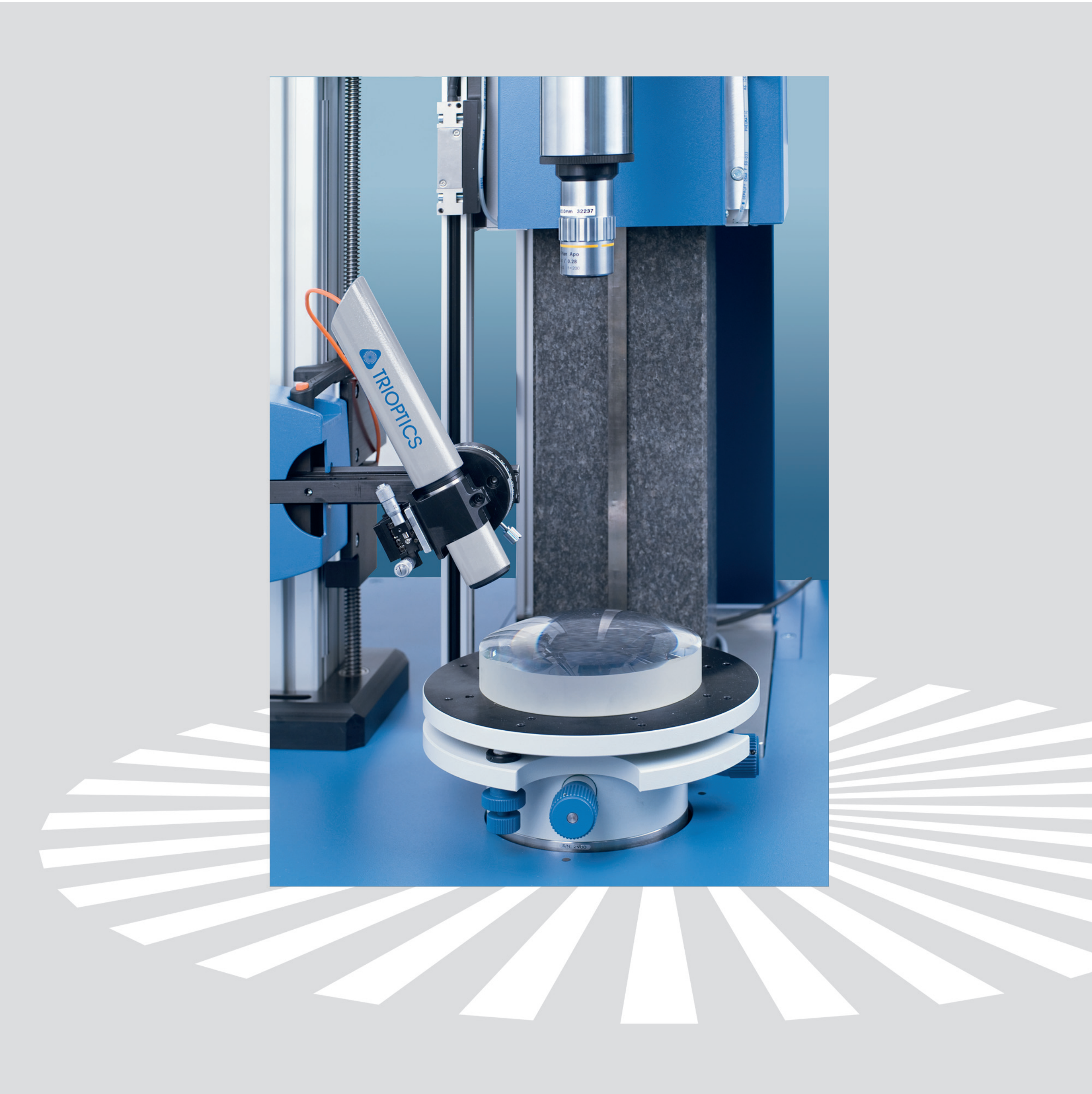
Quickstart Manual

AspheroCheck®



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Contents

1. Introduction

1.1 AspheroCheck for OptiCentric® systems

The AspheroCheck module is available as an upgrade for OptiCentric® systems with an air bearing.

NOTE

The AspheroCheck module is available to two versions with different length linear stages.

The standard module is operated manually. A motorized version is available upon request.

The following parameters of aspheric lenses can be measured:

- Shift and tilt of the aspherical axis in relation to the reference axis of rotation
- Shift and tilt of the aspherical axis in relation to the optical axis of the lens
- Shift and angle between both aspherical axes (in the case of lenses with two aspheric surfaces)

1.2 Notes

The AspheroCheck module can be used exclusively to measure surfaces rotationally symmetrical to the Z-axis.

The basic concepts and mathematical relationships are described in DIN ISO 10110-12.

The aspheric surface is described by the following equation:

$$p = \frac{1}{R_0} \cdot \frac{h^2}{1 + \sqrt{1 - (c+1)\frac{h^2}{R_0^2}}} + A_1 \cdot h^1 + A_2 \cdot h^2 + A_3 \cdot h^3 + \cdots$$

c: conic constant

h: abscissa

R_0: paraxial radius of curvature

A_i: asphere coefficients

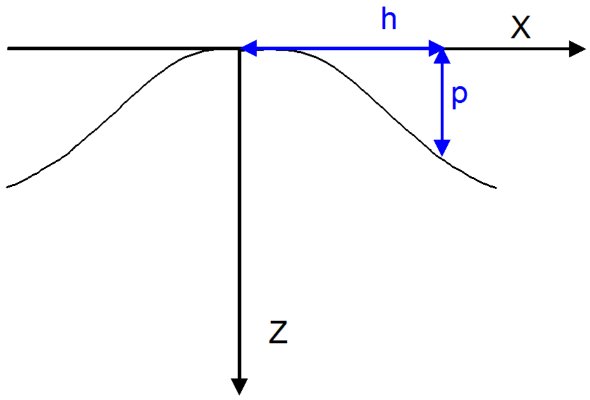


Fig. 1-1

1.3 Documentation

This documentation describes operation of the AspheroCheck module and the additional software functions.

The documentation supplied separately (operator's manual and software description for OptiCentric®) contains all information necessary for the safe operation of the measurement system and for use of the accompanying software.

Read this brief operator's manual and the accompanying documentation 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 (see page 3) for additional information.

2. Design and Function

This chapter describes the design of the measurement system and its basic functions.

> **NOTE**
>
> The configuration of your measurement system may differ from the one described here.

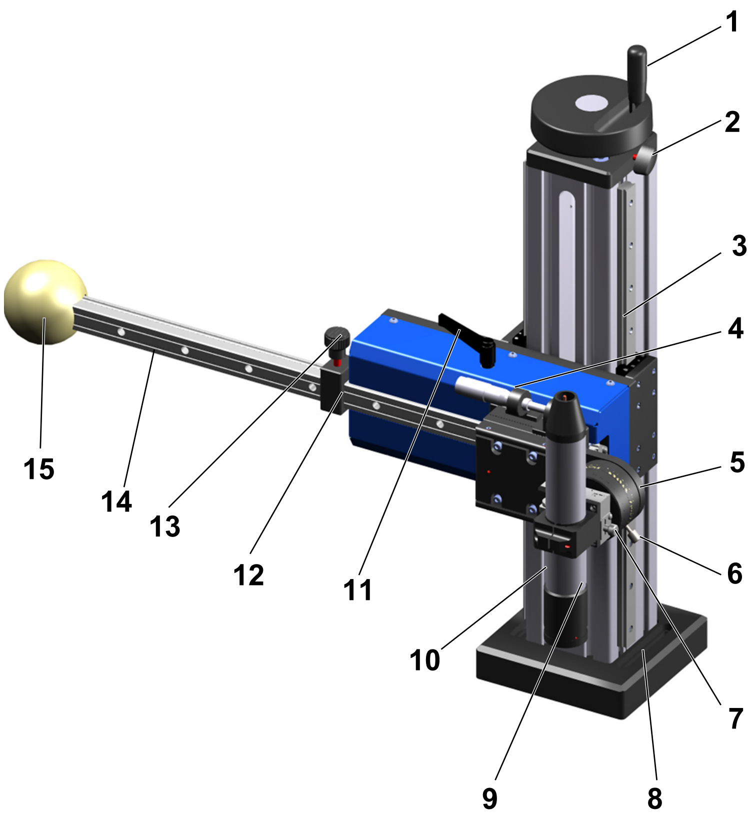


Fig. 2-1

1	Manual height adjustment
2	Locking screw for height adjustment
3	Z-axis linear stage
4	Micrometer screw for adjusting the sensor in the X direction
5	Rotary table for adjusting the sensor's setting angle
6	Locking screw for rotary table
7	Lock for rotary table

8	Slotted holes for aligning the AspheroCheck module on the table
9	Distance sensor (chromatic sensor)
10	Micrometer screw for adjusting the sensor (not visible)
11	Clamping lever for linear stage
12	Sliding end-stop
13	Locking screw for end-stop
14	X-axis linear stage
15	Ball to protection against injury

2.1 Measurement principle

The OptiCentric software can be used to accurately determine shift and slope of an aspheric axis in the X and Y direction.

This measurement requires a OptiCentric® measurement system with air bearing and an AspheroCheck® module. This module has a high-precision distance sensor.

During the measurement the sensor is moved close to the outer edge of the lens to be examined. The sensor is adjusted to be perpendicular to the sample surface. While the sample rotates, the runout of the surface is measured without touching the sample.

At the same time, the autocollimator determines the centration error of this surface in the paraxial area (MultiLens measurement).

Both values are then combined to determine the position and the slope of the aspherical axis.

3. Installation and Initial Startup

3.1 Transport

NOTE

Please note the documentation provided separately (OptiCentric® operator's manual and software description)

3.2 Storage

– If the AspheroCheck module is to be stored prior to installation, store it in a dry and dust-free environment at 15°C to 32°C.
– If the AspheroCheck module is stored without packaging, cover it with the supplied dust protection sheet.

3.3 Mounting the AspheroCheck module

Required tools

- Allen key (hex) size 5 mm
- Allen key (hex) size 3 mm
- Allen key (hex) size 2 mm

1. Place the AspheroCheck module on the left side of the base plate of the OptiCentric®.

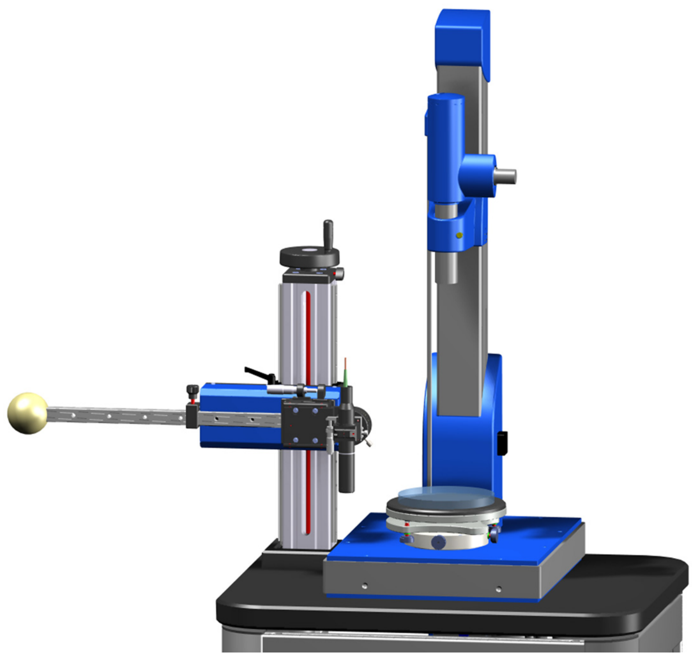


Fig. 3-1

2. Insert and screw in the four screws **1**.

NOTE!

The screws of the AspheroCheck module should only be fully tightened after it has been adjusted.

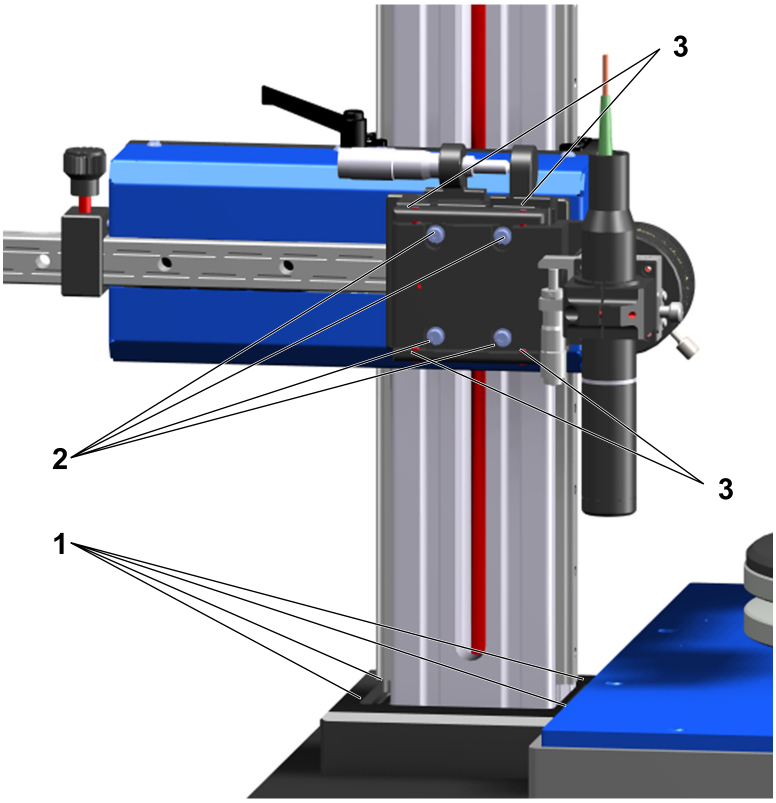


Fig. 3-2

3. Loosen the thumb screw **5** on the chromatic sensor and set the scale to "0".

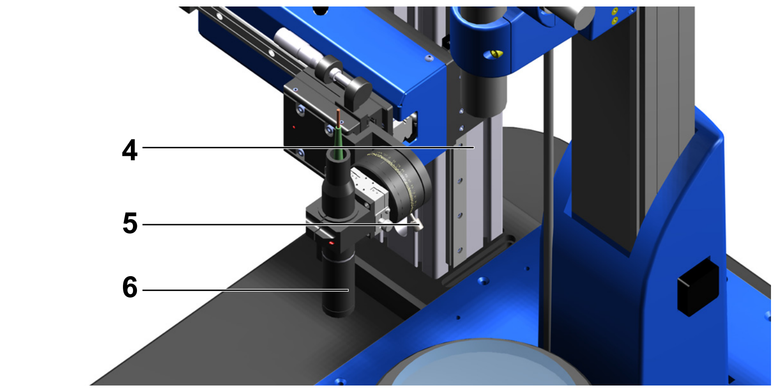


Fig. 3-3

4. Re-tighten the thumb screw.
5. Visually check whether the chromatic sensor **6** is parallel to the column **4** of the AspheroCheck module.

If not, follow these steps:

– Loosen the four screws **2**.

– Turn the set screws **3** to adjust the inclination of the chromatic sensor.

– When the chromatic sensor is parallel to the column of the AspheroCheck module, retighten the four screws **2**.

3.4 Centering the chromatic sensor

This chapter describes how to accurately align the chromatic sensor with the axis of rotation of the tip-tilt table.

Required material

- Paper with a drawn cross
- Adhesive tape

Selecting the tip-tilt table

1. Perform the preparations as described in the section "General Information on Operation of the Measurement System" of the separate OptiCentric® operator's manual and software description.
2. Screw on any head lens or rotate the lens changer accordingly.
3. Place the paper with the drawn cross on the tip-tilt table.

   The cross should be placed directly in the center of the table.

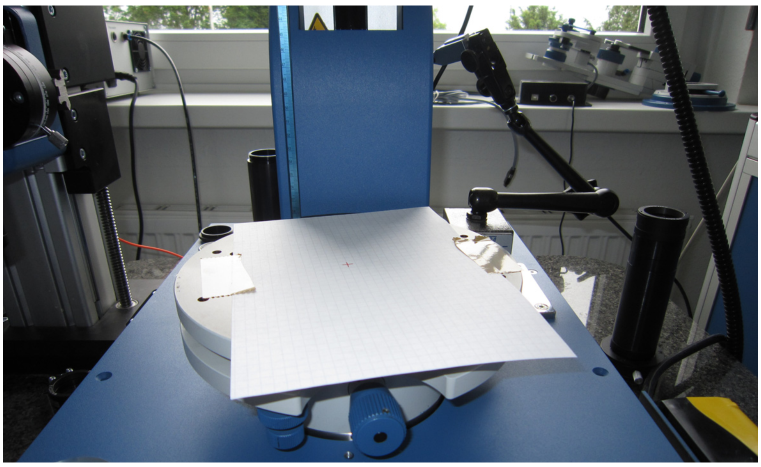
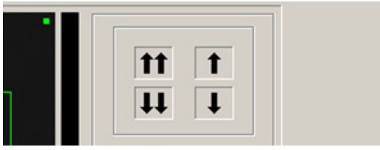


Fig.3-4



4. Use the arrow keys to move the autocollimator until the crosshair can be seen clearly on the paper.
5. Move the paper until the crosshair and the marking lie directly on top of one another.
6. Use the adhesive tape to fix the paper on the tip-tilt table.
7. Select `<Tools> <Airbearing Rotation Control>`.

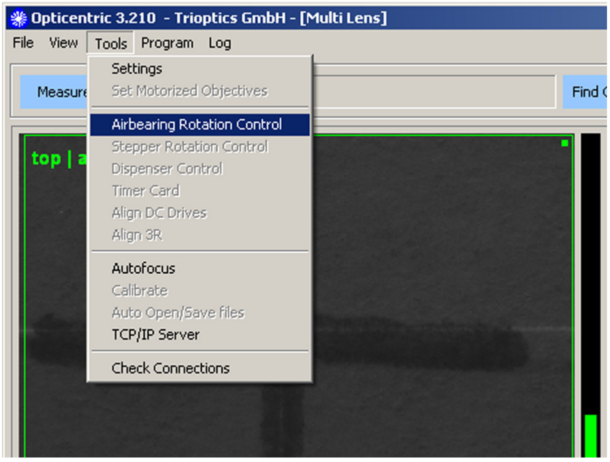


Fig.3-5

8. For easier orientation within camera image, move the "Airbearing Rotation Control" window so that the corner is located within the intersection point (see Fig.3-6).

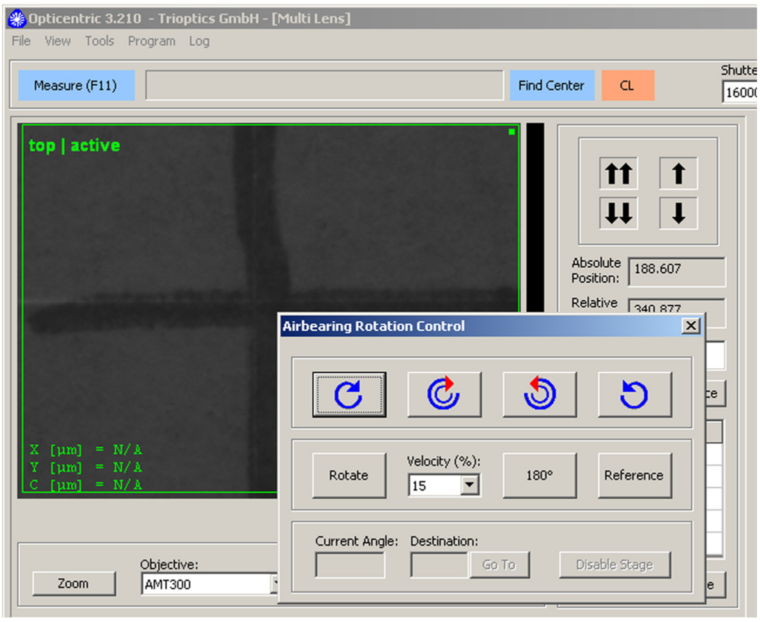


Fig.3-6

9. Click the `180°` button.

   The tip-tilt table rotates by 180°.

The intersection point should still be in the same position in the camera image after that (see Fig.3-6).

Otherwise:

– Turn the adjustment screws of the tip-tilt table to move the marking.

– Turn the tip-tilt table once more and check again.

Aligning the sensor

1. Loosen the thumb screw **1** on the chromatic sensor and set the scale to "0".

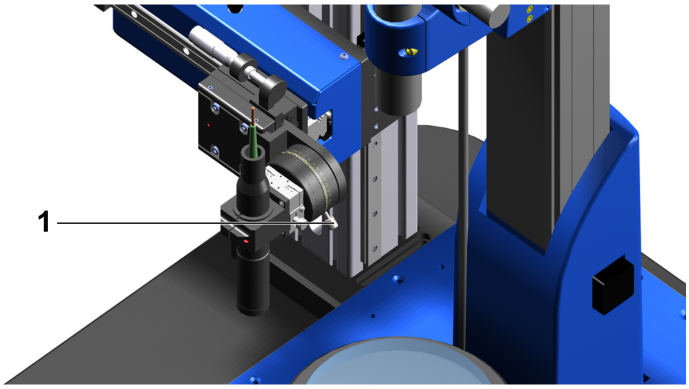


Fig. 3-7

2. Re-tighten the thumb screw.
3. Loosen the clamping lever **2**.
4. Loosen the thumb scew **3** of the adjustable stop.

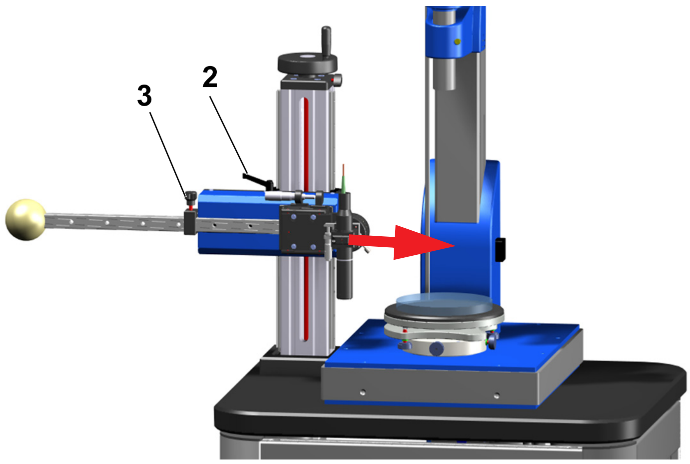


Fig. 3-8

5. Move the chromatic sensor in the guidance until it has approximately reached the axis of rotation.

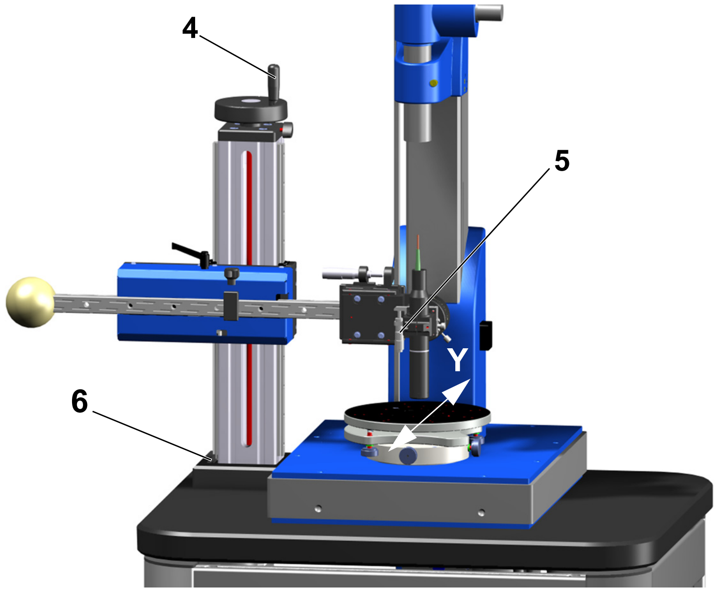


Fig. 3-9

6. Adjust the height of the chromatic sensor until the focus point is visible on the paper.
   - Coarse adjustment via crank **4**
   - Fine adjustment via screw **5**
7. Check whether the focus point can be positioned on the cross.

   If a deviation is observed in the Y direction:
   - Loosen the four screws **6**.
   - Move the entire AspheroCheck module on the base plate until the focus point is located on the cross in Y-direction.
   - Retighten the four screws.
8. Push the chromatic sensor back.
9. Remove the paper with the marking.

3.5 Calibrate sensor azimuth alignment

Required tools

- Plane-parallel plate

1. Place the plane-parallel plate on the tip-tilt table.
2. Unscrew and remove the head lens or turn the lens turret accordingly.
3. Log in as Supervisor.
4. Select <Program> <Centering in Reflexion>.

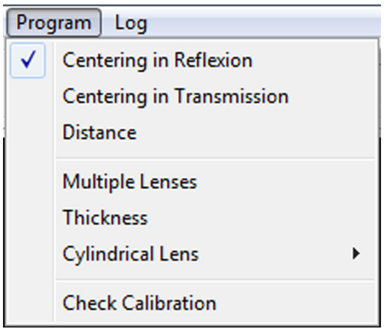


Fig.3-10

5. Under Unit select [sec] (seconds).
6. Check the box next to Wobble.
7. Under Objective select None.

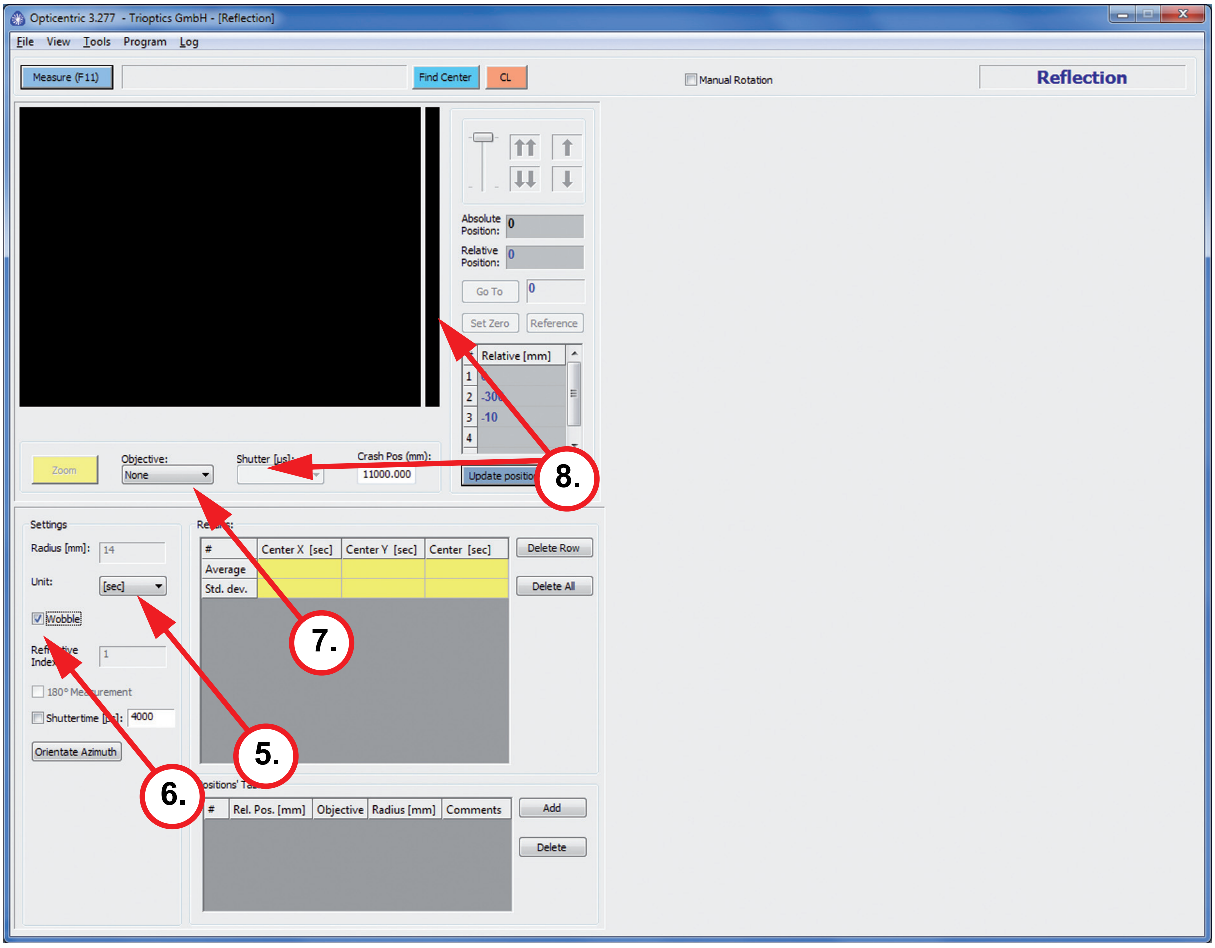


Fig.3-11

8. Check the intensity of illumination and adjust the shutter, if required.
9. Right-click in the camera window and tick the checkmark for `Display circle Points`, `Display live values` and `Display vector` (see Fig.3-12).

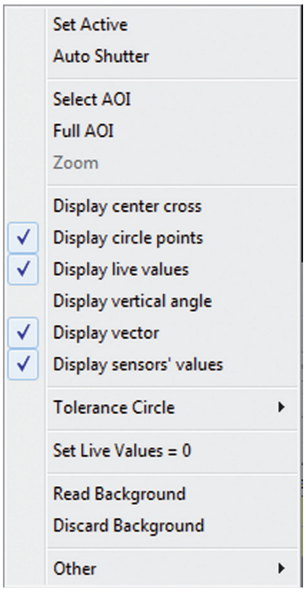


Fig.3-12

10.Click `Find Center`.

11.Verify that the area of interest (AOI) is above the center.

If the area of interest is not correct, right-click on the camera window, click on `Select AOI` and enlarge the area of interest using the cursor.

12.Click `Measure` to start the measurement.

The tip-tilt table rotates and the measurement points are recorded.

13.To adjust the inclination of the tip-tilt table, **carefully** turn the adjustment screws.

- Turn on live values
- The tilt in the X-direction is supposed to be large, e.g. 100 µm
- The tilt in the Y-direction is supposed to be as small as possible, approaching "0"

NOTE!

It is recommended to tilt the image of the reticle on the left side of the circle.

14.Set the scale on the chromatic sensor to "0".

15.Loosen the clamping lever **2**.

16.Loosen the thumb screw **1** of the adjustable stop.

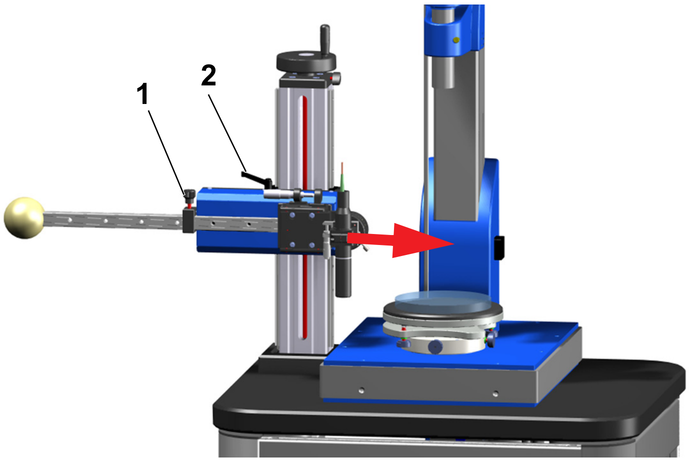


Fig. 3-13

17.Move the chromatic sensor in the guidance close to the edge of the plane-parallel plate.

18.Turn on the control unit for the chromatic sensor.

Fig. 3-14

19.Adjust the height of the chromatic sensor until it receives a signal.

– Coarse adjustment via crank **3**

– Fine adjustment via screw **4**

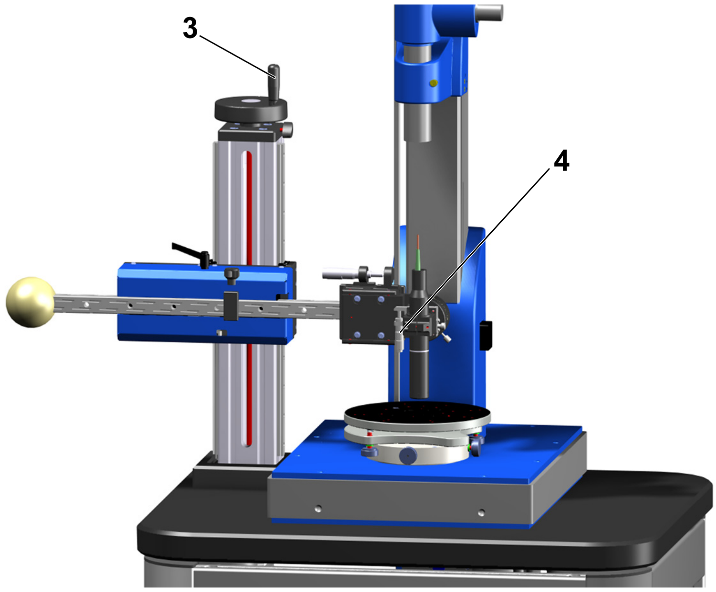


Fig. 3-15

20.Select `<View> <Display Signal of Distance Sensor>`.

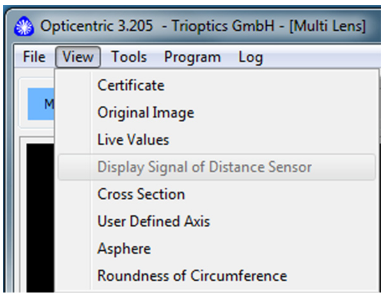


Fig.3-16

21.Click **Find Center**.

The tip-tilt table revolves once. The monitor displays a sine curve.

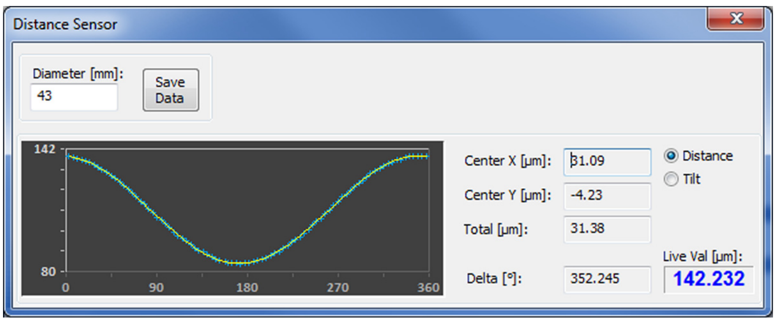


Fig.3-17

If the displayed sine curve is truncated, proceed as follows:

– Adjust the height of the sensor.

– Click **Find Center** again.

Or:

- Move the sensor closer to the axis of rotation. This will reduce the amplitude of the sine curve.
- Click **Find Center** again.

22. Once a full sine curve is displayed, read the phase from the field delta [°].
23. Select `<Tools> <Sensor>`; `Optical Sensor` tab.
24. Enter the reading with the same sign in the field **Phase [degree]**.

3.6 Adjust control unit shutter rate

1. Turn on the control unit for the chromatic sensor.

Fig. 3-18

2. Use the distance sensor to focus the surface of the sample.
3. Observe the control unit's display. The intensity should be between 3 and 99.

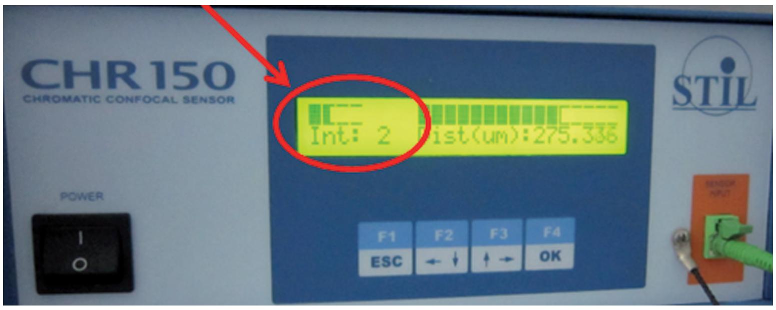


Fig. 3-19

If the signal is too weak or if there is no signal, the shutter rate must be reduced.

NOTE!

Shutter rate = 1/shutter time

A lower shutter rate means a stronger signal.

Follow these steps:

4. Press the **F3** key.

   This menu appears:

Fig. 3-20

5. Press the **F3** key again.

   The current shutter rate is displayed.

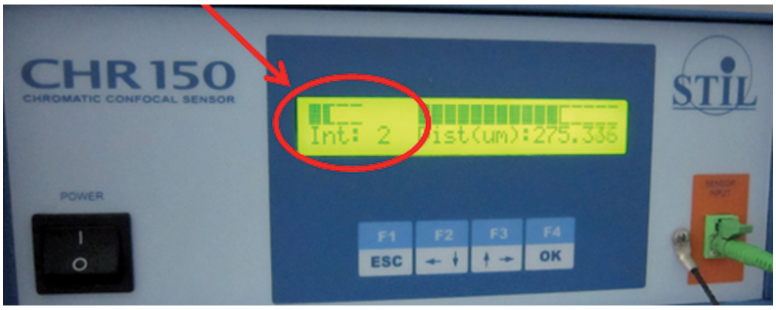


Fig. 3-21

   – To reduce the shutter rate, press the **F2** key.

   – To increase the shutter rate, press the **F3** key.

   – Press **F4** to apply the setting and close the menu.

6. Continue with the measurement.

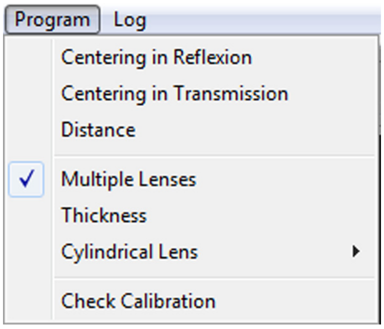
4. Measuring an Asphere

This chapter describes how to measure shift and tilt of an aspherical axis to a given reference axis.

4.1 Requirements

- The measurement system must be switched on (see separate OptiCentric® operator's manual and software description).
- The distance sensor must be centered (see chapter 3.4, page 13).
- The phase must be determined and entered (see chapter 3.5, page 17).
- The control unit shutter rate must be set correctly (see chapter 3.6, page 22).

4.2 Preparation



1. Log in as Supervisor.
2. Select `<Program> <Multiple Lenses>` (Measurement mode "Centration error of multi-lens systems").

4.3 Create and save design file

First the design data for the lens in the paraxial range must be entered.

1. Create a design table as described in the section "Preparation for a MultiLens® measurement" of the separate OptiCentric® operator's manual and software description.

#	Shutter [µs]	Seq.	Meas. Type	Relative pos [mm]	Objective
1	4000	2	m	61.22	AMT300
2	4000	1	m	94.56	AMT300

Fig. 4-1: Design data for a sample

NOTE

The design file must not contain more than two surfaces!

- If shift and tilt of the aspherical axis are to be determined in relation to the axis of rotation, only the data of the **top surface** need to be entered.
- If shift and tilt of the aspherical axis are to be determined in relation to the optical axis of the lens, the data of **both surfaces** must be entered.

– Save the data as described in the section "Saving the design table" of the separate OptiCentric® operator's manual and software description.

4.4 Enter asphere parameters

NOTE

You can find the asphere parameters in the technical drawing or the optical design program.

1. Click the `Surface 1` button.

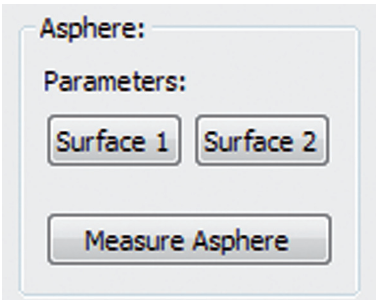


Fig. 4-2

The input window for the asphere surface parameters appears.

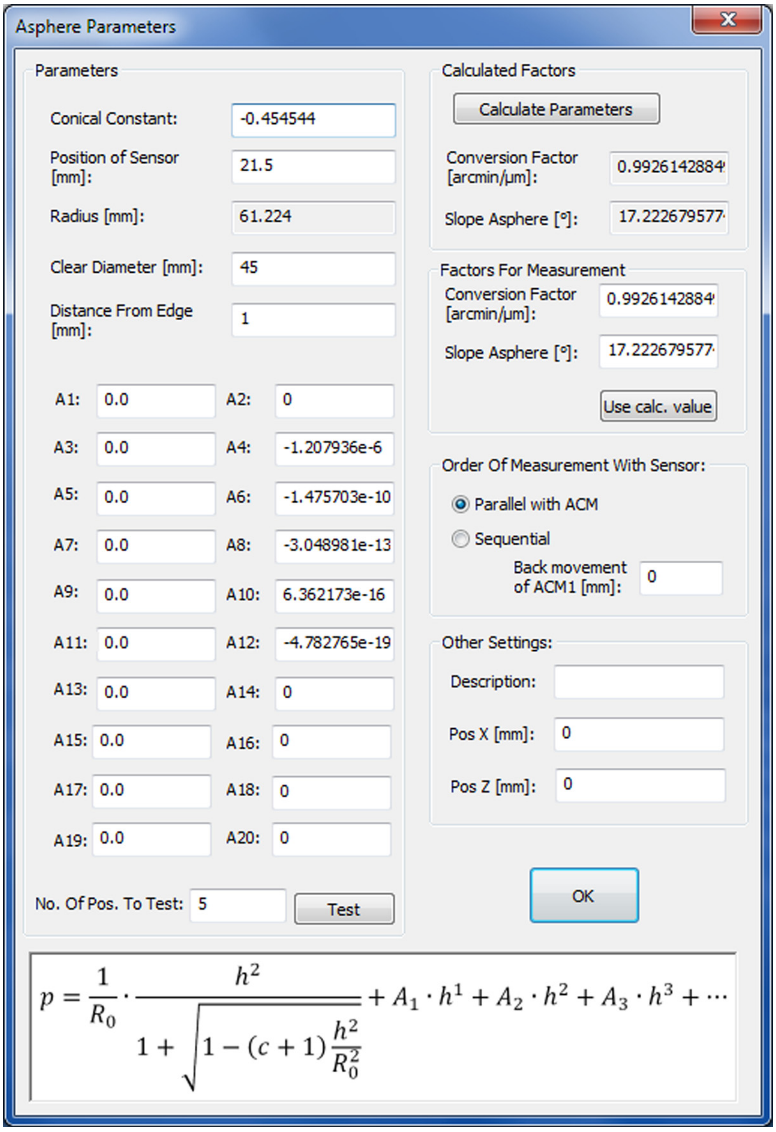


Fig. 4-3

2. Enter the parameters.

Conic Constant	Conic constant
Position of Sensor (mm)	Measuring position
Radius (mm)	The radius is taken from the design data of the first surface.
Clear Diameter (mm)	Diameter
Distance From Edge (mm)	Distance from the edge
A2 ... A20	Asphere coefficients

Convention regarding positive/negative signs

It is important that the asphere coefficients are entered with the correct positive or negative sign.

If the coordinate system of the measurement system and that of the optics designer are different, the mathematical sign may differ from the technical drawing.

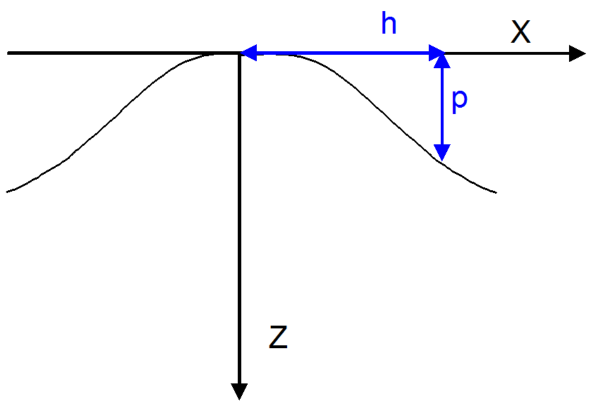


Fig. 4-4: Coordinate system of the measurement system

The positive Z-axis points downwards into the table plane

> **NOTE**
>
> The conic constant is independent of the orientation. All other parameters change the positive or negative sign depending on the orientation.

4.5 Check entered data

1. Enter the number of positions in `No of Pos. To Test` that are to be determined for the sagittal height.

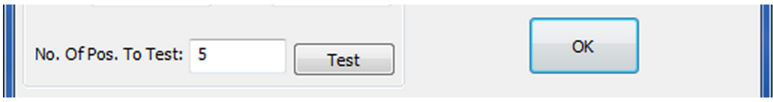


Fig. 4-5: Example

2. Click the `Test` button.

   The determined values are displayed:

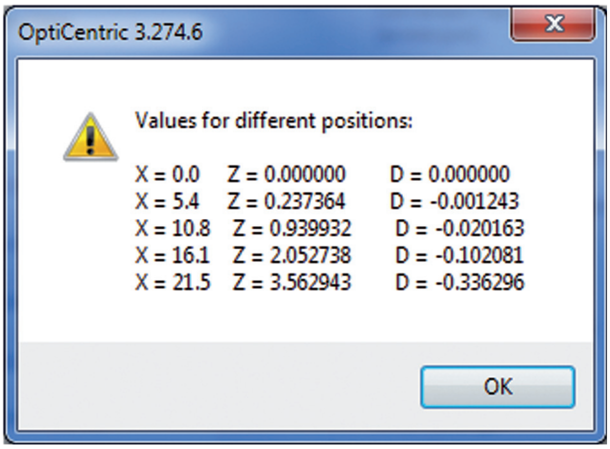


Fig. 4-6: Example

   The maximum x-value for which the sagittal height is calculated is equal to the value in the `Position of Sensor` field.
   In this example 5 sagittal heights are determined at equal intervals of 0 to 21.5 mm.

3. Compare the calculated sagittal heights with the sagittal heights in the technical drawing or from the optical design program.

4. Click **OK** to close the window.

5. If necessary, correct the entered asphere parameters and/or the positive or negative sign.

4.6 Determine conversion factor and slope

The measurement signal of the distance sensor, under constant slope of an asphere, depends on the position at which the distance sensor detects the runout of the asphere.

The software determines a conversion factor from the measurement position and the asphere data. This conversion factor is used to interpret the measurement data.

In addition, the slope of the asphere at the measurement position is determined.

1. Click the `Calculate Parameters` button.

   The conversion factor and the slope are calculated and shown on a gray background in the `Calculated Factors` box.

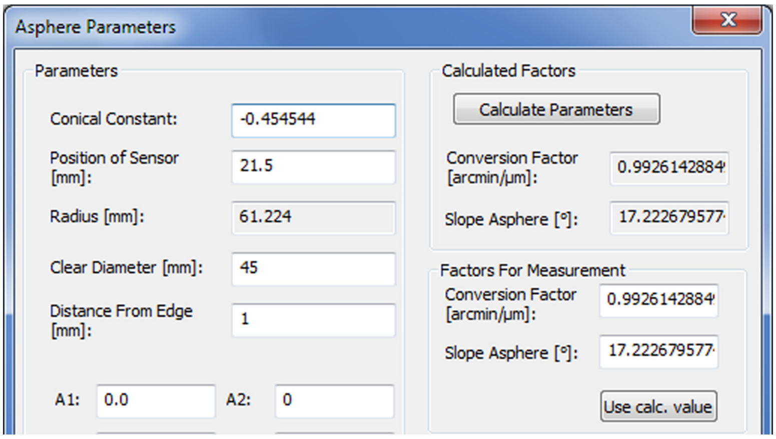


Fig. 4-7: Example

Confirm or change values

– To apply the calculated values for the measurement, click the `Use Calc. Values` button.
  The conversion factor and the slop of the asphere at the measurement point are applied and shown in white in the fields under `Factors for Measurement`.

NOTE

You can change the values. Then the changed values are used for interpretation of the measurement data. In other words, the measurement program can use a conversion factor differing from the calculation or another angle of the sensor.

The `Angle Sensor` field does not affect the measurement and can remain blank.

4.7 Specify measurement conditions

– Under `Order Of Measurement With Sensor` select one of the options:

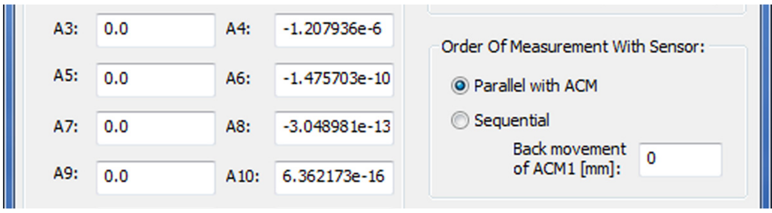


Fig. 4-8

- `Parallel with ACM`
  The measurement of the asphere runout is performed at the same time as the paraxial centration error measurement.
- `Sequential`
  In the case of sequential measurement, first the paraxial centration error measurement is performed with the autocollimator.

  Then the autocollimator moves back by the value in `Back movement of ACM 1` and clears the path for the distance sensor.

  The distance sensor can be moved to the measurement position manually. If the prompt is queried with **OK**, the measurement is continued with the chromatic sensor.

NOTE

A sequential measurement is useful if there could be a collision between the distance sensor and the autocollimator.

4.8 Other settings

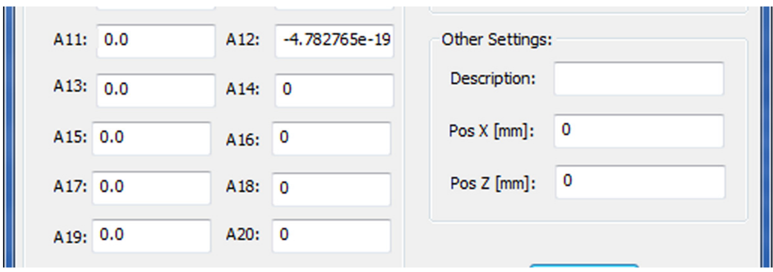


Fig. 4-9

In these fields you can add additional information that is not used for the measurement itself.

4.9 Save asphere parameters

1. If all parameters are entered correctly, click `OK`.

   The window for entering the asphere parameters is closed.

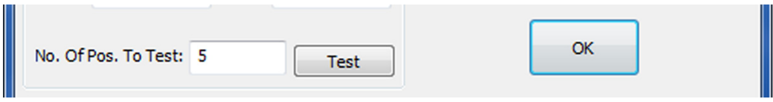


Fig. 4-10

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

4.10 Prepare a certificate

Before a measurement you have to define which results are to be included in the certificate. For example, the measured asphere slope can be referenced to the rotational axis of the air bearing or to the optical axis of the sample.

1. Click the `Define Output` button.

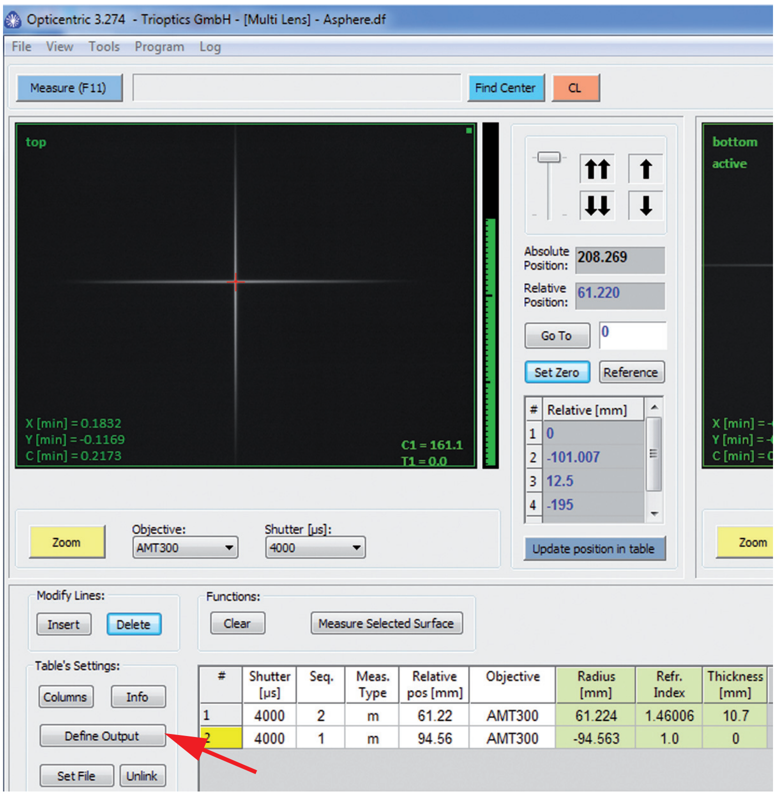


Fig. 4-11

2. Select one of the options:

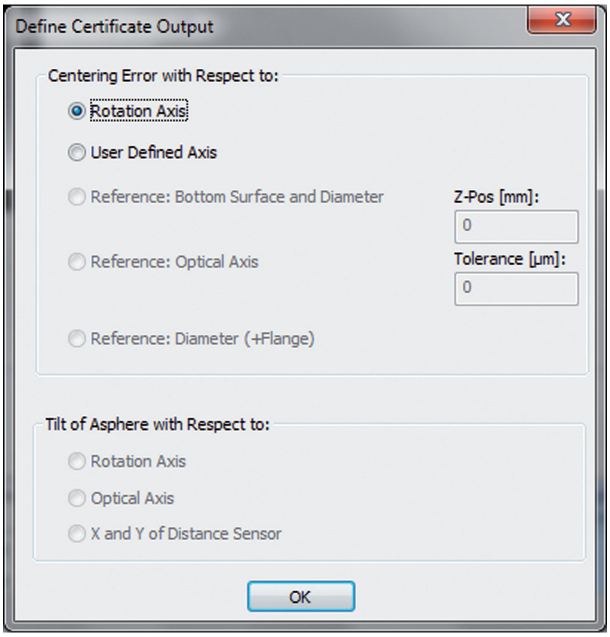


Fig. 4-12

NOTE

The radio buttons under `Centering Error with Respect to:` relate to a pure centration error measurement, i.e. they do not relate to the asphere measurement.

`Tilt of Asphere with Respect to:` lists the options that affect the asphere slope.

`Centering Error with Respect to:`	Centration error related to:
`Rotation Axis`	Axis of rotation of the air bearing
`User Defined Axis`	Mechanical housing axis
`Reference: Bottom Surface and Diameter`	Bottom surface and circumference center (for measurement of single lenses with MultiLens)

Refer-ence: Optical Axis	Optical axis
Refer-ence: Diameter (+Flange)	Circumference center and flange (for measurement of single lenses with MultiLens)
Tilt of Asphere with Respect to:	
Rotation Axis	Outputs the tilt of the asphere axis of the top surface to the rotational axis of the air bearing.
Optical Axis	Outputs the tilt of the asphere axis to the optical axis of the lens. In this case the optical axis is a con-necting line between both paraxial centers of curvature of the first and second surface of the sample. In other words, the centration errors of both surfaces must also be calculated.
X and Y of Distance Sensor	The raw data of the distance sensor are included in the certificate. In other words the measured amplitude is shown in x and y components.

3. Click **OK** to apply the inputs and leave the window.

4.11 Placing and aligning the sample

1. Place the sample on the sample holder.

> **NOTE**
>
> If a sample holder is used, this must be precisely aligned to the axis of rotation.
>
> Proceed as described in the separate Opti-Centric® operator's manual and software description.

2. 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
1	4000	2	m	61.22	AMT300
2	4000	1	m	94.56	AMT300

Fig. 4-13

3. Align the sample so that the optical axis roughly coincides with the rotational axis of the air bearing.

4. Now move the top ACM upwards if needed.

5. Loosen the thumb screw **1** on the chromatic sensor.

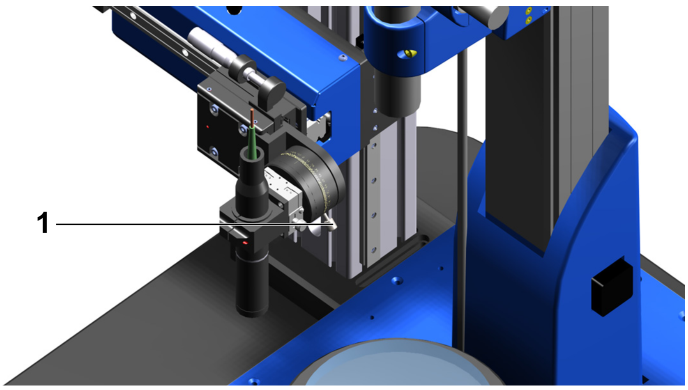


Fig. 4-14

6. Adjust the setting angle (slope asphere) on the scale.

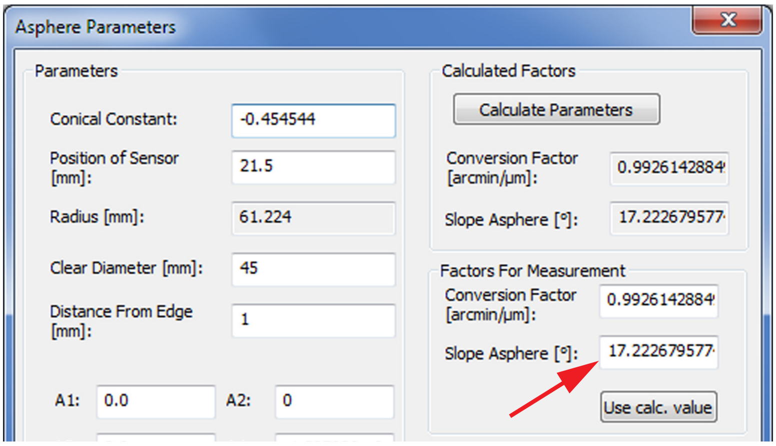


Fig. 4-15

NOTE

The setting angle must be set with an accuracy of +/- 2°.

7. Re-tighten the thumb screw.
8. Loosen the thumb screw **1** of the adjustable stop.

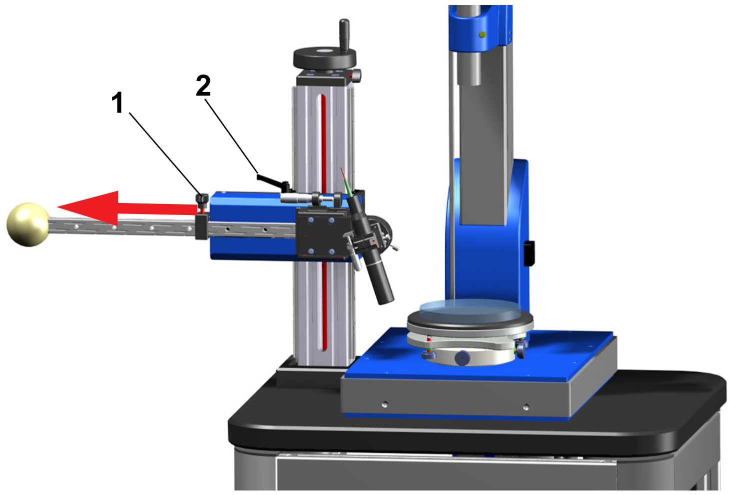


Fig. 4-16

9. Slide the end-stop to the left.
10. Loosen the clamping lever **2**.

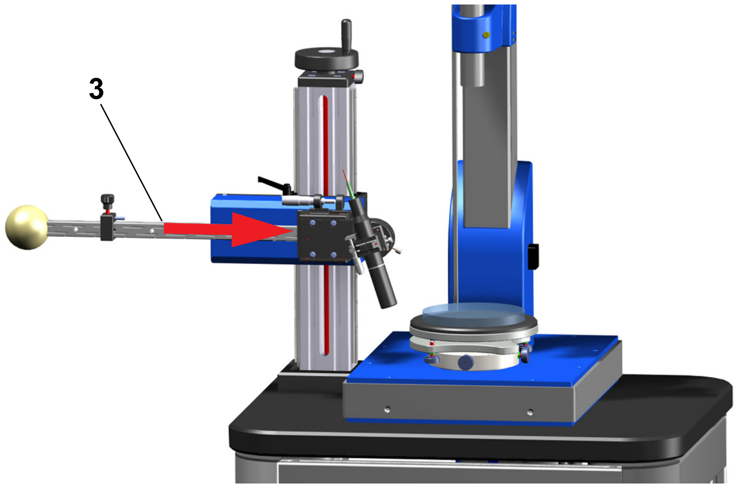


Fig. 4-17

11. Move the linear stage **3** and distance sensor towards the sample.
    The distance sensor must be placed as close as possible to the edge of the asphere surface being tested.

> **CAUTION!**
>
> **Damage to the measurement system**
>
> – Make sure that it does not collide with the autocollimator.

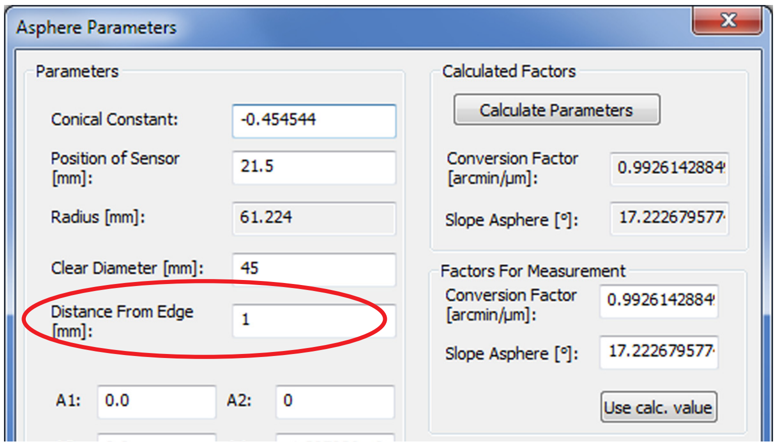


Fig. 4-18

12. Move the end-stop to the right and tighten the thumb screw **1** in order to later retrieve this position again.

13. Tighten the clamping lever **2**.

4.12 Set the operating point of the sensor

The operating distance of the sensor is around 10 mm (depending on the model).

NOTE

The operating point of the optical distance sensor is a small luminous point. It can quickly be made visible with a piece of paper.

1. Turn on the control unit for the chromatic sensor.

Fig. 4-19

2. Observe the control unit of the distance sensor.
3. On the height adjustment **1**, turn the micrometer screw for X shift **2** and the micrometer screw for gap **3** until a signal is displayed.

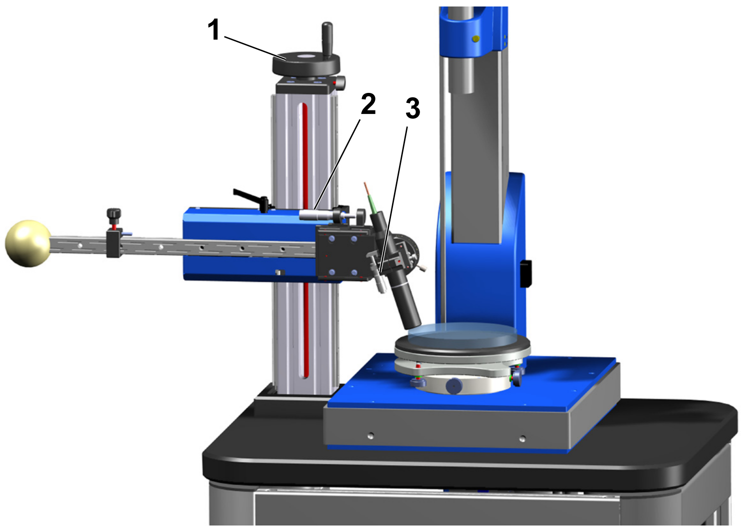


Fig. 4-20

Fine adjustment

The operating point h must be precisely calculated for the fine adjustment.

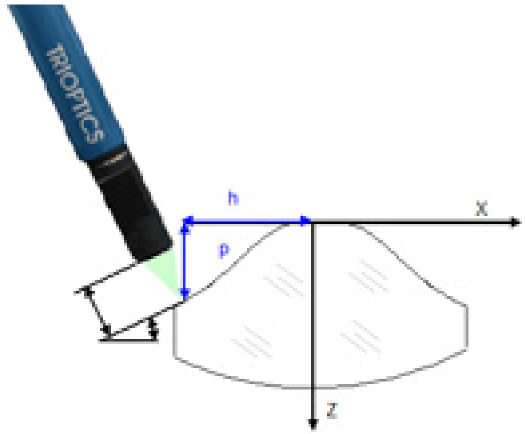


Fig. 4-21

1. Carefully use the X-Translation stage until the chromatic sensor is at the edge of the sample and the signal on the control unit display disappears.
2. Now the sensor can be shifted by an amount Δ in the X direction on the sample. Calculate the operating point with the following formula:

$h = Ø/2 - \Delta$ Ø: Diameter of the sample h: Operating distance

3. In order to shift the sensor, use the micrometer screw **1**. 1 rotation equals 0.5 mm travel.

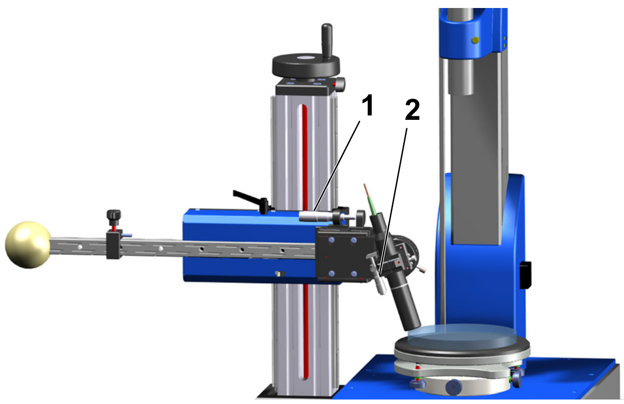


Fig. 4-22

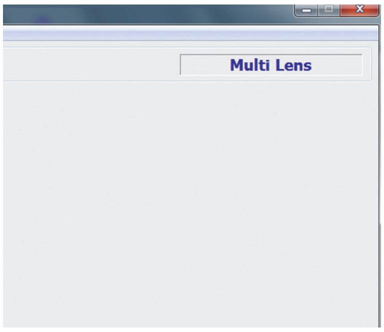
4. In order to change the operating distance between sensor and surface, without shifting the measured surface of h, use the micrometer screw **2** close to the distance sensor.

4.13 Taking a measurement

The measurement of an aspheric lens in the paraxial range is identical to the MultiLens® measurement of an achromat.

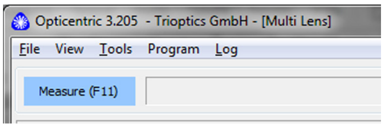
In addition to the centration error measurement, the signal of the distance sensor is measured at the same time or during an addional rotation.

Then all the recorded data is used for calculation and the result is output in the certificate.



1. Make sure that the MultiLens measuring mode is selected.

> **NOTE**
>
> Please contact the administrator to change the measuring mode if necessary.



2. Click `Measure (F11)`.

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

Display certificate

– Click `<View> <Certificate>`.

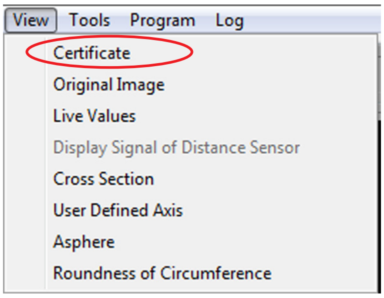


Fig. 4-23

> **NOTE**
>
> Under `Settings` -> `General` the unit for the certificate must be set to "Arcmin".

Display signal of the distance sensor

Similar to the autocollimator camera images, there is also a real-time value display and a display of the measured displacement values for the distance sensor.

– Click `<View>` `<Display Signal of Distance Sensor>`.

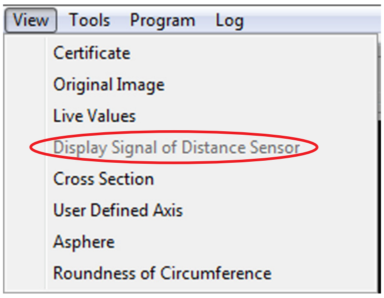


Fig. 4-24

If the surface being measured is tilted with respect to the axis of rotation, the sensor's distance signal follows a sine function. The measurement points are shown by small blue crosses. Once the rotation has finished, a correction sine curve is plotted by these points.

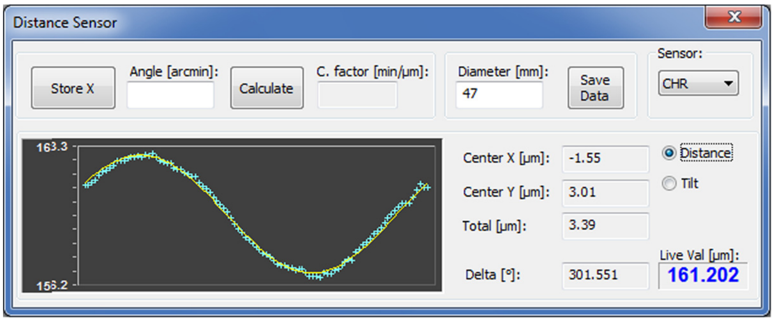


Fig. 4-25

This correction curve is used to determine the amplitude and phase of the runout error. The result is shown in the component view `Center X [µm]` and `Center X [µm]`.

5. Index

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