Kalibrierschein / *Calibration Certificate*

erstellt durch das Kalibrierlaboratorium
issued by the calibration laboratory

Kalibrierzeichen	K03904
Calibration mark	D-K-21703-01-00
	2023-10

Carl Zeiss IQS Deutschland GmbH
Carl-Zeiss-Straße 22
DE - 73447 Oberkochen
℡ +49 7364 20 6337
✉ info.metrology.de@zeiss.com

Gegenstand *Object*	3D Koordinatenmessgerät *3D coordinate measuring machine*
Hersteller *Manufacturer*	Carl Zeiss
Typ *Type*	XENOS
Fabrikat/Serien-Nr. *Serial number*	182524
Inventar Nr. *Inventory number*	
Auftraggeber *Customer*	MICRORECTIF 10 rue de l'Innovation FR-42000 St-Etienne
Auftragsnummer *Order No*	8580737612/100
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	22
Datum der Kalibrierung *Date of calibration*	12.10.2023

Dieser Kalibrierschein dokumentiert die metrologische Rückführbarkeit auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multi-lateralen 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 metrological 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.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine sind bei Nennung des für die Freigabe Verantwortlichen in Klarschrift auch ohne Unterschrift gültig.
Die dargestellten Ergebnisse gelten nur für den kalibrierten Gegenstand.
This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory.
Calibration certificates with the full name of the approval responsible person are valid without signature.
The results shown apply only to the calibrated item.

Datum der Ausstellung *Date of issue*	Freigabe durch *Approval by*	Bearbeiter *Person in charge*
30.10.2023	Sven Dobler	P. Lerendu

1.   Calibration object

The indication error of length measurement error E_L, repeatability range R_0, the single-stylus form error $P_{Form.Sph.1\times25:SS:Tact}$, the scanning mode form error on a sphere $P_{Form.Sph.Scan:PP:Tact}$, the scanning mode time $\tau_{Sph.Scan:PP:Tact}$, the multi-stylus form error $P_{Form.Sph.5\times25:MS:Tact}$, the multi-stylus size error $P_{Size.Sph.5\times25:MS:Tact}$ and the multi-stylus location error $L_{Dia.5\times25:MS:Tact}$, as well as the four-axis deviation FR, FT and FA were measured on the coordinate measuring machine.

The coordinate measuring machine had the following configuration during calibration:

Controller:	C99N #AK031620
Probe:	VAST-G-C1 #0029V0GZ
Rotary table:	0028YKAA
Measurement software:	CALYPSO 7.4.12.03
CAA file:	guideway.caa 10/10/2023
Reference sphere:	#D-04600-A
X measuring range:	900 mm
Y measuring range:	1500 mm
Z measuring range:	640 mm

Calibrated measuring volume:

X direction:	900 mm
Y direction:	1500 mm
Z direction:	640 mm

The coordinate measuring machine had the following specification during calibration:

Length measurement error $E_{0,MPE}$: $0.30\ \mu m + 1.00 \cdot 10^{-6} \cdot l$ (l is the length)

Length measurement error $E_{150,MPE}$: $0.50\ \mu m + 1.00 \cdot 10^{-6} \cdot l$ (l is the length)

Repeatability range $R_{0,MPL}$:	0.20 µm
Single-stylus form error $P_{Form.Sph.1\times25:SS:Tact,MPE}$:	0.40 µm
Multi-stylus form error $P_{Form.Sph.5\times25:MS:Tact,MPE}$:	1.20 µm
Multi-stylus size error $P_{Size.Sph.5\times25:MS:Tact,MPE}$:	0.40 µm
Multi-stylus location error $L_{Dia.5\times25:MS:Tact,MPE}$:	0.60 µm
Scanning mode form error $P_{Form.Sph.Scan:PP:Tact,MPE}$:	0.60 µm
Scanning mode time $\tau_{Sph.Scan:PP:Tact,MPL}$:	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 DKD-R 4-3 sheet 18.1:2018-09 "Calibration of the Metrological Properties of Coordinate Measuring Machines (CMM) as per 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 and DIN EN ISO 10360-5:2020-11.

The length measurement errors E_L were measured via mechanical probing on step gauges. The single-stylus form error $P_{Form.Sph.1\times25:SS:Tact}$, the scanning mode form error on a sphere $P_{Form.Sph.Scan:PP:Tact}$, the scanning mode time $\tau_{Sph.Scan:PP:Tact}$, the multi-stylus form error $P_{Form.Sph.5\times25:MS:Tact}$, the multi-stylus size error $P_{Size.Sph.5\times25:MS:Tact}$ and the multi-stylus location error $L_{Dia.5\times25:MS:Tact}$, were measured on a 25 mm ceramic sphere.
The indication errors FR, FT and FA of the four-axis error were determined using a rotary table check with two 30 mm spheres with ball spacing of a horizontal distance and a radial distance of 206 mm each between the ball center points.

During the measurements, the temperature compensation on the coordinate measuring machine was active and in use.

The standards used are documented with the respective measurement results. The traceable temperature measuring device ALMEMO H20100776 with calibration certificate no. 30116-D-K-15007-01-00-2023-01 was used for the CMM-independent temperature measurement.

3.   Calibration location

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

MICRORECTIF, 10 rue de l'Innovation, FR-42000 St-Etienne

4.   Measurement conditions

The measurement results were valid at the time of the measurement. Furthermore, they apply only to the installation site and for the machine configurations at the time of the calibration. All settings and correction values have been documented by the calibration lab. The values were saved to the following directory:

R:\IMT-VAGK\06_Standards\10360-DAkkS-Ausland\02_KMG-Abnahmen\#Frankreich\Microrectif ST-Etienne\Xenos Nr.182524\2023-10\KMG-Daten

5.   Environmental conditions

The temperatures during calibration are documented in point 6 Measurement results.

6. Measurement results

6.1 Length measurement error E_0 and E_{150} / repeatability range R_0

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

Step gauge 1:
ID number: 1912-03
Calibration label: 29595-D-K-15007-01-00-2022-11
Calibration uncertainty U (k=2): $0.04 \ \mu m + 0.09 \cdot 10^{-6} \cdot l$
Thermal expansion coefficient (CTE): $-0.01 \cdot 10^{-6}$ / K
Calibration uncertainty (CTE): U (k=2): $0.01 \cdot 10^{-6}$ / K

Step gauge 2:
ID number: SE1100296
Calibration label: 59927-D-K-15151-01-00-2023-09
Calibration uncertainty U (k=2): $0.06 \ \mu m + 0.23 \cdot 10^{-6} \cdot l$
Thermal expansion coefficient (CTE): $11.77 \cdot 10^{-6}$ / K
Calibration uncertainty (CTE): U (k=2): $0.15 \cdot 10^{-6}$ / K

Step gauge 3:
ID number: SE0700855
Calibration label: 59926-D-K-15151-01-00-2023-09
Calibration uncertainty U (k=2): $0.06 \ \mu m + 0.27 \cdot 10^{-6} \cdot l$
Thermal expansion coefficient: $11.50 \cdot 10^{-6}$ / K
Calibration uncertainty (CTE): U (k=2): $1.15 \cdot 10^{-6}$ / K

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

Length measurement errors E_0 in position 1 (Direction X)
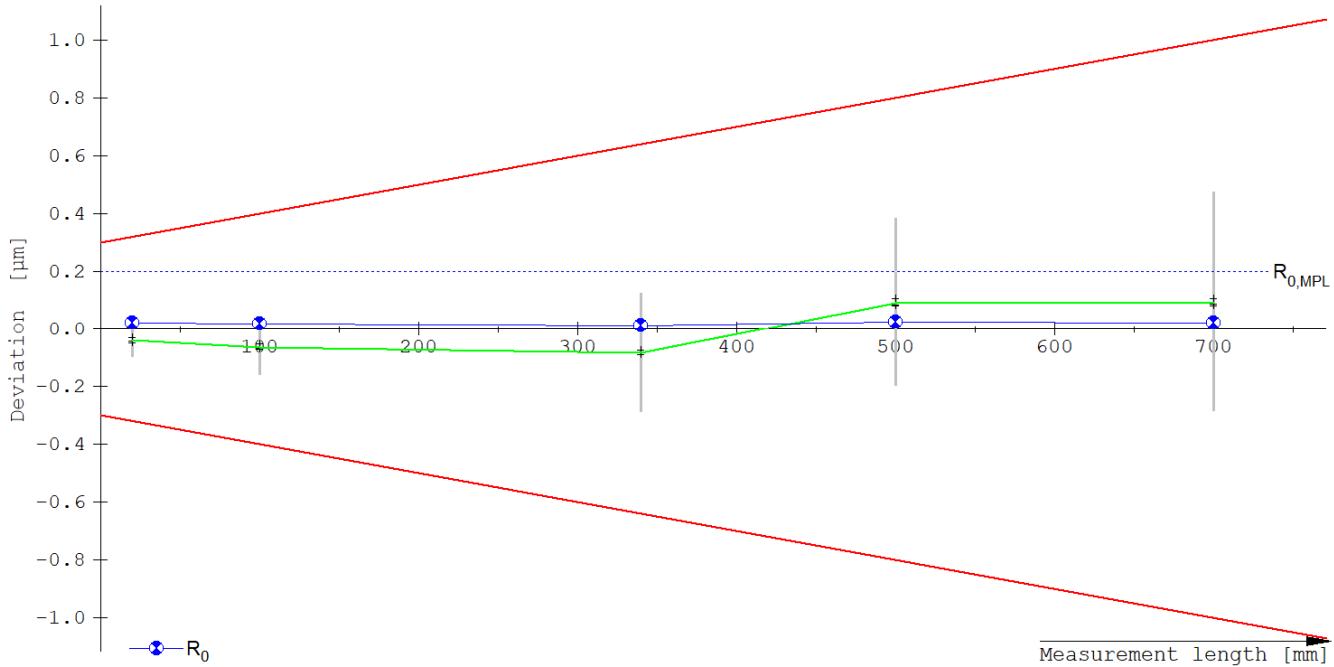
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 825 mm	Y = -668 mm	Z = -234 mm
Last roller:	X = 125 mm	Y = -673 mm	Z = -236 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.21   End of measurements: 20.21

Length measurement errors E_0 in position 2 (Direction Y)
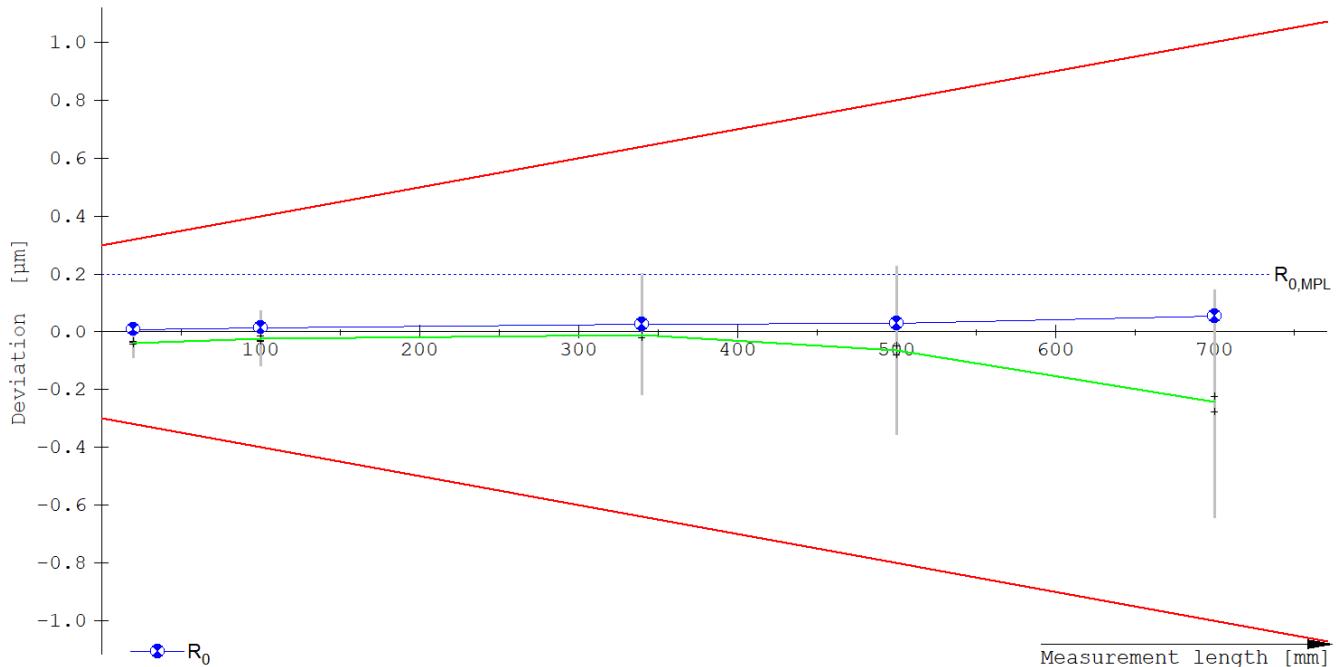
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 449 mm	Y = -1046 mm	Z = -234 mm
Last roller:	X = 452 mm	Y = -346 mm	Z = -235 mm

Temperature of step gauge in °C:
Beginning of measurements: 20.22   End of measurements: 20.22

Length measurement errors E_0 in position 3 (Direction Z)
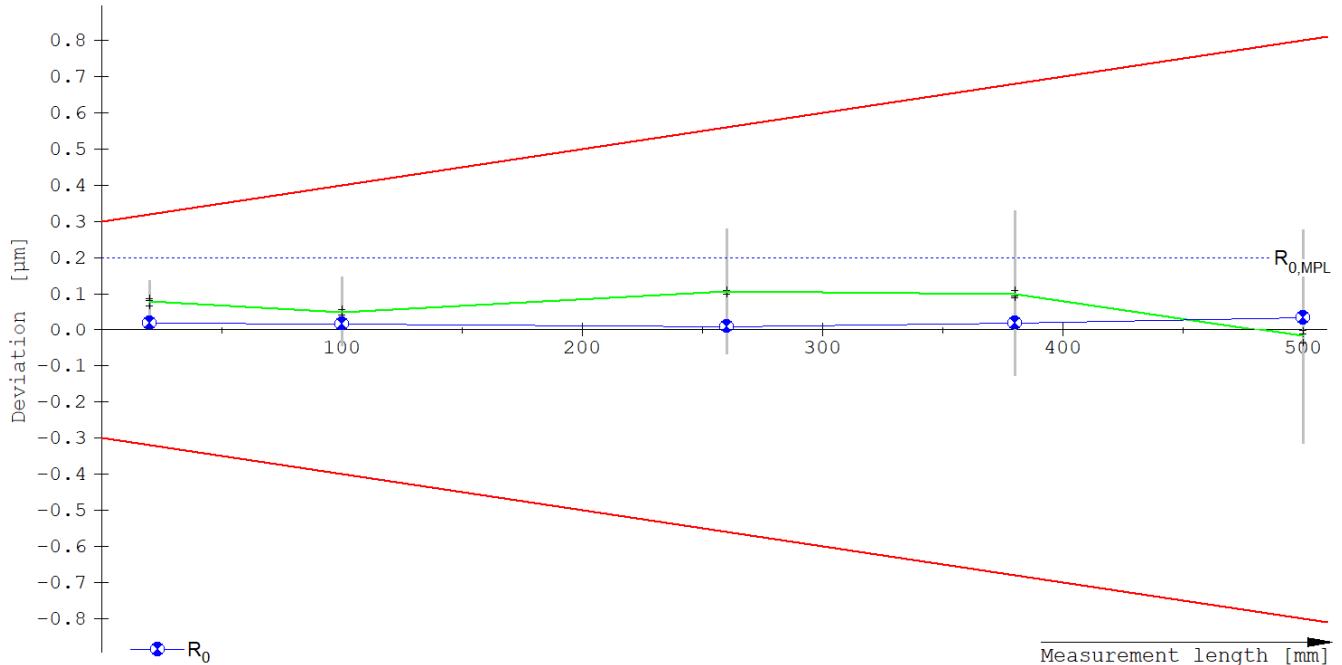
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- *U (E)* with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 633 mm	Y = -671 mm	Z = -507 mm
Last roller:	X = 633 mm	Y = -670 mm	Z = -7 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.08   End of measurements: 20.09

ZEISS

Length measurement errors E_0 in position 4 (R3D Direction Avant Droit)
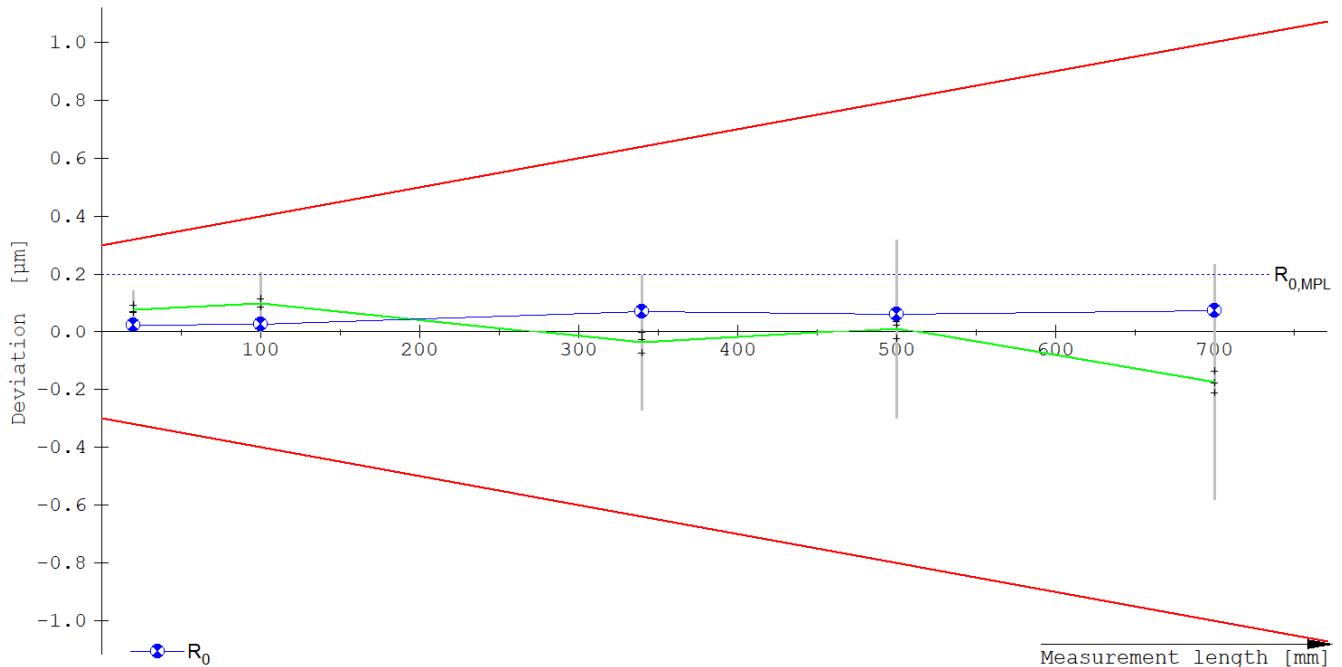
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 666 mm	Y = -1086 mm	Z = -508 mm
Last roller:	X = 260 mm	Y = -679 mm	Z = -107 mm

Temperature of step gauge in °C:
Beginning of measurements: 20.23   End of measurements: 20.23

Length measurement errors E_0 in position 5 (R3D Direction Avant Gauche)
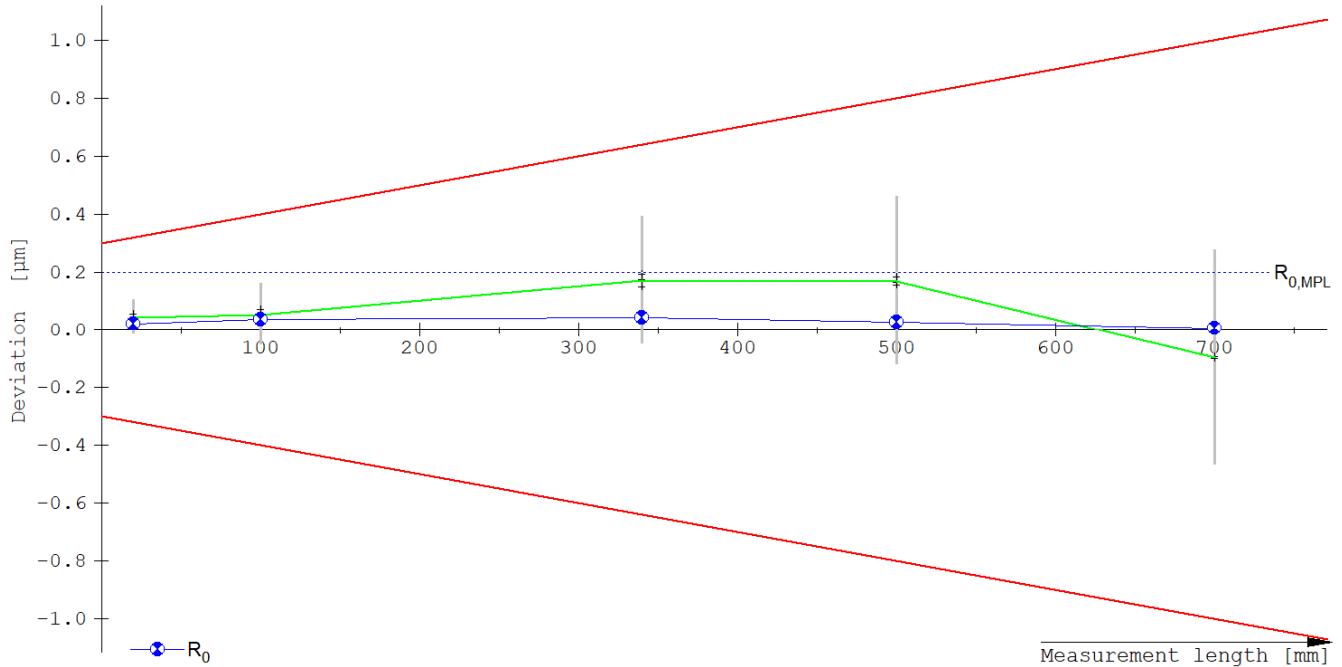
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 220 mm	Y = -1072 mm	Z = -508 mm
Last roller:	X = 653 mm	Y = -694 mm	Z = -107 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.18   End of measurements: 20.19

Length measurement errors E_0 in position 6 (R3D Direction Arrière Gauche)
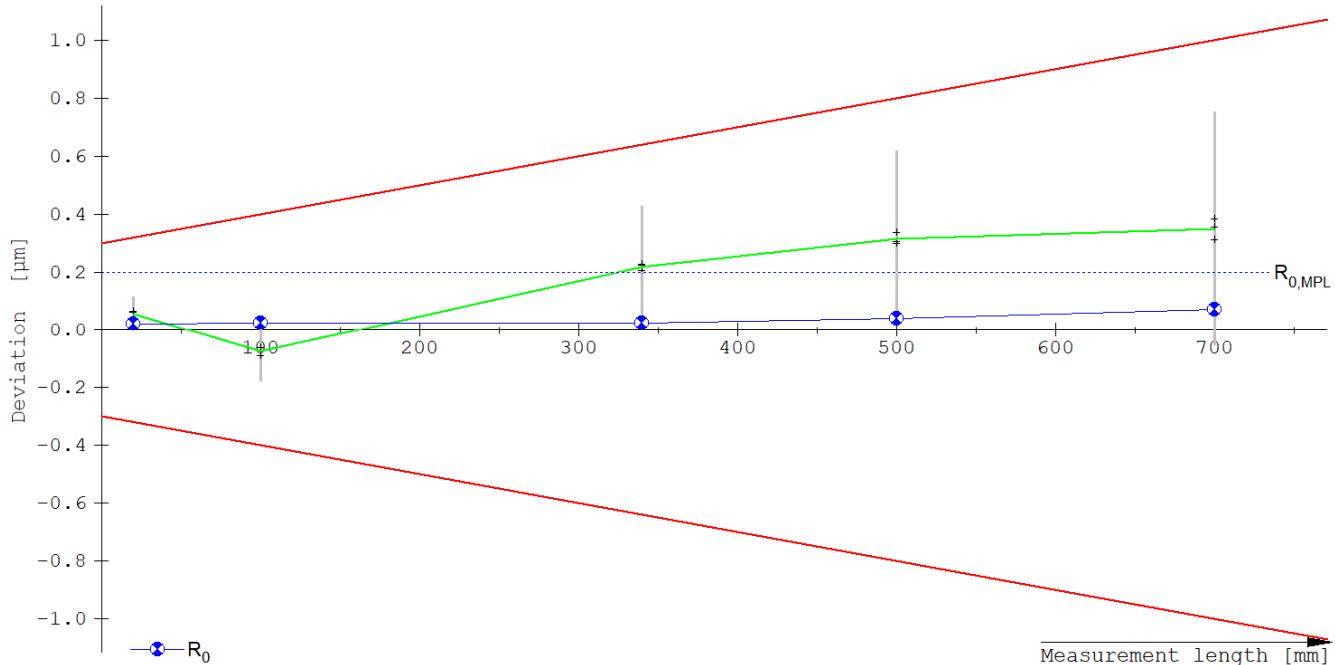
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- *U (E)* with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 234 mm	Y = -655 mm	Z = -508 mm
Last roller:	X = 640 mm	Y = -1061 mm	Z = -107 mm

Temperature of step gauge in °C:
Beginning of measurements: 20.19   End of measurements: 20.20

Length measurement errors E_0 in position 7 (R3D Direction Arrière Droit)
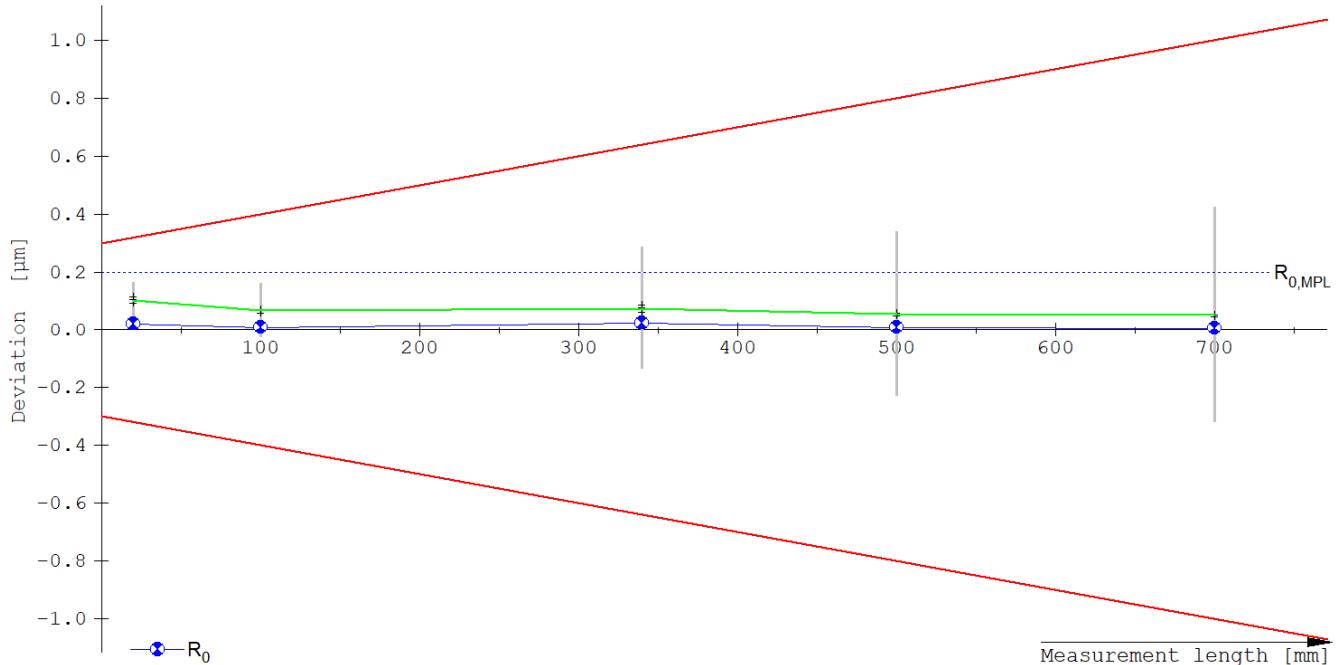
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 665 mm	Y = -454 mm	Z = -508 mm
Last roller:	X = 260 mm	Y = -861 mm	Z = -107 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.19   End of measurements: 20.19

Length measurement errors E_0 in position 8 (X_Axis_SGB_700)
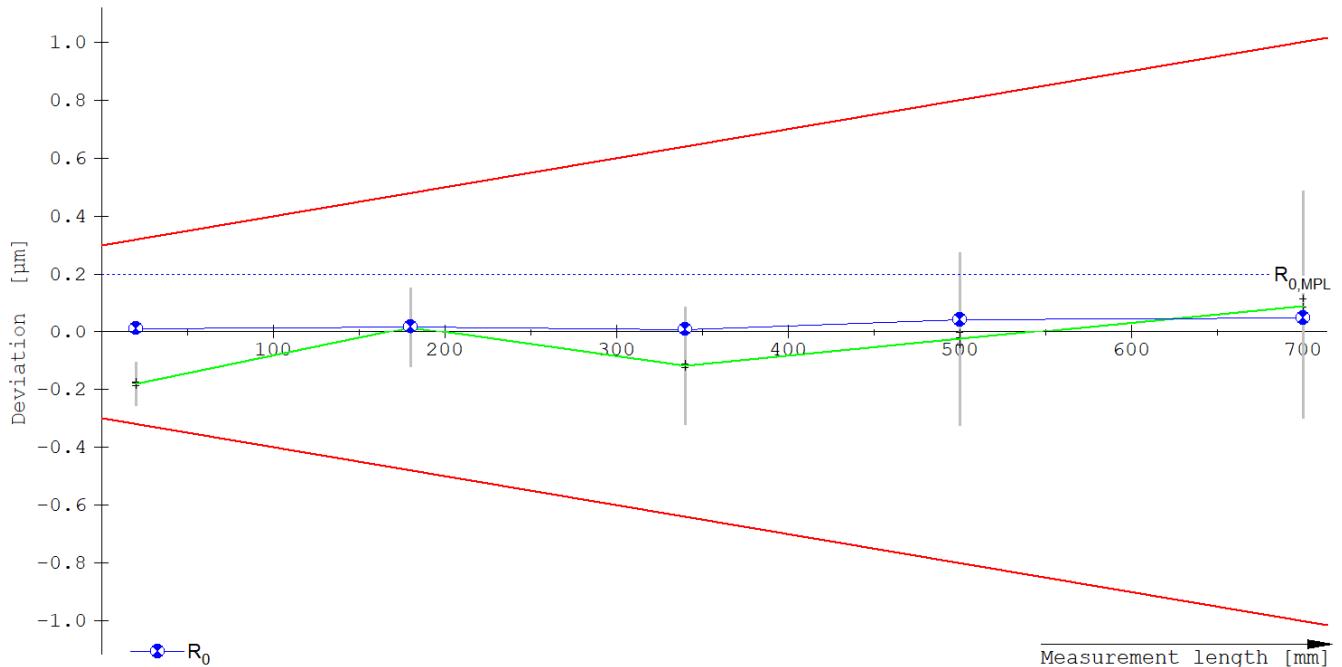
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- *U (E)* with the values for the errors of indication as mean points.

Location of artifact:

First roller:	X = 799 mm	Y = -672 mm	Z = -266 mm
Last roller:	X = 99 mm	Y = -668 mm	Z = -266 mm

Temperature of step gauge in °C:

Beginning of measurements: 19.99   End of measurements: 20.00

Length measurement errors E_0 in position 9 (Y_Axis_SGB_1100)
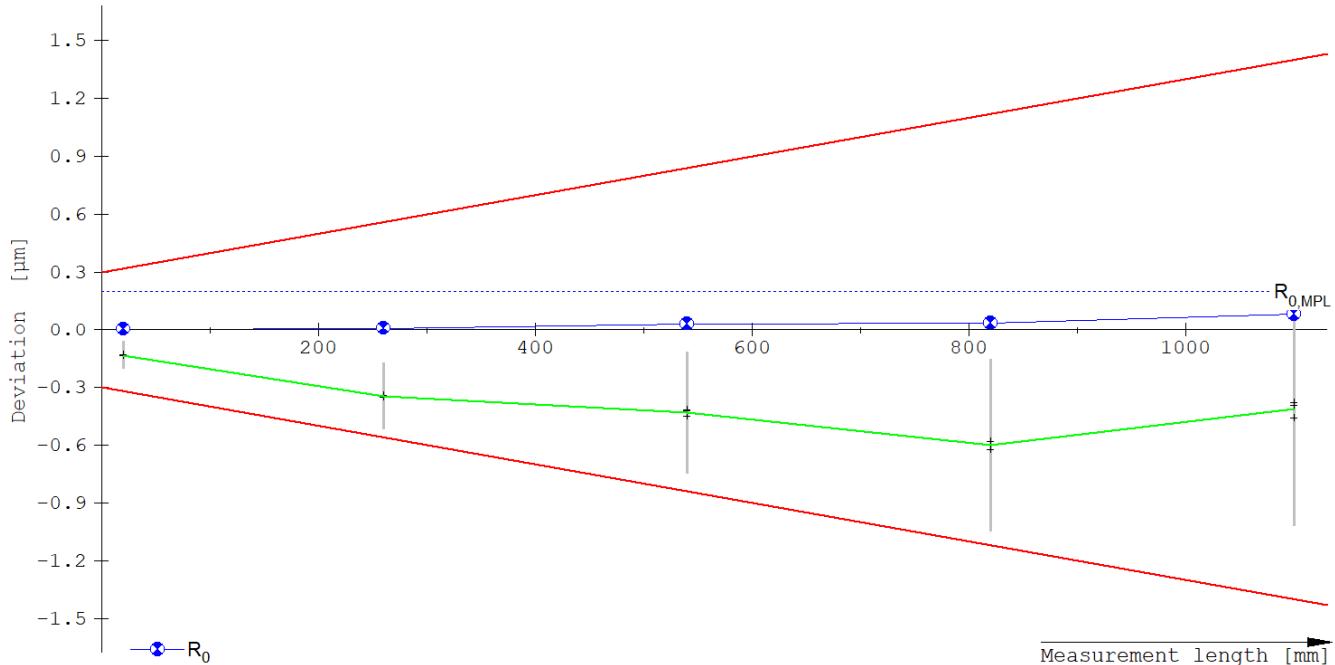
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- *U (E)* with the values for the errors of indication as mean points.

Location of artifact:

First roller:	X = 447 mm	Y = -1214 mm	Z = -265 mm
Last roller:	X = 452 mm	Y = -114 mm	Z = -267 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.14   End of measurements: 20.14

Length measurement errors E_0 in position 10 (3D_SGB_1100)
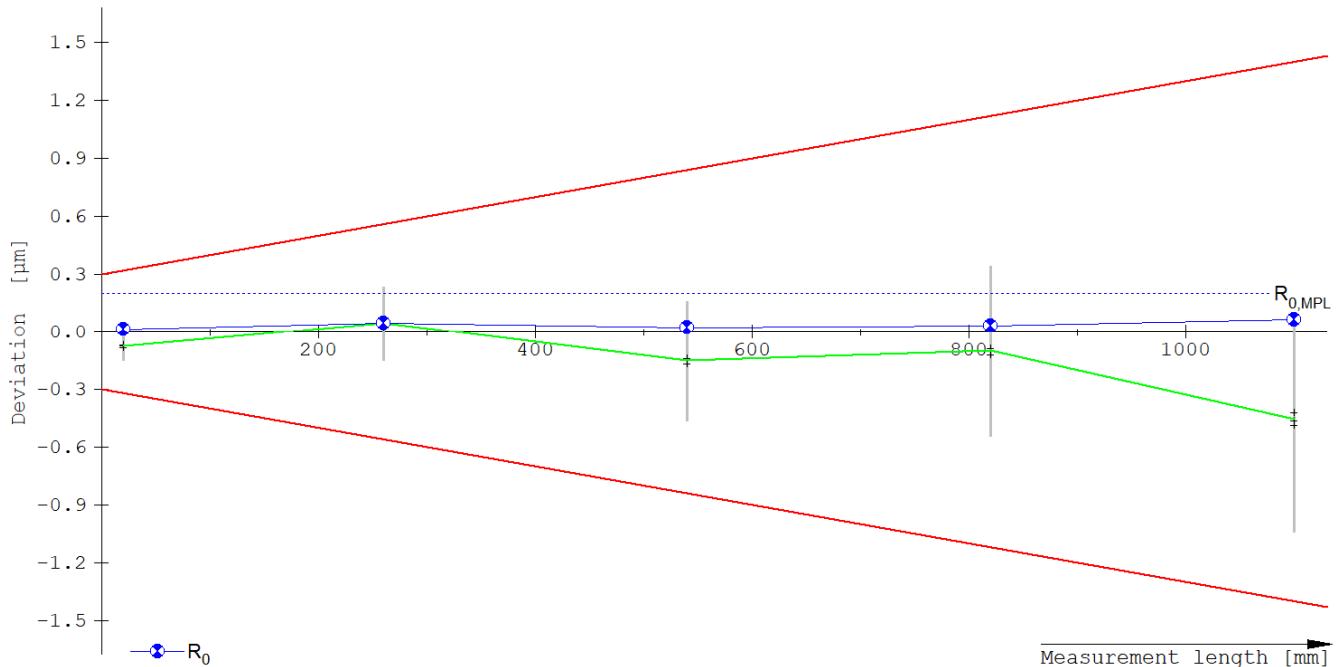
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- *U (E)* with the values for the errors of indication as mean points.

Location of artifact:

First roller:	X = 746 mm	Y = -1131 mm	Z = -405 mm
Last roller:	X = 175 mm	Y = -243 mm	Z = -87 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.11   End of measurements: 20.11

Length measurement errors E_0 in position 11 (E150_L_YZ_PRB_3)
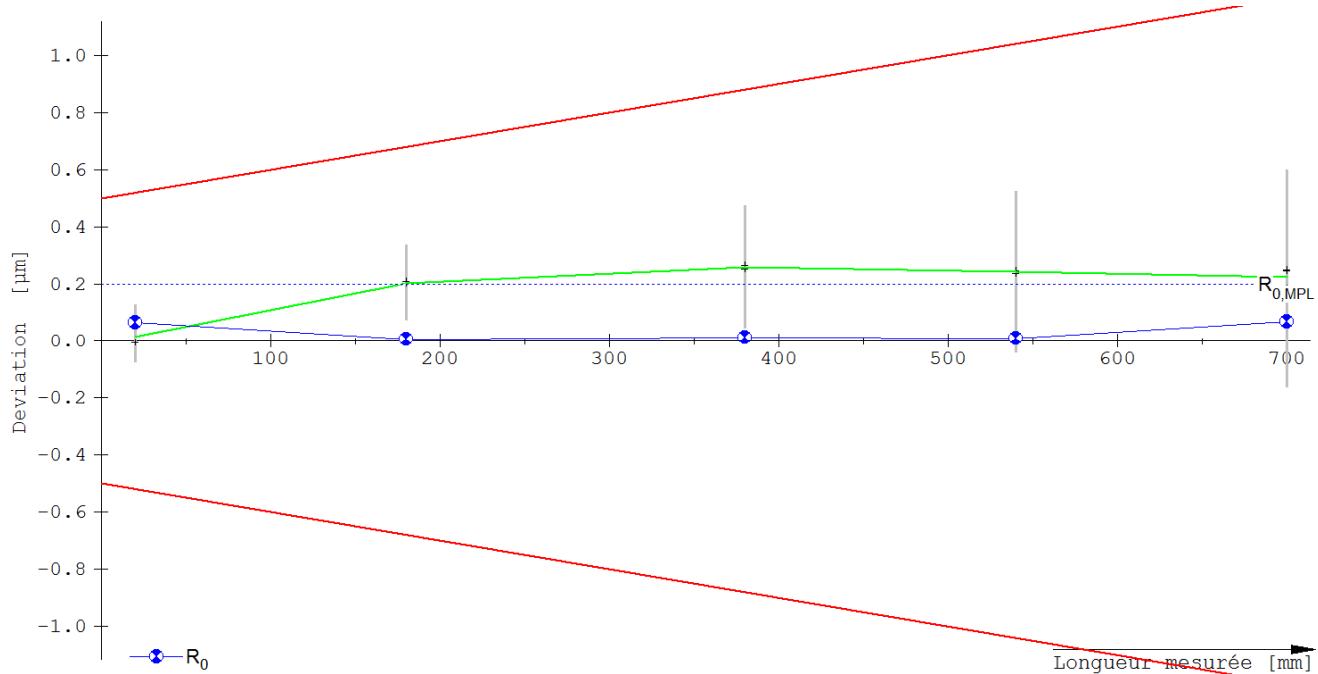
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

First roller:	X = 447 mm	Y = -1020 mm	Z = -440 mm
Last roller:	X = 453 mm	Y = -446 mm	Z = -40 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.30   End of measurements: 20.30

Length measurement errors E_0 in position 12 (E150_R_YZ_PRB_5)
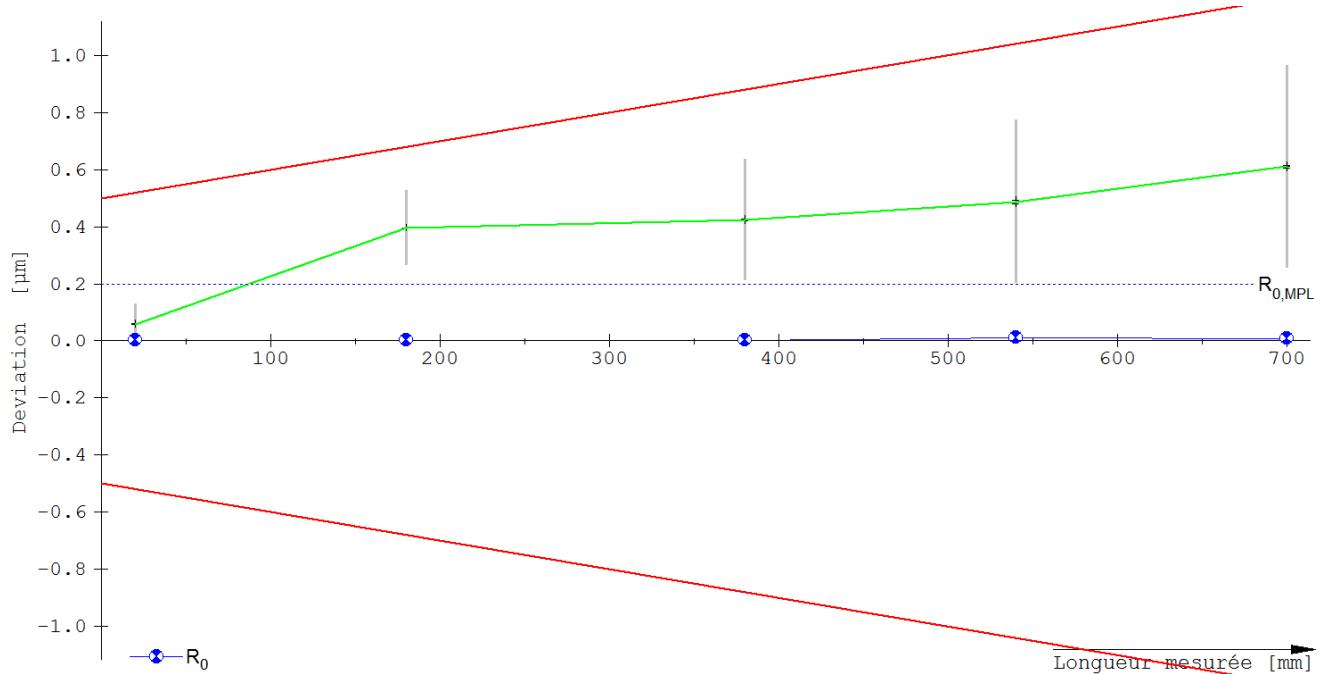
The scattering intervals (bars) centered on the points represent the uncertainty intervals +/- U (E) with the values for the errors of indication as mean points.

Location of artifact:

|			
First roller:	X = 447 mm	Y = -1020 mm	Z = -440 mm
Last roller:	X = 453 mm	Y = -446 mm	Z = -40 mm

Temperature of step gauge in °C:

Beginning of measurements: 20.29   End of measurements: 20.30

6.2 Four-axis error FR, FT and FA

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

Sphere A ID number:	1186
Sphere B ID number:	1029
Sphere A calibration label:	44007 D-K-15151-01-00 2021-09
Sphere B calibration label:	44008 D-K-15151-01-00 2021-09
Sphere A form error:	0.14 µm
Sphere B form error:	0.10 µm
Sphere A form calibration uncertainty U (k=2):	1.00 µm
Sphere B form calibration uncertainty U (k=2):	1.00 µm

The rotary table check was centered on the rotary table axis of the CMM. The height and radial distance of 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 = (0.41 ± 0.37) µm

Tangential four-axis error FT

The permissible limit is: 1.50 µm

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

FT = (0.68 ± 0.14) µm

Axial four-axis error FA

The permissible limit is: 1.20 µm

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

FA = (0.42 ± 0.70) µm

Location of artifact: X=320 mm   Y=-1200 mm   Z=-600 mm

Temperature of the artifact in °C
Start: 20.12   End: 20.23

6.3 Single-stylus form error $P_{\text{Form.Sph.1×25:SS:Tact}}$

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

ID number:	D-02028
Calibration label:	59928-D-K-15151-01-00-2023-09
Diameter:	24.9851 mm
Diameter calibration uncertainty U (k=2):	0.10 µm + 0.40 · 10^{-6} · l
Roundness error:	0.05 µm
Form calibration uncertainty U (k=2):	0.05 µm
Thermal expansion coefficient (CTE):	5.50 · 10^{-6} / K
Calibration uncertainty (CTE): U (k=2):	1.00 · 10^{-6} / K

The permissible limit is: 0.40 µm

The result for single-stylus form error is:

$$P_{\text{Form.Sph.1×25:SS:Tact}} = (0.21 \pm 0.08)\ \text{µm}$$

Location of artifact: X=449 mm   Y=-871 mm   Z=-387 mm

Temperature of the artifact in °C: 20.27

6.4   Scanning mode form error on a sphere $P_{Form.Sph.Scan:PP:Tact}$, and scanning mode time $\tau_{Sph.Scan:PP:Tact}$

The following calibrated sphere was used to determine the scanning mode form error on a sphere and the scanning mode time:

ID number:	D-02028
Calibration label:	59928-D-K-15151-01-00-2023-09
Diameter:	24.9851 mm
Diameter calibration uncertainty U (k=2):	0.10 µm + 0.40 · 10^{-6} · l
Roundness error:	0.05 µm
Form calibration uncertainty U (k=2):	0.05 µm
Thermal expansion coefficient (CTE):	5.50 · 10^{-6} / K
Calibration uncertainty (CTE): U (k=2):	1.00 · 10^{-6} / K

The permissible limit for scanning mode form error on a sphere is: 0.60 µm

The result for scanning mode form error on a sphere is:

$$P_{Form.Sph.Scan:PP:Tact} = (0.35 \pm 0.08) \text{ µm}$$

The permissible limit for the scanning mode time is: 40.0 s

The scanning mode time was:

$$\tau_{Sph.Scan:PP:Tact} = (39.0 \pm 0.90) \text{ s}$$

Location of the artifact: X=449 mm   Y=-871 mm   Z=-387 mm
Temperature of the artifact in °C: 20.22

6.5 Multi-stylus error $P_{Form.Sph.5\times25:MS:Tact}$, $P_{Size.Sph.5\times25:MS:Tact}$, $L_{Dia.5\times25:MS:Tact}$

The following reference sphere was used to measure the multi-stylus error $P_{Form.Sph.5\times25:MS:Tact}$, $P_{Size.Sph.5\times25:MS:Tact}$, $L_{Dia.5\times25:MS:Tact}$:

ID number:	D-02028
Calibration label:	59928-D-K-15151-01-00-2023-09
Diameter:	24.9851 mm
Diameter calibration uncertainty U (k=2):	0.10 µm + 0.40 · 10^{-6} · l
Roundness error:	0.05 µm
Form calibration uncertainty U (k=2):	0.05 µm
Thermal expansion coefficient (CTE):	5.50 · 10^{-6} / K
Calibration uncertainty (CTE): U (k=2):	1.00 · 10^{-6} / K

The permissible limit for multi-stylus form error is: 1.20 µm

The multi-stylus form error was:

$$P_{Form.Sph.5\times25:MS:Tact} = (0.43 \pm 0.08)\ \text{µm}$$

The permissible limit for multi-stylus size error is: 0.40 µm

The multi-stylus size error was:

$$P_{Size.Sph.5\times25:MS:Tact} = (0.24 \pm 0.12)\ \text{µm}$$

The permissible limit for multi-stylus location error is: 0.60 µm

The multi-stylus location error was:

$$L_{Dia.5\times25:MS:Tact} = (0.29 \pm 0.08)\ \text{µm}$$

Location of artifact: X = 410 mm   Y = -818 mm   Z = -361 mm

Temperature of the artifact in °C: 20.28

6.6 Repeatability range R_0

The permissible limit for repeatability range R_0 is: 0.20 µm

The result for repeatability range R_0 is:

$$R_0 = (0.08 \pm 0.03) \text{ µm}$$

7. Measurement uncertainty (test uncertainty)

The measurement uncertainties (test uncertainties acc. to DIN ISO/TS 23165:2008 and ISO/TS 17865:2016) of the individual parameters are specified with the results.

The extended measurement uncertainty (test uncertainty) is specified. It is calculated by multiplying the standard measurement uncertainty by the extension factor $k = 2$ and for form deviations $k = 1.645$. It was determined in accordance with EA-4/02 M: 2022.
The values of the measurement parameter lie within the specified range with a probability of approximately 95%.

8. Statement of conformity

Taking the measurement uncertainty (test uncertainty) of the test 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 a signatory to the multilateral recognition agreement for calibration certificates of the European Cooperation for Accreditation (EA) and the International Laboratory Accreditation Cooperation (ILAC). For further signatories in and outside of Europe, please visit the EA and ILAC websites (www.european-accreditation.org) and ILAC (www.ilac.org).

-- End of calibration certificate --