Accred. no. 10436
Proficiency testing
ISO/IEC 17043

**To participants**

# Report on an interlaboratory comparison (ILC weights 2022:1)

The bag carrying the weight set for calibration.


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## Calculations

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# Content

## *Abstract*

This report presents the outcome of an inter-comparison on weights with 7 participating laboratories.

Prior to the circulation of the weights among the participant laboratories most of them were calibrated by RISE (Swedish National Metrological Institute) and a minority by METTLER TOLEDO (accredited laboratory).

RISE performed all calibrations after the circulation. Their average from both calibrations serve as assigned inter-comparison reference values. Together with the combined reference uncertainty they are used to calculate En-values at each measuring point and for each participant.

This report covers all together 94 calibrations of weights made by 7 laboratories in 6 countries. Their calibration certificates were mostly in their local language but sometimes in English.

Many uncertainty claims are comparable between participants.

The summarized results from 94 number of calibrations has 0 results got En values above 1.

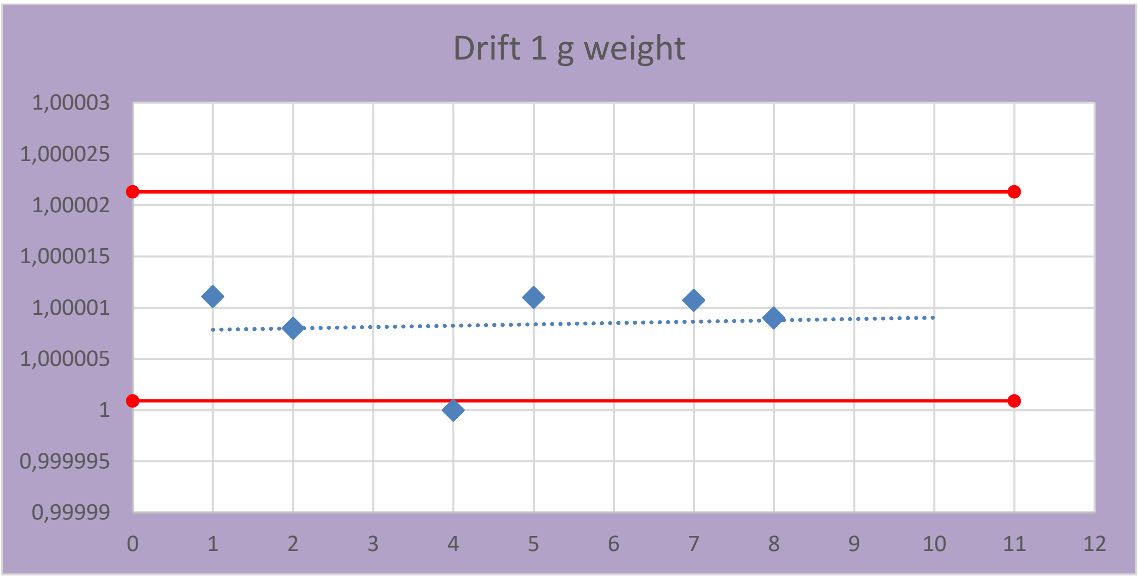
The result of this intercomparison in general is extremely good compared to intercomparisons in other fields. This is probably related to long historic cooperation in the mass field in Europe and development of mass comparator that are used for calibrations.

The stability of the weights was followed during the circulation as seen below for the 1 g weight.

The red lines are the limits of uncertainty by the reference laboratory and the blue squares the results from the different laboratories.

The dotted line is trying to find if there is a trend of the mass values.

All weights had in principle the same stability.

## *Purpose and implementation of the comparison*

This interlaboratory comparison serves as a tool to verify results reported by calibration laboratories.

It is an effective method to demonstrate technical capacity of the participant and serves as a technical base for accreditation as required by ISO/IEC 17025:2017 (SS-EN ISO/IEC 17025:2018) as specified in point 7.7.2.

## *Advisory group*

The intercomparison has followed the recommendations of the advisory group. The advisory group has defined the set-up of weights that should be included in the ILC weights 2022:1.

The advisory group consist of Peter Lau MNE Konsult and Håkan Källgren Swedish Metrology and Quality.

## *Information about the intercomparison*

The information about the intercomparison was given in 3 different media:

- Linkedin
- The data base https://www.eptis.org
- On the web https://smquality.se/interlaboratory-comparisons-ilc

The information on the web was done in 2 steps. General information as ILC weights 2022:1 published on smquality.se and enclosed to this report in annex 1.

Detailed information as a description of the intercomparison/ILC is published on smquality.se
and enclosed to this report the reporting forms as annex 2.

## *Participating laboratories and measuring scheme for the comparison*

| **Laboratory** |
|---|
| RISE (NMI) and METTLER TOLEDO (accredited) |
| Oy G.W. Berg & Co Ab |
| Lahti Precision Oy |
| IKM laboratorium AS |
| Kalibrierstelle Baselland |
| METRON SERV SRL |
| ZWIEBEL SAS |
| UAB “Milgeda” |
| RISE, reference laboratory Sweden |

The circulation started in week 11 and ended in week 40 2023.

The participants are accredited by NA, Cofrac, FINAS, DAkkS, RENAR and LIETUVOS NACIONALINIS AKREDITACIJOS BIURAS.

The reference laboratory RISE, Sweden has the status as a National Metrology Institute, NMI and did the main part of the reference calibrations. Some weights were newly purchased from Mettler Toledo that made the initial calibration as an accredited laboratory.

## *Principles concerning the calibration in general.*

The reference laboratory and one accredited laboratory calibrated all weights at the beginning and after finishing the circulation.

During the whole exercise the preliminary reported results were used for checking possible drift behaviour of the weights. The purpose was to maintain equal conditions for all participants over the total measurement period. In doubt the weights were planned to be called back for a new reference calibration, which however was not necessary.

## *Conditions and transport during the measurement period*

A special case having special filters and insulation for humidity and vibrations was used for transport.

## *Weights for calibration*

The participants were asked to calibrate at the following weights having the density values.

| Weight | Density, value or possible range | Weight | Density, value or possible range | Weight | Density, value or possi-ble range |
|---|---|---|---|---|---|
| mg | kg/m³ | g | kg/m³ | kg | kg/m³ |
| 1 | >3000 | 1 | 5300--16000 | 1 | 7810--8210 |
| 2 | >3000 | 2 | 6000--12000 | 2 | 7810--8210 |
| 5 | >3000 | 5 | 6900—9600 | | |
| 10 | >3000 | 10 | 7270—8890 | | |
| 20 | >3000 | 20 | 7500--8570 | | |
| 50 | >3000 | 50 | 8009,4 | | |
| 100 | >3000 | 100 | 7810--8210 | | |
| 200 | >3000 | 200 | 7810--8210 | | |
| 500 | >4400 | 500 | 7 989,0 | | |

## *Reference calibration certificates:*

Before the circulation from RISE
105102-1151714-K01, 105102-2F003564-K06, MYmPX11043-K01

Before circulation from Mettler-Toledo
C239866459--65

After circulation from RISE
105102-1217064-K01

## *Calibration instructions*

The laboratories were allowed maximum 10 days for their calibration. In the call they were advised to use their own calibration and reporting procedures.
The result should be presented as the conventional mass value as defined by OIML Document D 28
The laboratories should not express a classification according to the rules in OIML Recommendation 111.

## *Planning and administrative details*

## *Administrative information*

| Address to send the required documents: |
|---|
| Swedish Metrology and Quality AB<br>Håkan Källgren<br>Dragspelsgatan 21<br>SE-504 72 Borås, Sweden<br>e-mail: hakan.kallgren@smquality.se<br>Phone: +46 705 774 931 |

Summary of the timeline planning in the call:

- The preliminary results (excel-protocol) should be sent to the organiser when the parcel was sent to next participant.
- One week after the calibration/measurement the calibration certificate should be sent to the evaluator of the intercomparison.
- A draft report should be dispatched to the participants 2 weeks after receiving the last calibration certificate. The organiser was not able to deliver according to this rule and will allow more time in upcoming intercomparisons.
- Comments or feed-back on the draft report to the organiser were expected within 1 week.
- Final report should be finalized within 2 weeks after receiving all comments or feed-back from the participants.

## *Analysis of the calibration results*

The evaluator used the principles of the ISO/IEC 17043:2010 in the reporting.

As an easy-to-understand measure to judge each participant result its distance to the assigned reference value is used, normalized with respect to the uncertainty in this difference. This measure the En-value is calculated for every calibrated weight according to equation 1).

$$En_{i,j} = \frac{x_{i,j} - x_{ref,j}}{\sqrt{U_{i,j}^2 + U_{ref,j}^2}} \qquad \text{(eq. 1)}$$

$x_{i,j}$: Single measurement result (deviation from nominal mass value); index *i* and *j* count the various participants and weights respectively.

$x_{ref,j}$: Assigned inter-comparison reference value for weight *j*.

$U_{i,j}$: The estimated expanded uncertainty (k=2) stated by each laboratory *i* for respective weight *j*.

$U_{ref,j}$: The estimated expanded uncertainty (k=2) of the assigned reference value for the same weight *j*.

$En_{i,j}$: The calculated En-value for each participant i and each weight *j*.

## *Inter-comparison reference value and its uncertainty*

The reference values $x_{ref,j}$ are calculated as the average from the first and last calibration provided by the reference laboratory or the accredited laboratory and the reference laboratory.

$$x_{ref,j} = \frac{R_{1,j} + R_{2,j}}{2} \qquad \text{(eq. 2)}$$

For each instrument

$x_{ref,j}$: The calculated inter-comparison reference value for weight *j*.
*j:* Counting the different weights.
$R_{1,j}$ & $R_{2,j}$: The assigned comparison reference values provided by the reference laboratory at start and end. In the result tables and the diagrams only the symbol REF is used is used for identifying the assigned reference result.

For some weights the reported uncertainties differed slightly between the calibration at the beginning and the end. Thus, the measurement uncertainty for weight was calculated as the uncertainty of their mean (equation 3).

$$U\left(x_{ref,j}\right) = 2\sqrt{\left(\frac{U\left(R_{1,j}\right)}{2\cdot 2}\right)^2 + \left(\frac{U\left(R_{2,j}\right)}{2\cdot 2}\right)^2} + \frac{1}{2}\left|R_{2,j} - R_{1,j}\right| \quad \text{(eq. 3)}$$

*$U(x_{refj})$:* The combined expanded uncertainty – average from two calibrations.
*$U(R_{1,j})$:* The expanded uncertainty (k=2) for weight j stated in the first calibration
*$U(R_{2,j})$:* The expanded uncertainty (k=2) for weight j stated in the final calibration

The first number 2 in the denominator comes from transformation from k=2 to standard uncertainty k=1. The second number 2 in the denominator is due to the average (number 2 in the denominator in equation 2). The number 2 in front of equation 3 then transforms this back to k=2. The exponent 2 is due to the quadratic combination law of uncertainty contributions.
Finally, if there is a change in the mass of a weight between first and final calibration half of this difference is added to the combined uncertainty to catch this possible drift. However, the differences found are far below the stated calibration uncertainties (factor 0,05 to 0,5 at maximum) and thus do not really contribute to the uncertainty of the reference values.

## *The principle of the intercomparison*

An absolute value of $E_n$ of less than |1| is often used as a criterion for an acceptable measurement quality, according to ISO/IEC 17043:2010, B.4.1.1. It means a reported deviation $x_i$ from the nominal mass value by a participant does not deviate more from the assigned reference comparison value $x_{ref}$ than what can be expected from the calculated uncertainty in this difference.

$$E_n < 1: \quad \left|x_i - x_{ref}\right| < \sqrt{U_i^2 + U_{ref}^2} \qquad \text{(eq. 4)}$$

However, to make this measure a reliable one for an inter-comparison the reference $U_{ref}$ must be small enough not to contribute significantly to the right side of equation 4. Due to the quadratic combination ideally $U_{ref}$ should be in the range of 1/3 of $U_i$. This is not always easy to achieve, which means that relatively high En-values although between -1 and +1 must be regarded not totally reliable if $U_{ref}$ and $U_i$ are of the same size or if $U_{ref} > U_i$.

## *Measuring results on calibration in the ILC*

The following tables present the found mass deviations from the weights nominal value along with the stated measurement uncertainty for each weight.

Besides these “deviations” and “uncertainty” also the reported “determined mass values” are listed in the following tables. This presentation is chosen to allow the participants to compare the tabled data in this report with their own documentation. The unit chosen is µg for the mg- and g-weight pieces. This contrasts with the used reporting protocol in excel, but it makes the numbers easier to compare. For the two large weights in the kg-region mg was used as unit for comparison.

It was the ambition of the organizer to directly incorporate the excel-protocols from participants into the evaluation calculations for reporting the outcome of the comparison measurements after first having checked all data against those in the calibration certificates delivered in a separate calibration certificate. This worked very well.

The following tables are built with increasing participant identity numbers and list at the bottom the belonging reference value based on the average of two calibrations denoted as REF.

Together with the estimated uncertainty $U_{ref,j}$ these two values are used for calculating each participants $E_n$-value displayed in the last column.

The participant identity P1 to P7 is chosen in random and not timely order and it is kept he same in all tables and diagrams. Empty lines in the table simply mean that this participant did not provide a calibration result for this weight. The results are presented in three parts, first for the mg-weights then for the g-weights and the two kg-weights.

## Result of the mg wire weights.

*Table 1: Calibration results for mass piece 1 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 1,0054 | 5,4 | 3 | **0,46** |
| P2 | | | | |
| P3 | 1,0010 | 1,0 | 50 | **-0,06** |
| P4 | 1,0029 | 2,9 | 1 | **-0,80** |
| P5 | 1,0039 | 3,9 | 1 | **-0,04** |
| P6 | 1,0039 | 3,9 | 2 | **-0,02** |
| P7 | | | | |
| REF | 1,00395 | 3,95 | 0,86 | |

*Diagram 1*

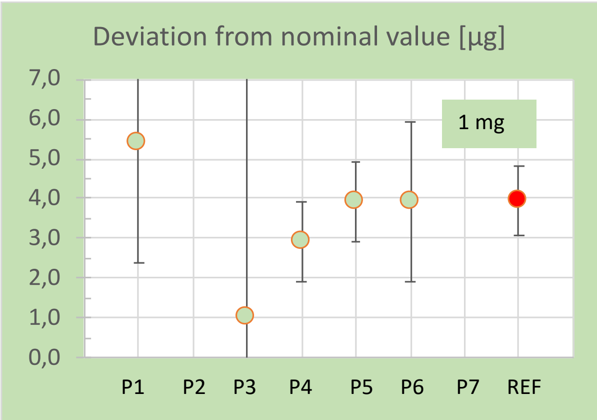



*Table 2: Calibration results for mass piece 2 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 1,9983 | -1,7 | 3 | **-0,40** |
| P2 | | | | |
| P3 | | | | |
| P4 | 1,9996 | -0,4 | 1 | **0,04** |
| P5 | 1,9994 | -0,6 | 1 | **-0,12** |
| P6 | | | | |
| P7 | | | | |
| REF | 1,99955 | -0,45 | 0,76 | |

*Diagram 2*

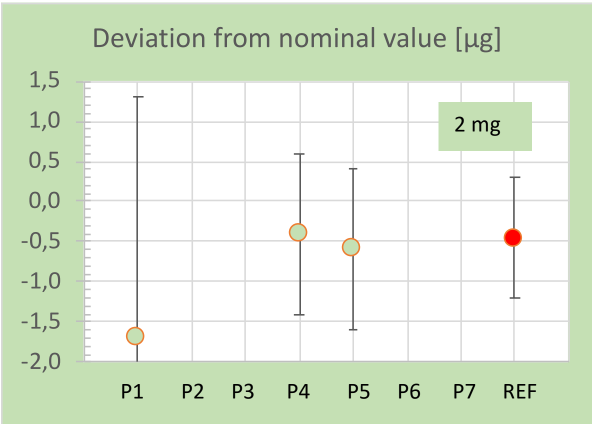
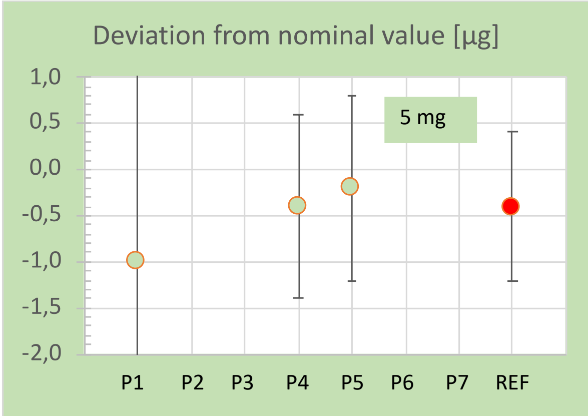


*Table 3: Calibration results for mass piece 5 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 4,9990 | -1,0 | 3 | **-0,19** |
| P2 | | | | |
| P3 | | | | |
| P4 | 4,9996 | -0,4 | 1 | **0,00** |
| P5 | 4,9998 | -0,2 | 1 | **0,16** |
| P6 | | | | |
| P7 | | | | |
| REF | 4,9996 | -0,4 | 0,81 | |

*Diagram 3*




Comment: The reference value is marked in red the diagrams. One can observe a very good consensus between the results of the participant and the reference values, which leads to low En-values. Several participants only calibrated a selection of the mg-weights. Participant P7 did not provide any result for the mg-weights but is shown as well in the tables to make it easier for all participants to check their presented data coupled to their laboratory identity.

*Table 4: Calibration results for mass piece 10 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 10,0068 | 6,8 | 3 | **0,86** |
| P2 | | | | |
| P3 | 10,0010 | 1,0 | 50 | **-0,06** |
| P4 | 10,0040 | 4,0 | 1 | **-0,07** |
| P5 | 10,0035 | 3,5 | 1 | **-0,44** |
| P6 | 10,0037 | 3,7 | 3 | **-0,13** |
| P7 | | | | |
| REF | 10,0041 | 4,1 | 0,91 | |

*Diagram 4*

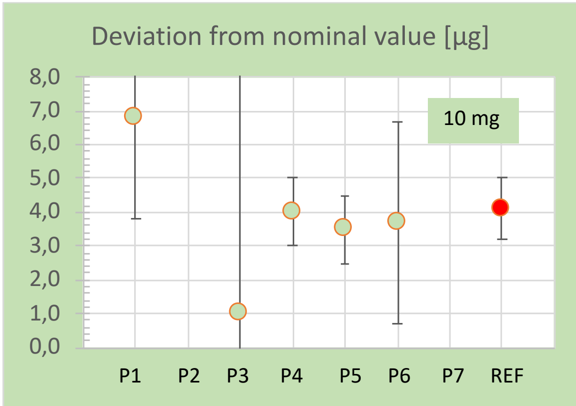



*Table 5: Calibration results for mass piece 20 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 20,0016 | 1,6 | 4 | **0,31** |
| P2 | | | | |
| P3 | | | | |
| P4 | 20,0005 | 0,5 | 1 | **0,11** |
| P5 | 20,0007 | 0,7 | 1 | **0,27** |
| P6 | | | | |
| P7 | | | | |
| REF | 20,0004 | 0,35 | 0,86 | |

*Diagram 5*

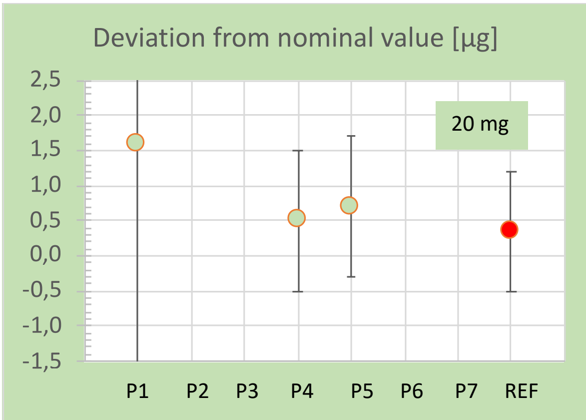
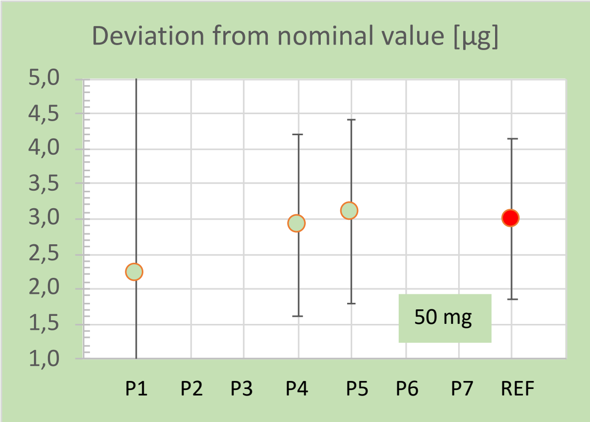


*Table 6: Calibration results for mass piece 50 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 50,0031 | 2,2 | 5 | **-0,16** |
| P2 | | | | |
| P3 | | | | |
| P4 | 50,0029 | 2,9 | 1,3 | **-0,06** |
| P5 | 50,0031 | 3,1 | 1,3 | **0,06** |
| P6 | | | | |
| P7 | | | | |
| REF | 50,0030 | 3,0 | 1,1 | |

*Diagram 6*




Comment: For P1 (50 mg) a different result was reported in the calibration certificate compared to the excel-protocol.

*Table 7: Calibration results for mass piece 100 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 100,0063 | 6,3 | 7 | **0,59** |
| P2 | | | | |
| P3 | 100,0010 | 1,0 | 50 | **-0,02** |
| P4 | 100,0018 | 1,8 | 1,6 | **-0,15** |
| P5 | 100,0021 | 2,1 | 1,5 | **0,00** |
| P6 | 100,0023 | 2,3 | 5 | **0,04** |
| P7 | | | | |
| REF | 100,0021 | 2,1 | 1,23 | |

*Diagram 7*

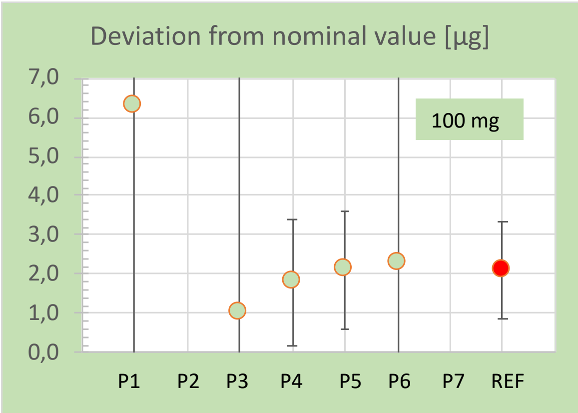



*Table 8: Calibration results for mass piece 200 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 200,0021 | 2,1 | 9 | **0,01** |
| P2 | | | | |
| P3 | | | | |
| P4 | 200,0028 | 2,8 | 2 | **0,29** |
| P5 | 200,0021 | 2,1 | 2 | **0,02** |
| P6 | | | | |
| P7 | | | | |
| REF | 200,0021 | 2,05 | 1,7 | |

*Diagram 8*

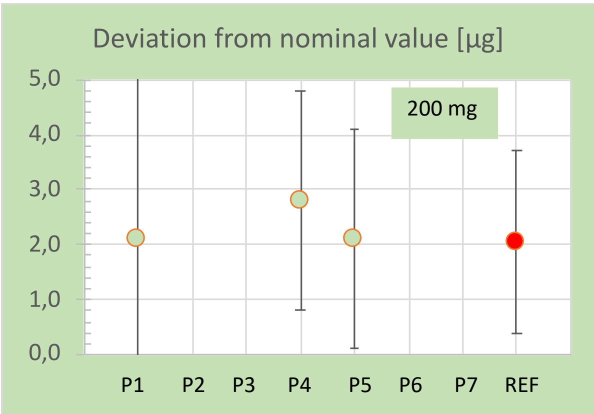
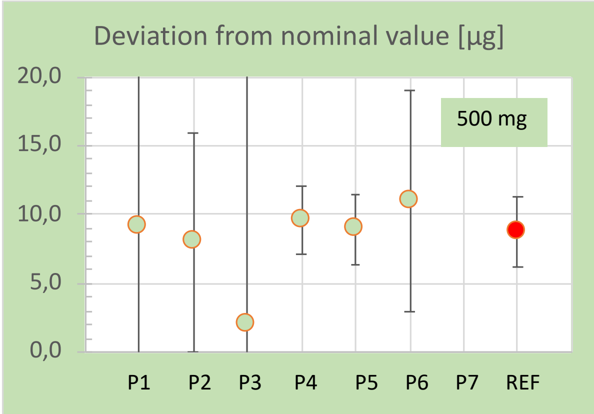


*Table 9: Calibration results for mass piece 500 mg*

| Partici-pant | Measured mass value | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [mg] | [µg] | [µg] | |
| P1 | 500,0091 | 9,1 | 12 | **0,03** |
| P2 | 500,0083 | 8,0 | 8 | **-0,09** |
| P3 | 500,0020 | 2,0 | 57 | **-0,12** |
| P4 | 500,0096 | 9,6 | 2,5 | **0,23** |
| P5 | 500,0089 | 8,9 | 2,5 | **0,04** |
| P6 | 500,0113 | 11,0 | 8 | **0,27** |
| P7 | | | | |
| REF | 500,0088 | 8,75 | 2,62 | |

*Diagram 9*




Comment: In total the participating laboratories executed 36 calibrations on the 8 mg-weights, all with acceptable result. The maximum En-value of 0,86 is a valid one as the relation between the participants $U_{i,j}$ and $U_{ref,j}$ has the necessary relation of 3:1 (see equation 1).

# Result of the g-weights

*Table 10: Calibration results for mass piece 1 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [µg] | [µg] | |
| P1 | 1,000009 | 9 | 20 | **-0,07** |
| P2 | 1,000011 | 11 | 10 | **0,04** |
| P3 | 1,000008 | 8 | 51 | **-0,05** |
| P4 | 1,0000107 | 10,7 | 3 | **0,02** |
| P5 | | | | |
| P6 | | | | |
| P7 | 1,000000 | 0 | 260 | **-0,04** |
| REF | 1,0000106 | 10,6 | 6,2 | |

*Diagram 10*

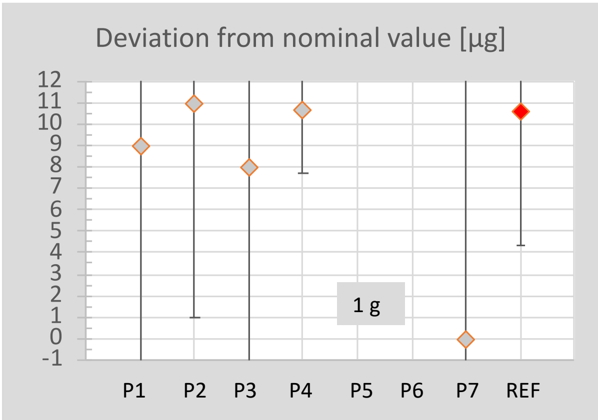



*Table 11: Calibration results for mass piece 2 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [µg] | [µg] | |
| P1 | 2,000017 | 17,4 | 20 | **-0,22** |
| P2 | 2,000020 | 20,0 | 13 | **-0,14** |
| P3 | 2,000021 | 21,0 | 50 | **-0,02** |
| P4 | 2,000021 | 20,7 | 4 | **-0,17** |
| P5 | | | | |
| P6 | 2,000021 | 21,0 | 13 | **-0,08** |
| P7 | 2,000020 | 20,0 | 260 | **-0,01** |
| REF | 2,0000222 | 22,15 | 7,6 | |

*Diagram 11*

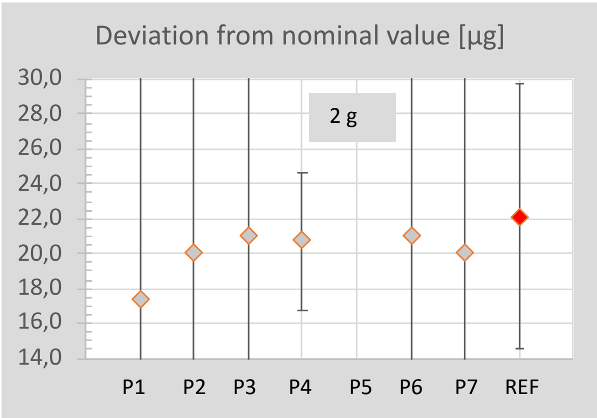
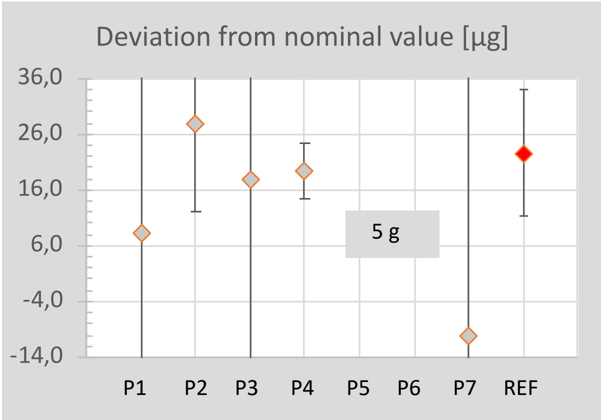


*Table 12: Calibration results for mass piece 5 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [µg] | [µg] | |
| P1 | 5,0000084 | 8,4 | 30 | **-0,44** |
| P2 | 5,0000282 | 28 | 16 | **0,27** |
| P3 | 5,000018 | 18 | 51 | **-0,09** |
| P4 | 5,0000195 | 19,5 | 5 | **-0,25** |
| P5 | | | | |
| P6 | | | | |
| P7 | 4,99999 | -10 | 270 | **-0,12** |
| REF | 5,0000227 | 22,7 | 11,3 | |

*Diagram 12*




Comment: For the g-weights a larger spread in uncertainty claims between the participants can be observed (factor >50 between highest and lowest uncertainty). Participant P4 has always lower uncertainty than that of the reference value. This does however, in no way reduce the credibility of the very acceptable En-values.

*Table 13: Calibration results for mass piece 10 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [µg] | [µg] | |
| P1 | 10,0000085 | 8,5 | 30 | **-0,34** |
| P2 | 10,000018 | 18 | 21 | **-0,06** |
| P3 | 10,000006 | 6,0 | 54 | **-0,24** |
| P4 | 10,0000131 | 13,1 | 7 | **-0,48** |
| P5 | | | | |
| P6 | 10,000003 | 3 | 20 | **-0,71** |
| P7 | 9,999980 | -20 | 270 | **-0,15** |
| REF | 10,0000195 | 19,5 | 12 | |

*Diagram 13*

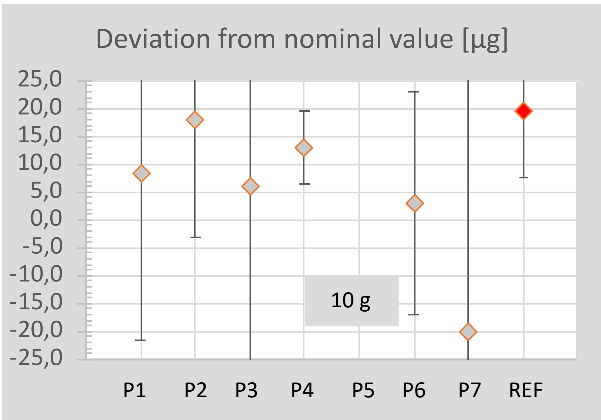



*Table 14: Calibration results for mass piece 20 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [µg] | [µg] | |
| P1 | 20,00001 | 10 | 40 | **-0,45** |
| P2 | 20,000021 | 21 | 26 | **-0,27** |
| P3 | 20,000004 | 4 | 68 | **-0,36** |
| P4 | 20,0000283 | 28,3 | 8 | **-0,06** |
| P5 | | | | |
| P6 | | | | |
| P7 | 20,00002 | 20 | 280 | **-0,03** |
| REF | 20,0000295 | 29,5 | 18 | |

*Diagram 14*

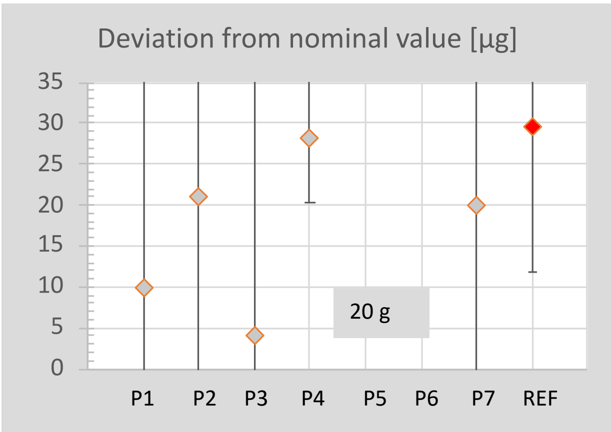
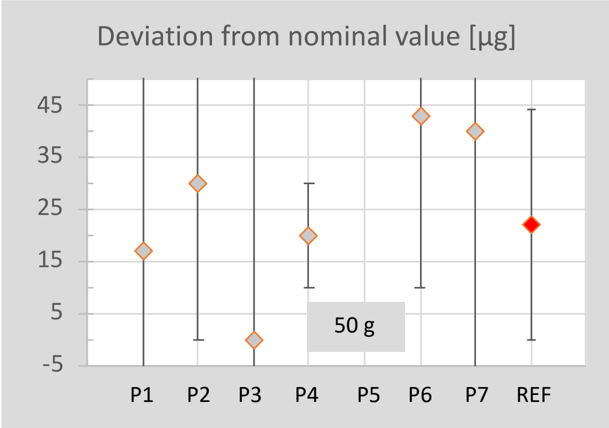


*Table 15: Calibration results for mass piece 50 g*

*Diagram 15*

(g)

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | g | [µg] | [µg] | |
| P1 | 50,000017 | 17 | 40 | **-0,11** |
| P2 | 50,00003 | 30 | 30 | **0,21** |
| P3 | 50,00000 | 0 | 96 | **-0,22** |
| P4 | 50,00002 | 20 | 10 | **-0,08** |
| P5 | | | | |
| P6 | 50,000043 | 43 | 33 | **0,53** |
| P7 | 50,00004 | 40 | 310 | **0,06** |
| REF | 50,000022 | 22 | 22 | |




From 50g calibration results non has an En-value close to +1 or -1. Maximum En-value is 0,76, which means all participants perform an equivalent calibration although with varying measurement uncertainty.

*Table 16: Calibration results for mass piece 100 g*

*Diagram 16*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | g | [µg] | [µg] | |
| P1 | 100,000018 | 18 | 70 | **-0,60** |
| P2 | 100,00007 | 70 | 60 | **0,10** |
| P3 | 100,00008 | 80 | 220 | **0,07** |
| P4 | 100,000081 | 81 | 16 | **0,51** |
| P5 | | | | |
| P6 | 100,00005 | 50 | 50 | **-0,23** |
| P7 | 100,00013 | 130 | 360 | **0,18** |
| REF | 100,000064 | 63,5 | 31 | |

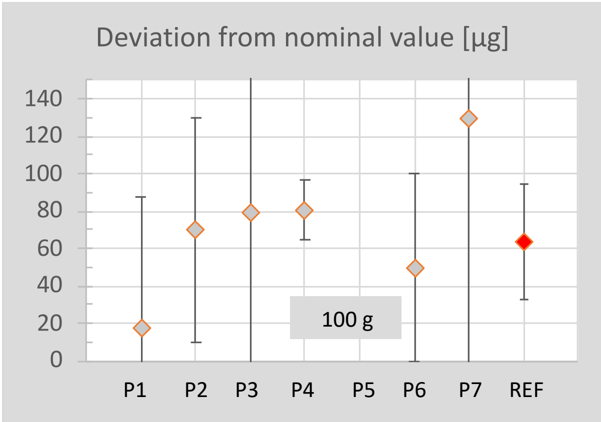



*Table 17: Calibration results for mass piece 200 g*

*Diagram 17*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | g | [µg] | [µg] | |
| P1 | 199,999998 | -2 | 140 | **-0,76** |
| P2 | 200,0001 | 100 | 110 | **-0,11** |
| P3 | 200,00007 | 70 | 350 | **-0,12** |
| P4 | 200,000116 | 116 | 30 | **0,03** |
| P5 | | | | |
| P6 | 200,00008 | 80 | 100 | **-0,29** |
| P7 | 199,9999 | -100 | 1000 | **-0,21** |
| REF | 200,000114 | 114 | 60 | |

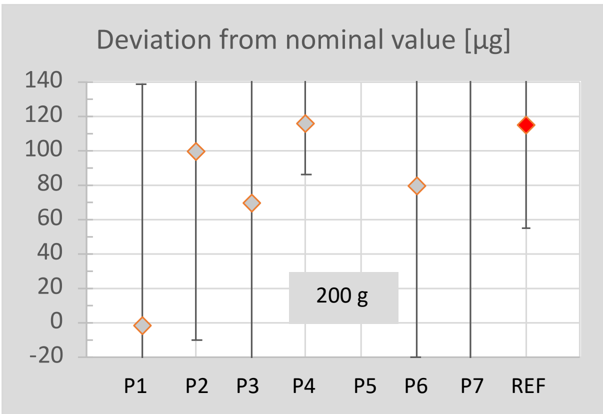
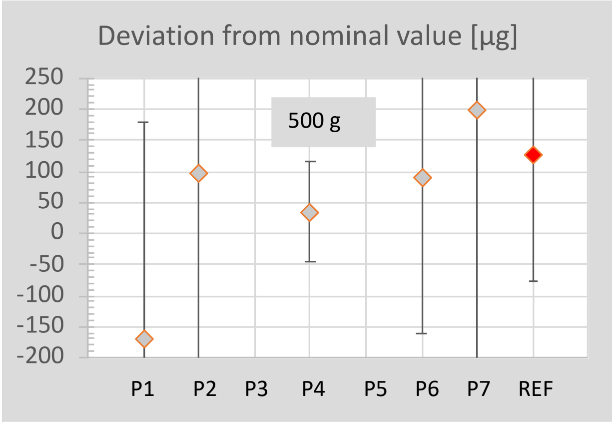


*Table 18: Calibration results for mass piece 500 g*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | g | [µg] | [µg] | |
| P1 | 499,99983 | -170 | 350 | **-0,73** |
| P2 | 500,0001 | 100 | 400 | **-0,06** |
| P3 | | | | |
| P4 | 500,000036 | 36 | 80 | **-0,41** |
| P5 | | | | |
| P6 | 500,00009 | 90 | 250 | **-0,11** |
| P7 | 500,0002 | 200 | 1600 | **0,05** |
| REF | 500,000125 | 125 | 202 | |

*Diagram 18*




# Result of the kg-weights

For the presentation of these two weights the unit g was chosen together with the uncertainty in mg

*Table 19: Calibration results for mass piece 1 kg*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [mg] | [mg] | |
| P1 | 1000,00095 | 0,95 | 0,79 | **-0,14** |
| P2 | 1000,00119 | 1,2 | 0,60 | **0,08** |
| P3 | | | | |
| P4 | 1000,0011 | 1,1 | 0,16 | **-0,02** |
| P5 | | | | |
| P6 | | | | |
| P7 | 1000,0017 | 1,7 | 2,6 | **0,21** |
| REF | 1,0000011 | 1,1 | 0,85 | |

*Diagram 19*

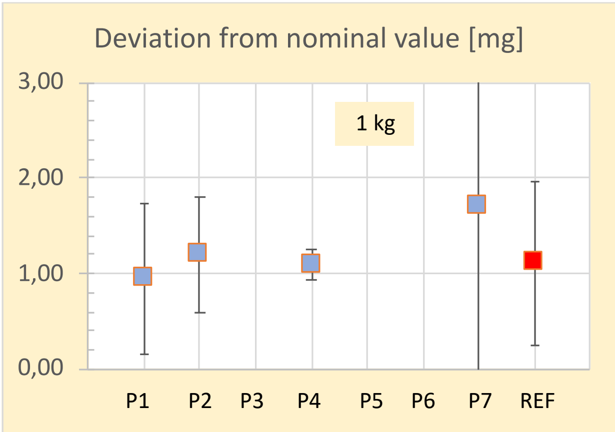
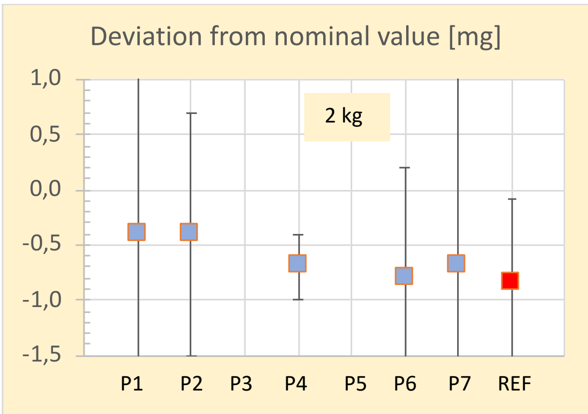



*Table 20: Calibration results for mass piece 2kg*

| Partici-pant | Measured weight | Deviation from nominal value | Stated uncertainty | En-value |
|---|---|---|---|---|
| | [g] | [mg] | [mg] | |
| P1 | 1999,9996 | -0,4 | 2,0 | **0,21** |
| P2 | 1999,99959 | -0,4 | 1,1 | **0,34** |
| P3 | | | | |
| P4 | 1999,9993 | -0,7 | 0,3 | **0,18** |
| P5 | | | | |
| P6 | 1999,9992 | -0,8 | 1,0 | **0,04** |
| P7 | 1999,9993 | -0,7 | 4,6 | **0,03** |
| REF | 1,99999915 | -0,85 | 0,76 | |

*Diagram 20*




Comment: In these 9 results no En-value was above 0,34, which again means a very convincing consensus. It should be noted that three of the results for 1 kg are given with a lower uncertainty than that of the reference laboratory, which however does not question the high confidence in the calculated En-values. The reason for the reference situation is due to a primary calibration of the 1 kg-weight in a false (lower) quality class.

## *Comments on the calibration certificates*

-- not a part of the intercomparison

Most of the laboratories report measurement error, but others the mass value.

Most of the laboratories specified their uncertainty with 2 digits in the certificate, but some laboratories gave 1 or 3 significant digits and that is not following the rules about presentation of uncertainty values.

All laboratories have an accreditation by their national accreditation body.

## *Additions and changes to the DRAFT report*

There are some redactional changes in tables 15 -18.

## *Final conclusions*

In this inter comparison most of the participants could demonstrate a capacity to calibrate and give relevant values in relationship to their uncertainties.

Many uncertainty claims are comparable between participants.

Participant P4 has mostly lower uncertainty than that of the reference value. This does however, in no way reduce the credibility of the very acceptable En-values. The participant has calibrated to better uncertainty values than was announced in the description of the intercomparison.

It should be noted that three of the results for 1 kg are given with a lower uncertainty than that of the reference laboratory, which however does not question the high confidence in the calculated En-values. The reason for the reference situation is due to a primary calibration of the 1 kg-weight in a false (lower) quality class.

The summarized results from 94 number of calibrations have 0 results got En values above 1.

## *Acknowledgement*

Thanks to Peter Lau, the main implementor of the calculations.

We also acknowledge the primary calibrations by RISE Sweden that supported the ILC with reference calibrations.

## Annex 1 ILC weights 2022:1

***Published on*** https://smquality.se/

## Annex 2 *D*escription of the intercomparison/ILC

***Published on*** https://smquality.se/

# *Appendix 1 Reporting form*

**ILC- Weight 2022:1** | **Calibration of weights**

Code for opening the transportation box: 504

**Documentation of calibration results** | **Comparison ID**

| | |
|---|---|
| Laboratory: | |
| Person: | |
| e-mail: | |
| Date: | |

## mg-wire weights

| Nominal mass | Calibrated con-ventional mass value | Stated error in mass | Measurement uncertain-ty in mass determination | Used in comparison: Stated error | Used in comparison: Measurement uncertainty | *From certificate*: Stated error | *From certificate*: Measurement uncertainty |
|---|---|---|---|---|---|---|---|
| [mg] | [mg] | [mg] | [mg] | [mg] | [mg] | [mg] | [mg] |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 5 | | | | | | | |
| 10 | | | | | | | |
| 20 | | | | | | | |
| 50 | | | | | | | |
| 100 | | | | | | | |
| 200 | | | | | | | |
| 500 | | | | | | | |

## g-weights

| Nominal mass | Calibrated con-ventional mass value | Stated error in mass | Measurement uncertain-ty in mass determination | Stated error | Measurement uncertainty | Stated error | Measurement uncertainty |
|---|---|---|---|---|---|---|---|
| [g] | [g] | [mg] | [mg] | [mg] | [mg] | [mg] | [mg] |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 5 | | | | | | | |
| 10 | | | | | | | |
| 20 | | | | | | | |
| 50 | | | | | | | |
| 100 | | | | | | | |
| 200 | | | | | | | |
| 500 | | | | | | | |

## kg-weights

| Nominal mass | Calibrated con-ventional mass value | Stated error in mass | Measurement uncertain-ty in mass determination | Stated error | Measurement uncertainty | Stated error | Measurement uncertainty |
|---|---|---|---|---|---|---|---|
| [kg] | [kg] | [mg] | [mg] | [mg] | [mg] | [mg] | [mg] |
| 1 | | | | | | | |
| 2 | | | | | | | |

## *References:*


- ISO/IEC 17043:2010 Conformity assessment – General requirements for proficiency testing
- ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories
- ISO 13528 Statistical methods for use in proficiency testing by interlaboratory comparison.
- Evaluation of measurement data – Guide to the expression of uncertainty in measurement, GUM (JCGM 100:2008)
- EA-4/02 M:2022 Evaluation of Uncertainty of Measurement in Calibration
- International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)