



TRIOPTICS

TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

OptiCentric®

Inspection, Alignment,
Cementing and Assembly
of Optics



OptiTest

OptiSpheric
OptiCentric
OptiAngle

Inspection and Assembly of Lenses

LENS CENTRATION

According to ISO 10110 a centering error is present when the optical and the reference axis of a lens do not coincide, respectively these are different in position or direction.

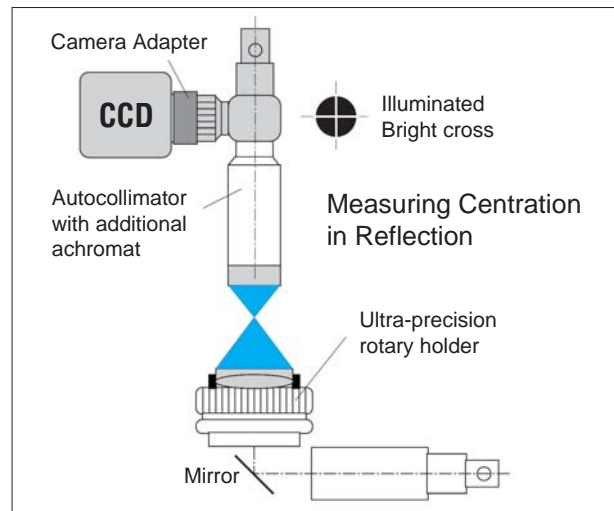
During the process of cementing, alignment and bonding of lenses in a mount, significant centering errors could result and add to the machining errors of a lens. Consequently, the requirements of a high performance optical system can be fulfilled only when all the production steps from the centering tolerance measurement to the assembly of the lens in a mount are planned and designed as an integrated concept.

The TRIOPTICS comprehensive line of equipment -under the generic name OptiCentric® has been specifically designed to cover applications related to any type of optical components and to respond to different accuracy degrees. The OptiCentric®-System also covers all the production steps from the centration measurement to the alignment, cementing and assembly of optics. The OptiCentric® includes valuable tools for any application, from simple and affordable visual instruments to complex, fully automated and PC-controlled production and laboratory stations.

MEASUREMENT PRINCIPLE

The normal procedure to identify the centering errors is to rotate the sample in transmitted or reflected light.

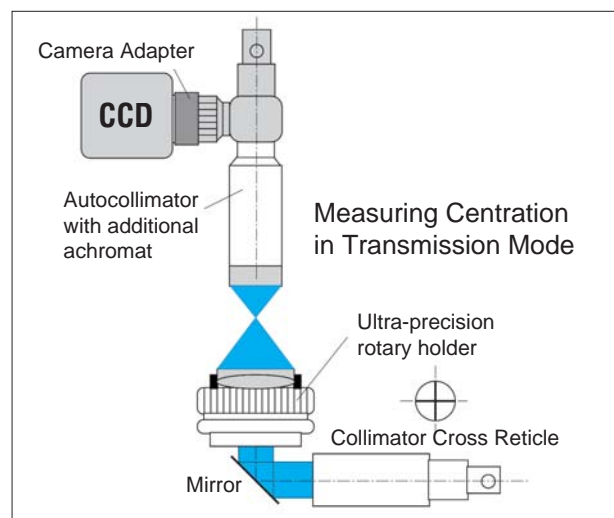
For the measurement, an autocollimator with additional optics is focused either in the center of curvature of the surface (Reflection Mode) or in the focal plane of the lens (Transmission Mode). For the measurement in transmission a collimator is addi-



nally needed. The parallel beam emerging from the collimator is focussed in the focal plane of the sample to be measured.

The images reflected from the lens surfaces (Reflection method) as well as the images projected into the focus of the lens (Transmission method) are observed through the eyepiece of an autocollimator, of a telescope or of a microscope.

In Transmission method it is not possible to determine which of the two surfaces of a lens is producing the centration error. In some cases, a lens tested in transmission can reveal no centering error, although the lens is tilted in the mount. The images reflected from the lens surfaces, however, represent an undoubtable criterion for the surface tilt and the individual centering errors.



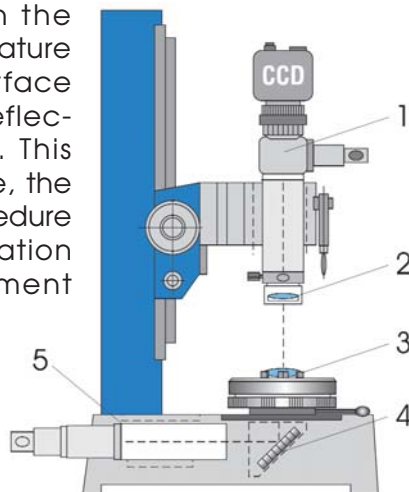
The Reflection method is the only total and true method of measurement of centration errors. However, the Reflection method is in many cases difficult to manage. On the other hand, the Transmission method with some mechanical constraints gives in many cases satisfactory results. For a good economy of the optical manufacturing both methods should be considered.

When a centration error is present, the observed image describes a circle, while the sample is rotated around a reference or datum axis. The diameter of this circle is proportional with the size of the centering errors. The result of the measurement can be given as radius of the run out circle (in μm) or as tilt of the surface or of the lens axis (in arcsec).

OptiCentric®

In this set up an autocollimator equipped with additional head lenses is focussed in the image plane of the sample (Transmission method) or in the centre of curvature of the lens surface under test (Reflection method). This set up is simple, the focussing procedure and the operation of the instrument can be easily carried out.

OptiCentric® Basic Set-Up



1. Autocollimator with CCD-Camera
2. Additional Achromat in X-,Y- adj.Mount
3. Sample
4. Mirror
5. Collimator

However, this set up requires the values of the focal length or radius of curvature of the sample to be known, otherwise the calculation of the centration errors is not possible. Difficulties are also experienced when measuring samples with longer focal lengths or

radii of curvature. To accommodate longer focal lengths or longer radii of curvature either a large number of additional focussing optics or a long travel mechanism is necessary.

The TRIOPTICS measurement systems described before are of modular design, so that the instruments are upgradeable and compatible with each other. To make the selection of the suitable equipment easier, in a first step the main instrument parts are presented:

OPTICAL SENSING HEAD

The Optical Sensing Head is designed to view and quantify the size of the centration error in single and multiple optical components. The Optical Sensing Head is also the basic unit used for alignment of single elements before cementing or mounting in cells.

The Optical Sensing Head is basically an optical set up (e.g. an autocollimator or telescope) equipped with an appropriate reticle. The illumination unit behind the reticle is adapted to the reflecting properties of the sample. The range of illumination units offered by TRIOPTICS are complete assemblies with condenser optics and different light sources:

- Low power bulb
- High power halogene lamp with fiber optic guide
- NIR-illumination
- Laser illumination

The reticles mounted in the measuring head allow for direct reading of the radius of the run out circle described by the focussed or reflected images produced by the rotating sample. The eyepiece reticles (used for error reading) can be selected from a large range of scales or tolerance circles. The illuminated reticles (projected into the sample centre of curvature or in its focus) are mostly bright crosses or pinholes.

The Optical Sensing Heads offered by TRIOPTICS are of modular design so that the viewing and measuring of the centration errors or lens alignment can be carried out:

- visually- looking into an Eyepiece
- visually- looking at a Video Monitor
- automated, PC-controlled

The visual control using the eyepiece is the most simple and cheapest solution. However, the accuracy and repeatability is limited and very much depending on the qualification and the degree of fatigue of the operator.



OptiCentric® Visual
Stand with fine travel and Rotary Holder

The visual control using the eyepiece, CCD-camera, CCD-adapter optics and video monitor increases the comfort in operation, allows the operator to better concentrate on the rotation of sample, however, it has the same limitation concerning the accuracy and repeatability.

None of these equipments provides records of the centration errors or of the accuracy achieved in alignment and cementing, so that optics rejected by customers could quickly annihilate the advantage of the low price of this equipment.

The use of an automated, PC-controlled Optical Sensing Head increases dramatical-



OptiCentric®, PC-controlled. Stand B with fine travel mechanism

ly the accuracy and repeatability, provides records of the tolerances achieved and is not dependent on the qualification or fatigue of the operator. The CCD-camera is in this case connected to a frame grabber mounted in the PC. The software controls the measuring process, so that the accuracy and repeatability are less operator dependent. The direct measurement data as

the radius of the run out circle are automatically determined and used for calculation of the deviation (transmission method) and of the tilt angle (reflection method).

The measuring certificate includes data presented according to the standard ISO10110, so that a direct comparison with the tolerance values are possible. To further increase the capabilities of the system and the efficiency in the optical shop, a number of options as electronically generated scales, tolerance circles or a Yes/No selection are available.

Each of the TRIOPTICS-Optical Sensing Heads can be upgraded according to the changing customer needs.

STANDS WITH TRAVEL MECHANISMS

The Optical Sensing Head is normally mounted on a stand having capabilities to move up and down the measuring head to adapt to a certain range of radii of curvature (for



centration in reflection) or of focal length (for centration in transmission). The necessary movement of the measuring head is realised with different mechanisms and controllers. The measuring head movement can be done:

- manually
- motorized-using a controller with buttons for speed and travel
- motorized, PC-controlled

Stand with stepper motor drive
(OptiCentric® MOT)

For manual travel control, the TRIOPTICS stands are equipped with coaxial rotating knobs for coarse and fine travel. This solution is cheaper, however, the time needed for moving the measuring head reduces the efficiency. Moreover, the travel is limited, since the height of the stand must be selected so that the operator works in a seated position. Consequently, to cover a certain range of radii/focal length a large number of additional optics is necessary.

The motorized version uses stepper motor and controller to increase the speed of movement and the travel of the measuring head. Having a longer travel, the number of additional optics necessary to cover a certain range of radii/focal length is reduced compared with the manual version.

The automated, PC-controlled version allows driving to the focussing positions for an unlimited number of radii/focal length. These positions are either known from the optical design of the lens or can be found in teach-in procedure and recorded for future use. In this way, the alignment and assembly of multiple element lenses become easier. In connection with an automated measuring head, the motorized, PC-controlled stand can be integrated into a fully automated measurement and production process.

The manual stands from TRIOPTICS are optionally equipped with digital slides showing at any time the position of the measuring head and helping the operator to find the focussing positions. In the motorized versions, the position of the measuring head is given by the stepper motor controller.

All the stands can be used for measurement in Transmission or/and Reflection. The equipment for Transmission supplementary includes a collimator and a deflection mirror mounted in the stand base.

STANDS FOR DUAL HEAD INSTRUMENTS

For alignment and assembly of complex multi-element objective lenses TRIOPTICS developed a dual head instrument series allowing for simultaneous alignment and mea-



Stand for Dual Head Instruments

surement of bottom and upper lens surfaces. This proprietary design improves dramatically the capabilities of the instrument in the field of lens assembly and measurement of centration errors.

STANDS FOR MEASUREMENT AND ASSEMBLY OF HEAVY OBJECTIVE LENSES

The OptiCentric® product line covers all conceivable applications from measurement and cementing of tiny endoscope lenses until assembly of large, heavy objective lenses.

The OptiCentric® UltraStable® series provides solid and stable instrument frame, anti-vibration isolators, heavy duty air bearings and rigid tip-tilt adjustable tables.



Assembly of OptiCentric® UltraStable® series

The heavy duty air bearings have a diameter of 300mm, an extremely high stiffness, axial and radial errors significantly lower

than 50 nanometers and a load capacity of 500 Kg.



OptiCentric® UltraStable® series has been further developed to cover special applications in the space industry, military and astronomy. The special versions are able to support large and heavy samples with height up to 2 metres and weight up to 500 Kg.

OptiCentric® UltraStable® for samples with height of 2m and weight up to 500Kg

LENS ROTATION DEVICES

General

Since the viewing and the measurement of the centration errors are possible only when the lens is rotated (except for extremely expensive errorless focussing devices), the availability of a lens holding and rotary device is crucial for completing a centration measurement.

The accuracy of the centration measurement and of the alignment/mounting of lenses is determined by the two basic components of an centering/mounting equipment:

- Optical Sensing Head
- Lens Rotation Device

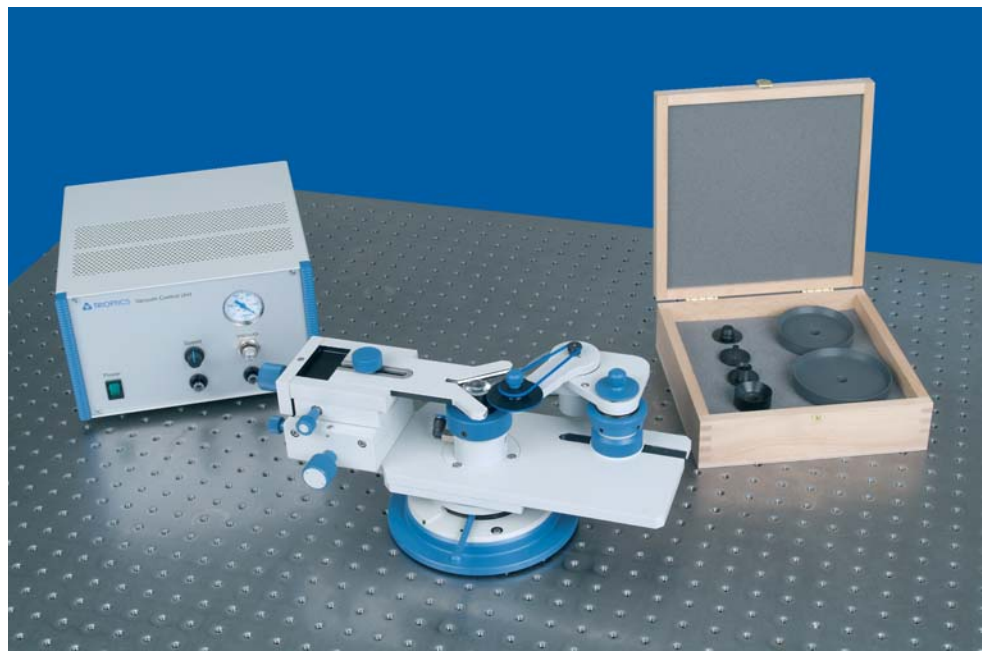
Many optics manufacturers underestimate the importance of the Lens Rotation Devices in ensuring the required accuracy. Since the use of accurate CCD-cameras and complex image processing software provides a high accuracy of Optical Sensing Heads, the largest error source in lens centering and mounting is in many cases the Lens Rotation Device. Many of the Lens Rotation Devices used in the optical manufacturing do not provide a reference rotation axis which is enough accurate and stable. TRIOPTICS invested a large amount of work in designing a complete range of accurate devices for lens rotation:

Description

Motorized Vacuum-Lens Rotation Device

The sample lays on a non rotating plastic chuck. The cylinder edge of the lens is in contact with a V-plate. The position of the V-plate can be finely adjusted using the two micrometers stages for x- and y-direction. The non rotating plastic chuck is adjustable in the height, so that samples of different thickness can be accommodated.

Code	Description
4-300-40	Motorized Vacuum-Lens Rotation Device, two micrometer stages for positioning of the V-plates, Range Dia. 5-75 mm, Vacuum pump, Control Module
4-300-31	Extension of the Dia. Range to 75-100 mm
4-300-95	Accessories for measurement of small lenses (Dia.<5mm)



Motorized Vacuum-Lens Rotation Device

A friction drive with different friction wheels enables the lens rotation. The position of the lens on the non rotating plastic chuck is secured by vacuum. The vacuum adapter is equipped with a precision glass window which allows viewing of the projected image, while the lens is secured by vacuum. The vacuum pump and the electronics for speed and vacuum regulation are integrated in a control module. Due to the presence of the vacuum pump, a compressed air net is not necessary.

When accurately manufactured and correctly operated, this device offers very good results in accuracy and repeatability. Errors of the cylinder edge, when present, are averaged, so that the measurement results are reproducible.

With the support of a special software module of OptiCentric® even the measurement of square, rectangular or free form samples becomes possible.

Main applications are the measurement of centring errors of spherical and aspherical lenses and cementing of achromats or objective lenses. Using plastic V-plates, even the assembly of some lenses in mount becomes possible with this device. However, there are limitations of the use of this device for assembly work. With this limitation, the Motorized Vacuum-Lens Rotation Devices features the best price/performance ratio and is a reliable accessory for accurate measurement of centration errors.

Ultra-Precision Air Bearing Table

This device combines the accuracy of an ultra-precision air bearing (run out less $0.05\mu\text{m}$) with a stable tilt and translation stage. Due to the high stiffness and accuracy, the ultra-precision air bearing table is especially suitable for the assembly of high performance multi-lens objectives.

The air bearing integrated in TRIOPTICS equipment are specially designed for optical applications providing outstanding accuracy and stiffness and a central hole for

measurement in transmission or checking multi-element objective lenses. The precision



AB 100 air bearing series

rotation drive provides smooth rotation - without any vibrations-and if necessary accurate angular positioning.

For long life operation the air bearing are supplied with complete air drying, filtering and pressure control unit.

AB 100 air bearing series

The AB 100 series is used for the big majority of applications as measurement and assembly of digital camera, mobile phones, endoscope optics, scanner optics or any other objective lenses with diameters from 1-100...150mm.



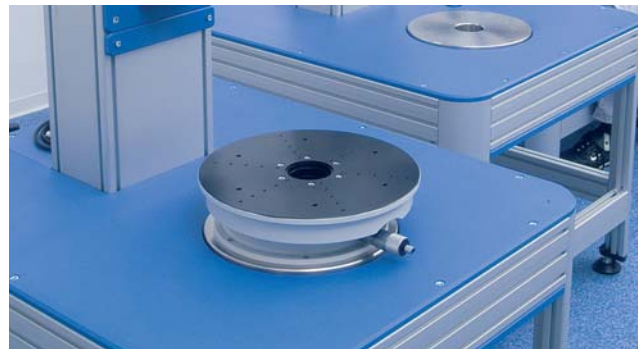
AB 100 series with tip-tilt table TRT-200

Code	Description
4-300-34	Air bearing rotary table AB 100, axial and radial run out less 0.05 μ m, with tip-tilt table TRT-200, dia. 200mm. Including air drying unit, air filter, pressure control gage, complete air supply connections to air supply net. Measurement in reflection and transmission, manual rotation Tip-Tilt Table Tilt: two orthogonal axes, tilt range: +/-1.5°, sensitivity: +/-1 arcsec, Translation: two orthogonal axes, translation range +/-5mm, sensitivity: +/-1 μ m Table surface: dia. 200 mm, fixture facilities: 8xM6 on dia. 175mm, 8xM6 on dia. 100mm, 8xM4 on dia. 70mm
4-300-36	Motorized air bearing rotary table AB 100, axial/radial run out less 0.05 μ m, with tip-tilt table TRT-200 for Measurement in reflection and transmission, motorized rotation. DC-motor drive, gear unit and controller for start, stop and speed control. Otherwise as 4-300-34.
4-300-49	Motorized air bearing rotary table AB 100, axial/radial run out less 0.05 μ m, with tip-tilt table TRT-200 for measurement in reflection and transmission, motorized rotation and positioning. Controller for accurate positioning. Software for PC-control of all parameters. Positioning accuracy better 1 arcmin, including reference sensor to determine the reference position and the origin of the angle vector (necessary for checking multi-lens systems). Otherwise as 4-300-36

The tip-tilt table with diameter 200 mm (TRT-200) allows for easy and precise alignment of the samples (2-tilt axes, 2-translation axes) and provides the necessary stability for accurate assembly work.

AB 300 air bearing series

For large and heavy optical assemblies TRIOPTICS developed the UltraStable® AB 300 air bearing line. This product line is recommended for large optical assemblies



AB 300 series air bearing with tip-tilt table TRT-340

Code	Description
4-305-34	Air bearing rotary table AB 300, axial and radial run out less 0.08 μ m, with tip-tilt table TRT-340, dia. 340mm. Including air drying unit, air filter, pressure control gage, complete air supply connections to air supply net. Measurement in reflection and transmission, manual rotation Tip-Tilt Table Tilt: two orthogonal axes, tilt range: +/-1.5°, sensitivity: +/-1 arcsec, Translation: two orthogonal axes, translation range +/-5mm, sensitivity: +/-1 μ m Table surface: dia. 340 mm, fixture facilities: 8xM6 on dia. 250mm, 8xM6 on dia. 175mm, 8xM4 on dia. 100mm
4-305-36	Motorized air bearing rotary table AB 300, axial/radial run out less 0.08 μ m, with tip-tilt table TRT-340 for measurement in reflection and transmission, motorized rotation and positioning. DC-motor drive for accurate angular positioning of the rotary table, controller and precision gear, controller for start, stop and speed control. Otherwise as 4-305-34
4-305-49	Motorized air bearing rotary table AB 300, axial/radial run out less 0.08 μ m, with tip-tilt table TRT-340 for measurement in reflection and transmission, motorized rotation and positioning. Controller for accurate angular positioning of the rotary table. Software for PC-control of all parameters. Positioning accuracy better 1 arcmin, reference sensor to determine the reference position and the origin of the angle vector (necessary for checking multi-lens systems). Otherwise as 4-305-36

with diameter up to 600mm and weight up to 500Kg.

The tip-tilt table with diameter of 340 mm (TRT-340) allows for easy and precise alignment of the samples (2-tilt axes, 2-translation axes) and provides outstanding stability and stiffness for accurate assembly work.

When the pre-alignment of the lens chuck or lens cell is accurately made, the Ultra-Precision Air Bearing Table gives the highest possible accuracy for assembly, cementing or bonding of lenses in mounts. Using the ultra-stable and finely adjustable tilt and translation tables, not only tiny changes in tilt as small as 1 arcsec are achievable, but also the assembly of heavy, large, multi-lens objectives is possible.

The measurement of multi-lens objectives and automated cementing and bonding in

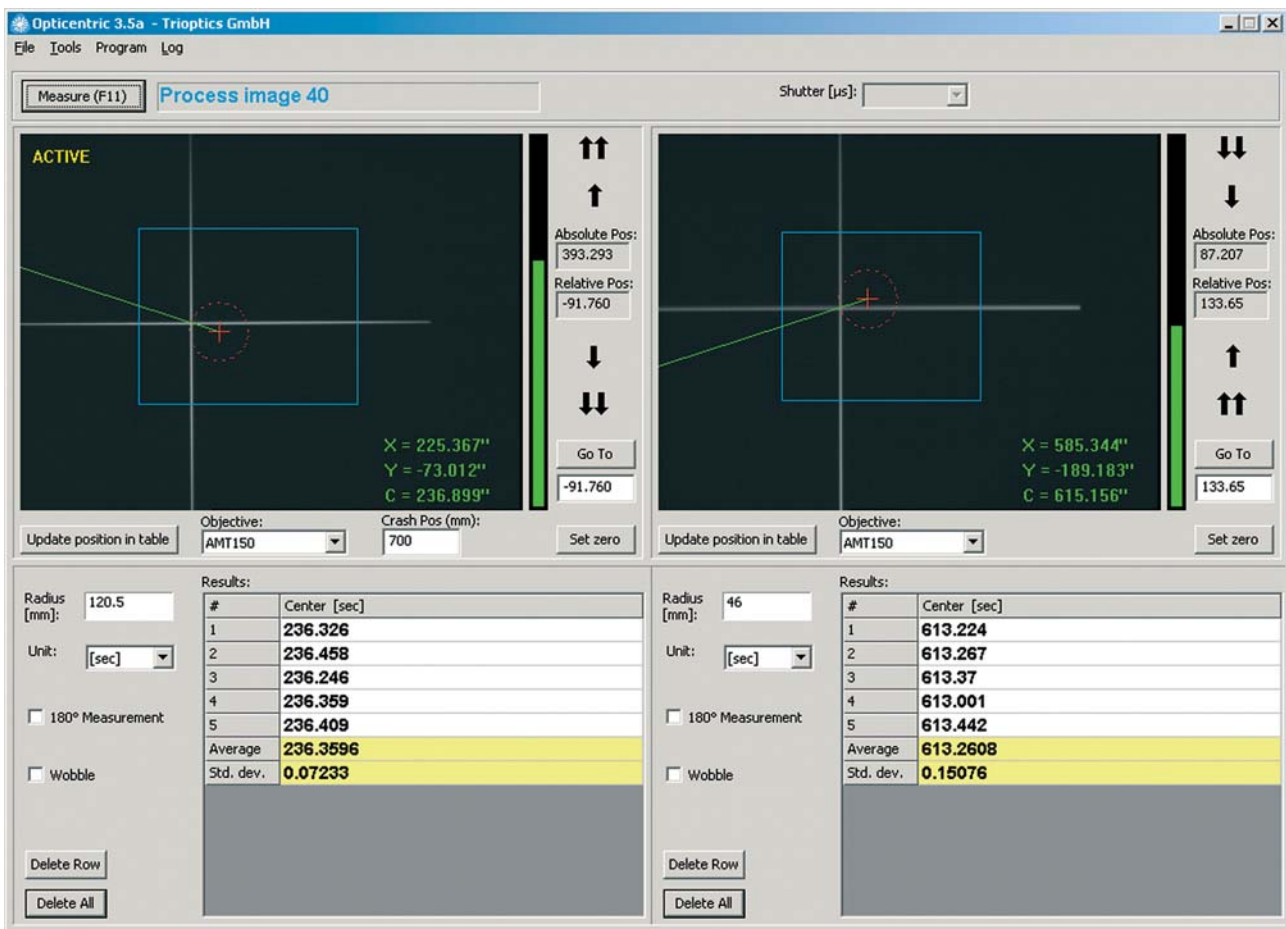
mount requires motorized air bearings with accurate positioning unit and reference sensor.

Software

The advanced software is designed to work under Windows XP® operating systems. The software fulfils the need of the optical shop for easy, intuitive operation and features a large number of options to accommodate a large variety of specific requirements.

The software modules „Centration in Transmission“ and „Centration in Reflection“ allow for free rotation of the sample and provide an outstanding accuracy even in difficult measuring situations as poor contrast, anti-reflex coated surfaces, very small lenses etc.

The software features one or multiple live



The screenshot shows the 'Opticentric 3.5a - Trioptics GmbH' software interface. It features two main measurement windows side-by-side, each displaying a live video feed of a lens surface with a blue square measurement area and a red crosshair. The left window shows 'Process image 40' and the right window shows 'Shutter [µs]:'. Below each window are control panels for 'Absolute Pos:', 'Relative Pos:', and 'Go To' buttons. The bottom section contains two 'Results:' tables, each with a 'Radius [mm]' input field and a 'Unit: [sec]' dropdown. The left table shows results for a radius of 120.5 mm, and the right table shows results for a radius of 46 mm. Both tables include columns for '#', 'Center [sec]', 'Average', and 'Std. dev.'.

#	Center [sec]
1	236.326
2	236.458
3	236.246
4	236.359
5	236.409
Average	236.3596
Std. dev.	0.07233

#	Center [sec]
1	613.224
2	613.267
3	613.37
4	613.001
5	613.442
Average	613.2608
Std. dev.	0.15076

Simultaneous measurement in reflection of both lens surfaces

images and provides simultaneously measurement data for both lens surfaces. This software feature requires the OptiCentric® Dual Head for simultaneous measurement of upper and bottom lens surfaces.

To adapt to different hardware configurations e.g different reticle patterns (bright cross, dark cross, pinhole, etc.), the software features selectable options. Further options enable to select different measurement units: mm/inch, arcsec, microrad, etc. To increase the efficiency in production process, the software allows to save the optimized process parameter for future use.

Further features of the software:

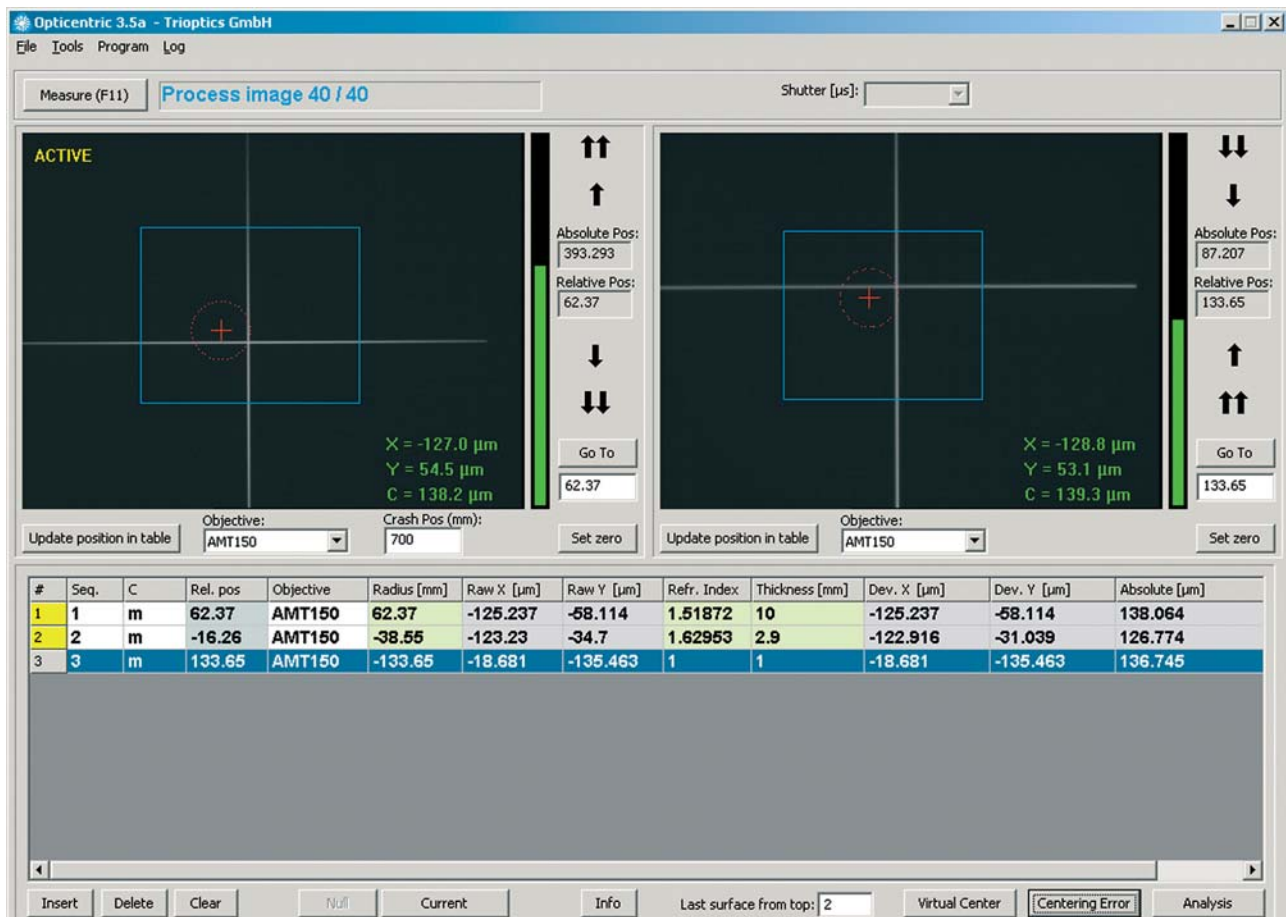
- Real time monitor display of the camera image from one or several measuring heads
- Real time, continuous display of the measurement value

- Vector display of the size and direction of the error
- Computer generated single cross for initial alignment
- Computer generated tolerance circles or angle graduations for quick checking of production quantities
- Automatic threshold i.e. automatic adjustment to the sample reflectivity
- Automatic calibration procedure by means of a calibrated sample. The calibration can be checked at customer site.

In addition to the standard instrument capabilities, a lot of outstanding software features are available:

MultiLens® Software Package

This very complex software module is intended to be used either for alignment and assembly of objective lenses or for checking



The screenshot shows the Opticentric 3.5a software interface. It features two live camera images side-by-side, each with a blue crosshair and a red dashed circle indicating the measurement area. The left image shows a measurement with X = -127.0 μm, Y = 54.5 μm, and C = 138.2 μm. The right image shows a measurement with X = -128.8 μm, Y = 53.1 μm, and C = 139.3 μm. Below the images are controls for objective selection (AMT150) and crash position (700 mm). At the bottom, there is a table with the following data:

#	Seq.	C	Rel. pos	Objective	Radius [mm]	Raw X [μm]	Raw Y [μm]	Refr. Index	Thickness [mm]	Dev. X [μm]	Dev. Y [μm]	Absolute [μm]
1	1	m	62.37	AMT150	62.37	-125.237	-58.114	1.51872	10	-125.237	-58.114	138.064
2	2	m	-16.26	AMT150	-38.55	-123.23	-34.7	1.62953	2.9	-122.916	-31.039	126.774
3	3	m	133.65	AMT150	-133.65	-18.681	-135.463	1	1	-18.681	-135.463	136.745

Dual live image for multi-lens checking

the centration errors of completely mounted optical assemblies. Checking mounted objective lenses provides precise data about the assembly technology applied. In this way the MultiLens® software becomes an indispensable tool for process optimizing.

In addition to the position of each lens surface, the sub-module **CentricAnalyser** provides 3D data related to position of the optical axis of each lens, doublet, triplet or any other lens group. A best fit optical axis of the objective lens can be calculated and all data are referenced to this axis. Combining these features with adequate assembly techniques, even high performance, expensive objective out of tolerances lenses can be trimmed up realigned within the tolerances.

AspheroCheck®

AspheroCheck® is a new software module requiring the hardware module AspheroHead for accurate measurement of centration errors of aspheric surfaces. Depending on the hardware module selected the angle and the displacement in space coordinates of the axis of the asphere can be determined simultaneously or in two measurement steps.

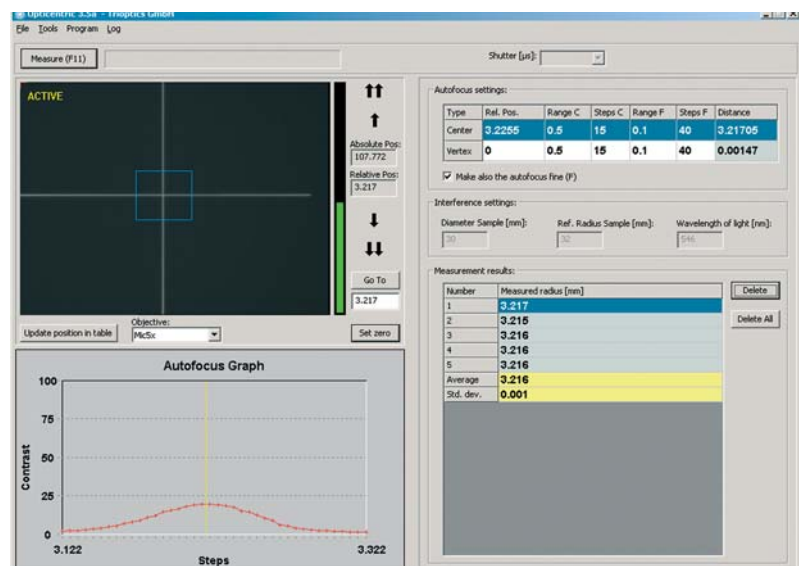
CylinderCheck®

CylinderCheck® is a new software module requiring a specific hardware module for accurate measurement of centration errors of cylindrical surfaces.

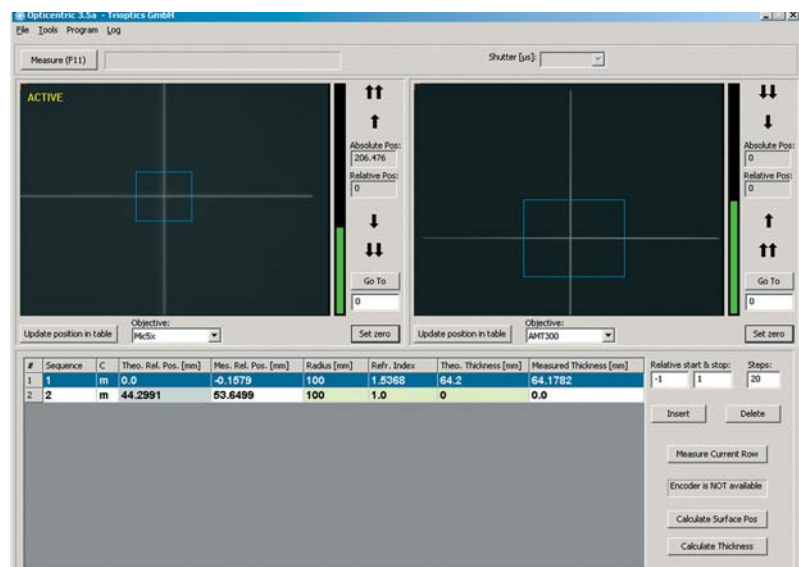
SmartAlign®

This proprietary software module is specially developed for easy and ultra-accurate alignment and cementing or assembly of optical systems.

This software module requires the AB 100 or AB 300 air bearing series. When using this technology no time consuming alignment of the first lens surface or mount reference is necessary. The benefit in reducing the production time is significant. The second main feature of the SmartAlign® technology allows for use of non-centered or poorly centered optical elements in cementing or assembly process. The final result is an extreme accuracy which is not depending on the centration status of the optical elements but on the accuracy of the alignment tools.



Measurement of radii of curvature



Measurement of lens thickness

Extending of measuring capabilities

Due to the modular design of the instrument, new options and software modules can be easily added to further increase the measuring capabilities of the instrument

Measurement of lens thickness and radii of curvature

The measurement of lens thickness and comparison with the design data is important for the assembly of objective lenses. A more important and critical parameter is the distance between the lenses or lens groups. Responding to customer requirements, TRIOPTICS added a software module for accurate measurement of lens thickness and lens distances, so that all the data necessary for assembly of complex objectives is provided by OptiCentric® system. A large selection of lens thickness/distance measurement devices is available and fully integrated in the system.

Since the OptiCentric® provides accurate measurement data about almost optical parameters as radius of curvature, lens thickness, focal length etc. the measurement of the refractive index of each lens becomes possible. For advise and necessary hardware components please contact TRIOPTICS representatives.

Measurement of Plano Optics

The addition of a software module-belonging to OptiAngle® (another subsystem of OptiTest)-and the use of specific mechanical fixtures converts the OptiCentric® to a powerful tool for angle measurement of:

- wedges and filters
- 90°-prisms
- parallelism of plane plates
- deviation angle through wedges and prisms
- mirror tilt
- alignment of CD-optical heads
- wobble of rotating glass disks

More detailed information on measurement of plano optics is included in TRIOPTICS brochure OptiAngle®

Program Survey

As already mentioned, the instruments described before have a modular design. The components and accessories are compatible with each other, so that the instruments can be easily upgraded or configured for new applications. To make the selection of appropriate equipment easier, the main instrument versions are presented below:

OptiCentric®

The conventional series OptiCentric® is based on an optical set up featuring measurement of centration errors in focal plane (measurement in transmission) or in the centre of curvature (measurement in reflection acc. to ISO 10110). The series OptiCentric® is flexible and covers simple applications in the field of centration errors measurement and cementing of optics. This product line is conveniently priced and offers a good ratio price/performance when the number of radii of curvature during one measurement is limited. The measurement range and speed are limited, especially when different centres of curvatures must be focussed in. An upgrade of the series to MultiLens® applications or SmartAlign® technology is difficult. The OptiCentric® series is equipped with stands with manual focussing. The Centration Error Analysers are either of visual type or PC-controlled.

The PC-controlled OptiCentric® Station - depending on the focal length of the autocollimator used in the error analyser- achieves an accuracy in the range of one arcsec and can detect deviations or decentrations in the range of 2-3µm up to 0.5µm.

These basic instruments are also available in special versions with extended travel range or extended measurement range.

Code	Type	Description
4-100-02	OptiCentric®	PC-controlled, complete Measurement and Assembly Station incl. CCD-Camera, Frame Grabber and software package Centric 1 for centration measurement in Reflection/Transmission and Alignment/Cementing. Stand B with fine height adjustment, travel range up to 250mm.
4-103-02	OptiCentric® L	As 4-100-02, travel range up to 400 mm
4-100-12	OptiCentric®-Video	Complete Measurement and Assembly Station as 4-100-02, however, without Frame Grabber and Software. Optical sensing head with CCD-Camera and b/w Video-Monitor.
4-100-22	OptiCentric®-Visual	Complete Measurement and Assembly Station as 4-100-02, however, without Frame Grabber and Software. Optical sensing head with Eyepiece only.



OptiCentric® PC-controlled, manual focussing

The measurement and assembly stations OptiCentric® are completely equipped, however, without Lens Rotation Devices which have to be ordered according to the specific customer applications.

OptiCentric® MOT

OptiCentric® MOT is a comprehensive range of equipment for optical alignment and assembly covering a wide range of appli-

cations. This Inspection and Production Station is PC-controlled and equipped with an accurate stepper motor for positioning of the measuring head. The measuring head can be programmed to drive to several focus positions or centres of curvature of multi element lenses. In this way the measurement of centration errors, assembly, cementing or bonding of multi-element lenses becomes easier and can be fully automated.

The accurate and fast AutoFocus increase the accuracy and extend dramatically the applications field: measurement of radii of

Code	Description
4-400-02	OptiCentric® MOT PC-controlled Test Station for Centration measurement, cementing and alignment of optics. Min. sample diameter: 0.5mm Max. sample diameter: 225mm Facilities for mounting AB 100 (air bearing with diameter 100mm)
4-401-06	OptiCentric® MOT 600/100 Max. sample diameter: 600mm Facilities for mounting AB 100 (air bearing with diameter 100mm) Other features as 4-400-02
4-401-08	OptiCentric® MOT 600/300 Ultra Stable® Max. sample diameter: 600mm Facilities for mounting AB 300 (air bearing with diameter 300mm)

curvature, of lens thickness or distance between the lens elements, of the focal length or refractive index can be easily accomplished by adding software modules.

OptiCentric® MOT offers a large flexibility concerning the dimensions or the weight of the samples. As an industry's standard OptiCentric® MOT is used in very different industrial fields from tiny endoscope and mobile phone optics (diameters smaller than 0.5mm) up to large and heavy optical assemblies with dimensions up to 2 metres, diameters up to 800mm and weights up to 500Kg.



OptiCentric MOT 600/100 UltraStable equipped with air bearing AB 300



OptiCentric® MOT equipped with air bearing AB 100 and accessories

For complex measurement and assembly work TRIOPTICS developed the OptiCentric® Dual series. This series also covers a wide field of applications and dimensional range of objective lenses.



OptiCentric® MOT Dual Optical Head

Code	Description
4-405-02	OptiCentric® MOT Dual Optical Head PC-controlled Test Station for Centration measurement, cementing and alignment of optics. Min. sample diameter: 0.5mm Max. sample diameter: 225mm Facilities for mounting AB 100 (air bearing with diameter 100mm)
4-405-04	OptiCentric® MOT 400/100 Dual Optical Head Max. sample diameter: 400mm Other features similar with 4-405-02
4-405-06	OptiCentric® MOT 600/100 Dual Optical Head Max. sample diameter: 600mm Other features similar with 4-405-02
4-405-40	OptiCentric® MOT 400/300 Dual Optical Head UltraStable Max. sample diameter: 400mm Facilities for mounting AB 300 (air bearing with diameter 300mm)
4-405-60	OptiCentric® MOT 600/300 Dual Optical Head UltraStable® Max. sample diameter: 600mm Other features similar with 4-405-40

A range of fully automated **Cementing and Bonding Stations** are available. The process of inspection, alignment, bonding and curing is completely automated. In the Test Mode each function and device can be individually adjusted and optimized. After this, the process parameters are stored in a set up file and used for the subsequent production process. The software allows the input of tolerances and stops the process when the tolerances are exceeded. Please contact the TRIOPTICS representatives for more detailed information.