Advances in aspheric lens alignment

TRIOPTICS
See the Difference

Dr. Christian Buß, 2024-09-26

TRIOPTICS

Centration measurement and application expertise

Technology

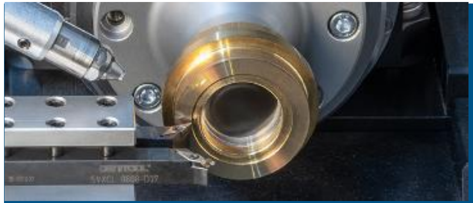
- Basics on centration measurement
- MultiLens®

General products

- OptiCentric® 101 to 800 UP
- OptiCentric® DUAL

Additional measurement

- Center thickness and air gap
- Measurement without rotation



Alignment turning

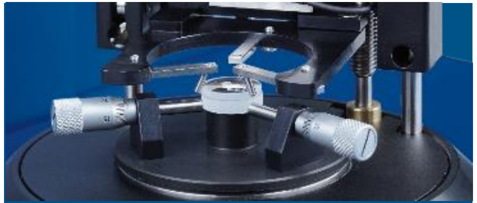
- VIR, UV, IR
- Aspheres, Cylinders
- Brass, Al, Steel, INVAR, Ti

Special lenses

- Aspheres
- Cylinders
- IR lenses

Basics lens alignment

- Manual assembly processes
- SmartAlign: alignment w/o preadjustment



Automated lens alignment

- Doublet alignment wrt lens barrel
- Doublet alignment wrt optical axis
- Single lens on arbor

Bonding

- Lens to cell in 2D and 5D

State of the art for the measurement of aspheres

Focusing autocollimator

– Paraxial area only
– No information on the tilting of the asphere

Profile recognition (tactile)

+ Direct topography measurement
+ Affordable
– Damage to the optical surface
– No referencing of the lower surface
– Time-consuming, complete surface scan

Scanning optical distance sensor

+ Complete topography measurement (with metrology frame)
– Reference of the lower surface requires special sample holders and additional measurements of reference (3 balls or flange and cylinder surfaces of swap holder)

Interferometer + CGH

+ Complete topography measurement
+ Fast
– Expensive CGH is required for any asphere design
– No referencing of the lower surface

Stitching Interferometer

+ Full topography measurement
+ Flexible
– Expensive
– No referencing of the lower surface

Focusing autocollimator with optical distance sensor

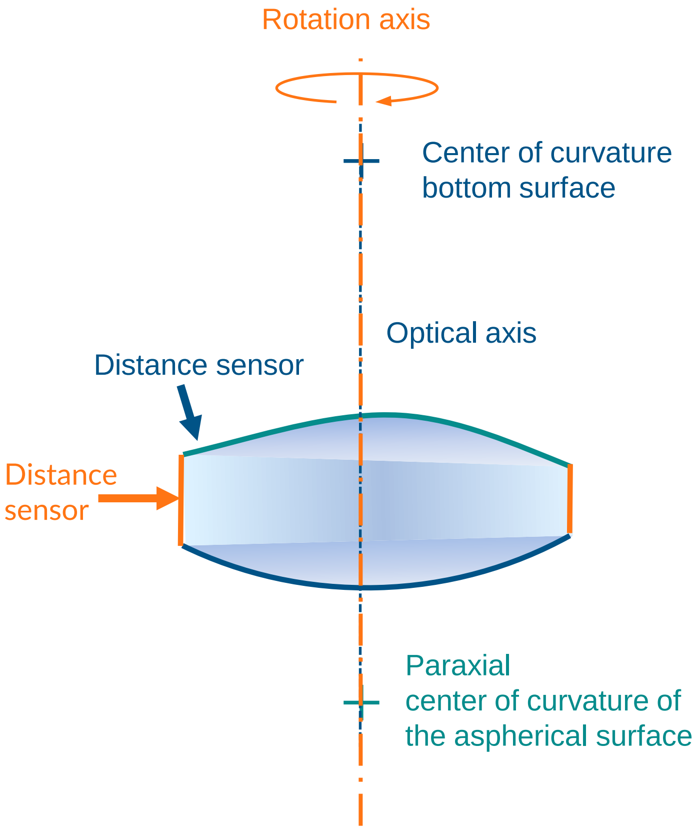
+ Direct measurement of the lower lens surface
+ Fast
– No complete topography measurement (few form errors recognizable)

Centration testing of aspheres

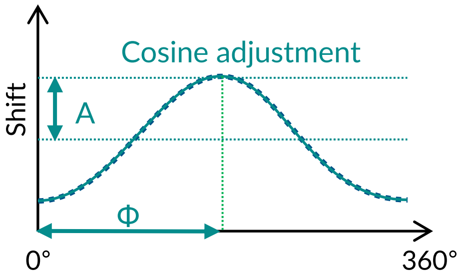
1. Measurement of paraxial centering based on the autocollimator
2. Alignment to the rotation axis
3. Measurement of asphere tilt by non-contact distance sensor
4. Optional: measurement of further reference surfaces

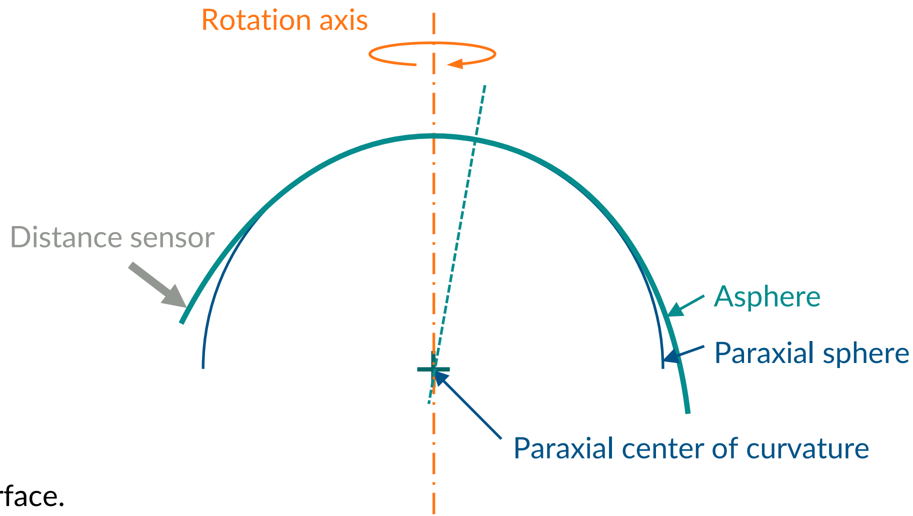
   or in case of alignment turning

4. Machining of reference surfaces for further assembly



Measurement principle AspheroCheck® UP





- Amplitude A proportional to the tilting of the aspherical surface.
- Phase Φ indicates the azimuth angle of tilting.
- Automatic compensation of the influence of the displacement due to the paraxial centering error known from the autocollimator measurement.

Solutions

AspheroCheck® UP

The specialist for highest precision aspheric lens measurement

AspheroCheck® on OptiCentric® 101

Universal and customizable usage

AspheroCheck® on ATS

Make perfectly aligned aspheres for assembly

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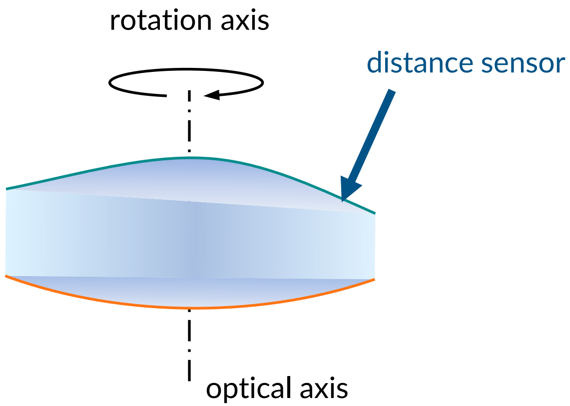
Double-sided aspheres

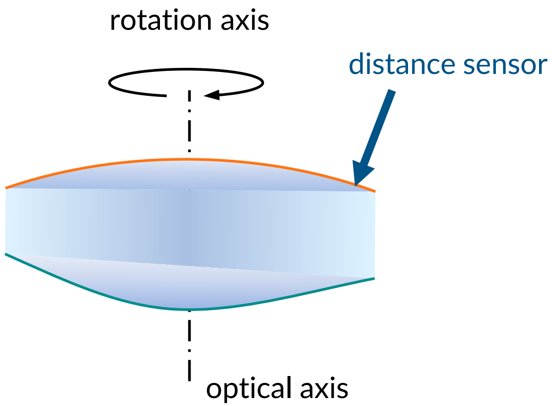
Measurement of double-sided aspheres



Method 1

Sequential measurement of both asphere axes

- Azimuth orientation of both measurements must be known
  - “flip” holder
- Combination of two datasets using the (paraxial) optical axis as reference; no external reference needed
- Cycle time < 3 min



AspheroFlip

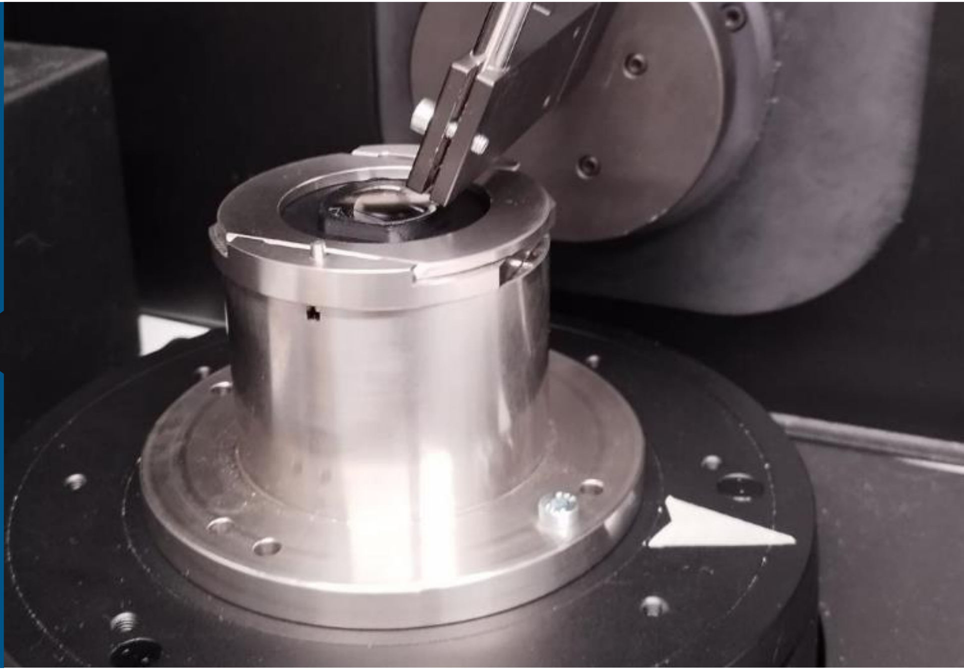
Special holder for double-sided aspheres:

➢ **AspheroFlip**

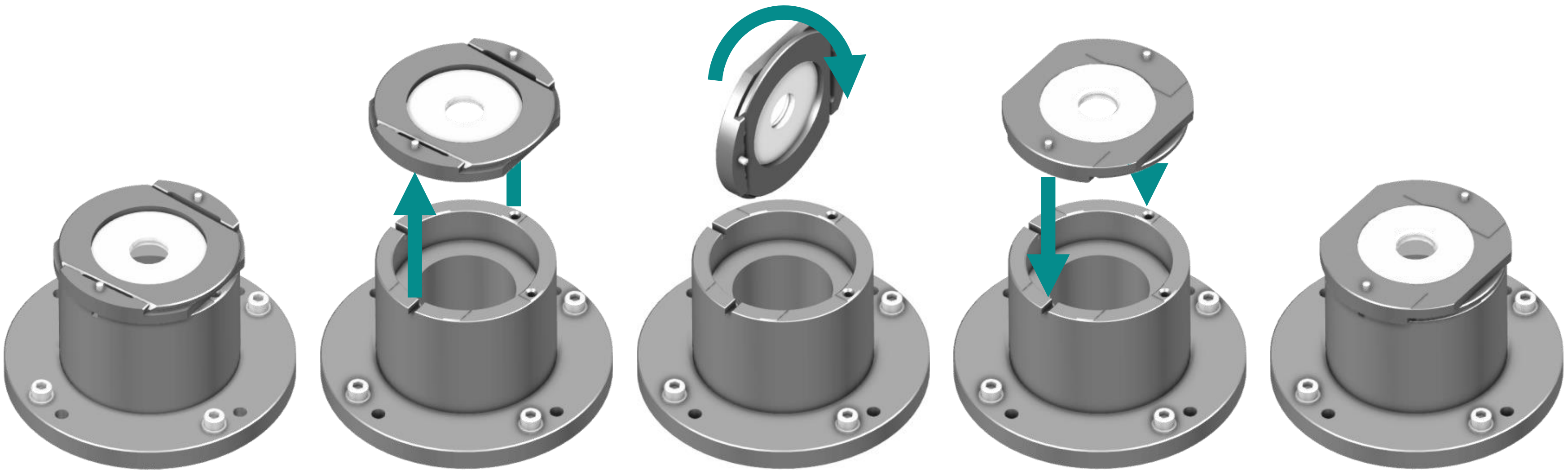
- Measurement of the asphere axis is always performed from the top
- Lens is flipped
- Fitting pins ensure tight azimuth tolerance and define axis of rotation between measurements

Available for:

- OptiCentric® 101
- AspheroCheck® UP



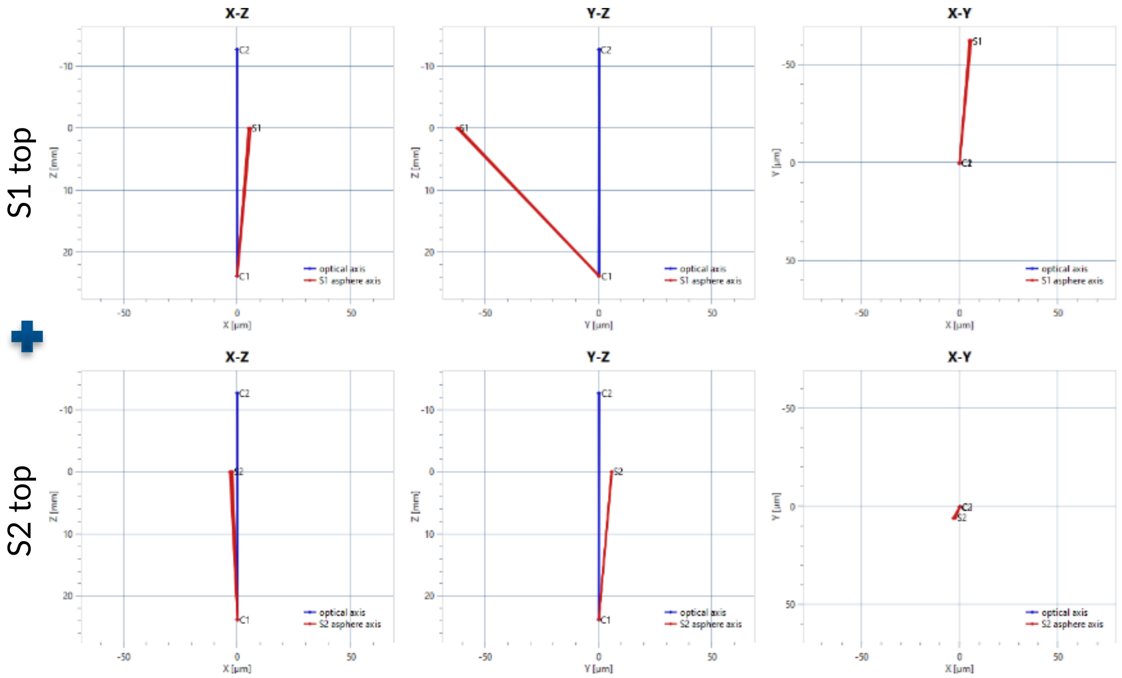
Lens flipping



Measurement of double-sided aspheres

Sample:
- Biconvex double-aspheric lens
- Diameter: 25 mm (Øe 22.5 mm)
- Aspheric parameters same on both sides

Measurement:
- Using AspheroCheck® UP
- Automated (paraxial) optical axis alignment
- Automated sensor measurement
  R = 10 mm
  conversion factor = 2.1 arcmin / µm
- 5 repetitions per side



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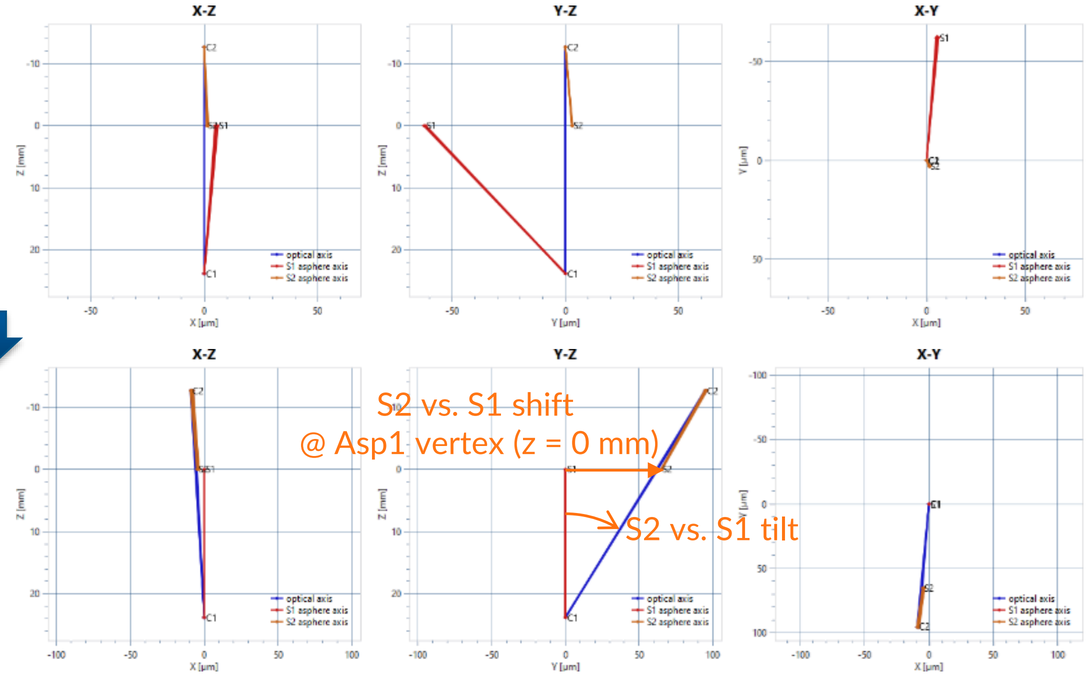
combined dataset

S2 vs. S1

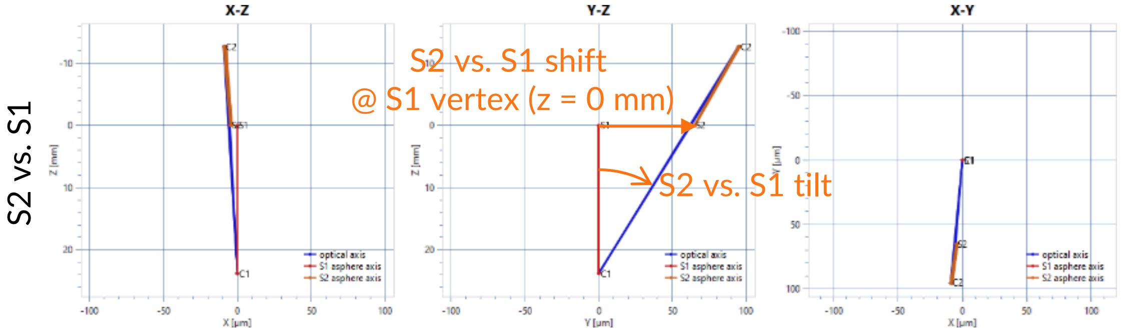


Measurement of double-sided aspheres

Sample:
- Biconvex double-aspheric lens
- Diameter: 25 mm (Øe 22.5 mm)
- Aspheric parameters same on both sides

Measurement:
- Using AspheroCheck® UP
- Automated (paraxial) optical axis alignment
- Automated sensor measurement
  R = 10 mm
  conversion factor = 2.1 arcmin / µm
- 5 full repetitions (including alignment)

S2 asphere axis with respect to S1 asphere axis							
		Shift [µm]			Tilt [']		
#	Z [mm]	X	Y	Abs	X	Y	Abs
1	0.0	-4.8	65.1	65.3	1.17	-8.18	8.26
2	0.0	-3.4	64.8	64.9	1.26	-8.06	8.15
3	0.0	-3.6	65.6	65.7	1.23	-8.27	8.36
4	0.0	-4.8	65.3	65.5	1.23	-8.20	8.29
5	0.0	-3.6	65.0	65.1	1.03	-8.15	8.21
average		**-4.0**	**65.2**	**65.3**	**1.18**	**-8.17**	**8.26**
std.dev.		0.6	0.3	0.3	0.08	0.07	0.07

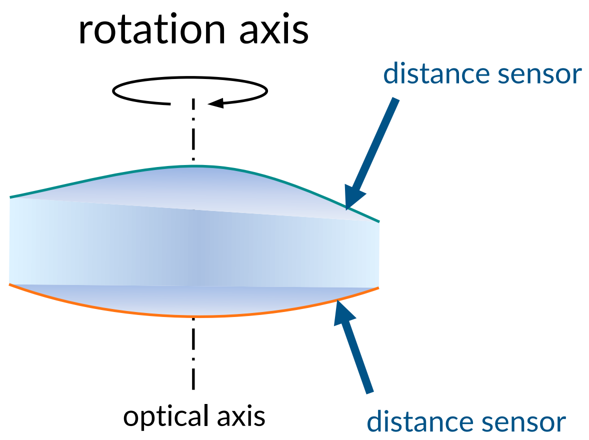


Measurement of double-sided aspheres

Method 2:
Direct measurement of top and bottom surfaces with distance sensor(s)

- Sequential measurement of surf #1 and #2
  by automated sensor positioning of single sensor or
- Parallel measurement in dual sensor setup; cycle time <1min

- Needs custom lens holder design to grant physical access to bottom surface
- Limitations for some sample geometries (small lenses, biconcave lenses)



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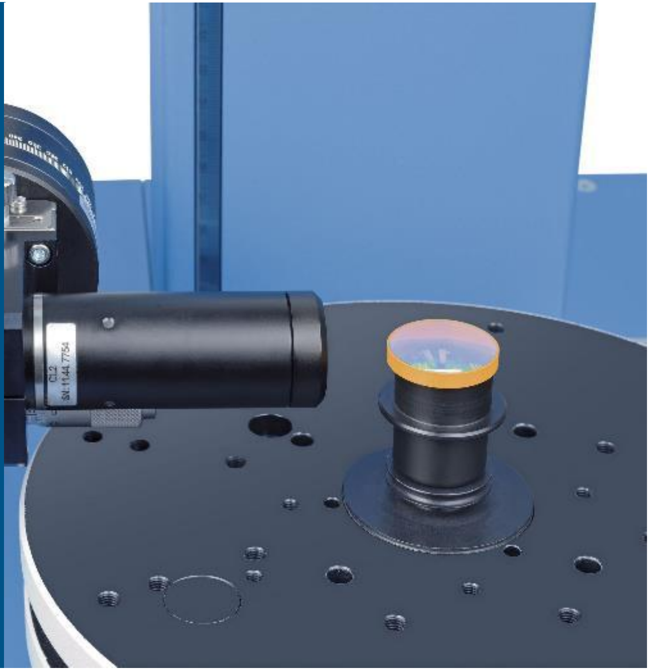
Conclusions and summary

- Same measurement principle is established on different platforms
- We cover applications from asphere testing to apshere assembly
- All devices support
  - Prealignment (simplifies interpretation of sensor signals)
  - Sensor fusion (each sensor does what it can do best
  - What you see is what you get (you can see a simple measurement, no need to rely on point cloud analysis)

- TRIOPTICS has provided solutions for small (2mm) to large (>200 mm), single- and double-sided, plastic and glass, IR and many VIS applications
- Double-sided asphere measurement without external references using the paraxial optical axis as reference (!)



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A member of the JENOPTIK Group