TRIOPTICS

See the Difference.

# OptiCentric® 100

## Highly Precise Lens Centering Measurement, Alignment and Assembly Systems

# LEADING TO THE FUTURE OF OPTICS

Optical systems have changed the world. And they will continue to do so. TRIOPTICS is significantly involved in this process.

We see ourselves as a solution provider for optical measurement and manufacturing systems and offer our customers the right system for their current and future applications.

www.trioptics.com

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# OptiCentric®

The OptiCentric® product group sets the global standard for optical centering testing and manual and automated lens alignment.

With an extremely high degree of lens centering measurement accuracy and integrated operation, OptiCentric® systems are indispensable in modern optics productions. Regardless of whether the sample has a small or a very large diameter, works in the visual or infrared spectral range, or must be aligned, cemented, bonded or just measured: the OptiCentric® systems are modularly designed so that the appropriate system can be chosen for the desired applications and samples.


OptiCentric® 100

**Definitions of Terms:**

The terms cementing and bonding are not consistently used in optics production.
For TRIOPTICS, the following applies:

**Cementing:** Aligning and cementing of individual lenses to each other (doublets or triplets) or on an arbor.

**Bonding:** Aligning, assembly and bonding one or more lenses in a cell

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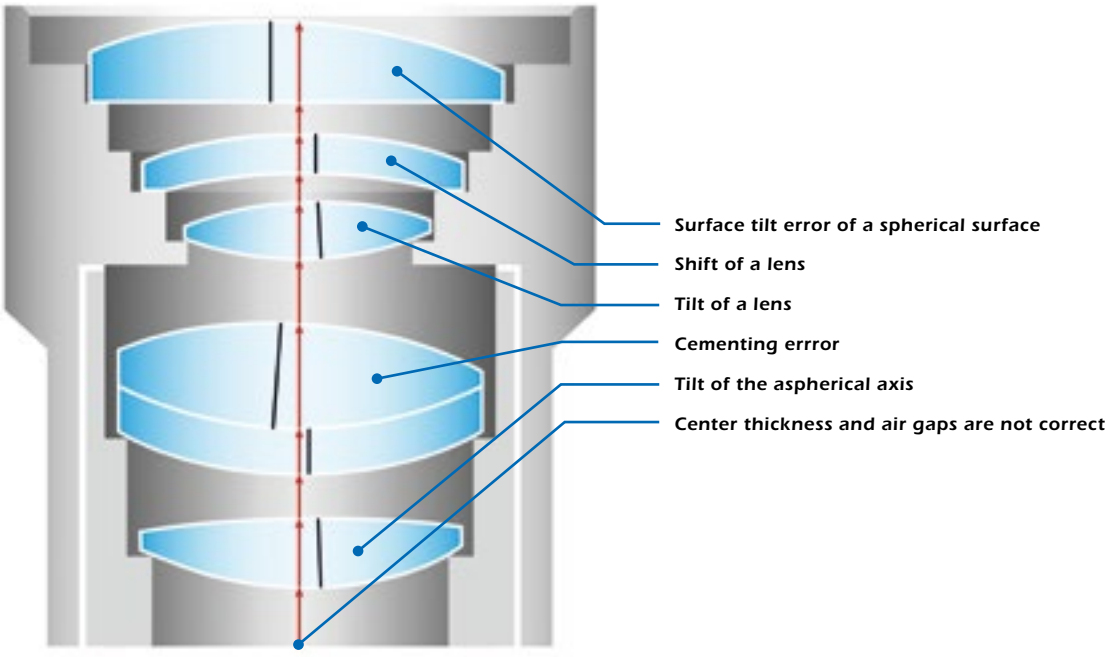
# Advantages of OptiCentric® Systems

- Highest absolute accuracy of 0.1 µm and highest resolution of the measurement head
- Lens centering measurement of all types of optics, in UV, VIS and IR: spherical, aspherical and cylindrical lenses and lens assemblies
- Testing of complex lens assemblies with the MultiLens software module
- Fast and precise alignment processes, thanks to the OptiCentric® software module SmartAlign
- Exchangeable head lenses for virtually unlimited measurement range
- Measurement in reflection and transmission
- Modular and integrated OptiCentric® accessories
- Large diameter range from 0.5 mm to 800 mm: OptiCentric® systems are available in the sizes OptiCentric® 100, OptiCentric® 300 and OptiCentric® 300 & 600 UP

# Centering Errors of Optics

Centering errors have a critical influence on the optical image quality of an imaging system.
There is a centering error when the optical axis of a lens does not correspond with a given reference axis.
The centering error is then the angle between the optical axis of the sample and the reference axis.

An overview of typical assembly and centering errors can be found in the adjacent drawing.



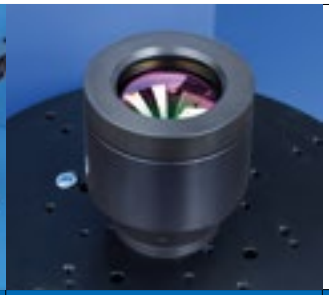
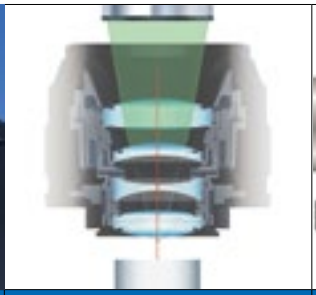
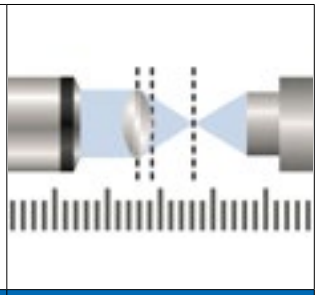

## OptiCentric® Systems

- avoid these centering errors in the cementing and bonding process
- determine these centering errors precisely and in correspondence with the DIN / ISO standard 10110-6 DIN / ISO Norm 10110-6

# Applications

## Application Overview – Measuring Single Lenses and Lens Assemblies

|  |  |  |  |
|---|---|---|---|
| **Centering Testing of Spherical Single Lenses** | **Centering Testing of Single Lenses without Mechanical Reference** | **Testing of Cylinder Lenses** | **Testing of Aspheres** |
| All OptiCentric® 100 Systems are equipped with the Lens Rotation Device; no air bearing is required | OptiCentric® 100 Dual or OptiCentric® 3D 100 Dual, with one or two gauges depending on reference | An OptiCentric® 100 System with CylinderCheck Upgrade, depending on application | OptiCentric® 100 Dual or OptiCentric® 3D 100 Dual with AspheroCheck Upgrade |

|  |  |  |  |
|---|---|---|---|
| **Centering Testing of Groups of Surfaces within Optical Systems** | **Centering Testing of Groups of Surfaces within Infrared Lens Assemblies** | **Center Thickness and Air Gap Measurement, as well as Centering Testing of Single Lenses and Lens Assemblies** | **Measuring Centering Errors, Effective Focal Lengths, Flange Focal Length, Radius and on-axis MTF** |
| Up to 20 surfaces<br>OptiCentric® 100,<br>OptiCentric® 3D 100<br>Up to 40 surfaces:<br>OptiCentric® 100 Dual,<br>OptiCentric® 3D 100 Dual<br>Always with the MultiLens software module and gauges | Up to 10 surfaces[1]:<br>OptiCentric® 100 IR,<br>OptiCentric® 3D 100 IR<br>Up to 15 surfaces[1]:<br>OptiCentric® 100 Dual IR,<br>OptiCentric® 3D 100 Dual IR<br>Always with the MultiLens software module and gauges<br>[1]Depending on sample | OptiCentric® 3D 100<br>OptiCentric® 3D 100 Dual<br>OptiCentric® 3D 100 IR<br>OptiCentric® 3D 100 Dual IR | All OptiCentric® 100 Systems with VIS measurement head and with OptiSpheric® Upgrade |

# Application Overview – Aligment and Cementing of Doublets

| | Alignment of Doublets with the Edge and the Bottom Surface of the Bottom Lens as Reference | Alignment of Doublets with the Optical Axis of the Bottom Lens as Reference |
|---|---|---|
| **System for Automated Aligment and Cementing** | Automated Version not available | - OptiCentric® Cementing and MultiCentric® Cementing for Lens Alignment and Cementing with respect to the optical axis |
| **Manual Lens Alignment and Cementing Equipment** | - All OptiCentric® 100 Systems, no air bearing required<br>- Lens Rotation Device | - All OptiCentric® 100 Systems with air bearing<br>- Seats for Lenses<br>- SmartAlign software module |
| **Finishing** | | Edge processing, fastening with Bell Clamping method in the lathe |
| **Image Quality of the Cemented Element** | Image quality depends on the quality of the edge processing and the production accuracy of the edge, Image quality may not be optimal | Maximum Image quality independent of edge properties |

- The applications on the lens rotation device are performed in reflection or transmission; all others only in reflection.
- All applications can be performed with lenses from the entire spectral range

# Application Overview – Alignment of Spherical and Aspherical Lenses on Arbor

| |  |  |
|---|---|---|
| | **Alignment of Spherical and Aspherical Lenses on Arbor, Reference: Air Bearing Axis** | **Alignment of Spherical and Aspherical Lenses on Arbor, Reference: Arbor Axis** |
| **System for Automated Assembly** | OptiCentric® Cementing for alignment on arbor | OptiCentric® Cementing for alignment on arbor |
| **Manual Assembly Equipment** | - All OptiCentric® 100 Systems with air bearing<br>- Clamping device for arbor | - All OptiCentric® 100 Systems with air bearing<br>- Clamping device for arbor<br>- SmartAlign software module<br>- 2 distance sensors |
| **Image Quality of Lens After Finishing** | Image quality depends on the alignment of the arbor with respect to the rotation axis, Image quality may not be optimal | High Image quality |

- All applications are performed in reflection.
- All applications can be performed with lenses from the entire spectral range.
- In the case of aspherical lenses, only the spherical component (optical axis) is considered.

# Application Overview – Bonding

| |  |  |  |  |
|---|---|---|---|---|
| | **Bonding in 2 Degrees of Freedom, Reference: Air Bearing Axis** | **Bonding in 2 Degrees of Freedom, Reference: Cell axis** | **Bonding in 5 Degrees of Freedom, Reference: Cell Axis** | **Alignment of a Lens within an Optical System** |
| **System for automated bonding** | OptiCentric® Bonding 2D | OptiCentric® Bonding 2D | OptiCentric® Bonding 5D | Upon request |
| **Manual Bonding Equipment** | All OptiCentric® 100 Systems with air bearing | All OptiCentric® 100 Systems with air bearing<br>- SmartAlign software module<br>- 2 distance sensors | Upon request | All OptiCentric® 100 Systems with air bearing<br>- SmartAlign software module<br>- 2 distance sensors |
| **Image Quality of the Lens System** | Image quality may not be optimal.<br>- The air bearing axis and cell axis may not correspond.<br>- Alignment can only be performed in two degrees of freedom<br>- Dependent on production quality of the recess<br>- Only the top lens surface is aligned | Image quality may not be optimal.<br>- Alignment can only be performed in two degrees of freedom<br>- Dependent on production quality of the recess<br>- Only the top lens surface is aligned | Maximum image quality | - Improves the image quality of an existing system<br>- Only the top lens surface is aligned |

- All applications can be performed with lenses from the entire spectral range, only for the alignment of a lens within an IR optical system an IR measurement head is required
- All measurements are performed in reflection.
- All processes depend on the production accuracy of the cell and on the curing process and other properties of the adhesive.

# Overview of OptiCentric® 100 Systems

**OptiCentric® 100**

The industry standard for centering testing and manual lens alignment and assembly

**OptiCentric® 100 IR**

Assemble and test IR lens systems

**OptiCentric® 3D 100**

Centering testing and center thickness/air gap measurement in one system

**OptiCentric® 100 Dual**

Centering testing of lenses and complex optical systems

**OptiCentric® Cementing**

Significant increase in efficiency and accuracy when cementing

- to the optical axis
- on an arbor

**MultiCentric® Cementing**

For the shortest cycle times and very high accuracy when cementing with the optical axis as reference

## The following combinations of the systems presented above are also available:

**OptiCentric® 3D 100 Dual**

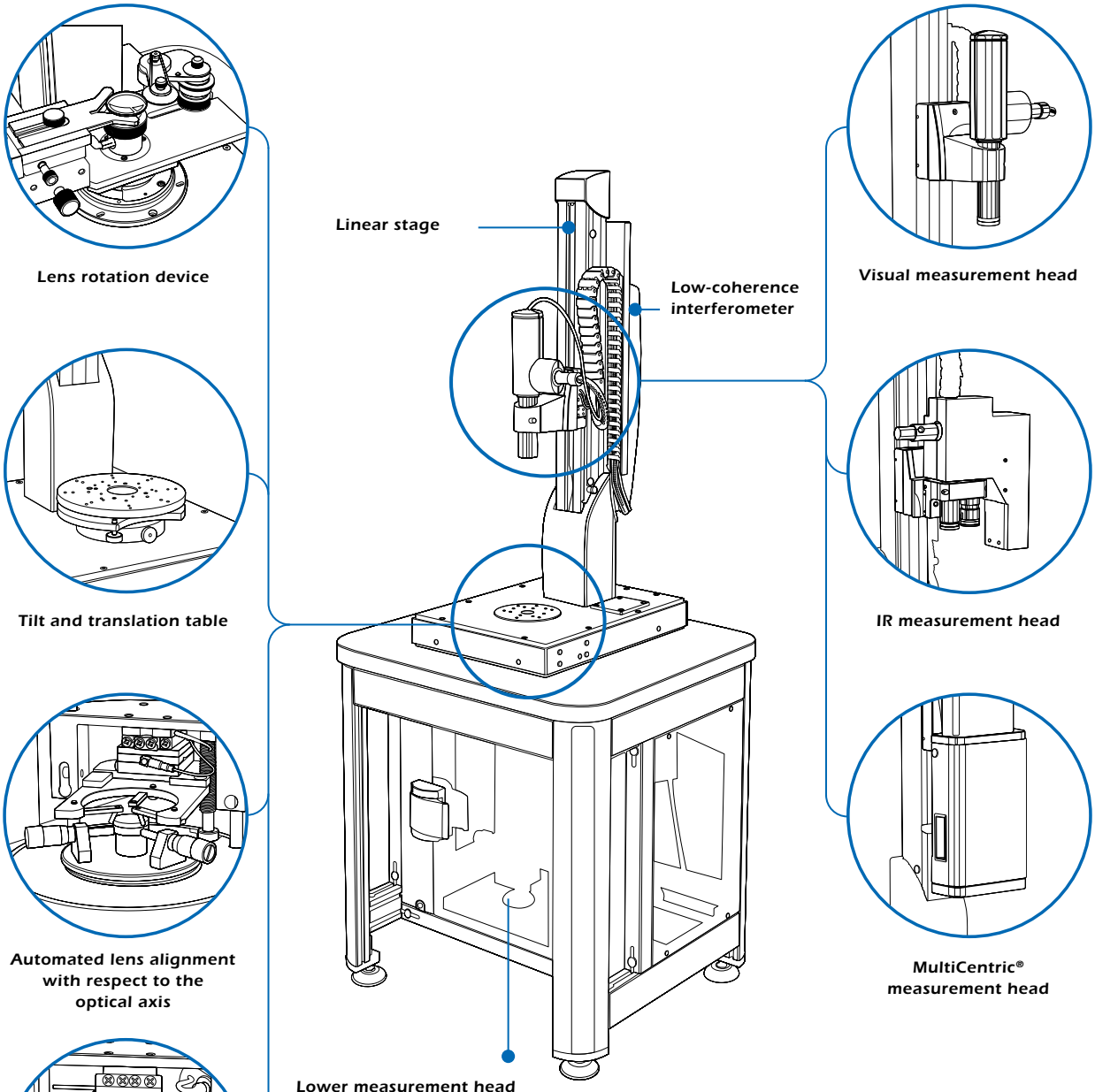
**OptiCentric® 3D 100 IR**

**OptiCentric® 100 Dual IR**

**OptiCentric® 3D 100 Dual IR**

# System Overview

## Modular Structure of the OptiCentric® Systems

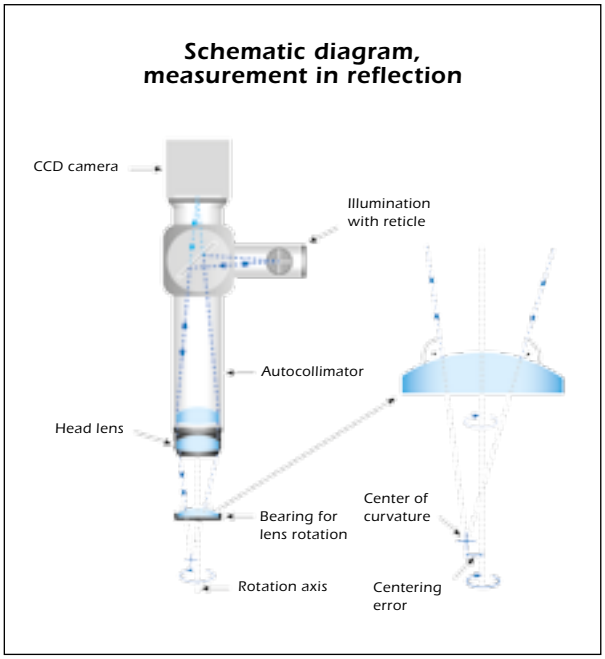


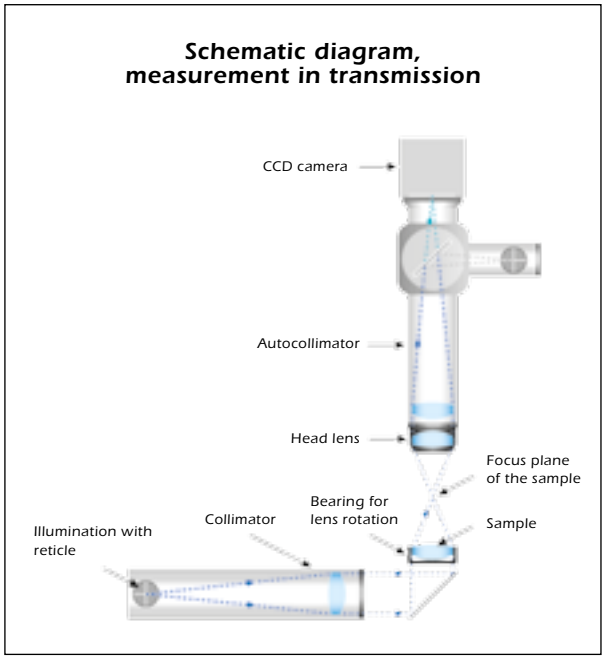
## Configuration for Measurement in Reflection and Transmission

Centering errors can be measured in two different ways, in each of which the sample rotates around the reference axis. Differentiation is made between:

- Measurement in reflection: the center of curvature is the reference point for the centering error measurement
- Measurement in transmission: the focus point is the reference point for the centering error measurement

Every OptiCentric® system measures in reflection. The option to also be able to measure in transmission can additionally be ordered.




## Comparison of Measurement in Reflection and Transmission

The values of centering error measurement in reflection and transmission differ and are only comparable with each other to a limited degree. A simple relationship between the two measurement methods for centering error measurement of single lenses without cell is given by:

$T = (n - 1) \times R$

Where: R = surface tilt error of the top surface as a result of the measurement in reflection
T = angle deviation for the measurement in transmission
n = refractive index of the glass

# Rotation Devices for Samples

The precise rotation and holding device of the sample has a significant influence on measurement accuracy. For that reason, TRIOPTICS attaches great importance to the careful development and selection of rotation devices.

## Air Bearing

A precise air bearing is a prerequisite for highly accurate lens centering testing and serves as a reference during the measurement. All modern OptiCentric® systems are equipped with an air bearing; it can optionally be left out in an OptiCentric® 100 system.

The OptiCentric® 100 systems are optionally equipped with a manual or motorized stable tilt and translation table (TRT 200) for the alignment and testing of optics.

Beside the tilt and translation table TRIOPTICS offers mechanical clamping devices and upgrades for the automated cementing of lenses.

OptiCentric® 100 with air bearing

## Motorized Lens Rotation Device

The motorized lens rotation device is a rotation device for measuring and aligning single lenses and doublets. The outer edge and the bottom surface serve as a reference.

No air bearing is required for the motorized rotation device. Equipped with a so-called „bridge“, the lens rotation device can be operated on the OptiCentric® 100 systems equipped with an air bearing.

TRIOPTICS now offers two lens rotation devices. In addition to the existing lens rotation device, TRIOPTICS has now developed a new lens rotation device which is better scalable using adjusting screws.

OptiCentric® 100
with lens rotation device

Lens rotation device with scalable adjusting screws.

## Measurement Heads

OptiCentric® systems determine the centering errors of optics, with a high degree of accuracy and in real time, with their measurement head. It consists of an electronic autocollimator with a CCD camera, LED lighting and the reticle.

TRIOPTICS offers three different measurement heads for the OptiCentric® systems. Available for selection are:

- Standard measurement head with visual autocollimator
- IR measurement head for testing IR lens assemblies (VIS-MWIR or VIS-LWIR)
- MultiCentric® measurement head, which shortens the measurement time and is particularly well suited for lens alignment and cementing with respect to the optical axis

In order to be able to focus on the center of curvature (reflection measurement) or on the focus position (transmission measurement) of different lenses, the measurement heads are equipped with head lenses, resulting in unbeatable benefits:

- Optimized magnification for each individual lens surface
- Practically unlimited measurement range
- No long, time-consuming movements of the measurement head

In order to be able to change out the focusing head lenses quickly and without complications, TRIOPTICS optionally equips its systems with manual or motorized revolving turrets for the exchange of head lenses.

OptiCentric® 3D 100 with revolving turret for the exchange of head lenses

### Stage for Measurement Head

The measurement head is mounted on a height-adjustable stage. This stage enables the user to set the measurement head to the desired height with the help of the software. As a result, the measurement process is extensively automated and multi-lens systems can be quickly aligned and assembled. OptiCentric® 100 is equipped with a motorized stage which has a travel of 450 mm. Travels of 250 mm, 550 mm or 900 mm are optionally available.

# The OptiCentric® 100 Series

The OptiCentric® 100 systems are the most successful of the OptiCentric® product series. They measure and produce a wide range of samples with diameters from 0.5 mm to 225 mm and a weight of up to 20 kg. As a result, OptiCentric® 100 is the standard in a wide variety of fields of the optical industry. Applications range from tiny endoscopy and mobile telephone lenses to photography and film camera lenses.


OptiCentric® 100 with lens rotation device

# OptiCentric® 100

## The Industry Standard for Centering Testing and Manually Alignment, Cementing and Bonding of Lenses

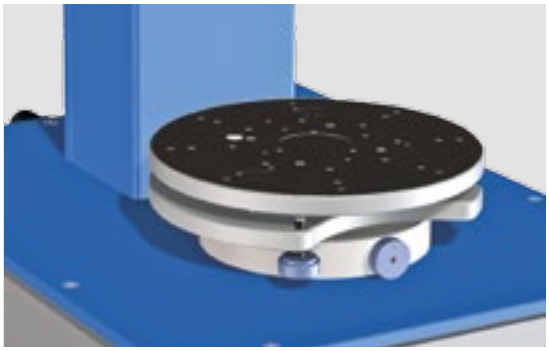
The OptiCentric® 100 system is the bestselling system of the OptiCentric® series. It is used around the world in optics production, quality assurance and development..

OptiCentric® 100 is equipped with a visual measurement head and available in two configurations in its basic version:

- OptiCentric® 100 without air bearing
- OptiCentric® 100 with air bearing

OptiCentric® 100 without air bearing is normally equipped with a lens rotation device which is used to measure the centering errors of single lenses and to cement doublets with the outer edge and the center of curvature of the bottom lens as a reference.

OptiCentric® 100 with air bearing is equipped with a tilt and translation table (TRT) and is used for assembling and testing lens. Equipped with a mechanical clamping device, lenses can be cemented on a arbor, for example.



From top to bottom: manual tilt and translation table, automated tilt and translation table, mechanical clamping device

# OptiCentric® 100 IR

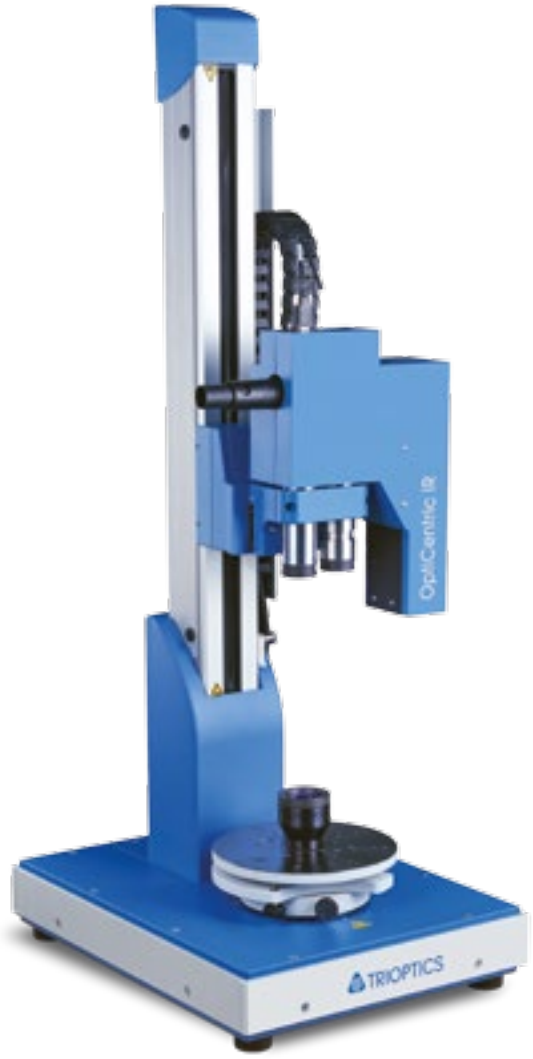
## Precisely Test IR Lens Assemblies

OptiCentric® 100 IR is TRIOPTICS' solution for centering testing of infrared optics. The system is equipped with a flexible-changeover VIS-MWIR or VIS-LWIR measurement head and can test all types of infrared optics.

### Best Accuracy for the Lens Centering Measurement and the Assembly of IR-Optics

In order to achieve the maximum possible accuracy when assembling and testing infrared optics, the selection of the appropriate wavelength (VIS or IR) is of crucial importance for centering testing:

- The measurement of single lenses and the assembling of lens assemblies in reflection can be performed in the visual. The highest degree of accuracy, at 0.1 µm, is also achieved here.
- By contrast, the testing of lens assemblies and lens groups within an optical system with the MultiLens software module, as well as measuring in transmission, are only possible in the infrared spectrum.




OptiCentric® 100 IR
with VIS-LWIR measurement head

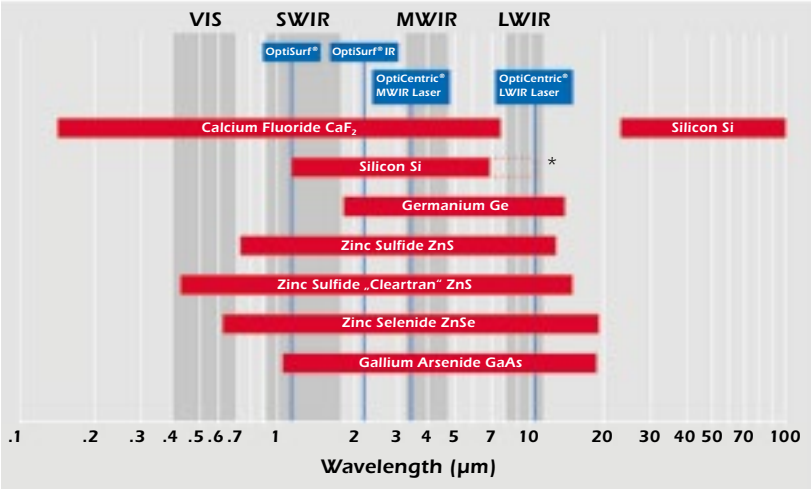
## Advantages of the OptiCentric® 100 IR Systems

- Simple changeover between the visual and infrared wavelength
- The centering measurement accuracy of the MWIR and LWIR measurement heads is 1-2 µm due to the wavelength and the lower resolution in the IR camera, compared with visual cameras.
- Lens centering testing, as well as center thickness and air gap measurement (OptiCentric® 3D 100 IR)
- OptiCentric® 100 Dual IR for testing complex, multi-lensed optics
- Software is customized for measurement in the infrared
- Due to the laser light source, a pinhole is required as the reticle instead of a cross


OptiCentric® IR measurement head with VIS-MWIR light source

## Systems with IR Measurement Head:

- OptiCentric® 3D 100 IR
- OptiCentric® 100 Dual IR
- OptiCentric® 3D 100 Dual IR




Comparison of light-permeable areas of typical infrared lens materials and the available OptiCentric® measurement heads.

*Dependent on the strength of the doping and the dopant

# OptiCentric® 3D 100

## Centering Testing and Center Thickness/ Air Gap Measurement in One System

For the complete opto-mechanical characterization of optical systems, which are already mounted, the OptiSurf® low-coherence interferometer is integrated into the OptiCentric® 100 system, which is then called the OptiCentric® 3D 100. This combination of both measurement systems results in a significant increase in measurement accuracy. The center thicknesses and lens distances can only be determined with maximum accuracy as a result of the highly accurate cetering testing and subsequent adjustment of the sample.

OptiSurf® is available in three configuration variants; each one can be integrated in an OptiCentric® system:

OptiCentric® 3D 100
with integrated OptiSurf®
low-coherence interferometer

**Spezification for the Center Thickness and Air Gap Measurement with OptiCentric® 3D Systems**

| OptiSurf® | Measurement accuracy (optical thickness) | Light source | Scan ranges (optical thickness) |
|---|---|---|---|
| **Standard** | 1 µm | 1.3 µm | 400 mm, 600 mm or 800 mm |
| **Ultra Precision** | 0.15 µm | 1.3 µm | 200 mm, 400 mm, 600 mm or 800 mm |
| **IR** | upon request | 2.2 µm | 200 mm or 400 mm |

## Additional Systems with Integrated Center Thickness Measurement:

- OptiCentric® 3D 100 Dual
- OptiCentric® 3D 100 IR
- OptiCentric® 3D 100 Dual IR