	1.73542E-07	1.25

Table 31 – UME results

t_{nom}/ °C	Average signal/ V	U (*k*=2)/ °C
231.93	3.04820E-12	0.450
250	5.65552E-12	0.365
300	2.62463E-11	0.239
400	2.82142E-10	0.153
419.53	4.14031E-10	0.158
500	1.64388E-09	0.500
600	6.40119E-09	0.541
660.32	1.26061E-08	0.278
700	1.88845E-08	0.584
800	4.54960E-08	0.682
900	9.43265E-08	0.797
961.78	1.39601E-07	0.865
1000	1.74501E-07	0.926
Cs at 500	1.642757E-09	0.186
Na at 500 1	1.642436E-09	0.201
Na at 500 2	1.646458E-09	0.500
Cs at 600	6.393067E-09	0.225
Na at 600 1	6.390457E-09	0.247
Na at 600 2	6.428157E-09	0.541

Table 32 - METAS results

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.050570E-12	0.27
250	5.680598E-12	0.26
300	2.614062E-11	0.26
400	2.817738E-10	0.27
419.53	4.136607E-10	0.28
500	1.642834E-09	0.41
600	6.396595E-09	0.54
660.32	1.260422E-08	0.55
700	1.882986E-08	0.56
800	4.522818E-08	0.58
900	9.375495E-08	0.61
961.78	1.386242E-07	0.64
1000	1.732983E-07	0.66
Cs at 500	1.641018E-09	0.29
WRC at 500	1.646466E-09	0.52

Table 33 NPL results

t_{nom}/ °C	Mean signal/ A	Median signal/ A	Weighted signal/ A
231.93	3.042216E-12	3.040492E-12	3.040487E-12
250	5.660377E-12	5.668058E-12	5.682344E-12
300	2.628614E-11	2.622463E-11	2.621541E-11
400	2.818459E-10	2.819321E-10	2.819498E-10
419.53	4.148718E-10	4.140475E-10	4.140060E-10
500	1.644876E-09	1.642165E-09	1.641531E-09
600	6.389806E-09	6.390204E-09	6.388230E-09
660.32	1.259201E-08	1.260027E-08	1.259240E-08
700	1.881691E-08	1.881418E-08	1.879902E-08
800	4.522579E-08	4.521226E-08	4.523153E-08
900	9.378328E-08	9.373710E-08	9.376533E-08
961.78	1.387072E-07	1.385516E-07	1.386306E-07
1000	1.737807E-07	1.735425E-07	1.736783E-07

Table 34 – mean, median and weighted mean values for all the LP5 measurements with the variable temperature blackbody sources

t_{nom}/ °C	NPL – mean/ A	NPL-median/ A	equiv dT* from median / °C	NPL-wghted mean/ A	UME – mean/ A	UME-median/ A	equiv dT* from median / °C	UME-wghted mean/ A	METAS – mean/ A	METAS-median/ A	equiv dT* from median / °C	METAS – wghted mean/ A
231.93	8.3539E-15	1.0078E-14	0.09	1.0083E-14	-	-	-	-	5.9858E-15	7.7097E-15	0.07	7.7147E-15
250	2.0221E-14	1.2540E-14	0.07	-1.7458E-15	-1.9197E-14	-2.6878E-14	-0.14	-4.1164E-14	-4.8587E-15	-1.2540E-14	-0.07	-2.6825E-14
300	-1.4551E-13	-8.4006E-14	-0.12	-7.4784E-14	3.7424E-13	4.3575E-13	0.59	4.4497E-13	-3.9859E-14	2.1650E-14	0.03	3.0872E-14
400	-7.2102E-14	-1.5831E-13	-0.03	-1.7606E-13	-	-	-	-	2.9656E-13	2.1036E-13	0.04	1.9260E-13
419.53	-1.2111E-12	-3.8681E-13	-0.05	-3.4534E-13	4.7472E-12	5.5715E-12	0.70	5.6130E-12	-8.4107E-13	-1.6775E-14	0.00	2.4685E-14
500	-2.0422E-12	6.6892E-13	0.03	1.3033E-12	1.6289E-11	1.9000E-11	0.75	1.9634E-11	-9.9218E-13	1.7190E-12	0.07	2.3533E-12
600	6.7896E-12	6.3915E-12	0.08	8.3655E-12	-1.4167E-11	-1.4566E-11	-0.19	-1.2592E-11	1.1381E-11	1.0983E-11	0.14	1.2957E-11
660.32	1.2213E-11	3.9529E-12	0.03	1.1822E-11	7.5569E-12	-7.0342E-13	-0.01	7.1658E-12	1.4089E-11	5.8287E-12	0.04	1.3698E-11
700	1.2947E-11	1.5679E-11	0.09	3.0841E-11	9.4829E-11	9.7561E-11	0.53	1.1272E-10	6.7613E-11	7.0345E-11	0.38	8.5507E-11
800	2.3901E-12	1.5921E-11	0.04	-3.3491E-12	-3.3973E-11	-2.0441E-11	-0.06	-3.9712E-11	2.7024E-10	2.8377E-10	0.78	2.6450E-10
900	-2.8330E-11	1.7853E-11	0.03	-1.0381E-11	6.9736E-11	1.1592E-10	0.19	8.7685E-11	5.4318E-10	5.8937E-10	0.94	5.6113E-10
961.78	-8.3041E-11	7.2561E-11	0.09	-6.4856E-12	-	-	-	-	8.9428E-10	1.0499E-09	1.25	9.7084E-10
1000	-4.8243E-10	-2.4416E-10	-0.25	-3.8006E-10	-2.3828E-10	0.0000E+00	0.00	-1.3590E-10	7.2071E-10	9.5898E-10	0.97	8.2309E-10
Cs at 500	-3.8582E-12	-1.1471E-12	-0.05	-5.1272E-13					-2.1192E-12	5.9199E-13	0.02	1.2263E-12
Na/ WRC‡ at 500 1	2.1693E-12	4.8804E-12	0.25	1.6470E-09					-2.4396E-12	2.7152E-13	0.01	9.0586E-13
Na at 500 2									1.5823E-12	4.2934E-12	0.17	4.9277E-12
Cs at 600									3.2618E-12	2.8637E-12	0.04	4.8377E-12
Na at 600 1									6.5102E-13	2.5290E-13	0.00	2.2269E-12
Na at 600 2									3.8351E-11	3.7953E-11	0.49	3.9927E-11

Table 35 - differences of the laboratory results from the mean, median and weighted mean values for the LP5 thermometer – table 1 of 2

‡ At 500 °C NPL used a Cs heatpipe blackbody and the wide range cavity (WRC); METAS used a Cs and a Na heatpipe blackbody.

t_{nom}/ °C	LNE – mean/ A	LNE-median/ A	equiv dT from median / °C	LNE-wghted mean/ A	PTB – mean/ A	PTB-median/ A	equiv dT from median / °C	PTB-wghted mean/ A	CEM – mean/ A	CEM-median/ A	equiv dT from median / °C	CEM-wghted mean/ A
231.93	-1.7239E-15	0.0000E+00	0.00	4.9979E-18	-4.9026E-15	-3.1787E-15	-0.03	-3.1737E-15	-7.7132E-15	-5.9893E-15	-0.05	-5.9843E-15
250	-7.1435E-14	-7.9116E-14	-0.42	-9.3402E-14	2.7646E-14	1.9965E-14	0.10	5.6800E-15	4.7624E-14	3.9943E-14	0.21	2.5657E-14
300	-6.4964E-14	-3.4553E-15	0.00	5.7668E-15	-6.5850E-14	-4.3414E-15	-0.01	4.8806E-15	-5.8054E-14	3.4553E-15	0.00	1.2677E-14
400	-4.7517E-13	-5.6138E-13	-0.10	-5.7913E-13	8.6208E-14	0.0000E+00	0.00	-1.7751E-14	1.6450E-13	7.8296E-14	0.01	6.0545E-14
419.53	-1.5128E-12	-6.8855E-13	-0.09	-6.4709E-13	-8.0752E-13	1.6775E-14	0.00	5.8235E-14	-3.7468E-13	4.4961E-13	0.06	4.9107E-13
500	-6.2578E-12	-3.5467E-12	-0.14	-2.9123E-12	-3.6166E-12	-9.0549E-13	-0.04	-2.7115E-13	-3.3801E-12	-6.6892E-13	-0.03	-3.4582E-14
600	-7.4383E-12	-7.8364E-12	-0.10	-5.8624E-12	-5.9934E-12	-6.3915E-12	-0.08	-4.4175E-12	9.4281E-12	9.0300E-12	0.12	1.1004E-11
660.32	-3.1463E-11	-3.9723E-11	-0.30	-3.1854E-11	-1.1360E-11	-1.9620E-11	-0.15	-1.1751E-11	8.9637E-12	7.0342E-13	0.01	8.5727E-12
700	-1.1512E-10	-1.1239E-10	-0.62	-9.7229E-11	-4.1853E-11	-3.9121E-11	-0.22	-2.3959E-11	-1.8411E-11	-1.5679E-11	-0.09	-5.1678E-13
800	-2.3433E-10	-2.2080E-10	-0.62	-2.4007E-10	-2.9452E-11	-1.5921E-11	-0.04	-3.5192E-11	2.5122E-11	3.8654E-11	0.11	1.9383E-11
900	-4.3026E-10	-3.8408E-10	-0.62	-4.1232E-10	-9.0288E-11	-4.4105E-11	-0.07	-7.2339E-11	-6.4036E-11	-1.7853E-11	-0.03	-4.6087E-11
961.78	-5.8308E-10	-4.2748E-10	-0.52	-5.0652E-10	-2.2816E-10	-7.2561E-11	-0.09	-1.5161E-10				
1000												

Table 36 - differences of the laboratory results from the mean, median and weighted mean values for the LP5 thermometer – table 2 of 2

8 ANALYSIS OF THE MEASUREMENTS WITH THE FP SOURCES

Fixed point	Gain used	Bgrd corrected Signal/ V	lab U (*k*=2) / °C	Required gain	Signal at required gain / V	dT from NPL result / °C	dT corrected for Zn point drift[1] / °C	dT from INRiM result / °C	dT corrected for Zn point drift[2] / °C	U (*k=2*) with gain ratio & drift uncert / °C	U (*k=2*) also with reference value uncert / °C
In	10^10	0.775825	0.08	10^9	0.084166	0.000	0.000	0.102	0.080	0.09	0.10
Sn	10^9	1.836495	0.06	10^9	1.8364952	0.000	0.000	0.040	0.010	0.07	0.07
Zn	10^7	1.984784	0.02	10^7	1.9847841	0.000	0.000	0.062	0.004	0.07	0.08
Al	10^6	5.488178	0.03	10^6	5.4881776	0.000	0.000	0.123	0.018	0.13	0.13
Ag	10^5	5.653369	0.07	10^5	5.6533689	0.000	0.000	0.248	0.064	0.23	0.24

Table 37 – results of the NPL fixed-point measurements with the INRiM thermometer – direct comparison of results

[1] relative to the NPL measurements, calculated from the drift in the thermometer at the zinc fixed-point – see Table 5
[2] relative to the INRiM measurements, calculated from the drift in the thermometer at the zinc fixed-point – see Table 5

Fixed point	Gain used	Bgrd corrected signal/ V	Bgrd corrected signal ignoring gain/ V	lab U (*k*=2) / °C	Required gain	Signal at required gain/ V	dT from NPL result / °C	dT corrected for Zn point drift/ °C	dT from INRiM result / °C	dT corrected for Zn point drift/ °C	U (*k=2*) with gain ratio & drift uncert / °C	U (*k=2*) also with reference value uncert / °C
Zn	10^7	1.98204E-07	1.982037	0.06	10^7	1.982037	-0.074	0.016	-0.011	0.021	0.09	0.09
Zn	10^6	1.98307E-07	0.198307	0.06	10^7	1.982041	-0.074	0.016	-0.011	0.021	0.09	0.09
Ag 1	10^5	5.64260E-05	5.642604	0.20	10^5	5.642604	-0.324	-0.037	-0.075	0.027	0.30	0.30
Ag 2	10^4	5.70133E-05	0.570133	0.20	10^5	5.643423	-0.299	-0.013	-0.050	0.051	0.30	0.31

Table 38 – results of the CEM fixed-point measurements with the INRiM thermometer – direct comparison of results

Fixed point	Gain used	Bgrd corrected signal / mV	Signal corrected for emissivity / mV	Bgrd corrected Signal / V	lab U (*k*=2) / °C	Required gain	Signal at required gain/ V	dT from NPL result / °C	dT corrected for Zn point drift/ °C	dT from INRiM result / °C	dT corrected for Zn point drift/ °C	U (k=2) with gain ratio & drift uncert / °C	U (k=2) also with ref. value uncert / °C
In	10^9	83.71	83.75	0.08375	0.016	10^9	0.08375	-0.103	-0.081	0.000	0.000	0.03	0.06
Sn	10^9	1833.09	1833.88	1.83388	0.014	10^9	1.83388	-0.040	-0.010	0.000	0.000	0.04	0.04
Zn	10^7	1981.61	1982.46	1.98246	0.018	10^7	1.98246	-0.063	-0.005	0.000	0.000	0.07	0.07
Al	10^6	5478.84	5481.20	5.48120	0.022	10^6	5.48120	-0.123	-0.018	0.000	0.000	0.13	0.13
Ag	10^5	5642.67	5645.10	5.64510	0.026	10^5	5.64510	-0.249	-0.064	0.000	0.000	0.22	0.23

Table 39 – results of the INRiM fixed-point measurements with the INRiM thermometer – direct comparison of results

Fixed point	Gain used	Bgrd corrected Signal/ V	lab U (*k*=2) / °C	Required gain	Signal at required gain / V	dT from NPL result / °C	dT corrected for Zn point drift / °C	dT from INRiM result / °C	dT corrected for Zn point drift / °C	U (*k=2*) with drift uncert / °C	U (k=2) also with reference value uncert / °C
In	10^10	0.772745	0.062	10^9	0.0838469	-0.078	-0.068	0.025	0.012	0.08	0.09
Sn	10^9	1.834863	0.020	10^9	1.834863	-0.025	-0.012	0.015	-0.002	0.04	0.04
Zn	10^7	1.983950	0.026	10^7	1.983950	-0.022	0.003	0.040	0.007	0.07	0.08

Table 40 – results of the UME fixed-point measurements with the INRiM thermometer – direct comparison of results

Fixed point temperature / °C	NPL results		CEM results		INRiM results		UME results	
	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C
156.599	0.000	156.599	-	-	-0.081	156.518	-0.068	156.530
231.928	0.000	231.928	-	-	-0.010	231.918	-0.012	231.916
419.527	0.000	419.527	0.016	419.543	-0.005	419.522	0.003	419.530
660.323	0.000	660.323	-	-	-0.018	660.305	-	-
961.780	0.000	961.780	-0.025	961.755	-0.064	961.716	-	-

Table 41 – the thermometer indicated values, in terms of temperature, for the fixed-point measurements, relative to the NPL measurements (the reference)

Fixed point	Mean value/ °C	Median value/ °C	Weighted mean value/ °C
In	156.549	156.530	156.528
Sn	231.921	231.918	231.919
Zn	419.531	419.528	419.528
Al	660.314	660.314	660.322
Ag	961.750	961.755	961.773

Table 42 – the mean, median and weighted mean values for the fixed-point measurements with the INRiM thermometer

Fixed point	NPL – mean / °C	NPL – median / °C	NPL – weighted mean/ °C	CEM – mean* / °C	CEM – median* / °C	CEM – weighted* mean/ °C	INRiM – mean / °C	INRiM – median / °C	INRiM – weighted mean/ °C	UME – mean / °C	UME – median / °C	UME – weighted mean/ °C
In	0.05	0.07	0.07	-	-	-	-0.03	-0.01	-0.01	-0.02	0.00	0.00
Sn	0.01	0.01	0.01	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00
Zn	0.00	0.00	0.00	0.01	0.01	0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00
Al	0.01	0.01	0.00	-	-	-	-0.01	-0.01	-0.02	-	-	-
Ag	0.03	0.03	0.01	0.00	0.00	-0.02	-0.03	-0.04	-0.06	-	-	-

Table 43 – the differences of the laboratory measurements from the mean, median and weighted mean values for the INRiM thermometer measurements with the fixed-points

* calculated from the averages of the CEM Zn point and the CEM Ag point measurements

The results with the LP5 thermometer follow

Fixed point	Range used	Bgrd corrected Signal/ A	lab U (*k*=2) / °C	Required range	Signal at required range / A	dT from NPL result / °C	dT corrected for Zn point drift† / °C	dT from INRiM result / °C	dT corrected for Zn point drift/ °C	U (*k=2*) with range ratio & drift uncert / °C
Sn	R1	3.04800E-12	0.09	R1	3.04800E-12	0.000	0.000	0.325	0.041	0.11
Zn	R1	4.14357E-10	0.04	R1	4.14357E-10	0.000	0.000	0.514	-0.020	0.13
Al	R2	1.25937E-08	0.07	R2	1.25937E-08	0.000	0.000	0.781	-0.189	0.23
Ag	R2	1.38800E-07	0.13	R2	1.38800E-07	0.000	0.000	1.713	0.016	0.40

Table 44 – results of the NPL fixed-point measurements with the LP5 thermometer – direct comparison of results

Fixed point	Range used	Bgrd corrected signal/ A	lab U (*k*=2) / °C	Required range	Signal at required range / A	dT from NPL result / °C	dT corrected for Zn point drift/ °C	dT from INRiM result / °C	dT corrected for Zn point drift/ °C	U (*k=2*) with gain ratio & drift uncert / °C
Zn	R1	4.14927E-10	0.08	R1	4.14927E-10	0.073	0.123	0.587	0.104	0.28
Zn	R1	4.12569E-10	0.07	R1	4.12569E-10	-0.231	-0.181	0.285	-0.198	0.28
Ag 1	R2	1.38577E-07	0.28	R2	1.38577E-07	-0.274	-0.115	1.443	-0.093	0.93
Ag 2	R2	1.38002E-07	0.12	R2	1.38002E-07	-0.981	-0.822	0.742	-0.793	0.89
						dT from CEM average* / °C	dT corrected for Zn point drift/ °C			
Zn	R2	4.15112E-10	0.08	R2	4.15112E-10	0.154	0.154	-	-	0.28
Zn	R2	4.12714E-10	0.07	R2	4.12714E-10	-0.155	-0.155	-	-	0.28

Table 45 – results of the CEM fixed-point measurements with the LP5 thermometer – direct comparison of results

* so that the CEM measurements on range R2 could be directly compared to the UME measurements (Table 46) without adjustment using the range ratio.

Fixed point	Range used	Bgrd corrected signal/ A	Signal corrected for emissivity/ A	lab U (*k*=2) / °C	Required range	Signal at required range/ A	dT from NPL result / °C	dT corrected for Zn point drift/ °C	dT from INRiM result / °C	dT corrected for Zn point drift / °C	U (*k=2*) with gain ratio & drift uncert / °C
Sn	R1	3.01179E-12	3.01309E-12	0.516	R1	3.01309E-12	-0.325	-0.041	0.000	0.000	0.520
Zn	R1	4.10187E-10	4.10363E-10	0.022	R1	4.10363E-10	-0.519	0.014	0.000	0.000	0.122
Al	R2	1.24868E-08	1.24922E-08	0.020	R2	1.24922E-08	-0.788	0.180	0.000	0.000	0.219
Ag	R2	1.37339E-07	1.37398E-07	0.028	R2	1.37398E-07	-1.731	-0.037	0.000	0.000	0.383

Table 46 – results of the INRiM fixed-point measurements with the LP5 thermometer – direct comparison of results

Fixed point	Range used	Bgrd corrected Signal/ A	lab U (*k*=2) / °C	Required range	Signal at required range / A	dT from NPL result / °C	dT corrected for Zn point drift/ °C	dT from INRiM result / °C	dT corrected for Zn point drift/ °C	U (*k=2*) with drift uncert / °C
Sn	R1	3.03065E-12	0.47	R1	3.03065E-12	-0.162	-0.040	0.164	0.003	0.47
Zn	R2	4.11979E-10	0.13	R1	4.17417E-10	0.391	0.621	0.902	0.599	1.29
Al	R2	1.25181E-08	0.05	R2	1.25181E-08	-0.585	-0.168	0.201	-0.350	0.22
						dT from CEM average / °C	dT corrected for Zn point drift/ °C			
Zn	R2	4.11979E-10	0.05	R2	4.11979E-10	-0.250	-0.070	-	-	0.17

Table 47 – results of the UME fixed-point measurements with the LP5 thermometer – direct comparison of results

Fixed point Temperature / °C	NPL results		CEM results		INRiM results		UME results	
	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C	dT from reference/ °C	Resultant indicated t/ °C
231.928	0.000	231.928			-0.041	231.887	-0.040	231.888
419.527	0.000	419.527	-0.029	419.498	0.014	419.541	0.621	420.148
660.323	0.000	660.323			0.180	660.503	-0.168	660.155
961.780?	0.000	961.780	-0.468	961.312	-0.037	961.743		

Table 48 – the thermometer indicated values, in terms of temperature, for the fixed-point measurements, relative to the NPL measurements (the reference)

Fixed point	Mean value/ °C	Median value/ °C	Weighted mean value/ °C
Sn	231.901	231.888	231.924
Zn	419.679	419.534	419.533
Al	660.327	660.323	660.330
Ag	961.612	961.743	961.724

Table 49 – the mean, median and weighted mean values for the fixed-point measurements with the LP5 thermometer

Fixed point	NPL – mean / °C	NPL – median / °C	NPL – weighted mean/ °C	CEM – mean / °C	CEM – median / °C	CEM – weighted mean/ °C	INRiM – mean/ °C	INRiM – median / °C	INRiM – weighted mean/ °C	UME – mean / °C	UME – median / °C	UME – weighted mean/ °C
Sn	0.027	0.040	0.004	-	-	-	-0.014	-0.001	-0.038	-0.013	0.000	-0.036
Zn	-0.152	-0.007	-0.006	-0.180	-0.036	-0.035	-0.138	0.007	0.007	0.470	0.614	0.615
Al	-0.004	0.000	-0.007	-	-	-	0.176	0.180	0.174	-0.172	-0.168	-0.174
Ag	0.168	0.037	0.056	-0.300	-0.432	-0.412	0.132	0.000	0.019	-	-	-

Table 50 – the differences of the laboratory measurements from the mean, median and weighted mean values for the LP5 measurements with the fixed-points

Fixed point	Mean value/ °C	Median value/ °C	Weighted mean value/ °C
Zn	419.492	419.492	419.476

Table 51 – the mean, median and weighted mean values for the CEM and UME Zn point measurements on range R2

Fixed point	CEM – mean/ °C	CEM – median/ °C	CEM – weighted mean/ °C	UME – mean/ °C	UME – median/ °C	UME – weighted mean/ °C
Zn	0.035	0.035	0.051	-0.035	-0.035	-0.020

Table 52 – the differences of the CEM and UME measurements from the mean, median and weighted mean values for the Zn point on range R2

9 DETAILED LABORATORY UNCERTAINTY BUDGETS

9.1 UNCERTAINTY BUDGETS FOR THE NPL FIXED-POINT MEASUREMENTS

INRiM thermometer – In fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.003	B	√3	0.00
Standard deviation of measurements	0.015	A	√300	0.00
Reproducibility of melts/ freezes	0.110	B	2√3	0.03
Resolution of INRiM thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.004	B	√3	0.00
Gain ratio measurements	0.026	B	1	0.03
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.04**
Total NPL expanded uncertainty (k = 2)				**0.08**
Thermometer drift				0.013
Total NPL comparison uncertainty				**0.045**
Expanded NPL comparison uncertainty (k =2)				**0.09**

Table 53: uncertainty components for the NPL In FP measurements for the INRIM thermometer

INRiM thermometer – Sn fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.004	B	√3	0.00
Standard deviation of measurements	0.003	A	√150	0.00
Reproducibility of melts/ freezes	0.010	B	2√3	0.00
Resolution of INRiM thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.006	B	√3	0.00
Gain ratio measurements	0.028	B	1	0.03
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.03**
Total NPL expanded uncertainty (k = 2)				**0.06**
Thermometer drift				0.019
Total NPL comparison uncertainty				**0.04**
Expanded NPL comparison uncertainty (k =2)				**0.07**

Table 54: uncertainty components for the NPL Sn FP measurements for the INRIM thermometer

INRiM thermometer – Zn fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.008	B	√3	0.00
Standard deviation of measurements	0.001	A	√200	0.00
Reproducibility of melts/ freezes	0.010	B	2√3	0.00
Resolution of INRiM thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.012	B	√3	0.01
Gain ratio measurements	0.006	B	1	0.01
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.01**
Total NPL expanded uncertainty (k = 2)				**0.02**
Thermometer drift				0.035
Total NPL comparison uncertainty				**0.04**
Expanded NPL comparison uncertainty (k =2)				**0.07**

Table 55: uncertainty components for the NPL Zn FP measurements for the INRIM thermometer

INRiM thermometer – Al fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.015	B	√3	0.01
Standard deviation of measurements	0.002	A	√300	0.00
Reproducibility of melts/ freezes	0.010	B	2√3	0.00
Resolution of INRiM thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.021	B	√3	0.01
Gain ratio measurements	0.000	B	1	0.00
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.02**
Total NPL expanded uncertainty (k = 2)				**0.03**
Thermometer drift				0.064
Total NPL comparison uncertainty				**0.07**
Expanded NPL comparison uncertainty (k =2)				**0.13**

Table 56: uncertainty components for the NPL Al FP measurements for the INRIM thermometer

INRiM thermometer – Ag fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.025	B	√3	0.01
Standard deviation of measurements	0.011	A	√200	0.00
Reproducibility of melts/ freezes	0.030	B	2√3	0.01
Resolution of INRiM thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.035	B	√3	0.02
Gain ratio measurements	0.009	B	1	0.01
Temperature coefficient	0.040	B	√3	0.02
Total NPL combined uncertainty (k = 1)				**0.04**
Total NPL expanded uncertainty (k = 2)				**0.07**
Thermometer drift				0.111
Total NPL comparison uncertainty				**0.12**
Expanded NPL comparison uncertainty (k =2)				**0.23**

Table 57: uncertainty components for the NPL Ag FP measurements for the INRIM thermometer

LP5 thermometer – Sn fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.004	B	√3	0.00
Standard deviation of measurements	0.250	A	√150	0.02
Reproducibility of melts/ freezes	0.140	B	2√3	0.04
Resolution of LP5 thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.006	B	√3	0.00
Gain ratio measurements	0.000	B	1	0.00
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.05**
Total NPL expanded uncertainty (k = 2)				**0.09**
Thermometer drift				0.032
Total NPL comparison uncertainty				**0.06**
Expanded NPL comparison uncertainty (k =2)				**0.11**

Table 58: uncertainty components for the NPL Sn FP measurements for the LP5 thermometer

LP5 thermometer – Zn fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.008	B	√3	0.00
Standard deviation of measurements	0.010	A	√200	0.00
Reproducibility of melts/ freezes	0.050	B	2√3	0.01
Resolution of LP5 thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.011	B	√3	0.01
Gain ratio measurements	0.000	B	1	0.00
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.02**
Total NPL expanded uncertainty (k = 2)				**0.03**
Thermometer drift				0.060
Total NPL comparison uncertainty				**0.06**
Expanded NPL comparison uncertainty (k =2)				**0.13**

Table 59: uncertainty components for the NPL Zn FP measurements for the LP5 thermometer

LP5 thermometer – Al fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.015	B	√3	0.01
Standard deviation of measurements	0.010	A	√300	0.00
Reproducibility of melts/ freezes	0.090	B	2√3	0.03
Resolution of LP5 thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.021	B	√3	0.01
Gain ratio measurements	0.012	B	1	0.01
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.03**
Total NPL expanded uncertainty (k = 2)				**0.07**
Thermometer drift				0.109
Total NPL comparison uncertainty				**0.11**
Expanded NPL comparison uncertainty (k =2)				**0.23**

Table 60: uncertainty components for the NPL Al FP measurements for the LP5 thermometer

LP5 thermometer – Ag fixed point Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Fixed point impurity	0.001	B	√3	0.00
Fixed point emissivity	0.025	B	√3	0.01
Standard deviation of measurements	0.010	A	√200	0.00
Reproducibility of melts/ freezes	0.200	B	2√3	0.06
Resolution of LP5 thermometer	0.010	B	2√3	0.00
Alignment on aperture	0.010	B	√3	0.01
Size of source effect/ thermal profile	0.035	B	√3	0.02
Gain ratio measurements	0.020	B	1	0.02
Temperature coefficient	0.000	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.07**
Total NPL expanded uncertainty (k = 2)				**0.13**
Thermometer drift				0.191
Total NPL comparison uncertainty				**0.20**
Expanded NPL comparison uncertainty (k =2)				**0.40**

Table 61: uncertainty components for the NPL Ag FP measurements for the LP5 thermometer

9.2 UNCERTAINTY BUDGETS FOR THE NPL VTBB MEASUREMENTS

INRiM - 156 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1)/ / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.00
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.026	B	1	0.03
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.013
Total NPL comparison uncertainty				**0.10**
Expanded NPL comparison uncertainty (k =2)				**0.20**

Table 62 - uncertainty components for the NPL VTBB measurements at 156 °C using the INRiM thermometer

INRiM - 200 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1 / °C)
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.00
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.02	B	1	0.02
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.016
Total NPL comparison uncertainty				**0.10**
Expanded NPL comparison uncertainty (k =2)				**0.20**

Table 63 - uncertainty components for the NPL VTBB measurements at 200 °C using the INRiM thermometer

INRiM - 232 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.00
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.03	B	1	0.03
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.019
Total NPL comparison uncertainty				**0.10**
Expanded NPL comparison uncertainty (k =2)				**0.20**

Table 64 - uncertainty components for the NPL VTBB measurements at 232 °C using the INRiM thermometer

INRiM - 250 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.01
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.03	B	1	0.03
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.020
Total NPL comparison uncertainty				**0.10**
Expanded NPL comparison uncertainty (k =2)				**0.20**

Table 65 - uncertainty components for the NPL VTBB measurements at 250 °C using the INRiM thermometer

INRiM - 300 °C with the Cs heatpipe Source of uncertainty	Value/ / °C	Type A or B	Divisor	u (k = 1)/ / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.01
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.04	B	√3	0.02
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.004	B	1	0.00
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.04	B	√3	0.02
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.21**
Thermometer drift				0.024
Total NPL comparison uncertainty				**0.11**
Expanded NPL comparison uncertainty (k =2)				**0.22**

Table 66 - uncertainty components for the NPL VTBB measurements at 300 °C using the INRiM thermometer

INRiM - 400 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.006	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.033
Total NPL comparison uncertainty				**0.11**
Expanded NPL comparison uncertainty (k =2)				**0.21**

Table 67 - uncertainty components for the NPL VTBB measurements at 400 °C using the INRiM thermometer

INRiM - 420 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.006	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.035
Total NPL comparison uncertainty				**0.11**
Expanded NPL comparison uncertainty (k =2)				**0.21**

Table 68 - uncertainty components for the NPL VTBB measurements at 420 °C using the INRiM thermometer

INRiM - 500 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.008	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.10**
Total NPL expanded uncertainty (k = 2)				**0.20**
Thermometer drift				0.044
Total NPL comparison uncertainty				**0.11**
Expanded NPL comparison uncertainty (k =2)				**0.22**

Table 69 - uncertainty components for the NPL Cs VTBB measurements at 500 °C using the INRiM thermometer

INRiM - 500 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.03	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.008	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.48**
Thermometer drift				0.044
Total NPL comparison uncertainty				**0.24**
Expanded NPL comparison uncertainty (k =2)				**0.49**

Table 70 - uncertainty components for the NPL WRC VTBB measurements at 500 °C using the INRiM thermometer

INRiM - 600 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.04	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.47**
Thermometer drift				0.056
Total NPL comparison uncertainty				**0.24**
Expanded NPL comparison uncertainty (k =2)				**0.48**

Table 71 - uncertainty components for the NPL VTBB measurements at 600 °C using the INRiM thermometer

INRiM - 660 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.04	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.015	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.48**
Thermometer drift				0.064
Total NPL comparison uncertainty				**0.25**
Expanded NPL comparison uncertainty (k =2)				**0.50**

Table 72 - uncertainty components for the NPL VTBB measurements at 660 °C using the INRiM thermometer

INRiM - 700 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.05	B	√3	0.03
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.015	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.48**
Thermometer drift				0.069
Total NPL comparison uncertainty				**0.25**
Expanded NPL comparison uncertainty (k =2)				**0.50**

Table 73 - uncertainty components for the NPL VTBB measurements at 700 °C using the INRiM thermometer

INRiM - 800 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.06	B	√3	0.03
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.006	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.02	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.49**
Thermometer drift				0.084
Total NPL comparison uncertainty				**0.26**
Expanded NPL comparison uncertainty (k =2)				**0.52**

Table 74 - uncertainty components for the NPL VTBB measurements at 800 °C using the INRiM thermometer

INRiM - 900 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.07	B	√3	0.04
Standard deviation - source temperature	0.06	A	√50	0.01
Standard deviation - INRiM thermometer	0.01	A	√50	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.008	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.02	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.24**
Total NPL expanded uncertainty (k = 2)				**0.49**
Thermometer drift				0.100
Total NPL comparison uncertainty				**0.26**
Expanded NPL comparison uncertainty (k =2)				**0.53**

Table 75 - uncertainty components for the NPL VTBB measurements at 900 °C using the INRiM thermometer

INRiM - 960 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.07	B	√3	0.04
Standard deviation - source temperature	0.05	A	√40	0.01
Standard deviation - INRiM thermometer	0.01	A	√40	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.009	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.06	B	√3	0.03
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.49**
Thermometer drift				0.111
Total NPL comparison uncertainty				**0.27**
Expanded NPL comparison uncertainty (k =2)				**0.54**

Table 76 - uncertainty components for the NPL VTBB measurements at 962 °C using the INRiM thermometer

INRiM - 1000 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.08	B	√3	0.05
Standard deviation - source temperature	0.04	A	√30	0.01
Standard deviation - INRiM thermometer	0.01	A	√30	0.00
Calibration of INRiM thermometer	0.15	A	2	0.08
Resolution of INRiM thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.009	B	1	0.01
Repeatability of calibration	0.06	A	1	0.06
Temperature gradients across source	0.06	B	√3	0.03
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.49**
Thermometer drift				0.118
Total NPL comparison uncertainty				**0.27**
Expanded NPL comparison uncertainty (k =2)				**0.54**

Table 77 - uncertainty components for the NPL VTBB measurements at 1000 °C using the INRiM thermometer

LP5 - 232 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.00
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.23	A	√30	0.04
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.13**
Total NPL expanded uncertainty (k = 2)				**0.25**
Thermometer drift				0.032
Total NPL comparison uncertainty				**0.13**
Expanded NPL comparison uncertainty (k =2)				**0.27**

Table 78 - uncertainty components for the NPL VTBB measurements at 232 °C using the LP5

LP5 - 250 °C with the H_2O heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.01
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.16	A	√30	0.03
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.13**
Total NPL expanded uncertainty (k = 2)				**0.25**
Thermometer drift				0.034
Total NPL comparison uncertainty				**0.13**
Expanded NPL comparison uncertainty (k =2)				**0.26**

Table 79 - uncertainty components for the NPL VTBB measurements at 250 °C using the LP5

LP5 - 300 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.01	B	√3	0.01
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.04	A	√30	0.01
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.04	B	√3	0.02
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.00	B	1	0.00
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.04	B	√3	0.02
Total NPL combined uncertainty (k = 1)				**0.13**
Total NPL expanded uncertainty (k = 2)				**0.25**
Thermometer drift				0.041
Total NPL comparison uncertainty				**0.13**
Expanded NPL comparison uncertainty (k =2)				**0.26**

Table 80 - uncertainty components for the NPL VTBB measurements at 300 °C using the LP5

LP5 - 400 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.02	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.01	B	1	0.01
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.12**
Total NPL expanded uncertainty (k = 2)				**0.25**
Thermometer drift				0.057
Total NPL comparison uncertainty				**0.14**
Expanded NPL comparison uncertainty (k =2)				**0.27**

Table 81 - uncertainty components for the NPL VTBB measurements at 400 °C using the LP5

LP5 - 420 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.01	B	1	0.01
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.12**
Total NPL expanded uncertainty (k = 2)				**0.24**
Thermometer drift				0.060
Total NPL comparison uncertainty				**0.14**
Expanded NPL comparison uncertainty (k =2)				**0.28**

Table 82 - uncertainty components for the NPL VTBB measurements at 420 °C using the LP5

LP5 - 500 °C with the Cs heatpipe Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.03	A	2	0.02
Emissivity of reference source	0.02	B	√3	0.01
Standard deviation - source temperature	0.00	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.01	B	1	0.01
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.12**
Total NPL expanded uncertainty (k = 2)				**0.25**
Thermometer drift				0.075
Total NPL comparison uncertainty				**0.15**
Expanded NPL comparison uncertainty (k =2)				**0.29**

Table 83 - uncertainty components for the NPL Cs VTBB measurements at 500 °C using the LP5

LP5 - 500 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.03	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.01	B	√3	0.01
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.01	B	1	0.01
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.01	B	√3	0.01
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.50**
Thermometer drift				0.075
Total NPL comparison uncertainty				**0.26**
Expanded NPL comparison uncertainty (k =2)				**0.52**

Table 84 - uncertainty components for the NPL WRC VTBB measurements at 500 °C using the LP5

LP5 - 600 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.04	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.01	B	1	0.01
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.50**
Thermometer drift				0.095
Total NPL comparison uncertainty				**0.27**
Expanded NPL comparison uncertainty (k =2)				**0.54**

Table 85 - uncertainty components for the NPL VTBB measurements at 600 °C using the LP5

LP5 - 660 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.04	B	√3	0.02
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.024	B	1	0.02
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.51**
Thermometer drift				0.109
Total NPL comparison uncertainty				**0.28**
Expanded NPL comparison uncertainty (k =2)				**0.55**

Table 86 - uncertainty components for the NPL VTBB measurements at 660 °C using the LP5

LP5 - 700 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.05	B	√3	0.03
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - LP5 thermometer	0.01	A	√30	0.00
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.024	B	1	0.02
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.51**
Thermometer drift				0.118
Total NPL comparison uncertainty				**0.28**
Expanded NPL comparison uncertainty (k =2)				**0.56**

Table 87 - uncertainty components for the NPL VTBB measurements at 700 °C using the LP5

LP5 - 800 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.06	B	√3	0.03
Standard deviation - source temperature	0.01	A	√30	0.00
Standard deviation - LP5 thermometer	0.06	A	√30	0.01
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.03	B	1	0.03
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.51**
Thermometer drift				0.144
Total NPL comparison uncertainty				**0.29**
Expanded NPL comparison uncertainty (k =2)				**0.58**

Table 88 - uncertainty components for the NPL VTBB measurements at 800 °C using the LP5

LP5 - 900 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.07	B	√3	0.04
Standard deviation - source temperature	0.01	A	√60	0.00
Standard deviation - LP5 thermometer	0.06	A	√60	0.01
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.034	B	1	0.03
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.26**
Total NPL expanded uncertainty (k = 2)				**0.51**
Thermometer drift				0.172
Total NPL comparison uncertainty				**0.31**
Expanded NPL comparison uncertainty (k =2)				**0.61**

Table 89 - uncertainty components for the NPL VTBB measurements at 900 °C using the LP5

LP5 - 960 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.07	B	√3	0.04
Standard deviation - source temperature	0.01	A	√35	0.00
Standard deviation - LP5 thermometer	0.06	A	√35	0.01
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.04	B	1	0.04
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.25**
Total NPL expanded uncertainty (k = 2)				**0.51**
Thermometer drift				0.191
Total NPL comparison uncertainty				**0.32**
Expanded NPL comparison uncertainty (k =2)				**0.64**

Table 90 - uncertainty components for the NPL VTBB measurements at 962 °C using the LP5

LP5 - 1000 °C with the WRC Source of uncertainty	Value / °C	Type A or B	Divisor	u (k = 1) / °C
Reference blackbody source	0.44	A	2	0.22
Emissivity of reference source	0.08	B	√3	0.05
Standard deviation - source temperature	0.01	A	√40	0.00
Standard deviation - LP5 thermometer	0.06	A	√40	0.01
Calibration of LP5 thermometer	0.18	A	2	0.09
Resolution of LP5 thermometer	0.01	B	2√3	0.00
Resolution of source temperature	0.01	B	2√3	0.00
Alignment on source	0.00	B	√3	0.00
Size of source effect/ thermal profile	0.00	B	√3	0.00
DVM calibration	0.00	B	√3	0.00
Gain ratio measurements	0.04	B	1	0.04
Repeatability of calibration	0.08	A	1	0.08
Temperature gradients across source	0.00	B	√3	0.00
Total NPL combined uncertainty (k = 1)				**0.26**
Total NPL expanded uncertainty (k = 2)				**0.52**
Thermometer drift				0.203
Total NPL comparison uncertainty				**0.33**
Expanded NPL comparison uncertainty (k =2)				**0.66**

Table 91 - uncertainty components for the NPL VTBB measurements at 1000 °C using the LP5

9.3 UNCERTAINTY BUDGETS FOR THE CEM FIXED POINT MEASUREMENTS

INRIM thermometer Source of uncertainty/ °C	Zn	Ag
Standard deviation of thermometer signal	0.000	0.001
Standard deviation of background signal	0.001	0.000
Multimeter calibration (for thermometer signal)	0.003	0.003
Multimeter drift (for thermometer signal)	0.000	0.000
Multimeter (thermometer) resolution	0.000	0.000
Effective radius determination	0.000	0.000
FP temperature uniformity	0.014	0.014
FP emissivity	0.018	0.059
FP impurities	0.001	0.027
Repeatability of measurements	0.011	0.074
Effect of ambient temperature	0.012	0.012
Effect of ambient humidity	0.010	0.010
Total CEM combined uncertainty (k = 1)/ °C	**0.03**	**0.10**
Total CEM expanded uncertainty (k = 2)/ °C	**0.06**	**0.20**
Thermometer drift	0.035	0.111
Gain ratio	0.003	0.028
Total CEM comparison uncertainty (k = 1)/ °C	**0.045**	**0.15**
Expanded CEM comparison uncertainty (k =2)/ °C	**0.09**	**0.30**

Table 92 - uncertainty components for the CEM FP measurements with the INRiM thermometer

LP5 thermometer Source of uncertainty/ °C	Zn set 1	Zn set 2	Ag set 1	Ag set 2
Standard deviation of thermometer signal	0.000	0.000	0.000	0.000
Standard deviation of background signal	0.000	0.000	0.000	0.000
Thermometer resolution	0.000	0.000	0.000	0.000
Effective radius	0.000	0.000	0.000	0.000
FP temperature uniformity	0.014	0.014	0.014	0.014
FP emissivity	0.018	0.018	0.059	0.059
FP impurities	0.000	0.000	0.003	0.003
Repeatability of measurements	0.015	0.002	0.125	0.008
Effect of ambient temperature	0.023	0.023	0.025	0.025
Effect of ambient humidity	0.017	0.017	0.019	0.019
Total CEM combined uncertainty (*k* = 1)/ °C	**0.04**	**0.04**	**0.14**	**0.06**
Total CEM expanded uncertainty (*k* = 2)/ °C	**0.08**	**0.07**	**0.28**	**0.12**
Thermometer drift	0.060	0.060	0.191	0.191
Additional drift – difference in CEM results	0.120	0.120	0.400	0.400
Gain ratio	0.000	0.000	0.000	0.000
Total CEM comparison uncertainty (*k* = 1)/ °C	**0.14**	**0.14**	**0.47**	**0.45**
Expanded CEM comparison uncertainty (*k* =2)/ °C	**0.28**	**0.28**	**0.93**	**0.89**

Table 93 - uncertainty components for the CEM FP measurements with the LP5

9.4 UNCERTAINTY BUDGETS FOR THE UME FIXED POINT MEASUREMENTS

INRiM thermometer Source of uncertainty	In	Sn	Zn
	Standard uncertainty (u_i)/ V		
Fixed point emissivity	0.000154	0.000367	0.000397
Size of source effect	0.000031	0.000073	0.000079
Plateau identification (average)	0.000113	0.000080	0.000038
Repeatability of melts/ freezes (average)	0.000457	0.000472	0.000237
Gain ratio	0.001070	0.000156	0.00000
Total UME combined uncertainty (*k* = 1)/ V	**0.001183**	**0.000649**	**0.000475**
Total UME combined uncertainty (*k* = 1)/ °C	**0.031**	**0.010**	**0.013**
Total UME expanded uncertainty (*k* = 2)/ °C	**0.062**	**0.020**	**0.026**
Thermometer drift	0.013	0.019	0.035
Gain ratio	0.017	0.00	0.00
Total UME comparison uncertainty (*k* = 1)/ °C)	**0.038**	**0.021**	**0.038**
Expanded UME comparison uncertainty (*k* =2)	**0.076**	**0.042**	**0.075**

Table 94: uncertainty components for the UME FP measurements with the INRIM thermometer

LP5 thermometer Source of uncertainty	Sn	Zn (R1)	Zn (R2)	Al
	Standard uncertainty (u_i)/ A			
Fixed point emissivity	6.06E-16	8.24E-14	8.24E-14	2.50E-12
Size of source effect	4.55E-17	6.18E-15	6.18E-15	1.88E-13
Plateau identification (average)	1.54E-14	1.55E-13	1.55E-13	2.58E-13
Repeatability of melts/ freezes (average)	1.99E-14	4.53E-13	4.53E-13	1.61E-12
Gain ratio	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total UME combined uncertainty (*k* = 1)/ V	**2.54E-14**	**4.91E-13**	**4.91E-13**	**3.23E-12**
Total UME combined uncertainty (*k* = 1)/ °C	**0.23**	**0.06**	**0.06**	**0.03**
Total UME expanded uncertainty (*k* = 2)/ °C	**0.47**	**0.13**	**0.13**	**0.05**
Thermometer drift	0.032	0.060	0.060	0.109
Range ratio	0.00	0.64	0.00	0.00
Total UME comparison uncertainty (*k* = 1)/ °C)	**0.24**	**0.65**	**0.09**	**0.11**
Expanded UME comparison uncertainty (*k* =2)/ °C	**0.47**	**1.29**	**0.17**	**0.22**

Table 95: uncertainty components for the UME FP measurements with the LP5 thermometer

9.5 UNCERTAINTY BUDGETS FOR THE CEM VTBB MEASUREMENTS

INRIM thermometer Source of uncertainty/ °C	156	200	232	250	300	400	420	500	600	660	700	800	900
Standard deviation of thermometer signal	0.031	0.001	0.007	0.001	0.002	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.003
Standard deviation of background signal	0.205	0.037	0.010	0.006	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.002	0.001
Multimeter resolution (for thermometer signal)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Multimeter calibration (for thermometer signal)	0.003	0.001	0.002	0.001	0.003	0.004	0.003	0.001	0.003	0.002	0.001	0.007	0.004
Multimeter drift (for thermometer signal)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effective radius determination	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
Effect of ambient temperature	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Effect of ambient humidity	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Repeatability of measurements	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Resistance bridge	0.000	-	-	-	-	-	-	-	-	-	-	-	-
Standard deviation of resistance bridge readings	0.001	-	-	-	-	-	-	-	-	-	-	-	-
Calibration and drift of resistance bridge	0.001	-	-	-	-	-	-	-	-	-	-	-	-
Calibration of bridge internal standard resistor	0.001	-	-	-	-	-	-	-	-	-	-	-	-
Drift of bridge internal resistor	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Thermocouple EMF measurement	-	0.024	0.023	0.022	0.020	0.018	0.017	0.016	0.015	0.014	0.014	0.013	0.012
Thermocouple cold junction	-	0.025	0.023	0.022	0.021	0.018	0.018	0.017	0.015	0.014	0.014	0.013	0.012
Thermocouple/ PRT calibration	0.010	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.100	0.100	0.100	0.100	0.100
Thermocouple/ PRT drift	0.006	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Blackbody furnace stability	0.080	0.004	0.003	0.003	0.003	0.002	0.002	0.006	0.002	0.003	0.002	0.002	0.006
Back wall temperature drop	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004	0.004	0.004	0.004
Blackbody emissivity	0.013	0.019	0.021	0.023	0.027	0.038	0.040	0.050	0.064	0.073	0.079	0.096	0.115
Total CEM combined uncertainty (*k* = 1)/ °C	**0.22**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.14**	**0.14**	**0.14**	**0.15**	**0.17**
Total CEM expanded uncertainty (*k* = 2)/ °C	**0.45**	**0.31**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.31**	**0.27**	**0.28**	**0.29**	**0.31**	**0.33**
Thermometer drift	0.013	0.016	0.019	0.020	0.024	0.033	0.035	0.044	0.056	0.064	0.069	0.084	0.100
Gain ratio	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CEM comparison uncertainty (*k* = 1)/ °C	**0.22**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.16**	**0.16**	**0.15**	**0.15**	**0.16**	**0.17**	**0.19**
Expanded CEM comparison uncertainty (*k* =2)/ °C	**0.45**	**0.31**	**0.30**	**0.30**	**0.30**	**0.31**	**0.31**	**0.32**	**0.29**	**0.31**	**0.32**	**0.35**	**0.39**

Table 96 - uncertainty budgets for the CEM VTBB measurements using the INRiM thermometer

LP5 thermometer Source of uncertainty/ °C	232	250	300	400	420	500	600	660	700	800	900
Standard deviation of thermometer signal	0.132	0.043	0.015	0.003	0.002	0.004	0.003	0.002	0.001	0.002	0.003
Standard deviation of background signal	0.023	0.013	0.003	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
Thermometer resolution	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effective radius determination	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effect of ambient temperature	0.026	0.026	0.025	0.024	0.024	0.024	0.025	0.025	0.025	0.025	0.025
Effect of ambient humidity	0.020	0.020	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Repeatability of measurements	0.042	0.042	0.041	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
Thermocouple EMF measurement	0.023	0.022	0.020	0.018	0.017	0.016	0.015	0.014	0.014	0.013	0.012
Thermocouple cold junction	0.023	0.022	0.021	0.018	0.018	0.017	0.015	0.014	0.014	0.013	0.012
Thermocouple calibration	0.130	0.130	0.130	0.130	0.130	0.130	0.101	0.100	0.100	0.100	0.100
Thermocouple drift	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Blackbody furnace stability	0.008	0.003	0.003	0.013	0.002	0.003	0.005	0.002	0.001	0.005	0.004
Back wall temperature drop	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004	0.004	0.004	0.004
Blackbody emissivity	0.007	0.007	0.008	0.012	0.012	0.015	0.020	0.022	0.024	0.030	0.035
Total CEM combined uncertainty (*k* = 1)/ °C	**0.21**	**0.16**	**0.16**	**0.15**	**0.15**	**0.15**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**
Total CEM expanded uncertainty (*k* = 2)/ °C	**0.41**	**0.32**	**0.31**	**0.31**	**0.31**	**0.31**	**0.26**	**0.26**	**0.26**	**0.26**	**0.27**
Thermometer drift	0.03	0.03	0.04	0.06	0.06	0.07	0.10	0.11	0.12	0.14	0.17
Additional uncertainty due to Zn point drift at CEM	0.06	0.07	0.08	0.11	0.12	0.15	0.19	0.22	0.24	0.29	0.34
Gain ratio	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CEM comparison uncertainty (*k* = 1)/ °C	**0.22**	**0.18**	**0.18**	**0.20**	**0.20**	**0.23**	**0.25**	**0.28**	**0.30**	**0.35**	**0.41**
Expanded CEM comparison uncertainty (*k* =2)/ °C	**0.43**	**0.36**	**0.36**	**0.40**	**0.41**	**0.46**	**0.50**	**0.55**	**0.59**	**0.70**	**0.81**

Table 97 – uncertainty budgets for the CEM VTBB measurements using the LP5 thermometer

9.6 UNCERTAINTY BUDGETS FOR THE UME VTBB MEASUREMENTS

INRIM thermometer Source of uncertainty/ °C	200	250	300	420	500	600	660	700	800	900	1000
Standard deviation - INRIM thermometer	0.011	0.027	0.035	0.041	0.037	0.052	0.047	0.054	0.270	0.240	0.142
Reference radiation thermometer	0.397	0.393	0.394	0.393	0.393	0.393	0.393	0.393	0.394	0.395	0.394
Emissivity of reference source	0.007	0.008	0.010	0.014	0.017	0.021	0.024	0.027	0.192	0.229	0.270
Size of source effect/ thermal profile	0.001	0.001	0.002	0.002	0.003	0.003	0.004	0.004	0.005	0.006	0.007
Gain ratio measurements	0.002	0.002	0.002	0.000	0.000	0.004	0.005	0.005	0.046	0.055	0.065
Repeatability of calibration	0.266	0.092	0.113	0.170	0.091	0.153	0.110	0.109	0.301	0.294	0.203
Total UME combined uncertainty (*k* = 1)/ °C	**0.478**	**0.404**	**0.411**	**0.430**	**0.405**	**0.425**	**0.411**	**0.412**	**0.598**	**0.596**	**0.542**
Total UME expanded uncertainty (*k* = 2)/ °C	**0.955**	**0.808**	**0.822**	**0.860**	**0.810**	**0.850**	**0.822**	**0.824**	**1.196**	**1.193**	**1.084**
Thermometer drift	0.016	0.020	0.024	0.035	0.044	0.056	0.064	0.069	0.084	0.100	0.118
Gain ratio	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total UME comparison uncertainty (*k* = 1)/ °C	**0.480**	**0.405**	**0.412**	**0.431**	**0.407**	**0.429**	**0.416**	**0.418**	**0.604**	**0.605**	**0.555**
Expanded UME comparison uncertainty (*k* =2)/ °C	**0.960**	**0.809**	**0.824**	**0.862**	**0.814**	**0.857**	**0.832**	**0.835**	**1.208**	**1.209**	**1.110**

Table 98: uncertainty components for the UME VTBB measurements with the INRIM thermometer

LP5 thermometer Source of uncertainty/ °C	250	300	420	500	600	660	700	800	900	1000
Standard deviation – LP5 thermometer	0.077	0.162	0.041	0.055	0.049	0.057	0.072	0.133	0.243	0.172
Reference radiation thermometer	0.393	0.394	0.393	0.393	0.393	0.393	0.393	0.394	0.395	0.394
Emissivity of reference source	0.007	0.009	0.013	0.016	0.021	0.023	0.026	0.188	0.222	0.264
Size of source effect/ thermal profile	0.000	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003
Gain ratio measurements	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Repeatability of calibration	0.259	0.137	0.078	0.124	0.124	0.278	0.228	0.313	0.323	0.305
Total UME combined uncertainty (*k* = 1)/ °C	**0.477**	**0.447**	**0.402**	**0.416**	**0.415**	**0.485**	**0.460**	**0.553**	**0.607**	**0.590**
Total UME expanded uncertainty (*k* = 2)/ °C	**0.953**	**0.894**	**0.805**	**0.831**	**0.830**	**0.969**	**0.921**	**1.106**	**1.214**	**1.179**
Thermometer drift	0.034	0.041	0.060	0.075	0.095	0.109	0.118	0.144	0.172	0.203
Gain ratio	0.000	0.447	0.654	0.814	0.000	0.000	0.000	0.000	0.000	0.000
Total UME comparison uncertainty (*k* = 1)/ °C	**0.478**	**0.634**	**0.771**	**0.917**	**0.426**	**0.497**	**0.475**	**0.572**	**0.631**	**0.623**
Expanded UME comparison uncertainty (*k* =2)/ °C	**0.956**	**1.268**	**1.541**	**1.834**	**0.852**	**0.993**	**0.951**	**1.143**	**1.262**	**1.247**

Table 99: uncertainty components for the UME VTBB measurements with the LP5 thermometer

9.7 UNCERTAINTY BUDGETS FOR PTB VTBB MEASUREMENTS

INRIM thermometer Source of uncertainty/ °C	156	200	232	250	300	400	420	500	600	660	700	800	900	962
Blackbody source†	0.032	0.032	0.033	0.033	0.048	0.018	0.018	0.020	0.022	0.037	0.038	0.041	0.044	0.047
Standard deviation of blackbody temperature	0.001	0.001	0.002	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Standard deviation of thermometer signal	0.003	0.001	0.003	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Standard deviation of background signal	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Size of source effect/ thermal profile	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gain ratio measurements	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total PTB combined uncertainty (*k* = 1)/ °C	**0.032**	**0.032**	**0.033**	**0.035**	**0.048**	**0.018**	**0.018**	**0.020**	**0.022**	**0.037**	**0.038**	**0.041**	**0.044**	**0.047**
Total PTB expanded uncertainty (*k* = 2)/ °C	**0.064**	**0.064**	**0.066**	**0.069**	**0.096**	**0.035**	**0.036**	**0.039**	**0.044**	**0.073**	**0.075**	**0.081**	**0.088**	**0.094**
Thermometer drift	0.013	0.016	0.019	0.020	0.024	0.033	0.035	0.044	0.056	0.064	0.069	0.084	0.100	0.111
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000
Total PTB comparison uncertainty (*k* = 1)/ °C	**0.03**	**0.04**	**0.04**	**0.04**	**0.05**	**0.04**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.11**	**0.12**
Expanded PTB comparison uncertainty (*k* =2)/ °C	**0.07**	**0.07**	**0.08**	**0.08**	**0.11**	**0.07**	**0.08**	**0.10**	**0.12**	**0.15**	**0.16**	**0.19**	**0.22**	**0.24**

Table 100: uncertainty components for the PTB VTBB measurements with the INRiM thermometer

† This component includes uncertainties in the corrections for the cavity emissivity, the radial temperature and axial non-uniformity of the cavity, the temperature drop across the cavity back wall and the uncertainty in the calibration of the PRT.

LP5 thermometer Source of uncertainty/ °C	232	250	300	400	420	500	600	660	700	800	900	962
Blackbody source	0.033	0.033	0.048	0.018	0.018	0.020	0.022	0.037	0.038	0.041	0.044	0.047
Standard deviation of blackbody temperature	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.0000	0.000	0.000	0.000	0.001
Standard deviation of thermometer signal	0.022	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Standard deviation of background signal	0.039	0.022	0.007	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Size of source effect/ thermal profile	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gain ratio measurements	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total PTB combined uncertainty (*k* = 1)/ °C	**0.056**	**0.043**	**0.049**	**0.018**	**0.018**	**0.020**	**0.022**	**0.037**	**0.038**	**0.041**	**0.044**	**0.047**
Total PTB expanded uncertainty (*k* = 2)/ °C	**0.111**	**0.085**	**0.097**	**0.035**	**0.036**	**0.039**	**0.044**	**0.073**	**0.075**	**0.081**	**0.088**	**0.094**
Thermometer drift	0.032	0.034	0.041	0.057	0.060	0.075	0.095	0.109	0.118	0.144	0.172	0.191
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000
Total PTB comparison uncertainty (*k* = 1)/ °C	**0.064**	**0.055**	**0.064**	**0.059**	**0.063**	**0.077**	**0.098**	**0.115**	**0.124**	**0.150**	**0.178**	**0.196**
Expanded PTB comparison uncertainty (*k* =2)/ °C	**0.128**	**0.109**	**0.127**	**0.119**	**0.125**	**0.155**	**0.196**	**0.230**	**0.248**	**0.299**	**0.355**	**0.393**

Table 101: uncertainty components for the PTB VTBB measurements with the LP5 thermometer

9.8 UNCERTAINTY BUDGETS FOR LNE VTBB MEASUREMENTS

Blackbody reference source for INRIM thermometer measurements Source of uncertainty/ °C	H_2O heatpipe		Cs heatpipe		Na heatpipe	
	150	250	300	600	600	950
Emissivity of the BB cavity	0.004	0.006	0.024	0.055	0.060	0.115
Spectral band	0.006	0.009	0.013	0.037	0.040	0.070
Radiance uniformity of the BB aperture	0.025	0.025	0.063	0.033	0.060	0.080
Short term stability of the BB	0.004	0.004	0.030	0.030	0.153	0.153
Calibration of the contact thermometer within the BB	0.002	0.002	0.003	0.008	0.280	0.400
Implementation of the contact thermometer	0.009	0.009	0.029	0.029	0.060	0.060
Drift of the contact thermometer	0.004	0.004	0.004	0.004	0.060	0.060
Electrical connections	0.002	0.002	0.002	0.002	0.100	0.090
Drift of the multimeter	0.0001	0.0002	0.009	0.010	0.030	0.030
Melting ice	-	-	-	-	0.050	0.050
Total LNE source uncertainty (*k* = 1)/ °C	**0.028**	**0.029**	**0.081**	**0.086**	**0.359**	**0.473**
Position of the contact thermometer's sensitive element / cavity backwall	0.100	0.200	0.100	0.100	0.200	0.200
Correction and uncertainty of the multimeter calibration	0.030	0.030	0.050	0.060	0.100	0.100
LNE expanded source uncertainty (*k* = 2)/ °C	**0.19**	**0.29**	**0.31**	**0.33**	**1.02**	**1.25**

Table 102: uncertainty components for the LNE VTBB measurements with the INRiM thermometer

INRIM thermometer Source of uncertainty/ °C	156	200	232	250	300	400	420	500	600 Cs	600 Na	660	700	800	900	962
Blackbody source*	0.095	0.120	0.135	0.145	0.155	0.160	0.160	0.165	0.165	0.510	0.530	0.540	0.575	0.605	0.625
Standard deviation of signal	0.007	0.006	0.005	0.004	0.010	0.024	0.012	0.016	0.027	0.036	0.014	0.012	0.013	0.018	0.140
Total LNE combined uncertainty (*k* = 1)/ °C	**0.105**	**0.125**	**0.140**	**0.150**	**0.165**	**0.185**	**0.170**	**0.180**	**0.195**	**0.545**	**0.540**	**0.555**	**0.700**	**0.625**	**0.770**
Total LNE expanded uncertainty (*k* = 2)/ °C	**0.210**	**0.250**	**0.280**	**0.300**	**0.330**	**0.370**	**0.340**	**0.360**	**0.390**	**1.090**	**1.080**	**1.110**	**1.400**	**1.250**	**1.540**
Thermometer drift	0.013	0.016	0.019	0.020	0.024	0.033	0.035	0.044	0.056	0.056	0.064	0.069	0.084	0.100	0.111
Gain ratio	0.008	0.012	0.006	0.007	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total LNE uncertainty (*k* = 1)/ °C	**0.10**	**0.13**	**0.14**	**0.15**	**0.17**	**0.19**	**0.18**	**0.18**	**0.20**	**0.55**	**0.55**	**0.56**	**0.71**	**0.63**	**0.78**
Expanded LNE uncertainty (*k* =2)/ °C	**0.21**	**0.25**	**0.28**	**0.30**	**0.33**	**0.37**	**0.35**	**0.37**	**0.40**	**1.09**	**1.09**	**1.12**	**1.41**	**1.27**	**1.55**

Table 103: uncertainty components for the LNE VTBB measurements with the INRiM thermometer – all thermometer components

* Values obtained by interpolation from Table 102

Blackbody reference source for LP5 measurements	H_2O heatpipe		Cs heatpipe		Na heatpipe	
Source of uncertainty/ °C	150	250	300	600	600	950
Emissivity of the BB cavity	0.004	0.006	0.024	0.055	0.060	0.115
Spectral band	0.006	0.009	0.013	0.037	0.040	0.070
Radiance uniformity of the BB aperture	0.025	0.025	0.063	0.033	0.060	0.080
Short term stability of the BB	0.003	0.003	0.005	0.003	0.020	0.014
Calibration of the contact thermometer within the BB	0.002	0.002	0.003	0.008	0.280	0.400
Implementation of the contact thermometer	0.009	0.009	0.029	0.029	0.060	0.060
Drift of the contact thermometer	0.004	0.004	0.004	0.004	0.060	0.060
Electrical connections	0.002	0.002	0.002	0.002	0.100	0.090
Drift of the multimeter	0.0001	0.0002	0.009	0.010	0.030	0.030
Melting ice	-	-	-	-	0.050	0.050
Total LNE source uncertainty (*k* = 1)/ °C	**0.028**	**0.029**	**0.075**	**0.081**	**0.325**	**0.448**
Position of the contact thermometer's sensitive element / cavity backwall	0.100	0.200	0.100	0.100	0.200	0.200
Correction and uncertainty of the multimeter calibration	0.030	0.030	0.050	0.060	0.100	0.100
LNE expanded source uncertainty (*k* = 2)/ °C	**0.19**	**0.29**	**0.30**	**0.32**	**0.95**	**1.20**

Table 104: uncertainty components for the LNE VTBB measurements with the LP5

LP5 thermometer Source of uncertainty/ °C	232	250	300	400	420	500	600 Cs	660 Na	700	800	900	962
Blackbody source*	0.135	0.145	0.150	0.155	0.155	0.155	0.160	0.495	0.510	0.545	0.580	0.600
Standard deviation of signal	0.160	0.093	0.024	0.006	0.004	0.011	0.052	0.022	0.014	0.024	0.014	0.018
Total LNE combined uncertainty (*k* = 1)/ °C	**0.300**	**0.235**	**0.175**	**0.160**	**0.160**	**0.170**	**0.210**	**0.520**	**0.525**	**0.570**	**0.595**	**0.620**
Total LNE expanded uncertainty (*k* = 2)/ °C	**0.600**	**0.470**	**0.035**	**0.320**	**0.320**	**0.340**	**0.420**	**1.040**	**1.050**	**1.14**	**1.19**	**1.240**
Thermometer drift	0.032	0.034	0.041	0.057	0.060	0.075	0.095	0.109	0.118	0.144	0.172	0.191
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total LNE comparison uncertainty (*k* = 1)/ °C	**0.30**	**0.24**	**0.18**	**0.17**	**0.17**	**0.18**	**0.23**	**0.53**	**0.54**	**0.59**	**0.62**	**0.65**
Expanded LNE comparison uncertainty (*k* =2)/ °C	**0.60**	**0.48**	**0.36**	**0.34**	**0.34**	**0.37**	**0.47**	**1.06**	**1.08**	**1.17**	**1.24**	**1.30**

Table 105: Uncertainty components for the LNE VTBB measurements with the LP5 - all thermometer components

* Values obtained by interpolation from Table 104

9.9 UNCERTAINTY BUDGETS FOR THE METAS VTBB MEASUREMENTS

INRIM thermometer Source of uncertainty/ °C	156.6	200	232	250	300	400
BB calibration at PTB	0.075	0.085	0.090	0.090	0.095	0.025
SPRT accuracy on ITS-90 incl. propagation of WTP-Drift over 1 year	0.003	0.003	0.003	0.003	0.005	0.005
Thermal coupling between BB and SPRT	0.011	0.011	0.012	0.012	0.012	0.013
Electrical measurement of the SPRT	0.003	0.003	0.003	0.003	0.003	0.003
BB radial homogeneity (over aperture of 20 mm)	0.030	0.030	0.030	0.030	0.025	0.020
BB temperature stability during the measurements	0.010	0.010	0.010	0.010	0.010	0.010
Uncertainty of emissivity (incl. correction for e < 1)	0.007	0.009	0.010	0.010	0.026	0.031
Background radiation at 20 °C	0.003	0.003	0.003	0.002	0.010	0.005
Thermal losses by radiation	0.003	0.003	0.003	0.003	0.003	0.004
Thermal losses by convection	0.006	0.009	0.010	0.011	0.012	0.009
Resolution pyrometer	0.010	0.010	0.010	0.010	0.010	0.010
Standard deviation of the pyrometer	0.200	0.200	0.200	0.150	0.040	0.010
Reproducibility of the position of the pyrometer ±0.2 mm on three axes	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS combined uncertainty (*k* = 1)/ °C	**0.217**	**0.221**	**0.223**	**0.179**	**0.112**	**0.051**
Total METAS expanded uncertainty (*k* = 2)/ °C	**0.433**	**0.441**	**0.445**	**0.358**	**0.224**	**0.102**
Thermometer drift	0.013	0.016	0.019	0.020	0.024	0.035
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000
Total METAS comparison uncertainty (*k* = 1)/ °C	**0.22**	**0.22**	**0.22**	**0.18**	**0.11**	**0.06**
Expanded comparison uncertainty (*k* =2)/ °C	**0.43**	**0.44**	**0.45**	**0.36**	**0.23**	**0.12**

Table 106: uncertainty components for the METAS VTBB measurements with the INRIM thermometer (SPRT sensors)

INRIM thermometer Source of uncertainty/ °C	420	500 (Cs)	500 (Na)	600 (Cs)	600 (Na)	660 (Na)
BB calibration at PTB	0.025	0.025	0.035	0.030	0.045	0.050
SPRT accuracy on ITS-90 incl. propagation of WTP-Drift over 1 year	0.005	0.005	0.005	0.005	0.005	0.005
Thermal coupling between BB and SPRT	0.013	0.014	0.014	0.015	0.015	0.016
Electrical measurement of the SPRT	0.003	0.004	0.004	0.004	0.004	0.004
BB radial homogeneity (over aperture of 20 mm)	0.020	0.020	0.025	0.015	0.030	0.035
BB temperature stability during the measurements	0.010	0.005	0.015	0.005	0.015	0.015
Uncertainty of emissivity (incl. correction for e < 1)	0.031	0.038	0.044	0.042	0.049	0.053
Background radiation at 20 °C	0.005	0.005	0.005	0.005	0.005	0.005
Thermal losses by radiation	0.004	0.005	0.005	0.010	0.010	0.013
Thermal losses by convection	0.009	0.007	0.007	0.008	0.008	0.009
Resolution pyrometer	0.010	0.010	0.010	0.010	0.010	0.010
Standard deviation of the pyrometer	0.010	0.010	0.010	0.010	0.010	0.010
Reproducibility of the position of the pyrometer ±0.2 mm on three axes	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS combined uncertainty (*k* = 1)/ °C	**0.051**	**0.055**	**0.067**	**0.060**	**0.079**	**0.174**
Total METAS expanded uncertainty (*k* = 2)/ °C	**0.102**	**0.110**	**0.135**	**0.119**	**0.158**	**0.087**
Thermometer drift	0.035	0.044	0.044	0.056	0.056	0.064
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000
Total METAS comparison uncertainty (*k* = 1)/ °C	**0.06**	**0.07**	**0.08**	**0.08**	**0.10**	**0.11**
Expanded comparison uncertainty (*k* =2)/ °C	**0.12**	**0.14**	**0.16**	**0.16**	**0.19**	**0.22**

Table 107: uncertainty components for the METAS VTBB measurements with the INRIM thermometer (SPRT sensors) - continued

INRIM thermometer Source of uncertainty	500	600	700	800	900	962	1000
BB calibration at PTB	0.035	0.045	0.06	0.070	0.080	0.090	0.100
TC type S accuracy on ITS-90	0.150	0.150	0.150	0.150	0.150	0.150	0.150
Thermal coupling between BB and TC	0.087	0.115	0.173	0.230	0.289	0.318	0.346
Electrical measurement of the TC	0.150	0.150	0.100	0.100	0.100	0.100	0.100
Radial homogeneity (over aperture of 20 mm)	0.025	0.030	0.040	0.050	0.060	0.065	0.070
Temperature stability during the measurements	0.015	0.015	0.015	0.020	0.020	0.020	0.020
Uncertainty of emissivity (incl. correction for e < 1)	0.044	0.049	0.055	0.042	0.042	0.055	0.067
Background radiation at 20 °C	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Thermal losses by radiation	0.005	0.010	0.010	0.020	0.025	0.028	0.030
Thermal losses by convection	0.007	0.008	0.009	0.010	0.011	0.012	0.013
Resolution pyrometer	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Standard deviation of the pyrometer	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Reproducibility of the position of the pyrometer ±0.2 mm on three axes	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS combined uncertainty (*k* = 1)/ °C	**0.238**	**0.253**	**0.267**	**0.309**	**0.359**	**0.388**	**0.416**
Total METAS expanded uncertainty (*k* = 2)/ °C	**0.477**	**0.507**	**0.534**	**0.619**	**0.719**	**0.776**	**0.833**
Thermometer drift	0.044	0.056	0.069	0.084	0.100	0.111	0.118
Gain ratio	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total METAS comparison uncertainty (*k* = 1)/ °C	**0.24**	**0.26**	**0.28**	**0.32**	**0.37**	**0.40**	**0.43**
Expanded comparison uncertainty (*k* =2)/ °C	**0.48**	**0.52**	**0.55**	**0.64**	**0.75**	**0.81**	**0.87**

Table 108: uncertainty components for the METAS VTBB measurements with the INRIM thermometer (thermocouple sensors)

LP5 thermometer Source of uncertainty/ °C	232	250	300	400	420	500 (Cs)	500 (Na)	600 (Cs)	600 (Na)	660 (Na)
BB calibration at PTB	0.090	0.090	0.095	0.025	0.025	0.025	0.035	0.030	0.045	0.050
SPRT accuracy on ITS-90 incl. propagation of WTP-Drift over 1 year	0.003	0.003	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Thermal coupling between BB and SPRT	0.012	0.012	0.012	0.013	0.013	0.014	0.014	0.015	0.015	0.016
Electrical measurement of the SPRT	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004
BB radial homogeneity (over aperture of 20 mm)	0.030	0.030	0.025	0.020	0.020	0.020	0.025	0.015	0.030	0.035
BB temperature stability during the measurements	0.010	0.010	0.010	0.010	0.010	0.005	0.015	0.005	0.015	0.015
Uncertainty of emissivity (incl. correction for e < 1)	0.010	0.010	0.026	0.031	0.031	0.038	0.044	0.042	0.049	0.053
Background radiation at 20 °C	0.003	0.002	0.010	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Thermal losses by radiation	0.003	0.003	0.003	0.004	0.004	0.005	0.005	0.010	0.010	0.013
Thermal losses by convection	0.010	0.011	0.012	0.009	0.009	0.007	0.007	0.008	0.008	0.009
Resolution pyrometer	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Standard deviation of the pyrometer	0.200	0.150	0.040	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Reproducibility of the position of the pyrometer ±0.2 mm on three axes	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS combined uncertainty (*k* = 1)/ °C	**0.223**	**0.179**	**0.112**	**0.051**	**0.051**	**0.055**	**0.067**	**0.060**	**0.079**	**0.174**
Total METAS expanded uncertainty (*k* = 2)/ °C	**0.445**	**0.358**	**0.224**	**0.102**	**0.102**	**0.110**	**0.135**	**0.119**	**0.158**	**0.087**
Thermometer drift	0.032	0.034	0.041	0.057	0.060	0.075	0.075	0.095	0.095	0.109
Range ratio	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
Total METAS comparison uncertainty (*k* = 1)/ °C	**0.225**	**0.182**	**0.119**	**0.076**	**0.079**	**0.093**	**0.101**	**0.113**	**0.124**	**0.139**
Expanded comparison uncertainty (*k* =2)/ °C	**0.45**	**0.37**	**0.24**	**0.15**	**0.16**	**0.19**	**0.20**	**0.23**	**0.25**	**0.28**

Table 109: uncertainty components for the METAS VTBB measurements with the LP5 thermometer (SPRT sensors)

LP5 thermometer Source of uncertainty	500	600	700	800	900	962	1000
BB calibration at PTB	0.035	0.045	0.06	0.070	0.080	0.090	0.100
TC type S accuracy on ITS-90	0.150	0.150	0.150	0.150	0.150	0.150	0.150
Thermal coupling between BB and TC	0.087	0.115	0.173	0.230	0.289	0.318	0.346
Electrical measurement of the TC	0.150	0.150	0.100	0.100	0.100	0.100	0.100
Radial homogeneity (over aperture of 20 mm)	0.025	0.030	0.040	0.050	0.060	0.065	0.070
Temperature stability during the measurements	0.015	0.015	0.015	0.020	0.020	0.020	0.020
Uncertainty of emissivity (incl. correction for e < 1)	0.044	0.049	0.055	0.042	0.042	0.055	0.067
Background radiation at 20 °C	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Thermal losses by radiation	0.005	0.010	0.010	0.020	0.025	0.028	0.030
Thermal losses by convection	0.007	0.008	0.009	0.010	0.011	0.012	0.013
Resolution pyrometer	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Standard deviation of the pyrometer	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Reproducibility of the position of the pyrometer ±0.2 mm on three axes	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS combined uncertainty (*k* = 1)/ °C	**0.238**	**0.253**	**0.267**	**0.309**	**0.359**	**0.388**	**0.416**
Total METAS expanded uncertainty (*k* = 2)/ °C	**0.477**	**0.507**	**0.534**	**0.619**	**0.719**	**0.776**	**0.833**
Thermometer drift	0.075	0.095	0.118	0.144	0.172	0.191	0.203
Range ratio	0.000	0.001	0.001	0.001	0.001	0.001	0.001
Total METAS comparison uncertainty (*k* = 1)/ °C	**0.250**	**0.271**	**0.292**	**0.341**	**0.398**	**0.432**	**0.463**
Expanded comparison uncertainty (*k* =2)/ °C	**0.50**	**0.54**	**0.58**	**0.68**	**0.80**	**0.87**	**0.93**

Table 110: uncertainty components for the METAS VTBB measurements with the LP5 thermometer (thermocouple sensors)

9.10 UNCERTAINTY BUDGETS FOR THE INRIM FIXED POINT MEASUREMENTS

Uncertainty component	**Fixed-Points**				
	In	**Sn**	**Zn**	**Al**	**Ag**
	Standard uncertainty (u_i) (mK)				
Impurities	3	3	5	5	5
Emissivity	2	3	5	6	7
Temperature drop	1	2	3	4	5
Plateau identification	4	1	1	2	2
Size of source effect	5	5	5	5	5
Repeatability	3	1	1	3	7
Total INRIM uncertainty u_{FP} (k = 1)	**8**	**7**	**9**	**11**	**13**
Total INRIM expanded uncertainty U_{FP} (k=2)	**16**	**14**	**18**	**22**	**26**
Gain ratio	0	0	0	0	0
Thermometer drift	13	19	35	64	111
Total INRIM comparison uncertainty u	**15**	**20**	**36**	**65**	**112**
Expanded INRIM comparison uncertainty U (k =2)	**31**	**40**	**72**	**129**	**224**

Table 111: uncertainty components for the INRiM FP measurements for the INRiM thermometer

Uncertainty component	**Fixed-Points**			
	Sn	**Zn**	**Al**	**Ag**
	Standard uncertainty (u_i) (mK)			
Impurities	3	5	5	5
Emissivity	3	5	6	7
Temperature drop	2	3	4	5
Plateau identification	250	5	2	3
Size of source effect	5	5	5	5
Repeatability	64	2	2	8
Total INRIM uncertainty u_{FP} (k = 1)	**258**	**11**	**10**	**14**
Total INRIM expanded uncertainty U_{FP} (k = 2)	**516**	**22**	**20**	**28**
Range ratio	0	0	0	0
Thermometer drift	32	60	109	191
Total INRIM comparison uncertainty u	**260**	**61**	**110**	**192**
Expanded INRIM comparison uncertainty U (k = 2)	**520**	**122**	**219**	**383**

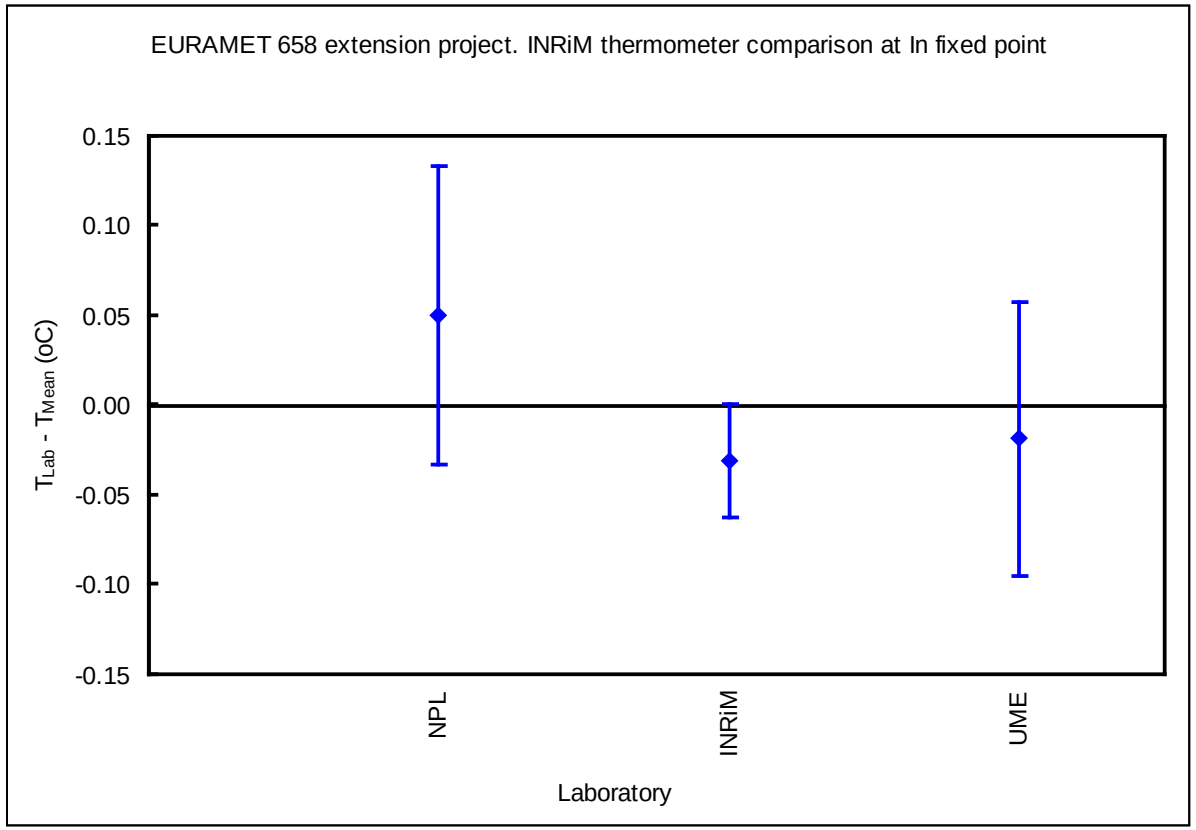
Table 112: uncertainty components for the INRiM FP measurements for the LP5 thermometer

10 THE DOE AND QDE_{95} VALUES FOR THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY COMPARISON FOR THE INRIM THERMOMETER. UNCERTAINTIES INCLUDE THE LABORATORY, THERMOMETER DRIFT AND GAIN RATIO COMPONENTS ONLY

10.1 THE RESULTS OF THE MEASUREMENTS USING THE FIXED-POINTS

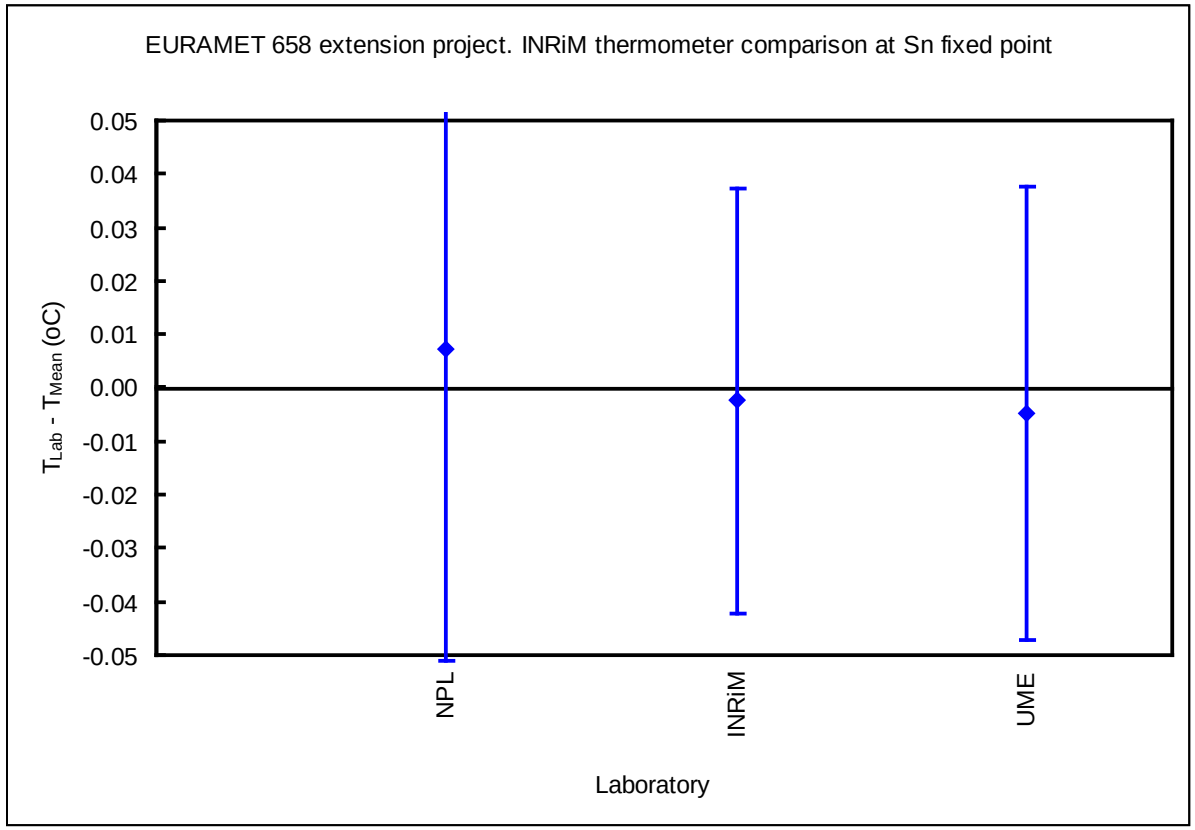
	NPL	INRiM	UME
NPL	-	0.08 ± 0.09	0.07 ± 0.11
INRiM	*0.15*	-	-0.01 ± 0.08
UME	*0.16*	*0.08*	-

Table 113 – direct comparison of the results for the calibration of the INRiM thermometer at the In point



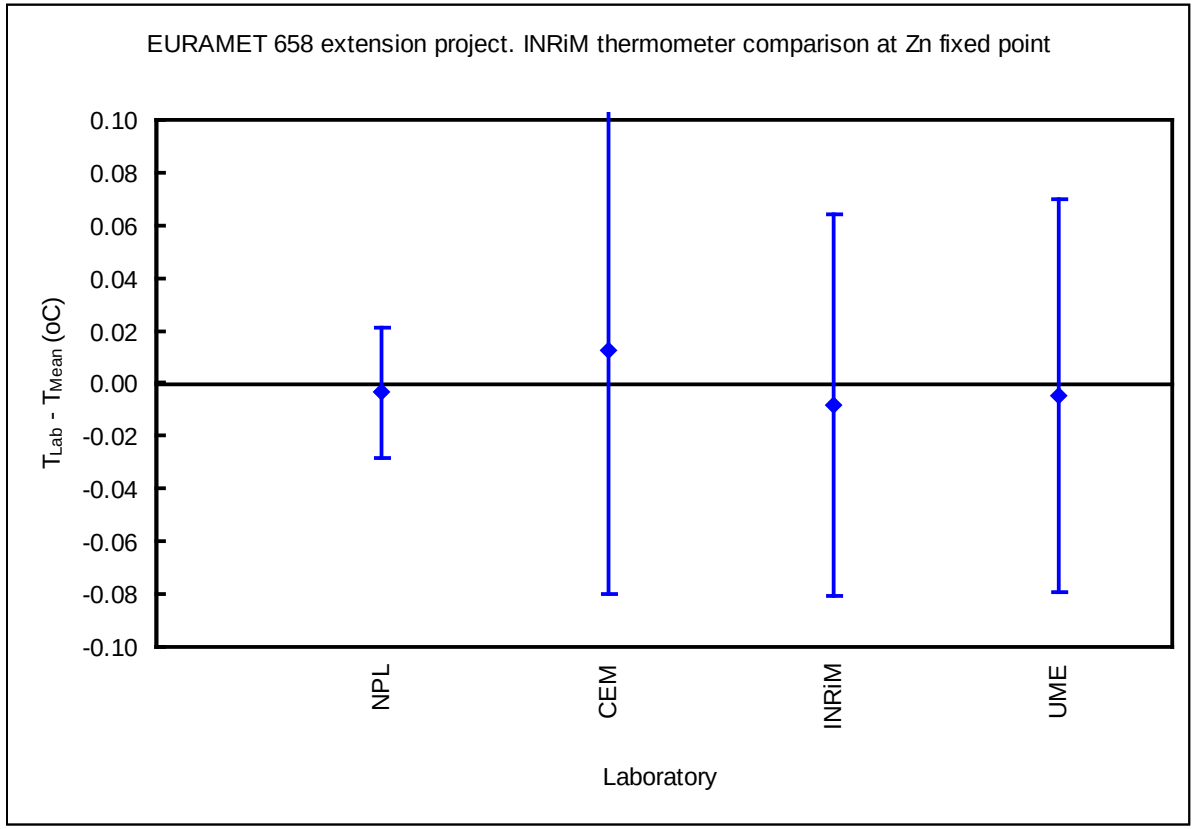
	NPL	INRiM	UME
NPL	-	0.01 ± 0.07	0.01 ± 0.07
INRiM	*0.07*	-	0.00 ± 0.06
UME	*0.07*	*0.06*	-

Table 114 – direct comparison of the results for the calibration of the INRiM thermometer at the Sn point



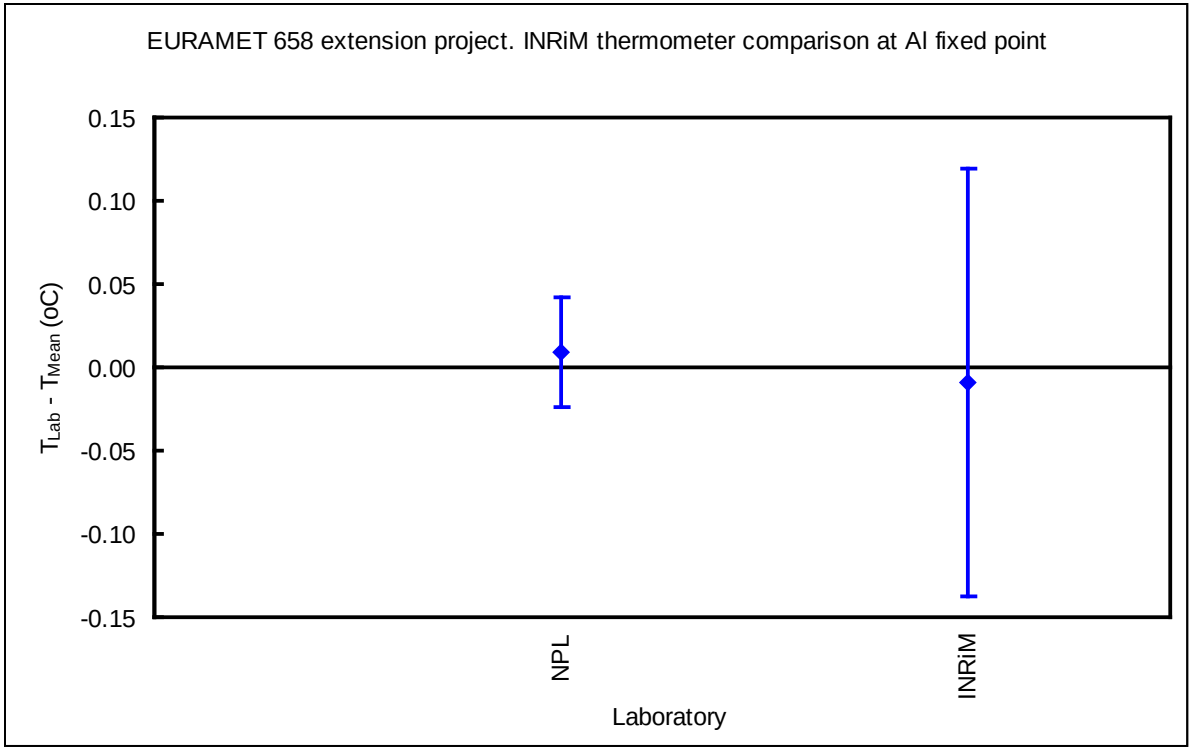
	NPL	CEM	INRiM	UME
NPL	-	-0.02 ± 0.10	0.00 ± 0.08	0.00 ± 0.08
CEM	*0.10*	-	0.02 ± 0.12	0.02 ± 0.12
INRiM	*0.08*	*0.12*	-	0.00 ± 0.10
UME	*0.08*	*0.12*	*0.10*	-

Table 115 – direct comparison of the results for the calibration of the INRiM thermometer at the Zn point



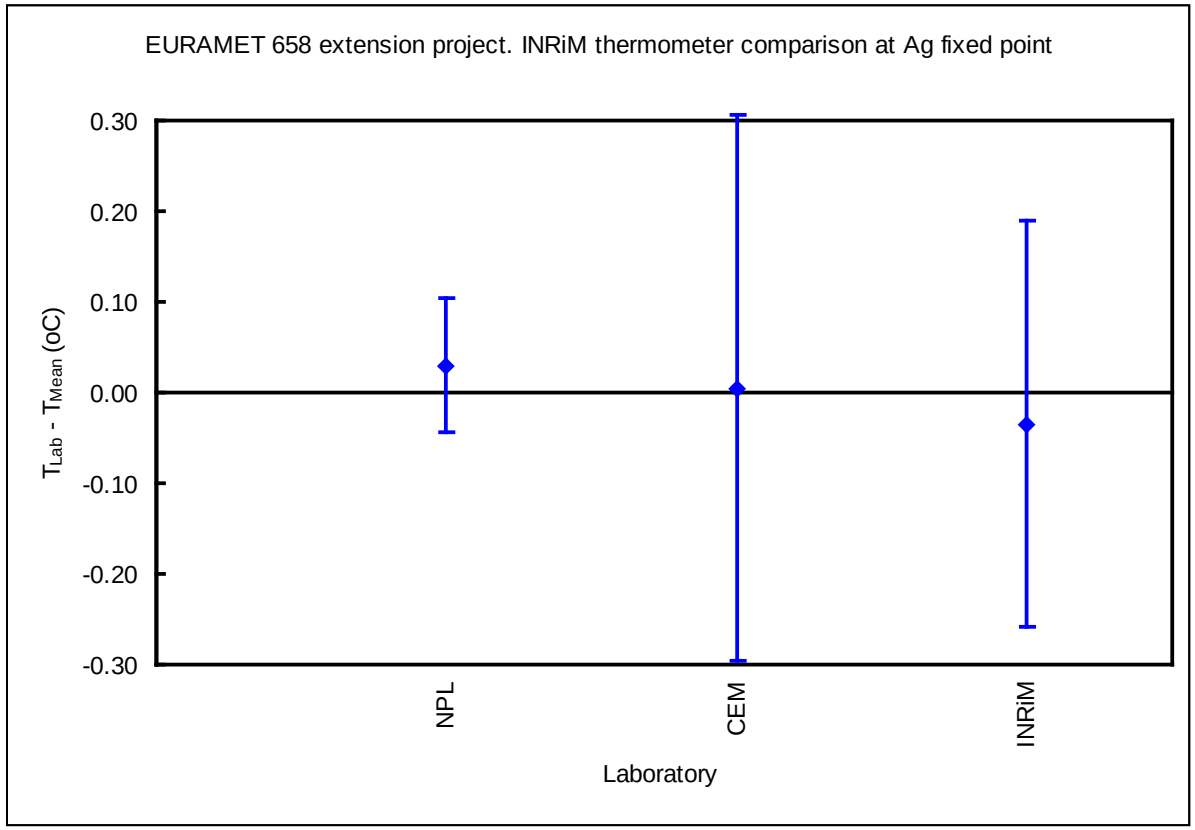
	NPL	INRiM
NPL	-	0.02 ± 0.13
INRiM	*0.13*	-

Table 116 – direct comparison of the results for the calibration of the INRiM thermometer at the Al point



	NPL	CEM	INRiM
NPL	-	0.03 ± 0.31	0.06 ± 0.24
CEM	*0.31*	-	0.04 ± 0.38
INRiM	*0.26*	*0.37*	-

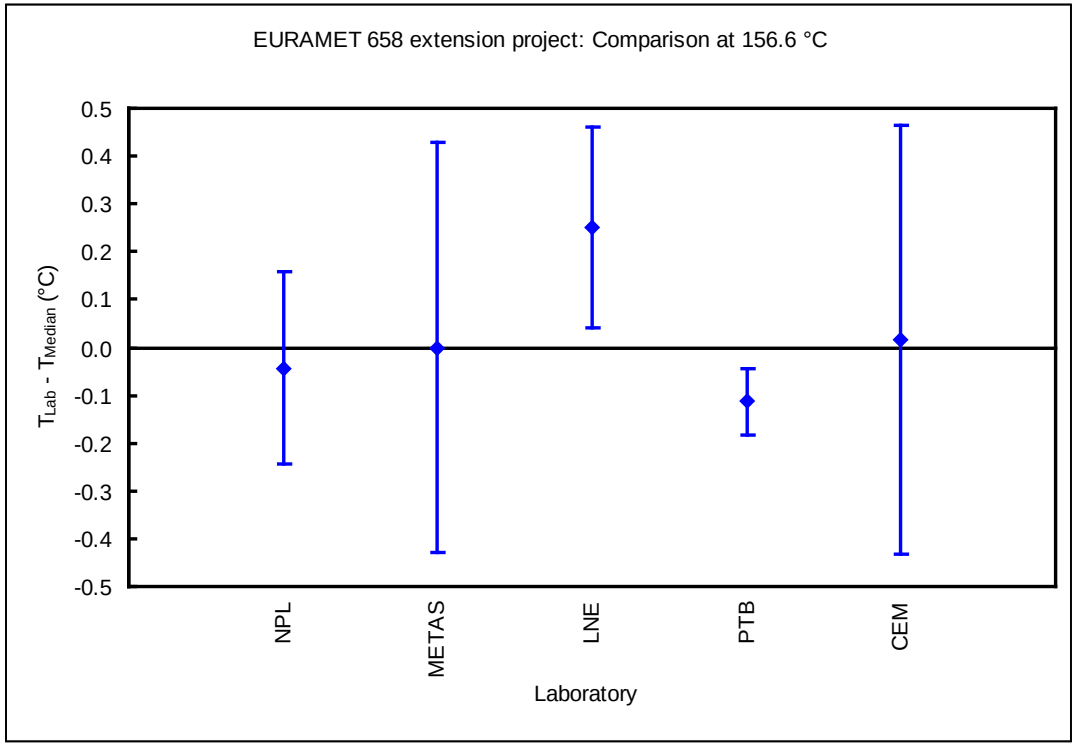
Table 117 – direct comparison of the results for the calibration of the INRiM thermometer at the Ag point



10.2 THE RESULTS OF THE MEASUREMENTS USING THE VARIABLE TEMPERATURE BLACKBODY SOURCES

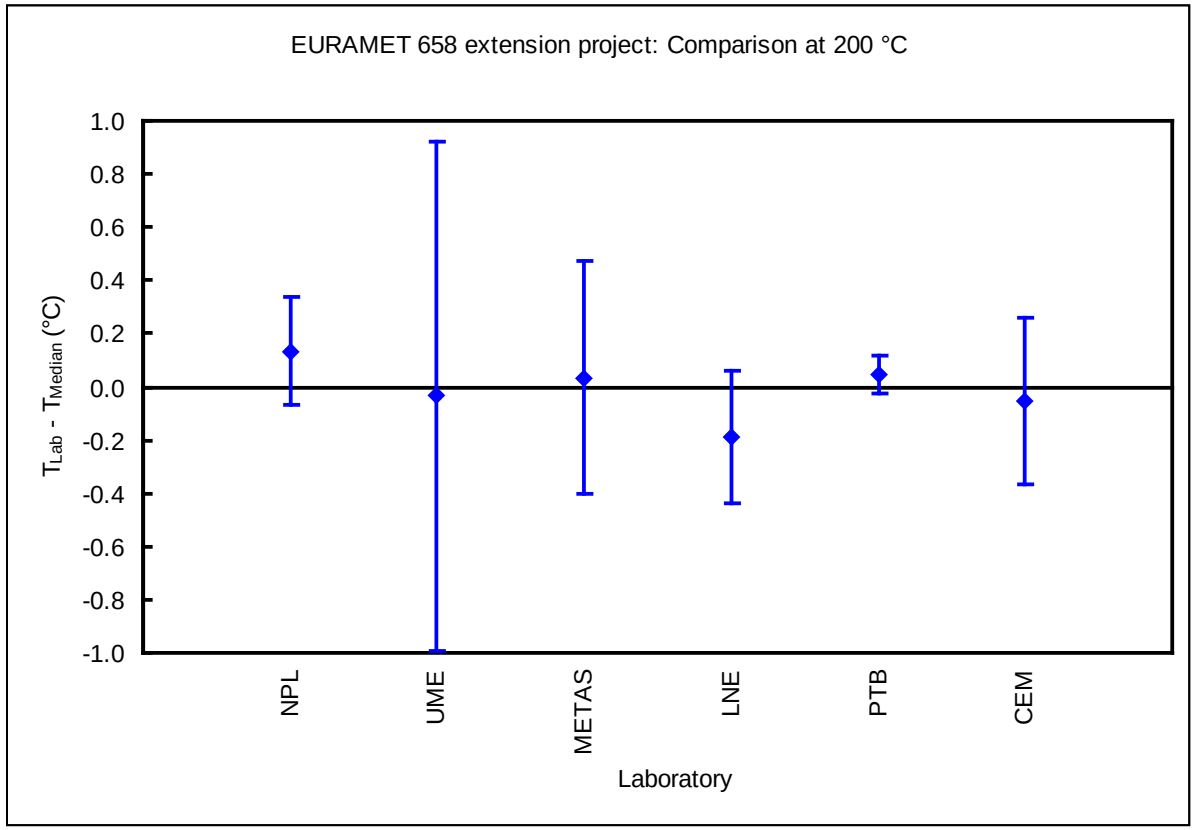
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.04 ± 0.48	-0.29 ± 0.29	0.07 ± 0.21	-0.06 ± 0.49
METAS	*0.47*	-	-0.25 ± 0.48	0.11 ± 0.44	-0.02 ± 0.62
LNE	*0.53*	*0.65*	-	0.36 ± 0.22	0.23 ± 0.50
PTB	*0.25*	*0.48*	*0.55*	-	-0.13 ± 0.46
CEM	*0.50*	*0.61*	*0.65*	*0.51*	-

Table 118 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 157 °C



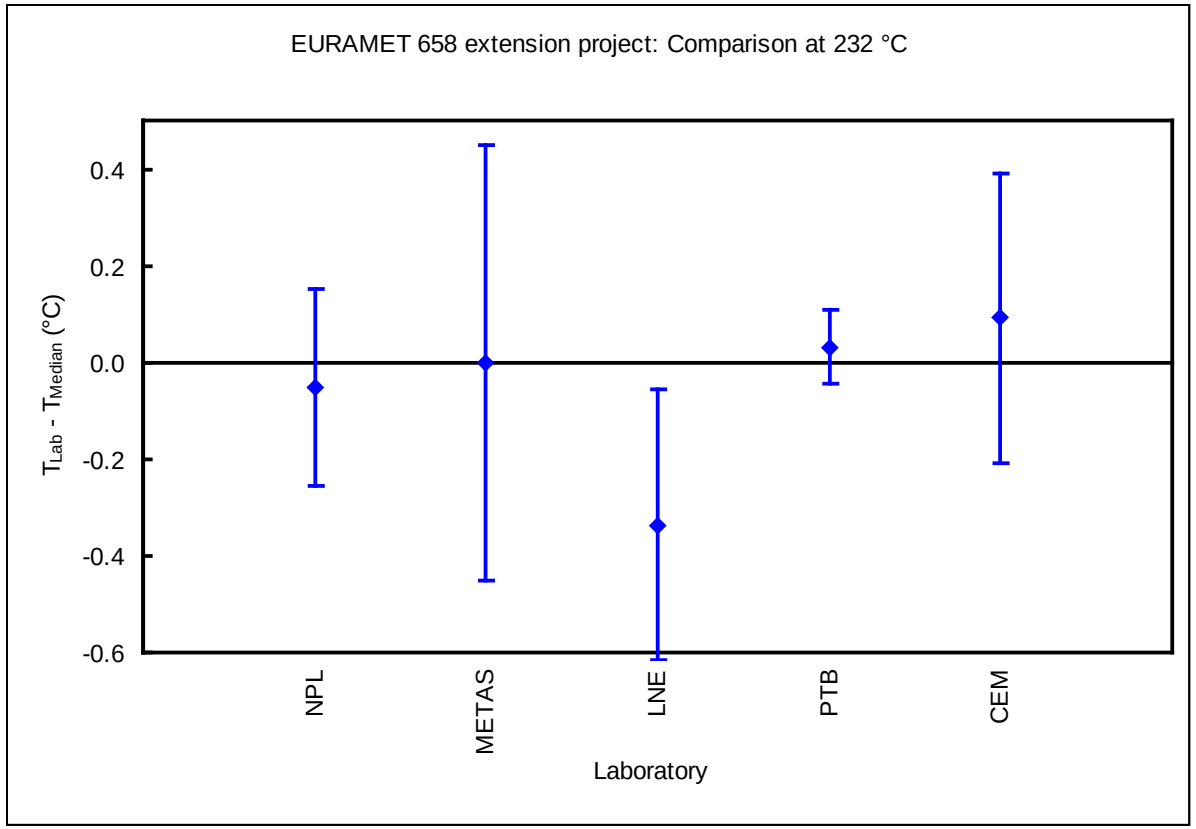
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	0.17 ± 0.98	0.10 ± 0.48	0.32 ± 0.32	0.09 ± 0.22	0.19 ± 0.37
UME	*1.01*	-	-0.07 ± 1.06	0.15 ± 0.99	-0.08 ± 0.96	0.02 ± 1.01
METAS	*0.51*	*1.04*	-	0.22 ± 0.51	-0.01 ± 0.45	0.09 ± 0.54
LNE	*0.58*	*1.01*	*0.64*	-	-0.23 ± 0.26	-0.13 ± 0.40
PTB	*0.27*	*0.95*	*0.44*	*0.45*	-	0.10 ± 0.32
CEM	*0.49*	*0.99*	*0.55*	*0.47*	*0.36*	-

Table 119 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 200 °C



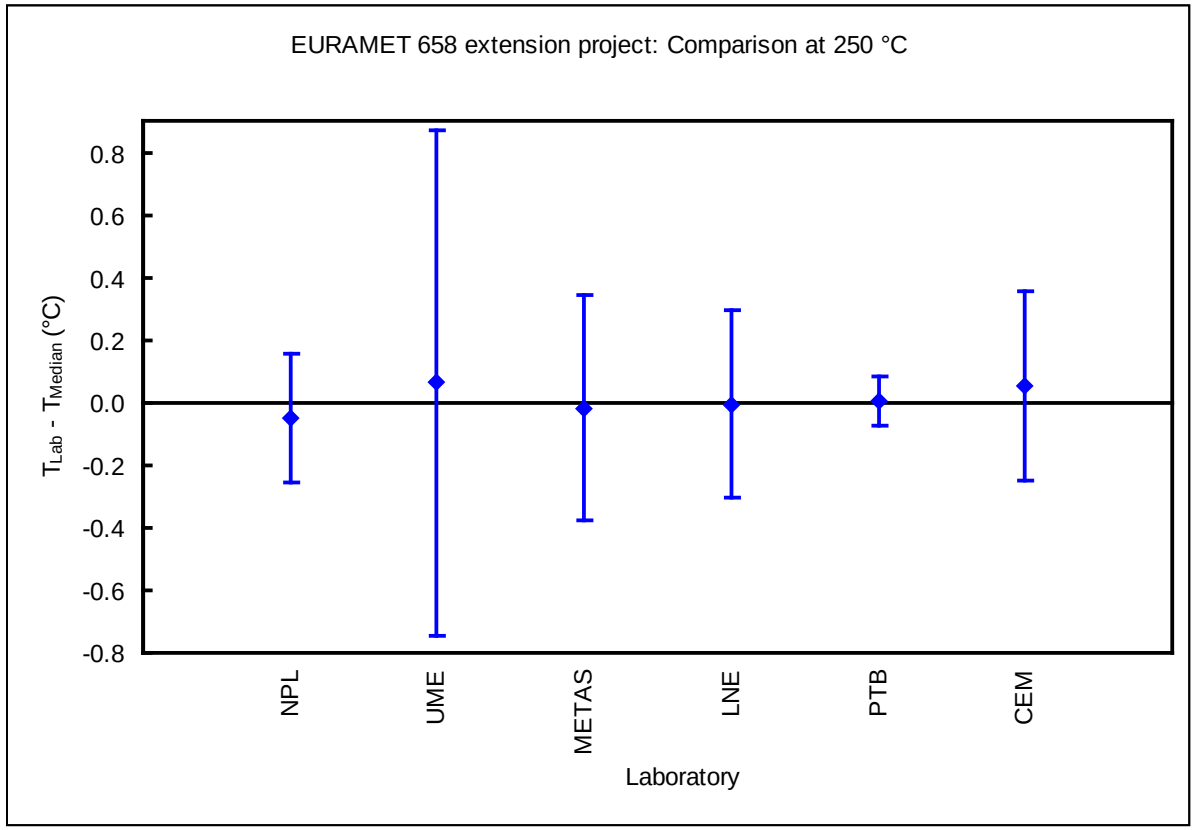
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.05 ± 0.49	0.29 ± 0.35	-0.08 ± 0.22	-0.14 ± 0.36
METAS	*0.49*	-	0.34 ± 0.53	-0.03 ± 0.46	-0.09 ± 0.54
LNE	*0.57*	*0.77*	-	-0.37 ± 0.29	-0.43 ± 0.41
PTB	*0.26*	*0.45*	*0.61*	-	-0.06 ± 0.31
CEM	*0.44*	*0.56*	*0.77*	*0.33*	-

Table 120 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 232 °C



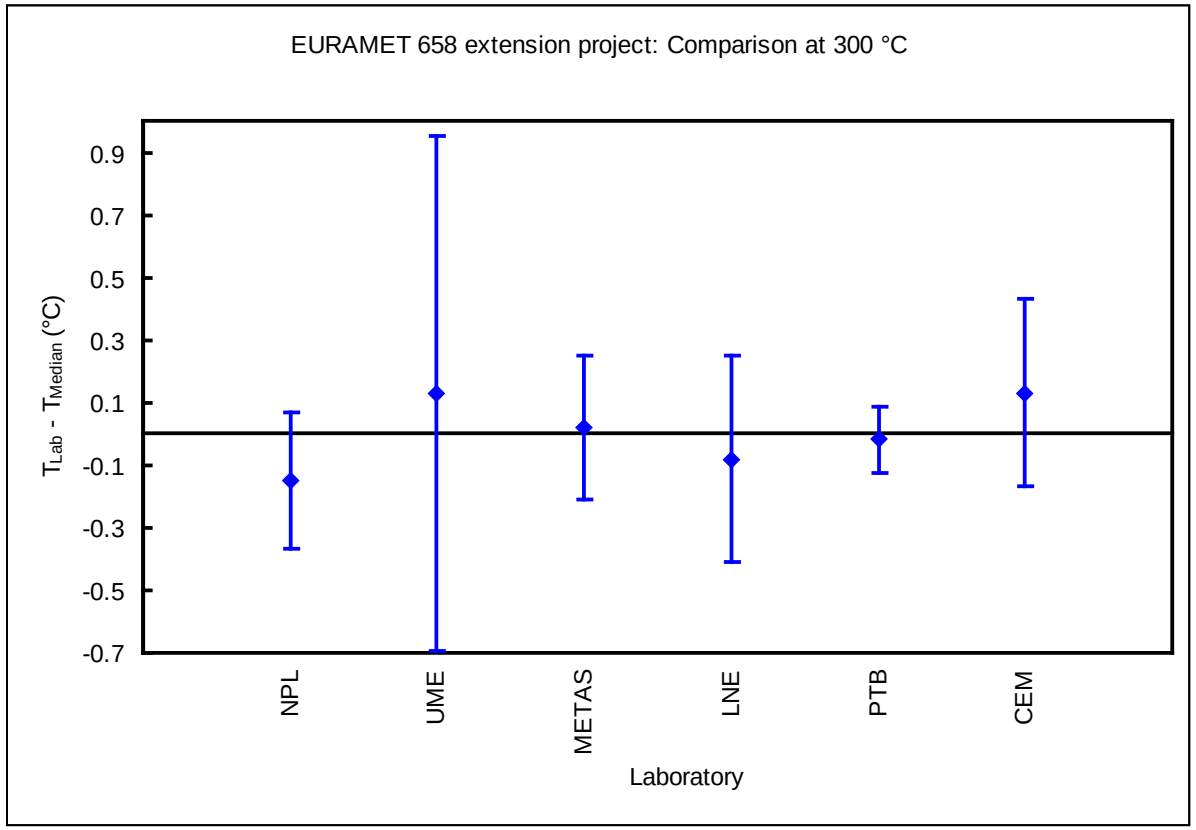
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.11 ± 0.84	-0.03 ± 0.41	-0.05 ± 0.36	-0.06 ± 0.22	-0.10 ± 0.36
UME	*0.85*	-	0.08 ± 0.89	0.07 ± 0.86	0.06 ± 0.81	0.01 ± 0.86
METAS	*0.41*	*0.88*	-	-0.01 ± 0.47	-0.02 ± 0.37	-0.07 ± 0.47
LNE	*0.37*	*0.85*	*0.46*	-	-0.01 ± 0.31	-0.06 ± 0.42
PTB	*0.24*	*0.80*	*0.36*	*0.30*	-	-0.05 ± 0.31
CEM	*0.41*	*0.85*	*0.48*	*0.43*	*0.32*	-

Table 121 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 250 °C



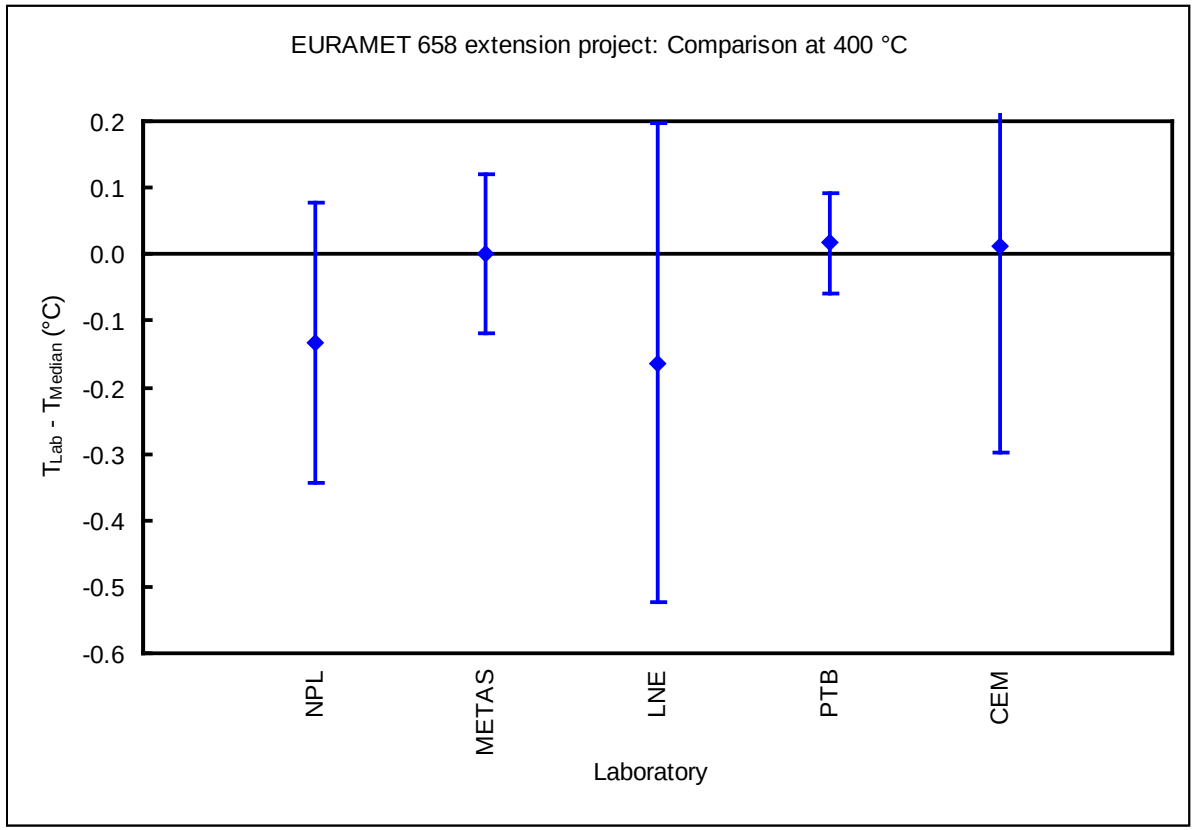
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.28 ± 0.85	-0.17 ± 0.32	-0.07 ± 0.39	-0.13 ± 0.24	-0.28 ± 0.37
UME	*0.99*	-	0.11 ± 0.86	0.21 ± 0.89	0.15 ± 0.83	0.00 ± 0.88
METAS	*0.43*	*0.86*	-	0.10 ± 0.40	0.04 ± 0.25	-0.11 ± 0.38
LNE	*0.41*	*0.96*	*0.44*	-	-0.06 ± 0.35	-0.21 ± 0.45
PTB	*0.33*	*0.86*	*0.26*	*0.36*	-	-0.15 ± 0.32
CEM	*0.58*	*0.87*	*0.43*	*0.58*	*0.41*	-

Table 122 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 300 °C



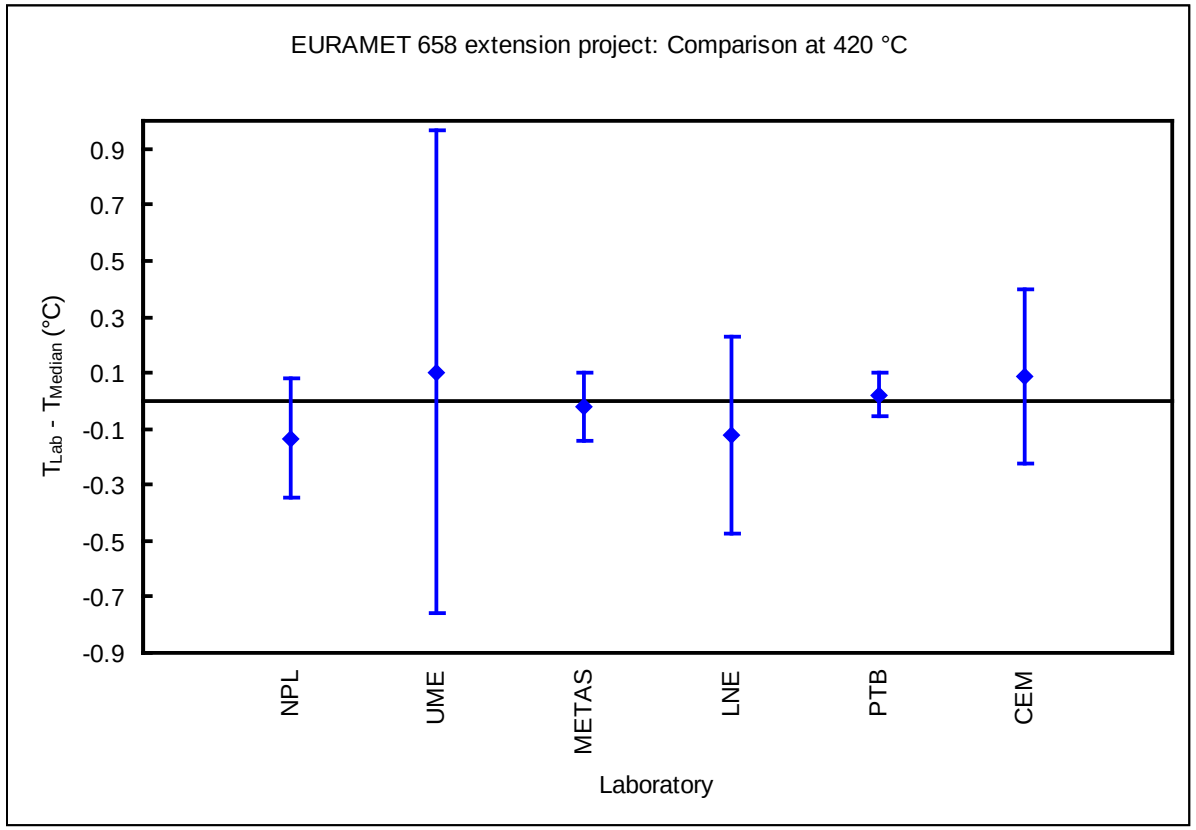
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.13 ± 0.24	0.03 ± 0.42	-0.15 ± 0.22	-0.15 ± 0.38
METAS	*0.33*	-	0.16 ± 0.38	-0.02 ± 0.14	-0.01 ± 0.33
LNE	*0.41*	*0.48*	-	-0.18 ± 0.37	-0.18 ± 0.48
PTB	*0.33*	*0.14*	*0.48*	-	0.00 ± 0.32
CEM	*0.46*	*0.33*	*0.57*	*0.31*	-

Table 123 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 400 °C



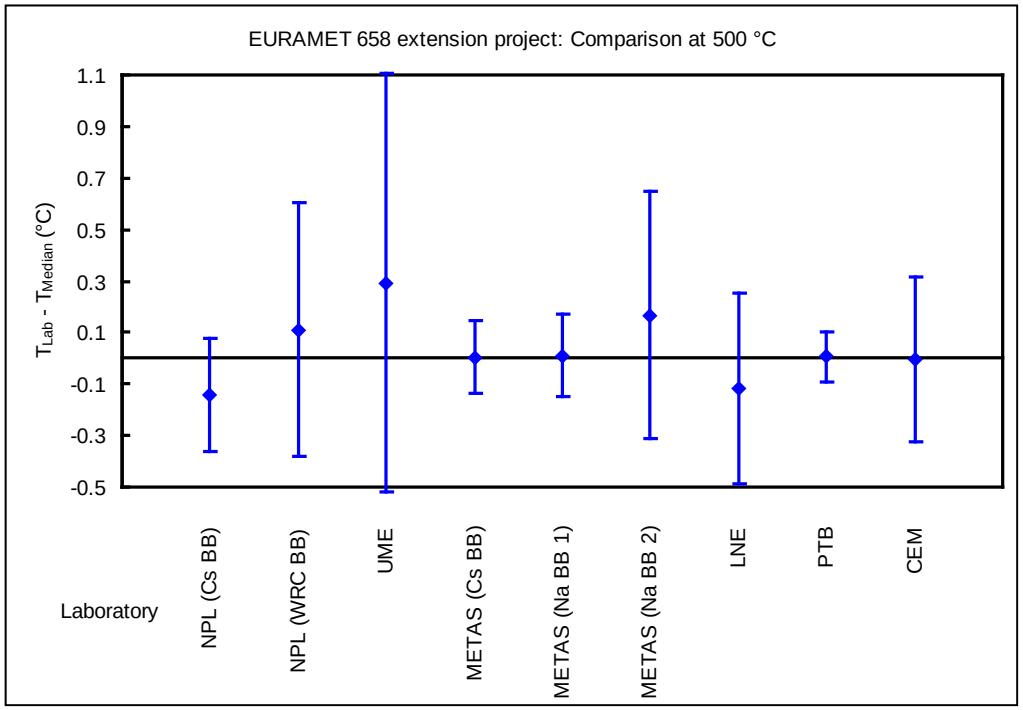
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.23 ± 0.89	-0.11 ± 0.24	-0.01 ± 0.41	-0.15 ± 0.23	-0.22 ± 0.38
UME	*0.98*	-	0.12 ± 0.87	0.23 ± 0.93	0.08 ± 0.87	0.02 ± 0.92
METAS	*0.31*	*0.89*	-	0.10 ± 0.37	-0.04 ± 0.14	-0.11 ± 0.33
LNE	*0.40*	*1.01*	*0.41*	-	-0.15 ± 0.36	-0.21 ± 0.47
PTB	*0.34*	*0.86*	*0.16*	*0.44*	-	-0.06 ± 0.32
CEM	*0.53*	*0.90*	*0.39*	*0.60*	*0.34*	-

Table 124 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 420 °C



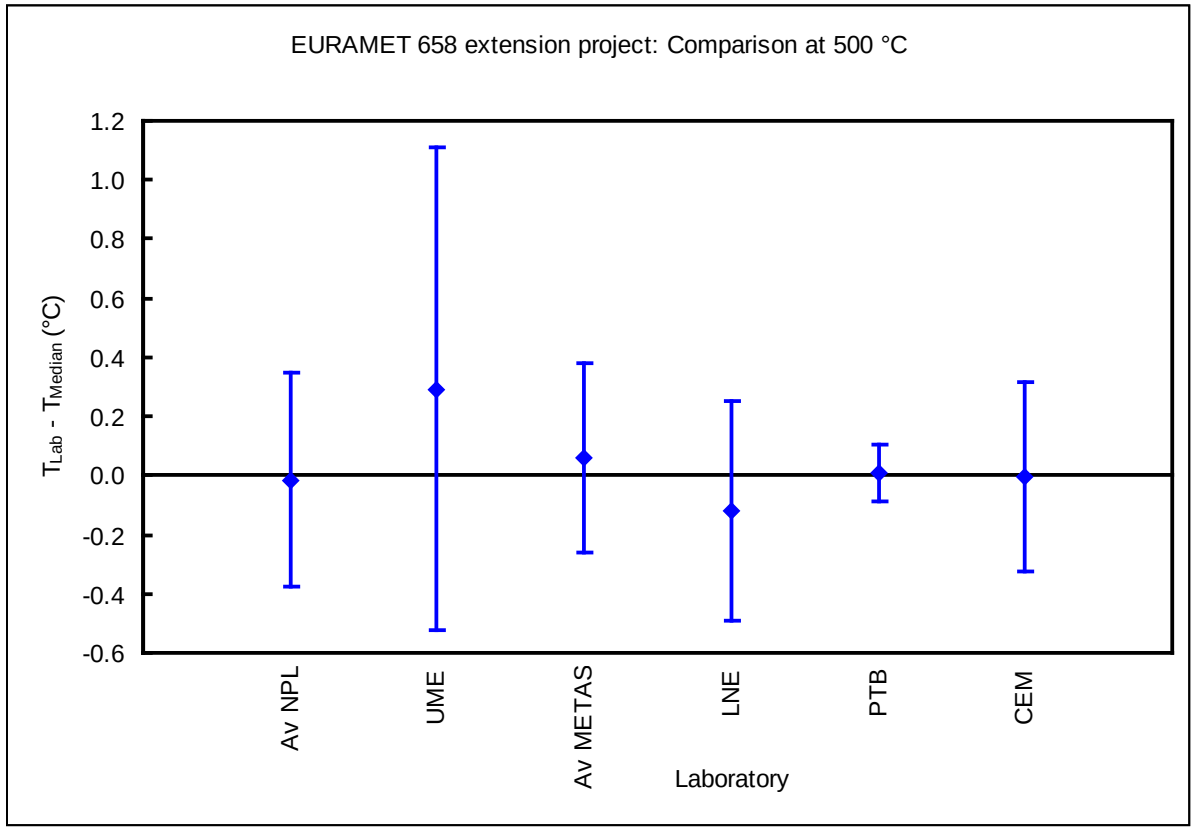
	NPL (Cs BB)	NPL (WRC BB)	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE	PTB	CEM
NPL (Cs BB)	-	-0.25 ± 0.54	-0.43 ± 0.84	-0.15 ± 0.26	-0.15 ± 0.27	-0.31 ± 0.53	-0.02 ± 0.43	-0.15 ± 0.24	-0.14 ± 0.39
NPL (WRC BB)	*0.70*	-	-0.18 ± 0.95	0.11 ± 0.51	0.10 ± 0.52	-0.05 ± 0.69	0.23 ± 0.61	0.11 ± 0.50	0.12 ± 0.59
UME	*1.13*	*1.00*	-	0.29 ± 0.83	0.28 ± 0.83	0.13 ± 0.95	0.41 ± 0.90	0.29 ± 0.82	0.30 ± 0.88
METAS (Cs BB)	*0.36*	*0.54*	*0.98*	-	-0.01 ± 0.21	-0.16 ± 0.50	0.12 ± 0.40	0.00 ± 0.17	0.01 ± 0.35
METAS (Na BB 1)	*0.38*	*0.54*	*0.97*	*0.21*	-	-0.16 ± 0.51	0.13 ± 0.40	0.00 ± 0.19	0.02 ± 0.36
METAS (Na BB 2)	*0.74*	*0.68*	*0.96*	*0.58*	*0.58*	-	0.28 ± 0.61	0.16 ± 0.49	0.17 ± 0.58
LNE	*0.42*	*0.74*	*1.15*	*0.45*	*0.47*	*0.79*	-	-0.12 ± 0.38	-0.11 ± 0.49
PTB	*0.35*	*0.53*	*0.97*	*0.17*	*0.18*	*0.57*	*0.44*	-	0.01 ± 0.33
CEM	*0.46*	*0.62*	*1.03*	*0.34*	*0.35*	*0.65*	*0.53*	*0.33*	-

Table 125 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 500 °C, with data from different sources



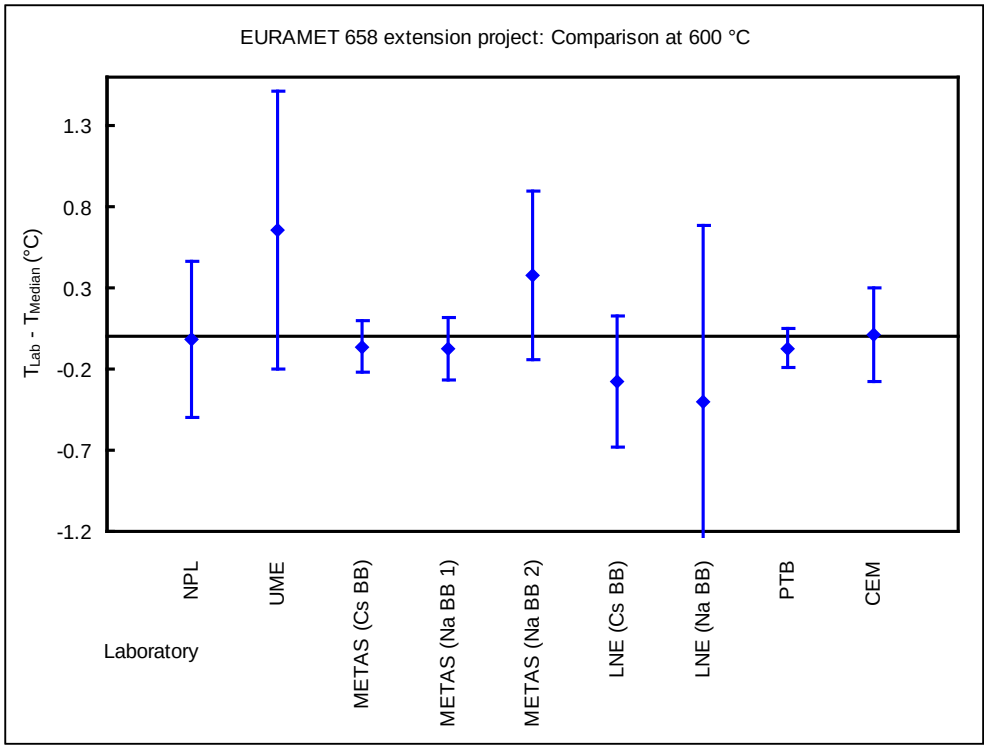
	Average NPL	UME	Average METAS	LNE	PTB	CEM
Av NPL	-	-0.31 ± 0.89	-0.07 ± 0.48	0.10 ± 0.52	-0.02 ± 0.37	-0.01 ± 0.48
UME	*1.05*	-	0.23 ± 0.88	0.41 ± 0.90	0.29 ± 0.82	0.30 ± 0.88
Av METAS	*0.49*	*0.97*	-	0.18 ± 0.49	0.05 ± 0.33	0.07 ± 0.45
LNE	*0.55*	*1.15*	*0.59*	-	-0.12 ± 0.38	-0.11 ± 0.49
PTB	*0.37*	*0.97*	*0.34*	*0.44*	-	0.01 ± 0.33
CEM	*0.47*	*1.03*	*0.46*	*0.53*	*0.33*	-

Table 126 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 500 °C – average data



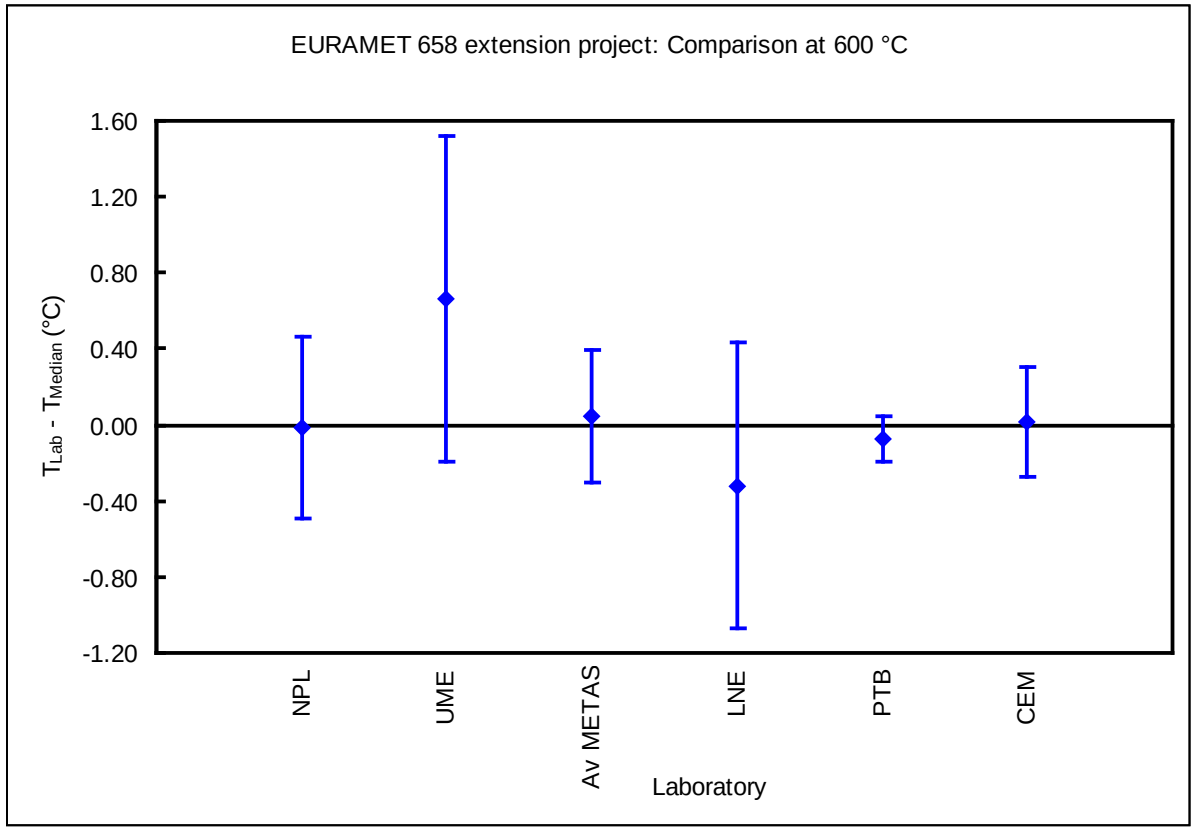
	NPL	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE (Cs BB)	LNE (Na BB)	PTB	CEM
NPL	-	-0.68 ± 0.98	0.05 ± 0.51	0.06 ± 0.52	-0.39 ± 0.71	0.26 ± 0.63	0.39 ± 1.19	0.06 ± 0.50	-0.03 ± 0.56
UME	*1.48*	-	0.72 ± 0.87	0.73 ± 0.88	0.29 ± 1.00	0.94 ± 0.95	1.07 ± 1.39	0.73 ± 0.87	0.65 ± 0.91
METAS (Cs BB)	*0.51*	*1.44*	-	0.01 ± 0.25	-0.44 ± 0.54	0.21 ± 0.43	0.34 ± 1.10	0.01 ± 0.20	-0.08 ± 0.33
METAS (Na BB 1)	*0.52*	*1.46*	*0.24*	-	-0.45 ± 0.55	0.20 ± 0.44	0.33 ± 1.11	0.00 ± 0.23	-0.09 ± 0.35
METAS (Na BB 2)	*0.97*	*1.13*	*0.88*	*0.90*	-	0.65 ± 0.66	0.78 ± 1.21	0.45 ± 0.53	0.36 ± 0.60
LNE (Cs BB)	*0.78*	*1.71*	*0.57*	*0.57*	*1.19*	-	0.13 ± 1.16	-0.20 ± 0.42	-0.29 ± 0.49
LNE (Na BB)	*1.39*	*2.21*	*1.26*	*1.26*	*1.78*	*1.16*	-	-0.33 ± 1.10	-0.42 ± 1.13
PTB	*0.50*	*1.45*	*0.20*	*0.22*	*0.89*	*0.55*	*1.25*	-	-0.09 ± 0.31
CEM	*0.55*	*1.39*	*0.36*	*0.38*	*0.85*	*0.70*	*1.36*	*0.35*	-

Table 127 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 600 °C, with data from different sources



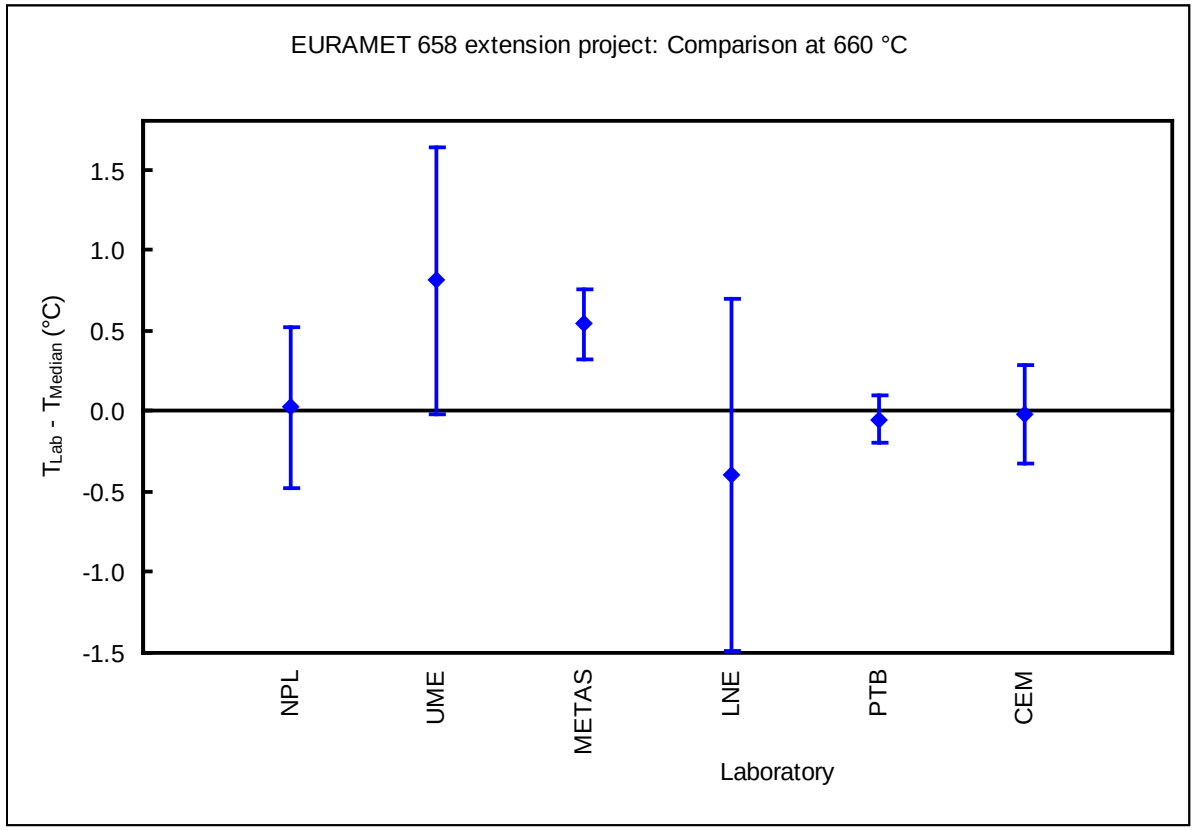
	NPL	UME	Av METAS	LNE	PTB	CEM
NPL	-	-0.68 ± 0.98	-0.06 ± 0.60	0.30 ± 0.89	0.06 ± 0.50	-0.03 ± 0.56
UME	*1.48*	-	0.62 ± 0.93	0.98 ± 1.14	0.73 ± 0.87	0.65 ± 0.91
Av METAS	*0.59*	*1.38*	-	0.36 ± 0.83	0.12 ± 0.37	0.03 ± 0.46
LNE	*1.05*	*1.92*	*1.05*	-	-0.25 ± 0.76	-0.33 ± 0.80
PTB	*0.50*	*1.45*	*0.43*	*0.88*	-	-0.09 ± 0.31
CEM	*0.55*	*1.39*	*0.45*	*1.00*	*0.35*	-

Table 128 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 600 °C – average data



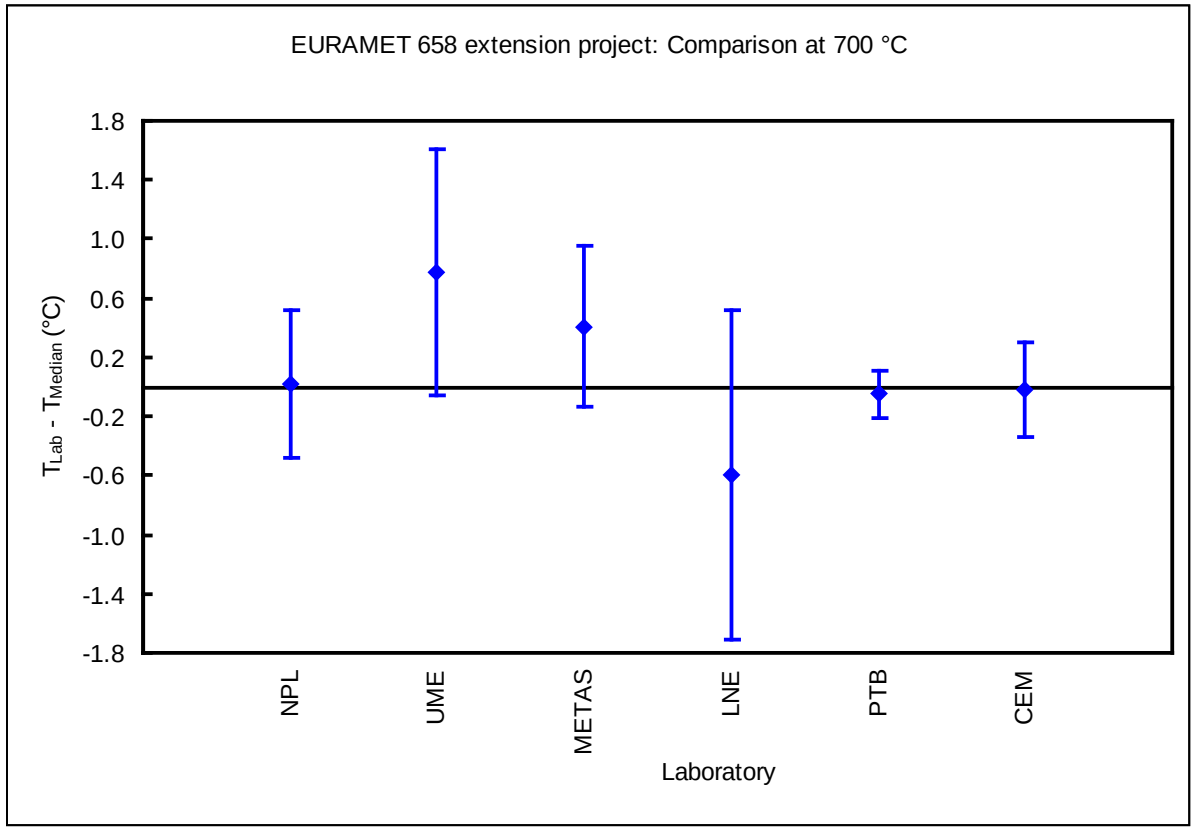
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.79 ± 0.97	-0.52 ± 0.55	0.42 ± 1.20	0.08 ± 0.52	0.04 ± 0.59
UME	*1.58*	-	0.27 ± 0.86	1.20 ± 1.37	0.86 ± 0.85	0.83 ± 0.89
METAS	*0.97*	*0.99*	-	0.93 ± 1.11	0.59 ± 0.26	0.56 ± 0.38
LNE	*1.41*	*2.33*	*1.85*	-	-0.34 ± 1.10	-0.37 ± 1.13
PTB	*0.53*	*1.56*	*0.81*	*1.26*	-	-0.03 ± 0.34
CEM	*0.58*	*1.56*	*0.87*	*1.32*	*0.34*	-

Table 129 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 660 °C



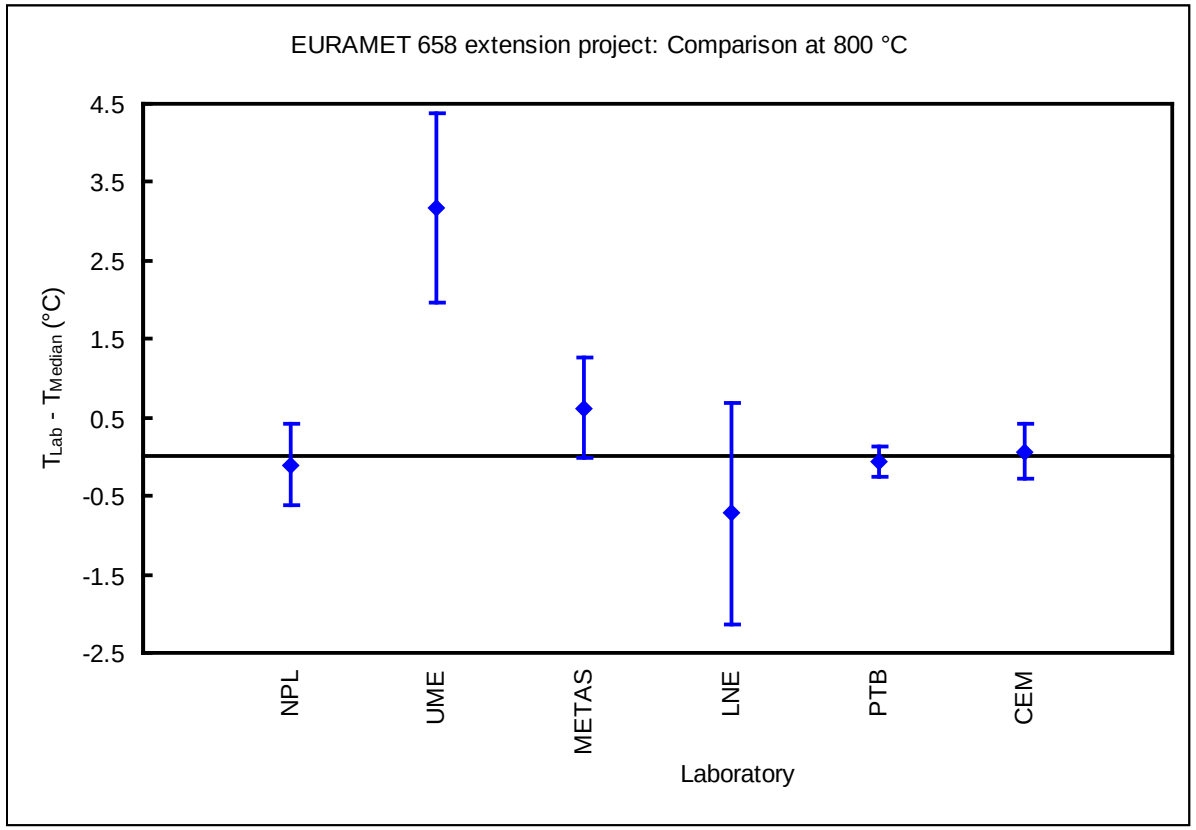
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.75 ± 0.97	-0.39 ± 0.74	0.62 ± 1.23	0.07 ± 0.52	0.05 ± 0.59
UME	*1.55*	-	0.37 ± 1.00	1.37 ± 1.40	0.83 ± 0.85	0.80 ± 0.89
METAS	*1.00*	*1.20*	-	1.00 ± 1.25	0.46 ± 0.57	0.43 ± 0.64
LNE	*1.63*	*2.52*	*2.03*	-	-0.55 ± 1.13	-0.57 ± 1.17
PTB	*0.53*	*1.52*	*0.93*	*1.48*	-	-0.03 ± 0.36
CEM	*0.59*	*1.53*	*0.96*	*1.53*	*0.35*	-

Table 130 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 700 °C



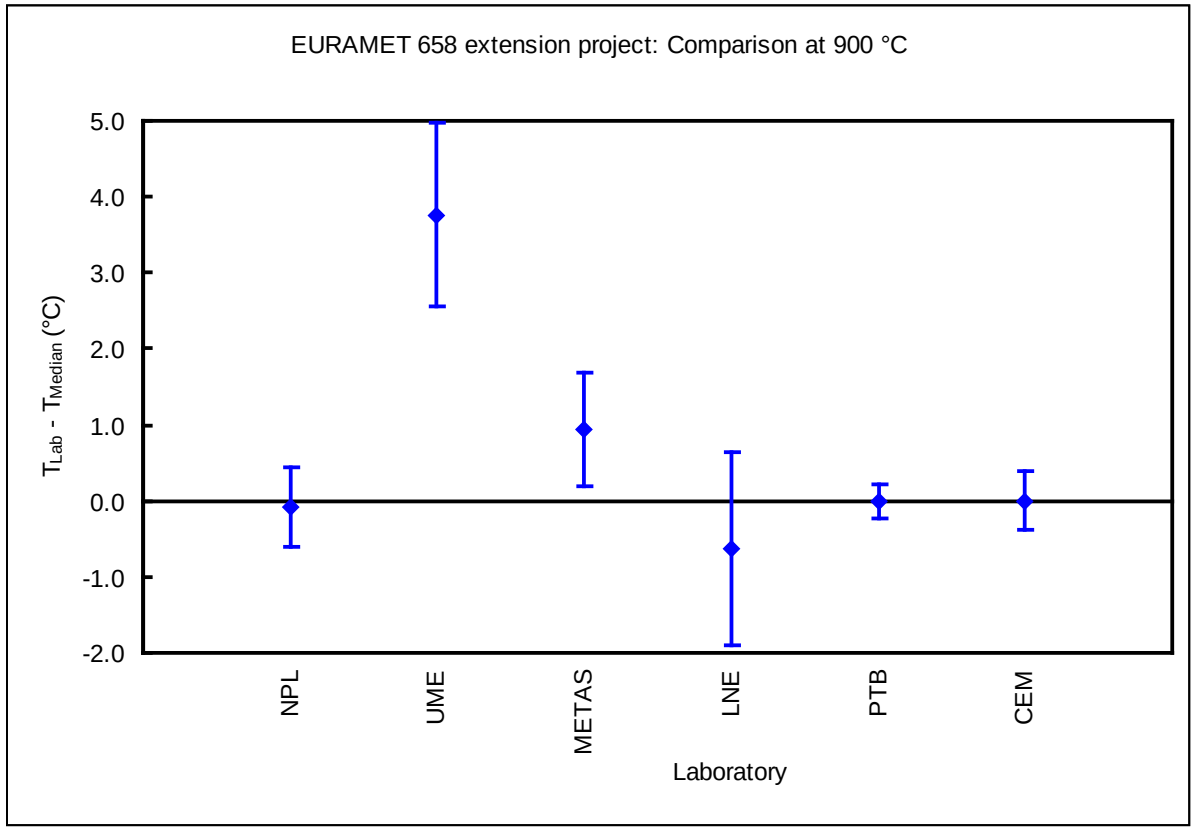
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-3.27 ± 1.31	-0.72 ± 0.82	0.62 ± 1.50	-0.04 ± 0.55	-0.16 ± 0.63
UME	*4.35*	-	2.56 ± 1.37	3.89 ± 1.86	3.23 ± 1.22	3.11 ± 1.26
METAS	*1.39*	*3.68*	-	1.33 ± 1.55	0.68 ± 0.67	0.55 ± 0.73
LNE	*1.86*	*5.42*	*2.61*	-	-0.66 ± 1.42	-0.78 ± 1.45
PTB	*0.54*	*4.24*	*1.23*	*1.83*	-	-0.12 ± 0.40
CEM	*0.69*	*4.14*	*1.15*	*1.98*	*0.45*	-

Table 131 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 800 °C



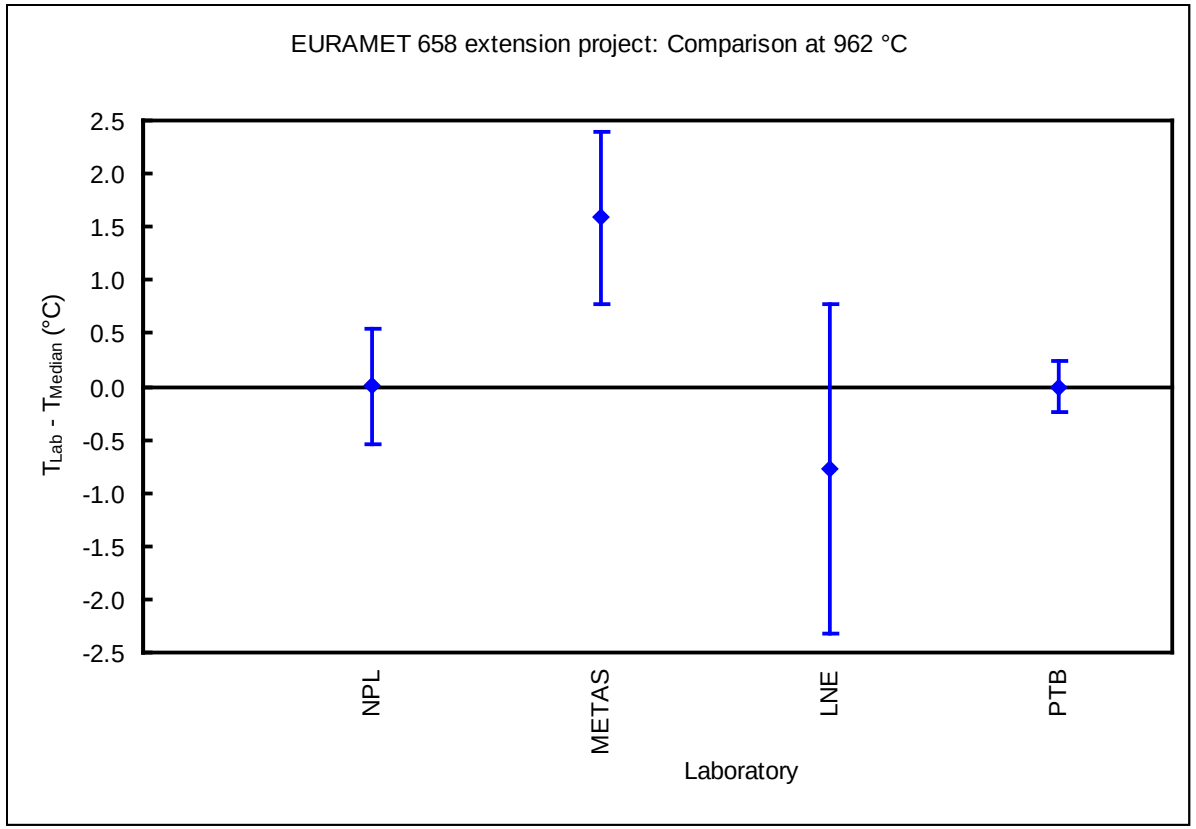
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-3.85 ± 1.32	-1.03 ± 0.92	0.54 ± 1.38	-0.08 ± 0.57	-0.09 ± 0.66
UME	*4.93*	-	2.82 ± 1.42	4.39 ± 1.75	3.76 ± 1.23	3.76 ± 1.27
METAS	*1.78*	*3.99*	-	1.57 ± 1.48	0.94 ± 0.78	0.94 ± 0.85
LNE	*1.68*	*5.83*	*2.78*	-	-0.62 ± 1.29	-0.63 ± 1.33
PTB	*0.58*	*4.77*	*1.59*	*1.69*	-	-0.01 ± 0.45
CEM	*0.67*	*4.80*	*1.63*	*1.73*	*0.44*	-

Table 132 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 900 °C



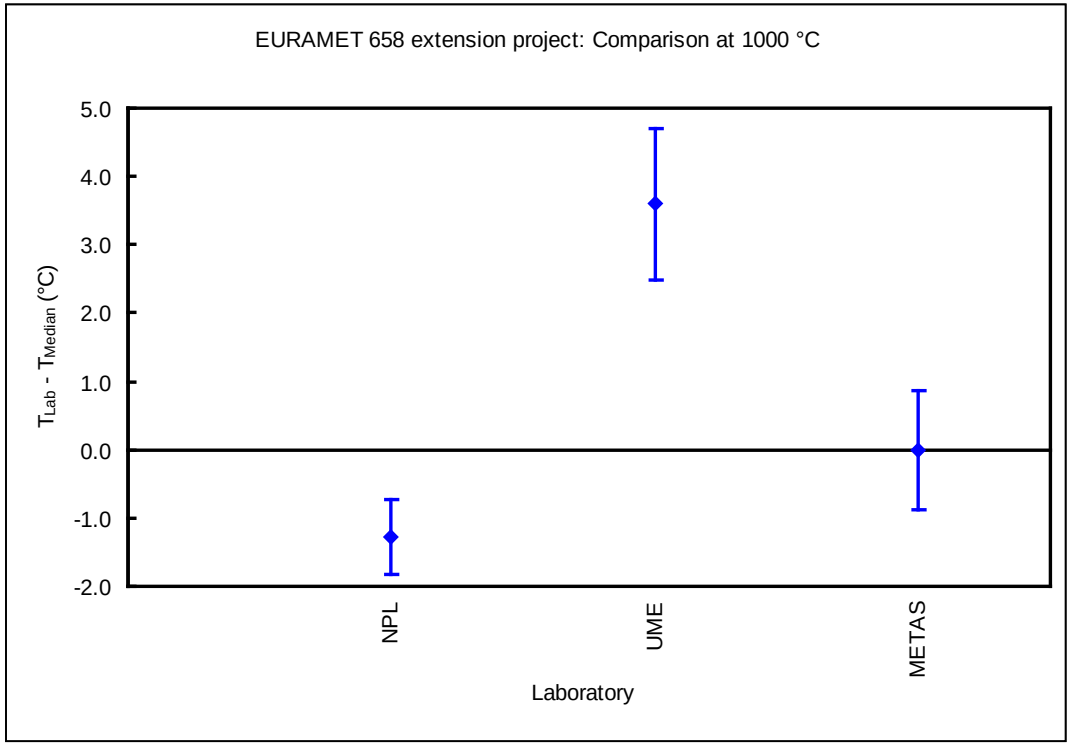
	NPL	METAS	LNE	PTB	CEM
NPL	-	-1.58 ± 0.97	0.78 ± 1.64	0.01 ± 0.59	-0.06 ± 0.48
METAS	*2.38*	-	2.37 ± 1.75	1.59 ± 0.85	-0.02 ± 0.62
LNE	*2.14*	*3.80*	-	-0.77 ± 1.57	0.23 ± 0.50
PTB	*0.58*	*2.29*	*2.07*	-	-0.13 ± 0.46
CEM	*0.48*	*0.61*	*0.65*	*0.51*	-

Table 133 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 962 °C



	NPL	UME	METAS
NPL	-	-4.88 ± 1.24	-1.28 ± 1.03
UME	*5.89*	-	3.60 ± 1.41
METAS	*2.12*	*4.76*	-

Table 134 – direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 1000 °C

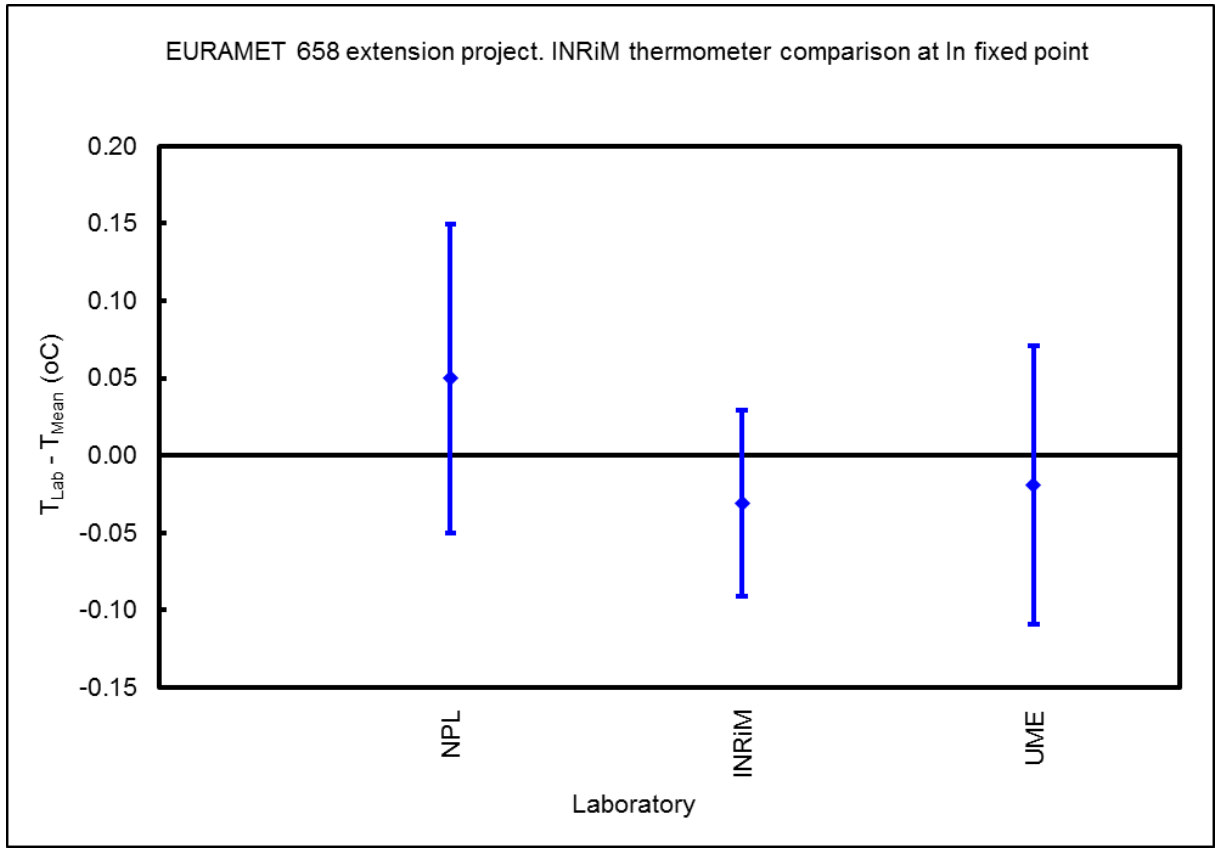


11 THE DOE AND QDE_{95} VALUES FOR THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY COMPARISON FOR THE INRIM THERMOMETER. UNCERTAINTIES ALSO INCLUDE THE REFERENCE VALUE UNCERTAINTY

11.1 THE RESULTS OF THE MEASUREMENTS USING THE FIXED-POINTS

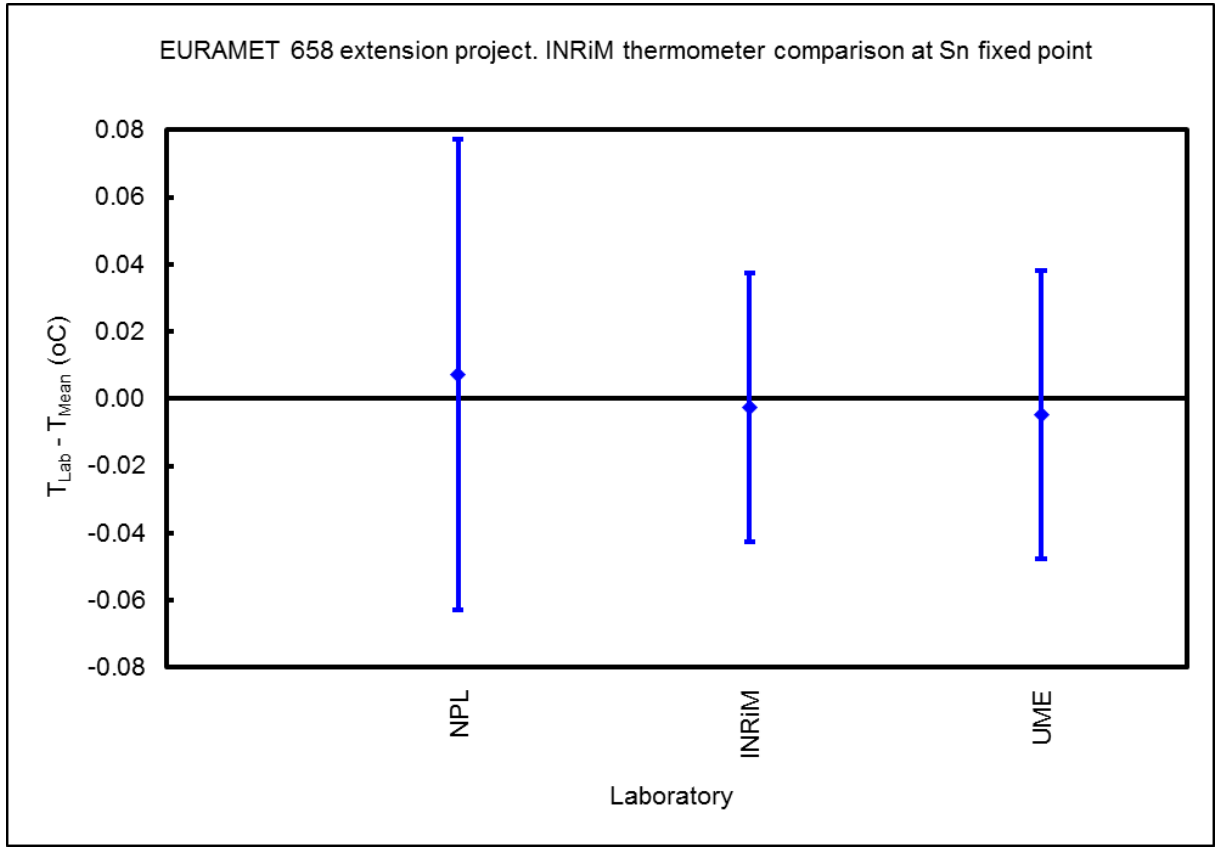
	NPL	INRiM	UME
NPL	-	0.081 ± 0.117	0.068 ± 0.135
INRiM	*0.177*	-	-0.012 ± 0.108
UME	*0.180*	*0.108*	-

Table 135 – direct comparison of the results of the In fixed point measurement with the INRiM thermometer



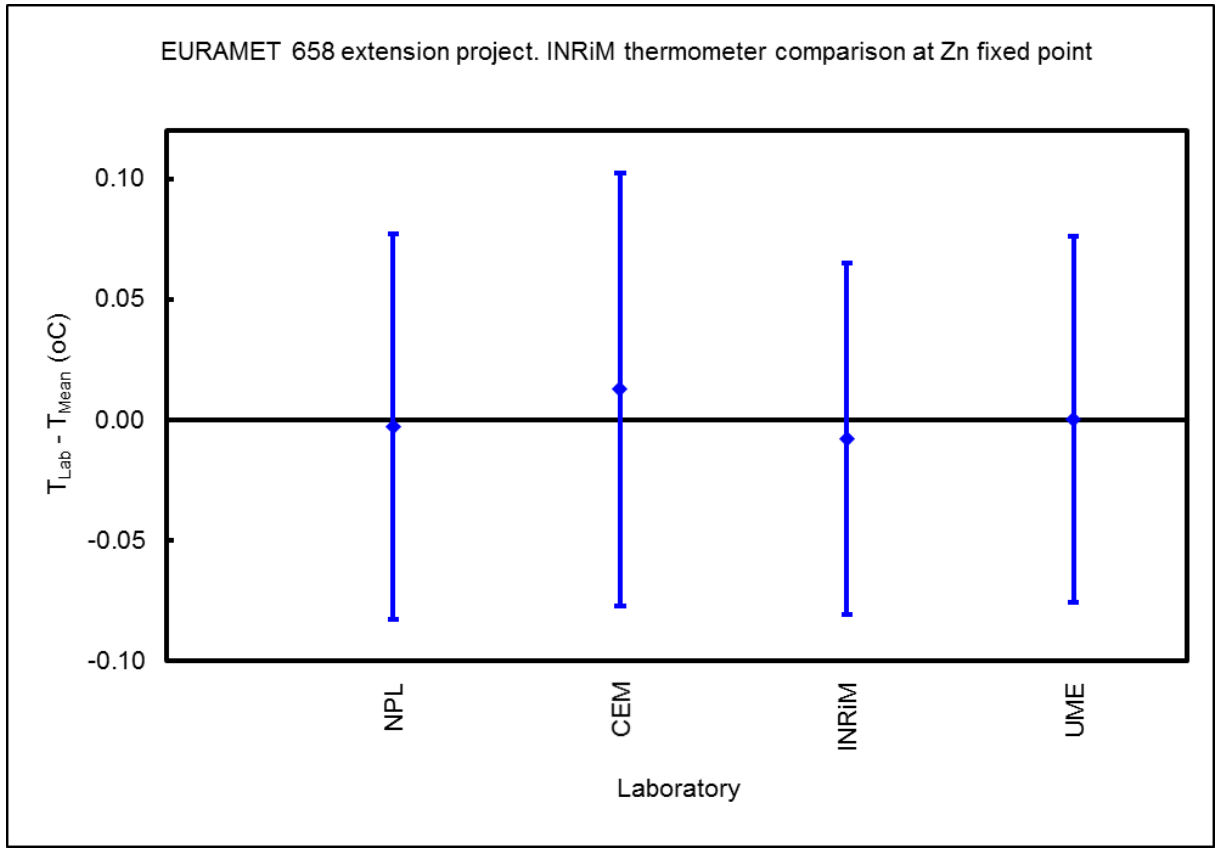
	NPL	INRiM	UME
NPL	-	0.010 ± 0.081	0.012 ± 0.082
INRiM	*0.081*	-	0.002 ± 0.059
UME	*0.084*	*0.058*	-

Table 136 - – direct comparison of the results of the Sn fixed point measurement with the INRiM thermometer



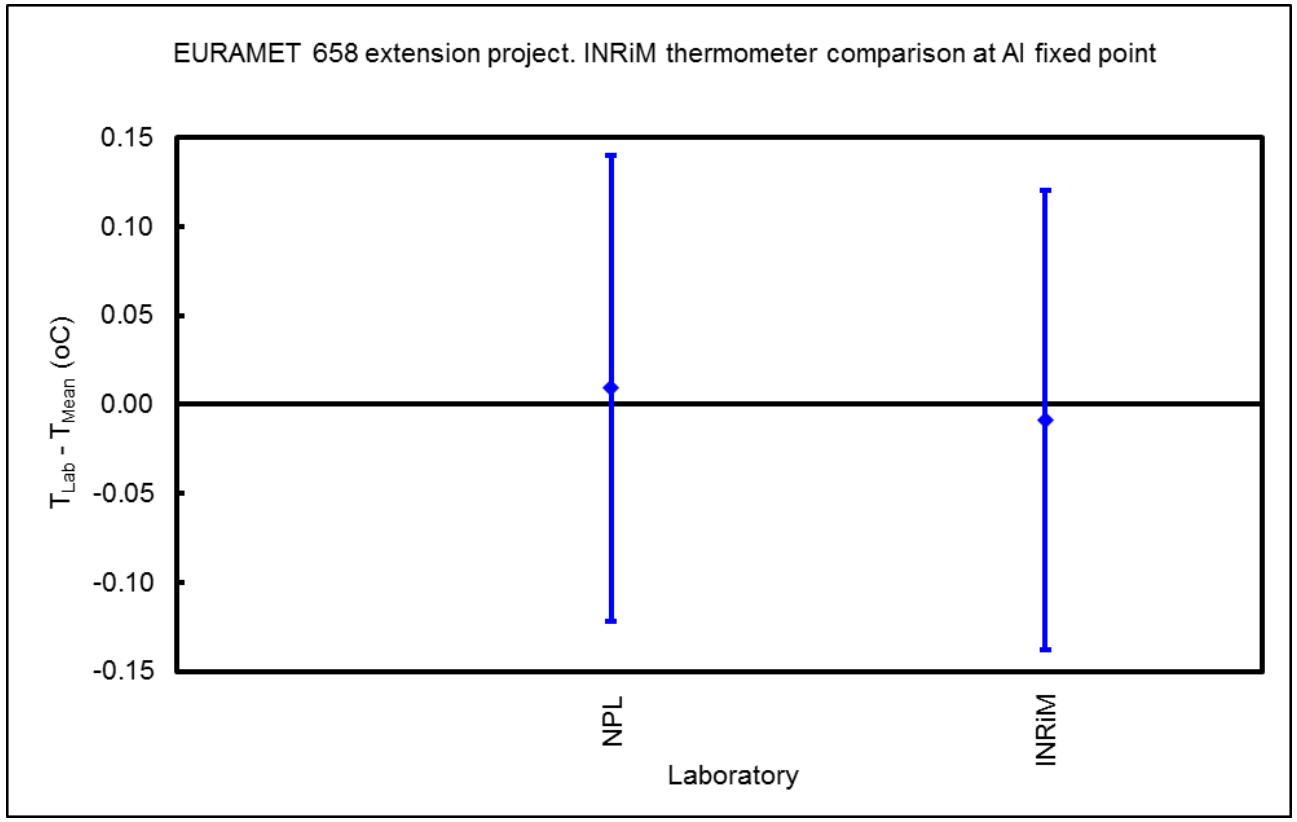
	NPL	CEM	INRiM	UME
NPL	-	-0.016 ± 0.120	0.005 ± 0.108	-0.003 ± 0.110
CEM	*0.122*	-	0.021 ± 0.116	0.013 ± 0.118
INRiM	*0.106*	*0.120*	-	-0.008 ± 0.105
UME	*0.108*	*0.118*	*0.104*	-

Table 137 – direct comparison of the results of the Zn fixed point measurement with the INRiM thermometer



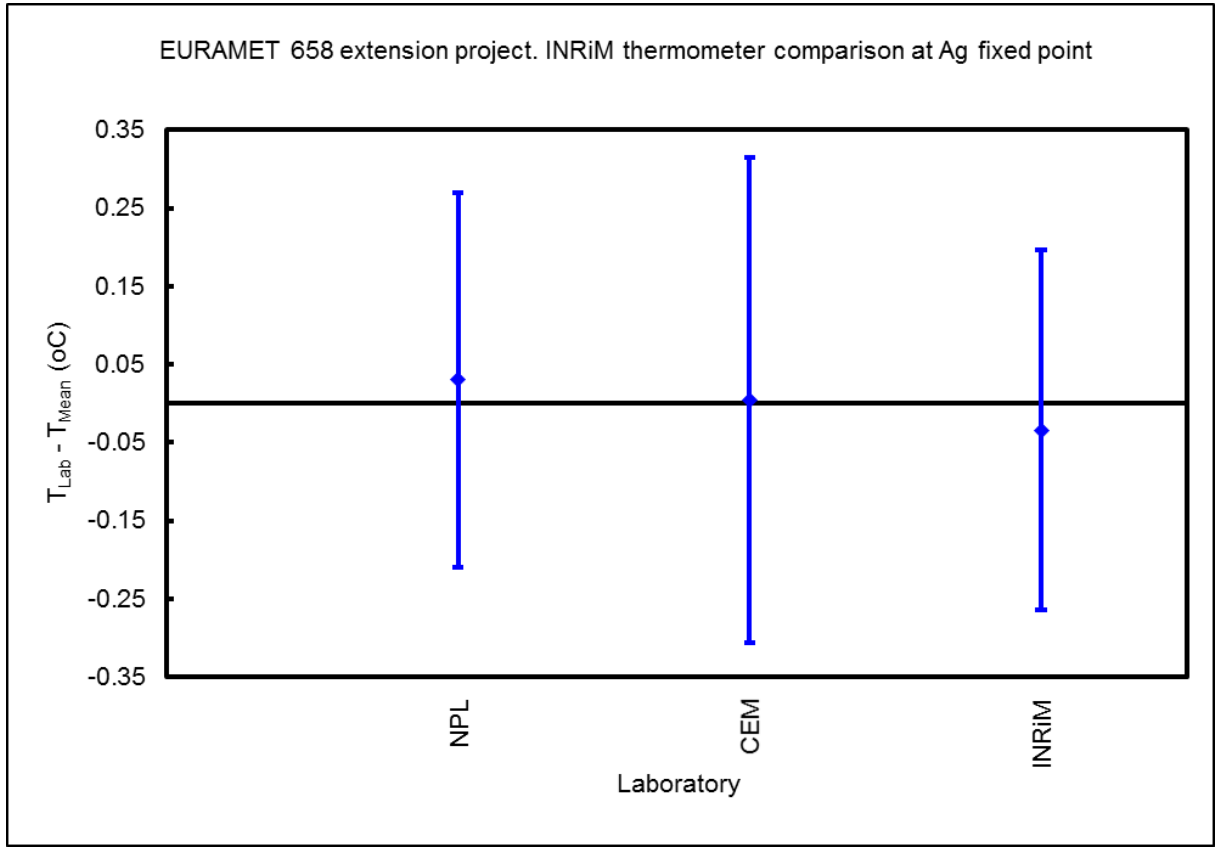
	NPL	INRiM
NPL	-	0.018 ± 0.184
INRiM	*0.183*	-

Table 138 – direct comparison of the results of the Al fixed point measurement with the INRiM thermometer



	NPL	CEM	INRiM
NPL	-	0.025 ± 0.392	0.064 ± 0.332
CEM	*0.386*	-	0.039 ± 0.386
INRiM	*0.349*	*0.384*	-

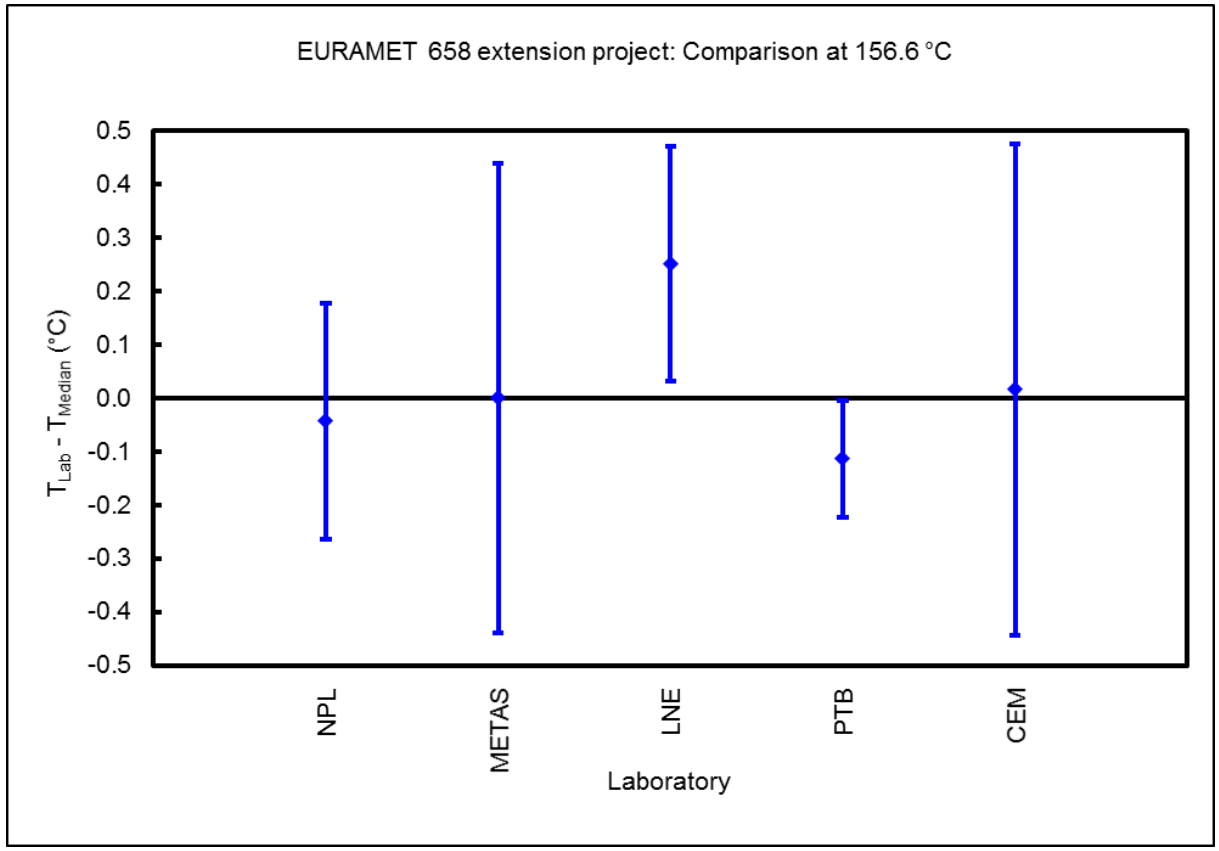
Table 139 – direct comparison of the results of the Ag fixed point measurement with the INRiM thermometer



11.2 THE RESULTS OF THE MEASUREMENTS USING THE VARIABLE TEMPERATURE BLACKBODY SOURCES

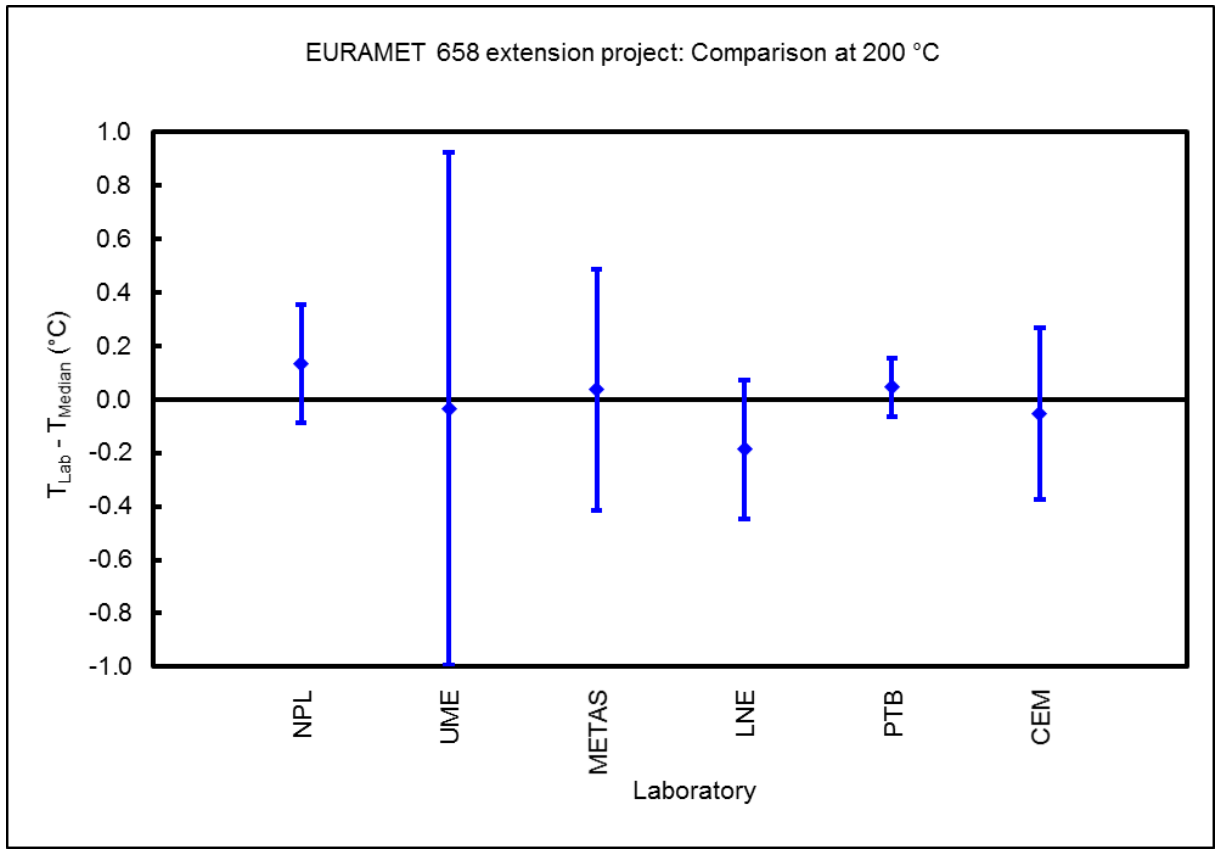
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.04 ± 0.49	-0.29 ± 0.31	0.07 ± 0.25	-0.06 ± 0.51
METAS	*0.49*	-	-0.25 ± 0.49	0.11 ± 0.45	-0.02 ± 0.64
LNE	*0.55*	*0.66*	-	0.36 ± 0.25	0.23 ± 0.51
PTB	*0.28*	*0.50*	*0.57*	-	-0.13 ± 0.47
CEM	*0.51*	*0.63*	*0.66*	*0.53*	-

Table 140 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 157 °C



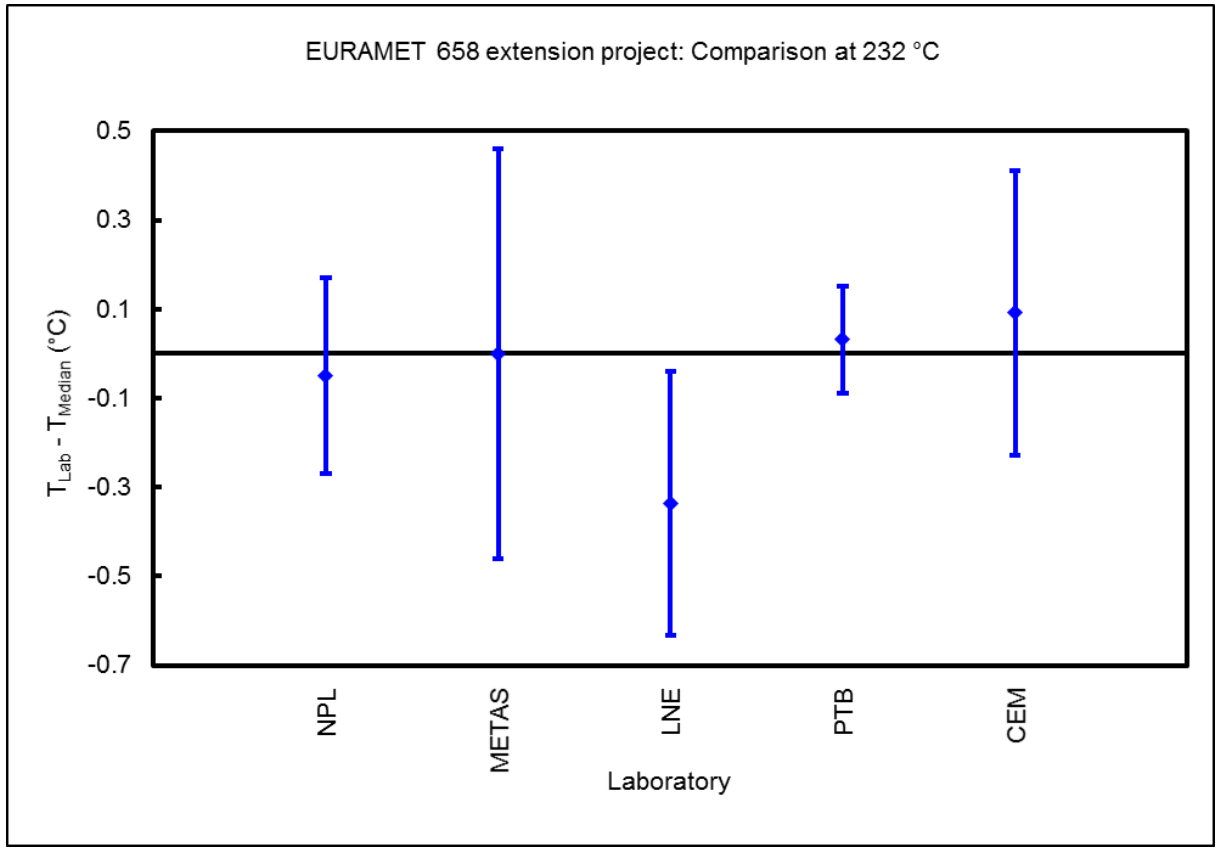
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	0.17 ± 0.98	0.10 ± 0.50	0.32 ± 0.34	0.09 ± 0.25	0.19 ± 0.39
UME	*1.02*	-	-0.07 ± 1.06	0.15 ± 0.99	-0.08 ± 0.97	0.02 ± 1.01
METAS	*0.53*	*1.04*	-	0.22 ± 0.52	-0.01 ± 0.46	0.09 ± 0.55
LNE	*0.60*	*1.02*	*0.65*	-	-0.23 ± 0.28	-0.13 ± 0.41
PTB	*0.29*	*0.96*	*0.46*	*0.46*	-	0.10 ± 0.34
CEM	*0.51*	*0.99*	*0.57*	*0.48*	*0.38*	-

Table 141 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 200 °C



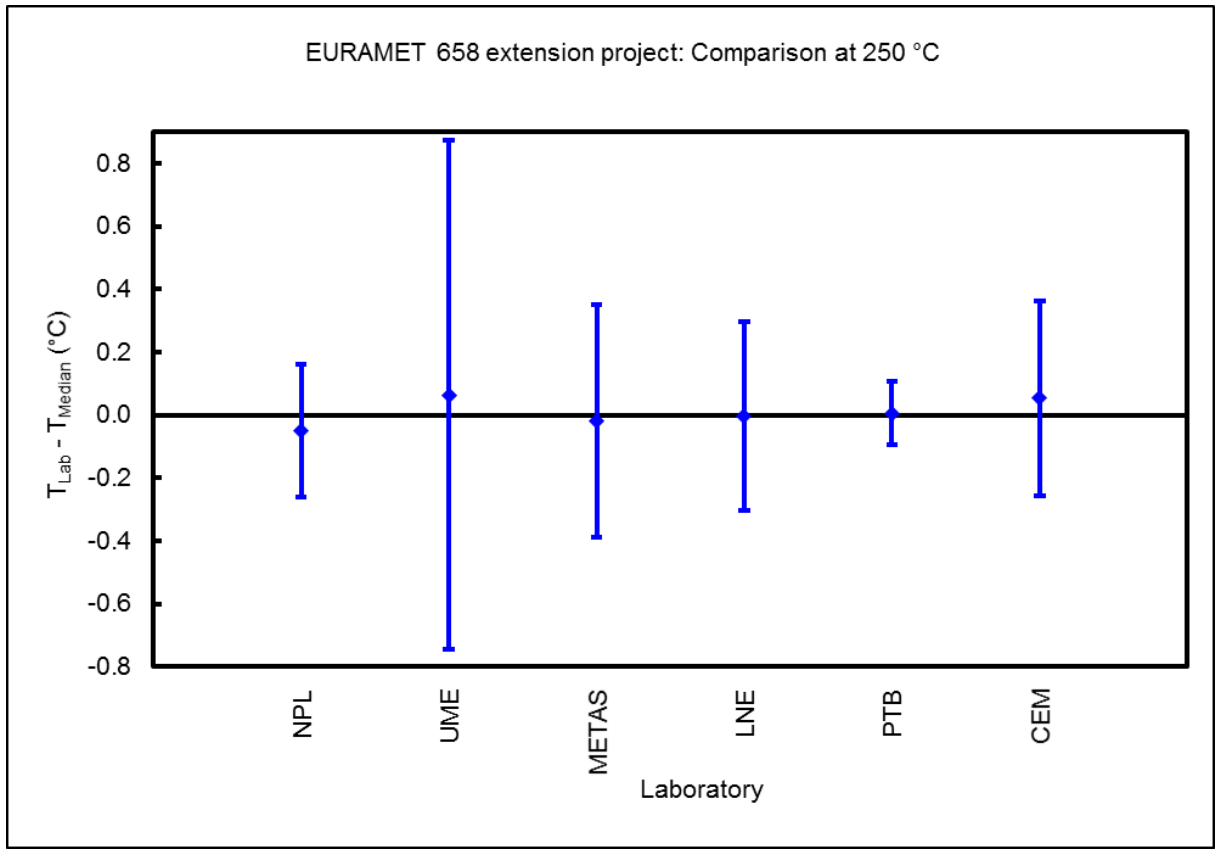
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.05 ± 0.51	0.29 ± 0.37	-0.08 ± 0.25	-0.14 ± 0.39
METAS	*0.51*	-	0.34 ± 0.55	-0.03 ± 0.48	-0.09 ± 0.56
LNE	*0.59*	*0.79*	-	-0.37 ± 0.32	-0.43 ± 0.44
PTB	*0.29*	*0.47*	*0.63*	-	-0.06 ± 0.34
CEM	*0.47*	*0.58*	*0.79*	*0.36*	-

Table 142 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 232 °C



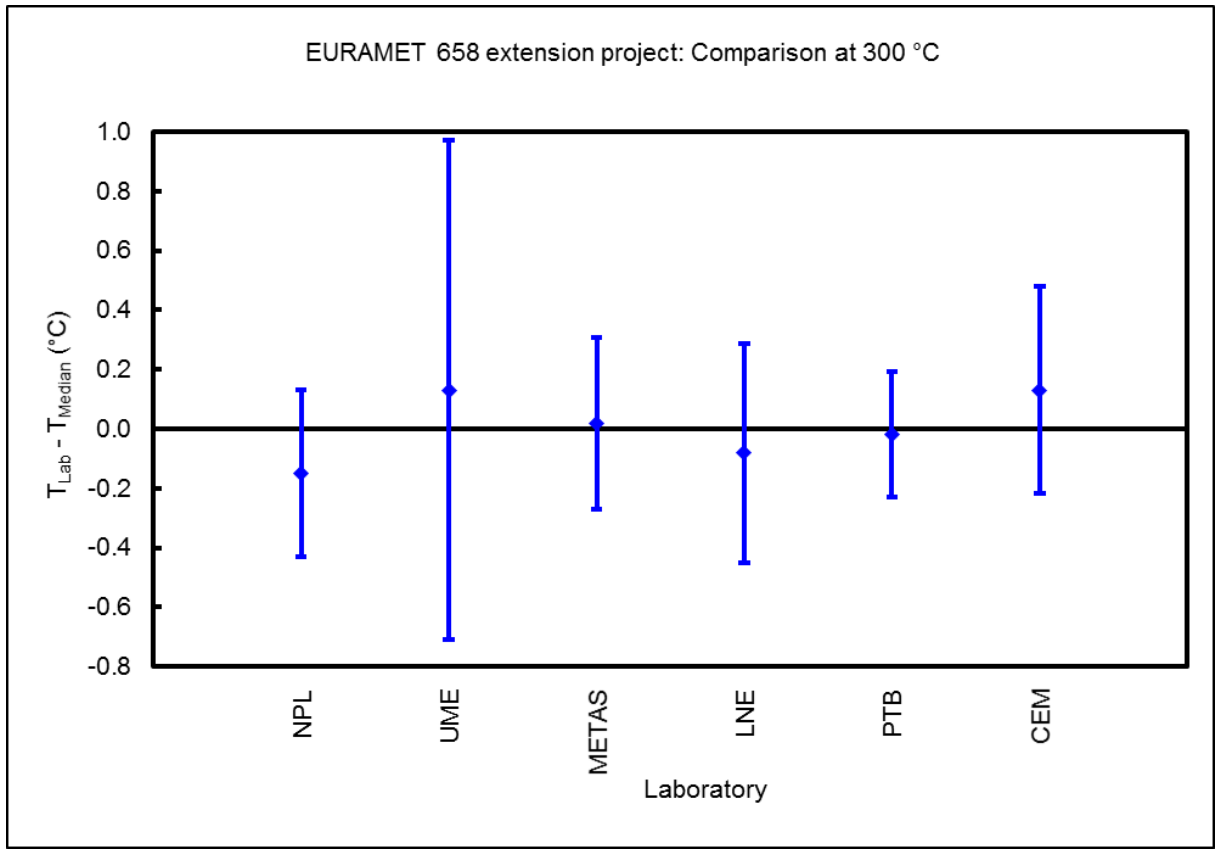
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.11 ± 0.84	-0.03 ± 0.43	-0.05 ± 0.37	-0.06 ± 0.23	-0.10 ± 0.37
UME	*0.85*	-	0.08 ± 0.89	0.07 ± 0.86	0.06 ± 0.82	0.01 ± 0.87
METAS	*0.42*	*0.88*	-	-0.01 ± 0.48	-0.02 ± 0.38	-0.07 ± 0.48
LNE	*0.37*	*0.85*	*0.47*	-	-0.01 ± 0.32	-0.06 ± 0.43
PTB	*0.25*	*0.80*	*0.38*	*0.31*	-	-0.05 ± 0.33
CEM	*0.42*	*0.85*	*0.49*	*0.44*	*0.33*	-

Table 143 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 250 °C



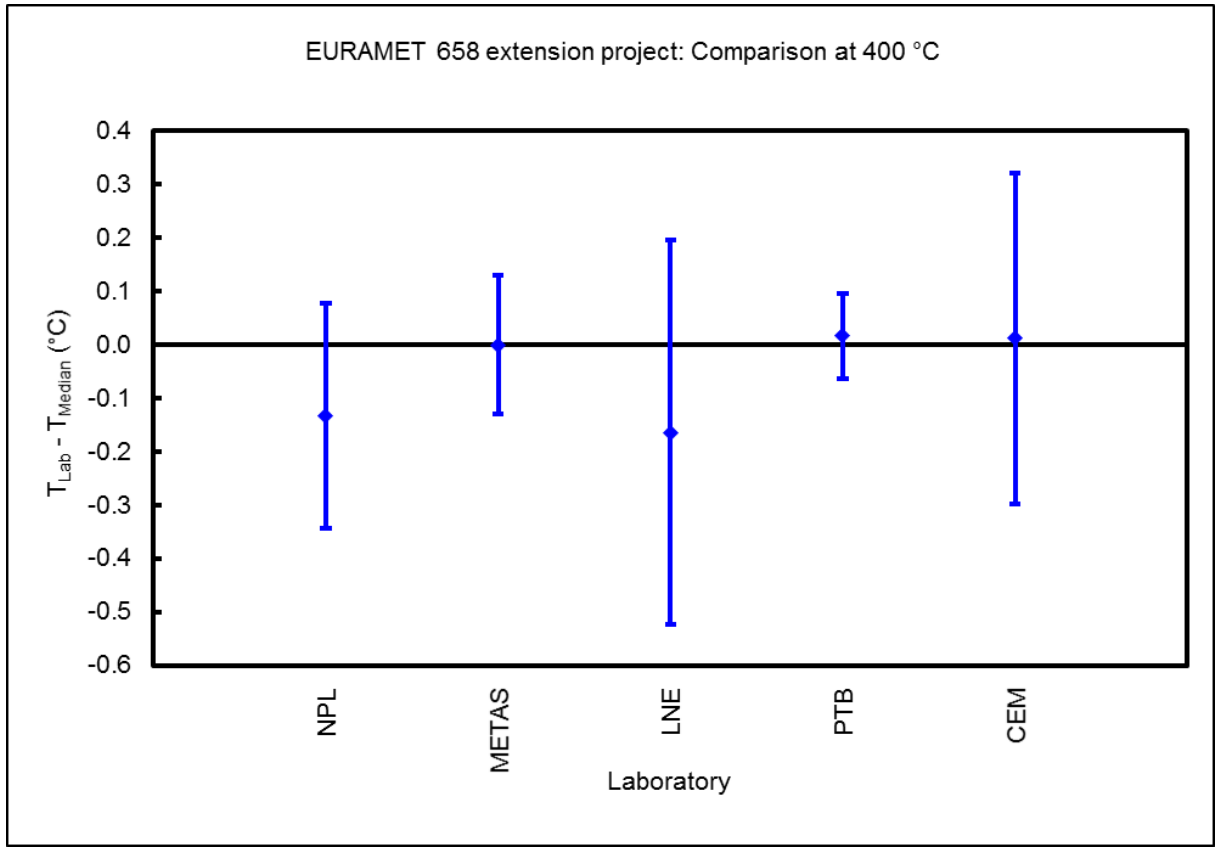
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.28 ± 0.89	-0.17 ± 0.40	-0.07 ± 0.46	-0.13 ± 0.35	-0.28 ± 0.45
UME	*1.02*	-	0.11 ± 0.89	0.21 ± 0.92	0.15 ± 0.87	0.00 ± 0.91
METAS	*0.50*	*0.90*	-	0.10 ± 0.47	0.04 ± 0.36	-0.11 ± 0.46
LNE	*0.47*	*0.99*	*0.50*	-	-0.06 ± 0.43	-0.21 ± 0.51
PTB	*0.42*	*0.90*	*0.36*	*0.43*	-	-0.15 ± 0.41
CEM	*0.65*	*0.90*	*0.50*	*0.63*	*0.49*	-

Table 144 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 300 °C



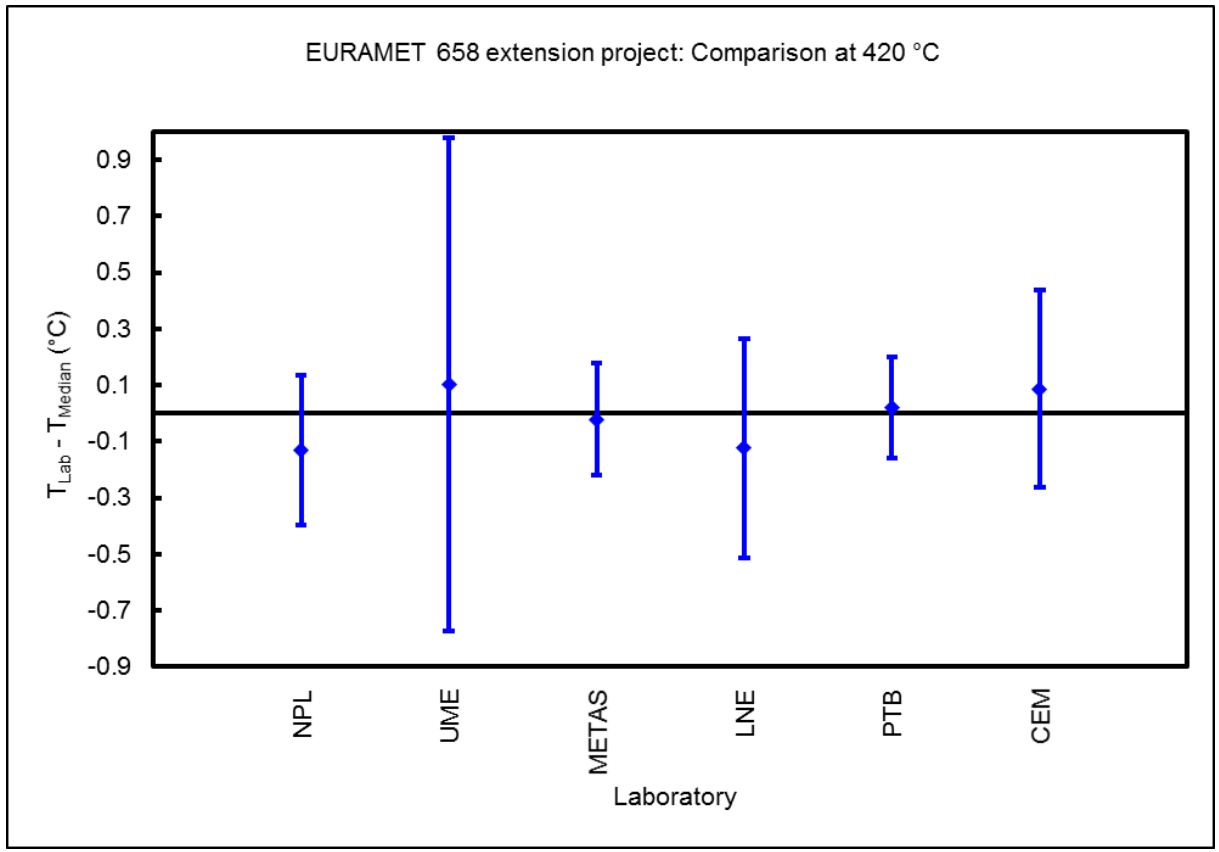
	NPL	METAS	LNE	PTB	CEM
NPL	-	-0.13 ± 0.25	0.03 ± 0.42	-0.15 ± 0.23	-0.15 ± 0.38
METAS	*0.34*	-	0.16 ± 0.38	-0.02 ± 0.15	-0.01 ± 0.34
LNE	*0.41*	*0.48*	-	-0.18 ± 0.37	-0.18 ± 0.48
PTB	*0.33*	*0.15*	*0.48*	-	0.00 ± 0.32
CEM	*0.46*	*0.33*	*0.57*	*0.31*	-

Table 145 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 400 °C



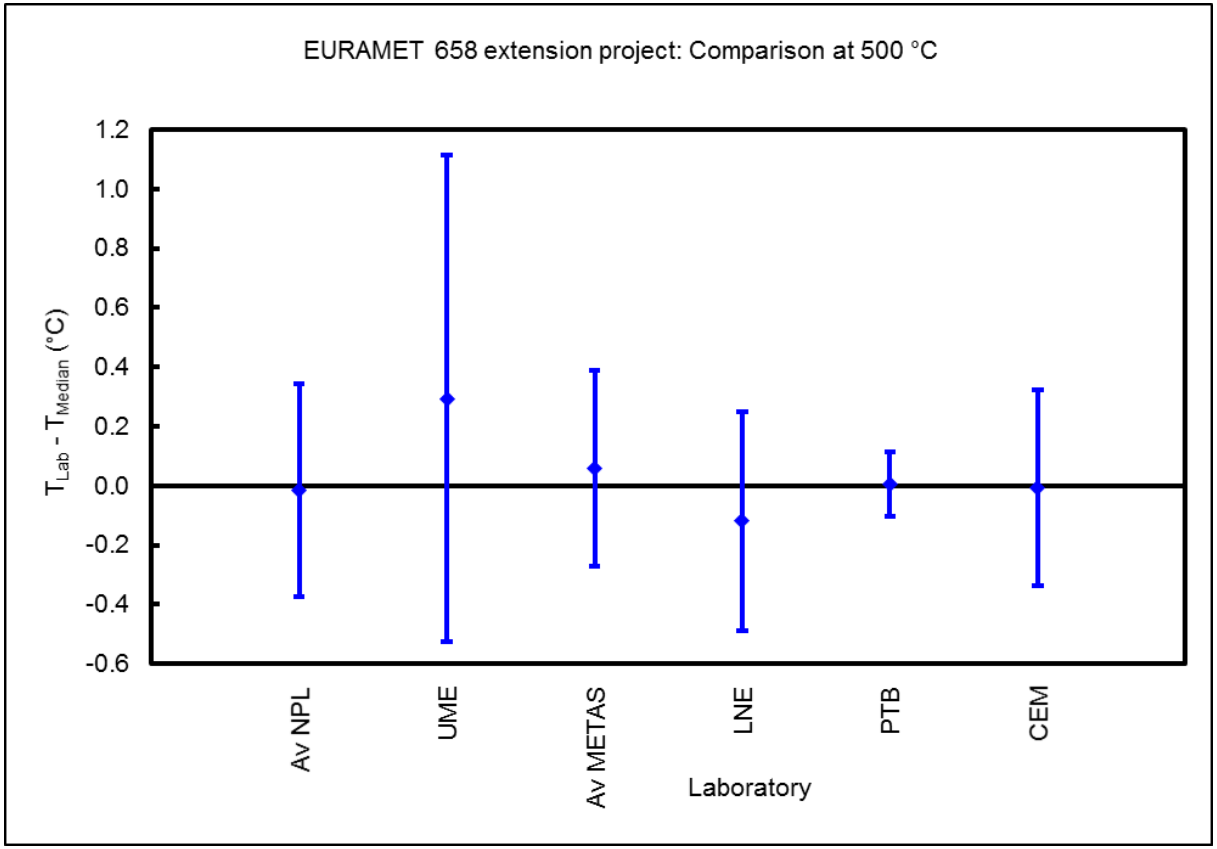
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.23 ± 0.92	-0.11 ± 0.33	-0.01 ± 0.47	-0.15 ± 0.32	-0.22 ± 0.44
UME	*1.01*	-	0.12 ± 0.90	0.23 ± 0.96	0.08 ± 0.90	0.02 ± 0.94
METAS	*0.39*	*0.91*	-	0.10 ± 0.44	-0.04 ± 0.27	-0.11 ± 0.40
LNE	*0.46*	*1.04*	*0.47*	-	-0.15 ± 0.43	-0.21 ± 0.52
PTB	*0.42*	*0.89*	*0.28*	*0.50*	-	-0.06 ± 0.39
CEM	*0.58*	*0.93*	*0.45*	*0.65*	*0.41*	-

Table 146 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 420 °C



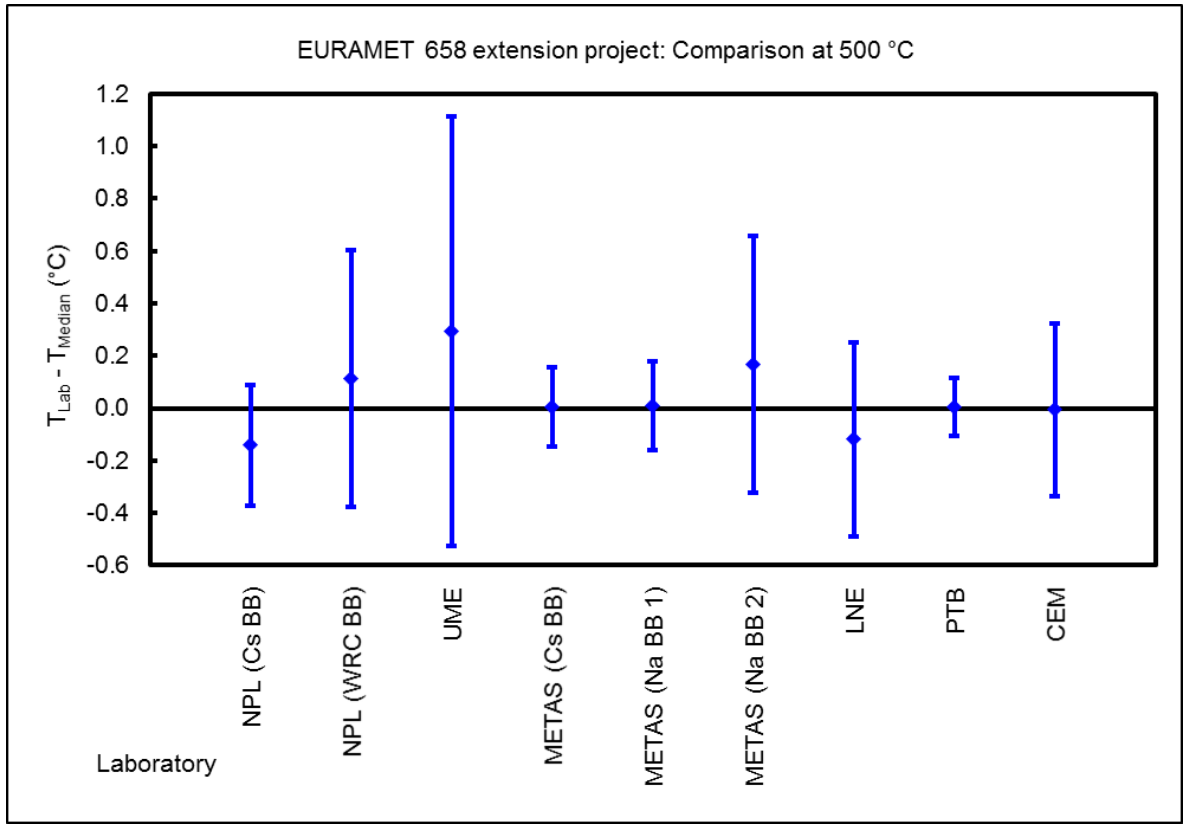
	Av NPL	UME	Av METAS	LNE	PTB	CEM
Av NPL	-	-0.31 ± 0.90	-0.07 ± 0.49	0.10 ± 0.52	-0.02 ± 0.38	-0.01 ± 0.49
UME	*1.05*	-	0.23 ± 0.88	0.41 ± 0.90	0.29 ± 0.83	0.30 ± 0.88
Av METAS	*0.50*	*0.98*	-	0.18 ± 0.50	0.05 ± 0.35	0.07 ± 0.47
LNE	*0.55*	*1.16*	*0.59*	-	-0.12 ± 0.39	-0.11 ± 0.50
PTB	*0.37*	*0.98*	*0.36*	*0.45*	-	0.01 ± 0.35
CEM	*0.48*	*1.04*	*0.47*	*0.53*	*0.34*	-

Table 147 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 500 °C – average data



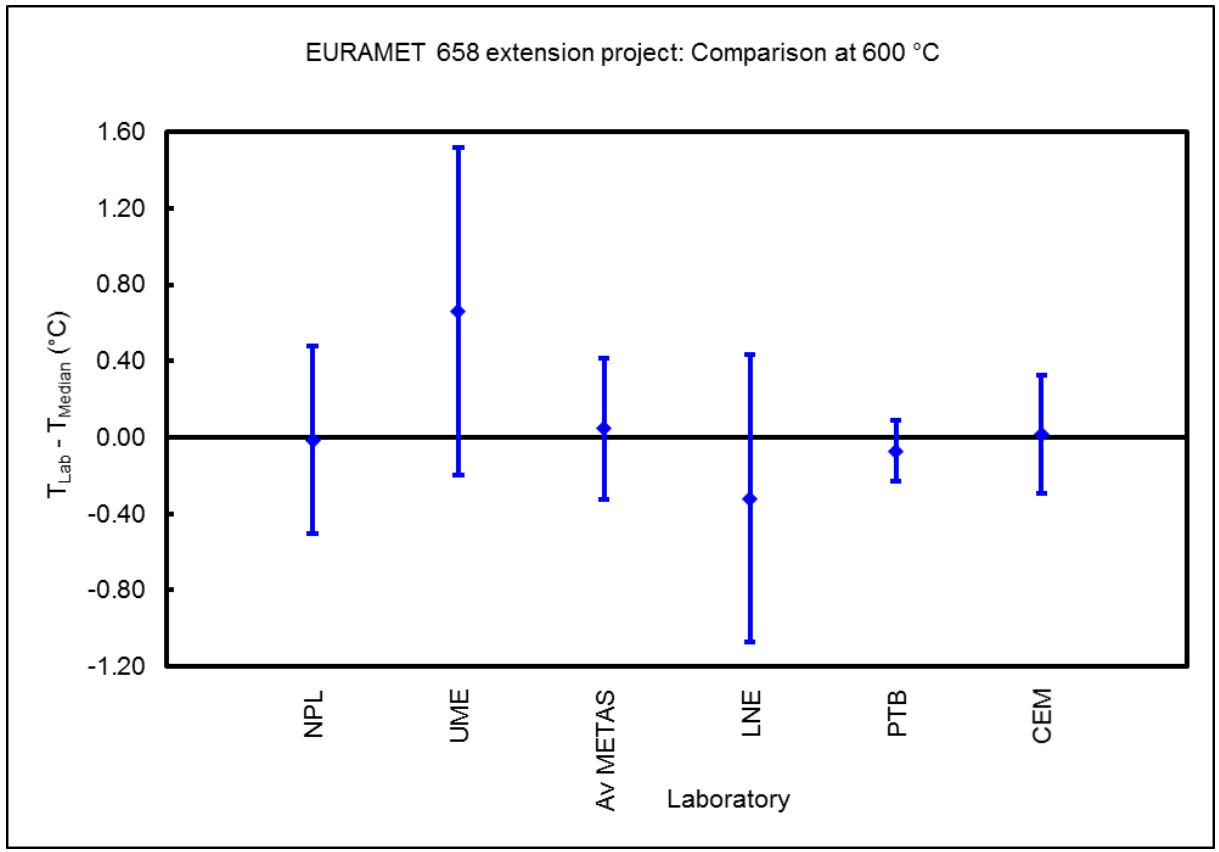
	NPL (Cs BB)	NPL (WRC BB)	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE	PTB	CEM
NPL (Cs BB)	-	-0.25 ± 0.54	-0.43 ± 0.85	-0.15 ± 0.28	-0.15 ± 0.29	-0.31 ± 0.54	-0.02 ± 0.44	-0.15 ± 0.26	-0.14 ± 0.40
NPL (WRC BB)	*0.70*	-	-0.18 ± 0.96	0.11 ± 0.51	0.10 ± 0.52	-0.05 ± 0.69	0.23 ± 0.61	0.11 ± 0.50	0.12 ± 0.59
UME	*1.14*	*1.00*	-	0.29 ± 0.83	0.28 ± 0.84	0.13 ± 0.96	0.41 ± 0.90	0.29 ± 0.83	0.30 ± 0.88
METAS (Cs BB)	*0.37*	*0.54*	*0.98*	-	-0.01 ± 0.23	-0.16 ± 0.51	0.12 ± 0.40	0.00 ± 0.19	0.01 ± 0.36
METAS (Na BB 1)	*0.39*	*0.55*	*0.98*	*0.22*	-	-0.16 ± 0.52	0.13 ± 0.41	0.00 ± 0.20	0.02 ± 0.37
METAS (Na BB 2)	*0.75*	*0.68*	*0.97*	*0.59*	*0.59*	-	0.28 ± 0.61	0.16 ± 0.50	0.17 ± 0.59
LNE	*0.43*	*0.74*	*1.16*	*0.46*	*0.47*	*0.79*	-	-0.12 ± 0.39	-0.11 ± 0.50
PTB	*0.36*	*0.53*	*0.98*	*0.18*	*0.20*	*0.58*	*0.45*	-	0.01 ± 0.35
CEM	*0.47*	*0.62*	*1.04*	*0.36*	*0.36*	*0.67*	*0.53*	*0.34*	-

Table 148 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 500 °C, with data from different sources



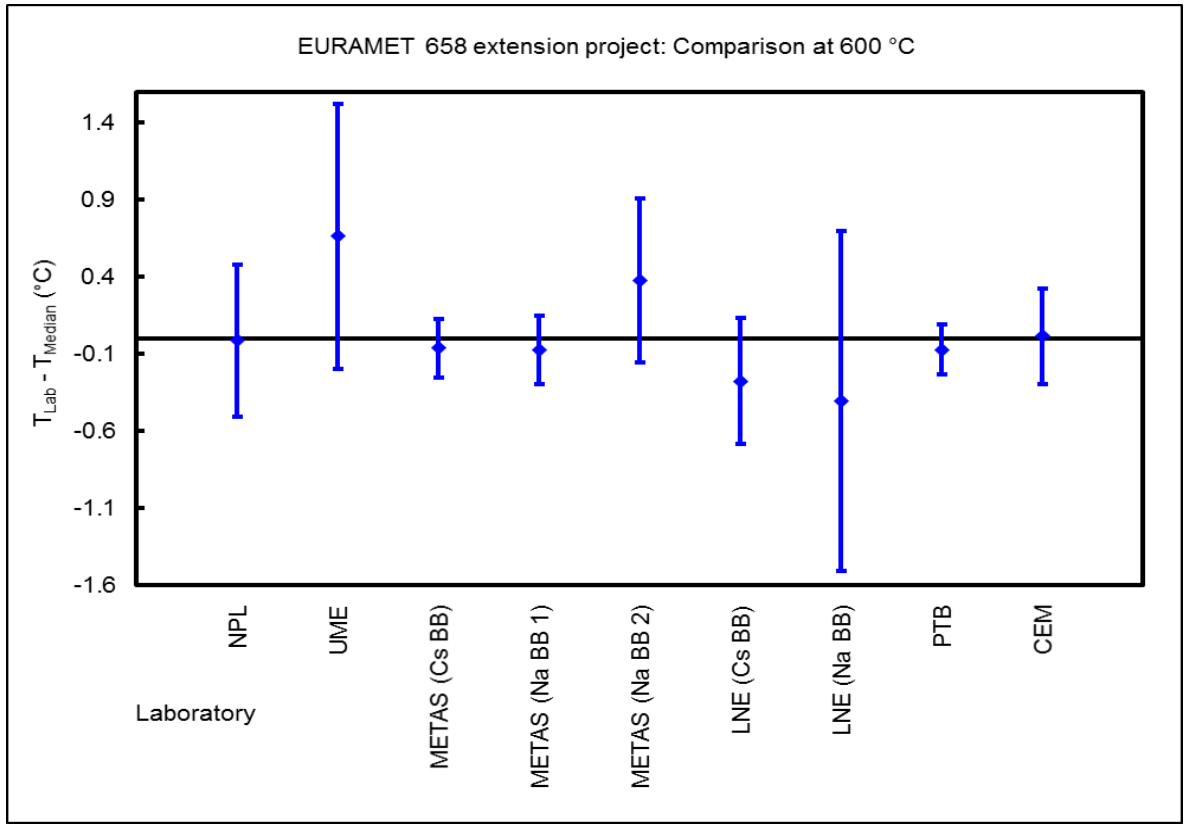
	NPL	UME	Av METAS	LNE	PTB	CEM
NPL	-	-0.68 ± 0.99	-0.06 ± 0.61	0.30 ± 0.90	0.06 ± 0.52	-0.03 ± 0.58
UME	*1.49*	-	0.62 ± 0.93	0.98 ± 1.14	0.73 ± 0.87	0.65 ± 0.91
Av METAS	*0.61*	*1.38*	-	0.36 ± 0.84	0.12 ± 0.40	0.03 ± 0.48
LNE	*1.05*	*1.92*	*1.06*	-	-0.25 ± 0.77	-0.33 ± 0.81
PTB	*0.52*	*1.45*	*0.46*	*0.89*	-	-0.09 ± 0.35
CEM	*0.57*	*1.40*	*0.48*	*1.01*	*0.38*	-

Table 149 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 600 °C – average data



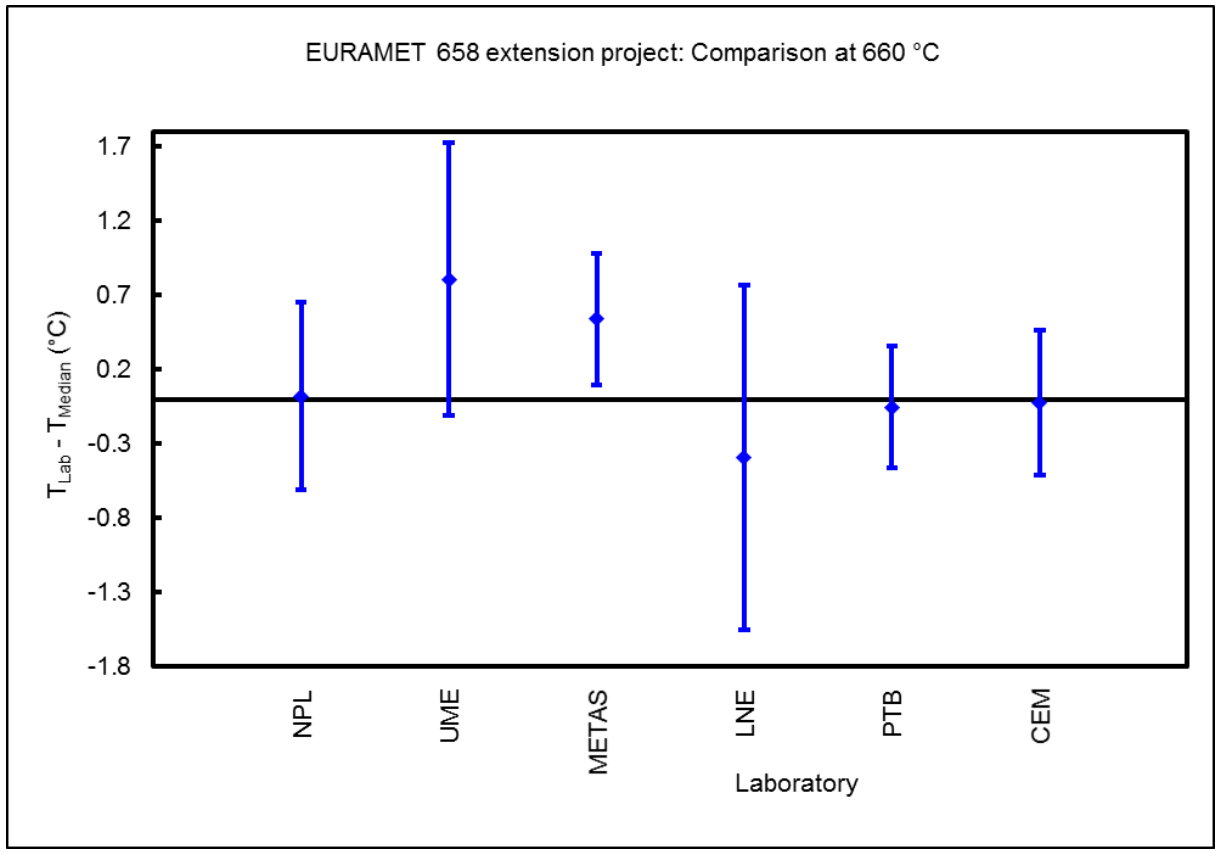
	NPL	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE (Cs BB)	LNE (Na BB)	PTB	CEM
NPL	-	-0.68 ± 0.99	0.05 ± 0.53	0.06 ± 0.54	-0.39 ± 0.72	0.26 ± 0.64	0.39 ± 1.20	0.06 ± 0.52	-0.03 ± 0.58
UME	*1.49*	-	0.72 ± 0.88	0.73 ± 0.89	0.29 ± 1.01	0.94 ± 0.95	1.07 ± 1.40	0.73 ± 0.87	0.65 ± 0.91
METAS (Cs BB)	*0.52*	*1.44*	-	0.01 ± 0.29	-0.44 ± 0.56	0.21 ± 0.45	0.34 ± 1.12	0.01 ± 0.25	-0.08 ± 0.36
METAS (Na BB 1)	*0.54*	*1.46*	*0.29*	-	-0.45 ± 0.57	0.20 ± 0.47	0.33 ± 1.12	0.00 ± 0.27	-0.09 ± 0.38
METAS (Na BB 2)	*0.98*	*1.13*	*0.90*	*0.92*	-	0.65 ± 0.67	0.78 ± 1.22	0.45 ± 0.55	0.36 ± 0.61
LNE (Cs BB)	*0.79*	*1.72*	*0.59*	*0.59*	*1.20*	-	0.13 ± 1.17	-0.20 ± 0.44	-0.29 ± 0.51
LNE (Na BB)	*1.40*	*2.21*	*1.28*	*1.27*	*1.79*	*1.17*	-	-0.33 ± 1.11	-0.42 ± 1.14
PTB	*0.52*	*1.45*	*0.24*	*0.27*	*0.90*	*0.57*	*1.26*	-	-0.09 ± 0.35
CEM	*0.57*	*1.40*	*0.39*	*0.41*	*0.87*	*0.71*	*1.37*	*0.38*	-

Table 150 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 600 °C, with data from different sources



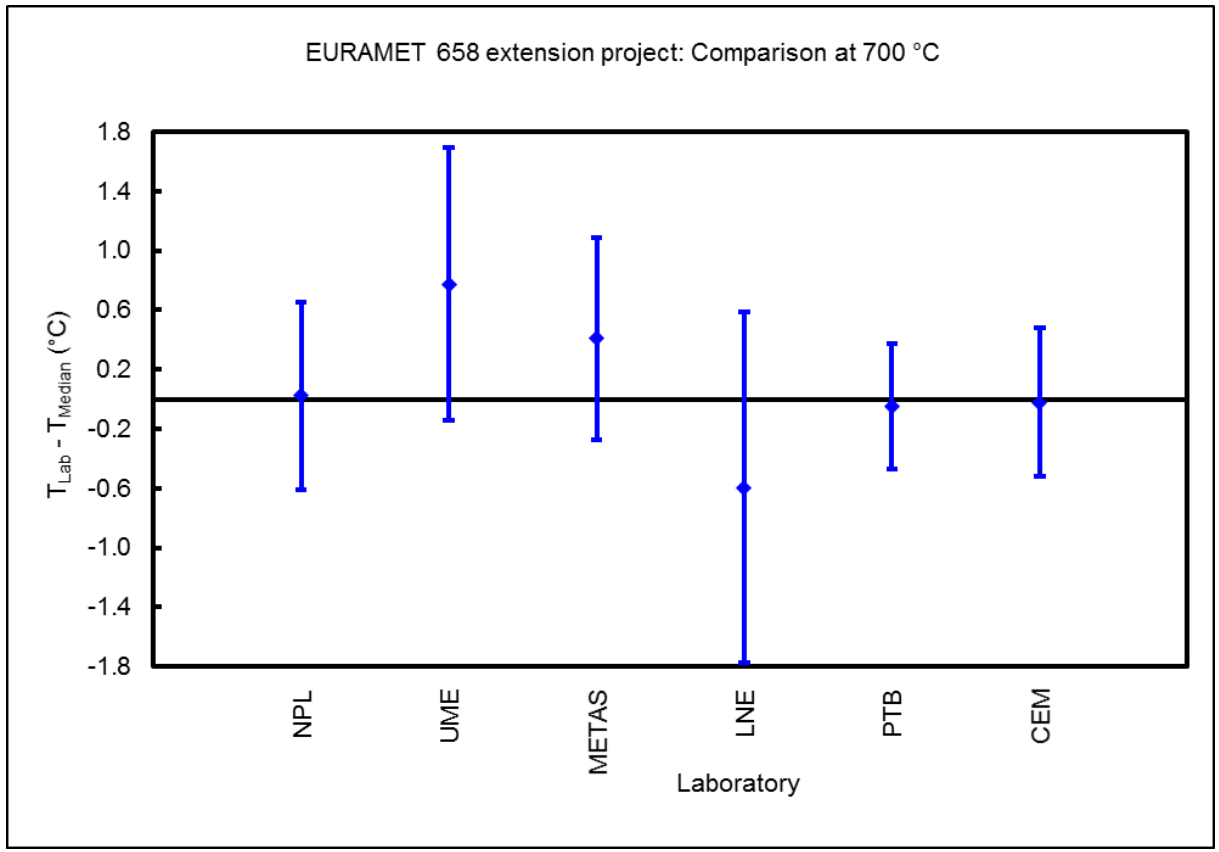
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.79 ± 1.12	-0.52 ± 0.77	0.42 ± 1.32	0.08 ± 0.75	0.04 ± 0.80
UME	*1.70*	-	0.27 ± 1.02	1.20 ± 1.48	0.86 ± 1.01	0.83 ± 1.04
METAS	*1.15*	*1.13*	-	0.93 ± 1.24	0.59 ± 0.60	0.56 ± 0.66
LNE	*1.52*	*2.42*	*1.96*	-	-0.34 ± 1.23	-0.37 ± 1.26
PTB	*0.75*	*1.69*	*1.09*	*1.37*	-	-0.03 ± 0.64
CEM	*0.78*	*1.69*	*1.10*	*1.43*	*0.63*	-

Table 151 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 660 °C



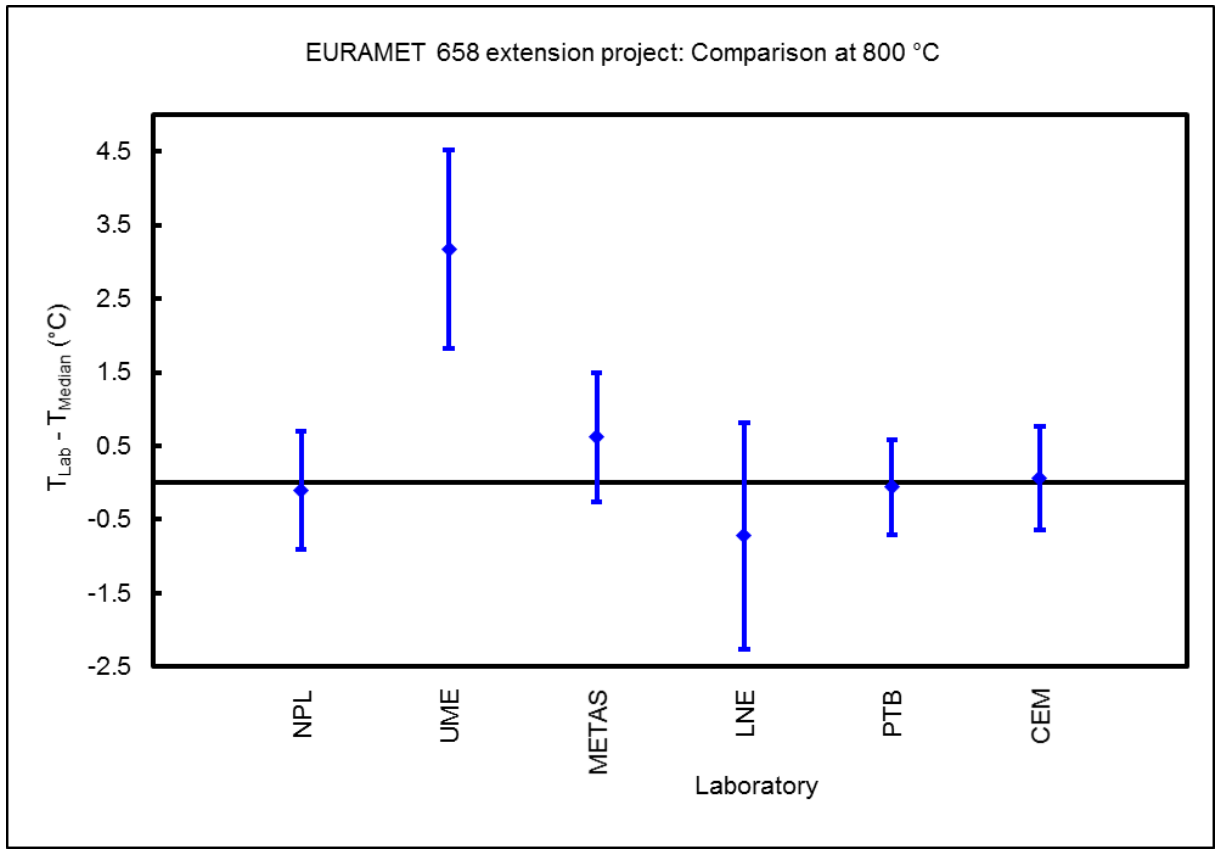
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.75 ± 1.12	-0.39 ± 0.93	0.62 ± 1.34	0.07 ± 0.76	0.05 ± 0.80
UME	*1.67*	-	0.37 ± 1.14	1.37 ± 1.50	0.83 ± 1.01	0.80 ± 1.05
METAS	*1.15*	*1.32*	-	1.00 ± 1.36	0.46 ± 0.80	0.43 ± 0.84
LNE	*1.72*	*2.60*	*2.13*	-	-0.55 ± 1.25	-0.57 ± 1.28
PTB	*0.75*	*1.66*	*1.12*	*1.58*	-	-0.03 ± 0.65
CEM	*0.79*	*1.66*	*1.13*	*1.63*	*0.64*	-

Table 152 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 700 °C



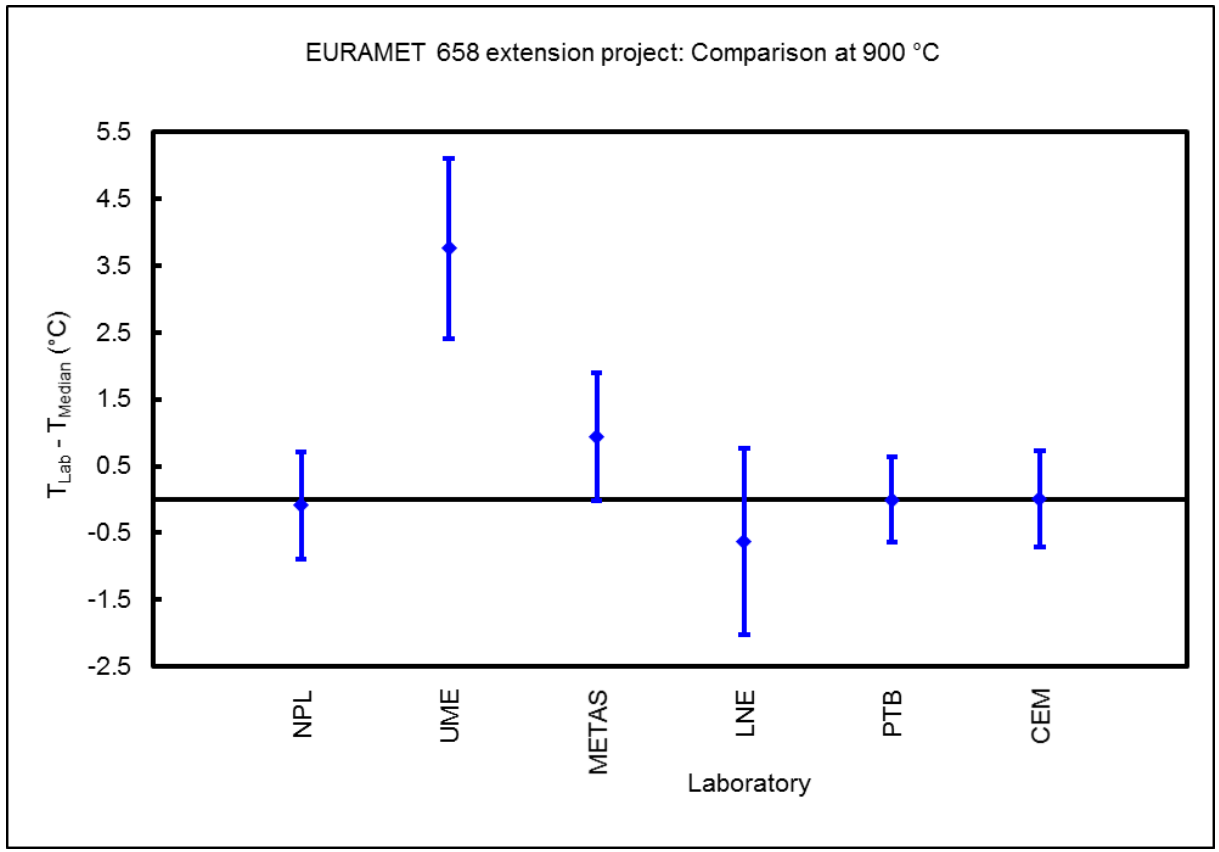
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-3.27 ± 1.57	-0.72 ± 1.19	0.62 ± 1.74	-0.04 ± 1.02	-0.16 ± 1.06
UME	*4.56*	-	2.56 ± 1.61	3.89 ± 2.05	3.23 ± 1.49	3.11 ± 1.52
METAS	*1.70*	*3.88*	-	1.33 ± 1.77	0.68 ± 1.09	0.55 ± 1.12
LNE	*2.06*	*5.58*	*2.79*	-	-0.66 ± 1.67	-0.78 ± 1.69
PTB	*1.01*	*4.46*	*1.57*	*2.04*	-	-0.12 ± 0.95
CEM	*1.09*	*4.36*	*1.48*	*2.18*	*0.96*	-

Table 153 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 800 °C



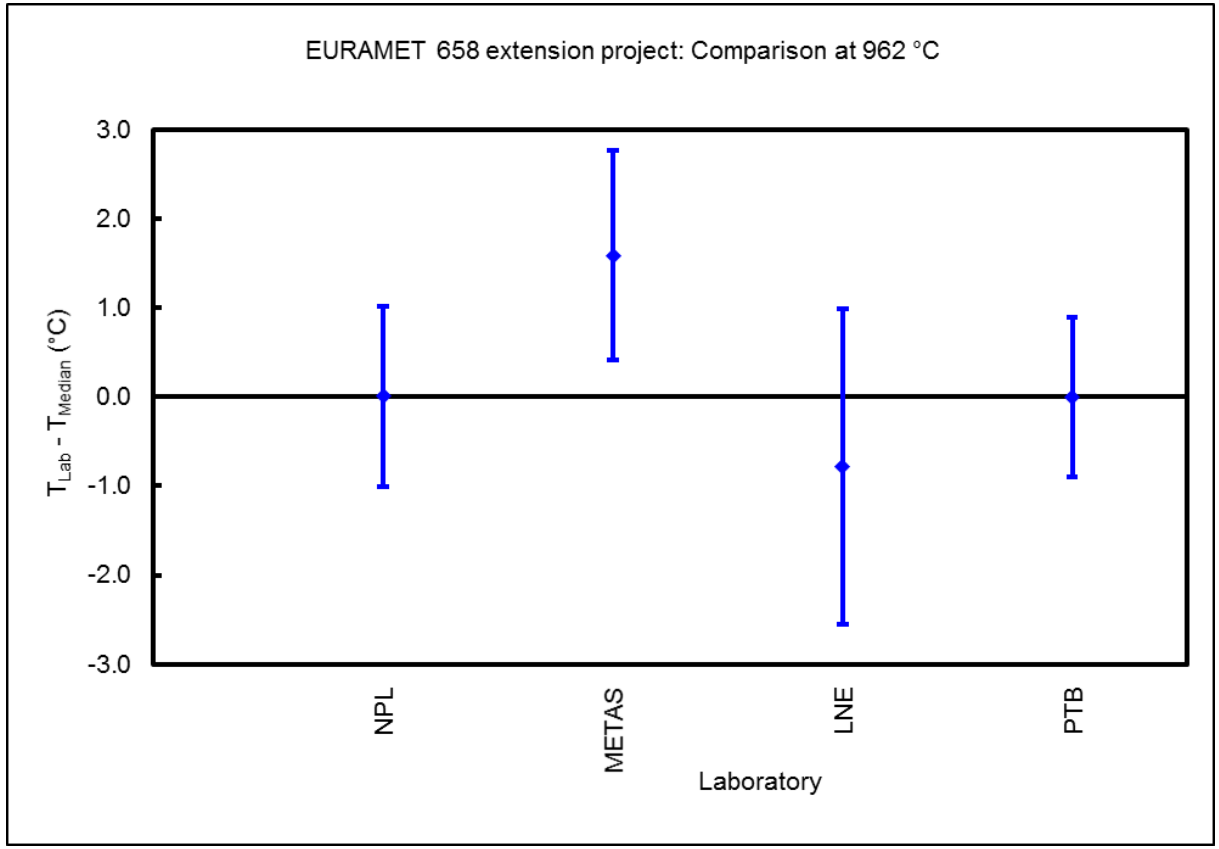
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-3.85 ± 1.57	-1.03 ± 1.25	0.54 ± 1.61	-0.08 ± 1.02	-0.09 ± 1.08
UME	*5.14*	-	2.82 ± 1.66	4.39 ± 1.95	3.76 ± 1.49	3.76 ± 1.53
METAS	*2.06*	*4.18*	-	1.57 ± 1.70	0.94 ± 1.15	0.94 ± 1.20
LNE	*1.88*	*5.98*	*2.96*	-	-0.62 ± 1.54	-0.63 ± 1.57
PTB	*1.01*	*4.99*	*1.89*	*1.90*	-	-0.01 ± 0.96
CEM	*1.07*	*5.01*	*1.92*	*1.94*	*0.95*	-

Table 154 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 900 °C



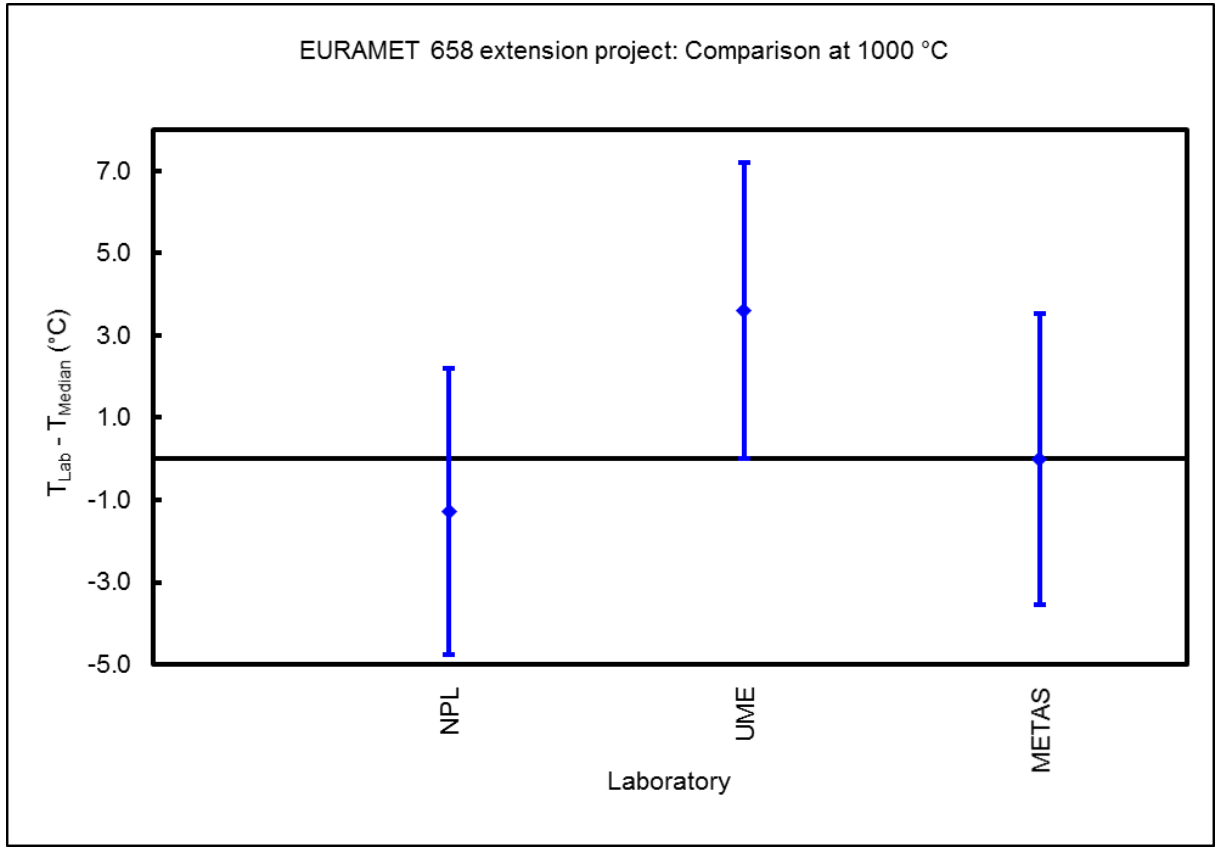
	NPL	METAS	LNE	PTB	CEM
NPL	-	-1.58 ± 1.56	0.78 ± 2.04	0.01 ± 1.35	-0.06 ± 0.48
METAS	*2.86*	-	2.37 ± 2.13	1.59 ± 1.48	-0.02 ± 0.62
LNE	*2.47*	*4.12*	-	-0.77 ± 1.98	0.23 ± 0.50
PTB	*1.33*	*2.81*	*2.42*	-	-0.13 ± 0.46
CEM	*0.48*	*0.61*	*0.65*	*0.51*	-

Table 155 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 962 °C



	NPL	UME	METAS
NPL	-	-4.88 ± 5.01	-1.28 ± 4.96
UME	*9.00*	-	3.60 ± 5.05
METAS	*5.46*	*7.76*	-

Table 156 - direct comparison of the results for the INRiM thermometer variable temperature blackbody measurements at 1000 °C



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APPENDIX 1

PROTOCOL FOR THE COMPARISON

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

HELEN MCEVOY

JANUARY 2018

Department for
Business, Energy
& Industrial Strategy

FUNDED BY BEIS

Appendix 1

Protocol for the Comparison:

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Helen McEvoy
Engineering, Materials & Electrical Science

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Approved on behalf of NPL by
Dr Stephanie Bell, Science Area Leader

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PROTOCOL FOR PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

1 RATIONALE

The purpose of this collaboration is to undertake an examination of some underlying parameters in temperature scale realisation using InGaAs-based radiation thermometers (size-of source effect, fixed-point realisation and ambient effects) as well as a comparison of variable-temperature blackbody sources over the temperature range from 156 to 1000 °C.

2 ORGANISATION

The project will be coordinated by:

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3 PARTICIPANTS

The participants in the project are:

Institute	Contact person
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4 PROJECT END DATE

The measurements are due to be completed by the end of December 2008, with the final project report to be completed by the end of December 2009.

5 CIRCULATION SCHEME

The thermometer will be circulated according to the following schedule:

Institute	Time periods
PTB	1 August 2007 to 30 September 2007
NPL	1 October 2007 to 30 November 2007
CEM	1 December 2007 to 29 February 2008
UME	1 March 2008 to 30 April 2008
METAS	1 May 2008 to 30 June 2008
LNE	1 July 2008 to 30 September 2008
INRiM	1 October 2008 to 30 November 2008

In the last week of each period the laboratory that is completing the measurements should arrange for the thermometers to be transferred to the next institute. Wherever possible, door-to-door transportation should be used to minimise the risk of damage to the instruments. The laboratory completing the measurements is responsible for paying the transport costs for the transfer to the next institute. The institute receiving the thermometers should carry out the check described in 7.4 and confirm to the coordinating laboratory by e-mail or fax that the thermometers have arrived safely. At the end of the circulation the thermometers should be returned to the originating institutes who should then confirm the performance of their instruments.

6 TRANSFER INSTRUMENTS

The two transfer instruments are an LP5, provided by IKE Stuttgart, and a transfer thermometer provided by INRiM, Italy. Both instruments are InGaAs photodiode devices with a peak wavelength of nominally 1.6 μm. Technical information about the thermometers is given in Appendix 1.

Additionally, a zinc point blackbody source, supplied by INRiM, will be circulated along with the transfer thermometers so that the performance and stability of the thermometers can be checked regularly. This zinc point was used in the TRIRAT project, and details can be found in Appendix 1. Instructions for using the zinc point are provided.

7 INITIAL MEASUREMENTS

7.1 – Stabilisation: the stabilisation time for the thermometers is given in Appendix 1. It is recommended that the thermometers be left to stabilise for at least two hours after switch-on before starting measurements. The thermometers should subsequently be left switched on, if possible, for the duration of all the measurements.

7.2 – Lens cleaning: Superficial dust should be blown off the front lens of the thermometer using clean air or other means but otherwise the lens should NOT be cleaned. The protective lens cap should be placed on the front of the thermometer in-between measurements and great care should be taken not to touch the front lens.

7.3 – Positioning: the thermometers should be set up and aligned at the prescribed working distance according to the local procedure, with reference to any specific instructions supplied with the thermometers.

7.4 – Check on arrival at each institute: to make sure that they have not been damaged during transport, a quick check should be made of the thermometers' output when viewing the supplied Zn fixed-point blackbody source. For the INRiM thermometer the working distance should be **330 mm** from the stainless steel flange on the front of the furnace to the front of the objective nose of the thermometer; for the IKE LP5 the working distance should be **610 mm** from the stainless steel flange on the front of the furnace to the front of the objective nose of the thermometer. Instructions for using the Zn point are provided. The results of the check should be e-mailed or faxed to the coordinator.

8 PROBLEMS

Should any problems arise with the operation of the instruments, both the coordinator and the organisation supplying the thermometer should be contacted.

9 REQUIRED MEASUREMENTS

The following gives information about the measurements to be made at each laboratory. Participants should perform as many of the measurements as possible. Measurements should be made according to the usual method used at each laboratory, but following any specific instructions given below. During the measurements the internal instrument temperature (t_{int}), the ambient temperature (t_{amb}) and the relative humidity (RH_{amb}) should be recorded.

Please note:

All the measurements with the IKE thermometer should be made at a distance of **750 mm** from the target to the front of the objective nose.

All the measurements with the INRiM thermometer should be made at a distance of **470 mm** from the target to the front of the objective nose.

9.1 SIZE-OF-SOURCE EFFECT

The size-of-source effect should be made using either the indirect method (i.e. by obscuring the central portion of the field-of-view of the thermometer by means of a blackened disc or spot placed in front of the source) or the direct method (by viewing a stable, uniform source and varying the aperture diameter) or, if the institute wishes, both methods.

If using the indirect method, measurements should be made using spot sizes of both **3 mm and 6 mm diameter** for the IKE LP5 and **6 mm diameter** only for the INRiM thermometer. Measurements should be made using all available apertures of a suitable diameter.

Results - The results shall be presented in the form of a table giving the SSE for each aperture size. For measurements using the indirect method, the table should include columns for the following information: aperture size (mm), 'on spot' thermometer output, 'off spot' output, background signal, SSE, the individual uncertainty components in determining the SSE (u_1, u_2, u_3,…), the total combined uncertainty U_{SSE}, t_{amb}, RH_{amb} and t_{int}.

For measurements using the direct method, the source should be set to a temperature of 500 °C. The results table should include columns for the following information: aperture size (mm), thermometer output, background signal, SSE, the individual uncertainty components in determining the SSE (u_1, u_2, u_3,…), the total combined uncertainty U_{SSE}, t_{amb}, RH_{amb} and t_{int}.

9.2 FIXED-POINT CALIBRATION

The thermometers should be calibrated following the laboratory's usual local procedure using freezing point blackbody sources of In (for the INRiM thermometer), Sn, Zn, Al and Ag (or as many of the fixed-points as are available). At least 3 freeze/melt cycles should be performed with each fixed-point. If suitable fixed-point blackbody sources are not available, variable temperature blackbody sources can be used instead. In this case, the source should be set to within 0.2 °C of the fixed-point temperature and its temperature, as measured by the contact thermometer within the source, should also be recorded over the duration of each set of measurements.

With each thermometer a scan should be performed across the blackbody aperture during a melt and freeze plateau, or across the aperture of the variable temperature blackbody source, to assess the temperature profile. This can be used, if necessary, to perform any corrections due to the size-of-source effect.

Additionally, the thermometer output must be corrected to allow for the size-of-source effect. The correction should be performed according to the laboratory's usual method using the results of the SSE measurements carried out in Section 9.1 and the temperature profile of the fixed-point blackbody aperture. The correction should be from the actual fixed-point blackbody aperture diameter to a reference target of 20 mm diameter.

Results – The following information shall be provided:

a) The blackbody geometry, aperture diameter and emissivity data, and information about the contact sensor within the source (if appropriate).

b) For each fixed-point plateau the average background measurement, the average thermometer output and the average thermometer output corrected for background as well as the standard deviation of the measurements. If using variable temperature blackbody sources the average source temperature for each set of measurements should also be given as well as the standard deviation of the measurements.

c) The ambient conditions $t_{amb,}$ RH_{amb} and $t_{int.}$

d) The thermometer output corrected for SSE to a reference target of 20 mm diameter.

e) The individual uncertainty components in the fixed-point calibration (u_1, u_2, u_3,…) and the total combined uncertainty $U_{calibration}$.

9.3 GAIN RATIO MEASUREMENTS

Gain ratio values should be determined for the settings of amplifier gain used in the fixed-point calibration, by measuring the signal ratios with successive pairs of amplifier gain settings. These measurements may be carried out during a melting or freezing realisation of the appropriate fixed-points or during measurements of the variable temperature blackbodies at appropriate temperatures.

Results – The following information shall be provided:

a) The average background signal and thermometer output signal for measurements made at amplifier gain 1 along with the background-corrected signal;

b) The average background signal and thermometer output signal for measurements made at amplifier gain 2 along with the background-corrected signal;

c) The gain ratio: (background corrected output at amplifier gain 2 / background corrected output at amplifier gain 1)

f) The ambient conditions $t_{amb,}$ RH_{amb} and $t_{int.}$

g) The individual uncertainty components in the measurement of the gain ratio (u_1, u_2, u_3,…) and the total combined uncertainty $U_{gainratio}$.

9.4 MEASUREMENTS USING VARIABLE TEMPERATURE BLACKBODY SOURCES

Measurements should be made at the following temperatures using variable temperature blackbody sources.

The blackbody aperture diameter should be set to 20 mm diameter. If this is not practical the aperture size should be set to an appropriate value, preferably as close as possible to 20 mm diameter. The temperature of the sources should be set to within 0.2 °C of the specified temperatures.

At each temperature a series of measurements should be made of both the thermometer output and the temperature of the source as measured using the contact thermometer within the source. Measurements of the background signal should also be carried out.

The temperatures for the measurements should be:

1. Those corresponding to the In fixed-point (for the INRiM thermometer), then (for both thermometers) the Sn, Zn, Al and Ag fixed-points (if not already carried out under 9.2 above);

2. 200 °C (for the INRiM thermometer), then (for both thermometers) 250 °C, 300 °C and then every 100 °C up to and including 1000 °C if possible.

One complete measurement run should be performed with repeat measurements being carried out at at least five temperatures across the range.

At a minimum of two temperatures for each source (suggest the highest and lowest temperatures) the thermometer should be scanned across the aperture of the blackbody to determine the temperature profile. This will provide information about the temperature uniformity across the source and will be used for any corrections necessary to account for the size-of-source effect.

If the diameter of the blackbody aperture is different from 20 mm, then the thermometer output should be corrected to correspond to the reference target size of 20 mm diameter, using the size-of-source effect results obtained in Section 9.1 and, if necessary, the temperature profile of the furnace.

Results –

The following information should be provided:

a) A description of the blackbody source including blackbody cavity geometry, aperture diameter and emissivity data, and information about the contact sensor within the source.

b) The average thermometer output, the average background signal and the average thermometer output corrected for background at each temperature, the average temperature of the blackbody source and the standard deviation of all the measurements.

c) The results of the scans across the blackbody apertures, including the thermometer output and the blackbody temperature.

d) The thermometer output corrected for SSE to a reference target of 20 mm diameter (if necessary).

e) The ambient conditions t_{amb}, RH_{amb} and $t_{int.}$

f) The individual uncertainty components in the measurements of the blackbody sources (u_1, u_2, u_3,…) and the total combined uncertainty $U_{blackbody}$.

9.5 MEASUREMENTS OF EFFECT OF AMBIENT CONDITIONS

If facilities in the laboratory allow, measurements should be made of the effect of changes in ambient temperature and humidity on the output of each of the thermometers. Measurements should be made while viewing a stable blackbody source (either a fixed-point or variable temperature blackbody) at a temperature of nominally 660 °C. If the laboratory wishes, additional measurements may be made at 232 °C and 962 °C.

The effect of ambient temperature should be measured by recording the output of the thermometer over the range from 18 °C and 26 °C, or over a smaller range if this is more practical. Measurements should be made at intervals of every 2 °C. A set of measurements should be made while viewing a source at 660 °C. If the laboratory wishes, another set of measurements should be made while viewing a source at 232 °C, and a third while viewing a source at 962 °C.

The effect of humidity should be measured at an ambient temperature of 23 °C by recording the output of the thermometer with ambient conditions of 30%, 50% and 70% relative humidity (or at suitable intervals over a smaller range if this is not practical). A set of measurements should be made while viewing a source at 660 °C. If the laboratory wishes, another set of measurements should be made while viewing a source at 232 °C, and a third while viewing a source at 962 °C.

Results –

The following information should be provided:

a) The average thermometer output and background signal for each measurement set at each temperature, the average thermometer output corrected for background and the standard deviation of the measurements. If using a variable temperature blackbody source the average temperature of the source over the duration of the measurements should also be given along with the standard deviation.

b) The average ambient temperature and relative humidity for each measurement set at each temperature, along with t_{int}.

c) The individual uncertainty components in the measurements of the ambient temperature effect (u_1, u_2, u_3,…) and the total combined uncertainty $U_{teffect}$.

d) The individual uncertainty components in the measurements of the relative humidity effect (u_1, u_2, u_3,…) and the total combined uncertainty $U_{RHeffect}$.

10 REPORTING OF THE RESULTS

The following information should be sent to the coordinator within one month of completing the measurements. Please supply both a paper copy and an electronic version.

10.1 DESCRIPTION OF THE EQUIPMENT

All the equipment used for the measurements should be described along with details of the measurement methods, calculations and any assumptions that have been made. The electronic version should be in the form of a Word document.

10.2 RESULTS

The results should be supplied in the form of an Excel spreadsheet / workbook and presented as detailed in Section 9.

10.3 UNCERTAINTIES

The individual uncertainty components for each of the measured parameters should be listed along with the total combined uncertainty of the measurements. All uncertainties should be expressed as k=2; i.e. providing a level of confidence of approximately 95%.

11 APPENDIX 1

11.1 TECHNICAL INFORMATION ABOUT THE THERMOMETERS

11.1.1 IKE LP5

Wavelength: 1568 nm, 36 nm bandwidth

Temperature range: ~230 °C (Sn point) to ~1085 °C (Cu point)

Target size: 2 mm at 750 mm working distance

Working distance: this should be measured from the target to the front of the objective nose of the radiation thermometer

Warm-up time: 1 hour from switch-on

Output: the output is in terms of both photocurrent and temperature. For this comparison only the photocurrent values should be used

Background measurements: these should be performed by placing the lens cap on the front of the thermometer, taking great care not to touch the front lens.

Dimensions: approximately 135 mm high x 175 mm wide x 605 mm long (including objective nose and eyepiece)

11.1.2 INRiM thermometer

Wavelength: 1.5 μm to 1.7 μm

Temperature range: 150 °C to 1000 °C

Target size: 5 mm at 470 mm working distance

Working distance: this should be measured from the target to the front of the objective nose of the radiation thermometer

Warm-up time: 1 hour from switch-on

Output: the output is in terms of voltage

Background measurements: these should be performed by placing the lens cap on the front of the thermometer, taking great care not to touch the front lens.

Dimensions: 170 mm high x 126 mm wide and 400 mm long (including the objective nose)

11.1.3 Zinc point blackbody source

Blackbody dimensions: 9 mm diameter x 61.5 mm long with a 120° end cone

Emissivity: 0.99957 (open aperture)

Dimensions: 150 mm x 260 mm x 315 mm

Weight: 5.7 kg including the ingot

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APPENDIX 2

INSTRUCTIONS FOR USING THE TRANSFER ZINC FIXED-POINT FURNACE

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

HELEN MCEVOY

JANUARY 2018

Department for
Business, Energy
& Industrial Strategy

FUNDED BY BEIS

Appendix 2

Instructions for using the transfer Zinc fixed-point furnace

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Helen McEvoy
Engineering, Materials & Electrical Science

Operational guidelines for the check at the Zn point

Check at the Zn point

Check at the Zn point must be done at arrival at each institute using for this purpose the transfer blackbody furnace. The results of these checks must be transmitted to NPL **immediately** (Helen.Mcevoy@npl.co.uk). In case of dubious results NPL will contact thermometer's supplier, i.e., IKE or INRiM.

Note: For detailed information about the Zn-point furnace, refer to the paper:
F. Girard, T. Ricolfi, "A transportable blackbody furnace for the accurate realization of the fixed points of indium, tin and zinc", Meas. Sci. Technol. 9, 1215-1218 (1998)

Experimental set up

- The thermometers must be positioned at the following distances from the Zn-point furnace:
  INRiM thermometer: **330 mm** between the end of the objective lens holder and the front stainless steel flange of the furnace.
  IKE thermometer: **610 mm** between the front of the radiation thermometer housing and the front stainless steel flange of the furnace.

- The alignment of the thermometers can be made visually by illuminating the interior of the furnace with a suitable illuminator (eg, fiber optic). If thermometer and furnace are properly aligned, observing through the thermometer eyepiece one will see several concentric circles located in different focal planes.

- The following gain must be set:
  INRiM thermometer: $\mathbf{10^7}$ V/A.
  IKE thermometer:

Running the furnace

The parameters on the temperature controller of the furnace have been set to run automatically 2 cycles each of them being comprised of one melt and one freeze. In this way it is possible to check both thermometers in succession utilizing the two freezing plateaus. The operations to start the automatic cycles after switching on the furnace are as follows:

- Press button "**PAR**" two times in quick succession and release it immediately: the display will indicate "**prog**" on the top and "**idle**" below.
- Press the button with vertical arrow (Δ) and release it immediately: the display will indicate "**prog**" on the top and "**run**" below.

The controller now starts running the set program. No further intervention of the operator is needed.

Notes:
- The execution of the whole program including two melts and two freezes will take approximately 5 and half hours.

-The temperature regulator will indicate 424 °C during the melting phase and 417.5 °C during the freezing phase. Do not switch off the furnace before terminating the program. The program will be terminated when the set point display indicates 0 °C after completing the second freeze.

Warning: in case of mistake in the above operations, simply wait a few seconds for the regulator to restore the stand-by condition then repeat the procedure. Do not change the parameters that have been set. Should any problem arise, contact INRiM immediately (f.girard@inrim.it).

Check of positioning

The quality of the melting plateaus is not optimum because of the fast temperature change in the furnace. However a melting plateau may be used to check the alignment of the thermometer. To this purpose, the furnace should be slightly rotated or displaced laterally and vertically during the plateau to ensure that the cone of sight of the thermometer is not partially obstructed.

Measurements during freeze

At the beginnining of the freezing plateau, the following parameters should be measured:
- Ambient temperature t_{amb}
- Relative humidity RH
- Zero signal S_0 by masking the lens with the objective cap.

During the freezing plateau, the following quantities must be measured:
Signals output S in millivolts and resistance R_{int} of the internal PRT (for INRiM thermometer) and temperature t_{int} of IKE thermometer.

(The INRiM thermometer is provided with a 100 Ω PRT for measuring its internal temperature. A four-wire cable is supplied for this purpose. The internal temperature t_{int} can be obtained from the PRT resistance R_{int} according to the relationship

$$t_{int}\ (°C) = -274.8501 + 2.857835\ R_{int} - 1.151867 \bullet 10^{-3}\ R_{int}^2 \qquad (1)$$

The range of applicability of Eq. (1) is from t_{int} = 20 °C to t_{int} = 30 °C).

As representative of the Zn-point signal S_{Zn}, the **average of at least 25 readings taken during a time interval of 10 minutes around the maximum of the plateau** should be considered.

After completing the freezing plateau, the temperature of the furnace will be increased automatically to repeat a melt-freeze cycle. Replace the first thermometer with the other one and repeat the operations above including the check of positioning during the melting plateau.

Note: the Zn point is to be intended for performance and stability checks of the thermometers and not for calibration, because of its low quality. Any possible comparison with other Zn points would provide not significant results

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APPENDIX 3

THE RESULTS AND ANALYSIS OF THE SSE, GAIN/ RANGE RATIO AND AMBIENT CONDITIONS MEASUREMENTS

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

JANUARY 2018

Department for Business, Energy & Industrial Strategy

FUNDED BY BEIS

APPENDIX 3

The Results and Analysis of the SSE, Gain/ Range Ratio and Ambient Conditions Measurements

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Helen McEvoy
Engineering, Materials & Electrical Science

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Approved on behalf of NPL by
Dr Stephanie Bell, Science Area Leader.

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1 THE SSE MEASUREMENTS

1.1 SSE APPARATUS USED AT EACH INSTITUTE

The size-of-source effect (SSE) measurements were made using either the 'indirect' method (with the central portion of the field-of-view of the thermometer obscured by means of a blackened spot or disc) or the 'direct' method (using a blackbody source and a series of apertures) or both methods. For the 'indirect' measurements, the spot size for the INRiM thermometer measurements was to be 6 mm in diameter; the spot sizes for the LP5 thermometer measurements were to be 3 mm and 6 mm in diameter. A summary of the apparatus used at each institute is given in Table 1. Full details can be found in Appendices 7 to 13.

Institute	Method used	Brief description of apparatus
PTB	Direct	Caesium heatpipe blackbody source at nominally 500 °C
NPL	Direct	Sodium heatpipe blackbody source at nominally 500 °C
NPL	Indirect	Integrating sphere with 3 mm and 6 mm blackbodies
CEM	Indirect	Integrating sphere with 3 mm and 6 mm spots
UME	Indirect	Integrating sphere with 3 mm and 6 mm spots
METAS	Direct	Caesium heatpipe blackbody source at nominally 500 °C
LNE	Indirect	Integrating sphere with 4 mm and 6.82 mm spots
INRiM	Indirect	Integrating sphere with 3 mm and 6 mm flattened discs

Table 1: details of the SSE methods used in each of the institutes

1.2 THE RESULTS OF THE SSE MEASUREMENTS

The results of the SSE measurements made at each institute are given in Tables 2 to 22. For the direct measurements, the SSE at each aperture diameter, x, is given by:

$$SSE(x) = \frac{\{Signal\ with\ aperture\ (x) - background\ signal\}}{\{Signal\ with\ maximum\ \ diameter\ \ aperture - background\ signal\}}$$

For the indirect measurements, the SSE is given by:

$$SSE = \frac{\{Signal\ viewing\ spot - background\ signal\}}{\{Signal\ viewing\ \ sphere - background\ signal\}}$$

Plots of the results of the measurements are given in Figures 1 to 13, along with the $k = 2$ uncertainty bars.

1.2.1 Results of the SSE measurements for the INRiM thermometer

PTB results: INRiM thermometer, **direct method**					
Aperture size Ø /mm	SSE (Ø 40 mm) without e-correction	Cs-bb e-correction (Ø 40 mm)	SSE (Ø 40 mm) with e-correction	std. dev. k=1	U_{SSE} k=2
40.0	1.000000	1.000000	1.00000	2.7E-05	6E-05
30.0	1.000094	1.000429	0.99967	2.8E-05	6E-05
20.0	1.00006	1.000736	0.99933	3.0E-05	6E-05
17.5	1.00014	1.000794	0.99934	3.0E-05	7E-05
15.0	1.00004	1.000844	0.99920	3.0E-05	7E-05
12.5	1.00004	1.000886	0.99915	3.2E-05	7E-05
10.0	0.99994	1.000921	0.99902	3.4E-05	7E-05
7.5	0.99997	1.000948	0.99902	4.6E-05	1E-04
5.0	0.9982	1.000967	0.9973	5.2E-04	2E-03

Table 2: the PTB SSE results with the INRiM thermometer (direct method)

NPL measurements: INRiM thermometer, **direct method**†						
Aperture diameter / mm	SSE run 1	SSE run 2	SSE run 3	SSE run 4	Average SSE	Uncertainty (k=2)
3	0.47239	0.47224	0.47247	-	0.47237	0.00023
4	0.82178	0.82382	0.82315	0.82310	0.82296	0.00171
5	0.99856	0.99861	0.99852	0.99867	0.99859	0.00013
7	0.99968	0.99980	0.99989	0.99981	0.99979	0.00018
9	0.99976	0.99987	0.99993	0.99991	0.99987	0.00016
12	0.99984	0.99996	1.00004	1.00001	0.99996	0.00017
15	0.99991	1.00002	1.00003	1.00007	1.00001	0.00014
20	0.99996	1.00005	1.00006	1.00012	1.00005	0.00013
25	1.00003	1.00012	1.00014	1.00015	1.00011	0.00011
30	1.00002	1.00006	1.00003	1.00011	1.00005	0.00008
40	1.00000	1.00000	1.00000	1.00000	1.00000	0.00000

Table 3: the NPL SSE results with the INRiM thermometer (direct method)

† in the calculation of the SSE, the thermometer signals were corrected to compensate for the change in emissivity of the source as the aperture size was increased.

NPL measurements: INRiM thermometer, **indirect method**, 6 mm blackbody						
Aperture diameter / mm	SSE run 1	SSE run 2	SSE run 3	SSE run 4	Average SSE	Uncertainty (*k=2*)
7	9.173E-05	9.042E-05	8.838E-05	8.963E-05	9.004E-05	2.811E-06
9	2.070E-04	2.093E-04	2.069E-04	2.094E-04	2.081E-04	2.755E-06
12	3.207E-04	3.203E-04	3.202E-04	3.201E-04	3.203E-04	4.865E-07
15	4.015E-04	3.991E-04	3.975E-04	4.002E-04	3.996E-04	3.334E-06
18	4.681E-04	4.656E-04	4.668E-04	4.670E-04	4.669E-04	2.025E-06
20	5.053E-04	5.031E-04	5.048E-04	5.042E-04	5.044E-04	1.884E-06
25	5.933E-04	5.922E-04	5.942E-04	5.930E-04	5.932E-04	1.622E-06
30	6.716E-04	6.695E-04	6.715E-04	6.703E-04	6.707E-04	2.043E-06
40	8.116E-04	8.075E-04	8.102E-04	8.091E-04	8.096E-04	3.393E-06
50	9.120E-04	9.114E-04	9.110E-04	9.111E-04	9.114E-04	9.018E-07

Table 4: the NPL SSE results with the INRiM thermometer (indirect method)

CEM results: INRiM thermometer, **indirect**, 6 mm spot		
Aperture diameter/ mm	SSE	U (*k=2*)
6.3	0.000000	-
10.4	0.000265	0.000050
14.1	0.000406	0.000044
19.5	0.000501	0.000034
24.1	0.000591	0.000030
28.9	0.000681	0.000029
33.8	0.000751	0.000028
39.1	0.000827	0.000030
49.1	0.000946	0.000035
59.0	0.001062	0.000046
63.3	0.001220	0.000061
100.0	0.001810	0.000110

Table 5: the CEM SSE results with the INRiM thermometer (indirect mthod)

UME results: INRiM thermometer, **indirect**, 6 mm spot			
Aperture size / mm	SSE	$U_{SSE\ (k=1.0)}$	U/ %
50	0.001264	3.1E-05	2.49
40	0.001097	2.8E-05	2.52
30	0.000876	2.3E-05	2.63
20	0.000620	1.4E-05	2.32
15	0.000472	8.7E-06	1.85
10	0.000276	4.3E-06	1.55
8	0.000161	2.5E-06	1.57

Table 6: the UME SSE results with the INRiM thermometer (indirect method)

METAS results: INRiM thermometer, **direct** method		
Aperture diameter/ mm	SSE	U (*k=2*) / °C
50	1.000000	0.00043
40	1.000025	0.00043
35	1.000252	0.00043
30	1.000174	0.00043
27	0.999849	0.00043
23	0.999965	0.00043
20	1.000110	0.00043
17	1.000060	0.00043
13	0.999851	0.00043
10	0.999667	0.00043
7	0.999632	0.00043
5	0.988740	0.00043

Table 7: the METAS SSE results with the INRiM thermometer (direct method)

LNE results: INRiM, **indirect** method, 6.82 mm spot		
Aperture diameter/ mm	SSE	U (*k=2*)
6	0.000001	1.311E-4
8	0.000110	6.227E-5
10	0.000260	1.052E-4
12	0.000369	1.880E-4
15	0.000513	1.319E-4
20	0.000736	1.961E-4
30	0.001264	2.331E-4
40	0.001756	1.757E-4
50	0.002303	1.585E-4
60	0.002883	2.920E-4
70	0.003440	3.703E-4
6	-0.000001	1.311E-4

Table 8: the LNE SSE results with the INRiM thermometer (indirect method)

INRiM results: INRiM thermometer, **indirect**, 6 mm spot		
Aperture diameter/ mm	SSE (%)	U (%) (*k=2*)
8	0.0194	0.0007
10	0.0315	0.0011
12	0.0405	0.0014
15	0.0508	0.0017
15 rpt	0.0507	0.0017
20	0.0650	0.0022
25	0.0788	0.0027
30	0.0892	0.0030
35	0.0990	0.0034
40	0.1079	0.0037
50	0.1226	0.0042
60	0.1369	0.0047
70	0.1534	0.0052
80	0.1723	0.0059
90	0.1907	0.0065
100	0.2078	0.0071

Table 9: the INRiM SSE results with the INRiM thermometer (indirect method)

1.2.2 Results of the SSE measurements for the LP5 thermometer

PTB results: LP5 thermometer, **direct** method					
aperture size Ø /mm	SSE (Ø40 mm) without e-correction	Cs-bb e-correction (Ø 40 mm)	SSE (Ø40 mm) with e-correction	Std. dev. *k*=1	U_{SSE} *k*=2
40.0	1.000000	1.000000	1.00000	9.9E-06	2E-05
30.0	1.000211	1.000429	0.999782	1.2E-05	3E-05
20.0	1.000405	1.000736	0.999669	1.3E-05	3E-05
15.0	1.000476	1.000844	0.999632	1.4E-05	3E-05
10.0	1.000550	1.000921	0.999629	1.4E-05	3E-05
7.5	1.000680	1.000948	0.999732	1.4E-05	3E-05
5.0	1.000541	1.000967	0.999574	1.5E-05	4E-05
4.0	1.000628	1.000973	0.999656	1.5E-05	4E-05
3.0	1.000591	1.000977	0.999614	1.6E-05	4E-05
2.0	0.99860	1.000980	0.99763	1.3E-04	3E-04

Table 10: the PTB SSE results with the LP5 thermometer (direct method)

NPL measurements: LP5 thermometer, **direct** method†						
Aperture diameter / mm	SSE run 1	SSE run 2	SSE run 3	SSE run 4	Average SSE	Uncertainty (*k=2*)
1.5	-	0.85652	0.84410	0.85969	0.8534	0.0165
2	0.99706	0.99653	0.99741	0.99429	0.9963	0.0028
2.5	0.99943	0.99937	0.99954	0.99962	0.9995	0.0002
3	0.99950	0.99942	0.99959	0.99969	0.9996	0.0002
4	0.99956	0.99944	0.99963	0.99967	0.9996	0.0002
5	0.99953	0.99957	0.99961	0.99966	0.9996	0.0001
7	0.99954	0.99956	0.99969	0.99958	0.9996	0.0001
9	0.99954	0.99958	0.99968	0.99963	0.9996	0.0001
12	0.99954	0.99968	0.99967	0.99965	0.9996	0.0001
15	0.99950	0.99970	0.99966	0.99970	0.9996	0.0002
20	0.99949	0.99973	0.99969	0.99974	0.9997	0.0002
25	0.99966	0.99984	0.99981	0.99989	0.9998	0.0002
30	0.99963	0.99984	0.99981	0.99990	0.9998	0.0002
40	1.00000	1.00000	1.00000	1.00000	1.0000	0.0000

Table 11: the NPL SSE results with the LP5 thermometer (direct method)

† in the calculation of the SSE, the thermometer signals were corrected to compensate for the change in emissivity of the source as the aperture size was increased.

NPL measurements: LP5 thermometer, **indirect** method, 3 mm diameter blackbody						
Aperture diameter / mm	SSE run 1	SSE run 2	SSE run 3	SSE run 4	Average SSE	Uncertainty (*k=2*)
4	0.0000513	0.0000547	0.0000571	0.0000605	0.0000559	0.0000078
5	0.0000558	0.0000598	0.0000613	0.0000605	0.0000594	0.0000049
6	0.0000661	0.0000688	0.0000706	0.0000725	0.0000695	0.0000055
7	0.0000683	0.0000743	0.0000778	0.0000824	0.0000757	0.0000118
9	0.0000848	0.0000840	0.0000826	0.0000915	0.0000857	0.0000079
12	0.0000913	0.0000899	0.0000942	0.0000988	0.0000936	0.0000078
15	0.0000984	0.0001037	0.0001035	0.0001065	0.0001030	0.0000068
18	0.0001052	0.0001095	0.0001071	0.0001084	0.0001075	0.0000037
20	0.0001100	0.0001126	0.0001137	0.0001159	0.0001131	0.0000049
25	0.0001146	0.0001182	0.0001234	0.0001198	0.0001190	0.0000073
30	0.0001300	0.0001324	0.0001292	0.0001260	0.0001294	0.0000053
40	0.0001437	0.0001466	0.0001443	0.0001427	0.0001443	0.0000033
50	0.0001605	0.0001612	0.0001597	0.0001590	0.0001601	0.0000020

Table 12: the NPL SSE results with the LP5 thermometer (indirect method, 3 mm blackbody)

NPL measurements: LP5 thermometer, **indirect** method, 6 mm diameter blackbody						
Aperture diameter / mm	SSE run 1	SSE run 2	SSE run 3	SSE run 4	Average SSE	Uncertainty (*k=2*)
7	0.0000221	0.0000152	0.0000167	0.0000105	0.0000161	0.0000095
9	0.0000281	0.0000209	0.0000228	0.0000221	0.0000235	0.0000064
12	0.0000356	0.0000306	0.0000328	0.0000324	0.0000329	0.0000042
15	0.0000432	0.0000407	0.0000411	0.0000444	0.0000423	0.0000035
18	0.0000523	0.0000477	0.0000509	0.0000536	0.0000511	0.0000051
20	***0.0000500***[†]	0.0000556	0.0000567	0.0000591	0.0000571	0.0000036
25	0.0000663	0.0000674	0.0000670	0.0000712	0.0000680	0.0000044
30	0.0000802	0.0000821	0.0000812	0.0000848	0.0000821	0.0000039
40	0.0001085	0.0001108	0.0001105	0.0001134	0.0001108	0.0000041
50	0.0001353	0.0001394	0.0001369	0.0001394	0.0001378	0.0000040

Table 13: the NPL SSE results with the LP5 thermometer (indirect method, 6 mm blackbody)

[†] this value is not consistent with the others and has therefore not been included in the average.

CEM results: LP5 thermometer, **indirect**, 3 mm spot		
Aperture diameter/ mm	SSE	U (*k=2*)
6.3	0.000000	-
10.4	0.000059	0.000008
14.1	0.000076	0.000007
19.5	0.000101	0.000005
24.1	0.000117	0.000005
28.9	0.000122	0.000004
33.8	0.000127	0.000004
39.1	0.000131	0.000004
49.1	0.000140	0.000005
59.0	0.000181	0.000008
63.3	0.000207	0.000023
100.0	0.000342	0.000043

Table 14: the CEM SSE results with the LP5 thermometer (indirect method, 3 mm spot)

CEM results: LP5 thermometer, **indirect**, 6 mm spot		
Aperture diameter/ mm	SSE	U (*k=2*)
6.3	0.000000	-
10.4	0.000018	0.000004
14.1	0.000018	0.000004
19.5	0.000039	0.000004
24.1	0.000054	0.000004
28.9	0.000070	0.000004
33.8	0.000079	0.000004
39.1	0.000086	0.000004
49.1	0.000110	0.000004
59.0	0.000138	0.000005
63.3	0.000169	0.000007
100.0	0.000280	0.000020

Table 15: the CEM SSE results with the LP5 thermometer (indirect method, 6 mm spot)

UME results: LP5 thermometer, **indirect**, 3 mm spot			
Aperture size/ mm	SSE	$U_{SSE\ (k=1.0)}$	U/ %
50	0.000767	1.3E-05	1.69
40	0.000634	1.2E-05	1.91
30	0.000472	1.0E-05	2.13
20	0.000296	1.2E-05	4.05
15	0.000226	1.3E-05	5.64
10	0.000152	1.4E-05	9.02
8	0.000140	1.0E-05	7.26
5	0.000088	1.1E-05	12.22

Table 16: the UME SSE results with the LP5 thermometer (indirect method, 3 mm spot)

UME results: LP5 thermometer, **indirect**, 6 mm spot			
Aperture size/ mm	SSE	$U_{SSE\ (k=1.0)}$	U/ %
50	0.000677	9.1E-06	1.35
40	0.000544	9.1E-06	1.66
30	0.000365	8.9E-06	2.44
20	0.000204	8.7E-06	4.29
15	0.000141	8.7E-06	6.15
10	0.000061	8.6E-06	14.14
8	0.000043	8.6E-06	20.20

Table 17: the UME SSE results with the LP5 thermometer (indirect method, 6 mm spot)

METAS results: LP5 thermometer, **direct** method		
Aperture diameter/ mm	SSE	U (*k=2*) / °C
50	1.000000	0.00043
40	1.000008	0.00043
35	1.000058	0.00043
30	1.000008	0.00043
27	1.000023	0.00043
23	1.000104	0.00043
20	1.000150	0.00043
17	1.000116	0.00043
13	1.000092	0.00043
10	1.000286	0.00043
7	1.000311	0.00043
5	1.000236	0.00043

Table 18: the METAS SSE results with the LP5 thermometer (direct method)

LNE results: LP5 thermometer, **indirect** method, 4 mm spot		
Aperture diameter / mm	SSE	U (*k=2*)
4	0.000004	1.135E-4
6	0.000058	7.929E-4
8	0.000104	9.487E-5
10	0.000146	1.076E-4
12	0.000192	1.810E-4
15	0.000272	6.603E-5
20	0.000408	1.272E-4
30	0.000735	3.393E-4
40	0.001119	1.469E-4
50	0.001553	3.673E-4
60	0.001983	6.053E-4
70	0.002574	8.958E-4
4	-0.000004	1.135E-4

Table 19: the LNE SSE results with the LP5 thermometer (indirect method, 4 mm spot)

LNE results: LP5, **indirect** method, 6.82 mm spot		
Aperture diameter/ mm	SSE	U (*k=2*)
6	-0.00000198	5.178E-06
8	0.00001688	6.346E-05
10	0.00005975	4.280E-05
12	0.00010119	5.094E-05
15	0.00015316	6.190E-05
20	0.00026058	7.539E-05
30	0.00051823	4.275E-04
40	0.00078841	8.068E-04
50	0.00107212	1.485E-03
60	0.00140196	1.723E-03
70	0.00173278	3.130E-03
6	0.00000198	5.178E-06

Table 20: the LNE SSE results with the LP5 thermometer (indirect method, 6.82 mm spot)

INRiM results: LP5 thermometer, **indirect** method, 3 mm spot		
Aperture diameter/ mm	SSE/ %	U (*k=2*)/ %
4	0.0041	0.0001
5	0.0073	0.0002
6	0.0091	0.0003
8	0.0118	0.0004
10	0.0150	0.0005
10 rpt	0.0158	0.0005
12	0.0186	0.0006
15	0.0229	0.0007
20	0.0294	0.0009
25	0.0370	0.0012
30	0.0436	0.0014
35	0.0494	0.0016
40	0.0550	0.0018
50	0.0659	0.0021
60	0.0762	0.0024
70	0.0851	0.0027
80	0.0945	0.0030
90	0.1027	0.0033
100	0.1106	0.0035

Table 21: the INRiM SSE results with the LP5 thermometer (indirect method, 3mm spot)

INRiM results: LP5 thermometer, **indirect** method, 6 mm spot		
Aperture diameter/ mm	SSE/ %	U (*k=2*)/ %
8	0.0035	0.0001
10	0.0065	0.0002
12	0.0093	0.0003
12 rpt	0.0091	0.0003
15	0.0133	0.0004
20	0.0198	0.0006
25	0.0275	0.0009
30	0.0335	0.0011
35	0.0398	0.0013
40	0.0452	0.0014
50	0.0559	0.0018
60	0.0665	0.0021
70	0.0754	0.0024
80	0.0842	0.0027
90	0.0918	0.0029
100	0.0997	0.0032

Table 22: the INRiM SSE results with the LP5 thermometer (indirect method, 6 mm spot)

1.3 THE PLOTS OF THE RESULTS OF THE MEASUREMENTS

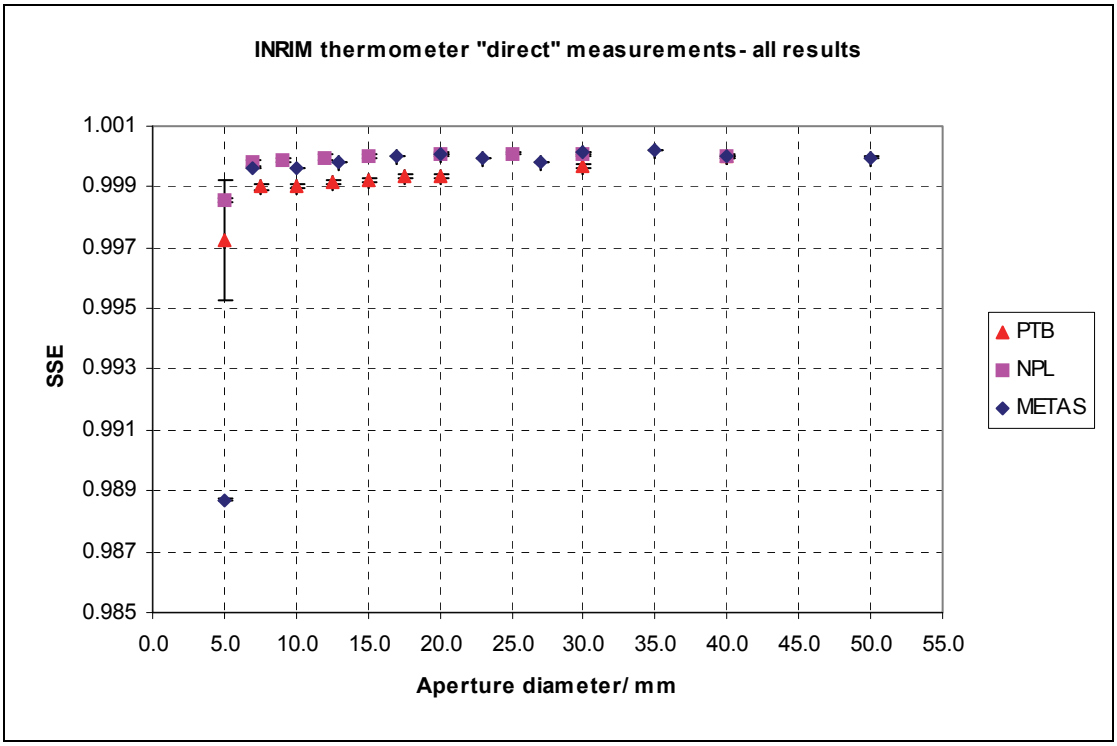


Figure 1: the results of the 'direct' SSE measurements with the INRiM thermometer

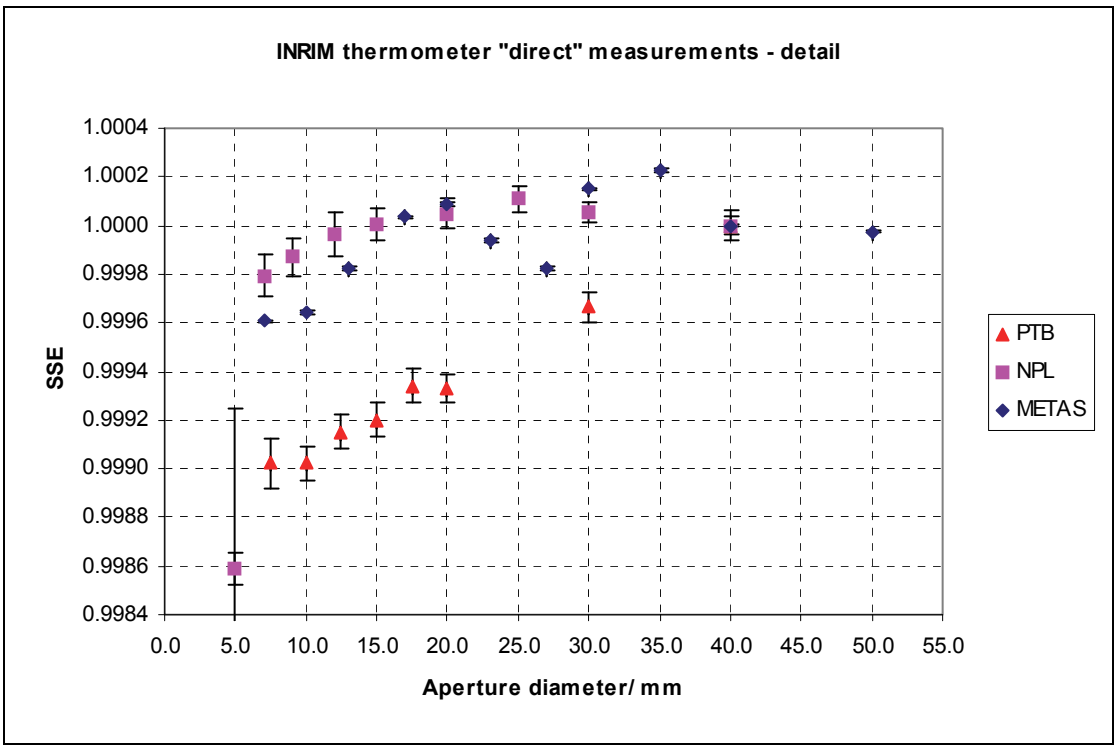


Figure 2: the detailed results of the 'direct' SSE measurements for the INRiM thermometer

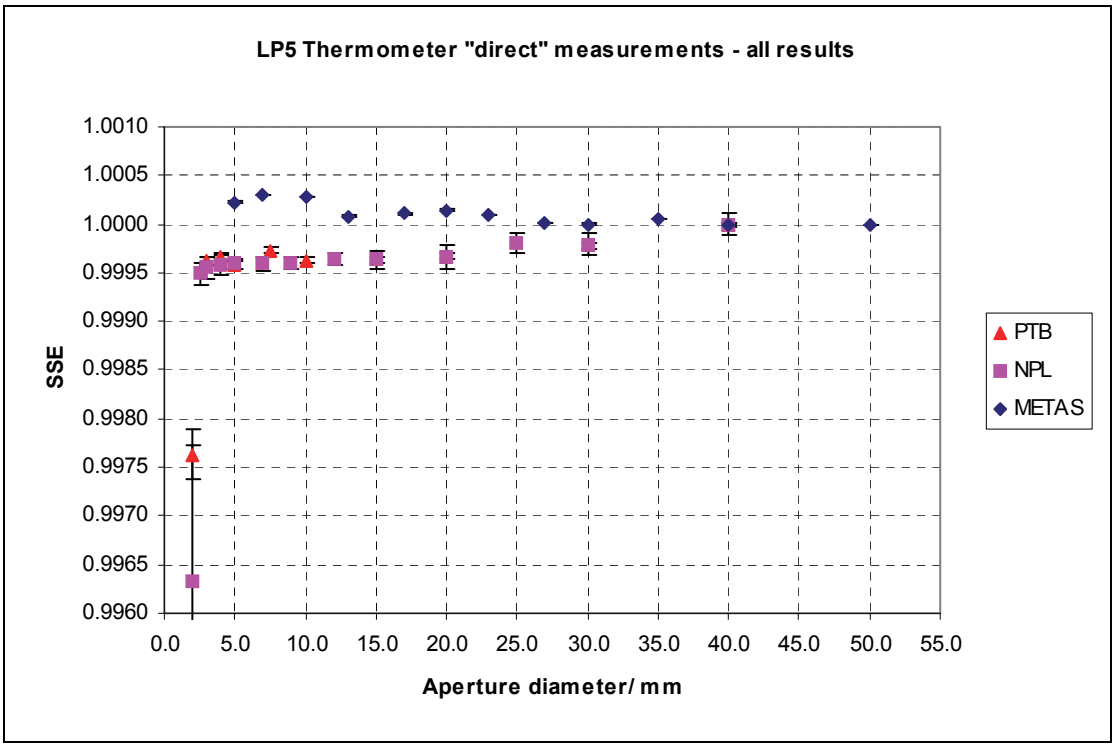


Figure 3: the results of the 'direct' SSE measurements for the LP5

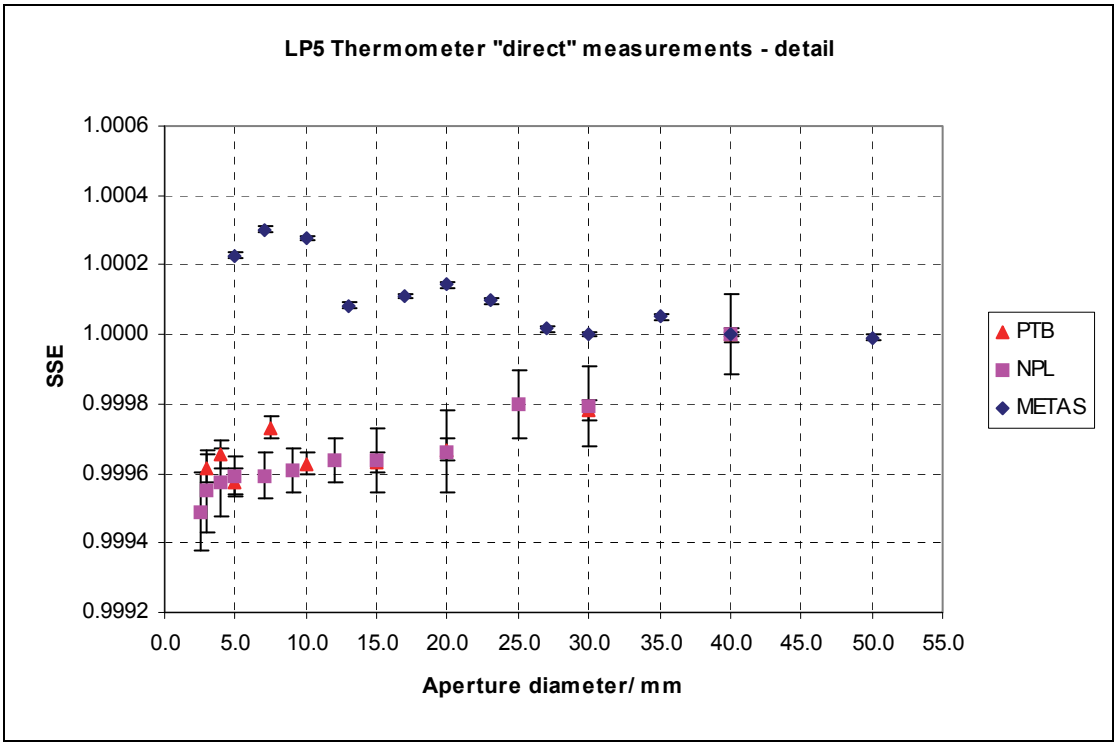


Figure 4: the detailed results of the 'direct' SSE measurements for the LP5

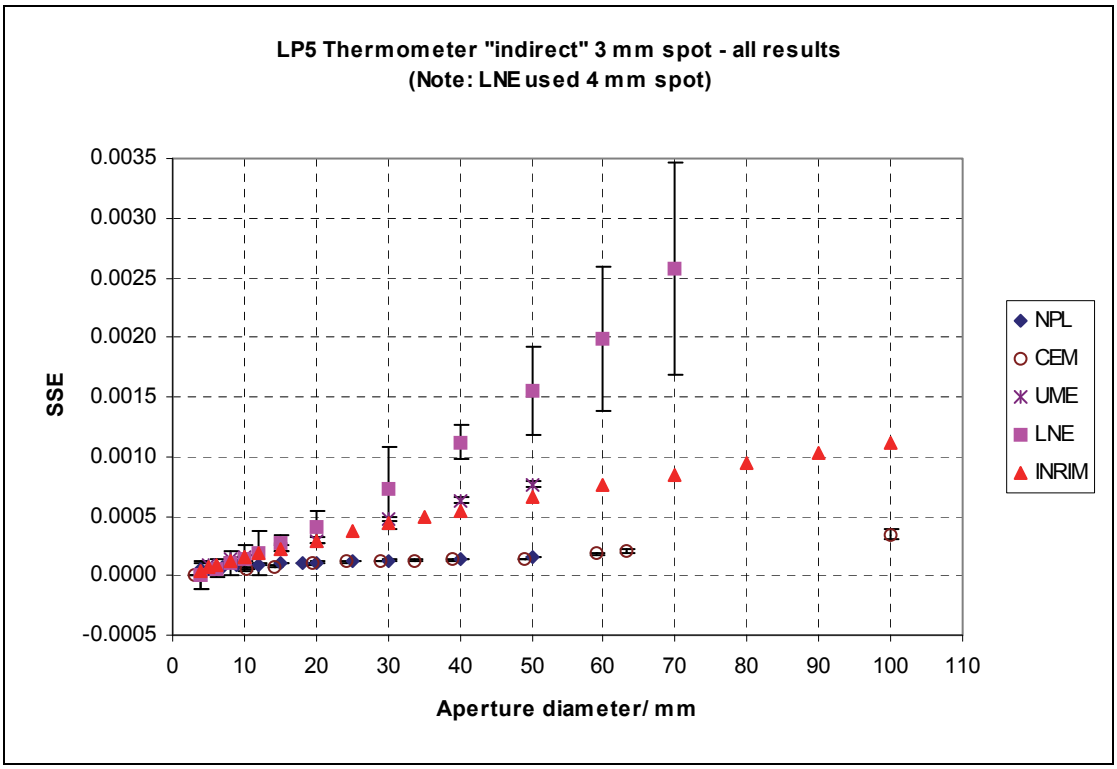


Figure 5: the results of the 'indirect' SSE measurements for the LP5 (3 mm spot)

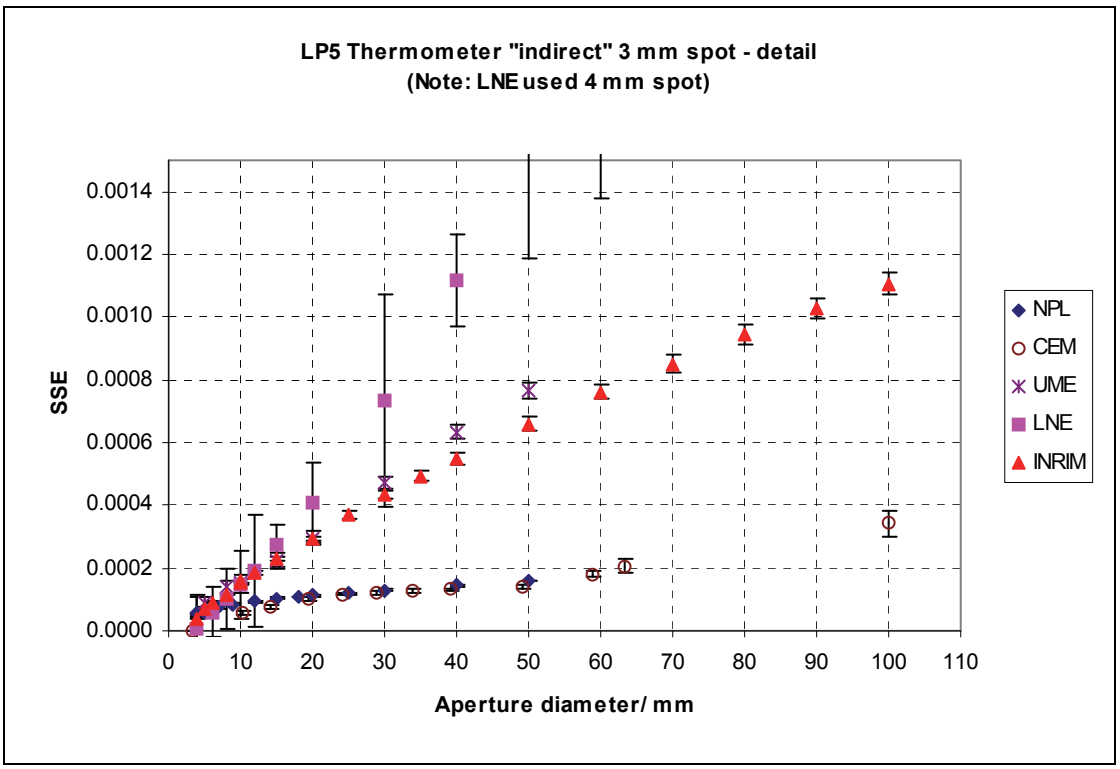


Figure 6: the detailed results of the 'indirect' SSE measurements for the LP5 (3 mm spot)

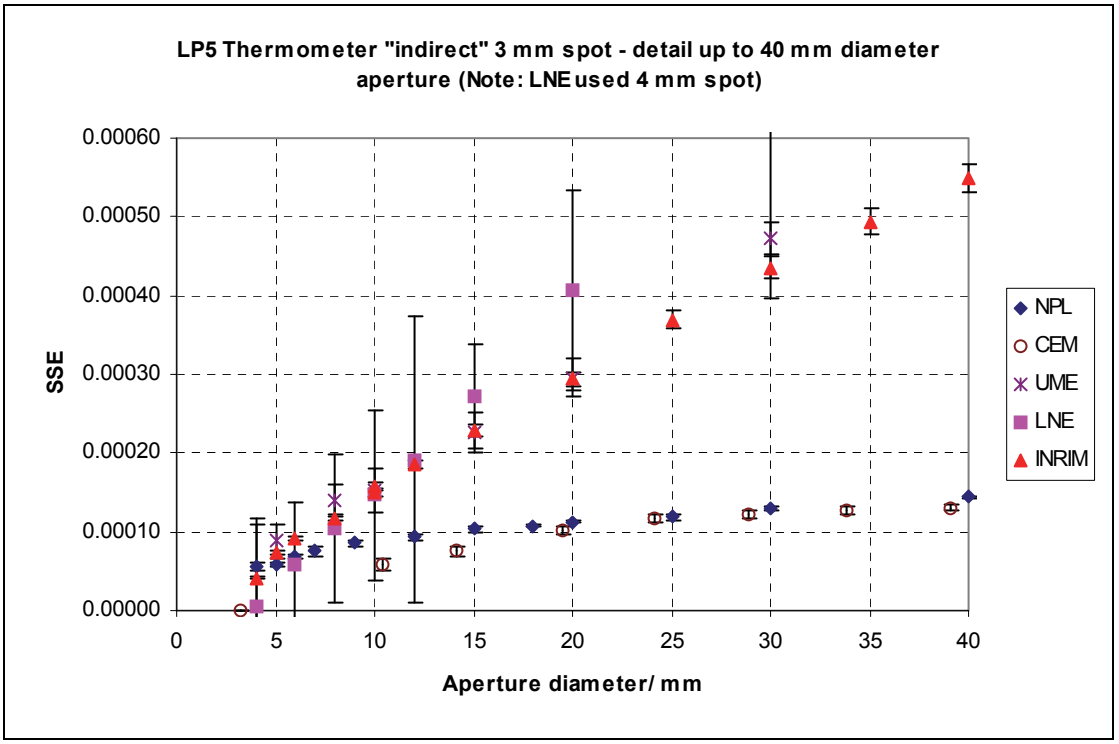


Figure 7: detailed results of the 'indirect' SSE measurements for the LP5 up to 40 mm diameter (3 mm spot)

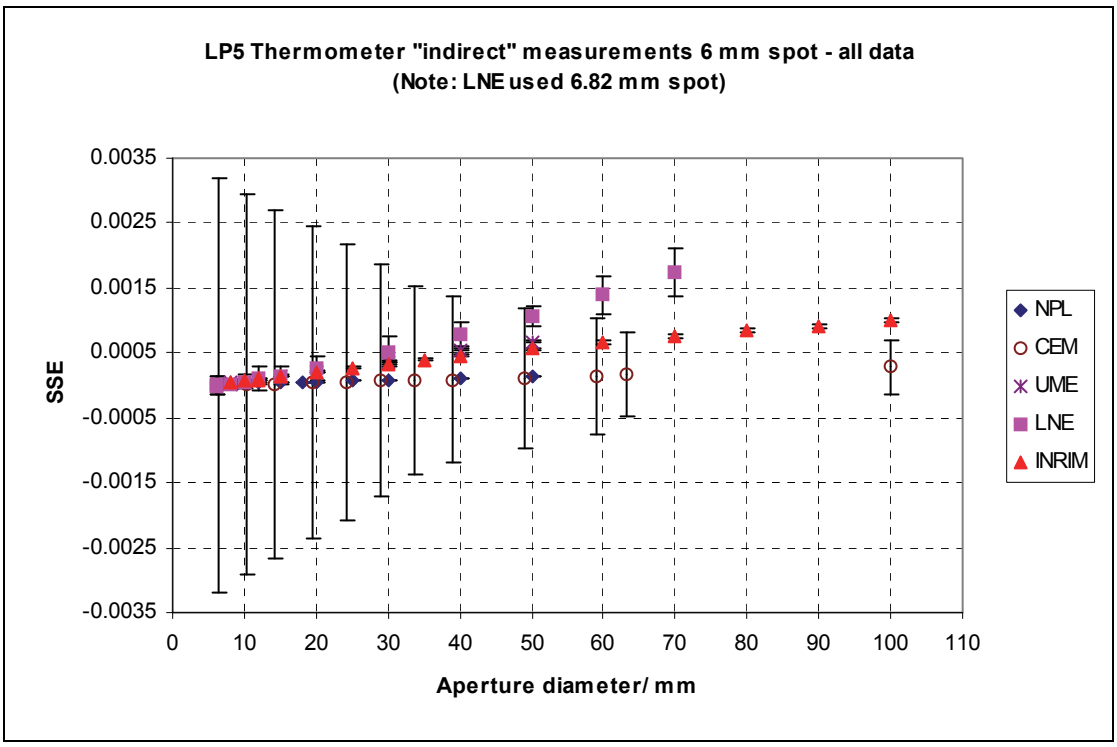


Figure 8: results of the 'indirect' SSE measurements for the LP5 (6 mm spot)

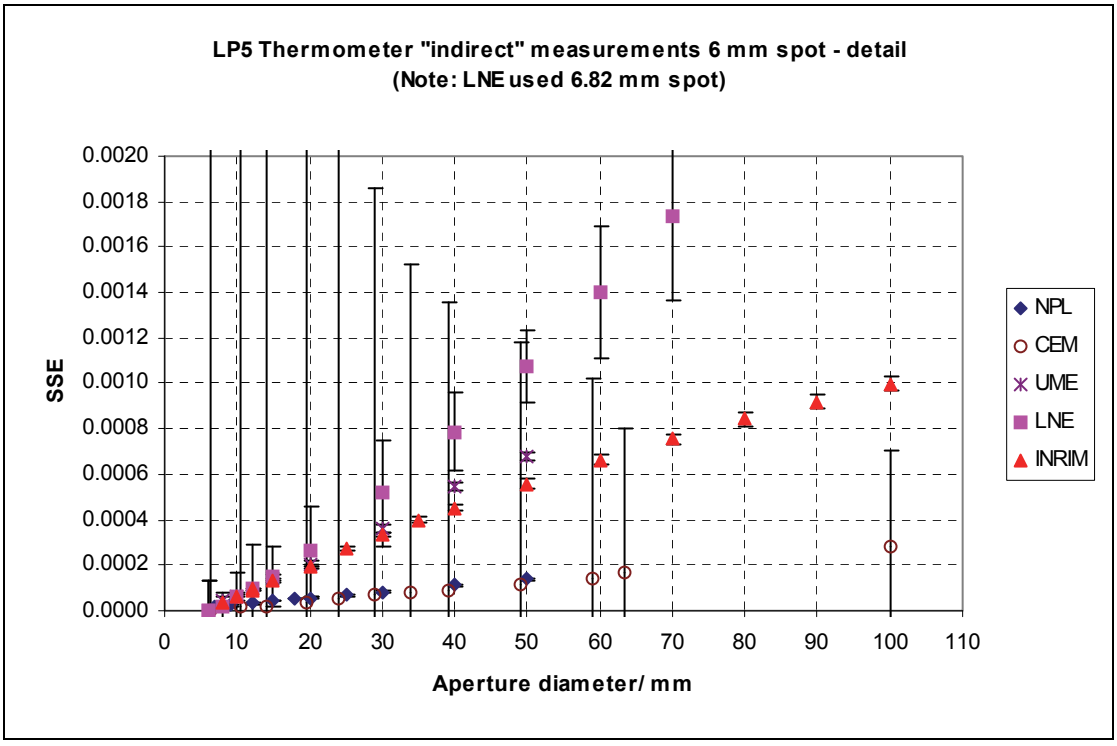


Figure 9: detailed results of the 'indirect' SSE measurements for the LP5 (6 mm spot)

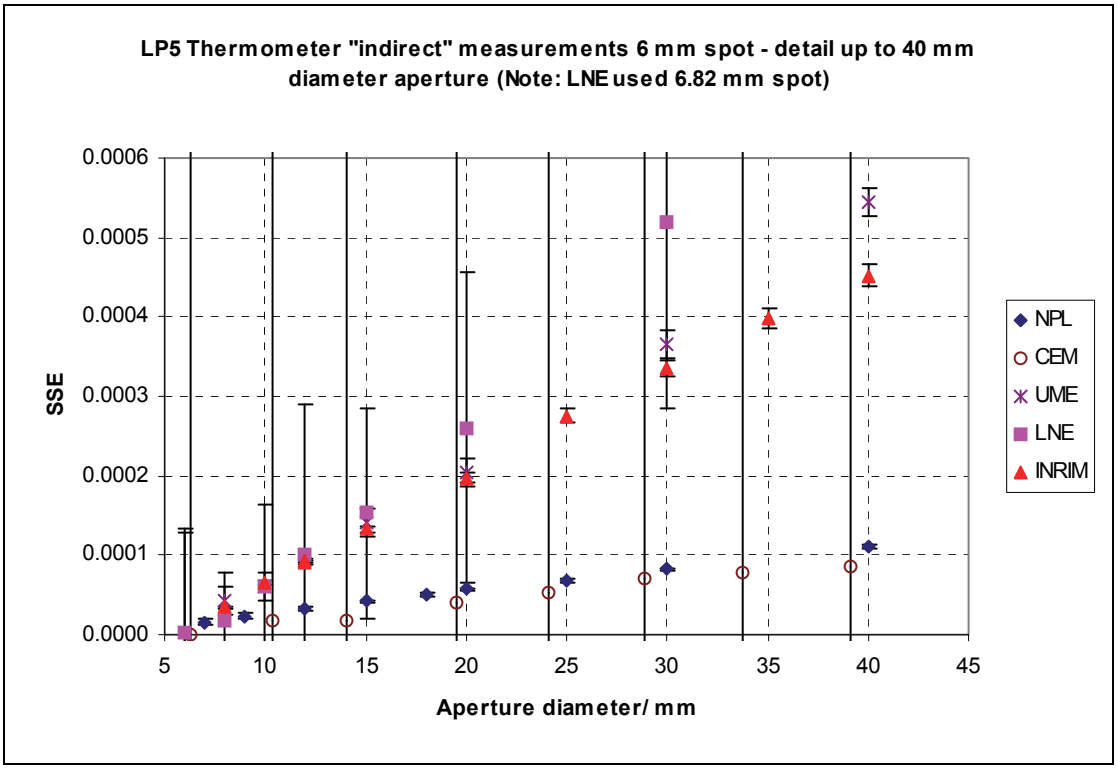


Figure 10: detailed results of the 'indirect' SSE measurements for the LP5 up to 40 mm diameter (6 mm spot)

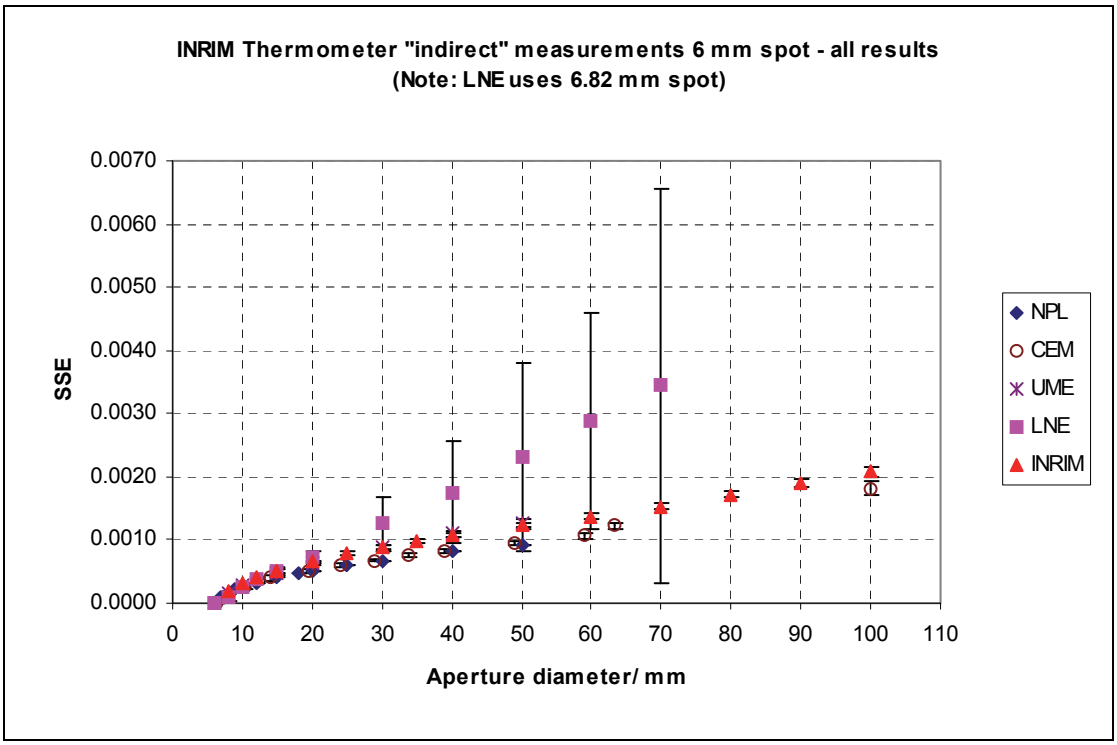


Figure 11: results of the 'indirect' SSE measurements for the INRiM thermometer (6 mm spot)

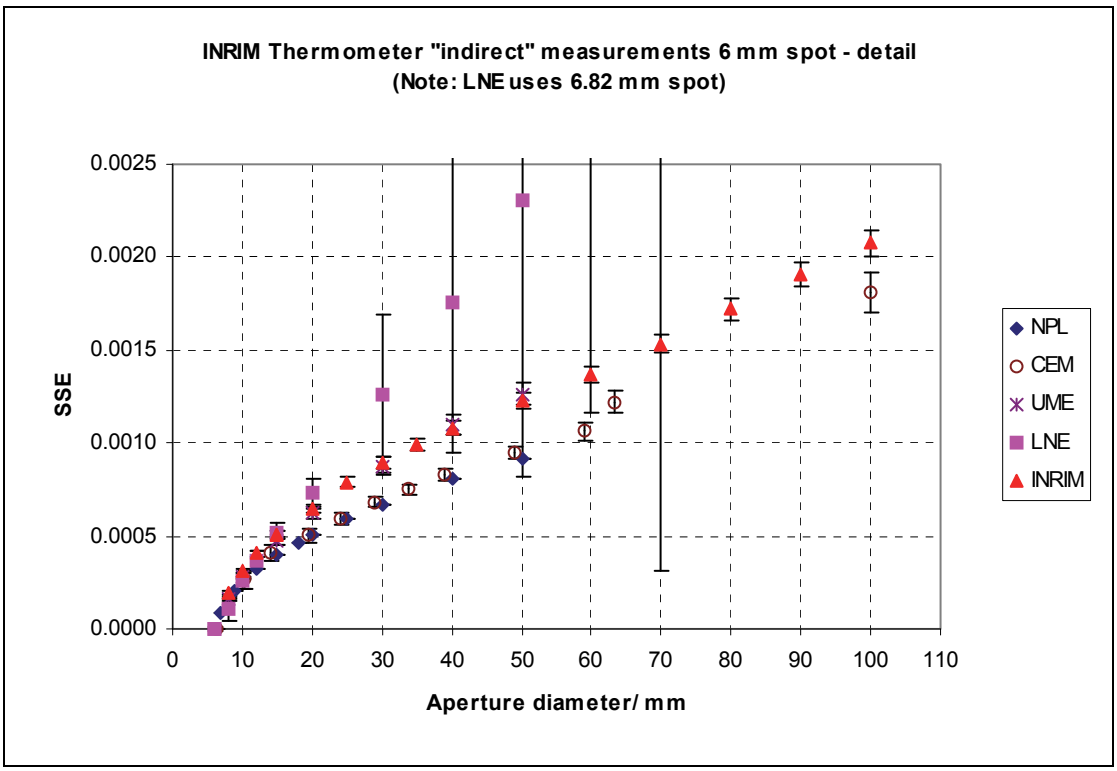


Figure 12: detailed results of the 'indirect' SSE measurements for the INRiM thermometer (6 mm spot)

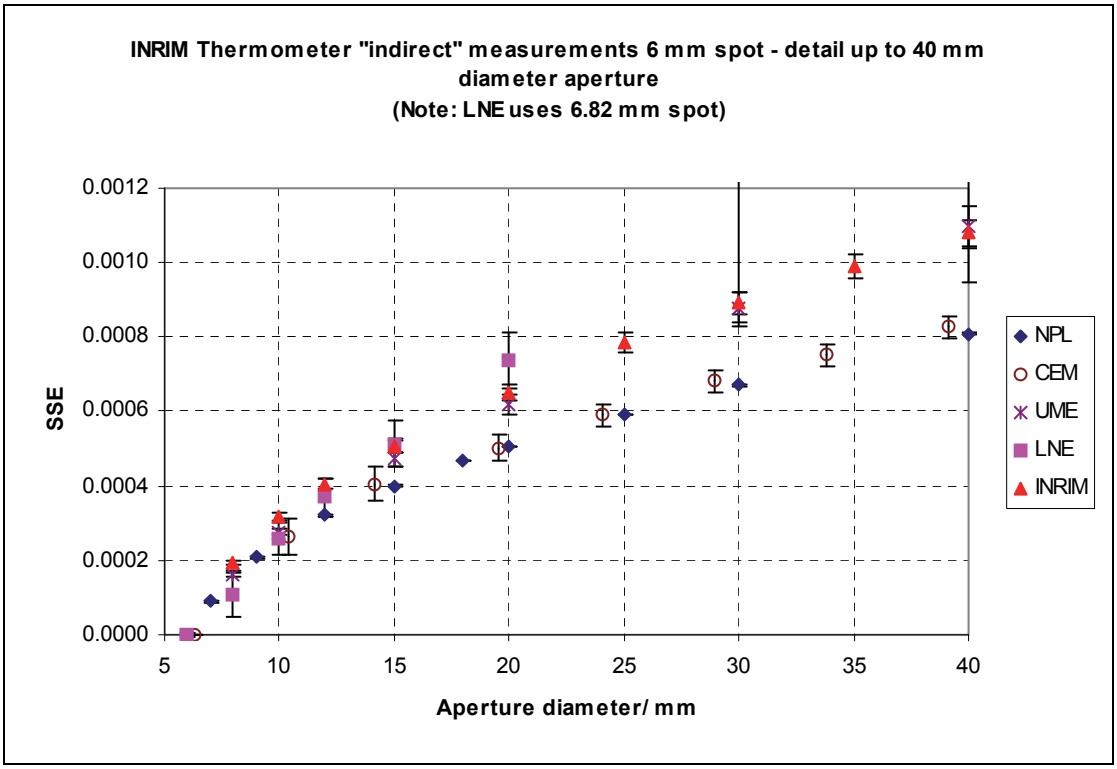


Figure 13: detailed results of the 'indirect' SSE measurements for the INRiM thermometer up to 40 mm diameter (6 mm spot)

1.4 ANALYSIS OF THE SSE RESULTS, DISCUSSIONS AND CONCLUSIONS

1.4.1 Analysis of the results

The SSE measurements were made using the aperture sizes available at each institute. This resulted in the measurements being made at a range of different aperture sizes, with only some overlap between institutes. In order to be able to directly compare all the results, and so that a comparison reference value could be calculated, the data sets from each participant were initially fitted using a Chebyshev polynomial expression[1] [1]. This polynomial expression was then used to provide, for each participant, an interpolated SSE over the range of apertures used by that participant. The average SSE value could then be calculated for specific aperture diameters in order to provide a comparison reference value at these diameters. The specific aperture diameters chosen for the indirect method were 5 mm (for the measurements with the 3 mm diameter spot) then (for both spots) 7 mm, 10 mm, every 5 mm to 30 mm, and then 40 mm, 50 mm, 60 mm, 70 mm, 80 mm and 100 mm. The specific aperture diameters chosen for the direct method were 3 mm (for the LP5), 5 mm (for both thermometers), 10 mm, and then every 5 mm to 40 mm.

The order of the polynomial fit for each participant was generally chosen to be $\leq n/2$, with n being the number of supplied data pairs (aperture diameter, SSE) from that participant, and ensuring that the fit was a good approximation to the data considering the estimated uncertainties of the measurements. The root mean square (rms) residual for each fit was used as an additional uncertainty component and was combined in quadrature with the participant's measurement uncertainty. The total uncertainty values were interpolated, where necessary, to give the values at each of the chosen aperture diameters. Information about the fitting, including Chebyshev coefficients and residuals and total combined uncertainties, is given in Tables 23 to 64.

In order to compare the results more rigorously a comparison reference value was needed. For each chosen aperture diameter the mean, weighted mean (weighted with respect to the laboratory measurement uncertainty) and median SSE values were calculated from the fitted data. The differences (laboratory – mean or median) were then calculated and the results are shown in Tables 65 to 105 and in the accompanying Figures. Discontinuities occur when the number of data sets (participants) changes. Since the LNE indirect measurements were carried out using spots that were different sizes from the other laboratories (although the measured SSE values were consistently higher than those of the other laboratories), the mean/ median/ weighted mean values and the laboratory differences were calculated both with and without the LNE data.

The arithmetic mean was chosen as the reference value for both thermometers and for both SSE methods. Since it was simply being used as a tool to facilitate the comparison of the results it was not assigned an uncertainty.

The calculated degrees of equivalence (DOE) and quantified demonstrated equivalence (QDE_{95}[2]) values for pairs of participants are given in Tables 106 to 196 (DOE and QDE_{95} values are, respectively, top right and bottom left sections of the Tables). The QDE_{95} values for each pair of labs (*i*,*j*) were calculated from the equation:

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1 The Chebyshev coefficients are obtained using values of *x* transformed to lie in the range (-1/+1) by the equation: *xx* = ((*x* – *xmin*) – (*xmax* – *x*))/(*xmax* – *xmin*), *xmin and xmax* being the minimum and maximum aperture diameters respectively.

The coefficients *a*(0), *a*(1), …, *a*(n) are given for the Chebyshev series:

$$y = 0.5 * a(0) + \sum_{j=1}^{n} (a(j) * T(j))$$

where *T*(*j*) is defined as cos(*j***z*) and where cos(*z*) = *xx*

2 For example, Wood, B. M., Douglas, R. J., *Metrologia*, 1998, **35**, pp 187-196

$$QDE_{95\,(i,j)} = \left|\Delta SSE\right|_{(i,j)} + \left\{1.645 + 0.3295 \exp\left(\frac{-4.05\ \left|\Delta SSE\right|_{(i,j)}}{u_{(i,j)}}\right)\right\} u_{(i,j)} \qquad \textbf{Equation 1}$$

where $\left|\Delta SSE\right|_{(i,j)}$ is the absolute difference in the SSE values between the two laboratories and $u_{(i,j)}$ is the combined $k = 1$ uncertainty.

The difference between each laboratory and the mean value at each aperture diameter, along with the estimated $k = 2$ measurement uncertainties, are given in the Figures accompanying the Tables.

1.4.2 Discussion of the results

It should be noted that some of the observed differences are due to the fitting function (as evidenced by the residuals of the fits – see Sections 1.5 and 1.6) and are not a real effect. It should also be noted that there is a considerable spread in the uncertainty values of the different participants (for example there is about a factor of ten spread in the uncertainties for the INRiM thermometer using the direct method), as well as inconsistencies in the results of the participants. It would be interesting to understand the reason(s) behind some of these inconsistencies, and whether some laboratories have maybe over- or under-estimated any uncertainty components.

Measurements using the 'direct' method:

1) For the INRiM thermometer, the NPL and METAS results are in reasonably good agreement, although not within the measurement uncertainties, whereas the PTB results are consistently lower and not within the measurement uncertainties. For the LP5 thermometer, the PTB and NPL results are in good agreement within the measurement uncertainties whereas the METAS results are consistently higher and not within the measurement uncertainties.

Measurements using the 'indirect' method:

1) As has been stated earlier, LNE used spots that were of a larger diameter than those of the other laboratories. However, the LNE SSE values are consistently higher, for both thermometers, compared to the results of the other laboratories, which is counterintuitive. LNE has suggested that this is possibly due to the arrangement of the LNE SSE apparatus, which has a diaphragm aperture some distance in front of the integrating sphere and could have resulted in light leakage. Alternatively, it might be that the metal spots have a not-insignificant transmission.

2) For both the INRiM thermometer and the LP5, the NPL and CEM results are in good agreement with each other, whereas the UME and INRiM results are consistently higher but in close agreement with each other. The results, apart from those of LNE, are in better agreement for the INRiM thermometer than for the LP5.

Comparison between the two methods:

The 'direct' and 'indirect' methods each provide an assessment of the SSE of a radiation thermometer but the methodology is different. The 'direct' method shows the relative change in signal of the radiation thermometer as the aperture size is varied, with the results normalised to the signal at the maximum diameter aperture. The 'indirect' method shows the change in 'residual' signal (most of the field-of-view of the radiation thermometer is obscured) relative to the radiance of the integrating sphere and the results are not normalised to a particular aperture size. Thus the two methods give different values: for a radiation thermometer with good SSE characteristics the values will be near 1 for the 'direct' method and small for the 'indirect method'. Although initially an attempt was made to directly compare the results between the

two methods it was found to be overly complex and this was not done. Instead the comparison was limited to those laboratories using the same method.

1.5 THE FITTING DATA FOR THE INRIM THERMOMETER SSE MEASUREMENTS

1.5.1 Direct SSE measurements

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
5	0.997250	0.997258	0.000008
7.5	0.999022	0.998980	-0.000042
10	0.999025	0.999111	0.000086
12.5	0.999150	0.999073	-0.000077
15	0.999201	0.999211	0.000010
17.5	0.999342	0.999371	0.000029
20	0.999329	0.999314	-0.000015
30	0.999665	0.999665	0.000000
40	1.000000	1.000000	0.000000
		Root mean square residual =	0.000090

Table 23 – the PTB direct SSE measurements with the INRiM thermometer

Table 24 – the Chebyshev polynomial coefficients (PTB, direct measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	2.00049019E+00
1	2.50729091E-03
2	6.17030851E-04
3	-3.46389633E-05
4	-1.43854827E-03
5	-1.10147284E-03
6	-7.94785071E-04

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
5	0.998590	0.998619	0.000029
7	0.999790	0.999682	-0.000108
9	0.999870	0.999982	0.000112
12	0.999960	0.999960	0.000000
15	1.000010	0.999942	-0.000068
20	1.000050	1.000107	0.000057
25	1.000110	1.000082	-0.000028
30	1.000050	1.000057	0.000007
40	1.000000	1.000000	0.000000
		Root mean square residual =	0.000130

Table 25 – the NPL direct SSE measurements with the INRiM thermometer

Table 26 – the Chebyshev polynomial coefficients (NPL, direct measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	2.00004441E+00
1	5.74066672E-04
2	-1.85389736E-04
3	1.59177763E-04
4	-3.01357881E-04
5	-4.29280819E-05
6	-2.26001315E-04

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
5	0.988715	0.988741	0.000025
7	0.999607	0.999505	-0.000102
10	0.999643	0.999883	0.000240
13	0.999826	0.999517	-0.000309
17	1.000035	1.000269	0.000234
20	1.000086	1.000080	-0.000005
23	0.999940	0.999749	-0.000191
27	0.999824	1.000014	0.000190
30	1.000149	1.000056	-0.000093
35	1.000227	1.000240	0.000012
40	1.000000	0.999999	-0.000001
		Root mean square residual =	0.000388

Table 27 – the METAS direct SSE measurements with the INRiM thermometer

(Note that the METAS data has been adjusted to give the SSE values relative to a 40 mm diameter aperture to be consistent with the maximum diameter apertures of NPL and PTB.)

Table 28 – the Chebyshev polynomial coefficients (METAS, direct measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	1.99861248E+00
1	2.53117720E-03
2	-1.37947063E-03
3	1.79094451E-03
4	-1.46746192E-03
5	9.00800389E-04
6	-1.32309191E-03
7	4.06293619E-04
8	-7.66480785E-04

1.5.2 Indirect measurements – 6 mm diameter spot

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
7	0.000090	0.000093	0.000003
9	0.000208	0.000203	-0.000005
12	0.000320	0.000321	0.000001
15	0.000400	0.000404	0.000004
18	0.000467	0.000467	0.000000
20	0.000504	0.000504	-0.000001
25	0.000593	0.000590	-0.000003
30	0.000671	0.000674	0.000003
40	0.000810	0.000809	-0.000001
50	0.000911	0.000911	0.000000
		Root mean square residual =	0.000004

Table 29 – the NPL indirect SSE measurements with the INRiM thermometer

Table 30 - the Chebyshev polynomial coefficients (NPL, indirect measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	1.17690672E-03
1	3.75400915E-04
2	-7.33357043E-05
3	2.33295642E-05
4	-1.29803075E-05
5	1.06044545E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
6.3	0.000000	-0.000001	-0.000001
10.4	0.000265	0.000269	0.000004
14.1	0.000406	0.000399	-0.000007
19.5	0.000501	0.000510	0.000009
24.1	0.000591	0.000588	-0.000003
28.9	0.000681	0.000671	-0.000010
33.8	0.000751	0.000756	0.000005
39.1	0.000827	0.000836	0.000009
49.1	0.000946	0.000934	-0.000012
59.0	0.001062	0.001072	0.000010
63.3	0.001220	0.001215	-0.000005
100.0	0.001810	0.001810	0.000000
		Root mean square residual =	0.000011

Table 31 – the CEM indirect SSE measurements with the INRiM thermometer

Table 32 - the Chebyshev polynomial coefficients (CEM, indirect measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	2.84505341E-03
1	1.43377163E-03
2	1.11161150E-04
3	-2.17265280E-04
4	-4.84241062E-04
5	-3.11065800E-04
6	-1.44878010E-04

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
8	0.000161	0.000166	0.000005
10	0.000276	0.000268	-0.000008
15	0.000472	0.000472	0.000000
20	0.000620	0.000625	0.000005
30	0.000876	0.000872	-0.000004
40	0.001097	0.001099	0.000002
50	0.001264	0.001264	0.000000
		Root mean square residual =	0.000008

Table 33 - the UME indirect SSE measurements with the INRiM thermometer

Table 34 - the Chebyshev polynomial coefficients (UME, indirect measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	1.59065746E-03
1	5.34242855E-04
2	-6.67330627E-05
3	1.44838459E-05
4	-1.36965957E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
6	0.000000	0.000003	0.000003
8	0.000110	0.000125	0.000016
10	0.000260	0.000242	-0.000018
12	0.000369	0.000353	-0.000016
15	0.000513	0.000512	-0.000001
20	0.000736	0.000764	0.000028
30	0.001264	0.001250	-0.000014
40	0.001756	0.001757	0.000001
50	0.002303	0.002305	0.000002
60	0.002883	0.002883	0.000000
70	0.003440	0.003440	0.000000
		Root mean square residual =	0.000017

Table 35 - the LNE indirect SSE measurements with the INRiM thermometer (6.82 mm spot)

Table 36 - the Chebyshev polynomial coefficients (LNE, indirect measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	3.41197415E-03
1	1.70325069E-03
2	3.47455017E-05
3	1.49968337E-05
4	-1.91977895E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
8	0.000194	0.000214	0.000020
10	0.000315	0.000305	-0.000010
12	0.000405	0.000388	-0.000017
15	0.000508	0.000501	-0.000007
20	0.000650	0.000661	0.000011
25	0.000788	0.000791	0.000003
30	0.000892	0.000899	0.000007
35	0.000990	0.000991	0.000001
40	0.001079	0.001073	-0.000006
50	0.001226	0.001221	-0.000005
60	0.001369	0.001371	0.000002
70	0.001534	0.001537	0.000003
80	0.001723	0.001720	-0.000003
90	0.001907	0.001909	0.000002
100	0.002078	0.002077	-0.000001
		Root mean square residual =	0.000010

Table 37 - INRiM indirect SSE measurements with the INRiM thermometer

Table 38 - the Chebyshev polynomial coefficients (INRiM, indirect measurements with INRiM thermometer)

Index	Chebyshev coefficient
0	2.48548674E-03
1	8.69673574E-04
2	-6.70436839E-05
3	6.21703860E-05
4	-3.00531075E-05

1.6 THE FITTING DATA FOR THE LP5 SSE MEASUREMENTS

1.6.1 Direct SSE measurements

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
3	0.999614	0.999627	0.000013
4	0.999656	0.999632	-0.000024
5	0.999574	0.999635	0.000061
7.5	0.999732	0.999642	-0.000090
10	0.999629	0.999647	0.000018
15	0.999632	0.999658	0.000026
20	0.999669	0.999675	0.000006
30	0.999782	0.999768	-0.000014
40	1.000000	1.000004	0.000004
		Root mean square residual =	0.000053

Table 39 – the PTB direct SSE measurements with the LP5

Table 40 – the Chebyshev polynomial coefficients (PTB, direct measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.99949828E+00
1	1.68306680E-04
2	6.65231462E-05
3	1.99795384E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
2.5	0.999490	0.999499	0.000009
3	0.999551	0.999537	-0.000014
4	0.999575	0.999579	0.000004
5	0.999593	0.999593	0.000000
7	0.999593	0.999597	0.000004
9	0.999609	0.999606	-0.000003
12	0.999637	0.999633	-0.000004
15	0.999639	0.999645	0.000006
20	0.999662	0.999659	-0.000003
25	0.999800	0.999801	0.000001
30	0.999794	0.999794	0.000000
40	1.000000	1.000000	0.000000
		Root mean square residual =	0.000010

Table 41 – the NPL direct SSE measurements with the LP5

Table 42 – the Chebyshev polynomial coefficients (NPL, direct measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.99910719E+00
1	-9.20282317E-05
2	-1.21613373E-04
3	4.53050143E-05
4	1.61771234E-04
5	2.27249438E-04
6	1.55604450E-04
7	7.01209419E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
5	1.000228	1.000270	0.000041
7	1.000303	1.000251	-0.000052
10	1.000278	1.000218	-0.000060
13	1.000084	1.000180	0.000096
17	1.000109	1.000130	0.000022
20	1.000143	1.000096	-0.000046
23	1.000096	1.000067	-0.000029
27	1.000016	1.000039	0.000023
30	1.000000	1.000025	0.000025
35	1.000050	1.000016	-0.000034
40	1.000000	1.000016	0.000016
		Root mean square residual =	0.000058

Table 43 – the METAS direct SSE measurements with the LP5

(Note that the METAS data has been adjusted to give the SSE values relative to a 40 mm diameter aperture to be consistent with the maximum diameter apertures of NPL and PTB.)

Table 44 – the Chebyshev polynomial coefficients (METAS, direct measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	2.00018998E+000
1	-1.34251133E-004
2	4.70046345E-005
3	-5.30560445E-006
4	-1.20254445E-005

1.6.2 Indirect measurements – 3 mm diameter spot

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
4	0.000056	0.000056	0.000000
5	0.000059	0.000062	0.000003
6	0.000069	0.000069	-0.000001
7	0.000076	0.000074	-0.000002
9	0.000086	0.000084	-0.000002
12	0.000094	0.000095	0.000001
15	0.000103	0.000103	0.000000
18	0.000107	0.000109	0.000002
20	0.000113	0.000113	-0.000001
25	0.000119	0.000120	0.000001
30	0.000129	0.000127	-0.000002
40	0.000144	0.000145	0.000001
50	0.000160	0.000160	0.000000
		Root mean square residual =	0.000002

Table 45 – the NPL indirect SSE measurements with the LP5

Table 46 – the Chebyshev polynomial coefficients (NPL, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	2.36172801E-04
1	4.75469723E-05
2	-7.51575789E-06
3	4.64102214E-06
4	-2.85082027E-06

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
3.2	0.000000	0.000001	0.000001
10.4	0.000059	0.000056	-0.000003
14.1	0.000076	0.000078	0.000002
19.5	0.000101	0.000102	0.000001
24.1	0.000117	0.000115	-0.000002
28.9	0.000122	0.000123	0.000001
33.8	0.000127	0.000127	0.000000
39.1	0.000131	0.000129	-0.000002
49.1	0.000140	0.000142	0.000002
59.0	0.000181	0.000180	-0.000001
63.3	0.000207	0.000207	0.000000
100.0	0.000342	0.000342	0.000000
		Root mean square residual =	0.000002

Table 47 – the CEM indirect SSE measurements with the LP5

Table 48– the Chebyshev polynomial coefficients (CEM, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	4.05069880E-04
1	1.92217845E-04
2	1.14309484E-05
3	-7.75393161E-06
4	-4.26797850E-05
5	-1.37467689E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
5	0.000088	0.000095	0.000007
8	0.000140	0.000129	-0.000011
10	0.000152	0.000154	0.000002
15	0.000226	0.000224	-0.000002
20	0.000296	0.000302	0.000006
30	0.000472	0.000470	-0.000002
40	0.000634	0.000633	-0.000001
50	0.000767	0.000768	0.000001
		Root mean square residual =	0.000007

Table 49 – the UME indirect SSE measurements with the LP5

Table 50 – the Chebyshev polynomial coefficients (UME, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	8.58752344E-04
1	3.47817375E-04
2	1.74197800E-06
3	-1.14132592E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
4	0.000000	0.000001	0.000001
6	0.000058	0.000054	-0.000004
8	0.000104	0.000103	-0.000001
10	0.000146	0.000150	0.000004
12	0.000192	0.000197	0.000005
15	0.000272	0.000270	-0.000002
20	0.000408	0.000404	-0.000004
30	0.000735	0.000733	-0.000002
40	0.001119	0.001127	0.000008
50	0.001553	0.001544	-0.000009
60	0.001983	0.001987	0.000004
70	0.002574	0.002573	-0.000001
		Root mean square residual =	0.000006

Table 51 – the LNE indirect SSE measurements with the LP5 (4 mm spot)

Table 52 - the Chebyshev polynomial coefficients (LNE, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	2.26626131E-03
1	1.26735708E-03
2	1.41212001E-04
3	3.57999058E-06
4	1.30203021E-05
5	1.49742250E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
4	0.000041	0.000051	0.000010
5	0.000073	0.000068	-0.000005
6	0.000091	0.000085	-0.000006
8	0.000118	0.000119	0.000001
10	0.000154	0.000152	-0.000002
12	0.000186	0.000183	-0.000003
15	0.000229	0.000229	0.000000
20	0.000294	0.000302	0.000008
25	0.000370	0.000369	-0.000001
30	0.000436	0.000433	-0.000003
35	0.000494	0.000494	0.000000
40	0.000550	0.000551	0.000001
50	0.000659	0.000659	0.000000
60	0.000762	0.000759	-0.000003
70	0.000851	0.000854	0.000003
80	0.000945	0.000943	-0.000002
90	0.001027	0.001028	0.000001
100	0.001106	0.001106	0.000000
		Root mean square residual =	0.000004

Table 53 – the INRiM indirect SSE measurements with the LP5

Table 54 – the Chebyshev polynomial coefficients (INRiM, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.26307904E-03
1	5.18372779E-04
2	-5.07067929E-05
3	9.12601710E-06
4	-2.57555545E-06

1.6.3 Indirect measurements – 6 mm diameter spot

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
7	0.000016	0.000016	0.000000
9	0.000023	0.000023	0.000000
12	0.000033	0.000034	0.000001
15	0.000042	0.000043	0.000000
18	0.000051	0.000051	0.000000
20	0.000057	0.000056	-0.000001
25	0.000068	0.000069	0.000001
30	0.000082	0.000082	0.000000
40	0.000111	0.000111	0.000000
50	0.000138	0.000138	0.000000
		Root mean square residual =	0.000001

Table 55– the NPL indirect SSE measurements with the LP5

Table 56– the Chebyshev polynomial coefficients (NPL, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.56924523E-04
1	6.01122606E-05
2	-6.17954252E-07
3	8.72674441E-07
4	-9.94456357E-07

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
6.3	0.000000	0.000003	0.000003
10.4	0.000018	0.000011	-0.000007
14.1	0.000018	0.000022	0.000004
19.5	0.000039	0.000040	0.000001
24.1	0.000054	0.000055	0.000001
28.9	0.000070	0.000068	-0.000002
33.8	0.000079	0.000078	-0.000001
39.1	0.000086	0.000088	0.000002
49.1	0.000110	0.000107	-0.000003
59.0	0.000138	0.000143	0.000005
63.3	0.000169	0.000166	-0.000003
100.0	0.000280	0.000280	0.000000
		Root mean square residual =	0.000005

Table 57– the CEM indirect SSE measurements with the LP5

Table 58– the Chebyshev polynomial coefficients (CEM, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	3.17645999E-04
1	1.72114524E-04
2	1.11943495E-05
3	-1.89165499E-05
4	-2.86640582E-05
5	-1.45344305E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
8	0.000043	0.000039	-0.000004
10	0.000061	0.000068	0.000007
15	0.000141	0.000136	-0.000005
20	0.000204	0.000206	0.000002
30	0.000365	0.000365	0.000000
40	0.000544	0.000544	0.000000
50	0.000677	0.000677	0.000000
		Root mean square residual =	0.000007

Table 59 – the UME indirect SSE measurements with the LP5

Table 60 – the Chebyshev polynomial coefficients (UME, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	7.18282595E-04
1	3.29562367E-04
2	5.04331611E-06
3	-1.06244237E-05
4	-6.04600305E-06

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
6	0.000000	-0.000006	-0.000006
8	0.000017	0.000025	0.000008
10	0.000060	0.000059	-0.000001
12	0.000100	0.000095	-0.000005
15	0.000150	0.000154	0.000004
20	0.000260	0.000263	0.000003
30	0.000520	0.000513	-0.000007
40	0.000790	0.000795	0.000005
50	0.001100	0.001097	-0.000003
60	0.001400	0.001403	0.000003
70	0.001700	0.001699	-0.000001
		Root mean square residual =	0.000006

Table 61 – the LNE indirect SSE measurements with the LP5 (6.82 mm spot)

Table 62 – the Chebyshev polynomial coefficients (LNE, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.58341705E-03
1	8.71683019E-04
2	5.48251774E-05
3	-1.91595489E-05

Aperture diameter/ mm	SSE (raw data)	SSE (fitted data)	Residual
8	0.000035	0.000033	-0.000002
10	0.000065	0.000063	-0.000002
12	0.000092	0.000092	0.000000
15	0.000133	0.000135	0.000002
20	0.000198	0.000205	0.000007
25	0.000275	0.000271	-0.000004
30	0.000335	0.000334	-0.000001
35	0.000398	0.000395	-0.000003
40	0.000452	0.000453	0.000001
50	0.000559	0.000562	0.000003
60	0.000665	0.000662	-0.000003
70	0.000754	0.000755	0.000001
80	0.000842	0.000841	-0.000001
90	0.000918	0.000921	0.000003
100	0.000997	0.000996	-0.000001
		Root mean square residual =	0.000003

Table 63 – the INRiM indirect SSE measurements with the LP5

Table 64 – the Chebyshev polynomial coefficients (INRiM, indirect measurements with LP5 thermometer)

Index	Chebyshev coefficient
0	1.11776914E-03
1	4.77153218E-04
2	-4.43026562E-05
3	4.04405319E-06

1.7 THE ANALYSIS OF THE DIFFERENCES BETWEEN THE SSE RESULTS

1.7.1 Results for the INRiM thermometer – direct measurements

Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
5	0.998191	0.994872	0.997258
7	0.999361	0.999378	0.999505
10	0.999571	0.999585	0.999643
15	0.999611	0.999703	0.999942
20	0.999740	0.999834	1.000080
25	0.999417	0.999501	0.999809
30	0.999886	0.999926	1.000056
40	1.000000	1.000000	1.000000

Table 65 – the calculated arithmetic and weighted mean and the median SSE values for the direct measurements with the INRiM thermometer

Aperture diameter/ mm	Difference (PTB - weighted mean SSE)	Difference (PTB - mean SSE)	Difference (PTB - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	-0.000934	0.002385	0.000000	0.002007
7	-0.000525	-0.000543	-0.000670	0.000190
10	-0.000459	-0.000473	-0.000531	0.000176
15	-0.000399	-0.000492	-0.000731	0.000176
20	-0.000426	-0.000520	-0.000766	0.000173
25	-0.000805	-0.000889	-0.001196	0.000173
30	-0.000220	-0.000261	-0.000391	0.000173
40	0.000000	0.000000	0.000000	0.000173

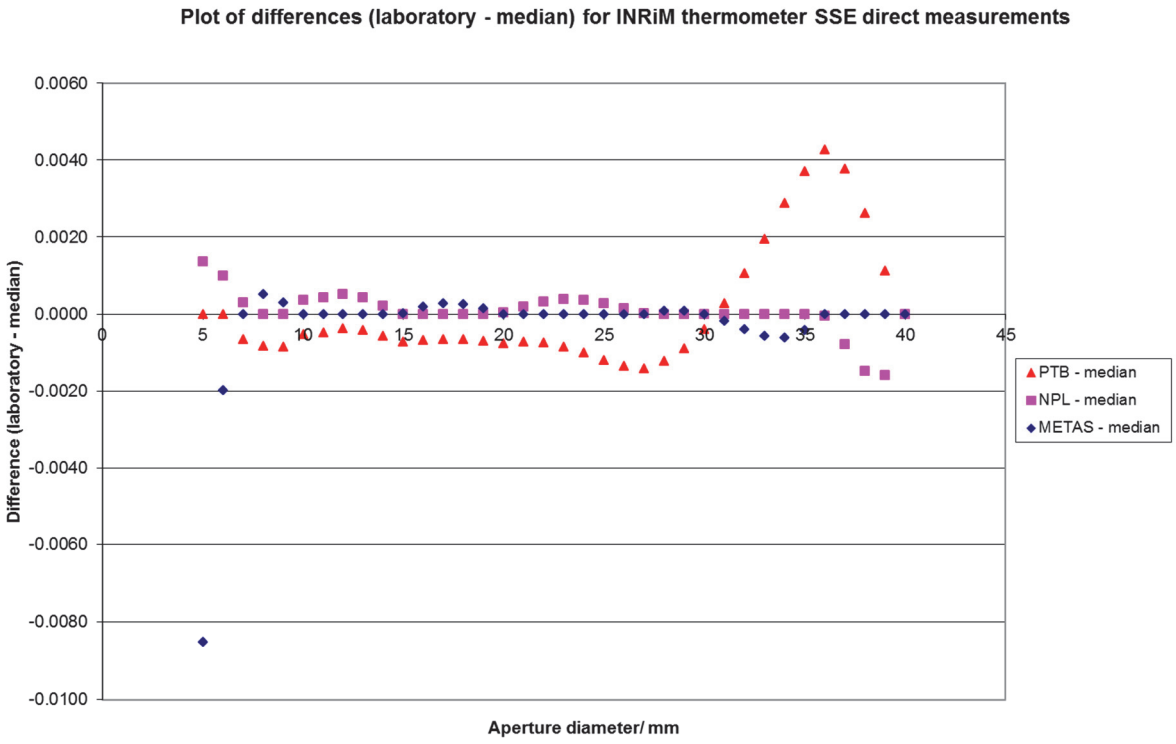
Table 66 – differences between PTB results and averages, direct measurements with the INRiM thermometer

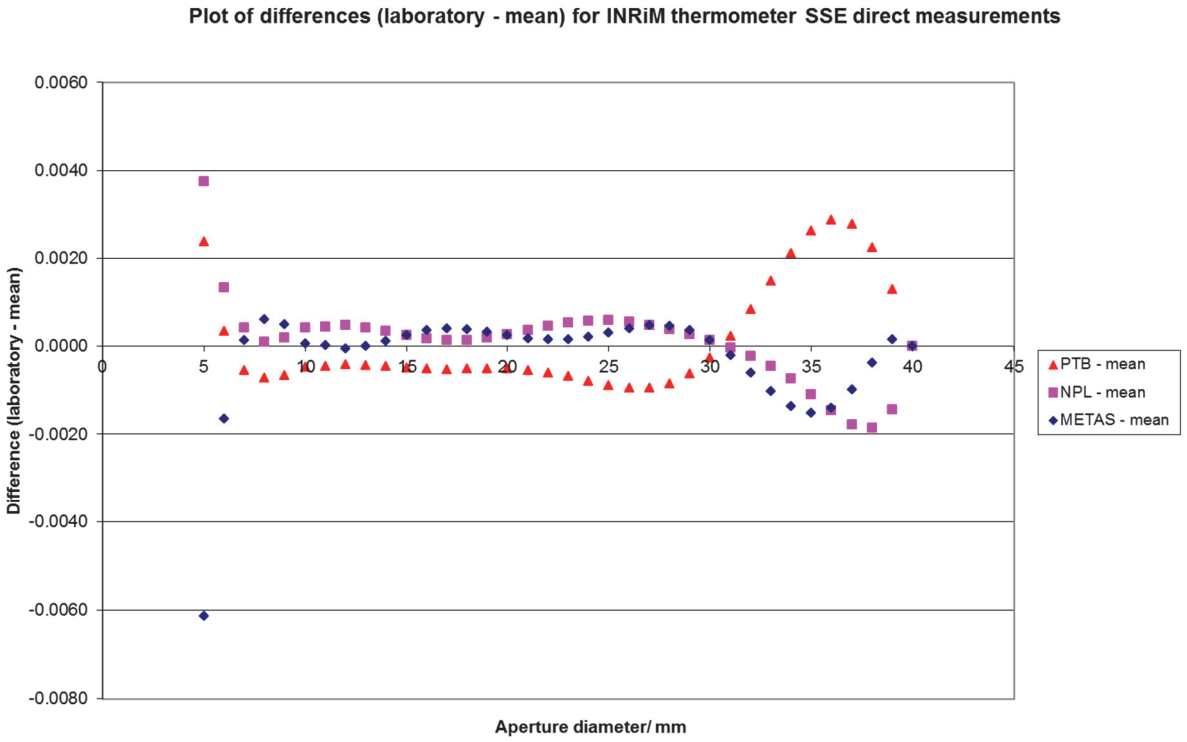
Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	0.000428	0.003747	0.001362	0.000164
7	0.000434	0.000416	0.000290	0.000174
10	0.000430	0.000416	0.000358	0.000171
15	0.000332	0.000239	0.000000	0.000165
20	0.000367	0.000273	0.000026	0.000165
25	0.000665	0.000581	0.000273	0.000159
30	0.000171	0.000131	0.000001	0.000155
40	0.000000	0.000000	0.000000	0.000155

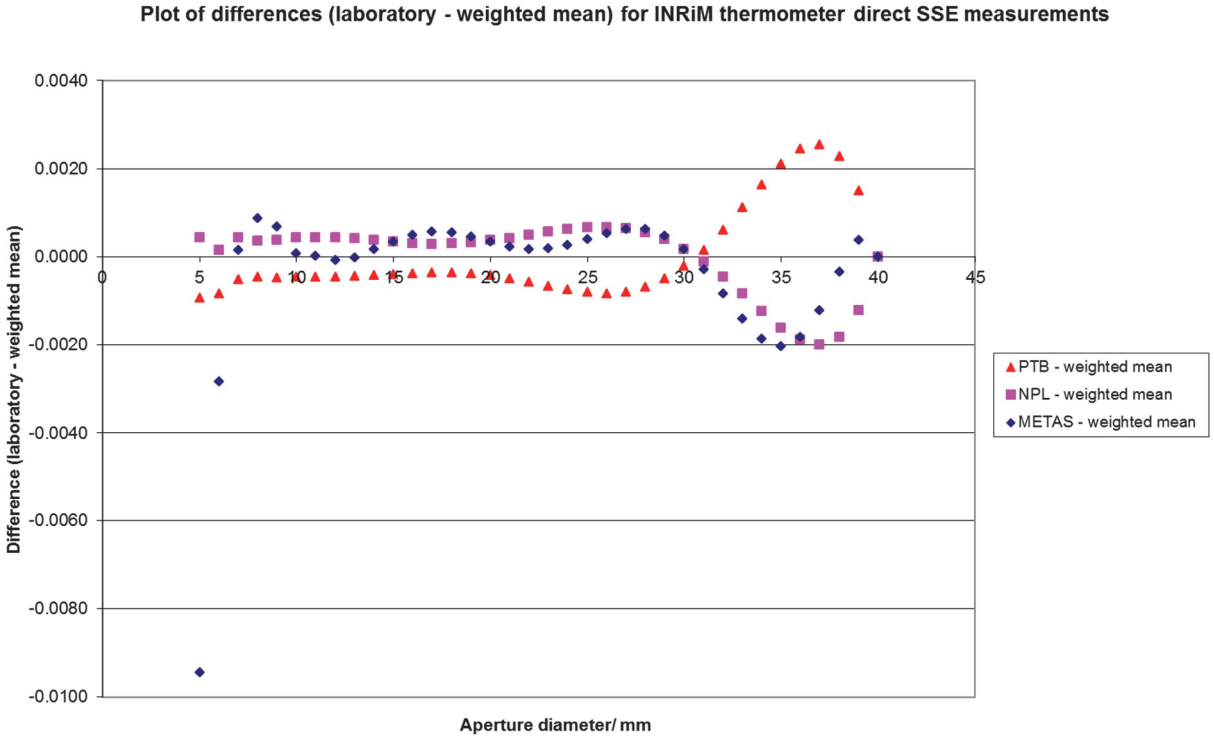
Table 67 – differences between NPL results and averages, direct measurements with the INRiM thermometer

Aperture diameter/ mm	Difference (METAS - weighted mean SSE)	Difference (METAS - mean SSE)	Difference (METAS - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	-0.009451	-0.006132	-0.008517	0.000776
7	0.000144	0.000127	0.000000	0.000776
10	0.000072	0.000058	0.000000	0.000776
15	0.000346	0.000253	0.000014	0.000776
20	0.000340	0.000247	0.000000	0.000776
25	0.000392	0.000308	0.000000	0.000776
30	0.000170	0.000130	0.000000	0.000776
40	-0.000001	-0.000001	-0.000001	0.000776

Table 68 – differences between METAS results and averages, direct measurements with the INRiM thermometer




Plot of differences (laboratory - mean) for INRiM thermometer SSE direct measurements
Difference (laboratory - mean)
0.0060
0.0040
0.0020
0.0000
-0.0020
-0.0040
-0.0060
-0.0080
0
5
10
15
20
25
30
35
40
45
Aperture diameter/ mm
PTB - mean
NPL - mean
METAS - mean


Plot of differences (laboratory - weighted mean) for INRiM thermometer direct SSE measurements
Difference (laboratory - weighted mean)
0.0040
0.0020
0.0000
-0.0020
-0.0040
-0.0060
-0.0080
-0.0100
0
5
10
15
20
25
30
35
40
45
Aperture diameter/ mm
PTB - weighted mean
NPL - weighted mean
METAS - weighted mean

1.7.2 Results for the LP5 thermometer – direct measurements

Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
3	0.999585	0.999582	0.999582
5	0.999723	0.999836	0.999635
7	0.999749	0.999827	0.999641
10	0.999740	0.999817	0.999647
15	0.999789	0.999807	0.999657
20	0.999807	0.999800	0.999675
25	0.999843	0.999846	0.999801
30	0.999859	0.999856	0.999794
40	1.000000	1.000000	1.000000

Table 69 – the calculated arithmetic and weighted mean and the median SSE values for the direct measurements with the LP5 thermometer

Aperture diameter/ mm	Difference (PTB - weighted mean SSE)	Difference (PTB - mean SSE)	Difference (PTB - median SSE)	Total ($k = 2$) uncertainty (fitted data)
3	0.000043	0.000045	0.000045	0.000113
5	-0.000088	-0.000201	0.000000	0.000113
7	-0.000108	-0.000186	0.000000	0.000112
10	-0.000093	-0.000170	0.000000	0.000110
15	-0.000132	-0.000149	0.000000	0.000110
20	-0.000132	-0.000125	0.000000	0.000110
25	-0.000135	-0.000138	-0.000093	0.000110
30	-0.000090	-0.000088	-0.000026	0.000109
40	0.000004	0.000004	0.000004	0.000108

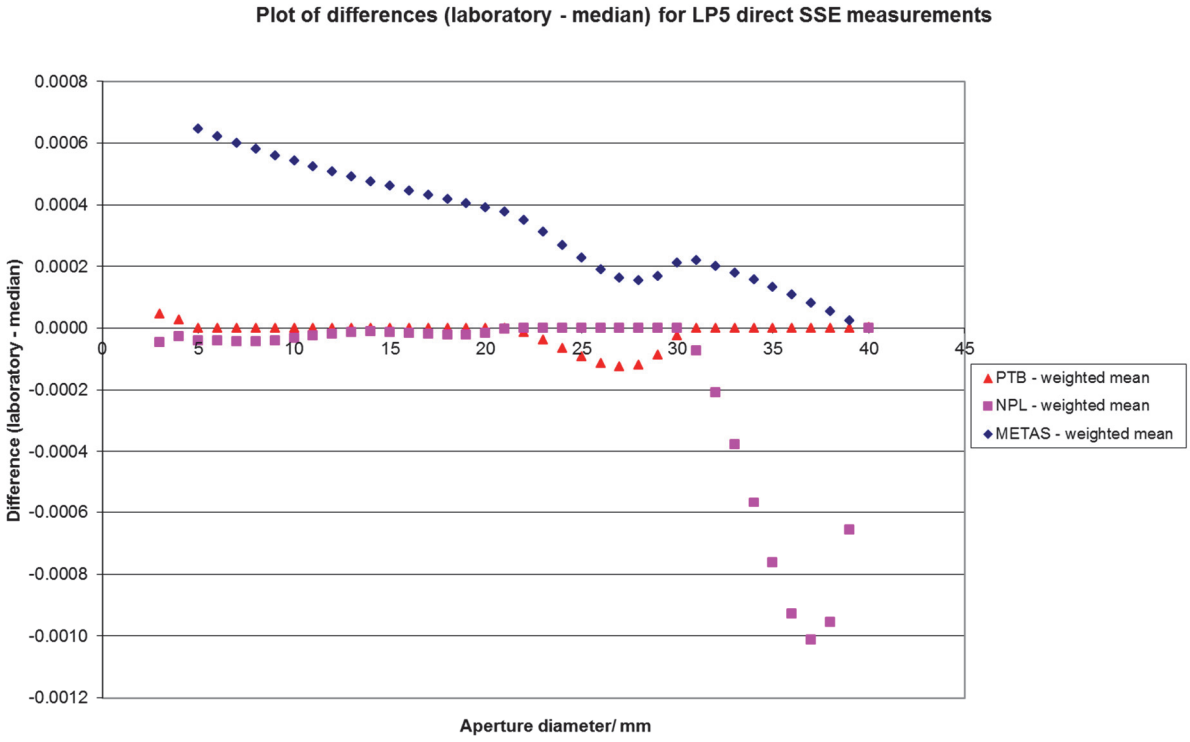
Table 70 – differences between PTB results and averages, direct measurements with the LP5 thermometer

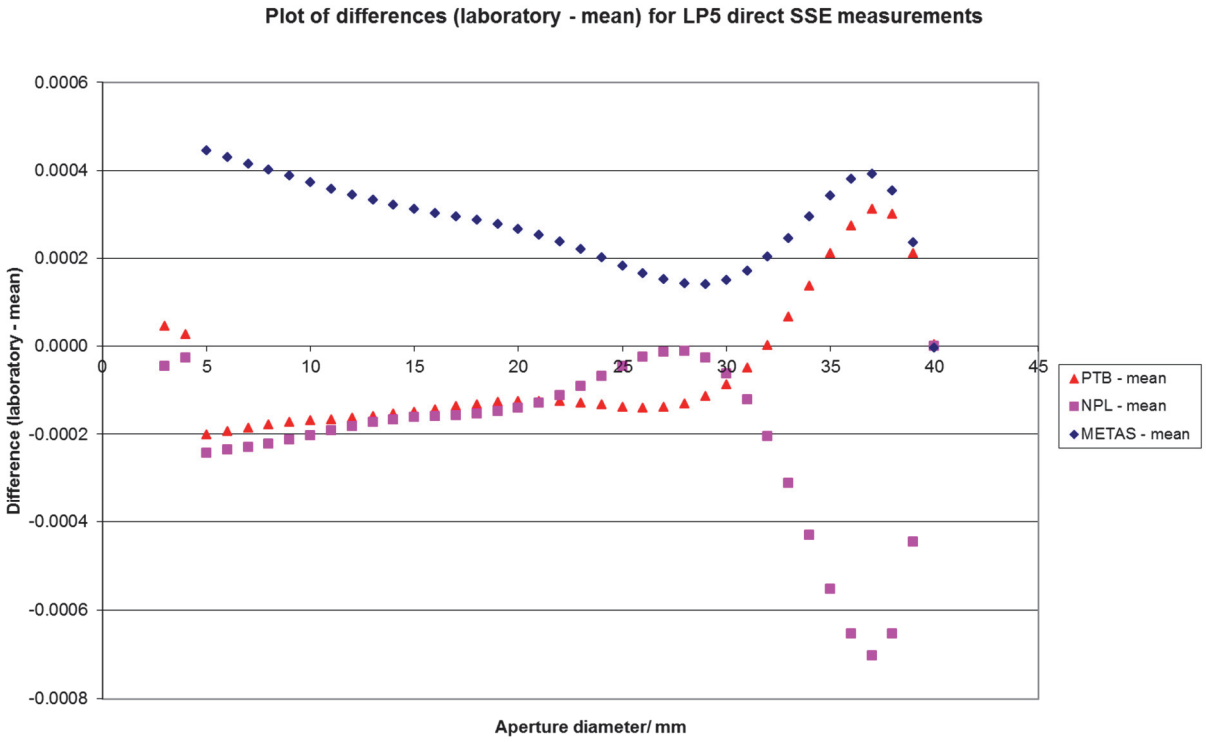
Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
3	-0.000047	-0.000045	-0.000045	0.000119
5	-0.000130	-0.000243	-0.000042	0.000058
7	-0.000152	-0.000229	-0.000044	0.000069
10	-0.000126	-0.000203	-0.000033	0.000065
15	-0.000144	-0.000162	-0.000013	0.000094
20	-0.000148	-0.000141	-0.000015	0.000119
25	-0.000042	-0.000045	0.000000	0.000101
30	-0.000065	-0.000062	0.000000	0.000119
40	0.000000	0.000000	0.000000	0.000119

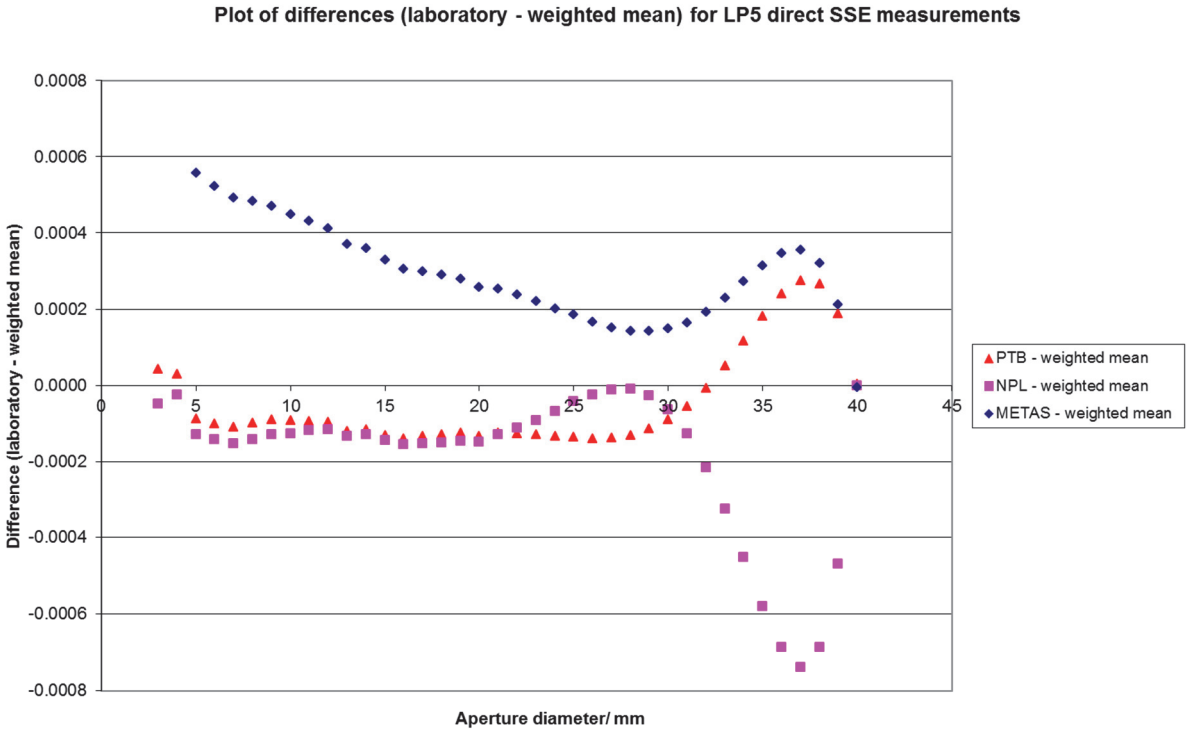
Table 71 – differences between NPL results and averages, direct measurements with the LP5 thermometer

Aperture diameter/ mm	Difference (METAS - weighted mean SSE)	Difference (METAS - mean SSE)	Difference (METAS - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	0.000558	0.000444	0.000646	0.000110
7	0.000492	0.000415	0.000601	0.000110
10	0.000449	0.000372	0.000542	0.000110
15	0.000329	0.000311	0.000461	0.000110
20	0.000259	0.000266	0.000391	0.000110
25	0.000186	0.000183	0.000228	0.000110
30	0.000148	0.000150	0.000213	0.000110
40	-0.000004	-0.000004	-0.000004	0.000110

Table 72 – differences between METAS results and averages, direct measurements with the LP5 thermometer




Plot of differences (laboratory - mean) for LP5 direct SSE measurements
Difference (laboratory - mean)
0.0006
0.0004
0.0002
0.0000
-0.0002
-0.0004
-0.0006
-0.0008
0
5
10
15
20
25
30
35
40
45
Aperture diameter/ mm
PTB - mean
NPL - mean
METAS - mean


Plot of differences (laboratory - weighted mean) for LP5 direct SSE measurements
Difference (laboratory - weighted mean)
0.0008
0.0006
0.0004
0.0002
0.0000
-0.0002
-0.0004
-0.0006
-0.0008
0
5
10
15
20
25
30
35
40
45
Aperture diameter/ mm
PTB - weighted mean
NPL - weighted mean
METAS - weighted mean

1.7.3 Results for the INRiM thermometer – indirect measurements

Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
7	9.1342E-05	7.2240E-05	6.5150E-05
10	2.5562E-04	2.6237E-04	2.4972E-04
15	4.1904E-04	4.6210E-04	4.7174E-04
20	5.2228E-04	6.1449E-04	6.2538E-04
25	6.0650E-04	7.4881E-04	7.5347E-04
30	6.8918E-04	8.7694E-04	8.7169E-04
40	8.2507E-04	1.1170E-03	1.0726E-03
50	9.2620E-04	1.3286E-03	1.2210E-03
60	1.2455E-03	1.7843E-03	1.3711E-03
70	1.5663E-03	2.1976E-03	1.6158E-03
80	2.0299E-03	2.1764E-03	2.1764E-03
100	1.9973E-03	1.9437E-03	1.9437E-03

Table 73 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the INRiM thermometer – 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	1.4606E-06	2.0563E-05	2.7652E-05	0.000008
10	-8.2384E-06	-1.4982E-05	-2.3313E-06	0.000008
15	-1.5483E-05	-5.8542E-05	-6.8182E-05	0.000008
20	-1.8706E-05	-1.1092E-04	-1.2181E-04	0.000008
25	-1.6752E-05	-1.5907E-04	-1.6373E-04	0.000008
30	-1.5618E-05	-2.0337E-04	-1.9812E-04	0.000008
40	-1.6040E-05	-3.0792E-04	-2.6356E-04	0.000008
50	-1.4731E-05	-4.1712E-04	-3.0948E-04	0.000008

Table 74 – differences between NPL results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (CEM - weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	-3.2575E-05	-1.3473E-05	-6.3834E-06	0.000055
10	-5.9070E-06	-1.2651E-05	0.0000E+00	0.000055
15	2.8278E-06	-4.0232E-05	-4.9872E-05	0.000047
20	-3.2998E-06	-9.5510E-05	-1.0640E-04	0.000040
25	-3.6572E-06	-1.4597E-04	-1.5063E-04	0.000037
30	1.2568E-06	-1.8650E-04	-1.8125E-04	0.000036
40	2.2536E-05	-2.6935E-04	-2.2499E-04	0.000038
50	1.5319E-05	-3.8707E-04	-2.7943E-04	0.000042
60	-1.4639E-04	-6.8521E-04	-2.7203E-04	0.000054
70	4.9528E-05	-5.8178E-04	0.0000E+00	0.000074
80	6.0266E-04	4.5618E-04	4.5618E-04	0.000086
100	-1.8727E-04	-1.3374E-04	-1.3374E-04	0.000112

Table 75 – differences between CEM results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	1.2800E-05	6.0558E-06	1.8707E-05	0.000018
15	5.2700E-05	9.6398E-06	0.0000E+00	0.000024
20	1.0310E-04	1.0892E-05	0.0000E+00	0.000032
25	1.4697E-04	4.6581E-06	0.0000E+00	0.000040
30	1.8251E-04	-5.2501E-06	0.0000E+00	0.000049
40	2.7390E-04	-1.7984E-05	2.6377E-05	0.000058
50	3.3742E-04	-6.4967E-05	4.2670E-05	0.000064

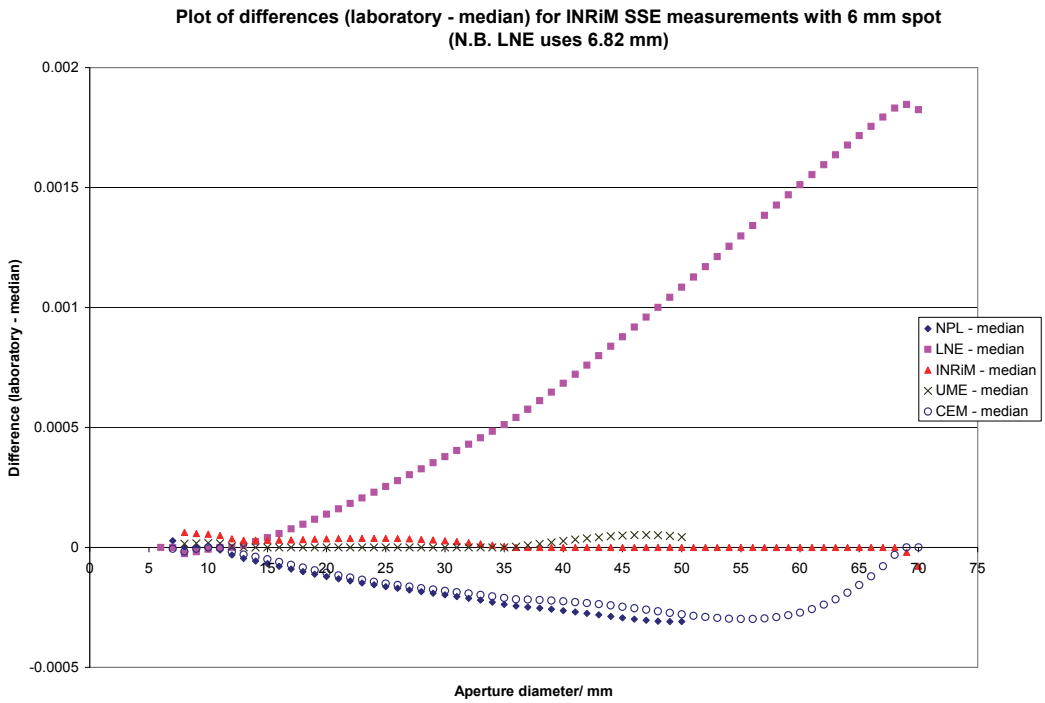
Table 76 – differences between UME results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot, including all data

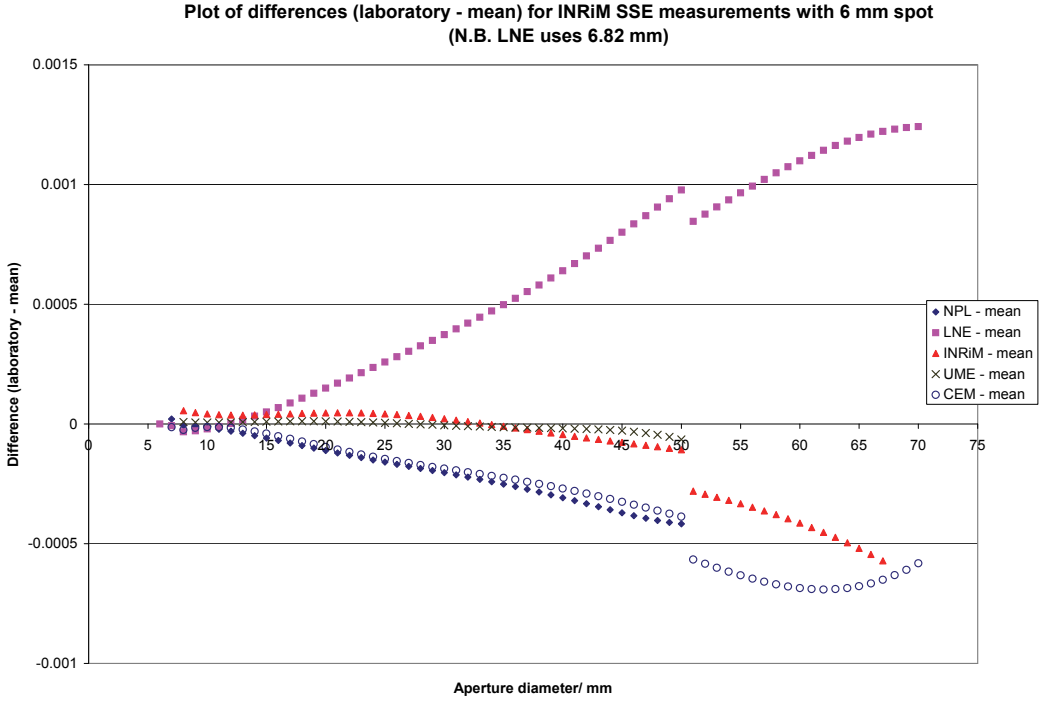
Aperture diameter/ mm	Difference (LNE - weighted mean SSE)	Difference (LNE - mean SSE)	Difference (LNE - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	-2.6192E-05	-7.0897E-06	0.0000E+00	0.000048
10	-1.3981E-05	-2.0725E-05	-8.0743E-06	0.000055
15	9.3106E-05	5.0046E-05	4.0406E-05	0.000071
20	2.4152E-04	1.4931E-04	1.3842E-04	0.000083
25	4.0049E-04	2.5817E-04	2.5352E-04	0.000254
30	5.6070E-04	3.7295E-04	3.7820E-04	0.000429
40	9.3150E-04	6.3962E-04	6.8398E-04	0.000808
50	1.3792E-03	9.7679E-04	1.0844E-03	0.001485
60	1.6372E-03	1.0984E-03	1.5116E-03	0.001724
70	1.8735E-03	1.2422E-03	1.8240E-03	0.003131

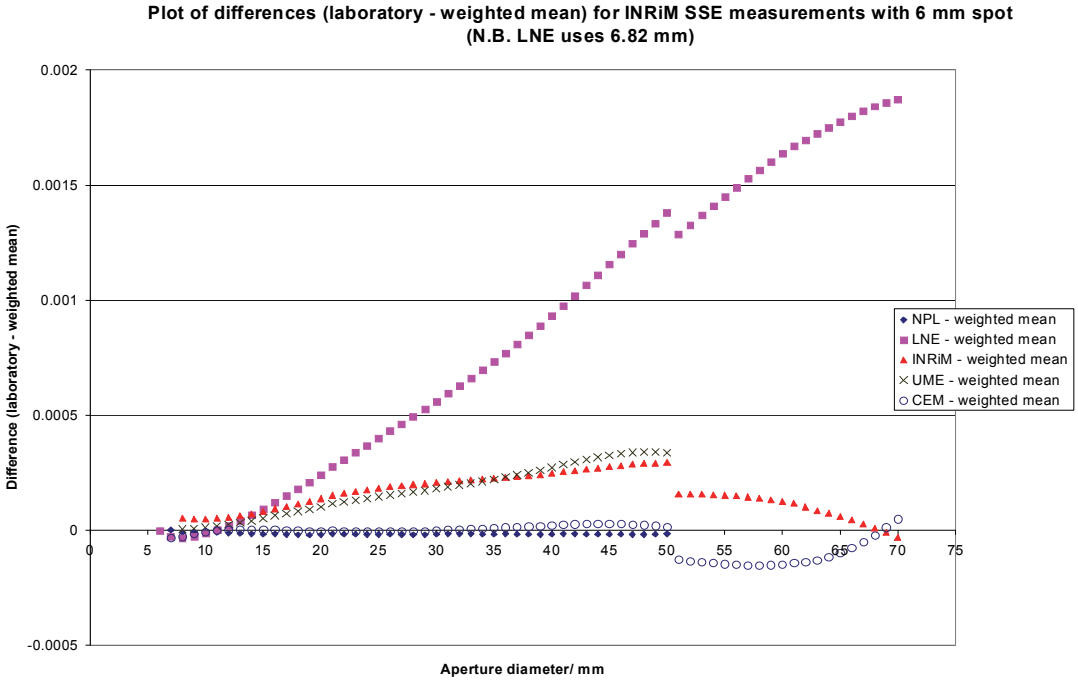
Table 77 – differences between LNE results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (INRiM- weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	4.9047E-05	4.2303E-05	5.4954E-05	0.000023
15	8.2148E-05	3.9088E-05	2.9449E-05	0.000026
20	1.3843E-04	4.6220E-05	3.5327E-05	0.000030
25	1.8452E-04	4.2207E-05	3.7549E-05	0.000033
30	2.0993E-04	2.2176E-05	2.7426E-05	0.000036
40	2.4752E-04	-4.4361E-05	0.0000E+00	0.000042
50	2.9475E-04	-1.0764E-04	0.0000E+00	0.000046
60	1.2563E-04	-4.1319E-04	0.0000E+00	0.000051
70	-2.9108E-05	-6.6042E-04	-7.8636E-05	0.000056
80	-3.0969E-04	-4.5618E-04	-4.5618E-04	0.000062
100	8.0214E-05	1.3374E-04	1.3374E-04	0.000073

Table 78 – differences between INRiM results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot, including all data


Plot of differences (laboratory - median) for INRiM SSE measurements with 6 mm spot
(N.B. LNE uses 6.82 mm)
Difference (laboratory - median)
Aperture diameter/ mm
NPL - median
LNE - median
INRiM - median
UME - median
CEM - median


Plot of differences (laboratory - mean) for INRiM SSE measurements with 6 mm spot
(N.B. LNE uses 6.82 mm)
Difference (laboratory - mean)
Aperture diameter/ mm
NPL - mean
LNE - mean
INRiM - mean
UME - mean
CEM - mean



Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
7	9.2066E-05	7.5785E-05	7.5785E-05
10	2.5585E-04	2.6755E-04	2.5907E-04
15	4.1804E-04	4.4959E-04	4.4681E-04
20	5.2033E-04	5.7716E-04	5.7218E-04
25	6.0615E-04	6.8427E-04	6.7815E-04
30	6.8901E-04	7.8370E-04	7.8106E-04
40	8.2498E-04	9.5705E-04	9.6010E-04
50	9.2617E-04	1.0844E-03	1.0812E-03
60	1.2447E-03	1.2351E-03	1.2351E-03
70	1.5659E-03	1.5765E-03	1.5765E-03
80	2.0299E-03	2.1764E-03	2.1764E-03
100	1.9973E-03	1.9437E-03	1.9437E-03

Table 79 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the INRiM thermometer – 6 mm diameter spot **excluding LNE data**

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	7.3624E-07	1.7018E-05	1.7018E-05	0.000008
10	-8.4637E-06	-2.0164E-05	-1.1685E-05	0.000008
15	-1.4481E-05	-4.6031E-05	-4.3246E-05	0.000008
20	-1.6758E-05	-7.3588E-05	-6.8608E-05	0.000008
25	-1.6401E-05	-9.4524E-05	-8.8410E-05	0.000008
30	-1.5442E-05	-1.1014E-04	-1.0750E-04	0.000008
40	-1.5954E-05	-1.4802E-04	-1.5107E-04	0.000008
50	-1.4694E-05	-1.7292E-04	-1.6977E-04	0.000008

Table 80 – differences between NPL results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot **excluding LNE data**

Aperture diameter/ mm	Difference (CEM - weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total (k = 2) uncertainty (fitted data)
7	-3.3299E-05	-1.7018E-05	-1.7018E-05	0.000055
10	-6.1323E-06	-1.7832E-05	-9.3534E-06	0.000055
15	3.8293E-06	-2.7720E-05	-2.4936E-05	0.000047
20	-1.3519E-06	-5.8181E-05	-5.3201E-05	0.000040
25	-3.3058E-06	-8.1429E-05	-7.5315E-05	0.000037
30	1.4329E-06	-9.3262E-05	-9.0624E-05	0.000036
40	2.2622E-05	-1.0944E-04	-1.1249E-04	0.000038
50	1.5356E-05	-1.4287E-04	-1.3972E-04	0.000042
60	-1.4564E-04	-1.3601E-04	-1.3601E-04	0.000054
70	4.9907E-05	3.9318E-05	3.9318E-05	0.000074
80	6.0266E-04	4.5618E-04	4.5618E-04	0.000086
100	-1.8727E-04	-1.3374E-04	-1.3374E-04	0.000112

Table 81 – differences between CEM results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot **excluding LNE data**

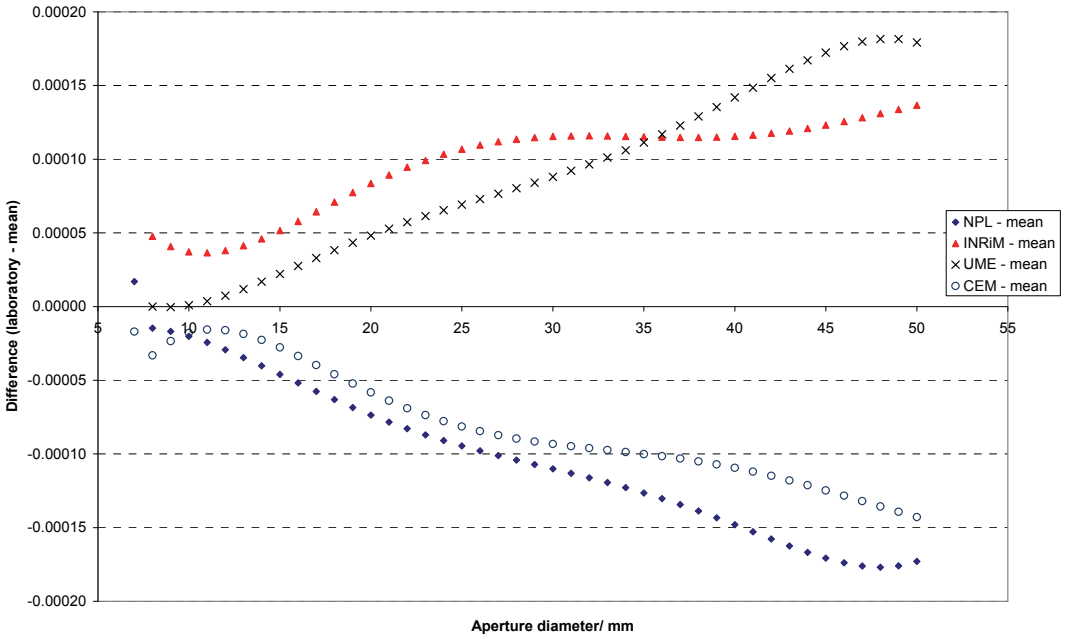
Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total (k = 2) uncertainty (fitted data)
10	1.2574E-05	8.7449E-07	9.3534E-06	0.000018
15	5.3701E-05	2.2151E-05	2.4936E-05	0.000024
20	1.0505E-04	4.8221E-05	5.3201E-05	0.000032
25	1.4732E-04	6.9202E-05	7.5315E-05	0.000040
30	1.8268E-04	8.7986E-05	9.0624E-05	0.000049
40	2.7399E-04	1.4192E-04	1.3887E-04	0.000058
50	3.3746E-04	1.7923E-04	1.8239E-04	0.000064

Table 82 – differences between UME results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot **excluding LNE data**

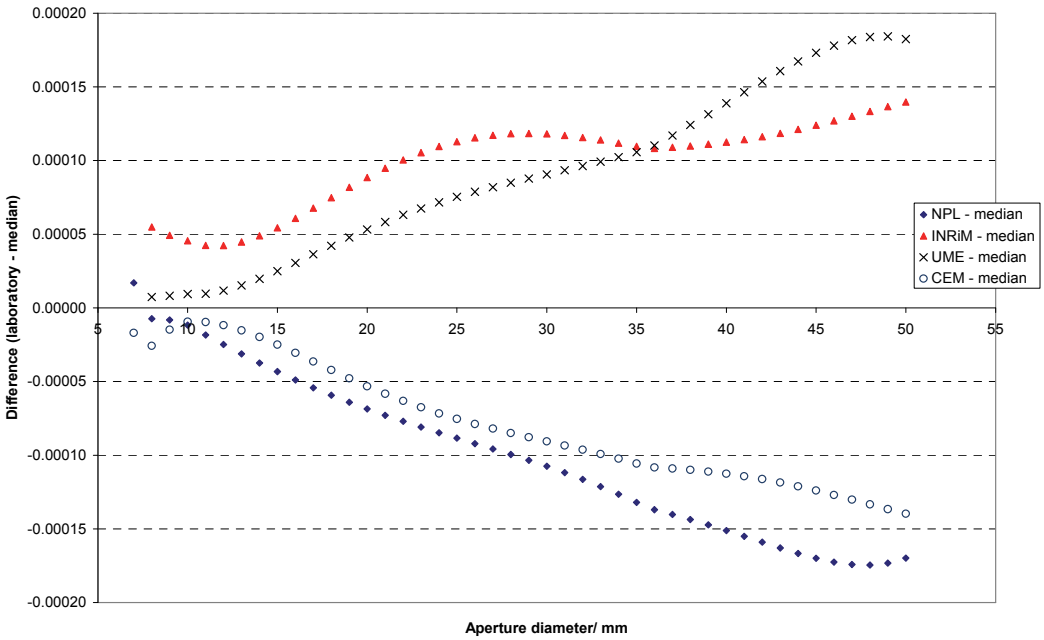
Aperture diameter/ mm	Difference (INRiM- weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total (k = 2) uncertainty (fitted data)
10	4.8821E-05	3.7121E-05	4.5600E-05	0.000023
15	8.3150E-05	5.1600E-05	5.4385E-05	0.000026
20	1.4038E-04	8.3548E-05	8.8528E-05	0.000030
25	1.8487E-04	1.0675E-04	1.1286E-04	0.000033
30	2.1011E-04	1.1541E-04	1.1805E-04	0.000036
40	2.4761E-04	1.1554E-04	1.1249E-04	0.000042
50	2.9479E-04	1.3656E-04	1.3972E-04	0.000046
60	1.2639E-04	1.3601E-04	1.3601E-04	0.000051
70	-2.8729E-05	-3.9318E-05	-3.9318E-05	0.000056
80	-3.0969E-04	-4.5618E-04	-4.5618E-04	0.000062
100	8.0214E-05	1.3374E-04	1.3374E-04	0.000073

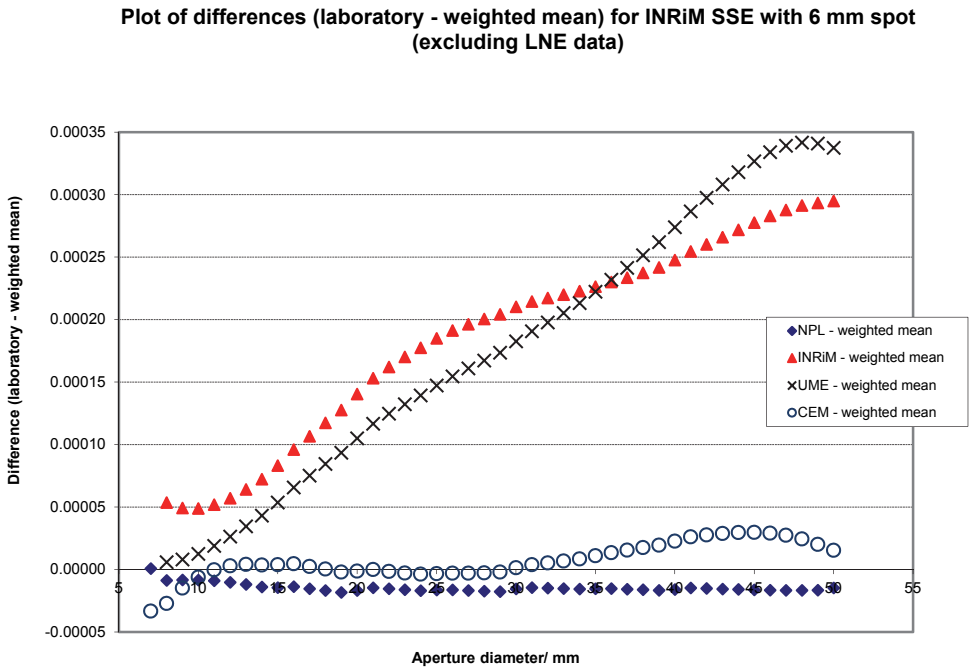
Table 83 – differences between INRiM results and averages, indirect measurements with the INRiM thermometer, 6 mm diameter spot **excluding LNE data**

Plot of differences (laboratory - mean) for INRiM SSE with 6 mm spot (excluding LNE data)



Plot of differences (laboratory - median) for INRiM SSE with 6 mm spot (excluding LNE data)





1.7.4 LP5 Results – indirect measurements with 3 mm diameter spot

Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
5	5.6519E-05	5.3824E-05	6.2365E-05
7	7.2728E-05	8.0705E-05	7.8446E-05
10	9.4810E-05	1.1937E-04	1.4989E-04
15	1.1827E-04	1.8191E-04	2.2428E-04
20	1.2921E-04	2.4489E-04	3.0154E-04
25	1.4384E-04	3.1001E-04	3.6936E-04
30	1.4803E-04	3.7762E-04	4.3323E-04
40	1.5973E-04	5.1735E-04	5.5122E-04
50	1.7555E-04	6.5499E-04	6.5907E-04
60	2.9518E-04	9.7739E-04	7.5941E-04
70	5.4476E-04	1.2295E-03	8.5395E-04
80	6.5926E-04	6.4846E-04	6.4846E-04
100	7.8960E-04	7.2388E-04	7.2388E-04

Table 84 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total (k = 2) uncertainty (fitted data)
5	5.8466E-06	8.5407E-06	0.0000E+00	0.000005
7	1.4181E-06	-6.5591E-06	-4.3001E-06	0.000007
10	-6.9667E-06	-3.1522E-05	-6.2049E-05	0.000006
15	-1.5273E-05	-7.8908E-05	-1.2129E-04	0.000005
20	-1.6694E-05	-1.3237E-04	-1.8902E-04	0.000005
25	-2.3965E-05	-1.9014E-04	-2.4949E-04	0.000005
30	-2.0726E-05	-2.5032E-04	-3.0593E-04	0.000005
40	-1.4470E-05	-3.7208E-04	-4.0596E-04	0.000004
50	-1.5641E-05	-4.9508E-04	-4.9916E-04	0.000004

Table 85 – differences between NPL results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

Aperture diameter/ mm	Difference (CEM- weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total (k = 2) uncertainty (fitted data)
5	-4.0810E-05	-3.8116E-05	-4.6657E-05	0.000009
7	-4.1097E-05	-4.9074E-05	-4.6815E-05	0.000009
10	-4.1435E-05	-6.5990E-05	-9.6517E-05	0.000009
15	-3.5234E-05	-9.8869E-05	-1.4125E-04	0.000008
20	-2.5141E-05	-1.4082E-04	-1.9747E-04	0.000006
25	-2.6641E-05	-1.9281E-04	-2.5216E-04	0.000006
30	-2.3870E-05	-2.5346E-04	-3.0907E-04	0.000006
40	-2.9866E-05	-3.8748E-04	-4.2135E-04	0.000006
50	-3.1587E-05	-5.1103E-04	-5.1511E-04	0.000007
60	-1.0938E-04	-7.9160E-04	-5.7362E-04	0.000012
70	-2.8337E-04	-9.6815E-04	-5.9256E-04	0.000027
80	-3.0579E-04	-2.9499E-04	-2.9499E-04	0.000032
100	-4.4759E-04	-3.8188E-04	-3.8188E-04	0.000043

Table 86 – differences between CEM results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total (k = 2) uncertainty (fitted data)
5	3.8196E-05	4.0890E-05	3.2349E-05	0.000026
7	4.4231E-05	3.6253E-05	3.8512E-05	0.000025
10	5.9256E-05	3.4701E-05	4.1741E-06	0.000031
15	1.0601E-04	4.2377E-05	0.0000E+00	0.000030
20	1.7315E-04	5.7470E-05	8.2004E-07	0.000028
25	2.4145E-04	7.5277E-05	1.5931E-05	0.000026
30	3.2204E-04	9.2443E-05	3.6833E-05	0.00024
40	4.7340E-04	1.1579E-04	8.1915E-05	0.000028
50	5.9197E-04	1.1253E-04	1.0845E-04	0.000030

Table 87 – differences between UME results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

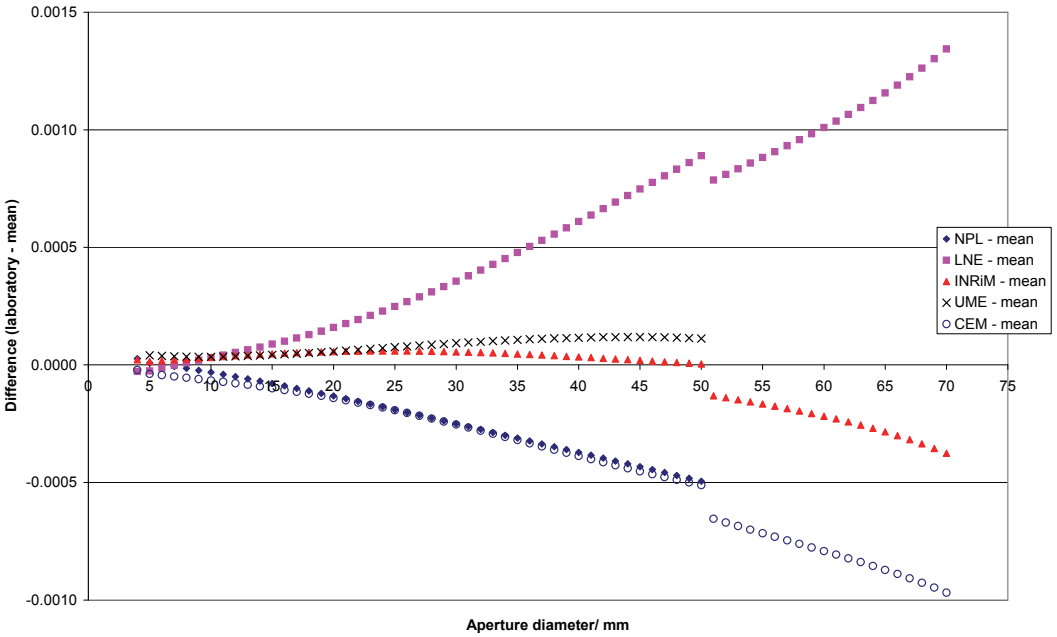
Aperture diameter/ mm	Difference (LNE - weighted mean SSE)	Difference (LNE - mean SSE)	Difference (LNE - median SSE)	Total (k = 2) uncertainty (fitted data)
5	-2.8402E-05	-2.5708E-05	-3.4248E-05	0.000097
7	5.7182E-06	-2.2591E-06	0.0000E+00	0.000088
10	5.5082E-05	3.0527E-05	0.0000E+00	0.000108
15	1.5175E-04	8.8119E-05	4.5742E-05	0.000067
20	2.7474E-04	1.5907E-04	1.0242E-04	0.000128
25	4.1450E-04	2.4833E-04	1.8899E-04	0.000234
30	5.8532E-04	3.5573E-04	3.0012E-04	0.000340
40	9.6752E-04	6.0990E-04	5.7603E-04	0.000147
50	1.3689E-03	8.8949E-04	8.8541E-04	0.000367
60	1.6918E-03	1.0096E-03	1.2276E-03	0.000605
70	2.0285E-03	1.3437E-03	1.7193E-03	0.000896

Table 88 – differences between LNE results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

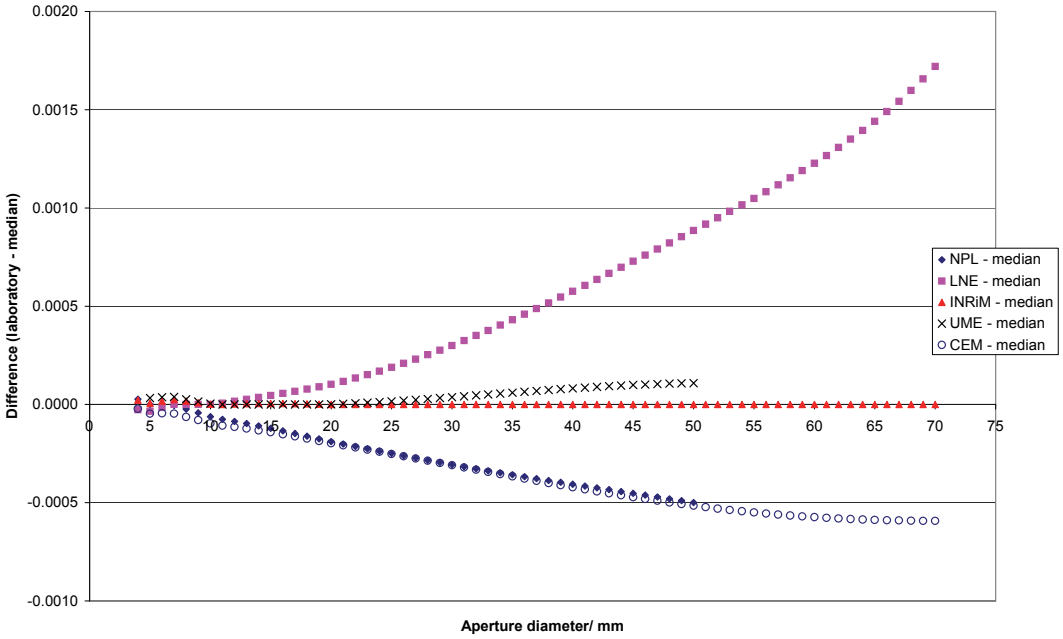
Aperture diameter/ mm	Difference (INRiM - weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total (k = 2) uncertainty (fitted data)
5	1.1699E-05	1.4393E-05	5.8527E-06	0.000008
7	2.9616E-05	2.1639E-05	2.3898E-05	0.000009
10	5.6838E-05	3.2283E-05	1.7559E-06	0.000009
15	1.1092E-04	4.7280E-05	4.9026E-06	0.000011
20	1.7233E-04	5.6650E-05	0.0000E+00	0.000012
25	2.2552E-04	5.9346E-05	0.0000E+00	0.000014
30	2.8520E-04	5.5609E-05	0.0000E+00	0.000016
40	3.9149E-04	3.3873E-05	0.0000E+00	0.000019
50	4.8352E-04	4.0819E-06	0.0000E+00	0.000023
60	4.6424E-04	-2.1798E-04	0.0000E+00	0.000026
70	3.0919E-04	-3.7559E-04	0.0000E+00	0.000028
80	2.8419E-04	2.9499E-04	2.9499E-04	0.000031
100	3.1616E-04	3.8188E-04	3.8188E-04	0.000036

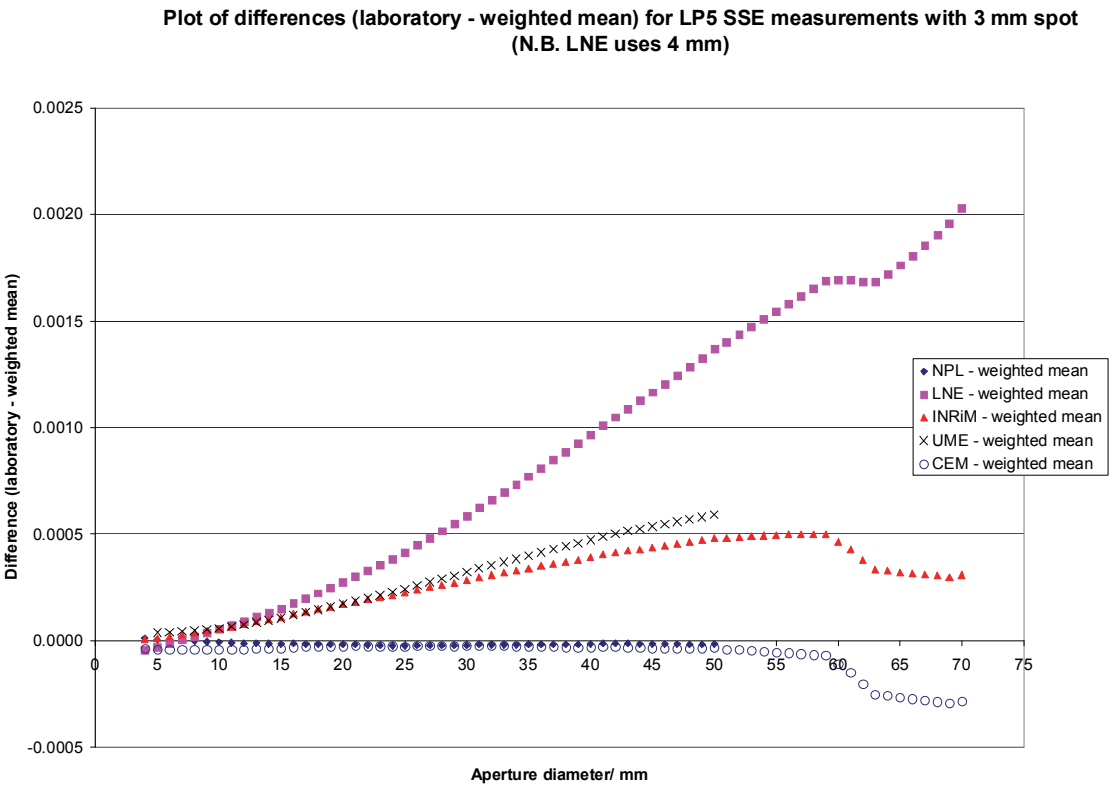
Table 89 – differences between INRiM results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot, including all data

Plot of differences (laboratory - mean) for LP5 SSE measurements with 3 mm spot (N.B. LNE uses 4 mm)



Plot of differences (laboratory - median) for LP5 SSE measurements with 3 mm spot (N.B. LNE uses 4 mm)





Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
5	5.6559E-05	6.0251E-05	6.5291E-05
10	7.2712E-05	8.1270E-05	8.8245E-05
15	9.4727E-05	1.1173E-04	1.1975E-04
20	1.1772E-04	1.5988E-04	1.6364E-04
25	1.2900E-04	2.0512E-04	2.0703E-04
30	1.4372E-04	2.4793E-04	2.4462E-04
40	1.4797E-04	2.8869E-04	2.8027E-04
50	1.5923E-04	3.6487E-04	3.4824E-04
60	1.7543E-04	4.3262E-04	4.0949E-04
70	2.9460E-04	4.7260E-04	4.7260E-04
80	5.4379E-04	5.5767E-04	5.5767E-04
90	6.5926E-04	6.4846E-04	6.4846E-04
100	7.8960E-04	7.2388E-04	7.2388E-04

Table 90 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the LP5 thermometer – 3 mm diameter spot **excluding LNE data**

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	5.8056E-06	2.1137E-06	-2.9264E-06	0.000005
7	1.4340E-06	-7.1239E-06	-1.4099E-05	0.000007
10	-6.8833E-06	-2.3890E-05	-3.1902E-05	0.000006
15	-1.4724E-05	-5.6878E-05	-6.0643E-05	0.000005
20	-1.6478E-05	-9.2604E-05	-9.4510E-05	0.000005
25	-2.3848E-05	-1.2806E-04	-1.2474E-04	0.000005
30	-2.0663E-05	-1.6139E-04	-1.5296E-04	0.000005
40	-1.3968E-05	-2.1961E-04	-2.0298E-04	0.000004
50	-1.5522E-05	-2.7271E-04	-2.4958E-04	0.000004

Table 91 – differences between NPL results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot **excluding LNE data**

Aperture diameter/ mm	Difference (CEM- weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	-4.0851E-05	-4.4543E-05	-4.9583E-05	0.000009
7	-4.1081E-05	-4.9639E-05	-5.6614E-05	0.000009
10	-4.1351E-05	-5.8358E-05	-6.6370E-05	0.000009
15	-3.4685E-05	-7.6839E-05	-8.0603E-05	0.000008
20	-2.4925E-05	-1.0105E-04	-1.0296E-04	0.000006
25	-2.6524E-05	-1.3073E-04	-1.2742E-04	0.000006
30	-2.3807E-05	-1.6453E-04	-1.5611E-04	0.000006
40	-2.9363E-05	-2.3500E-04	-2.1837E-04	0.000006
50	-3.1467E-05	-2.8865E-04	-2.6553E-04	0.000007
60	-1.0880E-04	-2.8681E-04	-2.8681E-04	0.000012
70	-2.8240E-04	-2.9628E-04	-2.9628E-04	0.000027
80	-3.0579E-04	-2.9499E-04	-2.9499E-04	0.000032
100	-4.4759E-04	-3.8188E-04	-3.8188E-04	0.000043

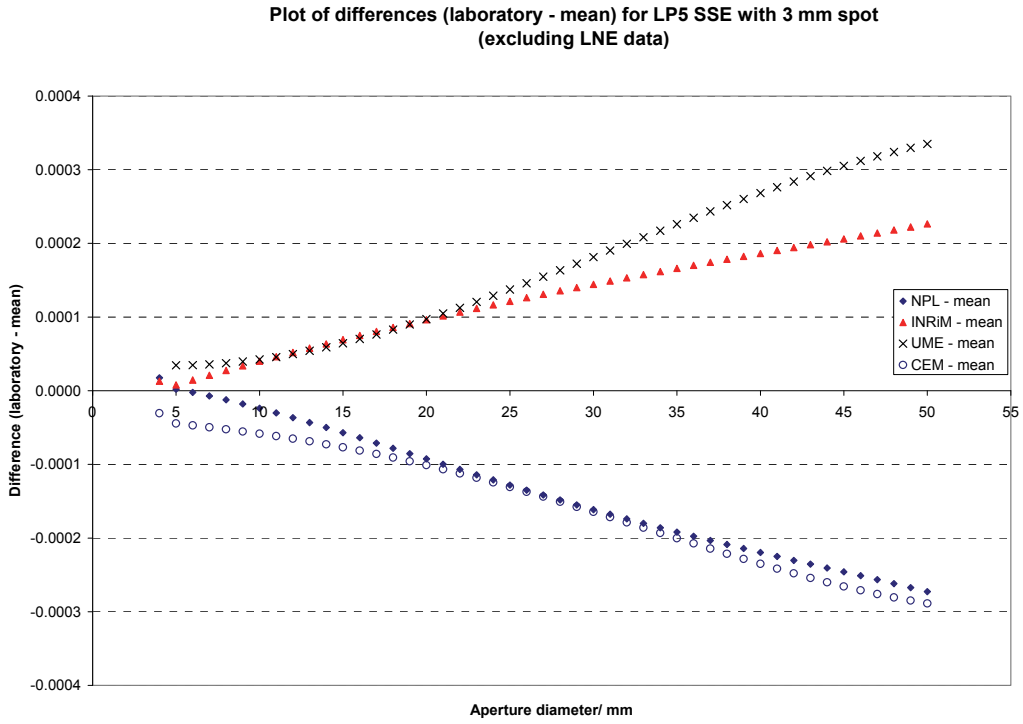
Table 92 – differences between CEM results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spotexcluding LNE data****

Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	3.8155E-05	3.4463E-05	2.9423E-05	0.000026
7	4.4247E-05	3.5689E-05	2.8713E-05	0.000025
10	5.9339E-05	4.2333E-05	3.4321E-05	0.000031
15	1.0656E-04	6.4407E-05	6.0643E-05	0.000030
20	1.7336E-04	9.7237E-05	9.5330E-05	0.000028
25	2.4157E-04	1.3736E-04	1.4067E-04	0.000026
30	3.2210E-04	1.8138E-04	1.8980E-04	0.00024
40	4.7390E-04	2.6826E-04	2.8489E-04	0.000028
50	5.9209E-04	3.3491E-04	3.5803E-04	0.000030

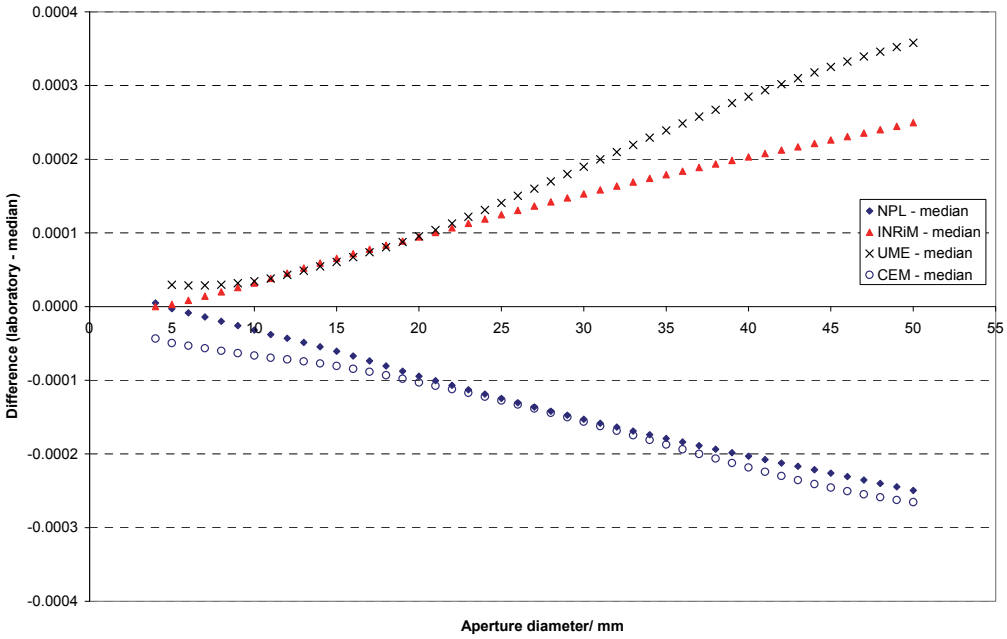
Table 93 – differences between UME results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot **excluding LNE data**

Aperture diameter/ mm	Difference (INRiM - weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
5	1.1658E-05	7.9665E-06	2.9264E-06	0.000008
7	2.9632E-05	2.1074E-05	1.4099E-05	0.000009
10	5.6921E-05	3.9915E-05	3.1902E-05	0.000009
15	1.1146E-04	6.9310E-05	6.5545E-05	0.000011
20	1.7254E-04	9.6417E-05	9.4510E-05	0.000012
25	2.2564E-04	1.2143E-04	1.2474E-04	0.000014
30	2.8527E-04	1.4454E-04	1.5296E-04	0.000016
40	3.9199E-04	1.8635E-04	2.0298E-04	0.000019
50	4.8364E-04	2.2645E-04	2.4958E-04	0.000023
60	4.6481E-04	2.8681E-04	2.8681E-04	0.000026
70	3.1016E-04	2.9628E-04	2.9628E-04	0.000028
80	2.8419E-04	2.9499E-04	2.9499E-04	0.000031
100	3.1616E-04	3.8188E-04	3.8188E-04	0.000036

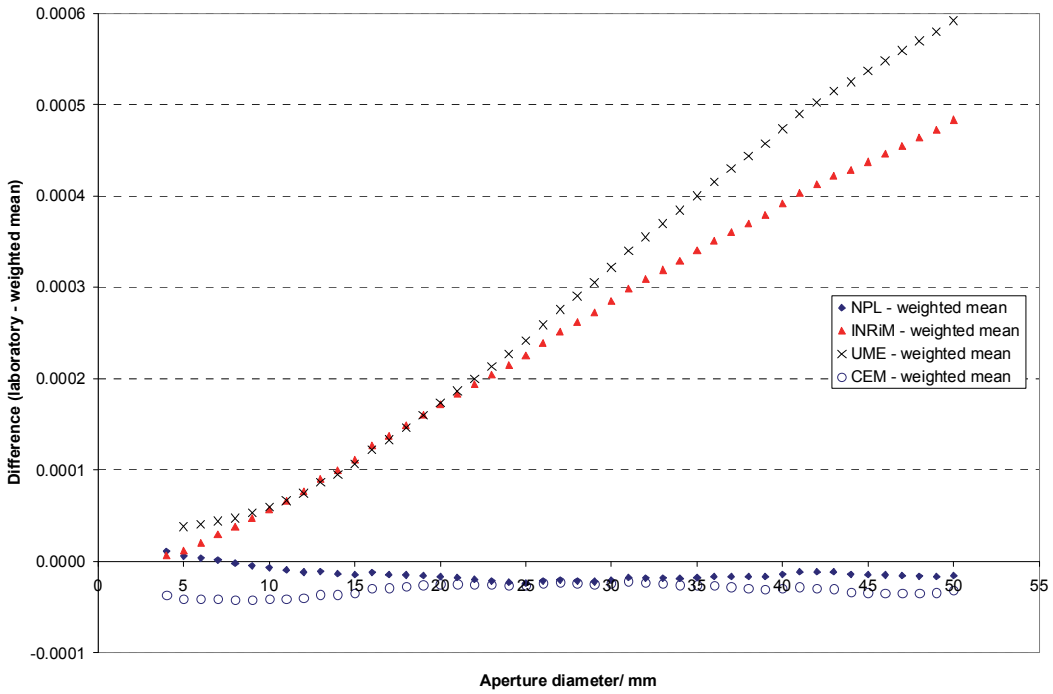
Table 94 – differences between INRiM results and averages, indirect measurements with the LP5 thermometer, 3 mm diameter spot **excluding LNE data**



Plot of differences (laboratory - median) for LP5 SSE with 3 mm spot (excluding LNE data)



Plot of differences (laboratory - weighted mean) for LP5 SSE with 3 mm spot (excluding LNE data)



1.7.5 LP5 Results – indirect measurements with 6 mm diameter spot

Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
7	1.3529E-05	9.5983E-06	9.3378E-06
10	3.3536E-05	4.5404E-05	5.9160E-05
15	5.2770E-05	9.8638E-05	1.3538E-04
20	6.9223E-05	1.5415E-04	2.0454E-04
25	8.4726E-05	2.1230E-04	2.7075E-04
30	9.6804E-05	2.7296E-04	3.3415E-04
40	1.2543E-04	3.9837E-04	4.5300E-04
50	1.5254E-04	5.1664E-04	5.6207E-04
60	2.5738E-04	7.3757E-04	6.6237E-04
70	3.4126E-04	8.8881E-04	7.5489E-04
80	4.3531E-04	5.6657E-04	5.6657E-04
100	5.1038E-04	6.3790E-04	6.3790E-04

Table 95 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the LP5 thermometer – 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	0.000002	0.000006	0.000007	0.000005
10	-0.000007	-0.000018	-0.000032	0.000003
15	-0.000010	-0.000056	-0.000093	0.000003
20	-0.000013	-0.000098	-0.000149	0.000003
25	-0.000016	-0.000143	-0.000202	0.000003
30	-0.000015	-0.000191	-0.000252	0.000003
40	-0.000015	-0.000288	-0.000342	0.000003
50	-0.000015	-0.000379	-0.000424	0.000003

Table 96 – differences between NPL results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (CEM - weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	-0.000010	-0.000006	-0.000006	0.000011
10	-0.000024	-0.000036	-0.000049	0.000011
15	-0.000028	-0.000074	-0.000110	0.000011
20	-0.000027	-0.000112	-0.000162	0.000011
25	-0.000027	-0.000155	-0.000213	0.000011
30	-0.000026	-0.000202	-0.000264	0.000011
40	-0.000036	-0.000309	-0.000364	0.000011
50	-0.000043	-0.000407	-0.000453	0.000011
60	-0.000110	-0.000590	-0.000515	0.000011
70	-0.000129	-0.000676	-0.000542	0.000014
80	-0.000143	-0.000274	-0.000274	0.000016
100	-0.000230	-0.000358	-0.000358	0.000022

Table 97 – differences between CEM results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot, including all data

Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	0.000034	0.000023	0.000009	0.000022
15	0.000083	0.000037	0.000001	0.000022
20	0.000136	0.000051	0.000001	0.000022
25	0.000197	0.000069	0.000011	0.000022
30	0.000269	0.000092	0.000031	0.000023
40	0.000418	0.000145	0.000091	0.000023
50	0.000525	0.000160	0.000115	0.000023

Table 98 – differences between UME results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot, including all data

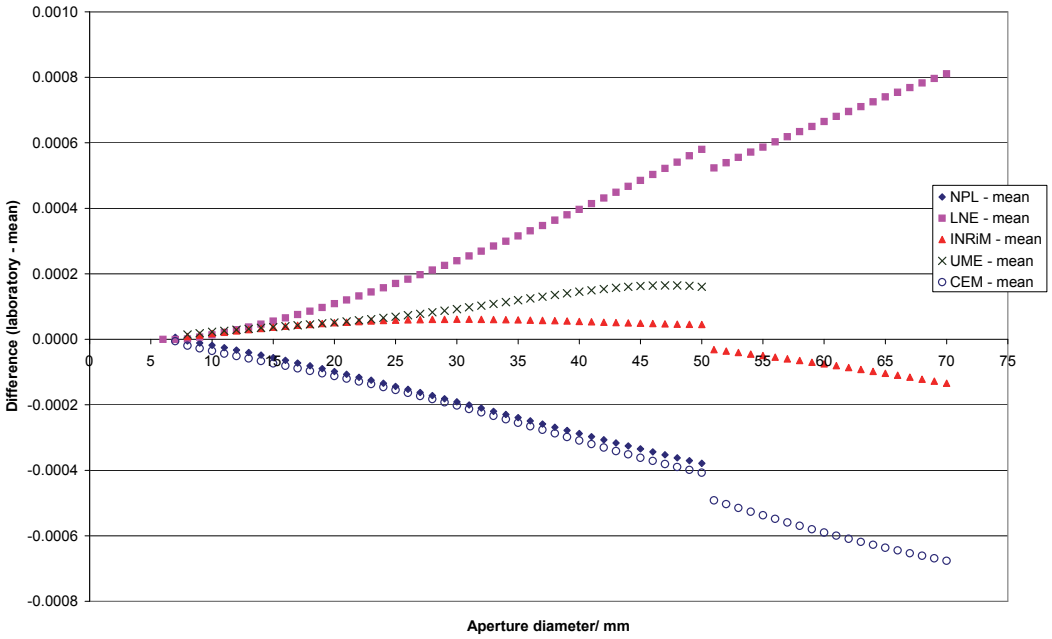
Aperture diameter/ mm	Difference (LNE - weighted mean SSE)	Difference (LNE - mean SSE)	Difference (LNE - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	-0.000004	0.000000	0.000000	0.000097
10	0.000026	0.000014	0.000000	0.000106
15	0.000101	0.000056	0.000019	0.000132
20	0.000193	0.000108	0.000058	0.000196
25	0.000298	0.000170	0.000112	0.000215
30	0.000416	0.000240	0.000178	0.000233
40	0.000670	0.000397	0.000342	0.000176
50	0.000944	0.000580	0.000535	0.000159
60	0.001145	0.000665	0.000740	0.000292
70	0.001358	0.000810	0.000944	0.000370

Table 99 – differences between LNE results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot, including all data

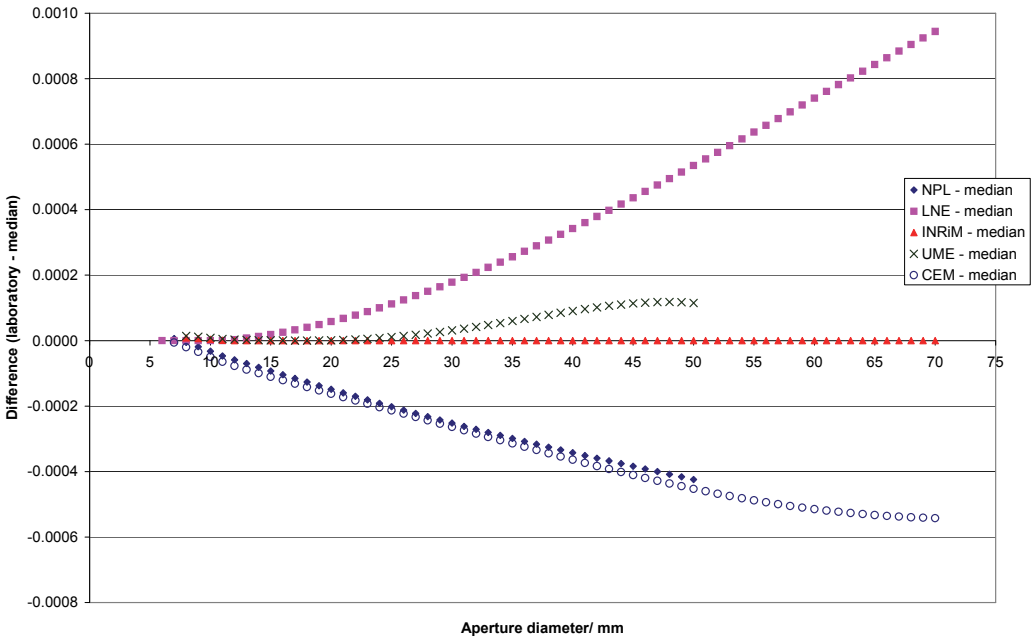
Aperture diameter/ mm	Difference (INRiM - weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	0.000030	0.000018	0.000004	0.000006
15	0.000083	0.000037	0.000000	0.000007
20	0.000135	0.000050	0.000000	0.000009
25	0.000186	0.000058	0.000000	0.000011
30	0.000237	0.000061	0.000000	0.000012
40	0.000328	0.000055	0.000000	0.000016
50	0.000410	0.000045	0.000000	0.000019
60	0.000405	-0.000075	0.000000	0.000022
70	0.000414	-0.000134	0.000000	0.000025
80	0.000405	0.000274	0.000274	0.000028
100	0.000485	0.000358	0.000358	0.000032

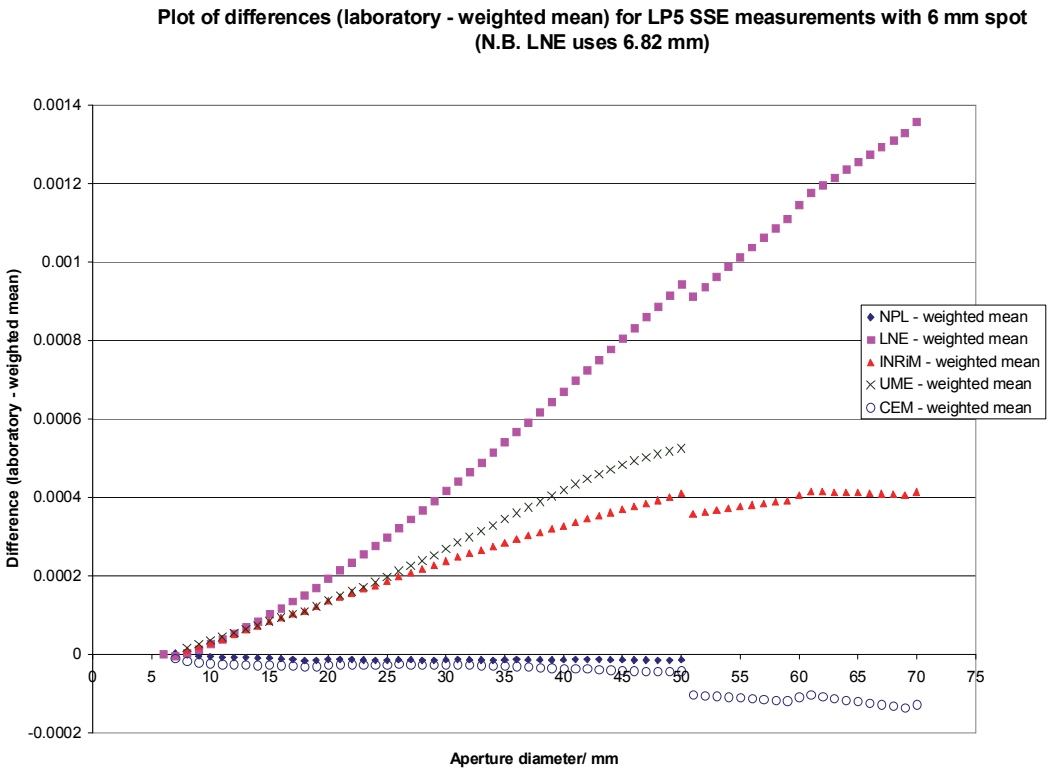
Table 100 – differences between INRiM results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot, including all data

Plot of differences (laboratory - mean) for LP5 SSE measurements with 6 mm spot (N.B. LNE uses 6.82 mm)



Plot of differences (laboratory - median) for LP5 SSE measurements with 6 mm spot (N.B LNE uses 6.82 mm)





Aperture diameter/ mm	Weighted mean SSE value	Arithmetic mean SSE value	Median SSE value
7	1.3539E-05	9.7286E-06	9.7286E-06
10	3.3518E-05	4.1965E-05	4.5082E-05
15	5.2737E-05	8.4760E-05	8.8958E-05
20	6.9192E-05	1.2705E-04	1.3027E-04
25	8.4677E-05	1.6972E-04	1.6982E-04
30	9.6752E-05	2.1304E-04	2.0814E-04
40	1.2528E-04	2.9912E-04	2.8182E-04
50	1.5227E-04	3.7163E-04	3.4995E-04
60	2.5600E-04	4.0505E-04	4.0505E-04
70	3.3982E-04	4.8368E-04	4.8368E-04
80	4.3531E-04	5.6657E-04	5.6657E-04
100	5.1038E-04	6.3790E-04	6.3790E-04

Table 101 – the calculated arithmetic and weighted mean and the median SSE values for the indirect measurements with the LP5 thermometer – 6 mm diameter spot **excluding LNE data

Aperture diameter/ mm	Difference (NPL - weighted mean SSE)	Difference (NPL - mean SSE)	Difference (NPL - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	0.000002	0.000006	0.000006	0.000005
10	-0.000007	-0.000015	-0.000018	0.000003
15	-0.000010	-0.000042	-0.000046	0.000003
20	-0.000013	-0.000071	-0.000074	0.000003
25	-0.000016	-0.000101	-0.000101	0.000003
30	-0.000015	-0.000131	-0.000126	0.000003
40	-0.000015	-0.000188	-0.000171	0.000003
50	-0.000014	-0.000234	-0.000212	0.000003

Table 102 – differences between NPL results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot **excluding LNE data **

Aperture diameter/ mm	Difference (CEM - weighted mean SSE)	Difference (CEM - mean SSE)	Difference (CEM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
7	-0.000010	-0.000006	-0.000006	0.000011
10	-0.000024	-0.000032	-0.000035	0.000011
15	-0.000028	-0.000060	-0.000064	0.000011
20	-0.000027	-0.000085	-0.000088	0.000011
25	-0.000027	-0.000112	-0.000112	0.000011
30	-0.000026	-0.000143	-0.000138	0.000011
40	-0.000036	-0.000210	-0.000193	0.000011
50	-0.000043	-0.000262	-0.000240	0.000011
60	-0.000108	-0.000257	-0.000257	0.000011
70	-0.000127	-0.000271	-0.000271	0.000014
80	-0.000143	-0.000274	-0.000274	0.000016
100	-0.000230	-0.000358	-0.000358	0.000022

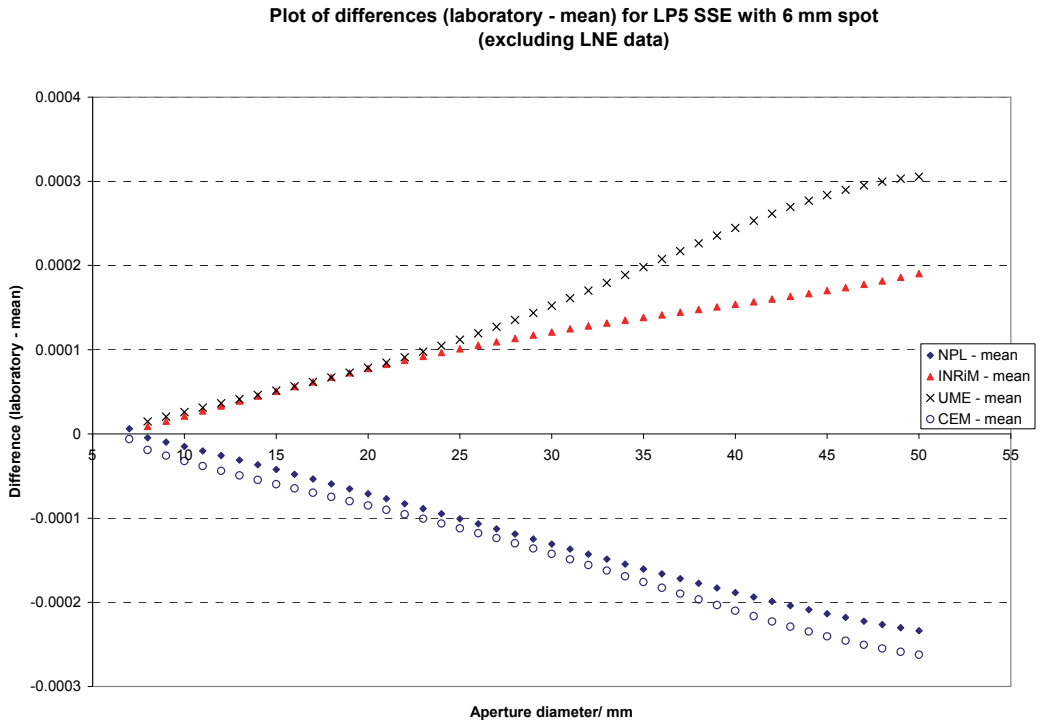
Table 103 – differences between CEM results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot **excluding LNE data **

Aperture diameter/ mm	Difference (UME - weighted mean SSE)	Difference (UME - mean SSE)	Difference (UME - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	0.000034	0.000026	0.000023	0.000022
15	0.000083	0.000051	0.000047	0.000022
20	0.000136	0.000079	0.000075	0.000022
25	0.000197	0.000112	0.000112	0.000022
30	0.000269	0.000152	0.000157	0.000023
40	0.000418	0.000245	0.000262	0.000023
50	0.000525	0.000305	0.000327	0.000023

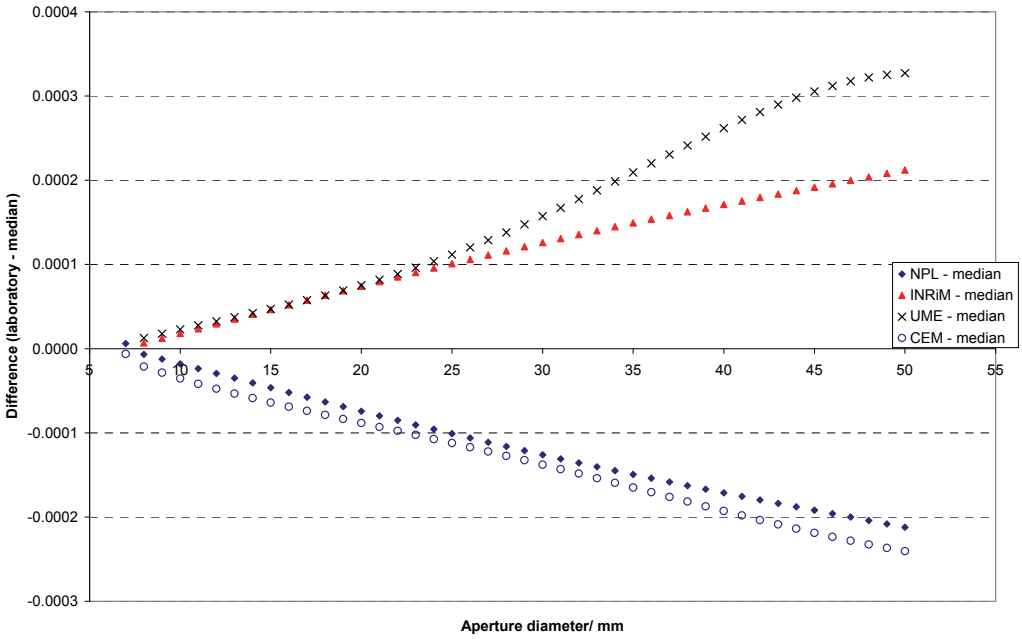
Table 104 – differences between UME results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot **excluding LNE data **

Aperture diameter/ mm	Difference (INRiM - weighted mean SSE)	Difference (INRiM - mean SSE)	Difference (INRiM - median SSE)	Total ($k = 2$) uncertainty (fitted data)
10	0.000030	0.000021	0.000018	0.000006
15	0.000083	0.000051	0.000046	0.000007
20	0.000135	0.000077	0.000074	0.000009
25	0.000186	0.000101	0.000101	0.000011
30	0.000237	0.000121	0.000126	0.000012
40	0.000328	0.000154	0.000171	0.000016
50	0.000410	0.000190	0.000212	0.000019
60	0.000406	0.000257	0.000257	0.000022
70	0.000415	0.000271	0.000271	0.000025
80	0.000405	0.000274	0.000274	0.000028
100	0.000485	0.000358	0.000358	0.000032

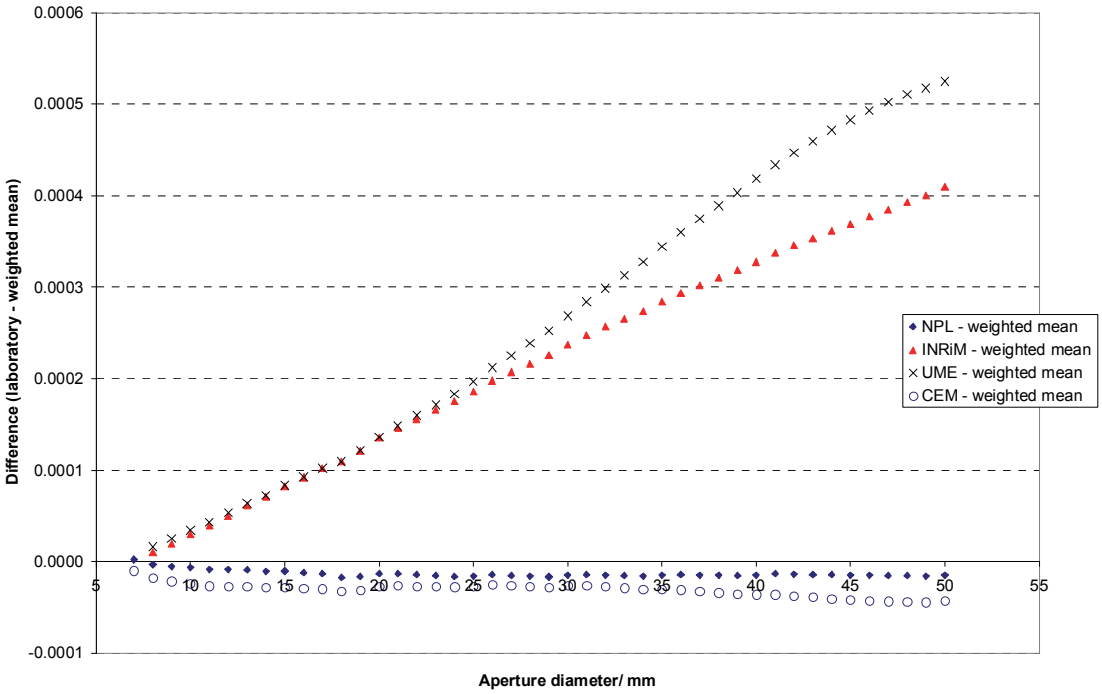
Table 105 – differences between INRiM results and averages, indirect measurements with the LP5 thermometer, 6 mm diameter spot **excluding LNE data **



Plot of differences (laboratory - median) for LP5 SSE with 6 mm spot (excluding LNE data)



Plot of differences (laboratory - weighted mean) for LP5 SSE with 6 mm spot (excluding LNE data)

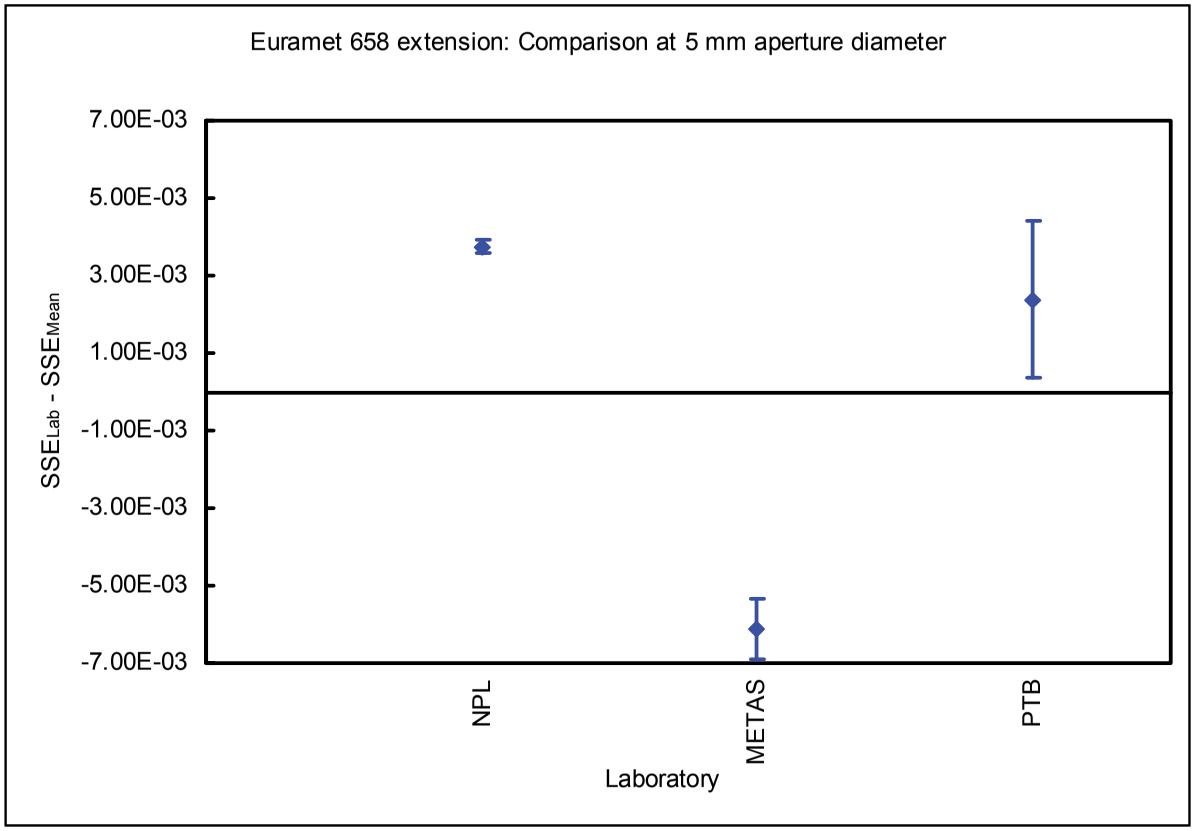


1.8 THE QDE_{95} AND DOE VALUES FOR THE SSE RESULTS

1.8.1 The INRiM thermometer direct SSE results

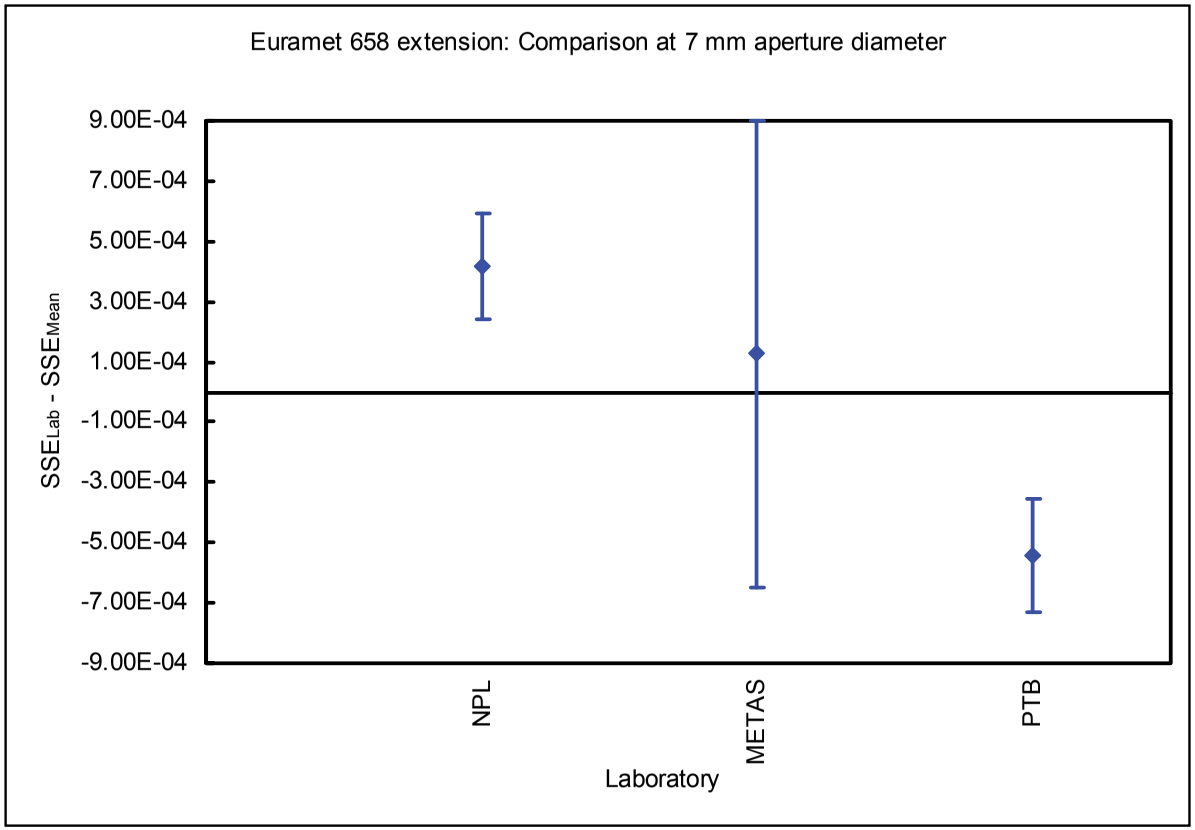
	NPL	METAS	PTB
NPL	-	0.009879 ± 7.931E-04	0.001362 ± 2.013E-03
METAS	*0.010531*	-	-0.008517 ± 2.151E-03
PTB	*0.003019*	*0.010287*	-

Table 106 – comparison of direct SSE measurements with the INRiM thermometer, 5 mm diameter aperture



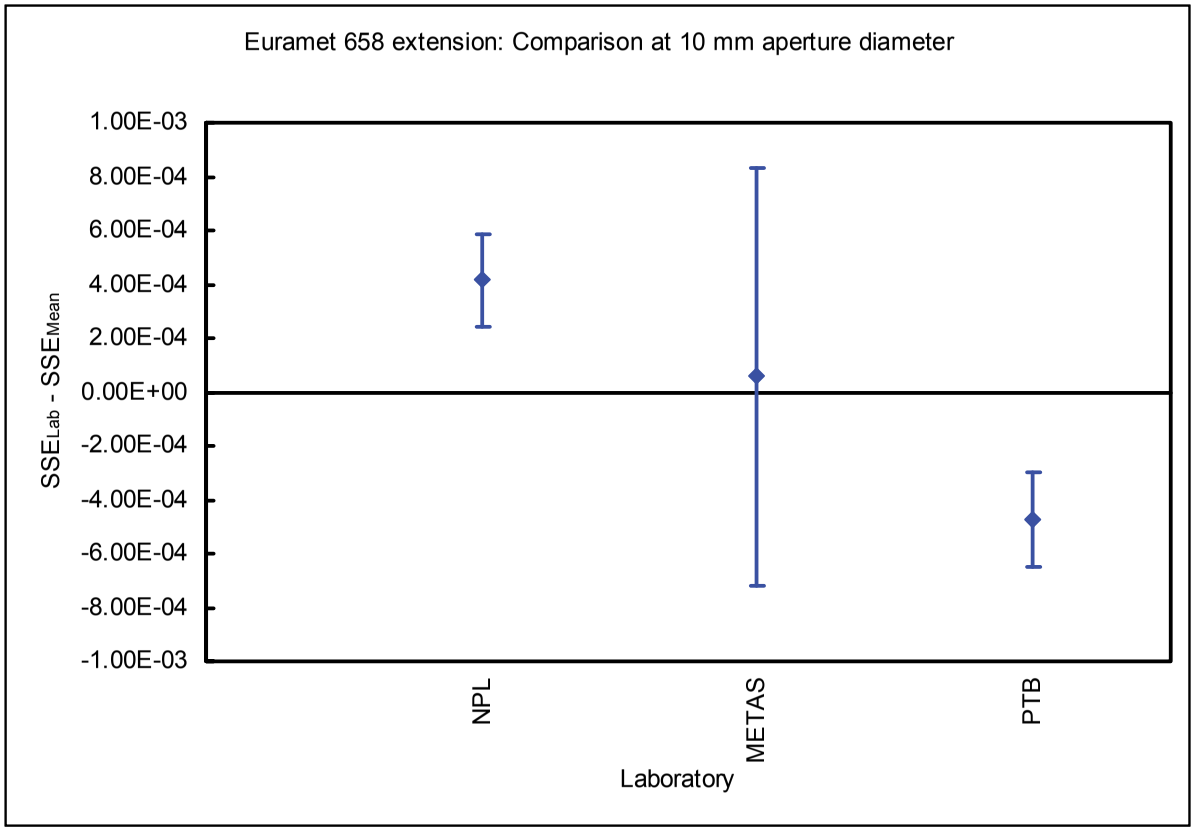
	NPL	METAS	PTB
NPL	-	0.000290 ± 7.954E-04	0.000959 ± 2.582E-04
METAS	*0.000951*	-	0.000670 ± 7.990E-04
PTB	*0.001171*	*0.001327*	-

Table 107 – comparison of direct SSE measurements with the INRiM thermometer, 7 mm diameter aperture



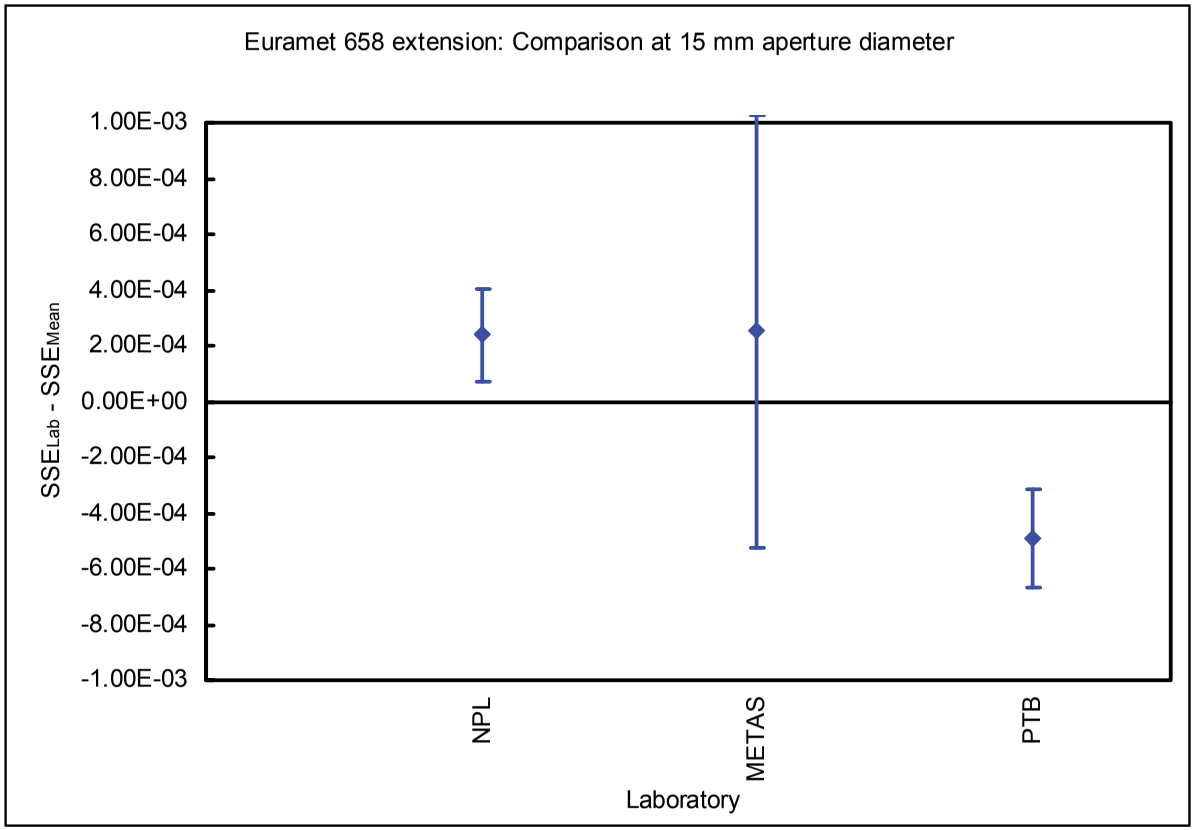
	NPL	METAS	PTB
NPL	-	0.000358 ± 7.947E-04	0.000889 ± 2.460E-04
METAS	*0.001015*	-	0.000531 ± 7.958E-04
PTB	*0.001091*	*0.001186*	-

Table 108 – comparison of direct SSE measurements with the INRiM thermometer, 10 mm diameter aperture



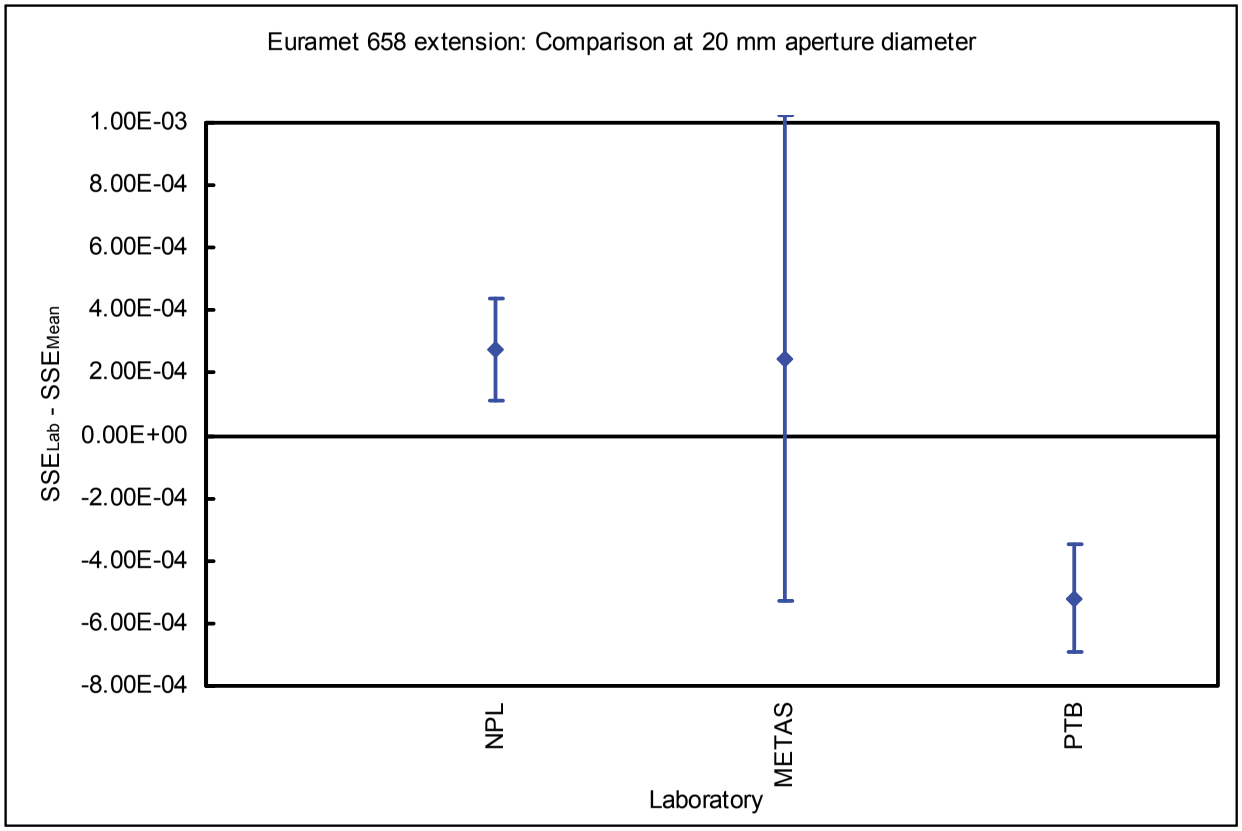
	NPL	METAS	PTB
NPL	-	-0.000014 ± 7.933E-04	0.000731 ± 2.413E-04
METAS	*0.000780*	-	0.000745 ± 7.958E-04
PTB	*0.000930*	*0.001400*	-

Table 109 – comparison of direct SSE measurements with the INRiM thermometer, 15 mm diameter aperture



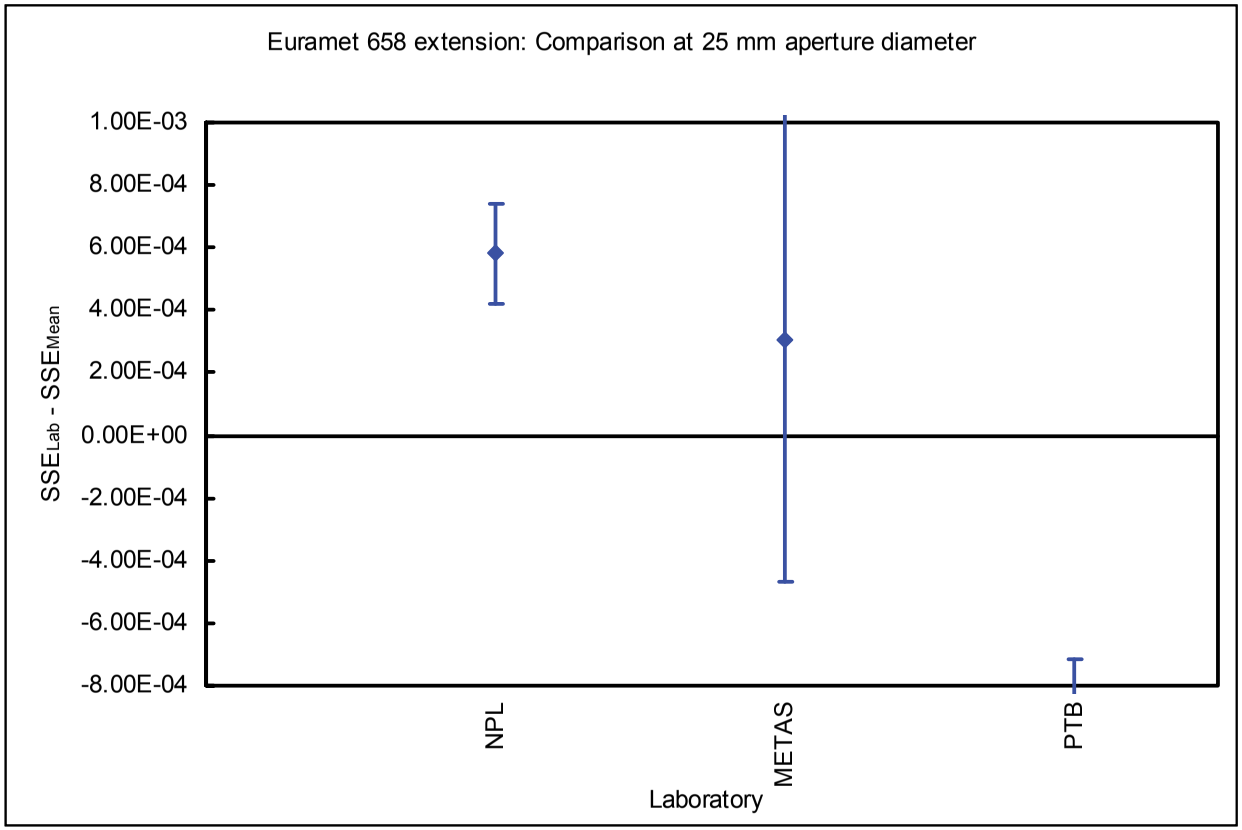
	NPL	METAS	PTB
NPL	-	0.000026 ± 7.931E-04	0.000793 ± 2.379E-04
METAS	*0.000778*	-	0.000766 ± 7.950E-04
PTB	*0.000988*	*0.001420*	-

Table 110 – comparison of direct SSE measurements with the INRiM thermometer, 20 mm diameter aperture



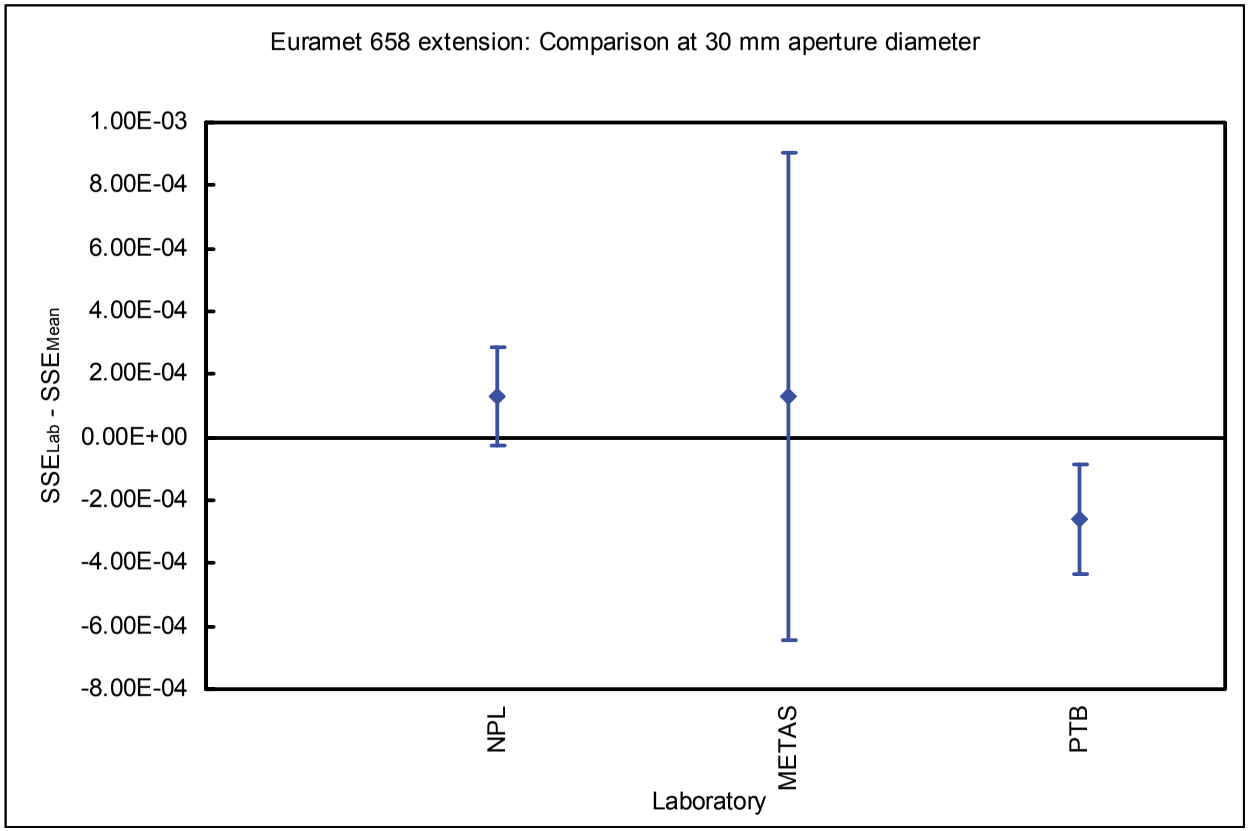
	NPL	METAS	PTB
NPL	-	0.000273 ± 7.921E-04	0.001469 ± 2.348E-04
METAS	*0.000933*	-	0.001196 ± 7.950E-04
PTB	*0.001663*	*0.001850*	-

Table 111 – comparison of direct SSE measurements with the INRiM thermometer, 25 mm diameter aperture



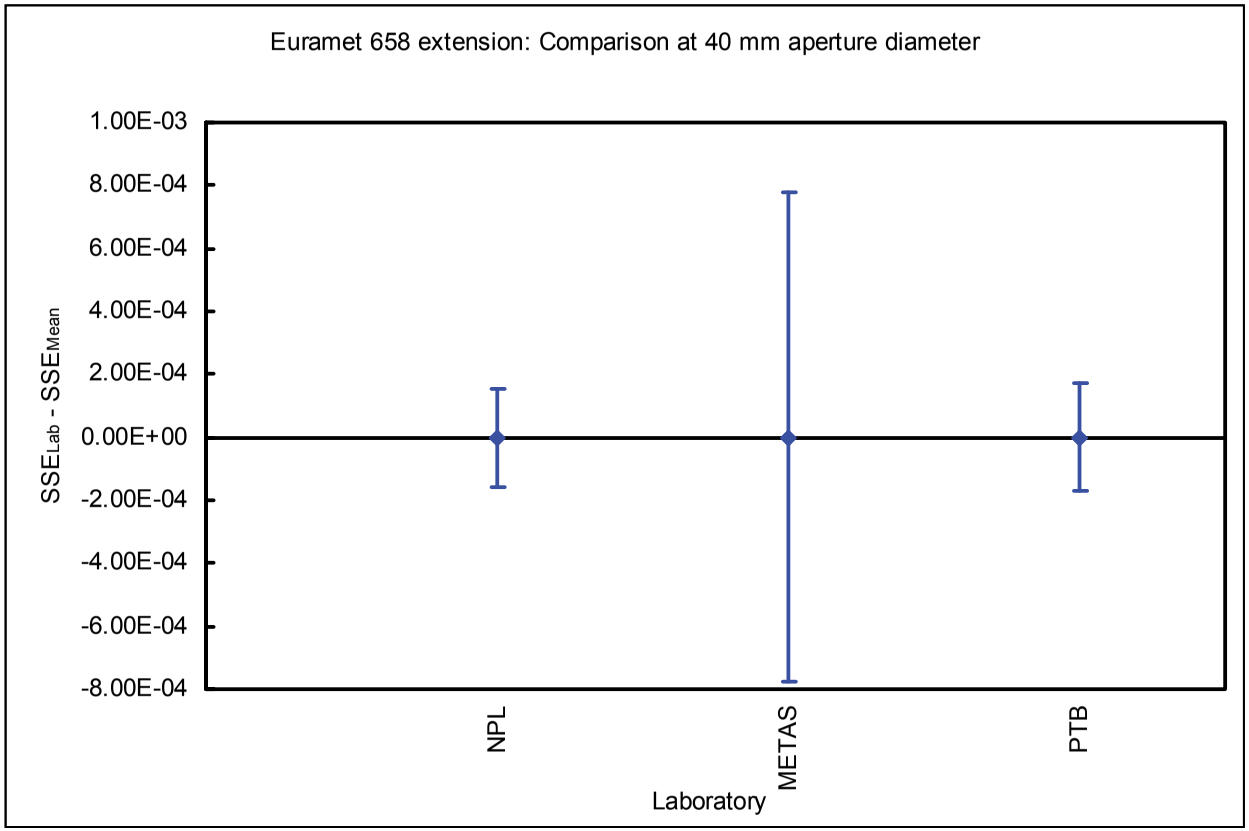
	NPL	METAS	PTB
NPL	-	0.000001 ± 7.914E-04	0.000391 ± 2.323E-04
METAS	*0.000781*	-	0.000391 ± 7.950E-04
PTB	*0.000582*	*0.001047*	-

Table 112 – comparison of direct SSE measurements with the INRiM thermometer, 30 mm diameter aperture



	NPL	METAS	PTB
NPL	-	0.000001 ± 7.914E-04	0.000000 ± 2.323E-04
METAS	*0.000781*	-	-0.000001 ± 7.950E-04
PTB	*0.000229*	*0.000785*	-

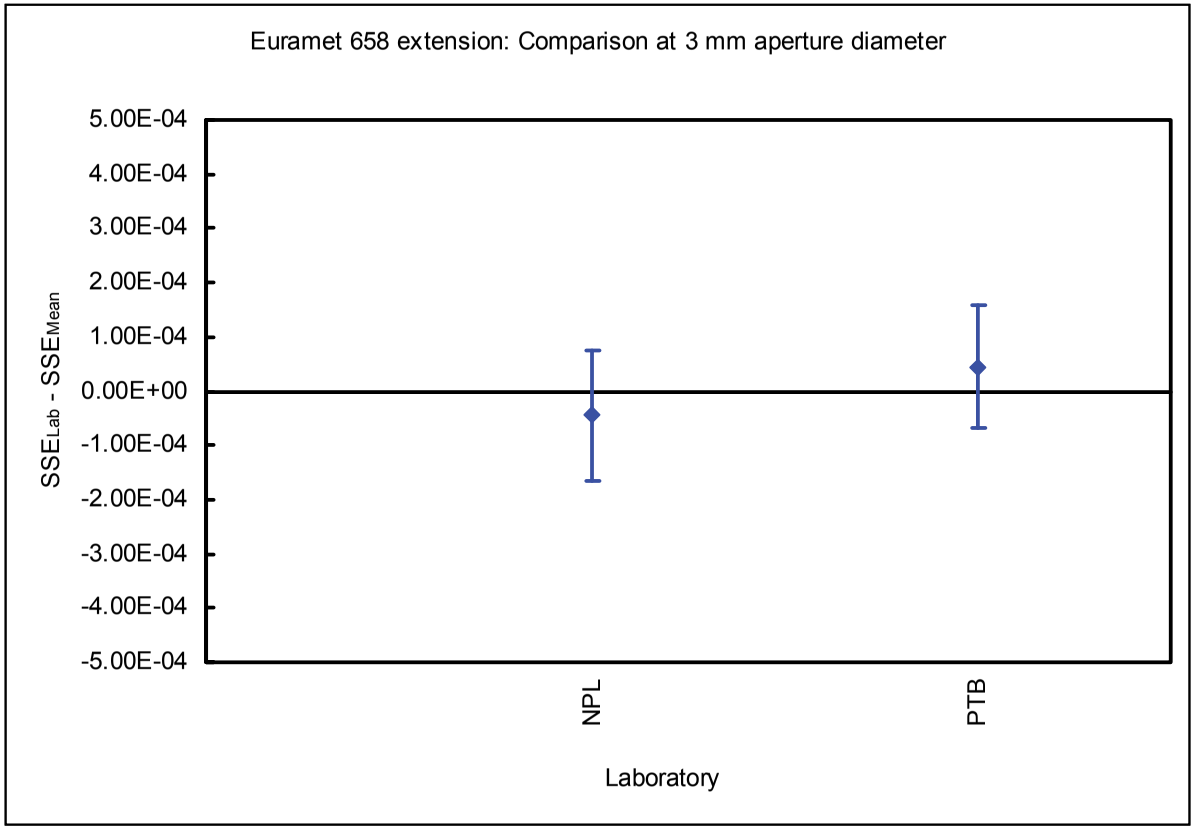
Table 113 – comparison of direct SSE measurements with the INRiM thermometer, 40 mm diameter aperture



1.8.2 The LP5 thermometer ‘direct’ SSE results

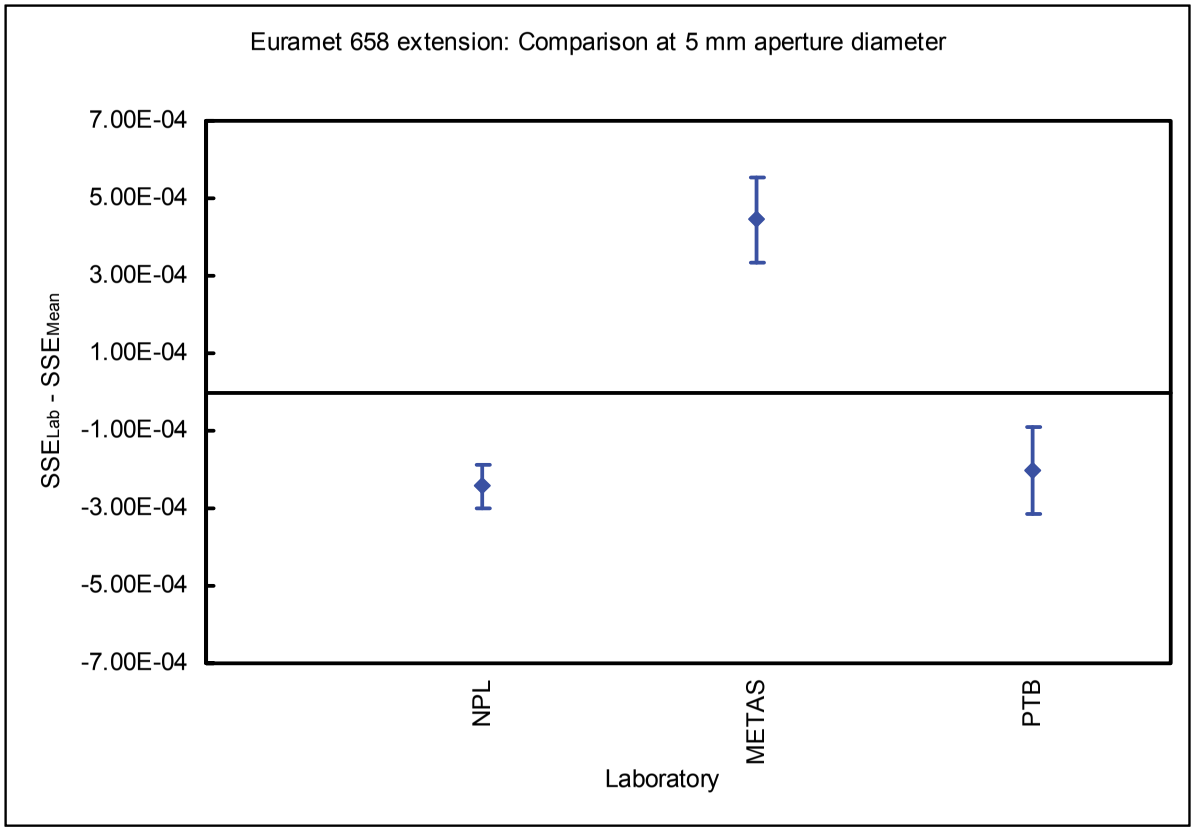
	NPL	PTB
NPL	-	-0.000090 ± 1.645E-04
PTB	*0.000226*	-

Table 114 – comparison of direct SSE measurements with the LP5 thermometer, 3 mm diameter aperture



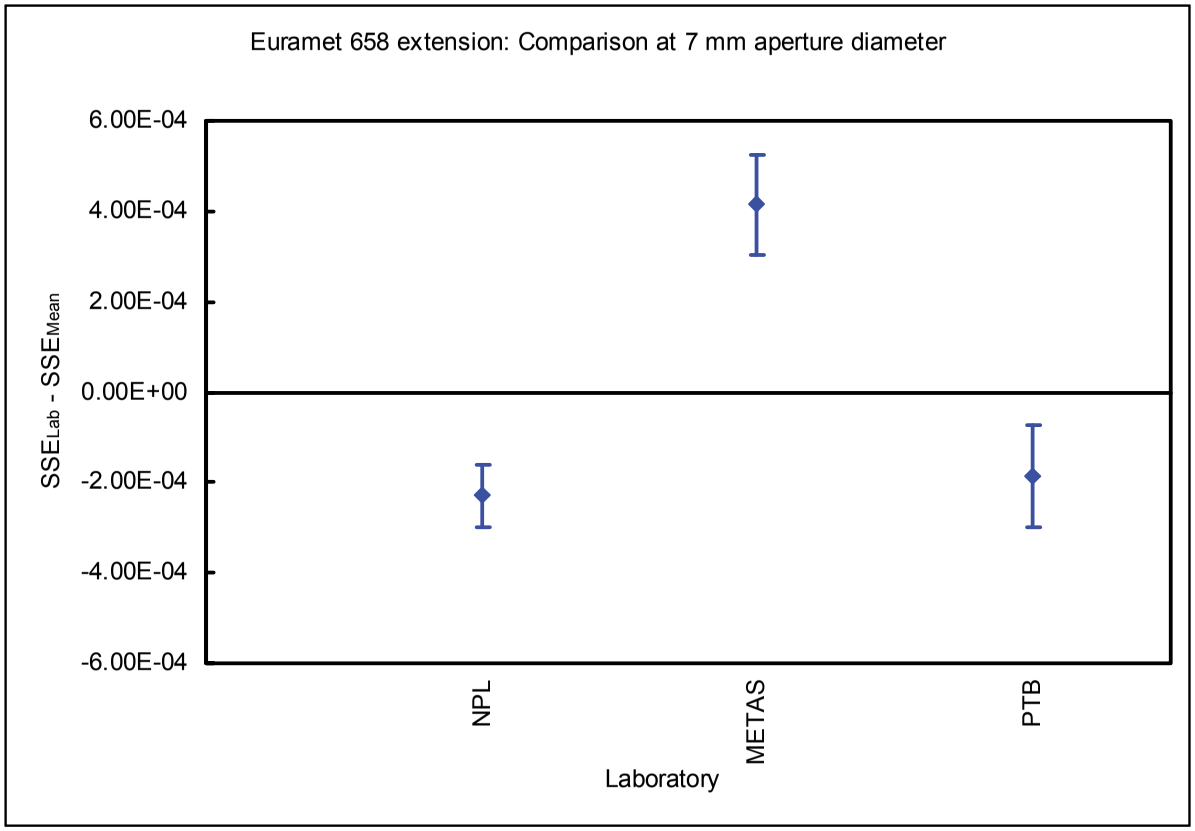
	NPL	METAS	PTB
NPL	-	-0.000687 ± 1.243E-04	-0.000042 ± 1.271E-04
METAS	*0.000790*	-	0.000646 ± 1.580E-04
PTB	*0.000148*	*0.000776*	-

Table 115 – comparison of direct SSE measurements with the LP5 thermometer, 5 mm diameter aperture



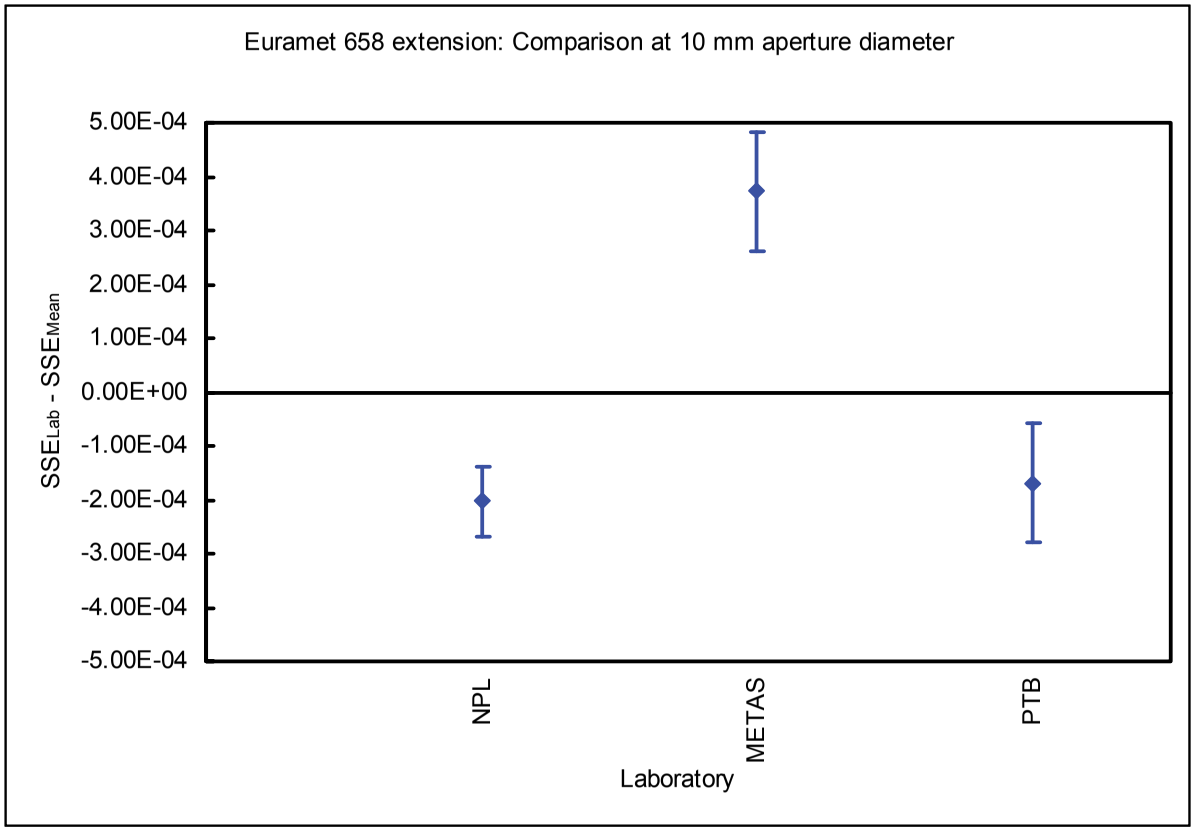
	NPL	METAS	PTB
NPL	-	-0.000644 ± 1.300E-04	-0.000044 ± 1.313E-04
METAS	*0.000751*	-	0.000601 ± 1.569E-04
PTB	*0.000153*	*0.000730*	-

Table 116 – comparison of direct SSE measurements with the LP5 thermometer, 7 mm diameter aperture



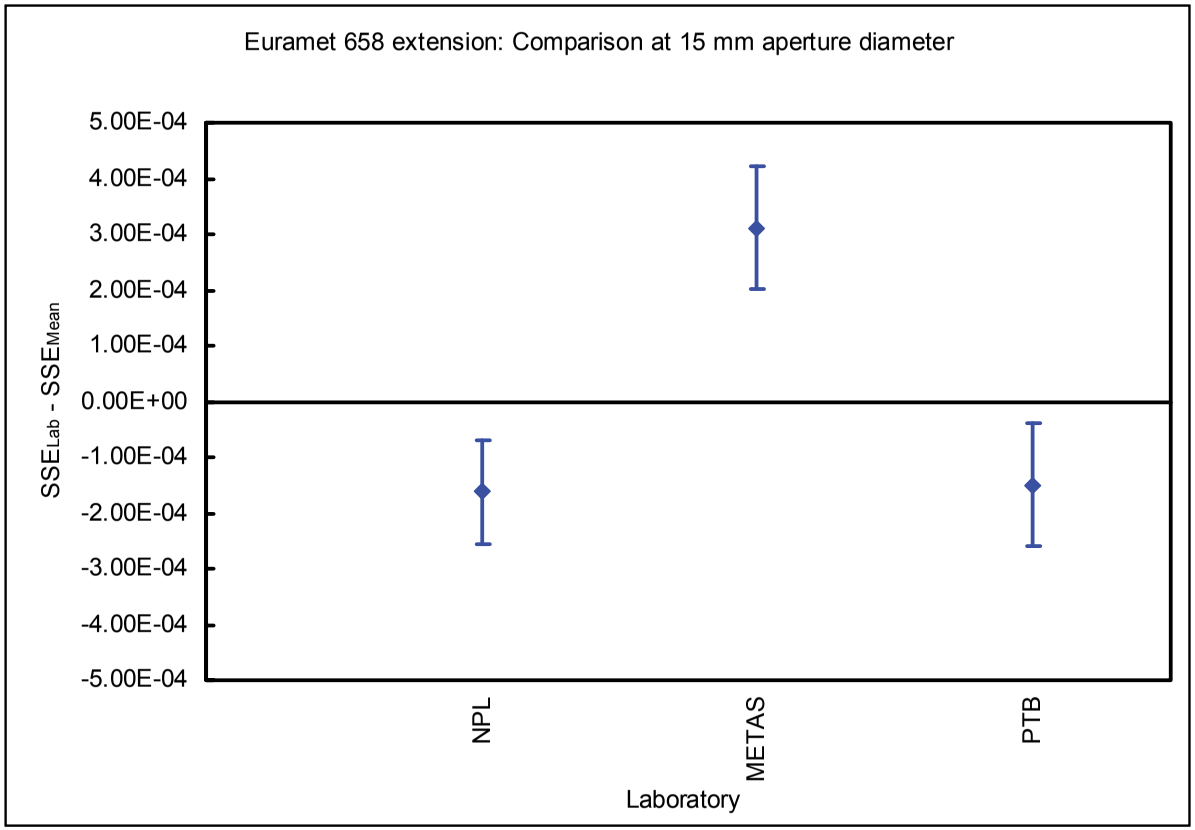
	NPL	METAS	PTB
NPL	-	-0.000575 ± 1.281E-04	-0.000033 ± 1.281E-04
METAS	*0.000680*	-	0.000542 ± 1.558E-04
PTB	*0.000141*	*0.000670*	-

Table 117 – comparison of direct SSE measurements with the LP5 thermometer, 10 mm diameter aperture



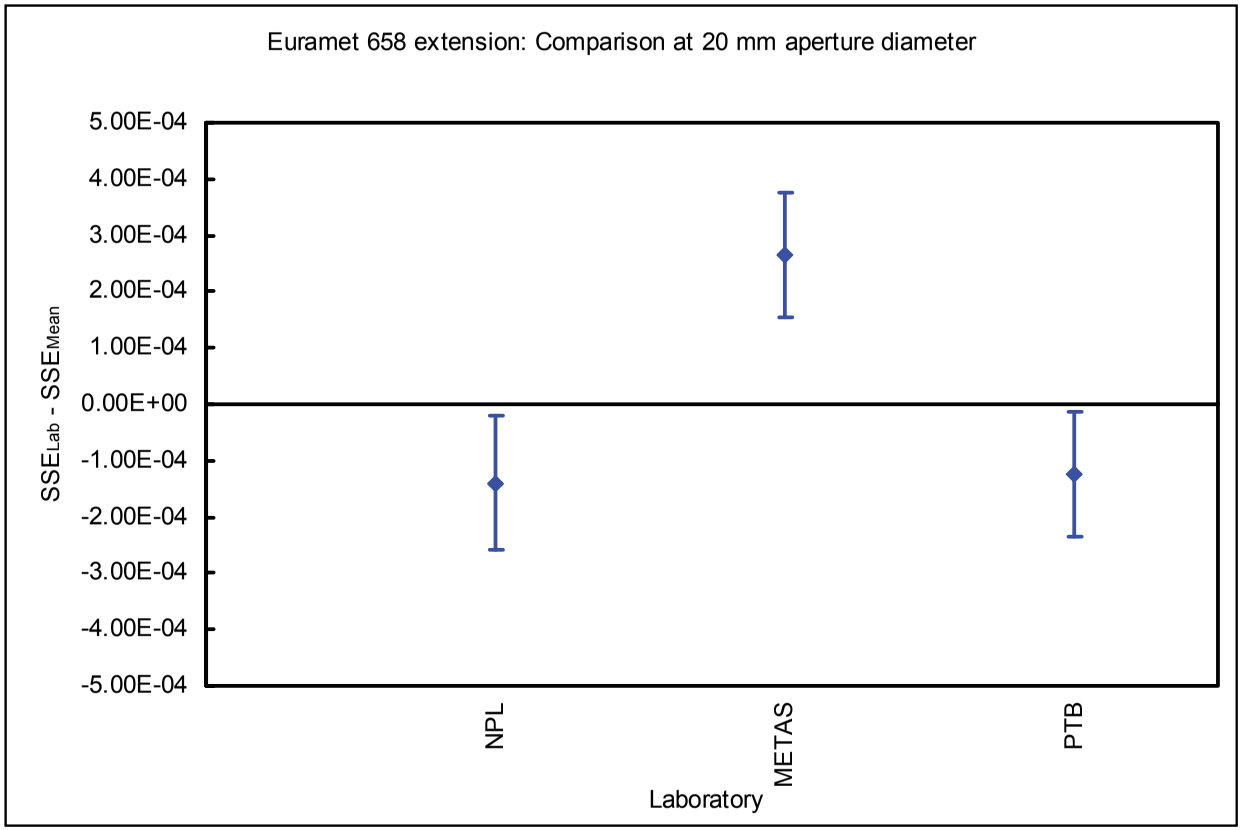
	NPL	METAS	PTB
NPL	-	-0.000474 ± 1.449E-04	-0.000013 ± 1.449E-04
METAS	*0.000593*	-	0.000461 ± 1.558E-04
PTB	*0.000144*	*0.000589*	-

Table 118 – comparison of direct SSE measurements with the LP5 thermometer, 15 mm diameter aperture



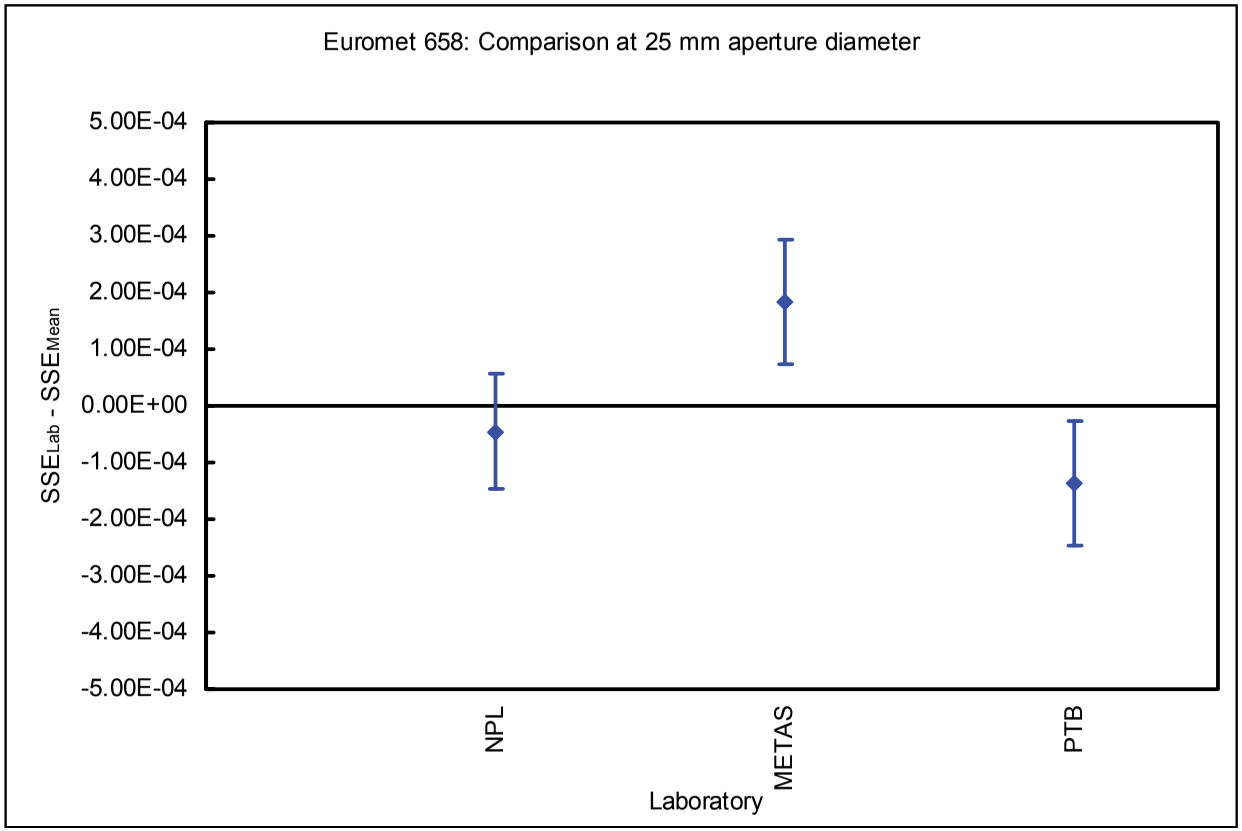
	NPL	METAS	PTB
NPL	-	-0.000406 ± 1.623E-04	-0.000015 ± 1.623E-04
METAS	*0.000540*	-	0.000391 ± 1.558E-04
PTB	*0.000161*	*0.000519*	-

Table 119 – comparison of direct SSE measurements with the LP5 thermometer, 20 mm diameter aperture



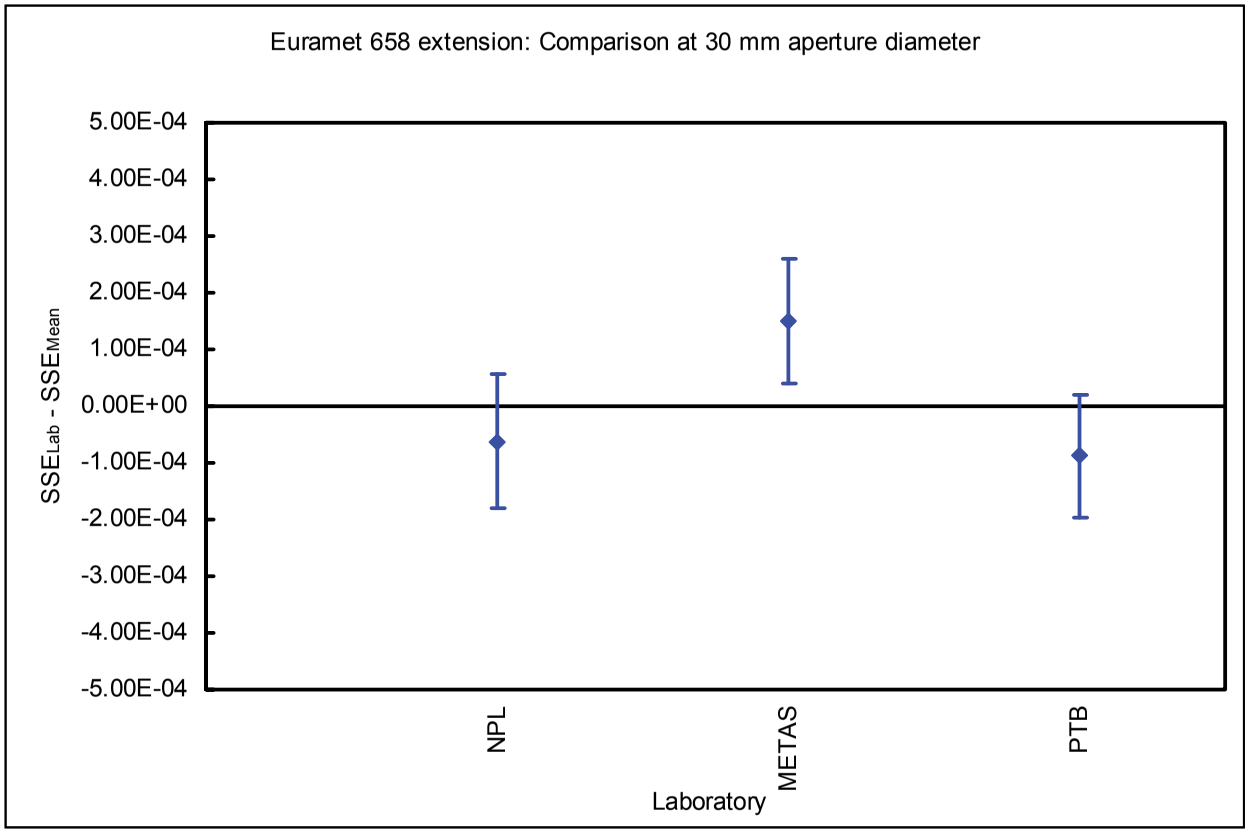
	NPL	METAS	PTB
NPL	-	-0.000228 ± 1.495E-04	0.000093 ± 1.495E-04
METAS	*0.000351*	-	0.000321 ± 1.558E-04
PTB	*0.000216*	*0.000449*	-

Table 120 – comparison of direct SSE measurements with the LP5 thermometer, 25 mm diameter aperture



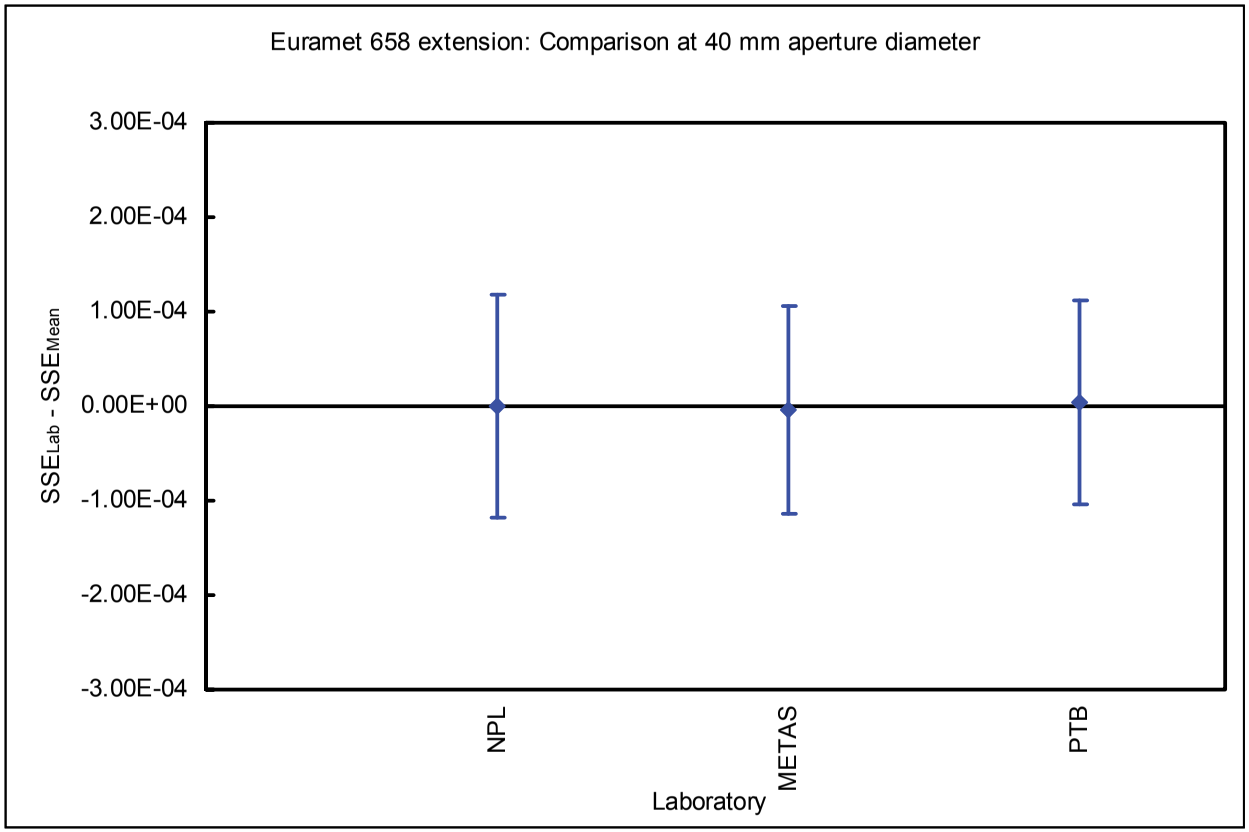
	NPL	METAS	PTB
NPL	-	-0.000213 ± 1.620E-04	0.000026 ± 1.611E-04
METAS	*0.000346*	-	0.000238 ± 1.549E-04
PTB	*0.000165*	*0.000366*	-

Table 121 – comparison of direct SSE measurements with the LP5 thermometer, 30 mm diameter aperture



	NPL	METAS	PTB
NPL	-	0.000004 ± 1.620E-04	-0.000004 ± 1.604E-04
METAS	*0.000159*	-	-0.000008 ± 1.542E-04
PTB	*0.000158*	*0.000152*	-

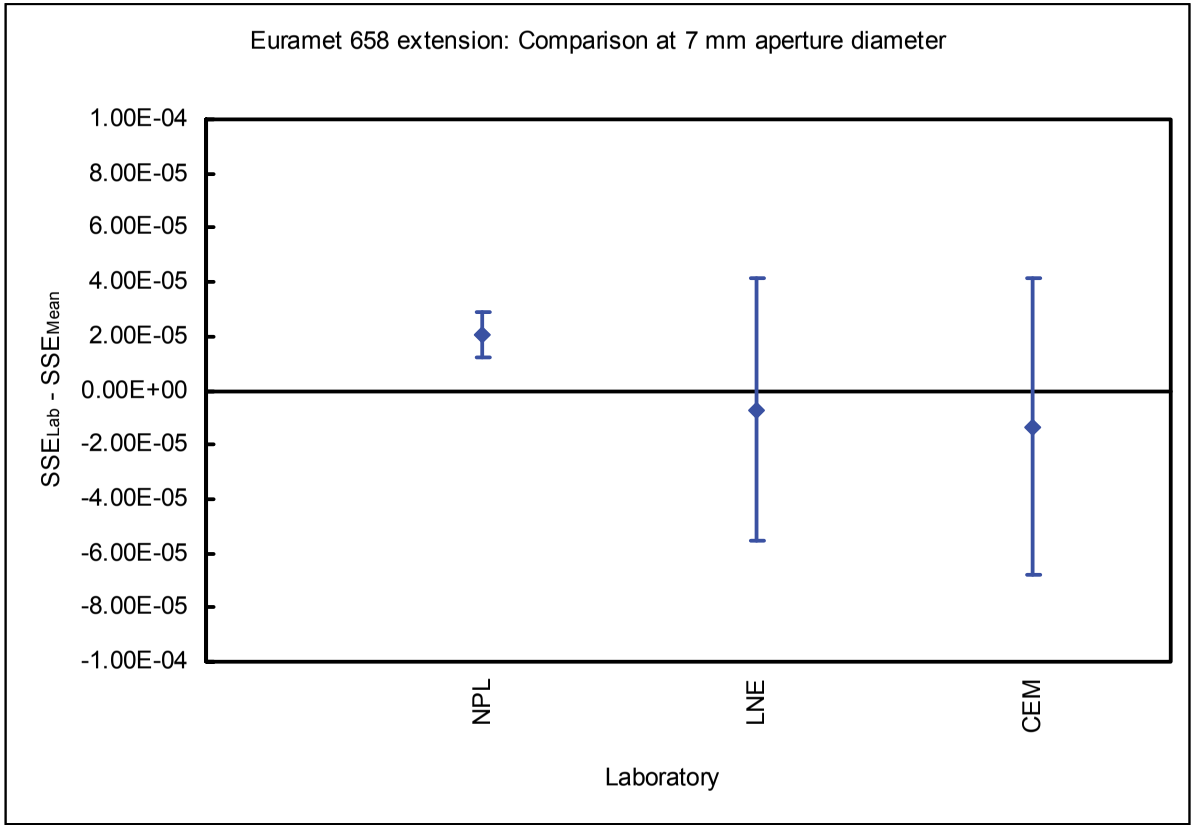
Table 122 – comparison of direct SSE measurements with the LP5 thermometer, 40 mm diameter aperture



1.8.3 The INRiM thermometer ‘indirect’ SSE results – 6 mm spot, all data

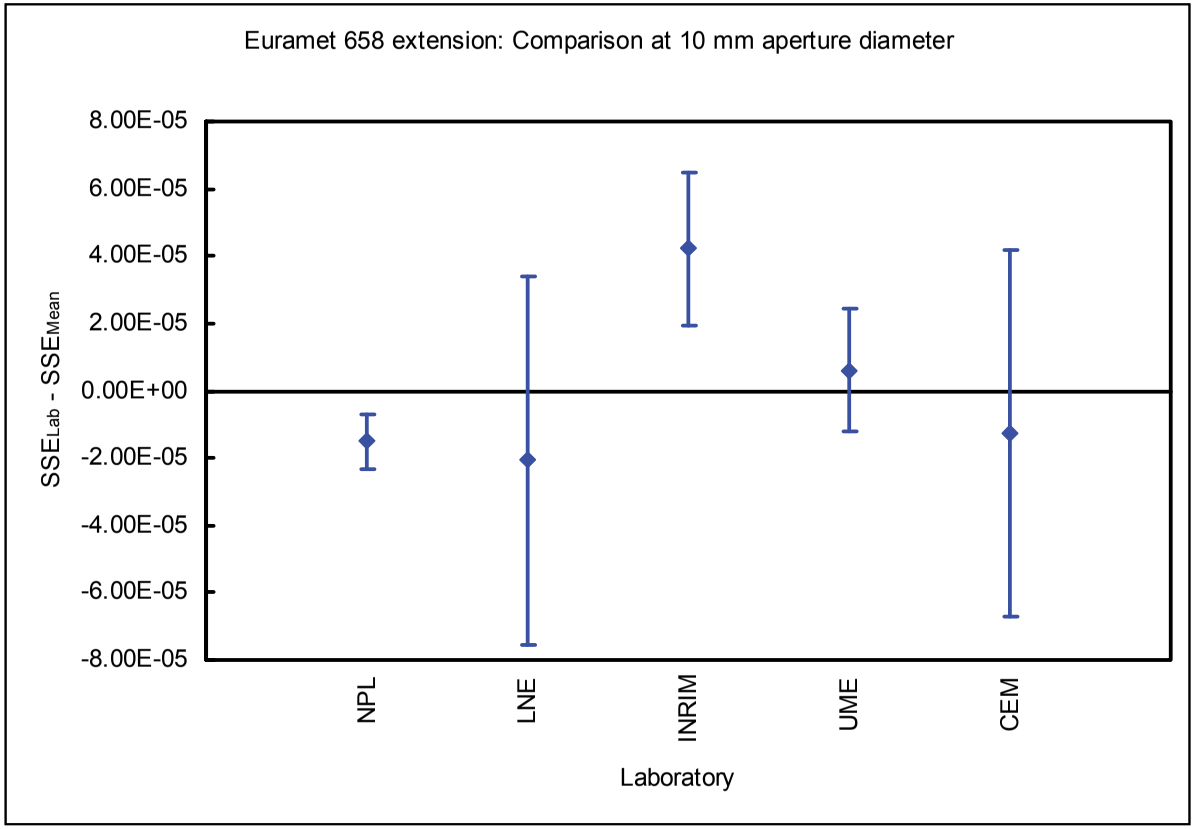
	NPL	LNE	CEM
NPL	-	2.7652E-05 ± 4.899E-05	3.4036E-05 ± 5.523E-05
LNE	*6.8029E-05*	-	6.3834E-06 ± 7.292E-05
CEM	*7.9521E-05*	*7.2276E-05*	-

Table 123 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 7 mm diameter aperture



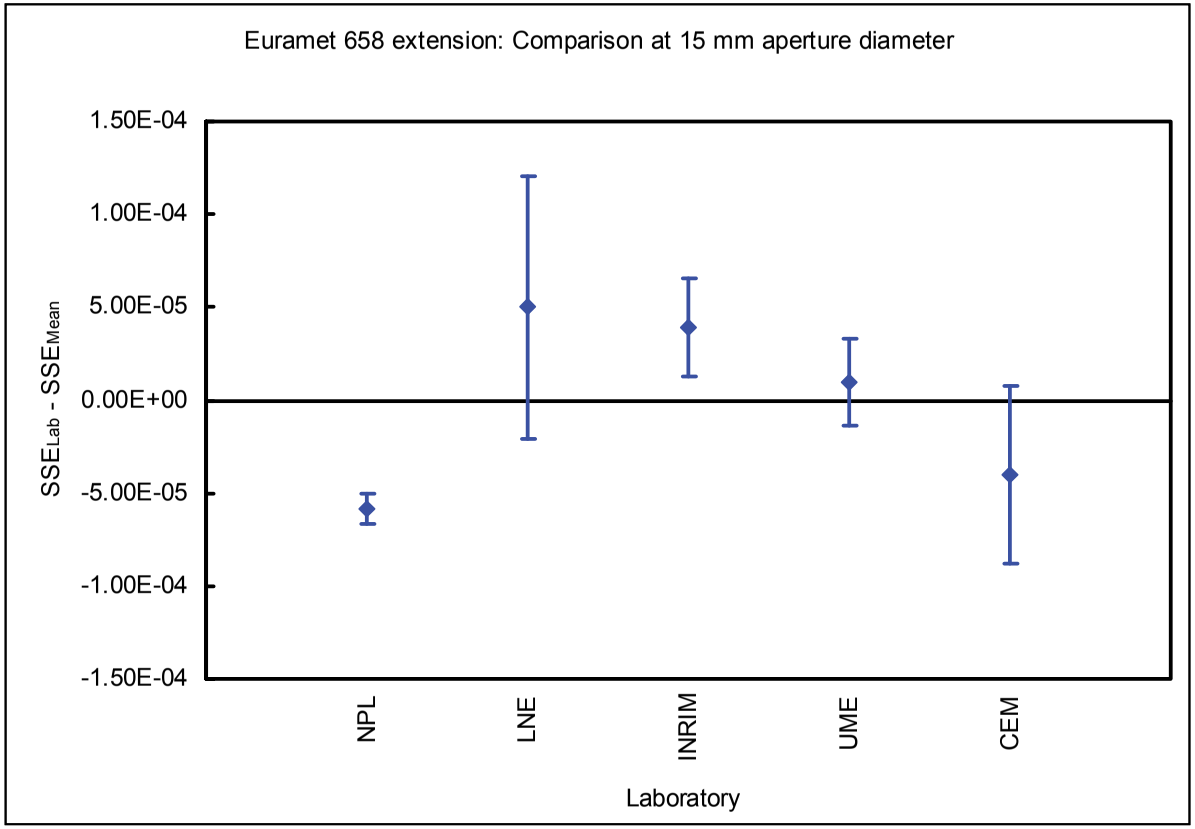
	NPL	LNE	INRIM	UME	CEM
NPL	-	5.7430E-06 ± 5.525E-05	-5.7285E-05 ± 2.407E-05	-2.1038E-05 ± 1.986E-05	-2.3313E-06 ± 5.521E-05
LNE	*5.5104E-05*	-	-6.3028E-05 ± 5.918E-05	-2.6781E-05 ± 5.760E-05	-8.0743E-06 ± 7.728E-05
INRIM	*7.7083E-05*	*1.1170E-04*	-	3.6247E-05 ± 2.906E-05	5.4954E-05 ± 5.915E-05
UME	*3.7378E-05*	*7.4374E-05*	*6.0152E-05*	-	1.8707E-05 ± 5.757E-05
CEM	*5.4207E-05*	*7.7094E-05*	*1.0361E-04*	*6.6738E-05*	-

Table 124 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 10 mm diameter aperture



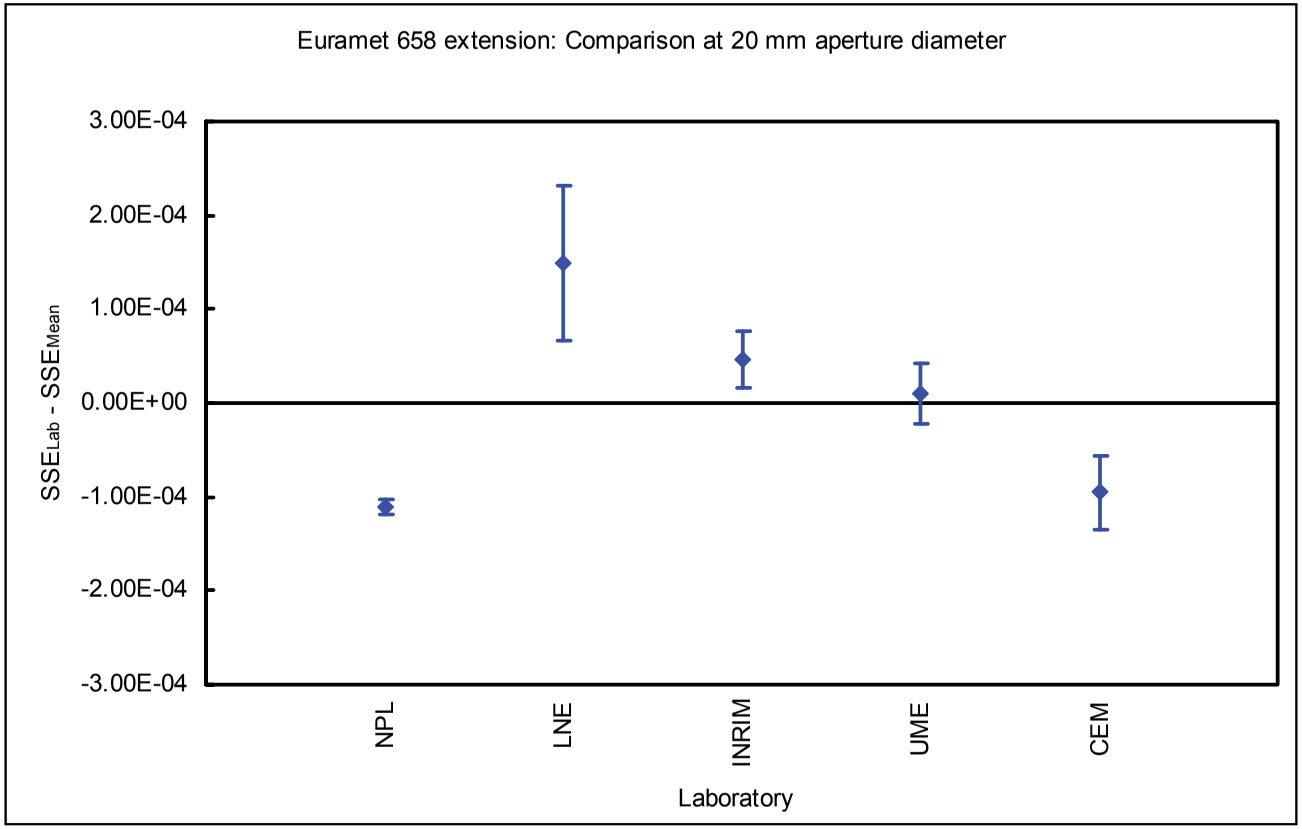
	NPL	LNE	INRIM	UME	CEM
NPL	-	-1.0859E-04 ± 7.108E-05	-9.7631E-05 ± 2.763E-05	-6.8182E-05 ± 2.497E-05	-1.8310E-05 ± 4.809E-05
LNE	*1.6705E-04*	-	1.0958E-05 ± 7.541E-05	4.0406E-05 ± 7.447E-05	9.0278E-05 ± 8.506E-05
INRIM	*1.2036E-04*	*7.6808E-05*	-	2.9449E-05 ± 3.546E-05	7.9320E-05 ± 5.428E-05
UME	*8.8722E-05*	*1.0181E-04*	*5.8620E-05*	-	4.9872E-05 ± 5.298E-05
CEM	*5.8229E-05*	*1.6024E-04*	*1.2397E-04*	*9.3451E-05*	-

Table 125 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 15 mm diameter aperture



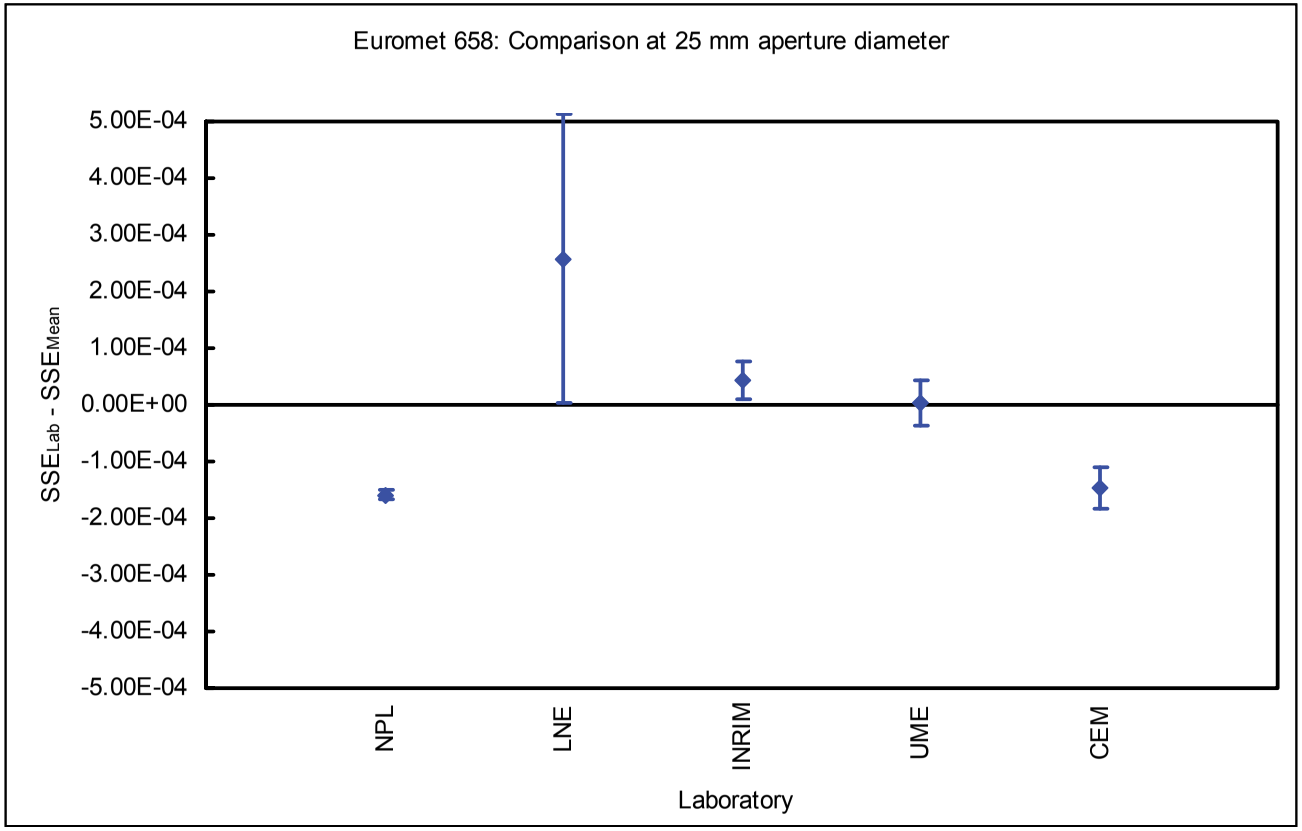
	NPL	LNE	INRIM	UME	CEM
NPL	-	-2.6023E-04 ± 8.309E-05	-1.5714E-04 ± 3.087E-05	-1.2181E-04 ± 3.324E-05	-1.5407E-05 ± 4.063E-05
LNE	*3.2857E-04*	-	1.0309E-04 ± 8.790E-05	1.3842E-04 ± 8.876E-05	2.4482E-04 ± 9.179E-05
INRIM	*1.8252E-04*	*1.7540E-04*	-	3.5327E-05 ± 4.391E-05	1.4173E-04 ± 4.974E-05
UME	*1.4915E-04*	*2.1143E-04*	*7.1452E-05*	-	1.0640E-04 ± 5.125E-05
CEM	*4.9138E-05*	*3.2032E-04*	*1.8264E-04*	*1.4855E-04*	-

Table 126 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 20 mm diameter aperture



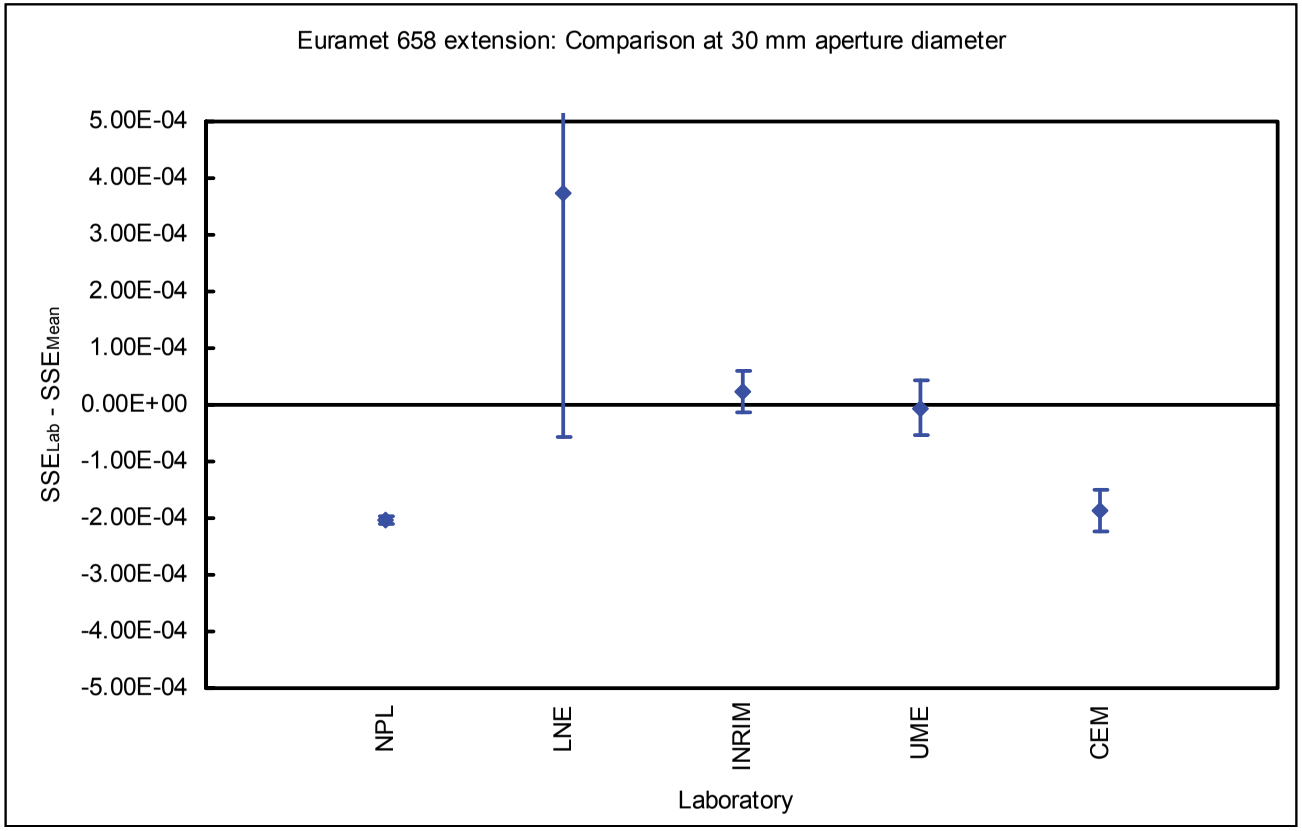
	NPL	LNE	INRIM	UME	CEM
NPL	-	-4.1724E-04 ± 2.538E-04	-2.0127E-04 ± 3.439E-05	-1.6373E-04 ± 4.111E-05	-1.3095E-05 ± 3.790E-05
LNE	*6.2603E-04*	-	2.1597E-04 ± 2.559E-04	2.5352E-04 ± 2.569E-04	4.0415E-04 ± 2.564E-04
INRIM	*2.2956E-04*	*4.2650E-04*	-	3.7549E-05 ± 5.237E-05	1.8818E-04 ± 4.990E-05
UME	*1.9753E-04*	*4.6483E-04*	*8.0650E-05*	-	1.5063E-04 ± 5.475E-05
CEM	*4.4651E-05*	*6.1504E-04*	*2.2922E-04*	*1.9566E-04*	-

Table 127 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 25 mm diameter aperture



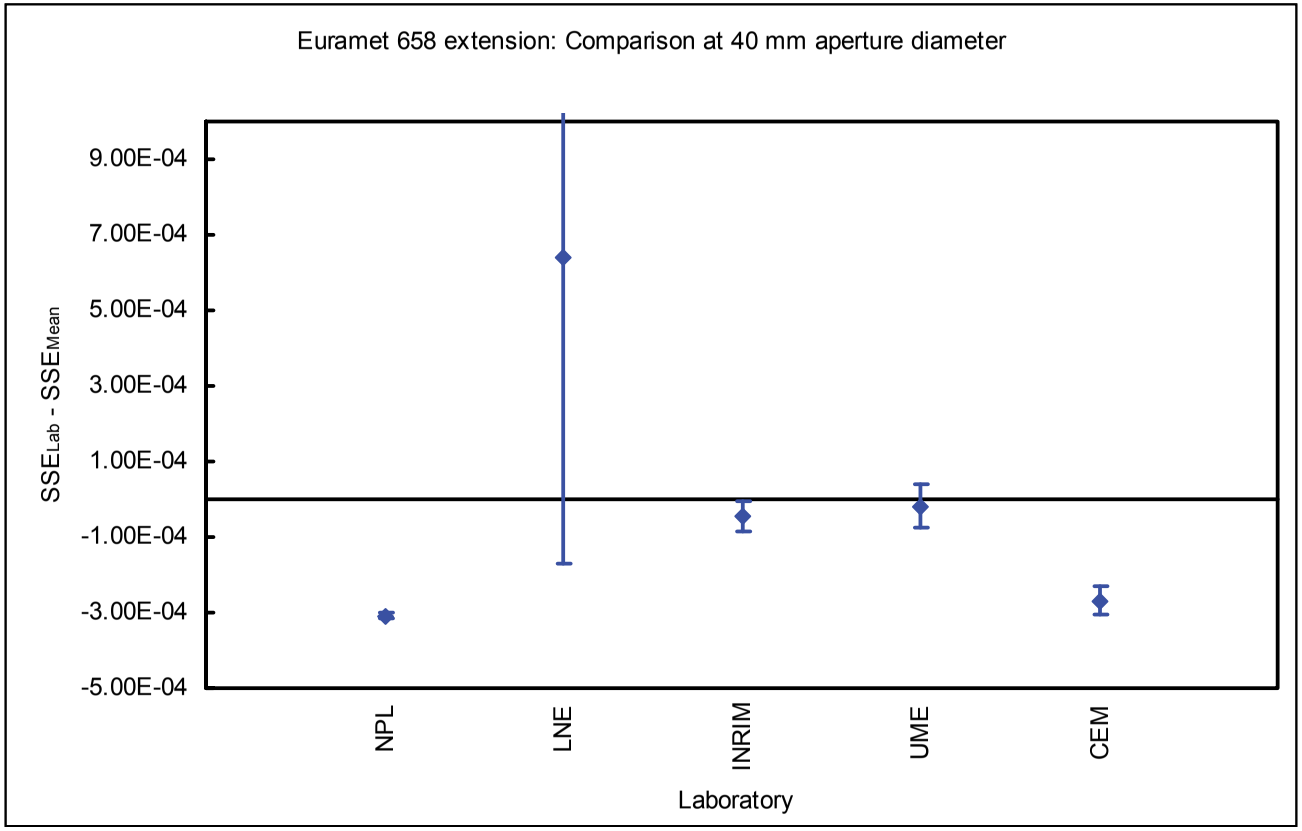
	NPL	LNE	INRIM	UME	CEM
NPL	-	-5.7632E-04 ± 4.289E-04	-2.2555E-04 ± 3.720E-05	-1.9812E-04 ± 4.937E-05	-1.6875E-05 ± 3.713E-05
LNE	*9.2908E-04*	-	3.5077E-04 ± 4.304E-04	3.7820E-04 ± 4.316E-04	5.5944E-04 ± 4.303E-04
INRIM	*2.5615E-04*	*7.0483E-04*	-	2.7426E-05 ± 6.075E-05	2.0867E-04 ± 5.131E-05
UME	*2.3873E-04*	*7.3322E-04*	*7.7654E-05*	-	1.8125E-04 ± 6.071E-05
CEM	*4.7566E-05*	*9.1340E-04*	*2.5087E-04*	*2.3118E-04*	-

Table 128 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 30 mm diameter aperture



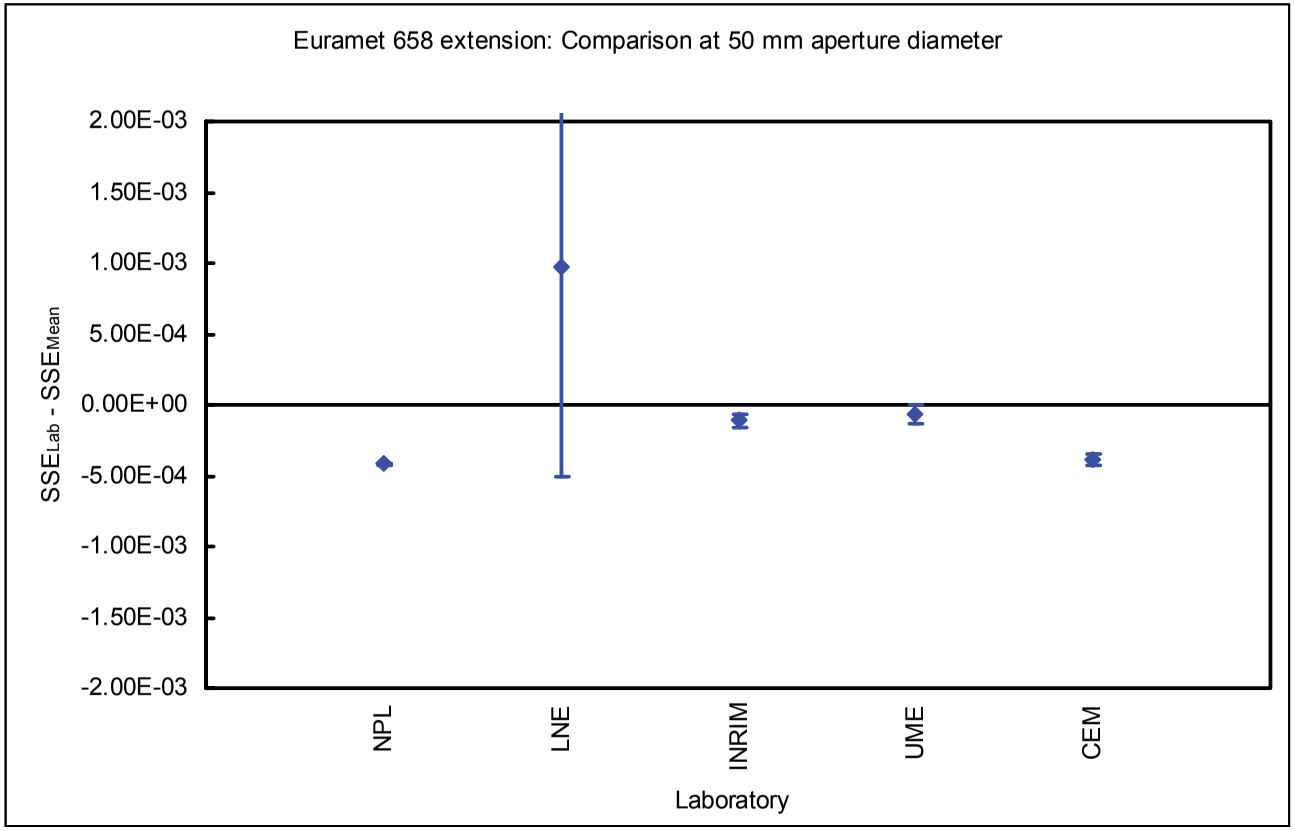
	NPL	LNE	INRIM	UME	CEM
NPL	-	-9.4754E-04 ± 8.076E-04	-2.6356E-04 ± 4.258E-05	-2.8994E-04 ± 5.881E-05	-3.8576E-05 ± 3.849E-05
LNE	*1.6118E-03*	-	6.8398E-04 ± 8.086E-04	6.5760E-04 ± 8.096E-04	9.0896E-04 ± 8.084E-04
INRIM	*2.9859E-04*	*1.3492E-03*	-	-2.6377E-05 ± 7.168E-05	2.2499E-04 ± 5.622E-05
UME	*3.3831E-04*	*1.3237E-03*	*8.5936E-05*	-	2.5136E-04 ± 6.933E-05
CEM	*7.0232E-05*	*1.5739E-03*	*2.7123E-04*	*3.0838E-04*	-

Table 129 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 40 mm diameter aperture



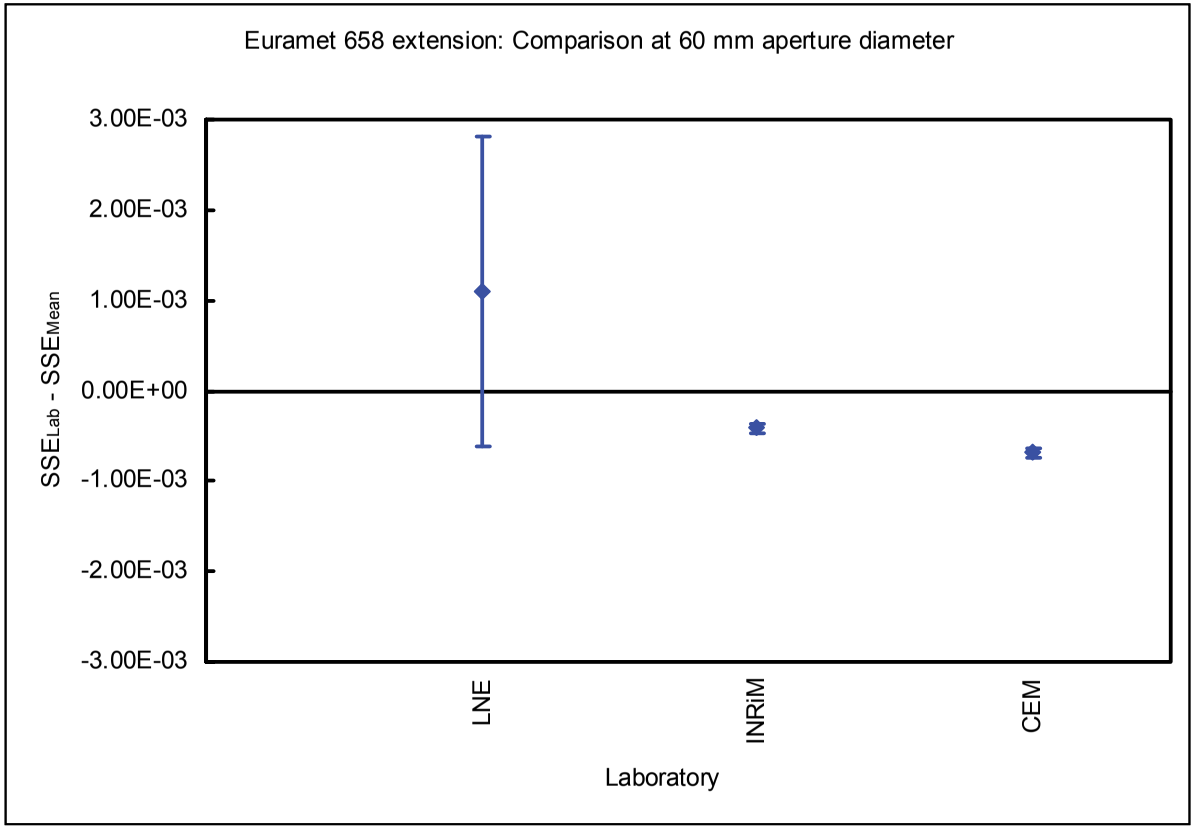
	NPL	LNE	INRIM	UME	CEM
NPL	-	-1.3939E-03 ± 1.485E-03	-3.0948E-04 ± 4.691E-05	-3.5215E-04 ± 6.453E-05	-3.0050E-05 ± 4.303E-05
LNE	*2.6155E-03*	-	1.0844E-03 ± 1.486E-03	1.0418E-03 ± 1.486E-03	1.3639E-03 ± 1.486E-03
INRIM	*3.4807E-04*	*2.3071E-03*	-	-4.2670E-05 ± 7.897E-05	2.7943E-04 ± 6.264E-05
UME	*4.0523E-04*	*2.2652E-03*	*1.0779E-04*	-	3.2210E-04 ± 7.673E-05
CEM	*6.5466E-05*	*2.5859E-03*	*3.3095E-04*	*3.8521E-04*	-

Table 130 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 50 mm diameter aperture



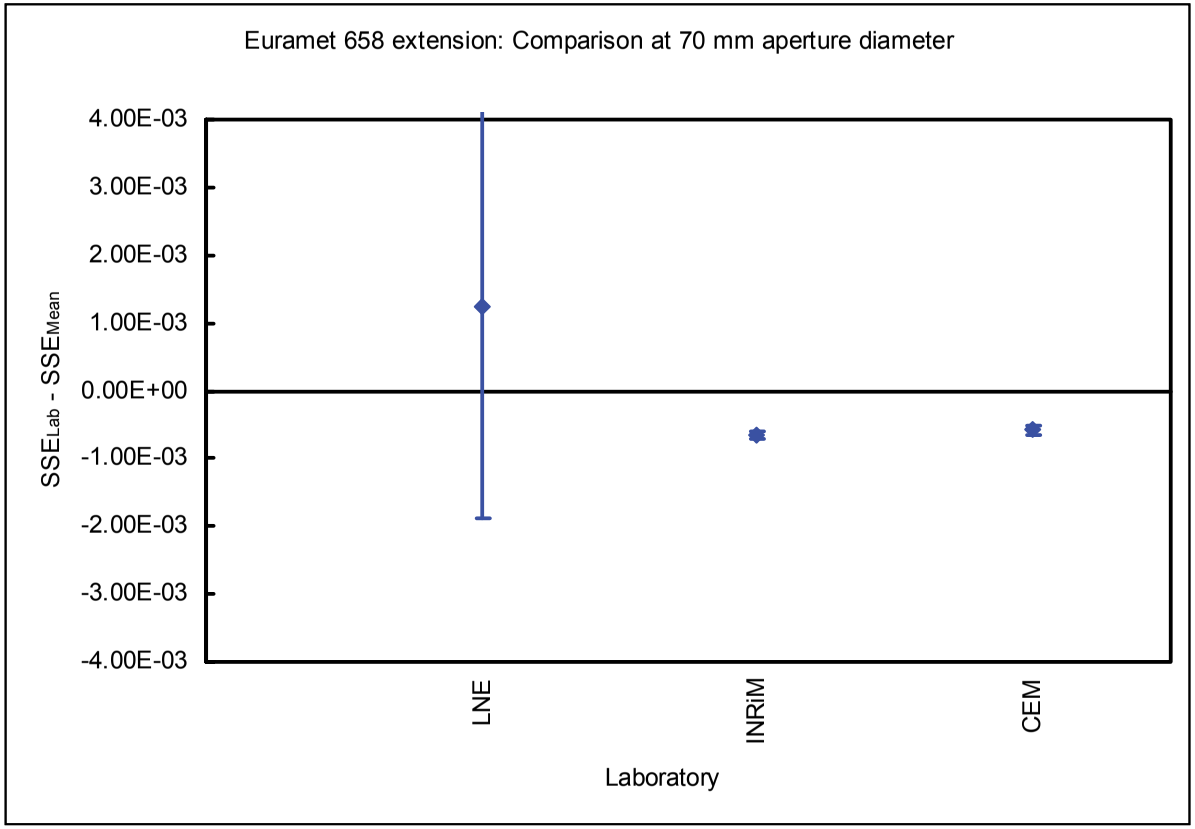
	LNE	INRiM	CEM
LNE	-	1.5116E-03 ± 1.725E-03	1.7836E-03 ± 1.725E-03
INRiM	*2.9302E-03*	-	2.7203E-04 ± 7.434E-05
CEM	*3.2022E-03*	*3.3317E-04*	-

Table 131 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 60 mm diameter aperture



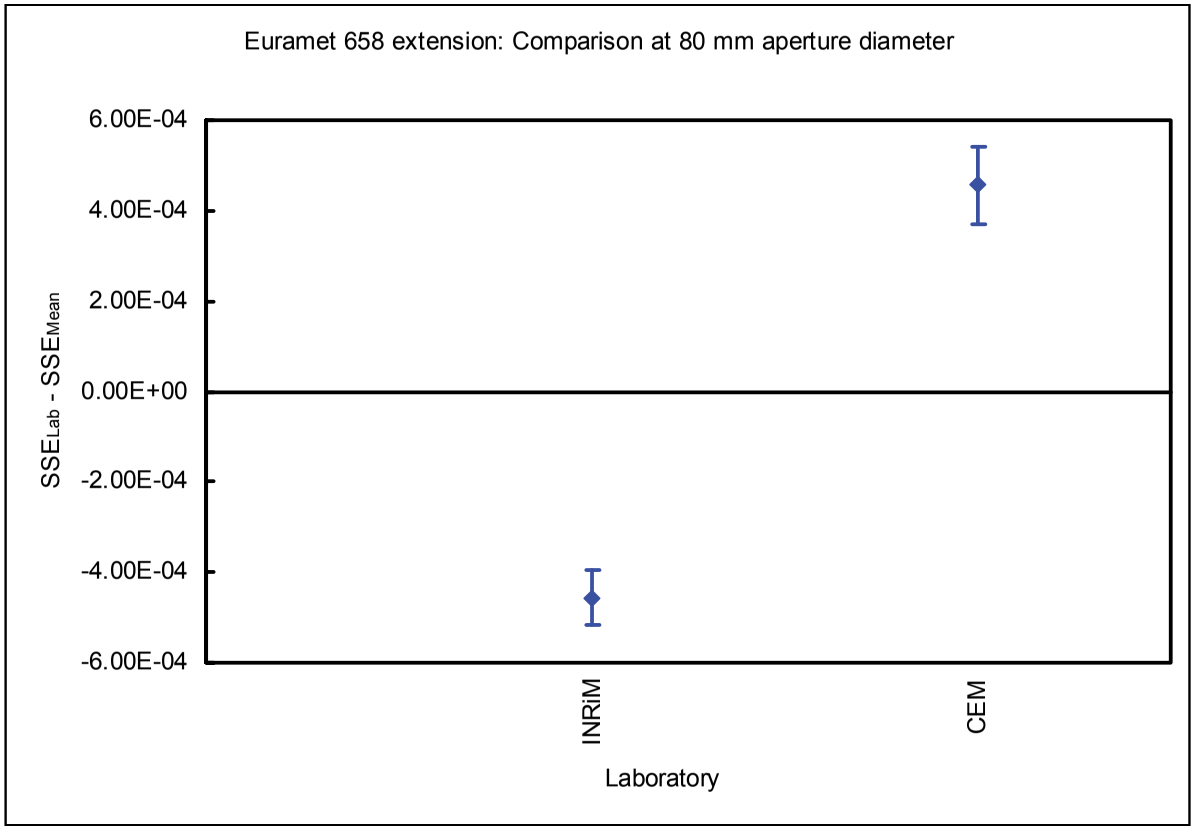
	LNE	INRiM	CEM
LNE	-	1.9026E-03 ± 3.131E-03	1.8240E-03 ± 3.131E-03
INRiM	*4.4817E-03*	-	-7.8636E-05 ± 9.243E-05
CEM	*4.4042E-03*	*1.5467E-04*	-

Table 132 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 70 mm diameter aperture



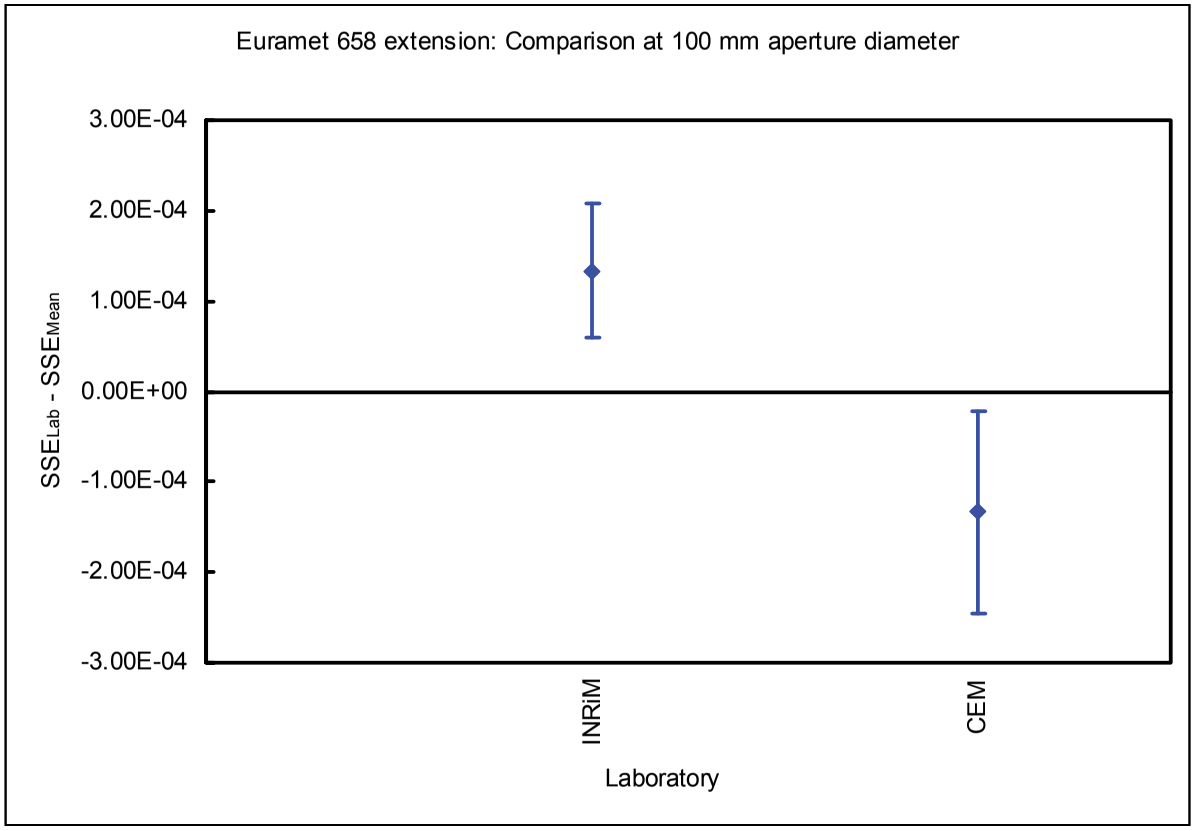
	INRiM	CEM
INRiM	-	-9.1236E-04 ± 1.063E-04
CEM	*9.9976E-04*	-

Table 133 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	2.6748E-04 ± 1.341E-04
CEM	*3.7775E-04*	-

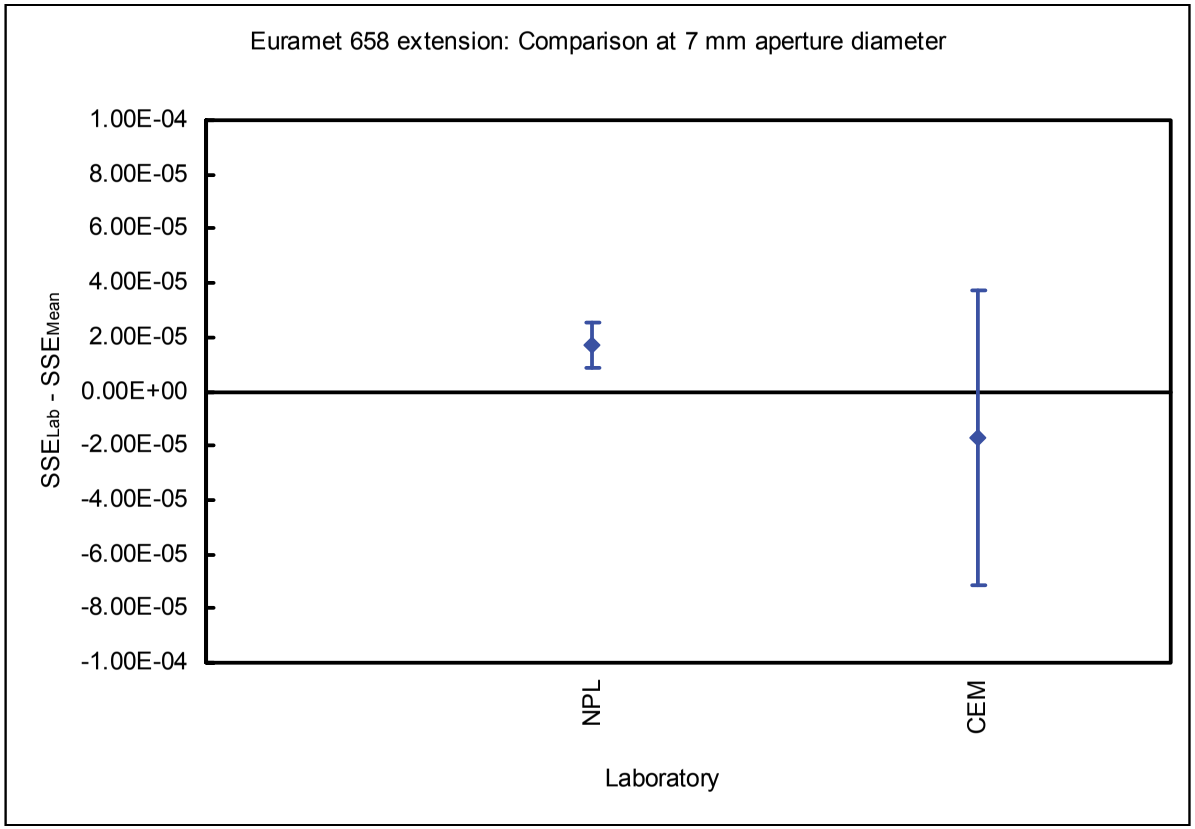
Table 134 – comparison of indirect SSE measurements with the INRiM thermometer, with 6 mm diameter spot and 100 mm diameter aperture



1.8.4 The INRiM thermometer ‘indirect’ SSE results – 6 mm spot, excl. LNE

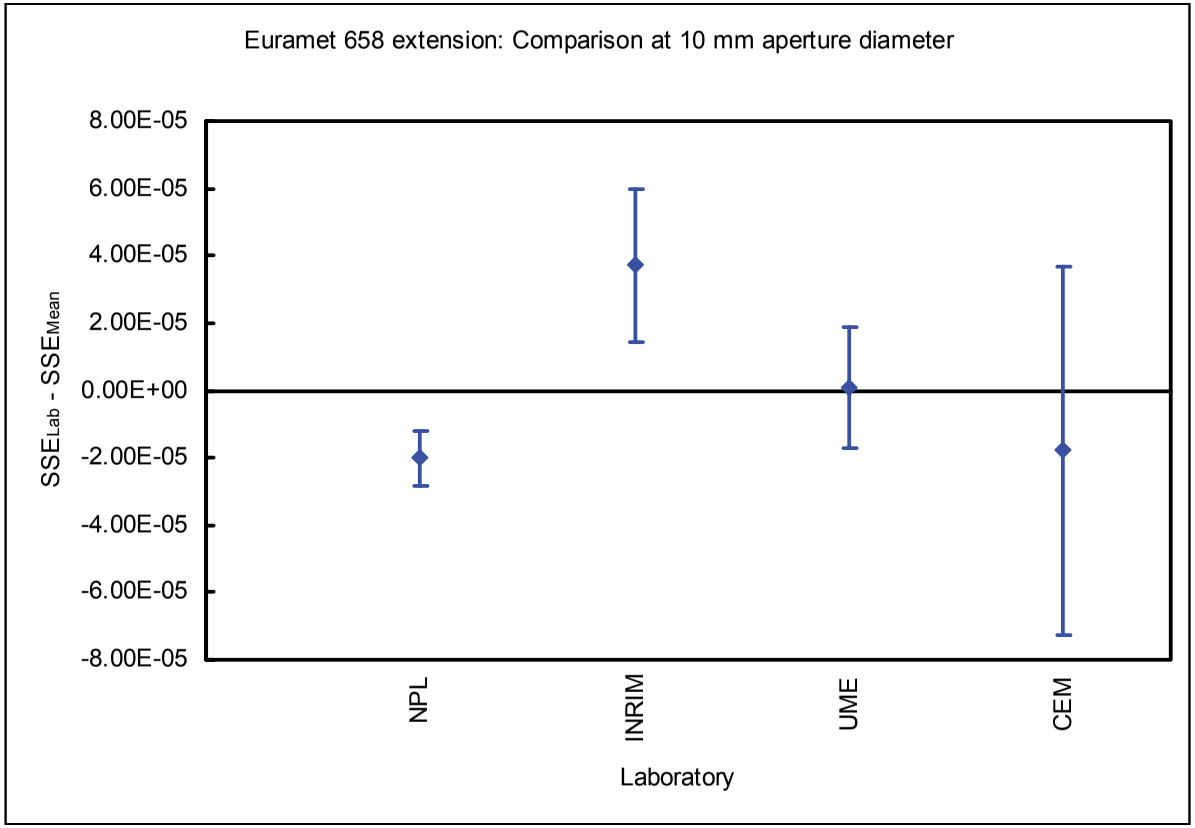
	NPL	CEM
NPL	-	3.4036E-05 ± 5.523E-05
CEM	*7.9521E-05*	-

Table 135 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 7 mm diameter aperture



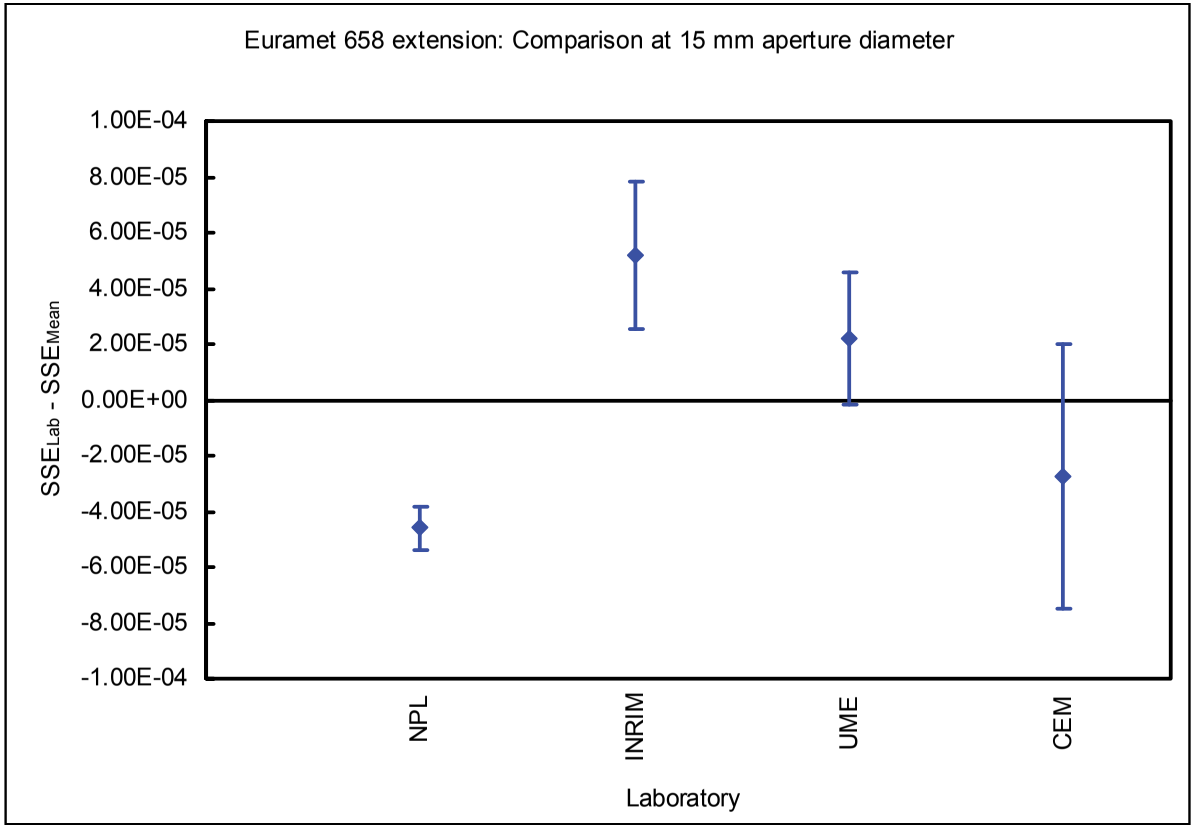
	NPL	INRIM	UME	CEM
NPL	-	-5.7285E-05 ± 2.407E-05	-2.1038E-05 ± 1.986E-05	-2.3313E-06 ± 5.521E-05
INRIM	*7.7083E-05*	-	3.6247E-05 ± 2.906E-05	5.4954E-05 ± 5.915E-05
UME	*3.7378E-05*	*6.0152E-05*	-	1.8707E-05 ± 5.757E-05
CEM	*5.4207E-05*	*1.0361E-04*	*6.6738E-05*	-

Table 136 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 10 mm diameter aperture



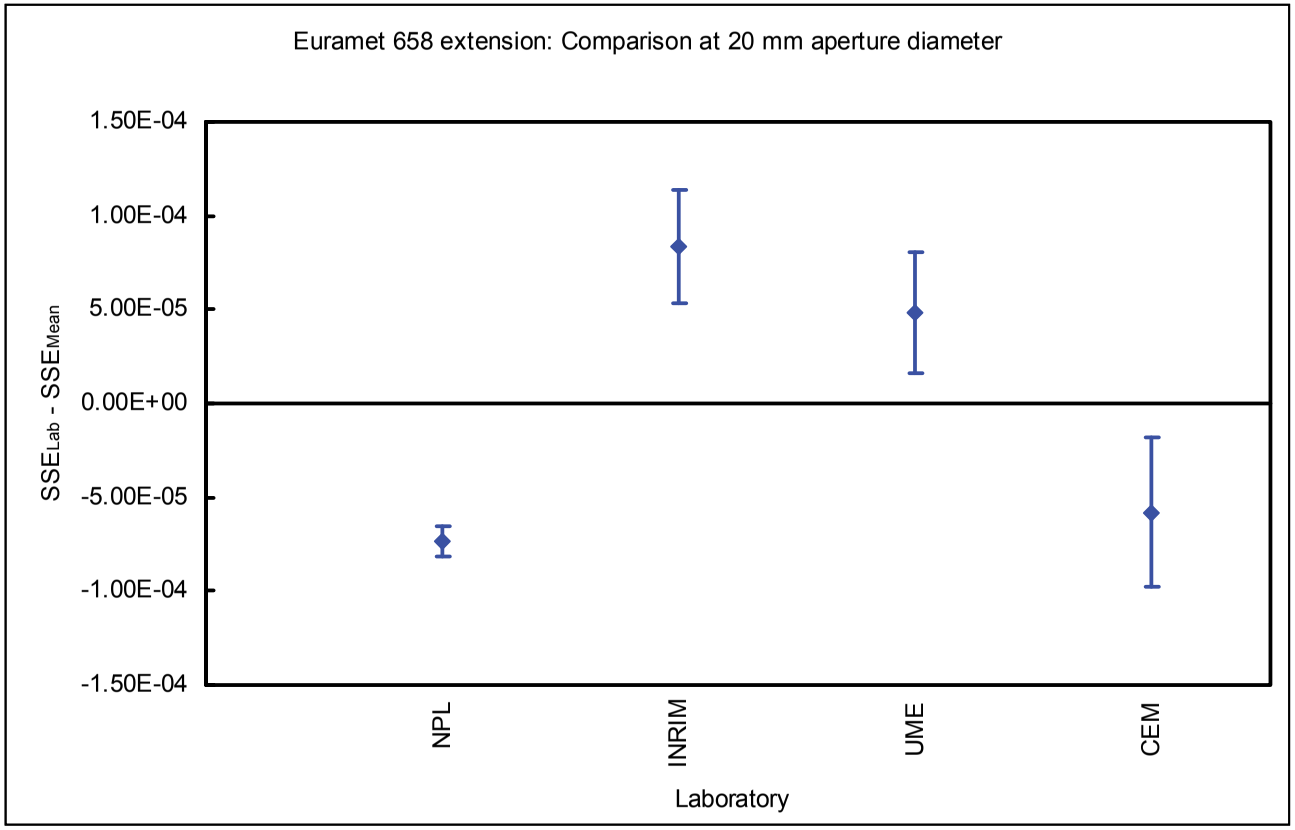
	NPL	INRIM	UME	CEM
NPL	-	-9.7631E-05 ± 2.763E-05	-6.8182E-05 ± 2.497E-05	-1.8310E-05 ± 4.809E-05
INRIM	*1.2036E-04*	-	2.9449E-05 ± 3.546E-05	7.9320E-05 ± 5.428E-05
UME	*8.8722E-05*	*5.8620E-05*	-	4.9872E-05 ± 5.298E-05
CEM	*5.8229E-05*	*1.2397E-04*	*9.3451E-05*	-

Table 137– comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 15 mm diameter aperture



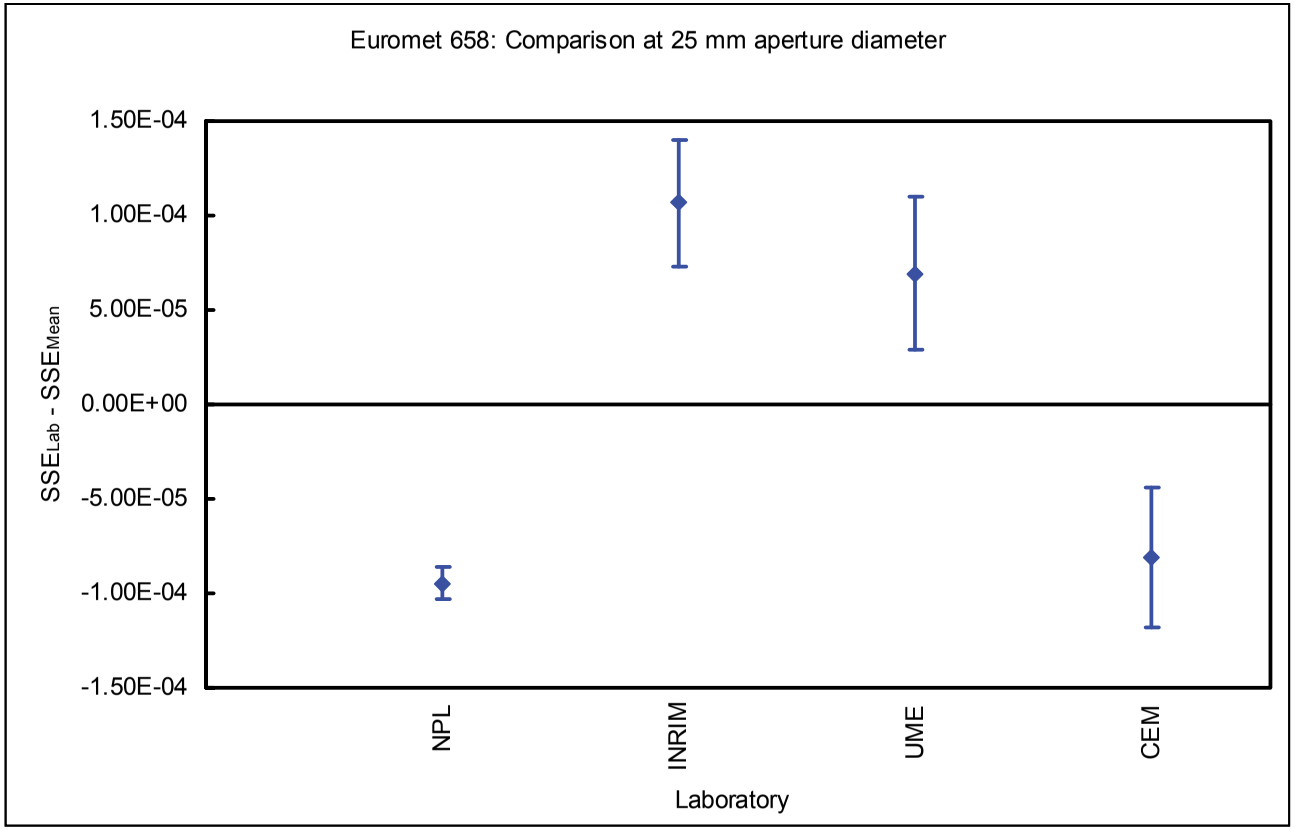
	NPL	INRIM	UME	CEM
NPL	-	-1.5714E-04 ± 3.087E-05	-1.2181E-04 ± 3.324E-05	-1.5407E-05 ± 4.063E-05
INRIM	*1.8252E-04*	-	3.5327E-05 ± 4.391E-05	1.4173E-04 ± 4.974E-05
UME	*1.4915E-04*	*7.1452E-05*	-	1.0640E-04 ± 5.125E-05
CEM	*4.9138E-05*	*1.8264E-04*	*1.4855E-04*	-

Table 138 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 20 mm diameter aperture



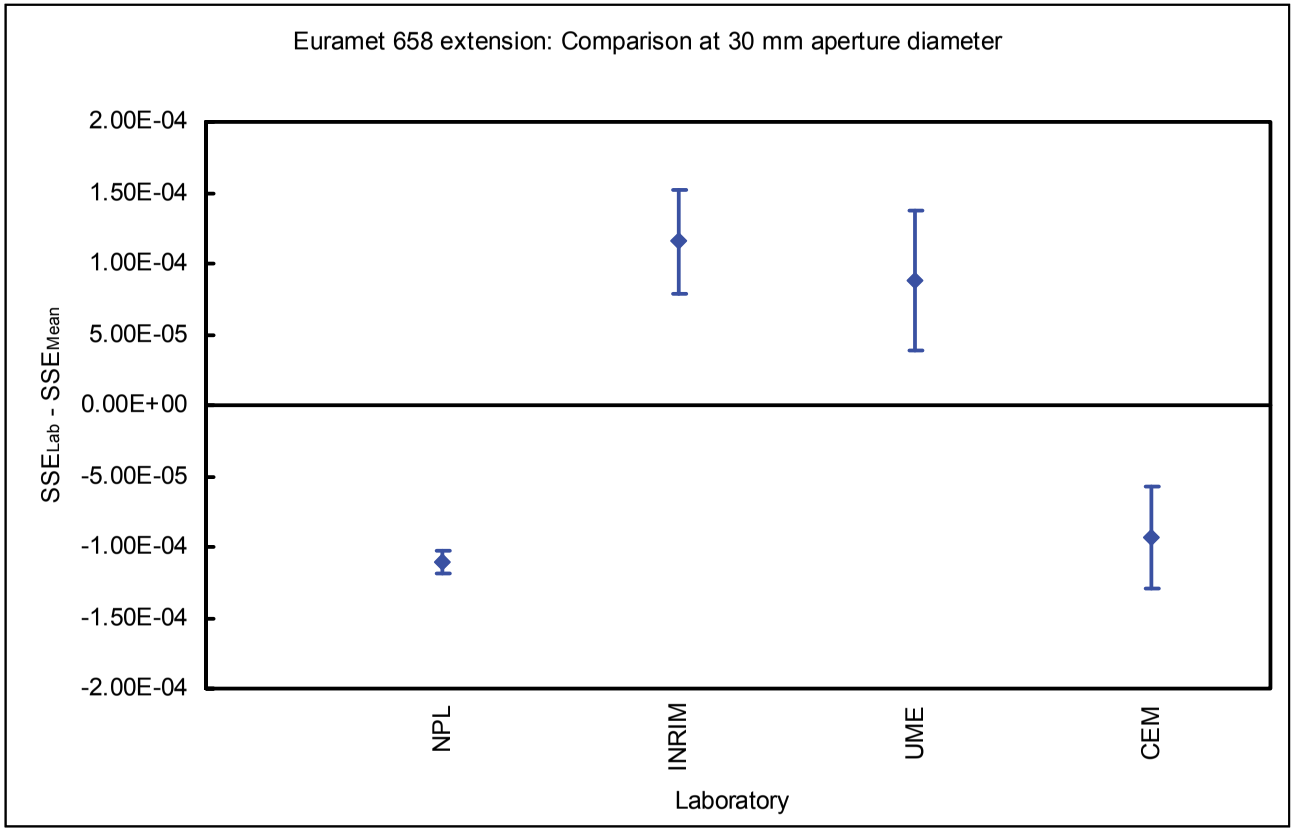
	NPL	INRIM	UME	CEM
NPL	-	-2.0127E-04 ± 3.439E-05	-1.6373E-04 ± 4.111E-05	-1.3095E-05 ± 3.790E-05
INRIM	*2.2956E-04*	-	3.7549E-05 ± 5.237E-05	1.8818E-04 ± 4.990E-05
UME	*1.9753E-04*	*8.0650E-05*	-	1.5063E-04 ± 5.475E-05
CEM	*4.4651E-05*	*2.2922E-04*	*1.9566E-04*	-

Table 139 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 25 mm diameter aperture



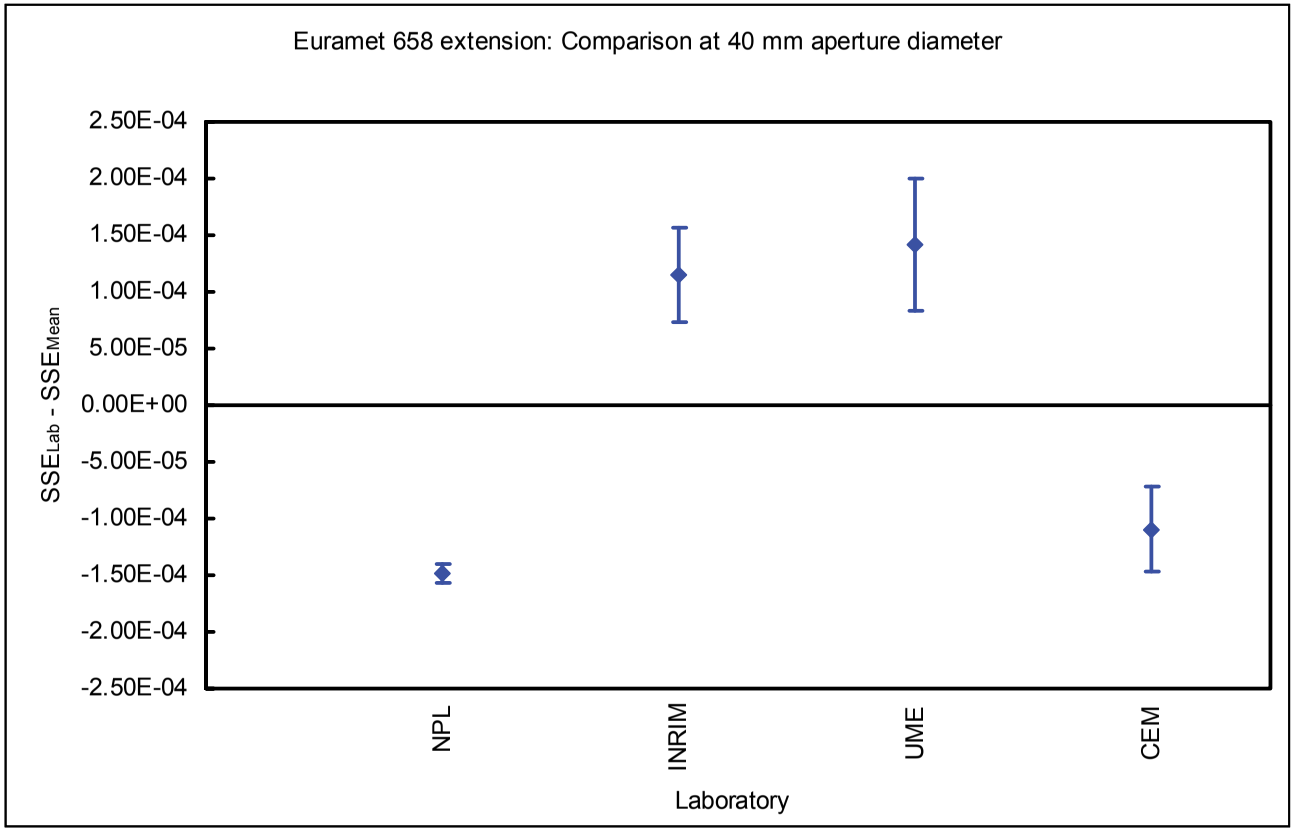
	NPL	INRIM	UME	CEM
NPL	-	-2.2555E-04 ± 3.720E-05	-1.9812E-04 ± 4.937E-05	-1.6875E-05 ± 3.713E-05
INRIM	*2.5615E-04*	-	2.7426E-05 ± 6.075E-05	2.0867E-04 ± 5.131E-05
UME	*2.3873E-04*	*7.7654E-05*	-	1.8125E-04 ± 6.071E-05
CEM	*4.7566E-05*	*2.5087E-04*	*2.3118E-04*	-

Table 140 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 30 mm diameter aperture



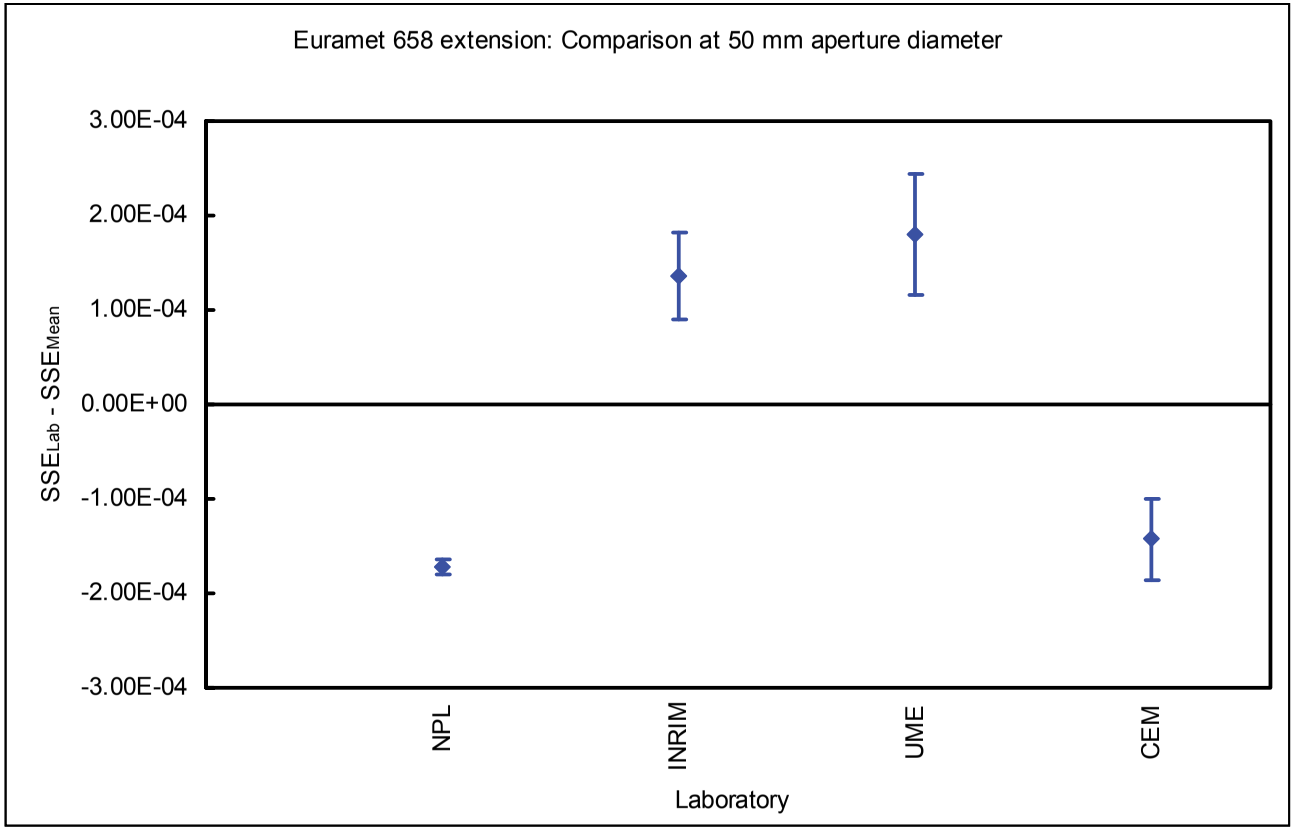
	NPL	INRIM	UME	CEM
NPL	-	-2.6356E-04 ± 4.258E-05	-2.8994E-04 ± 5.881E-05	-3.8576E-05 ± 3.849E-05
INRIM	*2.9859E-04*	-	-2.6377E-05 ± 7.168E-05	2.2499E-04 ± 5.622E-05
UME	*3.3831E-04*	*8.5936E-05*	-	2.5136E-04 ± 6.933E-05
CEM	*7.0232E-05*	*2.7123E-04*	*3.0838E-04*	-

Table 141 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 40 mm diameter aperture



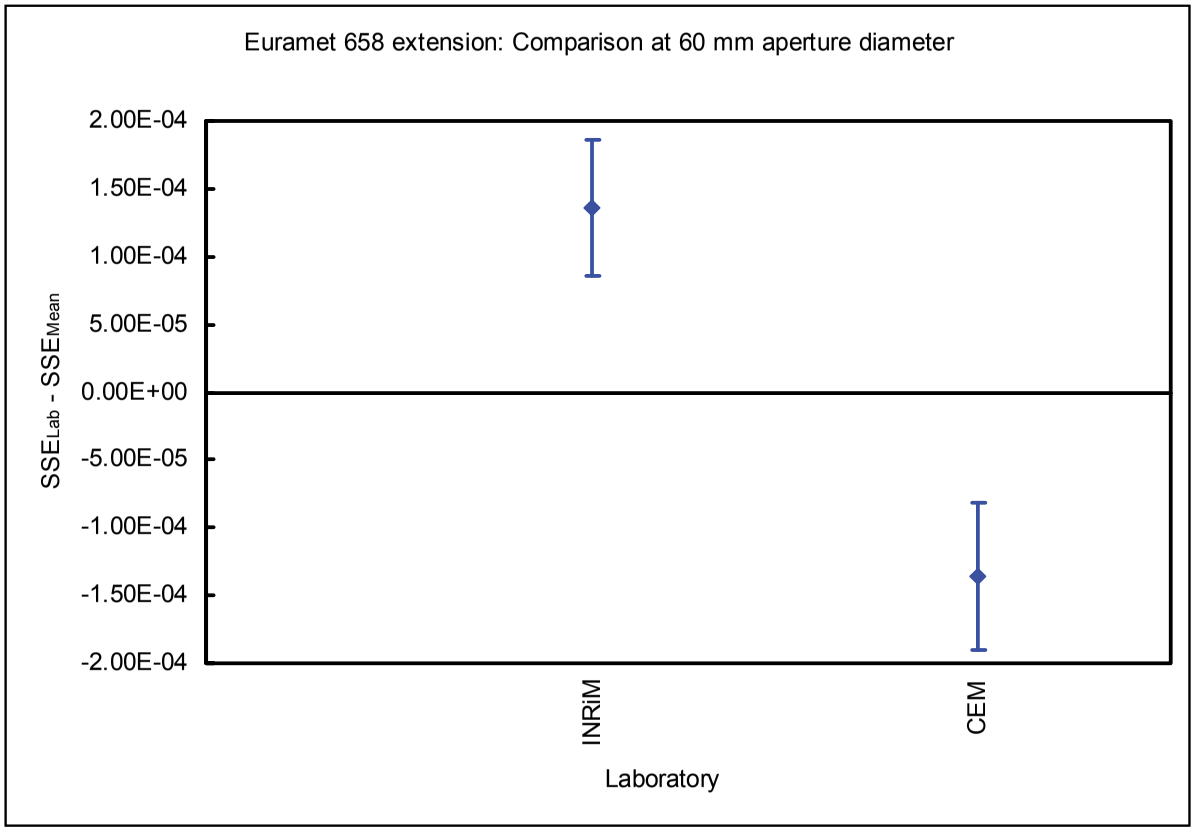
	NPL	INRIM	UME	CEM
NPL	-	-3.0948E-04 ± 4.691E-05	-3.5215E-04 ± 6.453E-05	-3.0050E-05 ± 4.303E-05
INRIM	*3.4807E-04*	-	-4.2670E-05 ± 7.897E-05	2.7943E-04 ± 6.264E-05
UME	*4.0523E-04*	*1.0779E-04*	-	3.2210E-04 ± 7.673E-05
CEM	*6.5466E-05*	*3.3095E-04*	*3.8521E-04*	-

Table 142 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 50 mm diameter aperture



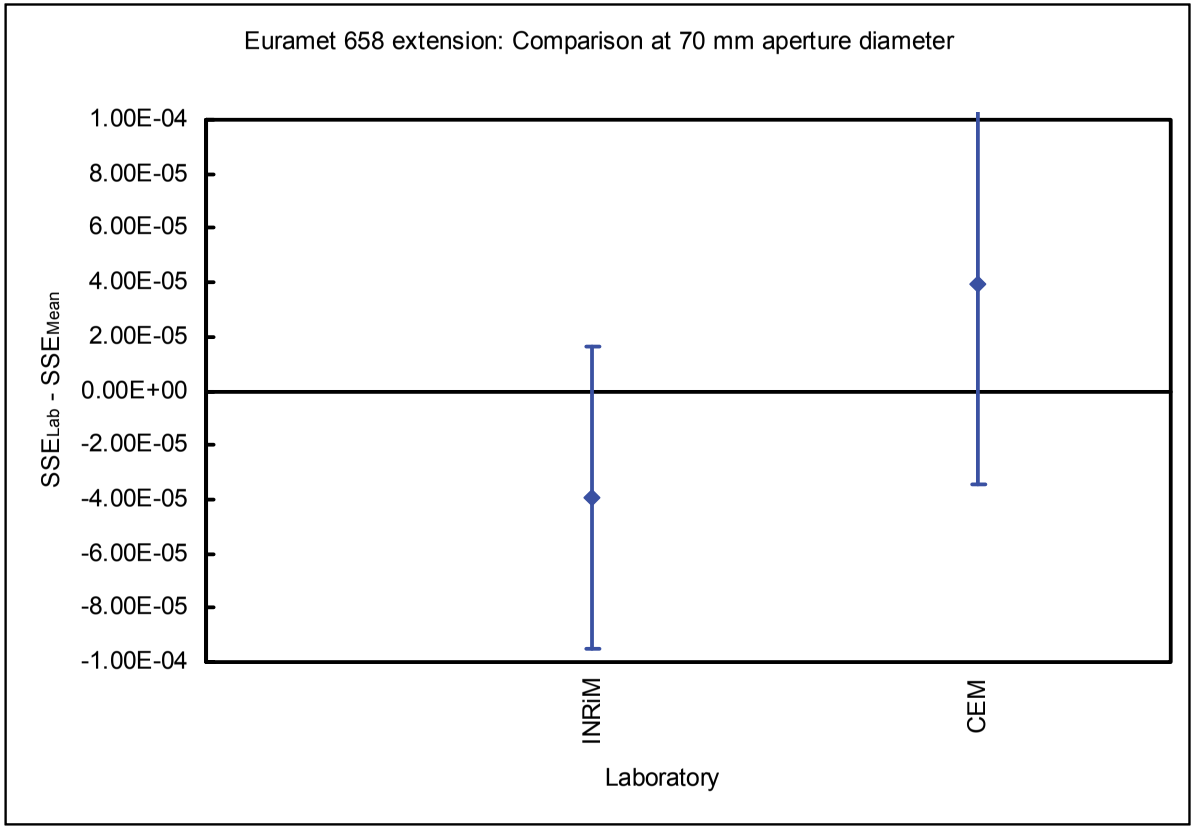
	INRiM	CEM
INRiM	-	2.7203E-04 ± 7.434E-05
CEM	*3.3317E-04*	-

Table 143 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 60 mm diameter aperture



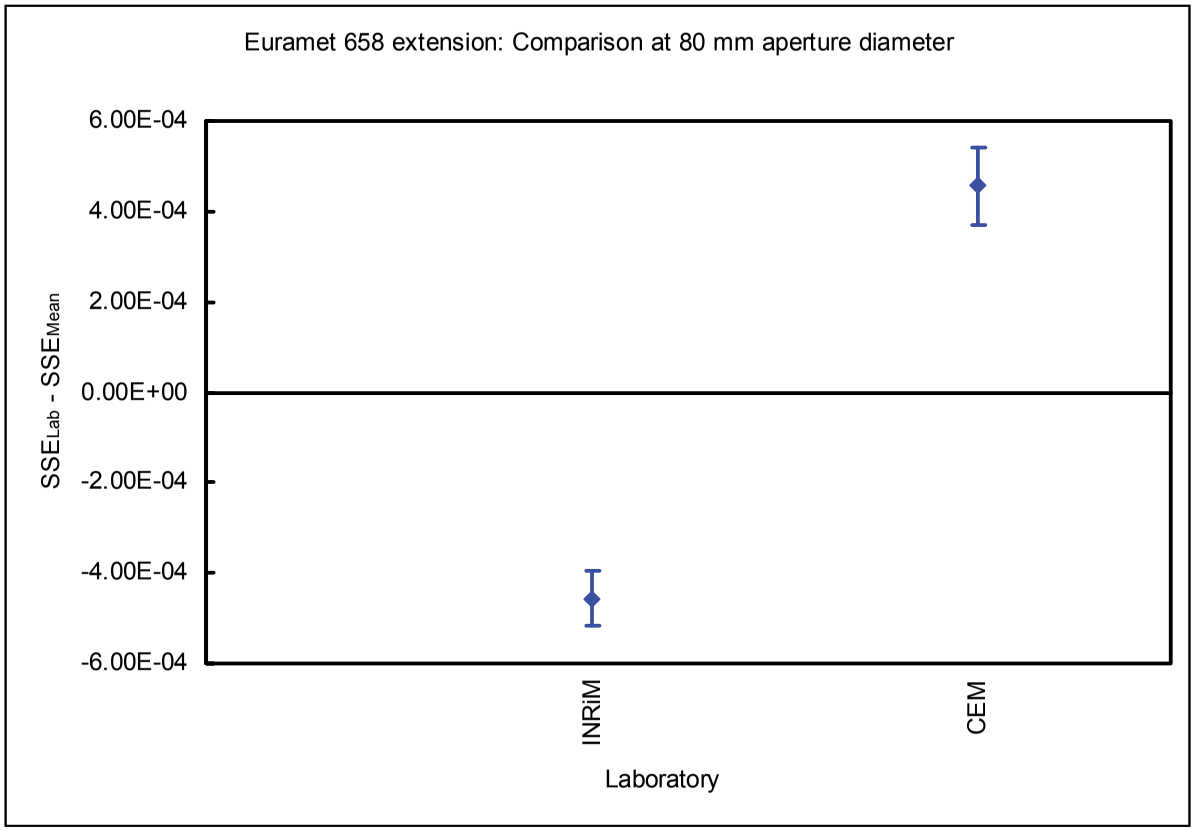
	INRiM	CEM
INRiM	-	-7.8636E-05 ± 9.243E-05
CEM	*1.5467E-04*	-

Table 144 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 70 mm diameter aperture



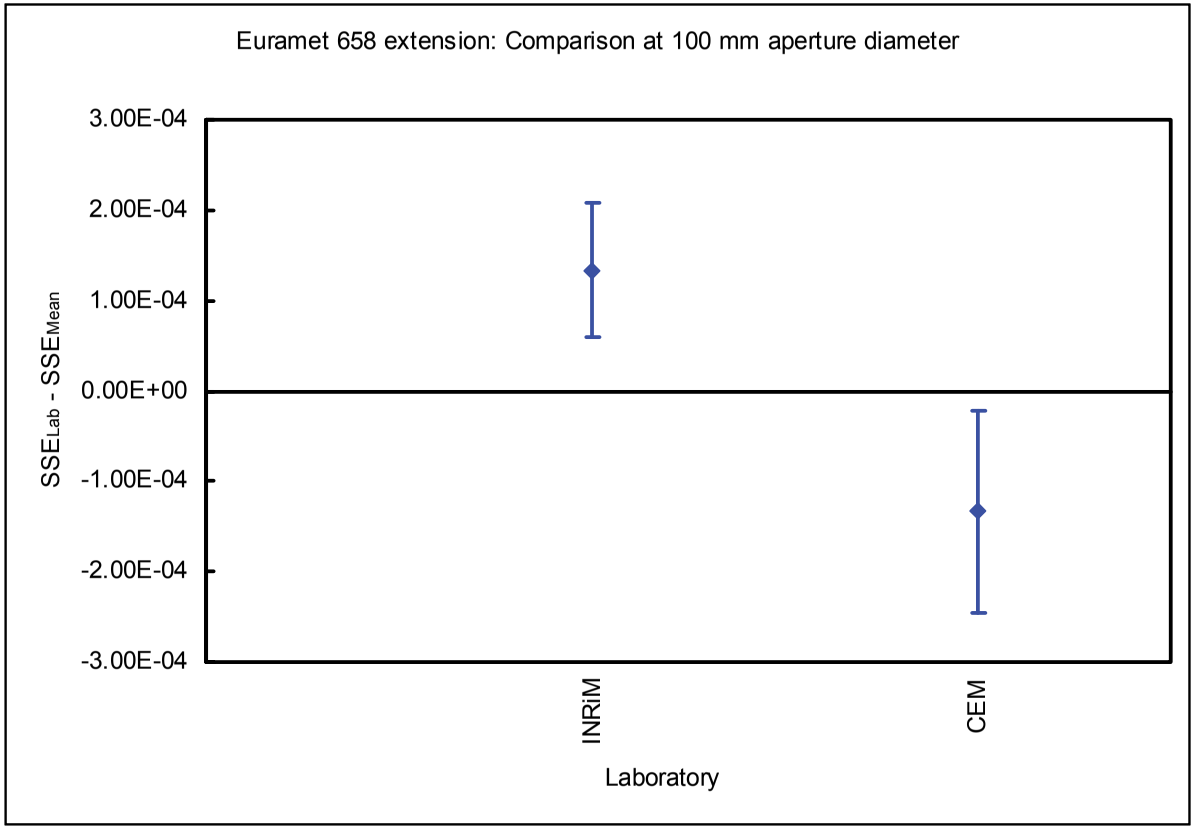
	INRiM	CEM
INRiM	-	-9.1236E-04 ± 1.063E-04
CEM	*9.9976E-04*	-

Table 145 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	2.6748E-04 ± 1.341E-04
CEM	*3.7775E-04*	-

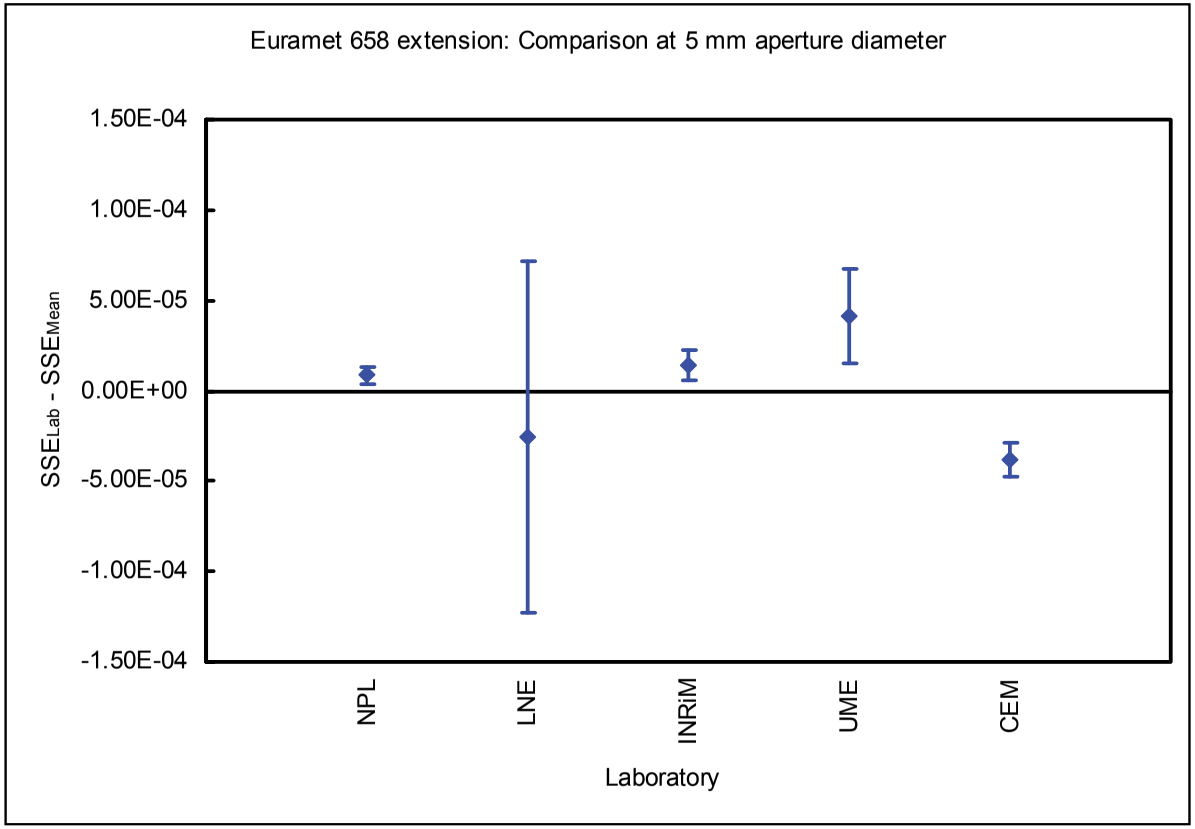
Table 146 – comparison of indirect SSE measurements with the INRiM thermometer, excluding LNE data - 6 mm diameter spot and 100 mm diameter aperture



1.8.5 The LP5 thermometer 'indirect' SSE results – 3 mm spot

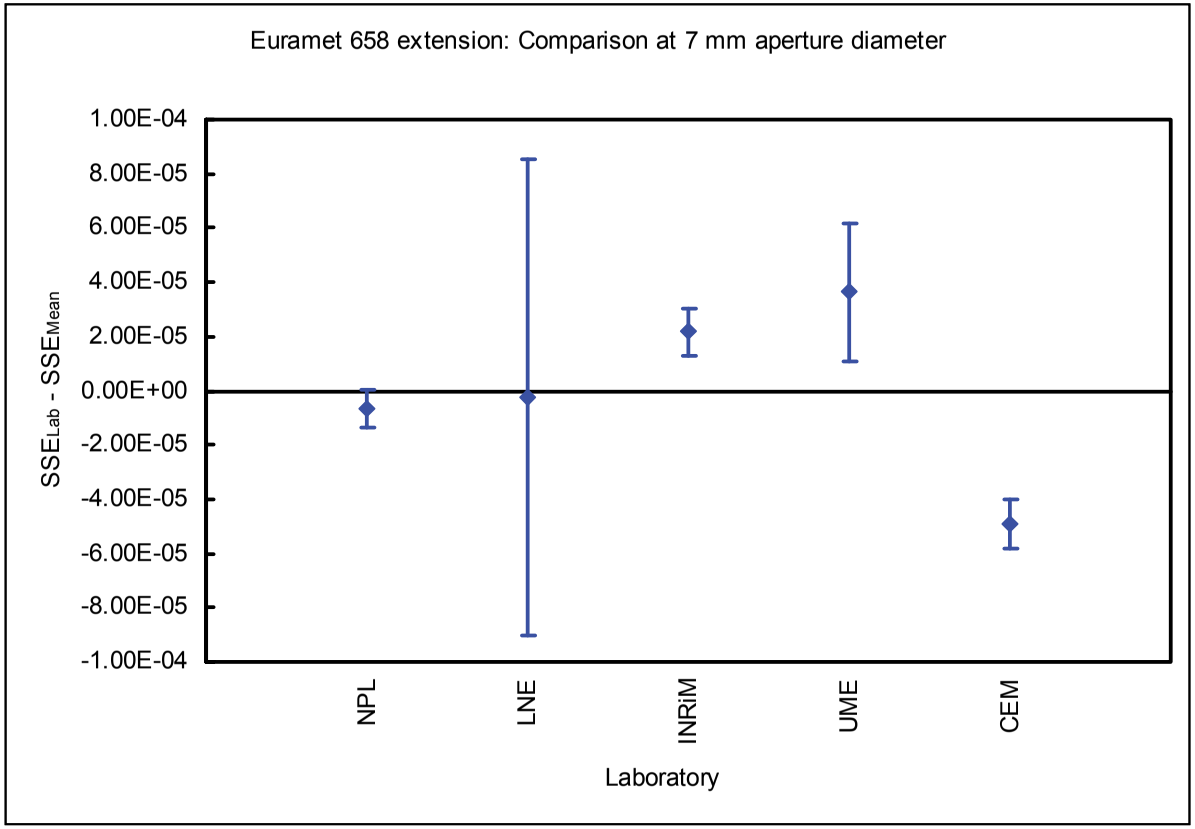
	NPL	LNE	INRiM	UME	CEM
NPL	-	3.4248E-05 ± 9.727E-05	-5.8527E-06 ± 9.559E-06	-3.2349E-05 ± 2.649E-05	4.6657E-05 ± 1.027E-05
LNE	*1.1518E-04*	-	-4.0101E-05 ± 9.751E-05	-6.6597E-05 ± 1.006E-04	1.2408E-05 ± 9.758E-05
INRiM	*1.3726E-05*	*1.2088E-04*	-	-2.6496E-05 ± 2.738E-05	5.2509E-05 ± 1.237E-05
UME	*5.4140E-05*	*1.4941E-04*	*4.9015E-05*	-	7.9006E-05 ± 2.763E-05
CEM	*5.5103E-05*	*9.8411E-05*	*6.2684E-05*	*1.0173E-04*	-

Table 147 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 5 mm diameter aperture



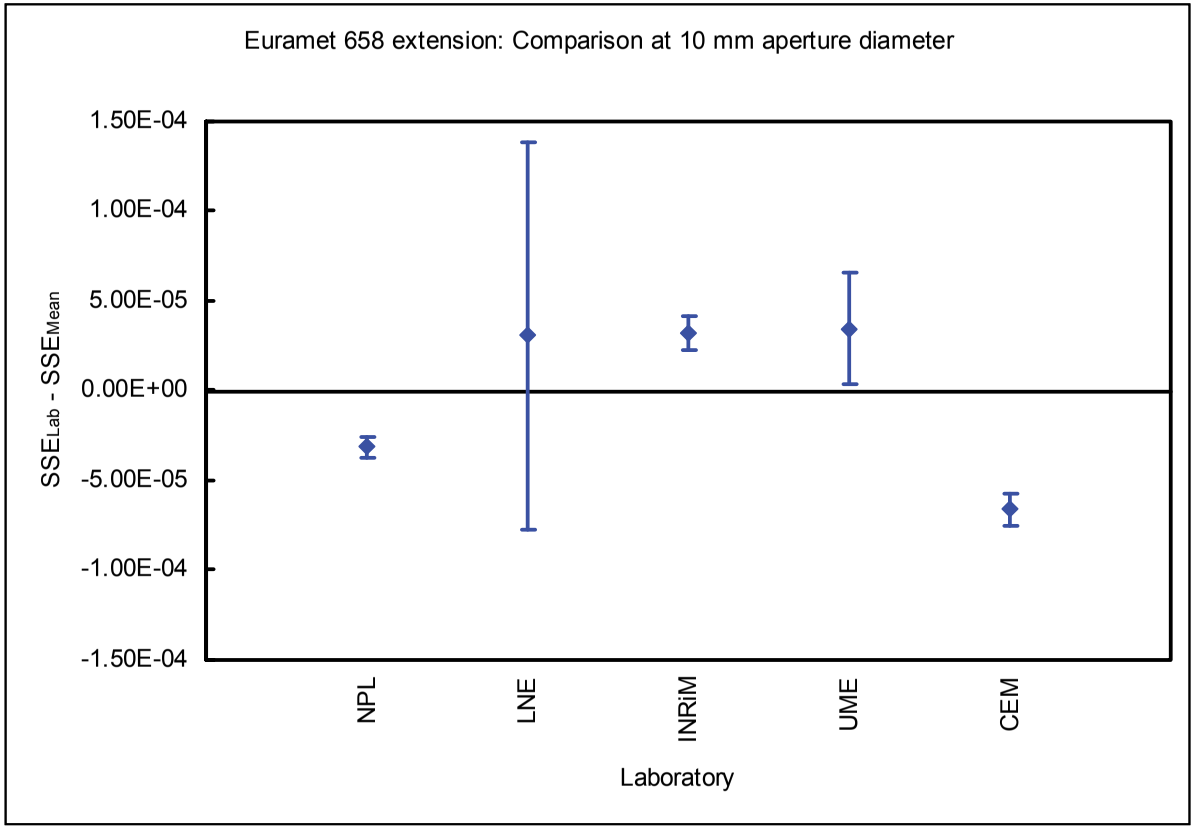
	NPL	LNE	INRiM	UME	CEM
NPL	-	-4.3001E-06 ± 8.819E-05	-2.8198E-05 ± 1.124E-05	-4.2812E-05 ± 2.623E-05	4.2515E-05 ± 1.160E-05
LNE	*8.6626E-05*	-	-2.3898E-05 ± 8.833E-05	-3.8512E-05 ± 9.145E-05	4.6815E-05 ± 8.838E-05
INRiM	*3.7440E-05*	*9.8174E-05*	-	-1.4614E-05 ± 2.669E-05	7.0714E-05 ± 1.260E-05
UME	*6.4387E-05*	*1.1423E-04*	*3.6616E-05*	-	8.5328E-05 ± 2.684E-05
CEM	*5.2058E-05*	*1.1970E-04*	*8.1076E-05*	*1.0741E-04*	-

Table 148 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 7 mm diameter aperture



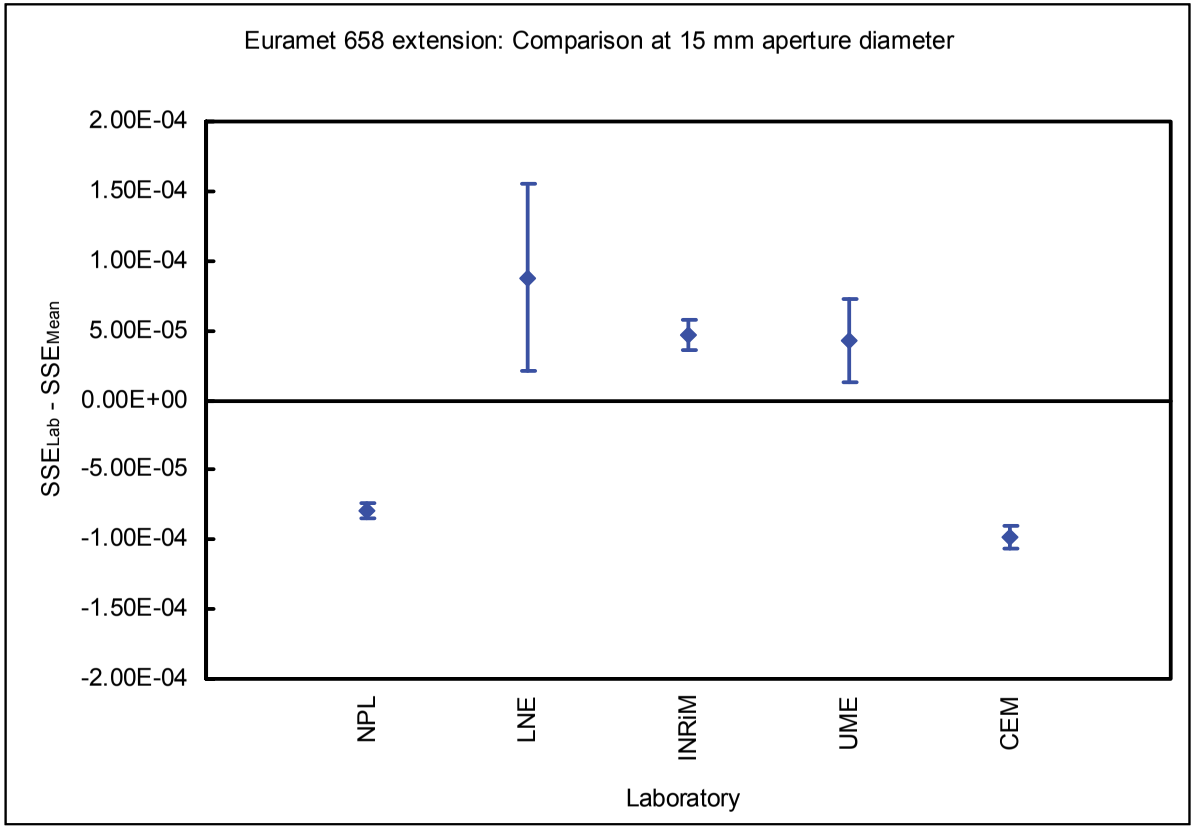
	NPL	LNE	INRiM	UME	CEM
NPL	-	-6.2049E-05 ± 1.084E-04	-6.3804E-05 ± 1.089E-05	-6.6223E-05 ± 3.180E-05	3.4468E-05 ± 1.072E-05
LNE	*1.5142E-04*	-	-1.7559E-06 ± 1.087E-04	-4.1741E-06 ± 1.127E-04	9.6517E-05 ± 1.087E-04
INRiM	*7.2758E-05*	*1.0687E-04*	-	-2.4183E-06 ± 3.267E-05	9.8272E-05 ± 1.306E-05
UME	*9.2380E-05*	*1.1066E-04*	*3.2241E-05*	-	1.0069E-04 ± 3.261E-05
CEM	*4.3286E-05*	*1.8592E-04*	*1.0902E-04*	*1.2751E-04*	-

Table 149 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 10 mm diameter aperture



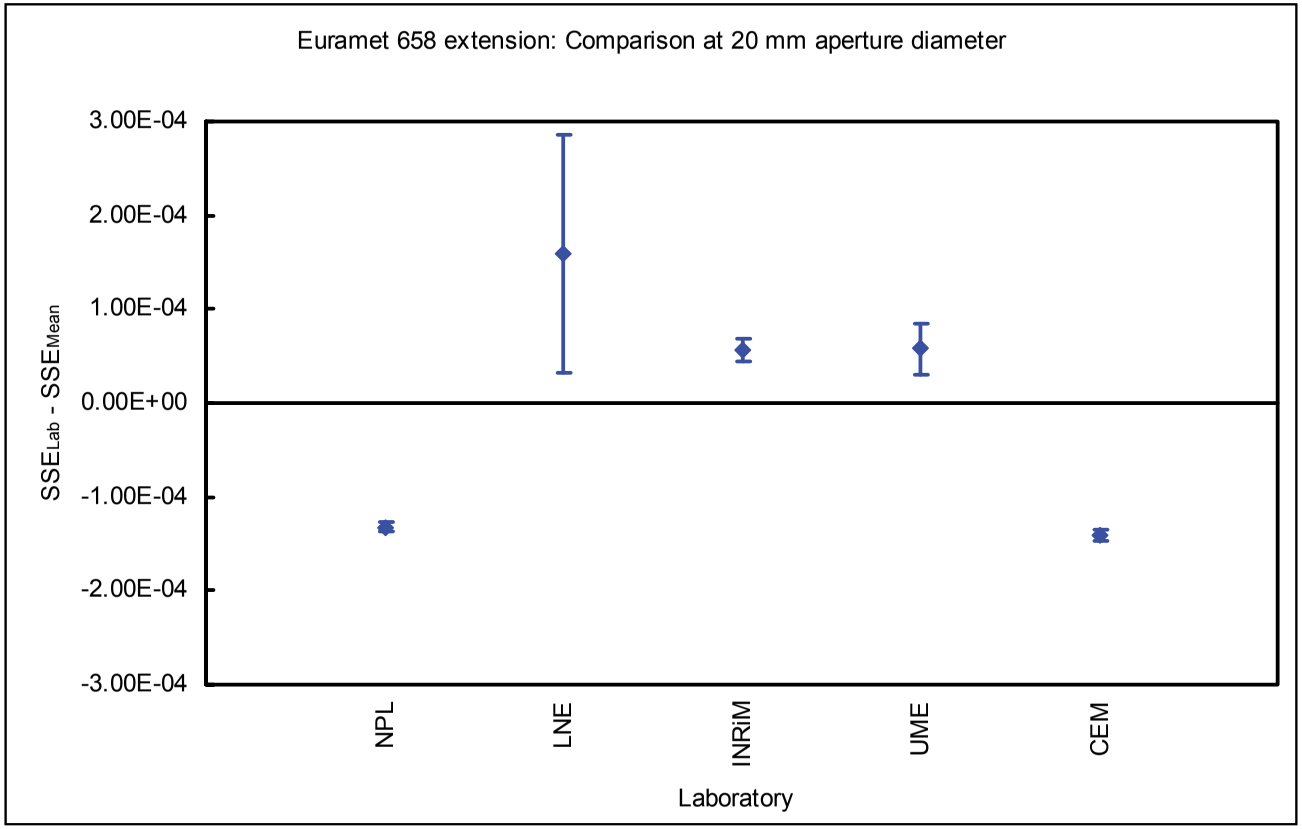
	NPL	LNE	INRiM	UME	CEM
NPL	-	-1.6703E-04 ± 6.731E-05	-1.2619E-04 ± 1.205E-05	-1.2129E-04 ± 2.999E-05	1.9961E-05 ± 9.618E-06
LNE	*2.2239E-04*	-	4.0839E-05 ± 6.798E-05	4.5742E-05 ± 7.332E-05	1.8699E-04 ± 6.759E-05
INRiM	*1.3610E-04*	*9.6841E-05*	-	4.9026E-06 ± 3.146E-05	1.4615E-04 ± 1.352E-05
UME	*1.4595E-04*	*1.0612E-04*	*3.2246E-05*	-	1.4125E-04 ± 3.061E-05
CEM	*2.7872E-05*	*2.4258E-04*	*1.5727E-04*	*1.6642E-04*	-

Table 150 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 15 mm diameter aperture



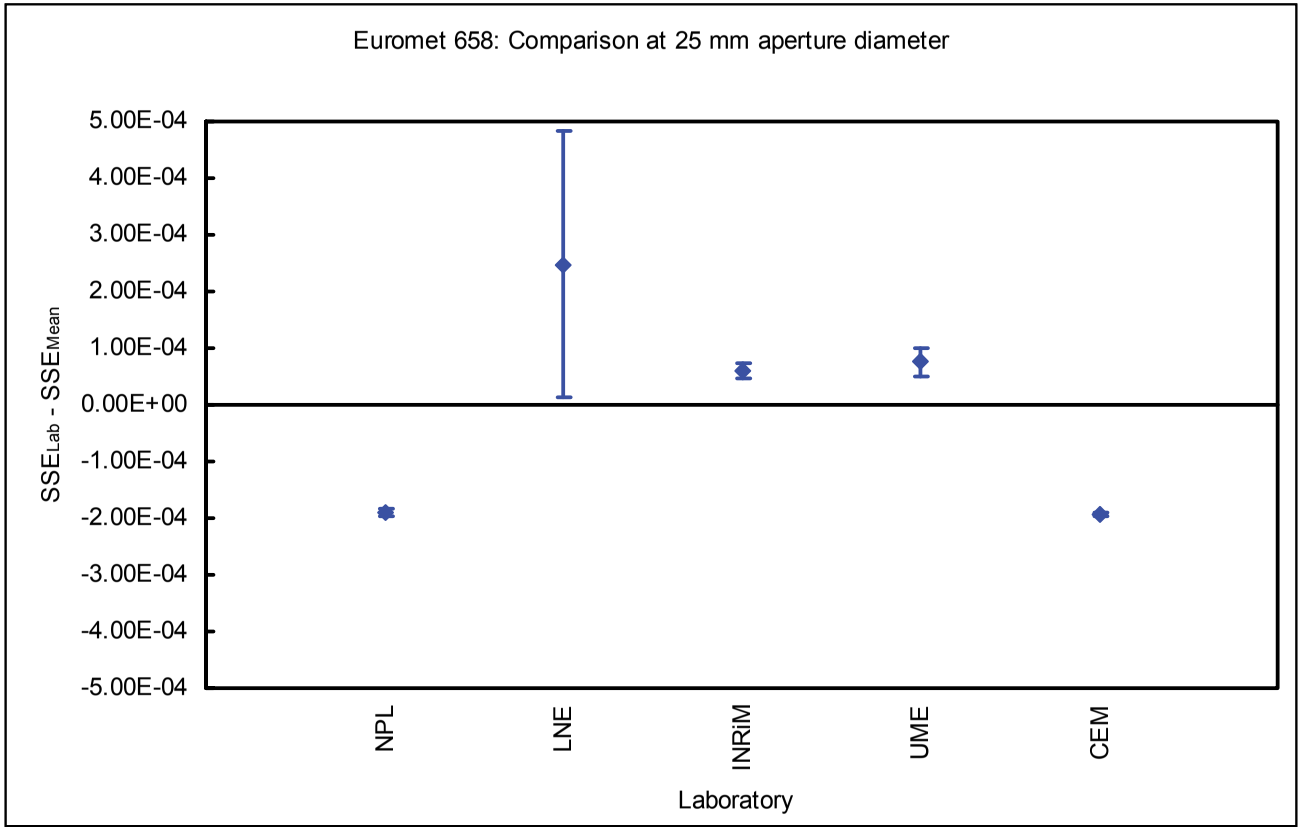
	NPL	LNE	INRiM	UME	CEM
NPL	-	-2.9144E-04 ± 1.278E-04	-1.8902E-04 ± 1.320E-05	-1.8984E-04 ± 2.818E-05	8.4469E-06 ± 7.937E-06
LNE	*3.9657E-04*	-	1.0242E-04 ± 1.283E-04	1.0160E-04 ± 1.307E-04	2.9988E-04 ± 1.279E-04
INRiM	*1.9988E-04*	*2.0801E-04*	-	-8.2004E-07 ± 3.040E-05	1.9747E-04 ± 1.390E-05
UME	*2.1302E-04*	*2.0916E-04*	*2.9852E-05*	-	1.9829E-04 ± 2.851E-05
CEM	*1.4975E-05*	*4.0508E-04*	*2.0890E-04*	*2.2174E-04*	-

Table 151 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 20 mm diameter aperture



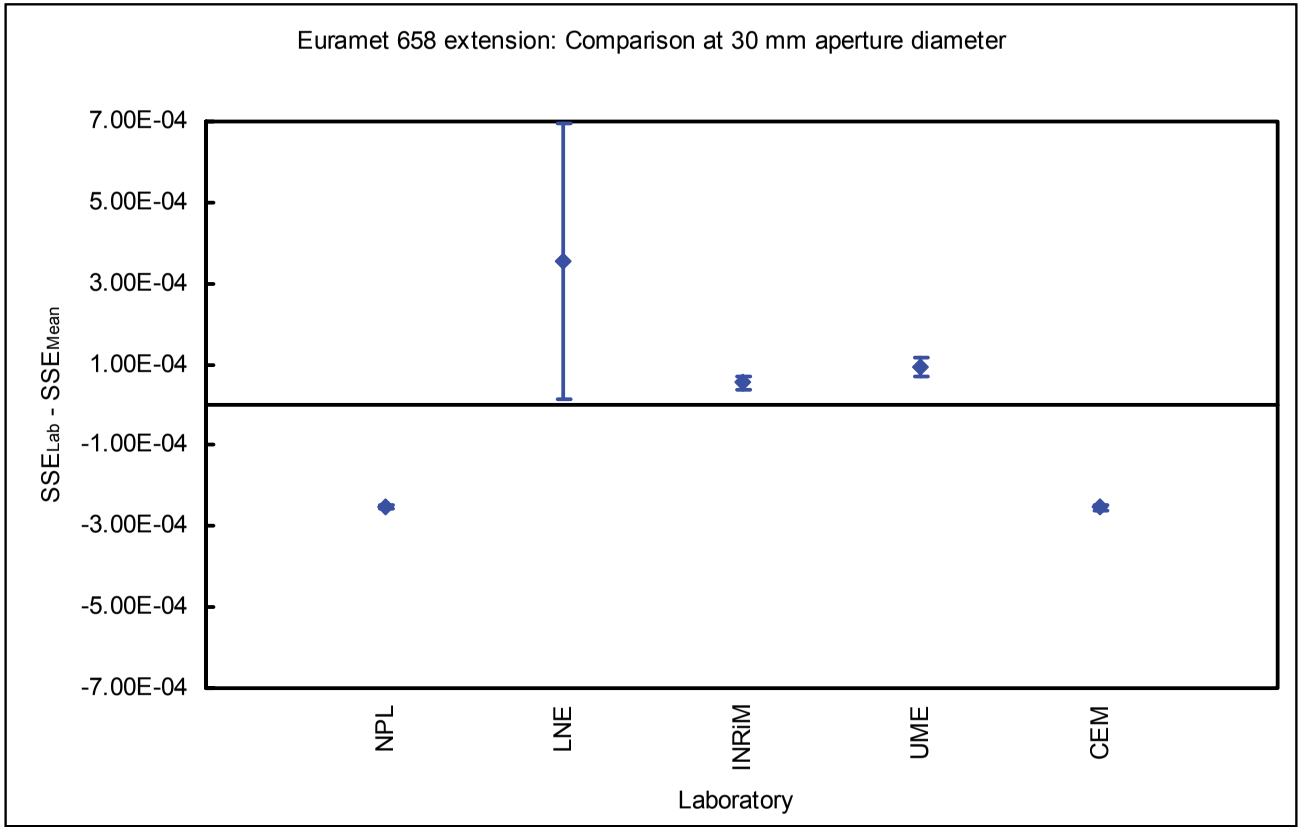
	NPL	LNE	INRiM	UME	CEM
NPL	-	-4.3847E-04 ± 2.336E-04	-2.4949E-04 ± 1.527E-05	-2.6542E-04 ± 2.663E-05	2.6754E-06 ± 8.292E-06
LNE	*6.3062E-04*	-	1.8899E-04 ± 2.340E-04	1.7305E-04 ± 2.350E-04	4.4115E-04 ± 2.336E-04
INRiM	*2.6204E-04*	*3.8150E-04*	-	-1.5931E-05 ± 2.973E-05	2.5216E-04 ± 1.560E-05
UME	*2.8732E-04*	*3.6645E-04*	*4.0447E-05*	-	2.6809E-04 ± 2.682E-05
CEM	*9.5959E-06*	*6.3332E-04*	*2.6499E-04*	*2.9015E-04*	-

Table 152 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 25 mm diameter aperture



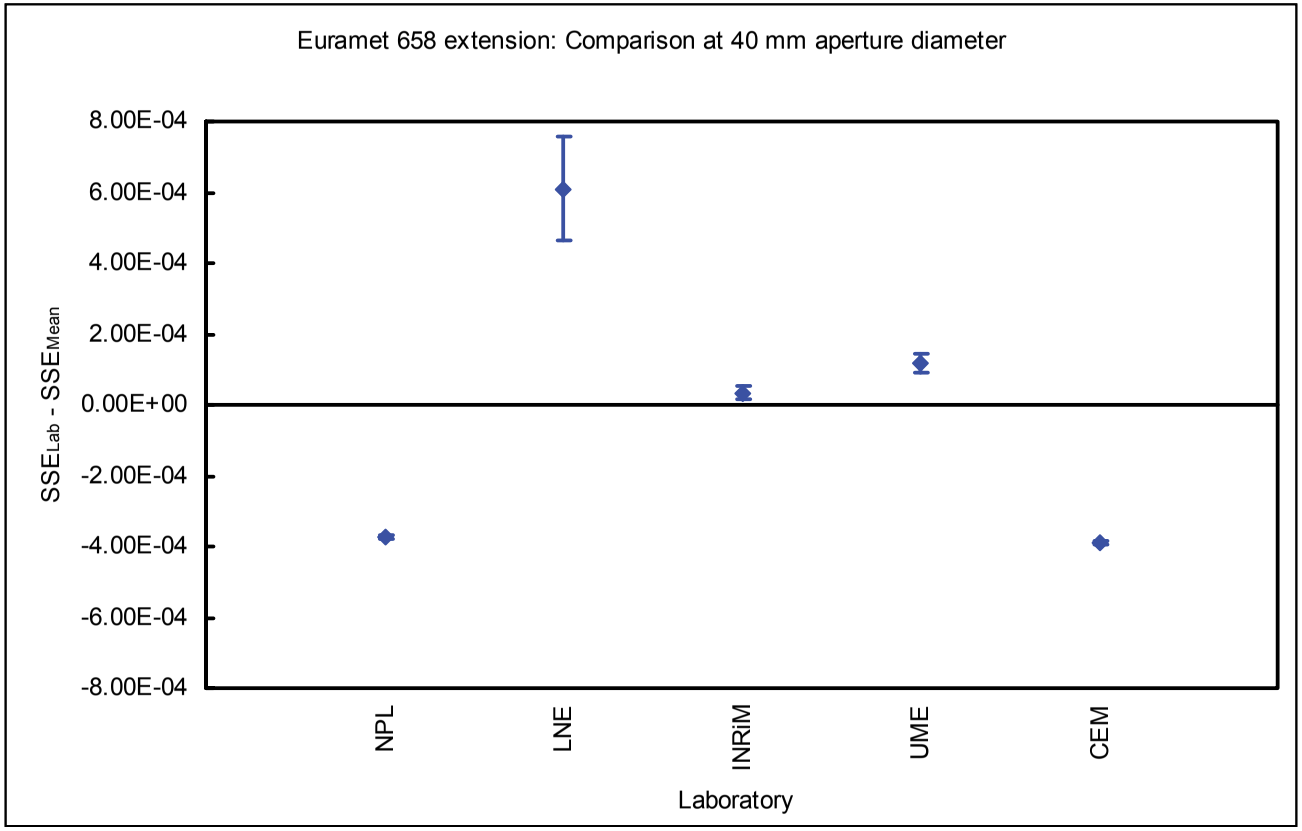
	NPL	LNE	INRiM	UME	CEM
NPL	-	-6.0605E-04 ± 3.396E-04	-3.0593E-04 ± 1.677E-05	-3.4276E-04 ± 2.488E-05	3.1440E-06 ± 7.412E-06
LNE	*8.8535E-04*	-	3.0012E-04 ± 3.399E-04	2.6329E-04 ± 3.404E-04	6.0919E-04 ± 3.396E-04
INRiM	*3.1972E-04*	*5.7975E-04*	-	-3.6833E-05 ± 2.923E-05	3.0907E-04 ± 1.704E-05
UME	*3.6322E-04*	*5.4338E-04*	*6.0875E-05*	-	3.4591E-04 ± 2.506E-05
CEM	*9.2799E-06*	*8.8850E-04*	*3.2309E-04*	*3.6652E-04*	-

Table 153 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 30 mm diameter aperture



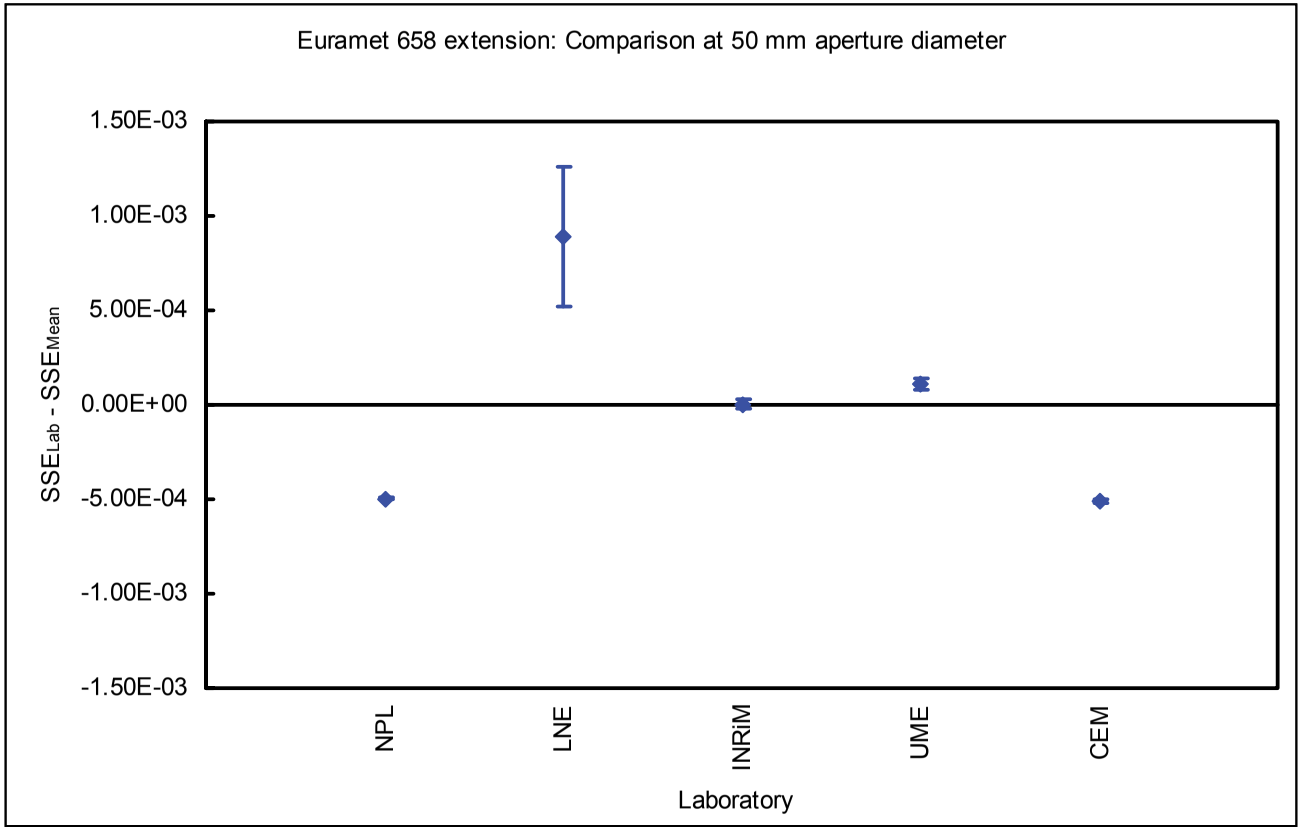
	NPL	LNE	INRiM	UME	CEM
NPL	-	-9.8199E-04 ± 1.474E-04	-4.0596E-04 ± 1.980E-05	-4.8787E-04 ± 2.812E-05	1.5396E-05 ± 7.122E-06
LNE	*1.1032E-03*	-	5.7603E-04 ± 1.486E-04	4.9412E-04 ± 1.499E-04	9.9738E-04 ± 1.475E-04
INRiM	*4.2224E-04*	*6.9826E-04*	-	-8.1915E-05 ± 3.384E-05	4.2135E-04 ± 2.014E-05
UME	*5.1100E-04*	*6.1745E-04*	*1.0975E-04*	-	5.0327E-04 ± 2.835E-05
CEM	*2.1253E-05*	*1.1187E-03*	*4.3791E-04*	*5.2659E-04*	-

Table 154 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 40 mm diameter aperture



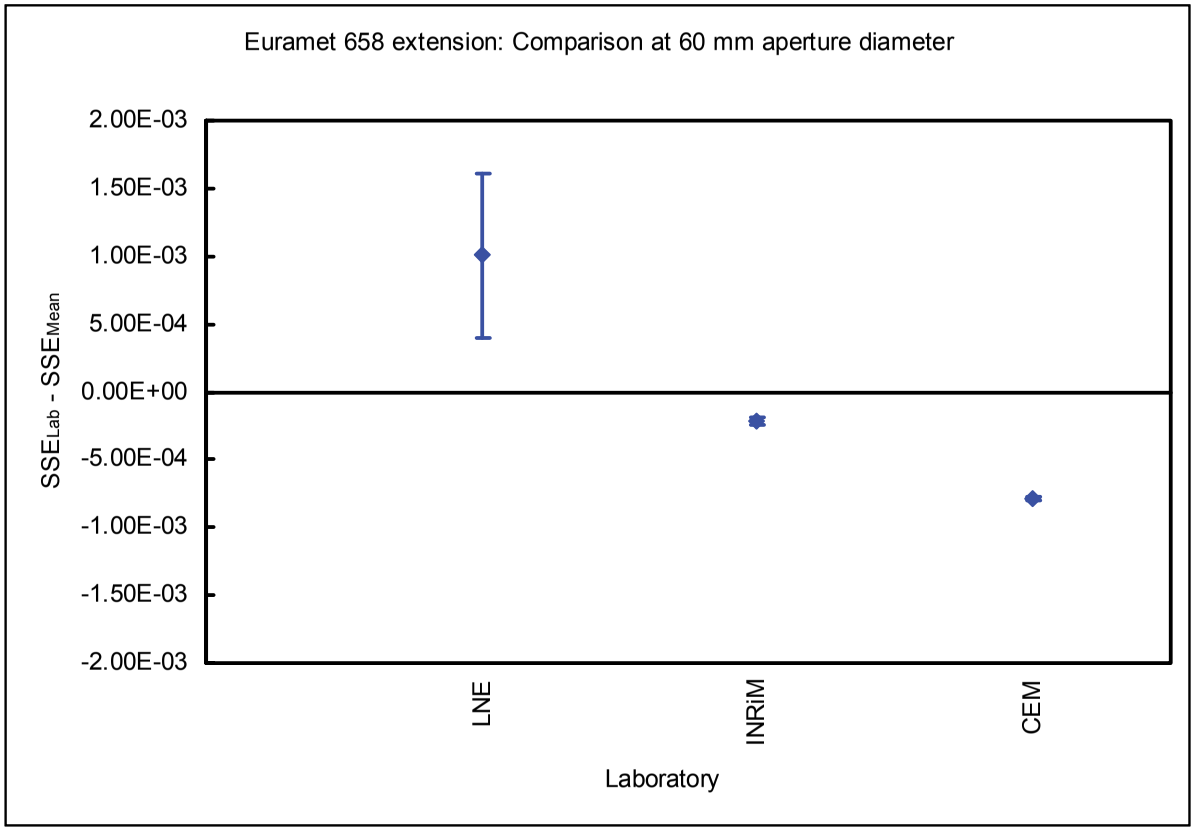
	NPL	LNE	INRiM	UME	CEM
NPL	-	-1.3846E-03 ± 3.675E-04	-4.9916E-04 ± 2.294E-05	-6.0761E-04 ± 2.982E-05	1.5946E-05 ± 7.814E-06
LNE	*1.6868E-03*	-	8.8541E-04 ± 3.681E-04	7.7695E-04 ± 3.686E-04	1.4005E-03 ± 3.675E-04
INRiM	*5.1803E-04*	*1.1882E-03*	-	-1.0845E-04 ± 3.717E-05	5.1511E-04 ± 2.353E-05
UME	*6.3214E-04*	*1.0802E-03*	*1.3902E-04*	-	6.2356E-04 ± 3.027E-05
CEM	*2.2373E-05*	*1.7028E-03*	*5.3446E-04*	*6.4845E-04*	-

Table 155 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 50 mm diameter aperture



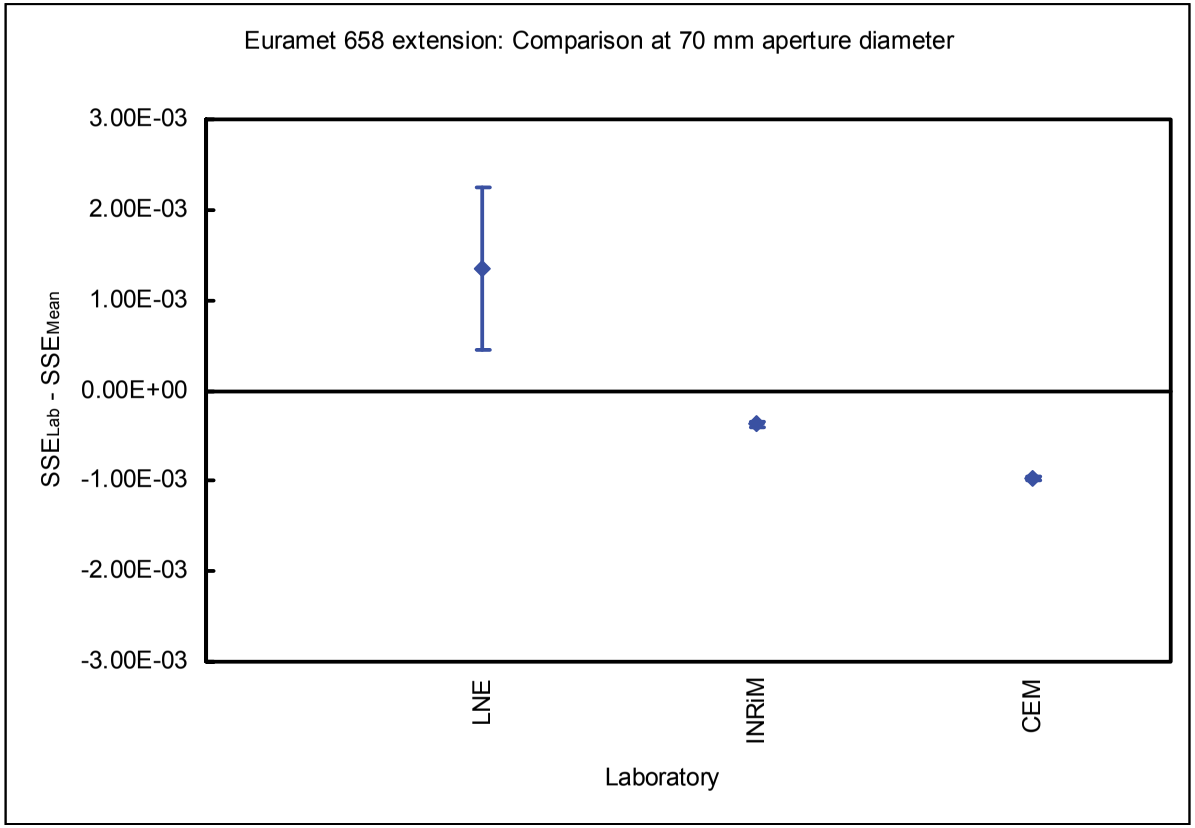
	LNE	INRiM	CEM
LNE	-	1.2276E-03 ± 6.060E-04	1.8012E-03 ± 6.056E-04
INRiM	*1.7260E-03*	-	5.7362E-04 ± 2.850E-05
CEM	*2.2993E-03*	*5.9706E-04*	-

Table 156 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 60 mm diameter aperture



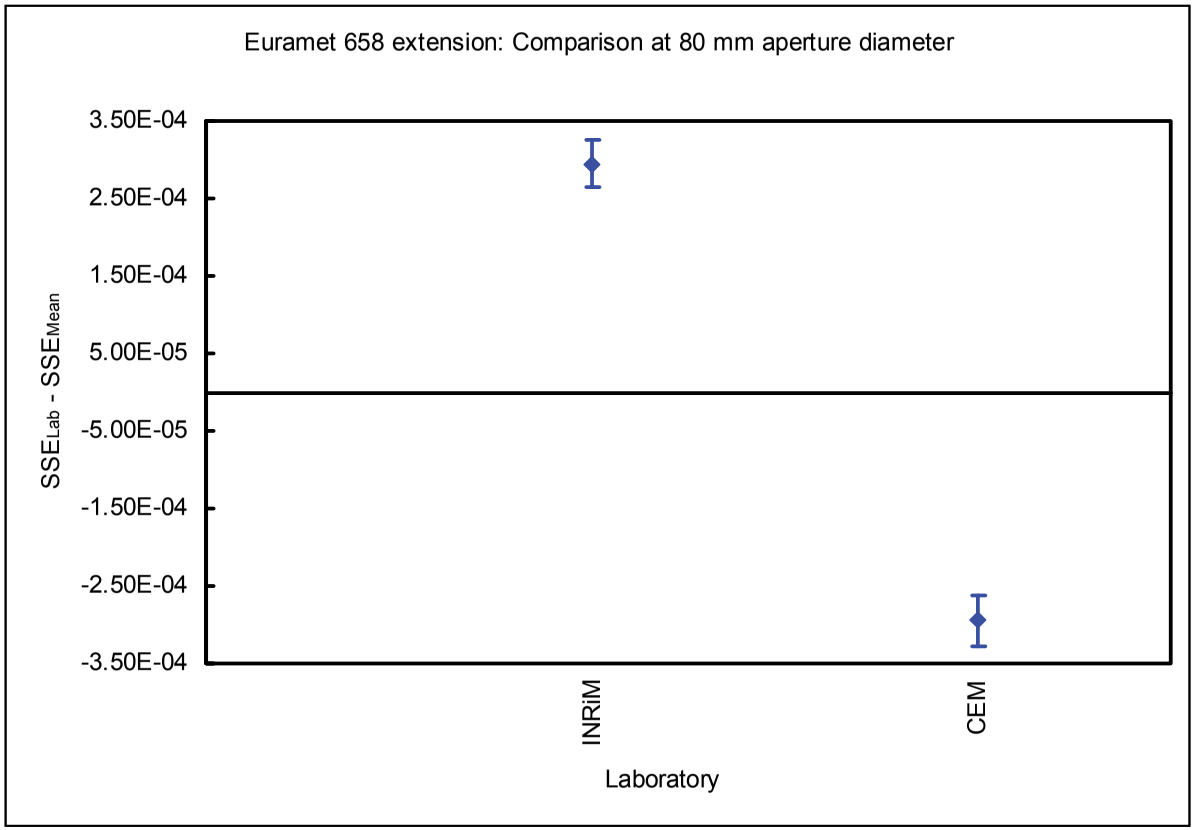
	LNE	INRiM	CEM
LNE	-	1.7193E-03 ± 8.963E-04	2.3119E-03 ± 8.963E-04
INRiM	*2.4565E-03*	-	5.9256E-04 ± 3.923E-05
CEM	*3.0491E-03*	*6.2483E-04*	-

Table 157 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 70 mm diameter aperture



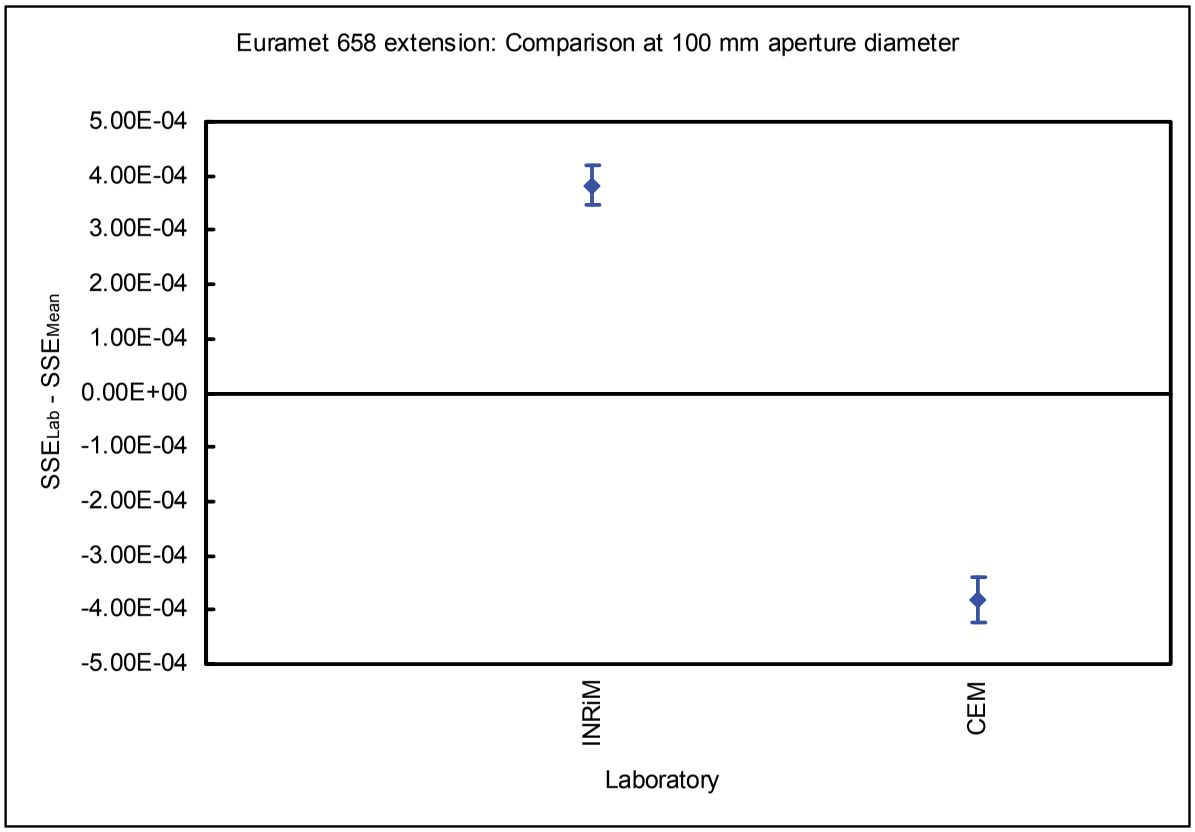
	INRiM	CEM
INRiM	-	5.8998E-04 ± 4.506E-05
CEM	*6.2704E-04*	-

Table 158 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	7.6375E-04 ± 5.641E-05
CEM	*8.1015E-04*	-

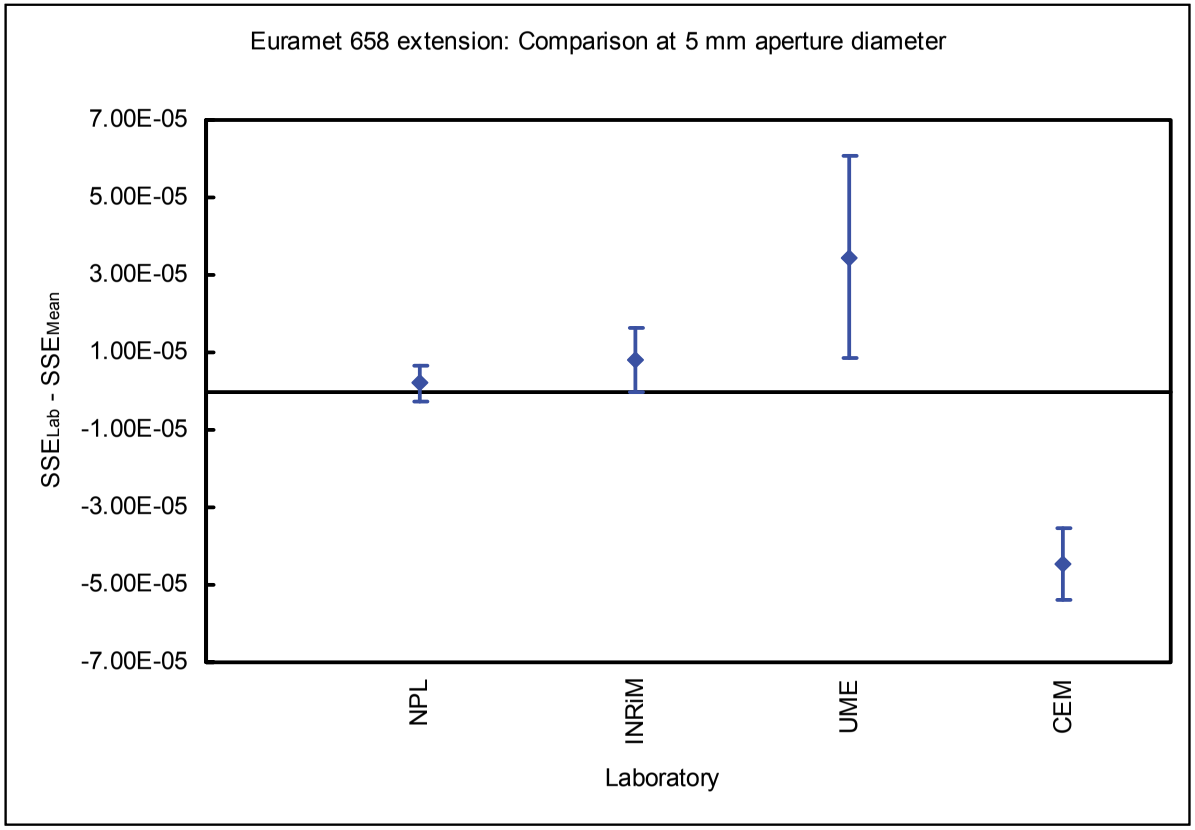
Table 159 – comparison of indirect SSE measurements with the LP5 thermometer, 3 mm diameter spot and 100 mm diameter aperture



1.8.6 The LP5 thermometer ‘indirect’ SSE results – 3 mm spot excl. LNE

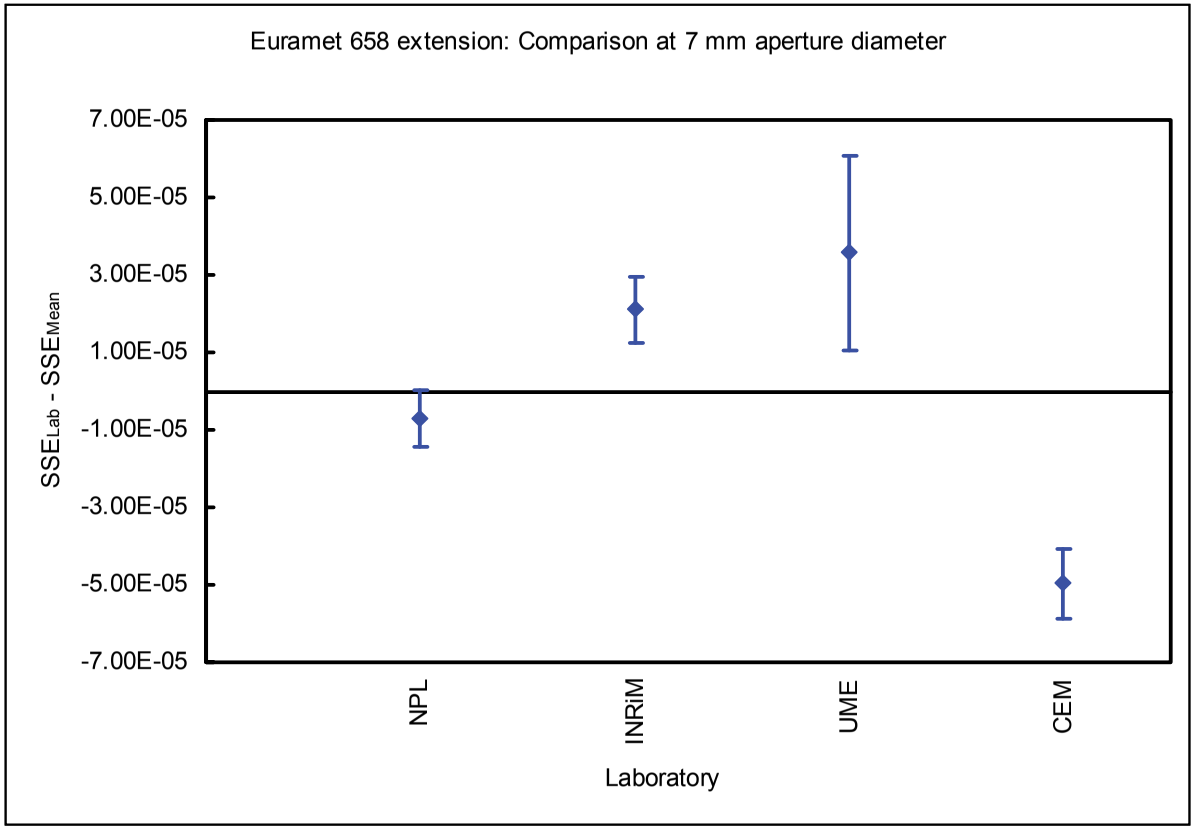
	NPL	INRiM	UME	CEM
NPL	-	-5.8527E-06 ± 9.559E-06	-3.2349E-05 ± 2.649E-05	4.6657E-05 ± 1.027E-05
INRiM	*1.3726E-05*	-	-2.6496E-05 ± 2.738E-05	5.2509E-05 ± 1.237E-05
UME	*5.4140E-05*	*4.9015E-05*	-	7.9006E-05 ± 2.763E-05
CEM	*5.5103E-05*	*6.2684E-05*	*1.0173E-04*	-

Table 160 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 5 mm diameter aperture



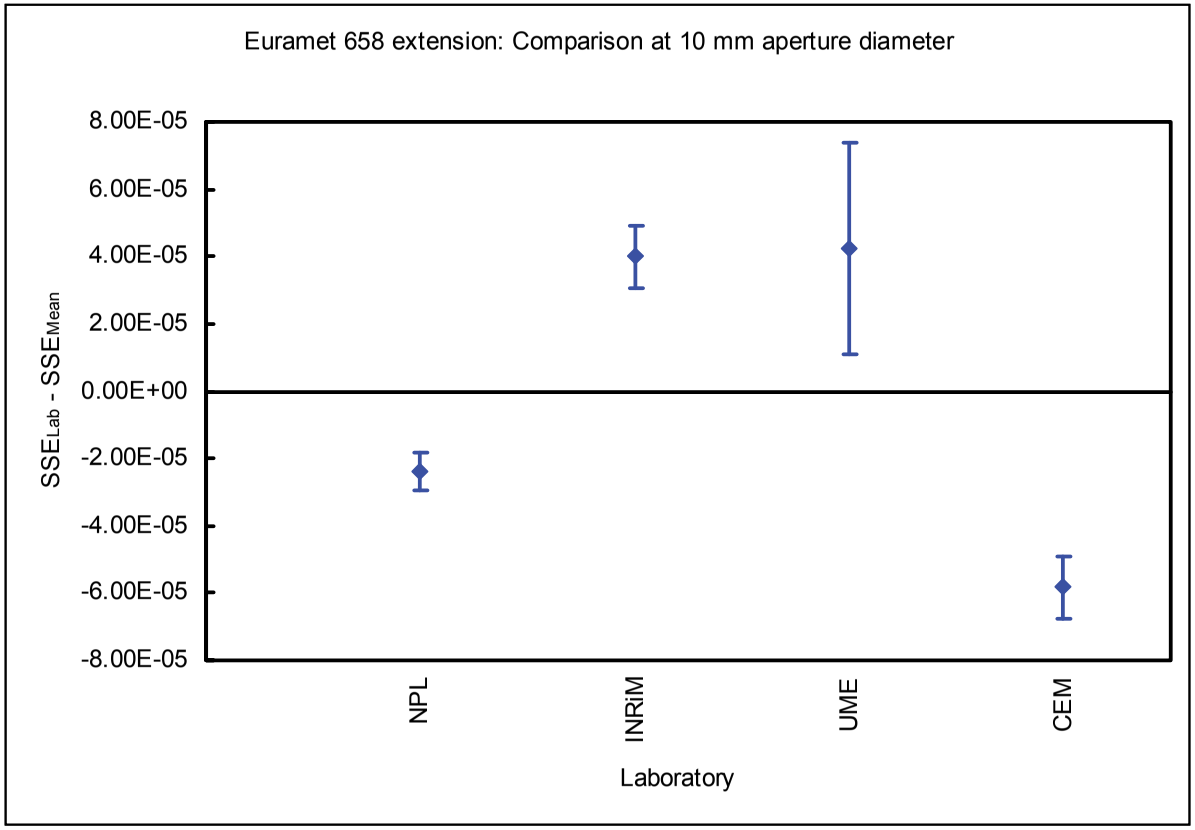
	NPL	INRiM	UME	CEM
NPL	-	-2.8198E-05 ± 1.124E-05	-4.2812E-05 ± 2.623E-05	4.2515E-05 ± 1.160E-05
INRiM	*3.7440E-05*	-	-1.4614E-05 ± 2.669E-05	7.0714E-05 ± 1.260E-05
UME	*6.4387E-05*	*3.6616E-05*	-	8.5328E-05 ± 2.684E-05
CEM	*5.2058E-05*	*8.1076E-05*	*1.0741E-04*	-

Table 161 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 7 mm diameter aperture



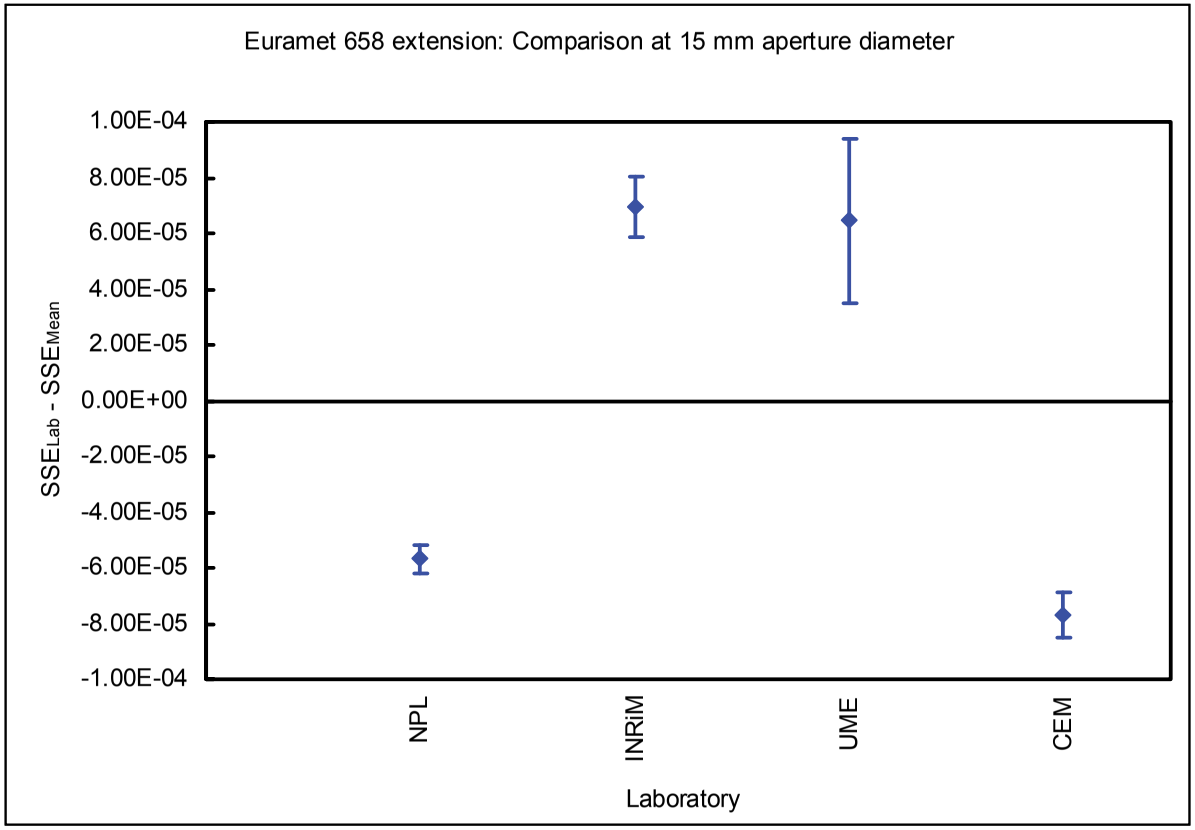
	NPL	INRiM	UME	CEM
NPL	-	-6.3804E-05 ± 1.089E-05	-6.6223E-05 ± 3.180E-05	3.4468E-05 ± 1.072E-05
INRiM	*7.2758E-05*	-	-2.4183E-06 ± 3.267E-05	9.8272E-05 ± 1.306E-05
UME	*9.2380E-05*	*3.2241E-05*	-	1.0069E-04 ± 3.261E-05
CEM	*4.3286E-05*	*1.0902E-04*	*1.2751E-04*	-

Table 162 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 10 mm diameter aperture



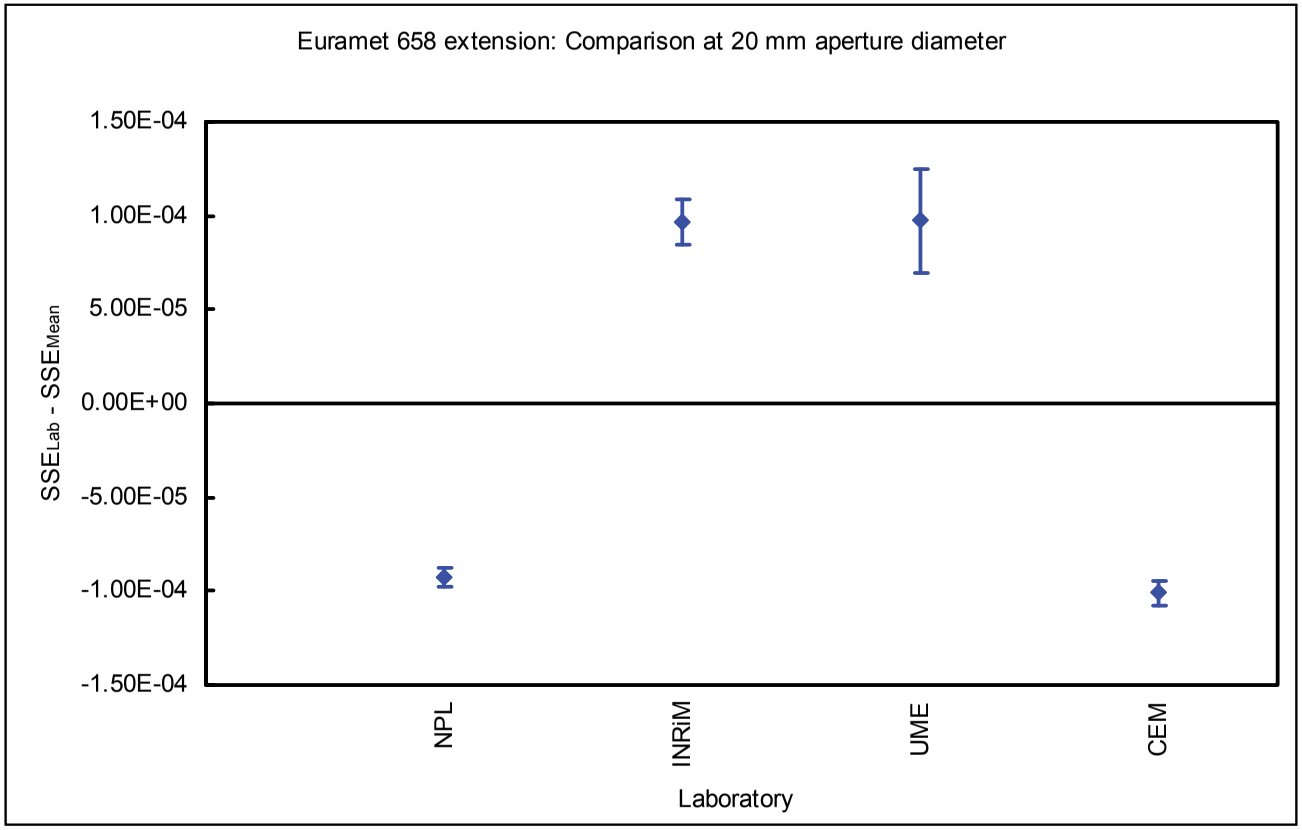
	NPL	INRiM	UME	CEM
NPL	-	-1.2619E-04 ± 1.205E-05	-1.2129E-04 ± 2.999E-05	1.9961E-05 ± 9.618E-06
INRiM	*1.3610E-04*	-	4.9026E-06 ± 3.146E-05	1.4615E-04 ± 1.352E-05
UME	*1.4595E-04*	*3.2246E-05*	-	1.4125E-04 ± 3.061E-05
CEM	*2.7872E-05*	*1.5727E-04*	*1.6642E-04*	-

Table 163 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 15 mm diameter aperture



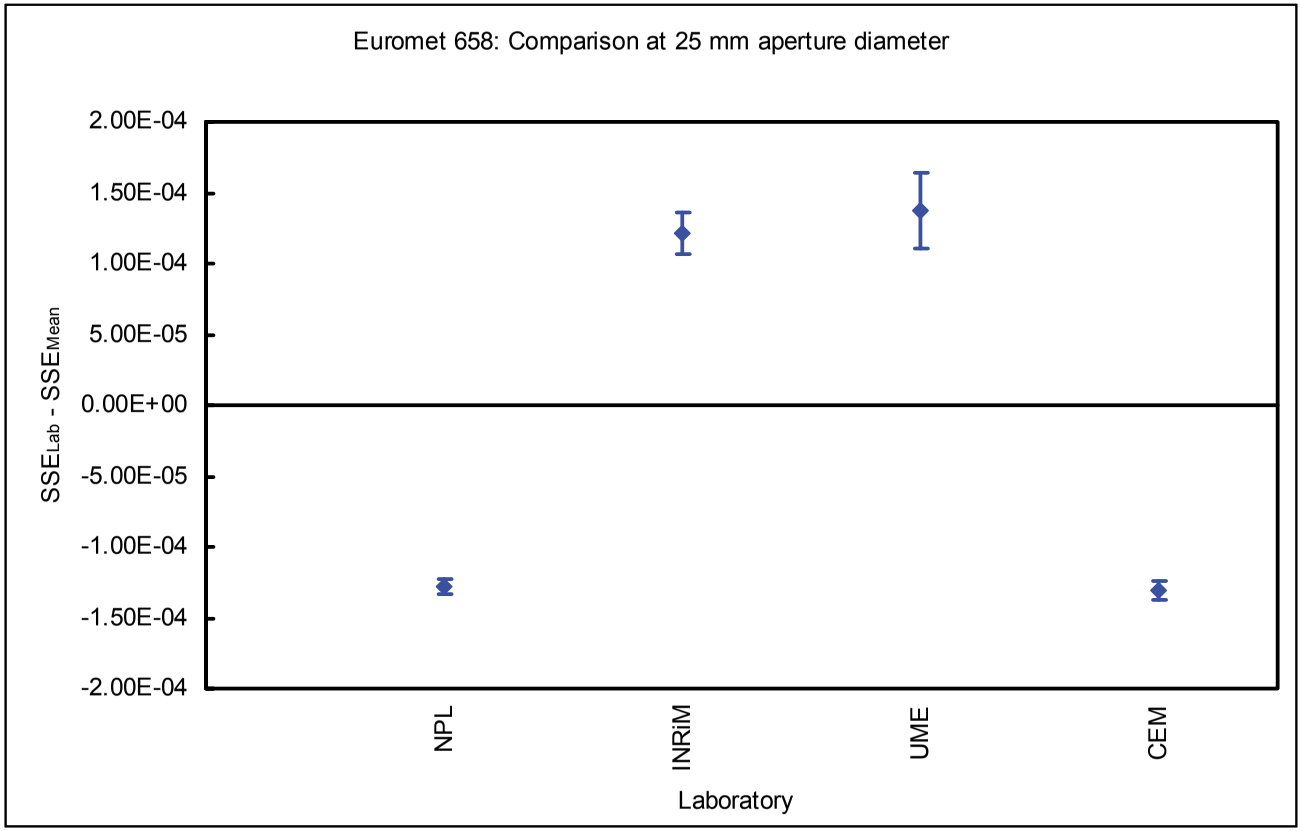
	NPL	INRiM	UME	CEM
NPL	-	-1.8902E-04 ± 1.320E-05	-1.8984E-04 ± 2.818E-05	8.4469E-06 ± 7.937E-06
INRiM	*1.9988E-04*	-	-8.2004E-07 ± 3.040E-05	1.9747E-04 ± 1.390E-05
UME	*2.1302E-04*	*2.9852E-05*	-	1.9829E-04 ± 2.851E-05
CEM	*1.4975E-05*	*2.0890E-04*	*2.2174E-04*	-

Table 164 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 20 mm diameter aperture



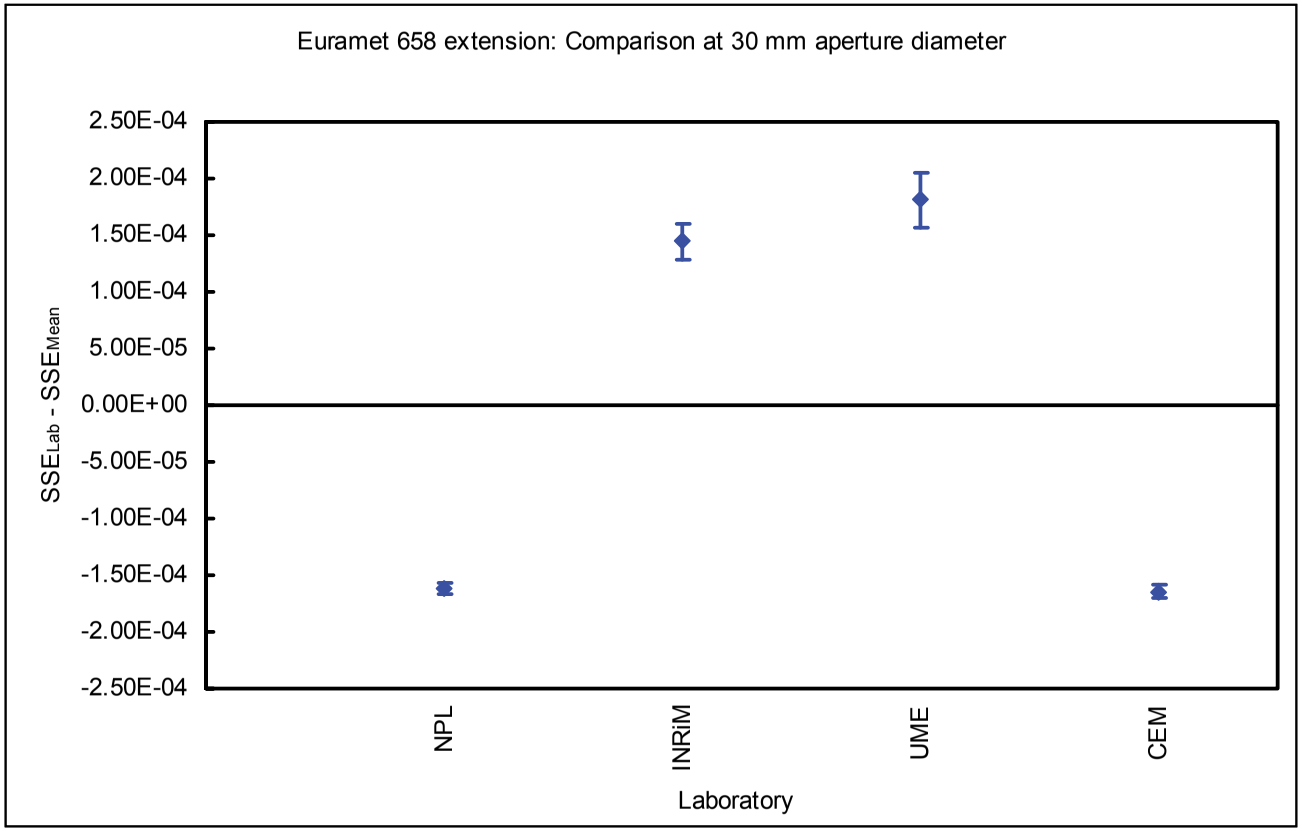
	NPL	INRiM	UME	CEM
NPL	-	-2.4949E-04 ± 1.527E-05	-2.6542E-04 ± 2.663E-05	2.6754E-06 ± 8.382E-06
INRiM	*2.6204E-04*	-	-1.5931E-05 ± 2.973E-05	2.5216E-04 ± 1.565E-05
UME	*2.8732E-04*	*4.0447E-05*	-	2.6809E-04 ± 2.685E-05
CEM	*9.6735E-06*	*2.6503E-04*	*2.9018E-04*	-

Table 165 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 25 mm diameter aperture



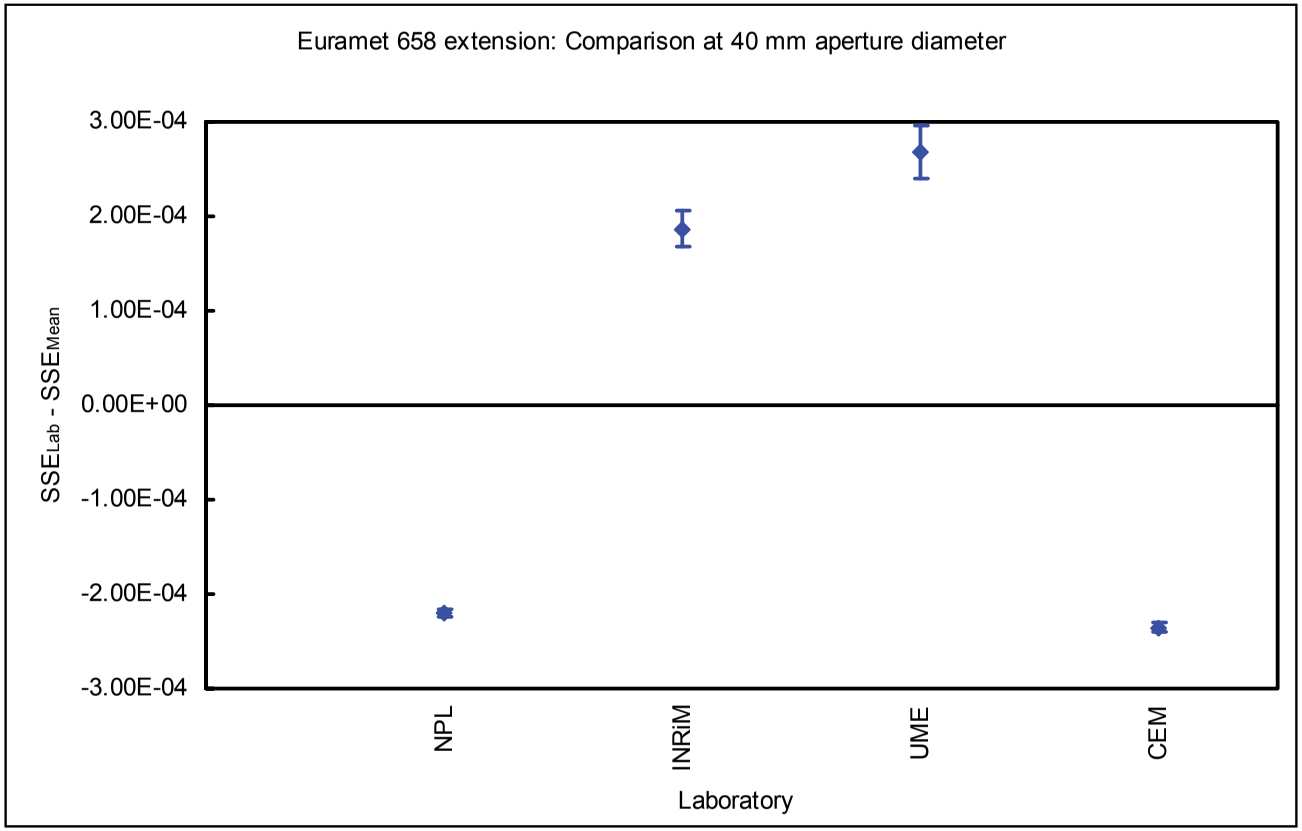
	NPL	INRiM	UME	CEM
NPL	-	-3.0593E-04 ± 1.677E-05	-3.4276E-04 ± 2.488E-05	3.1440E-06 ± 7.412E-06
INRiM	*3.1972E-04*	-	-3.6833E-05 ± 2.923E-05	3.0907E-04 ± 1.704E-05
UME	*3.6322E-04*	*6.0875E-05*	-	3.4591E-04 ± 2.506E-05
CEM	*9.2799E-06*	*3.2309E-04*	*3.6652E-04*	-

Table 166 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 30 mm diameter aperture



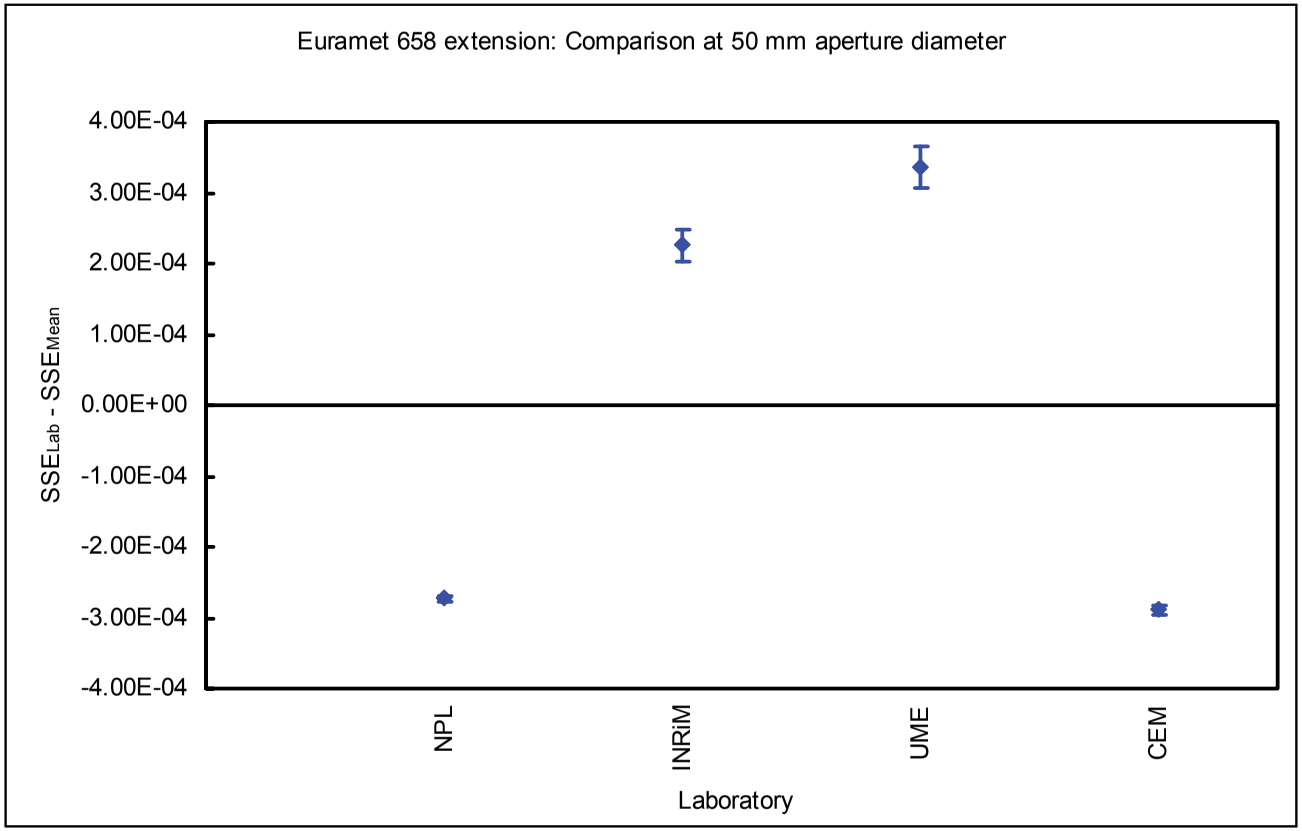
	NPL	INRiM	UME	CEM
NPL	-	-4.0596E-04 ± 1.980E-05	-4.8787E-04 ± 2.812E-05	1.5396E-05 ± 7.122E-06
INRiM	*4.2224E-04*	-	-8.1915E-05 ± 3.384E-05	4.2135E-04 ± 2.014E-05
UME	*5.1100E-04*	*1.0975E-04*	-	5.0327E-04 ± 2.835E-05
CEM	*2.1253E-05*	*4.3791E-04*	*5.2659E-04*	-

Table 167 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 40 mm diameter aperture



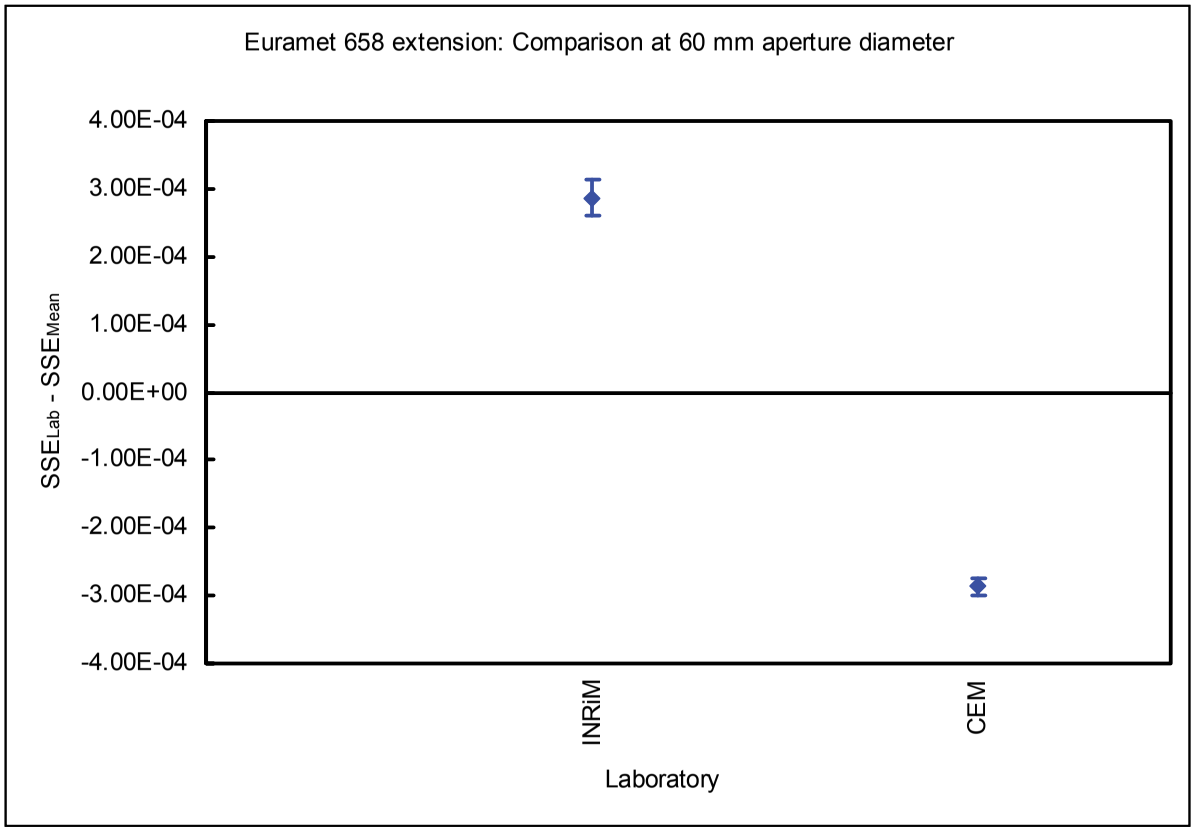
	NPL	INRiM	UME	CEM
NPL	-	-4.9916E-04 ± 2.294E-05	-6.0761E-04 ± 2.982E-05	1.5946E-05 ± 7.814E-06
INRiM	*5.1803E-04*	-	-1.0845E-04 ± 3.717E-05	5.1511E-04 ± 2.353E-05
UME	*6.3214E-04*	*1.3902E-04*	-	6.2356E-04 ± 3.027E-05
CEM	*2.2373E-05*	*5.3446E-04*	*6.4845E-04*	-

Table 168 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 50 mm diameter aperture



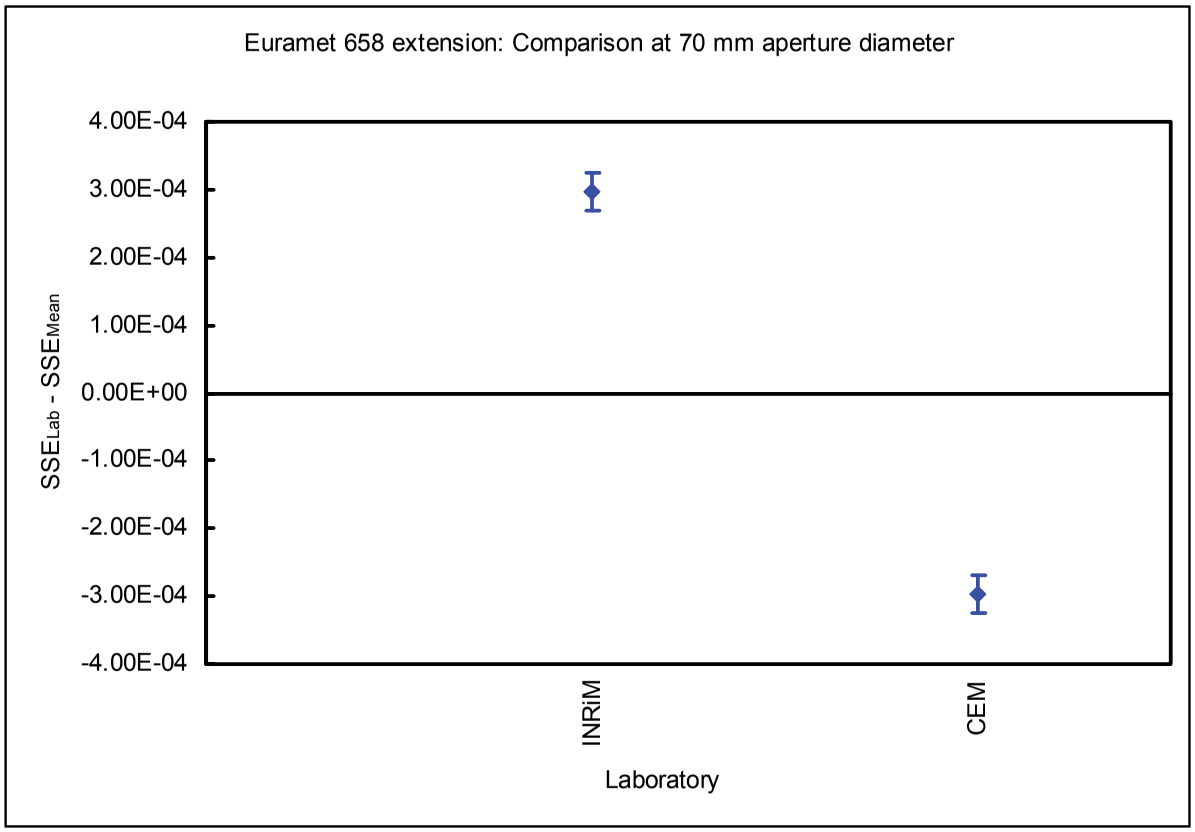
	INRiM	CEM
INRiM	-	5.7362E-04 ± 2.850E-05
CEM	*5.9706E-04*	-

Table 169 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 60 mm diameter aperture



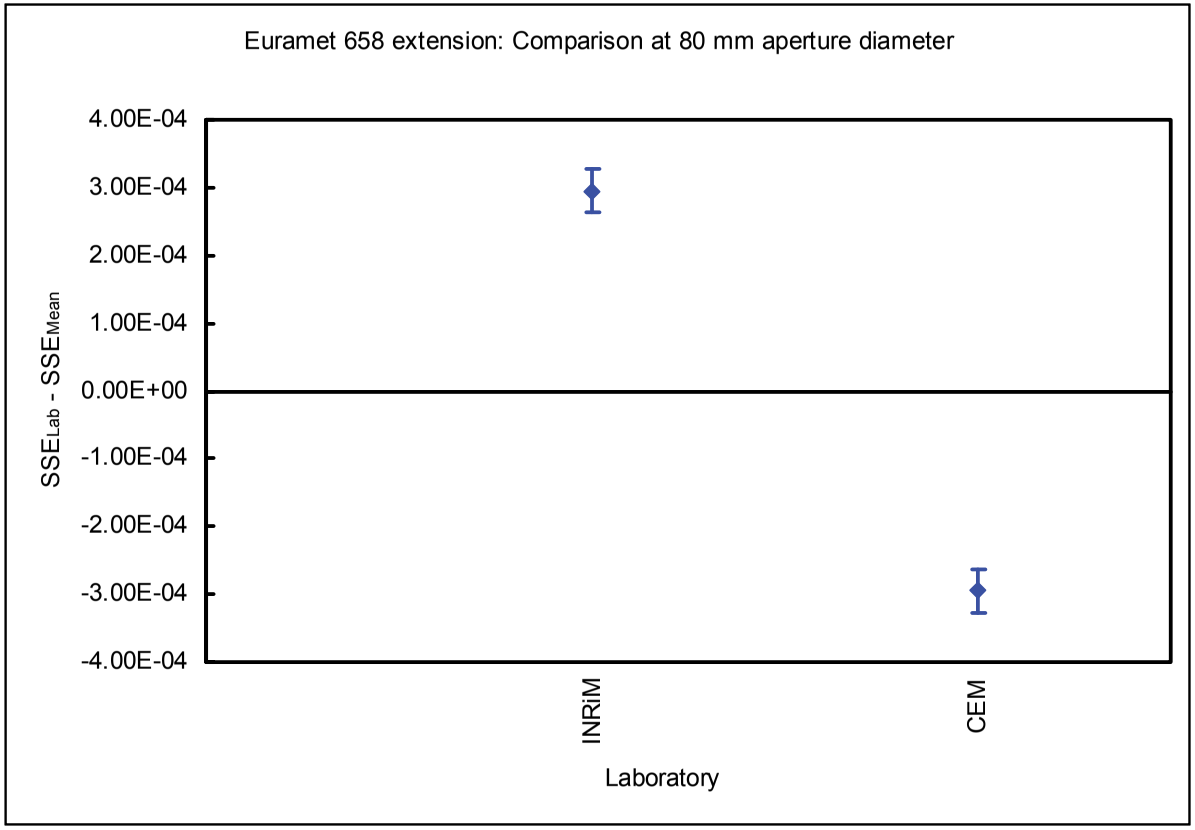
	INRiM	CEM
INRiM	-	5.9256E-04 ± 3.923E-05
CEM	*6.2483E-04*	-

Table 170 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 70 mm diameter aperture



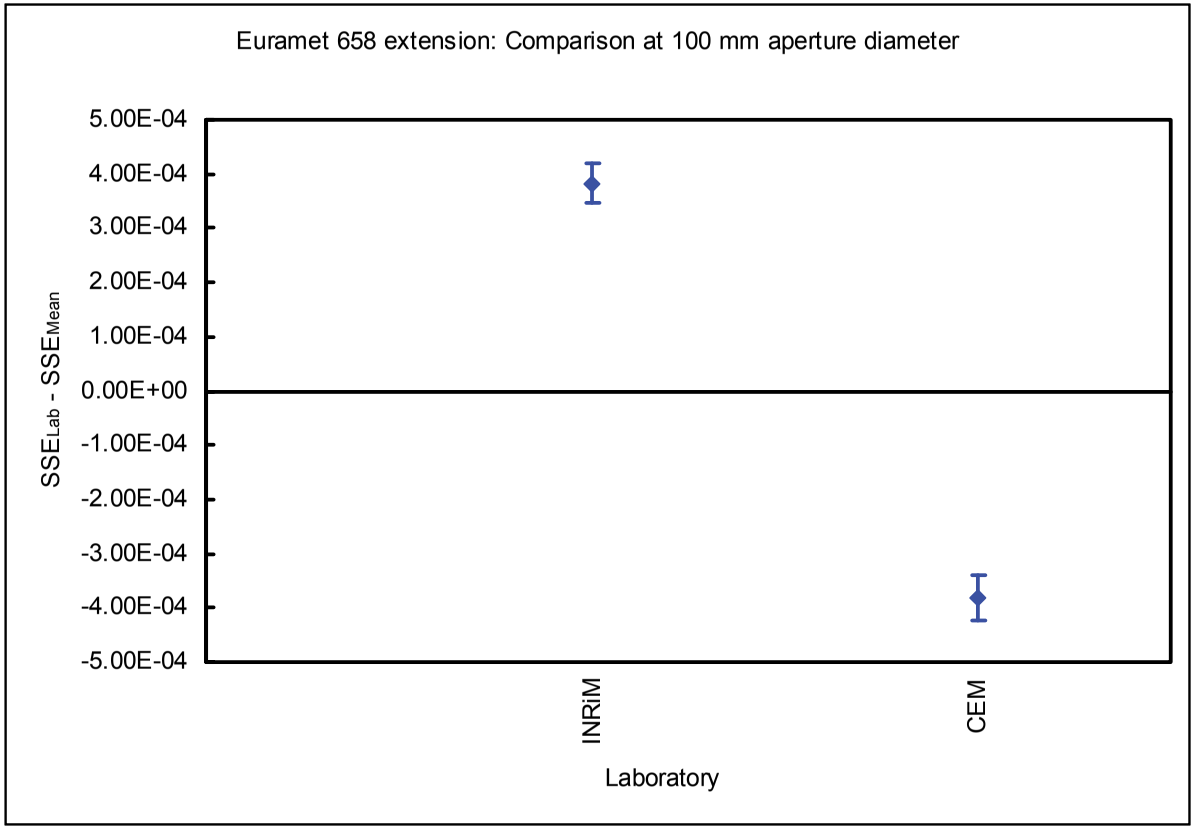
	INRiM	CEM
INRiM	-	5.8998E-04 ± 4.506E-05
CEM	*6.2704E-04*	-

Table 171 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	7.6375E-04 ± 5.641E-05
CEM	*8.1015E-04*	-

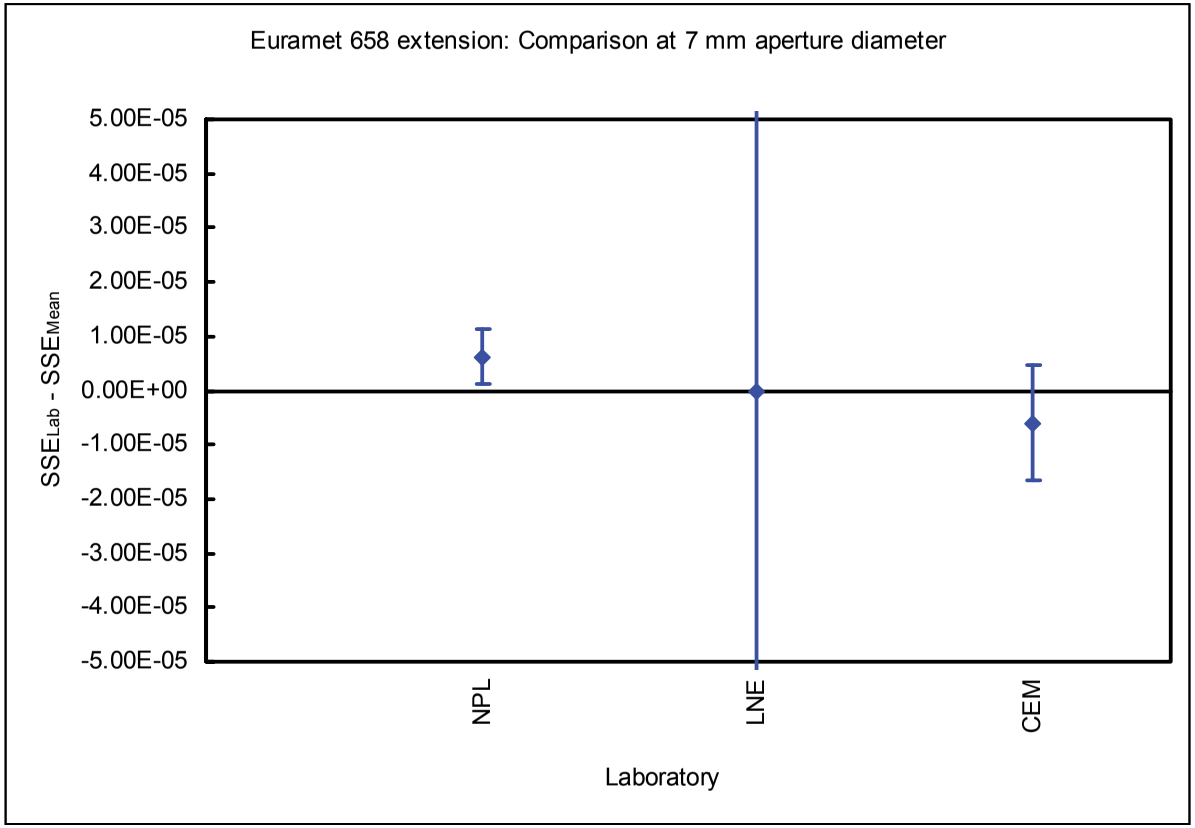
Table 172 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 3 mm diameter spot and 100 mm diameter aperture



1.8.7 The LP5 thermometer ‘indirect’ SSE results – 6 mm spot

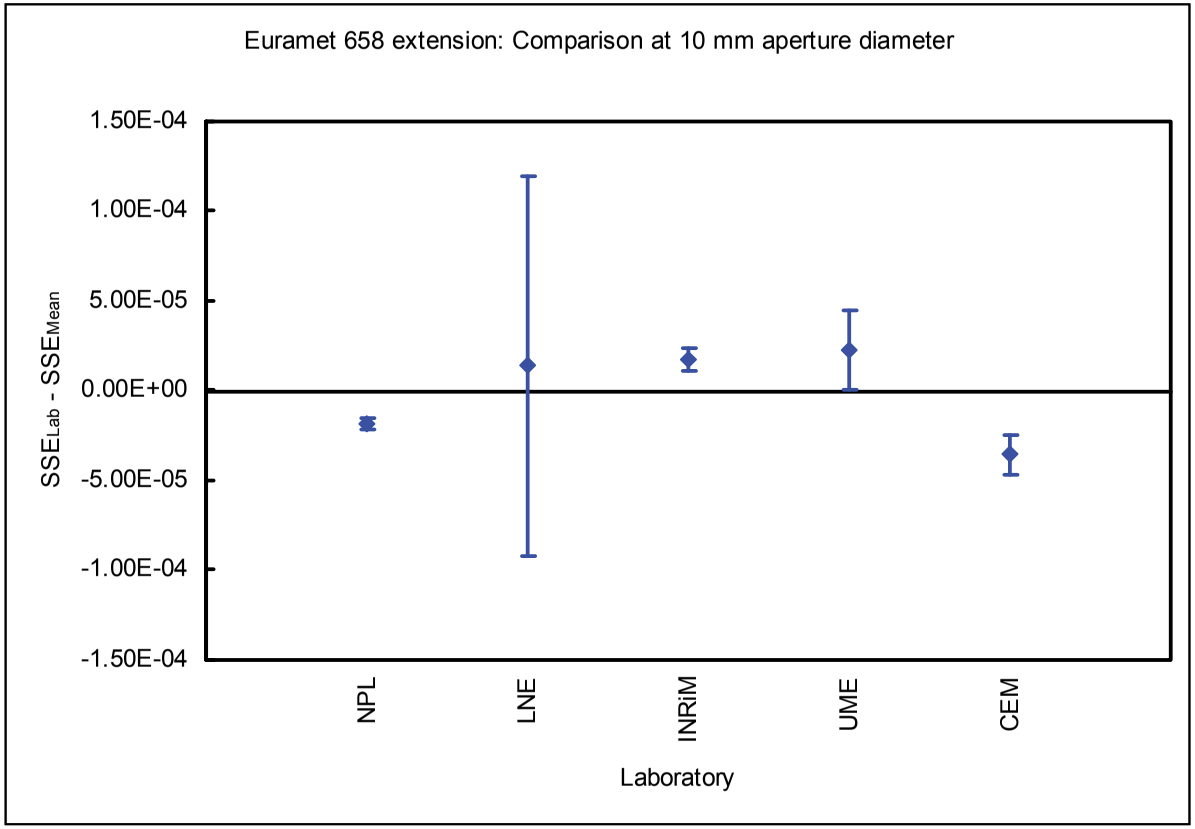
	NPL	LNE	CEM
NPL	-	0.000007 ± 9.757E-05	0.000012 ± 1.186E-05
LNE	*0.000096*	-	0.000006 ± 9.802E-05
CEM	*0.000022*	*0.000096*	-

Table 173 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 7 mm diameter aperture



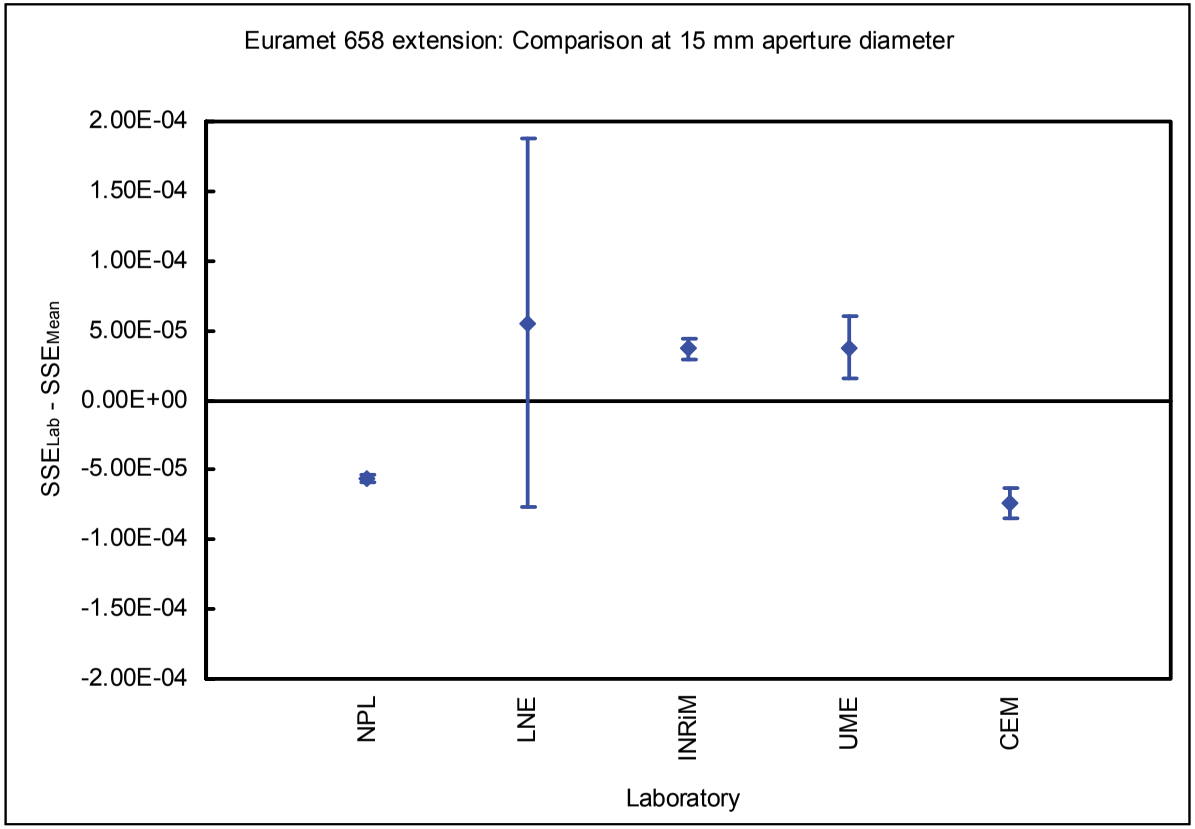
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000032 ± 1.059E-04	-0.000036 ± 7.165E-06	-0.000041 ± 2.242E-05	0.000017 ± 1.116E-05
LNE	*0.000121*	-	-0.000004 ± 1.060E-04	-0.000009 ± 1.081E-04	0.000049 ± 1.064E-04
INRiM	*0.000042*	*0.000104*	-	-0.000005 ± 2.307E-05	0.000053 ± 1.241E-05
UME	*0.000059*	*0.000107*	*0.000024*	-	0.000058 ± 2.460E-05
CEM	*0.000026*	*0.000137*	*0.000064*	*0.000078*	-

Table 174 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 10 mm diameter aperture



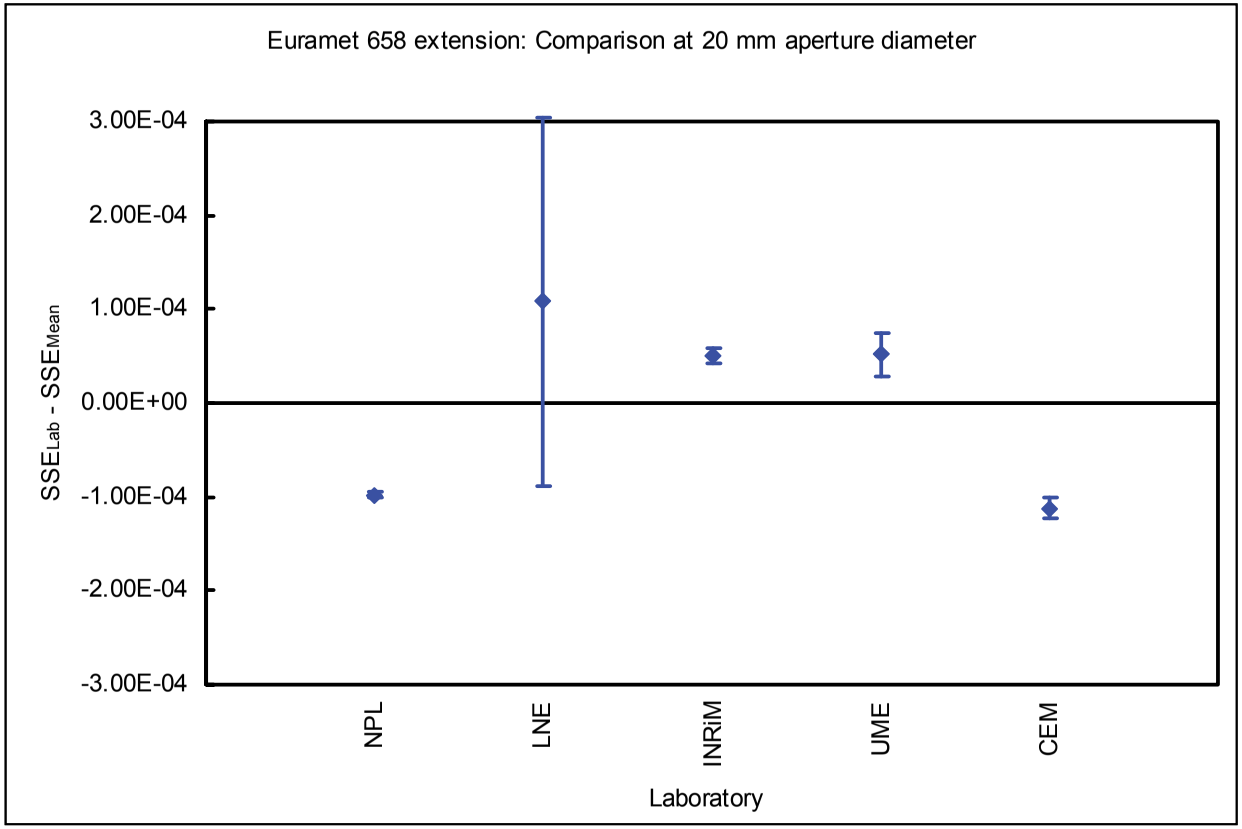
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000112 ± 1.325E-04	-0.000093 ± 7.821E-06	-0.000094 ± 2.249E-05	0.000018 ± 1.100E-05
LNE	*0.000221*	-	0.000019 ± 1.327E-04	0.000018 ± 1.343E-04	0.000129 ± 1.329E-04
INRiM	*0.000099*	*0.000135*	-	-0.000001 ± 2.351E-05	0.000110 ± 1.296E-05
UME	*0.000112*	*0.000136*	*0.000023*	-	0.000111 ± 2.475E-05
CEM	*0.000027*	*0.000238*	*0.000121*	*0.000131*	-

Table 175 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 15 mm diameter aperture



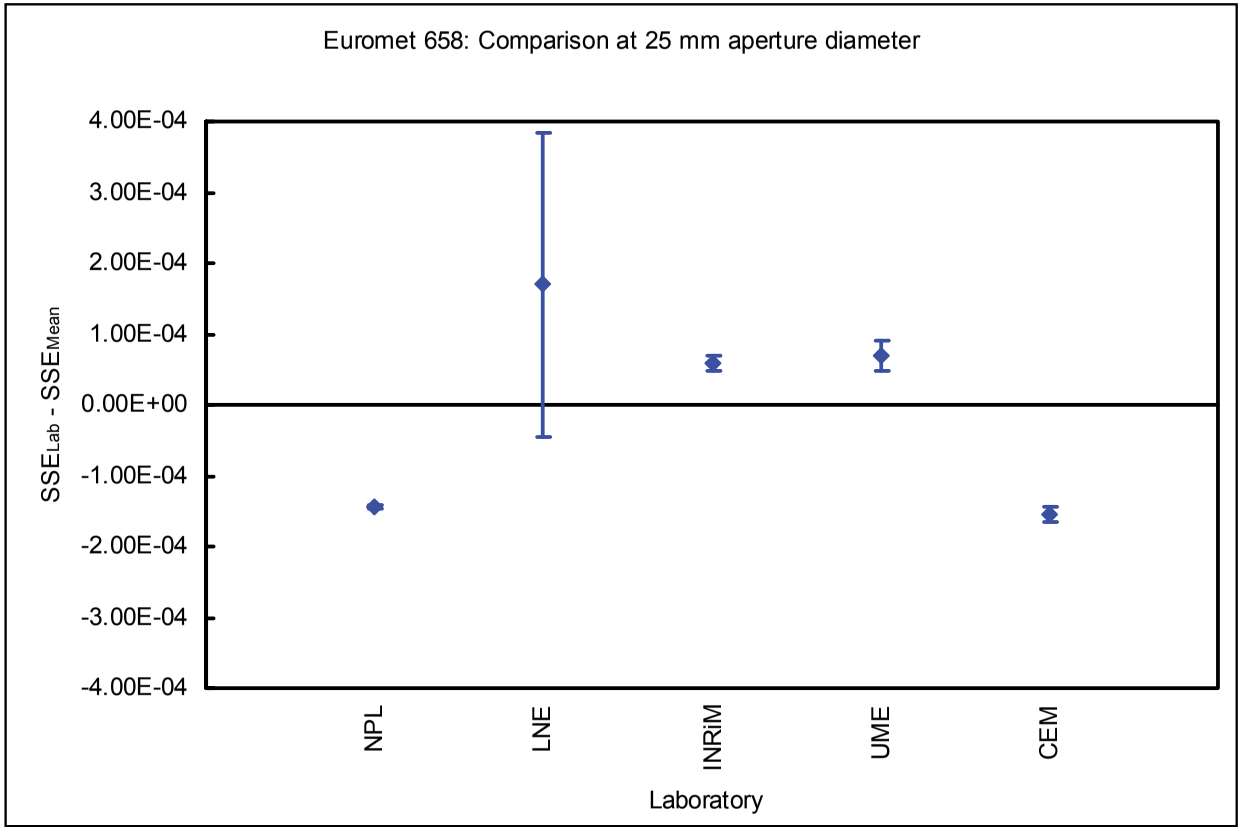
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000207 ± 1.965E-04	-0.000149 ± 9.127E-06	-0.000150 ± 2.249E-05	0.000014 ± 1.110E-05
LNE	*0.000368*	-	0.000058 ± 1.967E-04	0.000057 ± 1.977E-04	0.000221 ± 1.968E-04
INRiM	*0.000156*	*0.000223*	-	-0.000001 ± 2.398E-05	0.000162 ± 1.386E-05
UME	*0.000168*	*0.000223*	*0.000024*	-	0.000164 ± 2.479E-05
CEM	*0.000023*	*0.000382*	*0.000174*	*0.000184*	-

Table 176 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 20 mm diameter aperture



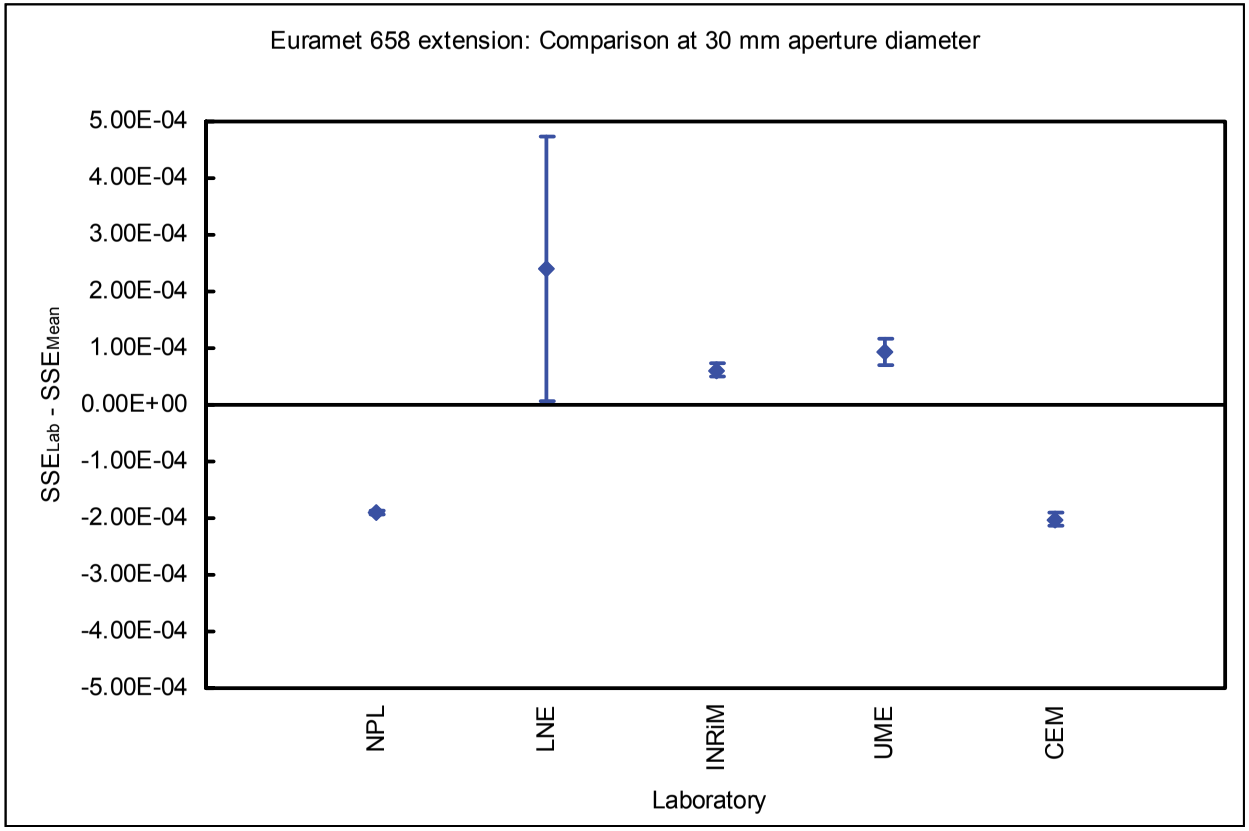
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000314 ± 2.149E-04	-0.000202 ± 1.106E-05	-0.000213 ± 2.268E-05	0.000011 ± 1.123E-05
LNE	*0.000491*	-	0.000112 ± 2.152E-04	0.000101 ± 2.161E-04	0.000325 ± 2.152E-04
INRiM	*0.000211*	*0.000289*	-	-0.000011 ± 2.489E-05	0.000213 ± 1.520E-05
UME	*0.000231*	*0.000280*	*0.000031*	-	0.000224 ± 2.496E-05
CEM	*0.000020*	*0.000502*	*0.000226*	*0.000244*	-

Table 177 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 25 mm diameter aperture



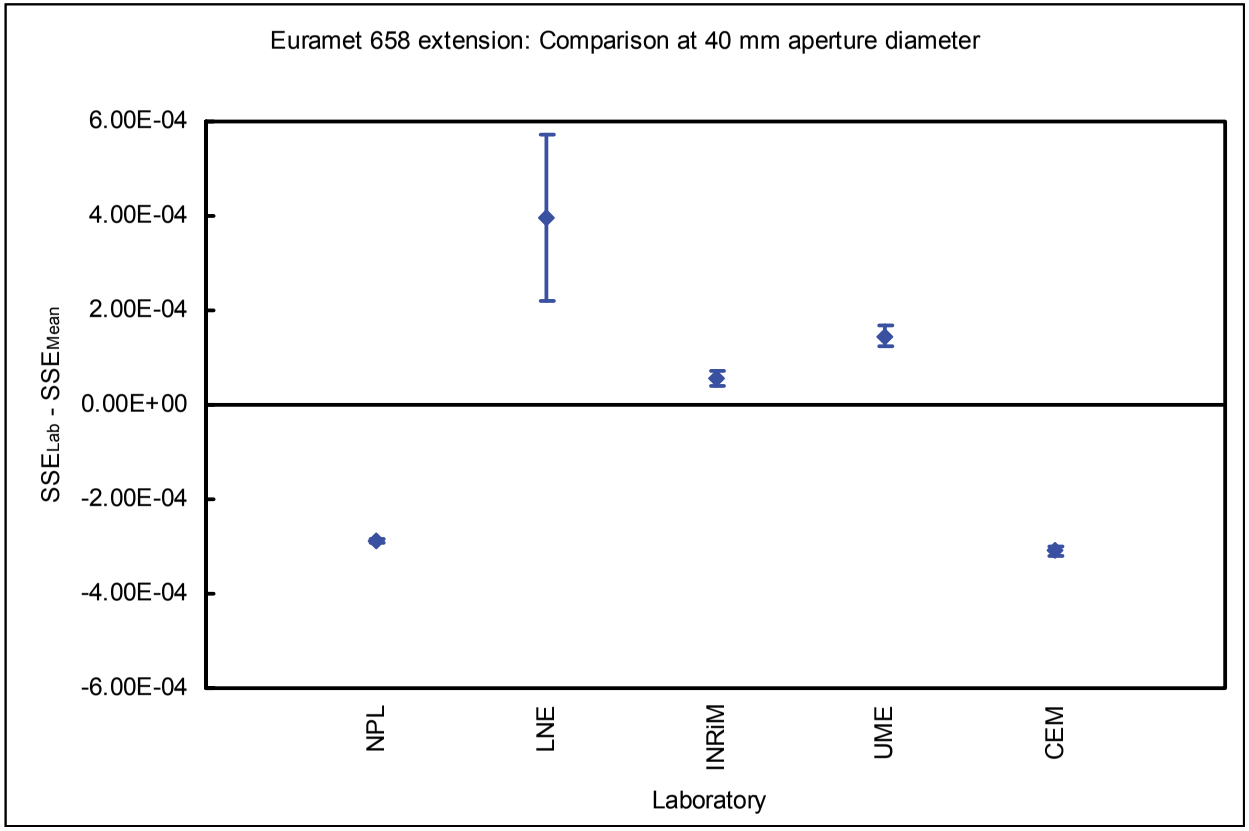
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000431 ± 2.334E-04	-0.000252 ± 1.260E-05	-0.000283 ± 2.282E-05	0.000012 ± 1.119E-05
LNE	*0.000622*	-	0.000178 ± 2.337E-04	0.000147 ± 2.345E-04	0.000442 ± 2.336E-04
INRiM	*0.000262*	*0.000371*	-	-0.000031 ± 2.576E-05	0.000264 ± 1.638E-05
UME	*0.000302*	*0.000340*	*0.000052*	-	0.000295 ± 2.510E-05
CEM	*0.000021*	*0.000634*	*0.000277*	*0.000316*	-

Table 178 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 30 mm diameter aperture



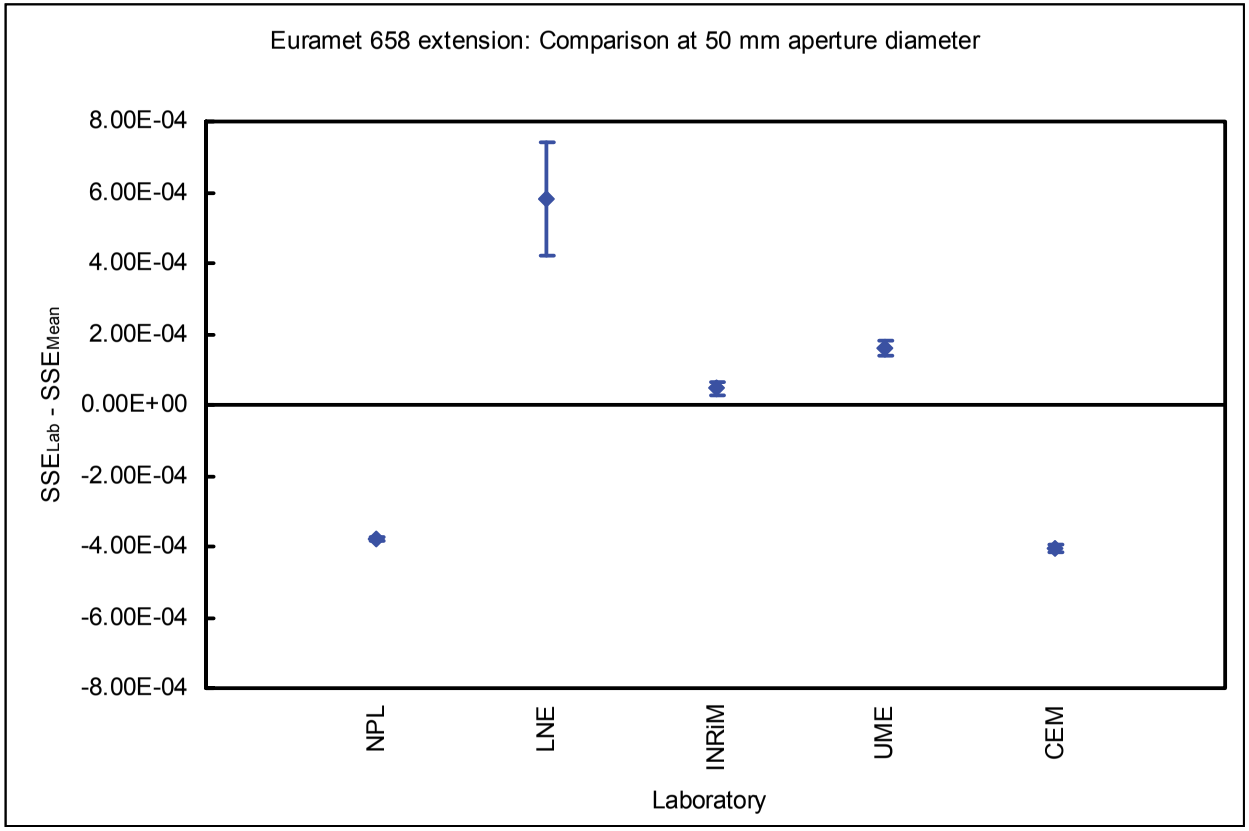
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000685 ± 1.762E-04	-0.000342 ± 1.591E-05	-0.000433 ± 2.314E-05	0.000021 ± 1.120E-05
LNE	*0.000830*	-	0.000342 ± 1.768E-04	0.000252 ± 1.776E-04	0.000706 ± 1.765E-04
INRiM	*0.000355*	*0.000488*	-	-0.000091 ± 2.779E-05	0.000364 ± 1.904E-05
UME	*0.000452*	*0.000398*	*0.000114*	-	0.000454 ± 2.539E-05
CEM	*0.000031*	*0.000851*	*0.000379*	*0.000475*	-

Table 179 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 40 mm diameter aperture



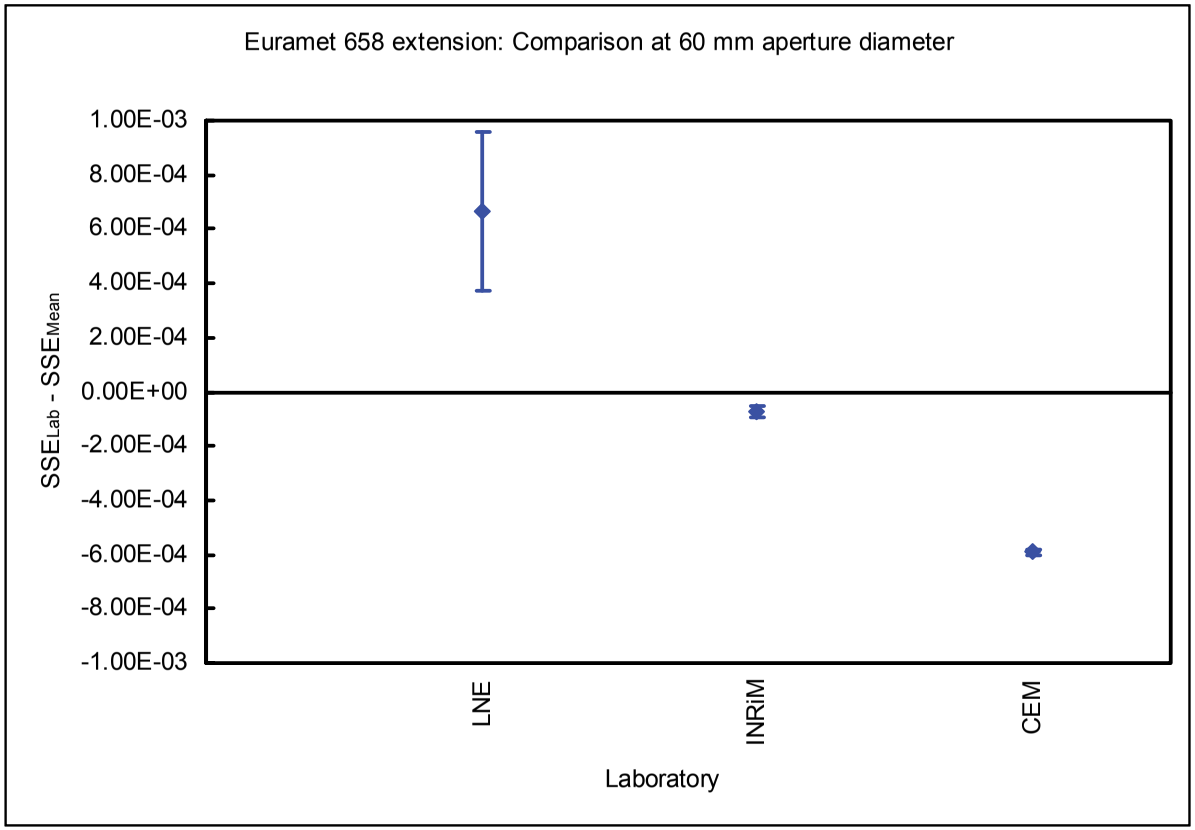
	NPL	LNE	INRiM	UME	CEM
NPL	-	-0.000959 ± 1.590E-04	-0.000424 ± 1.909E-05	-0.000539 ± 2.314E-05	0.000028 ± 1.123E-05
LNE	*0.001090*	-	0.000535 ± 1.601E-04	0.000420 ± 1.606E-04	0.000987 ± 1.593E-04
INRiM	*0.000440*	*0.000666*	-	-0.000115 ± 2.973E-05	0.000453 ± 2.179E-05
UME	*0.000558*	*0.000552*	*0.000139*	-	0.000568 ± 2.540E-05
CEM	*0.000038*	*0.001118*	*0.000470*	*0.000588*	-

Table 180 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 50 mm diameter aperture



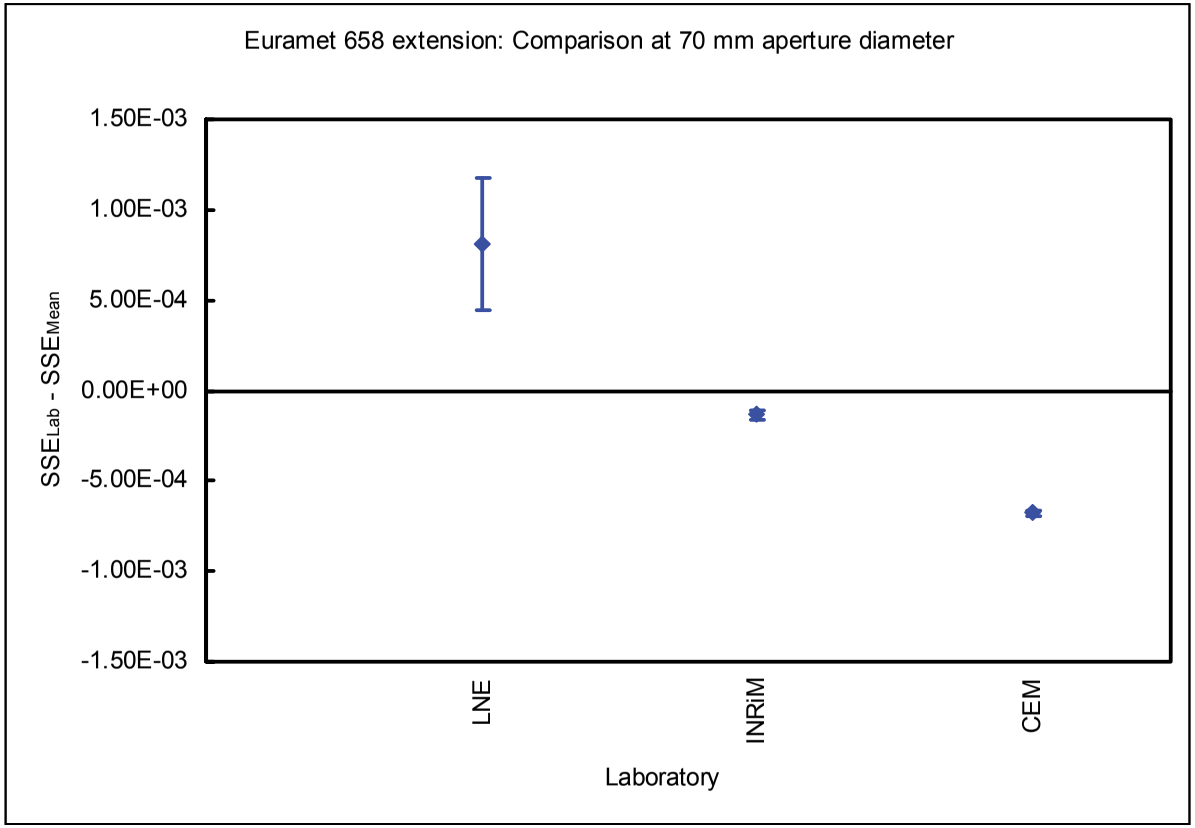
	LNE	INRiM	CEM
LNE	-	0.000740 ± 2.931E-04	0.001255 ± 2.925E-04
INRiM	*0.000981*	-	0.000515 ± 2.488E-05
CEM	*0.001495*	*0.000535*	-

Table 181 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 60 mm diameter aperture



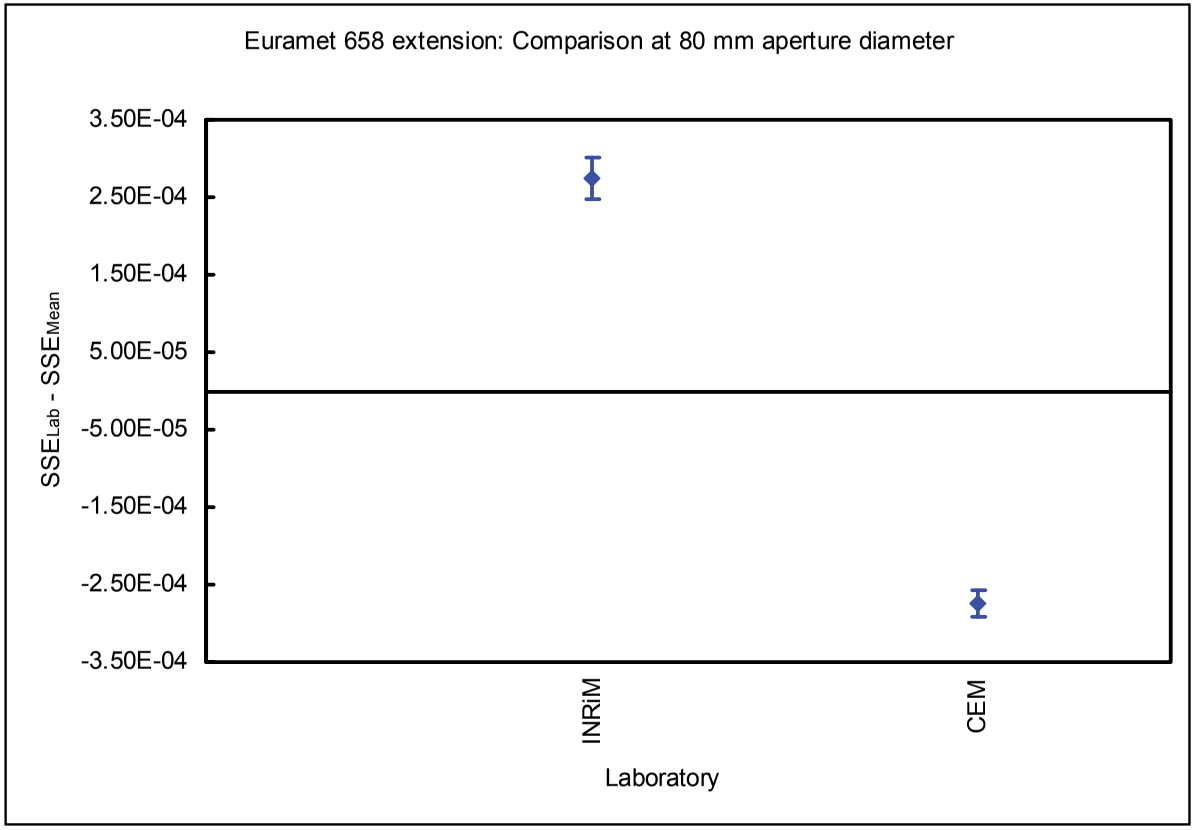
	LNE	INRiM	CEM
LNE	-	0.000944 ± 3.713E-04	0.001487 ± 3.707E-04
INRiM	*0.001250*	-	0.000542 ± 2.841E-05
CEM	*0.001792*	*0.000566*	-

Table 182 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 70 mm diameter aperture



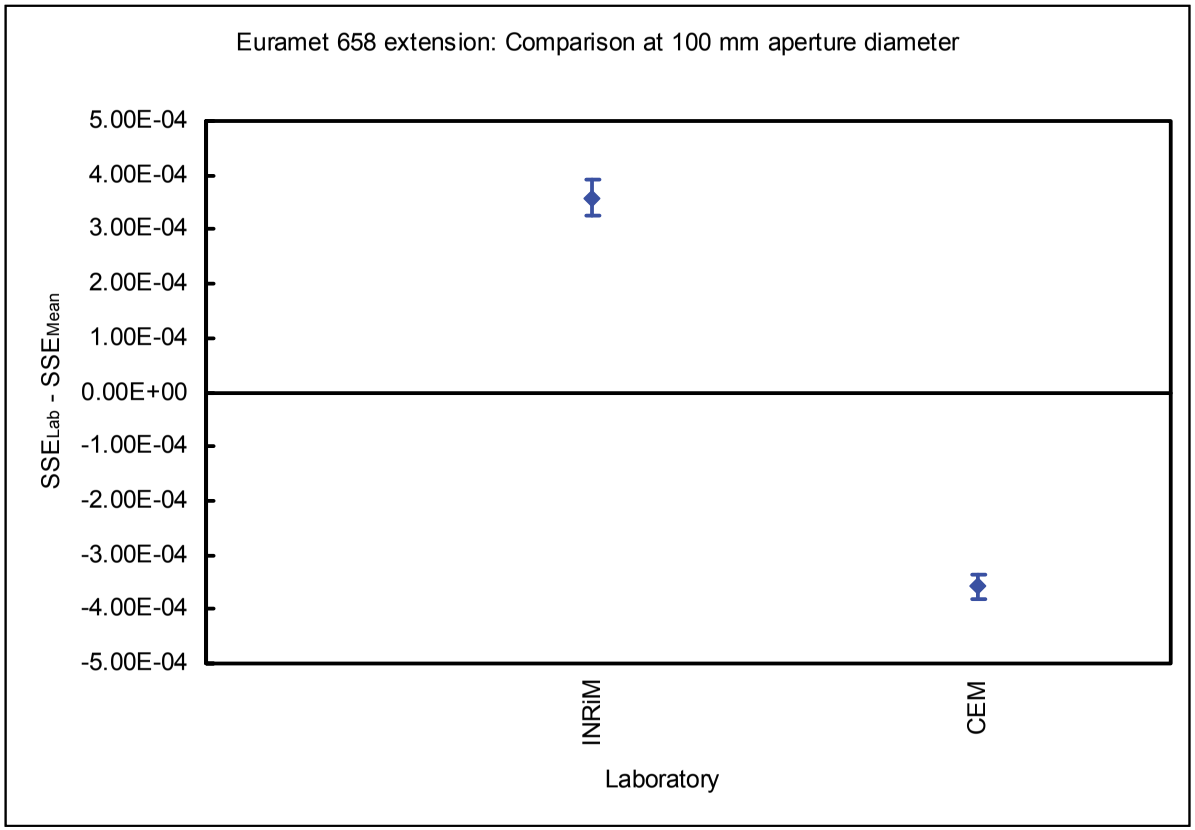
	INRiM	CEM
INRiM	-	0.000548 ± 3.209E-05
CEM	*0.000575*	-

Table 183 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	0.000716 ± 3.942E-05
CEM	*0.000748*	-

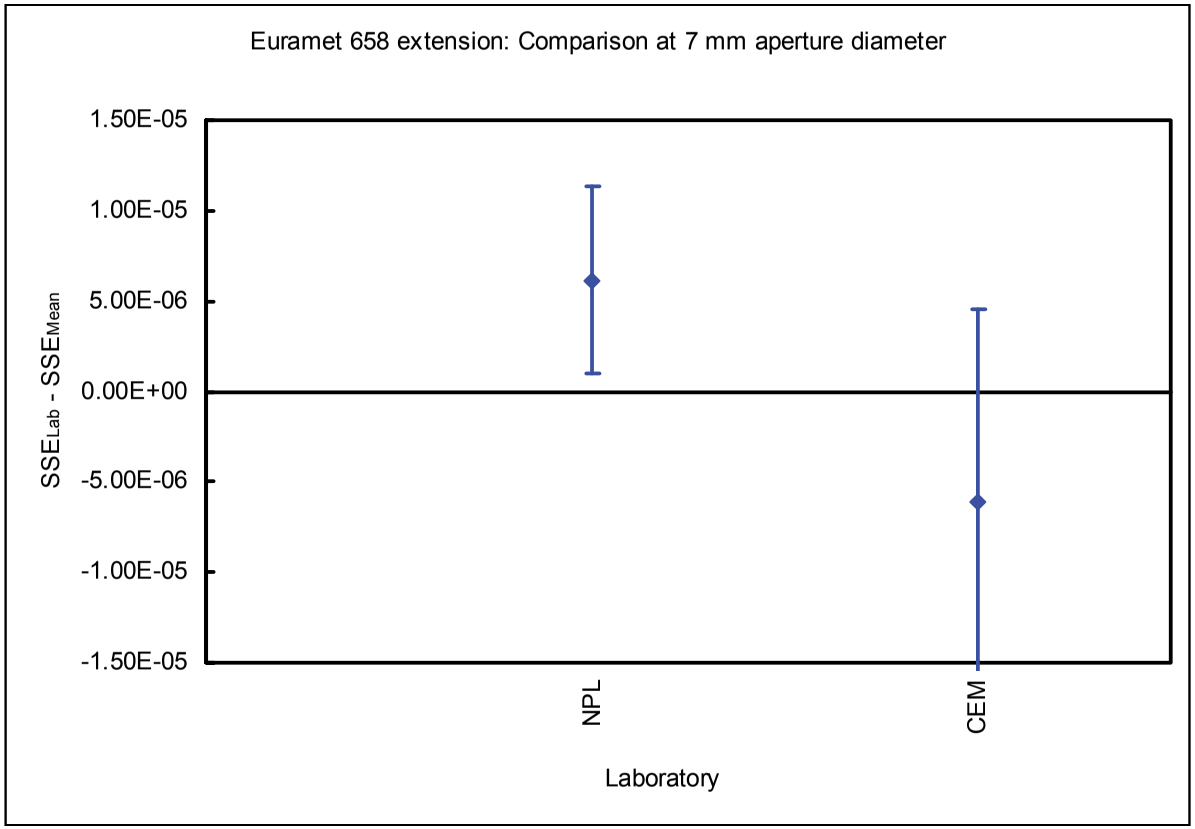
Table 184 – comparison of indirect SSE measurements with the LP5 thermometer with 6 mm diameter spot and 100 mm diameter aperture



1.8.8 The LP5 thermometer ‘indirect’ SSE results – 6 mm spot, excl. LNE

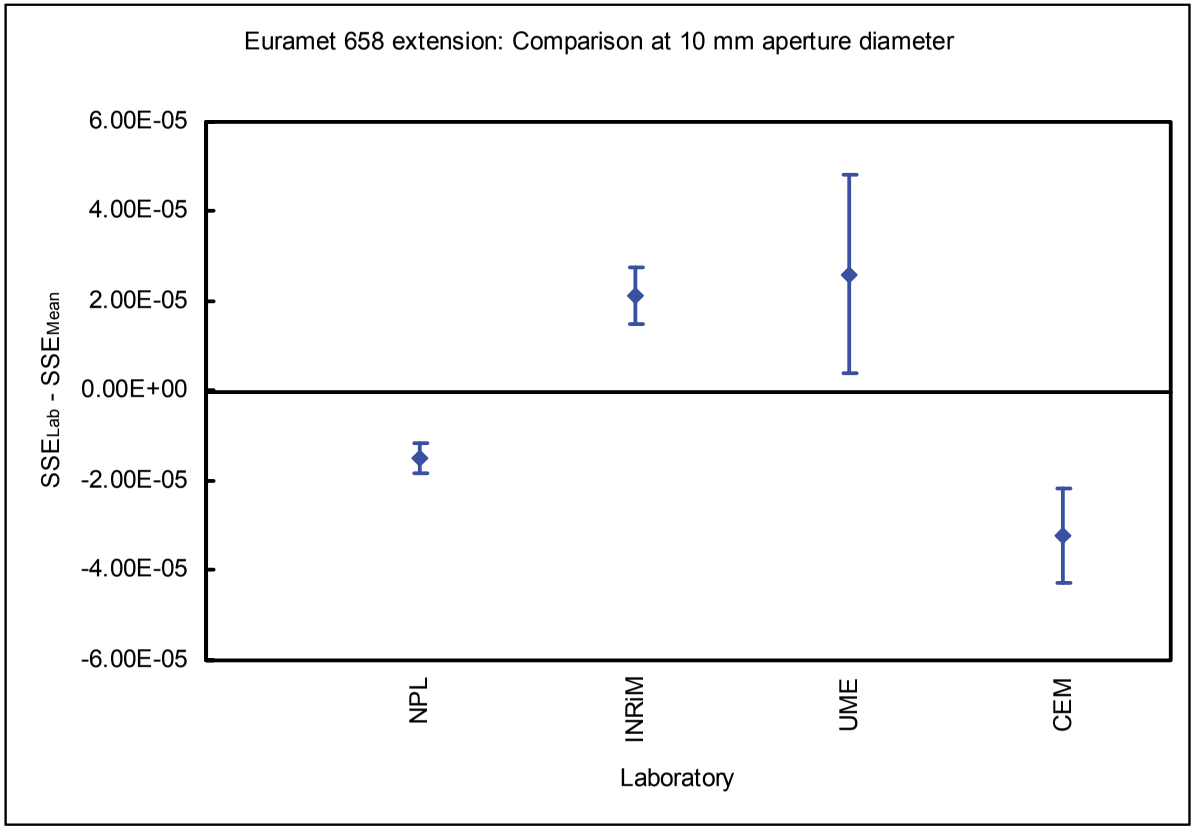
	NPL	CEM
NPL	-	0.000012 ± 1.186E-05
CEM	*0.000022*	-

Table 185 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 7 mm diameter aperture



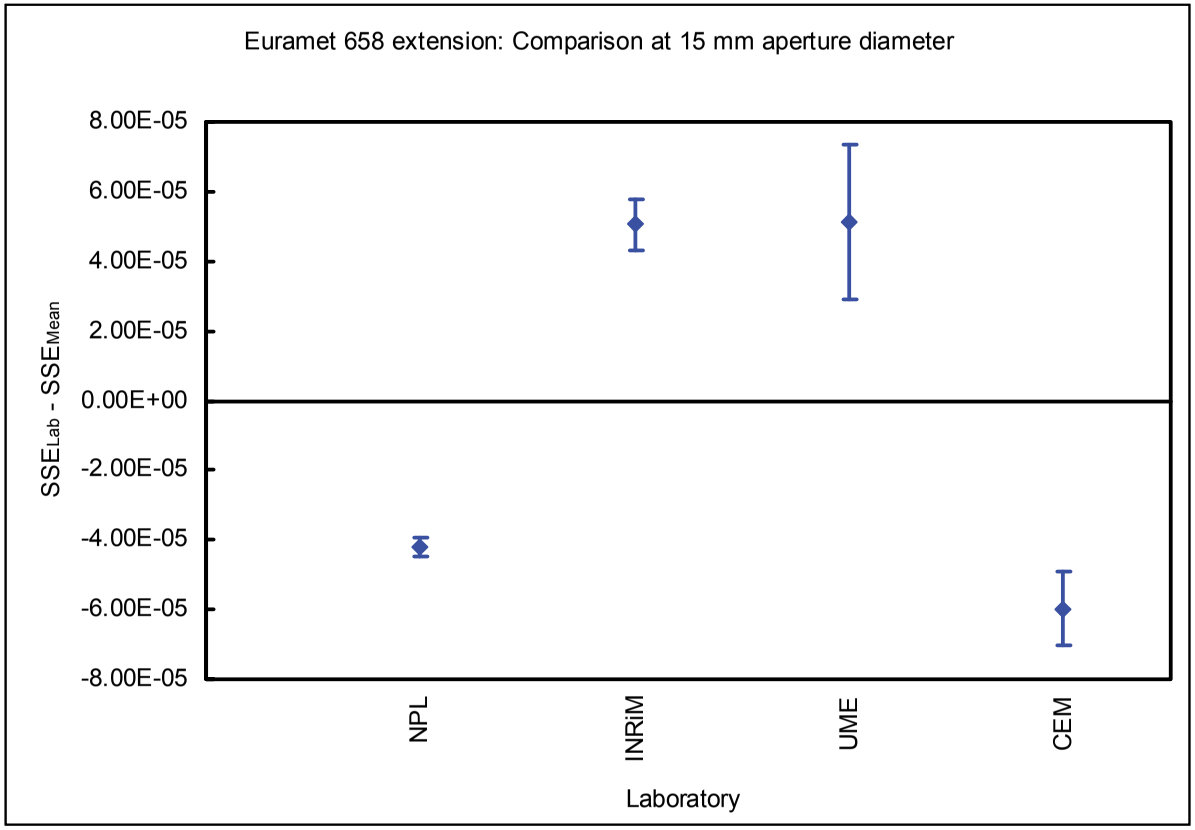
	NPL	INRiM	UME	CEM
NPL	-	-0.000036 ± 7.165E-06	-0.000041 ± 2.242E-05	0.000017 ± 1.116E-05
INRiM	*0.000042*	-	-0.000005 ± 2.307E-05	0.000053 ± 1.241E-05
UME	*0.000059*	*0.000024*	-	0.000058 ± 2.460E-05
CEM	*0.000026*	*0.000064*	*0.000078*	-

Table 186 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 10 mm diameter aperture



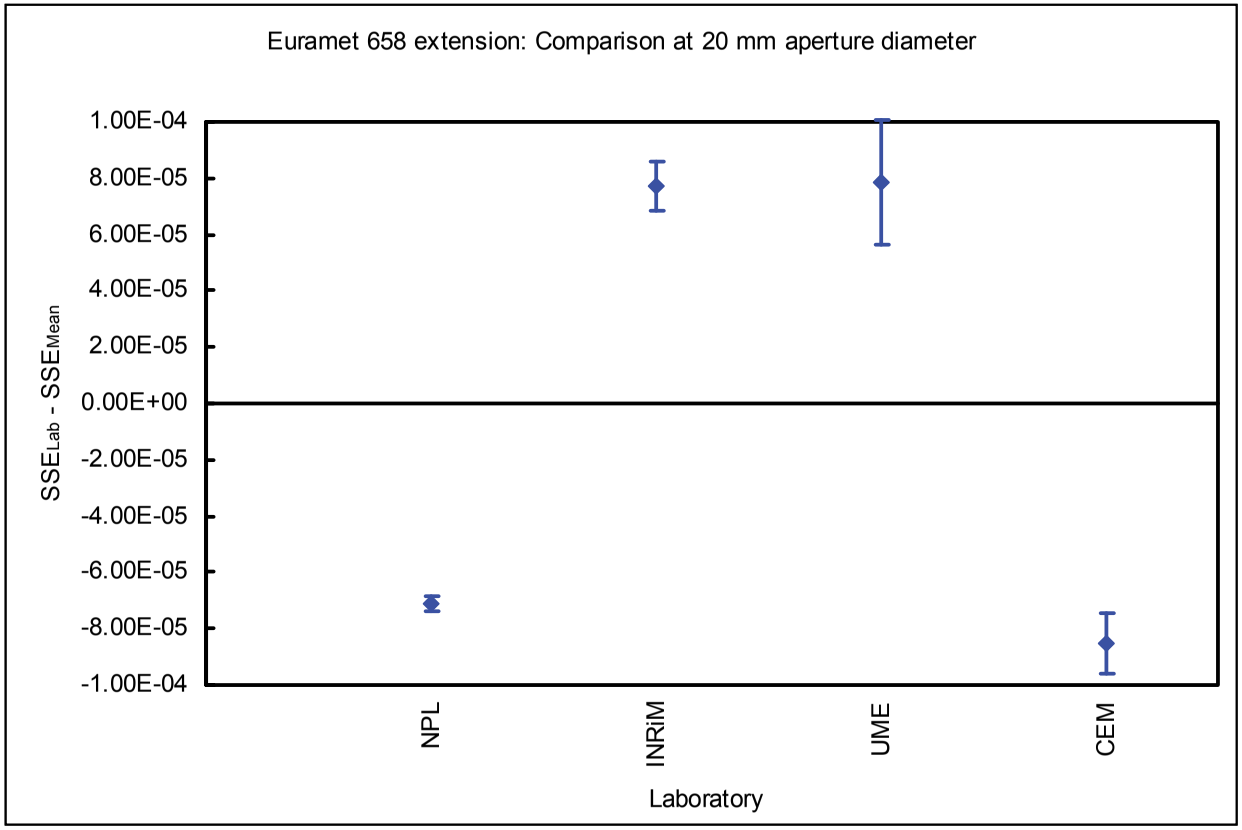
	NPL	INRiM	UME	CEM
NPL	-	-0.000093 ± 7.821E-06	-0.000094 ± 2.249E-05	0.000018 ± 1.100E-05
INRiM	*0.000099*	-	-0.000001 ± 2.351E-05	0.000110 ± 1.296E-05
UME	*0.000112*	*0.000023*	-	0.000111 ± 2.475E-05
CEM	*0.000027*	*0.000121*	*0.000131*	-

Table 187 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 15 mm diameter aperture



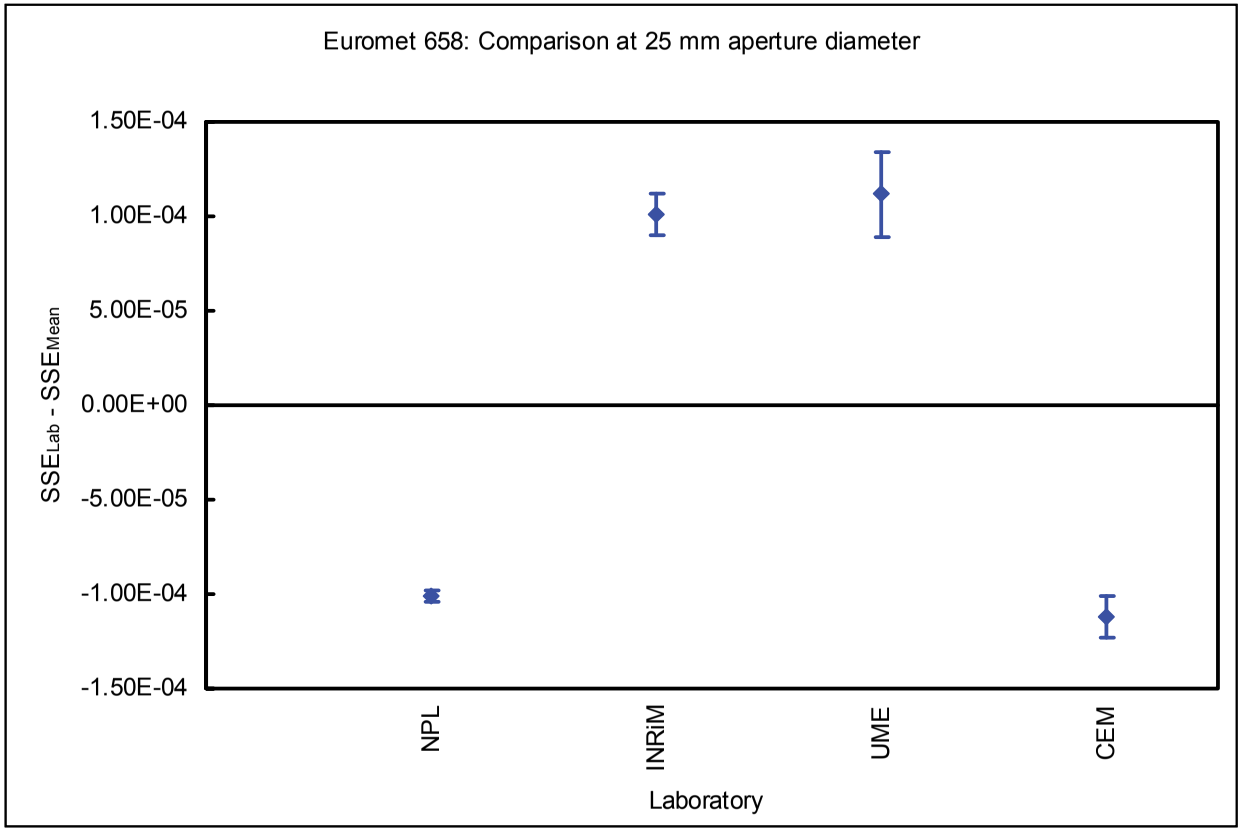
	NPL	INRiM	UME	CEM
NPL	-	-0.000149 ± 9.127E-06	-0.000150 ± 2.249E-05	0.000014 ± 1.110E-05
INRiM	*0.000156*	-	-0.000001 ± 2.398E-05	0.000162 ± 1.386E-05
UME	*0.000168*	*0.000024*	-	0.000164 ± 2.479E-05
CEM	*0.000023*	*0.000174*	*0.000184*	-

Table 188 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 20 mm diameter aperture



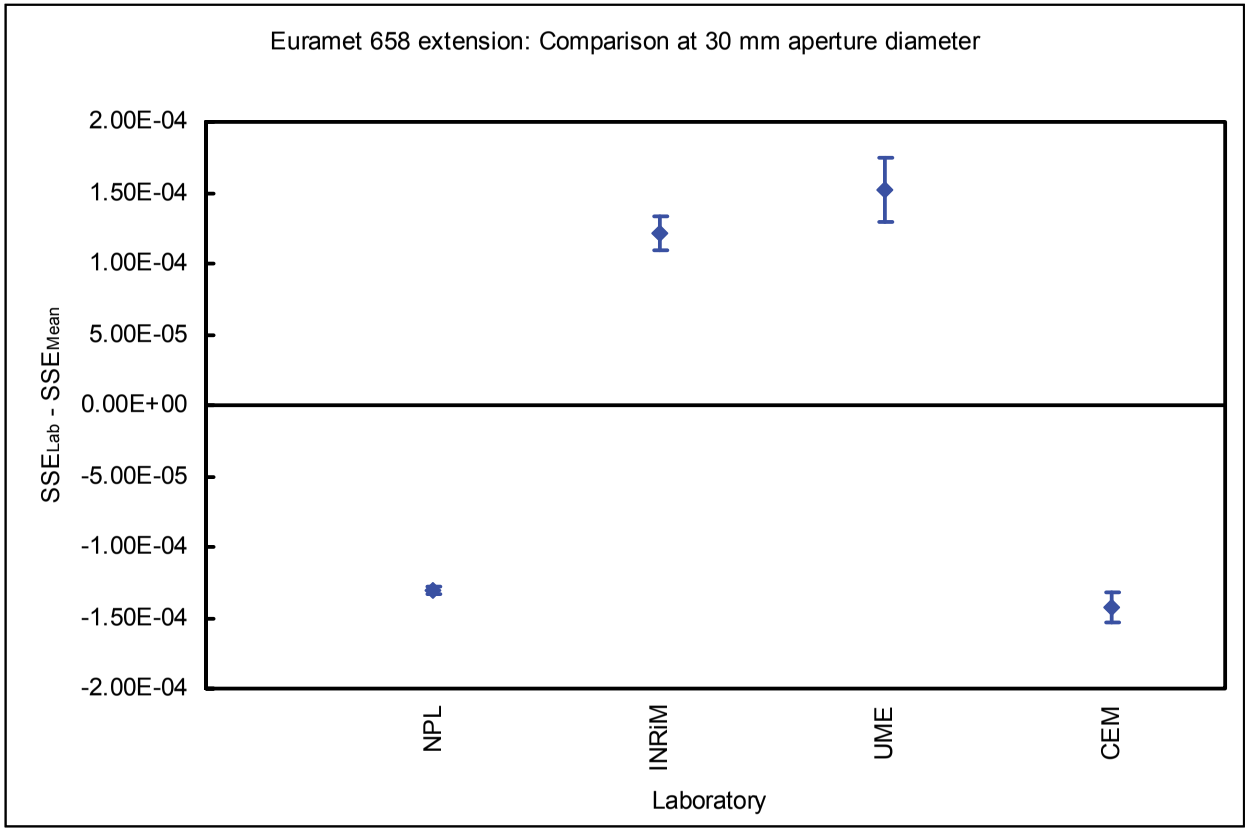
	NPL	INRiM	UME	CEM
NPL	-	-0.000202 ± 1.106E-05	-0.000213 ± 2.268E-05	0.000011 ± 1.123E-05
INRiM	*0.000211*	-	-0.000011 ± 2.489E-05	0.000213 ± 1.520E-05
UME	*0.000231*	*0.000031*	-	0.000224 ± 2.496E-05
CEM	*0.000020*	*0.000226*	*0.000244*	-

Table 189 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 25 mm diameter aperture



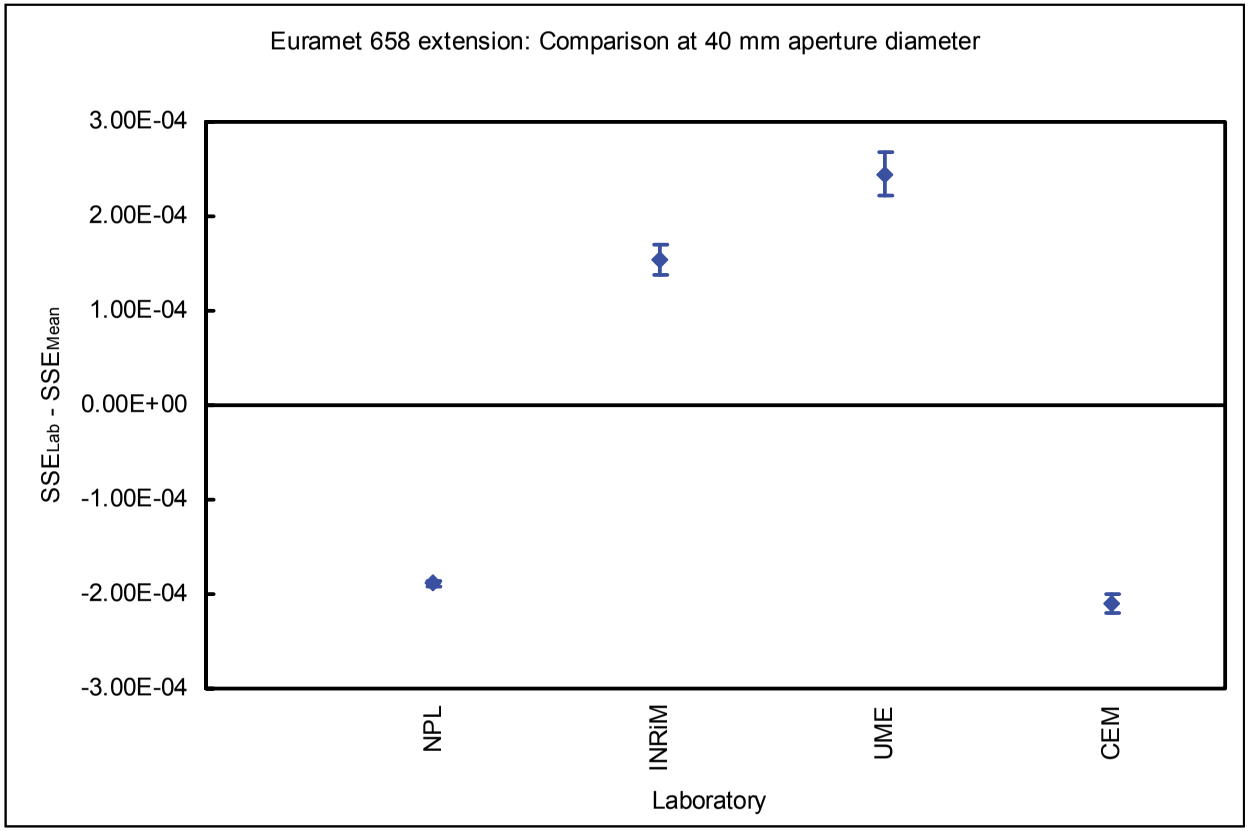
	NPL	INRiM	UME	CEM
NPL	-	-0.000252 ± 1.260E-05	-0.000283 ± 2.282E-05	0.000012 ± 1.119E-05
INRiM	*0.000262*	-	-0.000031 ± 2.576E-05	0.000264 ± 1.638E-05
UME	*0.000302*	*0.000052*	-	0.000295 ± 2.510E-05
CEM	*0.000021*	*0.000277*	*0.000316*	-

Table 190 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 30 mm diameter aperture



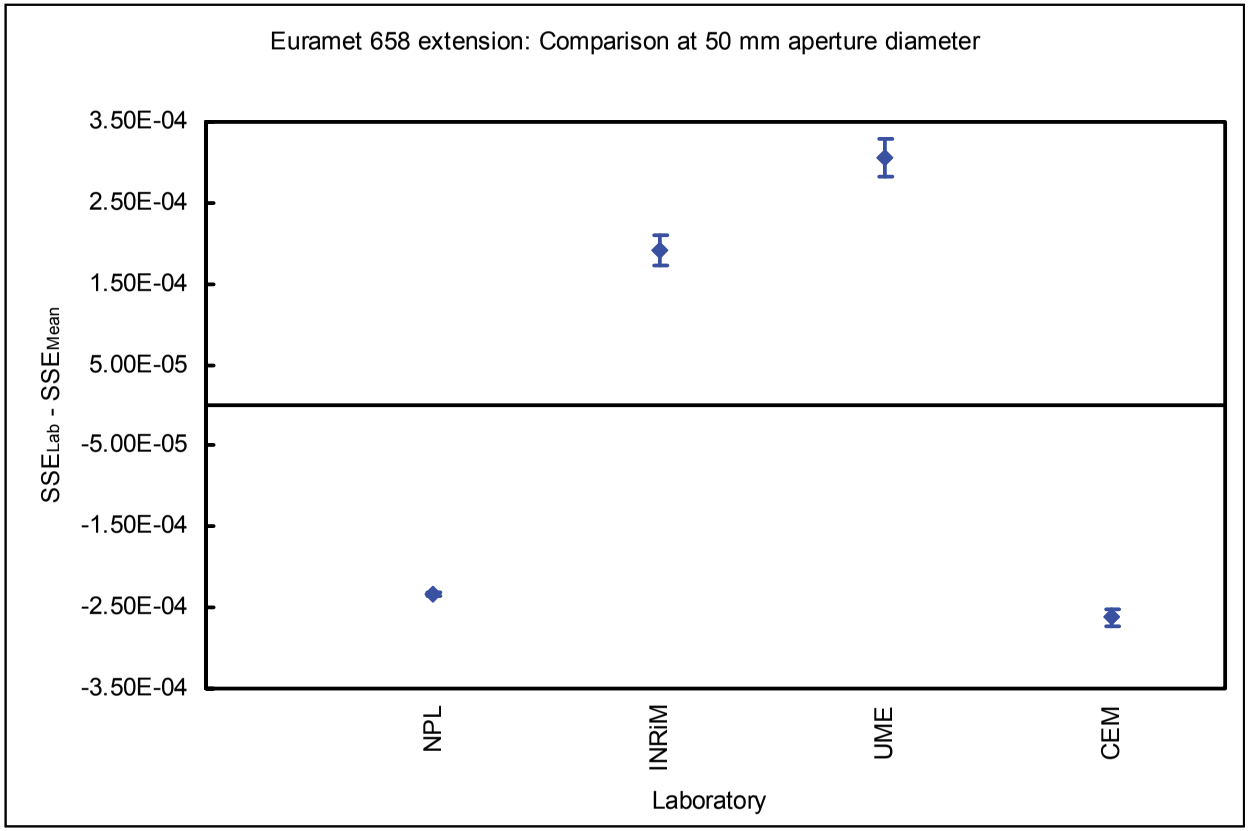
	NPL	INRiM	UME	CEM
NPL	-	-0.000342 ± 1.591E-05	-0.000433 ± 2.314E-05	0.000021 ± 1.120E-05
INRiM	*0.000355*	-	-0.000091 ± 2.779E-05	0.000364 ± 1.904E-05
UME	*0.000452*	*0.000114*	-	0.000454 ± 2.539E-05
CEM	*0.000031*	*0.000379*	*0.000475*	-

Table 191 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 40 mm diameter aperture



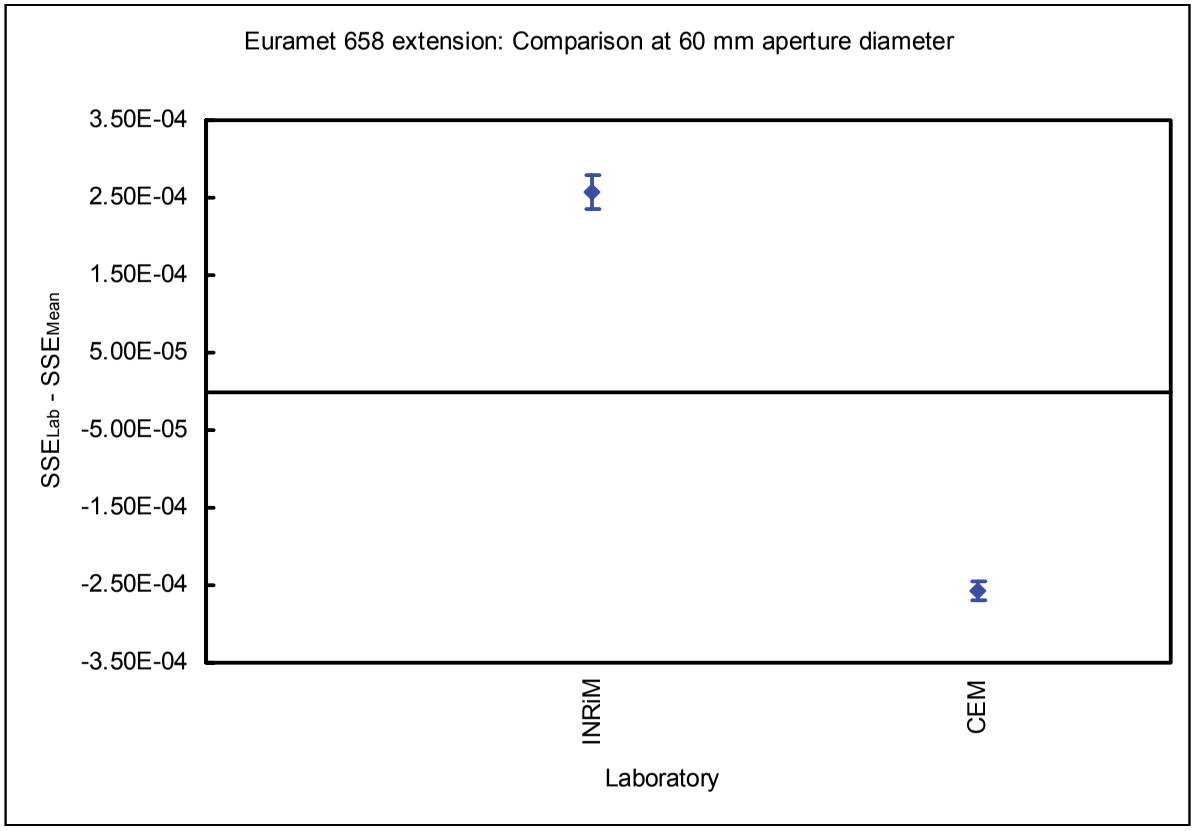
	NPL	INRiM	UME	CEM
NPL	-	-0.000424 ± 1.909E-05	-0.000539 ± 2.314E-05	0.000028 ± 1.123E-05
INRiM	*0.000440*	-	-0.000115 ± 2.973E-05	0.000453 ± 2.179E-05
UME	*0.000558*	*0.000139*	-	0.000568 ± 2.540E-05
CEM	*0.000038*	*0.000470*	*0.000588*	-

Table 192 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 50 mm diameter aperture



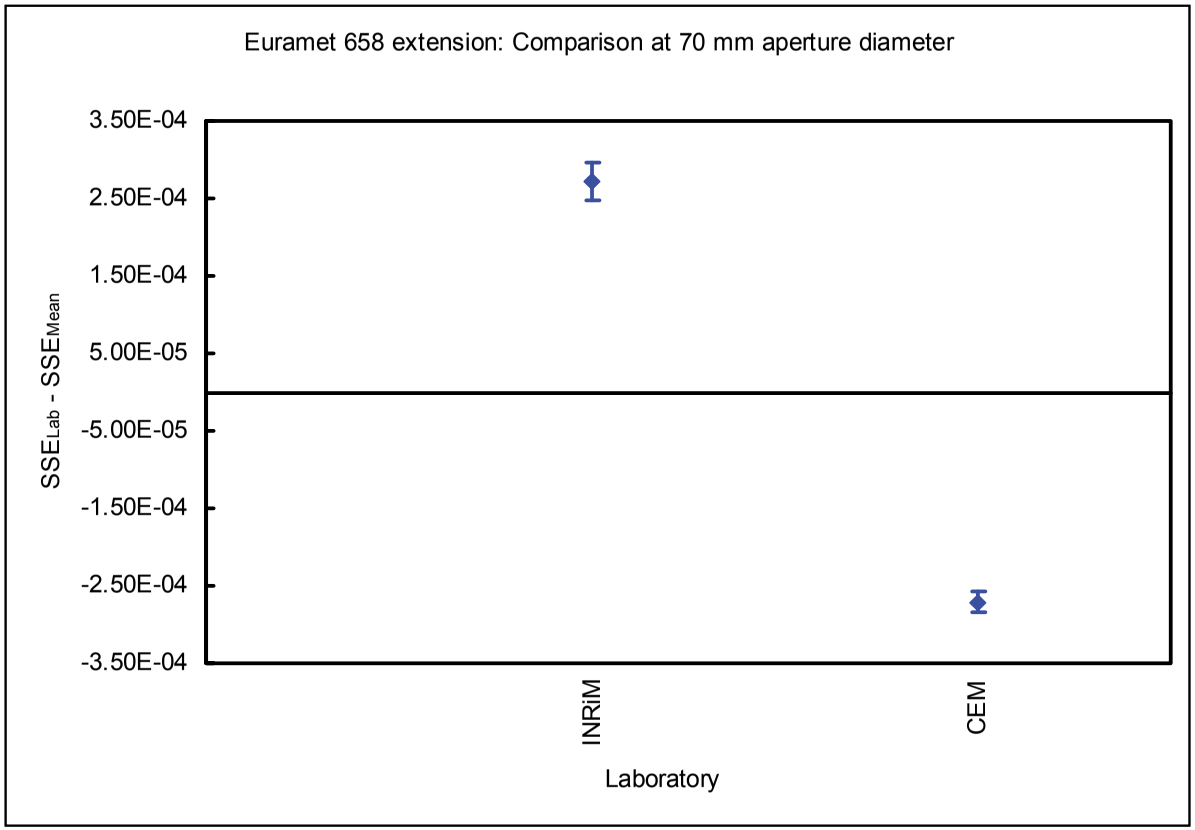
	INRiM	CEM
INRiM	-	0.000515 ± 2.488E-05
CEM	*0.000535*	-

Table 193 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 60 mm diameter aperture



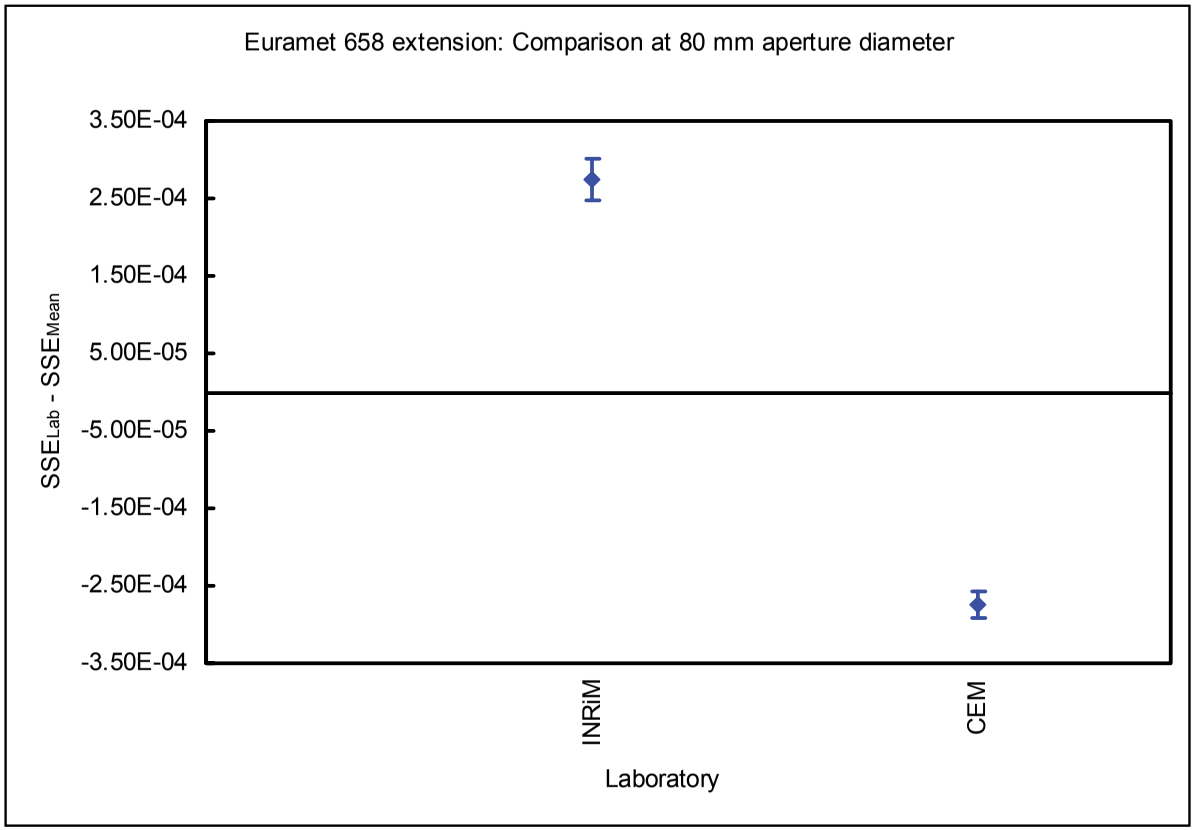
	INRiM	CEM
INRiM	-	0.000542 ± 2.841E-05
CEM	*0.000566*	-

Table 194 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 70 mm diameter aperture



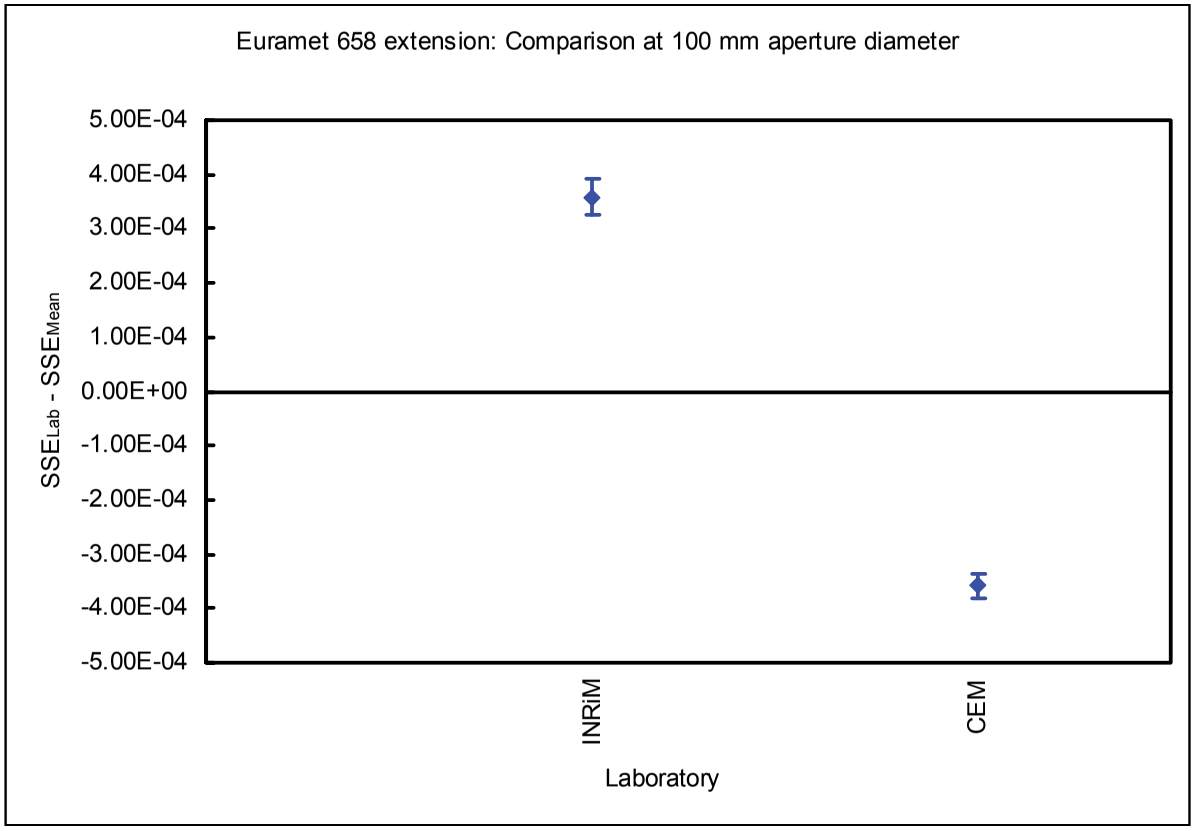
	INRiM	CEM
INRiM	-	0.000548 ± 3.209E-05
CEM	*0.000575*	-

Table 195 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 80 mm diameter aperture



	INRiM	CEM
INRiM	-	0.000716 ± 3.942E-05
CEM	*0.000748*	-

Table 196 – comparison of indirect SSE measurements with the LP5 thermometer, excluding LNE data - 6 mm diameter spot and 100 mm diameter aperture



2 THE GAIN RATIO MEASUREMENTS

2.1 APPARATUS USED FOR GAIN RATIO MEASUREMENTS

The results of the measurements of the gain and range ratios of the two thermometers are given in Tables 197 to 203. The majority of the laboratories measured the gain ratios using a stable reference blackbody source set at appropriate temperatures. The INRiM measurements were made using a high stability tungsten ribbon lamp and/or an integrating sphere with suitable neutral filters mounted on the front of the objective of the thermometers.

2.2 RESULTS OF THE MEASUREMENTS

2.2.1 The results for the LP5 thermometer

Laboratory	Nominal source temperature/ °C	Range ratio R2/ R1	Uncertainty (*k=2*)
PTB	420	0.999822†	1 E^{-13} A
PTB	600	1.000063	8 E^{-14} A
NPL	500	1.000352	0.000204
CEM	400 to 600	1.000452	0.00106
UME	232	0.982026	0.083850
UME	250	0.997150	0.031816
LNE	600	0.009907*	0.018392
METAS	420	1.000552	0.00105 °C
INRiM	N/A	1.001268	0.000094

Table 197: the results of the range ratio measurements with the LP5 thermometer

† This is the average of two values
*The LNE value was measured using the LP5 analogue output (voltage) rather than the photocurrent, and is not consistent with the other values. It has therefore not been included in the subsequent analysis. (This only affects the range ratio measurements; the other measurements were carried out using the photocurrent.)

2.2.2 The results for the INRiM thermometer

CEM calculated the gain ratios by converting the thermometer signals from voltage to current using the value of the amplifier gain setting, leading to gain ratios of ~1.0. In order to compare the CEM results with those of the other laboratories, the values have been re-calculated by converting the signals back to the 'raw' voltage values. The CEM values in square brackets are the original values.

Laboratory	INRiM gain ratio $x10^{10}$/ $x10^{9}$	Uncertainty (*k=2*)
PTB	9.21948	0.00080
NPL	9.21781	0.00303
CEM	[0.92143] 9.21425	[0.02401] 0.24014
UME	9.21615	0.02642
LNE	-	-
METAS	9.22504	0.00105 °C
INRiM	-	-

Table 198: the results of the gain ratio measurements for the INRiM thermometer ($x10^{10}$/ $x10^{9}$ gains)

Laboratory	INRiM gain ratio $x10^9$/ $x10^8$	Uncertainty (*k=2*)
PTB	10.89522	0.00090
NPL	10.88970	0.00615
CEM	[1.08874] 10.88744	[0.00128] 0.1278
UME	10.88964	0.00071
LNE	-	-
METAS	10.89079	0.00105 °C
INRiM	10.88963	0.00102

Table 199: the results of the gain ratio measurements for the INRiM thermometer ($x10^9$/ $x10^8$ gains)

Laboratory	INRiM gain ratio $x10^8$/ $x10^7$	Uncertainty (*k=2*)
PTB	10.05744	0.00001
NPL	10.05739	0.00137
CEM	[1.00575] 10.05747	[0.00014] 0.00137
UME	-	-
LNE	10.06362	0.00302
METAS	-	-
INRiM	10.05765	0.00095

Table 200: the results of the gain ratio measurements for the INRiM thermometer ($x10^8$/ $x10^7$ gains)

Laboratory	INRiM gain ratio $x10^7$/ $x10^6$	Uncertainty (*k=2*)
PTB	9.99478	0.00002
NPL	9.99382	0.00097
CEM	[0.99948] 9.99482	[0.00020] 0.00203
UME	9.99496	0.00095
LNE	9.99980	0.00127
METAS	9.99241	0.00105 °C
INRiM	9.99524	0.00094

Table 201: the results of the gain ratio measurements for the INRiM thermometer ($x10^7$/ $x10^6$ gains)

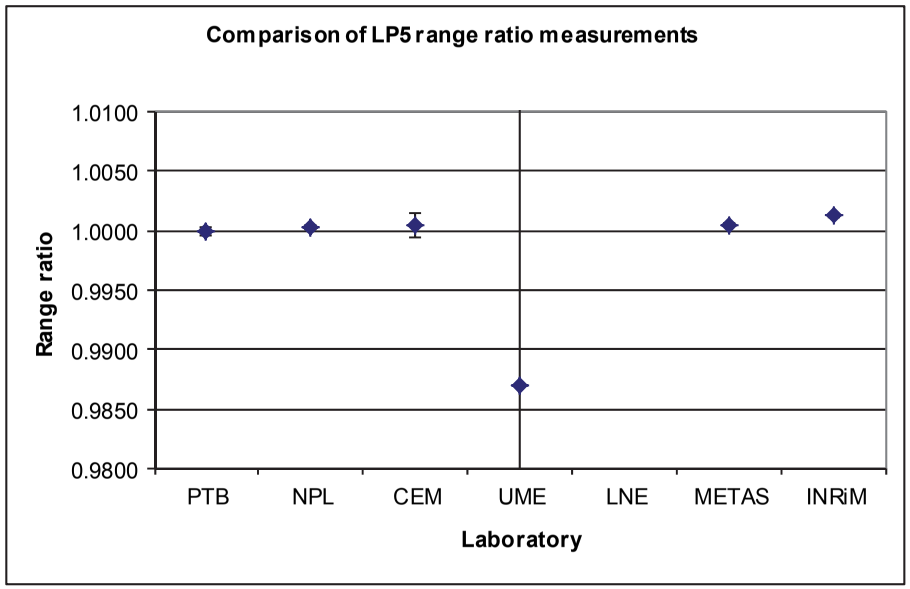
Laboratory	INRiM gain ratio $x10^6$/ $x10^5$	Uncertainty (*k=2*)
PTB	10.00859	0.00002
NPL	10.00861	0.00053
CEM	[1.00034] 10.00335	[0.00010] 0.00097
UME	9.97569	0.00721
LNE	10.00582	0.00080
METAS	10.00498	0.00105 °C
INRiM	10.00430	0.00094

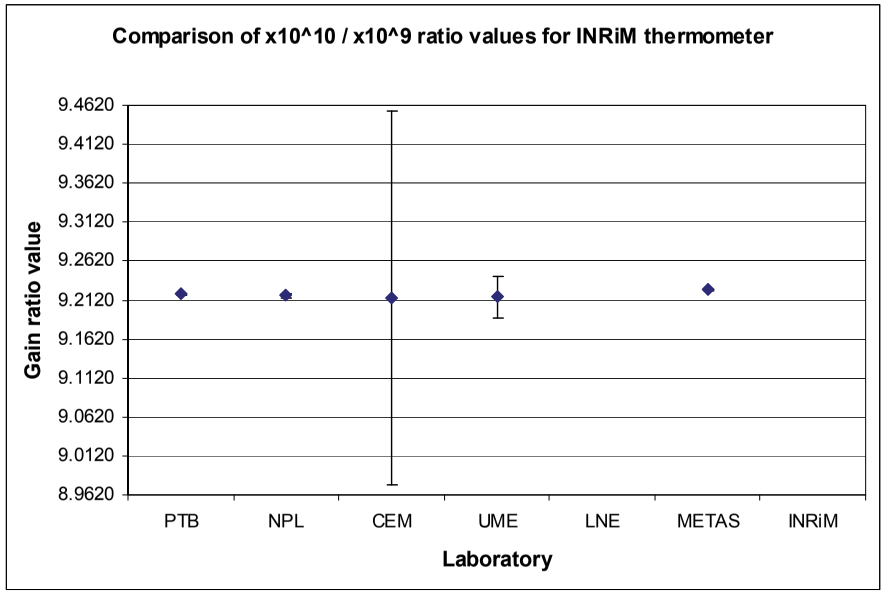
Table 202: the results of the gain ratio measurements for the INRiM thermometer ($x10^6$/ $x10^5$ gains)

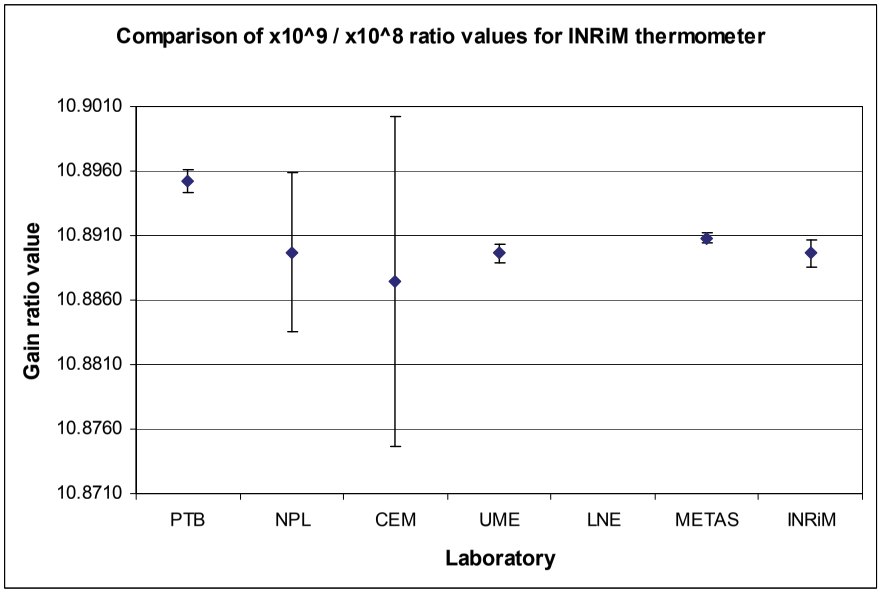
Laboratory	INRiM gain ratio x10^5/ x10^4	Uncertainty (*k=2*)
PTB	9.89589	0.00003
NPL	9.89421	0.00049
CEM	[0.98984] 9.89844	[0.00020] 0.00199
UME	9.87689	0.20126
LNE	-	-
METAS	9.89060	0.00105 °C
INRiM	-	-

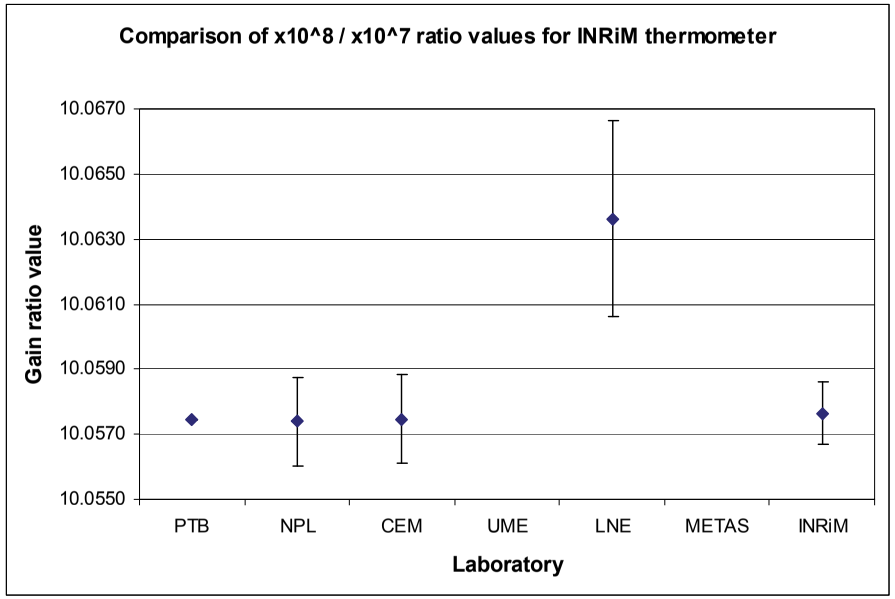
Table 203: the results of the gain ratio measurements for the INRiM thermometer (x10^5/ x10^4 gains)

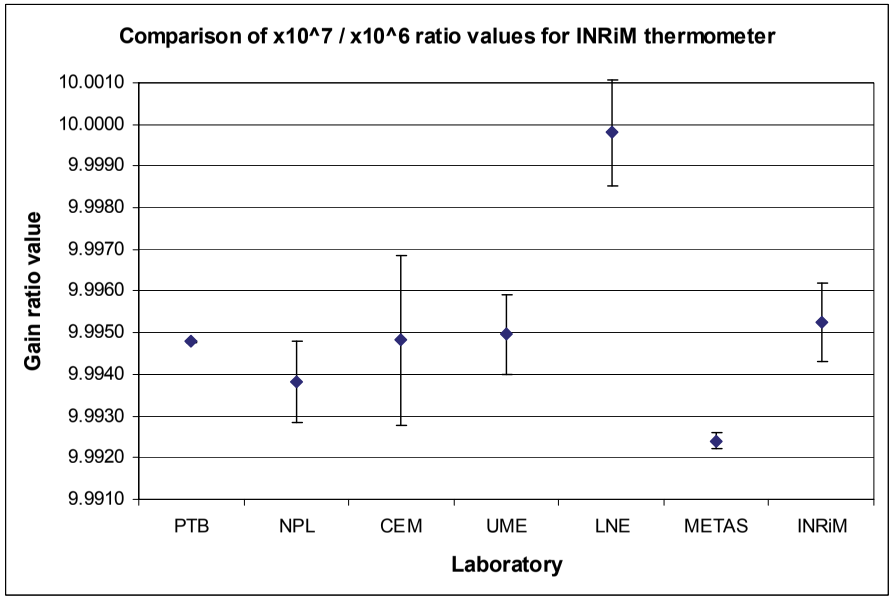
The results are plotted graphically in the seven Figures below, along with the $k = 2$ uncertainty bars. Where the gain/ range ratio uncertainty was given in terms of a different unit (for example, the METAS uncertainties were given in terms of an equivalent temperature uncertainty) the values were converted to be in terms of the gain/ range ratio value, so that all the results could be plotted and compared consistently.

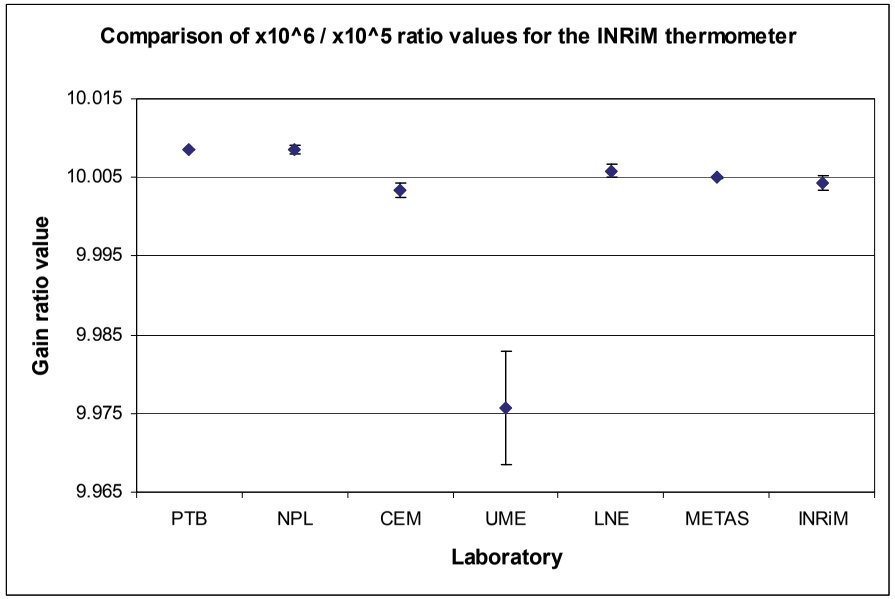

Comparison of LP5 range ratio measurements
Range ratio
1.0100
1.0050
1.0000
0.9950
0.9900
0.9850
0.9800
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

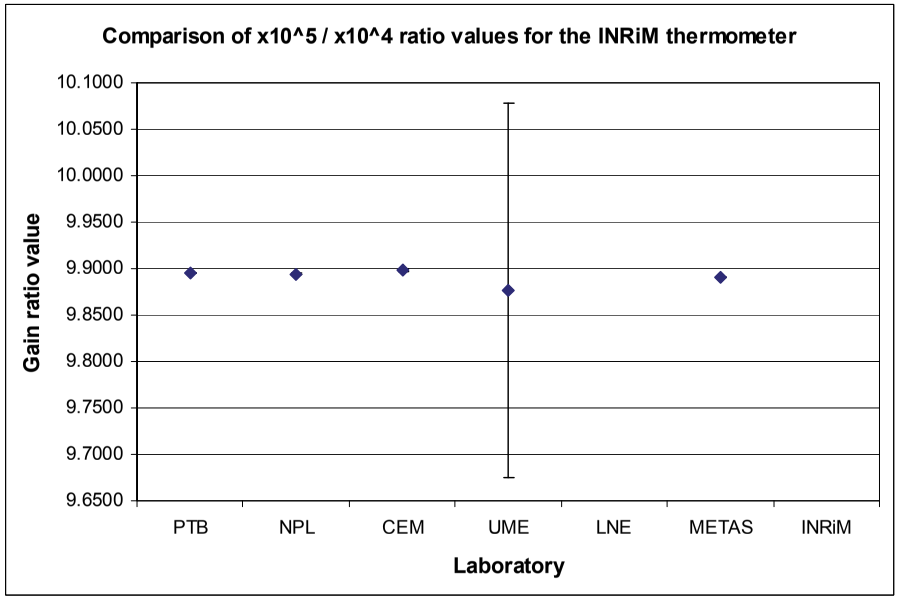

Comparison of x10^10 / x10^9 ratio values for INRiM thermometer
Gain ratio value
9.4620
9.4120
9.3620
9.3120
9.2620
9.2120
9.1620
9.1120
9.0620
9.0120
8.9620
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^9 / x10^8 ratio values for INRiM thermometer
Gain ratio value
10.9010
10.8960
10.8910
10.8860
10.8810
10.8760
10.8710
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^8 / x10^7 ratio values for INRiM thermometer
Gain ratio value
10.0670
10.0650
10.0630
10.0610
10.0590
10.0570
10.0550
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^7 / x10^6 ratio values for INRiM thermometer
Gain ratio value
10.0010
10.0000
9.9990
9.9980
9.9970
9.9960
9.9950
9.9940
9.9930
9.9920
9.9910
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^6 / x10^5 ratio values for the INRiM thermometer
Gain ratio value
10.015
10.005
9.995
9.985
9.975
9.965
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^5 / x10^4 ratio values for the INRiM thermometer
Gain ratio value
10.1000
10.0500
10.0000
9.9500
9.9000
9.8500
9.8000
9.7500
9.7000
9.6500
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

2.3 ANALYSIS OF THE GAIN RATIO RESULTS

For the LP5 thermometer, when a laboratory had provided two or more values for the range ratio, measured at different source temperatures, the average value for that laboratory was calculated.

The mean and median values of the participant results were then calculated for each of the measured gain or range ratios. As was noted previously, the LNE result for the LP5 was not consistent with those of the other laboratories, due to it having been measured using the analogue (voltage) signal rather than the photocurrent, and so it has not been included in any of the analysis.

Summaries of the mean and median values are given in Tables 204 to 210 below, along with the difference (laboratory – mean or median). The differences are also plotted in the Figures following Table 210. Two uncertainty values (k = 2) are given: the first is the laboratory uncertainty; the other is the laboratory uncertainty combined with the standard deviation (stdev) of the mean (i.e. the standard deviation divided by √(number of measurements)).

It was felt to be inappropriate to analyse the results further by calculating the DOE and QDE_{95} values.

2.3.1 Average results for the LP5

Laboratory	R2/R1	Diff from mean	Diff from median	Laboratory		U (k=2) with stdev of mean of all results
				u (k=1)	U (k=2)	
PTB	0.999902*	0.001645	-0.000500	0.000169	0.000337*	0.004523
NPL	1.000352	0.002095	-0.000050	0.000102	0.000204	0.004515
CEM	1.000452	0.002195	0.000050	0.000530	0.001060	0.004634
UME	0.987016*	-0.011241	-0.013386	0.021888	0.043776*	0.044008
LNE	0.009907	-0.988350	-0.990495		0.018392	
METAS	1.000552	0.002295	0.000150	0.000011	0.000022	0.004511
INRiM	1.001268	0.003011	0.000866	0.000047	0.000094	0.004512
Average	**0.998257**					
Stdev	**0.005525**					
/√(n)	**0.002255**					
Median	**1.000402**					

Table 204: the differences from the mean and median for the LP5 range ratio results

* average values calculated. The total laboratory uncertainty includes the stated laboratory uncertainty plus additional uncertainty for the standard deviation of the mean laboratory value.

2.3.2 Average results for the INRiM thermometer

Laboratory	10^10/10^9	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	9.21948	0.00094	0.00167	0.00040	0.00080	0.00377
NPL	9.21781	-0.00073	0.00000	0.00152	0.00303	0.00477
CEM	9.21425	-0.00430	-0.00356	0.12007	0.24014	0.24017
UME	9.21615	-0.00240	-0.00167	0.01321	0.02642	0.02668
LNE						
METAS	9.22504	0.00650	0.00723	0.00024	0.00047	0.00371
INRiM						
Average	**9.21855**					
Stdev	**0.00412**					
/√(n)	**0.00184**					
Median	**9.21781**					

Table 205: the differences from the mean and median for the INRiM x10^{10}/ x10^{9} gain ratio results

Laboratory	10^9/10^8	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	10.89522	0.00482	0.00555	0.00045	0.00090	0.00231
NPL	10.88970	-0.00070	0.00003	0.00308	0.00615	0.00651
CEM	10.88744	-0.00296	-0.00223	0.00639	0.01278	0.01295
UME	10.88964	-0.00076	-0.00003	0.00035	0.00071	0.00224
LNE						
METAS	10.89079	0.00039	0.00112	0.00020	0.00040	0.00216
INRiM	10.88963	-0.00077	-0.00004	0.00051	0.00102	0.00236
Average	**10.89040**					
Stdev	**0.00260**					
/√(n)	**0.00106**					
Median	**10.88967**					

Table 206: the differences from the mean and median for the INRiM x10^{9}/ x10^{8} gain ratio results

Laboratory	10^8/10^7	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	10.05744	-0.00127	-0.00003	0.00000	0.00001	0.00246
NPL	10.05739	-0.00133	-0.00008	0.00069	0.00137	0.00281
CEM	10.05747	-0.00125	0.00000	0.00068	0.00137	0.00281
UME						
LNE	10.06362	0.00491	0.00615	0.00151	0.00302	0.00389
METAS						
INRiM	10.05765	-0.00107	0.00018	0.00047	0.00095	0.00263
Average	**10.05872**					
Stdev	**0.00275**					
/√(n)	**0.00123**					
Median	**10.05747**					

Table 207: the differences from the mean and median for the INRiM x10^8/ x10^7 gain ratio results

Laboratory	10^7/10^6	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	9.99478	-0.00033	-0.00003	0.00001	0.00002	0.00172
NPL	9.99382	-0.00130	-0.00100	0.00049	0.00097	0.00198
CEM	9.99482	-0.00030	0.00000	0.00102	0.00203	0.00266
UME	9.99496	-0.00016	0.00014	0.00048	0.00095	0.00197
LNE	9.99980	0.00468	0.00498	0.00063	0.00127	0.00214
METAS	9.99241	-0.00271	-0.00241	0.00010	0.00020	0.00174
INRiM	9.99524	0.00012	0.00042	0.00047	0.00094	0.00196
Average	**9.99512**					
Stdev	**0.00228**					
/√(n)	**0.00086**					
Median	**9.99482**					

Table 208: the differences from the mean and median for the INRiM x10^7/ x10^6 gain ratio results

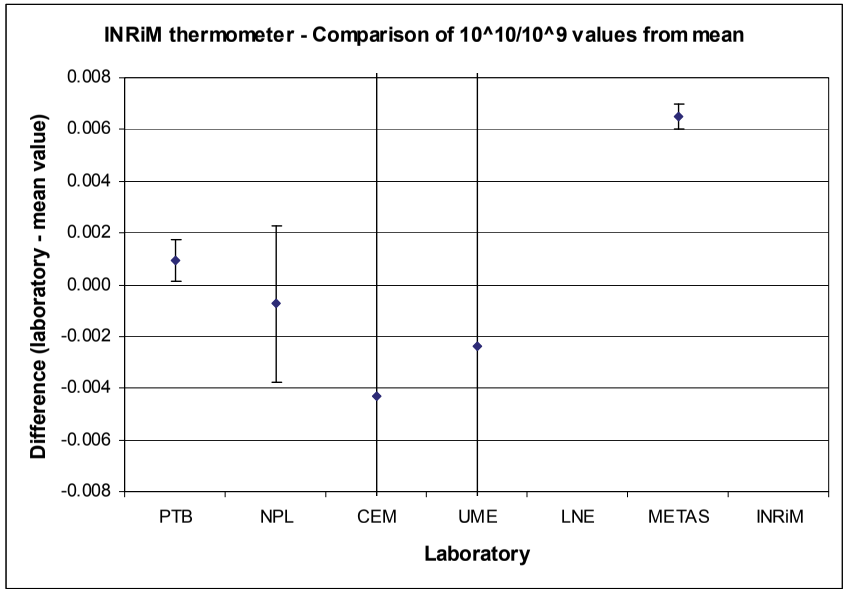
Laboratory	10^6/10^5	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	10.00859	0.00697	0.00361	0.00001	0.00002	0.00878
NPL	10.00861	0.00699	0.00363	0.00027	0.00053	0.00879
CEM	10.00335	0.00173	-0.00163	0.00048	0.00097	0.00883
UME	9.97569	-0.02593	-0.02929	0.00360	0.00721	0.01136
LNE	10.00582	0.00420	0.00084	0.00040	0.00080	0.00881
METAS	10.00498	0.00336	0.00000	0.00006	0.00011	0.00878
INRiM	10.00430	0.00268	-0.00068	0.00047	0.00094	0.00883
Average	**10.00162**					
Stdev	**0.01161**					
/√(n)	**0.00439**					
Median	**10.00498**					

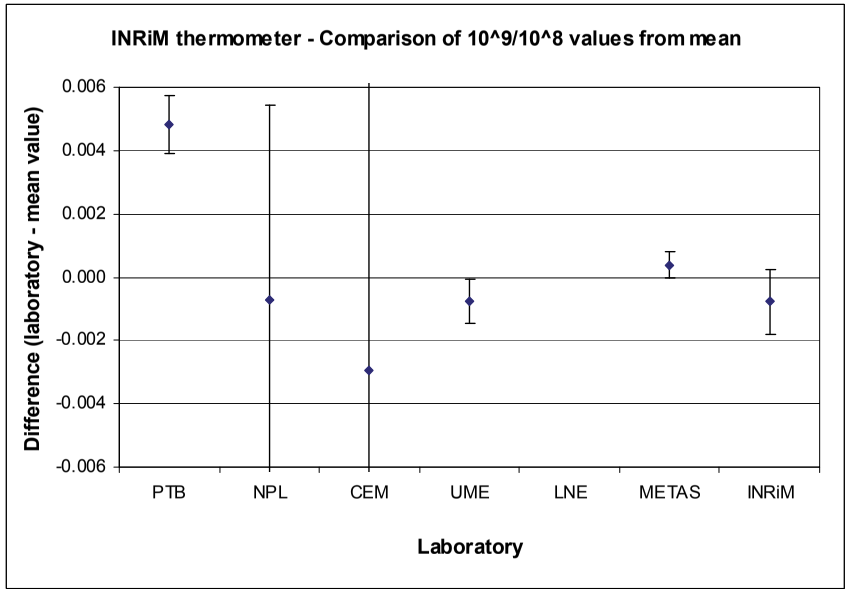
Table 209: the differences from the mean and median for the INRiM x10^6/ x10^5 gain ratio results

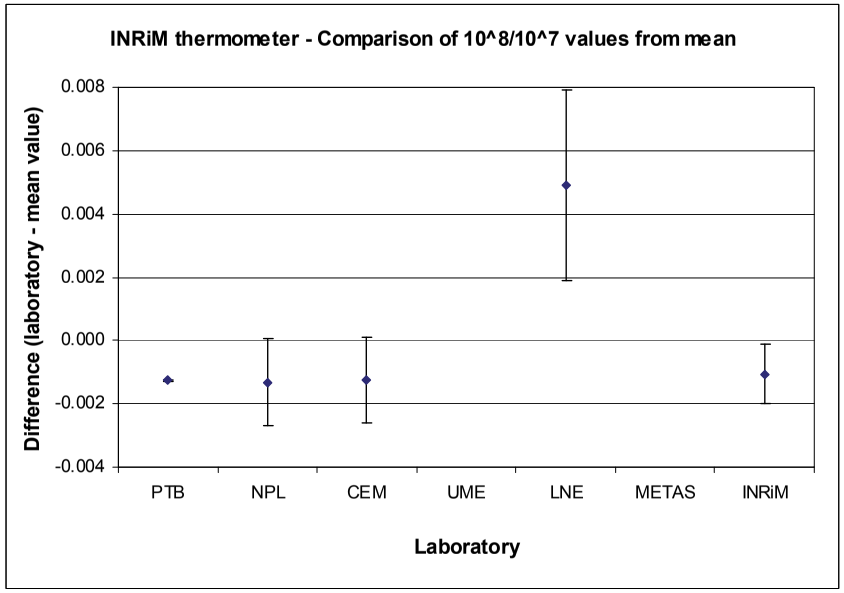
Laboratory	10^5/10^4	Diff from mean	Diff from median	u (k=1)	U (k=2)	U (k=2) with stdev of mean of all results
PTB	9.89589	0.00469	0.00168	0.00002	0.00003	0.00760
NPL	9.89421	0.00301	0.00000	0.00025	0.00049	0.00761
CEM	9.89844	0.00723	0.00423	0.00100	0.00199	0.00786
UME	9.87689	-0.01432	-0.01732	0.10063	0.20126	0.20141
LNE						
METAS	9.89060	-0.00061	-0.00361	0.00003	0.00006	0.00760
INRiM						
Average	**9.89120**					
Stdev	**0.00850**					
/√(n)	**0.00380**					
Median	**9.89421**					

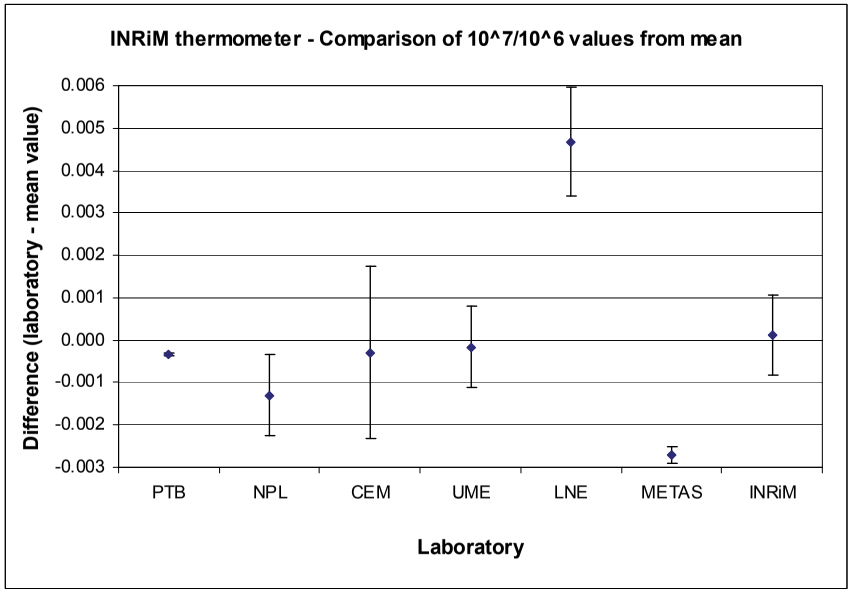
Table 210: the differences from the mean and median for the INRiM x10^5/ x10^4 gain ratio results

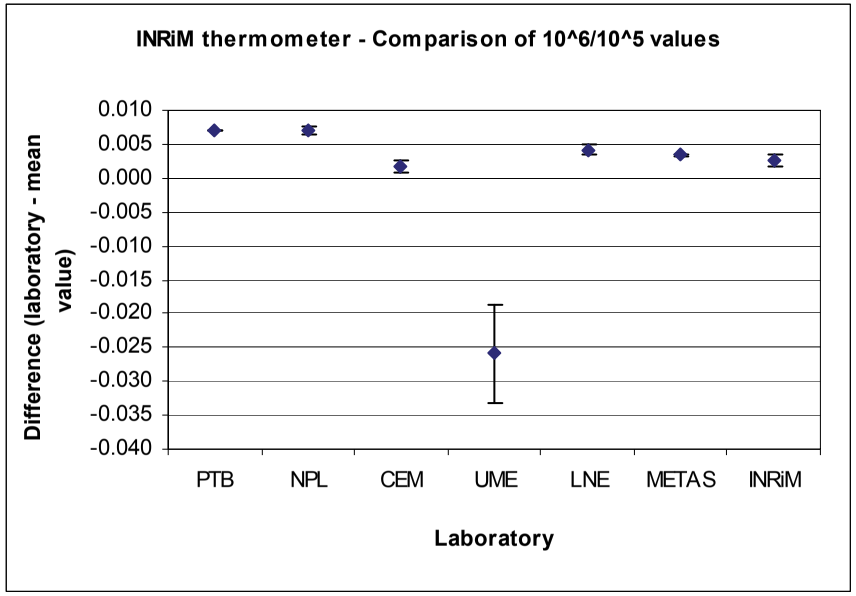
2.3.3 Comparison of the INRiM thermometer results: differences from the mean value

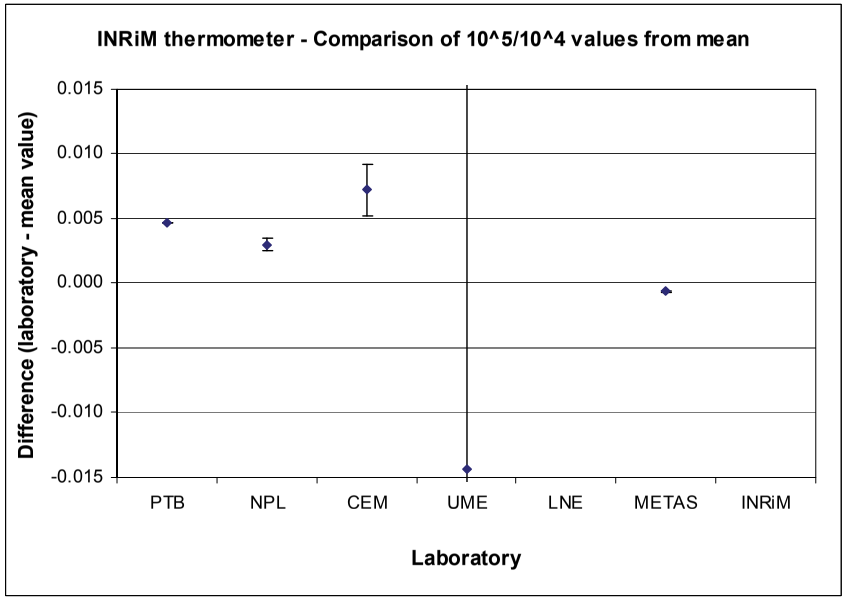


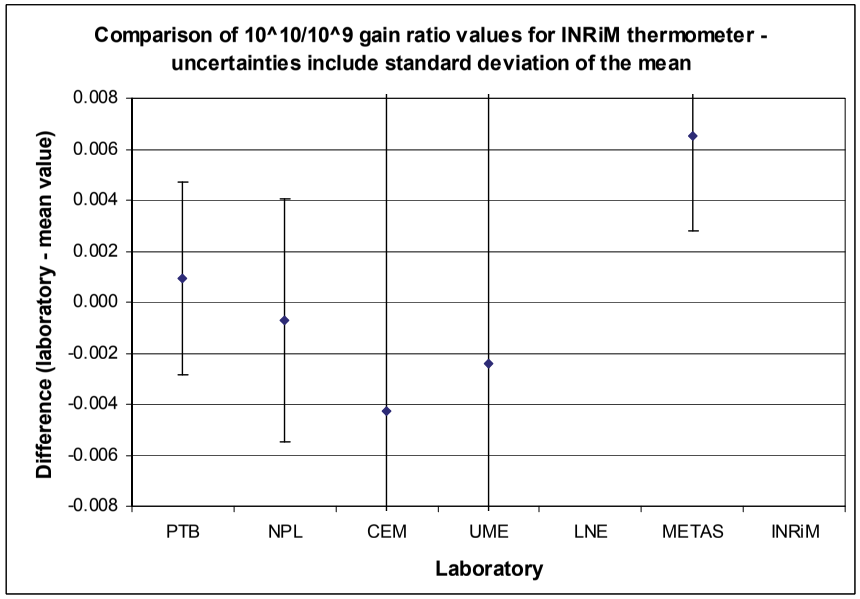


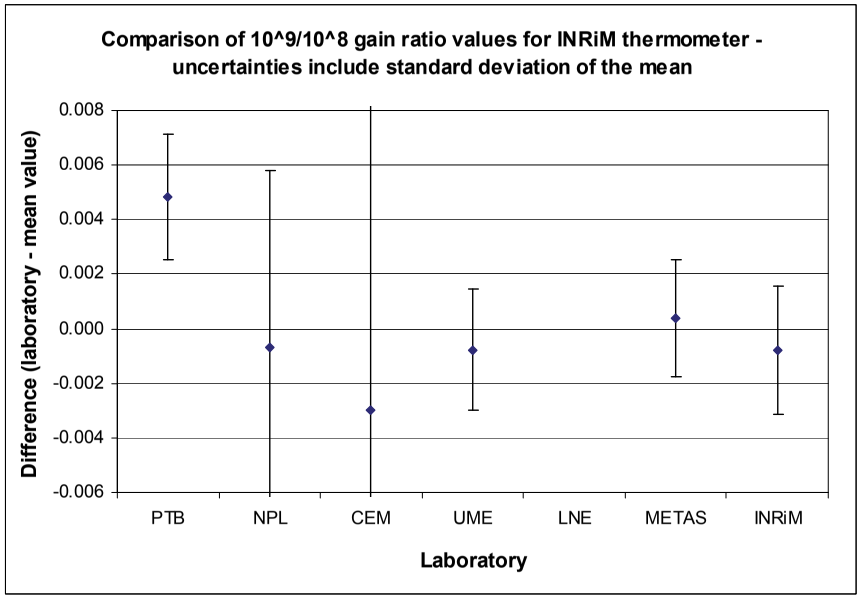


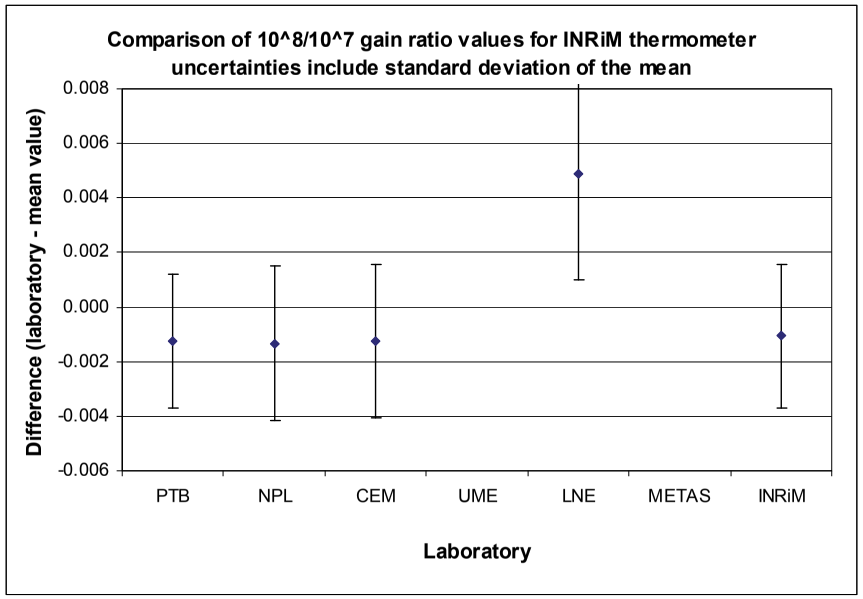


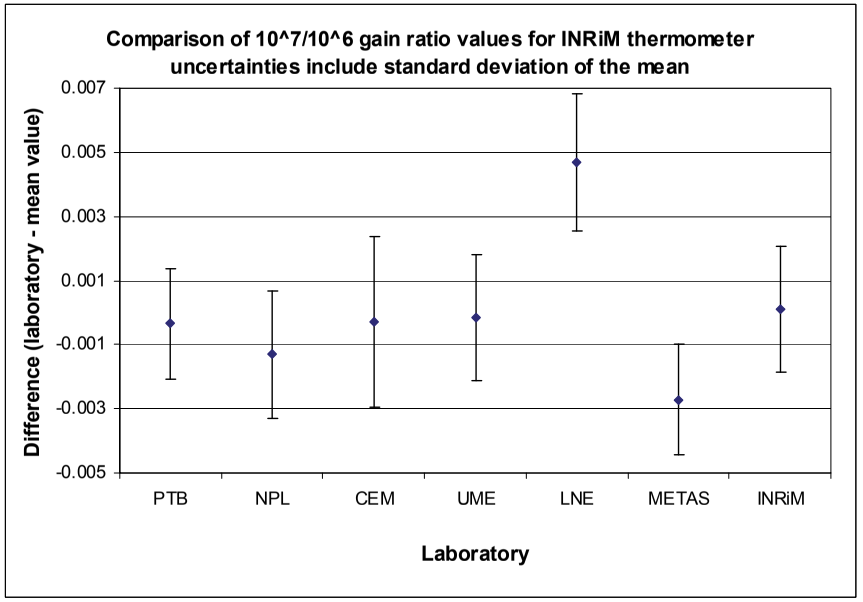

INRiM thermometer - Comparison of 10^6/10^5 values
Difference (laboratory - mean value)
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

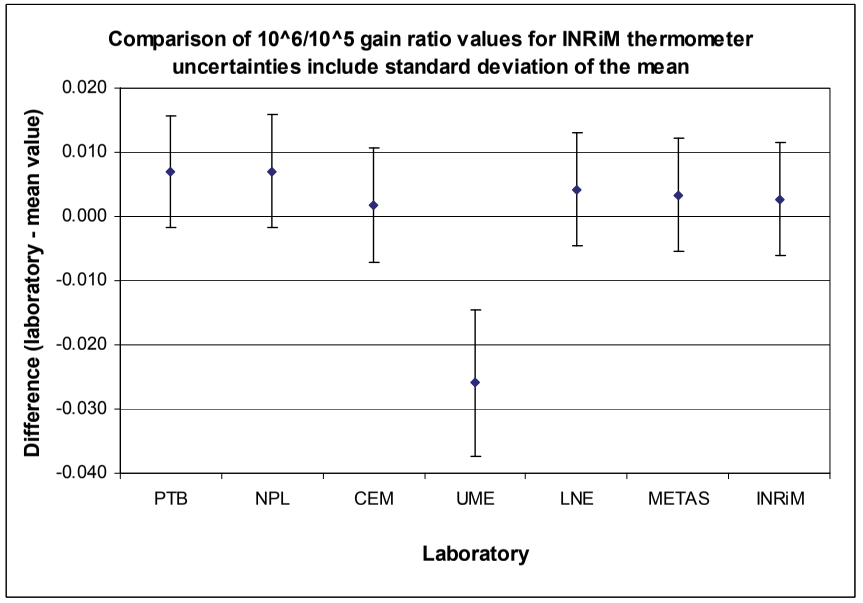

INRiM thermometer - Comparison of 10^5/10^4 values from mean
Difference (laboratory - mean value)
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

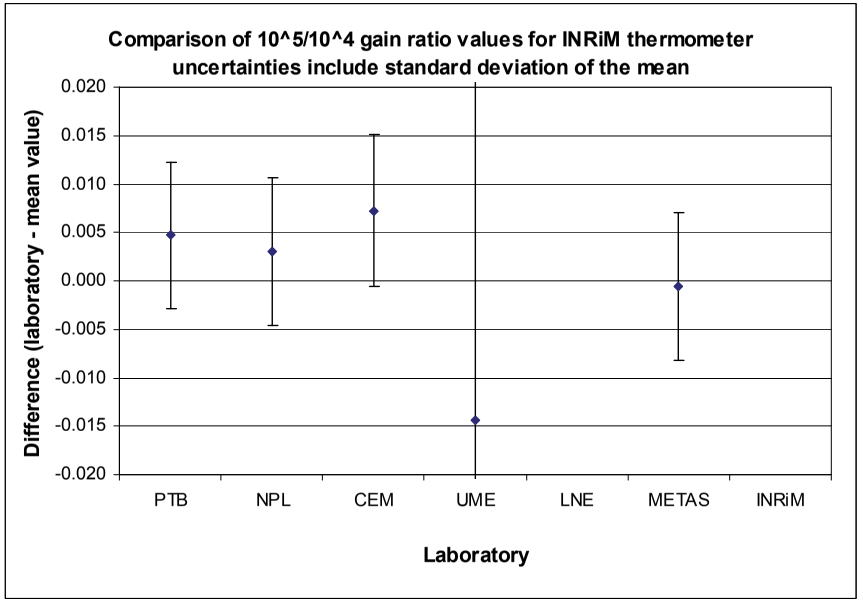

Comparison of 10^10/10^9 gain ratio values for INRiM thermometer - uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of 10^9/10^8 gain ratio values for INRiM thermometer - uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

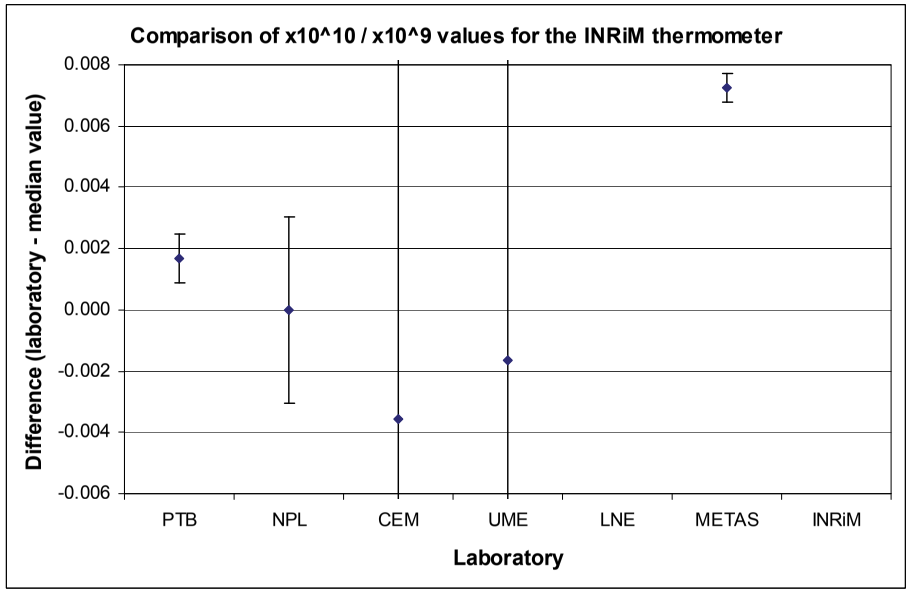

Comparison of 10^8/10^7 gain ratio values for INRiM thermometer
uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

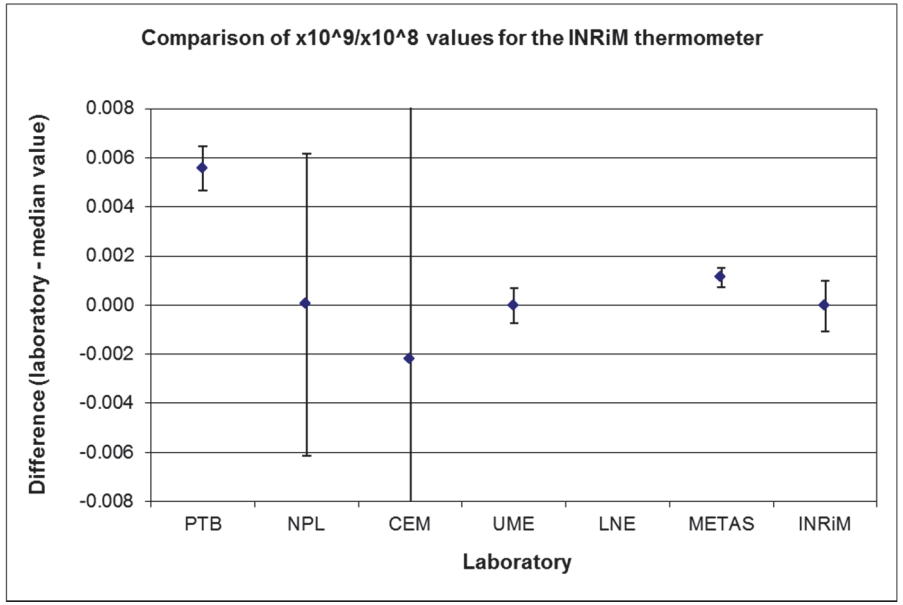

Comparison of 10^7/10^6 gain ratio values for INRiM thermometer
uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.007
0.005
0.003
0.001
-0.001
-0.003
-0.005
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

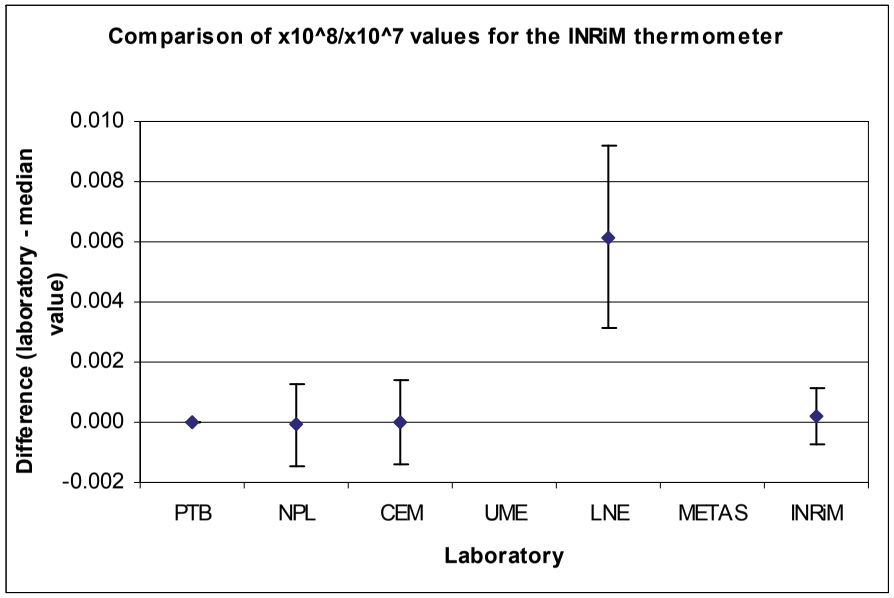

Comparison of 10^6/10^5 gain ratio values for INRiM thermometer
uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.020
0.010
0.000
-0.010
-0.020
-0.030
-0.040
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

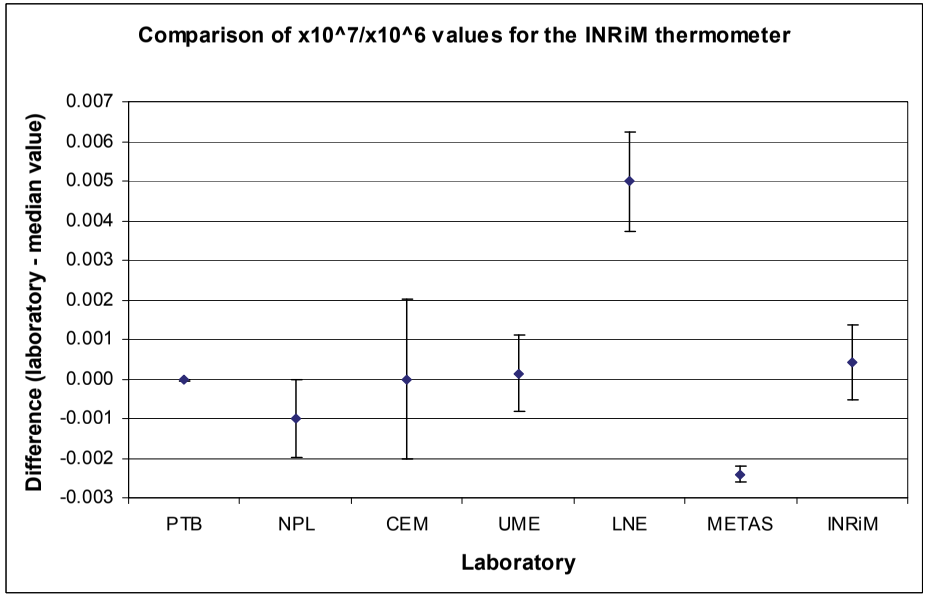

Comparison of 10^5/10^4 gain ratio values for INRiM thermometer
uncertainties include standard deviation of the mean
Difference (laboratory - mean value)
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

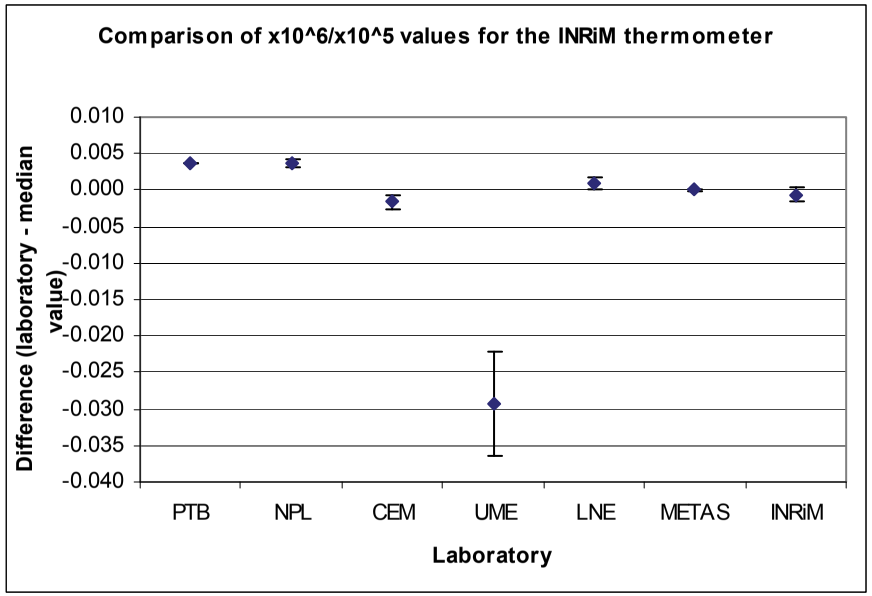
2.3.4 Comparison of the INRiM thermometer results: differences from the median value

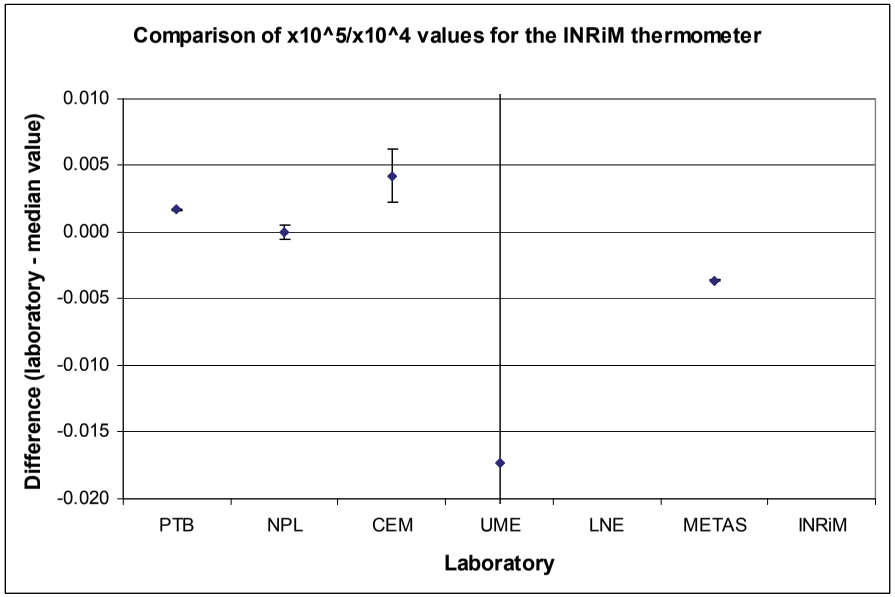




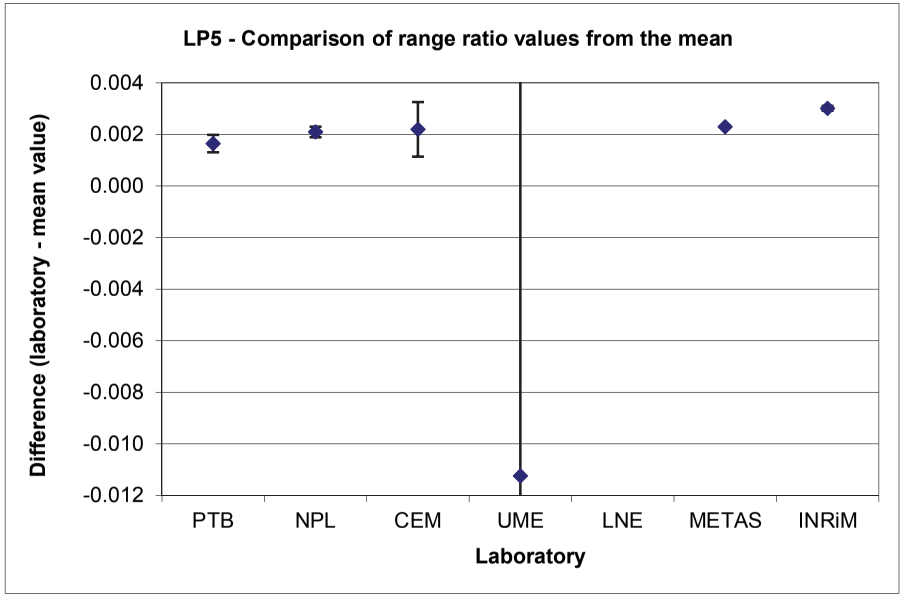


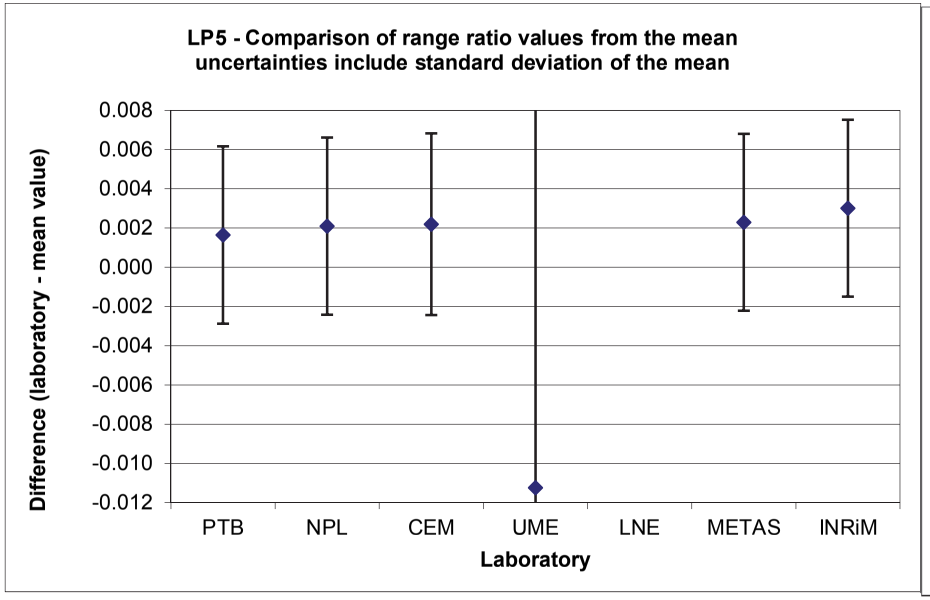


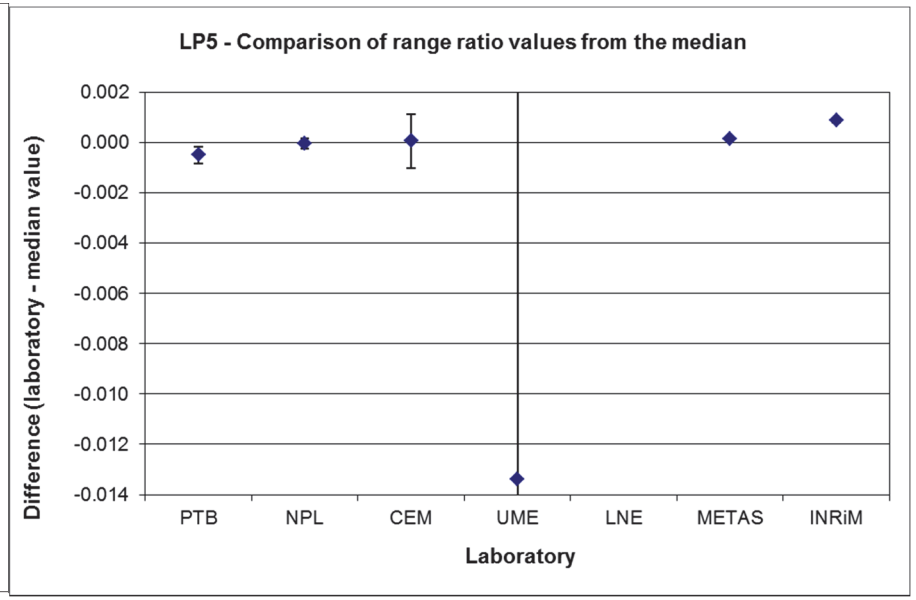

Comparison of x10^6/x10^5 values for the INRiM thermometer
Difference (laboratory - median value)
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory


Comparison of x10^5/x10^4 values for the INRiM thermometer
Difference (laboratory - median value)
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
PTB
NPL
CEM
UME
LNE
METAS
INRiM
Laboratory

2.3.5 Comparison of the LP5 results: differences from the mean and median values







2.4 DISCUSSION OF THE RESULTS

2.4.1 The INRiM thermometer results

The majority of the measurement results are in reasonably good agreement, taking into account the quoted measurement uncertainties, with the occasional outlying data point.

2.4.2 The LP5 results

The range ratio value from LNE was measured using the LP5 analogue output, rather than the photocurrent, and was completely inconsistent with the values from the other laboratories. The results from the other laboratories were in good agreement with the exception of the UME value, which was significantly lower. UME measured the range ratio very close to the bottom of the LP5 temperature range, where the background on range R2 was a significant component of the overall signal level. This could have impacted on the results. However, the UME value does agree with those of the other laboratories within the quoted measurement uncertainties.

3 EFFECT OF AMBIENT TEMPERATURE AND RELATIVE HUMIDITY

Only CEM, INRiM and NPL carried out the measurements of the effect of changing ambient temperature and relative humidity. CEM and INRiM carried out the full range of measurements. The NPL laboratory only has a small amount of temperature adjustment and no humidity control, so the measurements at NPL were somewhat limited. The results of all the measurements are given in the following tables.

3.1 THE RESULTS OF THE MEASUREMENTS

The results of the measurements made at CEM, INRiM and NPL are given in Tables 211 to 218 and Figures 14 to 17 below.

Amplifier Gain Setting / V/A	Average temperature of the source / °C	St. dev. of the temperature source / °C	Average Output Signal / mV	Average Background Signal / mV	Background Corrected Signal / mV	Measurement Standard Deviation / mV	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	$U_{teffect}$ (k=2) / %
10^9	231.35	0.01	1794.10	-2.84	1796.94	0.40	17.7	75	18.4	12
			1802.80	4.04	1798.76	0.45	27.7	55	28.6	
10^7	412.85	0.01	1757.64	-0.49	1758.13	0.10	17.9	58	18.6	12
			1754.21	-0.47	1754.68	0.12	27.8	37	28.7	
10^6	670.4	0.05	6124.8	-0.45	6125.3	2.9	17.8	52	18.6	12
			6109.9	-0.53	6110.4	2.2	27.8	62	28.8	
10^5	963.6	0.05	5717.8	-0.45	5718.3	1.4	17.9	72	18.8	12
			5696.8	-0.54	5697.3	1.5	27.9	53	29.0	

Table 211: Results of the INRiM measurements of the ambient temperature effect for the INRiM thermometer

Amplifier Gain Setting / V/A	Average temperature of the source / °C	St. dev. of the temperature source / °C	Average Output Signal / mV	Average Background Signal / mV	Background Corrected Signal / mV	Measurement Standard Deviation / mV	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	$U_{RHeffect}$ (k=2) / %
10^9	232.35	0.01	1860.75	-0.25	1861.00	0.23	22.9	32	23.7	32
			1859.50	-0.22	1859.72	0.32		72		
10^7	412.80	0.01	1756.60	-0.48	1757.08	0.12	22.9	32	23.7	32
			1755.47	-0.48	1755.95	0.15		69		
10^6	670.5	0.05	6127.3	-0.48	6127.8	2.8	22.8	31	23.7	32
			6123.7	-0.49	6124.2	2.8		72		
10^5	964.0	0.06	5722.5	-0.49	5723.0	1.5	22.9	33	23.9	32
			5719.4	-0.50	5719.9	1.9		70		

Table 212: Results of the INRiM measurements of the humidity effect for the INRiM thermometer

Amplifier Gain Setting (range)	Average temperature of the source / °C	St. dev. of the temperature source / °C	Average Output Signal / nA	Average Background Signal / pA	Background Corrected Signal / nA	Measurement Standard Deviation / nA	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	$U_{teffect}$ (k=2) / %	
R2	659.83	0.02	12.465	-1.6	12.467	0.003	18.3	55	25.15	18	
	659.68		12.427	0.9	12.426		20.3	47	27.08		18
	659.67		12.452	3.2	12.448		22.0	51	28.90	18	
	659.71		12.464	3.8	12.460		24.0	49	29.20		18
	659.64		12.444	4.1	12.440		25.9	50	29.20		
R2	960.14	0.02	137.184	-1.6	137.186	0.02	18.7	55	25.06	13	
	959.81		136.559	4.0	136.555		23.2	52	29.21		15
	959.76		136.423	4.4	136.419		26.0	54	29.21		

Table 213: Results of the INRiM measurements of the ambient temperature effect for the LP5 thermometer

Note: the yellow shading indicates where the thermometer cell temperature was below the specified limits.

Amplifier Gain Setting (range)	Average temperature of the source / °C	St. dev. of the temperature source / °C	Average Output Signal / nA	Average Background Signal / pA	Background Corrected Signal / nA	Measurement Standard Deviation / nA	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	$U_{RHeffect}$ (k=2) / %
R2	659.15	0.02	12.430	3.4	12.426	0.003	23.8	29	29.21	32
			12.393	4.5	12.389			73	29.21	
R2	959.16	0.02	136.377	3.4	136.374	0.02	23.6	25	29.23	32
			135.953	4.6	135.948			71	29.22	

Table 214: Results of the INRiM measurements of the humidity effect for the LP5 thermometer

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	s($t_{Au/Pt}$) / °C	dark current, S_0 / A	average signal, S / A	S_{extr} a 660,32 °C / A	S_{extr}-S_0 / A	Standard deviation / A	t_{amb} / °C	s(t_{amb}) / °C	RH_{amb} / %rh	s(RH_{amb}) / %rh	t_{int} / °C	$U(S)$ / A	$U(S)$ / °C
18	50	660.22	0.0014	-5.1330E-10	5.4849E-06	5.4913E-06	5.4918E-06	1.8320E-10	17.67	0.13	55.99	0.25	19.47	1.768E-08	0.28
19	50	660.38	0.0023	-5.1130E-10	5.4944E-06	5.4906E-06	5.4911E-06	6.1362E-11	19.03	0.15	56.93	0.47	20.22	1.769E-08	0.28
20	50	660.16	0.0016	-5.3340E-10	5.4796E-06	5.4898E-06	5.4904E-06	5.0449E-11	20.21	0.10	48.96	0.38	21.38	1.768E-08	0.28
21	50	660.35	0.0034	-5.6570E-10	5.4873E-06	5.4854E-06	5.4860E-06	2.1107E-10	21.37	0.35	45.20	0.72	23.57	1.771E-08	0.28
22	50	660.31	0.0038	-5.5360E-10	5.4867E-06	5.4873E-06	5.4879E-06	9.9133E-11	22.16	0.21	43.73	0.46	23.52	1.769E-08	0.28
24	50	660.39	0.0017	-5.6020E-10	5.4881E-06	5.4836E-06	5.4842E-06	4.0333E-11	23.69	0.10	48.40	0.23	24.63	1.768E-08	0.28
24	50	660.26	0.0019	-5.7090E-10	5.4800E-06	5.4838E-06	5.4844E-06	1.8378E-10	24.04	0.15	40.29	0.30	25.46	1.769E-08	0.28
26	50	660.36	0.0015	-5.9030E-10	5.4848E-06	5.4823E-06	5.4829E-06	1.6450E-11	26.22	0.07	42.04	1.78	27.39	1.768E-08	0.28
26	50	660.35	0.0016	-5.8700E-10	5.4855E-06	5.4836E-06	5.4842E-06	2.0851E-10	25.97	0.09	42.51	0.29	27.52	1.769E-08	0.28
23	40	660.36	0.0014	-5.5350E-10	5.4865E-06	5.4840E-06	5.4845E-06	3.9213E-11	22.78	0.11	39.63	0.32	23.88	1.768E-08	0.28
23	50	660.44	0.0012	-5.5110E-10	5.4934E-06	5.4857E-06	5.4863E-06	6.4629E-11	22.70	0.08	50.48	0.46	24.23	1.768E-08	0.28
23	70	660.38	0.0008	-5.5290E-10	5.4885E-06	5.4847E-06	5.4853E-06	4.8281E-11	22.76	0.09	72.03	0.81	23.88	1.768E-08	0.28

Table 215: Results of the CEM measurements for the INRiM thermometer

(Note that the signal, which was given in terms of voltage, has been converted to current using the amplifier gain setting).

The results are plotted graphically in Figures 14 and 15.

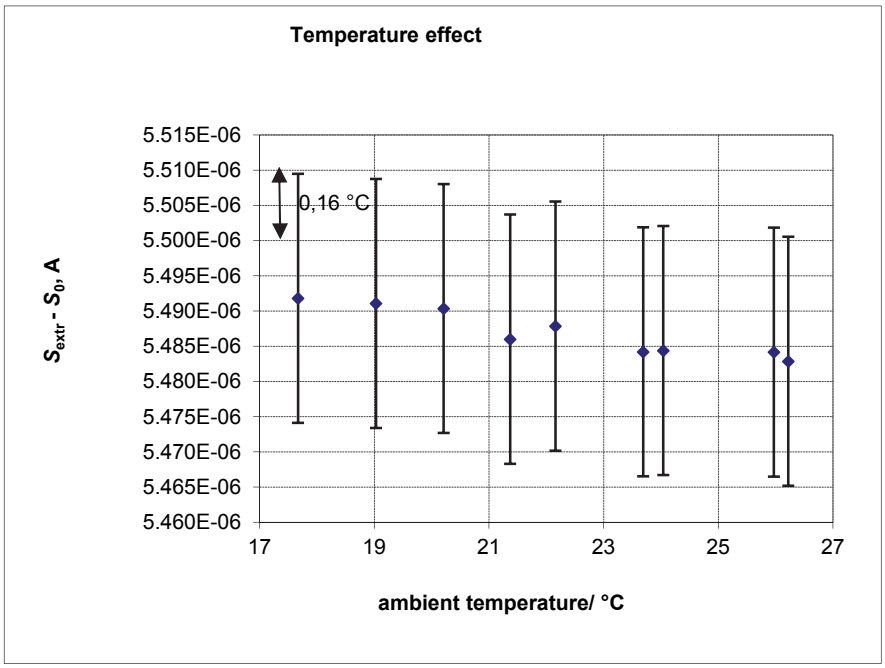


Figure 14: the CEM results for the effect of ambient temperature on the INRiM thermometer

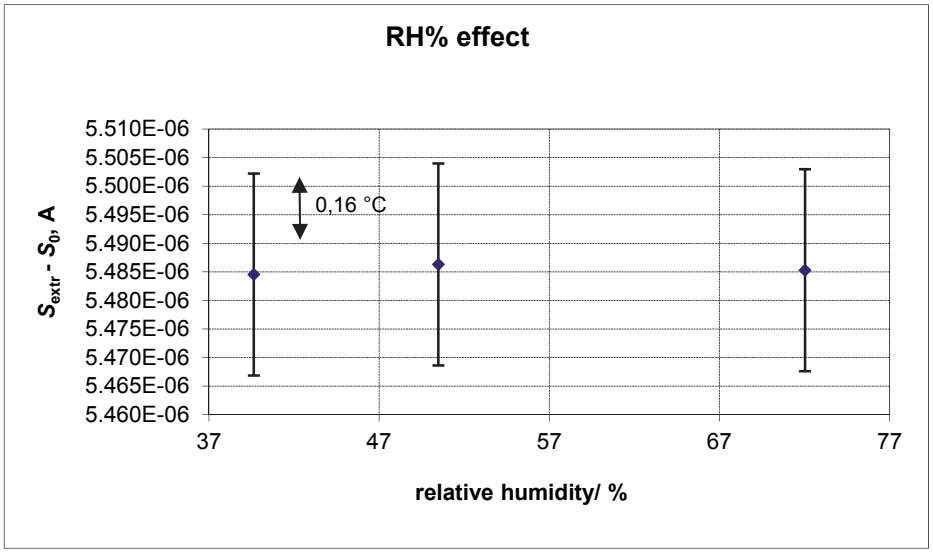


Figure 15: the CEM results for the effect of relative humidity on the INRiM thermometer

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	s($t_{Au/Pt}$) / °C	dark current, S_0 / A	average signal, S / A	S_{extr} a 660,32 °C / A	S_{extr}-S_0 / A	Standard deviation / A	t_{amb} / °C	s(t_{amb}) / °C	RH_{amb} / %rh	s(RH_{amb}) / %rh	t_{int} / °C	*U(S)* / A	*U(S)* / °C
18	50	660.28	0.0026	5.7877E-13	1.2535E-08	1.2540E-08	1.2540E-08	3.2641E-13	17.67	0.13	55.99	0.25	27.61	3.33E-11	0.25
19	50	660.43	0.0024	8.6042E-13	1.2567E-08	1.2552E-08	1.2552E-08	1.0815E-13	19.03	0.15	56.93	0.47	28.03	3.33E-11	0.25
20	50	660.2	0.0022	2.6086E-12	1.2545E-08	1.2561E-08	1.2558E-08	1.1231E-13	20.21	0.1	48.96	0.38	29.06	3.33E-11	0.25
21	50	660.41	0.0018	2.7102E-12	1.2597E-08	1.2585E-08	1.2582E-08	1.9541E-13	21.37	0.35	45.2	0.72	29.22	3.35E-11	0.25
22	50	660.37	0.0034	2.6609E-12	1.2585E-08	1.2578E-08	1.2576E-08	2.4928E-13	22.16	0.21	43.73	0.46	29.22	3.34E-11	0.25
24	50	660.43	0.0031	2.8120E-12	1.2563E-08	1.2548E-08	1.2545E-08	3.5487E-13	23.69	0.1	48.4	0.23	29.22	3.33E-11	0.25
24	50	660.31	0.0038	2.6388E-12	1.2558E-08	1.2559E-08	1.2557E-08	3.5487E-13	24.04	0.15	40.29	0.3	29.22	3.33E-11	0.25
26	50	660.4	0.0017	2.8121E-12	1.2576E-08	1.2565E-08	1.2563E-08	9.8759E-14	26.22	0.07	42.04	1.78	29.22	3.33E-11	0.25
26	50	660.37	0.0021	2.8095E-12	1.2577E-08	1.2570E-08	1.2567E-08	2.2766E-13	25.97	0.09	42.51	0.29	29.22	3.33E-11	0.25
23	40	660.41	0.0028	2.5981E-12	1.2567E-08	1.2555E-08	1.2553E-08	1.7380E-13	22.78	0.11	39.63	0.32	29.22	3.33E-11	0.25
23	50	660.51	0.0023	2.6837E-12	1.2584E-08	1.2559E-08	1.2556E-08	4.1867E-13	22.7	0.08	50.48	0.46	29.22	3.33E-11	0.25
23	70	660.42	0.0039	2.8430E-12	1.2560E-08	1.2547E-08	1.2544E-08	2.0647E-13	22.76	0.09	72.03	0.81	29.22	3.33E-11	0.25

Table 216: the CEM results for the effect of ambient temperature on the LP5 thermometer

Note: the yellow shading indicates where the cell temperature was below the specified limits.

The results are plotted graphically in Figures 16 and 17.

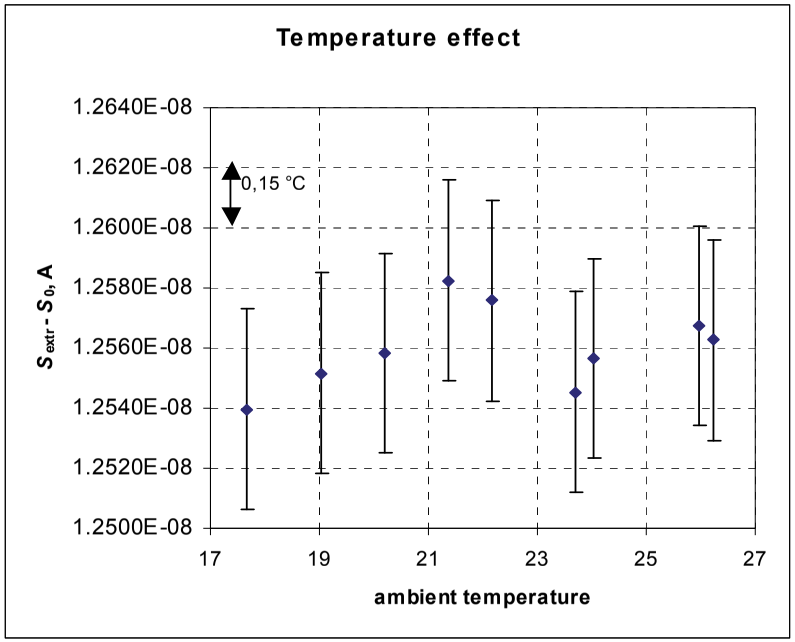


Figure 16: CEM results for the effect of temperature on the LP5

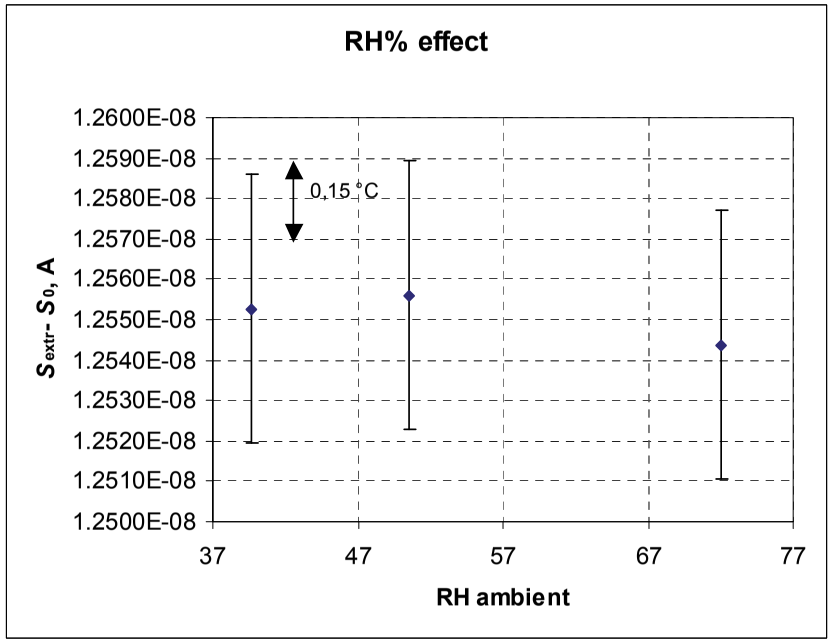


Figure 17: CEM results for the effect of relative humidity on the LP5

Ambient temp. / °C & RH / %rh	Internal temp / °C	t_{BB} / °C	t_{BB} std dev / °C	Signal / V	Bgrd signal / V	Bgrd corrected signal/ V	Signal std deviation/ V
21.1 / 29	22.00	659.87	0.00	5.471272	-0.000525	5.471797	8.210E-05
21.1 / 29	22.02	659.87	0.00	5.471048	-0.000525	5.471573	6.867E-05
23.8 / 37	24.92	659.86	0.00	5.468346	-0.000553	5.468899	1.105E-04
23.8 / 37	24.93	659.86	0.00	5.468231	-0.000553	5.468784	1.518E-04
23.9 / 37	24.88	660.86	0.01	5.524544	-0.000553	5.525097	4.796E-04
23.9 / 37	24.89	660.84	0.01	5.524014	-0.000553	5.524567	1.189E-04
22.1 / 43	23.19	660.82	0.00	5.525029	-0.000536	5.525565	1.850E-04
22.1 / 43	23.19	660.82	0.00	5.525250	-0.000536	5.525786	5.450E-05
22.2 / 43	23.12	659.88	0.00	5.471235	-0.000535	5.471770	3.233E-04
22.2 / 43	23.13	659.88	0.01	5.471019	-0.000535	5.471554	2.657E-04

Table 217: Results of the NPL measurements for the INRiM thermometer

Ambient temp. / °C & RH / %rh	Internal temp / °C	t_{BB} / °C	t_{BB} std dev / °C	Signal / A	Bgrd signal / A	Bgrd corrected signal/ A	Signal std deviation/ A
21.1 / 28	28.66	659.88	0.00	1.255691E-08	1.03821E-12	1.255587E-08	4.9964E-13
21.1 / 28	28.67	659.87	0.00	1.255584E-08	1.03821E-12	1.255481E-08	3.7411E-13
23.8 / 38	29.22	659.87	0.00	1.256291E-08	2.04829E-12	1.256086E-08	8.9812E-13
23.8 / 38	29.22	659.87	0.01	1.256297E-08	2.04829E-12	1.256092E-08	9.4297E-13
23.7 / 38	29.22	660.86	0.01	1.269432E-08	2.04813E-12	1.269227E-08	5.8258E-13
23.7 / 38	29.22	660.85	0.00	1.269283E-08	2.04813E-12	1.269078E-08	5.8479E-13
22.1 / 43	29.21	660.83	0.01	1.268954E-08	1.95133E-12	1.268759E-08	6.4780E-13
22.1 / 43	29.21	660.84	0.00	1.269078E-08	1.95133E-12	1.268883E-08	8.2813E-13

Table 218: Results of the NPL measurements for the LP5 thermometer

Note: the yellow shading again indicates where the thermometer cell temperature was below the specified limits.

The INRiM measurements with the LP5 were adjusted to correct for the small changes in the reference blackbody temperature during the measurements. The thermometer signal sensitivities in terms of V/ °C or A/ °C, or V/ %rh or A/ %rh were then calculated. The sensitivities in terms of an equivalent temperature were also calculated for more clarity.

The LP5 measurements made with the cell temperature out of specification are given for indication only.

The results of the calculations are given in Tables 219 to 226. Again, the yellow shading indicates where the LP5 cell temperature was below the specified limits.

3.2 THE RESULTS IN TERMS OF SENSITIVITIES

Amplifier Gain Setting / V/A	Average Temperature Of the source / °C	Background Corrected Signal / mV	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	Ambient Temperature Sensitivity/ V/ °C_{amb}	Sensitivity in Terms of Equivalent Temperature/ °C/ °C_{amb}	Internal Temperature Sensitivity/ V/ °C_{int}	Sensitivity in Terms of Equivalent Temperature/ °C/ °C_{int}	$U_{teffect}$ ($k=2$) / %
10^9	231.35	1796.94	17.7	75	18.4	0.00018	0.003	0.00018	0.003	12
		1798.76	27.7	55	28.6					
10^7	412.85	1758.13	17.9	58	18.6	-0.00035	-0.010	-0.00034	-0.010	12
		1754.68	27.8	37	28.7					
10^6	670.4	6125.3	17.8	52	18.6	-0.00148	-0.024	-0.00145	-0.023	12
		6110.4	27.8	62	28.8					
10^5	963.6	5718.3	17.9	72	18.8	-0.00209	-0.014	-0.00205	-0.013	12
		5697.3	27.9	53	29.0					

Table 219: INRiM measurements of the temperature effect with the INRiM thermometer

Note that the relative humidity also varied during the measurements and this could have had an impact on the results.

Amplifier Gain Setting/ V/A	Average Temperature Of the source / °C	Background Corrected Signal / mV	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	Relative Humidity Sensitivity/ V/ %rh	Sensitivity in Terms of Equivalent Temperature/ °C/ %rh	$U_{RHeffect}$ ($k=2$) /
10^9	232.35	1861.00	22.9	32	23.7	-0.00003	0.000	32
		1859.72		72				
10^7	412.80	1757.08	22.9	32	23.7	-0.00003	-0.001	32
		1755.95		69				
10^6	670.5	6127.8	22.8	31	23.7	-0.00009	-0.001	32
		6124.2		72				
10^5	964.0	5723.0	22.9	33	23.9	-0.00008	-0.002	32
		5719.9		70				

Table 220: INRiM measurements of the humidity effect with the INRiM thermometer

Amplifier gain setting (range)	Average temperature of the source / °C	Background corrected signal / nA	Signal corrected for changes in source temp‡. / nA	Ambient temperature t_{amb} / °C	Relative humidity RH_{amb} / %rh	Internal temperature t_{int} / °C	Ambient temperature sensitivity† / nA/ °C_{amb}	Sensitivity in terms of equivalent temperature†/ °C/ °C_{amb}	Ambient temperature sensitivity*/ nA/ °C_{amb}	Sensitivity in terms of equivalent temperature*/ °C/ °C_{amb}	$U_{teffect}$ ($k=2$) / %	
R2	659.83	12.467	12.467	18.3	55	25.15	-	-	-	-	18	
	659.68	12.426	12.446	20.3	47	27.08	-0.010	-0.08	-	-		18
	659.67	12.448	12.469	22.0	51	28.90	0.001	0.01	-	-	18	
	659.71	12.460	12.476	24.0	49	29.20	0.002	0.01	-	-		18
	659.64	12.440	12.465	25.9	50	29.20	0.000	0.00	-0.006	-0.04		
R2	960.14	137.186	137.186	18.7	55	25.06	-	-	-	-	13	
	959.81	136.555	136.827	23.2	52	29.21	-0.081	-0.10	-	-		15
	959.76	136.419	136.731	26.0	54	29.21	-0.062	-0.08	-0.034	-0.04		

Table 221: INRiM measurements of the ambient temperature effect with the LP5 thermometer

‡ relative to the blackbody temperature during the first measurement set
† Calculated relative to the results at the lowest ambient temperature/ relative humidity
* Ignoring the values where the cell temperature was out of specification.

Amplifier Gain Setting (range)	Average temperature of the source / °C)	Background Corrected Signal / nA	Ambient Temperature t_{amb} / °C	Relative Humidity RH_{amb} / %rh	Internal Temperature t_{int} / °C	Relative Humidity Sensitivity / nA/ %rh	Sensitivity in Terms of Equivalent Temperature/ °C/ %rh	$U_{RHeffect}$ ($k=2$) / %
R2	659.15	12.426	23.8	29	29.21	-0.001	-0.007	32
		12.389		73	29.21			
R2	959.16	136.374	23.6	25	29.23	-0.009	-0.011	32
		135.948		71	29.22			

Table 222: INRiM measurements of the humidity effect with the LP5 thermometer

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	S_{extr}-S_0 / A	t_{amb} / °C	RH_{amb} / %rh	t_{int} / °C	S_{extr}-S_0 / V	Ambient temperature sensitivity†/ V/ °C_{amb}	Sensitivity in terms of equivalent temperature difference†/ °C/ °C_{amb}	Internal temperature sensitivity†/ V/ °C_{int}	Sensitivity in terms of equivalent temperature difference†/ °C/ °C_{int}	U (*k=2*) / °C
18	50	660.22	5.4918E-06	17.67	55.99	19.47	5.4918	-	-	-	-	
19	50	660.38	5.4911E-06	19.03	56.93	20.22	5.4911	-0.00054	-0.010	-0.00098	-0.017	0.28
20	50	660.16	5.4904E-06	20.21	48.96	21.38	5.4904	-0.00057	-0.010	-0.00076	-0.013	0.28
21	50	660.35	5.4860E-06	21.37	45.20	23.57	5.4860	-0.00157	-0.028	-0.00142	-0.025	0.28
22	50	660.31	5.4879E-06	22.16	43.73	23.52	5.4879	-0.00088	-0.015	-0.00097	-0.017	0.28
24	50	660.39	5.4842E-06	23.69	48.40	24.63	5.4842	-0.00126	-0.022	-0.00147	-0.026	0.28
24	50	660.26	5.4844E-06	24.04	40.29	25.46	5.4844	-0.00116	-0.021	-0.00124	-0.022	0.28
26	50	660.36	5.4829E-06	26.22	42.04	27.39	5.4829	-0.00105	-0.018	-0.00113	-0.020	0.28
26	50	660.35	5.4842E-06	25.97	42.51	27.52	5.4842	-0.00092	-0.016	-0.00095	-0.017	0.28

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	S_{extr}-S_0 / A	t_{amb} / °C	RH_{amb} / %rh	t_{int} / °C	S_{extr}-S_0 / V	Relative humidity sensitivity†/ V/ %rh	Sensitivity in terms of equivalent temperature difference†/ °C/ %rh	U (*k=2*) / °C
23	40	660.36	5.4845E-06	22.78	39.63	23.88	5.4845	-	-	0.28
23	50	660.44	5.4863E-06	22.70	50.48	24.23	5.4863	0.00016	0.003	0.28
23	70	660.38	5.4853E-06	22.76	72.03	23.88	5.4853	0.00002	0.000	0.28

Table 223: CEM measurements with the INRiM thermometer

† Calculated relative to the results at the lowest ambient temperature/ relative humidity

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	S_{extr}-S_0 / A	t_{amb} / °C	RH_{amb} / %rh	t_{int} / °C	Ambient temperature sensitivity†/ nA/ °C$_{amb}$	Sensitivity in terms of equivalent temperature difference†/ °C/ °C$_{amb}$	Ambient temperature sensitivity*/ nA/ °C$_{amb}$	Sensitivity in terms of equivalent temperature difference*/ °C/ °C$_{amb}$	U (*k=2*) / °C
18	50	660.28	1.2540E-08	17.67	55.99	27.61	-	-	-	-	
19	50	660.43	1.2552E-08	19.03	56.93	28.03	0.009	0.07	-	-	
20	50	660.20	1.2558E-08	20.21	48.96	29.06	0.007	0.06	-	-	
21	50	660.41	1.2582E-08	21.37	45.20	29.22	0.012	0.09	-	-	
22	50	660.37	1.2576E-08	22.16	43.73	29.22	0.008	0.06	-0.008	-0.07	0.25
24	50	660.43	1.2545E-08	23.69	48.40	29.22	0.001	0.01	-0.016	-0.12	0.25
24	50	660.31	1.2557E-08	24.04	40.29	29.22	0.003	0.02	-0.010	-0.07	0.25
26	50	660.40	1.2563E-08	26.22	42.04	29.22	0.003	0.02	-0.004	-0.03	0.25
26	50	660.37	1.2567E-08	25.97	42.51	29.22	0.003	0.03	-0.003	-0.03	0.25

t_{nom} / °C	RH_{nom} / %rh	t_R / °C	S_{extr}-S_0 / A	t_{amb} / °C	RH_{amb} / %rh	t_{int} / °C	Relative humidity sensitivity†/ nA/ %rh	Sensitivity in terms of equivalent temperature difference†/ °C/ %rh	U (*k=2*) / °C
23	40	660.41	1.2553E-08	22.78	39.63	29.22	-	-	
23	50	660.51	1.2556E-08	22.70	50.48	29.22	0.000	+0.002	0.25
23	70	660.42	1.2544E-08	22.76	72.03	29.22	0.000	-0.002	0.25

Table 224: CEM measurements with the LP5 thermometer

† Calculated relative to the results at the lowest ambient temperature/ relative humidity
* Ignoring the values where the cell temperature was out of specification.

Ambient temp./ °C & RH/ %rh	Internal temp / °C	t_{BB} / °C	Bgrd corrected signal/ V	Signal corrected for changes in source temp.‡ / V	Ambient temperature sensitivity†/ V/ °C_{amb}	Sensitivity in terms of equivalent temperature difference†/ °C/ °C_{amb}	Internal temperature sensitivity†/ V/ °C_{int}	Sensitivity in terms of equivalent temperature difference†/ °C/ °C_{int}
21.1 / 29	22.00	659.87	5.471797	5.471797	-0.00076	-0.01	-0.00070	-0.01
21.1 / 29	22.02	659.87	5.471573	5.471394	-0.00090	-0.02	-0.00083	-0.02
23.8 / 37	24.92	659.86	5.468899	5.469551	-0.00105	-0.02	-0.00102	-0.02
23.8 / 37	24.93	659.86	5.468784	5.469170	-0.00090	-0.01	-0.00088	-0.01
23.9 / 37	24.88	660.86	5.525097	5.468657	-0.00042	0.00	-0.00035	0.00
23.9 / 37	24.89	660.84	5.524567	5.469064	-0.00011	0.00	-0.00009	0.00
22.1 / 43	23.19	660.82	5.525565	5.471175	-0.00076	-0.02	-0.00074	-0.02
22.1 / 43	23.19	660.82	5.525786	5.471488	-0.00095	-0.02	-0.00093	-0.02
22.2 / 43	23.12	659.88	5.471770	5.470765	-0.00076	-0.01	-0.00070	-0.01
22.2 / 43	23.13	659.88	5.471554	5.470549	-0.00090	-0.02	-0.00083	-0.02

Table 225: NPL measurements with the INRiM thermometer

‡ relative to the blackbody temperature during the first measurement set
† Calculated relative to the results at the lowest ambient temperature/ relative humidity

Note that the relative humidity also varied during the measurements and this could have had an impact on the results.

Ambient temp./ °C & RH/ %rh	Internal temp / °C	t_{BB} / °C	Bgrd corrected signal/ A	Signal corrected for changes in source temp.‡ / A	Ambient temperature sensitivity†/ nA/ °C_{amb}	Sensitivity in terms of equivalent temperature difference†/ °C/ °C_{amb}	Ambient temperature sensitivity*/ nA/ °C_{amb}	Sensitivity in terms of equivalent temperature difference*/ °C/ °C_{amb}
21.1 / 28	28.66	659.88	1.255587E-08	1.255587E-08	-	-	-	-
21.1 / 28	28.67	659.87	1.255481E-08	1.255579E-08	0.000	0.00	-	-
23.8 / 38	29.22	659.87	1.256086E-08	1.256147E-08	0.002	0.02	-	-
23.8 / 38	29.22	659.87	1.256092E-08	1.256198E-08	0.002	0.02	-	-
23.7 / 38	29.22	660.86	1.269227E-08	1.256301E-08	0.003	0.02	-	-
23.7 / 38	29.22	660.85	1.269078E-08	1.256298E-08	0.003	0.02	-	-
22.1 / 43	29.21	660.83	1.268759E-08	1.256248E-08	0.007	0.05	0.00	-0.001
22.1 / 43	29.21	660.84	1.268883E-08	1.256232E-08	0.006	0.05	0.00	-0.001

Table 226: NPL measurements with the LP5 thermometer

‡ relative to the blackbody temperature during the first measurement set
† Calculated relative to the results at the lowest ambient temperature
* Ignoring the values where the cell temperature was out of specification.

Note that the relative humidity also varied during the measurements and this could have had an impact on the results.

3.3 DISCUSSION OF THE RESULTS AND CONCLUSIONS

The NPL results have been ignored in the following discussion, because the number of measurement data points was very limited. It should also be noted that the uncertainties of the CEM and INRiM measurements are large compared to the magnitude of the observed effect, making it difficult to see any clear dependence of the thermometers' signals on changes in room temperature and relative humidity.

3.3.1 Results for the INRiM thermometer:

The INRiM thermometer results show a small negative coefficient for both ambient temperature and relative humidity changes.

Temperature coefficient: The INRiM measurements showed a temperature coefficient, over nominally the 18 °C to 29 °C internal temperature range, equivalent to between approximately -0.00 °C per °C_{int} and -0.02 °C per °$C_{int,}$ depending on the reference source temperature. The CEM measurements showed a temperature coefficient, over nominally the 19.5 °C to 27.5 °C internal temperature range, equivalent to approximately -0.02 °C per °C_{int} at a reference source temperature of 660 °C. The INRiM results at 660 °C were equivalent to the average CEM results at 660 °C.

Looking at the participant measurements of the fixed-point and variable temperature blackbody sources (Sections 6, 7 and 8 of the main comparison report), the typical internal temperature range for the INRiM thermometer was 23 °C to 28 °C (the overall range was from 22.8 °C to 28.1 °C). The uncertainty/required correction due to these variations in the internal temperature would equate to a maximum value equivalent to approximately ± 0.05 °C, which is negligible compared to the overall laboratory uncertainties and the repeatability of the measurements.

Humidity coefficient: The INRiM results showed a humidity coefficient, over the ~30 %rh to 70 %rh humidity range, equivalent to approximately 0.000 °C per %rh to -0.002 °C per %rh depending on the reference source temperature. The CEM measurement results showed a humidity coefficient, over the ~40 %rh to 72 %rh humidity range, equivalent to approximately 0.000 °C per %rh to +0.003 °C per %rh at a reference source temperature of 660 °C.

The typical laboratory relative humidity range for the variable temperature and fixed-point measurements was 25 %rh to 50 %rh, with the overall range from 18 %rh to 76 %rh. The uncertainty/required correction due to these variations in the relative humidity would equate, typically, to a maximum value equivalent to approximately ± 0.04 °C. No correction was applied to any of the results, due to the discrepancy in the measured values (negative for the INRiM results and positive for the CEM results), and the fact that the relative humidity tended to fluctuate during the variable temperature blackbody (VTBB) and fixed point (FP) measurements in each laboratory: this means that any effect has already been taken into account within the repeatability of the measurements.

3.3.2 Results for the LP5 thermometer:

No laboratory submitted results for measurements with the fixed-point and variable temperature blackbody sources where the LP5 cell temperature was outside its specification. Therefore, in the following analysis, only those values where the cell temperature was within its specification have been considered.

Temperature coefficient: The INRiM measurements showed a temperature coefficient, over the ~23 °C to 26 °C ambient temperature range, equivalent to -0.04 °C per °C_{amb}. The CEM measurements showed a temperature coefficient, over the ~21 °C to 26 °C ambient temperature range, of approximately -0.03 °C per °C_{amb} to -0.12 °C per °C_{amb} at a source temperature of 660 °C.

The typical laboratory temperature range for the variable temperature and fixed-point measurements with the LP5 was 22 °C to 24 °C, with the overall range from 21.6 °C to 24.9 °C. The uncertainty/required correction due to these variations would equate generally from approximately ± 0.03 °C to ± 0.10 °C depending on the sensitivity value chosen. No correction has been applied to the results to take this into account: it is assumed that this will be covered by the laboratory uncertainty and the repeatability of the measurements.

Humidity coefficient: The INRiM measurement results showed a humidity coefficient, over the ~25 %rh to 70 %rh humidity range, of approximately -0.007 °C per %rh to -0.011 °C per %rh depending on the reference source temperature. The CEM measurement results showed a humidity coefficient, over the ~40 %rh to 72%rh humidity range, of approximately ±0.002 °C per %rh at a reference source temperature of 660 °C.

The typical laboratory relative humidity range for the variable temperature and fixed-point measurements was 25 %rh to 50 %rh, with the overall range from 18 %rh to 76 %rh. The uncertainty/required correction due to these variations in the relative humidity would generally equate to approximately from ± 0.03 °C to ± 0.13 °C depending on the sensitivity value chosen. No correction was applied to any of the results, due to the discrepancy in the measured values, and the fact that the relative humidity tended to fluctuate during the measurement process in each laboratory; therefore any effect has already been taken into account within the repeatability of the measurements.

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APPENDIX 4

THE QDE_{95} AND DOE VALUES FOR THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY COMPARISON FOR THE LP5 THERMOMETER AND THE DIRECT COMPARISON OF THE FP AND COMBINED VTBB AND FP RESULTS FOR BOTH THERMOMETERS

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

HELEN MCEVOY

JANUARY 2018

Department for
Business, Energy
& Industrial Strategy

FUNDED BY BEIS

APPENDIX 4

The QDE_{95} and DOE Values for the Fixed-Point and Variable Temperature Blackbody Comparison for the LP5 Thermometer and the Direct Comparison of the FP and Combined VTBB and FP Results for both Thermometers

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Helen McEvoy
Engineering, Materials & Electrical Science

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Approved on behalf of NPL by
Dr Stephanie Bell, Science Area Leader

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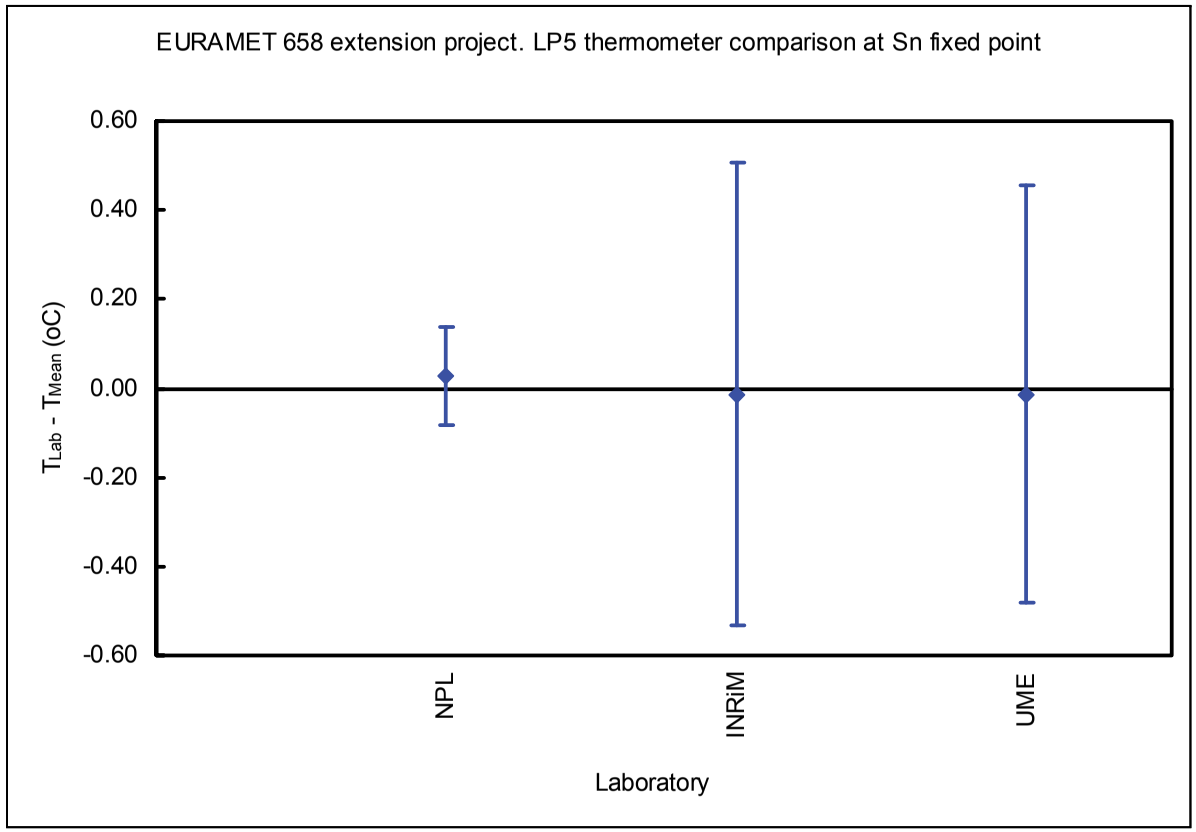
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1 THE DOE AND QDE95 RESULTS FOR THE LP5 THERMOMETER MEASUREMENTS USING THE FIXED POINTS ONLY

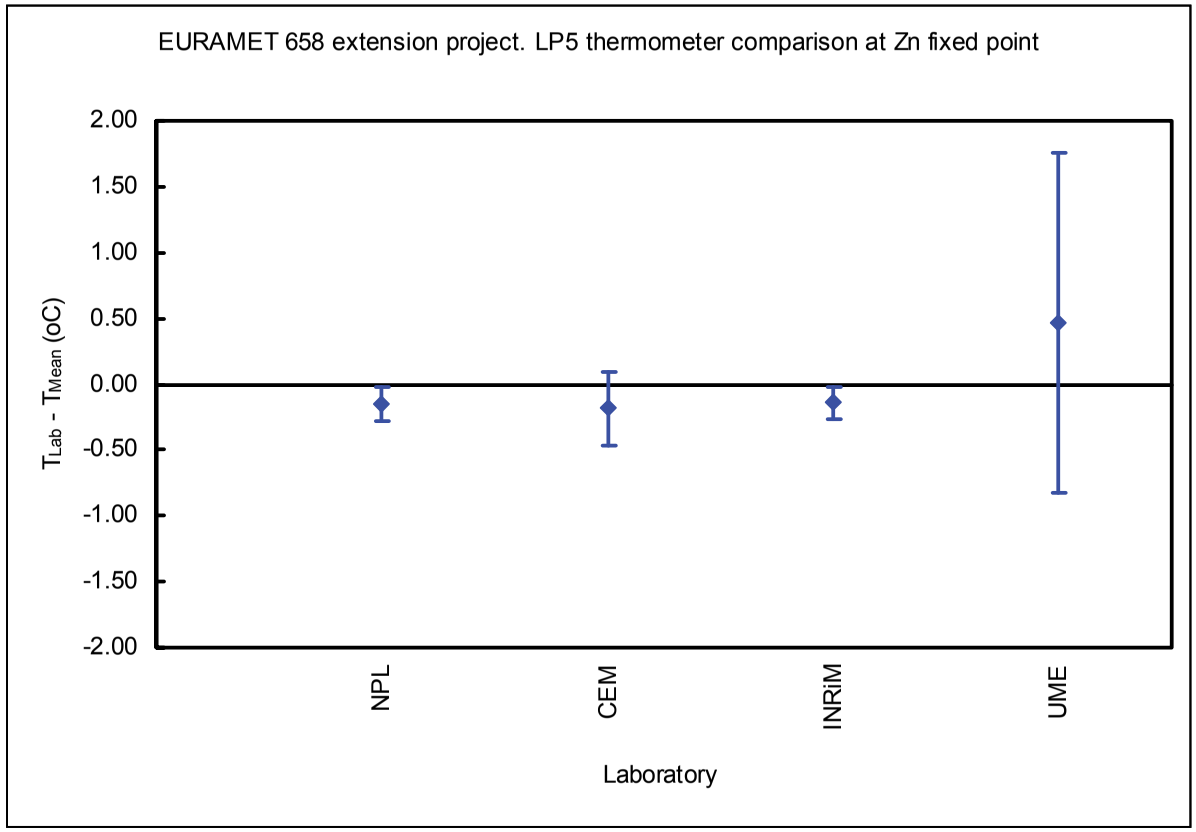
	NPL	INRiM	UME
NPL	-	0.041 ± 0.532	0.040 ± 0.483
INRiM	*0.525*	-	-0.001 ± 0.701
UME	*0.478*	*0.692*	-

Table 1 – direct comparison of the results for the calibration of the LP5 thermometer at the Sn point



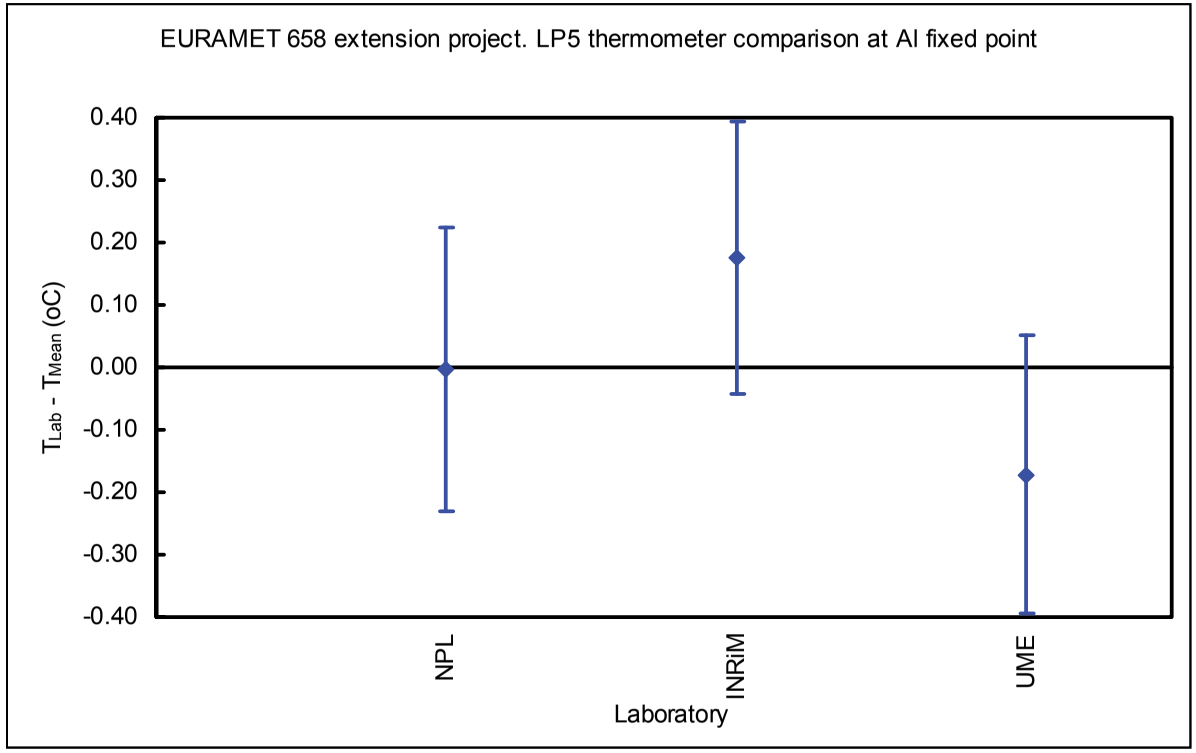
	NPL	CEM	INRiM	UME
NPL	-	0.029 ± 0.307	-0.014 ± 0.175	-0.621 ± 1.142
CEM	*0.305*	-	-0.043 ± 0.305	-0.650 ± 1.169
INRiM	*0.173*	*0.310*	-	-0.607 ± 1.142
UME	*1.563*	*1.614*	*1.549*	-

Table 2 - direct comparison of the results for the calibration of the LP5 thermometer at the Zn point with range R1



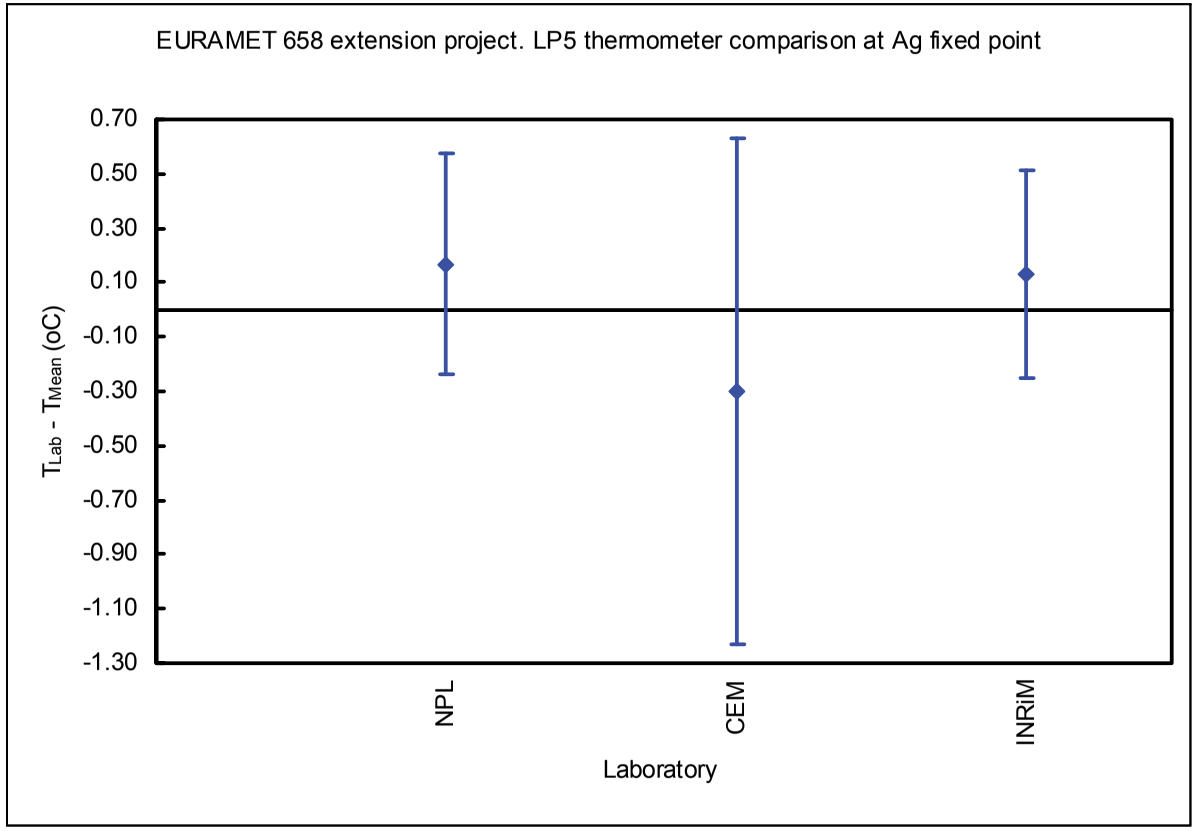
	NPL	INRiM	UME
NPL	-	-0.180 ± 0.316	0.168 ± 0.319
INRiM	*0.440*	-	0.348 ± 0.313
UME	*0.431*	*0.605*	-

Table 3 – direct comparison of the results for the calibration of the LP5 thermometer at the Al point



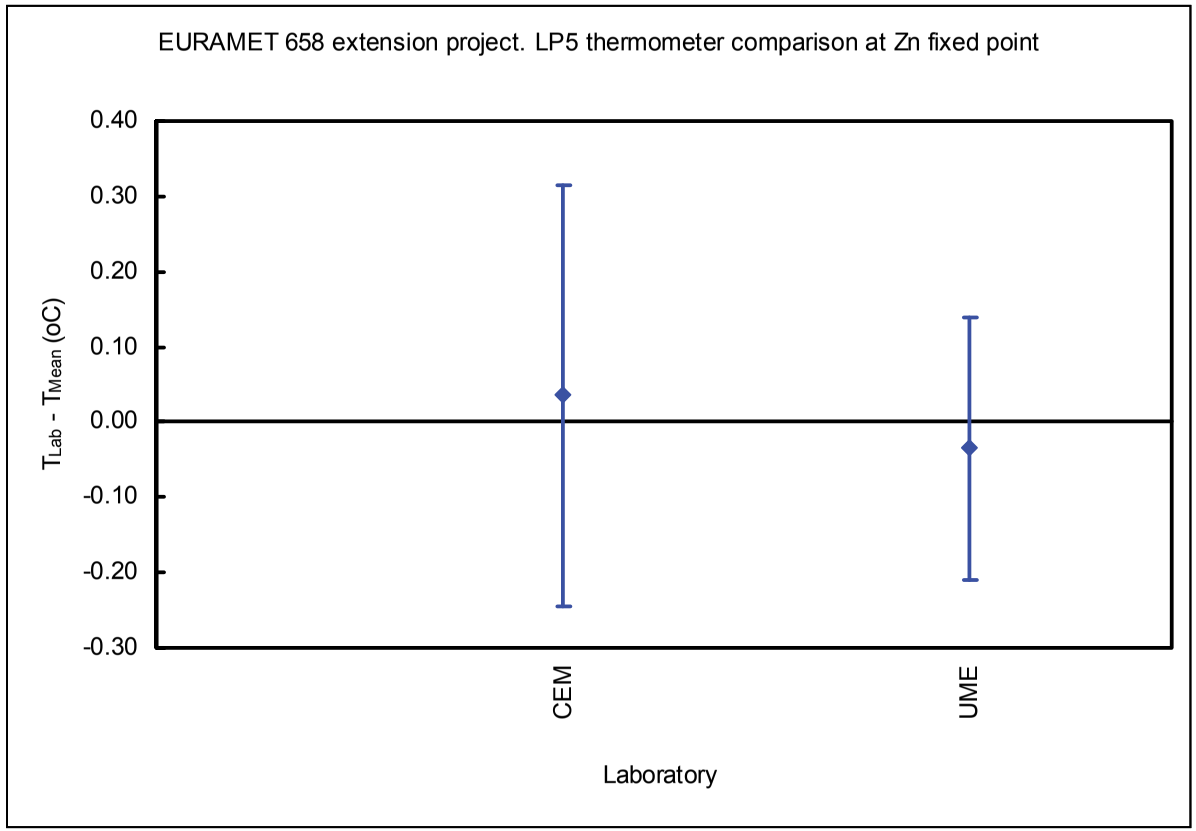
	NPL	CEM	INRiM
NPL	-	0.468 ± 1.014	0.037 ± 0.556
CEM	*1.306*	-	-0.432 ± 1.005
INRiM	*0.548*	*1.264*	-

Table 4 – direct comparison of the results for the calibration of the LP5 thermometer at the Ag point



	CEM	UME
CEM	-	0.070 ± 0.330
UME	*0.351*	-

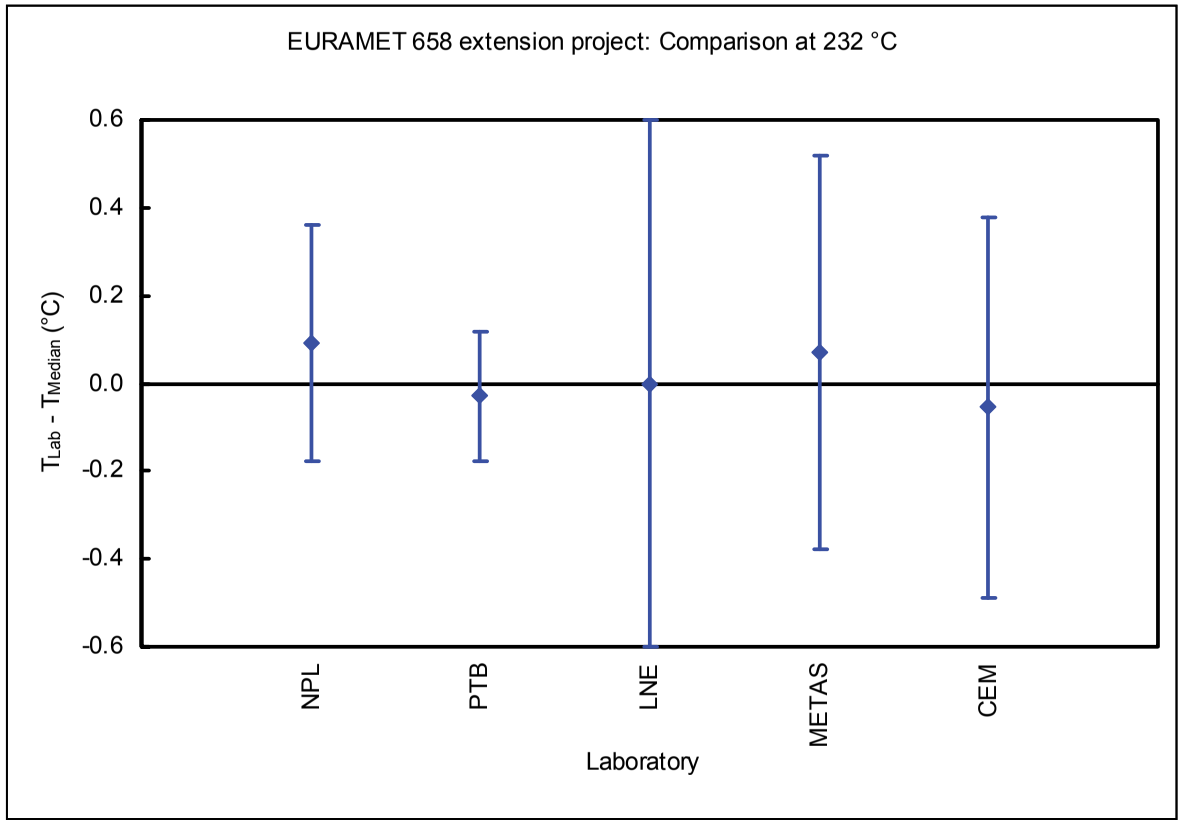
Table 5– direct comparison of the results for the calibration of the LP5 thermometer at the Zn point with range R2



2 THE DOE AND QDE_{95} RESULTS FOR THE LP5 THERMOMETER MEASUREMENTS USING THE VTBBS

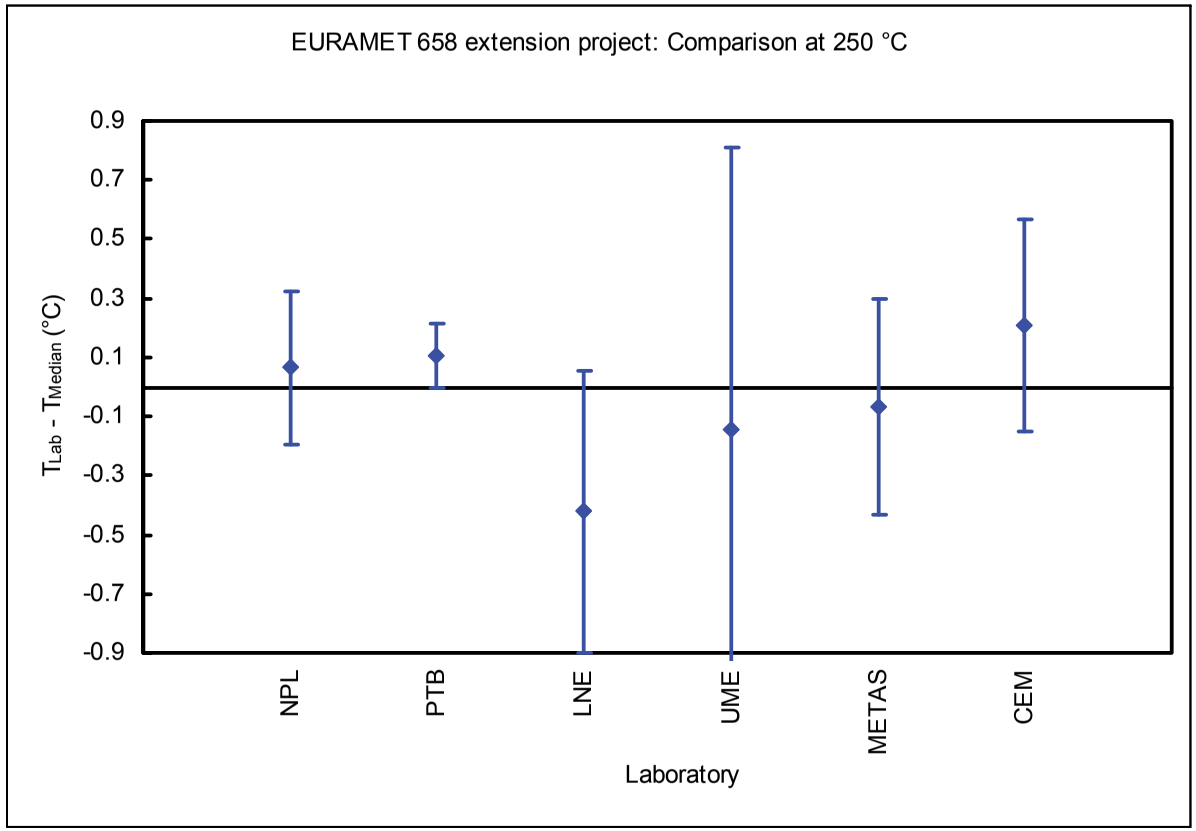
	NPL	PTB	LNE	METAS	CEM
NPL	-	0.12 ± 0.305	0.09 ± 0.657	0.02 ± 0.524	0.15 ± 0.511
PTB	*0.37*	-	-0.03 ± 0.618	-0.10 ± 0.473	0.03 ± 0.459
LNE	*0.67*	*0.61*	-	-0.07 ± 0.750	0.05 ± 0.741
METAS	*0.51*	*0.50*	*0.75*	-	0.13 ± 0.626
CEM	*0.58*	*0.45*	*0.73*	*0.66*	-

Table 6 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 232 °C



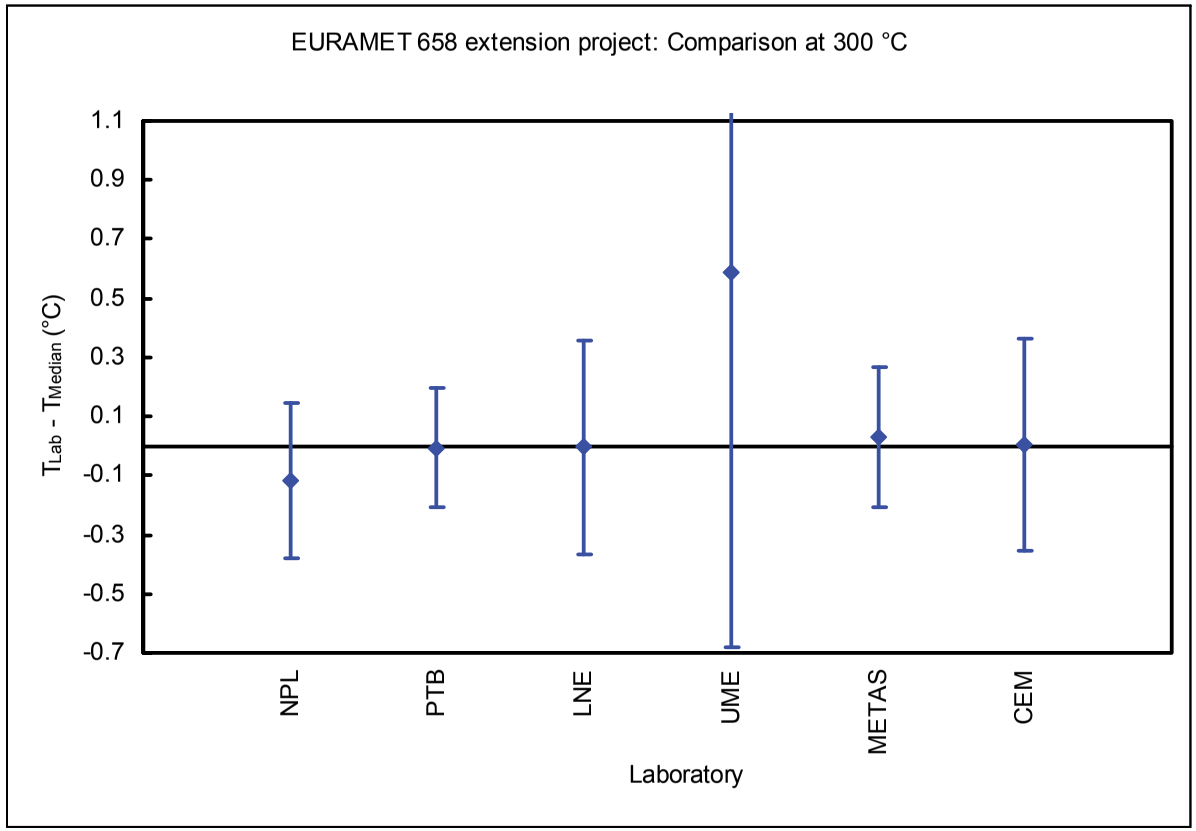
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.04 ± 0.281	0.49 ± 0.546	0.21 ± 0.990	0.13 ± 0.448	-0.14 ± 0.442
PTB	*0.29*	-	0.53 ± 0.492	0.25 ± 0.962	0.17 ± 0.381	-0.10 ± 0.374
LNE	*0.94*	*0.93*	-	-0.28 ± 1.069	-0.36 ± 0.603	-0.63 ± 0.598
UME	*1.05*	*1.06*	*1.18*	-	-0.08 ± 1.023	-0.35 ± 1.020
METAS	*0.51*	*0.49*	*0.85*	*1.01*	-	-0.28 ± 0.511
CEM	*0.51*	*0.42*	*1.12*	*1.20*	*0.70*	-

Table 7 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 250 °C



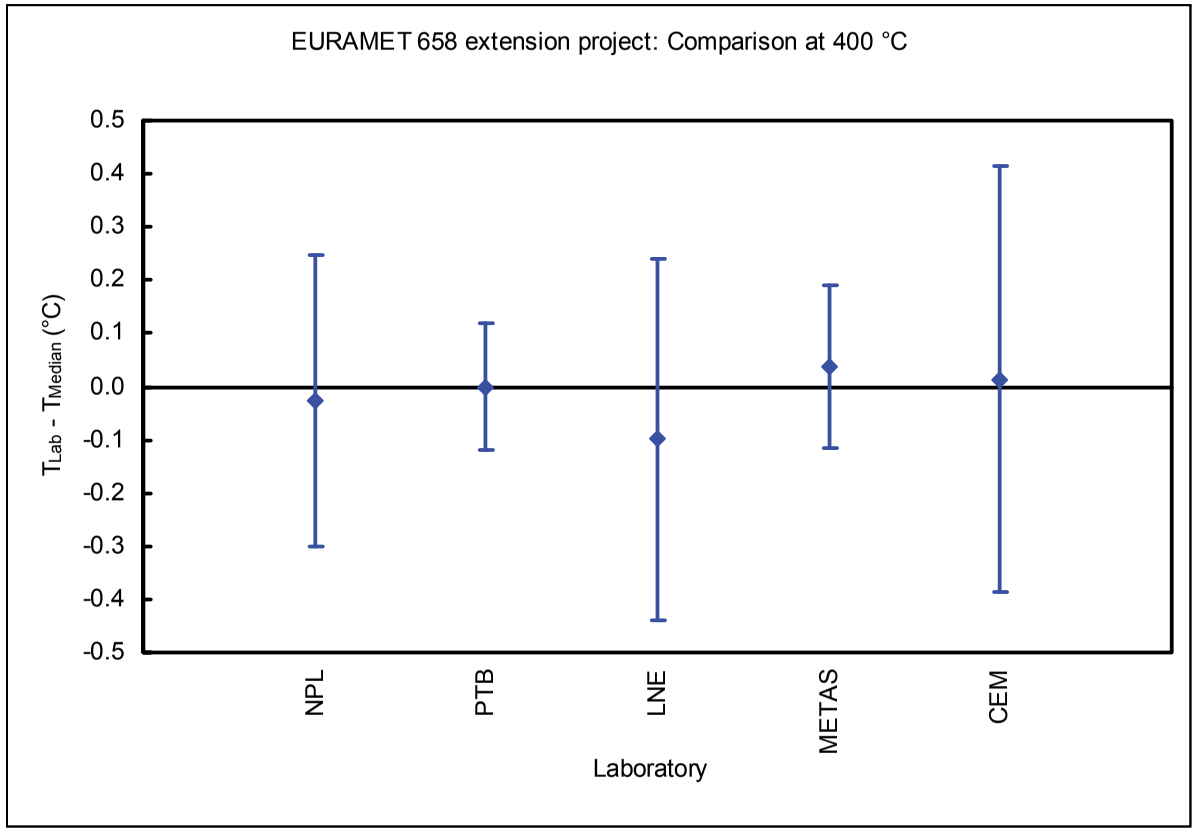
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.11 ± 0.331	-0.11 ± 0.446	-0.70 ± 1.295	-0.14 ± 0.355	-0.12 ± 0.446
PTB	*0.39*	-	0.00 ± 0.412	-0.59 ± 1.284	-0.04 ± 0.312	-0.01 ± 0.413
LNE	*0.49*	*0.41*	-	-0.59 ± 1.318	-0.03 ± 0.432	-0.01 ± 0.510
UME	*1.77*	*1.65*	*1.68*	-	0.56 ± 1.290	0.58 ± 1.318
METAS	*0.44*	*0.31*	*0.43*	*1.62*	-	0.02 ± 0.433
CEM	*0.50*	*0.41*	*0.50*	*1.67*	*0.43*	-

Table 8 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 300 °C



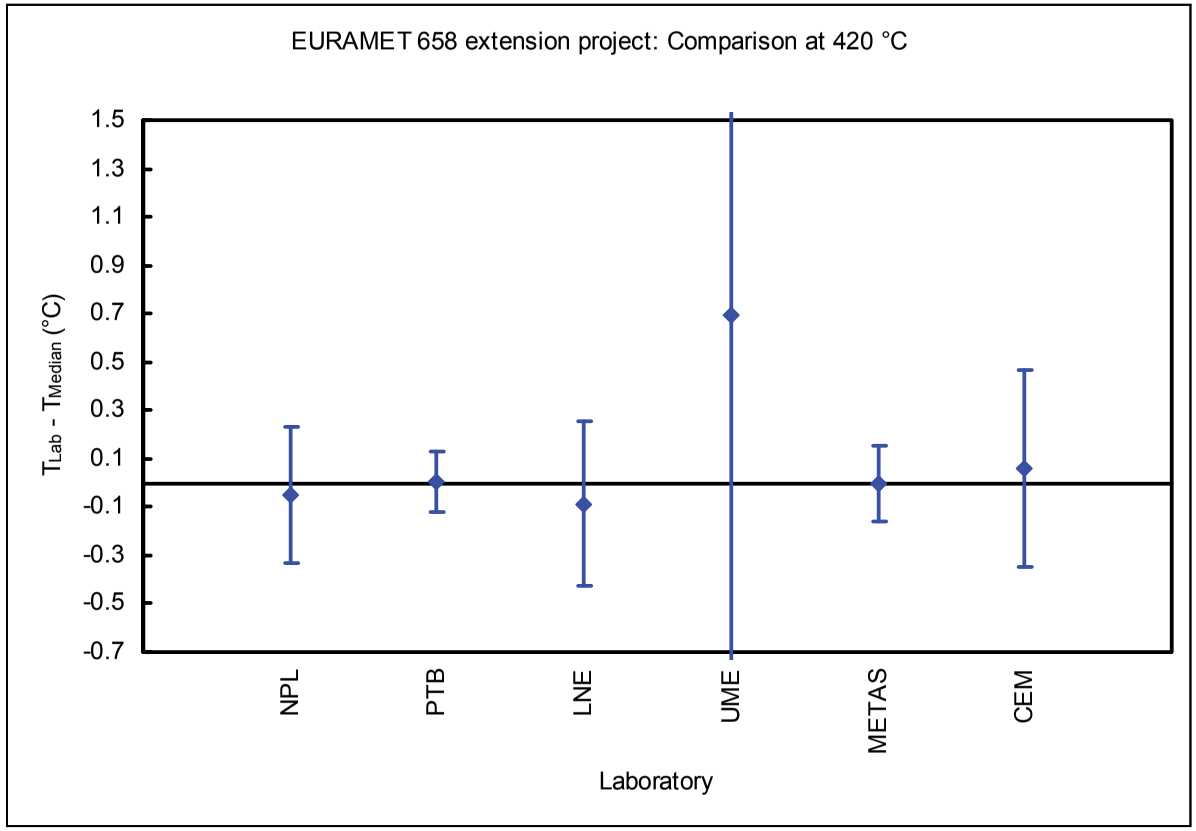
	NPL	PTB	LNE	METAS	CEM
NPL	-	-0.03 ± 0.299	0.07 ± 0.437	-0.06 ± 0.314	-0.04 ± 0.484
PTB	*0.30*	-	0.10 ± 0.360	-0.04 ± 0.194	-0.01 ± 0.416
LNE	*0.45*	*0.40*	-	-0.14 ± 0.373	-0.11 ± 0.524
METAS	*0.33*	*0.20*	*0.45*	-	0.02 ± 0.427
CEM	*0.48*	*0.41*	*0.56*	*0.42*	-

Table 9 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 400 °C



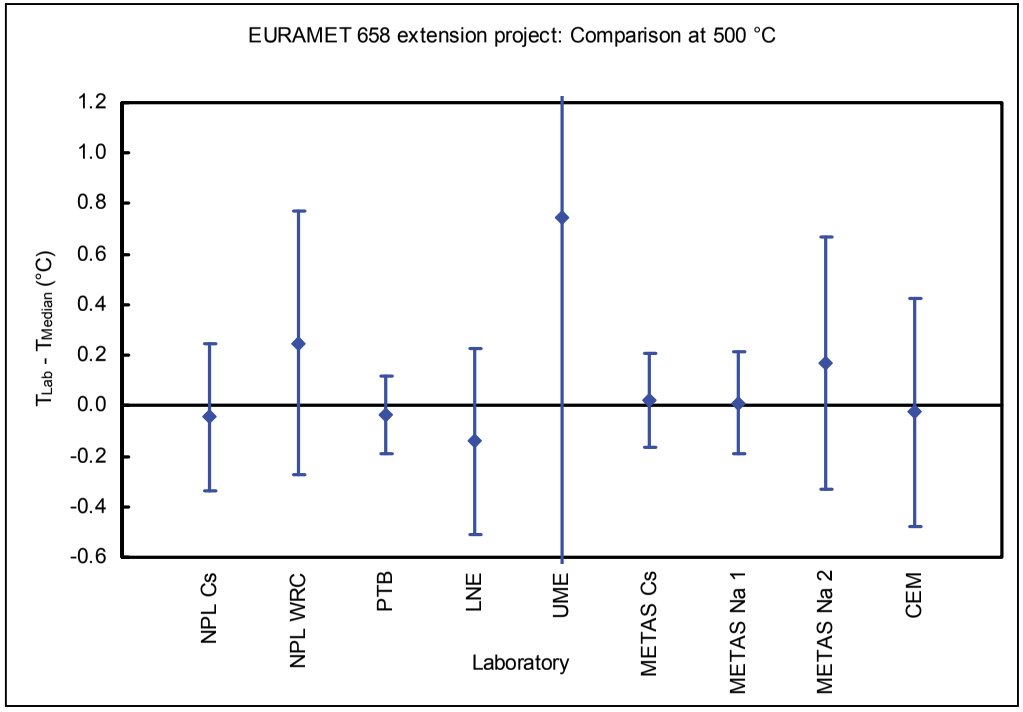
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.05 ± 0.307	0.04 ± 0.440	-0.74 ± 1.566	-0.05 ± 0.322	-0.11 ± 0.495
PTB	*0.32*	-	0.09 ± 0.362	-0.69 ± 1.546	0.00 ± 0.202	-0.05 ± 0.427
LNE	*0.44*	*0.40*	-	-0.78 ± 1.578	-0.09 ± 0.375	-0.14 ± 0.531
UME	*2.04*	*1.97*	*2.09*	-	0.70 ± 1.549	0.64 ± 1.594
METAS	*0.33*	*0.20*	*0.40*	*1.98*	-	-0.06 ± 0.438
CEM	*0.53*	*0.43*	*0.59*	*1.96*	*0.44*	-

Table 10 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 420 °C



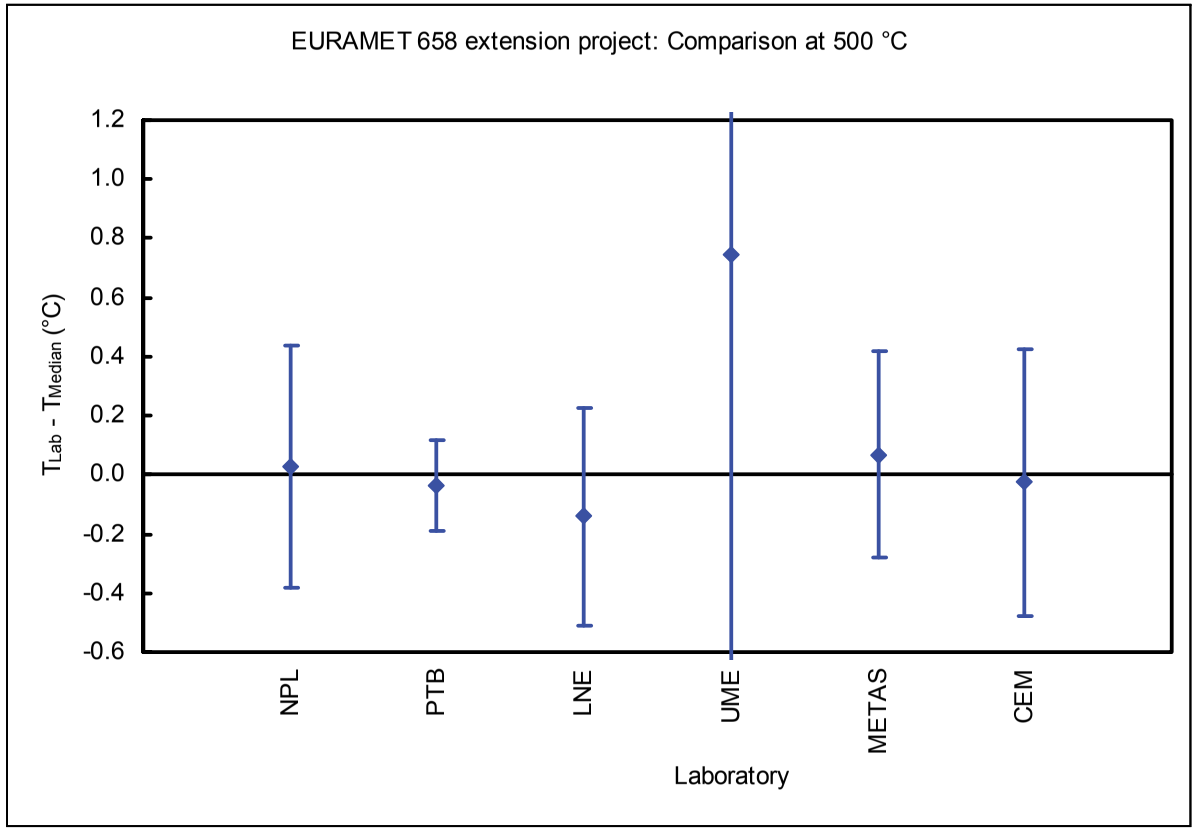
	NPL Cs	NPL WRC	PTB	LNE	UME	METAS Cs	METAS Na 1	METAS Na 2	CEM
NPL Cs	-	-0.29 ± 0.598	-0.01 ± 0.330	0.10 ± 0.471	-0.79 ± 1.857	-0.07 ± 0.346	-0.06 ± 0.354	-0.22 ± 0.579	-0.02 ± 0.539
NPL WRC	*0.79*	-	0.28 ± 0.544	0.39 ± 0.640	-0.50 ± 1.907	0.22 ± 0.554	0.24 ± 0.559	0.08 ± 0.723	0.27 ± 0.692
PTB	*0.32*	*0.73*	-	0.11 ± 0.401	-0.78 ± 1.841	-0.06 ± 0.242	-0.05 ± 0.254	-0.21 ± 0.523	-0.01 ± 0.480
LNE	*0.50*	*0.91*	*0.44*	-	-0.89 ± 1.871	-0.16 ± 0.414	-0.15 ± 0.421	-0.31 ± 0.622	-0.11 ± 0.586
UME	*2.33*	*2.11*	*2.31*	*2.43*	-	0.72 ± 1.844	0.74 ± 1.845	0.58 ± 1.901	0.77 ± 1.890
METAS Cs	*0.36*	*0.68*	*0.26*	*0.51*	*2.25*	-	0.01 ± 0.274	-0.15 ± 0.533	0.05 ± 0.491
METAS Na 1	*0.36*	*0.70*	*0.26*	*0.50*	*2.26*	*0.27*	-	-0.16 ± 0.539	0.04 ± 0.496
METAS Na 2	*0.70*	*0.72*	*0.64*	*0.82*	*2.17*	*0.59*	*0.61*	-	0.20 ± 0.675
CEM	*0.53*	*0.85*	*0.47*	*0.62*	*2.34*	*0.49*	*0.49*	*0.76*	-

Table 11– direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 500 °C, with data from different sources



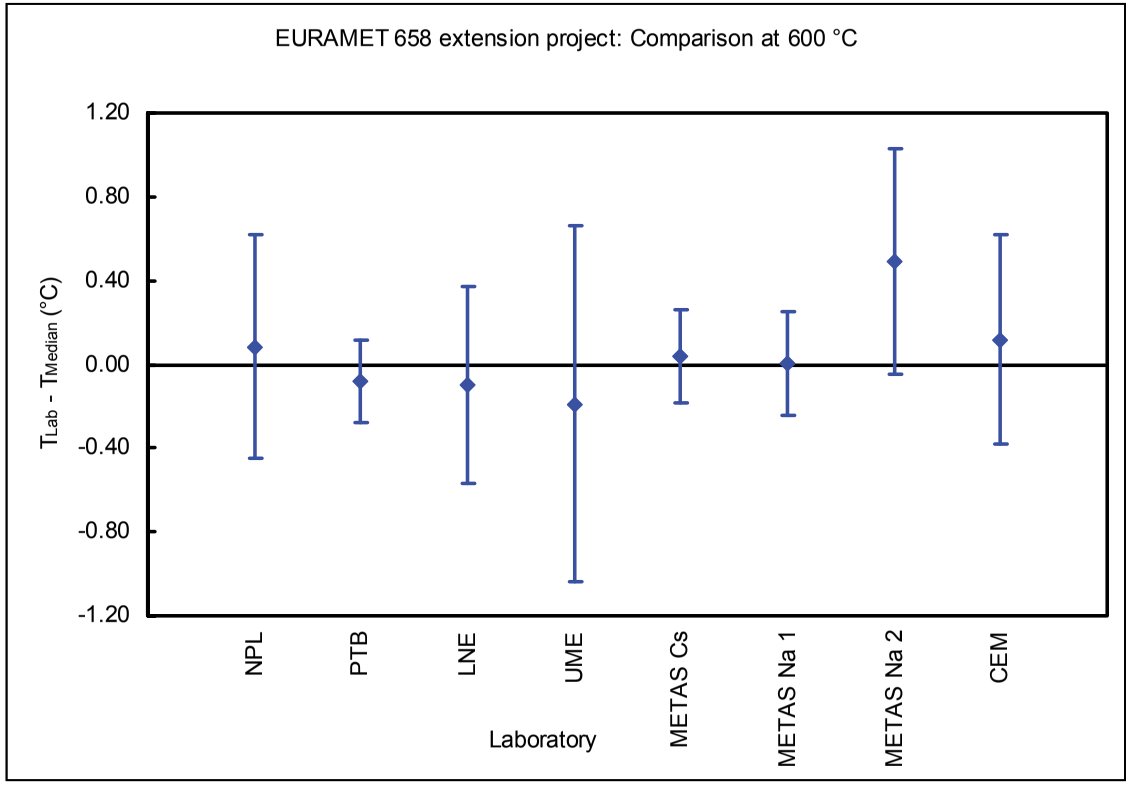
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.06 ± 0.438	0.17 ± 0.552	-0.72 ± 1.879	-0.04 ± 0.539	0.05 ± 0.612
PTB	*0.45*	-	0.11 ± 0.401	-0.78 ± 1.841	-0.10 ± 0.383	-0.01 ± 0.480
LNE	*0.63*	*0.44*	-	-0.89 ± 1.871	-0.21 ± 0.509	-0.11 ± 0.586
UME	*2.28*	*2.31*	*2.43*	-	0.68 ± 1.867	0.77 ± 1.890
METAS	*0.53*	*0.43*	*0.63*	*2.23*	-	0.09 ± 0.573
CEM	*0.61*	*0.47*	*0.62*	*2.34*	*0.59*	-

Table 12 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 500 °C – average data



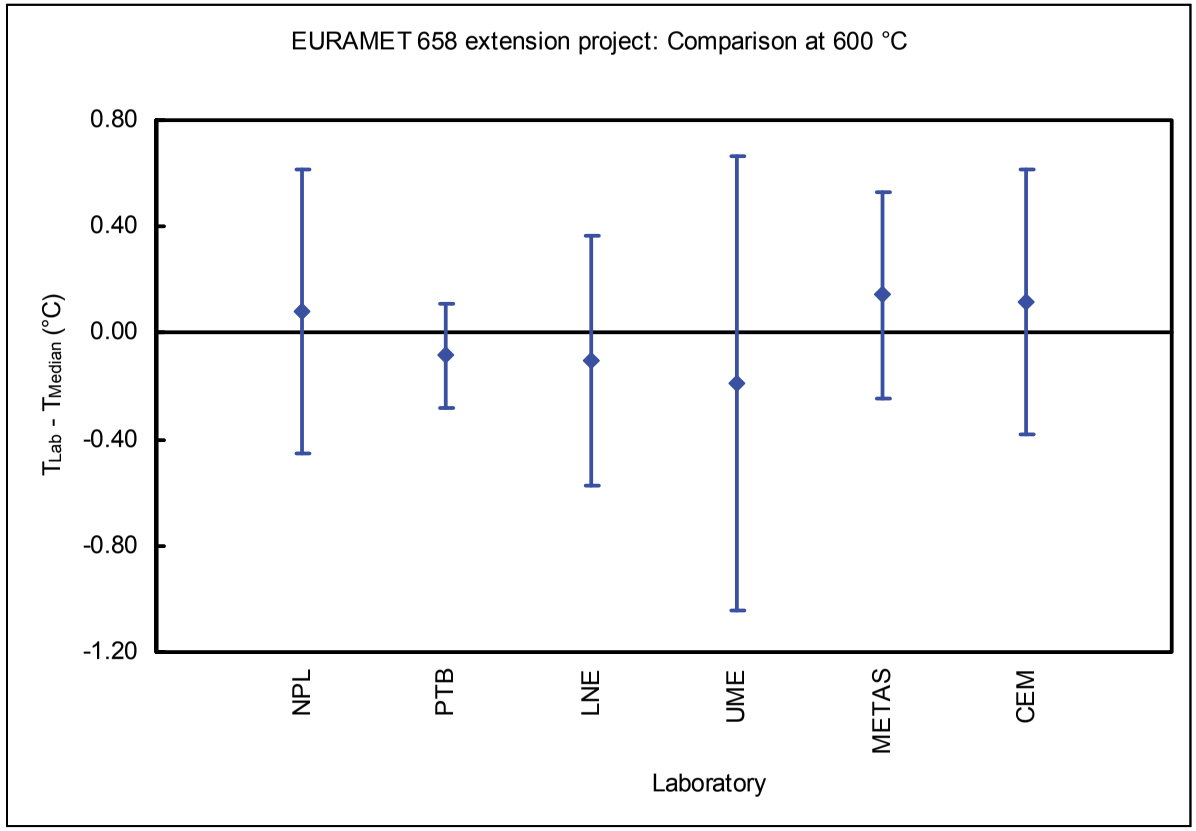
	NPL	PTB	LNE	UME	METAS Cs	METAS Na 1	METAS Na 2	CEM
NPL	-	0.17 ± 0.570	0.19 ± 0.712	0.27 ± 1.006	0.05 ± 0.581	0.08 ± 0.589	-0.41 ± 0.761	-0.03 ± 0.732
PTB	*0.64*	-	0.02 ± 0.509	0.11 ± 0.874	-0.12 ± 0.299	-0.09 ± 0.316	-0.57 ± 0.576	-0.20 ± 0.537
LNE	*0.79*	*0.50*	-	0.09 ± 0.973	-0.14 ± 0.521	-0.11 ± 0.531	-0.59 ± 0.717	-0.22 ± 0.686
UME	*1.12*	*0.88*	*0.97*	-	-0.23 ± 0.881	-0.19 ± 0.887	-0.68 ± 1.009	-0.31 ± 0.987
METAS Cs	*0.57*	*0.37*	*0.58*	*0.97*	-	0.03 ± 0.334	-0.45 ± 0.586	-0.08 ± 0.548
METAS Na 1	*0.60*	*0.35*	*0.56*	*0.95*	*0.33*	-	-0.49 ± 0.595	-0.11 ± 0.557
METAS Na 2	*1.04*	*1.05*	*1.18*	*1.51*	*0.94*	*0.98*	-	0.37 ± 0.736
CEM	*0.72*	*0.65*	*0.79*	*1.13*	*0.56*	*0.59*	*0.98*	-

Table 13 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 600 °C, with data from different sources



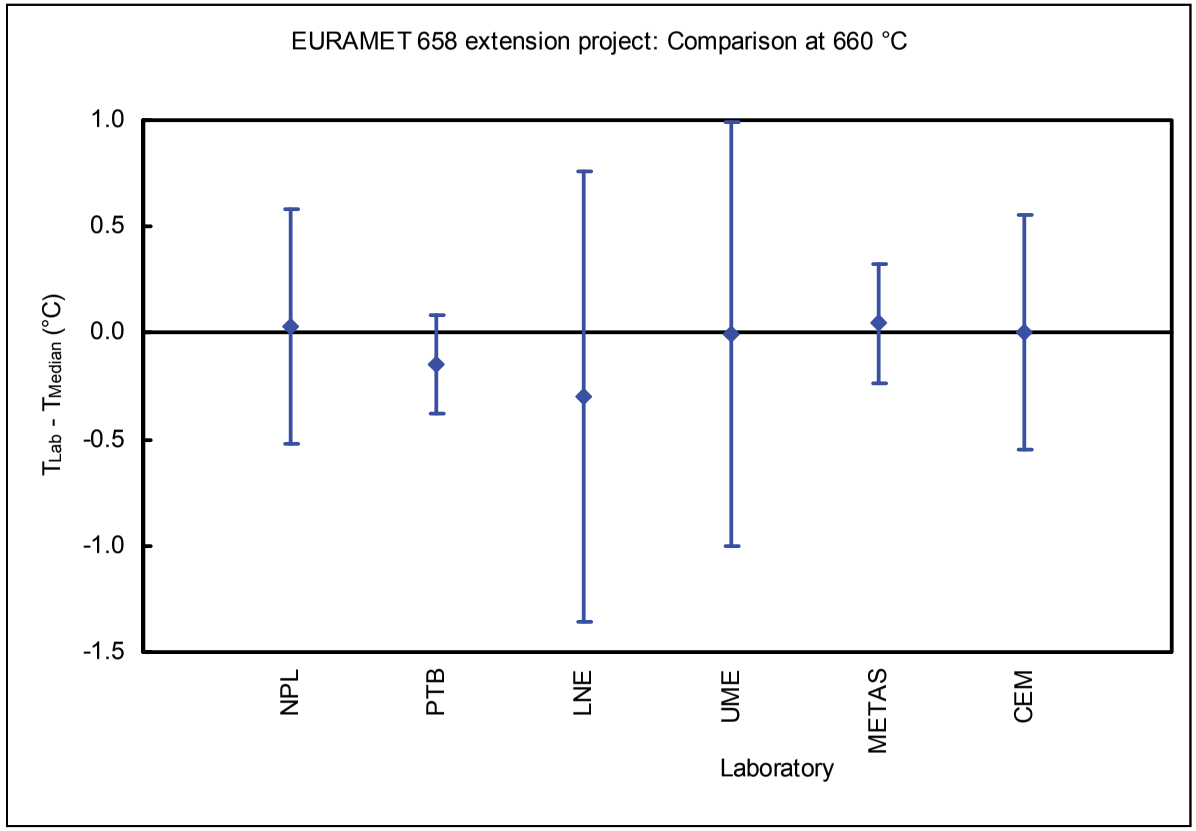
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.17 ± 0.570	0.19 ± 0.712	0.27 ± 1.006	-0.06 ± 0.662	-0.03 ± 0.732
PTB	*0.64*	-	0.02 ± 0.509	0.11 ± 0.874	-0.23 ± 0.437	-0.20 ± 0.537
LNE	*0.79*	*0.50*	-	0.09 ± 0.973	-0.24 ± 0.611	-0.22 ± 0.686
UME	*1.12*	*0.88*	*0.97*	-	-0.33 ± 0.937	-0.31 ± 0.987
METAS	*0.66*	*0.59*	*0.75*	*1.11*	-	0.03 ± 0.634
CEM	*0.72*	*0.65*	*0.79*	*1.13*	*0.62*	-

Table 14 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 600 °C - average data



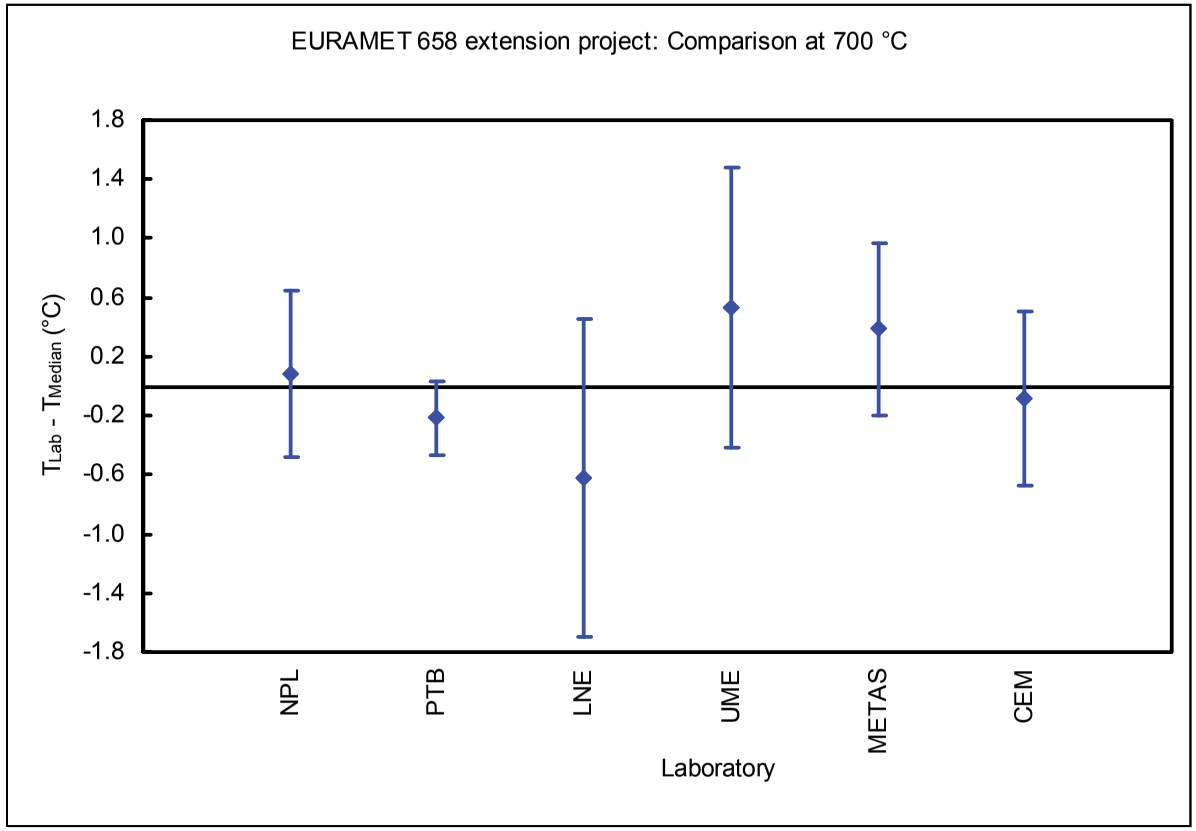
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.18 ± 0.600	0.33 ± 1.196	0.04 ± 1.138	-0.01 ± 0.620	0.02 ± 0.782
PTB	*0.68*	-	0.15 ± 1.085	-0.14 ± 1.020	-0.19 ± 0.361	-0.15 ± 0.598
LNE	*1.34*	*1.10*	-	-0.30 ± 1.453	-0.34 ± 1.096	-0.31 ± 1.195
UME	*1.12*	*1.04*	*1.54*	-	-0.05 ± 1.032	-0.01 ± 1.136
METAS	*0.61*	*0.49*	*1.26*	*1.01*	-	0.04 ± 0.618
CEM	*0.77*	*0.66*	*1.31*	*1.12*	*0.61*	-

Table 15 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 660 °C



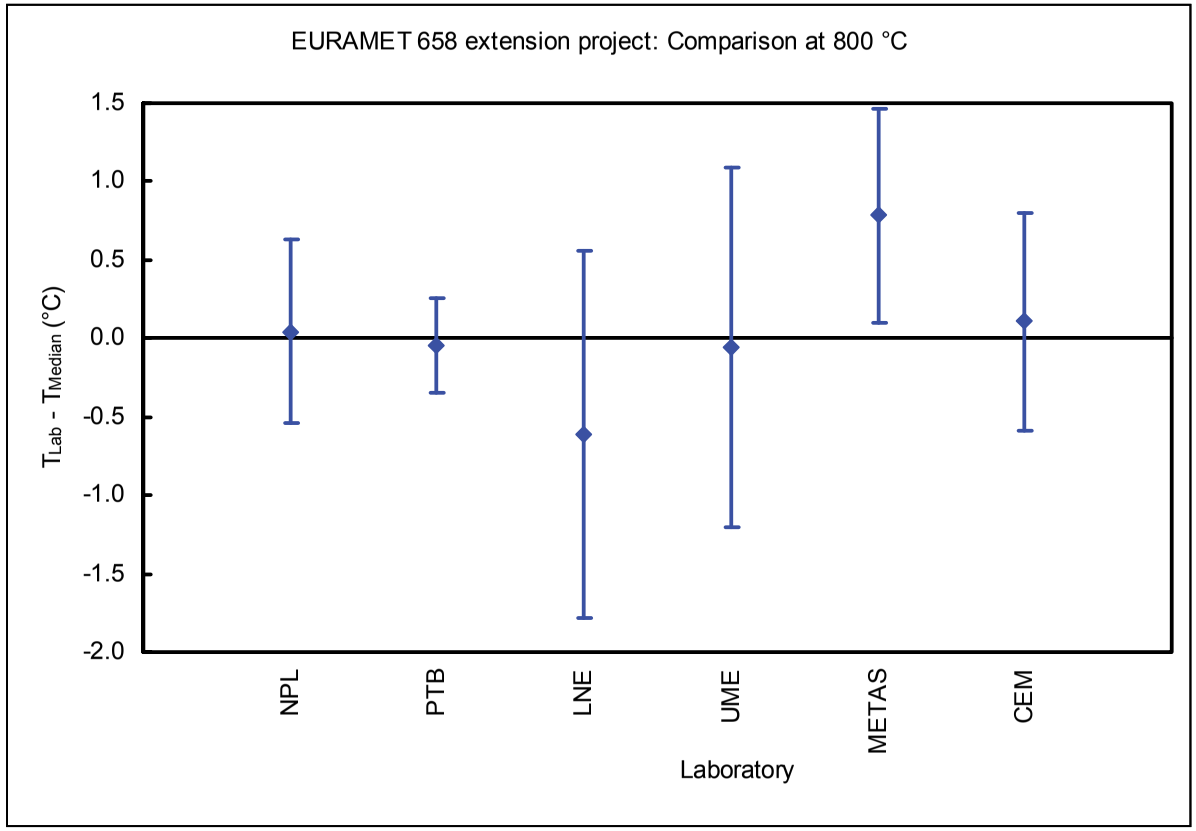
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.30 ± 0.615	0.71 ± 1.218	-0.45 ± 1.104	-0.30 ± 0.811	0.17 ± 0.815
PTB	*0.81*	-	0.41 ± 1.108	-0.75 ± 0.983	-0.60 ± 0.635	-0.13 ± 0.640
LNE	*1.71*	*1.33*	-	-1.15 ± 1.439	-1.01 ± 1.228	-0.53 ± 1.231
UME	*1.36*	*1.56*	*2.34*	-	0.15 ± 1.116	0.62 ± 1.119
METAS	*0.97*	*1.12*	*2.02*	*1.13*	-	0.47 ± 0.830
CEM	*0.87*	*0.68*	*1.55*	*1.54*	*1.16*	-

Table 16 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 700 °C



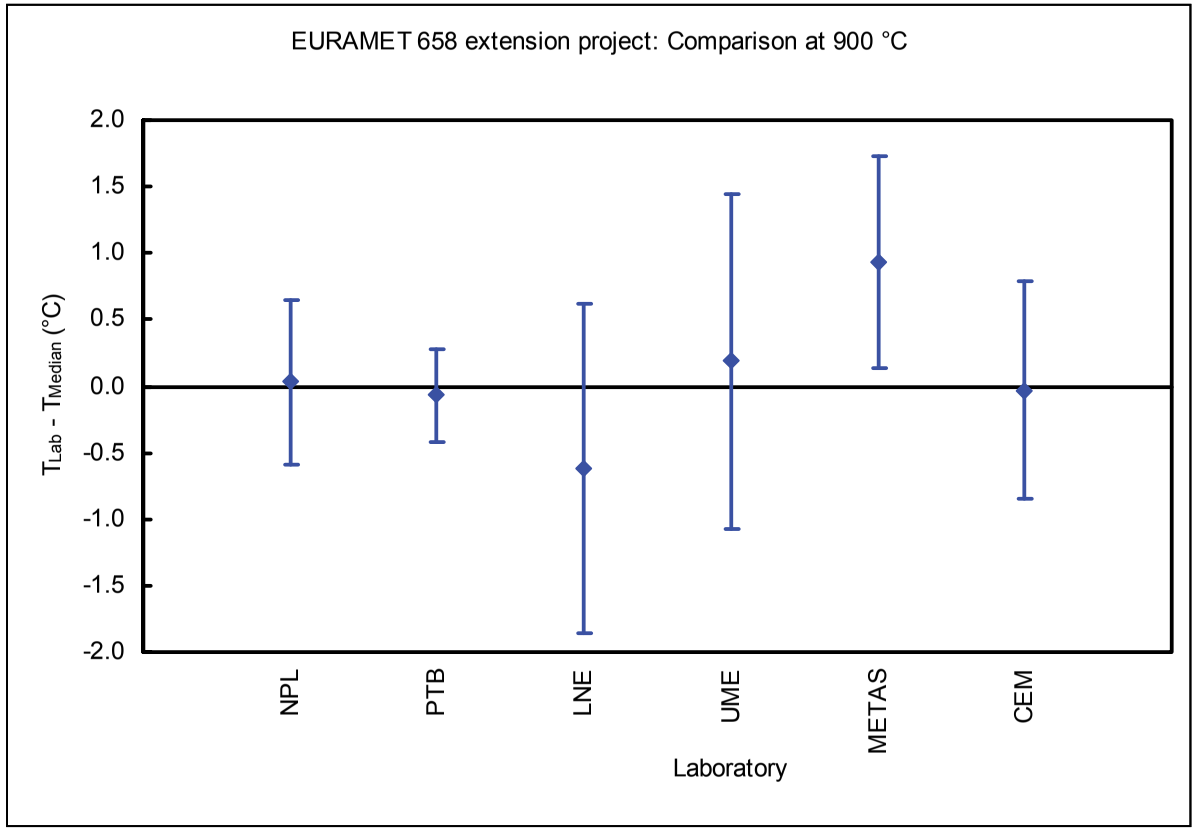
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.09 ± 0.654	0.66 ± 1.307	0.10 ± 1.283	-0.74 ± 0.896	-0.06 ± 0.907
PTB	*0.66*	-	0.57 ± 1.208	0.01 ± 1.182	-0.83 ± 0.745	-0.15 ± 0.757
LNE	*1.74*	*1.57*	-	-0.56 ± 1.636	-1.40 ± 1.354	-0.72 ± 1.361
UME	*1.27*	*1.16*	*1.92*	-	-0.84 ± 1.331	-0.16 ± 1.338
METAS	*1.48*	*1.44*	*2.51*	*1.94*	-	0.68 ± 0.974
CEM	*0.89*	*0.80*	*1.85*	*1.35*	*1.48*	-

Table 17 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 800 °C



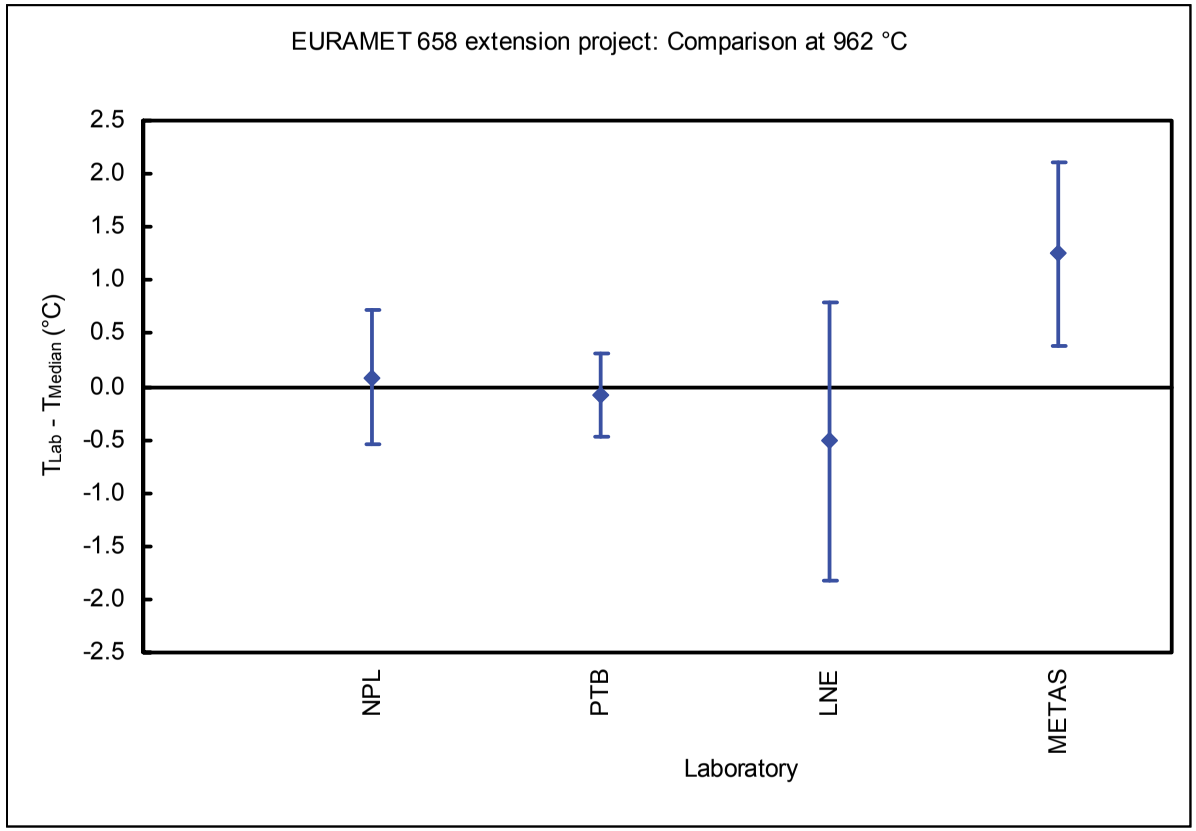
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.10 ± 0.708	0.65 ± 1.383	-0.16 ± 1.403	-0.91 ± 1.005	0.06 ± 1.019
PTB	*0.72*	-	0.55 ± 1.290	-0.26 ± 1.311	-1.01 ± 0.873	-0.04 ± 0.888
LNE	*1.79*	*1.61*	-	-0.80 ± 1.769	-1.56 ± 1.474	-0.59 ± 1.483
UME	*1.40*	*1.38*	*2.27*	-	-0.75 ± 1.493	0.21 ± 1.502
METAS	*1.74*	*1.73*	*2.77*	*1.98*	-	0.97 ± 1.139
CEM	*1.00*	*0.87*	*1.82*	*1.53*	*1.90*	-

Table 18 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 900 °C



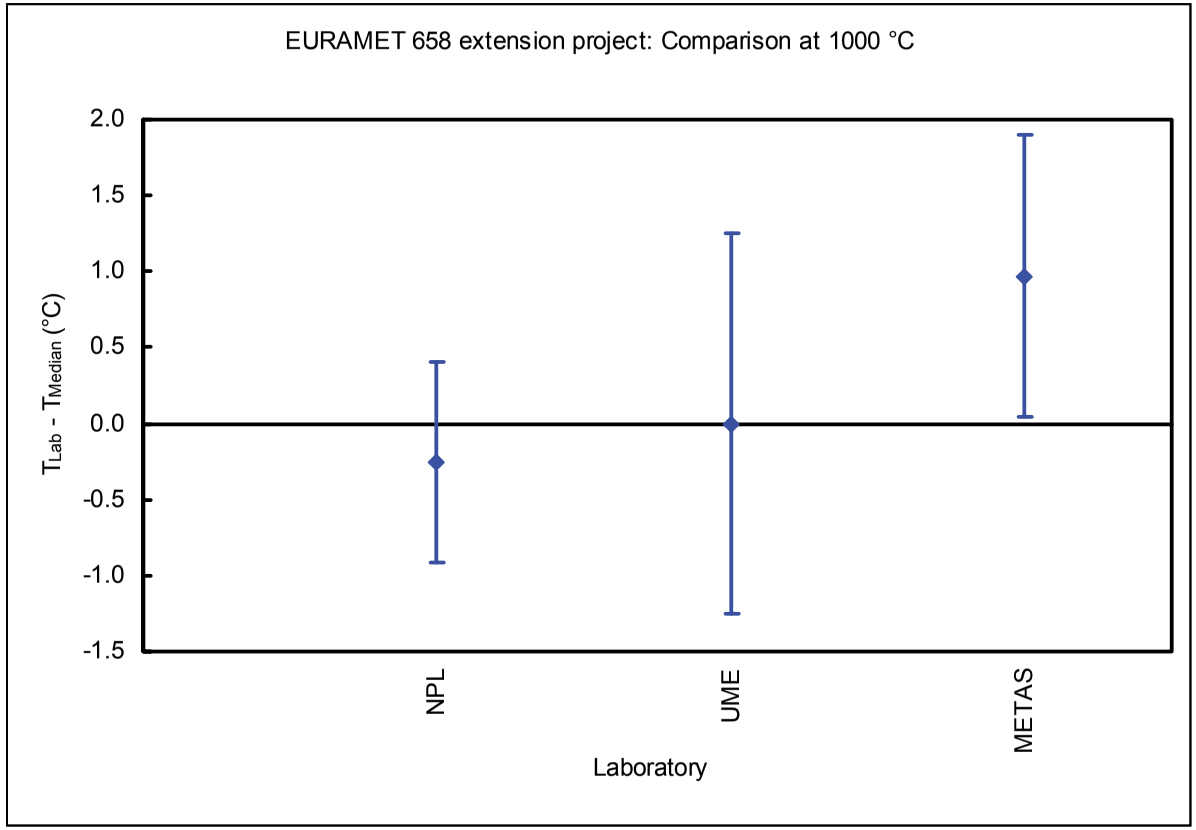
	NPL	PTB	LNE	METAS	CEM
NPL	-	0.17 ± 0.748	0.60 ± 1.447	-1.16 ± 1.074	-0.06 ± 0.481
PTB	*0.81*	-	0.43 ± 1.358	-1.34 ± 0.950	-0.02 ± 0.622
LNE	*1.80*	*1.56*	-	-1.77 ± 1.561	0.23 ± 0.497
METAS	*2.05*	*2.12*	*3.05*	-	-0.13 ± 0.455
CEM	*0.48*	*0.61*	*0.65*	*0.51*	-

Table 19 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 962 °C



	NPL	UME	METAS
NPL	-	-0.25 ± 1.411	-1.22 ± 1.137
UME	*1.47*	-	-0.97 ± 1.553
METAS	*2.16*	*2.25*	-

Table 20 – direct comparison of the results for the LP5 thermometer variable temperature blackbody measurements at 1000 °C



3 ANALYSIS OF THE COMBINED FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY MEASUREMENT RESULTS

The results were also analysed by combining the data using the fixed-point sources (FP) with the data from the variable temperature blackbody sources (VTBB) at the fixed-point temperatures, and performing a direct comparison of the results.

3.1 THE LP5 RESULTS.

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	FP	R1	231.93	3.04800E-12	R1	3.04800E-12	-0.003	3.04770E-12	0.00	3.04770E-12	0.11
231.93	VTBB	R1	232.03	3.06186E-12	R1	3.06186E-12	-0.003	3.06156E-12	-0.10	3.05057E-12	0.27
419.53	FP	R1	419.53	4.14357E-10	R1	4.14357E-10	-0.005	4.14317E-10	0.00	4.14317E-10	0.13
419.53	VTBB	R1	419.42	4.12869E-10	R1	4.12869E-10	-0.005	4.12830E-10	0.11	4.13661E-10	0.28
660.32	FP	R2	660.32	1.25937E-08	R2	1.25937E-08	-0.009	1.25925E-08	0.00	1.25925E-08	0.23
660.32	VTBB	R2	660.04	1.25680E-08	R2	1.25680E-08	-0.009	1.25668E-08	0.28	1.26042E-08	0.55
961.78	FP	R2	961.78	1.38800E-07	R2	1.38800E-07	-0.016	1.38787E-07	0.00	1.38787E-07	0.40
961.78	VTBB	R2	961.78	1.38637E-07	R2	1.38637E-07	-0.016	1.38624E-07	0.00	1.38624E-07	0.64

Table 21 – the combined NPL measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	VTBB	R1	231.946	3.03946E-12	R1	3.03946E-12	0	3.03946E-12	-0.016	3.03774E-12	0.128
419.53	VTBB	R1	419.530	4.14019E-10	R1	4.14019E-10	0	4.14019E-10	0.000	4.14019E-10	0.125
660.32	VTBB	R2	660.312	1.25796E-08	R2	1.25796E-08	0	1.25796E-08	0.008	1.25806E-08	0.230
961.78	VTBB	R2	961.748	1.38461E-07	R2	1.38461E-07	0	1.38461E-07	0.032	1.38488E-07	0.393
231.93	VTBB	R1	231.947	3.03869E-12	R1	3.03869E-12	0	3.03869E-12	-0.017	3.03689E-12	0.147
231.93	VTBB	R1	419.512	4.13968E-10	R1	4.13968E-10	0	4.13968E-10	0.018	4.14109E-10	0.125
961.78	VTBB	R2	961.696	1.38400E-07	R2	1.38400E-07	0	1.38400E-07	0.084	1.38470E-07	0.393

Table 22 – the PTB measurements at the fixed-point temperatures, using variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	VTBB	R1	231.76	2.99090E-12	R1	2.99090E-12	0.293	3.02238E-12	0.17	3.04049E-12	0.60
419.53	VTBB	R1	419.63	4.09805E-10	R1	4.09805E-10	0.551	4.14118E-10	-0.10	4.13359E-10	0.34
419.53	VTBB	R2	660.06	1.23955E-08	R2	1.23955E-08	1.000	1.25259E-08	0.26	1.25605E-08	1.06
660.32	VTBB	R2	961.63	1.36561E-07	R2	1.36561E-07	1.751	1.37998E-07	0.15	1.38124E-07	1.30

Table 23 – the LNE measurements at the fixed-point temperatures, variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	FP	R1	231.93	3.03065E-12	R1	3.03065E-12	0.136	3.04541E-12	0.00	3.04541E-12	0.47
419.53	FP	R2	419.53	4.11979E-10	R1	4.17417E-10	0.255	4.19450E-10	0.00	4.19450E-10	1.29
419.53	VTBB	R2	417.73	3.98655E-10	R1	4.03899E-10	0.224	4.05635E-10	1.80	4.19619E-10	1.54
660.32	FP	R2	660.32	1.25181E-08	R2	1.25181E-08	0.463	1.25791E-08	0.00	1.25791E-08	0.22
660.32	VTBB	R2	655.68	1.19562E-08	R2	1.19562E-08	0.405	1.20076E-08	4.64	1.25996E-08	0.99

Table 24 – the combined UME measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	VTBB	R1	231.913	3.02060E-12	R1	3.02060E-12	0.237	3.04632E-12	0.020	3.04820E-12	0.450
419.53	VTBB	R1	419.500	4.10290E-10	R1	4.10290E-10	0.446	4.13790E-10	0.030	4.14031E-10	0.158
419.53	VTBB	R2	660.335	1.25020E-08	R2	1.25020E-08	0.810	1.26081E-08	-0.020	1.26061E-08	0.278
660.32	VTBB	R2	961.678	1.38340E-07	R2	1.38340E-07	1.417	1.39516E-07	0.100	1.39601E-07	0.865

Table 25 – the METAS measurements at the fixed-point temperatures, using variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	VTBB	R1	231.91	3.02262E-12	R1	3.02262E-12	0.02	3.02522E-12	0.02	3.02740E-12	0.43
419.53	FP	R1	419.53	4.14927E-10	R1	4.14927E-10	0.045	4.15284E-10	0.00	4.15284E-10	0.28
419.53	FP	R1	419.53	4.12569E-10	R1	4.12569E-10	0.045	4.12924E-10	0.00	4.12924E-10	0.28
419.53	VTBB	R1	419.55	4.14299E-10	R1	4.14299E-10	0.045	4.14655E-10	-0.02	4.14497E-10	0.41
660.32	VTBB	R2	660.35	1.25941E-08	R2	1.25941E-08	0.08	1.26049E-08	-0.03	1.26010E-08	0.55
961.78	FP	R2	961.78	1.38577E-07	R2	1.38577E-07	0.143	1.38696E-07	0.00	1.38696E-07	0.93
961.78	FP	R2	961.78	1.38002E-07	R2	1.38002E-07	0.143	1.38121E-07	0.00	1.38121E-07	0.89

Table 26 - the combined CEM measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources for the LP5

t_{nom} / °C	FP or VTBB	Range used	t_{BB} / °C	Bgrd corrected signal/ A	Required range	Signal at required range/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	u (k=2) with range ratio & drift uncertainty* / °C
231.93	FP	R1	231.93	3.01309E-12	R1	3.01309E-12	0.281	3.04348E-12	0.00	3.04348E-12	0.520
419.53	FP	R1	419.53	4.10363E-10	R1	4.10363E-10	0.528	4.14502E-10	0.00	4.14502E-10	0.122
660.32	FP	R2	660.32	1.24922E-08	R2	1.24922E-08	0.959	1.26182E-08	0.00	1.26182E-08	0.219
961.78	FP	R2	961.78	1.37398E-07	R2	1.37398E-07	1.678	1.38784E-07	0.00	1.38784E-07	0.383

Table 27 – the INRiM measurements at the fixed-point temperatures, using fixed-point sources for the LP5

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.04914E-12	0.19
419.53	4.13989E-10	0.20
660.32	1.25983E-08	0.39
961.78	1.38705E-07	0.52
Sn FP	3.04770E-12	0.11
VTBB at Sn	3.05057E-12	0.27
Zn FP	4.14317E-10	0.13
VTBB at Zn	4.13661E-10	0.28
Al FP	1.25925E-08	0.23
VTBB at Al	1.26042E-08	0.55
Ag FP	1.38787E-07	0.40
VTBB at Ag	1.38624E-07	0.64

Table 28 - the average NPL results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.03731E-12	0.147
419.53	4.14064E-10	0.125
660.32	1.25806E-08	0.230
961.78	1.38479E-07	0.393

Table 29 – the average PTB results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.04049E-12	0.60
419.53	4.13359E-10	0.34
660.32	1.25606E-08	1.06
961.78	1.38124E-07	1.30

Table 30 – the average LNE results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.04541E-12	0.47
419.53	4.19535E-10	1.42
660.32	1.25893E-08	0.61
Zn FP	4.19450E-10	1.29
VTBB at Zn	4.19619E-10	1.54
Al FP	1.25791E-08	0.22
VTBB at Al	1.25996E-08	0.99

Table 31 – the average UME results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.04820E-12	0.45
419.53	4.14031E-10	0.16
660.32	1.26061E-08	0.28
961.78	1.39601E-07	0.87

Table 32 – the average METAS results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.03450E-12	0.43
419.53	4.14235E-10	0.34
660.32	1.26010E-08	0.55
961.78	1.38408E-07	0.91
Zn FP	4.14104E-10	0.28
VTBB at Zn	4.14497E-10	0.41

Table 33 – the average CEM results

t_{nom}/ °C	Average signal/A	U (k=2)/ °C
231.93	3.04348E-12	0.52
419.53	4.14502E-10	0.12
660.32	1.26182E-08	0.22
961.78	1.38784E-07	0.38

Table 34 – the average INRiM results

t_{nom}/ °C	Mean signal/ A	Median signal/ A	Weighted signal/ A
231.93	3.04265E-12	3.04348E-12	3.04185E-12
419.53	4.14816E-10	4.14064E-10	4.14178E-10
660.32	1.25934E-08	1.25983E-08	1.26003E-08
961.78	1.38684E-07	1.38592E-07	1.38684E-07

Table 35– mean, median and weighted mean values for all the LP5 measurements

t_{nom}/ °C	NPL – mean/ A	NPL – median/ A	equiv dT* from median / °C	NPL- wghted mean/ A	PTB – mean/ A	PTB – median/ A	equiv dT* from median / °C	PTB- wghted mean/ A	LNE – mean/ A	LNE – median/ A	equiv dT* from median / °C	LNE – wghted mean/ A
231.93	6.4907E-15	5.6608E-15	0.05	7.2900E-15	-5.3368E-15	-6.1667E-15	-0.06	-4.5374E-15	-2.1548E-15	-2.9847E-15	-0.03	-1.3554E-15
419.53	-8.2723E-13	-7.4891E-14	-0.01	-1.8881E-13	-7.5234E-13	0.0000E+00	0.00	-1.1392E-13	-1.4574E-12	-7.0510E-13	-0.09	-8.1902E-13
660.32	4.9094E-12	0.0000E+00	0.00	-1.9521E-12	-1.2840E-11	-1.7750E-11	-0.13	-1.9702E-11	-3.2890E-11	-3.7800E-11	-0.29	-3.9752E-11
961.78	2.1952E-11	1.1325E-10	0.14	2.1786E-11	-2.0455E-10	-1.1325E-10	-0.14	-2.0471E-10	-5.5945E-10	-4.6815E-10	-0.56	-5.5961E-10
Sn FP	5.0582E-15	4.2283E-15	0.04	5.8575E-15	-	-	-	-	-	-	-	-
VTBB -Sn	7.9232E-15	7.0933E-15	0.06	8.7226E-15	-	-	-	-	-	-	-	-
Zn FP	-4.9912E-13	2.5322E-13	0.03	1.3929E-13	-	-	-	-	-	-	-	-
VTBB -Zn	-1.1553E-12	-4.0300E-13	-0.05	-5.1692E-13	-	-	-	-	-	-	-	-
Al FP	-9.4082E-13	-5.8502E-12	-0.04	-7.8024E-12	-	-	-	-	-	-	-	-
VTBB -Al	1.0760E-11	5.8502E-12	0.04	3.8981E-12	-	-	-	-	-	-	-	-
Ag FP	1.0345E-10	1.9475E-10	0.23	1.0329E-10	-	-	-	-	-	-	-	-
VTBB -Ag	-5.9548E-11	3.1750E-11	0.04	-5.9714E-11	-	-	-	-	-	-	-	-

Table 36 - differences of the laboratory results from the mean, median and weighted mean values for the LP5 thermometer – table 1 of 3

t_{nom}/ °C	UME – mean/ A	UME - median/ A	equiv dT* from median / °C	UME- wghted mean/ A	METAS - mean/ A	METAS- median/ A	equiv dT* from median / °C	METAS- wghted mean/ A	CEM - mean/ A	CEM- median/ A	equiv dT* from median / °C	CEM – wghted mean/ A
231.93	2.7646E-15	1.9347E-15	0.02	3.5639E-15	5.5532E-15	4.7233E-15	0.04	6.3526E-15	-8.1468E-15	-8.9767E-15	-0.08	-7.3474E-15
419.53	4.7183E-12	5.4707E-12	0.69	5.3567E-12	-7.8534E-13	-3.3000E-14	0.00	-1.4692E-13	-5.8149E-13	1.7085E-13	0.02	5.6930E-14
660.32	-4.1097E-12	-9.0192E-12	-0.07	-1.0971E-11	1.2660E-11	7.7502E-12	0.06	5.7981E-12	7.5597E-12	2.6502E-12	0.02	6.9810E-13
961.78	-	-	-	-	9.1745E-10	1.0088E-09	1.21	9.1729E-10	-2.7537E-10	-1.8407E-10	-0.22	-2.7553E-10
Zn FP	4.6340E-12	5.3863E-12	0.68	5.2724E-12	-	-	-	-	-7.1256E-13	3.9781E-14	0.01	-7.4143E-14
VTBB -Zn	4.8027E-12	5.5550E-12	0.70	5.4411E-12	-	-	-	-	-3.1934E-13	4.3300E-13	0.05	3.1908E-13
Al FP	-1.4379E-11	-1.9289E-11	-0.15	-2.1241E-11	-	-	-	-	-	-	-	-
VTBB -Al	6.1597E-12	1.2502E-12	0.01	-7.0190E-13	-	-	-	-	-	-	-	-

Table 37 - differences of the laboratory results from the mean, median and weighted mean values for the LP5 thermometer – table 2 of 3

t_{nom}/ °C	INRiM - mean/ A	INRiM - median/ A	equiv dT* from median/ °C	INRiM -wghted mean/ A
231.93	8.2987E-16	0.0000E+00	0.00	1.6292E-15
419.53	-3.1447E-13	4.3787E-13	0.06	3.2395E-13
660.32	2.4712E-11	1.9802E-11	0.15	1.7850E-11
961.78	9.9957E-11	1.9125E-10	0.23	9.9790E-11

Table 38 - differences of the laboratory results from the mean, median and weighted mean values for the LP5 thermometer – table 3 of 3

3.2 THE INRIM THERMOMETER RESULTS

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	FP	10^10	156.60	0.775825	10^9	0.084166	-0.025	0.084062	0.00	0.084062	0.09
156.60	VTBB	10^10	156.63	0.777632	10^9	0.084362	-0.025	0.084258	-0.03	0.084127	0.20
231.93	FP	10^9	231.93	1.836495	10^9	1.836495	-0.035	1.834224	0.00	1.834224	0.07
231.93	VTBB	10^9	232.05	1.841034	10^9	1.841034	-0.035	1.838757	-0.12	1.830977	0.20
419.53	FP	10^7	419.53	1.984784	10^7	1.984784	-0.066	1.982329	0.00	1.982329	0.07
419.53	VTBB	10^7	419.43	1.976805	10^7	1.976805	-0.066	1.974360	0.10	1.978075	0.21
660.32	FP	10^6	660.32	5.488178	10^6	5.488178	-0.120	5.481389	0.00	5.481389	0.13
660.32	VTBB	10^6	660.03	5.477611	10^6	5.477611	-0.120	5.470836	0.30	5.487479	0.50
961.78	FP	10^5	961.78	5.653369	10^5	5.653369	-0.210	5.646376	0.00	5.646376	0.23
961.78	VTBB	10^5	961.78	5.656693	10^5	5.656693	-0.210	5.649696	0.00	5.649696	0.54

Table 39 – the combined NPL measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	VTBB	10^10	156.566	0.771526	10^9	0.083684	0.00	0.083684	0.034	0.083824	0.07
231.93	VTBB	10^9	231.947	1.837326	10^9	1.837326	0.00	1.837326	-0.017	1.836253	0.08
419.53	VTBB	10^7	419.519	1.983355	10^7	1.983355	0.00	1.983355	0.011	1.983756	0.08
660.32	VTBB	10^6	660.328	5.483683	10^6	5.483683	0.00	5.483683	-0.008	5.483208	0.15
961.78	VTBB	10^5	961.728	5.647521	10^5	5.647521	0.00	5.647521	0.052	5.649249	0.24
419.53	VTBB	10^7	419.516	1.983341	10^7	1.983341	0.00	1.983341	0.014	1.983862	0.08
961.78	VTBB	10^5	961.693	5.646728	10^5	5.646728	0.00	5.646728	0.087	5.649622	0.24

Table 40 – the PTB measurements at the fixed-point temperatures, using variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	VTBB	10^8	156.53	0.007810	10^9	0.085053	-0.002	0.085046	0.07	0.085340	0.21
231.93	VTBB	10^7	231.76	0.016235	10^9	1.779335	-0.002	1.779202	0.17	1.790126	0.28
231.93	VTBB	10^8	231.76	0.167536	10^9	1.824540	-0.002	1.824403	0.17	1.835372	0.28
419.53	VTBB	10^7	419.68	1.984168	10^7	1.984168	-0.004	1.984019	-0.15	1.978393	0.35
660.32	VTBB	10^6	660.02	5.447661	10^6	5.447661	-0.007	5.447253	0.30	5.463960	1.09
961.78	VTBB	10^5	961.62	5.618921	10^5	5.618921	-0.013	5.618499	0.16	5.623788	1.55

Table 41– the LNE measurements at the fixed-point temperatures, using variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	FP	10^10	156.60	0.772745	10^9	0.083847	-0.02	0.083782	0.000	0.083782	0.076
231.93	FP	10^9	231.93	1.834863	10^9	1.834863	-0.02	1.833453	0.000	1.833453	0.042
419.53	FP	10^7	419.53	1.983950	10^7	1.983950	-0.04	1.982426	0.000	1.982426	0.075
419.53	VTBB	10^7	417.73	1.923257	10^7	1.923257	-0.04	1.921779	1.796	1.986788	0.86
660.32	VTBB	10^6	655.68	5.281204	10^6	5.281204	-0.07	5.277146	4.640	5.532395	0.83

Table 42 – the combined UME measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	VTBB	10^10	156.604	0.777185	10^9	0.084247	0.002	0.084254	-0.004	0.084238	0.43
231.93	VTBB	10^9	231.915	1.833114	10^9	1.833114	0.002	1.833251	0.015	1.834219	0.45
419.53	VTBB	10^7	419.485	1.980357	10^7	1.980357	0.004	1.980506	0.045	1.982182	0.12
660.32	VTBB	10^6	660.174	5.508215	10^6	5.508215	0.007	5.508628	0.146	5.516949	0.22
961.78	VTBB	10^5	961.861	5.705270	10^5	5.705270	0.013	5.705697	-0.081	5.702984	0.81

Table 43 – the METAS measurements at the fixed-point temperatures, using variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	VTBB	10^9	156.57	0.084268	10^9	0.084268	0.009	0.084306	0.03	0.084429	0.45
231.93	VTBB	10^9	231.88	1.838722	10^9	1.838722	0.013	1.839550	0.05	1.842792	0.30
231.93	VTBB	10^9	232.02	1.842625	10^9	1.842625	0.013	1.843454	-0.09	1.837608	0.30
419.53	FP	10^7	419.53	1.982037	10^7	1.982037	0.024	1.982929	0.00	1.982929	0.09
419.53	FP	10^6	419.53	0.198307	10^7	1.982041	0.024	1.982932	0.00	1.982932	0.09
419.53	VTBB	10^7	419.49	1.983845	10^7	1.983845	0.024	1.984738	0.04	1.986226	0.31
660.32	VTBB	10^6	660.29	5.480883	10^6	5.480883	0.044	5.483348	0.03	5.485046	0.31
961.78	FP	10^5	961.78	5.642604	10^5	5.642604	0.076	5.645142	0.00	5.645142	0.30
961.78	FP	10^4	961.78	0.570133	10^5	5.643423	0.076	5.645962	0.00	5.645962	0.30

Table 44 – the combined CEM measurements at the fixed-point temperatures, using fixed-point and variable temperature blackbody sources

t_{nom} / °C	FP or VTBB	Gain used	t_{BB} / °C	Bgrd corrected signal/ V	Required gain	Signal at required gain / V	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	u (k=2) with range ratio & drift uncertainty* / °C
156.60	FP	10^9	156.60	0.083746	10^9	0.083746	-0.003	0.083733	0.00	0.083733	0.031
231.93	FP	10^9	231.93	1.833878	10^9	1.833878	-0.004	1.833603	0.00	1.833603	0.040
419.53	FP	10^7	419.53	1.982461	10^7	1.982461	-0.008	1.982164	0.00	1.982164	0.072
660.32	FP	10^6	660.32	5.481196	10^6	5.481196	-0.015	5.480374	0.00	5.480374	0.129
961.78	FP	10^5	961.78	5.645096	10^5	5.645096	-0.025	5.644250	0.00	5.644250	0.224

Table 45 – the INRiM measurements at the fixed-point temperatures, using fixed-point blackbody sources

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.084094	0.14
231.93	1.832600	0.14
419.53	1.980202	0.14
660.32	5.484434	0.31
961.78	5.648036	0.39
In FP	0.084062	0.09
VTBB at In	0.084127	0.20
Sn FP	1.834224	0.07
VTBB at Sn	1.830977	0.20
Zn FP	1.982329	0.07
VTBB at Zn	1.978075	0.21
Al FP	5.481389	0.13
VTBB at Al	5.487479	0.50
Ag FP	5.646376	0.23
VTBB at Ag	5.649696	0.54

Table 46 – the average NPL results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.083824	0.07
231.93	1.836253	0.08
419.53	1.983809	0.08
660.32	5.483208	0.15
961.78	5.649436	0.24

Table 47 – the average PTB results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.085340	0.21
231.93	1.812749	0.28
419.53	1.978393	0.35
660.32	5.463960	1.09
961.78	5.623788	1.55

Table 48 – the average LNE results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.083782	0.08
231.93	1.833453	0.04
419.53	1.984607	0.47
660.32	5.532395	0.83
Zn FP	1.982426	0.07
VTBB at Zn	1.986788	0.86

Table 49 – the average UME results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.084238	0.43
231.93	1.834219	0.45
419.53	1.982182	0.12
660.32	5.516949	0.22
961.78	5.702984	0.81

Table 50 – the average METAS results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.084429	0.45
231.93	1.840200	0.30
419.53	1.984029	0.20
660.32	5.485046	0.31
961.78	5.645552	0.30
Zn FP	1.982931	0.09
VTBB at Zn	1.986226	0.31

Table 51 – the average CEM results

t_{nom}/ °C	Average signal/V	U (k=2)/ °C
156.60	0.083733	0.03
231.93	1.833603	0.04
419.53	1.982164	0.07
660.32	5.480374	0.13
961.78	5.644250	0.22

Table 52 – the average INRiM results

t_{nom}/ °C	Mean signal/ V	Median signal/ V	Weighted signal/ V
156.60	0.084208	0.084094	0.083801
231.93	1.831907	1.833878	1.833813
419.53	1.982240	1.982461	1.982662
660.32	5.492455	5.484434	5.487614
961.78	5.652482	5.646794	5.648236

Table 53 – mean, median and weighted mean values for all the INRiM thermometer measurements

t_{nom}/ °C	NPL – mean/ V	NPL – median/ V	equiv dT* from median/ °C	NPL-wghted mean/ V	PTB – mean/ V	PTB – median/ V	equiv dT* from median/ °C	PTB-wghted mean/ V	LNE – mean/ V	LNE – median/ V	equiv dT* from median/ °C	LNE – wghted mean/ V
156.60	-0.000113	0.000000	0.00	0.000294	-0.000384	-0.000271	-0.07	0.000023	0.001132	0.001246	0.30	0.001539
231.93	0.000693	-0.001278	-0.02	-0.001213	0.004345	0.002374	0.04	0.002439	-0.019159	-0.021130	-0.33	-0.021064
419.53	-0.002039	-0.002259	-0.06	-0.002461	0.001569	0.001348	0.04	0.001147	-0.003847	-0.004068	-0.11	-0.004269
660.32	-0.008022	0.000000	0.00	-0.003180	-0.009247	-0.001226	-0.02	-0.004406	-0.028495	-0.020474	-0.36	-0.023654
961.78	-0.004446	0.001242	0.04	-0.000200	-0.017273	-0.000082	0.00	-0.002724	-0.028694	-0.023006	-0.69	-0.024447
In FP	-0.000146	-0.000033	-0.01	0.000261	-	-	-	-				
VTBB -In	-0.000081	0.000033	0.01	0.000326	-	-	-	-				
Sn FP	0.002316	0.000345	0.01	0.000410	-	-	-	-	-	-	-	-
VTBB -Sn	-0.000931	-0.002902	-0.04	-0.002837	-	-	-	-	-	-	-	-
Zn FP	0.000089	-0.000132	0.00	-0.000333	-	-	-	-	-	-	-	-
VTBB -Zn	-0.004166	-0.004386	-0.12	-0.004588	-	-	-	-	-	-	-	-
Al FP	-0.011067	-0.003045	-0.05	-0.006225	-	-	-	-	-	-	-	-
VTBB -Al	-0.004977	0.003045	0.05	-0.000135	-	-	-	-	-	-	-	-
Ag FP	-0.006106	-0.000418	-0.01	-0.001860	-	-	-	-	-	-	-	-
VTBB -Ag	-0.002786	0.002902	0.09	0.001460	-	-	-	-	-	-	-	-

Table 54 - differences of the laboratory results from the mean, median and weighted mean values for the INRiM thermometer – table 1 of 3

t_{nom}/ °C	UME – mean/ V	UME – median/ V	equiv dT* from median/ °C	UME-wghted mean/ V	METAS – mean/ V	METAS-median/ V	equiv dT* from median/ °C	METAS-wghted mean/ V	CEM – mean/ V	CEM-median/ V	equiv dT* from median/ °C	CEM – wghted mean/ V
156.60	-0.000425	-0.000312	-0.08	-0.000018	0.000030	0.000144	0.04	0.000437	0.000221	0.000334	0.08	0.000628
231.93	0.001545	-0.000425	-0.01	-0.000360	0.002311	0.000340	0.01	0.000405	0.008293	0.006322	0.10	0.006387
419.53	0.002366	0.002146	0.06	0.001944	-0.000059	-0.000279	-0.01	-0.000481	0.001789	0.001568	0.04	0.001367
660.32	0.039940	0.047962	0.85	0.044781	0.024494	0.032515	0.57	0.029335	-0.007409	0.000612	0.01	-0.002568
961.78	-	-	-	-	0.050502	0.056190	1.69	0.054748	-0.006930	-0.001242	-0.04	-0.002684
Zn FP	0.000185	-0.000035	0.00	-0.000237	-	-	-	-	0.000690	0.000470	0.01	0.000268
VTBB -Zn	0.004547	0.004327	0.12	0.004125	-	-	-	-	0.003985	0.003765	0.10	0.003563

Table 55 - differences of the laboratory results from the mean, median and weighted mean values for the INRiM thermometer – table 2 of 3

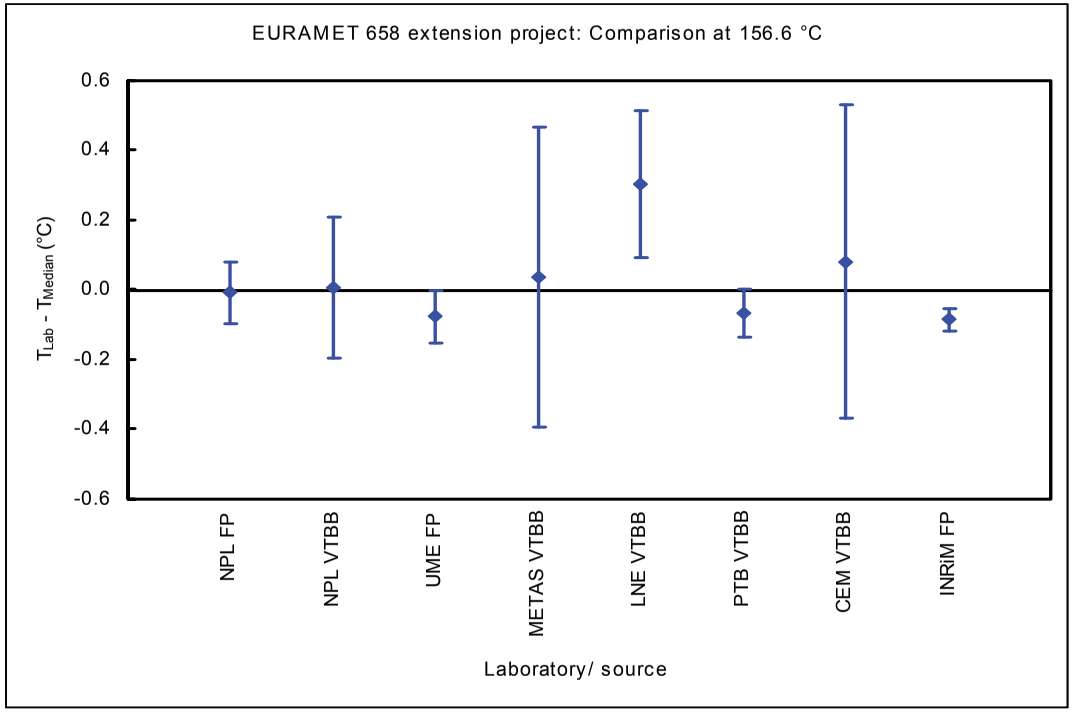
t_{nom}/ °C	INRiM – mean/ V	INRiM – median/ V	equiv dT* from median/ °C	INRiM - wghted mean/ V
156.60	-0.000462	-0.000348	-0.09	-0.000055
231.93	0.001971	0.000000	0.00	0.000065
419.53	0.000221	0.000000	0.00	-0.000201
660.32	-0.011260	-0.003238	-0.06	-0.006418
961.78	-0.007386	-0.001698	-0.05	-0.003139

Table 56 - differences of the laboratory results from the mean, median and weighted mean values for the INRiM thermometer – table 3 of 3

4 ALL THE INRIM THERMOMETER MEASUREMENTS AT THE FIXED-POINT TEMPERATURES USING FIXED-POINT (FP) AND VARIABLE TEMPERATURE BLACKBODY SOURCES (VTBB)

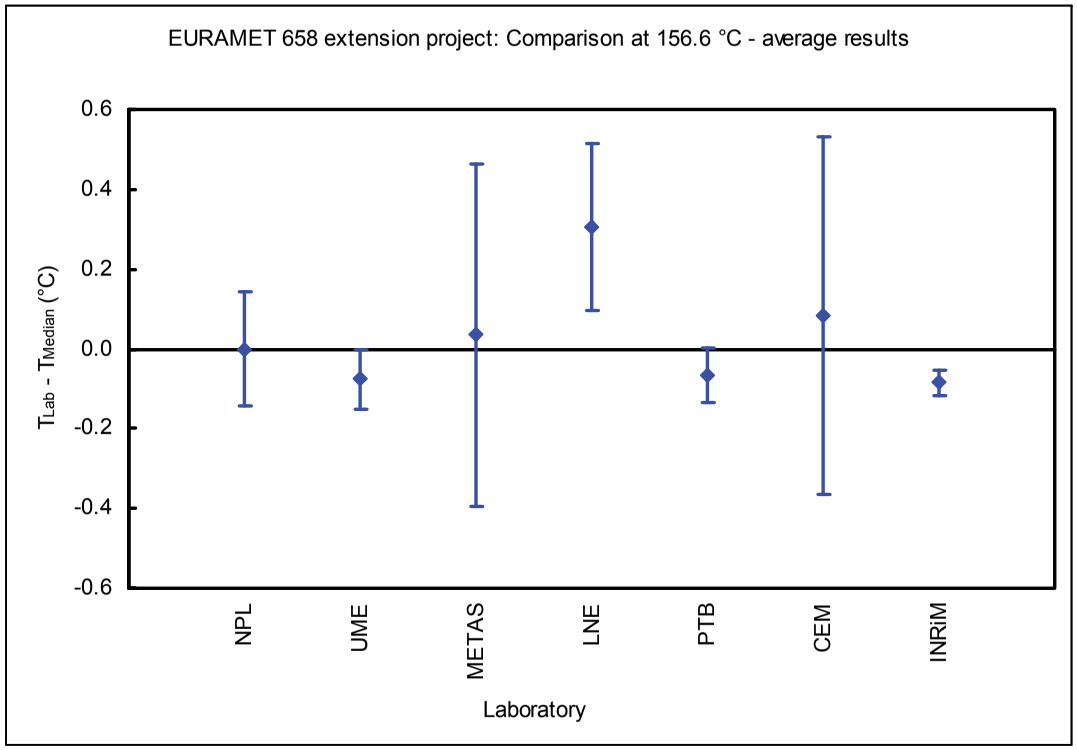
	NPL FP	NPL VTBB	UME FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM FP
NPL FP	-	-0.02 ± 0.22	0.07 ± 0.12	-0.04 ± 0.44	-0.31 ± 0.23	0.06 ± 0.11	-0.09 ± 0.46	0.08 ± 0.09
NPL VTBB	*0.22*	-	0.08 ± 0.22	-0.03 ± 0.48	-0.30 ± 0.29	0.07 ± 0.21	-0.07 ± 0.49	0.09 ± 0.20
UME FP	*0.16*	*0.26*	-	-0.11 ± 0.44	-0.38 ± 0.22	-0.01 ± 0.10	-0.16 ± 0.46	0.01 ± 0.08
METAS VTBB	*0.44*	*0.47*	*0.48*	-	-0.27 ± 0.48	0.10 ± 0.44	-0.05 ± 0.62	0.12 ± 0.43
LNE VTBB	*0.50*	*0.54*	*0.56*	*0.66*	-	0.37 ± 0.22	0.22 ± 0.50	0.39 ± 0.21
PTB VTBB	*0.15*	*0.25*	*0.10*	*0.47*	*0.55*	-	-0.15 ± 0.45	0.02 ± 0.08
CEM VTBB	*0.48*	*0.50*	*0.54*	*0.61*	*0.63*	*0.53*	-	0.17 ± 0.45
INRiM FP	*0.15*	*0.26*	*0.08*	*0.48*	*0.56*	*0.08*	*0.54*	-

Table 57 – direct comparison of the results for the INRiM thermometer measurements at the In fixed-point temperature



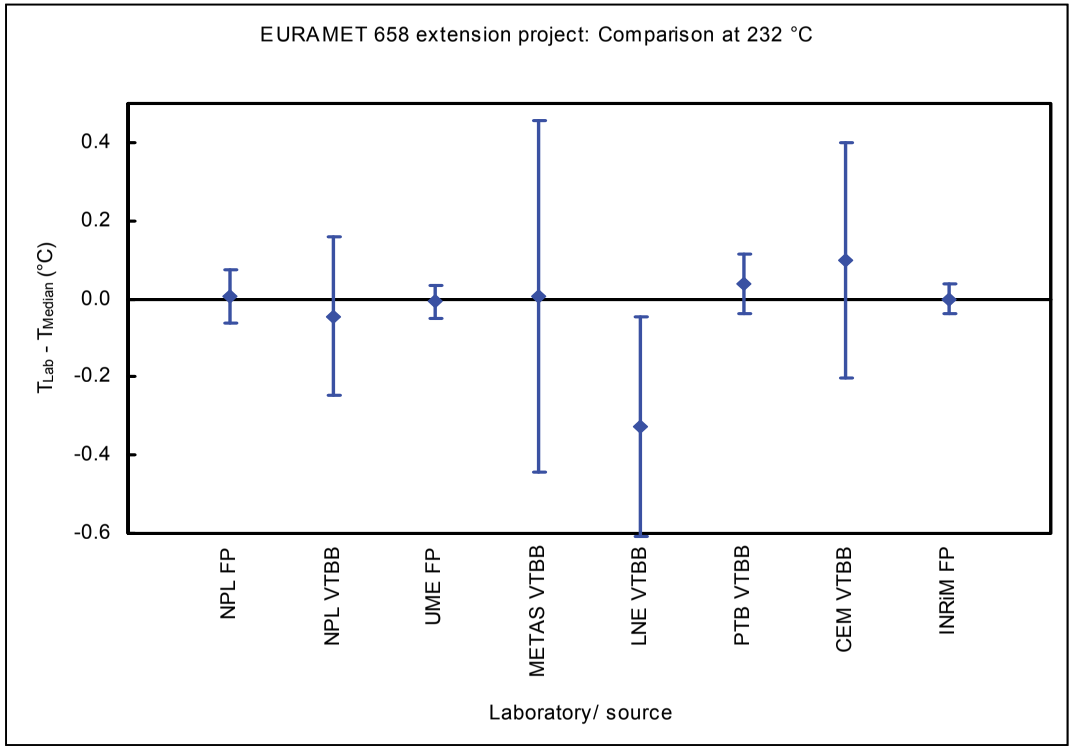
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	0.08 ± 0.16	-0.04 ± 0.45	-0.30 ± 0.26	0.07 ± 0.16	-0.08 ± 0.47	0.09 ± 0.15
UME	*0.21*	-	-0.11 ± 0.44	-0.38 ± 0.22	-0.01 ± 0.10	-0.16 ± 0.46	0.01 ± 0.08
METAS	*0.45*	*0.48*	-	-0.27 ± 0.48	0.10 ± 0.44	-0.05 ± 0.62	0.12 ± 0.43
LNE	*0.51*	*0.56*	*0.66*	-	0.37 ± 0.22	0.22 ± 0.50	0.39 ± 0.21
PTB	*0.20*	*0.10*	*0.47*	*0.55*	-	-0.15 ± 0.45	0.02 ± 0.08
CEM	*0.49*	*0.54*	*0.61*	*0.63*	*0.53*	-	0.17 ± 0.45
INRiM	*0.21*	*0.08*	*0.48*	*0.56*	*0.08*	*0.54*	-

Table 58 – direct comparison of the results for the INRiM thermometer measurements at the In fixed-point temperature – average data



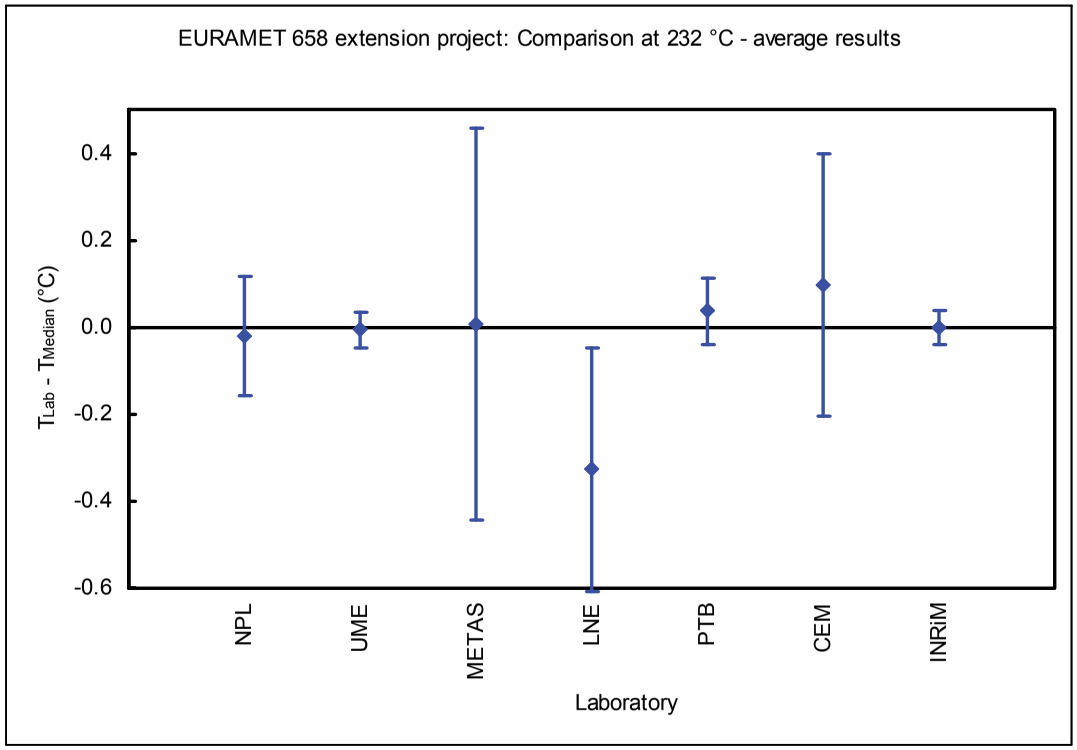
	NPL FP	NPL VTBB	UME FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM FP
NPL FP	-	0.05 ± 0.22	0.01 ± 0.08	0.00 ± 0.46	0.33 ± 0.29	-0.03 ± 0.10	-0.09 ± 0.31	0.01 ± 0.08
NPL VTBB	*0.23*	-	-0.04 ± 0.21	-0.05 ± 0.49	0.28 ± 0.35	-0.08 ± 0.22	-0.14 ± 0.36	-0.04 ± 0.21
UME FP	*0.08*	*0.22*	-	-0.01 ± 0.45	0.32 ± 0.28	-0.04 ± 0.09	-0.10 ± 0.30	-0.01 ± 0.06
METAS VTBB	*0.45*	*0.49*	*0.44*	-	0.33 ± 0.53	-0.03 ± 0.46	-0.09 ± 0.54	0.01 ± 0.45
LNE VTBB	*0.57*	*0.57*	*0.55*	*0.77*	-	-0.36 ± 0.29	-0.42 ± 0.41	-0.33 ± 0.28
PTB VTBB	*0.12*	*0.26*	*0.12*	*0.45*	*0.60*	-	-0.06 ± 0.31	0.04 ± 0.09
CEM VTBB	*0.35*	*0.44*	*0.36*	*0.56*	*0.76*	*0.33*	-	0.10 ± 0.30
INRiM FP	*0.08*	*0.22*	*0.06*	*0.44*	*0.56*	*0.11*	*0.35*	-

Table 59 – direct comparison of the results for the INRiM thermometer measurements at the Sn fixed-point temperature



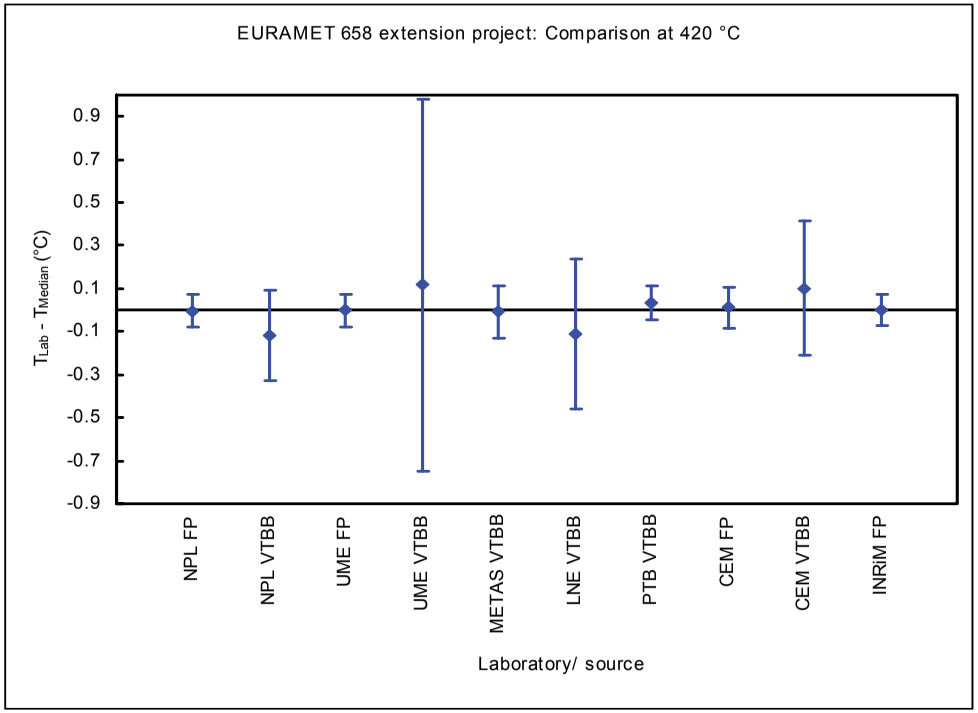
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	-0.01 ± 0.14	-0.03 ± 0.47	0.31 ± 0.31	-0.06 ± 0.16	-0.12 ± 0.33	-0.02 ± 0.14
UME	*0.14*	-	-0.01 ± 0.45	0.32 ± 0.28	-0.04 ± 0.09	-0.10 ± 0.30	-0.01 ± 0.06
METAS	*0.46*	*0.44*	-	0.33 ± 0.53	-0.03 ± 0.46	-0.09 ± 0.54	0.01 ± 0.45
LNE	*0.56*	*0.55*	*0.77*	-	-0.36 ± 0.29	-0.42 ± 0.41	-0.33 ± 0.28
PTB	*0.19*	*0.12*	*0.45*	*0.60*	-	-0.06 ± 0.31	0.04 ± 0.09
CEM	*0.39*	*0.36*	*0.56*	*0.76*	*0.33*	-	0.10 ± 0.30
INRiM	*0.14*	*0.06*	*0.44*	*0.56*	*0.11*	*0.35*	-

Table 60 – direct comparison of the results for the INRiM thermometer measurements at the Sn fixed-point temperature – average data



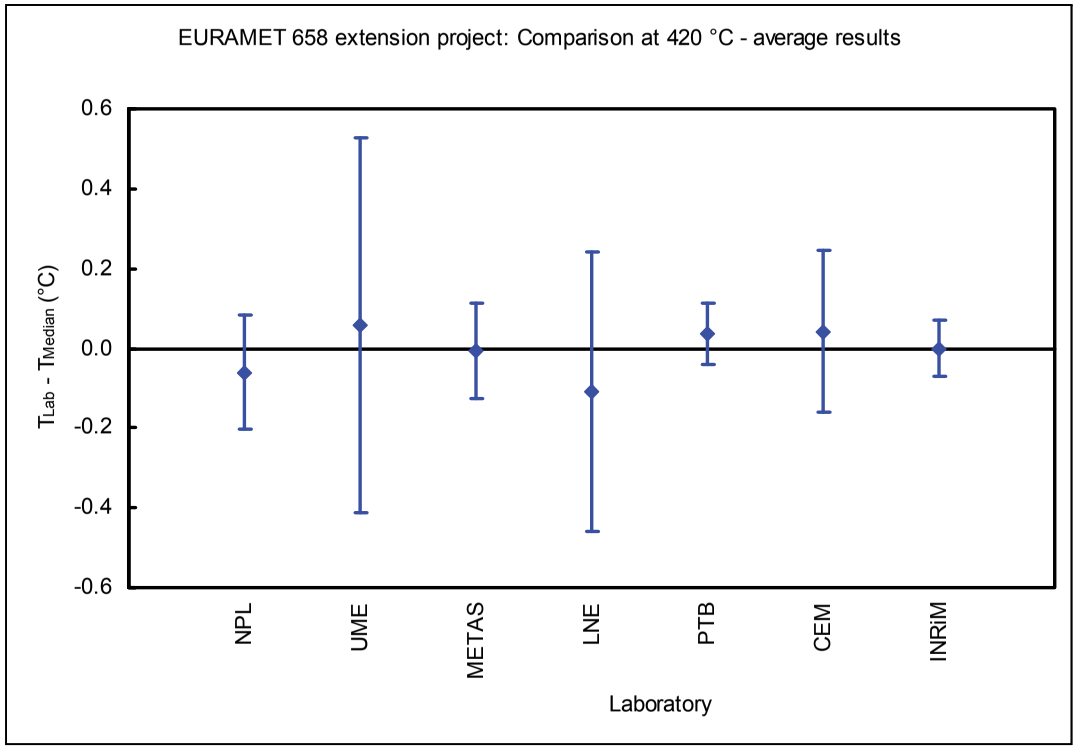
	NPL FP	NPL VTBB	UME FP	UME VTBB	METAS VTBB	LNE VTBB	PTB VTBB	CEM FP	CEM VTBB	INRiM FP
NPL FP	-	0.11 ± 0.23	0.00 ± 0.11	-0.12 ± 0.87	0.00 ± 0.14	0.11 ± 0.36	-0.04 ± 0.11	-0.02 ± 0.12	-0.10 ± 0.32	0.00 ± 0.10
NPL VTBB	*0.30*	-	-0.12 ± 0.23	-0.23 ± 0.89	-0.11 ± 0.24	-0.01 ± 0.41	-0.15 ± 0.23	-0.13 ± 0.23	-0.22 ± 0.38	-0.12 ± 0.22
UME FP	*0.10*	*0.30*	-	-0.12 ± 0.87	0.01 ± 0.14	0.11 ± 0.36	-0.04 ± 0.11	-0.01 ± 0.12	-0.10 ± 0.32	0.00 ± 0.10
UME VTBB	*0.88*	*0.98*	*0.88*	-	0.12 ± 0.87	0.23 ± 0.93	0.08 ± 0.87	0.10 ± 0.87	0.02 ± 0.92	0.12 ± 0.87
METAS VTBB	*0.14*	*0.31*	*0.14*	*0.89*	-	0.10 ± 0.37	-0.04 ± 0.14	-0.02 ± 0.15	-0.11 ± 0.33	-0.01 ± 0.14
LNE VTBB	*0.41*	*0.40*	*0.41*	*1.01*	*0.41*	-	-0.15 ± 0.36	-0.12 ± 0.36	-0.21 ± 0.47	-0.11 ± 0.36
PTB VTBB	*0.13*	*0.34*	*0.13*	*0.86*	*0.16*	*0.44*	-	0.02 ± 0.12	-0.07 ± 0.32	0.04 ± 0.11
CEM FP	*0.12*	*0.32*	*0.12*	*0.87*	*0.15*	*0.42*	*0.13*	-	-0.09 ± 0.33	0.01 ± 0.12
CEM VTBB	*0.37*	*0.53*	*0.37*	*0.90*	*0.39*	*0.60*	*0.34*	*0.36*	-	0.10 ± 0.32
INRiM FP	*0.10*	*0.30*	*0.10*	*0.88*	*0.14*	*0.41*	*0.13*	*0.12*	*0.37*	-

Table 61 – direct comparison of the results for the INRiM thermometer measurements at the Zn fixed-point temperature



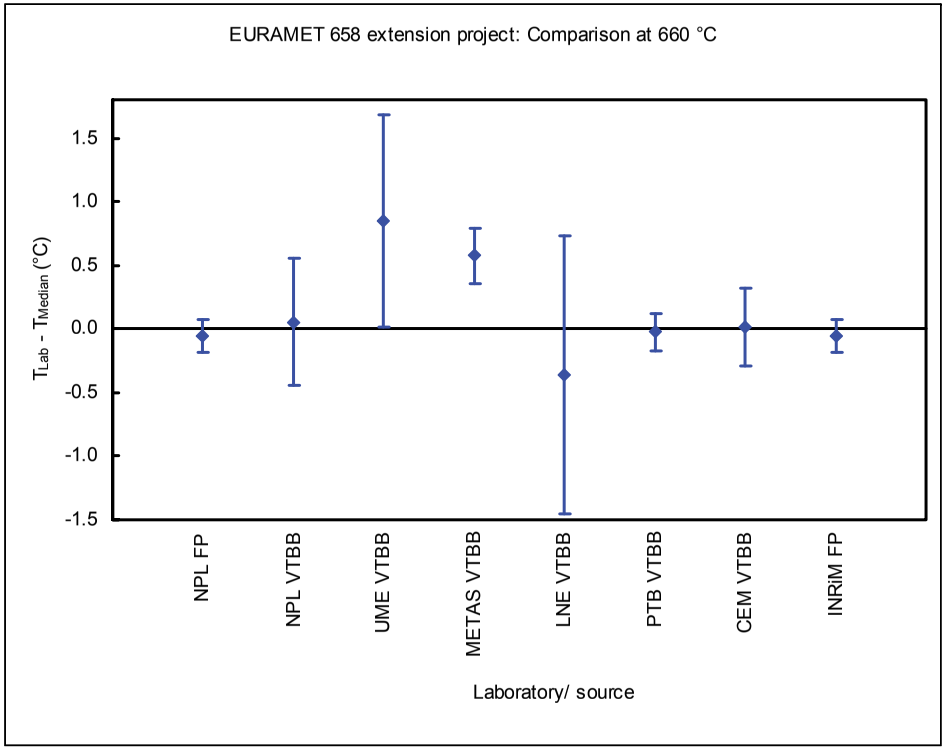
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	-0.12 ± 0.49	-0.05 ± 0.19	0.05 ± 0.38	-0.10 ± 0.16	-0.10 ± 0.25	-0.06 ± 0.16
UME	*0.53*	-	0.07 ± 0.48	0.17 ± 0.59	0.02 ± 0.48	0.02 ± 0.51	0.06 ± 0.47
METAS	*0.21*	*0.49*	-	0.10 ± 0.37	-0.04 ± 0.14	-0.05 ± 0.24	-0.01 ± 0.14
LNE	*0.38*	*0.66*	*0.41*	-	-0.15 ± 0.36	-0.15 ± 0.41	-0.11 ± 0.36
PTB	*0.23*	*0.47*	*0.16*	*0.44*	-	-0.01 ± 0.22	0.04 ± 0.11
CEM	*0.31*	*0.50*	*0.25*	*0.49*	*0.21*	-	0.04 ± 0.22
INRiM	*0.19*	*0.48*	*0.14*	*0.41*	*0.13*	*0.23*	-

Table 62 – direct comparison of the results for the INRiM thermometer measurements at the Zn fixed-point temperature – average data



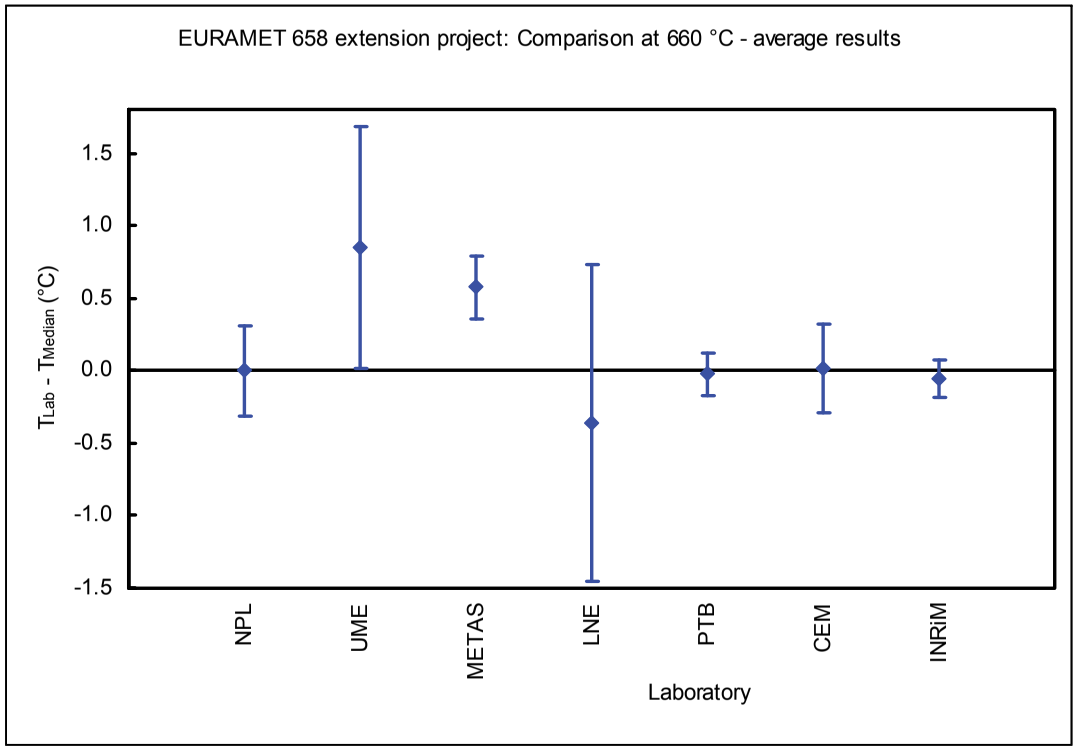
	NPL FP	NPL VTBB	UME VTBB	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM FP
NPL FP	-	-0.11 ± 0.51	-0.90 ± 0.84	-0.63 ± 0.26	0.31 ± 1.10	-0.03 ± 0.20	-0.06 ± 0.33	0.00 ± 0.18
NPL VTBB	*0.55*	-	-0.79 ± 0.97	-0.52 ± 0.54	0.42 ± 1.20	0.08 ± 0.52	0.04 ± 0.58	0.11 ± 0.51
UME VTBB	*1.59*	*1.59*	-	0.27 ± 0.86	1.21 ± 1.37	0.87 ± 0.85	0.84 ± 0.89	0.90 ± 0.84
METAS VTBB	*0.84*	*0.97*	*0.99*	-	0.94 ± 1.11	0.60 ± 0.26	0.56 ± 0.38	0.63 ± 0.26
LNE VTBB	*1.23*	*1.41*	*2.34*	*1.85*	-	-0.34 ± 1.10	-0.37 ± 1.13	-0.30 ± 1.10
PTB VTBB	*0.20*	*0.53*	*1.56*	*0.81*	*1.26*	-	-0.03 ± 0.34	0.04 ± 0.20
CEM VTBB	*0.35*	*0.58*	*1.57*	*0.87*	*1.32*	*0.34*	-	0.07 ± 0.33
INRiM FP	*0.18*	*0.55*	*1.60*	*0.84*	*1.23*	*0.20*	*0.35*	-

Table 63 – direct comparison of the results for the INRiM thermometer measurements at the Al fixed-point temperature



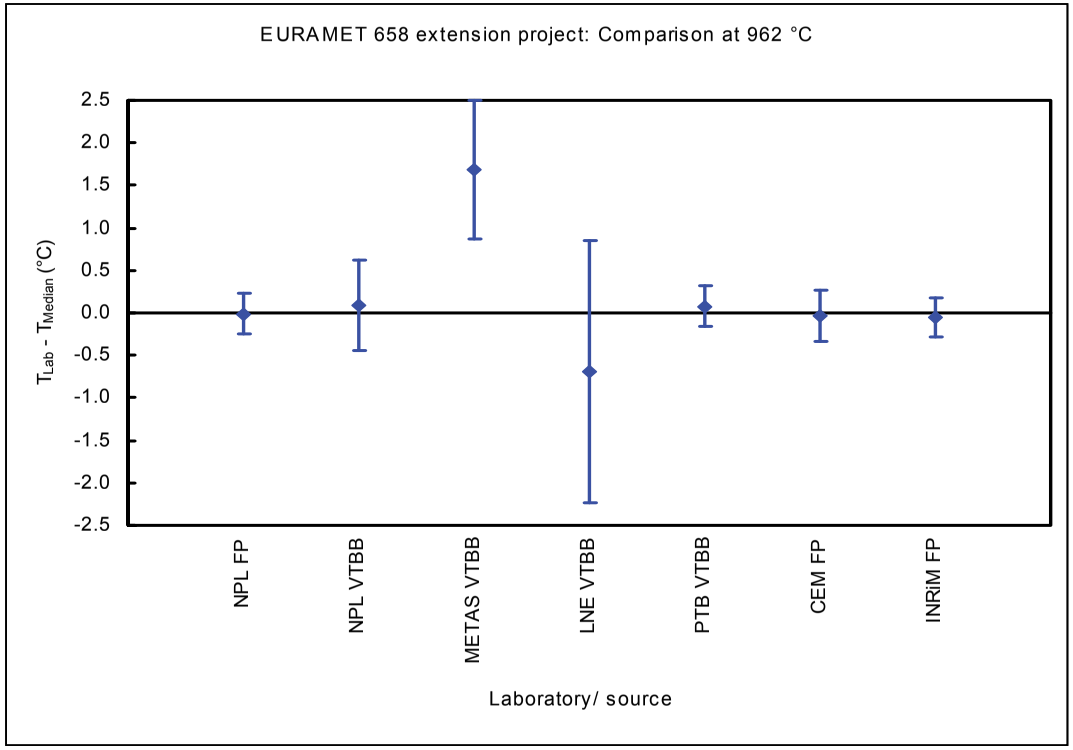
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	-0.85 ± 0.89	-0.57 ± 0.38	0.36 ± 1.13	0.02 ± 0.35	-0.01 ± 0.44	0.06 ± 0.34
UME	*1.58*	-	0.27 ± 0.86	1.21 ± 1.37	0.87 ± 0.85	0.84 ± 0.89	0.90 ± 0.84
METAS	*0.89*	*0.99*	-	0.94 ± 1.11	0.60 ± 0.26	0.56 ± 0.38	0.63 ± 0.26
LNE	*1.31*	*2.34*	*1.85*	-	-0.34 ± 1.10	-0.37 ± 1.13	-0.30 ± 1.10
PTB	*0.34*	*1.56*	*0.81*	*1.26*	-	-0.03 ± 0.34	0.04 ± 0.20
CEM	*0.43*	*1.57*	*0.87*	*1.32*	*0.34*	-	0.07 ± 0.33
INRiM	*0.35*	*1.60*	*0.84*	*1.23*	*0.20*	*0.35*	-

Table 64 – direct comparison of the results for the INRiM thermometer measurements at the Al fixed-point temperature – average data



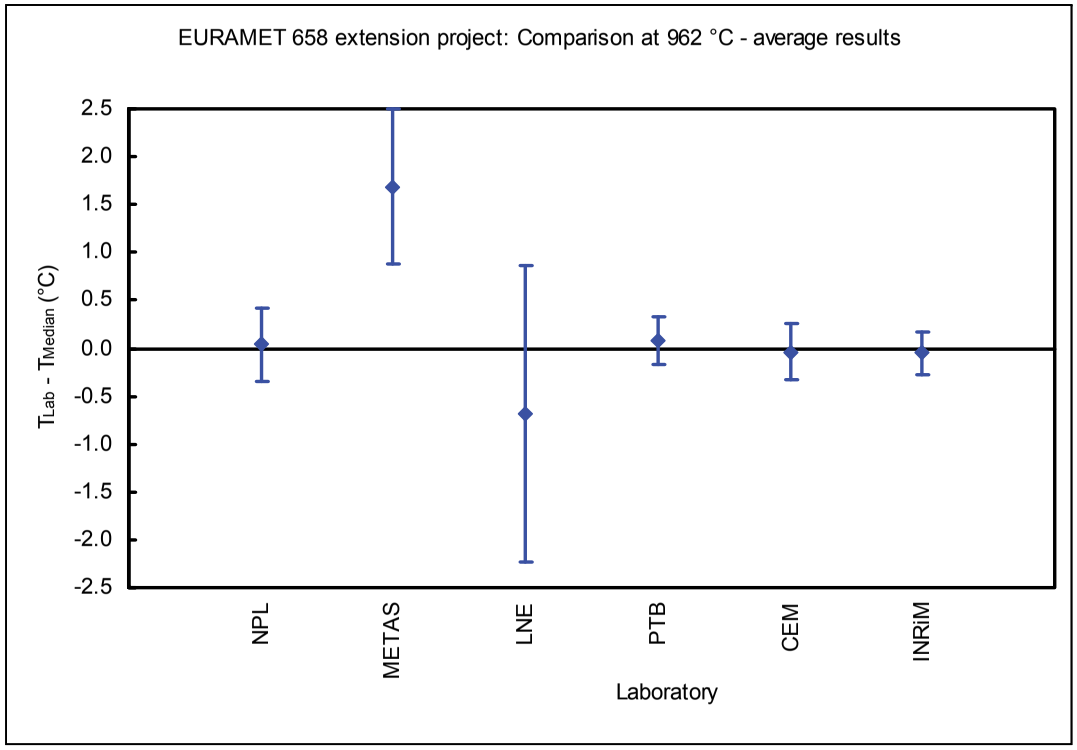
	NPL FP	NPL VTBB	METAS VTBB	LNE VTBB	PTB VTBB	CEM FP	INRiM FP
NPL FP	-	-0.10 ± 0.59	-1.70 ± 0.84	0.68 ± 1.57	-0.09 ± 0.34	0.02 ± 0.38	0.04 ± 0.32
NPL VTBB	*0.61*	-	-1.60 ± 0.97	0.78 ± 1.64	0.01 ± 0.59	0.12 ± 0.62	0.14 ± 0.58
METAS VTBB	*2.39*	*2.40*	-	2.38 ± 1.75	1.61 ± 0.85	1.72 ± 0.86	1.74 ± 0.84
LNE VTBB	*1.98*	*2.13*	*3.82*	-	-0.77 ± 1.57	-0.65 ± 1.58	-0.64 ± 1.57
PTB VTBB	*0.37*	*0.58*	*2.30*	*2.07*	-	0.12 ± 0.39	0.13 ± 0.33
CEM FP	*0.37*	*0.65*	*2.44*	*1.96*	*0.44*	-	0.01 ± 0.37
INRiM FP	*0.33*	*0.63*	*2.43*	*1.94*	*0.40*	*0.37*	-

Table 65 – direct comparison of the results for the INRiM thermometer measurements at the Ag fixed-point temperature



	NPL	METAS	LNE	PTB	CEM	INRiM
NPL	-	-1.65 ± 0.90	0.73 ± 1.60	-0.04 ± 0.46	0.07 ± 0.49	0.09 ± 0.45
METAS	*2.39*	-	2.38 ± 1.75	1.61 ± 0.85	1.72 ± 0.86	1.74 ± 0.84
LNE	*2.05*	*3.82*	-	-0.77 ± 1.57	-0.65 ± 1.58	-0.64 ± 1.57
PTB	*0.45*	*2.30*	*2.07*	-	0.12 ± 0.39	0.13 ± 0.33
CEM	*0.50*	*2.44*	*1.96*	*0.44*	-	0.01 ± 0.37
INRiM	*0.47*	*2.43*	*1.94*	*0.40*	*0.37*	-

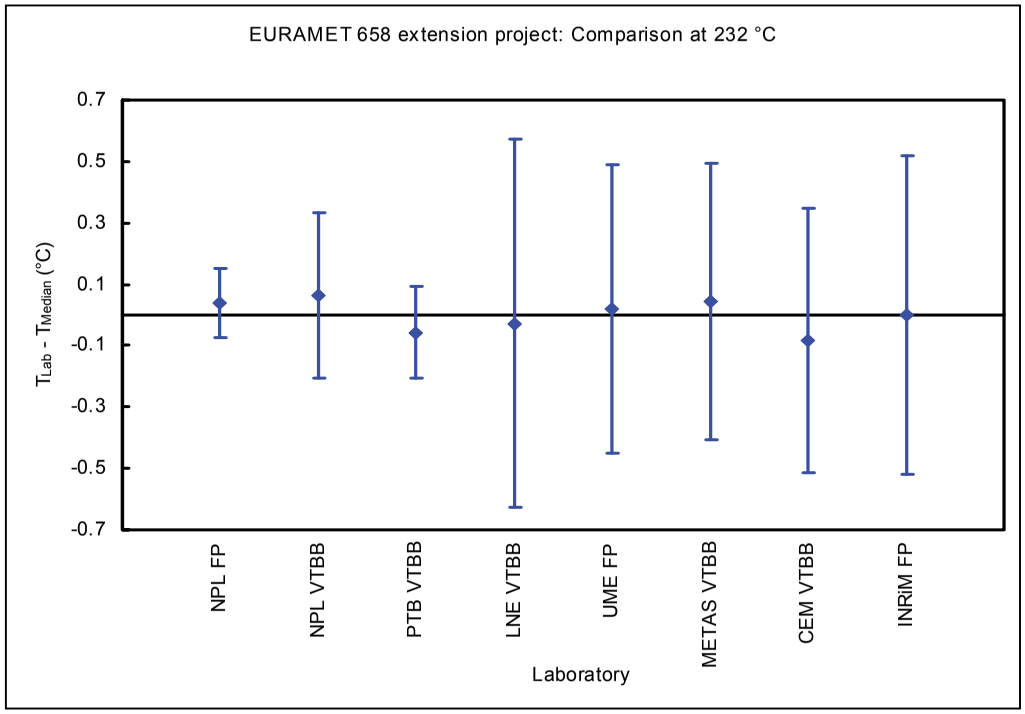
Table 66 – direct comparison of the results for the INRiM thermometer measurements at the Ag fixed-point temperature – average data



5 ALL THE LP5 THERMOMETER MEASUREMENTS AT THE FIXED-POINT TEMPERATURES USING FPS AND VTBBS

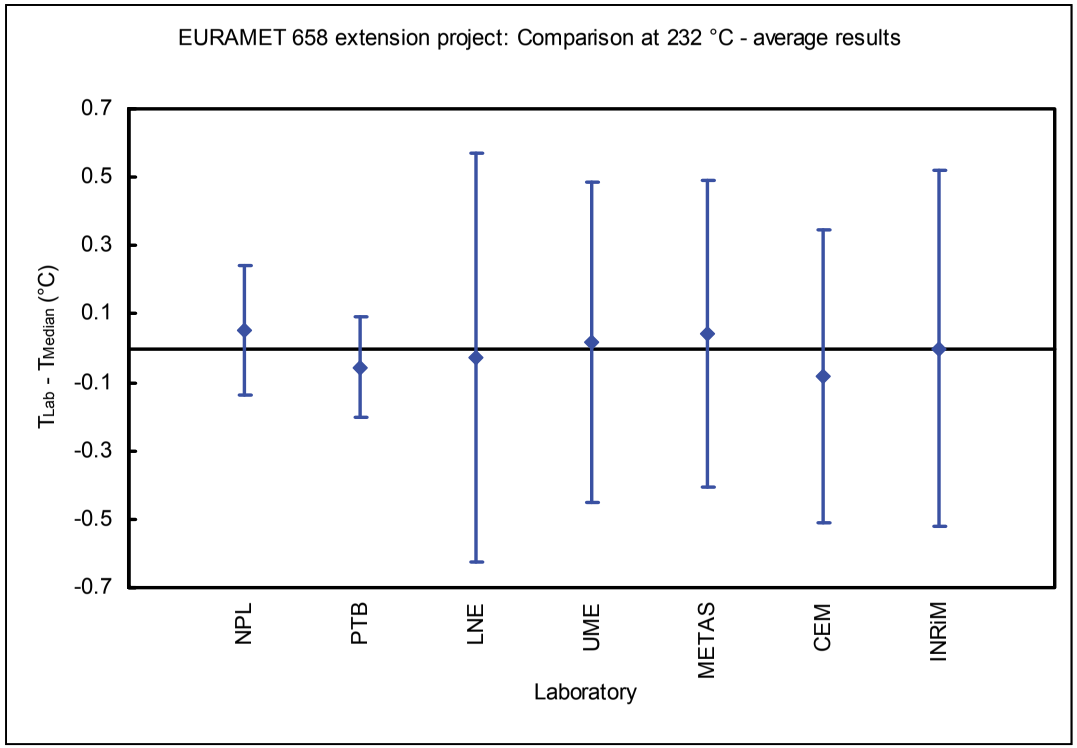
	NPL FP	NPL VTBB	PTB VTBB	LNE VTBB	UME FP	METAS VTBB	CEM VTBB	INRiM FP
NPL FP	-	-0.03 ± 0.292	0.10 ± 0.185	0.07 ± 0.610	0.02 ± 0.483	0.00 ± 0.464	0.12 ± 0.444	0.04 ± 0.532
NPL VTBB	*0.29*	-	0.12 ± 0.307	0.09 ± 0.658	0.05 ± 0.542	0.02 ± 0.525	0.15 ± 0.508	0.06 ± 0.586
PTB VTBB	*0.25*	*0.38*	-	-0.03 ± 0.618	-0.07 ± 0.493	-0.10 ± 0.473	0.03 ± 0.454	-0.06 ± 0.540
LNE VTBB	*0.61*	*0.67*	*0.61*	-	-0.04 ± 0.762	-0.07 ± 0.750	0.05 ± 0.738	-0.03 ± 0.794
UME FP	*0.47*	*0.54*	*0.50*	*0.75*	-	-0.03 ± 0.651	0.10 ± 0.637	0.02 ± 0.701
METAS VTBB	*0.46*	*0.52*	*0.50*	*0.75*	*0.64*	-	0.13 ± 0.622	0.04 ± 0.688
CEM VTBB	*0.49*	*0.57*	*0.45*	*0.73*	*0.65*	*0.66*	-	-0.08 ± 0.675
INRiM FP	*0.52*	*0.59*	*0.54*	*0.78*	*0.69*	*0.68*	*0.68*	-

Table 67 - direct comparison of the results for the LP5 thermometer measurements at the Sn fixed-point temperature



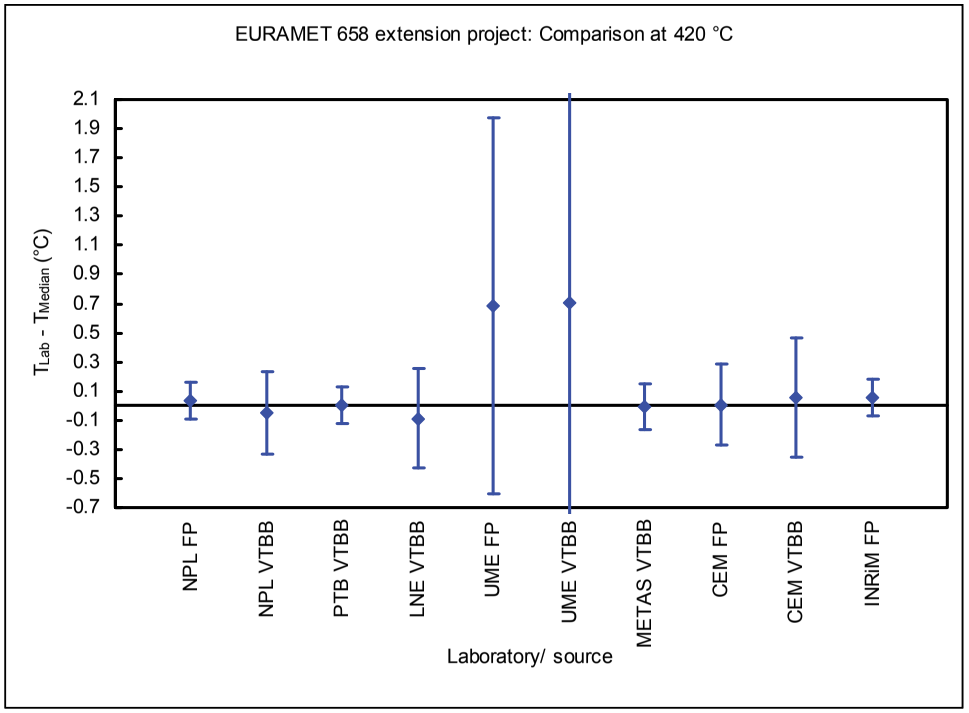
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	0.11 ± 0.241	0.08 ± 0.630	0.03 ± 0.508	0.01 ± 0.489	0.13 ± 0.470	0.05 ± 0.554
PTB	*0.31*	-	-0.03 ± 0.618	-0.07 ± 0.493	-0.10 ± 0.473	0.03 ± 0.454	-0.06 ± 0.540
LNE	*0.63*	*0.61*	-	-0.04 ± 0.762	-0.07 ± 0.750	0.05 ± 0.738	-0.03 ± 0.794
UME	*0.50*	*0.50*	*0.75*	-	-0.03 ± 0.651	0.10 ± 0.637	0.02 ± 0.701
METAS	*0.48*	*0.50*	*0.75*	*0.64*	-	0.13 ± 0.622	0.04 ± 0.688
CEM	*0.53*	*0.45*	*0.73*	*0.65*	*0.66*	-	-0.08 ± 0.675
INRiM	*0.55*	*0.54*	*0.78*	*0.69*	*0.68*	*0.68*	-

Table 68 – direct comparison of the results for the LP5 thermometer measurements at the Sn fixed-point temperature – average data



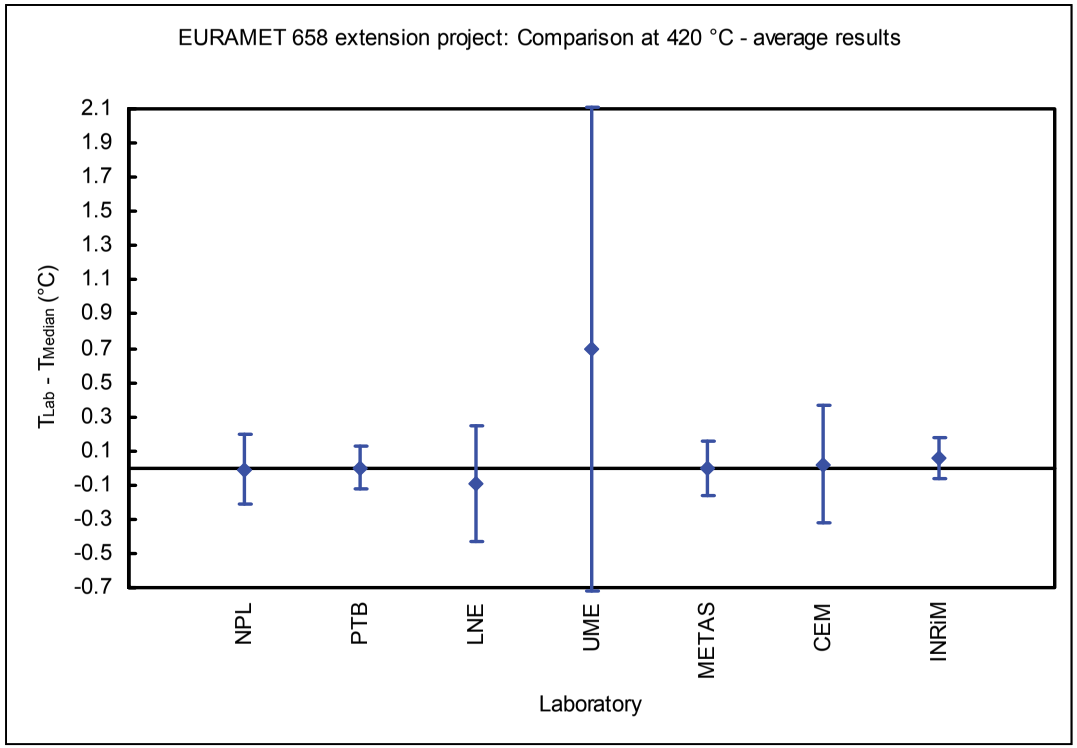
	NPL FP	NPL VTBB	PTB VTBB	LNE VTBB	UME FP	UME VTBB	METAS VTBB	CEM FP	CEM VTBB	INRiM FP
NPL FP	-	0.08 ± 0.307	0.03 ± 0.177	0.12 ± 0.362	-0.65 ± 1.298	-0.67 ± 1.545	0.04 ± 0.202	0.03 ± 0.307	-0.02 ± 0.429	-0.02 ± 0.175
NPL VTBB	*0.34*	-	-0.05 ± 0.307	0.04 ± 0.440	-0.73 ± 1.322	-0.75 ± 1.565	-0.05 ± 0.322	-0.06 ± 0.396	-0.11 ± 0.496	-0.11 ± 0.305
PTB VTBB	*0.18*	*0.32*	-	0.09 ± 0.362	-0.68 ± 1.298	-0.70 ± 1.545	0.00 ± 0.201	-0.01 ± 0.307	-0.05 ± 0.429	-0.06 ± 0.175
LNE VTBB	*0.42*	*0.44*	*0.40*	-	-0.77 ± 1.336	-0.79 ± 1.577	-0.08 ± 0.375	-0.09 ± 0.440	-0.14 ± 0.533	-0.14 ± 0.361
UME FP	*1.72*	*1.82*	*1.75*	*1.87*	-	-0.02 ± 2.010	0.69 ± 1.301	0.68 ± 1.322	0.63 ± 1.355	0.63 ± 1.298
UME VTBB	*1.95*	*2.05*	*1.98*	*2.09*	*1.98*	-	0.71 ± 1.548	0.70 ± 1.565	0.65 ± 1.594	0.65 ± 1.545
METAS VTBB	*0.21*	*0.33*	*0.20*	*0.40*	*1.76*	*1.99*	-	-0.01 ± 0.321	-0.06 ± 0.439	-0.06 ± 0.200
CEM FP	*0.30*	*0.40*	*0.30*	*0.47*	*1.77*	*1.99*	*0.32*	-	-0.05 ± 0.496	-0.05 ± 0.305
CEM VTBB	*0.42*	*0.53*	*0.43*	*0.59*	*1.75*	*1.97*	*0.44*	*0.49*	-	0.00 ± 0.428
INRiM FP	*0.18*	*0.36*	*0.20*	*0.44*	*1.70*	*1.93*	*0.23*	*0.31*	*0.42*	-

Table 69 – direct comparison of the results for the LP5 thermometer measurements at the Zn fixed-point temperature



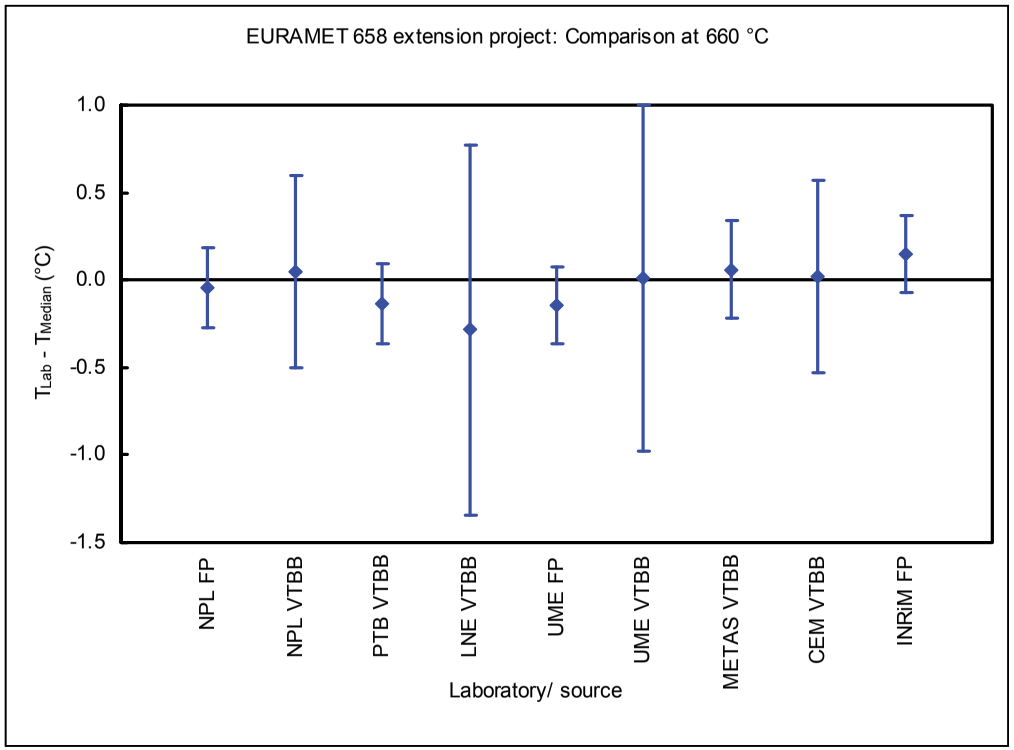
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	-0.01 ± 0.238	0.08 ± 0.396	-0.70 ± 1.430	-0.01 ± 0.257	-0.03 ± 0.399	-0.06 ± 0.237
PTB	*0.23*	-	0.09 ± 0.362	-0.69 ± 1.421	0.00 ± 0.201	-0.02 ± 0.366	-0.06 ± 0.175
LNE	*0.42*	*0.40*	-	-0.78 ± 1.456	-0.08 ± 0.375	-0.11 ± 0.484	-0.14 ± 0.361
UME	*1.88*	*1.87*	*1.98*	-	0.70 ± 1.425	0.67 ± 1.457	0.64 ± 1.421
METAS	*0.25*	*0.20*	*0.40*	*1.87*	-	-0.03 ± 0.379	-0.06 ± 0.200
CEM	*0.39*	*0.36*	*0.52*	*1.87*	*0.37*	-	-0.03 ± 0.365
INRiM	*0.26*	*0.20*	*0.44*	*1.81*	*0.23*	*0.36*	-

Table 70 – direct comparison of the results for the LP5 thermometer measurements at the Zn fixed-point temperature – average data



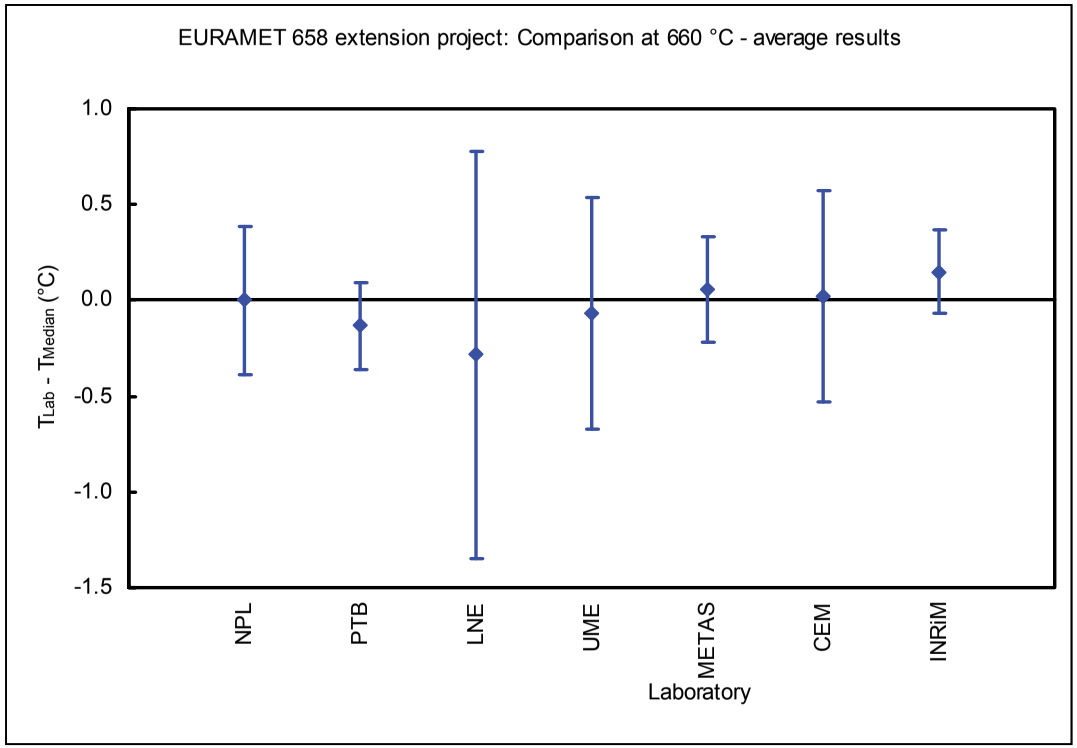
	NPL FP	NPL VTBB	PTB VTBB	LNE VTBB	UME FP	UME VTBB	METAS VTBB	CEM VTBB	INRiM FP
NPL FP	-	-0.09 ± 0.595	0.09 ± 0.323	0.24 ± 1.084	0.10 ± 0.319	-0.05 ± 1.016	-0.10 ± 0.359	-0.06 ± 0.595	-0.19 ± 0.316
NPL VTBB	*0.61*	-	0.18 ± 0.596	0.33 ± 1.194	0.19 ± 0.594	0.03 ± 1.133	-0.01 ± 0.616	0.02 ± 0.778	-0.11 ± 0.592
PTB VTBB	*0.36*	*0.68*	-	0.15 ± 1.085	0.01 ± 0.321	-0.14 ± 1.016	-0.19 ± 0.361	-0.15 ± 0.596	-0.28 ± 0.317
LNE VTBB	*1.16*	*1.33*	*1.10*	-	-0.14 ± 1.083	-0.29 ± 1.450	-0.34 ± 1.096	-0.31 ± 1.194	-0.43 ± 1.082
UME FP	*0.37*	*0.69*	*0.31*	*1.09*	-	-0.16 ± 1.015	-0.20 ± 0.357	-0.17 ± 0.594	-0.30 ± 0.313
UME VTBB	*1.00*	*1.11*	*1.03*	*1.53*	*1.04*	-	-0.05 ± 1.028	-0.01 ± 1.133	-0.14 ± 1.014
METAS VTBB	*0.40*	*0.61*	*0.49*	*1.26*	*0.50*	*1.01*	-	0.04 ± 0.616	-0.09 ± 0.354
CEM VTBB	*0.59*	*0.76*	*0.66*	*1.31*	*0.66*	*1.12*	*0.61*	-	-0.13 ± 0.592
INRiM FP	*0.45*	*0.62*	*0.54*	*1.33*	*0.55*	*1.03*	*0.39*	*0.63*	-

Table 71 – direct comparison of the results for the LP5 thermometer measurements at the Al fixed-point temperature



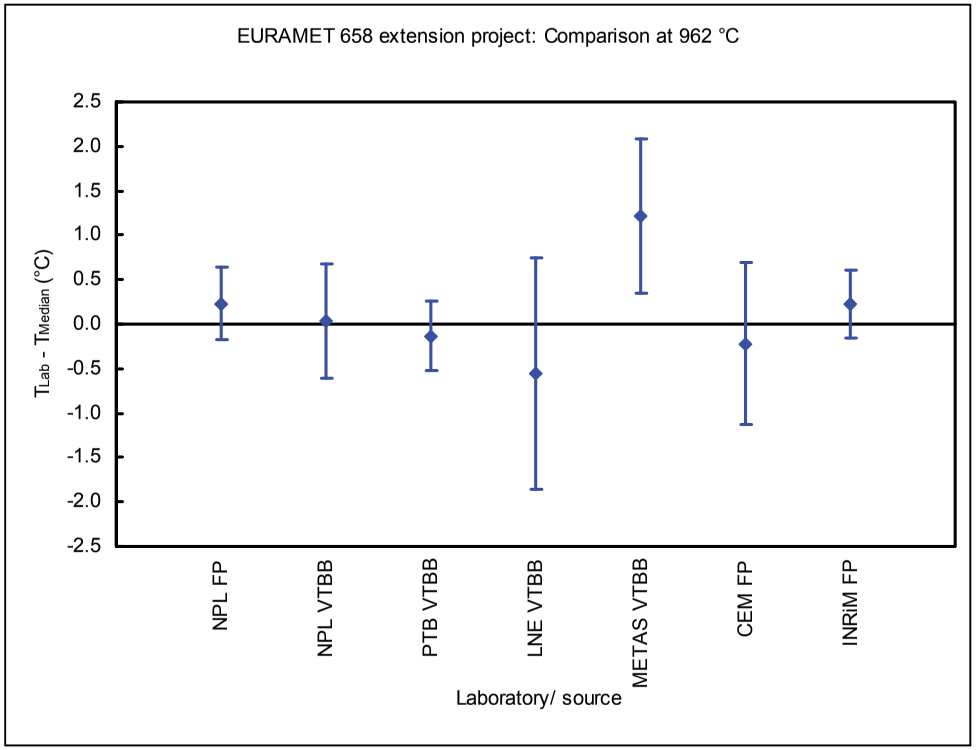
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	0.13 ± 0.452	0.29 ± 1.129	0.07 ± 0.721	-0.06 ± 0.478	-0.02 ± 0.674	-0.15 ± 0.446
PTB	*0.51*	-	0.15 ± 1.085	-0.07 ± 0.649	-0.19 ± 0.361	-0.15 ± 0.596	-0.28 ± 0.317
LNE	*1.24*	*1.10*	-	-0.22 ± 1.221	-0.34 ± 1.096	-0.31 ± 1.194	-0.43 ± 1.082
UME	*0.72*	*0.65*	*1.27*	-	-0.13 ± 0.667	-0.09 ± 0.819	-0.22 ± 0.645
METAS	*0.48*	*0.49*	*1.26*	*0.70*	-	0.04 ± 0.616	-0.09 ± 0.354
CEM	*0.66*	*0.66*	*1.31*	*0.82*	*0.61*	-	-0.13 ± 0.592
INRiM	*0.52*	*0.54*	*1.33*	*0.75*	*0.39*	*0.63*	-

Table 72 – direct comparison of the results for the LP5 thermometer measurements at the Al fixed-point temperature – average data



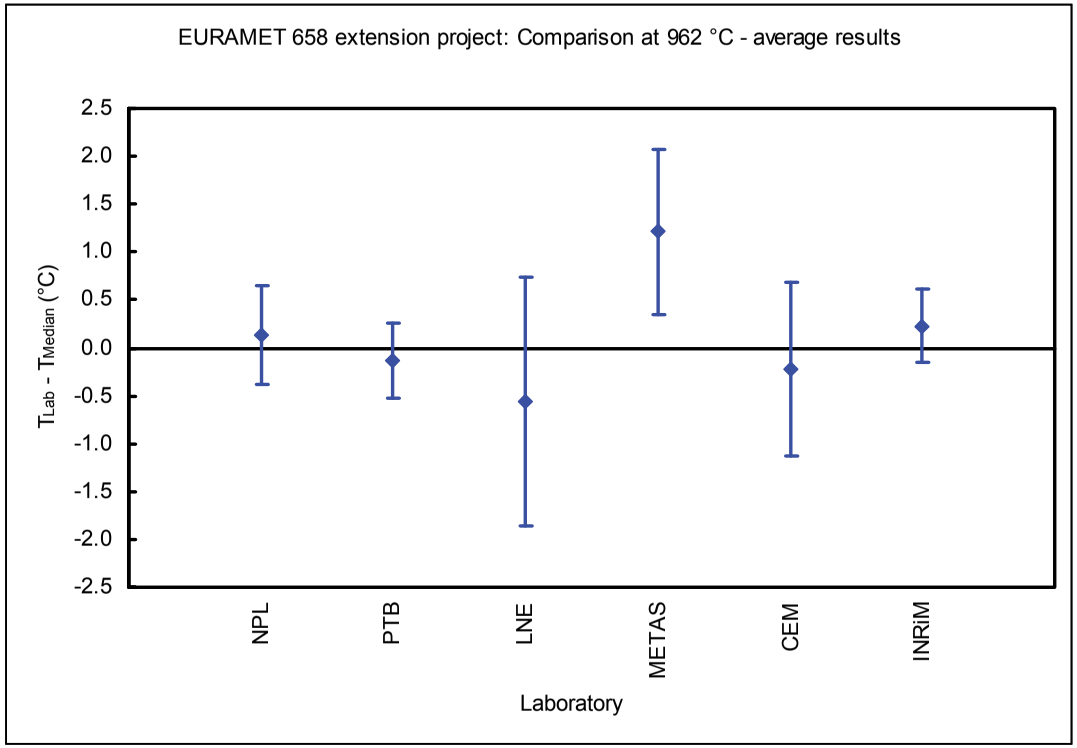
	NPL FP	NPL VTBB	PTB VTBB	LNE VTBB	METAS VTBB	CEM FP	INRiM FP
NPL FP	-	0.20 ± 0.757	0.37 ± 0.564	0.80 ± 1.361	-0.98 ± 0.955	0.45 ± 0.998	0.00 ± 0.556
NPL VTBB	*0.83*	-	0.17 ± 0.751	0.60 ± 1.449	-1.17 ± 1.076	0.26 ± 1.114	-0.19 ± 0.746
PTB VTBB	*0.83*	*0.81*	-	0.43 ± 1.358	-1.35 ± 0.950	0.09 ± 0.993	-0.37 ± 0.548
LNE VTBB	*1.92*	*1.80*	*1.56*	-	-1.77 ± 1.561	-0.34 ± 1.588	-0.79 ± 1.355
METAS VTBB	*1.76*	*2.06*	*2.13*	*3.06*	-	1.43 ± 1.257	0.98 ± 0.946
CEM FP	*1.28*	*1.20*	*0.98*	*1.69*	*2.47*	-	-0.45 ± 0.989
INRiM FP	*0.55*	*0.82*	*0.82*	*1.91*	*1.76*	*1.27*	-

Table 73 – direct comparison of the results for the LP5 thermometer measurements at the Ag fixed-point temperature

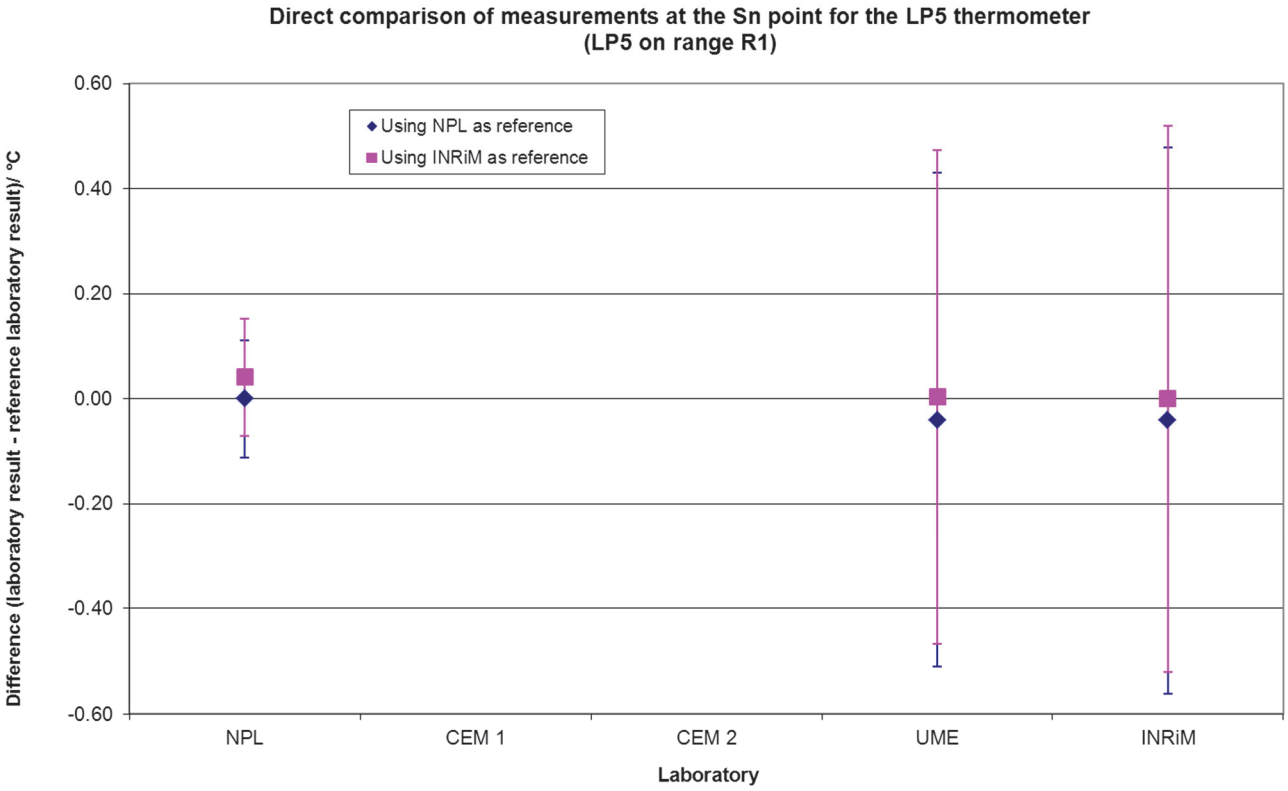


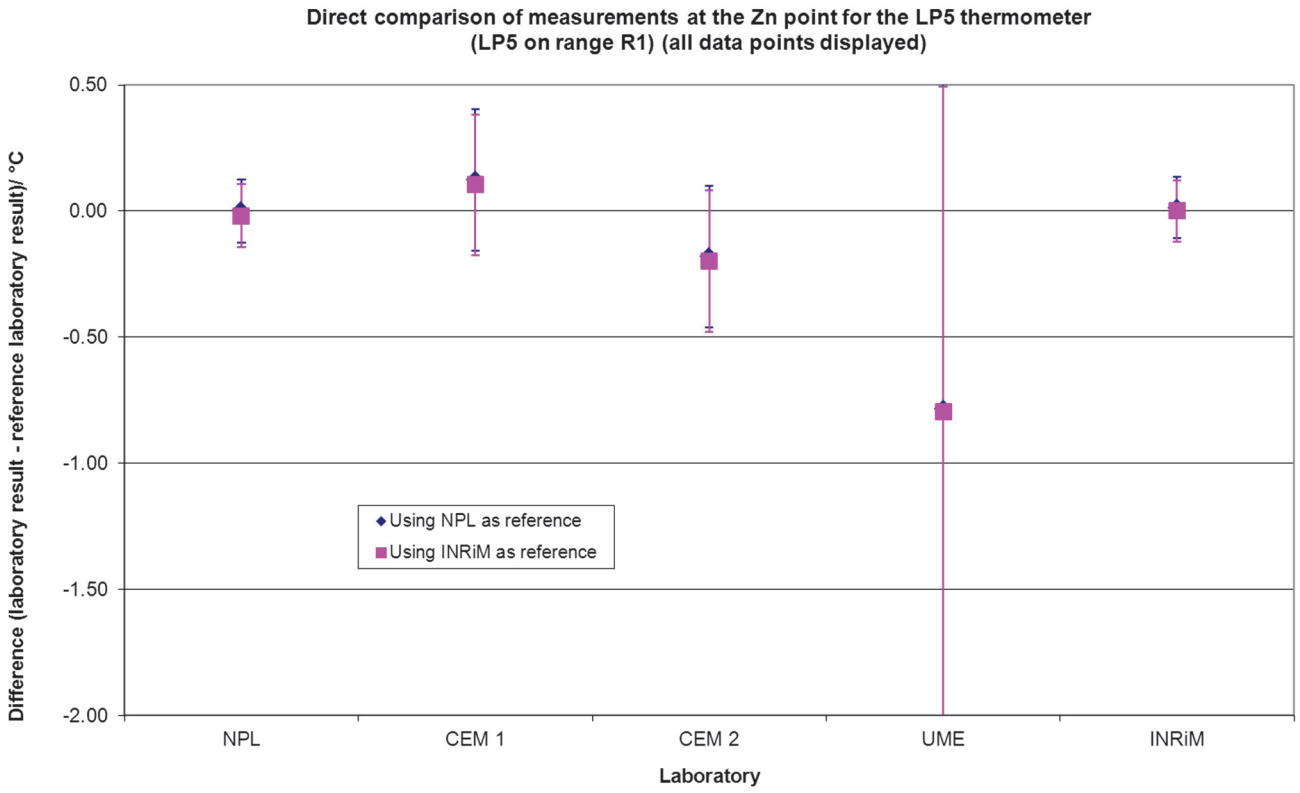
	NPL	PTB	LNE	METAS	CEM	INRiM
NPL	-	0.27 ± 0.653	0.70 ± 1.401	-1.08 ± 1.010	0.36 ± 1.051	-0.09 ± 0.647
PTB	*0.81*	-	0.43 ± 1.358	-1.35 ± 0.950	0.09 ± 0.993	-0.37 ± 0.548
LNE	*1.85*	*1.56*	-	-1.77 ± 1.561	-0.34 ± 1.588	-0.79 ± 1.355
METAS	*1.91*	*2.13*	*3.06*	-	1.43 ± 1.257	0.98 ± 0.946
CEM	*1.23*	*0.98*	*1.69*	*2.47*	-	-0.45 ± 0.989
INRiM	*0.66*	*0.82*	*1.91*	*1.76*	*1.27*	-

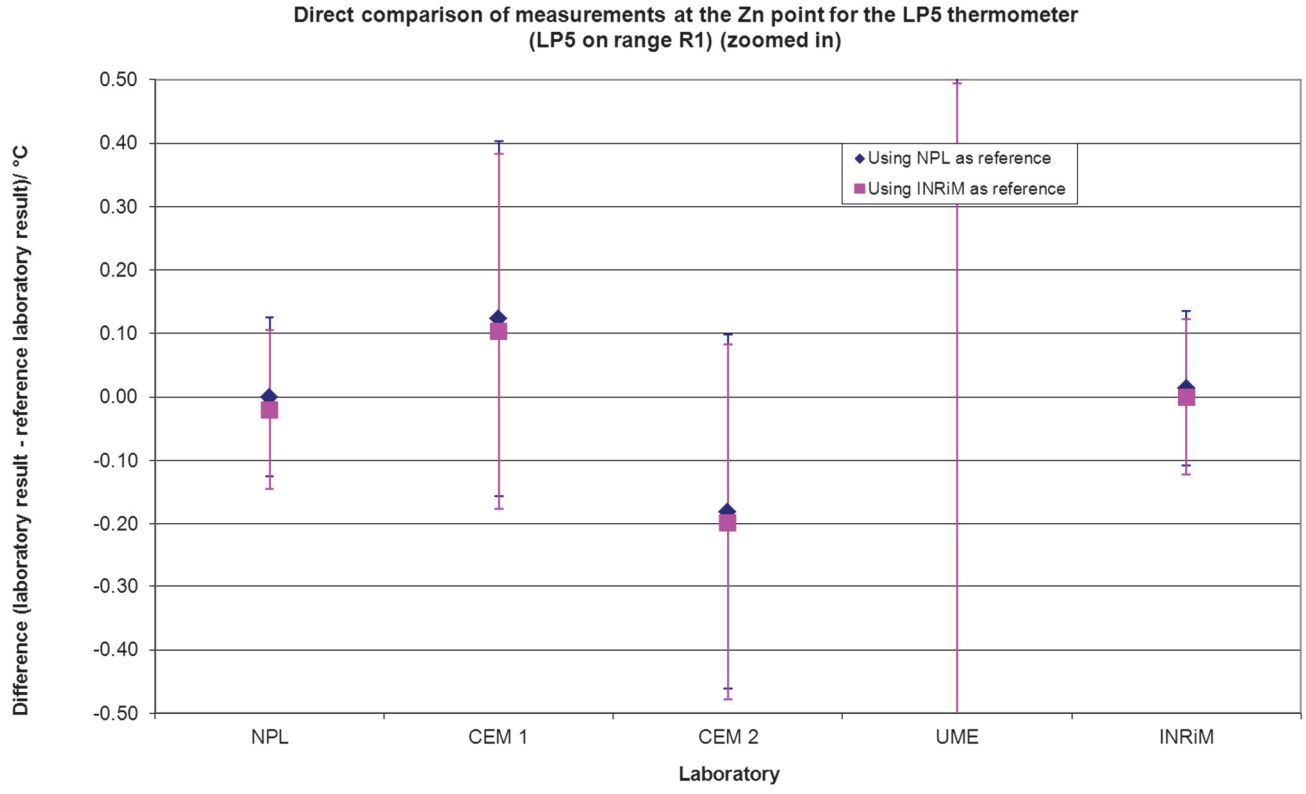
Table 74 – direct comparison of the results for the LP5 thermometer measurements at the Ag fixed-point temperature – average data

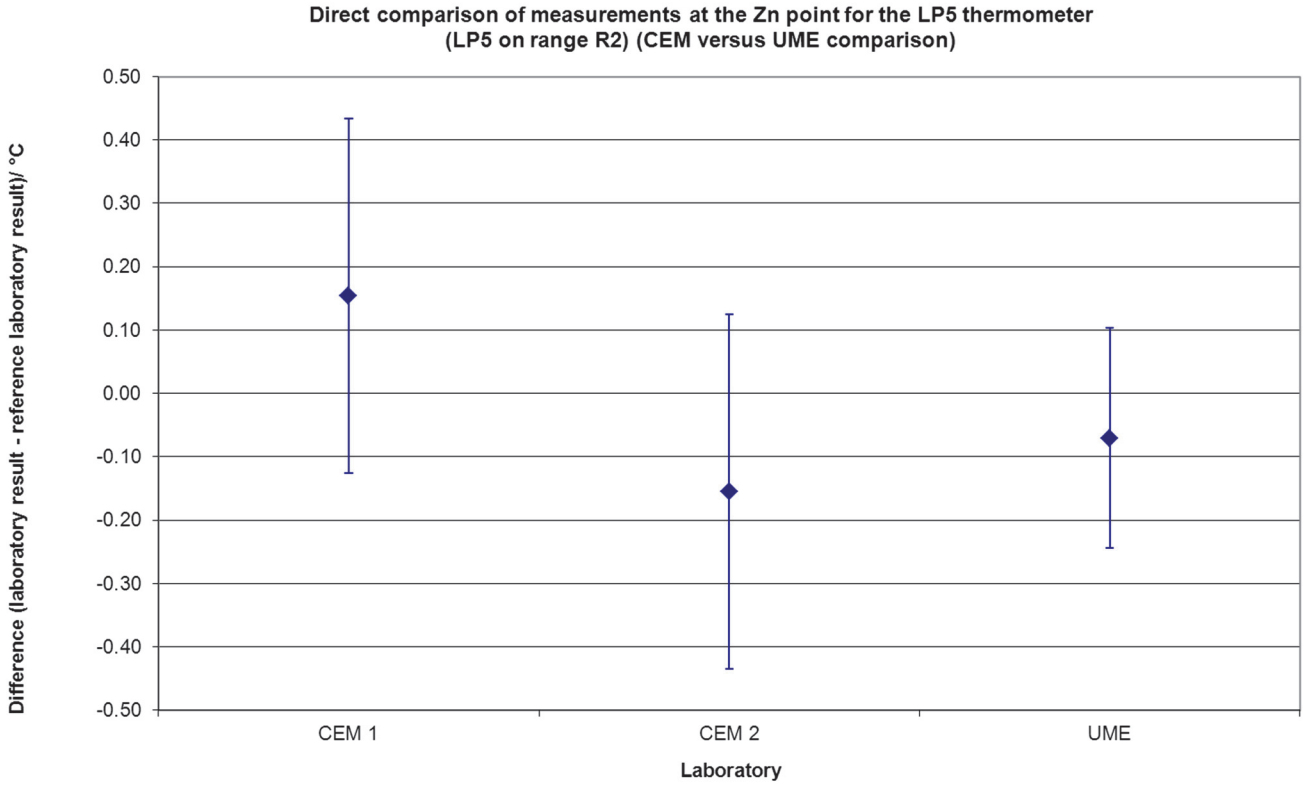


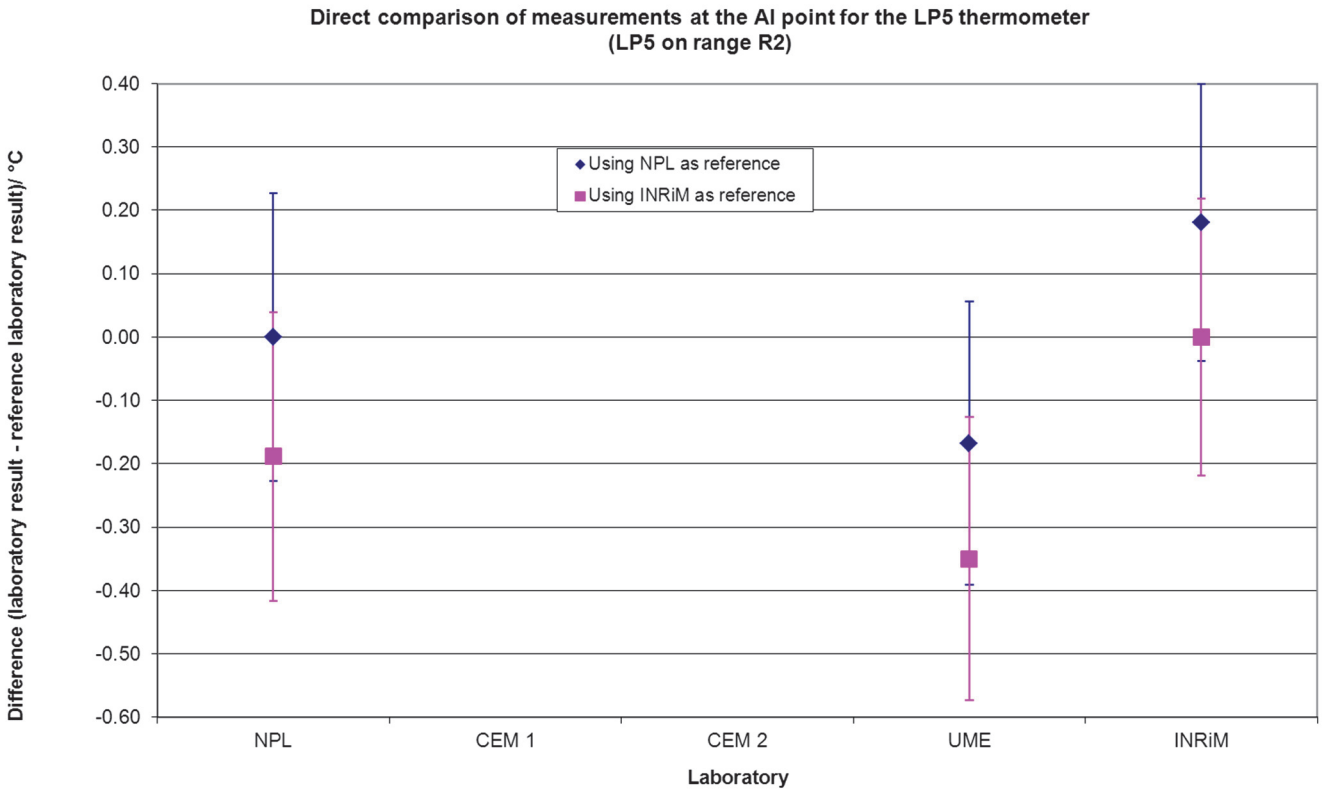
6 PLOTS OF RESULTS OF THE DIRECT COMPARISON OF THE MEASUREMENTS WITH THE FIXED-POINTS FOR THE LP5 THERMOMETER AND INRIM THERMOMETERS

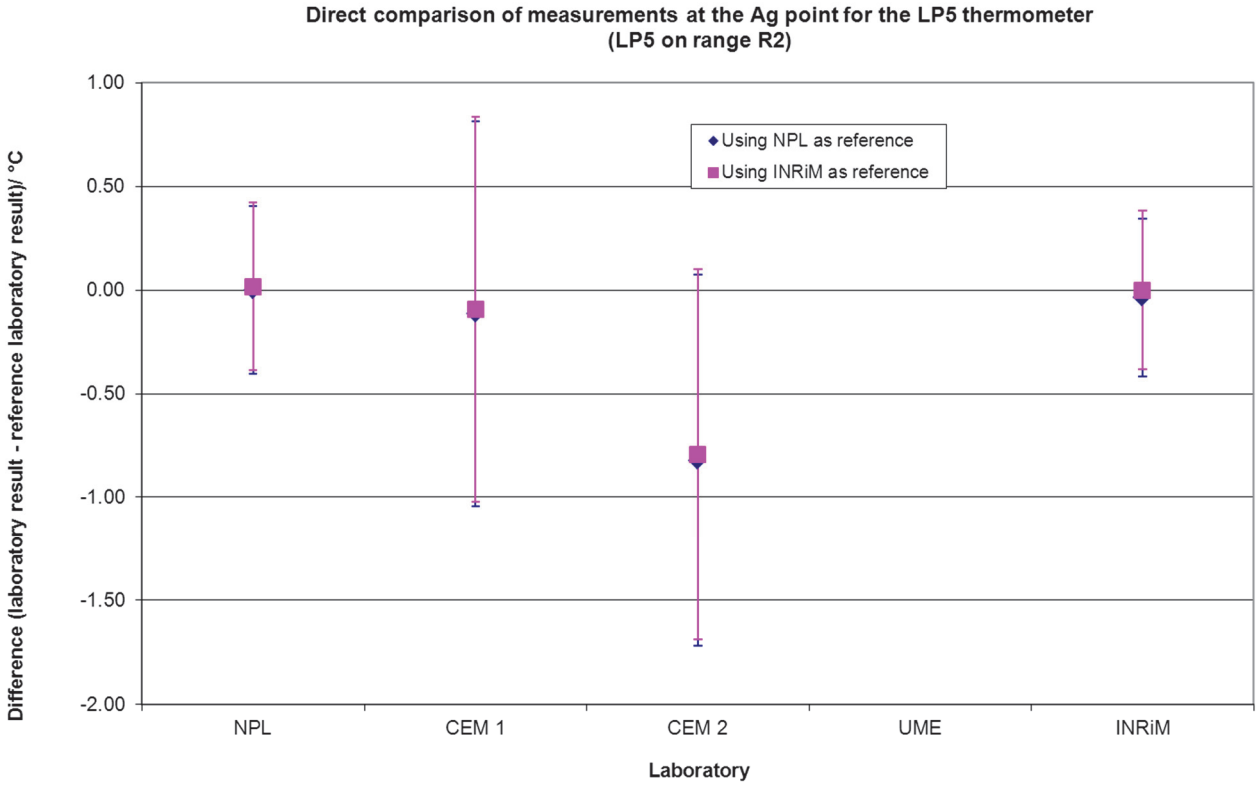


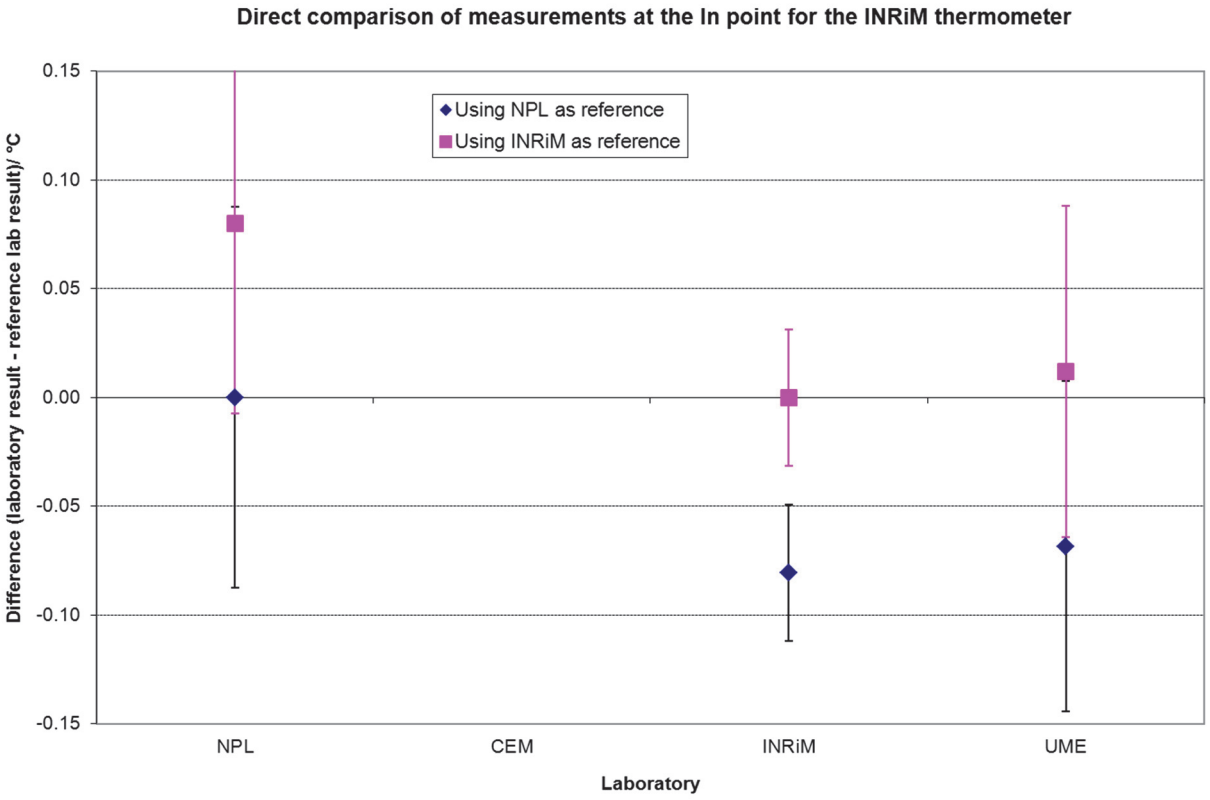

Direct comparison of measurements at the Zn point for the LP5 thermometer
(LP5 on range R1) (all data points displayed)
Difference (laboratory result - reference laboratory result)/ °C
0.50
0.00
-0.50
-1.00
-1.50
-2.00
Using NPL as reference
Using INRiM as reference
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

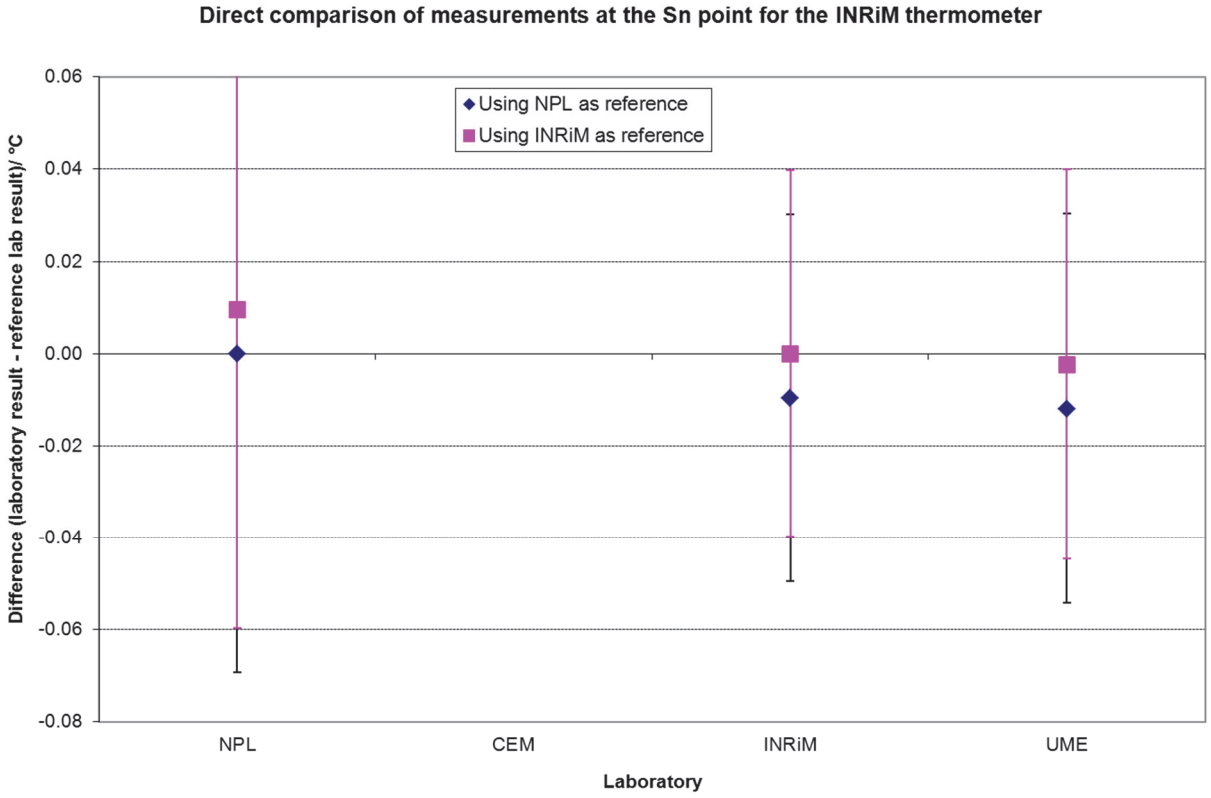

Direct comparison of measurements at the Zn point for the LP5 thermometer
(LP5 on range R1) (zoomed in)
Difference (laboratory result - reference laboratory result)/ °C
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
Using NPL as reference
Using INRiM as reference
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

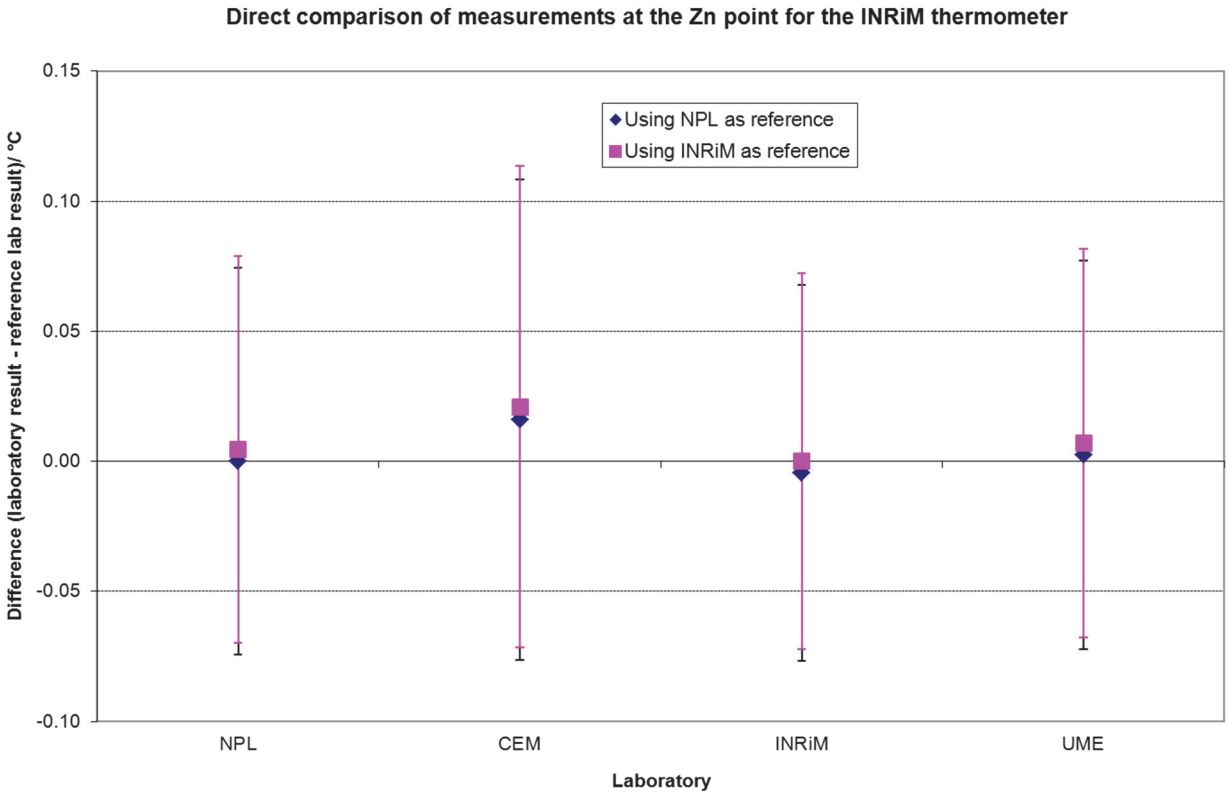

Direct comparison of measurements at the Zn point for the LP5 thermometer
(LP5 on range R2) (CEM versus UME comparison)
Difference (laboratory result - reference laboratory result)/ °C
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
CEM 1
CEM 2
UME
Laboratory

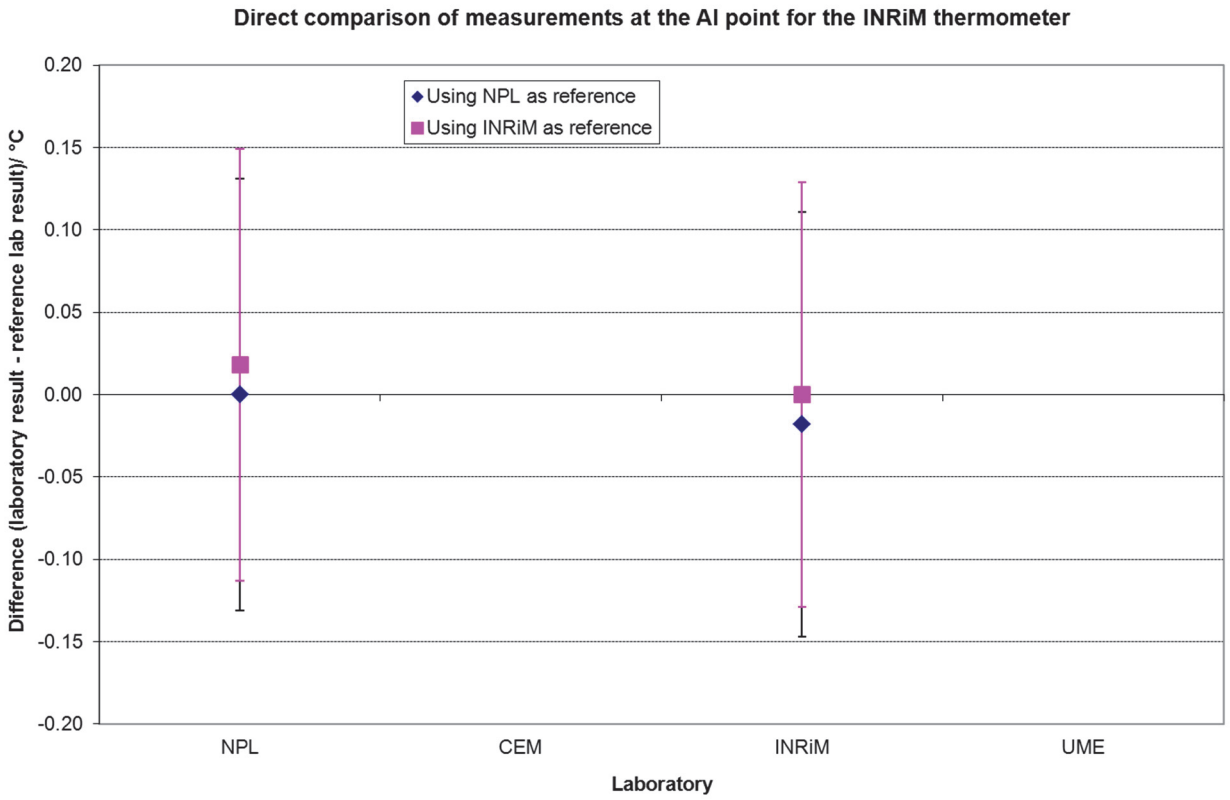

Direct comparison of measurements at the Al point for the LP5 thermometer
(LP5 on range R2)
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference laboratory result)/ °C
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

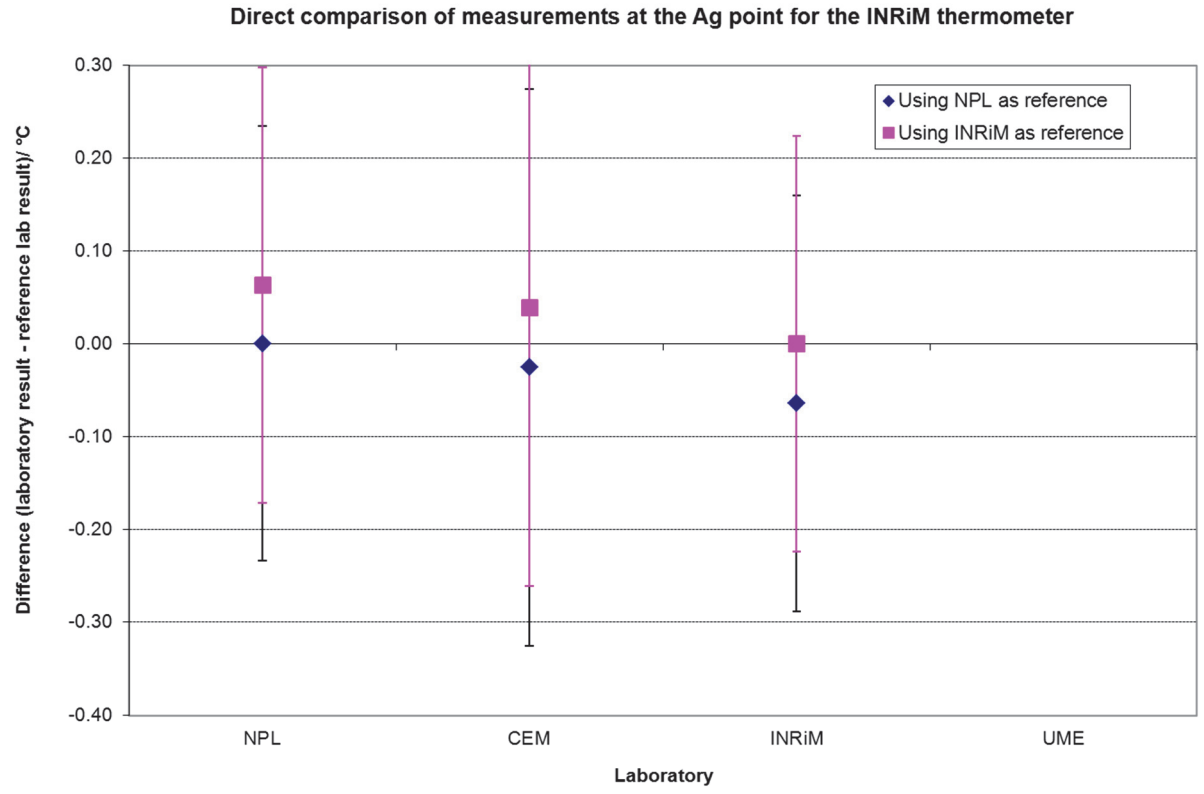

Direct comparison of measurements at the Ag point for the LP5 thermometer
(LP5 on range R2)
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference laboratory result)/ °C
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory


Direct comparison of measurements at the In point for the INRiM thermometer
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference lab result)/ °C
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
NPL
CEM
INRiM
UME
Laboratory


Direct comparison of measurements at the Sn point for the INRiM thermometer
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference lab result)/ °C
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
NPL
CEM
INRiM
UME
Laboratory


Direct comparison of measurements at the Zn point for the INRiM thermometer
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference lab result)/ °C
0.15
0.10
0.05
0.00
-0.05
-0.10
NPL
CEM
INRiM
UME
Laboratory


Direct comparison of measurements at the Al point for the INRiM thermometer
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference lab result)/ °C
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
NPL
CEM
INRiM
UME
Laboratory


Direct comparison of measurements at the Ag point for the INRiM thermometer
Using NPL as reference
Using INRiM as reference
Difference (laboratory result - reference lab result)/ °C
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
NPL
CEM
INRiM
UME
Laboratory

NPL
National Physical Laboratory

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APPENDIX 5

RESULTS OF THE ANALYSIS OF THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY MEASUREMENTS USING A CALIBRATION FIT FROM THE MEDIAN OF THE RESULTS FROM ALL THE LABORATORIES

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

HELEN MCEVOY

JANUARY 2018

Department for
Business, Energy
& Industrial Strategy

FUNDED BY BEIS

APPENDIX 5

Results of the Analysis of the Fixed-Point and Variable Temperature Blackbody Measurements using a Calibration Fit from the Median of the Results from all the Laboratories

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation from 156 °C to 1000 °C

Helen McEvoy
Engineering, Materials & Electrical Science

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Approved on behalf of NPL by
Dr Stephanie Bell, Science Area Leader

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1 ANALYSIS USING A FIT OF THE MEDIAN OF ALL THE RESULTS

A calibration fit was also determined using the median of all the laboratory values. For each laboratory's measurements, the thermometer signals were firstly corrected to a common gain or range (x10^6 for the INRiM thermometer and ranges R1 and R2 for the LP5) using the laboratory's gain or range ratio values (where available) as described previously (Section 5 of the main report). Using the zinc point measurements (Section 1 of the report) the results were corrected to compensate for any drift from the start of the comparison (i.e. relative to PTB). For temperatures other than the zinc point, the correction was scaled using the ratio $(t_{source})^2/(t_{zinc})^2$. This temperature correction could be converted to an equivalent signal correction using Equation 1. This correction was applied to the signal values.

$$\Delta S = \Delta T \frac{c_2}{\lambda T^2} S \qquad \textbf{Equation 1}$$

where ΔS is the correction to the thermometer signal S for a temperature correction ΔT, T is the source temperature in K, and λ is the operational wavelength, taken to be 1.57 μm and 1.60 μm respectively for the LP5 and the INRiM thermometer, as given in the technical specifications for the thermometers.

An additional uncertainty was also added to the laboratory measurement uncertainty to allow for the drift of the thermometer during the comparison. The results were then corrected to account for any difference between the actual blackbody temperature, t_{BB}, and the required comparison temperature, t_{nom} also using Equation 1. The average thermometer signal for each laboratory at each temperature t_{nom} was then calculated. Finally, the median of all the results from all the laboratories was calculated for each t_{nom}.

A least squares fit of the median results was performed using a version of the Planck form of the Sakuma-Hattori interpolation equation, Equation 2. This was done in three ways: i) using the FPBB results only; ii) using the VTBB results only; iii) using all the VTBB and FP results to provide a calibration fit for the entire data set of results.

$$S(T) = \frac{a_1}{\exp(c_2/(a_2 T + a_3)) - 1} \qquad \textbf{Equation 2}$$

where $S(T)$ is the output voltage of the thermometer, T is the temperature in kelvin, c_2 is the second radiation constant and a_1, a_2 and a_3 are constants.

The results of the comparison of all the fitted measurements are given in Tables 1 to 113 below and in the accompanying plots. It was found that, for both thermometers, discrepancies in the results at 1000 °C resulted in a poor calibration fit, as is evidenced by the (relatively) large RMS residuals of the fit. The fitting was therefore also done with the 1000 °C data excluded, and this led to a much better result (lower, more acceptable residuals).

The DOE or QDE_{95} for the results using the calibration fit of the medians of the entire datasets (i.e. including all the FP and VTBB data), with the 1000 °C points excluded from the fits, were calculated for both thermometers (for the LP5 using range R1 only), and are given in this Appendix for reference. Again it should be emphasised that the results are only applicable for a wavelength near 1.6 microns and do not ensure equivalence at other wavelengths.

2 VTBB RESULTS WITH THE INRIM THERMOMETER USING THE MEDIAN OF THE VTBB DATA FOR THE FITTING PROCESS

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB})/ °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB})/ °C	U (k=2)/ °C
156.60	10^10	156.57	0.776219	7.6972E-05	0.009	7.7007E-05	0.03	7.7120E-05	156.609	0.039	156.712	0.142	0.56
200.00	10^10	200.00	5.135394	5.0924E-04	0.011	5.0947E-04	0.00	5.0947E-04	199.875	-0.125	199.924	-0.076	0.51
231.93	10^9	231.88	1.838722	1.6801E-03	0.013	1.6808E-03	0.05	1.6838E-03	231.976	0.096	231.990	0.110	0.30
250.00	10^9	250.04	3.381156	3.0894E-03	0.014	3.0908E-03	-0.04	3.0867E-03	250.088	0.048	250.085	0.045	0.30
300.00	10^8	300.02	1.370938	1.3638E-02	0.016	1.3644E-02	-0.02	1.3637E-02	300.174	0.154	300.130	0.110	0.30
400.00	10^7	399.89	1.362019	0.136273	0.023	1.3633E-01	0.11	1.3663E-01	399.957	0.067	399.864	-0.026	0.31
419.53	10^7	419.49	1.983845	0.198487	0.024	1.9858E-01	0.04	1.9873E-01	419.643	0.153	419.546	0.056	0.31
500.00	10^7	499.89	7.547499	0.755141	0.030	7.5548E-01	0.11	7.5673E-01	499.944	0.054	499.846	-0.044	0.32
600.00	10^6	600.03	2.837789	2.837789	0.038	2.839066	-0.03	2.838061	600.169	0.139	600.109	0.079	0.29
660.32	10^6	660.29	5.480883	5.480883	0.044	5.483348	0.03	5.485046	660.306	0.016	660.291	0.001	0.31
700.00	10^6	700.03	8.093755	8.093755	0.047	8.097395	-0.03	8.095089	699.979	-0.051	700.001	-0.029	0.32
800.00	10^5	799.87	1.899449	19.000850	0.058	19.009397	0.13	19.028698	799.765	-0.105	799.913	0.043	0.35
900.00	10^5	899.98	3.858663	38.599565	0.069	38.616927	0.02	38.621974	899.581	-0.399	899.898	-0.082	0.39
231.93	10^9	232.02	1.842625	1.6836E-03	0.013	1.6844E-03	-0.09	1.6790E-03	232.037	0.017	232.051	0.031	0.30
300.00	10^8	300.08	1.375069	1.3679E-02	0.016	1.3685E-02	-0.08	1.3655E-02	300.285	0.205	300.241	0.161	0.30
500.00	10^7	500.03	7.566450	0.757037	0.030	7.5738E-01	-0.03	7.5704E-01	500.112	0.082	500.015	-0.015	0.32
700.00	10^6	699.99	8.094334	8.094334	0.047	8.097975	0.01	8.098744	699.986	-0.004	700.009	0.019	0.32
900.00	10^5	899.88	3.856424	38.577167	0.069	38.594519	0.12	38.624786	899.492	-0.388	899.808	-0.072	0.39

Table 1 - results of the CEM VTBB measurements performed on the 'low range' with the INRiM thermometer, analysed using the fit of the median of the VTBB data

‡ calculated relative to the start of the comparison, i.e. from the PTB Zn point check

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB})/ °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB})/ °C	U (k=2)/ °C
156.60	10^9	156.57	0.084268	7.6997E-05	0.009	7.7031E-05	0.03	7.7144E-05	156.616	0.046	156.718	0.148	0.36
200.00	10^9	200.00	0.557157	5.0908E-04	0.011	5.0931E-04	0.00	5.0931E-04	199.867	-0.133	199.916	-0.084	0.31
231.93	10^8	231.88	0.168944	1.6807E-03	0.013	1.6814E-03	0.05	1.6844E-03	231.986	0.106	232.000	0.120	0.30
250.00	10^8	250.04	0.310514	3.0890E-03	0.014	3.0904E-03	-0.04	3.0863E-03	250.084	0.044	250.081	0.041	0.30
300.00	10^7	300.02	0.136309	1.3638E-02	0.016	1.3644E-02	-0.02	1.3637E-02	300.174	0.154	300.130	0.110	0.30
400.00	10^6	399.89	0.136278	0.136278	0.023	1.3634E-01	0.11	1.3664E-01	399.959	0.069	399.867	-0.023	0.31
419.53	10^6	419.49	0.198507	0.198507	0.024	1.9860E-01	0.04	1.9875E-01	419.649	0.159	419.552	0.062	0.31
500.00	10^6	499.89	0.755142	0.755142	0.030	7.5548E-01	0.11	7.5673E-01	499.944	0.054	499.846	-0.044	0.32
600.00	10^5	600.03	0.283681	2.837761	0.038	2.839038	-0.03	2.838033	600.168	0.138	600.109	0.079	0.29
660.32	10^5	660.29	0.547934	5.481181	0.044	5.483646	0.03	5.485344	660.311	0.021	660.296	0.006	0.31
700.00	10^5	700.03	0.809106	8.093774	0.047	8.097415	-0.03	8.095108	699.979	-0.051	700.002	-0.028	0.32
800.00	10^4	799.87	0.191880	18.999437	0.058	19.007983	0.13	19.027283	799.756	-0.114	799.904	0.034	0.35
900.00	10^4	899.98	0.389795	38.596576	0.069	38.613937	0.02	38.618983	899.569	-0.411	899.886	-0.094	0.39
231.93	10^8	232.02	0.169206	1.6833E-03	0.013	1.6840E-03	-0.09	1.6787E-03	232.031	0.011	232.045	0.025	0.30
300.00	10^7	300.08	0.136723	1.3679E-02	0.016	1.3686E-02	-0.08	1.3656E-02	300.286	0.206	300.242	0.162	0.30
500.00	10^6	500.03	0.756917	0.756917	0.030	7.5726E-01	-0.03	7.5692E-01	500.102	0.072	500.004	-0.026	0.32
700.00	10^5	699.99	0.809125	8.093962	0.047	8.097603	0.01	8.098372	699.981	-0.009	700.004	0.014	0.32
900.00	10^4	899.88	0.389568	38.574084	0.069	38.591435	0.12	38.621700	899.479	-0.401	899.796	-0.084	0.39

Table 2 - results of the CEM VTBB measurements performed on the 'high range' with the INRiM thermometer, analysed using the fit of the median of the VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB})/ °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB})/ °C	U (k=2) / °C
156.60	10^10	156.566	0.771526	7.64095E-05	0.00	7.64095E-05	0.034	7.65365E-05	156.447	-0.119	156.550	-0.016	0.070
200	10^10	200.035	5.165212	5.11546E-04	0.00	5.11546E-04	-0.035	5.10833E-04	199.977	-0.057	200.026	-0.009	0.072
231.93	10^9	231.947	1.837326	1.67760E-03	0.00	1.67760E-03	-0.017	1.67662E-03	231.921	-0.026	231.935	-0.011	0.076
250	10^9	250.039	3.377719	3.08409E-03	0.00	3.08409E-03	-0.039	3.08014E-03	250.021	-0.018	250.018	-0.021	0.080
300	10^8	300.023	1.366982	1.35988E-02	0.00	1.35988E-02	-0.023	1.35904E-02	300.051	0.028	300.007	-0.015	0.107
400	10^7	400.021	1.366276	1.36699E-01	0.00	1.36699E-01	-0.021	1.36643E-01	400.093	0.072	400.000	-0.020	0.075
419.53	10^7	419.519	1.983355	1.98439E-01	0.00	1.98439E-01	0.011	1.98479E-01	419.606	0.087	419.509	-0.010	0.079
500	10^6	500.020	0.757357	7.57357E-01	0.00	7.57357E-01	-0.020	7.57134E-01	500.111	0.091	500.013	-0.007	0.096
600	10^6	600.019	2.835811	2.83581E+00	0.00	2.83581E+00	-0.019	2.83516E+00	600.071	0.051	600.011	-0.008	0.120
660.32	10^6	660.328	5.483683	5.48368E+00	0.00	5.48368E+00	-0.008	5.48321E+00	660.312	-0.017	660.296	-0.032	0.147
700	10^6	700.032	8.097138	8.09714E+00	0.00	8.09714E+00	-0.032	8.09469E+00	699.975	-0.057	699.998	-0.034	0.157
800	10^5	800.017	1.900651	1.90228E+01	0.00	1.90228E+01	-0.017	1.90203E+01	799.857	-0.160	800.005	-0.012	0.187
900	10^5	900.026	3.861526	3.86484E+01	0.00	3.86484E+01	-0.026	3.86420E+01	899.706	-0.319	900.023	-0.002	0.219
961.78	10^5	961.728	5.647521	5.65237E+01	0.00	5.65237E+01	0.052	5.65410E+01	961.278	-0.450	961.720	-0.008	0.242
156.60	10^10	156.623	0.773692	7.66239E-05	0.00	7.66239E-05	-0.023	7.65389E-05	156.505	-0.117	156.608	-0.015	0.070
250	10^9	250.087	3.382039	3.08803E-03	0.00	3.08803E-03	-0.087	3.07922E-03	250.061	-0.026	250.058	-0.029	0.078
419.53	10^7	419.516	1.983341	1.98438E-01	0.00	1.98438E-01	0.014	1.98490E-01	419.606	0.090	419.508	-0.008	0.079
500	10^6	500.042	0.757390	7.57390E-01	0.00	7.57390E-01	-0.042	7.56915E-01	500.114	0.072	500.016	-0.026	0.096
700	10^5	700.048	0.809186	8.09881E+00	0.00	8.09881E+00	-0.048	8.09510E+00	699.997	-0.051	700.020	-0.028	0.157
961.78	10^5	961.693	5.646728	5.65158E+01	0.00	5.65158E+01	0.087	5.65447E+01	961.254	-0.439	961.697	0.003	0.242

Table 3 - results of the PTB VTBB measurements with the INRiM thermometer, analysed using the fit of the median of the VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB})/ °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB})/ °C	U (k=2)/ °C
156.60	10^8	156.53	0.007810	7.76065E-05	-0.002	7.76006E-05	0.071	7.78687E-05	156.769	0.240	156.871	0.342	0.21
200	10^7	199.90	0.004967	4.96682E-04	-0.002	4.96645E-04	0.104	4.98711E-04	199.233	-0.663	199.283	-0.613	0.25
200	10^7	199.89	0.005054	5.05373E-04	-0.002	5.05335E-04	0.107	5.07498E-04	199.670	-0.224	199.719	-0.175	0.25
200	10^8	199.90	0.051248	5.09253E-04	-0.002	5.09214E-04	0.100	5.11262E-04	199.862	-0.038	199.911	0.011	0.25
231.93	10^7	231.76	0.016235	1.62356E-03	-0.002	1.62344E-03	0.174	1.63341E-03	230.981	-0.775	230.996	-0.760	0.28
231.93	10^8	231.76	0.167536	1.66481E-03	-0.002	1.66468E-03	0.170	1.67469E-03	231.699	-0.061	231.714	-0.046	0.28
250	10^7	249.83	0.030599	3.05999E-03	-0.002	3.05976E-03	0.171	3.07694E-03	249.778	-0.052	249.775	-0.054	0.30
250	10^8	249.83	0.307849	3.05909E-03	-0.002	3.05886E-03	0.171	3.07610E-03	249.769	-0.060	249.766	-0.063	0.30
300	10^7	300.17	0.136254	0.0136257	-0.003	0.0136246	-0.175	0.0135595	300.121	-0.054	300.077	-0.098	0.32
300	10^8	300.08	1.366253	0.0135764	-0.003	0.0135754	-0.084	0.0135441	299.987	-0.097	299.944	-0.141	0.33
400	10^7	399.91	1.356838	0.135687	-0.004	0.135676	0.095	0.135932	399.711	-0.194	399.619	-0.287	0.37
400	10^7	400.12	1.365849	0.136588	-0.004	0.136577	-0.124	0.136242	400.048	-0.076	399.955	-0.169	0.34
419.53	10^7	419.68	1.984168	0.198421	-0.004	0.198406	-0.151	0.197843	419.597	-0.084	419.500	-0.181	0.35
500	10^7	500.11	7.564966	0.756512	-0.005	0.756455	-0.108	0.755228	500.031	-0.077	499.933	-0.175	0.37
600	10^6	600.11	2.833294	2.833294	-0.006	2.833082	-0.112	2.829329	599.988	-0.124	599.929	-0.183	0.39
600	10^6	600.02	2.828271	2.828271	-0.006	2.828059	-0.020	2.827406	599.837	-0.183	599.777	-0.242	0.40
600	10^6	600.01	2.824760	2.824760	-0.006	2.824548	-0.014	2.824068	599.731	-0.284	599.671	-0.343	1.09
660.32	10^6	660.02	5.447661	5.447661	-0.007	5.447252	0.297	5.463960	659.661	-0.362	659.646	-0.377	1.09
700	10^6	699.85	8.043894	8.043894	-0.008	8.043290	0.149	8.054703	699.268	-0.583	699.290	-0.561	1.12
700	10^6	700.11	8.060855	8.060855	-0.008	8.060251	-0.112	8.051669	699.491	-0.621	699.513	-0.599	1.11
800	10^5	800.20	1.893828	18.949308	-0.010	18.947888	-0.203	18.917923	799.348	-0.855	799.495	-0.707	1.41
900	10^5	899.89	3.844127	38.463648	-0.011	38.460763	0.112	38.488876	898.958	-0.930	899.273	-0.615	1.26
900	10^5	899.92	3.841956	38.441921	-0.011	38.439039	0.084	38.460167	898.871	-1.045	899.186	-0.730	1.27
961.78	10^5	961.62	5.618921	56.221912	-0.013	56.217696	0.160	56.270615	960.354	-1.267	960.794	-0.826	1.55

Table 4 - results of the LNE VTBB measurements with the INRiM thermometer, analysed using the fit of the median of the VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ mV	Bgrd corrected signal/ V	Signal at x10^6 gain/ V	Zn point drift/ °C	Signal corrected for Zn point drift/ V	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60	10^10	156.604	777.185	0.777185	7.69634E-05	0.00	7.69691E-05	7.69549E-05	156.599	-0.005	156.702	0.098	0.43
231.93	10^9	231.915	1833.114	1.833114	1.67462E-03	0.00	1.67475E-03	1.67563E-03	231.872	-0.043	231.887	-0.028	0.45
419.53	10^7	419.485	1980.357	1.980357	1.98186E-01	0.00	1.98201E-01	1.98369E-01	419.541	0.056	419.444	-0.041	0.12
660.32	10^6	660.174	5508.215	5.508215	5.50821	0.01	5.50863	5.51695	660.755	0.581	660.740	0.567	0.22
961.78	10^5	961.861	5705.270	5.705270	57.08111	0.01	57.08539	57.05824	962.966	1.105	963.412	1.551	0.81
200	10^10	199.995	5154.564	5.154564	5.10448E-04	0.00	5.10486E-04	5.10597E-04	199.925	-0.070	199.974	-0.021	0.44
250	10^9	249.986	3368.463	3.368463	3.07723E-03	0.00	3.07746E-03	3.07886E-03	249.955	-0.031	249.952	-0.034	0.36
300	10^8	300.010	1367.415	1.367415	1.36047E-02	0.00	1.36057E-02	1.36019E-02	300.070	0.059	300.026	0.016	0.23
400	10^7	400.063	1366.687	1.366687	1.36773E-01	0.00	1.36783E-01	1.36612E-01	400.124	0.061	400.032	-0.031	0.12
500[1]	10^7	499.953	7560.209	7.560209	7.56595E-01	0.00	7.56652E-01	7.57182E-01	500.048	0.095	499.950	-0.003	0.14
500[2]	10^7	499.976	7563.477	7.563477	7.56923E-01	0.00	7.56979E-01	7.57256E-01	500.077	0.102	499.979	0.004	0.16
600[1]	10^6	600.015	2835.845	2.835845	2.83584	0.01	2.83606	2.83556	600.078	0.063	600.019	0.004	0.16
600[2]	10^6	599.731	2825.946	2.825946	2.82595	0.01	2.82616	2.83512	599.779	0.048	599.720	-0.011	0.19
300[1]	10^8	300.040	1369.291	1.369291	1.36233E-02	0.00	1.36243E-02	1.36094E-02	300.120	0.080	300.077	0.036	0.23
400[1]	10^7	400.058	1366.927	1.366927	1.36797E-01	0.00	1.36807E-01	1.36650E-01	400.133	0.075	400.041	-0.017	0.12
600[1]	10^6	599.988	2834.872	2.834872	2.83487	0.01	2.83508	2.83549	600.049	0.061	599.989	0.002	0.16
500[3]	10^7	499.820	7563.477	7.563477	7.56923E-01	0.00	7.56979E-01	7.59030E-01	500.077	0.257	499.979	0.159	0.48
600[3]	10^6	599.280	2825.946	2.825946	2.82595	0.01	2.82616	2.85020	599.779	0.499	599.720	0.440	0.52
700[3]	10^6	699.941	8125.120	8.125120	8.12512	0.01	8.12573	8.13028	700.349	0.408	700.372	0.431	0.55
800[3]	10^5	799.917	1908.946	1.908946	19.09896	0.01	19.10039	19.11273	800.381	0.464	800.530	0.613	0.64
900[3]	10^5	899.924	3882.634	3.882634	38.84568	0.01	38.84859	38.86780	900.502	0.578	900.820	0.896	0.75
1000[3]	10^5	1000.048	7070.470	7.070470	70.73992	0.01	70.74522	70.72651	1000.745	0.697	1001.276	1.228	0.87
800[3]	10^5	799.950	1909.781	1.909781	19.10732	0.01	19.10876	19.11617	800.438	0.487	800.587	0.636	0.64
1000[3]	10^5	1000.095	7071.588	7.071588	70.75110	0.01	70.75640	70.71924	1000.773	0.679	1001.304	1.210	0.87

Table 5 - results of the METAS VTBB measurements with the INRiM thermometer, analysed using the fit of the median of the VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
200	10^9	201.26	0.587914	5.37003E-04	-0.019	5.36590E-04	-1.261	5.09558E-04	201.185	-0.076	201.232	-0.028	0.957
250	10^9	250.78	3.470968	3.17040E-03	-0.023	3.16796E-03	-0.783	3.08667E-03	250.849	0.065	250.845	0.062	0.810
300	10^8	299.80	1.365282	1.35800E-02	-0.028	1.35695E-02	0.200	1.36439E-02	299.971	0.171	299.928	0.128	0.825
419.53	10^7	417.73	1.923257	0.192423	-0.041	0.192275	1.796	0.198779	417.910	0.176	417.813	0.079	0.862
500	10^7	497.10	7.285188	0.728886	-0.051	0.728326	2.896	0.760296	497.498	0.394	497.400	0.296	0.815
600	10^6	596.25	2.739827	2.739827	-0.065	2.737722	3.750	2.859868	597.072	0.822	597.011	0.761	0.857
660.32	10^6	655.68	5.281204	5.281204	-0.074	5.277146	4.640	5.532395	656.578	0.899	656.560	0.880	0.832
700	10^6	695.58	7.833208	7.833208	-0.080	7.827189	4.421	8.158800	696.391	0.813	696.410	0.832	0.835
800	10^5	797.27	1.910186	19.055416	-0.098	19.040774	2.730	19.448674	799.978	2.708	800.126	2.856	1.222
900	10^5	897.37	3.894053	38.845858	-0.117	38.816008	2.628	39.485398	900.373	3.000	900.691	3.318	1.230
1000	10^5	1000.09	7.221856	72.042977	-0.139	71.987617	-0.087	71.952881	1003.911	3.824	1004.450	4.363	1.141

Table 6 - results of the UME VTBB measurements with the INRiM thermometer, analysed using the fit of the median of the VTBB data

t_{nom} / °C)	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point drift/ °C	Signal corrected for Zn point drift/ V	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.6	x10^10	156.63	0.777632	7.70750E-05	-0.025	7.69796E-05	7.68604E-05	156.602	-0.030	156.704	0.073	0.20
200	x10^9	199.93	0.556989	5.08879E-04	-0.031	5.08249E-04	5.09679E-04	199.814	-0.116	199.863	-0.067	0.20
200	x10^9	200.02	0.562683	5.14081E-04	-0.031	5.13445E-04	5.13005E-04	200.071	0.049	200.119	0.098	0.20
200	x10^10	200.02	5.186709	5.14081E-04	-0.031	5.13445E-04	5.13037E-04	200.071	0.051	200.119	0.100	0.20
231.93	x10^9	232.05	1.841034	1.68201E-03	-0.035	1.67993E-03	1.67282E-03	231.961	-0.089	231.975	-0.075	0.20
250	x10^9	250.01	3.372291	3.08100E-03	-0.038	3.07719E-03	3.07602E-03	249.952	-0.059	249.950	-0.062	0.20
250	x10^9	250.05	3.376714	3.08505E-03	-0.038	3.08123E-03	3.07580E-03	249.993	-0.061	249.990	-0.064	0.20
250	x10^8	250.05	0.310083	3.08505E-03	-0.038	3.08123E-03	3.07580E-03	249.993	-0.061	249.990	-0.064	0.20
300	x10^8	300.06	1.365190	1.35824E-02	-0.045	1.35656E-02	1.35444E-02	299.961	-0.096	299.917	-0.140	0.22
300	x10^7	300.02	0.135586	1.35670E-02	-0.045	1.35503E-02	1.35418E-02	299.919	-0.104	299.875	-0.148	0.22
300	x10^8	300.02	1.363646	1.35670E-02	-0.045	1.35502E-02	1.35417E-02	299.919	-0.104	299.875	-0.148	0.22
400	x10^7	400.22	1.369248	0.137010	-0.062	0.136840	0.136235	400.146	-0.077	400.053	-0.170	0.21
400	x10^7	400.00	1.363649	0.136449	-0.062	0.136280	0.136270	399.937	-0.067	399.844	-0.160	0.21
419.53	x10^7	419.43	1.976805	0.197803	-0.066	0.197558	0.197930	419.366	-0.063	419.269	-0.160	0.21
500	x10^7	499.89	7.546142	0.755081	-0.082	0.754147	0.755422	499.826	-0.062	499.728	-0.160	0.22
500	x10^6	499.89	0.755081	0.755081	-0.082	0.754147	0.755378	499.826	-0.066	499.728	-0.164	0.22
500	x10^7	500.22	7.612328	0.761704	-0.082	0.760761	0.758302	500.412	0.197	500.314	0.099	0.49
600	x10^6	600.05	2.842331	2.842331	-0.105	2.838815	2.837102	600.161	0.110	600.102	0.051	0.48
600	x10^5	600.05	0.283980	2.842244	-0.105	2.838729	2.837104	600.159	0.110	600.099	0.051	0.48
660.32	x10^6	660.03	5.477611	5.477611	-0.120	5.470836	5.487479	660.083	0.057	660.067	0.042	0.50
660.32	x10^5	660.03	0.547319	5.477901	-0.120	5.471125	5.487392	660.088	0.056	660.072	0.040	0.50
700	x10^6	699.95	8.105329	8.105329	-0.130	8.095303	8.099225	699.951	0.002	699.974	0.025	0.50
700	x10^5	699.96	0.809842	8.105389	-0.130	8.095362	8.098718	699.952	-0.004	699.975	0.018	0.50
700	x10^6	700.00	8.111707	8.111707	-0.130	8.101673	8.101673	700.035	0.035	700.057	0.057	0.50
800	x10^5	799.81	1.899315	19.009499	-0.158	18.985984	19.014538	799.607	-0.201	799.754	-0.053	0.52
900	x10^5	900.19	3.867533	38.708629	-0.189	38.660748	38.613394	899.756	-0.432	900.072	-0.115	0.53
900	x10^4	900.17	0.390889	38.708630	-0.189	38.660748	38.616849	899.756	-0.418	900.072	-0.101	0.53
900	x10^5	900.03	3.865023	38.683503	-0.189	38.635652	38.628543	899.656	-0.373	899.972	-0.056	0.53
961.78	x10^5	961.78	5.656693	56.615634	-0.210	56.545602	56.545602	961.344	-0.436	961.787	0.007	0.54
1000	x10^5	1000.00	7.025350	70.313988	-0.223	70.227011	70.227011	999.412	-0.588	999.940	-0.060	0.54
1000	x10^5	1000.12	7.034740	70.407971	-0.223	70.320878	70.274399	999.654	-0.465	1000.182	0.063	0.54

Table 7- results of the NPL VTBB measurements with the INRiM thermometer, analysed using the fit of the median of the VTBB data

3 AVERAGE LABORATORY RESULTS FOR VARIABLE TEMPERATURE BLACKBODY MEASUREMENTS WITH THE INRIM THERMOMETER

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.71316E-05	0.46
200	5.09391E-04	0.41
231.93	1.68147E-03	0.30
250	3.08653E-03	0.30
300	1.36461E-02	0.30
400	0.136635	0.31
419.53	0.198735	0.31
500	0.756854	0.32
600	2.838047	0.29
660.32	5.485195	0.31
700	8.096828	0.32
800	19.027990	0.35
900	38.621861	0.39

Table 8 – CEM results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.65377E-05	0.070
200	5.10833E-04	0.072
231.93	1.67662E-03	0.076
250	3.07968E-03	0.079
300	1.35904E-02	0.107
400	0.136643	0.075
419.53	0.198484	0.079
500	0.757025	0.096
600	2.835165	0.120
660.32	5.483208	0.147
700	8.094893	0.157
800	19.020313	0.187
900	38.641963	0.219
961.78	56.542882	0.242

Table 9 - PTB results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.78687E-05	0.21
200	5.05824E-04	0.25
231.93	1.65405E-03	0.28
250	3.07652E-03	0.30
300	0.0135518	0.33
400	0.136087	0.36
419.53	0.197843	0.35
500	0.755228	0.37
600	2.826935	0.63
660.32	5.463960	1.09
700	8.053186	1.12
800	18.917923	1.41
900	38.474521	1.26
961.78	56.270615	1.55
600 Cs	2.828368	0.40
600 Na	2.824068	1.09

Table 10 - LNE results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
200	5.09558E-04	0.957
250	3.08667E-03	0.810
300	1.36439E-02	0.825
419.53	0.198779	0.862
500	0.760296	0.815
600	2.859868	0.857
660.32	5.532395	0.832
700	8.158800	0.835
800	19.448674	1.222
900	39.485398	1.230
1000	71.952881	1.141

Table 11 – UME results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.69549E-05	0.43
200	5.10597E-04	0.44
231.93	1.67563E-03	0.45
250	3.07886E-03	0.36
300	1.36056E-02	0.23
400	0.136631	0.12
419.53	0.198369	0.12
500	0.757823	0.26
600	2.839092	0.26
660.32	5.516949	0.22
700	8.130282	0.55
800	19.114447	0.64
900	38.867797	0.75
961.78	57.058238	0.81
1000	70.722878	0.87
Cs at 500	0.757182	0.14
Na at 500 1	0.757256	0.16
Na at 500 2	0.759030	0.48
Cs at 600	2.835526	0.16
Na at 600 1	2.835120	0.19
Na at 600 2	2.850198	0.52

Table 12 - METAS results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.68604E-05	0.20
200	5.11907E-04	0.20
231.93	1.67282E-03	0.20
250	3.07587E-03	0.20
300	1.35426E-02	0.22
400	0.136252	0.21
419.53	0.197930	0.21
500	0.756367	0.31
600	2.837103	0.48
660.32	5.487435	0.50
700	8.099872	0.50
800	19.014538	0.52
900	38.619595	0.53
961.78	56.545602	0.54
1000	70.250705	0.54
Cs at 500	0.755400	0.22
WRC at 500	0.758302	0.49

Table 13 - NPL results

t_{nom}/ °C	Median signal/ V
156.6	7.69549E-05
200	5.10077E-04
231.93	1.67563E-03
250	3.07927E-03
300	1.35980E-02
400	1.36631E-01
419.53	0.198427
500	0.756939
600	2.837575
660.32	5.486315
700	8.098350
800	19.024152
900	38.631912
961.78	56.544242
1000	70.722878

Table 14 – median values for all the INRiM thermometer VTBB measurements

4 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB MEASUREMENTS ONLY WITH THE INRIM THERMOMETER

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
7.69549E-05	429.75	429.745	-0.005
5.10077E-04	473.15	473.055	-0.095
1.67563E-03	505.08	505.037	-0.043
3.07927E-03	523.15	523.123	-0.027
1.35980E-02	573.15	573.199	+0.049
1.36631E-01	673.15	673.218	+0.068
0.198427	692.68	692.753	+0.073
0.756939	773.15	773.224	+0.074
2.837575	873.15	873.274	+0.124
5.486315	933.47	933.508	+0.038
8.098350	973.15	973.141	-0.009
19.024152	1073.15	1073.015	-0.135
38.631912	1173.15	1172.791	-0.359
56.544242	1234.93	1234.490	-0.440
70.722878	1273.15	1273.837	+0.687

Table 15 – results of the fit using all the data points

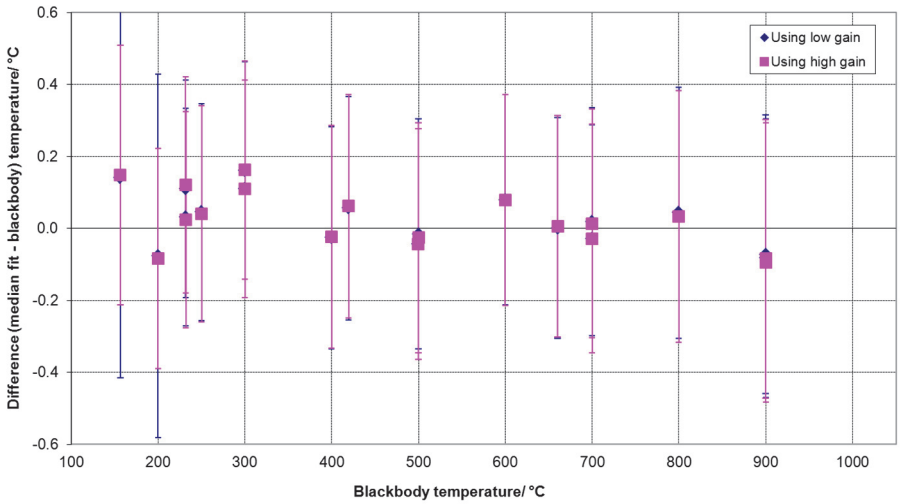
Coefficients of the fit: a_1 = 7.9623414810E+04
a_2 = 1.6044766473E-06
a_3 = 3.6358270522E-06

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
7.69549E-05	429.75	429.848	0.098
5.10077E-04	473.15	473.104	-0.046
1.67563E-03	505.08	505.052	-0.028
3.07927E-03	523.15	523.120	-0.030
1.35980E-02	573.15	573.155	0.005
1.36631E-01	673.15	673.125	-0.025
0.198427	692.68	692.656	-0.024
0.756939	773.15	773.126	-0.024
2.837575	873.15	873.215	0.065
5.486315	933.47	933.493	0.023
8.098350	973.15	973.164	0.014
19.024152	1073.15	1073.164	0.014
38.631912	1173.15	1173.107	-0.043
56.544242	1234.93	1234.932	0.002
70.722878*	1273.15*	1274.368*	1.218*

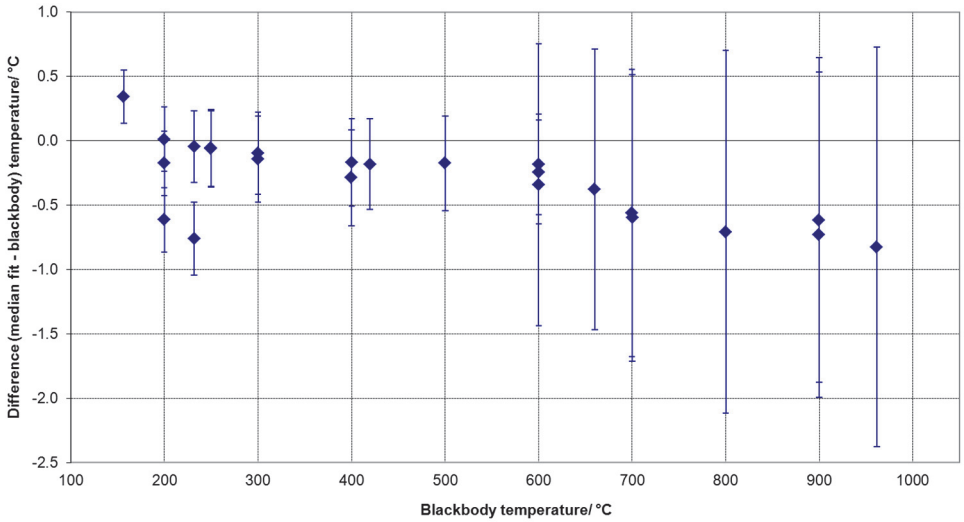
Table 16 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 7.8080727969E+04
a_2 = 1.6096510783E-06
a_3 = 1.9010860243E-06

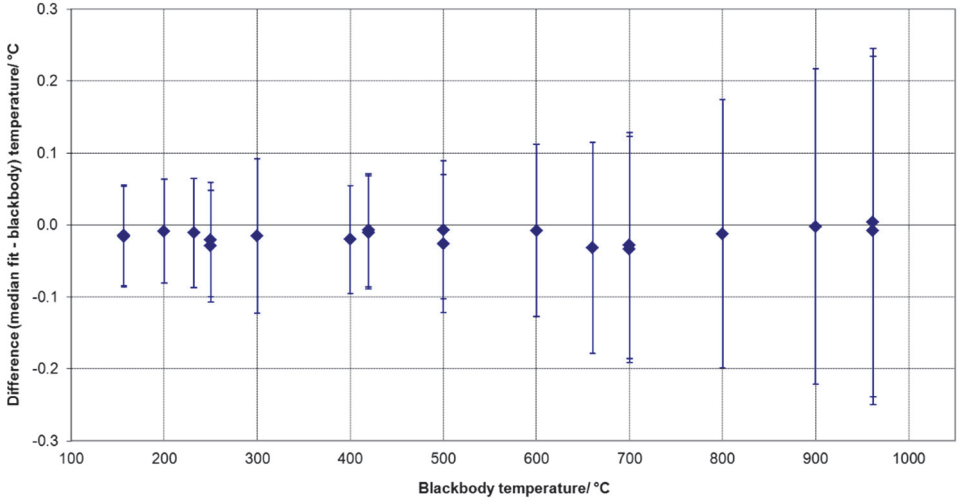
CEM results - Difference between temperature using median data fit excluding 1000 °C data and blackbody temperature with the INRIM thermometer



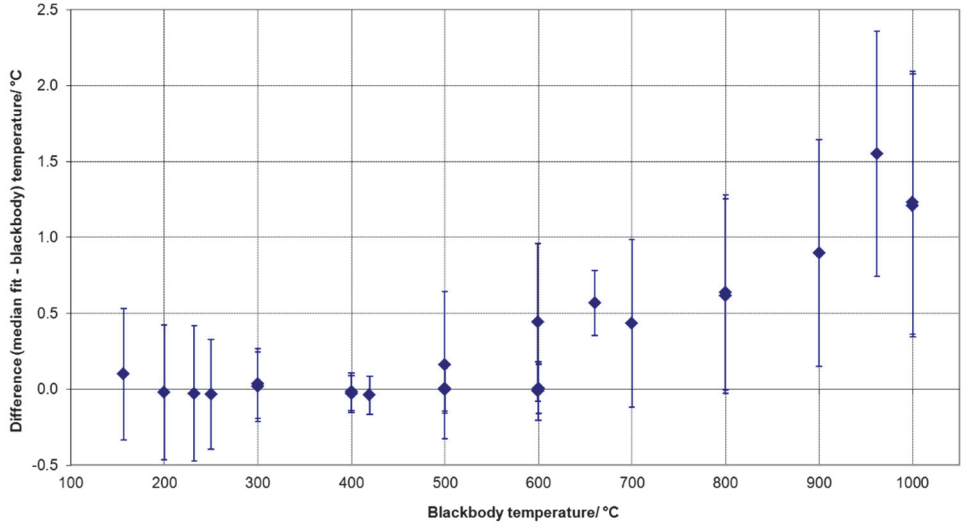
LNE results - Difference between temperature using median data fit excluding 1000 °C data and blackbody temperature with the INRIM thermometer

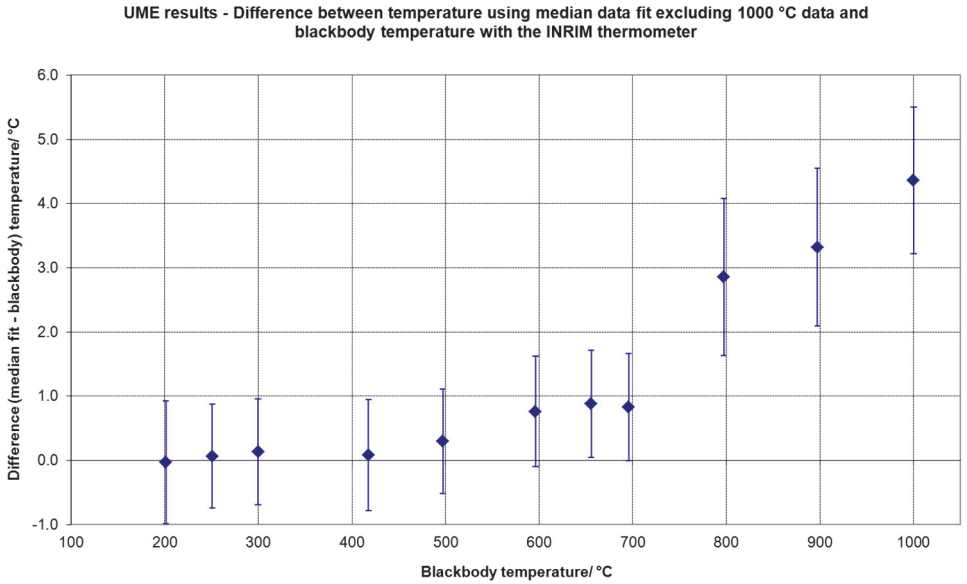


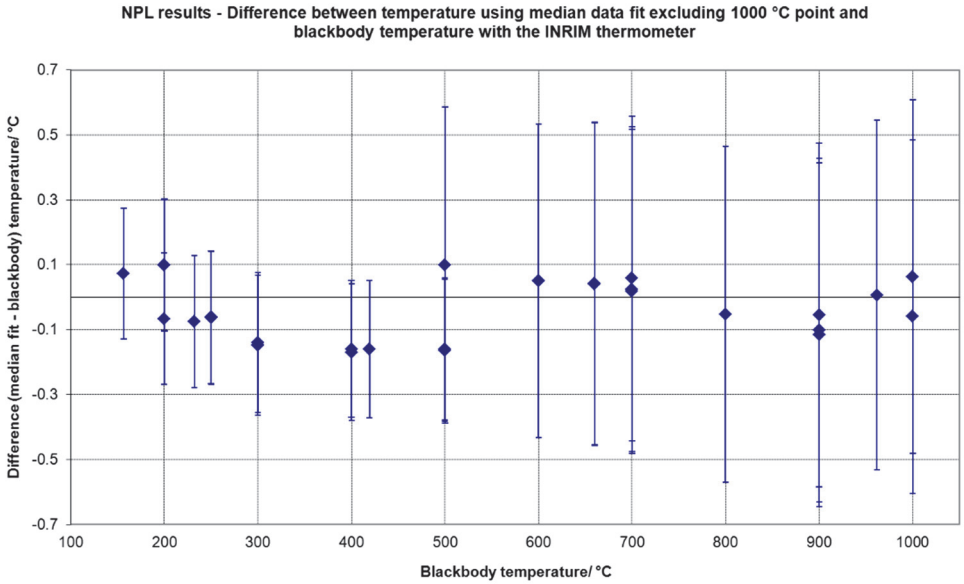
PTB results - Difference between temperature using median data fit excluding the 1000 °C data and blackbody temperature with the INRIM thermometer



METAS results - Difference between temperature using median data fit excluding 1000 °C data and blackbody temperature with the INRIM thermometer




UME results - Difference between temperature using median data fit excluding 1000 °C data and blackbody temperature with the INRIM thermometer
Difference (median fit - blackbody) temperature/ °C
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
100
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C


NPL results - Difference between temperature using median data fit excluding 1000 °C point and blackbody temperature with the INRIM thermometer
Difference (median fit - blackbody) temperature/ °C
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
-0.7
100
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C

5 THE FP RESULTS WITH THE INRIM THERMOMETER USING THE MEDIAN OF ALL THE FP DATA FOR THE FITTING PROCESS

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
419.527	10^7	419.527	1.982037	0.198307	0.024	0.198396	0.00	0.198396	419.534*	0.007	0.09
419.527	10^6	419.527	0.198307	0.198307	0.024	0.198396	0.00	0.198396	-	-	-
961.78	10^5	961.78	5.642604	56.444951	0.076	56.470340	0.00	56.470340	961.777*	-0.003	0.30
961.78	10^4	961.78	0.570133	56.453143	0.076	56.478537	0.00	56.478537	-	-	-

Table 17 - results of the CEM FP measurements with the INRiM thermometer, analysed using the fit of the median of the FP data

* average temperature values calculated

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.599	10^10	156.599	0.772745	7.65952E-05	-0.016	7.65363E-05	0.000	7.65363E-05	156.611	0.012	0.08
231.928	10^9	231.928	1.834863	1.67617E-03	-0.022	1.67488E-03	0.000	1.67488E-03	231.913	-0.015	0.04
419.527	10^7	419.527	1.983950	0.198495	-0.041	0.198343	0.000	0.198343	419.519	-0.008	0.08

Table 18 - results of the UME FP measurements with the INRiM thermometer, analysed using the fit of the median of the FP data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.599	10^10	156.599	0.775825	7.68959E-05	-0.025	7.68007E-05	0.00	7.68007E-05	156.682	0.084	0.09
231.928	10^9	231.928	1.836495	0.0016779	-0.035	1.67579E-03	0.00	1.67579E-03	231.929	0.001	0.07
419.527	10^7	419.527	1.984784	0.198601	-0.066	0.198355	0.00	0.198355	419.523	-0.004	0.07
660.323	10^6	660.323	5.488178	5.488178	-0.120	5.481389	0.00	5.481389	660.343	0.020	0.13
961.78	10^5	961.78	5.653369	56.582364	-0.210	56.512373	0.00	56.512373	961.891	0.111	0.23

Table 19 - results of the NPL FP measurements with the INRiM thermometer, analysed using the fit of the median of the FP data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.599	10^9	156.599	0.08375	7.65000E-05	-0.003	7.64885E-05	0.00	7.64885E-05	156.598	-0.001	0.032
231.928	10^9	231.928	1.83388	0.0016752	-0.004	0.0016750	0.00	0.0016750	231.915	-0.013	0.040
419.527	10^7	419.527	1.98246	0.198341	-0.008	0.198311	0.00	0.198311	419.511	-0.016	0.073
660.323	10^6	660.323	5.48120	5.481196	-0.015	5.480374	0.00	5.480374	660.324	0.001	0.129
961.78	10^5	961.78	5.64510	56.475224	-0.025	56.466756	0.00	56.466756	961.753	-0.027	0.224

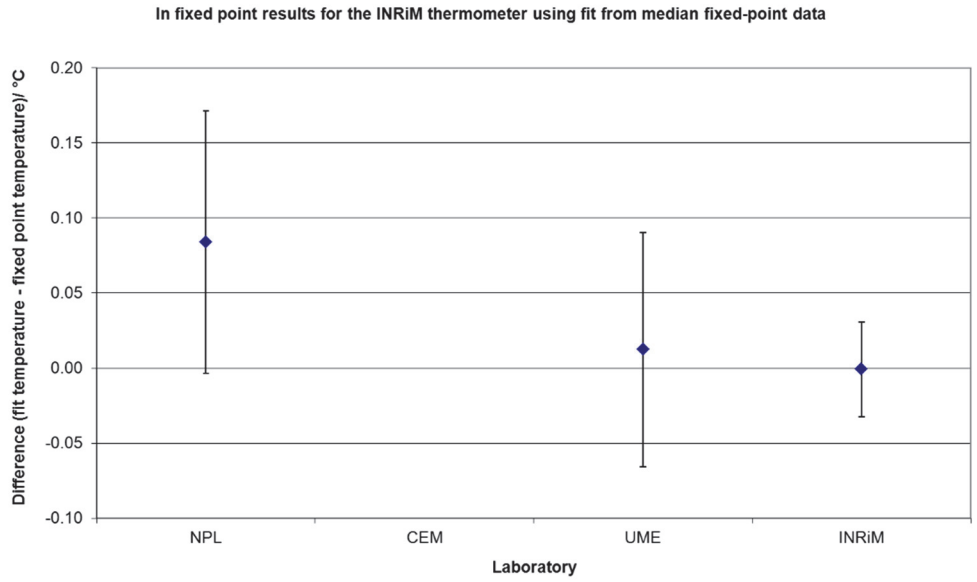
Table 20 - results of the INRiM FP measurements with the INRiM thermometer, analysed using the fit of the median of the FP data

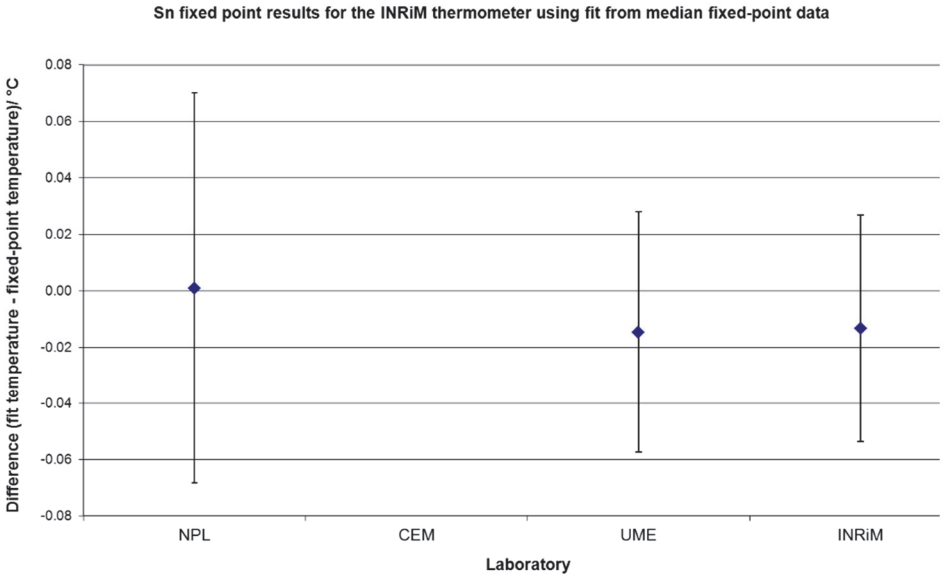
6 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – FP MEASUREMENTS ONLY WITH THE INRIM THERMOMETER

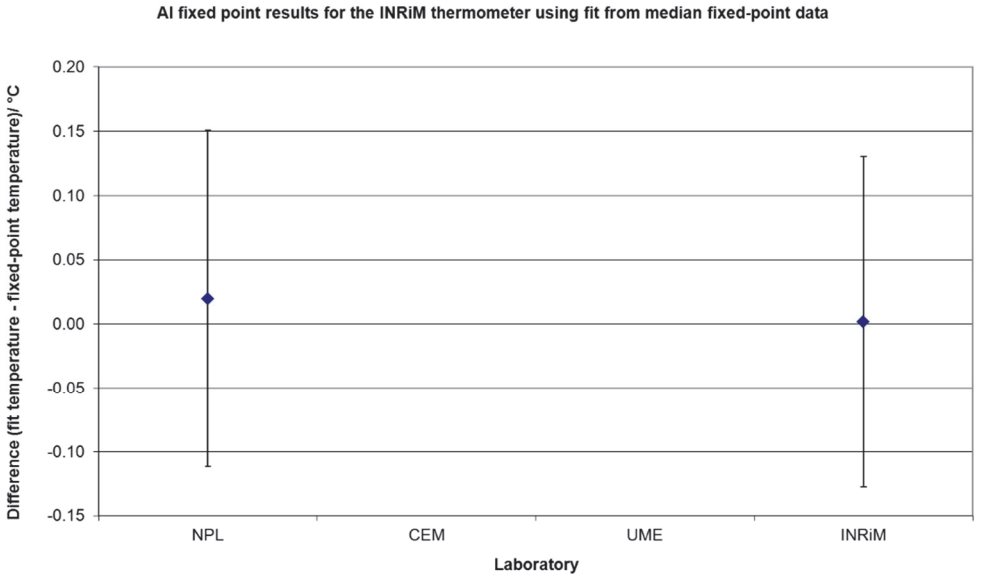
Median thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
7.65363E-05	429.748	429.761	0.012
1.67495E-03	505.078	505.065	-0.013
1.98349E-01	692.677	692.671	-0.006
5.48088E+00	933.473	933.484	0.011
5.64744E+01	1234.930	1234.927	-0.003

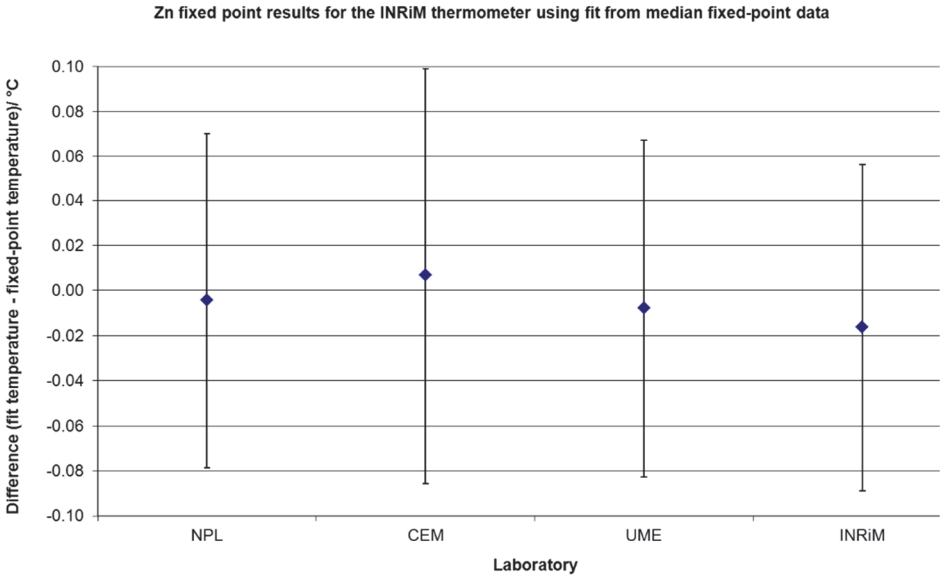
Table 21 – results of the fit using all the data points

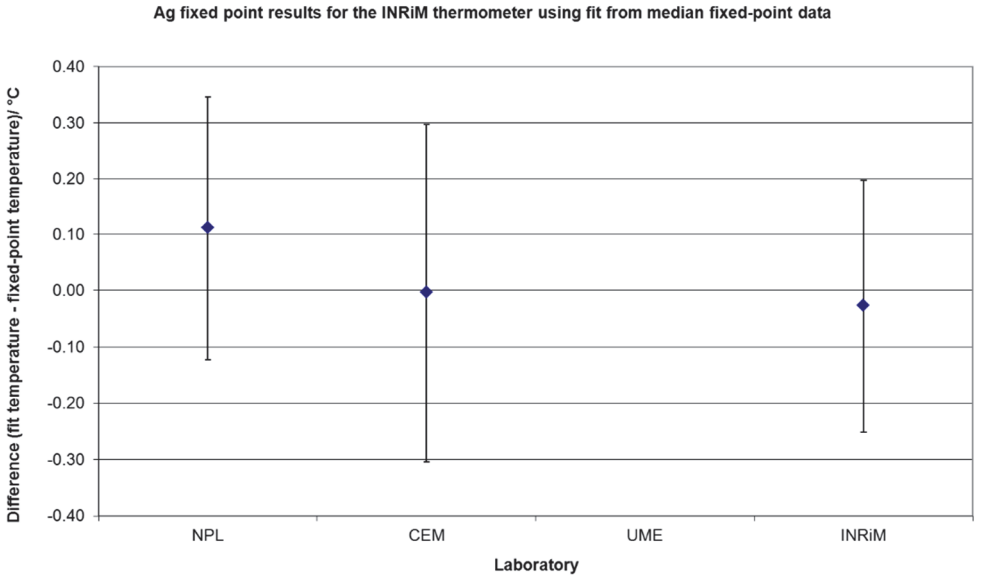
Coefficients of the fit: a_1 = 7.7844496301E+04
a_2 = 1.6102028635E-06
a_3 = 1.7227117692E-06




Sn fixed point results for the INRiM thermometer using fit from median fixed-point data
Difference (fit temperature - fixed-point temperature)/ °C
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
NPL
CEM
UME
INRiM
Laboratory


Al fixed point results for the INRiM thermometer using fit from median fixed-point data
Difference (fit temperature - fixed-point temperature)/ °C
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
NPL
CEM
UME
INRiM
Laboratory


Zn fixed point results for the INRiM thermometer using fit from median fixed-point data
Difference (fit temperature - fixed-point temperature)/ °C
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
NPL
CEM
UME
INRiM
Laboratory


Ag fixed point results for the INRiM thermometer using fit from median fixed-point data
Difference (fit temperature - fixed-point temperature)/ °C
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
NPL
CEM
UME
INRiM
Laboratory

7 THE VTBB AND FP RESULTS WITH THE INRIM THERMOMETER USING THE MEDIAN OF ALL THE VTBB AND FP DATA FOR THE FITTING PROCESS

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} – t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60	10^10	156.57	0.776219	7.6972E-05	0.009	7.7007E-05	0.03	7.7120E-05	156.628	0.058	156.737	0.167	0.56
200.00	10^10	200.00	5.135394	5.0924E-04	0.011	5.0947E-04	0.00	5.0947E-04	199.889	-0.111	199.941	-0.059	0.51
231.93	10^9	231.88	1.838722	1.6801E-03	0.013	1.6808E-03	0.05	1.6838E-03	231.987	0.107	232.002	0.122	0.30
250.00	10^9	250.04	3.381156	3.0894E-03	0.014	3.0908E-03	-0.04	3.0867E-03	250.097	0.057	250.094	0.054	0.30
300.00	10^8	300.02	1.370938	1.3638E-02	0.016	1.3644E-02	-0.02	1.3637E-02	300.180	0.160	300.133	0.113	0.30
400.00	10^7	399.89	1.362019	0.136273	0.023	1.3633E-01	0.11	1.3663E-01	399.958	0.068	399.858	-0.032	0.31
419.53	10^7	419.49	1.983845	0.198487	0.024	1.9858E-01	0.04	1.9873E-01	419.643	0.153	419.539	0.049	0.31
419.53*	x10^7	419.53	1.982037	0.198307	0.024	0.198396	0.00	0.198396	419.594*	0.064*	419.490*	-0.040*	0.09*
419.53*	x10^6	419.53	0.198307	0.198307	0.024	0.198396	0.00	0.198396	-	-	-	-	-
500.00	10^7	499.89	7.547499	0.755141	0.030	7.5548E-01	0.11	7.5673E-01	499.944	0.054	499.839	-0.051	0.32
600.00	10^6	600.03	2.837789	2.837789	0.038	2.839066	-0.03	2.838061	600.171	0.141	600.107	0.077	0.29
660.32	10^6	660.29	5.480883	5.480883	0.044	5.483348	0.03	5.485046	660.311	0.021	660.294	0.004	0.31
700.00	10^6	700.03	8.093755	8.093755	0.047	8.097395	-0.03	8.095089	699.986	-0.044	700.011	-0.019	0.32
800.00	10^5	799.87	1.899449	19.000850	0.058	19.009397	0.13	19.028698	799.783	-0.087	799.941	0.071	0.35
900.00	10^5	899.98	3.858663	38.599565	0.069	38.616927	0.02	38.621974	899.612	-0.368	899.951	-0.029	0.39
961.78*	x10^5	961.78	5.642604	56.444951	0.076	56.470340	0.00	56.470340	961.170*	-0.610*	961.643*	-0.137*	0.30*
961.78*	x10^4	961.78	0.570133	56.453143	0.076	56.478537	0.00	56.478537	-	-	-	-	-
231.93	10^9	232.02	1.842625	1.6836E-03	0.013	1.6844E-03	-0.09	1.6790E-03	232.047	0.027	232.063	0.043	0.30
300.00	10^8	300.08	1.375069	1.3679E-02	0.016	1.3685E-02	-0.08	1.3655E-02	300.291	0.211	300.244	0.164	0.30
500.00	10^7	500.03	7.566450	0.757037	0.030	7.5738E-01	-0.03	7.5704E-01	500.112	0.082	500.007	-0.023	0.32
700.00	10^6	699.99	8.094334	8.094334	0.047	8.097975	0.01	8.098744	699.994	0.004	700.018	0.028	0.32
900.00	10^5	899.88	3.856424	38.577167	0.069	38.594519	0.12	38.624786	899.523	-0.357	899.861	-0.019	0.39

Table 22 – results of the CEM measurements on the 'low range' with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

‡ calculated relative to the start of the comparison, i.e. from the PTB Zn point check

* FP measurements. For these, temperatures for the average data from the two ranges was calculated

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} – t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60	10^9	156.57	0.084268	7.6997E-05	0.009	7.7031E-05	0.03	7.7144E-05	156.634	0.064	156.744	0.174	0.36
200.00	10^9	200.00	0.557157	5.0908E-04	0.011	5.0931E-04	0.00	5.0931E-04	199.881	-0.119	199.933	-0.067	0.31
231.93	10^8	231.88	0.168944	1.6807E-03	0.013	1.6814E-03	0.05	1.6844E-03	231.997	0.117	232.012	0.132	0.30
250.00	10^8	250.04	0.310514	3.0890E-03	0.014	3.0904E-03	-0.04	3.0863E-03	250.093	0.053	250.090	0.050	0.30
300.00	10^7	300.02	0.136309	1.3638E-02	0.016	1.3644E-02	-0.02	1.3637E-02	300.179	0.159	300.132	0.112	0.30
400.00	10^6	399.89	0.136278	0.136278	0.023	1.3634E-01	0.11	1.3664E-01	399.960	0.070	399.861	-0.029	0.31
419.53	10^6	419.49	0.198507	0.198507	0.024	1.9860E-01	0.04	1.9875E-01	419.649	0.159	419.545	0.055	0.31
500.00	10^6	499.89	0.755142	0.755142	0.030	7.5548E-01	0.11	7.5673E-01	499.944	0.054	499.839	-0.051	0.32
600.00	10^5	600.03	0.283681	2.837761	0.038	2.839038	-0.03	2.838033	600.170	0.140	600.106	0.076	0.29
660.32	10^5	660.29	0.547934	5.481181	0.044	5.483646	0.03	5.485344	660.316	0.026	660.300	0.010	0.31
700.00	10^5	700.03	0.809106	8.093774	0.047	8.097415	-0.03	8.095108	699.987	-0.043	700.011	-0.019	0.32
800.00	10^4	799.87	0.191880	18.999437	0.058	19.007983	0.13	19.027283	799.773	-0.097	799.932	0.062	0.35
900.00	10^4	899.98	0.389795	38.596576	0.069	38.613937	0.02	38.618983	899.600	-0.380	899.939	-0.041	0.39
231.93	10^8	232.02	0.169206	1.6833E-03	0.013	1.6840E-03	-0.09	1.6787E-03	232.041	0.021	232.057	0.037	0.30
300.00	10^7	300.08	0.136723	1.3679E-02	0.016	1.3686E-02	-0.08	1.3656E-02	300.291	0.211	300.244	0.164	0.30
500.00	10^6	500.03	0.756917	0.756917	0.030	7.5726E-01	-0.03	7.5692E-01	500.101	0.071	499.996	-0.034	0.32
700.00	10^5	699.99	0.809125	8.093962	0.047	8.097603	0.01	8.098372	699.989	-0.001	700.013	0.023	0.32
900.00	10^4	899.88	0.389568	38.574084	0.069	38.591435	0.12	38.621700	899.510	-0.370	899.849	-0.031	0.39

Table 23 – results of the CEM measurements on the 'high range' with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} – t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60	10^10	156.566	0.771526	7.64095E-05	0.00	7.64095E-05	0.034	7.65365E-05	156.466	-0.100	156.576	0.010	0.070
200	10^10	200.035	5.165212	5.11546E-04	0.00	5.11546E-04	-0.035	5.10833E-04	199.991	-0.044	200.043	0.009	0.072
231.93	10^9	231.947	1.837326	1.67760E-03	0.00	1.67760E-03	-0.017	1.67662E-03	231.932	-0.015	231.947	0.000	0.076
250	10^9	250.039	3.377719	3.08409E-03	0.00	3.08409E-03	-0.039	3.08014E-03	250.030	-0.009	250.027	-0.012	0.080
300	10^8	300.023	1.366982	1.35988E-02	0.00	1.35988E-02	-0.023	1.35904E-02	300.056	0.034	300.010	-0.013	0.107
400	10^7	400.021	1.366276	1.36699E-01	0.00	1.36699E-01	-0.021	1.36643E-01	400.094	0.073	399.994	-0.026	0.075
419.53	10^7	419.519	1.983355	1.98439E-01	0.00	1.98439E-01	0.011	1.98479E-01	419.606	0.087	419.502	-0.017	0.079
500	10^6	500.020	0.757357	7.57357E-01	0.00	7.57357E-01	-0.020	7.57134E-01	500.110	0.090	500.005	-0.014	0.096
600	10^6	600.019	2.835811	2.83581E+00	0.00	2.83581E+00	-0.019	2.83516E+00	600.072	0.053	600.009	-0.010	0.120
660.32	10^6	660.328	5.483683	5.48368E+00	0.00	5.48368E+00	-0.008	5.48321E+00	660.317	-0.012	660.300	-0.028	0.147
700	10^6	700.032	8.097138	8.09714E+00	0.00	8.09714E+00	-0.032	8.09469E+00	699.983	-0.049	700.007	-0.025	0.157
800	10^5	800.017	1.900651	1.90228E+01	0.00	1.90228E+01	-0.017	1.90203E+01	799.874	-0.143	800.033	0.016	0.187
900	10^5	900.026	3.861526	3.86484E+01	0.00	3.86484E+01	-0.026	3.86420E+01	899.737	-0.288	900.076	0.051	0.219
961.78	10^5	961.728	5.647521	5.65237E+01	0.00	5.65237E+01	0.052	5.65410E+01	961.319	-0.409	961.793	0.064	0.242
156.60	10^10	156.623	0.773692	7.66239E-05	0.00	7.66239E-05	-0.023	7.65389E-05	156.524	-0.099	156.634	0.011	0.070
250	10^9	250.087	3.382039	3.08803E-03	0.00	3.08803E-03	-0.087	3.07922E-03	250.070	-0.017	250.066	-0.020	0.078
419.53	10^7	419.516	1.983341	1.98438E-01	0.00	1.98438E-01	0.014	1.98490E-01	419.606	0.090	419.502	-0.014	0.079
500	10^6	500.042	0.757390	7.57390E-01	0.00	7.57390E-01	-0.042	7.56915E-01	500.113	0.071	500.008	-0.034	0.096
700	10^5	700.048	0.809186	8.09881E+00	0.00	8.09881E+00	-0.048	8.09510E+00	700.005	-0.043	700.029	-0.019	0.157
961.78	10^5	961.693	5.646728	5.65158E+01	0.00	5.65158E+01	0.087	5.65447E+01	961.295	-0.398	961.769	0.075	0.242

Table 24 - results of the PTB measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} – t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60	10^8	156.53	0.007810	7.76065E-05	-0.002	7.76006E-05	0.071	7.78687E-05	156.788	0.259	156.897	0.368	0.21
200	10^7	199.90	0.004967	4.96682E-04	-0.002	4.96645E-04	0.104	4.98711E-04	199.247	-0.649	199.300	-0.596	0.25
200	10^7	199.89	0.005054	5.05373E-04	-0.002	5.05335E-04	0.107	5.07498E-04	199.683	-0.210	199.736	-0.157	0.25
200	10^8	199.90	0.051248	5.09253E-04	-0.002	5.09214E-04	0.100	5.11262E-04	199.876	-0.024	199.928	0.028	0.25
231.93	10^7	231.76	0.016235	1.62356E-03	-0.002	1.62344E-03	0.174	1.63341E-03	230.991	-0.765	231.008	-0.748	0.28
231.93	10^8	231.76	0.167536	1.66481E-03	-0.002	1.66468E-03	0.170	1.67469E-03	231.710	-0.050	231.725	-0.034	0.28
250	10^7	249.83	0.030599	3.05999E-03	-0.002	3.05976E-03	0.171	3.07694E-03	249.787	-0.043	249.784	-0.046	0.30
250	10^8	249.83	0.307849	3.05909E-03	-0.002	3.05886E-03	0.171	3.07610E-03	249.778	-0.051	249.775	-0.054	0.30
300	10^7	300.17	0.136254	0.0136257	-0.003	0.0136246	-0.175	0.0135595	300.126	-0.048	300.080	-0.095	0.32
300	10^8	300.08	1.366253	0.0135764	-0.003	0.0135754	-0.084	0.0135441	299.993	-0.092	299.946	-0.138	0.33
400	10^7	399.91	1.356838	0.135687	-0.004	0.135676	0.095	0.135932	399.712	-0.193	399.613	-0.293	0.37
400	10^7	400.12	1.365849	0.136588	-0.004	0.136577	-0.124	0.136242	400.048	-0.075	399.949	-0.175	0.34
419.53	10^7	419.68	1.984168	0.198421	-0.004	0.198406	-0.151	0.197843	419.597	-0.084	419.493	-0.188	0.35
500	10^7	500.11	7.564966	0.756512	-0.005	0.756455	-0.108	0.755228	500.030	-0.078	499.925	-0.183	0.37
600	10^6	600.11	2.833294	2.833294	-0.006	2.833082	-0.112	2.829329	599.990	-0.122	599.927	-0.186	0.39
600	10^6	600.02	2.828271	2.828271	-0.006	2.828059	-0.020	2.827406	599.839	-0.181	599.775	-0.245	0.40
600	10^6	600.01	2.824760	2.824760	-0.006	2.824548	-0.014	2.824068	599.732	-0.282	599.669	-0.346	1.09
660.32	10^6	660.02	5.447661	5.447661	-0.007	5.447252	0.297	5.463960	659.666	-0.357	659.649	-0.374	1.09
700	10^6	699.85	8.043894	8.043894	-0.008	8.043290	0.149	8.054703	699.276	-0.575	699.299	-0.551	1.12
700	10^6	700.11	8.060855	8.060855	-0.008	8.060251	-0.112	8.051669	699.499	-0.613	699.523	-0.589	1.11
800	10^5	800.20	1.893828	18.949308	-0.010	18.947888	-0.203	18.917923	799.365	-0.837	799.523	-0.679	1.41
900	10^5	899.89	3.844127	38.463648	-0.011	38.460763	0.112	38.488876	898.989	-0.900	899.326	-0.562	1.26
900	10^5	899.92	3.841956	38.441921	-0.011	38.439039	0.084	38.460167	898.902	-1.014	899.239	-0.677	1.27
961.78	10^5	961.62	5.618921	56.221912	-0.013	56.217696	0.160	56.270615	960.394	-1.226	960.866	-0.755	1.55

Table 25 - results of the LNE measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt ($t_{nom} - t_{BB}$) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt ($t_{fit} - t_{BB}$) / °C	t from fit without 1000 °C data/ °C	dt ($t_{fit} - t_{BB}$) / °C	U (k=2) / °C
156.60	10^10	156.604	777.185	0.777185	7.69634E-05	0.00	7.69691E-05	7.69549E-05	156.617	0.014	156.727	0.123	0.43
231.93	10^9	231.915	1833.114	1.833114	1.67462E-03	0.00	1.67475E-03	1.67563E-03	231.883	-0.032	231.898	-0.017	0.45
419.53	10^7	419.485	1980.357	1.980357	1.98186E-01	0.00	1.98201E-01	1.98369E-01	419.541	0.057	419.437	-0.047	0.12
660.32	10^6	660.174	5508.215	5.508215	5.50821	0.01	5.50863	5.51695	660.760	0.586	660.744	0.571	0.22
961.78	10^5	961.861	5705.270	5.705270	57.08111	0.01	57.08539	57.05824	963.007	1.146	963.484	1.624	0.81
200	10^10	199.995	5154.564	5.154564	5.10448E-04	0.00	5.10486E-04	5.10597E-04	199.939	-0.056	199.991	-0.004	0.44
250	10^9	249.986	3368.463	3.368463	3.07723E-03	0.00	3.07746E-03	3.07886E-03	249.964	-0.022	249.961	-0.025	0.36
300	10^8	300.010	1367.415	1.367415	1.36047E-02	0.00	1.36057E-02	1.36019E-02	300.075	0.065	300.028	0.018	0.23
400	10^7	400.063	1366.687	1.366687	1.36773E-01	0.00	1.36783E-01	1.36612E-01	400.125	0.062	400.026	-0.037	0.12
500[1]	10^7	499.953	7560.209	7.560209	7.56595E-01	0.00	7.56652E-01	7.57182E-01	500.048	0.094	499.943	-0.011	0.14
500[2]	10^7	499.976	7563.477	7.563477	7.56923E-01	0.00	7.56979E-01	7.57256E-01	500.077	0.101	499.972	-0.004	0.16
600[1]	10^6	600.015	2835.845	2.835845	2.83584	0.01	2.83606	2.83556	600.080	0.065	600.016	0.002	0.16
600[2]	10^6	599.731	2825.946	2.825946	2.82595	0.01	2.82616	2.83512	599.781	0.050	599.717	-0.014	0.19
300[1]	10^8	300.040	1369.291	1.369291	1.36233E-02	0.00	1.36243E-02	1.36094E-02	300.126	0.086	300.079	0.039	0.23
400[1]	10^7	400.058	1366.927	1.366927	1.36797E-01	0.00	1.36807E-01	1.36650E-01	400.134	0.076	400.034	-0.023	0.12
600[1]	10^6	599.988	2834.872	2.834872	2.83487	0.01	2.83508	2.83549	600.051	0.063	599.987	-0.001	0.16
500[3]	10^7	499.820	7563.477	7.563477	7.56923E-01	0.00	7.56979E-01	7.59030E-01	500.077	0.257	499.972	0.152	0.48
600[3]	10^6	599.280	2825.946	2.825946	2.82595	0.01	2.82616	2.85020	599.781	0.501	599.717	0.437	0.52
700[3]	10^6	699.941	8125.120	8.125120	8.12512	0.01	8.12573	8.13028	700.357	0.416	700.382	0.441	0.55
800[3]	10^5	799.917	1908.946	1.908946	19.09896	0.01	19.10039	19.11273	800.399	0.482	800.558	0.641	0.64
900[3]	10^5	899.924	3882.634	3.882634	38.84568	0.01	38.84859	38.86780	900.533	0.609	900.874	0.950	0.75
1000[3]	10^5	1000.048	7070.470	7.070470	70.73992	0.01	70.74522	70.72651	1000.792	0.745	1001.361	1.313	0.87
800[3]	10^5	799.950	1909.781	1.909781	19.10732	0.01	19.10876	19.11617	800.455	0.505	800.615	0.665	0.64
1000[3]	10^5	1000.095	7071.588	7.071588	70.75110	0.01	70.75640	70.71924	1000.821	0.726	1001.390	1.295	0.87

Table 26 - results of the METAS measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt (t_{nom} – t_{BB}) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit without 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
156.60*	10^10	156.60	0.772745	7.65952E-05	-0.016	7.65363E-05	0.000	7.65363E-05	156.500	-0.100	156.610	0.010	0.08
200	10^9	201.26	0.587914	5.37003E-04	-0.019	5.36590E-04	-1.261	5.09558E-04	201.199	-0.062	201.249	-0.012	0.957
231.93*	10^9	231.93	1.834863	1.67617E-03	-0.022	1.67488E-03	0.000	1.67488E-03	231.885	-0.045	231.900	-0.030	0.04
250	10^9	250.78	3.470968	3.17040E-03	-0.023	3.16796E-03	-0.783	3.08667E-03	250.858	0.074	250.854	0.070	0.810
300	10^8	299.80	1.365282	1.35800E-02	-0.028	1.35695E-02	0.200	1.36439E-02	299.977	0.177	299.930	0.130	0.825
419.53	10^7	417.73	1.923257	0.192423	-0.041	0.192275	1.796	0.198779	417.910	0.176	417.807	0.072	0.862
419.53*	10^7	419.53	1.983950	0.198495	-0.041	0.198343	0.000	0.198343	419.580	0.050	419.476	-0.054	0.08
500	10^7	497.10	7.285188	0.728886	-0.051	0.728326	2.896	0.760296	497.497	0.393	497.392	0.288	0.815
600	10^6	596.25	2.739827	2.739827	-0.065	2.737722	3.750	2.859868	597.074	0.824	597.008	0.759	0.857
660.32	10^6	655.68	5.281204	5.281204	-0.074	5.277146	4.640	5.532395	656.583	0.903	656.563	0.884	0.832
700	10^6	695.58	7.833208	7.833208	-0.080	7.827189	4.421	8.158800	696.399	0.820	696.419	0.841	0.835
800	10^5	797.27	1.910186	19.055416	-0.098	19.040774	2.730	19.448674	799.996	2.725	800.154	2.884	1.222
900	10^5	897.37	3.894053	38.845858	-0.117	38.816008	2.628	39.485398	900.404	3.031	900.744	3.372	1.230
1000	10^5	1000.09	7.221856	72.042977	-0.139	71.987617	-0.087	71.952881	1003.960	3.873	1004.536	4.449	1.141

Table 27 - results of the UME measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

* Fixed point measurements

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt ($t_{nom} - t_{BB}$) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt ($t_{fit} - t_{BB}$) / °C	t from fit without 1000 °C data/ °C	dt ($t_{fit} - t_{BB}$) / °C
156.6	x10^10	156.63	0.777632	7.70750E-05	-0.025	7.69796E-05	7.68604E-05	156.620	-0.011	156.730	0.098	0.20
156.6*	x10^10	156.6	0.775825	7.68959E-05	-0.025	7.68007E-05	7.68007E-05	156.572	-0.028	156.682	0.082	0.09
200	x10^9	199.93	0.556989	5.08879E-04	-0.031	5.08249E-04	5.09679E-04	199.828	-0.102	199.881	-0.049	0.20
200	x10^9	200.02	0.562683	5.14081E-04	-0.031	5.13445E-04	5.13005E-04	200.084	0.063	200.137	0.115	0.20
200	x10^10	200.02	5.186709	5.14081E-04	-0.031	5.13445E-04	5.13037E-04	200.084	0.065	200.137	0.117	0.20
231.93	x10^9	232.05	1.841034	1.68201E-03	-0.035	1.67993E-03	1.67282E-03	231.971	-0.079	231.987	-0.063	0.20
231.93*	x10^9	231.93	1.836495	0.0016779	-0.035	1.67579E-03	1.67579E-03	231.900	-0.030	231.916	-0.014	0.07
250	x10^9	250.01	3.372291	3.08100E-03	-0.038	3.07719E-03	3.07602E-03	249.961	-0.050	249.958	-0.053	0.20
250	x10^9	250.05	3.376714	3.08505E-03	-0.038	3.08123E-03	3.07580E-03	250.002	-0.052	249.999	-0.055	0.20
250	x10^8	250.05	0.310083	3.08505E-03	-0.038	3.08123E-03	3.07580E-03	250.002	-0.052	249.999	-0.055	0.20
300	x10^8	300.06	1.365190	1.35824E-02	-0.045	1.35656E-02	1.35444E-02	299.966	-0.091	299.919	-0.138	0.22
300	x10^7	300.02	0.135586	1.35670E-02	-0.045	1.35503E-02	1.35418E-02	299.924	-0.099	299.878	-0.145	0.22
300	x10^8	300.02	1.363646	1.35670E-02	-0.045	1.35502E-02	1.35417E-02	299.924	-0.099	299.877	-0.146	0.22
400	x10^7	400.22	1.369248	0.137010	-0.062	0.136840	0.136235	400.146	-0.077	400.047	-0.176	0.21
400	x10^7	400.00	1.363649	0.136449	-0.062	0.136280	0.136270	399.938	-0.066	399.838	-0.166	0.21
419.53	x10^7	419.43	1.976805	0.197803	-0.066	0.197558	0.197930	419.366	-0.063	419.262	-0.167	0.21
419.53*	x10^7	419.53	1.984784	0.198601	-0.066	0.198355	0.198355	419.583	0.053	419.479	-0.051	0.07
500	x10^7	499.89	7.546142	0.755081	-0.082	0.754147	0.755422	499.825	-0.062	499.720	-0.167	0.22
500	x10^6	499.89	0.755081	0.755081	-0.082	0.754147	0.755378	499.825	-0.066	499.720	-0.171	0.22
500	x10^7	500.22	7.612328	0.761704	-0.082	0.760761	0.758302	500.411	0.196	500.306	0.091	0.49
600	x10^6	600.05	2.842331	2.842331	-0.105	2.838815	2.837102	600.163	0.112	600.100	0.048	0.48
600	x10^5	600.05	0.283980	2.842244	-0.105	2.838729	2.837104	600.160	0.112	600.097	0.048	0.48
660.32	x10^6	660.03	5.477611	5.477611	-0.120	5.470836	5.487479	660.088	0.062	660.071	0.046	0.50
660.32	x10^5	660.03	0.547319	5.477901	-0.120	5.471125	5.487392	660.093	0.061	660.076	0.044	0.50
660.32*	x10^6	660.32	5.488178	5.488178	-0.120	5.481389	5.481389	660.276	-0.044	660.260	-0.060	0.13
700	x10^6	699.95	8.105329	8.105329	-0.130	8.095303	8.099225	699.959	0.010	699.983	0.034	0.50
700	x10^5	699.96	0.809842	8.105389	-0.130	8.095362	8.098718	699.960	0.004	699.984	0.028	0.50
700	x10^6	700.00	8.111707	8.111707	-0.130	8.101673	8.101673	700.043	0.043	700.067	0.067	0.50
800	x10^5	799.81	1.899315	19.009499	-0.158	18.985984	19.014538	799.624	-0.183	799.782	-0.025	0.52
900	x10^5	900.19	3.867533	38.708629	-0.189	38.660748	38.613394	899.786	-0.401	900.126	-0.062	0.53
900	x10^4	900.17	0.390889	38.708630	-0.189	38.660748	38.616849	899.786	-0.387	900.126	-0.048	0.53
900	x10^5	900.03	3.865023	38.683503	-0.189	38.635652	38.628543	899.686	-0.342	900.025	-0.003	0.53

Table 28 - results of the NPL measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

961.78	x10^5	961.78	5.656693	56.615634	-0.210	56.545602	56.545602	961.385	-0.395	961.859	0.079	0.54
961.78*	x10^5	961.78	5.653369	56.582364	-0.210	56.512373	56.512373	961.285	-0.495	961.758	-0.022	0.23
1000	x10^5	1000.00	7.025350	70.313988	-0.223	70.227011	70.227011	999.460	-0.540	1000.025	0.025	0.54
1000	x10^5	1000.12	7.034740	70.407971	-0.223	70.320878	70.274399	999.702	-0.418	1000.267	0.148	0.54

Table 28- results of the NPL measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data - continued

* Fixed point measurements

t_{nom} / °C	Gain used	t_{BB} / °C	Bgrd corrected Signal/ V	Signal at x10^6 gain/ V	Zn point check drift‡/ °C	Signal corrected for Zn point drift/ V	dt ($t_{nom} - t_{BB}$) / °C	Signal corrected to t_{nom}/ V	t from median fit/ °C	dt ($t_{fit} - t_{BB}$) / °C	t from fit without 1000 °C data/ °C	dt ($t_{fit} - t_{BB}$) / °C
156.60*	10^9	156.60	0.08375	7.65000E-05	-0.003	7.64885E-05	7.64885E-05	156.487	-0.113	156.597	-0.003	0.032
231.93*	10^9	231.93	1.83388	0.0016752	-0.004	0.0016750	0.0016750	231.886	-0.044	231.902	-0.028	0.040
419.53*	10^7	419.53	1.98246	0.198341	-0.008	0.198311	0.198311	419.571	0.041	419.467	-0.063	0.073
660.32*	10^6	660.32	5.48120	5.481196	-0.015	5.480374	5.480374	660.258	-0.062	660.241	-0.079	0.129
961.78*	10^5	961.78	5.64510	56.475224	-0.025	56.466756	56.466756	961.147	-0.633	961.620	-0.160	0.224

Table 29 – results of the INRiM measurements with the INRiM thermometer, analysed using the fit of the median of the FP & VTBB data

* Fixed-point measurements

8 AVERAGE LABORATORY RESULTS FOR THE VTBB AND FP BLACKBODY MEASUREMENTS WITH THE INRIM THERMOMETER

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.71316E-05	0.46
200	5.09391E-04	0.41
231.93	1.68147E-03	0.30
250	3.08653E-03	0.30
300	1.36461E-02	0.30
400	1.36635E-01	0.31
419.53	1.98622E-01	0.24
500	7.56854E-01	0.32
600	2.83805E+00	0.29
660.32	5.48520E+00	0.31
700	8.09683E+00	0.32
800	1.90280E+01	0.35
900	3.86219E+01	0.39
961.78	5.64744E+01	0.30
419.53 VTBB	1.98735E-01	0.31
419.53 FP	1.98396E-01	0.09

Table 30 – CEM results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.65377E-05	0.070
200	5.10833E-04	0.072
231.93	1.67662E-03	0.076
250	3.07968E-03	0.079
300	1.35904E-02	0.107
400	1.36643E-01	0.075
419.53	1.98484E-01	0.079
500	7.57025E-01	0.096
600	2.83516E+00	0.120
660.32	5.48321E+00	0.147
700	8.09489E+00	0.157
800	1.90203E+01	0.187
900	3.86420E+01	0.219
961.78	5.65429E+01	0.242

Table 31 - PTB results

t_{nom}/ °C	Average signal/ V	U (k=2/ °C)
156.6	7.78687E-05	0.21
200	5.05824E-04	0.25
231.93	1.65405E-03	0.28
250	3.07652E-03	0.30
300	0.0135518	0.33
400	0.136087	0.36
419.53	0.197843	0.35
500	0.755228	0.37
600	2.826935	0.63
660.32	5.463960	1.09
700	8.053186	1.12
800	18.917923	1.41
900	38.474521	1.26
961.78	56.270615	1.55
600 Cs	2.828368	0.40
600 Na	2.824068	1.09

Table 32 - LNE results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.69549E-05	0.43
200	5.10597E-04	0.44
231.93	1.675634E-03	0.45
250	3.078861E-03	0.36
300	0.0136056	0.23
400	0.136631	0.12
419.53	0.198369	0.12
500	0.757823	0.26
600	2.839092	0.26
660.32	5.516949	0.22
700	8.130282	0.55
800	19.114447	0.64
900	38.867797	0.75
961.78	57.058238	0.81
1000	70.722878	0.87
Cs at 500	0.7571825	0.14
Na at 500 1	0.7572563	0.16
Na at 500 2	0.7590300	0.48
Cs at 600	2.8355255	0.16
Na at 600 1	2.8351201	0.19
Na at 600 2	2.8501981	0.52

Table 33 - METAS results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.68306E-05	0.15
200	5.11907E-04	0.20
231.93	1.67431E-03	0.14
250	3.07587E-03	0.20
300	1.35426E-02	0.22
400	0.136252	0.21
419.53	0.198143	0.14
500	0.756367	0.31
600	2.837103	0.48
660.32	5.485420	0.37
700	8.099872	0.50
800	19.014538	0.52
900	38.619595	0.53
961.78	56.528987	0.38
1000	70.250705	0.54
Cs at 500	0.755400	0.22
WRC at 500	0.758302	0.49
156.6 VTBB	7.68604E-05	0.20
156.6 FP	7.68007E-05	0.09
231.93 VTBB	1.67282E-03	0.20
231.93 FP	1.67579E-03	0.07
419.53 VTBB	0.197930	0.21
419.53 FP	0.198355	0.07
660.32 VTBB	5.487435	0.50
660.32 FP	5.481389	0.13
961.78 VTBB	56.545602	0.54
961.78 FP	56.512373	0.23

Table 34 - NPL results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.65363E-05	0.078
200	5.09558E-04	0.957
231.93	1.67488E-03	0.043
250	3.08667E-03	0.810
300	1.36439E-02	0.825
419.53	0.198561	0.469
500	0.760296	0.815
600	2.859868	0.857
660.32	5.532395	0.832
700	8.158800	0.835
800	19.448674	1.222
900	39.485398	1.230
1000	71.952881	1.141
419.53 VTBB	0.198779	0.862
419.53 FP	0.198343	0.075

Table 35 – UME results

t_{nom}/ °C	Average signal/ V	U (k=2)/ °C
156.6	7.64885E-05	0.032
231.93	0.0016750	0.040
419.53	0.198311	0.073
660.32	5.480374	0.129
961.78	56.466756	0.224

Table 36 - the INRiM results

t_{nom}/ °C	Median signal/ V
156.6	7.68306E-05
200	5.10077E-04
231.93	1.67495E-03
250	3.07927E-03
300	1.35980E-02
400	0.136631
419.53	0.198369
500	0.756939
600	2.837575
660.32	5.485195
700	8.098350
800	19.024152
900	38.631912
961.78	56.501713
1000	70.722878

Table 37 – median values for all the INRiM thermometer VTBB and FP measurements

9 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB AND FP MEASUREMENTS WITH THE INRIM THERMOMETER

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
7.68306E-05	429.75	429.730	-0.020
5.10077E-04	473.15	473.069	-0.081
1.67495E-03	505.08	505.036	-0.044
3.07927E-03	523.15	523.132	-0.018
1.35980E-02	573.15	573.204	0.054
0.136631	673.15	673.218	0.068
0.198369	692.68	692.737	0.057
0.756939	773.15	773.223	0.073
2.837575	873.15	873.276	0.126
5.485195	933.47	933.494	0.024
8.098350	973.15	973.149	-0.001
19.024152	1073.15	1073.033	-0.117
38.631912	1173.15	1172.822	-0.328
56.501713	1234.93	1234.403	-0.527
70.722878	1273.15	1273.885	0.735

Table 38 – results of the fit using all the data points

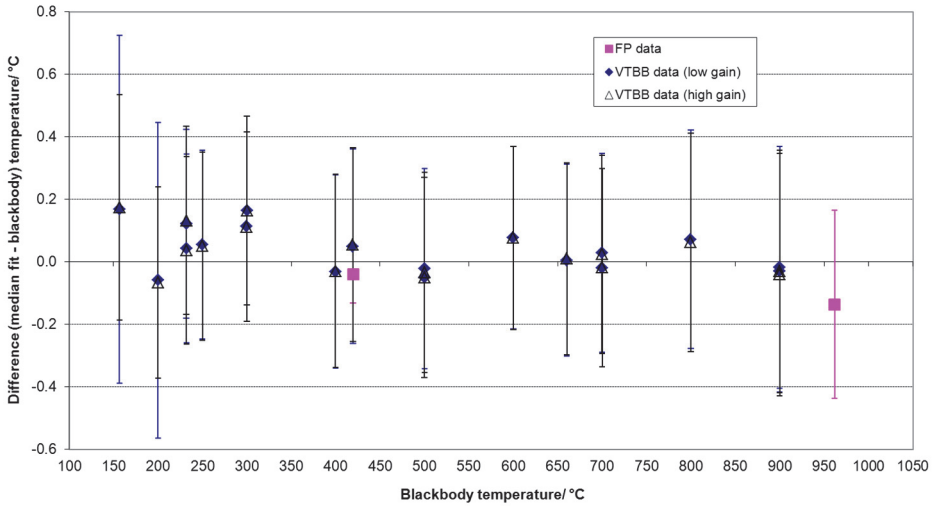
Coefficients of the fit: a_1 = 7.9494048587E+04
a_2 = 1.6049172730E-06
a_3 = 3.4711159949E-06

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
7.68306E-05	429.75	429.840	0.090
5.10077E-04	473.15	473.121	-0.029
1.67495E-03	505.08	505.052	-0.028
3.07927E-03	523.15	523.129	-0.021
1.35980E-02	573.15	573.157	0.007
0.136631	673.15	673.119	-0.031
0.198369	692.68	692.633	-0.047
0.756939	773.15	773.118	-0.032
2.837575	873.15	873.212	0.062
5.485195	933.47	933.477	0.007
8.098350	973.15	973.173	0.023
19.024152	1073.15	1073.192	0.042
38.631912	1173.15	1173.161	0.011
56.501713	1234.93	1234.876	-0.054
70.722878*	1273.15*	1274.454*	1.304*

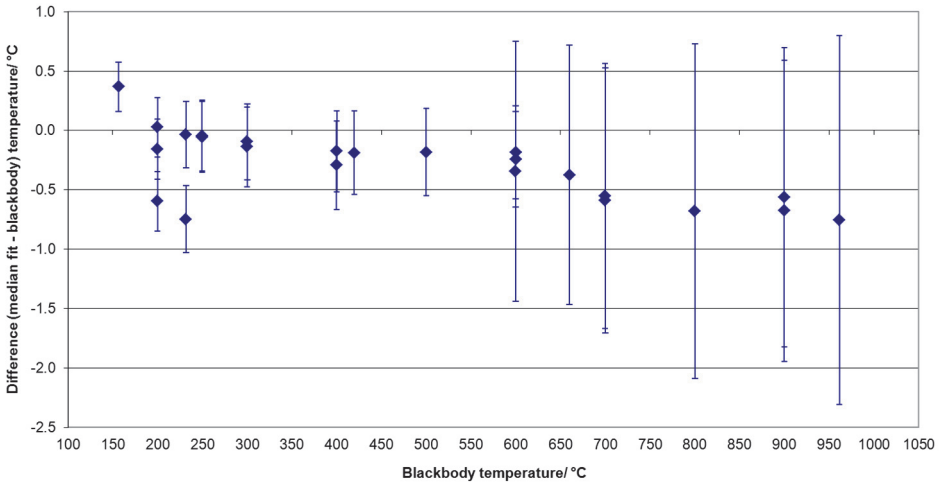
Table 39 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 7.7847021794E+04
a_2 = 1.6104579903E-06
a_3 = 1.6131384647E-06

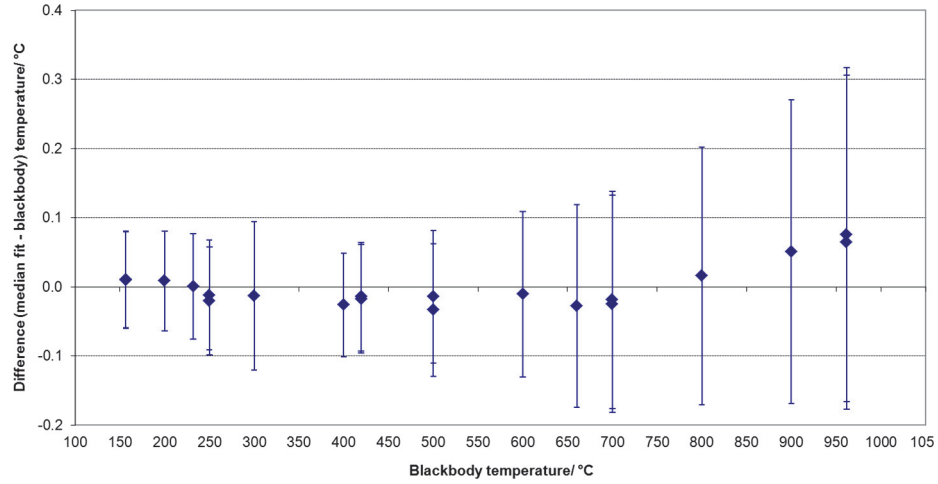
CEM results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



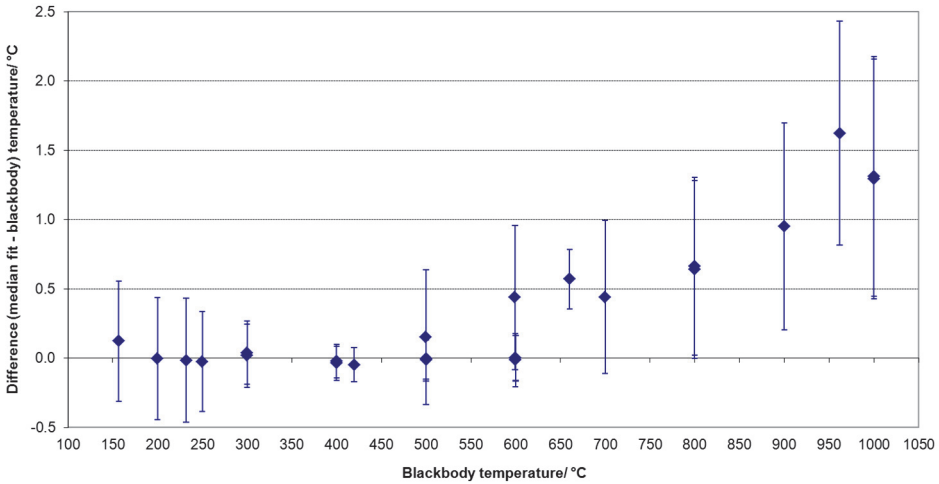
LNE results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



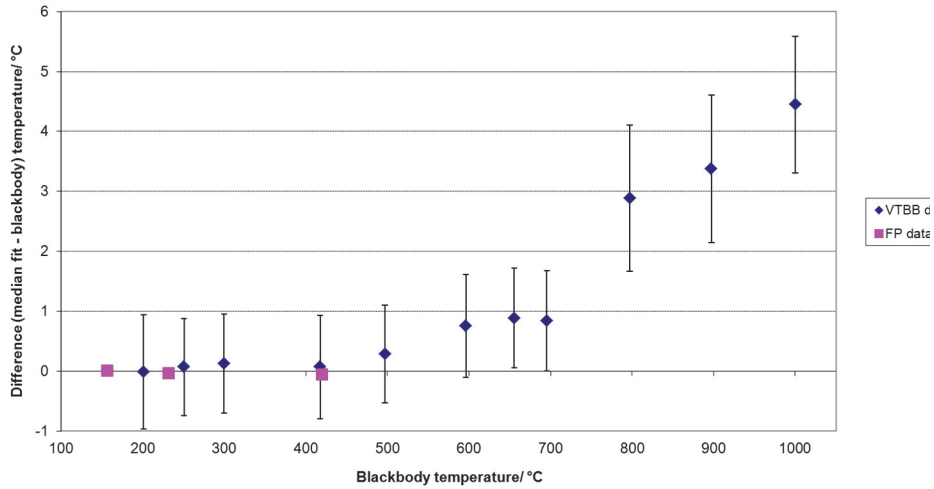
PTB results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



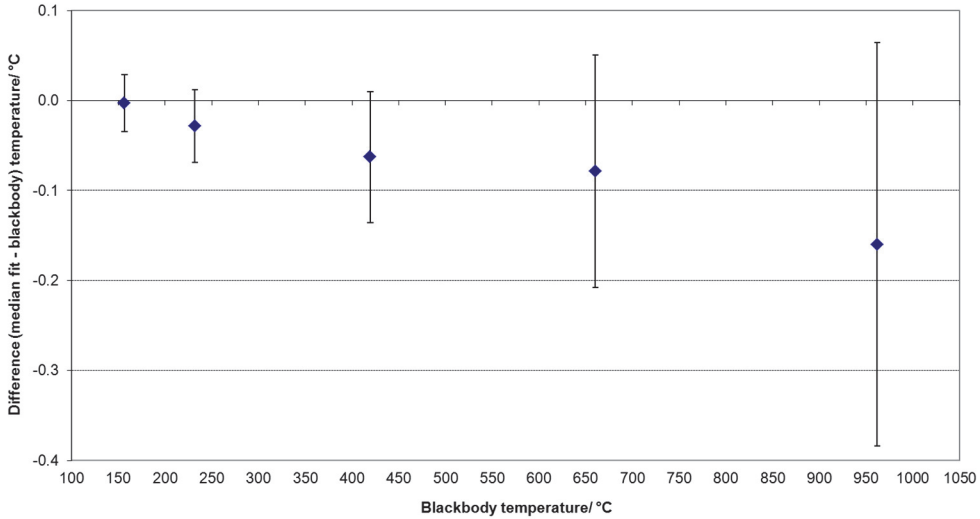
METAS results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



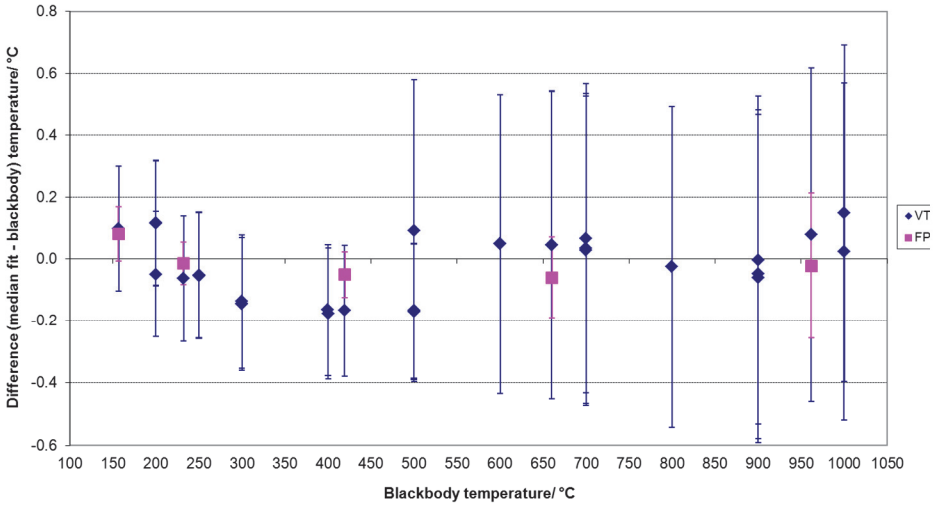
UME results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



INRiM results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



NPL results - Difference between fit temperature using median of VTBB and FP data (excluding 1000 °C) and blackbody temperature with the INRIM thermometer



10 ANALYSIS OF THE VTBB RESULTS WITH THE LP5 USING THE MEDIAN OF ALL THE VTBB DATA FOR THE FITTING PROCESS

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.91	3.02262E-12	3.02262E-12	0.02	3.02523E-12	0.02	3.02740E-12	231.766	-0.144	231.861	-0.049	0.43
250.00	R1	250.11	5.72417E-12	5.72417E-12	0.03	5.72910E-12	-0.11	5.70798E-12	250.198	0.088	250.266	0.156	0.36
300.00	R1	300.09	2.62564E-11	2.62564E-11	0.03	2.62790E-11	-0.09	2.62129E-11	300.099	0.009	300.103	0.013	0.36
400.00	R1	399.94	2.81427E-10	2.81427E-10	0.04	2.81669E-10	0.06	2.82011E-10	399.986	0.046	399.906	-0.034	0.40
419.53	R1	419.55	4.14299E-10	4.14299E-10	0.05	4.14656E-10	-0.02	4.14497E-10	419.660	0.110	419.569	0.019	0.41
500.00	R1	499.98	1.63872E-09	1.63872E-09	0.06	1.64013E-09	0.02	1.64063E-09	499.987	0.007	499.877	-0.103	0.45
600.00	R1	600.09	6.39791E-09	6.39791E-09	0.07	6.40342E-09	-0.09	6.39648E-09	600.252	0.162	600.168	0.078	0.50
660.32	R2	660.35	1.25941E-08	1.25884E-08	0.08	1.25993E-08	-0.03	1.25953E-08	660.390	0.040	660.348	-0.002	0.56
700.00	R2	700.10	1.88022E-08	1.87938E-08	0.09	1.88099E-08	-0.10	1.87917E-08	700.060	-0.040	700.058	-0.042	0.59
800.00	R2	799.91	4.51797E-08	4.51593E-08	0.11	4.51982E-08	0.09	4.52306E-08	799.775	-0.135	799.909	-0.001	0.70
900.00	R2	900.01	9.36263E-08	9.35841E-08	0.13	9.36646E-08	-0.01	9.36584E-08	899.610	-0.400	899.936	-0.074	0.82
231.93	R1	232.07	3.05435E-12	3.05435E-12	0.02	3.05698E-12	-0.14	3.04159E-12	232.057	-0.013	232.152	0.082	0.41
300.00	R1	300.14	2.63234E-11	2.63234E-11	0.03	2.63461E-11	-0.14	2.62431E-11	300.190	0.050	300.195	0.055	0.36
500.00	R1	500.09	1.64322E-09	1.64322E-09	0.06	1.64463E-09	-0.09	1.64236E-09	500.166	0.076	500.056	-0.034	0.45
700.00	R2	700.04	1.87879E-08	1.87794E-08	0.09	1.87956E-08	-0.04	1.87883E-08	699.982	-0.058	699.979	-0.061	0.59
900.00	R2	899.92	9.36075E-08	9.35653E-08	0.13	9.36458E-08	0.08	9.36958E-08	899.580	-0.340	899.906	-0.014	0.82

Table 40- results of the CEM variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

‡ Compared to the PTB value at the start of the comparison.

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R2	231.91	3.04783E-12	3.04783E-12	0.02	3.05045E-12	0.02	3.05265E-12	232.028	0.118	232.053	0.143	2.90
250.00	R2	250.11	5.77088E-12	5.77088E-12	0.03	5.77584E-12	-0.11	5.75455E-12	250.457	0.347	250.475	0.365	1.55
300.00	R2	300.09	2.61516E-11	2.61516E-11	0.03	2.61741E-11	-0.09	2.61083E-11	299.937	-0.153	299.939	-0.151	0.52
400.00	R2	399.94	2.81632E-10	2.81632E-10	0.04	2.81874E-10	0.06	2.82217E-10	399.961	0.021	399.940	0.000	0.40
419.53	R2	419.55	4.14570E-10	4.14570E-10	0.05	4.14927E-10	-0.02	4.14768E-10	419.629	0.079	419.605	0.055	0.41
500.00	R2	499.98	1.63960E-09	1.63960E-09	0.06	1.64101E-09	0.02	1.64152E-09	499.951	-0.029	499.922	-0.058	0.46
600.00	R2	600.09	6.40066E-09	6.40066E-09	0.07	6.40617E-09	-0.09	6.39923E-09	600.239	0.149	600.217	0.127	0.50
660.32	R2	660.35	1.25941E-08	1.25941E-08	0.08	1.26050E-08	-0.03	1.26010E-08	660.414	0.064	660.403	0.053	0.55
700.00	R2	700.10	1.88022E-08	1.88022E-08	0.09	1.88184E-08	-0.10	1.88002E-08	700.114	0.014	700.114	0.014	0.59
800.00	R2	799.91	4.51797E-08	4.51797E-08	0.11	4.52186E-08	0.09	4.52510E-08	799.928	0.018	799.964	0.054	0.70
900.00	R2	900.01	9.36263E-08	9.36263E-08	0.13	9.37069E-08	-0.01	9.37007E-08	899.895	-0.115	899.982	-0.028	0.81
231.93	R2	232.07	3.08452E-12	3.08452E-12	0.02	3.08718E-12	-0.14	3.07164E-12	232.361	0.291	232.386	0.316	1.81
300.00	R2	300.14	2.61924E-11	2.61924E-11	0.03	2.62150E-11	-0.14	2.61125E-11	299.993	-0.147	299.994	-0.146	0.45
500.00	R2	500.09	1.64412E-09	1.64412E-09	0.06	1.64553E-09	-0.09	1.64326E-09	500.131	0.041	500.101	0.011	0.46
700.00	R2	700.04	1.87879E-08	1.87879E-08	0.09	1.88041E-08	-0.04	1.87968E-08	700.036	-0.004	700.035	-0.005	0.59
900.00	R2	899.92	9.36075E-08	9.36075E-08	0.13	9.36881E-08	0.08	9.37381E-08	899.865	-0.055	899.952	0.032	0.81

Table 41 - results of the CEM variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.946	3.03946E-12	3.03946E-12	0.00	3.03946E-12	-0.016	3.03773E-12	231.90	-0.05	231.99	0.05	0.13
250	R1	250.089	5.70504E-12	5.70504E-12	0.00	5.70504E-12	-0.089	5.68800E-12	250.07	-0.02	250.14	0.05	0.11
300	R1	300.020	2.62226E-11	2.62226E-11	0.00	2.62226E-11	-0.020	2.62081E-11	300.02	0.00	300.03	0.01	0.13
400	R1	400.021	2.82049E-10	2.82049E-10	0.00	2.82049E-10	-0.021	2.81932E-10	400.05	0.03	399.97	-0.05	0.12
419.53	R1	419.530	4.14019E-10	4.14019E-10	0.00	4.14019E-10	0.000	4.14019E-10	419.58	0.05	419.49	-0.04	0.13
500	R1	500.015	1.64206E-09	1.64206E-09	0.00	1.64206E-09	-0.015	1.64169E-09	500.06	0.05	499.95	-0.06	0.15
600	R1	600.017	6.38577E-09	6.38577E-09	0.00	6.38577E-09	-0.017	6.38444E-09	600.02	0.01	599.94	-0.08	0.20
660.32	R2	660.312	1.25796E-08	1.25809E-08	0.00	1.25809E-08	0.008	1.25819E-08	660.25	-0.06	660.21	-0.10	0.23
700	R2	700.031	1.87788E-08	1.87806E-08	0.00	1.87806E-08	-0.031	1.87749E-08	699.90	-0.13	699.90	-0.13	0.25
800	R2	800.012	4.52005E-08	4.52049E-08	0.00	4.52049E-08	-0.011	4.52008E-08	799.79	-0.22	799.93	-0.08	0.30
900	R2	900.011	9.37001E-08	9.37093E-08	0.00	9.37093E-08	-0.011	9.37021E-08	899.68	-0.33	900.01	0.00	0.36
961.78	R2	961.748	1.38461E-07	1.38475E-07	0.00	1.38475E-07	0.032	1.38501E-07	961.21	-0.53	961.69	-0.06	0.39
231.93	R1	231.947	3.03869E-12	3.03869E-12	0.00	3.03869E-12	-0.017	3.03689E-12	231.89	-0.06	231.98	0.04	0.15
300	R1	300.027	2.62522E-11	2.62522E-11	0.00	2.62522E-11	-0.027	2.62324E-11	300.06	0.04	300.07	0.04	0.20
419.53	R1	419.512	4.13968E-10	4.13968E-10	0.00	4.13968E-10	0.018	4.14109E-10	419.57	0.06	419.48	-0.03	0.13
500	R1	500.049	1.64205E-09	1.64205E-09	0.00	1.64205E-09	-0.048	1.64083E-09	500.06	0.02	499.95	-0.10	0.15
700	R2	700.028	1.87822E-08	1.87840E-08	0.00	1.87840E-08	-0.028	1.87789E-08	699.92	-0.11	699.92	-0.11	0.25
961.78	R2	961.696	1.38400E-07	1.38414E-07	0.00	1.38414E-07	0.084	1.38484E-07	961.14	-0.55	961.61	-0.08	0.39

Table 42 - results of the PTB variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.946	3.03946E-12	3.03916E-12	0.00	3.03916E-12	-0.016	3.03744E-12	231.92	-0.02	231.95	0.00	0.13
250	R1	250.089	5.70504E-12	5.70448E-12	0.00	5.70448E-12	-0.089	5.68745E-12	250.09	0.00	250.10	0.01	0.11
300	R1	300.020	2.62226E-11	2.62200E-11	0.00	2.62200E-11	-0.020	2.62056E-11	300.00	-0.02	300.00	-0.02	0.13
400	R1	400.021	2.82049E-10	2.82021E-10	0.00	2.82021E-10	-0.021	2.81904E-10	399.99	-0.03	399.97	-0.05	0.12
419.53	R1	419.530	4.14019E-10	4.13978E-10	0.00	4.13978E-10	0.000	4.13979E-10	419.51	-0.02	419.48	-0.05	0.13
500	R1	500.015	1.64206E-09	1.64190E-09	0.00	1.64190E-09	-0.015	1.64153E-09	499.99	-0.03	499.96	-0.06	0.16
600	R1	600.017	6.38577E-09	6.38515E-09	0.00	6.38515E-09	-0.017	6.38381E-09	599.97	-0.05	599.94	-0.07	0.20
660.32	R2	660.312	1.25796E-08	1.25796E-08	0.00	1.25796E-08	0.008	1.25807E-08	660.22	-0.09	660.21	-0.10	0.23
700	R2	700.031	1.87788E-08	1.87788E-08	0.00	1.87788E-08	-0.031	1.87731E-08	699.90	-0.13	699.90	-0.14	0.25
800	R2	800.012	4.52005E-08	4.52005E-08	0.00	4.52005E-08	-0.011	4.51963E-08	799.88	-0.13	799.91	-0.10	0.30
900	R2	900.011	9.37001E-08	9.37001E-08	0.00	9.37001E-08	-0.011	9.36930E-08	899.88	-0.13	899.97	-0.04	0.36
961.78	R2	961.748	1.38461E-07	1.38461E-07	0.00	1.38461E-07	0.032	1.38488E-07	961.51	-0.24	961.63	-0.12	0.39
231.93	R1	231.947	3.03869E-12	3.03839E-12	0.00	3.03839E-12	-0.017	3.03659E-12	231.92	-0.03	231.94	0.00	0.15
300	R1	300.027	2.62522E-11	2.62496E-11	0.00	2.62496E-11	-0.027	2.62298E-11	300.04	0.01	300.04	0.01	0.20
419.53	R1	419.512	4.13968E-10	4.13928E-10	0.00	4.13928E-10	0.018	4.14069E-10	419.50	-0.01	419.48	-0.03	0.13
500	R1	500.049	1.64205E-09	1.64189E-09	0.00	1.64189E-09	-0.048	1.64067E-09	499.99	-0.06	499.96	-0.09	0.16
700	R2	700.028	1.87822E-08	1.87822E-08	0.00	1.87822E-08	-0.028	1.87770E-08	699.92	-0.11	699.91	-0.11	0.25
961.78	R2	961.696	1.38400E-07	1.38400E-07	0.00	1.38400E-07	0.084	1.38470E-07	961.43	-0.26	961.56	-0.14	0.39

Table 43 - results of the PTB variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.76	2.99090E-12	2.99090E-12	0.293	3.02242E-12	0.17	3.04056E-12	231.74	-0.02	231.84	0.07	0.60
250	R1	249.83	5.59107E-12	5.59107E-12	0.314	5.64998E-12	0.17	5.68232E-12	249.78	-0.05	249.85	0.02	0.44
250	R1	249.84	5.30973E-12	5.30973E-12	0.314	5.36569E-12	0.16	5.39480E-12	248.25	-1.59	248.32	-1.52	0.48
250	R1	249.83	5.59853E-12	5.59853E-12	0.314	5.65753E-12	0.17	5.69005E-12	249.82	-0.01	249.89	0.06	0.44
300	R1	300.19	2.60880E-11	2.60880E-11	0.378	2.63629E-11	-0.19	2.62213E-11	300.21	0.02	300.22	0.03	0.36
400	R1	399.93	2.77908E-10	2.77908E-10	0.520	2.80836E-10	0.07	2.81215E-10	399.84	-0.09	399.76	-0.17	0.33
400	R1	400.14	2.79379E-10	2.79379E-10	0.521	2.82322E-10	-0.14	2.81534E-10	400.10	-0.04	400.02	-0.12	0.34
419.53	R1	419.63	4.09805E-10	4.09805E-10	0.551	4.14123E-10	-0.10	4.13363E-10	419.59	-0.03	419.50	-0.12	0.34
500	R1	500.11	1.62441E-09	1.62441E-09	0.687	1.64152E-09	-0.11	1.63864E-09	500.04	-0.07	499.93	-0.18	0.37
600	R2	600.16	6.32775E-09	6.32775E-09	0.876	6.39443E-09	-0.16	6.38247E-09	600.14	-0.02	600.05	-0.10	0.45
600	R2	600.13	6.32566E-09	6.32566E-09	0.876	6.39232E-09	-0.13	6.38241E-09	600.11	-0.02	600.02	-0.11	0.47
660.32	R2	660.06	1.23955E-08	1.23955E-08	1.000	1.25261E-08	0.26	1.25608E-08	659.84	-0.22	659.79	-0.26	1.06
700	R2	699.83	1.84743E-08	1.84743E-08	1.087	1.86689E-08	0.17	1.86990E-08	699.28	-0.55	699.28	-0.55	1.06
700	R2	700.11	1.85300E-08	1.85300E-08	1.088	1.87253E-08	-0.11	1.87050E-08	699.60	-0.52	699.59	-0.52	1.08
800	R2	800.07	4.45481E-08	4.45481E-08	1.323	4.50175E-08	-0.07	4.49920E-08	799.27	-0.80	799.41	-0.66	1.17
900	R2	899.88	9.22973E-08	9.22973E-08	1.580	9.32699E-08	0.12	9.33437E-08	898.98	-0.90	899.30	-0.58	1.22
900	R2	899.94	9.23564E-08	9.23564E-08	1.580	9.33297E-08	0.06	9.33649E-08	899.07	-0.87	899.40	-0.54	1.24
961.78	R2	961.63	1.36561E-07	1.36561E-07	1.751	1.38000E-07	0.15	1.38126E-07	960.64	-0.98	961.12	-0.51	1.30

Table 44- results of the LNE variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.76	2.99090E-12	2.99090E-12	0.293	3.02242E-12	0.17	3.04056E-12	231.77	0.01	231.80	0.03	0.60
250	R1	249.83	5.59107E-12	5.59107E-12	0.314	5.64998E-12	0.17	5.68232E-12	249.80	-0.03	249.82	-0.01	0.44
250	R1	249.84	5.30973E-12	5.30973E-12	0.314	5.36569E-12	0.16	5.39480E-12	248.26	-1.58	248.28	-1.56	0.48
250	R1	249.83	5.59853E-12	5.59853E-12	0.314	5.65753E-12	0.17	5.69005E-12	249.84	0.01	249.86	0.03	0.44
300	R1	300.19	2.60880E-11	2.60880E-11	0.378	2.63629E-11	-0.19	2.62213E-11	300.20	0.00	300.20	0.00	0.36
400	R1	399.93	2.77908E-10	2.77908E-10	0.520	2.80836E-10	0.07	2.81215E-10	399.78	-0.15	399.76	-0.18	0.33
400	R1	400.14	2.79379E-10	2.79379E-10	0.521	2.82322E-10	-0.14	2.81534E-10	400.04	-0.10	400.02	-0.12	0.34
419.53	R1	419.63	4.09805E-10	4.09805E-10	0.551	4.14123E-10	-0.10	4.13363E-10	419.53	-0.10	419.50	-0.12	0.34
500	R1	500.11	1.62441E-09	1.62441E-09	0.687	1.64152E-09	-0.11	1.63864E-09	499.97	-0.14	499.94	-0.17	0.37
600	R2	600.16	6.32775E-09	6.32775E-09	0.876	6.39443E-09	-0.16	6.38247E-09	600.09	-0.07	600.06	-0.09	0.45
600	R2	600.13	6.32566E-09	6.32566E-09	0.876	6.39232E-09	-0.13	6.38241E-09	600.06	-0.07	600.04	-0.09	0.47
660.32	R2	660.06	1.23955E-08	1.23955E-08	1.000	1.25261E-08	0.26	1.25608E-08	659.82	-0.24	659.81	-0.25	1.06
700	R2	699.83	1.84743E-08	1.84743E-08	1.087	1.86689E-08	0.17	1.86990E-08	699.29	-0.54	699.29	-0.54	1.06
700	R2	700.11	1.85300E-08	1.85300E-08	1.088	1.87253E-08	-0.11	1.87050E-08	699.60	-0.51	699.60	-0.51	1.08
800	R2	800.07	4.45481E-08	4.45481E-08	1.323	4.50175E-08	-0.07	4.49920E-08	799.37	-0.70	799.40	-0.67	1.17
900	R2	899.88	9.22973E-08	9.22973E-08	1.580	9.32699E-08	0.12	9.33437E-08	899.19	-0.69	899.28	-0.60	1.22
900	R2	899.94	9.23564E-08	9.23564E-08	1.580	9.33297E-08	0.06	9.33649E-08	899.29	-0.65	899.38	-0.57	1.24
961.78	R2	961.63	1.36561E-07	1.36561E-07	1.751	1.38000E-07	0.15	1.38126E-07	960.95	-0.68	961.08	-0.55	1.30

Table 45- results of the LNE variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.913	3.0206E-12	3.02059E-12	0.237	3.04635E-12	0.02	3.04824E-12	231.960	0.047	232.055	0.142	0.450
419.53	R1	419.500	4.1029E-10	4.10295E-10	0.446	4.13795E-10	0.03	4.14035E-10	419.551	0.052	419.460	-0.039	0.158
660.32	R2	660.335	1.2502E-08	1.24947E-08	0.810	1.26013E-08	-0.02	1.25993E-08	660.405	0.070	660.363	0.028	0.278
961.78	R2	961.678	1.3834E-07	1.38261E-07	1.417	1.39441E-07	0.10	1.39526E-07	962.368	0.690	962.843	1.165	0.865
250	R1	249.986	5.6051E-12	5.60506E-12	0.254	5.65287E-12	0.01	5.65558E-12	249.798	-0.188	249.866	-0.119	0.365
300	R1	300.011	2.6007E-11	2.60067E-11	0.305	2.62285E-11	-0.01	2.62204E-11	300.030	0.019	300.034	0.023	0.239
400	R1	400.063	2.8005E-10	2.80050E-10	0.421	2.82439E-10	-0.06	2.82080E-10	400.121	0.059	400.041	-0.022	0.153
500[1]	R1	499.955	1.6277E-09	1.62775E-09	0.556	1.64163E-09	0.05	1.64278E-09	500.047	0.092	499.937	-0.018	0.186
500[2]	R1	499.963	1.6276E-09	1.62764E-09	0.556	1.64152E-09	0.04	1.64246E-09	500.043	0.080	499.932	-0.031	0.201
600[1]	R1	600.014	6.3365E-09	6.33653E-09	0.709	6.39058E-09	-0.01	6.38946E-09	600.085	0.071	600.001	-0.014	0.225
600[2]	R1	599.728	6.3123E-09	6.31232E-09	0.708	6.36616E-09	0.27	6.38703E-09	599.767	0.039	599.682	-0.045	0.247
300	R1	300.040	2.6079E-11	2.60794E-11	0.305	2.63019E-11	-0.04	2.62726E-11	300.130	0.090	300.134	0.095	0.239
400	R1	400.060	2.8016E-10	2.80163E-10	0.421	2.82553E-10	-0.06	2.82210E-10	400.141	0.081	400.060	0.001	0.153
600[1]	R1	599.988	6.3348E-09	6.33481E-09	0.709	6.38885E-09	0.01	6.38975E-09	600.062	0.074	599.978	-0.010	0.225
500[3]	R1	499.803	1.6276E-09	1.62764E-09	0.555	1.64152E-09	0.20	1.64648E-09	500.043	0.239	499.932	0.129	0.500
600[3]	R1	599.237	6.3123E-09	6.31232E-09	0.707	6.36616E-09	0.76	6.42475E-09	599.767	0.530	599.682	0.446	0.541
700[3]	R2	699.935	1.8713E-08	1.87029E-08	0.880	1.88624E-08	0.07	1.88743E-08	700.348	0.413	700.345	0.411	0.584
800[3]	R2	799.890	4.5069E-08	4.50439E-08	1.070	4.54281E-08	0.11	4.54680E-08	800.412	0.522	800.547	0.657	0.682
900[3]	R2	899.923	9.3482E-08	9.34300E-08	1.279	9.42269E-08	0.08	9.42755E-08	900.507	0.585	900.835	0.913	0.797
1000[3]	R2	1000.039	1.7303E-07	1.72936E-07	1.507	1.74411E-07	-0.04	1.74373E-07	1000.693	0.654	1001.269	1.231	0.926
800[3]	R2	799.949	4.5097E-08	4.50721E-08	1.070	4.54566E-08	0.05	4.54749E-08	800.491	0.541	800.626	0.676	0.682
1000[3]	R2	1000.080	1.7314E-07	1.73044E-07	1.507	1.74520E-07	-0.08	1.74441E-07	1000.803	0.723	1001.380	1.300	0.926

Table 46- results of the METAS variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using a Na heatpipe with PRT;
[3] values obtained using a Na heatpipe with thermocouple.

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.913	3.0206E-12	3.02225E-12	0.237	3.04803E-12	0.02	3.04992E-12	232.006	0.093	232.031	0.118	0.450
419.53	R1	419.500	4.1029E-10	4.10521E-10	0.446	4.14023E-10	0.03	4.14264E-10	419.515	0.015	419.491	-0.009	0.158
660.32	R2	660.335	1.2502E-08	1.25016E-08	0.810	1.26082E-08	-0.02	1.26062E-08	660.439	0.104	660.428	0.093	0.278
961.78	R2	961.678	1.3834E-07	1.38337E-07	1.417	1.39517E-07	0.10	1.39603E-07	962.770	1.092	962.896	1.218	0.865
250	R1	249.986	5.6051E-12	5.60815E-12	0.254	5.65599E-12	0.01	5.65870E-12	249.830	-0.155	249.849	-0.137	0.365
300	R1	300.011	2.6007E-11	2.60210E-11	0.305	2.62430E-11	-0.01	2.62349E-11	300.032	0.021	300.033	0.022	0.239
400	R1	400.063	2.8005E-10	2.80205E-10	0.421	2.82595E-10	-0.06	2.82236E-10	400.088	0.025	400.066	0.003	0.153
500[1]	R1	499.955	1.6277E-09	1.62865E-09	0.556	1.64254E-09	0.05	1.64368E-09	500.012	0.057	499.983	0.028	0.186
500[2]	R1	499.963	1.6276E-09	1.62854E-09	0.556	1.64243E-09	0.04	1.64336E-09	500.008	0.045	499.978	0.015	0.201
600[1]	R1	600.014	6.3365E-09	6.34002E-09	0.709	6.39410E-09	-0.01	6.39299E-09	600.083	0.068	600.060	0.046	0.225
600[2]	R1	599.728	6.3123E-09	6.31581E-09	0.708	6.36968E-09	0.27	6.39055E-09	599.764	0.037	599.742	0.014	0.247
300	R1	300.040	2.6079E-11	2.60938E-11	0.305	2.63164E-11	-0.04	2.62871E-11	300.132	0.092	300.133	0.093	0.239
400	R1	400.060	2.8016E-10	2.80318E-10	0.421	2.82709E-10	-0.06	2.82366E-10	400.108	0.048	400.086	0.026	0.153
600[1]	R1	599.988	6.3348E-09	6.33831E-09	0.709	6.39237E-09	0.01	6.39328E-09	600.060	0.072	600.038	0.050	0.225
500[3]	R1	499.803	1.6276E-09	1.62854E-09	0.555	1.64243E-09	0.20	1.64739E-09	500.008	0.204	499.978	0.175	0.500
600[3]	R1	599.237	6.3123E-09	6.31581E-09	0.707	6.36968E-09	0.76	6.42830E-09	599.764	0.528	599.742	0.505	0.541
700[3]	R2	699.935	1.8713E-08	1.87132E-08	0.880	1.88728E-08	0.07	1.88847E-08	700.412	0.478	700.412	0.477	0.584
800[3]	R2	799.890	4.5069E-08	4.50687E-08	1.070	4.54531E-08	0.11	4.54931E-08	800.578	0.688	800.614	0.724	0.682
900[3]	R2	899.923	9.3482E-08	9.34816E-08	1.279	9.42789E-08	0.08	9.43275E-08	900.808	0.886	900.896	0.973	0.797
1000[3]	R2	1000.039	1.7303E-07	1.73032E-07	1.507	1.74507E-07	-0.04	1.74469E-07	1001.163	1.124	1001.316	1.278	0.926
800[3]	R2	799.949	4.5097E-08	4.50970E-08	1.070	4.54816E-08	0.05	4.55000E-08	800.657	0.707	800.693	0.743	0.682
1000[3]	R2	1000.080	1.7314E-07	1.73140E-07	1.507	1.74617E-07	-0.08	1.74537E-07	1001.274	1.193	1001.427	1.347	0.926

Table 47 - results of the METAS variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
250	R1	250.78	5.76788E-12	5.76788E-12	0.129	5.79270E-12	-0.78	5.64102E-12	250.53	-0.25	250.60	-0.19	0.96
300	R2	299.80	2.60561E-11	2.63989E-11	0.154	2.65125E-11	0.20	2.66607E-11	300.42	0.62	300.42	0.62	1.27
419.53	R2	417.73	3.98655E-10	4.03899E-10	0.224	4.05637E-10	1.80	4.19639E-10	418.51	0.78	418.42	0.69	1.54
500	R2	497.10	1.56268E-09	1.58323E-09	0.278	1.59005E-09	2.90	1.66126E-09	497.97	0.87	497.86	0.76	1.83
600	R2	596.25	6.07226E-09	6.15213E-09	0.354	6.17861E-09	3.75	6.45990E-09	597.29	1.04	597.20	0.95	2.24
660.32	R2	655.68	1.19562E-08	1.21135E-08	0.405	1.21656E-08	4.64	1.27661E-08	657.08	1.40	657.03	1.35	2.57
700	R2	695.58	1.80514E-08	1.82889E-08	0.440	1.83676E-08	4.42	1.91616E-08	697.61	2.03	697.61	2.03	2.75
800	R2	797.27	4.40370E-08	4.46163E-08	0.537	4.48083E-08	2.73	4.57878E-08	798.69	1.42	798.82	1.55	3.34
900	R2	897.37	9.18374E-08	9.30455E-08	0.643	9.34458E-08	2.63	9.50902E-08	899.26	1.89	899.59	2.21	3.96
1000	R2	1000.09	1.72885E-07	1.75159E-07	0.760	1.75913E-07	-0.09	1.75826E-07	1002.21	2.12	1002.79	2.70	4.59

Table 48- results of the UME variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
250	R1	250.78	5.76788E-12	5.69299E-12	0.129	5.71749E-12	-0.78	5.56778E-12	250.15	-0.63	250.17	-0.61	1.20
300	R2	299.80	2.60561E-11	2.60561E-11	0.154	2.61683E-11	0.20	2.63146E-11	299.93	0.13	299.93	0.13	0.90
419.53	R2	417.73	3.98655E-10	3.98655E-10	0.224	4.00371E-10	1.80	4.14191E-10	417.76	0.03	417.74	0.01	0.81
500	R2	497.10	1.56268E-09	1.56268E-09	0.278	1.56940E-09	2.90	1.63970E-09	497.05	-0.05	497.02	-0.08	0.84
600	R2	596.25	6.07226E-09	6.07226E-09	0.354	6.09839E-09	3.75	6.37603E-09	596.16	-0.09	596.14	-0.11	0.85
660.32	R2	655.68	1.19562E-08	1.19562E-08	0.405	1.20077E-08	4.64	1.26004E-08	655.82	0.14	655.81	0.13	0.99
700	R2	695.58	1.80514E-08	1.80514E-08	0.440	1.81291E-08	4.42	1.89128E-08	696.28	0.70	696.27	0.70	0.95
800	R2	797.27	4.40370E-08	4.4037E-08	0.537	4.42265E-08	2.73	4.51933E-08	797.15	-0.12	797.19	-0.09	1.14
900	R2	897.37	9.18374E-08	9.18374E-08	0.643	9.22326E-08	2.63	9.38556E-08	897.52	0.15	897.61	0.23	1.26
1000	R2	1000.09	1.72885E-07	1.72885E-07	0.760	1.73629E-07	-0.09	1.73543E-07	1000.27	0.18	1000.42	0.34	1.25

Table 49 - results of the UME variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	232.03	3.061856E-12	3.061856E-12	-0.003	3.061563E-12	-0.10	3.050555E-12	232.10	0.07	232.19	0.16	0.27
250	R1	249.99	5.672646E-12	5.672646E-12	-0.003	5.672104E-12	0.01	5.674006E-12	249.90	-0.09	249.97	-0.02	0.26
250	R1	249.99	5.681434E-12	5.681434E-12	-0.003	5.680891E-12	0.01	5.683748E-12	249.95	-0.04	250.01	0.03	0.26
250	R1	250.06	5.695074E-12	5.695074E-12	-0.003	5.694529E-12	-0.06	5.684031E-12	250.02	-0.04	250.09	0.03	0.26
300	R1	300.06	2.618329E-11	2.618329E-11	-0.003	2.618078E-11	-0.06	2.614057E-11	299.96	-0.09	299.97	-0.09	0.26
400	R1	400.00	2.817535E-10	2.817535E-10	-0.005	2.817266E-10	0.00	2.817551E-10	400.00	0.00	399.92	-0.08	0.27
400	R1	400.06	2.821617E-10	2.821617E-10	-0.005	2.821347E-10	-0.06	2.817919E-10	400.07	0.01	399.99	-0.07	0.27
419.53	R1	419.42	4.128693E-10	4.128693E-10	-0.005	4.128298E-10	0.11	4.136617E-10	419.43	0.00	419.34	-0.09	0.27
500[1]	R2	499.89	1.639063E-09	1.638486E-09	-0.006	1.638330E-09	0.11	1.641029E-09	499.92	0.02	499.81	-0.09	0.29
500[1]	R1	499.89	1.638486E-09	1.638486E-09	-0.006	1.638329E-09	0.11	1.641013E-09	499.92	0.02	499.81	-0.09	0.29
500[2]	R1	500.22	1.652192E-09	1.652192E-09	-0.006	1.652034E-09	-0.22	1.646458E-09	500.46	0.24	500.35	0.13	0.52
600	R1	600.04	6.398232E-09	6.398232E-09	-0.008	6.397620E-09	-0.04	6.394339E-09	600.18	0.13	600.09	0.05	0.54
660.32	R2	660.04	1.256802E-08	1.256359E-08	-0.009	1.256239E-08	0.28	1.259983E-08	660.11	0.07	660.07	0.03	0.55
700	R2	700.00	1.881512E-08	1.880850E-08	-0.010	1.880670E-08	0.00	1.880670E-08	700.04	0.04	700.04	0.04	0.56
700	R2	700.00	1.884819E-08	1.884156E-08	-0.010	1.883976E-08	0.00	1.883976E-08	700.22	0.22	700.22	0.22	0.56
800	R2	799.80	4.515964E-08	4.514375E-08	-0.012	4.513943E-08	0.20	4.521235E-08	799.61	-0.18	799.75	-0.05	0.59
900	R2	900.19	9.380092E-08	9.376791E-08	-0.014	9.375895E-08	-0.19	9.364140E-08	899.76	-0.43	900.09	-0.10	0.62
900	R2	900.01	9.385286E-08	9.381983E-08	-0.014	9.381086E-08	-0.01	9.380233E-08	899.84	-0.17	900.17	0.16	0.62
961.78	R2	961.78	1.386374E-07	1.385886E-07	-0.016	1.385754E-07	0.00	1.385754E-07	961.33	-0.45	961.81	0.03	0.64
1000	R2	1000.00	1.733113E-07	1.732503E-07	-0.017	1.732337E-07	0.00	1.732337E-07	999.50	-0.50	1000.07	0.07	0.65
1000	R2	1000.17	1.734897E-07	1.734286E-07	-0.017	1.734120E-07	-0.17	1.732406E-07	999.68	-0.50	1000.25	0.08	0.65

Table 50- results of the NPL variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R1

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using the NPL wide range cavity (WRC).

t_{nom} /°C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check‡/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	232.03	3.061856E-12	3.062934E-12	-0.003	3.062641E-12	-0.10	3.051629E-12	232.14	0.11	232.16	0.13	0.27
250	R1	249.99	5.672646E-12	5.674643E-12	-0.003	5.674100E-12	0.01	5.676003E-12	249.93	-0.06	249.94	-0.05	0.26
250	R1	249.99	5.681434E-12	5.683434E-12	-0.003	5.682890E-12	0.01	5.685749E-12	249.97	-0.01	249.99	0.01	0.26
250	R1	250.06	5.695074E-12	5.697079E-12	-0.003	5.696534E-12	-0.06	5.686032E-12	250.04	-0.01	250.06	0.01	0.26
300	R1	300.06	2.618329E-11	2.619250E-11	-0.003	2.619000E-11	-0.06	2.614977E-11	299.96	-0.10	299.96	-0.09	0.26
400	R1	400.00	2.817535E-10	2.818527E-10	-0.005	2.818258E-10	0.00	2.818543E-10	399.95	-0.04	399.93	-0.06	0.27
400	R1	400.06	2.821617E-10	2.822610E-10	-0.005	2.822340E-10	-0.06	2.818911E-10	400.02	-0.04	400.00	-0.06	0.27
419.53	R1	419.42	4.128693E-10	4.130146E-10	-0.005	4.129751E-10	0.11	4.138073E-10	419.38	-0.04	419.36	-0.07	0.27
500	R2	499.89	1.639063E-09	1.639063E-09	-0.006	1.638906E-09	0.11	1.641607E-09	499.87	-0.03	499.84	-0.05	0.29
500	R1	499.89	1.638486E-09	1.639063E-09	-0.006	1.638906E-09	0.11	1.641591E-09	499.87	-0.03	499.84	-0.05	0.29
500	R1	500.22	1.652192E-09	1.652774E-09	-0.006	1.652616E-09	-0.22	1.647038E-09	500.41	0.19	500.38	0.16	0.52
600	R1	600.04	6.398232E-09	6.400484E-09	-0.008	6.399872E-09	-0.04	6.396590E-09	600.16	0.11	600.14	0.09	0.54
660.32	R2	660.04	1.256802E-08	1.256802E-08	-0.009	1.256681E-08	0.28	1.260427E-08	660.13	0.09	660.12	0.08	0.55
700	R2	700.00	1.881512E-08	1.881512E-08	-0.010	1.881332E-08	0.00	1.881332E-08	700.09	0.09	700.09	0.09	0.56
700	R2	700.00	1.884819E-08	1.884819E-08	-0.010	1.884639E-08	0.00	1.884639E-08	700.27	0.27	700.27	0.27	0.56
800	R2	799.80	4.515964E-08	4.515964E-08	-0.012	4.515532E-08	0.20	4.522827E-08	799.75	-0.05	799.79	-0.01	0.59
900	R2	900.19	9.380092E-08	9.380092E-08	-0.014	9.379195E-08	-0.19	9.367436E-08	900.03	-0.16	900.12	-0.07	0.62
900	R2	900.01	9.385286E-08	9.385286E-08	-0.014	9.384388E-08	-0.01	9.383535E-08	900.11	0.10	900.20	0.19	0.62
961.78	R2	961.78	1.386374E-07	1.386374E-07	-0.016	1.386241E-07	0.00	1.386241E-07	961.70	-0.08	961.83	0.05	0.64
1000	R2	1000.00	1.733113E-07	1.733113E-07	-0.017	1.732947E-07	0.00	1.732947E-07	999.93	-0.07	1000.08	0.08	0.65
1000	R2	1000.17	1.734897E-07	1.734897E-07	-0.017	1.734731E-07	-0.17	1.733016E-07	1000.11	-0.06	1000.27	0.09	0.65

Table 51 - results of the NPL variable temperature blackbody measurements for analysis using the fit of the median VTBB data – range R2

11 AVERAGE LABORATORY RESULTS FOR VARIABLE TEMPERATURE BLACKBODY MEASUREMENTS WITH THE LP5

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.034497E-12	0.42
250	5.707980E-12	0.36
300	2.622800E-11	0.36
400	2.820111E-10	0.40
419.53	4.144973E-10	0.41
500	1.641497E-09	0.45
600	6.396482E-09	0.50
660.32	1.259529E-08	0.56
700	1.879001E-08	0.59
800	4.523057E-08	0.70
900	9.367706E-08	0.82

Table 52 – CEM results – range R1

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.062145E-12	2.36
250	5.754551E-12	1.55
300	2.611042E-11	0.48
400	2.822168E-10	0.40
419.53	4.147678E-10	0.41
500	1.642389E-09	0.46
600	6.399232E-09	0.50
660.32	1.260098E-08	0.55
700	1.879850E-08	0.59
800	4.525100E-08	0.70
900	9.371937E-08	0.81

Table 53 - CEM results - range R2

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.03731E-12	0.14
250	5.68800E-12	0.11
300	2.62203E-11	0.16
400	2.81932E-10	0.12
419.53	4.14064E-10	0.13
500	1.64126E-09	0.15
600	6.38444E-09	0.20
660.32	1.25819E-08	0.23
700	1.87769E-08	0.25
800	4.52008E-08	0.30
900	9.37021E-08	0.36
961.78	1.38493E-07	0.39

Table 54 - PTB results – range R1

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.03701E-12	0.14
250	5.68745E-12	0.11
300	2.62177E-11	0.16
400	2.81904E-10	0.12
419.53	4.14024E-10	0.13
500	1.64110E-09	0.16
600	6.38381E-09	0.20
660.32	1.25807E-08	0.23
700	1.87750E-08	0.25
800	4.51963E-08	0.30
900	9.36930E-08	0.36
961.78	1.38479E-07	0.39

Table 55 - PTB results - range R2

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.04056E-12	0.60
250	5.58906E-12	0.45
300	2.62213E-11	0.36
400	2.81374E-10	0.34
419.53	4.13363E-10	0.34
500	1.63864E-09	0.37
600	6.38244E-09	0.46
660.32	1.25608E-08	1.06
700	1.87020E-08	1.07
800	4.49920E-08	1.17
900	9.33543E-08	1.23
961.78	1.38126E-07	1.30

Table 56 - LNE results – range R1

t_{nom}/ °C	Average signal/ A	U (*k*=2)/ °C
231.93	3.04056E-12	0.60
250	5.58906E-12	0.45
300	2.62213E-11	0.36
400	2.81374E-10	0.34
419.53	4.13363E-10	0.34
500	1.63864E-09	0.37
600	6.38244E-09	0.46
660.32	1.25608E-08	1.06
700	1.87020E-08	1.07
800	4.49920E-08	1.17
900	9.33543E-08	1.23
961.78	1.38126E-07	1.30

Table 57 - LNE results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
250	5.64102E-12	0.96
300	2.66607E-11	1.27
419.53	4.19639E-10	1.54
500	1.66126E-09	1.83
600	6.45990E-09	2.24
660.32	1.27661E-08	2.57
700	1.91616E-08	2.75
800	4.57878E-08	3.34
900	9.50902E-08	3.96
1000	1.75826E-07	4.59

Table 58 – UME results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
250	5.56778E-12	1.20
300	2.63146E-11	0.90
419.53	4.14191E-10	0.81
500	1.63970E-09	0.84
600	6.37603E-09	0.85
660.32	1.26004E-08	0.99
700	1.89128E-08	0.95
800	4.51933E-08	1.14
900	9.38556E-08	1.26
1000	1.73543E-07	1.25

Table 59 - UME results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.048237E-12	0.45
250	5.655583E-12	0.36
300	2.624654E-11	0.24
400	2.821450E-10	0.15
419.53	4.140355E-10	0.16
500	1.643905E-09	0.30
600	6.397750E-09	0.31
660.32	1.259928E-08	0.28
700	1.887433E-08	0.58
800	4.547147E-08	0.68
900	9.427552E-08	0.80
961.78	1.395261E-07	0.86
1000	1.744070E-07	0.93
Cs at 500	1.642776E-09	0.19
Na at 500 1	1.642455E-09	0.20
Na at 500 2	1.646482E-09	0.50
Cs at 600	6.389609E-09	0.23
Na at 600 1	6.387026E-09	0.25
Na at 600 2	6.424754E-09	0.54

Table 60 - METAS results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.049919E-12	0.45
250	5.658704E-12	0.36
300	2.626102E-11	0.24
400	2.823007E-10	0.15
419.53	4.142639E-10	0.16
500	1.644812E-09	0.30
600	6.401280E-09	0.31
660.32	1.260623E-08	0.28
700	1.888474E-08	0.58
800	4.549656E-08	0.68
900	9.432754E-08	0.80
961.78	1.396031E-07	0.86
1000	1.745032E-07	0.93
Cs at 500	1.643683E-09	0.19
Na at 500 1	1.643362E-09	0.20
Na at 500 2	1.647391E-09	0.50
Cs at 600	6.393135E-09	0.23
Na at 600 1	6.390551E-09	0.25
Na at 600 2	6.428299E-09	0.54

Table 61 - METAS results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.05056E-12	0.27
250	5.68059E-12	0.26
300	2.61406E-11	0.26
400	2.81774E-10	0.27
419.53	4.13662E-10	0.27
500	1.64283E-09	0.37
600	6.39426E-09	0.54
660.32	1.25998E-08	0.55
700	1.88229E-08	0.56
800	4.52124E-08	0.59
900	9.37219E-08	0.62
961.78	1.38578E-07	0.64
1000	1.73237E-07	0.65
Cs at 500	1.641021E-09	0.29
WRC at 500	1.646458E-09	0.52

Table 62 - NPL results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.05163E-12	0.27
250	5.68259E-12	0.26
300	2.61498E-11	0.26
400	2.81873E-10	0.27
419.53	4.13807E-10	0.27
500	1.64341E-09	0.37
600	6.39651E-09	0.54
660.32	1.26043E-08	0.55
700	1.88295E-08	0.56
800	4.52283E-08	0.59
900	9.37549E-08	0.62
961.78	1.38627E-07	0.64
1000	1.73298E-07	0.65
Cs at 500	1.641599E-09	0.29
WRC at 500	1.647038E-09	0.52

Table 63 - NPL results - range R2

t_{nom}/ °C	Median signal/ A
231.93	3.040555E-12
250	5.668089E-12
300	2.622467E-11
400	2.819319E-10
419.53	4.140499E-10
500	1.642165E-09
600	6.395373E-09
660.32	1.259729E-08
700	1.880645E-08
800	4.522146E-08
900	9.371201E-08
961.78	1.385354E-07
1000	1.744070E-07

Table 64 – median values for all the LP5 range R1 VTBB measurements

t_{nom}/ °C	Median signal/ A
231.93	3.049919E-12
250	5.670649E-12
300	2.621952E-11
400	2.819044E-10
419.53	4.141072E-10
500	1.641743E-09
600	6.390163E-09
660.32	1.260069E-08
700	1.881401E-08
800	4.521230E-08
900	9.373711E-08
961.78	1.385530E-07
1000	1.735433E-07

Table 65 - median values for all the LP5 range R2 VTBB measurements

12 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB MEASUREMENTS ONLY WITH THE LP5 ON RANGE R1

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.04056E-12	505.08	505.057	-0.023
5.66809E-12	523.15	523.028	-0.122
2.62247E-11	573.15	573.175	0.025
2.81932E-10	673.15	673.183	0.033
4.14050E-10	692.68	692.734	0.054
1.64216E-09	773.15	773.218	0.068
6.39537E-09	873.15	873.297	0.147
1.25973E-08	933.47	933.525	0.055
1.88065E-08	973.15	973.191	0.041
4.52215E-08	1073.15	1072.990	-0.160
9.37120E-08	1173.15	1172.836	-0.314
1.38535E-07	1234.93	1234.437	-0.493
1.74407E-07	1273.15	1273.839	0.689

Table 66 – results of the fit using all the data points

Coefficients of the fit: a_1 = 2.3753775486E-04
a_2 = 1.5632785418E-06
a_3 = 2.1442667274E-06

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.040555E-12	505.08	505.152	0.072
5.668089E-12	523.15	523.096	-0.054
2.622467E-11	573.15	573.179	0.029
2.819319E-10	673.15	673.102	-0.048
4.140499E-10	692.68	692.643	-0.037
1.642165E-09	773.15	773.108	-0.042
6.395373E-09	873.15	873.213	0.063
1.259729E-08	933.47	933.483	0.013
1.880645E-08	973.15	973.189	0.039
4.522146E-08	1073.15	1073.124	-0.026
9.371201E-08	1173.15	1173.162	0.012
1.385354E-07	1234.93	1234.909	-0.021
1.744070E-07	1273.15	1274.415	1.265

Table 67 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 2.3153835258E-04
a_2 = 1.5700593246E-06
a_3 = -3.1279215261E-07

13 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB MEASUREMENTS ONLY WITH THE LP5 ON RANGE R2

Thermometer signal/ A	Temperature/ K	Fitted temperature/ K	Residual/ K
3.04992E-12	505.08	505.173	0.093
5.67065E-12	523.15	523.058	-0.092
2.62195E-11	573.15	573.150	0.000
2.81904E-10	673.15	673.117	-0.033
4.14107E-10	692.68	692.675	-0.005
1.64174E-09	773.15	773.130	-0.020
6.39016E-09	873.15	873.181	0.031
1.26007E-08	933.47	933.532	0.062
1.88140E-08	973.15	973.240	0.090
4.52123E-08	1073.15	1073.060	-0.090
9.37371E-08	1173.15	1173.093	-0.057
1.38553E-07	1234.93	1234.766	-0.164
1.73543E-07	1273.15	1273.334	0.184

Table 68 – results of the fit using all the data points

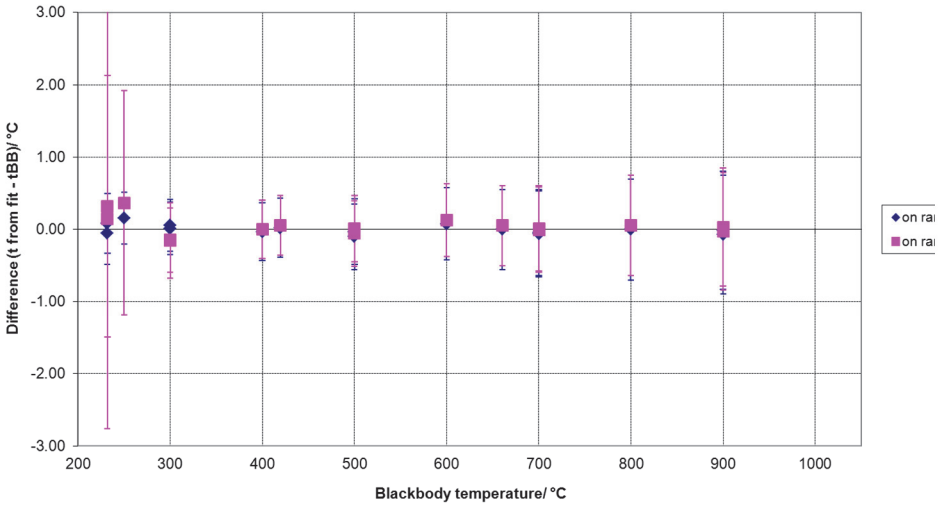
Coefficients of the fit: a_1 = 2.3396415485E-04
a_2 = 1.5671745633E-06
a_3 = 7.9012079839E-07

Thermometer signal/ A	Temperature/ K	Fitted temperature/ K	Residual/ K
3.049919E-12	505.08	505.198	0.118
5.670649E-12	523.15	523.076	-0.074
2.621952E-11	573.15	573.151	0.001
2.819044E-10	673.15	673.095	-0.055
4.141072E-10	692.68	692.651	-0.029
1.641743E-09	773.15	773.101	-0.049
6.390163E-09	873.15	873.159	0.009
1.260069E-08	933.47	933.521	0.051
1.881401E-08	973.15	973.240	0.090
4.521230E-08	1073.15	1073.096	-0.054
9.373711E-08	1173.15	1173.180	0.030
1.385530E-07	1234.93	1234.892	-0.038
1.735433E-07	1273.15	1273.487	0.337

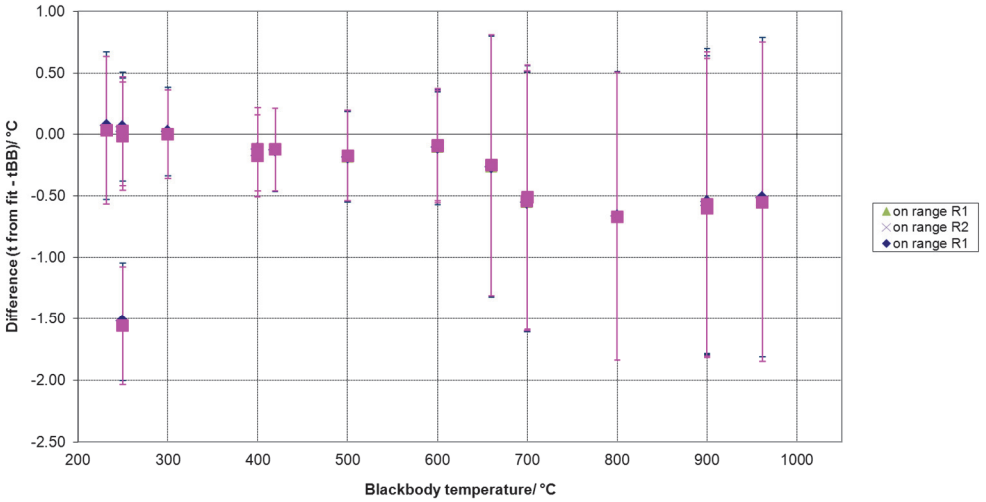
Table 69 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 2.3238246941E-04
a_2 = 1.5689746552E-06
a_3 = 1.3773345985E-07

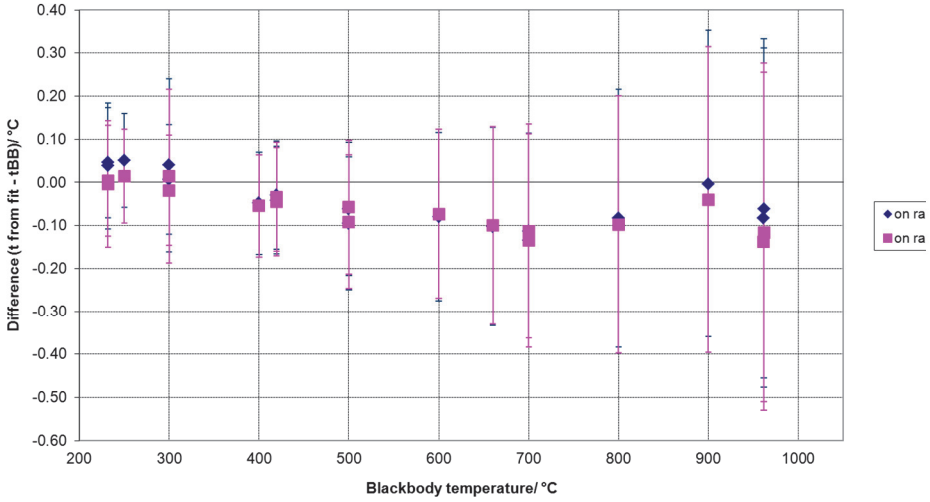
CEM results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)



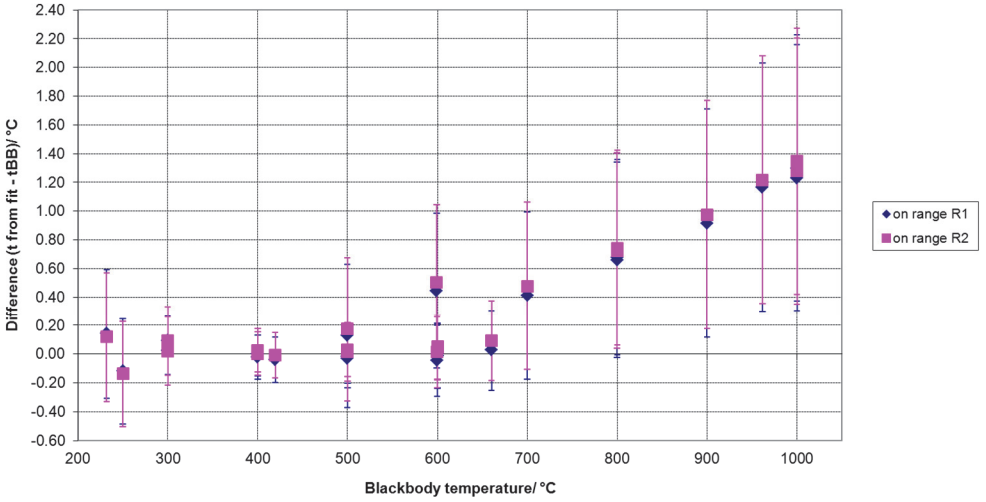
LNE results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)

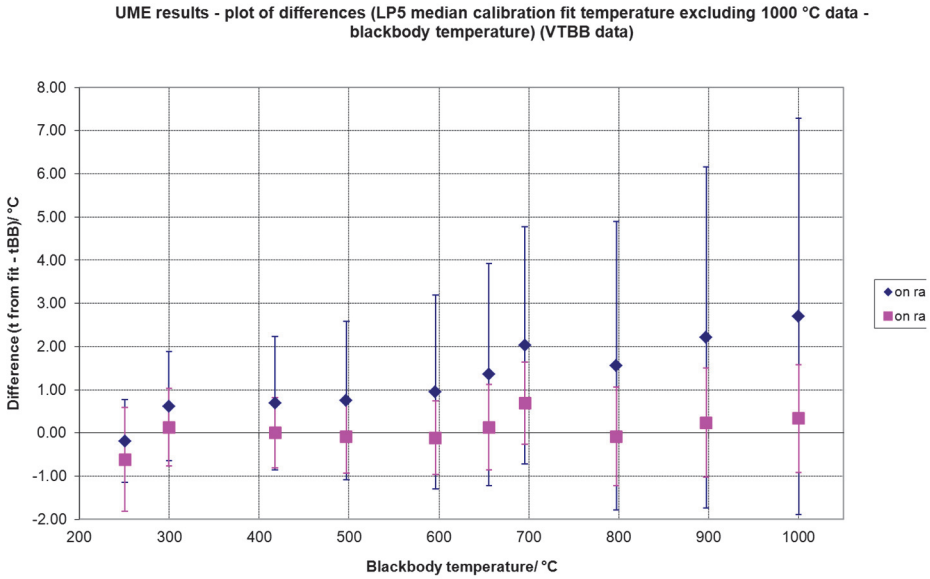


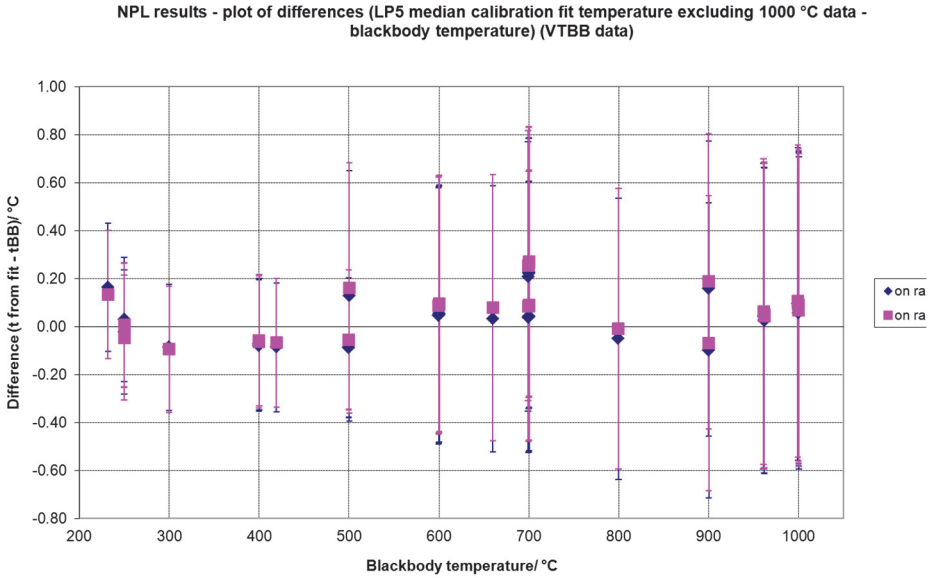
PTB results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)



METAS results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)




UME results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)
Difference (t from fit - tBB)/ °C
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
on ra
on ra


NPL results - plot of differences (LP5 median calibration fit temperature excluding 1000 °C data - blackbody temperature) (VTBB data)
Difference (t from fit - tBB)/ °C
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
on ra
on ra

14 THE FP RESULTS WITH THE LP5 USING THE MEDIAN OF ALL THE FP DATA FOR THE FITTING PROCESS

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
419.527	R1	419.527	4.13748E-10*	4.13748E-10	0.05	4.14093E-10†	0.00	4.14093E-10†	419.457	-0.070	0.28
419.527	R2	419.527	4.13913E-10*	4.13726E-10	0.05	-	0.00	-	-	-	-
961.78	R2	961.78	1.38289E-07*	1.38227E-07	0.14	1.38346E-07	0.00	1.38346E-07	961.457	-0.323	0.92

Table 70 - results of the CEM FP blackbody measurements for analysis using the fit of the median FP data – range R1

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
419.527	R2	419.527	4.13913E-10*	4.13913E-10	0.05	4.14269E-10	0.00	4.14269E-10	419.529	0.002	0.28
961.78	R2	961.78	1.38289E-07*	1.38289E-07	0.14	1.38408E-07	0.00	1.38408E-07	961.332	-0.448	0.91

Table 71 results of the CEM FP blackbody measurements for analysis using the fit of the median FP data – range R2

* taking average signals
† average temperature calculated

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.03065E-12	3.03065E-12	0.120	3.04369E-12	0.00	3.04369E-12	231.940	0.012	0.47
419.527	R2	419.527	4.11979E-10	4.17417E-10	0.225	4.19213E-10	0.00	4.19213E-10	420.101	0.574	1.29
660.323	R2	660.323	1.25181E-08	1.26833E-08	0.409	1.27379E-08	0.00	1.27379E-08	661.365	1.042	2.29

Table 72 - results of the UME FP blackbody measurements for analysis using the fit of the median FP data – range R1

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.03065E-12	2.99130E-12	0.120	3.00417E-12	0.00	3.00417E-12	231.524	-0.404	0.83
419.527	R2	419.527	4.11979E-10	4.11979E-10	0.225	4.13752E-10	0.00	4.13752E-10	419.464	-0.063	0.17
660.323	R2	660.323	1.25181E-08	1.25181E-08	0.409	1.25720E-08	0.00	1.25720E-08	660.156	-0.167	0.22

Table 73 - results of the UME FP blackbody measurements for analysis using the fit of the median FP data – range R2

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.04800E-12	3.04800E-12	-0.003	3.04770E-12	0.00	3.04770E-12	231.977	0.049	0.11
419.527	R1	419.527	4.14357E-10	4.14357E-10	-0.005	4.14317E-10	0.00	4.14317E-10	419.485	-0.042	0.13
660.323	R2	660.323	1.25937E-08	1.25893E-08	-0.009	1.25881E-08	0.00	1.25881E-08	660.239	-0.084	0.23
961.78	R2	961.78	1.38800E-07	1.38751E-07	-0.016	1.38738E-07	0.00	1.38738E-07	961.927	0.147	0.40

Table 74 results of the NPL FP blackbody measurements for analysis using the fit of the median FP data – range R1

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.04800E-12	3.04907E-12	-0.003	3.04878E-12	0.00	3.04878E-12	231.935	0.007	0.11
419.527	R1	419.527	4.14357E-10	4.14503E-10	-0.005	4.14463E-10	0.00	4.14463E-10	419.554	0.027	0.13
660.32	R2	660.32	1.25937E-08	1.25937E-08	-0.009	1.25925E-08	0.00	1.25925E-08	660.312	-0.011	0.23
961.78	R2	961.78	1.38800E-07	1.38800E-07	-0.016	1.38787E-07	0.00	1.38787E-07	961.785	0.005	0.40

Table 75 - results of the NPL FP blackbody measurements for analysis using the fit of the median FP data – range R2

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.01309E-12	3.01309E-12	0.281	3.04352E-12	0.00	3.04352E-12	231.939	0.011	0.520
419.527	R1	419.527	4.10363E-10	4.10363E-10	0.528	4.14507E-10	0.00	4.14507E-10	419.509	-0.018	0.122
660.323	R2	660.323	1.24922E-08	1.24763E-08	0.959	1.26023E-08	0.00	1.26023E-08	660.347	0.024	0.219
961.78	R2	961.78	1.37398E-07	1.37224E-07	1.678	1.38610E-07	0.00	1.38610E-07	961.773	-0.007	0.383

Table 76- results of the INRiM FP blackbody measurements for analysis using the fit of the median FP data – range R1

t_{nom} / °C)	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check / °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB})/ °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.928	R1	231.928	3.01309E-12	3.01691E-12	0.281	3.04737E-12	0.00	3.04737E-12	231.922	-0.006	0.520
419.527	R1	419.527	4.10363E-10	4.10884E-10	0.528	4.15033E-10	0.00	4.15033E-10	419.626	0.099	0.122
660.323	R2	660.323	1.24922E-08	1.24922E-08	0.959	1.26183E-08	0.00	1.26183E-08	660.506	0.183	0.219
961.78	R2	961.78	1.37398E-07	1.37398E-07	1.678	1.38785E-07	0.00	1.38785E-07	961.783	0.003	0.383

Table 77- results of the INRiM FP blackbody measurements for analysis using the fit of the median FP data – range R2

15 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – FP MEASUREMENTS ONLY WITH THE LP5 ON RANGES R1 AND R2

Median thermometer signal/ A	Temperature/ K	Fitted temperature/ K	Residual/ K
3.04369E-12	505.078	505.090	0.012
4.14412E-10	692.677	692.647	-0.030
1.26023E-08	933.473	933.497	0.024
1.38610E-07	1234.93	1234.924	-0.006

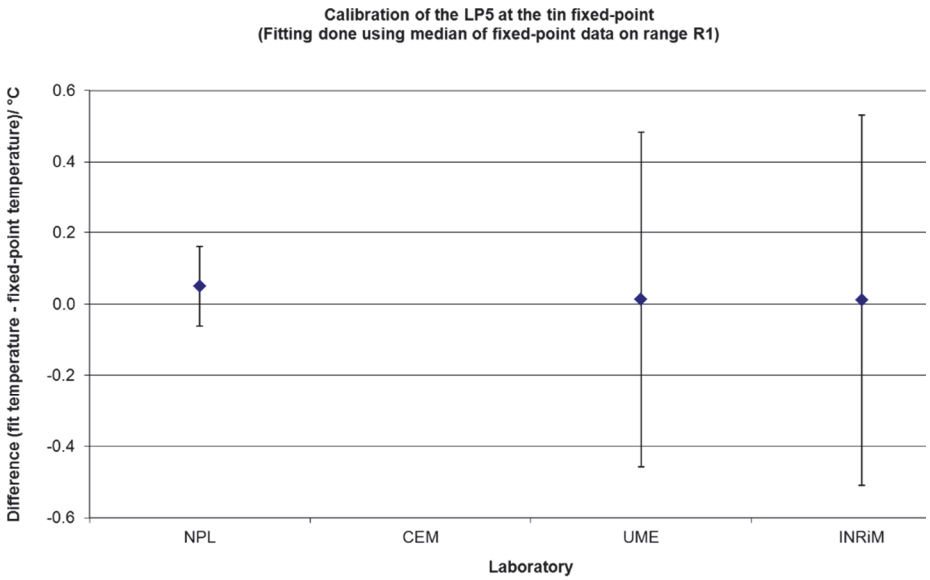
Table 78 – results of the fit using range R1

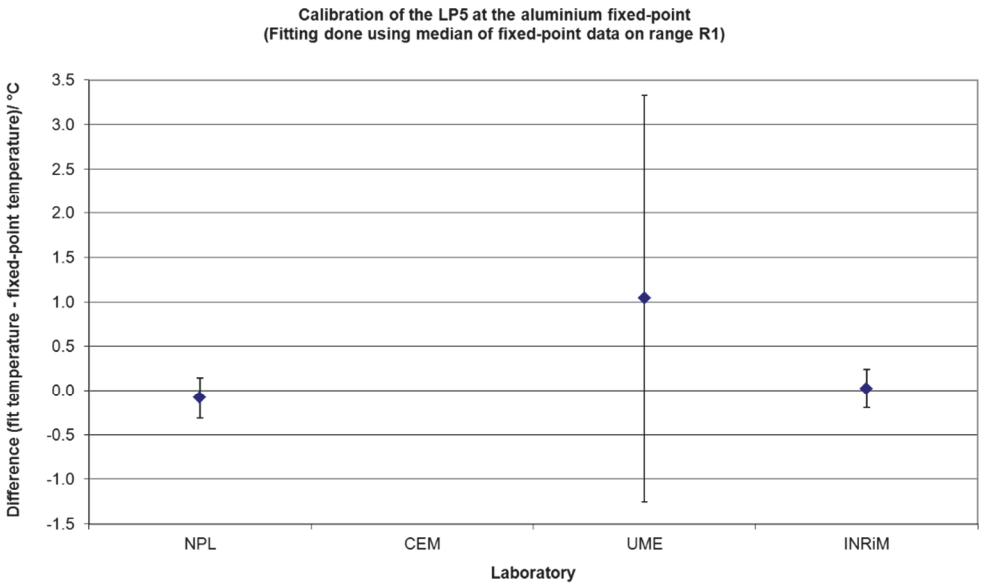
Coefficients of the fit: a_1 = 2.3247408177E-04
a_2 = 1.5688268391E-06
a_3 = 2.7454651265E-07

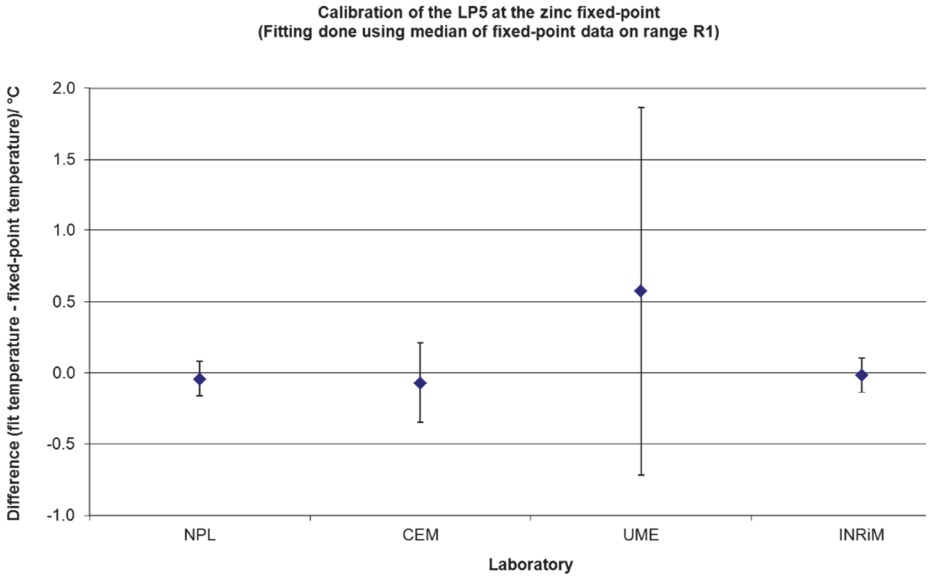
Median thermometer signal/ A	Temperature/ K	Fitted temperature/ K	Residual/ K
3.047370E-12	505.078	505.072	-0.006
4.143660E-10	692.677	692.691	0.014
1.259250E-08	933.473	933.462	-0.011
1.387850E-07	1234.93	1234.933	0.003

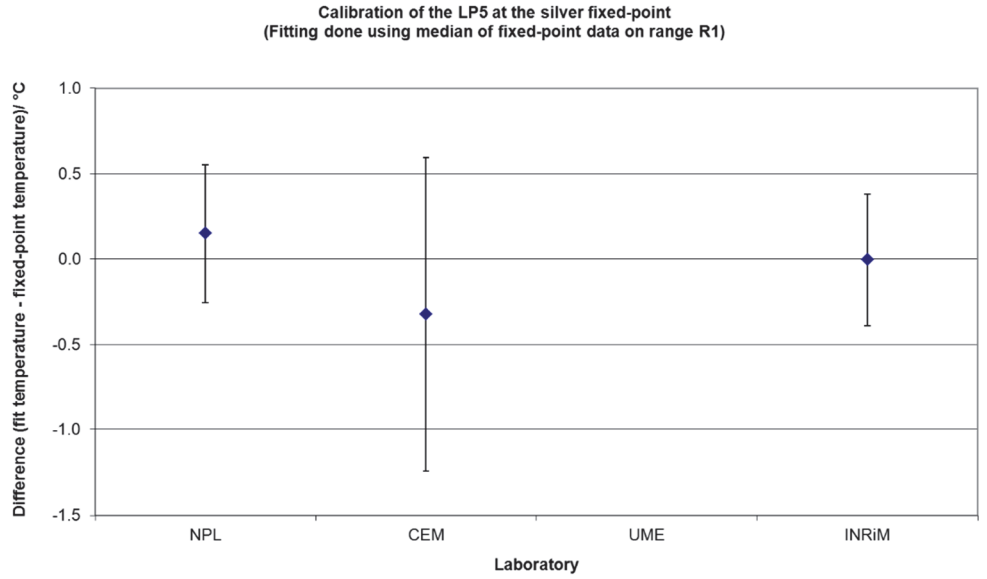
Table 79– results of the fit using range R2

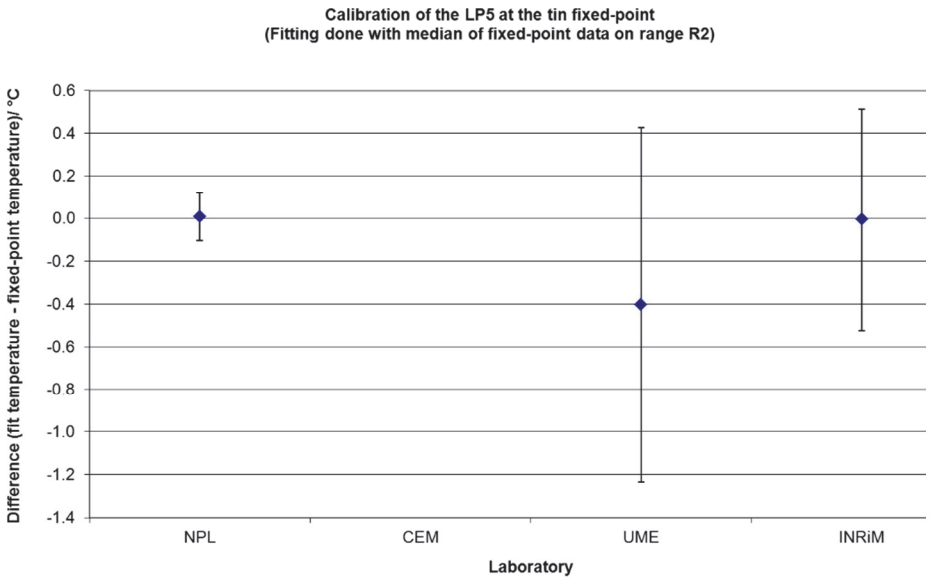
Coefficients of the fit: a_1 = 2.3544818438E-04
a_2 = 1.5653700980E-06
a_3 = 1.5474554056E-06

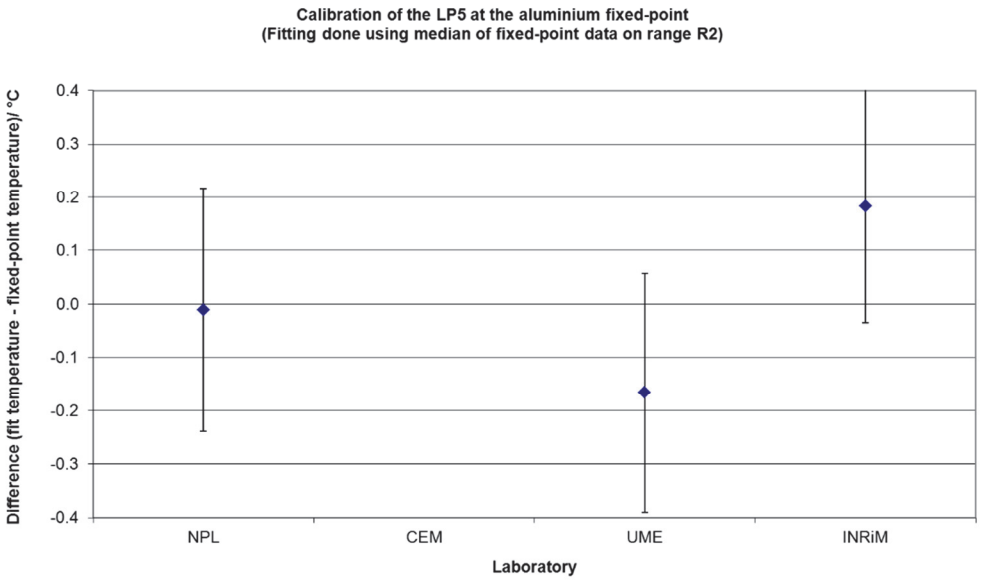

Calibration of the LP5 at the tin fixed-point
(Fitting done using median of fixed-point data on range R1)
Difference (fit temperature - fixed-point temperature)/ °C
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
NPL
CEM
UME
INRiM
Laboratory

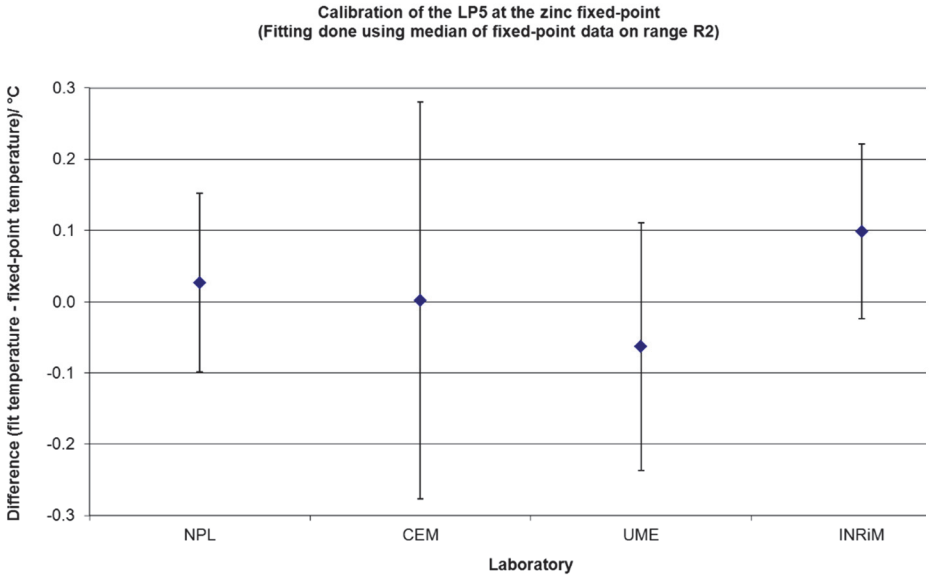

Calibration of the LP5 at the aluminium fixed-point
(Fitting done using median of fixed-point data on range R1)
Difference (fit temperature - fixed-point temperature)/ °C
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
NPL
CEM
UME
INRiM
Laboratory

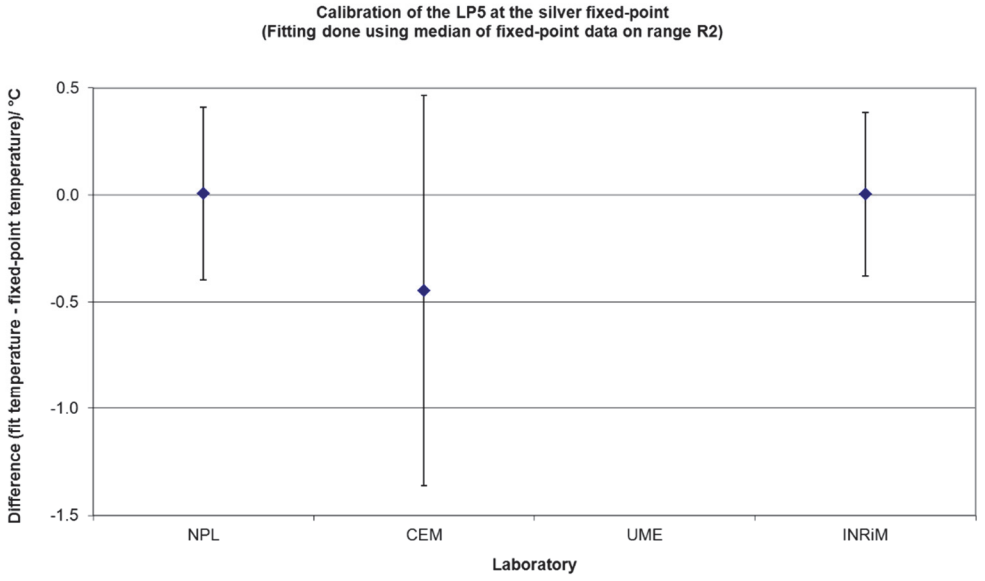

Calibration of the LP5 at the zinc fixed-point
(Fitting done using median of fixed-point data on range R1)
Difference (fit temperature - fixed-point temperature)/ °C
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
NPL
CEM
UME
INRiM
Laboratory


Calibration of the LP5 at the silver fixed-point
(Fitting done using median of fixed-point data on range R1)
Difference (fit temperature - fixed-point temperature)/ °C
1.0
0.5
0.0
-0.5
-1.0
-1.5
NPL
CEM
UME
INRiM
Laboratory


Calibration of the LP5 at the tin fixed-point
(Fitting done with median of fixed-point data on range R2)
Difference (fit temperature - fixed-point temperature)/ °C
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
NPL
CEM
UME
INRiM
Laboratory


Calibration of the LP5 at the aluminium fixed-point
(Fitting done using median of fixed-point data on range R2)
Difference (fit temperature - fixed-point temperature)/ °C
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
NPL
CEM
UME
INRiM
Laboratory


Calibration of the LP5 at the zinc fixed-point
(Fitting done using median of fixed-point data on range R2)
Difference (fit temperature - fixed-point temperature)/ °C
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
NPL
CEM
UME
INRiM
Laboratory


Calibration of the LP5 at the silver fixed-point
(Fitting done using median of fixed-point data on range R2)
Difference (fit temperature - fixed-point temperature)/ °C
0.5
0.0
-0.5
-1.0
-1.5
NPL
CEM
UME
INRiM
Laboratory

16 THE VTBB AND FP RESULTS WITH THE LP5 USING THE MEDIAN OF ALL THE VTBB AND FP DATA FOR THE FITTING PROCESS

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.91	3.02262E-12	3.02262E-12	0.02	3.02523E-12	0.02	3.02740E-12	231.754	-0.156	231.847	-0.063	0.43
250.00	R1	250.11	5.72417E-12	5.72417E-12	0.03	5.72910E-12	-0.11	5.70798E-12	250.188	0.078	250.254	0.144	0.36
300.00	R1	300.09	2.62564E-11	2.62564E-11	0.03	2.62790E-11	-0.09	2.62129E-11	300.092	0.002	300.096	0.006	0.36
400.00	R1	399.94	2.81427E-10	2.81427E-10	0.04	2.81669E-10	0.06	2.82011E-10	399.985	0.045	399.906	-0.034	0.40
419.53	R1	419.55	4.14299E-10	4.14299E-10	0.05	4.14656E-10	-0.02	4.14497E-10	419.660	0.110	419.570	0.020	0.41
419.53*	R1	419.53	4.13748E-10	4.13748E-10	0.05	4.14093E-10†	0.00	4.14093E-10†	419.589†	0.059	419.499†	-0.031	0.28
419.53*	R2	419.53	4.13913E-10	4.13726E-10	0.05	-	0.00	-	-	-	-	-	-
500.00	R1	499.98	1.63872E-09	1.63872E-09	0.06	1.64013E-09	0.02	1.64063E-09	499.990	0.010	499.881	-0.099	0.45
600.00	R1	600.09	6.39791E-09	6.39791E-09	0.07	6.40342E-09	-0.09	6.39648E-09	600.256	0.166	600.173	0.083	0.50
660.32	R2	660.35	1.25941E-08	1.25884E-08	0.08	1.25993E-08	-0.03	1.25953E-08	660.395	0.045	660.353	0.003	0.56
700.00	R2	700.10	1.88022E-08	1.87938E-08	0.09	1.88099E-08	-0.10	1.87917E-08	700.064	-0.036	700.062	-0.038	0.59
800.00	R2	799.91	4.51797E-08	4.51593E-08	0.11	4.51982E-08	0.09	4.52306E-08	799.777	-0.133	799.909	-0.001	0.70
900.00	R2	900.01	9.36263E-08	9.35841E-08	0.13	9.36646E-08	-0.01	9.36584E-08	899.608	-0.402	899.929	-0.081	0.82
961.78*	R2	961.78	1.38289E-07	1.38227E-07	0.14	1.38346E-07	0.00	1.38346E-07	961.054	-0.726	961.519	-0.261	0.92
231.93	R1	232.07	3.05435E-12	3.05435E-12	0.02	3.05698E-12	-0.14	3.04159E-12	232.045	-0.025	232.138	0.068	0.41
300.00	R1	300.14	2.63234E-11	2.63234E-11	0.03	2.63461E-11	-0.14	2.62431E-11	300.183	0.043	300.187	0.047	0.36
500.00	R1	500.09	1.64322E-09	1.64322E-09	0.06	1.64463E-09	-0.09	1.64236E-09	500.169	0.079	500.060	-0.030	0.45
700.00	R2	700.04	1.87879E-08	1.87794E-08	0.09	1.87956E-08	-0.04	1.87883E-08	699.986	-0.054	699.983	-0.057	0.59
900.00	R2	899.92	9.36075E-08	9.35653E-08	0.13	9.36458E-08	0.08	9.36958E-08	899.578	-0.342	899.899	-0.021	0.82

Table 80- results of the CEM variable temperature and FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

* fixed-point data
† average value used

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R2	231.91	3.04783E-12	3.04783E-12	0.02	3.05045E-12	0.02	3.05265E-12	232.034	0.124	232.058	0.148	2.90
250.00	R2	250.11	5.77088E-12	5.77088E-12	0.03	5.77584E-12	-0.11	5.75455E-12	250.463	0.353	250.480	0.370	1.55
300.00	R2	300.09	2.61516E-11	2.61516E-11	0.03	2.61741E-11	-0.09	2.61083E-11	299.943	-0.147	299.944	-0.146	0.52
400.00	R2	399.94	2.81632E-10	2.81632E-10	0.04	2.81874E-10	0.06	2.82217E-10	399.966	0.026	399.946	0.006	0.40
419.53	R2	419.55	4.14570E-10	4.14570E-10	0.05	4.14927E-10	-0.02	4.14768E-10	419.633	0.083	419.610	0.060	0.41
419.53*	R2	419.53	4.13913E-10	4.13913E-10	0.05	4.14269E-10	0.00	4.14269E-10	419.550	0.020	419.527	-0.003	0.28
500.00	R2	499.98	1.63960E-09	1.63960E-09	0.06	1.64101E-09	0.02	1.64152E-09	499.955	-0.025	499.927	-0.053	0.46
600.00	R2	600.09	6.40066E-09	6.40066E-09	0.07	6.40617E-09	-0.09	6.39923E-09	600.241	0.151	600.220	0.130	0.50
660.32	R2	660.35	1.25941E-08	1.25941E-08	0.08	1.26050E-08	-0.03	1.26010E-08	660.415	0.065	660.405	0.055	0.55
700.00	R2	700.10	1.88022E-08	1.88022E-08	0.09	1.88184E-08	-0.10	1.88002E-08	700.114	0.014	700.114	0.014	0.59
800.00	R2	799.91	4.51797E-08	4.51797E-08	0.11	4.52186E-08	0.09	4.52510E-08	799.926	0.016	799.960	0.050	0.70
900.00	R2	900.01	9.36263E-08	9.36263E-08	0.13	9.37069E-08	-0.01	9.37007E-08	899.890	-0.120	899.974	-0.036	0.81
961.78*	R2	961.78	1.38289E-07	1.38289E-07	0.14	1.38408E-07	0.00	1.38408E-07	961.436	-0.344	961.557	-0.223	0.91
231.93	R2	232.07	3.08452E-12	3.08452E-12	0.02	3.08718E-12	-0.14	3.07164E-12	232.368	0.298	232.392	0.322	1.81
300.00	R2	300.14	2.61924E-11	2.61924E-11	0.03	2.62150E-11	-0.14	2.61125E-11	299.999	-0.141	300.000	-0.140	0.45
500.00	R2	500.09	1.64412E-09	1.64412E-09	0.06	1.64553E-09	-0.09	1.64326E-09	500.134	0.044	500.106	0.016	0.46
700.00	R2	700.04	1.87879E-08	1.87879E-08	0.09	1.88041E-08	-0.04	1.87968E-08	700.036	-0.004	700.035	-0.005	0.59
900.00	R2	899.92	9.36075E-08	9.36075E-08	0.13	9.36881E-08	0.08	9.37381E-08	899.860	-0.060	899.943	0.023	0.81

Table 81 - results of the CEM variable temperature and FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

* fixed-point data

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.946	3.03946E-12	3.03946E-12	0.00	3.03946E-12	-0.016	3.03773E-12	231.88	-0.06	231.98	0.03	0.13
250	R1	250.089	5.70504E-12	5.70504E-12	0.00	5.70504E-12	-0.089	5.68800E-12	250.06	-0.03	250.13	0.04	0.11
300	R1	300.020	2.62226E-11	2.62226E-11	0.00	2.62226E-11	-0.020	2.62081E-11	300.01	-0.01	300.02	0.00	0.13
400	R1	400.021	2.82049E-10	2.82049E-10	0.00	2.82049E-10	-0.021	2.81932E-10	400.05	0.03	399.97	-0.05	0.12
419.53	R1	419.530	4.14019E-10	4.14019E-10	0.00	4.14019E-10	0.000	4.14019E-10	419.58	0.05	419.49	-0.04	0.13
500	R1	500.015	1.64206E-09	1.64206E-09	0.00	1.64206E-09	-0.015	1.64169E-09	500.07	0.05	499.96	-0.06	0.15
600	R1	600.017	6.38577E-09	6.38577E-09	0.00	6.38577E-09	-0.017	6.38444E-09	600.03	0.01	599.94	-0.07	0.20
660.32	R2	660.312	1.25796E-08	1.25809E-08	0.00	1.25809E-08	0.008	1.25819E-08	660.26	-0.06	660.21	-0.10	0.23
700	R2	700.031	1.87788E-08	1.87806E-08	0.00	1.87806E-08	-0.031	1.87749E-08	699.90	-0.13	699.90	-0.13	0.25
800	R2	800.012	4.52005E-08	4.52049E-08	0.00	4.52049E-08	-0.011	4.52008E-08	799.80	-0.22	799.93	-0.08	0.30
900	R2	900.011	9.37001E-08	9.37093E-08	0.00	9.37093E-08	-0.011	9.37021E-08	899.68	-0.33	900.00	-0.01	0.36
961.78	R2	961.748	1.38461E-07	1.38475E-07	0.00	1.38475E-07	0.032	1.38501E-07	961.21	-0.54	961.67	-0.07	0.39
231.93	R1	231.947	3.03869E-12	3.03869E-12	0.00	3.03869E-12	-0.017	3.03689E-12	231.88	-0.07	231.97	0.02	0.15
300	R1	300.027	2.62522E-11	2.62522E-11	0.00	2.62522E-11	-0.027	2.62324E-11	300.06	0.03	300.06	0.03	0.20
419.53	R1	419.512	4.13968E-10	4.13968E-10	0.00	4.13968E-10	0.018	4.14109E-10	419.57	0.06	419.48	-0.03	0.13
500	R1	500.049	1.64205E-09	1.64205E-09	0.00	1.64205E-09	-0.048	1.64083E-09	500.07	0.02	499.96	-0.09	0.15
700	R2	700.028	1.87822E-08	1.87840E-08	0.00	1.87840E-08	-0.028	1.87789E-08	699.92	-0.11	699.92	-0.11	0.25
961.78	R2	961.696	1.38400E-07	1.38414E-07	0.00	1.38414E-07	0.084	1.38484E-07	961.13	-0.56	961.60	-0.10	0.39

Table 82 - results of the PTB variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.946	3.03946E-12	3.03916E-12	0.00	3.03916E-12	-0.016	3.03744E-12	231.93	-0.01	231.95	0.01	0.13
250	R1	250.089	5.70504E-12	5.70448E-12	0.00	5.70448E-12	-0.089	5.68745E-12	250.09	0.00	250.11	0.02	0.11
300	R1	300.020	2.62226E-11	2.62200E-11	0.00	2.62200E-11	-0.020	2.62056E-11	300.01	-0.01	300.01	-0.01	0.13
400	R1	400.021	2.82049E-10	2.82021E-10	0.00	2.82021E-10	-0.021	2.81904E-10	399.99	-0.03	399.97	-0.05	0.12
419.53	R1	419.530	4.14019E-10	4.13978E-10	0.00	4.13978E-10	0.000	4.13979E-10	419.51	-0.02	419.49	-0.04	0.13
500	R1	500.015	1.64206E-09	1.64190E-09	0.00	1.64190E-09	-0.015	1.64153E-09	499.99	-0.02	499.96	-0.05	0.16
600	R1	600.017	6.38577E-09	6.38515E-09	0.00	6.38515E-09	-0.017	6.38381E-09	599.97	-0.05	599.95	-0.07	0.20
660.32	R2	660.312	1.25796E-08	1.25796E-08	0.00	1.25796E-08	0.008	1.25807E-08	660.22	-0.09	660.21	-0.10	0.23
700	R2	700.031	1.87788E-08	1.87788E-08	0.00	1.87788E-08	-0.031	1.87731E-08	699.90	-0.13	699.90	-0.14	0.25
800	R2	800.012	4.52005E-08	4.52005E-08	0.00	4.52005E-08	-0.011	4.51963E-08	799.88	-0.14	799.91	-0.10	0.30
900	R2	900.011	9.37001E-08	9.37001E-08	0.00	9.37001E-08	-0.011	9.36930E-08	899.88	-0.13	899.96	-0.05	0.36
961.78	R2	961.748	1.38461E-07	1.38461E-07	0.00	1.38461E-07	0.032	1.38488E-07	961.50	-0.25	961.62	-0.13	0.39
231.93	R1	231.947	3.03869E-12	3.03839E-12	0.00	3.03839E-12	-0.017	3.03659E-12	231.92	-0.02	231.95	0.00	0.15
300	R1	300.027	2.62522E-11	2.62496E-11	0.00	2.62496E-11	-0.027	2.62298E-11	300.05	0.02	300.05	0.02	0.20
419.53	R1	419.512	4.13968E-10	4.13928E-10	0.00	4.13928E-10	0.018	4.14069E-10	419.51	-0.01	419.48	-0.03	0.13
500	R1	500.049	1.64205E-09	1.64189E-09	0.00	1.64189E-09	-0.048	1.64067E-09	499.99	-0.06	499.96	-0.09	0.16
700	R2	700.028	1.87822E-08	1.87822E-08	0.00	1.87822E-08	-0.028	1.87770E-08	699.92	-0.11	699.91	-0.11	0.25
961.78	R2	961.696	1.38400E-07	1.38400E-07	0.00	1.38400E-07	0.084	1.38470E-07	961.43	-0.27	961.55	-0.15	0.39

Table 83 - results of the PTB variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.76	2.99090E-12	2.99090E-12	0.293	3.02242E-12	0.17	3.04056E-12	231.73	-0.04	231.82	0.06	0.60
250	R1	249.83	5.59107E-12	5.59107E-12	0.314	5.64998E-12	0.17	5.68232E-12	249.77	-0.06	249.84	0.01	0.44
250	R1	249.84	5.30973E-12	5.30973E-12	0.314	5.36569E-12	0.16	5.39480E-12	248.23	-1.60	248.30	-1.53	0.48
250	R1	249.83	5.59853E-12	5.59853E-12	0.314	5.65753E-12	0.17	5.69005E-12	249.81	-0.02	249.88	0.05	0.44
300	R1	300.19	2.60880E-11	2.60880E-11	0.378	2.63629E-11	-0.19	2.62213E-11	300.21	0.01	300.21	0.02	0.36
400	R1	399.93	2.77908E-10	2.77908E-10	0.520	2.80836E-10	0.07	2.81215E-10	399.84	-0.09	399.76	-0.17	0.33
400	R1	400.14	2.79379E-10	2.79379E-10	0.521	2.82322E-10	-0.14	2.81534E-10	400.10	-0.04	400.02	-0.12	0.34
419.53	R1	419.63	4.09805E-10	4.09805E-10	0.551	4.14123E-10	-0.10	4.13363E-10	419.59	-0.03	419.50	-0.12	0.34
500	R1	500.11	1.62441E-09	1.62441E-09	0.687	1.64152E-09	-0.11	1.63864E-09	500.05	-0.07	499.94	-0.18	0.37
600	R2	600.16	6.32775E-09	6.32775E-09	0.876	6.39443E-09	-0.16	6.38247E-09	600.14	-0.02	600.06	-0.10	0.45
600	R2	600.13	6.32566E-09	6.32566E-09	0.876	6.39232E-09	-0.13	6.38241E-09	600.11	-0.02	600.03	-0.10	0.47
660.32	R2	660.06	1.23955E-08	1.23955E-08	1.000	1.25261E-08	0.26	1.25608E-08	659.84	-0.22	659.80	-0.26	1.06
700	R2	699.83	1.84743E-08	1.84743E-08	1.087	1.86689E-08	0.17	1.86990E-08	699.29	-0.54	699.29	-0.55	1.06
700	R2	700.11	1.85300E-08	1.85300E-08	1.088	1.87253E-08	-0.11	1.87050E-08	699.60	-0.51	699.60	-0.52	1.08
800	R2	800.07	4.45481E-08	4.45481E-08	1.323	4.50175E-08	-0.07	4.49920E-08	799.28	-0.80	799.41	-0.66	1.17
900	R2	899.88	9.22973E-08	9.22973E-08	1.580	9.32699E-08	0.12	9.33437E-08	898.98	-0.91	899.30	-0.59	1.22
900	R2	899.94	9.23564E-08	9.23564E-08	1.580	9.33297E-08	0.06	9.33649E-08	899.07	-0.87	899.39	-0.55	1.24
961.78	R2	961.63	1.36561E-07	1.36561E-07	1.751	1.38000E-07	0.15	1.38126E-07	960.64	-0.99	961.10	-0.53	1.30

Table 84- results of the LNE variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.76	2.99090E-12	2.99090E-12	0.293	3.02242E-12	0.17	3.04056E-12	231.78	0.01	231.80	0.04	0.60
250	R1	249.83	5.59107E-12	5.59107E-12	0.314	5.64998E-12	0.17	5.68232E-12	249.80	-0.02	249.82	-0.01	0.44
250	R1	249.84	5.30973E-12	5.30973E-12	0.314	5.36569E-12	0.16	5.39480E-12	248.27	-1.57	248.29	-1.55	0.48
250	R1	249.83	5.59853E-12	5.59853E-12	0.314	5.65753E-12	0.17	5.69005E-12	249.84	0.02	249.86	0.03	0.44
300	R1	300.19	2.60880E-11	2.60880E-11	0.378	2.63629E-11	-0.19	2.62213E-11	300.20	0.01	300.20	0.01	0.36
400	R1	399.93	2.77908E-10	2.77908E-10	0.520	2.80836E-10	0.07	2.81215E-10	399.78	-0.15	399.76	-0.17	0.33
400	R1	400.14	2.79379E-10	2.79379E-10	0.521	2.82322E-10	-0.14	2.81534E-10	400.04	-0.09	400.02	-0.11	0.34
419.53	R1	419.63	4.09805E-10	4.09805E-10	0.551	4.14123E-10	-0.10	4.13363E-10	419.53	-0.09	419.51	-0.12	0.34
500	R1	500.11	1.62441E-09	1.62441E-09	0.687	1.64152E-09	-0.11	1.63864E-09	499.98	-0.14	499.95	-0.17	0.37
600	R2	600.16	6.32775E-09	6.32775E-09	0.876	6.39443E-09	-0.16	6.38247E-09	600.09	-0.07	600.07	-0.09	0.45
600	R2	600.13	6.32566E-09	6.32566E-09	0.876	6.39232E-09	-0.13	6.38241E-09	600.06	-0.07	600.04	-0.09	0.47
660.32	R2	660.06	1.23955E-08	1.23955E-08	1.000	1.25261E-08	0.26	1.25608E-08	659.82	-0.24	659.81	-0.25	1.06
700	R2	699.83	1.84743E-08	1.84743E-08	1.087	1.86689E-08	0.17	1.86990E-08	699.29	-0.54	699.29	-0.54	1.06
700	R2	700.11	1.85300E-08	1.85300E-08	1.088	1.87253E-08	-0.11	1.87050E-08	699.60	-0.51	699.60	-0.51	1.08
800	R2	800.07	4.45481E-08	4.45481E-08	1.323	4.50175E-08	-0.07	4.49920E-08	799.37	-0.70	799.40	-0.67	1.17
900	R2	899.88	9.22973E-08	9.22973E-08	1.580	9.32699E-08	0.12	9.33437E-08	899.19	-0.69	899.27	-0.61	1.22
900	R2	899.94	9.23564E-08	9.23564E-08	1.580	9.33297E-08	0.06	9.33649E-08	899.29	-0.66	899.37	-0.57	1.24
961.78	R2	961.63	1.36561E-07	1.36561E-07	1.751	1.38000E-07	0.15	1.38126E-07	960.95	-0.68	961.07	-0.56	1.30

Table 85- results of the LNE variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.913	3.0206E-12	3.02059E-12	0.237	3.04635E-12	0.02	3.04824E-12	231.948	0.035	232.041	0.128	0.450
419.53	R1	419.500	4.1029E-10	4.10295E-10	0.446	4.13795E-10	0.03	4.14035E-10	419.551	0.052	419.461	-0.038	0.158
660.32	R2	660.335	1.2502E-08	1.24947E-08	0.810	1.26013E-08	-0.02	1.25993E-08	660.410	0.075	660.369	0.033	0.278
961.78	R2	961.678	1.3834E-07	1.38261E-07	1.417	1.39441E-07	0.10	1.39526E-07	962.361	0.683	962.830	1.152	0.865
250	R1	249.986	5.6051E-12	5.60506E-12	0.254	5.65287E-12	0.01	5.65558E-12	249.787	-0.199	249.855	-0.131	0.365
300	R1	300.011	2.6007E-11	2.60067E-11	0.305	2.62285E-11	-0.01	2.62204E-11	300.023	0.012	300.027	0.016	0.239
400	R1	400.063	2.8005E-10	2.80050E-10	0.421	2.82439E-10	-0.06	2.82080E-10	400.120	0.057	400.041	-0.022	0.153
500[1]	R1	499.955	1.6277E-09	1.62775E-09	0.556	1.64163E-09	0.05	1.64278E-09	500.050	0.095	499.941	-0.014	0.186
500[2]	R1	499.963	1.6276E-09	1.62764E-09	0.556	1.64152E-09	0.04	1.64246E-09	500.046	0.082	499.937	-0.026	0.201
600[1]	R1	600.014	6.3365E-09	6.33653E-09	0.709	6.39058E-09	-0.01	6.38946E-09	600.089	0.075	600.006	-0.008	0.225
600[2]	R1	599.728	6.3123E-09	6.31232E-09	0.708	6.36616E-09	0.27	6.38703E-09	599.771	0.044	599.688	-0.040	0.247
300	R1	300.040	2.6079E-11	2.60794E-11	0.305	2.63019E-11	-0.04	2.62726E-11	300.123	0.083	300.127	0.088	0.239
400	R1	400.060	2.8016E-10	2.80163E-10	0.421	2.82553E-10	-0.06	2.82210E-10	400.140	0.080	400.060	0.001	0.153
600[1]	R1	599.988	6.3348E-09	6.33481E-09	0.709	6.38885E-09	0.01	6.38975E-09	600.067	0.079	599.984	-0.005	0.225
500[3]	R1	499.803	1.6276E-09	1.62764E-09	0.555	1.64152E-09	0.20	1.64648E-09	500.046	0.242	499.937	0.133	0.500
600[3]	R1	599.237	6.3123E-09	6.31232E-09	0.707	6.36616E-09	0.76	6.42475E-09	599.771	0.535	599.688	0.451	0.541
700[3]	R2	699.935	1.8713E-08	1.87029E-08	0.880	1.88624E-08	0.07	1.88743E-08	700.352	0.417	700.350	0.415	0.584
800[3]	R2	799.890	4.5069E-08	4.50439E-08	1.070	4.54281E-08	0.11	4.54680E-08	800.414	0.524	800.547	0.657	0.682
900[3]	R2	899.923	9.3482E-08	9.34300E-08	1.279	9.42269E-08	0.08	9.42755E-08	900.504	0.582	900.828	0.905	0.797
1000[3]	R2	1000.039	1.7303E-07	1.72936E-07	1.507	1.74411E-07	-0.04	1.74373E-07	1000.684	0.645	1001.252	1.213	0.926
800[3]	R2	799.949	4.5097E-08	4.50721E-08	1.070	4.54566E-08	0.05	4.54749E-08	800.492	0.543	800.626	0.676	0.682
1000[3]	R2	1000.080	1.7314E-07	1.73044E-07	1.507	1.74520E-07	-0.08	1.74441E-07	1000.794	0.714	1001.363	1.282	0.926

Table 86- results of the METAS variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using a Na heatpipe with PRT;
[3] values obtained using a Na heatpipe with thermocouple.

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	231.913	3.0206E-12	3.02225E-12	0.237	3.04803E-12	0.02	3.04992E-12	232.012	0.099	232.036	0.123	0.450
419.53	R1	419.500	4.1029E-10	4.10521E-10	0.446	4.14023E-10	0.03	4.14264E-10	419.519	0.020	419.496	-0.003	0.158
660.32	R2	660.335	1.2502E-08	1.25016E-08	0.810	1.26082E-08	-0.02	1.26062E-08	660.440	0.105	660.429	0.094	0.278
961.78	R2	961.678	1.3834E-07	1.38337E-07	1.417	1.39517E-07	0.10	1.39603E-07	962.763	1.085	962.884	1.206	0.865
250	R1	249.986	5.6051E-12	5.60815E-12	0.254	5.65599E-12	0.01	5.65870E-12	249.837	-0.149	249.854	-0.132	0.365
300	R1	300.011	2.6007E-11	2.60210E-11	0.305	2.62430E-11	-0.01	2.62349E-11	300.037	0.026	300.039	0.027	0.239
400	R1	400.063	2.8005E-10	2.80205E-10	0.421	2.82595E-10	-0.06	2.82236E-10	400.092	0.030	400.072	0.009	0.153
500[1]	R1	499.955	1.6277E-09	1.62865E-09	0.556	1.64254E-09	0.05	1.64368E-09	500.015	0.061	499.987	0.033	0.186
500[2]	R1	499.963	1.6276E-09	1.62854E-09	0.556	1.64243E-09	0.04	1.64336E-09	500.011	0.048	499.983	0.020	0.201
600[1]	R1	600.014	6.3365E-09	6.34002E-09	0.709	6.39410E-09	-0.01	6.39299E-09	600.084	0.070	600.063	0.049	0.225
600[2]	R1	599.728	6.3123E-09	6.31581E-09	0.708	6.36968E-09	0.27	6.39055E-09	599.766	0.038	599.745	0.017	0.247
300	R1	300.040	2.6079E-11	2.60938E-11	0.305	2.63164E-11	-0.04	2.62871E-11	300.138	0.098	300.139	0.099	0.239
400	R1	400.060	2.8016E-10	2.80318E-10	0.421	2.82709E-10	-0.06	2.82366E-10	400.112	0.052	400.092	0.032	0.153
600[1]	R1	599.988	6.3348E-09	6.33831E-09	0.709	6.39237E-09	0.01	6.39328E-09	600.062	0.074	600.041	0.052	0.225
500[3]	R1	499.803	1.6276E-09	1.62854E-09	0.555	1.64243E-09	0.20	1.64739E-09	500.011	0.208	499.983	0.180	0.500
600[3]	R1	599.237	6.3123E-09	6.31581E-09	0.707	6.36968E-09	0.76	6.42830E-09	599.766	0.530	599.745	0.508	0.541
700[3]	R2	699.935	1.8713E-08	1.87132E-08	0.880	1.88728E-08	0.07	1.88847E-08	700.412	0.478	700.412	0.477	0.584
800[3]	R2	799.890	4.5069E-08	4.50687E-08	1.070	4.54531E-08	0.11	4.54931E-08	800.575	0.686	800.610	0.720	0.682
900[3]	R2	899.923	9.3482E-08	9.34816E-08	1.279	9.42789E-08	0.08	9.43275E-08	900.804	0.881	900.887	0.965	0.797
1000[3]	R2	1000.039	1.7303E-07	1.73032E-07	1.507	1.74507E-07	-0.04	1.74469E-07	1001.156	1.117	1001.303	1.264	0.926
800[3]	R2	799.949	4.5097E-08	4.50970E-08	1.070	4.54816E-08	0.05	4.55000E-08	800.654	0.705	800.689	0.740	0.682
1000[3]	R2	1000.080	1.7314E-07	1.73140E-07	1.507	1.74617E-07	-0.08	1.74537E-07	1001.266	1.186	1001.413	1.333	0.926

Table 87 - results of the METAS variable temperature blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93*	R1	231.93	3.03065E-12	3.03065E-12	0.120	3.04369E-12	0.00	3.04369E-12	231.92	-0.01	232.02	0.09	0.47
250	R1	250.78	5.76788E-12	5.76788E-12	0.129	5.79270E-12	-0.78	5.64102E-12	250.52	-0.27	250.58	-0.20	0.96
300	R2	299.80	2.60561E-11	2.63989E-11	0.154	2.65125E-11	0.20	2.66607E-11	300.41	0.61	300.41	0.61	1.27
419.53	R2	417.73	3.98655E-10	4.03899E-10	0.224	4.05637E-10	1.80	4.19639E-10	418.51	0.78	418.42	0.69	1.54
419.53*	R2	419.53	4.11979E-10	4.17417E-10	0.225	4.19213E-10	0.00	4.19213E-10	420.23	0.70	420.14	0.61	1.29
500	R2	497.10	1.56268E-09	1.58323E-09	0.278	1.59005E-09	2.90	1.66126E-09	497.97	0.87	497.87	0.76	1.83
600	R2	596.25	6.07226E-09	6.15213E-09	0.354	6.17861E-09	3.75	6.45990E-09	597.29	1.05	597.21	0.96	2.24
660.32	R2	655.68	1.19562E-08	1.21135E-08	0.405	1.21656E-08	4.64	1.27661E-08	657.08	1.40	657.04	1.36	2.57
660.32*	R2	660.32	1.25181E-08	1.26833E-08	0.409	1.27379E-08	0.00	1.27379E-08	661.43	1.11	661.39	1.07	2.29
700	R2	695.58	1.80514E-08	1.82889E-08	0.440	1.83676E-08	4.42	1.91616E-08	697.61	2.04	697.61	2.03	2.75
800	R2	797.27	4.40370E-08	4.46163E-08	0.537	4.48083E-08	2.73	4.57878E-08	798.69	1.42	798.82	1.55	3.34
900	R2	897.37	9.18374E-08	9.30455E-08	0.643	9.34458E-08	2.63	9.50902E-08	899.26	1.89	899.58	2.21	3.96
1000	R2	1000.09	1.72885E-07	1.75159E-07	0.760	1.75913E-07	-0.09	1.75826E-07	1002.20	2.11	1002.77	2.68	4.59

Table 88- results of the UME variable temperature and FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

* fixed-point data

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93*	R1	231.93	3.03065E-12	2.99130E-12	0.120	3.00417E-12	0.00	3.00417E-12	231.61	-0.32	231.63	-0.30	0.83
250	R1	250.78	5.76788E-12	5.69299E-12	0.129	5.71749E-12	-0.78	5.56778E-12	250.16	-0.62	250.18	-0.61	1.20
300	R2	299.80	2.60561E-11	2.60561E-11	0.154	2.61683E-11	0.20	2.63146E-11	299.94	0.14	299.94	0.14	0.90
419.53	R2	417.73	3.98655E-10	3.98655E-10	0.224	4.00371E-10	1.80	4.14191E-10	417.77	0.03	417.75	0.01	0.81
419.53*	R2	419.53	4.11979E-10	4.11979E-10	0.225	4.13752E-10	0.00	4.13752E-10	419.48	-0.05	419.46	-0.07	0.17
500	R2	497.10	1.56268E-09	1.56268E-09	0.278	1.56940E-09	2.90	1.63970E-09	497.06	-0.05	497.03	-0.07	0.84
600	R2	596.25	6.07226E-09	6.07226E-09	0.354	6.09839E-09	3.75	6.37603E-09	596.16	-0.08	596.14	-0.11	0.85
660.32	R2	655.68	1.19562E-08	1.19562E-08	0.405	1.20077E-08	4.64	1.26004E-08	655.82	0.15	655.81	0.13	0.99
660.32*	R2	660.32	1.25181E-08	1.25181E-08	0.409	1.25720E-08	0.00	1.25720E-08	660.17	-0.15	660.16	-0.16	0.22
700	R2	695.58	1.80514E-08	1.80514E-08	0.440	1.81291E-08	4.42	1.89128E-08	696.28	0.70	696.27	0.70	0.95
800	R2	797.27	4.40370E-08	4.4037E-08	0.537	4.42265E-08	2.73	4.51933E-08	797.15	-0.12	797.18	-0.09	1.14
900	R2	897.37	9.18374E-08	9.18374E-08	0.643	9.22326E-08	2.63	9.38556E-08	897.52	0.14	897.60	0.23	1.26
1000	R2	1000.09	1.72885E-07	1.72885E-07	0.760	1.73629E-07	-0.09	1.73543E-07	1000.26	0.18	1000.41	0.32	1.25

Table 89 - results of the UME variable temperature and FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

* fixed-point data

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	232.03	3.061856E-12	3.061856E-12	-0.003	3.061563E-12	-0.10	3.050555E-12	232.09	0.06	232.18	0.15	0.27
231.93*	R1	231.93	3.04800E-12	3.04800E-12	-0.003	3.04770E-12	0.00	3.04770E-12	231.96	0.03	232.05	0.12	0.11
250	R1	249.99	5.672646E-12	5.672646E-12	-0.003	5.672104E-12	0.01	5.674006E-12	249.89	-0.10	249.96	-0.03	0.26
250	R1	249.99	5.681434E-12	5.681434E-12	-0.003	5.680891E-12	0.01	5.683748E-12	249.93	-0.05	250.00	0.02	0.26
250	R1	250.06	5.695074E-12	5.695074E-12	-0.003	5.694529E-12	-0.06	5.684031E-12	250.01	-0.05	250.07	0.02	0.26
300	R1	300.06	2.618329E-11	2.618329E-11	-0.003	2.618078E-11	-0.06	2.614057E-11	299.96	-0.10	299.96	-0.09	0.26
400	R1	400.00	2.817535E-10	2.817535E-10	-0.005	2.817266E-10	0.00	2.817551E-10	400.00	0.00	399.92	-0.08	0.27
400	R1	400.06	2.821617E-10	2.821617E-10	-0.005	2.821347E-10	-0.06	2.817919E-10	400.07	0.01	399.99	-0.07	0.27
419.53	R1	419.42	4.128693E-10	4.128693E-10	-0.005	4.128298E-10	0.11	4.136617E-10	419.43	0.00	419.34	-0.09	0.27
419.53*	R1	419.53	4.14357E-10	4.14357E-10	-0.005	4.14317E-10	0.00	4.14317E-10	419.62	0.09	419.53	0.00	0.13
500[1]	R2	499.89	1.639063E-09	1.638486E-09	-0.006	1.638330E-09	0.11	1.641029E-09	499.92	0.03	499.81	-0.08	0.29
500[1]	R1	499.89	1.638486E-09	1.638486E-09	-0.006	1.638329E-09	0.11	1.641013E-09	499.92	0.03	499.81	-0.08	0.29
500[2]	R1	500.22	1.652192E-09	1.652192E-09	-0.006	1.652034E-09	-0.22	1.646458E-09	500.46	0.24	500.35	0.13	0.52
600	R1	600.04	6.398232E-09	6.398232E-09	-0.008	6.397620E-09	-0.04	6.394339E-09	600.18	0.14	600.10	0.06	0.54
660.32	R2	660.04	1.256802E-08	1.256359E-08	-0.009	1.256239E-08	0.28	1.259983E-08	660.12	0.08	660.07	0.04	0.55
660.32*	R2	660.32	1.25937E-08	1.25893E-08	-0.009	1.25881E-08	0.00	1.25881E-08	660.31	-0.01	660.27	-0.05	0.23
700	R2	700.00	1.881512E-08	1.880850E-08	-0.010	1.880670E-08	0.00	1.880670E-08	700.05	0.05	700.04	0.04	0.56
700	R2	700.00	1.884819E-08	1.884156E-08	-0.010	1.883976E-08	0.00	1.883976E-08	700.23	0.23	700.23	0.23	0.56
800	R2	799.80	4.515964E-08	4.514375E-08	-0.012	4.513943E-08	0.20	4.521235E-08	799.61	-0.18	799.75	-0.05	0.59
900	R2	900.19	9.380092E-08	9.376791E-08	-0.014	9.375895E-08	-0.19	9.364140E-08	899.76	-0.43	900.08	-0.11	0.62
900	R2	900.01	9.385286E-08	9.381983E-08	-0.014	9.381086E-08	-0.01	9.380233E-08	899.84	-0.17	900.16	0.15	0.62
961.78	R2	961.78	1.386374E-07	1.385886E-07	-0.016	1.385754E-07	0.00	1.385754E-07	961.33	-0.45	961.79	0.01	0.64
961.78*	R2	961.78	1.38800E-07	1.38751E-07	-0.016	1.38738E-07	0.00	1.38738E-07	961.52	-0.26	961.99	0.21	0.40
1000	R2	1000.00	1.733113E-07	1.732503E-07	-0.017	1.732337E-07	0.00	1.732337E-07	999.49	-0.51	1000.05	0.05	0.65
1000	R2	1000.17	1.734897E-07	1.734286E-07	-0.017	1.734120E-07	-0.17	1.732406E-07	999.67	-0.50	1000.24	0.06	0.65

Table 90- results of the NPL variable temperature blackbody and FP measurements for analysis using the fit of the median FP & VTBB data – range R1

* fixed-point data
[1] values obtained using a Cs heatpipe with PRT;
[2] values obtained using the NPL wide range cavity (WRC).

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93	R1	232.03	3.061856E-12	3.062934E-12	-0.003	3.062641E-12	-0.10	3.051629E-12	232.15	0.12	232.17	0.14	0.27
231.93*	R1	231.93	3.04800E-12	3.04907E-12	-0.003	3.04878E-12	0.00	3.04878E-12	232.02	0.09	232.04	0.11	0.11
250	R1	249.99	5.672646E-12	5.674643E-12	-0.003	5.674100E-12	0.01	5.676003E-12	249.93	-0.06	249.95	-0.04	0.26
250	R1	249.99	5.681434E-12	5.683434E-12	-0.003	5.682890E-12	0.01	5.685749E-12	249.98	-0.01	250.00	0.01	0.26
250	R1	250.06	5.695074E-12	5.697079E-12	-0.003	5.696534E-12	-0.06	5.686032E-12	250.05	-0.01	250.07	0.01	0.26
300	R1	300.06	2.618329E-11	2.619250E-11	-0.003	2.619000E-11	-0.06	2.614977E-11	299.96	-0.09	299.97	-0.09	0.26
400	R1	400.00	2.817535E-10	2.818527E-10	-0.005	2.818258E-10	0.00	2.818543E-10	399.96	-0.04	399.94	-0.06	0.27
400	R1	400.06	2.821617E-10	2.822610E-10	-0.005	2.822340E-10	-0.06	2.818911E-10	400.03	-0.03	400.01	-0.05	0.27
419.53	R1	419.42	4.128693E-10	4.130146E-10	-0.005	4.129751E-10	0.11	4.138073E-10	419.39	-0.04	419.36	-0.06	0.27
419.53*	R1	419.53	4.14357E-10	4.14503E-10	-0.005	4.14463E-10	0.00	4.14463E-10	419.57	0.04	419.55	0.02	0.13
500	R2	499.89	1.639063E-09	1.639063E-09	-0.006	1.638906E-09	0.11	1.641607E-09	499.87	-0.02	499.84	-0.05	0.29
500	R1	499.89	1.638486E-09	1.639063E-09	-0.006	1.638906E-09	0.11	1.641591E-09	499.87	-0.02	499.84	-0.05	0.29
500	R1	500.22	1.652192E-09	1.652774E-09	-0.006	1.652616E-09	-0.22	1.647038E-09	500.41	0.19	500.39	0.17	0.52
600	R1	600.04	6.398232E-09	6.400484E-09	-0.008	6.399872E-09	-0.04	6.396590E-09	600.16	0.12	600.14	0.10	0.54
660.32	R2	660.04	1.256802E-08	1.256802E-08	-0.009	1.256681E-08	0.28	1.260427E-08	660.13	0.09	660.12	0.08	0.55
660.32*	R2	660.32	1.25937E-08	1.25937E-08	-0.009	1.25925E-08	0.00	1.25925E-08	660.32	0.00	660.31	-0.01	0.23
700	R2	700.00	1.881512E-08	1.881512E-08	-0.010	1.881332E-08	0.00	1.881332E-08	700.09	0.09	700.09	0.09	0.56
700	R2	700.00	1.884819E-08	1.884819E-08	-0.010	1.884639E-08	0.00	1.884639E-08	700.27	0.27	700.27	0.27	0.56
800	R2	799.80	4.515964E-08	4.515964E-08	-0.012	4.515532E-08	0.20	4.522827E-08	799.75	-0.05	799.78	-0.01	0.59
900	R2	900.19	9.380092E-08	9.380092E-08	-0.014	9.379195E-08	-0.19	9.367436E-08	900.03	-0.16	900.11	-0.08	0.62
900	R2	900.01	9.385286E-08	9.385286E-08	-0.014	9.384388E-08	-0.01	9.383535E-08	900.11	0.10	900.19	0.18	0.62
961.78	R2	961.78	1.386374E-07	1.386374E-07	-0.016	1.386241E-07	0.00	1.386241E-07	961.70	-0.08	961.82	0.04	0.64
961.78*	R2	961.78	1.38800E-07	1.38800E-07	-0.016	1.38787E-07	0.00	1.38787E-07	961.89	0.11	962.01	0.23	0.40
1000	R2	1000.00	1.733113E-07	1.733113E-07	-0.017	1.732947E-07	0.00	1.732947E-07	999.92	-0.08	1000.07	0.07	0.65
1000	R2	1000.17	1.734897E-07	1.734897E-07	-0.017	1.734731E-07	-0.17	1.733016E-07	1000.10	-0.07	1000.25	0.08	0.65

Table 91 - results of the NPL variable temperature and FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

* fixed-point data

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93*	R1	231.93	3.01309E-12	3.01309E-12	0.281	3.04352E-12	0.00	3.04352E-12	231.922	-0.008	232.015	0.085	0.520
419.53*	R1	419.53	4.10363E-10	4.10363E-10	0.528	4.14507E-10	0.00	4.14507E-10	419.641	0.111	419.552	0.022	0.122
660.32*	R2	660.32	1.24922E-08	1.24763E-08	0.959	1.26023E-08	0.00	1.26023E-08	660.418	0.098	660.376	0.056	0.219
961.78*	R2	961.78	1.37398E-07	1.37224E-07	1.678	1.38610E-07	0.00	1.38610E-07	961.369	-0.411	961.835	0.055	0.383

Table 92- results of the INRiM FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R1

t_{nom} / °C	Range used	t_{BB} / °C	Bgrd corrected Signal/ A	Signal on range R1/ A	Drift from Zn point check/ °C	Signal corrected for Zn point drift/ A	dt (t_{nom} - t_{BB}) / °C	Signal corrected to t_{nom}/ A	t from median fit/ °C	dt (t_{fit} – t_{BB}) / °C	t from fit no 1000 °C data/ °C	dt (t_{fit} – t_{BB}) / °C	U (k=2) / °C
231.93*	R1	231.93	3.01309E-12	3.01691E-12	0.281	3.04737E-12	0.00	3.04737E-12	232.006	0.076	232.030	0.100	0.520
419.53*	R1	419.53	4.10363E-10	4.10884E-10	0.528	4.15033E-10	0.00	4.15033E-10	419.647	0.117	419.624	0.094	0.122
660.32*	R2	660.32	1.24922E-08	1.24922E-08	0.959	1.26183E-08	0.00	1.26183E-08	660.516	0.196	660.505	0.185	0.219
961.78*	R2	961.78	1.37398E-07	1.37398E-07	1.678	1.38785E-07	0.00	1.38785E-07	961.888	0.108	962.009	0.229	0.383

Table 93- results of the INRiM FP blackbody measurements for analysis using the fit of the median FP & VTBB data – range R2

* fixed-point data

17 AVERAGE LABORATORY RESULTS FOR FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY MEASUREMENTS WITH THE LP5

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.034497E-12	0.42
250	5.707980E-12	0.36
300	2.622800E-11	0.36
400	2.820111E-10	0.40
419.53	4.142952E-10	0.34
500	1.641497E-09	0.45
600	6.396482E-09	0.50
660.32	1.259529E-08	0.56
700	1.879001E-08	0.59
800	4.523057E-08	0.70
900	9.367706E-08	0.82
961.78	1.38346E-07	0.92
419.53 VTBB	4.144973E-10	0.41
419.53 FP	4.14093E-10	0.28

Table 94 – CEM results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.062145E-12	2.36
250	5.754551E-12	1.55
300	2.611042E-11	0.48
400	2.822168E-10	0.40
419.53	4.145186E-10	0.35
500	1.642389E-09	0.46
600	6.399232E-09	0.50
660.32	1.260098E-08	0.55
700	1.879850E-08	0.59
800	4.525100E-08	0.70
900	9.371937E-08	0.81
961.78	1.38408E-07	0.91
419.53 VTBB	4.14768E-10	0.41
419.53 FP	4.14269E-10	0.28

Table 95 - CEM results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.03731E-12	0.14
250	5.68800E-12	0.11
300	2.62203E-11	0.16
400	2.81932E-10	0.12
419.53	4.14064E-10	0.13
500	1.64126E-09	0.15
600	6.38444E-09	0.20
660.32	1.25819E-08	0.23
700	1.87769E-08	0.25
800	4.52008E-08	0.30
900	9.37021E-08	0.36
961.78	1.38493E-07	0.39

Table 96 - PTB results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.03701E-12	0.14
250	5.68745E-12	0.11
300	2.62177E-11	0.16
400	2.81904E-10	0.12
419.53	4.14024E-10	0.13
500	1.64110E-09	0.16
600	6.38381E-09	0.20
660.32	1.25807E-08	0.23
700	1.87750E-08	0.25
800	4.51963E-08	0.30
900	9.36930E-08	0.36
961.78	1.38479E-07	0.39

Table 97 - PTB results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04056E-12	0.60
250	5.58906E-12	0.45
300	2.62213E-11	0.36
400	2.81374E-10	0.34
419.53	4.13363E-10	0.34
500	1.63864E-09	0.37
600	6.38244E-09	0.46
660.32	1.25608E-08	1.06
700	1.87020E-08	1.07
800	4.49920E-08	1.17
900	9.33543E-08	1.23
961.78	1.38126E-07	1.30

Table 98 - LNE results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04056E-12	0.60
250	5.58906E-12	0.45
300	2.62213E-11	0.36
400	2.81374E-10	0.34
419.53	4.13363E-10	0.34
500	1.63864E-09	0.37
600	6.38244E-09	0.46
660.32	1.25608E-08	1.06
700	1.87020E-08	1.07
800	4.49920E-08	1.17
900	9.33543E-08	1.23
961.78	1.38126E-07	1.30

Table 99 - LNE results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04369E-12	0.47
250	5.64102E-12	0.96
300	2.66607E-11	1.27
419.53	4.19426E-10	1.42
500	1.66126E-09	1.83
600	6.45990E-09	2.24
660.32	1.27520E-08	2.43
700	1.91616E-08	2.75
800	4.57878E-08	3.34
900	9.50902E-08	3.96
1000	1.75826E-07	4.59
419.53 VTBB	4.19639E-10	1.54
419.53 FP	4.19213E-10	1.29
660.32 VTBB	1.27661E-08	2.57
660.32 FP	1.27379E-08	2.29

Table 100 – UME results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.00417E-12	0.83
250	5.56778E-12	1.20
300	2.63146E-11	0.90
419.53	4.13971E-10	0.49
500	1.63970E-09	0.84
600	6.37603E-09	0.85
660.32	1.25862E-08	0.61
700	1.89128E-08	0.95
800	4.51933E-08	1.14
900	9.38556E-08	1.26
1000	1.73543E-07	1.25
419.53 VTBB	4.14191E-10	0.81
419.53 FP	4.13752E-10	0.17
660.32 VTBB	1.26004E-08	0.99
660.32 FP	1.25720E-08	0.22

Table 101 - UME results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.048237E-12	0.45
250	5.655583E-12	0.36
300	2.624654E-11	0.24
400	2.821450E-10	0.15
419.53	4.140355E-10	0.16
500	1.643905E-09	0.30
600	6.397750E-09	0.31
660.32	1.259928E-08	0.28
700	1.887433E-08	0.58
800	4.547147E-08	0.68
900	9.427552E-08	0.80
961.78	1.395261E-07	0.86
1000	1.744070E-07	0.93
Cs at 500	1.642776E-09	0.19
Na at 500 1	1.642455E-09	0.20
Na at 500 2	1.646482E-09	0.50
Cs at 600	6.389609E-09	0.23
Na at 600 1	6.387026E-09	0.25
Na at 600 2	6.424754E-09	0.54

Table 102 - METAS results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.049919E-12	0.45
250	5.658704E-12	0.36
300	2.626102E-11	0.24
400	2.823007E-10	0.15
419.53	4.142639E-10	0.16
500	1.644812E-09	0.30
600	6.401280E-09	0.31
660.32	1.260623E-08	0.28
700	1.888474E-08	0.58
800	4.549656E-08	0.68
900	9.432754E-08	0.80
961.78	1.396031E-07	0.86
1000	1.745032E-07	0.93
Cs at 500	1.643683E-09	0.19
Na at 500 1	1.643362E-09	0.20
Na at 500 2	1.647391E-09	0.50
Cs at 600	6.393135E-09	0.23
Na at 600 1	6.390551E-09	0.25
Na at 600 2	6.428299E-09	0.54

Table 103 - METAS results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04913E-12	0.19
250	5.68059E-12	0.26
300	2.61406E-11	0.26
400	2.81774E-10	0.27
419.53	4.13989E-10	0.20
500	1.64283E-09	0.37
600	6.39426E-09	0.54
660.32	1.25940E-08	0.39
700	1.88229E-08	0.56
800	4.52124E-08	0.59
900	9.37219E-08	0.62
961.78	1.38618E-07	0.58
1000	1.73237E-07	0.65
Cs at 500	1.641021E-09	0.29
WRC at 500	1.646458E-09	0.52
231.93 VTBB	3.050555E-12	0.27
231.93 FP	3.047705E-12	0.11
419.53 VTBB	4.136617E-10	0.27
419.53 FP	4.143172E-10	0.13
660.32 VTBB	1.259983E-08	0.55
660.32 FP	1.258807E-08	0.23
961.78 VTBB	1.385781E-07	0.64
961.78 FP	1.38738E-07	0.40

Table 104 - NPL results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04352E-12	0.520
419.53	4.14507E-10	0.122
660.32	1.26023E-08	0.219
961.78	1.38610E-07	0.383

Table 105 - INRiM results – range R1

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.05020E-12	0.19
250	5.68259E-12	0.26
300	2.61498E-11	0.26
400	2.81873E-10	0.27
419.53	4.14135E-10	0.20
500	1.64341E-09	0.37
600	6.39651E-09	0.54
660.32	1.25984E-08	0.39
700	1.88295E-08	0.56
800	4.52283E-08	0.59
900	9.37549E-08	0.62
961.78	1.38667E-07	0.58
1000	1.73298E-07	0.65
Cs at 500	1.641599E-09	0.29
WRC at 500	1.647038E-09	0.52
231.93 VTBB	3.051629E-12	0.27
231.93 FP	3.048777E-12	0.11
419.53 VTBB	4.138073E-10	0.27
419.53 FP	4.144630E-10	0.13
660.32 VTBB	1.260427E-08	0.55
660.32 FP	1.259250E-08	0.23
961.78 VTBB	1.386269E-07	0.64
961.78 FP	1.38787E-07	0.40

Table 106 - NPL results - range R2

t_{nom}/ °C	Average signal/ A	U (k=2)/ °C
231.93	3.04737E-12	0.520
419.53	4.15033E-10	0.122
660.32	1.26183E-08	0.219
961.78	1.38785E-07	0.383

Table 107 - INRiM results - range R2

t_{nom}/ °C	Median signal/ A
231.93	3.043515E-12
250	5.668089E-12
300	2.622467E-11
400	2.819319E-10
419.53	4.140643E-10
500	1.642165E-09
600	6.395373E-09
660.32	1.259529E-08
700	1.880645E-08
800	4.522146E-08
900	9.371201E-08
961.78	1.385511E-07
1000	1.744070E-07

Table 108 – median values for all the LP5 range R1 VTBB and FP measurements

t_{nom}/ °C	Median signal/ A
231.93	3.047374E-12
250	5.670649E-12
300	2.621952E-11
400	2.819044E-10
419.53	4.141351E-10
500	1.641743E-09
600	6.390163E-09
660.32	1.259838E-08
700	1.881401E-08
800	4.521230E-08
900	9.373711E-08
961.78	1.385730E-07
1000	1.735433E-07

Table 109 - median values for all the LP5 range R2 VTBB and FP measurements

18 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB AND FP MEASUREMENTS WITH THE LP5 ON RANGE R1

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.04351E-12	505.08	505.072	-0.008
5.66809E-12	523.15	523.017	-0.133
2.62247E-11	573.15	573.168	0.018
2.81932E-10	673.15	673.181	0.031
4.14064E-10	692.68	692.735	0.055
1.64216E-09	773.15	773.221	0.071
6.39537E-09	873.15	873.302	0.152
1.25953E-08	933.47	933.514	0.044
1.88065E-08	973.15	973.195	0.045
4.52215E-08	1073.15	1072.992	-0.158
9.37120E-08	1173.15	1172.833	-0.317
1.38551E-07	1234.93	1234.449	-0.481
1.74407E-07	1273.15	1273.829	0.679

Table 110 – results of the fit using all the data points

Coefficients of the fit: a_1 = 2.3776587965E-04
a_2 = 1.5629825223E-06
a_3 = 2.2711068851E-06

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.043515E-12	505.08	505.165	0.085
5.668089E-12	523.15	523.085	-0.065
2.622467E-11	573.15	573.172	0.022
2.819319E-10	673.15	673.102	-0.048
4.140643E-10	692.68	692.646	-0.034
1.642165E-09	773.15	773.112	-0.038
6.395373E-09	873.15	873.219	0.069
1.259529E-08	933.47	933.473	0.003
1.880645E-08	973.15	973.193	0.043
4.522146E-08	1073.15	1073.124	-0.026
9.371201E-08	1173.15	1173.155	0.005
1.385511E-07	1234.93	1234.915	-0.015
1.744070E-07	1273.15	1274.398	1.248

Table 111 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 2.3184090065E-04
a_2 = 1.5696694426E-06
a_3= -1.5164544373E-07

19 RESULTS OF THE FITTING PROCESS USING THE SAKUMA HATTORI FIT – VTBB AND FP MEASUREMENTS WITH THE LP5 ON RANGE R2

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.04737E-12	505.08	505.156	0.076
5.67065E-12	523.15	523.064	-0.086
2.62195E-11	573.15	573.155	0.005
2.81904E-10	673.15	673.121	-0.029
4.14135E-10	692.68	692.683	0.003
1.64174E-09	773.15	773.134	-0.016
6.39016E-09	873.15	873.183	0.033
1.25984E-08	933.47	933.516	0.046
1.88140E-08	973.15	973.240	0.090
4.52123E-08	1073.15	1073.058	-0.092
9.37371E-08	1173.15	1173.089	-0.061
1.38573E-07	1234.93	1234.784	-0.146
1.73543E-07	1273.15	1273.326	0.176

Table 112 – results of the fit using all the data points

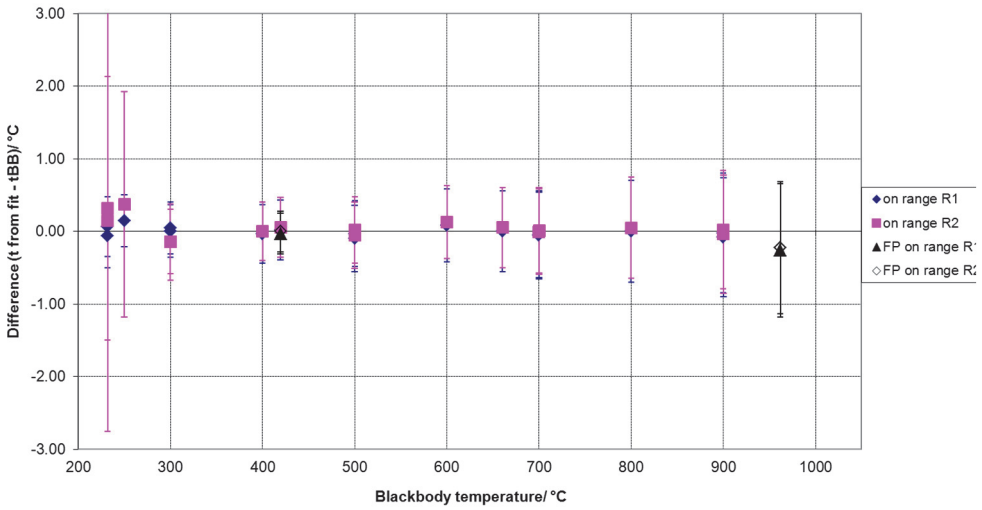
Coefficients of the fit: a_1 = 2.3399679213E-04
a_2 = 1.5671605021E-06
a_3 = 7.8122016526E-07

Thermometer signal/ V	Temperature/ K	Fitted temperature/ K	Residual/ K
3.047374E-12	505.08	505.180	0.100
5.670649E-12	523.15	523.081	-0.069
2.621952E-11	573.15	573.156	0.006
2.819044E-10	673.15	673.101	-0.049
4.141351E-10	692.68	692.660	-0.020
1.641743E-09	773.15	773.106	-0.044
6.390163E-09	873.15	873.162	0.012
1.259838E-08	933.47	933.505	0.035
1.881401E-08	973.15	973.240	0.090
4.521230E-08	1073.15	1073.093	-0.057
9.373711E-08	1173.15	1173.172	0.022
1.385730E-07	1234.93	1234.904	-0.026
1.735433E-07	1273.15	1273.473	0.323

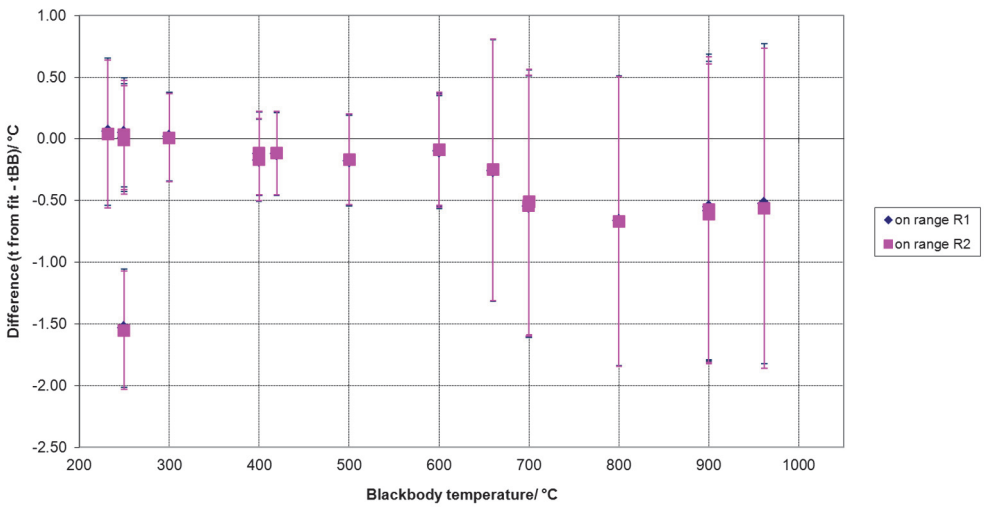
Table 113 – results of the fit, excluding the 1000 °C data in the fitting process but using the coefficients to calculate the corresponding fitted temperature at 1000 °C

Coefficients of the fit: a_1 = 2.3247978764E-04
a_2 = 1.5688863581E-06
a_3 = 1.5575130071E-07

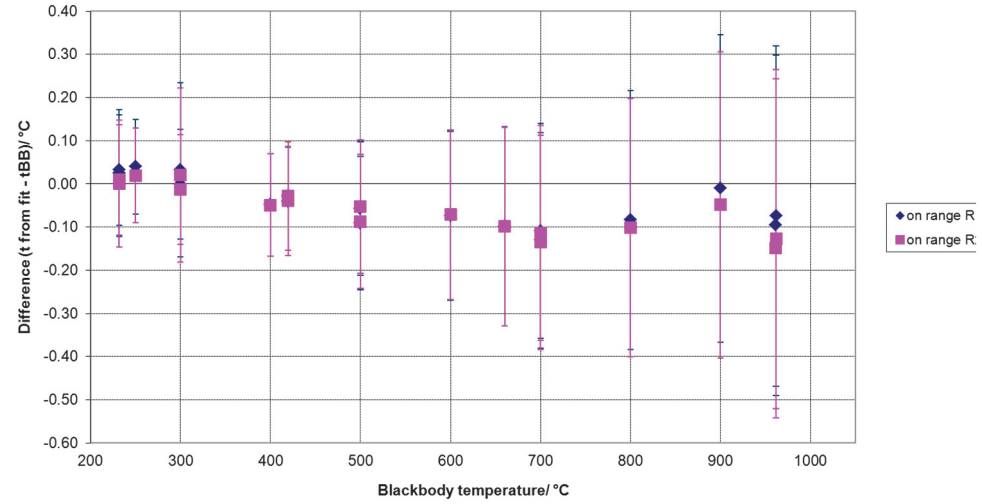
CEM results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5



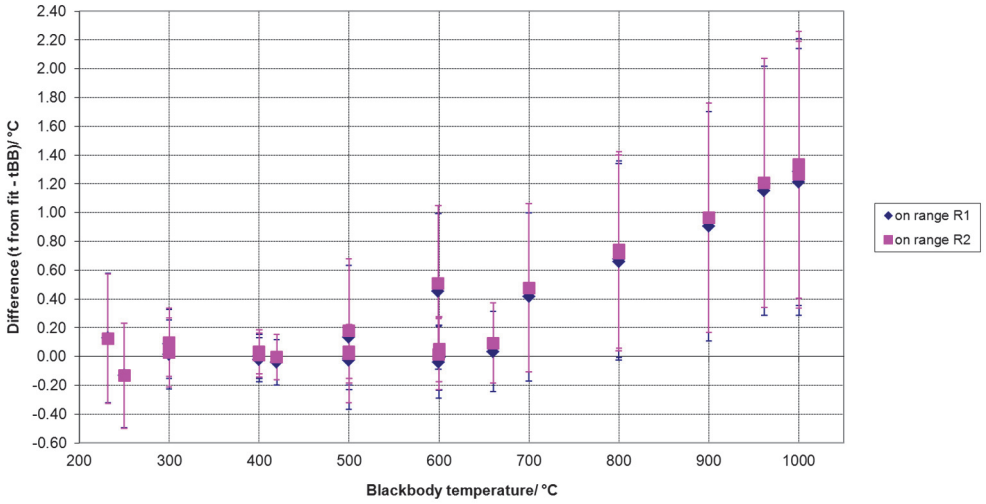
LNE results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5



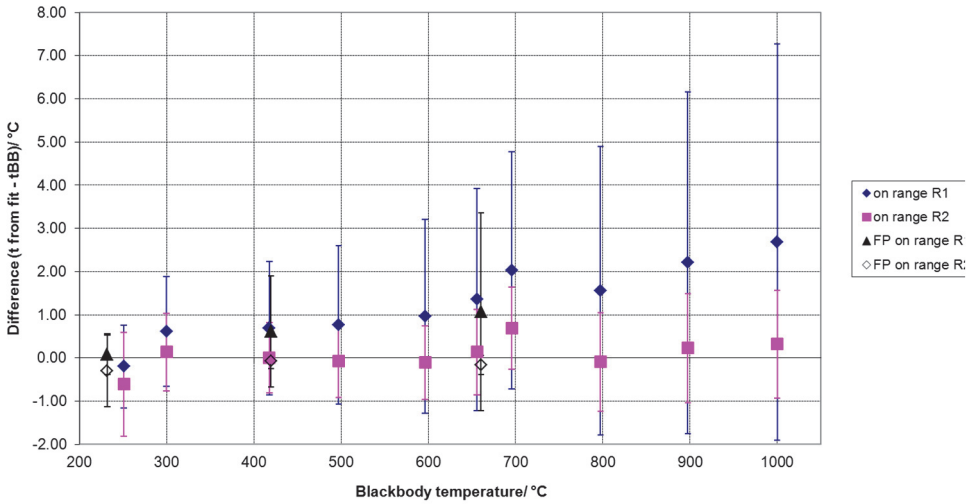
PTB results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5



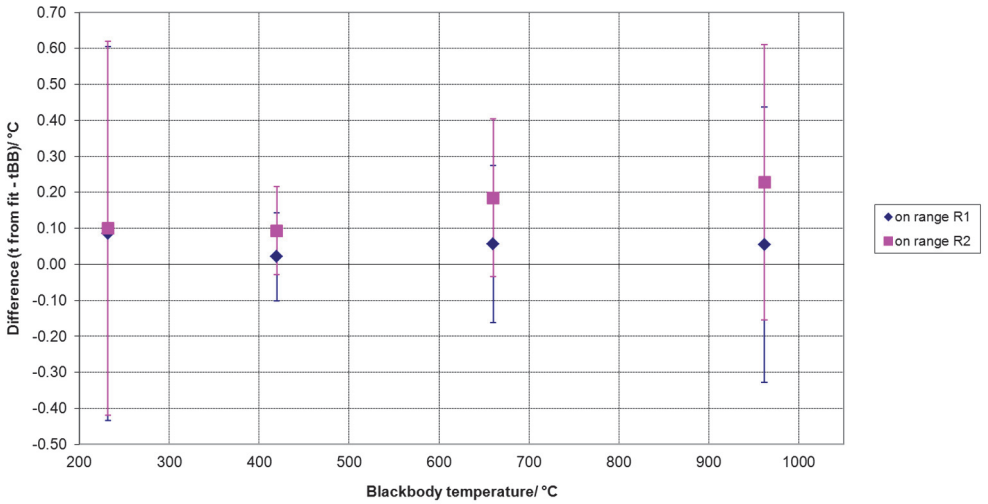
METAS results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5



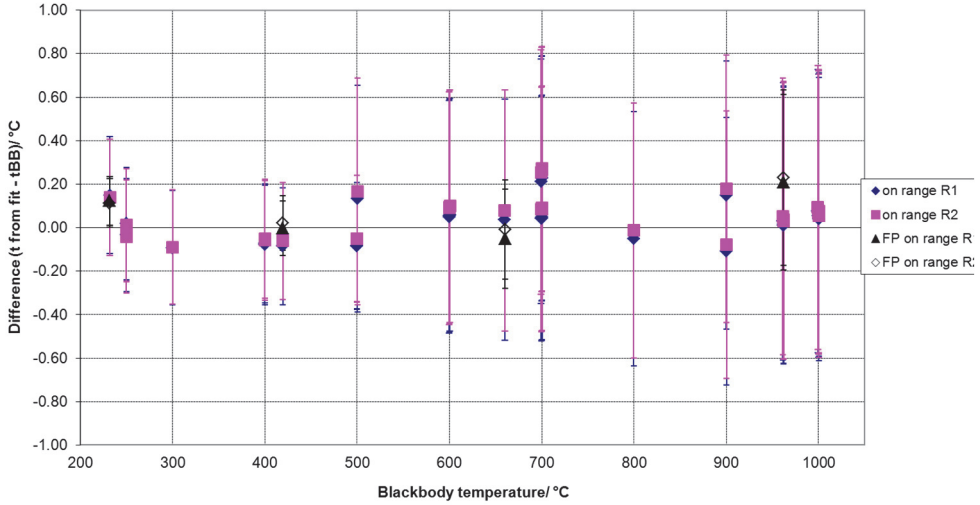
UME results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5

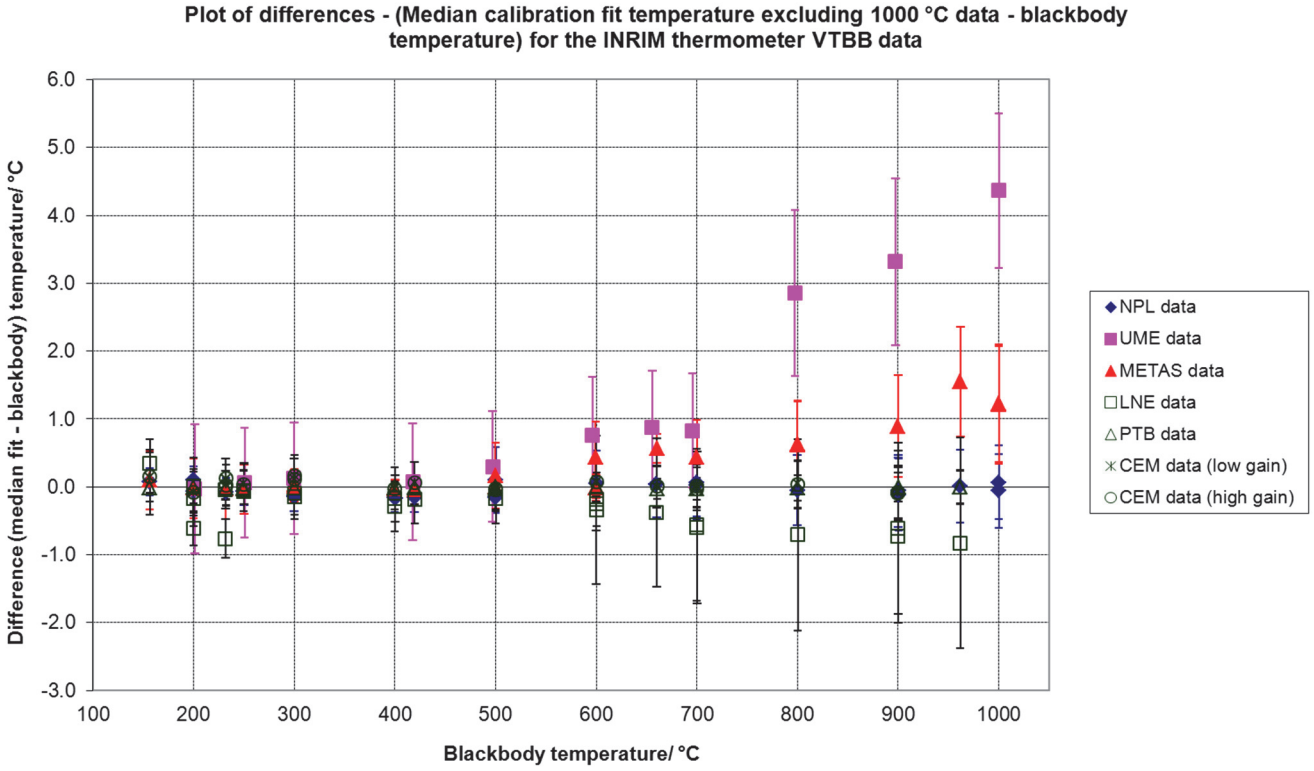


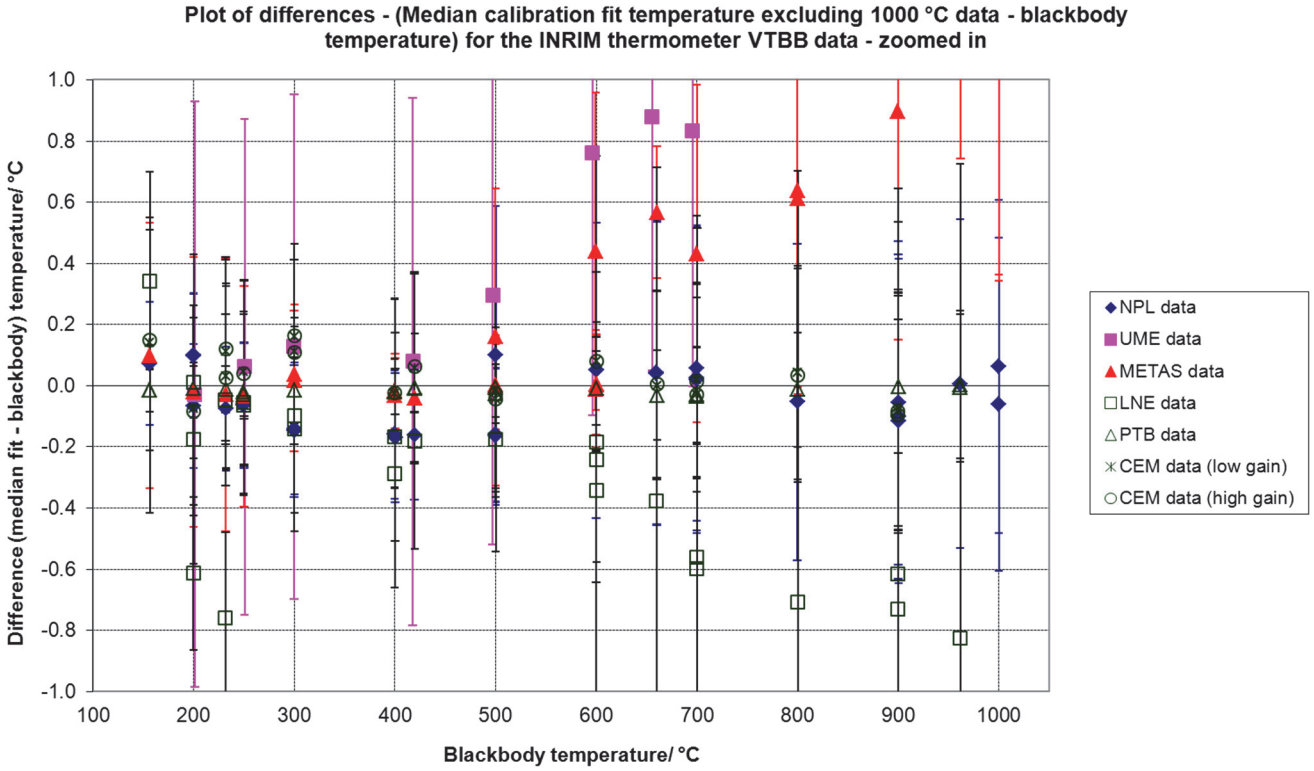
INRiM results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5

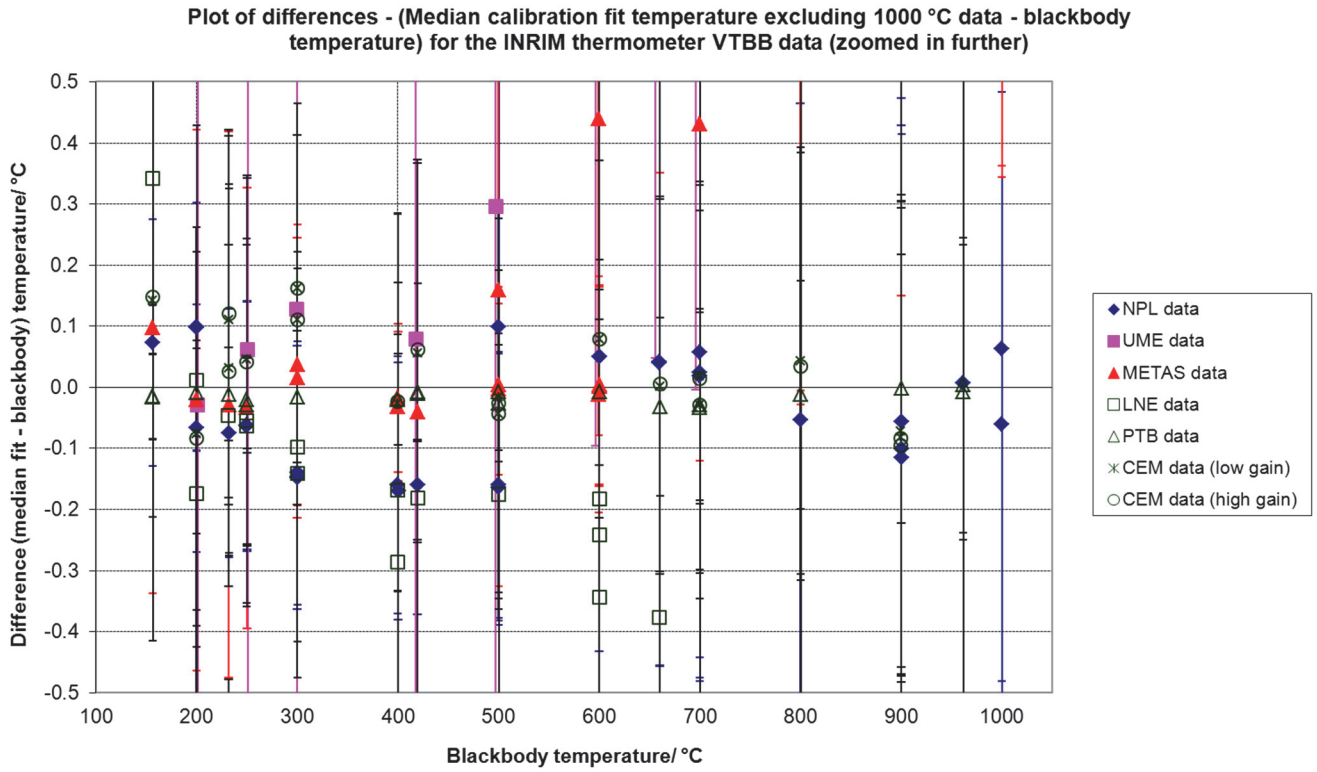


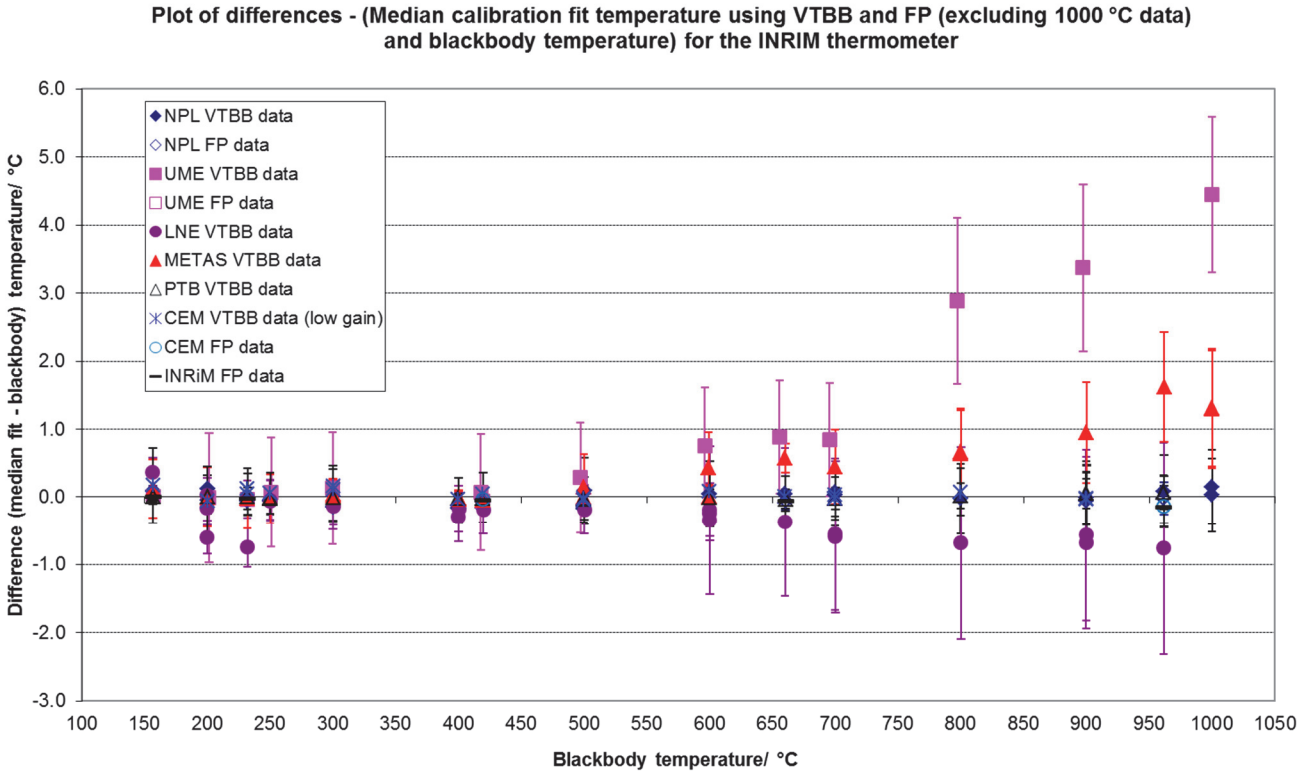
NPL results - Differences (fit temperature using median of VTBB and FP data (excluding 1000 °C) - blackbody temperature) for LP5

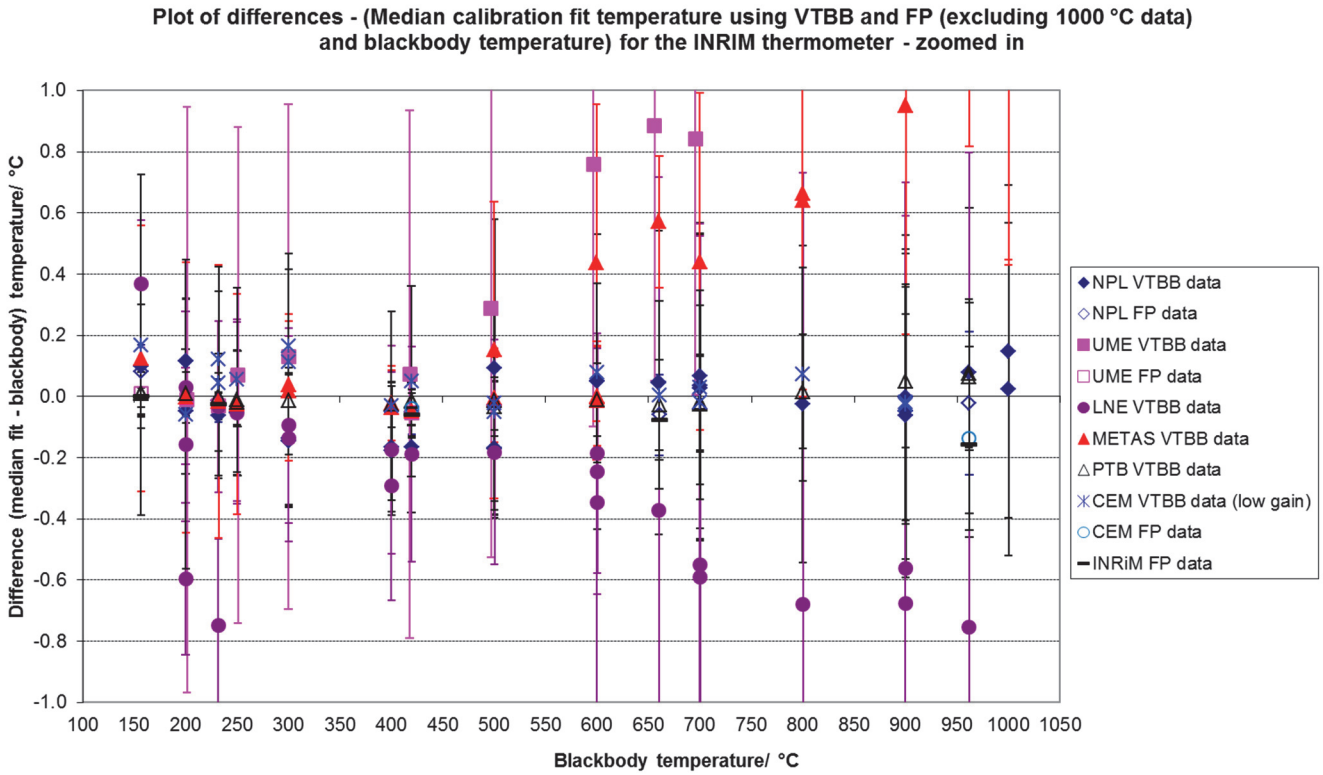


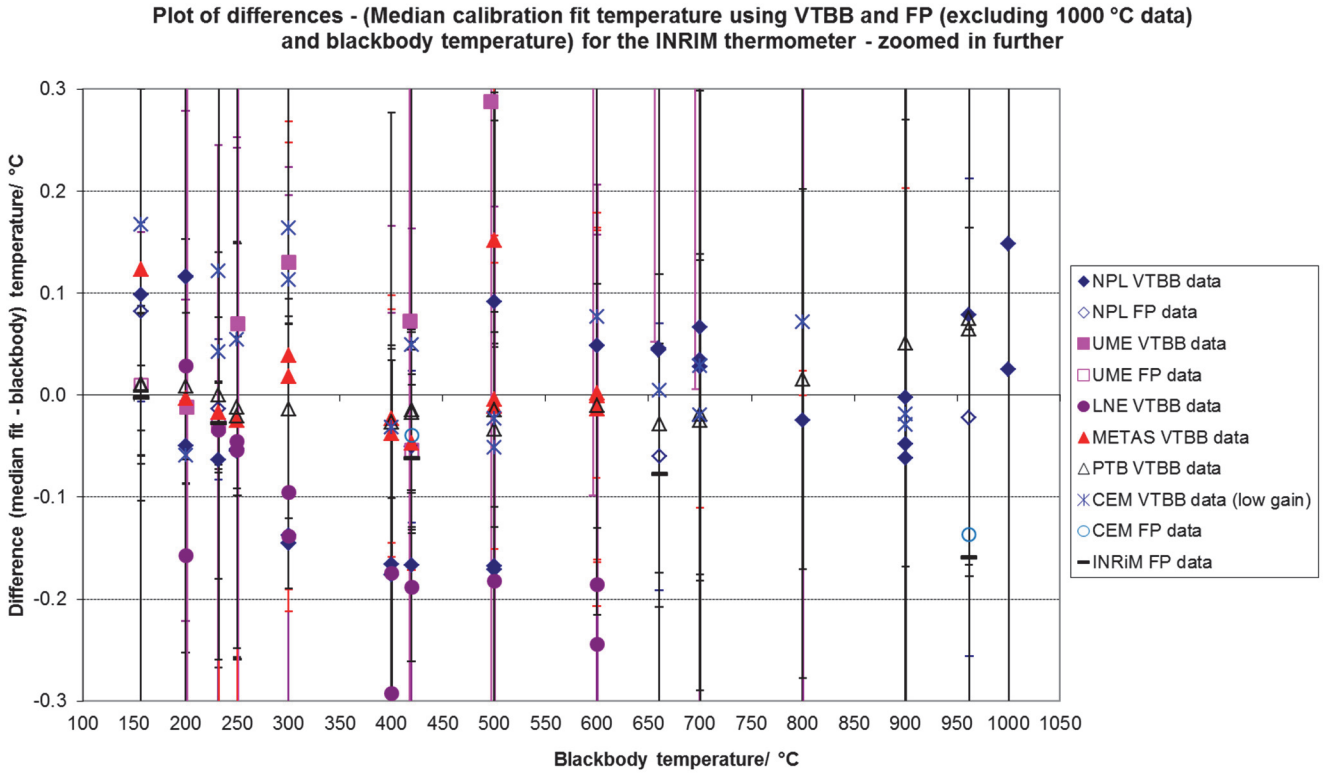

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the INRIM thermometer VTBB data
Difference (median fit - blackbody) temperature/ °C
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
100
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)

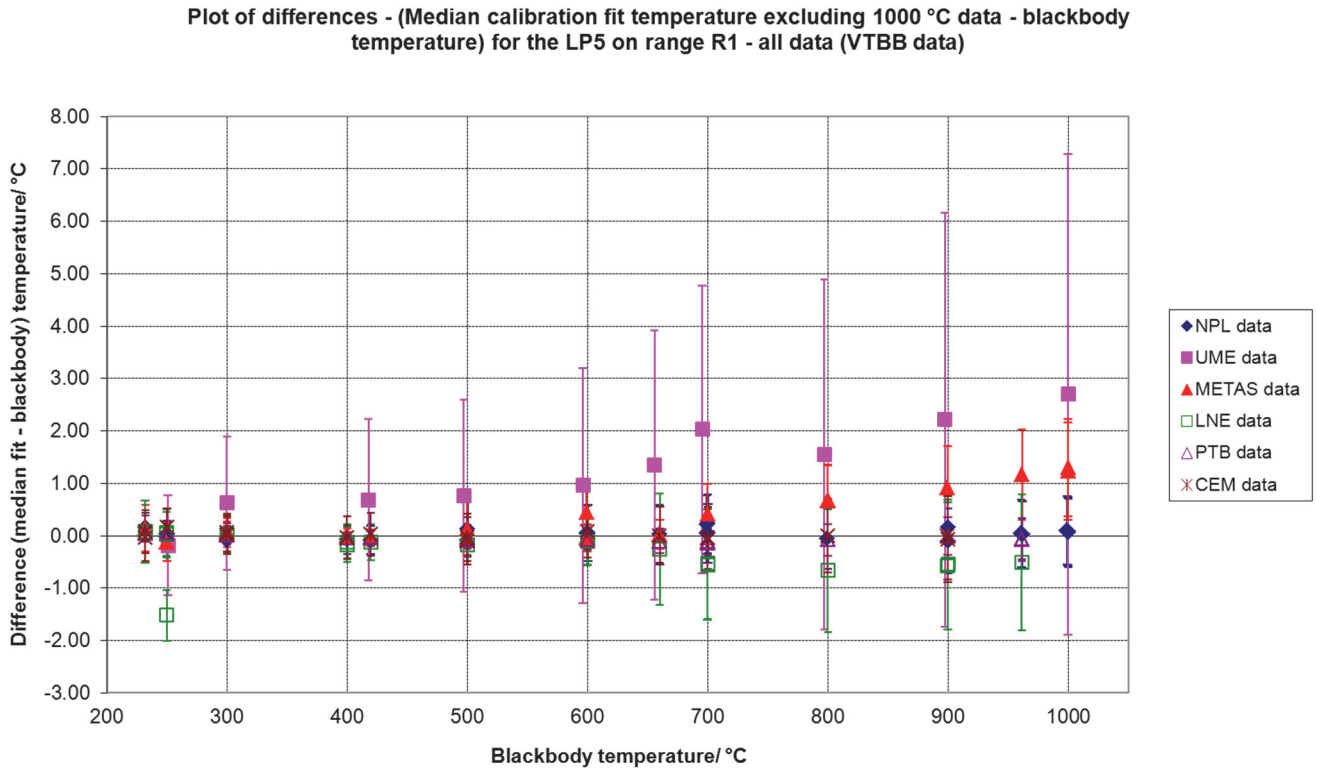

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the INRIM thermometer VTBB data - zoomed in
Difference (median fit - blackbody) temperature/ °C
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
100
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)

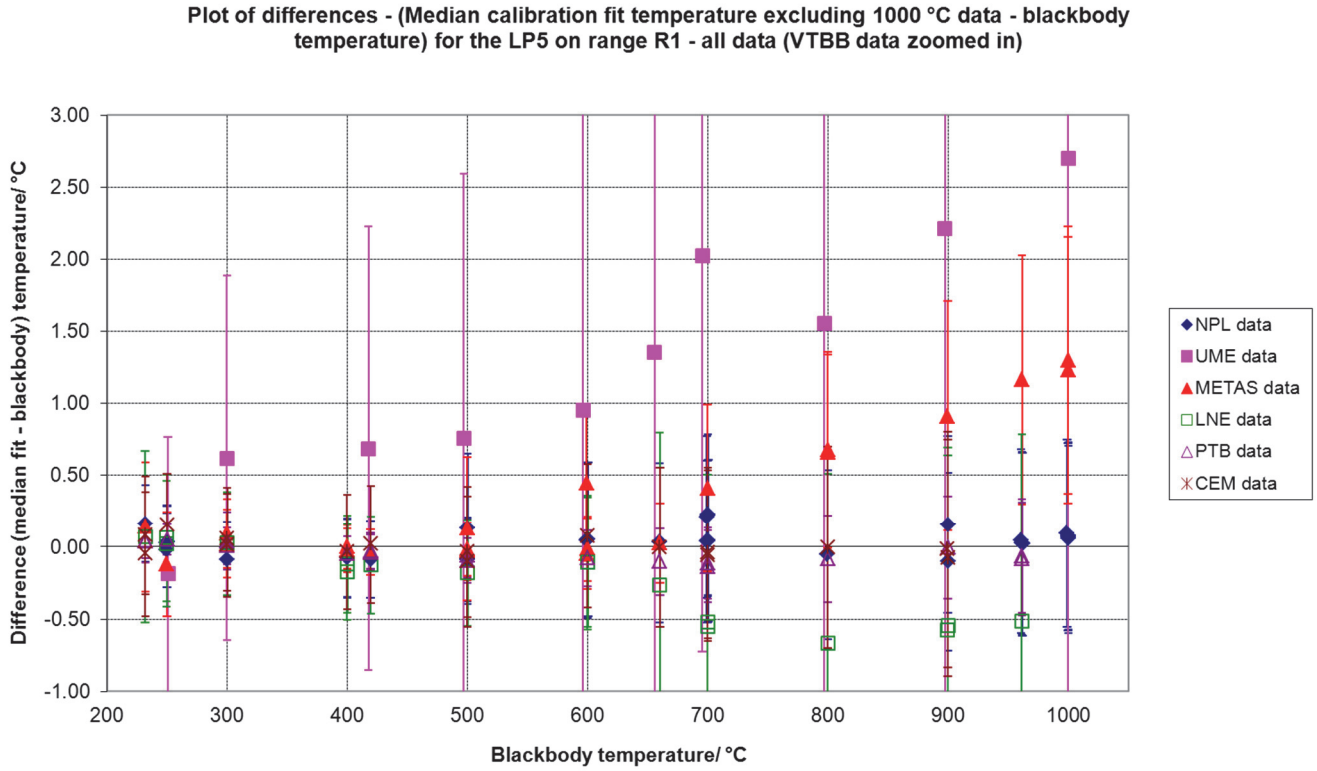

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the INRIM thermometer VTBB data (zoomed in further)
Difference (median fit - blackbody) temperature/ °C
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)


Plot of differences - (Median calibration fit temperature using VTBB and FP (excluding 1000 °C data) and blackbody temperature) for the INRIM thermometer
Difference (median fit - blackbody) temperature/ °C
Blackbody temperature/ °C
NPL VTBB data
NPL FP data
UME VTBB data
UME FP data
LNE VTBB data
METAS VTBB data
PTB VTBB data
CEM VTBB data (low gain)
CEM FP data
INRiM FP data

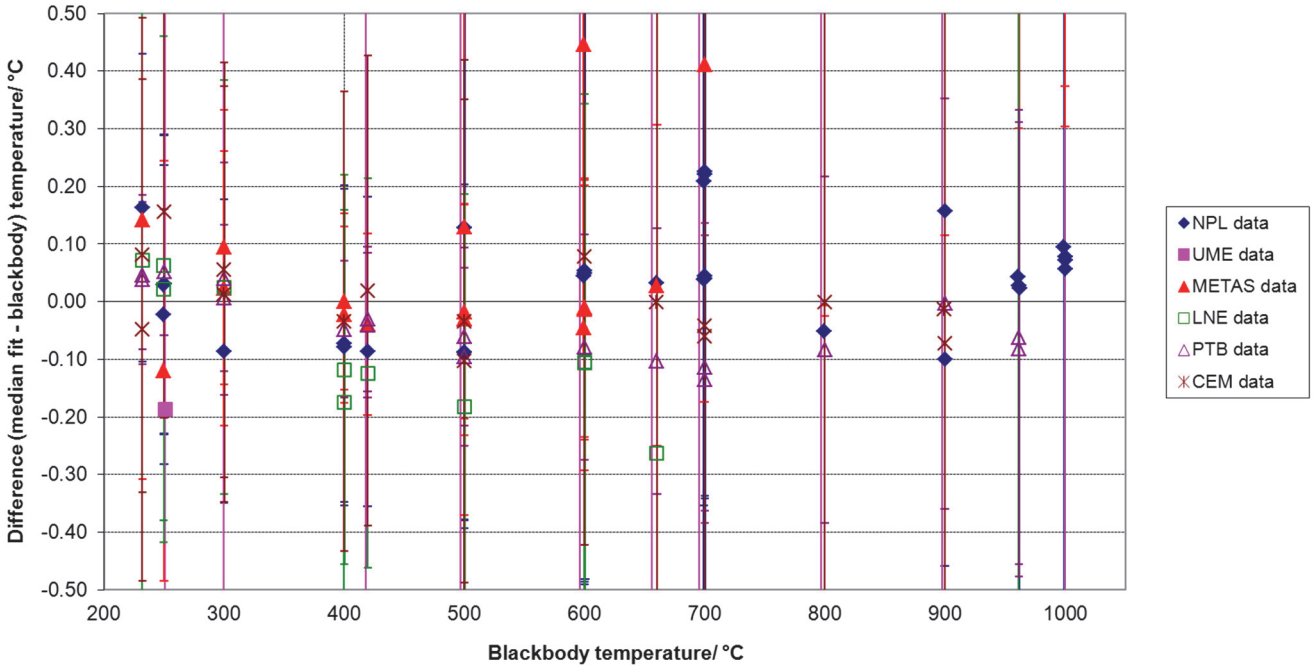

Plot of differences - (Median calibration fit temperature using VTBB and FP (excluding 1000 °C data) and blackbody temperature) for the INRIM thermometer - zoomed in
Difference (median fit - blackbody) temperature/ °C
Blackbody temperature/ °C
NPL VTBB data
NPL FP data
UME VTBB data
UME FP data
LNE VTBB data
METAS VTBB data
PTB VTBB data
CEM VTBB data (low gain)
CEM FP data
INRiM FP data


Plot of differences - (Median calibration fit temperature using VTBB and FP (excluding 1000 °C data) and blackbody temperature) for the INRIM thermometer - zoomed in further
Difference (median fit - blackbody) temperature/ °C
Blackbody temperature/ °C
NPL VTBB data
NPL FP data
UME VTBB data
UME FP data
LNE VTBB data
METAS VTBB data
PTB VTBB data
CEM VTBB data (low gain)
CEM FP data
INRiM FP data

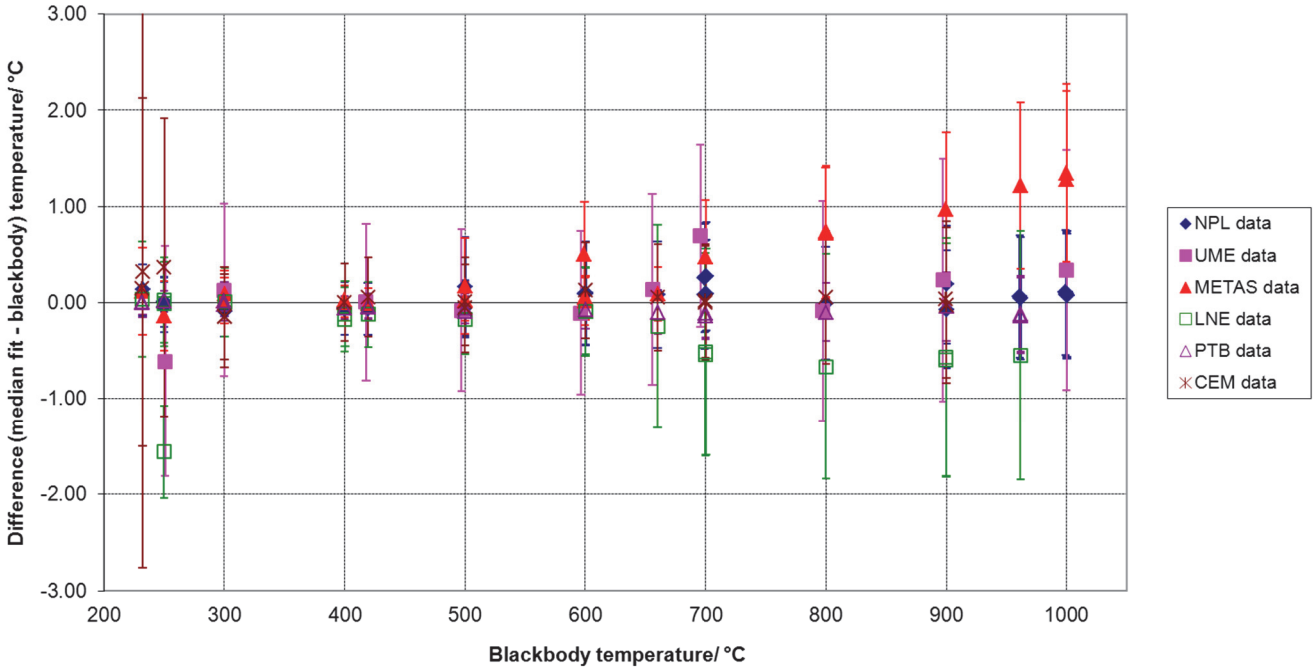

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data (VTBB data)
Difference (median fit - blackbody) temperature/ °C
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data

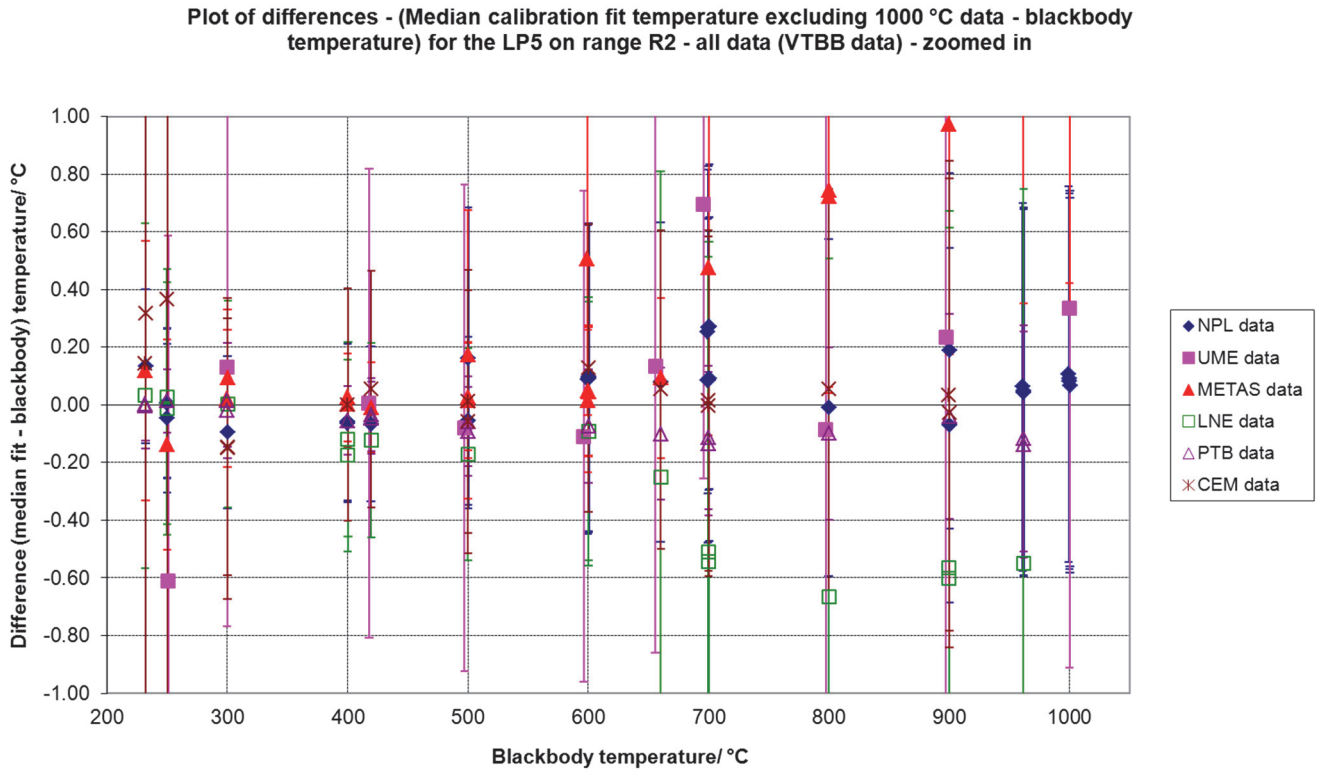

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data (VTBB data zoomed in)
Difference (median fit - blackbody) temperature/ °C
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data

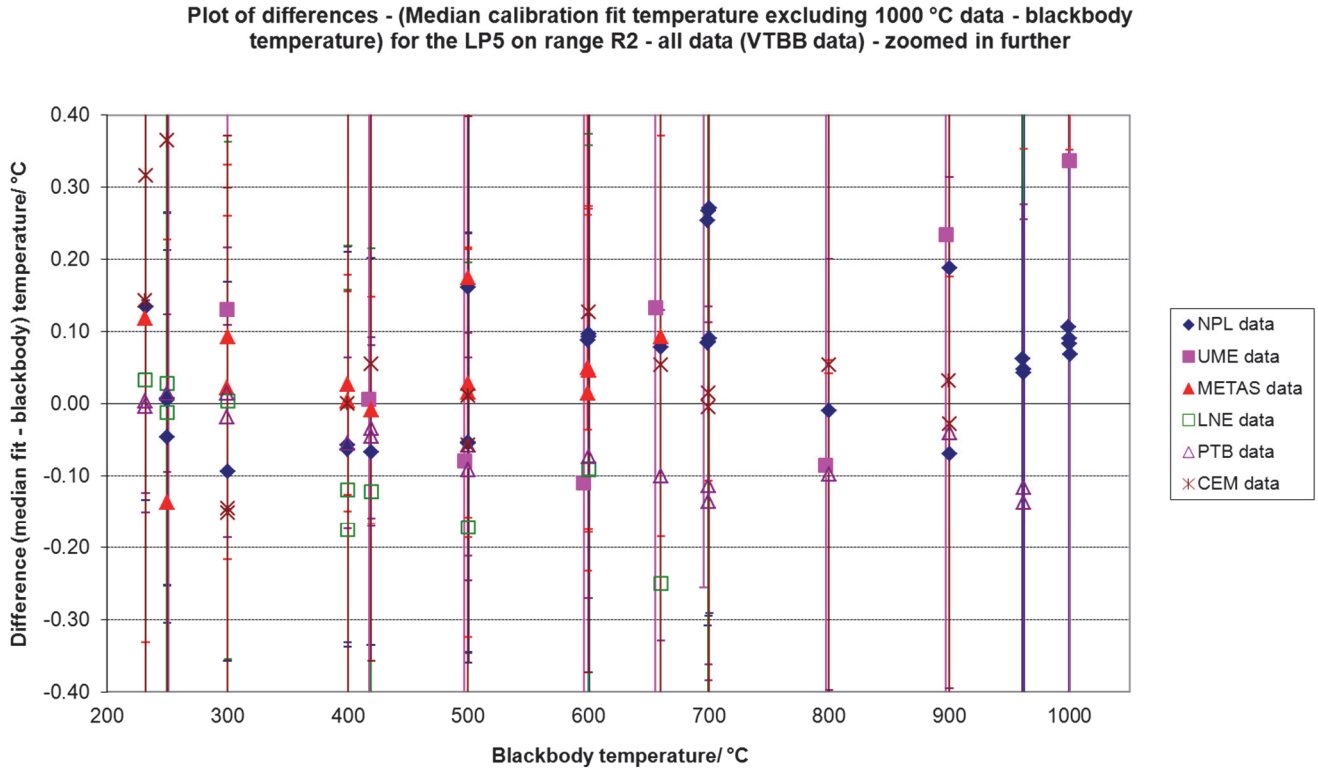
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data (VTBB data zoomed in further)



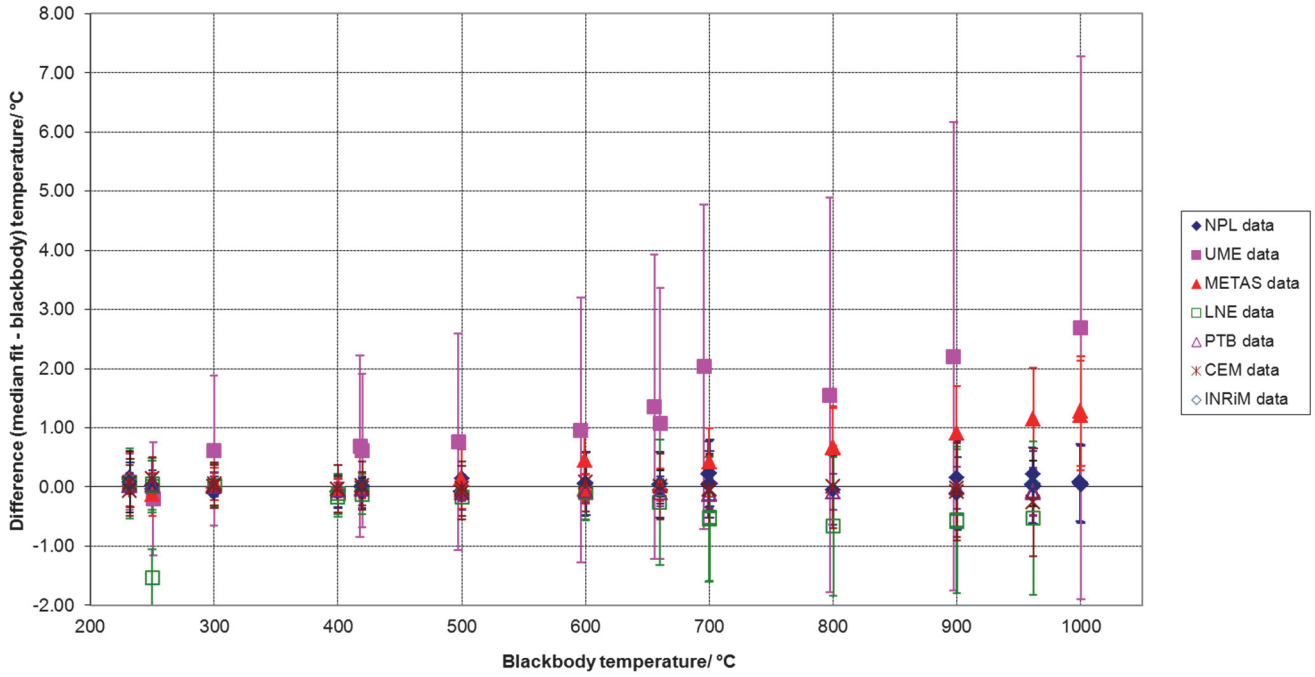
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data (VTBB data)



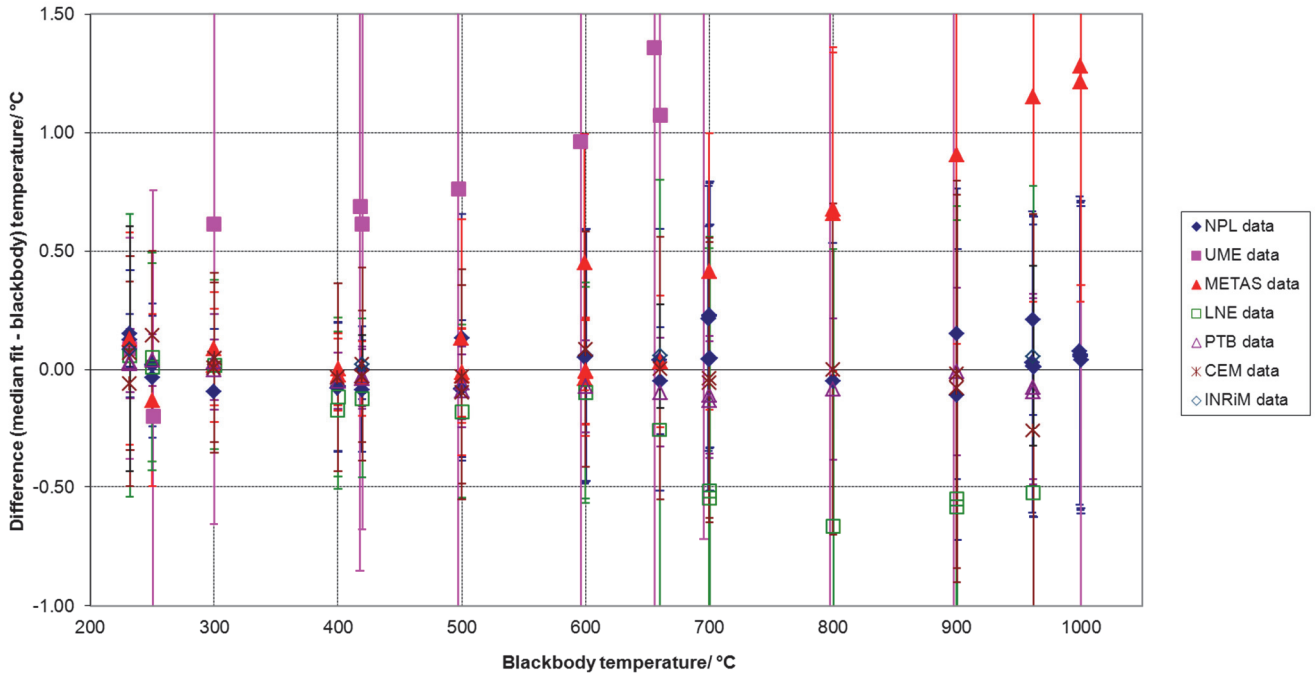

Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data (VTBB data) - zoomed in
Difference (median fit - blackbody) temperature/ °C
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data


Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data (VTBB data) - zoomed in further
Difference (median fit - blackbody) temperature/ °C
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
200
300
400
500
600
700
800
900
1000
Blackbody temperature/ °C
NPL data
UME data
METAS data
LNE data
PTB data
CEM data

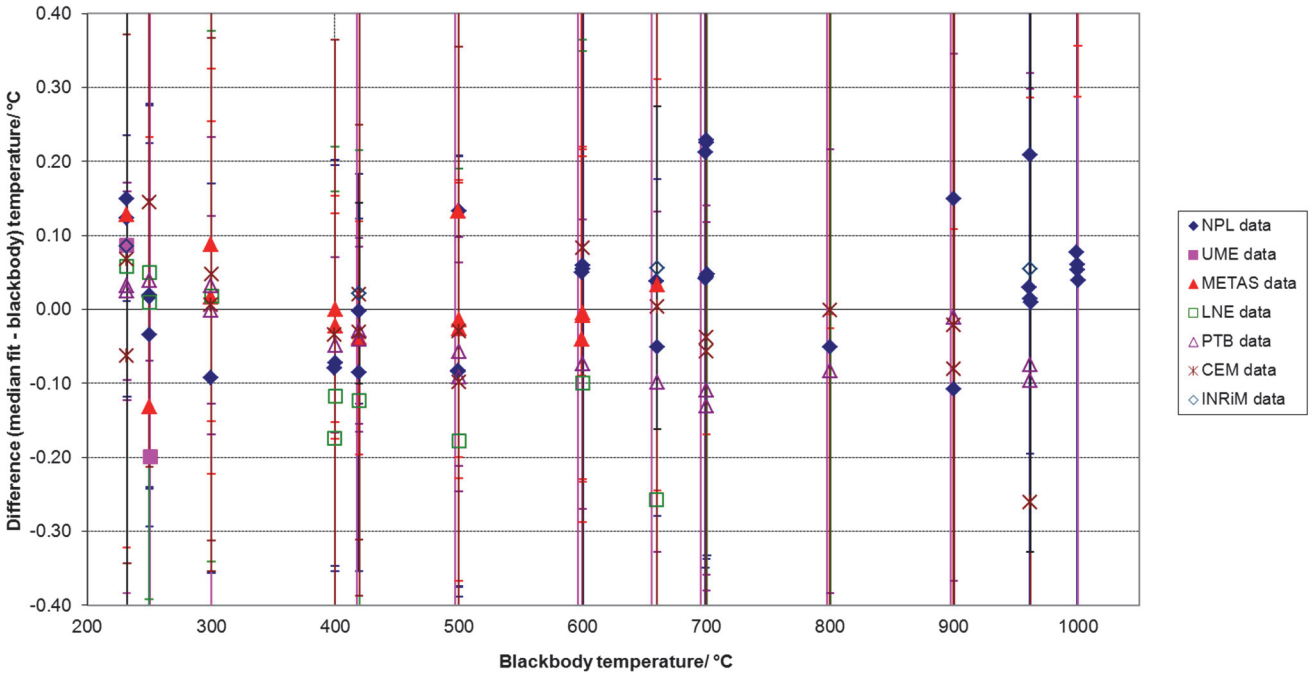
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data (VTBB & FP data)



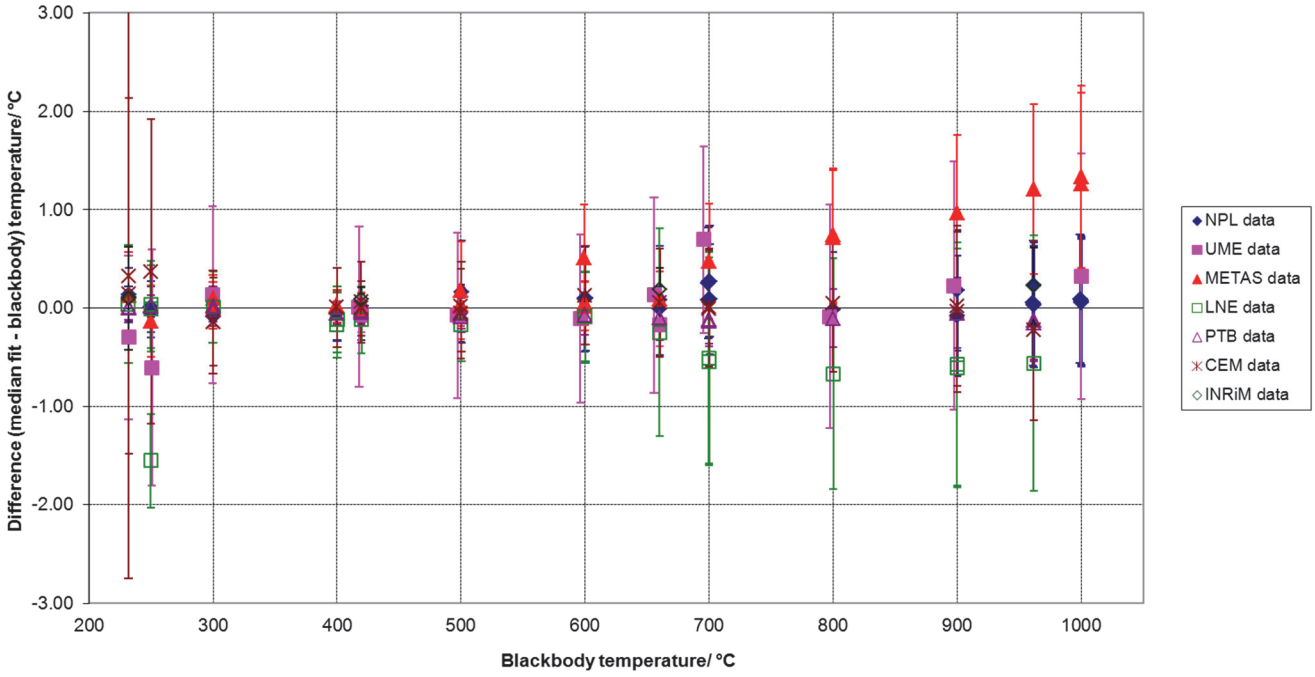
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data zoomed in (VTBB & FP data)



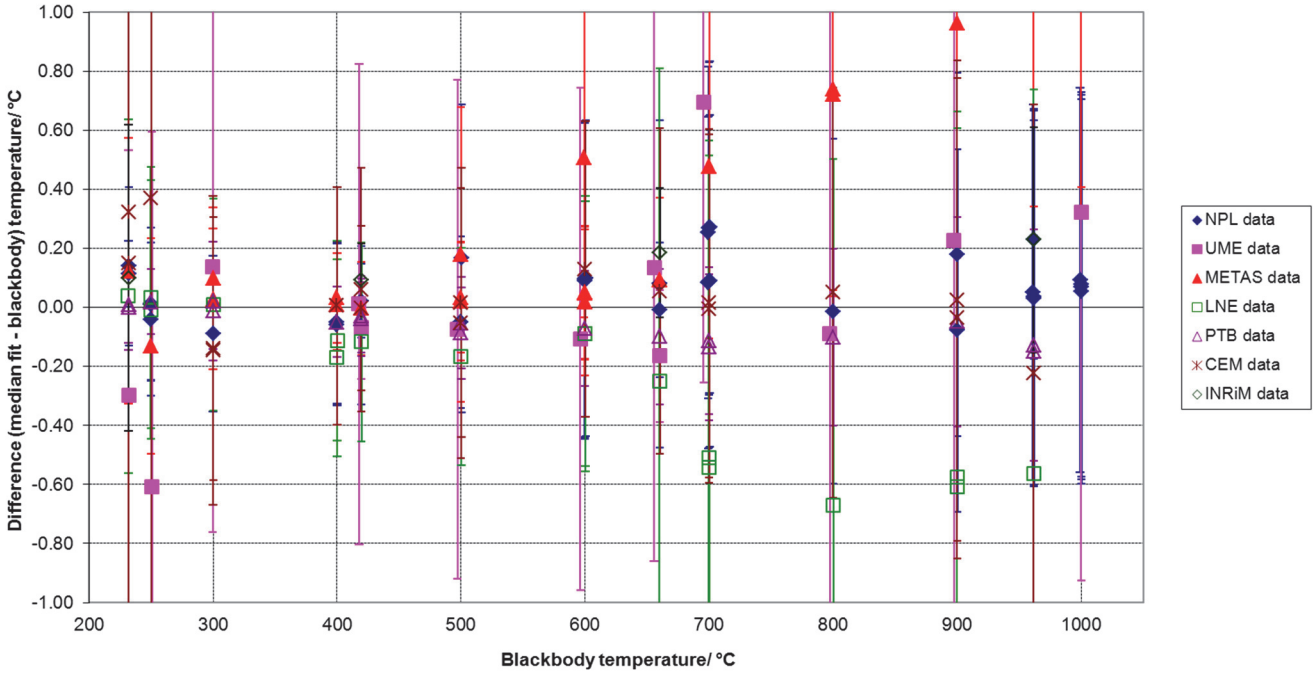
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R1 - all data zoomed in further (VTBB & FP data)



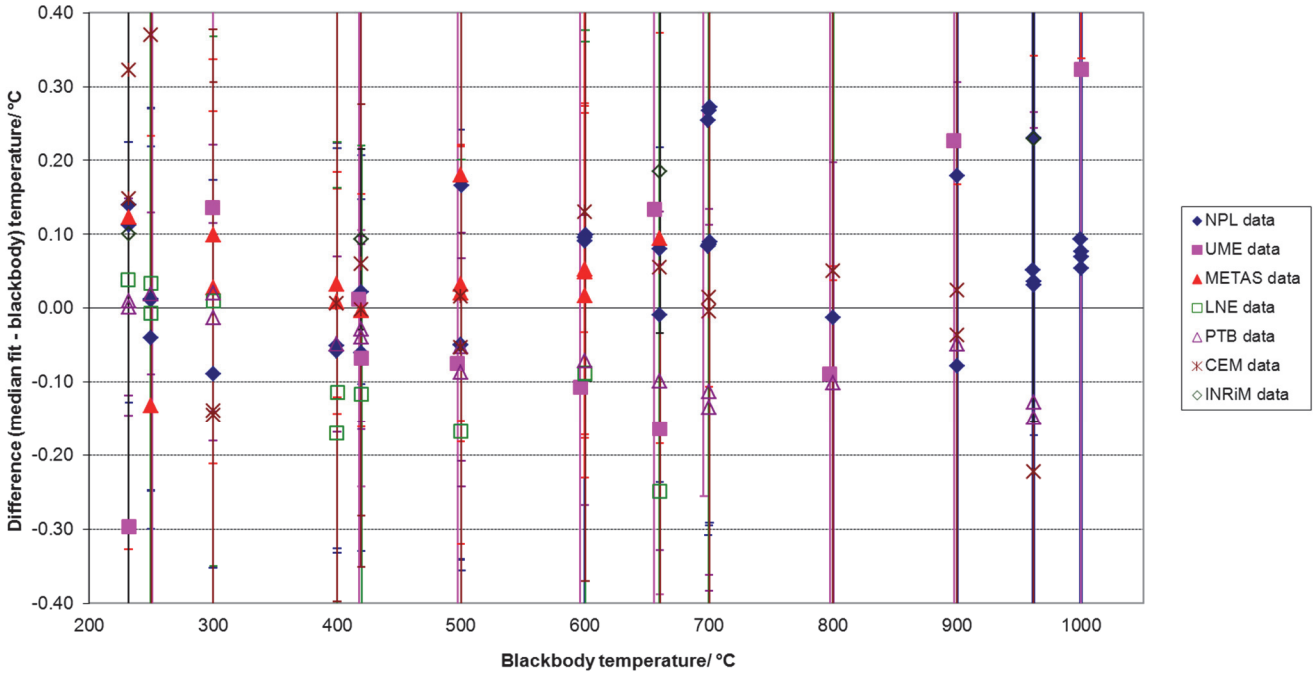
Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data (VTBB & FP data)



Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data zoomed in (VTBB & FP data)



Plot of differences - (Median calibration fit temperature excluding 1000 °C data - blackbody temperature) for the LP5 on range R2 - all data zoomed in further (VTBB & FP data)

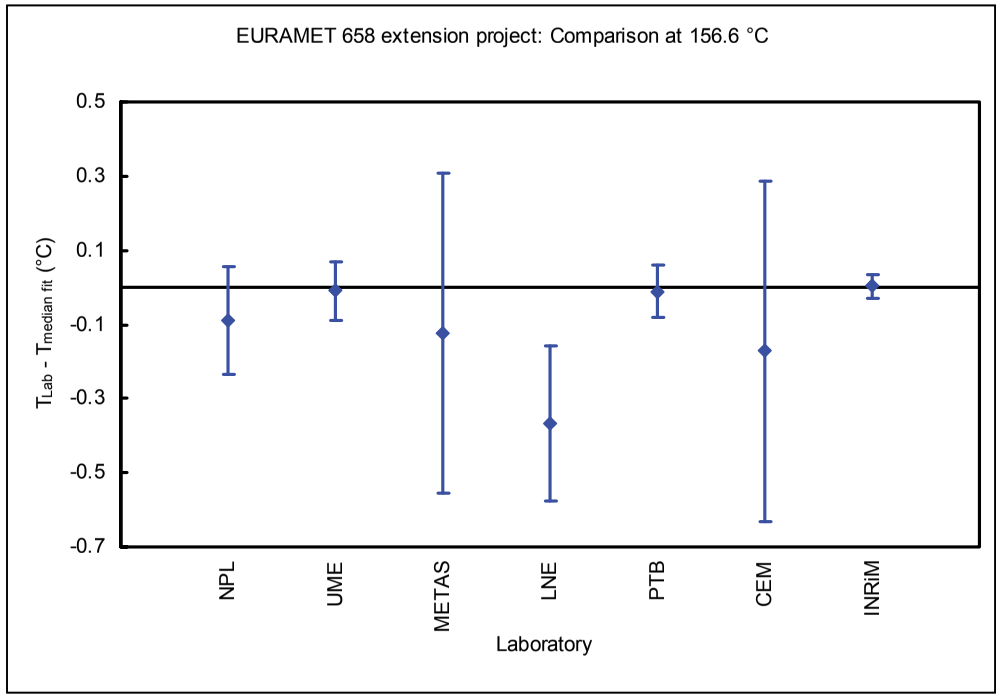


20 THE QDE_{95} AND DOE VALUES FOR THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY COMPARISON, USING THE FIT OF ALL THE DATA

20.1 THE RESULTS FOR THE INRIM THERMOMETER USING THE FIT OF ALL THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY DATA

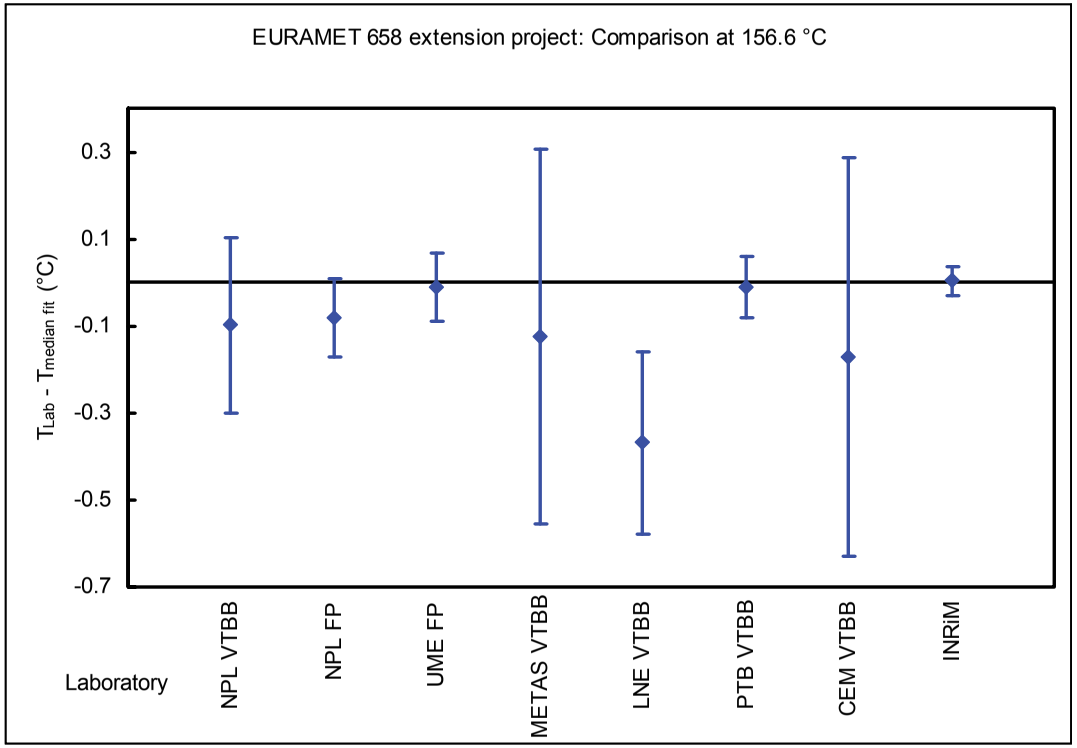
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	-0.08 ± 0.165	0.03 ± 0.454	0.28 ± 0.256	-0.08 ± 0.162	0.08 ± 0.482	-0.09 ± 0.149
UME	*0.22*	-	0.11 ± 0.437	0.36 ± 0.224	0.00 ± 0.104	0.16 ± 0.465	-0.01 ± 0.084
METAS	*0.45*	*0.48*	-	0.24 ± 0.479	-0.11 ± 0.436	0.05 ± 0.629	-0.13 ± 0.431
LNE	*0.49*	*0.54*	*0.64*	-	-0.36 ± 0.221	-0.20 ± 0.505	-0.37 ± 0.212
PTB	*0.21*	*0.10*	*0.48*	*0.54*	-	0.16 ± 0.464	-0.01 ± 0.077
CEM	*0.50*	*0.55*	*0.62*	*0.62*	*0.55*	-	-0.17 ± 0.460
INRiM	*0.22*	*0.09*	*0.49*	*0.55*	*0.08*	*0.56*	-

Table 114 – the results for the INRiM thermometer at 156.6 °C – all data averaged



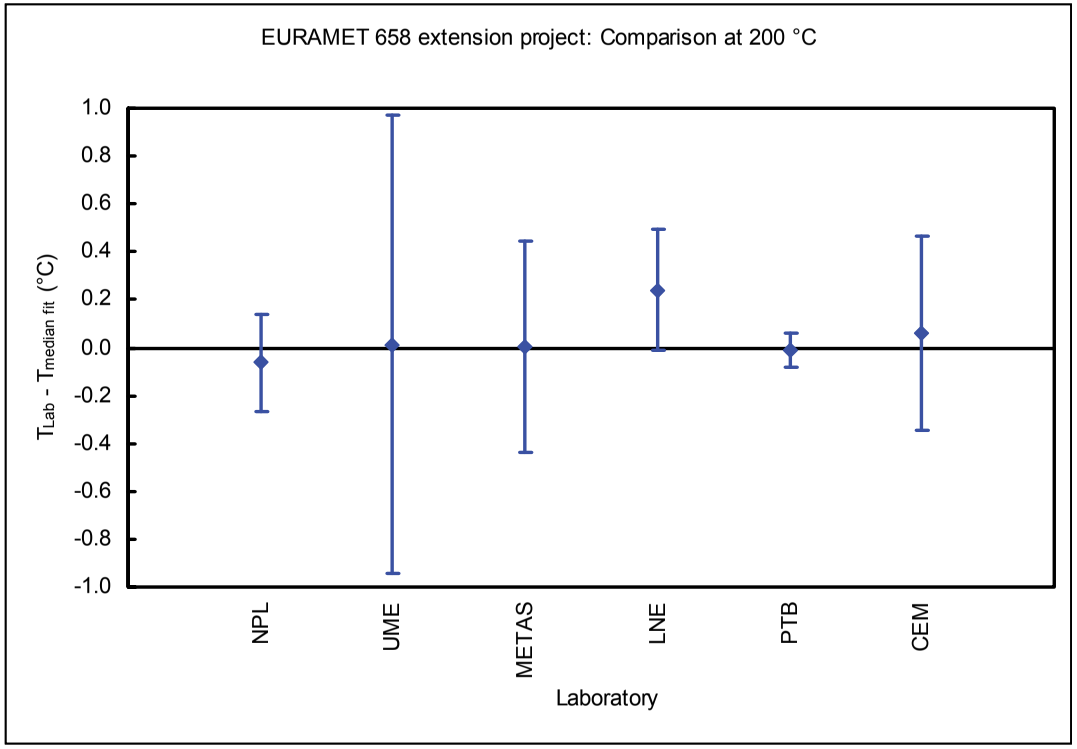
	NPL VTBB	NPL FP	UME FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM
NPL VTBB	-	-0.02 ± 0.221	-0.09 ± 0.216	0.03 ± 0.475	0.27 ± 0.291	-0.09 ± 0.214	0.07 ± 0.501	-0.10 ± 0.204
NPL FP	*0.22*	-	-0.07 ± 0.119	0.04 ± 0.439	0.29 ± 0.228	-0.07 ± 0.114	0.09 ± 0.468	-0.08 ± 0.095
UME FP	*0.27*	*0.17*	-	0.11 ± 0.437	0.36 ± 0.224	0.00 ± 0.104	0.16 ± 0.465	-0.01 ± 0.084
METAS VTBB	*0.47*	*0.44*	*0.48*	-	0.24 ± 0.479	-0.11 ± 0.436	0.05 ± 0.629	-0.13 ± 0.431
LNE VTBB	*0.51*	*0.47*	*0.54*	*0.64*	-	-0.36 ± 0.221	-0.20 ± 0.505	-0.37 ± 0.212
PTB VTBB	*0.26*	*0.17*	*0.10*	*0.48*	*0.54*	-	0.16 ± 0.464	-0.01 ± 0.077
CEM VTBB	*0.51*	*0.49*	*0.55*	*0.62*	*0.62*	*0.55*	-	-0.17 ± 0.460
INRiM	*0.27*	*0.16*	*0.09*	*0.49*	*0.55*	*0.08*	*0.56*	-

Table 115 – the results for the INRiM thermometer at 156.6 °C – FP and VTBB data separated



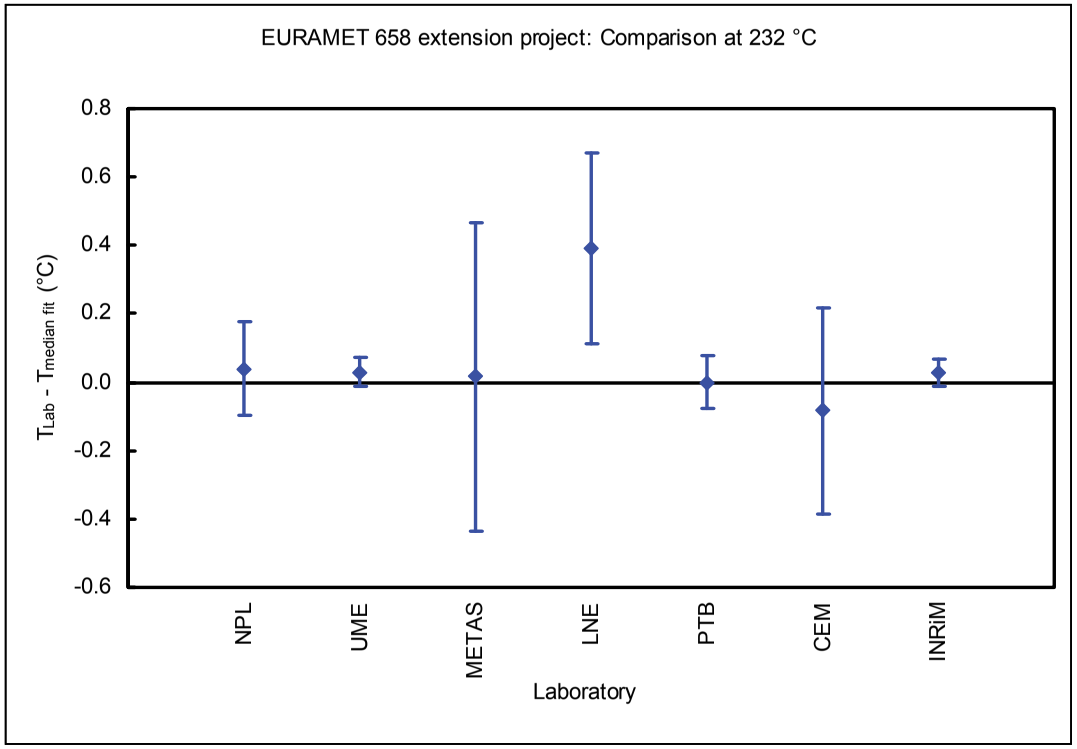
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	-0.07 ± 0.978	-0.06 ± 0.484	-0.30 ± 0.322	-0.05 ± 0.215	-0.12 ± 0.453
UME	*0.97*	-	0.01 ± 1.053	-0.23 ± 0.989	0.02 ± 0.959	-0.05 ± 1.039
METAS	*0.49*	*1.04*	-	-0.24 ± 0.506	0.01 ± 0.446	-0.06 ± 0.598
LNE	*0.57*	*1.07*	*0.66*	-	0.25 ± 0.260	0.18 ± 0.476
PTB	*0.23*	*0.94*	*0.44*	*0.46*	-	-0.07 ± 0.412
CEM	*0.50*	*1.02*	*0.60*	*0.57*	*0.43*	-

Table 116 – the results for the INRiM thermometer at 200 °C – all data averaged



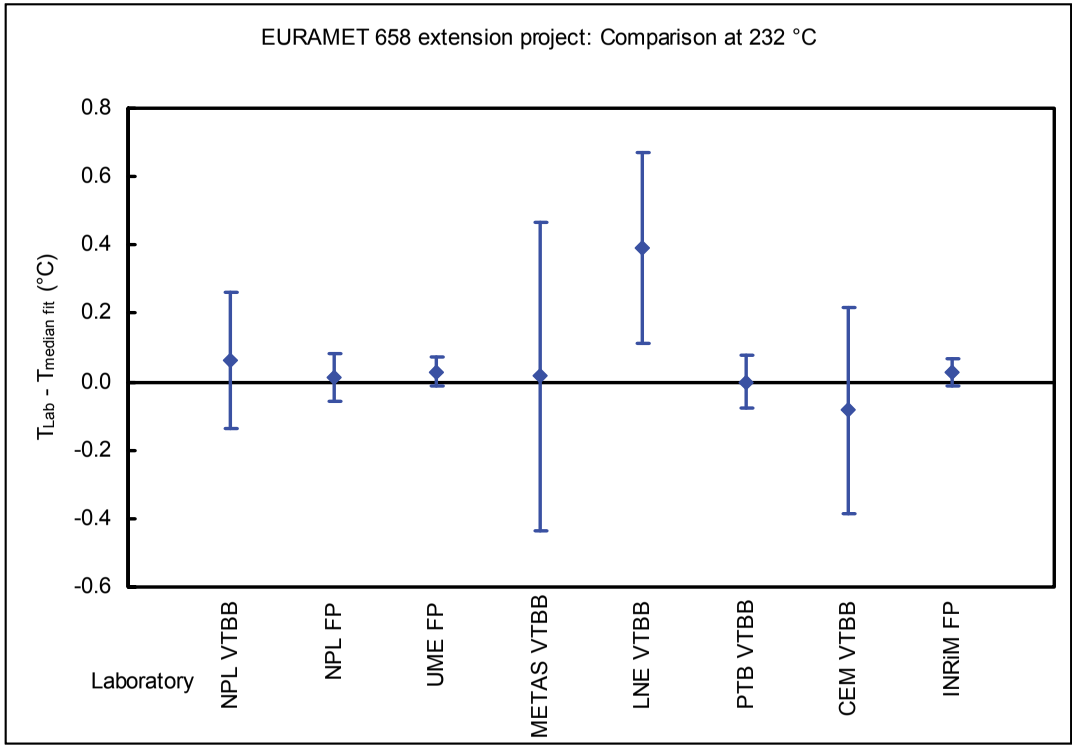
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	0.01 ± 0.143	0.02 ± 0.470	-0.35 ± 0.312	0.04 ± 0.156	0.12 ± 0.330	0.01 ± 0.143
UME	*0.14*	-	0.01 ± 0.452	-0.36 ± 0.283	0.03 ± 0.087	0.11 ± 0.303	0.00 ± 0.059
METAS	*0.46*	*0.44*	-	-0.37 ± 0.530	0.02 ± 0.456	0.10 ± 0.541	-0.01 ± 0.452
LNE	*0.61*	*0.59*	*0.81*	-	0.39 ± 0.290	0.47 ± 0.410	0.36 ± 0.283
PTB	*0.17*	*0.10*	*0.45*	*0.63*	-	0.08 ± 0.309	-0.03 ± 0.086
CEM	*0.40*	*0.36*	*0.56*	*0.81*	*0.34*	-	-0.11 ± 0.303
INRiM	*0.14*	*0.06*	*0.44*	*0.60*	*0.10*	*0.36*	-

Table 117 – the results for the INRiM thermometer at 232°C – all data averaged



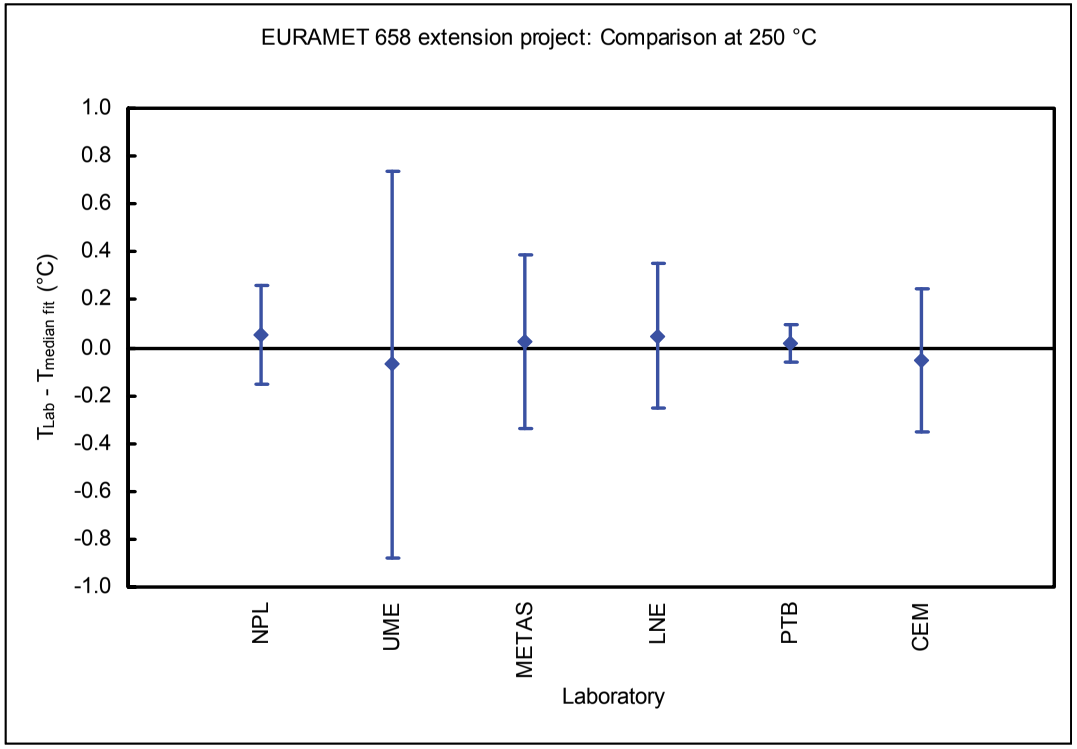
	NPL VTBB	NPL FP	UME FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM FP
NPL VTBB	-	0.05 ± 0.212	0.03 ± 0.205	0.05 ± 0.492	-0.33 ± 0.344	0.06 ± 0.214	0.15 ± 0.361	0.03 ± 0.204
NPL FP	*0.23*	-	-0.02 ± 0.082	0.00 ± 0.455	-0.38 ± 0.289	0.01 ± 0.103	0.10 ± 0.308	-0.01 ± 0.081
UME FP	*0.21*	*0.09*	-	0.01 ± 0.452	-0.36 ± 0.283	0.03 ± 0.087	0.11 ± 0.303	0.00 ± 0.059
METAS VTBB	*0.49*	*0.45*	*0.44*	-	-0.37 ± 0.530	0.02 ± 0.456	0.10 ± 0.541	-0.01 ± 0.452
LNE VTBB	*0.61*	*0.61*	*0.59*	*0.81*	-	0.39 ± 0.290	0.47 ± 0.410	0.36 ± 0.283
PTB VTBB	*0.24*	*0.10*	*0.10*	*0.45*	*0.63*	-	0.08 ± 0.309	-0.03 ± 0.086
CEM VTBB	*0.45*	*0.35*	*0.36*	*0.56*	*0.81*	*0.34*	-	-0.11 ± 0.303
INRiM FP	*0.21*	*0.08*	*0.06*	*0.44*	*0.60*	*0.10*	*0.36*	-

Table 118 – the results for the INRiM thermometer at 232 °C – FP and VTBB data separated



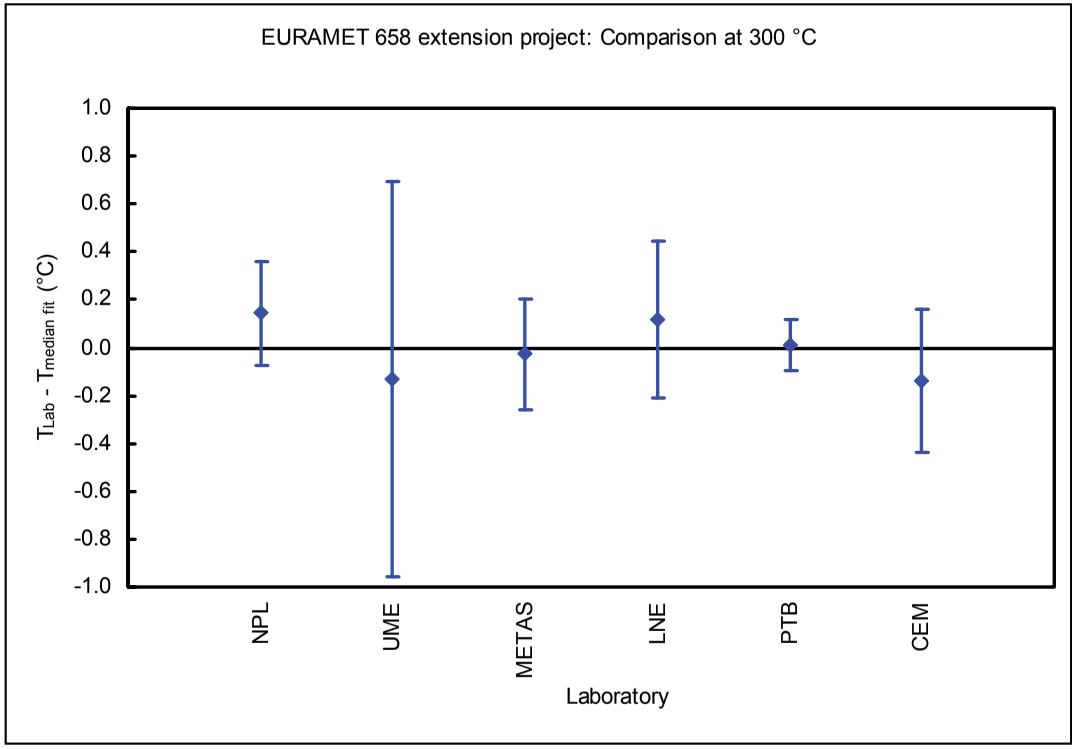
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	0.12 ± 0.836	0.03 ± 0.414	0.00 ± 0.363	0.04 ± 0.219	0.11 ± 0.363
UME	*0.85*	-	-0.10 ± 0.887	-0.12 ± 0.864	-0.09 ± 0.814	-0.02 ± 0.864
METAS	*0.41*	*0.89*	-	-0.02 ± 0.469	0.01 ± 0.369	0.08 ± 0.469
LNE	*0.36*	*0.88*	*0.46*	-	0.03 ± 0.310	0.10 ± 0.424
PTB	*0.23*	*0.81*	*0.36*	*0.31*	-	0.07 ± 0.310
CEM	*0.41*	*0.85*	*0.48*	*0.46*	*0.33*	-

Table 119 – the results for the INRiM thermometer at 250 °C – all data averaged



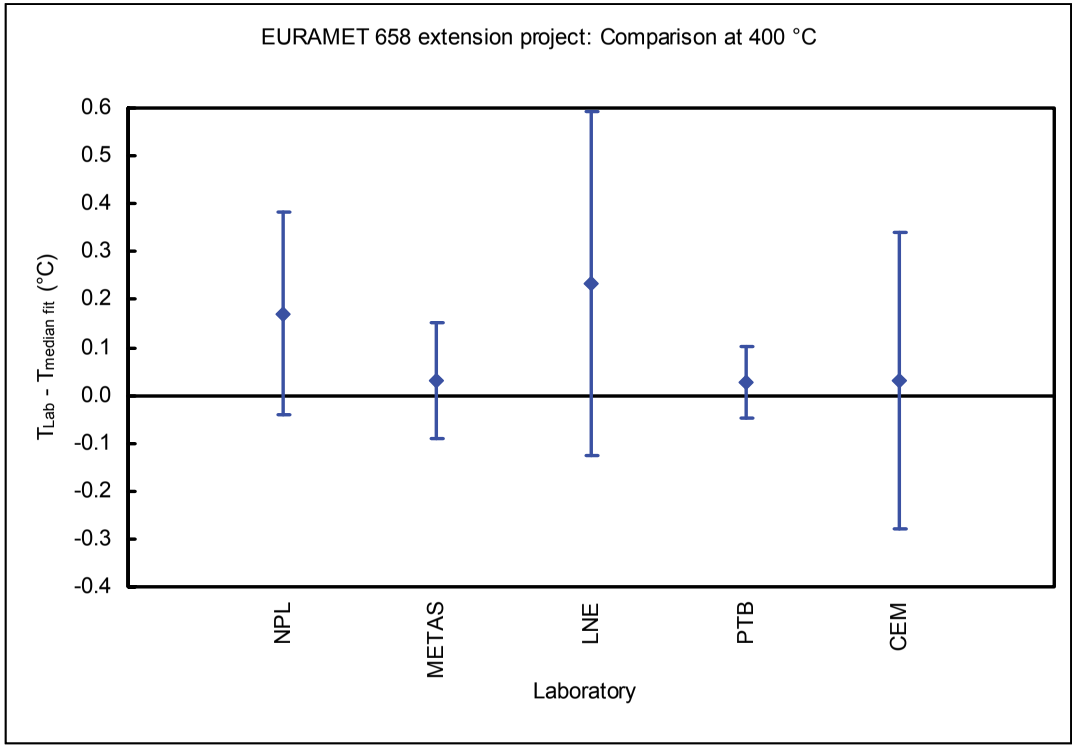
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	0.27 ± 0.852	0.17 ± 0.315	0.03 ± 0.394	0.13 ± 0.241	0.28 ± 0.369
UME	*0.98*	-	-0.10 ± 0.856	-0.25 ± 0.888	-0.14 ± 0.831	0.01 ± 0.877
METAS	*0.43*	*0.86*	-	-0.15 ± 0.402	-0.04 ± 0.254	0.11 ± 0.378
LNE	*0.39*	*0.99*	*0.48*	-	0.10 ± 0.347	0.25 ± 0.446
PTB	*0.33*	*0.86*	*0.26*	*0.39*	-	0.15 ± 0.319
CEM	*0.58*	*0.86*	*0.43*	*0.62*	*0.41*	-

Table 120 – the results for the INRiM thermometer at 300 °C – all data averaged



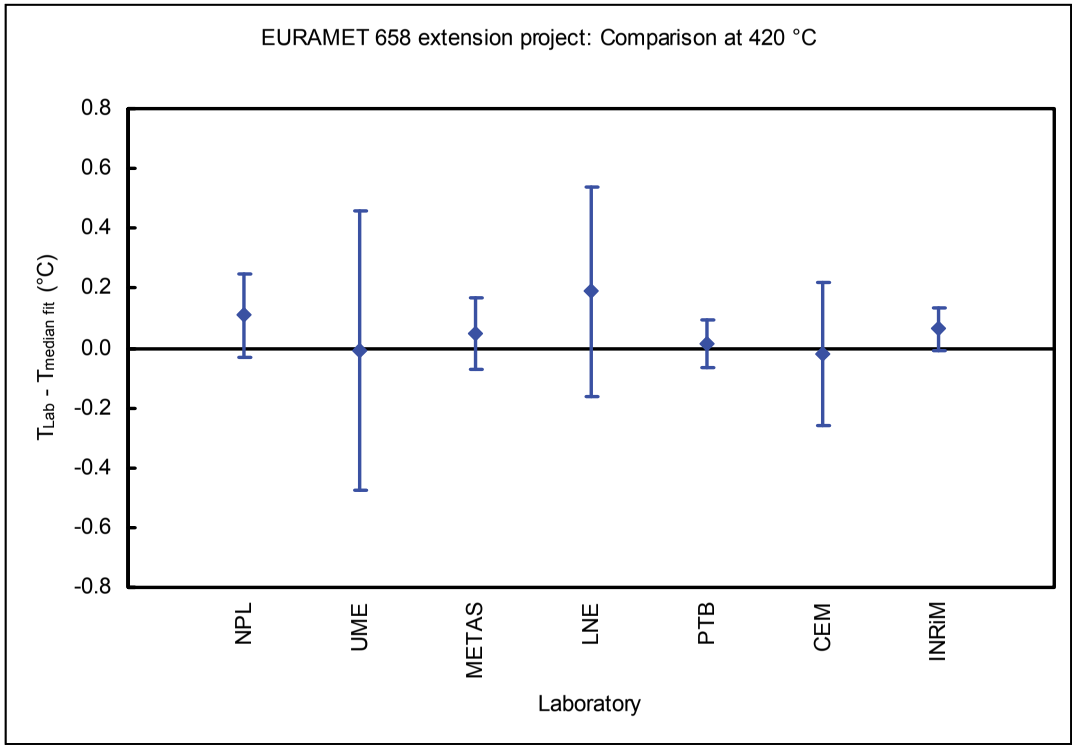
	NPL	METAS	LNE	PTB	CEM
NPL	-	0.14 ± 0.242	-0.06 ± 0.417	0.14 ± 0.224	0.14 ± 0.375
METAS	*0.34*	-	-0.20 ± 0.379	0.00 ± 0.141	0.00 ± 0.332
LNE	*0.43*	*0.52*	-	0.21 ± 0.368	0.20 ± 0.475
PTB	*0.33*	*0.14*	*0.51*	-	0.00 ± 0.319
CEM	*0.45*	*0.33*	*0.60*	*0.31*	-

Table 121 – the results for the INRiM thermometer at 400 °C – all data averaged



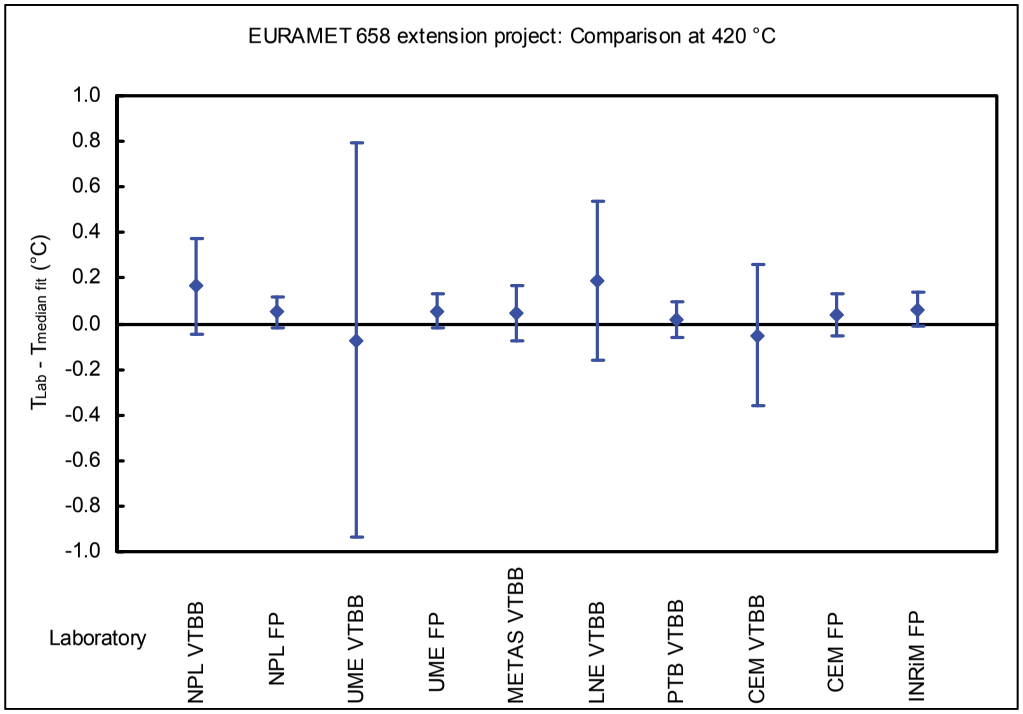
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	0.12 ± 0.489	0.06 ± 0.185	-0.08 ± 0.377	0.09 ± 0.161	0.13 ± 0.277	0.05 ± 0.159
UME	*0.53*	-	-0.06 ± 0.484	-0.20 ± 0.585	-0.02 ± 0.475	0.01 ± 0.526	-0.07 ± 0.474
METAS	*0.22*	*0.49*	-	-0.14 ± 0.370	0.03 ± 0.144	0.07 ± 0.266	-0.02 ± 0.140
LNE	*0.40*	*0.68*	*0.45*	-	0.17 ± 0.359	0.21 ± 0.423	0.13 ± 0.357
PTB	*0.23*	*0.47*	*0.15*	*0.47*	-	0.04 ± 0.251	-0.05 ± 0.107
CEM	*0.36*	*0.52*	*0.29*	*0.56*	*0.26*	-	-0.08 ± 0.249
INRiM	*0.18*	*0.48*	*0.14*	*0.42*	*0.14*	*0.29*	-

Table 122 – the results for the INRiM thermometer at 420 °C – all data averaged



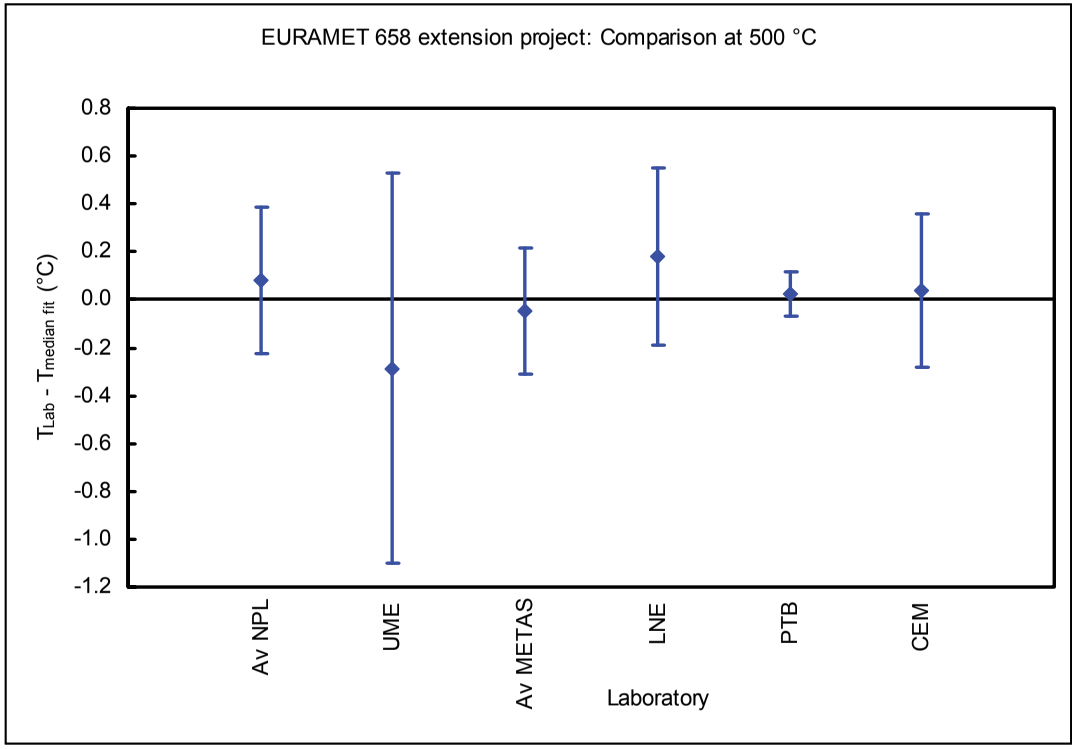
	NPL VTBB	NPL FP	UME VTBB	UME FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	CEM FP	INRiM FP
NPL VTBB	-	0.12 ± 0.221	0.24 ± 0.888	0.11 ± 0.223	0.12 ± 0.242	-0.02 ± 0.408	0.15 ± 0.224	0.22 ± 0.374	0.13 ± 0.228	0.10 ± 0.222
NPL FP	*0.30*	-	0.12 ± 0.865	0.00 ± 0.103	0.00 ± 0.139	-0.14 ± 0.357	0.03 ± 0.105	0.10 ± 0.318	0.01 ± 0.114	-0.01 ± 0.101
UME VTBB	*0.99*	*0.88*	-	-0.13 ± 0.866	-0.12 ± 0.871	-0.26 ± 0.931	-0.09 ± 0.866	-0.02 ± 0.916	-0.11 ± 0.867	-0.14 ± 0.865
UME FP	*0.30*	*0.10*	*0.88*	-	0.01 ± 0.142	-0.13 ± 0.358	0.04 ± 0.109	0.11 ± 0.319	0.01 ± 0.117	-0.01 ± 0.104
METAS VTBB	*0.32*	*0.14*	*0.88*	*0.14*	-	-0.14 ± 0.370	0.03 ± 0.144	0.10 ± 0.332	0.01 ± 0.150	-0.02 ± 0.140
LNE VTBB	*0.40*	*0.43*	*1.04*	*0.43*	*0.45*	-	0.17 ± 0.359	0.24 ± 0.468	0.15 ± 0.361	0.13 ± 0.357
PTB VTBB	*0.34*	*0.12*	*0.86*	*0.13*	*0.15*	*0.47*	-	0.07 ± 0.320	-0.02 ± 0.120	-0.05 ± 0.107
CEM VTBB	*0.53*	*0.37*	*0.90*	*0.37*	*0.38*	*0.63*	*0.34*	-	-0.09 ± 0.323	-0.11 ± 0.318
CEM FP	*0.32*	*0.11*	*0.88*	*0.12*	*0.15*	*0.45*	*0.13*	*0.36*	-	-0.02 ± 0.116
INRiM FP	*0.29*	*0.10*	*0.89*	*0.10*	*0.14*	*0.42*	*0.14*	*0.38*	*0.12*	-

Table 123 – the results for the INRiM thermometer at 420 °C – FP and VTBB data separated



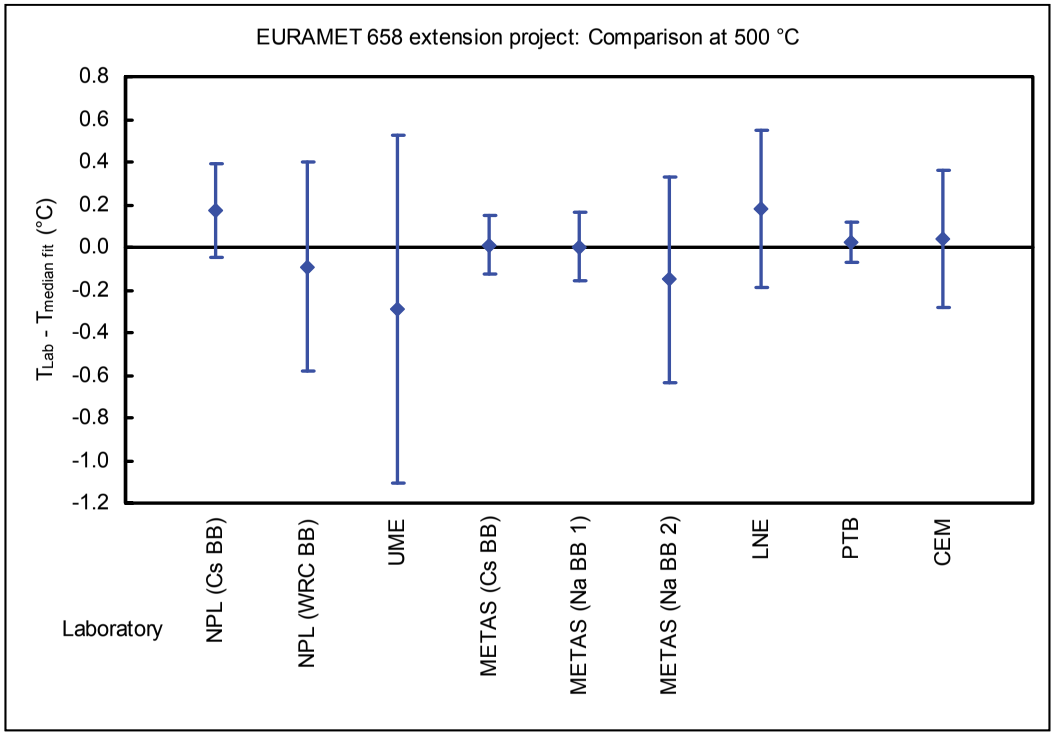
	Av NPL	UME	Av METAS	LNE	PTB	CEM
Av NPL	-	0.37 ± 0.871	0.13 ± 0.404	-0.10 ± 0.481	0.06 ± 0.323	0.04 ± 0.444
UME	*1.09*	-	-0.24 ± 0.856	-0.47 ± 0.895	-0.31 ± 0.820	-0.33 ± 0.875
Av METAS	*0.47*	*0.96*	-	-0.23 ± 0.453	-0.07 ± 0.279	-0.09 ± 0.414
LNE	*0.51*	*1.21*	*0.60*	-	0.16 ± 0.382	0.14 ± 0.489
PTB	*0.34*	*0.99*	*0.31*	*0.48*	-	-0.02 ± 0.334
CEM	*0.44*	*1.05*	*0.44*	*0.55*	*0.33*	-

Table 124 – the results for the INRiM thermometer at 500 °C – all data averaged



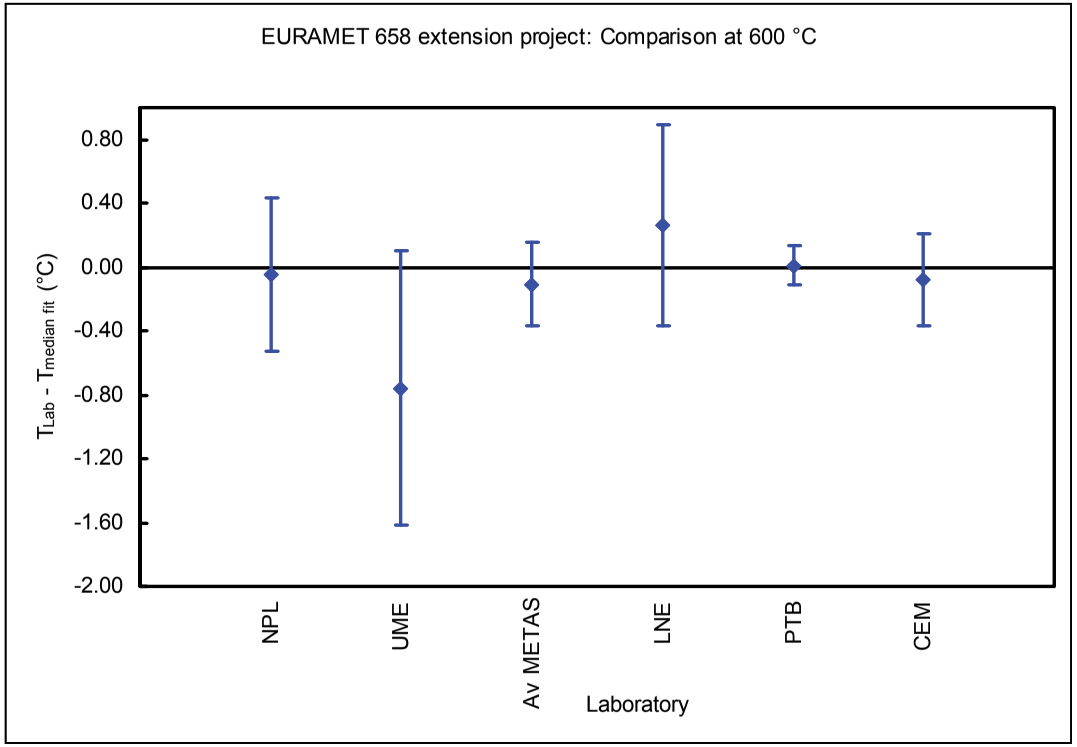
	NPL (Cs BB)	NPL (WRC BB)	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE	PTB	CEM
NPL (Cs BB)	-	0.26 ± 0.537	0.46 ± 0.844	0.16 ± 0.261	0.17 ± 0.272	0.32 ± 0.528	-0.01 ± 0.428	0.15 ± 0.240	0.13 ± 0.388
NPL (WRC BB)	*0.70*	-	0.20 ± 0.951	-0.10 ± 0.510	-0.10 ± 0.515	0.06 ± 0.686	-0.27 ± 0.612	-0.12 ± 0.499	-0.13 ± 0.585
UME	*1.15*	*1.01*	-	-0.30 ± 0.827	-0.29 ± 0.830	-0.14 ± 0.945	-0.47 ± 0.893	-0.31 ± 0.820	-0.33 ± 0.875
METAS (Cs BB)	*0.37*	*0.54*	*0.99*	-	0.01 ± 0.213	0.16 ± 0.500	-0.17 ± 0.393	-0.01 ± 0.169	-0.03 ± 0.349
METAS (Na BB 1)	*0.39*	*0.54*	*0.98*	*0.21*	-	0.16 ± 0.506	-0.18 ± 0.400	-0.02 ± 0.186	-0.04 ± 0.358
METAS (Na BB 2)	*0.76*	*0.68*	*0.96*	*0.58*	*0.58*	-	-0.33 ± 0.604	-0.18 ± 0.489	-0.19 ± 0.577
LNE	*0.42*	*0.78*	*1.21*	*0.50*	*0.51*	*0.83*	-	0.16 ± 0.379	0.14 ± 0.487
PTB	*0.34*	*0.54*	*0.99*	*0.17*	*0.19*	*0.58*	*0.47*	-	-0.02 ± 0.334
CEM	*0.45*	*0.63*	*1.05*	*0.35*	*0.36*	*0.67*	*0.55*	*0.33*	-

Table 125 – the results for the INRiM thermometer at 500 °C – data separated according to source type



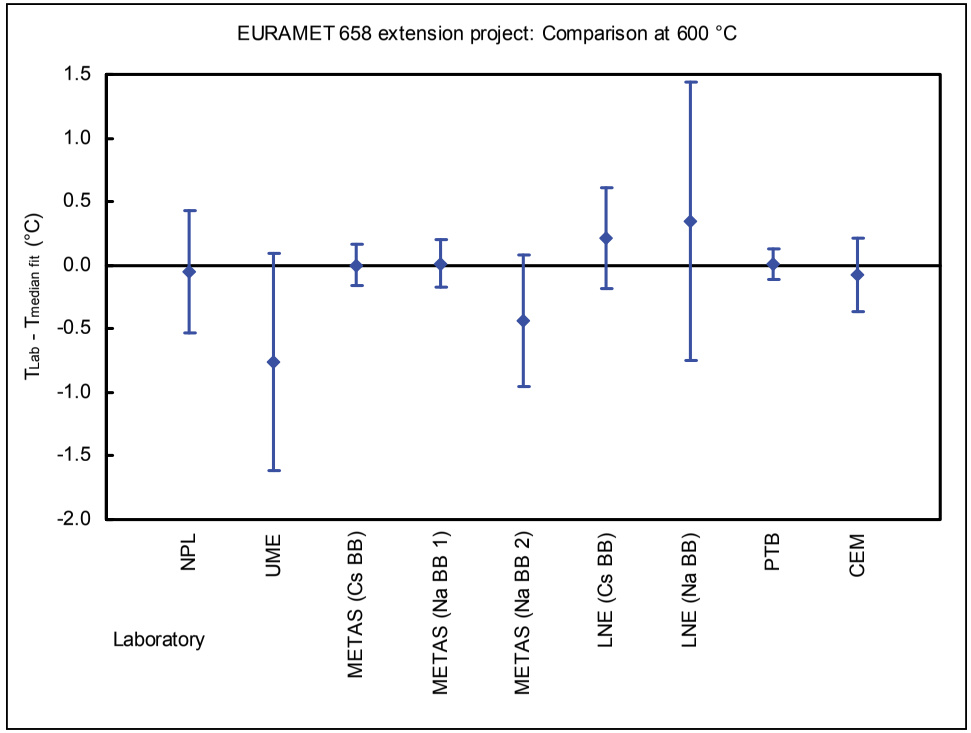
	NPL	UME	Av METAS	LNE	PTB	CEM
NPL	-	0.71 ± 0.984	0.06 ± 0.548	-0.31 ± 0.794	-0.06 ± 0.498	0.03 ± 0.563
UME	*1.52*	-	-0.65 ± 0.896	-1.02 ± 1.064	-0.77 ± 0.866	-0.68 ± 0.905
Av METAS	*0.55*	*1.39*	-	-0.36 ± 0.681	-0.12 ± 0.286	-0.03 ± 0.389
LNE	*0.97*	*1.89*	*0.93*	-	0.25 ± 0.641	0.34 ± 0.693
PTB	*0.50*	*1.48*	*0.35*	*0.78*	-	0.09 ± 0.314
CEM	*0.55*	*1.43*	*0.38*	*0.91*	*0.35*	-

Table 126 – the results for the INRiM thermometer at 600 °C – all data averaged



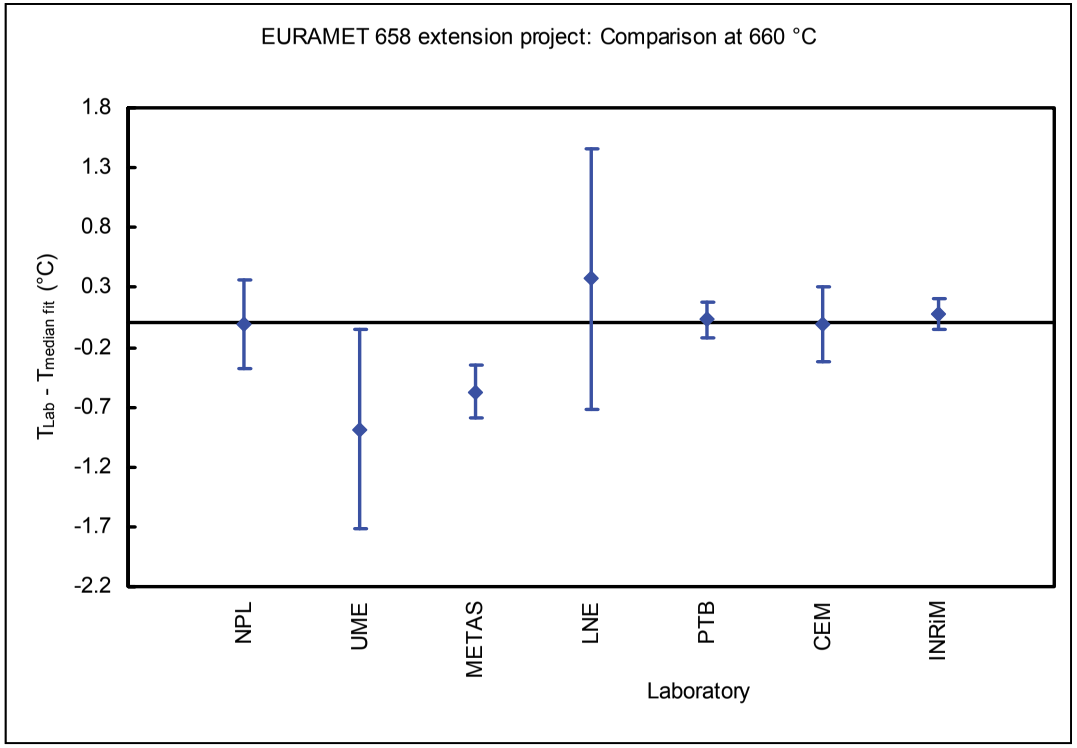
	NPL	UME	METAS (Cs BB)	METAS (Na BB 1)	METAS (Na BB 2)	LNE (Cs BB)	LNE (Na BB)	PTB	CEM
NPL	-	0.71 ± 0.984	-0.05 ± 0.509	-0.06 ± 0.519	0.39 ± 0.710	-0.26 ± 0.625	-0.39 ± 1.197	-0.06 ± 0.498	0.03 ± 0.563
UME	*1.52*	-	-0.76 ± 0.872	-0.77 ± 0.878	-0.32 ± 1.003	-0.97 ± 0.945	-1.10 ± 1.390	-0.77 ± 0.866	-0.68 ± 0.905
METAS (Cs BB)	*0.51*	*1.48*	-	-0.01 ± 0.248	0.44 ± 0.544	-0.22 ± 0.428	-0.35 ± 1.106	-0.01 ± 0.200	0.08 ± 0.331
METAS (Na BB 1)	*0.52*	*1.49*	*0.24*	-	0.45 ± 0.554	-0.20 ± 0.440	-0.33 ± 1.111	0.00 ± 0.225	0.09 ± 0.347
METAS (Na BB 2)	*0.97*	*1.16*	*0.88*	*0.91*	-	-0.65 ± 0.654	-0.78 ± 1.212	-0.45 ± 0.534	-0.36 ± 0.595
LNE (Cs BB)	*0.78*	*1.75*	*0.57*	*0.57*	*1.19*	-	-0.13 ± 1.165	0.20 ± 0.415	0.29 ± 0.492
LNE (Na BB)	*1.39*	*2.25*	*1.27*	*1.26*	*1.78*	*1.17*	-	0.34 ± 1.101	0.42 ± 1.133
PTB	*0.50*	*1.48*	*0.20*	*0.22*	*0.89*	*0.55*	*1.26*	-	0.09 ± 0.314
CEM	*0.55*	*1.43*	*0.36*	*0.38*	*0.85*	*0.70*	*1.36*	*0.35*	-

Table 127 – the results for the INRiM thermometer at 600 °C – data separated according to source type



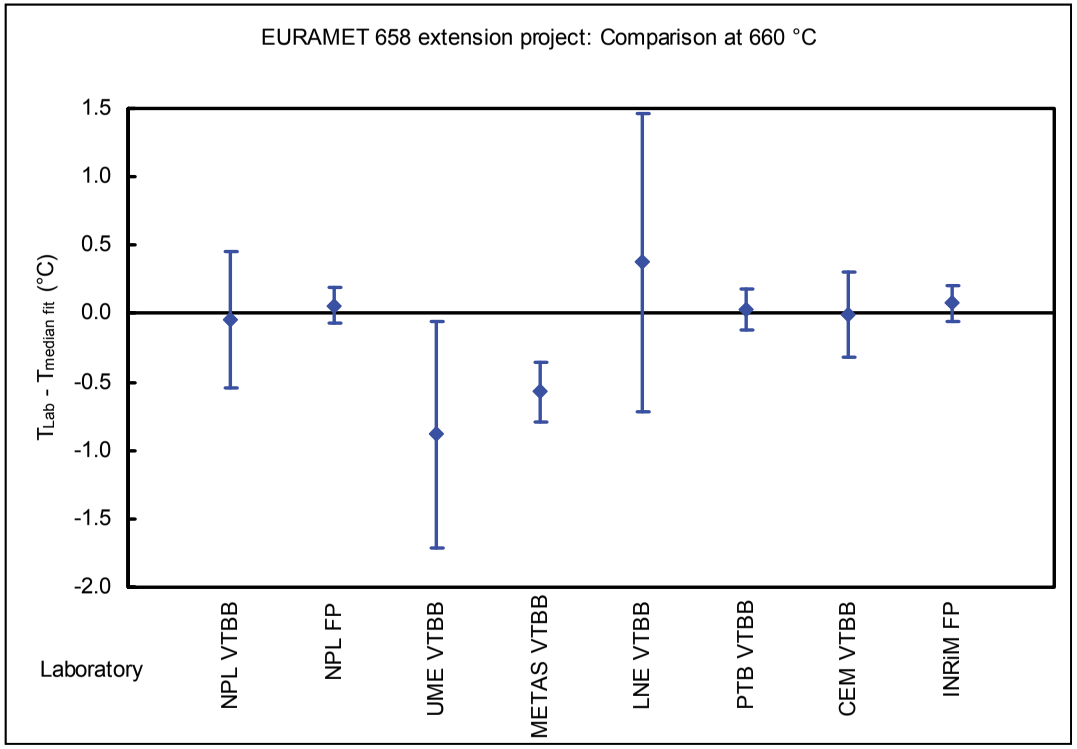
	NPL	UME	METAS	LNE	PTB	CEM	INRiM
NPL	-	0.87 ± 0.912	0.56 ± 0.434	-0.38 ± 1.152	-0.04 ± 0.402	0.00 ± 0.486	-0.09 ± 0.396
UME	*1.62*	-	-0.31 ± 0.860	-1.26 ± 1.371	-0.91 ± 0.845	-0.88 ± 0.888	-0.96 ± 0.842
METAS	*0.92*	*1.03*	-	-0.94 ± 1.112	-0.60 ± 0.264	-0.56 ± 0.380	-0.65 ± 0.255
LNE	*1.34*	*2.39*	*1.86*	-	0.35 ± 1.100	0.38 ± 1.133	0.29 ± 1.098
PTB	*0.40*	*1.61*	*0.82*	*1.26*	-	0.04 ± 0.343	-0.05 ± 0.195
CEM	*0.48*	*1.61*	*0.88*	*1.33*	*0.34*	-	-0.09 ± 0.336
INRiM	*0.42*	*1.65*	*0.86*	*1.22*	*0.22*	*0.37*	-

Table 128– the results for the INRiM thermometer at 660 °C – all data averaged



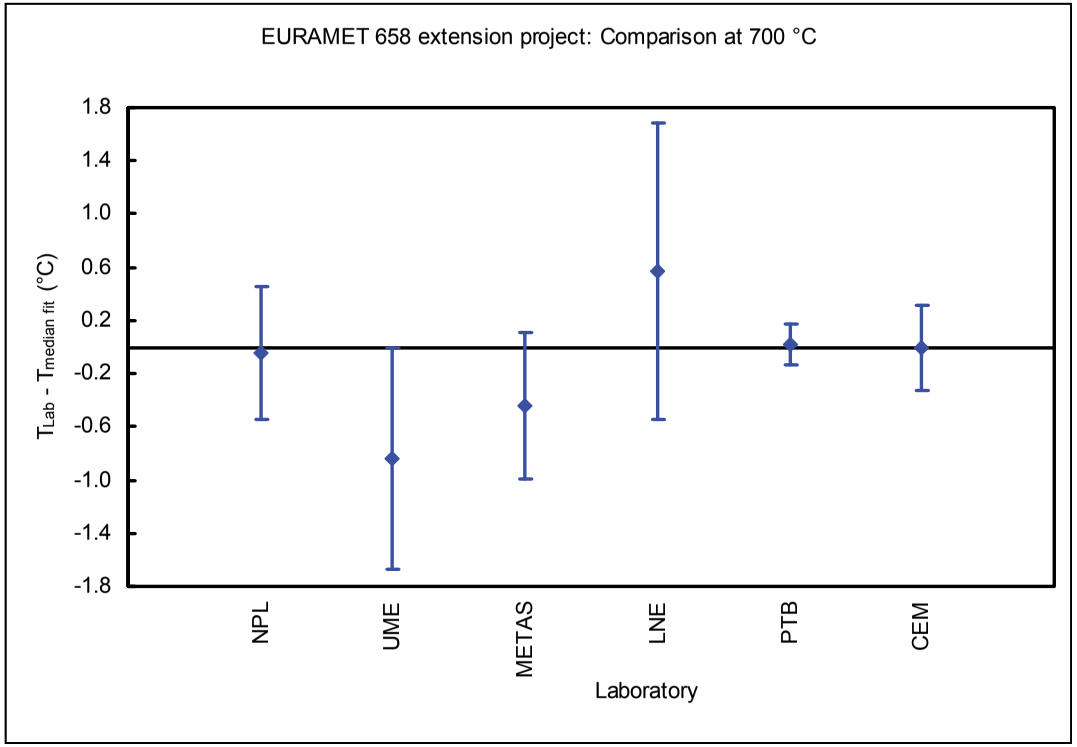
	NPL VTBB	NPL FP	UME VTBB	METAS VTBB	LNE VTBB	PTB VTBB	CEM VTBB	INRiM FP
NPL VTBB	-	-0.11 ± 0.517	0.84 ± 0.971	0.53 ± 0.546	-0.42 ± 1.199	-0.07 ± 0.521	-0.04 ± 0.588	-0.12 ± 0.516
NPL FP	*0.55*	-	0.94 ± 0.842	0.63 ± 0.256	-0.31 ± 1.098	0.03 ± 0.196	0.07 ± 0.336	-0.02 ± 0.183
UME VTBB	*1.64*	*1.64*	-	-0.31 ± 0.860	-1.26 ± 1.371	-0.91 ± 0.845	-0.88 ± 0.888	-0.96 ± 0.842
METAS VTBB	*0.97*	*0.84*	*1.03*	-	-0.94 ± 1.112	-0.60 ± 0.264	-0.56 ± 0.380	-0.65 ± 0.255
LNE VTBB	*1.42*	*1.23*	*2.39*	*1.86*	-	0.35 ± 1.100	0.38 ± 1.133	0.29 ± 1.098
PTB VTBB	*0.53*	*0.20*	*1.61*	*0.82*	*1.26*	-	0.04 ± 0.343	-0.05 ± 0.195
CEM VTBB	*0.58*	*0.35*	*1.61*	*0.88*	*1.33*	*0.34*	-	-0.09 ± 0.336
INRiM FP	*0.56*	*0.18*	*1.65*	*0.86*	*1.22*	*0.22*	*0.37*	-

Table 129 – the results for the INRiM thermometer at 660 °C – FP and VTBB data separated



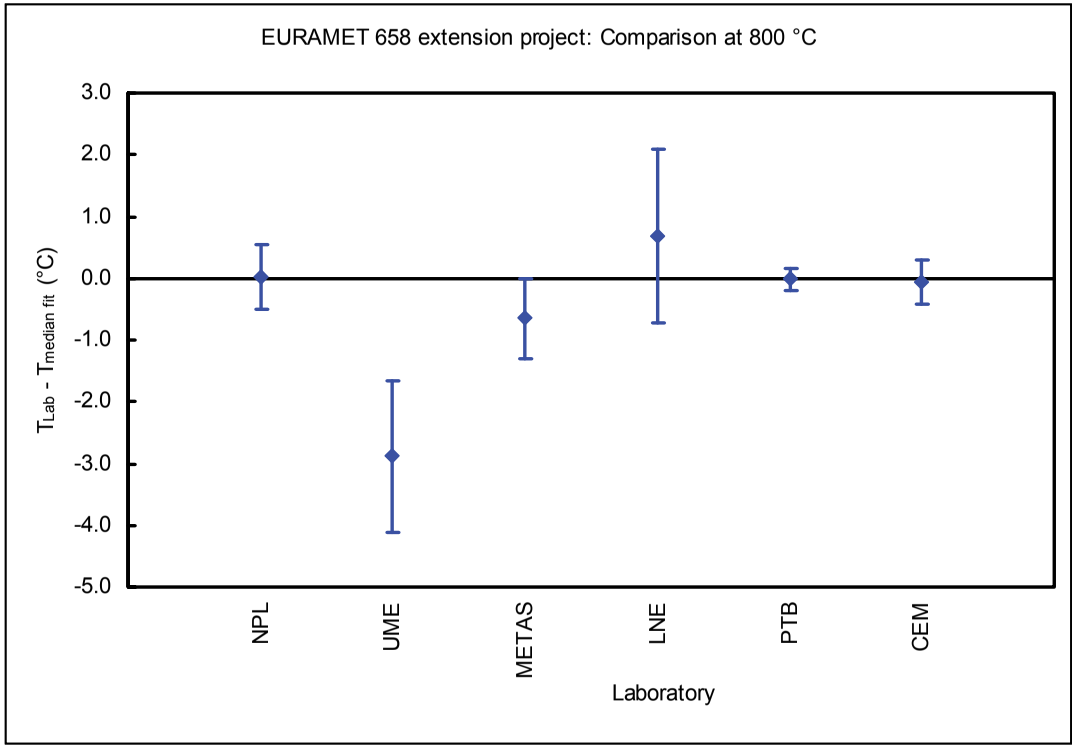
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	0.80 ± 0.973	0.40 ± 0.743	-0.61 ± 1.226	-0.06 ± 0.524	-0.04 ± 0.593
UME	*1.60*	-	-0.40 ± 1.000	-1.41 ± 1.397	-0.86 ± 0.850	-0.84 ± 0.894
METAS	*1.01*	*1.23*	-	-1.01 ± 1.248	-0.46 ± 0.572	-0.44 ± 0.636
LNE	*1.63*	*2.56*	*2.04*	-	0.55 ± 1.131	0.57 ± 1.165
PTB	*0.53*	*1.56*	*0.93*	*1.48*	-	0.03 ± 0.357
CEM	*0.58*	*1.57*	*0.96*	*1.54*	*0.35*	-

Table 130 – the results for the INRiM thermometer at 700 °C – all data averaged



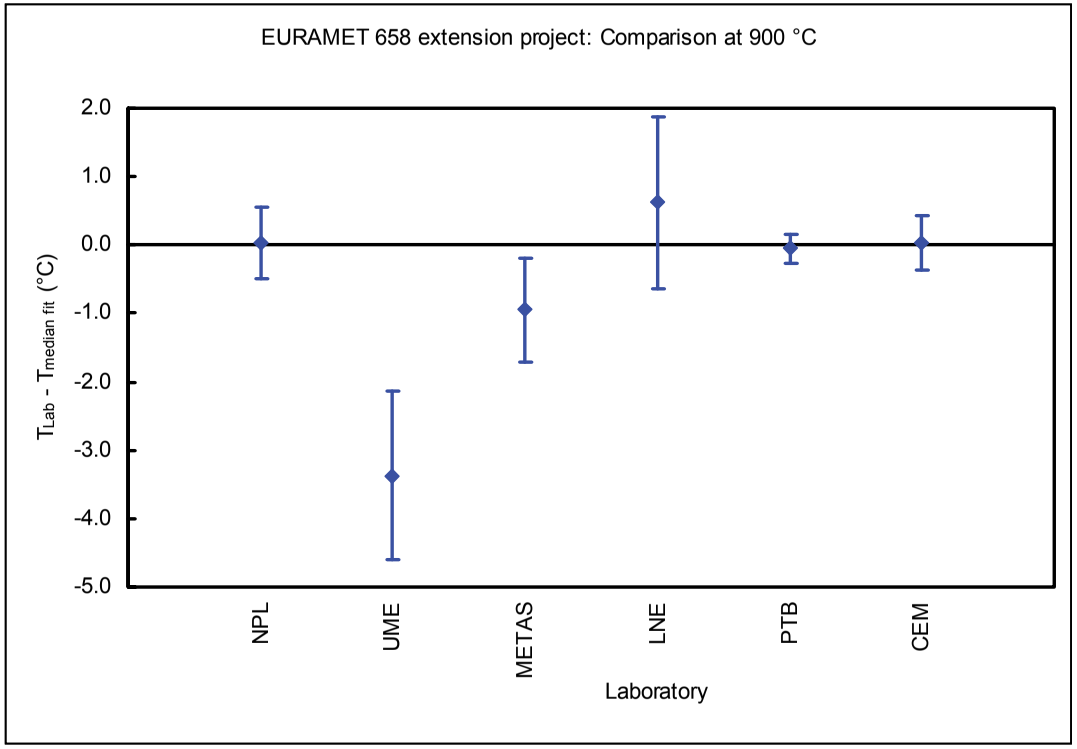
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	2.91 ± 1.327	0.68 ± 0.823	-0.65 ± 1.502	0.04 ± 0.551	0.09 ± 0.625
UME	*4.00*	-	-2.23 ± 1.380	-3.56 ± 1.866	-2.87 ± 1.236	-2.82 ± 1.271
METAS	*1.36*	*3.37*	-	-1.33 ± 1.548	-0.64 ± 0.667	-0.59 ± 0.729
LNE	*1.90*	*5.10*	*2.61*	-	0.70 ± 1.422	0.75 ± 1.453
PTB	*0.54*	*3.89*	*1.19*	*1.87*	-	0.05 ± 0.397
CEM	*0.64*	*3.86*	*1.19*	*1.94*	*0.40*	-

Table 131 – the results for the INRiM thermometer at 800 °C – all data averaged



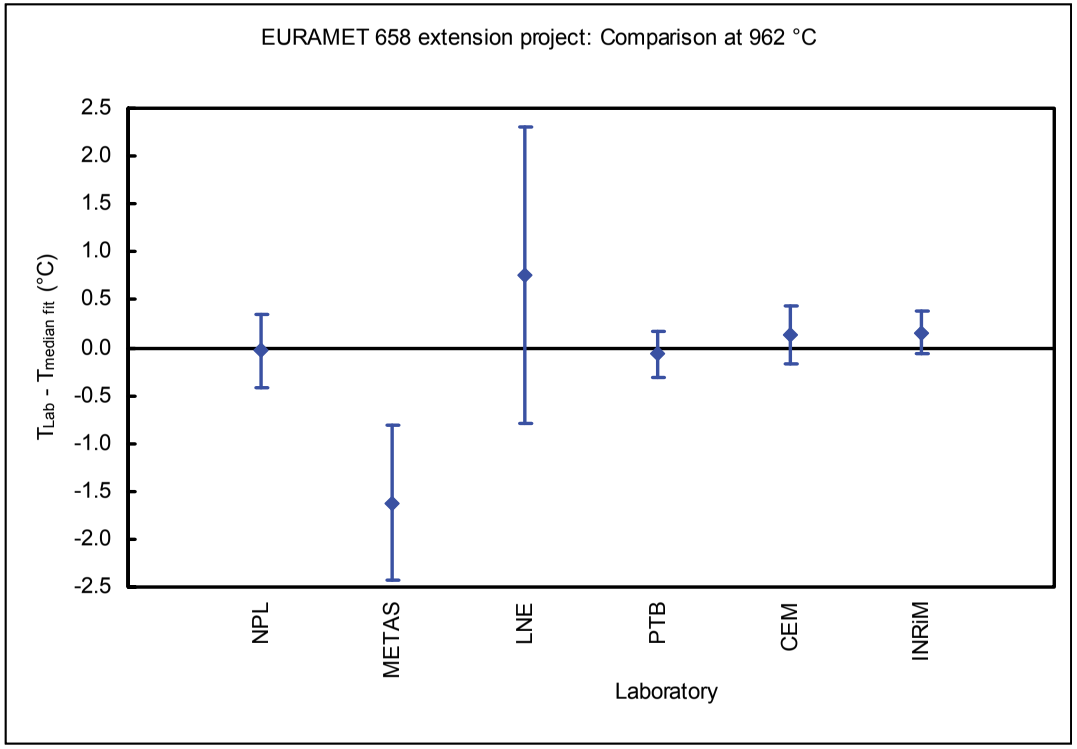
	NPL	UME	METAS	LNE	PTB	CEM
NPL	-	3.41 ± 1.339	0.99 ± 0.918	-0.58 ± 1.370	0.09 ± 0.573	0.01 ± 0.658
UME	*4.51*	-	-2.42 ± 1.441	-3.99 ± 1.763	-3.32 ± 1.249	-3.40 ± 1.290
METAS	*1.74*	*3.61*	-	-1.57 ± 1.469	-0.90 ± 0.781	-0.98 ± 0.845
LNE	*1.72*	*5.44*	*2.78*	-	0.67 ± 1.282	0.59 ± 1.322
PTB	*0.59*	*4.35*	*1.54*	*1.73*	-	-0.08 ± 0.447
CEM	*0.65*	*4.46*	*1.67*	*1.68*	*0.47*	-

Table 132 – the results for the INRiM thermometer at 900 °C – all data averaged



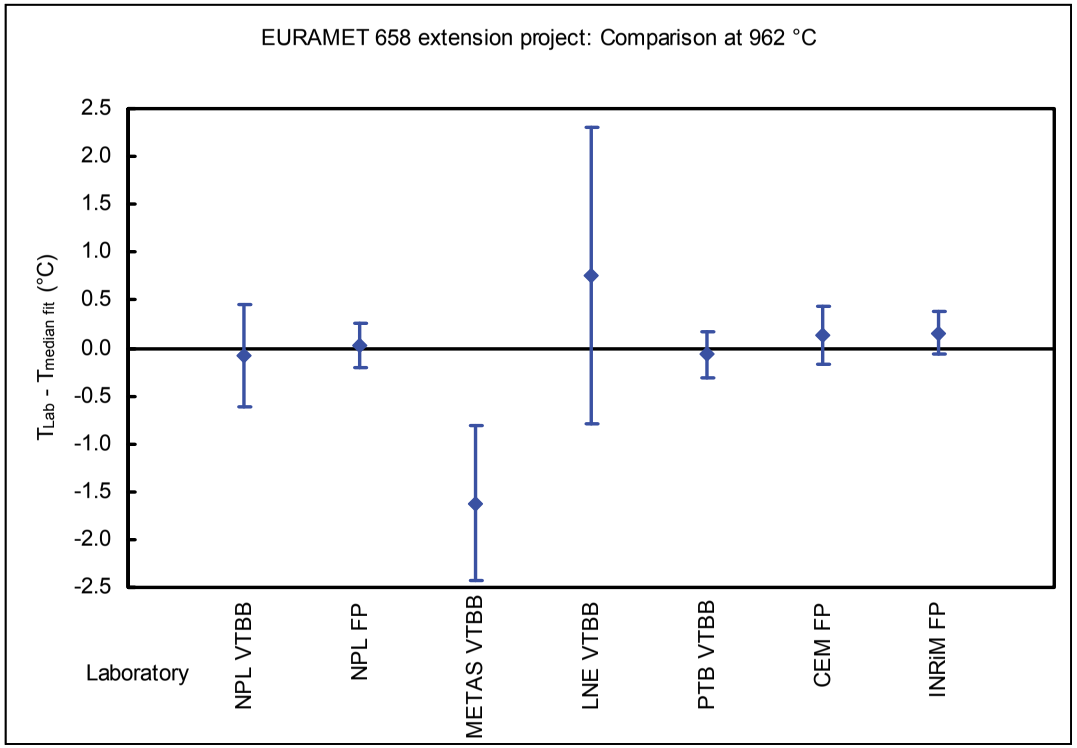
	NPL	METAS	LNE	PTB	CEM	INRiM
NPL	-	1.60 ± 0.896	-0.78 ± 1.597	0.04 ± 0.454	-0.16 ± 0.488	-0.19 ± 0.445
METAS	*2.33*	-	-2.38 ± 1.749	-1.55 ± 0.845	-1.76 ± 0.864	-1.78 ± 0.840
LNE	*2.10*	*3.82*	-	0.82 ± 1.569	0.62 ± 1.579	0.59 ± 1.566
PTB	*0.45*	*2.25*	*2.12*	-	-0.21 ± 0.386	-0.23 ± 0.330
CEM	*0.57*	*2.47*	*1.93*	*0.52*	-	-0.02 ± 0.375
INRiM	*0.56*	*2.47*	*1.90*	*0.50*	*0.37*	-

Table 133 – the results for the INRiM thermometer at 962 °C – all data averaged



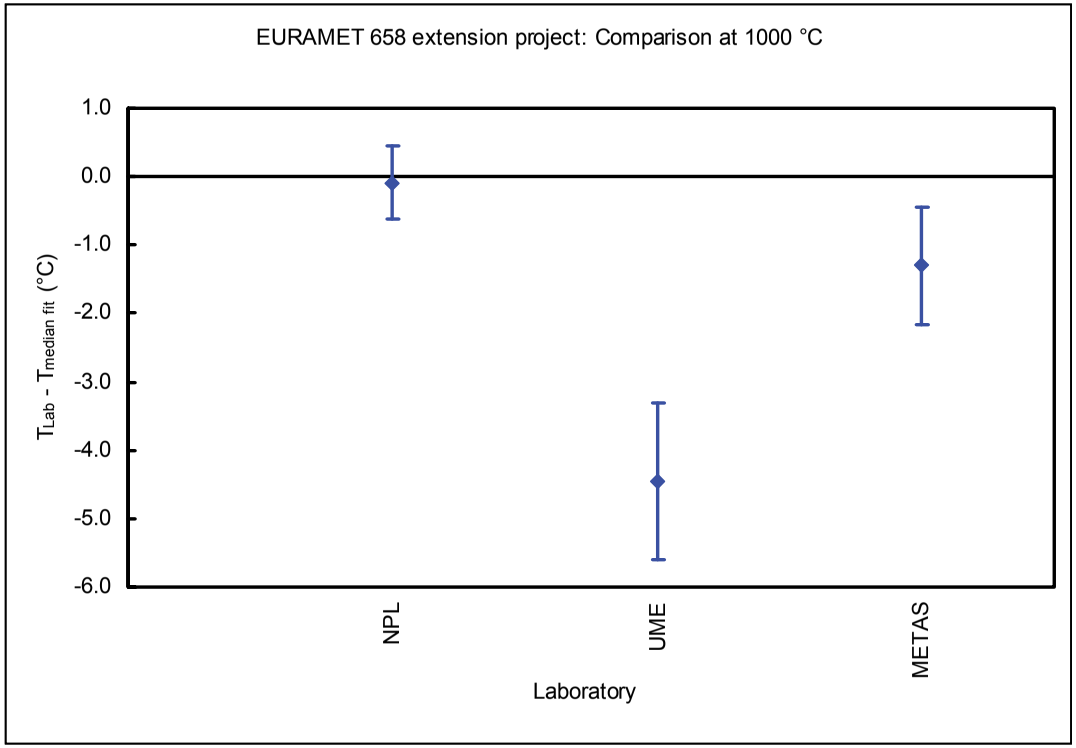
	NPL VTBB	NPL FP	METAS VTBB	LNE VTBB	PTB VTBB	CEM FP	INRiM FP
NPL VTBB	-	-0.10 ± 0.587	1.54 ± 0.973	-0.83 ± 1.644	-0.01 ± 0.592	-0.22 ± 0.618	-0.24 ± 0.585
NPL FP	*0.61*	-	1.65 ± 0.842	-0.73 ± 1.570	0.09 ± 0.334	-0.11 ± 0.379	-0.14 ± 0.321
METAS VTBB	*2.35*	*2.34*	-	-2.38 ± 1.751	-1.55 ± 0.845	-1.76 ± 0.864	-1.78 ± 0.840
LNE VTBB	*2.19*	*2.03*	*3.82*	-	0.82 ± 1.571	0.62 ± 1.582	0.59 ± 1.569
PTB VTBB	*0.58*	*0.37*	*2.25*	*2.12*	-	-0.21 ± 0.386	-0.23 ± 0.330
CEM FP	*0.73*	*0.43*	*2.47*	*1.93*	*0.52*	-	-0.02 ± 0.375
INRiM FP	*0.72*	*0.40*	*2.47*	*1.90*	*0.50*	*0.37*	-

Table 134 – the results for the INRiM thermometer at 962 °C – FP and VTBB data separated



	NPL	UME	METAS
NPL	-	4.36 ± 1.264	1.22 ± 1.026
UME	*5.40*	-	-3.15 ± 1.434
METAS	*2.06*	*4.32*	-

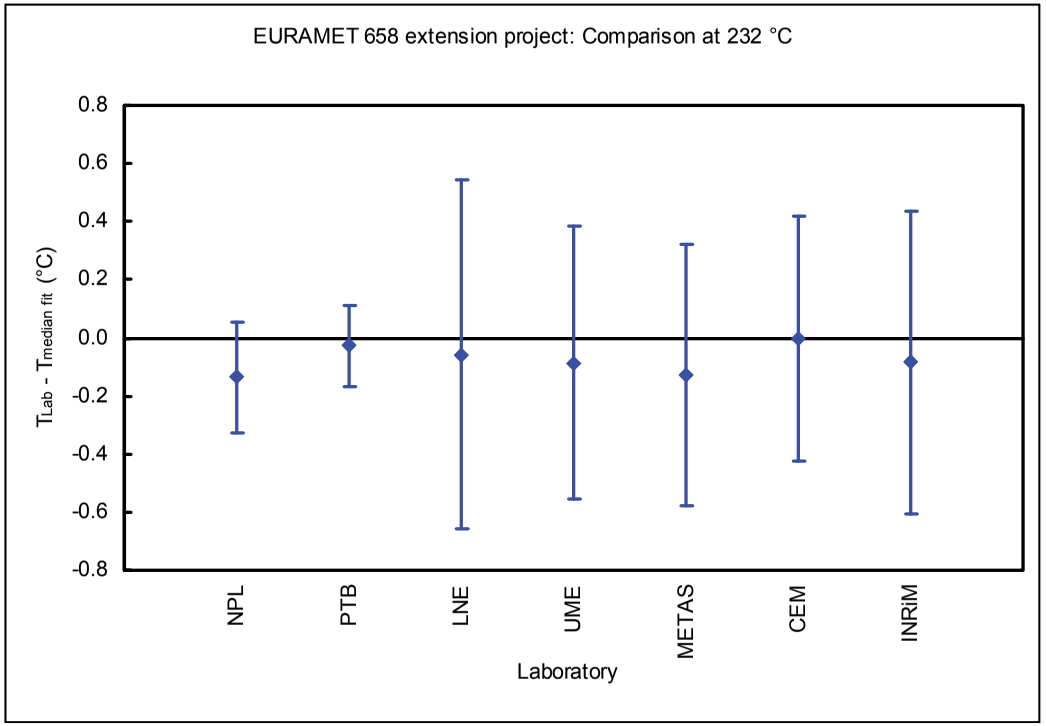
Table 135 – the results for the INRiM thermometer at 1000 °C – all data averaged



20.2 THE RESULTS FOR THE LP5 ON RANGE R1 USING THE FIT OF ALL THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY DATA

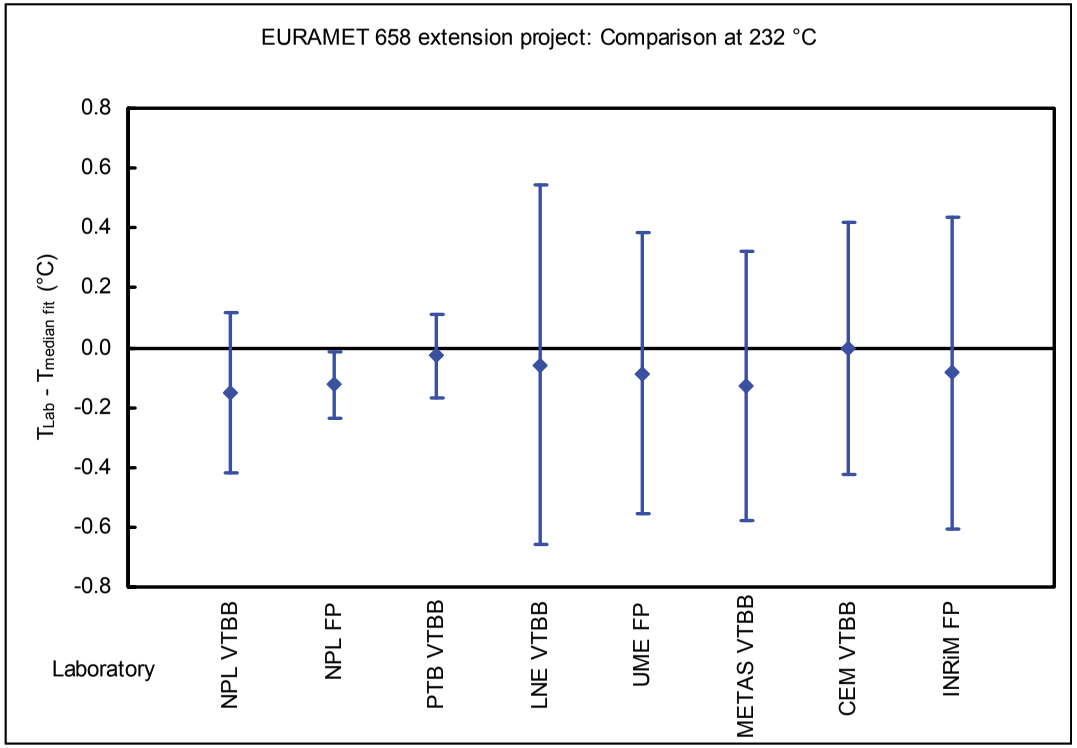
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	-0.11 ± 0.234	-0.08 ± 0.629	-0.05 ± 0.507	-0.01 ± 0.488	-0.13 ± 0.464	-0.05 ± 0.553
PTB	*0.30*	-	0.03 ± 0.616	0.06 ± 0.490	0.10 ± 0.471	-0.03 ± 0.445	0.06 ± 0.538
LNE	*0.63*	*0.60*	-	0.03 ± 0.762	0.07 ± 0.750	-0.06 ± 0.734	0.03 ± 0.794
UME	*0.50*	*0.49*	*0.75*	-	0.04 ± 0.651	-0.08 ± 0.633	0.00 ± 0.701
METAS	*0.48*	*0.50*	*0.74*	*0.64*	-	-0.13 ± 0.618	-0.04 ± 0.688
CEM	*0.52*	*0.44*	*0.73*	*0.64*	*0.65*	-	0.08 ± 0.670
INRiM	*0.55*	*0.54*	*0.78*	*0.69*	*0.68*	*0.67*	-

Table 136 – the results for the LP5 at 232 °C – all data averaged



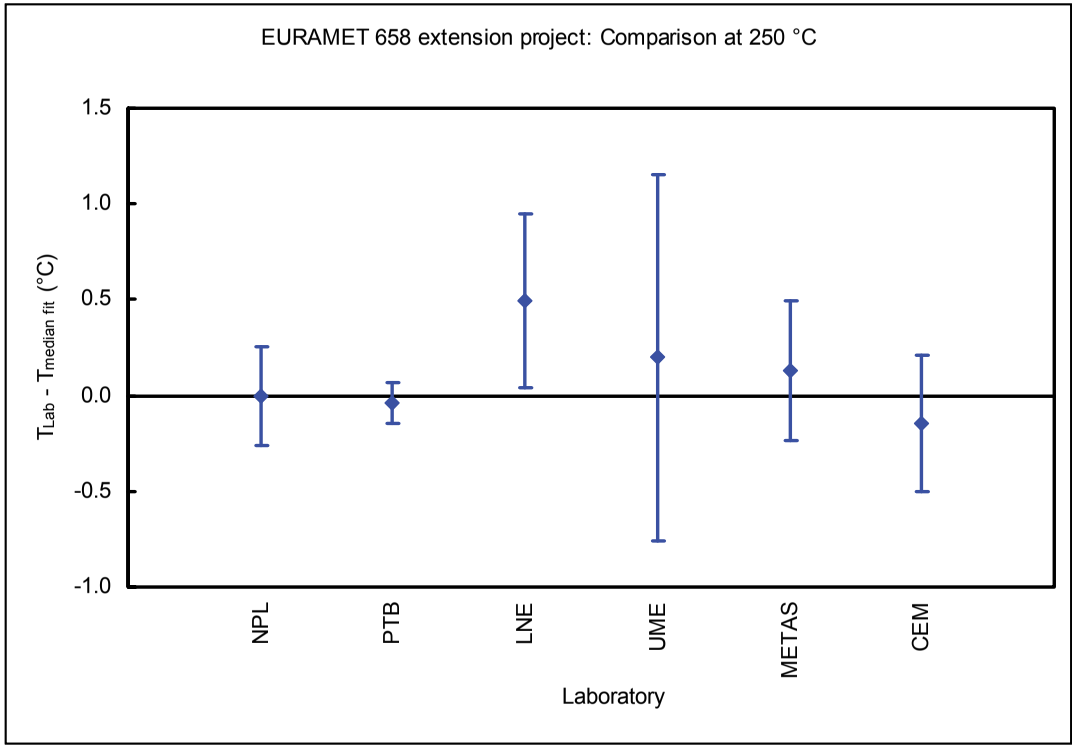
	NPL VTBB	NPL FP	PTB VTBB	LNE VTBB	UME FP	METAS VTBB	CEM VTBB	INRiM FP
NPL VTBB	-	-0.03 ± 0.290	-0.12 ± 0.301	-0.09 ± 0.657	-0.06 ± 0.541	-0.02 ± 0.524	-0.15 ± 0.501	-0.06 ± 0.585
NPL FP	*0.29*	-	-0.10 ± 0.177	-0.07 ± 0.610	-0.04 ± 0.483	0.00 ± 0.464	-0.12 ± 0.438	-0.04 ± 0.532
PTB VTBB	*0.37*	*0.24*	-	0.03 ± 0.616	0.06 ± 0.490	0.10 ± 0.471	-0.03 ± 0.445	0.06 ± 0.538
LNE VTBB	*0.67*	*0.61*	*0.60*	-	0.03 ± 0.762	0.07 ± 0.750	-0.06 ± 0.734	0.03 ± 0.794
UME FP	*0.54*	*0.48*	*0.49*	*0.75*	-	0.04 ± 0.651	-0.08 ± 0.633	0.00 ± 0.701
METAS VTBB	*0.51*	*0.46*	*0.50*	*0.74*	*0.64*	-	-0.13 ± 0.618	-0.04 ± 0.688
CEM VTBB	*0.57*	*0.49*	*0.44*	*0.73*	*0.64*	*0.65*	-	0.08 ± 0.670
INRiM FP	*0.58*	*0.52*	*0.54*	*0.78*	*0.69*	*0.68*	*0.67*	-

Table 137 – the results for the LP5 at 232 °C – FP and VTBB data separated



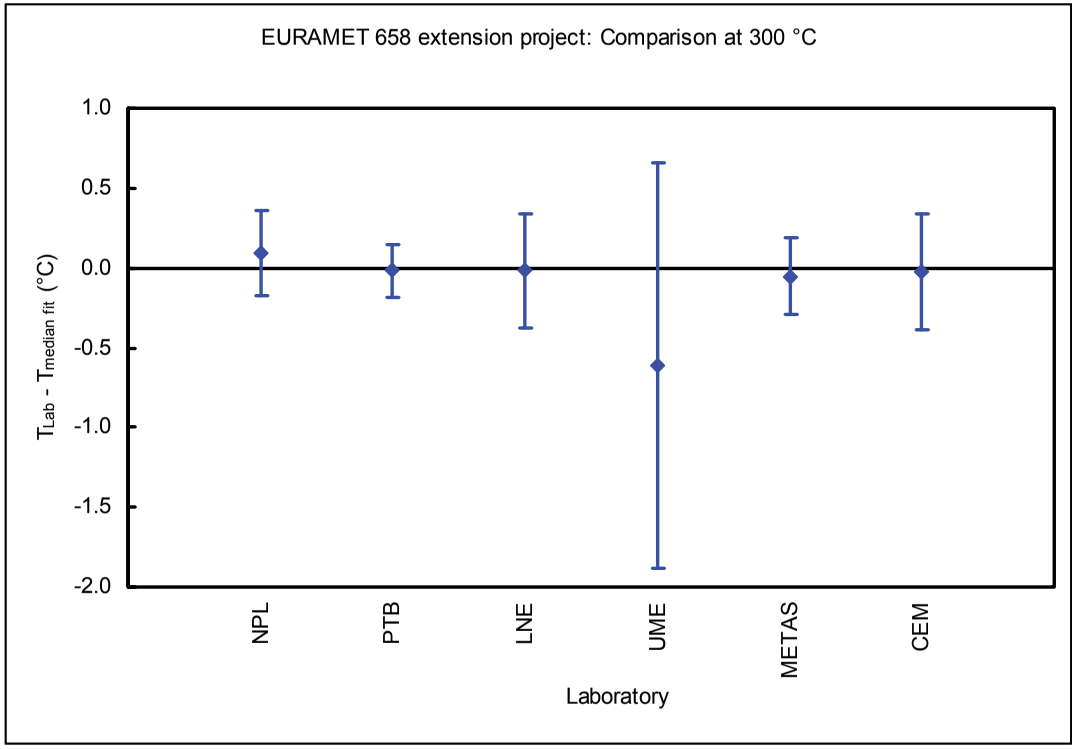
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.04 ± 0.281	-0.49 ± 0.522	-0.20 ± 0.990	-0.13 ± 0.448	0.14 ± 0.442
PTB	*0.29*	-	-0.53 ± 0.466	-0.24 ± 0.962	-0.17 ± 0.381	0.10 ± 0.374
LNE	*0.92*	*0.91*	-	0.29 ± 1.058	0.36 ± 0.582	0.64 ± 0.577
UME	*1.05*	*1.05*	*1.18*	-	0.07 ± 1.023	0.34 ± 1.020
METAS	*0.51*	*0.49*	*0.84*	*1.01*	-	0.28 ± 0.511
CEM	*0.51*	*0.42*	*1.11*	*1.19*	*0.70*	-

Table 138 – the results for the LP5 at 250 °C – all data averaged



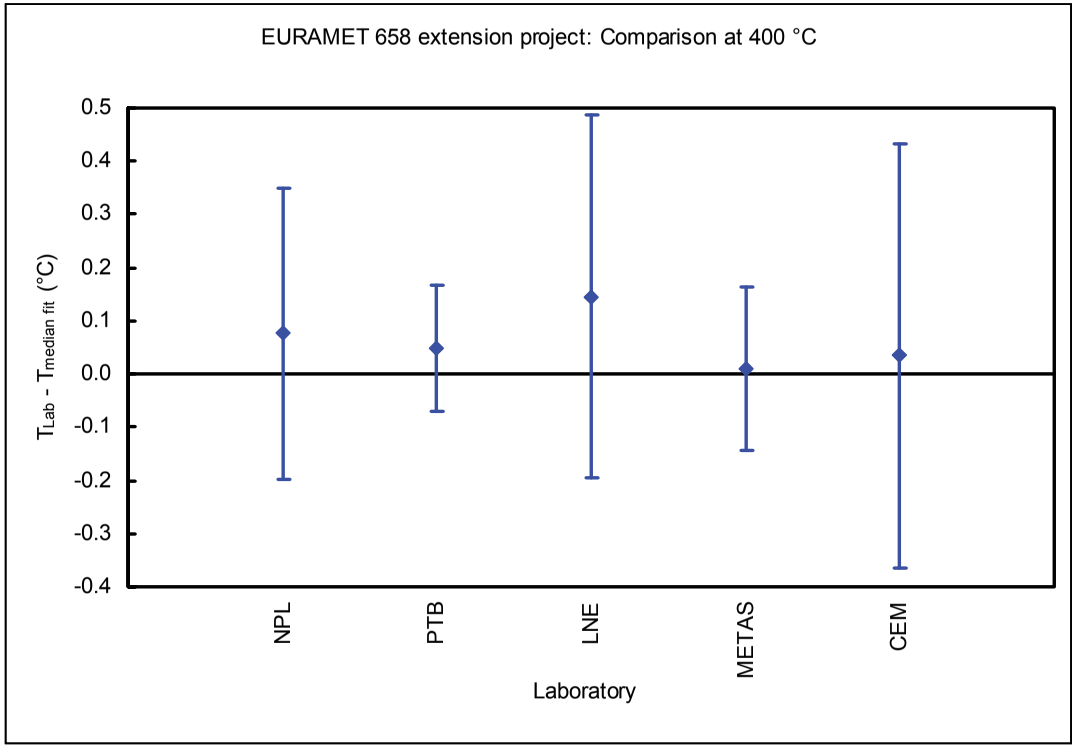
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	0.11 ± 0.310	0.11 ± 0.446	0.71 ± 1.295	0.14 ± 0.355	0.12 ± 0.446
PTB	*0.37*	-	0.00 ± 0.396	0.60 ± 1.278	0.04 ± 0.290	0.01 ± 0.396
LNE	*0.49*	*0.39*	-	0.60 ± 1.318	0.03 ± 0.432	0.01 ± 0.510
UME	*1.77*	*1.65*	*1.68*	-	-0.56 ± 1.290	-0.59 ± 1.318
METAS	*0.44*	*0.29*	*0.43*	*1.63*	-	-0.03 ± 0.433
CEM	*0.50*	*0.39*	*0.50*	*1.68*	*0.43*	-

Table 139– the results for the LP5 at 300 °C – all data averaged



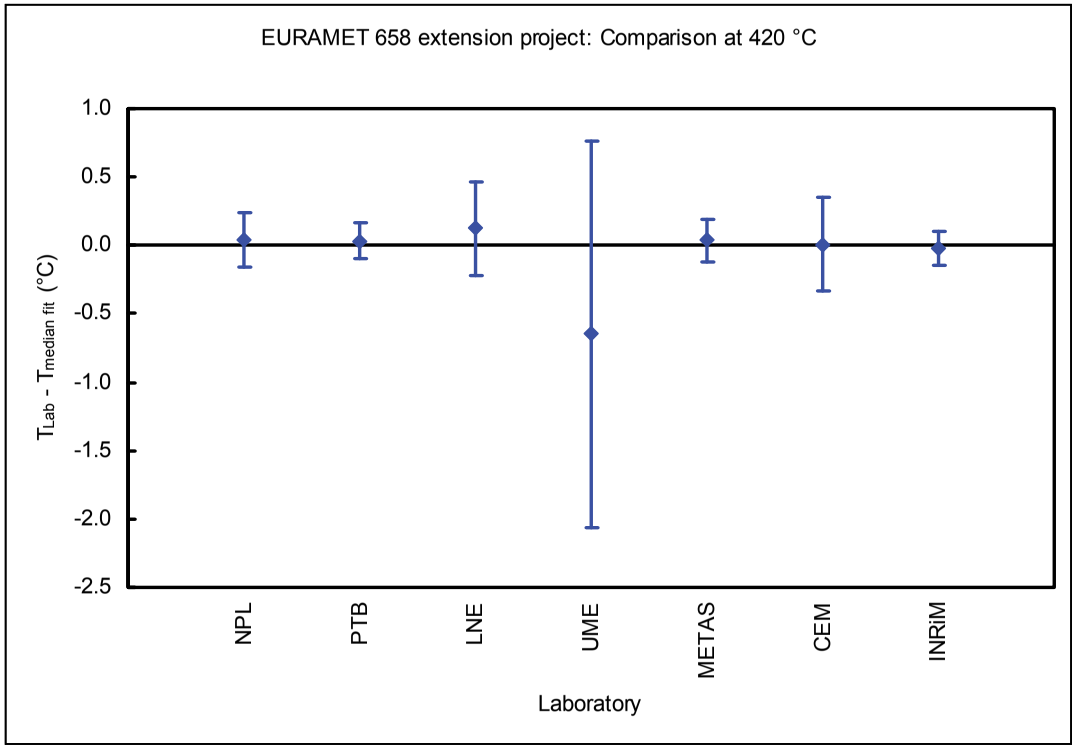
	NPL	PTB	LNE	METAS	CEM
NPL	-	0.03 ± 0.299	-0.07 ± 0.437	0.07 ± 0.314	0.04 ± 0.484
PTB	*0.30*	-	-0.10 ± 0.360	0.04 ± 0.194	0.01 ± 0.416
LNE	*0.45*	*0.40*	-	0.14 ± 0.373	0.11 ± 0.524
METAS	*0.33*	*0.20*	*0.45*	-	-0.02 ± 0.427
CEM	*0.48*	*0.41*	*0.56*	*0.42*	-

Table 140 – the results for the LP5 at 400 °C – all data averaged



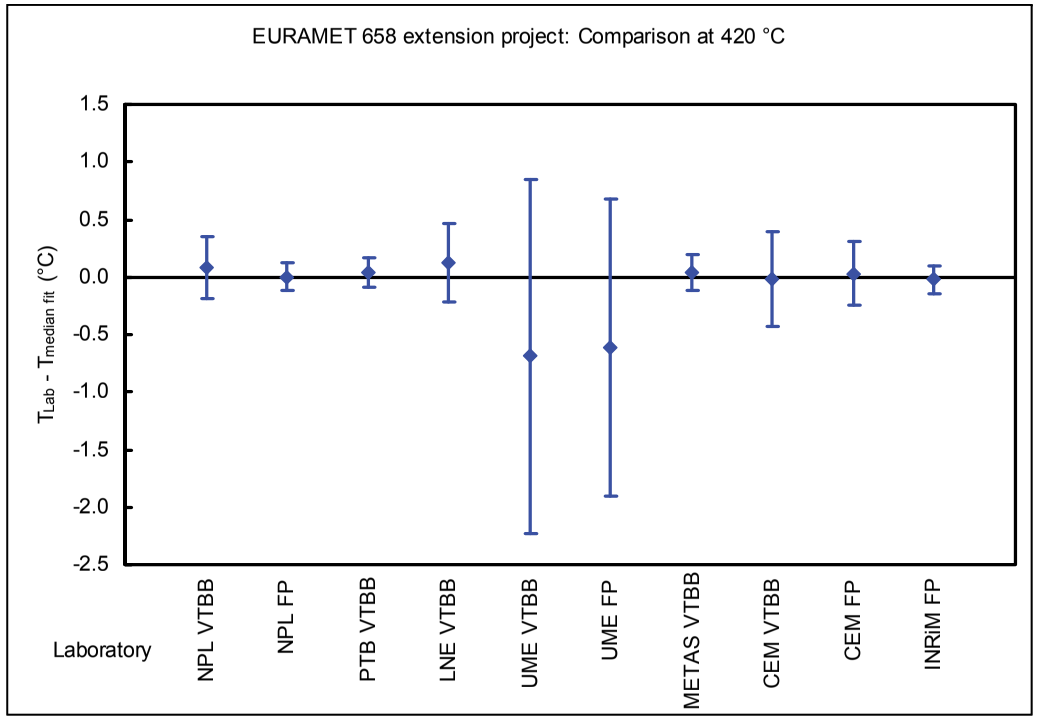
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	0.01 ± 0.233	-0.08 ± 0.393	0.69 ± 1.430	0.01 ± 0.252	0.04 ± 0.397	0.07 ± 0.232
PTB	*0.23*	-	-0.09 ± 0.362	0.68 ± 1.422	0.00 ± 0.202	0.03 ± 0.366	0.06 ± 0.175
LNE	*0.41*	*0.39*	-	0.77 ± 1.457	0.08 ± 0.375	0.12 ± 0.484	0.14 ± 0.361
UME	*1.87*	*1.86*	*1.97*	-	-0.69 ± 1.425	-0.66 ± 1.458	-0.63 ± 1.422
METAS	*0.25*	*0.20*	*0.40*	*1.86*	-	0.03 ± 0.379	0.06 ± 0.200
CEM	*0.39*	*0.36*	*0.53*	*1.86*	*0.38*	-	0.03 ± 0.365
INRiM	*0.26*	*0.20*	*0.44*	*1.80*	*0.23*	*0.36*	-

Table 141 – the results for the LP5 at 420 °C – all data averaged



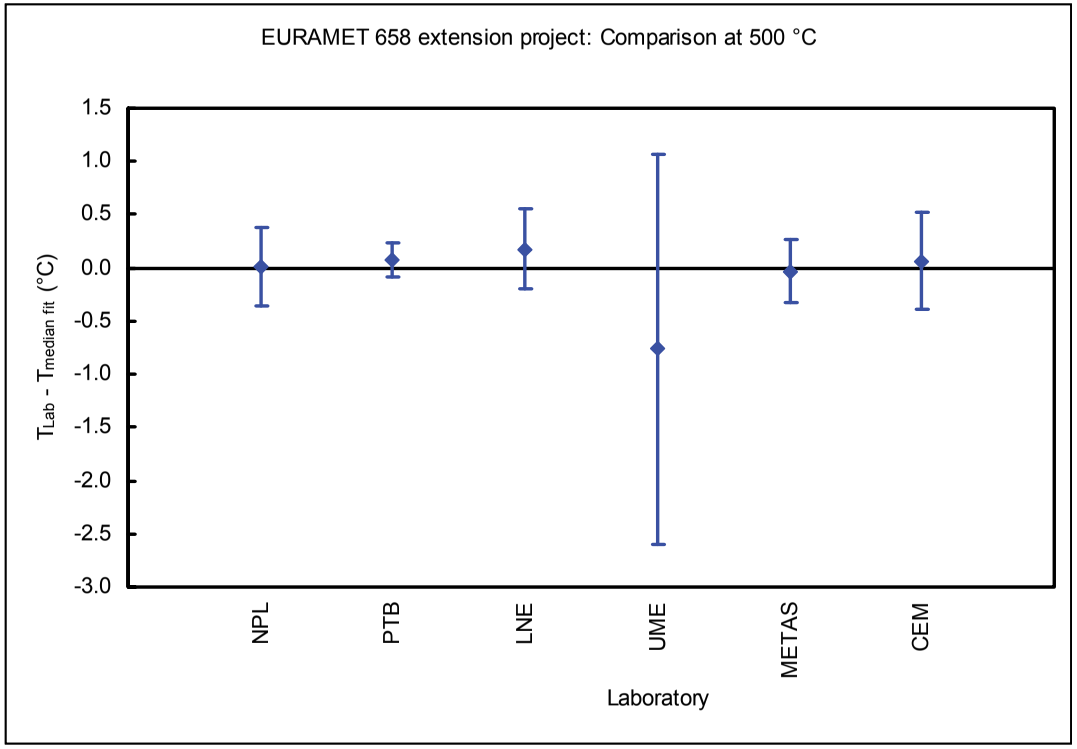
	NPL VTBB	NPL FP	PTB VTBB	LNE VTBB	UME VTBB	UME FP	METAS VTBB	CEM VTBB	CEM FP	INRiM FP
NPL VTBB	-	0.08 ± 0.296	0.05 ± 0.296	-0.04 ± 0.432	0.77 ± 1.564	0.70 ± 1.319	0.05 ± 0.311	0.11 ± 0.488	0.05 ± 0.388	0.11 ± 0.295
NPL FP	*0.33*	-	-0.03 ± 0.178	-0.12 ± 0.360	0.69 ± 1.546	0.62 ± 1.298	-0.04 ± 0.201	0.02 ± 0.427	-0.03 ± 0.307	0.02 ± 0.175
PTB VTBB	*0.31*	*0.18*	-	-0.09 ± 0.361	0.72 ± 1.546	0.65 ± 1.298	0.00 ± 0.202	0.05 ± 0.427	0.00 ± 0.307	0.06 ± 0.175
LNE VTBB	*0.43*	*0.42*	*0.39*	-	0.81 ± 1.578	0.74 ± 1.335	0.08 ± 0.373	0.14 ± 0.530	0.09 ± 0.439	0.14 ± 0.359
UME VTBB	*2.06*	*1.97*	*2.00*	*2.11*	-	-0.07 ± 2.011	-0.73 ± 1.549	-0.67 ± 1.594	-0.72 ± 1.566	-0.67 ± 1.546
UME FP	*1.79*	*1.69*	*1.72*	*1.84*	*1.97*	-	-0.65 ± 1.301	-0.59 ± 1.355	-0.64 ± 1.322	-0.59 ± 1.298
METAS VTBB	*0.32*	*0.21*	*0.20*	*0.40*	*2.00*	*1.73*	-	0.06 ± 0.437	0.01 ± 0.322	0.06 ± 0.200
CEM VTBB	*0.52*	*0.42*	*0.43*	*0.59*	*1.99*	*1.71*	*0.44*	-	-0.05 ± 0.495	0.00 ± 0.426
CEM FP	*0.39*	*0.30*	*0.30*	*0.47*	*2.01*	*1.74*	*0.32*	*0.49*	-	0.05 ± 0.306
INRiM FP	*0.35*	*0.18*	*0.20*	*0.44*	*1.94*	*1.66*	*0.23*	*0.42*	*0.32*	-

Table 142 – the results for the LP5 at 420 °C – FP and VTBB data separated



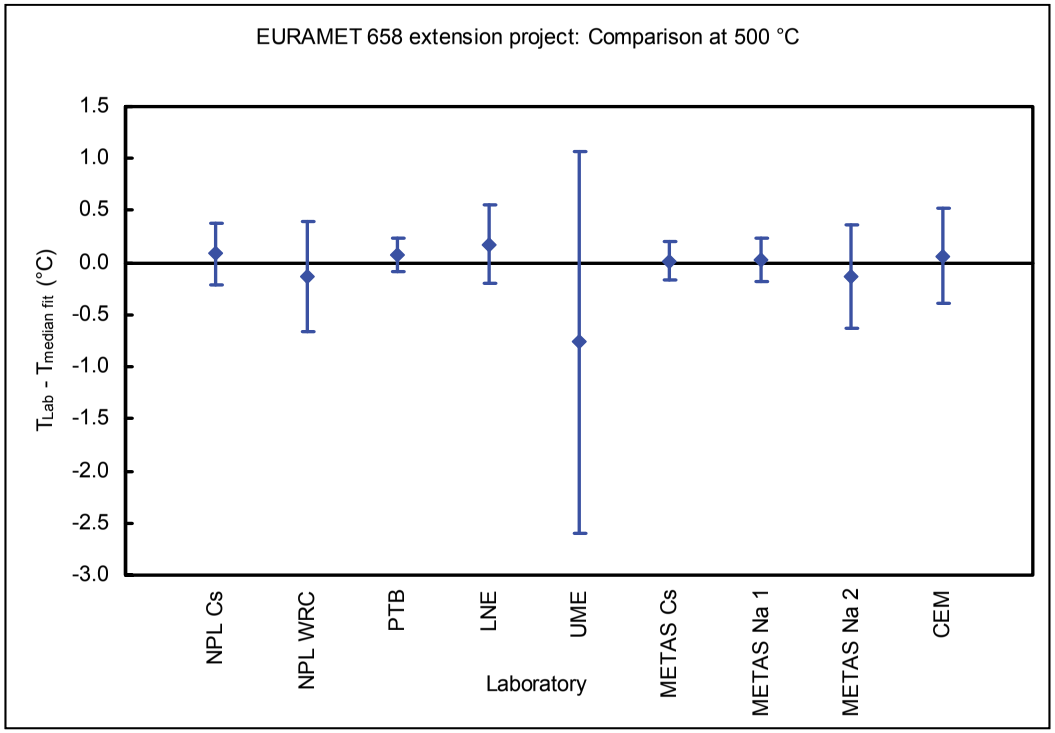
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.06 ± 0.399	-0.17 ± 0.522	0.77 ± 1.871	0.04 ± 0.472	-0.05 ± 0.584
PTB	*0.41*	-	-0.10 ± 0.401	0.84 ± 1.841	0.10 ± 0.334	0.01 ± 0.480
LNE	*0.60*	*0.44*	-	0.94 ± 1.871	0.21 ± 0.474	0.11 ± 0.586
UME	*2.32*	*2.36*	*2.48*	-	-0.73 ± 1.858	-0.83 ± 1.890
METAS	*0.47*	*0.38*	*0.60*	*2.27*	-	-0.10 ± 0.542
CEM	*0.58*	*0.47*	*0.62*	*2.39*	*0.56*	-

Table 143 – the results for the LP5 at 500 °C – all data averaged



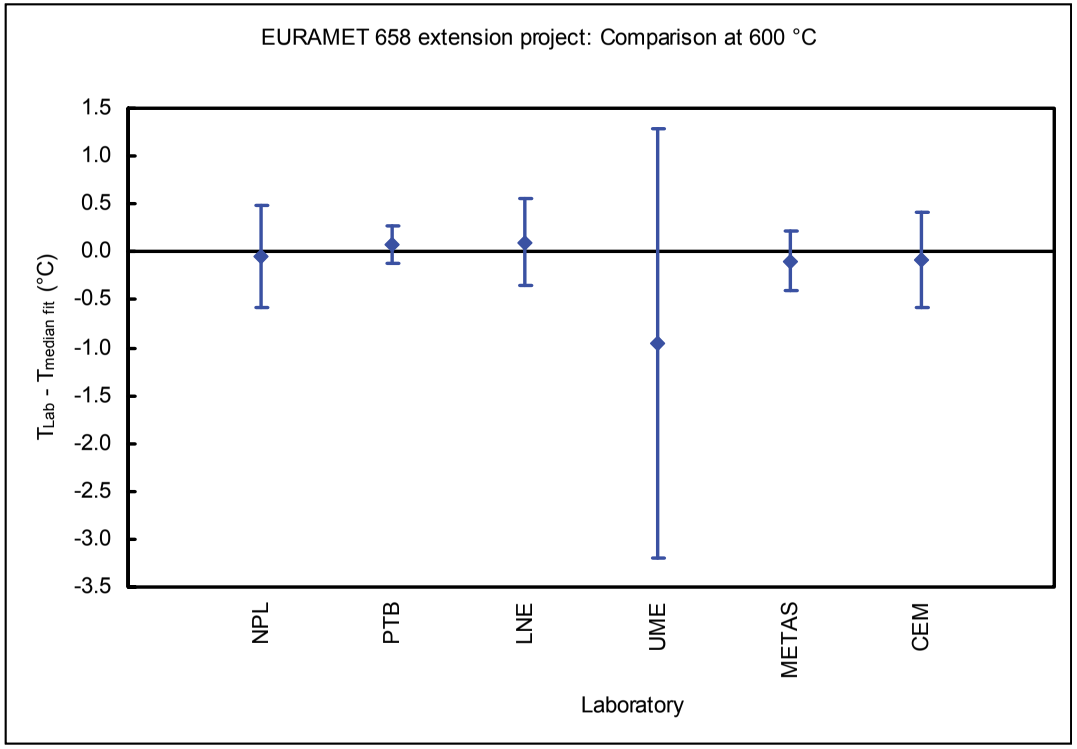
	NPL Cs	NPL WRC	PTB	LNE	UME	METAS Cs	METAS Na 1	METAS Na 2	CEM
NPL Cs	-	0.22 ± 0.598	0.01 ± 0.330	-0.09 ± 0.471	0.84 ± 1.857	0.07 ± 0.346	0.06 ± 0.354	0.22 ± 0.579	0.02 ± 0.539
NPL WRC	*0.71*	-	-0.21 ± 0.544	-0.31 ± 0.640	0.63 ± 1.907	-0.15 ± 0.554	-0.16 ± 0.559	0.00 ± 0.723	-0.20 ± 0.692
PTB	*0.32*	*0.66*	-	-0.10 ± 0.401	0.84 ± 1.841	0.06 ± 0.242	0.05 ± 0.254	0.21 ± 0.523	0.01 ± 0.480
LNE	*0.50*	*0.84*	*0.44*	-	0.94 ± 1.871	0.16 ± 0.414	0.15 ± 0.421	0.31 ± 0.622	0.11 ± 0.586
UME	*2.38*	*2.22*	*2.36*	*2.48*	-	-0.77 ± 1.844	-0.79 ± 1.845	-0.63 ± 1.901	-0.83 ± 1.890
METAS Cs	*0.37*	*0.61*	*0.26*	*0.51*	*2.30*	-	-0.01 ± 0.274	0.15 ± 0.533	-0.05 ± 0.491
METAS Na 1	*0.36*	*0.63*	*0.27*	*0.50*	*2.31*	*0.27*	-	0.16 ± 0.539	-0.04 ± 0.496
METAS Na 2	*0.70*	*0.71*	*0.64*	*0.82*	*2.21*	*0.60*	*0.61*	-	-0.20 ± 0.675
CEM	*0.53*	*0.78*	*0.47*	*0.62*	*2.39*	*0.49*	*0.49*	*0.76*	-

Table 144 – the results for the LP5 at 500 °C – data separated according to source type



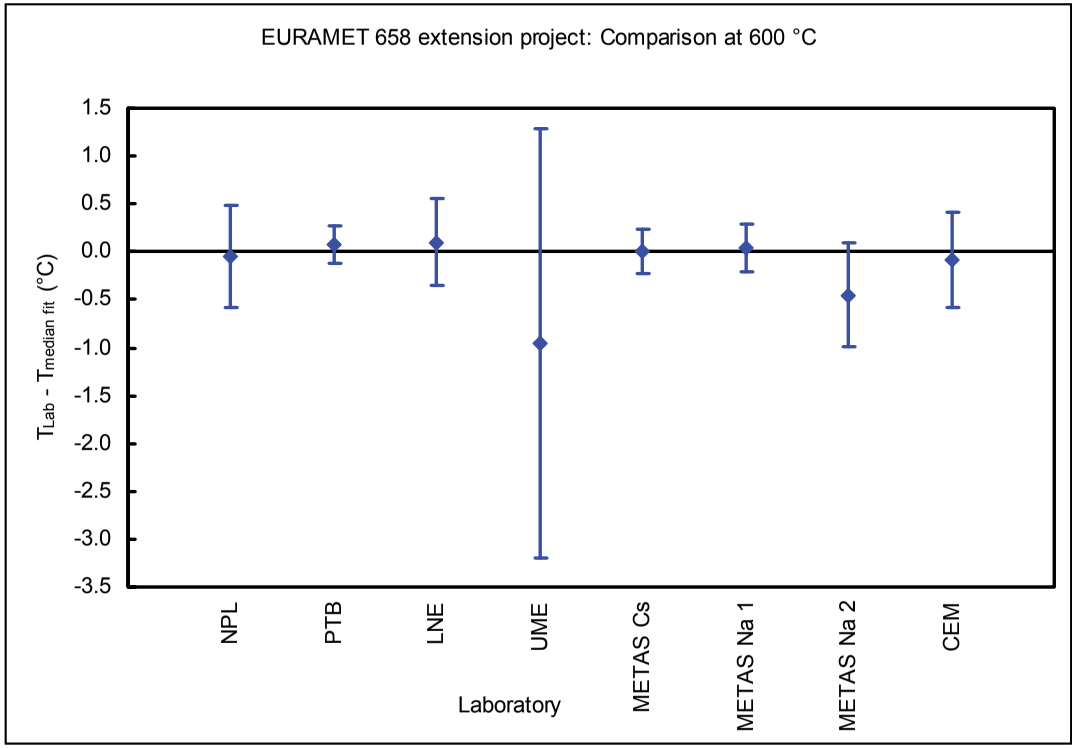
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.13 ± 0.570	-0.15 ± 0.704	0.91 ± 2.307	0.04 ± 0.618	0.03 ± 0.732
PTB	*0.61*	-	-0.03 ± 0.498	1.03 ± 2.253	0.17 ± 0.367	0.16 ± 0.537
LNE	*0.75*	*0.49*	-	1.06 ± 2.290	0.20 ± 0.552	0.18 ± 0.677
UME	*2.82*	*2.90*	*2.95*	-	-0.86 ± 2.266	-0.88 ± 2.299
METAS	*0.61*	*0.48*	*0.66*	*2.74*	-	-0.02 ± 0.588
CEM	*0.72*	*0.61*	*0.75*	*2.79*	*0.58*	-

Table 145 – the results for the LP5 at 600 °C – all data averaged



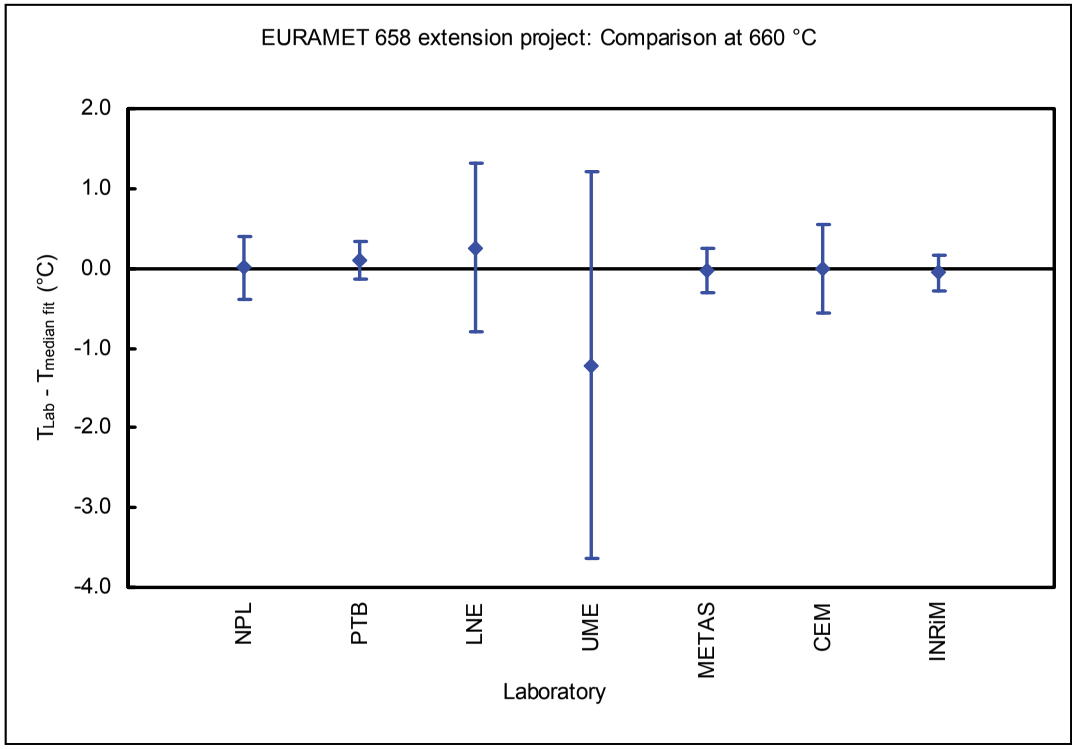
	NPL	PTB	LNE	UME	METAS Cs	METAS Na 1	METAS Na 2	CEM
NPL	-	-0.13 ± 0.570	-0.15 ± 0.704	0.91 ± 2.307	-0.06 ± 0.581	-0.09 ± 0.589	0.40 ± 0.761	0.03 ± 0.732
PTB	*0.61*	-	-0.03 ± 0.498	1.03 ± 2.253	0.07 ± 0.299	0.03 ± 0.316	0.53 ± 0.576	0.16 ± 0.537
LNE	*0.75*	*0.49*	-	1.06 ± 2.290	0.09 ± 0.510	0.06 ± 0.520	0.55 ± 0.708	0.18 ± 0.677
UME	*2.82*	*2.90*	*2.95*	-	-0.97 ± 2.256	-1.00 ± 2.258	-0.51 ± 2.309	-0.88 ± 2.299
METAS Cs	*0.58*	*0.32*	*0.53*	*2.83*	-	-0.03 ± 0.334	0.46 ± 0.586	0.09 ± 0.548
METAS Na 1	*0.61*	*0.32*	*0.52*	*2.87*	*0.33*	-	0.49 ± 0.595	0.12 ± 0.557
METAS Na 2	*1.02*	*1.00*	*1.13*	*2.47*	*0.94*	*0.98*	-	-0.37 ± 0.736
CEM	*0.72*	*0.61*	*0.75*	*2.79*	*0.56*	*0.60*	*0.98*	-

Table 146 – the results for the LP5 at 600 °C – data separated according to source type



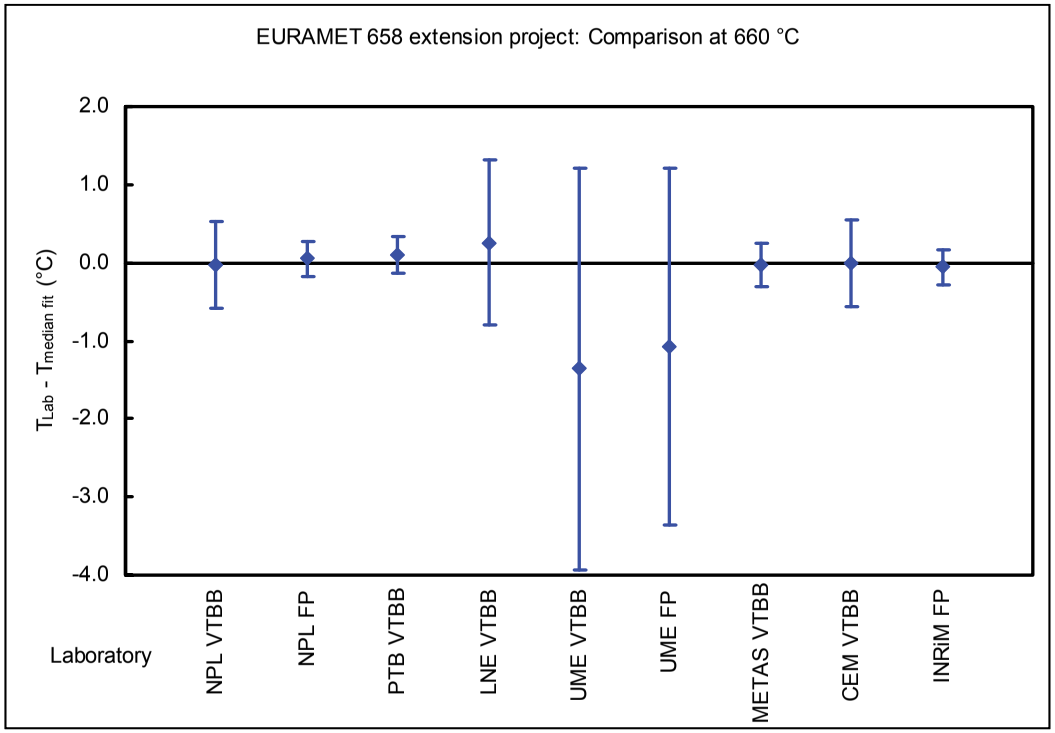
	NPL	PTB	LNE	UME	METAS	CEM	INRiM
NPL	-	-0.09 ± 0.453	-0.25 ± 1.130	1.22 ± 2.462	0.04 ± 0.480	0.01 ± 0.676	0.06 ± 0.448
PTB	*0.48*	-	-0.16 ± 1.085	1.31 ± 2.442	0.13 ± 0.361	0.10 ± 0.598	0.15 ± 0.317
LNE	*1.21*	*1.11*	-	1.47 ± 2.652	0.29 ± 1.096	0.26 ± 1.195	0.31 ± 1.082
UME	*3.26*	*3.33*	*3.66*	-	-1.18 ± 2.447	-1.21 ± 2.493	-1.16 ± 2.441
METAS	*0.47*	*0.43*	*1.21*	*3.20*	-	-0.03 ± 0.618	0.02 ± 0.354
CEM	*0.67*	*0.62*	*1.28*	*3.27*	*0.61*	-	0.05 ± 0.594
INRiM	*0.46*	*0.42*	*1.22*	*3.18*	*0.35*	*0.59*	-

Table 147 – the results for the LP5 at 660 °C – all data averaged



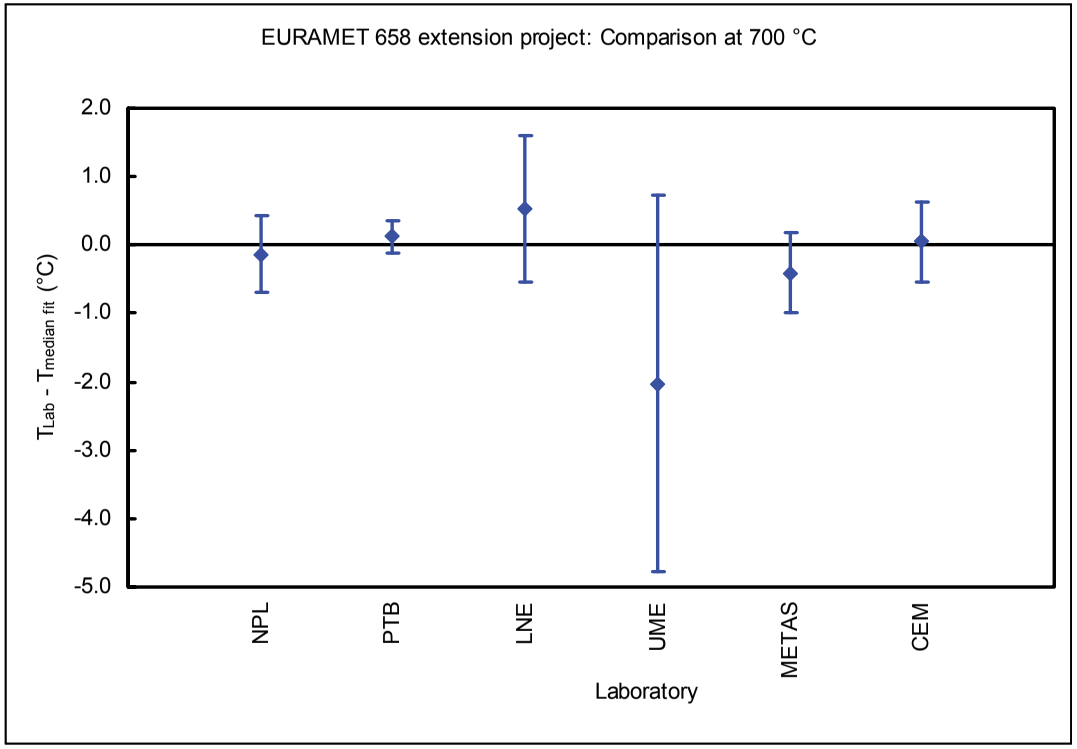
	NPL VTBB	NPL FP	PTB VTBB	LNE VTBB	UME VTBB	UME FP	METAS VTBB	CEM VTBB	INRiM FP
NPL VTBB	-	-0.09 ± 0.599	-0.14 ± 0.600	-0.29 ± 1.196	1.32 ± 2.630	1.04 ± 2.357	0.00 ± 0.620	-0.03 ± 0.785	0.02 ± 0.596
NPL FP	*0.61*	-	-0.05 ± 0.323	-0.21 ± 1.084	1.41 ± 2.581	1.13 ± 2.302	0.08 ± 0.359	0.05 ± 0.600	0.11 ± 0.316
PTB VTBB	*0.65*	*0.33*	-	-0.16 ± 1.085	1.46 ± 2.582	1.17 ± 2.302	0.13 ± 0.361	0.10 ± 0.601	0.15 ± 0.317
LNE VTBB	*1.31*	*1.14*	*1.11*	-	1.61 ± 2.781	1.33 ± 2.524	0.29 ± 1.096	0.26 ± 1.197	0.31 ± 1.082
UME VTBB	*3.49*	*3.54*	*3.58*	*3.91*	-	-0.28 ± 3.444	-1.32 ± 2.586	-1.35 ± 2.631	-1.30 ± 2.581
UME FP	*2.99*	*3.03*	*3.07*	*3.41*	*3.41*	-	-1.04 ± 2.308	-1.07 ± 2.357	-1.02 ± 2.301
METAS VTBB	*0.61*	*0.39*	*0.43*	*1.21*	*3.46*	*2.95*	-	-0.03 ± 0.621	0.02 ± 0.354
CEM VTBB	*0.77*	*0.60*	*0.62*	*1.28*	*3.52*	*3.02*	*0.61*	-	0.05 ± 0.597
INRiM FP	*0.59*	*0.37*	*0.42*	*1.22*	*3.43*	*2.92*	*0.35*	*0.59*	-

Table 148 – the results for the LP5 at 660 °C – FP and VTBB data separated



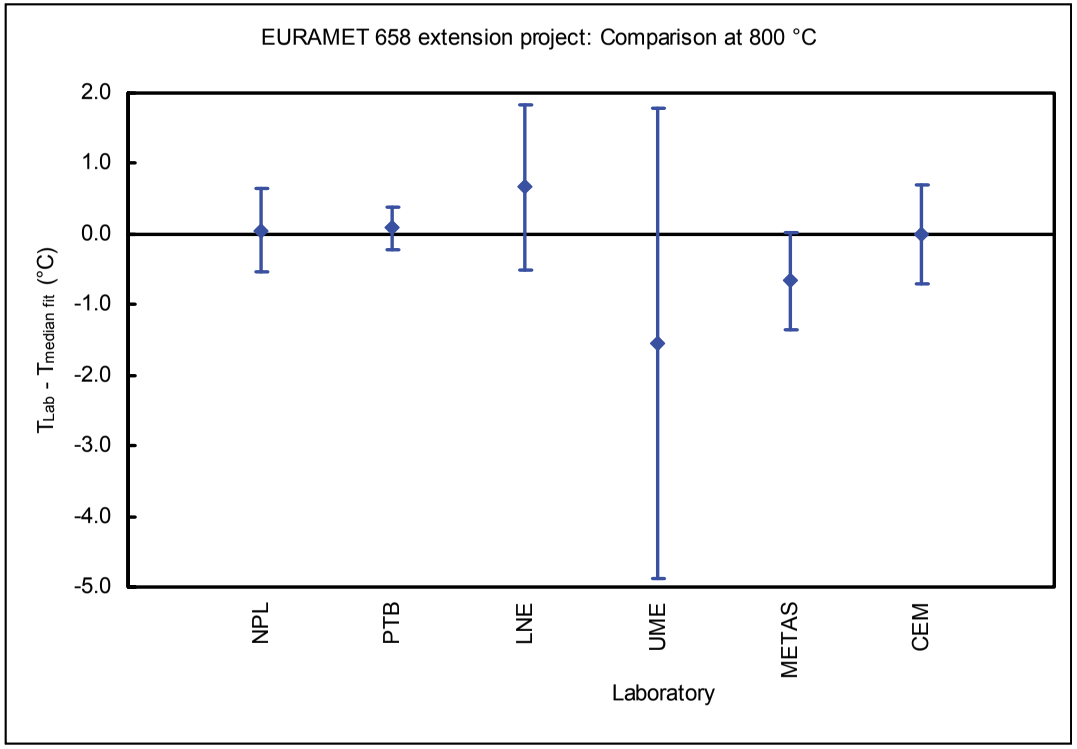
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.25 ± 0.615	-0.67 ± 1.206	1.90 ± 2.806	0.28 ± 0.811	-0.18 ± 0.815
PTB	*0.76*	-	-0.41 ± 1.096	2.15 ± 2.760	0.53 ± 0.635	0.07 ± 0.640
LNE	*1.66*	*1.32*	-	2.56 ± 2.949	0.95 ± 1.216	0.48 ± 1.219
UME	*4.21*	*4.42*	*4.99*	-	-1.62 ± 2.810	-2.08 ± 2.812
METAS	*0.96*	*1.06*	*1.95*	*3.93*	-	-0.46 ± 0.830
CEM	*0.87*	*0.64*	*1.50*	*4.39*	*1.15*	-

Table 149 – the results for the LP5 at 700 °C – all data averaged



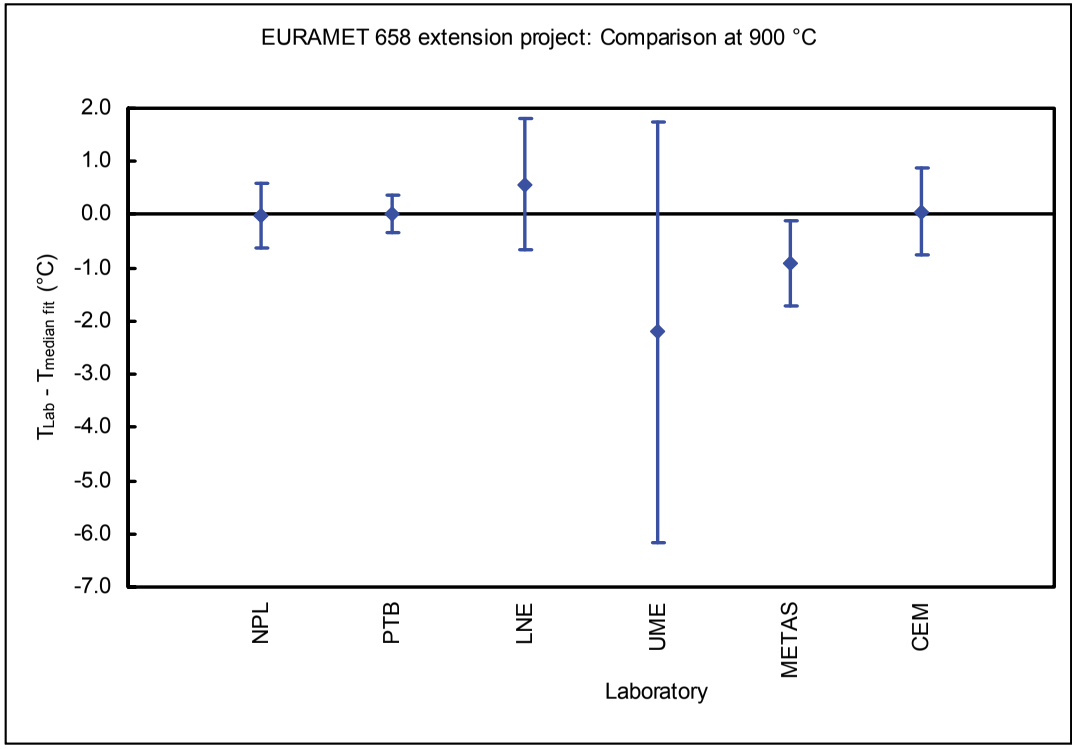
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.03 ± 0.658	-0.61 ± 1.308	1.60 ± 3.389	0.72 ± 0.899	0.05 ± 0.909
PTB	*0.65*	-	-0.58 ± 1.208	1.64 ± 3.352	0.75 ± 0.745	0.08 ± 0.757
LNE	*1.69*	*1.58*	-	2.22 ± 3.538	1.33 ± 1.354	0.66 ± 1.361
UME	*4.40*	*4.40*	*5.13*	-	-0.89 ± 3.407	-1.55 ± 3.410
METAS	*1.46*	*1.36*	*2.45*	*3.76*	-	-0.67 ± 0.974
CEM	*0.89*	*0.76*	*1.79*	*4.37*	*1.47*	-

Table 150 – the results for the LP5 at 800 °C – all data averaged



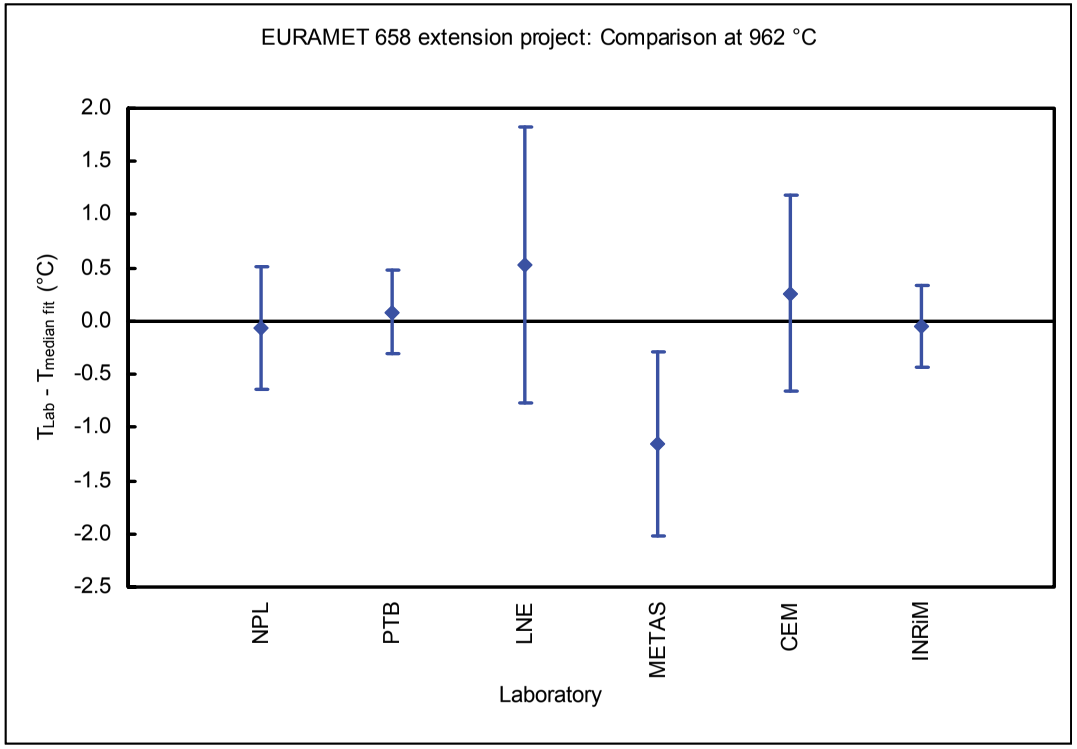
	NPL	PTB	LNE	UME	METAS	CEM
NPL	-	-0.03 ± 0.710	-0.59 ± 1.373	2.19 ± 4.003	0.88 ± 1.007	-0.07 ± 1.020
PTB	*0.70*	-	-0.56 ± 1.278	2.22 ± 3.971	0.92 ± 0.873	-0.04 ± 0.888
LNE	*1.73*	*1.61*	-	2.77 ± 4.141	1.47 ± 1.463	0.52 ± 1.473
UME	*5.49*	*5.49*	*6.18*	-	-1.30 ± 4.035	-2.26 ± 4.038
METAS	*1.71*	*1.63*	*2.68*	*4.67*	-	-0.96 ± 1.139
CEM	*1.01*	*0.87*	*1.74*	*5.59*	*1.89*	-

Table 151 – the results for the LP5 at 900 °C – all data averaged



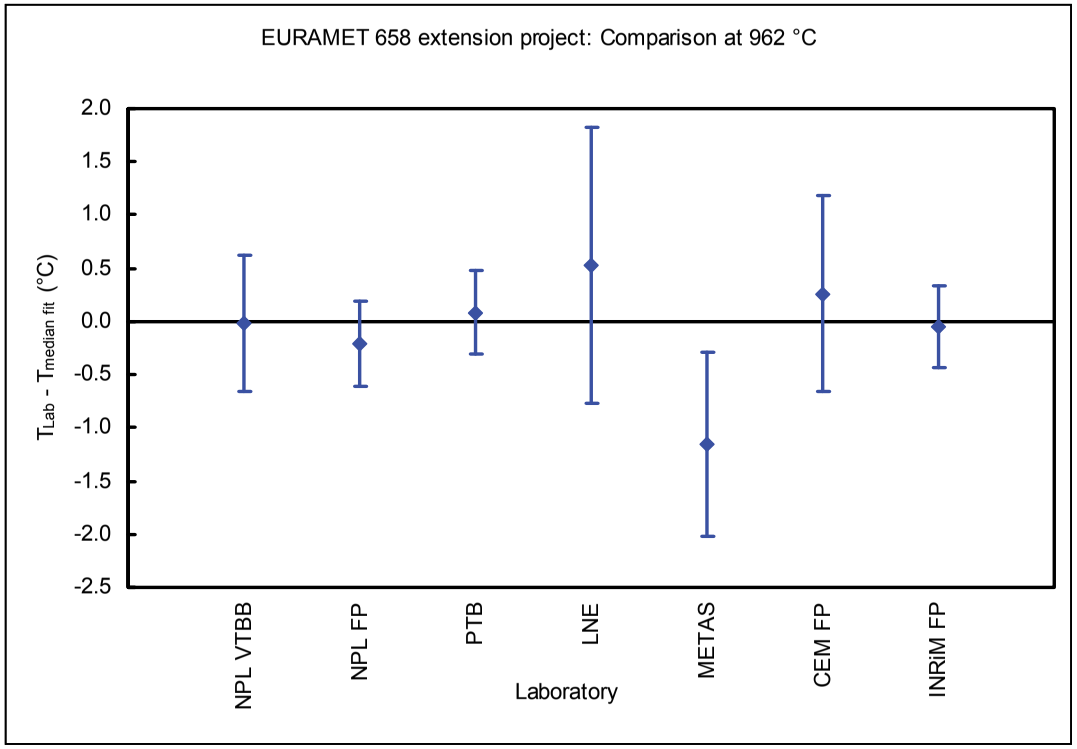
	NPL	PTB	LNE	METAS	CEM	INRiM
NPL	-	-0.15 ± 0.700	-0.59 ± 1.423	1.09 ± 1.040	-0.33 ± 1.085	-0.01 ± 0.694
PTB	*0.75*	-	-0.44 ± 1.358	1.24 ± 0.950	-0.18 ± 0.998	0.14 ± 0.549
LNE	*1.77*	*1.57*	-	1.68 ± 1.561	0.26 ± 1.591	0.58 ± 1.355
METAS	*1.94*	*2.02*	*2.96*	-	-1.41 ± 1.261	-1.10 ± 0.946
CEM	*1.24*	*1.04*	*1.64*	*2.45*	-	0.32 ± 0.994
INRiM	*0.68*	*0.60*	*1.70*	*1.87*	*1.15*	-

Table 152 – the results for the LP5 at 962 °C – all data averaged



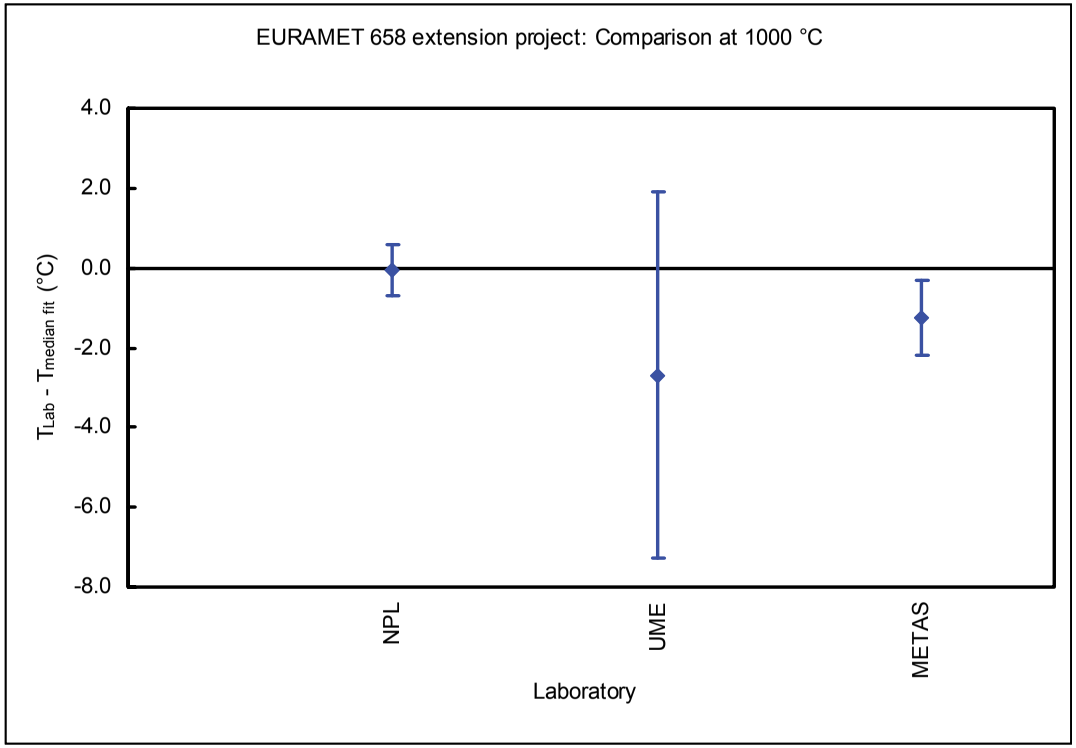
	NPL VTBB	NPL FP	PTB	LNE	METAS	CEM FP	INRiM FP
NPL VTBB	-	0.19 ± 0.754	-0.10 ± 0.748	-0.54 ± 1.448	1.13 ± 1.074	-0.28 ± 1.117	0.04 ± 0.743
NPL FP	*0.83*	-	-0.29 ± 0.564	-0.73 ± 1.361	0.94 ± 0.954	-0.47 ± 1.003	-0.15 ± 0.556
PTB	*0.76*	*0.76*	-	-0.44 ± 1.358	1.24 ± 0.950	-0.18 ± 0.998	0.14 ± 0.549
LNE	*1.75*	*1.86*	*1.57*	-	1.68 ± 1.561	0.26 ± 1.591	0.58 ± 1.355
METAS	*2.02*	*1.73*	*2.02*	*2.96*	-	-1.41 ± 1.261	-1.10 ± 0.946
CEM FP	*1.22*	*1.30*	*1.04*	*1.64*	*2.45*	-	0.32 ± 0.994
INRiM FP	*0.73*	*0.62*	*0.60*	*1.70*	*1.87*	*1.15*	-

Table 153 – the results for the LP5 at 962 °C – FP and VTBB data separated



	NPL	UME	METAS
NPL	-	2.63 ± 4.634	1.19 ± 1.132
UME	*6.45*	-	-1.44 ± 4.680
METAS	*2.12*	*5.35*	-

Table 154 – the results for the LP5 at 1000 °C – all data averaged



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APPENDIX 6

RESULTS OF THE ANALYSIS OF THE FIXED-POINT AND VARIABLE TEMPERATURE BLACKBODY MEASUREMENTS USING THE NPL AND INRIM CALIBRATION FITS

EURAMET 658 EXTENSION PROJECT TO EXAMINE UNDERLYING PARAMETERS IN RADIANCE TEMPERATURE SCALE REALISATION FROM 156 °C TO 1000 °C

HELEN MCEVOY

JANUARY 2018

Department for
Business, Energy
& Industrial Strategy

FUNDED BY BEIS

Appendix 6

Results of the Analysis of the Fixed-Point and Variable Temperature Blackbody Measurements using the NPL and INRiM Calibration Fits

EURAMET 658 Extension Project to Examine Underlying Parameters in Radiance Temperature Scale Realisation
From 156 °C to 1000 °C

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Approved on behalf of NPL by
Dr Stephanie Bell, Science Area Leader

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1 RESULTS ANALYSIS USING THE NPL AND INRIM FIXED-POINT CALIBRATIONS

NPL and INRiM carried out measurements using all of the appropriate fixed-points: indium, tin, zinc, aluminium and silver. Conveniently, these measurements had been carried out close to the beginning and at the end of the comparison. The results from these two laboratories were therefore used to provide two calibration fits for each thermometer.

Firstly, for each thermometer, the NPL and INRiM fixed-point results were corrected to a common range or gain (x10^6 for the INRiM thermometer; range R1 and also range R2 for the LP5 thermometer) using the NPL or INRiM measured gain or range ratios. A least squares fit of the results was then performed using a version of the Planck form of the Sakuma-Hattori interpolation equation:

$$S(T) = \frac{a_1}{\exp(c_2/(a_2 T + a_3)) - 1} \qquad \textbf{Equation 1}$$

where $S(T)$ is the output voltage of the thermometer, T is the temperature in kelvin, c_2 is the second radiation constant and a_1, a_2 and a_3 are constants.

For all laboratories, the fixed-point and variable temperature blackbody results were firstly corrected to the same range or gain setting that was used in the fitting process using the range or gain ratio measurements made at that particular laboratory. The additional uncertainty component arising from correcting the signals for gain was calculated, for each temperature, and included as an additional component in the laboratory measurement uncertainty, as described in Section 5.1.1 of the main report. Where a particular laboratory had not measured sufficient gain ratios for the INRiM thermometer for this to be possible, the average value from the results of all the other laboratories was used instead (see Appendix 3). In this case the standard deviation of the results was taken to be the uncertainty of the gain ratio value.

Using the coefficients calculated from the NPL and INRiM calibration fits, all thermometer signals were converted to temperature. For temperatures other than the zinc point, the correction was scaled using the ratio $(t_{source})^2/(t_{zinc})^2$. An additional uncertainty was also added to the laboratory measurement uncertainty to allow for the drift of the thermometer during the comparison, as described in Section 5.1.1 of the main comparison report.

The results of the comparison of all the fitted measurements are given in Tables 1 to 31. The differences (calibration temperature – blackbody temperature) are plotted in the Figures following the Tables. The results of the fixed-point measurements were kept separate from those of the variable temperature blackbody sources. No DOE or QDE_{95} values were calculated for this method of comparison.

1.1 THE VTBB RESULTS WITH THE INRIM THERMOMETER

t_{BB} / °C	Gain used	Bgrd corrected signal/ A	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit / °C	Temp corrected for Zn point drift[a]/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit[b]/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty* / °C
156.57	10^10	7.7622E-11	0.776219	7.6972E-05	0.45	156.644	156.679	0.109	156.734	156.747	0.177	0.56
200.00	10^10	5.1354E-10	5.13539	5.0924E-04	0.31	199.863	199.905	-0.095	199.941	199.956	-0.044	0.51
231.88	10^9	1.8387E-09	1.83872	1.6801E-03	0.30	231.934	231.981	0.101	232.005	232.022	0.142	0.30
250.04	10^9	3.3812E-09	3.38116	3.0894E-03	0.30	250.030	250.082	0.042	250.098	250.117	0.077	0.30
300.02	10^8	1.3709E-08	1.37094	1.3638E-02	0.30	300.079	300.141	0.121	300.141	300.163	0.143	0.30
399.89	10^7	1.3620E-07	1.36202	0.136273	0.30	399.815	399.900	0.010	399.874	399.904	0.014	0.31
419.49	10^7	1.9838E-07	1.98385	0.198487	0.30	419.496	419.586	0.096	419.557	419.589	0.099	0.31
499.89	10^7	7.5475E-07	7.54750	0.755141	0.31	499.790	499.902	0.012	499.862	499.902	0.012	0.32
600.03	10^6	2.8378E-06	2.83779	2.837789	0.27	600.037	600.180	0.150	600.137	600.188	0.158	0.29
660.29	10^6	5.4809E-06	5.48088	5.480883	0.28	660.205	660.368	0.078	660.329	660.387	0.097	0.31
700.03	10^6	8.0938E-06	8.09375	8.093755	0.29	699.905	700.083	0.053	700.048	700.111	0.081	0.32
799.87	10^5	1.8994E-05	1.89945	19.000850	0.31	799.785	800.001	0.131	799.985	800.062	0.192	0.35
899.98	10^5	3.8587E-05	3.85866	38.599565	0.33	899.728	899.986	0.006	900.001	900.093	0.113	0.39
232.02	10^9	1.8426E-09	1.84263	1.6836E-03	0.30	231.994	232.042	0.022	232.066	232.083	0.063	0.30
300.08	10^8	1.3751E-08	1.37507	1.3679E-02	0.30	300.191	300.252	0.172	300.252	300.274	0.194	0.30
500.03	10^7	7.5664E-07	7.56645	0.757037	0.31	499.958	500.070	0.040	500.030	500.070	0.040	0.32
699.99	10^6	8.0943E-06	8.09433	8.094334	0.29	699.913	700.090	0.100	700.056	700.119	0.129	0.32
899.88	10^5	3.8564E-05	3.85642	38.577167	0.33	899.639	899.897	0.017	899.911	900.003	0.123	0.39

Table 1- results of the CEM measurements performed on the 'low range' with the INRiM thermometer, analysed using the calibration fits

[a] Using the calculated drift from the NPL measurements;
[b] Using the calculated drift from the INRiM measurements.

t_{BB} / °C	Gain used	Bgrd corrected signal/ A	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty*/ °C
156.57	10^9	8.4268E-11	0.084268	7.6997E-05	0.36	156.650	156.685	0.115	156.741	156.753	0.183	0.36
200.00	10^9	5.5716E-10	0.557157	5.0908E-04	0.30	199.855	199.897	-0.103	199.934	199.948	-0.052	0.31
231.88	10^8	1.6894E-09	0.168944	1.6807E-03	0.30	231.944	231.991	0.111	232.015	232.032	0.152	0.30
250.04	10^8	3.1051E-09	0.310514	3.0890E-03	0.30	250.026	250.078	0.038	250.094	250.113	0.073	0.30
300.02	10^7	1.3631E-08	0.136309	1.3638E-02	0.30	300.079	300.141	0.121	300.140	300.162	0.142	0.30
399.89	10^6	1.3628E-07	0.136278	0.136278	0.30	399.817	399.902	0.012	399.876	399.907	0.017	0.31
419.49	10^6	1.9851E-07	0.198507	0.198507	0.30	419.501	419.591	0.101	419.562	419.594	0.104	0.31
499.89	10^6	7.5514E-07	0.755142	0.755142	0.31	499.790	499.902	0.012	499.862	499.902	0.012	0.32
600.03	10^5	2.8368E-06	0.283681	2.837761	0.27	600.036	600.179	0.149	600.137	600.188	0.158	0.29
660.29	10^5	5.4793E-06	0.547934	5.481181	0.28	660.210	660.374	0.084	660.334	660.392	0.102	0.31
700.03	10^5	8.0911E-06	0.809106	8.093774	0.29	699.905	700.083	0.053	700.048	700.111	0.081	0.32
799.87	10^4	1.9188E-05	0.191880	18.999437	0.31	799.775	799.991	0.121	799.976	800.052	0.182	0.35
899.98	10^4	3.8980E-05	0.389795	38.596576	0.33	899.716	899.974	-0.006	899.989	900.081	0.101	0.39
232.02	10^8	1.6921E-09	0.169206	1.6833E-03	0.30	231.988	232.036	0.016	232.060	232.077	0.057	0.30
300.08	10^7	1.3672E-08	0.136723	1.3679E-02	0.30	300.191	300.253	0.173	300.253	300.275	0.195	0.30
500.03	10^6	7.5692E-07	0.756917	0.756917	0.31	499.947	500.059	0.029	500.020	500.060	0.030	0.32
699.99	10^5	8.0913E-06	0.809125	8.093962	0.29	699.908	700.085	0.095	700.051	700.114	0.124	0.32
899.88	10^4	3.8957E-05	0.389568	38.574084	0.33	899.626	899.884	0.004	899.899	899.991	0.111	0.39

Table 2- results of the CEM measurements performed on the 'high range' with the INRiM thermometer, analysed using the calibration fits

t_{BB} / °C	Gain used	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
156.566	10^10	7.71526E-01	7.64095E-05	0.064	156.491	156.517	-0.049	156.582	156.585	0.019	0.070
200.035	10^10	5.16521E+00	5.11546E-04	0.064	199.977	200.007	-0.027	200.055	200.059	0.024	0.072
231.947	10^9	1.83733E+00	1.67760E-03	0.066	231.891	231.927	-0.020	231.963	231.967	0.021	0.076
250.039	10^9	3.37772E+00	3.08409E-03	0.069	249.977	250.015	-0.024	250.045	250.050	0.011	0.080
300.023	10^8	1.36698E+00	1.35988E-02	0.096	299.973	300.018	-0.005	300.034	300.040	0.017	0.107
400.021	10^7	1.36628E+00	1.36699E-01	0.035	399.974	400.036	0.015	400.033	400.041	0.020	0.075
419.519	10^7	1.98335E+00	1.98439E-01	0.036	419.483	419.549	0.030	419.544	419.552	0.032	0.079
500.020	10^6	7.57357E-01	7.57357E-01	0.039	499.986	500.069	0.049	500.059	500.069	0.049	0.096
600.019	10^6	2.83581E+00	2.83581E+00	0.044	599.978	600.082	0.063	600.078	600.091	0.071	0.120
660.328	10^6	5.48368E+00	5.48368E+00	0.073	660.255	660.375	0.046	660.379	660.394	0.065	0.147
700.032	10^6	8.09714E+00	8.09714E+00	0.075	699.950	700.080	0.048	700.092	700.108	0.076	0.157
800.017	10^5	1.90065E+00	1.90228E+01	0.081	799.934	800.093	0.076	800.135	800.154	0.137	0.187
900.026	10^5	3.86153E+00	3.86484E+01	0.088	899.923	900.113	0.087	900.196	900.219	0.193	0.219
961.728	10^5	5.64752E+00	5.65237E+01	0.094	961.599	961.808	0.080	961.923	961.949	0.221	0.242
156.623	10^10	7.73692E-01	7.66239E-05	0.064	156.550	156.575	-0.048	156.640	156.643	0.020	0.070
250.087	10^9	3.38204E+00	3.08803E-03	0.067	250.017	250.054	-0.033	250.085	250.089	0.002	0.078
419.516	10^7	1.98334E+00	1.98438E-01	0.036	419.482	419.548	0.032	419.543	419.551	0.035	0.079
500.042	10^6	7.57390E-01	7.57390E-01	0.039	499.989	500.071	0.030	500.062	500.072	0.030	0.096
700.048	10^5	8.09186E-01	8.09881E+00	0.075	699.971	700.102	0.053	700.114	700.130	0.082	0.157
961.693	10^5	5.64673E+00	5.65158E+01	0.094	961.575	961.784	0.091	961.899	961.925	0.232	0.242

Table 3 - results of the PTB measurements with the INRiM thermometer, analysed using the calibration fits

t_{BB} / °C	Gain used	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty* / °C
156.53	10^8	0.00781	7.76065E-05	0.21	156.815	156.838	0.309	156.905	156.906	0.377	0.21
199.90	10^7	0.00497	4.96682E-04	0.25	199.235	199.264	-0.632	199.314	199.316	-0.581	0.25
199.89	10^7	0.00505	5.05373E-04	0.25	199.671	199.700	-0.194	199.750	199.751	-0.142	0.25
199.90	10^8	0.05125	5.09253E-04	0.25	199.863	199.892	-0.008	199.942	199.944	0.044	0.25
231.76	10^7	0.01624	1.62356E-03	0.28	230.954	230.987	-0.769	231.026	231.028	-0.728	0.28
231.76	10^8	0.16754	1.66481E-03	0.28	231.672	231.705	-0.055	231.743	231.746	-0.014	0.28
249.83	10^7	0.03060	3.05999E-03	0.30	249.736	249.771	-0.058	249.804	249.807	-0.023	0.30
249.83	10^8	0.30785	3.05909E-03	0.29	249.727	249.762	-0.066	249.795	249.798	-0.031	0.30
300.17	10^7	0.13625	0.0136257	0.32	300.046	300.088	-0.087	300.107	300.110	-0.065	0.32
300.08	10^8	1.36625	0.0135764	0.33	299.912	299.955	-0.130	299.974	299.976	-0.108	0.33
399.91	10^7	1.35684	0.135687	0.37	399.596	399.654	-0.251	399.655	399.659	-0.246	0.37
400.12	10^7	1.36585	0.136588	0.33	399.932	399.991	-0.133	399.992	399.996	-0.128	0.34
419.68	10^7	1.98417	0.198421	0.34	419.478	419.540	-0.142	419.539	419.543	-0.139	0.35
500.11	10^7	7.56497	0.756512	0.36	499.911	499.989	-0.119	499.984	499.989	-0.119	0.37
600.11	10^6	2.83329	2.833294	0.38	599.902	600.000	-0.112	600.002	600.008	-0.104	0.39
600.02	10^6	2.82827	2.828271	0.39	599.750	599.848	-0.171	599.850	599.856	-0.163	0.40
600.01	10^6	2.82476	2.824760	1.09	599.644	599.742	-0.272	599.744	599.750	-0.264	1.09
660.02	10^6	5.44766	5.447661	1.08	659.611	659.724	-0.299	659.735	659.742	-0.281	1.09
699.85	10^6	8.04389	8.043894	1.11	699.250	699.372	-0.479	699.392	699.400	-0.451	1.12
700.11	10^6	8.06085	8.060855	1.11	699.473	699.595	-0.517	699.616	699.623	-0.489	1.11
800.20	10^5	1.89383	18.949308	1.40	799.435	799.583	-0.619	799.635	799.644	-0.558	1.41
899.89	10^5	3.84413	38.463648	1.24	899.185	899.362	-0.526	899.457	899.469	-0.420	1.26
899.92	10^5	3.84196	38.441921	1.25	899.098	899.275	-0.640	899.370	899.381	-0.534	1.27
961.62	10^5	5.61892	56.221912	1.54	960.685	960.882	-0.739	961.009	961.022	-0.599	1.55

Table 4 – results of the LNE measurements with the INRiM thermometer, analysed using the calibration fits

t_{BB} / °C	Gain used	Bgrd corrected Signal / mV	Signal at 10^6 gain / mV	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty*/ °C
156.604	10^10	777.185	0.077	7.69634E-05	0.433	156.642	156.668	0.065	156.732	156.737	0.133	0.43
231.915	10^9	1833.114	1.675	1.67462E-03	0.445	231.840	231.878	-0.037	231.912	231.918	0.003	0.45
419.485	10^7	1980.357	198.186	1.98186E-01	0.102	419.414	419.484	-0.001	419.475	419.487	0.002	0.12
660.174	10^6	5508.215	5508.215	5.50821	0.174	660.691	660.818	0.645	660.815	660.837	0.664	0.22
961.861	10^5	5705.270	57081.108	57.08111	0.776	963.276	963.499	1.639	963.602	963.641	1.780	0.81
199.995	10^10	5154.564	0.510	5.10448E-04	0.441	199.922	199.955	-0.039	200.001	200.007	0.012	0.44
249.986	10^9	3368.463	3.077	3.07723E-03	0.358	249.909	249.949	-0.037	249.977	249.984	-0.002	0.36
300.010	10^8	1367.415	13.605	1.36047E-02	0.224	299.989	300.037	0.026	300.050	300.058	0.048	0.23
400.063	10^7	1366.687	136.773	1.36773E-01	0.102	400.001	400.067	0.004	400.061	400.072	0.009	0.12
499.953	10^7	7560.209	756.595	7.56595E-01	0.110	499.919	500.006	0.053	499.991	500.006	0.053	0.14
499.976	10^7	7563.477	756.923	7.56923E-01	0.135	499.948	500.035	0.059	500.020	500.035	0.060	0.16
600.015	10^6	2835.845	2835.845	2.83584	0.119	599.979	600.090	0.075	600.079	600.098	0.083	0.16
599.731	10^6	2825.946	2825.946	2.82595	0.158	599.680	599.791	0.060	599.780	599.799	0.068	0.19
300.040	10^8	1369.291	13.623	1.36233E-02	0.224	300.039	300.087	0.047	300.101	300.109	0.069	0.23
400.058	10^7	1366.927	136.797	1.36797E-01	0.102	400.010	400.076	0.018	400.070	400.081	0.023	0.12
599.988	10^6	2834.872	2834.872	2.83487	0.119	599.949	600.061	0.073	600.050	600.069	0.081	0.16
499.820	10^7	7563.477	756.923	7.56923E-01	0.477	499.948	500.035	0.215	500.020	500.035	0.215	0.48
599.280	10^6	2825.946	2825.946	2.82595	0.507	599.680	599.791	0.511	599.780	599.799	0.519	0.52
699.941	10^6	8125.120	8125.120	8.12512	0.534	700.316	700.454	0.513	700.459	700.483	0.542	0.55
799.917	10^5	1908.946	19098.963	19.09896	0.619	800.450	800.618	0.701	800.651	800.679	0.762	0.64
899.924	10^5	3882.634	38845.676	38.84568	0.719	900.709	900.910	0.985	900.982	901.016	1.092	0.75
1000.048	10^5	7070.470	70739.916	70.73992	0.833	1001.125	1001.362	1.314	1001.485	1001.526	1.478	0.87
799.950	10^5	1909.781	19107.325	19.10732	0.619	800.506	800.675	0.724	800.707	800.736	0.786	0.64
1000.095	10^5	7071.588	70751.095	70.75110	0.833	1001.153	1001.390	1.296	1001.514	1001.555	1.460	0.87

Table 5– results of the METAS measurements with the INRiM thermometer, analysed using the calibration fits

t_{BB} / °C	Gain used	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
201.26	10^9	0.587914	5.37003E-04	0.955	201.202	201.214	-0.047	201.281	201.265	0.004	0.957
250.78	10^9	3.470968	3.17040E-03	0.808	250.828	250.842	0.059	250.896	250.877	0.094	0.810
299.80	10^8	1.365282	1.35800E-02	0.822	299.922	299.939	0.139	299.983	299.961	0.161	0.825
417.73	10^7	1.923257	0.192423	0.860	417.829	417.853	0.119	417.889	417.856	0.122	0.862
497.10	10^7	7.285188	0.728886	0.810	497.425	497.456	0.352	497.496	497.456	0.352	0.815
596.25	10^6	2.739827	2.739827	0.850	597.043	597.082	0.833	597.142	597.090	0.840	0.857
655.68	10^6	5.281204	5.281204	0.822	656.593	656.638	0.959	656.716	656.656	0.977	0.832
695.58	10^6	7.833208	7.833208	0.824	696.444	696.493	0.914	696.585	696.520	0.941	0.835
797.27	10^5	1.910186	19.055416	1.196	800.155	800.215	2.945	800.356	800.276	3.006	1.222
897.37	10^5	3.894053	38.845858	1.193	900.709	900.781	3.409	900.983	900.888	3.515	1.230
1000.09	10^5	7.221856	72.042977	1.084	1004.452	1004.537	4.450	1004.816	1004.703	4.616	1.141

Table 6– results of the UME measurements with the INRiM thermometer, analysed using the calibration fits

t_{BB} / °C	Gain used	Bgrd corrected signal/ V	Signal at 10^6 gain/ V	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty*/ °C
156.63	10^10	0.777632	7.70750E-05	0.20	156.672	156.672	0.040	156.762	156.740	0.108	0.20
199.93	10^9	0.556989	5.08879E-04	0.20	199.845	199.845	-0.085	199.923	199.896	-0.034	0.20
200.02	10^9	0.562683	5.14081E-04	0.20	200.101	200.101	0.080	200.179	200.152	0.131	0.20
200.02	10^10	5.186709	5.14081E-04	0.20	200.101	200.101	0.081	200.179	200.152	0.133	0.20
232.05	10^9	1.841034	1.68201E-03	0.20	231.967	231.967	-0.083	232.038	232.007	-0.043	0.20
250.01	10^9	3.372291	3.08100E-03	0.20	249.947	249.947	-0.065	250.015	249.982	-0.030	0.20
250.05	10^9	3.376714	3.08505E-03	0.20	249.987	249.987	-0.067	250.055	250.022	-0.032	0.20
250.05	10^8	0.310083	3.08505E-03	0.20	249.987	249.987	-0.067	250.055	250.022	-0.032	0.20
300.06	10^8	1.365190	1.35824E-02	0.21	299.928	299.928	-0.129	299.990	299.950	-0.107	0.22
300.02	10^7	0.135586	1.35670E-02	0.21	299.887	299.887	-0.136	299.948	299.908	-0.114	0.22
300.02	10^8	1.363646	1.35670E-02	0.21	299.887	299.887	-0.137	299.948	299.908	-0.115	0.22
400.22	10^7	1.369248	0.137010	0.20	400.089	400.089	-0.134	400.149	400.094	-0.129	0.21
400.00	10^7	1.363649	0.136449	0.20	399.881	399.881	-0.123	399.940	399.885	-0.119	0.21
419.43	10^7	1.976805	0.197803	0.20	419.310	419.310	-0.120	419.371	419.313	-0.117	0.21
499.89	10^7	7.546142	0.755081	0.20	499.784	499.784	-0.103	499.857	499.785	-0.103	0.22
499.89	10^6	0.755081	0.755081	0.20	499.784	499.784	-0.107	499.857	499.785	-0.107	0.22
500.22	10^7	7.612328	0.761704	0.48	500.370	500.370	0.155	500.443	500.371	0.156	0.49
600.05	10^6	2.842331	2.842331	0.47	600.174	600.174	0.123	600.274	600.182	0.131	0.48
600.05	10^5	0.283980	2.842244	0.47	600.171	600.171	0.123	600.272	600.180	0.131	0.48
660.03	10^6	5.477611	5.477611	0.48	660.147	660.147	0.121	660.271	660.165	0.140	0.50
660.03	10^5	0.547319	5.477901	0.48	660.152	660.152	0.120	660.276	660.171	0.138	0.50
699.95	10^6	8.105329	8.105329	0.48	700.057	700.057	0.108	700.200	700.085	0.136	0.50
699.96	10^5	0.809842	8.105389	0.48	700.058	700.058	0.101	700.201	700.086	0.130	0.50
700.00	10^6	8.111707	8.111707	0.48	700.140	700.140	0.140	700.283	700.169	0.169	0.50
799.81	10^5	1.899315	19.009499	0.49	799.844	799.844	0.036	800.044	799.905	0.097	0.52
900.19	10^5	3.867533	38.708629	0.49	900.163	900.163	-0.024	900.436	900.270	0.082	0.53
900.17	10^4	0.390889	38.708630	0.49	900.163	900.163	-0.011	900.436	900.270	0.096	0.53
900.03	10^5	3.865023	38.683503	0.49	900.063	900.063	0.035	900.336	900.169	0.141	0.53
961.78	10^5	5.656693	56.615634	0.49	961.876	961.876	0.096	962.201	962.016	0.236	0.54
1000.00	10^5	7.025350	70.313988	0.49	1000.028	1000.028	0.028	1000.387	1000.191	0.191	0.54
1000.12	10^5	7.034740	70.407971	0.49	1000.270	1000.270	0.151	1000.630	1000.434	0.315	0.54

Table 7– results of the NPL measurements with the INRiM thermometer, analysed using the calibration fits

1.2 THE VTBB RESULTS WITH THE LP5 THERMOMETER

(N.B calibration fits were performed using data corrected to range R1 and corrected to range R2)

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R1/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift[a]/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift[b]/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with range ratio & drift uncertainty*/ °C
231.91	R1	3.02262E-12	3.02262E-12	0.41	231.687	231.714	-0.196	232.026	231.769	-0.141	0.43
250.11	R1	5.72417E-12	5.72417E-12	0.32	250.112	250.141	0.031	250.455	250.179	0.069	0.36
300.09	R1	2.62564E-11	2.62564E-11	0.31	299.997	300.031	-0.059	300.361	300.030	-0.060	0.36
399.94	R1	2.81427E-10	2.81427E-10	0.31	399.866	399.913	-0.027	400.310	399.854	-0.086	0.40
419.55	R1	4.14299E-10	4.14299E-10	0.31	419.538	419.588	0.038	420.004	419.520	-0.030	0.41
499.98	R1	1.63872E-09	1.63872E-09	0.31	499.865	499.928	-0.052	500.440	499.838	-0.142	0.45
600.09	R1	6.39791E-09	6.39791E-09	0.26	600.146	600.225	0.135	600.903	600.134	0.044	0.50
660.35	R2	1.25941E-08	1.25884E-08	0.27	660.302	660.393	0.043	661.192	660.314	-0.036	0.56
700.10	R2	1.88022E-08	1.87938E-08	0.27	699.988	700.086	-0.014	700.976	700.021	-0.079	0.59
799.91	R2	4.51797E-08	4.51593E-08	0.27	799.753	799.873	-0.037	801.023	799.862	-0.048	0.70
900.01	R2	9.36263E-08	9.35841E-08	0.28	899.656	899.799	-0.211	901.258	899.869	-0.141	0.82
232.07	R1	3.05435E-12	3.05435E-12	0.39	231.978	232.005	-0.065	232.316	232.059	-0.011	0.41
300.14	R1	2.63234E-11	2.63234E-11	0.31	300.089	300.123	-0.017	300.453	300.121	-0.019	0.36
500.09	R1	1.64322E-09	1.64322E-09	0.31	500.044	500.107	0.017	500.619	500.017	-0.073	0.45
700.04	R2	1.87879E-08	1.87794E-08	0.27	699.909	700.008	-0.032	700.897	699.942	-0.098	0.59
899.92	R2	9.36075E-08	9.35653E-08	0.28	899.626	899.769	-0.151	901.228	899.839	-0.081	0.82

Table 8 - results of the CEM measurements with the LP5 thermometer, analysed using the calibration fits for range R1

[a] Using the calculated drift from the NPL measurements;
[b] Using the calculated drift from the INRiM measurements.

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
231.91	R2	3.04783E-12	3.04783E-12	2.90	231.909	231.936	0.026	232.222	231.965	0.055	2.90
250.11	R2	5.77088E-12	5.77088E-12	1.54	250.345	250.374	0.264	250.661	250.384	0.274	1.55
300.09	R2	2.61516E-11	2.61516E-11	0.49	299.841	299.875	-0.215	300.172	299.841	-0.249	0.52
399.94	R2	2.81632E-10	2.81632E-10	0.31	399.885	399.932	-0.008	400.283	399.827	-0.113	0.40
419.55	R2	4.14570E-10	4.14570E-10	0.31	419.554	419.604	0.054	419.971	419.488	-0.062	0.41
499.98	R2	1.63960E-09	1.63960E-09	0.31	499.878	499.940	-0.040	500.393	499.790	-0.190	0.46
600.09	R2	6.40066E-09	6.40066E-09	0.26	600.152	600.232	0.142	600.833	600.064	-0.026	0.50
660.35	R2	1.25941E-08	1.25941E-08	0.26	660.312	660.402	0.052	661.114	660.236	-0.114	0.55
700.10	R2	1.88022E-08	1.88022E-08	0.26	699.998	700.097	-0.003	700.891	699.936	-0.164	0.59
799.91	R2	4.51797E-08	4.51797E-08	0.26	799.766	799.885	-0.025	800.920	799.759	-0.151	0.70
900.01	R2	9.36263E-08	9.36263E-08	0.26	899.671	899.814	-0.196	901.135	899.747	-0.263	0.81
232.07	R2	3.08452E-12	3.08452E-12	1.81	232.243	232.269	0.199	232.555	232.298	0.228	1.81
300.14	R2	2.61924E-11	2.61924E-11	0.41	299.897	299.931	-0.209	300.228	299.897	-0.243	0.45
500.09	R2	1.64412E-09	1.64412E-09	0.31	500.057	500.119	0.029	500.572	499.969	-0.121	0.46
700.04	R2	1.87879E-08	1.87879E-08	0.26	699.919	700.018	-0.022	700.812	699.857	-0.183	0.59
899.92	R2	9.36075E-08	9.36075E-08	0.26	899.640	899.784	-0.136	901.105	899.717	-0.203	0.81

Table 9 - results of the CEM measurements with the LP5 thermometer, analysed using the calibration fits for range R2

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with Range R1/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty*/ °C
231.946	R1	3.03946E-12	3.03946E-12	0.111	231.84	231.84	-0.10	232.18	231.90	-0.05	0.13
250.089	R1	5.70504E-12	5.70504E-12	0.085	250.01	250.02	-0.07	250.36	250.05	-0.04	0.11
300.020	R1	2.62226E-11	2.62226E-11	0.097	299.95	299.95	-0.07	300.31	299.95	-0.07	0.13
400.021	R1	2.82049E-10	2.82049E-10	0.035	399.98	399.98	-0.04	400.42	399.92	-0.10	0.12
419.530	R1	4.14019E-10	4.14019E-10	0.036	419.50	419.51	-0.02	419.97	419.44	-0.09	0.13
500.015	R1	1.64206E-09	1.64206E-09	0.039	500.00	500.00	-0.01	500.57	499.91	-0.10	0.15
600.017	R1	6.38577E-09	6.38577E-09	0.044	599.99	600.00	-0.02	600.74	599.90	-0.11	0.20
660.312	R2	1.25796E-08	1.25809E-08	0.073	660.24	660.25	-0.06	661.14	660.17	-0.14	0.23
700.031	R2	1.87788E-08	1.87806E-08	0.075	699.92	699.93	-0.11	700.90	699.86	-0.17	0.25
800.012	R2	4.52005E-08	4.52049E-08	0.081	799.88	799.89	-0.12	801.15	799.88	-0.13	0.30
900.011	R2	9.37001E-08	9.37093E-08	0.088	899.86	899.87	-0.14	901.46	899.94	-0.07	0.36
961.748	R2	1.38461E-07	1.38475E-07	0.094	961.45	961.47	-0.28	963.29	961.60	-0.15	0.39
231.947	R1	3.03869E-12	3.03869E-12	0.132	231.84	231.84	-0.11	232.17	231.89	-0.05	0.15
300.027	R1	2.62522E-11	2.62522E-11	0.184	299.99	299.99	-0.03	300.36	299.99	-0.03	0.20
419.512	R1	4.13968E-10	4.13968E-10	0.036	419.50	419.50	-0.01	419.96	419.43	-0.08	0.13
500.049	R1	1.64205E-09	1.64205E-09	0.039	500.00	500.00	-0.04	500.57	499.91	-0.14	0.15
700.028	R2	1.87822E-08	1.87840E-08	0.075	699.93	699.94	-0.08	700.92	699.88	-0.15	0.25
961.696	R2	1.38400E-07	1.38414E-07	0.094	961.38	961.40	-0.30	963.21	961.53	-0.17	0.39

Table 10 - results of the PTB measurements with the LP5 thermometer, analysed using the calibration fits for range R1

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with Range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncertainty*/ °C
231.946	R1	3.03946E-12	3.03916E-12	0.111	231.83	231.83	-0.11	232.14	231.86	-0.08	0.13
250.089	R1	5.70504E-12	5.70448E-12	0.085	250.00	250.00	-0.09	250.31	250.01	-0.08	0.11
300.020	R1	2.62226E-11	2.62200E-11	0.097	299.93	299.94	-0.08	300.27	299.90	-0.12	0.13
400.021	R1	2.82049E-10	2.82021E-10	0.035	399.95	399.96	-0.06	400.35	399.85	-0.17	0.12
419.530	R1	4.14019E-10	4.13978E-10	0.036	419.48	419.48	-0.05	419.90	419.37	-0.16	0.13
500.015	R1	1.64206E-09	1.64190E-09	0.039	499.97	499.98	-0.04	500.48	499.82	-0.19	0.16
600.017	R1	6.38577E-09	6.38515E-09	0.044	599.95	599.96	-0.06	600.63	599.79	-0.23	0.20
660.312	R2	1.25796E-08	1.25796E-08	0.073	660.20	660.21	-0.10	661.00	660.04	-0.27	0.23
700.031	R2	1.87788E-08	1.87788E-08	0.075	699.87	699.88	-0.15	700.76	699.72	-0.32	0.25
800.012	R2	4.52005E-08	4.52005E-08	0.081	799.82	799.84	-0.18	800.98	799.71	-0.31	0.30
900.011	R2	9.37001E-08	9.37001E-08	0.088	899.79	899.80	-0.21	901.25	899.73	-0.28	0.36
961.748	R2	1.38461E-07	1.38461E-07	0.094	961.38	961.39	-0.35	963.06	961.37	-0.37	0.39
231.947	R1	3.03869E-12	3.03839E-12	0.132	231.82	231.83	-0.12	232.14	231.85	-0.09	0.15
300.027	R1	2.62522E-11	2.62496E-11	0.184	299.98	299.98	-0.05	300.31	299.94	-0.08	0.20
419.512	R1	4.13968E-10	4.13928E-10	0.036	419.47	419.48	-0.03	419.89	419.36	-0.15	0.13
500.049	R1	1.64205E-09	1.64189E-09	0.039	499.97	499.97	-0.07	500.48	499.82	-0.22	0.16
700.028	R2	1.87822E-08	1.87822E-08	0.075	699.89	699.90	-0.13	700.78	699.74	-0.29	0.25
961.696	R2	1.38400E-07	1.38400E-07	0.094	961.30	961.32	-0.38	962.98	961.30	-0.40	0.39

Table 11 - results of the PTB measurements with the LP5 thermometer, analysed using the calibration fits for range R2

t_{BB} / °C	Range used	Bgrd corrected Signal / nA	Bgrd corrected signal/ A	Signal with range R1/ A	lab U (k=2) / °C	Temp from NPL fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with drift uncertainty*/ °C
231.76	R1	0.00299	2.99090E-12	2.99090E-12	0.60	231.39	231.69	-0.07	231.73	231.74	-0.02	0.60
249.83	R1	0.00559	5.59107E-12	5.59107E-12	0.43	249.41	249.73	-0.10	249.75	249.77	-0.06	0.44
249.84	R1	0.00531	5.30973E-12	5.30973E-12	0.47	247.87	248.19	-1.65	248.22	248.23	-1.61	0.48
249.83	R1	0.00560	5.59853E-12	5.59853E-12	0.44	249.45	249.77	-0.06	249.79	249.81	-0.02	0.44
300.19	R1	0.02609	2.60880E-11	2.60880E-11	0.35	299.77	300.15	-0.05	300.13	300.15	-0.05	0.36
399.93	R1	0.27791	2.77908E-10	2.77908E-10	0.31	399.24	399.77	-0.16	399.69	399.71	-0.22	0.33
400.14	R1	0.27938	2.79379E-10	2.79379E-10	0.32	399.51	400.03	-0.11	399.95	399.97	-0.17	0.34
419.63	R1	0.40981	4.09805E-10	4.09805E-10	0.32	418.97	419.52	-0.10	419.43	419.46	-0.17	0.34
500.11	R1	1.62441	1.62441E-09	1.62441E-09	0.34	499.29	499.99	-0.13	499.87	499.90	-0.22	0.37
600.16	R2	6.32775	6.32775E-09	6.32775E-09	0.41	599.23	600.11	-0.04	599.98	600.02	-0.13	0.45
600.13	R2	6.32566	6.32566E-09	6.32566E-09	0.42	599.20	600.08	-0.04	599.96	599.99	-0.13	0.47
660.06	R2	12.39548	1.23955E-08	1.23955E-08	1.04	658.84	659.84	-0.21	659.72	659.77	-0.29	1.06
699.83	R2	18.47426	1.84743E-08	1.84743E-08	1.03	698.22	699.31	-0.52	699.20	699.25	-0.58	1.06
700.11	R2	18.53000	1.85300E-08	1.85300E-08	1.05	698.53	699.62	-0.49	699.52	699.56	-0.55	1.08
800.07	R2	44.54806	4.45481E-08	4.45481E-08	1.14	798.05	799.38	-0.70	799.31	799.37	-0.70	1.17
899.88	R2	92.29729	9.22973E-08	9.22973E-08	1.17	897.58	899.17	-0.71	899.18	899.25	-0.64	1.22
899.94	R2	92.35645	9.23564E-08	9.23564E-08	1.19	897.68	899.27	-0.67	899.28	899.34	-0.60	1.24
961.63	R2	136.56060	1.36561E-07	1.36561E-07	1.24	959.15	960.91	-0.72	960.97	961.04	-0.58	1.30

Table 12 - results of the LNE measurements with the LP5 thermometer, analysed using the calibration fits for range R1

Note: due to the inconsistent value for the LNE range ratio value it was not possible to correct the signal levels to a different range. The blue highlighted values indicate those that have not been corrected.

t_{BB} / °C	Range used	Bgrd corrected Signal/ nA	Bgrd corrected signal/ A	Signal with range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with drift uncertainty*/ °C
231.76	R1	0.00299	2.99090E-12	2.99090E-12	0.60	231.38	231.68	-0.08	231.70	231.71	-0.05	0.60
249.83	R1	0.00559	5.59107E-12	5.59107E-12	0.43	249.40	249.72	-0.11	249.71	249.73	-0.10	0.44
249.84	R1	0.00531	5.30973E-12	5.30973E-12	0.47	247.86	248.18	-1.66	248.18	248.19	-1.65	0.48
249.83	R1	0.00560	5.59853E-12	5.59853E-12	0.44	249.44	249.76	-0.07	249.75	249.77	-0.06	0.44
300.19	R1	0.02609	2.60880E-11	2.60880E-11	0.35	299.75	300.13	-0.06	300.08	300.10	-0.09	0.36
399.93	R1	0.27791	2.77908E-10	2.77908E-10	0.31	399.23	399.75	-0.18	399.63	399.65	-0.29	0.33
400.14	R1	0.27938	2.79379E-10	2.79379E-10	0.32	399.49	400.01	-0.13	399.89	399.91	-0.23	0.34
419.63	R1	0.40981	4.09805E-10	4.09805E-10	0.32	418.95	419.50	-0.12	419.37	419.39	-0.24	0.34
500.11	R1	1.62441	1.62441E-09	1.62441E-09	0.34	499.27	499.96	-0.15	499.79	499.81	-0.30	0.37
600.16	R2	6.32775	6.32775E-09	6.32775E-09	0.41	599.20	600.08	-0.07	599.88	599.92	-0.24	0.45
600.13	R2	6.32566	6.32566E-09	6.32566E-09	0.42	599.17	600.06	-0.07	599.85	599.89	-0.24	0.47
660.06	R2	12.39548	1.23955E-08	1.23955E-08	1.04	658.80	659.81	-0.25	659.60	659.64	-0.41	1.06
699.83	R2	18.47426	1.84743E-08	1.84743E-08	1.03	698.18	699.28	-0.56	699.07	699.12	-0.71	1.06
700.11	R2	18.53000	1.85300E-08	1.85300E-08	1.05	698.49	699.59	-0.52	699.38	699.43	-0.68	1.08
800.07	R2	44.54806	4.45481E-08	4.45481E-08	1.14	798.00	799.33	-0.74	799.15	799.21	-0.86	1.17
899.88	R2	92.29729	9.22973E-08	9.22973E-08	1.17	897.53	899.12	-0.76	898.99	899.06	-0.83	1.22
899.94	R2	92.35645	9.23564E-08	9.23564E-08	1.19	897.63	899.22	-0.73	899.09	899.15	-0.79	1.24
961.63	R2	136.56060	1.36561E-07	1.36561E-07	1.24	959.09	960.85	-0.78	960.76	960.83	-0.79	1.30

Table 13 - results of the LNE measurements with the LP5 thermometer, analysed using the calibration fits for range R2

Note: due to the inconsistent value for the LNE range ratio value it was not possible to correct the signal levels to a different range. The blue highlighted values indicate those that have not been corrected.

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R1/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
231.913	R1	3.0206E-12	3.02059E-12	0.445	231.669	231.908	-0.005	232.007	231.963	0.050	0.45
419.500	R1	4.1029E-10	4.10295E-10	0.102	419.030	419.480	-0.019	419.495	419.413	-0.086	0.16
660.335	R2	1.2502E-08	1.24947E-08	0.174	659.593	660.410	0.075	660.481	660.332	-0.003	0.28
961.678	R2	1.3834E-07	1.38261E-07	0.776	961.197	962.629	0.951	963.028	962.767	1.089	0.86
249.986	R1	5.6051E-12	5.60506E-12	0.358	249.484	249.741	-0.245	249.827	249.780	-0.205	0.36
300.011	R1	2.6007E-11	2.60067E-11	0.224	299.655	299.963	-0.048	300.018	299.962	-0.049	0.24
400.063	R1	2.8005E-10	2.80050E-10	0.102	399.624	400.049	-0.014	400.068	399.990	-0.073	0.15
499.955	R1	1.6277E-09	1.62775E-09	0.110	499.428	499.989	0.034	500.002	499.900	-0.055	0.19
499.963	R1	1.6276E-09	1.62764E-09	0.135	499.424	499.985	0.022	499.998	499.896	-0.067	0.20
600.014	R1	6.3365E-09	6.33653E-09	0.119	599.345	600.060	0.046	600.100	599.970	-0.045	0.23
599.728	R1	6.3123E-09	6.31232E-09	0.158	599.027	599.742	0.014	599.782	599.652	-0.076	0.25
300.040	R1	2.6079E-11	2.60794E-11	0.224	299.755	300.063	0.023	300.118	300.062	0.022	0.24
400.060	R1	2.8016E-10	2.80163E-10	0.102	399.644	400.069	0.009	400.088	400.010	-0.050	0.15
599.988	R1	6.3348E-09	6.33481E-09	0.119	599.322	600.038	0.050	600.078	599.947	-0.041	0.23
499.803	R1	1.6276E-09	1.62764E-09	0.477	499.424	499.985	0.181	499.998	499.896	0.092	0.50
599.237	R1	6.3123E-09	6.31232E-09	0.507	599.027	599.742	0.506	599.782	599.652	0.415	0.54
699.935	R2	1.8713E-08	1.87029E-08	0.534	699.487	700.377	0.442	700.475	700.313	0.378	0.58
799.890	R2	4.5069E-08	4.50439E-08	0.619	799.432	800.513	0.624	800.701	800.504	0.614	0.68
899.923	R2	9.3482E-08	9.34300E-08	0.719	899.409	900.701	0.779	901.010	900.775	0.852	0.80
1000.039	R2	1.7303E-07	1.72936E-07	0.833	999.477	1000.999	0.960	1001.460	1001.183	1.144	0.93
799.949	R2	4.5097E-08	4.50721E-08	0.619	799.511	800.592	0.643	800.780	800.583	0.634	0.68
1000.080	R2	1.7314E-07	1.73044E-07	0.833	999.587	1001.110	1.029	1001.571	1001.293	1.213	0.93

Table 14 - results of the METAS measurements with the LP5 thermometer, analysed using the calibration fits for range R1

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
231.913	R1	3.0206E-12	3.02225E-12	0.445	231.674	231.914	0.001	231.987	231.943	0.031	0.45
419.500	R1	4.1029E-10	4.10521E-10	0.102	419.041	419.491	-0.009	419.458	419.376	-0.124	0.16
660.335	R2	1.2502E-08	1.25016E-08	0.174	659.612	660.429	0.094	660.413	660.264	-0.071	0.28
961.678	R2	1.3834E-07	1.38337E-07	0.776	961.230	962.662	0.984	962.909	962.648	0.970	0.86
249.986	R1	5.6051E-12	5.60815E-12	0.358	249.490	249.747	-0.239	249.806	249.759	-0.227	0.36
300.011	R1	2.6007E-11	2.60210E-11	0.224	299.662	299.970	-0.041	299.993	299.936	-0.075	0.24
400.063	R1	2.8005E-10	2.80205E-10	0.102	399.634	400.059	-0.004	400.032	399.954	-0.108	0.15
499.955	R1	1.6277E-09	1.62865E-09	0.110	499.441	500.002	0.047	499.955	499.853	-0.102	0.19
499.963	R1	1.6276E-09	1.62854E-09	0.135	499.437	499.998	0.035	499.951	499.849	-0.114	0.20
600.014	R1	6.3365E-09	6.34002E-09	0.119	599.362	600.077	0.063	600.040	599.910	-0.105	0.23
599.728	R1	6.3123E-09	6.31581E-09	0.158	599.044	599.759	0.031	599.722	599.592	-0.136	0.25
300.040	R1	2.6079E-11	2.60938E-11	0.224	299.762	300.070	0.031	300.093	300.037	-0.003	0.24
400.060	R1	2.8016E-10	2.80318E-10	0.102	399.654	400.079	0.019	400.052	399.974	-0.085	0.15
599.988	R1	6.3348E-09	6.33831E-09	0.119	599.339	600.055	0.066	600.018	599.887	-0.101	0.23
499.803	R1	1.6276E-09	1.62854E-09	0.477	499.437	499.998	0.194	499.951	499.849	0.045	0.50
599.237	R1	6.3123E-09	6.31581E-09	0.507	599.044	599.759	0.522	599.722	599.592	0.355	0.54
699.935	R2	1.8713E-08	1.87132E-08	0.534	699.508	700.397	0.463	700.400	700.238	0.303	0.58
799.890	R2	4.5069E-08	4.50687E-08	0.619	799.457	800.539	0.649	800.611	800.414	0.524	0.68
899.923	R2	9.3482E-08	9.34816E-08	0.719	899.439	900.731	0.808	900.902	900.667	0.744	0.80
1000.039	R2	1.7303E-07	1.73032E-07	0.833	999.512	1001.034	0.995	1001.334	1001.056	1.017	0.93
799.949	R2	4.5097E-08	4.50970E-08	0.619	799.536	800.617	0.668	800.690	800.493	0.543	0.68
1000.080	R2	1.7314E-07	1.73140E-07	0.833	999.622	1001.145	1.064	1001.445	1001.167	1.087	0.93

Table 15 - results of the METAS measurements with the LP5 thermometer, analysed using the calibration fits for range R2

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R1/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
250.78	R1	5.76788E-12	5.76788E-12	0.953	250.34	250.47	-0.31	250.68	250.51	-0.27	0.96
299.80	R2	2.60561E-11	2.63989E-11	0.894	300.19	300.35	0.55	300.56	300.35	0.55	1.27
417.73	R2	3.98655E-10	4.03899E-10	0.805	418.21	418.44	0.70	418.67	418.37	0.64	1.54
497.10	R2	1.56268E-09	1.58323E-09	0.831	497.63	497.91	0.81	498.20	497.82	0.72	1.83
596.25	R2	6.07226E-09	6.15213E-09	0.830	596.90	597.26	1.01	597.65	597.17	0.92	2.24
655.68	R2	1.19562E-08	1.21135E-08	0.969	656.66	657.08	1.40	657.54	657.00	1.32	2.57
695.58	R2	1.80514E-08	1.82889E-08	0.921	697.18	697.64	2.06	698.17	697.57	1.99	2.75
797.27	R2	4.40370E-08	4.46163E-08	1.106	798.24	798.79	1.52	799.50	798.78	1.51	3.34
897.37	R2	9.18374E-08	9.30455E-08	1.214	898.79	899.45	2.08	900.39	899.52	2.15	3.96
1000.09	R2	1.72885E-07	1.75159E-07	1.179	1001.73	1002.51	2.43	1003.73	1002.70	2.61	4.59

Table 16 - results of the UME measurements with the LP5 thermometer, analysed using the calibration fits for range R1

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
250.78	R1	5.76788E-12	5.69299E-12	0.953	249.94	250.07	-0.71	250.25	250.08	-0.70	1.20
299.80	R2	2.60561E-11	2.60561E-11	0.894	299.71	299.87	0.07	300.04	299.83	0.03	0.90
417.73	R2	3.98655E-10	3.98655E-10	0.805	417.51	417.74	0.00	417.93	417.62	-0.11	0.81
497.10	R2	1.56268E-09	1.56268E-09	0.831	496.76	497.04	-0.06	497.27	496.89	-0.21	0.84
596.25	R2	6.07226E-09	6.07226E-09	0.830	595.79	596.16	-0.09	596.47	595.99	-0.26	0.85
655.68	R2	1.19562E-08	1.19562E-08	0.969	655.40	655.81	0.13	656.19	655.65	-0.03	0.99
695.58	R2	1.80514E-08	1.80514E-08	0.921	695.81	696.26	0.68	696.69	696.10	0.52	0.95
797.27	R2	4.40370E-08	4.4037E-08	1.106	796.56	797.11	-0.16	797.71	796.98	-0.29	1.14
897.37	R2	9.18374E-08	9.18374E-08	1.214	896.79	897.44	0.07	898.24	897.38	0.00	1.26
1000.09	R2	1.72885E-07	1.72885E-07	1.179	999.36	1000.14	0.05	1001.18	1000.16	0.07	1.25

Table 17 - results of the UME measurements with the LP5 thermometer, analysed using the calibration fits for range R2

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R1/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
232.03	R1	3.061856E-12	3.061856E-12	0.26	232.05	232.05	0.02	232.38	232.10	0.07	0.27
249.99	R1	5.672646E-12	5.672646E-12	0.25	249.84	249.84	-0.15	250.18	249.88	-0.11	0.26
249.99	R1	5.681434E-12	5.681434E-12	0.25	249.89	249.89	-0.10	250.23	249.93	-0.06	0.26
250.06	R1	5.695074E-12	5.695074E-12	0.25	249.96	249.96	-0.09	250.30	250.00	-0.06	0.26
300.06	R1	2.618329E-11	2.618329E-11	0.25	299.90	299.90	-0.16	300.26	299.90	-0.16	0.26
400.00	R1	2.817535E-10	2.817535E-10	0.25	399.92	399.92	-0.07	400.37	399.86	-0.13	0.27
400.06	R1	2.821617E-10	2.821617E-10	0.25	399.99	399.99	-0.07	400.44	399.93	-0.13	0.27
419.42	R1	4.128693E-10	4.128693E-10	0.24	419.36	419.36	-0.07	419.82	419.29	-0.14	0.27
499.89	R2	1.639063E-09	1.638486E-09	0.25	499.86	499.86	-0.04	500.43	499.77	-0.13	0.29
499.89	R1	1.638486E-09	1.638486E-09	0.25	499.86	499.86	-0.04	500.43	499.77	-0.13	0.29
500.22	R1	1.652192E-09	1.652192E-09	0.50	500.40	500.40	0.18	500.98	500.31	0.09	0.52
599.66	R1	6.368180E-09	6.368180E-09	0.50	599.76	599.76	0.10	600.51	599.67	0.01	0.54
600.43	R1	6.428283E-09	6.428283E-09	0.50	600.54	600.54	0.11	601.30	600.45	0.02	0.54
600.04	R1	6.398232E-09	6.398232E-09	0.50	600.15	600.15	0.11	600.91	600.06	0.01	0.54
660.04	R2	1.256802E-08	1.256359E-08	0.51	660.11	660.11	0.08	661.00	660.03	0.00	0.55
700.47	R2	1.890124E-08	1.889459E-08	0.51	700.54	700.54	0.07	701.53	700.47	0.00	0.56
699.36	R2	1.869786E-08	1.869128E-08	0.51	699.42	699.42	0.07	700.41	699.36	0.00	0.56
700.00	R2	1.881512E-08	1.880850E-08	0.51	700.07	700.07	0.07	701.06	700.00	0.00	0.56
700.40	R2	1.892227E-08	1.891561E-08	0.51	700.66	700.66	0.25	701.65	700.59	0.19	0.56
699.29	R2	1.871670E-08	1.871011E-08	0.51	699.53	699.53	0.24	700.51	699.46	0.17	0.56
700.00	R2	1.884819E-08	1.884156E-08	0.51	700.25	700.25	0.25	701.24	700.18	0.18	0.56
799.80	R2	4.515964E-08	4.514375E-08	0.51	799.71	799.71	-0.09	800.98	799.70	-0.10	0.59
900.19	R2	9.380092E-08	9.376791E-08	0.51	899.95	899.95	-0.24	901.55	900.02	-0.17	0.62
900.01	R2	9.385286E-08	9.381983E-08	0.51	900.03	900.03	0.02	901.64	900.10	0.09	0.62
961.05	R2	1.380435E-07	1.379949E-07	0.51	960.88	960.88	-0.17	962.71	961.01	-0.04	0.64
962.03	R2	1.388408E-07	1.387920E-07	0.51	961.83	961.83	-0.20	963.67	961.96	-0.06	0.64
961.78	R2	1.386374E-07	1.385886E-07	0.51	961.59	961.59	-0.19	963.42	961.72	-0.06	0.64
1000.33	R2	1.736251E-07	1.735640E-07	0.51	1000.12	1000.12	-0.22	1002.10	1000.29	-0.04	0.65
999.18	R2	1.725317E-07	1.724710E-07	0.51	999.00	999.00	-0.18	1000.98	999.18	0.00	0.65
1000.00	R2	1.733113E-07	1.732503E-07	0.51	999.80	999.80	-0.20	1001.78	999.97	-0.03	0.65
1000.17	R2	1.734897E-07	1.734286E-07	0.51	999.98	999.98	-0.20	1001.96	1000.15	-0.02	0.65

Table 18 - results of the NPL measurements with the LP5 thermometer, analysed using the calibration fits for range R1

t_{BB} / °C	Range used	Bgrd corrected signal/ A	Signal with range R2/ A	lab U (k=2) / °C	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncertainty* / °C
232.03	R1	3.061856E-12	3.062934E-12	0.26	232.05	232.05	0.02	232.36	232.08	0.05	0.27
249.99	R1	5.672646E-12	5.674643E-12	0.25	249.84	249.84	-0.15	250.16	249.85	-0.14	0.26
249.99	R1	5.681434E-12	5.683434E-12	0.25	249.89	249.89	-0.10	250.20	249.90	-0.09	0.26
250.06	R1	5.695074E-12	5.697079E-12	0.25	249.96	249.96	-0.09	250.28	249.97	-0.08	0.26
300.06	R1	2.618329E-11	2.619250E-11	0.25	299.90	299.90	-0.16	300.23	299.86	-0.19	0.26
400.00	R1	2.817535E-10	2.818527E-10	0.25	399.92	399.92	-0.07	400.32	399.82	-0.18	0.27
400.06	R1	2.821617E-10	2.822610E-10	0.25	399.99	399.99	-0.07	400.39	399.89	-0.17	0.27
419.42	R1	4.128693E-10	4.130146E-10	0.24	419.36	419.36	-0.07	419.77	419.24	-0.18	0.27
499.89	R2	1.639063E-09	1.639063E-09	0.25	499.86	499.86	-0.04	500.37	499.71	-0.19	0.29
499.89	R1	1.638486E-09	1.639063E-09	0.25	499.86	499.86	-0.04	500.37	499.71	-0.19	0.29
500.22	R1	1.652192E-09	1.652774E-09	0.50	500.40	500.40	0.18	500.92	500.25	0.03	0.52
599.66	R1	6.368180E-09	6.370422E-09	0.50	599.76	599.76	0.10	600.44	599.59	-0.07	0.54
600.43	R1	6.428283E-09	6.430545E-09	0.50	600.54	600.54	0.11	601.22	600.37	-0.06	0.54
600.04	R1	6.398232E-09	6.400484E-09	0.50	600.15	600.15	0.11	600.83	599.98	-0.06	0.54
660.04	R2	1.256802E-08	1.256802E-08	0.51	660.11	660.11	0.08	660.92	659.95	-0.09	0.55
700.47	R2	1.890124E-08	1.890124E-08	0.51	700.54	700.54	0.07	701.43	700.38	-0.09	0.56
699.36	R2	1.869786E-08	1.869786E-08	0.51	699.42	699.42	0.07	700.32	699.26	-0.10	0.56
700.00	R2	1.881512E-08	1.881512E-08	0.51	700.07	700.07	0.07	700.96	699.91	-0.09	0.56
700.40	R2	1.892227E-08	1.892227E-08	0.51	700.66	700.66	0.25	701.55	700.49	0.09	0.56
699.29	R2	1.871670E-08	1.871670E-08	0.51	699.53	699.53	0.24	700.42	699.36	0.07	0.56
700.00	R2	1.884819E-08	1.884819E-08	0.51	700.25	700.25	0.25	701.14	700.09	0.09	0.56
799.80	R2	4.515964E-08	4.515964E-08	0.51	799.71	799.71	-0.09	800.86	799.58	-0.22	0.59
900.19	R2	9.380092E-08	9.380092E-08	0.51	899.95	899.95	-0.24	901.42	899.88	-0.31	0.62
900.01	R2	9.385286E-08	9.385286E-08	0.51	900.03	900.03	0.02	901.50	899.96	-0.05	0.62
961.05	R2	1.380435E-07	1.380435E-07	0.51	960.88	960.88	-0.17	962.55	960.86	-0.20	0.64
962.03	R2	1.388408E-07	1.388408E-07	0.51	961.83	961.83	-0.20	963.51	961.81	-0.22	0.64
961.78	R2	1.386374E-07	1.386374E-07	0.51	961.59	961.59	-0.19	963.27	961.57	-0.21	0.64
1000.33	R2	1.736251E-07	1.736251E-07	0.51	1000.12	1000.12	-0.22	1001.94	1000.13	-0.20	0.65
999.18	R2	1.725317E-07	1.725317E-07	0.51	999.00	999.00	-0.18	1000.82	999.02	-0.17	0.65
1000.00	R2	1.733113E-07	1.733113E-07	0.51	999.80	999.80	-0.20	1001.62	999.81	-0.19	0.65
1000.17	R2	1.734897E-07	1.734897E-07	0.51	999.98	999.98	-0.20	1001.80	999.99	-0.18	0.65

Table 19 - results of the NPL measurements with the LP5 thermometer, analysed using the calibration fits for range R2

1.3 THE FIXED-POINT RESULTS

Fixed point	Gain used	Bgrd corrected signal/ V	lab U (*k*=2) / °C	Signal at 10^6 gain/ V	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (*k=2*) with range ratio & drift uncert/ °C
In	10^10	0.775825	0.08	7.68959E-05	156.623	156.623	0.025	156.714	156.691	0.093	0.09
Sn	10^9	1.836495	0.06	0.0016779	231.896	231.896	-0.032	231.967	231.937	0.009	0.07
Zn	10^7	1.984784	0.02	0.198601	419.527	419.527	0.000	419.588	419.530	0.003	0.07
Al	10^6	5.488178	0.03	5.488178	660.335	660.335	0.012	660.459	660.354	0.031	0.13
Ag	10^5	5.653369	0.07	56.582364	961.776	961.776	-0.004	962.100	961.916	0.136	0.23

Table 20 – results of the NPL fixed-point measurements with the INRiM thermometer – analysed using the calibration fits to the data

Fixed point	Gain used	Bgrd corrected signal/ V	Bgrd corrected signal ignoring gain/ V	lab U (*k*=2) / °C	Signal at 10^6 gain / V	Temp from NPL fit/ °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (*k=2*) with range ratio & drift uncert/ °C
Zn	10^7	1.98204E-07	1.982037	0.06	0.198307	419.447	419.537	0.010	419.508	419.540	0.013	0.09
Zn	10^6	1.98307E-07	0.198307	0.06	0.198307	419.447	419.537	0.010	419.508	419.540	0.013	0.09
Ag 1	10^5	5.64260E-05	5.642604	0.20	56.444951	961.361	961.647	-0.133	961.685	961.787	0.007	0.30
Ag 2	10^4	5.70133E-05	0.570133	0.20	56.453143	961.385	961.671	-0.109	961.710	961.811	0.031	0.30

Table 21 – results of the CEM fixed-point measurements with the INRiM thermometer – analysed using the calibration fits to the data

Fixed point	Gain used	Bgrd corrected Signal / mV	Signal corrected for emissivity / mV	Bgrd corrected signal/ V	lab U (*k*=2) / °C	Signal at 10^6 gain / V	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (*k=2*) with range ratio & drift uncert/ °C
In	10^9	83.71	83.75	0.08375	0.016	7.65000E-05	156.516	156.538	-0.060	156.606	156.606	0.008	0.032
Sn	10^9	1833.09	1833.88	1.83388	0.014	0.0016752	231.850	231.881	-0.047	231.922	231.922	-0.006	0.040
Zn	10^7	1981.61	1982.46	1.98246	0.018	0.198341	419.456	419.514	-0.013	419.517	419.517	-0.010	0.073
Al	10^6	5478.84	5481.20	5.48120	0.022	5.481196	660.210	660.316	-0.007	660.335	660.335	0.012	0.129
Ag	10^5	5642.67	5645.10	5.64510	0.026	56.475224	961.452	961.636	-0.144	961.777	961.777	-0.003	0.224

Table 22– results of the INRiM fixed-point measurements with the INRiM thermometer – analysed using the calibration fits to the data

Fixed point	Gain used	Bgrd corrected signal/ V	lab U (k=2) / °C	Signal at 10^6 gain/ V	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with range ratio & drift uncert/ °C
In	10^10	0.772745	0.062	7.65952E-05	156.542	156.551	-0.047	156.632	156.620	0.021	0.078
Sn	10^9	1.834863	0.020	0.0016762	231.867	231.880	-0.048	231.938	231.921	-0.007	0.043
Zn	10^7	1.983950	0.026	0.198495	419.498	419.523	-0.004	419.559	419.526	-0.001	0.075

Table 23– results of the UME fixed-point measurements with the INRiM thermometer – analysed using the calibration fits to the data

Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R1 / A	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with range ratio & drift uncert/ °C
Sn	R1	3.04800E-12	0.09	3.04800E-12	231.920	231.920	-0.008	232.258	231.975	0.047	0.11
Zn	R1	4.14357E-10	0.04	4.14357E-10	419.545	419.545	0.018	420.011	419.477	-0.050	0.13
Al	R2	1.25937E-08	0.07	1.25893E-08	660.308	660.308	-0.015	661.199	660.229	-0.094	0.23
Ag	R2	1.38800E-07	0.13	1.38751E-07	961.784	961.784	0.004	963.618	961.921	0.141	0.40

Table 24 – results of the NPL fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R1

Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R2 / A	Temp from NPL fit/ °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with range ratio & drift uncert/ °C
Zn	R1	4.14357E-10	0.04	4.14503E-10	419.545	419.545	0.018	419.963	419.429	-0.098	0.13
Al	R2	1.25937E-08	0.07	1.25937E-08	660.308	660.308	-0.015	661.111	660.141	-0.182	0.23
Ag	R2	1.38800E-07	0.13	1.38800E-07	961.784	961.784	0.004	963.466	961.768	-0.012	0.40

Table 25– results of the NPL fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R2

(Note that the results for the Sn point are not included for the R2 comparison as they can all be compared on range R1)

Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R1/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift‡ / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for average Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncert/ °C
Zn 1	R1	4.14927E-10	0.08	4.14927E-10	419.617	419.667	0.140	420.083	419.600	0.073	0.28
Zn 1	R2	4.15112E-10	0.08	4.14925E-10	419.617	419.667	0.140	420.083	419.600	0.073	0.28
Zn 2	R1	4.12569E-10	0.07	4.12569E-10	419.319	419.369	-0.158	419.785	419.302	-0.225	0.28
Zn 2	R2	4.12714E-10	0.07	4.12527E-10	419.314	419.364	-0.163	419.779	419.296	-0.231	0.28
Ag 1	R2	1.38577E-07	0.28	1.38514E-07	961.500	961.659	-0.121	963.333	961.797	0.017	0.94
Ag 2	R2	1.38002E-07	0.12	1.37940E-07	960.810	960.969	-0.811	962.641	961.105	-0.675	0.90

Table 26 – results of the CEM fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R1

‡ average of the two CEM zinc point check measurements

Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R2/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift / °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM fit / °C	Temp corrected for average Zn point drift / °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncert/ °C
Zn 1	R2	4.15112E-10	0.08	4.15112E-10	419.622	419.672	0.145	420.040	419.557	0.030	0.28
Zn 2	R2	4.12714E-10	0.07	4.12714E-10	419.319	419.369	-0.158	419.736	419.253	-0.274	0.28
Ag 1	R2	1.38577E-07	0.28	1.38577E-07	961.516	961.675	-0.105	963.197	961.662	-0.118	0.93
Ag 2	R2	1.38002E-07	0.12	1.38002E-07	960.827	960.986	-0.794	962.505	960.970	-0.810	0.89

Table 27 – results of the CEM fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R2

Fixed point	Range used	Bgrd corrected signal/ A	Signal corrected for emissivity/ A	lab U (k=2) / °C	Signal on range R1/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM calibration / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with gain ratio & drift uncert/ °C
Sn	R1	3.01179E-12	3.01309E-12	0.516	3.01309E-12	231.600	231.883	-0.045	231.938	231.938	0.010	0.520
Zn	R1	4.10187E-10	4.10363E-10	0.022	4.10363E-10	419.039	419.572	0.045	419.504	419.504	-0.023	0.122
Al	R2	1.24868E-08	1.24922E-08	0.020	1.24763E-08	659.453	660.421	0.098	660.342	660.342	0.019	0.219
Ag	R2	1.37339E-07	1.37398E-07	0.028	1.37224E-07	959.948	961.642	-0.138	961.775	961.775	-0.005	0.383

Table 28 – results of the INRiM fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R1

Fixed point	Range used	Bgrd corrected signal/ A	Signal corrected for emissivity/ A	lab U (k=2) / °C	Signal on range R2/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	Temp from INRiM calibration / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB})/ °C	U (k=2) with gain ratio & drift uncert/ °C
Sn	R1	3.01179E-12	3.01309E-12	0.516	3.01691E-12	231.625	231.908	-0.020	231.938	231.938	0.010	0.520
Zn	R1	4.10187E-10	4.10363E-10	0.022	4.10884E-10	419.087	419.620	0.093	419.504	419.504	-0.023	0.122
Al	R2	1.24868E-08	1.24922E-08	0.020	1.24922E-08	659.540	660.508	0.185	660.341	660.341	0.018	0.219
Ag	R2	1.37339E-07	1.37398E-07	0.028	1.37398E-07	960.100	961.794	0.014	961.775	961.775	-0.005	0.383

Table 29 – results of the INRiM fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R2

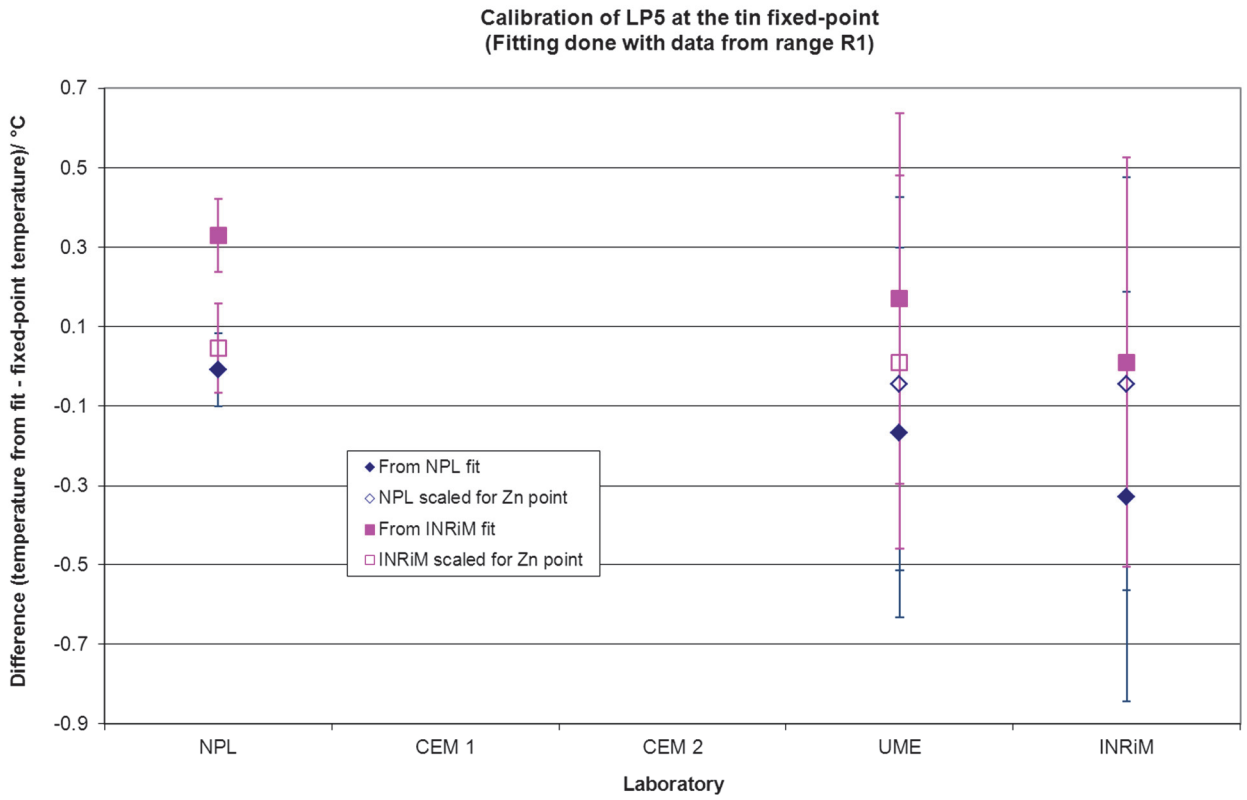
Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R1/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with drift uncert / °C
Sn	R1	3.03065E-12	0.47	3.03065E-12	231.761	231.884	-0.044	232.099	231.938	0.010	0.47
Zn	R2	4.11979E-10	0.13	4.17417E-10	419.931	420.161	0.634	420.397	420.094	0.567	1.29
Al	R2	1.25181E-08	0.05	1.26833E-08	661.016	661.434	1.111	661.908	661.358	1.035	2.29

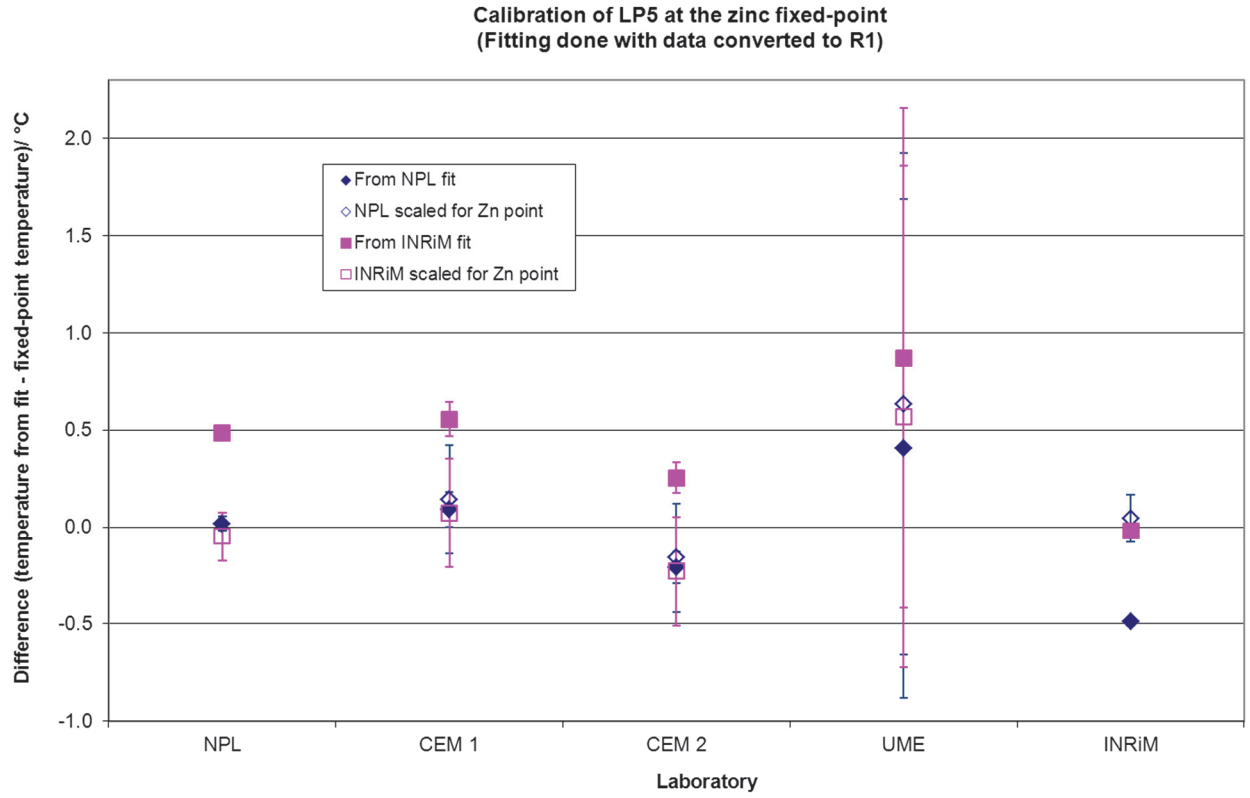
Table 30 – results of the UME fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R1

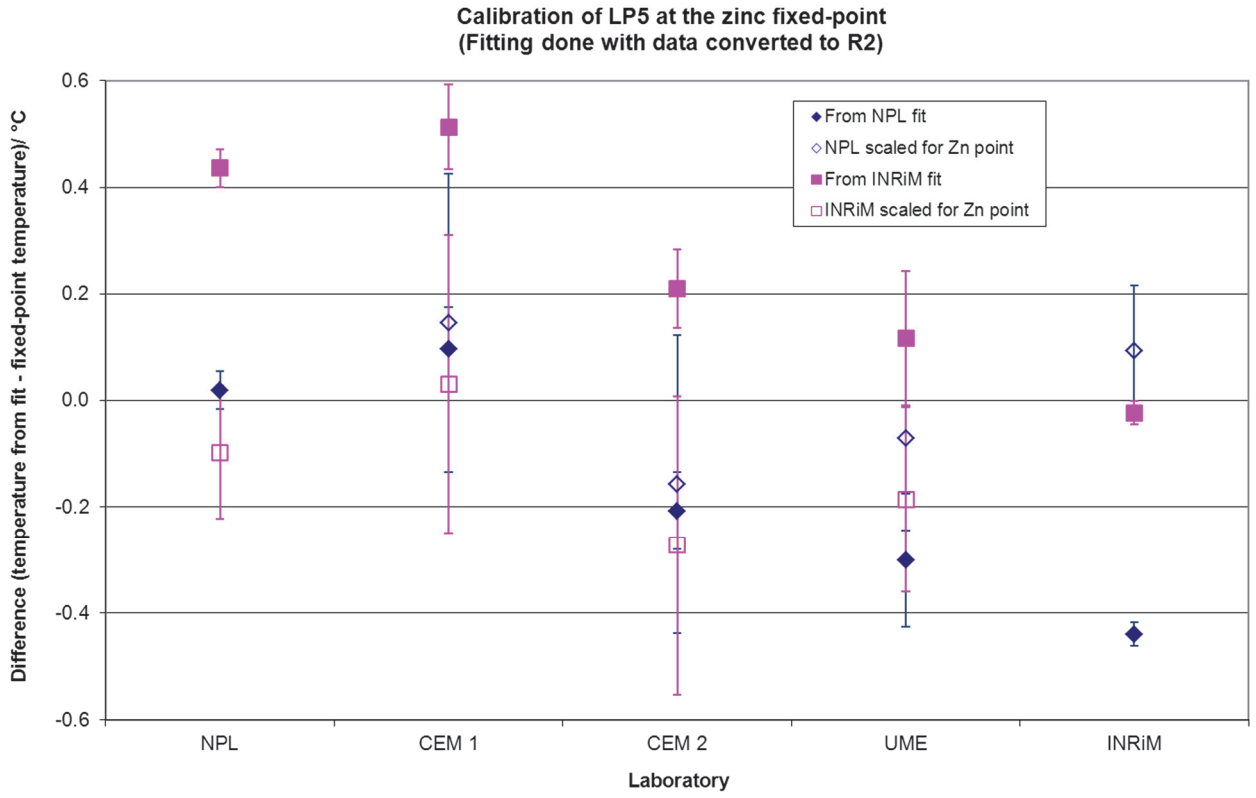
Fixed point	Range used	Bgrd corrected signal/ A	lab U (k=2) / °C	Signal on range R2/ A	Temp from NPL fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	Temp from INRiM fit / °C	Temp corrected for average Zn point drift/ °C	(t_{fit} - t_{BB}) / °C	U (k=2) with drift uncert / °C
Zn	R2	4.11979E-10	0.13	4.11979E-10	419.226	419.456	-0.071	419.643	419.340	-0.187	0.17
Al	R2	1.25181E-08	0.05	1.25181E-08	659.737	660.154	-0.169	660.538	659.988	-0.335	0.22

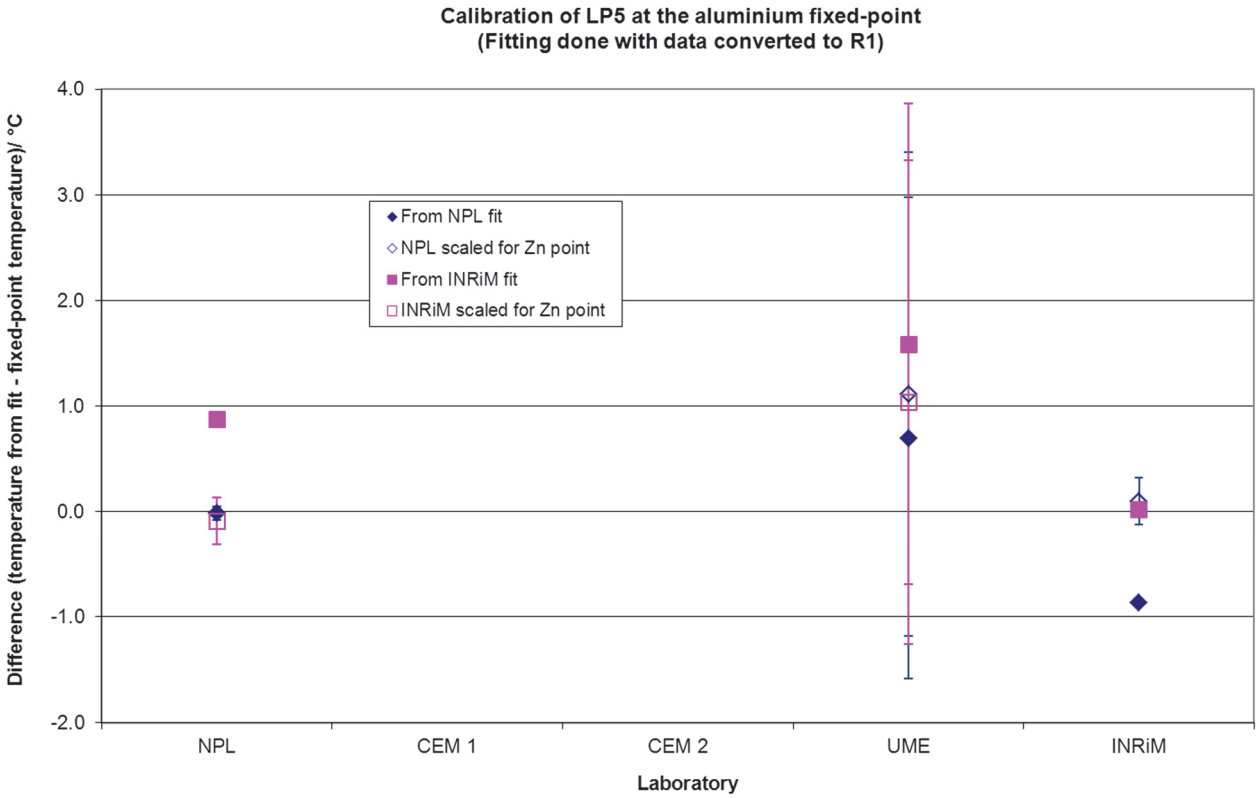
Table 31 – results of the UME fixed-point measurements with the LP5 thermometer – analysed using the calibration fits for range R2

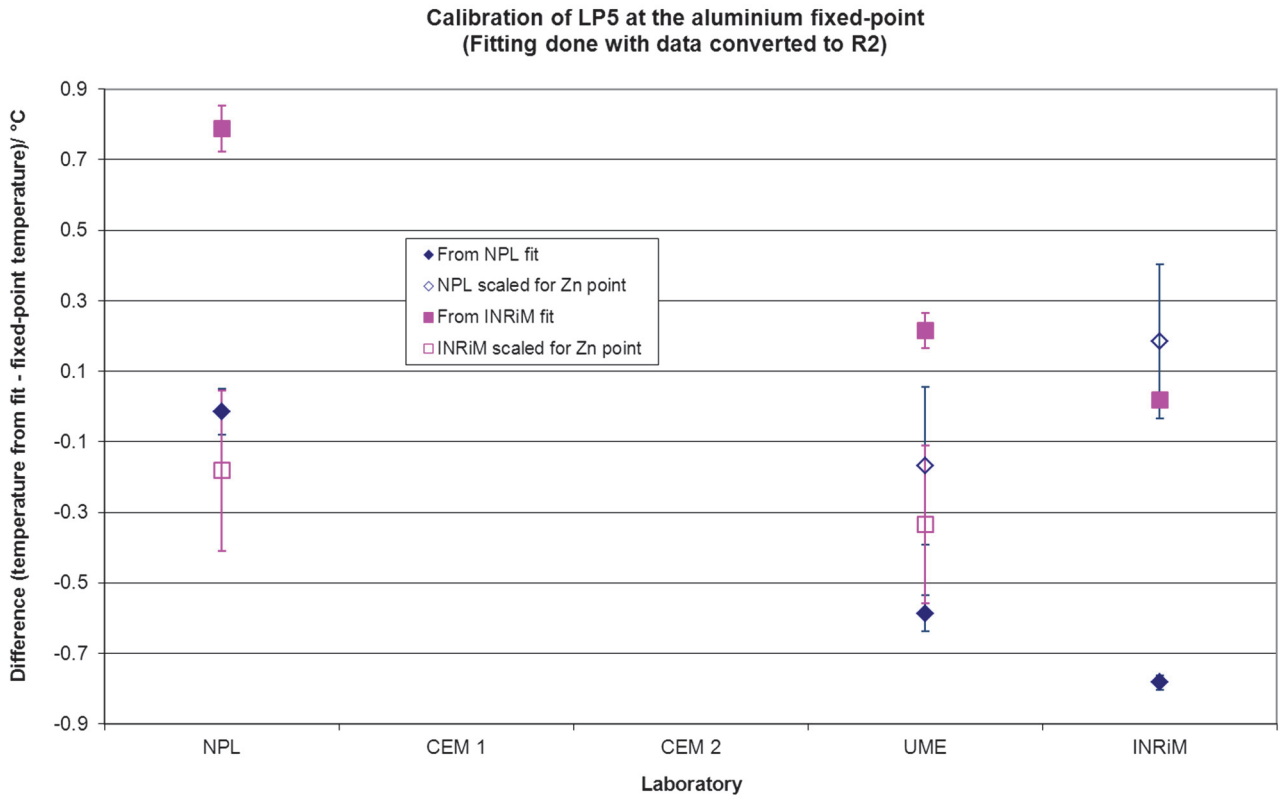
2 PLOTS OF RESULTS OF THE FIXED-POINT MEASUREMENTS USING THE CALIBRATION FITS FOR THE LP5 AND THE INRIM THERMOMETERS

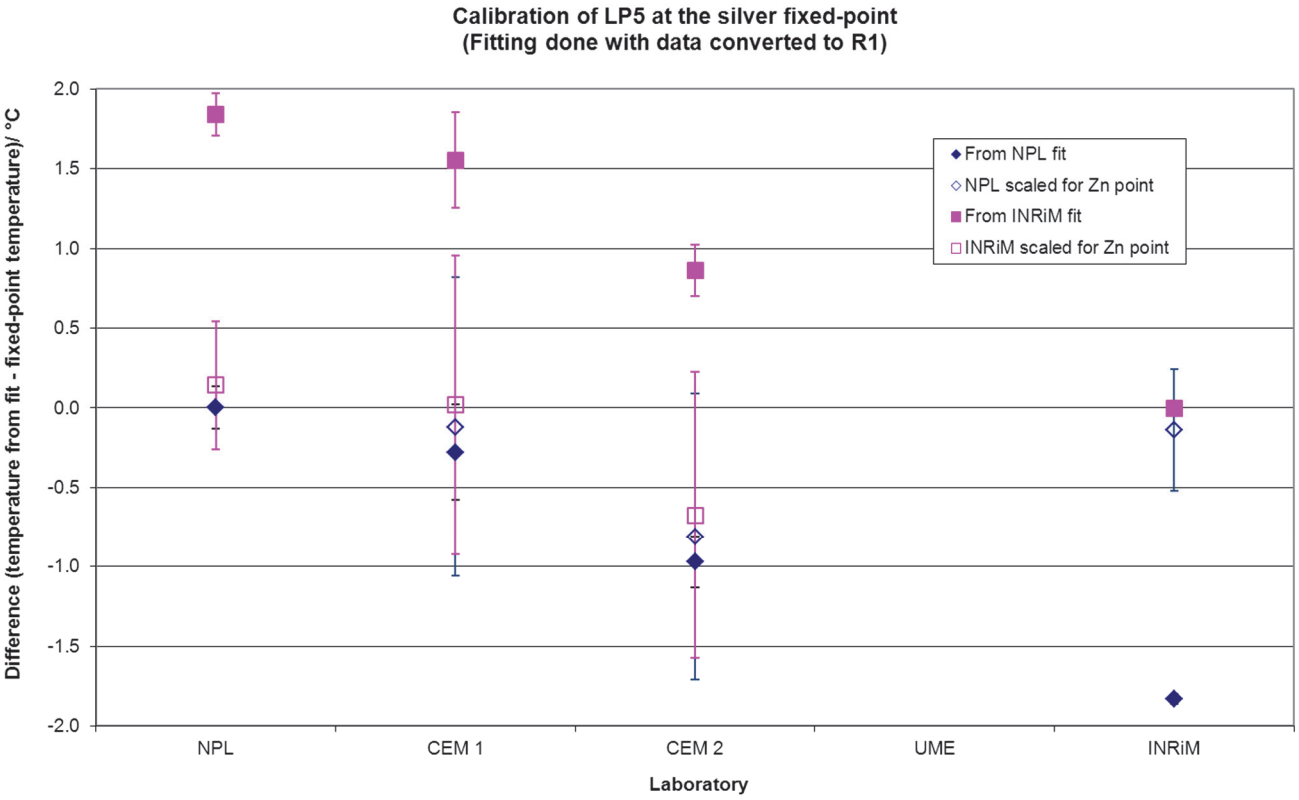


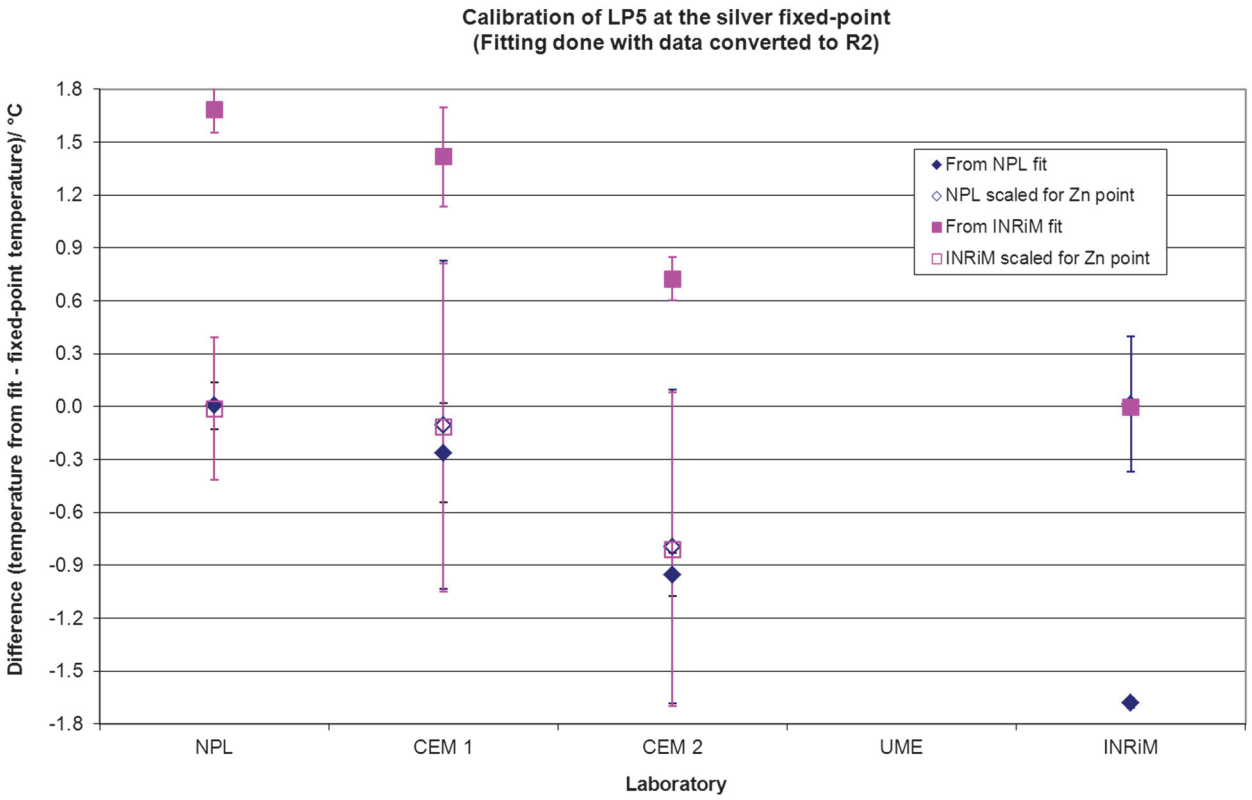


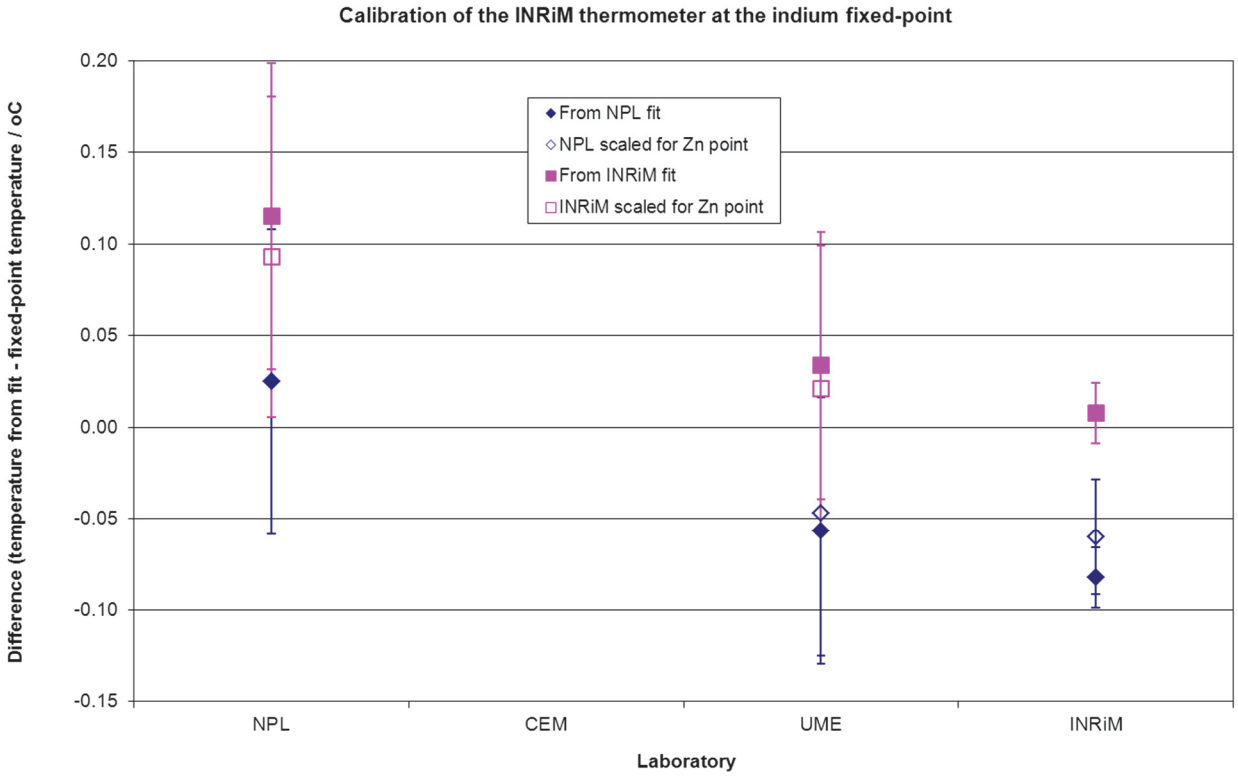

Calibration of LP5 at the zinc fixed-point
(Fitting done with data converted to R2)
Difference (temperature from fit - fixed-point temperature)/ °C
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

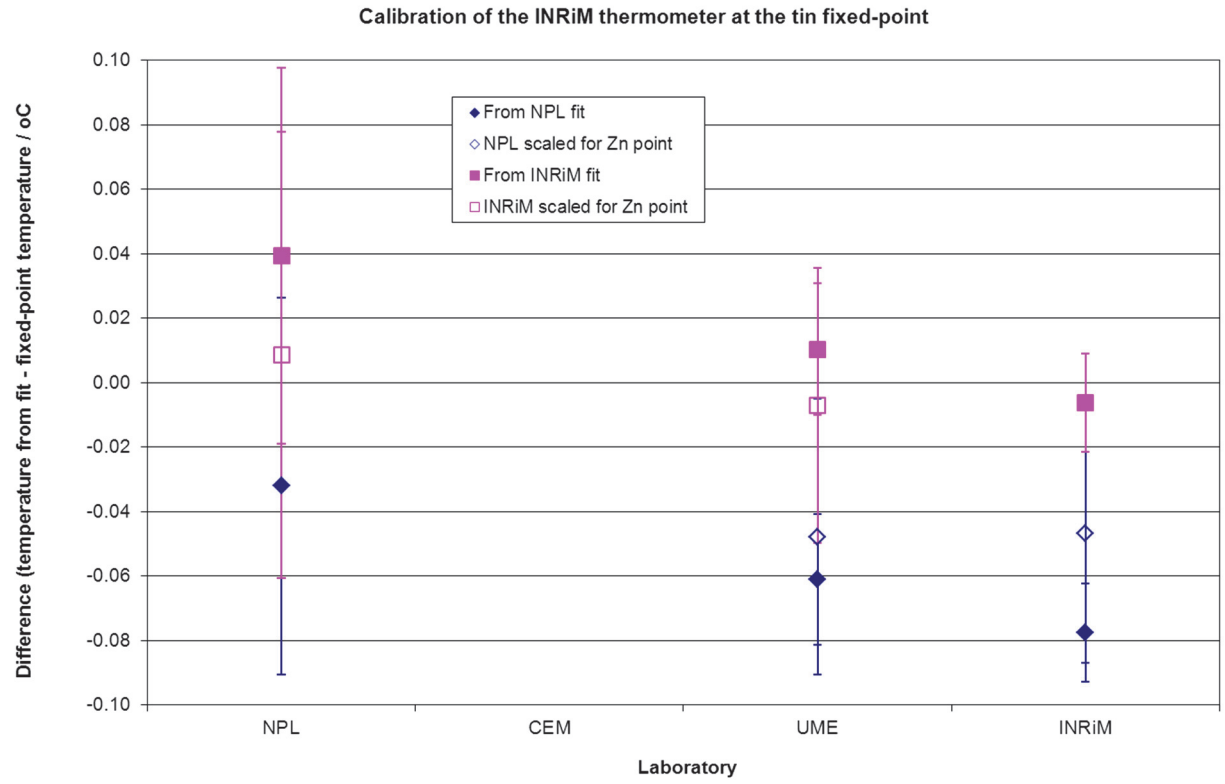

Calibration of LP5 at the aluminium fixed-point
(Fitting done with data converted to R1)
Difference (temperature from fit - fixed-point temperature)/ °C
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

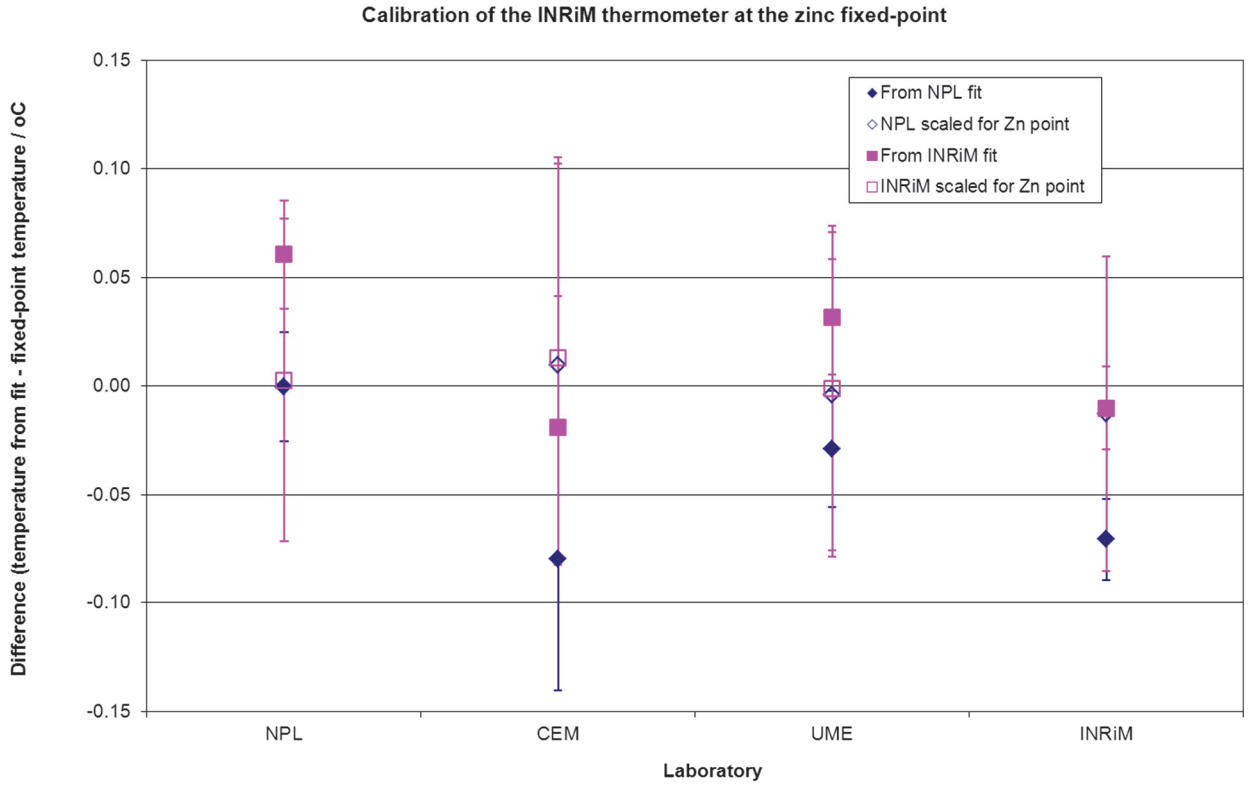

Calibration of LP5 at the aluminium fixed-point
(Fitting done with data converted to R2)
Difference (temperature from fit - fixed-point temperature)/ °C
0.9
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
-0.7
-0.9
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

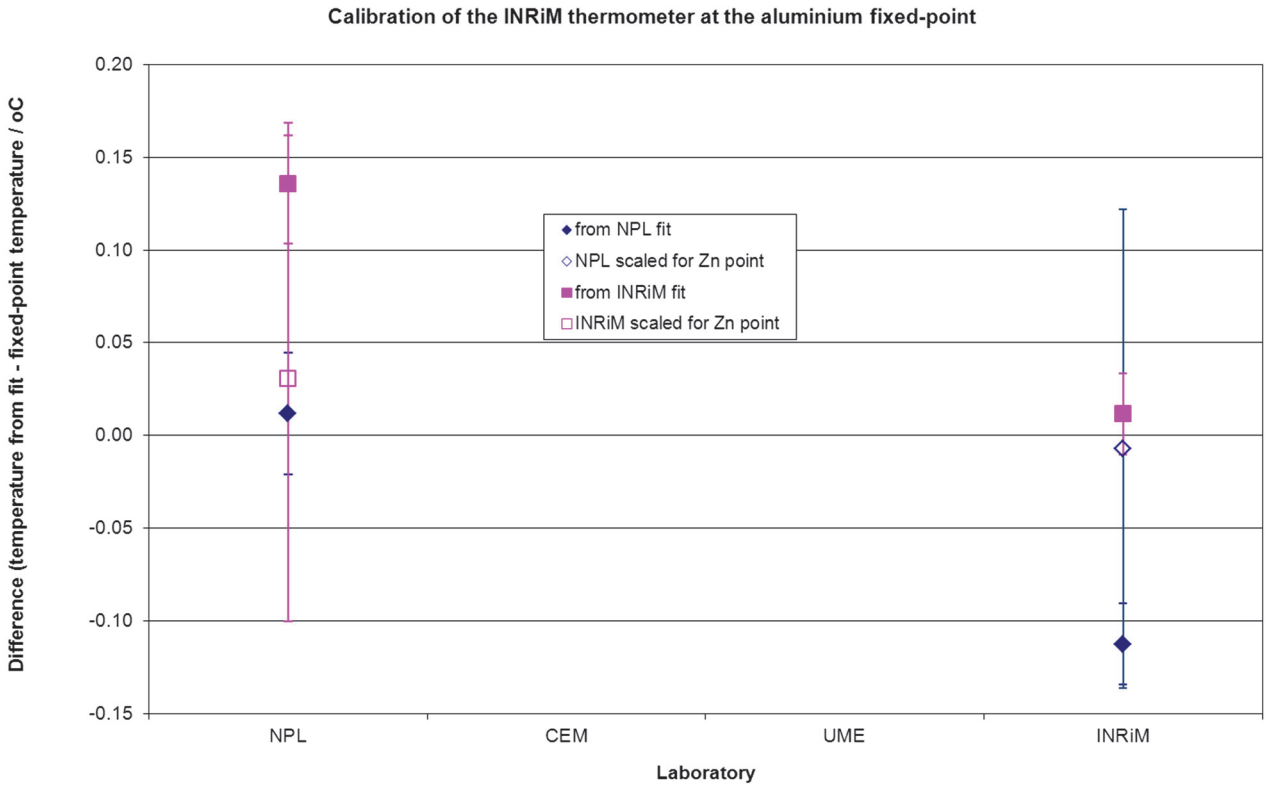

Calibration of LP5 at the silver fixed-point
(Fitting done with data converted to R1)
Difference (temperature from fit - fixed-point temperature)/ °C
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory

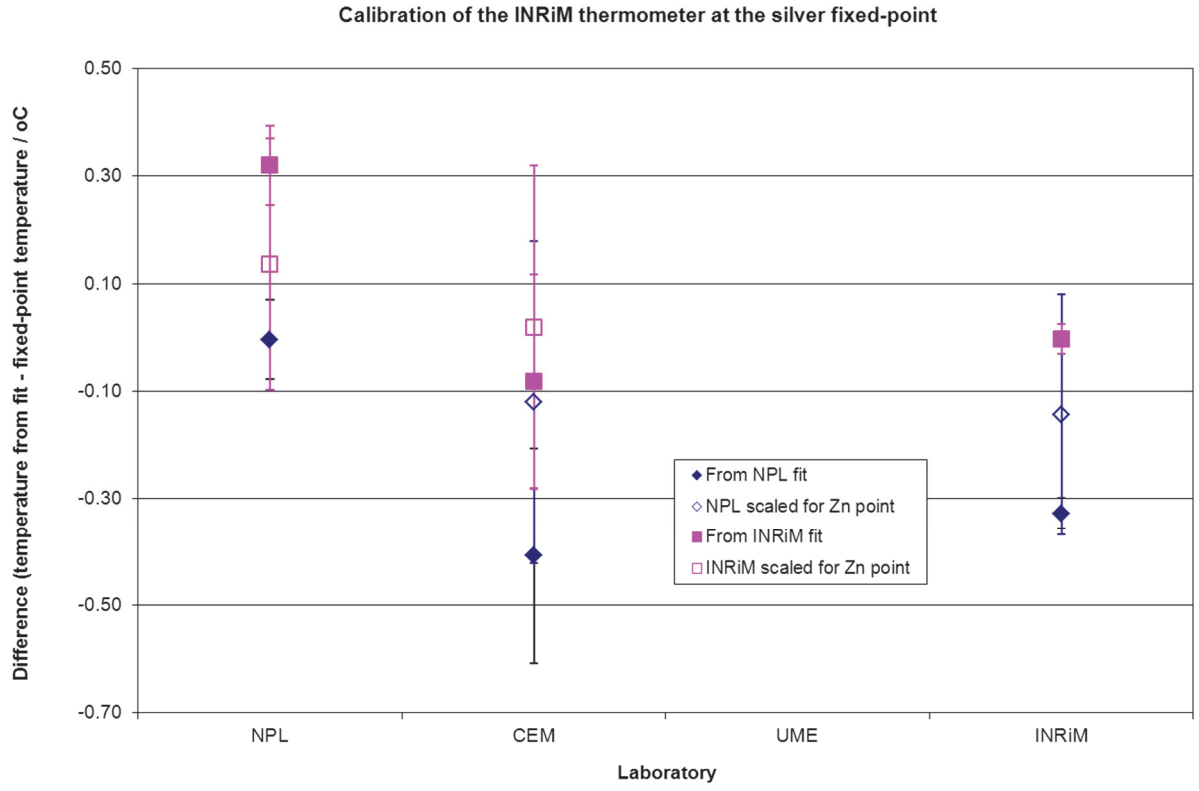

Calibration of LP5 at the silver fixed-point
(Fitting done with data converted to R2)
Difference (temperature from fit - fixed-point temperature)/ °C
1.8
1.5
1.2
0.9
0.6
0.3
0.0
-0.3
-0.6
-0.9
-1.2
-1.5
-1.8
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM 1
CEM 2
UME
INRiM
Laboratory


Calibration of the INRiM thermometer at the indium fixed-point
Difference (temperature from fit - fixed-point temperature / oC
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM
UME
INRiM
Laboratory

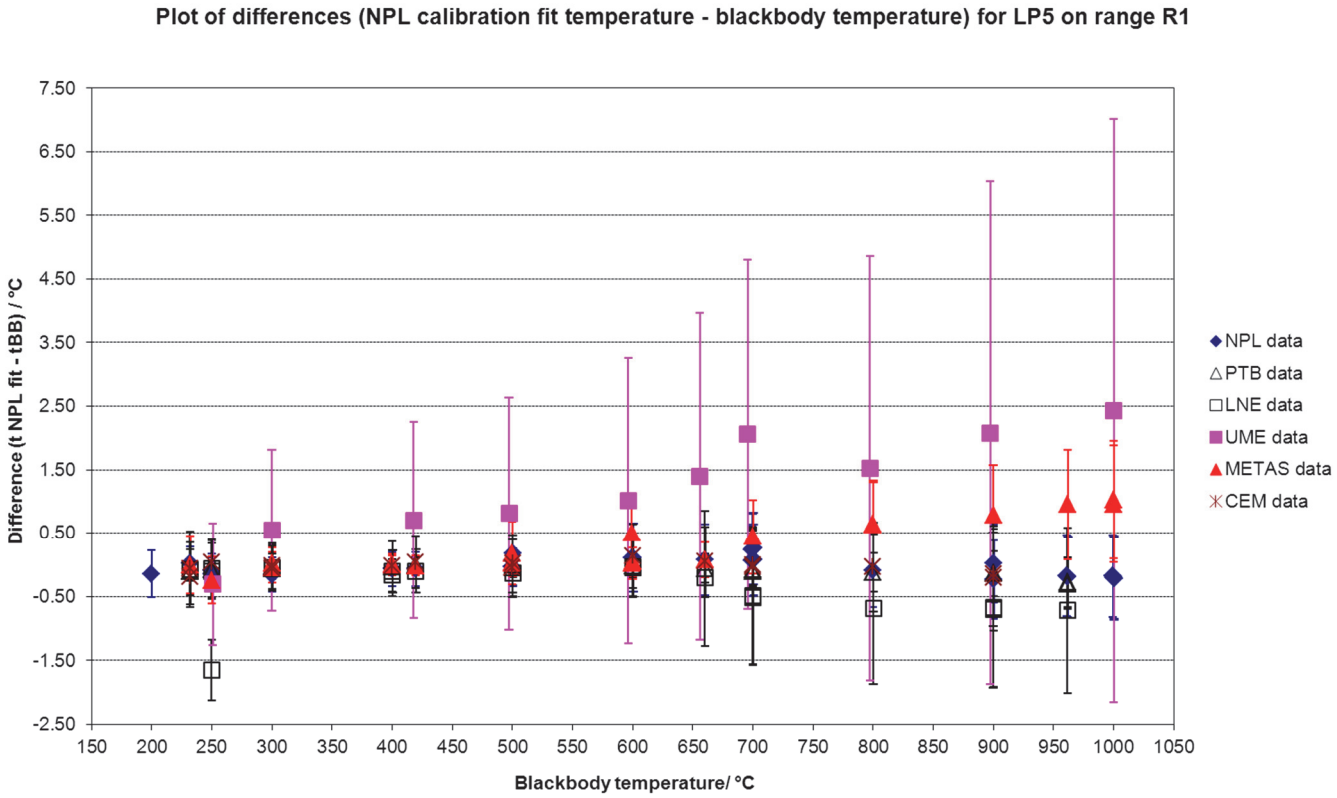

Calibration of the INRiM thermometer at the tin fixed-point
Difference (temperature from fit - fixed-point temperature / oC
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM
UME
INRiM
Laboratory

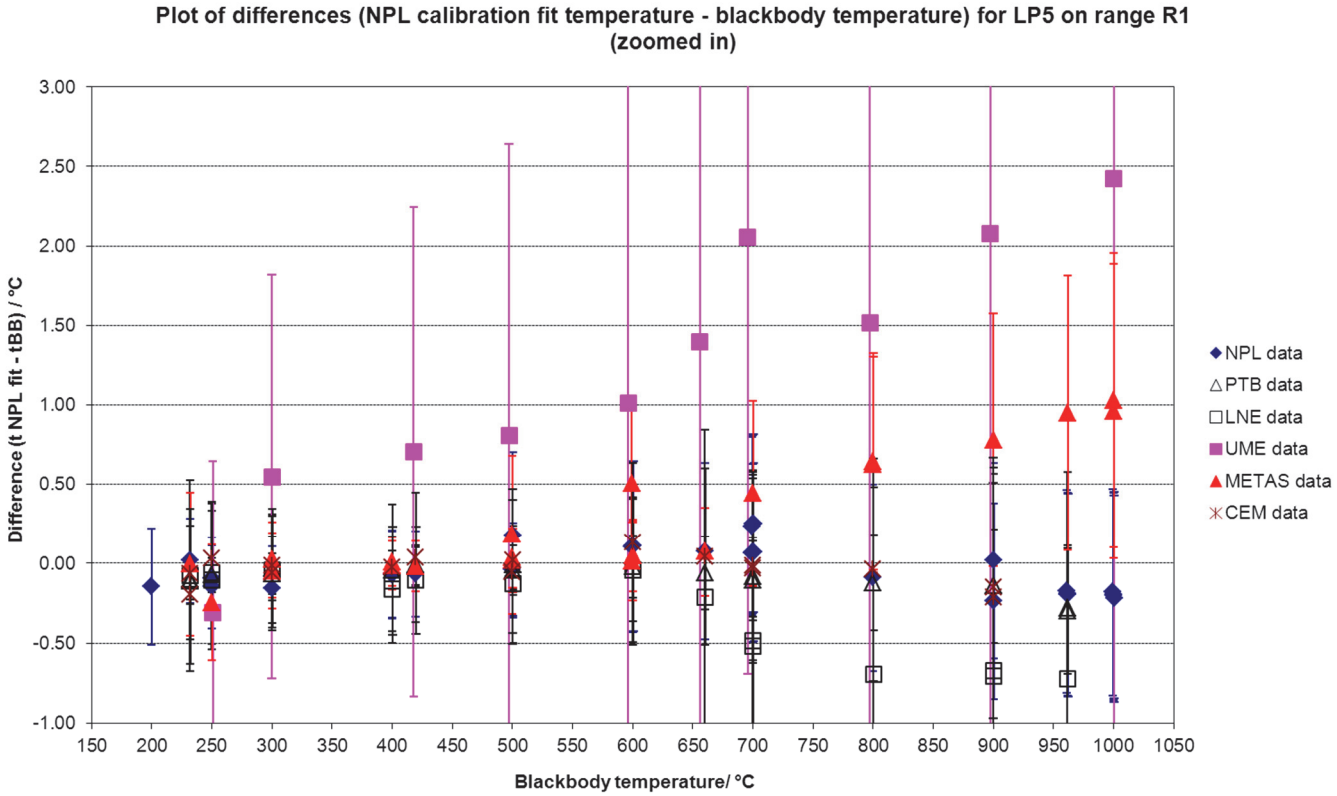

Calibration of the INRiM thermometer at the zinc fixed-point
Difference (temperature from fit - fixed-point temperature / oC
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM
UME
INRiM
Laboratory


Calibration of the INRiM thermometer at the aluminium fixed-point
Difference (temperature from fit - fixed-point temperature / oC
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
from NPL fit
NPL scaled for Zn point
from INRiM fit
INRiM scaled for Zn point
NPL
CEM
UME
INRiM
Laboratory

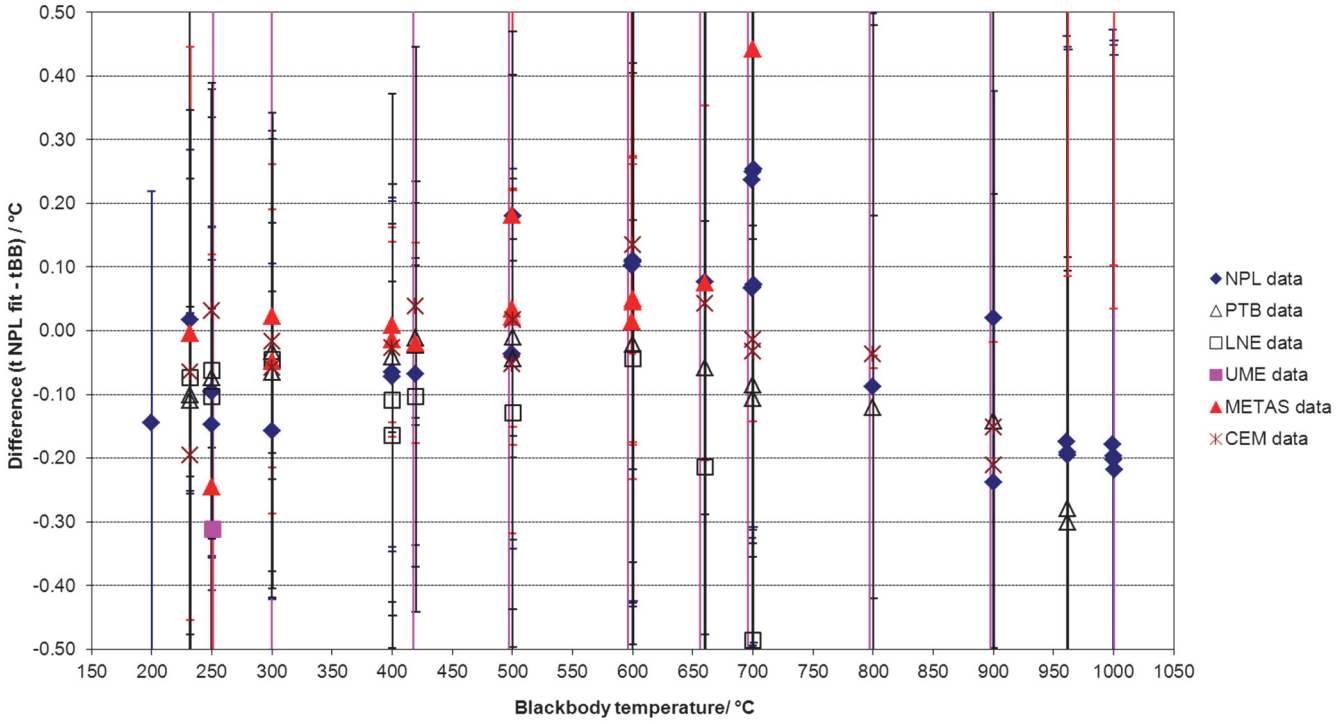

Calibration of the INRiM thermometer at the silver fixed-point
Difference (temperature from fit - fixed-point temperature / oC
0.50
0.30
0.10
-0.10
-0.30
-0.50
-0.70
From NPL fit
NPL scaled for Zn point
From INRiM fit
INRiM scaled for Zn point
NPL
CEM
UME
INRiM
Laboratory

3 DIFFERENCES BETWEEN THE CALIBRATION FITS AND THE BLACKBODY TEMPERATURE FOR THE LP5 THERMOMETER

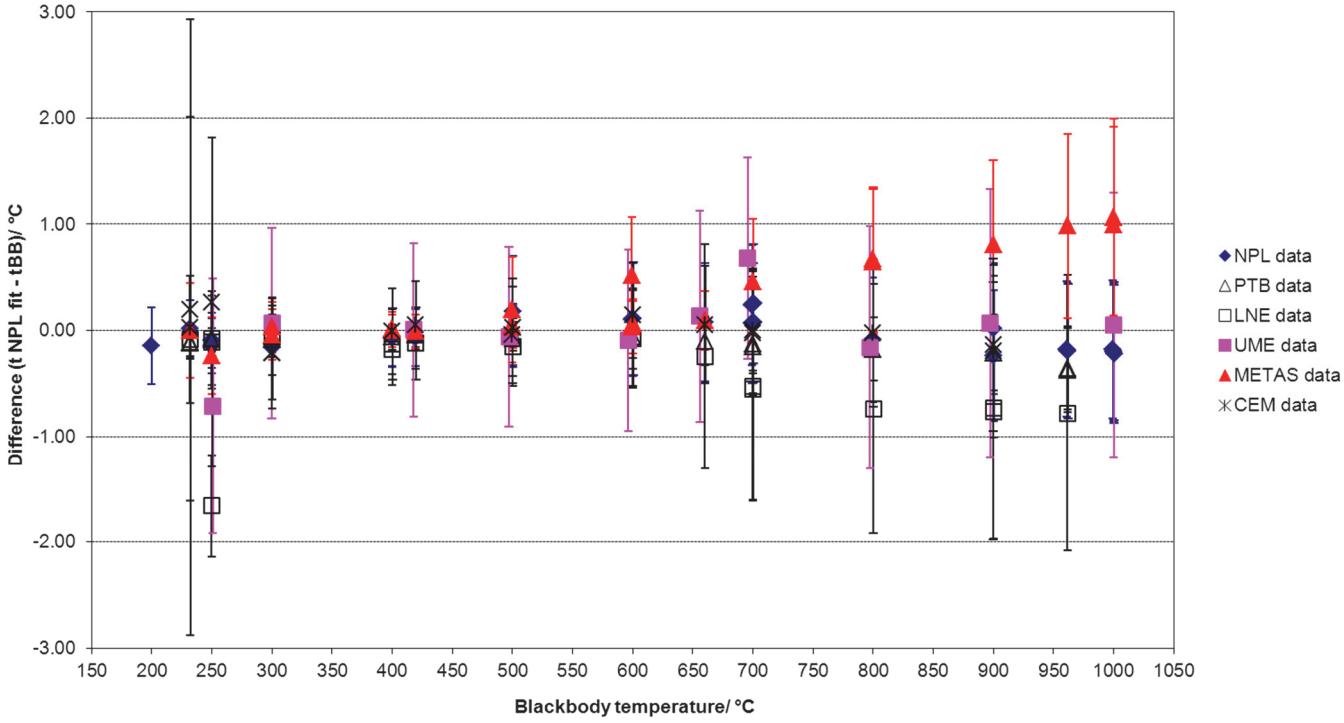


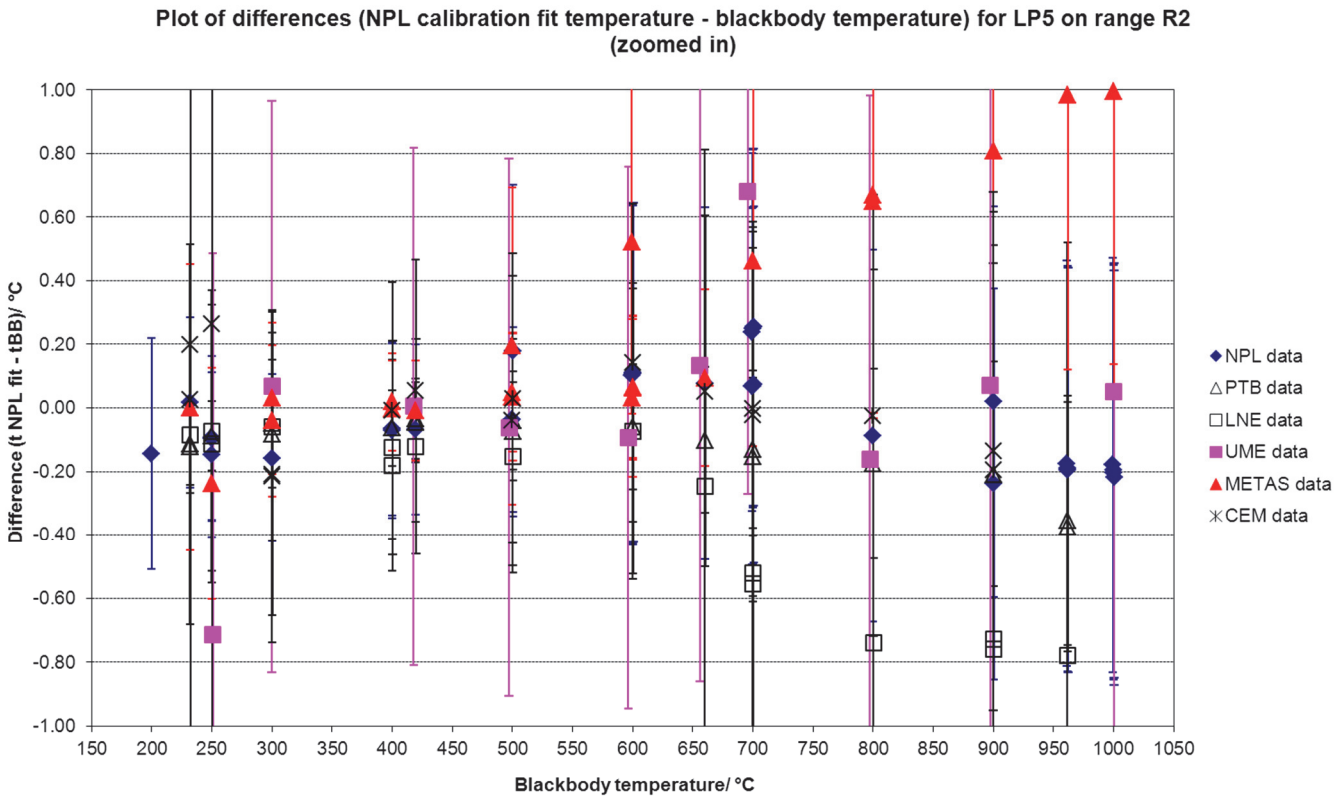


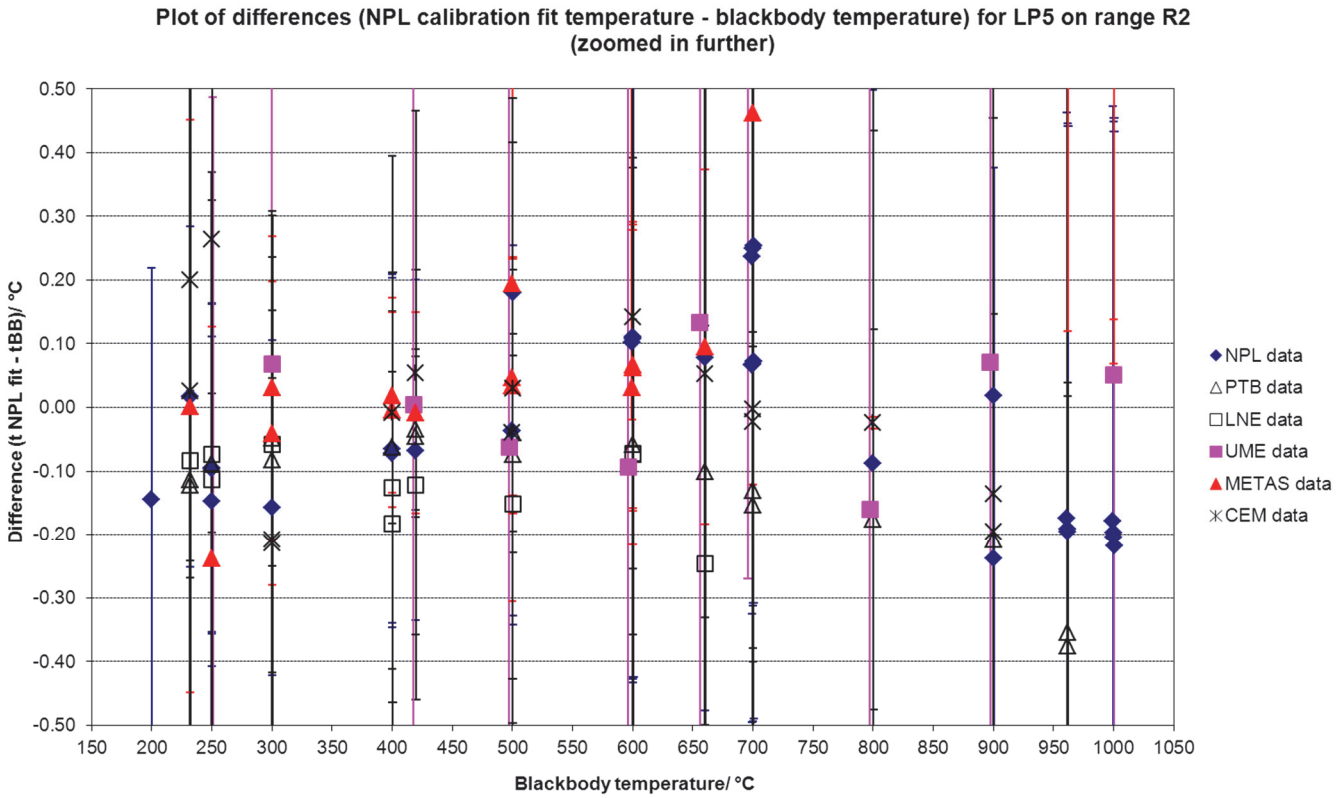
Plot of differences (NPL calibration fit temperature - blackbody temperature) for LP5 on range R1 (zoomed in further)

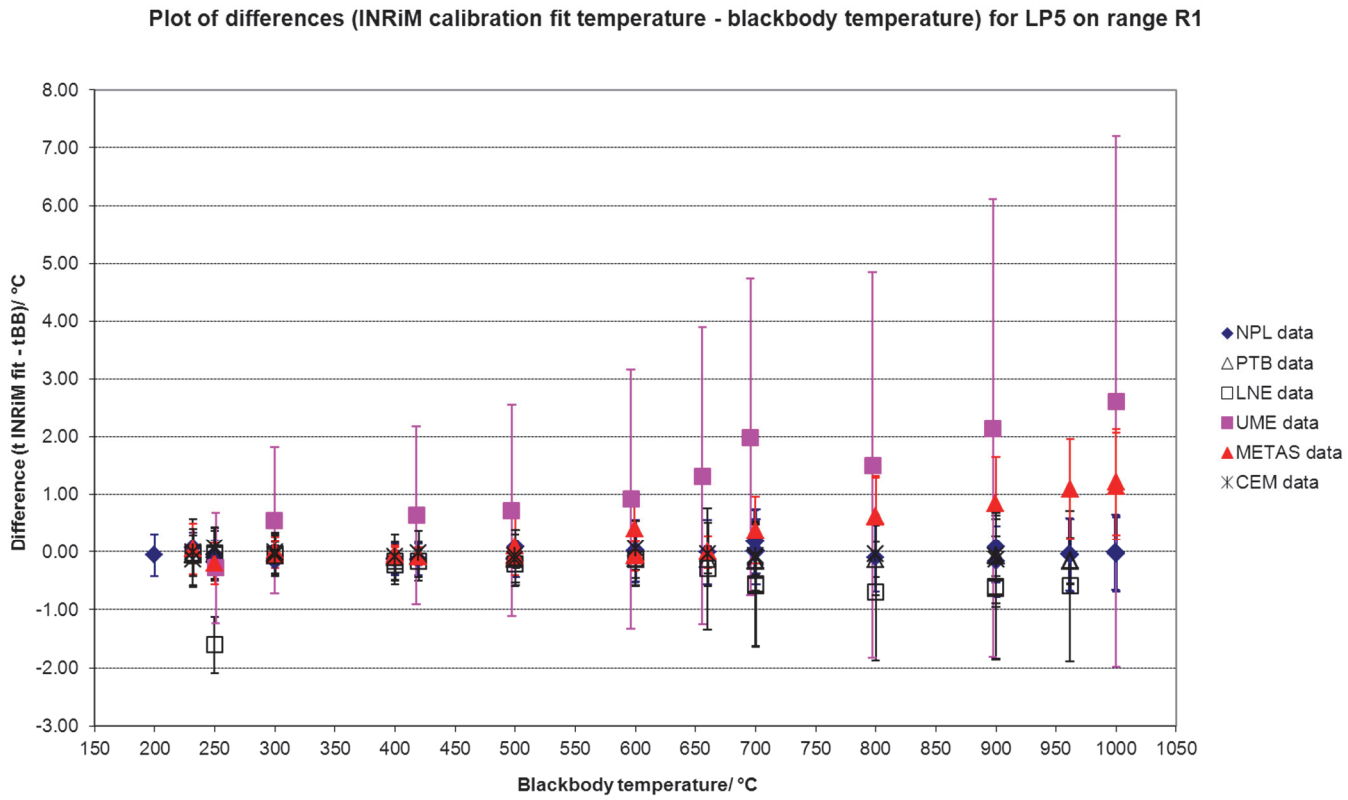


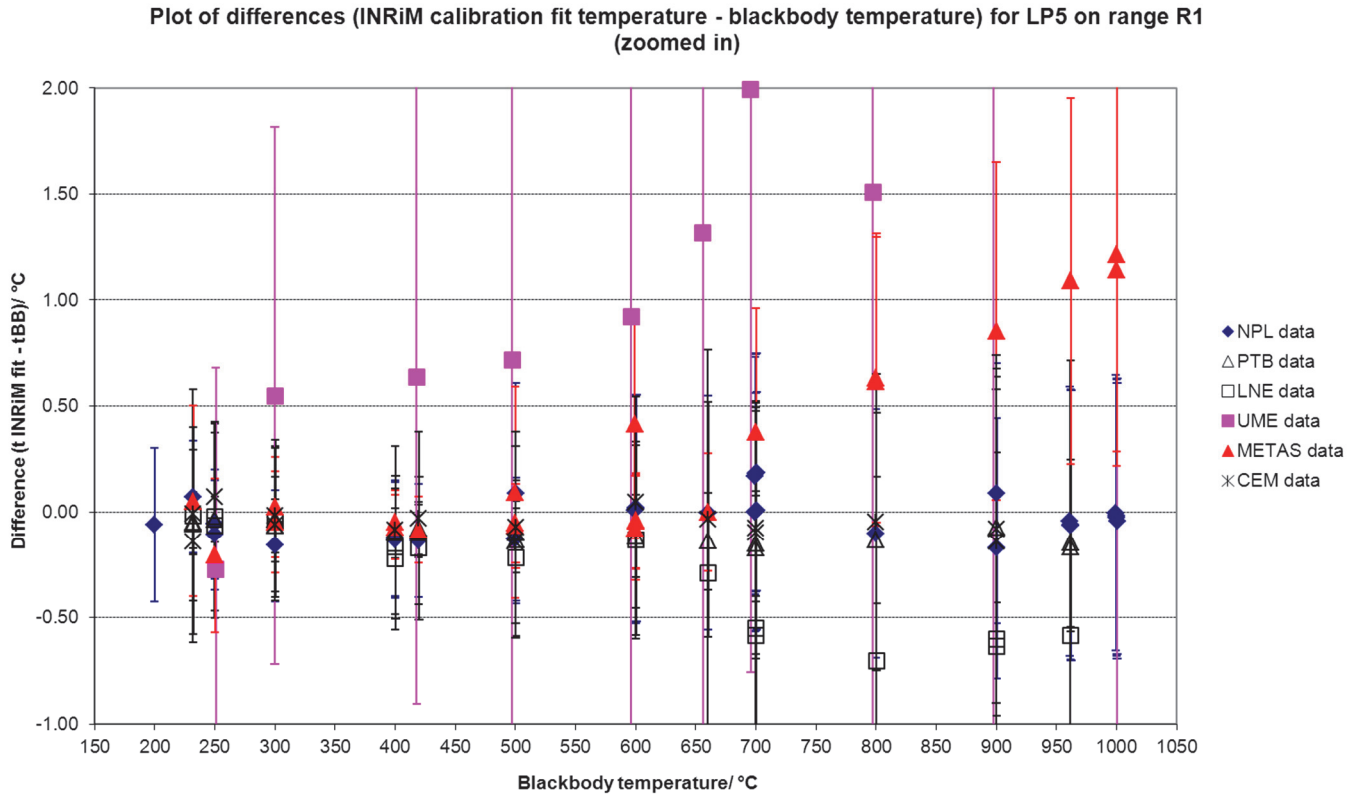
Plot of differences (NPL calibration fit temperature - blackbody temperature) for LP5 on range R2



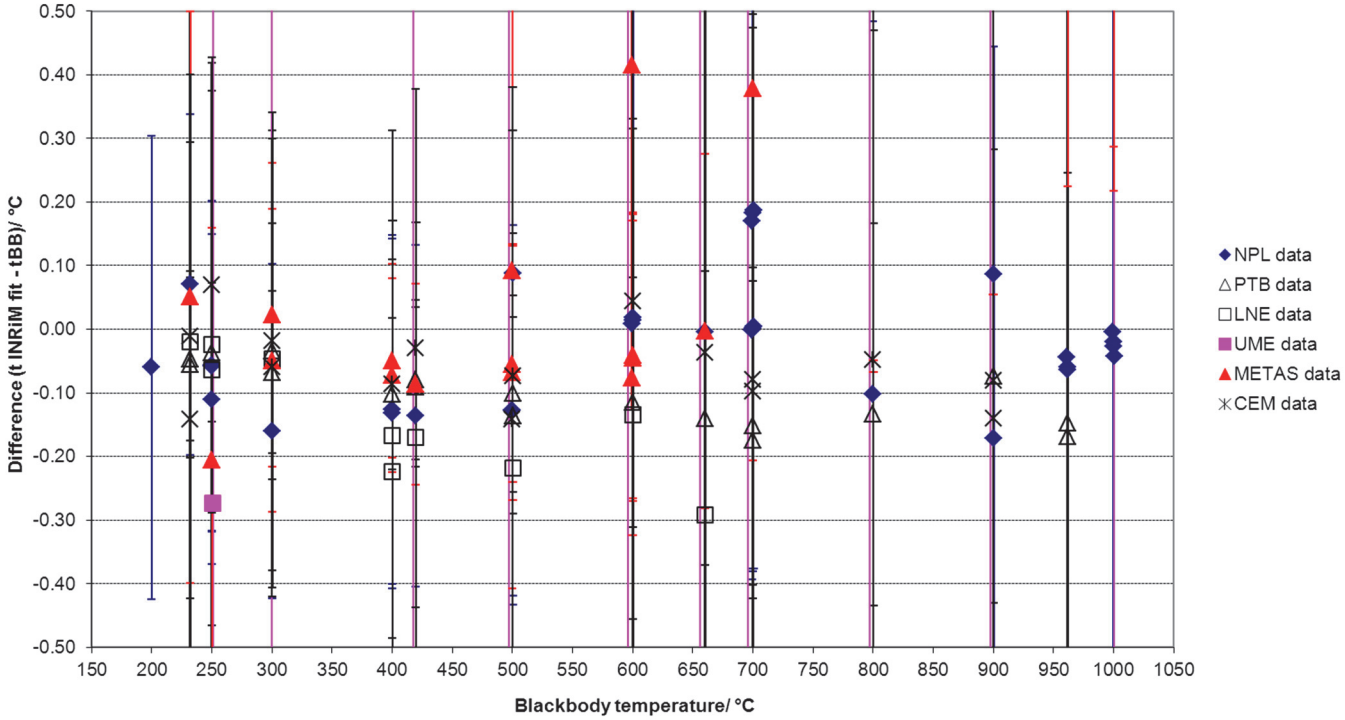

Plot of differences (NPL calibration fit temperature - blackbody temperature) for LP5 on range R2 (zoomed in)
Difference (t NPL fit - tBB)/ °C
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data


Plot of differences (NPL calibration fit temperature - blackbody temperature) for LP5 on range R2 (zoomed in further)
Difference (t NPL fit - tBB)/ °C
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data

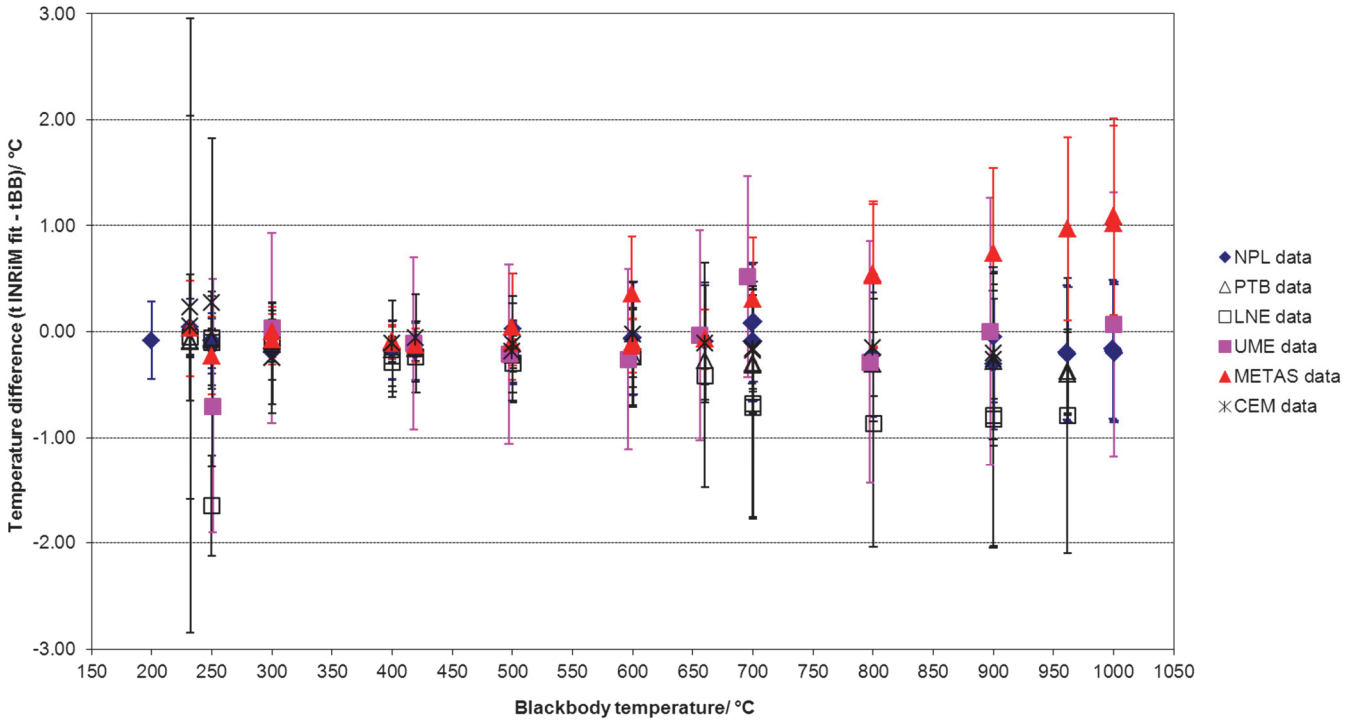

Plot of differences (INRiM calibration fit temperature - blackbody temperature) for LP5 on range R1
Difference (t INRiM fit - tBB)/ °C
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data

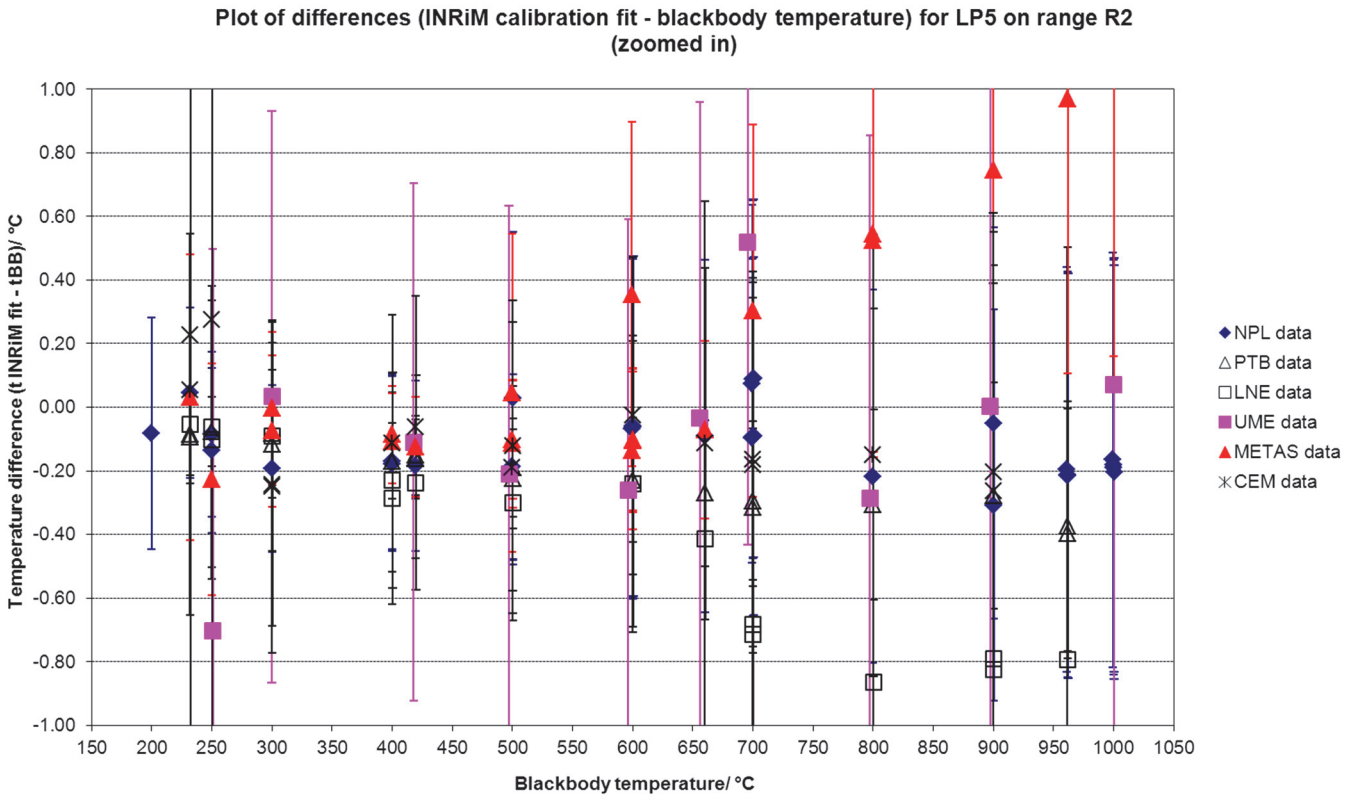

Plot of differences (INRiM calibration fit temperature - blackbody temperature) for LP5 on range R1 (zoomed in)
Difference (t INRiM fit - tBB)/ °C
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data

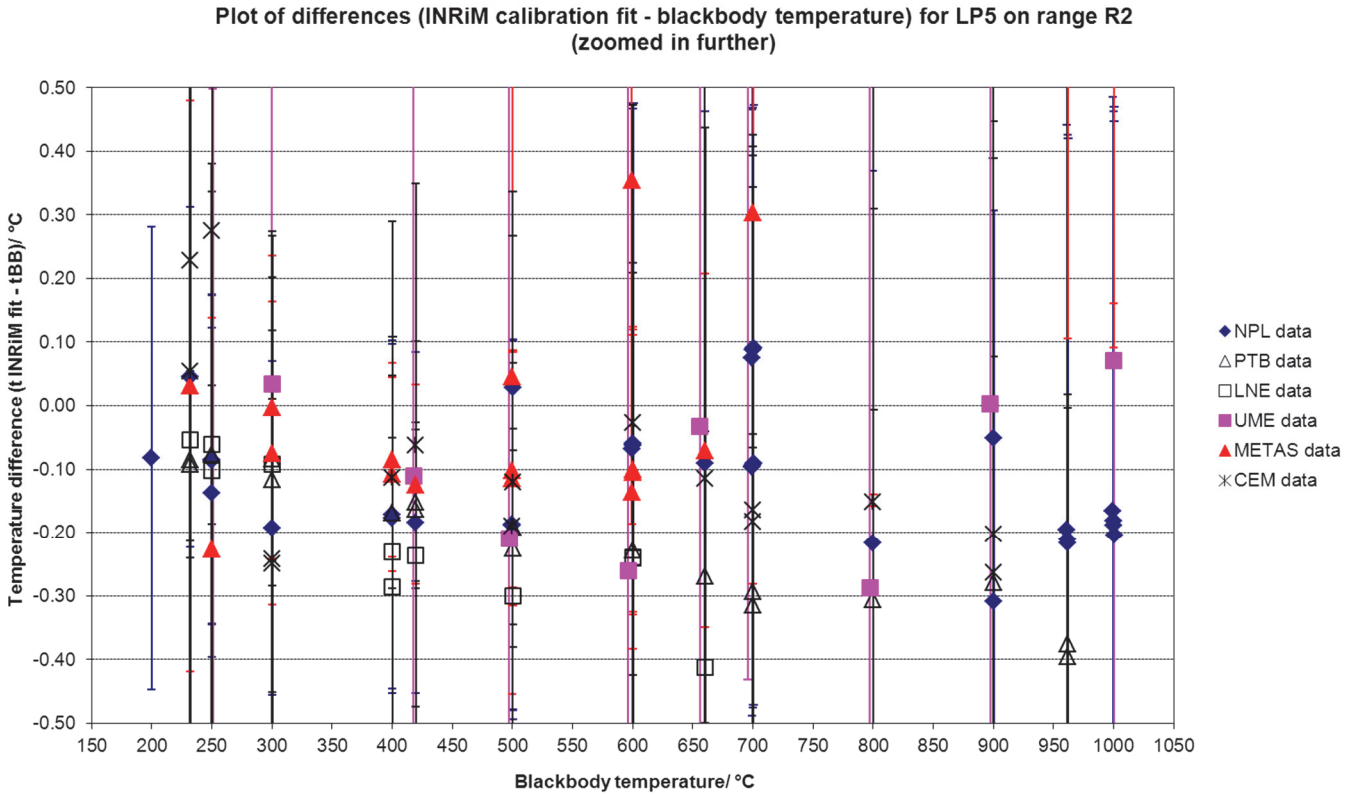
Plot of differences (INRiM calibration fit temperature - blackbody temperature) for LP5 on range R1 (zoomed in further)



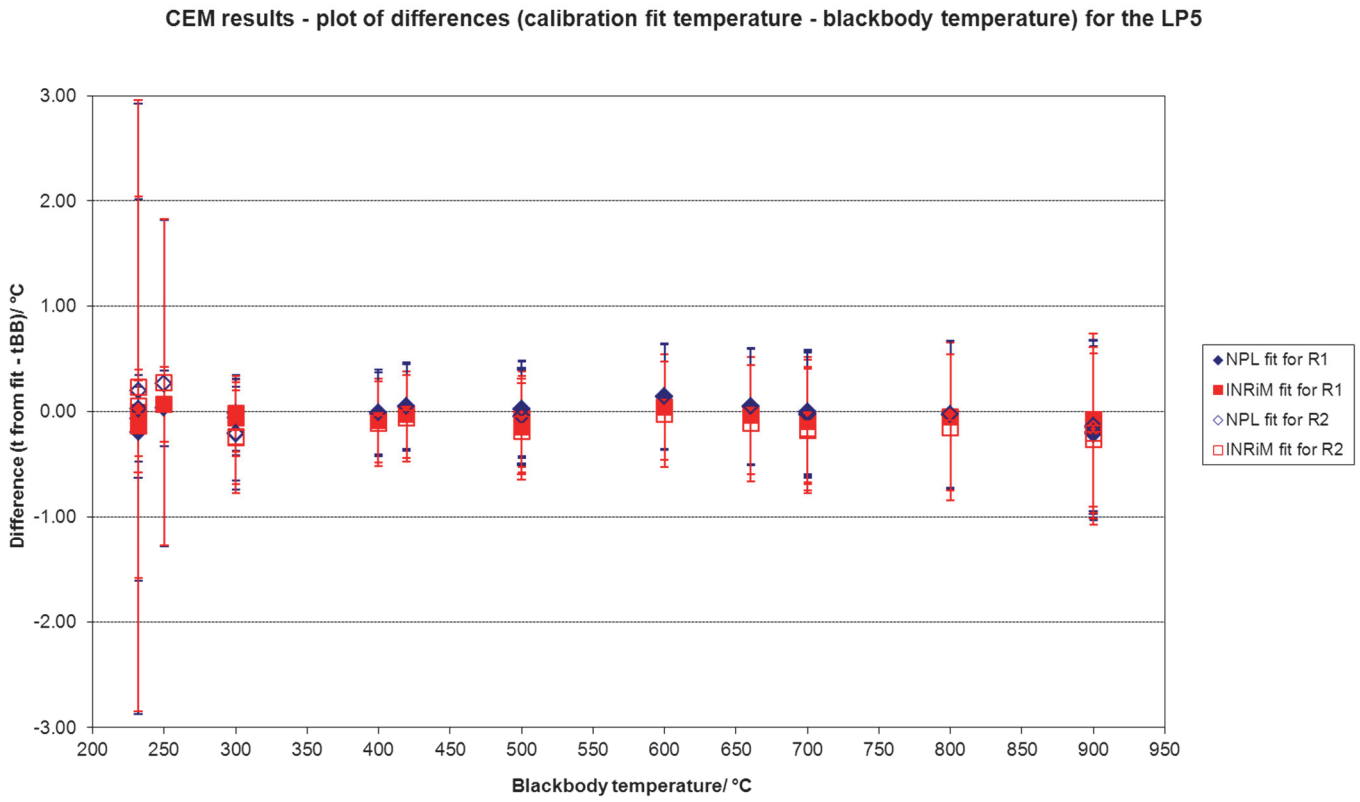
Plot of differences (INRiM calibration fit - blackbody temperature) for LP5 on range R2

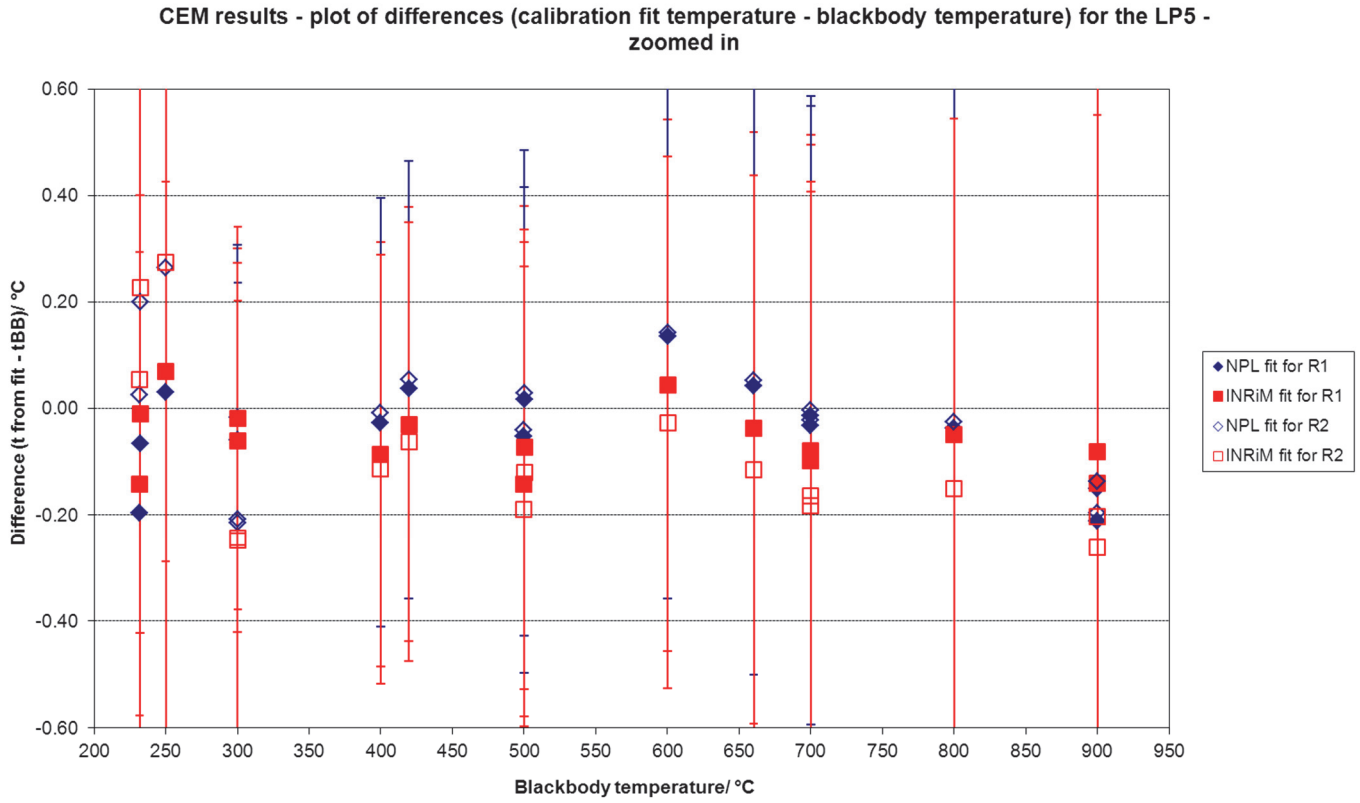



Plot of differences (INRiM calibration fit - blackbody temperature) for LP5 on range R2 (zoomed in)
Temperature difference (t INRiM fit - tBB)/ °C
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data

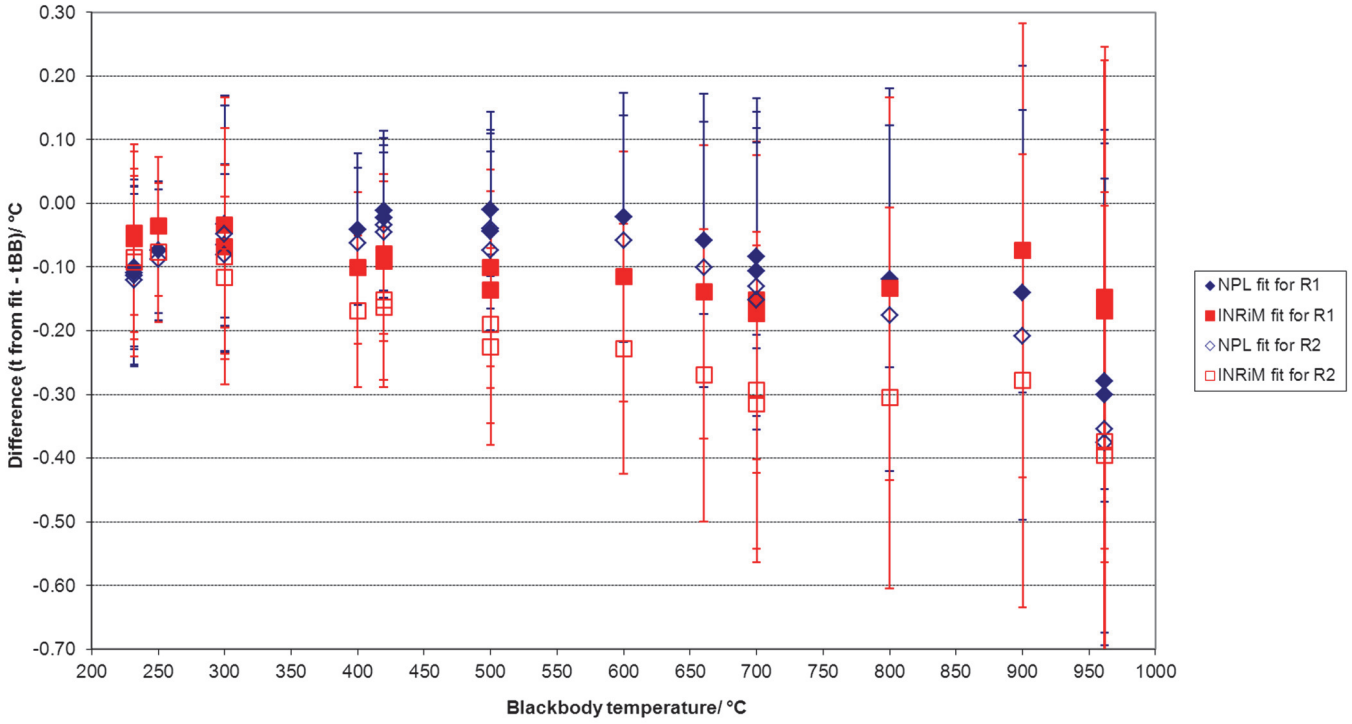

Plot of differences (INRiM calibration fit - blackbody temperature) for LP5 on range R2 (zoomed in further)
Temperature difference (t INRiM fit - tBB)/ °C
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C
NPL data
PTB data
LNE data
UME data
METAS data
CEM data

4 INDIVIDUAL LABORATORY RESULTS: DIFFERENCES BETWEEN THE CALIBRATION FITS AND THE BLACKBODY TEMPERATURE FOR THE LP5 THERMOMETER

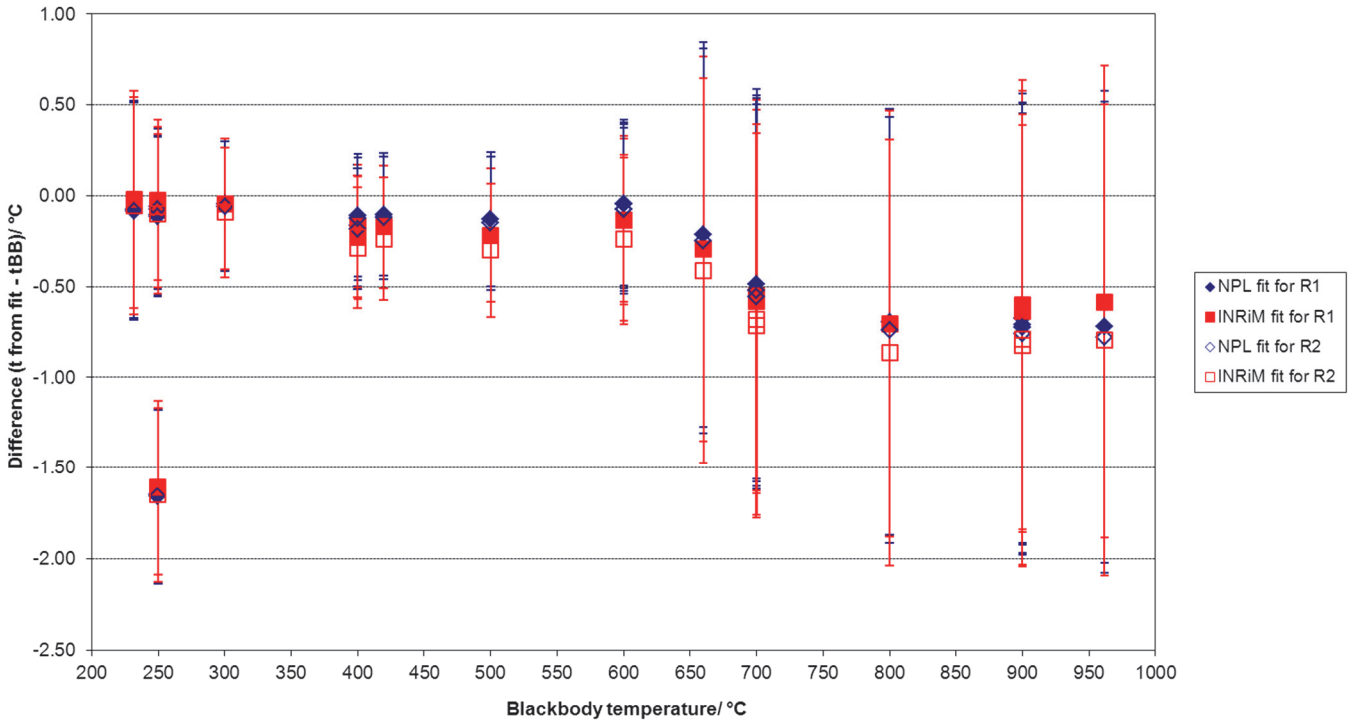




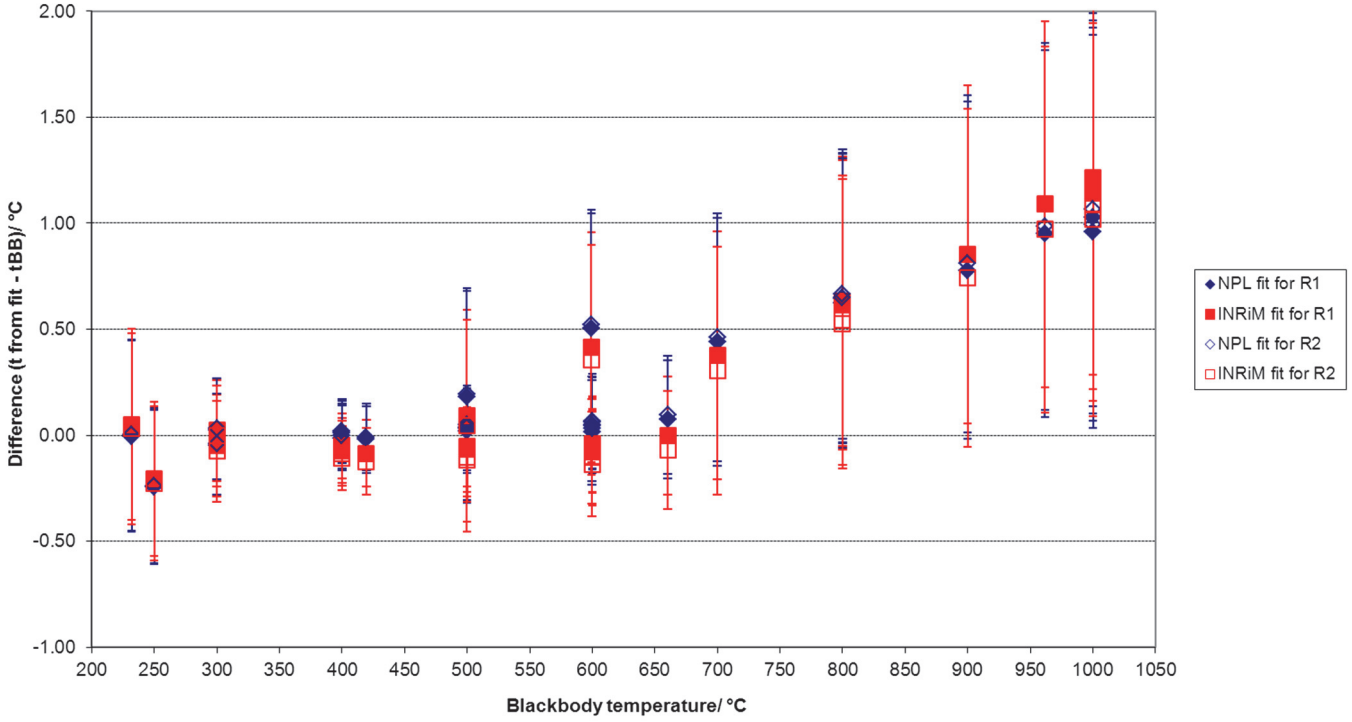
PTB results - plot of differences (calibration fit temperature - blackbody temperature) for the LP5



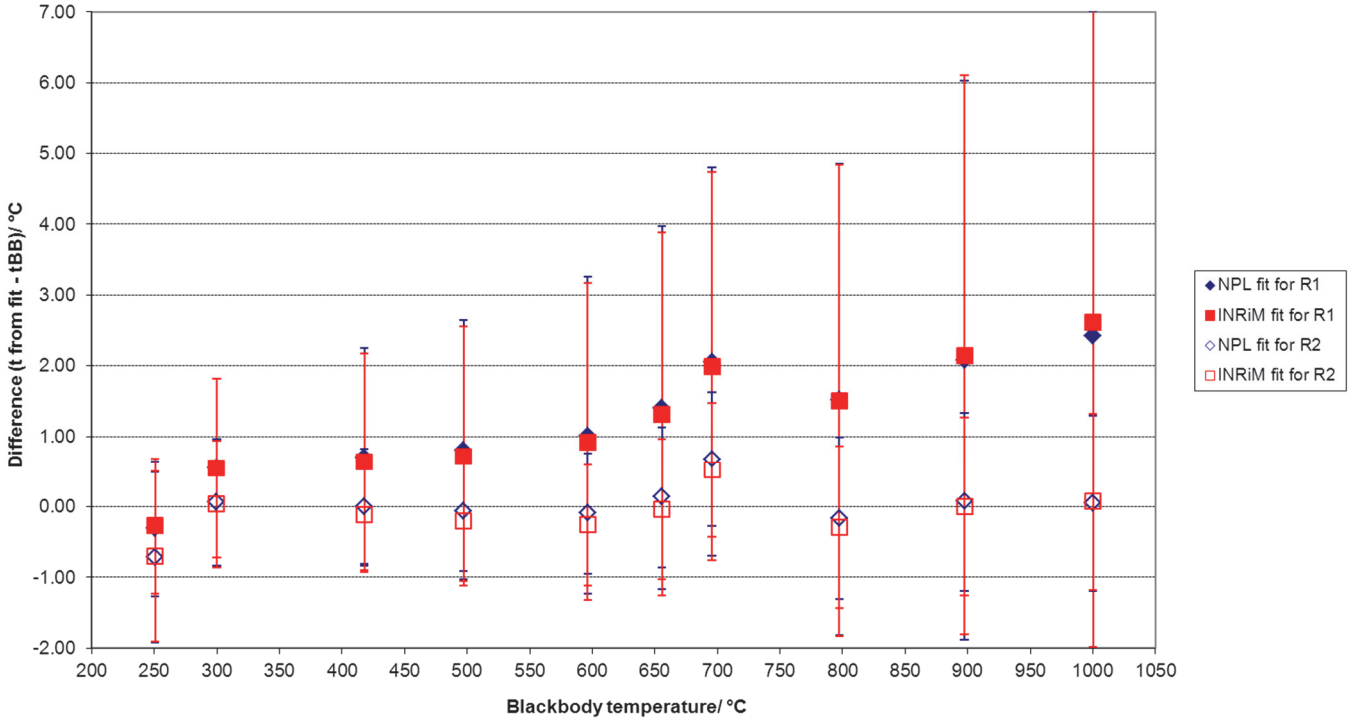
LNE results - plot of differences (calibration fit temperature - blackbody temperature) for the LP5

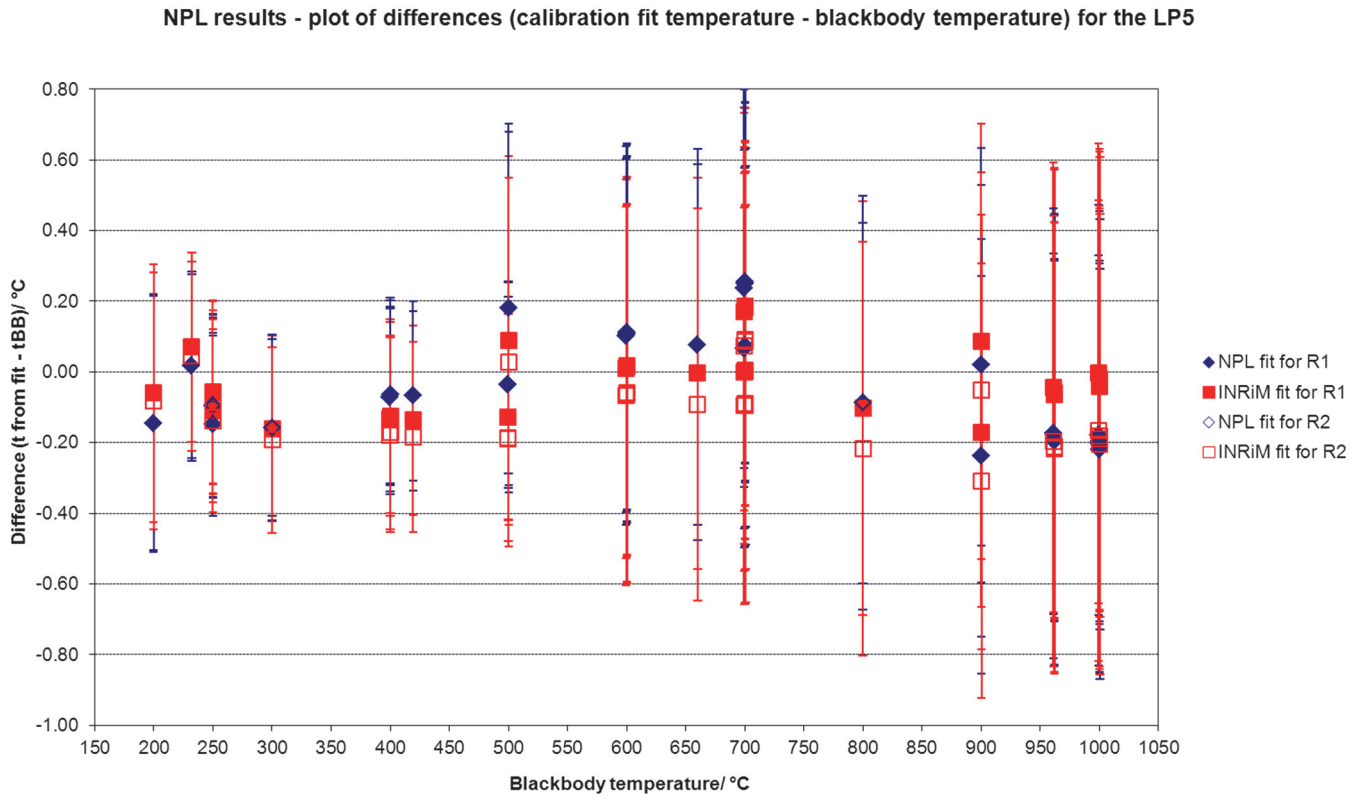


METAS results - plot of difference (calibration fit temperature - blackbody temperature) for the LP5

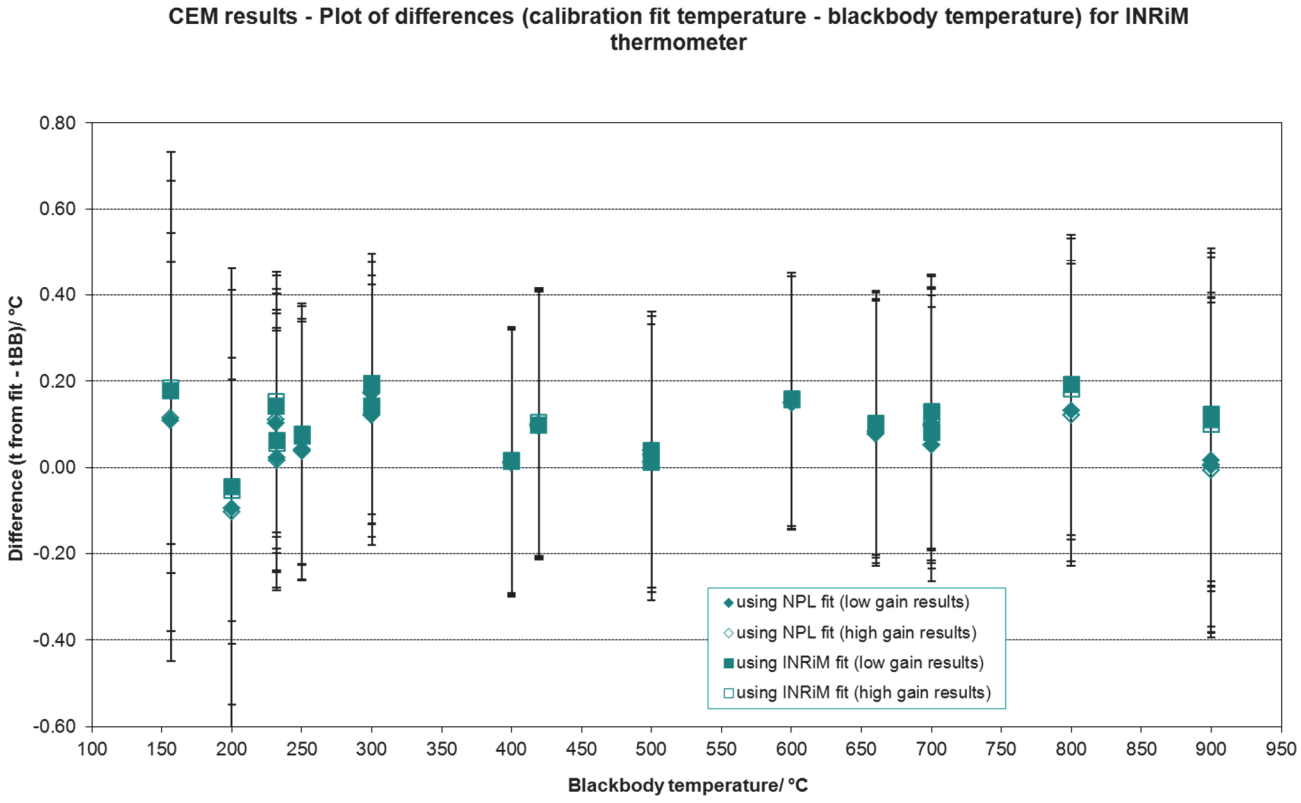


UME results - plot of differences (calibration fit temperature - blackbody temperature) for the LP5

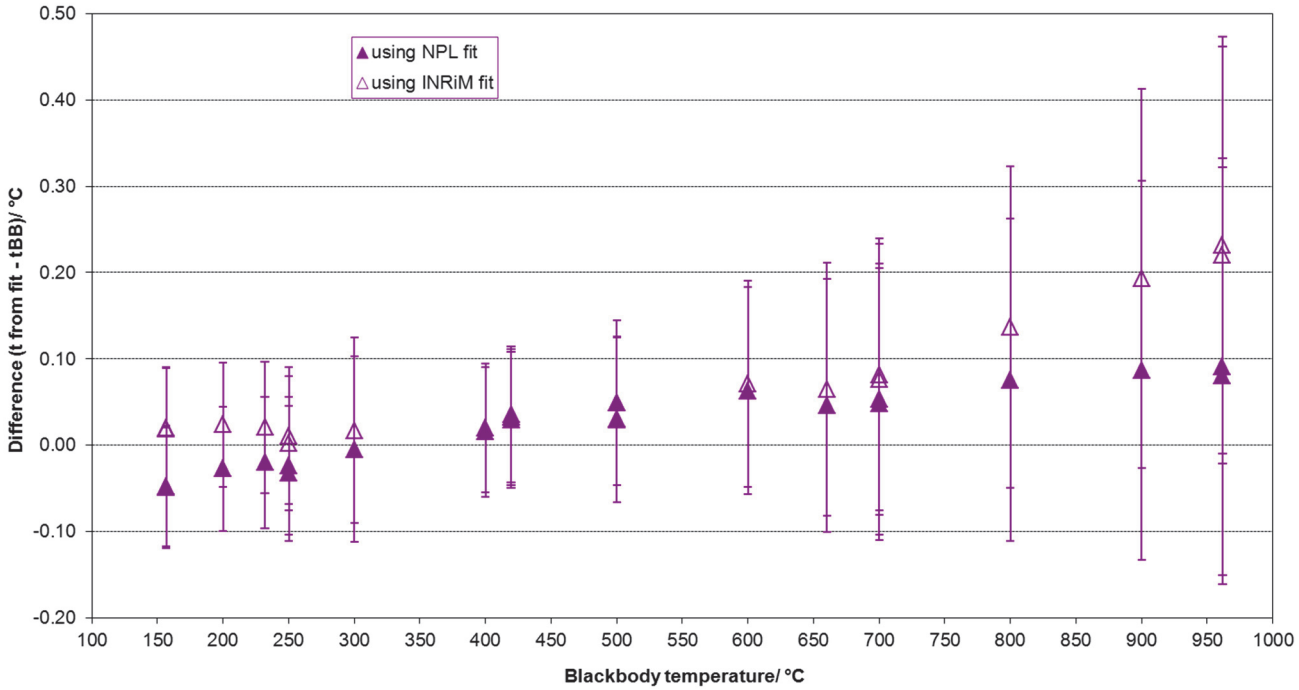




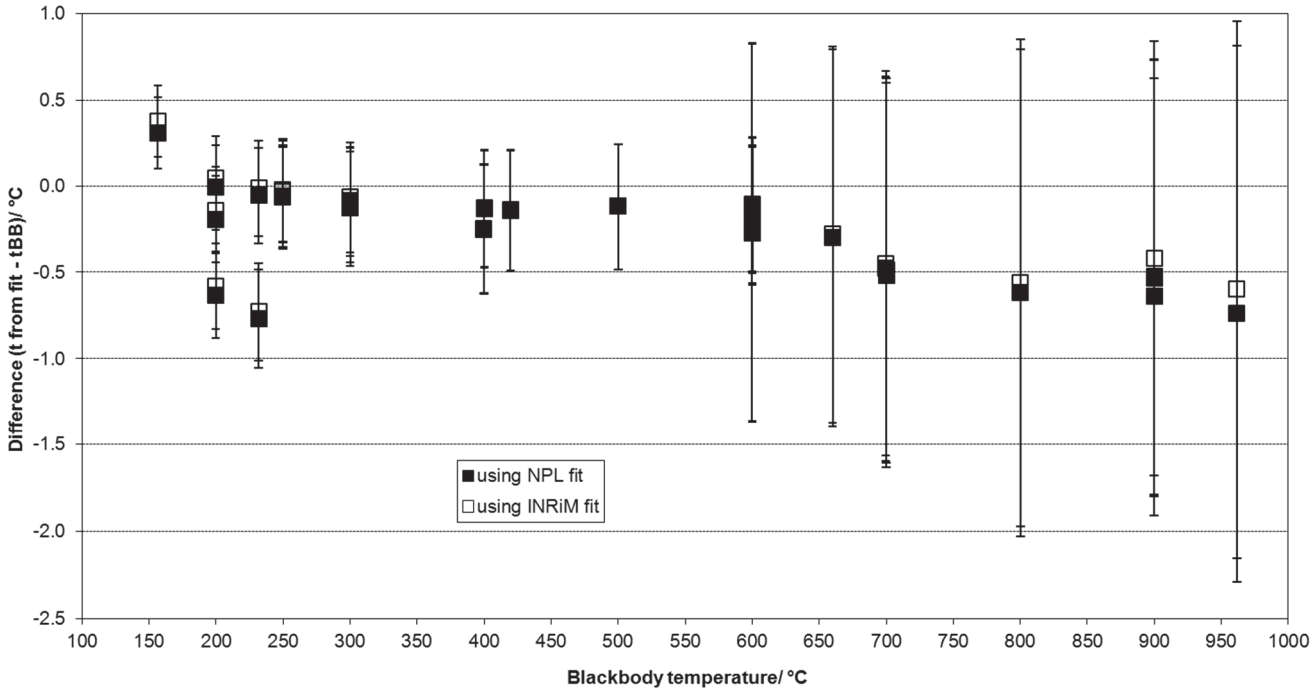
5 INDIVIDUAL LABORATORY RESULTS: DIFFERENCES BETWEEN THE CALIBRATION FITS AND THE BLACKBODY TEMPERATURE FOR THE INRIM THERMOMETER



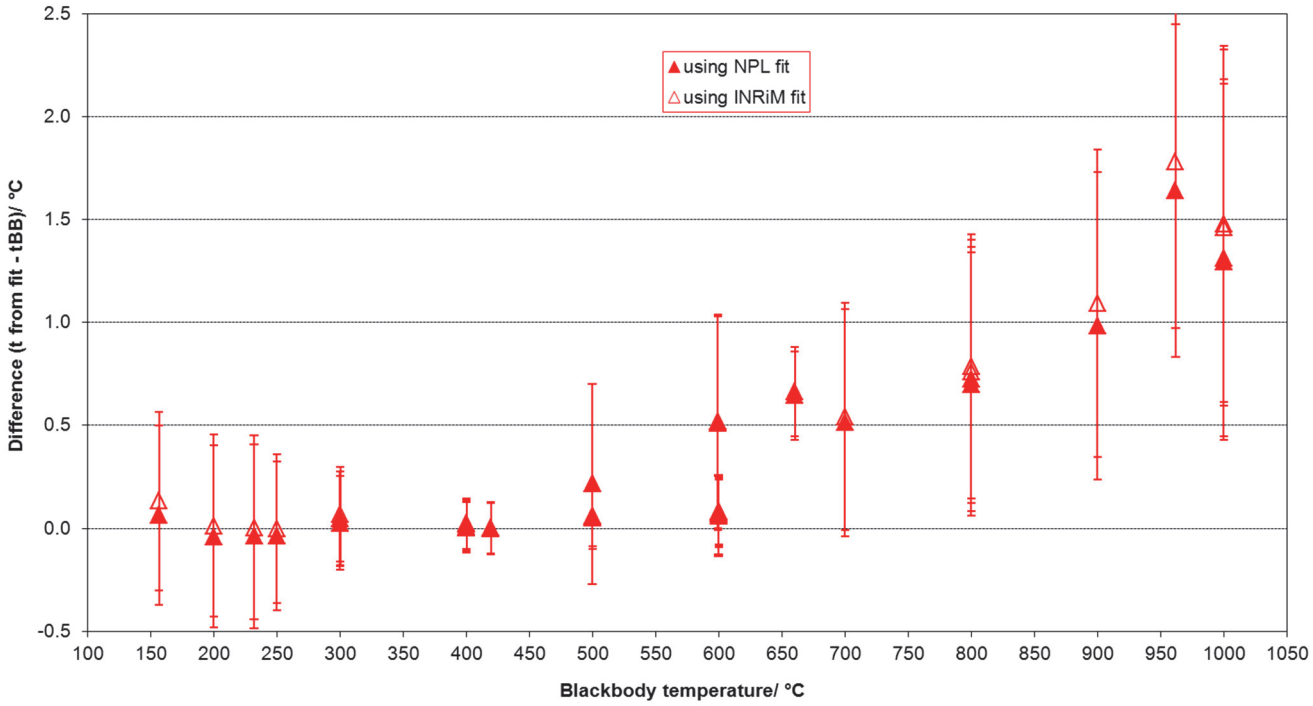
PTB results - Plot of differences (calibration fit temperature - blackbody temperature) for INRiM thermometer



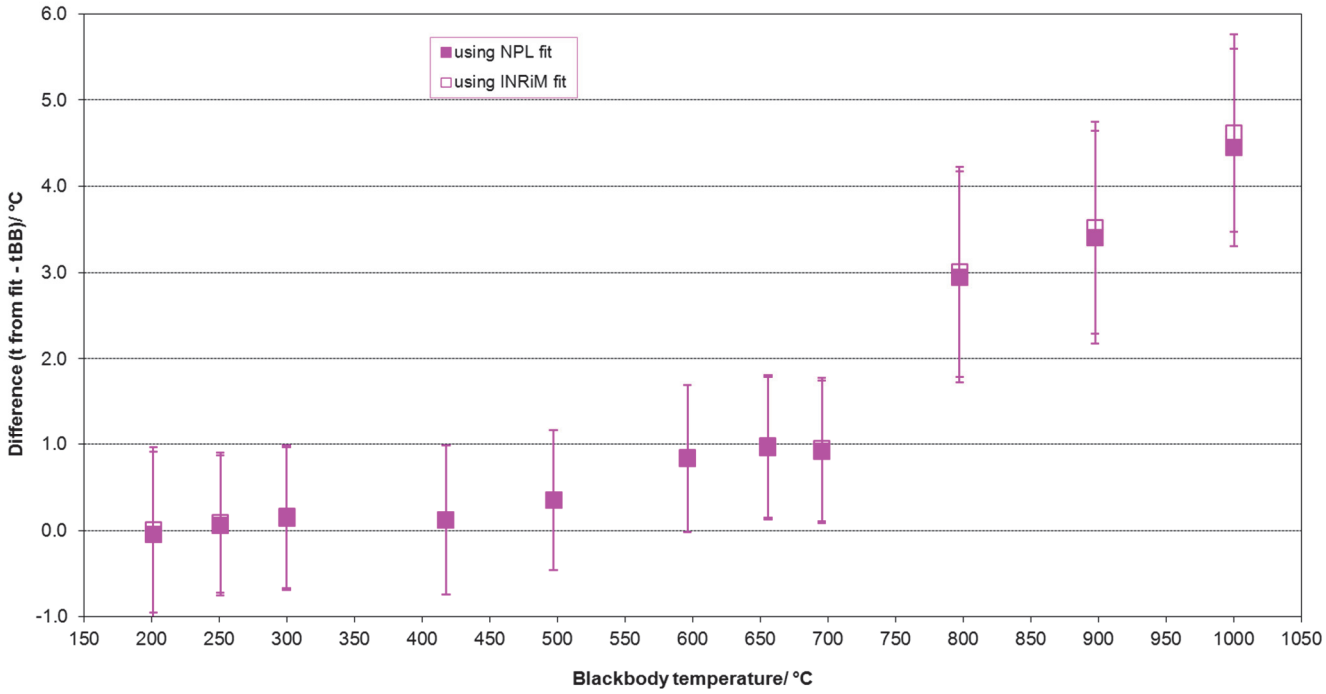
LNE results - Plot of differences (calibration fit temperature - blackbody temperature) for INRiM thermometer

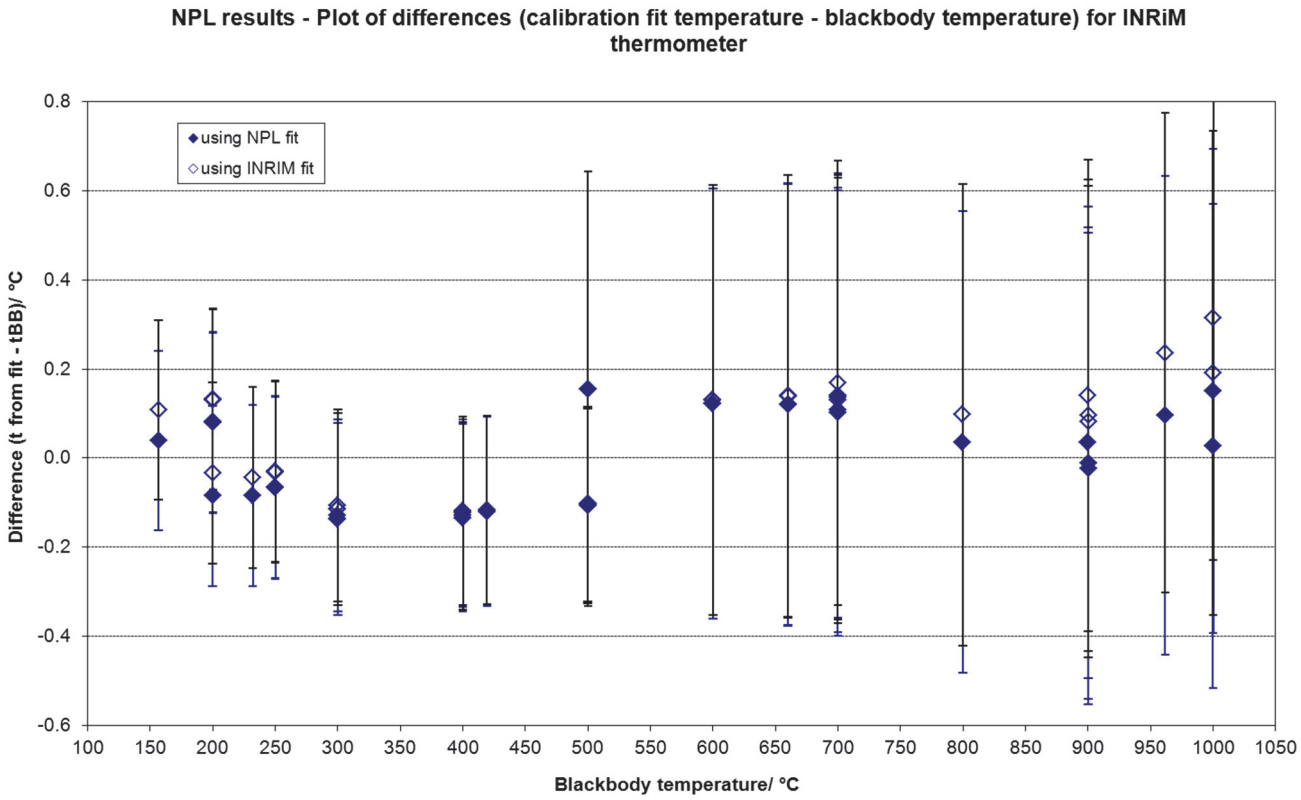


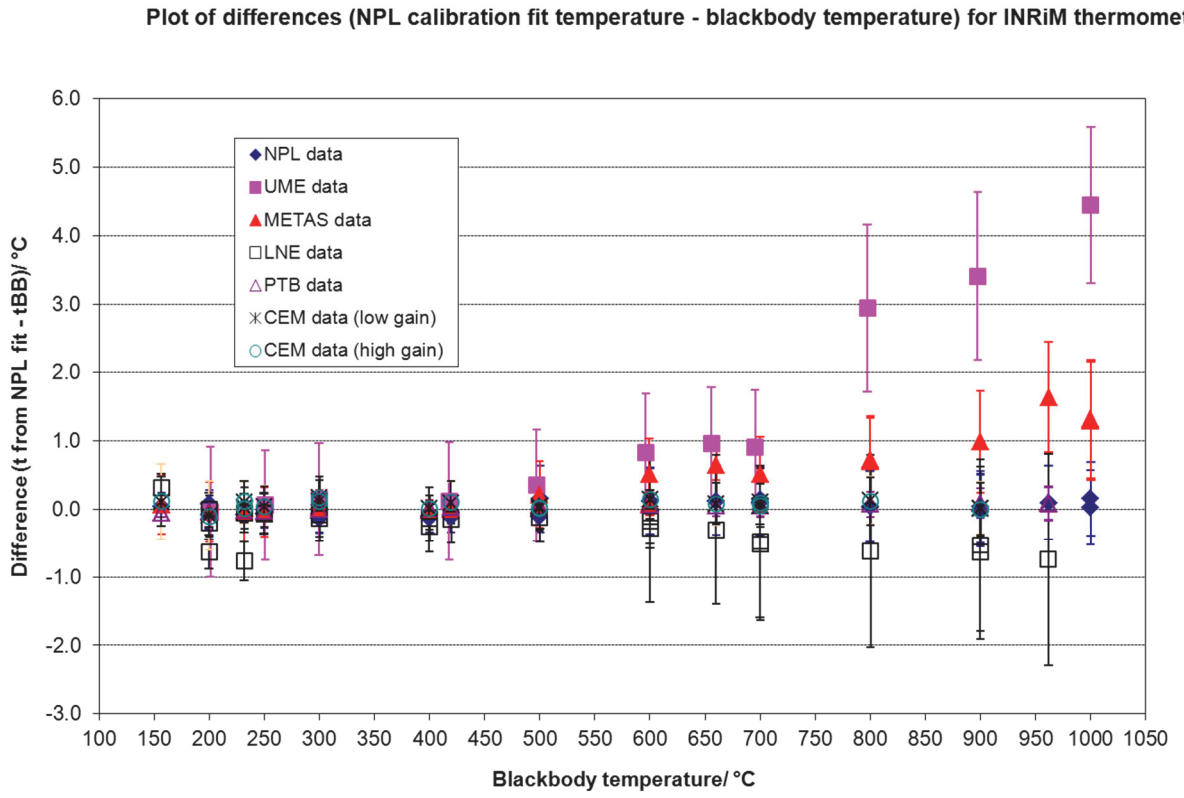
METAS results - Plot of differences (calibration fit temperature - blackbody temperature) for INRiM thermometer

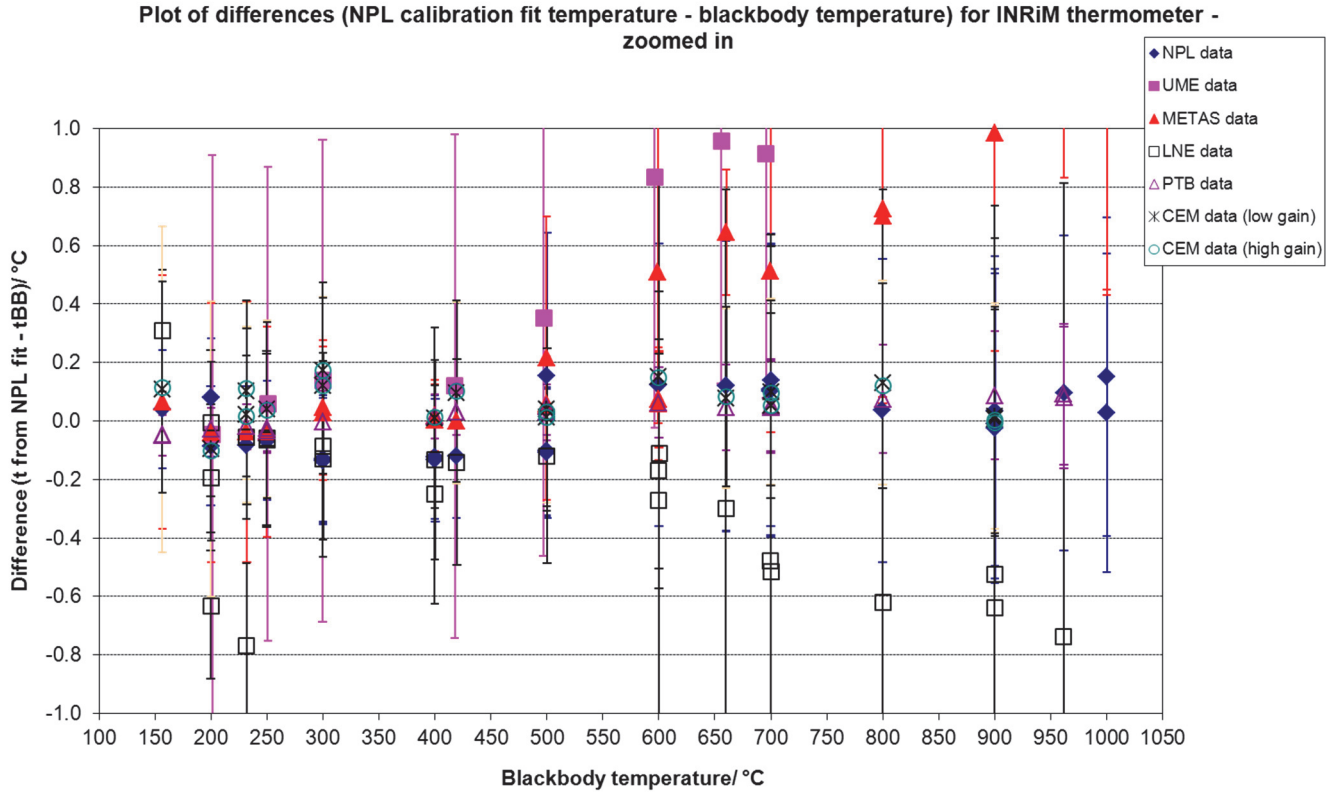


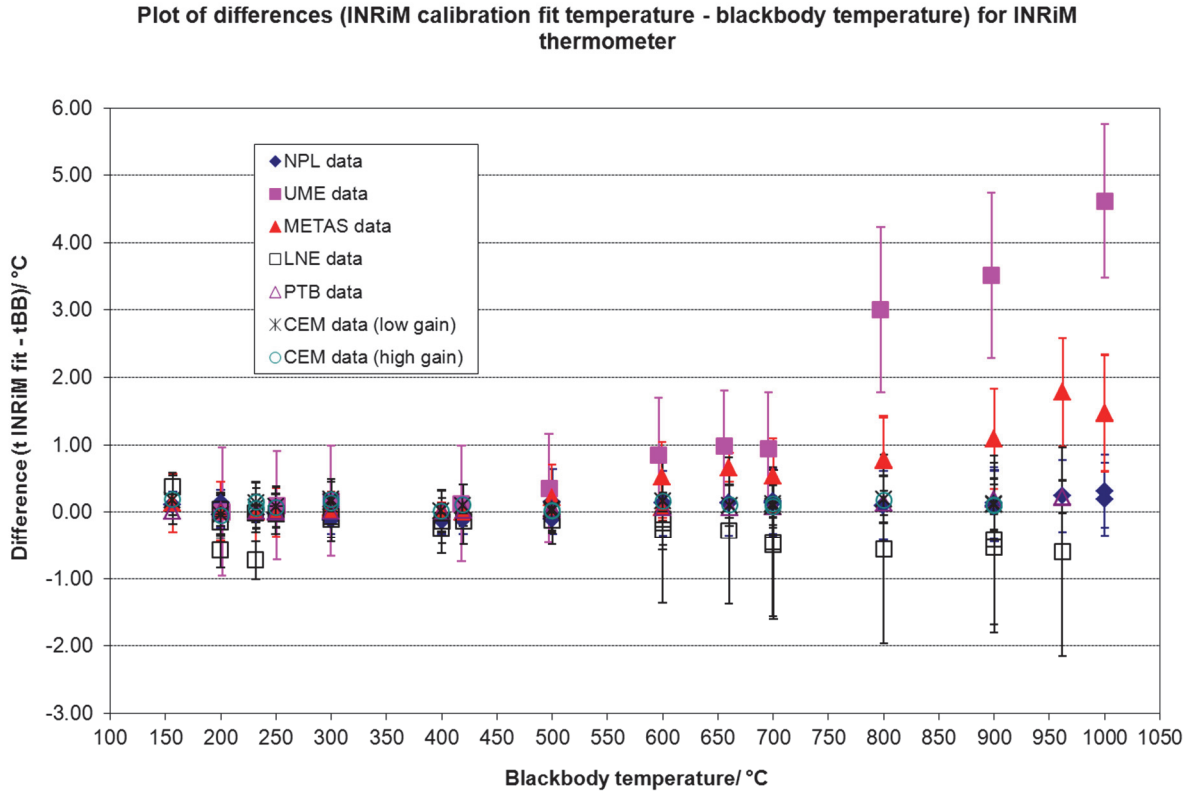
UME results - Plot of differences (calibration fit temperature - blackbody temperature) for INRiM thermometer

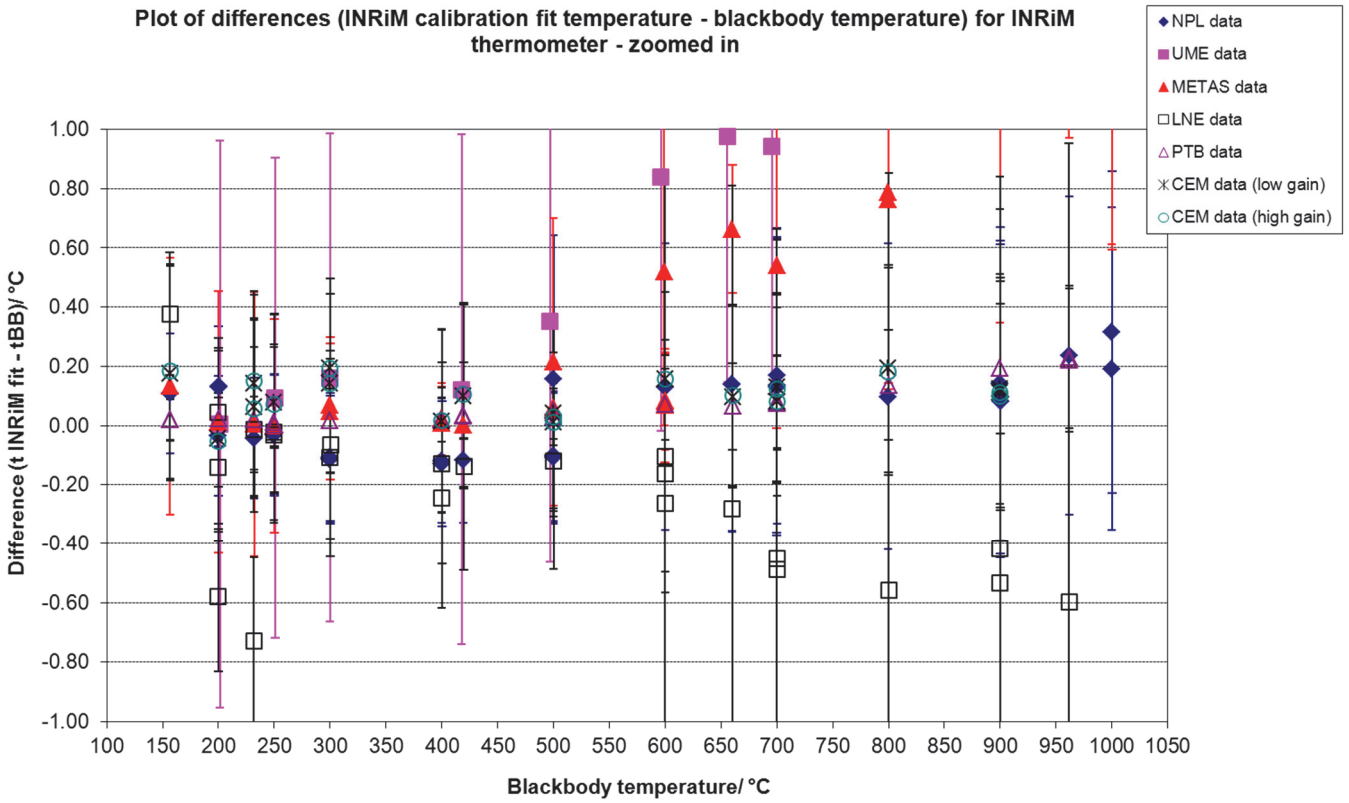



NPL results - Plot of differences (calibration fit temperature - blackbody temperature) for INRiM thermometer
using NPL fit
using INRIM fit
Difference (t from fit - tBB)/ °C
Blackbody temperature/ °C


Plot of differences (NPL calibration fit temperature - blackbody temperature) for INRiM thermometer
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)
Difference (t from NPL fit - tBB)/ °C
Blackbody temperature/ °C


Plot of differences (NPL calibration fit temperature - blackbody temperature) for INRiM thermometer - zoomed in
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)
Difference (t from NPL fit - tBB)/ °C
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C


Plot of differences (INRiM calibration fit temperature - blackbody temperature) for INRiM thermometer
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)
Difference (t INRiM fit - tBB)/ °C
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C


Plot of differences (INRiM calibration fit temperature - blackbody temperature) for INRiM thermometer - zoomed in
NPL data
UME data
METAS data
LNE data
PTB data
CEM data (low gain)
CEM data (high gain)
Difference (t INRiM fit - tBB)/ °C
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050
Blackbody temperature/ °C