Swedish Metrology and Quality AB

Accred. no. 10436
Proficiency testing
ISO/IEC 17043

To participants

Report on an interlaboratory comparison (ILC 2022:1) of the calibration in the length area.

Distance laser

Line scale of glass

Measuring tape

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Calculations

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Content

Abstract

The intercomparison ILC length 2022:2 concerns a measuring steel tape 50-meter, an Electro-optic distance meter (EDM) based on a red laser with a range of 50 meter and a glass scale of 200 mm length.

Seven laboratories have registered for participation but not all performed the calibration of all three instruments.

It was recognized during the intercomparison that the line scale remained very stable during the circulation. The difference stated between two calibrations by the reference laboratory was far below the measurement uncertainty.

For the Laser the detected change was of the same order as the calibration uncertainty.

The steel tape, however, changed by a factor 0,6 to 7,5 over the measuring range compared to the measurement uncertainty, which lead to a significant increase of the reference uncertainty. (see equation 3)

The number of calibration points in total was 121 and En-values higher than 1 were 35.

Those were separate as follows:

Steel tape: of 66 En-vales 27 were above 1

Laser: of 20 En-vales 8 were above 1

Glass scale: of 35 En-vales 0 was above 1

Purpose and implementation of the comparison

This interlaboratory comparison serves as a tool to verify results from the measurement carried out 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 during several meetings. The advisory group has defined the set-up of instruments that should be included in the ILC length 2022:1 intercomparison as well as the choice of measuring points that should be included in the evaluation of the results.
The members of the advisory group are Mikael Frennberg, Quality Control in Metrology Sweden, Peter Lau MNE konsult and Håkan Källgren SMQ.

Information about the intercomparison

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

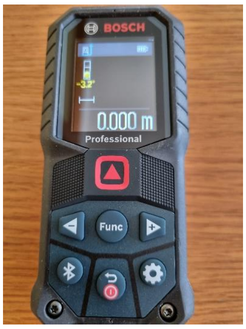
- Linkedin
- The data base https://www.eptis.org
- On the web https://smquality.se/interlaboratory-comparisons-ilc

The information on the web was done in 2 steps. General information as ILC Length 2022:1 referred to in annex 1 in this report.

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

Involved equipment.

Distance laser



Line scale of glass

Measuring tape

Participating laboratories in the comparison

Laboratory	**Delivery address**
Justervesenet **Reference laboratory**	Fetveien 99, 2007 Kjeller Norway
MTA srl	Via dei mestieri 8 Concorezzo, (MB) Italia
KIWA CERMET ITALIA SPA	Via Cadriano 23, 40057 Cadriano di Granarolo (BO) Italia
METROMAT SRL	str. Ady Endre nr. 44 Sacele jud Brasov 505600 Romania
Vilnius Tech, Institute of Geodesy, Calibration Laboratory	Sauletekio al.11, LT-10223 Vilnius, Lithuania
Danish Technology Institute	Gregerensvej 8H Attn. Målning och Kvalitet 2630 Tastrup Denmark
ISQ INSTITUTO SOLDADURA E QUALIDADE	Av. Prof. Dr. Cavaco Silva no 33 2740-120 Porto Salvo Portugal
Elastocon AB	Tvinnargatan 25, 507 30 BRÄMHULT, Sweden
Justervesenet **Reference laboratory**	Fetveien 99, 2007 Kjeller Norway

A majority performed a calibration on all equipment others only some objects.

The participants have an accreditation by SWEDAC, DANAK, ACCREDIA, ROMANIA RENAR and LIETUVOS NACIONALINIS AKREDITACIJOS BIURAS.

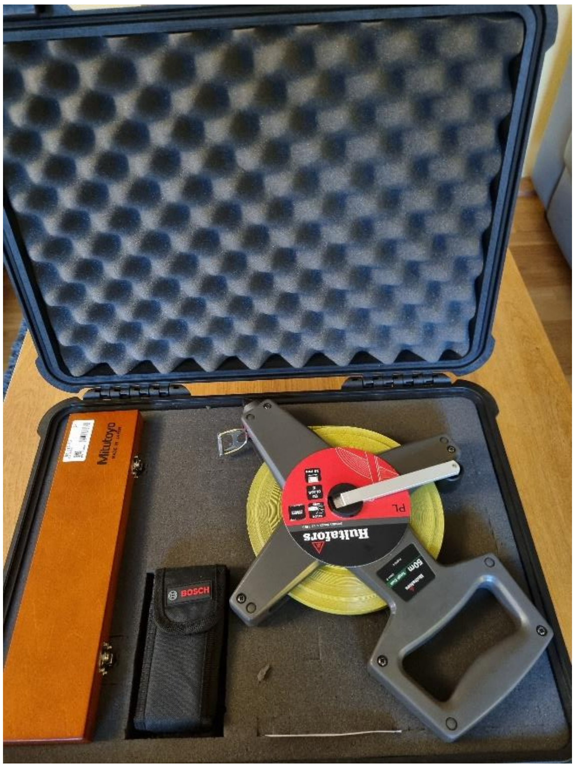
Principles on the calibration in general

The reference laboratory calibrated all equipment prior to the calibrations by the first participant (in the ILC) and the reference laboratory made a second calibration after the last participant had finished his work.

The organiser made a preliminary follow up after each individual calibration of a participant to find if there were some problems on the objects. The main purpose for doing so was to achieve as equal conditions as possible for all participants. In case of a too large drift, it was planned to organize an intermediate reference calibration.

Conditions and transport during the measurement period

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



Calibration instructions

The laboratories were allowed maximum 10 days for their calibrations.

In the call they were advised to use their own calibration procedures with focus on the following points which were important for the inter-comparison outcome. They were not allowed to perform any type of adjustment on the objects.

The laboratories further were encouraged to use their calculated uncertainty values for the actual results even if those would differ from the CMC values in their accreditation.

Compulsory calibration points

Each participant should calibrate according to the following parameters / measuring points on the objects:

Calibration points

The participants shall calibrate the objects according to the following mandatory points:

- Distance laser 50 m — 2, 7, 10, 13, 18, 20, 24, 30, 35, 40, 45 and 50 m
- Steel tape 50 m — 2, 7, 10, 13, 18, 20, 24, 30, 35, 40, 45 and 50 m
- Scale 200 mm — 5, 10, 30, 50, 80, 150 and 200 mm

The participants were allowed to record other points as described in their method and issue calibration certificates according to their method. However, the comparison was only evaluated and executed in the points (parameters) mentioned above.

Planning and administrative details

The laboratories were asked to send original calibration data in pre-defined forms (enclosed in annex 3) in digital form as excel files by e-mail before transporting the instrument case to the next laboratory.

It was possible to provide additional information or supplementary documentation eventually needed to understand the results.

Administrative information

Address to send the required documents:
Swedish Metrology and Quality AB Håkan Källgren Dragspelsgatan 21 SE-504 72 Borås, Sweden e-mail: hakan.kallgren@smquality.se Phone: +46705774931

Summary of the timeline planning in the call:

- The preliminary results should be sent to the organiser when the parcel was sent to the next participant.
- One week after finishing the calibration/measurement the calibration certificate should be send to the organizer of the intercomparison.
- A draft report should be sent to the participants 2 weeks after receiving the last calibration certificate.
- Comments on the draft report to the organiser were expected within 1 week.
- The comparison report should be finalized within 2 weeks after receiving comments from all participants.

Analysis of the calibration results

Each of the reported correction values c_i are compared to a corresponding reference correction c_{ref} defined by the average correction supplied by the National Metrology Institute Justervesenet Norway, who calibrated the instruments before and after the intercomparison exercise.

For each measurement point the results, i.e., the stated corrections of the participants were compared to each other and to a corresponding reference value and these they were used together with the reported uncertainties to calculate En-values according to equation 1

$$En = \frac{|c_i - c_{ref}|}{\sqrt{U_i^2 + U_{ref}^2}}$$

Equation 1

For each calibrated point

c_i: Single measurement result, index i counts the various participants.

c_{ref}: Corresponding reference value for comparison – provided from reference laboratory.

U_i: The estimated expanded uncertainty (k=2) stated by each laboratory.

U_{ref}: The calculated expanded uncertainty (k=2) based on the of the uncertainty given by the reference laboratory.

The expression in the denominator is a measure for the uncertainty in the difference in the nominator.

For an acceptable result the En-value should not exceed the absolute value of 1.

Both the reference correction c_{ref} and its uncertainty U_{ref} are composed from two calibrations

Inter-comparison reference value and uncertainty

Reference calibrations were performed by Justervesenet Norway before and after the circulation and present the base for evaluation as described below.

For all measurement points the inter-comparison reference values and their belonging uncertainties were calculated as

$$c_{ref} = \frac{c_{ref}(1)+c_{ref}(2)}{2} \quad \text{and} \quad U_{ref} = \frac{\sqrt{U^2(1)+U^2(2)}}{\sqrt{2}} + \left|\frac{c_{ref}(1)-c_{ref}(2)}{2}\right|$$

(1) and (2) here refer to the starting and finishing calibration respectively.

Equation 2 and 3

Traceability for the reference values R1 and R2 at each point

The traceability for the reference laboratory the National Metrology Institute of Norway - Justervesenet - is established by regular calibrations of the laboratory standards traceable to the realisation of the metre.

The results from the calibration of the equipment at the reference laboratory are documented in the following calibration certificates at the primary and final calibration respectively.

Calibration certificates -- reference laboratory

Scale 200 mm	296391-2 and 300038-2
Steel tape 50 m	296391-1 and 300038-1
Distance laser 50 m	296391-3 and 300038-3

Results Steel tape

The reference laboratory reported having used a tension force of 50 N during the calibration, and so did several of the participants. Of the 7 participants 6 took part in this part of the comparison. For the comparison the found corrections at 11 points are listed in 11 tables 2 diagrams (nr 1 and 2). The corrections are calculated as the difference of the distance from zero-point measured with a reference equipment and the nominal values set out on the steel tape. In the following tables the measured values are contained in column 2 and the corrections in column 3.

The first column always indicates the laboratories behind the results. The identity is randomly chosen and not in time order to preserve their identity. This identity is the same for all the objects throughout this report. Column 4 reveals the stated uncertainty in this measurement which also is an interesting aspect to compare.

The content in columns 3 and 4 are shown graphically in diagram 1 and 2 as symbols and “error-bars”.

The last column in the tables 1 to 11 contains the En-value which is calculated according to equation 1 with the data in column 3 and 4.

The common reference value and its uncertainty for each calibration point which is used for the En-value calculation is listed in the last row of each table. This value is also shown in the diagrams in the right most position. As seen the reference uncertainty is clearly lower than the participants claims which results in reliable En-values for the steel tape calibration.

Table 1 and 2 showing the corrections found at 2 m and 7 m distance from zero point.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	1,999969	-0,03	0,028	0,78
P2	1,99994	-0,06	0,09	0,10
P3	2,00000	0,00	0,50	0,14
P4	1,99988	-0,12	0,21	-0,23
P5	1,999875	-0,13	0,07	-0,73
P6				
P7	1,999671	-0,33	0,35	-0,74
R		-0,07	0,043	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	6,999912	-0,087	0,068	1,89
P2	6,99994	-0,06	0,16	1,13
P3	6,99980	-0,20	0,50	0,10
P4	6,99967	-0,33	0,46	-0,17
P5	6,999667	-0,33	0,24	-0,33
P6				
P7	6,998875	-1,13	0,70	-1,25
R		-0,25	0,053	

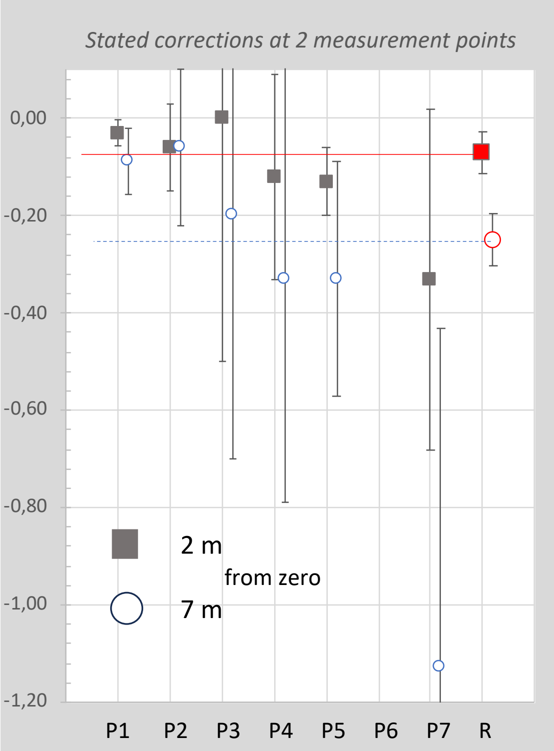


Diagram 1 presenting the results graphically

Table 3 and 4 representing the results at 10 and 13 m from the origin of the scale.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	9,999897	-0,102	0,092	2,14
P2	9,99992	-0,08	0,19	1,28
P3	9,99950	-0,50	1,3	-0,13
P4	9,99954	-0,46	0,61	-0,20
P5	9,999555	-0,44	0,30	-0,34
P6				
P7	9,998476	-1,5	1,0	-1,16
R		-0,335	0,058	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	12,99988	-0,120	0,12	2,12
P2	12,99971	-0,29	0,22	0,50
P3	12,99950	-0,50	1,3	-0,07
P4	12,99932	-0,68	0,76	-0,36
P5	12,999453	-0,55	0,36	-0,40
P6				
P7	12,997952	-2,0	1,4	-1,14
R		-0,405	0,068	

Table 5 and 6 stating the corrections at 18 and 24 m from the origin of the scale.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	17,999803	-0,197	0,16	2,00
P2	17,99966	-0,34	0,25	0,82
P3	17,99920	-0,80	1,3	-0,18
P4	17,99894	-1,06	1,0	-0,49
P5	17,99929	-0,71	0,46	-0,32
P6				
P7	17,997209	-2,80	1,7	-1,32
R		-0,56	0,093	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	23,999821	-0,179	0,20	2,06
P2	23,99963	-0,37	0,29	0,91
P3	23,99920	-0,800	1,3	-0,12
P4	23,99862	-1,380	1,31	-0,56
P5	23,999152	-0,85	0,58	-0,34
P6				
P7	23,996514	-3,50	1,7	-1,67
R		-0,65	0,10	

Table 7 and 8 corrections at 30 and 35 m from the origin of the scale.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	29,999895	-0,105	0,25	2,09
P2	29,99967	-0,33	0,33	1,02
P3	29,99920	-0,80	1,3	-0,08
P4	29,99847	-1,53	1,6	-0,52
P5	29,999064	-0,94	0,70	-0,35
P6				
P7	29,99553	-4,50	2,1	-1,81
R		-0,69	0,12	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	34,999975	-0,024	0,29	2,11
P2	34,99974	-0,26	0,36	1,15
P3				
P4	34,99837	-1,63	1,86	-0,50
P5	34,999032	-0,97	0,80	-0,33
P6				
P7	34,994886	-5,10	2,5	-1,76
R		-0,705	0,14	

Table 9. measurement point 40 m.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	39,999983	-0,017	0,33	2,08
P2	39,99976	-0,22	0,38	1,36
P3				
P4	39,99819	-1,81	2,11	-0,49
P5	39,998883	-1,12	0,90	-0,38
P6				
P7	39,994042	-6,00	2,8	-1,86
R		-0,775	0,15	

A graphic representation of the results at the various intermediate measuring points looks pretty much the same as diagram 1 and 2. They do not cover any additional information and are not shown. The relation between the participants results and the reference values are maintained in relative but expand in absolute terms with distance from the zero-point. It also can be seen that not all participants uncertainty bars overlap with the uncertainty of the reference value.

Comment: Due to the low reference uncertainty the En-values are valid. It means that the reference uncertainty (in the denominator of the En-formula) does not reduce the En-value which would be the case if it were larger.

Table 10 and 11 comparing the found corrections at 45 and 50 meters respectively.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	44,999958	-0,042	0,37	2,09
P2	44,99972	-0,28	0,40	1,41
P3				
P4	44,99795	-2,050	2,36	-0,49
P5	44,998684	-1,32	1,00	-0,43
P6				
P7	44,993476	-6,50	3,2	-1,75
R		-0,885	0,16	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-value
	[m]	[mm]	[mm]	
P1	50,0001886	0,179	0,41	2,70
P2	49,99972	-0,28	0,42	1,63
P3				
P4	49,99756	-2,44	2,6	-0,55
P5	49,998423	-1,58	1,1	-0,51
P6				
P7	49,992736	-7,30	3,5	-1,80
R		-1,01	0,15	

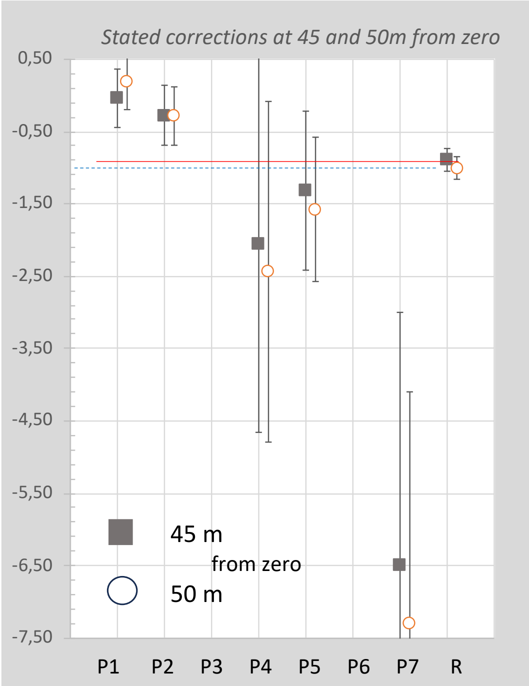


Diagram 2. Showing the corrections at the two most distant measuring points.

Results distance laser

Only three of seven participants took part in this exercise. An overview of the outcome is presented in diagram 3 showing that participant P2 managed to give a result over the total scale. The two others stopped at 18 and 20 m.

The result of this comparison is given in table 12 and 13 which combine several measurement points. Compared to the steel tape and the scale they contain a further column. Column 3 specifies the reading of the laser instrument and column 2 the reading from the reference instrument. The difference reference minus instrument reading defines the correction. This was not always clear in the calibration certificates.

Looking to the stated measurement uncertainties one finds a closer relation and the reference uncertainties are not always the lowest ones which means the calculated En-values are not as reliable as whished, because they influence the denominator in the En-formular too strong.

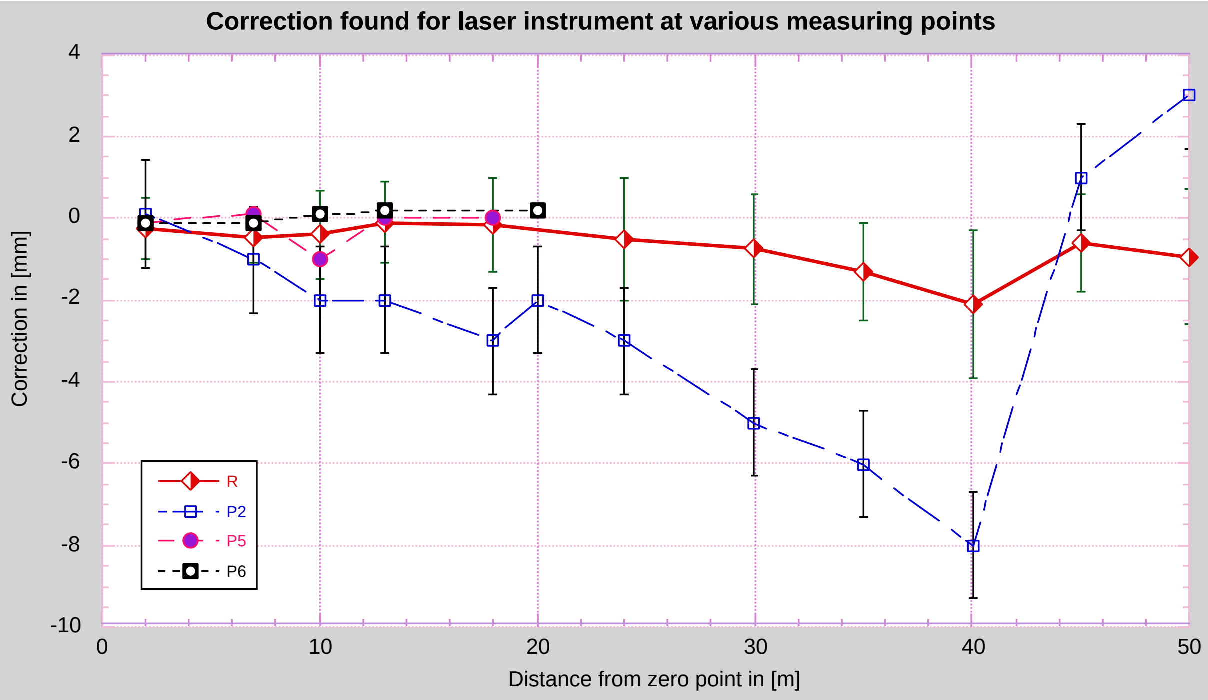


Diagram 3. Correction for three participants taking part in the comparison of the laser distance meter. For P2 and R the stated uncertainties are shown as well.

Table 12. Comparison results from 3 participants compared to the reference values at 2 to 13 meters.

	Partici-pant	Measured reference value	Instrument reading	Stated correction	Measurement uncertainty	En - value
		[m]	[m]	[mm]	[mm]	
Measurement point 2 m	P2	1,99931	1,9992	0,10	1,30	0,23
	P5	2,0229	2,023	-0,10	0,60	0,16
	P6	2,0000	2,0001	-0,10	0,8	0,14
	R			-0,25	0,75	
Measurement point 7 m	P2	6,99808	6,9991	-1,00	1,30	-0,50
	P5	7,0116	7,0115	0,10	0,90	0,30
	P6	6,9998	6,9999	-0,10	0,8	0,14
	R			-0,45	0,65	
Measurement point 10 m	P2	9,99756	10,0000	-2,00	1,30	-1,17
	P5	10,015	10,016	-1,00	1,00	-0,60
	P6	10,0000	9,9999	0,10	0,8	0,32
	R			-0,4	1,09	
Measurement point 13 m	P2	12,99739	12,9990	-2,00	1,30	-1,17
	P5	13,025	13,025	0,00	1,20	0,18
	P6	12,9982	12,998	0,20	0,8	0,41
	R			-0,1	1,0	

Table 13. Comparison results from 3 participants compared to the reference values at 18 to 50 meters.

	Partici-pant	Measured reference value	Instrument reading	Stated correction	Measurement uncertainty	En-value
		[m]	[m]	[mm]	[mm]	
Measurement point 18 m	P2	17,99621	17,9990	-3,00	1,3	-1,83
	P5	17,99	17,99	0,00	1,4	0,16
	R			-0,15	1,15	
Measurement point 24 m	P2	23,99483	23,998	-3,00	1,3	-1,83
	R			-0,50	1,5	
Measurement point 30 m	P2	29,99341	29,998	-5,00	1,3	-3,16
	R			-0,75	1,35	
Measurement point 35 m	P2	34,99212	34,998	-6,00	1,3	-3,83
	R			-1,30	1,2	
Measurement point 40 m	P2	39,99089	39,999	-8,00	1,3	-5,16
	R			-2,10	1,8	
Measurement point 45 m	P2	44,99005	44,999	1,00	1,3	0,83
	R			-0,60	1,2	
Measurement point 50 m	P2	49,98889	49,997	3,00	1,3	2,17
	R			-0,95	1,65	

Results line scale

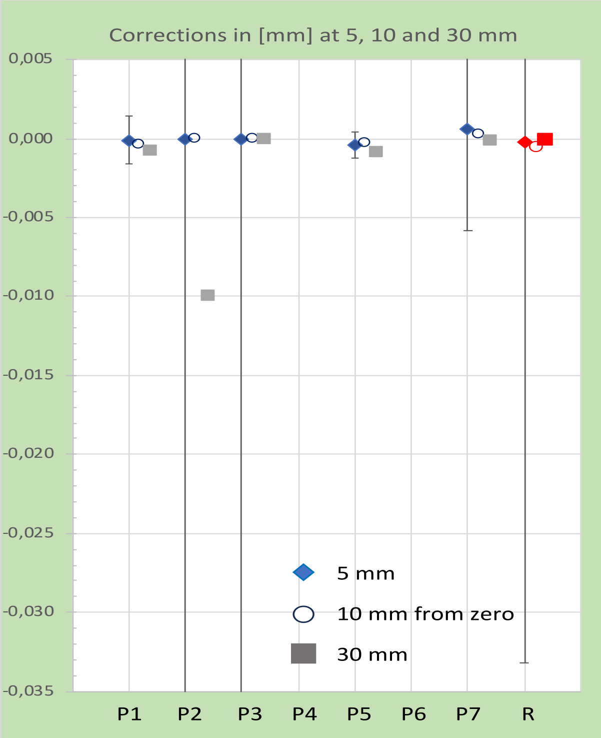
This part of the comparison was performed of 5 of the 7 participants and concerns the found correction in 7 measurement points of the scale. The results are presented with 7 tables one for each measurement point and 2 diagrams (nr 4 and 5).

As before the correction is calculated as the measured distance to the zero-point making up the reference value minus the nominal value of the scale at that point. The measured values are contained in column 2 and the calculated corrections in column 3. Column 4 contains the stated measurement uncertainties that vary considerably between the 5 participants. Compared to the uncertainty of the reference laboratory those uncertainties amount to 5 %, 181 %, 907 % 2 % and 20 % respectively. The very high uncertainty claims are, however, not the main cause for the extremely low En-values. All stated corrections fall within the uncertainty band of the reference values.

This can be clearly seen from diagram 4 that shows the results at the first three measurement points. This picture is valid over the entire measurement range – se also diagram 5 where the uncertainties are not included as this would not resolve any correction differences at all.

Table 14, 15 and 16 Giving the found correction from 5 participants at the first 3 measurement points.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	4,99990	-0,0001	0,0015	0,00
P2	5,00000	0,0000	0,06	0,00
P3	5,00000	0,0000	0,30	0,00
P4				
P5	4,99963	-0,0004	0,0008	-0,01
P6				
P7	5,0006	0,0006	0,0064	0,02
R		-0,0002	0,033	



Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	9,99960	-0,0004	0,0016	0,00
P2	10,00000	0,0000	0,06	0,01
P3	10,00000	0,0000	0,30	0,00
P4				
P5	9,99970	-0,0003	0,0008	0,01
P6				
P7	10,0002	0,0002	0,0065	0,02
R		-0,0005	0,033	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	29,99920	-0,0008	0,0017	-0,02
P2	29,99000	-0,0100	0,06	-0,14
P3	30,00000	0,0000	0,30	0,00
P4				
P5	29,99910	-0,0009	0,0009	-0,02
P6				
P7	29,9999	-0,0001	0,0071	0,00
R		-0,0001	0,033	

Diagram 4. Comparison of corrections (mm) stated at 5-, 10- and 30-mm distance from zero point with a large variation in uncertainty claims. The corresponding diagrams for the rest of measurement points would all look the same. Depending on the large uncertainties and deviation of one result diagram 5 shows the comparison in a different view.

Table 17 and 18 Corrections and belonging uncertainties at measurement points 50 and 80 mm.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	49,99950	-0,0005	0,0018	0,00
P2	50,00000	0,0000	0,06	0,01
P3	50,00000	0,0000	0,30	0,00
P4				
P5	50,00020	0,0002	0,0009	0,02
P6				
P7	50	0,0000	0,0078	0,01
R		-0,00035	0,033	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	79,99980	-0,0002	0,0019	0,00
P2	79,99000	-0,0100	0,06	-0,14
P3	80,00000	0,0000	0,30	0,00
P4				
P5	80,00080	-0,0008	0,001	-0,02
P6				
P7	80,0002	0,0002	0,0087	0,01
R		-0,00005	0,034	

Table 19 and 20 Corrections and belonging uncertainties at measurement points 150 and 200 mm.

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	149,99880	-0,0012	0,0023	-0,07
P2	149,9900	-0,0100	0,06	-0,16
P3	150,0000	0,0000	0,30	0,00
P4				
P5	150,00120	0,0012	0,0011	0,00
P6				
P7	150,000	0,0000	0,011	-0,03
R		0,0011	0,034	

Partici-pant	Measured value	Stated correction	Measurement uncertainty	En-vlaue
	[mm]	[mm]	[mm]	
P1	199,99820	-0,0018	0,0025	-0,08
P2	199,99000	-0,0100	0,06	-0,16
P3	200,00000	0,0000	0,30	0,00
P4				
P5	199,99943	-0,0006	0,0012	-0,04
P6				
P7	199,9996	-0,0004	0,012	-0,04
R		0,0009	0,034	

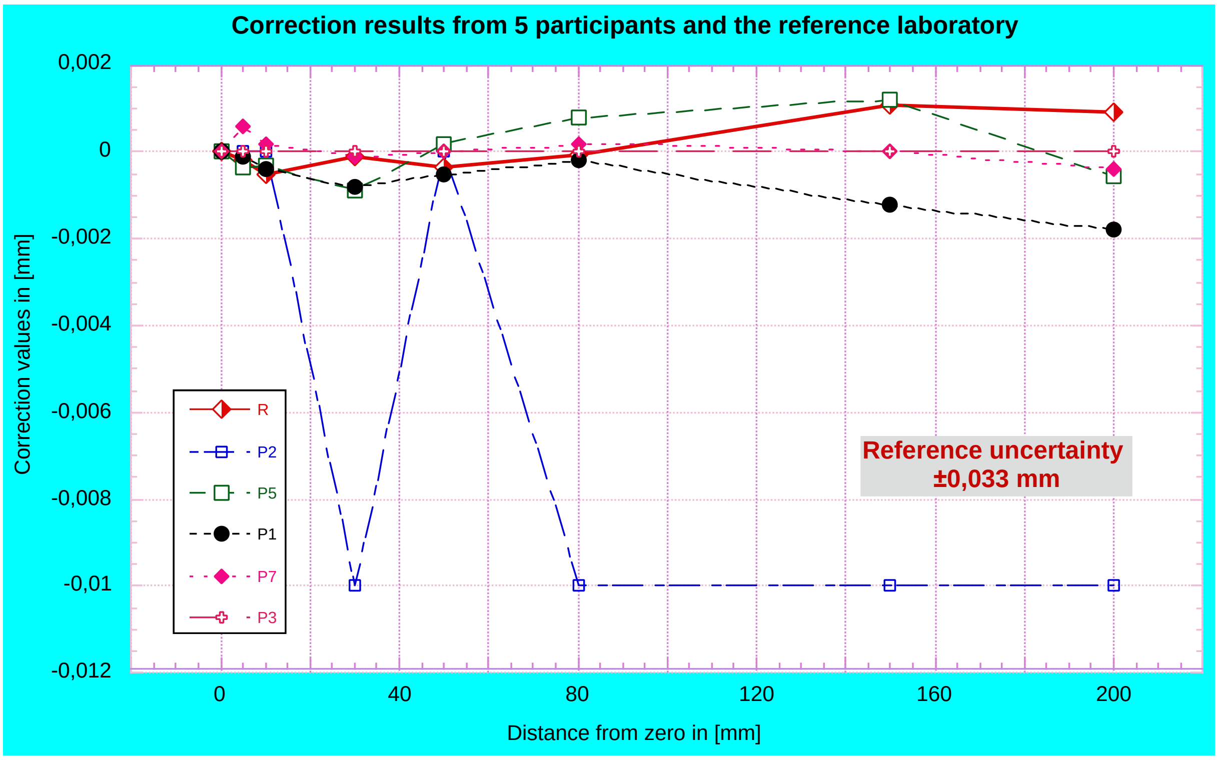


Diagram 5. Corrections as a function of distance to zero point. The reference uncertainty is three times as large than the scale on the left axis. Thus, there is an incredible overlap of the reference uncertainty with the participants results.

Comments on calibration certificates

-not a part of the intercomparison

2 laboratories and the reference laboratory inform that the force applied on the steel tape was 50 N.

One laboratory explains the relation between the true value and the correction.

One laboratory explains the process of clamping on the ruler/line scale.

One laboratory indicates the deviations in a diagram.

One laboratory refers the reading to the lower part of the indication on the steel tape.

Several laboratories are inconsistent how to indicate error and correction.

Most of the laboratories mention the reference temperature to be 20°C.

Calibration certificates are issued in the local language and in some cases in English.

Uncertainty is sometimes described as a fixed value and sometimes as a formula using a fixed term and a part related to the length. This could give some complications for clients.

Additions and changes to the DRAFT report

Table 13 was updated compared to the draft due to a writing error. The text was slightly changed in few points and some misspellings were corrected.

Final conclusions

In this inter comparison were there surprising many of the participants that demonstrate a questionable result when calibration the steel tape and the laser.

The number of calibration points in total was 121 and En-values higher than 1 were 35.

Those were separate as follows:

Steel tape: of 66 En-vales 27 were above 1

Laser: of 20 En-vales 8 were above 1

Glass scale: of 35 En-vales 0 was above 1

The ability of different laboratories to prove the correctness of their CMC values is not a part of an intercomparison of this type. It is up to the various laboratories to evaluate their results according to the requirements in ISO/IEC 17025:2017 as specified in point 7.7.3.

Acknowledgement

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We also acknowledge the primary calibrations by Justervesenet Norway that supported the ILC with reference calibrations.

Annex 1 ILC Length 2021:1 published on www.smquality.se

Annex 2 Revised description of the intercomparison/ILC published on www.smquality.se

Annex 3 reporting form for preliminary calibration results.

ILC- 2022:1 **Calibration of Measuring tape 50 m, Laser distance meter, glass scale**

Documentation of up to 3 calibration results **Comparison ID**

Laboratory:	
Person:	
e-mail:	
Date:	

50 m measuring tape Model PL 50 m /Hultafors

Calibration points on tape	Measured reference value	Stated correction	Stated measurement uncertainty
[m]	[m]	[mm]	[mm]
0			
2			
7			
10			
13			
18			
20			
24			
30			
35			
40			
45			
50			

Distance Laser Model GLM 50-27 C / Bosch

Calibration points	Measured reference value	Instrument reading	Stated correction	Stated measurement uncertainty
[m]	[m]	[m]	[mm]	[mm]
2				
7				
10				
13				
18				
20				
24				
30				
35				
40				
45				
50				

Precision length scale Model HL 1-200 / D A-type / Mitutoyo

Calibration points on scale	Measured reference value	Stated correction	Stated measurement uncertainty
[mm]	[mm]	[mm]	[mm]
0			
5			
10			
30			
50			
80			
150			
200			

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:2013 Evaluation of Uncertainty of Measurement in Calibration
- International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)
- ISO 3650:1998 Geometrical product specifications (GPS)-Length Standards-Gauge blocks
- ILAC-G8:09/2019 Guidelines on Decision Rules and Statements of Conformity