TRIOPTICS

TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

OptiSpheric®

The Industry's Standard for Lens Testing



OptiTest

OptiSpheric

OptiCentric

OptiAngle

OptiSpheric®
The Universal Test Station for Lenses and Optical Systems

OptiSpheric® is the Industry's Standard for Lens Testing and is used worldwide to completely measure and qualify optical components and systems. The world's largest laboratories and the major optical manufacturers are trusting to the TRIOPTICS's new generation of optical test equipment. There are many reasons for this confidence:

- highest accuracy and reliability
- accuracy directly traceable to international standards
- comprehensive, reliable software
- custom programming of test sequences
- vast range of applications
- ultra-accurate auto focus or precision mechanical focus stage
- multi-wavelength capabilities
- perfect in function and design

OptiSpheric® is a fully automated optical test station featuring rapid, ultra-accurate and objective performance characterization of a wide variety of optical components and lens systems.

Responding to customer requirements for increased speed and accuracy in measurement of optical parameters, **OptiSpheric®** provides dramatically increased overall accuracy and software control of the complete measuring procedure.



OptiSpheric® Auto Focus with accessories for measurement of Centration errors

All aspects of the data acquisition starting with the powerful Auto Focus system, data calculation, calibration and the display of the data are under software control and fully automated.

The operation is simple: once the test parameters for one lens are defined, these can be saved to a set up file and used for further measurements. The measured data are accurate and repeatable.

The software package provides menu-driven operator guidance and advanced data management. Flexibility and experiments in the test laboratories are ensured by the newest software feature including script tool for custom programming of test sequences

OptiSpheric® is the latest family member of the **OptiTest®** – the industry's most comprehensive equipment line for **Integrated Optical Testing**. It provides fast and reliable test results of almost all optical parameters:

- Effective Focal Length (EFL)
- Modulation Transfer Function (MTF)
- Back Focal Length (BFL)
- Radius of Curvature (R)
- Flange Focal Length (FFL)

OptiSpheric® is PC-controlled, modular and upgradeable. Extension modules include **multi-wave length test capabilities** and the measurement of:

- Plano Optics (wedges, plane-parallel plates, 90°-prisms, etc)
- Centration Errors in Transmission and Reflection
- Centration errors of aspheric lenses
- Thickness of lenses
- CD and DVD optics
- Wave Front

The measurement of plano optics can be easily achieved by simply adding some mechanical fixtures and a software module. In this way the wedge angle, mirror tilt angle, parallelism of windows, filters and plates and many other parameters of plano optics can be measured quickly and accurately.

With this vast range of applications, **Opti-Spheric®** shows where the manufacturing process needs improvement and becomes an indispensable tool for quality assurance in the optical shop or for the research work in the laboratory.



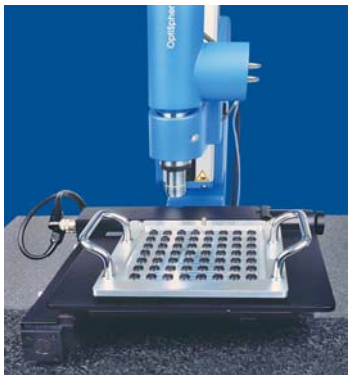
OptiSpheric® AF with large reticle changer for multi-wave length measurement



OptiSpheric® with mechanical focusing stage and accessories for Centration measurement

Set up

The **Measuring Head** is basically an optical sensor including an autocollimating device, a high resolution CCD-Camera and appropriate illuminated targets. The illumination unit behind the reticle is adapted to the reflecting properties of the sample. The high resolution CCD-camera is mounted so that the focal plane of the measuring head precisely corresponds with the CCD-camera chip. The CCD-camera is connected to a frame grabber mounted in the PC.



Mesuring Head with multi-lens sample holder

The **Stand** can be either a motorized stage featuring micro-step operation (OptiSpheric® Auto Focus) or a mechanical precision stage with two travel mechanisms: a coarse travel and a coaxial ultra-fine focusing mechanism (OptiSpheric®).

The ultra-fine mechanism is especially useful in applications where a smooth, precise motion of optical instruments or subsystems are required. The bottom body of the stand contains the collimator with manual or fully automated reticle changer and an adjustable mirror for beam deviation.

The **Collimator** is equipped with a rotateable reticle and filter changer. Depending on the measurement range and the spectral range required, the reticle changer can be equipped with 4, 6 or 10 reticles and a corresponding number of filters. The standard measuring wave length is 546nm. If multi-wave capabilities are required, the OptiSpheric® can be up graded to measure at several wave lengths in visible or near infrared range.
For fully automated operation TRIOPTICS developed a precision motorized reticle and filter changer. The selection and rotation into the working position of the most appropriate reticle or filter is software controlled.



Self-centering mount 5-75mm with X,Y-translation capabilities



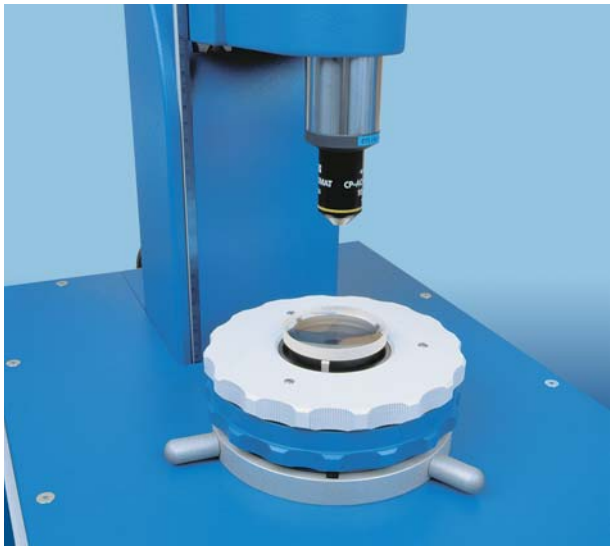
Self-centering mount 3-35mm with X,Y-translation capabilities

The **Sample Holder** is normally a self-centering mount with diameter range of 3-35mm or 5-75 mm. Both self-centering holders are equipped with accurate translation facilities in X, Y-directions. Depending on the configuration of the instrument and applications, further holders for diameters from 1mm to 200 mm can be supplied.



Collimator with automated reticle changer and controller

The measurement of high volume components (e.g. molded lenses, IOL's, micro lens arrays, etc.) in production environment requires a customized multi-lens sample holder (a multi-lens tray).



Precision rotary holder for Centration measurement



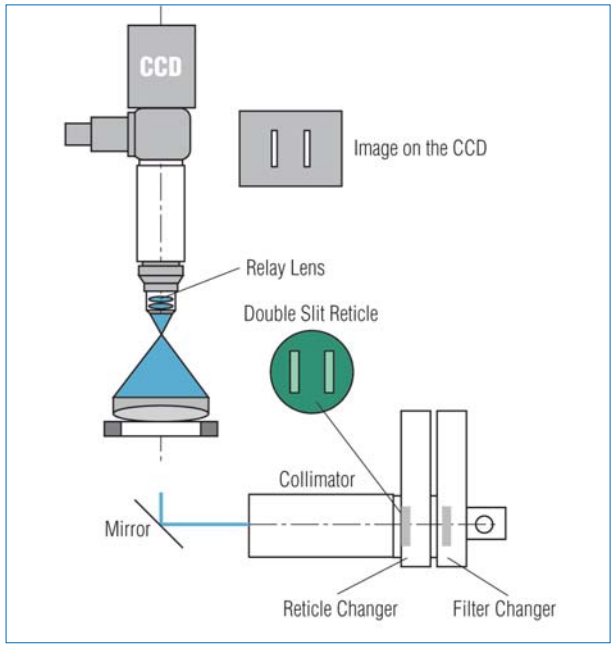
Vacuum Rotary Chuck for Centration measurement

For applications as measurement of centration errors the standard sample holders are replaced by high precision rotary holders or vacuum chucks. These special sample holders allow an accurate positioning and rotation of the samples and thus an ultra-accurate Centration errors measurement. For applications where the alignment and assembly of optical systems is important, a rotary air bearing stage is recommended.

Operating Principle

Effective Focal Length

A highly corrected collimator projects the image of a double slit to infinity. The parallel ray bundles enter the lens under test parallel to the optical axis and emerge from the lens as a convergent beam intersecting in the focal plane. The image of the double slit formed in the focal plane of the lens under test is collected by the head lens of the measuring head and focused on the high resolution CCD camera.The measuring head with the CCD camera can be accurately moved up and down using the travel mechanism of the stand or the auto focus stage until the image of the double slit is sharply seen on the monitor.



To determine the best focus, OptiSpheric®-Software uses powerful algorithms to calculate the best contrast or the MTF (based

on a requested spatial frequency or a bundle of spatial frequencies) and determines objectively (not operator dependent), accurately and with highest repeatability the position of the best focal plane.

The software controlled Auto Focus of OptiSpheric® allows reliable finding of the focal plane even when measuring samples with poor imaging quality. In the best focus position the size of the projected collimator target is precisely determined and thus the effective focal length (EFL) of the lens under test. OptiSpheric® is measuring the reticle image directly on the CCD-chip with sub pixel accuracy (1/30 pixel accuracy. This simply brings the measurement accuracy of a software controlled instrument in a different class: approx. 10 times higher compared with a visual instrument

When measuring negative focal length, the parallel beam emerging from the collimator enters the lens under test parallel to the optical axes and emerges from the lens as a divergent beam. In this case a virtual image is formed behind the lens under test. The head lens used in this case focuses in the virtual focal point of the lens under test. The head lens must have a a back focal length exceeding the EFL of the sample by 10-20mm.

OptiSpheric® is supplied with calibration files for any measurement and wave length range. Only Trioptics's instruments are calibrated using master samples certified by the International Standard Institutes (PTB-Germany, NPL-UK or NIST –USA). The accuracy specified for OptiSpheric is directly traceable to international standards.

MTF-Measurement

Modulation Transfer Function (MTF) is a parameter describing the performance of optical systems.

The resulting image produced by a lens or an optical system will be somewhat degraded due to aberrations and diffraction phenomena, in addition to the assembly and alignment errors in the optics. In the image, bright areas will not appear as bright as they do in the object, and dark or shadowed areas will not be as black as those observed in the original patterns.

The MTF is describing the ability of on optical system to transfer the details of an object to the image and has the value 1 for a theoretically perfect optical system and the value 0 for a system being unable to produce an image.

The set up for MTF measurement includes the standard optical head equipped with a high resolution relay lens. Narrow bandwidth interference filters (e.g. 546.1nm) are mounted into the filter changer of the collimator.

OptiSpheric® can be customized to measure the MTF at different wavelengths. Instruments versions measuring MTF over the visible or near-infrared spectral range are available.

The basic measurement procedure for MTF-calculation is based on the analysis of the image of a slit target. The MTF calculated from the slit evaluation is very accurate and should be used to analyze the lens performance.

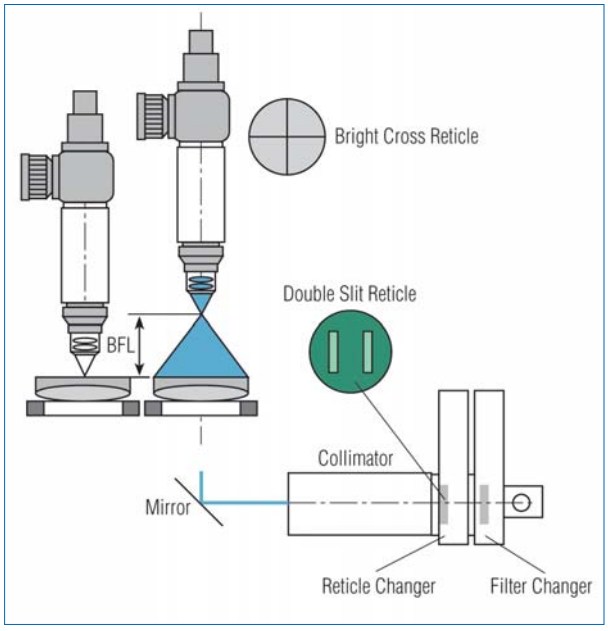
Further measurement procedures are based on the evaluation of special patterns with proprietary design developed by TRIOPTICS. The advantage is simultaneous measurement of MTF in tangential and saggital direction and –if requested- the simultaneous measurement of EFL and MTF. In this way **OptiSpheric®** provides consistent accuracy at an unmatched speed of measurement. The measurement becomes very cost effective and affordable for production quantities.

The measuring process normally includes a collimator projecting a target with a suitable pattern. The sample under test collects the target and transfers it in its own image plane. A high performance relay lens picks up this image and focuses on to the high resolution CCD-camera chip. The intensity profile of the target is scanned electronically in both the radial and tangential direction. The data is collected and, by using Fourier Transform techniques, the MTF is calculated and displayed on the PC-monitor in real-time.
The software calculates and displays the MTF value at selected spatial frequencies, the theoretical MTF-graph and the effective MTF-graph

Back Focal Length

The Back Focal Length (BFL) is the distance from the lens vertex to the rear (back) focal point of the lens.
To measure the BFL, in a first step the Measuring Head equipped with micro-objectives or achromats is focused on the **vertex of the lens** (sample) surface. Two procedures can be employed to determine the position of the lens vertex:

- either the illuminated reticle of the measuring head (bright cross, Siemens Star, etc) is projected on the lens vertex, reflected back and focused on the CCD-camera
- or the measuring head - used as a telescope- is directly viewing the lens vertex (or a mark, dust, etc. existing on the lens surface) via relay lens and CCD-camera



In both cases the measuring head is finely focused until the image reflected by the lens vertex (or the vertex itself) is sharply seen on the PC-monitor.

In a second step the accurate finding of the **focal plane** position of the lens (sample) is accomplished: the collimator projects the image of its reticle over the lens under test. The lens under test focuses the reticle image in its focal plane. The measuring head with the head lenses picks up this image and focuses it on CCD-Chip.



OptiSpheric® with Digital Linear Scale

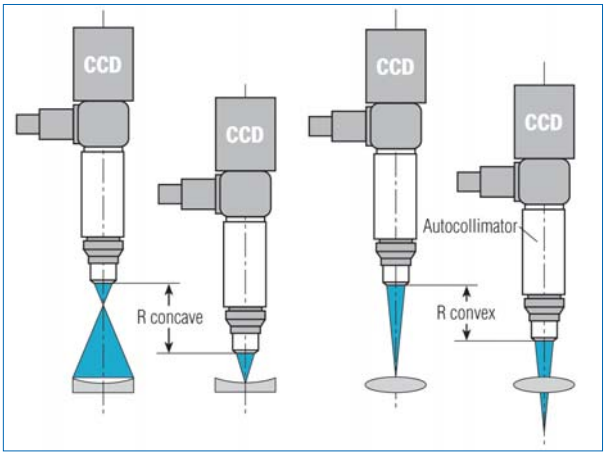
The measuring head is finely moved up or down until the image of the collimator reticle is sharply focused on the CCD-chip.
The best focus positions for the **lens vertex** and the lens **focal plane** are normally found using the Auto Focus feature of the **OptiSpheric®**.

In case of the instruments equipped with manual focusing, a software feature displaying the contrast as a colored plot is assisting the operator.

The BFL is determined as the distance between the surface vertex (step 1) and the lens focal plane (step 2). This distance can be measured in different ways: directly with the Auto Focus device or by means of a **linear encoder** or **digital linear scale** which is attached to the focusing stage or travel mechanism of the measuring head.

Radius of curvature

The measurement of radii of curvature is similar with the BFL measurement. Focusing is now performed on the lens vertex and in the center of curvature. The distance is measured in the same way as the BFL.
The best focus positions for lens vertex and center of curvature are normally found using the Auto Focus feature of the OptiSpheric®. In case of the instruments equipped with manual focusing, a software feature displaying the contrast as a colored plot is assisting the operator.



Manual focusing or Auto Focus

The OptiSpheric® stepper motor stages operated in Micro Step mode feature high resolution in sub micrometer range and speed in operation. In combination with the powerful Auto Focus feature the stepper motor stages provide ultra-accurate positioning and easy operation. The software controlled measuring procedure and the Auto Focus system will significantly reduce the dependence on the qualification or tiredness of the operator.



OptiSpheric®
with Auto Focus stage

When testing optics in large quantities or with highest accuracy the use of the Auto Focus is indispensable.
Combined with the software package featuring measurement certificate, storage of measurement data and statistical evaluation the AutoFocus optical station fulfills the requirements of modern optical testing and of ISO 9000.
The Auto Focus driven measuring procedure provides not only more reliable but also more accurate measurement data.



OptiSpheric® with manual focusing stage

However, when measuring small quantities of optics and flexibility is an important requirement, the use of the Manual Stand of OptiSpheric® becomes justifiable.

The OptiSpheric® Stand with the fast rack and pinion mechanism and the coaxial ultra-fine focu-

sing mechanism responds optimally to the basic requirements of optical measurement: quick positioning of the measuring head for efficient testing work and smooth focusing.

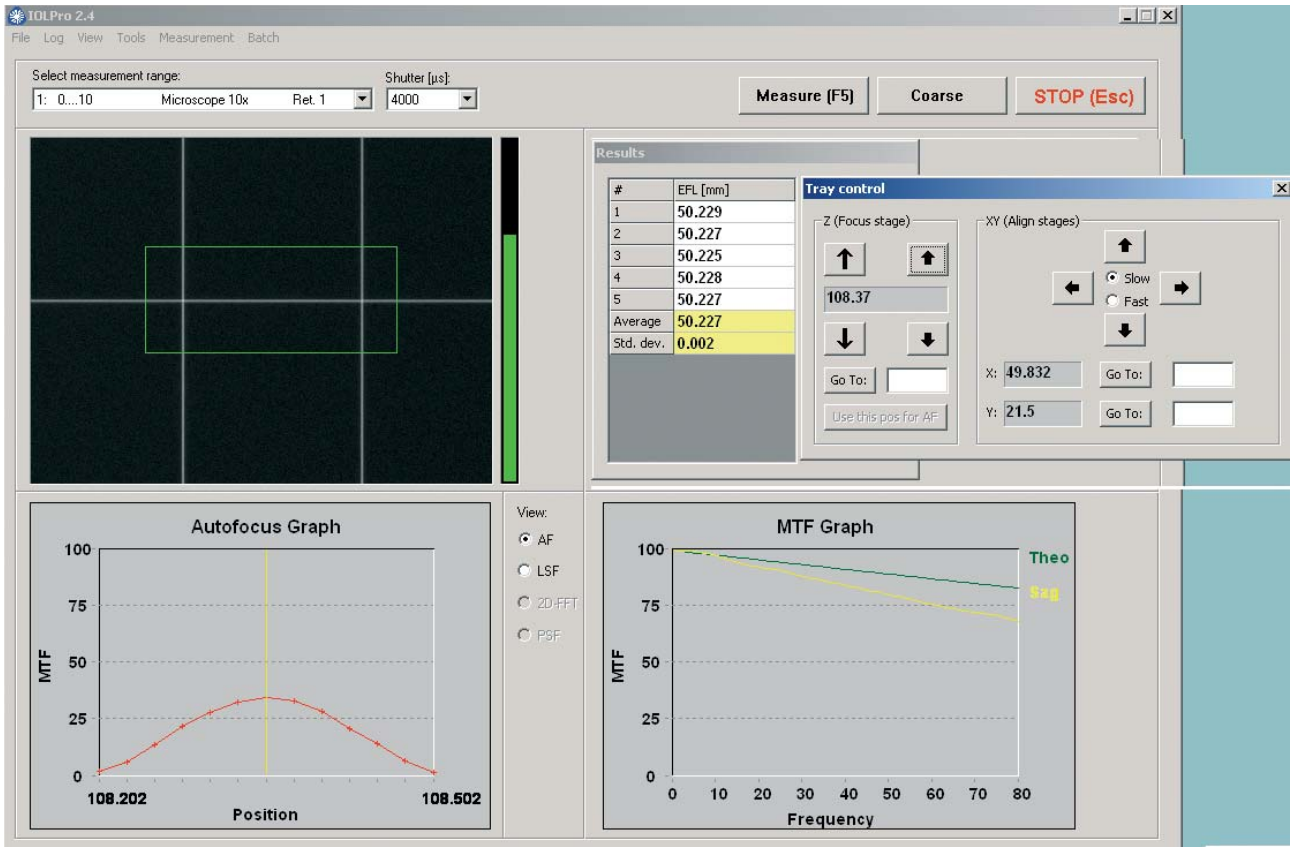
However, the accuracy of the manual OptiSpheric® is lower than of OptiSpheric® Auto Focus and the operator's influence on the measurement results is considerably higher.

Software

The advanced software is designed to work under Windows operating systems and fulfils the need of the optical shop for easy, intuitive operation. It offers a high level of speed and accuracy and provides consistent, reliable results.

The software module of OptiSpheric® is part of the TRIOPTICS's concept of **Integrated Optical Testing**. Any need for additional measurement capabilities can be simply fulfilled by enabling software features from related products (e.g. OptiAngle® for angle measurements, OptiCentric® for measurement of Centration errors, etc.). This modular approach enables OptiSpheric® to be configured or upgraded according to the operator's requirements.

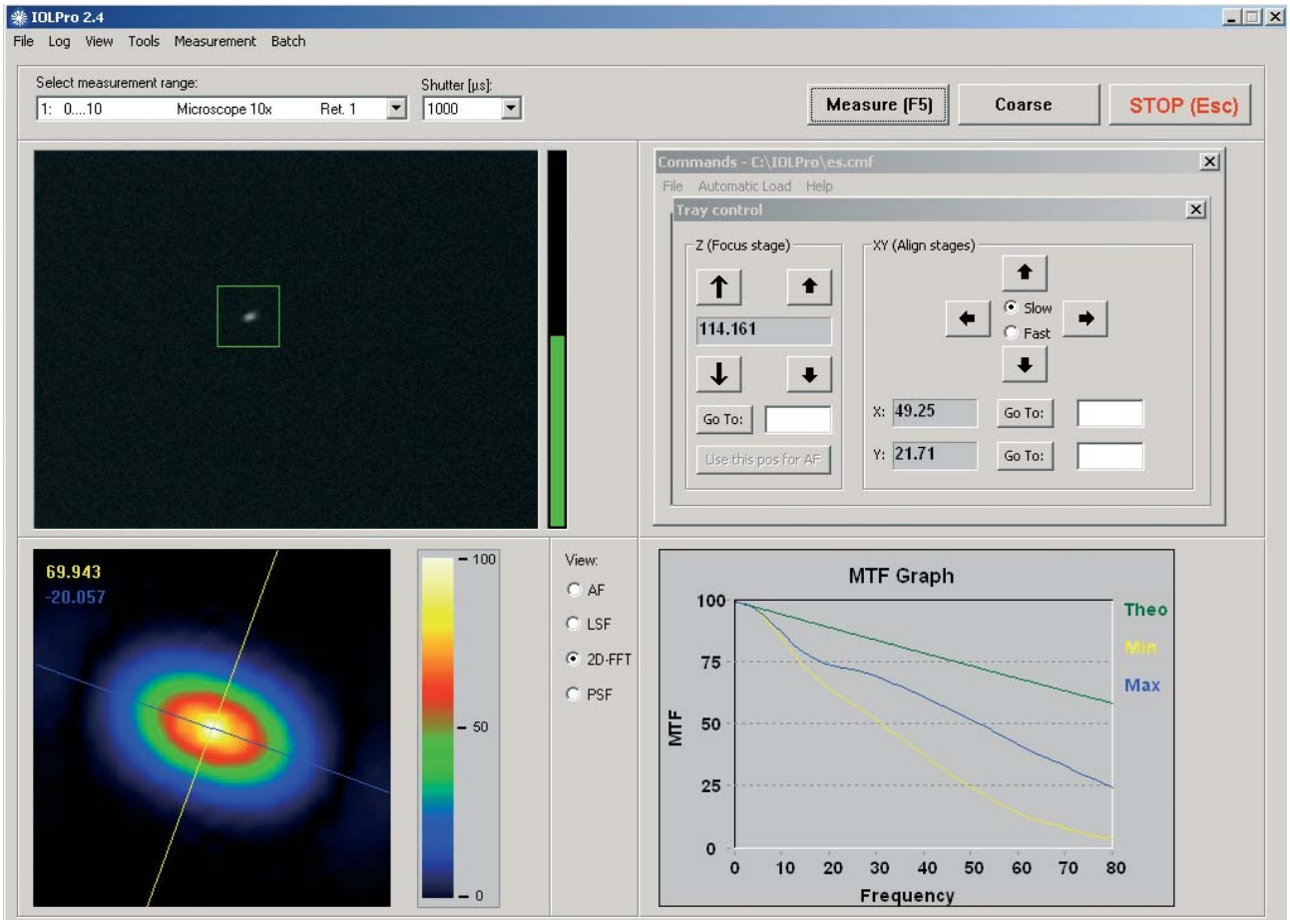
Based on the long tradition and experience of TRIOPTICS in developing world class optical instruments the new software package provides Auto Focus, Through Focus Scan, Set up files, user and supervisor access to set up files, Pass or Fail features, storage of lens and batch data, data analysis with Excel etc. Newest feature includes script tool for custom programming of test sequences. Measurement certificate, storage of measurement data, statistical evaluation are since long standard features of our software.



Simultaneous EFL and MTF Measurement

OptiSpheric®-Software provides unique features in order to optimize the measurement process:

- Simultaneous measurement of the EFL and MTF using special target pattern and specific software calculation
- Alternative MTF measurement using a slit or a pinhole as a target. While the slit based MTF measurement is accurate, it shows the optical performance in one azimuth only. The pinhole based MTF measurement provides information over the full lens aperture and is ideal for real time alignment during assembly of objective lenses.
- Automated selection and positioning of the suitable reticle (target) for the current application
- Set up files with the optimized process parameters with password protected access for operator and supervisor
- Script tools for custom programming and analysis –ideal for R&D laboratories
- Transfer of the main functions to a dedicated keyboard, so that even unskilled operators can provide reliable measurement results in production environment
- Extensive data processing with MS EXCEL



Pinhole based MTF Measurement

Responding to the requirements for full automation of the measurement process, TRIOPTICS has developed a special software module–**OptiSpheric Pro**-enabling measurement of production quantities with automated tray system.

After loading the lens tray, just a mouse click is necessary in order to start and complete a lens batch measurement.

The OptiSpheric can be configured to measure the MTF in sagittal and tangential direction or to perform tests over the full lens aperture (using pinhole target). The spatial frequencies of interest can be selected prior to measurement. The real time measurement results can be compared with the calculated theoretical MTF values or with optical design files.

Extending the measuring capabilities

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 OptiSpheric 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

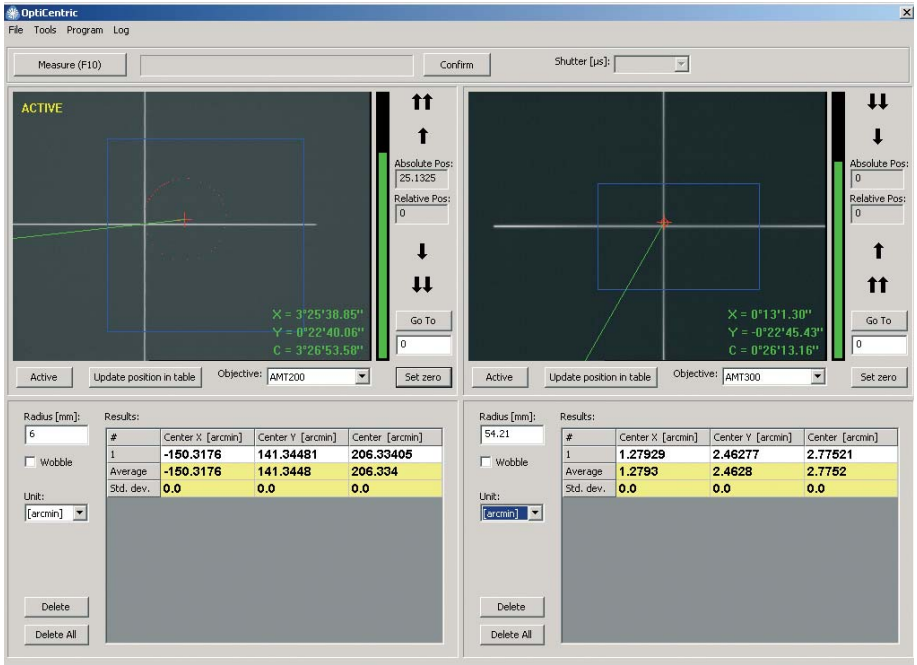
The angle measurements of plano optics are made directly with the autocollimator of the measuring head (without additional head lenses). Extension for measurement of plano optics includes:

- Software module **Angle 1**
- Mechanical fixtures : three-ball supports of different diameters, prism fixtures, etc. (to be mounted on the instrument tilt table).

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

Measurement of centering errors

The OptiSpheric® performance can be further increased by adding software modules and accessories from OptiCentric® (another subsystems of OptiTest). Applications include measurement of centering errors in transmission and reflection. Using appropriate accessories even the alignment or cementing of optics can be carried out. With this extension of the measuring capabilities the OptiSpheric® becomes a valuable and indispensable quality tool for any optical shop or laboratory.



Simultaneous measurement of two lens surfaces

OptiSpheric®/OptiCentric®: This powerful combination features full capabilities for measurement of almost optical parameters and and for measurement of Centration errors, alignment, cementing and assembly of optical systems. In addition to the standard OptiSpheric®/OptiCentric® instrument line, a lot of outstanding hardware and software system components can be selected:

- **OptiSpheric®/OptiCentric® Dual Measuring Head**-for simultaneous measure ment of bottom and upper lens surfaces
- **MultiLens** Software Package-for automated checking of Centration errors of lenses in mounted condition with large number of elements
- **SmartAlign** Software Package for easy and errorless alignment of objective lenses before cementing

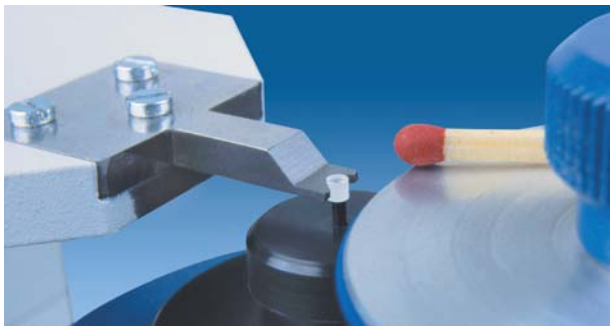


OptiSpheric® /OptiCentric®
Dual Measuring Head

A large range of accessories for accurate and efficient measurement of centering errors are available:

- precision rotary holders
- lens rotation devices with vacuum
- tilt and translation precision tables
- ultra precision air bearing tables, etc.

Illumination devices have been specifically designed to provide reliable results even in difficult applications as surfaces with AR-coating.



Vacuum Chuck for very small lenses

The software module provides fast and accurate results, shows the size and direction of the decentration and evaluates even extremely weak and blurred images.

Multi-Wavelength measurement capabilities

To respond to industry requirements for providing measurement capabilities at different wavelengths, TRIOPTICS developed the OptiSpheric® Multi-Wave able to measure almost of the optical parameters at different wavelengths. Normally several wavelengths in visible spectral range are offered, e.g. 400nm, 546nm, 650nm and



OptiSpheric Multi-Wave with special reticle changer and multiple relay lens

780nm. On request measurement capabilities in near-infrared (NIR) or ultra violet(UV) spectral range are provided.

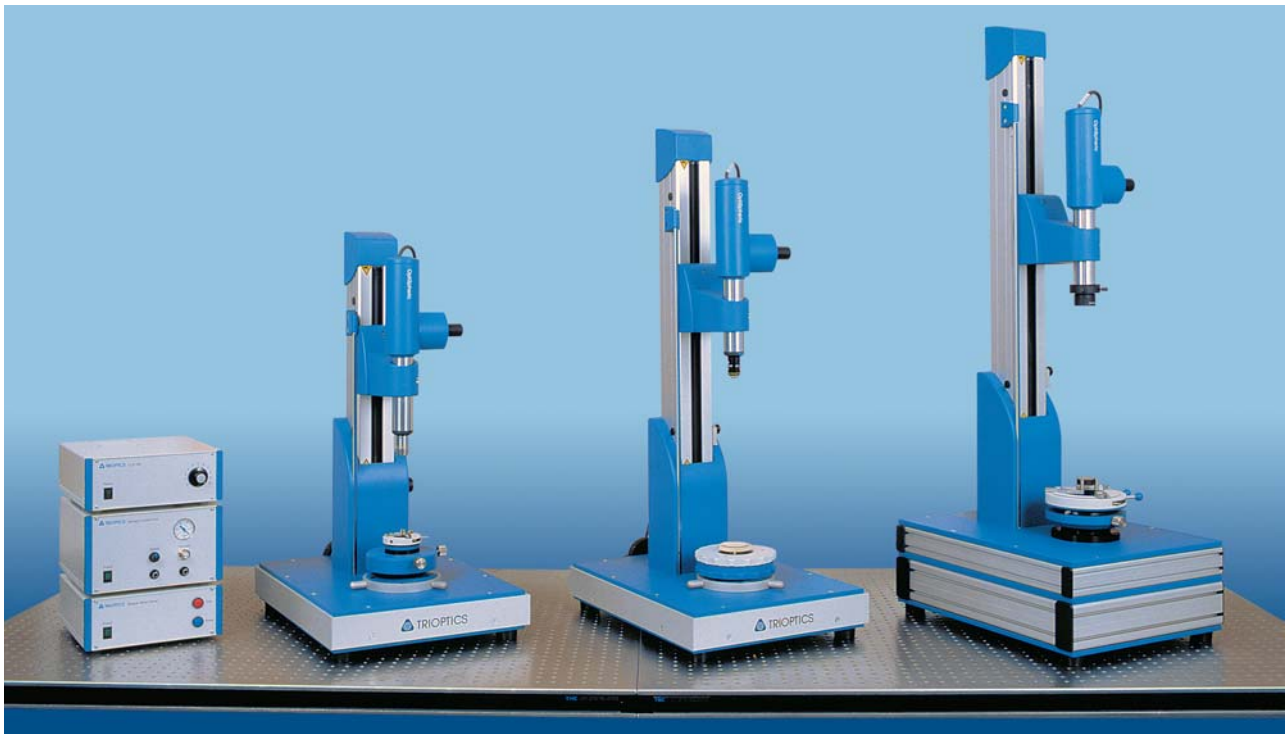
The multi-wavelength capabilities require a complex instrument design, a specific adjustment of the instrument and an individual matching of all instrument components to the wavelengths requested. Unlike other suppliers TRIOPTICS is providing a real multi-wavelength design and is offering **real multi-wavelength measuring capabilities:**

- Special CCD-Cameras, enhanced for the intended spectral range, provide optimal measurement capabilities

Finally an individual calibration for each wavelength and each measurement range is performed and certified.

Leadership in optical testing

The TRIOPTICS leadership in optical testing is the result of the unprecedented co operation with our customers. The multitude



A few product versions of OptiSpheric® family

- A special collimator is adjusted such that the reticle for a certain wavelength is accurately set at the BFL corresponding to the wavelength
- Narrow interference filters are used to precisely select the required wave length
- The relay lens of the measuring head is selected to optimally cover the wave length range requested. NIR or UV corrected rely lenses are used for regions of the spectral range outside the visible range

of OptiSpheric® product versions illustrates the level of understanding of customer needs.

Let's take the range of focal lengths: from the standard OptiSpheric® covering a EFL range up to 250mm to the OptiSpheric® 2000 covering a measurement range up to 2000mm, our customers can select from the broad OptiSpheric® family further intermediate product versions in order to optimally meet their specific requirements.



OptiSpheric Autotray for production testing

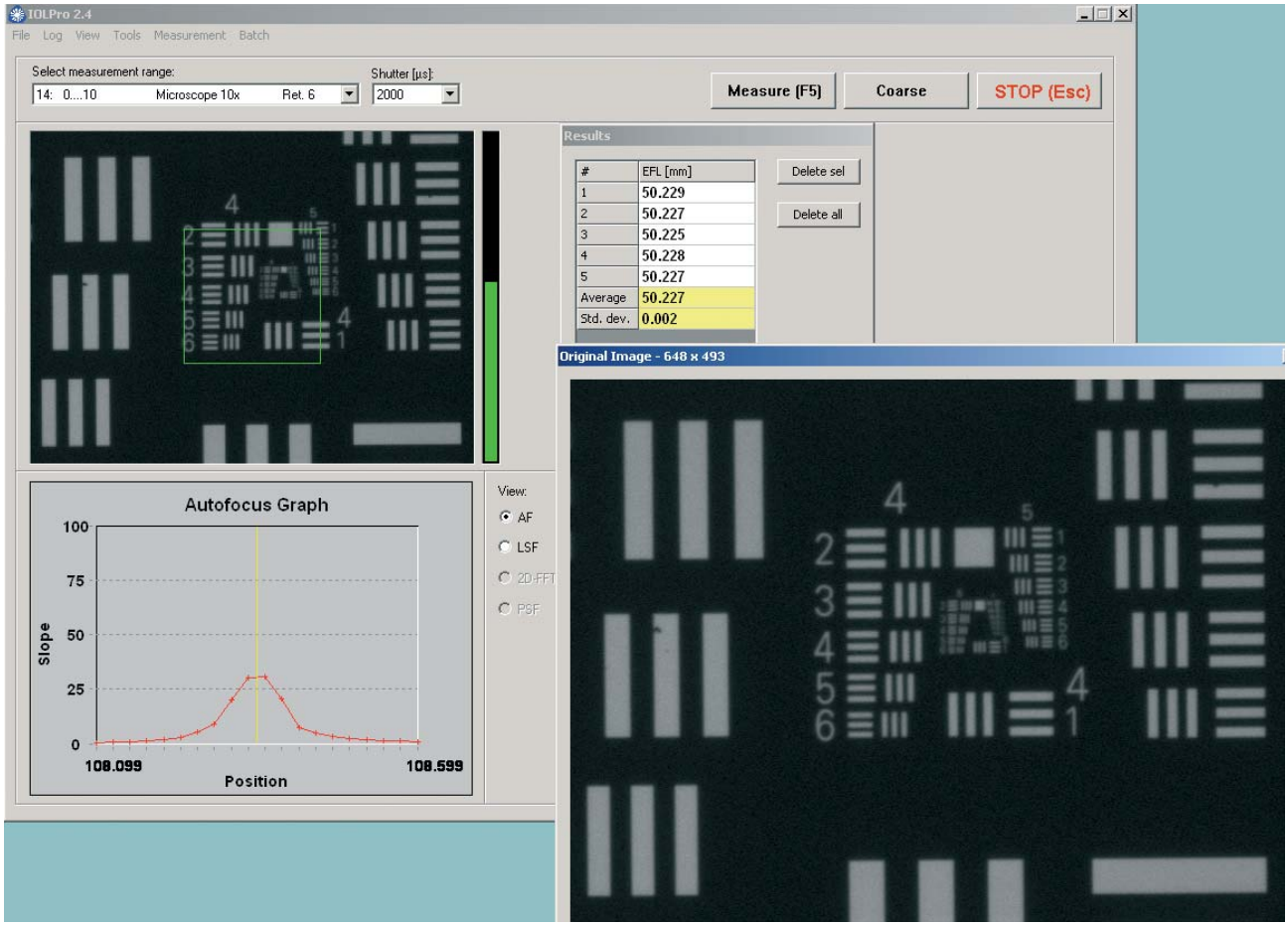
Let's think of applications:
Due to the modular design of the instrument, new options and software modules can be easily added to further increase the measuring capabilities of the instrument. Measurement of plano optics and Centration errors has been mentioned before.
However more and new applications are continuously added to the OptiSpheric® system:

- Checking the centration errors of molded aspheric lenses
- Measurement of lens distances in objective lenses
- Measurement of Centre thickness of lenses
- Complete characterisation of IOL's

To respond to customer needs for testing of large quantities of lenses in production environment, TRIOPTICS developed an OptiSpheric® station working with an automated tray system and fully automated measuring procedure.

Once a lens tray with 30 to 60 lens seats is kinematically placed on an open frame with two translation precision stages, the **OptiSpheric® PRO software** positions each lens on the optical axis of the instruments, performs an accurate focusing, calculates and displays the measurement data and produces on request a Pass/Fail result.

Applications include the production testing of intraocular lenses (IOL), micro lens arrays, small molded aspheric lenses, etc.



IOL Measurement –EFL, MTF, Resolution Efficiency

ORDERING INFORMATION

	OptiSpheric	OptiSpheric L	OptiSpheric Autofocus	OptiSpheric L Autofocus
BASIC INSTRUMENT Optical Test Station for measuring parameters of **lenses** and **lens systems: EFL, BFL, FFL, MTF, Radius and Centering Errors:**	**4-600-00**	**4-603-00**	**4-650-00**	**4-653-00**
• Stand with autocollimator fixture, coarse travel mechanism (250/400mm) and coaxial ultra-fine focusing mechanism, sensitivity better 5µm.	●	●		
• Stand with linear stage with stepper motor, stepper motor controller, travel 250/450 mm			●	●
• 45°-mirror for beam deflection mounted in stand base	●	●	●	●
• Measuring Head with electronic autocollimator equipped with high resolution 1/2" CCD-Camera with mains supply	●	●	●	●
• X, Y-translation stage for additional head lenses	●	●	●	●
• Collimator with Reticle Changer featuring reticles for measurement of EFL, MTF, optical image quality and centration errors	●	●	●	●
• Illumination adapter with interference filter 546.1nm	●	●	●	●
• Self centering sample holder diam. 3...35 mm with conical interface for quick mounting	●	●	●	●
• Tilt table D 100mm with central hole D 20mm	●	●	●	●
• Additional head lenses incl. achromats in mount AMT 50-38, AMT100-38, AMT 150-38, AMT 200-38, AMT-300-38, microobjective 3.2X with adapter and high performance microobjective (5X or 10X) for MTF-Measurement	●	●	●	●
• Cold-light-illumination 150 W with fiber optic flexible cable 1 m length	●	●	●	●
• Software Kit Spheric 1 for: EFL-Measurement, MTF-Measurement, Radius and BFL-Measurement (manual focusing)	●	●		
• Software Kit Spheric 2 for: EFL-Measurement, MTF-Measurement Radius and BFL-Measurement (Auto Focus)			●	●
• Frame Grabber Board	●	●	●	●
• LCD-01-Position measuring device mounted on stand incl. LCD linear slide, 300/450 mm, resolution 0.01mm	**4-300-110**	**4-300-112**		
• Option for Very Small Focal Length (approx. 1mm) includes a x, y-translation stage for the sample holder, sample holder for small samples and software module.	**4-600-015**			
• Self-Centering Holder SCH 75, Dia. 5-75mm with conical interface for quick mounting	**4-600-018**			
• Complete calibration device incl. calibration wedge, both sides better 5, with calibration certificate, accuracy +/-1arcsec, mounted in two tilt axes adjustable mount with rotation facilities	**4-300-051**			
• Software Kit Angle 1 for measurement of wedges, deflection angles, plan-parallel plates, tilt of mirrors, 90°-prisms, roof prisms, wobble	**4-600-240**			

Accessories for centering errors measurement: see **OptiCentric** – Accessories for plano optics measurement: see **OptiAngle**

OptiSpheric System

In addition to the basic instruments the OptiSpheric family offers a wide range of product versions covering any conceivable applications and any measuring range. The system is modular and upgradeable offering a high level of customization. The customer receives a system-not only for the immediate need but for the future one too. Some of the most popular product versions are listed below:

Produc-No.	Product Name	Short Description
4-650-01	OptiSpheric Auto Focus 250 RC	Fully automated Optical Test Station with software controlled motorized 6 positions Reticle Changer. Fully automated measurement process. Further features as 4-650-00
4-653-01	OptiSpheric Auto Focus 450 RC	Fully automated Optical Test Station with software controlled motorized 6 positions Reticle Changer. Vertical travel: 450mm. Fully automated measurement process. Further features as 4-653-00
4-653-12	OptiSpheric Auto Focus 1000	Instrument specially designed for large optics with longer focal lengths
4-660-00	OptiSpheric AutoTray SA	Stand Alone Optical Test Station with automated tray system for ultra-fast measurement of high volume components in production environment.
4-660-01	OptiSpheric AutoTray TT	Table Top Optical Test Station with automated tray system for ultra-fast measurement of high volume components in production environment
4-655-00	OptiSpheric/ OptiCentric Dual Head	Combined Optical Test Station with two optical heads for measurement of optical parameters and Centration errors, for alignment and assembly of optical systems
4-650-12	OptiSpheric IOL	Instrument specially designed for measurement of intraocular lenses (IOL)
4-660-12	OptiSpheric IOL AutoTray TT	Table Top instrument for IOL measurement with automated tray system. Ultra-fast measurement of high volume components in production environment
4-660-15	OptiSpheric IOL AutoTray SA	Stand Alone instrument for IOL measurement with automated tray system. Ultra-fast measurement of high volume components in production environment
4-600-15	OptiSpheric Visual	Visual Test Station for measurement of EFL, BFL, Radius, Angle, Centration errors
4-600-20	OptiSpheric Visual LR	Visual Horizontal Bench for measurement of long focal lengths in the range from 450mm to 1200mm
4-653-20	OptiSpheric AutoFocus LR	Instrument designed for testing very large optics with diameter up to 300mm and focal length up to 2000mm

TRIOPTICS's instrument line is continuously developed to cover new applications or in order to integrate the latest developments in optical testing and image processing. Just send us your measurement problem, we can select the suitable solution from hundreds of standard systems, components and accessories. Or we can use our previous custom work in order to offer you a comprehensive and affordable test station.

Technical Data

Instrument	Lens Diameter	Measuring Range		
		EFL	BFL and Radius	MTF
OptiSpheric® Manual Focusing, automated measurement	3-35 (75) mm	+3...+250 mm -3... -250 mm	±3...± 250mm	absolute MTF-Test: 5...75 mm EFL relative MTF-Test : 5-250 mm EFL
OptiSpheric® L Long Focusing stage	1-35 (75/150) mm	+3...+500 mm -3... -500 mm	±3...± 400mm	absolute MTF-Test: 5...75 mm EFL relative MTF-Test : 5-500 mm EFL
OptiSpheric® **Auto Focus 250** Auto Focus, automated measurement	3-35 (75) mm	+3...+250 mm - 3...- 250 mm	±3...± 200mm	absolute MTF-Test: 5...75 mm EFL relative MTF-Test : 5-250 mm
OptiSpheric® **Auto Focus 350** Auto Focus, automated measurement	3-35(75/100) mm	+3...+350 mm -3...-350 mm	±3...± 300mm	absolute MTF-Test: 5...75 mm EFL relative MTF-Test : 5-350 mm
OptiSpheric® **Auto Focus 450** Auto Focus, automated measurement	5-35(75/150) mm	+5...+450 mm - 5...- 450 mm	± 3...± 400mm	absolute MTF-Test: 5...100 mm EFL relative MTF-Test : 5-450 mm
OptiSpheric® **Auto Focus 1000** Auto Focus, automated measurement	5-35(75/200) mm	+5...+1000 mm -5...-1000 mm	± 5...± 500mm	absolute MTF-Test: 5...150 mm EFL relative MTF-Test : 5-1000 mm
OptiSpheric® **Auto Focus 1500** Auto Focus, automated measurement	5-35(75/200) mm	+5...+1500 mm -5...-1200 mm	± 5...± 750mm	absolute MTF-Test: 5...500 mm EFL relative MTF-Test : 5-1200 mm

System Performance	EFL	
Resolution:	0.03...0.2%	
Measurement Accuracy	5...25 mm: 0.1%.....0.3% 25 500 mm: 0.03%...0.1% 500...1000 mm: 0.05%...0.3%	
Measurement Time	Manual focusing: 3-20 sec. Measurement time: mouse click	AutoFocus: First measurement: 5-8 sec. Next measurements: 3-5 sec.
	MTF	
Test mode	manual focusing, automatic measurement	focusing+measurement: automatic, on-axis
Wavelength range	400-1000nm	
Spatial frequency:	0-500 lp/mm-higher frequencies available on request	
MTF-Measurement / Slit evaluation • Repeatability • Accuracy	 1% 2%	
	BFL, FFL and Radius of curvature	
Repeatability:	0.02 to 0.2%	
Accuracy:	0.03 to 0.3%	
	Centration Errors	
Repeatability:	± 0.1µm or ± 1 arcsec	
Accuracy:	± 0.2µm or ± 2 arcsec	
Measurement Time:	3-15 sec	
Measurement range:	± 1...± 2000mm	
	Angle Measurement	
Resolution:	0.01 arcsec	
Repeatability:	0.2 arcsec	
Accuracy:	1 arcsec	

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