MarForm

MarForm
MFU 200 Aspheric 3D

MEASURING TECHNOLOGY IN LENS PRODUCTION

High-precision 3D measuring station to measure and evaluate surfaces of optical components.

This is what we mean by EXACTLY.

- 0 +

Mahr

EXACTLY

COMPACT FORM MEASURING MACHINE MFU 200 ASPHERIC

Mahr developed the **MarForm MFU 200 Aspheric 3D** to enable optical components to be tested quickly in 2D / 3D close to the production area. MarForm measuring machines have been recognized for decades for their accuracy and stability.

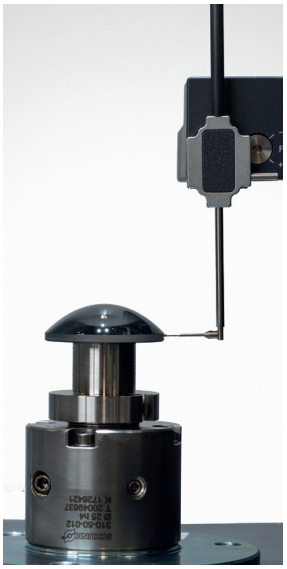
The T7W measuring system is equipped with a motorized rotary axis. It allows the probe arm to gradually be brought into the desired probing position. Measurements from any position are possible. Many evaluation options for aspheres, diffractive optics (DOE) and freeforms are available in the software MarWin.

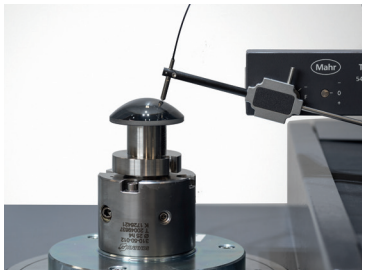
With the **MarForm MFU 200 Aspheric 3D** this experience has now been made available to the optical industry.

Highest Accuracy

The measuring station **MarForm MFU 200 Aspheric 3D**, an advancement of the reference formtester MarForm MFU 100, is a high-precision form measuring machine used by more than 300 customers worldwide. For production-related measurements in the optical industry, important innovations have been implemented:

- Measuring cabin equipped with shock absorbers and level control
- Real-time compensation by reference rulers in X- and Z- measuring axes. Even the smallest deviations in the measuring process are recorded and corrected immediately.
- High temperature stability over a long period
- High-precision rotary axis with a roundness deviation of < 20 nm using Mahr precision rotary stroke bearings.





More information
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OPTICAL AND TACTILE MEASUREMENT

Optical and tactile measurements of surfaces can be performed with the **MarForm MFU 200 Aspheric 3D**. An interferometric point sensor (IPS) is used for the optical measurement.

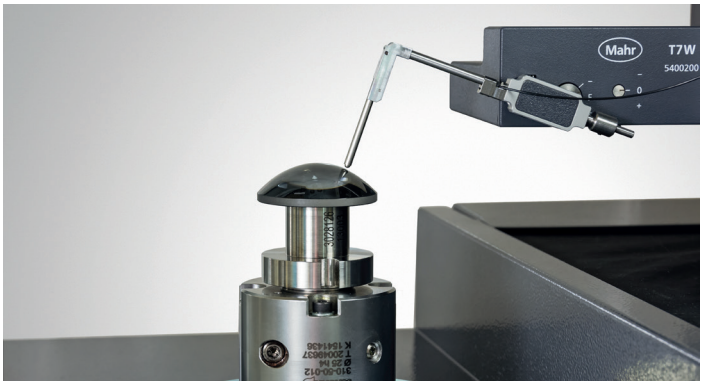
A wide range of probe arms are available for tactile measurements. The optical as well as the tactile sensor can be positioned at any desired angle (0° to 360°) by a motorized swivel joint and thus offering high flexibility.

Several optical and tactile probes, also in combination, can be used with the measuring system T7W.

The measuring probes are magnetically held and thus easily exchangeable.

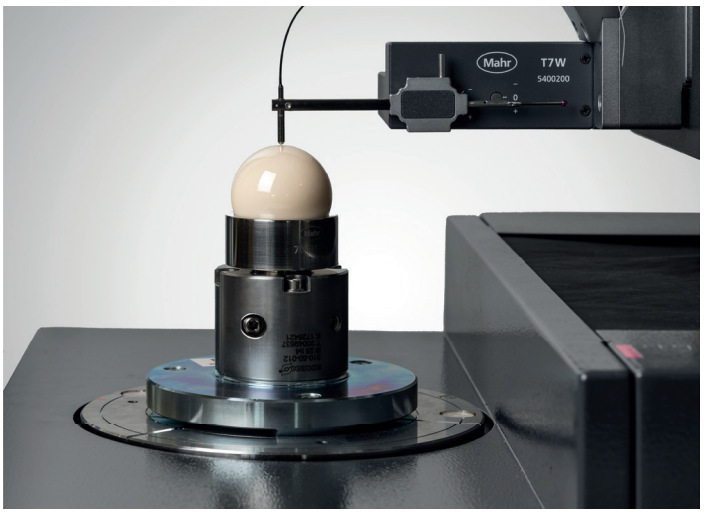
ADVANTAGES AT A GLANCE

- Contact-free measurement with an optical probe
- No damage to polished surfaces
- High measuring speed
- Measurement with tactile probes on rough surfaces
- Determination of reference elements with optical and tactile probe arms in combination
- Adjusting of coordinate systems



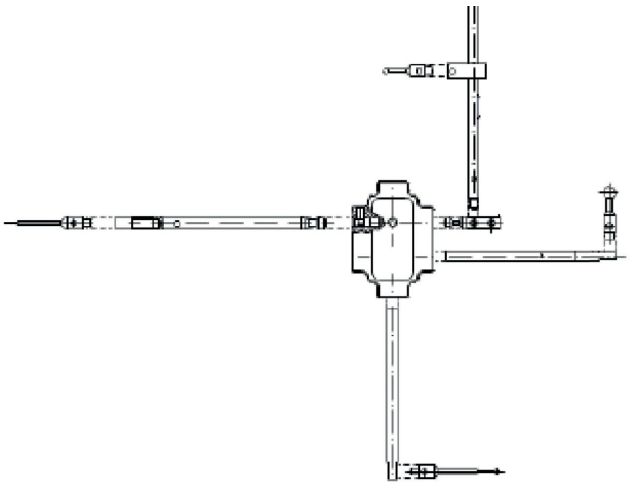
AUTOMATIC TILTING AND CENTERING

The exact alignment of the rotary axis is a precondition for a precise and reproducible measurement of aspheres.
The **MarForm MFU 200 Aspheric 3D** has an automatic tilting and centering function. With a calibration set the tilting and centering of the rotary axis can be aligned exactly. For the precise measurement of a 3D topography of aspheres, it is very important to know the apex of the optics. Before starting the measurement the apex is determined by a measuring program and the axis is realigned. Thus, even the smallest errors caused by clamping the specimen are compensated.



T7W PROBE ARM KIT, MOTOR-DRIVEN, ROTATING

The **T7W measuring system** is equipped with a motorized rotary axis. It allows the probe arm to be gradually brought into the desired probing position. Measurements from any position are possible.



The probe arms of the **T7W measuring system** are exchangeable. Due to its motorized rotary axis, so-called star probe arms – probe arms with different probing elements – can be set up, so that different probe arms (optical/tactile) can be used in one measuring sequence.

T7W measuring system, motorized, with angularly flexible probe arm 360° for MarForm MFU 200 Aspheric 3D.

- Total range 2000 µm
- Zero probe with a working range ± 500 µm
- Measuring force adjustable from 0.01 N to 0.2 N
- Two-way measuring direction
- Probe angle, selectable in 1° increments
- Motor driven in 360°
- Probe arms easily exchangeable (with magnetic holder)
- Flexible star probe possible
- Optional combination of optical and tactile probe arms
- Mechanical and electrical overload protection

T7W PROBE ARM KIT

The probe arm kit for the T7W measuring system was designed for flexible measurements of different geometries.

Probe arm kit in a storage case, comprising of:

Item no. 5400200

- Device for balancing of the probe arms
- Stylus dia. 0.5/L=20 mm/M2a
- Stylus dia. 1.0/L=20 mm/M2a
- Stylus dia. 1.0/L=15 mm/M2a
- Stylus dia. 1.5/L=10 mm/M2a
- Stylus dia. 3.0/L=10 mm/M2a
- Stylus dia. 3.0/L=25 mm/M2a
- Weight 0.5 gr
- Weight 1.5 gr
- Weight 1.5 gr
- Weight 2.0 gr
- Weight 3.0 gr
- Weight 5.0 gr
- Weight 10.0 gr
- Probe arm L=15 mm 2xM2
- Stylus extension 10 mm /M2
- Stylus extension 20 mm /M2

Item no. 5400221

- Stylus extension 30 mm /M2
- Stylus extension 40 mm /M2
- Rotary joint M2
- Screwdriver SW 0.9
- Center line rotary joint M2
- Wrench 1.0
- Stylus holder M2i, transverse
- Stylus insert M2i transverse
- 2x holder M2i transverse
- Guideway
- Actuator

FREE TRACKING - CONTOUR TRACKING

The **MarForm MFU 200 Aspheric 3D** is the universal measuring machine for asphere and freeform measuring tasks.

Advantages

- Automatic tilting and centring:
  - User-independent positioning
  - Centering
  - Alignment of measuring objects
- Active tracking: Automatic measurement of unknown surfaces; the sensor (optical and tactile) automatically follows the surface
- Probe combination: Optical sensors and tactile probes can be combined in one probe system; can be moved in space (360°)
- Flexible measuring tasks in one machine
  - Form
  - Contour
  - Roughness
  - Axis offset of lenses
  - Radial runout error
  - Tilt error of lenses
- MarWin software platform with "Aspheric" measurement and evaluation package for:
  - Spheres
  - Aspheres
  - Toroids
  - Off-axis lenses
  - DOEs (diffractive optical elements)
  - Special lenses
  - Freeform lenses

Dynamic real-time compensation

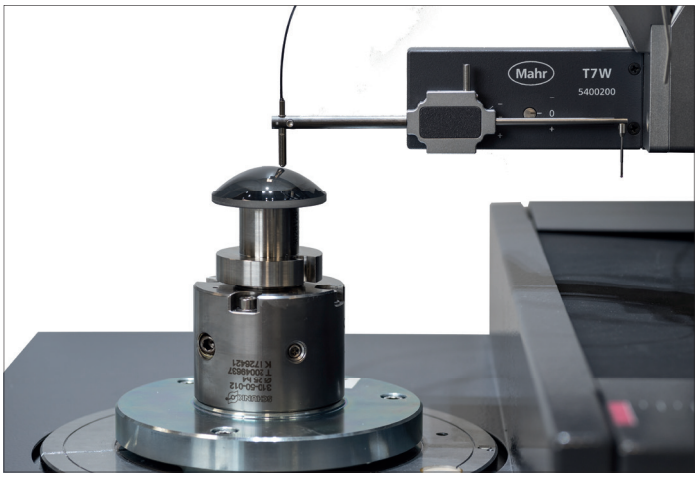
Mahr's high-precision measuring instruments use real-time error compensation in space. This provides maximum protection to the machine and the measurement against external influences. It works on the following principle:

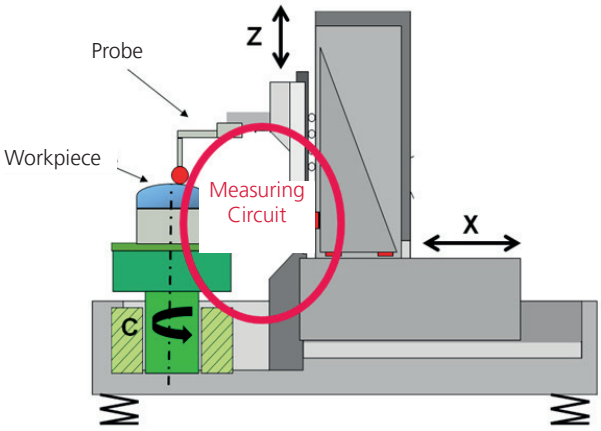
- Spatial reference standards represent dimensional standards.
- The deviations are recorded.
- The deviations recorded are corrected in real time when the measuring point is recorded.

The accuracy achieved is much superior to previous reference systems and better than can be seen from the catalog data. The type of application determines whether this type of system is recommended.

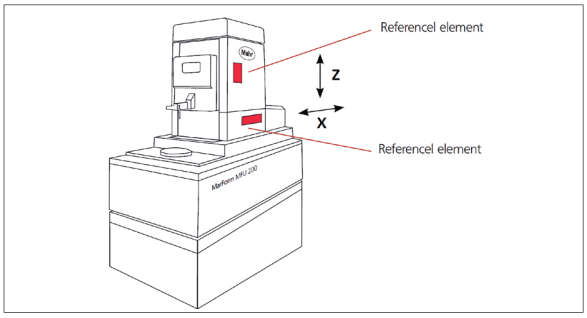
The technology used by Mahr can also record and correct unsystematic deviations that arise, for example, from external influences or the movement of the machine itself. The measuring system knows at any given moment where exactly the stylus element is located in space. In combination with a highly dynamic digital controller, this also improves the positioning accuracy of the system.

An extremely high level of reproducibility can be achieved, even in fluctuating conditions.



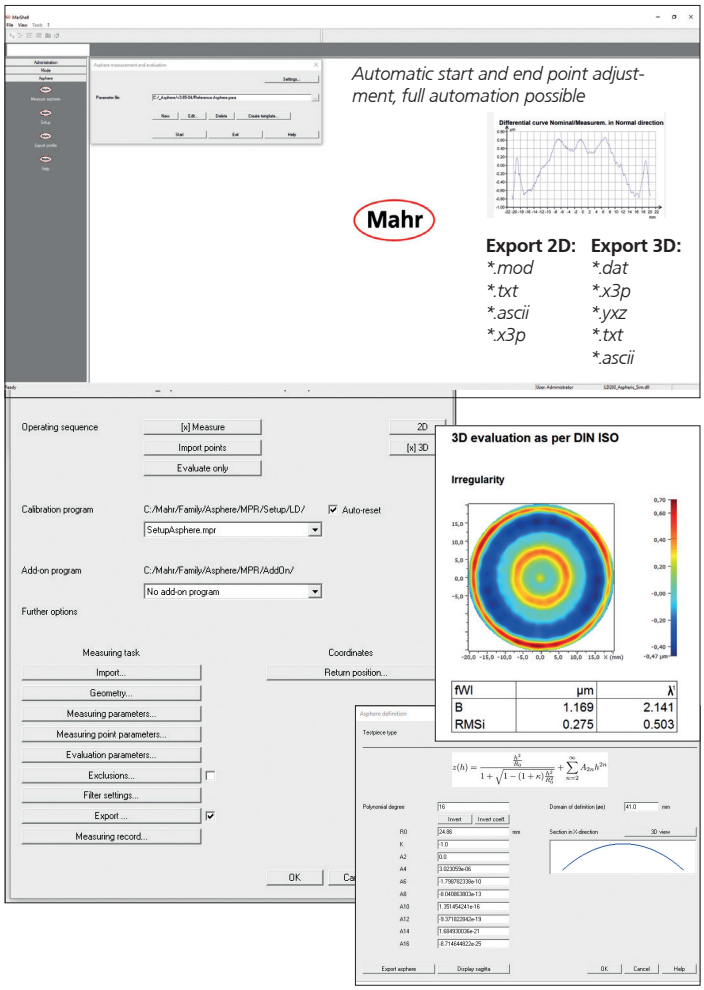


Compact machine design --> small measuring circle



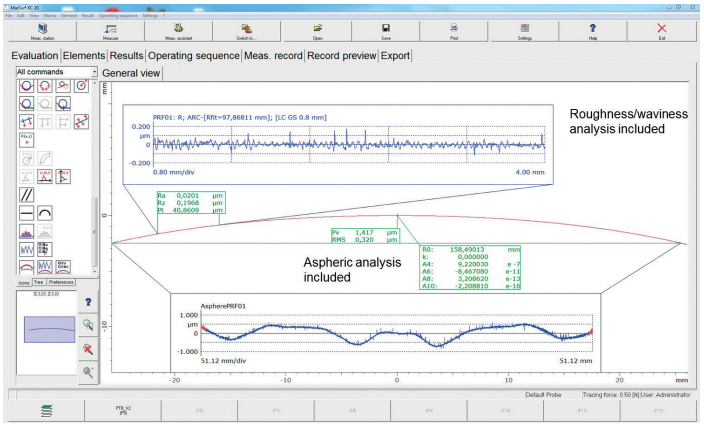
Dynamic real-time compensation of linear axes

SOFTWARE



MARWIN EASYCONTOUR WITH OPTIONS

- Asphere measurments included
- Roughness and waviness analysis
- Profile analysis
- Parameters with tolerances

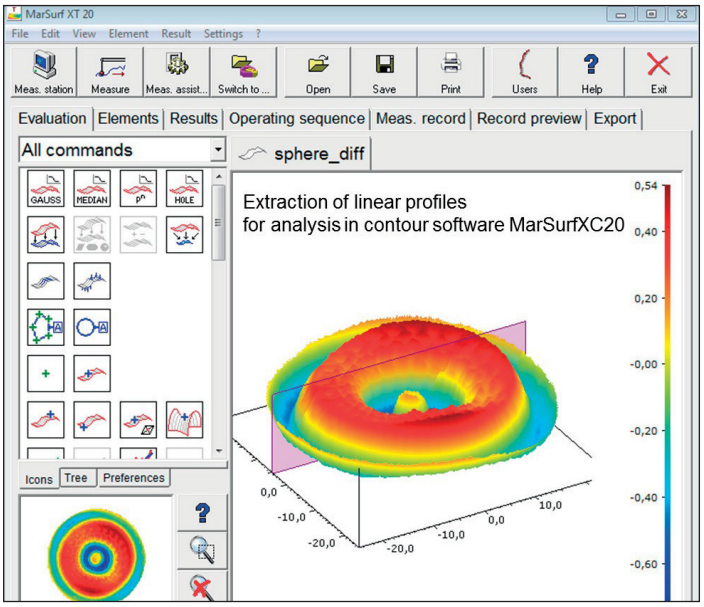


OPTION TOPOGRAPHY

- Measurement and evaluation of 3D surface parameters
- Extraction of linear profiles for evaluation in the MarWin Easy-Contour software.

ASPHERIC.LIB

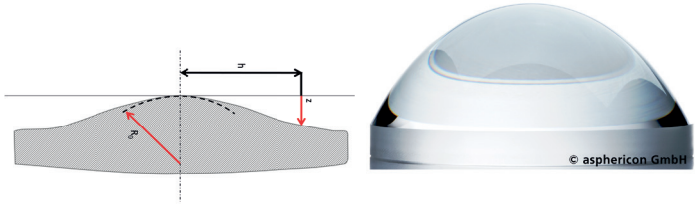
- Automatic 2D and 3D measurement
- Calibration of actual profile to nominal profile (2D and 3D), radius best fit, sagitta table
- Analysis of form deviation and slope error
- Derivation of aspheric coefficients
- Astigmatism analysis
- Profile export for machine correction
  - *.x3p
  - *.xyz
  - *.txt
  - *.dat
  - *.ascii
- Automatic measuring record



MEASUREMENT OF ASPHERES

$$z(h)=\frac{\frac{h^2}{R_0}}{1+\sqrt{1-(1+k)\times\left(\frac{h}{R_0}\right)^2}}+\sum_{n=2}^{5}A_{2n}\times h^{2n}$$

Before starting the measurement, the nominal aspheric parameters must be entered into the evaluation software Aspheric.lib. In the next step, the measuring data is recorded and compared with the nominal asphere. The radius R, the RMS value, the PV value and the slope error are shown displayed as parameters. Evaluation according to DIN ISO 10110 (A, B, C and RMSt, RMSi, RMSa).



In the measuring and evaluation software Aspheric.lib the individual parameters, such as the radius of curvature R, conic constant k and the aspheric coefficients Ai, can be adjusted (BestFit).

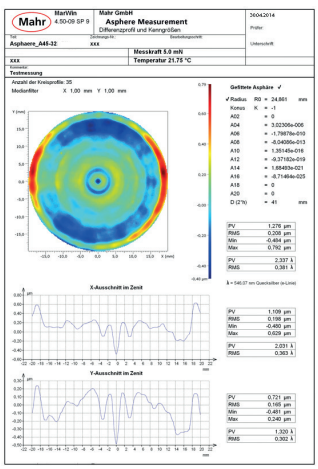
The differential topography between the recorded measuring values and the nominal asphere is displayed as a colour-coded linear chart. The 2D segments and the differential topography can then be exported in known formats for correction for the processing machine.

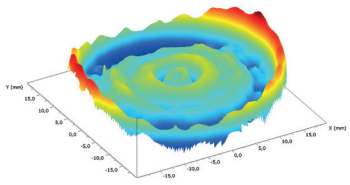
Measuring process

- Setting of nominal parameters (R, k, Ai)
- Automatic apex search of aspheres
- Measurement of the topography with circular paths
- Evaluation as 3D differential topography and 2D differential profile
- Evaluation according to DIN ISO 10110 following characteristics of R, RMS, PV, Slope Error

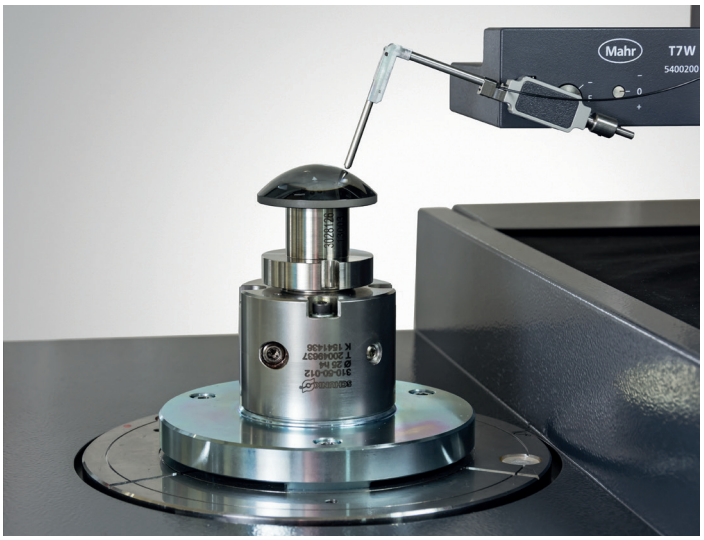
MEASUREMENT OF STEEP ASPHERES

The T7W probing system is equipped with a motorized rotary axis. This rotary axis enables the automatic positioning of the optical or tactile senor to the desired angular position.

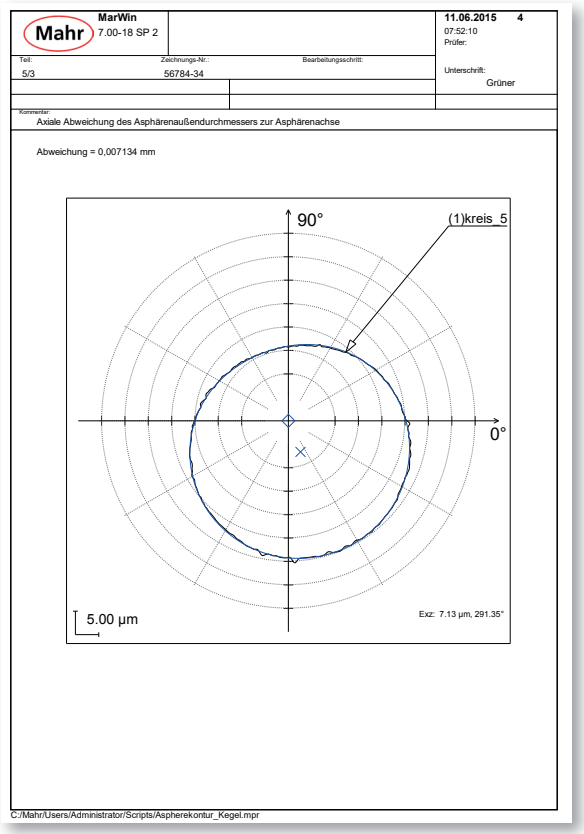


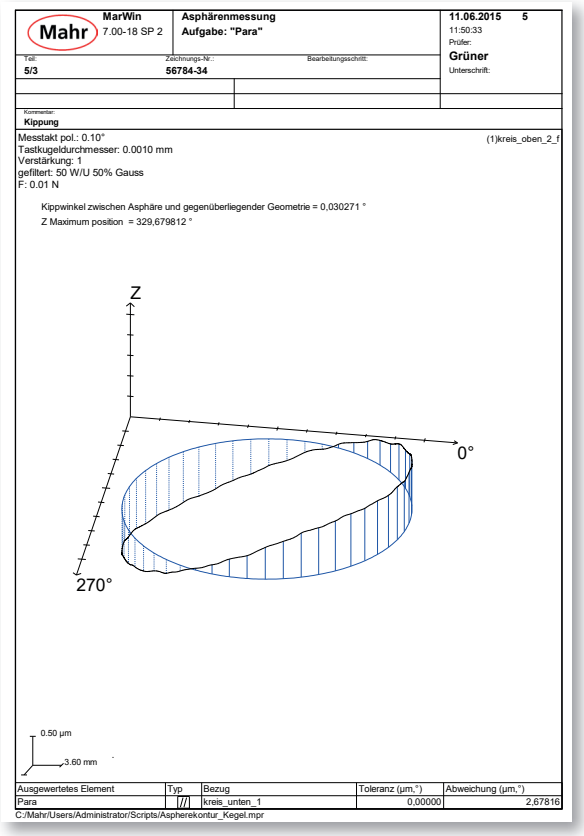


Thus, it is possible to measure and evaluate the apex area as well as the slope on steep spheres and aspheres with high accuracy.



MEASUREMENT OF FORM, CONTOUR, ROUGHNESS AS WELL AS OFFSET AND TILT OF ASPHERES





The **MarForm MFU 200 Aspheric 3D** is a high-accuracy reference formtester.

Various optical and tactile form measuring tasks can be performed.

Not only optics can be measured with the **MarForm MFU 200 Aspheric 3D** – it is possible to perform complex contour measurements on non-optical also surfaces.

The new continuous path control allows moving along a nominal contour by moving two axes simultaneously. A measuring speed of up to 5 mm/s can be achieved.

The optical probe IPS 15 allows measuring the roughness on surfaces.

For the standard evaluation of form, contour and roughness measurement, the comprehensive and easy-to-use evaluation software MarWin is available.

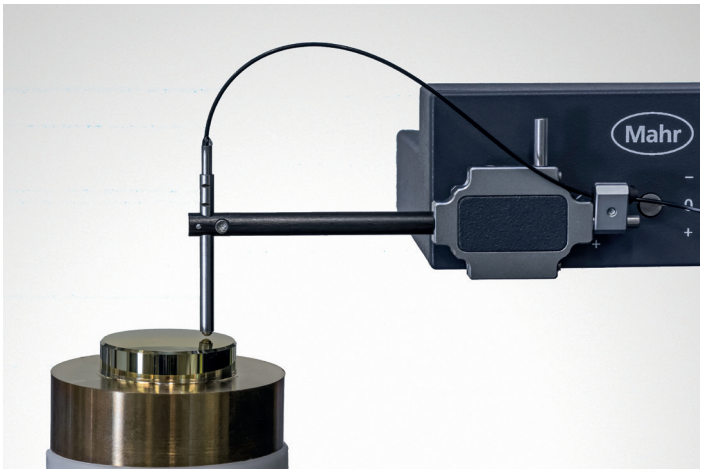
The tactile measurement of the cylindrical part of optics and automatic calculation of axis offset (offset of optical or mechanical axis) is one example of the many applications.

MEASUREMENT OF DIFFRACTIVE OPTICS

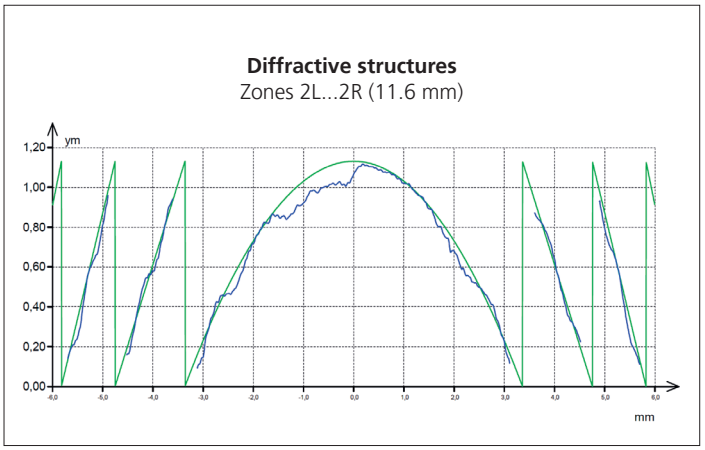
Diffractive optical elements (DOE) are used in a wide range of applications such as image processing, photo technology, medical technology, multimedia and automotive engineering.

DOEs are manufactured to such a high standard that they are used with high-power lasers in industrial applications. Their main jobs are beam splitting and beam forming.

Mahr's measuring technology can be used to test and analyse the high standards of DOEs. It can measure the individual zones, such as form deviation, zone height and zone spacing and provide a profile export for the machine correction.

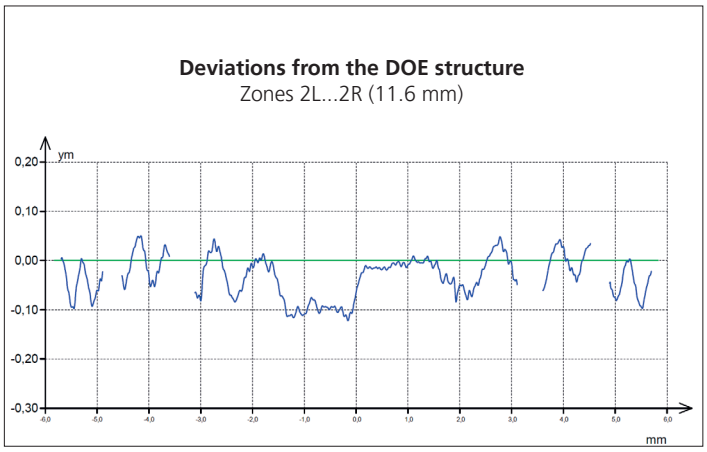


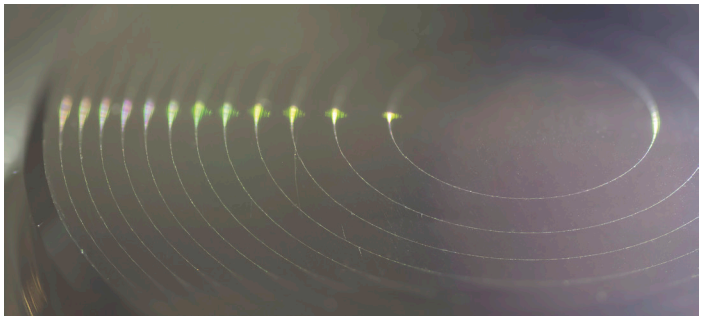
- Analysis with constant zone width or constant zone height
- Analysis and substraction of the base shape (aspheric, spheric, plane)
- Error analysis of form deviation (PV, RMS)
- Detailed analysis of each zone
- Output parameters with tolerances for each zone: Angle, zone height, form deviation, zone distance
- Profile export for machine correction



Mahr	MarWin 9.00-21	Mahr GmbH Asphere measurement Diffractive structures	05.05.2017 3 15:40:56 Inspector: Administrator Signature:
Part: Reference DOE	Drawing no.:	Machining operation:	
Probe arm LP R 21-10-5_47 1123	Measuring force 0.5 mN		LD 260 - 116215
Comment:			

Heights	Icon	Nominal size (µm)	UT (µm)	LT (µm)	Actual size (µm)	Deviation (µm)
ZONE_0_H_-3.3...3.3		1,130	0,200	-0,200	1,131	0,001
ZONE_1L_H_-4.7...-3.5		1,130	0,200	-0,200	1,124	-0,006
ZONE_1R_H_3.5...4.7		1,130	0,200	-0,200	1,130	-0,000
ZONE_2L_H_-5.7...-4.9		1,130	0,200	-0,200	1,157	0,027
ZONE_2R_H_4.9...5.7		1,130	0,200	-0,200	1,137	0,007
ZONE_3L_H_-6.6...-5.9		1,130	0,200	-0,200	1,141	0,011
ZONE_3R_H_5.9...6.6		1,130	0,200	-0,200	1,126	-0,004
ZONE_4L_H_-7.4...-6.8		1,130	0,200	-0,200	1,192	0,061
ZONE_4R_H_6.8...7.4		1,130	0,200	-0,200	1,174	0,044
ZONE_5L_H_-8.2...-7.6		1,130	0,200	-0,200	1,085	-0,045
ZONE_5R_H_7.6...8.2		1,130	0,200	-0,200	1,122	-0,008
ZONE_6L_H_-8.8...-8.3		1,130	0,200	-0,200	1,076	-0,054
ZONE_6R_H_8.3...8.8		1,130	0,200	-0,200	1,102	-0,028
ZONE_7L_H_-9.4...-9.0		1,130	0,200	-0,200	1,127	-0,004
ZONE_7R_H_9.0...9.4		1,130	0,200	-0,200	1,049	-0,081
ZONE_8L_H_-10.0...-9.6		1,130	0,200	-0,200	1,047	-0,084
ZONE_8R_H_9.6...10.0		1,130	0,200	-0,200	1,075	-0,056
ZONE_9L_H_-10.6...-10.2		1,130	0,200	-0,200	1,155	0,025
ZONE_9R_H_10.2...10.6		1,130	0,200	-0,200	1,049	-0,081
ZONE_10L_H_-11.1...-10.7		1,130	0,200	-0,200	1,098	-0,033
ZONE_10R_H_10.7...11.1		1,130	0,200	-0,200	1,144	0,014
ZONE_11L_H_-11.6...-11.2		1,130	0,200	-0,200	1,180	0,049
ZONE_11R_H_11.2...11.6		1,130	0,200	-0,200	1,290	0,160
ZONE_12L_H_-12.0...-11.6		1,130	0,200	-0,200	1,246	0,116
ZONE_12R_H_11.7...12.0		1,130	0,200	-0,200	1,391	0,261!
ZONE_13L_H_-12.5...-12.1		1,130	0,200	-0,200	1,189	0,059
ZONE_13R_H_12.2...12.5		1,130	0,200	-0,200	1,178	0,048





More information
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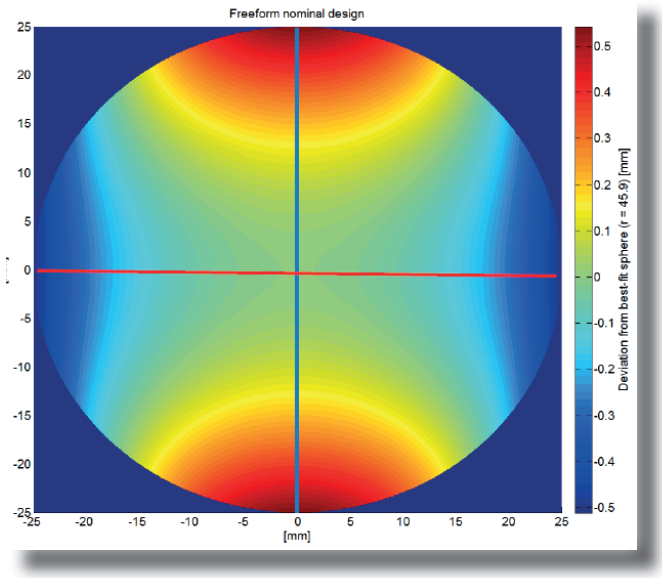
MEASUREMENT OF OPTICAL FREEFORM, OFF-AXIS ASPHERES AND TOROIDS

The highly accurate 3D measuring station **MarForm MFU 200 Aspheric 3D** offers the kinematic possibilities to measure optical freeforms, off-axis aspheres and toroids.

Measurement

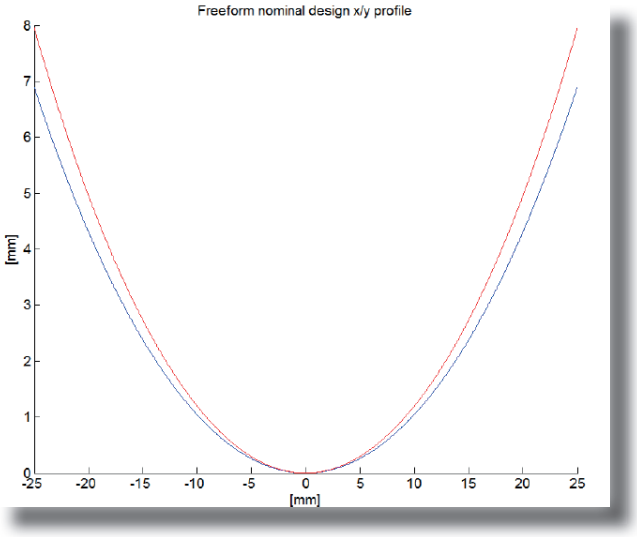
If freeforms or topography of unknown aspheres are to be measured, there is a further operating mode available – free tracking. The optical or tactile sensor follows the surface and tracks the measuring axis when the sensor signal touches the range limit. This measurement is performed at high speed. Thus, unknown topographies can be recorded quickly and precisely. Off-axis aspheres, toroids and freeforms can be measured and evaluated, always using a program adapted to the respective optical element.

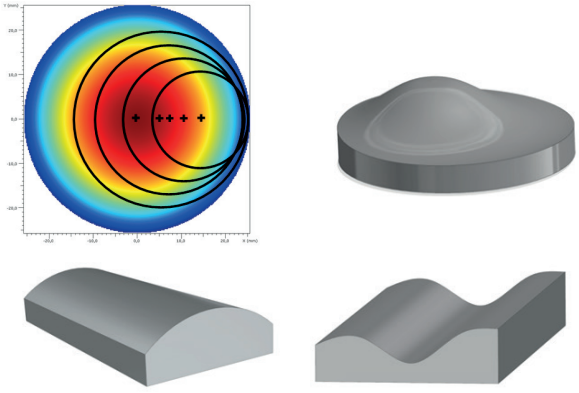
As a result a 3D point cloud of the measured surface is available. The 3D point cloud can be used for calculating asphere parameters. For measurements of freeforms this point cloud can be overlaid with a 3D CAD model. The deviations of the nominal-actual comparison are shown in a record. (The evaluation by 3D CAD model is not part of the standard scope of delivery. It has to be ordered separately if required).



Evaluation

If 3D nominal data are available, they can be compared with the measured topography. The software calculates the deviation between the measuring points and the nominal topography. The correction values are calculated using this data. For an exact correction, the axis reference and the angle position of the nominal data and the measuring point must be identical. Fiducial reference surfaces of the optics or clamping device can be used. The measurement results of freeforms, off-axis aspheres and toroids are generated as a 3D point cloud and can be used with 3D software for further evaluation (e.g. target / actual comparison). (The 3D software for evaluation is not included in the scope of delivery.)





CLOSED LOOP
INTEGRATION INTO THE POLISHING PROCESS

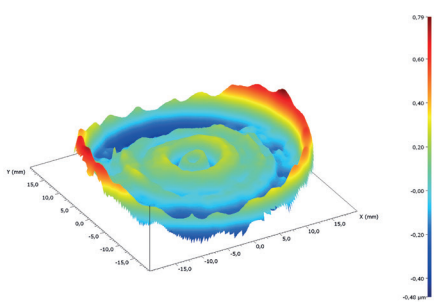
Mahr Export to polishing machine

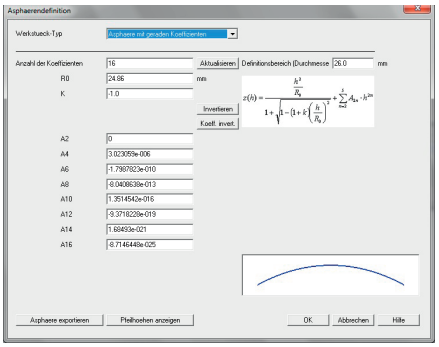
- Differential profile output in machine-readable format for optimal control of the machine tools
- The following diamond formats can be exported from the measuring machine (2D and / or 3D)
- Profile export for machine correction
  - -*.x3p
  - -*.xyz
  - -*.txt
  - -*.dat
  - -*.ascii

Mahr Import from polishing machine

- Import of geometry data
  - Aspheric formula
  - Parameters

- **Grinding**
- **Polishing**
- **Diamond turning**
- **MRF polishing**
- **Ion beam finishing**





CALIBRATION SET

Calibration set for MarForm MFU 200 Aspheric 3D comprising of:

- Calibration cylinder
- Calibration ball for clamping diameter 25 mm

For calibration of:

- optical and tactile measuring probes
- measuring systems

Automatic measuring sequences for axis and probe arm calibration.

TECHNICAL DATA MARFORM MFU 200 ASPHERIC 3D

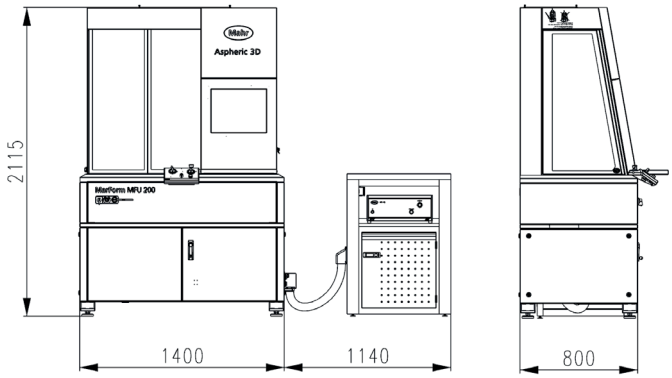
Properties of the horizontal measuring axis (X-axis)	
Measuring path	180 mm
Straightness deviation per 100 mm	0.15 µm
Tracing length (Lt)	0.1 mm to 180 mm
Positioning speed	0.1 mm/s to 50 mm/s
Measuring speed	0.1 mm/s to 50 mm/s
Properties of the vertical measuring axis (Z-axis)	
Measuring path	320 mm
Straightness deviation per 100 mm	0.1 µm
Tracing length (Lt)	0.1 mm to 320 mm
Positioning speed	0.1 mm/s to 50 mm/s
Measuring speed	0.1 mm/s to 50 mm/s
Path control of the Z-axis as a measuring function (Z+ / Z-) / Path control of the X-axis as a measuring function (X+ / X-)	
Resolution	1 nm
Positioning uncertainty	1 µm (with probe return)
Speed	freely adjustable up to 10 mm/s
Properties of the horizontal measuring axis (Y-axis)	
Measuring path	6 mm
Positioning uncertainty	0.5 µm / 5 mm
Properties of the circular measuring axis (C-axis)	
Roundness deviation	0.02 + 0.0004 µm / mm measuring height
Axial runout	0.04 + 0.0002 µm / mm measuring radius
RPM	0.1 to 200 min^{-1}
Resolution	0.0001°
Properties of the automatic centering and tilting table	
Table diameter	180 mm
Table load, centric	200 N
Travel path (X-; Y-; A-; B-axis)	± 1.8 mm
Positioning uncertainty	1.0 µm
Properties of the probe system (measuring direction Z+ / Z-)	
Probe measuring range	± 0.5 mm (60 mm probe arm)
Resolution	0.6 nm
Probe arm swivel range (Hb)	360°
Function 3D measuring station	
Measuring time	approx. 5 to 10 min.
C-axis	Measuring and positioning speed < 360 °/s / Rotation speed up to 1200 °/s

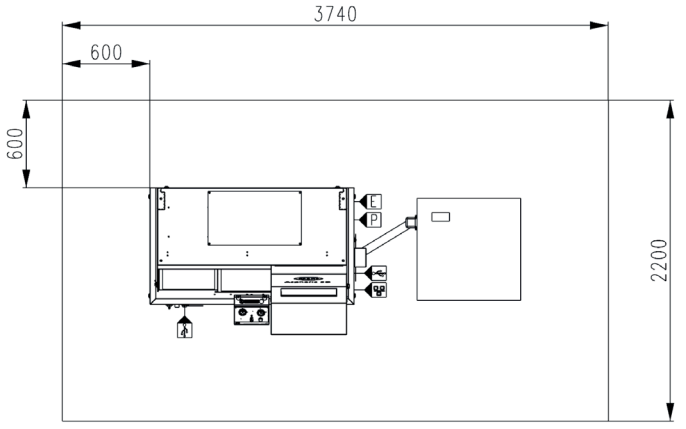
OPTICAL SENSOR IPS 15

Properties	
Resolution of display	< 0.1 nm
Absolute measuring range HNA	± 5 µm
Limit angle HNA	± 28°
Spot size (focusing)	1 µm to 3 µm
Working distance	< 0.5 mm
General Data	
Operating temperature (recommend)	+ 20°C ± 2K (with temperature change < 1 K/h)
Resolution	< 1 nm
Laser class	class 1M, infrared

FLOOR PLAN MARFORM MFU 200 ASPHERIC 3D

General Data	
Operating temperature	+ 15°C to + 35°C
Suggested working temperature	20°C ± 2K
Temperature change	< 0.5 K/h
Compressed air	6 bar





benötigte Aufstellfläche ca. 3,74 m x 2,2 m
approx. required floor space

E	elektrischer Anschluss electrical connection	90-240 V; 50 Hz; 1200 VA; 1/NPE
P	pneumatischer Anschluss pneumatic connection	G1/4"; 6 bar; 35 l/min
	USB Anschluss USB connector	
	Netzwerkanschluss network connection	Ethernet RJ 45

PRODUCTION METROLOGY

MarSurf UD 130 Aspheric 2D
Precision 2D measuring station for measuring and evaluating optical components.

WebCode: 22044
www.mahr.com

MarForm MFU 200 Aspheric
High-precision contour measurement of spheres and aspheres. 3D determination of form error early in production process.

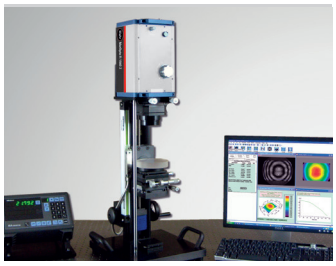
WebCode: 21881
www.mahr.com

MarSurf LD 130 / 260 Aspheric 2D / 3D
High-precision contour measurement of spheres and aspheres. 3D determination of form error early in production process.

WebCode: 21880
www.mahr.com

MarOpto TWI 60
Tilted wave Interferometer for fast and highly accurate measurement of aspheres.

WebCode: 21879
www.mahr.com



MarOpto FI 1040 Z
Full featured Fizeau interferometer for flat or spherical surfaces.

WebCode: 21874
www.mahr.com

MarOpto FI 1100 Z
Fizeau interferometer for fast measurements of flat, concave and convex surfaces.

WebCode: 21875
www.mahr.com

MarOpto MT 150
Highly precise Fizeau interferometer measuring tower for the testing of spherical lenses.

WebCode: 22066
www.mahr.com

MarOpto MT 50
A compact Fizeau workshop interferometer for the testing of spherical components in the production environment.

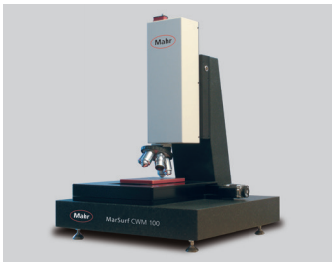
WebCode: 22064
www.mahr.com

MarSurf WM 100
Optical roughness measurement on highly polished optical components in the nanoscale range.

WebCode: 20565
www.mahr.com

MarSurf CWM 100
User-friendly, high-precision contactless topography measurement on optical components.

WebCode: 20566
www.mahr.com



PRODUCTION METROLOGY

MarVision MM 420
Stereo zoom microscope for detecting defects on large lenses.

WebCode: 20875
www.mahr.com

MarVision MM 320
Video measuring microscope with integrated edge finder and digital display. Entry-level instrument for optical geometry metrology.

WebCode: 20874
www.mahr.com

MarVision SM 150 / 151
Stereo zoom microscope with digital camera for detecting defects.

WebCode: 21050
www.mahr.com

MarVision SM 160 / 161
Stereo zoom microscope for detecting defects on large lenses.

WebCode: 21050
www.mahr.com

Precimar SM 60
Length measuring bench
A user-friendly measuring instrument for fast, precise outside measurements on workpieces.

WebCode: 22735
www.mahr.com

MarVision QM 300
Video workshop measuring microscope. High precision for your quality control.

WebCode: 20879
www.mahr.com

MarSurf XR 1
Mobile roughness measurement with Bluetooth between drive unit and evaluation unit.

WebCode: 20555
www.mahr.com

MarSurf CM expert
Powerful confocal microscope for the three-dimensional measurement and analysis of surfaces.

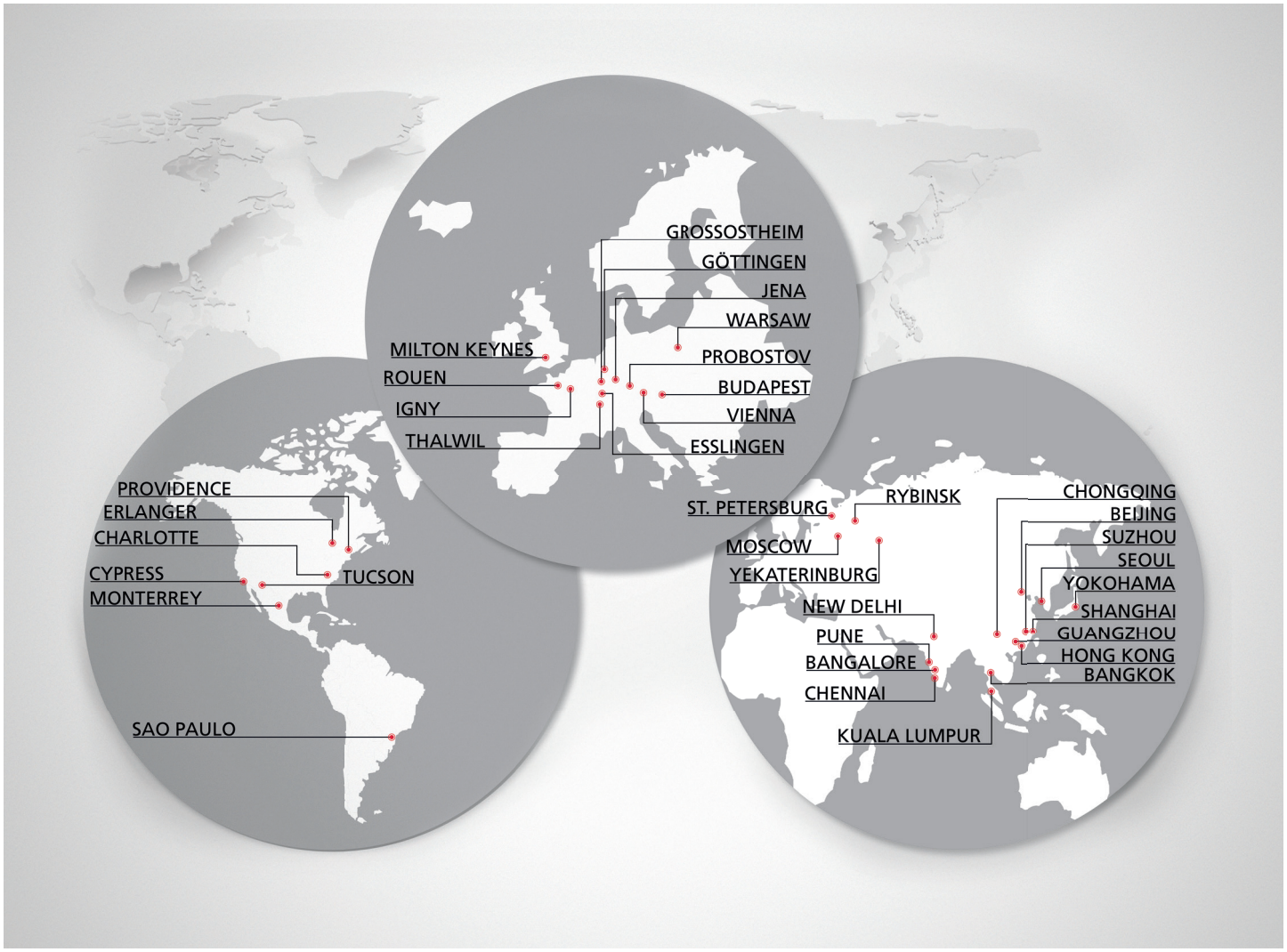
WebCode: 22662
www.mahr.com

MarCator
Digital and Dial Indicators
Its easy handling makes it one of the most diverse tools for everyday testing.

WebCode: 20234
www.mahr.com

MarCal
Calipers
Digital and mechanical calipers for inner, outer and step measurements.

WebCode: 20066
www.mahr.com



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Close to our customers.

Got **QUESTIONS?** Want more **INFORMATION?**

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