EURAMET.T-K9 Regional Key Comparison
ITS-90 SPRT calibration from the Ar TP to the Zn FP

Final report

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1 Introduction

This is a report to the Technical Committee for Thermometry of EURAMET (EURAMET TC-T) on the regional key comparison EURAMET.T-K9 of SPRT calibration on the International Temperature Scale of 1990 (ITS-90) [1] from 83.8058 K (the Ar triple point) to 692.677 K (the Zn fixed point). The transfer standards used are long-stem SPRTs.

EURAMET.T-K9 is an RMO key comparison linked to the CIPM key comparison CCT-K9 [2]. The comparison is organized in five separate collapsed Stars, each one having a CCT-K9 participant as pilot, which provides the link to the KCRV of CCT-K9. Four to five participating laboratories are involved in each Star. The pilots of the five Stars are LNE-Cnam, PTB, INRiM, VSL, NPL. LNE-Cnam is also the coordinator of the comparison, in charge of the collection of the measurement reports from all participants and the preparation of the final report.

1.1 Participating laboratories

Thirty-one NMI laboratories were originally involved in this comparison, including the pilots of the five Stars. Table 1.1 reports the list of participating laboratories. There were few changes regarding the participating laboratories, with respect to the original list included into the comparison protocol (see Appendix I):

- DPM (Albania) didn't reply to any of the messages sent by the coordinator and/or the pilot of Star 5 (NPL) and didn't perform any of the actions listed in the protocol. It was withdrawn from the comparison and is not reported in Table 1.1.
- MCAA (Malta) announced its will to abandon this comparison in an e-mail sent to the pilot of Star 3 (INRiM) on the 18th of May 2015. It was removed from the list of participating laboratories and is not reported in Table 1.1.
- The name of MKEH (Hungary) was changed into BFKH. The new name BFKH is used in this report.
- The name of VMT/FTMC (Lithuania) was changed into FTMC.

Acronym	Country	Laboratory full name	Star number
BEV	Austria	Bundesamt für Eich- und Vermessungswesen	5
BFKH	Hungary	Government Office of the Capital City Budapest	5
BIM	Bulgaria	Bulgarian Institute of Metrology	5
BoM	North Macedonia	Bureau of Metrology	4
CEM	Spain	Centro Español de Metrología	1
CMI	Czech Republic	Czech Metrology Institute	2
DMDM	Serbia	Directorate of Measures and Precious Metals	3
DTI	Denmark	Danish Technological Institute	4
EIM	Greece	Hellenic Institute of Metrology	5
FTMC	Lithuania	Centre for Physical Sciences and Technology	4
GUM	Poland	Central Office of Measures/Główny Urząd Miar	4
HMI	Croatia	Croatian Metrology Institute	3
IMBiH	Bosnia-Herzegovina	Institute of Metrology of Bosnia and Herzegovina	3
INM	Romania	National Institute of Metrology	5
INRiM	Italy	Istituto Nazionale di Ricerca Metrologica	3 (pilot)
IPQ	Portugal	Instituto Português da Qualidade	1
JV	Norway	Justervesenet - Norwegian Metrology Service	1
LNE-Cnam	France	Laboratoire National de Métrologie et d'Essais - Conservatoire National des Arts et Métiers (LNE-CNAM)	1 (pilot, coordinator)
MIKES VTT	Finland	Centre for Metrology and Accreditation	2
MIRS/ UL-FE/ LMK	Slovenia	University of Ljubljana, Faculty of Electrical Engineering	3
NPL	United Kingdom	National Physical Laboratory	5 (pilot)
NSAI- NML	Ireland	NSAI National Metrology Laboratory	2
PTB	Germany	Physikalisch-Technische Bundesanstalt	2 (pilot)
RISE	Sweden	Research Institutes of Sweden (formerly SP)	4
ROTH+CO. AG	Switzerland	ROTH+CO. AG	3
SMD	Belgium	FPS Economy, DG Quality and Safety, Metrology Division	1
SMU	Slovakia	Slovak Institute of Metrology	2
UME	Turkey	Ulusal Metroloji Enstitüsü	2
VSL	The Netherlands	VSL	4 (pilot)

Table 1.1 List of participating laboratories

2 Protocol used in the comparison

2.1 Protocol

Each participating NMI selected two of their own SPRTs for use in the comparison. NMIs calibrated their SPRTs at every available ITS-90 fixed point within the range of this comparison. Each NMI selected only one of the two calibrated thermometers, hereafter referred to as “travelling thermometer”, for delivering to the pilot of the Star where it was involved. The second thermometer, hereafter referred to as “backup thermometer”, was kept by the NMI at disposal, in case of troubles with the travelling thermometer. The travelling thermometer and its initial calibration results were provided to the pilot laboratory, which assigned **an identifier in the format L*ij***, where i = {1..5} identifies the Star number and j = {1..5} is a progressive value, incremented upon each thermometer arrival to the pilot laboratory. In case a backup thermometer had to be used, the same identifier as for the travelling thermometer was employed, appending the suffix ‘S’ (e.g., L*ij*S). Following the calibration realized by the pilot laboratories, the SPRTs were returned to their respective owners, and each NMI completed a final set of calibrations at their facility. All measurement results, corresponding uncertainties, and fixed-point cell uncertainty budgets were reported to the pilot laboratory in a format suggested by Appendices A to C in the EURAMET.T-K9 protocol (the protocol is included here as Appendix I).

For each thermometer in their Star, the five pilots prepared tables containing results and uncertainties of the measurements performed at their laboratory facility, in the format suggested by Appendices A to C in the EURAMET.T-K9 protocol. Once the full measurement cycle was completed for all the thermometers involved in a Star, the pilot transferred to the coordinator the whole dataset of the Star. This included reports of the measurements carried out at the participating laboratories before and after thermometer travelling, as well as those related to the measurements performed in the pilot laboratory.

In order to provide a reliable linkage to the CCT-K9 comparison, the protocol of EURAMET.T-K9 requested that pilot laboratories employ the same equipment as that used in CCT-K9. It recommended also that each pilot use one of the SPRTs involved in CCT-K9.

2.2 Calculating temperature differences with CCT-K9 KCRV

We begin with an explicit derivation of the calculations used in this comparison, reproduced from the original protocol. In accordance with the notation employed in the original protocol, we identify each laboratory with the letter L_{ij}, where i is the Star number and j is the laboratory number within the i-th Star. L_{ij} identifies also the travelling thermometer of a given participating laboratory (see Table 3.1). If the backup thermometer is used instead, the identifier is commuted into L_{ij}S. Star pilots are identified with the letter P_i.

Resistance ratios, W (see W definition in ITS-90 [1]), were measured at each of the six fixed points included in this comparison. Each participating NMI L_{ij} recorded initial values of $W_{\mathrm{L}ij,\mathrm{before}}$ for its travelling SPRT and $W_{\mathrm{L}ij\mathrm{S,before}}$ for its backup SPRT. The travelling SPRT was then transported to the pilot laboratory P_i, where $W_{\mathrm{L}ij,\mathrm{P}i}$ was measured. Finally, the SPRT returned to its NMI for a third and final measurement $W_{\mathrm{L}ij,\mathrm{after}}$. In case troubles were identified with the travelling SPRT of a given NMI, a cycle of measurements was carried out on the backup thermometer, in order to get a full set of values $\{W_{\mathrm{L}ij\mathrm{S,before}}, W_{\mathrm{L}ij\mathrm{S,P}i}, W_{\mathrm{L}ij\mathrm{S,after}}\}$. Here the subscripts ‘before’ and ‘after’ refer to measurements taken at the NMI facility, respectively before and after travelling to and from the Star pilot. All W values may have included multiple realizations for each SPRT at each fixed point.

Average W values are calculated by:

$$\bar{W}_{\mathrm{L}ij} = \frac{1}{2}\left(W_{\mathrm{L}ij,\mathrm{before}} + W_{\mathrm{L}ij,\mathrm{after}}\right) \tag{1}$$

The temperature difference $\Delta T_{(\mathrm{L}ij-\mathrm{P}i)}$ between the fixed-point realization performed at the pilot P_i and each participating NMI L_{ij} is calculated as:

$$\Delta T_{(\mathrm{L}ij-\mathrm{P}i)} = \frac{\overline{W}_{\mathrm{L}ij} - W_{\mathrm{L}ij,\mathrm{P}i}}{\mathrm{d}W_\mathrm{r}/dT} + C_{\mathrm{L}ij} \tag{2}$$

where $\mathrm{d}W_\mathrm{r}/\mathrm{d}T$ represents the sensitivity of the reference function W_r defined in the ITS-90 and $C_{\mathrm{L}ij}$ is a term used to account for uncertainty associated with the travel, handling, or stability of the SPRT. Its expected value is assumed to be zero, with an associated uncertainty that will be discussed below.

The temperature difference $\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})}$ between the fixed-point realized by the NMI L_{ij} and the KCRV of CCT-K9 is calculated using the following equation:

$$\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})} = \Delta T_{(\mathrm{L}ij-\mathrm{P}i)} + \Delta T_{(\mathrm{P}i-\mathrm{KCRV})} \tag{3}$$

where $\Delta T_{(\mathrm{P}i-\mathrm{KCRV})}$ is the difference between the fixed-point temperature realized by the P_i Star pilot and the KCRV of the CCT-K9 comparison. $\Delta T_{(\mathrm{P}i-\mathrm{KCRV})}$ is retrieved from the CCT-K9 report [2], where it is named $\Delta T_{\mathrm{NMI\text{-}KCRV}}$ (see equation 2.5 in [2]).

2.3 Calculating uncertainties

The standard uncertainties presented in this report are denoted by *u.* The corresponding expanded uncertainties, defining an interval estimated to have a level of confidence of 95.45 %, are denoted by *U*.

Uncertainty budgets provided by each NMI are used to calculate the uncertainty of each laboratory's final value $\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})}$. Some NMIs provided two uncertainty budgets, one associated to the 'before' measurement set and the other to the 'after' one. Others supplied a single budget, which was considered valuable for both the 'before' and the 'after' sets. All the participating NMIs classified each uncertainty contribution in their budgets according to the evaluation method used, i.e. Type A, evaluated statistically, or Type B, evaluated in any other fashion. Conversely, despite an explicit request inside the original protocol, almost none of them provided information on whether a contribution was strongly correlated between measurements (*systematic*) or fluctuated randomly (*random*). This was presumably due to an error in the reporting worksheet templates provided in appendices B and C of the protocol (see page 132 in this report), where no specific field was available to enter information on random/systematic breakdown. Therefore, as the uncertainty budgets established by the participant NMIs conformed with the model of page 132, it was decided that the uncertainty components related to the phase transition realization repeatability, the propagated TPW, the SPRT self-heating and the heat flux are classified as random, while the others are classified as systematic. The NMIs didn't raise objections, but some of them required slight adjustments. The uncertainty budgets reported in Appendix II display the random/systematic breakdown for each laboratory.

The uncertainty in $\overline{W}_{Lij}$, arising from the combined 'before' and 'after' travelling measurement sets, is calculated combining the uncertainties provided by the NMI for these two sets. Random components were treated as completely uncorrelated and combined according to GUM [3] section 5.1.2. Systematic components were treated as correlated and combined according to GUM [3] section 5.2.2.

This leads to:

$$u^2(\overline{W}_{Lij}) = \frac{1}{4}\left(\frac{u_\mathrm{R}^2(W_{Lij,\mathrm{before}})}{n_\mathrm{before}} + \frac{u_\mathrm{R}^2(W_{Lij,after})}{n_\mathrm{after}}\right) + \left(\frac{u_\mathrm{S}(W_{Lij,\mathrm{before}})}{2} + \frac{u_\mathrm{S}(W_{Lij,\mathrm{after}})}{2}\right)^2 \tag{4}$$

where $u_R(W_{Lij,\text{before}})$ and $u_R(W_{Lij,\text{after}})$ are the random parts of the uncertainties respectively associated to the 'before' and 'after' measurements, n_{before} and n_{after} (see datasets in sections 3.5 to 3.28) are the number of realizations measured by that particular SPRT at the indicated fixed point respectively 'before' and 'after' travelling, and $u_S(W_{Lij,\text{before}})$ and $u_S(W_{Lij,\text{after}})$ are the systematic components of the 'before' and 'after' measurements.

Every SPRT used in the comparison is assigned a transfer uncertainty associated with its measurements at each fixed point. The transfer uncertainties $u(C_{Lij})$ are calculated from the shift in W measured at the NMI before and after transport to the pilot laboratory.

$$u(C_{\mathrm{L}ij}) = \frac{1}{2\sqrt{3}} \frac{|W_{\mathrm{L}ij,\mathrm{before}} - W_{\mathrm{L}ij,\mathrm{after}}|}{\mathrm{d}W_{\mathrm{r}}/dT} \tag{5}$$

In other words, the transfer of the SPRT to and from the pilot laboratory introduces an uncertainty about the mean value $\overline{W}_{Lij}$, which is bounded by the minimum and maximum measured values, $W_{Lij,\text{before}}$ and $W_{Lij,\text{after}}$, and is assumed to have a rectangular distribution.

The total uncertainty in $\Delta T_{(Lij-Pi)}$ is then:

$$u^2_{(\mathrm{L}ij-\mathrm{P}i)} = \frac{1}{(dW_r/dT)^2}\left(u^2(\overline{W}_{\mathrm{L}ij}) + u^2(W_{\mathrm{L}ij,Pi})\right) + u^2(C_{\mathrm{L}ij}) \tag{6}$$

where $u(W_{\mathrm{L}ij,\mathrm{P}i})$ is the uncertainty about the measurement of thermometer L_{ij} carried out at the pilot laboratory P_i.

The uncertainty associated to the temperature difference $\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})}$ is:

$$u^2_{(\mathrm{L}ij-KCRV)} = u^2_{(\mathrm{L}ij-\mathrm{P}i)} + u^2_{(\mathrm{P}i-KCRV)} + 2u_{[(\mathrm{L}ij-\mathrm{P}i),(\mathrm{P}i-KCRV)]} \tag{7}$$

where:

- $u^2_{(\mathrm{P}i-KCRV)}$ is the uncertainty associated to the deviation of the temperature of the P_i Star pilot from the CCT-K9 KCRV. $u^2_{(\mathrm{P}i-KCRV)}$ is retrieved from the CCT-K9 report [2], where it is named $u^2(\Delta T_{\mathrm{NMI-KCRV}})$ (see equation 2.17 in [2]).
- $2u_{[(\mathrm{L}ij-\mathrm{P}i),(\mathrm{P}i-KCRV)]}$ is the covariance associated to $\Delta T_{(\mathrm{L}ij-Pi)}$ and $\Delta T_{(\mathrm{P}i-\mathrm{KCRV})}$, namely $2u_{[(\mathrm{L}ij-\mathrm{P}i),(\mathrm{P}i-KCRV)]} = cov(\Delta T_{(\mathrm{L}ij-Pi)}, \Delta T_{(\mathrm{P}i-\mathrm{KCRV})})$. This is a term accounting for the correlation of measurements carried out by each pilot laboratory, respectively in CCT-K9 and EURAMET.T-K9. The evaluation of this correlation term is detailed in the following section 2.4.

2.4 Estimating correlations between CCT-K9 and EURAMET.T-K9

The link between EURAMET.T-K9 and the CCT-K9 KCRVs is provided by the five pilot laboratories through equation (3), with the uncertainties expressed in equation (7). The uncertainties of the pilots are counted in both the first two terms of equation (7) and are likely to be correlated. The third term of equation (7) accounts for this correlation and we explain here how we evaluate those correlations.

In Equation (3), the term $\Delta T_{(Pi-KCRV)}$ can be expressed in terms of the quantities reported into equation (2.5) of the CCT-K9 report [2], which leads to:

$$\Delta T_{(\mathrm{P}i-\mathrm{KCRV})} = {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i} - {}_{\mathrm{CCT-K9}}\overline{\Delta T} \tag{8}$$

where ${}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}$ is the temperature realized in CCT-K9 by a given laboratory P$_i$ (named ΔT_{NMI} in CCT-K9, see equation (2.4) in [2])
and ${}_{\mathrm{CCT-K9}}\overline{\Delta T}$ is the CCT-K9 KCRV (named $\overline{\Delta T}$ in CCT-K9, see equation (2.6) in [2]).

Therefore, combining equations (2) and (8) we can rewrite equation (3) in the following way:

$$\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})} = \frac{\overline{W}_{\mathrm{L}ij} - W_{\mathrm{L}ij,\mathrm{P}i}}{\mathrm{d}W_{\mathrm{r}}/dT} + C_{\mathrm{L}ij} + {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i} - {}_{\mathrm{CCT-K9}}\overline{\Delta T} \tag{9}$$

The uncertainty associated to $\Delta T_{(\mathrm{L}ij-\mathrm{KCRV})}$ is calculated according to section 5.2.2 (Correlated input quantities) of the GUM [3]. While W is a unitless quantity, uncertainties in W are expressed in kelvin (after scaling each uncertainty by the value of $dW_r/\mathrm{d}T$ at the given fixed point), as is customary. Therefore, in the subsequent equations the term $u_T(W)$ is employed, where the subscript T indicates that any uncertainty component related to W is expressed in kelvin:

$$\begin{gathered} u^2_{(\mathrm{L}ij-KCRV)} = \\ u_T^2(\overline{W}_{\mathrm{L}ij}) + u_T^2(W_{Lij,Pi}) + u^2(C_{\mathrm{L}ij}) \\ + u^2({}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) + u^2({}_{\mathrm{CCT-K9}}\overline{\Delta T}) - 2u({}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}, {}_{\mathrm{CCT-K9}}\overline{\Delta T}) \\ -2u_T(W_{Lij,Pi}, {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) \\ + \\ -2u_T(\overline{W}_{\mathrm{L}ij}, W_{Lij,Pi}) + 2u_T(\overline{W}_{\mathrm{L}ij}, C_{\mathrm{L}ij}) \\ +2u_T(\overline{W}_{\mathrm{L}ij}, {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) - 2u_T(\overline{W}_{\mathrm{L}ij}, {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) \\ -2u_T(W_{Lij,Pi}, C_{\mathrm{L}ij}) + 2u_T(W_{Lij,Pi}, {}_{\mathrm{CCT-K9}}\overline{\Delta T}) \\ +2u(C_{\mathrm{L}ij}, {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) - 2u(C_{\mathrm{L}ij}, {}_{\mathrm{CCT-K9}}\overline{\Delta T}) \end{gathered} \tag{10}$$

The covariances mentioned in the last four lines of equation (10) are all null, because they involve pairs of uncorrelated variables. Some of these pairs are composed of variables belonging both to EURAMET.T-K9, which are uncorrelated according to the analysis performed in the previous sections of this report. Some other pairs are composed of one variable belonging to EURAMET.T-K9 and one of CCT-K9, which are uncorrelated because the respective random variables are independent. Therefore the last four lines of equation (10) are equal to zero, while the second line coincides with equation (6) and the third line matches equation (2.14) in CCT-K9 [2], i.e. $u^2_{(\mathrm{P}i-KCRV)}$.

Consequently, equation (10) can be rewritten as:

$$u^2_{(\mathrm{L}ij-KCRV)} = u^2_{(\mathrm{L}ij-\mathrm{P}i)} + u^2_{(\mathrm{P}i-KCRV)} - 2u_T(W_{Lij,Pi}, {}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}) \tag{11}$$

Therefore, the correlation term in equation (11) involves measurements performed at the pilot laboratories P$_i$ in the two comparisons, respectively EURAMET.T-K9 and CCT-K9. These laboratories provided statements (see section 3.3, page 15) about the equipment used for measurements EURAMET.T-K9, which is substantially the same than the one used in CCT-K9. In addition, they provided in EURAMET.T-K9 uncertainty budgets nearly identical to the ones of CCT-K9, with few exceptions where, when a different equipment was employed, an additional uncertainty was introduced to account for the link between EURAMET.T-K9 and CCT-K9.

Consequently, we considered that the systematic components of the EURAMET.T-K9 uncertainty budgets provided by the pilot laboratories, $u_{\mathrm{S},T}(W_{Lij,Pi})$, are fully correlated with those provided by the same laboratories in CCT-K9, $u_{\mathrm{S}}({}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i})$, leading to:

$$u_T\left(W_{Lij,Pi}\,,\,{}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}\right) = u_{\mathrm{S},T}\left(W_{Lij,Pi}\right) \cdot u_{\mathrm{S}}\left({}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}\right) \cong u_{\mathrm{S},T}^2\left(W_{Lij,Pi}\right) \qquad (12)$$

The approximation in equation (12) is a consequence of the fact that the systematic uncertainties of the pilot laboratories are nearly identical in EURAMET.T-K9 and CCT-K9, so $u_{\mathrm{S},T}\left(W_{Lij,Pi}\right) \cong u_{\mathrm{S}}\left({}_{\mathrm{CCT-K9}}\Delta T_{\mathrm{P}i}\right)$.

3 Devices used and measurement results

3.1 Devices used

Each participating NMI calibrated two of its own SPRTs, then selected one of them as 'travelling thermometer' for use in the comparison and coordinated its transport to the Star pilot laboratory. A 'backup thermometer' was prepared as well, to be used in case of troubles with the travelling thermometer, as already explained in section 2.1.

The SPRTs used in the comparison are listed in Table 3.1.

Star n.	Laboratory.	SPRT ID	Manufacturer	Model n.	Serial n.
1	CEM	L13	YIF	WZPB	94336
1	IPQ	L14	Tinsley	5187SA	280433
1	JV	L12	ISOTECH	670	067
1	SMD	L11	Tinsley	5187SA	9540-7
2	CMI	L23	Fluke/Hart Scientific	5681-S	4219
2	MIKES VTT	L24	ISOTECH	670SQ	280
2	NSAI-NML	L21	Fluke/Hart Scientific	5681-S	1516
2	SMU	L22	Fluke/Hart Scientific	5681-S	1875
2	UME	L25	Fluke/Hart Scientific	5681-S	1365
3	DMDM	L33	Fluke/Hart Scientific	5699	0290
3	HMI	L34			1589
3	IMBIH	L35	ISOTECH	670SQ	343
3	MIRS/ UL-FE/ LMK	L32 (replaced by backup SPRT L32S)	Fluke/Hart Scientific	5681-S	1408
3	MIRS/ UL-FE/ LMK	L32S	Fluke/Hart Scientific	5681-S	1559
3	ROTH+CO. AG	L31	Fluke/Hart Scientific	5681	1784
4	BoM	L45	Fluke/Hart Scientific	5683	4234
4	DTI	L44	Accumac	AM1960	1620486
4	FTMC	L43	Fluke/Hart Scientific	5681	1714
4	GUM	L41	Fluke/Hart Scientific	5681	1710
4	RISE	L42	ISOTECH	670QS	290
5	BEV	L53			5221
5	BFKH	L52			268145
5	BiM	L51	Vladimir plant - Etalon	ПТС-10	520
5	EIM	L55			1544
5	INM	L54			1640

Table 3.1 SPRTs used in this comparison

The comparison protocol didn't prescribe specific procedures that participating laboratories must apply to stabilize SPRTs in their calibrations. However, one of the duties of the participants (chapter 5 of the comparison protocol, see Appendix I, page 125 of this report) was to provide an uncertainty budget compliant with CCT-WG3 recommendations. This prescription referred particularly to document CCT/08-19-rev on "Uncertainties in the realisation of the SPRT subranges of the ITS-90" [6] (now superseded by the Guide to the Realization of the ITS-90). In [6], paragraphs 9.3 and 9.4 define (through a list of assumptions) the necessary thermal treatment (annealing) that an SPRT must receive in order to deliver an uncertainty budget compliant with the recommendations of CCT-WG3. Therefore, we assume that any participating laboratory applied stabilization procedures compliant with those recommended by CCT-WG3 in [6].

3.2 Stabilization of SPRTs at the pilot laboratories

Upon receipt at the pilot laboratories, and before calibration, the participant SPRTs were annealed to ensure their stabilization. Each pilot used its own ordinary annealing procedures.

In Star n. 1, LNE-Cnam annealed the SPRTs at about 480 °C over an 8 h period, after which they were removed directly from the annealing furnace to the room-temperature environment. They were measured at the triple point of water once cooled. If the shift in triple point resistance due to the annealing cycle (difference of the resistance values before and after annealing) corresponded to less than 0.5 mK, the SPRT was considered stable and ready for calibration. If the shift exceeded 0.5 mK, the annealing process was repeated. All the SPRTs in Star n. 1 were stable within less than three annealing cycles.

In Star n. 2, if the difference between the SPRT resistances measured at the laboratory of the participant and at PTB disagreed by more than 0.5 mK, the SPRTs was annealed for three hours at 430 °C. At the end of the annealing the SPRTs were directly removed from the annealing furnace and the SPRT resistance was measured after cooling. As long as the change of the SPRT resistance after the annealing was larger than 0.5 mK the annealing was repeated. At PTB the maximum number of annealing cycles is five. All the SPRTs with PTB-results reported within Star n. 2 complied with the specified stability criterium.

In Star n. 3, all SPRTs on arrival at INRiM were measured first at the triple point of water and then subjected to annealing process at 480 °C. After annealing, the measurements at triple point of water were repeated, once SPRTs were cooled. If the shift in triple point resistance due to the annealing cycle (difference of the resistance values before and after annealing) corresponded to less than 0.5 mK, the SPRT was considered stable and ready for calibration. If the shift exceeded 0.5 mK, the annealing process was repeated. Only one SPRT in Star n. 3 wasn't stable after first annealing process and submitted to a second cycle.

In Star n. 4, VSL annealed all SPRTs at 450 °C over a period of 3 to 4 hours, after which they were removed directly from the anneal furnace. After reaching room temperature, the SPRTs were measured at the triple point of water. The difference in resistance at the triple point of water had to be smaller than 1 mK. If the thermometer was not stable within this criterion, the annealing procedure was repeated. All SPRTs in Star n.4 were stable in two or three annealing cycles.

In Star n. 5, at NPL, thermometers were annealed at about 450 °C for a period of 3 h, after which they were removed directly from the annealing furnace to the room-temperature environment. They were measured at the triple point of water once cooled. If the shift in triple point resistance due to the anneal cycle (difference of the resistance values before and after annealing) corresponded to less than 0.1 mK, the SPRT was considered stable and ready for calibration. If the shift exceeded 0.1 mK, the annealing process was repeated. All the SPRTs in Star n. 5 required three or four annealing cycles.

Star n.	Lab	ID	$R_{TPW,Lij,before}$ Ω	$R_{TPW,Pi,receipt}$ Ω	$R_{TPW,Pi,end}$ Ω	$R_{TPW,Lij,return}$ Ω	$R_{TPW,Lij,after}$ Ω	max. ΔT mK
1	CEM	L13	25.3393600	**25.3394078‡**	25.3393754	**25.3392339†**	25.3393505	1.74
1	IPQ	L14	25.2082650	25.2082925	25.2082605	**25.2082370†**	**25.2083540‡**	1.17
1	JV	L12	**25.1906388†**	25.1906775	25.1906827	25.1906856	**25.1907361‡**	0.97
1	SMD	L11	25.1252221	25.1252303	25.1251567	**25.1253032‡**	*25.1250759†*	2.27
2	CMI	L23	25.6128790	25.6128700	**25.6128303†**	25.6128660	**25.6130190‡**	1.89
2	MIKES VTT	L24	**25.2846328†**	25.2846340	**25.2848090‡**	25.2848077	25.2847135	1.76
2	NSAI-NML	L21	25.4513220	25.4513170	25.4513021	**25.4513270‡**	**25.4512910†**	0.36
2	SMU	L22	25.5380121	**25.5378230†**	25.5378770	25.5378620	**25.5380409‡**	2.18
2	UME	L25	25.4058829	25.4059190	**25.4060600‡**	25.4059689	**25.4058701†**	1.90
3	DMDM	L33	**25.5129529‡**	**25.5129048†**	25.5129484	25.5129477	25.5129479	0.48
3	HMI	L34	**25.4398121†**	25.4398398	**25.4399015‡**	25.4398323	25.4398588	0.89
3	IMBIH	L35	**25.2204659†**	25.2206023	25.2206473	25.2208147	**25.2208983‡**	4.32
3	MIRS/ UL-FE/ LMK	L32S	25.6836862	25.6836416	25.6836967	**25.6835982†**	**25.6836994‡**	1.01
3	ROTH+ CO. AG	L31	**25.2611938‡**	25.2610813	25.2611560	**25.2610203†**	25.2611858	1.74
4	BoM	L45	**25.1280659‡**	**25.1278865†**	25.1279847	25.1280222	25.1279975	1.79
4	DTI	L44	**25.9088490†**	25.9088681	25.9089696	25.9090140	**25.9090440‡**	1.95
4	FTMC	L43	25.3319350	**25.3318777†**	25.3321210	**25.3322240‡**	25.3321900	3.46
4	GUM	L41	25.4357206	**25.4356486†**	25.4357841	25.4357575	**25.4358464‡**	1.98
4	RISE	L42	25.2600224	**25.2600045†**	25.2600882	25.2601026	**25.2601248‡**	1.20
5	BEV	L53	25.5203123	**25.5203234‡**	25.5203180	25.5203167	**25.5202996†**	0.24
5	BFKH	L52	24.8565220	24.8565289	24.8565316	**24.8565410‡**	**24.8564680†**	0.73
5	BiM	L51	9.9613645	**9.9613815‡**	9.9613791	9.9613715	**9.9613635†**	0.45
5	EIM	L55	25.4355491	**25.4355668‡**	25.4355644	25.4355110	**25.4354711†**	0.96
5	INM	L54	25.5147880	**25.5148149‡**	25.5147106	25.5147060	**25.5146680†**	1.47

Table 3.2 Evolution of the resistance at the water triple point of all the SPRTs involved in this comparison. $R_{TPW,Lij,before}$ *is the resistance measured by the NMI (L_{ij}) at the end of the preliminary calibration performed 'before travelling' and communicated to the Star pilot.* $R_{TPW,Pi,receipt}$ *is the resistance measured by the pilot laboratory P_i after annealing upon SPRT receipt and prior to start the calibration.* $R_{TPW,Pi,end}$ *is the resistance measured by the pilot laboratory P_i at the end of the calibration performed by the pilot.* $R_{TPW,Lij,return}$ *is the resistance measured by the NMI (L_{ij}) upon SPRT return to the NMI and prior to start the final calibration.* $R_{TPW,Lij,after}$ *is the resistance measured by the NMI (L_{ij}) 'after' the end of the final calibration. The last column* ***max. ΔT*** *reports the maximum resistance shift expressed in its equivalent temperature. The symbols* ***†*** *and* ***‡*** *represent respectively the minimum and the maximum resistance value measured on each SPRT at the TPW.*

3.3 Data collection at pilot laboratories

Star n. 1

Comparison measurements at LNE-Cnam were performed from September 2015 through July 2016. The fixed-point cells and the measurement systems were the same used in CCT-K9, in order to provide a direct link to the KCRV. A single calibration batch of thermometers was measured as part of the comparison. The batch contained six SPRTs, of which four from the participating laboratories (L11, L12, L13 and L14) and two from LNE-Cnam. These latter were the same used in CCT-K9. They were included to provide an additional consistency check with CCT-K9 results.

Detailed information on the equipment used at LNE-Cnam is reported here:

- The cells employed in EURAMET.T-K9 were the same than the ones used for CCT-K9 measurements:
  Zinc FP: Zn1;
  Tin FP: Sn6;
  In FP: In125;
  Ga FP: Pyr136;
  H_2O TP: HS1047;
  Hg TP: Hg5;
  Ar TP: Ar2.
- The measurement system used in EURAMET.T-K9 was the same than that employed for CCT-K9 measurements. It was composed of the following instruments:
  Resistance bridge: ASL F900 s.n. 007115/02
  Standard resistors: Tinsley model 5685A, s.n. 259326 (100 Ω) and 220368 (25 Ω)
- Both the CCT-K9 thermometers of LNE-Cnam, L&N 1825320 and YSI B91280, were measured during Star 1 measurements. At all the measured fixed points, they both provided measurements consistent with CCT-K9 results, within the uncertainties of CCT-K9.

Star n. 2

The measurements at PTB were carried out between June 2015 and March 2016. Because some participants announced a delay of the delivery of the SPRTs the calibrations at PTB were carried out subsequently and separately for each participant. These calibrations were performed in two different working groups with different equipment, i.e. the calibrations at the Ar and Hg fixed point in PTB-WG 7.43 and the calibrations at temperatures above the TPW in PTB-WG 7.42. For different reasons, the same equipment was not always used during CCT-K9 and EURAMET.T-K9. In each case, however, it was ensured that the resistance-ratio bridges and standard resistors used had a valid and traceable calibration.

The realization of the ITS-90 fixed points at PTB is based on ensembles of fixed-point cells (national standards) for each fixed-point temperature. The stability of the scale realization is monitored by mutual cell comparisons at regular time intervals and the replacement of cells if there are indications of instability or drift. During the time frame of CCT-K9 and EURAMET.T-K9 there were no changes of the scale realization at PTB. For calibrations, mostly working standards of very high quality are used. The differences between the fixed-point temperatures of working standards and national scale realizations are known very precisely and checked at regular time intervals. In the stated uncertainty budgets these variations and resulting uncertainty contributions are fully included (e.g., the use of different cells or equipment). To each fixed-point temperature one or two so-called monitor SPRTs are associated which are only operated at this temperature and the TPW. Although the W values of monitor SPRTs are not as stable and reliable as the fixed-point temperatures of cells, measurements with monitor SPRTs are used as an independent consistency check of the temperature stability of cells.

Detailed information on the equipment used at PTB is reported here:

- The cells employed in EURAMET.T-K9 were:
  - Zinc FP: ISOTECH/Zn 326
  - Tin FP: ISOTECH/SnX
  - In FP: ISOTECH/In22
  - Ga FP: YSI/Ga213
  - H_2O TP: ISOTECH s/n 902 and 993Q
  - Hg TP: ISOTECH, S/N M090
  - Ar TP: INM/CNAM, S/N 26
- The measurement system used in EURAMET.T-K9 was:
  - Resistance bridges: ASL F900, ASL F18

Star n. 3

Comparison measurements at INRiM were performed from November 2015 through May 2016. Two calibration batches were measured. The first batch contained SPRTs L31, L32, L33 and the SPRT used by INRiM in CCT-K9. This latter was included to provide an additional consistency check with CCT-K9 results. The second batch contained SPRTs L34, L35, L32, L32S and the SPRT used by INRiM in CCT-K9.

During the first batch all SPRTs exhibited a steady increase in TPW resistance during the calibration process, after an initial decrease due to high temperature exposure. L32 showed a completely different behaviour. It also decreased initially, as all the others, but then remained essentially constant, unlike the others. For this reason, a measurement with the backup SPRT, L32S, was considered. However, the SPRT L32 was re-measured during the second batch, to see the behaviour. Finally, the participant laboratory preferred L32S to be used over L32.

Detailed information on the equipment used at INRiM is reported here:

- The cells employed in EURAMET.T-K9 by INRiM were the same than the ones used in CCT-K9:
  - Zinc FP: ZnCo3
  - Tin FP: SnCo1, SnLei3
  - In FP: InICA1
  - Ga FP: GaAlu1
  - H_2O TP: IMGC34, NMi006
  - Hg TP: Hg41
  - Ar TP: ArIMGC
- The measurement system used in EURAMET.T-K9 was:
  - Resistance bridge: ASL F18
  - Standard resistors: Tinsley 5685A (used in CCT-K9)
- The CCT-K9 thermometer HART 1283 was measured during Star 3 measurements in EURAMET.T-K9. At all the measured fixed points, it provided measurements consistent with CCT-K9 results, within the uncertainties of CCT-K9.

Star n. 4

Comparison measurements at VSL were performed from March 2015 to April 2017. From March 2015 to April 2016, the SPRTs L41, L42, L43 and L45 were measured. Also, a SPRT from VSL was included; this SPRT is the same as used in CCT-K9 to provide an additional consistency check with the CCT-K9 results. From December 2016 to February 2017 the SPRT L44 was measured.

The fixed-point cells and the measurement systems were the same used in CCT-K9, in order to provide a direct link to the KCRV.

Detailed information on the equipment used at VSL is reported here:

- The cells employed in EURAMET.T-K9 are:
  - Zinc FP: VSL89T099 (Zn2), VSL04T073 (Zn3)
  - Tin FP: VSL89T48 (Sn1), VSL04T104 (Sn3)
  - In FP: VSL89T056 (In1), VSL04T233 (In3)
  - Ga FP: VSL89T020, VSL89T021

H_2O TP: VSL06T003, VSL08T005
Hg TP: VSL89T009, VSL89T010
Ar TP: Ar01

These are all the same cells as used in the CCT-K9, except the triple point of water n. VSL08T005.

- The measurement system used in EURAMET.T-K9 is:
  Resistance bridges: MI6010T, MI6015T
  Standard resistors: 1 Ω Tinsley 5684, 10 Ω Tinsley 5684B, 25 Ω Tinsley 5684S, 100 Ω Tinsley 5684C

  This system is the same used in CCT-K9.
- A CCT-K9 thermometer of VSL was measured in Star 4 as described above.

Star n. 5

Comparison measurements at NPL were performed between 20 July 2015 and 10 February 2016, as a single batch of 5 thermometers. In the case of SPRTs L52, L54 and L55 the same equipment was used as for CCT-K9. Exceptions at Zn, Sn, In and Ar were made for SPRTs L51 and L53, due to thermometers being unsuitable for use in NPL primary fixed-point cells. When a non CCT-K9 cell was used, NPL corrected for the temperature difference between the CCT-K9 cell and the EURAMET.T-K9 cell and introduced an additional uncertainty on the link to CCT-K9.

Detailed information on the equipment used at NPL is reported here:

- The cells employed in EURAMET.T-K9 were:
  Zinc FP: Zn 10/09 (used in CCT-K9), Zn 322
  Tin FP: Sn-A (used in CCT-K9), Sn 1/00,
  In FP: In 6/01, In 9/08 (used in CCT-K9)
  Ga FP: Ga 6 (used in CCT-K9)
  H2O TP: B11 50 767, B11 50 768
  Hg TP: Hg1C (used in CCT-K9)
  Ar TP: Pond Ar 14341, Pond Ar 10272 (used in CCT-K9)
- The measurement system used in EURAMET.T-K9 was:
  Resistance bridge: ASL F900 (used in CCT-K9)
  Standard resistors: Tinsley Model 5685A 100 Ω
- The CCT-K9 thermometers of NPL were not measured in Star 5, as such measurement was not mandatory in the protocol.

3.4 SPRT data collected from participating laboratories

NMIs reported their ‘before’ and ‘after’ *W* values in a tabular worksheet, as required by the comparison protocol. In some cases, NMI-reported measurement uncertainties in Appendix A of the protocol differed from the NMI-supplied uncertainty budget in Appendix C of the protocol. In these cases, each participating laboratory was asked to determine if either Appendix A or Appendix C uncertainties should be used.

NMI data sets are compiled along with the corresponding measurements performed at the Star pilot P_i for each SPRT listed in Table 3.1. Each table includes values of *W*, the associated expanded uncertainties *U*, the number of degrees of freedom and the number of realizations, as supplied by NMIs.

3.5 BEV (Austria) dataset

Fixed point		W	U (mK)	dof	n. realizations
Before Pilot	Zn	2.5686663	1.905	∞	1
	Sn	1.8926565	1.704	∞	1
	In	1.6097045	1.300	∞	1
	Ga	1.1181224	1.100	∞	1
	Hg	0.8441620	1.100	∞	1
	Ar	0.2159569	1.000	∞	1
At Pilot	Zn	2.5686642	0.821	12	3
	Sn	1.8926594	1.038	446	3
	In	1.6097048	1.005	59	3
	Ga	1.1181202	0.141	32	3
	Hg	0.8441621	0.364	12	3
	Ar	0.2159624	1.152	5650	3
After Pilot	Zn	2.5686691	1.901	∞	1
	Sn	1.8926613	1.634	∞	1
	In	1.6097089	1.298	∞	1
	Ga	1.1181197	1.100	∞	1
	Hg	0.8441617	1.100	∞	1
	Ar	0.2159591	1.000	∞	1

Table 3.5 Data supplied by the participating laboratory BEV 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.6 BFKH (Hungary) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5683447	2.190	36	4
	Sn	1.8924803	1.580	50	3
	In	1.6095859	1.080	43	3
	Ga	1.1180982	0.490	157	3
	Hg	0.8441970	0.430	50	3
	Ar				
At Pilot	Zn	2.5683271	0.552	21	4
	Sn	1.8924790	0.349	12	3
	In	1.6095853	0.505	10	3
	Ga	1.1180977	0.124	12947	3
	Hg	0.8441915	0.153	379	3
	Ar				
After Pilot	Zn	2.5683480	2.190	36	5
	Sn	1.8924868	1.580	50	3
	In	1.6095921	1.080	43	3
	Ga	1.1180993	0.490	157	3
	Hg	0.8441961	0.430	50	3
	Ar				

Table 3.6 Data supplied by the participating laboratory BFKH 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.7 BiM (Bulgaria) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5686637	3.740	∞	3
	Sn	1.8926671	1.600	∞	3
	In	1.6097132	1.580	∞	3
	Ga	1.1181240	0.780	∞	3
	Hg	0.8441590	0.960	∞	3
	Ar				
At Pilot	Zn	2.5686517	0.866	22	3
	Sn	1.8926651	0.718	4737	4
	In	1.6097101	0.465	101	3
	Ga	1.1181172	0.113	688	3
	Hg	0.8441584	0.175	28	3
	Ar				
After Pilot	Zn	2.5686480	3.740	∞	3
	Sn	1.8926688	1.600	∞	3
	In	1.6097134	1.580	∞	3
	Ga	1.1181239	0.780	∞	3
	Hg	0.8441571	0.960	∞	3
	Ar				

Table 3.7 Data supplied by the participating laboratory BiM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.8 BoM (North Macedonia) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5681806	2.353	24	3
	Sn	1.8923830	1.080	27	3
	In				
	Ga	1.1180860	0.501	39	3
	Hg	0.8442088	0.167	86	3
	Ar				
At Pilot	Zn	2.5681774	0.840	103	3
	Sn	1.8923832	0.640	24	3
	In				
	Ga	1.1180840	0.260	159	3
	Hg	0.8442094	0.220	27	3
	Ar				
After Pilot	Zn	2.5681834	3.053	24	3
	Sn	1.8923826	0.272	27	3
	In				
	Ga	1.1180864	0.138	39	3
	Hg	0.8442090	0.145	86	3
	Ar				

Table 3.8 Data supplied by the participating laboratory BoM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.9 CEM (Spain) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687993	0.878	2365	3
	Sn	1.8927373	0.601	9366	3
	In	1.6097594	0.785	92040	3
	Ga	1.1181327	0.267	1134	3
	Hg	0.8441479	0.380	2185	3
	Ar	0.2158927	0.647	1761	3
At Pilot	Zn	2.5687975	0.990	226736	3
	Sn	1.8927348	0.570	2009	3
	In	1.6097602	0.550	41888	3
	Ga	1.1181305	0.215	3038	3
	Hg	0.8441485	0.353	23	3
	Ar	0.2158943	0.597	17	3
After Pilot	Zn	2.5687987	0.775	27047	3
	Sn	1.8927383	0.881	1196222	3
	In	1.6097598	0.647	284961	3
	Ga	1.1181317	0.220	120	3
	Hg	0.8441481	0.244	83863	3
	Ar	0.2158922	0.788	1265	3

Table 3.9 Data supplied by the participating laboratory CEM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.10 CMI (Czech Republic) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688060	0.900	∞	5
	Sn	1.8927395	0.600	∞	4
	In	1.6097630	0.780	∞	4
	Ga	1.1181315	0.320	∞	11
	Hg	0.8441476	0.400	∞	6
	Ar	0.2158898	0.840	∞	5
At Pilot	Zn	2.5688078	1.300	25	4
	Sn	1.8927399	1.040	3	4
	In	1.6097629	0.900	117	3
	Ga	1.1181322	0.240	4	2
	Hg	0.8441467	0.400	9	3
	Ar	0.2158867	0.640	18	4
After Pilot	Zn	2.5688038	0.900	∞	6
	Sn	1.8927384	0.600	∞	5
	In	1.6097625	0.780	∞	4
	Ga	1.1181315	0.320	∞	4
	Hg	0.8441473	0.400	∞	5
	Ar	0.2158900	0.840	∞	4

Table 3.10 Data supplied by the participating laboratory CMI 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.11 DMDM (Serbia) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687548	2.040	239	3
	Sn	1.8927127	1.560	146	3
	In	1.6097429	1.940	757	3
	Ga	1.1181293	0.720	199	3
	Hg	0.8441506	0.720	776	3
	Ar				
At Pilot	Zn	2.5687529	0.880	107	3
	Sn	1.8927108	0.620	20	3
	In	1.6097415	0.660	5667	4
	Ga	1.1181280	0.240	15	3
	Hg	0.8441521	0.140	88	3
	Ar				
After Pilot	Zn	2.5687560	2.040	239	3
	Sn	1.8927126	1.560	146	3
	In	1.6097436	1.940	757	3
	Ga	1.1181290	0.720	199	3
	Hg	0.8441507	0.720	776	3
	Ar				

Table 3.11 Data supplied by the participating laboratory DMDM ‘before’ and ‘after’ thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.12 DTI (Denmark) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5682659	1.240	882	3
	Sn	1.8924365	0.680	3354	3
	In	1.6095553	1.020	288	3
	Ga	1.1180918	0.320	2649	4
	Hg	0.8441996	0.440	7716	4
	Ar	0.2161398	0.440	185	4
At Pilot	Zn	2.5682711	0.840	320	3
	Sn	1.8924393	0.520	573	3
	In	1.6095557	0.520	17	3
	Ga	1.1180917	0.260	179	3
	Hg	0.8441994	0.260	27	4
	Ar	0.2161454	0.360	14	3
After Pilot	Zn	2.5682637	1.220	406	3
	Sn	1.8924350	0.660	12916	3
	In	1.6095553	0.980	2279	3
	Ga	1.1180912	0.320	654	3
	Hg	0.8441989	0.440	260	3
	Ar	0.2161243	4.598	3	3

Table 3.12 Data supplied by the participating laboratory DTI 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

DTI measurements performed at the argon triple point after the SPRT return were poorly reproducible, with respect to those performed before SPRT circulation. DTI informed the Star pilot of this problem before the end of the measurements. The reason was a failure in DTI argon triple point cell, which was fixed after the end of the comparison, preventing the realization of a new set of measurements. The uncertainty budget in Table 3.12 accounts for the poor reproducibility of measurements performed 'After Pilot' at the argon triple point.

3.13 EIM (Greece) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688693	1.820	∞	2
	Sn	1.8927768	1.200	∞	2
	In	1.6097894	1.740	∞	2
	Ga	1.1181360	0.620	∞	2
	Hg	0.8441408	0.580	∞	2
	Ar	0.2158544	0.720	∞	3
At Pilot	Zn	2.5688664	0.684	148	3
	Sn	1.8927759	0.190	897	3
	In	1.6097858	0.259	112	3
	Ga	1.1181365	0.133	23645	3
	Hg	0.8441407	0.161	71	3
	Ar	0.2158532	0.193	46	4
After Pilot	Zn	2.5688655	1.620	∞	3
	Sn	1.8927740	1.140	∞	2
	In	1.6097890	1.700	∞	2
	Ga	1.1181367	0.480	∞	2
	Hg	0.8441404	0.580	∞	2
	Ar	0.2158564	0.800	∞	2

Table 3.13 Data supplied by the participating laboratory EIM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.14 FTMC (Lithuania) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687737	1.660	291	3
	Sn	1.8927209	1.320	3780	3
	In				
	Ga	1.1181255	0.520	572	3
	Hg	0.8441492	0.580	1878	3
	Ar				
At Pilot	Zn	2.5687768	0.820	153	4
	Sn	1.8927232	0.520	172	3
	In				
	Ga	1.1181290	0.320	116	3
	Hg	0.8441493	0.400	6	4
	Ar				
After Pilot	Zn	2.5687693	1.600	291	3
	Sn	1.8927205	1.400	3780	3
	In				
	Ga	1.1181250	0.540	572	3
	Hg	0.8441492	0.560	1878	3
	Ar				

Table 3.14 Data supplied by the participating laboratory FTMC 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.15 GUM (Poland) dataset

Fixed point		W	U (mK)	dof	n. realizations
Before Pilot	Zn	2.5688042	1.190	753	3
	Sn	1.8927367	0.670	1268	3
	In	1.6097622	0.850	10716	3
	Ga	1.1181307	0.420	8311	3
	Hg	0.8441465	0.470	79414	3
	Ar	0.2158833	0.790	132863	4
At Pilot	Zn	2.5688011	0.880	92	4
	Sn	1.8927376	0.660	20	3
	In	1.6097598	0.400	41	4
	Ga	1.1181310	0.240	225	4
	Hg	0.8441471	0.220	28	3
	Ar	0.2158848	1.300	2	3
After Pilot	Zn	2.5688061	1.270	753	3
	Sn	1.8927367	0.670	1268	3
	In	1.6097616	0.950	10716	3
	Ga	1.1181311	0.430	8311	3
	Hg	0.8441461	0.480	79414	3
	Ar	0.2158863	0.750	132863	3

Table 3.15 Data supplied by the participating laboratory GUM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.16 HMI (Croatia) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687701	4.671	71	3
	Sn	1.8927224	2.044	104	3
	In				
	Ga	1.1181283	0.961	127	3
	Hg	0.8441490	0.852	131	3
	Ar				
At Pilot	Zn	2.5687757	0.880	107	3
	Sn	1.8927235	0.620	20	3
	In				
	Ga	1.1181296	0.240	15	3
	Hg	0.8441499	0.140	88	3
	Ar				
After Pilot	Zn	2.5687687	4.669	71	3
	Sn	1.8927222	2.042	104	3
	In				
	Ga	1.1181271	0.947	130	3
	Hg	0.8441489	0.853	133	3
	Ar				

Table 3.16 Data supplied by the participating laboratory HMI 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.17 IMBiH (Bosnia – Herzegovina) dataset

Fixed point		W	U (mK)	dof	n. realizations
Before Pilot	Zn	2.5684048	3.612	53	3
	Sn	1.8925071	2.356	622	3
	In				
	Ga	1.1181011	1.281	3114	3
	Hg	0.8441846	1.568	5338	2
	Ar				
At Pilot	Zn	2.5683953	0.880	107	3
	Sn	1.8925090	0.620	20	3
	In				
	Ga	1.1181017	0.240	15	3
	Hg	0.8441867	0.140	88	3
	Ar				
After Pilot	Zn	2.5684038	3.612	53	3
	Sn	1.8925045	2.356	622	3
	In				
	Ga	1.1181000	1.281	3114	3
	Hg	0.8441850	1.568	5338	3
	Ar				

Table 3.17 Data supplied by the participating laboratory IMBiH 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.18 INM (Romania) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688539	2.600	1056	4
	Sn	1.8927670	2.200	2719	4
	In	1.6097809	2.000	758	4
	Ga	1.1181368	0.600	5037	5
	Hg	0.8441419	0.500	1797	4
	Ar	0.2158611	1.200	242	4
At Pilot	Zn	2.5688511	1.454	63	4
	Sn	1.8927677	1.142	7	3
	In	1.6097802	0.443	1786	3
	Ga	1.1181353	0.240	624	3
	Hg	0.8441422	0.261	28772	3
	Ar	0.2158668	0.910	16	3
After Pilot	Zn	2.5688549	2.600	1056	4
	Sn	1.8927679	2.200	2719	4
	In	1.6097828	2.000	758	4
	Ga	1.1181362	0.600	5037	5
	Hg	0.8441416	0.500	1797	4
	Ar	0.2158610	1.200	242	4

Table 3.18 Data supplied by the participating laboratory INM 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.19 IPQ (Portugal) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688030	1.610	5032	3
	Sn	1.8927410	1.253	1594	3
	In	1.6097660	1.730	6683	3
	Ga	1.1181300	0.719	198	3
	Hg	0.8441470	0.750	236	3
	Ar	0.2158840	0.797	302	3
At Pilot	Zn	2.5688024	0.998	14862	4
	Sn	1.8927357	0.511	38506	3
	In	1.6097615	0.574	5447	3
	Ga	1.1181306	0.208	3778	3
	Hg	0.8441481	0.500	6	3
	Ar	0.2158858	1.342	3	3
After Pilot	Zn	2.5688120	1.634	3145	3
	Sn	1.8927370	1.284	1096	3
	In	1.6097620	1.759	3715	3
	Ga	1.1181310	0.721	196	3
	Hg	0.8441470	0.800	181	3
	Ar	0.2158850	0.844	224	3

Table 3.19 Data supplied by the participating laboratory IPQ 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.20 JV (Norway) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5685906	2.840	6	2
	Sn	1.8926158	1.780	30	2
	In	1.6096764	2.000	625	2
	Ga	1.1181149	0.900	625	2
	Hg	0.8441683	1.000	75	2
	Ar	0.2159968	1.860	1435913	2
At Pilot	Zn	2.5685903	1.125	959	4
	Sn	1.8926148	0.527	17384	3
	In	1.6096786	0.627	2590	3
	Ga	1.1181145	0.197	6022	3
	Hg	0.8441688	0.369	13	3
	Ar	0.2159938	0.477	70	3
After Pilot	Zn	2.5685911	2.840	6	2
	Sn	1.8926141	1.780	30	2
	In	1.6096753	2.000	625	2
	Ga	1.1181146	0.900	625	2
	Hg	0.8441681	1.000	75	2
	Ar	0.2159961	1.860	1435913	2

Table 3.20 Data supplied by the participating laboratory JV ‘before’ and ‘after’ thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.21 MIKES VTT (Finland) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5684501	1.880	∞	1
	Sn	1.8925392	1.278	∞	1
	In				
	Ga	1.1181037	0.886	∞	1
	Hg	0.8441819	0.756	∞	1
	Ar	0.2160609	1.376	∞	1
At Pilot	Zn	2.5684514	1.320	28	5
	Sn	1.8925391	1.100	3	4
	In				
	Ga	1.1181058	0.240	15	2
	Hg	0.8441803	0.440	7	3
	Ar	0.2160623	0.660	13	3
After Pilot	Zn	2.5684510	1.924	∞	3
	Sn	1.8925391	1.338	∞	3
	In				
	Ga	1.1181041	0.920	∞	3
	Hg	0.8441822	0.742	∞	3
	Ar	0.2160632	1.578	∞	3

Table 3.21 Data supplied by the participating laboratory MIKES VTT 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.22 MIRS/ UL-FE/ LMK (Slovenia) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688039	0.843	51	3
	Sn	1.8927385	0.484	2952	3
	In	1.6097618	0.528	1069	3
	Ga	1.1181323	0.182	109	3
	Hg	0.8441460	0.210	212	3
	Ar	0.2158826	0.254	611	3
At Pilot	Zn	2.5688037	0.880	107	3
	Sn	1.8927398	0.620	20	3
	In	1.6097612	0.660	5667	3
	Ga	1.1181318	0.240	15	3
	Hg	0.8441469	0.140	88	3
	Ar	0.2158844	0.500	9	3
After Pilot	Zn	2.5688053	0.843	51	3
	Sn	1.8927383	0.484	2952	3
	In	1.6097613	0.528	1069	3
	Ga	1.1181325	0.182	109	3
	Hg	0.8441463	0.210	212	3
	Ar	0.2158828	0.254	611	3

Table 3.22 Data supplied by the participating laboratory MIRS/ UL-FE/ LMK 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.23 NSAI – NML (Ireland) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687620	1.800	244016	3
	Sn	1.8927138	1.440	∞	3
	In	1.6097420	1.920	∞	3
	Ga	1.1181286	0.600	∞	3
	Hg	0.8441520	0.660	∞	3
	Ar				
At Pilot	Zn	2.5687693	1.300	31	4
	Sn	1.8927167	0.980	6	4
	In	1.6097466	0.900	31	4
	Ga	1.1181288	0.240	1	3
	Hg	0.8441518	0.340	25	3
	Ar				
After Pilot	Zn	2.5687617	1.800	244016	3
	Sn	1.8927135	1.440	∞	3
	In	1.6097421	1.920	∞	3
	Ga	1.1181285	0.600	∞	3
	Hg	0.8441512	0.660	∞	3
	Ar				

Table 3.23 Data supplied by the participating laboratory NSAI – NML 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.24 RISE (Sweden) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5685195	1.340	121	3
	Sn	1.8925781	1.040	62	3
	In	1.6096519	1.120	84	3
	Ga	1.1181100	0.540	162	3
	Hg	0.8441744	0.540	162	3
	Ar	0.2160270	1.680	55	3
At Pilot	Zn	2.5685196	0.960	36	3
	Sn	1.8925800	0.620	37	3
	In	1.6096522	0.360	60	3
	Ga	1.1181106	0.240	191	3
	Hg	0.8441750	0.240	27	3
	Ar	0.2160237	0.260	40	3
After Pilot	Zn	2.5685196	1.340	121	2
	Sn	1.8925778	1.040	62	2
	In	1.6096512	1.120	84	2
	Ga	1.1181098	0.540	162	2
	Hg	0.8441745	0.540	162	2
	Ar	0.2160281	1.680	55	2

Table 3.24 Data supplied by the participating laboratory RISE 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.25 ROTH+CO. AG (Switzerland) dataset

Fixed point		***W***	***U* (mK)**	**dof**	**n. realizations**
Before Pilot	Zn	2.5687337	1.520	2524	3
	Sn	1.8926993	1.140	3572	3
	In	1.6097360	1.680	445611	3
	Ga	1.1181275	0.600	21359	3
	Hg	0.8441537	0.780	57582	3
	Ar	0.2159173	0.720	335	3
At Pilot	Zn	2.5687300	0.880	107	3
	Sn	1.8926996	0.620	20	3
	In	1.6097339	0.660	5667	3
	Ga	1.1181263	0.240	15	3
	Hg	0.8441537	0.140	88	3
	Ar	0.2159211	0.500	9	3
After Pilot	Zn	2.5687335	1.520	2524	3
	Sn	1.8926981	1.140	3572	3
	In	1.6097354	1.680	445611	3
	Ga	1.1181266	0.600	21359	3
	Hg	0.8441528	0.780	57582	3
	Ar	0.2159178	0.720	335	3

Table 3.25 Data supplied by the participating laboratory ROTH+CO. AG 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.26 SMD (Belgium) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5688131	1.299	120	6
	Sn	1.8927291	0.935	150	3
	In	1.6097558	0.790	350	3
	Ga	1.1181302	0.323	380	5
	Hg	0.8441474	0.192	320	3
	Ar	0.2158872	0.627	400	4
At Pilot	Zn	2.5687935	1.275	1213	3
	Sn	1.8927309	0.515	43834	3
	In	1.6097594	0.583	11823	3
	Ga	1.1181301	0.209	2321	3
	Hg	0.8441477	0.806	26	3
	Ar	0.2158919	0.644	8	3
After Pilot	Zn	2.5687986	1.227	120	4
	Sn	1.8927339	0.925	150	3
	In	1.6097589	0.784	350	3
	Ga	1.1181306	0.318	380	4
	Hg	0.8441470	0.188	320	3
	Ar	0.2158852	0.623	400	4

Table 3.26 Data supplied by the participating laboratory SMD 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

3.27 SMU (Slovakia) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5686033	1.540	89	2
	Sn	1.8926173	0.808	156	2
	In	1.6096827	0.790	100	2
	Ga	1.1181154	0.262	12	2
	Hg	0.8441724	0.576	157	2
	Ar				
At Pilot	Zn	2.5685965	1.300	48	4
	Sn	1.8926196	0.900	125	4
	In	1.6096806	0.900	156	4
	Ga	1.1181163	0.240	4	3
	Hg	0.8441682	0.320	73	3
	Ar				
After Pilot	Zn	2.5686039	1.524	89	2
	Sn	1.8926178	0.829	156	2
	In	1.6096830	0.796	100	2
	Ga	1.1181155	0.267	12	2
	Hg	0.8441725	0.585	157	2
	Ar				

Table 3.27 Data supplied by the participating laboratory SMU 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

After the end of the comparison SMU noticed that the inner well and the graphite crucible of their zinc cell were damaged. The failure occurred during the comparison measurements when zinc was in the liquid state. Zinc was contaminated and the fixed-point temperature was affected by anomalous deviations.

3.28 UME (Turkey) dataset

Fixed point		*W*	*U* (mK)	dof	n. realizations
Before Pilot	Zn	2.5687532	1.488	∞	3
	Sn	1.8927085	0.996	∞	3
	In	1.6097401	1.014	∞	3
	Ga	1.1181276	0.400	∞	3
	Hg	0.8441538	0.440	∞	3
	Ar	0.2159144	0.768	∞	3
At Pilot	Zn	2.5687534	1.300	23	3
	Sn	1.8927087	0.900	44	3
	In	1.6097412	0.900	44	3
	Ga	1.1181280	0.240	4	3
	Hg	0.8441524	0.520	6	3
	Ar	0.2159129	0.800	9	4
After Pilot	Zn	2.5687517	1.488	∞	3
	Sn	1.8927084	0.996	∞	3
	In	1.6097404	1.014	∞	3
	Ga	1.1181269	0.400	∞	3
	Hg	0.8441545	0.440	∞	3
	Ar	0.2159142	0.768	∞	3

Table 3.28 Data supplied by the participating laboratory UME 'before' and 'after' thermometer travelling, and data of measurements performed by the Star pilot. U is the expanded uncertainty at the k = 2 level.

4 Results of the comparison

Tables and plots from section 4.1 through section 4.6 summarize the deviations ($\Delta T_{(Lij-\mathrm{KCRV})}$) of NMI results from the KCRV of CCT-K9 at each fixed point. Tables and plots from section 4.7 through section 4.30 provide the same results, organized by laboratory. Error bars in all of these plots show the uncertainty ($U_{(Lij\text{-}KCRV)}$) in the value $\Delta T_{(Lij-\mathrm{KCRV})}$ at the k = 2 level.

4.1 Zinc

The results of this comparison at the zinc point are summarized in Table 4.1 and Figure 4.1.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij\text{-}KCRV)}$ mK	Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij\text{-}KCRV)}$ mK
BEV	-0.80	1.62	IMBiH	1.97	2.77
BFKH	3.74	1.08	INM	-0.85	2.44
BIM	-0.59	3.27	IPQ	2.48	2.22
BoM	3.86	1.71	JV	1.19	1.19
CEM	1.43	0.98	MIKES VTT	1.45	2.11
CMI	0.85	1.41	MIRS/ UL-FE/ LMK	-0.35	0.89
DMDM	0.11	1.71	NSAI-NML	-0.45	1.92
DTI	0.73	1.37	RISE	2.52	1.33
EIM	-1.47	1.69	ROTH+CO. AG	0.41	1.59
FTMC	1.01	1.80	SMD	4.55	2.82
GUM	3.69	1.35	SMU	3.72	1.39
HMI	-2.39	4.35	UME	1.42	1.69

Table 4.1 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the zinc point. Uncertainties are displayed at the k = 2 level

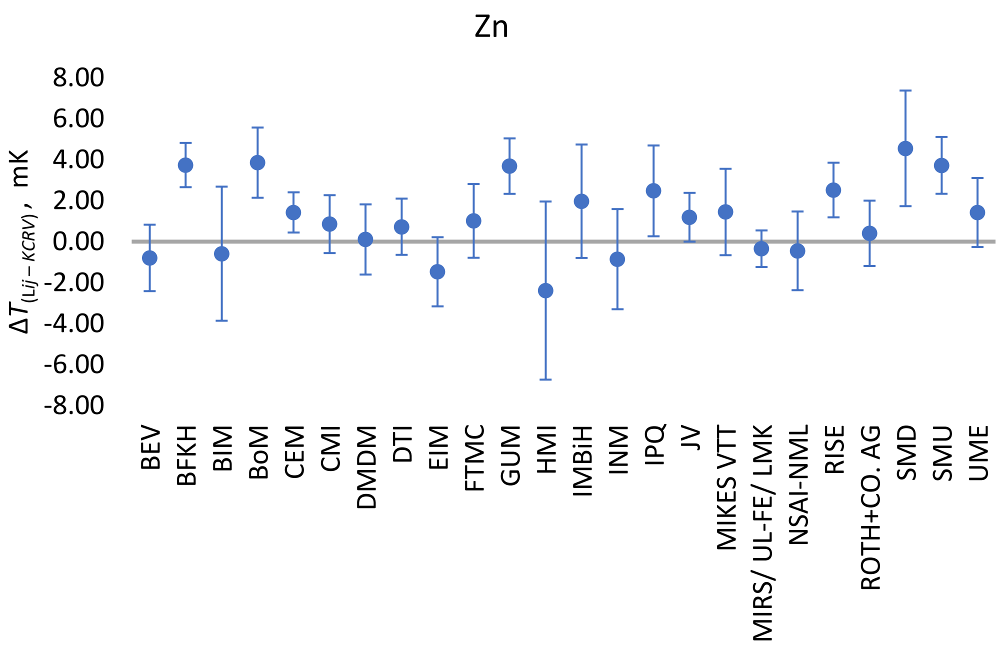

Figure 4.1 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the zinc point. Error bars represent uncertainty $U_{(Lij\text{-}KCRV)}$

4.2 Tin

The results of this comparison at the tin point are summarized in Table 4.2 and Figure 4.2.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK	Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
BEV	-0.05	1.81	IMBiH	-0.78	1.52
BFKH	1.33	1.35	INM	0.01	2.10
BIM	0.87	1.14	IPQ	1.17	1.40
BoM	0.43	0.91	JV	0.34	0.64
CEM	1.10	0.96	MIKES VTT	0.29	1.74
CMI	0.02	1.26	MIRS/ UL-FE/ LMK	-0.31	0.64
DMDM	0.58	1.24	NSAI-NML	-0.53	1.55
DTI	-0.42	0.46	RISE	-0.02	0.72
EIM	-0.05	1.22	ROTH+CO. AG	-0.16	1.22
FTMC	-0.13	1.21	SMD	0.45	1.27
GUM	0.29	0.51	SMU	-0.27	0.98
HMI	-0.22	1.84	UME	0.20	1.01

Table 4.2 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the tin point. Uncertainties are displayed at the k = 2 level

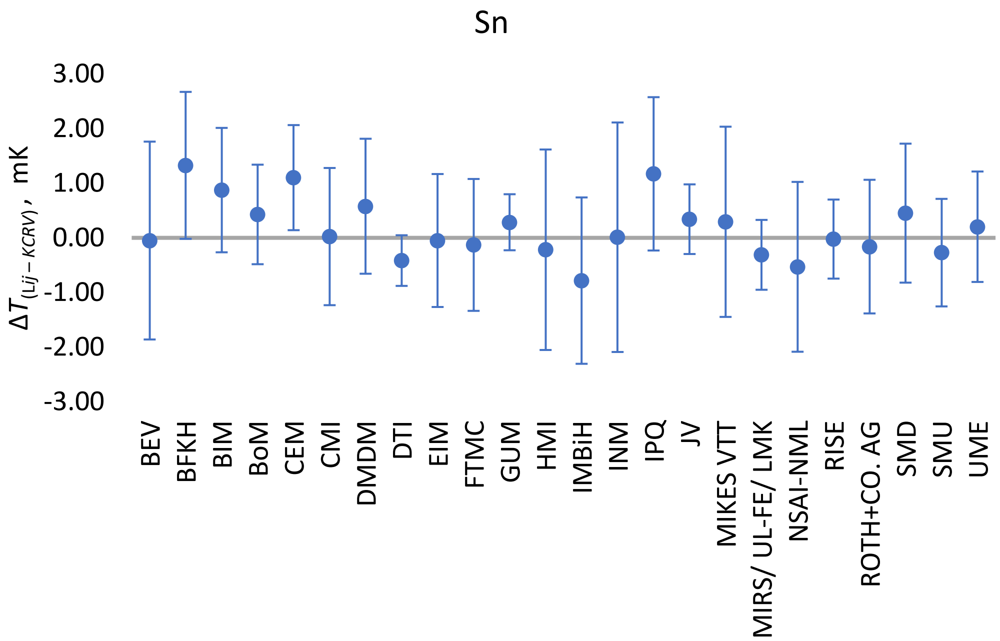

Figure 4.2 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the tin point. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.3 Indium

The results of this comparison at the indium point are summarized in Table 4.3 and Figure 4.3.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK	Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
BEV	0.21	1.58	IMBiH		
BFKH	0.69	1.17	INM	0.13	1.79
BIM	0.56	0.86	IPQ	1.30	1.80
BoM			JV	-0.07	0.48
CEM	0.48	0.75	MIKES VTT		
CMI	0.02	0.89	MIRS/ UL-FE/ LMK	0.08	0.58
DMDM	0.46	1.76	NSAI-NML	-1.13	1.98
DTI	-0.13	1.06	RISE	-0.19	0.56
EIM	0.59	1.63	ROTH+CO. AG	0.44	1.72
FTMC			SMD	0.11	0.96
GUM	0.54	0.84	SMU	0.64	0.92
HMI			UME	-0.19	1.12

Table 4.3 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the indium point. Uncertainties are displayed at the k = 2 level

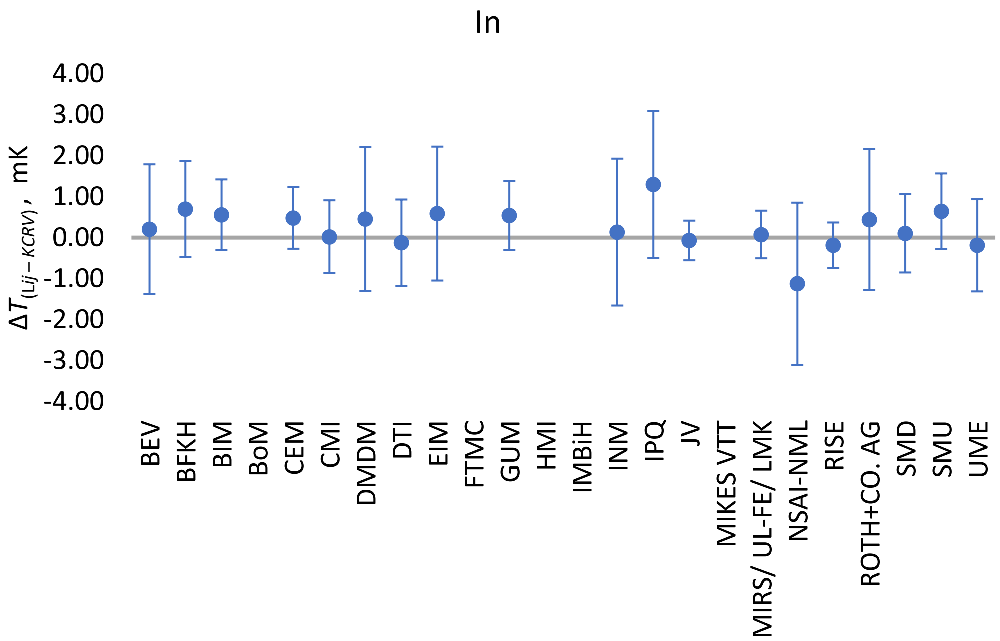

Figure 4.3 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the indium point. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.4 Gallium

The results of this comparison at the gallium point are summarized in Table 4.4 and Figure 4.4.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK	Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
BEV	0.14	0.70	IMBiH	-0.25	0.64
BFKH	0.20	0.42	INM	0.23	0.49
BIM	1.66	0.44	IPQ	-0.39	0.68
BoM	0.42	0.66	JV	-0.30	0.56
CEM	0.07	0.48	MIKES VTT	-0.53	0.76
CMI	-0.22	0.40	MIRS/ UL-FE/ LMK	0.18	0.34
DMDM	0.32	0.61	NSAI-NML	-0.12	0.62
DTI	-0.19	0.41	RISE	-0.32	0.46
EIM	-0.10	0.49	ROTH+CO. AG	0.23	0.69
FTMC	-1.08	0.62	SMD	-0.28	0.49
GUM	-0.16	0.48	SMU	-0.27	0.36
HMI	-0.44	0.84	UME	-0.24	0.40

Table 4.4 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the gallium point. Uncertainties are displayed at the k = 2 level

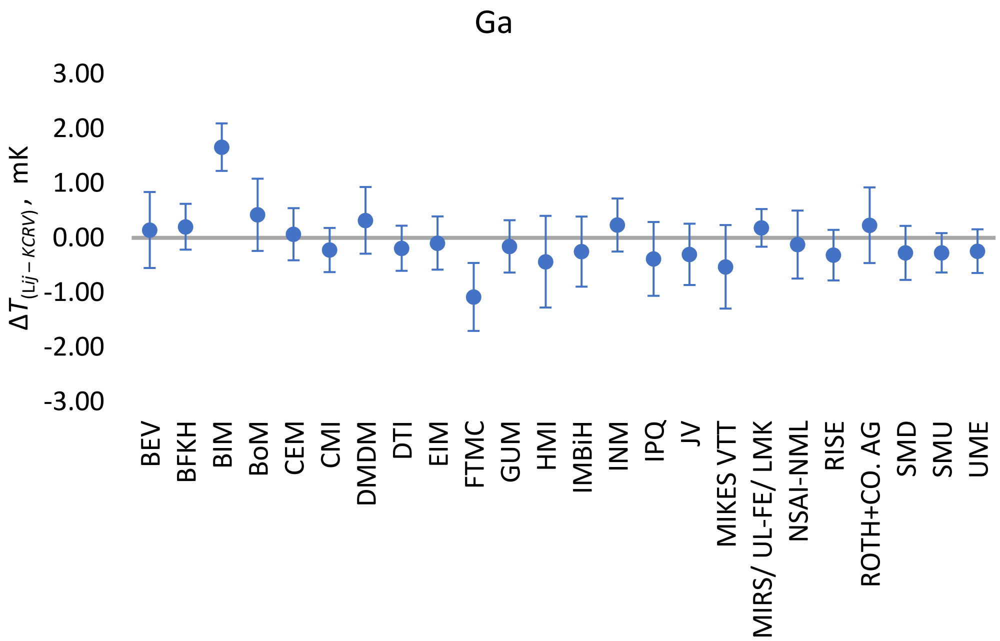

Figure 4.4 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the gallium point. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.5 Mercury

The results of this comparison at the mercury point are summarized in Table 4.5 and Figure 4.5.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK	Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
BEV	0.00	0.87	IMBiH	-0.28	0.55
BFKH	1.30	0.33	INM	-0.05	0.37
BIM	-0.02	0.55	IPQ	0.48	1.00
BoM	-0.20	0.67	JV	0.60	0.74
CEM	0.65	0.78	MIKES VTT	0.55	0.80
CMI	0.31	0.44	MIRS/ UL-FE/ LMK	0.00	0.31
DMDM	-0.17	0.68	NSAI-NML	0.07	0.60
DTI	-0.11	0.47	RISE	-0.20	0.45
EIM	0.03	0.56	ROTH+CO. AG	0.07	0.82
FTMC	-0.09	0.67	SMD	0.63	1.03
GUM	-0.27	0.47	SMU	1.16	0.59
HMI	-0.05	0.27	UME	0.55	0.57

Table 4.5 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the mercury point. Uncertainties are displayed at the k = 2 level

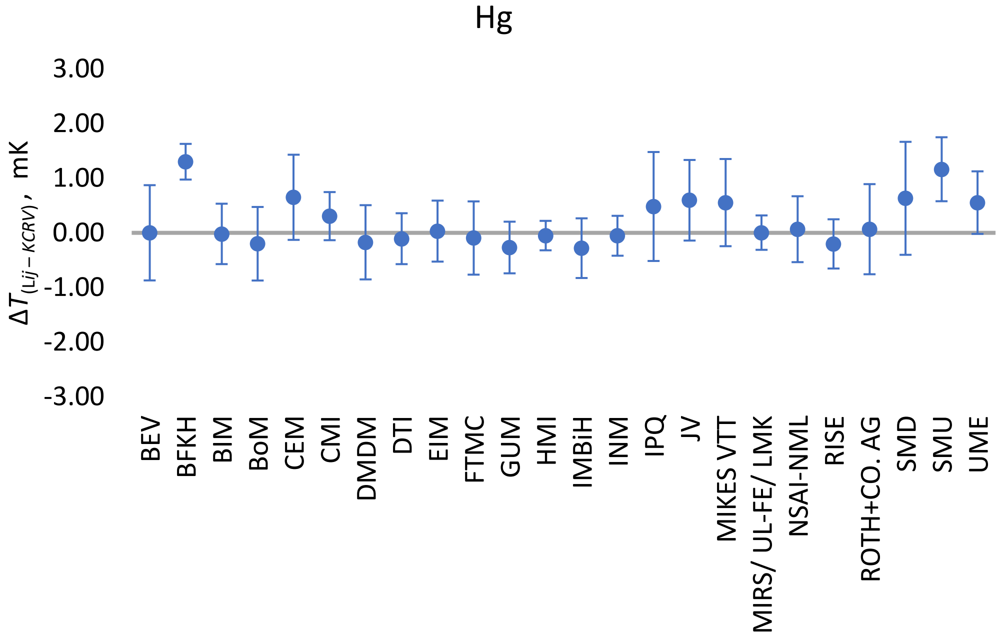

Figure 4.5 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the mercury point. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.6 Argon

The results of this comparison at the argon point are summarized in Table 4.6 and Figure 4.6.

Laboratory	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK	**Laboratory**	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
BEV	-0.66	1.53	IMBiH		
BFKH			INM	-0.98	1.06
BIM			IPQ	-0.47	1.68
BoM			JV	0.45	1.09
CEM	-0.60	1.20	MIKES VTT	0.04	1.52
CMI	0.84	1.03	MIRS/ UL-FE/ LMK	-0.17	1.16
DMDM			NSAI-NML		
DTI	-3.89	2.57	RISE	0.06	1.57
EIM	0.86	0.88	ROTH+CO. AG	-0.60	1.32
FTMC			SMD	-1.49	1.16
GUM	-0.82	1.55	SMU		
HMI			UME	0.42	1.05

Table 4.6 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the argon point. Uncertainties are displayed at the k = 2 level

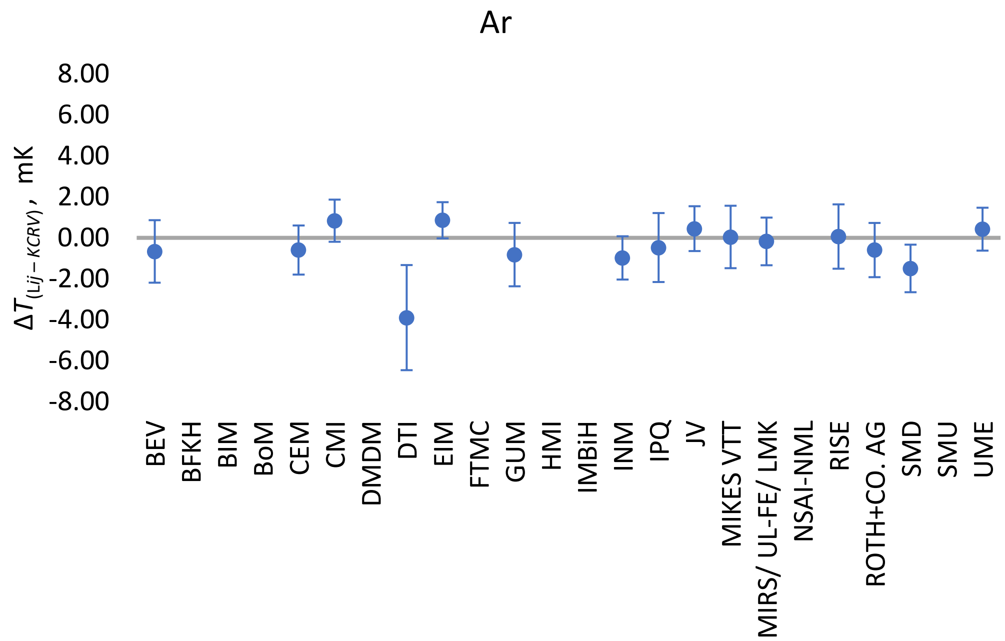

Figure 4.6 Deviations $\Delta T_{(Lij-KCRV)}$ measured at the argon point. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.7 BEV – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-0.80	1.62
Sn	-0.05	1.81
In	0.21	1.58
Ga	0.14	0.70
Hg	0.00	0.87
Ar	-0.66	1.53

Table 4.7 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BEV. Uncertainties are displayed at the k = 2 level.

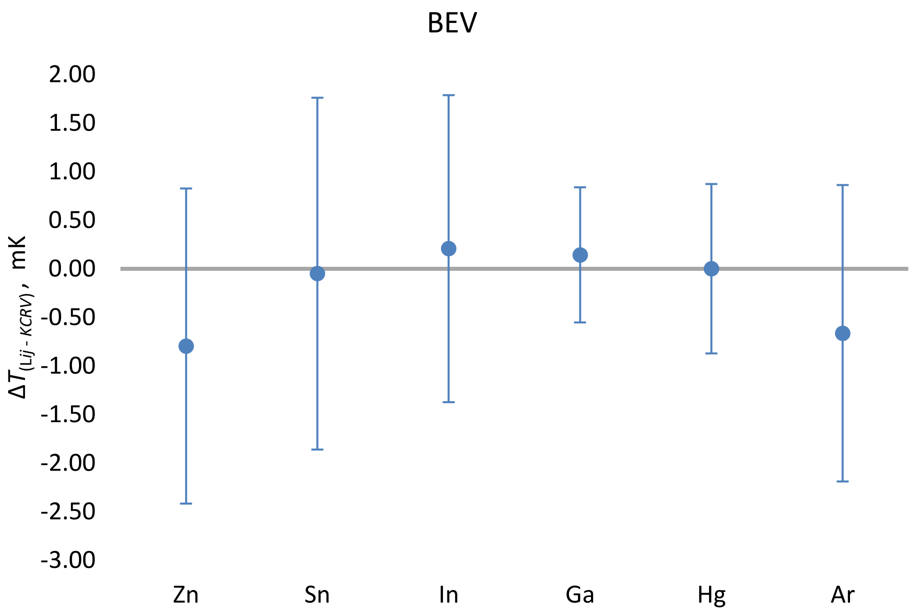

Figure 4.7 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BEV. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.8 BFKH – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	3.74	1.08
Sn	1.33	1.35
In	0.69	1.17
Ga	0.20	0.42
Hg	1.30	0.33
Ar		

Table 4.8 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BFKH. Uncertainties are displayed at the k = 2 level.

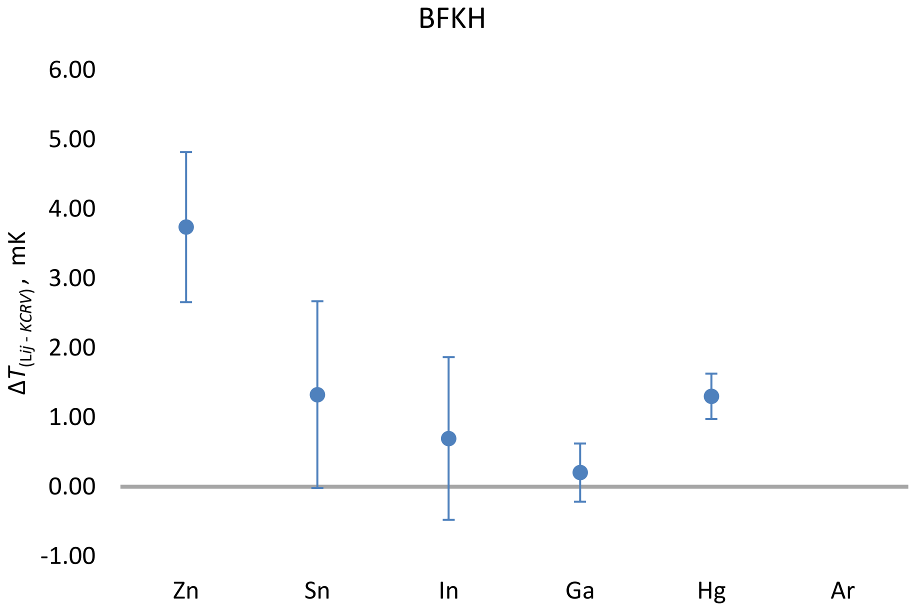

Figure 4.8 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BFKH. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.9 BIM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-0.59	3.27
Sn	0.87	1.14
In	0.56	0.86
Ga	1.66	0.44
Hg	-0.02	0.55
Ar		

Table 4.9 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BIM. Uncertainties are displayed at the k = 2 level.

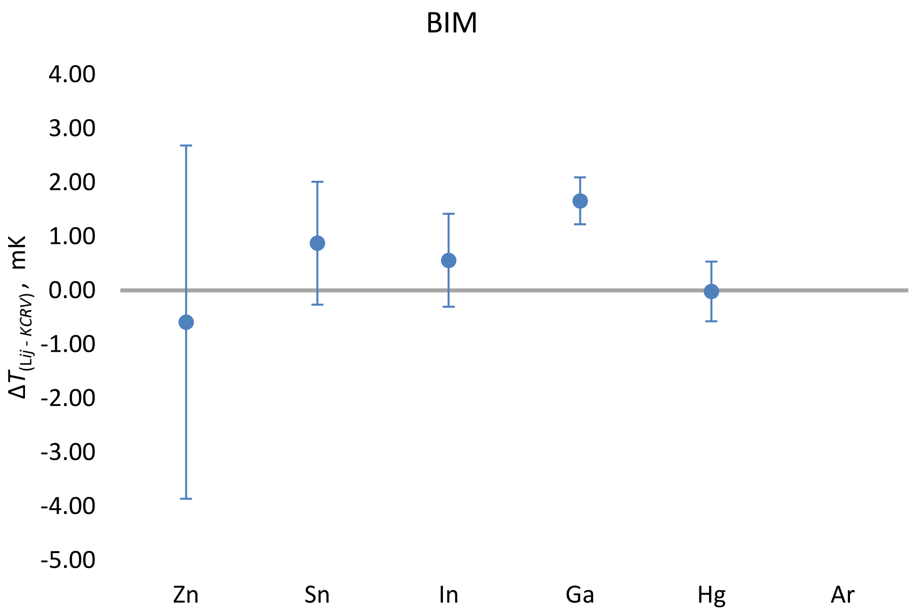

Figure 4.9 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BIM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.10 BoM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	3.86	1.71
Sn	0.43	0.91
In		
Ga	0.42	0.66
Hg	-0.20	0.67
Ar		

Table 4.10 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BoM. Uncertainties are displayed at the k = 2 level.

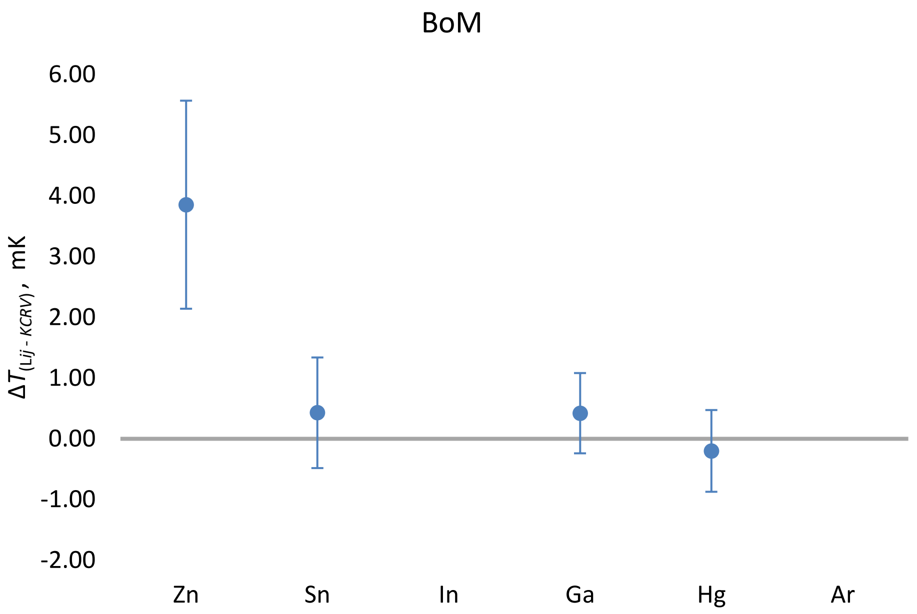

Figure 4.10 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at BoM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.11 CEM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.43	0.98
Sn	1.10	0.96
In	0.48	0.75
Ga	0.07	0.48
Hg	0.65	0.78
Ar	-0.60	1.20

Table 4.11 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at CEM. Uncertainties are displayed at the k = 2 level.

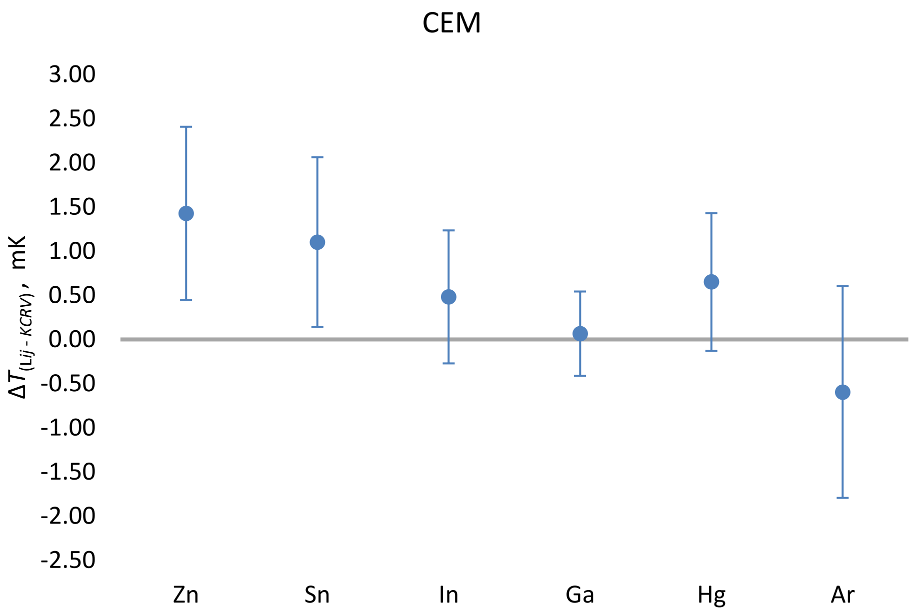

Figure 4.11 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at CEM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.12 CMI – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	0.85	1.41
Sn	0.02	1.26
In	0.02	0.89
Ga	-0.22	0.40
Hg	0.31	0.44
Ar	0.84	1.03

Table 4.12 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at CMI. Uncertainties are displayed at the k = 2 level.

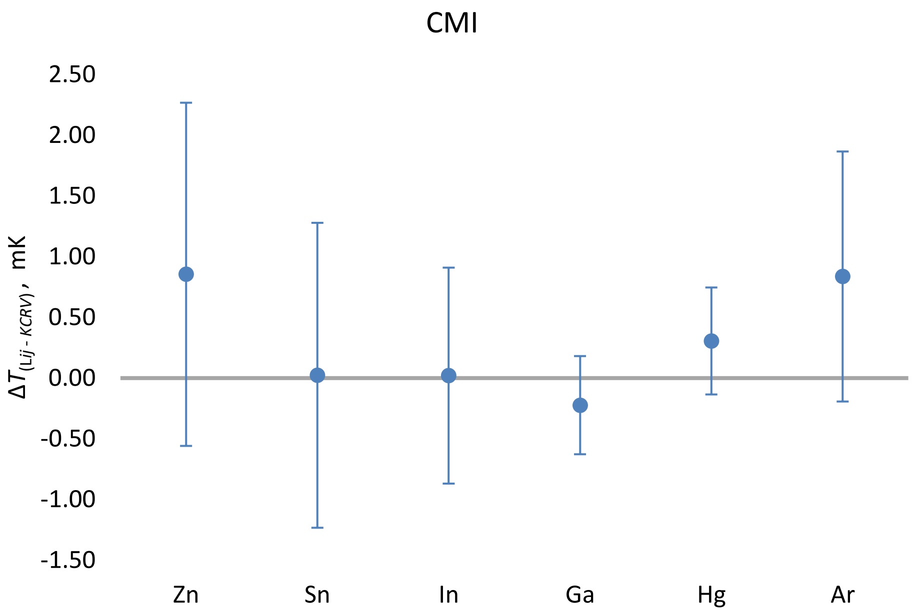

Figure 4.12 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at CMI. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.13 DMDM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	0.11	1.71
Sn	0.58	1.24
In	0.46	1.76
Ga	0.32	0.61
Hg	-0.17	0.68
Ar		

Table 4.13 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at DMDM. Uncertainties are displayed at the k = 2 level.

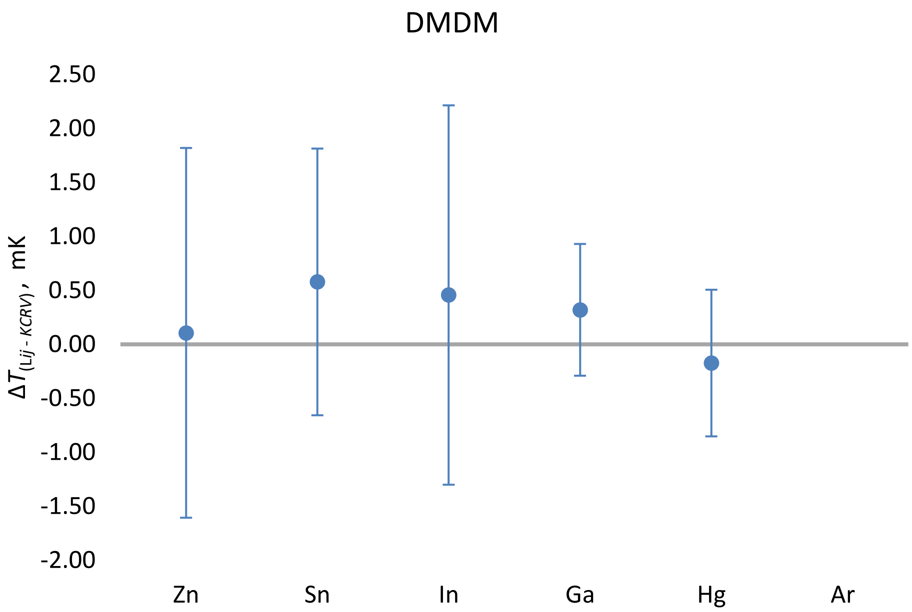

Figure 4.13 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at DMDM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.14 DTI – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	0.73	1.37
Sn	-0.42	0.46
In	-0.13	1.06
Ga	-0.19	0.41
Hg	-0.11	0.47
Ar	-3.89	2.57

Table 4.14 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at DTI. Uncertainties are displayed at the k = 2 level.

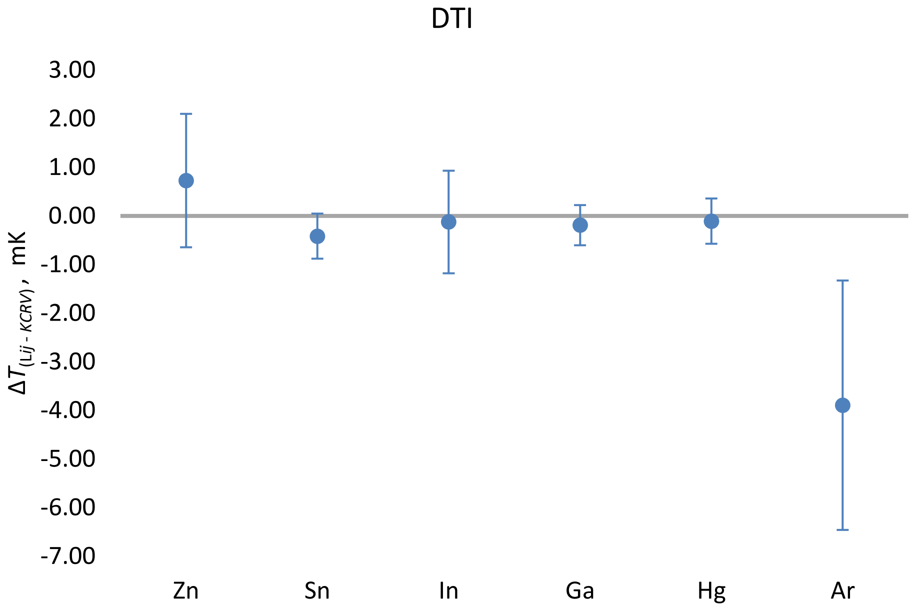

Figure 4.14 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at DTI. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.15 EIM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-1.47	1.69
Sn	-0.05	1.22
In	0.59	1.63
Ga	-0.10	0.49
Hg	0.03	0.56
Ar	0.86	0.88

Table 4.15 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at EIM. Uncertainties are displayed at the k = 2 level.

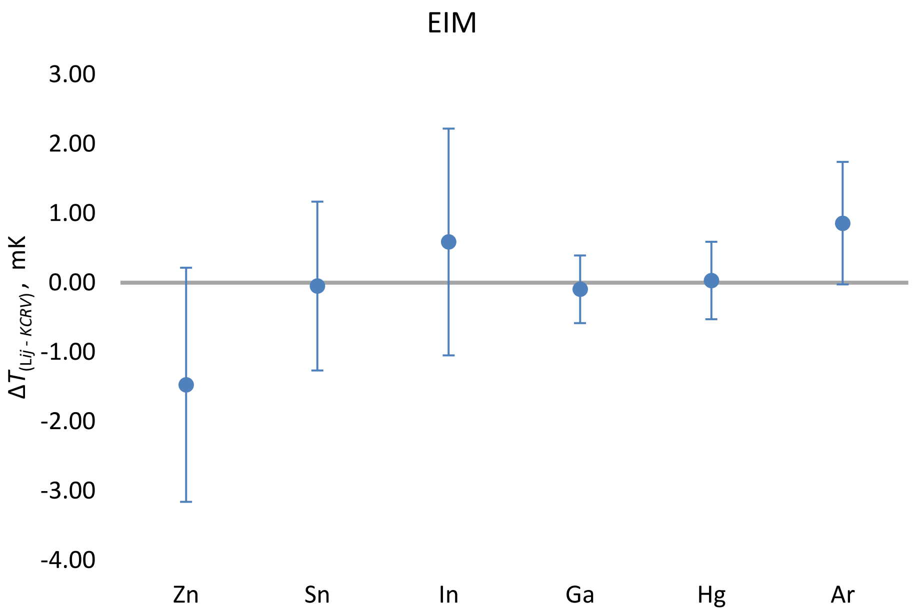

Figure 4.15 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at EIM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.16 FTMC – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.01	1.80
Sn	-0.13	1.21
In		
Ga	-1.08	0.62
Hg	-0.09	0.67
Ar		

Table 4.16 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at FTMC. Uncertainties are displayed at the k = 2 level.

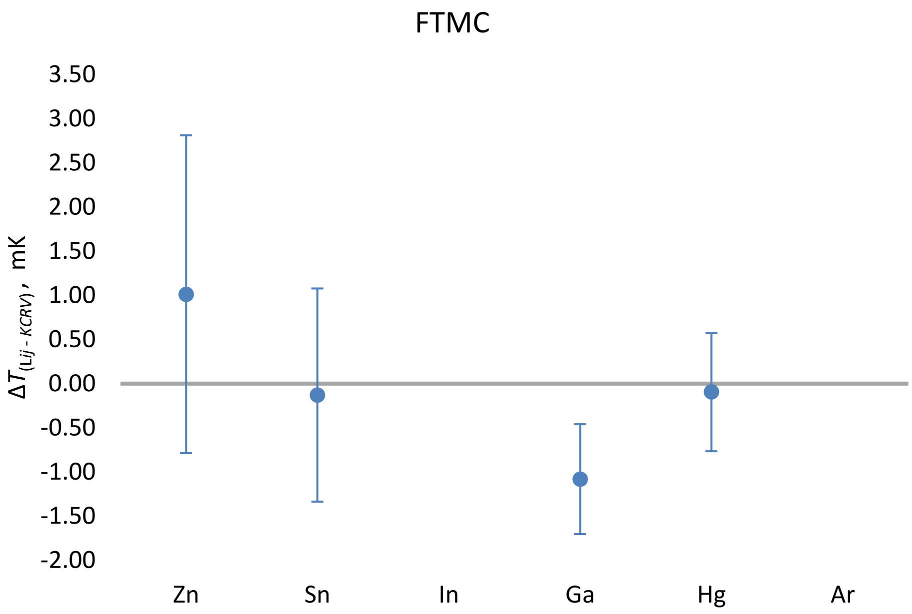

Figure 4.16 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at FTMC. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.17 GUM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	3.69	1.35
Sn	0.29	0.51
In	0.54	0.84
Ga	-0.16	0.48
Hg	-0.27	0.47
Ar	-0.82	1.55

Table 4.17 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at GUM. Uncertainties are displayed at the k = 2 level.

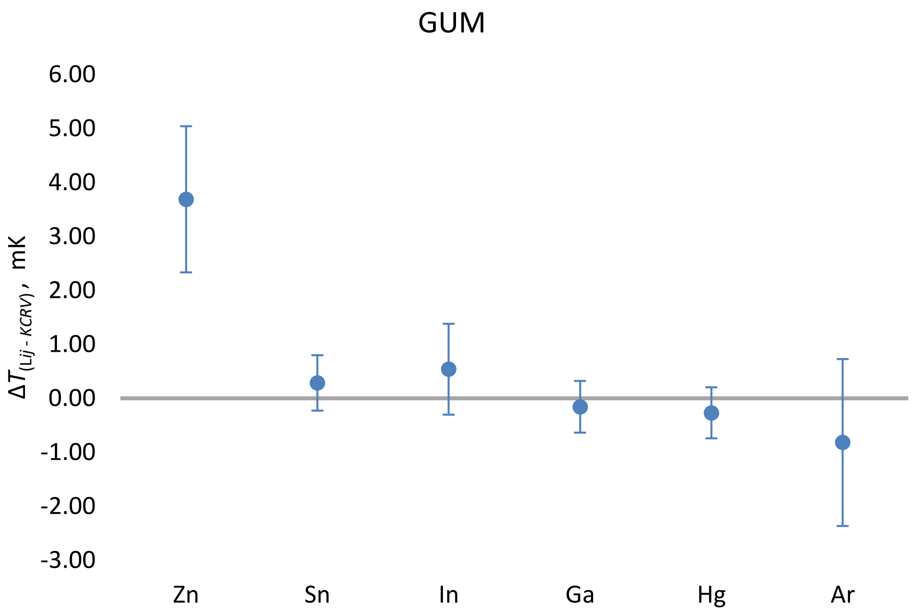

Figure 4.17 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at GUM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.18 HMI – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-2.39	4.35
Sn	-0.22	1.84
In		
Ga	-0.44	0.84
Hg	-0.05	0.27
Ar		

Table 4.18 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at HMI. Uncertainties are displayed at the k = 2 level.

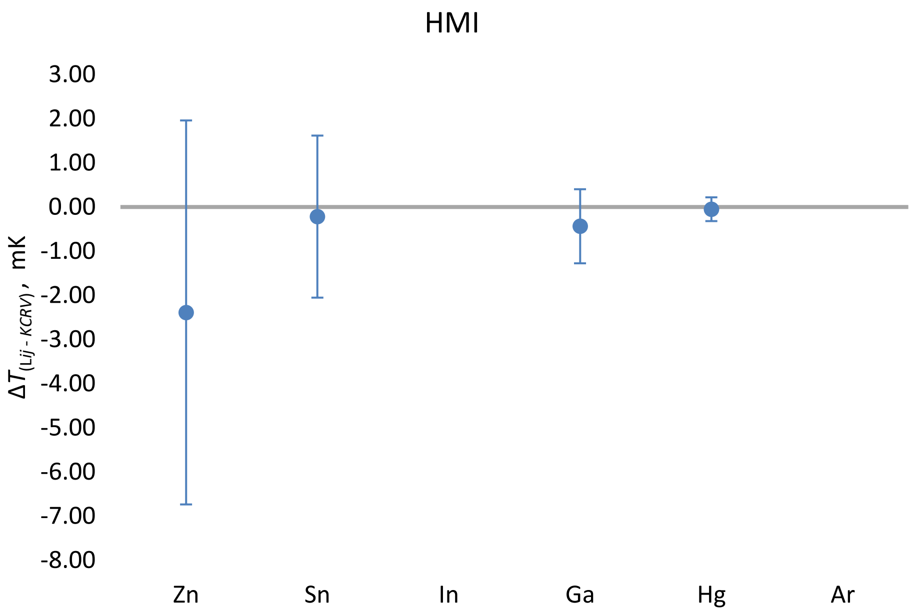

Figure 4.18 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at HMI. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.19 IMBiH – results

	$\Delta T_{(Lij - KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.97	2.77
Sn	-0.78	1.52
In		
Ga	-0.25	0.64
Hg	-0.28	0.55
Ar		

Table 4.19 Deviation $\Delta T_{(Lij - KCRV)}$ at each fixed-point measured at IMBiH. Uncertainties are displayed at the k = 2 level.

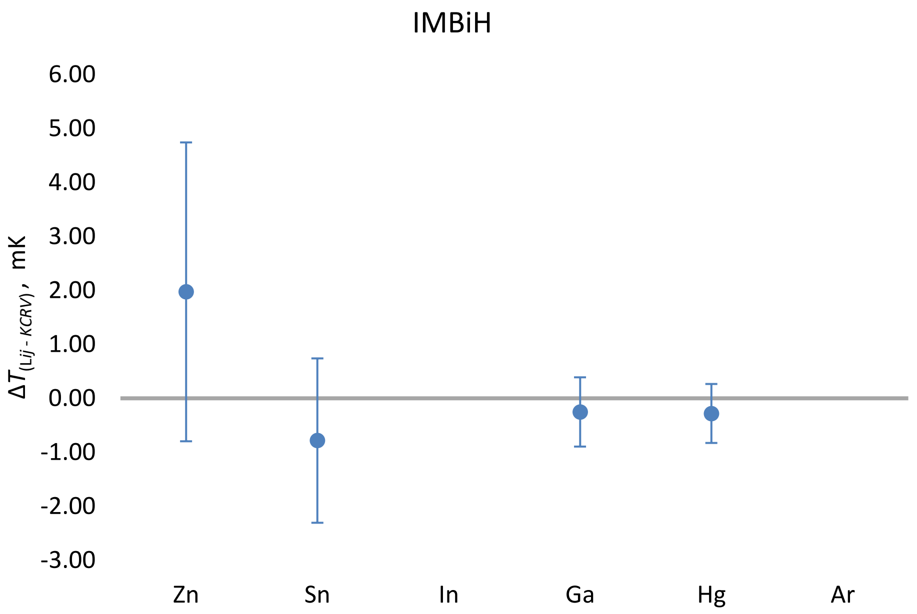

Figure 4.19 Deviation $\Delta T_{(Lij - KCRV)}$ at each fixed-point measured at IMBiH. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.20 INM – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-0.85	2.44
Sn	0.01	2.10
In	0.13	1.79
Ga	0.23	0.49
Hg	-0.05	0.37
Ar	-0.98	1.06

Table 4.20 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at INM. Uncertainties are displayed at the k = 2 level.

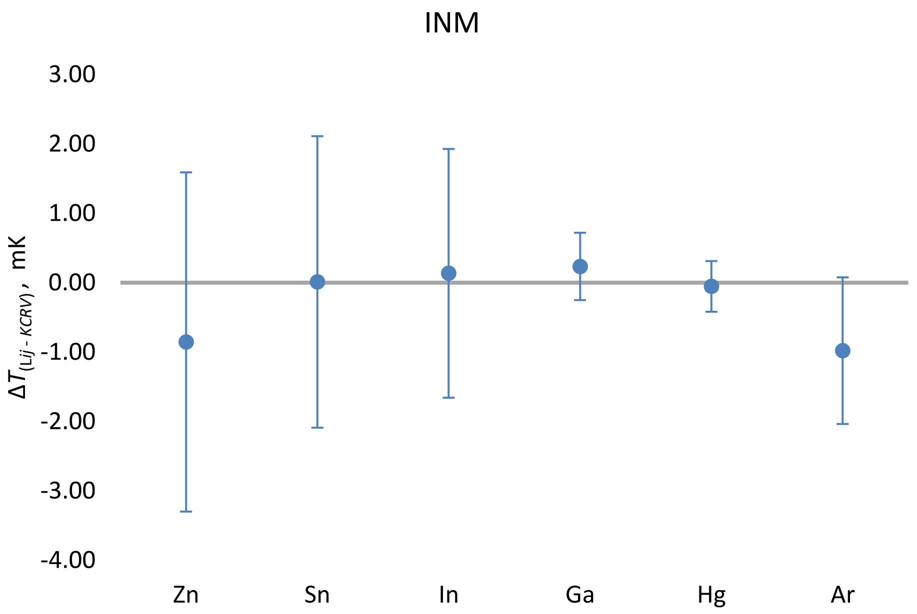

Figure 4.20 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at INM. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.21 IPQ – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	2.48	2.22
Sn	1.17	1.40
In	1.30	1.80
Ga	-0.39	0.68
Hg	0.48	1.00
Ar	-0.47	1.68

Table 4.21 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at IPQ. Uncertainties are displayed at the k = 2 level.

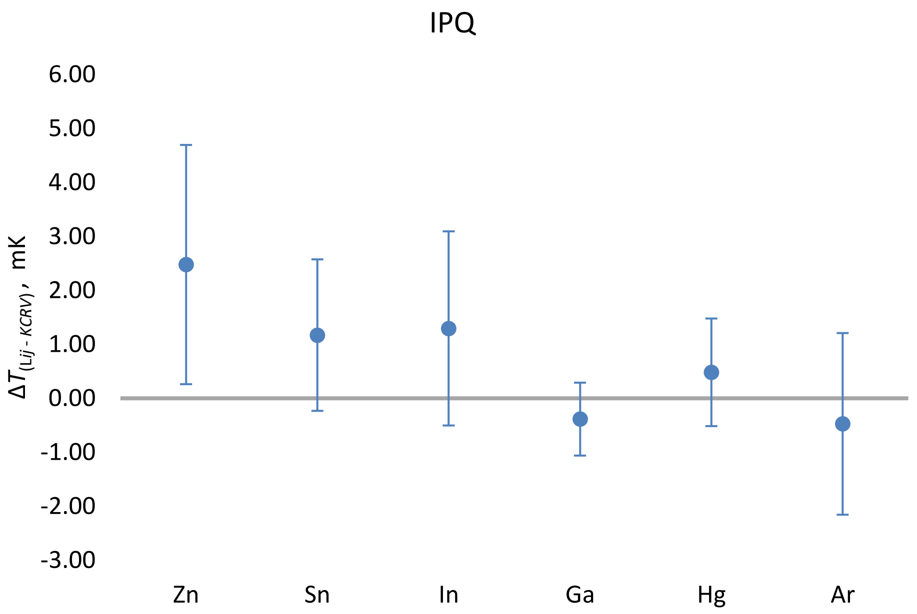

Figure 4.21 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at IPQ. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.22 JV – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.19	1.19
Sn	0.34	0.64
In	-0.07	0.48
Ga	-0.30	0.56
Hg	0.60	0.74
Ar	0.45	1.09

Table 4.22 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at JV. Uncertainties are displayed at the k = 2 level.

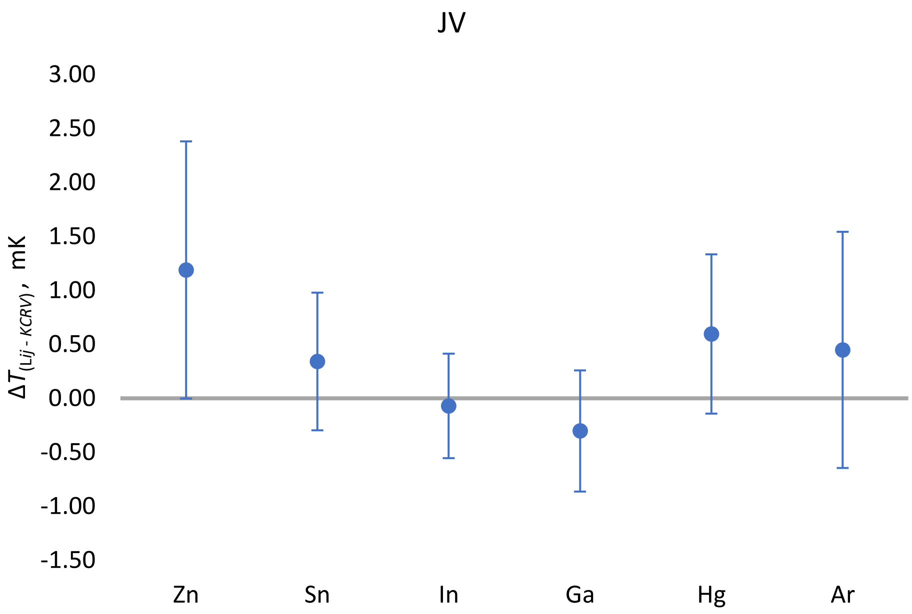

Figure 4.22 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at JV. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.23 MIKES VTT – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.45	2.11
Sn	0.29	1.74
In		
Ga	-0.53	0.76
Hg	0.55	0.80
Ar	0.04	1.52

Table 4.23 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at MIKES VTT. Uncertainties are displayed at the k = 2 level.

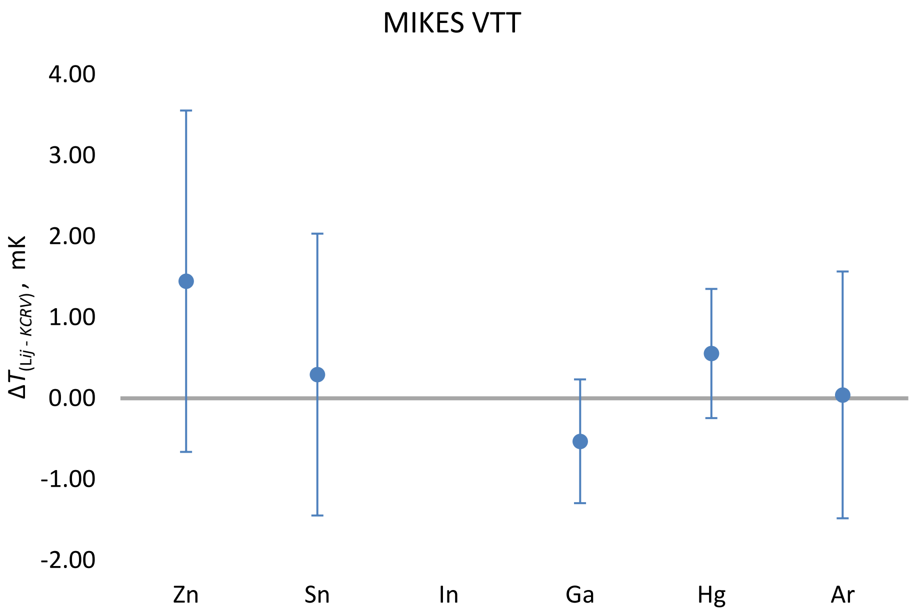

Figure 4.23 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at MIKES VTT. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.24 MIRS/ UL-FE/ LMK – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-0.35	0.89
Sn	-0.31	0.64
In	0.08	0.58
Ga	0.18	0.34
Hg	0.00	0.31
Ar	-0.17	1.16

Table 4.24 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at MIRS/ UL-FE/ LMK. Uncertainties are displayed at the k = 2 level.

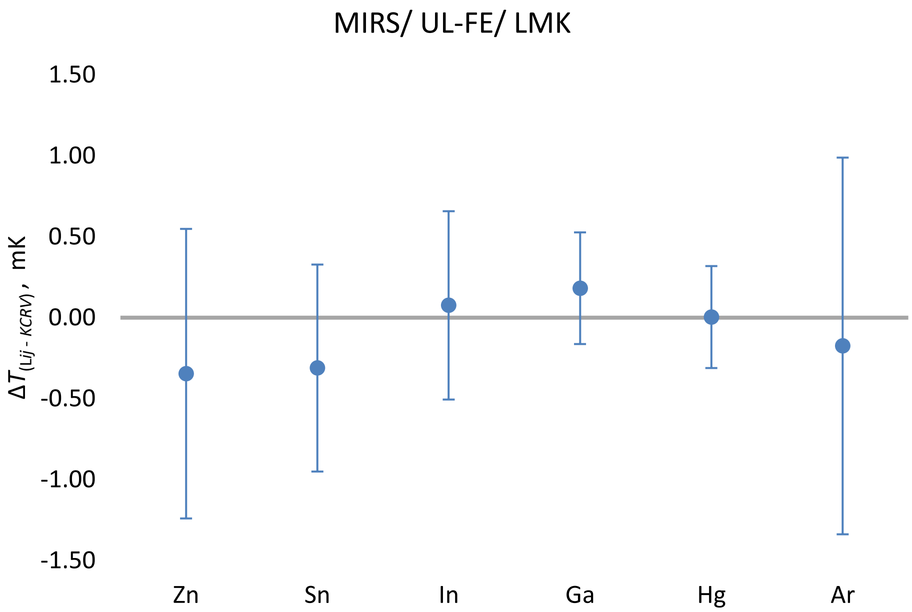

Figure 4.24 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at MIRS/ UL-FE/ LMK. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.25 NSAI-NML – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	-0.45	1.92
Sn	-0.53	1.55
In	-1.13	1.98
Ga	-0.12	0.62
Hg	0.07	0.60
Ar		

Table 4.25 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at NSAI-NML. Uncertainties are displayed at the k = 2 level.

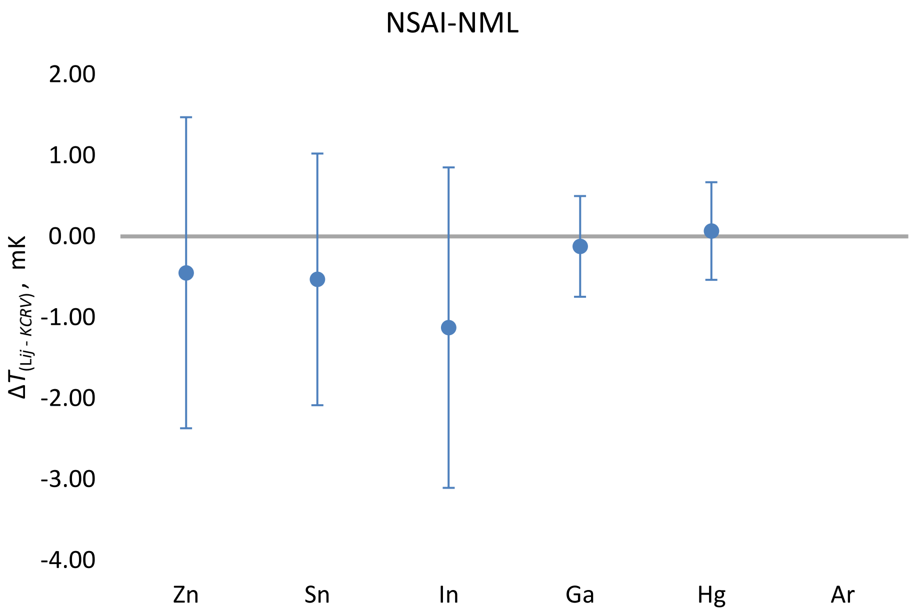

Figure 4.25 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at NSAI-NML. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.26 RISE – results

	$\Delta T_{(Lij-KCRV)}$ mK	**$U_{(Lij-KCRV)}$** mK
Zn	2.52	1.33
Sn	-0.02	0.72
In	-0.19	0.56
Ga	-0.32	0.46
Hg	-0.20	0.45
Ar	0.06	1.57

Table 4.26 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at RISE. Uncertainties are displayed at the k = 2 level.

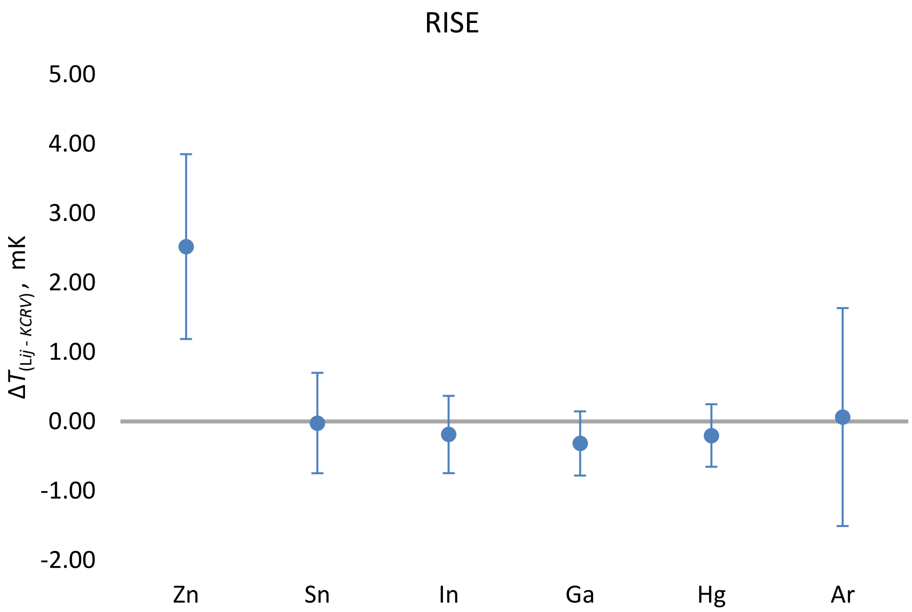

Figure 4.26 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at RISE. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.27 ROTH+CO. AG – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	0.41	1.59
Sn	-0.16	1.22
In	0.44	1.72
Ga	0.23	0.69
Hg	0.07	0.82
Ar	-0.60	1.32

Table 4.27 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at ROTH+CO. AG. Uncertainties are displayed at the k = 2 level.

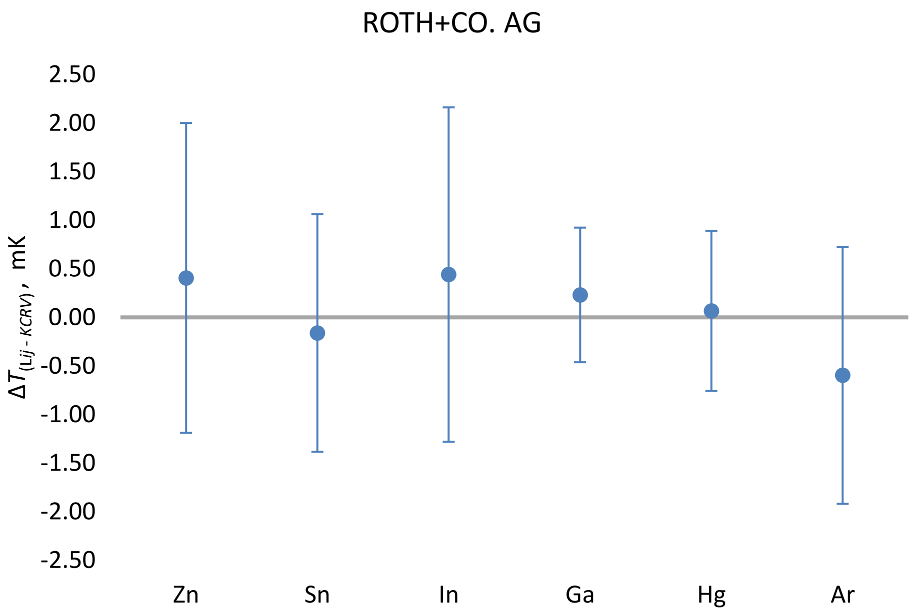

Figure 4.27 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at ROTH+CO. AG. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.28 SMD – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	4.55	2.82
Sn	0.45	1.27
In	0.11	0.96
Ga	-0.28	0.49
Hg	0.63	1.03
Ar	-1.49	1.16

Table 4.28 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at SMD. Uncertainties are displayed at the k = 2 level.

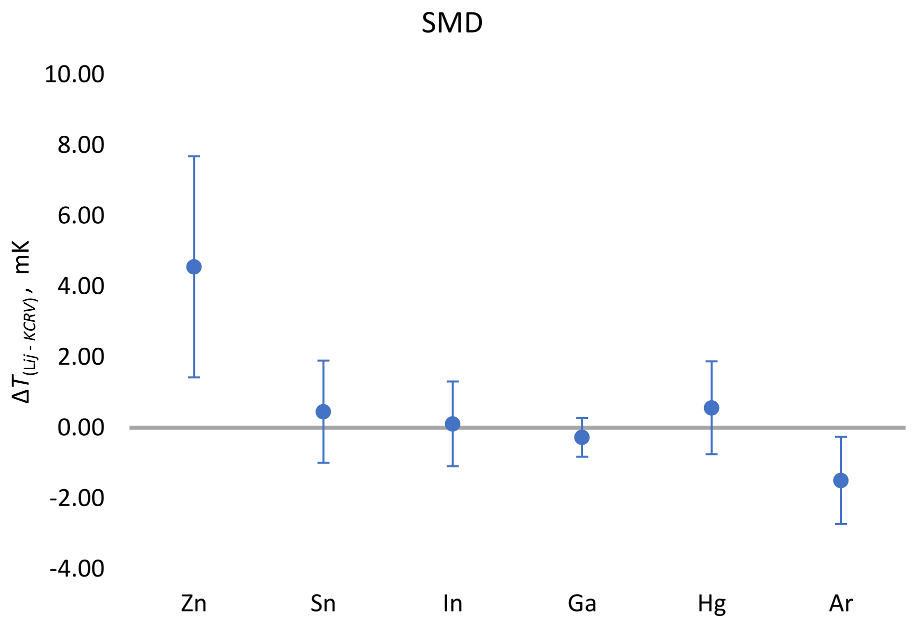

Figure 4.28 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at SMD. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.29 SMU – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	3.72	1.39
Sn	-0.27	0.98
In	0.64	0.92
Ga	-0.27	0.36
Hg	1.16	0.59
Ar		

Table 4.29 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at SMU. Uncertainties are displayed at the k = 2 level.

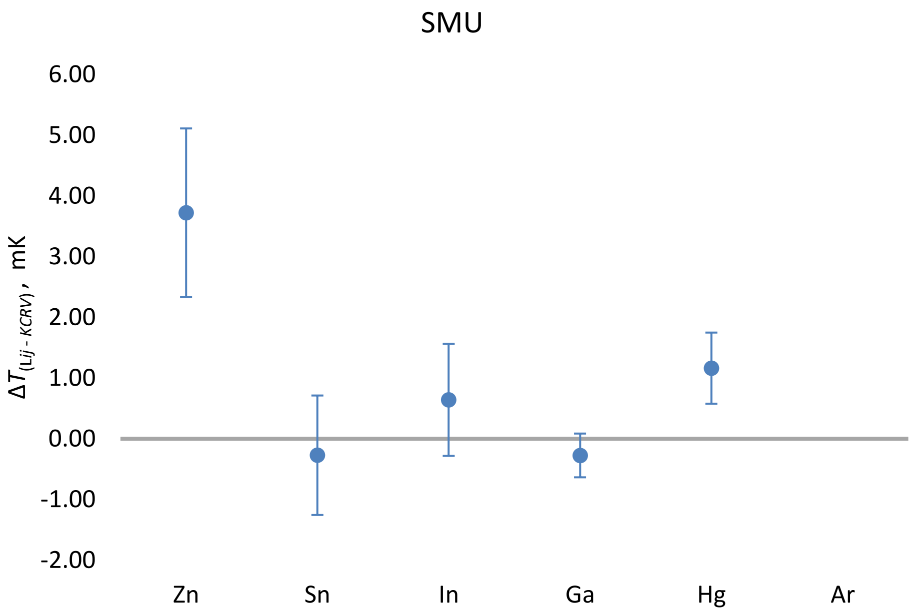

Figure 4.29 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at SMU. Error bars represent uncertainty $U_{(Lij-KCRV)}$

4.30 UME – results

	$\Delta T_{(Lij-KCRV)}$ mK	$U_{(Lij-KCRV)}$ mK
Zn	1.42	1.69
Sn	0.20	1.01
In	-0.19	1.12
Ga	-0.24	0.40
Hg	0.55	0.57
Ar	0.42	1.05

Table 4.30 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at UME. Uncertainties are displayed at the k = 2 level.

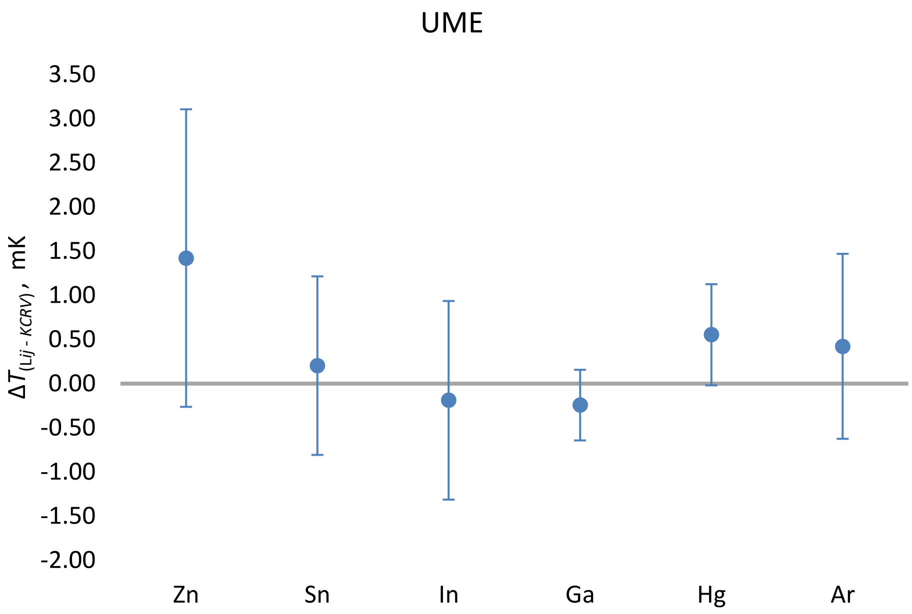

Figure 4.30 Deviation $\Delta T_{(Lij-KCRV)}$ at each fixed-point measured at UME. Error bars represent uncertainty $U_{(Lij-KCRV)}$

5 Degrees of equivalence (DoE)

The complete bilateral equivalence matrices for each fixed-point comparison are listed here. In these tables, the elements above the diagonal are the pair differences "Δ" (row – column) expressed in mK, and the expanded (*k*=2) uncertainty of the pair difference "u_Δ", also in mK. The elements below the diagonal are $QDE_{0.95}$ confidence intervals [4, 5], calculated as

$$QDE_{0.95} = |\Delta| + \left(1.654 + 0.3295 \times e^{\left(\frac{-4.05 \cdot |\Delta|}{u_\Delta}\right)}\right) \times u_\Delta \qquad (1)$$

5.1 DoE table at the Zinc fixed point

	BEV	BFKH	BIM	BoM
BEV		-4.53 ±1.95	-0.21 ±3.65	-4.65 ±2.36
BFKH	6.14		4.33 ±3.45	-0.12 ±2.03
BIM	3.59	7.16		-4.44 ±3.69
BoM	6.59	1.99	7.48	
CEM	3.78	3.51	4.83	4.05
CMI	3.42	4.35	4.40	4.83
DMDM	2.86	5.30	3.87	5.74
DTI	3.27	4.45	4.26	4.93
EIM	2.64	6.86	4.00	7.31
FTMC	3.80	4.45	4.69	4.89
GUM	6.22	1.70	7.19	2.16
HMI	5.46	9.81	6.34	10.09
IMBiH	5.41	4.21	6.09	4.57
INM	2.88	6.79	4.02	7.17
INRiM	2.13	4.63	3.41	5.27
IPQ	5.53	3.30	6.32	3.69
JV	3.64	3.87	4.65	4.38
LNE-Cnam	2.13	4.63	3.41	5.27
MIKES VTT	4.43	4.24	5.25	4.64
MIRS/ UL-FE/ LMK	2.02	5.24	3.35	5.79
NPL	2.13	4.63	3.41	5.27
NSAI-NML	2.55	6.00	3.73	6.42
PTB	2.13	4.63	3.41	5.27
RISE	5.04	2.63	6.02	3.12
ROTH+CO. AG	3.08	4.92	4.06	5.37
SMD	8.03	3.36	8.70	3.51
SMU	6.28	1.73	7.24	2.17
UME	4.14	3.96	5.05	4.41
VSL	2.13	4.63	3.41	5.27

Table 5.1 DoE at the Zinc fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	-2.22 ±1.90	-1.65 ±2.15	-0.90 ±2.36	-1.52 ±2.12
BFKH	2.31 ±1.46	2.88 ±1.78	3.63 ±2.03	3.01 ±1.75
BIM	-2.01 ±3.42	-1.44 ±3.57	-0.69 ±3.69	-1.32 ±3.55
BoM	2.43 ±1.97	3.00 ±2.22	3.75 ±2.42	3.13 ±2.20
CEM		0.57 ±1.72	1.32 ±1.97	0.70 ±1.69
CMI	2.01		0.75 ±2.22	0.13 ±1.97
DMDM	2.95	2.60		-0.62 ±2.19
DTI	2.10	1.94	2.46	
EIM	4.50	4.14	3.56	3.99
FTMC	2.17	2.26	2.97	2.28
GUM	3.64	4.44	5.38	4.55
HMI	7.48	7.01	6.35	6.87
IMBiH	3.07	3.70	4.55	3.81
INM	4.45	4.04	3.45	3.89
INRiM	2.23	2.02	1.69	1.86
IPQ	3.06	3.79	4.68	3.90
JV	1.58	1.93	2.80	1.99
LNE-Cnam	2.23	2.02	1.69	1.86
MIKES VTT	2.29	2.74	3.58	2.83
MIRS/ UL-FE/ LMK	2.86	2.58	2.09	2.42
NPL	2.23	2.02	1.69	1.86
NSAI-NML	3.65	3.27	2.75	3.12
PTB	2.23	2.02	1.69	1.86
RISE	2.46	3.26	4.20	3.37
ROTH+CO. AG	2.56	2.26	2.36	2.15
SMD	5.59	6.30	7.16	6.41
SMU	3.70	4.50	5.43	4.60
UME	1.92	2.42	3.30	2.51
VSL	2.23	2.02	1.69	1.86

Table 5.1 DoE at the Zinc fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	0.68 ±2.34	-1.81 ±2.42	-4.48 ±2.11	1.59 ±4.64
BFKH	5.21 ±2.00	2.73 ±2.10	0.05 ±1.73	6.13 ±4.48
BIM	0.88 ±3.68	-1.60 ±3.74	-4.28 ±3.54	1.80 ±5.44
BoM	5.33 ±2.40	2.84 ±2.49	0.17 ±2.18	6.24 ±4.67
CEM	2.90 ±1.95	0.41 ±2.05	-2.26 ±1.67	3.81 ±4.46
CMI	2.33 ±2.20	-0.16 ±2.29	-2.83 ±1.96	3.24 ±4.57
DMDM	1.58 ±2.40	-0.91 ±2.48	-3.58 ±2.18	2.49 ±4.67
DTI	2.20 ±2.17	-0.28 ±2.26	-2.96 ±1.93	3.12 ±4.56
EIM		-2.48 ±2.47	-5.16 ±2.16	0.92 ±4.66
FTMC	4.51		-2.68 ±2.25	3.40 ±4.71
GUM	6.94	4.53		6.08 ±4.55
HMI	4.91	7.27	9.82	
IMBiH	6.11	3.73	4.26	8.60
INM	3.15	4.37	6.84	5.70
INRiM	2.86	2.50	4.80	5.97
IPQ	6.24	3.82	3.36	8.88
JV	4.36	2.14	3.98	7.29
LNE-Cnam	2.86	2.50	4.80	5.97
MIKES VTT	5.14	2.84	4.30	7.81
MIRS/ UL-FE/ LMK	2.70	3.01	5.37	5.71
NPL	2.86	2.50	4.80	5.97
NSAI-NML	3.14	3.63	6.07	5.88
PTB	2.86	2.50	4.80	5.97
RISE	5.76	3.35	2.73	8.65
ROTH+CO. AG	3.79	2.64	5.00	6.61
SMD	8.73	6.30	3.50	11.21
SMU	6.99	4.58	1.91	9.87
UME	4.85	2.54	4.04	7.65
VSL	2.86	2.50	4.80	5.97

Table 5.1 DoE at the Zinc fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV	-2.77 ±3.21	0.06 ±2.93	-0.80 ±1.62	-3.27 ±2.75
BFKH	1.77 ±2.97	4.59 ±2.67	3.74 ±1.08	1.26 ±2.47
BIM	-2.56 ±4.29	0.27 ±4.09	-0.59 ±3.27	-3.07 ±3.95
BoM	1.88 ±3.26	4.71 ±2.99	3.86 ±1.71	1.38 ±2.80
CEM	-0.55 ±2.94	2.28 ±2.63	1.43 ±0.98	-1.05 ±2.42
CMI	-1.12 ±3.11	1.71 ±2.82	0.85 ±1.41	-1.62 ±2.63
DMDM	-1.87 ±3.26	0.96 ±2.99	0.11 ±1.71	-2.37 ±2.80
DTI	-1.25 ±3.09	1.58 ±2.80	0.73 ±1.37	-1.75 ±2.61
EIM	-3.44 ±3.24	-0.62 ±2.97	-1.47 ±1.69	-3.95 ±2.79
FTMC	-0.96 ±3.30	1.87 ±3.04	1.01 ±1.80	-1.47 ±2.86
GUM	1.71 ±3.08	4.54 ±2.79	3.69 ±1.35	1.21 ±2.60
HMI	-4.36 ±5.15	-1.53 ±4.99	-2.39 ±4.35	-4.87 ±4.88
IMBiH		2.83 ±3.69	1.97 ±2.77	-0.51 ±3.55
INM	5.87		-0.85 ±2.44	-3.33 ±3.30
INRiM	4.25	2.89		-2.48 ±2.22
IPQ	3.61	6.05	4.30	
JV	3.32	4.28	2.17	3.37
LNE-Cnam	4.25	2.89	*CCT-K9*	4.30
MIKES VTT	3.56	4.96	3.18	3.58
MIRS/ UL-FE/ LMK	4.71	2.74	1.09	4.79
NPL	4.25	2.89	*CCT-K9*	4.30
NSAI-NML	5.20	3.14	2.08	5.34
PTB	4.25	2.89	*CCT-K9*	4.30
RISE	3.19	5.66	3.62	2.54
ROTH+CO. AG	4.20	3.68	1.75	4.32
SMD	5.84	8.48	6.88	5.03
SMU	4.30	6.89	4.87	3.41
UME	3.35	4.72	2.81	3.37
VSL	4.25	2.89	*CCT-K9*	4.30

Table 5.1 DoE at the Zinc fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	-1.98 ±2.01	-0.80 ±1.62	-2.24 ±2.66	-0.45 ±1.85
BFKH	2.55 ±1.61	3.74 ±1.08	2.29 ±2.37	4.08 ±1.40
BIM	-1.78 ±3.48	-0.59 ±3.27	-2.04 ±3.89	-0.24 ±3.39
BoM	2.67 ±2.09	3.86 ±1.71	2.41 ±2.72	4.20 ±1.93
CEM	0.24 ±1.54	1.43 ±0.98	-0.02 ±2.33	1.77 ±1.33
CMI	-0.33 ±1.85	0.85 ±1.41	-0.59 ±2.54	1.20 ±1.67
DMDM	-1.08 ±2.09	0.11 ±1.71	-1.34 ±2.72	0.45 ±1.93
DTI	-0.46 ±1.82	0.73 ±1.37	-0.72 ±2.52	1.07 ±1.64
EIM	-2.66 ±2.07	-1.47 ±1.69	-2.92 ±2.70	-1.13 ±1.91
FTMC	-0.18 ±2.16	1.01 ±1.80	-0.43 ±2.77	1.36 ±2.01
GUM	2.50 ±1.80	3.69 ±1.35	2.24 ±2.51	4.03 ±1.62
HMI	-3.58 ±4.51	-2.39 ±4.35	-3.84 ±4.83	-2.04 ±4.44
IMBiH	0.78 ±3.01	1.97 ±2.77	0.53 ±3.48	2.32 ±2.91
INM	-2.04 ±2.72	-0.85 ±2.44	-2.30 ±3.23	-0.51 ±2.60
INRiM	-1.19 ±1.19	*CCT-K9*	-1.45 ±2.11	0.35 ±0.89
IPQ	1.29 ±2.52	2.48 ±2.22	1.03 ±3.06	2.82 ±2.39
JV		1.19 ±1.19	-0.26 ±2.42	1.54 ±1.49
LNE-Cnam	2.17		-1.45 ±2.11	0.35 ±0.89
MIKES VTT	2.42	3.18		1.79 ±2.29
MIRS/ UL-FE/ LMK	2.76	1.09	3.68	
NPL	2.17	*CCT-K9*	3.18	1.09
NSAI-NML	3.50	2.08	4.24	2.08
PTB	2.17	*CCT-K9*	3.18	1.09
RISE	2.80	3.62	3.14	4.19
ROTH+CO. AG	2.43	1.75	3.23	2.27
SMD	5.88	6.88	6.01	7.34
SMU	4.04	4.87	4.35	5.43
UME	2.07	2.81	2.66	3.34
VSL	2.17	*CCT-K9*	3.18	1.09

Table 5.1 DoE at the Zinc fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	-0.80 ±1.62	-0.35 ±2.51	-0.80 ±1.62	-3.32 ±2.10
BFKH	3.74 ±1.08	4.19 ±2.20	3.74 ±1.08	1.22 ±1.72
BIM	-0.59 ±3.27	-0.14 ±3.80	-0.59 ±3.27	-3.11 ±3.53
BoM	3.86 ±1.71	4.30 ±2.57	3.86 ±1.71	1.34 ±2.17
CEM	1.43 ±0.98	1.88 ±2.16	1.43 ±0.98	-1.09 ±1.65
CMI	0.85 ±1.41	1.30 ±2.39	0.85 ±1.41	-1.67 ±1.94
DMDM	0.11 ±1.71	0.56 ±2.57	0.11 ±1.71	-2.41 ±2.17
DTI	0.73 ±1.37	1.18 ±2.36	0.73 ±1.37	-1.79 ±1.91
EIM	-1.47 ±1.69	-1.02 ±2.56	-1.47 ±1.69	-3.99 ±2.15
FTMC	1.01 ±1.80	1.46 ±2.63	1.01 ±1.80	-1.51 ±2.24
GUM	3.69 ±1.35	4.14 ±2.35	3.69 ±1.35	1.17 ±1.90
HMI	-2.39 ±4.35	-1.94 ±4.75	-2.39 ±4.35	-4.91 ±4.55
IMBiH	1.97 ±2.77	2.42 ±3.37	1.97 ±2.77	-0.55 ±3.07
INM	-0.85 ±2.44	-0.41 ±3.11	-0.85 ±2.44	-3.37 ±2.78
INRiM	*CCT-K9*	0.45 ±1.92	*CCT-K9*	-2.52 ±1.33
IPQ	2.48 ±2.22	2.93 ±2.93	2.48 ±2.22	-0.04 ±2.59
JV	1.19 ±1.19	1.64 ±2.26	1.19 ±1.19	-1.33 ±1.79
LNE-Cnam	*CCT-K9*	0.45 ±1.92	*CCT-K9*	-2.52 ±1.33
MIKES VTT	1.45 ±2.11	1.90 ±2.85	1.45 ±2.11	-1.07 ±2.49
MIRS/ UL-FE/ LMK	-0.35 ±0.89	0.10 ±2.12	-0.35 ±0.89	-2.87 ±1.60
NPL		0.45 ±1.92	*CCT-K9*	-2.52 ±1.33
NSAI-NML	2.08		-0.45 ±1.92	-2.97 ±2.34
PTB	*CCT-K9*	2.08		-2.52 ±1.33
RISE	3.62	4.89	3.62	
ROTH+CO. AG	1.75	2.93	1.75	3.82
SMD	6.88	7.81	6.88	4.60
SMU	4.87	6.12	4.87	2.79
UME	2.81	3.97	2.81	2.87
VSL	*CCT-K9*	2.08	*CCT-K9*	3.62

Table 5.1 DoE at the Zinc fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	-1.20 ±2.27	-5.35 ±3.26	-4.52 ±2.13	-2.22 ±2.34
BFKH	3.33 ±1.93	-0.82 ±3.02	0.01 ±1.76	2.32 ±2.00
BIM	-0.99 ±3.64	-5.14 ±4.32	-4.31 ±3.56	-2.01 ±3.68
BoM	3.45 ±2.34	-0.70 ±3.30	0.13 ±2.21	2.43 ±2.40
CEM	1.02 ±1.87	-3.13 ±2.99	-2.30 ±1.70	0.00 ±1.95
CMI	0.45 ±2.13	-3.70 ±3.16	-2.87 ±1.98	-0.57 ±2.20
DMDM	-0.30 ±2.34	-4.45 ±3.30	-3.62 ±2.20	-1.32 ±2.40
DTI	0.32 ±2.10	-3.83 ±3.14	-3.00 ±1.95	-0.69 ±2.17
EIM	-1.88 ±2.32	-6.03 ±3.29	-5.20 ±2.18	-2.89 ±2.38
FTMC	0.61 ±2.40	-3.54 ±3.35	-2.71 ±2.27	-0.41 ±2.47
GUM	3.28 ±2.09	-0.87 ±3.13	-0.04 ±1.94	2.27 ±2.16
HMI	-2.79 ±4.63	-6.94 ±5.18	-6.11 ±4.56	-3.81 ±4.66
IMBiH	1.57 ±3.20	-2.58 ±3.95	-1.75 ±3.10	0.55 ±3.24
INM	-1.26 ±2.92	-5.41 ±3.73	-4.58 ±2.81	-2.28 ±2.97
INRiM	-0.41 ±1.59	-4.55 ±2.82	-3.72 ±1.39	-1.42 ±1.69
IPQ	2.07 ±2.73	-2.08 ±3.59	-1.25 ±2.62	1.06 ±2.78
JV	0.78 ±1.99	-3.36 ±3.06	-2.53 ±1.83	-0.23 ±2.06
LNE-Cnam	-0.41 ±1.59	-4.55 ±2.82	-3.72 ±1.39	-1.42 ±1.69
MIKES VTT	1.04 ±2.64	-3.11 ±3.52	-2.28 ±2.52	0.02 ±2.70
MIRS/ UL-FE/ LMK	-0.75 ±1.83	-4.90 ±2.96	-4.07 ±1.65	-1.77 ±1.91
NPL	-0.41 ±1.59	-4.55 ±2.82	-3.72 ±1.39	-1.42 ±1.69
NSAI-NML	-0.85 ±2.50	-5.00 ±3.41	-4.17 ±2.37	-1.87 ±2.56
PTB	-0.41 ±1.59	-4.55 ±2.82	-3.72 ±1.39	-1.42 ±1.69
RISE	2.11 ±2.08	-2.03 ±3.12	-1.20 ±1.92	1.10 ±2.15
ROTH+CO. AG		-4.15 ±3.24	-3.32 ±2.11	-1.02 ±2.32
SMD	6.81		0.83 ±3.15	3.13 ±3.29
SMU	5.06	3.48		2.30 ±2.18
UME	2.93	5.84	4.10	
VSL	1.75	6.88	4.87	2.81

Table 5.1 DoE at the Zinc fixed point (part 7)

	VSL
BEV	-0.80 ±1.62
BFKH	3.74 ±1.08
BIM	-0.59 ±3.27
BoM	3.86 ±1.71
CEM	1.43 ±0.98
CMI	0.85 ±1.41
DMDM	0.11 ±1.71
DTI	0.73 ±1.37
EIM	-1.47 ±1.69
FTMC	1.01 ±1.80
GUM	3.69 ±1.35
HMI	-2.39 ±4.35
IMBiH	1.97 ±2.77
INM	-0.85 ±2.44
INRiM	*CCT-K9*
IPQ	2.48 ±2.22
JV	1.19 ±1.19
LNE-Cnam	*CCT-K9*
MIKES VTT	1.45 ±2.11
MIRS/ UL-FE/ LMK	-0.35 ±0.89
NPL	*CCT-K9*
NSAI-NML	-0.45 ±1.92
PTB	*CCT-K9*
RISE	2.52 ±1.33
ROTH+CO. AG	0.41 ±1.59
SMD	4.55 ±2.82
SMU	3.72 ±1.39
UME	1.42 ±1.69
VSL	

Table 5.1 DoE at the Zinc fixed point (part 8)

5.2 DoE table at the Tin fixed point

	BEV	BFKH	BIM	BoM
BEV		-1.38 ±2.26	-0.92 ±2.14	-0.48 ±2.03
BFKH	3.23		0.45 ±1.76	0.90 ±1.62
BIM	2.69	1.94		0.45 ±1.46
BoM	2.20	2.24	1.67	
CEM	2.84	1.68	1.52	1.77
CMI	2.16	2.82	2.25	1.71
DMDM	2.47	2.26	1.74	1.53
DTI	1.97	2.91	2.30	1.69
EIM	2.15	2.87	2.30	1.75
FTMC	2.14	2.94	2.37	1.81
GUM	1.96	2.23	1.62	1.06
HMI	2.54	3.42	2.87	2.36
IMBiH	2.71	3.78	3.22	2.67
INM	2.72	3.37	2.85	2.39
INRiM	1.78	2.43	1.81	1.18
IPQ	3.11	1.92	1.86	2.13
JV	2.03	2.21	1.61	1.10
LNE-Cnam	1.78	2.43	1.81	1.18
MIKES VTT	2.55	2.85	2.33	1.94
MIRS/ UL-FE/ LMK	1.95	2.86	2.26	1.66
NPL	1.78	2.43	1.81	1.18
NSAI-NML	2.52	3.55	2.99	2.45
PTB	1.78	2.43	1.81	1.18
RISE	1.92	2.61	2.01	1.42
ROTH+CO. AG	2.15	2.98	2.41	1.85
SMD	2.38	2.40	1.86	1.54
SMU	2.06	2.97	2.38	1.81
UME	2.09	2.51	1.93	1.40
VSL	1.78	2.43	1.81	1.18

Table 5.2 DoE at the Tin fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	-1.15 ±2.05	-0.07 ±2.20	-0.63 ±2.19	0.37 ±1.87
BFKH	0.22 ±1.65	1.30 ±1.84	0.75 ±1.83	1.74 ±1.42
BIM	-0.23 ±1.49	0.85 ±1.69	0.30 ±1.68	1.29 ±1.23
BoM	-0.67 ±1.32	0.41 ±1.55	-0.15 ±1.54	0.84 ±1.02
CEM		1.08 ±1.58	0.52 ±1.57	1.52 ±1.07
CMI	2.38		-0.56 ±1.76	0.44 ±1.34
DMDM	1.83	2.03		0.99 ±1.32
DTI	2.40	1.56	2.08	
EIM	2.43	1.72	2.07	1.46
FTMC	2.50	1.73	2.14	1.39
GUM	1.71	1.42	1.43	1.27
HMI	3.03	2.22	2.64	1.89
IMBiH	3.37	2.44	2.98	1.72
INM	3.00	2.41	2.63	2.27
INRiM	1.89	1.23	1.60	0.80
IPQ	1.67	2.70	2.15	2.80
JV	1.71	1.51	1.44	1.41
LNE-Cnam	1.89	1.23	1.60	0.80
MIKES VTT	2.46	2.16	2.16	2.20
MIRS/ UL-FE/ LMK	2.36	1.53	2.03	0.80
NPL	1.89	1.23	1.60	0.80
NSAI-NML	3.14	2.23	2.75	1.60
PTB	1.89	1.23	1.60	0.80
RISE	2.11	1.42	1.79	1.10
ROTH+CO. AG	2.54	1.75	2.18	1.38
SMD	1.97	1.94	1.75	1.98
SMU	2.50	1.67	2.15	1.10
UME	2.05	1.61	1.73	1.54
VSL	1.89	1.23	1.60	0.80

Table 5.2 DoE at the Tin fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	0.00 ±2.18	0.08 ±2.18	-0.34 ±1.88	0.17 ±2.58
BFKH	1.38 ±1.81	1.46 ±1.81	1.04 ±1.44	1.54 ±2.28
BIM	0.92 ±1.67	1.00 ±1.66	0.59 ±1.25	1.09 ±2.16
BoM	0.48 ±1.52	0.56 ±1.51	0.14 ±1.05	0.65 ±2.05
CEM	1.15 ±1.55	1.23 ±1.54	0.82 ±1.09	1.32 ±2.07
CMI	0.07 ±1.75	0.15 ±1.74	-0.26 ±1.36	0.24 ±2.22
DMDM	0.63 ±1.73	0.71 ±1.73	0.29 ±1.34	0.80 ±2.21
DTI	-0.37 ±1.30	-0.29 ±1.29	-0.70 ±0.69	-0.20 ±1.89
EIM		0.08 ±1.71	-0.33 ±1.32	0.17 ±2.20
FTMC	1.68		-0.42 ±1.31	0.09 ±2.20
GUM	1.45	1.51		0.50 ±1.91
HMI	2.17	2.16	2.11	
IMBiH	2.35	2.27	2.39	2.58
INM	2.38	2.38	2.18	2.76
INRiM	1.19	1.21	0.71	1.84
IPQ	2.75	2.83	2.12	3.29
JV	1.54	1.61	0.81	2.19
LNE-Cnam	1.19	1.21	0.71	1.84
MIKES VTT	2.18	2.23	1.79	2.67
MIRS/ UL-FE/ LMK	1.44	1.38	1.27	1.91
NPL	1.19	1.21	0.71	1.84
NSAI-NML	2.15	2.08	2.17	2.43
PTB	1.19	1.21	0.71	1.84
RISE	1.39	1.39	1.05	1.96
ROTH+CO. AG	1.70	1.69	1.55	2.17
SMD	1.98	2.04	1.38	2.54
SMU	1.59	1.55	1.47	2.05
UME	1.63	1.68	1.12	2.21
VSL	1.19	1.21	0.71	1.84

Table 5.2 DoE at the Tin fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV	0.73 ±2.37	-0.06 ±2.77	-0.05 ±1.81	-1.22 ±2.29
BFKH	2.11 ±2.03	1.32 ±2.49	1.33 ±1.35	0.15 ±1.94
BIM	1.66 ±1.90	0.86 ±2.39	0.87 ±1.14	-0.30 ±1.81
BoM	1.21 ±1.77	0.42 ±2.29	0.43 ±0.91	-0.74 ±1.67
CEM	1.89 ±1.80	1.09 ±2.31	1.10 ±0.96	-0.07 ±1.70
CMI	0.81 ±1.97	0.01 ±2.45	0.02 ±1.26	-1.15 ±1.88
DMDM	1.36 ±1.96	0.57 ±2.44	0.58 ±1.24	-0.59 ±1.87
DTI	0.37 ±1.59	-0.43 ±2.15	-0.42 ±0.46	-1.59 ±1.48
EIM	0.73 ±1.95	-0.06 ±2.43	-0.05 ±1.22	-1.22 ±1.86
FTMC	0.65 ±1.94	-0.14 ±2.42	-0.13 ±1.21	-1.30 ±1.85
GUM	1.07 ±1.61	0.27 ±2.16	0.29 ±0.51	-0.89 ±1.49
HMI	0.57 ±2.38	-0.23 ±2.79	-0.22 ±1.84	-1.39 ±2.31
IMBiH		-0.79 ±2.59	-0.78 ±1.52	-1.95 ±2.07
INM	2.96		0.01 ±2.10	-1.16 ±2.53
INRiM	2.04	2.07		-1.17 ±1.40
IPQ	3.66	3.25	2.33	
JV	2.48	2.24	0.87	2.10
LNE-Cnam	2.04	2.07	*CCT-K9*	2.33
MIKES VTT	2.99	2.72	1.80	2.73
MIRS/ UL-FE/ LMK	1.86	2.24	0.84	2.75
NPL	2.04	2.07	*CCT-K9*	2.33
NSAI-NML	2.18	2.77	1.83	3.43
PTB	2.04	2.07	*CCT-K9*	2.33
RISE	2.15	2.18	0.71	2.49
ROTH+CO. AG	2.25	2.40	1.24	2.86
SMD	2.87	2.56	1.51	2.29
SMU	2.03	2.33	1.10	2.85
UME	2.49	2.31	1.07	2.39
VSL	2.04	2.07	*CCT-K9*	2.33

Table 5.2 DoE at the Tin fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	-0.39 ±1.92	-0.05 ±1.81	-0.34 ±2.51	0.26 ±1.92
BFKH	0.99 ±1.49	1.33 ±1.35	1.03 ±2.20	1.64 ±1.49
BIM	0.53 ±1.30	0.87 ±1.14	0.58 ±2.08	1.19 ±1.31
BoM	0.09 ±1.11	0.43 ±0.91	0.14 ±1.96	0.74 ±1.11
CEM	0.76 ±1.15	1.10 ±0.96	0.81 ±1.99	1.41 ±1.15
CMI	-0.32 ±1.41	0.02 ±1.26	-0.27 ±2.15	0.33 ±1.41
DMDM	0.24 ±1.39	0.58 ±1.24	0.28 ±2.13	0.89 ±1.39
DTI	-0.76 ±0.79	-0.42 ±0.46	-0.71 ±1.80	-0.10 ±0.79
EIM	-0.39 ±1.37	-0.05 ±1.22	-0.34 ±2.12	0.26 ±1.37
FTMC	-0.47 ±1.37	-0.13 ±1.21	-0.42 ±2.12	0.18 ±1.37
GUM	-0.06 ±0.82	0.29 ±0.51	-0.01 ±1.81	0.60 ±0.82
HMI	-0.56 ±1.94	-0.22 ±1.84	-0.51 ±2.53	0.09 ±1.94
IMBiH	-1.12 ±1.65	-0.78 ±1.52	-1.08 ±2.31	-0.47 ±1.65
INM	-0.33 ±2.20	0.01 ±2.10	-0.28 ±2.73	0.32 ±2.20
INRiM	-0.34 ±0.64	*CCT-K9*	-0.29 ±1.74	0.31 ±0.64
IPQ	0.83 ±1.54	1.17 ±1.40	0.88 ±2.24	1.48 ±1.54
JV		0.34 ±0.64	0.05 ±1.85	0.65 ±0.90
LNE-Cnam	0.87		-0.29 ±1.74	0.31 ±0.64
MIKES VTT	1.82	1.80		0.60 ±1.85
MIRS/ UL-FE/ LMK	1.40	0.84	2.15	
NPL	0.87	*CCT-K9*	1.80	0.84
NSAI-NML	2.26	1.83	2.77	1.70
PTB	0.87	*CCT-K9*	1.80	0.84
RISE	1.17	0.71	1.95	1.10
ROTH+CO. AG	1.65	1.24	2.27	1.38
SMD	1.41	1.51	2.13	1.94
SMU	1.58	1.10	2.24	1.15
UME	1.20	1.07	1.98	1.50
VSL	0.87	*CCT-K9*	1.80	0.84

Table 5.2 DoE at the Tin fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	-0.05 ±1.81	0.48 ±2.39	-0.05 ±1.81	-0.03 ±1.95
BFKH	1.33 ±1.35	1.86 ±2.06	1.33 ±1.35	1.35 ±1.53
BIM	0.87 ±1.14	1.40 ±1.93	0.87 ±1.14	0.90 ±1.35
BoM	0.43 ±0.91	0.96 ±1.80	0.43 ±0.91	0.45 ±1.16
CEM	1.10 ±0.96	1.63 ±1.83	1.10 ±0.96	1.12 ±1.20
CMI	0.02 ±1.26	0.55 ±2.00	0.02 ±1.26	0.05 ±1.45
DMDM	0.58 ±1.24	1.11 ±1.99	0.58 ±1.24	0.60 ±1.43
DTI	-0.42 ±0.46	0.11 ±1.62	-0.42 ±0.46	-0.39 ±0.86
EIM	-0.05 ±1.22	0.48 ±1.97	-0.05 ±1.22	-0.03 ±1.42
FTMC	-0.13 ±1.21	0.40 ±1.97	-0.13 ±1.21	-0.11 ±1.41
GUM	0.29 ±0.51	0.82 ±1.64	0.29 ±0.51	0.31 ±0.89
HMI	-0.22 ±1.84	0.31 ±2.41	-0.22 ±1.84	-0.19 ±1.97
IMBiH	-0.78 ±1.52	-0.25 ±2.18	-0.78 ±1.52	-0.76 ±1.69
INM	0.01 ±2.10	0.54 ±2.61	0.01 ±2.10	0.03 ±2.22
INRiM	*CCT-K9*	0.53 ±1.55	*CCT-K9*	0.02 ±0.72
IPQ	1.17 ±1.40	1.70 ±2.09	1.17 ±1.40	1.19 ±1.58
JV	0.34 ±0.64	0.87 ±1.68	0.34 ±0.64	0.36 ±0.96
LNE-Cnam	*CCT-K9*	0.53 ±1.55	*CCT-K9*	0.02 ±0.72
MIKES VTT	0.29 ±1.74	0.82 ±2.33	0.29 ±1.74	0.32 ±1.89
MIRS/ UL-FE/ LMK	-0.31 ±0.64	0.22 ±1.68	-0.31 ±0.64	-0.29 ±0.97
NPL		0.53 ±1.55	*CCT-K9*	0.02 ±0.72
NSAI-NML	1.83		-0.53 ±1.55	-0.51 ±1.71
PTB	*CCT-K9*	1.83		0.02 ±0.72
RISE	0.71	1.94	0.71	
ROTH+CO. AG	1.24	2.07	1.24	1.41
SMD	1.51	2.64	1.51	1.70
SMU	1.10	1.87	1.10	1.29
UME	1.07	2.27	1.07	1.30
VSL	*CCT-K9*	1.83	*CCT-K9*	0.71

Table 5.2 DoE at the Tin fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	0.11 ±2.19	-0.50 ±2.21	0.22 ±2.06	-0.25 ±2.07
BFKH	1.49 ±1.82	0.87 ±1.85	1.60 ±1.67	1.12 ±1.68
BIM	1.03 ±1.67	0.42 ±1.71	1.14 ±1.50	0.67 ±1.52
BoM	0.59 ±1.53	-0.02 ±1.56	0.70 ±1.34	0.23 ±1.36
CEM	1.26 ±1.56	0.65 ±1.59	1.37 ±1.38	0.90 ±1.40
CMI	0.18 ±1.75	-0.43 ±1.79	0.29 ±1.60	-0.18 ±1.61
DMDM	0.74 ±1.74	0.13 ±1.77	0.85 ±1.58	0.37 ±1.60
DTI	-0.26 ±1.31	-0.87 ±1.35	-0.15 ±1.09	-0.62 ±1.11
EIM	0.11 ±1.73	-0.50 ±1.76	0.22 ±1.57	-0.25 ±1.58
FTMC	0.03 ±1.72	-0.58 ±1.75	0.14 ±1.56	-0.33 ±1.57
GUM	0.45 ±1.33	-0.17 ±1.37	0.56 ±1.11	0.08 ±1.13
HMI	-0.06 ±2.21	-0.67 ±2.23	0.05 ±2.08	-0.42 ±2.10
IMBiH	-0.62 ±1.95	-1.24 ±1.98	-0.51 ±1.81	-0.99 ±1.83
INM	0.17 ±2.43	-0.44 ±2.46	0.28 ±2.32	-0.19 ±2.33
INRiM	0.16 ±1.22	-0.45 ±1.27	0.27 ±0.98	-0.20 ±1.01
IPQ	1.33 ±1.86	0.72 ±1.89	1.44 ±1.71	0.97 ±1.73
JV	0.50 ±1.38	-0.11 ±1.42	0.61 ±1.17	0.14 ±1.20
LNE-Cnam	0.16 ±1.22	-0.45 ±1.27	0.27 ±0.98	-0.20 ±1.01
MIKES VTT	0.45 ±2.13	-0.16 ±2.16	0.56 ±2.00	0.09 ±2.01
MIRS/ UL-FE/ LMK	-0.15 ±1.38	-0.76 ±1.42	-0.04 ±1.17	-0.51 ±1.20
NPL	0.16 ±1.22	-0.45 ±1.27	0.27 ±0.98	-0.20 ±1.01
NSAI-NML	-0.37 ±1.98	-0.98 ±2.01	-0.26 ±1.84	-0.73 ±1.85
PTB	0.16 ±1.22	-0.45 ±1.27	0.27 ±0.98	-0.20 ±1.01
RISE	0.14 ±1.42	-0.47 ±1.46	0.25 ±1.22	-0.23 ±1.24
ROTH+CO. AG		-0.61 ±1.76	0.11 ±1.57	-0.36 ±1.59
SMD	2.08		0.72 ±1.61	0.25 ±1.62
SMU	1.55	2.05		-0.47 ±1.41
UME	1.71	1.66	1.65	
VSL	1.24	1.51	1.10	1.07

Table 5.2 DoE at the Tin fixed point (part 7)

	VSL
BEV	-0.05 ±1.81
BFKH	1.33 ±1.35
BIM	0.87 ±1.14
BoM	0.43 ±0.91
CEM	1.10 ±0.96
CMI	0.02 ±1.26
DMDM	0.58 ±1.24
DTI	-0.42 ±0.46
EIM	-0.05 ±1.22
FTMC	-0.13 ±1.21
GUM	0.29 ±0.51
HMI	-0.22 ±1.84
IMBiH	-0.78 ±1.52
INM	0.01 ±2.10
INRiM	*CCT-K9*
IPQ	1.17 ±1.40
JV	0.34 ±0.64
LNE-Cnam	*CCT-K9*
MIKES VTT	0.29 ±1.74
MIRS/ UL-FE/ LMK	-0.31 ±0.64
NPL	*CCT-K9*
NSAI-NML	-0.53 ±1.55
PTB	*CCT-K9*
RISE	-0.02 ±0.72
ROTH+CO. AG	-0.16 ±1.22
SMD	0.45 ±1.27
SMU	-0.27 ±0.98
UME	0.20 ±1.01
VSL	

Table 5.2 DoE at the Tin fixed point (part 8)

5.3 DoE table at the Indium fixed point

	BEV	BFKH	BIM	BoM
BEV		-0.49 ±1.97	-0.35 ±1.80	
BFKH	2.15		0.14 ±1.45	
BIM	1.89	1.44		
BoM				
CEM	1.80	1.43	1.13	
CMI	1.81	1.89	1.56	
DMDM	2.36	2.11	1.92	
DTI	1.97	2.12	1.81	
EIM	2.35	1.98	1.82	
FTMC				
GUM	1.87	1.44	1.18	
HMI				
IMBiH				
INM	2.35	2.36	2.12	
INRiM	1.60	1.66	1.27	
IPQ	3.07	2.40	2.39	
JV	1.71	1.81	1.44	
LNE-Cnam	1.60	1.66	1.27	
MIKES VTT				
MIRS/ UL-FE/ LMK	1.66	1.70	1.34	
NPL	1.60	1.66	1.27	
NSAI-NML	3.42	3.71	3.46	
PTB	1.60	1.66	1.27	
RISE	1.81	1.95	1.59	
ROTH+CO. AG	2.33	2.09	1.89	
SMD	1.82	1.84	1.52	
SMU	1.98	1.46	1.24	
UME	2.05	2.22	1.92	
VSL	1.60	1.66	1.27	

Table 5.3 DoE at the Indium fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	-0.27 ±1.75	0.19 ±1.81	-0.25 ±2.36	0.33 ±1.90
BFKH	0.21 ±1.39	0.67 ±1.47	0.24 ±2.11	0.82 ±1.58
BIM	0.08 ±1.14	0.54 ±1.24	0.10 ±1.96	0.68 ±1.36
BoM				
CEM		0.46 ±1.17	0.02 ±1.91	0.61 ±1.30
CMI	1.43		-0.44 ±1.97	0.15 ±1.38
DMDM	1.88	2.11		0.58 ±2.05
DTI	1.68	1.38	2.30	
EIM	1.77	2.12	2.36	2.33
FTMC				
GUM	1.11	1.53	1.91	1.78
HMI				
IMBiH				
INM	2.02	1.97	2.53	2.10
INRiM	1.10	0.87	1.94	1.06
IPQ	2.43	2.93	2.93	3.14
JV	1.29	1.00	2.06	1.14
LNE-Cnam	1.10	0.87	1.94	1.06
MIKES VTT				
MIRS/ UL-FE/ LMK	1.19	1.04	1.96	1.24
NPL	1.10	0.87	1.94	1.06
NSAI-NML	3.35	2.94	3.76	2.86
PTB	1.10	0.87	1.94	1.06
RISE	1.44	1.11	2.18	1.17
ROTH+CO. AG	1.85	2.07	2.42	2.26
SMD	1.39	1.29	2.08	1.47
SMU	1.21	1.68	1.97	1.92
UME	1.79	1.46	2.39	1.51
VSL	1.10	0.87	1.94	1.06

Table 5.3 DoE at the Indium fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	-0.38 ±2.27		-0.33 ±1.79	
BFKH	0.11 ±2.01		0.16 ±1.44	
BIM	-0.03 ±1.85		0.02 ±1.20	
BoM				
CEM	-0.10 ±1.80		-0.06 ±1.13	
CMI	-0.57 ±1.86		-0.52 ±1.22	
DMDM	-0.13 ±2.40		-0.08 ±1.95	
DTI	-0.71 ±1.95		-0.66 ±1.35	
EIM			0.05 ±1.84	
FTMC				
GUM	1.81			
HMI				
IMBiH				
INM	2.54		2.10	
INRiM	1.95		1.23	
IPQ	2.75		2.40	
JV	2.07		1.41	
LNE-Cnam	1.95		1.23	
MIKES VTT				
MIRS/ UL-FE/ LMK	1.96		1.31	
NPL	1.95		1.23	
NSAI-NML	3.83		3.44	
PTB	1.95		1.23	
RISE	2.20		1.56	
ROTH+CO. AG	2.34		1.88	
SMD	2.08		1.49	
SMU	1.84		1.24	
UME	2.42		1.89	
VSL	1.95		1.23	

Table 5.3 DoE at the Indium fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV		0.07 ±2.39	0.21 ±1.58	-1.09 ±2.39
BFKH		0.56 ±2.14	0.69 ±1.17	-0.60 ±2.15
BIM		0.42 ±1.99	0.56 ±0.86	-0.74 ±1.99
BoM				
CEM		0.35 ±1.94	0.48 ±0.75	-0.81 ±1.95
CMI		-0.11 ±2.00	0.02 ±0.89	-1.28 ±2.01
DMDM		0.32 ±2.51	0.46 ±1.76	-0.84 ±2.51
DTI		-0.26 ±2.08	-0.13 ±1.06	-1.42 ±2.09
EIM		0.45 ±2.43	0.59 ±1.63	-0.71 ±2.43
FTMC				
GUM		0.40 ±1.98	0.54 ±0.84	-0.76 ±1.99
HMI				
IMBiH				
INM			0.13 ±1.79	-1.16 ±2.54
INRiM		1.77		-1.30 ±1.80
IPQ		3.26	2.78	
JV		1.86	0.49	2.90
LNE-Cnam		1.77	*CCT-K9*	2.78
MIKES VTT				
MIRS/ UL-FE/ LMK		1.85	0.59	2.78
NPL		1.77	*CCT-K9*	2.78
NSAI-NML		3.47	2.76	4.62
PTB		1.77	*CCT-K9*	2.78
RISE		1.94	0.65	3.03
ROTH+CO. AG		2.50	1.89	2.93
SMD		2.00	0.96	2.87
SMU		2.21	1.40	2.34
UME		2.17	1.16	3.23
VSL		1.77	*CCT-K9*	2.78

Table 5.3 DoE at the Indium fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	0.28 ±1.65	0.21 ±1.58		0.13 ±1.68
BFKH	0.76 ±1.27	0.69 ±1.17		0.62 ±1.31
BIM	0.63 ±0.99	0.56 ±0.86		0.48 ±1.04
BoM				
CEM	0.55 ±0.90	0.48 ±0.75		0.41 ±0.95
CMI	0.09 ±1.01	0.02 ±0.89		-0.06 ±1.06
DMDM	0.53 ±1.82	0.46 ±1.76		0.38 ±1.85
DTI	-0.06 ±1.16	-0.13 ±1.06		-0.20 ±1.20
EIM	0.66 ±1.70	0.59 ±1.63		0.51 ±1.73
FTMC				
GUM	0.61 ±0.97	0.54 ±0.84		0.46 ±1.02
HMI				
IMBiH				
INM	0.20 ±1.86	0.13 ±1.79		0.06 ±1.88
INRiM	0.07 ±0.48	*CCT-K9*		-0.08 ±0.58
IPQ	1.37 ±1.86	1.30 ±1.80		1.22 ±1.89
JV		-0.07 ±0.48		-0.15 ±0.76
LNE-Cnam	0.49			-0.08 ±0.58
MIKES VTT				
MIRS/ UL-FE/ LMK	0.79	0.59		
NPL	0.49	*CCT-K9*		0.59
NSAI-NML	2.74	2.76		2.90
PTB	0.49	*CCT-K9*		0.59
RISE	0.76	0.65		0.94
ROTH+CO. AG	2.01	1.89		1.92
SMD	1.11	0.96		1.10
SMU	1.57	1.40		1.47
UME	1.22	1.16		1.34
VSL	0.49	*CCT-K9*		0.59

Table 5.3 DoE at the Indium fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	0.21 ±1.58	1.33 ±2.53	0.21 ±1.58	0.40 ±1.68
BFKH	0.69 ±1.17	1.82 ±2.30	0.69 ±1.17	0.88 ±1.30
BIM	0.56 ±0.86	1.68 ±2.16	0.56 ±0.86	0.75 ±1.03
BoM				
CEM	0.48 ±0.75	1.61 ±2.12	0.48 ±0.75	0.67 ±0.94
CMI	0.02 ±0.89	1.15 ±2.17	0.02 ±0.89	0.21 ±1.05
DMDM	0.46 ±1.76	1.58 ±2.65	0.46 ±1.76	0.65 ±1.84
DTI	-0.13 ±1.06	1.00 ±2.24	-0.13 ±1.06	0.06 ±1.19
EIM	0.59 ±1.63	1.71 ±2.57	0.59 ±1.63	0.77 ±1.73
FTMC				
GUM	0.54 ±0.84	1.67 ±2.15	0.54 ±0.84	0.73 ±1.01
HMI				
IMBiH				
INM	0.13 ±1.79	1.26 ±2.67	0.13 ±1.79	0.32 ±1.88
INRiM	*CCT-K9*	1.13 ±1.98	*CCT-K9*	0.19 ±0.56
IPQ	1.30 ±1.80	2.42 ±2.67	1.30 ±1.80	1.48 ±1.88
JV	-0.07 ±0.48	1.06 ±2.04	-0.07 ±0.48	0.12 ±0.74
LNE-Cnam	*CCT-K9*	1.13 ±1.98	*CCT-K9*	0.19 ±0.56
MIKES VTT				
MIRS/ UL-FE/ LMK	0.08 ±0.58	1.20 ±2.06	0.08 ±0.58	0.26 ±0.81
NPL		1.13 ±1.98	*CCT-K9*	0.19 ±0.56
NSAI-NML	2.76		-1.13 ±1.98	-0.94 ±2.06
PTB	*CCT-K9*	2.76		0.19 ±0.56
RISE	0.65	2.64	0.65	
ROTH+CO. AG	1.89	3.73	1.89	2.14
SMD	0.96	3.05	0.96	1.23
SMU	1.40	3.57	1.40	1.72
UME	1.16	2.82	1.16	1.24
VSL	*CCT-K9*	2.76	*CCT-K9*	0.65

Table 5.3 DoE at the Indium fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	-0.23 ±2.34	0.10 ±1.85	-0.43 ±1.83	0.40 ±1.94
BFKH	0.25 ±2.08	0.59 ±1.51	0.05 ±1.49	0.88 ±1.62
BIM	0.12 ±1.93	0.45 ±1.29	-0.08 ±1.26	0.75 ±1.42
BoM				
CEM	0.04 ±1.88	0.37 ±1.22	-0.16 ±1.19	0.67 ±1.35
CMI	-0.42 ±1.94	-0.09 ±1.31	-0.62 ±1.28	0.21 ±1.43
DMDM	0.02 ±2.46	0.35 ±2.00	-0.18 ±1.99	0.65 ±2.09
DTI	-0.57 ±2.02	-0.23 ±1.43	-0.77 ±1.40	0.06 ±1.54
EIM	0.15 ±2.37	0.48 ±1.89	-0.06 ±1.88	0.78 ±1.98
FTMC				
GUM	0.10 ±1.92	0.43 ±1.28	-0.10 ±1.25	0.73 ±1.40
HMI				
IMBiH				
INM	-0.31 ±2.49	0.03 ±2.03	-0.51 ±2.02	0.32 ±2.12
INRiM	-0.44 ±1.72	-0.11 ±0.96	-0.64 ±0.92	0.19 ±1.12
IPQ	0.85 ±2.49	1.19 ±2.04	0.65 ±2.02	1.48 ±2.12
JV	-0.51 ±1.79	-0.18 ±1.07	-0.71 ±1.04	0.12 ±1.22
LNE-Cnam	-0.44 ±1.72	-0.11 ±0.96	-0.64 ±0.92	0.19 ±1.12
MIKES VTT				
MIRS/ UL-FE/ LMK	-0.36 ±1.82	-0.03 ±1.12	-0.57 ±1.09	0.27 ±1.27
NPL	-0.44 ±1.72	-0.11 ±0.96	-0.64 ±0.92	0.19 ±1.12
NSAI-NML	-1.57 ±2.62	-1.23 ±2.20	-1.77 ±2.18	-0.94 ±2.28
PTB	-0.44 ±1.72	-0.11 ±0.96	-0.64 ±0.92	0.19 ±1.12
RISE	-0.63 ±1.81	-0.30 ±1.11	-0.83 ±1.08	0.00 ±1.25
ROTH+CO. AG		0.33 ±1.97	-0.20 ±1.95	0.63 ±2.06
SMD	2.04		-0.53 ±1.33	0.30 ±1.48
SMU	1.95	1.64		0.83 ±1.46
UME	2.35	1.56	2.03	
VSL	1.89	0.96	1.40	1.16

Table 5.3 DoE at the Indium fixed point (part 7)

	VSL
BEV	0.21 ±1.58
BFKH	0.69 ±1.17
BIM	0.56 ±0.86
BoM	
CEM	0.48 ±0.75
CMI	0.02 ±0.89
DMDM	0.46 ±1.76
DTI	-0.13 ±1.06
EIM	0.59 ±1.63
FTMC	
GUM	0.54 ±0.84
HMI	
IMBiH	
INM	0.13 ±1.79
INRiM	*CCT-K9*
IPQ	1.30 ±1.80
JV	-0.07 ±0.48
LNE-Cnam	*CCT-K9*
MIKES VTT	
MIRS/ UL-FE/ LMK	0.08 ±0.58
NPL	*CCT-K9*
NSAI-NML	-1.13 ±1.98
PTB	*CCT-K9*
RISE	-0.19 ±0.56
ROTH+CO. AG	0.44 ±1.72
SMD	0.11 ±0.96
SMU	0.64 ±0.92
UME	-0.19 ±1.12
VSL	

Table 5.3 DoE at the Indium fixed point (part 8)

5.4 DoE table at the Gallium fixed point

	BEV	BFKH	BIM	BoM
BEV		-0.06 ±0.81	-1.52 ±0.82	-0.28 ±0.96
BFKH	0.80		-1.46 ±0.60	-0.22 ±0.78
BIM	2.19	1.95		1.24 ±0.79
BoM	1.08	0.88	1.89	
CEM	0.84	0.68	2.13	1.03
CMI	1.03	0.91	2.37	1.28
DMDM	0.97	0.76	1.96	0.90
DTI	1.00	0.88	2.34	1.25
EIM	0.95	0.83	2.29	1.19
FTMC	1.99	1.90	3.37	2.25
GUM	1.00	0.88	2.35	1.25
HMI	1.48	1.41	2.87	1.74
IMBiH	1.18	1.09	2.55	1.43
INM	0.85	0.63	1.96	0.88
INRiM	0.74	0.55	2.02	0.97
IPQ	1.33	1.24	2.71	1.59
JV	1.18	1.08	2.55	1.44
LNE-Cnam	0.74	0.55	2.02	0.97
MIKES VTT	1.53	1.45	2.91	1.78
MIRS/ UL-FE/ LMK	0.76	0.53	1.93	0.86
NPL	0.74	0.55	2.02	0.97
NSAI-NML	1.05	0.95	2.41	1.29
PTB	0.74	0.55	2.02	0.97
RISE	1.15	1.03	2.50	1.40
ROTH+CO. AG	0.97	0.80	2.10	1.01
SMD	1.12	1.01	2.48	1.38
SMU	1.06	0.93	2.40	1.32
UME	1.05	0.92	2.39	1.30
VSL	0.74	0.55	2.02	0.97

Table 5.4 DoE at the Gallium fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	0.08 ±0.84	0.37 ±0.80	-0.18 ±0.93	0.33 ±0.81
BFKH	0.14 ±0.64	0.43 ±0.58	-0.12 ±0.74	0.39 ±0.59
BIM	1.59 ±0.65	1.88 ±0.59	1.34 ±0.75	1.85 ±0.60
BoM	0.36 ±0.82	0.64 ±0.77	0.10 ±0.90	0.61 ±0.78
CEM		0.29 ±0.63	-0.25 ±0.77	0.26 ±0.63
CMI	0.81		-0.54 ±0.73	-0.03 ±0.58
DMDM	0.90	1.15		0.51 ±0.74
DTI	0.78	0.57	1.12	
EIM	0.74	0.67	1.06	0.65
FTMC	1.79	1.47	2.12	1.51
GUM	0.79	0.63	1.12	0.62
HMI	1.30	1.00	1.61	1.03
IMBiH	0.98	0.74	1.30	0.75
INM	0.74	0.98	0.78	0.95
INRiM	0.48	0.56	0.82	0.53
IPQ	1.13	0.83	1.45	0.86
JV	0.98	0.69	1.30	0.72
LNE-Cnam	0.48	0.56	0.82	0.53
MIKES VTT	1.34	1.03	1.66	1.06
MIRS/ UL-FE/ LMK	0.62	0.84	0.74	0.82
NPL	0.48	0.56	0.82	0.53
NSAI-NML	0.85	0.75	1.16	0.74
PTB	0.48	0.56	0.82	0.53
RISE	0.93	0.63	1.27	0.66
ROTH+CO. AG	0.89	1.12	0.92	1.09
SMD	0.91	0.63	1.24	0.65
SMU	0.83	0.54	1.18	0.56
UME	0.82	0.56	1.16	0.57
VSL	0.48	0.56	0.82	0.53

Table 5.4 DoE at the Gallium fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	0.24 ±0.85	1.23 ±0.93	0.30 ±0.84	0.58 ±1.09
BFKH	0.30 ±0.64	1.28 ±0.75	0.36 ±0.64	0.64 ±0.94
BIM	1.76 ±0.65	2.74 ±0.76	1.82 ±0.65	2.10 ±0.95
BoM	0.52 ±0.82	1.50 ±0.91	0.58 ±0.82	0.86 ±1.07
CEM	0.16 ±0.68	1.15 ±0.78	0.22 ±0.68	0.50 ±0.97
CMI	-0.13 ±0.63	0.86 ±0.74	-0.07 ±0.63	0.21 ±0.93
DMDM	0.42 ±0.78	1.40 ±0.87	0.48 ±0.78	0.76 ±1.04
DTI	-0.10 ±0.64	0.89 ±0.75	-0.03 ±0.63	0.25 ±0.94
EIM		0.99 ±0.79	0.06 ±0.68	0.34 ±0.97
FTMC	1.64		-0.93 ±0.79	-0.65 ±1.04
GUM	0.68	1.57		0.28 ±0.97
HMI	1.15	1.51	1.09	
IMBiH	0.85	1.56	0.80	1.10
INM	0.90	1.96	0.95	1.47
INRiM	0.51	1.59	0.56	1.13
IPQ	0.98	1.45	0.93	1.06
JV	0.83	1.47	0.78	1.02
LNE-Cnam	0.51	1.59	0.56	1.13
MIKES VTT	1.18	1.36	1.12	1.12
MIRS/ UL-FE/ LMK	0.77	1.85	0.82	1.37
NPL	0.51	1.59	0.56	1.13
NSAI-NML	0.78	1.68	0.77	1.19
PTB	0.51	1.59	0.56	1.13
RISE	0.78	1.40	0.72	0.97
ROTH+CO. AG	1.03	2.08	1.08	1.56
SMD	0.77	1.46	0.71	1.00
SMU	0.69	1.40	0.63	0.95
UME	0.68	1.45	0.63	0.99
VSL	0.51	1.59	0.56	1.13

Table 5.4 DoE at the Gallium fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV	0.40 ±0.95	-0.09 ±0.85	0.14 ±0.70	0.53 ±0.97
BFKH	0.46 ±0.77	-0.03 ±0.64	0.20 ±0.42	0.59 ±0.80
BIM	1.91 ±0.78	1.43 ±0.65	1.66 ±0.44	2.05 ±0.80
BoM	0.67 ±0.92	0.19 ±0.82	0.42 ±0.66	0.81 ±0.95
CEM	0.32 ±0.80	-0.17 ±0.68	0.07 ±0.48	0.45 ±0.83
CMI	0.03 ±0.76	-0.46 ±0.63	-0.22 ±0.40	0.16 ±0.79
DMDM	0.57 ±0.89	0.09 ±0.78	0.32 ±0.61	0.71 ±0.91
DTI	0.06 ±0.76	-0.42 ±0.64	-0.19 ±0.41	0.20 ±0.79
EIM	0.16 ±0.81	-0.33 ±0.69	-0.10 ±0.49	0.29 ±0.83
FTMC	-0.83 ±0.89	-1.32 ±0.79	-1.08 ±0.62	-0.70 ±0.92
GUM	0.10 ±0.80	-0.39 ±0.68	-0.16 ±0.48	0.23 ±0.83
HMI	-0.18 ±1.06	-0.67 ±0.97	-0.44 ±0.84	-0.05 ±1.08
IMBiH		-0.49 ±0.80	-0.25 ±0.64	0.13 ±0.93
INM	1.15		0.23 ±0.49	0.62 ±0.83
INRiM	0.78	0.64		0.39 ±0.68
IPQ	0.95	1.30	0.94	
JV	0.84	1.15	0.77	0.87
LNE-Cnam	0.78	0.64	*CCT-K9*	0.94
MIKES VTT	1.12	1.51	1.16	1.04
MIRS/ UL-FE/ LMK	1.03	0.59	0.47	1.19
NPL	0.78	0.64	*CCT-K9*	0.94
NSAI-NML	0.91	1.01	0.66	1.03
PTB	0.78	0.64	*CCT-K9*	0.94
RISE	0.78	1.10	0.70	0.81
ROTH+CO. AG	1.26	0.83	0.81	1.41
SMD	0.80	1.08	0.68	0.85
SMU	0.72	1.01	0.57	0.78
UME	0.74	1.00	0.57	0.82
VSL	0.78	0.64	*CCT-K9*	0.94

Table 5.4 DoE at the Gallium fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	0.45 ±0.89	0.14 ±0.70	0.67 ±1.03	-0.04 ±0.78
BFKH	0.51 ±0.70	0.20 ±0.42	0.73 ±0.87	0.02 ±0.54
BIM	1.96 ±0.71	1.66 ±0.44	2.19 ±0.88	1.48 ±0.56
BoM	0.72 ±0.87	0.42 ±0.66	0.95 ±1.01	0.24 ±0.75
CEM	0.37 ±0.74	0.07 ±0.48	0.60 ±0.90	-0.12 ±0.59
CMI	0.08 ±0.69	-0.22 ±0.40	0.31 ±0.86	-0.40 ±0.53
DMDM	0.62 ±0.83	0.32 ±0.61	0.85 ±0.98	0.14 ±0.70
DTI	0.11 ±0.70	-0.19 ±0.41	0.34 ±0.87	-0.37 ±0.54
EIM	0.21 ±0.74	-0.10 ±0.49	0.44 ±0.91	-0.28 ±0.60
FTMC	-0.78 ±0.84	-1.08 ±0.62	-0.55 ±0.99	-1.26 ±0.71
GUM	0.15 ±0.74	-0.16 ±0.48	0.37 ±0.90	-0.34 ±0.59
HMI	-0.13 ±1.01	-0.44 ±0.84	0.09 ±1.14	-0.62 ±0.91
IMBiH	0.05 ±0.85	-0.25 ±0.64	0.28 ±1.00	-0.43 ±0.73
INM	0.54 ±0.74	0.23 ±0.49	0.77 ±0.91	0.05 ±0.60
INRiM	0.30 ±0.56	*CCT-K9*	0.53 ±0.76	-0.18 ±0.34
IPQ	-0.08 ±0.88	-0.39 ±0.68	0.14 ±1.02	-0.57 ±0.76
JV		-0.30 ±0.56	0.23 ±0.95	-0.48 ±0.66
LNE-Cnam	0.77		0.53 ±0.76	-0.18 ±0.34
MIKES VTT	1.03	1.16		-0.71 ±0.84
MIRS/ UL-FE/ LMK	1.03	0.47	1.40	
NPL	0.77	*CCT-K9*	1.16	0.47
NSAI-NML	0.89	0.66	1.22	0.89
PTB	0.77	*CCT-K9*	1.16	0.47
RISE	0.71	0.70	0.97	0.97
ROTH+CO. AG	1.27	0.81	1.61	0.76
SMD	0.73	0.68	1.02	0.95
SMU	0.65	0.57	0.96	0.87
UME	0.68	0.57	1.01	0.86
VSL	0.77	*CCT-K9*	1.16	0.47

Table 5.4 DoE at the Gallium fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	0.14 ±0.70	0.27 ±0.93	0.14 ±0.70	0.46 ±0.84
BFKH	0.20 ±0.42	0.33 ±0.75	0.20 ±0.42	0.52 ±0.62
BIM	1.66 ±0.44	1.78 ±0.76	1.66 ±0.44	1.98 ±0.63
BoM	0.42 ±0.66	0.55 ±0.91	0.42 ±0.66	0.74 ±0.81
CEM	0.07 ±0.48	0.19 ±0.78	0.07 ±0.48	0.38 ±0.66
CMI	-0.22 ±0.40	-0.10 ±0.74	-0.22 ±0.40	0.09 ±0.61
DMDM	0.32 ±0.61	0.44 ±0.87	0.32 ±0.61	0.64 ±0.77
DTI	-0.19 ±0.41	-0.07 ±0.75	-0.19 ±0.41	0.13 ±0.62
EIM	-0.10 ±0.49	0.03 ±0.79	-0.10 ±0.49	0.22 ±0.67
FTMC	-1.08 ±0.62	-0.96 ±0.88	-1.08 ±0.62	-0.76 ±0.78
GUM	-0.16 ±0.48	-0.03 ±0.79	-0.16 ±0.48	0.16 ±0.67
HMI	-0.44 ±0.84	-0.31 ±1.04	-0.44 ±0.84	-0.12 ±0.96
IMBiH	-0.25 ±0.64	-0.13 ±0.89	-0.25 ±0.64	0.06 ±0.79
INM	0.23 ±0.49	0.36 ±0.79	0.23 ±0.49	0.55 ±0.67
INRiM	*CCT-K9*	0.12 ±0.62	*CCT-K9*	0.32 ±0.46
IPQ	-0.39 ±0.68	-0.26 ±0.92	-0.39 ±0.68	-0.07 ±0.82
JV	-0.30 ±0.56	-0.18 ±0.84	-0.30 ±0.56	0.01 ±0.73
LNE-Cnam	*CCT-K9*	0.12 ±0.62	*CCT-K9*	0.32 ±0.46
MIKES VTT	-0.53 ±0.76	-0.41 ±0.99	-0.53 ±0.76	-0.21 ±0.89
MIRS/ UL-FE/ LMK	0.18 ±0.34	0.31 ±0.71	0.18 ±0.34	0.50 ±0.58
NPL		0.12 ±0.62	*CCT-K9*	0.32 ±0.46
NSAI-NML	0.66		-0.12 ±0.62	0.19 ±0.78
PTB	*CCT-K9*	0.66		0.32 ±0.46
RISE	0.70	0.85	0.70	
ROTH+CO. AG	0.81	1.13	0.81	1.23
SMD	0.68	0.83	0.68	0.67
SMU	0.57	0.76	0.57	0.58
UME	0.57	0.76	0.57	0.61
VSL	*CCT-K9*	0.66	*CCT-K9*	0.70

Table 5.4 DoE at the Gallium fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	-0.09 ±0.98	0.42 ±0.85	0.42 ±0.78	0.39 ±0.80
BFKH	-0.03 ±0.81	0.48 ±0.65	0.48 ±0.55	0.45 ±0.58
BIM	1.43 ±0.82	1.94 ±0.66	1.93 ±0.56	1.90 ±0.59
BoM	0.19 ±0.96	0.70 ±0.83	0.70 ±0.75	0.67 ±0.77
CEM	-0.17 ±0.84	0.34 ±0.69	0.34 ±0.60	0.31 ±0.62
CMI	-0.45 ±0.80	0.05 ±0.64	0.05 ±0.54	0.02 ±0.57
DMDM	0.09 ±0.92	0.60 ±0.79	0.59 ±0.71	0.56 ±0.73
DTI	-0.42 ±0.81	0.08 ±0.64	0.08 ±0.55	0.05 ±0.57
EIM	-0.33 ±0.85	0.18 ±0.69	0.18 ±0.61	0.15 ±0.63
FTMC	-1.31 ±0.93	-0.81 ±0.79	-0.81 ±0.72	-0.84 ±0.74
GUM	-0.39 ±0.84	0.12 ±0.69	0.12 ±0.60	0.09 ±0.62
HMI	-0.67 ±1.09	-0.16 ±0.97	-0.16 ±0.91	-0.19 ±0.93
IMBiH	-0.48 ±0.94	0.02 ±0.81	0.02 ±0.74	-0.01 ±0.76
INM	0.00 ±0.85	0.51 ±0.69	0.51 ±0.60	0.48 ±0.63
INRiM	-0.23 ±0.69	0.28 ±0.49	0.27 ±0.36	0.24 ±0.40
IPQ	-0.62 ±0.97	-0.11 ±0.84	-0.11 ±0.77	-0.14 ±0.79
JV	-0.53 ±0.89	-0.03 ±0.75	-0.03 ±0.67	-0.06 ±0.69
LNE-Cnam	-0.23 ±0.69	0.28 ±0.49	0.27 ±0.36	0.24 ±0.40
MIKES VTT	-0.76 ±1.03	-0.26 ±0.91	-0.26 ±0.85	-0.29 ±0.86
MIRS/ UL-FE/ LMK	-0.05 ±0.77	0.46 ±0.60	0.46 ±0.50	0.43 ±0.53
NPL	-0.23 ±0.69	0.28 ±0.49	0.27 ±0.36	0.24 ±0.40
NSAI-NML	-0.35 ±0.93	0.15 ±0.79	0.15 ±0.72	0.12 ±0.74
PTB	-0.23 ±0.69	0.28 ±0.49	0.27 ±0.36	0.24 ±0.40
RISE	-0.55 ±0.83	-0.04 ±0.68	-0.04 ±0.59	-0.07 ±0.61
ROTH+CO. AG		0.51 ±0.85	0.51 ±0.78	0.47 ±0.80
SMD	1.21		0.00 ±0.61	-0.03 ±0.64
SMU	1.15	0.60		-0.03 ±0.54
UME	1.13	0.62	0.53	
VSL	0.81	0.68	0.57	0.57

Table 5.4 DoE at the Gallium fixed point (part 7)

	VSL
BEV	0.14 ±0.70
BFKH	0.20 ±0.42
BIM	1.66 ±0.44
BoM	0.42 ±0.66
CEM	0.07 ±0.48
CMI	-0.22 ±0.40
DMDM	0.32 ±0.61
DTI	-0.19 ±0.41
EIM	-0.10 ±0.49
FTMC	-1.08 ±0.62
GUM	-0.16 ±0.48
HMI	-0.44 ±0.84
IMBiH	-0.25 ±0.64
INM	0.23 ±0.49
INRiM	*CCT-K9*
IPQ	-0.39 ±0.68
JV	-0.30 ±0.56
LNE-Cnam	*CCT-K9*
MIKES VTT	-0.53 ±0.76
MIRS/ UL-FE/ LMK	0.18 ±0.34
NPL	*CCT-K9*
NSAI-NML	-0.12 ±0.62
PTB	*CCT-K9*
RISE	-0.32 ±0.46
ROTH+CO. AG	0.23 ±0.69
SMD	-0.28 ±0.49
SMU	-0.27 ±0.36
UME	-0.24 ±0.40
VSL	

Table 5.4 DoE at the Gallium fixed point (part 8)

5.5 DoE table at the Mercury fixed point

	BEV	BFKH	BIM	BoM
BEV		-1.30 ±0.93	0.02 ±1.03	0.20 ±1.10
BFKH	2.07		1.32 ±0.64	1.50 ±0.75
BIM	1.01	1.85		0.18 ±0.87
BoM	1.15	2.12	0.92	
CEM	1.61	1.35	1.46	1.70
CMI	1.12	1.45	0.91	1.17
DMDM	1.13	2.10	0.91	0.94
DTI	0.99	1.88	0.73	0.82
EIM	1.02	1.80	0.77	0.97
FTMC	1.09	2.01	0.86	0.95
GUM	1.10	2.04	0.85	0.81
HMI	0.90	1.70	0.60	0.77
IMBiH	1.15	2.11	0.91	0.86
INM	0.93	1.76	0.65	0.80
INRiM	0.86	1.57	0.54	0.76
IPQ	1.58	1.68	1.44	1.67
JV	1.54	1.37	1.38	1.62
LNE-Cnam	0.86	1.57	0.54	0.76
MIKES VTT	1.53	1.46	1.37	1.61
MIRS/ UL-FE/ LMK	0.91	1.67	0.62	0.83
NPL	0.86	1.57	0.54	0.76
NSAI-NML	1.04	1.80	0.82	1.02
PTB	0.86	1.57	0.54	0.76
RISE	1.04	1.96	0.78	0.80
ROTH+CO. AG	1.18	1.96	0.98	1.17
SMD	1.75	1.56	1.62	1.85
SMU	2.03	0.71	1.85	2.10
UME	1.41	1.29	1.23	1.48
VSL	0.86	1.57	0.54	0.76

Table 5.5 DoE at the Mercury fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	-0.65 ±1.17	-0.30 ±0.98	0.17 ±1.11	0.11 ±0.99
BFKH	0.65 ±0.85	1.00 ±0.55	1.47 ±0.75	1.41 ±0.57
BIM	-0.67 ±0.96	-0.33 ±0.71	0.15 ±0.88	0.09 ±0.72
BoM	-0.85 ±1.03	-0.51 ±0.80	-0.03 ±0.96	-0.09 ±0.82
CEM		0.35 ±0.90	0.82 ±1.03	0.76 ±0.91
CMI	1.09		0.48 ±0.81	0.41 ±0.64
DMDM	1.67	1.15		-0.07 ±0.82
DTI	1.51	0.94	0.81	
EIM	1.41	0.86	0.95	0.76
FTMC	1.59	1.06	0.94	0.80
GUM	1.67	1.11	0.83	0.72
HMI	1.38	0.78	0.75	0.54
IMBiH	1.71	1.16	0.88	0.78
INM	1.41	0.83	0.79	0.59
INRiM	1.29	0.67	0.75	0.50
IPQ	1.28	1.12	1.65	1.50
JV	1.05	1.01	1.59	1.42
LNE-Cnam	1.29	0.67	0.75	0.50
MIKES VTT	1.11	1.01	1.59	1.42
MIRS/ UL-FE/ LMK	1.34	0.75	0.81	0.59
NPL	1.29	0.67	0.75	0.50
NSAI-NML	1.40	0.86	1.00	0.82
PTB	1.29	0.67	0.75	0.50
RISE	1.59	1.03	0.80	0.66
ROTH+CO. AG	1.52	1.03	1.15	0.99
SMD	1.27	1.27	1.82	1.67
SMU	1.32	1.46	2.08	1.89
UME	0.96	0.85	1.46	1.27
VSL	1.29	0.67	0.75	0.50

Table 5.5 DoE at the Mercury fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	-0.03 ±1.04	0.10 ±1.10	0.27 ±0.99	0.05 ±0.91
BFKH	1.27 ±0.65	1.40 ±0.75	1.57 ±0.57	1.35 ±0.42
BIM	-0.05 ±0.79	0.08 ±0.87	0.25 ±0.73	0.03 ±0.62
BoM	-0.23 ±0.87	-0.10 ±0.95	0.07 ±0.82	-0.15 ±0.73
CEM	0.62 ±0.96	0.75 ±1.03	0.92 ±0.91	0.70 ±0.82
CMI	0.27 ±0.71	0.40 ±0.80	0.57 ±0.65	0.36 ±0.52
DMDM	-0.20 ±0.88	-0.08 ±0.95	0.10 ±0.83	-0.12 ±0.73
DTI	-0.14 ±0.73	-0.01 ±0.82	0.16 ±0.66	-0.06 ±0.54
EIM		0.13 ±0.87	0.30 ±0.73	0.08 ±0.62
FTMC	0.89		0.17 ±0.82	-0.04 ±0.72
GUM	0.91	0.87		-0.22 ±0.54
HMI	0.63	0.71	0.67	
IMBiH	0.96	0.92	0.71	0.74
INM	0.67	0.75	0.71	0.45
INRiM	0.55	0.68	0.66	0.28
IPQ	1.40	1.57	1.66	1.38
JV	1.33	1.51	1.59	1.29
LNE-Cnam	0.55	0.68	0.66	0.28
MIKES VTT	1.33	1.51	1.58	1.30
MIRS/ UL-FE/ LMK	0.63	0.75	0.74	0.42
NPL	0.55	0.68	0.66	0.28
NSAI-NML	0.81	0.94	0.97	0.69
PTB	0.55	0.68	0.66	0.28
RISE	0.83	0.82	0.65	0.59
ROTH+CO. AG	0.98	1.09	1.13	0.88
SMD	1.57	1.74	1.84	1.56
SMU	1.80	1.99	2.05	1.74
UME	1.18	1.37	1.43	1.12
VSL	0.55	0.68	0.66	0.28

Table 5.5 DoE at the Mercury fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV	0.28 ±1.03	0.05 ±0.95	0.00 ±0.87	-0.48 ±1.32
BFKH	1.58 ±0.64	1.36 ±0.49	1.30 ±0.33	0.82 ±1.05
BIM	0.26 ±0.78	0.03 ±0.66	-0.02 ±0.55	-0.50 ±1.14
BoM	0.08 ±0.87	-0.15 ±0.77	-0.20 ±0.67	-0.68 ±1.20
CEM	0.93 ±0.95	0.70 ±0.86	0.65 ±0.78	0.17 ±1.27
CMI	0.59 ±0.70	0.36 ±0.57	0.31 ±0.44	-0.18 ±1.09
DMDM	0.11 ±0.87	-0.12 ±0.77	-0.17 ±0.68	-0.66 ±1.21
DTI	0.17 ±0.72	-0.05 ±0.59	-0.11 ±0.47	-0.59 ±1.10
EIM	0.31 ±0.78	0.09 ±0.67	0.03 ±0.56	-0.45 ±1.14
FTMC	0.19 ±0.87	-0.04 ±0.76	-0.09 ±0.67	-0.58 ±1.20
GUM	0.01 ±0.72	-0.21 ±0.60	-0.27 ±0.47	-0.75 ±1.10
HMI	0.23 ±0.61	0.00 ±0.45	-0.05 ±0.27	-0.53 ±1.03
IMBiH		-0.23 ±0.66	-0.28 ±0.55	-0.76 ±1.14
INM	0.77		-0.05 ±0.37	-0.54 ±1.06
INRiM	0.73	0.37		-0.48 ±1.00
IPQ	1.70	1.41	1.31	
JV	1.63	1.33	1.20	1.23
LNE-Cnam	0.73	0.37	*CCT-K9*	1.31
MIKES VTT	1.63	1.33	1.21	1.26
MIRS/ UL-FE/ LMK	0.81	0.48	0.31	1.34
NPL	0.73	0.37	*CCT-K9*	1.31
NSAI-NML	1.02	0.73	0.60	1.38
PTB	0.73	0.37	*CCT-K9*	1.31
RISE	0.71	0.64	0.58	1.59
ROTH+CO. AG	1.17	0.91	0.82	1.50
SMD	1.87	1.59	1.48	1.43
SMU	2.10	1.79	1.65	1.63
UME	1.49	1.17	1.02	1.13
VSL	0.73	0.37	*CCT-K9*	1.31

Table 5.5 DoE at the Mercury fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	-0.60 ±1.14	0.00 ±0.87	-0.55 ±1.18	0.00 ±0.93
BFKH	0.71 ±0.81	1.30 ±0.33	0.75 ±0.86	1.30 ±0.45
BIM	-0.62 ±0.92	-0.02 ±0.55	-0.57 ±0.97	-0.02 ±0.64
BoM	-0.80 ±1.00	-0.20 ±0.67	-0.75 ±1.04	-0.20 ±0.74
CEM	0.05 ±1.07	0.65 ±0.78	0.10 ±1.12	0.65 ±0.84
CMI	-0.29 ±0.86	0.31 ±0.44	-0.25 ±0.91	0.30 ±0.54
DMDM	-0.77 ±1.00	-0.17 ±0.68	-0.73 ±1.05	-0.18 ±0.75
DTI	-0.70 ±0.87	-0.11 ±0.47	-0.66 ±0.92	-0.11 ±0.56
EIM	-0.56 ±0.93	0.03 ±0.56	-0.52 ±0.97	0.03 ±0.64
FTMC	-0.69 ±1.00	-0.09 ±0.67	-0.65 ±1.04	-0.10 ±0.74
GUM	-0.86 ±0.88	-0.27 ±0.47	-0.82 ±0.93	-0.27 ±0.57
HMI	-0.65 ±0.79	-0.05 ±0.27	-0.60 ±0.84	-0.05 ±0.41
IMBiH	-0.88 ±0.92	-0.28 ±0.55	-0.83 ±0.97	-0.28 ±0.63
INM	-0.65 ±0.82	-0.05 ±0.37	-0.61 ±0.88	-0.06 ±0.48
INRiM	-0.60 ±0.74	*CCT-K9*	-0.55 ±0.80	0.00 ±0.31
IPQ	-0.11 ±1.24	0.48 ±1.00	-0.07 ±1.28	0.48 ±1.05
JV		0.60 ±0.74	0.04 ±1.09	0.59 ±0.80
LNE-Cnam	1.20		-0.55 ±0.80	0.00 ±0.31
MIKES VTT	1.07	1.21		0.55 ±0.86
MIRS/ UL-FE/ LMK	1.25	0.31	1.26	
NPL	1.20	*CCT-K9*	1.21	0.31
NSAI-NML	1.32	0.60	1.31	0.68
PTB	1.20	*CCT-K9*	1.21	0.31
RISE	1.51	0.58	1.51	0.66
ROTH+CO. AG	1.44	0.82	1.44	0.87
SMD	1.25	1.48	1.29	1.52
SMU	1.34	1.65	1.43	1.71
UME	0.92	1.02	0.97	1.09
VSL	1.20	*CCT-K9*	1.21	0.31

Table 5.5 DoE at the Mercury fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	0.00 ±0.87	-0.07 ±1.06	0.00 ±0.87	0.20 ±0.98
BFKH	1.30 ±0.33	1.24 ±0.69	1.30 ±0.33	1.50 ±0.56
BIM	-0.02 ±0.55	-0.09 ±0.82	-0.02 ±0.55	0.18 ±0.71
BoM	-0.20 ±0.67	-0.27 ±0.90	-0.20 ±0.67	0.00 ±0.81
CEM	0.65 ±0.78	0.58 ±0.99	0.65 ±0.78	0.85 ±0.90
CMI	0.31 ±0.44	0.24 ±0.75	0.31 ±0.44	0.51 ±0.63
DMDM	-0.17 ±0.68	-0.24 ±0.91	-0.17 ±0.68	0.03 ±0.82
DTI	-0.11 ±0.47	-0.17 ±0.76	-0.11 ±0.47	0.10 ±0.65
EIM	0.03 ±0.56	-0.04 ±0.82	0.03 ±0.56	0.23 ±0.72
FTMC	-0.09 ±0.67	-0.16 ±0.90	-0.09 ±0.67	0.11 ±0.81
GUM	-0.27 ±0.47	-0.34 ±0.77	-0.27 ±0.47	-0.07 ±0.65
HMI	-0.05 ±0.27	-0.12 ±0.66	-0.05 ±0.27	0.15 ±0.53
IMBiH	-0.28 ±0.55	-0.35 ±0.81	-0.28 ±0.55	-0.08 ±0.71
INM	-0.05 ±0.37	-0.12 ±0.70	-0.05 ±0.37	0.15 ±0.58
INRiM	*CCT-K9*	-0.07 ±0.60	*CCT-K9*	0.20 ±0.45
IPQ	0.48 ±1.00	0.42 ±1.17	0.48 ±1.00	0.68 ±1.09
JV	0.60 ±0.74	0.53 ±0.95	0.60 ±0.74	0.80 ±0.86
LNE-Cnam	*CCT-K9*	-0.07 ±0.60	*CCT-K9*	0.20 ±0.45
MIKES VTT	0.55 ±0.80	0.49 ±1.00	0.55 ±0.80	0.76 ±0.92
MIRS/ UL-FE/ LMK	0.00 ±0.31	-0.06 ±0.68	0.00 ±0.31	0.21 ±0.55
NPL		-0.07 ±0.60	*CCT-K9*	0.20 ±0.45
NSAI-NML	0.60		0.07 ±0.60	0.27 ±0.75
PTB	*CCT-K9*	0.60		0.20 ±0.45
RISE	0.58	0.90	0.58	
ROTH+CO. AG	0.82	1.01	0.82	1.06
SMD	1.48	1.55	1.48	1.76
SMU	1.65	1.79	1.65	1.97
UME	1.02	1.17	1.02	1.36
VSL	*CCT-K9*	0.60	*CCT-K9*	0.58

Table 5.5 DoE at the Mercury fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	-0.07 ±1.20	-0.63 ±1.35	-1.16 ±1.05	-0.55 ±1.04
BFKH	1.23 ±0.89	0.67 ±1.08	0.14 ±0.67	0.75 ±0.66
BIM	-0.09 ±0.99	-0.65 ±1.17	-1.18 ±0.81	-0.57 ±0.80
BoM	-0.27 ±1.06	-0.83 ±1.23	-1.36 ±0.89	-0.75 ±0.88
CEM	0.58 ±1.13	0.02 ±1.30	-0.51 ±0.97	0.10 ±0.97
CMI	0.24 ±0.94	-0.33 ±1.12	-0.86 ±0.73	-0.25 ±0.72
DMDM	-0.24 ±1.07	-0.80 ±1.24	-1.34 ±0.90	-0.73 ±0.89
DTI	-0.17 ±0.95	-0.74 ±1.13	-1.27 ±0.75	-0.66 ±0.74
EIM	-0.04 ±1.00	-0.60 ±1.18	-1.13 ±0.81	-0.52 ±0.80
FTMC	-0.16 ±1.06	-0.73 ±1.23	-1.26 ±0.89	-0.65 ±0.88
GUM	-0.34 ±0.95	-0.90 ±1.14	-1.43 ±0.75	-0.82 ±0.74
HMI	-0.12 ±0.87	-0.68 ±1.07	-1.21 ±0.64	-0.60 ±0.63
IMBiH	-0.35 ±0.99	-0.91 ±1.17	-1.44 ±0.80	-0.83 ±0.79
INM	-0.12 ±0.90	-0.69 ±1.10	-1.22 ±0.69	-0.61 ±0.68
INRiM	-0.07 ±0.82	-0.63 ±1.03	-1.16 ±0.59	-0.55 ±0.57
IPQ	0.42 ±1.29	-0.15 ±1.44	-0.68 ±1.16	-0.07 ±1.15
JV	0.53 ±1.11	-0.04 ±1.27	-0.57 ±0.94	0.04 ±0.93
LNE-Cnam	-0.07 ±0.82	-0.63 ±1.03	-1.16 ±0.59	-0.55 ±0.57
MIKES VTT	0.49 ±1.15	-0.08 ±1.31	-0.61 ±0.99	0.00 ±0.98
MIRS/ UL-FE/ LMK	-0.06 ±0.88	-0.63 ±1.08	-1.16 ±0.66	-0.55 ±0.65
NPL	-0.07 ±0.82	-0.63 ±1.03	-1.16 ±0.59	-0.55 ±0.57
NSAI-NML	0.00 ±1.02	-0.57 ±1.20	-1.10 ±0.84	-0.49 ±0.83
PTB	-0.07 ±0.82	-0.63 ±1.03	-1.16 ±0.59	-0.55 ±0.57
RISE	-0.27 ±0.94	-0.83 ±1.13	-1.37 ±0.74	-0.76 ±0.73
ROTH+CO. AG		-0.56 ±1.32	-1.10 ±1.01	-0.49 ±1.00
SMD	1.66		-0.53 ±1.19	0.08 ±1.18
SMU	1.93	1.52		0.61 ±0.82
UME	1.32	1.16	1.29	
VSL	0.82	1.48	1.65	1.02

Table 5.5 DoE at the Mercury fixed point (part 7)

	VSL
BEV	0.00 ±0.87
BFKH	1.30 ±0.33
BIM	-0.02 ±0.55
BoM	-0.20 ±0.67
CEM	0.65 ±0.78
CMI	0.31 ±0.44
DMDM	-0.17 ±0.68
DTI	-0.11 ±0.47
EIM	0.03 ±0.56
FTMC	-0.09 ±0.67
GUM	-0.27 ±0.47
HMI	-0.05 ±0.27
IMBiH	-0.28 ±0.55
INM	-0.05 ±0.37
INRiM	*CCT-K9*
IPQ	0.48 ±1.00
JV	0.60 ±0.74
LNE-Cnam	*CCT-K9*
MIKES VTT	0.55 ±0.80
MIRS/ UL-FE/ LMK	0.00 ±0.31
NPL	*CCT-K9*
NSAI-NML	0.07 ±0.60
PTB	*CCT-K9*
RISE	-0.20 ±0.45
ROTH+CO. AG	0.07 ±0.82
SMD	0.63 ±1.03
SMU	1.16 ±0.59
UME	0.55 ±0.57
VSL	

Table 5.5 DoE at the Mercury fixed point (part 8)

5.6 DoE table at the Argon fixed point

	BEV	BFKH	BIM	BoM
BEV				
BFKH				
BIM				
BoM				
CEM	1.90			
CMI	3.01			
DMDM				
DTI	5.69			
EIM	2.97			
FTMC				
GUM	2.14			
HMI				
IMBiH				
INM	1.92			
INRiM	1.93			
IPQ	2.25			
JV	2.66			
LNE-Cnam	1.93			
MIKES VTT	2.51			
MIRS/ UL-FE/ LMK	2.11			
NPL	1.93			
NSAI-NML				
PTB	1.93			
RISE	2.55			
ROTH+CO. AG	1.98			
SMD	2.42			
SMU				
UME	2.61			
VSL	1.93			

Table 5.6 DoE at the Argon fixed point (part 1)

	CEM	CMI	DMDM	DTI
BEV	-0.07 ±1.94	-1.50 ±1.84		3.23 ±2.99
BFKH				
BIM				
BoM				
CEM		-1.43 ±1.58		3.30 ±2.83
CMI	2.73			4.73 ±2.76
DMDM				
DTI	5.63	7.00		
EIM	2.68	1.33		6.98
FTMC				
GUM	1.96	3.18		5.54
HMI				
IMBiH				
INM	1.74	3.03		5.20
INRiM	1.59	1.68		6.00
IPQ	2.03	2.93		5.94
JV	2.38	1.65		6.64
LNE-Cnam	1.59	1.68		6.00
MIKES VTT	2.26	2.32		6.39
MIRS/ UL-FE/ LMK	1.83	2.29		6.04
NPL	1.59	1.68		6.00
NSAI-NML				
PTB	1.59	1.68		6.00
RISE	2.31	2.33		6.43
ROTH+CO. AG	1.76	2.81		5.67
SMD	2.27	3.61		4.72
SMU				
UME	2.33	1.65		6.60
VSL	1.59	1.68		6.00

Table 5.6 DoE at the Argon fixed point (part 2)

	EIM	FTMC	GUM	HMI
BEV	-1.52 ±1.76		0.16 ±2.17	
BFKH				
BIM				
BoM				
CEM	-1.45 ±1.49		0.22 ±1.96	
CMI	-0.02 ±1.36		1.66 ±1.86	
DMDM				
DTI	-4.75 ±2.71		-3.08 ±3.00	
EIM			1.68 ±1.78	
FTMC				
GUM	3.14			
HMI				
IMBiH				
INM	2.97		1.86	
INRiM	1.58		2.09	
IPQ	2.90		2.34	
JV	1.59		2.83	
LNE-Cnam	1.58		2.09	
MIKES VTT	2.27		2.66	
MIRS/ UL-FE/ LMK	2.23		2.26	
NPL	1.58		2.09	
NSAI-NML				
PTB	1.58		2.09	
RISE	2.28		2.71	
ROTH+CO. AG	2.76		2.04	
SMD	3.55		2.28	
SMU				
UME	1.58		2.78	
VSL	1.58		2.09	

Table 5.6 DoE at the Argon fixed point (part 3)

	IMBiH	INM	INRiM	IPQ
BEV		0.32 ±1.86	-0.66 ±1.53	-0.19 ±2.27
BFKH				
BIM				
BoM				
CEM		0.38 ±1.60	-0.60 ±1.20	-0.12 ±2.07
CMI		1.82 ±1.48	0.84 ±1.03	1.31 ±1.97
DMDM				
DTI		-2.91 ±2.77	-3.89 ±2.57	-3.42 ±3.07
EIM		1.84 ±1.38	0.86 ±0.88	1.33 ±1.90
FTMC				
GUM		0.16 ±1.87	-0.82 ±1.55	-0.35 ±2.29
HMI				
IMBiH				
INM			-0.98 ±1.06	-0.51 ±1.99
INRiM		1.85		0.47 ±1.68
IPQ		2.18	1.89	
JV		2.68	1.36	2.58
LNE-Cnam		1.85	*CCT-K9*	1.89
MIKES VTT		2.55	1.50	2.44
MIRS/ UL-FE/ LMK		2.10	1.19	2.09
NPL		1.85	*CCT-K9*	1.89
NSAI-NML				
PTB		1.85	*CCT-K9*	1.89
RISE		2.60	1.54	2.49
ROTH+CO. AG		1.82	1.69	2.11
SMD		1.82	2.45	2.71
SMU				
UME		2.63	1.29	2.53
VSL		1.85	*CCT-K9*	1.89

Table 5.6 DoE at the Argon fixed point (part 4)

	JV	LNE-Cnam	MIKES VTT	MIRS/ UL-FE/ LMK
BEV	-1.11 ±1.88	-0.66 ±1.53	-0.71 ±2.16	-0.49 ±1.92
BFKH				
BIM				
BoM				
CEM	-1.04 ±1.62	-0.60 ±1.20	-0.64 ±1.94	-0.42 ±1.67
CMI	0.39 ±1.50	0.84 ±1.03	0.79 ±1.84	1.01 ±1.55
DMDM				
DTI	-4.34 ±2.79	-3.89 ±2.57	-3.94 ±2.98	-3.72 ±2.82
EIM	0.41 ±1.41	0.86 ±0.88	0.82 ±1.76	1.03 ±1.46
FTMC				
GUM	-1.27 ±1.89	-0.82 ±1.55	-0.86 ±2.17	-0.64 ±1.94
HMI				
IMBiH				
INM	-1.43 ±1.52	-0.98 ±1.06	-1.02 ±1.85	-0.81 ±1.57
INRiM	-0.45 ±1.09	*CCT-K9*	-0.04 ±1.52	0.17 ±1.16
IPQ	-0.92 ±2.01	-0.47 ±1.68	-0.52 ±2.27	-0.30 ±2.05
JV		0.45 ±1.09	0.41 ±1.88	0.62 ±1.60
LNE-Cnam	1.36		-0.04 ±1.52	0.17 ±1.16
MIKES VTT	2.00	1.50		0.22 ±1.92
MIRS/ UL-FE/ LMK	1.95	1.19	1.92	
NPL	1.36	*CCT-K9*	1.50	1.19
NSAI-NML				
PTB	1.36	*CCT-K9*	1.50	1.19
RISE	2.02	1.54	2.15	1.97
ROTH+CO. AG	2.46	1.69	2.32	1.91
SMD	3.25	2.45	3.11	2.67
SMU				
UME	1.49	1.29	1.96	1.90
VSL	1.36	*CCT-K9*	1.50	1.19

Table 5.6 DoE at the Argon fixed point (part 5)

	NPL	NSAI-NML	PTB	RISE
BEV	-0.66 ±1.53		-0.66 ±1.53	-0.73 ±2.19
BFKH				
BIM				
BoM				
CEM	-0.60 ±1.20		-0.60 ±1.20	-0.66 ±1.98
CMI	0.84 ±1.03		0.84 ±1.03	0.77 ±1.88
DMDM				
DTI	-3.89 ±2.57		-3.89 ±2.57	-3.96 ±3.01
EIM	0.86 ±0.88		0.86 ±0.88	0.79 ±1.80
FTMC				
GUM	-0.82 ±1.55		-0.82 ±1.55	-0.88 ±2.20
HMI				
IMBiH				
INM	-0.98 ±1.06		-0.98 ±1.06	-1.04 ±1.89
INRiM	*CCT-K9*		*CCT-K9*	-0.06 ±1.57
IPQ	-0.47 ±1.68		-0.47 ±1.68	-0.54 ±2.30
JV	0.45 ±1.09		0.45 ±1.09	0.39 ±1.91
LNE-Cnam	*CCT-K9*		*CCT-K9*	-0.06 ±1.57
MIKES VTT	0.04 ±1.52		0.04 ±1.52	-0.02 ±2.19
MIRS/ UL-FE/ LMK	-0.17 ±1.16		-0.17 ±1.16	-0.24 ±1.95
NPL			*CCT-K9*	-0.06 ±1.57
NSAI-NML				
PTB	*CCT-K9*			-0.06 ±1.57
RISE	1.54		1.54	
ROTH+CO. AG	1.69		1.69	2.37
SMD	2.45		2.45	3.16
SMU				
UME	1.29		1.29	1.98
VSL	*CCT-K9*		*CCT-K9*	1.54

Table 5.6 DoE at the Argon fixed point (part 6)

	ROTH+CO. AG	SMD	SMU	UME
BEV	-0.07 ±2.02	0.83 ±1.92		-1.09 ±1.85
BFKH				
BIM				
BoM				
CEM	0.00 ±1.79	0.90 ±1.67		-1.02 ±1.59
CMI	1.43 ±1.68	2.33 ±1.55		0.41 ±1.47
DMDM				
DTI	-3.30 ±2.89	-2.40 ±2.82		-4.32 ±2.77
EIM	1.45 ±1.59	2.35 ±1.46		0.44 ±1.37
FTMC				
GUM	-0.22 ±2.04	0.67 ±1.93		-1.24 ±1.87
HMI				
IMBiH				
INM	-0.38 ±1.69	0.51 ±1.57		-1.40 ±1.49
INRiM	0.60 ±1.32	1.49 ±1.16		-0.42 ±1.05
IPQ	0.12 ±2.14	1.02 ±2.04		-0.90 ±1.98
JV	1.05 ±1.72	1.94 ±1.60		0.03 ±1.51
LNE-Cnam	0.60 ±1.32	1.49 ±1.16		-0.42 ±1.05
MIKES VTT	0.64 ±2.02	1.54 ±1.92		-0.38 ±1.85
MIRS/ UL-FE/ LMK	0.42 ±1.76	1.32 ±1.64		-0.60 ±1.57
NPL	0.60 ±1.32	1.49 ±1.16		-0.42 ±1.05
NSAI-NML				
PTB	0.60 ±1.32	1.49 ±1.16		-0.42 ±1.05
RISE	0.66 ±2.05	1.56 ±1.95		-0.36 ±1.89
ROTH+CO. AG		0.90 ±1.76		-1.02 ±1.69
SMD	2.35			-1.92 ±1.56
SMU				
UME	2.41	3.20		
VSL	1.69	2.45		1.29

Table 5.6 DoE at the Argon fixed point (part 7)

	VSL
BEV	-0.66 ±1.53
BFKH	
BIM	
BoM	
CEM	-0.60 ±1.20
CMI	0.84 ±1.03
DMDM	
DTI	-3.89 ±2.57
EIM	0.86 ±0.88
FTMC	
GUM	-0.82 ±1.55
HMI	
IMBiH	
INM	-0.98 ±1.06
INRiM	*CCT-K9*
IPQ	-0.47 ±1.68
JV	0.45 ±1.09
LNE-Cnam	*CCT-K9*
MIKES VTT	0.04 ±1.52
MIRS/ UL-FE/ LMK	-0.17 ±1.16
NPL	*CCT-K9*
NSAI-NML	
PTB	*CCT-K9*
RISE	0.06 ±1.57
ROTH+CO. AG	-0.60 ±1.32
SMD	-1.49 ±1.16
SMU	
UME	0.42 ±1.05
VSL	

Table 5.6 DoE at the Argon fixed point (part 8)

List of acronyms

CCT	Comité Consultatif de Thermométrie - Consultative Committee for Thermometry
CIPM	Comité International des Poids et Mesures - International Committee for Weights and Measures
CIPM-MRA	CIPM Mutual Recognition Arrangement
DI	Designated Institute participating in the CIPM-MRA
EURAMET	The European Association of National Metrology Institutes
EURAMET TC-T	Technical Committee for Thermometry of EURAMET
FP	Fixed point
ID	Identifier
ITS-90	International Temperature Scale of 1990
KCRV	Key Comparison Reference Value
NMI	National Measurement Institute
RMO	Regional Metrology Organization
SPRT	Standard Platinum Resistance Thermometer
TP	Triple point
TPW	Triple Point of Water
W	SPRT resistance ratio as defined in the ITS-90: $W = R\,(T_{\text{fixed-point}})\,/\,R\,(273{,}15\ \text{K})$

References

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6. D.R. White *et al*, "Uncertainties in the Realisation of the SPRT Subranges of the ITS-90" CCT/08-19/rev https://www.bipm.org/documents/20126/28394148/working-document-ID-6518/03d5a165-01f8-7893-1f3a-5e5f9a88cd89 (requires CCT member access)

   Alternatively the following document is an update of CCT/08-19/rev, without access restriction
   "Guide to the Realization of the ITS-90 – Chapter 5 - Platinum Resistance Thermometry"
   https://www.bipm.org/utils/common/pdf/ITS-90/Guide_ITS-90_5_SPRT_2018.pdf

Appendix I Protocol of EURAMET.T-K9

EURAMET.T-K9 final protocol

Regional key comparison

ITS-90 SPRT Calibration from the Ar TP to the Zn FP

Following the (argumented) requests from FYR Macedonia and Albania, the coordinator and the pilots have accepted the following (02/04/2015):

BoM leaves the NPL star and joins the VSL star
DPM leaves the VSL star and joins the NPL star

A new contact name for DPM is Kreshnik_hakrama (k_hakrama@yahoo.com)

1 Objective
This comparison is designed to compare the realization of the ITS-90 through the calibration of SPRTs. The range of temperature covered in this comparison is from the triple point of Ar (83.8058 K) to the freezing point of Zn (692.677 K). The transfer standards used will be long-stem SPRTs.

This protocol matches closely the corresponding CCT-K9 key comparison protocol.

2 Topology of the comparison
The comparison is organized in five separate collapsed stars, each star having a CCT-K9 participant as pilot linking the measurements of 4 to 6 other participants (see Figure 1). LNE-CNAM was chosen as coordinator of the comparison and charged with the preparation of the protocol, the collection of the measurement reports from all participants and the preparation of the final report.

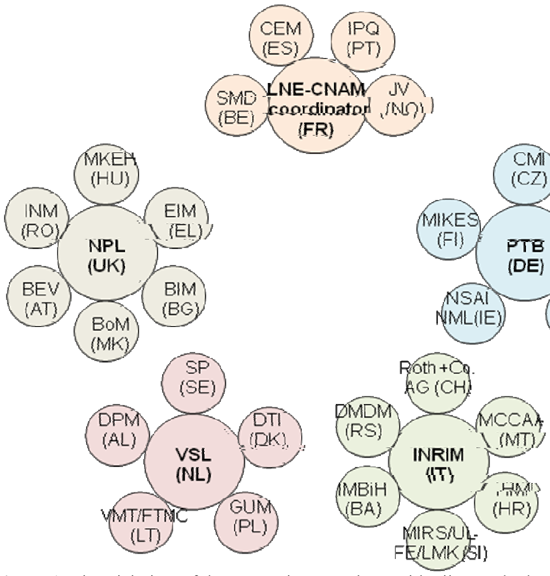

Figure 1: Pictorial view of the comparison topology with pilots and other participants.

3. Participants
The pilots of the 5 stars are:

- Star 1: LNE-Cnam (France)
- Star 2: PTB (Germany)
- Star 3: INRIM (Italy)
- Star 4: VSL (Netherlands)
- Star 5: NPL (United Kingdom)

The names, postal and e-mail addresses of the pilots are given in appendix D.
The other participants in each star are listed in appendix E.
The names, postal and e-mail addresses of the participants are given in appendix F.

4. Projected Timeline

Protocol Agreement	February, 2015
Transfer Standards Sent to the pilots	June, 2015
Transfer Standards Returned to NMIs	December, 2015
Transfer Standards Re-Measured by NMIs	June, 2016
Draft A Report Completed	December, 2016

5. Duties of the participants
Each participant will provide the following:

- 2 ITS-90 calibrated SPRTs
  - The participant will select his own SPRTs based on his own criteria for suitability and will convey the selection criteria to the Pilot Laboratory in his star,
  - The participant will calibrate the two selected SPRTs,
    After calibrating the two selected SPRTs, the participant will deliver one of the two calibrated SPRTs to the pilot of his star.

(here is the slight difference with the CCT-K9 protocol. A second thermometer is prepared and immediately kept at disposal in case of trouble with the transfer standard, particularly in case of carrier problems)

  - Each participant will repossess their thermometer and will make a re-calibration.
  - SPRTs are to be measured at every available fixed-point over the range of the comparison including the In FP and Ga MP

- Calibration results supplied in $\overline{W}(FP)$ for each Fixed Point (FP) with all corrections applied by the NMI such that the $\overline{W}(FP)$ values are equivalent to the ITS-90 assigned temperature values for 0 mA. Uncertainties, $u(\overline{W})$, may be specific to each SPRT.
  - Appendix A gives a reporting worksheet

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- The measurement equation used to compute each calibration result with an indication of which inputs vary randomly for each realized equilibrium and which inputs are systematic across all equilibriums for each fixed point within this comparison
    - Any quantities in the measurement equation that are a mixture of random and systematic effects for each SPRT should be broken into constituent parts that are either purely random or purely systematic within this comparison.
      An example of an SPRT measurement is given in Appendix B

- Uncertainty budget compliant with CCT WG3 that includes degrees of freedom associated to each component

    - A template for the uncertainty budget is given in Appendix C
      Sources of uncertainty may be added or deleted as needed
      An NMI/DI may choose to supply their own uncertainty budget (CMC and WG3 compliant) that includes degrees of freedom for each source of uncertainty

  (NMI/DI are encouraged to use the template, but if it prefers it may supply its own, taking care to not forget any uncertainty components (for this point, the suggested budget can be a help)

- Heat Flux (Immersion) profile for each fixed-point cell using the SPRTs of this comparison

    - [R(FP), 0 mA] and corresponding [immersion depth (sensor midpoint), cm]

- All results and required information will be e-mailed to the pilots and to the coordinator.

If you have questions about any aspect of the protocol or if you are not sure how to report something that is requested, please contact the coordinator prior to submitting your report. After reviewing all submitted reports, the pilots and/or coordinator will contact you if there is anything that is unclear or if any additional information is needed to complete the analysis of the data.

Note:
The thermometer numbers are assigned to NMI/DI SPRTs by loop and arrival date.

Example:
Third thermometer received in loop 4: L43 (each pilot is in charge to identify the laboratory associated with the thermometer L43, and to give to the laboratory the same name that the name of the thermometer)
The pilot in loop 4 is named P4. So the thermometer L43 is belonging to the participant 3 in loop 4.
It leads to a given number of Pi (i=1 to 5) and Lij (i=1 to 5), (j=1 to x depending of the number of participants in a loop)

In case the second thermometer is needed, the letter S will be added to the code. Example L43S will be the second thermometer sent by the participant 3 to the pilot of the loop 4.

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6. Duties of the coordinator:

- To identify the participants in each loop
- To prepare the protocol (with the help of the pilots)
- To send the protocol to all the participants for agreement
- To register the comparison and to keep contact with CCT and EURAMET at the different stages of the comparison
- To be informed of the state of progress of the comparison in the different stars / to communicate with the pilots (and participants) in case of delays or any other issues.
- To receive all the results of measurements, but the pilots will exploit the measurements made in their loop.
- To write the draft A and draft B, using the entries of the pilots and with the help of the pilots.
- To exchange with all the participants concerning draft A and draft B.

7. Duties of the pilots:

- To liaise with NMI/DI participants in their star regarding receipt and return of the SPRTs
- To check the initial value of R (TPW) of the SPRT delivered by each participant, before and after annealing, against the final value reported by each participant. In the case of significant discrepancy, to consult with the participant and/or the coordinator before proceeding with the calibration
- To carry out the calibration of the SPRTs using the same equipment as was used in CCT-K9, or equipment which is known to be compatible with that equipment. It is recommended that one of the SPRTs used by the Pilot in CCT-K9 is also included in the calibration experiments
- To prepare tables of results and uncertainties for the Pilot's calibration of the Participants' SPRTs in accordance with Appendices A, B and C, and to calculate the differences ΔT(Lij – Pi) and uncertainties u(Lij – Pi) (see below)
- To send this information to the Coordinator

8. Other instructions

- **Advice on handling the SPRTs:** The SPRTs must be handled with care and only by qualified metrology personnel. Hand-carriage of the SPRT from the participant lab to the pilot lab and viceversa is recommended and under the responsibility (and costs) of the participant.
- **Instructions for reporting the results:** The templates in Appendices A, B and C should be used for reporting the results.
- **Timetable for communicating the results to the pilot:** The participants must report the results of their measurements to the pilot at the time they deliver the SPRT to the pilot. In case the results of the recalibration (measurements performed after the return of the SPRT from the pilot lab) significantly deviates from the initial measurements, the participant must notify the pilot lab and deliver the recalibration measurements not later than the end of December 2015.

- **Financial aspects of the comparison:** each participating institute is responsible for its own costs for the measurements and transport of the SPRTs to and back from the pilot laboratory.

9. Method of Analysis and link to the CCT-K9 KCRV value.

For the EURAMET.T-K9 comparison, for each fixed points, and each NMI/DI, the fixed-point realization temperature differences from the KCRV and the associated uncertainty will be calculated using the following equations:

For each laboratory *Lij* in star i

$$\Delta T_{(Lij-KCRV)} = \Delta T_{(Lij-Pi)} + \Delta T_{(Pi-KCRV)}$$

$$u^2_{(Lij-KCRV)} = u^2_{(Lij-Pi)} + u^2_{(Pi-KCRV)}$$

The two values, $\Delta T_{Pi-KCRV}$ and $u_{Pi-KCRV}$ will be available from the CCT-K9 report.

$$\Delta T_{(Lij-Pi)} = \frac{[\overline{W}(FP)_{Lij} - \overline{W}(FP)_{Pi}]}{dW_r / dT} + C_{Lij}$$

C_{Lij} is a term used to account for uncertainty associated with the travel, handling, or stability of the SPRT and is taken to have a value of $C_{Lij} = 0$ and a standard uncertainty, $u_{C_{Lij}}$, of

$$u_{C_{Lij}} = \frac{abs\,[\overline{W}(FP)_{Lijbefore} - \overline{W}(FP)_{Lijafter}]}{(dW_r / dT).\sqrt{12}}$$

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Appendix A: Measurement Reporting Worksheet

Participating NMI/DI [ ]

Before sending SPRTs to Pilot Laboratory

	$\overline{W}(FP)$	$u[\overline{W}(FP)], mK$	n (*)	Comments (if any)
Zinc				
Tin				
Indium				
Gallium				
Mercury				
Argon				

(*) *n, Number of equilibria realized*

Final *R*(TPW) [ ] TPW Uncertainty:

On return to participating NMI

On Receipt *R*(TPW) [ ]

	$\overline{W}(FP)$	$u[\overline{W}(FP)], mK$	n (*)	Comments (if any)
Zinc				
Tin				
Indium				
Gallium				
Mercury				
Argon				

(*) *n, Number of equilibria realized*

Final *R*(TPW) [ ]

Fixed-Point Cell Information

	Type /manufacturer/serial number	L (cm) (*)	Open or sealed cell	Traceability
Zinc				
Tin				
Indium				
Gallium				
Mercury				
Argon				

(*) *Maximum thermometer Immersion depth into the substance measured to the thermal centre of the SPRT sensing element, cm*

Measurement System

Resistance Ratio Bridge Model	
Reference Resistor Model	
Resistor Enclosure Stability, mK	

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R(WTP) values during the calibration process:

All the R(WTP) values and the moment when they are measured according to the measurements at the other fixed points (zinc, tin, indium, gallium, mercury, argon), are requested, in a table.

Appendix B: Corrections applied to the measured values

The ratio value $W(\text{FP}_i)$ at the fixed point FP_i is given by the ratio of the SPRT resistance $R(\text{FP}_i)$ at the fixed point FP_i to the SPRT resistance $R(\text{TPW})$ at the triple point of water. The SPRT resistance measured at the fixed point FP_i (and the SPRT resistance $R(\text{TPW})$ measured at the triple point of water) must be corrected for the self-heating effect, the hydrostatic head effect and the residual gas pressure effect (see respectively section 2.1, 2.2 and 8.4 of CCT/08-19-rev document on "Uncertainties in the Realization of the SPRT Subranges of the ITS-90").

With:
$R_{meas}(\text{FP}_i)$ the resistance measured at fixed point FP_i
ΔR_{sh} the self-heating correction to the resistance
ΔR_{hydr} the hydrostatic head correction to the resistance
ΔR_p the residual gas pressure correction to the resistance
$R(\text{FP}_i)$ is computed as:

$$R(\text{FP}_i) = R_{meas}(\text{FP}_i) + \Delta R_{sh} + \Delta R_{hydr} + \Delta R_p$$

The applied corrections can be expressed in terms of temperature by simply dividing each one of them by the SPRT sensitivity coefficient $(\text{d}R/\text{d}T)_{\text{FPi}}$ at the temperature of the fixed point FP_i:

$$\Delta T_{sh} = \Delta R_{sh}/(\text{d}R/\text{d}T)_{\text{FPi}}$$
$$\Delta T_{hydr} = \Delta R_{hydr}/(\text{d}R/\text{d}T)_{\text{FPi}}$$
$$\Delta T_p = \Delta R_p/(\text{d}R/\text{d}T)_{\text{FPi}}$$

The applied corrections, expressed in terms of temperature, should be reported by the participants using the two tables below.

Before sending SPRTs to Pilot Laboratory

	self-heating		**hydrostatic**		**pressure**	
	correction mK	$u_{correction}$ mK	correction mK	$u_{correction}$ mK	correction mK	$u_{correction}$ mK
$\overline{R}$ (Zn)						
$\overline{R}$ (Sn)						
$\overline{R}$ (In)						
$\overline{R}$ (Ga)						
$\overline{R}$ (Hg)						
$\overline{R}$ (Ar)						

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After sending SPRT to Pilot Laboratory

	self-heating		hydrostatic		pressure	
	correction mK	$u_{correction}$ mK	correction mK	$u_{correction}$ mK	correction mK	$u_{correction}$ mK
$\overline{R}$ (Zn)						
$\overline{R}$ (Sn)						
$\overline{R}$ (In)						
$\overline{R}$ (Ga)						
$\overline{R}$ (Hg)						
$\overline{R}$ (Ar)						

Appendix C: Suggested Uncertainty Budget for the Determination of the *W*-Value of an SPRT

Participating NMI

	Ar		Hg		Ga		In		Sn		Zn		
	mK	**df**	**mK**	**df**	**mK**	**df**	**mK**	**df**	**mK**	**df**	**mK**	**df**	**Type A or B (*)**
Phase Transition Realization Repeatability													
Bridge (repeatability, non-linearity, AC quadrature)													
Reference resistor stability													
Chemical Impurities													
Hydrostatic-head													
Propagated TPW													
SPRT self-heating													
Heat Flux													
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure													
Combined Standard Uncertainty													
Expanded Uncertainty (*k*=2 level, using effective df)													

(*) write A or B depending on the method used

df: degree of freedom

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Appendix D:

Name, postal and e-mail addresses of the coordinator:

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Appendix E:
NMi/DI participants in each loop.

Loop 1: LNE-Cnam (France)	Loop 2: PTB (Germany)	Loop 3: INRIM (Italy)	Loop 4: VSL (Netherlands)	Loop 5: NPL (United Kingdom)
	MIKES (Finland)	Roth+Co.AG (Switzerland)	SP (Sweden)	MKEH (Hungary)
SMD (Belgium)	CMI (Czech Republic)	MCCAA (Malta)	DTI (Denmark)	EIM (Greece)
CEM (Spain)	UME (Turkey)	HMI (Croatia)	GUM (Poland)	BIM (Bulgaria)
IPQ (Portugal)	SMU (Slovakia)	MIRS/UL-FE/LMK (Slovenia)	VMT/FTMC (Lithuania)	BoM (FYR Macedonia)
JV (Norway)	NSAI NML (Ireland)	IMBiH (Bosnia-Herzegovina)	DPM (Albania)	BEV (Austria)
		DMDM (Serbia)		INM (Romania)

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Appendix F:
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Appendix II Detailed uncertainty tables

The following tables contain detailed uncertainties supplied by each NMI using the “Appendix C: Suggested Uncertainty Budget for the Determination of the *W*-Value of an SPRT” from the original EURAMET.T-K9 protocol, along with the uncertainties determined at the pilot laboratory.

The columns named “Type” provide indication about the classification of the uncertainty (either Type A or Type B). An additional information is supplied in brackets, to indicate whether an uncertainty component is related to either a random (R) or a systematic effect (S).

II.1 BEV (Austria) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.302	∞	0.382	∞	0.250	∞	0.435	∞	0.719	∞	0.793	∞	B (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.040	∞	0.027	∞	0.030	∞	0.050	∞	0.244	∞	0.079	∞	B (S)
Reference resistor stability	0.006	∞	0.024	∞	0.033	∞	0.049	∞	0.059	∞	0.085	∞	B (S)
Chemical Impurities	0.300	∞	0.250	∞	0.100	∞	0.300	∞	0.030	∞	0.030	∞	B (S)
Hydrostatic-head	0.019	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.032	∞	0.135	∞	0.184	∞	0.273	∞	0.327	∞	0.473	∞	B (R)
SPRT self-heating	0.030	∞	0.022	∞	0.058	∞	0.133	∞	0.120	∞	0.104	∞	B (R)
Heat Flux	0.231	∞	0.085	∞	0.031	∞	0.161	∞	0.119	∞	0.119	∞	B (R)
Pressure	0.000	∞	0.000	∞	0.058	∞	0.141	∞	0.095	∞	0.124	∞	B (S)
Combined Standard Uncertainty	0.489		0.487		0.341		0.650		0.852		0.953		
Expanded Uncertainty (*k*=2, using effective df)	0.977		0.974		0.681		1.300		1.704		1.905		

Table II.1 Uncertainty budget supplied by BEV, valid for measurements performed before SPRT travelling.

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
FP repeatability	0.096	5	0.145	5	0.044	5	0.271	5	0.169	5	0.332	5	A (R)
Bridge repeatability	0.001	19	0.007	19	0.004	19	0.008	19	0.006	19	0.013	19	A (R)
Stability of Rs	0.001	∞	0.002	∞	0.003	∞	0.004	∞	0.005	∞	0.008	∞	B (S)
Link to NPL CCT-K9 cell*	0.213	746	0.000	∞	0.000	∞	0.169	527	0.143	270	0.174	184	B (R)
Hydrostatic-head	0.019	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.006	32714	0.023	37632	0.032	11918	0.048	18825	0.057	31846	0.083	9634	B (S)
Bridge non-linearity	0.027	∞	0.029	∞	0.029	∞	0.030	∞	0.031	∞	0.033	∞	B (S)
Freq, quadrature	0.013	∞	0.014	∞	0.016	∞	0.067	∞	0.044	∞	0.033	∞	B (S)
SPRT self-heating	0.003	∞	0.003	∞	0.006	∞	0.016	∞	0.015	∞	0.011	∞	B (S)
Heat Flux	0.525	∞	0.092	∞	0.023	∞	0.375	∞	0.462	∞	0.133	∞	B (S)
Moisture	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxidation	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas Pressure	0.000	∞	0.016	∞	0.015	∞	0.037	∞	0.025	∞	0.033	∞	B (S)
Slope of Plateau	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Combined Standard Uncertainty	0.576	5650	0.182	12	0.071	32	0.503	59	0.519	446	0.411	12	
Expanded Uncertainty (*k*=2, using effective df)	1.152		0.364		0.141		1.005		1.038		0.821		

* Zero if NPL CCT-K9 cell was used

Table II.2 Uncertainty budget determined at NPL on BEV SPRT

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.302	∞	0.382	∞	0.250	∞	0.435	∞	0.719	∞	0.793	∞	B (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.025	∞	0.029	∞	0.030	∞	0.043	∞	0.049	∞	0.076	∞	B (S)
Reference resistor stability	0.006	∞	0.024	∞	0.033	∞	0.049	∞	0.059	∞	0.085	∞	B (S)
Chemical Impurities	0.300	∞	0.250	∞	0.100	∞	0.300	∞	0.030	∞	0.030	∞	B (S)
Hydrostatic-head	0.019	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.032	∞	0.135	∞	0.182	∞	0.272	∞	0.326	∞	0.469	∞	B (R)
SPRT self-heating	0.026	∞	0.022	∞	0.058	∞	0.133	∞	0.120	∞	0.104	∞	B (R)
Heat Flux	0.231	∞	0.085	∞	0.031	∞	0.161	∞	0.119	∞	0.119	∞	B (R)
Pressure	0.000	∞	0.000	∞	0.058	∞	0.141	∞	0.095	∞	0.124	∞	B (S)
Combined Standard Uncertainty	0.487		0.487		0.340		0.649		0.817		0.951		0.487
Expanded Uncertainty (*k*=2, using effective df)	0.975		0.974		0.679		1.298		1.634		1.901		0.975

Table II.3 Uncertainty budget supplied by BEV, valid for measurements performed after SPRT travelling.

II.2 BFKH (Hungary) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.110	20	0.110	22	0.410	18	0.690	32	1.000	30	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.000		0.000		0.000		0.000		0.000		B (S)
Reference resistor stability			0.060		0.080		0.120		0.140		0.210		B (S)
Chemical Impurities			0.030		0.100		0.110		0.110		0.120		B (S)
Hydrostatic-head			0.020		0.000		0.010		0.010		0.010		B (S)
Propagated TPW			0.150	16	0.150	35	0.150	35	0.150	35	0.150	35	A (R)
SPRT self-heating			0.050		0.060		0.050		0.080		0.090		B (R)
Heat Flux			0.050		0.050		0.210		0.220		0.120		B (R)
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure			0.000		0.010		0.030		0.020		0.030		B (S)
Combined Standard Uncertainty			0.21		0.24		0.51		0.77		1.05		
Expanded Uncertainty (k=2, using effective df)			0.43		0.49		1.08		1.58		2.19		

Table II.4 Uncertainty budget supplied by BFKH, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
FP repeatability			0.026	5	0.009	5	0.211	5	0.147	6	0.216	8	A (R)
Bridge repeatability			0.006	19	0.006	19	0.007	19	0.005	19	0.008	19	A (R)
Stability of Rs			0.002	∞	0.003	∞	0.004	∞	0.005	∞	0.008	∞	B (S)
Link to NPL CCT-K9 cell*			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (R)
Hydrostatic-head			0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW			0.024	4234	0.032	7426 4	0.048	1070 3	0.058	5114	0.085	2469	B (S)
Bridge non-linearity			0.029	∞	0.029	∞	0.030	∞	0.031	∞	0.033	∞	B (S)
Freq, quadrature			0.014	∞	0.016	∞	0.067	∞	0.044	∞	0.033	∞	B (S)
SPRT self-heating			0.028	∞	0.032	∞	0.035	∞	0.036	∞	0.033	∞	B (S)
Heat Flux			0.029	∞	0.017	∞	0.092	∞	0.017	∞	0.133	∞	B (S)
Moisture			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxidation			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas Pressure			0.016	∞	0.015	∞	0.037	∞	0.025	∞	0.033	∞	B (S)
Slope of Plateau			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Combined Standard Uncertainty			0.076	379	0.062	1294 7	0.252	10	0.174	12	0.276	21	0.076
Expanded Uncertainty (*k*=2, using effective df)			0.153		0.124		0.505		0.349		0.552		0.153

* Zero if NPL CCT-K9 cell was used

Table II.5 Uncertainty budget determined at NPL on BFKH SPRT

II.3 BiM (Bulgaria) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Xt Repeatability of readings			0.030	∞	0.003	∞	0.026	∞	0.103	∞	0.167	∞	(R)
C Xt/1 purity			0.149	∞	0.127	∞	0.330	∞	0.303	∞	0.862	∞	(S)
C Xt/2 Hydrostatic pressure correction			0.080	∞	0.008	∞	0.018	∞	0.014	∞	0.014	∞	(S)
C Xt/3 perturbing heat exchanges			0.109	∞	0.051	∞	0.132	∞	0.089	∞	0.086	∞	(R)
C Xt/4 self-heating correction			0.012	∞	0.008	∞	0.008	∞	0.008	∞	0.009	∞	(R)
C Xt/5 bridge linearity			0.012	∞	0.013	∞	0.014	∞	0.016	∞	0.014	∞	(S)
C Xt/6 AC/DC current			0.052	∞	0.056	∞	0.045	∞	0.057	∞	0.057	∞	(S)
C Xt/7 gas pressure			0.052	∞	0.020	∞	0.016	∞	0.027	∞	0.043	∞	(S)
X0,01 °C Repeatability of readings				∞		∞		∞		∞		∞	(S)
X0,01 °C Repeatability of temperature realized by cell				∞		∞		∞		∞		∞	(S)
X0,01 °C Short–term repeatability of calibrated SPRT			0.029	∞	0.009	∞	0.021	∞	0.026	∞	0.020	∞	(R)
C 0,01°C/1 purity and isotopic composition			0.063	∞	0.085	∞	0.128	∞	0.153	∞	0.222	∞	(S)
C 0,01°C/2 Hydrostatic pressure correction			0.002	∞	0.003	∞	0.002	∞	0.005	∞	0.022	∞	(S)
C 0,01°C/3 perturbing heat exchanges			0.017	∞	0.023	∞	0.034	∞	0.056	∞	0.058	∞	(R)
C 0,01°C/4 self-heating correction			0.010	∞	0.014	∞	0.021	∞	0.026	∞	0.041	∞	(R)
C 0,01°C/5 bridge linearity			0.013	∞	0.017	∞	0.021	∞	0.031	∞	0.043	∞	(S)
C 0,01°C/6 AC/DC current			0.046	∞	0.063	∞	0.068	∞	0.102	∞	0.162	∞	(S)
C 0,01°C/7 internal insulation leakage			0.025	∞	0.017	∞	0.026	∞	0.031	∞	0.089	∞	(S)
DRS/1 stability of RS			0.030	∞	0.031	∞	0.021	∞	0.027	∞	0.014	∞	(S)
DRS/2 temperature of RS			0.010	∞	0.010	∞	0.011	∞	0.011	∞	0.010	∞	(R)
SWt Wt scatter			0.037	∞	0.038	∞	0.016	∞	0.041	∞	0.043	∞	(R)
Combined Standard Uncertainty			0.24	∞	0.19	∞	0.39	∞	0.40	∞	0.94	∞	
Expanded Uncertainty (k=2, using effective df)			0.48		0.39		0.79		0.80		1.87		

Table II.6 Uncertainty budget supplied by BiM, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
FP repeatability			0.057	5	0.016	5	0.108	5	0.058	6	0.298	5	A (R)
Bridge repeatability			0.027	19	0.010	19	0.013	19	0.010	19	0.017	19	A (R)
Stability of Rs			0.002	∞	0.003	∞	0.004	∞	0.005	∞	0.008	∞	B (S)
Link to NPL CCT-K9 cell*			0.000	∞	0.000	∞	0.169	527	0.143	270	0.174	184	B (R)
Hydrostatic-head			0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW			0.025	740	0.034	665	0.052	537	0.060	1743	0.092	421	B (S)
Bridge non-linearity			0.029	∞	0.029	∞	0.030	∞	0.031	∞	0.033	∞	B (S)
Freq, quadrature			0.014	∞	0.016	∞	0.067	∞	0.044	∞	0.033	∞	B (S)
SPRT self-heating			0.011	∞	0.015	∞	0.017	∞	0.017	∞	0.015	∞	B (S)
Heat Flux			0.006	∞	0.006	∞	0.058	∞	0.312	∞	0.237	∞	B (S)
Moisture			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxidation			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas Pressure			0.016	∞	0.015	∞	0.037	∞	0.025	∞	0.033	∞	B (S)
Slope of Plateau			0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Combined Standard Uncertainty			0.088	28	0.057	688	0.232	101	0.359	4737	0.433	22	
Expanded Uncertainty (*k*=2, using effective df)			0.175		0.113		0.465		0.718		0.866		

* Zero if NPL CCT-K9 cell was used

Table II.7 Uncertainty budget determined at NPL on BiM SPRT

II.4 BoM (North Macedonia) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.204	3	0.239	3			0.381	3	0.579	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.150		0.150				0.200		0.250		B (S)
Reference resistor stability			0.150		0.150				0.250		0.350		B (S)
Chemical Impurities			0.198		0.136				0.296		0.564		B (S)
Hydrostatic-head			0.041		- 0.007				0.013		0.016		B (S)
Propagated TPW			0.225	99	0.215	99			0.226	99	0.268	99	B (R)
SPRT self-heating			0.037		0.073				0.084		0.139		B (R)
Heat Flux			0.218		0.191				0.201		0.107		B (R)
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure					- 0.020				0.033		0.044		B (S)
Combined Standard Uncertainty			0.477		0.457				0.659		0.971		
Expanded Uncertainty (*k*=2, using effective df)			0.953		0.914				1.319		1.943		

Table II.8 Uncertainty budget supplied by BoM, valid for measurements performed before and after SPRT travelling

	Ar		**Hg**		**Ga**		**In**		**Sn**		**Zn**		**Type**
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Realization repeatability	0.195	2	0.021	2	0.038	2	0.225	2	0.025	2	0.053	2	A (R)
SPRT resistance measurement	0.002	57	0.003	57	0.004	57	0.009	57	0.004	19	0.005	57	A (R)
Chemical Impurities	0.032	∞	0.012	∞	0.079	∞	0.027	∞	0.175	∞	0.312	∞	B (S)
Hydrostatic head	0.032	∞	0.071	∞	0.012	∞	0.033	∞	0.022	∞	0.027	∞	B (S)
SPRT self-heating (current)	0.015	∞	0.004	∞	0.004	∞	0.005	∞	0.006	∞	0.005	∞	B (S)
SPRT self-heating (extrapolation)	0.020	29	0.021	29	0.022	29	0.090	29	0.092	29	0.097	29	B (S)
Standard resistor	0.002	49	0.021	49	0.028	49	0.042	49	0.051	49	0.074	49	B (S)
Resistance ratio bridge	0.011	29	0.012	29	0.012	29	0.052	29	0.053	29	0.056	29	B (S)
TPW propagation	0.010	74	0.041	74	0.056	74	0.083	74	0.100	74	0.144	74	B (S)
Gas pressure	0.000	∞	0.004	∞	0.040	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Heat flux (evaluated during return measurements)	0.100	∞	0.064	3	0.044	4	0.083	4	0.217	5	0.184	4	B (S)
Combined Standard Uncertainty	0.226	4	0.112	27	0.126	159	0.285	5	0.322	24	0.419	103	
Expanded Uncertainty (*k*=2, using effective df)	0.450		0.220		0.250		0.570		0.640		0.840		

Table II.9 Uncertainty budget determined at VSL on BoM SPRT

II.5 CEM (Spain) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.072	2	0.056	2	0.046	2	0.045	2	0.061	2	0.121	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.063	»19	0.042	»19	0.033	»19	0.237	»19	0.042	»19	0.043	»19	A (S)
Reference resistor stability	0.002	∞	0.002	∞	0.002	∞	0.002	∞	0.002	∞	0.002	∞	B (S)
Chemical Impurities	0.028	∞	0.057	∞	0.039	∞	0.270	∞	0.171	∞	0.326	∞	B (S)
Hydrostatic-head	0.038	∞	0.082	∞	0.014	∞	0.038	∞	0.025	∞	0.031	∞	B (S)
Propagated TPW	0.010	∞	0.042	∞	0.056	∞	0.082	∞	0.097	∞	0.134	∞	B (S)
SPRT self-heating	0.019	∞	0.026	∞	0.030	∞	0.042	∞	0.042	∞	0.043	∞	B (R)
Heat Flux	0.304	∞	0.014	∞	0.012	∞	0.100	∞	0.058	∞	0.129	∞	B (S)
Insulation leakage	0.000	∞	0.002	∞	0.002	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation	0.006	∞	0.136	∞	0.093	∞	0.044	∞	0.201	∞	0.178	∞	B (S)
Gas pressure	0.014	∞	0.003	∞	0.001	∞	0.028	∞	0.019	∞	0.025	∞	B (S)
Combined Standard Uncertainty	0.32	1761	0.19	2185	0.13	1134	0.39	92040	0.30	9366	0.44	2365	
Expanded Uncertainty (*k*=2, using effective df)	0.65		0.38		0.27		0.78		0.60		0.88	0	

Table II.10 Uncertainty budget supplied by CEM, valid for measurements performed before SPRT travelling.

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Purity and gas pressure	0.060	∞	0.020	∞	0.047	∞	0.235	∞	0.206	∞	0.441	∞	B (S)
Hydrostatic pressure correction	0.048	∞	0.040	∞	0.004	∞	0.010	∞	0.006	∞	0.008	∞	B (S)
Spurious heat fluxes	0.200	∞	0.120	∞	0.029	∞	0.029	∞	0.059	∞	0.118	∞	B (R)
Self heating correction	0.142	2	0.012	2	0.023	55	0.003	77	0.011	63	0.005	67	A (R)
Bridge linearity	0.003	2	0.003	2	0.013	2	0.013	2	0.014	2	0.014	2	B (S)
Plateau interpretation					0.031	∞	0.065	∞	0.049	∞	0.059	∞	B (S)
TPW – Repeatability of the temperature generation	0.010	∞	0.038	∞	0.050	∞	0.072	∞	0.085	∞	0.116	∞	B (R)
TPW – Short term repeatability of the thermometer	0.004	286	0.050	70	0.041	111	0.045	84	0.136	104	0.056	94	A (R)
TPW – Purity and isotopic composition	0.001	∞	0.002	∞	0.003	∞	0.005	∞	0.006	∞	0.008	∞	B (S)
TPW – Hydrostatic pressure correction	0.000	∞	0.002	∞	0.002	∞	0.003	∞	0.004	∞	0.006	∞	B (S)
TPW – Spurious heat fluxes	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
TPW – Self heating correction	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
Internal insulation leakage	0.002	∞	0.008	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (S)
Temperature correction for Rs	0.012	∞	0.012	∞	0.012	∞	0.012	∞	0.015	∞	0.022	∞	B (S)
W repeatability	0.150	2	0.096	2	0.014	148	0.053	106	0.009	129	0.060	94	A (R)
Combined Standard Uncertainty	0.298	17	0.177	23	0.108	3038	0.275	41888	0.285	2009	0.495	226736	
Expanded Uncertainty (k=2, using effective df)	0.630		0.366		0.211		0.539		0.559		0.970		

Table II.11 Uncertainty budget determined at LNE-Cnam on CEM SPRT

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.108	2	0.014	2	0.067	2	0.028	2	0.027	2	0.057	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.217	»19	0.042	»19	0.036	»19	0.056	»19	0.067	»19	0.043	»19	A (S)
Reference resistor stability	0.002	∞	0.002	∞	0.002	∞	0.002	∞	0.002	∞	0.002	∞	B (S)
Chemical Impurities	0.028	∞	0.057	∞	0.039	∞	0.270	∞	0.171	∞	0.326	∞	B (S)
Hydrostatic-head	0.048	∞	0.082	∞	0.014	∞	0.038	∞	0.025	∞	0.031	∞	B (S)
Propagated TPW	0.010	∞	0.042	∞	0.056	∞	0.082	∞	0.097	∞	0.134	∞	B (S)
SPRT self-heating	0.019	∞	0.026	∞	0.030	∞	0.042	∞	0.042	∞	0.043	∞	B (R)
Heat Flux	0.304	∞	0.014	∞	0.012	∞	0.100	∞	0.058	∞	0.129	∞	B (S)
Insulation leakage	0.000	∞	0.002	∞	0.002	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation	0.008	∞	0.017	∞	0.023	∞	0.085	∞	0.380	∞	0.031	∞	B (S)
Gas pressure	0.014	∞	0.003	∞	0.001	∞	0.028	∞	0.019	∞	0.025	∞	B (S)
Combined Standard Uncertainty	0.39	1265	0.12	83863	0.11	120	0.32	284961	0.44	1196222	0.39	27047	
Expanded Uncertainty (*k*=2, using effective df)	0.79		0.24		0.22		0.65		0.88		0.78		

Table II.12 Uncertainty budget supplied by CEM, valid for measurements performed after SPRT travelling.

II.6 CMI (Czech Republic) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.055		0.045		0.029		0.080		0.058		0.115		A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.030		0.020		0.020		0.045		0.055		0.065		B (S)
Reference resistor stability	0.012		0.012		0.012		0.029		0.029		0.029		B (S)
Chemical Impurities	0.270		0.080		0.029		0.300		0.087		0.270		B (S)
Hydrostatic-head	0.055		0.082		0.020		0.038		0.038		0.031		B (S)
Propagated TPW	0.085		0.064		0.069		0.092		0.104		0.133		B (R)
SPRT self-heating	0.075		0.058		0.029		0.029		0.029		0.029		B (R)
Heat Flux	0.087		0.057		0.037		0.115		0.120		0.087		B (R)
Moisture	0.052		0.052		0.030		0.029		0.029		0.020		B (S)
SPRT Pt Oxydation	0.085		0.035		0.029		0.065		0.085		0.100		B (S)
Gas pressure	0.150		0.065		0.115		0.120		0.150		0.250		B (S)
Slope of Plateau	0.200		0.060		0.050		0.087		0.120		0.087		B (R)
Combined Standard Uncertainty	0.42		0.20		0.16		0.39		0.30		0.45		
Expanded Uncertainty (*k*=2, using effective df)	0.83		0.39		0.33		0.78		0.59		0.89		

Table II.13 Uncertainty budget supplied by CMI, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.220	4	0.150	3	0.110	3	0.180	3	0.540	4	0.410	4	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.010	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	B (S)
Reference resistor stability	0.010	∞	0.010	∞	0.020	∞	0.030	∞	0.030	∞	0.030	∞	B (S)
Chemical Impurities	0.200	∞	0.060	∞	0.070	∞	0.090	∞	0.150	∞	0.280	∞	B (S)
Hydrostatic-head	0.040	∞	0.070	∞	0.010	∞	0.030	∞	0.020	∞	0.030	∞	B (S)
Propagated TPW	0.020	∞	0.070	∞	0.060	∞	0.080	∞	0.100	∞	0.150	∞	B (S)
SPRT self-heating	0.020	∞	0.050	∞	0.020	∞	0.020	∞	0.030	∞	0.030	∞	B (S)
Heat Flux	0.100	∞	0.020	∞	0.100	∞	0.700	∞	0.700	∞	1.000	∞	B (S)
Insulation leakage		∞		∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation		∞		∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas pressure		∞	0.010	∞	0.020	∞	0.050	∞	0.030	∞	0.040	∞	B (S)
Combined Standard Uncertainty	0.320	18	0.200	9	0.120	4	0.450	117	0.520	3	0.650	25	
Expanded Uncertainty (*k*=2, using effective df)	0.640		0.410		0.250		0.900		1.040		1.300		

Table II.14 Uncertainty budget determined at PTB on CMI SPRT

II.7 DMDM (Serbia) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.050	119	0.100		0.080	119	0.110	119	0.200	119	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.053	∞	0.053		0.051	∞	0.051	∞	0.071	∞	B (S)
Reference resistor stability			0.007	∞	0.007		0.007	∞	0.007	∞	0.007	∞	B (S)
Chemical Impurities			0.100	∞	0.200		0.800	∞	0.500	∞	0.700	∞	B (S)
Hydrostatic-head			0.071	∞	0.012		0.033	∞	0.022	∞	0.027	∞	B (S)
Propagated TPW			0.170	39	0.240		0.460	39	0.560	39	0.650	39	A (R)
SPRT self-heating			0.021	∞	0.016		0.064	∞	0.101	∞	0.019	∞	B (R)
Heat Flux			0.080	∞	0.100		0.080	∞	0.090	∞	0.120	∞	B (R)
Insulation leakage			0.000	∞	0.000		0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation			0.001	∞	0.001		0.004	∞	0.015	∞	0.044	∞	B (S)
Gas pressure			0.270	∞	0.100		0.245	∞	0.100	∞	0.270	∞	B (S)
Combined Standard Uncertainty			0.36	776	0.36	199	0.97	757	0.78	146	1.02	239	
Expanded Uncertainty (*k*=2, using effective df)			0.72		0.72		1.93		1.56		2.05		

Table II.15 Uncertainty budget supplied by DMDM, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.030	3	0.080	3	0.050	3	0.200	3	0.180	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	B (S)
Reference resistor stability			0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Chemical Impurities			0.010	∞	0.008	∞	0.270	∞	0.180	∞	0.370	∞	B (S)
Hydrostatic-head			0.036	∞	0.004	∞	0.012	∞	0.008	∞	0.010	∞	B (S)
Propagated TPW			0.051	∞	0.067	∞	0.094	∞	0.111	∞	0.152	∞	B (S)
SPRT self-heating			0.006	∞	0.020	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Heat Flux			0.010	∞	0.060	∞	0.010	∞	0.075	∞	0.007	∞	B (S)
Insulation leakage													B (S)
SPRT Pt Oxydation				∞		∞		∞	0.100	∞	0.050	∞	B (S)
Gas pressure				∞		∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Combined Standard Uncertainty			0.070	88	0.120	15	0.330	5667	0.320	20	0.440	107	
Expanded Uncertainty (*k*=2, using effective df)			0.150		0.250		0.660		0.640		0.890		

Table II.16 Uncertainty budget determined at INRiM on DMDM SPRT

II.8 DTI (Denmark) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.079	3	0.030	3	0.030	3	0.150	2	0.053	2	0.140	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.010	∞	0.041	∞	0.054	∞	0.082	∞	0.100	∞	0.130	∞	B (S)
Reference resistor stability	0.008	∞	0.022	∞	0.032	∞	0.024	∞	0.026	∞	0.052	∞	B (S)
Chemical Impurities	0.200	∞	0.200	∞	0.130	∞	0.470	∞	0.300	∞	0.560	∞	B (S)
Hydrostatic-head	0.014	∞	0.031	∞	0.006	∞	0.014	∞	0.010	∞	0.012	∞	B (S)
Propagated TPW	0.010	∞	0.042	∞	0.057	∞	0.087	∞	0.100	∞	0.150	∞	B (R)
SPRT self-heating	0.045	∞	0.033	∞	0.036	∞	0.052	∞	0.054	∞	0.064	∞	B (R)
Heat Flux	0.000	∞	0.005	∞	0.010	∞	0.011	∞	0.010	∞	0.010	∞	B (R)
Insulation leakage	0.000	∞	0.005	∞	0.008	∞	0.017	∞	0.024	∞	0.044	∞	B (S)
SPRT Pt Oxydation	Covered by repeatability and the focus on W-values												
Gas pressure	0.000	∞	0.000	∞	0.020	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Combined Standard Uncertainty	0.22	185	0.22	7716	0.16	2649-	0.51	288	0.34	3354	0.62	882	
Expanded Uncertainty (*k*=2, using effective df)	0.44	-	0.43	-	0.33	-	1.0	-	0.68	-	1.2	-	

Table II.17 Uncertainty budget supplied by DTI, valid for measurements performed before SPRT travelling.

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Realization repeatability	0.137	5	0.051	2	0.036	4	0.080	4	0.025	4	0.097	5	A (R)
SPRT resistance measurement	0.002	57	0.002	57	0.002	57	0.005	57	0.005	19	0.006	57	A (R)
Chemical Impurities	0.032	∞	0.012	∞	0.079	∞	0.027	∞	0.175	∞	0.312	∞	B (S)
Hydrostatic head	0.032	∞	0.071	∞	0.012	∞	0.033	∞	0.022	∞	0.027	∞	B (S)
SPRT self-heating (current)	0.017	∞	0.004	∞	0.005	∞	0.006	∞	0.006	∞	0.006	∞	B (S)
SPRT self-heating (extrapolation)	0.019	29	0.021	29	0.021	29	0.088	29	0.090	29	0.096	29	B (S)
Standard resistor	0.005	49	0.021	49	0.028	49	0.042	49	0.051	49	0.073	49	B (S)
Resistance ratio bridge	0.011	29	0.012	29	0.012	29	0.051	29	0.052	29	0.055	29	B (S)
TPW propagation	0.013	74	0.054	74	0.073	74	0.109	74	0.131	74	0.189	74	B (S)
Gas pressure	0.000	∞	0.004	∞	0.040	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Heat flux (evaluated during return measurements)	0.100	∞	0.064	3	0.044	4	0.176	4	0.044	5	0.125	4	B (S)
Combined Standard Uncertainty	0.178	14	0.126	27	0.134	179	0.256	17	0.256	573	0.422	320	
Expanded Uncertainty (*k*=2, using effective df)	0.360		0.250		0.270		0.510		0.510		0.840		

Table II.18 Uncertainty budget determined at VSL on DTI SPRT

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	2.290	2	0.065	2	0.036	2	0.084	2	0.036	2	0.160	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.002	∞	0.009	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (S)
Reference resistor stability	0.003	∞	0.026	∞	0.017	∞	0.023	∞	0.036	∞	0.030	∞	B (S)
Chemical Impurities	0.200	∞	0.200	∞	0.130	∞	0.470	∞	0.300	∞	0.560	∞	B (S)
Hydrostatic-head	0.014	∞	0.031	∞	0.006	∞	0.014	∞	0.010	∞	0.012	∞	B (S)
Propagated TPW	0.010	∞	0.044	∞	0.059	∞	0.088	∞	0.110	∞	0.150	∞	B (R)
SPRT self-heating	0.040	∞	0.034	∞	0.037	∞	0.049	∞	0.050	∞	0.036	∞	B (R)
Heat Flux	0.000	∞	0.005	∞	0.010	∞	0.011	∞	0.010	∞	0.010	∞	B (R)
Insulation leakage	0.000	∞	0.005	∞	0.008	∞	0.017	∞	0.024	∞	0.044	∞	B (S)
SPRT Pt Oxydation	Covered by repeatability and the focus on W-values												
Gas pressure	0.000	∞	0.000	∞	0.020	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Combined Standard Uncertainty	2.30	2	0.22	260	0.15	654	0.49	2279	0.33	12916	0.61	406	
Expanded Uncertainty (k=2, using effective df)	4.60		0.44		0.31		1		0.65		1.2		

Table II.19 Uncertainty budget supplied by DTI, valid for measurements performed after SPRT travelling.

II.9 EIM (Greece) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.180	∞	0.017	∞	0.009	∞	0.071	∞	0.210	∞	0.235	∞	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.030	∞	0.002	∞	0.003	∞	0.014	∞	0.020	∞	0.036	∞	B (S)
Reference resistor stability	0.005	∞	0.022	∞	0.030	∞	0.043	∞	0.052	∞	0.074	∞	B (S)
Chemical Impurities	0.300	∞	0.250	∞	0.200	∞	0.800	∞	0.500	∞	0.700	∞	B (S)
Hydrostatic-head	0.020	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.010	∞	0.042	∞	0.056	∞	0.084	∞	0.102	∞	0.147	∞	B (R)
SPRT self-heating	0.029	∞	0.017	∞	0.009	∞	0.012	∞	0.017	∞	0.020	∞	B (R)
Heat Flux	0.160	∞	0.010	∞	0.010	∞	0.038	∞	0.005	∞	0.032	∞	B (R)
Insulation leakage	0.001	∞	0.006	∞	0.008	∞	0.012	∞	0.015	∞	0.021	∞	B (S)
SPRT Pt Oxydation	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	
Gas pressure	0.000	∞	0.010	∞	0.010	∞	0.100	∞	0.080	∞	0.120	∞	B (S)
Combined Standard Uncertainty	0.40		0.29		0.24		0.85		0.57		0.82		
Expanded Uncertainty (*k*=2, using effective df)	0.80		0.57		0.49		1.70		1.14		1.63		

Table II.20 Uncertainty budget supplied by EIM, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
FP repeatability	0.060	7	0.042	5	0.006	5	0.060	5	0.026	5	0.147	5	A (R)
Bridge repeatability	0.001	19	0.005	19	0.010	19	0.005	19	0.010	19	0.023	19	A (R)
Stability of Rs	0.001	∞	0.002	∞	0.003	∞	0.004	∞	0.005	∞	0.008	∞	B (S)
Link to NPL CCT-K9 cell*	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (R)
Hydrostatic-head	0.019	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.006	4494 7	0.023	1424 91	0.032	3376 6	0.049	4450	0.058	5951	0.086	1936	B (S)
Bridge non-linearity	0.027	∞	0.029	∞	0.029	∞	0.030	∞	0.031	∞	0.033	∞	B (S)
Freq, quadrature	0.013	∞	0.014	∞	0.016	∞	0.067	∞	0.044	∞	0.033	∞	B (S)
SPRT self-heating	0.018	∞	0.021	∞	0.025	∞	0.032	∞	0.030	∞	0.028	∞	B (S)
Heat Flux	0.064	∞	0.029	∞	0.035	∞	0.052	∞	0.017	∞	0.289	∞	B (S)
Moisture	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxidation	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas Pressure	0.000	∞	0.016	∞	0.015	∞	0.037	∞	0.025	∞	0.033	∞	B (S)
Slope of Plateau	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Combined Standard Uncertainty	0.096	46	0.081	71	0.066	2364 5	0.130	112	0.095	897	0.342	148	
Expanded Uncertainty (*k*=2, using effective df)	0.193		0.161		0.133		0.259		0.190		0.684		

* Zero if NPL CCT-K9 cell was used

Table II.21 Uncertainty budget determined at NPL on EIM SPRT

II.10 FTMC (Lithuania) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.050	2	0.065	2			0.100	2	0.230	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.050	49	0.050	49			0.040	49	0.045	49	A (S)
Reference resistor stability			0.010	∞	0.020	∞			0.030	∞	0.030	∞	B (S)
Chemical Impurities			0.250	∞	0.200	∞			0.500	∞	0.700	∞	B (S)
Hydrostatic-head			0.020	∞	0.020	∞			0.030	∞	0.030	∞	B (S)
Propagated TPW			0.120	∞	0.140	∞			0.400	∞	0.260	∞	B (S)
Propagated TPW			0.030	49	0.058	49			0.160	49	0.150	49	A (R)
SPRT self-heating			0.012	∞	0.012	∞			0.030	∞	0.030	∞	B (R)
Heat Flux			0.010	∞	0.013	∞			0.050	∞	0.045	∞	B (R)
Insulation leakage			0.010	∞	0.040	∞			0.040	∞	0.040	∞	B (S)
SPRT Pt Oxydation			0.016	∞	0.018	∞			0.040	∞	0.060	∞	B (S)
Gas pressure			0.000	∞	0.012	∞			0.018	∞	0.022	∞	B (S)
Combined Standard Uncertainty			0.28		0.27				0.70		0.80		
Expanded Uncertainty (*k*=2, using effective df)			0.56		0.54				1.40		1.60		

Table II.22 Uncertainty budget supplied by FTMC, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Realization repeatability			0.168	3	0.031	2			0.051	2	0.070	3	A (R)
SPRT resistance measurement			0.002	57	0.006	57			0.006	19	0.009	57	A (R)
Chemical Impurities			0.012	∞	0.079	∞			0.175	∞	0.312	∞	B (S)
Hydrostatic head			0.071	∞	0.012	∞			0.022	∞	0.027	∞	B (S)
SPRT self-heating (current)			0.004	∞	0.004	∞			0.006	∞	0.006	∞	B (S)
SPRT self-heating (extrapolation)			0.021	29	0.087	29			0.092	29	0.098	29	B (S)
Standard resistor			0.021	49	0.028	49			0.051	49	0.074	49	B (S)
Resistance ratio bridge			0.012	29	0.050	29			0.053	29	0.056	29	B (S)
TPW propagation			0.041	74	0.050	74			0.100	74	0.145	74	B (S)
Gas pressure			0.004	∞	0.040	∞			0.033	∞	0.043	∞	B (S)
Heat flux (evaluated during return measurements)			0.064	3	0.060	4			0.100	5	0.162	4	B (S)
Combined Standard Uncertainty			0.201	6	0.161	116			0.262	172	0.413	153	
Expanded Uncertainty (*k*=2, using effective df)			0.400		0.320				0.520		0.830		

Table II.23 Uncertainty budget determined at VSL on FTMC SPRT

II.11 GUM (Poland) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.126	∞	0.044	∞	0.043	∞	0.100	∞	0.116	∞	0.126	∞	B (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.051	39	0.035	39	0.057	39	0.108	39	0.152	39	0.311	39	A (S)
Reference resistor stability	0.001	∞	0.001	∞	0.001	∞	0.001	∞	0.001	∞	0.001	∞	B (S)
Chemical Impurities	0.200	∞	0.170	∞	0.180	∞	0.270	∞	0.200	∞	0.400	∞	B (S)
Hydrostatic-head	0.066	∞	0.142	∞	0.024	∞	0.066	∞	0.044	∞	0.054	∞	B (S)
Propagated TPW	0.011	∞	0.046	∞	0.062	∞	0.093	∞	0.112	∞	0.161	∞	B (R)
SPRT self-heating	0.030	∞	0.007	∞	0.003	∞	0.025	∞	0.032	∞	0.017	∞	B (R)
Heat Flux	0.298	∞	0.028	∞	0.015	∞	0.070	∞	0.070	∞	0.054	∞	B (R)
Insulation leakage													-
SPRT Pt Oxydation		∞		∞	0.002	∞	0.061	∞	0.067	∞	0.050	∞	B (S)
Gas pressure		∞	0.010	∞	0.040	∞	0.245	∞	0.100	∞	0.215	∞	B (S)
Combined Standard Uncertainty	0.40		0.24		0.22		0.44		0.36		0.65		
Expanded Uncertainty (*k*=2, using effective df)	0.79		0.47		0.44		0.88		0.73		1.31		

Table II.24 Uncertainty budget supplied by GUM, valid for measurements performed before and after SPRT travelling.

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Realization repeatability	0.636	2	0.022	2	0.038	3	0.089	3	0.006	2	0.129	3	A (R)
SPRT resistance measurement	0.002	57	0.003	57	0.004	57	0.009	57	0.004	19	0.005	57	A (R)
Chemical Impurities	0.032	∞	0.012	∞	0.079	∞	0.027	∞	0.175	∞	0.312	∞	B (S)
Hydrostatic head	0.032	∞	0.071	∞	0.012	∞	0.033	∞	0.022	∞	0.027	∞	B (S)
SPRT self-heating (current)	0.015	∞	0.004	∞	0.004	∞	0.005	∞	0.006	∞	0.005	∞	B (S)
SPRT self-heating (extrapolation)	0.020	29	0.021	29	0.022	29	0.090	29	0.092	29	0.097	29	B (S)
Standard resistor	0.002	49	0.021	49	0.028	49	0.042	49	0.051	49	0.074	49	B (S)
Resistance ratio bridge	0.011	29	0.012	29	0.012	29	0.052	29	0.053	29	0.056	29	B (S)
TPW propagation	0.010	74	0.041	74	0.056	74	0.083	74	0.100	74	0.144	74	B (S)
Gas pressure	0.000	∞	0.004	∞	0.040	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Heat flux (evaluated during return measurements)	0.100	∞	0.064	3	0.034	4	0.083	4	0.234	5	0.184	4	B (S)
Combined Standard Uncertainty	0.646	2	0.112	28	0.123	225	0.197	41	0.333	20	0.435	92	
Expanded Uncertainty (*k*=2, using effective df)	1.290		0.220		0.250		0.390		0.670		0.870		

Table II.25 Uncertainty budget determined at VSL on GUM SPRT

II.12 HMI (Croatia) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.066	2	0.088	2			0.068	2	0.137	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.158	74	0.187	71			0.297	63	0.413	58	B (S)
Reference resistor stability			0.017	50	0.023	50			0.039	50	0.053	50	B (S)
Chemical Impurities			0.300	50	0.300	50			0.800	50	2.081	50	B (S)
Hydrostatic-head			0.082	50	0.014	50			0.025	50	0.031	50	B (S)
Propagated TPW			0.222	40	0.295	40			0.499	40	0.677	40	B (R)
SPRT self-heating			0.013	50	0.014	50			0.012	50	0.011	50	B (R)
Heat Flux			0.040	8	0.077	8			0.197	8	0.504	8	A (R)
Insulation leakage			0.008	50	0.011	50			0.019	50	0.026	50	B (S)
SPRT Pt Oxydation			0.001	2	0.002	2			0.028	2	0.081	2	A (S)
Gas pressure			0.016	50	0.006	50			0.019	50	0.025	50	B (S)
Combined Standard Uncertainty			0.422		0.476				1.012		2.290		
Expanded Uncertainty (*k*=2, using effective df)			0.852		0.961				2.044		4.671		

Table II.26 Uncertainty budget supplied by HMI, valid for measurements performed before SPRT travelling.

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.030	3	0.080	3			0.200	3	0.180	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.020	40	0.020	40			0.020	40	0.020	40	B (S)
Reference resistor stability			0.010	∞	0.010	∞			0.010	∞	0.010	∞	B (S)
Chemical Impurities			0.010	∞	0.008	∞			0.180	∞	0.370	∞	B (S)
Hydrostatic-head			0.036	∞	0.004	∞			0.008	∞	0.010	∞	B (S)
Propagated TPW			0.051	∞	0.067	∞			0.111	∞	0.152	∞	B (S)
SPRT self-heating			0.006	∞	0.020	∞			0.010	∞	0.010	∞	B (S)
Heat Flux			0.010	∞	0.060	∞			0.075	∞	0.007	∞	B (S)
Insulation leakage													B (S)
SPRT Pt Oxydation				∞		∞			0.100	∞	0.050	∞	B (S)
Gas pressure				∞		∞			0.010	∞	0.010	∞	B (S)
Combined Standard Uncertainty			0.070	88	0.120	15			0.320	20	0.440	107	
Expanded Uncertainty (*k*=2, using effective df)			0.150		0.250				0.640		0.890		

Table II.27 Uncertainty budget determined at INRiM on HMI SPRT

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.057	2	0.032	2			0.021	2	0.015	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.162	79	0.187	71			0.297	63	0.415	59	B (S)
Reference resistor stability			0.017	50	0.023	50			0.039	50	0.053	50	B (S)
Chemical Impurities			0.300	50	0.300	50			0.800	50	2.081	50	B (S)
Hydrostatic-head			0.082	50	0.014	50			0.025	50	0.031	50	B (S)
Propagated TPW			0.223	40	0.295	40			0.499	40	0.678	40	B (R)
SPRT self-heating			0.013	50	0.013	50			0.009	50	0.005	50	B (R)
Heat Flux			0.040	8	0.077	8			0.197	8	0.504	8	A (R)
Insulation leakage			0.008	50	0.011	50			0.019	50	0.026	50	B (S)
SPRT Pt Oxydation			0.002	2	0.003	2			0.046	2	0.132	2	A (S)
Gas pressure			0.016	50	0.006	50			0.019	50	0.025	50	B (S)
Combined Standard Uncertainty			0.422		0.469				1.011		2.289		
Expanded Uncertainty (*k*=2, using effective df)			0.853		0.947				2.042		4.669		

Table II.28 Uncertainty budget supplied by HMI, valid for measurements performed after SPRT travelling.

II.13 IMBiH (Bosnia – Herzegovina) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.227	49	0.058	49			0.279	49	1.690	49	B (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.000	49	0.000	49			0.000	49	0.000	49	B (S)
Reference resistor stability			0.153	49	0.153	49			0.153	49	0.153	49	B (S)
Chemical Impurities			0.003	49	0.002	49			0.250	49	0.250	49	B (S)
Hydrostatic-head			0.081	49	0.002	49			0.008	49	0.012	49	B (S)
Propagated TPW			0.122	49	0.214	49			0.613	49	1.129	49	B (R)
SPRT self-heating			0.007	49	0.011	49			0.011	49	0.010	49	B (R)
Heat Flux			0.023	49	0.009	49			0.075	49	0.018	49	B (R)
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure													
Combined Standard Uncertainty			0.784		0.641				1.178		1.806		
Expanded Uncertainty (k=2, using effective df)			1.568		1.281				2.356		3.612		

Table II.29 Uncertainty budget supplied by IMBiH, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.190	3	0.030	3	0.080	3	0.050	3	0.200	3	0.180	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	B (S)
Reference resistor stability	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Chemical Impurities	0.028	∞	0.010	∞	0.008	∞	0.270	∞	0.180	∞	0.370	∞	B (S)
Hydrostatic-head	0.012	∞	0.036	∞	0.004	∞	0.012	∞	0.008	∞	0.010	∞	B (S)
Propagated TPW	0.018	∞	0.051	∞	0.067	∞	0.094	∞	0.111	∞	0.152	∞	B (S)
SPRT self-heating	0.010	∞	0.006	∞	0.020	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Heat Flux	0.115	∞	0.010	∞	0.060	∞	0.010	∞	0.075	∞	0.007	∞	B (S)
Insulation leakage													B (S)
SPRT Pt Oxydation		∞		∞		∞		∞	0.100	∞	0.050	∞	B (S)
Gas pressure		∞		∞		∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Combined Standard Uncertainty	0.250	9	0.070	88	0.120	15	0.330	5667	0.320	20	0.440	107	
Expanded Uncertainty (*k*=2, using effective df)	0.510		0.150		0.250		0.660		0.640		0.890		

Table II.30 Uncertainty budget determined at INRiM on IMBiH SPRT

II.14 INM (Romania) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.200	3	0.050	3	0.050	4	0.250	3	0.20	3	0.30	3	A (R)
Bridge (repeatability)	0.010	59	0.010	59	0.010	59	0.010	59	0.01	59	0.01	59	A (R)
Bridge (non-linearity, AC quadrature)	0.100		0.100		0.100		0.100		0.10		0.10		B (S)
Reference resistor stability	0.010		0.010		0.010		0.050		0.05		0.05		B (S)
Chemical Impurities	0.350		0.080		0.130		0.850		0.96		1.15		B (S)
Hydrostatic-head	0.050		0.040		0.006		0.010		0.01		0.01		B (S)
Propagated TPW	0.150	8×10^5	0.150	8×10^5	0.150	8×10^5	0.150	8×10^5	0.20	8×10^5	0.30	8×10^5	A and B (R)
SPRT self-heating	0.040		0.030		0.030		0.060		0.06		0.06		B (R)
Heat Flux	0.400		0.130		0.160		0.400		0.40		0.40		B (R)
Insulation leakage			0.010		0.010								B (S)
SPRT Pt Oxydation			0.010		0.100		0.100		0.10		0.10		B (S)
Gas pressure					0.010		0.020		0.02		0.02		B (S)
Combined Standard Uncertainty	0.60	242	0.25	1797	0.30	5037	1.00	758	1.10	2719	1.30	1056	
Expanded Uncertainty (k=2, using effective df)	1.20		0.50		0.60		2.00		2.20		2.60		

Table II.31 Uncertainty budget supplied by INM, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
FP repeatability	0.171	5	0.002	5	0.018	5	0.025	5	0.266	5	0.202	6	A (R)
Bridge repeatability	0.001	19	0.010	19	0.009	19	0.003	19	0.008	19	0.014	19	A (R)
Stability of Rs	0.001	∞	0.002	∞	0.003	∞	0.004	∞	0.005	∞	0.008	∞	B (S)
Link to NPL CCT-K9 cell*	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (R)
Hydrostatic-head	0.019	∞	0.041	∞	0.007	∞	0.019	∞	0.013	∞	0.016	∞	B (S)
Propagated TPW	0.006	58827	0.023	17424	0.032	26103	0.048	23729	0.059	3229	0.083	12712	B (S)
Bridge non-linearity	0.027	∞	0.029	∞	0.029	∞	0.030	∞	0.031	∞	0.033	∞	B (S)
Freq, quadrature	0.013	∞	0.014	∞	0.016	∞	0.067	∞	0.044	∞	0.033	∞	B (S)
SPRT self-heating	0.017	∞	0.018	∞	0.022	∞	0.029	∞	0.027	∞	0.024	∞	B (S)
Heat Flux	0.144	∞	0.017	∞	0.017	∞	0.037	∞	0.052	∞	0.283	∞	B (S)
Moisture	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxidation	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas Pressure	0.000	∞	0.016	∞	0.015	∞	0.037	∞	0.025	∞	0.033	∞	B (S)
Slope of Plateau	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Combined Standard Uncertainty	0.228	16	0.065	28772	0.060	624	0.111	1786	0.285	7	0.363	63	
Expanded Uncertainty (k=2, using effective df)	0.455		0.130		0.120		0.221		0.571		0.727		

* Zero if NPL CCT-K9 cell was used

Table II.32 Uncertainty budget determined at NPL on INM SPRT

II.15 IPQ (Portugal) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.005	29	0.004	29	0.008	29	0.009	29	0.008	29	0.012	29	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.025	∞	0.097	∞	0.129	∞	0.186	∞	0.218	∞	0.296	∞	B (S)
Reference resistor stability	0.014	∞	0.014	∞	0.014	∞	0.058	∞	0.058	∞	0.058	∞	B (S)
Chemical Impurities	0.300	∞	0.250	∞	0.200	∞	0.800	∞	0.500	∞	0.700	∞	B (S)
Hydrostatic-head	0.019	50	0.041	50	0.007	50	0.019	50	0.013	50	0.016	50	B (S)
Propagated TPW	0.290	50	0.290	50	0.256	50	0.299	50	0.290	50	0.290	50	B (R)
SPRT self-heating	0.018	50	0.029	50	0.035	50	0.034	50	0.032	50	0.028	50	B (R)
Heat Flux	0.050	50	0.035	50	0.080	50	0.066	50	0.160	50	0.040	50	B (R)
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure													
Combined Standard Uncertainty	0.42	224	0.40	181	0.39	196	0.88	3715	0.64	1096	0.82	3145	
Expanded Uncertainty (*k*=2, using effective df)	0.84		0.80		0.77		1.76		1.28		1.63		

Table II.33 Uncertainty budget supplied by IPQ, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Purity and gas pressure	0.060	∞	0.020	∞	0.047	∞	0.235	∞	0.206	∞	0.441	∞	B (S)
Hydrostatic pressure correction	0.048	∞	0.040	∞	0.004	∞	0.010	∞	0.006	∞	0.008	∞	B (S)
Spurious heat fluxes	0.200	∞	0.120	∞	0.029	∞	0.029	∞	0.059	∞	0.118	∞	B (R)
Self heating correction	0.259	2	0.183	2.00	0.026	52	0.007	51	0.012	46	0.055	15	A (R)
Bridge linearity	0.003	2	0.003	2	0.013	2	0.013	2	0.014	2	0.014	2	B (S)
Plateau interpretation					0.031	∞	0.065	∞	0.049	∞	0.059	∞	B (S)
TPW – Repeatability of the temperature generation	0.010	∞	0.038	∞	0.050	∞	0.072	∞	0.085	∞	0.116	∞	B (R)
TPW – Short term repeatability of the thermometer	0.057	272	0.008	45	0.003	84	0.040	59	0.049	64	0.016	48	A (R)
TPW – Purity and isotopic composition	0.001	∞	0.002	∞	0.003	∞	0.005	∞	0.006	∞	0.008	∞	B (S)
TPW – Hydrostatic pressure correction	0.000	∞	0.002	∞	0.002	∞	0.003	∞	0.004	∞	0.006	∞	B (S)
TPW – Spurious heat fluxes	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
TPW – Self heating correction	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
Internal insulation leakage	0.002	∞	0.008	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (S)
Temperature correction for Rs	0.012	∞	0.012	∞	0.012	∞	0.012	∞	0.015	∞	0.022	∞	B (S)
W repeatability	0.578	2	0.099	2	0.031	111	0.100	83	0.014	95	0.087	16	A (R)
Combined Standard Uncertainty	0.671	3	0.250	6	0.104	3778	0.287	5447	0.256	3850 6	0.499	1486 2	
Expanded Uncertainty (k=2, using effective df)	2.134		0.613		0.204		0.563		0.501		0.978		

Table II.34 Uncertainty budget determined at LNE-Cnam on IPQ SPRT

II.16 JV (Norway) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.01	1	0.17	1	0.09	1	0.2	1	0.38	1	0.89	1	A (R)
Repeatability of readings (FP)	0.02	59	0.03	59	0.03	59	0.03	59	0.03	59	0.03	59	A (R)
Bridge (repeatability. non-linearity. AC quadrature)	0.05	∞	0.06	∞	0.06	∞	0.06	∞	0.06	∞	0.07	∞	B (S)
Reference resistor stability	0.00	∞	0.00	∞	0.00	∞	0.00	∞	0.01	∞	0.01	∞	B (S)
Chemical Impurities	0.3	∞	0.25	∞	0.20	∞	0.80	∞	0.50	∞	0.70	∞	B (S)
Hydrostatic-head	0.04	∞	0.08	∞	0.01	∞	0.04	∞	0.03	∞	0.03	∞	B (S)
Repeatability of readings (TPW)	0.01	59	0.02	59	0.03	59	0.04	59	0.05	59	0.08	59	A (R)
Propagated TPW	0.11	∞	0.24	∞	0.30	∞	0.44	∞	0.53	∞	0.78	∞	B (R)
SPRT self-heating	0.21	∞	0.23	∞	0.23	∞	0.30	∞	0.31	∞	0.26	∞	B (R)
Heat Flux	0.05	∞	0.06	∞	0.03	∞	0.04	∞	0.09	∞	0.16	∞	B (R)
Insulation leakage	0.00	∞	0.00	∞	0.00	∞	0.00	∞	0.00	∞	0.00	∞	B (S)
SPRT Pt Oxydation	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas pressure	0.84	∞	0.18	∞	0.07	∞	0.17	∞	0.11	∞	0.15	∞	B (S)
Combined Standard Uncertainty	0.93		0.50		0.45		1.00		0.89		1.42	0.93	
Expanded Uncertainty (*k*=2, using effective df)	1.86		1.00		0.90		2.00		1.78		2.84	1.86	

Table II.35 Uncertainty budget supplied by JV, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Purity and gas pressure	0.060	∞	0.020	∞	0.047	∞	0.235	∞	0.206	∞	0.441	∞	B (S)
Hydrostatic pressure correction	0.048	∞	0.040	∞	0.004	∞	0.010	∞	0.006	∞	0.008	∞	B (S)
Spurious heat fluxes	0.200	∞	0.120	∞	0.029	∞	0.029	∞	0.059	∞	0.118	∞	B (R)
Self heating correction	0.098	2	0.021	2.00	0.008	52	0.006	51	0.006	49	0.015	11	A (R)
Bridge linearity	0.003	2	0.003	2	0.013	2	0.013	2	0.014	2	0.014	2	B (S)
Plateau interpretation					0.031	∞	0.065	∞	0.049	∞	0.059	∞	B (S)
TPW – Repeatability of the temperature generation	0.010	∞	0.038	∞	0.050	∞	0.072	∞	0.085	∞	0.116	∞	B (R)
TPW – Short term repeatability of the thermometer	0.013	292	0.034	25	0.006	114	0.108	101	0.057	84	0.091	27	A (R)
TPW – Purity and isotopic composition	0.001	∞	0.002	∞	0.003	∞	0.005	∞	0.006	∞	0.008	∞	B (S)
TPW – Hydrostatic pressure correction	0.000	∞	0.002	∞	0.002	∞	0.003	∞	0.004	∞	0.006	∞	B (S)
TPW – Spurious heat fluxes	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
TPW – Self heating correction	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
Internal insulation leakage	0.002	∞	0.008	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (S)
Temperature correction for Rs	0.012	∞	0.012	∞	0.012	∞	0.012	∞	0.015	∞	0.022	∞	B (S)
W repeatability	0.032	2	0.115	2	0.018	101	0.125	105	0.059	93	0.265	48	A (R)
Combined Standard Uncertainty	0.239	70	0.184	13	0.098	6022	0.314	2590	0.263	1738 4	0.563	959	
Expanded Uncertainty (k=2, using effective df)	0.475		0.398		0.193		0.615		0.516		1.103		

Table II.36 Uncertainty budget determined at LNE-Cnam on JV SPRT

II.17 MIKES VTT (Finland) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.105	∞	0.115	∞	0.081	∞	-	-	0.173	∞	0.260	∞	B (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.313	∞	0.074	∞	0.061	∞	-	-	0.212	∞	0.396	∞	B (S)
Reference resistor stability	0.063	∞	0.067	∞	0.069	∞	-	-	0.073	∞	0.078	∞	B (S)
Chemical Impurities	0.532	∞	0.320	∞	0.282	∞	-	-	0.511	∞	0.709	∞	B (S)
Hydrostatic-head	0.024	∞	0.051	∞	0.050	∞	-	-	0.016	∞	0.017	∞	B (S)
Propagated TPW	0.026	∞	0.104	∞	0.312	∞	-	-	0.240	∞	0.336	∞	B (R)
SPRT self-heating	0.023	∞	0.062	∞	0.021	∞	-	-	0.072	∞	0.069	∞	B (R)
Heat Flux	0.093	∞	0.010	∞	0.026	∞	-	-	0.023	∞	0.067	∞	B (R)
Insulation leakage	0	∞	0	∞	0	∞	-	-	0	∞	0	∞	B (S)
SPRT Pt Oxydation	0.006	∞	0.006	∞	0.006	∞	-	-	0.054	∞	0.157	∞	B (S)
Gas pressure	0	∞	0	∞	0.030	∞	-	-	0.013	∞	0.065	∞	B (S)
Combined Standard Uncertainty	0.688		0.378		0.443		-		0.639		0.940		
Expanded Uncertainty (*k*=2, using effective df)	1.38		0.76		0.89		-		1.28		1.88		

Table II.37 Uncertainty budget supplied by MIKES-VTT, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.23	3	0.18	3	0.08	3	0.23	4	0.6	4	0.43	5	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.01	∞	0.05	∞	0.05	∞	0.05	∞	0.05	∞	0.05	∞	B (S)
Reference resistor stability	0.01	∞	0.01	∞	0.02	∞	0.03	∞	0.03	∞	0.03	∞	B (S)
Chemical Impurities	0.2	∞	0.06	∞	0.07	∞	0.09	∞	0.15	∞	0.28	∞	B (S)
Hydrostatic-head	0.04	∞	0.07	∞	0.01	∞	0.03	∞	0.02	∞	0.03	∞	B (S)
Propagated TPW	0.02	∞	0.07	∞	0.06	∞	0.08	∞	0.1	∞	0.15	∞	B (S)
SPRT self-heating	0.02	∞	0.05	∞	0.02	∞	0.02	∞	0.03	∞	0.03	∞	B (S)
Heat Flux	0.1	∞	0.02	∞	0.1	∞	0.7	∞	0.7	∞	1	∞	B (S)
Insulation leakage		∞		∞	0	∞	0	∞	0	∞	0	∞	B (S)
SPRT Pt Oxydation		∞		∞	0	∞	0	∞	0	∞	0	∞	B (S)
Gas pressure		∞	0.01	∞	0.02	∞	0.05	∞	0.03	∞	0.04	∞	B (S)
Combined Standard Uncertainty	0.33	13	0.22	7	0.12	15	0.45	59	0.55	3	0.66	28	
Expanded Uncertainty (k=2, using effective df)	0.65		0.45		0.25		0.9		1.09		1.31		

Table II.38 Uncertainty budget determined at PTB on MIKES VTT SPRT

II.18 MIRS/ UL-FE/ LMK (Slovenia) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.038	5	0.041	5	0.042	5	0.069	5	0.049	5	0.236	5	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.027	60	0.027	60	0.027	60	0.027	60	0.027	60	0.027	60	A (S)
Reference resistor stability	0.001	180	0.001	180	0.001	180	0.001	180	0.001	180	0.001	180	A (S)
Chemical Impurities	0.030	∞	0.010	∞	0.010	∞	0.170	∞	0.170	∞	0.290	∞	B (S)
Hydrostatic-head	0.016	∞	0.035	∞	0.006	∞	0.016	∞	0.011	∞	0.013	∞	B (S)
Propagated TPW	0.020	∞	0.060	∞	0.070	∞	0.100	∞	0.130	∞	0.150	∞	B (R)
SPRT self-heating	0.020	∞	0.020	∞	0.020	∞	0.020	∞	0.020	∞	0.020	∞	B (R)
Heat Flux	0.110	∞	0.055	∞	0.015	∞	0.150	∞	0.080	∞	0.110	∞	A (R)
Insulation leakage	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation	0.000	∞	0.015	∞	0.015	∞	0.030	∞	0.040	∞	0.050	∞	B (S)
Gas pressure	0.000	∞	0.000	∞	0.000	∞	0.005	∞	0.005	∞	0.005	∞	B (S)
Combined Standard Uncertainty	0.127		0.105		0.091		0.264		0.242		0.421		
Expanded Uncertainty (k=2, using effective df)	0.250		0.210		0.180		0.530		0.480		0.840		

Table II.39 Uncertainty budget supplied by MIRS/ UL-FE/ LMK, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.190	3	0.030	3	0.080	3	0.050	3	0.200	3	0.180	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	B (S)
Reference resistor stability	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Chemical Impurities	0.028	∞	0.010	∞	0.008	∞	0.270	∞	0.180	∞	0.370	∞	B (S)
Hydrostatic-head	0.012	∞	0.036	∞	0.004	∞	0.012	∞	0.008	∞	0.010	∞	B (S)
Propagated TPW	0.018	∞	0.051	∞	0.067	∞	0.094	∞	0.111	∞	0.152	∞	B (S)
SPRT self-heating	0.010	∞	0.006	∞	0.020	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Heat Flux	0.115	∞	0.010	∞	0.060	∞	0.010	∞	0.075	∞	0.007	∞	B (S)
Insulation leakage													B (S)
SPRT Pt Oxydation		∞		∞		∞		∞	0.100	∞	0.050	∞	B (S)
Gas pressure		∞		∞		∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Combined Standard Uncertainty	0.250	9	0.070	88	0.120	15	0.330	5667	0.320	20	0.440	107	
Expanded Uncertainty (*k*=2, using effective df)	0.510		0.150		0.250		0.660		0.640		0.890		

Table II.40 Uncertainty budget determined at INRiM on MIRS/ UL-FE/ LMK SPRT

II.19 NSAI – NML (Ireland) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.150		0.110		0.140		0.300		0.140	160	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.030	∞	0.030	∞	0.060	∞	0.080	∞	0.140	∞	B (R)
Reference resistor stability			0.003	∞	0.003	∞	0.003	∞	0.003	∞	0.003	∞	B (S)
Chemical Impurities			0.250	∞	0.200	∞	0.780	∞	0.520	∞	0.710	∞	B (S)
Hydrostatic-head			0.050	∞	0.010	∞	0.020	∞	0.020	∞	0.020	∞	B (S)
Propagated TPW			0.120	∞	0.160	∞	0.240	∞	0.290	∞	0.410	∞	B (R)
SPRT self-heating			0.020	∞	0.030	∞	0.030	∞	0.030	∞	0.030	∞	B (R)
Heat Flux			0.010	∞	0.010	∞	0.020	∞	0.030	∞	0.080	∞	B (R)
Insulation leakage													
SPRT Pt Oxydation					0.060	∞	0.090	∞	0.150	∞	0.140	∞	B (S)
Gas pressure			0.080		0.080		0.480		0.200		0.260	∞	B (S)
Combined Standard Uncertainty			0.33		0.30		0.96		0.72		0.90		
Expanded Uncertainty (*k*=2, using effective df)			0.66		0.60		1.92		1.44		1.80		

Table II.41 Uncertainty budget supplied by NSAI - NML, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.100	3	0.170	3	0.270	4	0.440	4	0.390	4	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.050	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	B (S)
Reference resistor stability			0.010	∞	0.020	∞	0.030	∞	0.030	∞	0.030	∞	B (S)
Chemical Impurities			0.060	∞	0.070	∞	0.090	∞	0.150	∞	0.280	∞	B (S)
Hydrostatic-head			0.070	∞	0.010	∞	0.030	∞	0.020	∞	0.030	∞	B (S)
Propagated TPW			0.070	∞	0.060	∞	0.080	∞	0.100	∞	0.150	∞	B (S)
SPRT self-heating			0.050	∞	0.020	∞	0.020	∞	0.030	∞	0.030	∞	B (S)
Heat Flux			0.020	∞	0.100	∞	0.700	∞	0.700	∞	1.000	∞	B (S)
Insulation leakage				∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation				∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas pressure			0.010	∞	0.020	∞	0.050	∞	0.030	∞	0.040	∞	B (S)
Combined Standard Uncertainty			0.170	25	0.120	1	0.450	31	0.490	6	0.650	31	
Expanded Uncertainty (*k*=2, using effective df)			0.340		0.250		0.900		0.980		1.300		

Table II.42 Uncertainty budget determined at PTB on NSAI -NML SPRT

II.20 RISE (Sweden) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.350	2	0.090	2	0.090	2	0.220	2	0.220	2	0.240	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.040	>50	0.040	>50	0.040	>50	0.040	>50	0.040	>50	0.040	>50	B (S)
Reference resistor stability	0.080	>50	0.080	>50	0.080	>50	0.080	>50	0.080	>50	0.080	>50	B (S)
Chemical Impurities	0.690	>50	0.140	>50	0.060	>50	0.060	>50	0.290	>50	0.400	>50	B (S)
Hydrostatic-head	0.060	>50	0.040	>50	0.010	>50	0.020	>50	0.020	>50	0.020	>50	B (S)
Propagated TPW	0.030	>50	0.120	>50	0.160	>50	0.230	>50	0.270	>50	0.370	>50	B (R)
SPRT self-heating	0.030	>50	0.050	>50	0.050	>50	0.070	>50	0.070	>50	0.070	>50	B (R)
Heat Flux	0.170	>50	0.120	>50	0.120	>50	0.120	>50	0.120	>50	0.120	>50	B (R)
Insulation leakage	0.030	>50	0.030	>50	0.030	>50	0.030	>50	0.030	>50	0.030	>50	B (S)
SPRT Pt Oxydation	0.020	>50	0.080	>50	0.110	>50	0.160	>50	0.190	>50	0.260	>50	B (S)
Gas pressure	0.000	>50	0.000	>50	0.010	>50	0.010	>50	0.060	>50	0.080	>50	B (S)
Combined Standard Uncertainty	0.80		0.27		0.27		0.56		0.52		0.67		
Expanded Uncertainty (*k*=2, using effective df)	1.61		0.55		0.54		1.13		1.04		1.35		

Table II.43 Uncertainty budget supplied by RISE, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Realization repeatability	0.061	2	0.040	2	0.026	2	0.050	2	0.107	2	0.133	3	A (R)
SPRT resistance measurement	0.002	57	0.003	57	0.004	57	0.009	57	0.004	19	0.005	57	A (R)
Chemical Impurities	0.032	∞	0.012	∞	0.079	∞	0.027	∞	0.175	∞	0.312	∞	B (S)
Hydrostatic head	0.032	∞	0.071	∞	0.012	∞	0.033	∞	0.022	∞	0.027	∞	B (S)
SPRT self-heating (current)	0.015	∞	0.004	∞	0.004	∞	0.005	∞	0.006	∞	0.005	∞	B (S)
SPRT self-heating (extrapolation)	0.020	29	0.021	29	0.022	29	0.090	29	0.092	29	0.097	29	B (S)
Standard resistor	0.002	49	0.021	49	0.028	49	0.042	49	0.051	49	0.074	49	B (S)
Resistance ratio bridge	0.011	29	0.012	29	0.012	29	0.052	29	0.053	29	0.056	29	B (S)
TPW propagation	0.010	74	0.041	74	0.056	74	0.083	74	0.100	74	0.144	74	B (S)
Gas pressure	0.000	∞	0.004	∞	0.040	∞	0.049	∞	0.033	∞	0.043	∞	B (S)
Heat flux (evaluated during return measurements)	0.100	∞	0.064	3	0.044	4	0.083	4	0.176	5	0.271	4	B (S)
Combined Standard Uncertainty	0.129	40	0.117	27	0.123	191	0.182	60	0.314	37	0.480	36	
Expanded Uncertainty (*k*=2, using effective df)	0.260		0.230		0.250		0.360		0.630		0.960		

Table II.44 Uncertainty budget determined at VSL on RISE SPRT

II.21 ROTH+CO. AG (Switzerland) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.100	2	0.030	2	0.029	2	0.039	2	0.088	2	0.128	2	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.100	∞	0.200	∞	0.200	∞	0.200	∞	0.150	∞	0.150	∞	B (S)
Reference resistor stability	0.002	∞	0.009	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (R)
Reference resistor value	0.013	∞	0.053	∞	0.070	∞	0.101	∞	0.120	∞	0.162	∞	B (S)
Chemical Impurities	0.300	∞	0.250	∞	0.200	∞	0.800	∞	0.500	∞	0.700	∞	B (S)
Hydrostatic-head	0.095	∞	0.205	∞	0.035	∞	0.095	∞	0.064	∞	0.078	∞	B (S)
Propagated TPW	0.011	∞	0.045	∞	0.059	∞	0.085	∞	0.100	∞	0.136	∞	B (R)
SPRT self-heating	0.012	∞	0.016	∞	0.016	∞	0.021	∞	0.023	∞	0.019	∞	B (R)
Heat Flux	0.100	∞	0.007	∞	0.046	∞	0.054	∞	0.158	∞	0.137	∞	B (R)
Insulation leakage	0.000	∞	0.000	∞	0.000	∞	0.010	∞	0.010	∞	0.020	∞	B (S)
SPRT Pt Oxydation	0.001	∞	0.001	∞	0.001	∞	0.009	∞	0.036	∞	0.006	∞	B (S)
Gas pressure	0.010	∞	0.010	∞	0.040	∞	0.098	∞	0.066	∞	0.086	∞	B (S)
Combined Standard Uncertainty	0.360	335	0.385	57582	0.300	21359	0.843	445611	0.571	3572	0.762	2524	
Expanded Uncertainty (k=2, using effective df)	0.720		0.769		0.599		1.687		1.142		1.525		

Table II.45 Uncertainty budget supplied by ROTH+CO. AG, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.190	3	0.030	3	0.080	3	0.050	3	0.200	3	0.180	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	0.020	40	B (S)
Reference resistor stability	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Chemical Impurities	0.028	∞	0.010	∞	0.008	∞	0.270	∞	0.180	∞	0.370	∞	B (S)
Hydrostatic-head	0.012	∞	0.036	∞	0.004	∞	0.012	∞	0.008	∞	0.010	∞	B (S)
Propagated TPW	0.018	∞	0.051	∞	0.067	∞	0.094	∞	0.111	∞	0.152	∞	B (S)
SPRT self-heating	0.010	∞	0.006	∞	0.020	∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Heat Flux	0.115	∞	0.010	∞	0.060	∞	0.010	∞	0.075	∞	0.007	∞	B (S)
Insulation leakage													B (S)
SPRT Pt Oxydation		∞		∞		∞		∞	0.100	∞	0.050	∞	B (S)
Gas pressure		∞		∞		∞	0.010	∞	0.010	∞	0.010	∞	B (S)
Combined Standard Uncertainty	0.250	9	0.070	88	0.120	15	0.330	5667	0.320	20	0.440	107	
Expanded Uncertainty (k=2, using effective df)	0.510		0.150		0.250		0.660		0.640		0.890		

Table II.46 Uncertainty budget determined at INRiM on ROTH+CO. AG SPRT

II.22 SMD (Belgium) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.041	3	0.020	2	0.033	4	0.054	2	0.146	2	0.289	5	A (R)
National reference realization	0.200	100	0.027	100	0.050	100	0.050	100	0.082	100	0.317	100	B (S)
Repeatability of readings	0.002	19	0.001	19	0.002	19	0.002	19	0.005	19	0.004	19	A (R)
Bridge (repeatability. non-linearity. AC quad)	0.029	24	0.031	24	0.032	24	0.134	24	0.137	24	0.145	24	A (S)
Reference resistor value	0.105	100	0.053	100	0.071	100	0.105	100	0.128	100	0.186	100	B (S)
Reference resistor stability	0.013	300	0.006	300	0.009	300	0.013	300	0.016	300	0.023	300	A (S)
Chemical Impurities	0.100	100	0.020	100	0.020	100	0.250	100	0.310	100	0.275	100	B (S)
Hydrostatic-head	0.001	∞	0.001	∞	0.001	∞	0.002	∞	0.003	∞	0.003	∞	B (S)
Propagated TPW	0.116	150	0.058	150	0.078	150	0.116	150	0.145	150	0.204	150	B (R)
SPRT self-heating	0.004	9	0.013	9	0.018	9	0.024	9	0.020	9	0.025	9	A (R)
Heat Flux	0.160	100	0.014	∞	0.003	∞	0.026	∞	0.052	∞	0.046	∞	A (R)
Insulation leakage													B (S)
SPRT Pt Oxydation			0.020	∞	0.020	∞	0.100	∞	0.150	∞	0.200	∞	B (S)
Gas pressure			0.010	∞	0.100	∞	0.200	∞	0.150	∞	0.200	∞	B (S)
Combined Standard Uncertainty	0.32	400	0.10	320	0.17	380	0.40	350	0.48	150	0.66	120	
Expanded Uncertainty (*k*=2, using effective df)	0.63		0.19		0.32		0.79		0.94		1.30		

Table II.47 Uncertainty budget supplied by SMD, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Purity and gas pressure	0.060	∞	0.020	∞	0.047	∞	0.235	∞	0.206	∞	0.441	∞	B (S)
Hydrostatic pressure correction	0.048	∞	0.040	∞	0.004	∞	0.010	∞	0.006	∞	0.008	∞	B (S)
Spurious heat fluxes	0.200	∞	0.120	∞	0.029	∞	0.029	∞	0.059	∞	0.118	∞	B (R)
Self heating correction	0.079	2	0.046	2.00	0.032	32	0.045	92	0.004	59	0.010	49	A (R)
Bridge linearity	0.003	2	0.003	2	0.013	2	0.013	2	0.014	2	0.014	2	B (S)
Plateau interpretation					0.031	∞	0.065	∞	0.049	∞	0.059	∞	B (S)
TPW – Repeatability of the temperature generation	0.010	∞	0.038	∞	0.050	∞	0.072	∞	0.085	∞	0.116	∞	B (R)
TPW – Short term repeatability of the thermometer	0.024	377	0.324	31	0.026	86	0.048	89	0.039	70	0.292	98	A (R)
TPW – Purity and isotopic composition	0.001	∞	0.002	∞	0.003	∞	0.005	∞	0.006	∞	0.008	∞	B (S)
TPW – Hydrostatic pressure correction	0.000	∞	0.002	∞	0.002	∞	0.003	∞	0.004	∞	0.006	∞	B (S)
TPW – Spurious heat fluxes	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
TPW – Self heating correction	0.006	∞	0.024	∞	0.033	∞	0.047	∞	0.056	∞	0.076	∞	B (R)
Internal insulation leakage	0.002	∞	0.008	∞	0.011	∞	0.016	∞	0.019	∞	0.026	∞	B (S)
Temperature correction for Rs	0.012	∞	0.012	∞	0.012	∞	0.012	∞	0.015	∞	0.022	∞	B (S)
W repeatability	0.225	2	0.190	2	0.006	92	0.099	193	0.047	107	0.289	111	A (R)
Combined Standard Uncertainty	0.322	8	0.403	26	0.105	2321	0.291	1182 3	0.258	4383 4	0.638	1213	
Expanded Uncertainty (k=2, using effective df)	0.744		0.830		0.205		0.571		0.505		1.250		

Table II.48 Uncertainty budget determined at LNE-Cnam on SMD SPRT

II.23 SMU (Slovakia) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	-	-	0.064	3	0.034	3	0.073	3	0.095	3	0.635	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	-	-	0.025	3	0.025	3	0.125	3	0.110	3	0.110	3	B (S)
Reference resistor stability	-	-	0.017	4	0.017	4	0.012	4	0.012	4	0.012	4	B (S)
Chemical Impurities	-	-	0.250	0	0.010	0	0.320	0	0.350	0	0.270	0	B (S)
Hydrostatic-head	-	-	0.085	2	0.033	2	0.094	2	0.039	2	0.048	2	B (S)
Propagated TPW	-	-	0.064	3	0.084	3	0.118	3	0.138	3	0.181	3	B (R)
SPRT self-heating	-	-	0.020	3	0.021	3	0.026	3	0.028	3	0.026	3	B (R)
(522 perturbing)Heat Flux	-	-	0.073	2	0.053	2	0.106	2	0.077	2	0.229	2	B (R)
Insulation leakage	-	-	0.008	3	0.018	3	0.001	3	0.000	-	0.000	-	B (S)
SPRT Pt Oxydation	-	-	0.031	3	0.059	3	0.005	3	0.029	3	0.060	3	B (S)
Gas pressure	-	-	0.000	0	0.020	3	0.000	3	0.006	0	0.000	3	B (S)
Combined Standard Uncertainty	-	-	0.29	157	0.13	12	0.40	100	0.41	156	0.76	89	
Expanded Uncertainty (*k*=2, using effective df)	-	-	0.59		0.27		0.80		0.83		1.52		

Table II.49 Uncertainty budget supplied by SMU, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability			0.090	3	0.110	3	0.180	4	0.220	4	0.350	4	A (R)
Bridge (repeatability, non-linearity, AC quadrature)			0.050	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	B (S)
Reference resistor stability			0.010	∞	0.020	∞	0.030	∞	0.030	∞	0.030	∞	B (S)
Chemical Impurities			0.060	∞	0.070	∞	0.090	∞	0.150	∞	0.280	∞	B (S)
Hydrostatic-head			0.070	∞	0.010	∞	0.030	∞	0.020	∞	0.030	∞	B (S)
Propagated TPW			0.070	∞	0.060	∞	0.080	∞	0.100	∞	0.150	∞	B (S)
SPRT self-heating			0.050	∞	0.020	∞	0.020	∞	0.030	∞	0.030	∞	B (S)
Heat Flux			0.020	∞	0.100	∞	0.700	∞	0.700	∞	1.000	∞	B (S)
Insulation leakage				∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation				∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas pressure			0.010	∞	0.020	∞	0.050	∞	0.030	∞	0.040	∞	B (S)
Combined Standard Uncertainty			0.200	73	0.120	4	0.450	156	0.520	125	0.650	48	
Expanded Uncertainty (k=2, using effective df)			0.410		0.250		0.900		1.040		1.300		

Table II.50 Uncertainty budget determined at PTB on SMU SPRT

II.24 UME (Turkey) – detailed uncertainties

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.098		0.102		0.092		0.044		0.210		0.256		B (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.070		0.050		0.045		0.055		0.075		0.080		B (S)
Reference resistor stability	0.020		0.020		0.020		0.020		0.020		0.020		B (S)
Chemical Impurities	0.300		0.140		0.070		0.450		0.360		0.600		B (S)
Hydrostatic-head	0.034		0.035		0.015		0.034		0.022		0.027		B (S)
Propagated TPW	0.029		0.109		0.146		0.208		0.247		0.334		B (R)
SPRT self-heating	0.020		0.030		0.030		0.050		0.050		0.050		B (R)
Heat Flux	0.200		0.025		0.038		0.030		0.052		0.066		B (R)
Insulation leakage													
SPRT Pt Oxydation													
Gas pressure			0.030		0.020		0.040		0.040		0.050		B (S)
Combined Standard Uncertainty	0.38		0.22		0.20		0.51		0.50		0.74		
Expanded Uncertainty (*k*=2, using effective df)	0.77		0.44		0.40		1.01		1.00		1.49		

Table II.51 Uncertainty budget supplied by UME, valid for measurements performed before and after SPRT travelling

	Ar		Hg		Ga		In		Sn		Zn		Type
	mK	df	mK	df	mK	df	mK	df	mK	df	mK	df	
Phase Transition Realization Repeatability	0.330	4	0.220	3	0.110	3	0.230	3	0.230	3	0.390	3	A (R)
Bridge (repeatability, non-linearity, AC quadrature)	0.010	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	0.050	∞	B (S)
Reference resistor stability	0.010	∞	0.010	∞	0.020	∞	0.030	∞	0.030	∞	0.030	∞	B (S)
Chemical Impurities	0.020	∞	0.060	∞	0.070	∞	0.090	∞	0.150	∞	0.280	∞	B (S)
Hydrostatic-head	0.040	∞	0.070	∞	0.010	∞	0.030	∞	0.020	∞	0.030	∞	B (S)
Propagated TPW	0.020	∞	0.070	∞	0.060	∞	0.080	∞	0.100	∞	0.150	∞	B (S)
SPRT self-heating	0.020	∞	0.050	∞	0.020	∞	0.020	∞	0.030	∞	0.030	∞	B (S)
Heat Flux	0.100	∞	0.020	∞	0.100	∞	0.700	∞	0.700	∞	1.000	∞	B (S)
Insulation leakage		∞		∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
SPRT Pt Oxydation		∞		∞	0.000	∞	0.000	∞	0.000	∞	0.000	∞	B (S)
Gas pressure		∞	0.010	∞	0.020	∞	0.050	∞	0.030	∞	0.040	∞	B (S)
Combined Standard Uncertainty	0.400	9	0.260	6	0.120	4	0.450	44	0.450	44	0.650	23	
Expanded Uncertainty (*k*=2, using effective df)	0.800		0.510		0.250		0.900		0.900		1.300		

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