

Key comparison EURAMET.L-K7.2014

MEASURAND: Distance between the centre line position of the reference line and the centre line position of the measured line of the linescale

NOMINAL VALUES: 39 nominal values from 1 mm to 300 mm

x_{ik} : result of measurement carried out by laboratory i for the line centre at nominal distance L_k expressed as the deviation from nominal length in nm
 u_{ik} : combined standard uncertainty of x_{ik} reported by laboratory i
 The measurements were carried out in November 2014.

| Nominal position L_k ($k = 1$ to 39) / mm | LNE | | Puslit KIM-LIPI | |
|---|--------------------------------|--------------------------------|---|---|
| | $x_{LNE,k}$ / μm | $u_{LNE,k}$ / μm | $x_{\text{Puslit KIM-LIPI},k}$ / μm | $u_{\text{Puslit KIM-LIPI},k}$ / μm |
| 1 | 0.073 | 0.028 | 0.060 | 0.600 |
| 2 | -0.023 | 0.028 | 0.100 | 0.600 |
| 3 | -0.039 | 0.028 | 0.080 | 0.600 |
| 4 | 0.007 | 0.028 | 0.040 | 0.600 |
| 5 | -0.017 | 0.028 | 0.080 | 0.600 |
| 6 | -0.006 | 0.028 | 0.080 | 0.600 |
| 7 | -0.027 | 0.028 | 0.030 | 0.600 |
| 8 | 0.022 | 0.028 | -0.030 | 0.600 |
| 9 | -0.025 | 0.028 | 0.000 | 0.600 |
| 10 | -0.060 | 0.028 | 0.110 | 0.600 |
| 20 | -0.084 | 0.029 | -0.150 | 0.600 |
| 30 | -0.188 | 0.030 | -0.020 | 0.600 |
| 40 | -0.278 | 0.031 | 0.080 | 0.600 |
| 50 | -0.304 | 0.033 | 0.030 | 0.600 |
| 60 | -0.397 | 0.035 | -0.040 | 0.600 |
| 70 | -0.416 | 0.037 | 0.060 | 0.600 |
| 80 | -0.490 | 0.040 | -0.010 | 0.600 |
| 90 | -0.648 | 0.042 | -0.280 | 0.601 |
| 100 | -0.691 | 0.045 | -0.300 | 0.601 |
| 110 | -0.801 | 0.048 | -0.570 | 0.601 |
| 120 | -0.815 | 0.050 | -0.750 | 0.601 |
| 130 | -0.930 | 0.053 | -0.690 | 0.601 |
| 140 | -0.983 | 0.056 | -0.600 | 0.601 |
| 150 | -1.120 | 0.060 | -0.720 | 0.602 |
| 160 | -1.082 | 0.063 | -0.740 | 0.602 |
| 170 | -1.104 | 0.066 | -0.710 | 0.602 |
| 180 | -1.163 | 0.069 | -1.040 | 0.602 |
| 190 | -1.268 | 0.072 | -1.010 | 0.603 |
| 200 | -1.246 | 0.075 | -1.500 | 0.603 |
| 210 | -1.327 | 0.079 | -1.550 | 0.603 |
| 220 | -1.463 | 0.082 | -1.480 | 0.603 |
| 230 | -1.458 | 0.085 | -1.870 | 0.604 |
| 240 | -1.560 | 0.089 | -1.630 | 0.604 |
| 250 | -1.623 | 0.092 | -1.890 | 0.604 |
| 260 | -1.731 | 0.095 | -2.290 | 0.605 |
| 270 | -1.825 | 0.099 | -2.090 | 0.605 |
| 280 | -1.890 | 0.102 | -2.130 | 0.605 |
| 290 | -2.054 | 0.105 | -2.050 | 0.606 |
| 300 | -2.108 | 0.109 | -2.390 | 0.606 |

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MEASURAND: Distance between the centre line position of the reference line and the centre line position of the measured line of the linescale
NOMINAL VALUES: 39 nominal values from 1 mm to 300 mm

For each line position k the key comparison reference value x_{Rk} is obtained from the weighted mean x_{wk} (with weights w_{ik} , based on each reported uncertainty) of the participants' values x_{ik} by adding a constant C_k chosen such that the reference value is the nominal length $L_k = x_{wk} + C_k$. The standard uncertainties u_{Rk} of the key comparison reference values are obtained from the reported standard uncertainties u_{ik} .

$$x_{Rk} = L_k = \sum_{i=1}^n w_{ik} x_{ik} + C_k$$

$$u_{Rk} = \sqrt{\frac{1}{\sum_{i=1}^n \left(\frac{1}{u_{ik}}\right)^2}}$$

Nominal position L_k
($k = 1$ to 19)
/ mm

| | x_{Rk} / μm | u_{Rk} / μm |
|-----|-----------------------------|-----------------------------|
| 1 | 0.072 | 0.028 |
| 2 | -0.023 | 0.028 |
| 3 | -0.039 | 0.028 |
| 4 | 0.007 | 0.028 |
| 5 | -0.017 | 0.028 |
| 6 | -0.006 | 0.028 |
| 7 | -0.027 | 0.028 |
| 8 | 0.021 | 0.028 |
| 9 | -0.025 | 0.028 |
| 10 | -0.060 | 0.028 |
| 20 | -0.084 | 0.029 |
| 30 | -0.187 | 0.030 |
| 40 | -0.277 | 0.031 |
| 50 | -0.303 | 0.033 |
| 60 | -0.396 | 0.035 |
| 70 | -0.414 | 0.037 |
| 80 | -0.488 | 0.040 |
| 90 | -0.646 | 0.042 |
| 100 | -0.689 | 0.045 |

Nominal position L_k
($k = 1$ to 39)
/ mm

| | x_{Rk} / μm | u_{Rk} / μm |
|-----|-----------------------------|-----------------------------|
| 110 | -0.800 | 0.047 |
| 120 | -0.814 | 0.050 |
| 130 | -0.928 | 0.053 |
| 140 | -0.980 | 0.056 |
| 150 | -1.116 | 0.059 |
| 160 | -1.078 | 0.062 |
| 170 | -1.099 | 0.065 |
| 180 | -1.162 | 0.068 |
| 190 | -1.264 | 0.072 |
| 200 | -1.249 | 0.075 |
| 210 | -1.330 | 0.078 |
| 220 | -1.464 | 0.081 |
| 230 | -1.466 | 0.084 |
| 240 | -1.561 | 0.088 |
| 250 | -1.629 | 0.091 |
| 260 | -1.781 | 0.094 |
| 270 | -1.832 | 0.097 |
| 280 | -1.897 | 0.101 |
| 290 | -2.054 | 0.104 |
| 300 | -2.117 | 0.107 |

For each line position k the degree of equivalence of each laboratory i with respect to the key comparison reference value is given by a pair of terms, both expressed in μm :

$$D_{ik} = (x_{ik} + C_k) - x_{Rk} = x_{ik} - x_{wk}, \text{ and } U_{ik} \text{ its expanded uncertainty (coverage factor 2), } U_{ik} = (u_{ik}^2 - u_{Rk}^2)^{1/2}.$$

The calculation of the degree of equivalence between two laboratories i and j is not recommended for comparisons involving many measurands since it cannot be expressed with a single pair of terms. It would have to be calculated separately for each line position k and would then be given by a pair of terms both expressed in μm :

$$D_{ijk} = (x_{ik} - x_{jk}) \text{ and } U_{ijk} \text{ its expanded uncertainty (coverage factor 2), } U_{ijk} = (u_{ik}^2 - u_{jk}^2)^{1/2}.$$

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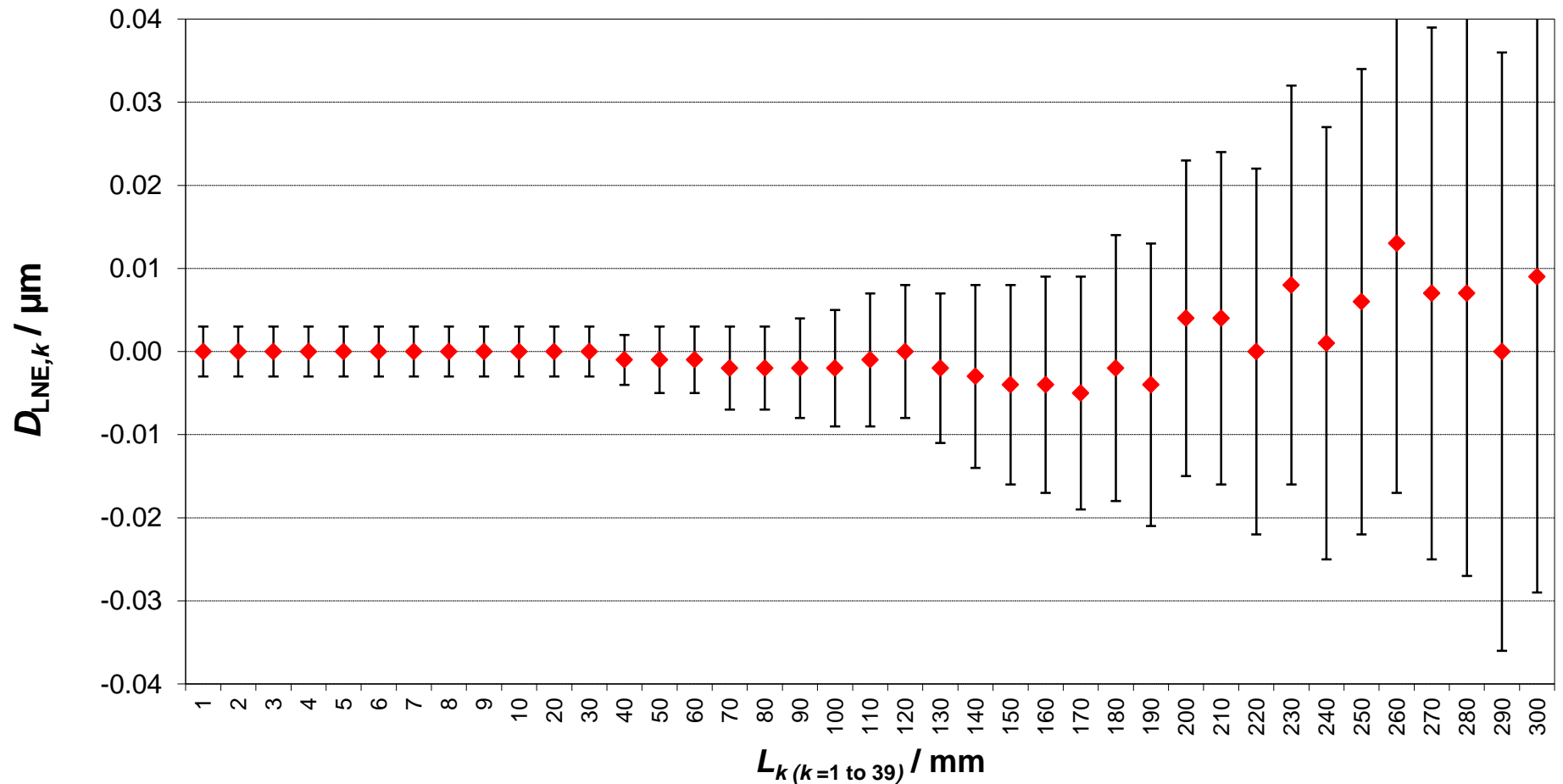
MEASURAND: Distance between the centre line position of the reference line and the centre line position of the measured line of the linescale

NOMINAL VALUES: 39 nominal values from 1 mm to 300 mm

Degrees of equivalence relative to the respective key comparison reference values D_{ik} and associated expanded uncertainty (coverage factor 2) U_{ik} for the 39 nominal positions

| Nominal position L_k ($k = 1$ to 39) / mm | LNE | | Puslit KIM-LIPI | |
|---|-----------------|-----------------|--------------------------|--------------------------|
| | $D_{LNE,k}$ | $U_{LNE,k}$ | $D_{Puslit\ KIM-LIPI,k}$ | $U_{Puslit\ KIM-LIPI,k}$ |
| | / μm | / μm | / μm | / μm |
| 1 | 0.000 | 0.003 | -0.012 | 1.199 |
| 2 | 0.000 | 0.003 | 0.123 | 1.199 |
| 3 | 0.000 | 0.003 | 0.119 | 1.199 |
| 4 | 0.000 | 0.003 | 0.033 | 1.199 |
| 5 | 0.000 | 0.003 | 0.097 | 1.199 |
| 6 | 0.000 | 0.003 | 0.086 | 1.199 |
| 7 | 0.000 | 0.003 | 0.057 | 1.199 |
| 8 | 0.000 | 0.003 | -0.051 | 1.199 |
| 9 | 0.000 | 0.003 | 0.025 | 1.199 |
| 10 | 0.000 | 0.003 | 0.170 | 1.199 |
| 20 | 0.000 | 0.003 | -0.066 | 1.199 |
| 30 | 0.000 | 0.003 | 0.167 | 1.199 |
| 40 | -0.001 | 0.003 | 0.357 | 1.199 |
| 50 | -0.001 | 0.004 | 0.333 | 1.199 |
| 60 | -0.001 | 0.004 | 0.356 | 1.198 |
| 70 | -0.002 | 0.005 | 0.474 | 1.198 |
| 80 | -0.002 | 0.005 | 0.478 | 1.198 |
| 90 | -0.002 | 0.006 | 0.366 | 1.198 |
| 100 | -0.002 | 0.007 | 0.389 | 1.198 |
| 110 | -0.001 | 0.008 | 0.230 | 1.198 |
| 120 | 0.000 | 0.008 | 0.064 | 1.198 |
| 130 | -0.002 | 0.009 | 0.238 | 1.198 |
| 140 | -0.003 | 0.011 | 0.380 | 1.197 |
| 150 | -0.004 | 0.012 | 0.396 | 1.197 |
| 160 | -0.004 | 0.013 | 0.338 | 1.197 |
| 170 | -0.005 | 0.014 | 0.389 | 1.197 |
| 180 | -0.002 | 0.016 | 0.122 | 1.197 |
| 190 | -0.004 | 0.017 | 0.254 | 1.197 |
| 200 | 0.004 | 0.019 | -0.251 | 1.196 |
| 210 | 0.004 | 0.020 | -0.220 | 1.196 |
| 220 | 0.000 | 0.022 | -0.016 | 1.196 |
| 230 | 0.008 | 0.024 | -0.404 | 1.196 |
| 240 | 0.001 | 0.026 | -0.069 | 1.195 |
| 250 | 0.006 | 0.028 | -0.261 | 1.195 |
| 260 | 0.013 | 0.030 | -0.509 | 1.195 |
| 270 | 0.007 | 0.032 | -0.258 | 1.194 |
| 280 | 0.007 | 0.034 | -0.233 | 1.194 |
| 290 | 0.000 | 0.036 | 0.004 | 1.194 |
| 300 | 0.009 | 0.038 | -0.273 | 1.194 |

EURAMET.L-K7.2014 : Line scale, nominal length, L_k
 Degrees of equivalence [$D_{LNE,k}$ and its expanded uncertainty (coverage factor 2) $U_{LNE,k}$] for LNE



EURAMET.L-K7.2014 : Line scale, nominal length, L_k
Degrees of equivalence [$D_{\text{Pulsit KIM-LIPI}, k}$ and its expanded uncertainty (coverage factor 2) $U_{\text{Pulsit KIM-LIPI}, k}$]
for Pulsit KIM-LIPI

