

## CCPR-K4, EURAMET.PR-K4, SIM.PR-K4 and COOMET.PR-K4.1

MEASURAND : Luminous flux of lamps

### Key comparison CCPR-K4

The individual measurements,  $x_i$ , of the participating laboratories take the form of ratios which depend on the reference used at the pilot laboratory, the PTB. This is cancelled out by normalization using the key comparison reference value,  $x_R$ . This procedure leads to normalized individual measurements:  $x_i / x_R$ .

The key comparison reference value,  $x_R$ , is calculated as the weighted average of the individual results  $x_i$ , weighted by the inverse square of the individual standard uncertainties,  $u_i$ , with the application of a minimum uncertainty cutoff of 0.30 %.

The INTI and the BIPM are excluded from the calculation of  $x_R$ .

The standard uncertainty of  $x_R$  is  $u_R = 0.1$  %. It is negligible compared to the  $u_i$  values.

The degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms:

$D_i = (x_i - x_R) / x_R$  and  $U_i$ , its expanded uncertainty ( $k = 2$ ), both expressed in relative units.  $U_i = 2u_i$ .

When required, the degree of equivalence between two laboratories is given by a pair of terms:

$D_{ij} = (x_i - x_j) / x_R$  and  $U_{ij}$ , its expanded uncertainty ( $k = 2$ ), both expressed in relative units.  $U_{ij}^2 = 2^2(u_i^2 + u_j^2)$ .

### Linking key comparison EURAMET.PR-K4 to CCPR-K4

The participants' measurements are given in Annex B of the EURAMET.PR-K4 Final Report.

Beside the pilot laboratory, PTB, INRIM and LNE-INM/Cnam acted as linking laboratories for EURAMET.PR-K4. The luminous flux maintained at the linking laboratories was used to evaluate the EURAMET reference value as a weighted luminous flux average.

By definition, the CCPR-K4 key comparison reference value and the EURAMET.PR-K4 reference value have identical values (see Section 4.2 of the EURAMET.PR-K4 Final Report, especially Table 4 and Figure 4), but the expanded uncertainty associated with the EURAMET reference value is about triply the expanded uncertainty associated with the CCPR-K4 key comparison reference value.

The realized or preserved luminous flux values of the EURAMET participants were compared with the EURAMET reference value in a star-type comparison at the pilot with batches of three to six lamps of various types. The degrees of equivalence with respect to the EURAMET reference value were evaluated and then directly transferred to the CCPR-K4 key comparison reference value.

## Linking key comparison SIM.PR-K4 to CCPR-K4

The ratio of the measurement results of the laboratories participating in SIM.PR-K4 to the measurement results obtained at the pilot laboratory, the CENAM, are given in Table 15 on page 11 of the SIM.PR-K4 Final Report.

NRC and NIST provide the link between key comparisons CCPR-K4 and SIM.PR-K4, and the linkage process is described in Section 9.2 of the SIM.PR-K4 Final Report.

The degree of equivalence of the participant in SIM.PR-K4 with respect to the key comparison reference value is given by a pair of terms both dimensionless:  $D_i$  and  $U_i$ , its expanded uncertainty ( $k = 2$ ), computed as explained in Section 9.2 of the Final Report.

## Linking key comparison COOMET.PR-K4.1 to CCPR-K4

The measurement results of the participants in COOMET.PR-K4.1 are given in Table 7 of the Final Report.

VNIOFI provides the link between key comparisons CCPR-K4 and COOMET.PR-K4.1, and the linkage process is described in Section 5 of the COOMET.PR-K4.1 Final Report.

The degree of equivalence of the NSC "Institute of Metrology" participant in COOMET.PR-K4.1 with respect to the key comparison reference value is given by a pair of term both dimensionless:  $D_i$  and  $U_i$ , its expanded uncertainty ( $k = 2$ ), computed as explained in Section 6 of the Final Report.

# CCPR-K4, EURAMET.PR-K4, SIM.PR-K4 and COOMET.PR-K4.1

MEASURAND : Luminous flux of lamps

Degrees of equivalence relative to the CCPR-K4 key comparison reference value  $x_R$

Lab *i* ↓

	$D_i$ / $10^{-2}$	$U_i$ / $10^{-2}$
LNE-INM/Cnam	0.69	0.58
NMISA	-0.01	1.06
NMIA	0.13	0.58
NMIJ	0.18	0.68
INRIM	-0.06	0.96
IO-CSIC	-0.43	1.70
NIM	-0.22	0.52
NIST	-0.21	0.62
NPL	0.37	0.40
NRC	0.99	2.00
METAS	-0.57	1.38
MKEH	0.43	1.30
PTB	-0.42	0.56
SMU	-0.88	2.20
VNIOFI	-0.51	0.66
INTI	-0.43	1.00
BIPM	0.32	1.02

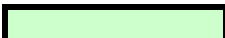

Lab *i* ↓

	$D_i$ / $10^{-2}$	$U_i$ / $10^{-2}$
MIKES	0.03	0.76
CMI	0.35	1.00
DMDM	0.43	1.20
INM(RO)	-0.71	1.30
VSL	1.20	1.10
GUM	-0.73	1.00
BIM	-1.00	2.60
BEV	-0.80	1.40
SP	0.02	1.40
CENAM	-0.41	1.09
INMETRO	0.48	2.08
INTI	-0.45	1.01
NSC "Institute of Metrology"	-0.94	1.05

In blue: participants in EURAMET.PR-K4 only

In green: participants in SIM.PR-K4 only

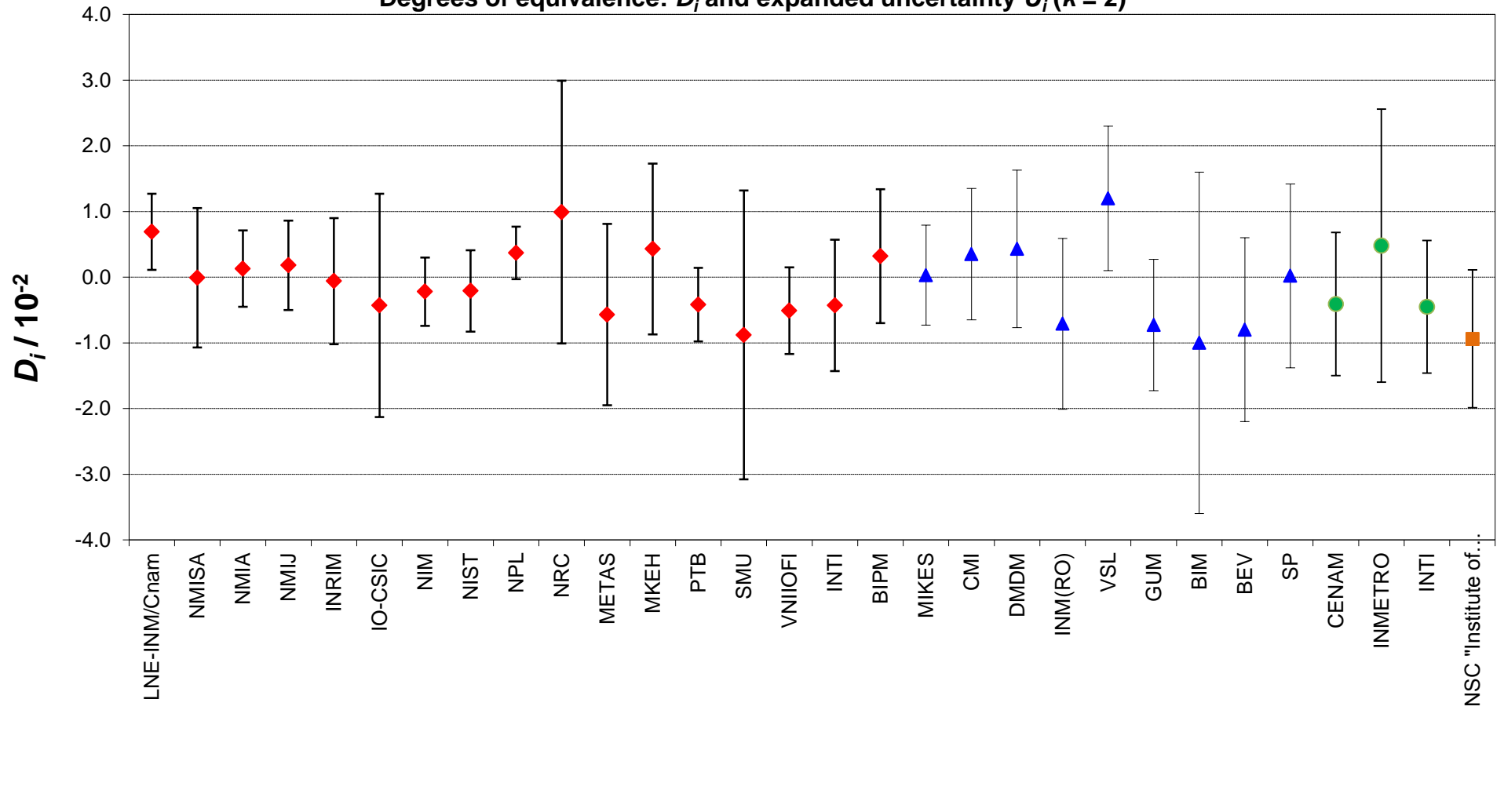
In orange: participant in COOMET.PR-K4.1 only

 Cutoff uncertainty (0.30 %) applied to the laboratory measurement in the calculation of  $x_R$   
 Laboratory excluded from the calculation of  $x_R$

Acronyms of participants in CCPR-K4 (1997 - 1998) have been updated in June 2015

# CCPR-K4, EURAMET.PR-K4, SIM.PR-K4 and COOMET.PR-K4.1 Luminous flux of lamps

Degrees of equivalence:  $D_i$  and expanded uncertainty  $U_i$  ( $k = 2$ )



Red diamonds: participants in CCPR-K4  
Blue triangles: participants in EURAMET.PR-K4 only

Green circles: participants in SIM.PR-K4 only  
Orange square: participant in COOMET.PR-K4.1 only