EURAMET Supplementary Comparison

Comparison of pocket type laser distance measuring instruments

EURAMET.L-S25 (P1354)

Instructions and technical protocol

Contents

Tres Cantos, 25 February 2015, Emilio Prieto

1 Introduction

The metrological equivalence of national measurement standards and of calibration certificates issued by national metrology institutes is established by a set of key and supplementary comparisons chosen and organized by the Consultative Committees of the CIPM and by the regional metrology organizations, respectively.

At the meeting in September 2010, the EUROMET TC Length decided to carry out a comparison for laser distance measuring instruments (EDMs), with the Central Office of Measures (GUM), Poland as the pilot laboratory. Four different instruments were used as artifacts until a maximum distance of 50 m.

In such comparison, EURAMET.L-S20, on laser distance measuring instruments, CEM (ES) participated using as standard a 50 m calibrated baseline, instead of the standard and method declared for their approved CMC (comparison to length interferometer, measuring range 25 m), searching for confirming the declared uncertainty for a longer range by using this different system.

In such comparison, 36 CEM results were OK but 4 values (those corresponding to the farthest supports of the baseline situated at 45 m and 50 m) were not. After investigation, CEM reached the conclusion that the bad definition and quality of the circulated target had the biggest influence on the results.

Then, CEM agreed with BEV (AT), which obtained full OK results in the comparison, to organize this new exercise. After the open call made at the 2014 EURAMET TC-L meeting, a request to participate was also received from VSL (NL).

In this new comparison, two Leica EDMs will be circulated; a D510 owned by CEM and a D810 owned by BEV, both with a measurement range of 200 m and a resolution of 0,1 mm. Calibration points will be the same as in the past comparison EURAMET.L-S20, so covering again a 50 m range. This time, to avoid problems with the quality of the target, instead of circulating a specific one, each participant will use its own set-up.

CEM will measure using two methods: the first one according to its approved CMC (for non-pocket type EDMs by using a laser interferometer until a maximum range of 25 m); the second one, the one used in EURAMET.L-S20, measuring the pocket-type EDMs on a calibrated multi-support baseline until a maximum range of 50 m.

The procedure outlined in this document is based on the technical protocol from the previous EURAMET.L-S20 comparison.

2 Organisation

2.1 Participants

Institute	**Adress**	**Contact**
CEM	Centro Español de Metrologia C/del Alfar ,2 ES-28760 Tres Cantos, Madrid Spain	Mar Pérez Phone: +34 91 8074 716 mmperezh@cem.minetur.es

Institute	**Adress**	**Contact**
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien Austria	Michael Matus Phone: +43 1 21 1106540 michael.matus@bev.gv.at
VSL	Dutch Metrology Institute Thijsseweg 11 2629 JA Delft The Netherlands	Gerard Kotte Phone: +31 15 2691 601 / 500 gkotte@vsl.nl

2.2 Time schedule

The comparison will be carried out by measuring both EDMs at the three NMIs in the shortest period of time (two weeks per laboratory).

2.3 Transportation

Transportation is on each laboratory's own responsibility and cost. The devices will be carefully packed and ready to be shipped with any appropriate carrier, preferably using a fast mail service.

2.4 Financial aspects, Insurance

Each laboratory covers the costs for the measurements and transportation as well as for any damages that may have occurred within its country.

3 Description of the Standard

The package contains:

Manufacturer, type	Serial no.	Dimensions	Declared uncertainty	Resolution
Leica DISTO D510		(143 x 58 x 29) mm	1 mm	0,1 mm
Leica DISTO D810		(164 x 61 x 31) mm	1 mm	0,1 mm

	
Leica DISTO D510 (owned CEM)	Leica DISTO D810 (owned BEV)

Manuals for DISTO D510 and DISTO D810 are available respectively at the following Internet addresses:

http://leica-geosystems.es/downloads123/cp/disto/DISTO%20D510/manuals/Leica%20DISTO%20D510%20MAN%20792312_en.pdf

http://leica-geosystems.es/downloads123/cp/disto/DISTO_D810_touch/manuals/Leica%20DISTO%20D810%20touch%20MAN%20799093_en.pdf

4 Handling and measurement instructions

Before calibration, the EDMs have to be inspected for damage. It should be checked if the batteries are discharged. Batteries should be replaced with new ones if necessary.

The EDMs have to be calibrated with beam pointing horizontally and facing display up.

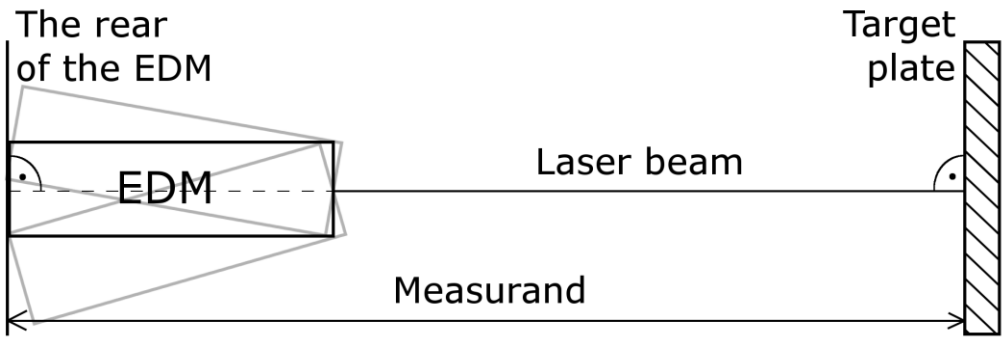
The EDMs have to be calibrated in 0.3 m and then at regularly spaced intervals **every 5 m** (as close as possible to this points) for the range up to 50 m.

The measurement results have to be corrected to the reference temperature of 20°C.

5 Measurand

Typically, the laser beam is not perpendicular to the back of EDM. Correct angular position of the EDM body to achieve perpendicular laser beam to the target plate.

The measurand for this comparison is the distance from the point at the rear of the angularly corrected EDM farthest from the target plate to the target plate (see Figure below).



6 Measurement uncertainty

The uncertainty of measurement shall be estimated according to the *ISO Guide for the Expression of Uncertainty in Measurement*. The laboratories are asked to report a detailed uncertainty budget. For this, the form in the annex may be used. In both, the results tables and the uncertainty budget, the measurement uncertainty has to be expressed in a length dependent form (typically sqrt[$(a)^2 + (b \cdot L)^2$] mm, L in m) using a coverage factor of $k = 2$.

7 Reporting

The measurement results, instrument descriptions and a detailed evaluation of the uncertainty of measurement have to be reported using the forms enclosed in the annex.

The report shall be sent **as soon as possible** after completing the measurements to CEM.

After completion of the circulation, CEM will prepare a first draft report.

Despite the small number of participants, the results will be analysed using the weighted mean as Key Comparison Reference Value, excluding from the calculation those results considered as outliers after performing a statistical analysis.

The check for consistency of the comparison results with their associated uncertainties will be made based on Birge ratio. The degrees of equivalence for each laboratory with respect to the KCRV will be evaluated using En values.

BEV will act as the linking participant to the previous comparison EURAMET.L-S20.

IMPORTANT: It is requested to participants to also supply information on their CMC claims (service numbers, CMC uncertainty) as these will be required for the sWG-CMC review of the results.

8 Appendix: Measurement results

Leica D510

Reference instrument indicated length in m	EDM indicated length in mm	Uncertainty in mm *(k = 2)*	
		Length independent part	Length dependent part (*L* in m)
0 .. 0,3			
0 .. 5			
0 .. 10			
0 .. 15			
0 .. 20			
0 .. 25			
0 .. 30			
0 .. 35			
0 .. 40			
0 .. 45			
0 .. 50			

Leica D810

Reference instrument indicated length in m	EDM indicated length in mm	Uncertainty in mm *(k = 2)*	
		Length independent part	Length dependent part (*L* in m)
0 .. 0,3			
0 .. 5			
0 .. 10			
0 .. 15			
0 .. 20			
0 .. 25			
0 .. 30			
0 .. 35			
0 .. 40			
0 .. 45			
0 .. 50			

Laboratory:.....

Date: ..... Signature:.....

9 Description of the measurement equipment

(only variations with respect to the information included in the Final Report of the comparison EURAMET.L-S20)

Short description of measurement bench (photo recommended) .....

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Length measurement instrument .....

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Additional remarks.....

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Laboratory:.....

Date: ..... Signature:.....

10 Uncertainty of measurement table

Description	*Quantity* x_i	*Standard uncertainty* $u(x_i)$	*Sensitivity coefficient* $c_i = \partial l/\partial x_i$	*Standard uncertainty* $u_i(l)$ / mm

Combined standard uncertainty u_c: .....

Expanded uncertainty U (k=2): .....

Laboratory:.....

Date: ..... Signature:.....