# Key comparisons CCPR-K3.b, APMP.PR-K3.b, CCPR-K3.b.2, CCPR-K3.b.1, and EUROMET.PR-K3.b.1

**MEASURAND :** Luminous responsivity of photometers

**The individual measurements, $x_i$, of the participating laboratories correspond to the results of a virtual calibration of the luminous responsivity of the same photometer.**

## Key comparison CCPR-K3.b

**The key comparison reference value, $x_R$, is calculated as the weighted mean of the participant's results, weighted by the inverse square of the individual standard uncertainties, $u_i$, with the application of a minimum uncertainty cutoff of 0.2%.**

**The KRISS is excluded from the calculation of $x_R$.**

**The standard uncertainty of $x_R$ is $u_R$ = 0.06%.**

**The degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms:**
**$D_i = (x_i - x_R)$ and $U_i$, its expanded uncertainty ($k$ = 2), both expressed in relative units.**
**$U_i = 2(u_i^2 + u_R^2 - u_{corr}^2 + u_{transfer}^2)^{1/2}$, where $u_{corr}$ is the correlation between $u_i$ and $u_R$. $u_{transfer}$ = 0.09%.**

**The degree of equivalence between two laboratories is given by a pair of terms:**
**$D_{ij} = D_i - D_j = (x_i - x_j)$ and $U_{ij}$, its expanded uncertainty ($k$ = 2), both expressed in relative units.**
**$U_{ij} = 2(u_i^2 + u_j^2 + 2u_{transfer}^2)^{1/2}$.**

## MSL primary reference

**Subsequent to the key comparison CCPR-K3.b and prior to the key comparison APMP.PR-K3.b, MSL re-established their primary reference, finding a relative change in value of +0.96% with a standard uncertainty of 0.04%.**

# Key comparisons CCPR-K3.b, APMP.PR-K3.b, CCPR-K3.b.2, CCPR-K3.b.1, and EUROMET.PR-K3.b.1

## Linking APMP.PR-K3.b results to CCPR-K3.b results

Three laboratories (NMIA, MSL and KRISS) participated in both comparisons. KRISS identified a problem with their reference photometer in the CCPR-K3.b key comparison, and the values obtained were not reliable. The two linking laboratories are thus: NMIA and MSL.

The computation of the linkage is described on pages 6 and 7 of the APMP.PR-K3.b Final Report.
The calculation of the degrees of equivalence relative to the CCPR-K3.b key comparison reference value, $D_i$ and $U_i$, and between pairs of laboratories, $D_{ij}$ and $U_{ij}$, is available from the Appendix B of the same Final Report.

<u>Notes:</u>

- For the two linking laboratories (NMIA and MSL), no new results are generated by the key comparison APMP.PR-K3.b.

- A new result is produced by the key comparison APMP.PR-K3.b for KRISS.

- The degrees of equivalence between two participants in APMP.PR-K3.b only, or between one participant in APMP.PR-K3.b only and one of the linking laboratories (NMIA or MSL) are calculated directly from the results of APMP.PR-K3.b:
$D_{ij}$ is calculated as the difference of the deviations of laboratories $i$ and $j$ from the pilot laboratory, and
$U_{ij}$ is calculated as twice the square root of the quadratic sum of the standard uncertainties of the deviations of laboratories $i$ and $j$ from the pilot laboratory.

- The degrees of equivalence between one participant in APMP.PR-K3.b only and one participant in CCPR-K3.b (except NMIA and MSL) are calculated as:
$D_{ij} = D_i - D_j$ and $U_{ij} = (U_i^2 + U_j^2)^{1/2}$. The correlation brought by the key comparison reference value is negligible.

# Key comparisons CCPR-K3.b, APMP.PR-K3.b, CCPR-K3.b.2, CCPR-K3.b.1, and EUROMET.PR-K3.b.1

## Linking CCPR-K3.b.2 results to CCPR-K3.b results

The link to the key comparison CCPR-K3.b is given by the pilot laboratory HUT that participated in both comparisons.
No new results are produced by the key comparison CCPR-K3.b.2 for HUT.

The degree of equivalence of KRISS relative to the CCPR-K3.b key comparison reference value is given by:
$D_{KRISS}$ = -0.0053 and $U_{KRISS}$ = 0.0060, see Appendix 2 of the Final Report.
The degrees of equivalence between  KRISS participant in CCPR-K3.b.2 and one laboratory $j$ participant in CCPR-K3.b are calculated,
see Appendix 2 of the Final Report.

The degrees of equivalence between KRISS participant in CCPR-K3.b.2 and one participant in APMP.PR-K3.b are not calculated.

## Linking CCPR-K3.b.1 results to CCPR-K3.b results

The link to the key comparison CCPR-K3.b is given by the pilot laboratory NMIA that participated in both comparisons.
No new results are produced by the key comparison CCPR-K3.b.1 for NMIA.

The degree of equivalence of SPRING Singapore relative to the CCPR-K3.b key comparison reference value is given by:
$D_{SPRING\ Singapore}$ = 0.0017 and $U_{SPRING\ Singapore}$ = 0.0030, see section 9 of the Final Report.

The pair-wise degrees of equivalence involving SPRING Singapore participant in CCPR-K3.b.1 are not calculated.

## Linking EUROMET.PR-K3.b.1 results to CCPR-K3.b results

The link to the key comparison CCPR-K3.b is given by the pilot laboratory IFA that participated in both comparisons.
No new results are produced by the key comparison EUROMET.PR-K3.b.1 for IFA.

The degree of equivalence of UME relative to the CCPR-K3.b key comparison reference value is given by:
$D_{UME}$ = 0.0041 and $U_{UME}$ = 0.0063, see Appendix 2 of the Final Report.

The degrees of equivalence between UME and the laboratories participant in CCPR-K3.b are given in Appendix 2 of the Final Report,
and reported in the Matrix of equivalence.

# Matrix of equivalence

**Lab j** ⟹

**Lab i** ⬇

| Lab i | $D_i$ / $10^{-2}$ | $U_i$ / $10^{-2}$ | LNE-INM $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | IFA $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | *NMIA $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | HUT $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | MSL $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | (KRISS) $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ | *NIM $D_{ij}$ / $10^{-2}$ | $U_{ij}$ / $10^{-2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LNE-INM | -0.80 | 0.57 | | | -1.18 | 0.86 | -0.89 | 0.71 | -0.45 | 0.86 | 0.01 | 0.79 | -2.90 | 0.86 | -0.93 | 0.66 |
| IFA | 0.38 | 0.61 | 1.18 | 0.86 | | | 0.29 | 0.74 | 0.73 | 0.89 | 1.19 | 0.82 | -1.72 | 0.89 | 0.25 | 0.69 |
| *NMIA | 0.09 | 0.39 | 0.89 | 0.71 | -0.29 | 0.74 | | | 0.44 | 0.74 | 0.90 | 0.67 | -2.01 | 0.74 | -0.04 | 0.50 |
| HUT | -0.35 | 0.61 | 0.45 | 0.86 | -0.73 | 0.89 | -0.44 | 0.74 | | | 0.46 | 0.82 | -2.45 | 0.89 | -0.48 | 0.69 |
| MSL | -0.81 | 0.51 | -0.01 | 0.79 | -1.19 | 0.82 | -0.90 | 0.67 | -0.46 | 0.82 | | | -2.91 | 0.82 | -0.94 | 0.61 |
| (KRISS) | 2.10 | 0.64 | 2.90 | 0.86 | 1.72 | 0.89 | 2.01 | 0.74 | 2.45 | 0.89 | 2.91 | 0.82 | | | 1.97 | 0.69 |
| *NIM | 0.13 | 0.30 | 0.93 | 0.66 | -0.25 | 0.69 | 0.04 | 0.50 | 0.48 | 0.69 | 0.94 | 0.61 | -1.97 | 0.69 | | |
| NIST | -0.15 | 0.42 | 0.65 | 0.73 | -0.53 | 0.76 | -0.24 | 0.60 | 0.20 | 0.76 | 0.66 | 0.69 | -2.25 | 0.76 | -0.28 | 0.53 |
| *NPL | -0.03 | 0.39 | 0.77 | 0.71 | -0.41 | 0.74 | -0.12 | 0.57 | 0.32 | 0.74 | 0.78 | 0.67 | -2.13 | 0.74 | -0.16 | 0.50 |
| NRC | 0.00 | 1.01 | 0.80 | 1.17 | -0.38 | 1.19 | -0.09 | 1.09 | 0.35 | 1.19 | 0.81 | 1.15 | -2.10 | 1.19 | -0.13 | 1.06 |
| METAS | 1.02 | 0.51 | 1.82 | 0.79 | 0.64 | 0.82 | 0.93 | 0.67 | 1.37 | 0.82 | 1.83 | 0.75 | -1.08 | 0.82 | 0.89 | 0.61 |
| OMH | -0.37 | 0.57 | 0.43 | 0.83 | -0.75 | 0.86 | -0.46 | 0.71 | -0.02 | 0.86 | 0.44 | 0.79 | -2.47 | 0.86 | -0.50 | 0.66 |
| *PTB | 0.35 | 0.37 | 1.15 | 0.70 | -0.03 | 0.74 | 0.26 | 0.56 | 0.70 | 0.74 | 1.16 | 0.66 | -1.75 | 0.74 | 0.22 | 0.49 |
| SMU | -0.24 | 1.54 | 0.56 | 1.66 | -0.62 | 1.67 | -0.33 | 1.60 | 0.11 | 1.67 | 0.57 | 1.64 | -2.34 | 1.67 | -0.37 | 1.58 |
| VNIIOFI | 0.30 | 0.49 | 1.10 | 0.78 | -0.08 | 0.81 | 0.21 | 0.65 | 0.65 | 0.81 | 1.11 | 0.74 | -1.80 | 0.81 | 0.17 | 0.59 |
| BIPM | -0.16 | 0.51 | 0.64 | 0.79 | -0.54 | 0.82 | -0.25 | 0.67 | 0.19 | 0.82 | 0.65 | 0.75 | -2.26 | 0.82 | -0.29 | 0.61 |
| MSL | 0.15 | 0.52 | 0.95 | 0.80 | -0.23 | 0.83 | 0.06 | 0.67 | 0.50 | 0.83 | 0.96 | 0.08 | -1.95 | 0.83 | 0.02 | 0.62 |
| CMS/ITRI | 1.3 | 1.4 | 2.1 | 1.6 | 0.9 | 1.5 | 1.2 | 1.4 | 1.7 | 1.5 | 2.1 | 1.6 | | | 1.2 | 1.4 |
| KRISS | -1.3 | 0.8 | -0.5 | 1.0 | -1.7 | 1.0 | -1.3 | 0.6 | -1.0 | 1.0 | -0.5 | 0.8 | | | -1.4 | 0.9 |
| NPLI | 1.4 | 2.6 | 2.2 | 2.7 | 1.0 | 2.7 | 1.4 | 2.5 | 1.8 | 2.7 | 2.2 | 2.6 | | | 1.3 | 2.6 |
| SPRING Singapore | -0.3 | 1.2 | 0.5 | 1.3 | -0.7 | 1.3 | -0.3 | 1.1 | 0.1 | 1.3 | 0.6 | 1.2 | | | -0.4 | 1.2 |
| KRISS | -0.53 | 0.60 | 0.27 | 0.84 | -0.91 | 0.87 | -0.62 | 0.72 | -0.18 | 0.87 | 0.28 | 0.80 | | | -0.66 | 0.67 |
| SPRING Singapore | 0.17 | 0.30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| UME | 0.41 | 0.63 | 1.21 | 0.85 | 0.03 | 0.87 | 0.32 | 0.73 | 0.76 | 0.87 | 1.22 | 0.81 | - | - | 0.28 | 0.68 |

| | |
|---|---|
| * Lab | the weight applied in the calculation of the key comparison reference value corresponds to the cutoff uncertainty |
| (Lab) | KRISS result not used in the calculation of the key comparison reference value due to a problem with its reference standard |
| MSL | amended scale of MSL |
| KRISS | participant laboratory in CCPR-K3.b.2 |
| SPRING Singapore | participant laboratory in CCPR-K3.b.1 |
| UME | participant laboratory in EUROMET.PR-K3.b.1 |

# Matrix of equivalence (Continued)

| Lab i | $D_i$ / $10^{-2}$ | $U_i$ / $10^{-2}$ | NIST $D_{ij}$ / $10^{-2}$ | NIST $U_{ij}$ / $10^{-2}$ | *NPL $D_{ij}$ / $10^{-2}$ | *NPL $U_{ij}$ / $10^{-2}$ | NRC $D_{ij}$ / $10^{-2}$ | NRC $U_{ij}$ / $10^{-2}$ | METAS $D_{ij}$ / $10^{-2}$ | METAS $U_{ij}$ / $10^{-2}$ | OMH $D_{ij}$ / $10^{-2}$ | OMH $U_{ij}$ / $10^{-2}$ | *PTB $D_{ij}$ / $10^{-2}$ | *PTB $U_{ij}$ / $10^{-2}$ | SMU $D_{ij}$ / $10^{-2}$ | SMU $U_{ij}$ / $10^{-2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LNE-INM | -0.80 | 0.57 | -0.65 | 0.73 | -0.77 | 0.71 | -0.80 | 1.17 | -1.82 | 0.79 | -0.43 | 0.83 | -1.15 | 0.70 | -0.56 | 1.66 |
| IFA | 0.38 | 0.61 | 0.53 | 0.76 | 0.41 | 0.74 | 0.38 | 1.19 | -0.64 | 0.82 | 0.75 | 0.86 | 0.03 | 0.74 | 0.62 | 1.67 |
| *NMIA | 0.09 | 0.39 | 0.24 | 0.60 | 0.12 | 0.57 | 0.09 | 1.09 | -0.93 | 0.67 | 0.46 | 0.71 | -0.26 | 0.56 | 0.33 | 1.60 |
| HUT | -0.35 | 0.61 | -0.20 | 0.76 | -0.32 | 0.74 | -0.35 | 1.19 | -1.37 | 0.82 | 0.02 | 0.86 | -0.70 | 0.74 | -0.11 | 1.67 |
| MSL | -0.81 | 0.51 | -0.66 | 0.69 | -0.78 | 0.67 | -0.81 | 1.15 | -1.83 | 0.75 | -0.44 | 0.79 | -1.16 | 0.66 | -0.57 | 1.64 |
| (KRISS) | 2.10 | 0.64 | 2.25 | 0.76 | 2.13 | 0.74 | 2.10 | 1.19 | 1.08 | 0.82 | 2.47 | 0.86 | 1.75 | 0.74 | 2.34 | 1.67 |
| *NIM | 0.13 | 0.30 | 0.28 | 0.53 | 0.16 | 0.50 | 0.13 | 1.06 | -0.89 | 0.61 | 0.50 | 0.66 | -0.22 | 0.49 | 0.37 | 1.58 |
| NIST | -0.15 | 0.42 | | | -0.12 | 0.60 | -0.15 | 1.11 | -1.17 | 0.69 | 0.22 | 0.73 | -0.50 | 0.58 | 0.09 | 1.61 |
| *NPL | -0.03 | 0.39 | 0.12 | 0.60 | | | -0.03 | 1.09 | -1.05 | 0.67 | 0.34 | 0.71 | -0.38 | 0.56 | 0.21 | 1.60 |
| NRC | 0.00 | 1.01 | 0.15 | 1.11 | 0.03 | 1.09 | | | -1.02 | 1.15 | 0.37 | 1.17 | -0.35 | 1.09 | 0.24 | 1.85 |
| METAS | 1.02 | 0.51 | 1.17 | 0.69 | 1.05 | 0.67 | 1.02 | 1.15 | | | 1.39 | 0.79 | 0.67 | 0.66 | 1.26 | 1.64 |
| OMH | -0.37 | 0.57 | -0.22 | 0.73 | -0.34 | 0.71 | -0.37 | 1.17 | -1.39 | 0.79 | | | -0.72 | 0.70 | -0.13 | 1.66 |
| *PTB | 0.35 | 0.37 | 0.50 | 0.58 | 0.38 | 0.56 | 0.35 | 1.09 | -0.67 | 0.66 | 0.72 | 0.70 | | | 0.59 | 1.60 |
| SMU | -0.24 | 1.54 | -0.09 | 1.61 | -0.21 | 1.60 | -0.24 | 1.85 | -1.26 | 1.64 | 0.13 | 1.66 | -0.59 | 1.60 | | |
| VNIIOFI | 0.30 | 0.49 | 0.45 | 0.67 | 0.33 | 0.65 | 0.30 | 1.14 | -0.72 | 0.74 | 0.67 | 0.78 | -0.05 | 0.64 | 0.54 | 1.63 |
| BIPM | -0.16 | 0.51 | -0.01 | 0.69 | -0.13 | 0.67 | -0.16 | 1.15 | -1.18 | 0.75 | 0.21 | 0.79 | -0.51 | 0.66 | 0.08 | 1.64 |
| MSL | 0.15 | 0.52 | 0.30 | 0.69 | 0.18 | 0.67 | 0.15 | 1.15 | -0.87 | 0.76 | 0.52 | 0.80 | -0.20 | 0.66 | 0.39 | 1.64 |
| CMS/ITRI | 1.3 | 1.4 | 1.5 | 1.5 | 1.3 | 1.4 | 1.3 | 1.7 | 0.3 | 1.5 | 1.7 | 1.5 | 1.0 | 1.4 | 1.5 | 2.1 |
| KRISS | -1.3 | 0.8 | -1.2 | 0.9 | -1.3 | 0.9 | -1.3 | 1.3 | -2.3 | 1.0 | -0.9 | 1.0 | -1.7 | 0.9 | -1.1 | 1.7 |
| NPLI | 1.4 | 2.6 | 1.6 | 2.6 | 1.4 | 2.6 | 1.4 | 2.8 | 0.4 | 2.7 | 1.8 | 2.7 | 1.1 | 2.6 | 1.6 | 3.0 |
| SPRING Singapore | -0.3 | 1.2 | -0.2 | 1.3 | -0.3 | 1.3 | -0.3 | 1.6 | -1.3 | 1.3 | 0.1 | 1.3 | -0.7 | 1.3 | -0.1 | 2.0 |
| KRISS | -0.53 | 0.60 | -0.38 | 0.74 | -0.50 | 0.72 | -0.53 | 1.18 | -1.55 | 0.80 | -0.16 | 0.84 | -0.88 | 0.71 | -0.29 | 1.66 |
| SPRING Singapore | 0.17 | 0.30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| UME | 0.41 | 0.63 | 0.56 | 0.75 | 0.44 | 0.73 | 0.41 | 1.18 | -0.61 | 0.81 | 0.78 | 0.85 | 0.06 | 0.72 | 0.65 | 1.67 |

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|---|---|
| * Lab | the weight applied in the calculation of the key comparison reference value corresponds to the cutoff uncertainty |
| (Lab) | KRISS result not used in the calculation of the key comparison reference value due to a problem with its reference standard |
| MSL | amended scale of MSL |
| KRISS | participant laboratory in CCPR-K3.b.2 |
| SPRING Singapore | participant laboratory in CCPR-K3.b.1 |
| UME | participant laboratory in EUROMET.PR-K3.b.1 |

# Matrix of equivalence (Continued)

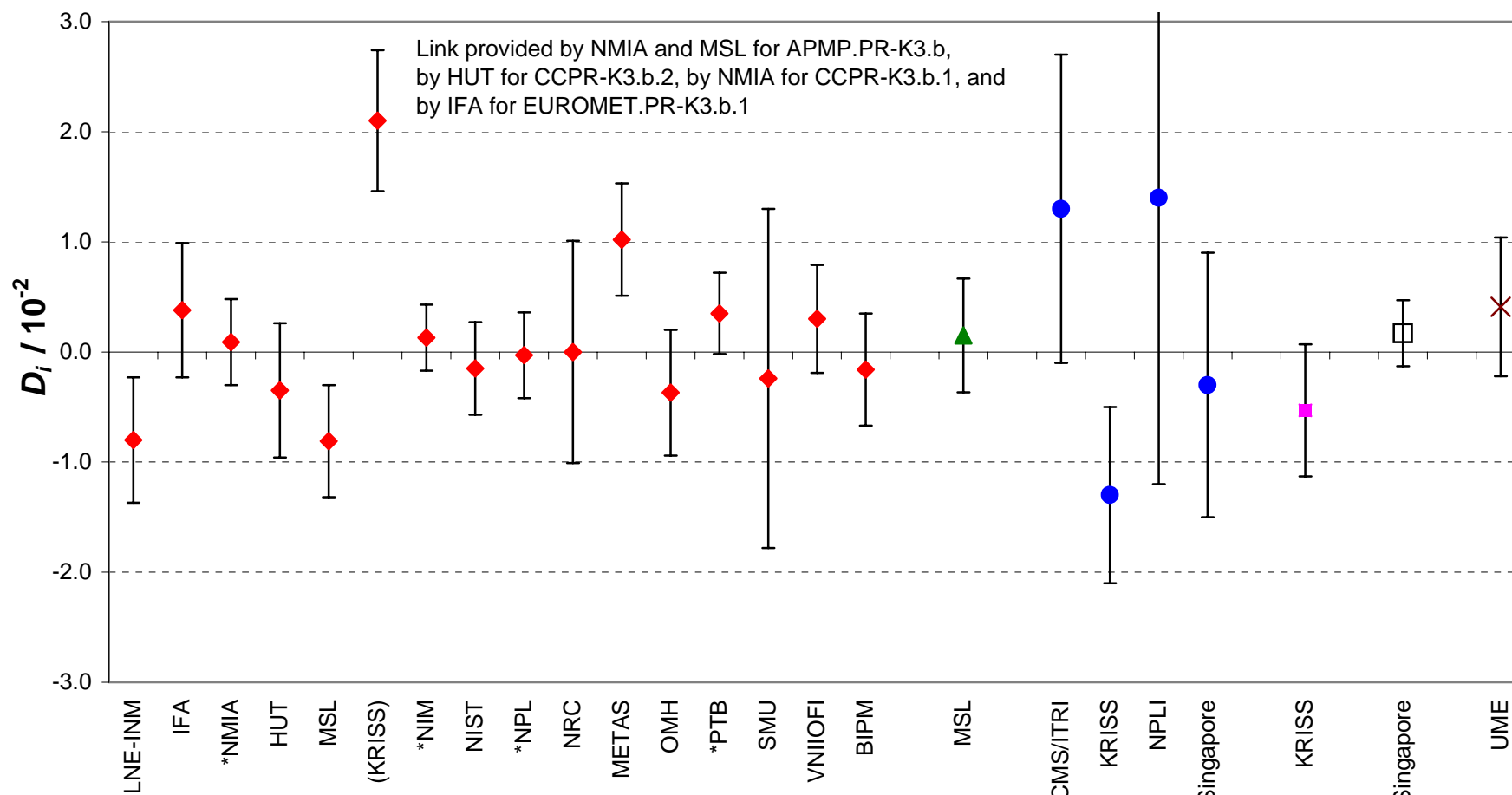| Lab i | $D_i$ /$10^{-2}$ | $U_i$ /$10^{-2}$ | VNIIOFI $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | BIPM $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | MSL $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | CMS/ITRI $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | KRISS $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | NPLI $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ | SPRING $D_{ij}$ /$10^{-2}$ | $U_{ij}$ /$10^{-2}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LNE-INM | -0.80 | 0.57 | -1.10 | 0.78 | -0.64 | 0.79 | -0.95 | 0.80 | -2.1 | 1.6 | 0.5 | 1.0 | -2.2 | 2.7 | -0.5 | 1.3 |
| IFA | 0.38 | 0.61 | 0.08 | 0.81 | 0.54 | 0.82 | 0.23 | 0.83 | -0.9 | 1.5 | 1.7 | 1.0 | -1.0 | 2.7 | 0.7 | 1.3 |
| *NMIA | 0.09 | 0.39 | -0.21 | 0.65 | 0.25 | 0.67 | -0.06 | 0.67 | -1.2 | 1.4 | 1.3 | 0.6 | -1.4 | 2.5 | 0.3 | 1.1 |
| HUT | -0.35 | 0.61 | -0.65 | 0.81 | -0.19 | 0.82 | -0.50 | 0.83 | -1.7 | 1.5 | 1.0 | 1.0 | -1.8 | 2.7 | -0.1 | 1.3 |
| MSL | -0.81 | 0.51 | -1.11 | 0.74 | -0.65 | 0.75 | -0.96 | 0.08 | -2.1 | 1.6 | 0.5 | 0.8 | -2.2 | 2.6 | -0.6 | 1.2 |
| (KRISS) | 2.10 | 0.64 | 1.80 | 0.81 | 2.26 | 0.82 | 1.95 | 0.83 |  |  |  |  |  |  |  |  |
| *NIM | 0.13 | 0.30 | -0.17 | 0.59 | 0.29 | 0.61 | -0.02 | 0.62 | -1.2 | 1.4 | 1.4 | 0.9 | -1.3 | 2.6 | 0.4 | 1.2 |
| NIST | -0.15 | 0.42 | -0.45 | 0.67 | 0.01 | 0.69 | -0.30 | 0.69 | -1.5 | 1.5 | 1.2 | 0.9 | -1.6 | 2.6 | 0.2 | 1.3 |
| *NPL | -0.03 | 0.39 | -0.33 | 0.65 | 0.13 | 0.67 | -0.18 | 0.67 | -1.3 | 1.4 | 1.3 | 0.9 | -1.4 | 2.6 | 0.3 | 1.3 |
| NRC | 0.00 | 1.01 | -0.30 | 1.14 | 0.16 | 1.15 | -0.15 | 1.15 | -1.3 | 1.7 | 1.3 | 1.3 | -1.4 | 2.8 | 0.3 | 1.6 |
| METAS | 1.02 | 0.51 | 0.72 | 0.74 | 1.18 | 0.75 | 0.87 | 0.76 | -0.3 | 1.5 | 2.3 | 1.0 | -0.4 | 2.7 | 1.3 | 1.3 |
| OMH | -0.37 | 0.57 | -0.67 | 0.78 | -0.21 | 0.79 | -0.52 | 0.80 | -1.7 | 1.5 | 0.9 | 1.0 | -1.8 | 2.7 | -0.1 | 1.3 |
| *PTB | 0.35 | 0.37 | 0.05 | 0.64 | 0.51 | 0.66 | 0.20 | 0.66 | -1.0 | 1.4 | 1.7 | 0.9 | -1.1 | 2.6 | 0.7 | 1.3 |
| SMU | -0.24 | 1.54 | -0.54 | 1.63 | -0.08 | 1.64 | -0.39 | 1.64 | -1.5 | 2.1 | 1.1 | 1.7 | -1.6 | 3.0 | 0.1 | 2.0 |
| VNIIOFI | 0.30 | 0.49 |  |  | 0.46 | 0.74 | 0.15 | 0.74 | -1.0 | 1.5 | 1.6 | 0.9 | -1.1 | 2.6 | 0.6 | 1.3 |
| BIPM | -0.16 | 0.51 | -0.46 | 0.74 |  |  | -0.31 | 0.76 | -1.5 | 1.5 | 1.1 | 1.0 | -1.6 | 2.7 | 0.1 | 1.3 |
| MSL | 0.15 | 0.52 | -0.15 | 0.74 | 0.31 | 0.76 |  |  | -1.1 | 1.6 | 1.5 | 0.8 | -1.2 | 2.6 | 0.4 | 1.2 |
| CMS/ITRI | 1.3 | 1.4 | 1.0 | 1.5 | 1.5 | 1.5 | 1.1 | 1.6 |  |  | 2.6 | 1.6 | -0.1 | 3.0 | 1.5 | 1.8 |
| KRISS | -1.3 | 0.8 | -1.6 | 0.9 | -1.1 | 1.0 | -1.5 | 0.8 | -2.6 | 1.6 |  |  | -2.7 | 2.6 | -1.1 | 1.3 |
| NPLI | 1.4 | 2.6 | 1.1 | 2.6 | 1.6 | 2.7 | 1.2 | 2.6 | 0.1 | 3.0 | 2.7 | 2.6 |  |  | 1.6 | 2.8 |
| SPRING Singapore | -0.3 | 1.2 | -0.6 | 1.3 | -0.1 | 1.3 | -0.4 | 1.2 | -1.5 | 1.8 | 1.1 | 1.3 | -1.6 | 2.8 |  |  |
| KRISS | -0.53 | 0.60 | -0.83 | 0.79 | -0.37 | 0.80 | - | - | - | - | - | - | - | - | - | - |
| SPRING Singapore | 0.17 | 0.30 | - | - | - | - | - | - | - | - | - | - | - | - |  |  |
| UME | 0.41 | 0.63 | 0.11 | 0.80 | 0.57 | 0.81 | - | - | - | - | - | - | - | - | - | - |

| | |
|---|---|
| * Lab | the weight applied in the calculation of the key comparison reference value corresponds to the cutoff uncertainty |
| (Lab) | KRISS result not used in the calculation of the key comparison reference value due to a problem with its reference standard |
| MSL | amended scale of MSL |
| KRISS | participant laboratory in CCPR-K3.b.2 |
| SPRING Singapore | participant laboratory in CCPR-K3.b.1 |
| UME | participant laboratory in EUROMET.PR-K3.b.1 |

## Matrix of equivalence (Continued)

Lab *i* ⇩

| Lab *i* | $D_i$ / $10^{-2}$ | $U_i$ / $10^{-2}$ | KRISS $D_{ij}$ / $10^{-2}$ | KRISS $U_{ij}$ / $10^{-2}$ | SPRING $D_{ij}$ / $10^{-2}$ | SPRING $U_{ij}$ / $10^{-2}$ | UME $D_{ij}$ / $10^{-2}$ | UME $U_{ij}$ / $10^{-2}$ |
|---|---|---|---|---|---|---|---|---|
| LNE-INM | -0.80 | 0.57 | -0.27 | 0.84 | - | - | -1.21 | 0.85 |
| IFA | 0.38 | 0.61 | 0.91 | 0.87 | - | - | -0.03 | 0.87 |
| *NMIA | 0.09 | 0.39 | 0.62 | 0.72 | - | - | -0.32 | 0.73 |
| HUT | -0.35 | 0.61 | 0.18 | 0.87 | - | - | -0.76 | 0.87 |
| MSL | -0.81 | 0.51 | -0.28 | 0.80 | - | - | -1.22 | 0.81 |
| (KRISS) | 2.10 | 0.64 | | | - | - | - | - |
| *NIM | 0.13 | 0.30 | 0.66 | 0.67 | - | - | -0.28 | 0.68 |
| NIST | -0.15 | 0.42 | 0.38 | 0.74 | - | - | -0.56 | 0.75 |
| *NPL | -0.03 | 0.39 | 0.50 | 0.72 | - | - | -0.44 | 0.73 |
| NRC | 0.00 | 1.01 | 0.53 | 1.18 | - | - | -0.41 | 1.18 |
| METAS | 1.02 | 0.51 | 1.55 | 0.80 | - | - | 0.61 | 0.81 |
| OMH | -0.37 | 0.57 | 0.16 | 0.84 | - | - | -0.78 | 0.85 |
| *PTB | 0.35 | 0.37 | 0.88 | 0.71 | - | - | -0.06 | 0.72 |
| SMU | -0.24 | 1.54 | 0.29 | 1.66 | - | - | -0.65 | 1.67 |
| VNIIOFI | 0.30 | 0.49 | 0.83 | 0.79 | - | - | -0.11 | 0.80 |
| BIPM | -0.16 | 0.51 | 0.37 | 0.80 | - | - | -0.57 | 0.81 |
| MSL | 0.15 | 0.52 | - | - | - | - | - | - |
| CMS/ITRI | 1.3 | 1.4 | - | - | - | - | - | - |
| KRISS | -1.3 | 0.8 | - | - | - | - | - | - |
| NPLI | 1.4 | 2.6 | - | - | - | - | - | - |
| SPRING Singapore | -0.3 | 1.2 | - | - | - | - | - | - |
| KRISS | -0.53 | 0.60 | | | - | - | - | - |
| SPRING Singapore | 0.17 | 0.30 | - | - | | | - | - |
| UME | 0.41 | 0.63 | - | - | - | - | | |

| | |
|---|---|
| * Lab | the weight applied in the calculation of the key comparison reference value corresponds to the cutoff uncertainty |
| (Lab) | KRISS result not used in the calculation of the key comparison reference value due to a problem with its reference standard |
| MSL | amended scale of MSL |
| KRISS | participant laboratory in CCPR-K3.b.2 |
| SPRING Singapore | participant laboratory in CCPR-K3.b.1 |
| UME | participant laboratory in EUROMET.PR-K3.b.1 |

**CCPR-K3.b, .1, .2, APMP.PR-K3.b, EUROMET.PR-K3.b.1    Luminous responsivity of photometers**
**Degrees of equivalence: $D_i$ and expanded uncertainty $U_i$ ($k$ = 2)**



Link provided by NMIA and MSL for APMP.PR-K3.b,
by HUT for CCPR-K3.b.2, by NMIA for CCPR-K3.b.1, and
by IFA for EUROMET.PR-K3.b.1

**Red diamonds**: CCPR-K3.b participants,
**Green triangle**: amended MSL value,
**Blue circles**: APMP.PR-K3.b participants only,
**Pink square**: CCPR-K3.b.2
**Empty black square**: CCPR-K3.b.1
**Brown cross**: EUROMET.PR-K3.b.1

**\*** uncertainty cutoff (0.2%) applied in the calculation of $x_R$,
(KRISS): laboratory excluded from the calculation of $x_R$.