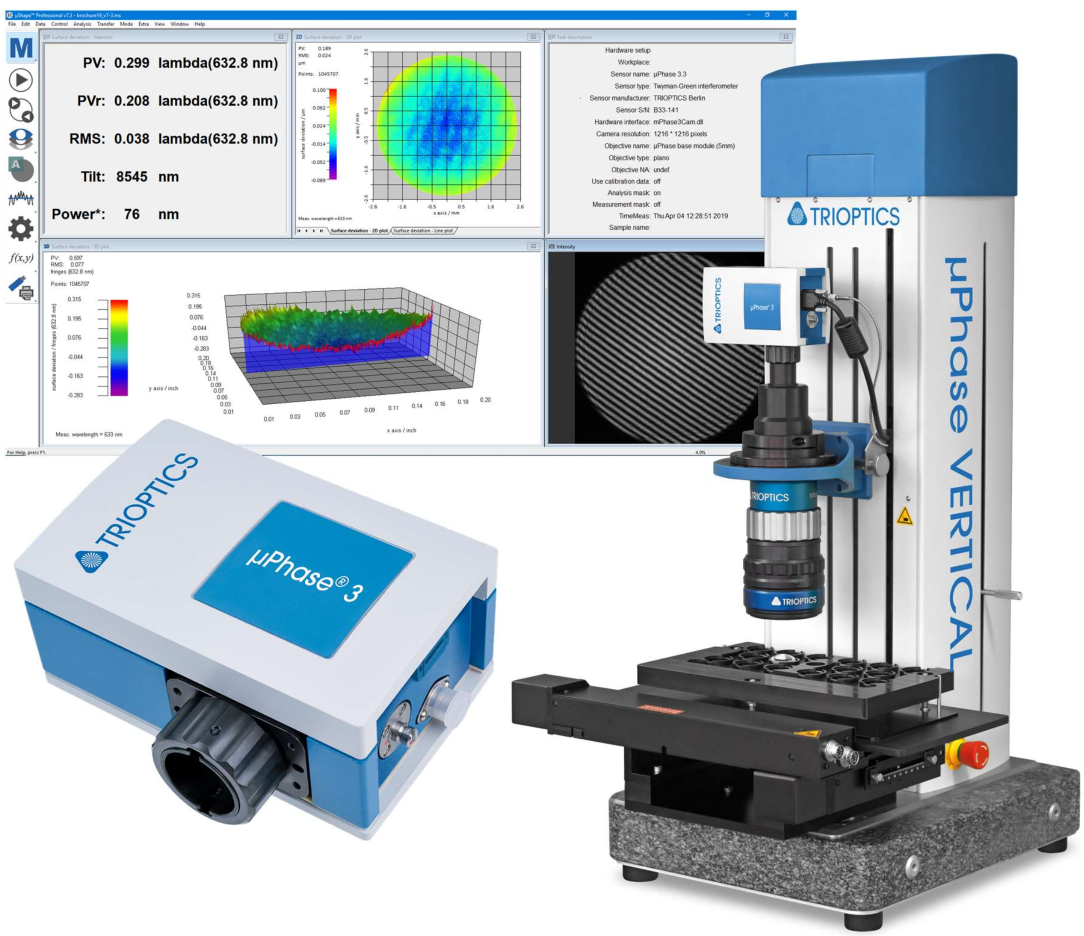
TRIOPTICS

TRIOPTICS BERLIN GMBH

µPhase® & µShape™

Compact and modular Interferometers



µPhase® Interferometers

Measure with Highest Precision

µPhase® interferometers offer objective and precise measurement results of surface and wavefront measurements - quickly and reliably.

µPhase® interferometers are compact, small and lightweight digital tools which can be used in almost any working environment. These measuring devices are perfectly complemented by the µShape™ measurement and analysis software to fulfill the highest expectations of quality management.

Measuring without Leaving Marks Behind

The µPhase® Interferometer systems are used for measuring high precision optical components made of glass, plastic, metal, ceramic and similar. The non-contact measurement method prevents damage to the sample under test and gives the most exact evaluation of the entire surface or wavefront.

Strong Arguments for µPhase® Line of Interferometers

- Compact size and modularity enable adaptation to a variety of production and working environments
- Objective digital measurement prevents human errors
- Well-structured and comprehensive software supports both production and lab use

Modular System Providing Stand Alone Interferometers and Turnkey Solutions

TRIOPTICS offers µPhase® interferometers as self-contained modular parts as well as pre-defined turnkey solutions.

µPhase® customers especially appreciate the space saving and modular concept of the µPhase® product line which allows the cost-effective utilization of the instruments.

Different sample examples: molding tool, IOL, ceramic seal surface, Zerodur sphere μShape™ Interferometer-Software

μPhase® Sensors

μPhase® 3.1	μPhase® 3.2	μPhase® 3.3

μPhase® Turnkey Solution (Sensor + Stand + Software)

PLANO DOWN	PLANO UP SPHERO UP	VERTICAL + Tray	UNIVERSAL	ST + R

μLens PLANO and SPHERO Objectives

The different parts of the μPhase® interferometer line are all compatible and form powerful measurement devices.

μPhase® 3 Sensors

Most Flexible Interferometer Sensors

These highly integrated phase-shifting Twyman-Green interferometer sensors meet the toughest demands for modern quality management. In combination with the measuring and analysis software μShape™ this high-performance precision measuring instrument provides information about the specimen's surface, wavefront or test objective aberration.

Advantages of μPhase® Sensors

- Compact size and modularity enable adaptation to different production and working environments
- Simple and fast adoption to different reflectivities for optimal image contrast adjustment
- Wide field of view alignment mode: Simple and fast alignment of the sample due to a second camera for alignment purposes
- High resolution cameras: 1200x1200 pixels and 600x600 pixels (μPhase® 3.1)
- Object plane focusing ability (μPhase® 3.3 only)
- High flexibility: Useable in any orientation and different stands

μPhase® 3

- Measurement accuracy traceable to international standards
- Standard measuring wavelength 632.8 nm; customized versions measuring at wavelengths from 355 nm to 1064 are also available upon request
- Robust, dust-proof housing

µLens Objectives

The µLens PLANO collimated test objectives and the µLens SPHERO spherical objectives complement the µPhase® interferometry systems and increase the flexibility and modularity of the complete system.
The µLens PLANO objectives allow for measurements of flat surfaces or optical systems in transmission from 2 mm upto 150 mm in diameter. The spherical test objectives range µLens SPHERO enable to test spherical and weak aspherical surfaces, as well as optical systems in transmission. Measurable sample radius (convex and concave) and diameter depend on the specific test lens.

The 100 mm PLANO objectives also allow to attach common Fizeau objectives (Fizeau lenses).

Further Advantages:

- Existing µPhase® systems can be expanded easily and at low cost thanks to the modularity and compatibility of the objective design
- Testing of small samples with radii under 1mm is possible
- High measuring precision through minimum wavefront aberration of the µPhase® and µLens objectives
- Field of view correction allows high measurement safety and interferometry with high fringe densities

µLens objectives

µLens PLANO overview

µLens PLANO	Numerical Aperture [mm]	Sample diameter [mm]
µLens PLANO 2	2	0.2 - 2
µPhase® base module	5	1 - 5
µLens PLANO 10	10	2 - 10
µLens PLANO 50	50	10 - 50
µLens PLANO 100	100	20 - 100
µLens PLANO 150	150	30 - 150

µLens SPHERO overview

µLens SPHERO objectives based on µLens PLANO 10

Description	f-number	NA	α [°]
µLens SPHERO 10 f/0.7	0.7	0.71	90
µLens SPHERO 10 f/1	1	0.50	60
µLens SPHERO 10 f/1.5	1,5	0,34	40
µLens SPHERO 10 f/3	3.0	0.17	19
µLens SPHERO 10 f/5.2	5.2	0.10	11
µLens SPHERO 10 f/7.6	7.6	0,07	4
µLens SPHERO 10 f/12	12	0,04	2

µLens SPHERO objectives based on µLens PLANO 50

Description	f-number	NA	α [°]
µLens SPHERO 50 f/0.7	0.7	0.71	90°
µLens SPHERO 50 f/1.0	1	0.56	60°
µLens SPHERO 50 f/1.5	1.5	0.34	40°
µLens SPHERO 50 f/2.4	2.4	0.21	24°
µLens SPHERO 50 f/4.2	4.2	0.12	14°

Information about objectives for the combination with µLens PLANO 100 and 150 on request.

µPhase® Turnkey Solutions

	Standard ■ Optionally □	PLANO Down	PLANO UP	SPHERO UP
1	Testing of flat surfaces	■	■	■
2	Testing of spherical surfaces			■
3	Testing of aspheric, toric or cylindrical surfaces			
4	Testing of wavefronts in transmission	□		
5	Radius measurement			relative
6	Low vibration sensitivity	■	■	■
7	Production use	■	■	■
8	Quality management use	■	■	■
9	R&D department use			
10	Measurement setup	vertically	vertically	vertically
11	Modular / upgradeability	□	□	□
12	Stage	table-top	table-top	table-top
	Special Features			
13	Stand-alone setup (no optical table needed)	□	■	■
14	radius/position measurement			
15	Usage of CGHs for aspheres, cylinders, torics			
16	Second movable platform			
17	Tray measurement			

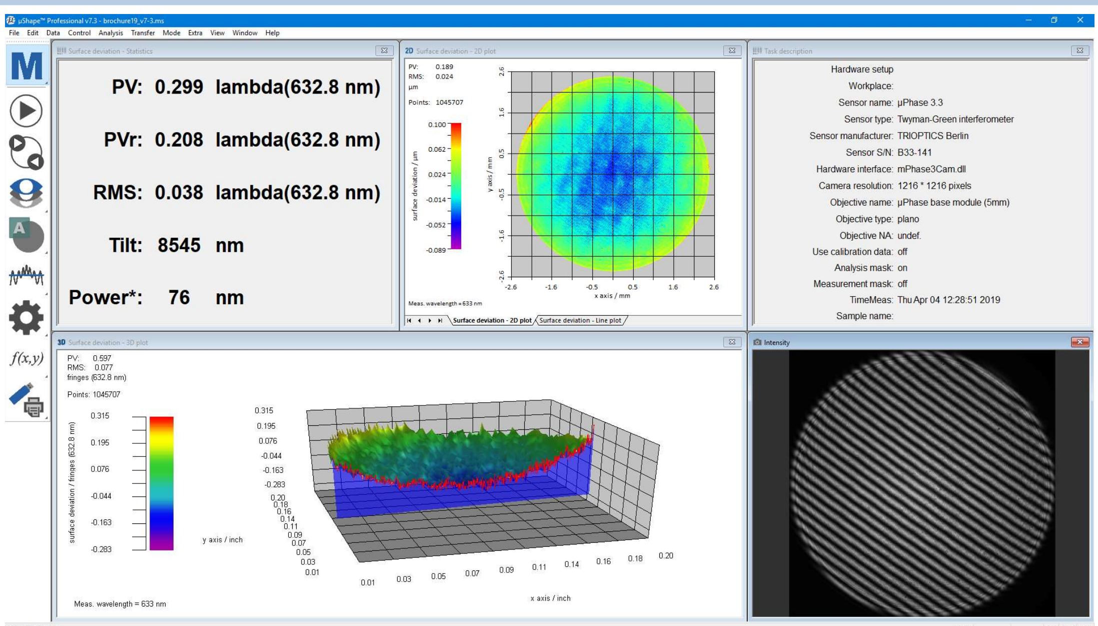
	ST	ST+R	VERTICAL	VERTICAL +Tray	UNIVERSAL
1	■	■	■	■	■
2	■	■	■	■	■
3			□	□	□
4	□	□	□	□	□
5	relative	absolute	absolute, automated	absolute, automated	absolute
6					
7	■	■	■	■	
8	■	■	■	■	□
9	■	■	■	■	■
10	vertically	vertically	vertically	vertically	horizontally
11	■	■	■	■	■
12	manually	manually	motorized	motorized	manually
13	□	□	□	□	
14	■	■	■	■	□
15			□	□	□
16			□	□	□
17				■	

µShape™ Software

The µShape™ Interferometer Software was originally developed for the µPhase® compact interferometers. In combination with the so-called GenPack µShape™ works with interferometers from other manufacturers, too. With its clear and menu driven user interface µShape™ perfectly deals with the variety of measurement requirements and provides several modules which expand the capabilities of µShape™.
µShape™ works with all Windows® versions and is designed for ease-of-use and modular functionality. It controls and displays the measurement results, stores and documents all measurement raw data and ensures maximum transparency and traceability.

µShape™ Software

The µShape™ software is used for measuring the topography of flat, spherical, cylindrical, toric and aspherical surfaces or wavefronts and is used in production, laboratory and research. Add-on modules enable to adapt the software to custom specific demands. These modules can be added at any time even after the initial purchase.
The µShape™ software is pre-installed on a state-of-the-art PC or laptop, included with every TRIOPTICS' µPhase® interferometer system. Ready-to-use configuration guarantees fast start to work.



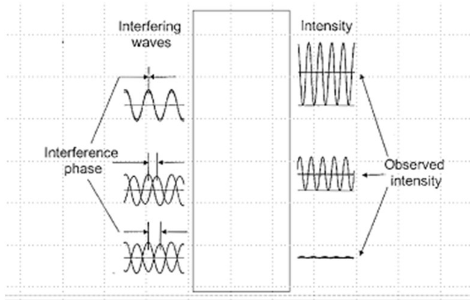
Typical µShape™ Screen

Features of the µShape^{TM} Measuring and Analysis Software (Selection)

- Different **user levels** with different access rights
- **Shortcuts** for most used program functions
- Comprehensive context-sensitive **direct help**
- Various **program modes** enable the separate visualization of calibration and measurement processes and its parameter with an integrated live camera image
- Automatic updates of displays and images after every change of analysis parameters or new measurement, allows **re-analyses** of measurements without new measurement
- Easily pre-configured **templates** for a wide range of measuring tasks and analyses; templates contain all parameters and settings, including configuration of screen display
- Graphic windows can be stored in **several graphic formats**
- **Export** of individual parameters or of selected data fields as text, binary or other common file formats (e.g. QED, Zygo XYZ, DigitalSurf) for external processing
- The measuring **results** are presented as parameters or graphically as a cross section, in 2D or 3D plots
- Configurable **Measurement Reports** show results at a glance
- Several analyses like **Zernike**, **Seidel**, **ISO**, **Legendre**, **Slope**

- Access control and configuration of **add-on modules** by **dongle**
- Analysis of **aspherical**, **cylindrical** or **toric** surfaces in spherical or CGH setups
- **External interface** for controlling the interferometer by external programs, e.g. in automated systems
- **MTF** analysis of focal or afocal optical components and systems
- Measuring **multiple apertures** in one shot, e.g. on polishing heads
- Statistical analysis of multiple sub-apertures at the same time (**MultiStat**) including tolerating and pass/fail indication
- **Prism** and **wedge** measurement and analysis
- Consideration of known sample deviations e.g. deviations caused by the optical design (**Sample Normal Data**)
- Analysis of the **tool offset** of lathe machines
- Analysis of **wafer plates**
- **Static fringe** analysis for fast measurements in instable environments

Interferometry



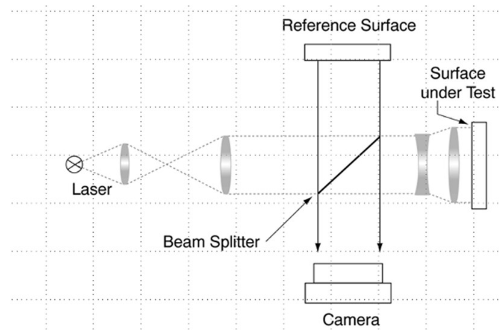
Interference principle

In interferometry coherent wavefronts are superimposed. The result of this superposition is a fringe pattern, the so-called interferogram. In case of two beam interference each fringe represents a constant phase difference between both waves. Thus the interferogram is a kind of a contour map of the test sample.

The standard design of an interferometer for surface shape testing consists of a collimated coherent light source which is divided by a beam splitter into two beams. The test beam is transformed by a beam shaping optic into a wavefront of nearly the same shape as the sample (commonly flat or spherical). Thus the rays of the test beam intersect the sample under test perpendicularly, are reflected in themselves and embossing the shape errors to the test wavefront. The modified test wavefront is recombined by the beam splitter with the reference beam, reflected at the internal interferometer reference surface, and imaged to the camera sensor. The space of both interferometer arms builds the test cavity. The interferometer measures the optical path difference (OPD) of this cavity for each point independently. Two setups are commonly used for surface and wavefront testing.

Twyman-Green Setup

A Twyman-Green interferometer is a modified Michelson interferometer. This



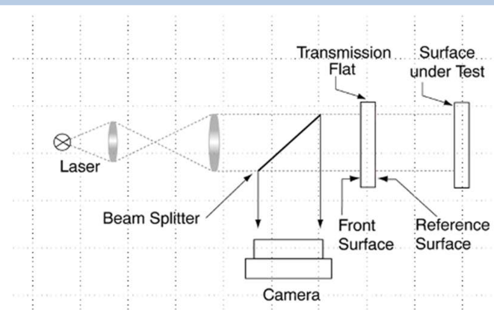
Twyman Green Setup

configuration offers high flexibility, because both interferometer arms can be modified independently of each other. So the intensity of reference and test arm can be easily adjusted to each other in order to get maximum fringe contrast. This is necessary when testing samples with different reflectivity and increases the range of applications enormously. Only a maximum fringe contrast enables a maximum resolution in depth.

As reference surface a surface can be used that is inexpensive and accurately producible independent from the sample size. The adaption to the sample size is done by conventional beam shaping optics introduced to the test arm. Contrary to the beam shaping optics for Fizeau interferometers (see next) these optics do not require an expensive Fizeau surface as final surface. Using a flat reference surface also guarantees equal phase shift over entire aperture.

As consequence of this flexibility the interference patterns which can be seen are not caused by the sample errors only but also by the aberrations of the additional optics in both interferometer arms. However, nowadays samples are not anymore evaluated according to its fringe pattern but by a determination of the phase map causing the fringe pattern. During this analysis the aberrations of the additional optics can be easily considered. Finally the software provides an objective digital measurement result.

Fizeau Setup



Fizeau Setup

The most commonly used interferometer for surface testing are Fizeau interferometers. The last surface of the beam shaping optic is the so-called Fizeau surface. It must have the same shape as the sample to be tested (commonly spherical or flat) and is placed concentric into the optical path, so the individual rays intersect perpendicular to the Fizeau surface. The major part of the light passes the Fizeau surface and is reflected at the test surface. The returning light interferes with the part of the light reflected at the Fizeau surface. So the Fizeau surface acts as beam splitter as well as reference surface. The reference arm length is identical zero, so the cavity is build up by the gap between the Fizeau and the test surface only and contains no further optical elements. That is the reason why a Fizeau interferogram commonly directly shows the deviations of the test sample from the reference surface, i.e. Fizeau surface and allows skilled people analysis of the fringe pattern to judge the sample. The quality of the Fizeau surface determines the accuracy of the Fizeau interferometer. Fizeau surfaces are commonly available with a quality of $\lambda/10$ – $\lambda/20$ PV on special request also better.

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More information and a list of Distributors: http://www.trioptics-berlin.de/links_en.htm

TRIOPTICS
Berlin GmbH

TRIOPTICS Berlin GmbH • Interferometer Business
Schwarzschildstraße 12 • 12489 Berlin / Germany
Phone: +49-30-6392 3456
Fax: +49-30-6392 3452
E-mail: support@trioptics-berlin.com • http://www.trioptics-berlin.com