TRIOPTICS

Operating Instructions and Software Description

OptiCentric® 100 IR

Valid for:

OptiCentric® 100 LWIR
OptiCentric® 100 MWIR

Translation of the original Operating Instructions Rev-0

Subsidiaries/Customer Service

Germany (Head office)

TRIOPTICS GmbH
Strandbaddamm 6
22880 Wedel
Germany

Phone: +49 4103 18006-0
Fax: +49 4103 18006-20
Email: sales@trioptics.com
www.trioptics.com

USA

TRIOPTICS USA
9087 Arrow Route, Unit 180
Rancho Cucamonga
CA 91730
USA

Phone: +1 626 962 5181
Fax: +1 626 962 5188
Email: sales@trioptics-usa.com
www.trioptics-usa.com

China

TRIOPTICS China
E.5/F., Bldg. M7
#1 JiuXianQiao East Road
100016, Beijing
China

Phone: +86 010 8456 6186
Fax: +86 010 8456 9901
Email: info@trioptics-china.com
www.trioptics-china.com

Taiwan

TRIOPTICS Taiwan Ltd.
3F, No.5 Andong Rd
Zhongli Dist.
Taoyuan City 32063
Taiwan

Phone: +886 3 462 0405
Fax: +886 3 462 3909
Email: info@trioptics.tw
www.trioptics.com.tw

France

TRIOPTICS France
76 rue d'Alsace
69100 Villeurbanne
France

Phone: +33 (0)4 7244 0203
Fax: +33 (0)4 7244 0506
Email: info@trioptics.fr
www.trioptics.fr

Korea

TRIOPTICS Korea Co., Ltd.
#701-101, Digital Empirell 486
Sin-Dong, Youngtong-Ku Suwon-City
Kyunggi-Do
440-050 Korea

Phone: +82 31 695 7450
Fax: + 82 31 695 7459
Email: info@trioptics.co.kr
www.trioptics.co.kr

Japan

TRIOPTICS Japan Co., Ltd.
4-6-25, Nakada, Suruga-ku
422-8041 Shizuoka-city
Japan

Phone: +81 54 203 4555
Fax: +81 54 203 4556
Email: info@trioptics.jp
www.trioptics.jp

TRIOPTICS Singapore Co., Ltd.
7030 Ang Mo Kio Ave 5
#09-59 Northstar
569880 Singapore

Phone: +65 9067 3787
Email: danny.ng@trioptics.com.sg
www.trioptics.com.sg

Table of contents

1 Introduction

1.1 The OptiCentric 100 IR measurement system

OptiCentric® 100 IR has been specially developed for centering testing of infrared optics.

The measurement system is equipped with a dual-band VIS-IR measurement head and can test all types of infrared optics. Switching between measurement in the visual wavelength range (VIS) and measurement in the infrared wavelength range is managed by the software.

The measurement system is equipped with a HeNe laser (IR line at 3.39 µm) that makes it possible to measure all lenses used in the IR range.

OptiCentric® 100 IR is computer-controlled and equipped with a stepper motor drive. The head lens can move to any number of focus positions and centers of curvature that have previously been saved.

The measurement procedure is largely automated, multi-lens objectives can thus easily be aligned and assembled.

1.2 Documentation

This documentation contains all information necessary for the safe operation of the measurement system and the accompanying software.

Read the instructions carefully before you start working with the measurement system. Pay special attention to the safety instructions.

The documentation including all third party documents must be stored with the measurement system and must be readily available when needed.

Please contact the manufacturer or the respective local subsidiary for additional information.

1.3 Target group

This documentation is aimed at people who work with the measurement system:

1.3.1 Qualified person

A qualified person uses his or her technical training, expertise, and experience, as well as knowledge of the relevant rules and regulations to assess assigned work and identify potential hazards.

1.3.2 Trained person

A trained person has been

- informed,
- trained,
- and instructed about the required safety measures and safety equipment concerning the assigned work and possible hazards in case of improper conduct.

Persons working with the device must be regularly trained about the associated dangers.

1.4 Safety notes layout

The operator's manual attaches different levels of importance to safety notes by using symbols and signal words.

Symbol	Signal word	Explanation
	DANGER	Imminent danger. Will result in death or severe bodily injury.
	WARNING	Possibly dangerous situation. May result in death or severe bodily injury.
	CAUTION Risk of injury	Possibly dangerous situation. May result in slight or minor injuries.
	CAUTION Risk of material damage	Possibly dangerous situation. May result in damage to property.
	NOTE	Notes that must be considered in order to ensure optimal results and secure operation of the system.

Additional symbols used

Symbol	Explanation
	Risk of electric shock
	Risk of laser radiation
	Risk of fire
	Risk of hand injuries
	Risk of being drawn in

The safety notes are structured as follows:

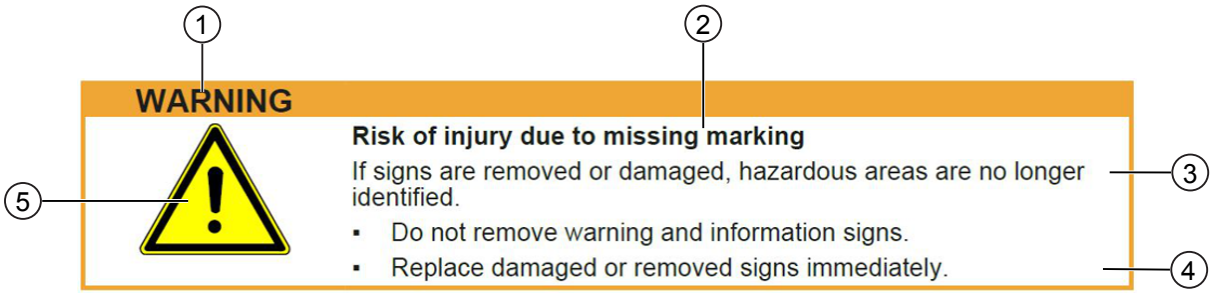


Fig. 1: Sample safety note

1	**Signal word** Specifies the severity of the hazard (see above).
2	**Type and source of danger** Specifies the type of danger associated with the warning and where this danger can occur.
3	**Cause and effect** Describes the cause of the danger or damage and its effects.
4	**Remedy** Describes how to prevent the danger.
5	**Symbol** Indicates the severity and nature of the hazard.

1.5 Action instructions

Action instructions are numbered when the correct sequence of the individual steps is important. Results of the action instructions are directly underneath.

Example

1. This is the first step.
   ⇨ This is the result of the first step.
2. This is the second step.
   ⇨ This is the result of the second step.

⇨ This is the result of the entire instruction.

1.6 Operating and control elements

Operating and control elements such as buttons, keys and switches are depicted in bold.

Example:

The **emergency stop** button is located on the right-hand side of the measurement system.

1.7 Operation via software

The menus and buttons in the software are depicted in a different font.

Example 1:

1. Click `Measure centration`.

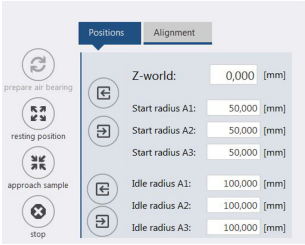


Fig. 2: Positions

Example 2:

1. Enter the password and click <Login>.

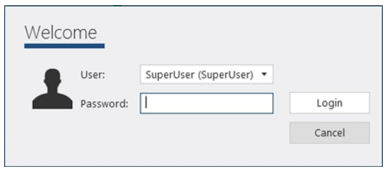


Fig. 3: Login

1.8 Designations

OptiCentric® and OptiSurf® are registered trademarks.

If a trademark is not expressly mentioned here, this omission does not indicate a license for using this trademark.

2 Safety notes

The measurement system was designed and built according to recognized rules of safety technology.

However, there are potential hazards for the operator, for other persons, for the measurement system itself as well as a risk of material damage.

WARNING

Risk of injury and risk of property damage

Installation, initial startup, operation and disposal of the measurement system may cause or be associated with mechanical, electrical and thermal hazards.

– Observe all safety instructions in this operator's manual.

2.1 Intended use

WARNING

Risk of injury and risk of property damage

Improper use of the measurement system may lead to bodily injuries and cause property damage.

– Always use the measurement system as intended and as described below.

OptiCentric® 100 IR may only be used for the measurement of optical components or optical systems. It is intended only for use in industrial and/or small or medium-sized companies.

Any other utilization is considered unintended use.

Only the accessories described in this operator's manual may be used. The measurement system and/or its accessories must not be modified in any way.

Intended use also includes compliance with the prescribed cleaning and maintenance intervals.

2.2 Foreseeable misuse

Abuse is hereby included.

Any use that goes beyond the aforementioned intended use is regarded as improper. The manufacturer is not liable for any injury to persons or material damage resulting from such improper use.

- The use of attachments, spare parts or wearing parts other than those described in the operator's manual is prohibited. If necessary, TRIOPTICS must approve the use of other parts explicitly.
- It is prohibited to deliberately cause collisions between the moving elements and between the optical elements.
- It is prohibited to enter the position information ("Rel. pos") in the position table incorrectly.
- Measurements of too large or too heavy optics according to the limits may not be performed.
- Never bypass the safety devices.
- It is prohibited to operate the measurement system beyond the indicated service life.
- It is prohibited to remove the variable limit stop of the upper linear axis or to place it at an incorrect lower position.
- Only light sources that are approved for this measurement system may be used.
- Cleaning and maintenance intervals must be adhered to.

2.3 General notes

– Be sure to read the manual before working with the measurement system. Comply with all warnings in the operator's manual and on the measurement system. Keep the operator's manual for later reference.

– If the measurement system emits unusual smells or smoke, immediately turn off the main switch and remove the plug from the wall outlet. Continued use of the measurement system constitutes a hazard and may result in fire, electrical shock, or injury. Immediately notify the manufacturer or the responsible local subsidiary.

– Do not use the measurement system if you suspect a malfunction or defect.

– The measurement system must be connected to a safety wall outlet with the specified voltage. Make sure the measurement system is grounded.

– Avoid damaging the connecting cables. Do not place any objects on cords or cables. Do not pull on cords or cables. Place cords and cables in such a way that they do not become a tripping hazard.

– Turn off the power and unplug the power plug from the measurement system and accessories, before cleaning or servicing the system.
– The lighting for any work on the measurement system must be in accordance with DIN EN 12464.

2.4 Employees

WARNING

Risk of injury or property damage when operated by insufficiently qualified employees

Inadequately trained employees are not familiar with the dangers associated with handling of the measurement system.

– The measurement system may only be operated and maintained by qualified and trained employees.

Installation and initial startup

Only employees of TRIOPTICS GmbH or correspondingly trained and authorized persons are permitted to install and operate the measurement system. This includes installing the software and the installation of accessories.

Operation

The measurement system may only be operated by *trained employees [▸ 12]*. In particular, they must have read and understood the operator's manual and the safety notes.

Maintenance and repairs

All maintenance and repair work must be carried out by *qualified employees [▸ 11]*.

2.5 Dangers during transport and installation

WARNING

Risk of injury

The transport and installation of the measurement system may be associated with hazards due to heavy and tipping parts.

– Only use suitable lifting gear.
– Never step under suspended loads.
– Make sure the measurement system is transported without being subjected to impact or jolting.
– Remove transports locks only during installation.

Transport

- Only employees of TRIOPTICS GmbH or correspondingly trained and authorized persons are permitted to move the measurement system.
- Make sure the measurement system is transported without being subjected to impact or jolting.
- Remove transports locks only during installation.
- Only use suitable lifting equipment.

  Weight specifications of the measurement system can be found in the section titled “Technical Data”.
- Never step under suspended loads.

Installation and initial startup

Only employees of TRIOPTICS GmbH or correspondingly trained and authorized persons are permitted to install and operate the measurement system. Improper setup or incorrect installation may damage the measurement system or impair its function. This will result in inaccurate measurement results.

Ambient temperature

In order to prevent damage from condensation, all the components must be acclimatized to the ambient temperature prior to installation.

Different installation site

Please inform TRIOPTICS GmbH if you wish to transport the system to a different installation site. This requires a re-calibration after relocating the system.

2.6 Hazards during operation of the measurement system

2.6.1 Electrical hazards

DANGER

Risk of electric shock

Electrical currents may pose a hazard.

– Disconnect the main power supply before working on electrical equipment.

Power supply

- Disconnect the main power supply before working on electrical equipment. Information on the main power supply can be found in the *Technical Data [▸ 29]* section.
- Do not touch live (energized) parts.
- Do not short-circuit or ground the power supply output.

Housing sections

- Do not remove any sections of the housing.
- Before you start work, make sure all sections of the housing are present and properly installed. Do not work on the machine if sections of the housing have been removed or are defective. Immediately reattach removed sections of the housing or notify TRIOPTICS Customer Service (see *Customer service [▸ 251]*).

Humidity

- Make sure that humidity cannot penetrate into the housing of the machine.
- Do not consume beverages at the workplace.
- Do not place the machine in a humid environment or outdoors.
- To avoid condensation, do not place the machine in environments with high temperature fluctuations. Information can be found in the *Installation site [▸ 48]* section.

2.6.2 Mechanical hazards

WARNING

Risk of injury

When working on the measurement system, injuries caused by crushing or shearing may occur.

– Please observe the following safety notes.

- Tie back long hair.
- Wear close fitting clothing.
- Keep a safe distance from rotating axes while measuring.
- Keep a safe distance from horizontally or vertically articulated axes while measuring.
- Never block the linear stages.
- Do not insert anything into the housing of the linear stages.
- The limit switch must be set up before moving the measurement head to the sample.

2.6.3 Danger from light sources

WARNING

Risk of burns and fire

Light-absorbing materials convert light into heat. High intensity visible light can cause damage to the eyes, skin or other materials in the environment.

– Wear suitable protective equipment.

- Avoid directly looking into the open clamping sleeve or the optical fiber output while the light source is switched on.
- Never uncover the open clamping sleeve or the optical fiber output.
- Never cover the open clamping sleeve or the optical fiber output with your hand or other parts of the body.

2.6.4 Danger due to laser

The intensity of the laser used is very high. The sensor can be destroyed by incorrect operation of the measurement system.

Please observe the following notes for handling the measurement system.

The operator shall be liable if the sensor is damaged by failure to observe these instructions.

WARNING

Risk of injury caused by laser

Improper use poses a risk to the health of the user or third parties caused by laser radiation.

If the housing is mounted properly, it is a class 1 laser.

– Avoid exposure of the eyes to scattered radiation.

CAUTION

Risk of material damage

The sensor can be destroyed by incorrect operation of the measurement system.

– The measurement system may only be operated by persons who are trained in its operation and the safety precautions.
– Never bring reflective surfaces into the beam path.
– Make sure that the shutter is closed when inserting samples.
– Always use a filter.
– Make sure that the shutter is closed when replacing a filter.

- Personal protective equipment (laser protective eyewear) must be worn during operation to protect the eyes and the skin.
- Never look directly or indirectly into the laser outlet opening.

2.6.5 Danger to the rotary air bearing

CAUTION

Risk of material damage

Rotating the air bearing without compressed air will result in damage to the air bearing. Precise measurements will then no longer be possible.

– Always turn on the compressed air supply first before using the measurement system.

- Ensure that the requirements in terms of the compressed air supply are met (see chapter section).
- Protect the contact surfaces against mechanical influences.

2.6.6 Risk due to pneumatic connections

WARNING

Risk of injury from compressed air

Flailing compressed air lines or pressurized components can result in crushing or impact injuries.

– Make sure that the compressed air supply is connected properly.
– Prior to maintenance or troubleshooting work, ensure that all lines are depressurized and secured against being switched on again.

2.6.7 Software

NOTE

Incorrect operation of the software will result in inaccurate measurement results.

– Familiarize yourself with the software and the correct settings before starting work.

Default settings

Changes to the default settings must only be made by authorized employees of the manufacturer.

2.7 Dangers due to IR lens material

WARNING

Risk of injury due to IR lens material

Improper handling of IR lens material poses a risk to the health of the user or third parties as well as the risk of environmental damage.

– Observe the following notes when handling the IR lens material.

– Wear suitable protective clothing when handling the IR lens material.
– In case of accidental skin contact, immediately wash the affected area with plenty of water.
– Only work with the IR lens material at a well ventilated workplace.
– Do not consume food or drinks and do not smoke while working with the IR lens material.
– Store the IR lens material in suitable containers and in a well-ventilated place to avoid environmental contamination.
– Do not allow IR lens material to enter the drain system.

2.8 Safety equipment

Do not operate the measurement system if the safety devices are not functioning correctly.

Emergency stop button

The function of the emergency stop button must be checked once a year.

After activating the emergency stop, the measurement system may only be re-started once the fault has been eliminated and there is no danger to persons or property.

2.9 Warning and information signs

Warning and information signs mark sites and locations where certain conditions may result in hazards.

WARNING

Danger of injury if warning and notice signs are removed or damaged

If notice signs have been removed or damaged, danger locations on the system may no longer be recognizable.

– Warning and notice signs may not be removed.
– Damaged or removed notice signs must be immediately replaced.

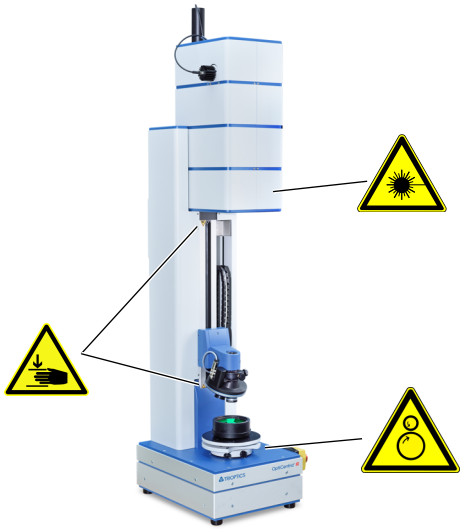


Fig. 4: Measurement system, warning signs

	Warning: laser beam
	Warning: danger of being pulled in
	Warning: hand injuries

2.10 Operator obligations

- The operator must ensure a general prohibition of alcohol and drugs for employees.
- The operator must ensure that only suitably qualified employees work on and with the measurement system.
- A briefing must be given when using for the first time, when personnel change and additionally at regular intervals.
- The operator must ensure that all necessary protective equipment is worn correctly.
- The operator must close off a safety zone of 2 m around the measurement system and make sure that nobody enters this zone without laser protective eyewear.
- The operator must ensure that persons working on and with the measurement system have read and understood the Operator's manual and safety instructions.

3 Technical Data

3.1 Dimensions of the measurement system

Height OptiCentric® 100 MWIR OptiCentric® 100 LWIR OptiCentric® 3D 100 MWIR OptiCentric® 3D 100 LWIR	 1774 mm 1651 mm 1702 mm 1678 mm
Width	443 mm
Depth	492 mm
Weight	approx. 85 kg

3.2 Specifications

Test parameter	Centering error
Possible measurement procedure	in reflection
Measurement accuracy for a single surface	0.1 µm
Maximum measuring range	± 450 mm
Reproducibility	0.05 µm
Repeatability	0.02 µm
Free aperture	30 mm
maximum number of surfaces in MultiLens measurement	approx. 20

3.3 Power supply

Voltage	90 - 250 VAC, 50-60 Hz
Current	10 A
max. power consumption	1500 W (proper grounding required)
Plug type	CEE 7/4 (EU Schuko)

3.4 Rotary air bearing

Load capacity	max. 20 kg
Run-out error	axial and radial < 0.05 µm
Compressed air required	4.5 - 5.0 bar
Air requirement	50 l/min

3.5 Tip-tilt-table

Name	TRT 200
Accuracy	± 2 arcsec; ± 1 µm
Load capacity	30 kg
Weight	22 kg

3.6 Light source

LED

Type of light source	LED
Wavelength	blank

Laser (MWIR)

Type of light source	HeNe laser
IR line	3.39 µm

Laser (LWIR)

Type of light source	HeNe laser
IR line	10.3 - 10.8 µm

4 Design and Function

4.1 OptiCentric® 100 IR

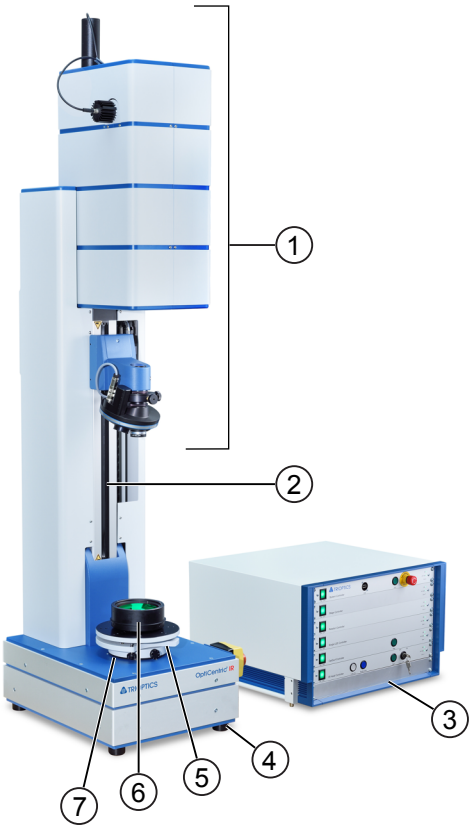


Fig. 5: Measurement system, overall view

1	**Optical measurement head** (VIS / IR measurement head)
2	**Air bearing linear stage**
3	**Electronics rack** Contains the control units
4	**Vibration-isolating rubber feet**
5	**Tip-tilt-table** alternative: Vacuum unit
6	**Sample**
7	**Rotation air bearing**

VIS / IR measurement head

VIS / IR tandem measurement head (dual wavelength)

The measurement head contains two electronic autocollimators for the visual (VIS) and infrared (IR) spectral ranges.

The measurement head can be switched over for measurements in the visual or infrared spectral range. Switching between VIS and IR mode is controlled by the software.

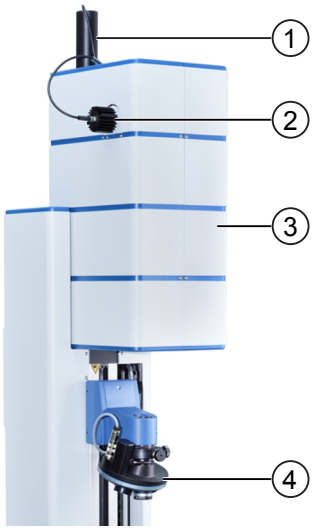


Fig. 6: Measurement head

1	**HeNe laser module** (only MWIR)
2	**LED illumination**
3	**Optical measurement head**
4	**Objective changer**

4.2 Accessories

Tip-tilt table (TRT 200)

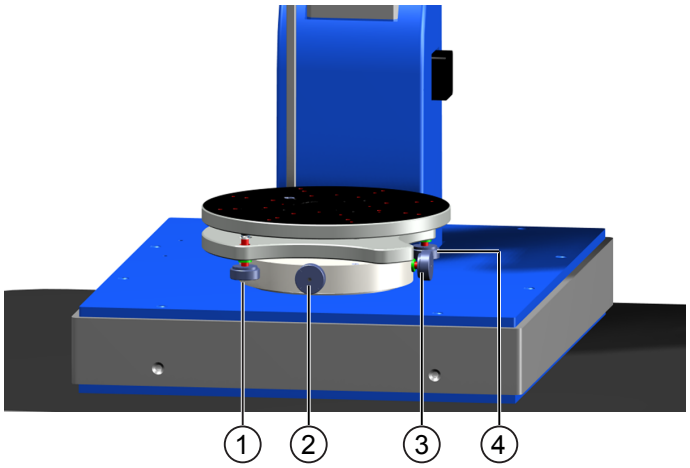


Fig. 7: Tip-tilt table TRT 200

1	**Knurled screw** For adjusting the tilt in Y-direction
2	**Knurled screw** For adjusting the shift in the Y-direction
3	**Knurled screw** For adjusting the shift in the X-direction
4	**Knurled screw** For adjusting the tilt in X-direction

Motorized lens rotation device with vacuum

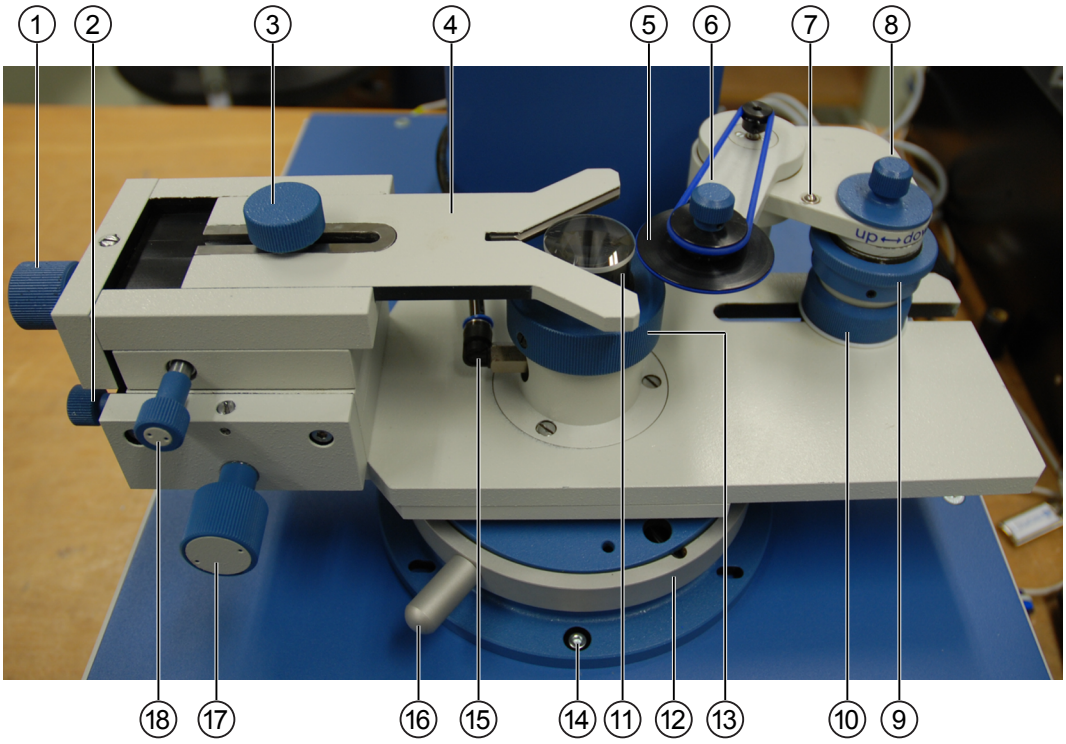


Fig. 8: Vacuum unit with lens rotation device

1	**Knurled screw** for moving the V-blade in X-direction
2	**Clamp for screw (1)** This clamping screw must be loosened to move the V-blade in X-direction.
3	**Fastening screw for V-blade**
4	**V-blade**
5	**Friction wheel**
6	**Handle for moving the pivot arm**
7	**Pivot arm lock**
8	**Knurled screw for clamping the height adjustment**
9	**Height adjustment of the pivot arm**
10	**Clamping screw** The clamping screw must be loosened to move the pivot arm in X-direction.
11	**Height adjustment of the cup point**
12	**Bridge** used to secure the vacuum unit above the air bearing
13	**Cup point**
14	**Fastening screws for the bridge**

15	**Connection for vacuum hose**
16	**Lever for locking the cone**
17	**Knurled screw** for moving the V-blade in Y-direction
18	**Clamp for screw (17)** The clamping screw must be loosened to move the V-blade in Y-direction.

Objective changer

An objective changer is recommended to change head lenses quickly and easily. OptiCentric® 100 IR offers a motorized Six-way changer, which is equipped with head lenses from our product range.

A manual objective changer is also available as an option.

Fig. 9: Objective changer, example

1	X/Y adapter
2	Head lenses

4.3 Control elements

4.3.1 Emergency stop

The emergency stop button is located on the right-hand side of the measurement system from the operator's point of view, and on the system controller.

Fig. 10: Emergency stop

To immediately interrupt the power supply of the motors in a dangerous situation, press the emergency stop button. The power supply is interrupted and all movements of the measurement system are stopped immediately.

CAUTION

Only use the emergency stop in emergencies.

4.3.2 Control units

System controller

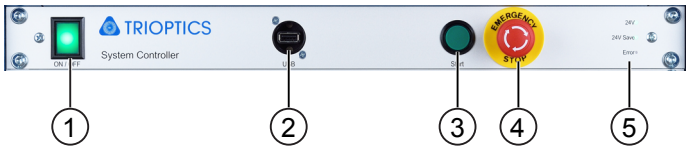


Fig. 11: System controller

1	**ON/OFF** Switching the system controller on/off. This switch is illuminated when the system controller is switched on
2	**USB** USB connection
3	**Start** Activate system controller • Button is illuminated when the controller can be activated. • Button goes off if the controller has not been activated.
4	**EMERGENCY STOP** Emergency stop button
5	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** save is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

Control unit for the stepper motor drive (Stage Controller)

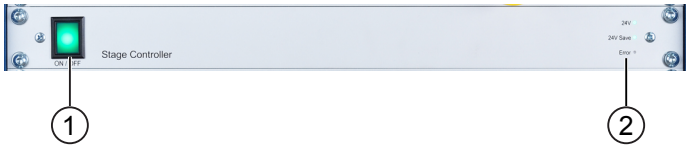


Fig. 12: Stage controller

1	**ON/OFF** Switch control unit on/off; illuminated when the control unit is switched on
2	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** save is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

Control unit for rotation (Rotation Controller)

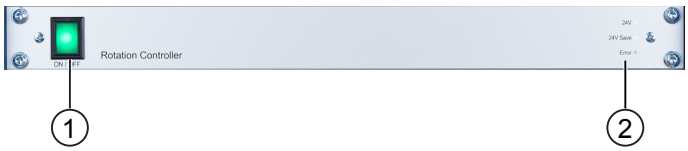


Fig. 13: Rotation Controller

1	**ON/OFF** Switch control unit on/off; illuminated when the control unit is switched on
2	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** save is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

Control unit for LED light source (Double LED Controller)

Fig. 14: Double LED Controller

1	**ON/OFF** Switch the control unit on/off; is illuminated when the control unit is switched on
2	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

Control unit for OptiSurf® (OptiSurf Controller), optional

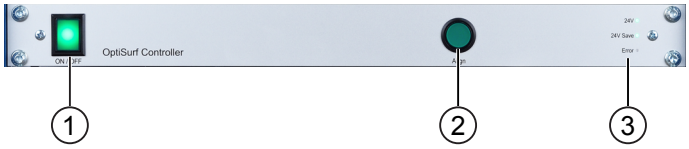


Fig. 15: OptiSurf controller

1	**ON/OFF** Switch control unit on/off; illuminated when the control unit is switched on
2	**Align** Switch alignment laser ON or OFF
3	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** save is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

NOTE

Type and source of danger

Consequences

– Do not leave the alignment laser on for longer than is necessary.

Control unit for laser light source (IR Head Controller)

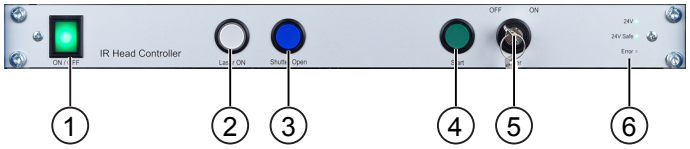


Fig. 16: IR Head Controller

1	**ON/OFF** Switch control unit on/off; illuminated when the control unit is switched on
2	**Laser ON** Switch laser on; lights up when the laser is switched on
3	**Shutter Open** • Button lights up when IR mode has been released • Button does not light up when the VIS mode is switched on.
4	**Start** Interlock released by the laser • Button is illuminated when the beam path for the IR measurement head has been released by the software and the controller can be activated. • Button goes off if the controller has not been activated.
5	**Laser On/OFF** Key switch; release laser and switch on IR camera
6	Displays: • **24V** is illuminated when the controller is connected to the supply voltage. • **24V save** save is illuminated when the supply voltage is connected and the motors can be operated. • **Error** is illuminated when an error occurs.

Control unit for vacuum

4.4 Measurement Principle

4.4.1 Centering Error Measurement in Reflection

The basis for the measurement is an electronic autocollimator. The following graphic shows the functional method and the tried and tested principle of centering error measurement in reflection.

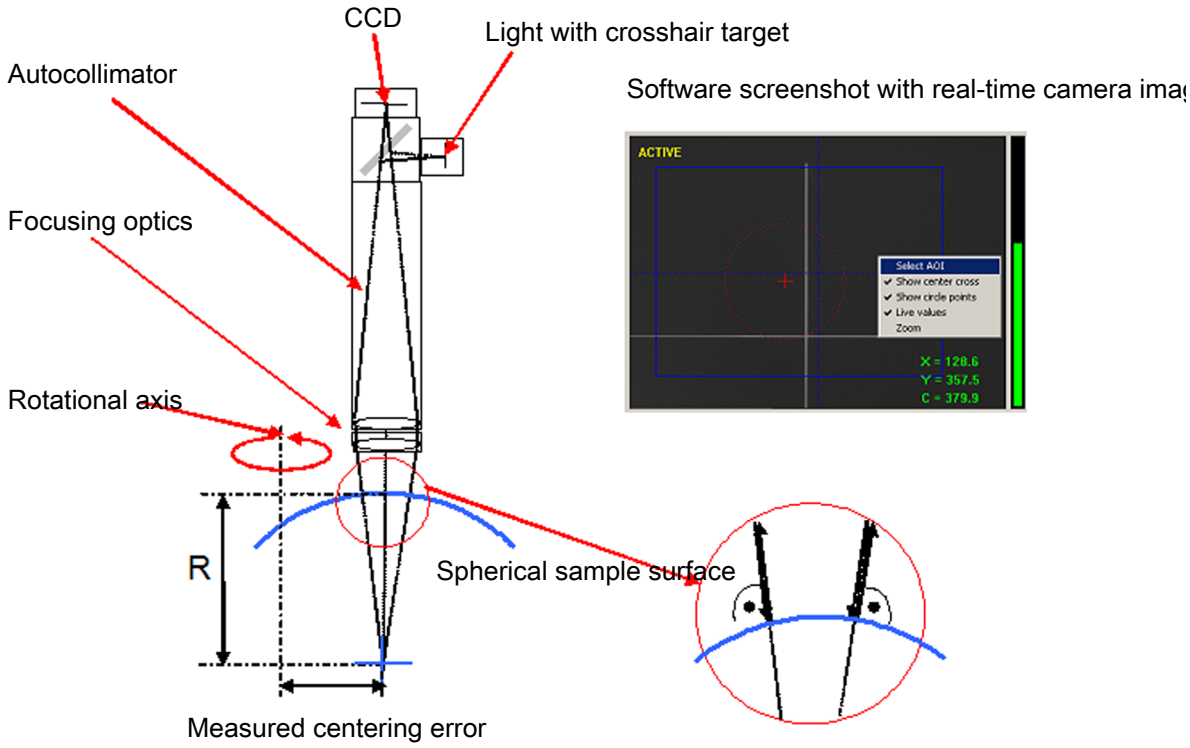


Fig. 17: Centering error measurement in reflection, schematic diagram

An illuminated target (bright crosshair on a dark background) is projected through a beam splitter and a focusing lens projected in the plane of the center of curvature of the sphere being studied. In this case, the light beams strike the surface nearly perpendicular.

A portion of the reflected light returns on precisely the same path on which it arrived (autocollimation condition) and is focused on a CCD chip. The image of the target appears on this chip.

A displacement of the center of curvature is represented directly in the image in a lateral displacement of the crosshair image.

If the sphere being examined is rotated about a reference axis, then circular movement of the center of curvature about the reference axis is transmitted to the CCD chip. The diameter or radius of this circle is directly proportional to the shift of the center of curvature to the reference axis.

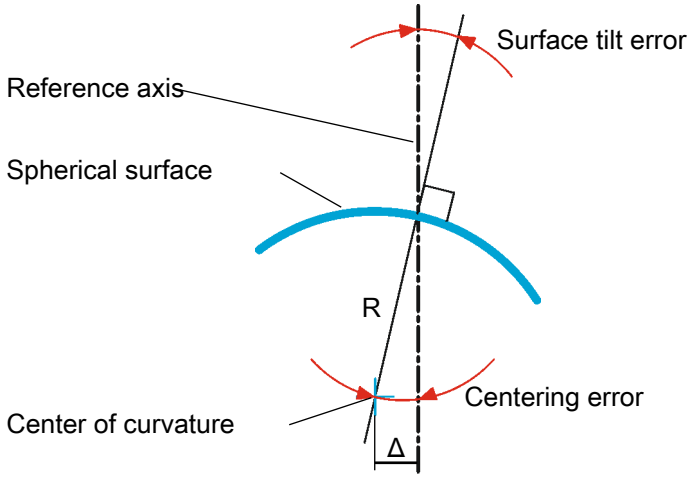


Fig. 18: Surface tilt error

The current crosshair image represents the exact position of the center of curvature in the XY plane.

Alternatively, the centering error of a spherical surface can also be represented as a surface tilt error.

$$\text{Surface tilt error} = \arcsin \frac{\text{Shift } \Delta}{\text{Radius of Curvature R}}$$

Powerful light sources and light-sensitive CCD sensors ensure that anti-reflective samples also provide an auto-collimation image that is sufficiently strong.

4.4.2 MultiLens® measurement

This comprehensive software module is used to measure, align and assemble lens systems. The centering error of each surface of complex and already assembled optical systems is determined.

The MultiLens® software provides complete information about the individual centering errors of every surface, without destroying the optics. The centering errors are measured in the reflection mode, starting with the surface that is located closest to the measurement head, followed by the surface below, and so on.

When focusing in the respective centers of curvature, it is necessary to take into account the MultiLens® principle:

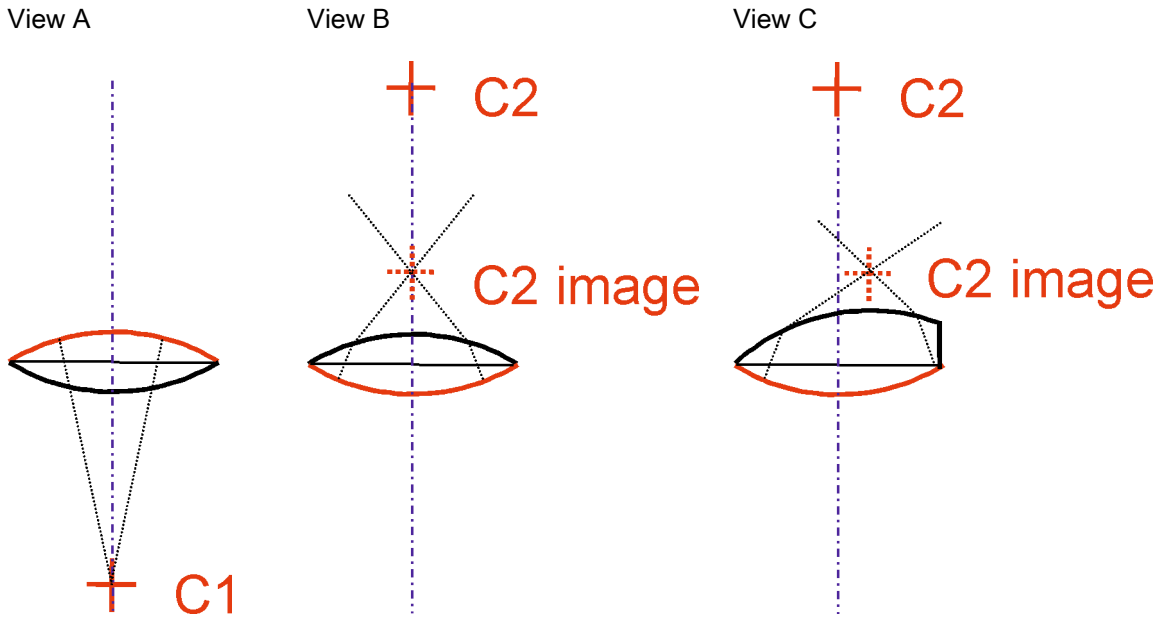


Fig. 19: MultiLens® measurement

- The focus point of the first surface is coincident with the center of curvature C1 (View A).
- Because the light beam is refracted at the first surface, in the second surface the focus point C2 image is shifted with respect to the geometrical center of curvature C2 (View B).
  This calculation requires the design data (radius, center thickness, refractive index) of the sample.
- The same applies to all of the following surfaces.
- When assessing the measurement, it is also necessary to take into account both the image-forming properties and the centering error of the first surface. If the exact centering error of the first surface is determined, it is possible to determine the centering error of the second surface, and so on (View C).

Ii is possible to measure 20 or more surfaces with a single autocollimator, with accuracies in the range of 1 µm and better.
Details can be found in the “Operator's manual and software description” for OptiCentric.

The measurement system uses the rotary axis of an air bearing as the reference axis. The air bearing has a radial runout in the range of 0.05 µm.

4.4.3 Description of the OptiSurf functions

After starting the software, the measurement system is automatically initialized and is then ready for use.

Before a measurement, the lens design of the sample is loaded or created with the software. The lens design incorporates information about the following properties of the sample:

- Target distances of the optical surfaces
- Type of surface (flat or spherical)
- Radii of curvature
- Refractive indices

Once the preparations are completed, the non-contact measurement of the center thicknesses and the air gaps is started using the OptiSurf Professional software.

After the measurement, the software compares the recorded distances with the lens design data and then analyzes and displays them.

The results are displayed in a chart and as a table. The data can be saved as an MHT file or exported for import into Excel.

4.4.4 OptiSurf measurement principle

The measurement principle is based on low-coherent interferometry. The light from a superluminescent diode (SLD) is divided by a beam splitter into an object beam and a reference beam. This is schematically represented in the illustration below:

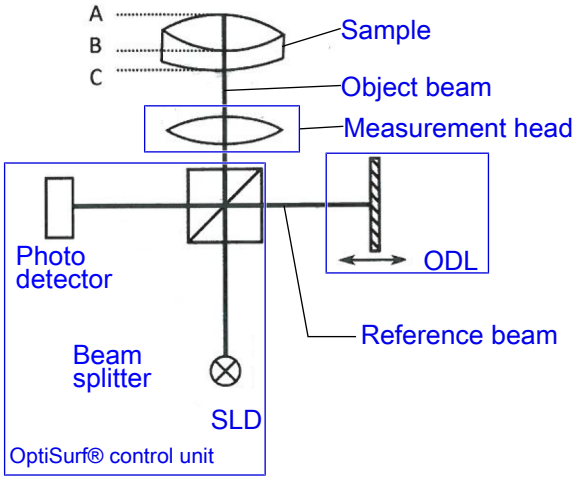


Fig. 20: OptiSurf measurement principle

The **object beam** illuminates the lens system along the measurement axis of the measurement system. Ideally, this corresponds to the optical axis of the sample. A portion of the incoming light beam is reflected to the measurement head on each surface of the lens system. The reflected light is guided to a photodetector.

The **reference beam** crosses the optical delay line (ODL). During the measurement, the optical path length (OPL) varies due to the optical delay line. The light is also directed to a photodetector and superimposed on the object beam.

If the OPL of the object beam and that of the reference beam match, interference modulations are the result. The modulation intensity is described by an envelope curve.

The positions of the maximum modulation determine the position of the surfaces.

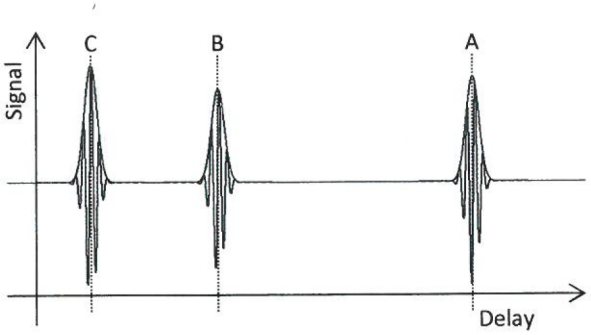


Fig. 21: OptiSurf interference modulations

5 Installation and Initial Startup

NOTE

Potential damage to the measurement system or its components due to improper installation

Improper setup or incorrect installation may damage the measurement system or impair its function. This will result in inaccurate measurement results.

– Only employees of TRIOPTICS GmbH or correspondingly trained and authorized persons are permitted to unpack, install, and commission the measurement system.

5.1 Transport

Temperature range during transport

+5 °C to +40 °C (humidity 40-65 %)

Delivery

The measurement system is delivered packed in a wooden crate.

The accessories are packed in boxes.

WARNING

Risk of injury

Working on the measurement system involves risks of injuries from cutting, piercing or crushing. Personal protective equipment required.

– Wear protective gloves to DIN EN 388.
– Wear a safety vest.
– Wear safety shoes of grade S2 to DIN EN ISO 20345.

Damage to the packaging

– Check the packaging for damage upon delivery.
– Document any damage to the packaging and report this immediately to *Customer service [▸ 251]*.

Means of transport

– If possible, transport the measurement system to its final location in the wooden crate.

5.2 Storage

– If the measurement system is to be stored prior to installation, store it in a dry and dust-free environment at +15 °C to +32 °C (humidity 40-65 %).

WARNING

Risk of injury from sharp components

Hands/arms can be injured on rough, sharp surfaces of crates, pallets or nails.

– Wear protective gloves to DIN EN 388.

5.3 Installation site

The set-up location for the measurement system must meet the following conditions:

– In closed heated rooms
– Level and sturdy surface
– Free of vibrations
– Constant ambient temperature (ideally 20 - -22 °C, max. 25 °C)
– Relative humidity 40 to 65 %
– Altitude: -50 to +2000 m above sea level
– Free of smoke and dust
– No direct sunlight
– Avoid setting up directly under the outlet of the air conditioning system

NOTE

Inaccurate measurement results due to vibration

If the measurement system is placed on a sturdy table, the vibration isolation through the rubber feet is sufficient for the proper operation of the measurement system.

– An optical measuring table is recommended for the highest accuracy.

5.4 Required space

Information on the required space can be found in the *Technical Data [▸ 29]* section.

NOTE

Required space

The operator must have at least 1 m of space in front of the device.

Ventilation requires a clearance of at least 0.1 m to the rear and sides.

5.5 Required external connections

Power supply

DANGER

Danger to life due to electric shock!

Electrical currents may pose a hazard.

– Connect the measurement system and the equipment only to properly grounded electrical outlets.

The measurement system and its accessories are available for 100 - 120 VAC or 220 - 240 VAC, 50 Hz or 60 Hz.

Two sockets (with at least C16 fuses) are required.

Compressed air

NOTE

Ask the provider what kind of compressor is best suited to ensure the following requirements.

- 5 bar
- max. residual dust content class 1 (to DIN ISO 8573-1)
  Residual oil content: max. 0.01 mg/m^3
  Residual dust: max. 0.1 µm
  Residual dust: max. 0.1 mg/m^3
- Max. residual water content class 3 (to DIN ISO 5873-1)
  Residual water dew point: -20 °C
  Residual water max. 0.88 g/m^3
- Air requirement: < 50 l/min
- 6 mm hose

Network connection

Optional

Internet access

Not mandatory, but recommended for remote support.

5.6 Cabling

DANGER

Risk of electric shock

Parts that are under tension due to faulty connections pose a risk of electric shock.

– Any work on the electrical system must be performed by appropriately qualified persons.
– Lock the switch cabinets.
– Check the electrical system on a regular basis.

– Connect all cables, optical fibers, connecting lines and compressed air hoses according to the labeling.

5.7 Software

The OptiCentric 9 program is preinstalled upon delivery of the measurement system if the measurement system is delivered with a PC.

5.8 Copy protection key (hardware dongle)

– Insert the copy protection plug (hardware dongle) into a USB port on your PC.

6 Operation

This chapter describes general topics related to operating the measurement system.

6.1 Pre-operation checks

CAUTION

Risk of material damage

– Do not operate the measurement system if parts are damaged.

1. Make sure the housing of the measurement system and the connecting cables are not damaged.
2. Make sure that there are no loose parts on the linear stages.
3. Make sure the compressed air supply is properly connected and the connecting hoses are not damaged.
4. Ensure that the sample holder and the optical components are clean.

6.2 Switching the measurement system on

CAUTION

Risk of material damage

Rotating the air bearing without compressed air will result in damage to the air bearing. Precise measurements will then no longer be possible.

– Always turn on the compressed air supply first before using the measurement system.

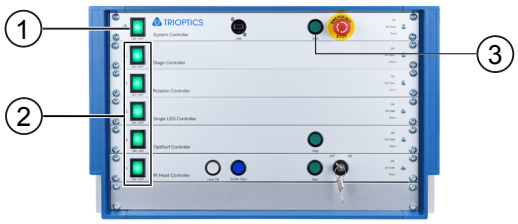


Fig. 22: Electronics rack

1. If fitted: Remove the dust protector hood from the measurement system.
2. Connect the measurement system to the power supply.
3. Switch on the compressed air supply.

4. Switch on the system controller with the **ON/OFF** switch **1** .
   ⇨ The PC will start up.
5. Switch on the other control units with the relevant **ON/OFF** switch **2** .
   ⇨ The start button on the system controller lights up green. The measurement system can be started.
6. Switch on the measurement system with the **Start** button on the system controller **3** .
   ⇨ The button does not light anymore.
7. Start the software as described in the *Starting the program and initializing the measurement system [▸ 52]* section.
8. Reference the axes as described in the *Starting the program and initializing the measurement system [▸ 52]* section.

⇨ The measurement system is now ready for operation.

6.3 Starting the program and initializing the measurement system

Fig. 23: Copy protection key (hardware dongle)

The Program OptiCentric 3 can be started as soon as the computer has booted completely and the measurement system is switched on (refer to chapter *Switching the measurement system on [▸ 51]*).

NOTE

The software can be started only if the copy protection plug (hardware dongle) is plugged into a USB port on your PC.

1. Start the software by double-clicking the desktop icon labeled `OptiCentric` .
   ⇨ You will see the following splash screen with vendor and version information:

Fig. 24: Startup screen

Reference cycle

The program is started. All axes are referenced. The message `Please wait` is displayed.

WARNING

Risk of injury from moving components

When working on the measurement system, injuries can be caused by movable components.

– During the reference cycle, maintain sufficient distance from the movable components of the measurement system.

Program and measurement system are operational after the reference cycle. The device displays the program window of the measurement program that was last selected.

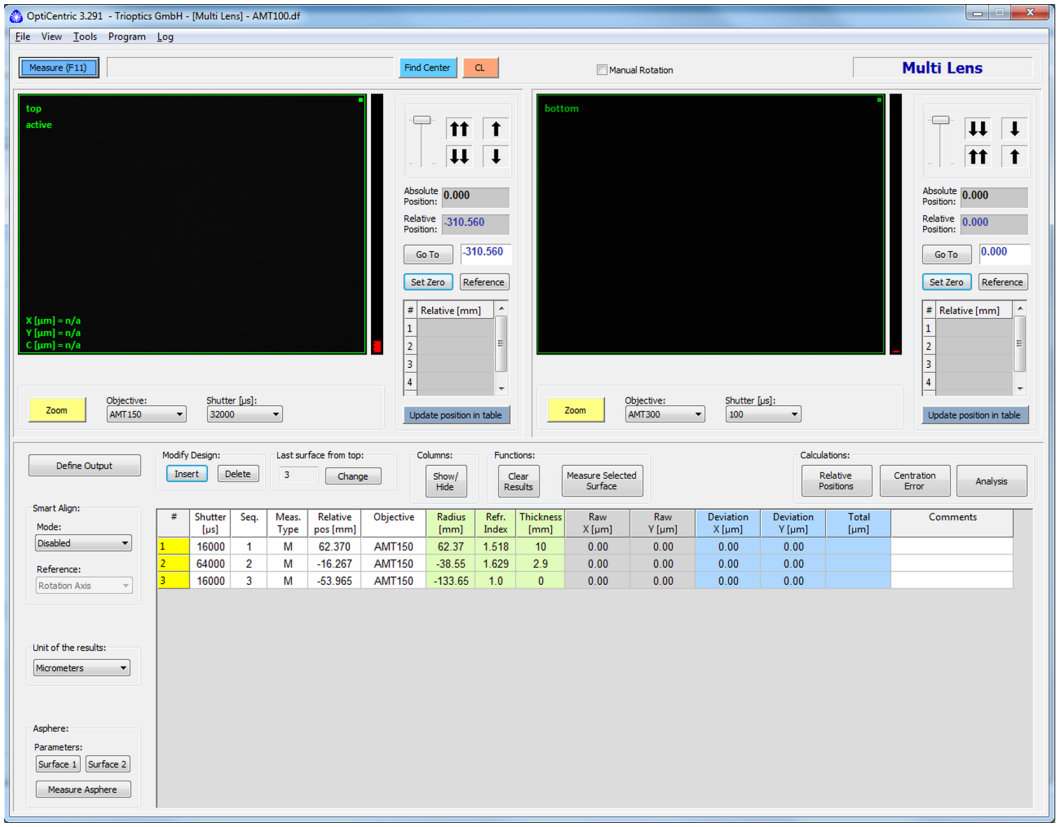


Fig. 25: Example: MultiLens program window

NOTE

A reference cycle is always mandatory after a restarting the measurement system or after an emergency stop. Otherwise the positions of the individual axes are unknown.

6.4 User rights

The software of the measurement system has the following user levels:

User	Rights
Operator	Has basic user rights. Can execute scripts, perform pre-configured measurements and issue certificates.
Supervisor	Authorized person with full user rights, for example: • Configure measurements • Edit and save scripts.
Administrator	Person with full user and configuration rights This user level is normally restricted to TRIOPTICS personnel for installation and maintenance of the measurement system.

NOTE

Change password

The password for the supervisor is preset to “admin” upon delivery of the measurement system.

– To change the password, select <Settings> <General> and set a new “Supervisor Password.”

– The “Administrator” user level is generally reserved for service staff of the manufacturer.

6.5 Login / Logout

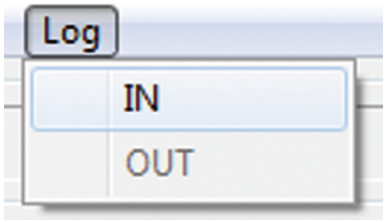


Fig. 26: Login

Follow these login steps:

1. Select <Log> <In>.
2. Enter the password and click <OK>.

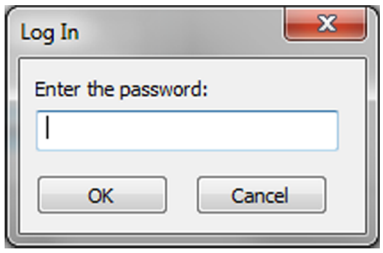


Fig. 27: Login

Follow these steps to logout:

Select <Log> <Out>.

The administrator or supervisor is logged off. Then you will have the restricted user rights of an operator again.

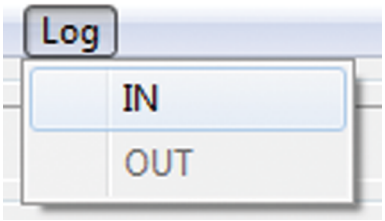


Fig. 28: Login

6.6 Placing and securing the sample

OptiCentric® 100 IR measures a wide range of samples with different dimensions and weights.

Preparation

Threaded holes are provided on air bearing and tip-tilt-table to mount the sample. For the dimensioned drawings please refer to the annex.

In some cases, the sample can be screwed on directly.

If this is not the case, a suitable retainer must be built for each individual sample.

Placing the sample

WARNING

Risk of injury

The sample can have a weight of up to 80 kg. A maximum weight of 20 kg is permissible when using the tip-tilt table.

– Only use suitable and tested lifting equipment to lift the sample.

1. Lift the sample onto the measurement system.
2. Fix the sample.

6.7 Moving the measurement head

This section describes the different ways to focus and to move to a specific position or a center of curvature.

The measurement head is is moved via the software by means of the arrow keys.

The following functions for moving the measurement head are available:

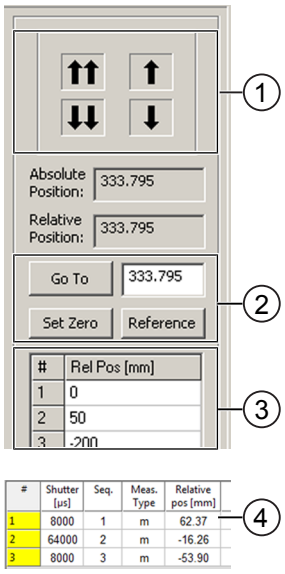


Fig. 29: Moving the measurement head, overview

1	Moves the measurement head using the arrow buttons
2	Move the measuring head using the GoTo button
3	Moves the measurement head to relative positions
4	Moves the measurement head via the design table

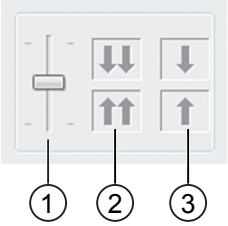


Fig. 30: Moving the measurement head, arrow buttons

Moves the measurement head using the arrow buttons

1	Slide bar Changes the speed at which the measurement head is moved. Adjust the slide bar upward: the speed is increased. Adjust the slide bar downward: the speed is reduced.
2	Double arrow buttons Move the measurement head up or down quickly The measurement head is moved at XXX % of the set speed.
3	Single arrow buttons Move the measuring head up or down slowly The measurement head is moved at XXX % of the set speed.

Move the measuring head using the GoTo button

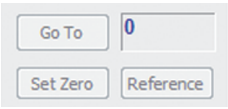


Fig. 31: Move the measuring head, Go To

1. Enter the desired position (relative to the set zero position) using the keypad.
2. Click on the Go To button.
   The linear stage is moved to the specified position.

Moves the measurement head to relative positions

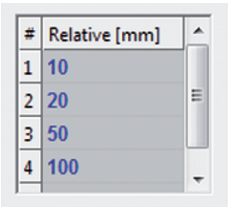


Fig. 32: Move the measuring head, relative position

Five positions (relative to the defined zero position) can be entered in the table.

– Double-click the column # to move the measurement head to the corresponding position.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]
1	8000	1	m	62.37
2	64000	2	m	-16.26
3	8000	3	m	-53.90

Fig. 33: Move the measuring head, design table

Moves the measuring head via the design table

– Double-click the column # to move the measurement head to the corresponding position.

6.8 Manually focus on a surface

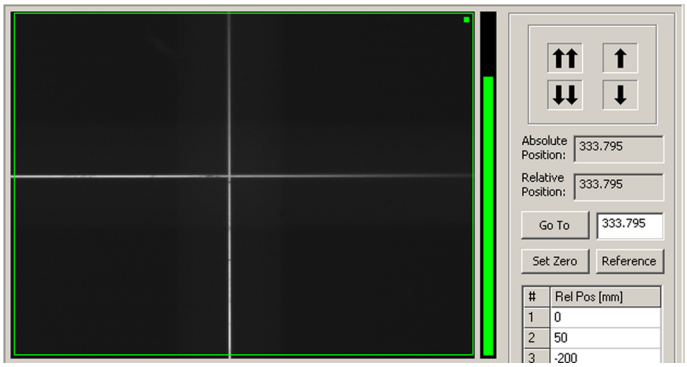


Fig. 34: Camera window

1. Select a head lens with positive focal length in the range of 50 to 500 mm.
2. Place a sheet of paper on the surface.Use the arrow keys to move the guide until the crosshair can clearly be seen on the paper.
3. Remove the paper and make any fine adjustments via the camera image.

6.9 Selecting the head lens

This section describes the criteria and the different options for selecting a head lens.

Please note the following criteria:

- The focal length of the head lens should generally be as small as possible. The smaller the effective focal length, the higher the measurement accuracy. However, this will also decrease the size of the image field. A greater focal length and thus a larger image field may be required if the sample is not fully pre-centered or if the tolerance is high.
- For a convex sample surface, the back focal length of the head lens must be greater than the radius of curvature to prevent the optics mechanically colliding with the sample.
- When measuring objectives, it may be necessary to use different head lenses.

With motorized objective changer

– Select the objective from the list.
  The objective changer will proceed accordingly.

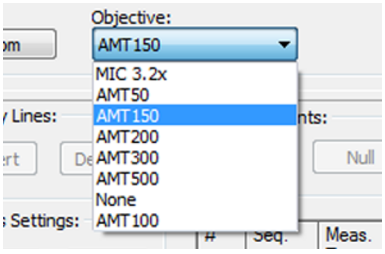


Fig. 35: Objectives

NOTE

Reference position in the case of different back focal lengths

The different back focal lengths of the objectives are compensated, so that a predetermined reference position is maintained.

NOTE

Type and source of danger

Refer to chapter *<Settings> Register <Objectives> (Head lenses) [▶ 179]* for information on how to assign head lenses to the motorized objective changer.

With motorized objective changer

1. Screw the required objectives into the desired position.
2. Turn the objective changer to the desired position.
3. Select the objective from the list.

NOTE

Incorrect measurement results in the case of incorrect allocation of the head lenses

If the objective selected in the software does not correspond to the objective that is actually mounted, the results of the measurement will be wrong.

Without objective changer

1. Unscrew the current head lens.
2. Screw the desired head lens in and select the corresponding objective from the list.

6.10 Intensity setting

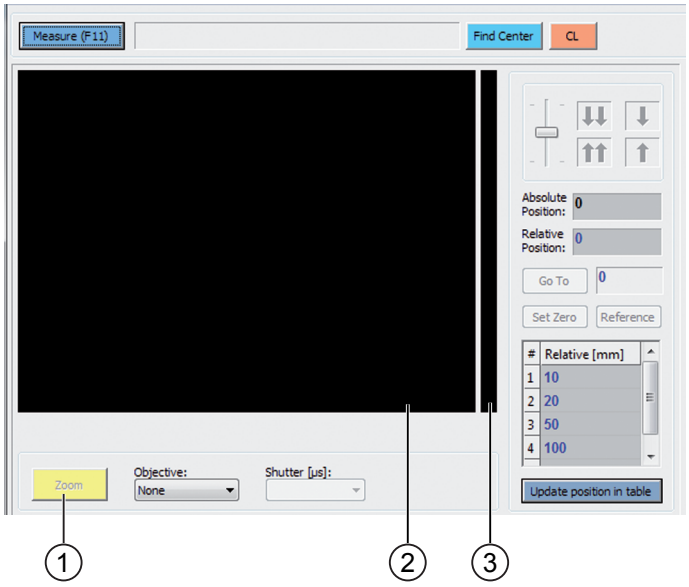


Fig. 36: Intensity setting

The intensity of the camera image **2** depends on various factors, including:

- Brightness of the light source
- Exposure time
- Number of surfaces
- Reflectivity of the lens surface
- Objective used

The bar graph **3** shows the light intensity in the measuring window (AOI):

- Green readout when saturated within a certain range
- Red readout if saturation level exceeded or not reached

NOTE

Low exposure times mean the effect of ambient light is minor. Motion artifacts do not occur.
The signal-to-noise ratio is better when using longer exposure times.
The required exposure time is shorter if brightness increases.

– Please note that cemented surfaces always require a slightly higher illumination.

– If necessary, change the exposure time in the drop down menu **1** `Shutter [µs]` until the bar graph for the light intensity is approximately at the center.

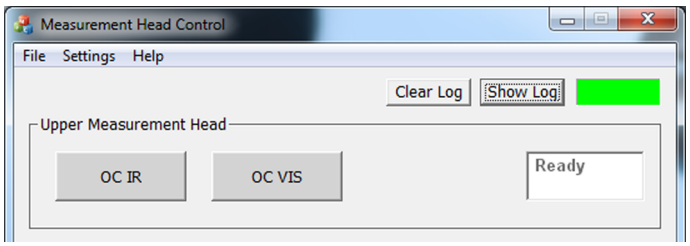
6.11 Setting VIS / IR mode

VIS mode is always active first when you switch on the measurement system.

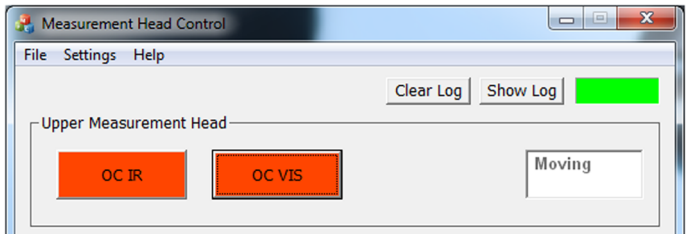
This chapter describes how to activate the IR mode after restarting the measurement system and how to switch between VIS and IR mode during operation.

6.11.1 Setting IR / VIS mode in the software (software OC 3.277)

View A



View B



View C

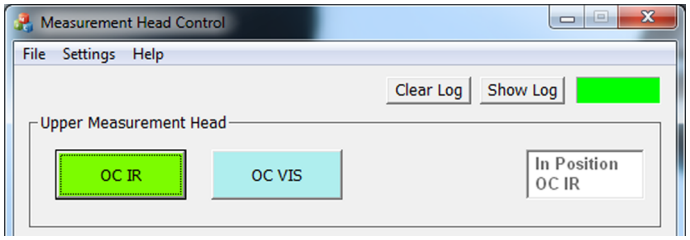


Fig. 37: Switch measurement mode from VIS to IR

NOTE

View in the window depends on the configuration of the measurement system

Depending on the configuration of your measurement system, there is a section available for each measurement head in which you can choose options for the measuring mode.

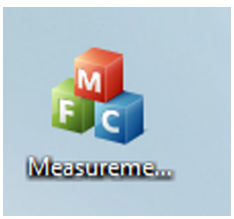


Fig. 38: Desktop Icon, Measurement Head Control

1. Close the software OptiCentric 3,277.
2. Click the desktop icon with the label `Measurement Head Control`. The window `Measurement Head Control` (view A) opens.
3. To move the measurement head to the IR position, click the `OC IR`button.
   Or:
   To move the measurement head to the VIS position, click the `OC VIS`button.

⇨ The mirror moves to release the beam path for the respective measurement head. During this time, both buttons turn red (view B).

⇨ Once switched over, the active measurement head is shown in green (view C).

4. Activate the relevant measuring mode on the IR Head Controller. To do this, follow the instructions in *Switch measurement head from VIS to IR [▸ 64]*.
5. Re-start the software OptiCentric 3,277.

⇨ The measurement system is now ready for operation with the new VIS / IR configuration.

6.11.2 Switch measurement head from VIS to IR

Activate IR mode

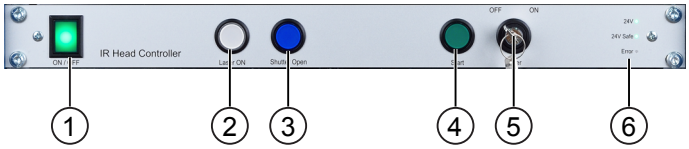


Fig. 39: IR Head Controller

To activate the measurement head for measurement in the IR mode, proceed as follows:

✓ Requirement: The IR mode has been set in the software as described in *Setting IR / VIS mode in the software (software OC 3.277) [▸ 63]*.

✓ The control lamp **Start (4)** on the IR Head Controller lights up.

1. Turn the **key-operated switch 5** to the **ON**position.
2. Press the **Start button (4)** on the IR Head Controller.

⇨ The control lamp **Laser ON (2)** lights up.

⇨ The control lamp **Shutter Open (3)** lights up.

⇨ The measurement system is ready for measurement in the IR mode.

Switch measurement head from IR to VIS mode

To switch the measurement head from IR mode to VIS mode, proceed as follows:

✓ Requirement: The IR mode has been set in the software as described in *Setting IR / VIS mode in the software (software OC 3.277) [▸ 63]*.

1. Turn the **key-operated switch 5** to the **OFF**position.

⇨ The control lamp **Shutter Open 3** turns off.

⇨ The measurement system is ready for measurement in the VIS mode.

Switch measurement head from VIS to IR mode

To switch the measurement head from VIS mode to IR mode, proceed as follows:

✓ This procedure only applies if the IR mode has already been activated during ongoing operation.

✓ Requirement: The IR mode has been set in the software as described in *Setting IR / VIS mode in the software (software OC 3.277)* [▸ 63].

1. Turn the **key-operated switch 5** to the **ON**position.
   ⇨ The control lamp **Shutter Open 3** lights up again.
   ⇨ The shutter turns on automatically.

⇨ The measurement system is ready for measurement in the IR mode.

6.12 The coordinate system

Fig. 40: Measurement system, coordinate system

The measurement system is delivered with a left-handed coordinate system.

X-axis	• parallel to the front of the measurement system • points right from the operator's point of view
Y-axis	• points back from the operator's point of view
Z-axis	• points downwards in the table • is parallel to the optical axis of the measurement head • corresponds to the rotational axis of the air bearing

6.13 Outputting measured values as a certificate

General texts

First, enter the information for the header of the certificate. Follow these steps:

1. Select <File> <Certificate Entries> (certificate entries).
2. Enter the texts and confirm with OK.

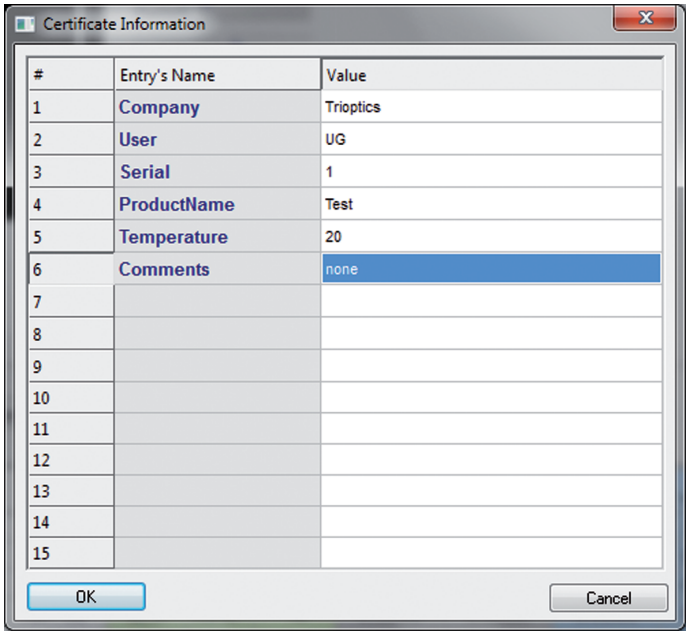


Fig. 41: Certificate, entering additional information

NOTE

Type and scope of the information

The columns "Entry name" and "Value" are free text fields. The maximum number of rows is 15.

Viewing the certificate

Select <View> <Certificate>.

The certificate is displayed.

Fig. 42: Certificate

Saving the certificate as an HTML file

1. Select <File> <Generate HTML Certificate>.
2. Enter the file name and click Save.

⇨ You can now open the certificate with the browser and print it.

Export certificate data, e.g., for import to Excel

1. Select <File> <Export to CSV>.
2. Enter the file name and click Save.

⇨ You can now import the certificate to Excel and edit or print it.

6.14 Emergency stop in dangerous situations

Fig. 43: Emergency stop

The emergency stop button is located on the right-hand side of the measurement system from the operator's point of view, and on the system controller.

To immediately interrupt the power supply of the motors in a dangerous situation, press the emergency stop button.

The power supply is interrupted and all movements of the measurement system are stopped immediately.

The emergency stop button locks into place.

NOTE

The power supply for the PC is not connected to the emergency stop. All data entered and measurement results are retained.

NOTE

Only use the emergency stop button in emergencies.

6.15 Restarting after emergency stop

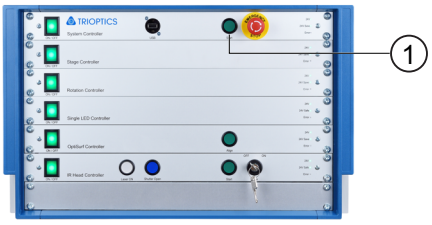


Fig. 44: Switching the measurement system on

1. Remove the reason for the danger and turn the emergency stop button to unlock it.
2. Press the **Start** button **(1)**to re-start the measurement system.

⇨ The measurement system is again ready for operation.

6.16 Switching the measurement system off

Follow these steps to disable the measurement system:

1. Close the software.
2. Switch off the system controller with the **ON/OFF** switch **1** .

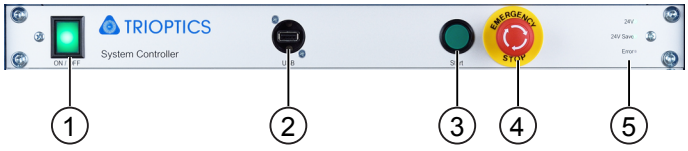


Fig. 45: System controller

⇨ The other control units are switched off.

⇨ The PC shuts down.

3. Switch off the monitor.
4. Switch off the compressed air supply.
5. Disconnect the measurement system to the power supply.
6. If fitted: Cover the measurement system with the dust protector hood.

7 Setting up the hardware

7.1 Mounting the tip-tilt-table

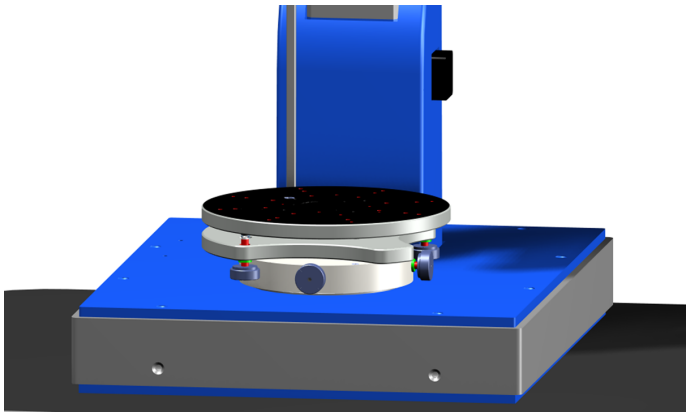


Fig. 46: Install the tip-tilt table TRT 200

Required tools

Allen key (hex) size 3 mm

1. Carefully place the tip-tilt-table on the air bearing.
   ⇨ The adjusting screws should be located at the front and on the right-hand side.
2. Tighten the four fastening screws.

7.2 Fitting/removing bridge and lens rotating device

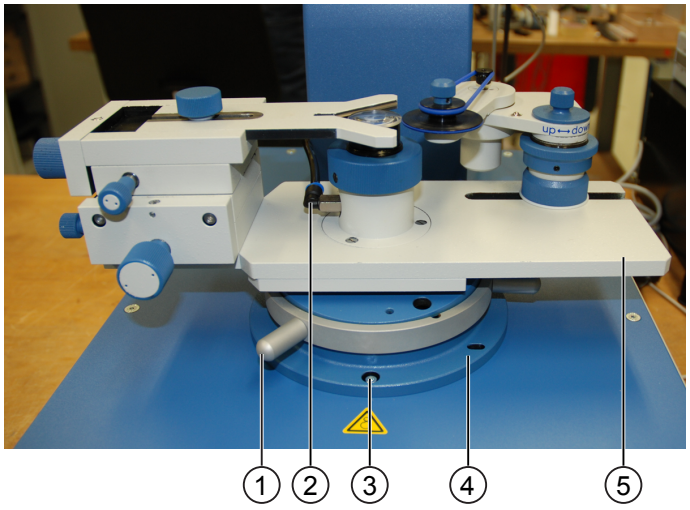


Fig. 47: Fitting/removing bridge and lens rotating device

Fitting bridge and lens rotating device

NOTE

The tip-tilt-table must be removed.

Required tools

Allen key (hex)

Material

Screws

Vacuum hose

Cable

1. Place the bridge **(4)** on the table of the measurement system.
   ⇨ The lever **(1)** should be on the right-hand side.
2. Tighten the three fastening screws **(3)** .
3. Place the cone of the lens rotating device into the receptacle of the bridge.
4. To lock the lens rotating device, swing the lever **(1)** to the left.
5. Connect the vacuum hose of the vacuum control unit to the connection of the lens rotating device. **(2)**.
6. Connect the monitor cable to the lens rotating device.
7. Connect the foot switch, if you wish to use one.
8. Connect the supply line of the lens rotating device to the power supply.

Removing bridge and lens rotating device

Required tools

Allen key (hex)

1. Loosen the connections for vacuum **(2)** and motor from the lens rotating device **(5)**.
2. Swing the lever **(1)** counter-clockwise and lift the lens rotating device upward to remove it.
3. Loosen the three fastening screws **(3)**.
4. Remove the bridge **(4)** .

7.3 Connecting and activating the probe

NOTE

The description only applies to external distance sensors (optical or tactile) with OptiCentric® MOT.

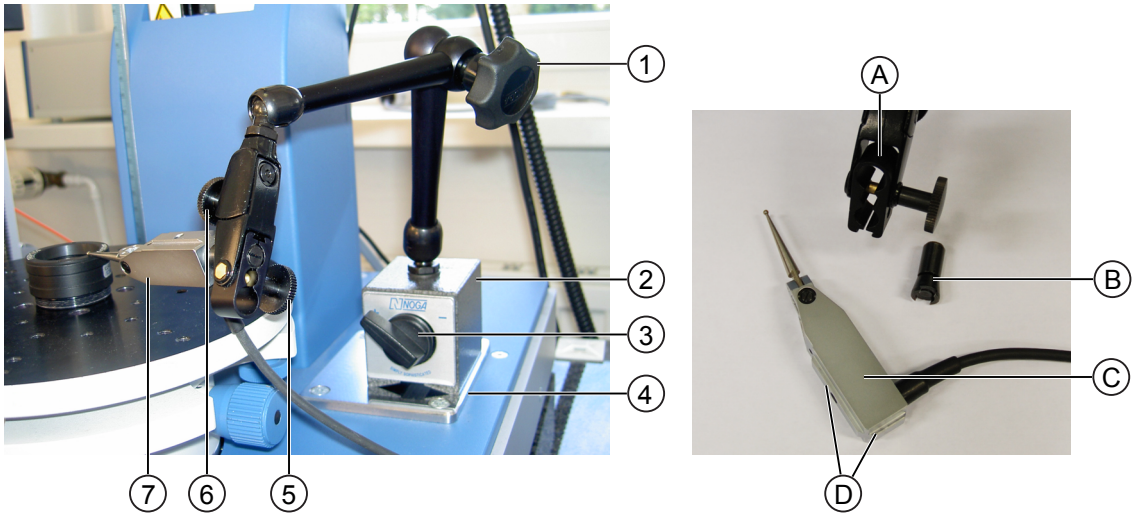


Fig. 48: TESA sensor

1. Place the foot **(2)** of the measuring sensor on the steel plate **(4)**.
2. Turn the switch **(3)** to "+" to secure the foot.
3. Connect the cables and wires according to the labeling.
4. Under `<Tools> <Settings>, select` the `<Distance Sensor>`tab.
5. Under `Choose sensor type` select the `TESA 1` or `TESA 2`sensor.
6. In COM port enter the number of the serial interface.
7. Tick the checkmark for Available.
8. Click OK.

Moving the probe head into position

1. For the rough setting: Loosen the star screw **(1)** and adjust the arm of the measuring sensor.
2. For the fine setting: Loosen the knurled screws **(5)** and **(6)** and adjust the arm of the measuring sensor.
   Tip:
   The measurement head **(C)** can be secured using the

dovetail clamp **(B)** in the clamp **(A)** .
Another option is to insert the dovetail **(D)** directly into the clamp **(A)** . The clamp **(B)** must be unscrewed.

3. Turn the probe head **(7)** so that the cable is pointing backwards or downwards.

NOTE

Gently press the probe sensor at the start of a measurement.

The starting position of the probe sensor should be approximately in the center of the measuring range.

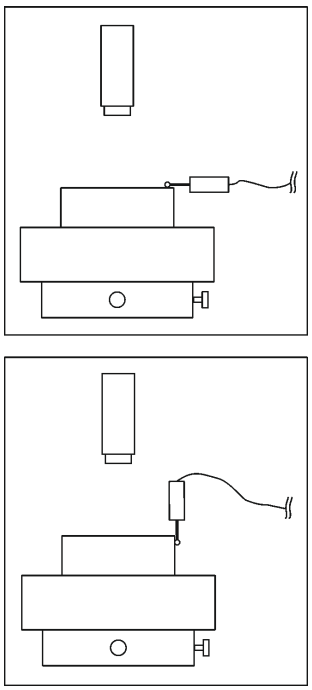


Fig. 49: Measuring axial run-out and radial run-out, schematic diagram

To **measure the axial run-out** the probe must be positioned on top of the sample. The probe must be able to move vertically.

To **measure the radial run-out** the probe must be positioned on the outer side of the sample. The probe must be able to move radially vertically.

8 Centering Error Measurement in Reflection

This chapter describes the measurement procedure for the wobble of a flat surface and the centering error of a spherical (lens) surface.

The measuring principle is described in *Centering Error Measurement in Reflection [▸ 42]*.

8.1 Preparation

General preparations

1. Perform the checks prior to operating the unit as described in chapter *Pre-operation checks [▸ 51]*.
2. Power up the measurement system as described in *Switching the measurement system on [▸ 51]*.
3. Select `<Program> <Centration in Reflection>` (measuring mode “Centering error measurement in reflection”).

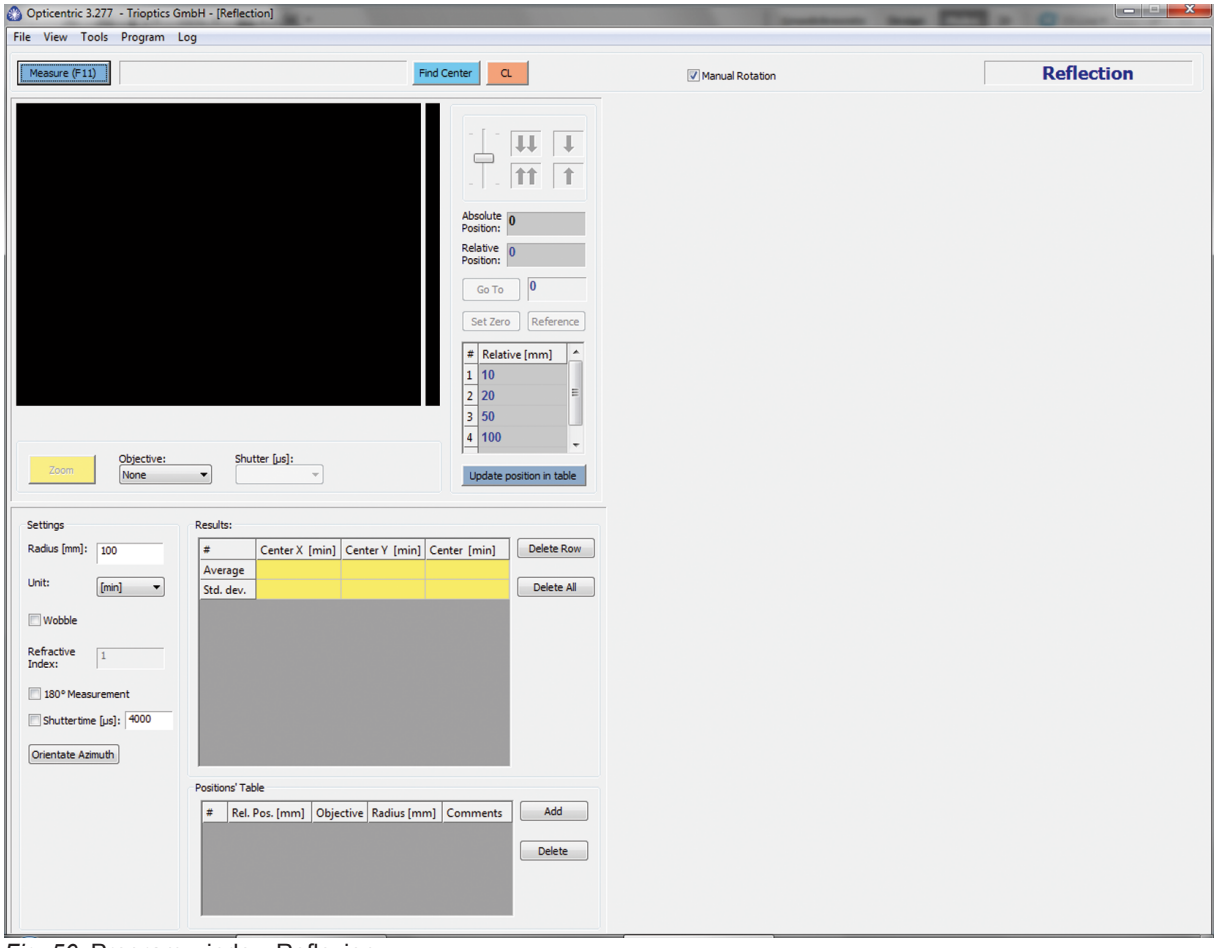


Fig. 50: Program window Reflexion

8.2 Measuring the wobble

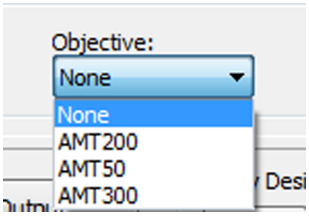


Fig. 51: program window Reflection, Objective

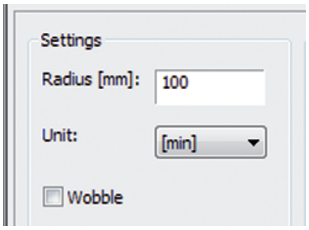


Fig. 52: program window Reflection, Wobble

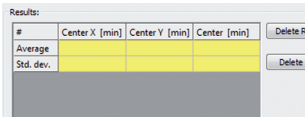


Fig. 53: program window Reflection, Results

The wobble of a flat surface is measured using collimated light in reflection.

1. Select the setting None under Objective to deselect the head lens of the autocollimator.
   ⇨ A motorized objective changer will move into position accordingly.
   ⇨ A manual objective changer must be set to an empty position.
   ⇨ If no objective changer is used, the head lens must be unscrewed and removed.
2. Control the intensity on the camera by adjusting the exposure time (“Shutter”) or by adjusting the light intensity of the light source (refer to chapter *Intensity setting [▸ 61]*).
3. Tick the checkmark for Wobble to measure the wobble.
4. Under Unit select min (minutes) or sec (seconds) to set an angular size for the unit of measurement.
5. To perform a measurement, click on the Measure button or use the **F11** function key.

⇨ The rotary bearing is rotated by 360°.

⇨ The results of this measurement are then listed in the table `Results`.

8.3 Measuring centering errors of a spherical lens surface

CAUTION

Material damages

For a convex sample surface, the back focal length of the head lens must be greater than the radius of curvature to prevent the optics mechanically colliding with the sample.

1. Use a suitable mount to place the sample into the measurement system.
2. Loosen the thumb screw and move the safety limit switch within the guidance (refer to chapter .
   ⇨ The safety limit switch has to limit the travel of the measurement head so that collisions with the sample are avoided.

⇨ If necessary, move the measurement head upwards.

3. Re-tighten the knurled nut.
4. Remove the checkmark for `Wobble`.
5. Enter the radius of curvature for the topmost sample surface into the field `Radius`.
6. Select the desired unit of measurement for the output under `Unit`.

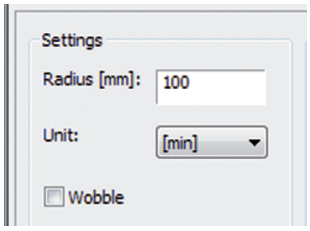


Fig. 54: program window Reflection, Wobble

NOTE

The design value is sufficient.

The radius is important if the results are provided as an angle (arc min, arc sec).

7. Select an appropriate head lens for the centering error measurement (refer to chapter *Selecting the head lens [▸ 60]*).
8. Focus on the vertex of the topmost sample surface (refer to chapter *Manually focus on a surface [▸ 59]*).
9. To set this position as a reference position, click Set Zero.
10. Enter the nominal radius into the position field and click on the button `Go To` to move to the center of curvature.
11. Now, check the focus of the autocollimation image and the intensity of the camera and amend it, if required.

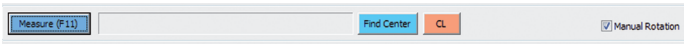


Fig. 55: program window MultiLens, Measure and Find Center buttons

NOTE

When using a vacuum rotary device, tick the checkmark in front of Manual Rotation (external rotation possible) before starting the measurement.

12. To perform a measurement, click on the button Measure or use the function key **F11**.

⇨ The rotary bearing is rotated by 360°.

⇨ The results of this measurement are then listed in the table “`Results`”.

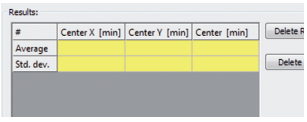


Fig. 56: program window Reflection, Results

8.4 Saving positions

The measurement settings can be saved for performing measurements for several individual surfaces in succession.

1. Click the button `Add` to add a row.
2. Enter values for the relative position, the head lens, the radius of curvature and a comment, if required.

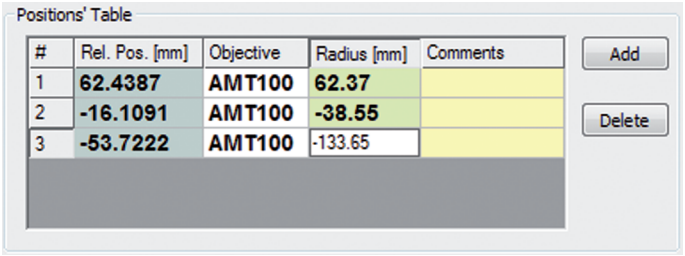


Fig. 57: program window Reflection, Positions table

3. Double-click the number # to move to a specific position.

⇨ The radius is added to the settings.

Storing values

– Select <File> `<Config File>` `<Save>` to store the values in the configuration file.

Loading values

– Select <File> `<Config File>` `<Open>` to load the values from the configuration file.

9 Centering error measurement in transmission

This chapter describes centering error measurement in transmission. Compared to measurement in reflection and the MultiLens® measurement, this measurement is fast and simple.

Generally, the measurement in transmission provides information on the offset of the optical axis to the reference axis. However, it is advisable to use caution when interpreting the measured data.

The measuring principle is described in .

9.1 Preparation

1. Perform the checks prior to operating the unit as described in chapter *Pre-operation checks [▸ 51]*.
2. Power up the measurement system as described in *Switching the measurement system on [▸ 51]*.
3. Select `<Program> <Centration in Transmission>` (measuring mode “Centering error measurement in transmission”).

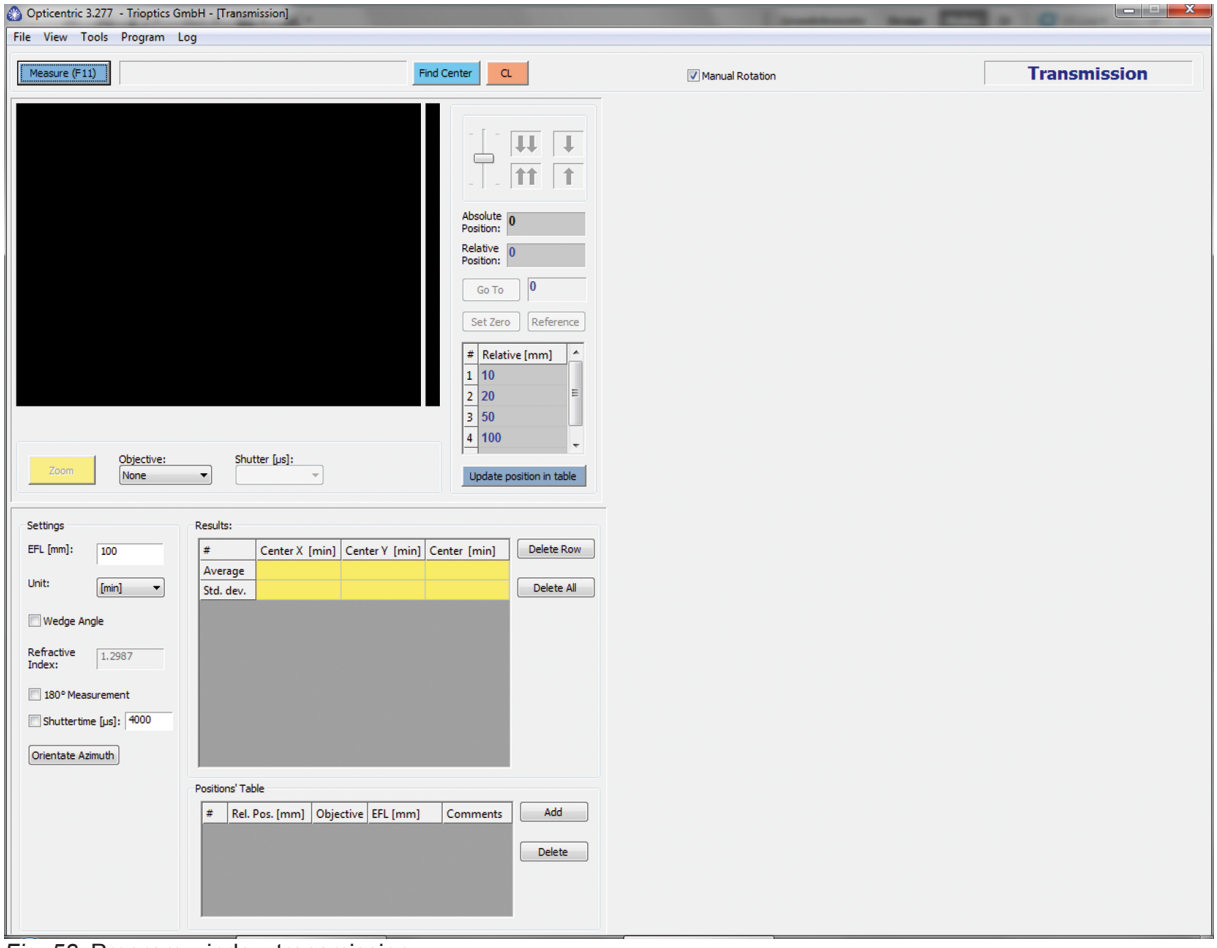


Fig. 58: Program window transmission

9.2 Measuring the centering error of a multi-lens optical system

CAUTION

Material damages

For a convex sample surface, the back focal length of the head lens must be greater than the radius of curvature to prevent the optics mechanically colliding with the sample.

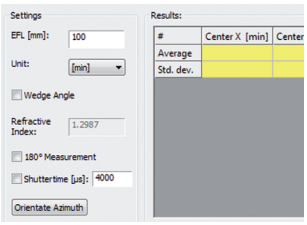


Fig. 59: program window Transmission, Settings

1. Use a suitable mount to place the sample into the measurement system.
2. Select an appropriate head lens for the centering error measurement.
3. Use the input field `EFL [mm]` to enter the focal length of the sample.
4. Select the desired unit of measurement for the output under `Unit`.
5. Remove the checkmark from `Wedge Angle`.
6. Focus on the vertex of the topmost sample surface (refer to chapter *Manually focus on a surface [▶ 59]*).
7. To set this position as a reference position, click `Set Zero`.
8. In order to move to the focal plane, enter the back focal length and click on the button `Go To`. Note the preceding positive or negative sign!
9. Now, check the focus of the autocollimation image and the intensity of the camera and amend it, if required.

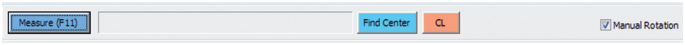


Fig. 60: program window, Measure and Find Center buttons

NOTE

When using a vacuum rotary device, tick the checkmark in front of Manual Rotation (enable motor rotation) before starting the measurement.

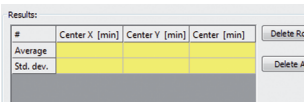


Fig. 61: Program window Transmission Results

1. To perform a measurement, click on the button Measure or use the function key **F11**.

⇨ The rotary bearing is rotated by 360°.

⇨ The results of this measurement are then listed in the Results table.

9.3 Saving positions

If multiple positions for multiple samples are to be measured in succession, the measurement settings can be saved.

1. Click the button `Add` to add a row.
2. Enter values for the relative position, the head lens, the effective focal length (EFL), and a comment, if required.

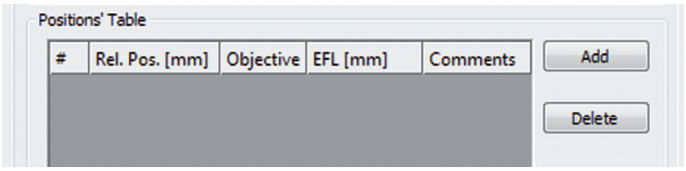


Fig. 62: program window Transmission, PositionsTable

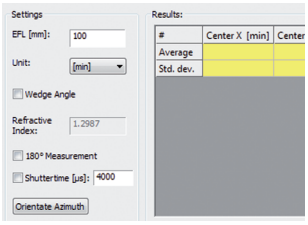


Fig. 63: program window Transmission, Settings

3. Double-click the number `#` to move to a specific position.
   ⇨ The effective focal length (EFL) is added to the settings.

Storing values

– Select `<File> <Config File> <Save>` to store the values in the configuration file.

Loading values

– Select `<File> <Config File> <Open>` to load the values from the configuration file.

10 Measurement of radii of curvature

This chapter describes how to measure the radius of curvature of a sample.

10.1 Preparation

1. Perform the checks prior to operating the unit as described in chapter *Pre-operation checks [▶ 51]*.
2. Power up the measurement system as described in *Switching the measurement system on [▶ 51]*.
3. Select `Program Distance` (measuring mode “Radii”).

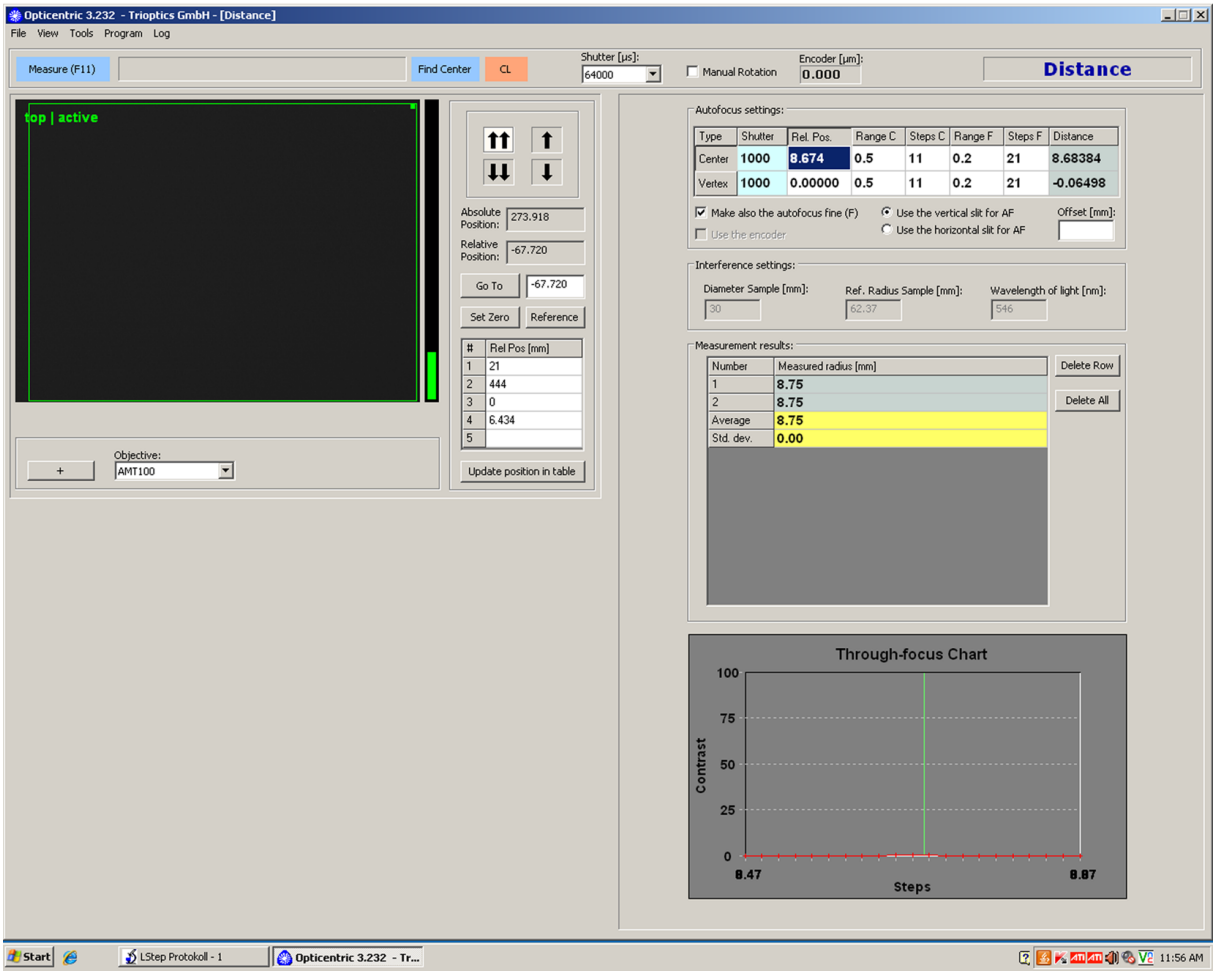


Fig. 64: Program window Distance

10.2 Measuring radii

1. Use a suitable mount to place the sample into the measurement system.
2. Select an appropriate head lens for the measurement.
3. Focus on the vertex of the topmost sample surface (refer to chapter 6.8, page 66).
4. To set this position as a reference position, click `Set Zero`.
5. Enter the nominal radius as the relative position for the center of curvature (Center).

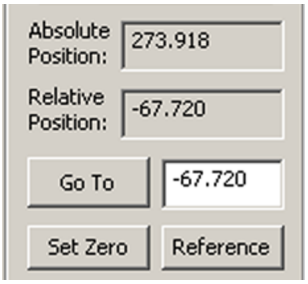


Fig. 65: Program window Distance Set Zero

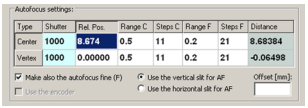


Fig. 66: Program window Distance Autofocus Settings

6. Enter the `Autofocus settings`. For further details refer to chapter *Program window "Distance" [165]*.
7. To conduct a measurement, click on the button `Measure` or use the function key **F11**.

   ⇨ The specified range around the first relative position is scanned for the position with the highest contrast (Best Focus Position). This is displayed in the Through-focus chart.

   ⇨ Subsequently, the best focus position is determined for the second relative position.

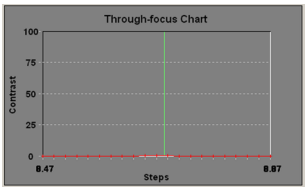


Fig. 67: Program window Distance Through-Focus Chart

⇨ The difference between the two positions is the radius of the measured surface. The result is then displayed in the `Measurement results` table.

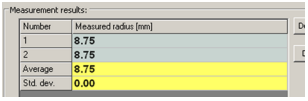


Fig. 68: Program window Distance Results

11 Edit design data

See also

MultiLens® measurement [▶ 44]

11.1 Creating the design table

As described in chapter *MultiLens® measurement [▶ 44]* beschrieben, the imaging effect of the surfaces in front must be taken into consideration when measuring centering errors of multi-lens systems.The imaging effect is essentially described by the lens design:

- Radius of curvature of the surfaces
- Refractive index of the medium behind the surface (for λ=546 nm)
- Distance to next surface

NOTE

Saving the design table

The design table can be prepared for a sample type and saved. Then, the saved parameters can be loaded and the measurements carried out.

Import design data from design file

If the design data for the sample were saved in a design file, they can be loaded.

1. Select <File> <Open Design file>.

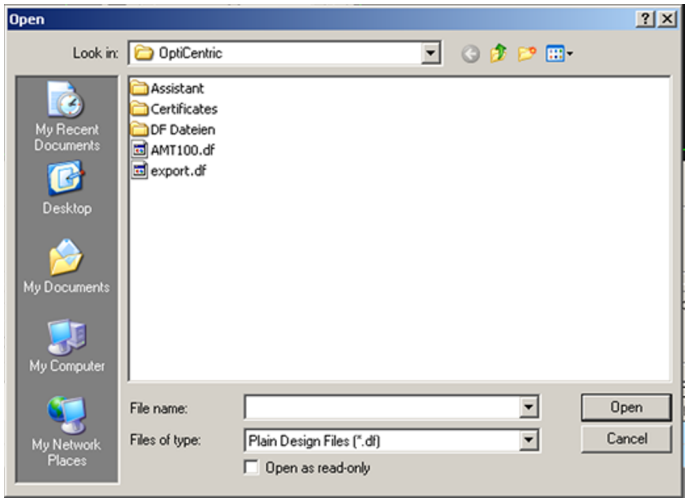


Fig. 69: Open the design file

2. Select the file (*.df) and click <Open>.

⇨ This reads in and displays the data.

NOTE

File format

*.df is a TRIOPTICS format.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Dev. X [µm]	Dev. Y [µm]	Absolute [µm]	Error	Threshold	Magnificat
1						62.37	1.51...	10								
2						-38.55	1.62...	2.9								
3						-133.65	1.0	0								

Fig. 70: Sample design data, AMT-100

Import design data from Zemax

If the design data for the sample are saved in a Zemax file, they can be imported.

1. Select <File> <Import Zemax file>.
2. Select the file (*.zmx) and click <Open>.

⇨ This reads in and displays the data.

NOTE

Enter the refractive index manually

The Zemax files only specify the types of glass, not the refractive index. The refractive index for the individual surfaces must be entered manually in Zemax' "Lens Data Editor".

Manually input or edit design data

NOTE

Storing the manually input design data

These manually input design data can be stored in a design file and imported again for measurements at a later date.

1. Select <File> <New>.
   ⇨ A new design table is created. It contains one row.

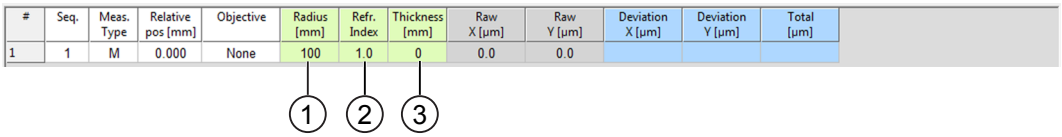


Fig. 71: Design file new

2. Now enter the values:

1	`Radius [mm]` Positive radius Negative radius Plane surface: enter “p”
2	`Refr. Index [mm]` Refractive index for λ = 546 nm
3	`Thickness [mm]` Distance to next surface; for last surface enter “0”

– Double-click in the box to enter or edit a value.

– To insert additional lines, click `<Modify Lines> <Insert>`
or:
Right click in the design table and select `Insert New Surface`.
One row for each optical surface!
– To delete the selected row, click `<Modify Lines> <Delete>`
or:
Right click in the design table and select `Delete Selected Surface(s)`.

Example

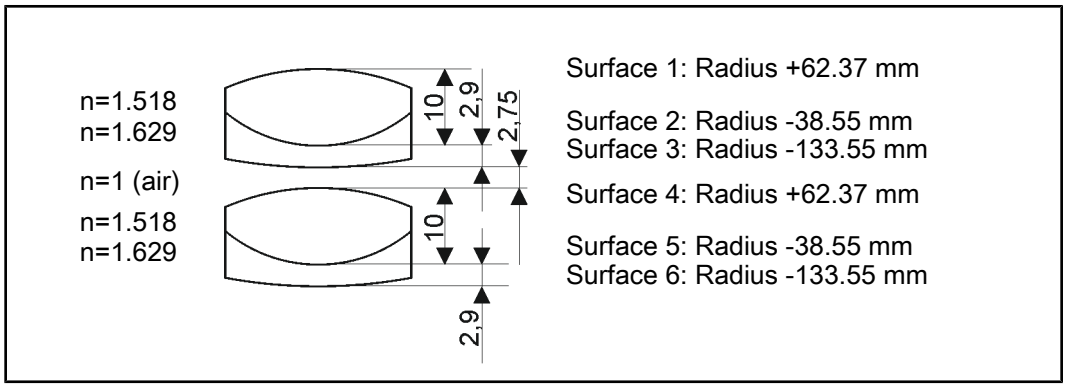


Fig. 72: Sample specimen, dimensions

#	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Dev. X [µm]	Dev. Y [µm]	Absolute [µm]	Error	Threshold	Magnification	Com
1	1				62.37	1.518	10									
2	2				-38.55	1.629	2.9									
3	3				-133.55	1	2.75									
4	4				62.37	1.518	10									
5	5				-38.55	1.629	2.9									
6	6				133.55	1	0									

Fig. 73: Sample specimen, design data

11.2 Saving the design table

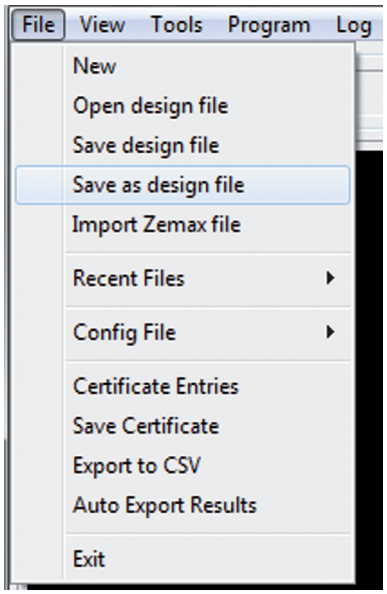


Fig. 74: Saving the design table

1. Select <File> <Save as design file> (Save as design table).
2. Select the directory and enter the file name (.df).
3. Click <Save>.

11.3 Changing the appearance of the design file

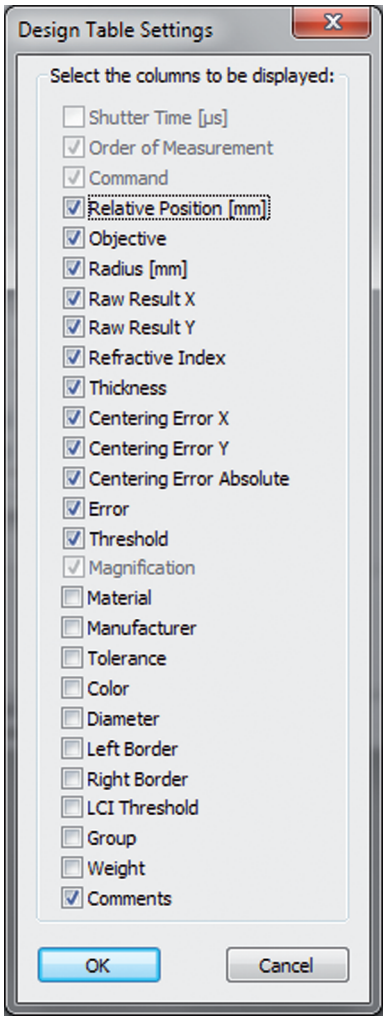


Fig. 75: Design table, settings

You can choose which columns are displayed in the design table.

– Click the `Columns` button.

  This opens a window where you can select the columns.

11.4 Calculate relative positions

The relative positions in the design table indicate the distance of the image of a center of curvature relative to the top lens vertex.

NOTE

Relative position of the first surface

For the upper surface, the relative position is equal to the radius of curvature.

1. Click <Calculate> <Relative Positions>.

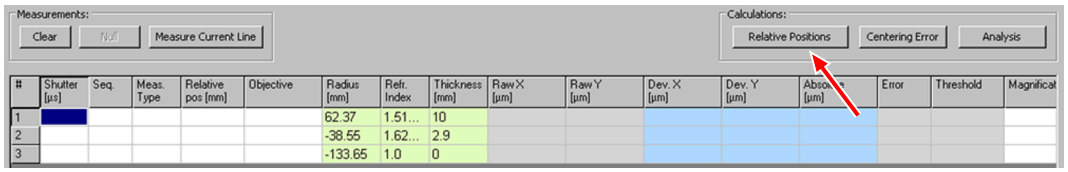


Fig. 76: Design data, relative positions

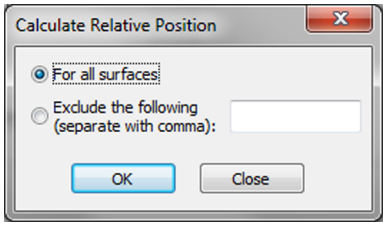


Fig. 77: Calculate relative positions, all surfaces

2. Select <For all surfaces> and click OK.

⇨ The relative positions of the individual surfaces are calculated and displayed in the Rel. pos. column

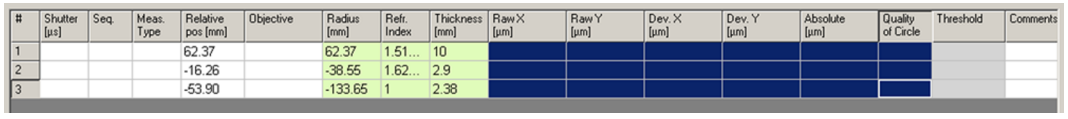


Fig. 78: Design data, relative positions calculated

12 Preparing for measurement

Requirement:

- Design file has already been created (refer to *Edit design data [▸ 85]*)

12.1 Opening the design table

1. Use a suitable mount to place the sample into the measurement system.
2. Select <File> <Open Design file>.
3. Select the file (*.df) and click <Open>.

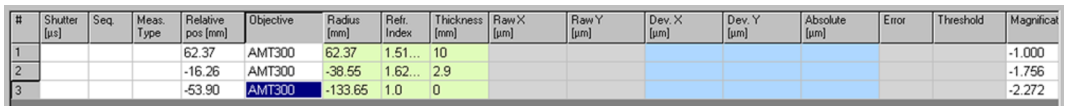
⇨ This reads in and displays the data.

12.2 Selecting the head lens

A suitable head lens has to be selected for each individual surface.

Please note the criteria listed in chapter *Selecting the head lens [▸ 60]*.

1. Enter the head lens description in the `Objective` column in the design data.



#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Dev. X [µm]	Dev. Y [µm]	Absolute [µm]	Error	Threshold	Magnificat
1				62.37	AMT300	62.37	1.51...	10								-1.000
2				-16.26	AMT300	-38.55	1.62...	2.9								-1.756
3				-53.90	AMT300	-133.65	1.0	0								-2.272

Fig. 79: Selecting the head lens

NOTE

Non-recognition of the head lens by the software

Pay close attention to the correct spelling (lowercase/uppercase, use of space).You can check the correct spelling in the `Objective` pull-down menu or under `<Settings> <Objectives>`.

2. To save the changes, select `<File> <Save design file>`.

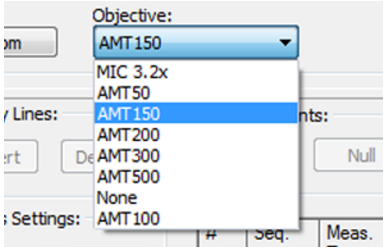


Fig. 80: Objectives

12.3 Checking relative positions and adjusting exposure time

The vertex is determined and set as the zero position. With this information, the measurement system can automatically focus on all other surfaces.

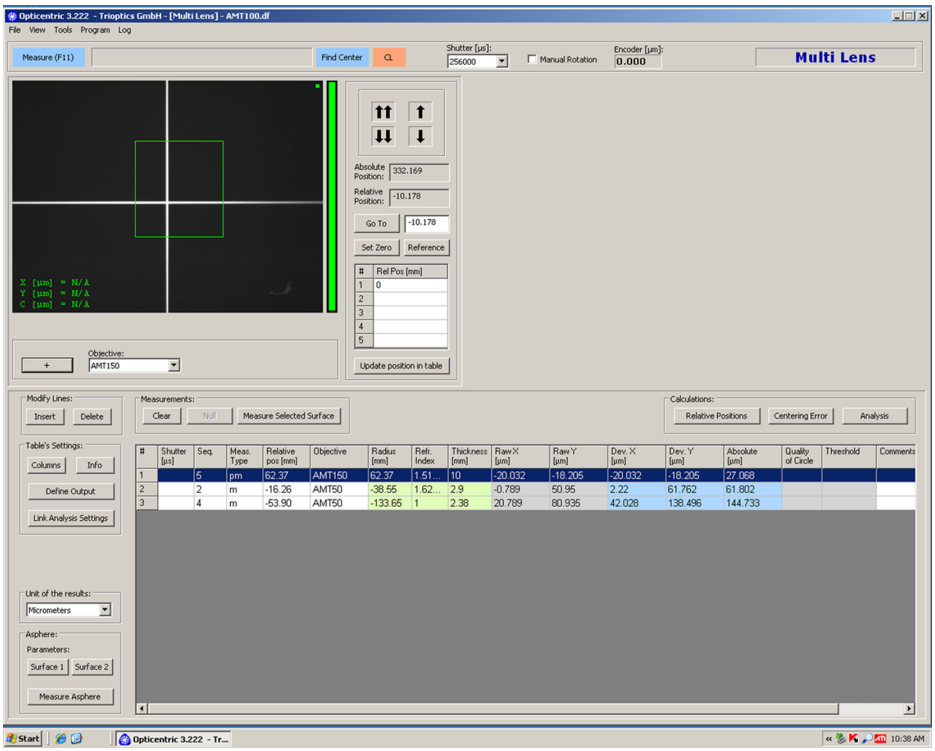
This chapter describes how the previously calculated relative positions (refer to chapter *Calculate relative positions [▶ 91]*) are checked.

The same operation determines the necessary exposure time for each surface.

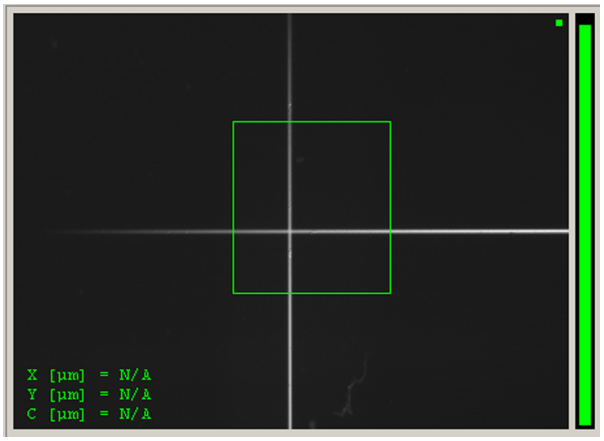
Set the vertex as zero position

To find the vertex, focus must be on the top of the uppermost surface.

View A



View B



Camera image is unevenly illuminated because the sample is not centered

Fig. 81: Find the vertex position

1. Place the sample on the tip-tilt-table
2. Place a sheet of paper on the sample and use the arrow keys to move the stage until the crosshair can be clearly seen on the paper.
3. Remove the paper.

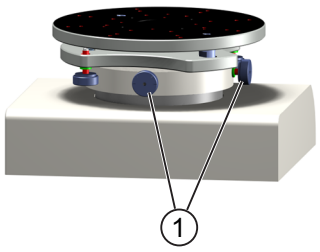


Fig. 82: Tip-tilt-table

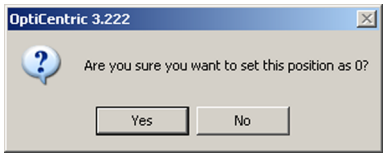


Fig. 83: Query: set current position as zero position

4. Now look at the camera image and use the arrow keys to move the stage until the crosshair can be clearly seen.
   ⇨ The camera image should be **evenly** illuminated (View A).
   Should this not be the case (as shown in View B), proceed as follows:
5. Center the sample approximately by hand.
6. Use the X/Y adjusting screws to center the tip-tilt-table **(1)**.
   ⇨ The vertex is found when the camera image is evenly illuminated and the crosshair can be clearly seen.
7. Click `Set Zero`.
8. Confirm the prompt with `Yes`.

⇨ The current position is set as the zero position.

Determine centers of curvature

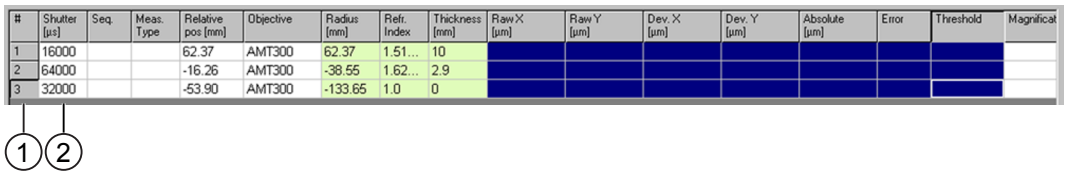


Fig. 84: Determine centers of curvature

✓ Precondition: the vertex has already been set as zero position

1. Double-click the 1 (column “#” to focus on the center of curvature of the first surface.
   ⇨ The crosshair should now be clearly seen in the camera image. If not, follow these steps:
2. If necessary, change the exposure time and/or the brightness of the light source (refer to chapter *Intensity setting [▸ 61]*).
3. Use the arrow keys to move the stage (refer to chapter *Moving the measurement head [▸ 57]*) until the crosshair can be clearly seen.
4. Click the `Update Position in table` button.
   ⇨ The values for the relative position and the exposure time are overwritten.
5. Repeat these steps for all other surfaces.
6. To save the changes, select `<File> <Save design file>`.

Calculate relative positions for individual surfaces

It is possible to recalculate the relative position for individual surfaces. This may be necessary if a relative position has been repeatedly corrected and you are unsure whether it still matches the original.

Follow these steps:

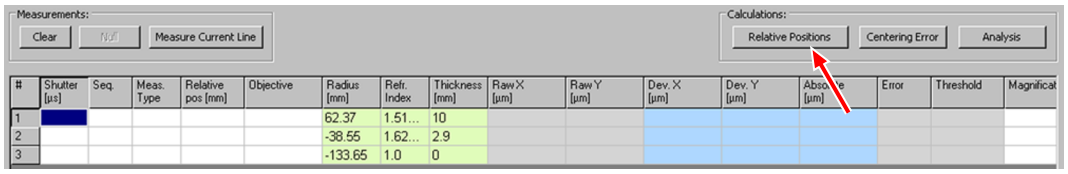


Fig. 85: Calculate relative positions

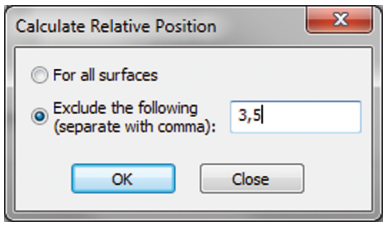


Fig. 86: Calculate relative positions, calculation mode

1. Click <Calculate> <Relative Positions>.
2. Select <Exclude the following (separate with comma)>.
3. Enter the numbers of the surfaces not to be recalculated separated by commas.
4. Click OK.

⇨ The relative positions of the surfaces are calculated and displayed in the Rel. pos. column.

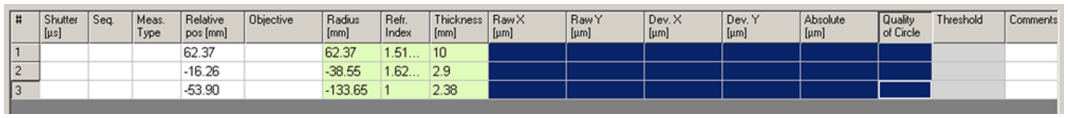


Fig. 87: Calculate relative positions, result

12.4 Finding the zero position and calculating relative positions

12.5 Assign measurement procedure

The appropriate method for measuring the centering error must be determined and recorded separately for each surface.

M	**Measurement** The sample is rotated by 360°. During the rotation, the software detects the position of the reticle image. After rotation, the software automatically calculates the centering error. **Application:** This method is recommended for most applications.
S	**Select** The sample is first rotated by 180°. The “`Select a cross`” message is displayed. – Click on the crosshair in the camera image. The software looks for a crosshair near where you clicked the mouse. Then the air bearing is turned by 180° back to the starting position. The “`Select a cross`” message is displayed. – Click on the crosshair in the camera image. The software automatically calculates the centering error. **Application:** This method is recommended if the intensity is low or the contrast is very weak and the “M” measurement is not successful
SA	**Select automatically** The sample is first rotated by 180°. The software automatically captures the image from the crosshair. Then the air bearing is turned by 180° back to the starting position. The software automatically captures the image from the crosshair. The software automatically calculates the centering error. **Application:** This method is recommended if a good circle cannot be obtained through very specific aberrations (interfering reflections, several cross images)
SG	**Select and grab** The sample is first rotated by 180°. The “`Select a cross`” message is displayed. – Click **precisely** on the crosshair in the camera image. The software adopts the position of the mouse click as the position of the crosshair. Then the air bearing is turned by 180° back to the starting position. The "Select a cross" message is displayed. – Click **precisely** on the crosshair in the camera image. The software automatically calculates the centering error. **Important!** If the mouse click is not precisely on the crosshair, incorrect positions will be used when calculating the centering error. **Application:** This method is recommended if a good circle cannot be obtained through very specific aberrations.

CX	**Cylindrical surface centering error in x direction** **Application:** This method is an optional measurement procedure for the measurement of cylinder lenses.
CY	**Cylindrical surface centering error in y direction** **Application:** This method is an optional measurement procedure for the measurement of cylinder lenses.
P	**Pause** The P is written before the letters of the measurement procedure to produce a pause, e.g. "psg" or "pm". – To continue the measurement, click `Continue`. **Application:** This method is used if changes have to be made during the measurement.
B	**Background subtraction** The B is written after the letters of the measurement procedure, for example "mb". The first image is taken as the background and subtracted from all subsequent images of this measurement. **Application:** This method is recommended if static interference occurs.

1. Enter the desired measurement procedure into the `Meas. Type` column in the design data.

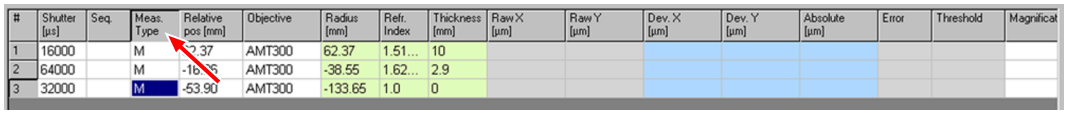


Fig. 88: Design table, define measurement procedure

2. To save the changes, select `<File> <Save design file>`.

12.6 Setting the sequence

MultiLens® measurement

During the measurement, the measurement head moves to the relative position of each surface to be measured. The surfaces are measured in the sequence indicated in the "#" column.

Depending on the sample, the sensor may have to travel back and forth a lot if the centers of curvature are approached in the order of the lens surfaces.

To avoid unnecessary movements of the measurement head and thus save time, it is possible to set the sequence in which the surfaces are measured. The order in which die individual surfaces are measured has no influence on the measurement accuracy.

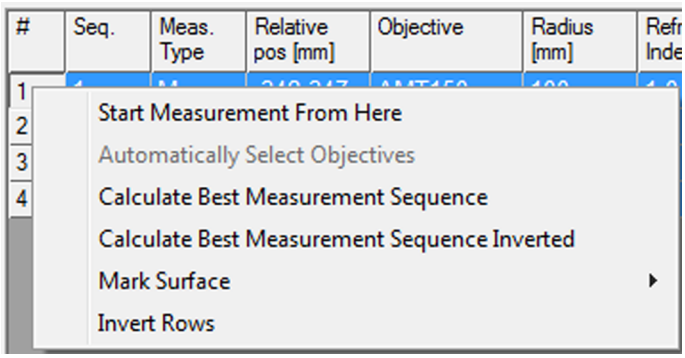


Fig. 89: Design table, calculate best sequence

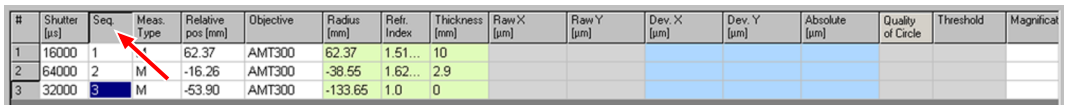
– Right click in the # column and select `Calculate Best Measurement Sequence`.
The numbers in the Seq. column are changed.

NOTE

If you wish to measure a particular surface (e.g. the one on top) last, select `Calculate Best Measurement Sequence Inverted`. The best sequence is calculated and inverted.

Or:

– Enter the calculated figures for the new sequence into the `Seq.` column.



#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Dev. X [µm]	Dev. Y [µm]	Absolute [µm]	Quality of Circle	Threshold	Magnificat
1	16000	1		62.37	AMT300	62.37	1.51...	10								
2	64000	2	M	-16.26	AMT300	-38.55	1.62...	2.9								
3	32000	3	M	-53.90	AMT300	-133.65	1.0	0								

Fig. 90: Design table, define sequence

– To save the changes, select `<File> <Save design file>`.

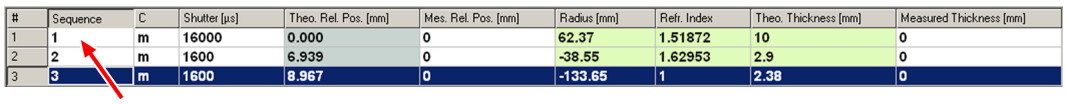
Measurement of Lens Thicknesses and Air Gaps

NOTE

Generally it is recommended to measure the surfaces from top to bottom. However, the sequence does not affect the measurement accuracy.

When measuring lens thicknesses and air gaps it is advisable to always measure the surfaces in ascending or in descending sequence in order to minimize the hysteresis effect.

1. Enter the calculated figures for the new sequence into the `Seq.` column.



#	Sequence	C	Shutter [µs]	Theo. Rel. Pos. [mm]	Mes. Rel. Pos. [mm]	Radius [mm]	Refr. Index	Theo. Thickness [mm]	Measured Thickness [mm]
1	1	m	16000	0.000	0	62.37	1.51872	10	0
2	2	m	1600	6.939	0	-38.55	1.62953	2.9	0
3	3	m	1600	8.967	0	-133.65	1	2.38	0

Fig. 91: Thickness measurement, define sequence

2. To save the changes, select `<File> <Save design file>`.

12.7 Setting the measuring window (AOI, area of interest)

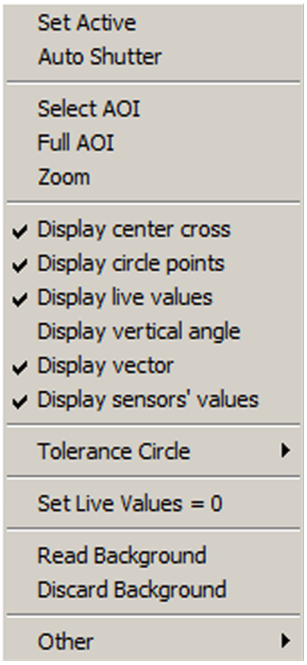


Fig. 92: Camera image, context menu

1. Move the cursor on the camera window and click the right mouse button.
2. Select `<Select AOI>`.
3. Use the cursor to select the area of interest.

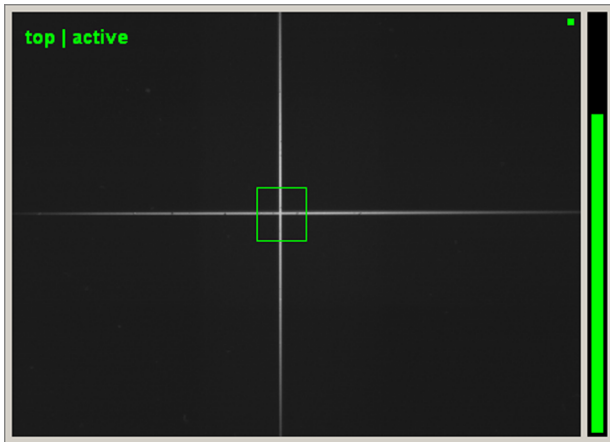


Fig. 93: Measuring window, Area of interest (AOI)

13 Conducting a MultiLens® measurement

This chapter describes how to measure centering errors of individual surfaces within multi-lens optical systems with highest accuracy.

13.1 Preparation for a MultiLens® measurement

General preparations

1. Perform the checks prior to operating the unit as described in chapter *[51]Pre-operation checks [51]*.
2. Power up the measurement system as described in *Switching the measurement system on [51]*.
3. Select `<Program> <Multiple Lenses>` (measuring mode “Centration error of multi-lens systems”).

Preparing a MultiLens® measurement

✓ Requirement: You have already created a design file (refer to chapter *Creating the design table [85]*).

1. Open the design file (refer to chapter *Opening the design table [93]*).
2. Select a suitable head lens for each surface (refer to chapter *Selecting the head lens [93]*).
3. Check the relative positions of the individual surfaces. If required, adjust the exposure time (refer to chapter *Checking relative positions and adjusting exposure time [94]*
4. Assign a measurement procedure to each surface (refer to chapter *Assign measurement procedure [98]*).
5. Define sequence in which the individual surfaces are to be measured (refer to chapter *Setting the sequence [100]*).

⇨ The preparations for a Multilens® measuring are now completed.

See also

Edit design data [85]

13.2 Conducting a MultiLens® measurement

✓ Ensure that the preparations described in chapter *Preparation for a MultiLens® measurement [▸ 103]* are completed and that a .df file is available.

1. Place the sample in the center of the air bearing or in the center of the tip-tilt-table.
2. To avoid collisions with the sample, move the safety limit switch (refer to chapter).
3. Select `<File> <Open Design file>`.
4. Highlight the file (*.df) and click `<Open>`.

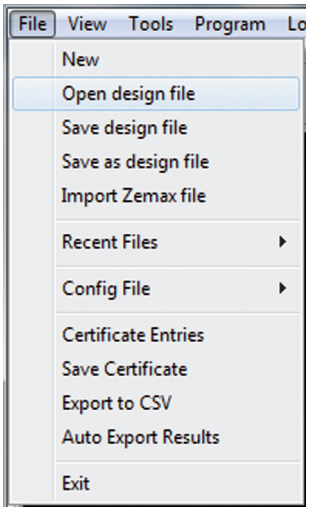


Fig. 94: Context menu, Open design file

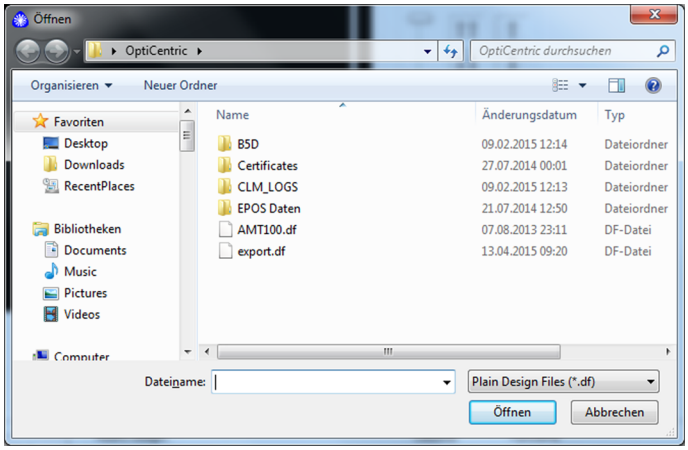


Fig. 95: Open the design file

⇨ This reads in and displays the data.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Dev. X [µm]	Dev. Y [µm]	Absolute [µm]	Quality of Circle	Threshold	Magnificat
1	16000	1	M	62.37	AMT300	62.37	1.51...	10								
2	64000	2	M	-16.26	AMT300	-38.55	1.62...	2.9								
3	32000	3	M	-53.90	AMT300	-133.65	1.0	0								

Fig. 96: Design table, Display of the design data

5. Select the head lens for the first surface to be measured.
6. Focus on the surface of the topmost surface (refer to chapter *Manually focus on a surface [▸ 59]*).
7. Click `Set Zero`.
8. Focus on the center of curvature of the first surface.
9. If necessary, move the sample on the air bearing until the crosshair is visible in the center of the monitor.
10. Click `Find Center`.

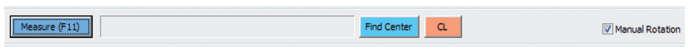


Fig. 97: program window MultiLens, Measure and Find Center buttons

⇨ The air bearing performs one revolution. The image of the crosshair describes a circle.

NOTE

If the circle is very large, the sample must be moved more into the center of the air bearing.

11. Click `Measure (F11)`.

NOTE

Press the **Esc** key on the keyboard to abort the measurement.

The raw data `Raw X [mm]` and `Raw Y [mm]` are displayed during the measurement. These raw data are only correct for the first surface, because the measurement is affected by refraction and centering errors.

Once the measurement has been taken, the corrected values for all surfaces are entered in the design table.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Deviation X [µm]	Deviation Y [µm]	Total [µm]	Quality of Circle	Quality Threshold	
1		5	pm	62.37	AMT150	62.37	1.518...	10	-20.03	-18.20	-20.03	-18.20				
2		2	m	-16.26	AMT50	-38.55	1.629...	2.9	-0.79	50.95	2.22	61.76				
3		4	m	-53.9	AMT50	-133.65	1	2.38	20.79	80.94	42.03	138.50				

Fig. 98: Design table, Display of the measurement data

13.3 Interpreting measurement results

The columns “Dev X [µm]” and “Dev Y [µm]” indicate the deviation from the center of curvature. The influence of the previous surfaces was factored and the exact geometric position of the center of curvature determined.The "Quality of circle" column specifies an index indicating the deviation of the crosshair trace from the perfect circle. The value is between 0 and 1, where "1" means that the measured points are 100% on the circle.

– If this value is below 0.8, the surface should be re-examined (refer to chapter *Measuring a single surface manually [▸ 106]*).
– If no value can be determined, the centering error for this surface is very small or a measuring method was selected which does not include rotation by 360°.

NOTE

The measurement results can be examined more closely using the Advanced Analyzer (refer to chapter *Advanced Analysis [▸ 109]*).

13.4 Measuring a single surface manually

1. Double-click the left mouse button on the surface number in the # column to focus the center of curvature.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective	Radius [mm]	Refr. Index	Thickness [mm]	Raw X [µm]	Raw Y [µm]	Deviation X [µm]	Deviation Y [µm]	Total [µm]	Quality of Circle	Quality Threshold
1		5	pm	62.37	AMT150	62.37	1.518...	10	-20.03	-18.20	-20.03	-18.20			
2		2	m	-16.26	AMT50	-38.55	1.629...	2.9	-0.79	50.95	2.22	61.76			
3		4	m	-53.9	AMT50	-133.65	1	2.38	20.79	80.94	42.03	138.50			

Fig. 99: Design table, Display of the measurement data

2. Look at the camera window:
   ⇨ Is the crosshair in the area of interest (AOI)? Enlarge the area of interest if necessary.
   ⇨ Is the focus position correct? Refocus if necessary.
3. Click Measure Selected Surface.

13.5 OptiSurf Thickness Report

NOTE

This option is only available for devices with OptiSurf (OC 3D).

After a single measurement or a MultiLens measurement, the values measured by OptiSurf (lens thickness and distances) can be exported to a .txt file.Specify the directory and name of the fileUnder <Tools> <Settings> select the <External Control> tab.

Specify the directory and name of the file

1. Under <Tools> <Settings> select the <External Control> tab.

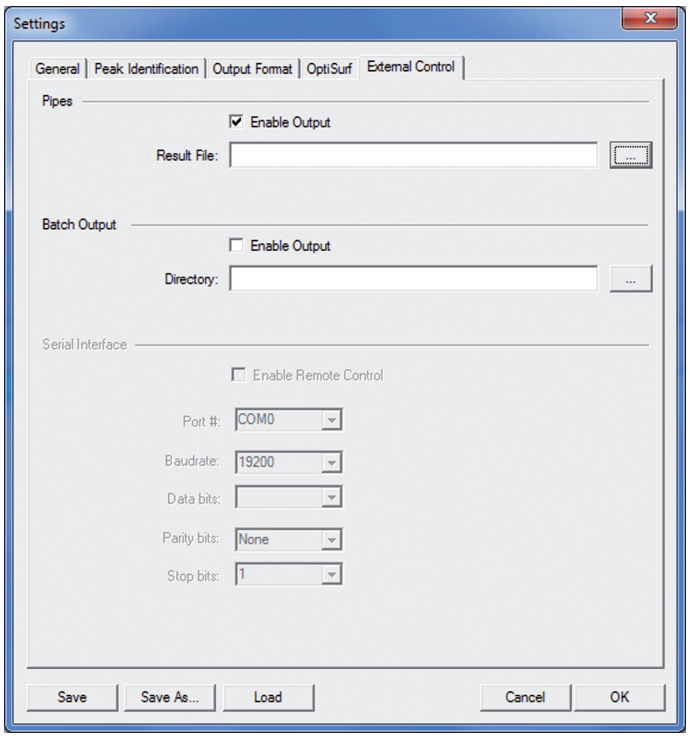


Fig. 100: Settings, defining external directories

2. Under Pipes, tick the checkmark next to Enable Output.
3. Click the ... button and select the path for the file.
4. Enter the name of the file under Result File.

Import a file

1. To import the file, right-click on the "Thickness" column in the design table and choose "Load Values From File".

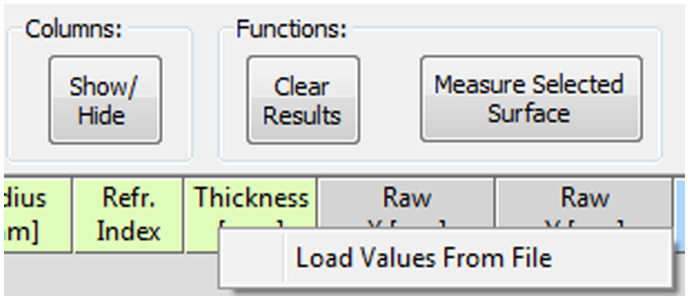


Fig. 101: Design table, load measured values

2. Go to the corresponding directory and select the .txt file.
3. Confirm with Save.

⇨ The results of the thickness measurement are now exported to OC.

See also

Advanced Analysis [▶ 109]

13.6 After completing the measurement

The following options are available:

– Save the measurement results in a certificate (refer to chapter *Outputting measured values as a certificate [▶ 67]*).
Or:
– Save the measurement results in the design file. Select <File> <Save design file>.
The results can be analyzed later on the measuring system or on a separate PC.
or:
– Click the Analysis button to open the Advanced Analyzer (refer to chapter).
The current measurement results are applied.
or:
– Start the measurement of the next sample.

14 Advanced Analysis

This chapter describes how to analyze the results from a MultiLens® measurement in detail. A separate software, the Advanced Analyzer is used for this purpose.

The data can be analyzed on the measurement system or on a separate PC.

14.1 Opening Advanced Analyzer and transferring data

On the measurement system

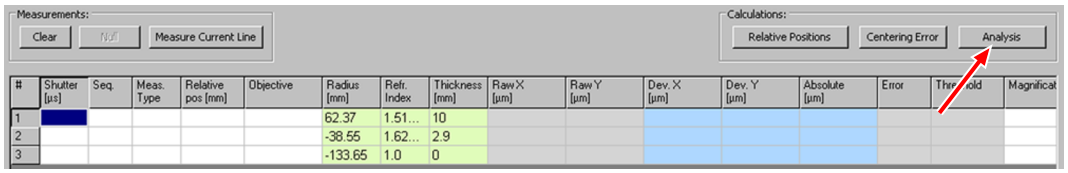


Fig. 102: Open Advanced Analyzer

– Once the MultiLens® measurement has finished, click the `Analysis` button.
The Advanced Analyzer software starts. The data are transferred and sorted into the table.
The top table shows the centering errors of the individual surfaces in relation to the axis of rotation. The number of lines is adjusted automatically.

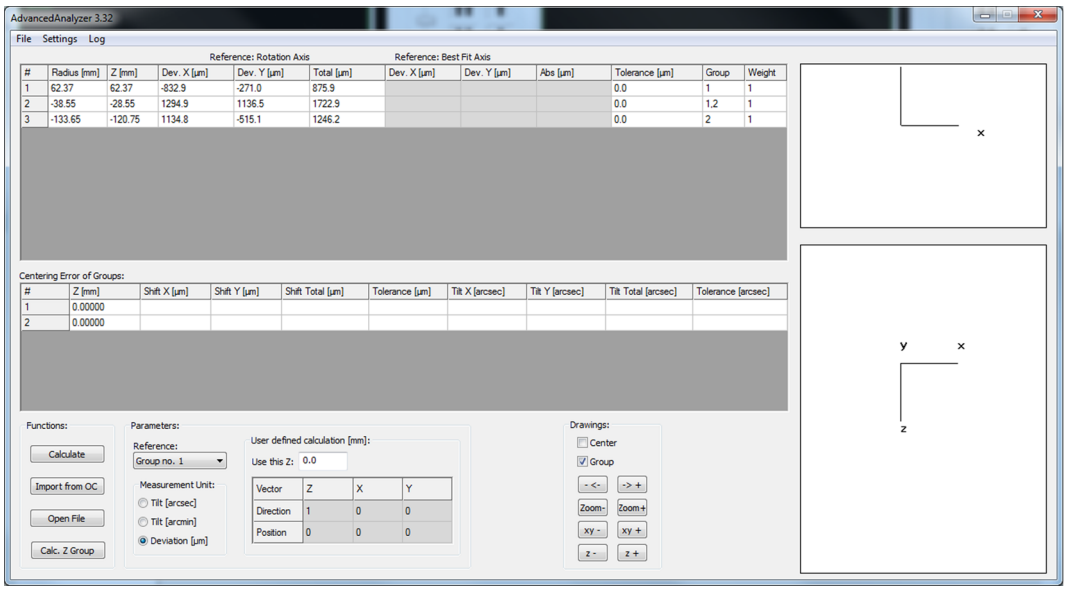


Fig. 103: Advanced Analyzer, Start

automati c data transfer

The data is transmitted to the Advanced Analyzer after each MultiLens® measurement.

NOTE

The data is only transferred automatically if the OptiCentric software and Advanced Analyzer are located in the same folder.

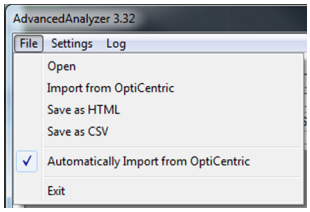


Fig. 104: Advanced Analyzer, automatic import

– To enable the automatic data transfer, in the `<File>` drop-down menu tick the checkmark for the `<Automatically Import from OptiCentric>` option.

On the PC

Fig. 105: Copy protection key (hardware dongle)

1. If you are working on a separate PC, insert the copy protection plug (hardware dongle) into one of the PC's USB ports.
2. Start the Advanced Analyzer software.

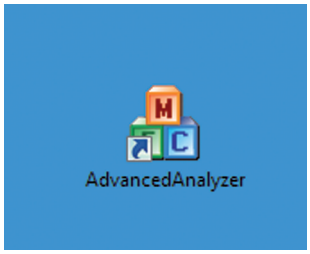


Fig. 106: Advanced Analyzer, Desktop icon

3. Select `<File> <Open>` or click the `Open File` button.
   ⇨ A dialog appears prompting you to open a .df file.
4. Select the desired .df file and click `Open`.

⇨ The top table shows the centering errors of the individual surfaces in relation to the axis of rotation.

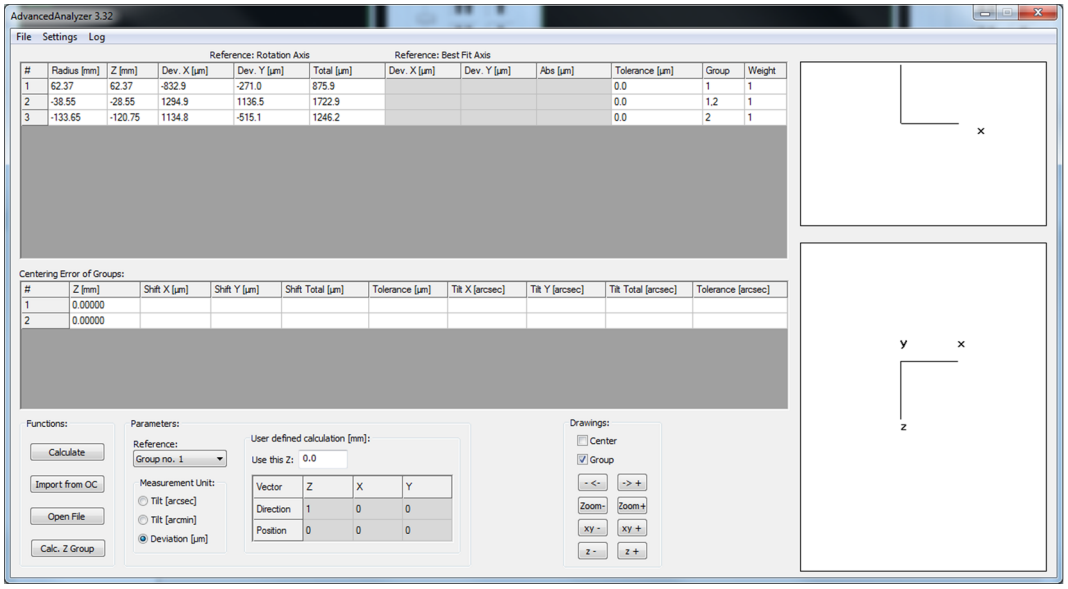


Fig. 107: Advanced Analyzer, Start view

14.2 Tolerances, PASS/FAIL

– Enter the maximum deviation for each surface in the Tolerance [µm] column.

NOTE

A value does not have to be set for every surface. Surfaces without a set tolerance will be ignored during the pass-fail query.

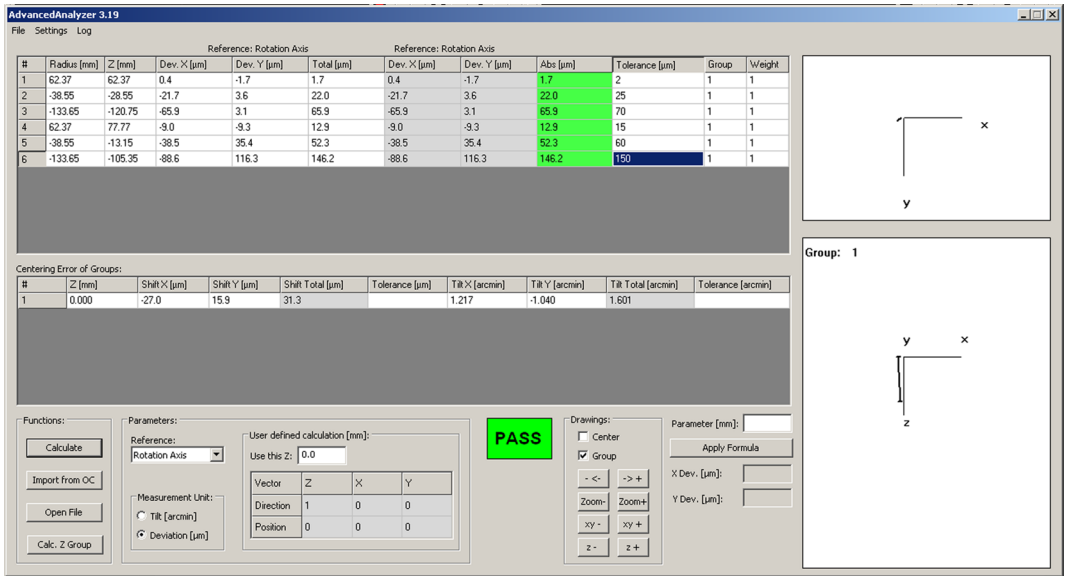


Fig. 108: Advanced Analyzer, PASS / FAIL display

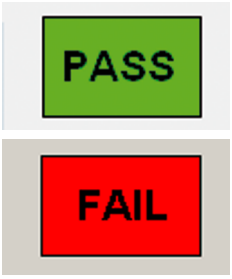


Fig. 109: Advanced Analyzer, PASS / FAIL

- If the tolerance is observed, the measured value is highlighted in green.
- If all measurements are within their tolerance, "PASS" is displayed as the overall result.
- If the tolerance is exceeded, the measured value is highlighted in red.
- If at least one measurement is outside its tolerance, "FAIL" is displayed as the overall result.

14.3 Assigning surfaces to groups

Depending on the sample and what is being analyzed, it is helpful to combine the different surfaces of a sample into groups.

Example:

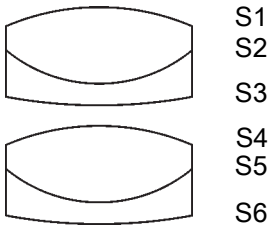


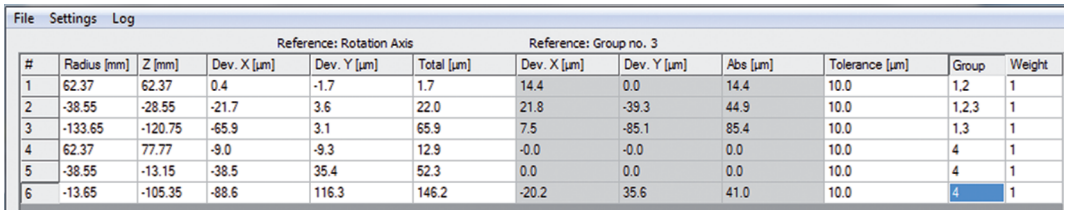
Fig. 110: Illustration sample

In the example shown above, it is possible to combine the following groups:

- top achromat = group 1:
  surfaces S1, S2, S3
- top lens of the top achromat = group 2:
  surfaces S1, S2
- bottom lens of the top achromat = group 3:
  surfaces S2, S3
- bottom achromat = group 4:
  surfaces S4, S5, S6

NOTE

If one surface belongs to several groups (such as in cemented surfaces), the group numbers are separated by commas.

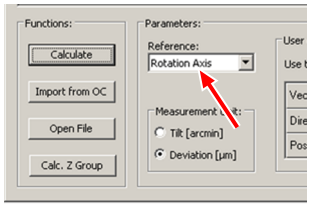


#	Radius [mm]	Z [mm]	Dev. X [µm]	Dev. Y [µm]	Total [µm]	Dev. X [µm]	Dev. Y [µm]	Abs [µm]	Tolerance [µm]	Group	Weight
1	62.37	62.37	0.4	-1.7	1.7	14.4	0.0	14.4	10.0	1,2	1
2	-38.55	-28.55	-21.7	3.6	22.0	21.8	-39.3	44.9	10.0	1,2,3	1
3	-133.65	-120.75	-65.9	3.1	65.9	7.5	-85.1	85.4	10.0	1,3	1
4	62.37	77.77	-9.0	-9.3	12.9	-0.0	-0.0	0.0	10.0	4	1
5	-38.55	-13.15	-38.5	35.4	52.3	0.0	0.0	0.0	10.0	4	1
6	-13.65	-105.35	-88.6	116.3	146.2	-20.2	35.6	41.0	10.0	4	1

Fig. 111: Advanced Analyzer, Defining groups

14.4 Select reference axis

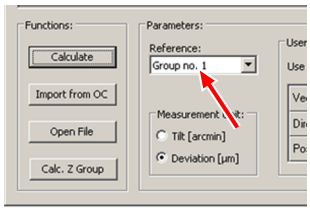
Different reference axes can be selected, depending on what is going to analyzed.



Example 1:

The position of the sample to the axis of rotation is to be tested.

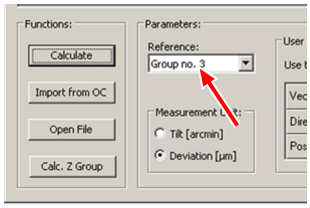
Reference: rotation axis



Example 2:

The position of the two achromats to each other is to be tested.

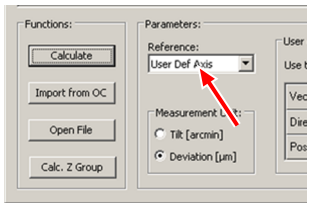
Reference: Group no. 1



Example 3:

The quality of the achromats (position of the individual lenses to each other) is to be tested.

Reference: Group no. 3



Example 4:

The position of the achromats in a mounting is to be tested.

Reference: user defined axis

Fig. 112: Advanced Analyzer, Select reference axis

NOTE

For information on the user defined axis, please refer to chapter *Measurement and alignment with a probe [▶ 119]*.

14.5 Weight

This value describes the importance of a surface to the overall results:

– If the weighting is the same for all surfaces, each centering error has the same weight when calculating the total centering error.

– If one surface has a very high weight compared to the other surfaces, the centering error of this surface, relative to the associated group axis, is smaller.

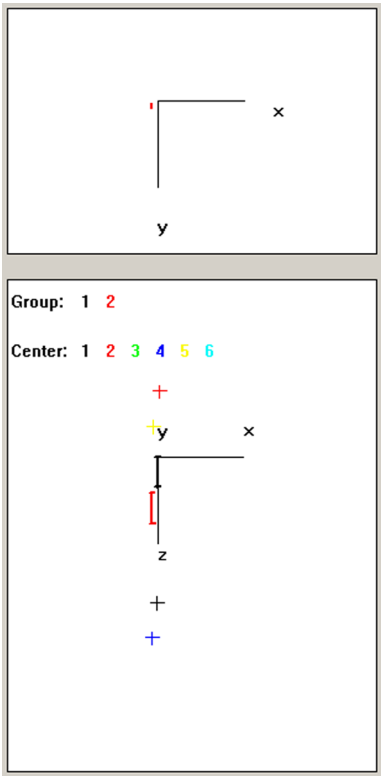
NOTE

The individual surfaces should be weighted by using the tolerance analysis and the lens design.

14.6 Graphical representation of the centering error

The graphical representation shows:

- the centers of curvature
- the optical axes of the groups
- the position of the groups' centering errors to each other



View X/Y plane

View X/Z plane

Fig. 113: Advanced Analyzer, Select representation level

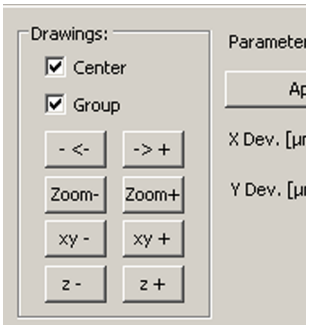


Fig. 114: Advanced Analyzer, Scale representation

– Click the - <- or -> + buttons in order to rotate the side view around the Z-axis.
– Click the Zoom- or Zoom+ buttons in order to scale the views.
– Click the xy- or xy+ buttons in order to scale the display in X-Y-direction. This function is comparable to the Zoom function, however, it only considers the X-Y-plane.
– To scale the display in z-direction, click on the buttons z- or z+. This function is comparable to zoom but only in the Z plane.

15 Measurement of lens thicknesses and air gaps

This chapter describes how to measure center thickness and air gaps of single lenses, plane optics and optical systems without contact.

In this measuring method, an autocollimator with head lens is used to focus on the sample surfaces ("Cats Eye Reflex") and read their position. The positions can be very precisely detected with the electronic autocollimator thanks to the auto focus function. The difference between two positions is proportional to the lens thickness.

NOTE

For a highly accurate measurement we recommend using OptiSurf®.

15.1 Preparation for a measurement of lens thicknesses and air gaps

General preparations

1. Perform the checks prior to operating the unit as described in chapter *[51]Pre-operation checks [51]*.
2. Power up the measurement system as described in *Switching the measurement system on [51]*.
3. Log in as Supervisor as described in chapter *Login / Logout [55]*.
4. Select `<Program> <Thickness>` (measuring mode “Thickness”.

Preparing measurement of lens thicknesses and air gaps

✓ Requirement: You have already created a design file (refer to chapter *Creating the design table [85]*).

1. Place a sample into the measurement system (refer to chapter *Placing and securing the sample [56]*).
2. Open the design file (refer to chapter *Opening the design table [93]*).
3. Check the relative positions of the individual surfaces. If required, adjust the exposure time (refer to chapter *Checking relative positions and adjusting exposure time [94]*
4. Define the Area of interest (AOI) (refer to chapter *Setting the measuring window (AOI, area of interest) [102]*).
5. Assign a measurement procedure to each surface (refer to chapter *Assign measurement procedure [98]*).

6. Define sequence in which the individual surfaces are to be measured (refer to chapter *Setting the sequence [▶ 100]*).

⇨ The preparations for measurements of lens thicknesses and air gaps are now completed.

See also

Selecting the head lens [▶ 93]

15.2 Conducting lens thickness and air gap measurements

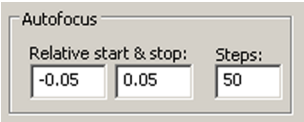


Fig. 115: Thickness measurement, autofocus

1. Enter the Autofocus settings. For further details refer to chapter *Software [▶ 137]*.
2. To perform a measurement, click on the `Measure` button or use the **F11** function key.

⇨ The specified range around the first relative position is scanned for the position with the highest contrast (`Best Focus Position`).

⇨ Subsequently, the best focus position is sought for the next relative position.

⇨ The measured difference of the relative positions is used to determine the true geometric distance by means of optical calculation, related to the design data. This is displayed in the `Measured Thickness` column.

#	Sequence	C	Shutter [µs]	Theo. Rel. Pos. [mm]	Mes. Rel. Pos. [mm]	Radius [mm]	Refr. Index	Theo. Thickness [mm]	Measured Thickness [mm]
1	1	m	16000	0.000	-0.041	62.37	1.51872	10	10.033
2	2	m	1600	6.939	6.938	-38.55	1.62953	2.9	3.000
3	3	m	1600	8.967	9.017	-133.65	1	2.38	0.0

Fig. 116: Design table, thickness measurement

15.3 Interpreting measurement results

16 Measurement and alignment with a probe

This chapter describes how the position of a mechanical support or the sample mount can be determined and adjusted, if necessary.

To do this, a probe is connected to the OptiCentric®100 via a serial interface.

The probe is based on the coordinate system of the measurement system. Since the centering error determination of the optics (measurements with the autocollimator) and mechanical measurements are based on the same coordinate system, the optical and mechanical measurements can be combined.

In this way you get a direct statement about the centering errors of the optics based on a mechanical reference (e.g. the mount).

16.1 Connecting and activating the probe

NOTE

The description only applies to external distance sensors (optical or tactile) with OptiCentric® MOT.

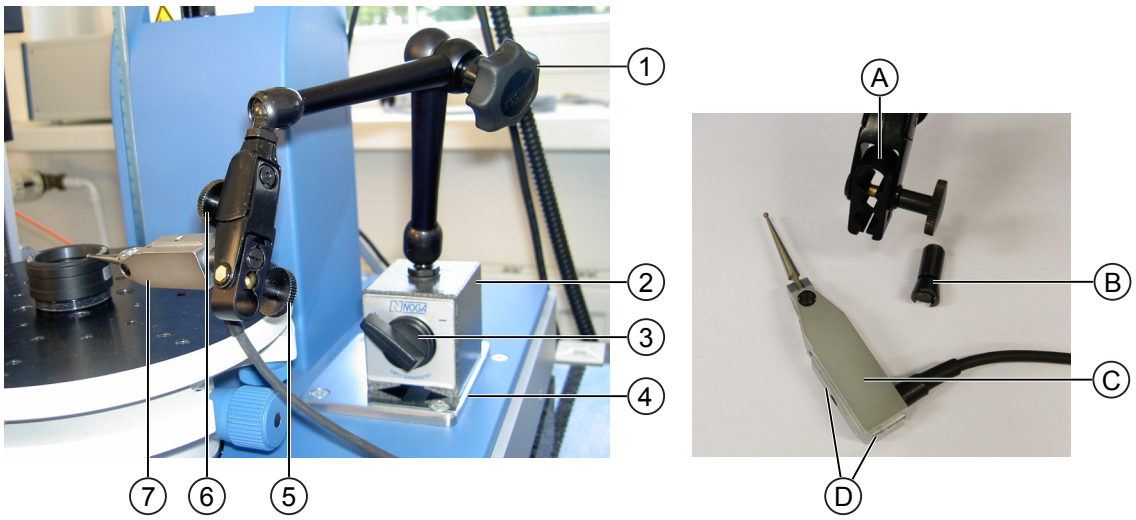


Fig. 117: TESA sensor

1. Place the foot **(2)** of the measuring sensor on the steel plate **(4)**.
2. Turn the switch **(3)** to "+" to secure the foot.
3. Connect the cables and wires according to the labeling.
4. Under `<Tools> <Settings>, select` the `<Distance Sensor>`tab.
5. Under `Choose sensor type` select the `TESA 1` or `TESA 2`sensor.
6. In COM port enter the number of the serial interface.
7. Tick the checkmark for Available.
8. Click OK.

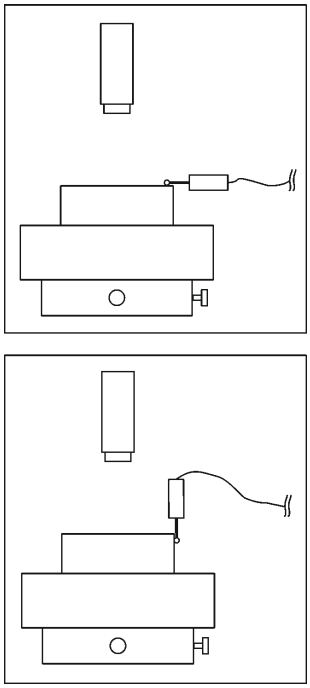
Moving the probe head into position

1. For the rough setting: Loosen the star screw **(1)** and adjust the arm of the measuring sensor.
2. For the fine setting: Loosen the knurled screws **(5)** and **(6)** and adjust the arm of the measuring sensor.
   Tip:
   The measurement head **(C)** can be secured using the dovetail clamp **(B)** in the clamp **(A)** .
   Another option is to insert the dovetail **(D)** directly into the clamp **(A)** . The clamp **(B)** must be unscrewed.
3. Turn the probe head **(7)** so that the cable is pointing backwards or downwards.

NOTE

Gently press the probe sensor at the start of a measurement.

The starting position of the probe sensor should be approximately in the center of the measuring range.



To **measure the axial run-out** the probe must be positioned on top of the sample. The probe must be able to move vertically.

To **measure the radial run-out** the probe must be positioned on the outer side of the sample. The probe must be able to move radially vertically.

Fig. 118: Measuring axial run-out and radial run-out, schematic diagram

16.2 Conducting the measurement

1. Attach the mechanical bracket or the sample mount.

NOTE

The probe must always touch the sample from a defined side. Otherwise, the coordinate system does not match.

2. Roughly center the sample beforehand.
3. Select <View> <User Defined Axis>.
   ⇨ This opens the following window in which the measurement with probe is triggered and evaluated.

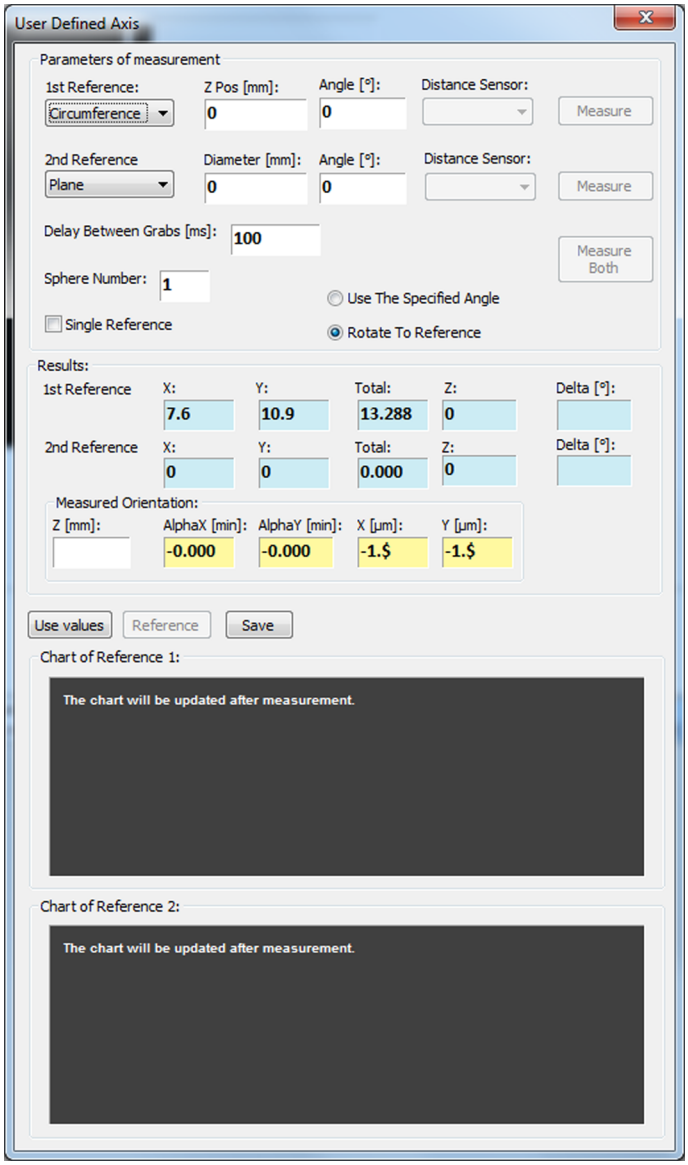


Fig. 119: Area of interest: User defined axis

NOTE

This window may remain open in parallel to the OptiCentric software main window and its functions can be accessed at any time.

4. Move the probe head to the measuring position (see *Connecting and activating the probe [▶ 119]*).

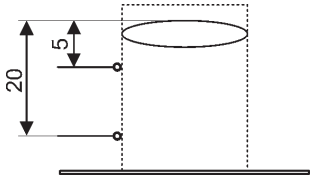


Fig. 120: Radial run-out measurement (two-point measurement), schematic diagram

Example 1:Measurement of the radial run-out at two defined positions

If you want to measure the position of a cylindrical mount in the space, then the radial run-out of the mount has to be determined at two different heights.

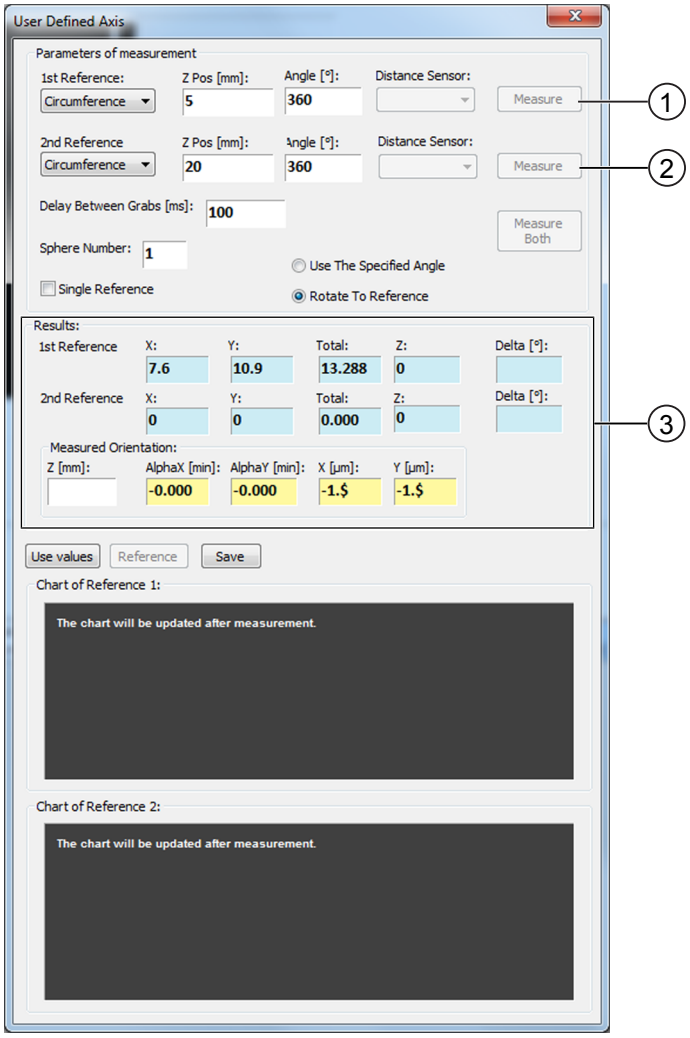


Fig. 121: Area of interest:User defined axis, define measuring points

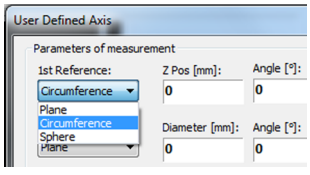


Fig. 122: Measure radial run-out (two-point measurement), define reference points

1. To specify that the radial run-out is to be determined, for `1st Reference select Circumference.`
2. In `Z Pos[mm]` enter the distance between the probe and the position of the lens vertex.
3. In `Angle [°]` enter the angle of rotation via which measured valuesare to be recorded.

NOTE

It is recommended that you always record values over a full rotation (360°).

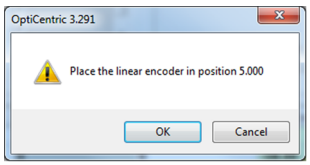


Fig. 123: Position probe, position 1

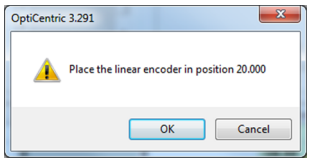


Fig. 124: Position probe, position 2

4. Enter the values for the second reference in the `2nd Reference` row accordingly.
5. To measure the first reference, click the top `Measure` **(1)**button.
   ⇨ `The message Place the linear encoder in position 5.000 appears.`
6. Adjust the tip of the probe so that it is 5 mm away from the lens vertex and slightly pressing the surface from the outside.
7. Click `OK`.
   ⇨ The measurement is carried out.
8. To measure the second reference, click the bottom `Measure` **(2)**button.
   ⇨ The following message is displayed `Place the linear encoder in position 20.000.`
9. Adjust the tip of the probe so that it is 20 mm away from the lens vertex and slightly pressing the surface from the outside.
10. Click `OK`.

⇨ The measurement is performed and the results displayed **(3)**.

X	X-position of the center of the circumference to the axis of rotation
Y	Y-position of the center of the circumference to the axis of rotation
Total	Show total distance to the axis of rotation
Z	Z-position, distance between the probe and the position of the lens vertex
Delta	
Measured Orientation	By using the measurement results it is possible to determine the position of the sample axis relative to the rotation axis for other Z positions to be entered (vertex of the supper sphere at Z=0). This is helpful for example when aligning.

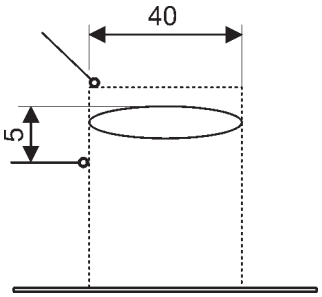


Fig. 125: Radial run-out measurement (1 point + axial run-out), schematic diagram

Example 2: Measurement of the radial run-out at a defined position + measurement of the axial run-out

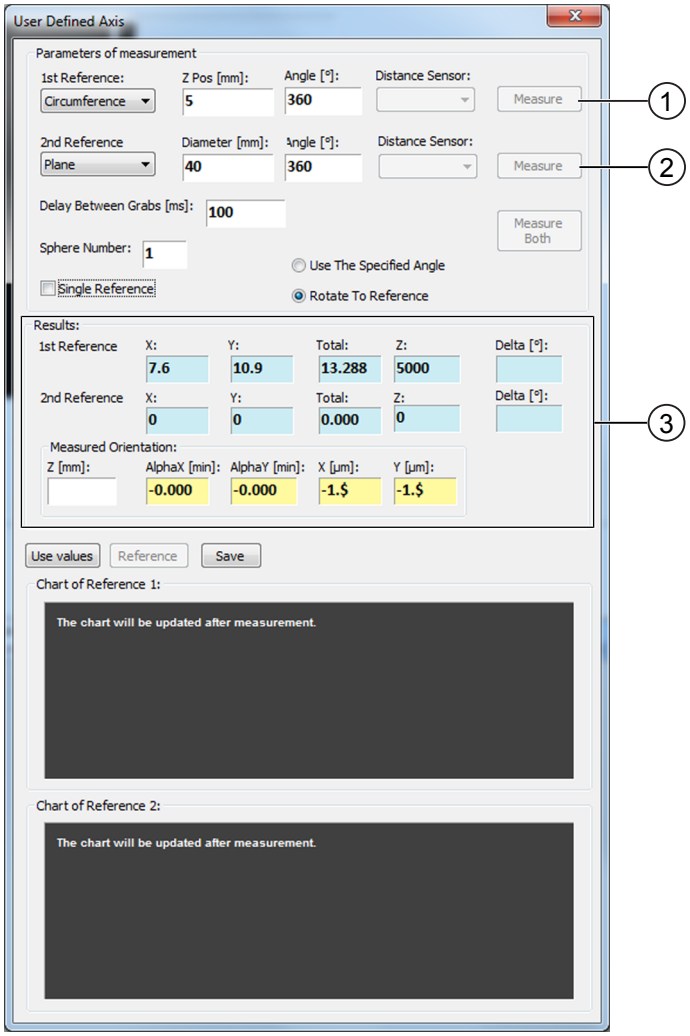


Fig. 126: Area of interest:User defined axis, define measuring points

1. To specify that the radial run-out is to be determined, for `1st Reference select Circumference`.
2. In `Z Pos[mm]` enter the distance between the probe and the position of the lens vertex.
3. In `Angle [°]` enter the angle of rotation via which measured valuesare to be recorded.

NOTE

It is recommended that you always record values over a full rotation (360 °).

4. To specify that the axial run-out is to be determined, for `2nd Reference select Plane`.

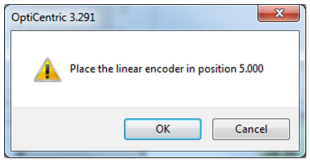


Fig. 127: Position probe, position 1

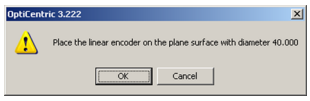


Fig. 128: Position probe, plane surface

5. In the `Diameter` box, enter the diameter of the probe position.
6. To measure the first reference, click the `Measure` **(1)**button.
   ⇨ The following message is displayed `Place the linear encoder in position 5.000.`
7. Adjust the tip of the probe so that it is 5 mm away from the lens vertex and slightly pressing the surface from the outside.
8. Click `OK`.
   ⇨ The measurement is carried out.
9. To measure the second reference, click the `Measure` **(2)**button.
   ⇨ The following message is displayed `The Place the linear encoder on the plane surface with diameter 40.000 message appears.`
10. Adjust the tip of the probe so that is slightly pressing on the surface with the 40 mm diameter from the top.

NOTE

The tip should touch as far as possible on the outside.

11. Click `OK`.

⇨ The measurement is carried out.

The results given are the X and Y position of the center of the circumference, the total distance to the axis of rotation and the angle of inclination of the planar surface.

17 Measurement of a Single Lens with Vacuum Unit

This chapter describes how to measure centering errors of individual lenses (spherical or plane) with highest accuracy.

17.1 Preparation

1. Install the bridge and vacuum unit (see *Fitting/removing bridge and lens rotating device [▸ 71]*).
2. Perform the checks prior to operating the unit (see *Pre-operation checks [▸ 51]*).
3. Switch on the measurement system (see *Switching the measurement system on [▸ 51]*).
4. Select a head lens (see *Selecting the head lens [▸ 93]*).

17.2 Select V-blade

1. Choose a V-blade suitable for the sample. Please note the following:

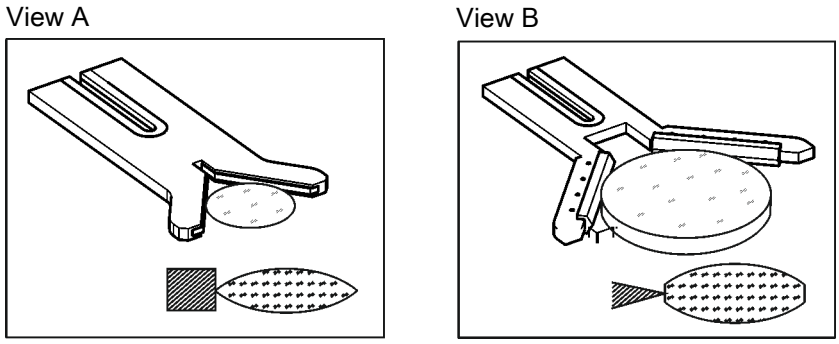


Fig. 129: Select V-blade, schematic diagram

⇨ The lens diameter must be within the range specified for the V-blade.

⇨ For lenses with a narrow rim (< 3 mm) use a V-blade with flat cutting edges.

⇨ In all other cases, use a V-blade with sharp cutting edges.

Replace V-blade

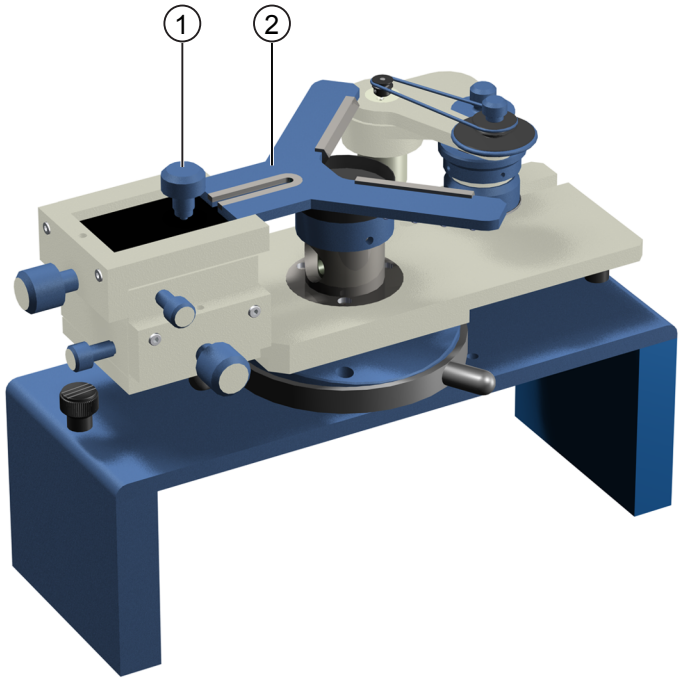


Fig. 130: Vacuum unit, replace V-blade

1. To replace the V-blade, loosen the knurled screw **(1)** and pull the V-blade **(2)** out of the stage.
2. Slide the new V-blade in and secure it using the knurled screw **(1)**.

17.3 Selecting a cup point

1. Choose a cup point suitable for the sample. Please note the following:
   ⇨ The cup point should be as large as possible, but smaller than the outer diameter of the sample.
   ⇨ The bevel must be on the inside, when putting a concave surface on the cup point.

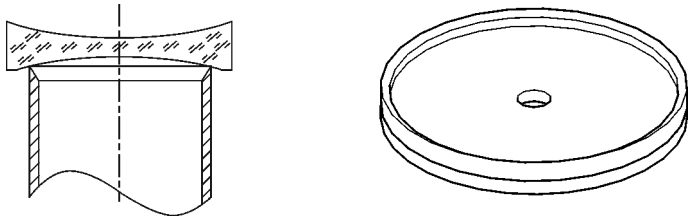


Fig. 131: Cup point, inner bevel

   ⇨ The bevel must be on the outside, when putting a convex surface on the cup point.

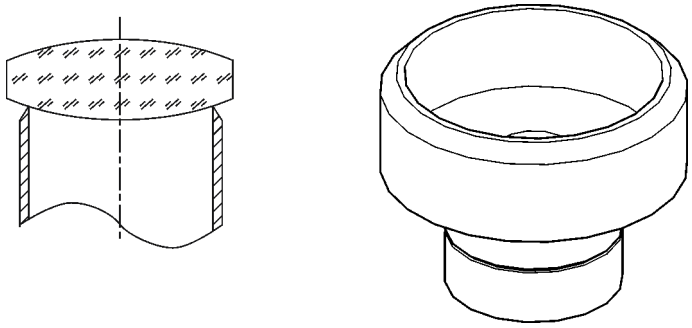


Fig. 132: Cup point, outer bevel

Insert cup point

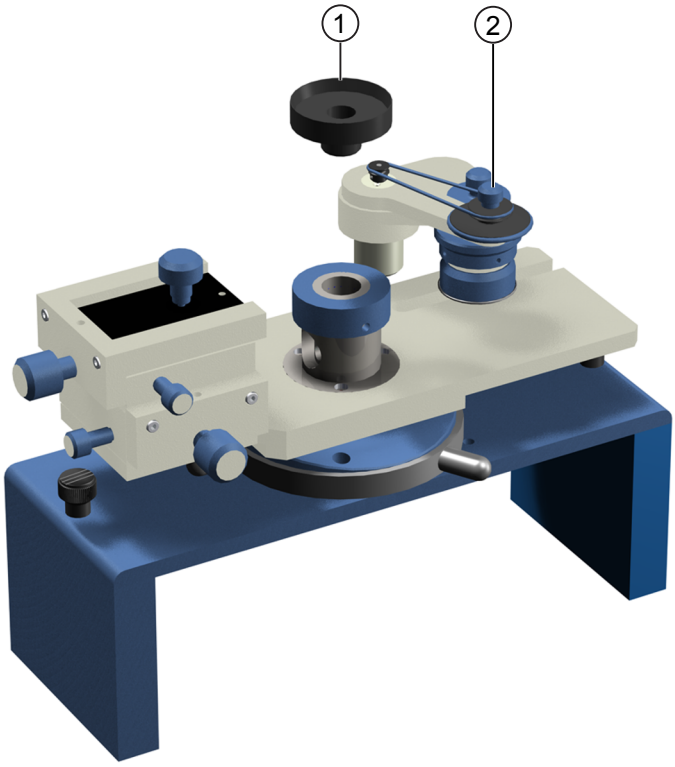


Fig. 133: Vacuum unit, replace cup point

1. Lock the pivot arm with the handle **(2)**.

NOTE

If you produce your own cup points, please refer to the attached drawings. Suitable material is Delrin or Teflon.

2. Insert the cup point **(1)** .

17.4 Placing and aligning the sample

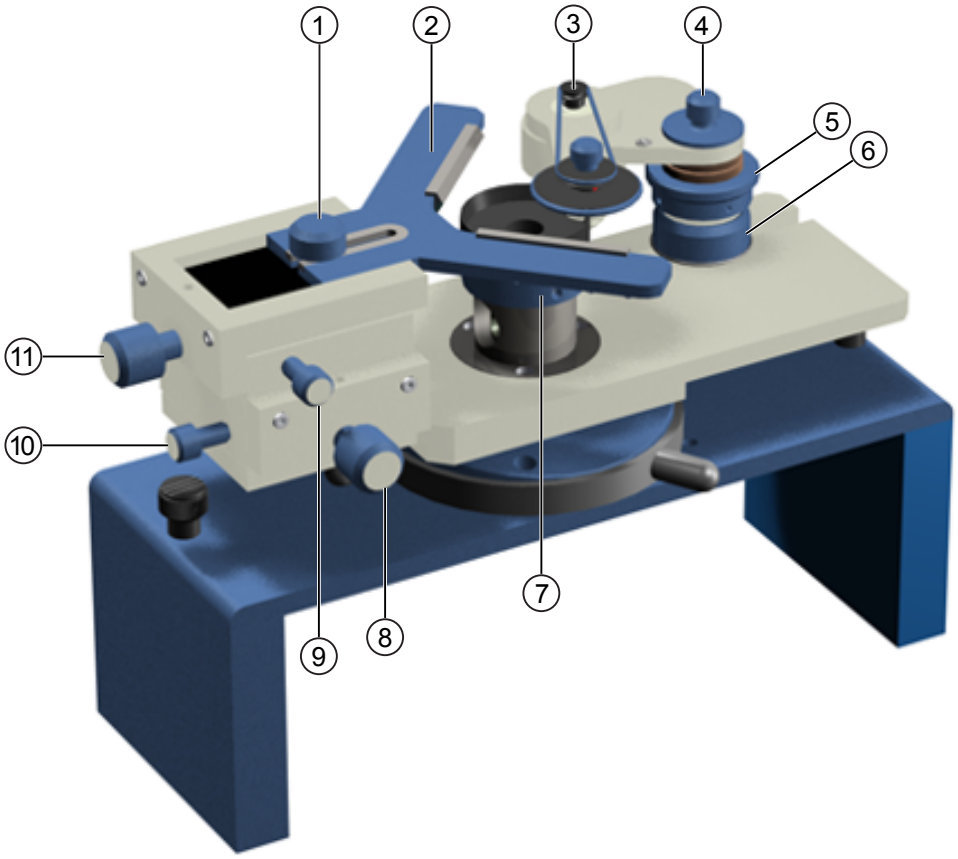


Fig. 134: Vacuum unit

1. Place the sample onto the cup point.

NOTE

The optical surface to be measured must be in top position when measuring in reflection.

2. Switch the vacuum control unit on (see *Control units [▸ 37]*).
3. Loosen the knurled screw **(1)** and pull the V-blade **(2)** until she touches the lens. Re-tighten the knurled nut.
4. Loosen the knurled screws **(9)** and **(10)** and adjust the adjustment screws **(8)** and **(13)**until the lens is centered to the V-blade and cup point. Re-tighten the knurled screws.
5. Use the knurled nut **(7)** (Up/Down) to adjust the height of the cup point until the cutting edge of the V-prism has reached the center of the lens' outer surface.
6. Loosen the pivot arm.

7. Adjust the adjusting nut **(5)**until the friction wheel reaches the center of the lens' outer surface.
8. Loosen the knurled screw **(6)** and move the pivot arm as a complete unit V-blade **(2)**, sample and handle **(?)** are in a line. Retighten the knurled nut.

17.5 First measurement

1. Log in as Supervisor (see *Login / Logout [▸ 55]*).
2. Select `<Program> <Centration in Reflection>`.
3. Focus on the surface (see *Manually focus on a surface [▸ 59]*).
   If the intensity distribution is off center, you must adjust either the specimen or the auxiliary lens (optical head).

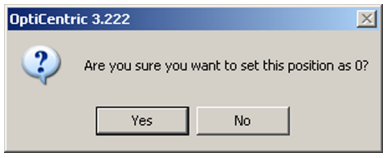


Fig. 135: Query: set current position as zero position

4. Click `Set Zero`.
5. Confirm the security prompt with `Yes`.
   ⇨ The current position is set as the zero position.

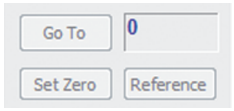


Fig. 136: Moving measurement head, Go To

6. Focus on the center of curvature of the surface (see *Moving the measurement head [▸ 57]*). Use the arrow keys to do this.
   Or:
   Use the `Go To` function (see *Moving the measurement head [▸ 57]*). Enter the value for the position to be moved to.

NOTE

When reflexion is low, it is advisable to set the shutter to the maximum speed. Reduce the shutter speed once the reticle has been found.

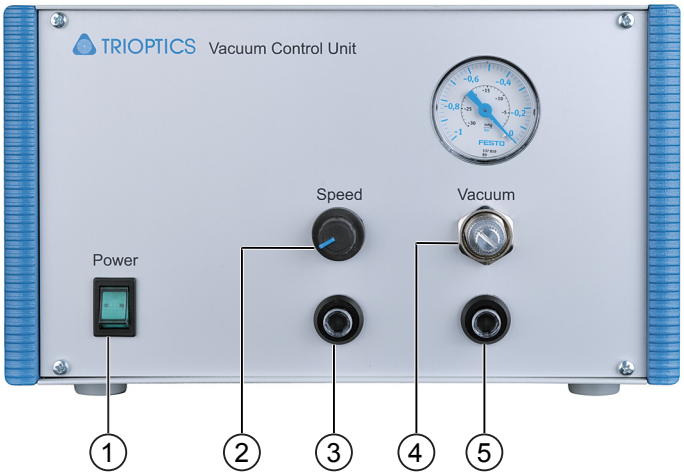


Fig. 137: Control unit for vacuum

7. Start the motor on the vacuum control unit.
   ⇨ The button **(3)** turns green.
8. To change the speed, turn the **(2)** Speed button.
9. Switch on the vacuum **(4)** and check whether the lens rotates smoothly.
   ⇨ If the rotation is uneven, increase the vacuum pressure.
   ⇨ If the lens rotation slows down, decrease the vacuum pressure.

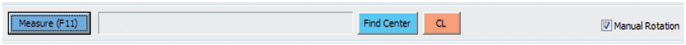


Fig. 138: MultiLens program window, Measure and Find Center buttons

10. To start the measurement, click `Measure` **(F11)**.

If the result is not in the enter of the camera image

– Align the head lens

If no complete circle is generated

If the measurement does not produce a full circle, increase the number of recorded frames or change the rotation speed.

1. Log in as an administrator.
2. Select <Tools> <Settings> and then the <General> tab (see *<Settings> Register <General> [▶ 184]*).
3. Enter a higher value in the Number of frames field.
4. Repeat the measurement.

17.6 Conducting further measurements

1. Turn off the motor.
2. Swing the pivot arm out and lock it in place.
3. Place the sample onto the cup point.
4. Loosen the pivot and swing it in.
5. Turn on the motor.
6. Click `Measure` **(F11)**.

18 Centering Errors in Aspherical Lenses

In contrast to spherical surfaces, rotationally symmetrical aspherical surfaces have an axis of symmetry. The aim of centering error measurement is therefore to determine to location of this axis of symmetry to the reference axis.

To do this, for an aspherical surface the following two values (each with an x and y component) must be determined:

- The shift of the paraxial center of curvature to the reference axis
- The angle of the aspherical axis of symmetry to the reference axis

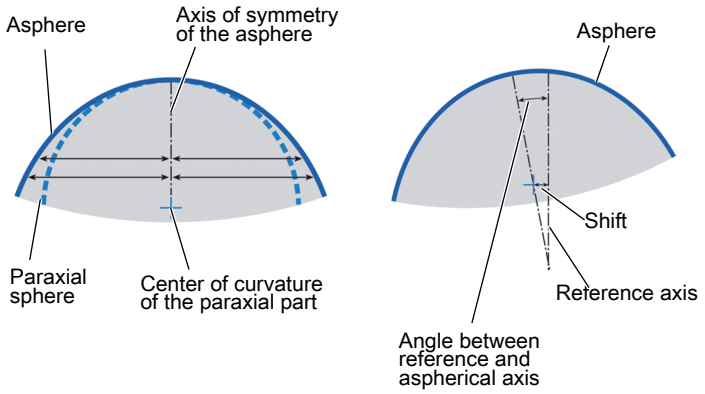


Fig. 139: aspherical lens, structure

The shift corresponds to the classic centering error of spherical surfaces and is measured in the same way by the electronic autocollimator.

An additional sensor is needed to measure the angle of the aspherical lens – the AspheroCheck® sensor by TRIOPTICS. This measures the run-out at the outer edge of the aspherical surface.

Once the shift and the angle of the aspherical surface have been determined, these data can be used to calculate the following parameters:

- Distance and tilt of the asphere with respect to the primary reference axis of the measurement system (equivalent to the axis of rotation)
- Distance and tilt of the asphere with respect to the optical axis of a single lens. The optical axis is the line passing through the centers of curvature of the spherical parts of the lens.
- Where the lens has two aspherical surfaces: the angle and distance of both asphere axes.

NOTE

Please refer to the separate documentation for the AspheroCheck module, which describes its operation and the additional software functions.

19 Software

The following section provides an overview of all available views in the software.

NOTE

Software version

This section demonstrates and explains the OptiCentric 3,277 software version.

If you are using a different software version, what appears in the windows may differ from what you see on your device.

19.1 General displays and icons

19.1.1 Menu bar

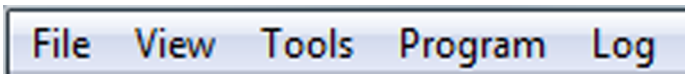


Fig. 140: Menu bar

The menu bar contains several menus from which submenus or functions can be invoked.

19.1.2 Toolbar

Fig. 141: Toolbar

1	`Measure (F11)` **button**: Start the measurement
2	**Status bar** Displays information about the movements and measurements currently being executed by the measurement system.
3	`Find Center` **button**: Rotate the air bearing by 360° to find the center of the circle radius of the reflection.
4	`CL` **button**: Only for TRIOPTICS employees
5	`Manual Rotation` Tick the checkmark for measuring lenses with a rotary device and a vacuum or when the air bearing is rotated by hand Deselect the checkmark for measuring with motorized air bearing
6	**Program display** Display of the selected measurement program

19.1.3 Moving the measurement head

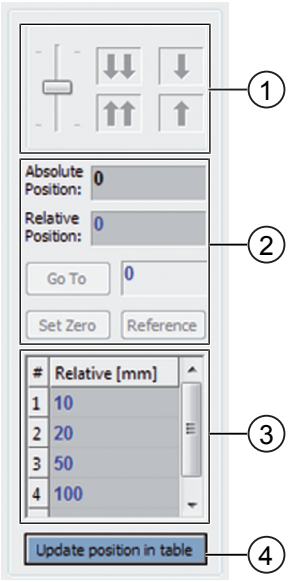


Fig. 142: Measurement head options

1	**Arrow keys for moving the measurement head** Double arrow: Moves the measuring head up or down quickly Single arrow: Moves the measuring head up or down slowly Slider: Change velocities. Slider to the top = maximum velocity
2	`Absolute Position`: Distance to the absolute zero position of the measurement system (uppermost position of the linear stage) `Relative Position`:Distance from the defined zero position `Go To` button: The linear stage is moved to the specified position (relative to the set zero position). Input field for the `Go To` button: Enter position (relative to the set zero position) for the Go To function. `Set Zero` button: Set current measurement head position as the zero position `Reference` button (without function)
3	`Rel. Pos. [mm]` 5 relative positions may be entered in this table and selected by double clicking the row number.
4	`Update position in table` button:(here without function, only for “MultiLens” measurement program)

19.1.4 Camera window

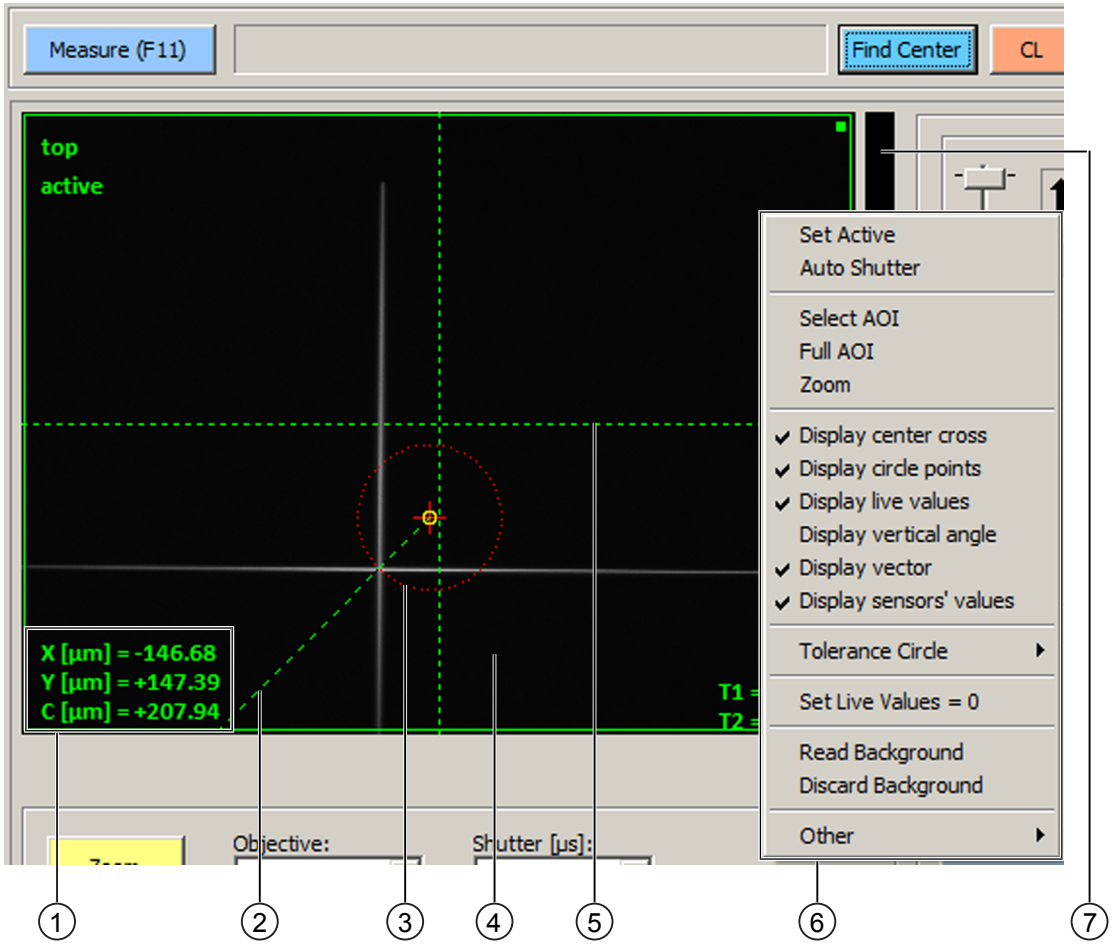
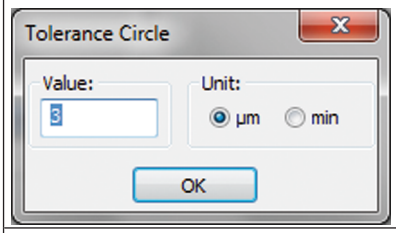


Fig. 143: Camera window

1	**Live values** X [µm]: Current centering error in direction of the X-axis Y [µm]: Current centering error in direction of the X-axis C [µm]: Total error
2	Vector indicating the location of the centering error in relation to the coordinate system
3	**Tolerance circle** Representation of the tolerated centering error
4	**Measuring window** (area of interest = AOI) During a measurement, the crosshair must be within the measuring window all the time.Please note: The crosshair may move out of the AOI while rotating when measuring large centering errors.
5	**Center Cross** Crosshairs of the camera

6	**Context menu in the camera window**
	`Set Active`: Selects active camera window (if there are several windows available) `Auto Shutter`: Automatically sets the exposure time
	`Select AOI`: Changes the measurement window (AOI) **(4)** `Full AOI`: sets the measurement window to maximum `Zoom`: Enlarge view (AOI) to the size of the measurement window
	`Display center cross`: Displays the center of the camera (5) `Display circle points`: Displays the measuring points of the centering error measurement `Display live values`: Displays the current readings in the camera window (1) `Display vertical angle`: Only for TRIOPTICS staff, for aligning the camera `Display vector`: Displays vector (2) `Display sensor's value`: Display values from the sensor
	`Tolerance circle`: `Display`: Displays the tolerated centration error **(3)** `Change Value`: Changes the tolerance 
	`Set live values = 0`: Resets live values to "0"
	`Read Background`: Reads background `Discard Background`: Discards background
	`Other` `Orientate Azimuth`: When a lens is to be aligned in the mount, the specimen is turned after the measurement so that it only has to be moved in the X direction. `Adjust Using Smart Align (Yellow Cross)`: Adjusts the center of curvature to the calculated axis `Adjust To Rotation Axis`: Adjusts the center of curvature to the rotation axis `Store Cross Position`: Stores the current cross position `Discard Cross Position`: Discards the current cross position `Save Image`: Saves the camera image `Switch Cameras`: for special configurations with three cameras, you can switch between the third camera being the right-hand one or the bottom one
7	**Bar graph of light intensity in the measurement window (AOI)** Green readout when saturation level within the predefined limits Red readout if saturation level exceeded or not reached

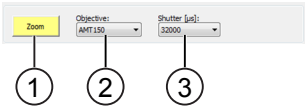


Fig. 144: Display options for camera image, Display options

Display options for the camera image

1	`Zoom`: Enlarge/reduce the representation
2	`Objective`: Selecting the head lens
3	`Shutter [µs]`: Enter exposure time

19.2 Menu

19.2.1 <File> menu

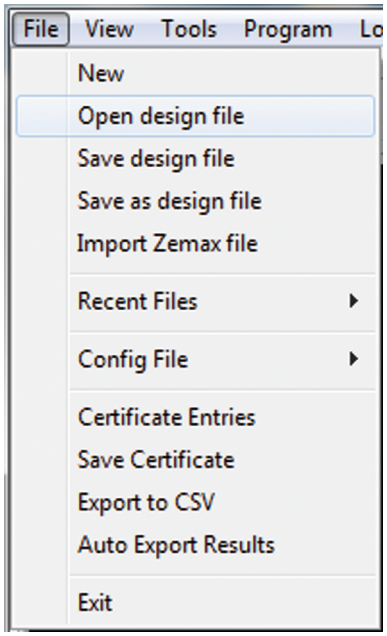


Fig. 145: Menu, File menu

New

Creates a new design file (.df) (for the MultiLens® and Thickness measurement programs)

NOTE

The `<File> <New>` command deletes all current design data, results and certificates.

Open design file

Opens the design file (.df)

Please consult *Opening the design table [▶ 93]* for a detailed description.

Save design file

Saves the design file

Save as design file

Saves the design file under a new name (.df)

Import Zemax file

Imports a Zemax file (.zmx)

Recent Files

Displays recently opened design files

Config File

Open: Opens the configuration file (for measurement programs "Reflection" and "Transmission")

Save: Saves the configuration file

Certificate entries

Opens the `Certificate Entries` window.

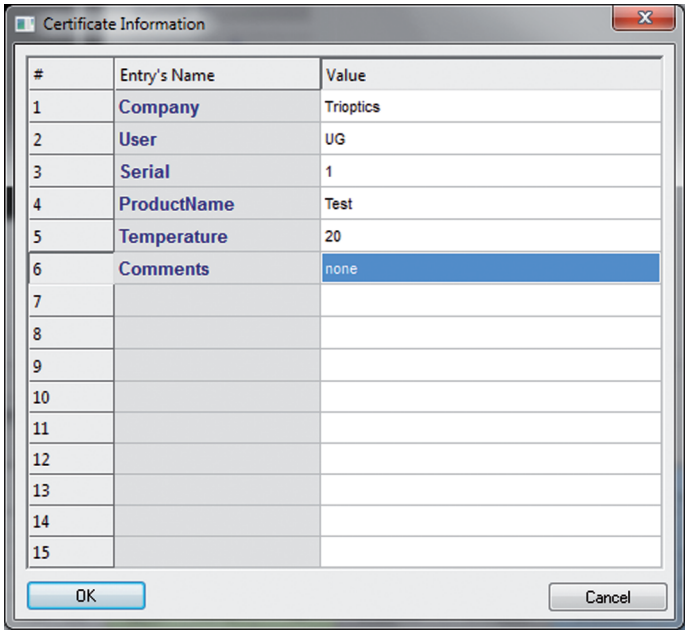


Fig. 146: File, Certificate entries

NOTE

The columns "Entry name" and "Value" are free text fields. The maximum number of rows is 15.

Save Certificate

Saves measurement results in an HTML file (.mht)

Export to CSV

Saves measurement results in table format .csv (for use in Excel, for example)

Auto Export Results

Automatically save all measurement values in a file.

1. Tick the checkmark for Auto Export Results.
2. Select Certificate Entries and click OK.
3. Perform the measurements.

⇨ This creates a text file whose name is assigned automatically and which includes the date and the serial number of the measurement system.
Example: 20131119_4-151-008.txt

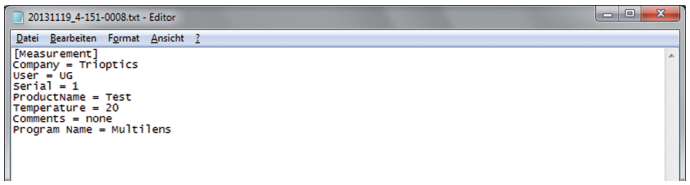


Fig. 147: File, Auto Export Results

Exit

Exits the program. The following data are stored and retrieved the next time the program is started:

- the selected measurement program
- any changed settings
- the appearance and position of windows and menus

19.2.2 <View> menu

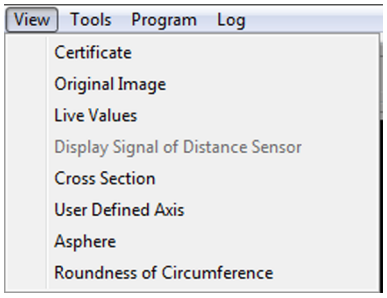
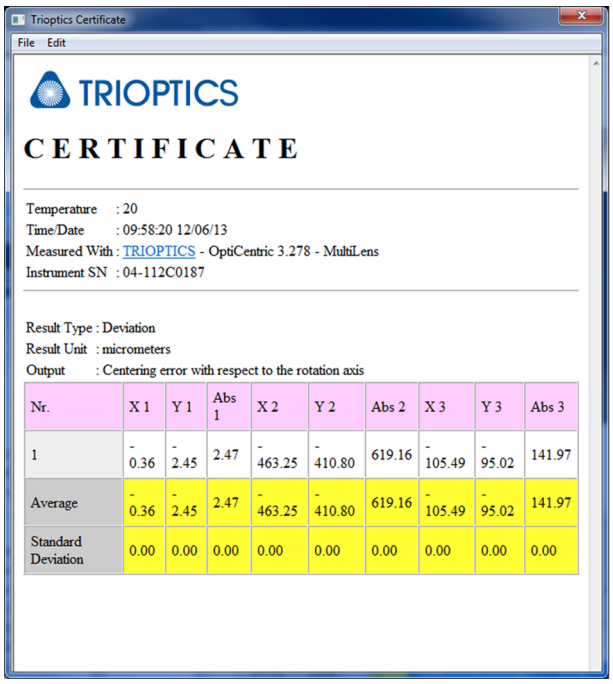


Fig. 148: Menu, View

Certificate

Displays the certificate



Nr.	X 1	Y 1	Abs 1	X 2	Y 2	Abs 2	X 3	Y 3	Abs 3
1	- 0.36	- 2.45	2.47	- 463.25	- 410.80	619.16	- 105.49	- 95.02	141.97
Average	- 0.36	- 2.45	2.47	- 463.25	- 410.80	619.16	- 105.49	- 95.02	141.97
Standard Deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Fig. 149: View, Certificate

Original Image

Displays the camera image at full screen size

Live Values

Additional window for displaying live values in large numbers

Display Signal of Distance Sensor

Display signal for the distance sensor

Cross Section

Representation of the intensity profile in X and Y direction across the area of interest (AOI)

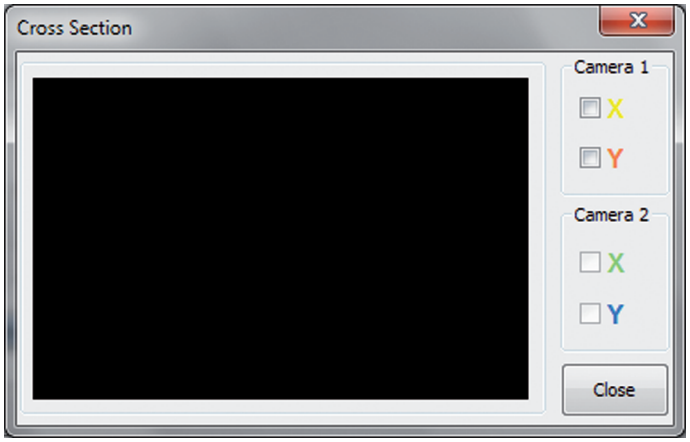


Fig. 150: View, Cross Section

User Defined Axis

Control box for the sensor, is used for determining a reference axis (for the mechanical mount of a sample, for example) for a MultiLens® measurement

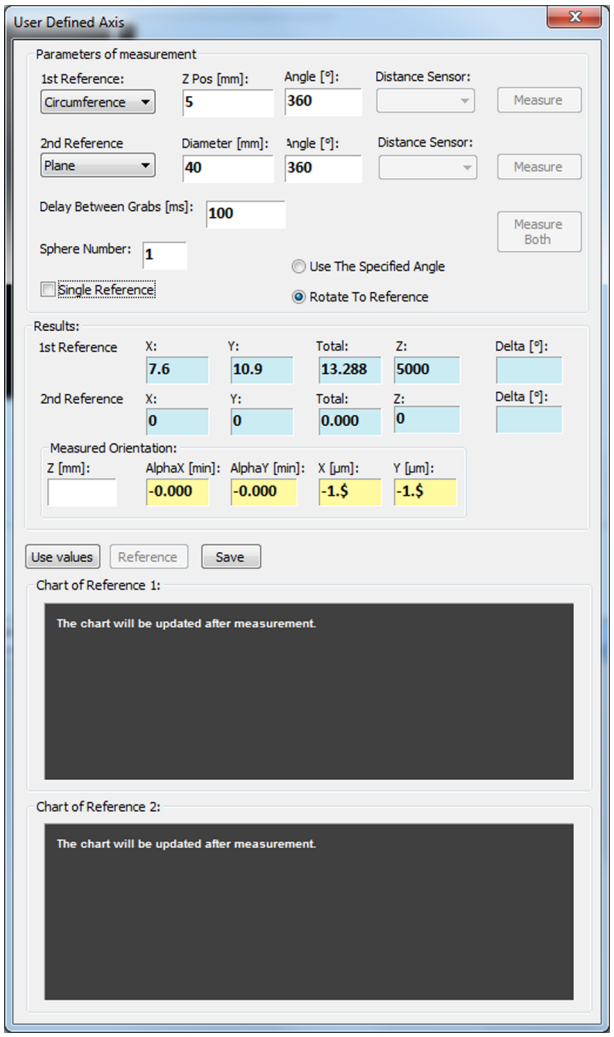


Fig. 151: User Defined Axis

Asphere

Dialog for extended asphere measurement

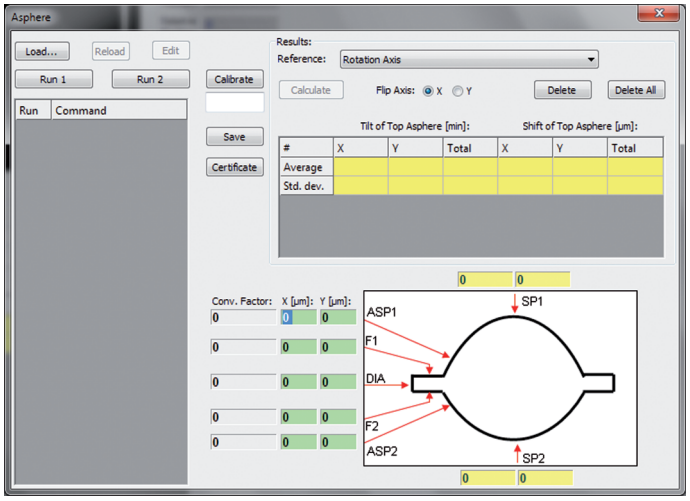


Fig. 152: View, Asphere

Roundness of Circumference

Dialog for testing the roundness of the lens and housing circumference

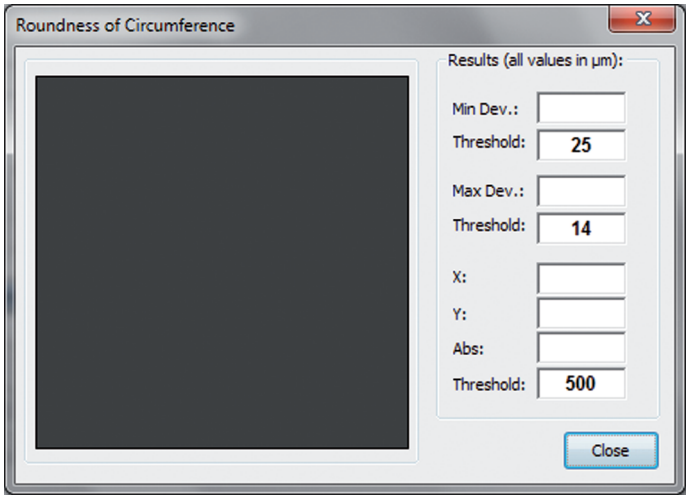


Fig. 153: View, Roundness of Circumference

19.2.3 <Tools> menu

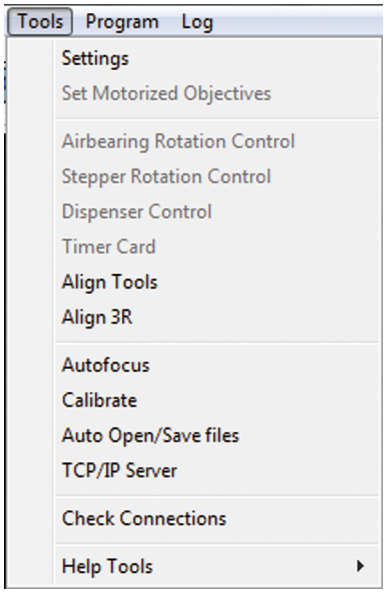


Fig. 154: Menu, Tools

Settings

For further information refer to chapter *Settings [▶ 174]*.

Set Motorized Objectives

If a motorized objective changer is used, the mounted head lenses are entered here.

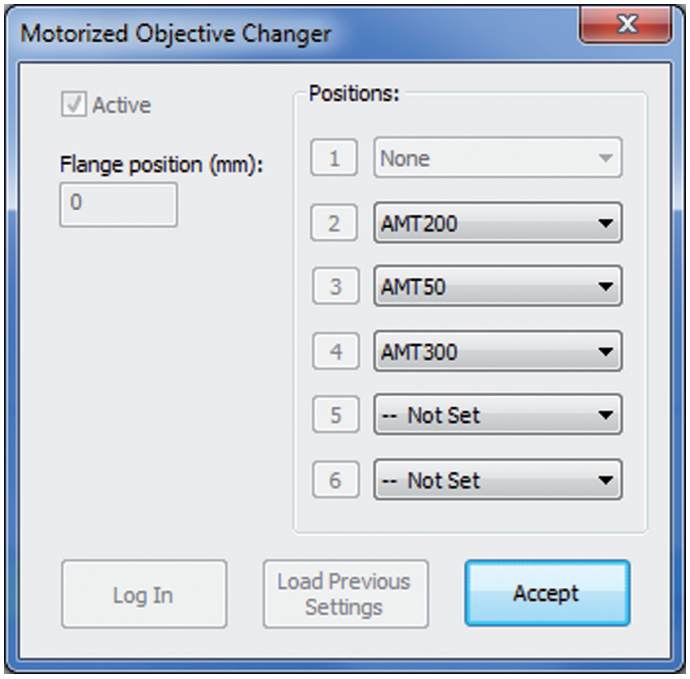


Fig. 155: Tools, Motorized Objective Changer

Airbearing Control Unit

Manual control of the air bearing

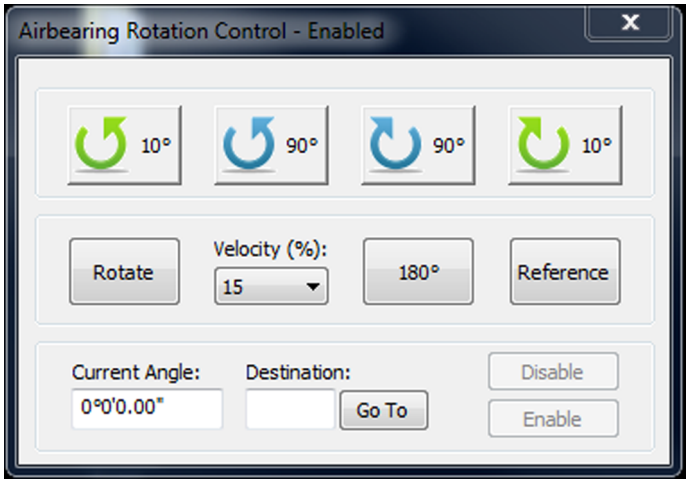


Fig. 156: Tools, Airbearing Rotation Control

Stepper Rotation Control

Special function, not used for this measurement system

Dispenser Control

Special function, not used for this measurement system

Timer Card

Special function, not used for this measurement system

Align Tools

Opens the `Align Tools` window.

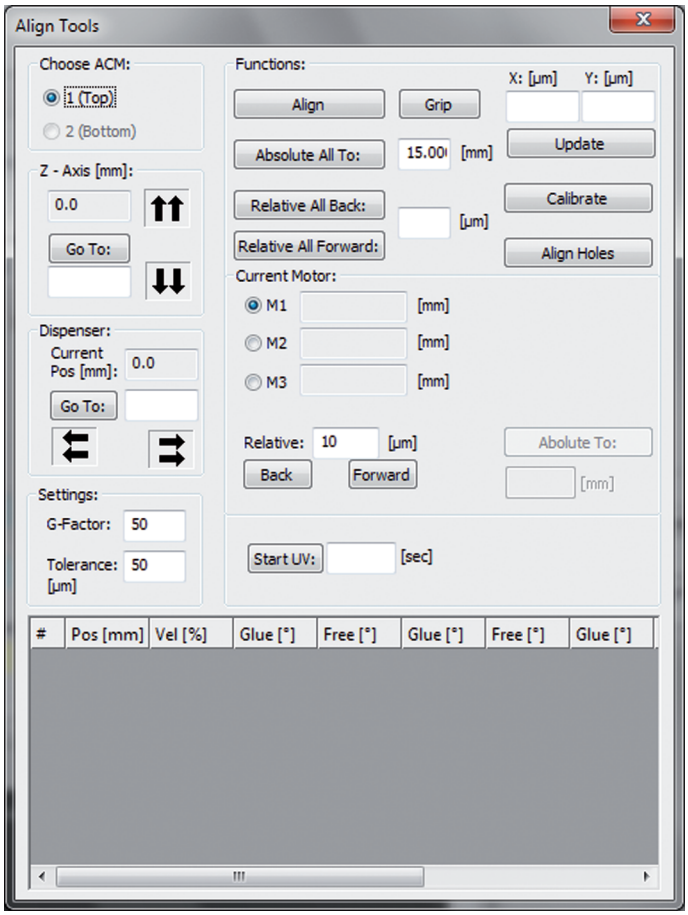


Fig. 157: Tools, Align Tools

Align 3R

Opens the `Alignment Control` window.

Special function, not used for this measurement system

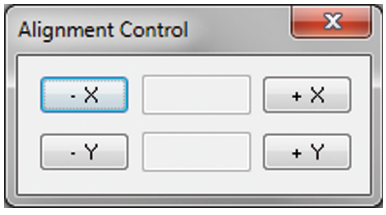


Fig. 158: Tools, Alignment Control

Autofocus

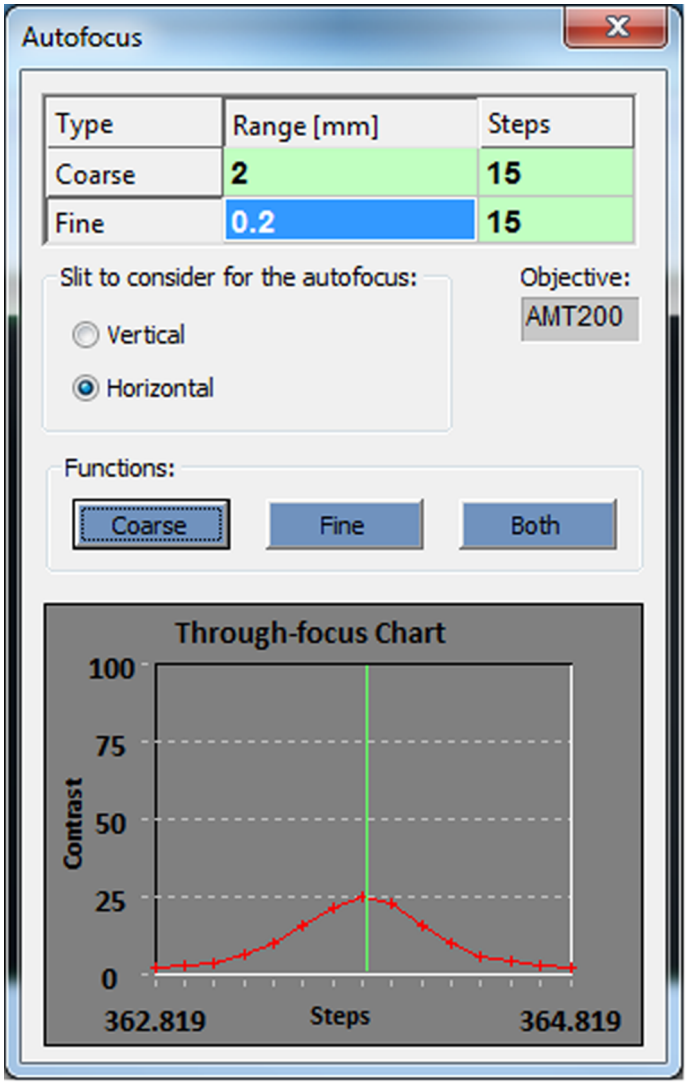


Fig. 159: Tools, Autofocus

Perform autofocus of the upper measurement axis manually.

NOTE

To cancel the autofocus process, press the ESC key or click on the X.

Calibration

Calibrate measurement system:

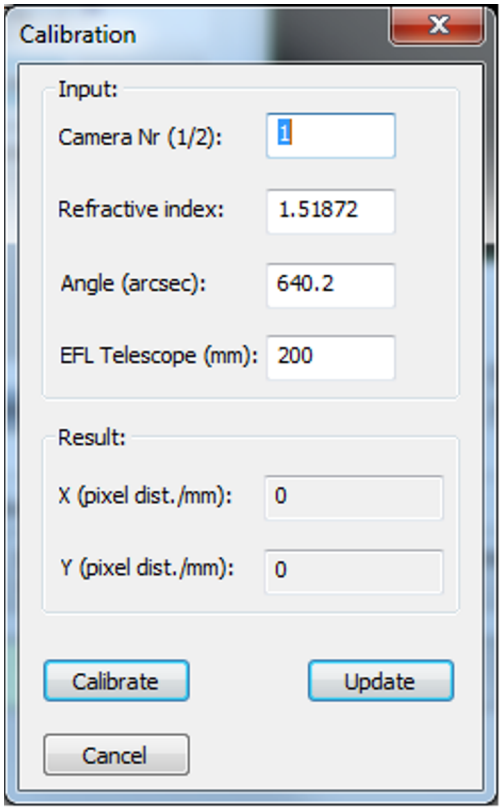


Fig. 160: Tools, Calibration

Auto Open/Save files

Automatically opens/save files

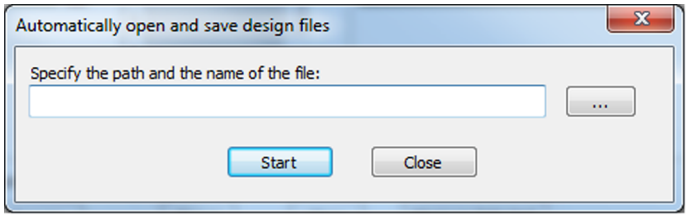


Fig. 161: Tools, Automatically open and save design files

TCP/IP Server

Connection between the software and a measurement device via TCP/IP. The measurement is started externally.

Special function, not used for this measurement system

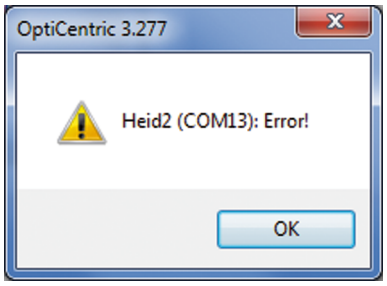


Fig. 162: Tools, Check connections

Check Connections

Reads values of the air bearing rotary encoder.

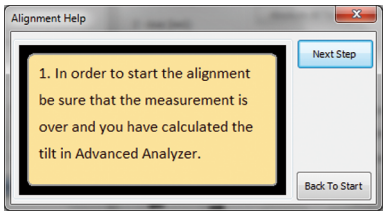


Fig. 163: Tools, Help Tools

Help Tools

Tilt Alignment

Opens the `Alignment Help` window. This wizard is used to align the specimen axis to the reference axis (the bearing's axis of rotation); this is particularly useful for example for OptiSurf measurements in the OC3D.

19.2.4 <Program> menu

`Centration in Reflection`	Centering Error Measurement in Reflection

	(refer to chapter *Centering Error Measurement in Reflection [▸ 75]*)
`Centration in Transmission`	Centering Error Measurement in Transmission (refer to chapter *Centering error measurement in transmission [▸ 79]*)
`Distance`	Distance measurement (e.g. measurement of radii) (refer to chapter *Measurement of radii of curvature [▸ 83]*)
`Multiple Lenses`	Measurement of multi-lens optical systems (refer to chapter *Conducting a MultiLens® measurement [▸ 103]*)
`Thickness`	Measurement of Lens Thicknesses and Air Gaps (refer to chapter *Measurement of lens thicknesses and air gaps [▸ 117]*)
`Cylindrical Lenses`	Measurement of cylinder lenses
`Check Calibration`	Check calibration

19.2.5 <Log> menu

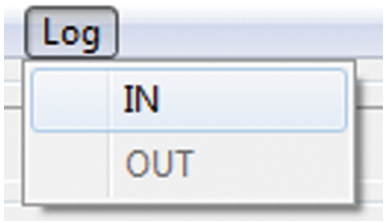


Fig. 164: Login

IN

Opens the "Login" window. Here you can log on as Administrator or Supervisor (see also chapter 6.5 “Login”, page 65).

OUT

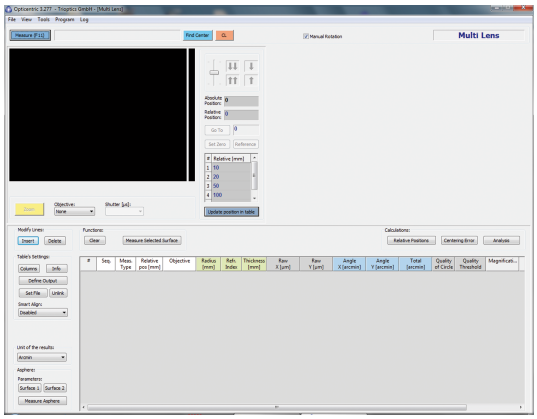
The administrator or supervisor is logged off. Then you will have the restricted user rights of an operator again.

19.3 The program windows

This chapter describes the functions and buttons of the individual program windows.

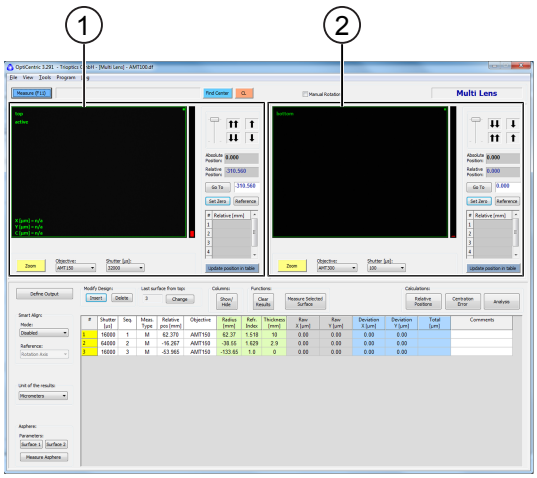
The display differs depending on the configuration of the measurement system as follows:

Ansicht A



Mess-System mit Einzelmesskopf

Ansicht B



Duales Mess-System

Fig. 165: Program windows, display forms

1	Camera window for the first measurement head (e.g. upper measurement head)
2	Camera window for the second measurement head (e.g. lower measurement head)

19.3.1 Program window “Reflection”

This mode measures the wobble of a plane face and the centering error of a spherical (lens) surface.The exact procedure is described in chapter *Centering Error Measurement in Reflection [▸ 75]*.

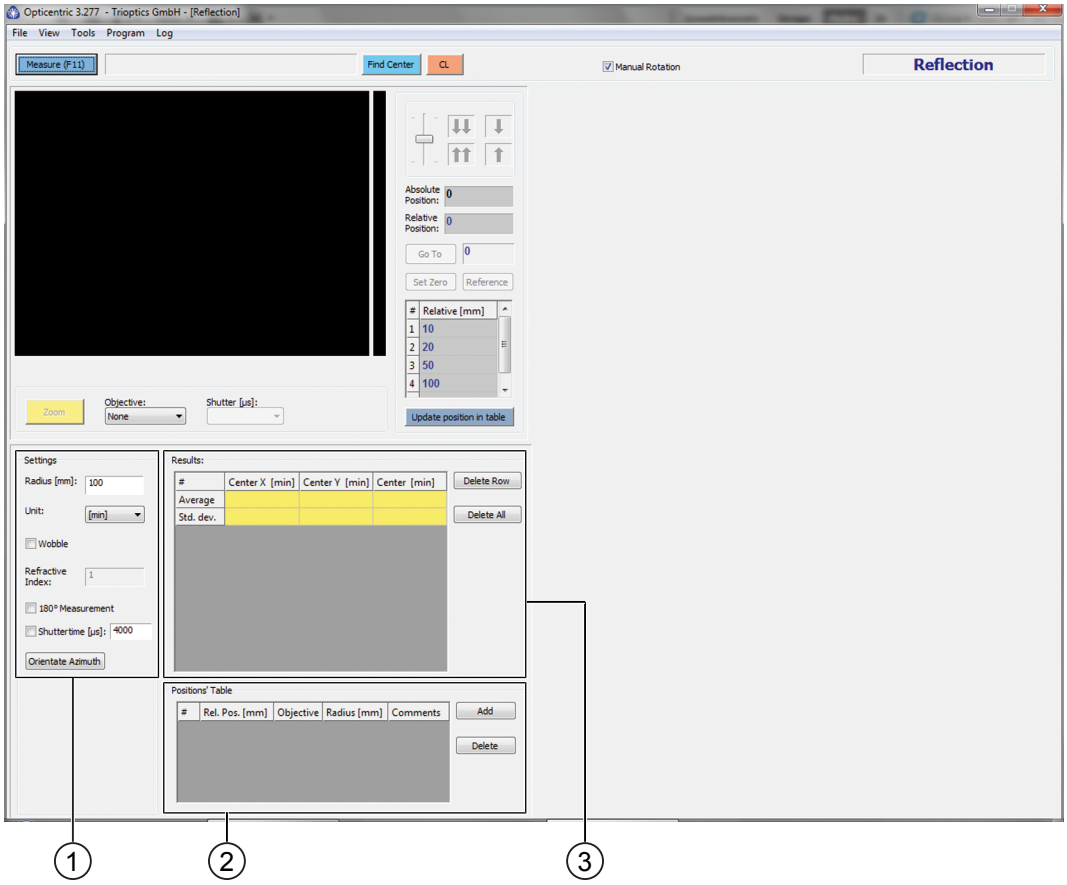


Fig. 166: program window Reflection

1	**Settings** `Radius [µm]` input field: Lens radius (without test surface) Option menu `Unit`: Units for the results (µm, mm, min, sec) `Wobble`: Tick the checkmark for measuring the wobble of a test surface `Display Deviation Cross`: (not yet implemented) `Refractive Index`: (without function here) `180° Measurement`: Tick the checkmark for a 180° measurement `Shutter time [µs]` input field: Tick the checkmark to select the exposure time of the camera entered here (this only makes sense if both camera windows are active and the measurement is supposed to use two different exposure times). `Orientate Azimuth`: When a lens is to be aligned in the mount, the specimen is turned after the measurement so that it only has to be moved in the X direction.
2	**Positions' Table** An unlimited number of relative positions with radius specification (sample), the selected head lens and comments may be entered in this table and selected by double clicking the row number. The table can be saved (`<File> <Config> <Save>`). `Add` button: Adds one row `Delete` button: Deletes the selected row
3	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

19.3.2 Program window “Transmission”

This mode measures the total centering error of multi-lens optical systems.

The exact procedure is described in chapter *Centering error measurement in transmission [▶ 79]*.

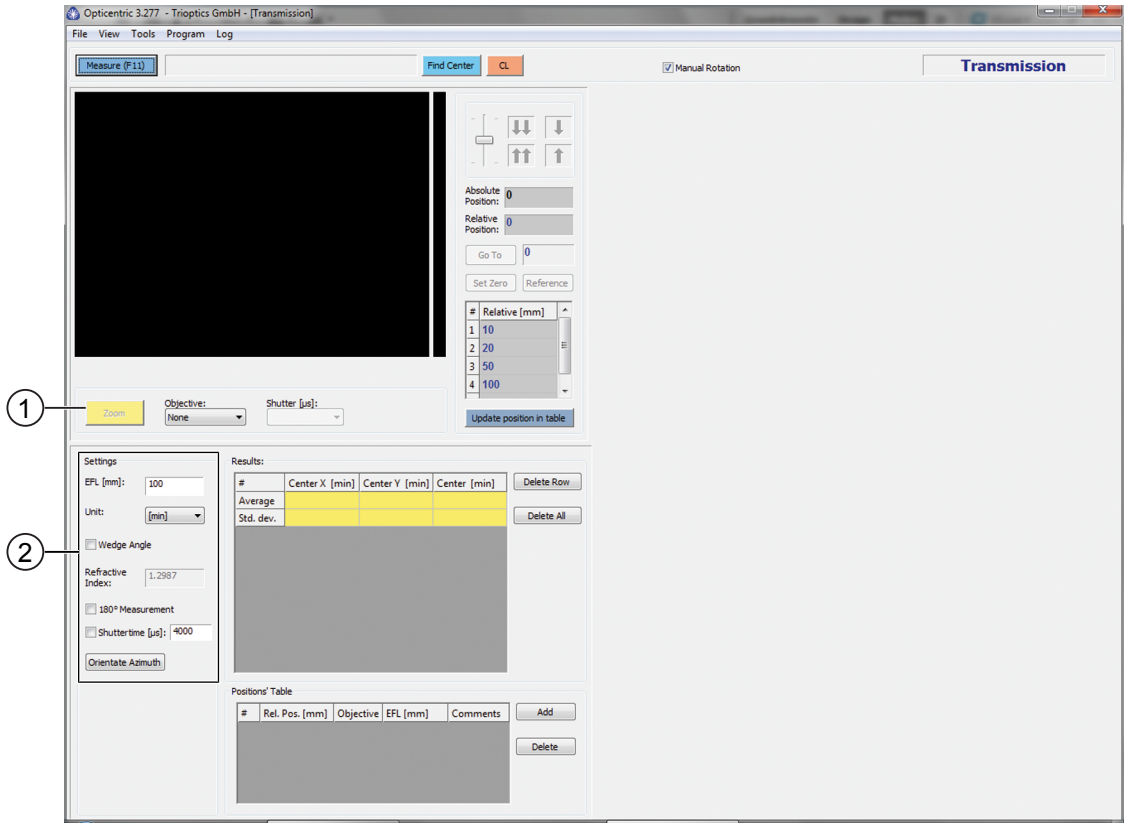


Fig. 167: program window Transmission

1	**+ button** – Click the button + to increase the area of interest (AOI) to the entire camera image area. The camera window will display `ZOOM`. – Click the button again – to undo the magnification.
2	**Settings** Input field `EFL [mm]`: Effective focal length of the sample (design value) Option menu `Unit`: Units for the results (µm, mm, min, sec) `Wedge Angle`: Tick the checkmark for measuring wedge errors (plano optics) in transmission `Refractive Index` input field: Refractive index n_e of the material (enabled when Wedge Angle is selected) `180° Measurement`: Tick the checkmark for a 180° measurement `Shutter time` input field: Tick the checkmark to select the exposure time of the camera entered here (this only makes sense if both camera windows are active and the measurement is supposed to use two different exposure times). `Orientate Azimuth`: When a lens is to be aligned in the mount, the specimen is turned after the measurement so that it only has to be moved in the X direction.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.3 Program window "MultiLens"

This mode precisely measures centering errors of the individual areas within multi-lens optical systems.

The exact procedure is described in chapters *Preparation for a MultiLens® measurement [▸ 103]* and *Conducting a MultiLens® measurement [▸ 104]*.

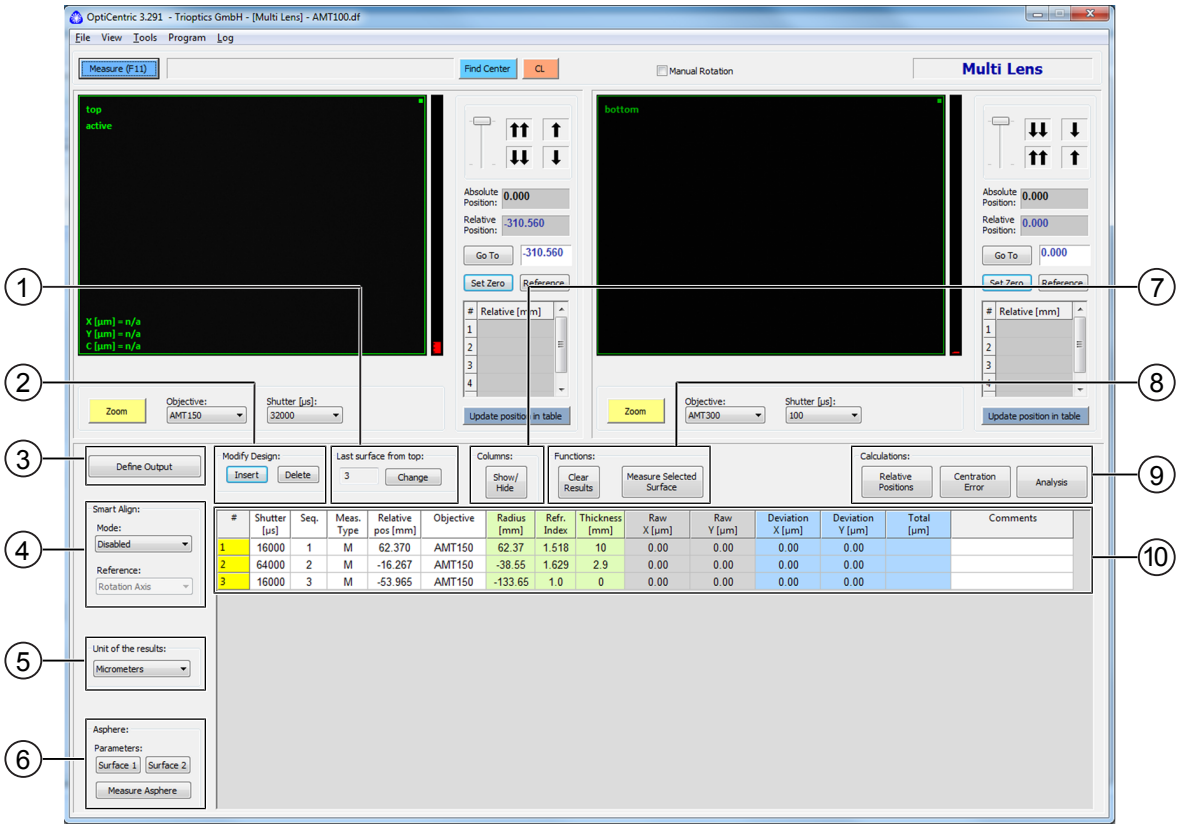
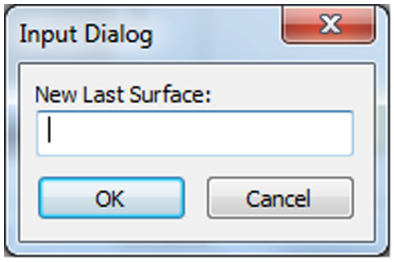
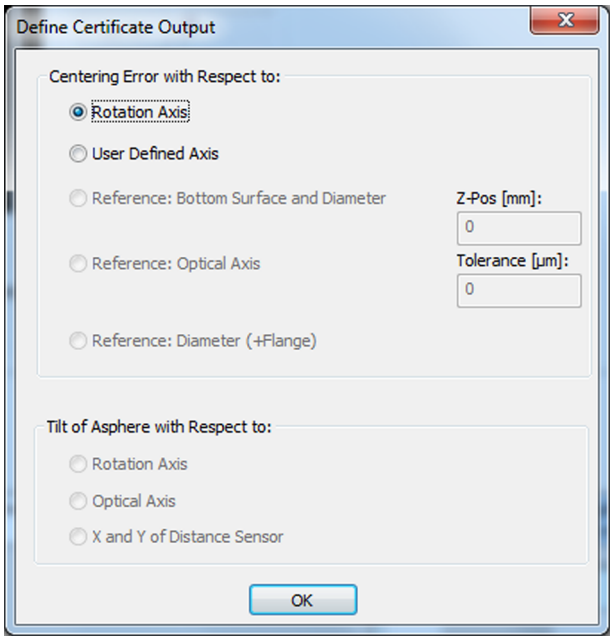


Fig. 168: program window MultiLens

1	**Last surface from top** (only appears for OptiCentric Dual) `Change` button: Click to open the Input dialog. Enter the number of the last surface to be measured with the top collimator. 
2	**Modify Design** `Insert` button: Adds a row to the design table `Delete` button: Deletes the selected row from the design table

3	`Define Output` button: opens a window where you can select the reference used as a basis for the values. – Click the `Centration Error` button to update the results. 
4	**Smart Align** `Mode` selection menu: Selecting the alignment mode `Disabled`: SmartAlign is disabled. `Single Surface`: Alignment of a single surface to a reference axis `Group Shift`: Alignment of a lens group to a reference axis by shifting `Tilt Parallel`: Alignment of a surface pair so that the resultant axis is parallel to a reference axis `Reference` selection menu: Select the reference axis `Rotation Axis`: Alignment to the axis of the pivot bearing `Optical Axis`: Alignment to the optical axis of another element `User Defined Axis`: Alignment to the mount axis
5	**Unit of the results** Option menu for selecting the unit of the results (µm or arcmin)
6	**Asphere** `Parameters` `Surface 1` button: Opens an input window for the parameters of the aspheres of the first surface `Surface 2` button: Opens an input window for the parameters of the aspheres of the second surface `Measure Asphere` button: Start the measurement

7	**Columns** `Show/Hide` button: Opens a window for selecting the parameters to be displayed in the design table (refer to chapter *Changing the appearance of the design file [▶ 90]*).
8	**Functions** `Clear Results` button: Deletes the results `Measure Selected Surface` button: Single measurement of the selected area/ row of the design table
9	**Calculations** `Relative Positions` button: Calculate relative positions `Centration Error` button: Calculates centering errors, for example after a single surface was subsequently measured via Measure Selected Surface `Analysis` button: Starts the Advanced Analyzer, check results
10	Design table

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.4 Program window “Distance”

This mode measures radii, for example.

The exact procedure is described in chapter *Measurement of radii of curvature [▶ 83]*.

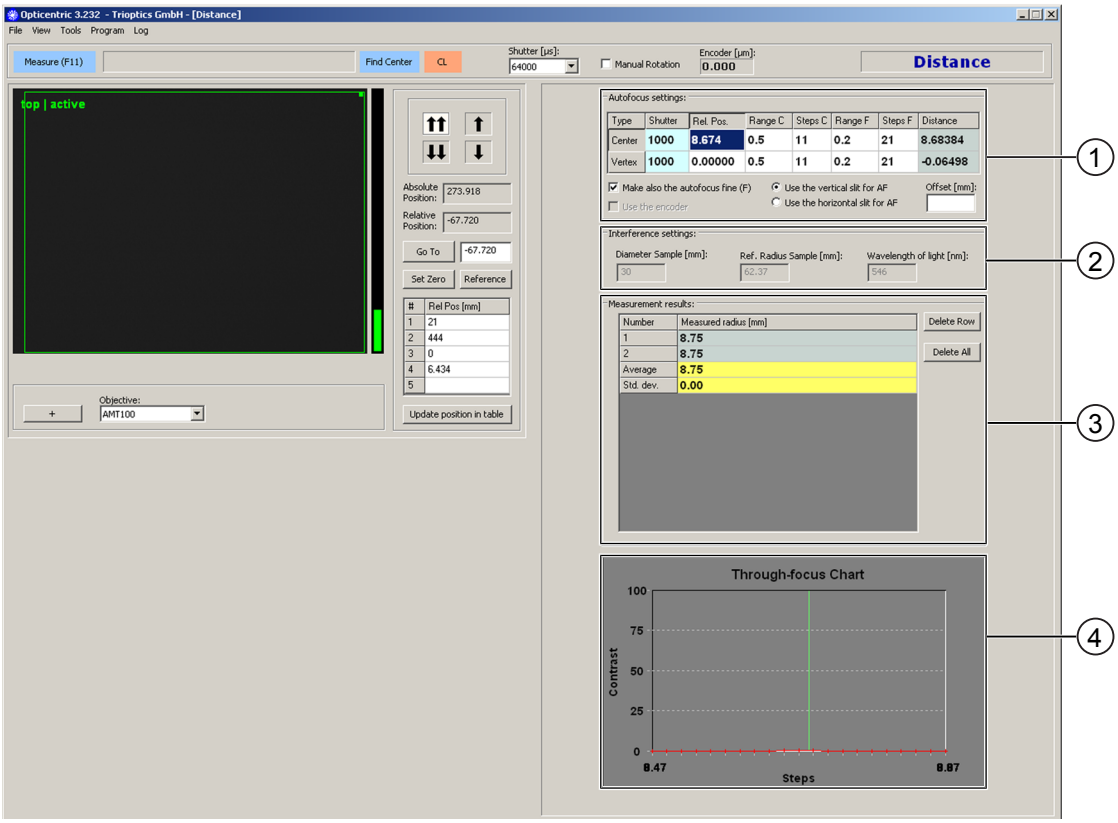


Fig. 169: program window Distance

1	**Autofocus settings**
	`Type`
	`Center`: Information on the center of curvature of the first surface
	`Vertex`: Information on the surface point/apex point
	`Shutter`: Exposure time
	`Rel.Pos.`: Relative position
	`Range C`: Autofocus area for coarse scan
	`Steps C`: Number of measurement steps for coarse scan
	`Range F`: Autofocus area for fine scan
	`Steps F`: Number of measurement steps for fine scan
	`Distance`
	`Make also the autofocus fine (F)`
	Checkmark ticked: A fine scan is performed after the coarse scan.

	`Use the encoder`
	Checkmark ticked: Position measurement of the measurement head position with external encoder (optional)
	`Use the vertical slit for AF`
	Selected: The vertical slit is used for the autofocus.
	`Use the horizontal slit for AF`
	Selected: The horizontal slit is used for the autofocus.
	`Offset [mm]`: Offset

2	**Interference Settings** additional output for circular radius measurement; can be activated under `<Tools> <Settings> <General> <Calculate Interference Ring>` `Diameter Sample [mm]`: Lens diameter `Ref. Radius Sample [mm]`: Nominal radius `Wavelength of light [nm]`: Wavelength, typically 633 nm
3	**Measurement Results** (Display of the measurement results) `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.
4	**Through-focus Chart** Autofocus curve showing the best focus position

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.5 Program window “Thickness”

This mode measures airspaces and lens thicknesses.The exact procedure is described in chapter *Measurement of lens thicknesses and air gaps [▶ 117]*.

1	Position table can be loaded from MultiLens
2	**Autofocus** `Relative start & stop`: Autofocus range `Steps`: Number of measurement steps
3	**Functions** `Insert` button: Inserts a row `Delete` button: Deletes a row `Measure Current Row` button: Measures the selected row `Calculate Surface Pos` button: Calculates the surface position `Calculate Thickness` button: Calculates the distance and/or the center thickness
4	Indicates if the (optional) linear encoder is properly connected

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.6 Program window “Check Calibration”

This mode checks the calibration of the measurement system.

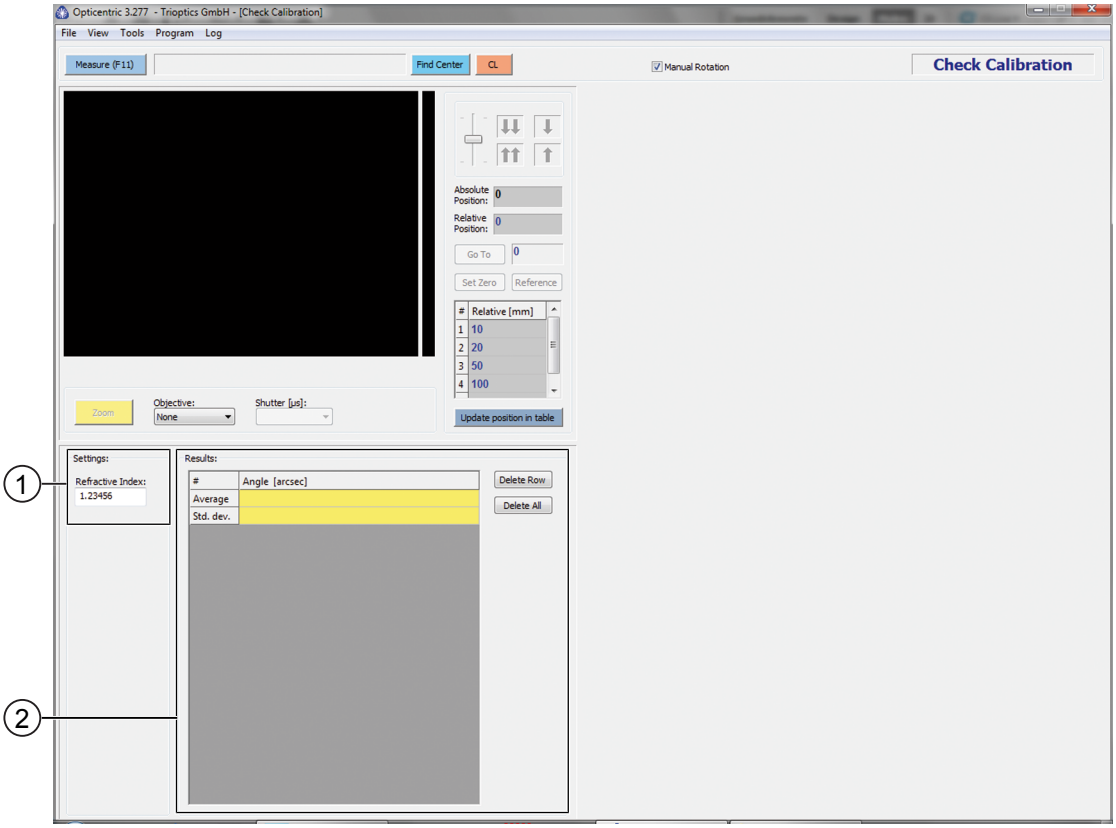


Fig. 170: Check Calibration

1	**Settings** `Refractive Index`: Enter the refractive index n_e of the wedge
2	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.7 Program window “Cylindrical Lens, Tilt with Respect to Edge”

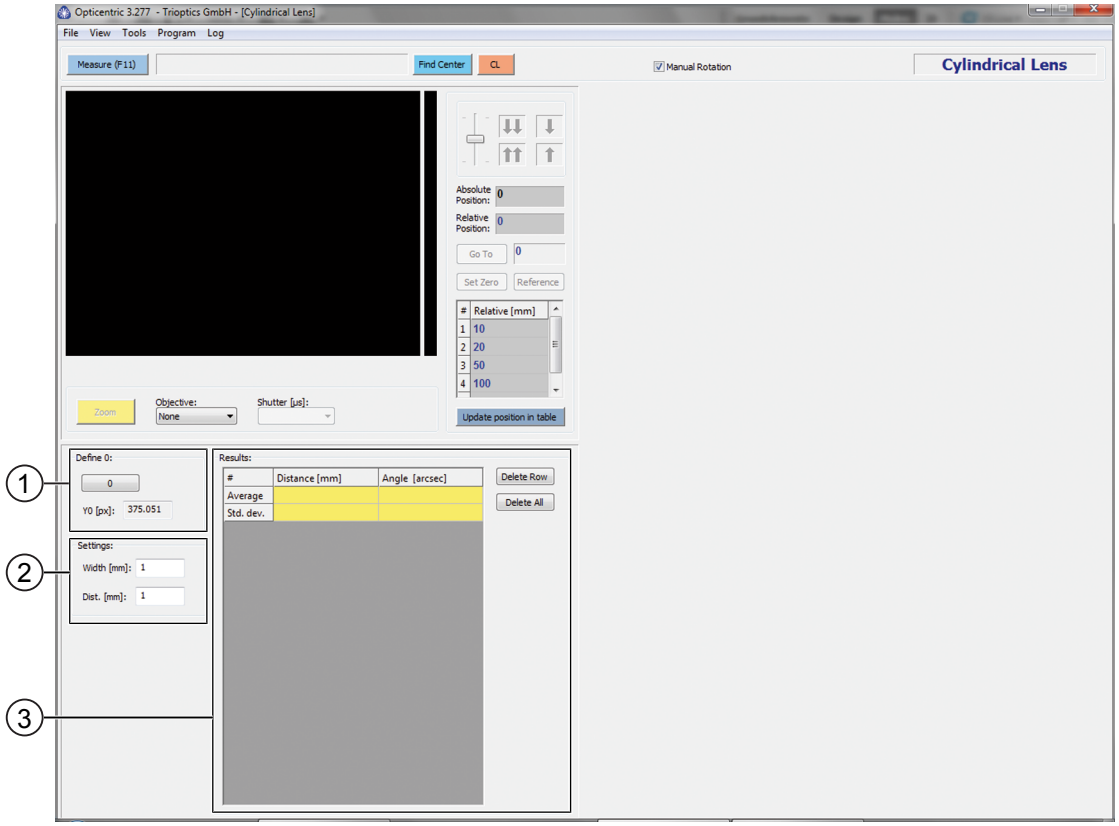


Fig. 171: Cylindrical Lens, Tilt with Respect to Edge

1	**Define 0** Starts calibration with master sample `0` button `YO [px]`: Output of the position of the zero line in pixels
2	**Settings** `Width [mm]`: exact width of the master sample `Dist. [mm]`: Distance between two measuring points
3	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.8 Program window “Cylindrical Lens, Tilt with Respect to Bottom Surface”

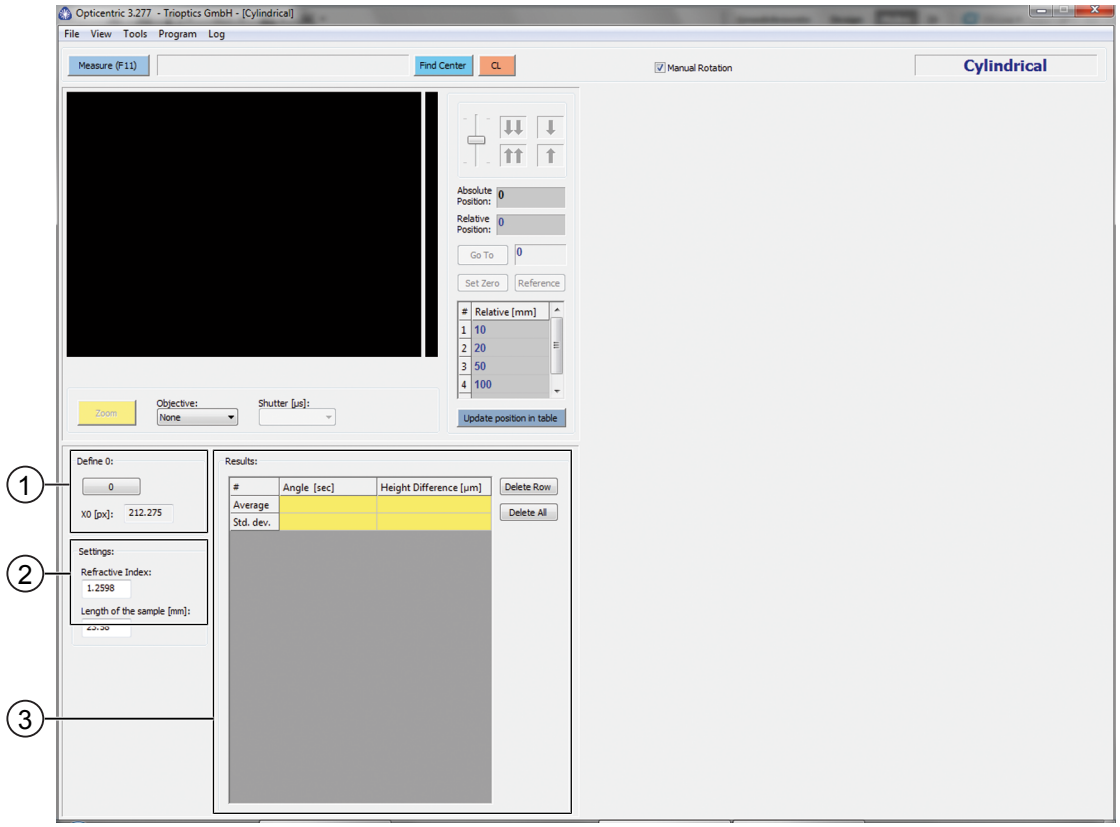


Fig. 172: Cylindrical Lens, Tilt with Respect to Bottom Surface

1	**Define 0** Button `0`: Determines the position of the reflected reticle (reference) in absence of a sample `XO [px]`: Output of the zero position in pixels (only for informational purposes)
2	**Settings** `Refractive Index`: Refractive index ne of the sample at 546 nm `Length of the sample [mm]`: Length of the sample
3	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.9 Program window “Cylindrical Lens, Clocking Angle of Single Surface”

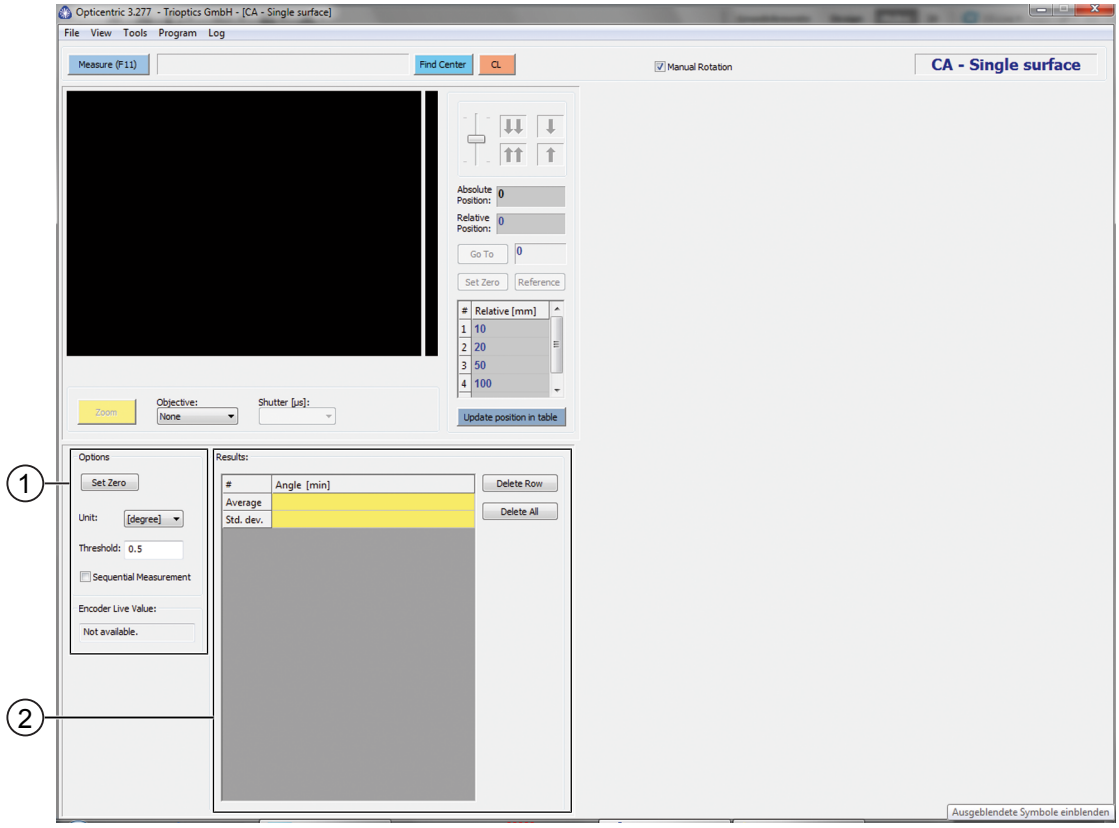


Fig. 173: Cylindrical Lens, Clocking Angle of Single Surface

1	**Options** `Set Zero` button: The current cylinder orientation is used as a reference. `Unit`: Unit of the displayed angle `Threshold`: Limit value `Sequential measurement`: no function with "Single Surface" measurement `Encoder Live Value`: Displays the position of the rotary table
2	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.3.1 Program window “Cylindrical Lens, Clocking Angle between two Cylinders”

0

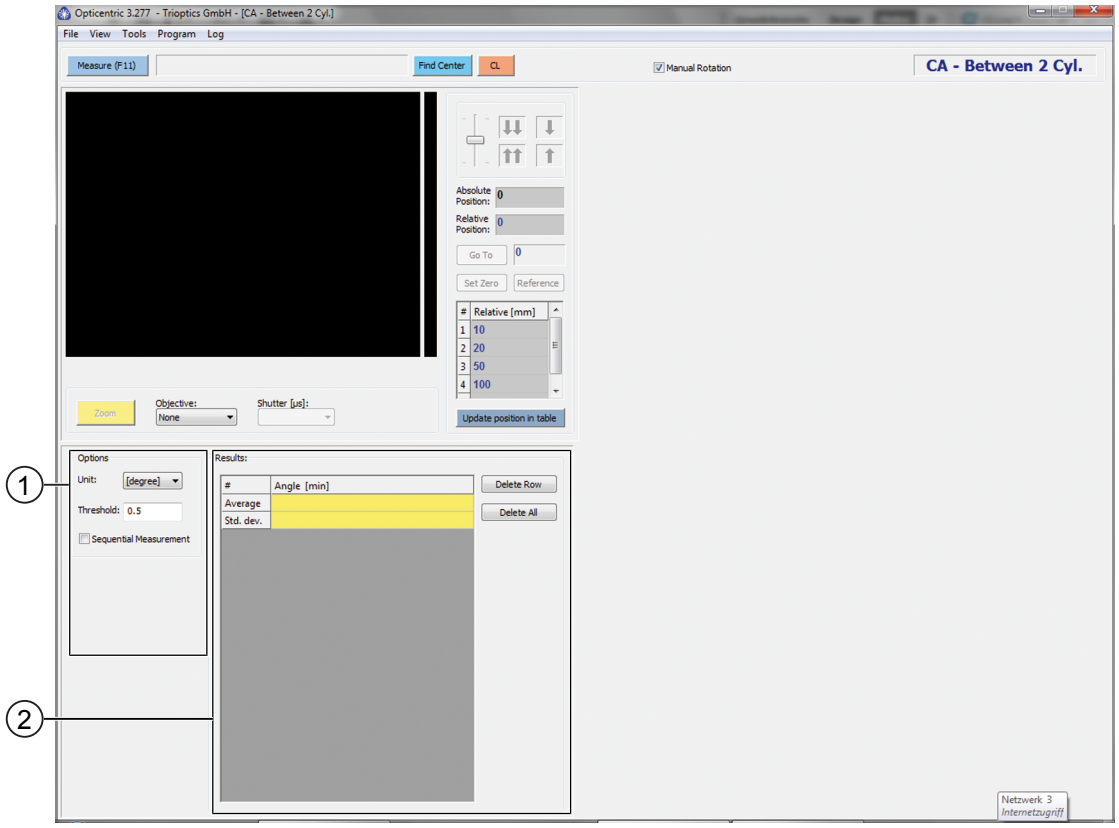


Fig. 174: Cylindrical Lens, Clocking Angle between two Cylinders

1	**Options** `Unit`: Unit of the displayed angle `Threshold`: Limit value `Sequential measurement`: Checkmark ticked: The measurements with the top and bottom collimator are performed sequentially (e.g. if the images overlap during simultaneous measurement).
2	**Results** Displays the results of a measurement `Delete Row` button: Deletes the selected row in the results list. `Delete All` button: Deletes all rows in the results list.

NOTE

All buttons and displays not explained here are identical to those for the program window “Reflection”.

19.4 Settings

This section shows and explains the individual tabs for the settings.

General functions in the <Settings> menu

Select <Tools> <Settings>. The following window opens:

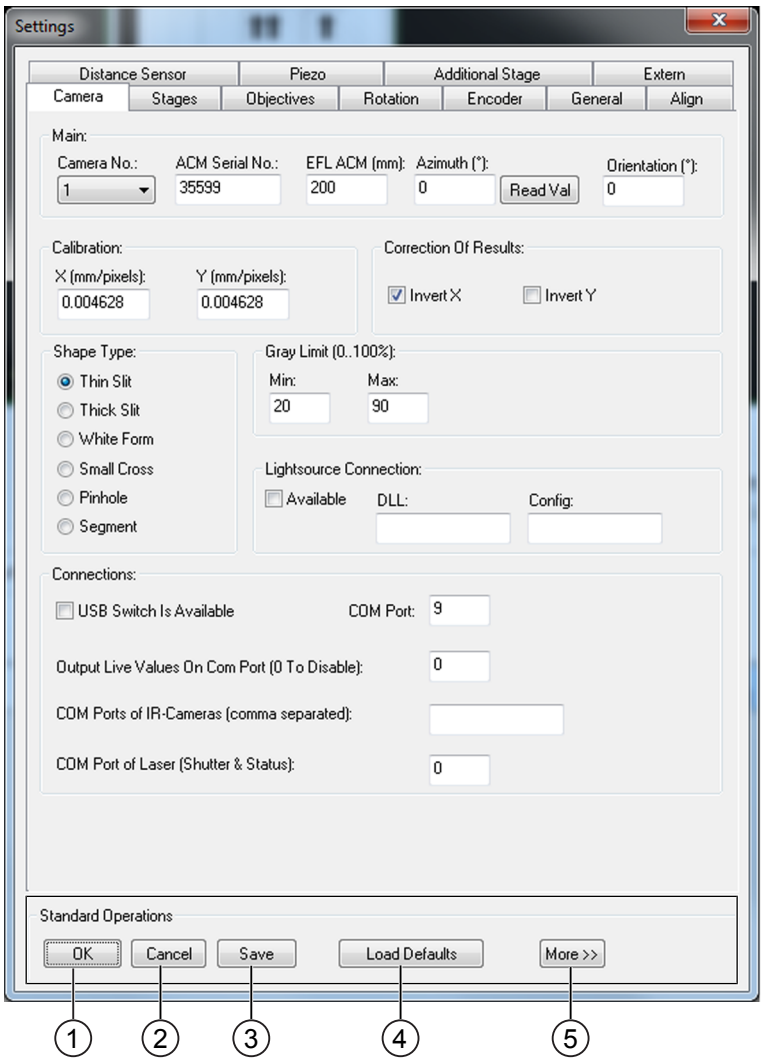


Fig. 175: Settings

The buttons for the standard options, which apply to all tabs, are located in the bottom section.

1	`OK`: Accept changes, but do not save
2	`Cancel`: Cancel, changes are not applied

3	`Save`: Apply and save changes
4	`Load Defaults`: Load default values
5	`More`: More>>/Hide<< Expand/hide window
	`Customer's Configuration File` `Load`: Load customized configuration file `Save`: Save customized configuration file

19.4.1 <Settings> Register <Camera>

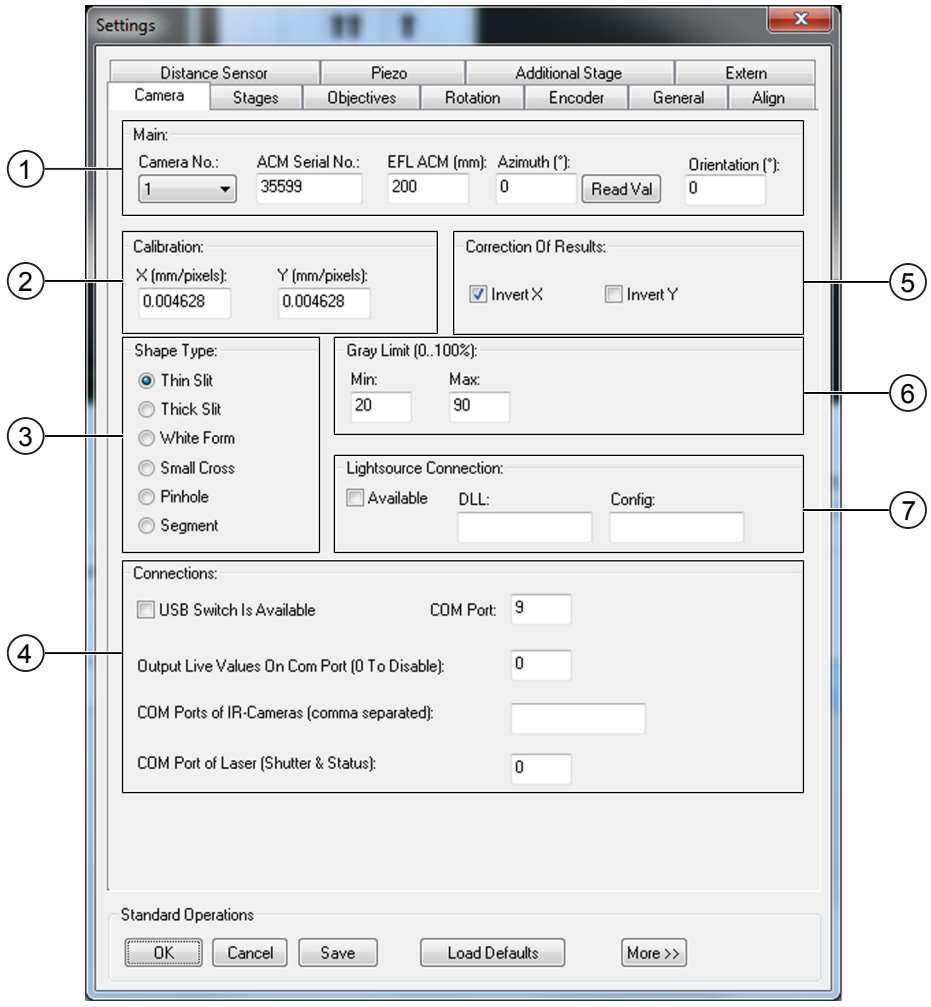


Fig. 176: Settings - Camera

1	**Main** `Camera No.`: Select the camera for which the settings are made

	• 1: top camera • 2: bottom camera `ACM Serial No.`: Serial number `EFL ACM (mm)`: Enter effective focal length of the autocollimator `Azimuth (°)`: Rotation of the two autocollimators to each other `Read Val`: read out curren value Orientation:
2	**Calibration** `X(mm/pixels)`: Value from calibration (applied automatically) `Y(mm/pixels)`: Value from calibration (applied automatically)

3	**ShapeType** Algorithm for cross recognition. The available options are: • Thin Slit Thick Slit • White Form • Small Cross • Pinhole • Segment
4	**Connections** `USB Switch Is Available`: Enable USB `COM Port`: COM port `Output Live Values On COM Port (0 To Disable)`: Enable live values output `COM Ports Of IR-Cameras (comma separated)`: COM ports of the IR camera (only with OC IR) `COM Port of Laser (Shutter & Status)`: COM port for laser shutter and status

5	**Correct Results** (only for service technicians)
	`Invert X`
	`Invert Y`

6	**Gray Limit (0..100%)** `Min`: enter lower limit value `Max`: enter upper limit value Bar graph of light intensity in the area of interest (AOI) turns red if the saturation is below the lower limit value or above the upper limit value.
7	**Lightsource connection** `Available`: Tick the checkmark when an LED controller is available `DLL`: Select DLL `Config.` : Select configuration file

19.4.2 <Settings> Register <Stages> (Drives)

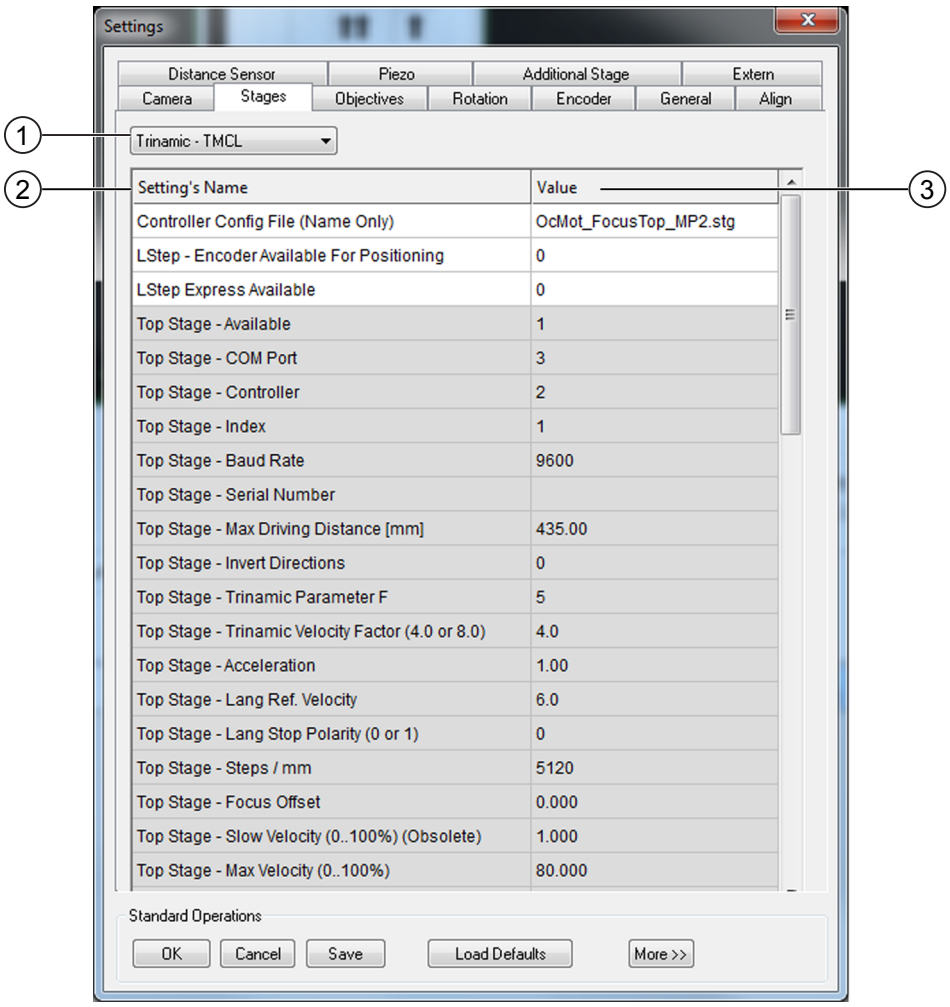


Fig. 177: Settings - Stages

1	**Option menu** Select the stage for which the settings are made
2	**Setting's Name** Setting
3	**Value** Value

NOTE

Incorrect measurement results due to faulty settings

This section is used for defining general settings for motors and drives.
Do not modify the settings without consulting TRIOPTICS.

19.4.3 <Settings> Register <Objectives> (Head lenses)

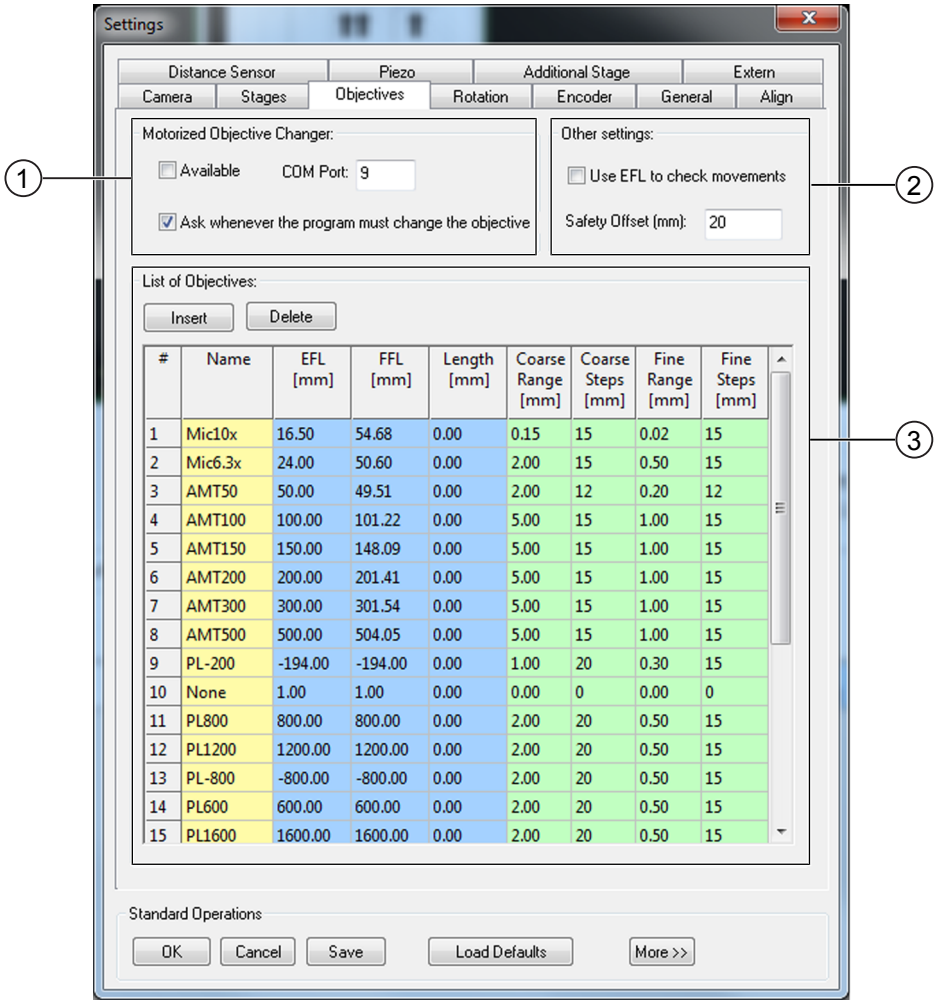


Fig. 178: Settings - Objectives

1	**Motorized Objective Changer** `Available`: Tick the checkmark, if available `COM Port Number`: of the serial interface `Ask whenever the program must change the objective`: Tick the checkmark if a confirmation is required by the user before each change of objective.
2	**Other settings** `Use EFL to check movements` `Safety Offset (mm)`: A safety offset can be specified in order to prevent the head lens colliding with the sample. Where: Relativposition < fACM - safety offset.

	If the head lens cannot keep to the safety offset, the movement is not performed. The message "`The stage can't drive more than the current objective EFL`" is displayed. (The stage cannot move further than the EFL of the selected head lens). Confirm with `OK` and select a different head lens.
3	**List of Objectives** List and calibration of all the head lenses provided with the device `Insert`: Inserts one row (= new head lens) `Delete`: Deletes a row

19.4.4 <Settings> Register <Rotation> (Rotation of the air bearing)

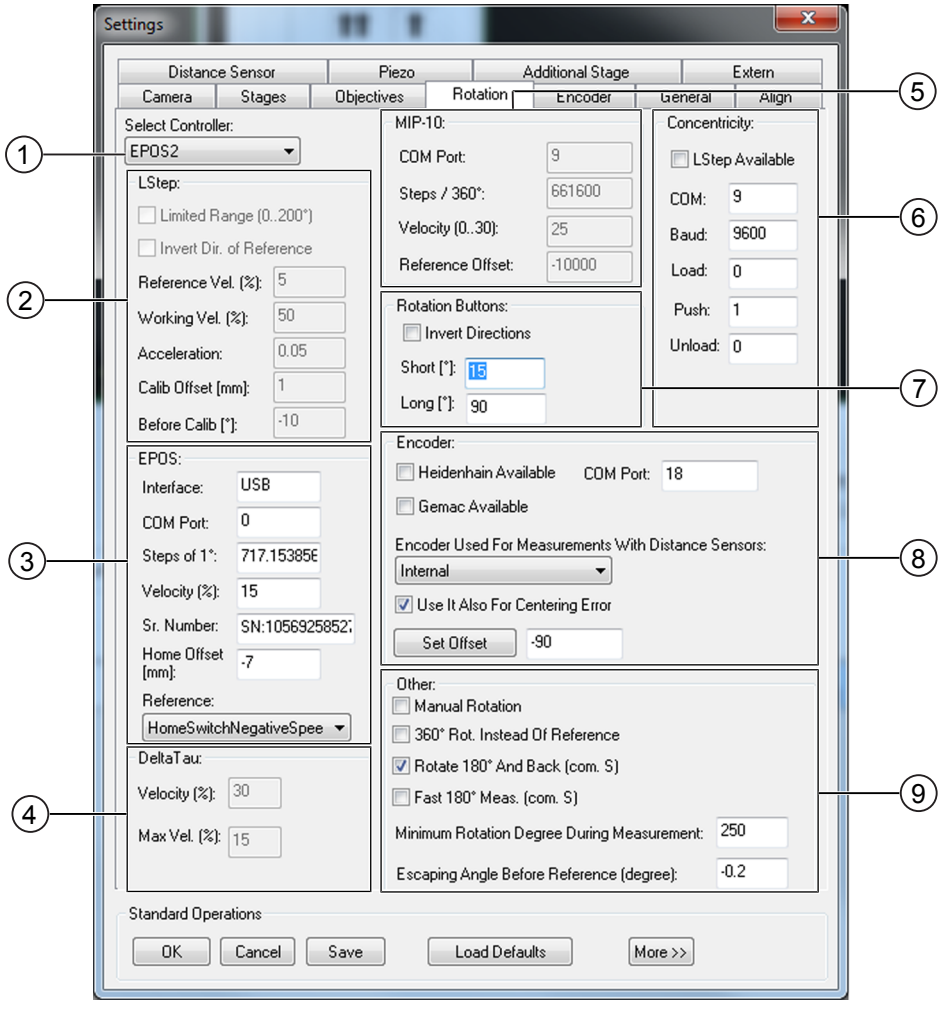


Fig. 179: Settings - Rotation

1	`Select Controller` **selection menu**: Select the control unit for which the settings are made
2	**LStep** `Limited Range (0..200°)`: Tick the checkmark for limiting the rotation range between 0 and 200° `Invert Dir. of Reference`: Tick the checkmark for reversing the direction of the reference `Reference Vel. (%)`: Velocity when searching reference marks `Working Vel. (%)`: Velocity during the measurement `Acceleration`: Acceleration `Calib Offset (mm)`: Calibration offset (mm) `Before Calib (°)`: prior to calibration
3	**EPOS** `Interface` Interface `COM Port`: Serial port number `Steps of 1°`: Number of steps for a rotation of 1° `Velocity (%)`: Speed `Sr. Number`: Serial number `Home Offset (mm)`: Offset position to the limit switch `Reference`: Direction of the reference cycle
4	**Delta Tau** `Velocity (%)`: Speed `Max. Vel. (%)`: Max. permissible velocity in (%)
5	**MIP-10** Settings for the motor control unit `COM Port`: Serial port number `Steps/360°`: Number of steps for 360° `Velocity (0..30)`: Velocity (100% = maximum velocity) `Reference Offset`: Offset between the reference position and the photoelectric sensor position

6	**Concentricity**
	`LStep Available`: Tick the checkmark to enable LStep
	`COM`: COM port
	`Baud`: Baudrate
	`Load`
	`Push`
	`Unload`

7	**Rotation Button** Allocation of the buttons for “Air bearing Rotation Control” `Invert Directions`: Reversing the direction of rotation `Short(°)`: Angle of rotation for a small rotation step `Long(°)`: Angle of rotation for a large rotation step
8	**Encoder** `Haidenhain Available`: Tick the checkmark to enable Haidenhain encoder `Gemac Available`: Tick the checkmark to enable Gemac encoder `COM Port`: Serial port number `Encoder Used For Measurements with Distance Sensors`: Selection menu for encoder being used • `Internal`: Encoder on the motor shaft (as standard) • `None`: without encoder `Use It Also For Centering Error`: Tick the checkmark if the encode should also be used to measure the centering error `Set Offset`: Fixed offset relationship between reference mark and rotary encoder When the button is clicked, the current value is read out. Alternatively enter the value.
9	**Other** `Manual Rotation`: `Tick the checkmark`: for measuring lenses with a rotary device and a vacuum or when the air bearing is rotated by hand `Deselect the checkmark`: for measuring with motorized air bearing `360° Rot. Instead Of Reference` Tick the checkmark if the 360° rotation shall be controlled by the stepper motor instead of the reference mark `Rotate 180° And Back (com S)`: Checkmark ticked: When using the measurement procedure “S” , the device is rotated back and forth by 180° only. This is used, for example, if the range of rotation is restricted. `Fast 180°Measurement` Checkmark ticked: When using the measurement procedure “S” , the device is rotated back and forth by 180° alternately for each surface. While the sample is rotated back by 180°, the next surface is already measured. `Minimum Rotation Degree During Measurement`: Minimum angle of rotation for a measurement `Escaping Angle Before Reference (degree)`: Offset position to the limit switch

19.4.5 <Settings> Register <Encoder> (Encoder)

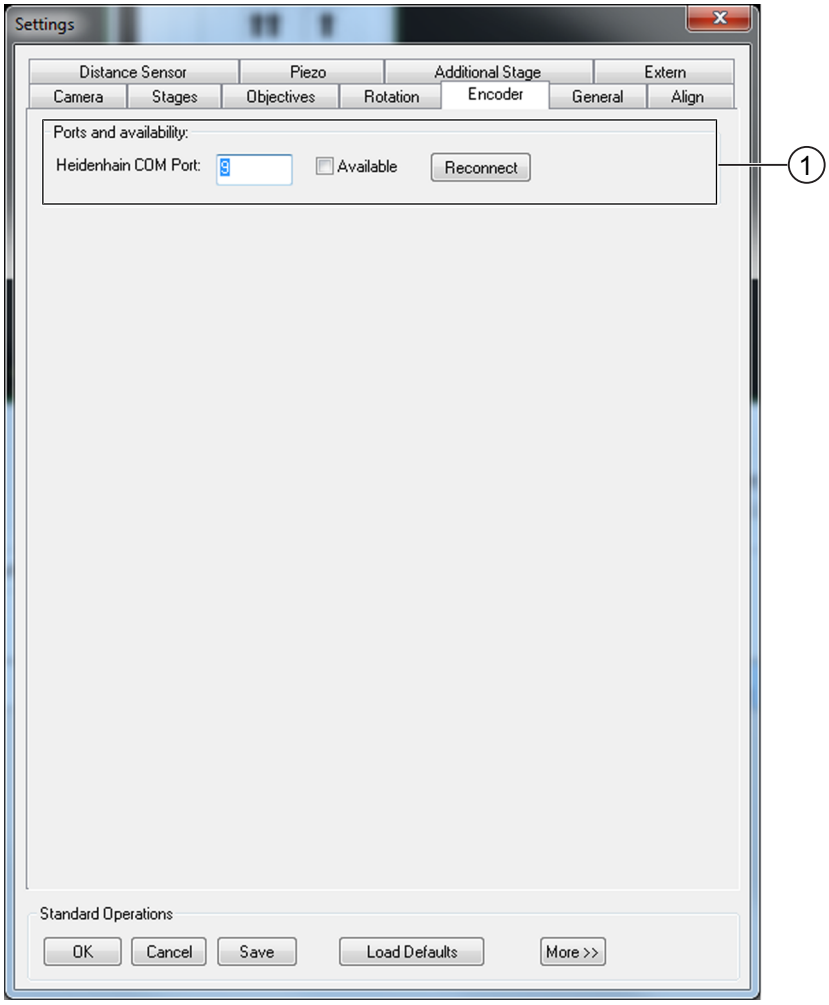


Fig. 180: Settings - Encoder

1	**Ports and availability** `Heidenhain COM Port`: Number of the serial interface for the Heidenhain position encoder `Available`: Tick the checkmark, if available `Reconnect`: Reconnect

19.4.6 <Settings> Register <General>

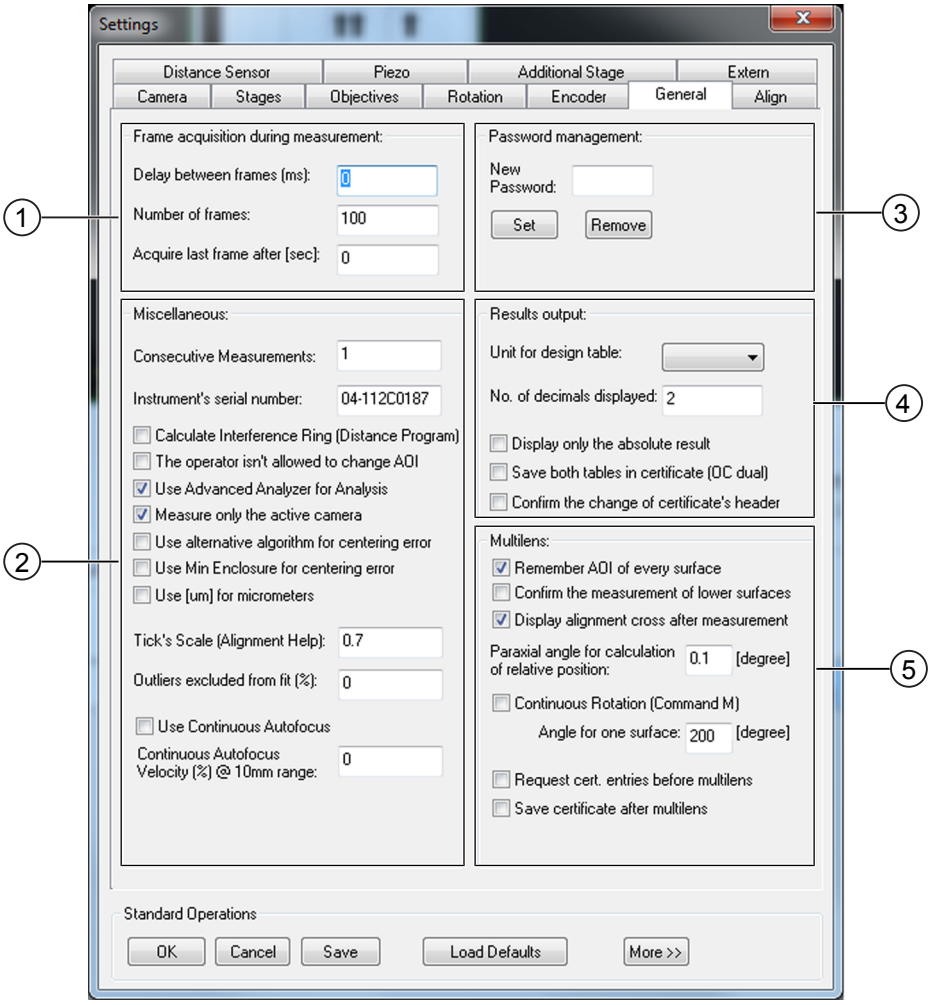


Fig. 181: Settings - General

1	**Frame acquisition during measurement** `Delay between frames (ms)`: Time period between two image recordings `Number of frames`: Number of measurement points when using manual rotation Should be defined so that a full circle is measured at the predetermined rotational speed. `Acquire last frame after (sec)`: Record the last image after ... seconds

2	**Miscellaneous**
	`Consecutive Measurements`: Number of measurements to be performed in succession
	`Instrument's serial number`: Serial number
	`Calculate Interference Ring (Distance Program:)` Tick checkmark if interference ring is to be calculated (radius program)
	`The operator isn't allowed to change AOI`: Tick the checkmark if the operator is not allowed to change the area of interest (AOI).
	`Use Advanced Analyzer for Analysis`: Use Advanced Analyzer for Multi-Lens evaluation
	`Measure only the active camera`: Only use the camera that is respectively active for the measurement
	`Use alternative algorithm for centering error`: Use alternative algorithm for centering error
	`Use Min Enclosure for centering error`: Tick checkmark if an algorithm is to be used that determines a circle around all measured points. (Specific DLLs are required for this.)
	`Use (um) for micrometers`: Tick checkmark for better display on other Windows systems
	`Tick's scale (Alignment Help)`: Internal conversion factor for scale divisions in displacement during alignment
	`Outliers excluded from fit (%)`: Specification of the data points in % that should not be considered for the fit
	`Use Continuous Autofocus`
	Default: without checkmark
	With checkmark: faster, but more imprecise, still sufficient
	`Continuous Autofocus Velocity(%) @ 10mm range`

3	**Password management** `New Password`: new password `Set`: setThe password must be at least 6 characters. `Remove`: Reset password to factory settings.

4	**Results output** (Output of the results of a measurement) `Unit for design table`: Unit `No. of decimals displayed`: Number of decimal places displayed `Display only the absolute result`: Tick the checkmark to display only the radial centering error. `Save both tables in certificate (OC dual)`: Tick the checkmark to save both tables in the certificate when using an OC Dual. `Confirm the change of certificate' s header`: Tick the checkmark if changes to the certificate entries require confirmation
5	**Multilens** (MultiLens) `Remember AOI of every surface`: Saves the area of interest (AOI) for each surface `Confirm the measurement of lower surfaces`: Checkmark ticked: when using systems with a dual measurement head, the measurement with the bottom measurement head must be confirmed. `Display alignment cross after measurement` Smart Align®: Projection of calculated optical or housing axis into the analyzed plane `Paraxial angle for calculation of relative position`: Paraxial angle used for calculating the location of the relative positions `Continuous Rotation (Command M)`: Tick the checkmark to continuously rotate during a MultiLens measurement (only possible if rotary encoder is available). `Angle for one surface`: Angle for a surface Request the cert. entries before multilens: Tick the checkmark if the certificate entries should be queried before the MultiLens measurement. Save certificate after multilens: Tick the checkmark if the certificate entries should be saved after the MultiLens measurement.

19.4.7 <Settings> Register <Align>

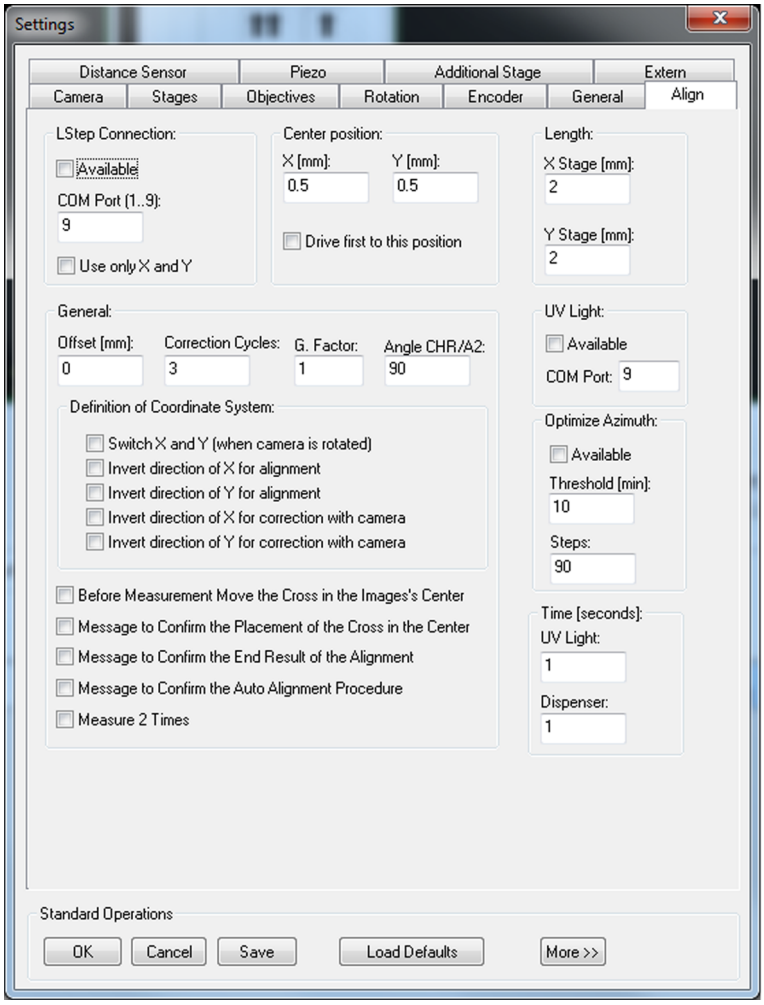


Fig. 182: Settings - Align

NOTE

Only for dual axis alignment control

The settings on this tab only apply to systems with a motorized, dual axis alignment control.

19.4.8 <Settings> Register <Distance Sensor>

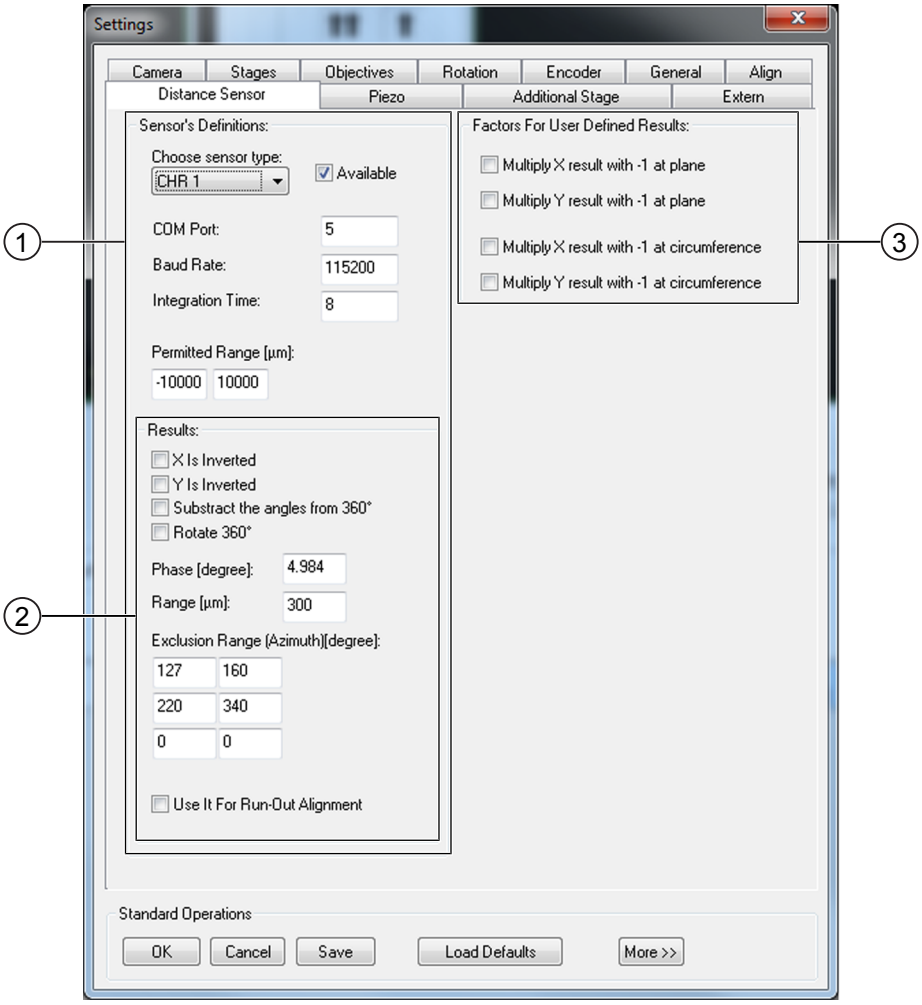


Fig. 183: Settings - Distance Sensor

1	**Sensor‘s Definitions** `Choose sensor type`: Select sensor type `Available`: Tick the checkmark, if available `COM Port`: Serial port number `Baud Rate`: Transfer rate `Integration Time`: Integration time `Permitted Range (µm)`: Range in which the sensor signal is permitted
2	**Results** `X is inverted`: Tick the checkmark to align the coordinate systems. `Y is inverted`: Tick the checkmark to align the coordinate systems. `Subtract the angles from 360°`: Tick the checkmark to align the coordinate systems. `Rotate 360°`: Tick the checkmark to rotate the motor by the nominal value of 360° (regardless of the reference mark). `Phase (degree)`: Azimuthal phasing of the coordinate system (default 0) `Range (µm)`: Measurement range (default 400 µm) `Exclusion Range (Azimuth)[degree]`: Beginning and end of three areas within which the measured values are to be ignored `Use It For Run-Out Alignment`

3	**Factors For User Defined Results** (Change sign of results)
	`Multiply X result with -1 at plane`
	`Multiply Y result with -1 at plane`
	`Multiply X result with -1 at circumference`
	`Multiply Y result with -1 at circumference`

19.4.9 <Settings> Register <Piezo>

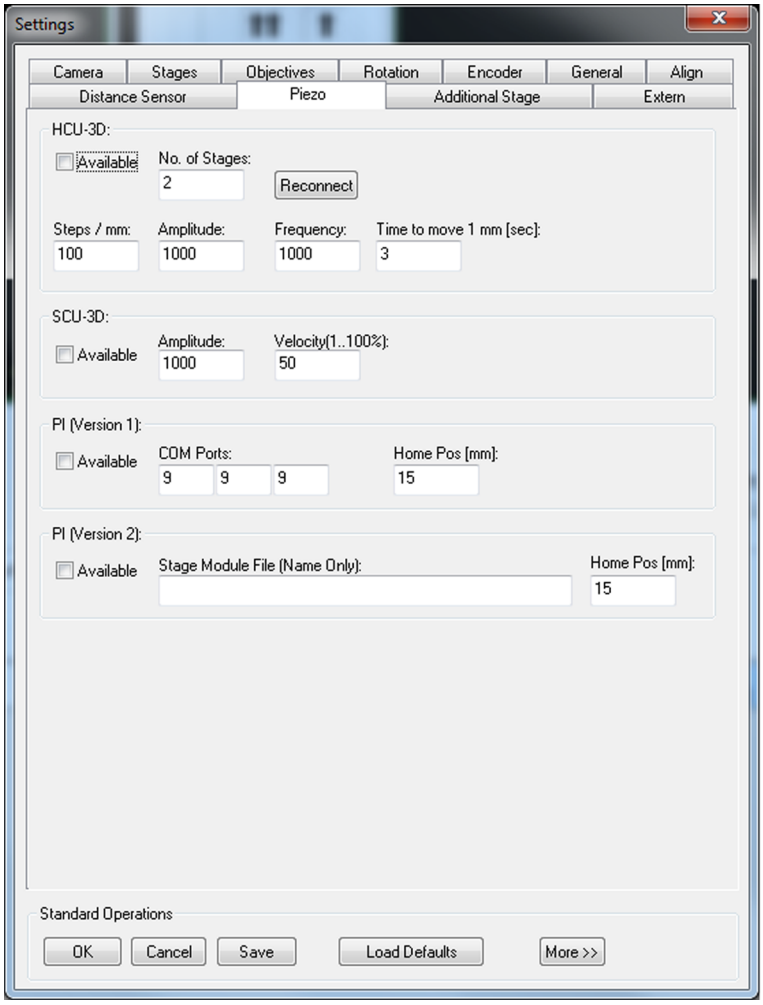


Fig. 184: Settings - Piezo

NOTE

Do not change system parameters!

All system settings in this register are preset at the factory and must not be changed without consulting TRIOPTICS.

19.4.1 <Settings> Register <External>

0

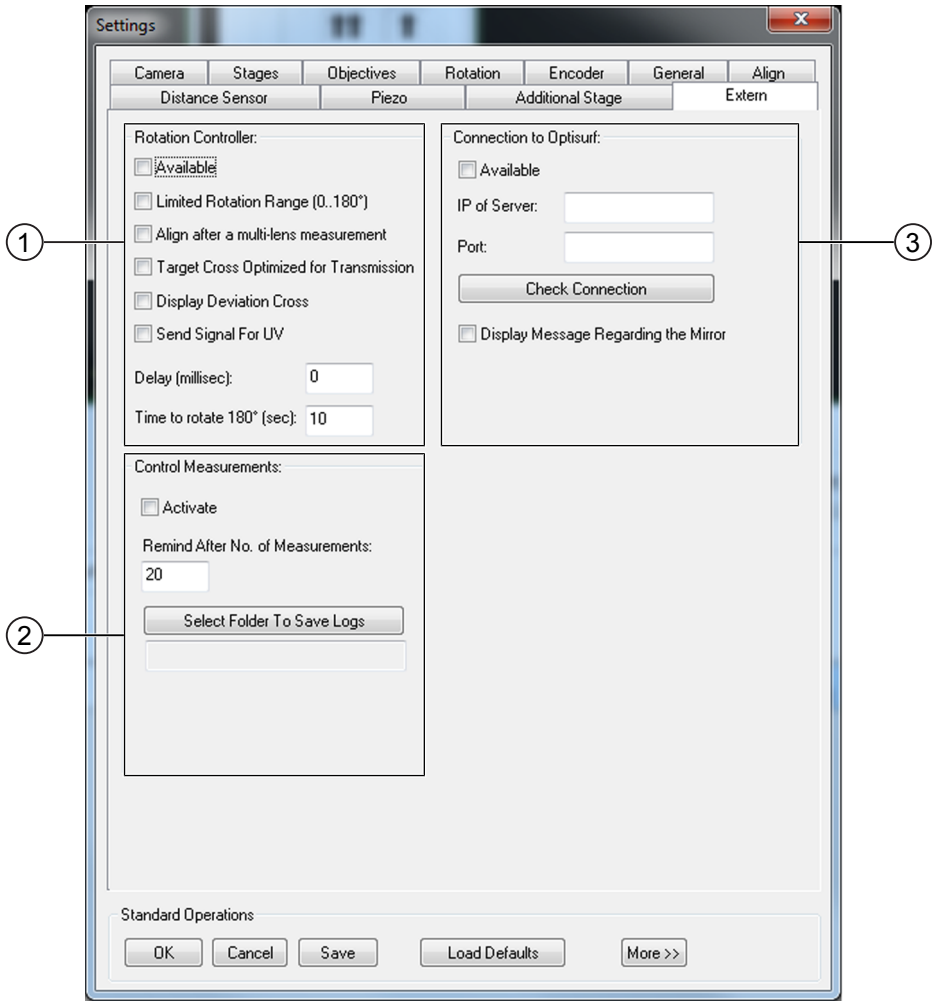


Fig. 185: Settings - External

1	**Rotation Controller** (Control unit for rotation) `Available`: Tick the checkmark, if available `Limited Rotation Range (0..180°)`: Tick the checkmark for limited rotational range (0...180°) `Align after a multi-lens measurement`: Tick the checkmark if you want to align after a Multilens measurement `Target Cross Optimized for Transmission`: Tick the checkmark if the target cross is to be optimized for transmission `Display Deviation Cross`: Special function when using an external controller `Send Signal For UV`: Tick the checkmark if the signal is to be sent for UV `Delay (millisec)`: Delay `Time to rotate 180° (sec)`: Time for 180° rotation

2	**Control Measurements** `Activate`: Tick the checkmark if regular test measurements are to be carried out `Remind After No. of Measurements`: Specify the number of measurements after which a reminder for a test measurement is to be issued `Select Folder To Save Logs`: Select folder for log files
3	**Connection to OptiSurf** `Available`: Tick the checkmark when OptiSurf is available `IP of Server`: Server to which OptiSurf is connected; usually the IP address of the PC `Port`: Port to which OptiSurf is connected `Check Connection`: Check connection `Display Message Regarding the Mirror`: Indicate whether the swivel mirror is folded in. If so, it is not possible to measure with OptiCentric.

19.4.1 <Settings> Register <Additional Stage>

1

NOTE

Do not change system parameters!

All system settings in this register are preset at the factory and must not be changed without consulting TRIOPTICS.

20 Operating OptiSurf

20.1 Starting the program

NOTE

The software can be started only if the copy protection plug (hardware dongle) is plugged into a USB port on your PC.

CAUTION

Risk of material damage

If OptiSurf is used without OptiCentric, it is necessary to ensure that the bottom collimator is in a safe position in order to avoid collision with the folding mirror.

– If necessary, start the OptiCentric software and use the arrow keys to move the bottom measurement head into the lower safe position (recommended "0").

NOTE

The laser requires a warm-up time of about 30 minutes until it is stable and delivers accurate measuring results.

Fig. 186: Copy protection key (hardware dongle)

Fig. 187: OptiSurf, Desktop icon

OptiSurf Professional can be started as soon as the computer has booted completely and the measurement system is turned on.

– Start the software by double-clicking the desktop icon labeled OptiSurf Professional.

You will see the following splash screen with vendor and version information:

Fig. 188: OptiSurf, Startup screen

All axes of the measurement system are being initialized. These include the Optical Delay Line (ODL), the focus drives and any motorized pivoting mirror.

Program and measurement system are operational after the reference cycle.

20.2 Login

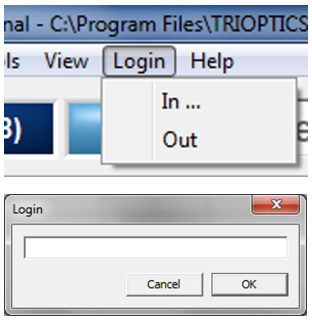


Fig. 189: Login

Follow these login steps:

1. Select `<Login> <In ...>`.
2. Enter the password and click `ok`.

20.3 Checking measurement conditions

The environmental conditions have an influence on the calculation of the center thicknesses since the refractive index is temperature-dependent.

NOTE

These effects are visible with OptiSurf UP systems. A temperature sensor is located near the specimen. Therefore the "Temperature Sample" and "Air Pressure" values are automatically set.

These effects are not observed in standard systems.

1. Click the "Meas. Parameter" tab.
2. Enter the temperature of the sample into the `Temperature Sample (°C)` **(1)** field.
3. Enter the temperature of the measurement system into the `Temperature Housing (°C)` **(2)** field.
4. Enter the air pressure into the `Air Pressure (hPa)` **(3)**field.
5. Under `Peak Identification` **(4)**, select the type of surface identification.
   `Auto`: automatic surface identification
   Can be used when a test measurement has been completed already and the settings for a sample type have been entered as well.
   `User Def.`: manual surface identification
   Recommended for test measurements (while making settings for a new sample) or for complex samples.
6. Under `Measurement` **(5)**, enter the number of measurements.
   `Single`: Single measurement
   `Multiple`: Serial measurement

20.4 Focusing or generating collimated light

This section provides a brief explanation of the general focusing procedure. When focusing, the lens is moved in the measurement head in order to optimize the signal quality.

NOTE

For the first sample calibration, the "Intensity Adjuster" should be opened at the same time to observe the signal and optimize it if necessary.

– Click the `<Focus Stage>` tab.

Focus position display

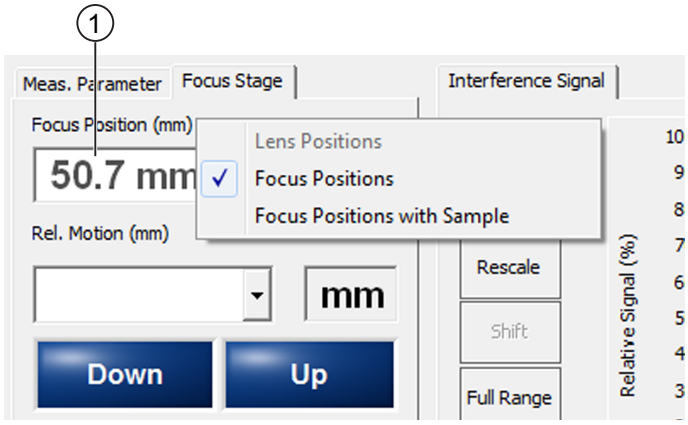


Fig. 190: Focus position, Display

1. Log on as Supervisor (refer to chapter *Login [▸ 194]*).
2. Right-click in the `Focus Position` **(1)** field to open the context menu.
   - ⇨ Select `Focus Position` to display the current focus position, measured from the output side of the measurement head, in field **(1)**.
   - ⇨ Select `Focus Position with Sample` to display the current focus position, taking into account the refraction of the sample, in field .**(1)**.

NOTE

The Lens Position setting is only needed for maintenance purposes.

Move by a specific value

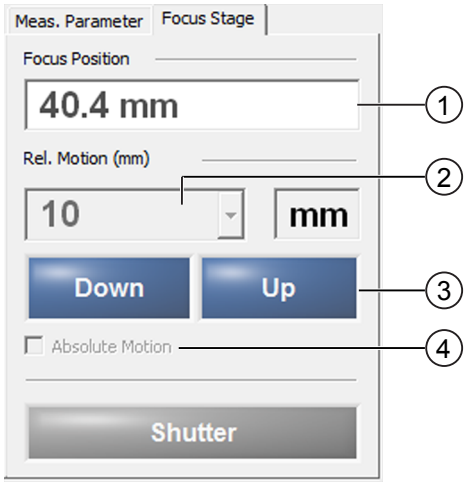


Fig. 191: Focus position, move to relative position

1. Remove the checkmark from `Absolute Motion` **(4)**.
   ⇨ Button 3 changes to Up/Down.
2. In the field `Rel. Motion (mm)` **(2)** enter the value by which movement is to be performed.
3. Click the `Up` or `Down` **(3)** button.
   ⇨ The focus position is moved up or down by the value entered in field **(2)** and updated accordingly in field **(1)**.

Moving to a position

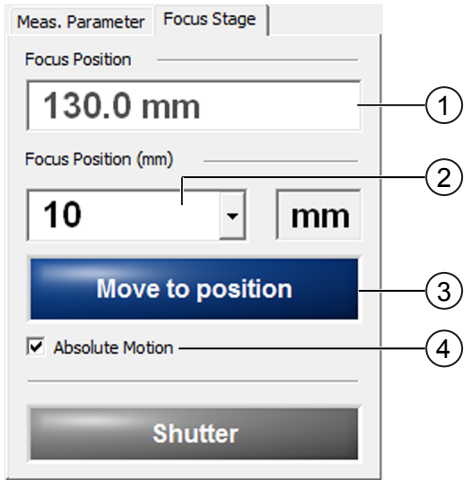


Fig. 192: Focus position, move to position

1. Set the checkmark under `Absolute Motion` **(4)**.
   ⇨ Button **(3)** changes to `Move to position`.
2. In field `Focus Position (mm)` **(2)**, enter Enter the desired position.
   or:
   For collimated light, in field **(2)** enter "`inf`" (infinite)
3. Click button `Move to Position` **(3)**.
   ⇨ The focus position is moved to the value entered in field **(2)** and displayed in field **(1)**.

Intensity Scanner

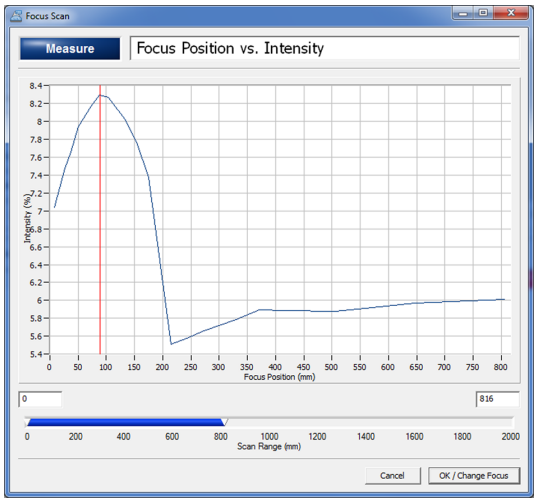


Fig. 193: Focus Scan

The Intensity Scanner is used to adjust the automatic focus position to the highest signal intensity.

1. Select `<Tools> <Intensity Adjuster>`.
   ⇨ The signal intensity on the measurement head is shown.
   ⇨ The graph shows the focus position with respect to the intensity.
2. Click `OK/Change Focus` to set the lens to the position of greatest intensity.

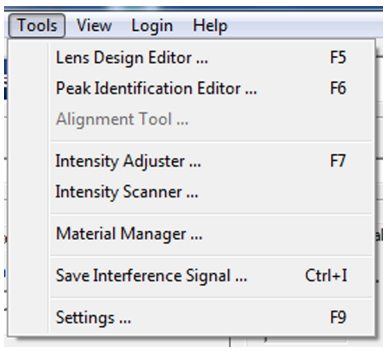


Fig. 194: <Tools> menu

Shutter

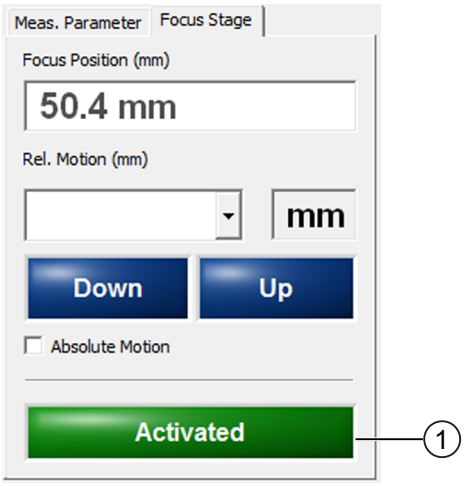


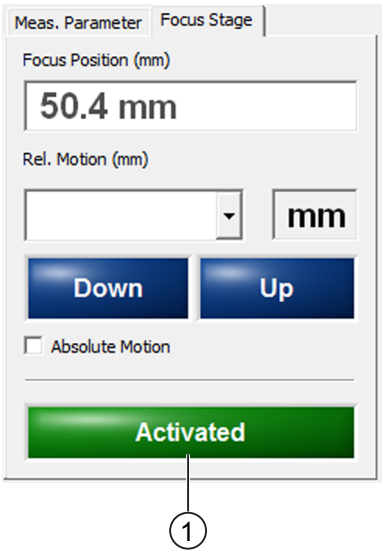
Fig. 195: Focus position, shutter activated

In measurement heads without motorized mirror (OptiSurf Standalone) "`Shutter`" appears on button **(1)**.

In measurement heads with mirror, "`Activated / De-activated`" appears on button **(1)**. The mirror is moved into or out of the beam path accordingly.

– If you click button **(1)**, the entire measurement head is closed by a shutter or the folding mirror is folded in or out.

20.5 Select measurement head



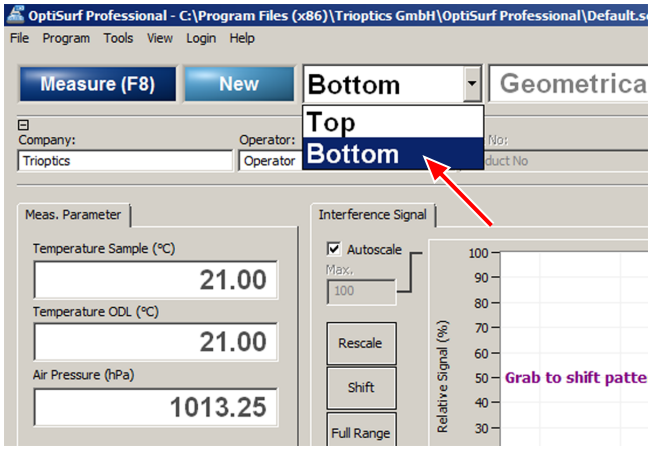


Fig. 196: Select measurement head

One characteristic of the mechanics of this measurement system is that there are two measurement heads. For very large optics it may be useful to use the bottom measurement head for the measurement with OptiSurf.

When OptiSurf is active, OptiCentric cannot be used because the mirror is in the beam path of the autocollimator. If the mirror is activated, the bottom axis in OptiCentric is blocked and cannot be moved.

CAUTION

Risk of material damage

The bottom pivoting mirror may only be activated when the head lens of the lower axis is in the lowermost position. This avoids collisions with the folding mirror.

– If necessary, start the OptiCentric software and use the arrow keys to move the bottom measurement head into the lower safe position (recommended "0").

1. Make sure that the mirror is moved out of the beam path. The button **(1)** must display "Activated".
2. Select the measurement head for the following measurement.

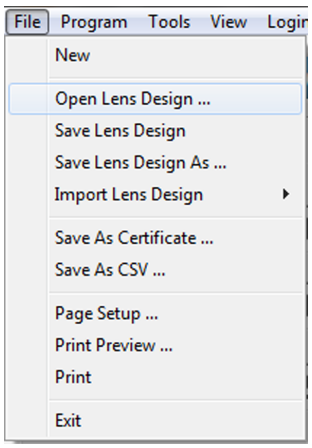
NOTE

The name of the measurement heads can be changed in `<Tools> <Settings>`in the `OptiSurf` tab.

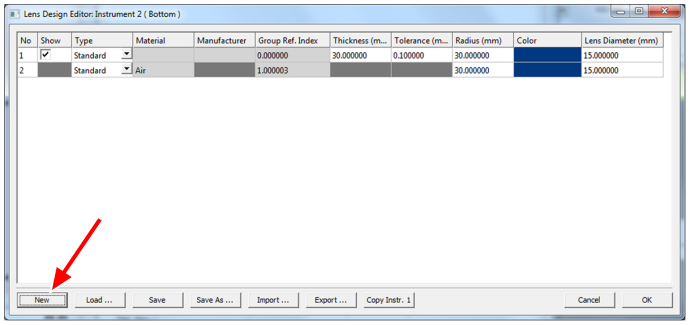
3. Connect the measuring fiber to the corresponding port.

20.6 Create new lens design

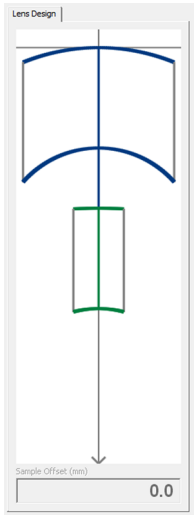
View A



View B



View C



View D

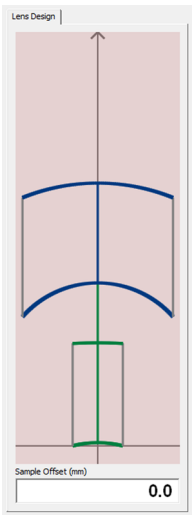


Fig. 197: Create new lens design

1. Log on as Supervisor (refer to chapter *Login [▸ 194]*).
2. First select the top measurement head (refer to chapter *Select measurement head [▸ 199]*)..
3. Select `<File> <New>`.**(View A)**
   or:
   Select `<Tools> <Lens Design Editor>` to open the "`Lens Design Editor`" window and click the `New` button **(View B)**.
   ⇨ The "`Lens Design Editor`" window opens with default values.
4. Change the individual parameters of the lens design.

⇨ Select the type from the drop-down menu:
"Flat" for plane surfaces
"Standard" for all other surfaces

⇨ Double-click a table cell to change a value.

⇨ Open the context menu with the right mouse button to remove or add surfaces or to change the material.

⇨ For an air gap, right-click in the Group Ref. Index column and select "Air Gap".
The lens design is depicted as a graphic **(View C)**.

NOTE

Type and source of danger

The figures for type, radius, color and lens diameter are only for the graphical representation.

The tolerance value is important, since in the case of "Auto" peak identification, the peak is searched within a window of ± 3x tolerance.

NOTE

The arrow in the view indicates the direction of light. If the top measurement head is selected, the beams are not displayed.

5. Click the Save As ... button.
6. Enter the filename and click OK.
   ⇨ Only one design for the top measurement head was created.
   To create the design for the bottom measurement head, proceed as follows:
7. Select the bottom measurement head (refer to chapter *Select measurement head [▸ 199]*)..
   ⇨ The design that was in the memory is loaded.
8. Click Copy Instr. 1 to copy the design data of the top measurement head to the bottom measurement head.
   ⇨ The graphical representation of the lens design is changed**(View D)**.
9. Click Save to save the values.
10. Click OK to close the "Lens Design Editor" window.

NOTE

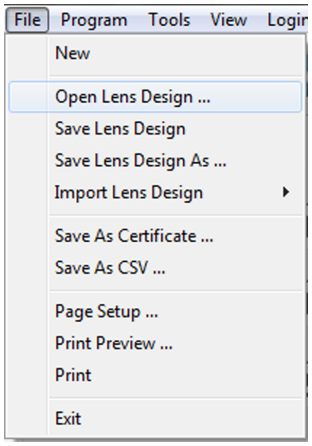
A lens design created in this way contains the complete design for both measurement heads.

Context menu in lens design

Add Surface Before	Adds surface before the currently marked surface
Duplicate Surface	Duplicates the surface
Delete Surface	Deletes the surface
Flip Lens Design	Flips the lens design
Select Material...	Selects the desired material
Air Gap	Air gap in the design
Select Color …	Choose color
Random Colors	Random color selection

20.7 Load and change lens design

View A



View B

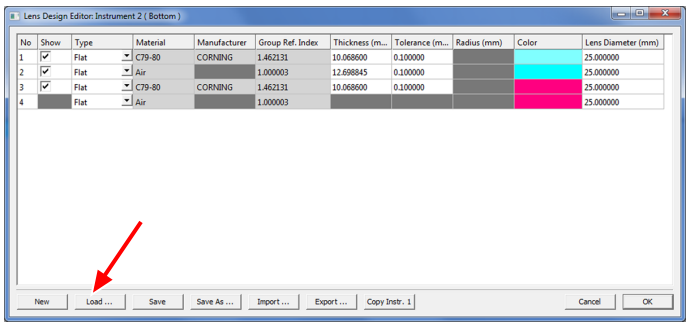


Fig. 198: Load and change lens design

1. Log on as Supervisor (refer to chapter *Login [▸ 194]*).
2. First select the top measurement head (refer to chapter *Select measurement head [▸ 199]*)..
3. Select `<File> <Open Lens Design>` **(View A).**
   or:
   Select `<Tools> <Lens Design Editor>` to open the "`Lens Design Editor`" window and click the `Load` button **(View B)**.
4. Select the XML file and click `Open`.
   ⇨ If the lens design was created on a measurement system with just one measurement head, the following error message appears:

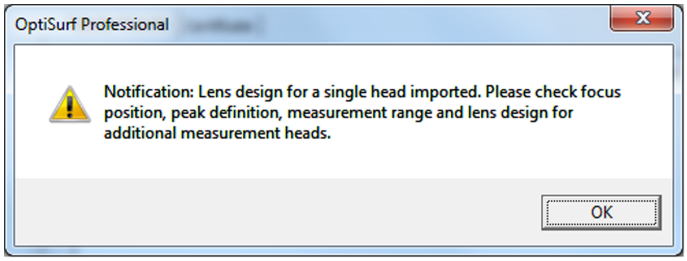


Fig. 199: Error message: Measurement system

5. Click `OK`.
   ⇨ If the focus position specified in the lens design deviates from the current position, the following error message appears:

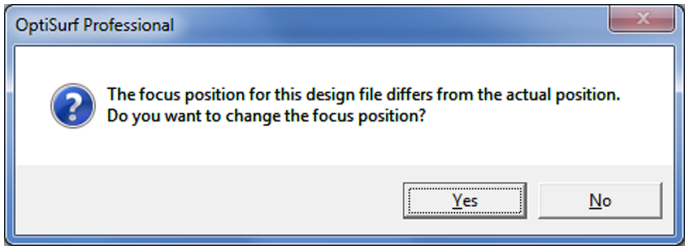


Fig. 200: Error message: Focus position

6. Click `Yes`.
7. If necessary, change the parameters of the lens design as described above.
8. Click `Save` to save the values.
9. Select the bottom measurement head (refer to chapter *Select measurement head [▸ 199]*)..
   ⇨ The design that was in the memory is loaded.
10. Click `Copy Instr. 1` to apply the design data for the bottom measurement head.
11. Click `Save` to save the values.
12. Click `OK` to close the "`Lens Design Editor`" window.

NOTE

A lens design created in this way contains the complete design for both measurement heads.

20.8 Create lens design for just the bottom measurement head

There are cases in which the lens designs for the top and the bottom measurement head are different.

In this case, two files have to be created/exported and imported for each one.

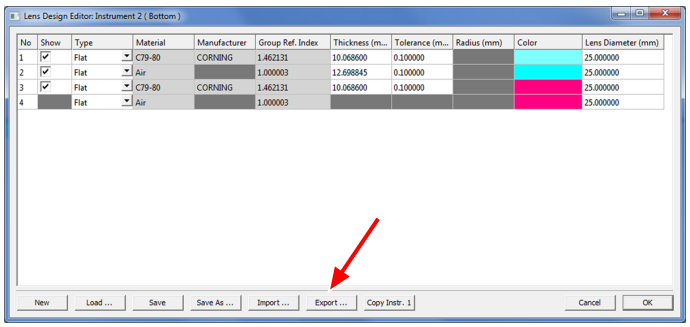


Fig. 201: Create lens design, bottom measurement head only

1. Log on as Supervisor (refer to chapter *Login [▸ 194]*).
2. First select the measurement head for which the lens design is to be created (refer to chapter *Select measurement head [▸ 199]*).
3. Create a lens design as described above.
4. Click the `Export ...` button.
5. Enter the filename and click `OK`.

20.9 Import lens design for just the bottom measurement head

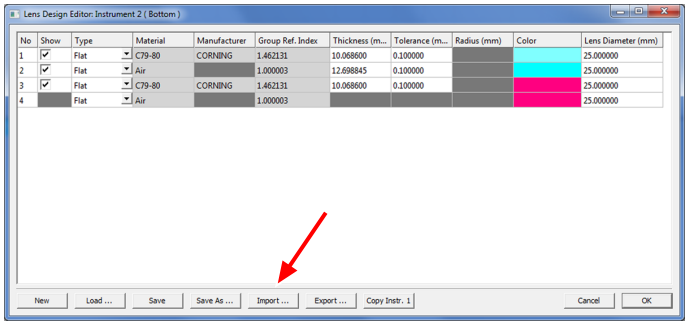


Fig. 202: Import lens design, bottom measurement head only

1. Log on as Supervisor (refer to chapter *Login [▶ 194]*).
2. Select the measurement head to be used for the measurement (refer to chapter *Select measurement head [▶ 199]*).
3. Click the `Import ...` button.
4. Select the file and click `OK`.

20.10 Preparing for measurement

1. Place the sample on the tip-tilt-table
2. Align the sample.

There are various options for aligning the sample:

- with OptiCentric®
- with OptiSurf and reflection point
- with OptiSurf and signal intensity

with OptiCentric®

It is recommended to measure the complete sample with MultiLens. In many cases it is sufficient to only measure and align the uppermost and lowermost surface.

The sample is aligned after the measurement is easiest via `<Tools> <Help Tools> <Tilt Alignment>` (see).

with OptiSurf and reflection point

NOTE

You need a sheet of paper with a hole.

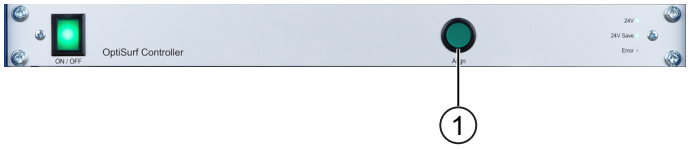


Fig. 203: OptiSurf controller

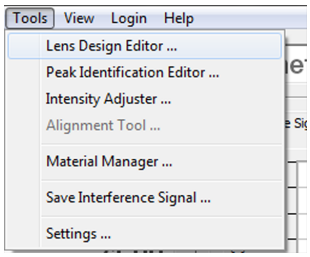
1. Switch on the alignment laser on the OptiSurf control unit **(1)** .
2. Hold the paper in the beam path so that the laser light passes through the hole and the reflections are visible on the underside of the paper.
3. Verify that the reflections converge in the center (hole in paper).
4. If necessary, adjust the stage accordingly with the adjustment screws.
5. Switch on the alignment laser on the OptiSurf control unit **(1)** .

with OptiSurf and signal intensity

NOTE

This possibility can only be used for a rough alignment, since the tilt of the sample cannot be adjusted with precision.

View A



View B

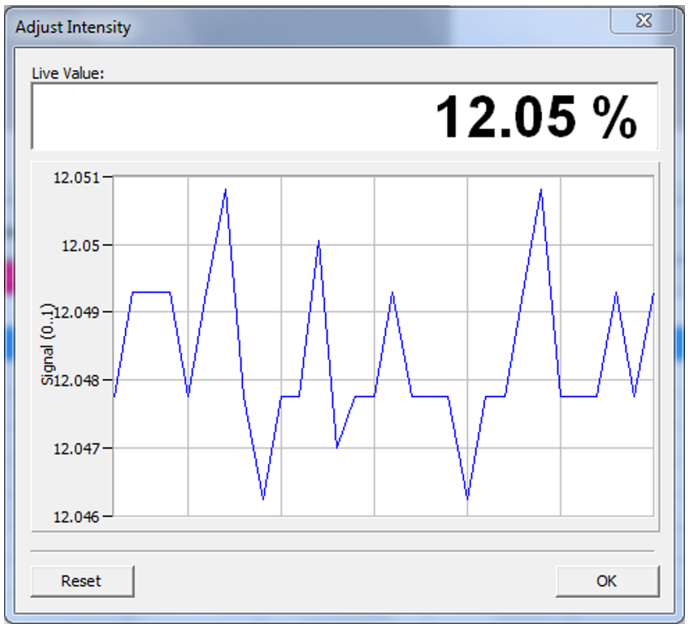


Fig. 204: Align sample, OptiSurf and signal strength

1. Select `<Tools> <Intensity Adjuster>` **(View A)**.
   ⇨ The signal strength on the measurement head is shown **(View B).**
2. Move and tilt the sample until the intensity has reached the max. value.
3. Adjust the stage accordingly with the adjustment screws.
4. Close the "`Adjust Intensity`" window with `OK`.

20.11 Conducting a measurement

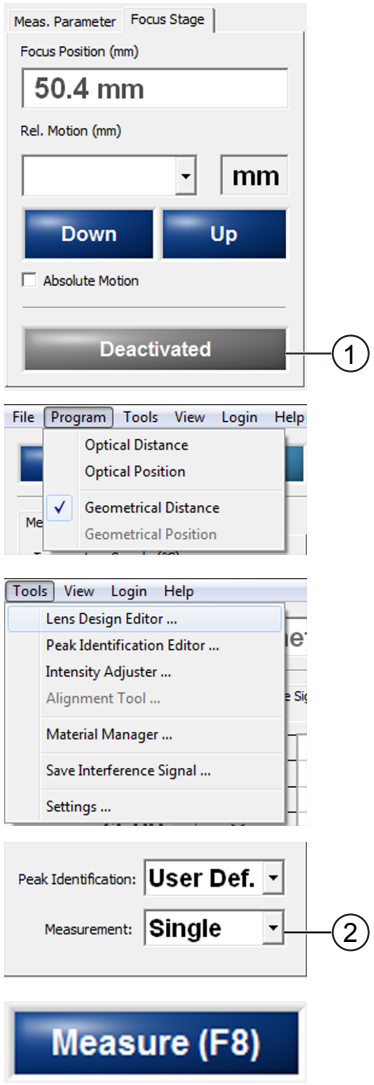


Fig. 205: Conducting a measurement

1. Select the measurement head for the following measurement (refer to chapter *Select measurement head [▶ 199]*).
2. Make sure that the mirror is moved into the beam path. Button **(1)** must show "`Deactivated`".
3. Make sure `<Program> <Geometrical Distance>` is selected.
4. Align the sample (refer to chapter).
5. Select `<Tools> <Intensity Adjuster>` and click `OK/Change Focus` to set the lens to the position of greatest intensity.
   or:
   Select `<Tools> <Intensity Adjuster>` and focus until the intensity reaches the maximum value.
6. Click `OK` to close the "`Adjust Intensity`" (signal strength) window.
7. Select `Measurement:Single` **(2)**..
8. To start the measurement, click `Measure` or press **F8**.
   ⇨ The monitor depicts "`Measuring`" (measurement in progress) and displays a bar showing the progress of the measurement.

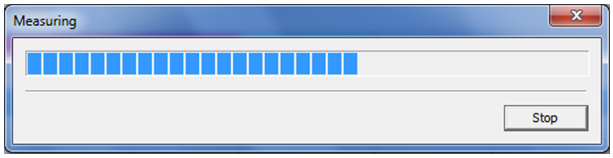


Fig. 206: Measurement, Progress indication

20.12 Results

After the measurement, the interference signal and the calculated results are displayed.

Interference signal

Four peaks should be visible for the chosen example with two optical flats.

The peaks are automatically assigned to a surface in the lens design and are numbered. They are depicted in the color that was assigned in the Lens Design Editor (refer to chapter *Create new lens design [201]*).

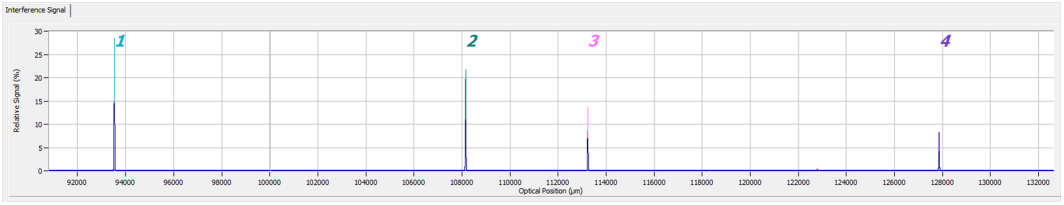


Fig. 207: Results, Diagram

Table

The table depicts the distances; the last surface is hidden.

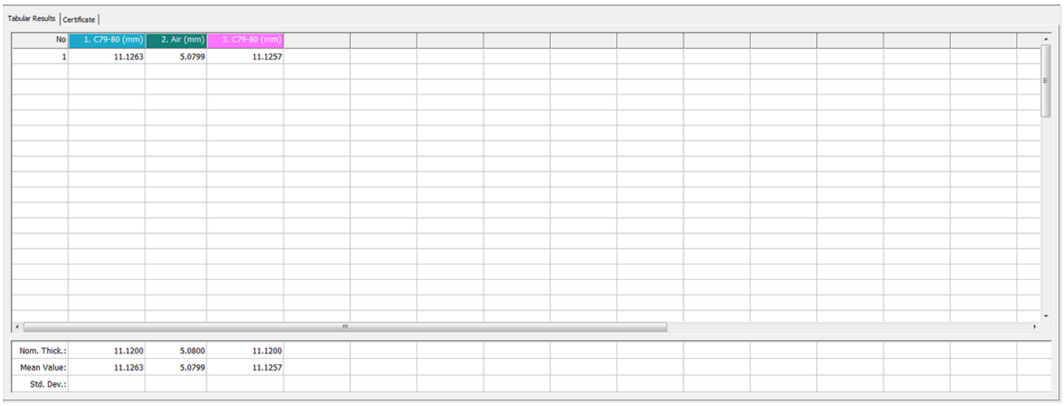


Fig. 208: Results, Table

20.13 Buttons and context menu in the interference signal section

– Click the right mouse button in the graphical display to open the context menu.

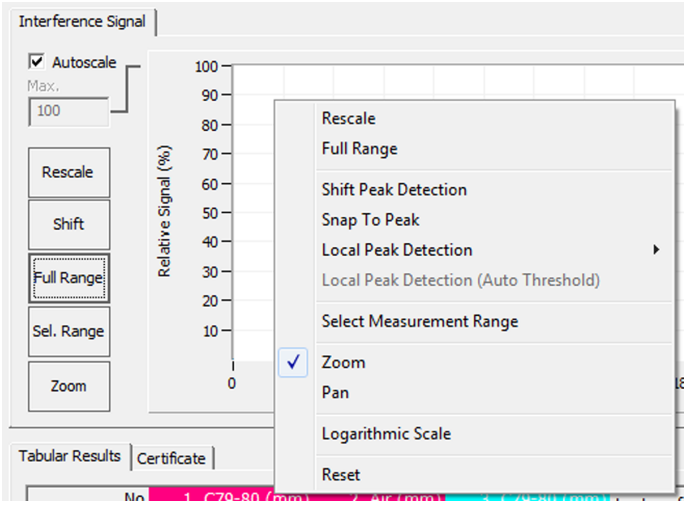


Fig. 209: Interference signal section, Context menu

`Rescale`	In the graphical display, the horizontal axis is increased according to the measurement range and the vertical axis is adjusted to the interference peaks.
`Full Range`	The available measurement range is depicted in the graphical display.
`Shift Peak Detection`	Move Peak display (only for "Manual" peak identification)
`Snap To Peak`	Snaps display onto the peak
`Local Peak Detection`	Analyzes a single peak
`Local Peak Detection (Auto Threshold)`	Threshold is automatically adjusted in manual mode
`Select Measurement Range`	Set the measurement range In the event that the sample is smaller than the measurement range, the measurement range can be reduced. This reduces the measurement time.

Zoom	**Zoom in:** click in the display **Zoom out:** Hold Shift and click in the display
Pan	Shifts display to left or right
Logarithmic Scale	Representation with logarithmic scale
Reset	Resets the view

20.14 Context menu in the results table

Click the right mouse button in the table to open the context menu.

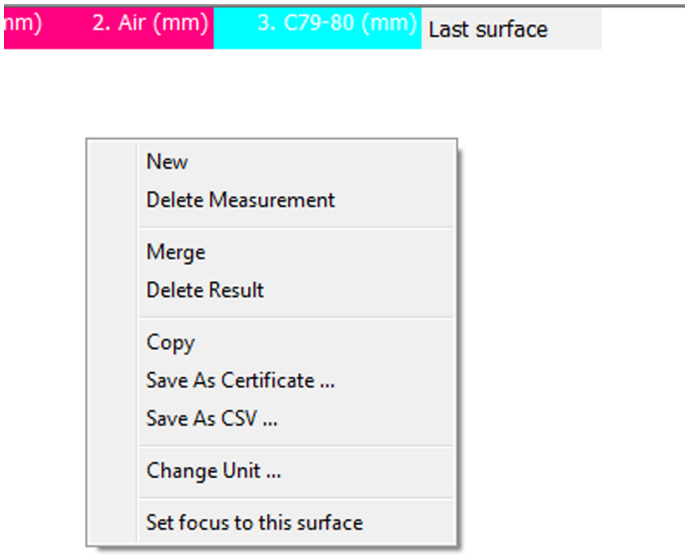


Fig. 210: Results, Table: Context menu

NOTE

Some functions can be accessed both via the context menu and via a button.

New	New measurement; all values are deleted
Delete Measurement	Deletes row in which the cursor is located
Merge	Merge two or more rows; any measured values are calculated

`Delete Result`	Deletes the results
`Copy`	Copy
`Save As Certificate ...`	Saves measurement results as a MHT file (.mht)
`Save As CSV ...`	Exports measurement results, e.g., for import to Excel (.csv)
`Change Unit ...`	Opens the "Change Unit" window, refer to chapter *<View> menu [▶ 233]*.
`Set focus to this surface`	Set focus to a specific surface in order to get a stronger signal

20.15 What to do if the number of peaks is not correct...

The number of peaks must be equal to or greater than the number of surfaces of the sample. If not, the alignment of the sample and the focus must be adjusted.

Possible cause

Case A

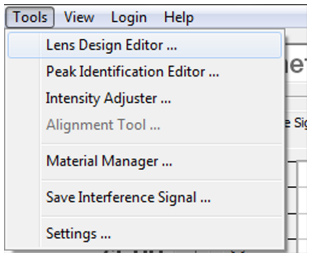
The measurement is not carried out along the optical axis of the sample. Because the measurement beam does not impinge on the vertices of the surfaces, the back reflection is tilted.

Case B

An incorrect focus position also leads to a lower intensity of individual surfaces, especially in cemented surfaces.

Troubleshooting for case A

View A



View B

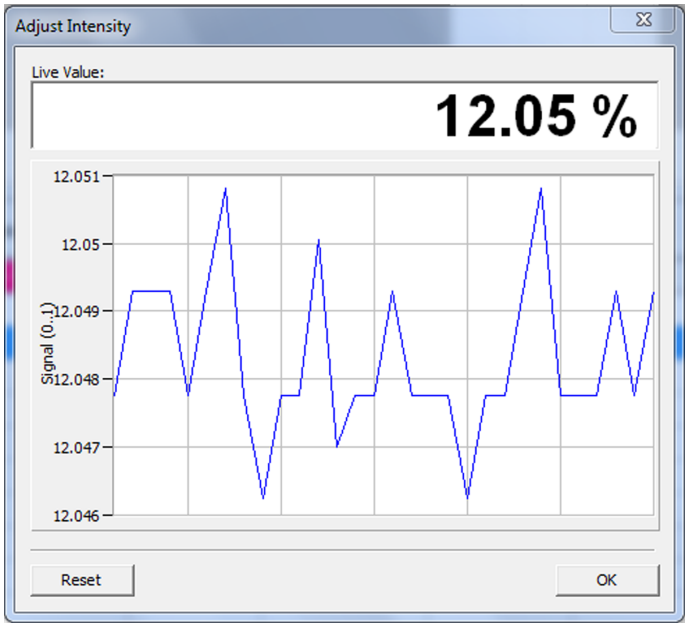


Fig. 211: Troubleshooting in the case of tilted back reflection

To remedy the problem, follow these steps:

1. Select `<Tools> <Intensity Adjuster>` **(View A)**.
   ⇨ The signal intensity on the measurement head is shown **(View B)**.
2. Check the lens is properly centered.
3. If necessary, center the lens as follows:
4. Focus on the center of curvature of the top surface.
5. Move the lens until the optical axis lies on the axis of rotation.
6. Restart the measurement.

Troubleshooting for case B

The focus position is also crucial for the measurement result (contrast / peak height).

The effect is particular significant for cemented surfaces and the focus position must be set with very high precision. For small radii, the focus position sometimes needs to be adjusted to within a few millimeters.

1. To remedy the problem, follow these steps:
2. Use the `Intensity Scanner` (refer to chapter *Focusing or generating collimated light [▸ 196]*) to find the optimal focus position.

or:
Perform the manual focus steps (refer to chapter *Focusing or generating collimated light [▶ 196]*) and take another measurement until all peaks are displayed optimally.

3. Select <File> <Save Lens Design> to save the design table. The focus position is saved at the same time.

20.16 How to deal with ghost reflections

Ghost reflections are reflections that arise due to multiple reflection on one surface.

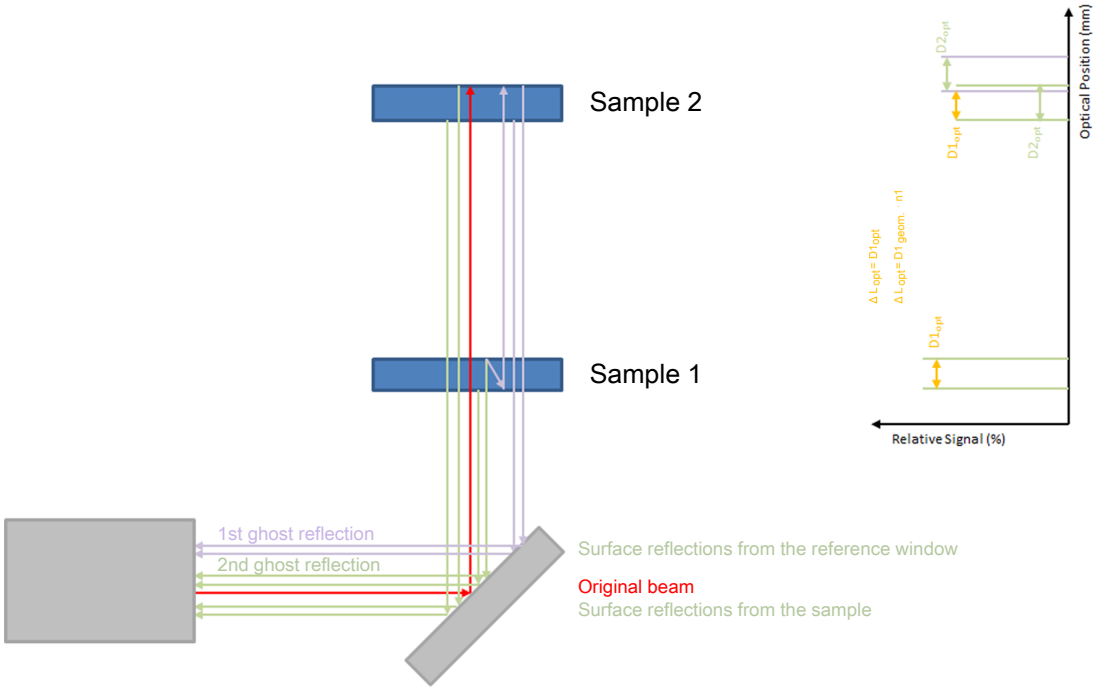


Fig. 212: Ghost reflexes, schematic diagram

Possible cause

Multiple reflections of the surfaces of the reference window can occur in the beam path. These are sometimes measured near the reference plate or the lens.

NOTE

The ghost peaks can often be even greater than the peak of the subsequent optic.

Troubleshooting

To remedy the problem, note the following:

– Select the tolerances of the optics to be as small as possible to avoid incorrect interpretation of the measurement results.

– The real peak is always the **first** peak of the sample peak (D2).

20.17 What to do when the measurement result is displayed as "failed"... ?

The automatic measurement has failed because the peaks are not identified correctly.

Possible causes

- Deviations of the measured peak structure from the optical design
- Some weak signals of individual surfaces

Troubleshooting

The parameters for the peak identification must be entered manually. Follow these steps:

Coarse adjustment

1. Select "`User Def.`" (user defined) for the peak identification **(4)**.
2. Click the right mouse button in the graphical display and select `Rescale` (adjust scale automatically) **(1)**.
3. Check that the measured pattern matches the expected pattern.
4. Click the right mouse button in the graphical display and select `Snap to Peak` **(3)**.
5. Click the right mouse button in the graphical display and select `Shift Peak Detection` **(2)**.

   ⇨ The window of the interference signal depicts the peak positions calculated for the lens design in the form of lines.

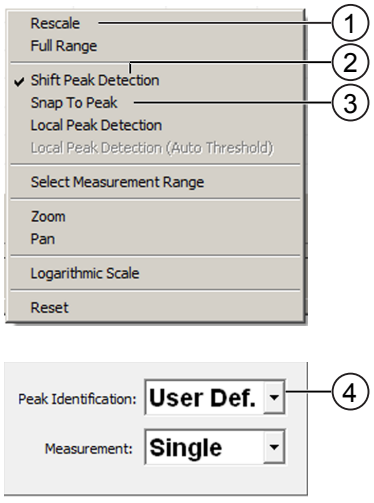


Fig. 213: Troubleshooting, Coarse adjustment

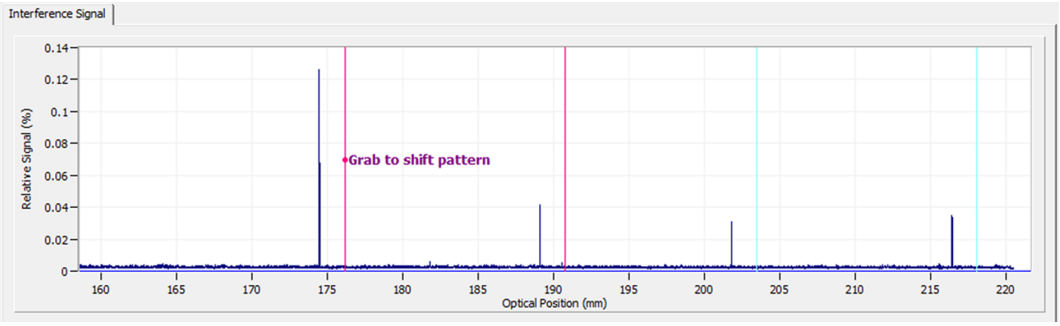


Fig. 214: Interference signal, Display of the calculated peak positions

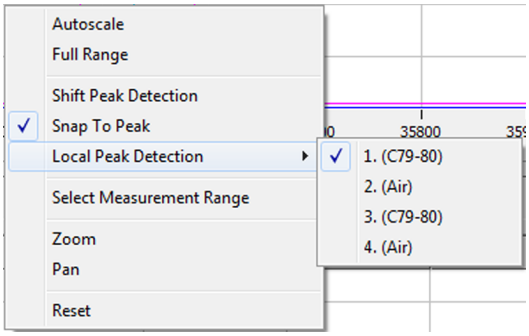
6. Click the item labeled `Grab to shift pattern` and hold the mouse button down.
   ⇨ Shift the line pattern until you see the best possible overlap.
   ⇨ If there is a matching line pattern, shift the pattern until the left line is superimposed over the left-most peak measured.

NOTE

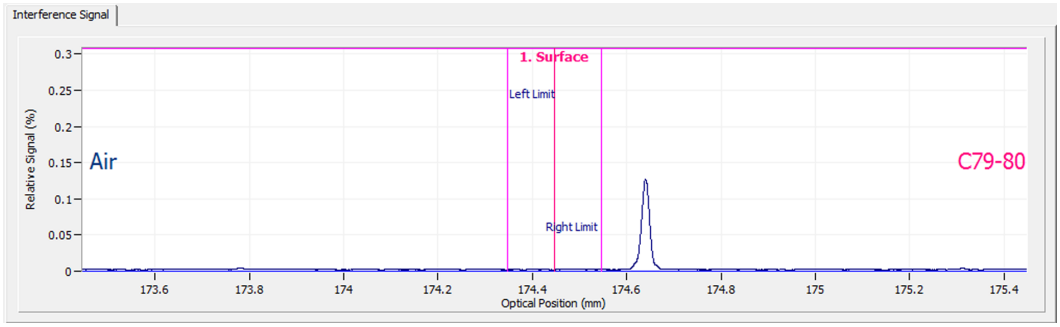
One peak must be positioned precisely.

Fine adjustment

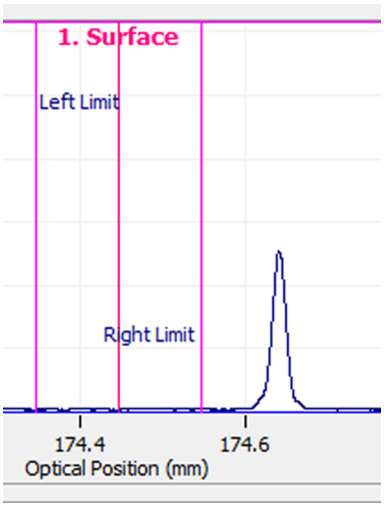
View A



View B



View C



View D

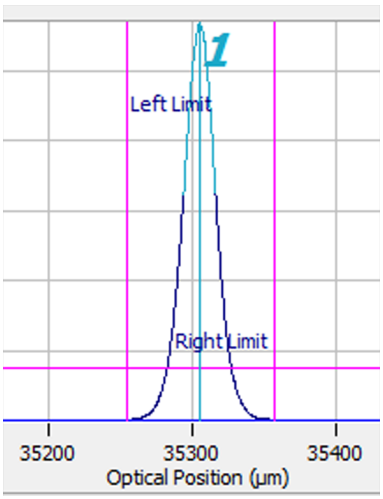


Fig. 215: Troubleshooting, Fine adjustment

1. Click with the right mouse button in the graphical display and select `Local Peak Detection` and then the first surface (in the example: `1. (C79-80)` **(View A)**).
   ⇨ The first peak is depicted zoomed.

2. Check whether the pattern (in this example the colored line of the 1st surface) is centered on the peak **(View B)**.
   If not, follow these steps:
   ⇨ Click the right mouse button in the graphical display and select `Shift Peak Detection`.
   ⇨ Click the item labeled `Grab to shift pattern` and hold the mouse button down.
   ⇨ Shift the line **exactly** to the maximum of the peak.
3. Click with the right mouse button in the graphical display and select `Local Peak Detection` and then the first surface (in the example: `1. (C79-80)`).
   Or:
   Double click the surface in the tabular summary of the measurement results.
   ⇨ This depicts the range in which the peak is searched **(View C)**:
   `Left Limit` : limits the range to the left
   `Right Limit` : limits the range to the right
   `Threshold`: limits the range to the bottom
   The illustration shows an example with incorrectly defined limits, which results in an undetected peak.
4. To shift a limit, click on the line, hold the mouse button down, and then drag the line to the desired position ("drag and drop") **(View D)**.
   ⇨ The vertical lines `Left Limit` and `Right Limit` must be to the left and right of the peak.
   ⇨ The horizontal line `Threshold` must be above the noise but below the peak.
5. Repeat steps 3 to 4 for the fine adjustment of all other surfaces.

Special notes

If the peaks are correctly identified, the following occurs:

- The upper part of the peaks is shown in color.
- The center thickness of the lenses and the distances are displayed.

20.18 Offset

The measurement has failed because the peaks are not identified correctly. With several surfaces, an approximately identical difference is detected between the expected and the measured position.

Possible causes

- Serious deviations from the lens design, e.g., improper air gaps

Troubleshooting

To remedy the problem, follow these steps:

1. Press and hold down the **Ctrl** key on the keyboard.
2. Click with the mouse on the first surface whose measured value deviates from the design. Continue to hold the left mouse button down and shift the expected position.
3. The offset values are stored under `<Tools> <Peak Identification Editor>`.

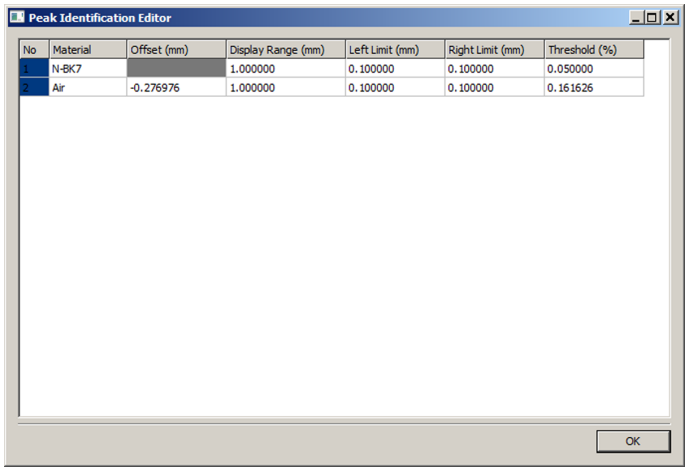


Fig. 216: Peak Identification Editor

20.19 Output of measurement results as a certificate

The measurement results can be output in a certificate after the measurement.

General texts

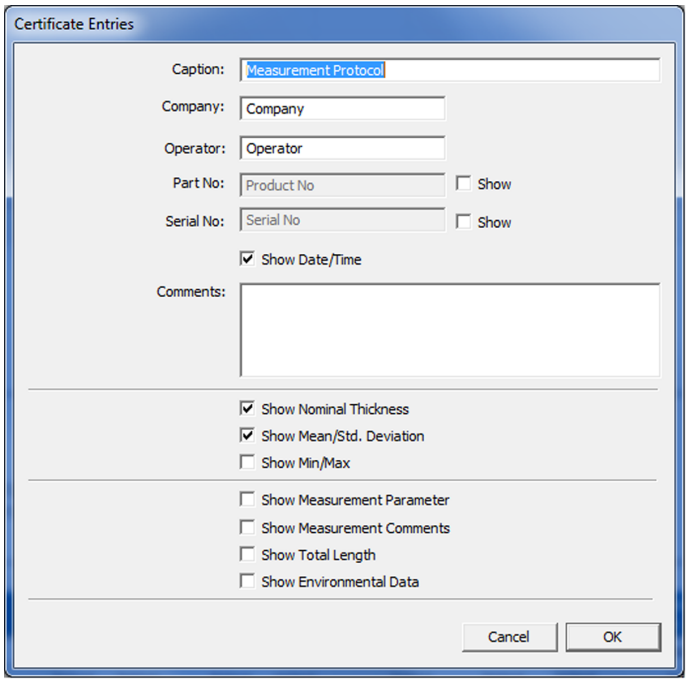


Fig. 217: Save measurement results in a certificate, Certificate entries

First, enter the information for the header of the certificate.
Follow these steps:

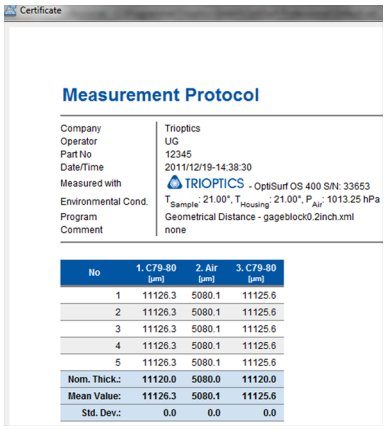
1. Select `<View> <Certificate Header>`.
2. Enter the texts and confirm with `OK`.

`Caption`	Headline
`Company`	Company name
`Operator`	Operator
`Part No.`	Part numbers
`Show`	Checkmark ticked: Part number is entered into the certificate
`Serial No.`	Serial number
`Show`	Checkmark ticked: Serial number is entered into the certificate

Show Date/Time	Checkmark ticked: Date and time are entered into the certificate
Comments	Comments
Show Nominal Thickness	Checkmark ticked: Nominal thickness as entered in the lens design is entered into the certificate
Show Mean/Std. Deviation	Checkmark ticked: Mean value and standard deviation are entered into the certificate (only if more than one measurement was carried out)
Show Min/Max	Checkmark ticked: Min. and max. value are entered into the certificate (only if more than one measurement was carried out)
Show Measurement Parameter	Checkmark ticked: Focus position and measurement range are entered into the certificate
Show Measurement Comments	Checkmark ticked: Comments are entered into the certificate
Show Total Length	Checkmark ticked: summed distances are entered into the certificate
Show Environmental Data	Checkmark ticked: Temperature and air pressure are entered into the certificate

Viewing the certificate

1. Select <View> <Certificate>.
   or:
   Click the Certificate tab in the table of the measurement results.
   ⇨ The certificate is displayed.


Certificate

Measurement Protocol

Company	Trioptics
Operator	UG
Part No	12345
Date/Time	2011/12/19-14:38:30
Measured with	TRIOPTICS - OptiSurf OS 400 S/N: 33653
Environmental Cond.	T_{Sample}: 21.00°, $T_{Housing}$: 21.00°, P_{Air}: 1013.25 hPa
Program	Geometrical Distance - gageblock0.2inch.xml
Comment	none

No	1. C79-80 [µm]	2. Air [µm]	3. C79-80 [µm]
1	11126.3	5080.1	11125.6
2	11126.3	5080.1	11125.6
3	11126.3	5080.1	11125.6
4	11126.3	5080.1	11125.6
5	11126.3	5080.1	11125.6
Nom. Thick.:	**11120.0**	**5080.0**	**11120.0**
Mean Value:	**11126.3**	**5080.1**	**11125.6**
Std. Dev.:	**0.0**	**0.0**	**0.0**

Fig. 218: Certificate, Example

Save certificate as MHT file

1. Select <File> <Save As Certificate>.
2. Enter the file name and click Save.
   ⇨ You can now open the certificate with the browser and print it.

Export certificate data, e.g., for import to Excel

1. Select <File> <Save As CSV>.
2. Enter the file name and click Save.
   ⇨ You can now import the certificate to Excel and edit or print it.

21 OptiSurf software

21.1 The program window

The program window opens after the software has been launched. The following sections describe the individual elements.

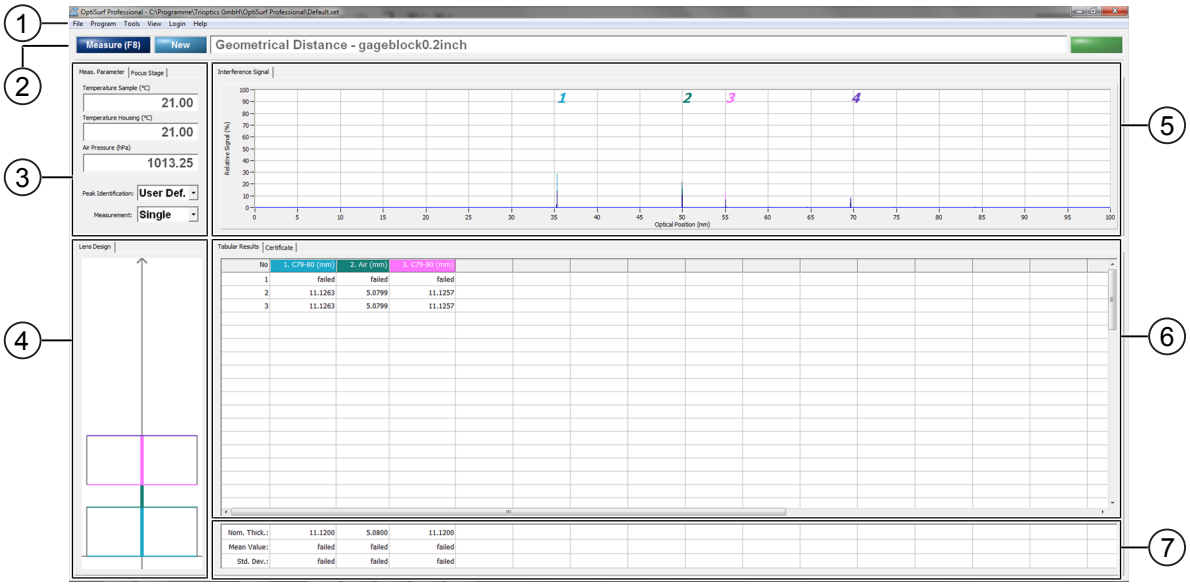


Fig. 219: OptiSurf, program window

1	Menu bar
2	Toolbar
3	Display and selection of measurement parameters or focus settings
4	Simplified view of the lens design
5	Displays the interference signal
6	Displays measurement results as a table or a certificate
7	Statistical analysis of results

Menu bar

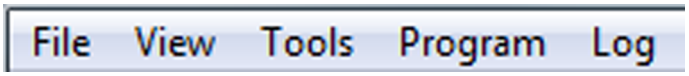


Fig. 220: Menu bar

The menu bar contains several menus from which sub-menus or functions can be invoked.

Toolbar

Fig. 221: OptiSurf, Toolbar

1	`Measure (F8)` button (starts measurement)
2	`New` button (new measurement)
3	Displays the selected program and the sample designation
4	Status display Green: Successful measurement Red: Failed measurement

21.2 User rights

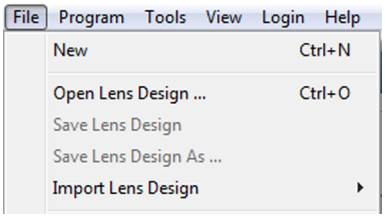


Fig. 222: File menu

Some software functions are only available to the supervisor or the administrator.

Unavailable functions are shown in gray and cannot be selected (see figure, left).

NOTE

These functions are marked with an asterisk * in the following software description.

21.3 <File> menu

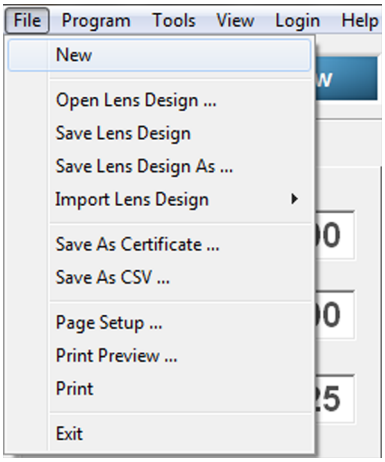


Fig. 223: <File> menu

New

Create new measurement.

If the results of previous measurements have not been saved, the following prompt is displayed: "`Unsaved measurement results. Do you want to continue? If you continue all results are lost!`"

– Click `Yes` to discard the results.
– Click `No` to keep the results.
– Save the results with `<Save As Certificate>` or `<Save As CSV>`.

Open Lens Design ... *

Load lens design (.xml)

Please consult *Create new lens design [▶ 201]* for a detailed description.

Save Lens Design *

Save lens design

Save Lens Design As ... *

Save lens design with a new name (.xml)

Import Lens Design

Import design file (.df) from OptiCentric®

The optical flat material names must be added manually.

Save As Certificate

Saves measurement results as a MHT file (.mht)

(also refer to chapter *Output of measurement results as a certificate [▶ 221]*)

Save AS CSV ...

Exports measurement results, e.g., for import to Excel (.csv)

(also refer to chapter *Output of measurement results as a certificate [▶ 221]*)

Page Setup ...

Opens the "Page Setup" window (setup screen).

NOTE

The output depends on the connected printer.

Here you can change the settings for the display and printing of the certificate.

Print Preview ...

Opens the certificate preview.

Print

Opens the "Print" window (printing)

NOTE

The output depends on the connected printer.

Select a printer and specify the page range to be printed.

Click Print to print the certificate.

Exit

Exits the program.

21.4 <Program> menu

<Program> menu

Here you can select the measurement method.

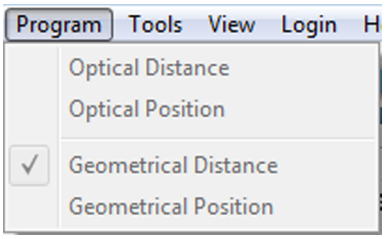


Fig. 224: <Program> menu

Optical Distance *

Measures the optical distances between the peaks (areas). The refractive index is not considered.

Optical Position *

Determines the peak position relative to the first peak. The refractive index is not considered.

Geometrical Distance *

Measures the geometrical distances between the peaks.

NOTE

For a general measure of center thicknesses and air gaps, the setting "Geometrical Distance" should be used.

21.5 <Tools> menu (help)

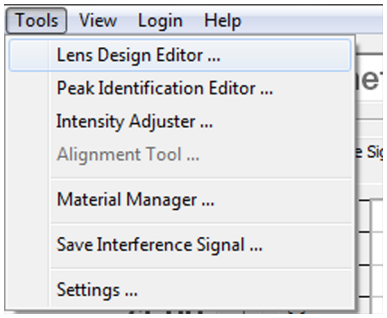


Fig. 225: <Tools> menu (help)

Lens Design Editor ... *

Opens the "Lens Design Editor" window (edit lens design) (also refer to chapter *Create new lens design [▶ 201]*).

Peak Identification Editor ...

Opens the "Peak Identification Editor" windows (edit peak identification).

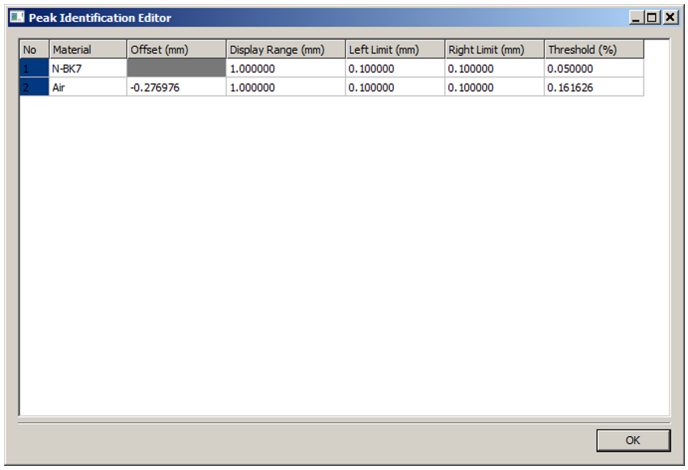


Fig. 226: Peak Identification Editor

Here you can read off and reset the offset (also refer to chapter *Offset [▶ 220]*).

Here you can enter default values for the limits (left limit, right limit, threshold) (also refer to chapter *What to do when the measurement result is displayed as "failed"... ? [▶ 216]*).

Alignment Tool ... *

This function must be enabled. To use the alignment tool, this entry must be called.

Intensity Adjuster

Opens the "Intensity Adjuster" window (signal strength) displaying the signal strength on the measurement head.

This can be used as a tool for aligning the sample (also refer to chapter *Preparing for measurement [▶ 206]*).

Intensity Scanner

The Intensity Scanner is used to adjust the automatic focus position to the highest signal intensity.

Material Manager ... *

Opens the "Material Manager" window. Here you can add, change, delete materials, and import from the databases of optical flats.

– Click `Add` to add a material.

A new window opens:

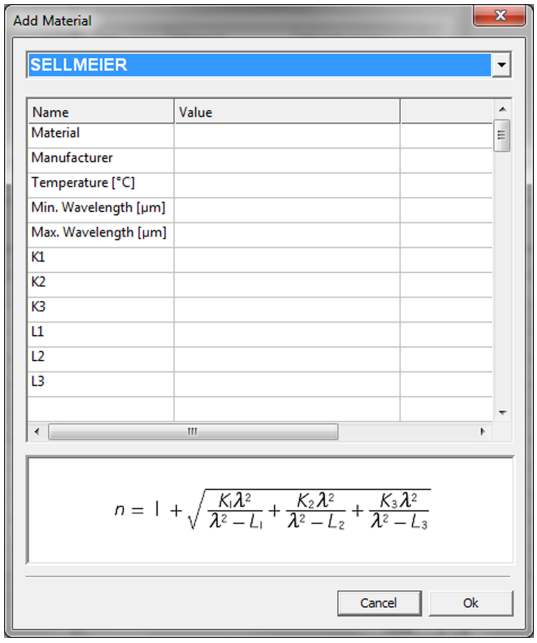


Fig. 227: Tools, Material Manager

– Select the dispersion description of the material to be imported:

- Extended3
- Fixed
- Herzberger
- Schott
- Sellmeier

– Enter all required values and click `OK`.

– To change a material, highlight the entry and click `Modify`.
A new window opens.
– Change the values and click `OK`.

– To delete a material, highlight the entry and click `Delete`.
– Confirm the prompt with `Yes`.

– Click `Import` to import data from a database of optical flats.
– Select the file (*.glb, *.agf) and confirm with `Open`.

NOTE

*.glb is a proprietary format of TRIOPTICS.

*.agf is the format of the Zemax database of optical flats.

Save Interference Signal ...

Use this function to save the interference signal as a binary file (for customer service).

Settings ...

Opens the `Settings` window.

For further information refer to chapter *Settings [▶ 236]*.

21.6 <View> menu

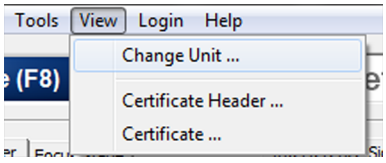


Fig. 228: <View> menu

Change Unit ...

Opens the "Change Unit" window.

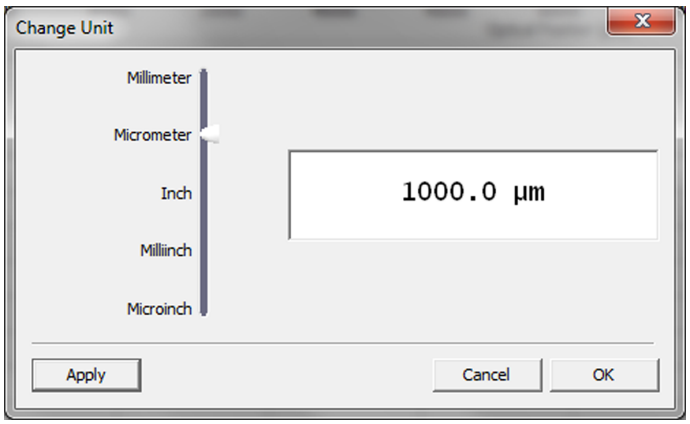


Fig. 229: <View> menu, Change Unit

– Use the slider to select the desired unit.
– An example is shown in the window to the right.
– Click `Apply` to apply the setting.
– Click `Cancel` to cancel making changes to the units.
– Click `OK` to apply the setting and close the window.

Certificate Header ...

Opens the "Certificate Header" window (see also *Output of measurement results as a certificate [▶ 221]*).

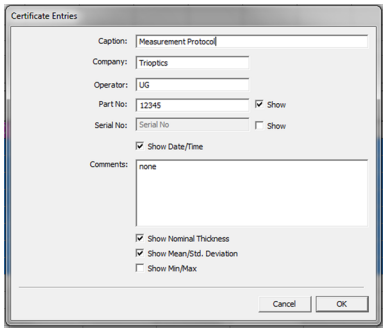


Fig. 230: <View> menu, Certificate Entries

Caption	Headline
Company	Company name
Operator	Operator
Part No.	Part numbers
Show	Checkmark ticked: Part number is entered into the certificate
Serial No.	Serial number
Show	Checkmark ticked: Serial number is entered into the certificate
Show Date/Time	Checkmark ticked: Date and time are entered into the certificate
Comments	Comments
Show Nominal Thickness	Checkmark ticked: Nominal thickness as entered in the lens design is entered into the certificate
Show Mean/Std. Deviation	Checkmark ticked: Mean value and standard deviation are entered into the certificate (only if more than one measurement was carried out)
Show Min/Max	Checkmark ticked: Min. and max. value are entered into the certificate (only if more than one measurement was carried out)
Cancel	Cancel making changes to the settings
OK	Save settings and close window

Certificate ...

Opens the certificate.

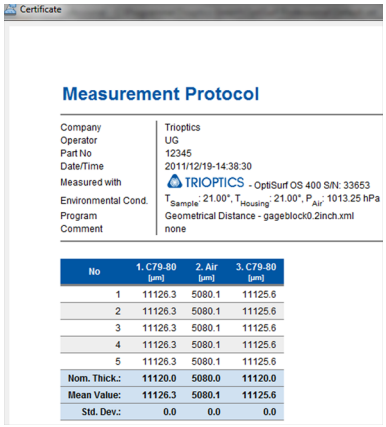


Fig. 231: Certificate, example

Page Setup	Setup page (see also <*File*> *menu [▸ 227]*, Page Setup …)
Print Preview	Print preview
Print	Print

21.7 <Login> menu

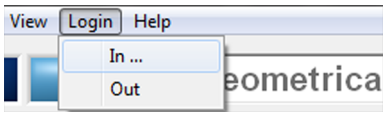


Fig. 232: <Login> menu

In ...

Opens the "Login" window. Here you can log in as Administrator or Supervisor (also refer to chapter *Login [▸ 194]*).

Out

The administrator or supervisor is logged off. Then you will have the restricted user rights of an operator again.

21.8 <Help> menu

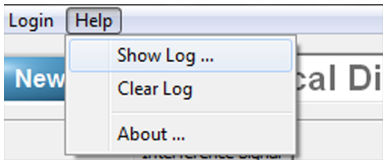


Fig. 233: <Help> menu

Show Log ...

Opens the "Log" window. Displays an internal function log.

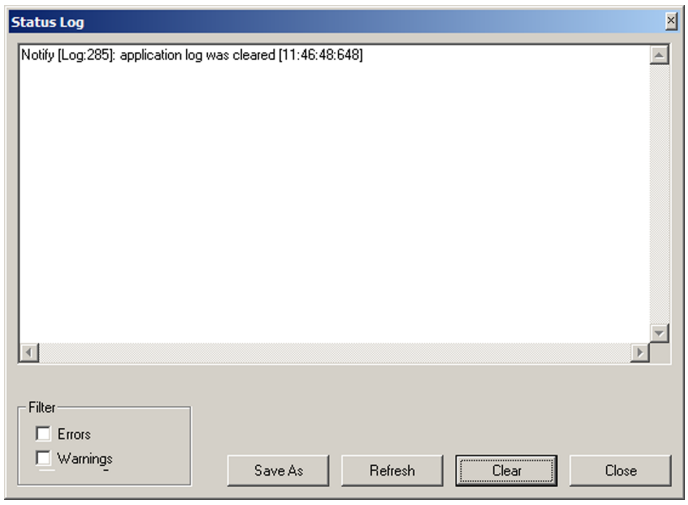


Fig. 234: <Help> menu, Status Log

Clear Log

Deletes the log.

About ...

Depicts the software version.

21.9 Settings

21.9.1 General functions in the <Settings> menu

Select <Tools> <Settings>. The following window opens:

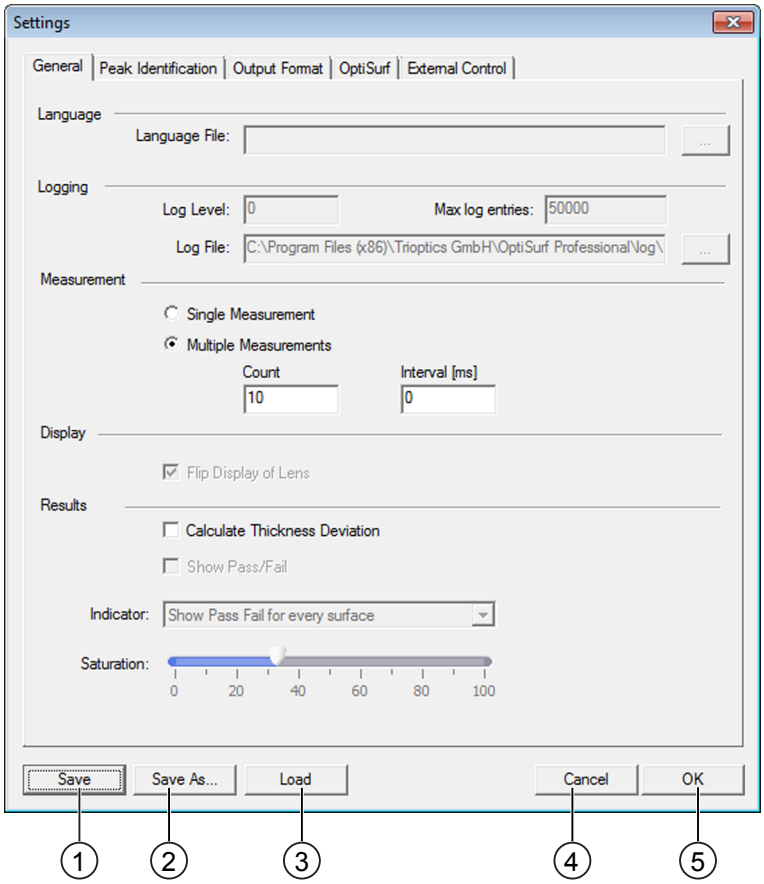


Fig. 235: Settings, General functions

The lower part of the window contains the buttons for the standard options that apply to all registers.

1	`Save:` Apply and save changes
2	`Save as:` Save settings with a new name (.set)
3	`Load:` Load settings (.set)
4	`Cancel:` Cancel making changes to the settings
5	`OK:` Save settings and close window

21.9.2 <Settings> Register <General>

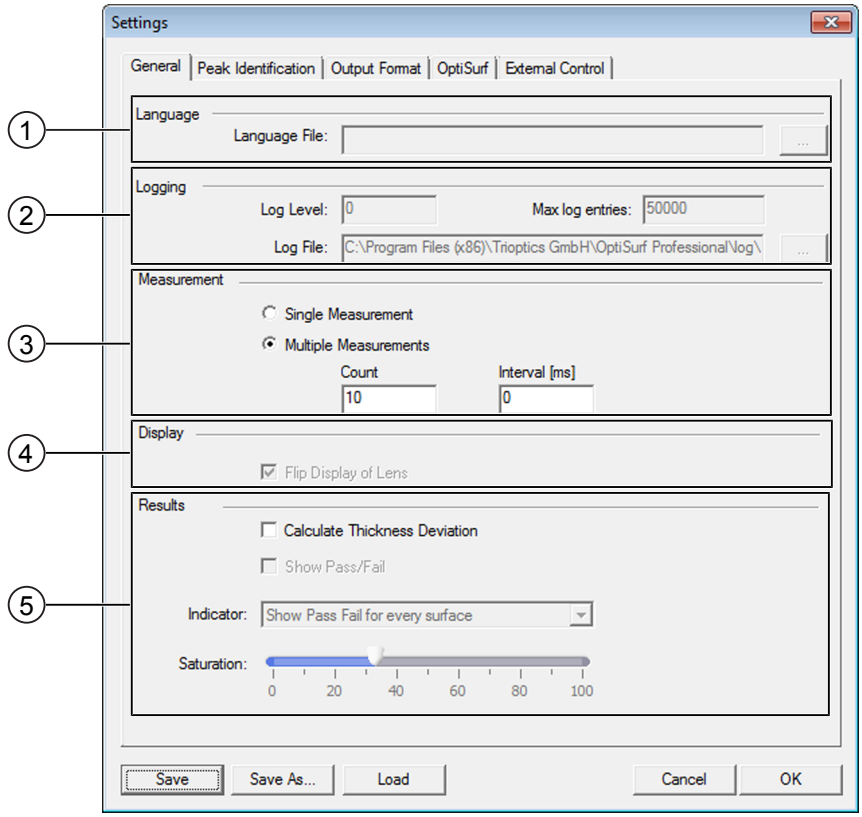


Fig. 236: Settings, Register <General>

1	**Language** Select language

2	**Logging**
	`Log Level`
	`Log File`
	The program settings for logging are preset at the factory.

3	**Measurement** `Single Measurement`: Single measurement `Multiple Measurement`: Multiple Measurement • `Count`: Number of measurements in case of multiple measurements. • `Interval`: Time period between two measurements
4	**Display** `Flip Display of Lens`: Ticked: the lens design is flipped (only for TRIOPTICS employees)
5	**Results** `Show Pass/Fail`: Checkmark ticked: Pass/Fail is indicated. `Indicator`: select what to display • Show Pass/Fail for every surface: • Show Pass/Fail for the complete sample: • Show Pass/Fail for both: • `Saturation`: Saturation of the color in the display

21.9.3 <Settings> Register <Peak Identification>

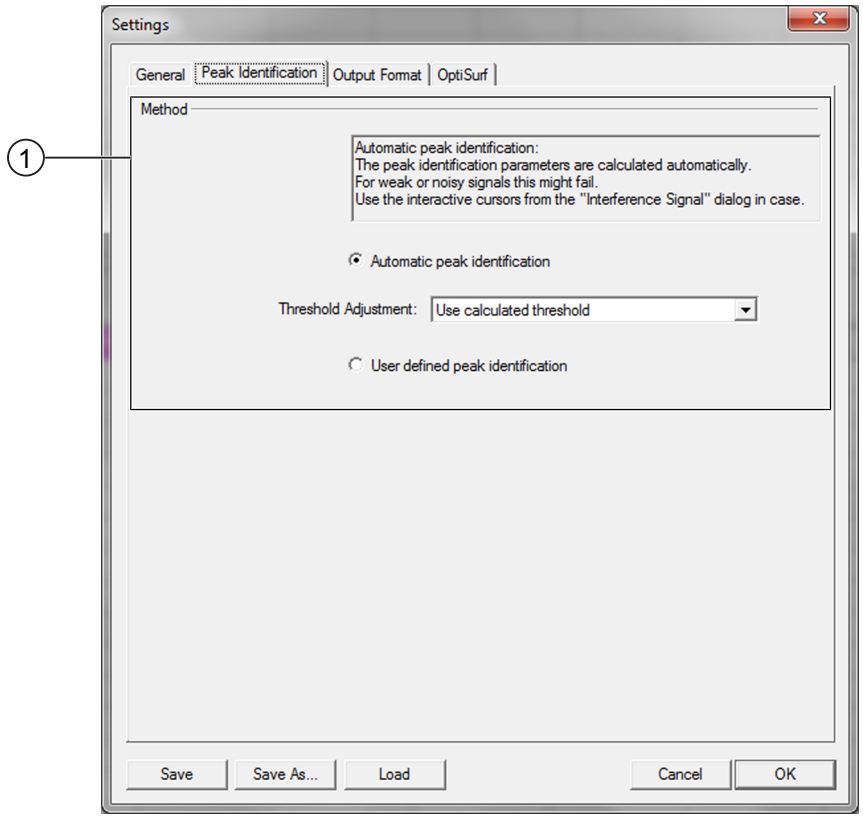


Fig. 237: Settings, Register <Peak Identification>

1	**Method** `Automatic peak identification`: The parameters for peak detection are calculated automatically. May not work for weak or noisy signals. `Threshold Adjustment`: If the peaks are not detected, the "sensitivity" of the algorithm can be adjusted: • `Use calculated threshold` • `Case of Failure -> Modify once` • `Case of Failure -> Modify three times` • `Case of Failure -> Modify five times` User defined peak identification Peak identification is performed manually (refer to chapter *What to do when the measurement result is displayed as "failed"... ? [▶ 216]*).

The "Automatic Peak detection" and "User defined peak detection" settings can be selected from the main interface.

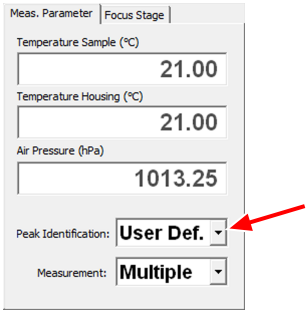


Fig. 238: Settings, Measurement Parameter

21.9.4 <Settings> Register <Output Format>

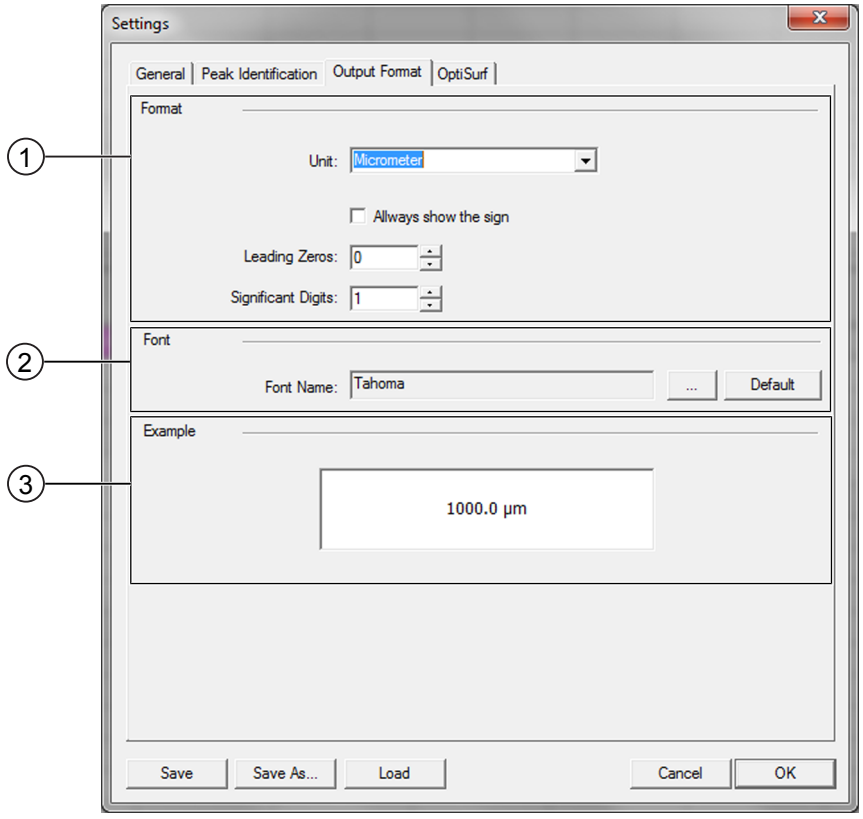


Fig. 239: Settings, Register <Output Format>

1	**Format** `Unit`: Select unit `Always show the sign`: Checkmark ticked: Sign is displayed `Leading Zeros`: Number of leading zeros `Significant Digits`: Number of decimal places
2	**Font** `Font Name`: Font Opens a new window for selecting the font, font style (bold italic), font size, and color. Confirm with OK. `Default`: Back to default setting
3	**Example** Example

21.9.5 <Settings> Register <OptiSurf>

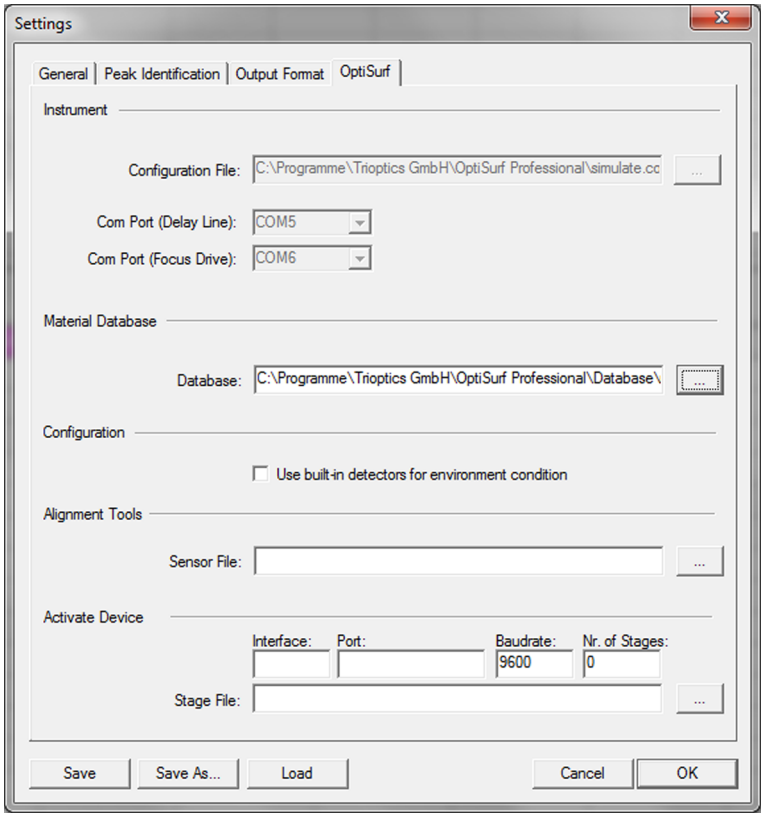


Fig. 240: Settings, Register <OptiSurf>

NOTE

Do not change system parameters!

All system settings in this register are preset at the factory and must not be changed without consulting TRIOPTICS.

22 Maintenance and repairs

DANGER

Risk of electric shock

Electrical currents may pose a hazard.

– Disconnect the main power supply before working on electrical equipment.

WARNING

Risk of injury from compressed air

Flailing compressed air lines or pressurized components can result in crushing or impact injuries.

– Ensure that all lines are depressurized before maintenance, repair and troubleshooting work.

CAUTION

Risk of material damage

Rotating the air bearing without compressed air will result in damage to the air bearing. Precise measurements will then no longer be possible.

– Always turn on the compressed air supply first before using the measurement system.

CAUTION

Risk of material damage

Moisture getting into the enclosure may damage the measurement system.

– Make sure that moisture cannot penetrate into the housing of the measurement system.
– Do not consume beverages at the workplace.

CAUTION

Risk of material damage

Improper handling of the measurement system may result in considerable damage to property.

– Before you start work, make sure all sections of the housing are present and properly installed.
– Do not work on the measurement system if sections of the housing have been removed or are defective.
– Immediately reattach removed sections of the housing or notify the manufacturer or the responsible local subsidiary.

NOTE

The measurement system may only be maintained by appropriately trained personnel. Improper maintenance leads to measurement errors.

22.1 Intervals

The components of the measurement system are largely designed to be maintenance free. However, changes to environmental parameters (temperature, humidity, etc.) may cause deviations in the alignment and thus the measurement results.

To promptly detect such deviations and to ensure the proper functioning of the components of the measurement system, please observe the following maintenance instructions:

Every 3 months

Check calibration of the measurement system (refer to chapter *Calibrate the measurement system [▸ 245]*).

Every 6 months

Conduct a performance check (refer to chapter *Conduct a performance check [▸ 246]*).

As required

Replace the lamp (refer to chapter *Replace the lamp [▸ 247]*).

22.2 Calibrate the measurement system

Required tool

Reference wedge

NOTE

The reference wedge is a plane-parallel surface with a known wedge error.

1. Remove the head lens of the camera.
2. Fasten the reference wedge 1 with screws.
3. Select `<Tools> <Calibrate>`.
4. Enter the following values:
   `Refractive Index`: Refractive index, refer to the specifications of the reference wedge
   `Angle (arcsec)`: Angle, refer to the specifications of the reference wedge
   `EFL Telescope (mm)`: nominal EFL of the autocollimator
5. To move the H-shaped calibration pattern to the center of the image area shown, turn the adjusting screws 2.
6. Click on `Calibrate` to start the calibration.
   ⇨ The message`Press OK when you see 2 horizontal slits` is displayed. (Click `OK`when you see 2 horizontal slits.).
7. Turn the knurled ring 1 of the reference wedge until you can see two horizontal lines (see Fig. 18-3).
8. Click `OK`.
   ⇨ The message `Press OK when you see 2 vertical slits` is displayed.
9. Turn the knurled ring 1 of the reference wedge until you can see two vertical lines (see Fig. 18-4).
10. Click `OK`.
11. Click `Update` to accept the values.
    ⇨ The following prompt is displayed: `Are you sure you want to update the calibration's values?` (Are you sure you want to update the calibration‘s values?).
12. Click `Yes` to calibrate the measurement system.

⇨ The following message is displayed: `The calibration's values were updated.` (The calibration‘s values were updated.).

⇨ The calibration process is completed.

22.3 Conduct a performance check

General information

To ensure proper functioning and consistent accuracy of the measurement system, TRIOPTICS recommends a regular performance check.

The values for the master sample are known. These are compared with the values determined with the measurement system. In this way, changes to the measurement system can be detected over a longer period of time.

Reference sample

You can obtain a reference sample from the measurement system manufacturer. This sample is especially certified and provides the same values under consistent measurement conditions.

However, you may also use your own sample for regular testing, for which you know the exact measurement values.

NOTE

In order to obtain consistent measurement values, the reference sample must always be stored under the same ambient conditions.

Test procedure

1. Make sure that the ambient conditions and the state of the reference sample are exactly as in the previous measurements.

NOTE

Type and source of danger

Optical measurements are sensitive to external influences. Avoid too much ambient light, contaminated samples (dust, grease or scratches), tilted samples, vibrations of the measurement system.

2. Determine the values for one or more master samples.
3. Repeat the measurement several times.
4. Print out the records.

Deviations

1. Compare the values with those of the reference sample.
2. If you detect deviations, first check the ambient conditions and repeat the test procedure if necessary.

NOTE

If there are significant deviations in the measurement results, the measurement system must be calibrated.

Archiving

– Carefully check and archive the measurement results.
– Carefully store the printouts of the readings of the performance check.

22.4 Replace the lamp

WARNING

Risk due to hot surfaces

The light source becomes very hot during operation.

– Read the enclosed documentation on the light source and follow the safety instructions.
– Do not disassemble the light source while hot, but leave to cool for 10 minutes.
– Do not operate the light source in the disassembled state.

– To replace the lamp, follow the instructions in the documentation for the light source.

22.5 PC and software

The measurement system is shipped with software that is installed under the Microsoft Windows® operating system.

The system operator is responsible for keeping the software free from viruses during operation of the machine.

22.6 Fuses

CAUTION

Electrical dangers when using incompatible fuses

Only replace fuses with identical ones.

Information about the fuses used can be found in the operator's manuals for each device.

22.7 Cleaning

In order to ensure proper functionality and accurate measurement results, the measurement system, the accessories, the samples and the environment must be kept clean and dust-free.

Always cover the measurement system with the protective cover included in the delivery when not in use.

The following cleaning steps should be taken as required:

- The lenses should be cleaned with isopropyl alcohol at regular intervals. It is important that the lenses be free of streaks after cleaning.
- The housing should be ideally be cleaned with compressed air at regular intervals.

DANGER

Danger of fire from highly flammable alcohol during cleaning work

– Observe the manufacturer's safety data sheet.
– Only store the volume actually required for the day at the workstation.

NOTE

If the measurement system is operated in a clean room, observe the cleaning guidelines in place.

NOTE

Improper cleaning of optical surfaces can cause damage

The optical surfaces are highly sensitive and should not be allowed to get contaminated.

Lenses damaged by cleaning are not covered by the warranty.

– Cleaning of optical surfaces may only be carried out by appropriately trained personnel.

Housing

CAUTION

Risk of material damage

The use of solvents or abrasives can cause damage to the measurement system.

– Never use solvents or abrasives to clean the measurement system.
– Do not spray the cleaning solution directly onto the measurement system.

– Use a solution of a mild detergent and water for cleaning.

– Wipe off the housing of the measurement system regularly with a soft, light, moist cloth.

Sample tray

NOTE

Risk of inaccurate measurement results

A dirty sample holder can contaminate the sample or cause it to become misaligned. This will result in inaccurate measurement results.

– Use isopropyl alcohol for cleaning
– Wipe the sample tray regularly with a soft, light, moist cloth.

Optical components of the measurement system

CAUTION

Risk of material damage

The optical surfaces are highly sensitive and should not be allowed to get contaminated.
Lenses damaged by cleaning are not covered by the warranty.

– Do not touch the optical surfaces.
– Only use clean, oil-free compressed air for cleaning.
– Have the cleaning done only by appropriately trained specialist staff.

– Blow contaminations on optical components away with compressed air, with a spiraling movement from inside to outside.
– For stubborn contaminations, use a soft cloth with high-purity isopropyl alcohol.

Optical surfaces

Optical surfaces are highly sensitive. Avoid any contaminants. Do not clean unless necessary.

23 What to Do If... ?

23.1 Customer service

If you cannot resolve the errors yourself, please contact Customer Service.

Accessibility

The customer service is available five days a week during normal office opening hours in your respective region.

Costs

During the warranty period the service is free.

23.2 Start Customer Service request

Any request for service must be made online.

– Open `http://www.trioptics.com`.
– Select `Contact & Service`.

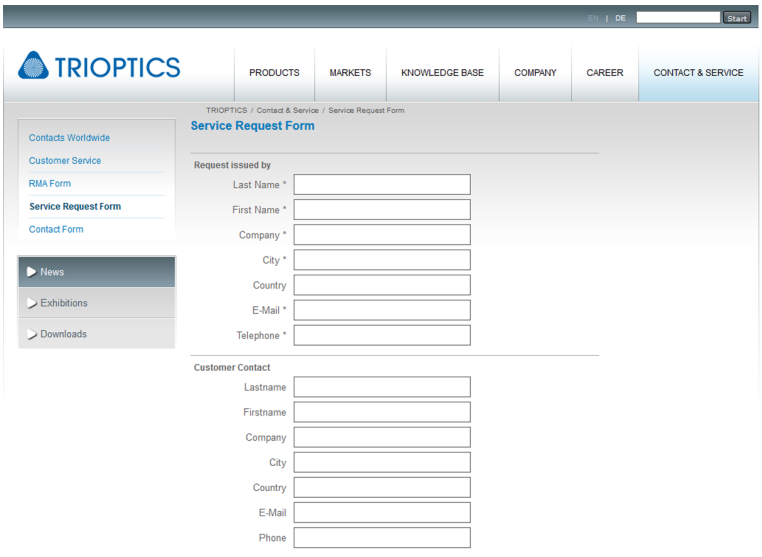


Fig. 241: Service request form

– Select `Service Request Form`.
– Fill in the respective fields.

  All fields marked with an asterisk (*) are mandatory. If you do not know what to enter, fill in "None".
– If necessary, select an attachment of the following file types: *.pdf, *.doc, *.docx, *.jpg, *.png, *.zip.

  The maximum size of the attachment is 5 MB.
– Click `Submit`.

23.3 Returning parts

Please use an RMA number (Return Material Authorization) to return any parts to TRIOPTICS. You can retrieve this number online.

1. Open `http://www.trioptics.com`.
2. Select `Contact & Service`.
3. Select `RMA Form`.

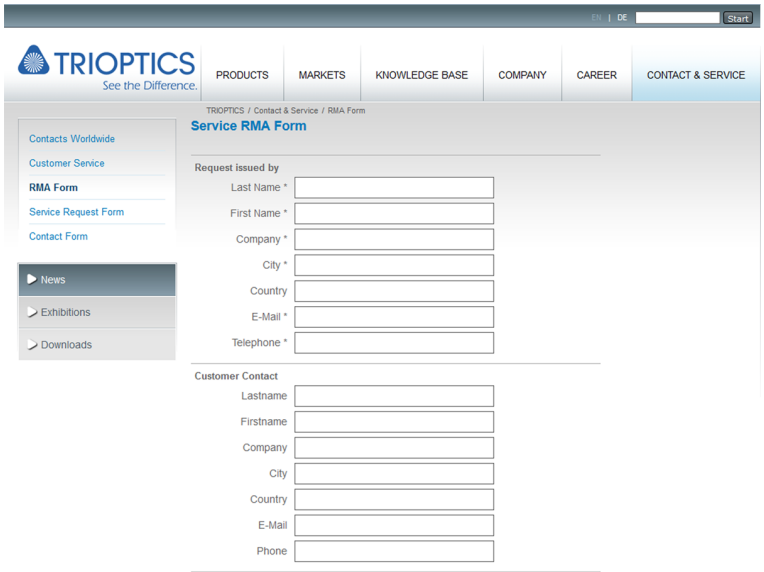


Fig. 242: Service RMA Form

4. Fill in the respective fields.
5. All fields marked with an asterisk (*) are mandatory. If you do not know what to enter, fill in "None".
6. If necessary, select an attachment of the following file types: *.pdf, *.doc, *.docx, *.jpg, *.png, *.zip.
   The maximum size of the attachment is 5 MB.
7. Click `Submit`.
   ⇨ Your RMA number will be mailed to you.
8. State your address and the RMA number on the return package to TRIOPTICS.

NOTE

An RMA number is required to ensure your parts are assigned and processed quickly.

24 Disassembly and Disposal

WARNING

Risk of injury

Mechanical or electrical hazards can occur when disassembling the product.

– Ensure that disassembly is only carried out by authorized specialist personnel.
– Please contact the manufacturer or the respective local subsidiary.

NOTE

Observe local regulations and laws on the disposal of environmentally harmful substances.

NOTE

Should you have any questions about disposal, please contact the manufacturer or the responsible local subsidiary.

– http://www.trioptics.com/company/distributors.php

24.1 Disposing of components

Components

The products mainly consist of steel and various copper and aluminum parts. Metallic materials are widely regarded as fully recyclable.

Separate the components for recycling according to the following categories:

- Steel and iron
- Aluminum
- Non-ferrous metal, such as motor windings
- Insulating materials
- Cables and wires
- Electronic scrap
- Batteries

Chemicals and additives

Sort the process chemicals and additives for disposal, for example according to the following categories:

- Oil

- Fat
- Cleaners and solvents
- Paint residues
- Anti-corrosion agents
- Other hazardous substances

Dispose of the separated components according to local regulations or via a specialist disposal company. The same applies for cloths and cleaning substances which have been used to carry out work on the machine.

Packaging material

- If necessary, contact a specialist waste disposal company.
- Wooden packaging for sea transport consists of impregnated wood. Please observe the local regulations.

24.2 Returns

All products

Returns must be registered with the manufacturer.

25 Warranty

TRIOPTICS grants a warranty of one year on material and processing defects, starting from delivery or installation at the customer (if the installation was carried out by TRIOPTICS).

Excluded from the warranty are supplied parts, such as the CCD array or FrameGrabber Board, which have a shorter manufacturer's warranty.

The warranty does not apply if the defects are caused by:

- Transport damages
- Damages from incorrect installation (if the installation was not carried out by TRIOPTICS)
- Accident, negligence or unauthorized influencing of the measurement system
- Failure to comply with the operating instructions
- Damages due to unauthorized changes to programming
- Damages due to unauthorized repair
- Use of incorrect spare parts

In a warranty case, TRIOPTICS is only obligated to replace or repair the defective parts. Consequential damages are not covered by this warranty. The customer is responsible for transport costs.

NOTE

Keep the original packaging in order to return the measurement system to the manufacturer in the event of a repair.

Index

P

R

S

T

U

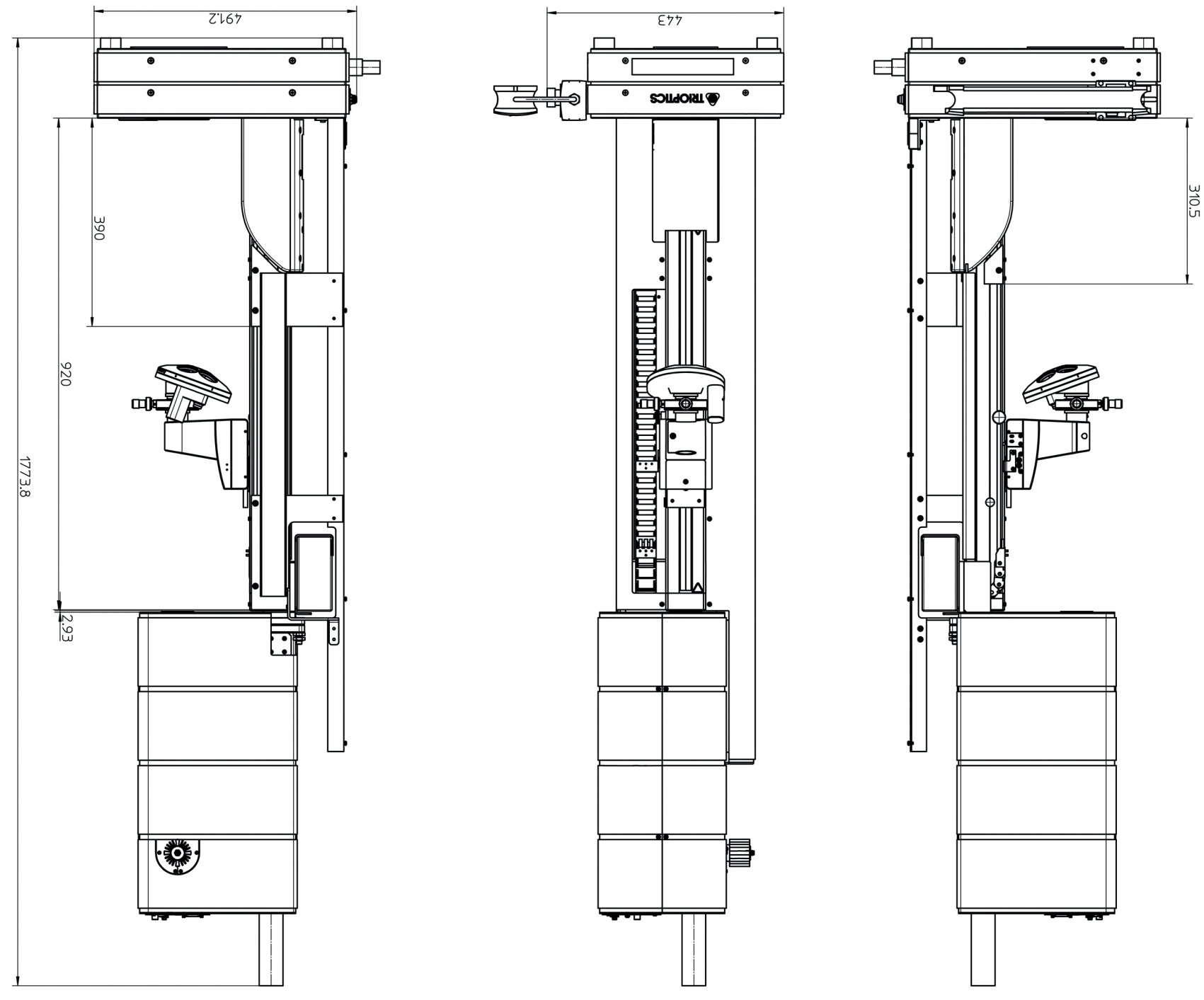
W

Z

26 Appendix

See also

- OptiCentric_100_MWIR_4-112-09.pdf [▶ 261]
- OptiCentric_100_LWIR_4-112-10.pdf [▶ 262]
- OptiCentric 3D 100 MWIR_4-151-03.pdf [▶ 263]
- OptiCentric_3D_100_LWIR_4-151-05.pdf [▶ 265]
- TRT-200-40_4-145-01b.pdf [▶ 266]
- Ringchuck Ø 2,5 mm [▶ 267]
- Ringchuck Ø 10 mm [▶ 269]
- Ringchuck Ø 30 mm [▶ 271]
- Ringchuck special [▶ 273]
- Sicherheitsdatenblatt_ZnSe.pdf [▶ 275]
- EC_Declaration_of_Conformity.pdf [▶ 293]

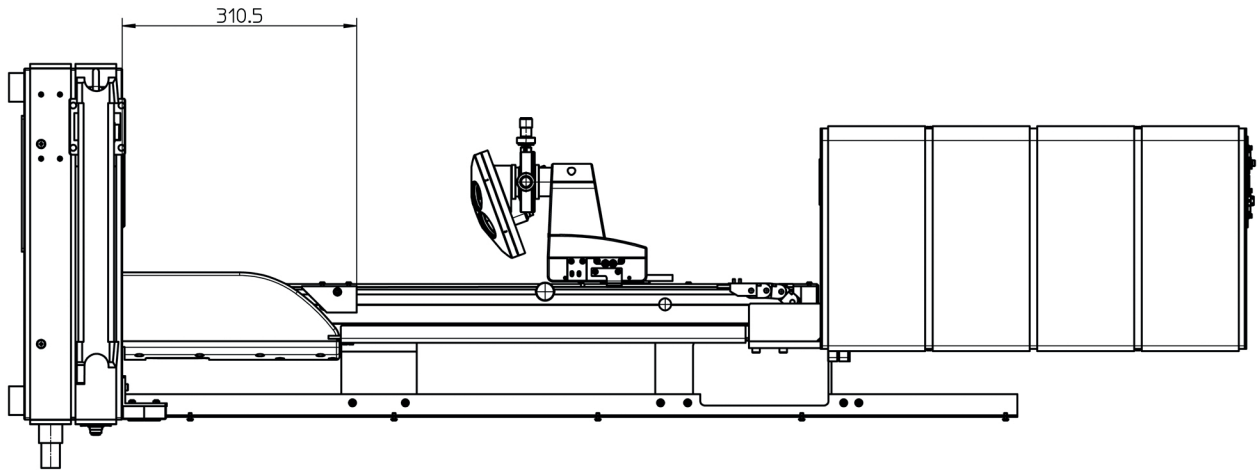


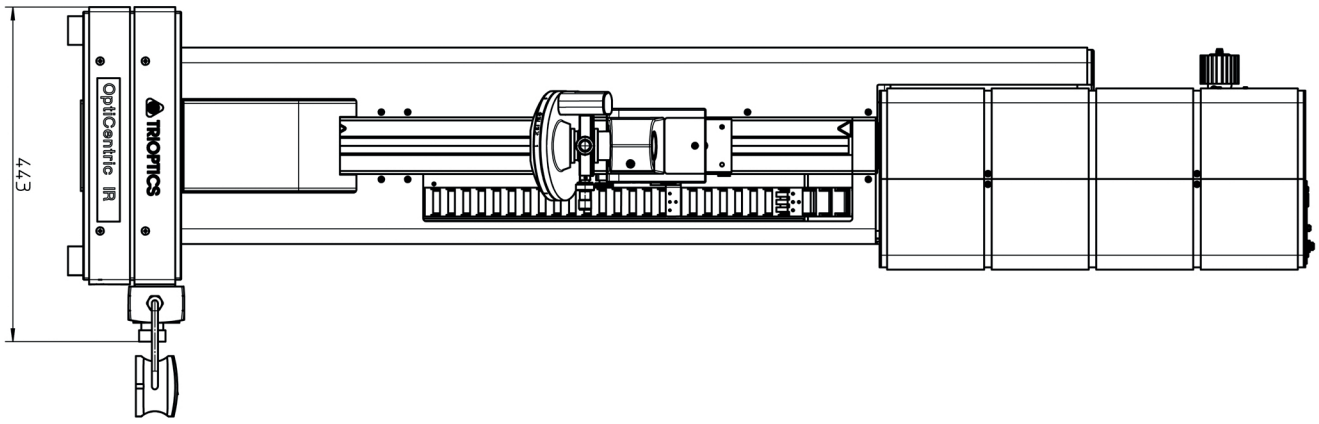
Ansichten links und rechts
zur Positionirung der Halter Für die Verkleidung

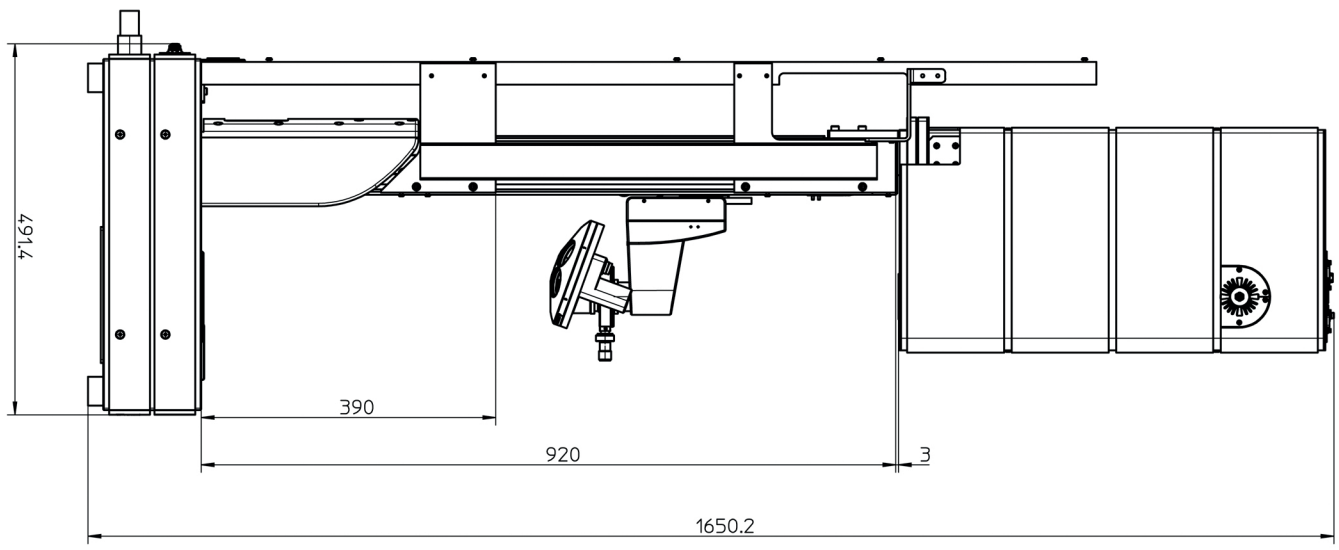
Ind.	Änderung/revision	Datum/date	Name	Allgemeintoleranzen / general tolerances DIN 7168-mK																
				Abmaße / tolerances Almaße	0,5 < 3	3 < 6	6 < 30	30 < 120	120 < 400	400 < 1000	1000 < 2000	2000 < 4000	Gewicht / weight ca.	Material / material						
					±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2,0	0,2							
	Gerät / device			Optic Centric																
				Zeichnungs-Nr. / dwg-No.																
				4-112-09																
				Maßstab / scale 1 : 1																
				Gewicht / weight kg																
				Werkstoff / material																
				Proj.																
				Datum/date																
				Name																
				2017																
				Bearb.	drawn	06.06.	Mbens													
				Gepr.	ckkd'															
				Format A1																
				Benennung / description																
				Optic Centric 100 MWIR																
				File-Name																
				\4-112-09_OpticCentric_100_MWIR																
				Bl.Nr. sheet 2 / 2																
				Ers.für / supers.																

EN ISO 1302 Ra 3.2 ISO 13715 +0,3 +0,1 −0,3 −0,1

Bei Original-Formatgröße







Allgemeintoleranzen / general tolerances: DIN 2768-mK

Maße dimens.	> 0,5 3	3 6	6 30	30 120	120 400	Symmetrie symmetry	Rundlauf run-out
Abmaße allow.	+- 0,1	+- 0,1	+- 0,2	+- 0,3	+- 0,5	0,5	0,2

Ind.	Änderung/revision	Datum/date	Name

Gerät / device

Proj.

Dat.m/date: 2015

Bearb. drawn

Gepr. chkd

Name

TRIOPTICS GmbH

Zeichnungs-Nr. / dwg-No.

Halbzeug/ scrap

Werkstoff / material: Material

Maßstab scale: 1 : 1

Gewicht weight: kg

Benennung / description

File-Name: .\

Ersatz für / supers.

Blatt sheet: 1 / 1

EN ISO 1302

Ra 3.2

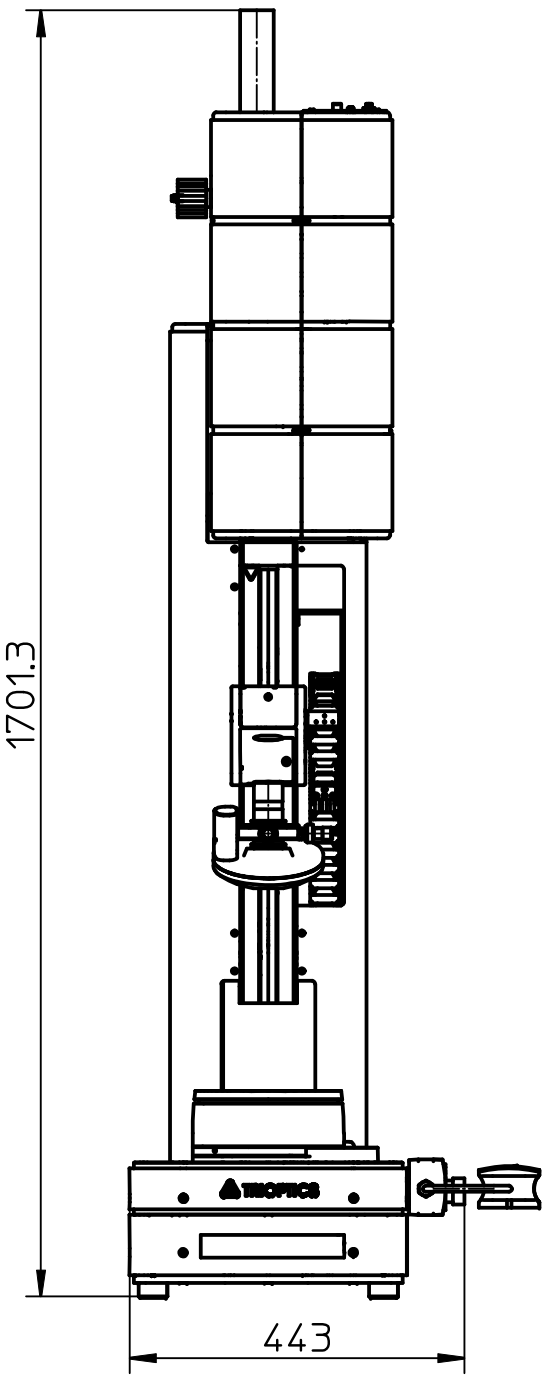
ISO 13715

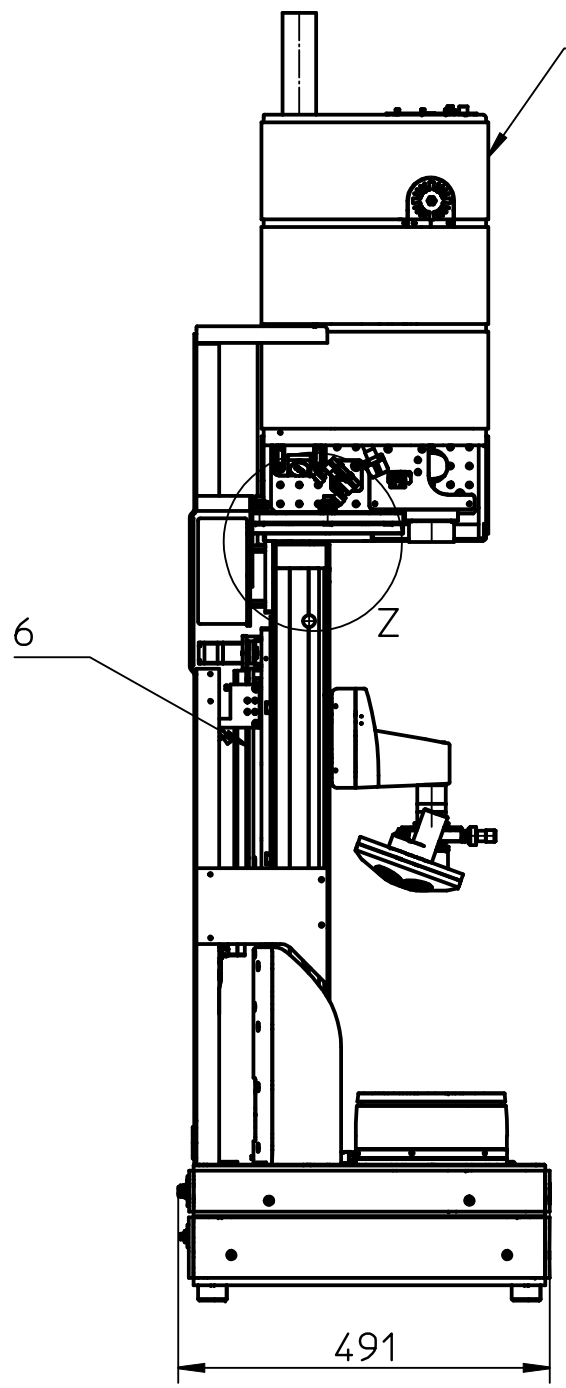
+0,3 +0,1

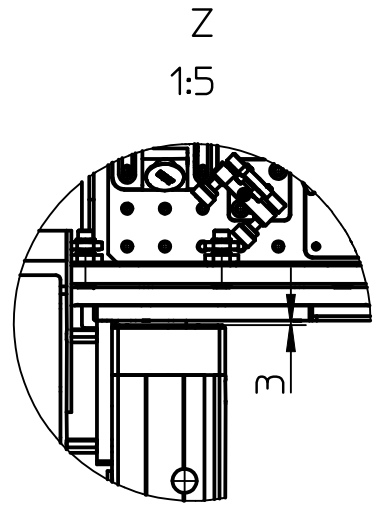
-0,3 -0,1

Bei Original-Formatgröße

100







EN ISO 1302 Ra 3.2 ISO 13715 +0,3 +0,1 -0,3 -0,1

Allgemeintoleranzen / general tolerance: DIN ISO 2768-mK

Maße dimens.	Abmaße allow.
> 0,5 3	+- 0,1
3 6	+- 0,1
6 30	+- 0,2
30 120	+- 0,3
120 400	+- 0,5
Symmetrie symmetry	0,5
Rundlauf run-out	0,2

Ind.	Änderung/revision	Datum/date	Name

Gerät / device: OptiCentric 3D

Option

Zeichnungs-Nr. / dwg-No.: 4-151-03

	Datum/date	Name
2016		
Bearb. drawn	09.12	Werner
Gepr. chkd'		Metz
		Format A3

Proj.

Maßstab scale | Gewicht weight: kg

Werkstoff / material

Benennung / description: OptiCentric 3D 100 MWIR.

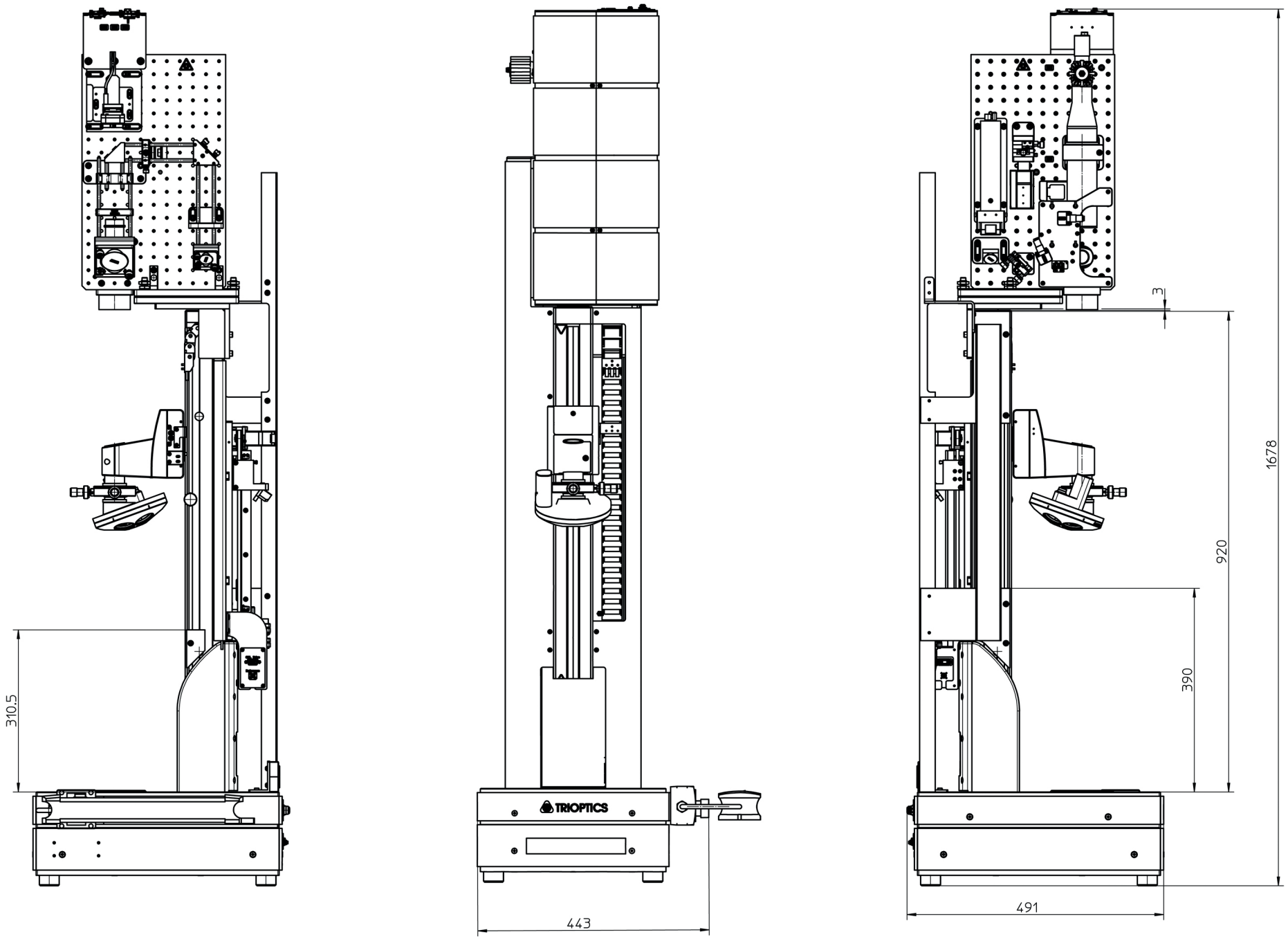
TRIOPTICS GmbH

File-Name: ..\4-151-03_OptiCentric 3D 100 MWIR

Blatt sheet: 1 / 1

Ers.für / supers.

Ansichten links und rechts
zur Positionirung der Halter Für die Verkleidung



EN ISO 1302 Ra 3.2 ISO 13715 +0,3 +0,1 -0,3 -0,1

Allgemeintoleranzen / general tolerances: DIN 2768-mK

Maße dimens.	> 0,5	3	6	30	120	400	Symmetrie symmetry	Rundlauf round	0,2				
		± 0,1	± 0,2	± 0,3	± 0,5	± 0,5							
Abmaße dimens.	± 0,1	3	6	30	120	400							

Ind.	Änderung/revision	Datum/date	Name

Gerät / device: OptiCentric 3D

Zeichnungs-Nr. / dwg-No.: 4-151-05

	Proj.	
2017	Datum/date	Name
Bearb. drawn	11.08.	Werner
Gepr. chkd		
	Format A1	

Maßstab scale: 1 : 1 | Gewicht weight: kg

Werkstoff / material

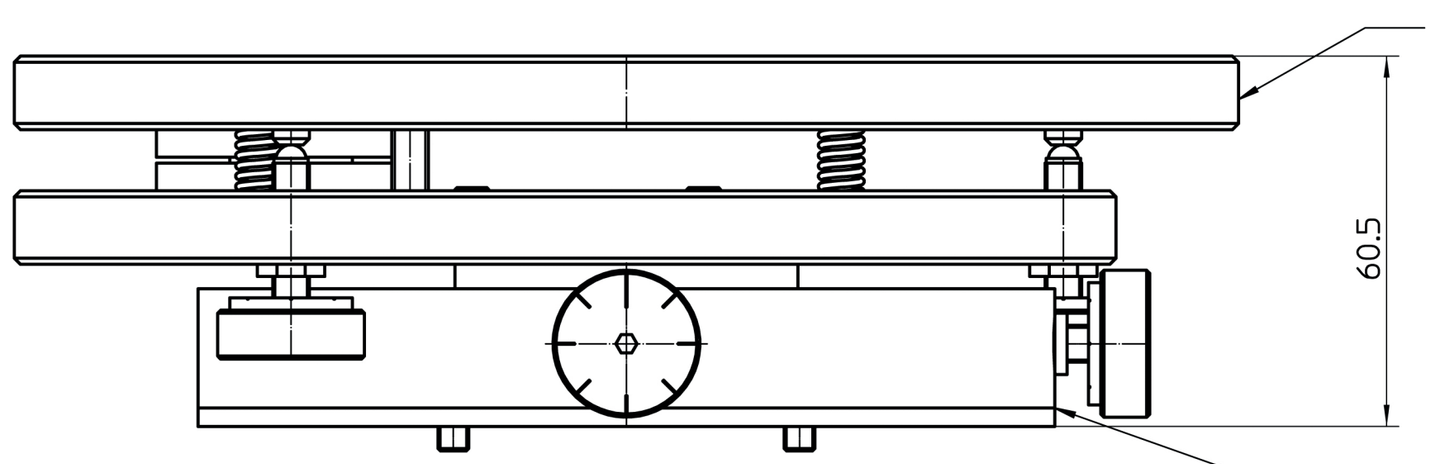
Benennung / description: OptiCentric 3D 100 LWIR

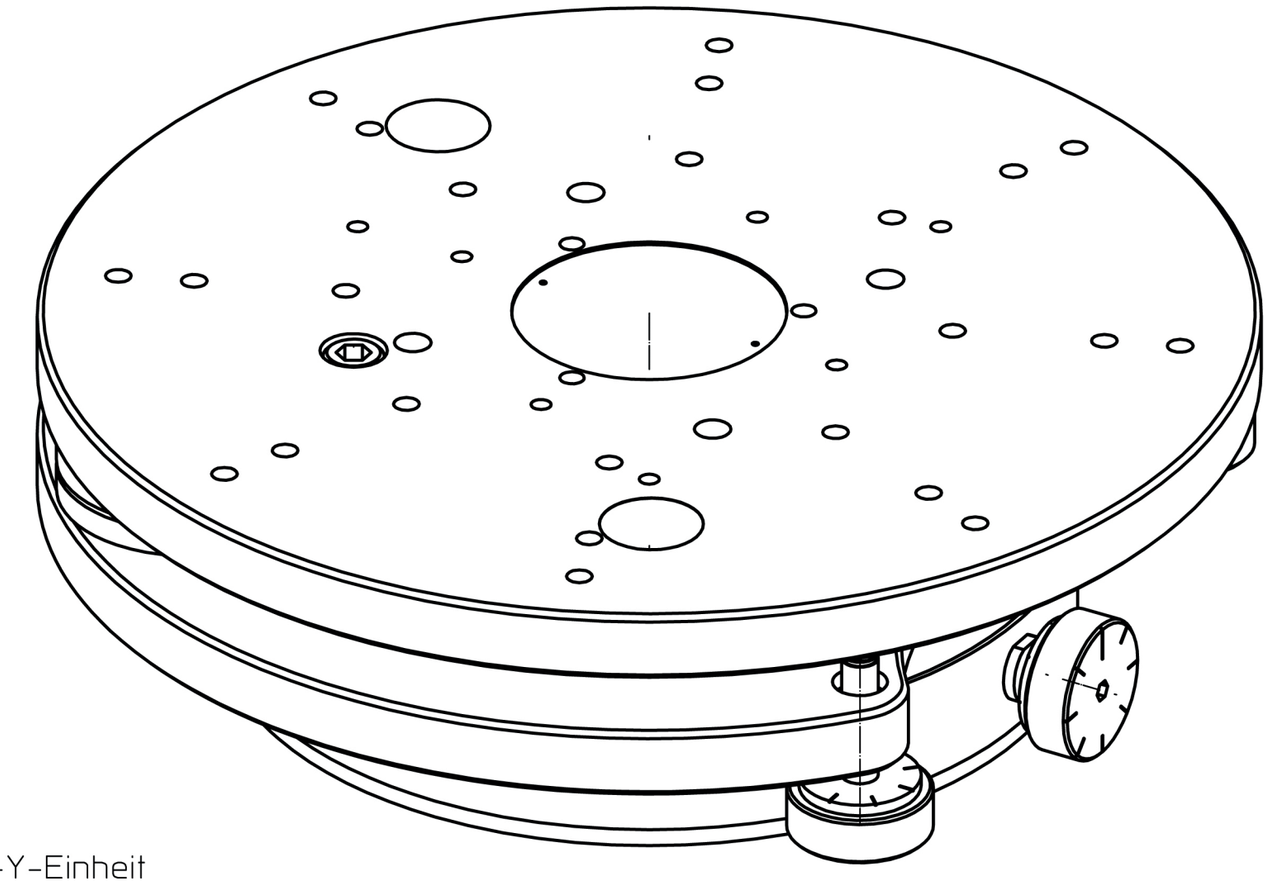
TRIOPTICS GmbH

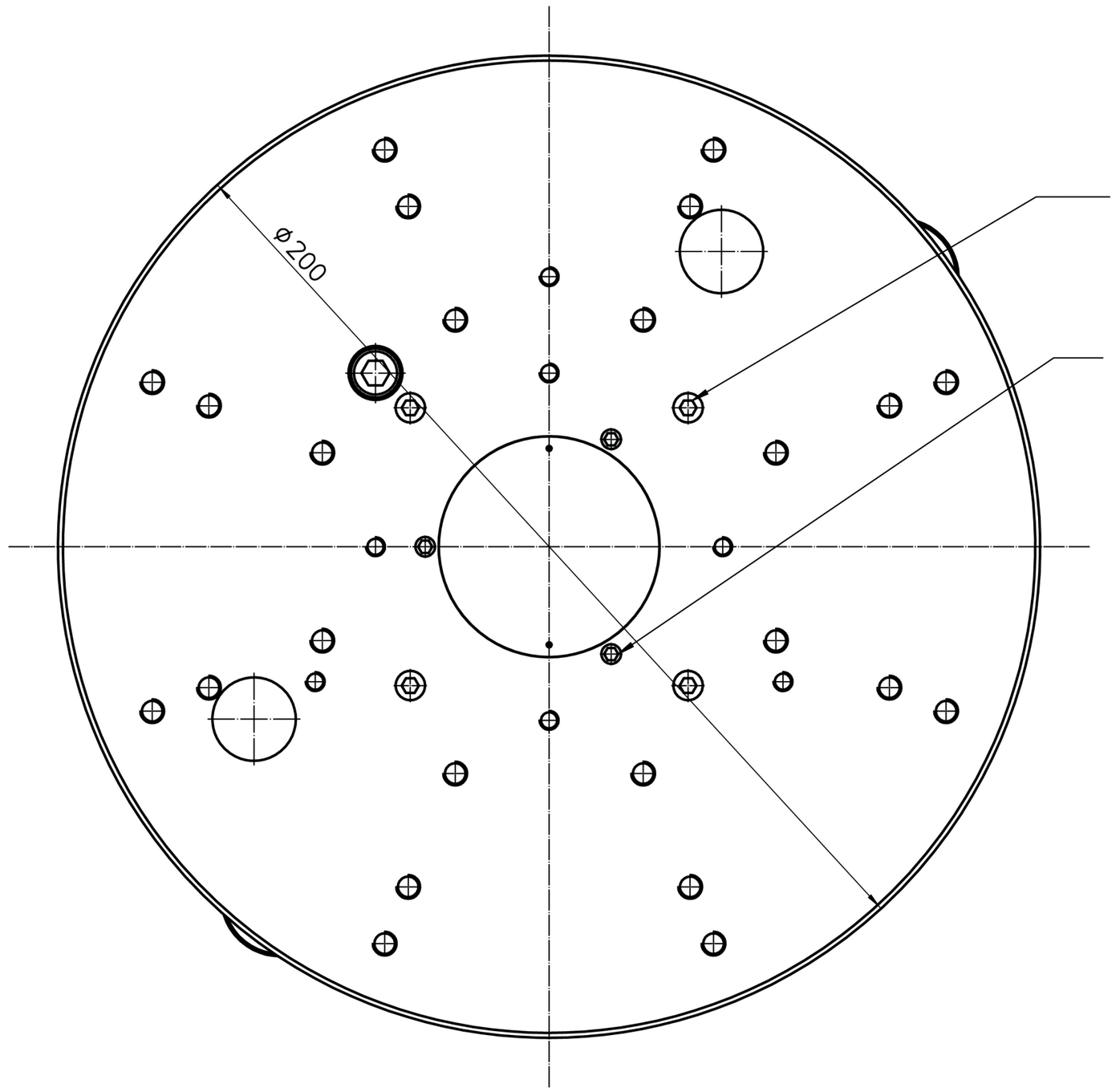
File-Name: ..\4-151-05_OptiCentic_3D_100_WIR

Blatt sheet: 2 / 2

Ers.für / supers.







Spezifikation:

Verstellung X-Richtung ± 2 mm
Verstellung Y-Richtung ± 2 mm
Verkippung ± 3°
Spindelsteigung der
Einstellschrauben 0.175 mm
Einstellempfindlichkeit linear < 1 µm
Einstellempfindlichkeit Kippung < 1 arcsec
max. Kippfehler
bei 2 mm linearer Verschiebung 5 arcsec

Allgemeintoleranzen nach DIN ISO 2768m

Längenmaße	Abmaße
über 0,5 bis 3	± 0,1
3 6	± 0,1
6 30	± 0,2
30 120	± 0,3
120 400	± 0,5

Rundlauftoleranz 0,2
Symmetrietoleranz 0,5
andere Größen s.Norm

gesehen/genehmigt
Gerät: OC
Nachbaufirma
Zeichnungs-Nr.: 4-145-01b

Allgemeintoleranzen DIN ISO 2768m
Oberflächen DIN ISO 1302

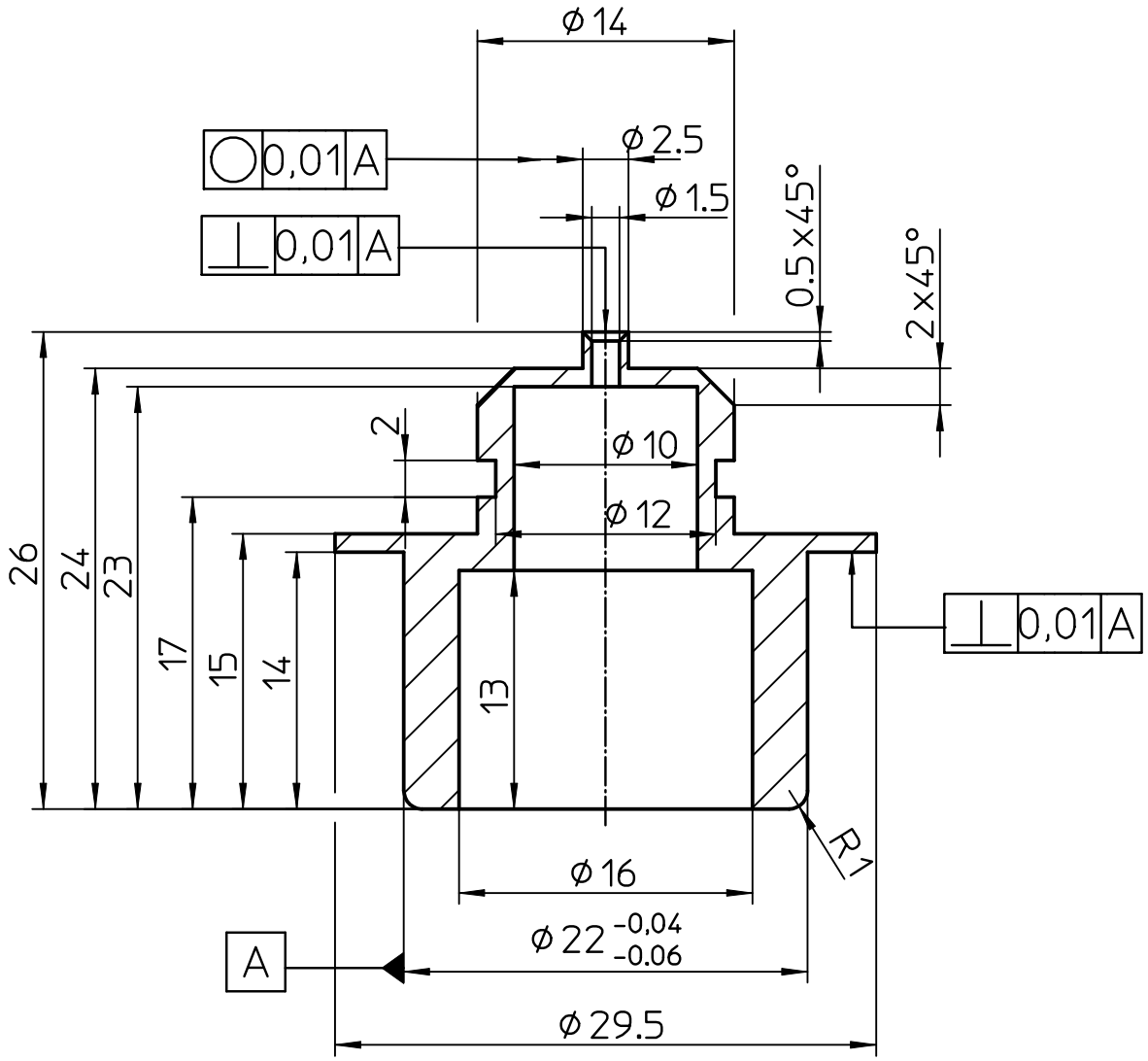
	Datum	Name
2010		
Bearb.	03.08.	Jahn
Gepr.		
Norm		
Fert.		

Maßstab 1 : 1
Gewicht kg
Werkstoff
Benennung: TRT-200-40

TRIOPTICS GmbH

File-Name: ..\4-145-01b_TRT-200-40
Blatt: Bl

Zust. | Änderung | Datum | Name
Ursprr. | Ers.für | Ers. durch



+0,3 +0,1

-0,3 -0,1

Allgemeintoleranzen nach DIN 7168 m B

Längenmaße	Abmaße
über 0,5 bis 3	+- 0,1
3 6	+- 0,1
6 30	+- 0,2
30 120	+- 0,3
120 400	+- 0,5

Symmetrie-toleranz 0,5

Rundlauf-toleranz 0,2

andere Größen s.Norm

gesehen/genehmigt

Gerät
OptiCentric
Vacuum Unit

Nachbaufirma

Zeichnungs-Nr.

Allgemeintoleranzen DIN 7168 m

Oberflächen DIN ISO 1302

Maßstab 2,5 : 1

Gewicht kg

Werkstoff
Polyacetal(Delrin) black

	Datum	Name
2002		
Bearb.	12.09	Popp
Gepr.		
Norm		
Fert.		

Bennenung
Ring Chuck
Dia 2,5

TRIOPTICS GmbH

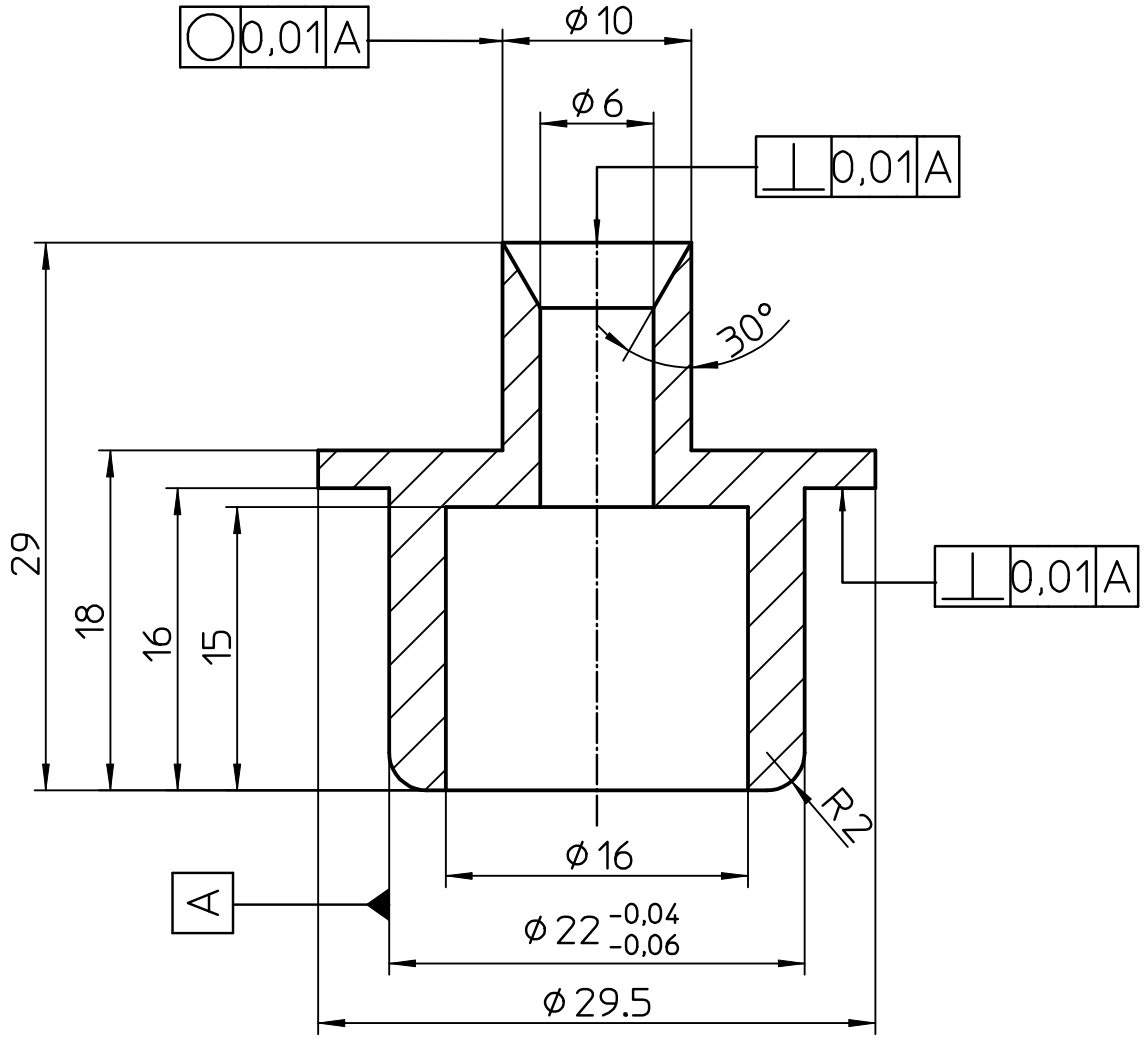
File-Name

Blatt
Bl

Zust.	Änderung	Datum	Name	Urspr.	Ers.für	Ers. durch

Bei Original-Formatgröße 0

100



+0,3 +0,1

-0,3 -0,1

Bei Original-Formatgröße

Allgemeintoleranzen nach DIN 7168 m B

Längenmaße	über 0,5 bis 3	+- 0,1
	3 6	+- 0,1
	6 30	+- 0,2
	30 120	+- 0,3
	120 400	+- 0,5
Abmaße	Symmetrie-toleranz	0,5
	Rundlauf-toleranz	0,2
	andere Größen s.Norm	

gesehen/genehmigt

Gerät
OptiCentric
Vacuum Unit

Nachbaufirma

Zeichnungs-Nr.

Allgemeintoleranzen DIN 7168 m

Oberflächen DIN ISO 1302

Maßstab 2,5 : 1

Gewicht kg

Werkstoff
Polyacetal (Delrin) black

	Datum	Name
2002		
Bearb.	06.06	Popp
Gepr.		
Norm		
Fert.		

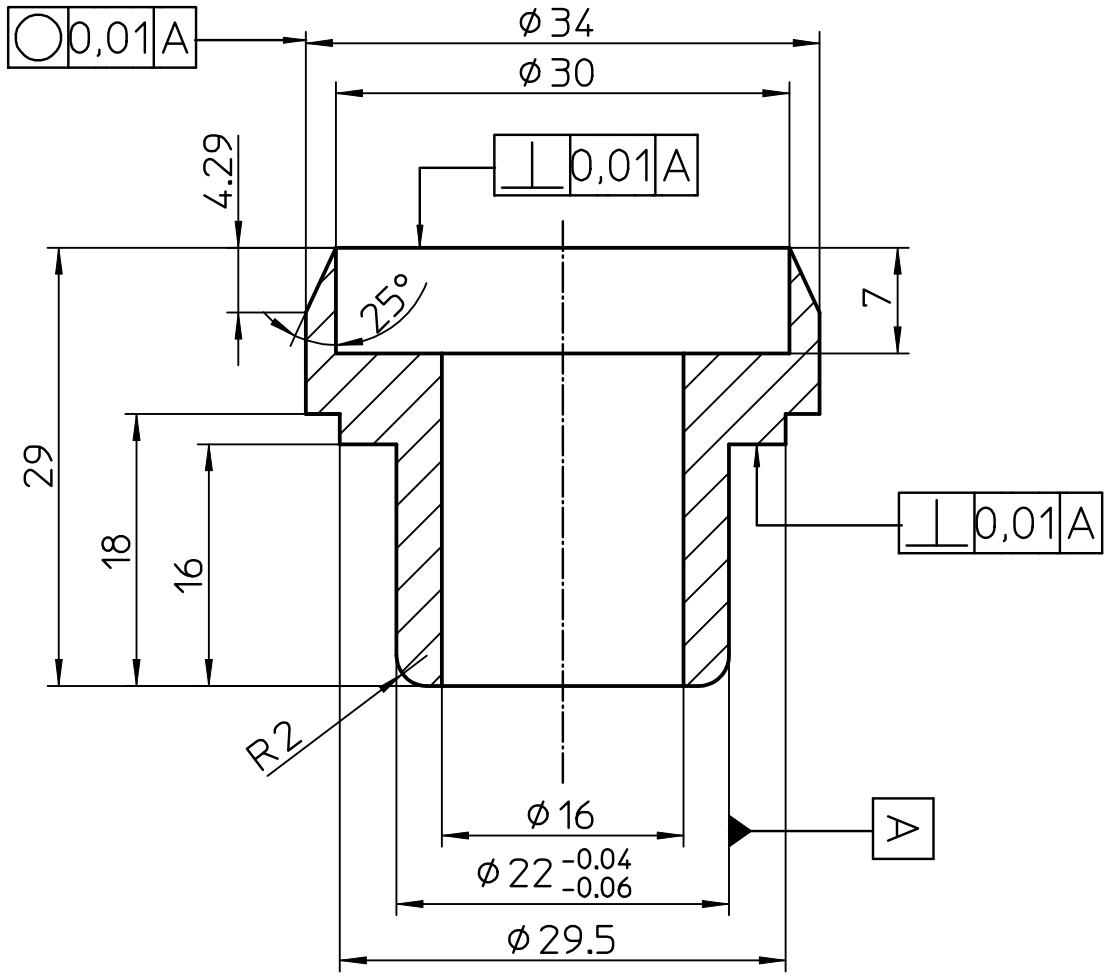
Bennenung
Ring Chuck Dia 10

TRIOPTICS GmbH

File-Name

Blatt
Bl

Zust.	Änderung	Datum	Name	Urspr.	Ers.für	Ers. durch



+0,3 +0,1

-0,3 -0,1

Allgemeintoleranzen nach DIN 7168 m B

Längenmaße	Abmaße
über 0,5 bis 3	+- 0,1
3 6	+- 0,1
6 30	+- 0,2
30 120	+- 0,3
120 400	+- 0,5
Symmetrie-toleranz	0,5
Rundlauf-toleranz	0,2
andere Größen s.Norm	

Bei Original-Formatgröße 0 100

Zust.	Änderung	Datum	Name

gesehen/genehmigt

Gerät
OptiCentric Vacuum Unit

Nachbaufirma

Zeichnungs-Nr.

Allgemeintoleranzen DIN 7168 m

Oberflächen DIN ISO 1302

	Datum	Name
2004		
Bearb.	02.03.	Popp
Gepr.		
Norm		
Fert.		

TRIOPTICS GmbH

Maßstab 2 : 1

Gewicht kg

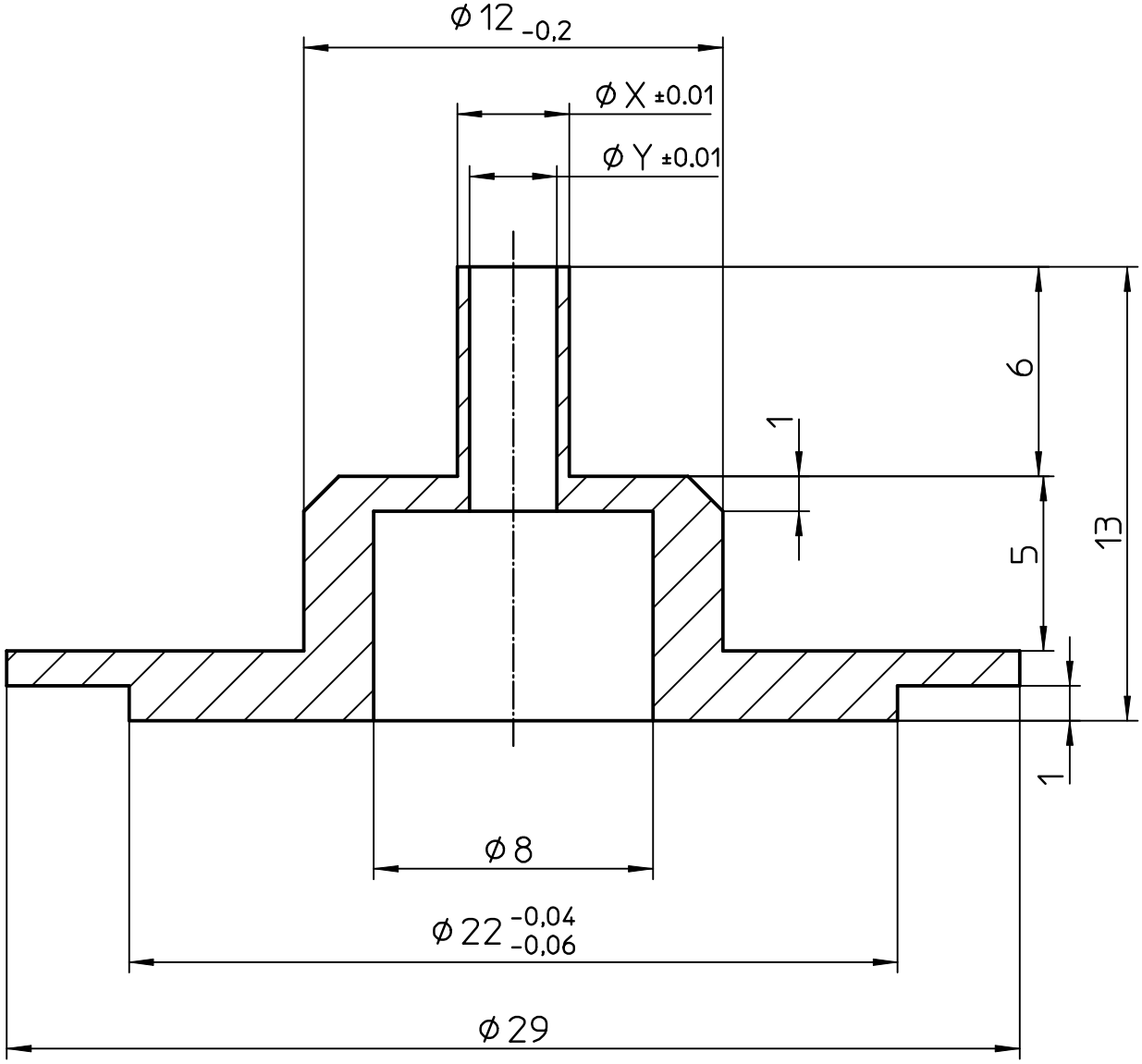
Werkstoff
Polyacetal (Delrin) black

Bennenung
Ring Chuck Dia 30

File-Name

Blatt Bl

Ursprung | Ers.für | Ers. durch



Allgemeintoleranzen nach DIN 7168 m B

Längenmaße	Abmaße
über 0,5 bis 3	+- 0,1
3 6	+- 0,1
6 30	+- 0,2
30 120	+- 0,3
120 400	+- 0,5

Symmetrie-toleranz 0,5 | Rundlauf-toleranz 0,2 | andere Größen s.Norm

gesehen/genehmigt

Nachbaufirma

Zeichnungs-Nr.

Gerät
OptiCentric Vacuum Unit

Allgemeintoleranzen DIN 7168 m

Oberflächen DIN ISO 1302

Maßstab 5 : 1

Gewicht kg

Werkstoff
Brass

	Datum	Name
2003		
Bearb.	04.12.	Popp
Gepr.		
Norm		
Fert.		

Bennenung
Special Ring chuck

TRIOPTICS GmbH

File-Name

Blatt

Bl

Zust.	Änderung	Datum	Name	Urspr.	Ers.für	Ers. durch

Bei Original-Formatgröße 0

IFA
Institute for Occupational Safety and Health
of the German Social Accident Insurance

GESTIS Substance Database

Zinc selenide

IDENTIFICATION

IDENTIFICATION

Zinc selenide

ZVG No:	109405
CAS No:	1315-09-9
EC No:	215-259-7
INDEX No:	034-002-00-8

CHARACTERISATION

SUBSTANCE GROUP CODE

134400 Zinc compounds
132100 Selenium compounds

STATE OF AGGREGATION

The substance is solid.

PROPERTIES

yellow
odourless

CHEMICAL CHARACTERISATION

Non-combustible substance.
Practically insoluble in water.
Acute or chronic health hazards result from the substance.
The substance is hazardous to the aquatic environment.

(see: chapter REGULATIONS).

Substance information in Wikipedia

FORMULA

ZnSe
SeZn
Zn^{2+} Se^{2-}

Molar mass: 144,33 g/mol

PHYSICAL AND CHEMICAL PROPERTIES

MELTING POINT

Melting point: > 1100 °C
Reference: 01219

DENSITY

DENSITY
Value: 5,42 g/cm³
Temperature: 15 °C
Reference: 01219

SOLUBILITY IN WATER

practically insoluble in water
Reference: 01219

HAZARDOUS REACTIONS

Decomposition temperature: > 400 °C

OCCUPATIONAL HEALTH AND FIRST AID

ROUTES OF EXPOSURE

Main Routes of exposure:
Intake of zinc selenide (Z) must be assumed to occur mainly via inhalation.[99999]

Respiratory tract:
Information on the kinetic characteristics of inhaled Z dusts is not available.

It must be generally considered that Z dusts, especially in case of high temperatures or humidity, tend to decompose readily when exposed to air.
The decomposition might result in the formation of strong toxic selenium compounds, particularly hydrogen selenide and selenium oxide.[99996]
Effective resorption via the respiratory tract should be assumed for these selenium compounds.[00083]
With reference to the zinc percentage a delayed resorption is to be expected.[00418]

Skin:
Studies on the skin-resorptive effects of Z are not available.[99983]
In principle, possible absorption should not be excluded, at least for the selenium proportion.[99999]

Gastrointestinal tract:
Kinetic data on gastrointestinal resorption, including animal experiments, are not available.[99983]
The possible decomposition reactions make any estimation in this regard impracticable.[99999]

TOXIC EFFECTS

Main toxic effects:
Acute effects:
Available substance-specific information is insufficient.[99983]
Chronic effects:
ditto:[99983]

Acute toxicity:
Information on the local toxic effects of Z is not found in the literature or in the findings of animal experiments.[99983]
A standard text simply refers to the general possibility of irritative effects.[07750]
A threshold concentration value of 44.5 mg/m3 was identified for rats with regard to the occurrence of toxic effects after exposure by inhalation. Data on the observed symptoms have not been reported.[07729]
Information on experiences with the occupational handling of the substance is restricted to a single study from a Z-producing company. Workers who were involved in the synthesis and cleaning of Z-crystals exhibited symptoms that corresponded to the symptoms of selenium toxicity: Headache, early fatigue, weakness, dizziness, dry sensation of the throat, vomiting, diarrhoea. These symptoms remained for approx. 7 days after termination of the exposure.
However, the observed effects were essentially ascribed to an exposure to hydrogen selenide, since the complaints mainly occurred in areas where a decomposition of Z should have been expected on technological grounds. This assumption was confirmed by relatively high concentrations of hydrogen selenide (0.11-0.77 mg/m3) in the air.
Altogether, the researchers assessed the toxicity of Z as moderate, but at the same time they referred to a hazard through the potential formation of highly toxic selenium compounds.[99996]
In this context, the pronounced lung damaging potential of hydrogen selenide and selenium oxide, which might be produced as decomposition products, should be

considered in addition to the above mentioned systemic effects.[99999]
Reports on the toxicity of Z after oral intake are not available, not even from animal experiments.
Provided that the selenium proportion characterises the active profile or that the release of H2Se is anticipated, the following toxicity image is expected: Disorders in the digestive tract, in the case of higher doses severe disorders of the CNS and the cardiovascular system as well as functional disorders of the liver, possibly also of the kidneys.[07729]

Chronic toxicity:
Experiences referring to the effects of a long-term exposure to pure Z are neither available from occupational handling nor from animal experiments.[99983]
In the workplace study from a Z-producing company mentioned before, the following long-term disorders were described in addition to the above complaints: Pain in the liver area, pain in the joints, loss of hair and chronic inflammation of the upper respiratory tract (chronic pharyngitis).
These typical symptoms correspond to the observations made after excessive selenium intake or exposure to hydrogen selenide. Here again, a causal link to the demonstrated high exposure to hydrogen selenide was considered to be paramount.
The researchers estimated a limitation of the room air concentration to a maximum of 2 mg/m3 to be sufficient to exclude a health hazard in connection with a pure Z exposure at the workplace.[99996]
However, considering the incomplete data this value cannot be regarded as established.
Independent of the potential toxicity of Z, the possible release of decomposition products with the known toxicity must be checked on a continuous basis.[99999]

Reproductive toxicity, Mutagenicity, Carcinogenicity:
For classifying the reproductive toxicity and mutagenic and carcinogenic potential see list in Annex VI of the CLP regulation or TRGS 905 or List of MAK values.
(see section REGULATIONS).
Reproductive toxicity:
Substance-specific information is not available.[99983]
The following consequences are assumed for anorganic selenium compounds:
There is no reason to fear a risk of damage to the developing embryo or foetus when MAK and BAT values are observed.
Mutagenicity:
Substance-specific data are not available.[99983]
Sodium selenide evidenced a genotoxic potential in in-vitro tests. A genotoxic potential was also evidenced for other selenium compounds, but only in the high dosage area (NOEL for the genotoxicity in vivo 0.8 mg Se per kg of body weight). It is assumed that there are protective mechanisms in the relevant low dosage area for humans that provide protection against genotoxic effects.
Carcinogenicity:
There are grounds for suspecting carcinogenic potential.
This preliminary assessment generally performed for anorganic selenium compounds is derived from animal experiments with selenium sulphide and sodium selenate, which showed carcinogenic potential only after exposure to high doses.[07619]

Biotransformation and Excretion:
Information on the metabolisation of Z is not available.[99983]
Distribution and excretion for resorbed zinc or selenium compounds, however, are for the most part known.
In the organism, resorbed zinc is found mainly in the bones, the liver, the kidneys and the blood. It is chiefly excreted with the faeces, and only to a minor extent with the urine.[07783]
Resorbed selenium is rapidly distributed in the organism and included in the general selenium metabolism, whereas it can occur in several compound forms.
The highest concentrations are reached in the liver and the kidneys. When selenium levels are normal, excretion takes place in approximately equal parts with the urine and the faeces. Excessive doses are mainly eliminated in the form of trimethylselenonium ion with urine and as dimethyl selenide with exhaled air.[00083]

Annotation:
This occupational health information was compiled on 04.03.2003.
It will be updated if necessary.
This information was translated from German into English by Übersetzungsbüro Branco.

FIRST AID

Eyes:
Rinse the affected eye with widely spread lids for 10 minutes under running water whilst protecting the unimpaired eye.
Arrange medical treatment.
[07750]

Skin:
Whilst protecting yourself, relocate the casualty away from the source of danger.
Remove contaminated clothing while protecting yourself.
Absorb dust from contaminated skin with dry cellulose (or similar material). Store all contaminated materials in closed containers.
Cleanse the affected skin areas thoroughly with soap under running water.
Arrange for medical treatment.
[07750, 99999]

Respiratory tract:
Whilst protecting yourself remove the casualty from the hazardous area and take him to the fresh air.
Lay the casualty down in a quiet place and protect him against hypothermia.
In the case of breathing difficulties have the casualty inhale oxygen.
As soon as possible repeatedly have the casualty deeply breath a glucocorticoid inhalation spray in.
If the casualty is unconscious but breathing lay him in a stable manner on his side.
Should mouth-to-mouth resuscitation be required, by all means ensure self-protection.
Arrange medical treatment.
[00160]

Swallowing:

Rinse the mouth and spit the fluids out.
If the casualty is conscious have him drink copious amounts of liquids (water).
Arrange medical treatment.
In case of spontaneous vomiting, to avoid aspiration keep the patient in a prone position with the head lower than the chest.

Information for physicians:
Information on the toxicity of zinc selenide is insufficient.[99983]
Regarding systemic effects it is assumed that the active profile is determined by the selenium proportion.[07729]
It must be considered that decomposition reactions can lead to the formation of highly toxic selenium compounds, especially hydrogen selenide and selenium dioxide.[99996]
Consequently, special attention should be paid to the typical symptoms for toxicity with selenium compounds:[99983]

Eyes: Burning sensation, lacrimation, reddening/swelling of the conjunctiva, possible lesions of the cornea.
Skin: Irritations mainly occur after extended contact.[99996]
Inhalation: Metallic taste, itching of the nose, runny nose (‘selenium cold’), possibly anosmia; sensation of thoracic compression, retrosternal pain, coughing, sore throat; development of a pulmonary oedema or severe bronchopneumonia (after intervals with only slight complaints); moreover hazard of resorptive effects (see below).
Ingestion: Resorptive effects might already occur after low doses.
Resorption: Gastrointestinal disorders (nausea, vomiting, diarrhoea), CNS disorders (dizziness, weakness, nervousness, headache); in severe cases possibly rapid cardiotoxic effects (cardiac arrhythmias), also liver damage and disorders of the kidney functions.[99983]

- First medical assistance:
Thoroughly rinse to completely remove the substance after eye contact; pain relief if needed. Then consultation with an ophthalmologist (unknown damage potential).
In order to prevent decomposition reactions (otherwise inhalation hazard), dusts should at first be removed from the skin in a dry condition. Only then thoroughly clean contaminated skin areas with soap and water. Observation of the patient.
Inhalation difficulties experienced on site require therapeutic priority:[99999]
Apply glucocorticoids (inhalation/i.v.) to prevent pulmonary oedema.[08013]
Ensure immediate physical stillness and prevent loss of heat.[08013]
The administration of oxygen is regarded as an essential preventive measure.
Pneumonia prophylaxis should soon follow.[00160]
Strict observation of the affected person.[08013] In case of ingestion of selenium compounds ensure immediate gastric irrigation (under the usual conditions) and – if required – gastroscopy as primary elimination of the poison. Further treatment depends on the symptoms.[00160]
Measures of cardiopulmonary cerebral reanimation might become required both after inhalation and after ingestion.
By all means transport of the patient to hospital is indicated, even if toxicity is only suspected. Besides the cardiovascular functions, the liver and kidney functions as well

as the pulmonary function (also in case of ingestion) must be especially monitored.
Currently an antidote cannot be recommended for Se toxicities.[08013]
Some authors refer to the antagonistic effects[08003] of vitamin E, which does not seem to be demonstrated.[08011]
Haemoperfusion probably has little effect.[00160]

Recommendations:
Provide the physician information about the substance/product and treatment already administered.
Decomposition reactions might be accompanied by the formation of the highly toxic compounds hydrogen selenide or selenium oxide.[99996]
Toxicity through selenium compounds can often be recognised by a metallic taste and a garlic-like odour. However, in some cases these symptoms are absent.[00083]
It was stated that BAL and Ca-EDTA are unsuitable for the therapy of selenium toxicities.[08011]

Annotation:
This first aid information was compiled on 04.03.2003.
It will be updated if necessary.
This information was translated from German into English by Übersetzungsbüro Branco.

SAFE HANDLING

TECHNICAL MEASURES - HANDLING

Workplace:
Provision of very good ventilation in the working area.
The floor should not have a floor drain.
Washing facility at the workplace required.
Eye bath required. These locations must be signposted
clearly.
When handling excessive amounts of the substance an emergency shower is required.

Equipment:
Use only closed apparatus.
If release of the substance cannot be prevented, then it should be suctioned off at the point of exit.
Consider emission limit values, a purification of waste gases if necessary.
Label containers and pipelines clearly.

Advice on safer handling:
Take care to maintain clean working place.
The substance must not be present at workplaces in quantities above that required for work to be progressed.
Do not leave container open.
Use leak-proof equipment with exhaust for refilling or transfer.
Avoid spillage.
Fill only into labelled container.

Avoid any contact when handling the substance.
Avoid rising dust.
Use an appropriate exterior vessel when transporting in fragile containers.

Cleaning and maintenance:
Use protective equipment while cleaning if necessary.
Avoid dust formation. Dust formation that cannot be avoided must be collected regularly.
Use a tested industrial vacuum cleaner or suction device.
Do not raise dust while cleaning.
Use of a blower for cleaning is not permitted.
Alternative: clean damp.
Only conduct maintenance and other work on or in the vessel or closed spaces after obtaining written permission.

TECHNICAL MEASURES - STORAGE

Storage:
Keep in locked storage or only make accessible to specialists or their authorised assistants.
Do not use any food containers - risk of mistake.
Containers have to be labelled clearly and permanently.
Store in the original container as much as possible.
Place fragile vessels in break-proof outer vessels.
Keep container tightly closed.
Storage temperature: Without any limitation.
Store in a dry place.
Keep container in a well-ventilated place.

Conditions of collocated storage:
Storage class 6.1 D (Not combustible, acutely toxic Cat. 3 or chronic effecting substances)
Only substances of the same storage class should be stored together.
Collocated storage with the following substances is prohibited:
- Pharmaceuticals, foods, and animal feeds including additives.
- Infectious, radioactive und explosive substances.
- Gases.
- Other explosive substances of storage class 4.1A.
- Strongly oxidizing substances of storage class 5.1A.
- Ammonium nitrate and preparations containing ammonium nitrate.
- Organic peroxides and self reactive substances.

Under certain conditions the collocated storage with the following sub-stances is permitted (For more details see TRGS 510):
- Flammable liquids of storage class 3.
- Flammable solid substances or desensitized substances of storage class 4.1B.
- Pyrophoric substances.
- Substances liberating flammable gases in contact with water.
- Oxidizing substances of storage class 5.1B.

The substance should not be stored with substances with which hazardous chemical

reactions are possible.

TECHNICAL MEASURES - FIRE AND EXPLOSION PROTECTION

Technical, constructive measures:
Substance is non-combustible. Select fire and explosion prevention measures according to the other used substances.

ORGANISATIONAL MEASURES

Instruction on the hazards and the protective measures using instruction manual (TRGS 555) are required with signature if just more than one minor hazard was detected.
Instruction must be provided before employment and then at a minimum of once per annum thereafter.
An escape and rescue plan must be prepared when the location, scale, and use of the work-site so demand.
It must be assured that the workplace limit values are being maintained. If the limit values are exceeded, additional protection measures are necessary.
The measurements must be recorded and kept on file.
The number of employees who work with the hazardous substance must be kept to a minimum.
Observe the restrictions on juvenile employment as defined in the "Jugendarbeitsschutzgesetz".
Observe the restrictions on activities of pregnant women according to the the „Mutterschutzgesetz“ (German Maternity Protection Act)
Only employees are permitted to enter the work areas. Signposting to this effect must be displayed.

PERSONAL PROTECTION

Body protection:
Depending on the risk, wear a tight protective clothing or a suitable chemical protection suit.

Respiratory protection:
In an emergency (e.g.: unintentional release of the substance, exceeding the occupational exposure limit value) respiratory protection must be worn. Consider the maximum period for wear.
Respiratory protection: Particle filter P3, colour code white.
Use insulating device for concentrations above the usage limits for filter devices, for oxygen concentrations below 17% volume, or in circumstances which are unclear.

Eye protection:
Sufficient eye protection should be worn.
Wear glasses with side protection.

Hand protection:
Use protective gloves. The glove material must be sufficiently impermeable and

resistant to the substance. Check the tightness before wear. Gloves should be well cleaned before being removed, then stored in a well ventilated location. Pay attention to skin care.
Skin protection cremes do not protect sufficiently against the substance.
Currently there is no information available regading suitable glove materials.
Experience says that polychloroprene, nitrile rubber, butyl rubber, fluoro-caoutchouc, and polyvinyl chloride are suitable as glove materials for protection against un-dissolved solids.

Occupational hygiene:
Foods, beverages and other articles of consumption must not be consumed at the work areas. Suitable areas are to be designated for these purposes.
Avoid inhalation of dust.
Avoid contact with clothing. Contaminated clothes must be exchanged and cleaned carefully.
Before a break it might be necessary to change clothes.
Provide washrooms with showers and if possible rooms with separate storage for street clothing and work clothing.
The skin must be washed with soap and water before breaks and at the end of work.
Apply fatty skin-care products after washing.

DISPOSAL CONSIDERATIONS

Hazardous waste according to Waste Catalogue Ordinance (AVV).
If there is no way of recycling it must be disposed of in compliance with the respective national and local regulations.

Collection of small amounts of substance:
Collect in container for toxic, inorganic residues and heavy metal salts and their solutions.
Collection vessels must be clearly labelled with a systematic description of their contents. Store the vessels in a well-ventilated location. Entrust them to the appropriate authorities for disposal.

ACCIDENTAL RELEASE MEASURES

Evacuate area. Warn affected surroundings.
The hazardous area may only be entered once suitable protective measures are implemented. Only then can the hazardous situation be removed.
Wear respiratory protection, eye protection, hand protection and body protection (see chapter Personal Protection).
Pick up without creating dust.
Afterwards ventilate area and wash spill site.

Endangerment of watert:
Severe hazard to waters. Avoid penetration into water, drainage, sewer, or the ground.
Inform the responsible authorities about penetration of even small quantities.

FIRE FIGHTING MEASURES

Instructions:
Substance is incombustible. Select fire fighting measures according to the surrounding conditions.

Special protective equipment:
In the case of inclusion in an ambient fire hazardous substances can be released.
Selenium dioxide
Metal oxide fume
Wear self-contained breathing apparatus and special tightly sealed suit.

REGULATIONS

Classification:
Acute toxicity, Category 3, oral; H301
Acute toxicity, Category 3, inhalation; H331
Specific Target Organ Toxicity (repeated exposure), Category 2; H373
Hazardous to the aquatic environment, Acute Category 1; H400
Hazardous to the aquatic environment, Chronic Category 1; H410

Signal Word: "Danger"

Hazard Statement - H-phrases:
H301: Toxic if swallowed.
H331: Toxic if inhaled.
H373: May cause damage to organs through prolonged or repeated exposure.
H410: Very toxic to aquatic life with long lasting effects.

Precautionary Statement - P-phrases:
P261: Avoid breathing dust.
P273: Avoid release to the environment.
P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P311: Call a POISON CENTER or doctor.
P501: Dispose of contents/ container to an approved waste disposal plant.

Manufacturer's specification by Sigma-Aldrich Group

Reference: 01221
State: 2015
Checked: 2015

The substance is listed in appendix VI, table 3.1 of CLP regulation.

The given classification can deviate from the listed classification, since this classification is to be complemented concerning missing or divergent danger classes and categories for the respective substance.

Reference: 99999

GHS-CLASSIFICATION OF MIXTURES

The classification of mixtures containing this substance results from Annex 1 of Regulation (EC) 1272/2008.

Reference: 07501

WORKPLACE LABELLING ACCORDING TO GERMAN ASR A1.3

Prohibition label:

No Smoking

No admittance for unauthorized persons

No eating and drinking

Warning label:

Caution - toxic material

Precept label:

Use safety goggles

Wear safety gloves

GERMAN WATER HAZARD CLASS

WGK 3 - severe hazard to waters
Manufacturer's specification by Sigma-Aldrich Group

TECHNICAL INSTRUCTIONS ON AIR QUALITY CONTROL (TA LUFT)

Chapter 5.2.2 Inorganic dusts
Class II
Also with the presence of several substances of the same class, the following values are in all not allowed to be exceeded in the exhaust gas:

Mass flow: 2,5 g/hr

or

Mass conc.: 0,5 mg/m³

Specified as Se.

TRANSPORT REGULATIONS

UN Number: 3283
Shipping name: Selenium compound, solid, n.o.s.
Hazard Identification Number: 60
Class: 6.1 (Toxic Substances)
Packing Group: II (medium danger)
Danger Label: 6.1

Special labelling: Symbol (fish and tree)

Tunnel restrictions:
Transports in bulk or in tanks: passage forbidden through tunnels of category D and E.
Other transports: passage forbidden through tunnels of category E.

Reference: 01221

TRGS 900 - GERMAN OCCUPATIONAL EXPOSURE LIMIT VALUES

0,05 mg/m³
with reference to the inhalable fraction

Peak limitation: Excursion factor 1

Duration 15 min, mean; 4 times per shift; interval 1 hour
Category II - Substances with systemic effects

There is no reason to fear a risk of damage to the developing embryo or foetus when AGW and BGW are adhered to.

Source: DFG

Scope:
Selenium compounds, inorganic

calculated as Selenium

RECOMMENDATIONS OF MAK-COMMISSIONRECOMMENDATIONS OF MAK-COMMISSION

This data is recommended by scientific experience and is not established law.

0,1 mg/m³
with reference to the alveolar fraction

Peak limitation: Excursion factor 4

Duration 15 min, mean; 4 times per shift; interval 1 hour
Category I - Substances for which local irritant effects determine the exposure limit value, also respiratory allegens

Pregnancy: Group C
There is no reason to fear a risk of damage to the developing embryo or foetus when MAK and BAT values are adhered to.

Zinc and inorganic zinc compounds

2 mg/m³
with reference to the inhalable fraction

Peak limitation: Excursion factor 2

Duration 15 min, mean; 4 times per shift; interval 1 hour
Category I - Substances for which local irritant effects determine the exposure limit value, also respiratory allegens

Pregnancy: Group C
There is no reason to fear a risk of damage to the developing embryo or foetus when MAK and BAT values are adhered to.

Zinc and inorganic zinc compounds

This data is recommended by scientific experience and is not established law.

0,02 mg/m³
with reference to the inhalable fraction

Peak limitation: Excursion factor 8
Duration 15 min, mean; 4 times per shift; interval 1 hour
Category II - Substances with systemic effects

Risk of percutaneous absorption

Carcinogenic: Category 3B
Substances which are proved/possibly carcinogenic and therefore give reason for concern. There are clues for carcinogenic effects which however are not enough for allocation into a different category. In case there are no genetically toxical effects a MAK-value can be defined.

Pregnancy: Group C
There is no reason to fear a risk of damage to the developing embryo or foetus when MAK and BAT values are adhered to.

Selenium compounds, inorganic

GERMAN BIOLOGICAL EXPOSURE INDICES

Parameter:	Selenium
Value:	150 µg/l
Assay material:	Serum
Sampling time:	not fixed
Reference:	08106

SEVESO III - Directive

Annex I Part 1 Section: H2
Acute toxic, Category 2 (all exposure routes) or Category 3 (inhalation exposure route) or Category 3 (oral route if neither acute inhalation toxicity classification nor acute dermal toxicity classification can be derived)
Qualifying quantity for the application of
Lower-tier requirements: 50 t
Upper-tier requirements: 200 t

Annex I Part 1 Section: E1
Hazardous to the aquatic environment, Category Acute 1 or Chronic 1
Qualifying quantity for the application of
Lower-tier requirements: 100 t
Upper-tier requirements: 200 t

RESTRICTIONS OF USE / BANS OF USE

Ordinance on Prohibitions of Use of Plant Protection Products

Attachment 1 for §§ 1 and 5
Plant protection products that consist of or contain the substance must not be utilised. Seed stock that is covered with or contains a plant protection product which consists of the substance or contains it must not be imported.
Information on exceptions can be taken from the Ordinance on Prohibitions of Use of Plant Protection Products.

FURTHER REGULATIONS

TRGS 200
Einstufung und Kennzeichnung von Stoffen, Zubereitungen und Erzeugnissen; Ausgabe Oktober 2011

TRGS 201
Einstufung und Kennzeichnung bei Tätigkeiten mit Gefahrstoffen; Ausgabe Februar 2017

TRGS 400
Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen; Ausgabe Dezember 2010; geändert und ergänzt September 2012

TRGS 555
Betriebsanweisung und Information der Beschäftigten; Ausgabe Februar 2017

TRGS 600
Substitution; Ausgabe August 2008

TRGS 402
Ermitteln und Beurteilen der Gefährdungen bei Tätigkeiten mit Gefahrstoffen: Inhalative Exposition; Ausgabe Januar 2010, zuletzt geändert und ergänzt Oktober 2016

TRGS 401
Gefährdung durch Hautkontakt, Ermittlung - Beurteilung - Maßnahmen; Ausgabe Juni 2008; zuletzt berichtigt März 2011

TRGS 500
Schutzmaßnahmen; Ausgabe Januar 2008, ergänzt Mai 2008

TRGS 509
Lagern von flüssigen und festen Gefahrstoffen in ortsfesten Behältern sowie Füll- und Entleerstellen für ortsbewegliche Behälter; Ausgabe September 2014, zuletzt berichtigt, geändert und ergänzt April 2017

TRGS 510
Lagerung von Gefahrstoffen in ortsbeweglichen Behältern; Ausgabe Januar 2013, geändert und ergänzt November 2014, berichtigt November 2015

LINKS

International Limit Values

REFERENCES

Reference: 00001
IFA: Erfassungs- und Pflegehandbuch der GESTIS-Stoffdatenbank (nicht öffentlich)
Data acquisition and maintenance manual of the GESTIS substance database (non-public)

Reference: 00083
Environmental Health Criteria (Serie), WHO, Genf

Reference: 00160
Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin (BgVV): Informationskartei für die Erkennung und Behandlung von Vergiftungen
(Federal Institute for Health Protection of Consumers and Veterinary Medicine: Information index for the detection and treatment of poisoning)

Reference: 00418
HSDB-Datenbankrecherche 2002

Reference: 01219
Archiviertes Sicherheitsdatenblatt (archived Material Safety Data Sheet), Merck

Reference: 01221
GHS-Sicherheitsdatenblatt (GHS Material Safety Data Sheet), Sigma-Aldrich

Reference: 01241
GHS-Sicherheitsdatenblatt (GHS Material Safety Data Sheet), Acros

Reference: 01251
GHS-Sicherheitsdatenblatt (GHS Material Safety Data Sheet), Alfa Aesar

Reference: 05300
TRGS 510 "Lagerung von Gefahrstoffen in ortsbeweglichen Behältern" Ausgabe Januar 2013, in der Fassung vom 30.11.2015

Reference: 05350
TRGS 900 "Arbeitsplatzgrenzwerte" Ausgabe Januar 2006, zuletzt geändert und ergänzt Juni 2017

Reference: 07501
Verordnung (EG) Nr. 790/2009 der Kommission vom 10. August 2009 zur Änderung der Verordnung (EG) Nr. 1272/2008 des Europäischen Parlaments und des Rates über die Einstufung, Kennzeichnung und Verpackung von Stoffen und Gemischen zwecks

Anpassung an den technischen und wissenschaftlichen Fortschritt
(EG-GHS-Verordnung, 1. Änderung)

Reference: 07619
DFG: Toxikologisch-arbeitsmedizinische Begründungen von MAK-Werten; Verlag Chemie

Reference: 07729
Chemisch-toxikologische Schadstoffkartei, Akademie der Wissenschaften, Leipzig

Reference: 07750
R. E. Lenga "The Sigma-Aldrich Library of Chemical Safety Data" 2nd edition, Sigma-Aldrich, Milwaukee 1988

Reference: 07783
E. Merian (Edt.): Metals and their Compounds in the Environment; VCH Verlagsgellschaft mbH, Weinheim 1991

Reference: 08003
W. Forth, D. Henschler, W. Rummel, K. Starke "Allgemeine und spezielle Pharmakologie und Toxikologie" 7. Aufl.; Spektrum Akademischer Verlag GmbH, Heidelberg 1996

Reference: 08011
M.J. Ellenhorn: Ellenhorn's Medical Toxicology, Diagnosis and Treatment of Human Poisoning; Williams & Wilkins, Baltimore Maryland 1997

Reference: 08013
Ludewig "Akute Vergiftungen" 9. Auflage, Wissenschaftliche Verlagsgesellschaft, Stuttgart 1999

Reference: 08106
DFG Deutsche Forschungsgemeinschaft: MAK- und BAT-Werte-Liste 2017, Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe, Mitteilung 53; WILEY-VCH

Reference: 99983
Literaturlisten - Standardwerke, erweitert (Bibliographical reference - standard works, extended)

Reference: 99996
Projektgebundene Literaturliste Nr. 2 (Project related bibliographical reference No 2)

Reference: 99999
Angabe des Bearbeiters (Indication of the editor)

EC-Declaration of Conformity

in accordance with the EC-Directive 2006/42/EG (Machinery Directive) of 17 May 2006

Manufacturer

TRIOPTICS GmbH
Hafenstraße 35-39
22880 Wedel
Germany

CE authorised person

Hans Martin Evers
TRIOPTICS GmbH
Hafenstraße 35-39
22880 Wedel
Germany

Description and identification of the machinery

Product / Article	OptiCentric®
Type	100 MWIR; 100 LWIR; 3D 100 MWIR; 3D 100 LWIR
Serial number	04-112-xxxx 04-151-xxxx
Project number	PRJ-4-112-4-151-2017-07-11-0001
Commercial name	OptiCentric® 100 IR OptiCentric® 3D 100 IR

It is expressly declared that the machinery fulfills all relevant provisions of the following EU Directives.

2006/42/EG	Machinery Directive (MD)
2014/30/EU	Electromagnetic Compatibility Directive (EMC)

Reference to the used harmonised standards

EN 349:1993+A1:2008; EN 614-1:2006+A1:2009; EN 894-1:1997+A1:2008; EN ISO 4414:2010; EN ISO 12100:2010; EN ISO 13849-1:2015; EN ISO 13849-2:2012; EN ISO 13850:2015; EN ISO 13855:2010; EN ISO 13857:2008; DIN EN 14120:2010; EN 60204:2006/AC:2010; DIN EN 60825-1:2014; DIN EN 61010-1:2010; EN 61326-1:2006

Wedel, 01.09.2017
Place, Date

Dr. Stefan Krey
General Manager

Hans Martin Evers
CE authorised person

TRIOPTICS

TRIOPTICS GmbH·Optische Instrumente·Strandbaddamm 6·D-22880 Wedel / Germany
Phone: +49-4103 - 18006 - 0·Fax:+49-4103 - 18006 - 20
Email:info@trioptics.com·http://www.trioptics.com

97-070-002