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Deutsche Akkreditierungsstelle GmbH

als Kalibrierlaboratorium im / as calibration laboratory in the

Deutscher Kalibrierdienst

DAkkS Deutsche Akkreditierungsstelle D-K-15007-01-00

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Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration mark

Gegenstand *Object*	3D Coordinate Measuring Machine
Hersteller *Manufacturer*	Carl Zeiss
Typ *Type*	XENOS 9/15/7
Fabrikat/Serien-Nr. *Serial number*	182524
Inventar Nr.	
Auftraggeber *Customer*	MICRORECTIF 10 rue de l'Innovation FR-42000 St-Etienne
Auftragsnummer *Order No.*	8580869468
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	18
Datum der Kalibrierung *Date of calibration*	10/18/2019

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.
This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the international Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
The user is obliged to have the object recalibrated at appropriate intervals.

Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy Head of the calibration laboratory*	Bearbeiter *Person in charge*
23.10.2019	Ilzhoefer	Datum: 24.10.2019 10:02 Uhr E.Werner

1. Calibration object

The indication error of length measuring error E_L, repeat range R_0, single stylus form error P_{FTU}, scanning probing error THP and the duration of the scanning test as well as four-axis error FR, FT and FA were measured on the coordinate measuring machine according to Directive DAkkS-DKD-R 4-3 page 18.1 "Calibration of the metrological properties of coordinate measuring machines (CMMs) acc. to DIN EN ISO 10360 and VDI/VDE 2617".

The coordinate measuring machine had the following configuration during the calibration:

Control:	C99N #AK031620
Probe:	VAST G-C1 #00294G1R
Measuring software:	CALYPSO 6.6.1209
CAA file:	guideway.caa / 10/17/2019
Reference sphere:	#D-04600-A
X measuring range:	900 mm
Y measuring range:	1500 mm
Z measuring range:	640 mm

Calibrated measured volume:

X- direction:	805 mm
Y- direction:	1342 mm
Z- direction:	573 mm

The coordinate measuring machine had the following specification:

Length measuring errors $E_{0,MPE}$: 0.30 µm + 1.00 · 10^{-6} · l (l is the length)

Length measuring errors $E_{150,MPE}$: 0.50 µm + 1.00 · 10^{-6} · l (l is the length)

Repeat range $R_{0,MPL}$:		0.20 µm
Single stylus form error P_{FTU} :		0.40 µm
Scanning probing error THP :		0.60 µm
Scanning test duration MPTτ:		40.0 s
Four-axis error :	MPE_{FR}:	1.50 µm
	MPE_{FT}:	1.50 µm
	MPE_{FA}:	1.20 µm

2. Calibration method

The metrological properties of the coordinate measuring machine (CMM) were calibrated in accordance with Directive DAkkS-DKD-R 4-3 Sheet 18.1 "Calibration of the metrological properties of coordinate measuring machines (CMMs) according to DIN EN ISO 10360 and VDI/VDE 2617". The following standards were applied:
DIN EN ISO 10360-2:2010-06, DIN EN ISO 10360-3:2000-08,
DIN EN ISO 10360-4:2003-06 and DIN EN ISO 10360-5:2011-01.

The length measuring errors E_L were determined via mechanical probing on step gauges. The single stylus form error P_{FTU}, the scanning probing error THP and the duration τ of the scanning test were determined using a ceramic* calibration sphere with a 25 mm diameter. The indication errors FR, FT and FA of the four-axis error were determined on two ceramic spheres (rotary table check) with d = 30 mm that were clamped with a vertical and a radial distance interval of 206 mm.

During the measurements, the temperature compensation of the scales of the coordinate measuring machine and the workpiece temperature compensation of the standards used were active.

The standards used are documented with the respective measuring results. The traceable temperature measuring device ALMEMO PM20054662 with calibration certificate no. 14355 D-K-15007-01-00 2018-02 was used for the CMM-independent temperature measurement.

* Contrary to the standard a ceramic ball is used instead of a steel ball.

3. Calibration location

The calibration was performed on-site. The coordinate measuring machine is located at:

MICRORECTIF, 10 rue de l'Innovation, St-Etienne

4. Measuring conditions

The measuring results were valid at the time of the measurement. Furthermore, they apply only to the respective installation site and the machine settings at the time of calibration. All settings and correction values were documented by the calibration lab. The values were stored in the following directory:

V:\05_DAkkS-10360\02_KMG-Abnahmen\Frankreich\Microrectif ST-Etienne\Xenos Nr.182524\2019-10

5. Ambient conditions

The temperatures prevailing during the calibration are documented in item 6 "Measurement results".

6. Measurement results

6.1 Length measuring error E_0 and E_{150} / repeat range R_0

The following step gauges were used to determine length measuring errors E_0 and E_{150} as well as repeat range R_0 :

Step gauge 1:	
ID number:	SE1100159 / PM20069727
Calibration mark:	17840 D-K-15007-01-00 2019-03
Calibration uncertainty U (k=2):	0.10 µm + 0.40 · 10^{-6} · l
Therm. expansion coefficient:	11.84 · 10^{-6} / K
Calibration uncertainty of therm. expansion coeff. U (k=2):	0.05 · 10^{-6} / K

Step gauge 2:	
ID number:	Zerodur-3 / PM20021112
Calibration mark:	18233 D-K-15007-01-00 2019-05
Calibration uncertainty U (k=2):	0.10 µm + 0.40 · 10^{-6} · l
Therm. expansion coefficient:	0.00 · 10^{-6} / K
Calibration uncertainty of therm. expansion coeff. U (k=2):	0.10 · 10^{-6} / K

The following diagrams show the determined length measuring errors E_L with their measuring uncertainties and the permissible length measuring error E_L.

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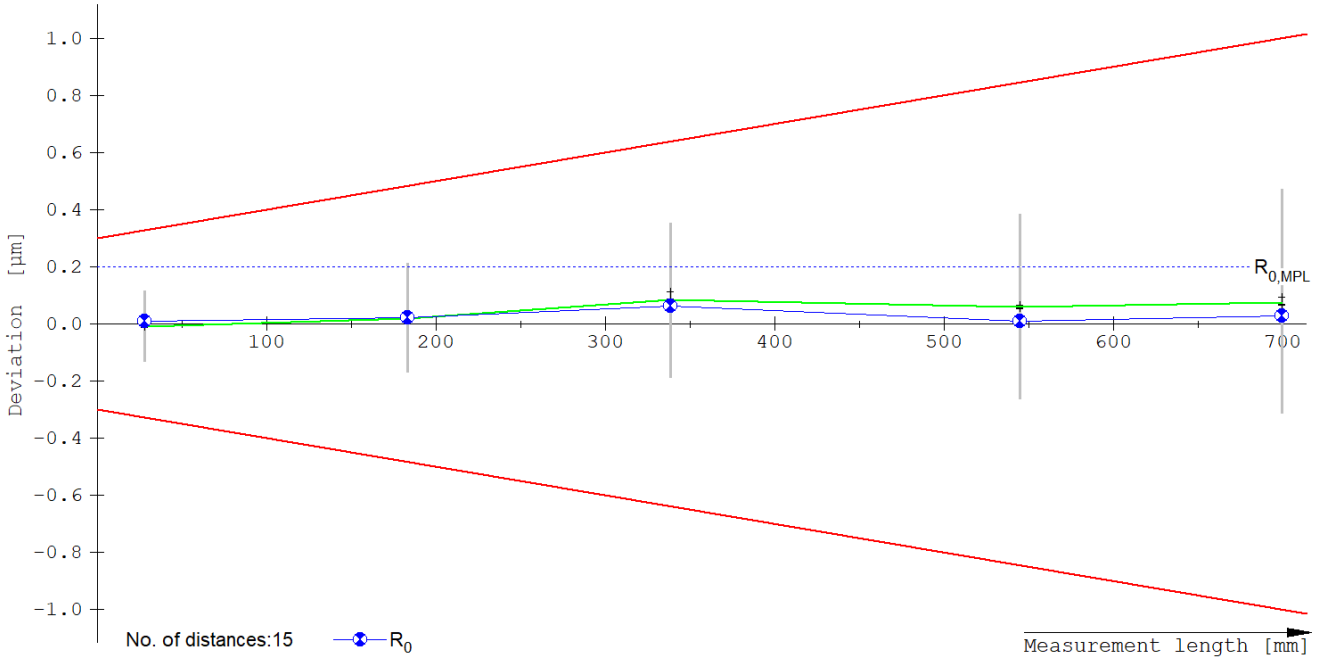
Length measuring errors E_0 in position 1 (X axis)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object:	First roller:	X=101 mm	Y=-794 mm	Z=-369 mm
	Last roller:	X=812 mm	Y=-789 mm	Z=-370 mm

Temperature of the step gauge in °C:

Start of measurements: 20.10 End of measurements: 20.10

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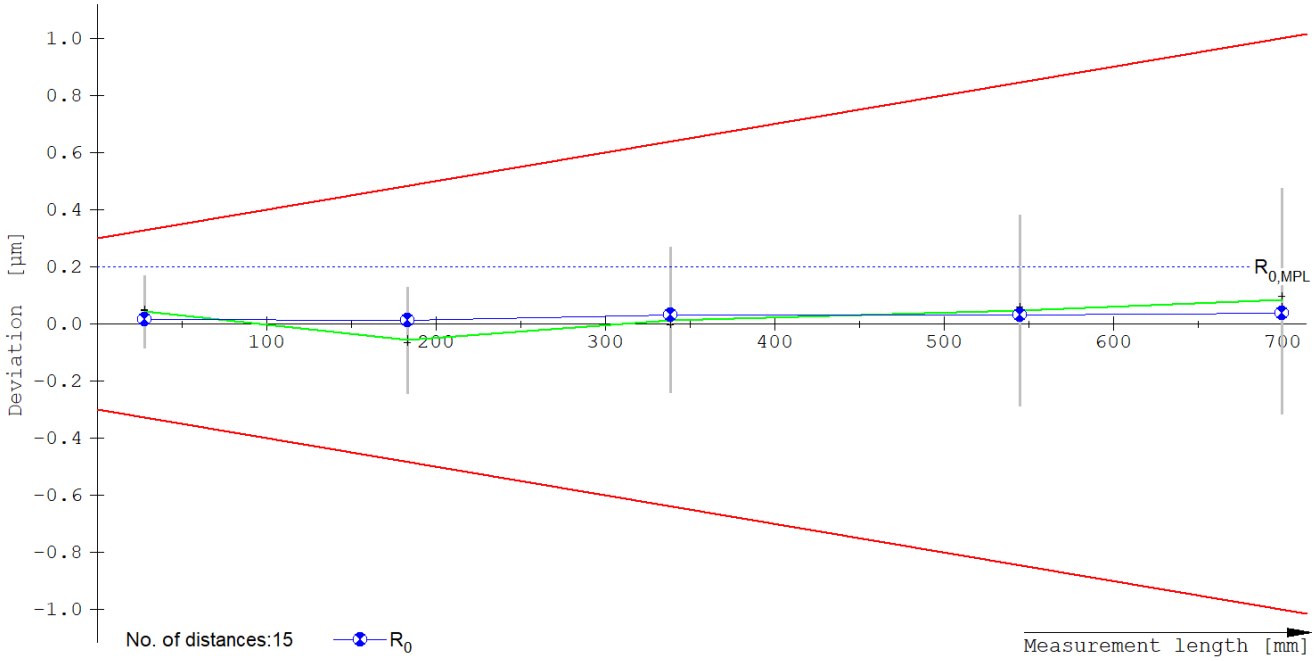
Length measuring errors E_0 in position 2 (Y axis)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object:	First roller:	X=451 mm	Y=-1272 mm	Z=-369 mm
	Last roller:	X=452 mm	Y= -560 mm	Z=-370 mm

Temperature of the step gauge in °C:

Start of measurements: 20.13 End of measurements: 20.11

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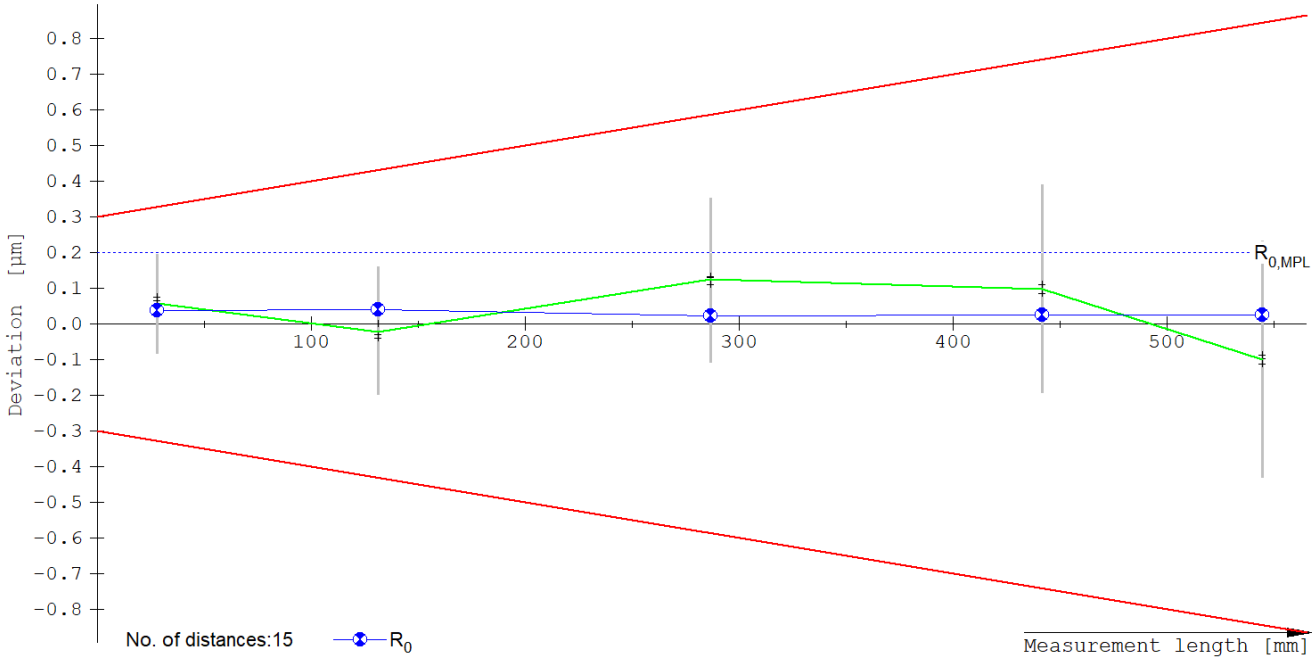
Length measuring errors E_0 in position 3 (Z-direction)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=647 mm Y=-1264 mm Z=-500 mm
Last roller: X=645 mm Y=-1259 mm Z= 57 mm

Temperature of the step gauge in °C:

Start of measurements: 20.07 End of measurements: 20.06

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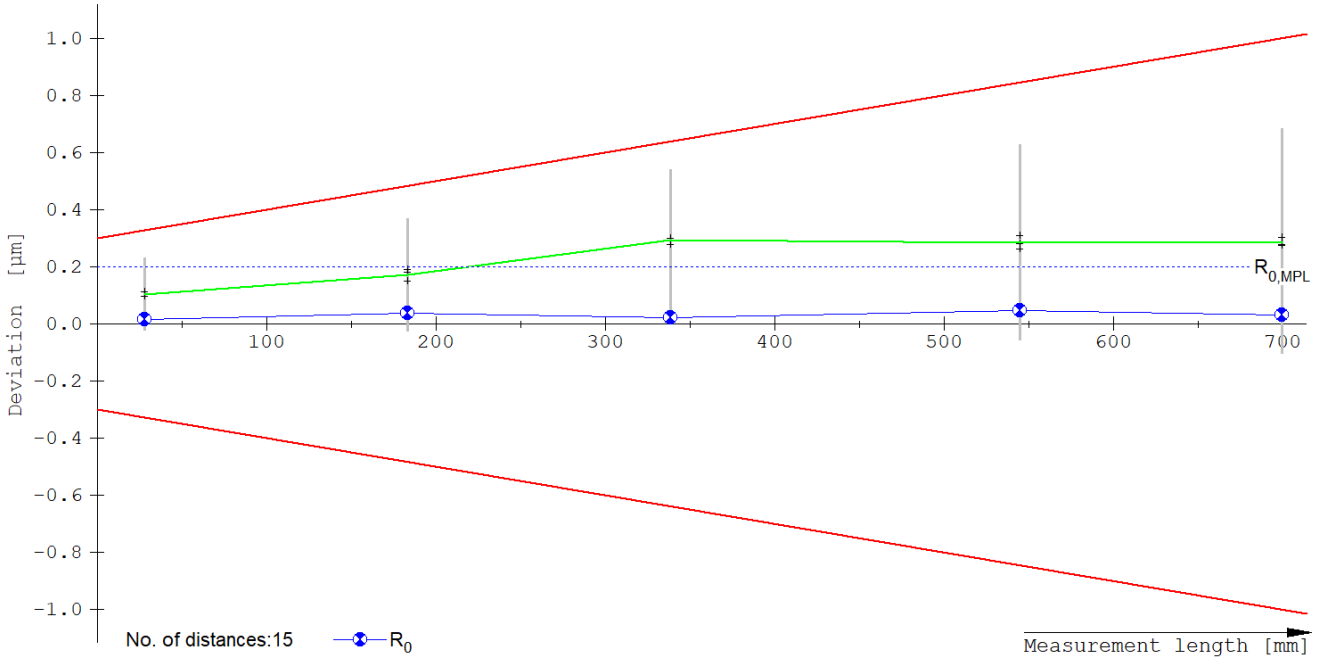
Length measuring errors E_0 in position 4 (Spatial position FR)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=809 mm Y=-1222 mm Z=-426 mm
Last roller: X=343 mm Y= -773 mm Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.05 End of measurements: 20.05

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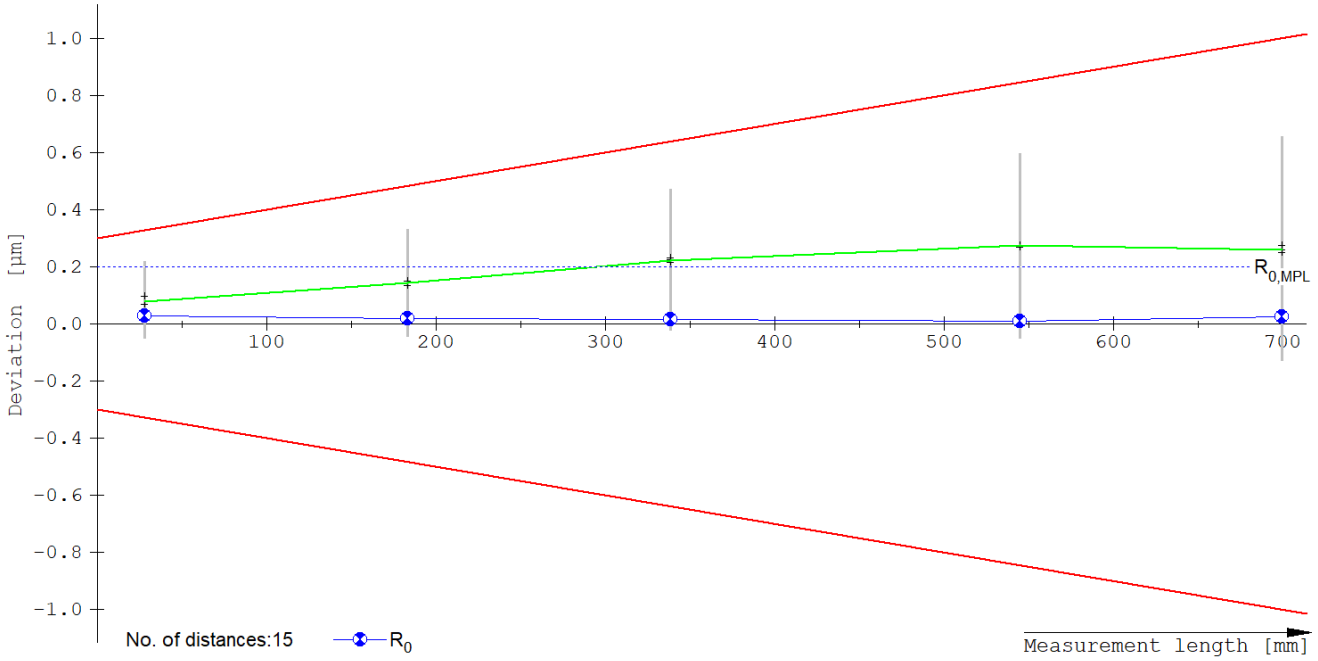
Length measuring errors E_0 in position 5 (Spatial position FL)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=288 mm Y=-1219 mm Z=-427 mm
Last roller: X=757 mm Y= -774 mm Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.04 End of measurements: 20.04

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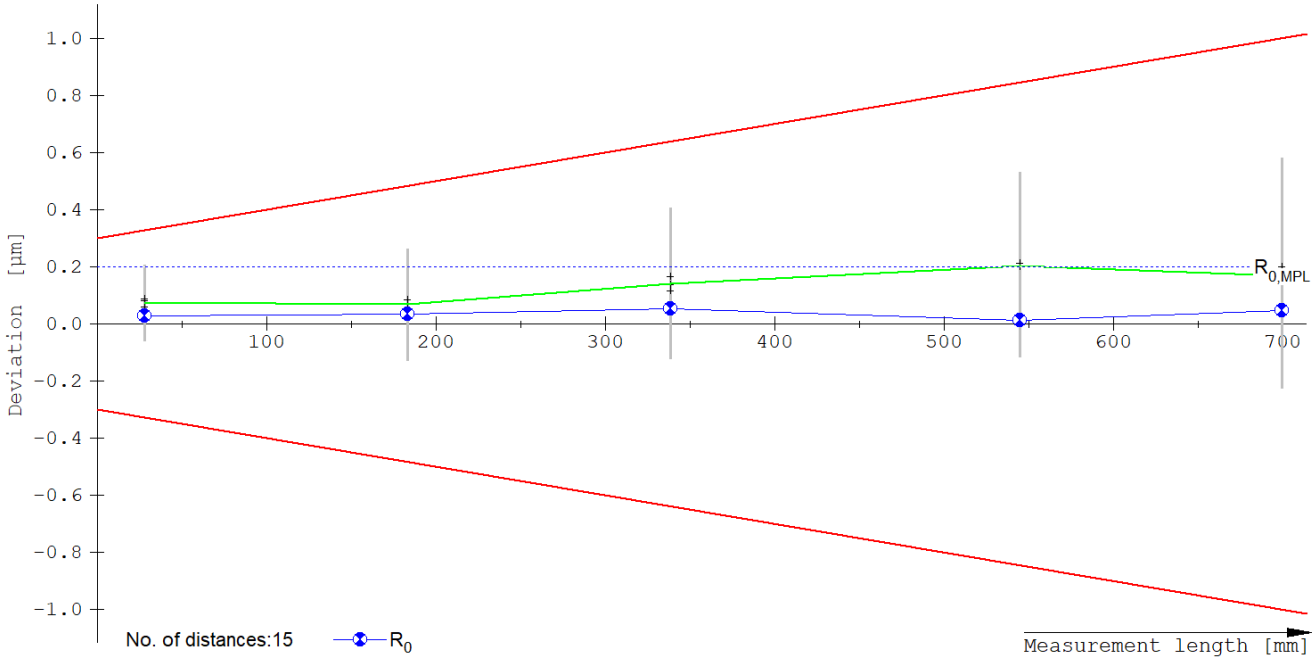
Length measuring errors E_0 in position 6 (Spatial position RL)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=290 mm Y= -720 mm Z=-427 mm
Last roller: X=755 mm Y=-1169 mm Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.04 End of measurements: 20.04

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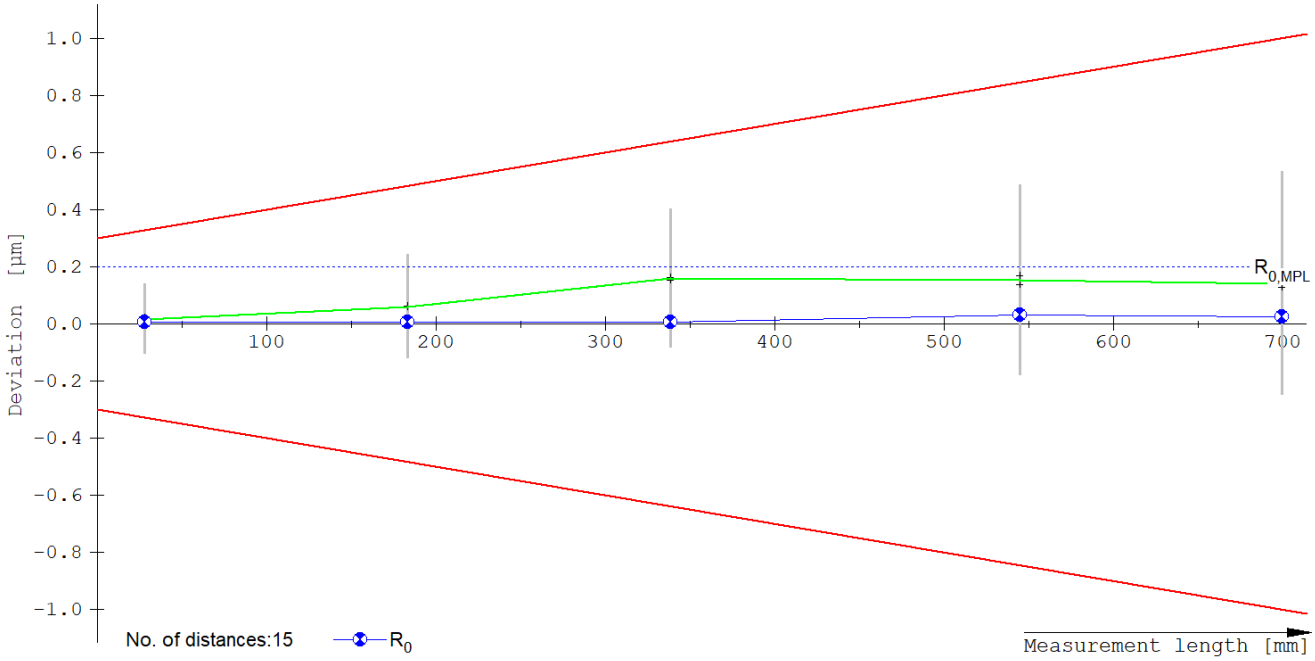
Length measuring errors E_0 in position 7 (Spatial position RR)



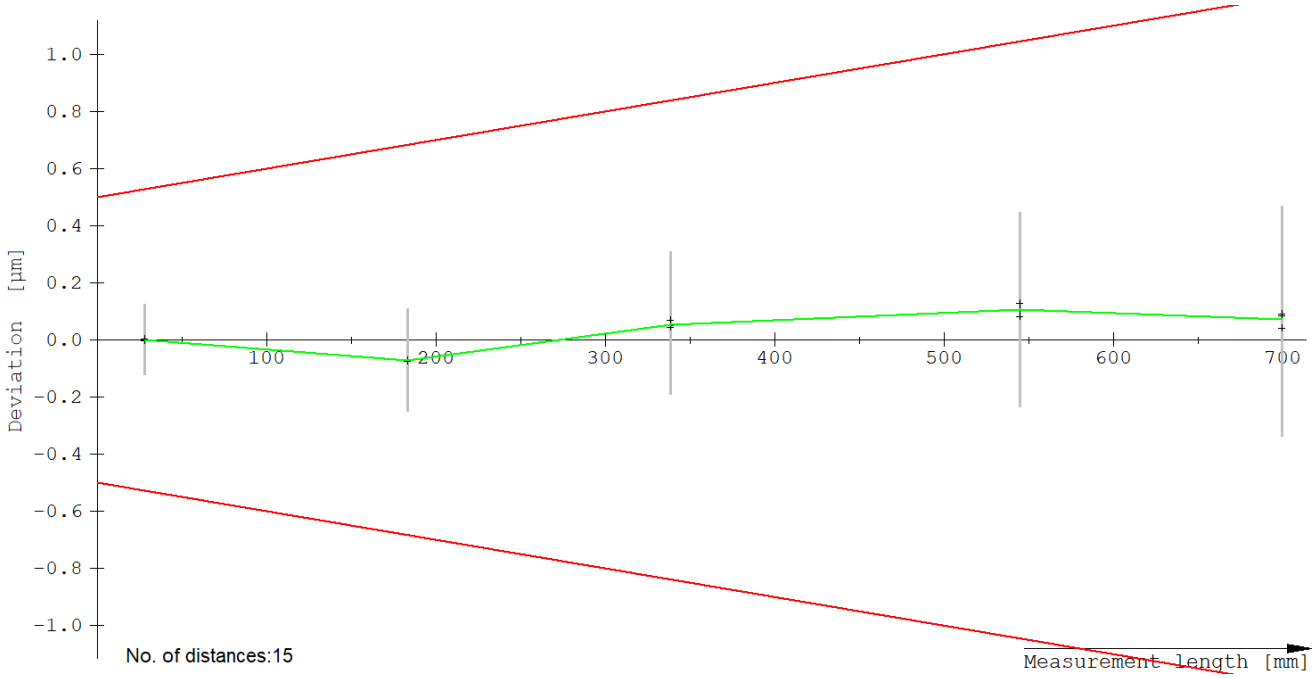
The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object:	First roller:	X=806 mm	Y= -716 mm	Z=-426 mm
	Last roller:	X=348 mm	Y=-1172 mm	Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.04 End of measurements: 20.04

Length measuring errors E_{150} in position 8 (MPE-E150_L)



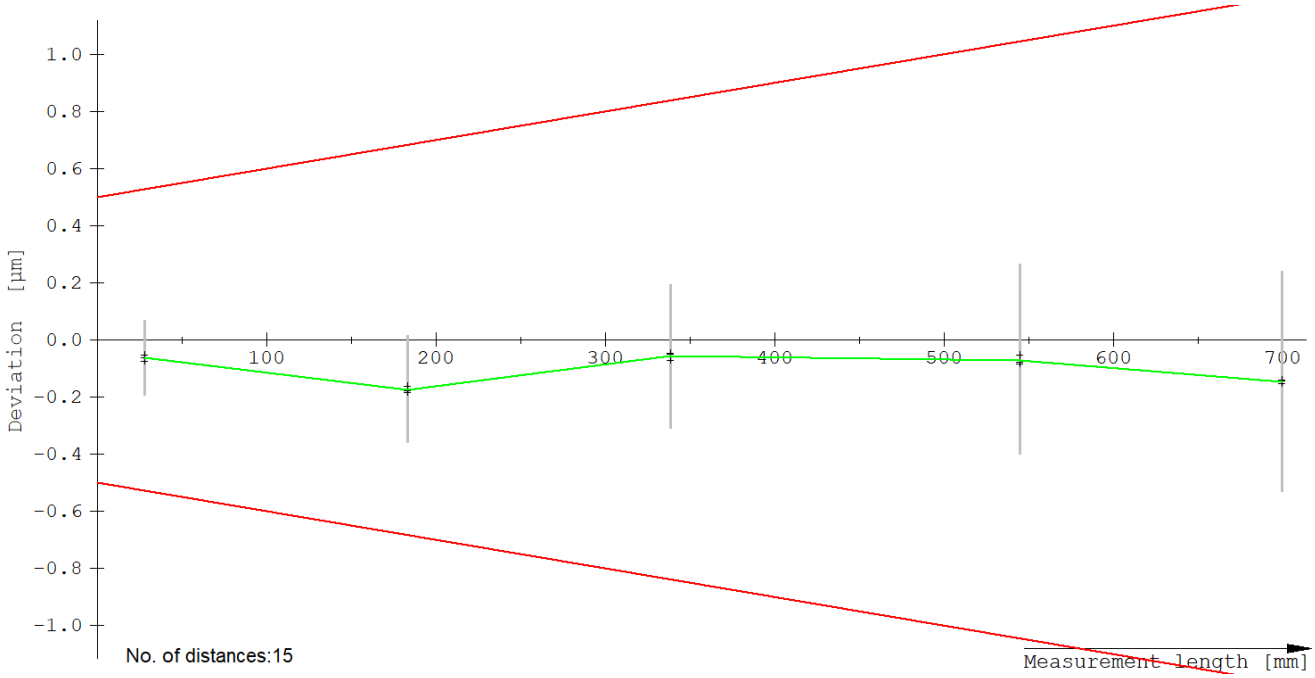
The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=453 mm Y=-1308 mm Z=-427 mm
Last roller: X=452 mm Y= -661 mm Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.06 End of measurements: 20.05

Length measuring errors E_{150} in position 9 (MPE-E150_R)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object:	First roller:	X=453 mm	Y=-1308 mm	Z=-427 mm
	Last roller:	X=452 mm	Y= -661 mm	Z=-129 mm

Temperature of the step gauge in °C:

Start of measurements: 20.05 End of measurements: 20.07

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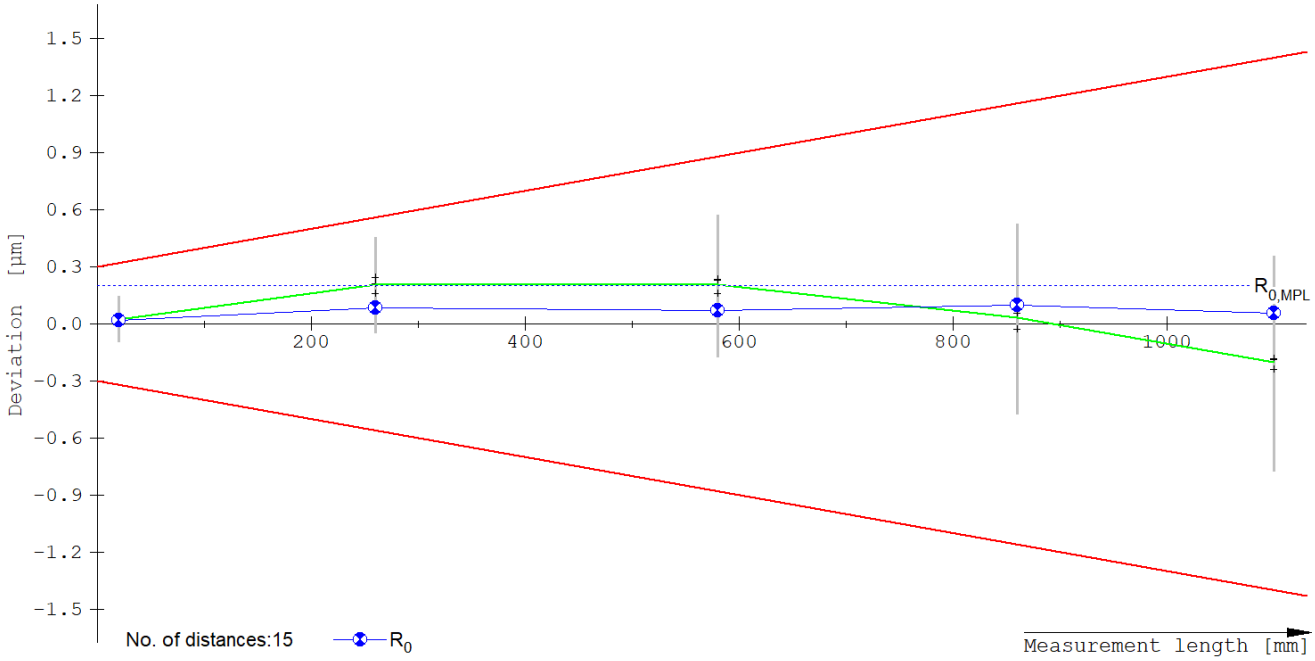
Length measuring errors E_0 in position 10 (SGB steel Y axis)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object:	First roller:	X=679 mm	Y=-1422 mm	Z=-562 mm
	Last roller:	X=679 mm	Y= -322 mm	Z=-562 mm

Temperature of the step gauge in °C:

Start of measurements: 20.05 End of measurements: 20.05

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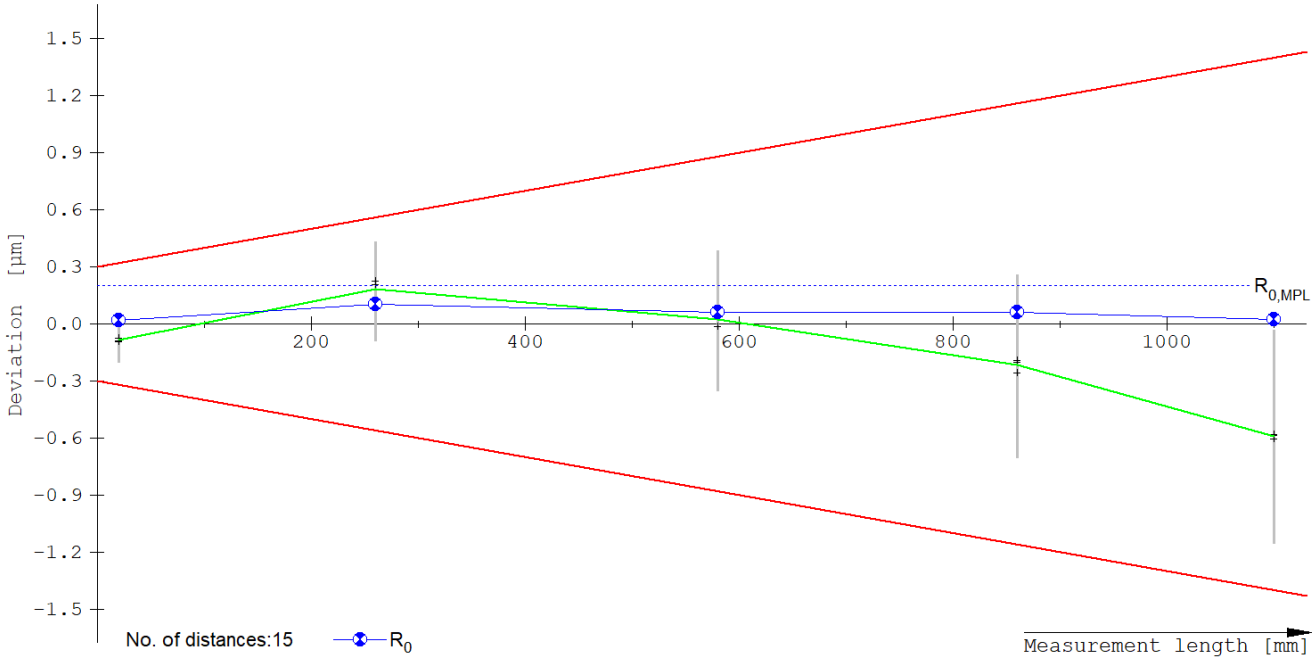
Length measuring errors E_0 in position 11 (SGB steel 3D)



The bar lengths represent the uncertainty intervals +/- *U* (*E*), and the central points represent the values obtained for the errors of indication.

Position of test object: First roller: X=771 mm Y=-1179 mm Z=-562 mm
Last roller: X=184 mm Y= -374 mm Z= -96 mm

Temperature of the step gauge in °C:

Start of measurements: 20.14 End of measurements: 20.13

6.2 Four-axis error FR, FT and FA

The following rotary table check was used to determine the four-axis errors:

ID number:	G01158B
ID number:	G01159B
Calibration mark, sphere A:	12036 D-K-15007-01-00 2017-03
Calibration mark, sphere B:	12037 D-K-15007-01-00 2017-03
Form error of sphere A:	0.10 µm
Form error of sphere B:	0.11 µm
Calibration uncertainty of sphere A form *U* (*k*=2):	0.10 µm
Calibration uncertainty of sphere B form *U* (*k*=2):	0.10 µm

The rotary table check was set up centered on the rotary table axis of the CMM.
The vertical and radial distance between the spheres is 206 mm.

Radial four-axis error FR

The permissible limit is: 1.50 µm

The result for the radial four-axis error FR is:

FR = (0.49 ± 0.36) µm

Tangential four-axis error FT

The permissible limit is: 1.50 µm

The result for the tangential four-axis error FT is:

FT = (0.78 ± 0.36) µm

Axial four-axis error FA

The permissible limit is: 1.20 µm

The result for the axial four-axis error FA is:

FA = (0.25 ± 0.44) µm

6.3 Single stylus form error P_{FTU}

The following calibration sphere was used to determine the single stylus form error:

ID number:	K4394
Calibration mark:	15712 D-K-15007-01-00 2018-08
Diameter:	24.9968 mm
Calibration uncertainty of diameter *U* (*k*=2):	0.08 µm + 0.40 · 10^{-6} · *l*
Roundness error:	0.05 µm
Calibration uncertainty of form *U* (*k*=2):	0.02 µm
Therm. expansion coefficient:	5.50 · 10^{-6} / K
Calibration uncertainty of therm. expansion coeff. *U* (*k*=2):	0.55 · 10^{-6} / K

The permissible limit is: 0.40 µm

The result for single stylus form deviation P_{FTU} is:

P_{FTU} = (0.08 ± 0.06) µm

Position of test object: X=449mm Y=-870mm Z=-387mm
Temperature of the test object in °C: 20.10

6.4 Scanning probing error THP and scanning test duration τ

The following calibration sphere was used to determine the scanning probing error THP and the scanning test duration τ:

ID number:	K4394
Calibration mark:	15712 D-K-15007-01-00 2018-08
Diameter:	24.9968 mm
Calibration uncertainty of diameter *U* (*k*=2):	0.08 µm + 0.40 · 10^{-6} · *l*
Roundness error:	0.05 µm
Calibration uncertainty of form *U* (*k*=2):	0.02 µm
Therm. expansion coefficient:	5.50 · 10^{-6} / K
Calibration uncertainty of therm. expansion coeff. *U* (*k*=2):	0.55 · 10^{-6} / K

The permissible limit for scanning probing error THP is: 0.60 µm

The result for probing error THP is:

THP = (0.28 ± 0.06) µm

The permissible limit for the scanning test duration τ is: 40.0 s

For the scanning test duration, τ equaled:

$$\tau = (35.0 \pm 0.90)\ s$$

Position of test object: X=449mm Y=-870mm Z=-387mm

Temperature of the test object in °C: 20.09

6.5 Repeat range R_0

The permissible limit value for repeat range R_0 is: 0.20 µm

For repeat range R_0 this resulted in:

$$R_0 = (0.10 \pm 0.06)\ \mu m$$

7. Measuring uncertainty (test uncertainty)

The measuring uncertainties (test uncertainties according to ISO/TS 23165:2005) of the individual parameters are specified along with the results.

The extended measuring uncertainty (test uncertainty) is specified. It is calculated by multiplying the standard measuring uncertainty by the extension factor $k = 2$. It was determined according to DAkkS-DKD-3. There is a 95% probability that the value of the measurand lies within the assigned value range.

8. Statement of conformity

Taking the measuring uncertainty (test uncertainty) into account, the coordinate measuring machine meets the specifications stipulated in the calibration certificate. The performance of the coordinate measuring machine in accordance with the specifications is verified.

Recognition of DAkkS calibration certificates:

The Deutsche Akkreditierungsstelle GmbH is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Co-operation (ILAC) for the mutual recognition of calibration certificates.
All other signatory Members within and outside of Europe are reported on the internet pages of EA (www.european-accreditation.org) and ILAC (www.ilac.org).