

## Key comparisons CCT-K5, CCT-K5.1, APMP.T-K5 and EUROMET.T-K5

MEASURAND : Temperature

NOMINAL TEMPERATURE :  $T_{\text{nom}} = 1700 \text{ }^\circ\text{C}$

### Key comparison CCT-K5

Four Tungsten-strip lamps were used as transfer standards for radiance temperature measurements at specific currents corresponding to each nominal temperature  $T_{\text{nom}}$ . To shorten the measurement time significantly the set of transfer standards was split in two sets of two lamps for simultaneous comparisons in two loops. The pilot of each loop measured both lamp sets in order to establish a linkage mechanism described on page 19 of the CCT-K5 Final Report.

$T_i$ : temperature value measured by laboratory  $i$

$u_i$ : standard uncertainty of  $T_i$

#### Lamp S/N C564

Lab <i>i</i>	$T_i$ / °C	$u_i$ / °C
VSL	1703.310	0.21
NMIA	1703.510	0.04
KRISS	1703.410	0.25
NIM	1703.480	0.31
A*STAR	1702.320	0.34
NMIJ	1703.930	0.31
VNIIM	1703.930	0.99

#### Lamp S/N C681

Lab <i>i</i>	$T_i$ / °C	$u_i$ / °C
VSL	1703.010	0.21
NMIA	1703.340	0.04
KRISS	1703.380	0.25
NIM	1703.810	0.31
A*STAR	1701.690	0.34
NMIJ	1703.770	0.31
VNIIM	1702.930	0.99

#### Lamp S/N C860

Lab <i>i</i>	$T_i$ / °C	$u_i$ / °C
NPL	1700.290	0.41
NIST	1701.530	0.55
CENAM	1700.730	0.65
LNE-INM	1699.710	0.38
INRIM	1700.970	0.21
PTB	1700.870	0.32

#### Lamp S/N C864

Lab <i>i</i>	$T_i$ / °C	$u_i$ / °C
NPL	1700.300	0.41
NIST	1701.190	0.55
CENAM	1700.650	0.65
LNE-INM	1700.400	0.38
INRIM	1700.760	0.21
PTB	1700.650	0.32

## Key comparison CCT-K5.1

This is a bilateral comparison between the PTB and the NRC.

$T_{\text{NRC}}$ : temperature value measured at the NRC

$u_{\text{NRC}}$ : standard uncertainty of  $T_{\text{NRC}}$

Lamp C598	$T_{\text{NRC}} = 1700.66 \text{ }^\circ\text{C}$	Lamp 644C	$T_{\text{NRC}} = 1700.72 \text{ }^\circ\text{C}$
	$u_{\text{NRC}} = 0.50 \text{ }^\circ\text{C}$		$u_{\text{NRC}} = 0.50 \text{ }^\circ\text{C}$

## Key comparison APMP.T-K5

Laboratory individual measurements of APMP.T-K5 participants are given in Appendix B of the APMP.T-K5 Final Report both in tabulated and in graphical forms. There were taken between 1997 and 2000.

## Key comparison EUROMET.T-K5

This comparison involved eight participants and was carried out from October 1999 to February 2001.

The two transfer standards were Lamp S/N C564 and Lamp S/N C681 already used in CCT-K5.

The individual laboratory measurements and their uncertainties are given in Tables 5 to 11 of the EUROMET.T-K5 Final Report.

## Key comparisons CCT-K5, CCT-K5.1, APMP.T-K5 and EUROMET.T-K5

### Key comparison CCT-K5

MEASURAND : Temperature

NOMINAL TEMPERATURE :  $T_{\text{nom}} = 1700 \text{ }^\circ\text{C}$

The key comparison reference value  $T_R$  for each nominal temperature  $T_{\text{nom}}$  and each lamp  $k$  is calculated on the basis of the median of measured radiance temperatures  $T_i(k, T_{\text{nom}})$ . Its standard uncertainty,  $u(T_R)$ , is obtained as the standard uncertainty of the median.

Lamp	$T_R / ^\circ\text{C}$	$u(T_R) / ^\circ\text{C}$
C564	1703.560	0.041
C681	1703.230	0.065
C860	1700.920	0.147
C864	1700.800	0.067

For each temperature  $T_{\text{nom}}$  the degree of equivalence of laboratory  $i$  with respect to the key comparison reference value is given by a pair of terms:  $D_i$  and its expanded uncertainty  $U_i$  ( $k = 2$ ) both expressed in K. The computation of  $D_i$  and  $U_i$  is explained in the Addendum to the CCT-K5 Final Report.

For each temperature  $T_{\text{nom}}$  the pair-wise degree of equivalence between laboratory  $i$  and  $j$  is given by two terms:  $D_{ij}$  and its expanded uncertainty  $U_{ij}$  ( $k = 2$ ). The computation of  $D_{ij}$  and  $U_{ij}$  is also explained in the Addendum of the CCT-K5 Final Report.

### Linking key comparison CCT-K5.1 to CCT-K5

The linkage is made through the common participation of PTB in both key comparisons, and is detailed in the CCT-K5 and CCT-K5.1 Linkage Report.

### Linking key comparison APMP.T-K5 to CCT-K5

The linkage is made through the common participation of NMIJ, NIM, KRISS and NMIA in both key comparisons, and is detailed in the Addendum to the APMP.T-K5 Final Report.

### Linking key comparison EUROMET.T-K5 to CCT-K5

The measurements of the EUROMET.T-K5 participants are directly linked to the key comparison reference value obtained in CCT-K5 as the protocols of the two key comparisons are identical and the transfer standards are the same (see in Chapter VII of the EUROMET.T-K5 Final Report).

Degrees of equivalence relative to the CCT-K5 key comparison reference values are computed for each of the transfer standards. Pair-wise degrees of equivalence inside EUROMET.T-K5 are available in the EUROMET.T-K5 Final Report (Tables 15 to 36).

## Key comparisons CCT-K5, CCT-K5.1, APMP.T-K5 and EUROMET.T-K5

MEASURAND : Temperature

NOMINAL TEMPERATURE :  $T_{nom} = 1700 \text{ }^\circ\text{C}$

Degrees of equivalence relative to the CCT-K5 key comparison reference value

Lab*i*



	$D_i$	$U_i$
	/ K	
VSL	-0.235	0.480
NPL	-0.565	0.854
NMIA	0.030	0.259
KRISS	0.000	0.571
NIM	0.250	0.740
A*STAR	-1.390	0.734
NMIJ	0.455	0.667
VNIIM	0.035	2.022
NIST	0.500	1.129
CENAM	-0.170	1.321
LNE-INM	-0.805	0.892
INRIM	0.005	0.482
PTB	-0.100	0.480
NRC	0.015	1.313
CMS/TRI	-1.80	1.58

Lamp S/N C564

	$D_i$	$U_i$
	/ K	
CEM	0.38	0.65
IPQ	-0.73	1.64
UME	-2.37	0.78
MKEH	-3.43	2.94
SMU	-1.59	0.55
SP	-0.46	1.82
MIKES	-2.22	3.76
VSL	-0.18	0.43

Lamp S/N C681

	$D_i$	$U_i$
	/ K	
CEM	0.21	0.81
IPQ	-1.61	1.75
UME	-2.69	0.95
MKEH	-3.81	3.30
SMU	-1.43	0.60
SP	-0.95	1.83
MIKES	-2.05	2.50
VSL	-0.30	0.44

Black: participants in CCT-K5

Green: participant in CCT-K5.1

Blue: participants in APMP.T-K5

Orange: participants in EUROMET.T-K5 (measurements with Lamp S/N C564)

Grey: participants in EUROMET.T-K5 (measurements with Lamp S/N C681)

# Key comparisons CCT-K5 and CCT-K5.1

MEASURAND : Temperature

NOMINAL TEMPERATURE :  $T_{nom} = 1700 \text{ }^\circ\text{C}$

Matrix of equivalence

Pair-wise degrees of equivalence involving APMP.T-K5 participants are not computed.

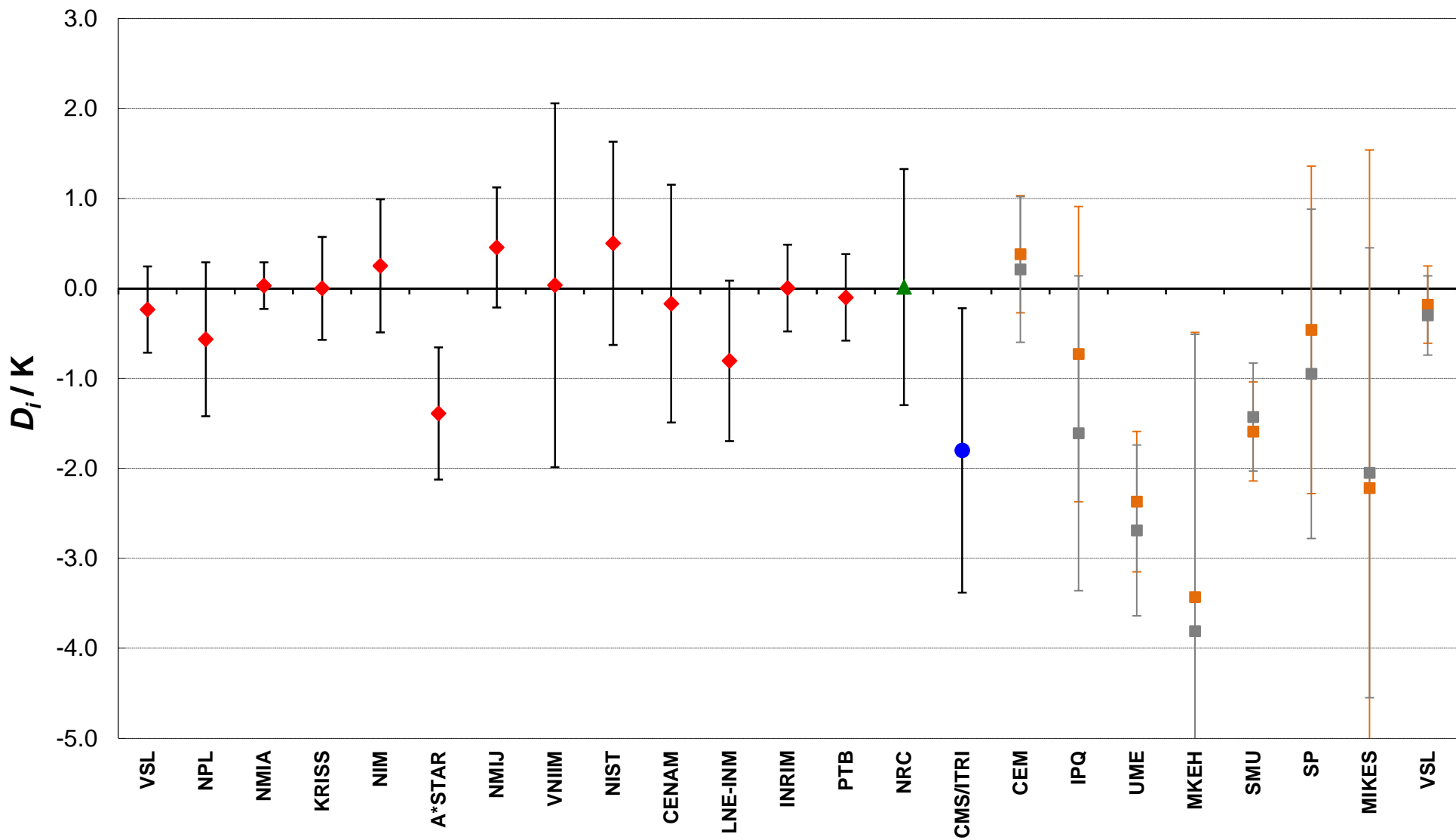
Lab <sub>i</sub>	$D_i$ / $U_i$		VSL		NPL		NMIA		KRISS		NIM		A*STAR		NMIJ		VNIIM	
	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$
VSL	-0.235	0.480																
NPL	-0.565	0.854	0.330	0.929														
NMIA	0.030	0.259	-0.330	0.929	0.265	0.433												
KRISS	0.000	0.571	0.265	0.433	0.595	0.834												
NIM	0.250	0.740	0.235	0.667	0.565	0.972	-0.030	0.511										
A*STAR	-1.390	0.734	0.485	0.813	0.815	1.052	0.220	0.673	0.250	0.816								
NMIJ	0.455	0.667	-1.155	0.816	-0.825	1.075	-1.420	0.723	-1.390	0.896	-1.640	1.038						
VNIIM	0.035	2.022	0.690	0.752	1.020	1.036	0.425	0.625	0.455	0.799	0.205	0.911	1.845	0.950				
NIST	0.500	1.129	0.270	2.054	0.600	2.155	0.005	2.025	0.035	2.099	-0.215	2.179	1.425	2.102	-0.420	2.117		
CENAM	-0.170	1.321	0.735	1.185	1.065	1.383	0.470	1.112	0.500	1.219	0.250	1.284	1.890	1.302	0.045	1.271	0.465	2.277
LNE-INM	-0.805	0.892	0.065	1.371	0.395	1.538	-0.200	1.309	-0.170	1.401	-0.420	1.458	1.220	1.475	-0.625	1.446	-0.205	2.379
INRIM	0.005	0.482	-0.570	0.907	-0.240	1.169	-0.835	0.809	-0.805	0.950	-1.055	1.033	0.585	1.056	-1.260	1.016	-0.840	2.146
PTB	-0.100	0.480	0.240	0.606	0.570	0.928	-0.025	0.446	0.005	0.669	-0.245	0.782	1.395	0.812	-0.450	0.760	-0.030	2.036
			0.135	0.775	0.465	1.046	-0.130	0.657	-0.100	0.825	-0.350	0.918	1.290	0.945	-0.555	0.900	-0.135	2.093

NRC	0.015	1.313	0.250	1.398	0.580	1.566	-0.015	1.338	0.015	1.432	-0.235	1.507	1.405	1.504	-0.440	1.473	-0.020	2.411
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Lab <sub>i</sub>	$D_i$ / $U_i$		NIST		CENAM		LNE-INM		INRIM		PTB		NRC	
	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$	$D_{ij}$ / $U_{ij}$	$U_{ij}$ / $K$
VSL	-0.235	0.480	-0.735	1.185	-0.065	1.371	0.570	0.907	-0.240	0.606	-0.135	0.775	-0.250	1.398
NPL	-0.565	0.854	-1.065	1.383	-0.395	1.538	0.240	1.169	-0.570	0.928	-0.465	1.046	-0.580	1.566
NMIA	0.030	0.259	-0.470	1.112	0.200	1.309	0.835	0.809	0.025	0.446	0.130	0.657	0.015	1.338
KRISS	0.000	0.571	-0.500	1.219	0.170	1.401	0.805	0.950	-0.005	0.669	0.100	0.825	-0.015	1.432
NIM	0.250	0.740	-0.250	1.284	0.420	1.458	1.055	1.033	0.245	0.782	0.350	0.918	0.235	1.507
A*STAR	-1.390	0.734	-1.890	1.302	-1.220	1.475	-0.585	1.056	-1.395	0.812	-1.290	0.945	-1.405	1.504
NMIJ	0.455	0.667	-0.045	1.271	0.625	1.446	1.260	1.016	0.450	0.760	0.555	0.900	0.440	1.473
VNIIM	0.035	2.022	-0.465	2.277	0.205	2.379	0.840	2.146	0.030	2.036	0.135	2.093	0.020	2.411
NIST	0.500	1.129			0.670	1.708	1.305	1.433	0.495	1.179	0.600	1.274	0.485	1.732
CENAM	-0.170	1.321	-0.670	1.708			0.635	1.554	-0.175	1.368	-0.070	1.451	-0.185	1.862
LNE-INM	-0.805	0.892	-1.305	1.433	-0.635	1.554			-0.810	0.978	-0.705	1.093	-0.820	1.587
INRIM	0.005	0.482	-0.495	1.179	0.175	1.368	0.810	0.978			0.105	0.766	-0.010	1.398
PTB	-0.100	0.480	-0.600	1.274	0.070	1.451	0.705	1.093	-0.105	0.766			-0.115	1.398

NRC	0.015	1.313	-0.485	1.732	0.185	1.862	0.820	1.587	0.010	1.398	0.115	1.398
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**CCT-K5, CCT-K5.1, APMP.T-K5 and EUROMET.T-K5 : Nominal temperature,  $T_{nom} = 1700\text{ }^{\circ}\text{C}$   
Degrees of equivalence,  $D_i$ , and expanded uncertainties ( $k = 2$ )  $U_i$ , expressed in K**



**Red diamonds:** participants in CCT-K5  
**Green triangle:** participant in CCT-K5.1  
**Blue circle:** participant in APMP.T-K5

**Orange squares:** participants in EUROMET.T-K5 (measurements with Lamp S/N C564)  
**Grey squares:** participants in EUROMET.T-K5 (measurements with Lamp S/N C681)