Report to the CCT on Key Comparison EUROMET.T-K6
(EUROMET Project no. 621)

Comparison of the realisations of local dew/frost-point temperature scales in the range -50 °C to +20 °C

DRAFT B

Final Version

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1. INTRODUCTION

Preparations for the EUROMET regional key comparison EUROMET.T-K6 were initiated in March 2001 under coordination of NPL. It was agreed in 2002 that MIKES will take over the coordination of the project. The technical protocol of the comparison was accepted by the participants and CCT WG7 in December 2003. Minor revisions were made to the protocol in July 2004 on the basis of the results of initial tests of transfer standards. The protocol is in Appendix 1.

By the end of 2003 totally 24 EUROMET member and corresponding NMIs had joined the project. Due to the large number of participants three loops were decided to run simultaneously. At the same time the European loop of CCT-K6 was starting, which had to be taken into account when deciding the schedule and considering the work load at all participating laboratories. To limit the work load of the coordinating laboratory, NMi-VSL and METAS were named as the co-pilots for the loops 2 and 3. The loops were linked to each other by common participants (PTB, CETIAT, iNRiM, INTA, METAS and GUM). The comparison in linked to the CCT-K6 through MIKES, NPL, iNRiM, INTA, NMi-VSL and VNIIM.

MBW Calibration Ltd manufactured and loaned six chilled mirror hygrometers to be used as the transfer standards in the comparison. All the instruments were delivered to the pilot laboratories by the end of February 2004. The pilots carried out thorough initial tests and the units were shipped to the first participating laboratories in autumn 2004. Final measurements were completed in January 2008.

2. ORGANIZATION

2.1 Comparison scheme and participants

Figure 2.1 illustrates the comparison scheme consisting of three lops linked to each other through two laboratories for each pair of loops.

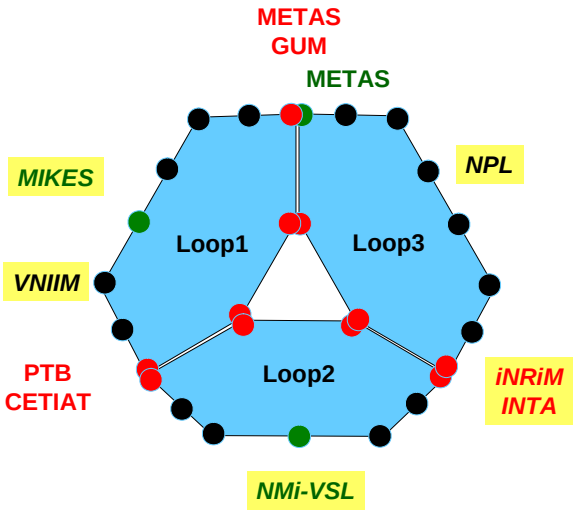

Figure 2.1 Scheme of the comparison. Only the pilots (green font), link laboratories between loops (red font) and link laboratories to CCT-K6 (yellow background) are shown.

A list of participating laboratories is represented in table 2.1. Detailed information of laboratories is given in Appendix 1.

Table 2.1 List of participants. Abbreviations used in this report are in parenthesis after the laboratory name. Participation types are: C=Coordinator, P=Pilot, L=link to the CCT-K6 (the numbers following P specifies the loop).

Name of the laboratory	**Country**	**Loop**	**Type**
Central Office of Measures (GUM)	Poland	1,3	
Centre for Metrology and Accreditation (MIKES)	Finland	1	C,P1,L
Centre Technique des Industries Aérauliques et Thermiques (CETIAT)	France	1,2	
Czech Metrology Institute (CMI)	Czech Republic	3	
D. I. Mendeleyev Institute for Metrology (VNIIM)	Russia	1	L
DELTA Danish Electronics (DELTA)	Denmark	1	
BEV / E+E Elektronik (BEV)	Austria	3	
Hellenic Institute of Metrology (EIM)	Greece	2	
Hungarian Trade Licensing Office (MKEH) [1)]	Hungary	3	
Instituto Nacional de Técnica Aeroespacial (INTA)	Spain	2,3	L
Instituto Português da Qualidade (IPQ)	Portugal	2	
Istituto Nazionale di Ricerca Metrologica (iNRiM) [2)]	Italy	2,3	L
National Metrology Institute of South Africa (NMISA) [3)]	South Africa	1	
National Metrology Laboratory (NML)	Ireland	3	
National Physical Laboratory (NPL)	UK	3	L
NMi van Swinden Laboratorium (NMi-VSL)	Netherlands	2	P2
Norwegian Metrology Service (JV)	Norway	1	
Physikalisch-Technische Bundesanstalt (PTB)	Germany	1,2	
Slovak Institute of Metrology (SMU)	Slovakia	3	
Swedish National Testing and Research Institute (SP)	Sweden	1	
Swiss Federal Office of Metrology and Accreditation (METAS)	Switzerland	1,3	P3
Ulusal Metroloji Enstitüsü (UME)	Turkey	2	
University of Ljubljana, Faculty of Electrical Engineering, Laboratory of Metrology and Quality (MIRS/FE-LMK)	Slovenia	2	
University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Laboratory for Process Measurements (LPM)	Croatia	2	

[1)] MKEH was formerly: National Office of Measures (OMH)
[2)] iNRiM was formerly: Istituto di Metrologia "G. Colonnetti" – CNR (IMGC)
[3)] NMISA was formerly: CSIR - National Metrology Laboratory (CSIR)

2.2 Comparison schedule

For each laboratory, 6 to 8 weeks were allowed for measurements and shipping to the next laboratory. Time was also reserved for the owner of the transfer standards for renewing the ATA Carnet documents (the instruments were sent to MBW Calibration Ltd in Switzerland at each time of renewing). Figures 1 to 3 in the Protocol (see Appendix 2) show the provisional timetables for all three loops.

The timetable was modified several times due to a number delays and changes in the order of participants in the loops. All changes were made in agreement with all participants. The delays were caused by

- delays in customs clearance
- other delays in transportations
- summer and Christmas holidays
- non-ideal synchronization between loops and with CCT-K6
- problems with laboratory facilities at some laboratories
- problems with the transfer standards (o-ring seals, LED, VCR connectors etc.)

After careful analysis of each problem with the transfer standards it was concluded that the reliability of the instruments or confidentiality of the results were not endangered due to the problems or repairs.

Actual dates of measurements at the participating laboratories are presented in table 2.2. In the loop 2 the final measurement set was carried out by INTA instead of the pilot laboratory (NMi-VSL) due sudden but temporary shortage of human resources at NMi. In the loop 3, also NPL carried out two sets of measurements because METAS (pilot) reported problems in its measurements.

Table 2.2 Actual dates of measurements at the laboratories

Loop 1		**Loop 2**		**Loop 3**	
Laboratory	**Meas. period**	**Laboratory**	**Meas. period**	**Laboratory**	**Meas. period**
MIKES1	06/2004 - 08/2004	NMi-VSL1	07/2004 - 08/2004	METAS1	06/2004 - 07/2004
PTB	11/2004 - 01/2005	CETIAT	10/2004 - 11/2004	NPL1	10/2004 - 11/2004
SP	03/2005	INTA	12/2004	GUM	01/2005 - 02/2005
DELTA	07/2006 - 08/2006	IPQ	01/2006 – 02/2006	CMI	04/2005
CETIAT	07/2005 - 08/2005	EIM	04/2005 - 05/2005	MKEH	05/2005 - 06/2005
GUM	10/2005 - 12/2005	iNRiM	05/2006	SMU	07/2005
METAS	03/2006	PTB	01/2005 - 03/2005	BEV	10/2005
NMISA	04/2006 - 05/2006	MIRS/FE-LMK	04/2006	NML	05/2005
JV	06/2006 - 07/2006	LPM	07/2007	INTA	11/2005
VNIIM	12/2006 - 02/2007	UME	01/2007 - 02/2007	iNRiM	02/2006
MIKES2	06/2007 - 08/2007	INTA2	12/2007 - 01/2008	METAS2	12/2006 - 01/2007
				NPL2	06/2006 - 08/2006

3. COMPARISON METHOD

3.1 Transfer standards

Six chilled mirror hygrometers were manufactured by MBW Calibration Ltd for this comparison. Before the manufacturing, MBW sent a batch of 10 industrial platinum resistance thermometers (PRT) to INTA for temperature calibration over the range of interest. The calibration covered also characterization of stability and hysteresis. On the basis of the calibration results the coordinator selected 6 sensors to be used in the transfer standards as the PRTs with direct access for resistance measurements. The primary dew-point temperature related signal in this comparison was obtained by measuring the resistance of the secondary PRT.

For preventing availability of prior information on the performance of the instruments to any participant, MBW kept the PRT identifications of each hygrometer in secret until December 2007 when the coordinator was informed about the PRTs.

Before the actual measurement phase of the comparison, the pilot laboratories carried out the same tests for the transfer standards of their loop. No single laboratory tested all the units. Tests covered:

- flow response
- effect of temperature of tubing and a pre-cooler
- forced-frost option
- mechanical effects (opening the sensor head)
- repeatability and reproducibility
- effect of resistance measurement method (AC, DC)
- linearity
- flow and pressure measurement

In all the units, errors due to the parameters listed above were found very small. Some small amendments, however, were made to the technical protocol and rotameters were added for checking the flow rate indications at all laboratories.

3.2 Measurements

Evidence on the performance of the transfer standards during the whole exercise was collected by several means.

- One of the most important properties of transfer standards is the long-term stability. This was monitored by comparing the initial and final results of the loop pilots and by comparing the results obtained by all participants with the transfer standards to their pair instrument. In addition, it was possible to monitor the long-term stability of the secondary PRT compared to the primary PRT based temperature measurement system integrated in the hygrometers by comparing the dew/frost-point temperature display readings to the resistance of the secondary PRT.
- At all laboratories initial measurements were done before starting the actual comparison measurements. In this way problems related to the sample gas flow rate or pressure could be identified. Recording both the PRT resistance and dew/frost-point temperature display readings allowed the pilots and coordinator to identify possible problems in resistance measurements.
- By measuring with the pair of transfer standards in parallel (or at least nominally simultaneously) four complete set of the calibration points random and systematic errors in the calibration system and the transfer standards could be studied. The condensate layer on the mirror was re-formed for each measurement.

The repeated measurements and use of two instruments reduced the uncertainty related to the transfer standards in the final comparison results. Thus, it was possible to obtain reliable information on the equivalence of the dew/frost-point calibrations at the participating laboratories.

3.3 Impartiality

The impartiality of the comparison was ensured by preventing prior information on the performance of the transfer standards before the comparison measurements. Therefore no communication regarding the measurement results were allowed between the participants during the exercise. When carrying out the final analysis on the equivalence between the

laboratories, only the first measurement period of the pilot laboratories were taken into account. The resistance-to-temperature conversions were done using a standardised equation and the characteristics of the PRTs actually in each transfer standard was not known by anyone in the participating laboratories before the end of the measurement phase of the comparison.

4. TRANSFER STANDARDS

4.1 Description of the transfer standards

All the transfer standards were new and of the same type:

Model: MBW 373 L
Tube connectors: VCR Cajon ® ¼"
Accessories: Endoscope, 4-wire cable for resistance measurements (3 m)
Serial numbers of the instruments:

Loop 1	Loop2	Loop3
03-0920	03-0922	03-0924
03-0921	03-0923	03-0925

4.2 Stability of the transfer standards

4.2.1 Difference between the paired hygrometers

Figures 4.1 to 4.3 show the difference between the transfer standards in each loop as reported by the participants. The results were derived from the reported resistance values using the EN 60751/A2:1995 conversion formula given in the technical protocol.

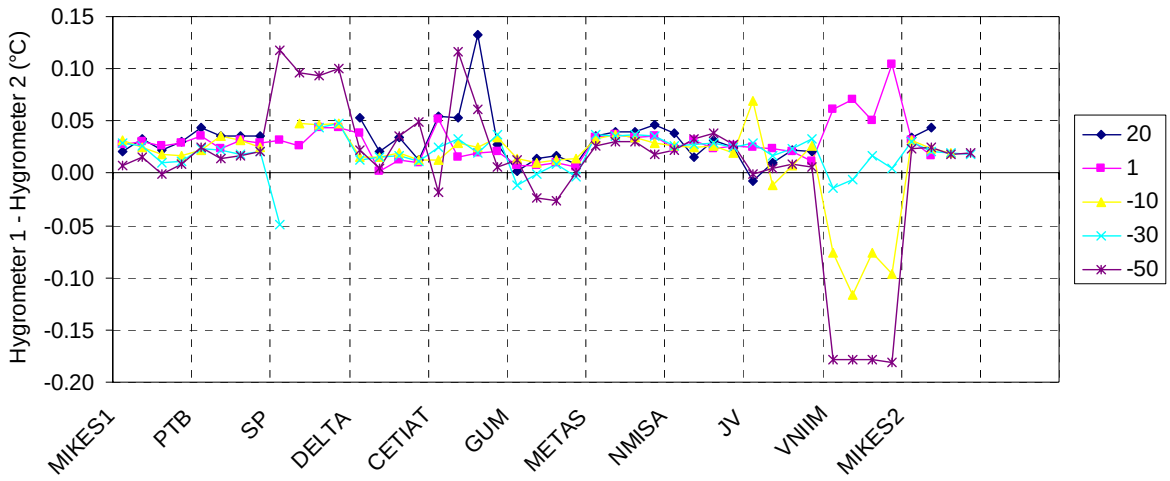

Figure 4.1 Difference between the transfer standards in the loop 1.

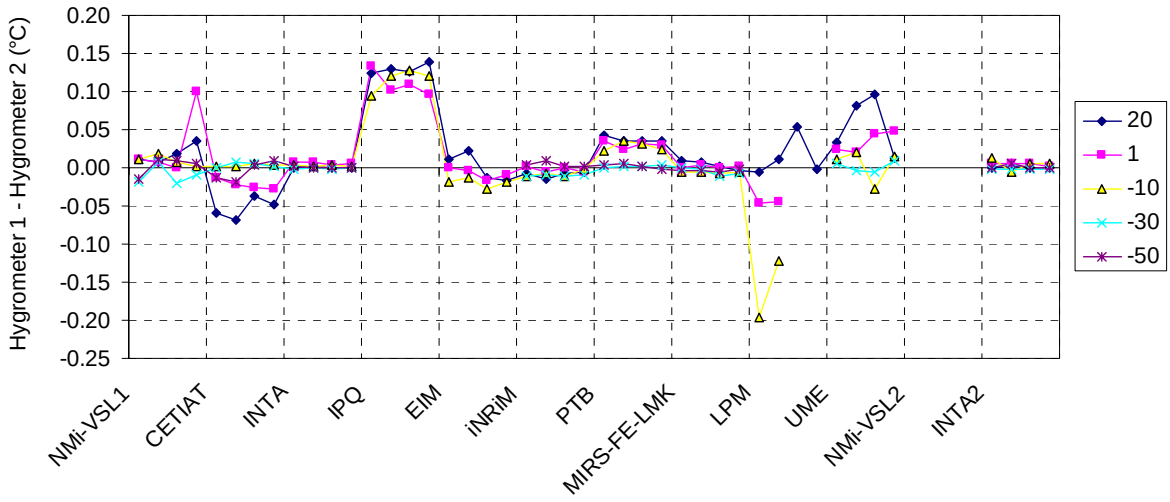

Figure 4.2 Difference between the transfer standards in the loop 2.

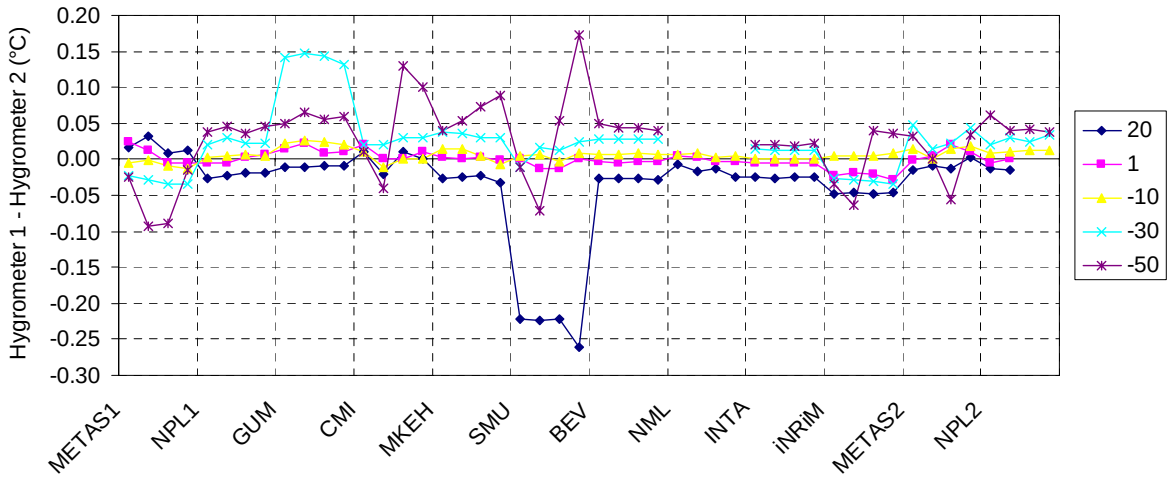

Figure 4.3 Difference between the transfer standards in the loop 3.

Although there are even large anomalies in the results, no drift or tendency can by identified in any loop. The anomalies will be discussed further later in this report.

4.2.2 Difference between the resistance based temperature and display readings

Display readings were recorded by hand or via serial port in the transfer standards. In the initial tests for the instruments, both methods were shown to give equivalent results. The display readings are compared with the results calculated from the resistance values recorded at the same time in figures 4.4 to 4.6.

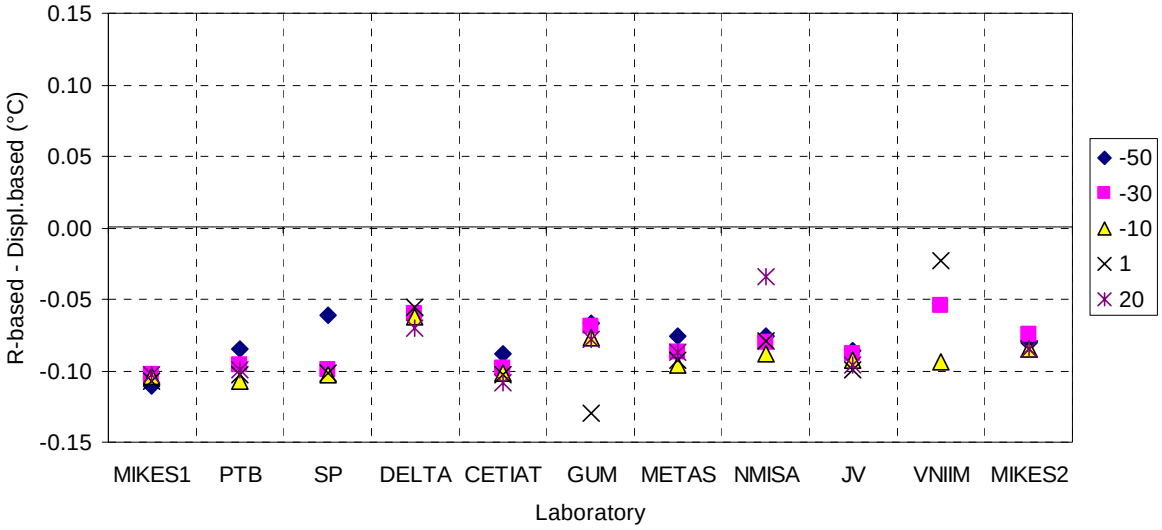

Figure 4.4 Difference between the results obtained by resistance measurements and display recording in the loop 1.

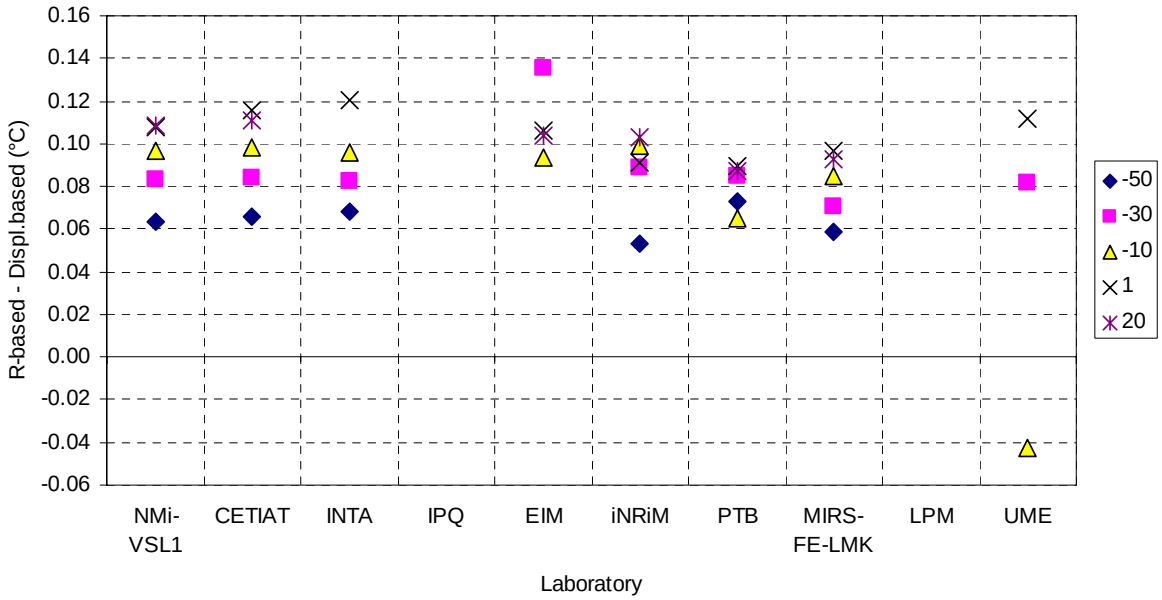

Figure 4.5 Difference between the results obtained by resistance measurements and display recording in the loop 2. (Note: only one hygrometer contributed to the EIM result at -30 °C; see Section 6.2)

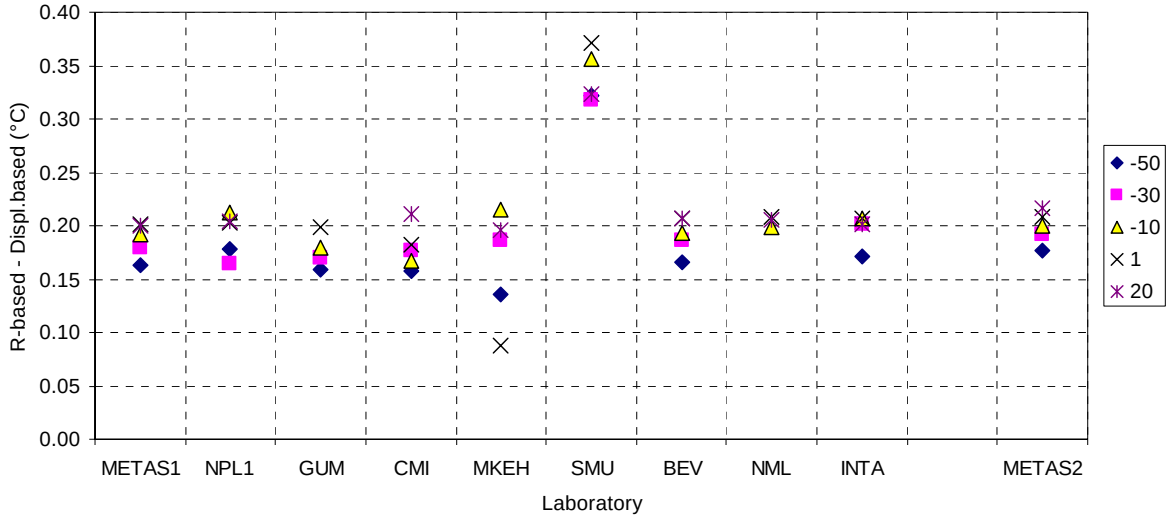

Figure 4.6 Difference between the results obtained by resistance measurements and display recording in the loop 3.

All laboratories did not report the hygrometer display readings. Although there are anomalies in the results, no drift or tendency can by identified in any loop. The anomalies will be discussed further later in this report.

4.2.3 Comparison of the results obtained in both ends of each loop

Figures 4.7 to 4.10 show the long-term stability of all the transfer standards as analysed from the repeated measurements at MIKES, INTA, METAS and NPL. In the figures, the laboratory reference values are compared to the dew/frost-point temperatures calculated from the resistance measurement results. The instruments are identified by the serial numbers in the figures. Only the mean values are shown here.

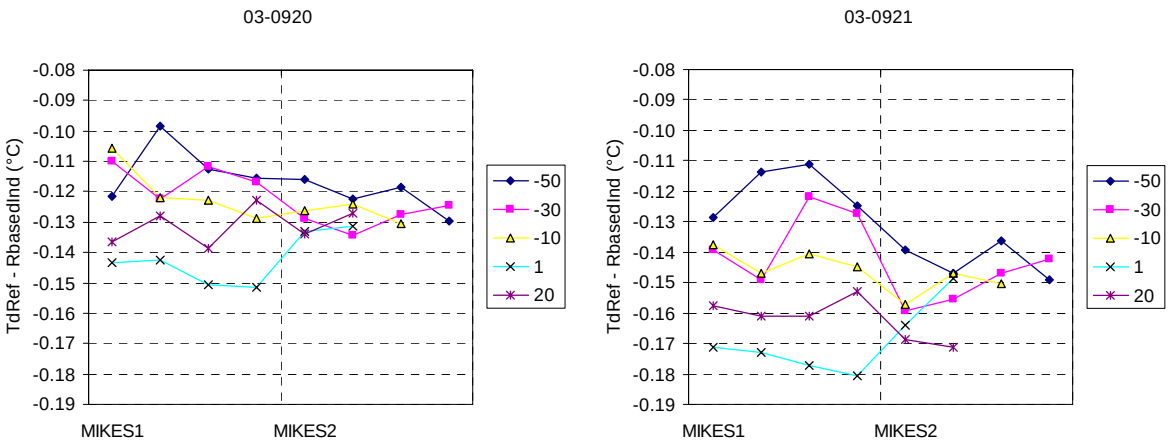

Figure 4.7 Comparison results obtained by MIKES in both ends of the loop 1.

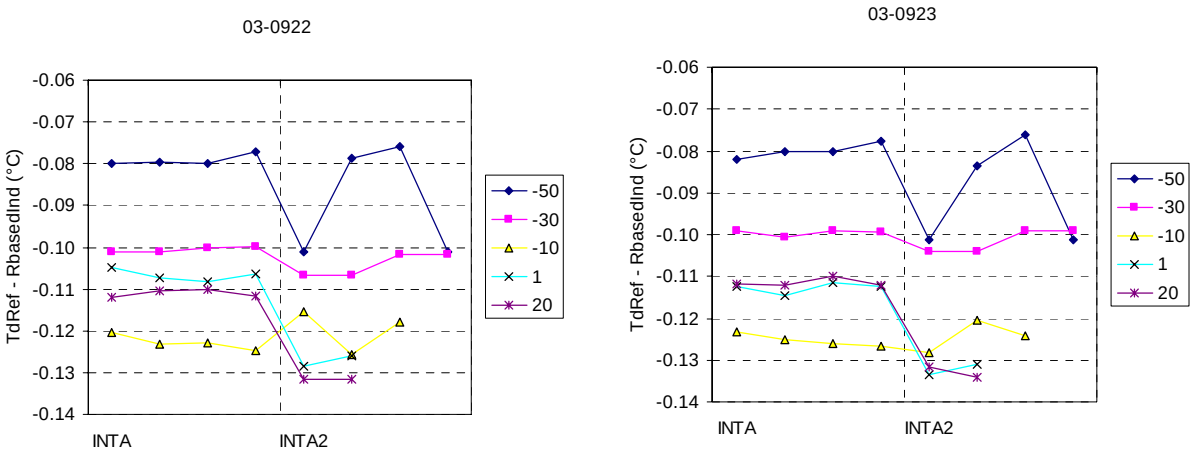

Figure 4.8 Comparison results obtained by INTA in both ends of the loop 2.

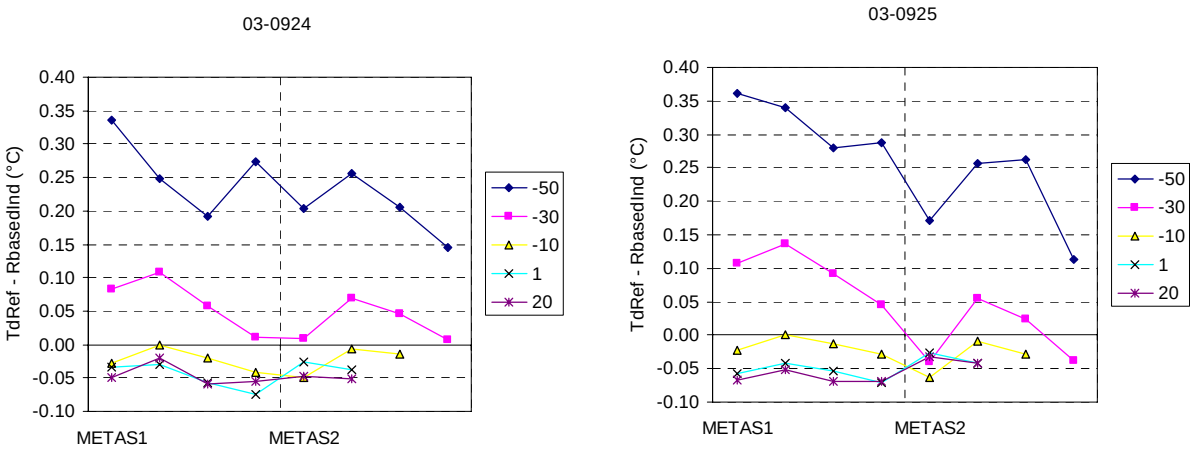

Figure 4.9 Comparison results obtained by METAS in both ends of the loop 3.

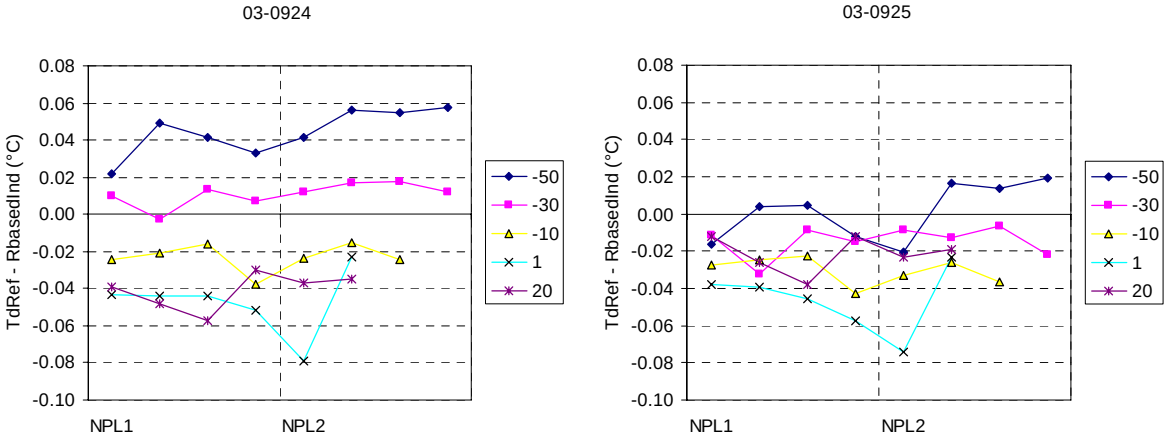

Figure 4.10 Comparison results obtained by NPL in both ends of the loop 3.

The expanded uncertainties of the mean values are between 0.04 °C and 0.06 °C (k=2) except for the METAS results at -50 °C and -30 °C of which the uncertainties are 0.27 °C and 0.08 °C, respectively.

These results do not show clear drift or tendency for any transfer standard. As described earlier the METAS results are poor in the lowest points due to problems with the METAS dew-point generator.

To quantify the uncertainty related to the long-term instabilities, the results were analysed further by studying the linearity of the hygrometer response in both sets of results. According to figures 4.11 to 4.13 the instruments showed small shifts in the zero points and slopes. These changes, however, are significantly smaller than the associated uncertainties. They are also smaller than the deviations of the results at each nominal point shown in figures 4.7 to 4.10.

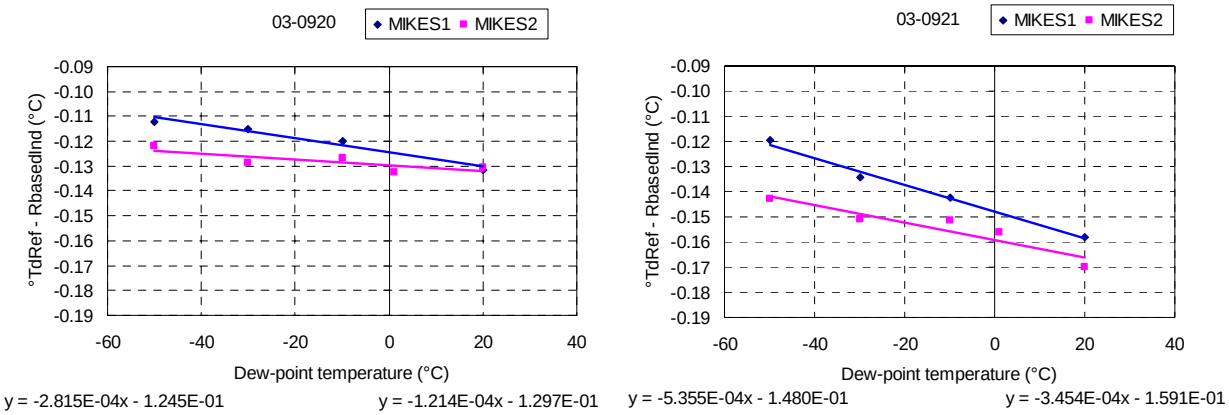

Figure 4.11 Comparison of linearity of the results obtained by MIKES in both ends of the loop 1. The equation of the linear fittings for MIKES1 and MIKES2 results are on the bottom left and right, respectively.

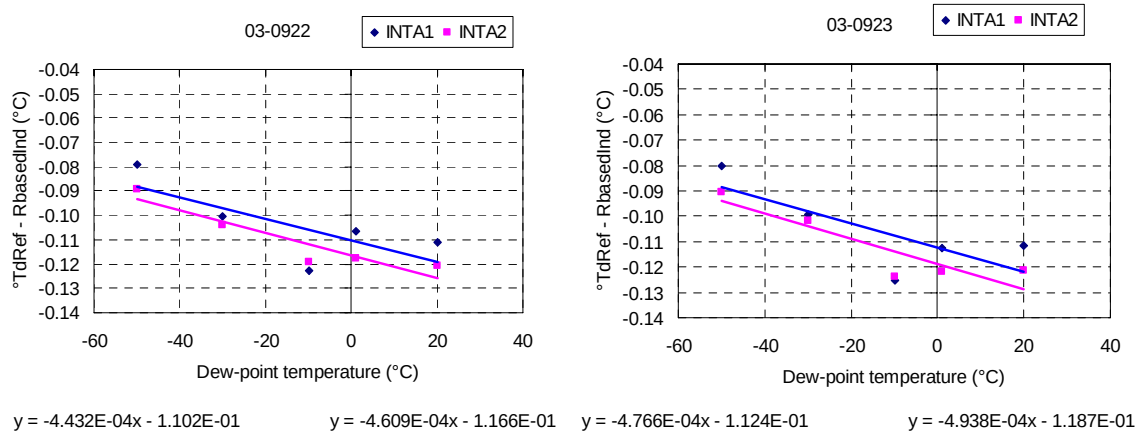

Figure 4.12 Comparison of linearity of the results obtained by INTA in both ends of the loop 2. The equation of the linear fittings for INTA1 and INTA2 results are on the bottom left and right, respectively.

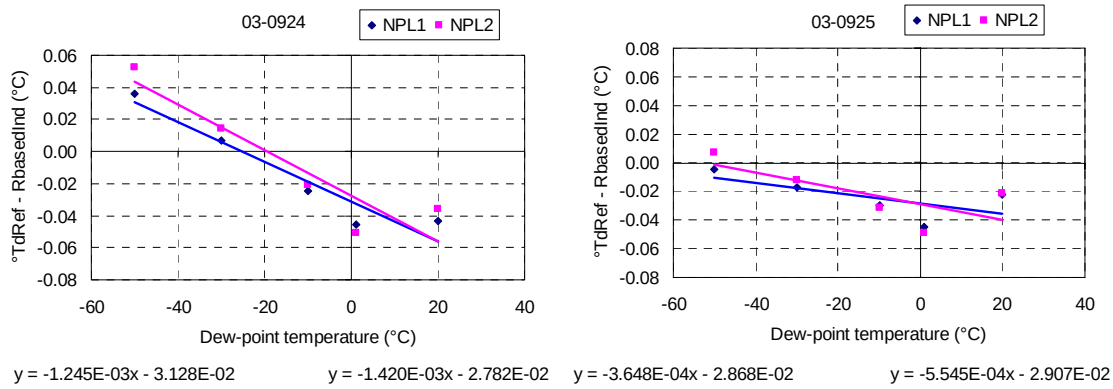

Figure 4.13 Comparison of linearity of the results obtained by NPL in both ends of the loop 3. The equation of the linear fittings for NPL1 and NPL2 results are on the bottom left and right, respectively.

In the diagrams of figure 4.11, the MIKES1 result at +1 °C was omitted because it differed about 0.02 °C from the linear fitting. The difference was almost the same in both instruments but such effect cannot be identified in the MIKES2 results. Therefore, it was concluded that the difference was due to some error in the reference dew-point temperature value. The error is well within the uncertainty of the reference value.

When comparing the instruments in each pair to each other, the results seem to change in the same way but the change is not constant at each point. The origin of the changes may be in the reference value or in the hygrometers (because they are of the same type). Thus, it was concluded that no time dependent correction due to the long-term instability can be applied but the corresponding uncertainty is added in the analysis. This is supported also by the results of an investigation of the linearity of results reported by other participants: no trend correlating with the changes in the results of the pilot laboratories could be found.

It is assumed that the transfer standards are independent to each other. The uncertainty due to the long-term instability (u_{Stab}) of a pair of instruments in a loop was calculated in the following way:

$$u_{Stab}^2(t_d) = \frac{1}{12}\left\{\left[f_{lab1,h1}(t_d) - f_{lab2,h1}(t_d)\right]^2 + \left[f_{lab1,h2}(t_d) - f_{lab2,h2}(t_d)\right]^2\right\} \qquad (4.1)$$

Here f is the linear fitting (shown in figures 4.11. to 4.13). The subscripts specify the numbers of measurements (1 or 2) of the pilot laboratory ('lab') and the transfer standard of the loop ('h1' or 'h2'). Table 4.1 shows the calculated standard uncertainties.

Table 4.1 Standard uncertainty due to the long-term instability of the pairs of transfer standards in the loops.

t_d (°C)	$u_{Stab}(t_d)$		
	Loop1	***Loop2***	***Loop3***
-50	0.0071	0.0022	0.0044
-30	0.0062	0.0025	0.0025
-10	0.0047	0.0026	0.0011
1	0.0039	0.0027	0.0004
20	0.0025	0.0029	0.0013

5. LOCAL DEW/FROST-POINT TEMPERATURE SCALES

Both primary and secondary realisations of dew/frost-point temperature scales are involved with this comparison. The primary realisations include two-pressure (2-P), single pressure (1-P) and coulometric (C) dew/frost-point generators. Combinations reference dew-point hygrometers and calibration systems of several types form the secondary systems used in the comparison. Table 5.1 gives a summary of the realisation methods. Detailed identifications of the dew/frost-point temperature realisations are given in Appendix 1.

Table 5.1 Summary of the realisation methods used by the participating laboratories and the measurement ranges covered in this comparison. (C=coulometric, 1-P=single pressure, 2-P=two-pressure, S=secondary).

Laboratory	**Country**	**Type and covered range**	
GUM	Poland	1-P	(-50 °C to +20 °C)
MIKES	Finland	1-P	(-50 °C to +20 °C)
CETIAT	France	1-P	(-50 °C to +20 °C)
CMI	Czech Republic	S	(-50 °C to +20 °C)
VNIIM	Russia	1-P	(-50 °C to +1 °C)
DELTA	Denmark	S	(-50 °C to +20 °C)
BEV / E+E	Austria	2-P	(-50 °C to +20 °C)
EIM	Greece	1-P	(-30 °C to +20 °C)
MKEH	Hungary	S	(-50 °C to +20 °C)
INTA	Spain	2-P	(-50 °C to +20 °C)
IPQ	Portugal	S	(-10 °C to +20 °C)
iNRiM	Italy	1-P	(-50 °C to +20 °C)
NMISA	South Africa	S	(-50 °C to +20 °C)
NML	Ireland	S	(-10 °C to +20 °C)
NPL	UK	1-P	(-50 °C to +20 °C)
NMi-VSL	Netherlands	1-P	(-50 °C to +20 °C)
JV	Norway	S	(-50 °C to +20 °C)
PTB	Germany	2-P C	(-10 °C to +20 °C) (-50 °C to -30 °C)
SMU	Slovakia	S	(-50 °C to +20 °C)
SP	Sweden	1-P	(-50 °C to +1 °C)
METAS	Switzerland	1-P	(-50 °C to +20 °C)
UME	Turkey	2-P	(-30 °C to +20 °C)
MIRS	Slovenia	1-P	(-50 °C to +20 °C)
LPM	Croatia	1-P	(-10 °C to +20 °C)

6. MEASUREMENT RESULTS

6.1 Summary of the results

Measurement results as reported by the participants are in Appendix 3. A single result (R_{lab}) at each measurement point for each laboratory was derived in the following way:

- Calculation of the mean difference between the laboratory reference dew-point temperature values (t_{dRi1} and t_{dRi2}) and the results obtained by the two transfer standards ($R_{hygr1,i}$ and $R_{hygr2,i}$)

- Calculation of the mean of results obtained from the four repetitions at the measurement point:

$$R_{lab} = \frac{1}{4}\left(\sum_{i=1}^{4} R_{lab,i}\right) + \delta_{rep} = \frac{1}{4}\left(\sum_{i=1}^{4} \frac{1}{2}(t_{dRi1} + t_{dRi2}) - \frac{1}{2}(R_{hygr1,i} + R_{hygr2,i})\right) + \delta_{rep} \quad (6.1)$$

where δ_{rep} is the correction due to non-ideal reproducibility of the results. Its estimate is zero but its standard uncertainty is calculated by:

$$u(\delta_{rep}) = \frac{1}{2\sqrt{3}}\left[\max\left(R_{lab,i}\right) - \min(R_{lab,i})\right] \quad (6.2)$$

The uncertainty of the result is calculated from the uncertainties of all initial results, $u(R_{lab,i})$:

$$u^2(R_{lab}) = \frac{1}{16}\left[\sum_{i=1}^{4} u^2(R_{lab,i})\right] + u^2(\delta_{rep})$$
$$= \frac{1}{16}\left[\sum_{i=1}^{4} u^2(t_{dRi}) + \frac{1}{4}\left(u^2(R_{hygr1,i}) + u^2(R_{hygr2,i})\right)\right] + \frac{1}{12}\left[\max(R_{lab,i}) - \min(R_{lab,i})\right]^2 \quad (6.3)$$

Because the hygrometers were calibrated nominally simultaneously, the combined uncertainty of the laboratory reference dew-point temperature values $u(t_{dRi1})$ and $u(t_{dRi2})$ reduce to a single component $u(t_{dRi})$ in equation (6.3). The uncertainties of the hygrometer results $u(R_{hygr1,i})$ and $u(R_{hygr1,i})$ are contributed by short-term instability and uncertainty of resistance measurement.

Figures 6.1 to 6.3 show the results obtained with equations (6.1) to (6.3). Error bars show the standard uncertainties of the estimates. Although the results are obtained mostly within ±0.5 °C from the nominal measurement point, the figures show the results more separated to improve their clarity.

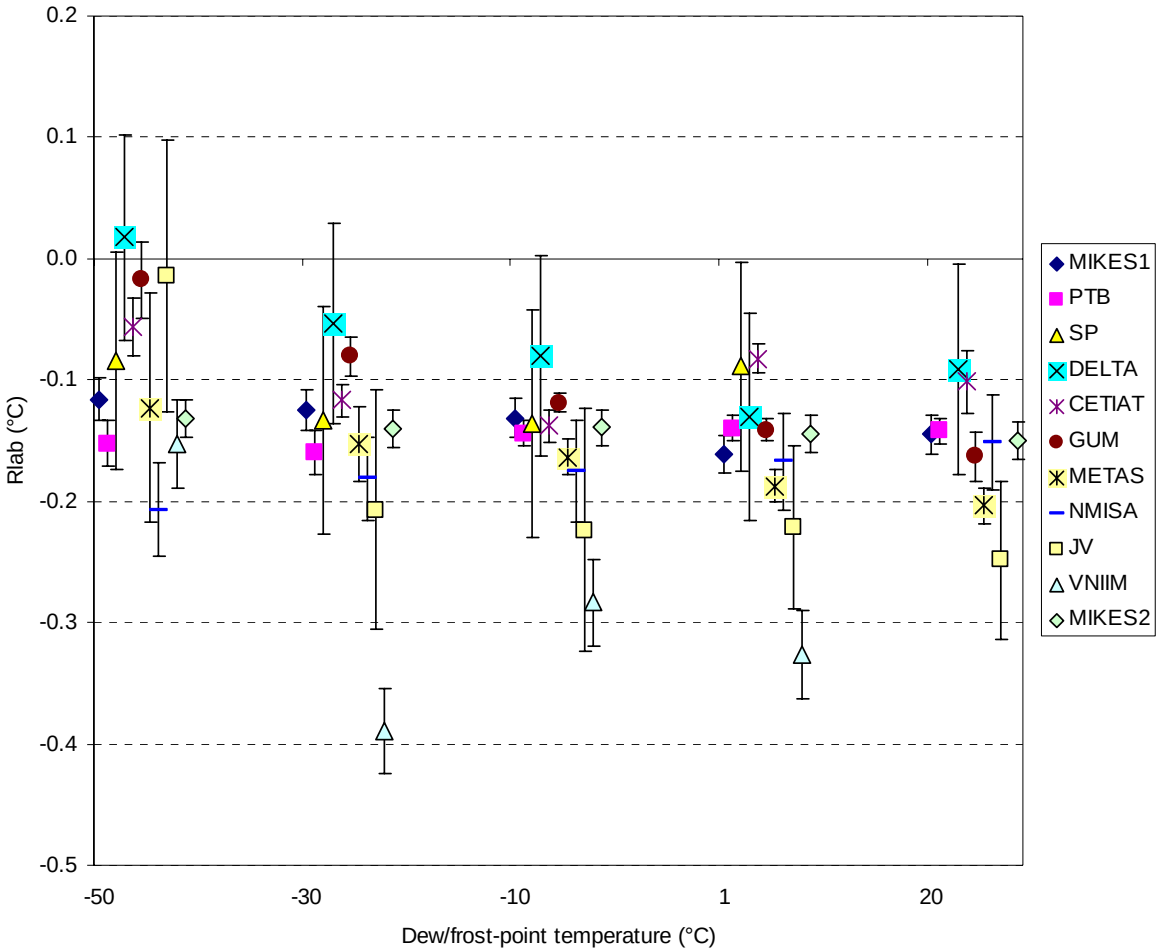

Figure 6.1 Combined measurement results of the loop 1. Uncertainties are shown at *k*=1 level. Note: The horizontal axis is not linear but shows only the nominal measurement points.

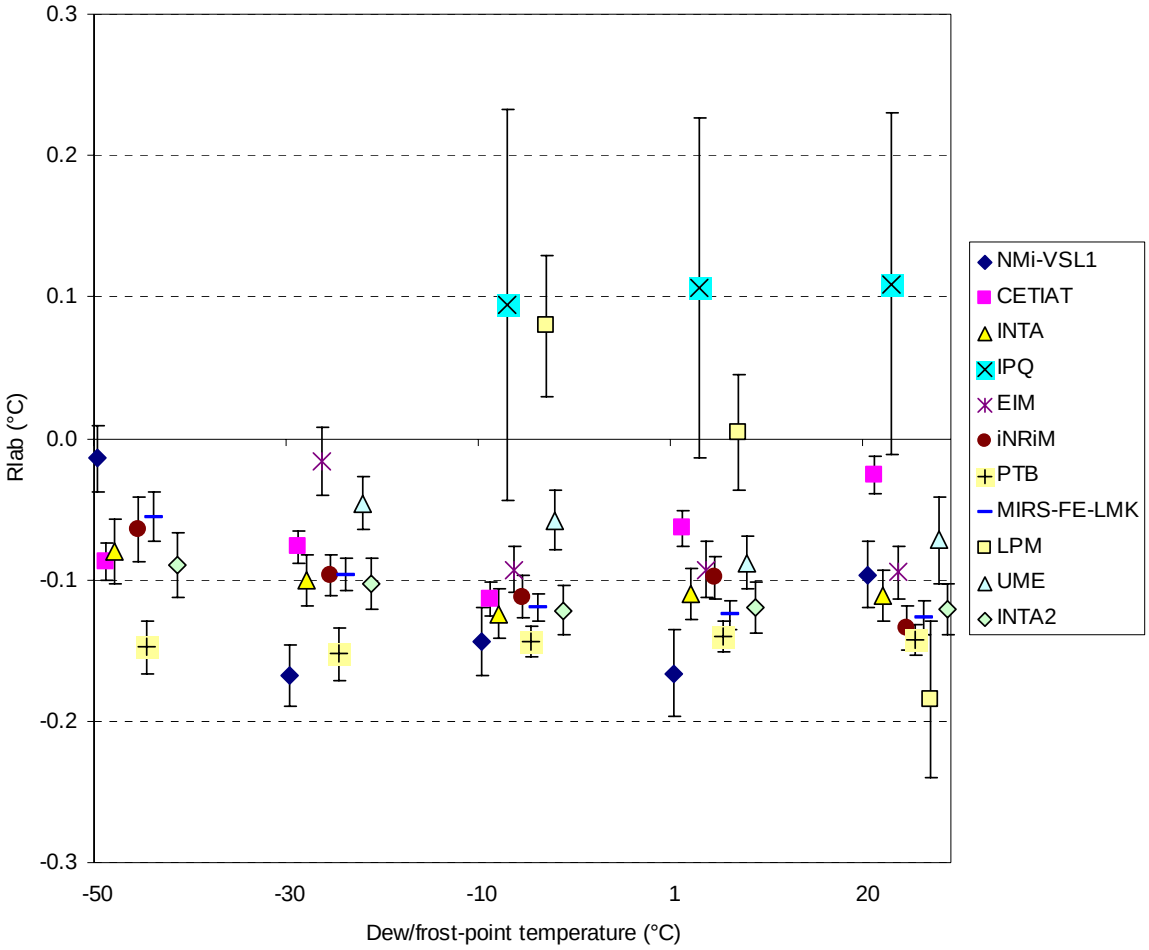

Figure 6.2 Combined measurement results of the loop 2. Uncertainties are shown at *k*=1 level. Note: The horizontal axis is not linear but shows only the nominal measurement points.

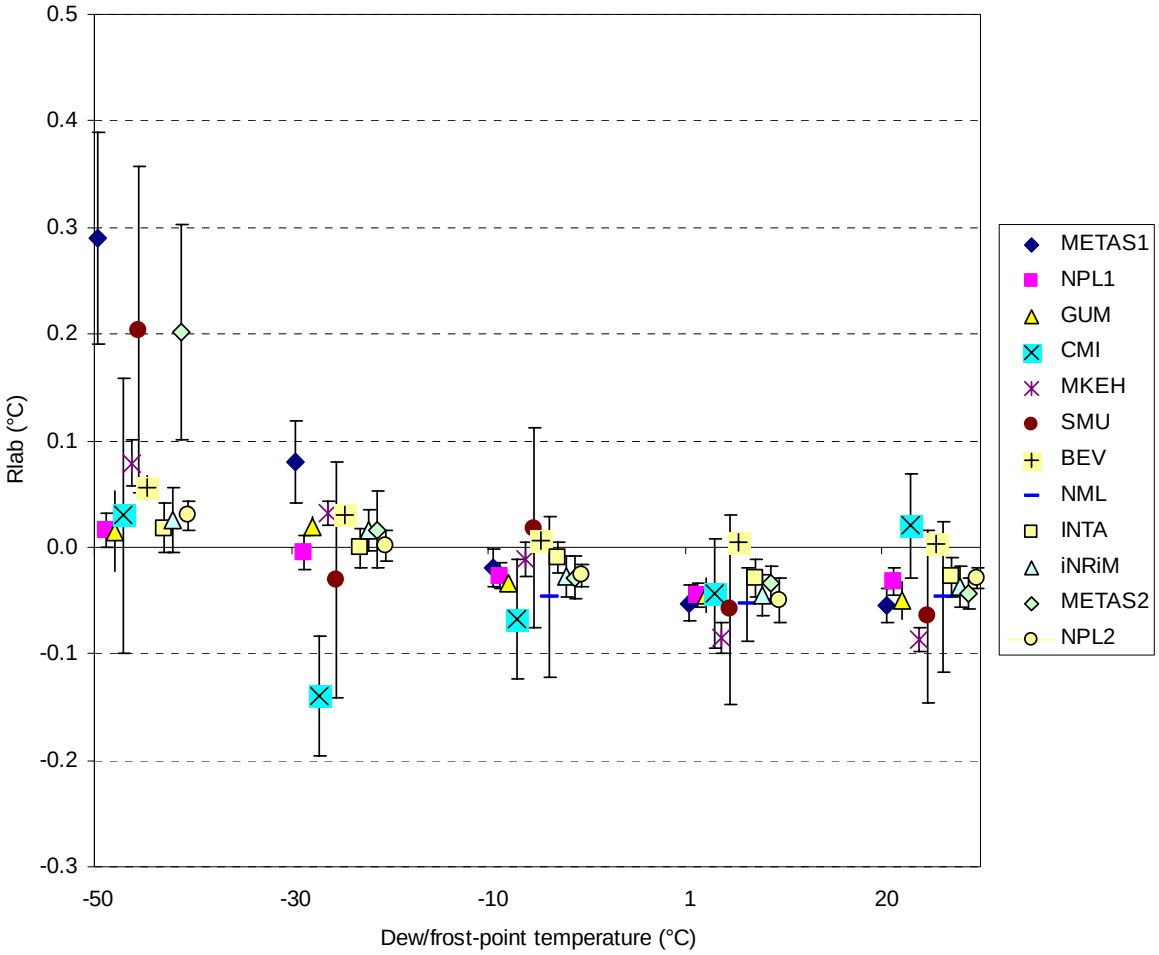

Figure 6.3 Combined measurement results of the loop 3. Uncertainties are shown at *k*=1 level. Note: The horizontal axis is not linear but shows only the nominal measurement points.

6.2 Notes on the results

CMI and NMISA did not fully meet the requirement for the maximum difference between the actual and nominal dew-point temperatures (±0.5 °C; see 4.1.10 in the protocol). CMI carried out the measurements of the point +1 °C at the actual dew-point temperature of +7 °C. For the point +20 °C, NMISA carried out measurements in the range between +14.8 °C and +17.5 °C. Because the non-linearity of the instruments is insignificant compared to the uncertainties stated by CMI and NMISA for their reference values, the results were included in the analysis without any additional modification.

SP repeated measurement only three times at the points of -30 °C and -10 °C. LPM repeated only twice at the points-10 °C and +1 °C. The second sets of measurements at MIKES and NPL include 2 to 4 repetitions. The reduced number of repetitions was taken into account when applying equations (6.1) and (6.3).

For the EIM result at -30 °C only the hygrometer 03-0922 was taken into account because of a problem with the LED power supply in the hygrometer 03-0923. The problem was reported by EIM and then fixed by the manufacturer before the next participant.

METAS increased the uncertainties of its results in the range below -10 °C after thorough investigation of the problems with the METAS generator system reported earlier.

CETIAT reported about leaks in the Loop1 transfer standards. No leaks were reported by other laboratories or found by the manufacturer soon after the CETIAT.

INTA reported about contamination when receiving the Loop2 instruments from CETIAT. The contamination was probably graphite dust. It is possible that the pump of the CETIAT generator was the source. No problems were found by CETIAT during the loop2 measurements.

UME increased the uncertainties of the UME results, because the stability monitoring showed that the long-term instability of pressure transducers in the UME generator has been underestimated.

7. BILATERAL EQUIVALENCE

7.1 Analysis method

As shown in figure 2.1 there are relationships of two types for any pair of laboratories in the comparison. In principle, the bilateral equivalence analysis for the first type consisting of laboratories of the same loop could be carried out in the same way as any single loop comparison. The second type consisting of pairs of laboratories from different loops is more difficult to handle. A further difficulty is caused by the facts that no laboratory participated in all loops and the linking laboratories are different for each pair of loops.

To maximize the data used in the final analysis (and thus the reliability of the results), results obtained in all three loops are taken into account when calculating the bilateral equivalence of any pair of laboratories. As illustrated in figure 7.1, there are six different routes for comparing any two laboratories to each other.

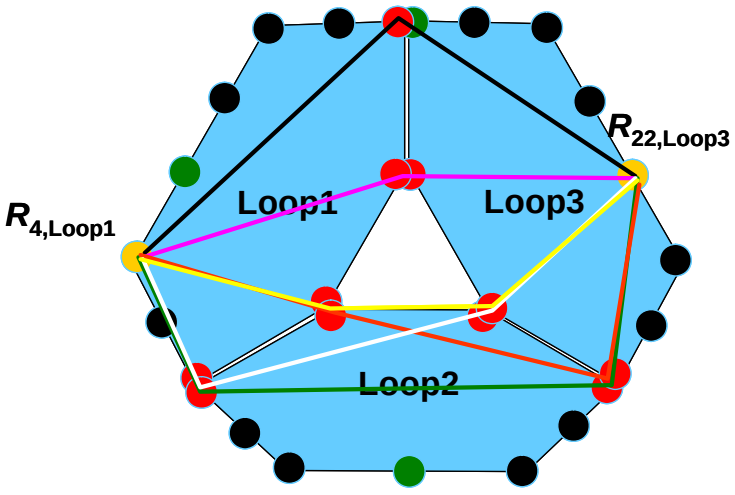

Figure 7.1 An example of comparing the results of two laboratories. The laboratories (no 4 and 22) are marked with yellow circles. Red circles represent the link laboratories between the loops. The six routes to compare the results are illustrated by the lines of different colours.

The bilateral equivalence can be calculated as:

$$D_{ij} = R_i - R_j = R_{i,loop(i)} + B(i,j) - R_{j,loop(j)} \qquad (7.1)$$

where subscripts i and j identify the laboratories and $loop(i)$ gives the loop number of the laboratory no. i. The discrete function B is:

$$\begin{cases} B(i,j) = \sum_{m=1}^{6}\left[\dfrac{\dfrac{P(i,j,m)}{u^2[P(i,j,m)]}}{\sum_{n=1}^{6}\left(u^{-2}[P(i,j,n)]\right)} + \delta(i,j,m)\right] & ;loop(i) \neq loop(j) \\ B(i,j) = 0 & ;loop(i) = loop(j) \end{cases}$$

$where$:

$$\begin{aligned} P(i,j,1) &= -R_{L(i,k,1),loop(i)} + R_{L(i,k,1),loop(k)} - R_{L(k,j,1),loop(k)} + R_{L(k,j,1),loop(j)} + \delta_{Stab}(i,j,m) \\ P(i,j,2) &= -R_{L(i,k,1),loop(i)} + R_{L(i,k,1),loop(k)} - R_{L(k,j,2),loop(k)} + R_{L(k,j,2),loop(j)} + \delta_{Stab}(i,j,m) \\ P(i,j,3) &= -R_{L(i,k,2),loop(i)} + R_{L(i,k,2),loop(k)} - R_{L(k,j,1),loop(k)} + R_{L(k,j,1),loop(j)} + \delta_{Stab}(i,j,m) \\ P(i,j,4) &= -R_{L(i,k,2),loop(i)} + R_{L(i,k,2),loop(k)} - R_{L(k,j,2),loop(k)} + R_{L(k,j,2),loop(j)} + \delta_{Stab}(i,j,m) \\ P(i,j,5) &= -R_{L(i,j,1),loop(i)} + R_{L(i,j,1),loop(j)} + \delta_{Stab}(i,j,m) \\ P(i,j,6) &= -R_{L(i,j,2),loop(i)} + R_{L(i,j,2),loop(j)} + \delta_{Stab}(i,j,m) \end{aligned} \qquad (7.2)$$

and $L(i,j,q)$ is the number of the qth link laboratory between the loops identified by $loop(i)$ and $loop(j)$ ($q \in \{1,2\}$). The index k refers to the loop that is not $loop(i)$ or $loop(j)$. The correction δ is defined as:

$$\delta(i,j,q) = \frac{1}{6}\left[\sum_{m=1}^{6}\left(\frac{\dfrac{P(i,j,m)}{u^2[P(i,j,m)]} - \dfrac{P(i,j,q)}{u^2[P(i,j,q)]}}{\sum_{n=1}^{6}\left(u^{-2}[P(i,j,n)]\right)}\right)\right] \quad \Rightarrow \quad \sum_{q=1}^{6}\delta(i,j,q) = 0 \qquad (7.3)$$

For $m < 5$, all transfer standards contribute to the correction due to the long-term instability of the transfer standards $\delta_{Stab}(i,j,m)$. As presented in Section 4.2. the mean corrections are estimated to zero, and:

$$\begin{cases} \langle \delta_{stab}(i,j,m) \rangle = 0 & 1 \le m \le 6 \\ u(\delta_{stab}(i,j,m)) = \sqrt{\sum_{k=1}^{3} u^2_{Stab,loop(k)}} \equiv u_{StabIJK} & m < 5 \\ u(\delta_{stab}(i,j,m)) = \sqrt{u^2_{Stab,loop(i)} + u^2_{Stab,loop(j)}} = u_{Stab}(i,j,m) & m \ge 5 \end{cases}$$

where $u_{Stab,loop(i)}$ is the standard uncertainty given in Table 4.1. When using the function B the equivalence is weighted by the combined uncertainties of the results of each route. It was

tested, however, that in this comparison the estimates of B would not change significantly even if the formula was based on the simple mean.

By following well-known principles of uncertainty estimation we derive an equation for the uncertainty of B:

$$\begin{cases} u^2[B(i,j)] = \left(\sum_{m=1}^{6} \left(u^{-2}[P(i,j,m)] \right) \right)^{-1} + \sum_{m=1}^{6} u^2[\delta(i,j,m)] & ;loop(i) \neq loop(j) \\ u^2[B(i,j)] = u^2_{Stab,loop(i)} & ;loop(i) = loop(j) \end{cases} \quad (7.4)$$

where e.g.:

$$\begin{aligned} u^2[P(i,j,1)] = {} & u^2(R_{L(i,k,1),loop(i)}) + u^2(R_{L(i,k,1),loop(k)}) + u^2(R_{L(k,j,1),loop(k)}) + u^2(R_{L(k,j,1),loop(j)}) \\ & + u^2_{StabIJK} - 2u(R_{L(i,k,1),loop(i)})u(R_{L(i,k,1),loop(k)})r_{L(i,k,1)} \\ & - 2u(R_{L(k,j,1),loop(k)})u(R_{L(k,j,1),loop(j)})r_{L(k,j,1)} \end{aligned}$$

and r is the correlation coefficient. The contribution of correction term is evaluated in the following way:

$$u^2[B(i,j)] \approx \left(\sum_{m=1}^{6} \left(u^{-2}[P(i,j,m)] \right) \right)^{-1} + u^2_{\delta(i,j)}$$

where: (7.5)

$$u^2_{\delta(i,j)} = \frac{1}{12}\left[\delta(i,j,m)_{\max} - \delta(i,j,m)_{\min} \right]$$

The results obtained by the link laboratories in different loops are correlated due to the use of the same reference equipment. The correlation coefficients were estimated on the basis of the uncertainty budgets provided by the link laboratories. From point of view of combined uncertainty the worst case approximation for the coefficient was 0.5. This value was used in calculating the final results.

Tables 7.1 and 7.2 show the calculated estimates and uncertainties of B. The maximum effect of the long-term instability of the transfer standards in the uncertainties is 0.001 °C when $loop(i) \neq loop(j)$.

Table 7.1 Calculated estimates of $B(i,j)$ when $loop(i) \neq loop(j)$

		$B(i,j)$				
$loop(i)$	$loop(j)$	t_d=-50 °C	t_d =-30 °C	t_d =-10 °C	t_d =1 °C	t_d =20 °C
1	2	-0.002	0.026	0.009	0.022	0.023
2	3	0.102	0.106	0.095	0.087	0.099
3	1	-0.087	-0.129	-0.103	-0.090	-0.119

Table 7.2 Calculated standard uncertainties of $B(i,j)$ when $loop(i) \neq loop(j)$

		$u(B(i,j))$				
$loop(i)$	$loop(j)$	t_d=-50 °C	t_d =-30 °C	t_d =-10 °C	t_d =1 °C	t_d =20 °C
1	2	0.022	0.010	0.007	0.007	0.007
2	3	0.024	0.010	0.007	0.007	0.009
3	1	0.022	0.009	0.006	0.008	0.008

The uncertainty of the bilateral equivalence is calculated as:

$$u^2(D_{ij}) = u^2(R_{i,loop(i)}) + u^2(B(i,j)) + u^2(R_{j,loop(j)}) \qquad (7.6)$$

When applying equations (7.1) and (7.6) to the results of the link laboratories following principles are followed:

- if the laboratories have participated in the same loop, the results of this loop are used for determining bilateral equivalence
- when a non-link laboratory is compared with a link laboratory that has not participated in the same loop, the equivalence value is calculated at first for both link laboratory results at two loops. Then, the final equivalence is taken as the mean value of the two equivalence values.

7.2 Results of the analysis

The bilateral degrees of equivalence (DoE) is determined as $(D_{ij}, U_{ij}) = (D_{ij}, 2u(D_{ij}))$ [1]. The DoE was calculated for each pair of participants at each nominal measurement point. The results are summarized in tables 7.3 to 7.7. In the tables, the laboratory identifications for R_i values are presented in the first columns on the left. The first line on top shows the laboratory identifications for R_j values.

Table 7.3 Degree of equivalence between the participants of EUROMET.T-K6 at the frost-point temperature -50 °C. DoE is expressed in degrees Celsius.

Lab *i* ↓ Lab *j* →

	MIKES		PTB		SP		DELTA		CETIAT		GUM		METAS		NMISA		JV		VNIIM		NMi-VSL		INTA		IPQ		EIM		iNRiM		MIRS-FE-LMK		LPM		UME		NPL		CMI		MKEH		SMU		BEV		NML	
	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij
MIKES			0.03	0.04	-0.03	0.14	-0.13	0.13	-0.05	0.04	-0.10	0.07	-0.16	0.11	0.09	0.07	-0.10	0.18	0.04	0.06	-0.10	0.07	-0.04	0.05					-0.05	0.05	-0.06	0.06					-0.04	0.06	-0.06	0.20	-0.11	0.07	-0.23	0.27	-0.09	0.06		
PTB	-0.03	0.04			-0.06	0.10	-0.17	0.10	-0.08	0.04	-0.13	0.05	-0.19	0.11	0.06	0.06	-0.13	0.13	0.00	0.05	-0.14	0.05	-0.08	0.05					-0.09	0.05	-0.10	0.04					-0.07	0.05	-0.09	0.14	-0.13	0.05	-0.26	0.19	-0.11	0.04		
SP	0.03	0.14	0.07	0.14			-0.10	0.19	-0.01	0.11	-0.07	0.15	-0.12	0.14	0.12	0.15	-0.07	0.22	0.07	0.15	-0.07	0.15	-0.01	0.11					-0.02	0.11	-0.03	0.15					-0.01	0.15	-0.03	0.24	-0.08	0.15	-0.20	0.30	-0.05	0.15		
DELTA	0.13	0.13	0.17	0.13	0.10	0.19			0.09	0.10	0.03	0.14	-0.02	0.14	0.22	0.14	0.03	0.21	0.17	0.14	0.03	0.14	0.09	0.10					0.08	0.10	0.07	0.14					0.09	0.14	0.07	0.23	0.03	0.14	-0.10	0.29	0.05	0.13		
CETIAT	0.05	0.04	0.08	0.04	0.01	0.11	-0.09	0.10			-0.05	0.06	-0.10	0.11	0.14	0.06	-0.06	0.13	0.08	0.06	-0.06	0.05	0.02	0.06					0.00	0.06	-0.02	0.04					0.01	0.05	-0.01	0.14	-0.06	0.05	-0.18	0.19	-0.03	0.05		
GUM	0.07	0.06	0.11	0.06	0.04	0.11	-0.06	0.10	0.01	0.06			-0.06	0.11	0.16	0.07	-0.03	0.14	0.11	0.07	-0.04	0.07	0.06	0.06					0.04	0.07	0.00	0.06					0.03	0.06	0.01	0.15	-0.04	0.06	-0.16	0.19	-0.01	0.06		
METAS	0.16	0.11	0.19	0.11	0.12	0.14	0.02	0.14	0.10	0.11	0.06	0.11			0.25	0.12	0.05	0.16	0.19	0.11	0.05	0.11	-0.05	0.11					-0.06	0.11	0.09	0.11					0.11	0.11	0.10	0.17	0.05	0.11	-0.08	0.21	0.07	0.11		
NMISA	-0.09	0.07	-0.05	0.07	-0.12	0.15	-0.22	0.14	-0.15	0.08	-0.19	0.09	-0.08	0.15			-0.19	0.19	-0.05	0.08	-0.20	0.09	-0.13	0.06					-0.15	0.07	-0.15	0.08					-0.14	0.08	-0.15	0.20	-0.20	0.08	-0.32	0.27	-0.18	0.08		
JV	0.10	0.18	0.14	0.18	0.07	0.22	-0.03	0.21	0.04	0.18	0.00	0.19	0.11	0.22	0.19	0.19			0.14	0.18	0.00	0.19	0.06	0.13					0.05	0.13	0.04	0.18					0.06	0.18	0.04	0.26	-0.01	0.18	-0.13	0.32	0.02	0.18		
VNIIM	-0.04	0.06	0.00	0.06	-0.07	0.15	-0.17	0.14	-0.10	0.08	-0.14	0.08	-0.03	0.15	0.05	0.08	-0.14	0.18			-0.14	0.09	-0.08	0.06					-0.09	0.06	-0.10	0.08					-0.08	0.08	-0.10	0.20	-0.15	0.08	-0.27	0.27	-0.12	0.08		
NMi-VSL	0.10	0.07	0.14	0.07	0.07	0.15	-0.03	0.14	0.04	0.08	0.01	0.09	0.11	0.15	0.20	0.09	0.00	0.19	0.14	0.09			0.07	0.05					0.06	0.06	0.04	0.06					0.07	0.07	0.06	0.20	0.01	0.08	-0.12	0.27	0.03	0.07		
INTA	0.04	0.05	0.08	0.05	0.01	0.11	-0.09	0.10	-0.02	0.06	-0.06	0.06	0.05	0.11	0.13	0.06	-0.06	0.13	0.08	0.06	-0.07	0.05							-0.01	0.05	-0.03	0.04					0.00	0.04	-0.01	0.14	-0.06	0.05	-0.18	0.19	-0.04	0.04		
IPQ																																															
EIM																																															
iNRiM	0.05	0.05	0.09	0.05	0.02	0.11	-0.08	0.10	0.00	0.06	-0.04	0.07	0.06	0.11	0.15	0.07	-0.05	0.13	0.09	0.06	-0.06	0.06	0.01	0.05							-0.01	0.05					0.02	0.05	0.00	0.14	-0.05	0.05	-0.17	0.19	-0.02	0.05		
MIRS-FE-LMK	0.06	0.06	0.10	0.06	0.03	0.15	-0.07	0.14	0.00	0.07	-0.04	0.08	0.07	0.15	0.15	0.08	-0.04	0.18	0.10	0.08	-0.04	0.06	0.02	0.05					0.01	0.05							0.03	0.06	0.02	0.20	-0.03	0.07	-0.16	0.27	-0.01	0.06		
LPM																																															
UME																																															
NPL	0.04	0.06	0.08	0.06	0.01	0.15	-0.09	0.14	-0.01	0.07	-0.05	0.08	0.05	0.15	0.14	0.08	-0.06	0.18	0.08	0.08	-0.07	0.07	-0.01	0.07					-0.02	0.07	-0.03	0.06							-0.01	0.19	-0.06	0.05	-0.19	0.26	-0.04	0.04		
CMI	0.06	0.20	0.10	0.20	0.03	0.24	-0.07	0.23	0.00	0.20	-0.04	0.20	0.07	0.24	0.15	0.20	-0.04	0.26	0.10	0.20	-0.06	0.20	0.01	0.20					-0.01	0.20	-0.02	0.20					0.01	0.19			-0.05	0.19	-0.17	0.32	-0.03	0.19		
MKEH	0.11	0.07	0.14	0.07	0.08	0.15	-0.03	0.14	0.05	0.08	0.01	0.08	0.12	0.15	0.20	0.08	0.01	0.18	0.15	0.08	-0.01	0.08	0.06	0.07					0.04	0.07	0.03	0.07					0.06	0.05	0.05	0.19			-0.12	0.26	0.02	0.04		
SMU	0.23	0.27	0.27	0.27	0.20	0.30	0.10	0.29	0.17	0.27	0.13	0.27	0.24	0.30	0.32	0.27	0.13	0.32	0.27	0.27	0.12	0.27	0.18	0.27					0.17	0.27	0.16	0.27					0.19	0.26	0.17	0.32	0.12	0.26			0.15	0.26		
BEV	0.09	0.06	0.12	0.06	0.05	0.15	-0.05	0.13	0.03	0.07	-0.01	0.08	0.09	0.15	0.18	0.08	-0.02	0.18	0.12	0.08	-0.03	0.07	0.03	0.07					0.02	0.07	0.01	0.06					0.04	0.04	0.03	0.19	-0.02	0.04	-0.15	0.26				
NML																																															

Table 7.4 Degree of equivalence between the participants of EUROMET.T-K6 at the frost-point temperature -30 °C. DoE is expressed in degrees Celsius.

Lab *i* ↓ Lab *j* →

	MIKES		PTB		SP		DELTA		CETIAT		GUM		METAS		NMISA		JV		VNIIM		NMi-VSL		INTA		IPQ		EIM		iNRiM		MIRS-FE-LMK		LPM		UME		NPL		CMI		MKEH		SMU		BEV		NML	
	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij
MIKES			0.04	0.03	0.01	0.17	-0.07	0.13	-0.01	0.03	-0.04	0.05	-0.02	0.05	0.06	0.06	0.08	0.15	0.26	0.07	0.07	0.06	0.00	0.03			-0.08	0.05	-0.01	0.03	0.00	0.04			-0.05	0.05	0.01	0.04	0.14	0.09	-0.03	0.05	0.04	0.17	-0.03	0.04		
PTB	-0.04	0.03			-0.04	0.12	-0.12	0.09	-0.05	0.03	-0.09	0.03	-0.06	0.05	0.01	0.05	0.04	0.11	0.22	0.05	0.02	0.04	-0.03	0.03			-0.13	0.04	-0.04	0.03	-0.05	0.03			-0.10	0.03	-0.03	0.03	0.10	0.07	-0.07	0.04	-0.01	0.12	-0.07	0.03		
SP	-0.01	0.17	0.03	0.17			-0.08	0.20	-0.02	0.12	-0.05	0.17	-0.03	0.13	0.05	0.17	0.07	0.22	0.26	0.17	0.06	0.17	-0.01	0.12			-0.09	0.17	-0.02	0.12	-0.01	0.17			-0.06	0.17	0.00	0.17	0.14	0.19	-0.04	0.17	0.03	0.23	-0.04	0.17		
DELTA	0.07	0.13	0.11	0.12	0.08	0.20			0.06	0.09	0.03	0.13	0.05	0.10	0.13	0.13	0.15	0.19	0.34	0.13	0.14	0.13	0.07	0.09			-0.01	0.13	0.06	0.09	0.07	0.12			0.02	0.13	0.08	0.13	0.22	0.15	0.04	0.13	0.11	0.20	0.04	0.12		
CETIAT	0.01	0.03	0.05	0.03	0.02	0.12	-0.06	0.09			-0.03	0.03	-0.02	0.05	0.07	0.04	0.10	0.11	0.28	0.05	0.08	0.04	0.01	0.03			-0.07	0.04	0.00	0.03	0.01	0.03			-0.04	0.03	0.03	0.03	0.16	0.07	-0.01	0.03	0.05	0.12	-0.01	0.03		
GUM	0.03	0.03	0.06	0.03	0.04	0.12	-0.04	0.09	0.02	0.03			0.02	0.05	0.09	0.04	0.11	0.11	0.29	0.05	0.10	0.04	0.05	0.04			-0.05	0.04	0.04	0.03	0.03	0.03			-0.02	0.03	0.04	0.03	0.17	0.06	0.00	0.03	0.06	0.12	0.00	0.03		
METAS	0.02	0.05	0.06	0.05	0.03	0.13	-0.05	0.10	0.02	0.05	-0.02	0.05			0.08	0.06	0.11	0.11	0.29	0.06	0.09	0.06	-0.02	0.05			-0.06	0.06	-0.03	0.04	0.02	0.05			-0.03	0.05	0.03	0.05	0.17	0.08	0.00	0.05	0.06	0.13	0.00	0.05		
NMISA	-0.06	0.06	-0.02	0.06	-0.05	0.17	-0.13	0.13	-0.06	0.06	-0.10	0.06	-0.03	0.07			0.03	0.16	0.21	0.08	0.01	0.07	-0.05	0.05			-0.14	0.07	-0.06	0.04	-0.06	0.06			-0.11	0.06	-0.05	0.06	0.09	0.10	-0.08	0.06	-0.02	0.17	-0.08	0.06		
JV	-0.08	0.15	-0.05	0.15	-0.07	0.22	-0.15	0.19	-0.09	0.15	-0.13	0.15	-0.05	0.15	-0.03	0.16			0.18	0.16	-0.01	0.15	-0.08	0.11			-0.16	0.15	-0.09	0.11	-0.08	0.15			-0.13	0.15	-0.07	0.15	0.06	0.17	-0.11	0.15	-0.05	0.22	-0.11	0.15		
VNIIM	-0.26	0.07	-0.23	0.06	-0.26	0.17	-0.34	0.13	-0.27	0.06	-0.31	0.07	-0.24	0.08	-0.21	0.08	-0.18	0.16			-0.20	0.07	-0.26	0.05			-0.35	0.07	-0.27	0.05	-0.27	0.06			-0.32	0.07	-0.26	0.07	-0.12	0.10	-0.29	0.07	-0.23	0.17	-0.29	0.06		
NMi-VSL	-0.07	0.06	-0.03	0.06	-0.06	0.17	-0.14	0.13	-0.08	0.05	-0.11	0.06	-0.04	0.07	-0.01	0.07	0.01	0.15	0.20	0.07			-0.06	0.04			-0.15	0.06	-0.07	0.04	-0.07	0.05			-0.12	0.05	-0.06	0.06	0.08	0.10	-0.09	0.06	-0.03	0.17	-0.09	0.05		
INTA	0.00	0.03	0.03	0.03	0.01	0.12	-0.07	0.09	-0.01	0.03	-0.05	0.04	0.02	0.05	0.05	0.05	0.08	0.11	0.26	0.05	0.06	0.04					-0.09	0.04	-0.01	0.03	-0.01	0.03			-0.06	0.03	0.01	0.03	0.14	0.07	-0.03	0.03	0.03	0.12	-0.03	0.03		
IPQ																																															
EIM	0.08	0.05	0.12	0.05	0.09	0.17	0.01	0.13	0.07	0.05	0.04	0.05	0.11	0.07	0.14	0.07	0.16	0.15	0.35	0.07	0.15	0.06	0.08	0.05					0.08	0.04	0.08	0.04					0.03	0.05	0.09	0.05	0.23	0.10	0.06	0.05	0.12	0.17	0.06	0.05		
iNRiM	0.01	0.03	0.04	0.03	0.02	0.12	-0.06	0.09	0.00	0.03	-0.04	0.03	0.03	0.04	0.06	0.04	0.09	0.11	0.27	0.05	0.07	0.04	0.01	0.03			-0.08	0.04			0.00	0.03			-0.05	0.03	0.02	0.03	0.15	0.06	-0.02	0.03	0.04	0.12	-0.02	0.03		
MIRS-FE-LMK	0.00	0.04	0.04	0.04	0.01	0.17	-0.07	0.12	-0.01	0.04	-0.04	0.04	0.03	0.06	0.06	0.06	0.08	0.15	0.27	0.06	0.07	0.05	0.00	0.04			-0.08	0.04	0.00	0.03					-0.05	0.04	0.01	0.04	0.15	0.09	-0.02	0.04	0.04	0.17	-0.02	0.03		
LPM																																															
UME	0.05	0.05	0.09	0.05	0.06	0.17	-0.02	0.13	0.04	0.04	0.01	0.05	0.08	0.06	0.11	0.06	0.13	0.15	0.32	0.07	0.12	0.05	0.05	0.04			-0.03	0.05	0.05	0.04	0.05	0.04					0.07	0.05	0.20	0.09	0.03	0.05	0.09	0.17	0.03	0.04		
NPL	-0.01	0.04	0.03	0.04	0.00	0.17	-0.08	0.13	-0.02	0.04	-0.05	0.05	0.02	0.06	0.05	0.06	0.07	0.15	0.26	0.07	0.06	0.06	-0.01	0.05			-0.09	0.05	-0.01	0.04	-0.01	0.04			-0.07	0.05			0.14	0.09	-0.04	0.04	0.03	0.17	-0.04	0.03		
CMI	-0.14	0.09	-0.11	0.09	-0.14	0.19	-0.22	0.15	-0.15	0.09	-0.19	0.09	-0.12	0.10	-0.09	0.10	-0.06	0.17	0.12	0.10	-0.08	0.10	-0.15	0.09			-0.23	0.10	-0.15	0.09	-0.15	0.09			-0.20	0.09	-0.14	0.09			-0.17	0.09	-0.11	0.18	-0.17	0.09		
MKEH	0.03	0.05	0.06	0.05	0.04	0.17	-0.04	0.13	0.02	0.04	-0.02	0.05	0.06	0.06	0.08	0.06	0.11	0.15	0.29	0.07	0.09	0.06	0.03	0.05			-0.06	0.05	0.02	0.05	0.02	0.04			-0.03	0.05	0.04	0.04	0.17	0.09			0.06	0.17	0.00	0.04		
SMU	-0.04	0.17	0.00	0.17	-0.03	0.23	-0.11	0.20	-0.04	0.17	-0.08	0.17	-0.01	0.17	0.02	0.17	0.05	0.22	0.23	0.17	0.03	0.17	-0.04	0.17			-0.12	0.17	-0.04	0.17	-0.04	0.17			-0.09	0.17	-0.03	0.17	0.11	0.18	-0.06	0.17			-0.06	0.17		
BEV	0.03	0.04	0.06	0.04	0.04	0.17	-0.04	0.12	0.02	0.04	-0.02	0.04	0.05	0.06	0.08	0.06	0.11	0.15	0.29	0.06	0.09	0.05	0.02	0.04			-0.06	0.05	0.02	0.04	0.02	0.03			-0.03	0.04	0.04	0.03	0.17	0.09	0.00	0.04	0.06	0.17				
NML																																															

Table 7.5 Degree of equivalence between the participants of EUROMET.T-K6 at the frost-point temperature -10 °C. DoE is expressed in degrees Celsius.

Lab *i* ↓ Lab *j* →

	MIKES		PTB		SP		DELTA		CETIAT		GUM		METAS		NMISA		JV		VNIIM		NMi-VSL		INTA		IPQ		EIM		iNRiM		MIRS-FE-LMK		LPM		UME		NPL		CMI		MKEH		SMU		BEV		NML	
	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij
MIKES			0.02	0.03	0.00	0.17	-0.05	0.13	0.00	0.03	-0.01	0.03	0.01	0.03	0.04	0.07	0.09	0.15	0.15	0.06	0.02	0.06	-0.01	0.03	-0.22	0.20	-0.03	0.04	-0.01	0.03	0.00	0.04	-0.20	0.11	-0.06	0.05	0.00	0.04	0.04	0.09	-0.02	0.06	-0.05	0.14	-0.03	0.03	0.02	0.07
PTB	-0.02	0.03			0.00	0.12	-0.07	0.09	-0.01	0.02	-0.03	0.02	0.00	0.03	0.03	0.05	0.08	0.11	0.14	0.04	0.00	0.04	-0.02	0.03	-0.23	0.14	-0.05	0.03	-0.02	0.03	-0.02	0.02	-0.22	0.08	-0.08	0.03	-0.02	0.03	0.02	0.06	-0.03	0.04	-0.06	0.10	-0.05	0.02	0.00	0.05
SP	0.00	0.17	0.01	0.17			-0.06	0.20	-0.01	0.12	-0.02	0.17	0.01	0.12	0.04	0.18	0.09	0.22	0.15	0.17	0.02	0.17	-0.01	0.12	-0.22	0.26	-0.03	0.17	-0.01	0.12	-0.01	0.17	-0.21	0.19	-0.07	0.17	-0.01	0.17	0.03	0.18	-0.02	0.17	-0.05	0.22	-0.04	0.17	0.01	0.18
DELTA	0.05	0.13	0.06	0.12	0.06	0.20			0.05	0.09	0.04	0.12	0.06	0.09	0.10	0.14	0.14	0.19	0.20	0.13	0.07	0.13	0.04	0.09	-0.17	0.23	0.02	0.13	0.05	0.09	0.05	0.12	-0.15	0.16	-0.01	0.13	0.05	0.13	0.09	0.15	0.03	0.13	0.00	0.18	0.02	0.12	0.07	0.14
CETIAT	0.00	0.03	0.01	0.02	0.01	0.12	-0.05	0.09			-0.01	0.02	0.00	0.03	0.04	0.05	0.09	0.11	0.15	0.04	0.02	0.04	-0.02	0.03	-0.22	0.14	-0.03	0.03	-0.01	0.03	0.00	0.02	-0.20	0.08	-0.06	0.04	0.00	0.03	0.04	0.06	-0.01	0.04	-0.04	0.10	-0.03	0.02	0.02	0.05
GUM	0.00	0.03	0.02	0.02	0.01	0.12	-0.05	0.09	0.01	0.02			0.02	0.03	0.05	0.05	0.10	0.11	0.16	0.04	0.02	0.04	0.00	0.03	-0.21	0.14	-0.03	0.03	0.01	0.02	0.00	0.02	-0.20	0.08	-0.06	0.03	0.00	0.02	0.04	0.06	-0.01	0.04	-0.04	0.10	-0.03	0.02	0.02	0.05
METAS	-0.01	0.03	0.00	0.03	-0.01	0.12	-0.06	0.09	0.00	0.03	-0.02	0.03			0.03	0.05	0.08	0.11	0.14	0.05	0.01	0.04	-0.04	0.03	-0.23	0.15	-0.04	0.03	-0.04	0.03	-0.02	0.03	-0.21	0.08	-0.08	0.04	-0.01	0.03	0.03	0.06	-0.03	0.05	-0.06	0.10	-0.05	0.03	0.01	0.05
NMISA	-0.04	0.07	-0.03	0.07	-0.04	0.18	-0.10	0.14	-0.04	0.07	-0.06	0.07	-0.01	0.07			0.05	0.16	0.11	0.09	-0.02	0.08	-0.05	0.05	-0.26	0.21	-0.07	0.07	-0.05	0.05	-0.05	0.07	-0.25	0.12	-0.11	0.08	-0.05	0.07	0.00	0.11	-0.06	0.08	-0.09	0.15	-0.08	0.07	-0.02	0.09
JV	-0.09	0.15	-0.08	0.15	-0.09	0.22	-0.14	0.19	-0.09	0.15	-0.10	0.15	-0.06	0.15	-0.05	0.16			0.06	0.16	-0.07	0.16	-0.10	0.11	-0.31	0.25	-0.12	0.15	-0.10	0.11	-0.10	0.15	-0.29	0.18	-0.16	0.16	-0.09	0.15	-0.05	0.17	-0.11	0.16	-0.14	0.21	-0.13	0.15	-0.07	0.16
VNIIM	-0.15	0.06	-0.14	0.06	-0.15	0.17	-0.20	0.13	-0.15	0.06	-0.16	0.06	-0.12	0.06	-0.11	0.09	-0.06	0.16			-0.13	0.07	-0.16	0.05	-0.37	0.21	-0.18	0.06	-0.16	0.05	-0.16	0.06	-0.35	0.12	-0.22	0.07	-0.15	0.06	-0.11	0.10	-0.17	0.08	-0.20	0.15	-0.19	0.06	-0.13	0.09
NMi-VSL	-0.02	0.06	-0.01	0.05	-0.02	0.17	-0.07	0.13	-0.01	0.06	-0.03	0.05	0.01	0.06	0.02	0.08	0.07	0.16	0.13	0.07			-0.03	0.04	-0.24	0.21	-0.05	0.06	-0.03	0.04	-0.02	0.05	-0.22	0.11	-0.09	0.06	-0.02	0.06	0.02	0.10	-0.04	0.07	-0.07	0.15	-0.05	0.05	0.00	0.08
INTA	0.01	0.03	0.02	0.03	0.01	0.12	-0.04	0.09	0.02	0.03	0.00	0.03	0.04	0.03	0.05	0.05	0.10	0.11	0.16	0.05	0.03	0.04			-0.21	0.14	-0.02	0.03	-0.01	0.03	0.00	0.03	-0.19	0.08	-0.06	0.04	0.01	0.03	0.05	0.06	-0.01	0.04	-0.04	0.10	-0.02	0.02	0.03	0.05
IPQ	0.22	0.20	0.23	0.20	0.22	0.26	0.17	0.23	0.22	0.20	0.20	0.20	0.25	0.20	0.26	0.21	0.31	0.25	0.37	0.21	0.24	0.21	0.22	0.20			0.19	0.20	0.21	0.14	0.21	0.20	0.02	0.22	0.15	0.20	0.22	0.20	0.26	0.22	0.20	0.21	0.17	0.24	0.18	0.20	0.24	0.21
EIM	0.03	0.04	0.04	0.04	0.03	0.17	-0.02	0.13	0.04	0.04	0.02	0.04	0.06	0.04	0.07	0.07	0.12	0.15	0.18	0.06	0.05	0.06	0.03	0.04	-0.19	0.20			0.02	0.03	0.03	0.03	-0.17	0.11	-0.03	0.05	0.03	0.04	0.07	0.09	0.01	0.06	-0.02	0.14	0.00	0.04	0.05	0.07
iNRiM	0.01	0.03	0.02	0.03	0.01	0.12	-0.05	0.09	0.01	0.03	-0.01	0.02	0.04	0.03	0.05	0.05	0.10	0.11	0.16	0.05	0.03	0.04	0.01	0.03	-0.21	0.14	-0.02	0.03			0.00	0.02	-0.20	0.08	-0.06	0.04	0.01	0.03	0.05	0.06	-0.01	0.04	-0.04	0.10	-0.03	0.02	0.03	0.05
MIRS-FE-LMK	0.00	0.04	0.02	0.03	0.01	0.17	-0.05	0.12	0.01	0.03	-0.01	0.03	0.04	0.03	0.05	0.07	0.10	0.15	0.16	0.06	0.02	0.05	0.00	0.03	-0.21	0.20	-0.03	0.03	-0.01	0.03			-0.20	0.11	-0.06	0.04	0.00	0.04	0.04	0.09	-0.01	0.06	-0.04	0.14	-0.03	0.03	0.02	0.07
LPM	0.20	0.11	0.21	0.11	0.21	0.19	0.15	0.16	0.21	0.11	0.19	0.11	0.23	0.11	0.25	0.12	0.29	0.18	0.35	0.12	0.22	0.11	0.20	0.11	-0.02	0.22	0.17	0.11	0.19	0.11	0.20	0.11			0.14	0.11	0.20	0.11	0.24	0.13	0.19	0.12	0.16	0.17	0.17	0.11	0.22	0.12
UME	0.06	0.05	0.08	0.05	0.07	0.17	0.01	0.13	0.07	0.05	0.05	0.05	0.10	0.05	0.11	0.08	0.16	0.16	0.22	0.07	0.09	0.06	0.07	0.05	-0.15	0.20	0.03	0.05	0.05	0.05	0.06	0.04	-0.14	0.11			0.06	0.05	0.10	0.09	0.05	0.07	0.02	0.15	0.03	0.04	0.08	0.08
NPL	0.00	0.04	0.01	0.04	0.01	0.17	-0.05	0.13	0.01	0.04	-0.01	0.03	0.03	0.04	0.05	0.07	0.09	0.15	0.15	0.06	0.02	0.06	0.00	0.04	-0.22	0.20	-0.03	0.04	-0.01	0.04	0.00	0.04	-0.20	0.11	-0.06	0.05			0.04	0.09	-0.02	0.06	-0.05	0.14	-0.03	0.03	0.02	0.07
CMI	-0.04	0.09	-0.03	0.09	-0.03	0.18	-0.09	0.15	-0.03	0.09	-0.05	0.09	-0.01	0.09	0.00	0.11	0.05	0.17	0.11	0.10	-0.02	0.10	-0.04	0.09	-0.26	0.22	-0.07	0.09	-0.05	0.09	-0.04	0.09	-0.24	0.13	-0.10	0.09	-0.04	0.09			-0.06	0.10	-0.09	0.16	-0.07	0.09	-0.02	0.11
MKEH	0.02	0.06	0.03	0.06	0.02	0.17	-0.03	0.13	0.02	0.06	0.00	0.06	0.05	0.06	0.06	0.08	0.11	0.16	0.17	0.08	0.04	0.07	0.02	0.06	-0.20	0.21	-0.01	0.06	0.00	0.06	0.01	0.06	-0.19	0.12	-0.05	0.07	0.02	0.06	0.06	0.10			-0.03	0.15	-0.02	0.06	0.04	0.08
SMU	0.05	0.14	0.06	0.14	0.05	0.22	0.00	0.18	0.05	0.14	0.03	0.14	0.08	0.14	0.09	0.15	0.14	0.21	0.20	0.15	0.07	0.15	0.05	0.14	-0.17	0.24	0.02	0.14	0.03	0.14	0.04	0.14	-0.16	0.17	-0.02	0.15	0.05	0.14	0.09	0.16	0.03	0.15			0.01	0.14	0.07	0.15
BEV	0.03	0.03	0.05	0.03	0.04	0.17	-0.02	0.12	0.04	0.03	0.02	0.02	0.07	0.03	0.08	0.07	0.13	0.15	0.19	0.06	0.05	0.05	0.03	0.04	-0.18	0.20	0.00	0.04	0.02	0.03	0.03	0.03	-0.17	0.11	-0.03	0.04	0.03	0.03	0.07	0.09	0.02	0.06	-0.01	0.14			0.05	0.07
NML	-0.02	0.07	-0.01	0.07	-0.01	0.18	-0.07	0.14	-0.01	0.07	-0.03	0.07	0.01	0.07	0.02	0.09	0.07	0.16	0.13	0.09	0.00	0.08	-0.02	0.07	-0.24	0.21	-0.05	0.07	-0.03	0.07	-0.02	0.07	-0.22	0.12	-0.08	0.08	-0.02	0.07	0.02	0.11	-0.04	0.08	-0.07	0.15	-0.05	0.07		

Table 7.6 Degree of equivalence between the participants of EUROMET.T-K6 at the dew-point temperature 1 °C. DoE is expressed in degrees Celsius.

Lab *i* ↓ Lab *j* →

	MIKES		PTB		SP		DELTA		CETIAT		GUM		METAS		NMISA		JV		VNIIM		NMi-VSL		INTA		IPQ		EIM		iNRiM		MIRS-FE-LMK		LPM		UME		NPL		CMI		MKEH		SMU		BEV		NML	
	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij
MIKES			-0.01	0.03	-0.07	0.13	-0.03	0.13	-0.08	0.03	-0.02	0.03	0.00	0.03	0.01	0.07	0.06	0.11	0.17	0.06	0.03	0.07	-0.04	0.03	-0.25	0.18	-0.05	0.05	-0.03	0.03	-0.01	0.04	-0.14	0.09	-0.05	0.04	-0.03	0.04	-0.03	0.08	0.01	0.05	-0.01	0.14	-0.08	0.03	-0.02	0.06
PTB	0.01	0.03			-0.06	0.09	-0.02	0.10	-0.06	0.02	-0.01	0.02	0.03	0.03	0.02	0.05	0.07	0.08	0.18	0.04	0.04	0.05	-0.01	0.03	-0.23	0.13	-0.04	0.03	-0.01	0.03	0.00	0.02	-0.13	0.07	-0.04	0.03	-0.01	0.03	-0.01	0.06	0.03	0.04	0.01	0.10	-0.06	0.02	0.00	0.04
SP	0.07	0.13	0.05	0.13			0.04	0.18	0.00	0.09	0.05	0.13	0.08	0.10	0.08	0.14	0.13	0.16	0.24	0.14	0.10	0.14	0.04	0.10	-0.17	0.22	0.03	0.13	0.04	0.09	0.06	0.13	-0.07	0.16	0.02	0.13	0.05	0.13	0.05	0.15	0.09	0.14	0.06	0.18	0.00	0.13	0.06	0.14
DELTA	0.03	0.13	0.01	0.13	-0.04	0.18			-0.05	0.10	0.01	0.13	0.03	0.10	0.04	0.14	0.09	0.17	0.20	0.14	0.06	0.14	0.00	0.10	-0.21	0.22	-0.01	0.14	0.00	0.10	0.02	0.13	-0.11	0.16	-0.02	0.13	0.01	0.13	0.00	0.15	0.04	0.14	0.02	0.19	-0.04	0.13	0.01	0.14
CETIAT	0.08	0.03	0.06	0.02	0.00	0.09	0.05	0.10			0.06	0.02	0.08	0.03	0.08	0.05	0.14	0.08	0.24	0.05	0.10	0.05	0.04	0.03	-0.17	0.13	0.03	0.03	0.05	0.03	0.06	0.02	-0.07	0.07	0.03	0.03	0.06	0.03	0.06	0.06	0.10	0.04	0.07	0.10	0.01	0.02	0.07	0.05
GUM	0.02	0.03	0.00	0.03	-0.05	0.10	-0.01	0.10	-0.06	0.03			0.02	0.03	0.03	0.05	0.08	0.08	0.19	0.05	0.04	0.05	-0.02	0.03	-0.23	0.13	-0.03	0.04	-0.01	0.03	0.00	0.03	-0.13	0.07	-0.04	0.03	0.00	0.03	0.00	0.06	0.04	0.04	0.01	0.10	-0.05	0.03	0.01	0.05
METAS	0.00	0.03	-0.03	0.03	-0.08	0.10	-0.03	0.10	-0.08	0.03	-0.02	0.03			0.00	0.05	0.06	0.08	0.16	0.05	0.01	0.05	-0.06	0.03	-0.26	0.13	-0.06	0.04	-0.06	0.03	-0.03	0.03	-0.16	0.07	-0.06	0.03	-0.03	0.03	-0.03	0.06	0.01	0.04	-0.02	0.10	-0.08	0.03	-0.02	0.05
NMISA	-0.01	0.07	-0.03	0.06	-0.08	0.14	-0.04	0.14	-0.08	0.07	-0.03	0.06	0.02	0.07			0.05	0.12	0.16	0.08	0.02	0.09	-0.04	0.05	-0.25	0.19	-0.05	0.07	-0.04	0.05	-0.02	0.07	-0.15	0.11	-0.06	0.07	-0.03	0.07	-0.03	0.10	0.01	0.08	-0.02	0.15	-0.08	0.07	-0.02	0.08
JV	-0.06	0.11	-0.08	0.10	-0.13	0.16	-0.09	0.17	-0.14	0.11	-0.08	0.10	-0.03	0.11	-0.05	0.12			0.11	0.12	-0.03	0.12	-0.10	0.08	-0.31	0.20	-0.11	0.11	-0.09	0.08	-0.07	0.11	-0.20	0.13	-0.11	0.11	-0.09	0.11	-0.09	0.13	-0.05	0.11	-0.07	0.17	-0.14	0.11	-0.08	0.12
VNIIM	-0.17	0.06	-0.19	0.06	-0.24	0.14	-0.20	0.14	-0.24	0.06	-0.19	0.06	-0.14	0.06	-0.16	0.08	-0.11	0.12			-0.14	0.09	-0.20	0.05	-0.41	0.18	-0.21	0.07	-0.20	0.05	-0.18	0.06	-0.31	0.10	-0.22	0.07	-0.19	0.06	-0.19	0.10	-0.15	0.07	-0.18	0.14	-0.24	0.06	-0.18	0.08
NMi-VSL	-0.03	0.07	-0.05	0.07	-0.10	0.14	-0.06	0.14	-0.11	0.07	-0.05	0.07	0.00	0.07	-0.02	0.09	0.03	0.12	0.14	0.09			-0.05	0.05	-0.27	0.19	-0.07	0.07	-0.05	0.05	-0.04	0.07	-0.17	0.11	-0.08	0.07	-0.03	0.07	-0.04	0.10	0.01	0.08	-0.02	0.15	-0.08	0.07	-0.03	0.09
INTA	0.04	0.03	0.01	0.03	-0.04	0.10	0.00	0.10	-0.04	0.03	0.02	0.03	0.06	0.03	0.04	0.05	0.10	0.08	0.20	0.05	0.05	0.05			-0.22	0.13	-0.02	0.04	0.01	0.03	0.01	0.03	-0.12	0.07	-0.02	0.03	0.02	0.03	0.02	0.06	0.06	0.04	0.03	0.10	-0.03	0.03	0.03	0.05
IPQ	0.25	0.18	0.22	0.18	0.17	0.22	0.21	0.22	0.17	0.18	0.22	0.18	0.27	0.18	0.25	0.19	0.31	0.20	0.41	0.18	0.27	0.19	0.22	0.18			0.20	0.18	0.22	0.13	0.23	0.18	0.10	0.20	0.19	0.18	0.24	0.18	0.24	0.19	0.28	0.18	0.25	0.22	0.19	0.18	0.25	0.18
EIM	0.05	0.05	0.02	0.04	-0.03	0.13	0.01	0.14	-0.03	0.05	0.03	0.04	0.07	0.05	0.05	0.07	0.11	0.11	0.21	0.07	0.07	0.07	0.02	0.05	-0.20	0.18			0.02	0.03	0.03	0.04	-0.10	0.09	-0.01	0.05	0.04	0.05	0.04	0.09	0.08	0.06	0.05	0.14	-0.01	0.04	0.05	0.07
iNRiM	0.03	0.03	0.01	0.03	-0.04	0.09	0.00	0.10	-0.05	0.03	0.01	0.03	0.06	0.03	0.04	0.05	0.09	0.08	0.20	0.05	0.05	0.05	-0.01	0.03	-0.22	0.13	-0.02	0.03			0.01	0.03	-0.12	0.07	-0.03	0.03	0.02	0.03	0.02	0.06	0.06	0.04	0.03	0.10	-0.03	0.02	0.03	0.05
MIRS-FE-LMK	0.01	0.04	-0.01	0.03	-0.06	0.13	-0.02	0.13	-0.07	0.03	-0.01	0.03	0.04	0.04	0.02	0.07	0.07	0.11	0.18	0.06	0.04	0.07	-0.02	0.04	-0.23	0.18	-0.03	0.04	-0.03	0.03			-0.13	0.09	-0.04	0.04	0.01	0.04	0.01	0.08	0.05	0.05	0.02	0.14	-0.04	0.03	0.02	0.06
LPM	0.14	0.09	0.12	0.09	0.07	0.16	0.11	0.16	0.06	0.09	0.12	0.09	0.17	0.09	0.15	0.11	0.20	0.13	0.31	0.10	0.17	0.11	0.11	0.09	-0.10	0.20	0.10	0.09	0.10	0.09	0.13	0.09			0.09	0.09	0.14	0.09	0.13	0.12	0.18	0.10	0.15	0.16	0.09	0.09	0.14	0.10
UME	0.05	0.04	0.03	0.04	-0.02	0.13	0.02	0.13	-0.03	0.04	0.03	0.04	0.08	0.04	0.06	0.07	0.11	0.11	0.22	0.07	0.08	0.07	0.02	0.04	-0.19	0.18	0.01	0.05	0.01	0.04	0.04	0.04	-0.09	0.09			0.04	0.04	0.04	0.09	0.08	0.05	0.06	0.14	-0.01	0.04	0.05	0.07
NPL	0.03	0.04	0.00	0.04	-0.05	0.13	-0.01	0.13	-0.05	0.04	0.01	0.04	0.05	0.04	0.03	0.07	0.09	0.11	0.19	0.06	0.03	0.07	-0.02	0.04	-0.24	0.18	-0.04	0.05	-0.03	0.04	-0.01	0.04	-0.14	0.09	-0.04	0.04			0.00	0.08	0.04	0.05	0.01	0.14	-0.05	0.03	0.01	0.06
CMI	0.03	0.08	0.01	0.08	-0.05	0.15	0.00	0.15	-0.05	0.08	0.01	0.08	0.05	0.08	0.03	0.10	0.09	0.13	0.19	0.10	0.04	0.10	-0.02	0.08	-0.24	0.19	-0.04	0.09	-0.03	0.08	-0.01	0.08	-0.13	0.12	-0.04	0.09	0.00	0.08			0.04	0.09	0.01	0.15	-0.05	0.08	0.01	0.10
MKEH	-0.01	0.05	-0.04	0.05	-0.09	0.14	-0.04	0.14	-0.09	0.05	-0.03	0.05	0.01	0.05	-0.01	0.08	0.05	0.11	0.15	0.07	-0.01	0.08	-0.06	0.05	-0.28	0.18	-0.08	0.06	-0.07	0.05	-0.05	0.05	-0.18	0.10	-0.08	0.05	-0.04	0.05	-0.04	0.09			-0.03	0.14	-0.09	0.04	-0.03	0.07
SMU	0.01	0.14	-0.01	0.14	-0.06	0.18	-0.02	0.19	-0.07	0.14	-0.01	0.14	0.04	0.14	0.02	0.15	0.07	0.17	0.18	0.14	0.02	0.15	-0.04	0.14	-0.25	0.22	-0.05	0.14	-0.05	0.14	-0.02	0.14	-0.15	0.16	-0.06	0.14	-0.01	0.14	-0.01	0.15	0.03	0.14			-0.06	0.13	0.00	0.14
BEV	0.08	0.03	0.05	0.03	0.00	0.13	0.04	0.13	0.00	0.03	0.06	0.03	0.10	0.03	0.08	0.07	0.14	0.11	0.24	0.06	0.08	0.07	0.03	0.04	-0.19	0.18	0.01	0.04	0.02	0.03	0.04	0.03	-0.09	0.09	0.01	0.04	0.05	0.03	0.05	0.08	0.09	0.04	0.06	0.13			0.06	0.06
NML	0.02	0.06	0.00	0.06	-0.06	0.14	-0.01	0.14	-0.06	0.06	0.00	0.06	0.04	0.06	0.02	0.08	0.08	0.12	0.18	0.08	0.03	0.09	-0.03	0.06	-0.25	0.18	-0.05	0.07	-0.04	0.06	-0.02	0.06	-0.14	0.10	-0.05	0.07	-0.01	0.06	-0.01	0.10	0.03	0.07	0.00	0.14	-0.06	0.06		

Table 7.7 Degree of equivalence between the participants of EUROMET.T-K6 at the dew-point temperature 20 °C. DoE is expressed in degrees Celsius.

Lab *i* ↓ Lab *j* →

	MIKES1		PTB		SP		DELTA		CETIAT		GUM		METAS		NMISA		JV		VNIIM		NMi-VSL1		INTA		IPQ		EIM		iNRiM		MIRS-FE-LMK		LPM		UME		NPL1		CMI		MKEH		SMU		BEV		NML	
	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij	Dij	Uij
MIKES			0.01	0.03			-0.05	0.14	-0.07	0.04	0.02	0.04	0.04	0.03	0.01	0.07	0.10	0.11			-0.03	0.05	0.00	0.03	-0.23	0.18	-0.03	0.04	0.01	0.03	0.00	0.04	0.06	0.10	-0.05	0.06	0.01	0.04	-0.05	0.08	0.06	0.05	0.04	0.12	-0.03	0.04	0.02	0.07
PTB	-0.01	0.03					-0.06	0.10	-0.07	0.04	0.01	0.03	0.05	0.03	0.00	0.05	0.10	0.08			-0.03	0.04	0.00	0.03	-0.24	0.13	-0.04	0.03	0.01	0.03	0.00	0.02	0.05	0.07	-0.06	0.04	0.00	0.03	-0.05	0.06	0.05	0.03	0.03	0.09	-0.04	0.02	0.01	0.05
SP																																															
DELTA	0.05	0.14	0.05	0.13					-0.02	0.10	0.07	0.14	0.10	0.10	0.06	0.15	0.16	0.17			0.03	0.14	0.05	0.10	-0.18	0.22	0.03	0.14	0.07	0.10	0.06	0.14	0.12	0.16	0.00	0.14	0.06	0.14	0.01	0.15	0.11	0.14	0.09	0.18	0.02	0.13	0.07	0.14
CETIAT	0.07	0.04	0.07	0.04			0.02	0.10			0.09	0.04	0.09	0.05	0.08	0.05	0.17	0.08			0.04	0.05	0.04	0.05	-0.16	0.13	0.04	0.04	0.06	0.04	0.07	0.04	0.13	0.08	0.02	0.05	0.08	0.04	0.03	0.06	0.13	0.04	0.11	0.09	0.04	0.04	0.09	0.05
GUM	-0.02	0.03	-0.02	0.03			-0.07	0.10	-0.06	0.05			0.03	0.04	-0.01	0.05	0.08	0.08			-0.05	0.04	-0.02	0.04	-0.25	0.13	-0.05	0.04	-0.01	0.03	-0.02	0.03	0.04	0.07	-0.07	0.05	-0.01	0.03	-0.07	0.06	0.04	0.03	0.02	0.09	-0.05	0.03	0.00	0.05
METAS	-0.04	0.03	-0.05	0.03			-0.10	0.10	-0.09	0.05	-0.03	0.04			-0.04	0.05	0.06	0.08			-0.07	0.04	-0.06	0.03	-0.28	0.13	-0.07	0.04	-0.05	0.03	-0.04	0.03	0.02	0.08	-0.10	0.05	-0.04	0.03	-0.09	0.06	0.02	0.04	0.00	0.09	-0.07	0.03	-0.02	0.05
NMISA	-0.01	0.07	-0.01	0.07			-0.06	0.15	-0.05	0.08	0.01	0.07	0.05	0.07			0.10	0.12			-0.03	0.08	-0.01	0.05	-0.24	0.19	-0.03	0.07	0.01	0.05	0.00	0.07	0.06	0.12	-0.06	0.08	0.00	0.07	-0.05	0.10	0.05	0.07	0.03	0.14	-0.04	0.07	0.01	0.09
JV	-0.10	0.11	-0.11	0.11			-0.16	0.17	-0.15	0.12	-0.09	0.11	-0.04	0.11	-0.10	0.12					-0.13	0.11	-0.11	0.08	-0.34	0.20	-0.13	0.11	-0.09	0.08	-0.10	0.11	-0.04	0.14	-0.15	0.12	-0.10	0.11	-0.15	0.13	-0.04	0.11	-0.06	0.16	-0.13	0.11	-0.08	0.12
VNIIM																																															
NMi-VSL	0.03	0.05	0.02	0.05			-0.03	0.14	-0.02	0.07	0.04	0.06	0.09	0.06	0.03	0.08	0.13	0.11					0.02	0.04	-0.21	0.18	0.00	0.06	0.04	0.04	0.03	0.05	0.09	0.11	-0.02	0.07	0.04	0.06	-0.02	0.09	0.09	0.06	0.07	0.13	0.00	0.05	0.05	0.07
INTA	0.00	0.03	0.00	0.03			-0.05	0.10	-0.04	0.05	0.02	0.04	0.06	0.03	0.01	0.05	0.11	0.08			-0.02	0.04			-0.23	0.13	-0.02	0.03	0.02	0.03	0.01	0.03	0.07	0.07	-0.05	0.05	0.01	0.03	-0.04	0.06	0.07	0.03	0.04	0.09	-0.02	0.03	0.03	0.05
IPQ	0.23	0.18	0.23	0.18			0.18	0.22	0.19	0.18	0.25	0.18	0.29	0.18	0.24	0.19	0.34	0.20			0.21	0.18	0.22	0.18			0.20	0.18	0.24	0.13	0.24	0.18	0.29	0.20	0.18	0.18	0.24	0.18	0.19	0.19	0.29	0.18	0.27	0.21	0.20	0.18	0.25	0.19
EIM	0.03	0.04	0.02	0.04			-0.03	0.14	-0.02	0.06	0.05	0.05	0.09	0.05	0.03	0.07	0.13	0.11			0.00	0.06	0.02	0.04	-0.20	0.18			0.04	0.03	0.03	0.04	0.09	0.10	-0.02	0.06	0.04	0.05	-0.02	0.08	0.09	0.05	0.07	0.13	0.00	0.04	0.05	0.07
iNRiM	-0.01	0.03	-0.01	0.03			-0.07	0.10	-0.06	0.04	0.01	0.03	0.05	0.03	-0.01	0.05	0.09	0.08			-0.04	0.04	-0.02	0.03	-0.24	0.13	-0.04	0.03			-0.01	0.03	0.05	0.07	-0.06	0.05	0.00	0.03	-0.06	0.06	0.05	0.03	0.03	0.09	-0.04	0.03	0.01	0.05
MIRS-FE-LMK	0.00	0.04	-0.01	0.03			-0.06	0.14	-0.05	0.06	0.01	0.04	0.05	0.04	0.00	0.07	0.10	0.11			-0.03	0.05	-0.02	0.04	-0.24	0.18	-0.03	0.04	0.01	0.04			0.06	0.10	-0.06	0.06	0.00	0.04	-0.05	0.08	0.06	0.04	0.04	0.12	-0.03	0.03	0.02	0.06
LPM	-0.06	0.10	-0.06	0.10			-0.12	0.16	-0.11	0.11	-0.04	0.10	0.00	0.10	-0.06	0.12	0.04	0.14			-0.09	0.11	-0.07	0.10	-0.29	0.20	-0.09	0.10	-0.05	0.10	-0.06	0.10			-0.11	0.11	-0.05	0.10	-0.11	0.12	0.00	0.10	-0.02	0.15	-0.09	0.10	-0.04	0.11
UME	0.05	0.06	0.05	0.06			0.00	0.14	0.01	0.08	0.07	0.07	0.11	0.07	0.06	0.08	0.15	0.12			0.02	0.07	0.04	0.06	-0.18	0.18	0.02	0.06	0.06	0.06	0.06	0.06	0.11	0.11			0.06	0.07	0.01	0.09	0.11	0.07	0.09	0.13	0.02	0.06	0.07	0.08
NPL	-0.01	0.04	-0.01	0.04			-0.06	0.14	-0.05	0.06	0.01	0.05	0.05	0.05	0.00	0.07	0.10	0.11			-0.04	0.06	-0.02	0.05	-0.24	0.18	-0.04	0.05	0.00	0.04	0.00	0.04	0.05	0.10	-0.06	0.07			-0.05	0.08	0.05	0.04	0.03	0.12	-0.04	0.03	0.01	0.06
CMI	0.05	0.08	0.04	0.08			-0.01	0.15	0.00	0.09	0.06	0.08	0.10	0.08	0.05	0.10	0.15	0.13			0.02	0.09	0.03	0.08	-0.19	0.19	0.02	0.08	0.06	0.08	0.05	0.08	0.11	0.12	-0.01	0.09	0.05	0.08			0.11	0.08	0.09	0.14	0.02	0.08	0.07	0.09
MKEH	-0.06	0.05	-0.06	0.04			-0.11	0.14	-0.10	0.06	-0.04	0.05	0.00	0.05	-0.05	0.07	0.04	0.11			-0.09	0.06	-0.07	0.05	-0.29	0.18	-0.09	0.05	-0.05	0.05	-0.06	0.04	0.00	0.10	-0.11	0.07	-0.05	0.04	-0.11	0.08			-0.02	0.12	-0.09	0.04	-0.04	0.07
SMU	-0.04	0.12	-0.04	0.12			-0.09	0.18	-0.08	0.13	-0.02	0.13	0.02	0.12	-0.03	0.14	0.06	0.16			-0.07	0.13	-0.05	0.13	-0.27	0.21	-0.07	0.13	-0.03	0.12	-0.04	0.12	0.02	0.15	-0.09	0.13	-0.03	0.12	-0.09	0.14	0.02	0.12			-0.07	0.12	-0.02	0.13
BEV	0.03	0.04	0.03	0.03			-0.02	0.13	-0.01	0.06	0.05	0.04	0.09	0.04	0.04	0.07	0.13	0.11			0.00	0.05	0.02	0.04	-0.20	0.18	0.00	0.04	0.04	0.04	0.03	0.03	0.09	0.10	-0.02	0.06	0.04	0.03	-0.02	0.08	0.09	0.04	0.07	0.12			0.05	0.06
NML	-0.02	0.07	-0.02	0.06			-0.07	0.14	-0.06	0.08	0.00	0.07	0.04	0.07	-0.01	0.09	0.08	0.12			-0.05	0.07	-0.03	0.07	-0.25	0.19	-0.05	0.07	-0.01	0.07	-0.02	0.06	0.04	0.11	-0.07	0.08	-0.01	0.06	-0.07	0.09	0.04	0.07	0.02	0.13	-0.05	0.06		

8. EUROMET COMPARISON REFERENCE VALUES (ERV)

8.1 ERV calculation method

Due to the nature of dew/frost-point temperature scales the only meaning of a comparison reference value determined by any method is to simplify the interpretation and further use of comparison results. Especially, when reviewing CMC claims according to the CCT review protocol comparison reference values are needed.

In this project, the calculation of the EUROMET comparison Reference Values (ERV) is carried out according to the procedure proposed by M. Cox [1,2]. Because there was no transfer standard measured by all participants or a subset of participants, absolute ERV values were not determined. Only the differences between ERVs and the results of each laboratory were calculated.

The calculations were carried out using weighted mean of results normalised to the loop of the laboratory under study (x). The normalisation was realised using the function B defined by equation (7.2):

$$R_x - R_{ERV} = R_x - \frac{\sum_{i=1}^{N} \frac{R_i'}{u^2(R_i')}}{\sum_{i=1}^{N} u^{-2}(R_i')} = R_x - \frac{\sum_{i=1}^{N} \frac{R_i + B(x,i)}{u^2(R_i) + u^2[B(x,i)]}}{\sum_{i=1}^{N} [u^2(R_i) + u^2[B(x,i)]]^{-1}}$$

$$u^2(R_x - R_{ERV}) = u^2(R_x) + \left(\sum_{i=1}^{N} [u^2(R_i) + u^2[B(x,i)]]^{-1} \right)^{-1} \qquad (8.1)$$

where N is the total number of participants and R_i is the result of ith laboratory.

If we set $R_x = 0$ and apply equation (8.1) in cases where the laboratory of interest is assumed to be in loops 1, 2 and 3, we can analyse the quality of the ERV calculation. For the purpose, two methods are used: a chi-squared consistency test [1-3] and comparison with values obtained in terms of simple mean and median. The analysis was carried out from the results of all laboratories and the results of the laboratories used primary dew/frost-point standards in this comparison. To avoid complicate correlation studies, it was decided to derive the final results from the results obtained with the primary standards. A summary of the analysis is in Appendix 4.

In both cases the chi-squared consistency test failed. Therefore, discrepant results were identified with the criterion [1]:

$$\left| R_x - R_{ERV} \right| > 2\sqrt{u^2(R_x) - u^2(R_{ERV})} \qquad (8.2)$$

The analysis was then repeated for the primary laboratory results excluding the discrepant results. As a result, all the results passed the chi-squared consistency test and ERVs are close to the mean values calculated with simples mean and median (see Appendix 4).

8.2 Final results of the ERV analysis

The results of all laboratories are compared to ERV according to the analysis described in the previous section. Due to the participation in two loops, the link laboratories form a special case. Their results were combined in the following way:

$$R_x - R_{ERV} = \frac{1}{2}\left[(R_x - R_{ERV})_{LoopA} + (R_x - R_{ERV})_{LoopB}\right]$$

$$u^2(R_x - R_{ERV}) = \frac{1}{4}\left[u^2(R_x - R_{ERV})_{LoopA} + u^2(R_x - R_{ERV})_{LoopB} + u_L{}^2\right] \qquad (8.3)$$

where

$$u_L{}^2 = \frac{1}{12}\left[(R_x - R_{ERV})_{LoopA} - (R_x - R_{ERV})_{LoopB}\right]^2$$

Here LoopA and LoopB refer to the loops in which the link laboratory participated. The outcomes of this analysis are shown in figures 8.1 to 8.5 and tables 8.1 to 8.2. All the uncertainties are at the 95 % confidence level (k=2). Table 8.3 summarizes the ERV uncertainties. The uncertainties are shown for each laboratory because they depend on the loop. Also, the uncertainties for the link laboratories differ from the others (as described by eq. (8.3)).

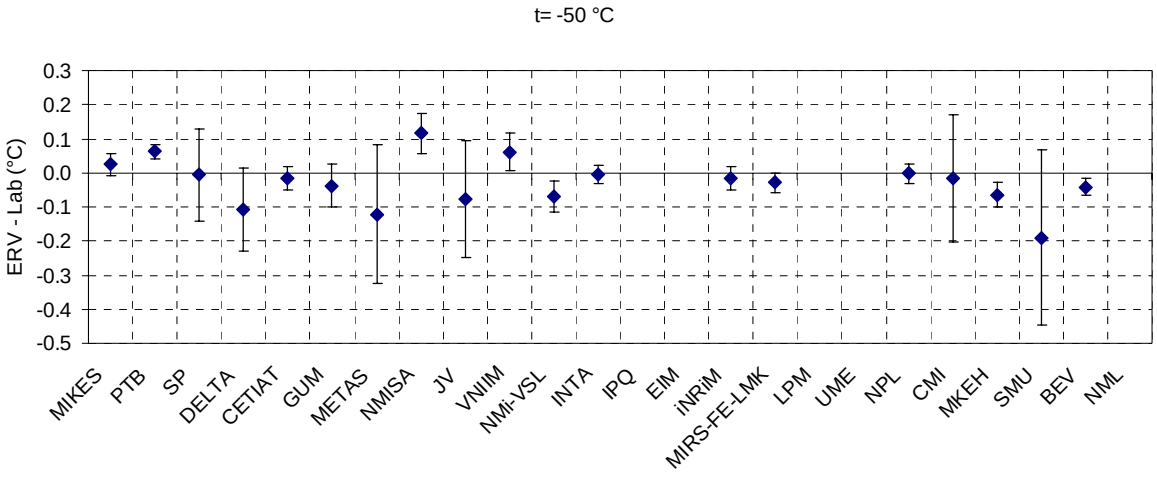

Figure 8.1 Difference between the ERV and the result of the laboratories at the nominal frost-point temperature -50 °C. Error bars show the expanded uncertainties (k=2).

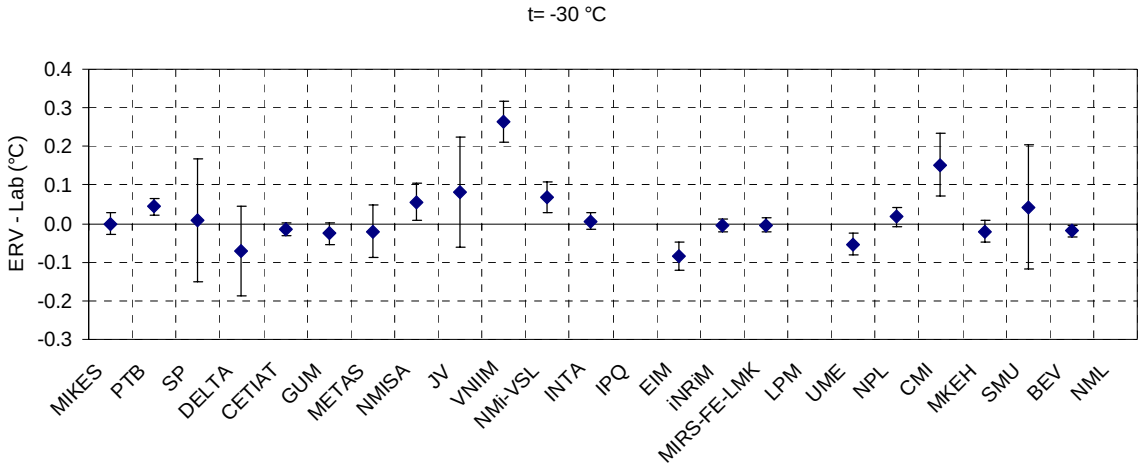

Figure 8.2 Difference between the ERV and the result of the laboratories at the nominal frost-point temperature -30 °C. Error bars show the expanded uncertainties (k=2).

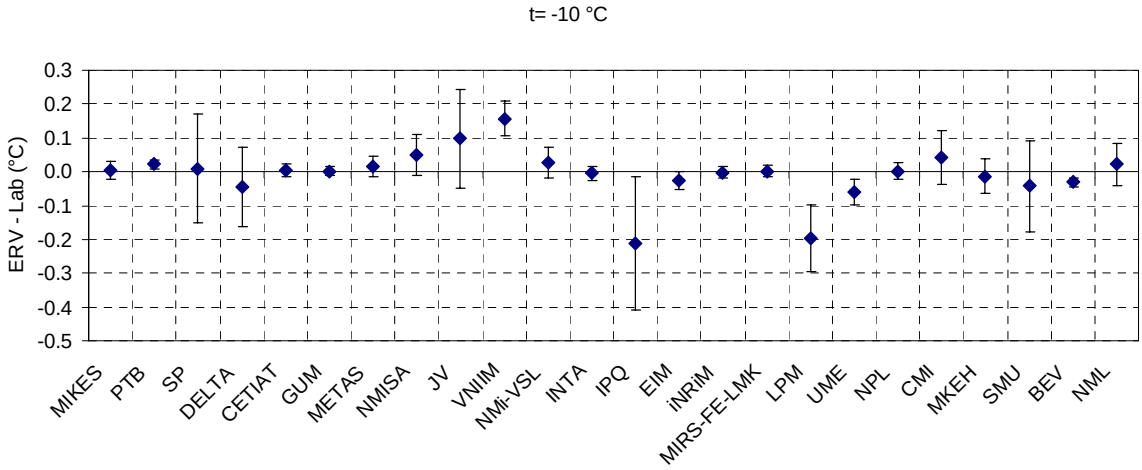

Figure 8.3 Difference between the ERV and the result of the laboratories at the nominal frost-point temperature -10 °C. Error bars show the expanded uncertainties (k=2).

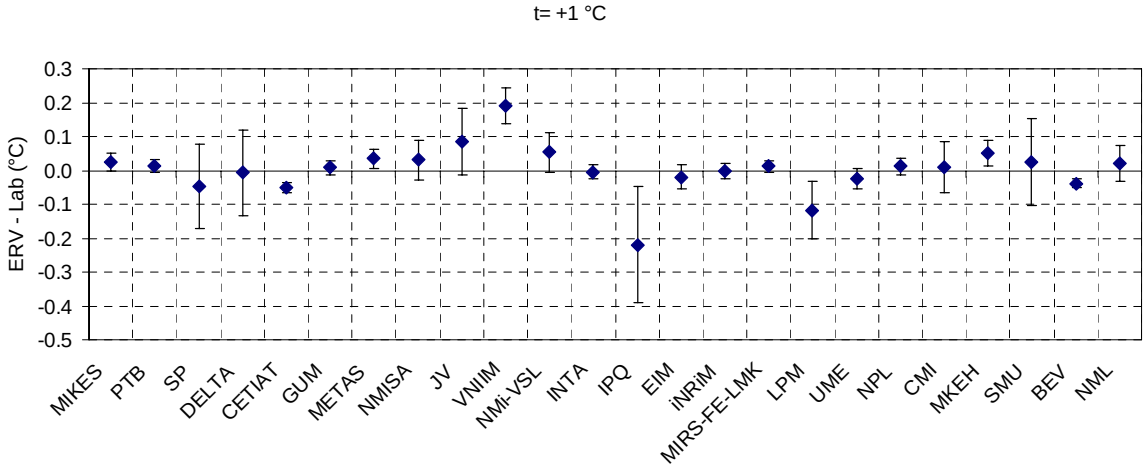

Figure 8.4 Difference between the ERV and the result of the laboratories at the nominal frost-point temperature +1 °C. Error bars show the expanded uncertainties (k=2).

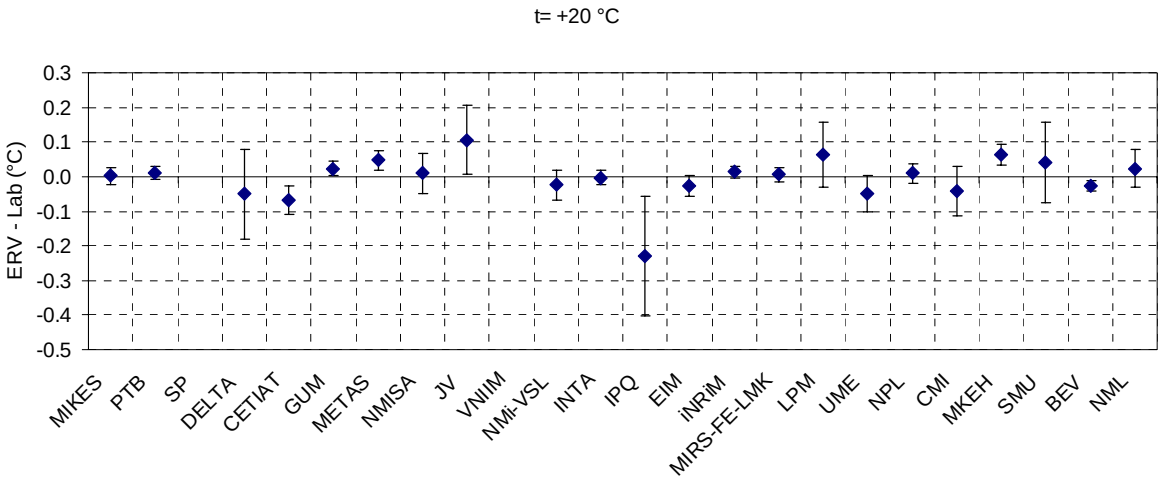

Figure 8.5 Difference between the ERV and the result of the laboratories at the nominal frost-point temperature +20 °C. Error bars show the expanded uncertainties (k=2).

Table 8.1 Estimates of the differences between the ERVs and the results of the laboratories (expressed in °C).

	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES	0.025	0.000	0.005	0.025	0.003
PTB	0.062	0.044	0.022	0.015	0.011
SP	-0.006	0.009	0.010	-0.048	
DELTA	-0.109	-0.072	-0.046	-0.006	-0.051
CETIAT	-0.016	-0.015	0.004	-0.052	-0.068
GUM	-0.037	-0.026	0.001	0.008	0.024
METAS	-0.122	-0.020	0.016	0.034	0.047
NMISA	0.116	0.057	0.049	0.031	0.009
JV	-0.077	0.082	0.098	0.085	0.107
VNIIM	0.062	0.264	0.158	0.190	
NMi-VSL	-0.071	0.068	0.026	0.053	-0.025
INTA	-0.005	0.007	-0.004	-0.004	-0.002
IPQ			-0.212	-0.219	-0.230
EIM		-0.084	-0.025	-0.020	-0.026
iNRiM	-0.017	-0.003	-0.002	-0.002	0.014
MIRS-FE-LMK	-0.029	-0.004	0.002	0.012	0.006
LPM			-0.197	-0.117	0.063
UME		-0.054	-0.060	-0.025	-0.049
NPL	-0.002	0.017	0.002	0.011	0.010
CMI	-0.016	0.152	0.042	0.010	-0.043
MKEH	-0.065	-0.020	-0.013	0.051	0.064
SMU	-0.190	0.043	-0.043	0.024	0.042
BEV	-0.042	-0.019	-0.031	-0.039	-0.027
NML			0.022	0.020	0.023

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Table 8.2 Expanded uncertainties of the differences between the ERVs and the results of the laboratories (k=2), expressed in °C.

	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES	0.032	0.029	0.026	0.025	0.026
PTB	0.023	0.023	0.014	0.019	0.018
SP	0.135	0.161	0.161	0.125	
DELTA	0.122	0.118	0.118	0.127	0.129
CETIAT	0.036	0.018	0.018	0.015	0.043
GUM	0.062	0.028	0.014	0.021	0.022
METAS	0.205	0.070	0.032	0.028	0.028
NMISA	0.060	0.050	0.062	0.058	0.059
JV	0.172	0.143	0.147	0.099	0.101
VNIIM	0.055	0.054	0.052	0.054	
NMi-VSL1	0.047	0.041	0.045	0.060	0.043
INTA	0.026	0.021	0.022	0.020	0.022
IPQ			0.197	0.172	0.172
EIM		0.037	0.027	0.035	0.031
iNRiM	0.035	0.017	0.017	0.023	0.018
MIRS-FE-LMK	0.029	0.019	0.016	0.018	0.022
LPM			0.100	0.084	0.094
UME		0.029	0.037	0.030	0.053
NPL1	0.030	0.025	0.026	0.025	0.028
CMI	0.187	0.082	0.081	0.075	0.072
MKEH	0.037	0.030	0.052	0.040	0.031
SMU	0.257	0.160	0.136	0.130	0.117
BEV	0.025	0.015	0.014	0.015	0.017
NML			0.063	0.053	0.054

Table 8.3 Expanded uncertainties of the ERVs (k=2) for each participant, expressed in °C.

	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES	0.018	0.010	0.007	0.008	0.008
PTB	0.012	0.007	0.005	0.006	0.006
SP	0.018	0.010	0.007	0.008	
DELTA	0.018	0.010	0.007	0.008	0.008
CETIAT	0.012	0.007	0.005	0.006	0.006
GUM	0.012	0.007	0.006	0.007	0.006
METAS	0.012	0.007	0.006	0.007	0.006
NMISA	0.018	0.010	0.007	0.008	0.008
JV	0.018	0.010	0.007	0.008	0.008
VNIIM	0.018	0.010	0.007	0.008	
NMi-VSL1	0.015	0.010	0.007	0.009	0.009
INTA	0.011	0.006	0.006	0.007	0.007
IPQ			0.007	0.009	0.009
EIM		0.010	0.007	0.009	0.009
iNRiM	0.011	0.006	0.006	0.007	0.007
MIRS-FE-LMK	0.015	0.010	0.007	0.009	0.009
LPM			0.007	0.009	0.009
UME		0.010	0.007	0.009	0.009
NPL1	0.016	0.008	0.009	0.011	0.009
CMI	0.016	0.008	0.009	0.011	0.009
MKEH	0.016	0.008	0.009	0.011	0.009
SMU	0.016	0.008	0.009	0.011	0.009
BEV	0.016	0.008	0.009	0.011	0.009
NML			0.009	0.011	0.009

9. LINKAGE BETWEEN EUROMET.T-K6 AND CCT-K6

Table 2.1 shows the laboratories that also participate in the CCT-K6 comparison. Through those laboratories the results reported here can be linked to the CCT-K6 results. Because the CCT comparison is still on-going, the analysis on the linkage cannot be carried yet out.

10. CONCLUSION AND DISCUSSION

10.1 General

The comparison method applied in this project was successful. The equivalence between a large number of laboratories was demonstrated at an uncertainty level that is better than achieved in other multilateral comparisons so far. Uncertainty estimations carried out by participants seem to be realistic in most cases. The results can be used for reviewing the CMCs of the participants (service category 3.1) according to the Review Protocol for Humidity CMCs (accepted by CCT-WG8 in 2005). Although the CMI and NMISA measurements at +1 °C and +20 °C, respectively, did not fulfil the requirement for the maximum difference between the actual and nominal dew-point temperatures, the CMCs of these institutes can be reviewed in the whole range of the comparison against the Protocol (ref. 2.1.1.3 and 2.1.1.4 of the Protocol).

Choosing completely new instruments to be used as the transfer standards proved to a good decision. However, even with them several problems appeared during the exercise. More attention should also paid to the handling the devices when packing, unpacking, connecting and disconnecting to the calibration systems. It would be beneficial in future comparisons to arrange a one day training/workshop on handling the transfer standards before starting the actual comparison. This would be useful for those in particular who have less experience with the type of instruments used in the comparison.

10.2 Identified anomalies in the results

Several anomalies were identified in the results reported in Section 4 but it was concluded that they do not indicate significant stability problems with the transfer standards. Here the anomalies are studied further.

When comparing the transfer standards of each pair to each other (figures 4.1 to 4.3) we find larger deviations in the loop 1 results of SP, CETIAT and VNIIM, in the loop 2results of NMi, CETIAT, IPQ, LPM and UME (loop 2) and in the loop3 results of METAS, GUM, CMI and SMU. Only the IPQ results show a temperature independent anomaly. Some of these are correlated with the anomalies in figures 4.4 to 4.6 as can be seen in the further notes on the deviations below:

- As the CETIAT generator is based on total re-circulation at ambient pressure level, the poorer repeatability of the results may be due to the reported leak (see Section 6.2).
- The VNIIM results show an exceptionally poor non-linearity for the instruments which causes the anomaly in figure 4.1. The results in figures 6.1 and 8.2 to 8.4 show also a clear shift in the mean results of VNIIM compared to other participants in the range above -50 °C. These indicate a significant problem in the used reference and/or measurement procedure when operating with chilled mirror hygrometers in this range.
- When studying the NMi-VSL results for the individual transfer standards, a larger temperature dependence of the results (for both instruments) as in the results reported by other Loop 2 participants was observed. The dependence, however, is not linear but about the same for both instruments. Also, the repeatability of the results for both instruments is poorer than in most results reported by other participants.
- The IPQ results show a larger anomaly for the hygrometer 03-0922. For both instruments the repeatability is good and the discrepancies in figures 6.2 and 8.2 to 8.5 are independent on the applied dew-point temperature. The discrepancies are within the estimated expanded uncertainties but it is highly recommended studying further and reducing the origin of the systematic error.
- The LPM calibration system is under development which is reflected in the results.
- At +20 °C, the UME results for the hygrometer 03-0922 show poorer repeatability compared to other results, which may indicate a problem with the temperature control of the sample tube (the reported ambient temperature was +21 °C).
- At -50 °C, results from several laboratories in the loop 3 show larger deviations in the difference between the instruments. The results are, however, in line with the stated uncertainties.
- The anomalous results of SMU in figures 4.3 and 4.6 indicate that there may have been a problem with resistance measurement at SMU. At +20 °C, the reported reference values for the two instruments are different probably due to non-simultaneous measurements, which may be the origin for the different behaviour of the SMU results in the figures at this measurement point.
- The GUM results in the loop 3 show highly non-linear temperature dependence for the hygrometer 03-0924 due to the results at -30 °C. The repeatability of the results is good but not in line with the results obtained by others.

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[2] M. Cox, The evaluation of key comparison data: determining the largest consistent subset, *Metrologia* **44** (2007) 187-200

[3] L. Nielsen, *Evaluation of measurement intercomparisons by the method of least squares*, Technical Report DFM-99-R39, DFM 2000

APPENDIX 1: DETAILED INFORMATION ON PARTICIPANTS

1. Updated contact information

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Centre Technique des Industries Aérauliques et Thermiques (CETIAT)	France	Domaine Scientifique de la Doua 25, avenue des Arts, 69603 Villeurbanne Cedex	Eric Georgin (Bertrand Blanquart)	eric.georgin@cetiat.fr
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BEV / E+E Elektronik (BEV)	Austria	Langwiesen 7, A-4209 Engerwitzdorf	Helmut Mitter	helmut.mitter@epluse.at
Hellenic Institute of Metrology (EIM)	Greece	Industrial Area of Thessaloniki, Block 45, GR-57022 Sindos	Miltiadis Anagnostou	miltiadis.anagnostou@eim.org.gr
Hungarian Trade Licensing Office (MKEH) [1)]	Hungary	Magyar Kereskedelmi Engedélyezési Hivatal, H-1124 Budapest, Németvölgyi út 37-39	Nagyné Szilágyi Zsófia	nagynesz@mkeh.hu
Instituto Nacional de Técnica Aeroespacial (INTA)	Spain	Centro de Metrologia y Calibración, Ctra. a Ajalvir, km. 4, 28850 Torrejon de Ardoz	Robert Benyon	benyonpr@inta.es
Instituto Português da Qualidade (IPQ)	Portugal	Rua António Giao 2, 2829-513 Caparica	Isabel Lóio	iloio@mail.ipq.pt
Istituto Nazionale di Ricerca Metrologica (iNRiM) [2)]	Italy	Strada delle Cacce, 73, 10135 – Torino	Vito Fernicola	v.fernicola@inrim.it
National Metrology Institute of South Africa (NMISA) [3)]	South Africa	Meiring Naudé Road, Brummeria, ZA-0001 Pretoria	Regina Mnguni	rmnguni@nmisa.org

National Metrology Laboratory (NML)	Ireland	Enterprise Ireland Campus, Glasnevin, Dublin 9	Plunkett Cromwell	plunkett.cromwell@enterprise-ireland.com
National Physical Laboratory (NPL)	UK	Queens Road, Teddington, Middlesex, TW11 0LW	Mark Stevens, Stephanie Bell	mark.stevens@npl.co.uk
NMi van Swinden Laboratorium (NMi-VSL)	Netherlands	Van Swinden Laboratium, Schoemakerstraat 97, P.O. Box 654, NL-2600 AR Delft	Rien Bosma	rbosma@nmi.nl
Norwegian Metrology Service (JV)	Norway	Fetveien 99, NO-2007 Kjeller	Reidun Anita Bergerud	reidunanita.bergerud @justervesenet.no
Physikalisch-Technische Bundesanstalt (PTB)	Germany	Bundesallee 100, 38116 Braunschweig	Norbert Böse	norbert.boese@ptb.de
Slovak Institute of Metrology (SMU)	Slovakia	Karloveská 63, 84255 Bratislava	Alexandra Masarykova	masarykova@smu.gov.sk
Swedish National Testing and Research Institute (SP)	Sweden	Energy Technology, Industrigatan 4, S-501 15 Borås	Per Jacobson	per.jacobsson@sp.se
Swiss Federal Office of Metrology and Accreditation (METAS)	Switzerland	Lindenweg 50, CH-3003 Bern-Wabern	Anton Steiner	anton.steiner@metas.ch
Ulusal Metroloji Enstitüsü (UME)	Turkey	Anibal Cad., Tubitak Gebze Yeleskesi, Besveler, TR-Gebze – Kocaeli 41470	Aliye Kartal Dogan	aliye.kartal@ume.tubitak.gov.tr
University of Ljubljana, Faculty of Electrical Engineering, Laboratory of Metrology and Quality (MIRS/FE-LMK)	Slovenia	Faculty of Electrical Engineering, Laboratory of Metrology and Quality, Trzaska 25, SI-1000 Ljubljana	Jovan Bojkovski	jovan.bojkovski@fe.uni-lj.si
University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Laboratory for Process Measurements (LPM)	Croatia	Faculty of Mechanical Engineering and Naval Architecture,Ivana Lucica 5, HR-10000 Zagreb	Davor Zvizdic	davor.zvizdic@fsb.hr

2. Detailed information on the dew-point temperature standards used by the participants in EUROMET.T-K6

Name of the laboratory	Country	Type of the standard [1)]	Identification of the standard
Central Office of Measures (GUM)	Poland	1-P	humidity generator DPG1
Centre for Metrology and Accreditation (MIKES)	Finland	1-P	Dew-point generator MDFG
Centre Technique des Industries Aérauliques et Thermiques (CETIAT)	France	1-P	Air-humidity generator GAH-BT
Czech Metrology Institute (CMI)	Czech Republic	S	Mix flow Dewpoint generator Michell with the dew-point hygrometer Michell S4000 RS (s/n 97171) calibrated at PTB
D. I. Mendeleyev Institute for Metrology (VNIIM)	Russia	1-P	VNIIM Standard Humidity Generator
DELTA Danish Electronics (DELTA)	Denmark	S	DELTA Dry range calibration system with the Michell S4020RS dew-point hygrometer calibrated at NPL
BEV / E+E Elektronik (BEV)	Austria	2-P	E+E Elektronik humidity reference generator Uw_Ref-A
Hellenic Institute of Metrology (EIM)	Greece	1-P	EIM humidity generator originally designed and constructed at NPL
Hungarian Trade Licensing Office (MKEH) [1)]	Hungary	S	Michell S4000 Precision Dewpointmeter with Michell DG-4 Dewpoint Generator
Instituto Nacional de Técnica Aeroespacial (INTA)	Spain	2-P	Range below 0 °C: INTA Low-range standard humidity generator Thunder Scientific 4500 with external pressure and temperature measurement Range above 0 °C: INTA High-range standard humidity generator Thunder Scientific 9000 with external pressure and temperature measurement
Instituto Português da Qualidade (IPQ)	Portugal	S	Thunder Scientific 2500 generator with the MBW 373 dew-point hygrometer (s/n 05-0812)
Istituto Nazionale di Ricerca Metrologica (iNRiM) [2)]	Italy	1-P	Humidity generators: Range below 0 °C: IMGC-02 Range above 0 °C: IMGC-01
National Metrology Institute of South Africa (NMISA) [3)]	South Africa	S	Reference standards: Michell S4000 (s/n 104717(instrument) & 104718(sensor)) and MBW 373LX (s/n 00-1220)
National Metrology Laboratory (NML)	Ireland	S	Thunder 2500 humidity generator with MBW DP30 Dew Point Hygrometer calibrated at INTA

National Physical Laboratory (NPL)	UK	1-P	Low Frost-point Generator (LFG) NPL Standard Humidity Generator (SHG)
NMi van Swinden Laboratorium (NMi-VSL)	Netherlands	1-P	NMi-VSL 1-P generator
Norwegian Metrology Service (JV)	Norway	S	Dew-point generator, Michell DG2, (s/n 105241) Optical dew-point hygrometer, MBW DP30 / K-1806 (s/n 99-0103) calibrated at NPL
Physikalisch-Technische Bundesanstalt (PTB)	Germany	2-P (-10 to +20 °C) C (-50 to -30 °C)	PTB 2P-1T generator PTB Coulometric trace humidity generator.
Slovak Institute of Metrology (SMU)	Slovakia	S	Pressure Swing Dryer PSD-2 (s/n 107063), Auto Dew-point Generator DG-4 (s/n 107086), Dew-point Hygrometer Michell S4020RS (s/n. 107088) Dew-point meter Michell S4020 (s/n. 107087)
Swedish National Testing and Research Institute (SP)	Sweden	1-P	SP humidity generator
Swiss Federal Office of Metrology and Accreditation (METAS)	Switzerland	1-P	151.4.11 CETIAT 1
Ulusal Metroloji Enstitüsü (UME)	Turkey	2-P	UME humidity generator system (model ST2500-LT)
University of Ljubljana, Faculty of Electrical Engineering, Laboratory of Metrology and Quality (MIRS/FE-LMK)	Slovenia	1-P	MIRS/FE-LMK Primary dew-point generator
University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Laboratory for Process Measurements (LPM)	Croatia	1-P	LPM generator

[1)] C=coulometric, 1-P=single pressure, 2-P=two-pressure, S=secondary

APPENDIX 2: TECHNICAL PROTOCOL

P621 EUROMET Key Comparison in Humidity (dew-point temperature)

Dew/Frost-Point Temperature -50 °C to +20 °C

Technical protocol

Contents

1. INTRODUCTION

1.1 Under the Mutual Recognition Arrangement (MRA)[1] the metrological equivalence of national measurement standards will be determined by a set of key comparisons chosen and organized by the Consultative Committees of the CIPM working closely with the Regional Metrology Organizations (RMOs).

1.2 At its 20th meeting in April 2000, the Consultative Committee for Thermometry, CCT, considered a Key Comparison on humidity as imperative for the related laboratories.

1.3 In 2001, it was agreed to organise a EUROMET Key Comparison to support the MRA.

1.4 This technical protocol has been drawn up by the pilot in consultation with the nominated participants listed in Section 2.

1.5 The procedures outlined in this document cover the technical procedure to be followed during measurement of the travelling standards. The procedure, which follows the guidelines established by the BIPM[2] and EUROMET[3], is based on current best practice in the use of dew/frost-point hygrometers and takes account of the experience gained from the regional comparisons over the years.

1.6 This comparison is aimed at establishing the degree of equivalence between realisations of local scales of dew/frost-point temperature of humid gas, in the range -50 °C to +20 °C, among the participating national metrology institutes.

2. ORGANIZATION

2.1 Participants

2.1.1 A list of participants representing is in table 1. Details of mailing and electronic addresses are given in Appendix 1.

2.1.2 The participants are divided in three groups. Each group will form a comparison loop. To link the loops to each other and to the CCT Key Comparison K6, each loop has two common participants with other loops and the CCT-K6.

2.1.3 MIKES is the Coordinator of the key comparison and the pilot for loop 1, taking main responsibility for running the key comparison. NMi and METAS are co-pilots being responsible for running loops 2 and 3, respectively.

2.1.4 By their declared intention to participate in this key comparison, the laboratories accept the general instructions and the technical protocol written down in this

[1] MRA, Mutual Recognition Arrangement, BIPM, 1999.

[2] T.J. Quinn, "Guidelines for key comparisons carried out by Consultative Committees," Appendix F to the MRA, BIPM, Paris.

[3] EUROMET Guide 3, EUROMET Guidelines on Conducting Comparisons

document and commit themselves to follow strictly the procedures of this protocol as well as the version of the "Guidelines for Key Comparisons" in effect at the time of the initiation of the Key Comparison.

2.1.5 Once the protocol and list of participants have been approved, no change to the protocol or list of participants may be made without prior agreement of all participants.

2.1.6 All participants must be able to submit an uncertainty budget of their humidity standards.

Table 1 List of participants (*C*=Coordinator, *P*=Pilot)

Central Office of Measures (GUM)	Poland	
Centre for Metrology and Accreditation (MIKES)	Finland	*C,P*
Centre Technique des Industries Aérauliques et Thermiques (CETIAT)	France	
CSIR - National Metrology Laboratory (CSIR)	South Africa	
Czech Metrology Institute (CMI)	Czech Republic	
D. I. Mendeleyev Institute for Metrology (VNIIM)	Russia	
DELTA Danish Electronics (DELTA)	Denmark	
E+E Elektronik (E+E)	Austria	
Hellenic Institute of Metrology (EIM)	Greece	
Instituto Nacional de Technica Aeroespacial (CEM/INTA)	Spain	
Instituto Português da Qualidade (IPQ)	Portugal	
Istituto di Metrologia "G. Colonnetti" – CNR (IMGC)	Italy	
National Metrology Laboratory (NML)	Ireland	
National Office of Measures (OMH)	Hungary	
National Physical Laboratory (NPL)	UK	
Nederlands Meetinstituut (NMi)	Netherlands	*P*
Norwegian Metrology Service (JV)	Norway	
Physikalisch-Technische Bundesanstalt (PTB)	Germany	
Slovak Institute of Metrology (SMU)	Slovakia	
Swedish National Testing and Research Institute (SP)	Sweden	
Swiss Federal Office of Metrology and Accreditation (METAS)	Switzerland	*P*
Ulusal Metroloji Enstitüsü (UME)	Turkey	
University of Ljubljana (FE-LMK)	Slovenia	
University of Zagreb (DZNM)	Croatia	

2.2 Method of comparison

2.2.1 The key comparison is a comparison of the realisations of local scales of dew/frost-point temperature at the participating national institutes.

2.2.2 The comparison will be made by calibration of a pair of travelling standards lent by the MBW Calibration Ltd (Switzerland). Each travelling standard will independently measure dew/frost-point temperature of a sample of moist gas produced by a participant's standard generator using the same measuring process.

2.2.3 Simultaneous measurements using a pair of standards gives information about the within-laboratory consistency of the measurements, the reproducibility of the instrument performance, and continuous feedback about the successful transport of the instruments without any major shift in performance.

2.2.4 The comparison is carried out in three parallel loops with separate travelling standards. There is one pair of hygrometers at each loop, which are at all times measured simultaneously. Measurements will start in the pilot/co-pilot laboratory. The other participants in the loop will then perform comparison measurements at the dew/frost-point temperatures required. The last participant will then return the travelling standards to the pilot of the loop to carry out final measurements to monitor drift. The comparison scheme is in figures 1 to 3. Allowing between 6 and 8 weeks per set of measurements (including shipping), this set of measurements will take up to 21 months.

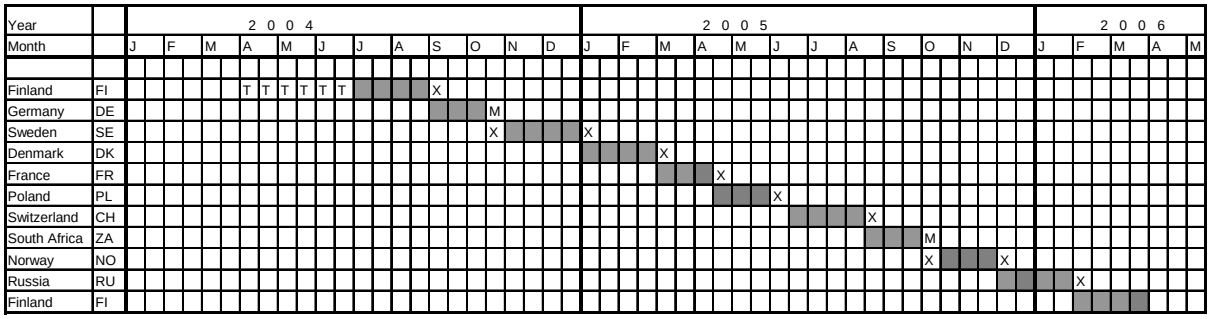

Figure 1 Comparison scheme of loop 1 (One column corresponds two weeks; M= transportation to MBW Calibration for a new ATA Carnet, ■ = measurement, X = measurement/transportation, T = testing the instruments)

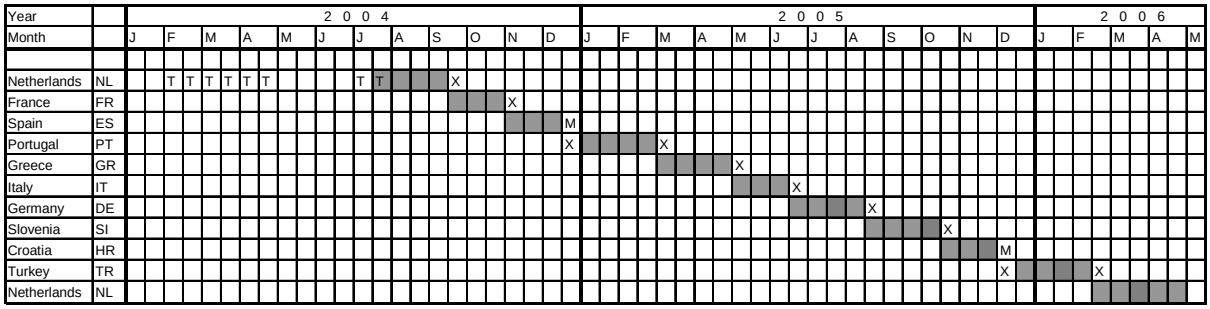

Figure 2 Comparison scheme of loop 2 (One column corresponds two weeks; M= transportation to MBW Calibration for a new ATA Carnet, ■ = measurement, X = measurement/transportation, T = testing the instruments)

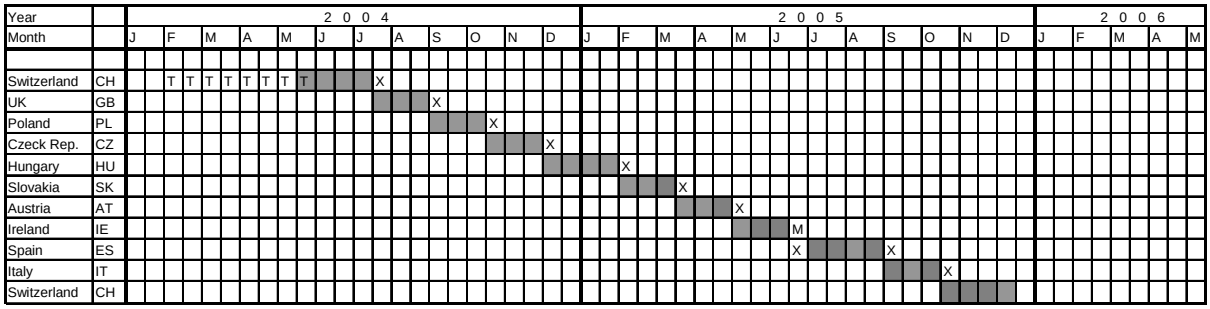

Figure 3 Comparison scheme of loop 3 (One column corresponds two weeks; M= transportation to MBW Calibration for a new ATA Carnet, ■ = measurement, X = measurement/transportation, T = testing the instruments)

2.2.5 All results are to be communicated directly to the Pilot of the corresponding loop within six weeks of the completion of the measurements by a laboratory.

2.2.6 If for some reason, the measurement facility is not ready or customs clearance takes too much time in a country, the participating laboratory must contact the pilot laboratory immediately. Exclusion of a participant's results from the report may occur if the results are not available in time to prepare the draft report.

2.2.7 In case of serious difficulty with customs, or other delays which might over-run the time period of the ATA Carnet, the pilot may request the instruments be returned to the holder of the ATA Carnet (MBW Calibration Ltd) or to the pilot laboratory, or the sequence of participation be changed to the most practical arrangement.

2.2.8 Within ten weeks after the completion of the last measurements in the loop, the Pilot sends all the results obtained in the loop to the Coordinator.

2.2.9 The Pilot informs the Coordinator about the progress in the loop. Especially, the Coordinator must be informed about delays in the schedule and the completion of the last measurements in the loop.

2.3 Handling of artefacts

2.3.1 The artefacts should be examined immediately upon receipt at the laboratory. All participants are expected to follow all instructions in the operator's manual provided by the instrument manufacturers for proper unpacking, subsequent packing and shipping to the next participant. During packing and unpacking, all participants should check the contents with the packing list including the operator's manual.

2.3.2 The travelling standards should only be handled by authorized persons and stored in such a way as to prevent damage.

2.3.3 During operation of the travelling standards, if there is any unusual occurrence, e.g., loss of heating or cooling control, the Pilot laboratory should be notified immediately before proceeding.

2.3.4

2.4 Transport of artefacts

2.4.1 The transportation process begins when the artefact leaves the sending laboratory and does not end until it reaches the destination laboratory. All participants should follow the following general guidelines:

(1) Plan the shipment well in advance. The recipient should be aware of any customs issues in their country that would delay the testing schedule. The shipping laboratory must be aware of any national regulations covering the travelling standard to be exported;

(2) Mark the shipping container "FRAGILE SCIENTIFIC INSTRUMENTS" “TO BE OPENED ONLY BY LABORATORY STAFF” and with arrows showing "THIS WAY UP"; attach tip and shock indicators if such devices are available;

(3) Determine the best way to ship the travelling standard to the next participant;

(4) Obtain the recipient's exact shipping address. If possible, have it shipped directly to the laboratory;

(5) Coordinate the shipping schedule with the recipient. The sending laboratory should provide the recipient with the carrier, the exact travel mode, and the estimated time of arrival;

(6) Instruct the recipient to confirm receipt and condition upon arrival to the sender and the pilot. A form for reporting on the receipt of the travelling standards is shown in Appendix 2.

2.4.2 Each travelling standard is supplied with its shipping container, which is sufficiently robust to ensure safe transportation.

2.4.3 The artefacts will be accompanied by a suitable customs ATA Carnet. Care should be taken with the timing of the ATA Carnet, which only lasts for one year.

2.5. Shipping Costs

2.5.1 Each laboratory is responsible for the cost of shipping to the next participant including any customs charges. The insurance of the instruments is arranged by MBW Calibration Ltd.

2.5.2 Each laboratory pays its share of the services provided by MBW Calibration Ltd (which lends the travelling standards). The cost per laboratory is 850 EUR.

2.6. Timetable

Activity	**Start Month**	**Provisional date**
Draft of technical protocol completed by MIKES and sent to participants		Dec. 2002
All comments received from participants		Feb. 2003
Discussion with participants		Feb. – April 2003
Submission of a revised protocol to participants for unanimous approval		Sep. 2003
Submission of revised protocol to CCT/WG6 and THERM TC Chairman		Oct. 2003
Travelling standards characterized by the pilots		Oct. - Dec. 2003
The fist set of key comparison measurements according to the protocol at the pilot laboratories	Month 1	Jan. 2004
Travelling standards sent to participant by pilots	Month 3-4	March - April 2004
Completion of measurements	Month 21 approx.	Late 2005
Draft A ready	Month 27 approx.	Early 2006
Deadline for comments on draft A	Month 29	Mid 2006
Draft B ready and submitted to THERM TC	Month 32	Late 2006

3. DESCRIPTION OF THE TRAVELLING STANDARDS

3.1. Artefacts

3.1.1 MBW Calibration Ltd lends two travelling standards per loop for the key comparison. The instruments are state-of-the-art, commercially available chilled-mirror type of dew-point hygrometers.

3.1.2 Details of travelling standards:
All the travelling standards are new and of the same type:

Model:	MBW 373 L
Size (in packing case):	75 x 69 x 41 cm
Weight (in packing case):	45 kg
Manufacturer:	MBW Calibration Ltd
Owner:	MBW Calibration Ltd
Electrical supply:	230 V / 50 Hz
Electrical connection:	Instrument socket IEC/EN 60320-2-2 (socket C14/plug C13) The instrument will be supolied with a Schuko (Continenetal Europe) plug Standard CEE 7/VII will be supplied)
Power:	300 W
Tube connectors:	VCR Cajon ® ¼"
Accessories:	Endoscope, 4-wire cable for resistance measurements (3 m)
Approximate value for insurance and customs declaration:	30 000 EUR

Serial numbers of the instruments are:

Loop 1	Loop2	Loop3
03-0920	03-0922	03-0924
03-0921	03-0923	03-0925

4. MEASUREMENT INSTRUCTIONS

4.1 Measurement process

4.1.1 All participants should refer to the operating manuals for instructions and precautions for using the travelling standards. Participants may perform any initial checks of the operation of the hygrometers that would be performed for a normal calibration. In the case of an unexpected instrument failure at a participant institute, the pilot institute should be informed in order to revise the time schedule, if necessary, as early as possible.

4.1.2 Sample gas generated by a participant's standard generator, is introduced into the inlet of a travelling standard hygrometer through a stainless steel tube terminating with a ¼

inch VCR fitting. Adapting Swagelok (for 6 mm tubes) connectors are instrument cases. The instruments should be connected in parallel. For dew points near ambient temperature (e.g. +20 °C) normal precautions (heating) should be used to protect against condensation in sample lines

4.1.3 Measurements are carried out at nominal dew-point temperatures of +20 °C and +1 °C and nominal frost-point temperatures of –10 °C, -30 °C and –50 °C. The value of +1 °C nominally represents 0 °C, while avoiding any complication due to phase change between water and ice.

4.1.4 In the range below 0 °C, a homogenous ice layer should cover the mirror and participants should report the applied condition in terms of frost-point temperature. The phase of condensate apparent on the mirrors of the travelling standards should also be reported.

4.1.5 Measurements should be done in rising order of dew/frost-point temperature.

4.1.6 Each measurement should be conducted with the instruments measuring in parallel and nominally simultaneously.

4.1.7 Four repeated full set of measurements are carried out, i.e. each nominal dew/frost-point temperature should be separately repeated (reproduced) four times to reduce the effect of any irreproducibility of the travelling standards.

4.1.8 If the scope of a laboratory does not cover the whole range of this comparison, the laboratory is allowed to limit measurements to the nominal dew/frost-point temperatures that are within the scope.

4.1.9 The condensate should be cleared and re-formed for each value or repetition of dew/frost-point temperature.

4.1.10 The values of dew/frost-point temperature applied to the travelling standards should be within ±0.5 °C of the five agreed nominal values for the comparison, and ideally closer than this. Deviations greater than this may increase the uncertainty in the comparison, for a particular result.

4.1.11 Operation with the travelling standards

Before any humidity measurements, initial actions should be taken:

1) Read the manual “Operating Instructions” delivered by the manufacturer (a copy of the instruction is in the transport case).

2) The pressure indication of the hygrometer is checked with a pressure gauge of the laboratory at two static pressure levels (no gas flow through the instrument): the ambient pressure and a pressure corresponding the sample gas pressure during dew/frost-point measurements.

3) For checking the flow rate indication of the hygrometer, a rotameter enclosed with the instrument is connected between the hygrometer outlet and a flow meter of the laboratory. At a flow rate of 0.5 l/min, the flow rate indications of the hygrometer, rotameter and the laboratory flow meter

are compared to each other (at a pressure corresponding the sample gas pressure during dew/frost-point measurements). It is highly recommended to carry out the test in the generator system used in the comparison. In a case of strongly fluctuating sample gas flow, the flow indicator of the hygrometer may show incorrect value.

4) When the hygrometer is in a standby mode (i.e. mirror temperature control and pre-cooler temperature control are switched off), the dew/frost-point temperature indication, resistance of a PRT embedded in the mirror and dew/frost-point temperature reading from the RS-232 port are recorded during ten minutes (at least ten measurements).

5) Check that ORIS is switched off (Menu Keys: "Control Setup" → "Dew/Frost Control": the square beside "Enable ORIS Below" should **not** be green)

6) Check that Force Frost function is switched on with a set point of -5 °C(Menu Keys: → "Control Setup" → "Dew/Frost Control": the square beside "Force Frost Below" should be green and the value "–5")

7) Set the hygrometer ready for cleaning with "Mirror Cleaning".

8) Remove the endoscope following carefully with separate instructions (a copy of the instruction is in the transport case).

9) Open the measuring head following carefully with separate instructions (a copy of the instruction is in the transport case).

10) Clean the mirror surface using cotton tips with distilled or de-ionised water preceded by initial cleaning with alcohol if necessary.

11) Close the measuring head following carefully with separate instructions (a copy of the instruction is in the transport case).

12) Replace the endoscope following carefully with separate instructions (a copy of the instruction is in the transport case).

<u>Dew/frost-point temperature measurements:</u>

1) Clean the mirror if needed according to the instructions above.

2) Set the indicated flow rate of sample gas at 0.5 l/min.

3) Set the pre-cooler control to Delta Mode with the target value 30 °C (Menu Keys: "Control Setup" → "Pre Cooler"→"Delta Mode Target").

4) Start measurements with "Dew/Frost Control" and "PreCooler" keys at the bottom bar (Fixed Function Keys)

5) A homogenous condensate should appear on the mirror; if not, the condensate should be cleared and re-formed with “Mirror Check” (Fixed Function Keys). If necessary, the mirror is cleaned according to the instructions above.

6) After reaching a stable reading, set the pre-cooler control to Fixed Mode with the target value 30 °C **above** the nominal dew/frost-point temperature (Menu Keys: “Control Setup” → “Pre Cooler”→”Fixed Mode Target”). (NOTE: At +20°C, the instrument changes automatically the entered +50 °C to +40 °C.)

7) After appropriate time of stabilisation, measurements are carried out collecting data described below (chapter 4.2).

8) Before changing the sample gas dew/frost-point temperature, the pre-cooler control of the hygrometer is set to Delta Mode (see instructions above).

9) Before measuring at the next measurement point, the condensate should be cleared and re-formed with “Mirror Check” or “Mirror Cleaning” (Fixed Function Keys)

4.1.12 Participants should avoid lengthy additional measurements, except those necessary to give confidence in the results of this comparison.

4.1.13 The travelling standards used in this comparison must not be modified, adjusted, or used for any purpose other than described in this document, nor given to any party other than the participants in the comparison.

4.1.14 The Pilot will make an assessment of any drift in the travelling standards during the comparison, based on measurements at the Pilot laboratory at the beginning and end of the comparison period. If drift is found, this will be taken into account in the final analysis of the comparison results.

4.1.15 If poor performance or failure of a travelling standard is detected, the Pilot of the loop will propose a course of action, subject to agreement of the participants.

4.2. Data collection

4.2.1 In the travelling standards, there are two 100-ohm platinum resistance thermometers (PRT) embedded beneath the surface of the chilled-mirror to measure the dew/frost-point temperature. One is used for system measurement and control. The resistance of the other one is measured via a Lemo connector in the rear panel. Dew/frost-point temperature readings used primarily in this comparison are obtained from the resistance of the second PRT. The current input to the PRT should be nominally 1 mA. The resistance of the PRT should be measured using a calibrated multi-meter or a resistance bridge, and then converted to a corresponding dew/frost-point temperature using the reference function of IEC 60751 as shown in Appendix 3. This reference function should be used to convert resistance to (arbitrary nominal) temperature.

4.2.2 Each measured value (incl. its experimental standard uncertainty) is obtained calculating the mean and standard deviation of at least 10 readings of the resistance of the PRT recorded during 10 to 20 minutes.

4.2.3 Participants may apply their own criteria of stability for acceptance of measurements.

4.2.4 As a supporting measurement, the digital display readings (and/or digital signal through a serial port in the rear panel) for dew/frost-point temperature, head temperature, pre-cooler temperature, flow rate and head pressure in the travelling standards should be monitored. The mean and standard deviation a set of at least 10 readings, taken over the same period as the dew/frost point measurements should be reported.

4.2.4 Values reported for dew/frost-point temperatures produced by a participant's standard generator should be the value applied to the instruments, after any allowances for pressure and temperature differences between the point of realisation (laboratory standard generator or reference hygrometer) and the point of use (travelling standards).

4.2.5 The data reported for the pair of instruments should be for simultaneous or near-simultaneous measurement of the same applied condition.

5. REPORTING OF MEASUREMENT RESULTS

5.1 Participants must report their measurement results of four repeated experiments, within six weeks of completing their measurements.

5.2 The pilot of the loop should accumulate data continually and should analyse the results for possible anomalies in the travelling standard. If problems arise, the Pilot should consult with the participant that submitted the data as soon as possible, and certainly before the distribution of Draft A of the Report of the comparison.. If the participant is a link between the loops, the Pilot must consult also with the Coordinator. The pilots must inform the Coordinator of all problems.

5.3 The parameter to be compared between the laboratories in this comparison is the difference found between the travelling standards and the laboratory dew-point temperature standard. Note that the values of dew-point temperature reported are “arbitrary” values calculated from the measured resistance output. The travelling standards are used simply as comparators.

5.4 Participants should report results to the pilot in terms of dew/frost-point temperature. The main measurement results comprise:

- values of dew/frost-point applied to the travelling standards, and associated standard uncertainty

- values measured using both travelling standards simultaneously (and their associated uncertainties derived from standard deviation of the set of readings)
- values of difference between applied dew/frost point and measured dew/frost point.

A provisional template for reporting results is shown in Appendix 5, and will be made available to participants in electronic form as an Excel spreadsheet. Use of this format, including calculations of means and differences, allows participants to see clearly the values and uncertainties of the parameters they are submitting for comparison.

5.5 From the data measured by each participant, results will be analysed in terms of differences between applied and measured dew-point temperatures. In each case, the difference will be taken between the applied (realised) value and the mean (mid-point) between the two hygrometer values.

5.6 In addition, the difference between the two hygrometer readings on all occasions will be analysed and will serve as a check of consistency.

5.7 The participants should report the conditions of realisation and measurement, as background information to support the main results. These conditions may include, pressure and temperature in saturator or reference hygrometer, pressure difference between saturator or reference hygrometer and travelling standards, measurement traceability, frequency of AC (or DC) resistance measurement, and other items. A provisional template for reporting conditions of measurement is shown in Appendix 6, and will be made available to participants in electronic form as an Excel spreadsheet.

5.8 Participants should provide a description of the operation of their dew/frost-point facilities used in the comparison.

5.9 Participants should also provide an example plot of equilibrium condition (resistance versus time) at a nominal frost-point temperature of -30 °C over at least one hour.

5.10 Any information obtained relating to the use of any results obtained by a participant during the course of the comparison shall be sent only to the pilot laboratory and as quickly as possible. The pilot laboratory will be responsible for coordinating how the information should be disseminated to other participants. The pilot laboratory informs the Coordinator about the progress and results obtained in the Pilot's loop. No communication whatsoever regarding any details of the comparison other than the general conditions described in this protocol shall occur between any of the participants or any party external to the comparison without the written consent of the Coordinator. The Coordinator will in turn seek permission of all the participants. This is to ensure that no bias from whatever accidental means can occur. These constraints on communication apply until the circulation of Draft A of the report of the comparisons.

5.11 If a participant significantly delays reporting of results to the Pilot, then a deadline will be agreed among the participants. If that deadline is not met, then inclusion of those results in the comparison report will not be guaranteed.

5.12 The Pilots must send the measurement results obtained in their loop to the Coordinator within ten weeks of completing the last measurements of the loop. The Pilots will also send an estimation on the uncertainty due to any drift of the travelling standard over the period of the comparison.

6. UNCERTAINTY OF MEASUREMENT

6.1 The uncertainty of the key comparison results will be derived from:

- the quoted uncertainty of the dew/frost-point realisation (applied dew/frost point temperature)
- the estimated uncertainty relating to the short-term stability of the travelling standard at the time of measurement
- the estimated uncertainty due to any drift of the travelling standard over the period of the comparison (estimated by the Pilots)
- the estimated uncertainty in mean values due to dispersion of repeated results (reflecting the combined reproducibility of laboratory standard and travelling standards)
- the estimated uncertainty die to non-linearity of the travelling standards in any case where measurements are significantly away from the agreed nominal value
- the estimated covariance between applied (laboratory standard) and measured (travelling standard) values of dew/frost-point temperature (if found significant)
- any other components of uncertainty that are thought to be significant

6.2 Participants are required to submit detailed analyses of uncertainty for their dew-point standards. Uncertainty analysis should be according to the approach given in the ISO Guide to the Expression of Uncertainty of Measurement. A list of the all significant components of the uncertainty budget should be evaluated, and should support the quoted uncertainties. Type B estimates of uncertainty may be regarded as having infinite degrees of freedom, or an alternative estimate of the number of degrees of freedom may be made following the methods in the ISO Guide. A provisional template for documentation of uncertainties is shown in Appendix 4, and will be made available to participants in electronic form as an Excel spreadsheet. Individual institutes may add to the template any additional uncertainties they consider relevant.

6.3 The pilot laboratories will collect draft uncertainty budgets as background information to the uncertainties quoted by participants for the comparison measurements. The Pilots and the Coordinator will review the uncertainty budgets for consistency among participants.

6.4 The uncertainty budget stated by the participating laboratory should be referenced to an internal report and/or a published article.

7. DETERMINATION OF THE KEY COMPARISON REFERENCE VALUE

7.1 The outputs of the key comparison are expected to be:

- Results of individual participants for comparison of the hygrometers against their dew point reference in terms of mean values for each hygrometer at each measured value, estimated standard uncertainty of each mean result and estimated standard uncertainty of comparison process (e.g. effect of long-term stability and non-linearity of the travelling standards) if necessary.
- Estimates of bilateral equivalence between every pair of participants at each measured dew-point temperature.
- A key comparison reference value (KCRV) for each nominal value of dew/frost point temperature in the comparison. The KCRV might be calculated as the mean of all valid results, or a weighted mean.
- Estimates of equivalence of each participant to the KCRV. This might be expressed in terms of the Degree of Equivalence (DOE) given as a difference and its uncertainty ($\Delta \pm U$), in °C.

7.2 Values of the above will be reached by a similar method used in the corresponding CCT Key Comparison (CCT KC 6).

7.3 In the field of dew-point standards, the KCRV does not have any absolute significance. It is calculated only for purposes such as the presentation and inter-relation of key comparison data for the MRA.

7.4 The Pilots will make an assessment of any drift in the travelling standards during the comparison. The assessment will be based on initial and final measurements done by the Pilots. If drift is found, this will be taken into account in the final analysis of the comparison results. If the drift is small compared with uncertainty values reported by the participants, an estimate for the drift may be set to zero with a standard uncertainty calculated according to the ISO Guide. In a case of a significant drift, the effect is taken into account by assigning a time-dependent value to KCRV, or by other suitable method so that the estimates of equivalence can be meaningfully calculated between results taken at different times.

7.5 If a travelling standard fails or performs poorly during the comparison, the Coordinator and Pilots will propose a course of action, subject to agreement of the participants. If the results of one of the travelling standards (from some or all participants) are deemed un-usable, and if measurements cannot be re-attempted, the KCRV and estimates of equivalence may be based on the results of satisfactory measurements using only one travelling standard.

APPENDIX 1. DETAILS OF PARTICIPATING INSTITUTES

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APPENDIX 2.
FORM FOR REPORTING ON RECEIPT OF TRAVELLING STANDARDS

TO: *(Pilot Laboratory)*

Fax:

FROM: *(Participating Laboratory)*

Fax:

We confirm having received the travelling standards of the EUROMET Key Comparison of Dew/Frost-Point Temperature (EUROMET P621) on:.....(date)

After visual inspection

☐ No damage has been noticed;

☐ The following damage must be reported:

Have the hygrometer transportation packages been opened during transit?
e.g., Customs ...

☐ No

☐ Yes: Please give details:

Is there any damage to the transportation packages?

☐ No

☐ Yes: Please give details:

Are there any visible signs of damage to the instruments?

☐ No

☐ Yes: Please give details:

Do you believe the travelling standards are functioning correctly?

☐

Yes

☐ No: Please indicate your concerns:

PACKING LIST *(Items will be added later)*

Received	Items	Dispatched

Laboratory: _____

Date: _____ Signature: _____

APPENDIX 3. IEC 60751 RELATIONSHIP

Based on the IEC 60751 (1995-07), a nominal resistance-temperature characteristic of the PRT in the travelling standard can be defined as follows:

for the temperature above 0 °C:

$$R_t = R_0(1 + At + Bt^2) \quad (1)$$

for the temperature below 0 °C:

$$R_t = R_0[1 + At + Bt^2 + C(t\text{-}100)t^3] \quad (2)$$

where:

t = temperature (ITS-90), °C,
R_t = resistance at temperature t,
R_0 = nominal resistance of 100 Ω at 0 °C,
A = 3.9083×10^{-3} °C^{-1},
B = -5.775×10^{-7} °C^{-2}, and
C = -4.183×10^{-12} °C^{-4}.

APPENDIX 4. PROVISIONAL TEMPLATE FOR DOCUMENTATION OF UNCERTAINTIES

Refer to Sheets “Uncert of generator” and “Uncert of other standard” in accompanying MS Excel file “Appendices 4to5_170903.xls”.

APPENDIX 5. PROVISIONAL TEMPLATE FOR REPORTING OF RESULTS

Refer to Sheet “Measurement results” in accompanying MS Excel file “Appendices 4to5_170903.xls”.

APPENDIX 6. PROVISIONAL TEMPLATES FOR REPORTING OF CONDITIONS OF MEASUREMENT

Background information to the key comparison measurements are reported using the following templates/guidance in accompanying MS Excel file "Appendices 4to5_170903.xls":

Sheet "Conditions":	Background information recorded at each separate repetition of each measurement point
Sheet "Initial Check":	Background information recorded during initial actions (see Chapter 4.1.11)
Sheet "Background Checklist":	Guidance for reporting the measurement set-up

This information is likely to be of secondary information but will become important if there should be any need to resolve anomalies which might appear in the results. Reporting of the main results is outlined in Appendix 5.

APPENDIX 3 RESULTS REPORTED BY THE PARTICIPANTS

Loop 1 / Estimates

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
Lab		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
MIKES1	Meas 1	-50.389171	80.111818	-50.510498	-0.1213269	-50.389171	80.108858	-50.51796	-0.1287893
MIKES1	Meas 2	-50.327511	80.145389	-50.425865	-0.0983536	-50.327511	80.139388	-50.440992	-0.1134804
MIKES1	Meas 3	-50.388388	80.115588	-50.500994	-0.1126058	-50.388388	80.116098	-50.499708	-0.1113201
MIKES1	Meas 4	-50.448879	80.090361	-50.564592	-0.115713	-50.448879	80.086853	-50.573436	-0.1245566
PTB	Meas 1	-50.038	80.2347	-50.18	-0.142	-50.038	80.2246	-50.206	-0.167
PTB	Meas 2	-50.052	80.2298	-50.193	-0.141	-50.052	80.224	-50.207	-0.155
PTB	Meas 3	-50.019	80.2422	-50.161	-0.142	-50.019	80.2356	-50.178	-0.159
PTB	Meas 4	-49.98	80.2566	-50.125	-0.145	-49.98	80.2484	-50.146	-0.166
SP	Meas 1	-49.896315	80.316455	-49.919091	-0.0227759	-49.896315	80.291636	-50.037	-0.140685
SP	Meas 2	-50.034917	80.285091	-50.009091	0.0258259	-50.034917	80.264545	-50.105	-0.0700832
SP	Meas 3	-49.753295	80.356636	-49.829091	-0.0757958	-49.753295	80.336909	-49.923	-0.1697049
SP	Meas 4	-49.88901	80.308636	-49.950909	-0.0618994	-49.88901	80.286182	-50.051	-0.1619903
DELTA	Meas 1	-50.317952	80.194842	-50.281492	0.03646	-50.317952	80.186045	-50.30364	0.0143116
DELTA	Meas 2	-50.193922	80.241262	-50.164611	0.0293113	-50.193922	80.239164	-50.169895	0.0240279
DELTA	Meas 3	-49.91886	80.349243	-49.892708	0.0261524	-49.91886	80.33517	-49.928146	-0.0092862
DELTA	Meas 4	-49.988875	80.324631	-49.954684	0.034191	-49.988875	80.305396	-50.003119	-0.014244
CETIAT	Meas 1	-50.263768	80.171696	-50.338879	-0.075111	-50.256549	80.181606	-50.313927	-0.0573785
CETIAT	Meas 2	-50.143091	80.256776	-50.124657	0.0184338	-50.137893	80.212623	-50.235831	-0.0979384
CETIAT	Meas 3	-50.181636	80.237436	-50.173354	0.0082818	-50.176276	80.215226	-50.229277	-0.053001
CETIAT	Meas 4	-49.965047	80.282846	-50.059012	-0.0939658	-49.96069	80.282234	-50.060553	-0.0998635
GUM	Meas 1	-50.053175	80.281047	-50.063545	-0.01037	-50.053175	80.276043	-50.076143	-0.0229684
GUM	Meas 2	-50.066916	80.263	-50.108986	-0.0420698	-50.066916	80.27215	-50.085947	-0.0190301
GUM	Meas 3	-50.055319	80.258483	-50.120359	-0.0650401	-50.055319	80.268688	-50.094665	-0.0393461
GUM	Meas 4	-50.047119	80.29957	-50.016902	0.0302173	-50.047119	80.29945	-50.017204	0.0299151
METAS	Meas 1	-49.949	80.2786	-50.069705	-0.120705	-49.949	80.26839	-50.095415	-0.146415
METAS	Meas 2	-50.019	80.25356	-50.13275	-0.11375	-50.019	80.24161	-50.16285	-0.14385
METAS	Meas 3	-50.059	80.25006	-50.141565	-0.082565	-50.059	80.23825	-50.1713	-0.1123
METAS	Meas 4	-49.859	80.31325	-49.982455	-0.123455	-49.859	80.3061	-50.00045	-0.14145
NMISA	Meas 1	-50.273154	80.114035	-50.484046	-0.2108925	-50.273154	80.105263	-50.506136	-0.2329826
NMISA	Meas 2	-50.28475	80.113898	-50.484396	-0.199646	-50.28475	80.100744	-50.517513	-0.232763
NMISA	Meas 3	-50.442937	80.065177	-50.607058	-0.164121	-50.442937	80.049957	-50.645376	-0.2024386
NMISA	Meas 4	-50.098833	80.190626	-50.291213	-0.1923795	-50.098833	80.179755	-50.318596	-0.2197623
JV	Meas 1	-50.363099	80.191	-50.2903	0.0727989	-50.362287	80.191364	-50.2893	0.0729871
JV	Meas 2	-49.972	80.3293	-49.942	0.03	-49.972	80.3277	-49.9461	0.0259
JV	Meas 3	-50.364366	80.1309	-50.4416	-0.0772338	-50.363563	80.1277	-50.4496	-0.0860375
JV	Meas 4	-50.13495	80.224	-50.2071	-0.07215	-50.13495	80.2218	-50.2127	-0.07775
VNIIM	Meas 1	-49.886	80.257	-50.124	-0.238	-49.87	80.334	-49.93	-0.06
VNIIM	Meas 2	-49.917	80.241	-50.164	-0.247	-49.901	80.318	-49.97	-0.069
VNIIM	Meas 3	-50.063	80.19	-50.293	-0.23	-50.047	80.267	-50.099	-0.052
VNIIM	Meas 4	-49.971	80.217	-50.225	-0.254	-49.955	80.295	-50.028	-0.073
MIKES2	Meas 1	-50.28654	80.154607	-50.402624	-0.1160844	-50.28654	80.145467	-50.425667	-0.1391274
MIKES2	Meas 2	-50.340474	80.122667	-50.462787	-0.122313	-50.340474	80.112847	-50.48751	-0.1470365
MIKES2	Meas 3	-50.479103	80.069026	-50.597832	-0.1187289	-50.479103	80.062076	-50.615329	-0.1362259
MIKES2	Meas 4	-50.360935	80.111577	-50.490708	-0.1297732	-50.360935	80.103857	-50.510144	-0.1492095

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
MIKES1	Meas 1	-29.485023	88.383024	-29.594894	-0.1098714	-29.485023	88.371494	-29.62414	-0.1391173
MIKES1	Meas 2	-29.729991	88.281483	-29.852442	-0.1224508	-29.729991	88.270942	-29.879175	-0.1491836
MIKES1	Meas 3	-29.694149	88.299944	-29.805619	-0.1114693	-29.694149	88.295924	-29.815815	-0.1216654
MIKES1	Meas 4	-29.912838	88.211653	-30.029544	-0.1167064	-29.912838	88.207383	-30.040374	-0.1275358
PTB	Meas 1	-30.022	88.1546	-30.17	-0.148	-30.022	88.145	-30.194	-0.172
PTB	Meas 2	-30.025	88.1531	-30.174	-0.149	-30.025	88.1445	-30.196	-0.171
PTB	Meas 3	-30.021	88.1532	-30.173	-0.152	-30.021	88.1465	-30.191	-0.17
PTB	Meas 4	-30.037	88.1492	-30.184	-0.147	-30.037	88.1409	-30.205	-0.168
SP	Meas 1	-29.910497	88.196545	-30.064	-0.1535034	-29.910497	88.215909	-30.015	-0.1045034
SP	Meas 2	0	0	0	0	0	0	0	0
SP	Meas 3	-29.950028	88.197364	-30.061	-0.1109723	-29.950028	88.180455	-30.104	-0.1539723
SP	Meas 4	-29.997342	88.177545	-30.112	-0.1146576	-29.997342	88.158455	-30.16	-0.1626576
DELTA	Meas 1	-30.013397	88.199878	-30.055123	-0.0417257	-30.013397	88.194951	-30.067615	-0.0542173
DELTA	Meas 2	-30.189226	88.130444	-30.231152	-0.0419258	-30.189226	88.124227	-30.246915	-0.0576883
DELTA	Meas 3	-30.226191	88.116608	-30.26623	-0.0400392	-30.226191	88.110042	-30.282875	-0.0566843
DELTA	Meas 4	-30.262156	88.094201	-30.323034	-0.0608782	-30.262156	88.08958	-30.334748	-0.0725917
CETIAT	Meas 1	-30.079036	88.148453	-30.185578	-0.1065427	-30.07302	88.140933	-30.204641	-0.1316214
CETIAT	Meas 2	-30.47591	87.993552	-30.578227	-0.1023176	-30.467326	87.983752	-30.603067	-0.1357413
CETIAT	Meas 3	-30.197303	88.106692	-30.291439	-0.0941353	-30.190055	88.102022	-30.303277	-0.1132214
CETIAT	Meas 4	-29.958085	88.195843	-30.065442	-0.1073562	-29.952106	88.183763	-30.096066	-0.1439599
GUM	Meas 1	-30.049031	88.175193	-30.11779	-0.0687587	-30.049031	88.179753	-30.10623	-0.0571986
GUM	Meas 2	-30.053446	88.160441	-30.155188	-0.1017421	-30.053446	88.160696	-30.154541	-0.1010956
GUM	Meas 3	-30.057433	88.167587	-30.137073	-0.0796401	-30.057433	88.16425	-30.145531	-0.0880987
GUM	Meas 4	-30.050536	88.17187	-30.126214	-0.075678	-30.050536	88.173393	-30.122353	-0.0718164
METAS	Meas 1	-30.092	88.13846	-30.21091	-0.11891	-30.092	88.12379	-30.248097	-0.156097
METAS	Meas 2	-30.217	88.08418	-30.348505	-0.131505	-30.217	88.0704	-30.383435	-0.166435
METAS	Meas 3	-30.126	88.12176	-30.253243	-0.1272425	-30.126	88.10732	-30.289847	-0.163847
METAS	Meas 4	-29.978	88.1674	-30.137546	-0.159546	-29.978	88.15339	-30.173063	-0.1950625
NMISA	Meas 1	-30.088269	88.117441	-30.264188	-0.1759189	-30.088269	88.107095	-30.290422	-0.202153
NMISA	Meas 2	-30.238	88.058957	-30.412445	-0.1744451	-30.238	88.048194	-30.439727	-0.201727
NMISA	Meas 3	-30.096625	88.12117	-30.254734	-0.1581093	-30.096625	88.109571	-30.284139	-0.1875145
NMISA	Meas 4	-30.305636	88.036884	-30.468391	-0.1627542	-30.305636	88.026874	-30.493765	-0.1881288
JV	Meas 1	-30.05814	88.1241	-30.2473	-0.1891596	-30.05814	88.1128	-30.276	-0.2178596
JV	Meas 2	-30.190487	88.0814	-30.3555	-0.1650135	-30.190487	88.0749	-30.372	-0.1815135
JV	Meas 3	-30.155008	88.0763	-30.3685	-0.2134921	-30.155008	88.0669	-30.3923	-0.2372921
JV	Meas 4	-30.202	88.0597	-30.4106	-0.2086	-30.202	88.0466	-30.4438	-0.2418
VNIIM	Meas 1	-30.069	88.037	-30.468	-0.399	-30.025	88.06	-30.41	-0.385
VNIIM	Meas 2	-29.828	88.135	-30.22	-0.392	-29.784	88.155	-30.17	-0.386
VNIIM	Meas 3	-29.679	88.198	-30.06	-0.381	-29.723	88.174	-30.121	-0.398
VNIIM	Meas 4	-29.947	88.091	-30.331	-0.384	-29.99	88.072	-30.379	-0.389
MIKES2	Meas 1	-30.472119	87.98627	-30.601103	-0.1289842	-30.472119	87.974319	-30.631405	-0.1592862
MIKES2	Meas 2	-30.290996	88.05413	-30.425165	-0.1341689	-30.290996	88.04557	-30.446545	-0.1555491
MIKES2	Meas 3	-30.277005	88.06226	-30.404557	-0.1275513	-30.277005	88.05457	-30.423732	-0.1467264
MIKES2	Meas 4	-30.282754	88.06123	-30.407168	-0.1244134	-30.282754	88.05414	-30.424822	-0.1420675

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
MIKES1	Meas 1	-9.3201439	96.311135	-9.4258723	-0.1057283	-9.3201439	96.298634	-9.457767	-0.1376231
MIKES1	Meas 2	-9.8966849	96.078751	-10.01876	-0.1220751	-9.8966849	96.06893	-10.043812	-0.1471272
MIKES1	Meas 3	-9.7230026	96.146592	-9.845686	-0.1226834	-9.7230026	96.139625	-9.8634597	-0.1404571
MIKES1	Meas 4	-9.8581348	96.091305	-9.9867332	-0.1285984	-9.8581348	96.084985	-10.002856	-0.1447216
PTB	Meas 1	-9.998	96.03595	-10.128	-0.13	-9.996	96.02783	-10.148	-0.152
PTB	Meas 2	-10.01	96.033	-10.135	-0.125	-10.003	96.02186	-10.164	-0.161
PTB	Meas 3	-10.012	96.03064	-10.141	-0.129	-10.006	96.02103	-10.166	-0.16
PTB	Meas 4	-9.991	96.03707	-10.125	-0.134	-9.988	96.02839	-10.147	-0.159
SP	Meas 1								
SP	Meas 2	-9.9809564	96.052091	-10.086	-0.1050436	-9.9809564	96.033455	-10.134	-0.1530436
SP	Meas 3	-9.9871906	96.045636	-10.103	-0.1158094	-9.9871906	96.027	-10.15	-0.1628094
SP	Meas 4	-10.032262	96.028273	-10.147	-0.1147382	-10.032262	96.009545	-10.195	-0.1627382
DELTA	Meas 1	-10.380184	95.916292	-10.4318	-0.0516164	-10.380184	95.910072	-10.447665	-0.0674813
DELTA	Meas 2	-10.004001	96.056346	-10.074567	-0.0705664	-10.004001	96.050378	-10.089791	-0.0857904
DELTA	Meas 3	-10.131723	96.002434	-10.212085	-0.080362	-10.131723	95.994661	-10.23191	-0.1001877
DELTA	Meas 4	-9.9501187	96.071774	-10.035213	-0.0850943	-9.9501187	96.066928	-10.047575	-0.0974562
CETIAT	Meas 1	-9.9614628	96.044279	-10.10612	-0.1446573	-9.9581105	96.040679	-10.115304	-0.1571931
CETIAT	Meas 2	-9.9907748	96.041899	-10.112191	-0.1214166	-9.9812251	96.034299	-10.131579	-0.1503534
CETIAT	Meas 3	-10.090836	96.005929	-10.203948	-0.113112	-10.083261	95.999149	-10.221243	-0.1379815
CETIAT	Meas 4	-9.9595053	96.053699	-10.08209	-0.1225847	-9.9519239	96.043399	-10.108365	-0.1564411
GUM	Meas 1	-9.9992797	96.042483	-10.110701	-0.1114215	-9.9992797	96.03718	-10.12423	-0.12495
GUM	Meas 2	-10.001977	96.04017	-10.116602	-0.1146252	-10.001977	96.036283	-10.126517	-0.1245398
GUM	Meas 3	-10.007967	96.038137	-10.121789	-0.1138227	-10.007967	96.033017	-10.13485	-0.1268834
GUM	Meas 4	-10.013346	96.037088	-10.124466	-0.11112	-10.013346	96.03157	-10.13854	-0.1251947
METAS	Meas 1	-10.103	95.9894	-10.24611	-0.14311	-10.103	95.9766	-10.278763	-0.175763
METAS	Meas 2	-10.043	96.01281	-10.186396	-0.143396	-10.043	95.99826	-10.22351	-0.18051
METAS	Meas 3	-10.12	95.97772	-10.275905	-0.155905	-10.12	95.9644	-10.309883	-0.1898825
METAS	Meas 4	-10.023	96.01958	-10.169125	-0.146125	-10.023	96.00816	-10.198258	-0.175258
NMISA	Meas 1	-10.25842	95.914363	-10.437515	-0.179095	-10.25842	95.90425	-10.463305	-0.2048855
NMISA	Meas 2	-10.1928	95.945202	-10.358849	-0.1660491	-10.1928	95.935358	-10.383974	-0.1911738
NMISA	Meas 3	-10.07935	95.996341	-10.228411	-0.1490608	-10.07935	95.986256	-10.25413	-0.1747805
NMISA	Meas 4	-10.371278	95.878673	-10.528543	-0.1572652	-10.371278	95.870952	-10.548232	-0.1769539
JV	Meas 1	-10.061503	95.9674	-10.3022	-0.2406968	-10.033874	95.9511	-10.3438	-0.3099265
JV	Meas 2	-10.029853	95.9977	-10.2249	-0.1950466	-10.029853	96.0021	-10.2137	-0.1838466
JV	Meas 3	-10.149099	95.9337	-10.3882	-0.2391011	-10.149099	95.931	-10.3951	-0.2460011
JV	Meas 4	-9.6814799	96.142	-9.8568	-0.1753201	-9.6814799	96.132	-9.8823	-0.2008201
VNIIM	Meas 1	-10.135	95.909	-10.451	-0.316	-10.089	95.957	-10.329	-0.24
VNIIM	Meas 2	-10.221	95.866	-10.561	-0.34	-10.175	95.93	-10.398	-0.223
VNIIM	Meas 3	-10.268	95.851	-10.599	-0.331	-10.222	95.899	-10.477	-0.255
VNIIM	Meas 4	-10.21	95.874	-10.54	-0.33	-10.164	95.93	-10.398	-0.234
MIKES2	Meas 1	-10.225116	95.948353	-10.351402	-0.1262857	-10.225116	95.936183	-10.382446	-0.1573296
MIKES2	Meas 2	-10.285352	95.925583	-10.409495	-0.1241428	-10.285352	95.916593	-10.432442	-0.1470901
MIKES2	Meas 3	-10.271158	95.928683	-10.401587	-0.1304293	-10.271158	95.920813	-10.421678	-0.1505198
MIKES2									

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
MIKES1	Meas 1	0.9608074	100.31965	0.8175183	-0.1432891	0.9608074	100.30879	0.7897245	-0.1710829
MIKES1	Meas 2	0.9525122	100.31672	0.8100196	-0.1424926	0.9525122	100.30488	0.7797178	-0.1727944
MIKES1	Meas 3	0.9490793	100.31222	0.7985028	-0.1505765	0.9490793	100.30182	0.7718864	-0.1771929
MIKES1	Meas 4	0.8412724	100.26966	0.6895817	-0.1516907	0.8412724	100.25829	0.6604838	-0.1807886
PTB	Meas 1	1.04	100.35988	0.921	-0.119	1.044	100.34724	0.889	-0.155
PTB	Meas 2	1.058	100.36385	0.931	-0.127	1.058	100.35424	0.907	-0.151
PTB	Meas 3	1.055	100.36446	0.933	-0.122	1.058	100.35335	0.905	-0.153
PTB	Meas 4	1.048	100.35869	0.918	-0.13	1.051	100.34831	0.892	-0.159
SP	Meas 1	1.0480942	100.393	1.006	-0.0420942	1.0480942	100.38064	0.974	-0.0740942
SP	Meas 2	0.9823071	100.36127	0.925	-0.0573071	0.9823071	100.35118	0.899	-0.0833071
SP	Meas 3	1.0044327	100.35591	0.911	-0.0934327	1.0044327	100.339	0.867	-0.1374327
SP	Meas 4	0.9311602	100.32873	0.841	-0.0901602	0.9311602	100.312	0.798	-0.1331602
DELTA	Meas 1	1.3582962	100.50712	1.2977875	-0.0605087	1.3582962	100.49191	1.2588535	-0.0994427
DELTA	Meas 2	1.2665592	100.43168	1.1046989	-0.1618603	1.2665592	100.43087	1.1026334	-0.1639258
DELTA	Meas 3	0.9654189	100.3273	0.8375599	-0.127859	0.9654189	100.32249	0.8252523	-0.1401666
DELTA	Meas 4	0.9733962	100.32581	0.8337337	-0.1396625	0.9733962	100.32165	0.8230973	-0.1502989
CETIAT	Meas 1	0.8847993	100.32095	0.8212985	-0.0635008	0.8976967	100.30566	0.7821672	-0.1155295
CETIAT	Meas 2	0.9177556	100.33146	0.8481967	-0.0695589	0.9284061	100.32939	0.842899	-0.0855071
CETIAT	Meas 3	0.9215274	100.3306	0.8459957	-0.0755317	0.9318419	100.32686	0.8364239	-0.095418
CETIAT	Meas 4	0.9344056	100.33901	0.8675196	-0.066886	0.9448014	100.33515	0.8576406	-0.0871608
GUM	Meas 1	1.0577351	100.35744	0.9146848	-0.1430503	1.0577351	100.35464	0.9075186	-0.1502165
GUM	Meas 2	1.0442023	100.35406	0.9060395	-0.1381628	1.0442023	100.35124	0.8988307	-0.1453717
GUM	Meas 3	1.0466288	100.35501	0.9084794	-0.1381494	1.0466288	100.35135	0.8991037	-0.1475251
GUM	Meas 4	1.0502117	100.35991	0.9210116	-0.1292001	1.0502117	100.35739	0.9145706	-0.1356412
METAS	Meas 1	0.963	100.3122	0.7989065	-0.1640935	0.963	100.299	0.765125	-0.197875
METAS	Meas 2	0.79	100.24021	0.61467	-0.17533	0.79	100.22594	0.578153	-0.211847
METAS	Meas 3	0.925	100.2954	0.7559125	-0.1690875	0.925	100.2821	0.721875	-0.203125
METAS	Meas 4	0.905	100.28703	0.73449	-0.17051	0.905	100.27311	0.6988659	-0.2061341
NMISA	Meas 1	1.1681456	100.39836	1.0194309	-0.1487147	1.1681456	100.38941	0.9965212	-0.1716244
NMISA	Meas 2	1.0145	100.338	0.8649457	-0.1495543	1.0145	100.32584	0.833813	-0.180687
NMISA	Meas 3	1.2213333	100.4167	1.0663636	-0.1549697	1.2213333	100.40732	1.0423437	-0.1789896
NMISA	Meas 4	1.2223462	100.41385	1.0590707	-0.1632755	1.2223462	100.40341	1.0323466	-0.1899995
JV	Meas 1	0.75801	100.2138	0.5471	-0.21091	0.75801	100.2042	0.5225	-0.23551
JV	Meas 2	1.1838206	100.37246	0.9532	-0.2306206	1.1838206	100.36331	0.9297	-0.2541206
JV	Meas 3	0.813	100.232	0.5937	-0.2193	0.813	100.2237	0.5724	-0.2406
JV	Meas 4	0.9349957	100.2931	0.75	-0.1849957	0.9349957	100.2886	0.7385	-0.1964957
VNIIM	Meas 1	0.728	100.166	0.425	-0.303	0.796	100.169	0.432	-0.364
VNIIM	Meas 2	0.683	100.15	0.384	-0.299	0.751	100.149	0.381	-0.37
VNIIM	Meas 3	0.69	100.15	0.384	-0.306	0.758	100.156	0.402	-0.356
VNIIM	Meas 4	0.683	100.167	0.427	-0.256	0.751	100.153	0.391	-0.36
MIKES2	Meas 1	1.0974661	100.377	0.964297	-0.133169	1.0974661	100.36492	0.9333796	-0.1640865
MIKES2	Meas 2	1.0580063	100.36222	0.9264693	-0.131537	1.0580063	100.35551	0.9092959	-0.1487104
MIKES2									
MIKES2									

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
MIKES1	Meas 1	19.79595	107.66132	19.659336	-0.1366137	19.79595	107.65315	19.638309	-0.1576402
MIKES1	Meas 2	19.773903	107.65606	19.645799	-0.1281046	19.773903	107.64335	19.613088	-0.1608151
MIKES1	Meas 3	19.863996	107.68695	19.725299	-0.1386973	19.863996	107.67835	19.703165	-0.1608309
MIKES1	Meas 4	19.869397	107.6952	19.746531	-0.1228657	19.869397	107.68346	19.716316	-0.1530807
PTB	Meas 1	20.026	107.75702	19.907	-0.119	20.036	107.74462	19.874	-0.162
PTB	Meas 2	20.042	107.76037	19.915	-0.127	20.047	107.74902	19.885	-0.162
PTB	Meas 3	20.042	107.76035	19.915	-0.127	20.048	107.74904	19.885	-0.163
PTB	Meas 4	20.038	107.76113	19.917	-0.121	20.044	107.74982	19.887	-0.157
SP									
SP									
SP									
SP									
DELTA	Meas 1	20.341904	107.92212	20.33107	-0.0108337	20.341904	107.90159	20.278213	-0.0636903
DELTA	Meas 2	20.01621	107.76455	19.925487	-0.0907226	20.01621	107.75644	19.904601	-0.111609
DELTA	Meas 3	19.732343	107.65902	19.653881	-0.0784619	19.732343	107.64586	19.62001	-0.1123329
DELTA	Meas 4	19.991309	107.74131	19.86568	-0.1256294	19.991309	107.73634	19.852881	-0.1384287
CETIAT	Meas 1	19.983232	107.753	19.89509	-0.0881415	19.997649	107.73734	19.854788	-0.1428604
CETIAT	Meas 2	20.058514	107.77804	19.959533	-0.0989812	20.073904	107.76324	19.921444	-0.1524603
CETIAT	Meas 3	19.918032	107.77044	19.939973	0.0219413	19.929375	107.72328	19.818605	-0.1107706
CETIAT	Meas 4	20.08442	107.78493	19.977265	-0.1071546	20.095314	107.77837	19.960382	-0.1349323
GUM	Meas 1	19.988343	107.71994	19.810672	-0.1776713	19.988343	107.71931	19.809059	-0.1792842
GUM	Meas 2	19.981889	107.72976	19.835937	-0.1459526	19.981889	107.72414	19.82149	-0.1603998
GUM	Meas 3	19.985347	107.73163	19.84075	-0.1445969	19.985347	107.72509	19.823935	-0.1614119
GUM	Meas 4	19.986938	107.72543	19.825	-0.1619376	19.986938	107.72196	19.81587	-0.1710672
METAS	Meas 1	19.846	107.6601	19.656007	-0.189993	19.846	107.6462	19.620238	-0.225762
METAS	Meas 2	20.012	107.72698	19.828117	-0.183883	20.012	107.71142	19.788075	-0.223925
METAS	Meas 3	20.003	107.7224	19.81633	-0.18667	20.003	107.7071	19.776956	-0.226044
METAS	Meas 4	18.944	107.31566	18.769749	-0.174251	18.944	107.29781	18.723825	-0.220175
NMISA	Meas 1	17.531685	106.78058	17.393877	-0.1378076	17.531685	106.76588	17.356069	-0.1756159
NMISA	Meas 2	14.92018	105.75848	14.766185	-0.1539953	14.92018	105.75271	14.751355	-0.1688248
NMISA	Meas 3	16.838429	106.51996	16.723661	-0.1147674	16.838429	106.50777	16.692328	-0.1461006
NMISA	Meas 4	14.832692	105.72777	14.687276	-0.1454159	14.832692	105.71826	14.662838	-0.1698541
JV	Meas 1	19.865006	107.655	19.6435	-0.2215056	19.865006	107.6581	19.6515	-0.2135056
JV	Meas 2	20.225012	107.7688	19.9364	-0.2886117	20.225012	107.7651	19.9269	-0.2981117
JV	Meas 3	19.935002	107.6681	19.6771	-0.2579017	19.935007	107.6597	19.6556	-0.2794072
JV	Meas 4	19.809998	107.6401	19.6052	-0.2047983	19.809998	107.632	19.5844	-0.2255983
VNIIM									
VNIIM									
VNIIM									
VNIIM									
MIKES2	Meas 1	20.026485	107.75199	19.892699	-0.1337862	20.026485	107.73849	19.857952	-0.1685323
MIKES2	Meas 2	20.033574	107.75733	19.906443	-0.1271315	20.033574	107.74012	19.862148	-0.1714266
MIKES2									
MIKES2									

Loop 1 / Uncertainties

Measurement point: -50 °C

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
Lab		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
MIKES1	Meas 1	0.02320494	0.0013419	0.0008683	0.023	0.0232049	0.000959	0.0042228	0.024
MIKES1	Meas 2	0.02450274	0.0013404	0.002452	0.025	0.0245027	0.0044182	0.0041598	0.025
MIKES1	Meas 3	0.02324113	0.0015847	0.0030774	0.023	0.0232322	0.0010055	0.0034617	0.024
MIKES1	Meas 4	0.02368359	0.0019412	0.0028617	0.024	0.0236836	0.0013203	0.0034691	0.024
PTB	Meas 1	0.025	0.005	0	0.025	0.025	0.008	0	0.026
PTB	Meas 2	0.025	0.005	0	0.025	0.025	0.007	0	0.026
PTB	Meas 3	0.025	0.006	0	0.026	0.025	0.006	0	0.026
PTB	Meas 4	0.025	0.006	0	0.026	0.025	0.007	0	0.026
SP	Meas 1	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 2	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 3	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 4	0.12	0	0	0.120	0.12	0	0	0.120
DELTA	Meas 1	0.12	0.0024354	0	0.120	0.12	0.0014595	0	0.120
DELTA	Meas 2	0.12	0.0022807	0	0.120	0.12	0.00259	0	0.120
DELTA	Meas 3	0.12	0.0035066	0	0.120	0.12	0.0031065	0	0.120
DELTA	Meas 4	0.12	0.0032258	0	0.120	0.12	0.0038476	0	0.120
CETIAT	Meas 1	0.01585814	0.0070358	0	0.017	0.0158581	0.003066	0	0.016
CETIAT	Meas 2	0.01585814	0.0020364	0	0.016	0.0158581	0.0018525	0	0.016
CETIAT	Meas 3	0.01585814	0.0030972	0	0.016	0.0158581	0.0019787	0	0.016
CETIAT	Meas 4	0.01585814	0.0041425	0	0.016	0.0158581	0.0046861	0	0.017
GUM	Meas 1	0.02903409	0.0012253	0	0.029	0.0290341	0.001708	0	0.029
GUM	Meas 2	0.02903387	0.0008867	0	0.029	0.0290339	0.000566	0	0.029
GUM	Meas 3	0.02903394	0.0012195	0	0.029	0.0290339	0.0008932	0	0.029
GUM	Meas 4	0.02903385	0.0005867	0	0.029	0.0290339	0.000573	0	0.029
METAS	Meas 1	0.13272362	0.00875	0	0.133	0.1327236	0.00575	0	0.133
METAS	Meas 2	0.13272362	0.0045	0	0.133	0.1327236	0.0035	0	0.133
METAS	Meas 3	0.13272362	0.006	0	0.133	0.1327236	0.00675	0	0.133
METAS	Meas 4	0.13272362	0.004375	0	0.133	0.1327236	0.003225	0	0.133
NMISA	Meas 1	0.05222229	0.0058944	0	0.053	0.0522223	0.0060235	0	0.053
NMISA	Meas 2	0.05222229	0.0048221	0	0.052	0.0522223	0.0040608	0	0.052
NMISA	Meas 3	0.05222229	0.0046948	0	0.052	0.0522223	0.0020766	0	0.052
NMISA	Meas 4	0.05222229	0.003485	0	0.052	0.0522223	0.0034571	0	0.052
JV	Meas 1	0.14516327	0.00125	0.00145	0.145	0.1451633	0.00175	0.00145	0.145
JV	Meas 2	0.14535259	0.005	0.00145	0.145	0.1453526	0.005	0.00145	0.145
JV	Meas 3	0.14590536	0.01	0.00145	0.146	0.1459054	0.01	0.00145	0.146
JV	Meas 4	0.14562752	0.0075	0.00145	0.146	0.1456275	0.0075	0.00145	0.146
VNIIM	Meas 1	0.0502	0.0059519	0	0.051	0.0502	0.0071569	0	0.051
VNIIM	Meas 2	0.05	0.0021544	0	0.050	0.05	0.0024465	0	0.050
VNIIM	Meas 3	0.0501	0.0034507	0	0.050	0.0501	0.0026291	0	0.050
VNIIM	Meas 4	0.05	0.0039619	0	0.050	0.05	0.0039619	0	0.050
MIKES2	Meas 1	0.02144343	0.0005665	0.0001872	0.021	0.0214434	0.0005665	0.0001872	0.021
MIKES2	Meas 2	0.02498848	0.0010598	0.0001872	0.025	0.0249885	0.0010598	0.0001872	0.025
MIKES2	Meas 3	0.02120382	0.0004884	0.0001872	0.021	0.0212038	0.0004884	0.0001872	0.021
MIKES2	Meas 4	0.02490134	0.0005982	0.0001872	0.025	0.0249013	0.0005982	0.0001872	0.025

Measurement point: -30 °C

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
MIKES1	Meas 1	0.0230575	0.0007574	0.0067261	0.024	0.0230575	0.0008672	0.0085181	0.025
MIKES1	Meas 2	0.0232549	0.0040142	0.0067261	0.025	0.0232549	0.0034956	0.0085181	0.025
MIKES1	Meas 3	0.0230481	0.0043503	0.0027323	0.024	0.0230481	0.0042844	0.0056895	0.024
MIKES1	Meas 4	0.0229058	0.0005605	0.0021638	0.023	0.0229058	0.0007027	0.0030784	0.023
PTB	Meas 1	0.025	0.01	0	0.027	0.025	0.008	0	0.026
PTB	Meas 2	0.025	0.009	0	0.027	0.025	0.009	0	0.027
PTB	Meas 3	0.025	0.009	0	0.027	0.025	0.009	0	0.027
PTB	Meas 4	0.025	0.008	0	0.026	0.025	0.008	0	0.026
SP	Meas 1	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 2	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 3	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 4	0.12	0	0	0.120	0.12	0	0	0.120
DELTA	Meas 1	0.116	0.0007357	0	0.116	0.116	0.0008099	0	0.116
DELTA	Meas 2	0.116	0.0046287	0	0.116	0.116	0.0047637	0	0.116
DELTA	Meas 3	0.116	0.0045733	0	0.116	0.116	0.0046518	0	0.116
DELTA	Meas 4	0.116	0.0027559	0	0.116	0.116	0.0029484	0	0.116
CETIAT	Meas 1	0.0158581	0.002549	0	0.016	0.0158581	0.002092	0	0.016
CETIAT	Meas 2	0.0158581	0.0012008	0	0.016	0.0158581	0.0003009	0	0.016
CETIAT	Meas 3	0.0158581	0.0017854	0	0.016	0.0158581	0.0016038	0	0.016
CETIAT	Meas 4	0.0158581	0.0018743	0	0.016	0.0158581	0.0016948	0	0.016
GUM	Meas 1	0.0169412	0.0008349	0	0.017	0.0169412	0.000492	0	0.017
GUM	Meas 2	0.0169413	0.0005731	0	0.017	0.0169413	0.0004334	0	0.017
GUM	Meas 3	0.0169413	0.0006442	0	0.017	0.0169413	0.0004494	0	0.017
GUM	Meas 4	0.0169409	0.0010812	0	0.017	0.0169409	0.0014118	0	0.017
METAS	Meas 1	0.0396358	0.0105	0	0.041	0.0396358	0.0275	0	0.048
METAS	Meas 2	0.0396358	0.0075	0	0.040	0.0396358	0.00675	0	0.040
METAS	Meas 3	0.0396358	0.0085	0	0.041	0.0396358	0.00575	0	0.040
METAS	Meas 4	0.0396358	0.009	0	0.041	0.0396358	0.00675	0	0.040
NMISA	Meas 1	0.0473686	0.0019396	0	0.047	0.0473686	0.0026418	0	0.047
NMISA	Meas 2	0.0473686	0.0037469	0	0.048	0.0473686	0.0028742	0	0.047
NMISA	Meas 3	0.0473686	0.0018177	0	0.047	0.0473686	0.0020138	0	0.047
NMISA	Meas 4	0.0473686	0.0016593	0	0.047	0.0473686	0.0019925	0	0.047
JV	Meas 1	0.1383355	0.005	0.00145	0.138	0.1383355	0.0075	0.00145	0.139
JV	Meas 2	0.1383355	0.005	0.00145	0.138	0.1383355	0.005	0.00145	0.138
JV	Meas 3	0.1385197	0.005	0.00145	0.139	0.1385197	0.0075	0.00145	0.139
JV	Meas 4	0.1394586	0.015	0.00145	0.140	0.1394586	0.0125	0.00145	0.140
VNIIM	Meas 1	0.0587	0.0068283	0	0.059	0.0587	0.0072482	0	0.059
VNIIM	Meas 2	0.05	0.0031585	0	0.050	0.05	0.0023369	0	0.050
VNIIM	Meas 3	0.05	0.0023735	0	0.050	0.05	0.0038706	0	0.050
VNIIM	Meas 4	0.0506	0.0088731	0	0.051	0.0506	0.0084897	0	0.051
MIKES2	Meas 1	0.0221385	0.000294	0.0002042	0.022	0.0221385	0.000294	0.0002042	0.022
MIKES2	Meas 2	0.0211552	0.0004497	0.0002042	0.021	0.0211552	0.0004497	0.0002042	0.021
MIKES2	Meas 3	0.0212736	0.0002381	0.0002042	0.021	0.0212736	0.0002381	0.0002042	0.021
MIKES2	Meas 4	0.0212279	0.0003191	0.0002042	0.021	0.0212279	0.0003191	0.0002042	0.021

Measurement point: -10 °C

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
MIKES1	Meas 1	0.0229793	0.0013746	0.0017372	0.023	0.0229793	0.0010832	0.003965	0.023
MIKES1	Meas 2	0.0225035	0.0012348	0.0017372	0.023	0.0225035	0.0003295	0.003965	0.023
MIKES1	Meas 3	0.0224948	0.0013798	0.0015656	0.023	0.0224948	0.0012253	0.0026178	0.023
MIKES1	Meas 4	0.0227703	0.0014132	0.0042894	0.023	0.0227703	0.0011834	0.0050987	0.023
PTB	Meas 1	0.015	0.0009	0	0.015	0.015	0.0011	0	0.015
PTB	Meas 2	0.015	0.0008	0	0.015	0.015	0.0011	0	0.015
PTB	Meas 3	0.015	0.0008	0	0.015	0.015	0.0009	0	0.015
PTB	Meas 4	0.015	0.0011	0	0.015	0.015	0.0011	0	0.015
SP	Meas 1	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 2	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 3	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 4	0.12	0	0	0.120	0.12	0	0	0.120
DELTA	Meas 1	0.116	0.0016057	0	0.116	0.116	0.0018118	0	0.116
DELTA	Meas 2	0.116	0.0013771	0	0.116	0.116	0.0013464	0	0.116
DELTA	Meas 3	0.116	0.0016674	0	0.116	0.116	0.0015706	0	0.116
DELTA	Meas 4	0.116	0.0074096	0	0.116	0.116	0.0077538	0	0.116
CETIAT	Meas 1	0.0158581	0.000636	0	0.016	0.0158581	0.0007969	0	0.016
CETIAT	Meas 2	0.0158581	0.0009654	0	0.016	0.0158581	0.0012948	0	0.016
CETIAT	Meas 3	0.0158581	0.0008843	0	0.016	0.0158581	0.0005268	0	0.016
CETIAT	Meas 4	0.0158581	0.0010581	0	0.016	0.0158581	0.0012567	0	0.016
GUM	Meas 1	0.0110196	0.0003087	0	0.011	0.0110196	0.0015367	0	0.011
GUM	Meas 2	0.0110199	0.0003416	0	0.011	0.0110199	0.0013576	0	0.011
GUM	Meas 3	0.0110204	0.0003523	0	0.011	0.0110204	0.0002808	0	0.011
GUM	Meas 4	0.0110208	0.0004267	0	0.011	0.0110208	0.0008046	0	0.011
METAS	Meas 1	0.0195898	0.00575	0	0.020	0.0195898	0.008	0	0.021
METAS	Meas 2	0.0195898	0.00175	0	0.020	0.0195898	0.003	0	0.020
METAS	Meas 3	0.0195898	0.0045	0	0.020	0.0195898	0.004	0	0.020
METAS	Meas 4	0.0195898	0.0065	0	0.021	0.0195898	0.005	0	0.020
NMISA	Meas 1	0.0581694	0.0016551	0	0.058	0.0581694	0.0014031	0	0.058
NMISA	Meas 2	0.0581694	0.00219	0	0.058	0.0581694	0.0021627	0	0.058
NMISA	Meas 3	0.0581694	0.0015779	0	0.058	0.0581694	0.0019887	0	0.058
NMISA	Meas 4	0.0581694	0.0024573	0	0.058	0.0581694	0.0007671	0	0.058
JV	Meas 1	0.136634	0.015	0.00145	0.137	0.136634	0.015	0.00145	0.137
JV	Meas 2	0.136634	0.015	0.00145	0.137	0.136634	0.015	0.00145	0.137
JV	Meas 3	0.136634	0.015	0.00145	0.137	0.136634	0.015	0.00145	0.137
JV	Meas 4	0.136634	0.015	0.00145	0.137	0.136634	0.015	0.00145	0.137
VNIIM	Meas 1	0.0503	0.0061345	0	0.051	0.0503	0.0071387	0	0.051
VNIIM	Meas 2	0.05	0.0032681	0	0.050	0.05	0.0038158	0	0.050
VNIIM	Meas 3	0.05	0.003761	0	0.050	0.05	0.0028664	0	0.050
VNIIM	Meas 4	0.0503	0.0053129	0	0.051	0.0503	0.0053129	0	0.051
MIKES2	Meas 1	0.0219928	0.0001933	0.0002216	0.022	0.0219928	0.0001933	0.0002216	0.022
MIKES2	Meas 2	0.0213094	0.0002262	0.0002216	0.021	0.0213094	0.0002262	0.0002216	0.021
MIKES2	Meas 3	0.0211797	0.0003528	0.0002216	0.021	0.0211797	0.0003528	0.0002216	0.021
MIKES2									

Measurement point: +1 °C

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
MIKES1	Meas 1	0.0208587	0.0008773	0.0033144	0.021	0.0208587	0.0013878	0.0057121	0.022
MIKES1	Meas 2	0.0208779	0.0012899	0.002719	0.021	0.0208779	0.0013017	0.0052652	0.022
MIKES1	Meas 3	0.0222909	0.0014914	0.0029634	0.023	0.0222909	0.0025502	0.0066236	0.023
MIKES1	Meas 4	0.0221028	0.0012335	0.0029634	0.022	0.0221028	0.0016155	0.0066236	0.023
PTB	Meas 1	0.015	0.0005	0	0.015	0.015	0.0003	0	0.015
PTB	Meas 2	0.015	0.0006	0	0.015	0.015	0.0005	0	0.015
PTB	Meas 3	0.015	0.0006	0	0.015	0.015	0.0006	0	0.015
PTB	Meas 4	0.015	0.0006	0	0.015	0.015	0.0005	0	0.015
SP	Meas 1	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 2	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 3	0.12	0	0	0.120	0.12	0	0	0.120
SP	Meas 4	0.12	0	0	0.120	0.12	0	0	0.120
DELTA	Meas 1	0.116	0.0028896	0	0.116	0.116	0.0192039	0	0.118
DELTA	Meas 2	0.116	0.0013771	0	0.116	0.116	0.0013464	0	0.116
DELTA	Meas 3	0.116	0.0062039	0	0.116	0.116	0.0062275	0	0.116
DELTA	Meas 4	0.116	0.0013604	0	0.116	0.116	0.001119	0	0.116
CETIAT	Meas 1	0.0158581	0.000433	0	0.016	0.0158581	0.0005197	0	0.016
CETIAT	Meas 2	0.0158581	0.0005682	0	0.016	0.0158581	0.0004017	0	0.016
CETIAT	Meas 3	0.0158581	0.0007952	0	0.016	0.0158581	0.0007006	0	0.016
CETIAT	Meas 4	0.0158581	0.0006984	0	0.016	0.0158581	0.0007071	0	0.016
GUM	Meas 1	0.0119617	0.0008055	0	0.012	0.0119617	0.000696	0	0.012
GUM	Meas 2	0.0119569	0.001307	0	0.012	0.0119569	0.0012381	0	0.012
GUM	Meas 3	0.0119567	0.000722	0	0.012	0.0119567	0.0007463	0	0.012
GUM	Meas 4	0.0119613	0.0012943	0	0.012	0.0119613	0.0011263	0	0.012
METAS	Meas 1	0.0174396	0.0025	0	0.018	0.0174396	0.00375	0	0.018
METAS	Meas 2	0.0181615	0.01725	0	0.025	0.0181615	0.0195	0	0.027
METAS	Meas 3	0.017258	0.002	0	0.017	0.017258	0.0035	0	0.018
METAS	Meas 4	0.0176023	0.0055	0	0.018	0.0176023	0.0045	0	0.018
NMISA	Meas 1	0.0564488	0.0016149	0	0.056	0.0564488	0.0012977	0	0.056
NMISA	Meas 2	0.0564488	0.0017416	0	0.056	0.0564488	0.0020028	0	0.056
NMISA	Meas 3	0.0564488	0.0050927	0	0.057	0.0564488	0.0041588	0	0.057
NMISA	Meas 4	0.0564488	0.0011939	0	0.056	0.0564488	0.0007987	0	0.056
JV	Meas 1	0.0916824	0.0075	0.0015	0.092	0.0916824	0.01	0.0015	0.092
JV	Meas 2	0.0918786	0.0175	0.0015	0.094	0.0918786	0.0125	0.0015	0.093
JV	Meas 3	0.0923995	0.015	0.0015	0.094	0.0923995	0.0175	0.0015	0.094
JV	Meas 4	0.0923995	0.0125	0.0015	0.093	0.0923995	0.0125	0.0015	0.093
VNIIM	Meas 1	0.05	0.002556	0	0.050	0.05	0.0025743	0	0.050
VNIIM	Meas 2	0.05	0.0018805	0	0.050	0.05	0.0029029	0	0.050
VNIIM	Meas 3	0.05	0.0040897	0	0.050	0.05	0.002976	0	0.050
VNIIM	Meas 4	0.0504	0.0035785	0	0.051	0.0504	0.003049	0	0.050
MIKES2	Meas 1	0.0211299	0.0008283	0.0002313	0.021	0.0211299	0.0008283	0.0002313	0.021
MIKES2	Meas 2	0.0208016	0.0003807	0.0002313	0.021	0.0208016	0.0003807	0.0002313	0.021
MIKES2									
MIKES2									

Measurement point: +20 °C

		Hygrometer 1 = 0920				Hygrometer 2 = 0921			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
MIKES1	Meas 1	0.0227299	0.000652	0.0007286	0.023	0.0227299	0.0010239	0.0013359	0.023
MIKES1	Meas 2	0.0220853	0.0010934	0.0007286	0.022	0.0220853	0.0009081	0.0013359	0.022
MIKES1	Meas 3	0.0221635	0.0008835	0.003472	0.022	0.0221635	0.0012972	0.0044605	0.023
MIKES1	Meas 4	0.0219515	0.0011542	0.003472	0.022	0.0219515	0.0011008	0.0044605	0.022
PTB	Meas 1	0.015	0.0002	0	0.015	0.015	0.0002	0	0.015
PTB	Meas 2	0.015	0.0005	0	0.015	0.015	0.0005	0	0.015
PTB	Meas 3	0.015	0.0003	0	0.015	0.015	0.0003	0	0.015
PTB	Meas 4	0.015	0.0003	0	0.015	0.015	0.0003	0	0.015
SP									
SP									
SP									
SP									
DELTA	Meas 1	0.116	0.0025966	0	0.116	0.116	0.0030327	0	0.116
DELTA	Meas 2	0.116	0.0028446	0	0.116	0.116	0.0029156	0	0.116
DELTA	Meas 3	0.116	0.0019842	0	0.116	0.116	0.0022147	0	0.116
DELTA	Meas 4	0.116	0.0014996	0	0.116	0.116	0.0009987	0	0.116
CETIAT	Meas 1	0.0158581	0.000747	0	0.016	0.0158581	0.0008773	0	0.016
CETIAT	Meas 2	0.0158581	0.0007209	0	0.016	0.0158581	0.000789	0	0.016
CETIAT	Meas 3	0.0158581	0.0007343	0	0.016	0.0158581	0.0008275	0	0.016
CETIAT	Meas 4	0.0158581	0.0004762	0	0.016	0.0158581	0.0006836	0	0.016
GUM	Meas 1	0.026708	0.00139	0	0.027	0.026708	0.0010917	0	0.027
GUM	Meas 2	0.0267088	0.0009512	0	0.027	0.0267088	0.0009664	0	0.027
GUM	Meas 3	0.0267087	0.0007751	0	0.027	0.0267087	0.0007734	0	0.027
GUM	Meas 4	0.0267085	0.0012964	0	0.027	0.0267085	0.0013123	0	0.027
METAS	Meas 1	0.0204108	0.0085	0	0.022	0.0204108	0.0115	0	0.023
METAS	Meas 2	0.018751	0.0125	0	0.023	0.018751	0.013	0	0.023
METAS	Meas 3	0.0184282	0.00275	0	0.019	0.0184282	0.0115	0	0.022
METAS	Meas 4	0.0196112	0.02125	0	0.029	0.0196112	0.018	0	0.027
NMISA	Meas 1	0.0543823	0.0131502	0	0.056	0.0543823	0.0069906	0	0.055
NMISA	Meas 2	0.0543823	0.001825	0	0.054	0.0543823	0.0024457	0	0.054
NMISA	Meas 3	0.0543823	0.0017261	0	0.054	0.0543823	0.0016786	0	0.054
NMISA	Meas 4	0.0543823	0.0053774	0	0.055	0.0543823	0.0045676	0	0.055
JV	Meas 1	0.0851822	0.0125	0.0015	0.086	0.0851822	0.015	0.0015	0.087
JV	Meas 2	0.0868102	0.0175	0.0015	0.089	0.0868102	0.0225	0.0015	0.090
JV	Meas 3	0.0858545	0.025	0.0015	0.089	0.0858545	0.0175	0.0015	0.088
JV	Meas 4	0.0850823	0.0125	0.0015	0.086	0.0850823	0.015	0.0015	0.086
VNIIM									
VNIIM									
VNIIM									
VNIIM									
MIKES2	Meas 1	0.0215481	0.0003792	0.0002476	0.022	0.0215481	0.0003792	0.0002476	0.022
MIKES2	Meas 2	0.0212152	0.0003038	0.0002476	0.021	0.0212152	0.0003038	0.0002476	0.021
MIKES2									
MIKES2									

Loop 2 / Estimates

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
Lab		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
NMi-VSL1	Meas 1	-50.01536	80.297722	-50.02155	-0.00619	-50.01536	80.303809	-50.00623	0.00913
NMi-VSL1	Meas 2	-49.98876	80.319958	-49.96556	0.0232	-49.98876	80.315538	-49.97669	0.01207
NMi-VSL1	Meas 3	-49.97994	80.295266	-50.02841	-0.04847	-49.97994	80.290677	-50.03848	-0.05854
NMi-VSL1	Meas 4	-49.99614	80.29986	-50.01582	-0.01968	-49.99614	80.297529	-50.02085	-0.02471
CETIAT	Meas 1	-50.035776	80.253896	-50.131909	-0.096133	-50.03258	80.260076	-50.116348	-0.0837681
CETIAT	Meas 2	-50.019541	80.254576	-50.130196	-0.1106558	-50.017322	80.262692	-50.109761	-0.0924382
CETIAT	Meas 3	-50.025751	80.265206	-50.10343	-0.077679	-50.023776	80.264546	-50.105092	-0.0813159
CETIAT	Meas 4	-50.028046	80.266526	-50.100107	-0.0720605	-50.028292	80.262396	-50.110506	-0.0822134
INTA	Meas 1	-50.00793	80.271335	-50.087998	-0.0800684	-50.00793	80.270611	-50.089821	-0.081891
INTA	Meas 2	-50.008622	80.271298	-50.088092	-0.0794698	-50.008622	80.270972	-50.088911	-0.0802888
INTA	Meas 3	-50.007663	80.271461	-50.08768	-0.0800169	-50.007663	80.27142	-50.087783	-0.0801195
INTA	Meas 4	-50.00899	80.272097	-50.08608	-0.0770894	-50.00899	80.271826	-50.086761	-0.0777709
IPQ									
IPQ									
IPQ									
IPQ									
EIM									
EIM									
EIM									
EIM									
iNRiM	Meas 1	-50.475267	80.098863	-50.5222	-0.0469333	-50.475267	80.097604	-50.5254	-0.0501333
iNRiM	Meas 2	-50.472978	80.102735	-50.5126	-0.0396221	-50.472978	80.098923	-50.5222	-0.0492221
iNRiM	Meas 3	-50.483943	80.077675	-50.5755	-0.0915571	-50.483943	80.076961	-50.5773	-0.0933571
iNRiM	Meas 4	-50.495819	80.081523	-50.566	-0.0701812	-50.495819	80.080595	-50.5682	-0.0723812
PTB	Meas 1	-49.787	80.3339	-49.93	-0.143	-49.787	80.3324	-49.934	-0.147
PTB	Meas 2	-50.051	80.2313	-50.189	-0.138	-50.051	80.2294	-50.194	-0.143
PTB	Meas 3	-50.051	80.2245	-50.206	-0.155	-50.051	80.2241	-50.207	-0.156
PTB	Meas 4	-49.988	80.2515	-50.138	-0.15	-49.988	80.2519	-50.137	-0.149
MIRS	Meas 1	-49.954716	80.304521	-50.004434	-0.0497176	-49.954933	80.305621	-50.001664	-0.0467309
MIRS	Meas 2	-49.954602	80.300726	-50.01399	-0.0593884	-49.954837	80.302091	-50.010552	-0.055715
MIRS	Meas 3	-49.955648	80.301866	-50.011119	-0.0554711	-49.956047	80.303796	-50.006259	-0.0502121
MIRS	Meas 4	-49.955189	80.298546	-50.019479	-0.0642896	-49.95559	80.298886	-50.018623	-0.0630329
LPM									
LPM									
LPM									
LPM									
UME									
UME									
UME									
UME									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2	Meas 1	-50	80.266282	-50.101189	-0.101189	-50	80.266282	-50.101189	-0.101189
INTA2	Meas 2	-50	80.275282	-50.078527	-0.078527	-50	80.273282	-50.083563	-0.083563
INTA2	Meas 3	-50	80.276282	-50.076009	-0.076009	-50	80.276282	-50.076009	-0.076009
INTA2	Meas 4	-50	80.266282	-50.101189	-0.101189	-50	80.266282	-50.101189	-0.101189

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
NMi-VSL1	Meas 1	-30.01352	88.1597	-30.15631	-0.14279	-30.01352	88.167429	-30.13856	-0.12504
NMi-VSL1	Meas 2	-30.00996	88.142134	-30.20194	-0.19198	-30.00996	88.138953	-30.20954	-0.19958
NMi-VSL1	Meas 3	-29.99954	88.148291	-30.18673	-0.18719	-29.99954	88.156366	-30.16645	-0.16691
NMi-VSL1	Meas 4	-30.01455	88.148559	-30.18419	-0.16964	-30.01455	88.152744	-30.17405	-0.1595
CETIAT	Meas 1	-29.994051	88.195033	-30.067495	-0.0734435	-29.990423	88.196423	-30.063971	-0.0735478
CETIAT	Meas 2	-30.005446	88.191643	-30.076089	-0.070643	-30.002013	88.190383	-30.079283	-0.0772702
CETIAT	Meas 3	-30.011448	88.188323	-30.084506	-0.0730578	-30.008111	88.187363	-30.086939	-0.0788284
CETIAT	Meas 4	-29.818737	88.260433	-29.901694	-0.0829574	-29.816175	88.260923	-29.900452	-0.0842767
INTA	Meas 1	-30.004962	88.179771	-30.106186	-0.1012232	-30.004962	88.180602	-30.10408	-0.0991172
INTA	Meas 2	-30.005393	88.179694	-30.106379	-0.100986	-30.005393	88.179873	-30.105928	-0.1005341
INTA	Meas 3	-30.004644	88.180284	-30.104886	-0.1002419	-30.004644	88.180735	-30.103741	-0.099097
INTA	Meas 4	-30.004128	88.180613	-30.104052	-0.0999237	-30.004128	88.180871	-30.103397	-0.0992695
IPQ									
IPQ									
IPQ									
IPQ									
EIM	Meas 1	-30.0411	88.2035	-30.046	-0.0049				
EIM	Meas 2	-30.0275	88.2147	-30.0177	0.0098				
EIM	Meas 3	-30.009	88.2062	-30.0393	-0.0303				
EIM	Meas 4	-29.9851	88.2122	-30.024	-0.0389				
iNRiM	Meas 1	-30.373336	88.032479	-30.4795	-0.1061643	-30.373336	88.037164	-30.4676	-0.0942643
iNRiM	Meas 2	-30.318677	88.056959	-30.4174	-0.098723	-30.318677	88.060762	-30.4078	-0.089123
iNRiM	Meas 3	-30.315548	88.056688	-30.4182	-0.1026525	-30.315548	88.06086	-30.4075	-0.0919525
iNRiM	Meas 4	-30.321663	88.055408	-30.4215	-0.0998365	-30.321663	88.058827	-30.4128	-0.0911365
PTB	Meas 1	-30.018	88.156	-30.167	-0.149	-30.018	88.1558	-30.167	-0.149
PTB	Meas 2	-30.027	88.1517	-30.178	-0.151	-30.027	88.1509	-30.179	-0.152
PTB	Meas 3	-30.056	88.139	-30.21	-0.154	-30.056	88.1385	-30.211	-0.155
PTB	Meas 4	-30.055	88.1394	-30.209	-0.154	-30.055	88.138	-30.212	-0.157
MIRS	Meas 1	-30.096738	88.14606	-30.191644	-0.0949058	-30.097089	88.146017	-30.191754	-0.0946647
MIRS	Meas 2	-30.099063	88.14591	-30.192024	-0.0929606	-30.098846	88.14673	-30.189945	-0.0910989
MIRS	Meas 3	-30.094593	88.142515	-30.20063	-0.1060365	-30.094553	88.14689	-30.18954	-0.0949873
MIRS	Meas 4	-30.094205	88.144645	-30.195231	-0.1010261	-30.094778	88.14721	-30.188729	-0.0939506
LPM									
LPM									
LPM									
LPM									
UME	Meas 1	-29.9457	88.228783	-29.9819	-0.0362	-29.9362	88.23003	-29.9788	-0.0426
UME	Meas 2	-29.9092	88.2384	-29.9575	-0.0483	-29.9092	88.2399	-29.9536	-0.0444
UME	Meas 3	-29.9633	88.2168	-30.0123	-0.049	-29.9633	88.2189	-30.007	-0.0437
UME	Meas 4	-29.929729	88.230844	-29.9768	-0.0470706	-29.92017	88.23099	-29.9763	-0.05613
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2	Meas 1	-30	88.179657	-30.106644	-0.1066443	-30	88.180657	-30.104109	-0.1041092
INTA2	Meas 2	-30	88.179657	-30.106644	-0.1066443	-30	88.180657	-30.104109	-0.1041092
INTA2	Meas 3	-30	88.181657	-30.101574	-0.1015741	-30	88.182657	-30.099039	-0.099039
INTA2	Meas 4	-30	88.181657	-30.101574	-0.1015741	-30	88.182657	-30.099039	-0.099039

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
NMi-VSL1	Meas 1	-9.99858	96.037793	-10.12214	-0.12356	-9.99858	96.034233	-10.13234	-0.13376
NMi-VSL1	Meas 2	-9.99332	96.017416	-10.17571	-0.18239	-9.99332	96.009808	-10.19356	-0.20024
NMi-VSL1	Meas 3	-9.98742	96.043529	-10.10683	-0.11941	-9.98742	96.041365	-10.11449	-0.12707
NMi-VSL1	Meas 4	-9.99435	96.037107	-10.12469	-0.13034	-9.99435	96.03561	-10.12724	-0.13289
CETIAT	Meas 1	-10.109571	96.002469	-10.212774	-0.1032026	-10.105337	96.003089	-10.211192	-0.1058557
CETIAT	Meas 2	-10.088774	96.007739	-10.199331	-0.1105564	-10.084499	96.008989	-10.196142	-0.1116435
CETIAT	Meas 3	-10.057568	96.018299	-10.172393	-0.1148256	-10.054725	96.016999	-10.175709	-0.1209845
CETIAT	Meas 4	-10.06585	96.013819	-10.183821	-0.1179716	-10.062985	96.013409	-10.184867	-0.1218825
INTA	Meas 1	-9.9939654	96.04104	-10.114384	-0.120419	-9.9939654	96.039919	-10.117242	-0.1232771
INTA	Meas 2	-9.9931801	96.040265	-10.116361	-0.1231808	-9.9931801	96.039462	-10.11841	-0.1252299
INTA	Meas 3	-9.9944044	96.03994	-10.117189	-0.1227851	-9.9944044	96.038666	-10.120438	-0.1260338
INTA	Meas 4	-9.9937654	96.039475	-10.118377	-0.1246114	-9.9937654	96.038613	-10.120575	-0.1268094
IPQ	Meas 1	-10.14858	96.08418	-10.004951	0.143629	-9.550432	96.28186	-9.5006272	0.0498048
IPQ	Meas 2	-10.14123	96.08712	-9.997451	0.143779	-9.575331	96.26165	-9.5521908	0.0231402
IPQ	Meas 3	-9.486672	96.35136	-9.3232996	0.1633724	-9.504425	96.29408	-9.4694489	0.0349761
IPQ	Meas 4	-9.469484	96.35602	-9.3114094	0.1580746	-9.40697	96.33368	-9.3684106	0.0385594
EIM	Meas 1	-9.9196	96.0757	-10.026	-0.1064	-9.9196	96.0828	-10.0079	-0.0883
EIM	Meas 2	-10.0223	96.0337	-10.1331	-0.1108	-10.0223	96.0387	-10.1203	-0.098
EIM	Meas 3	-9.9691	96.0602	-10.0654	-0.0963	-9.9691	96.0708	-10.0383	-0.0692
EIM	Meas 4	-10.0415	96.0322	-10.1369	-0.0954	-10.0415	96.0394	-10.1187	-0.0772
iNRiM	Meas 1	-10.274581	95.933013	-10.39	-0.1154188	-10.274581	95.937098	-10.3795	-0.1049188
iNRiM	Meas 2	-10.275318	95.933421	-10.389	-0.1136818	-10.275318	95.9366	-10.3808	-0.1054818
iNRiM	Meas 3	-10.28545	95.927197	-10.4048	-0.11935	-10.28545	95.93142	-10.3941	-0.10865
iNRiM	Meas 4	-10.285681	95.928766	-10.4007	-0.1150187	-10.285681	95.929806	-10.3981	-0.1124187
PTB	Meas 1	-9.998	96.03595	-10.128	-0.13	-9.996	96.02783	-10.148	-0.152
PTB	Meas 2	-10.01	96.033	-10.135	-0.125	-10.003	96.02186	-10.164	-0.161
PTB	Meas 3	-10.012	96.03064	-10.141	-0.129	-10.006	96.02103	-10.166	-0.16
PTB	Meas 4	-9.991	96.03707	-10.125	-0.134	-9.988	96.02839	-10.147	-0.159
MIRS	Meas 1	-10.109578	95.994774	-10.232404	-0.1228263	-10.110205	95.996537	-10.227906	-0.1177007
MIRS	Meas 2	-10.108548	95.996179	-10.22882	-0.1202718	-10.108591	95.998144	-10.223808	-0.1152166
MIRS	Meas 3	-10.10651	95.995659	-10.230146	-0.1236364	-10.106847	95.998444	-10.223042	-0.1161949
MIRS	Meas 4	-10.105955	95.996274	-10.228578	-0.1226229	-10.10636	95.998614	-10.222609	-0.1162494
LPM	Meas 1	-9.80298	96.210941	-9.68095	0.12203	-9.79154	96.29273	-9.4728933	0.3186467
LPM	Meas 2	-9.80507	96.176418	-9.76903	0.03604	-9.79165	96.229916	-9.6331549	0.1584951
LPM									
LPM									
UME	Meas 1	-9.936	96.0806	-10.0135	-0.0775	-9.936	96.0761	-10.025	-0.089
UME	Meas 2	-10.0653	96.049717	-10.0923	-0.027	-10.0653	96.041963	-10.1119	-0.0466
UME	Meas 4	-9.9867	96.067	-10.0482	-0.0615	-9.9789	96.0807	-10.0132	-0.0343
UME	Meas 3	-9.969	96.0761	-10.025	-0.056	-9.9499	96.0776	-10.0211	-0.0712
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2	Meas 1	-10	96.040879	-10.115411	-0.1154109	-10	96.035879	-10.128166	-0.1281655
INTA2	Meas 2	-10	96.036879	-10.125615	-0.1256146	-10	96.038879	-10.120513	-0.1205127
INTA2	Meas 3	-10	96.039879	-10.117962	-0.1179618	-10	96.037379	-10.124339	-0.1243391
INTA2	Meas 4	-10	96.039879	-10.117962	-0.1179618	-10	96.037879	-10.123064	-0.1230637

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
NMi-VSL1	Meas 1	1.01605	100.33151	0.84958	-0.16647	1.01605	100.32772	0.83934	-0.17671
NMi-VSL1	Meas 2	1.01842	100.31328	0.80095	-0.21747	1.01842	100.30983	0.79328	-0.22514
NMi-VSL1	Meas 3	1.01935	100.3497	0.89565	-0.1237	1.01935	100.34991	0.89565	-0.1237
NMi-VSL1	Meas 4	1.01623	100.35948	0.91868	-0.09755	1.01623	100.32034	0.81887	-0.19736
CETIAT	Meas 1	0.9320673	100.33283	0.851703	-0.0803643	0.9359171	100.33925	0.8681338	-0.0677833
CETIAT	Meas 2	0.9077982	100.32513	0.8319964	-0.0758018	0.9071791	100.33393	0.8545182	-0.0526609
CETIAT	Meas 3	0.8633686	100.30954	0.7920971	-0.0712714	0.8635443	100.32001	0.8188928	-0.0446515
CETIAT	Meas 4	0.8650453	100.30983	0.7928393	-0.072206	0.8641794	100.32044	0.8199933	-0.0441861
INTA	Meas 1	0.9972419	100.34878	0.8925134	-0.1047286	0.9972419	100.34583	0.8849762	-0.1122658
INTA	Meas 2	0.9987893	100.34836	0.8914494	-0.10734	0.9987893	100.34549	0.8840937	-0.1146957
INTA	Meas 3	0.9974656	100.34749	0.8892332	-0.1082324	0.9974656	100.34619	0.8858975	-0.1115681
INTA	Meas 4	0.9990963	100.34881	0.8926058	-0.1064905	0.9990963	100.34652	0.8867383	-0.112358
IPQ	Meas 1	0.7531684	100.35967	0.9199367	0.1667683	0.8548518	100.34727	0.8882009	0.0333491
IPQ	Meas 2	0.7427525	100.35371	0.904683	0.1619305	0.7472621	100.31592	0.8079669	0.0607048
IPQ	Meas 3	0.8563606	100.39594	1.0127657	0.1564051	0.7636892	100.31696	0.8106285	0.0469393
IPQ	Meas 4	0.8008289	100.37615	0.9621151	0.1612862	0.7561888	100.32074	0.8203026	0.0641138
EIM	Meas 1	0.8882	100.3193	0.8171	-0.0711	0.8882	100.3194	0.8173	-0.0709
EIM	Meas 2	1.0496	100.3644	0.9325	-0.1171	1.0496	100.3655	0.9354	-0.1142
EIM	Meas 3	0.9732	100.3371	0.8627	-0.1105	0.9732	100.3434	0.8788	-0.0944
EIM	Meas 4	0.9587	100.3402	0.8706	-0.0881	0.9587	100.3439	0.88	-0.0787
iNRiM	Meas 1	0.99801	100.35126	0.8982	-0.09981	0.99801	100.34966	0.8956	-0.10241
iNRiM	Meas 2	0.9918021	100.34446	0.8803	-0.1115021	0.9918021	100.34607	0.8854	-0.1064021
iNRiM	Meas 3	1.0172215	100.36224	0.9264	-0.0908215	1.0172215	100.36186	0.9264	-0.0908215
iNRiM	Meas 4	1.0166517	100.35976	0.9212	-0.0954517	1.0166517	100.36244	0.9264	-0.0902517
PTB	Meas 1	1.04	100.35988	0.921	-0.119	1.044	100.34724	0.889	-0.155
PTB	Meas 2	1.058	100.36385	0.931	-0.127	1.058	100.35424	0.907	-0.151
PTB	Meas 3	1.055	100.36446	0.933	-0.122	1.058	100.35335	0.905	-0.153
PTB	Meas 4	1.048	100.35869	0.918	-0.13	1.051	100.34831	0.892	-0.159
MIRS	Meas 1	1.0366795	100.35748	0.914791	-0.1218885	1.0372007	100.35767	0.915265	-0.1219357
MIRS	Meas 2	1.0386535	100.35645	0.912164	-0.1264895	1.0395003	100.35535	0.909336	-0.1301643
MIRS	Meas 3	1.0424589	100.35828	0.916826	-0.1256329	1.0418709	100.3582	0.916621	-0.1252499
MIRS	Meas 4	1.0409864	100.35842	0.917184	-0.1238024	1.0409664	100.35804	0.916229	-0.1247374
LPM	Meas 1	1.18232	100.46354	1.18624	0.00392	1.1896	100.48467	1.24029	0.05069
LPM	Meas 2	1.18134	100.44851	1.14776	-0.03358	1.1917	100.47012	1.20309	0.01139
LPM	Meas 3								
LPM	Meas 4								
UME	Meas 1	1.1499	100.42214	1.0802	-0.0697	1.1595	100.41623	1.0651	-0.0944
UME	Meas 2	1.1151565	100.40228	1.0295	-0.0856565	1.1151565	100.39444	1.0093	-0.1058565
UME	Meas 3	1.1136218	100.40702	1.0415	-0.0721218	1.1274303	100.39529	1.0116	-0.1158303
UME	Meas 4	1.1252029	100.41814	1.0699	-0.0553029	1.1334147	100.40251	1.03	-0.1034147
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2	Meas 1	1	100.34077	0.8715711	-0.1284289	1	100.33877	0.8664524	-0.1335476
INTA2	Meas 2	1	100.34177	0.8741304	-0.1258696	1	100.33977	0.8690117	-0.1309883
INTA2	Meas 3	1	100.34877	0.8920457	-0.1079543	1	100.34677	0.886927	-0.113073
INTA2	Meas 4	1	100.34827	0.890766	-0.109234	1	100.34777	0.8894863	-0.1105137

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
NMi-VSL1	Meas 1	19.94013	107.74945	19.88546	-0.05467	19.94013	107.74505	19.87517	-0.06496
NMi-VSL1	Meas 2	19.87267	107.69895	19.75678	-0.11589	19.87267	107.69626	19.74906	-0.12361
NMi-VSL1	Meas 3	19.88462	107.71231	19.79024	-0.09438	19.88462	107.70502	19.77222	-0.1124
NMi-VSL1	Meas 4	19.85122	107.70311	19.76707	-0.08415	19.85122	107.68943	19.73104	-0.12018
CETIAT	Meas 1	19.81557	107.69968	19.757871	-0.0576991	19.814732	107.72266	19.817009	0.0022771
CETIAT	Meas 2	20.02566	107.77649	19.955544	-0.0701165	20.024896	107.80253	20.022561	-0.0023356
CETIAT	Meas 3	20.079712	107.8066	20.033036	-0.0466766	20.079737	107.82068	20.069273	-0.0104642
CETIAT	Meas 4	19.905365	107.7434	19.870384	-0.0349806	19.906327	107.7627	19.920054	0.0137268
INTA	Meas 1	19.994813	107.74792	19.882691	-0.1121226	19.994813	107.74802	19.882948	-0.1118652
INTA	Meas 2	19.993685	107.74816	19.883295	-0.1103892	19.993685	107.74754	19.881696	-0.1119886
INTA	Meas 3	19.992749	107.74784	19.882491	-0.1102588	19.992749	107.74793	19.8827	-0.1100491
INTA	Meas 4	19.993271	107.74745	19.88148	-0.1117913	19.993271	107.74729	19.88107	-0.1122012
IPQ	Meas 1	19.76306	107.76943	19.937717	0.1746571	19.66691	107.68381	19.717354	0.0504439
IPQ	Meas 2	19.83163	107.79526	20.0042	0.1725695	19.69138	107.69067	19.735009	0.0436292
IPQ	Meas 3	19.77586	107.77421	19.95002	0.17416	19.66085	107.6809	19.709865	0.0490146
IPQ	Meas 4	19.57741	107.69701	19.751326	0.1739163	19.64529	107.6693	19.68001	0.0347205
EIM	Meas 1	19.9901	107.7479	19.8828	-0.1073	19.9901	107.744	19.8726	-0.1175
EIM	Meas 2	19.9794	107.7562	19.9039	-0.0755	19.9794	107.7478	19.8824	-0.097
EIM	Meas 3	19.9753	107.7429	19.8699	-0.1054	19.9753	107.7483	19.8837	-0.0916
EIM	Meas 4	19.9725	107.7477	19.8821	-0.0904	19.9725	107.7541	19.8985	-0.074
iNRiM	Meas 1	19.967659	107.72807	19.8314	-0.1362591	19.967659	107.73128	19.8391	-0.1285591
iNRiM	Meas 2	19.967543	107.7251	19.8237	-0.1438429	19.967543	107.73084	19.8391	-0.1284429
iNRiM	Meas 3	19.967544	107.72687	19.8288	-0.1387444	19.967544	107.72971	19.8366	-0.1309444
iNRiM	Meas 4	19.967605	107.72773	19.8314	-0.136205	19.967605	107.7296	19.8366	-0.131005
PTB	Meas 1	20.026	107.75702	19.907	-0.119	20.036	107.74462	19.874	-0.162
PTB	Meas 2	20.042	107.76037	19.915	-0.127	20.047	107.74902	19.885	-0.162
PTB	Meas 3	20.042	107.76035	19.915	-0.127	20.048	107.74904	19.885	-0.163
PTB	Meas 4	20.038	107.76113	19.917	-0.121	20.044	107.74982	19.887	-0.157
MIRS	Meas 1	19.957476	107.73301	19.844321	-0.1131553	19.957287	107.72954	19.835369	-0.121918
MIRS	Meas 2	19.95613	107.7309	19.838891	-0.117239	19.956585	107.72843	19.832534	-0.1240505
MIRS	Meas 3	19.958956	107.7268	19.828326	-0.1306298	19.95841	107.72577	19.825675	-0.132735
MIRS	Meas 4	19.962218	107.72416	19.821544	-0.140674	19.961517	107.72564	19.825336	-0.1361813
LPM	Meas 1	19.91076	107.71755	19.80452	-0.10624	19.92596	107.72595	19.82613	-0.09983
LPM	Meas 2	19.91124	107.68075	19.70981	-0.20143	19.92692	107.68231	19.71383	-0.21309
LPM	Meas 3	19.91348	107.67328	19.69058	-0.2229	19.92948	107.65889	19.65356	-0.27592
LPM	Meas 4	19.90988	107.68916	19.73143	-0.17845	19.92572	107.69621	19.74957	-0.17615
UME	Meas 1	20.207822	107.84707	20.138	-0.069822	20.22377	107.84024	20.1202	-0.1035701
UME	Meas 2	20.061682	107.81366	20.052	-0.0096816	20.061682	107.78221	19.9709	-0.0907816
UME	Meas 3	20.16476	107.86055	20.1727	0.00794	20.16476	107.82348	20.0772	-0.08756
UME	Meas 4	20.173577	107.82071	20.07	-0.1035771	20.174551	107.81635	20.0589	-0.1156507
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2	Meas 1	20	107.7425	19.868405	-0.1315951	20	107.7425	19.868405	-0.1315951
INTA2	Meas 2	20	107.7425	19.868405	-0.1315951	20	107.7415	19.865831	-0.1341689
INTA2	Meas 3	20	107.7515	19.891569	-0.1084311	20	107.7515	19.891569	-0.1084311
INTA2	Meas 4	20	107.7505	19.888995	-0.1110049	20	107.7505	19.888995	-0.1110049

Loop 2 / Uncertainties

Measurement point: -50 °C

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
NMi-VSL1	Meas 1	0.01550569	0.0017315	0	0.016	0.0155057	0.004163	0	0.016
NMi-VSL1	Meas 2	0.01550569	0.0030223	0	0.016	0.0155057	0.002338	0	0.016
NMi-VSL1	Meas 3	0.01550569	0.0031689	0	0.016	0.0155057	0.0061961	0	0.017
NMi-VSL1	Meas 4	0.01550569	0.0023617	0	0.016	0.0155057	0.003664	0	0.016
CETIAT	Meas 1	0.01585814	0.0039725	0	0.016	0.0158581	0.0063997	0	0.017
CETIAT	Meas 2	0.01585814	0.0035214	0	0.016	0.0158581	0.0041356	0	0.016
CETIAT	Meas 3	0.01585814	0.0029351	0	0.016	0.0158581	0.0029941	0	0.016
CETIAT	Meas 4	0.01585814	0.0034922	0	0.016	0.0158581	0.0043846	0	0.016
INTA	Meas 1	0.03188101	0.0023754	0	0.032	0.031881	0.0042514	0	0.032
INTA	Meas 2	0.03188101	0.0031811	0	0.032	0.031881	0.0050663	0	0.032
INTA	Meas 3	0.03188101	0.0030288	0	0.032	0.031881	0.0098181	0	0.033
INTA	Meas 4	0.03188101	0.0030811	0	0.032	0.031881	0.0047198	0	0.032
IPQ									
IPQ									
IPQ									
IPQ									
EIM									
EIM									
EIM									
EIM									
iNRiM	Meas 1	0.0250072	0.005	0.000288	0.026	0.0250072	0.006	0.000288	0.026
iNRiM	Meas 2	0.0250072	0.007	0.000288	0.026	0.0250072	0.01	0.000288	0.027
iNRiM	Meas 3	0.0250072	0.006	0.000288	0.026	0.0250072	0.007	0.000288	0.026
iNRiM	Meas 4	0.0250072	0.008	0.000288	0.026	0.0250072	0.008	0.000288	0.026
PTB	Meas 1	0.025	0.009	0	0.027	0.025	0.008	0	0.026
PTB	Meas 2	0.025	0.008	0	0.026	0.025	0.008	0	0.026
PTB	Meas 3	0.025	0.007	0	0.026	0.025	0.007	0	0.026
PTB	Meas 4	0.025	0.009	0	0.027	0.025	0.009	0	0.027
MIRS-FE-LM	Meas 1	0.02311898	0.0039	0	0.023	0.023119	0.0054	0	0.024
MIRS-FE-LM	Meas 2	0.02311898	0.0042	0	0.023	0.023119	0.0036	0	0.023
MIRS-FE-LM	Meas 3	0.02311898	0.0051	0	0.024	0.023119	0.0068	0	0.024
MIRS-FE-LM	Meas 4	0.02311898	0.0041	0	0.023	0.023119	0.0037	0	0.023
LPM									
LPM									
LPM									
LPM									
UME									
UME									
UME									
UME									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2									
INTA2									
INTA2									
INTA2									

Measurement point: -30 °C

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
NMi-VSL1	Meas 1	0.01622737	0.00226436	0	0.016	0.01622737	0.00296555	0	0.016
NMi-VSL1	Meas 2	0.01622737	0.00204499	0	0.016	0.01622737	0.00366862	0	0.017
NMi-VSL1	Meas 3	0.01622737	0.00231344	0	0.016	0.01622737	0.00365696	0	0.017
NMi-VSL1	Meas 4	0.01622737	0.00173491	0	0.016	0.01622737	0.00449123	0	0.017
CETIAT	Meas 1	0.01585814	0.0025555	0	0.016	0.01585814	0.00292273	0	0.016
CETIAT	Meas 2	0.01585814	0.00802708	0	0.018	0.01585814	0.00380506	0	0.016
CETIAT	Meas 3	0.01585814	0.00276398	0	0.016	0.01585814	0.00232752	0	0.016
CETIAT	Meas 4	0.01585814	0.00399861	0	0.016	0.01585814	0.00360565	0	0.016
INTA	Meas 1	0.02529085	0.00136569	0	0.025	0.02529085	0.00225647	0	0.025
INTA	Meas 2	0.02529085	0.00172559	0	0.025	0.02529085	0.00248401	0	0.025
INTA	Meas 3	0.02529085	0.00228486	0	0.025	0.02529085	0.00211132	0	0.025
INTA	Meas 4	0.02529085	0.00194798	0	0.025	0.02529085	0.00207206	0	0.025
IPQ									
IPQ									
IPQ									
IPQ									
EIM	Meas 1	0.01886312	0.0066	0.00025	0.020	0.01886312	0.0122	0.00025	0.022
EIM	Meas 2	0.01886312	0.0111	0.00025	0.022	0.01886312	0.0063	0.00025	0.020
EIM	Meas 3	0.01886312	0.0107	0.00025	0.022	0.01886312	0.0137	0.00025	0.023
EIM	Meas 4	0.01886312	0.0074	0.00025	0.020	0.01886312	0.011	0.00025	0.022
iNRiM	Meas 1	0.02084413	0.005	0.000288	0.021	0.02084413	0.006	0.000288	0.022
iNRiM	Meas 2	0.02084413	0.004	0.000288	0.021	0.02084413	0.005	0.000288	0.021
iNRiM	Meas 3	0.02084413	0.003	0.000288	0.021	0.02084413	0.002	0.000288	0.021
iNRiM	Meas 4	0.02084413	0.004	0.000288	0.021	0.02084413	0.004	0.000288	0.021
PTB	Meas 1	0.025	0.01	0	0.027	0.025	0.01	0	0.027
PTB	Meas 2	0.025	0.011	0	0.027	0.025	0.011	0	0.027
PTB	Meas 3	0.025	0.01	0	0.027	0.025	0.009	0	0.027
PTB	Meas 4	0.025	0.009	0	0.027	0.025	0.009	0	0.027
MIRS-FE-I	Meas 1	0.01470234	0.001932	0	0.015	0.01470234	0.00368	0	0.015
MIRS-FE-I	Meas 2	0.01470234	0.002953	0	0.015	0.01470234	0.004448	0	0.015
MIRS-FE-I	Meas 3	0.01470234	0.00134	0	0.015	0.01470234	0.00397	0	0.015
MIRS-FE-I	Meas 4	0.01470234	0.002302	0	0.015	0.01470234	0.003625	0	0.015
LPM									
LPM									
LPM									
LPM									
UME	Meas 1	0.02551409	0.0042	0.00289	0.026	0.02551409	0.0053	0.00289	0.026
UME	Meas 2	0.02551409	0.0013	0.00289	0.026	0.02551409	0.0017	0.00289	0.026
UME	Meas 3	0.02551409	0.00131	0.00289	0.026	0.02551409	0.00131	0.00289	0.026
UME	Meas 4	0.02551409	0.0016	0.00289	0.026	0.02551409	0.0017	0.00289	0.026
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2									
INTA2									
INTA2									
INTA2									
0.000									

Measurement point: -10 °C

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
NMi-VSL1	Meas 1	0.01968273	0.00739901	0	0.021	0.01968273	0.00645865	0	0.021
NMi-VSL1	Meas 2	0.01968273	0.00197604	0	0.020	0.01968273	0.00241996	0	0.020
NMi-VSL1	Meas 3	0.01968273	0.00192579	0	0.020	0.01968273	0.00278628	0	0.020
NMi-VSL1	Meas 4	0.01968273	0.0018712	0	0.020	0.01968273	0.00216621	0	0.020
CETIAT	Meas 1	0.01585814	0.00364806	0	0.016	0.01585814	0.00283382	0	0.016
CETIAT	Meas 2	0.01585814	0.00294026	0	0.016	0.01585814	0.00365946	0	0.016
CETIAT	Meas 3	0.01585814	0.00469197	0	0.017	0.01585814	0.00147691	0	0.016
CETIAT	Meas 4	0.01585814	0.00262322	0	0.016	0.01585814	0.00221986	0	0.016
INTA	Meas 1	0.025	0.00120446	0	0.025	0.025	0.00171401	0	0.025
INTA	Meas 2	0.025	0.00173634	0	0.025	0.025	0.00167633	0	0.025
INTA	Meas 3	0.025	0.00252492	0	0.025	0.025	0.00233102	0	0.025
INTA	Meas 4	0.025	0.00120621	0	0.025	0.025	0.00205618	0	0.025
IPQ	Meas 1	0.19532845	0.01038346	0.00288675	0.196	0.19532845	0.01117162	0.00288675	0.196
IPQ	Meas 2	0.19532845	0.00448063	0.00288675	0.195	0.19532845	0.00909398	0.00288675	0.196
IPQ	Meas 3	0.19532845	0.01074739	0.00288675	0.196	0.19532845	0.00515314	0.00288675	0.195
IPQ	Meas 4	0.19532845	0.00864292	0.00288675	0.196	0.19532845	0.02088976	0.00288675	0.196
EIM	Meas 1	0.01960526	0.0091	0.00025	0.022	0.01960526	0.0094	0.00025	0.022
EIM	Meas 2	0.01960526	0.0078	0.00025	0.021	0.01960526	0.0089	0.00025	0.022
EIM	Meas 3	0.01960526	0.009	0.00025	0.022	0.01960526	0.0047	0.00025	0.020
EIM	Meas 4	0.01960526	0.0073	0.00025	0.021	0.01960526	0.0076	0.00025	0.021
iNRiM	Meas 1	0.02059213	0.003	0.000288	0.021	0.02059213	0.002	0.000288	0.021
iNRiM	Meas 2	0.02059213	0.004	0.000288	0.021	0.02059213	0.003	0.000288	0.021
iNRiM	Meas 3	0.02059213	0.003	0.000288	0.021	0.02059213	0.003	0.000288	0.021
iNRiM	Meas 4	0.02059213	0.003	0.000288	0.021	0.02059213	0.003	0.000288	0.021
PTB	Meas 1	0.015	0.0009	0	0.015	0.015	0.0011	0	0.015
PTB	Meas 2	0.015	0.0008	0	0.015	0.015	0.0011	0	0.015
PTB	Meas 3	0.015	0.0008	0	0.015	0.015	0.0009	0	0.015
PTB	Meas 4	0.015	0.0011	0	0.015	0.015	0.0011	0	0.015
MIRS-FE-I	Meas 1	0.01355871	0.001231	0	0.014	0.01355871	0.003028	0	0.014
MIRS-FE-I	Meas 2	0.01355871	0.000988	0	0.014	0.01355871	0.001962	0	0.014
MIRS-FE-I	Meas 3	0.01355871	0.00228	0	0.014	0.01355871	0.002776	0	0.014
MIRS-FE-I	Meas 4	0.01355871	0.001083	0	0.014	0.01355871	0.002309	0	0.014
LPM	Meas 1	0.04836085	0.00386672	0	0.049	0.04836085	0.00545997	0	0.049
LPM	Meas 2	0.04836085	0.00233716	0	0.048	0.04836085	0.00386672	0	0.049
LPM									
LPM									
UME	Meas 1	0.02291488	0.00307318	0.00288675	0.023	0.02291488	0.00307318	0.00288675	0.023
UME	Meas 2	0.02291488	0.00924362	0.00288675	0.025	0.02291488	0.0069602	0.00288675	0.024
UME	Meas 3	0.02291488	0.00686375	0.00288675	0.024	0.02291488	0.00640312	0.00288675	0.024
UME	Meas 4	0.02291488	0.00163299	0.00288675	0.023	0.02291488	0.002	0.00288675	0.023
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2									
INTA2									
INTA2									
INTA2									

Measurement point: +1 °C

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
NMi-VSL1	Meas 1	0.01776229	0.00210307	0	0.018	0.01776229	0.00200277	0	0.018
NMi-VSL1	Meas 2	0.01776229	0.00324423	0	0.018	0.01776229	0.00202776	0	0.018
NMi-VSL1	Meas 3	0.01776229	0.00177952	0	0.018	0.01776229	0.0026989	0	0.018
NMi-VSL1	Meas 4	0.01776229	0.00224784	0	0.018	0.01776229	0.00240716	0	0.018
CETIAT	Meas 1	0.01585814	0.00228157	0	0.016	0.01585814	0.00131762	0	0.016
CETIAT	Meas 2	0.01585814	0.00448113	0	0.016	0.01585814	0.00403595	0	0.016
CETIAT	Meas 3	0.01585814	0.0023701	0	0.016	0.01585814	0.00237522	0	0.016
CETIAT	Meas 4	0.01585814	0.0014376	0	0.016	0.01585814	0.00132522	0	0.016
INTA	Meas 1	0.025	0.00526525	0	0.026	0.025	0.00469049	0	0.025
INTA	Meas 2	0.025	0.00541821	0	0.026	0.025	0.00508755	0	0.026
INTA	Meas 3	0.025	0.00598091	0	0.026	0.025	0.00524747	0	0.026
INTA	Meas 4	0.025	0.00535353	0	0.026	0.025	0.00652916	0	0.026
IPQ	Meas 1	0.17046116	0.00568652	8.0188E-06	0.171	0.17046116	0.00864389	8.0188E-06	0.171
IPQ	Meas 2	0.17046116	0.00653323	8.0188E-06	0.171	0.17046116	0.00517505	8.0188E-06	0.171
IPQ	Meas 3	0.17046116	0.00522803	8.0188E-06	0.171	0.17046116	0.00902594	8.0188E-06	0.171
IPQ	Meas 4	0.17046116	0.00533993	8.0188E-06	0.171	0.17046116	0.00878509	8.0188E-06	0.171
EIM	Meas 1	0.02117159	0.0043	0.00025	0.022	0.02117159	0.0045	0.00025	0.022
EIM	Meas 2	0.02117159	0.0038	0.00025	0.022	0.02117159	0.0032	0.00025	0.021
EIM	Meas 3	0.02117159	0.0033	0.00025	0.021	0.02117159	0.0034	0.00025	0.021
EIM	Meas 4	0.02117159	0.0046	0.00025	0.022	0.02117159	0.0052	0.00025	0.022
iNRiM	Meas 1	0.01911935	0.003	0.000288	0.019	0.01911935	0.008	0.000288	0.021
iNRiM	Meas 2	0.01911935	0.005	0.000288	0.020	0.01911935	0.008	0.000288	0.021
iNRiM	Meas 3	0.01911935	0.003	0.000288	0.019	0.01911935	0.008	0.000288	0.021
iNRiM	Meas 4	0.01911935	0.003	0.000288	0.019	0.01911935	0.01	0.000288	0.022
PTB	Meas 1	0.015	0.0005	0	0.015	0.015	0.0003	0	0.015
PTB	Meas 2	0.015	0.0006	0	0.015	0.015	0.0005	0	0.015
PTB	Meas 3	0.015	0.0006	0	0.015	0.015	0.0006	0	0.015
PTB	Meas 4	0.015	0.0006	0	0.015	0.015	0.0005	0	0.015
MIRS-FE-I	Meas 1	0.01433244	0.001112	0	0.014	0.01433244	0.001055	0	0.014
MIRS-FE-I	Meas 2	0.01433244	0.000853	0	0.014	0.01433244	0.00136	0	0.014
MIRS-FE-I	Meas 3	0.01433244	0.001544	0	0.014	0.01433244	0.002229	0	0.015
MIRS-FE-I	Meas 4	0.01433244	0.000935	0	0.014	0.01433244	0.001191	0	0.014
LPM	Meas 1	0.05575053	0.00699206	0	0.056	0.05575053	0.00516398	0	0.056
LPM	Meas 2	0.05575053	0.00699206	0	0.056	0.05575053	0.00823273	0	0.056
LPM									
LPM									
UME	Meas 1	0.02589219	0.00133333	0.00288675	0.026	0.02589219	0.002	0.00288675	0.026
UME	Meas 2	0.02589219	0.00163299	0.00288675	0.026	0.02589219	0.00179505	0.00288675	0.026
UME	Meas 3	0.02589219	0.001	0.00288675	0.026	0.02589219	0.001	0.00288675	0.026
UME	Meas 4	0.02589219	0.00152753	0.00288675	0.026	0.02589219	0.00213437	0.00288675	0.026
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2									
INTA2									
INTA2									
INTA2									

Measurement point: +20 °C

		Hygrometer 1 = 0922				Hygrometer 2 = 0923			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
NMi-VSL1	Meas 1	0.02211005	0.00143975	0	0.022	0.02211005	0.001138047	0	0.022
NMi-VSL1	Meas 2	0.02211005	0.00237244	0	0.022	0.02211005	0.002464188	0	0.022
NMi-VSL1	Meas 3	0.02211005	0.00264168	0	0.022	0.02211005	0.002379895	0	0.022
NMi-VSL1	Meas 4	0.02211005	0.00248174	0	0.022	0.02211005	0.002147518	0	0.022
CETIAT	Meas 1	0.01585814	0.01328742	0	0.021	0.01585814	0.014222341	0	0.021
CETIAT	Meas 2	0.01585814	0.00139667	0	0.016	0.01585814	0.001864319	0	0.016
CETIAT	Meas 3	0.01585814	0.00111056	0	0.016	0.01585814	0.000857965	0	0.016
CETIAT	Meas 4	0.01585814	0.00261354	0	0.016	0.01585814	0.003546914	0	0.016
INTA	Meas 1	0.025	0.00703608	0	0.026	0.025	0.006254742	0	0.026
INTA	Meas 2	0.025	0.00685884	0	0.026	0.025	0.004054726	0	0.025
INTA	Meas 3	0.025	0.00421954	0	0.025	0.025	0.006060827	0	0.026
INTA	Meas 4	0.025	0.00505992	0	0.026	0.025	0.005973872	0	0.026
IPQ	Meas 1	0.17077359	0.00427606	0.00288675	0.171	0.17077359	0.005027927	0.00288675	0.171
IPQ	Meas 2	0.17077359	0.00861893	0.00288675	0.171	0.17077359	0.010636495	0.00288675	0.171
IPQ	Meas 3	0.17077359	0.01074739	0.00288675	0.171	0.17077359	0.00515314	0.00288675	0.171
IPQ	Meas 4	0.17077359	0.00864292	0.00288675	0.171	0.17077359	0.020889756	0.00288675	0.172
EIM	Meas 1	0.02254515	0.0016	0.00025	0.023	0.02254515	0.0029	0.00025	0.023
EIM	Meas 2	0.02254515	0.0025	0.00025	0.023	0.02254515	0.0028	0.00025	0.023
EIM	Meas 3	0.02254515	0.0032	0.00025	0.023	0.02254515	0.0027	0.00025	0.023
EIM	Meas 4	0.02254515	0.003	0.00025	0.023	0.02254515	0.0041	0.00025	0.023
iNRiM	Meas 1	0.0209972	0.005	0.000288	0.022	0.0209972	0.005	0.000288	0.022
iNRiM	Meas 2	0.0209972	0.005	0.000288	0.022	0.0209972	0.005	0.000288	0.022
iNRiM	Meas 3	0.0209972	0.005	0.000288	0.022	0.0209972	0.005	0.000288	0.022
iNRiM	Meas 4	0.0209972	0.005	0.000288	0.022	0.0209972	0.008	0.000288	0.022
PTB	Meas 1	0.015	0.0002	0	0.015	0.015	0.0002	0	0.015
PTB	Meas 2	0.015	0.0005	0	0.015	0.015	0.0005	0	0.015
PTB	Meas 3	0.015	0.0003	0	0.015	0.015	0.0003	0	0.015
PTB	Meas 4	0.015	0.0003	0	0.015	0.015	0.0003	0	0.015
MIRS-FE-L	Meas 1	0.01494725	0.001734	0	0.015	0.01494725	0.001552	0	0.015
MIRS-FE-L	Meas 2	0.01494725	0.00377	0	0.015	0.01494725	0.003051	0	0.015
MIRS-FE-L	Meas 3	0.01494725	0.001744	0	0.015	0.01494725	0.001716	0	0.015
MIRS-FE-L	Meas 4	0.01494725	0.001002	0	0.015	0.01494725	0.000915	0	0.015
LPM	Meas 1	0.06102132	0.00185041	0	0.061	0.06102132	0.033385594	0	0.070
LPM	Meas 2	0.06102132	0.00193532	0	0.061	0.06102132	0.055963461	0	0.083
LPM	Meas 3	0.06102132	0.00195834	0	0.061	0.06102132	0.013880778	0	0.063
LPM	Meas 4	0.06102132	0.00185775	0	0.061	0.06102132	0.001482528	0	0.061
UME	Meas 1	0.03253694	0.001	0.00288675	0.033	0.03253694	0.001	0.00288675	0.033
UME	Meas 2	0.03253694	0	0.00288675	0.033	0.03253694	1.18424E-15	0.00288675	0.033
UME	Meas 3	0.03253694	0.00406885	0.00288675	0.033	0.03253694	0.001527525	0.00288675	0.033
UME	Meas 4	0.03253694	0.00316228	0.00288675	0.033	0.03253694	1.18424E-15	0.00288675	0.033
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
NMi-VSL2									
INTA2									
INTA2									
INTA2									
INTA2									

Loop 3 / Estimates

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
Lab		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
METAS1	Meas 1	-49.838693	80.503864	-49.502428	0.3362651	-49.838693	80.513884	-49.4772	0.3614931
METAS1	Meas 2	-50.015688	80.398313	-49.76824	0.2474481	-50.015688	80.435213	-49.67532	0.3403681
METAS1	Meas 3	-50.107174	80.339843	-49.9155	0.1916741	-50.107174	80.375163	-49.82655	0.2806241
METAS1	Meas 4	-49.982493	80.421663	-49.709445	0.2730479	-49.982493	80.427673	-49.69431	0.2881829
NPL1	Meas 1	-50.093142	80.27808	-50.07102	0.022122	-50.093142	80.26274	-50.10964	-0.016498
NPL1	Meas 2	-49.902422	80.36454	-49.8533	0.049122	-49.902422	80.34662	-49.89843	0.003992
NPL1	Meas 3	-49.977273	80.33169	-49.93602	0.041253	-49.977273	80.31726	-49.97236	0.004913
NPL1	Meas 4	-50.026654	80.30885	-49.99354	0.033114	-50.026654	80.29101	-50.038402	-0.011748
GUM	Meas 1	-50.024	80.3133	-49.982	0.042	-50.024	80.2936	-50.032	-0.008
GUM	Meas 2	-50.023	80.3054	-50.002	0.021	-50.023	80.2797	-50.067	-0.044
GUM	Meas 3	-50.027	80.3376	-49.921	0.106	-50.027	80.3156	-49.977	0.05
GUM	Meas 4	-50.027	80.2978	-50.021	0.006	-50.027	80.274	-50.081	-0.054
CMI	Meas 1	-49.87	80.391	-49.79	0.08	-49.87	80.386	-49.8	0.07
CMI	Meas 2	-49.86	80.354	-49.88	-0.02	-49.86	80.371	-49.84	0.02
CMI	Meas 3	-49.99	80.352	-49.88	0.11	-49.99	80.301	-50.01	-0.02
CMI	Meas 4	-49.96	80.343	-49.91	0.05	-49.96	80.302	-50.01	-0.05
MKEH	Meas 1	-50.29	80.2351	-50.179	0.111	-50.29	80.2193	-50.219	0.071
MKEH	Meas 2	-49.517	80.5378	-49.417	0.1	-49.517	80.5163	-49.471	0.046
MKEH	Meas 3	-49.755	80.454	-49.628	0.127	-49.755	80.4251	-49.701	0.054
MKEH	Meas 4	-49.909	80.3833	-49.803	0.106	-49.909	80.3496	-49.891	0.018
SMU	Meas 1	-51.023	79.979391	-50.82302	0.19998	-51.023	79.98372	-50.81211	0.21089
SMU	Meas 2	-51.006	79.891121	-51.04522	-0.03922	-51.006	79.919195	-50.97454	0.03146
SMU	Meas 3	-50.967	80.045427	-50.65678	0.31022	-50.967	80.023931	-50.71089	0.25611
SMU	Meas 4	-51.018	80.06761	-50.60092	0.41708	-51.018	79.998689	-50.77443	0.24357
BEV	Meas 1	-49.989493	80.337595	-49.920988	0.0685051	-49.989493	80.317931	-49.970818	0.0186756
BEV	Meas 2	-49.987137	80.338309	-49.919415	0.0677224	-49.987137	80.321181	-49.962425	0.0247117
BEV	Meas 3	-49.99726	80.341895	-49.910498	0.086762	-49.99726	80.324052	-49.955082	0.0421777
BEV	Meas 4	-50.000607	80.341509	-49.911284	0.0893226	-50.000607	80.325381	-49.951935	0.0486723
NML									
NML									
NML									
NML									
INTA	Meas 1	-50.01174	80.313049	-49.982961	0.0287792	-50.01174	80.304643	-50.004128	0.0076117
INTA	Meas 2	-50.011399	80.313062	-49.982928	0.0284705	-50.011399	80.30462	-50.004185	0.007214
INTA	Meas 3	-50.011132	80.312978	-49.983139	0.027993	-50.011132	80.306059	-50.000562	0.0105698
INTA	Meas 4	-50.012149	80.312794	-49.983601	0.0285478	-50.012149	80.304059	-50.005598	0.0065503
iNRiM	Meas 1	-50.15	80.25956	-50.1175	0.0325	-50.15	80.273228	-50.0833	0.0667
iNRiM	Meas 2	-50.154674	80.256836	-50.1246	0.0300736	-50.154674	80.282192	-50.0606	0.0940736
iNRiM	Meas 3	-50.19566	80.22861	-50.1956	5.952E-05	-50.19566	80.213071	-50.2346	-0.0389405
iNRiM	Meas 4	-50.199343	80.239058	-50.169	0.030343	-50.199343	80.224835	-50.205	-0.005657
METAS2	Meas 1	-50.027217	80.376006	-49.824425	0.2027925	-50.027217	80.363174	-49.856739	0.1704785
METAS2	Meas 2	-50.215875	80.32255	-49.959035	0.25684	-50.215875	80.322325	-49.959603	0.256272
METAS2	Meas 3	-49.9385	80.41245	-49.732647	0.205853	-49.9385	80.43465	-49.67674	0.26176
METAS2	Meas 4	-49.94675	80.3854	-49.800768	0.145982	-49.94675	80.372105	-49.834248	0.112502
NPL2	Meas 1	-49.973432	80.33335	-49.93184	0.041592	-49.973432	80.30878	-49.9937	-0.020268
NPL2	Meas 4	-49.912874	80.34757	-49.85692	0.055954	-49.912874	80.34757	-49.89603	0.016844
NPL2	Meas 5	-49.902861	80.36658	-49.84816	0.054701	-49.902861	80.350323	-49.8891	0.013761
NPL2	Meas 6	-49.983638	80.33554	-49.92632	0.057318	-49.983638	80.32041	-49.96443	0.019208

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
METAS1	Meas 1	-30.124946	88.20537	-30.04129	0.0836562	-30.124946	88.21444	-30.018295	0.1066512
METAS1	Meas 2	-30.192958	88.18798	-30.085375	0.1075833	-30.192958	88.19943	-30.056347	0.1366113
METAS1	Meas 3	-30.154941	88.18311	-30.09772	0.0572205	-30.154941	88.19679	-30.06304	0.0919005
METAS1	Meas 4	-30.316148	88.1011	-30.305615	0.0105333	-30.316148	88.11494	-30.270533	0.0456153
NPL1	Meas 1	-29.9256	88.25482	-29.9159	0.0097	-29.9256	88.24652	-29.937	-0.0114
NPL1	Meas 2	-29.8904	88.26391	-29.89287	-0.00247	-29.8904	88.25207	-29.9229	-0.0325
NPL1	Meas 3	-30.1777	88.157008	-30.1639	0.0138	-30.1777	88.14845	-30.186	-0.0083
NPL1	Meas 4	-30.1217	88.17648	-30.1145	0.0072	-30.1217	88.1677	-30.1368	-0.0151
GUM	Meas 1	-30.029	88.2432	-29.945	0.084	-30.029	88.1878	-30.086	-0.057
GUM	Meas 2	-30.028	88.2481	-29.933	0.095	-30.028	88.1898	-30.081	-0.053
GUM	Meas 3	-30.033	88.247	-29.936	0.097	-30.033	88.19	-30.08	-0.047
GUM	Meas 4	-30.031	88.243	-29.946	0.085	-30.031	88.1908	-30.078	-0.047
CMI	Meas 1	-29.81	88.255	-29.92	-0.11	-29.81	88.246	-29.94	-0.13
CMI	Meas 2	-29.94	88.194	-30.07	-0.13	-29.94	88.186	-30.09	-0.15
CMI	Meas 3	-29.91	88.205	-30.04	-0.13	-29.91	88.195	-30.07	-0.16
CMI	Meas 4	-29.99	88.172	-30.13	-0.14	-29.99	88.157	-30.16	-0.17
MKEH	Meas 1	-29.965	88.2599	-29.903	0.062	-29.965	88.2449	-29.941	0.024
MKEH	Meas 2	-30.14	88.1886	-30.084	0.056	-30.14	88.1745	-30.12	0.02
MKEH	Meas 3	-30.236	88.1441	-30.197	0.039	-30.236	88.1316	-30.228	0.008
MKEH	Meas 4	-30.055	88.2151	-30.017	0.038	-30.055	88.203	-30.047	0.008
SMU	Meas 1	-29.626	88.336346	-29.70921	-0.08321	-29.626	88.340959	-29.69753	-0.07153
SMU	Meas 2	-29.906	88.26223	-29.89714	0.00886	-29.906	88.255543	-29.9141	-0.0081
SMU	Meas 3	-29.628	88.360331	-29.64842	-0.02042	-29.628	88.355432	-29.66084	-0.03284
SMU	Meas 4	-29.651	88.355783	-29.65995	-0.00895	-29.651	88.34633	-29.68392	-0.03292
BEV	Meas 1	-30.009789	88.233816	-29.969263	0.0405254	-30.009789	88.222545	-29.997587	0.0122013
BEV	Meas 2	-30.01893	88.229631	-29.979753	0.0391766	-30.01893	88.21896	-30.007029	0.0119015
BEV	Meas 3	-29.985757	88.246459	-29.937267	0.0484898	-29.985757	88.235673	-29.964542	0.0212147
BEV	Meas 4	-30.00085	88.240731	-29.951429	0.0494203	-30.00085	88.230074	-29.978704	0.0221453
NML									
NML									
NML									
NML									
INTA	Meas 1	-30.002592	88.223331	-29.995755	0.0068371	-30.002592	88.217817	-30.009733	-0.0071411
INTA	Meas 2	-30.001737	88.223213	-29.996055	0.0056828	-30.001737	88.218156	-30.008875	-0.0071378
INTA	Meas 3	-30.000957	88.223276	-29.995894	0.0050623	-30.000957	88.218447	-30.008137	-0.0071806
INTA	Meas 4	-30.001621	88.223033	-29.996511	0.0051103	-30.001621	88.218351	-30.008381	-0.0067591
iNRiM	Meas 1	-30.172239	88.152695	-30.1748	-0.002561	-30.172239	88.162918	-30.1489	0.023339
iNRiM	Meas 2	-30.172618	88.153664	-30.1723	0.0003182	-30.172618	88.165332	-30.1429	0.0297182
iNRiM	Meas 3	-30.201615	88.143489	-30.1981	0.0035149	-30.201615	88.155423	-30.168	0.0336149
iNRiM	Meas 4	-30.200738	88.142846	-30.1999	0.0008385	-30.200738	88.1566	-30.1649	0.0358385
METAS2	Meas 1	-30.13445	88.17205	-30.125758	0.008692	-30.13445	88.15315	-30.17367	-0.03922
METAS2	Meas 2	-30.1865	88.17555	-30.116885	0.069615	-30.1865	88.16955	-30.132095	0.054405
METAS2	Meas 3	-30.1028	88.199235	-30.056841	0.045959	-30.1028	88.19029	-30.079519	0.023281
METAS2	Meas 4	-30.083	88.1915	-30.076452	0.006548	-30.083	88.17418	-30.120359	-0.037359
NPL2	Meas 1	-30.25042	88.12756	-30.23855	0.01187	-30.25042	88.11938	-30.25928	-0.00886
NPL2	Meas 2	-30.329074	88.09849	-30.31223	0.016844	-30.329074	88.08689	-30.34164	-0.012566
NPL2	Meas 3	-30.258149	88.1268	-30.24047	0.017679	-30.258149	88.11718	-30.26485	-0.006701
NPL2	Meas 4	-30.032448	88.21348	-30.02073	0.011718	-30.032448	88.20036	-30.054	-0.021552

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
METAS1	Meas 1	-10.123615	96.026706	-10.150948	-0.0273327	-10.123615	96.028536	-10.14628	-0.0226651
METAS1	Meas 2	-10.157415	96.024246	-10.157224	0.0001911	-10.157415	96.024436	-10.15674	0.0006751
METAS1	Meas 3	-10.107926	96.035337	-10.128932	-0.0210063	-10.107926	96.038797	-10.120105	-0.0121793
METAS1	Meas 4	-10.126085	96.019876	-10.16837	-0.0422846	-10.126085	96.025056	-10.155157	-0.0290716
NPL1	Meas 1	-10.0304	96.0644	-10.0549	-0.0245	-10.0304	96.06329	-10.0578	-0.0274
NPL1	Meas 2	-10.0507	96.05794	-10.0714	-0.0207	-10.0507	96.05625	-10.0757	-0.025
NPL1	Meas 3	-10.26866	95.97427	-10.2848	-0.01614	-10.26866	95.97164	-10.291	-0.02234
NPL1	Meas 4	-9.84	96.13364	-9.878	-0.038	-9.84	96.13164	-9.883	-0.043
GUM	Meas 1	-10.095	96.041	-10.115	-0.02	-10.095	96.0319	-10.138	-0.043
GUM	Meas 2	-10.095	96.0405	-10.116	-0.021	-10.095	96.03	-10.143	-0.048
GUM	Meas 3	-10.093	96.042	-10.112	-0.019	-10.093	96.0321	-10.137	-0.044
GUM	Meas 4	-10.094	96.0392	-10.119	-0.025	-10.094	96.0309	-10.14	-0.046
CMI	Meas 1	-8.69	96.575	-8.75	-0.06	-8.69	96.573	-8.76	-0.07
CMI	Meas 2	-8.02	96.832	-8.1	-0.08	-8.02	96.833	-8.09	-0.07
CMI	Meas 3	-8.65	96.588	-8.72	-0.07	-8.65	96.587	-8.72	-0.07
CMI	Meas 4	-8.55	96.629	-8.61	-0.06	-8.55	96.629	-8.61	-0.06
MKEH	Meas 1	-10.1	96.0473	-10.098	0.002	-10.1	96.0318	-10.113	-0.013
MKEH	Meas 2	-10.001	96.0761	-10.025	-0.024	-10.001	96.0706	-10.039	-0.038
MKEH	Meas 3	-9.502	96.2751	-9.517	-0.015	-9.502	96.2733	-9.522	-0.02
MKEH	Meas 4	-10.222	95.9979	-10.22	0.002	-10.222	95.9927	-10.212	0.01
SMU	Meas 1	-10.396	95.92103	-10.42051	-0.02451	-10.396	95.9194	-10.42467	-0.02867
SMU	Meas 2	-10.276	95.990761	-10.24264	0.03336	-10.276	95.988078	-10.24948	0.02652
SMU	Meas 3	-10.372	95.952186	-10.34102	0.03098	-10.372	95.953148	-10.33858	0.03342
SMU	Meas 4	-10.255	96.002092	-10.21374	0.04126	-10.255	95.998407	-10.22313	0.03187
BEV	Meas 1	-10.006545	96.084781	-10.002851	0.0036931	-10.006545	96.082232	-10.009146	-0.0026012
BEV	Meas 2	-9.9774134	96.096153	-9.9740028	0.0034106	-9.9774134	96.093596	-9.9802971	-0.0028837
BEV	Meas 3	-10.049415	96.072253	-10.034847	0.014568	-10.049415	96.06921	-10.042715	0.0067001
BEV	Meas 4	-9.9807211	96.099103	-9.966135	0.014586	-9.9807211	96.096253	-9.9734783	0.0072428
NML	Meas 1	-9.946	96.08971	-9.99	-0.044	-9.946	96.08717	-9.997	-0.051
NML	Meas 2	-9.949	96.08912	-9.992	-0.043	-9.949	96.08557	-10.001	-0.052
NML	Meas 3	-9.944	96.08938	-9.991	-0.047	-9.944	96.08854	-9.993	-0.049
NML	Meas 4	-9.952	96.08765	-9.996	-0.044	-9.952	96.08584	-10	-0.048
INTA	Meas 1	-9.9896341	96.086455	-9.9985306	-0.0088965	-9.9896341	96.086445	-9.9985561	-0.008922
INTA	Meas 2	-9.9848699	96.088207	-9.9940602	-0.0091903	-9.9848699	96.088205	-9.9940657	-0.0091958
INTA	Meas 3	-9.9835879	96.088472	-9.993385	-0.0097971	-9.9835879	96.088434	-9.9934831	-0.0098953
INTA	Meas 4	-9.9827577	96.088153	-9.9941995	-0.0114418	-9.9827577	96.088153	-9.9941995	-0.0114418
iNRiM	Meas 1	-9.9724845	96.087544	-9.9959	-0.0234155	-9.9724845	96.085704	-10.0005	-0.0280155
iNRiM	Meas 2	-9.9816376	96.082528	-10.0086	-0.0269624	-9.9816376	96.080907	-10.0127	-0.0310624
iNRiM	Meas 3	-9.9862017	96.080997	-10.0125	-0.0262983	-9.9862017	96.078969	-10.0176	-0.0313983
iNRiM	Meas 4	-10.056107	96.055458	-10.0775	-0.0213929	-10.056107	96.052235	-10.0859	-0.0297929
METAS2	Meas 1	-10.17455	95.9984	-10.223153	-0.048603	-10.17455	95.9927	-10.237693	-0.063143
METAS2	Meas 2	-10.2357	95.99085	-10.242413	-0.006713	-10.2357	95.9903	-10.243815	-0.008115
METAS2	Meas 3	-10.10115	96.040255	-10.116385	-0.015235	-10.10115	96.034805	-10.130289	-0.029139
METAS2	Meas 4	-10.143	96.0175	-10.174433	-0.0314325	-10.143	96.0104	-10.192544	-0.049544
NPL2	Meas 1	-9.93098	96.10375	-9.9544	-0.02342	-9.93098	96.10005	-9.96385	-0.03287
NPL2	Meas 2	-9.80083	96.15784	-9.81642	-0.01559	-9.80083	96.15373	-9.8269	-0.02607
NPL2	Meas 3	-9.7667691	96.16783	-9.79093	-0.0241609	-9.7667691	96.1631	-9.803	-0.0362309
NPL2	Meas 4	-9.7604682	96.17284	-9.77815	-0.0176818	-9.7604682	96.16799	-9.79052	-0.0300518

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
METAS1	Meas 1	0.8008623	100.29991	0.7674556	-0.0334067	0.8008623	100.29018	0.742555	-0.0583073
METAS1	Meas 2	1.0215023	100.38756	0.99178	-0.0297223	1.0215023	100.38285	0.979726	-0.0417763
METAS1	Meas 3	0.9841272	100.36196	0.92626	-0.0578672	0.9841272	100.36402	0.931533	-0.0525942
METAS1	Meas 4	0.8802869	100.31482	0.805615	-0.0746719	0.8802869	100.31661	0.810195	-0.0700919
NPL1	Meas 1	1.157	100.4354	1.114	-0.043	1.157	100.43722	1.11888	-0.03812
NPL1	Meas 2	1.189	100.44756	1.145	-0.044	1.189	100.44927	1.15	-0.039
NPL1	Meas 3	0.9309	100.34656	0.887	-0.0439	0.9309	100.34581	0.885	-0.0459
NPL1	Meas 4	0.8825	100.3246	0.831	-0.0515	0.8825	100.32226	0.825	-0.0575
GUM	Meas 1	1.06	100.3927	1.005	-0.055	1.06	100.3869	0.99	-0.07
GUM	Meas 2	1.061	100.3946	1.01	-0.051	1.061	100.3856	0.987	-0.074
GUM	Meas 3	1.064	100.4069	1.041	-0.023	1.064	100.4036	1.033	-0.031
GUM	Meas 4	1.065	100.4063	1.04	-0.025	1.065	100.4025	1.03	-0.035
CMI	Meas 1	7.11	102.756	7.06	-0.05	7.11	102.75	7.04	-0.07
CMI	Meas 2	7.37	102.863	7.33	-0.04	7.37	102.863	7.33	-0.04
CMI	Meas 3	7.19	102.792	7.15	-0.04	7.19	102.793	7.15	-0.04
CMI	Meas 4	7.42	102.885	7.39	-0.03	7.42	102.882	7.38	-0.04
MKEH	Meas 1	1.388	100.5118	1.31	-0.078	1.388	100.5105	1.307	-0.081
MKEH	Meas 2	1.401	100.518	1.326	-0.075	1.401	100.5177	1.325	-0.076
MKEH	Meas 3	0.953	100.3324	0.851	-0.102	0.953	100.3316	0.849	-0.104
MKEH	Meas 4	1.37	100.5028	1.287	-0.083	1.37	100.5033	1.288	-0.082
SMU	Meas 1	0.844	100.2972	0.76052	-0.08348	0.844	100.2968	0.75949	-0.08451
SMU	Meas 2	0.89	100.33938	0.86847	-0.02153	0.89	100.34445	0.88144	-0.00856
SMU	Meas 3	0.995	100.36178	0.9258	-0.0692	0.995	100.36645	0.93775	-0.05725
SMU	Meas 4	0.828	100.29618	0.75791	-0.07009	0.828	100.29587	0.75711	-0.07089
BEV	Meas 1	1.0279849	100.40059	1.0251338	-0.0028511	1.0279849	100.40211	1.0290094	0.0010246
BEV	Meas 2	1.0987254	100.42915	1.0982233	-0.0005021	1.0987254	100.43103	1.1030497	0.0043243
BEV	Meas 3	1.0079483	100.3967	1.0151705	0.0072222	1.0079483	100.39762	1.0175288	0.0095805
BEV	Meas 4	1.0122297	100.39861	1.0200699	0.0078402	1.0122297	100.39964	1.0226841	0.0104544
NML	Meas 1	1.039	100.38713	0.991	-0.048	1.039	100.38531	0.986	-0.053
NML	Meas 2	1.037	100.38423	0.983	-0.054	1.037	100.38299	0.98	-0.057
NML	Meas 3	1.032	100.38125	0.976	-0.056	1.032	100.38241	0.979	-0.053
NML	Meas 4	1.035	100.38254	0.979	-0.056	1.035	100.38358	0.982	-0.053
INTA	Meas 1	1.0114763	100.38289	0.979824	-0.0316523	1.0114763	100.38509	0.9854616	-0.0260147
INTA	Meas 2	1.0120341	100.38312	0.9804235	-0.0316106	1.0120341	100.38488	0.9849106	-0.0271234
INTA	Meas 3	1.011515	100.38296	0.9799964	-0.0315187	1.011515	100.385	0.9852153	-0.0262997
INTA	Meas 4	1.0115008	100.38315	0.9804883	-0.0310125	1.0115008	100.38523	0.9858237	-0.0256772
iNRiM	Meas 1	1.0283417	100.38078	0.9745	-0.0538417	1.0283417	100.38927	0.9962	-0.0321417
iNRiM	Meas 2	1.0263448	100.38007	0.9727	-0.0536448	1.0263448	100.38755	0.9916	-0.0347448
iNRiM	Meas 3	1.0268676	100.38026	0.9732	-0.0536676	1.0268676	100.38819	0.9934	-0.0334676
iNRiM	Meas 4	1.0279115	100.37716	0.9653	-0.0626115	1.0279115	100.38856	0.9944	-0.0335115
METAS2	Meas 1	0.96905	100.36815	0.9421	-0.02695	0.96905	100.3686	0.943253	-0.025797
METAS2	Meas 2	0.9168	100.3435	0.879016	-0.037784	0.9168	100.34185	0.87479	-0.04201
METAS2	Meas 3	0.84305	100.3139	0.80326	-0.03979	0.84305	100.30591	0.78281	-0.06024
METAS2	Meas 4	0.9145	100.3366	0.861354	-0.053146	0.9145	100.3326	0.85112	-0.06338
NPL2	Meas 1	1.072445	100.39002	0.9938	-0.078645	1.072445	100.38835	0.998074	-0.074371
NPL2	Meas 2	1.2801728	100.49126	1.2572	-0.0229728	1.2801728	100.49107	1.25671	-0.0234628
NPL2									
NPL2									

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C	Applied dew point (°C)	Resistance output (ohms)	Output in °C	Difference (meas dp - applied dp) in °C
METAS1	Meas 1	20.043468	107.79152	19.994205	-0.0492628	20.043468	107.78496	19.977322	-0.0661458
METAS1	Meas 2	19.966739	107.77323	19.947134	-0.0196055	19.966739	107.76097	19.915582	-0.0511575
METAS1	Meas 3	19.944882	107.7494	19.885805	-0.0590766	19.944882	107.74578	19.87649	-0.0683916
METAS1	Meas 4	19.968642	107.76008	19.913291	-0.055351	19.968642	107.7551	19.900475	-0.0681673
NPL1	Meas 1	20.172	107.84504	20.133	-0.039	20.172	107.85571	20.16	-0.012
NPL1	Meas 2	20.182	107.84563	20.134	-0.048	20.182	107.85405	20.156	-0.026
NPL1	Meas 3	20.228	107.86003	20.171	-0.057	20.228	107.86718	20.19	-0.038
NPL1	Meas 4	19.853	107.72479	19.823	-0.03	19.853	107.73157	19.841	-0.012
GUM	Meas 1	19.992	107.7682	19.935	-0.057	19.992	107.7727	19.946	-0.046
GUM	Meas 2	19.993	107.7687	19.936	-0.057	19.993	107.7727	19.946	-0.047
GUM	Meas 3	19.994	107.7707	19.941	-0.053	19.994	107.7741	19.950123	-0.0438774
GUM	Meas 4	19.994	107.7709	19.942	-0.052	19.994	107.7742	19.950389	-0.043611
CMI	Meas 1	18.93	107.395	18.97	0.04	18.64	107.276	18.67	0.03
CMI	Meas 2	18.71	107.291	18.71	0	18.93	107.384	18.95	0.02
CMI	Meas 3	18.68	107.287	18.7	0.02	18.65	107.274	18.66	0.01
CMI	Meas 4	18.75	107.314	18.77	0.02	18.94	107.388	18.96	0.02
MKEH	Meas 1	20.456	107.9268	20.343	-0.113	20.456	107.9373	20.37	-0.086
MKEH	Meas 2	19.78	107.6716	19.686	-0.094	19.78	107.6812	19.711	-0.069
MKEH	Meas 3	19.798	107.6799	19.708	-0.09	19.798	107.6889	19.731	-0.067
MKEH	Meas 4	20.4	107.9086	20.296	-0.104	20.4	107.9211	20.328	-0.072
SMU	Meas 1	20.284	107.83205	20.09922	-0.18478	20.074	107.83694	20.11181	0.03781
SMU	Meas 2	20.3545	107.86504	20.18414	-0.17036	20.145	107.87086	20.19912	0.05412
SMU	Meas 3	20.1705	107.78584	19.98028	-0.19022	19.961	107.79094	19.99341	0.03241
SMU	Meas 4	20.233	107.81393	20.05258	-0.18042	20.023	107.83375	20.1036	0.0806
BEV	Meas 1	20.059219	107.80979	20.04194	-0.0172792	20.059219	107.81977	20.067623	0.0084043
BEV	Meas 2	20.016503	107.79297	19.998626	-0.0178767	20.016503	107.80351	20.025762	0.0092588
BEV	Meas 3	19.978047	107.78406	19.975701	-0.0023463	19.978047	107.7944	20.002321	0.0242743
BEV	Meas 4	19.983057	107.78612	19.981014	-0.0020428	19.983057	107.79729	20.009749	0.026692
NML	Meas 1	20.037	107.79266	19.998	-0.039	20.037	107.79536	20.005	-0.032
NML	Meas 2	20.034	107.78153	19.969	-0.065	20.034	107.78814	19.986	-0.048
NML	Meas 3	20.029	107.78406	19.976	-0.053	20.029	107.78929	19.989	-0.04
NML	Meas 4	20.032	107.78301	19.973	-0.059	20.032	107.7922	19.997	-0.035
INTA	Meas 1	19.997281	107.777	19.957537	-0.0397441	19.997281	107.78678	19.982716	-0.0145651
INTA	Meas 2	19.997903	107.77677	19.956932	-0.040971	19.997903	107.78678	19.982699	-0.0152045
INTA	Meas 3	19.99773	107.77689	19.957244	-0.0404866	19.99773	107.78634	19.981564	-0.0161663
INTA	Meas 4	19.997892	107.77689	19.957252	-0.0406399	19.997892	107.78633	19.981537	-0.0163551
iNRiM	Meas 1	19.978737	107.75927	19.912	-0.0667368	19.978737	107.77764	19.9591	-0.0196368
iNRiM	Meas 2	19.976935	107.76083	19.9158	-0.061135	19.976935	107.77864	19.9617	-0.015235
iNRiM	Meas 3	19.9779	107.76108	19.9166	-0.0613	19.9779	107.77989	19.965	-0.0129
iNRiM	Meas 4	19.9758	107.76287	19.9212	-0.0546	19.9758	107.78049	19.9665	-0.0093
METAS2	Meas 1	19.9428	107.75315	19.89545	-0.04735	19.9428	107.75875	19.9099	-0.0329
METAS2	Meas 2	19.90955	107.73875	19.8584	-0.05115	19.90955	107.74245	19.86795	-0.0416
METAS2	Meas 3	19.836	107.70455	19.7704	-0.0656	19.836	107.7092	19.78235	-0.05365
METAS2	Meas 4	19.8847	107.731	19.83845	-0.04625	19.8847	107.7298	19.835375	-0.049325
NPL2	Meas 1	19.707121	107.66522	19.66984	-0.037281	19.707121	107.67057	19.68361	-0.023511
NPL2	Meas 2	19.499158	107.58526	19.46406	-0.035098	19.499158	107.59138	19.47981	-0.019348
NPL2									
NPL2									

Loop 3 / Uncertainties

Measurement point: -50 °C

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
METAS1	Meas 1	0.13272362	0.0065579	0	0.133	0.1327236	0.0054146	0	0.133
METAS1	Meas 2	0.13272362	0.0076552	0	0.133	0.1327236	0.0077256	0	0.133
METAS1	Meas 3	0.13272362	0.0074011	0	0.133	0.1327236	0.0047043	0	0.133
METAS1	Meas 4	0.13272362	0.0190881	0	0.134	0.1327236	0.0180326	0	0.134
NPL1	Meas 1	0.02	0.00585	0	0.021	0.02	0.00734	0	0.021
NPL1	Meas 2	0.02	0.0117	0	0.023	0.02	0.0135	0	0.024
NPL1	Meas 3	0.02	0.0044	0	0.020	0.02	0.00443	0	0.020
NPL1	Meas 4	0.02	0.006	0	0.021	0.02	0.0044	0	0.020
GUM	Meas 1	0.03184397	0.0005562	0	0.032	0.031844	0.00077	0	0.032
GUM	Meas 2	0.03184283	0.0008759	0	0.032	0.0318428	0.0007632	0	0.032
GUM	Meas 3	0.03184321	0.0006879	0	0.032	0.0318432	0.0007775	0	0.032
GUM	Meas 4	0.03184266	0.0007711	0	0.032	0.0318427	0.0006572	0	0.032
CMI	Meas 1	0.18	0.01	0.0014434	0.180	0.18	0.01	0.0014434	0.180
CMI	Meas 2	0.18	0.03	0.0014434	0.182	0.18	0.03	0.0014434	0.182
CMI	Meas 3	0.18	0.02	0.0014434	0.181	0.18	0.02	0.0014434	0.181
CMI	Meas 4	0.18	0.03	0.0014434	0.182	0.18	0.03	0.0014434	0.182
MKEH	Meas 1	0.025	0.016	0	0.030	0.025	0.012	0	0.028
MKEH	Meas 2	0.029	0.005	0	0.029	0.029	0.012	0	0.031
MKEH	Meas 3	0.026	0.019	0	0.032	0.026	0.012	0	0.029
MKEH	Meas 4	0.02	0.016	0	0.026	0.02	0.027	0	0.034
SMU	Meas 1	0.168	0.00342	0.009	0.168	0.168	0.00116	0.009	0.168
SMU	Meas 2	0.168	0.00128	0.009	0.168	0.168	0.00241	0.009	0.168
SMU	Meas 3	0.168	0.00213	0.009	0.168	0.168	0.00047	0.009	0.168
SMU	Meas 4	0.168	0.00143	0.009	0.168	0.168	0.00046	0.009	0.168
BEV	Meas 1	0.0113	0.0073991	0	0.014	0.0113	0.0065024	0	0.013
BEV	Meas 2	0.0113	0.0043991	0	0.012	0.0113	0.0070225	0	0.013
BEV	Meas 3	0.0108	0.0051297	0	0.012	0.0108	0.006248	0	0.012
BEV	Meas 4	0.0108	0.0059874	0	0.012	0.0108	0.0078024	0	0.013
NML									
NML									
NML									
NML									
INTA	Meas 1	0.03188101	0.0014627	0	0.032	0.031881	0.007494	0	0.033
INTA	Meas 2	0.03188101	0.0013712	0	0.032	0.031881	0.0075303	0	0.033
INTA	Meas 3	0.03188101	0.0015299	0	0.032	0.031881	0.006109	0	0.032
INTA	Meas 4	0.03188101	0.0012815	0	0.032	0.031881	0.007924	0	0.033
iNRiM	Meas 1	0.0250072	-0.006	0.000288	0.026	0.0250072	-0.0068	0.000288	0.026
iNRiM	Meas 2	0.0250072	-0.005	0.000288	0.026	0.0250072	-0.0055	0.000288	0.026
iNRiM	Meas 3	0.0250072	-0.0048	0.000288	0.025	0.0250072	-0.005	0.000288	0.026
iNRiM	Meas 4	0.0250072	-0.0069	0.000288	0.026	0.0250072	-0.0071	0.000288	0.026
METAS2	Meas 1	0.1327258	0.00775	0	0.133	0.1327258	0.0125	0	0.133
METAS2	Meas 2	0.13277659	0.01	0	0.133	0.1327766	0.0125	0	0.133
METAS2	Meas 3	0.13273827	0.005	0	0.133	0.1327383	0.005	0	0.133
METAS2	Meas 4	0.13272999	0.005	0	0.133	0.13273	0.00625	0	0.133
NPL2	Meas 1	0.02	0.019375	0	0.028	0.02	0.020179	0	0.028
NPL2	Meas 2	0.02	0.00567	0	0.021	0.02	0.00474	0	0.021
NPL2	Meas 3	0.02	0.00709	0	0.021	0.02	0.00712	0	0.021
NPL2	Meas 4	0.02	0.0352	0	0.040	0.02	0.032	0	0.038

Measurement point: -30 °C

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
METAS1	Meas 1	0.0396358	0.0097993	0	0.041	0.0396358	0.0125858	0	0.042
METAS1	Meas 2	0.0396358	0.0043067	0	0.040	0.0396358	0.0055723	0	0.040
METAS1	Meas 3	0.0396358	0.0044992	0	0.040	0.0396358	0.0048906	0	0.040
METAS1	Meas 4	0.0396358	0.0032787	0	0.040	0.0396358	0.0050202	0	0.040
NPL1	Meas 1	0.02	0.00413	0	0.020	0.02	0.00426	0	0.020
NPL1	Meas 2	0.02	0.00553	0	0.021	0.02	0.00603	0	0.021
NPL1	Meas 3	0.02	0.0031	0	0.020	0.02	0.00433	0	0.020
NPL1	Meas 4	0.02	0.00364	0	0.020	0.02	0.00402	0	0.020
GUM	Meas 1	0.0115137	0.0009693	0	0.012	0.0115137	0.0008314	0	0.012
GUM	Meas 2	0.0115133	0.000642	0	0.012	0.0115133	0.000642	0	0.012
GUM	Meas 3	0.0115078	0.0006624	0	0.012	0.0115078	0.000625	0	0.012
GUM	Meas 4	0.0115078	0.0007632	0	0.012	0.0115112	0.0007492	0	0.012
CMI	Meas 1	0.078	0.004	0.0014434	0.078	0.078	0.004	0.0014434	0.078
CMI	Meas 2	0.078	0.003	0.0014434	0.078	0.078	0.003	0.0014434	0.078
CMI	Meas 3	0.078	0.003	0.0014434	0.078	0.078	0.003	0.0014434	0.078
CMI	Meas 4	0.078	0.004	0.0014434	0.078	0.078	0.004	0.0014434	0.078
MKEH	Meas 1	0.019	0.038	0	0.042	0.019	0.034	0	0.039
MKEH	Meas 2	0.021	0.041	0	0.046	0.021	0.04	0	0.045
MKEH	Meas 3	0.013	0.005	0	0.014	0.013	0.007	0	0.015
MKEH	Meas 4	0.01	0.009	0	0.013	0.01	0.009	0	0.013
SMU	Meas 1	0.153	0.00161	0.009	0.153	0.153	0.0005	0.009	0.153
SMU	Meas 2	0.153	0.00147	0.009	0.153	0.153	0.00089	0.009	0.153
SMU	Meas 3	0.153	0.00098	0.009	0.153	0.153	0.00101	0.009	0.153
SMU	Meas 4	0.153	0.00021	0.009	0.153	0.153	0.00031	0.009	0.153
BEV	Meas 1	0.0097	0.0031102	0	0.010	0.0097	0.0032736	0	0.010
BEV	Meas 2	0.0097	0.0030076	0	0.010	0.0097	0.0029874	0	0.010
BEV	Meas 3	0.0111	0.0017204	0	0.011	0.0111	0.0017889	0	0.011
BEV	Meas 4	0.0111	0.0016783	0	0.011	0.0111	0.0018	0	0.011
NML									
NML									
NML									
NML									
INTA	Meas 1	0.0252909	0.0014258	0	0.025	0.0252909	0.0029674	0	0.025
INTA	Meas 2	0.0252909	0.0026079	0	0.025	0.0252909	0.003822	0	0.026
INTA	Meas 3	0.0252909	0.0014224	0	0.025	0.0252909	0.0039471	0	0.026
INTA	Meas 4	0.0252909	0.0015557	0	0.025	0.0252909	0.0036518	0	0.026
iNRiM	Meas 1	0.0208441	-0.0081	0.000288	0.022	0.0208441	-0.004	0.000288	0.021
iNRiM	Meas 2	0.0208441	-0.0023	0.000288	0.021	0.0208441	-0.0026	0.000288	0.021
iNRiM	Meas 3	0.0208441	-0.003	0.000288	0.021	0.0208441	-0.0028	0.000288	0.021
iNRiM	Meas 4	0.0208441	-0.0068	0.000288	0.022	0.0208441	-0.004	0.000288	0.021
METAS2	Meas 1	0.03995	0.0125	0	0.042	0.03995	0.015	0	0.043
METAS2	Meas 2	0.0398372	0.01	0	0.041	0.0398372	0.01	0	0.041
METAS2	Meas 3	0.0397025	0.0035	0	0.040	0.0397025	0.0045	0	0.040
METAS2	Meas 4	0.03995	0.005	0	0.040	0.03995	0.005	0	0.040
NPL2	Meas 1	0.02	0.00647	0	0.021	0.02	0.00647	0	0.021
NPL2	Meas 2	0.02	0.0023	0	0.020	0.02	0.0033	0	0.020
NPL2	Meas 3	0.02	0.00278	0	0.020	0.02	0.00167	0	0.020
NPL2	Meas 4	0.02	0.00545	0	0.021	0.02	0.00434	0	0.020

Measurement point: -10 °C

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
METAS1	Meas 1	0.0195898	0.0046981	0	0.020	0.0195898	0.0057676	0	0.020
METAS1	Meas 2	0.0195898	0.0102595	0	0.022	0.0195898	0.0091142	0	0.022
METAS1	Meas 3	0.0195898	0.0132724	0	0.024	0.0195898	0.0123532	0	0.023
METAS1	Meas 4	0.0195898	0.0053692	0	0.020	0.0195898	0.0055667	0	0.020
NPL1	Meas 1	0.02	0.003	0	0.020	0.02	0.002	0	0.020
NPL1	Meas 2	0.02	0.003	0	0.020	0.02	0.003	0	0.020
NPL1	Meas 3	0.02	0.003	0	0.020	0.02	0.003	0	0.020
NPL1	Meas 4	0.02	0.002	0	0.020	0.02	0.002	0	0.020
GUM	Meas 1	0.0110855	0.0004403	0	0.011	0.0110855	0.0005814	0	0.011
GUM	Meas 2	0.0110854	0.0004228	0	0.011	0.0110854	0.0003681	0	0.011
GUM	Meas 3	0.0110857	0.0004228	0	0.011	0.0110857	0.0004314	0	0.011
GUM	Meas 4	0.0110889	0.0004495	0	0.011	0.0110889	0.0005498	0	0.011
CMI	Meas 1	0.079	0.004	0.0014434	0.079	0.079	0.004	0.0014434	0.079
CMI	Meas 2	0.079	0.005	0.0014434	0.079	0.079	0.005	0.0014434	0.079
CMI	Meas 3	0.079	0.003	0.0014434	0.079	0.079	0.003	0.0014434	0.079
CMI	Meas 4	0.079	0.004	0.0014434	0.079	0.079	0.004	0.0014434	0.079
MKEH	Meas 1	0.052	0.048	0	0.071	0.052	0.041	0	0.066
MKEH	Meas 2	0.017	0.02	0	0.026	0.017	0.017	0	0.024
MKEH	Meas 3	0.011	0.01	0	0.015	0.011	0.015	0	0.019
MKEH	Meas 4	0.02	0.022	0	0.030	0.02	0.02	0	0.028
SMU	Meas 1	0.13	0.00138	0.009	0.130	0.13	0.00093	0.009	0.130
SMU	Meas 2	0.13	0.00102	0.009	0.130	0.13	0.00076	0.009	0.130
SMU	Meas 3	0.13	0.0005	0.009	0.130	0.13	0.00055	0.009	0.130
SMU	Meas 4	0.13	0.00071	0.009	0.130	0.13	0.00047	0.009	0.130
BEV	Meas 1	0.0068	0.0010846	0	0.007	0.0068	0.0006703	0	0.007
BEV	Meas 2	0.0068	0.0009838	0	0.007	0.0068	0.0010909	0	0.007
BEV	Meas 3	0.0086	0.0007549	0	0.009	0.0086	0.0007336	0	0.009
BEV	Meas 4	0.0086	0.0023227	0	0.009	0.0086	0.0024184	0	0.009
NML	Meas 1	0.053	0.0075	0.01	0.054	0.053	0.0074	0.01	0.054
NML	Meas 2	0.053	0.0206	0.01	0.058	0.053	0.0205	0.01	0.058
NML	Meas 3	0.053	0.0297	0.01	0.062	0.053	0.0293	0.01	0.061
NML	Meas 4	0.053	0.0277	0.01	0.061	0.053	0.0296	0.01	0.062
INTA	Meas 1	0.0208935	0.0009222	0	0.021	0.0208935	0.000894	0	0.021
INTA	Meas 2	0.0208935	0.0009506	0	0.021	0.0208935	0.0009516	0	0.021
INTA	Meas 3	0.0208935	0.0009352	0	0.021	0.0208935	0.0009368	0	0.021
INTA	Meas 4	0.0208935	0.008427	0	0.023	0.0208935	0.0081582	0	0.022
iNRiM	Meas 1	0.0205921	-0.0026	0.000288	0.021	0.0205921	-0.0028	0.000288	0.021
iNRiM	Meas 2	0.0205921	-0.0018	0.000288	0.021	0.0205921	-0.002	0.000288	0.021
iNRiM	Meas 3	0.0205921	-0.0018	0.000288	0.021	0.0205921	-0.0026	0.000288	0.021
iNRiM	Meas 4	0.0205921	-0.0025	0.000288	0.021	0.0205921	-0.0025	0.000288	0.021
METAS2	Meas 1	0.0198182	0.007	0	0.021	0.0198182	0.00675	0	0.021
METAS2	Meas 2	0.019775	0.0075	0	0.021	0.019775	0.01	0	0.022
METAS2	Meas 3	0.0200562	0.0055	0	0.021	0.0200562	0.0065	0	0.021
METAS2	Meas 4	0.0202178	0.0085	0	0.022	0.0202178	0.009	0	0.022
NPL2	Meas 1	0.02	0.00219	0	0.020	0.02	0.00289	0	0.020
NPL2	Meas 2	0.02	0.00186	0	0.020	0.02	0.00171	0	0.020
NPL2	Meas 3	0.02	0.00345	0	0.020	0.02	0.00488	0	0.021
NPL2	Meas 4	0.02	0.0097	0	0.022	0.02	0.0103	0	0.022

Measurement point: +1 °C

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
METAS1	Meas 1	0.0174396	0.0059656	0	0.018	0.0174396	0.0055826	0	0.018
METAS1	Meas 2	0.0174379	0.0047326	0	0.018	0.0174379	0.0047348	0	0.018
METAS1	Meas 3	0.0175325	0.0084171	0	0.019	0.0175325	0.0066425	0	0.019
METAS1	Meas 4	0.01806	0.0113313	0	0.021	0.01806	0.0113727	0	0.021
NPL1	Meas 1	0.02	0.001	0	0.020	0.02	0.001	0	0.020
NPL1	Meas 2	0.02	0.001	0	0.020	0.02	0.001	0	0.020
NPL1	Meas 3	0.02	0.001	0	0.020	0.02	0.001	0	0.020
NPL1	Meas 4	0.02	0.001	0	0.020	0.02	0.002	0	0.020
GUM	Meas 1	0.0167584	0.0261636	0	0.031	0.0167584	0.0011209	0	0.017
GUM	Meas 2	0.0167559	0.0270656	0	0.032	0.0167559	0.0010813	0	0.017
GUM	Meas 3	0.0167572	0.0009638	0	0.017	0.0167572	0.0009366	0	0.017
GUM	Meas 4	0.0167593	0.0013283	0	0.017	0.0167593	0.0013505	0	0.017
CMI	Meas 1	0.072	0.004	0.0014434	0.072	0.072	0.004	0.0014434	0.072
CMI	Meas 2	0.072	0.004	0.0014434	0.072	0.072	0.004	0.0014434	0.072
CMI	Meas 3	0.072	0.003	0.0014434	0.072	0.072	0.003	0.0014434	0.072
CMI	Meas 4	0.072	0.004	0.0014434	0.072	0.072	0.004	0.0014434	0.072
MKEH	Meas 1	0.023	0.029	0	0.037	0.023	0.028	0	0.036
MKEH	Meas 2	0.02	0.022	0	0.030	0.02	0.025	0	0.032
MKEH	Meas 3	0.012	0.026	0	0.029	0.012	0.026	0	0.029
MKEH	Meas 4	0.008	0.012	0	0.014	0.008	0.018	0	0.020
SMU	Meas 1	0.122	0.00079	0.009	0.122	0.122	0.001	0.009	0.122
SMU	Meas 2	0.122	0.00092	0.009	0.122	0.122	0.00073	0.009	0.122
SMU	Meas 3	0.122	0.00103	0.009	0.122	0.122	0.00178	0.009	0.122
SMU	Meas 4	0.122	0.00116	0.009	0.122	0.122	0.00153	0.009	0.122
BEV	Meas 1	0.0079	0.0024569	0	0.008	0.0079	0.002269	0	0.008
BEV	Meas 2	0.0079	0.0011951	0	0.008	0.0079	0.0009873	0	0.008
BEV	Meas 3	0.0065	0.0008721	0	0.007	0.0065	0.0009387	0	0.007
BEV	Meas 4	0.0065	0.001141	0	0.007	0.0065	0.0009561	0	0.007
NML	Meas 1	0.049	0.0086	0.01	0.051	0.049	0.01	0.01	0.051
NML	Meas 2	0.049	0.0087	0.01	0.051	0.049	0.011	0.01	0.051
NML	Meas 3	0.049	0.0082	0.01	0.051	0.049	0.01	0.01	0.051
NML	Meas 4	0.049	0.0069	0.01	0.050	0.049	0.008	0.01	0.051
INTA	Meas 1	0.025	0.0019806	0	0.025	0.025	0.0023022	0	0.025
INTA	Meas 2	0.025	0.0034295	0	0.025	0.025	0.0034255	0	0.025
INTA	Meas 3	0.025	0.0040186	0	0.025	0.025	0.0039292	0	0.025
INTA	Meas 4	0.025	0.0035303	0	0.025	0.025	0.0032809	0	0.025
iNRiM	Meas 1	0.0191193	-0.0038	0.000288	0.019	0.0191193	-0.0034	0.000288	0.019
iNRiM	Meas 2	0.0191193	-0.0046	0.000288	0.020	0.0191193	-0.0031	0.000288	0.019
iNRiM	Meas 3	0.0191193	-0.0036	0.000288	0.019	0.0191193	-0.0033	0.000288	0.019
iNRiM	Meas 4	0.0191193	-0.0053	0.000288	0.020	0.0191193	-0.0031	0.000288	0.019
METAS2	Meas 1	0.0185159	0.01	0	0.021	0.0185159	0.01	0	0.021
METAS2	Meas 2	0.0174023	0.0075	0	0.019	0.0174023	0.0075	0	0.019
METAS2	Meas 3	0.0171709	0.0025	0	0.017	0.0171709	0.0025	0	0.017
METAS2	Meas 4	0.0171837	0.0075	0	0.019	0.0171837	0.0075	0	0.019
NPL2	Meas 1	0.02	0.0016	0	0.020	0.02	0.0013	0	0.020
NPL2	Meas 2	0.02	0.006	0	0.021	0.02	0.005	0	0.021
NPL2	0	0	0	0	0.000	0	0	0	0.000
NPL2	0	0	0	0	0.000	0	0	0	0.000

Measurement point: +20 °C

		Hygrometer 1 = 0924				Hygrometer 2 = 0925			
		std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.	std.unc.ref (°C)	std.unc.short-term instab. (°C)	Resol./res. meas.std.unc. (°C)	combined std.unc.
METAS1	Meas 1	0.0184119	0.0029817	0	0.019	0.0184119	0.0021402	0	0.019
METAS1	Meas 2	0.0186098	0.0075085	0	0.020	0.0186098	0.0108795	0	0.022
METAS1	Meas 3	0.0241901	0.0223182	0	0.033	0.0241901	0.0232197	0	0.034
METAS1	Meas 4	0.0188102	0.0087653	0	0.021	0.0188102	0.0073255	0	0.020
NPL1	Meas 1	0.02	0.004	0	0.020	0.02	0.003	0	0.020
NPL1	Meas 2	0.02	0.003	0	0.020	0.02	0.002	0	0.020
NPL1	Meas 3	0.02	0.005	0	0.021	0.02	0.004	0	0.020
NPL1	Meas 4	0.02	0.004	0	0.020	0.02	0.003	0	0.020
GUM	Meas 1	0.0249909	0.0006872	0	0.025	0.0249909	0.0014161	0	0.025
GUM	Meas 2	0.0249905	0.00065	0	0.025	0.0249905	0.0006526	0	0.025
GUM	Meas 3	0.024991	0.0008482	0	0.025	0.024991	0.000807	0	0.025
GUM	Meas 4	0.0249899	0.0006401	0	0.025	0.0249899	0.0007619	0	0.025
CMI	Meas 1	0.069	0.003	0.0014434	0.069	0.069	0.003	0.0014434	0.069
CMI	Meas 2	0.069	0.002	0.0014434	0.069	0.069	0.003	0.0014434	0.069
CMI	Meas 3	0.069	0.002	0.0014434	0.069	0.069	0.002	0.0014434	0.069
CMI	Meas 4	0.069	0.002	0.0014434	0.069	0.069	0.003	0.0014434	0.069
MKEH	Meas 1	0.021	0.017	0	0.027	0.021	0.022	0	0.030
MKEH	Meas 2	0.015	0.015	0	0.021	0.015	0.016	0	0.022
MKEH	Meas 3	0.015	0.016	0	0.022	0.015	0.022	0	0.027
MKEH	Meas 4	0.009	0.007	0	0.011	0.009	0.012	0	0.015
SMU	Meas 1	0.114	0.00082	0.009	0.114	0.114	0.000243	0.009	0.114
SMU	Meas 2	0.114	0.00018	0.009	0.114	0.114	0.00012	0.009	0.114
SMU	Meas 3	0.114	0.00074	0.009	0.114	0.114	0.00071	0.009	0.114
SMU	Meas 4	0.114	0.00058	0.009	0.114	0.114	0.00067	0.009	0.114
BEV	Meas 1	0.0091	0.0036382	0	0.010	0.0091	0.0036654	0	0.010
BEV	Meas 2	0.0091	0.00142	0	0.009	0.0091	0.0015825	0	0.009
BEV	Meas 3	0.0075	0.0010988	0	0.008	0.0075	0.0009723	0	0.008
BEV	Meas 4	0.0075	0.0025747	0	0.008	0.0075	0.0028332	0	0.008
NML	Meas 1	0.049	0.0074	0.01	0.051	0.049	0.0076	0.01	0.051
NML	Meas 2	0.049	0.0075	0.01	0.051	0.049	0.0101	0.01	0.051
NML	Meas 3	0.049	0.0079	0.01	0.051	0.049	0.0099	0.01	0.051
NML	Meas 4	0.049	0.009	0.01	0.051	0.049	0.0096	0.01	0.051
INTA	Meas 1	0.025	0.0039845	0	0.025	0.025	0.0044313	0	0.025
INTA	Meas 2	0.025	0.0057484	0	0.026	0.025	0.0047157	0	0.025
INTA	Meas 3	0.025	0.004768	0	0.025	0.025	0.0037527	0	0.025
INTA	Meas 4	0.025	0.0048601	0	0.025	0.025	0.0044244	0	0.025
iNRiM	Meas 1	0.0209972	-0.0062	0.000288	0.022	0.0209972	-0.0031	0.000288	0.021
iNRiM	Meas 2	0.0209972	-0.0042	0.000288	0.021	0.0209972	-0.0025	0.000288	0.021
iNRiM	Meas 3	0.0209972	-0.0044	0.000288	0.021	0.0209972	-0.0023	0.000288	0.021
iNRiM	Meas 4	0.0209972	-0.0042	0.000288	0.021	0.0209972	-0.0021	0.000288	0.021
METAS2	Meas 1	0.0192769	0.01	0	0.022	0.0192769	0.01	0	0.022
METAS2	Meas 2	0.018751	0.0075	0	0.020	0.018751	0.0075	0	0.020
METAS2	Meas 3	0.0192769	0.01	0	0.022	0.0192769	0.01	0	0.022
METAS2	Meas 4	0.0183467	0.0025	0	0.019	0.0183467	0.0025	0	0.019
NPL2	Meas 1	0.02	0.002	0	0.020	0.02	0.003	0	0.020
NPL2	Meas 2	0.02	0.0015	0	0.020	0.02	0.0014	0	0.020
NPL2	Meas 3	0	0	0	0.000	0	0	0	0.000
NPL2	Meas 4	0	0	0	0.000	0	0	0	0.000

APPENDIX 4: ERV CALCULATIONS

Summary of the results obtained with different methods

LOOP 1

Sheet	1st calc. All laboratories / estimate				Primary labs / estimate				1st calc. All laboratories / Expanded uncertainty (k=2)		Primary labs / Expanded uncertainty (k=2)	
	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean	Weighted mean	Simple mean
R_m50new	-0.095	-0.061	-0.057	Failed	-0.096	-0.078	-0.071	Failed	0.012	0.027	0.013	0.025
R_m30new	-0.125	-0.145	-0.126	Failed	-0.123	-0.138	-0.125	Failed	0.007	0.017	0.008	0.015
R_m10new	-0.127	-0.120	-0.130	Failed	-0.126	-0.123	-0.130	Failed	0.006	0.017	0.006	0.014
R_p1new	-0.133	-0.134	-0.138	Failed	-0.132	-0.136	-0.134	Failed	0.006	0.015	0.006	0.013
R_p20new	-0.146	-0.139	-0.147	Failed	-0.143	-0.143	-0.142	Failed	0.007	0.015	0.007	0.012

	2nd calc. Primary labs / estimate				2nd calc. Primary labs / Expanded uncertainty (k=2)	
	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean
R_m50_2	-0.091	-0.084	-0.077	OK	0.018	0.031
R_m30_2	-0.125	-0.129	-0.126	OK	0.010	0.022
R_m10_2	-0.126	-0.132	-0.131	OK	0.007	0.020
R_p1_2	-0.137	-0.132	-0.132	OK	0.008	0.017
R_p20_2	-0.142	-0.140	-0.144	OK	0.008	0.012

LOOP 2

Sheet	1st calc. All laboratories / estimate				Primary labs / estimate				1st calc. All laboratories / Expanded uncertainty (k=2)		Primary labs / Expanded uncertainty (k=2)	
	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean	Weighted mean	Simple mean
R_m50new	-0.083	-0.068	-0.064	Failed	-0.084	-0.083	-0.083	Failed	0.010	0.027	0.011	0.025
R_m30new	-0.096	-0.119	-0.100	Failed	-0.095	-0.112	-0.098	Failed	0.007	0.017	0.007	0.015
R_m10new	-0.119	-0.111	-0.121	Failed	-0.118	-0.114	-0.119	Failed	0.006	0.017	0.006	0.014
R_p1new	-0.117	-0.117	-0.128	Failed	-0.115	-0.118	-0.110	Failed	0.006	0.015	0.006	0.013
R_p20new	-0.120	-0.116	-0.128	Failed	-0.118	-0.118	-0.125	Failed	0.007	0.015	0.007	0.012

	2nd calc. Primary labs / estimate				2nd calc. Primary labs / Expanded uncertainty (k=2)	
	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean
R_m50_2	-0.085	-0.092	-0.087	OK	0.015	0.031
R_m30_2	-0.100	-0.092	-0.100	OK	0.010	0.022
R_m10_2	-0.117	-0.122	-0.122	OK	0.007	0.020
R_p1_2	-0.113	-0.096	-0.104	OK	0.009	0.017
R_p20_2	-0.121	-0.101	-0.125	OK	0.009	0.011

LOOP 3

1st calc.

Sheet	All laboratories / estimate				Primary labs / estimate			
	Weighted mean	Simple mean	Median	Consistency	Weighted mean	Simple mean	Median	Consistency
R_m50new	0.031	0.042	0.030	Failed	0.028	0.033	0.018	Failed
R_m30new	0.013	-0.011	-0.005	Failed	0.014	-0.003	0.010	Failed
R_m10new	-0.019	-0.016	-0.028	Failed	-0.019	-0.018	-0.027	Failed
R_p1new	-0.025	-0.037	-0.045	Failed	-0.022	-0.037	-0.045	Failed
R_p20new	-0.023	-0.021	-0.024	Failed	-0.019	-0.026	-0.027	Failed

1st calc.

All laboratories / Expanded uncertainty (k=2)		Primary labs / Expanded uncertainty (k=2)	
Weighted mean	Simple mean	Weighted mean	Simple mean
0.010	0.027	0.011	0.025
0.006	0.017	0.006	0.015
0.005	0.017	0.005	0.014
0.006	0.015	0.006	0.013
0.007	0.015	0.007	0.012

2nd calc.

	Primary labs / estimate			
	Weighted mean	Simple mean	Median	Consistency
R_m50_2	0.014	0.011	0.017	OK
R_m30_2	0.012	0.016	0.010	OK
R_m10_2	-0.025	-0.028	-0.027	OK
R_p1_2	-0.034	-0.027	-0.038	OK
R_p20_2	-0.023	-0.022	-0.026	OK

2nd calc.

Primary labs / Expanded uncertainty (k=2)	
Weighted mean	Simple mean
0.016	0.027
0.008	0.023
0.009	0.020
0.011	0.017
0.009	0.012

Results of the first ERV calculation according to equation (8.1) and the identification of discrepant results according to the criterion in equation (8.2)

Rkcrv - Rlab

Lab id	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES1	0.020	0.001	0.005	0.030	0.001
PTB	0.056	0.036	0.018	0.008	-0.001
SP	-0.011	0.010	0.009	-0.043	
DELTA	-0.114	-0.070	-0.046	-0.001	-0.052
CETIAT	-0.040	-0.006	0.012	-0.049	-0.042
GUM	-0.079	-0.043	-0.007	0.009	0.019
METAS	0.027	0.029	0.038	0.056	0.060
NMISA	0.111	0.058	0.049	0.036	0.008
JV	-0.082	0.084	0.098	0.090	0.105
VNIIM	0.057	0.266	0.157	0.195	
NMi-VSL1	-0.070	0.073	0.026	0.051	-0.021
INTA	-0.004	0.005	0.006	-0.005	-0.006
IPQ			-0.213	-0.221	-0.227
EIM		-0.079	-0.025	-0.022	-0.023
iNRiM	-0.019	0.002	-0.006	-0.016	0.017
MIRS-FE-LM	-0.028	0.001	0.001	0.010	0.009
LPM			-0.197	-0.119	0.067
UME		-0.049	-0.060	-0.027	-0.046
NPL1	0.012	0.019	0.008	0.023	0.014
CMI	-0.002	0.154	0.049	0.021	-0.039
MKEH	-0.051	-0.018	-0.007	0.063	0.068
SMU	-0.176	0.045	-0.037	0.036	0.046
BEV	-0.028	-0.017	-0.024	-0.027	-0.023
NML			0.029	0.031	0.027
PTB	0.064	0.058	0.026	0.025	0.025
CETIAT	0.003	-0.018	-0.005	-0.051	-0.092
INTA	0.010	0.015	-0.009	0.006	0.009
iNRiM	0.002	-0.002	0.009	0.022	0.018
METAS	-0.262	-0.066	0.001	0.030	0.035
GUM	0.013	-0.005	0.015	0.023	0.031

U(Rkcrv - Rlab)

Lab id	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES1	0.029	0.027	0.025	0.024	0.025
PTB	0.029	0.027	0.016	0.017	0.017
SP	0.134	0.160	0.160	0.125	
DELTA	0.121	0.117	0.118	0.126	0.129
CETIAT	0.048	0.022	0.022	0.018	0.050
GUM	0.057	0.029	0.012	0.016	0.031
METAS	0.135	0.047	0.023	0.024	0.028
NMISA	0.058	0.049	0.061	0.058	0.058
JV	0.171	0.142	0.147	0.099	0.100
VNIIM	0.053	0.053	0.052	0.053	
NMi-VSL1	0.045	0.040	0.045	0.059	0.042
INTA	0.034	0.026	0.026	0.027	0.027
IPQ			0.196	0.171	0.172
EIM		0.036	0.026	0.034	0.030
iNRiM	0.039	0.022	0.022	0.025	0.023
MIRS-FE-LM	0.027	0.017	0.015	0.016	0.021
LPM			0.099	0.083	0.094
UME		0.028	0.037	0.029	0.052
NPL1	0.027	0.024	0.024	0.022	0.026
CMI	0.186	0.081	0.080	0.074	0.071
MKEH	0.034	0.029	0.051	0.038	0.030
SMU	0.256	0.160	0.136	0.129	0.116
BEV	0.022	0.014	0.011	0.011	0.015
NML			0.062	0.052	0.054
PTB	0.029	0.027	0.016	0.017	0.017
CETIAT	0.024	0.019	0.020	0.020	0.024
INTA	0.034	0.026	0.022	0.026	0.027
iNRiM	0.055	0.023	0.022	0.021	0.024
METAS	0.148	0.068	0.031	0.030	0.032
GUM	0.068	0.015	0.013	0.034	0.026

2*u(di)=2*sqrt(u^2(Rlab)-u^2(Rkcrv))

Lab id	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES1	0.023	0.025	0.024	0.023	0.022
PTB	0.022	0.025	0.014	0.014	0.014
SP	0.133	0.160	0.160	0.124	
DELTA	0.120	0.116	0.117	0.126	0.128
CETIAT	0.044	0.019	0.021	0.016	0.049
GUM	0.054	0.027	0.010	0.013	0.030
METAS	0.134	0.046	0.021	0.022	0.026
NMISA	0.055	0.048	0.060	0.057	0.057
JV	0.170	0.142	0.147	0.098	0.099
VNIIM	0.050	0.052	0.051	0.052	
NMi-VSL1	0.043	0.039	0.044	0.059	0.041
INTA	0.030	0.024	0.025	0.025	0.025
IPQ			0.196	0.171	0.171
EIM		0.034	0.025	0.033	0.028
iNRiM	0.036	0.020	0.020	0.023	0.021
MIRS-FE-LM	0.023	0.014	0.013	0.014	0.018
LPM			0.099	0.083	0.093
UME		0.026	0.036	0.027	0.052
NPL1	0.022	0.023	0.023	0.021	0.025
CMI	0.186	0.080	0.079	0.073	0.070
MKEH	0.030	0.027	0.050	0.037	0.029
SMU	0.256	0.159	0.135	0.129	0.116
BEV	0.015	0.010	0.009	0.007	0.011
NML			0.061	0.052	0.053
PTB	0.025	0.025	0.014	0.014	0.014
CETIAT	0.019	0.016	0.018	0.018	0.022
INTA	0.030	0.025	0.021	0.025	0.025
iNRiM	0.052	0.021	0.020	0.019	0.022
METAS	0.148	0.067	0.030	0.029	0.030
GUM	0.066	0.012	0.010	0.033	0.024

Outlier/irrelevant = 0

	t= -50 °C	t= -30 °C	t= -10 °C	t= +1 °C	t= +20 °C
MIKES1	1	1	1	0	1
PTB	0	0	0	1	1
SP	1	1	1	1	
DELTA	0	0	0	0	0
CETIAT	1	1	1	0	1
GUM	0	0	1	1	1
METAS	1	1	0	0	0
NMISA	0	0	0	0	0
JV	0	0	0	0	0
VNIIM	0	0	0	0	0
NMi-VSL1	0	0	1	1	1
INTA	1	1	1	1	1
IPQ	0	0	0	0	0
EIM	0	0	0	1	1
iNRiM	1	1	1	1	1
MIRS-FE-LM	0	1	1	1	1
LPM	0	0	0	0	1
UME	0	0	0	1	1
NPL1	1	1	1	0	1
CMI	0	0	0	0	0
MKEH	0	0	0	0	0
SMU	0	0	0	0	0
BEV	0	0	0	0	0
NML	0	0	0	0	0
PTB	0	0	0	0	0
CETIAT	1	0	1	0	0
INTA	1	1	1	1	1
iNRiM	1	1	1	0	1
METAS	0	1	1	0	0
GUM	1	1	0	1	0