



# TRIOPTICS

TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

## TriAngle®

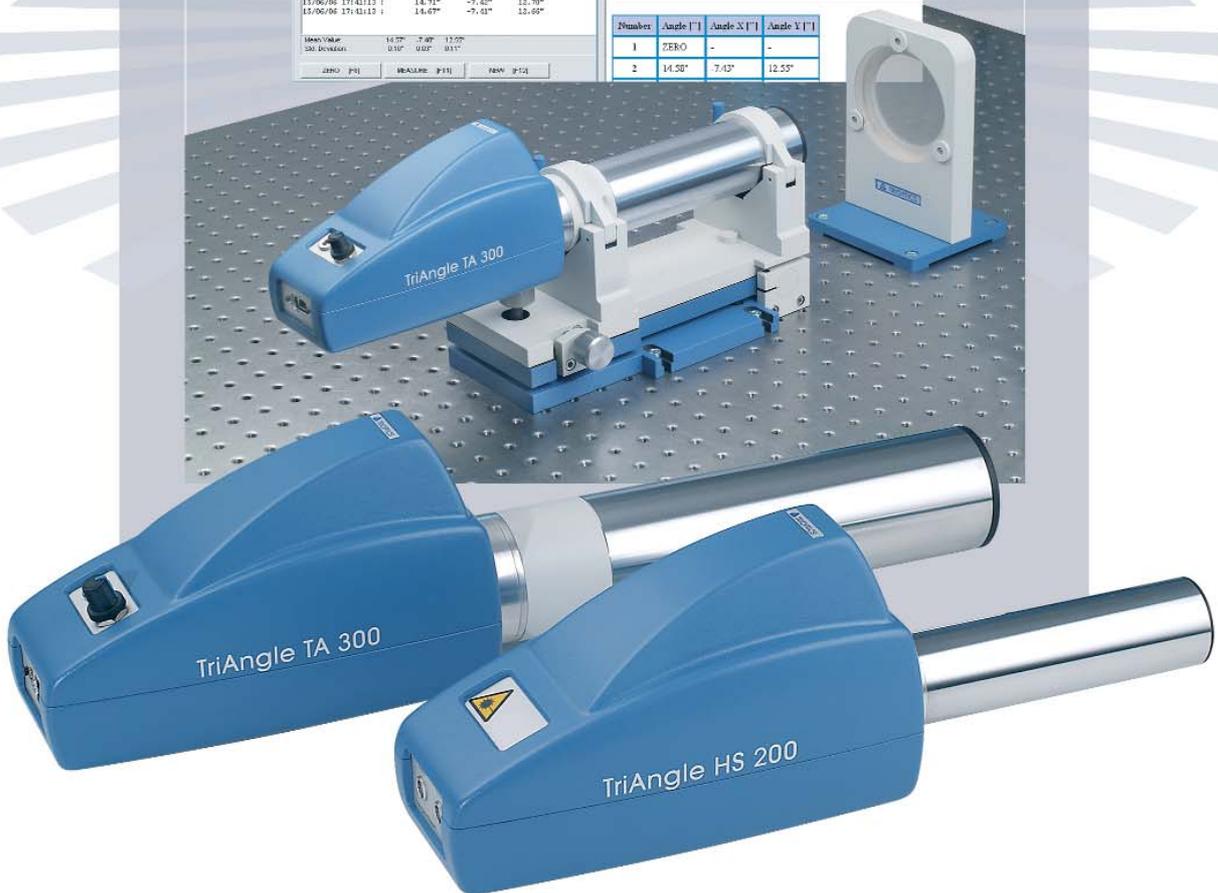
### Precision Electronic Autocollimators

The screenshot displays the software interface for the TriAngle autocollimator. It features a central window with a crosshair and a data table. To the right, there is a 'Certificate View' window showing a 'CERTIFICATE' from TRIOPTICS. The certificate includes the following details:

- Company: TRIOPTICS
- Department: R&D
- Serial No.: 1334
- Temperature: 22.0 °C
- Operator: Ben
- Date/Time: Thursday, June 15, 2006 15:11:23
- Measured Item: TRIANGLE - (Dansk) Ltd
- Measurement Program: AutoCollimation

Below the certificate, there is a table with the following data:

Number	Angle ["]	Angle X ["]	Angle Y ["]
1	ZERO	-	-
2	14.20"	7.43"	12.55"



**TriAngle®**  
Precision Electronic Autocollimators

DESCRIPTION

**TriAngle®**

The new Electronic Autocollimator series of TRIOPTICS integrates a high resolution CCD-sensor and is compatible with all TRIOPTICS objective tubes. The compatibility with objective tubes of different focal lengths leads to a variable measuring range and accuracy performance. In this way the TriAngle® series responds optimally to different customer requirements and can cover a large range of applications. The versatility of TriAngle® is further enhanced by the modular

design which allows fitting of different sensors, reticles and light sources. The digital camera interface enables the use of Notebook PC for measurements in the field.

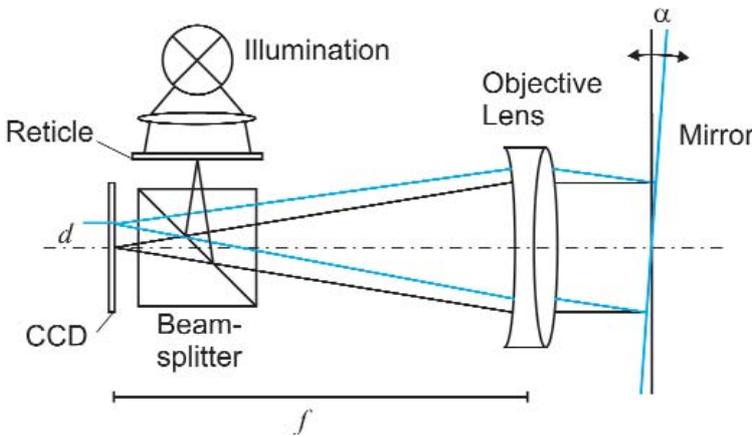
**TriAngle® HiSpeed (HS)**

The High Speed Detector Series Autocollimators takes advantage of a high bandwidth position sensitive silicon photodetector for angle measurement rates up to 10 kHz. The TriAngle® HS Series provides not only high speed measurement but highest accuracy and resolution as well. Automated alignment is made easy through the analog signal output for closed loop control operation. The strong laser illumination enhances the capability of TriAngle® HS to measure very small and low reflectivity surfaces.



TriAngle® and TriAngle® HiSpeed

MEASUREMENT PRINCIPLE

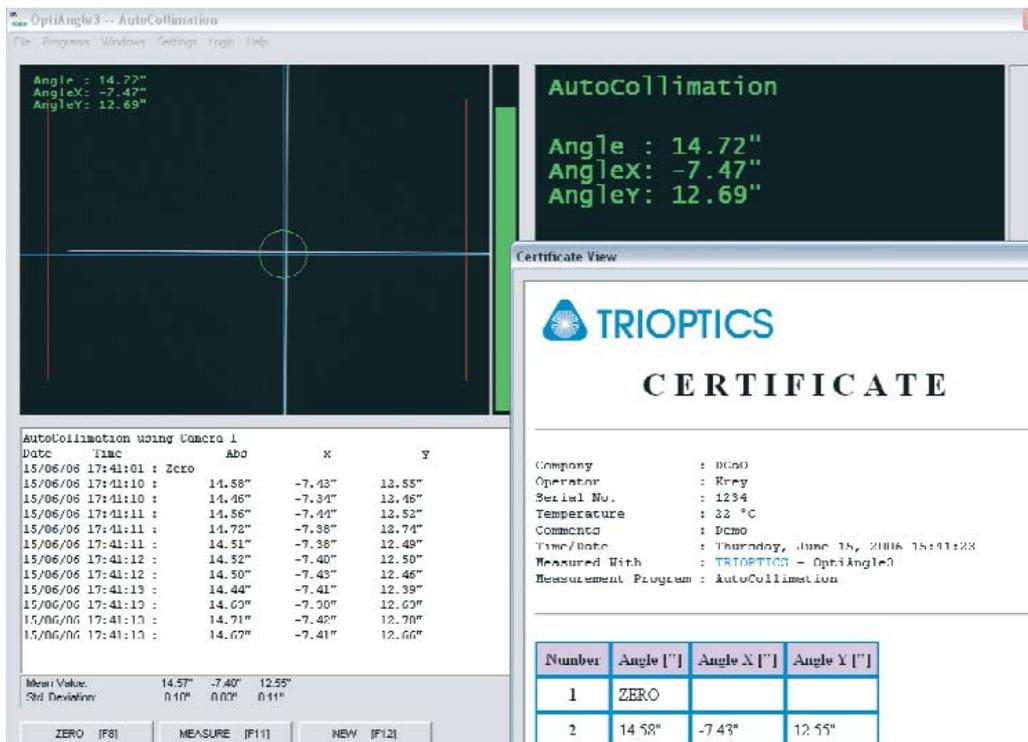


which the CCD of an electronic camera is located. Thus the illuminated reticle and the CCD plane are conjugate. When the collimated beam falls on a mirror which is almost perpendicular to the beam axis, the crosshair image will be located somewhat near the center of the CCD. If the reflector is now tilted by an angle  $\alpha$  the reflected image will be laterally displaced by the amount  $d$  with respect to the original position. This displacement  $d$  is a function of the tilt angle  $\alpha$  and the focal length  $f$  of the objective lens:  $d = 2\alpha f$ . When  $d$  is measured on the CCD the tilt angle  $\alpha$  of the mirror can be calculated:

$$\alpha = \frac{d}{2f}$$

The Autocollimator is a single instrument combining the functions of a collimator and a telescope. It detects small angular displacements of a mirror surface by means of its own collimated light. Autocollimation is an optical technique of projecting an illuminated reticle to infinity and receiving the reticle image back after reflection on a flat mirror surface. The received image is brought to the focus of the objective lens in

The displacement is linear with the tilt angle and the measurement result is independent from the instrument's distance to the mirror. In the TriAngle® system the comprehensive



OptiAngle® software package performs all the calculations for various measurement programs, taking also all necessary calibrations into account.

The comprehensive software includes sub modules for the measurement of tilt and wedge angles, prisms and polygons, alignment tasks, deflection angles, etc.

Application Screen

The user can switch the output between various angular units such as radians, degrees, arc minutes, arc seconds, MIL and many more to his preferences. New software modules refer to the straightness of guides or positioning of fast moving elements.

The TriAngle® series is designed for outstanding performance and flexibility. Depending on the focal length of the instrument, the standard measuring accuracy varies from 0.2 to 2 arcsec and the resolution is in the range of 0.01-0.1 arcsec. Higher performance is available on request. While a high power LED is the standard light source, other illumination types are available to adapt to specific sample characteristics. E.g. the intensive LASER light source is recommended for very small reflecting sample surfaces.

### FEATURES

- integrated sensor and light source
- large range of focal lengths available
- vacuum compatible version available (TriAngle® HS only)
- single cable interface with IEEE 1394 digital camera
- robust housing in new improved design

The extensive software package covers a multitude of applications. Custom measuring procedures can be easily interfaced with the software program. For more detailed analysis the data can be exported to MS Excel or other programs for numerical analysis. More software features:

- real-time camera and numerical display
- host PC interface with RS232 control
- simultaneous measurement with 2 autocollimators possible

- user defined graphical overlays for the camera window
- complete certificate and CSV output
- password protected user modes



Real time angle display and graphical overlays in camera window

### APPLICATIONS

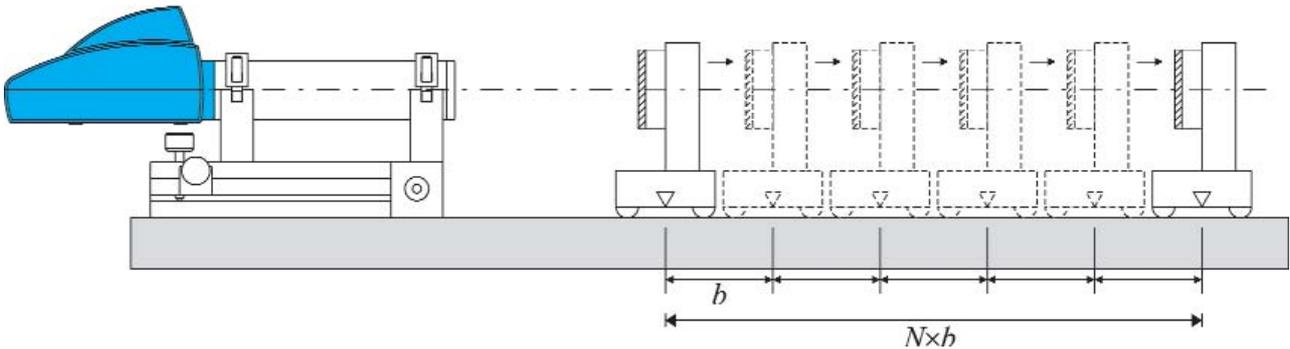
The applications of TriAngle® autocollimators are mainly related to the detection and measurement of small angular displacements. Examples are:

- straightness measurement of linear stages (pitch and yaw measurement)
- characterization of rotation stages (wobble and run out measurement)
- measurement of wedge, prism and polygon angles
- measurement of parallelism of reflecting surfaces
- measurement of surface flatness
- alignment of optical setups
- machine alignment
- CD/DVD ROM alignment (focussing and tracking measurement)
- thermal stability measurements
- vibration analysis (TriAngle® HiSpeed)

**Straightness Measurement**

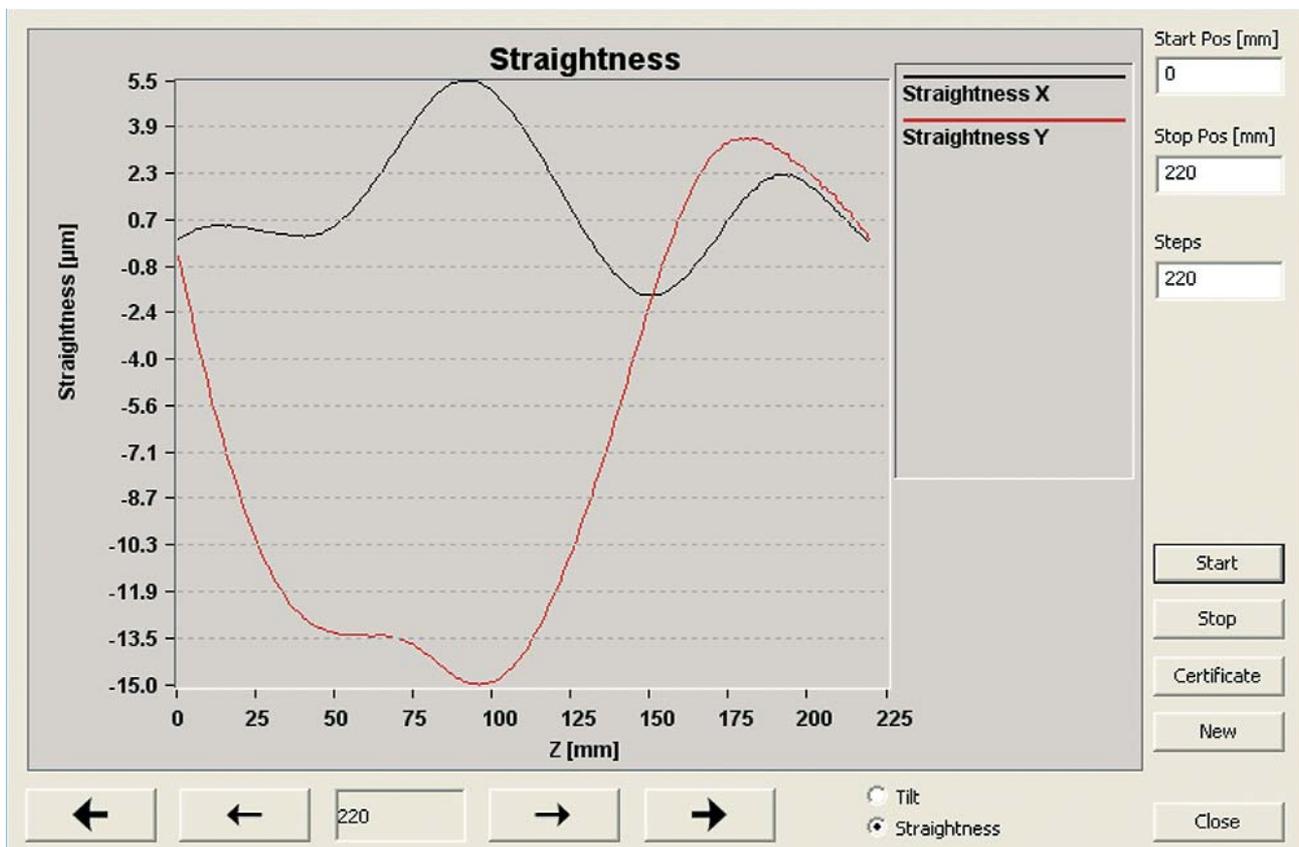
A reference mirror is moved with a constant step length  $b$  across the stage or guide to be measured. For each step the angular output of TriAngle® is recorded. The software

displays the pitch and yaw angular measurement data as well as the straightness deviation. Motor driver software modules for standard DC- and stepper-motors are included which makes the measurement of motorized stages very convenient.



$$\delta(z_n) = b \sum_{i=1}^n \tan \alpha_i$$

**Straightness Measurement with TriAngle®**



Straightness Measurement of a linear stage

## Wedge Measurement

The parallel beam emerging from the TriAngle® autocollimator is reflected back from both surfaces of the wedge. The wedge angle  $\delta$  is given by

$$\delta = \frac{d}{2nf}$$

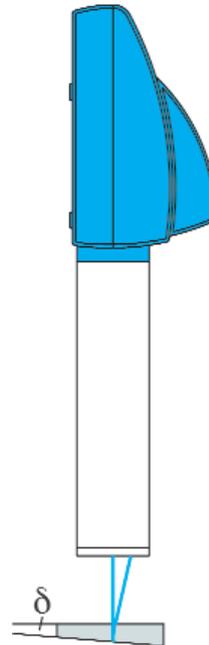
Where

$d$  = displacement of the reticle image on the CCD sensor

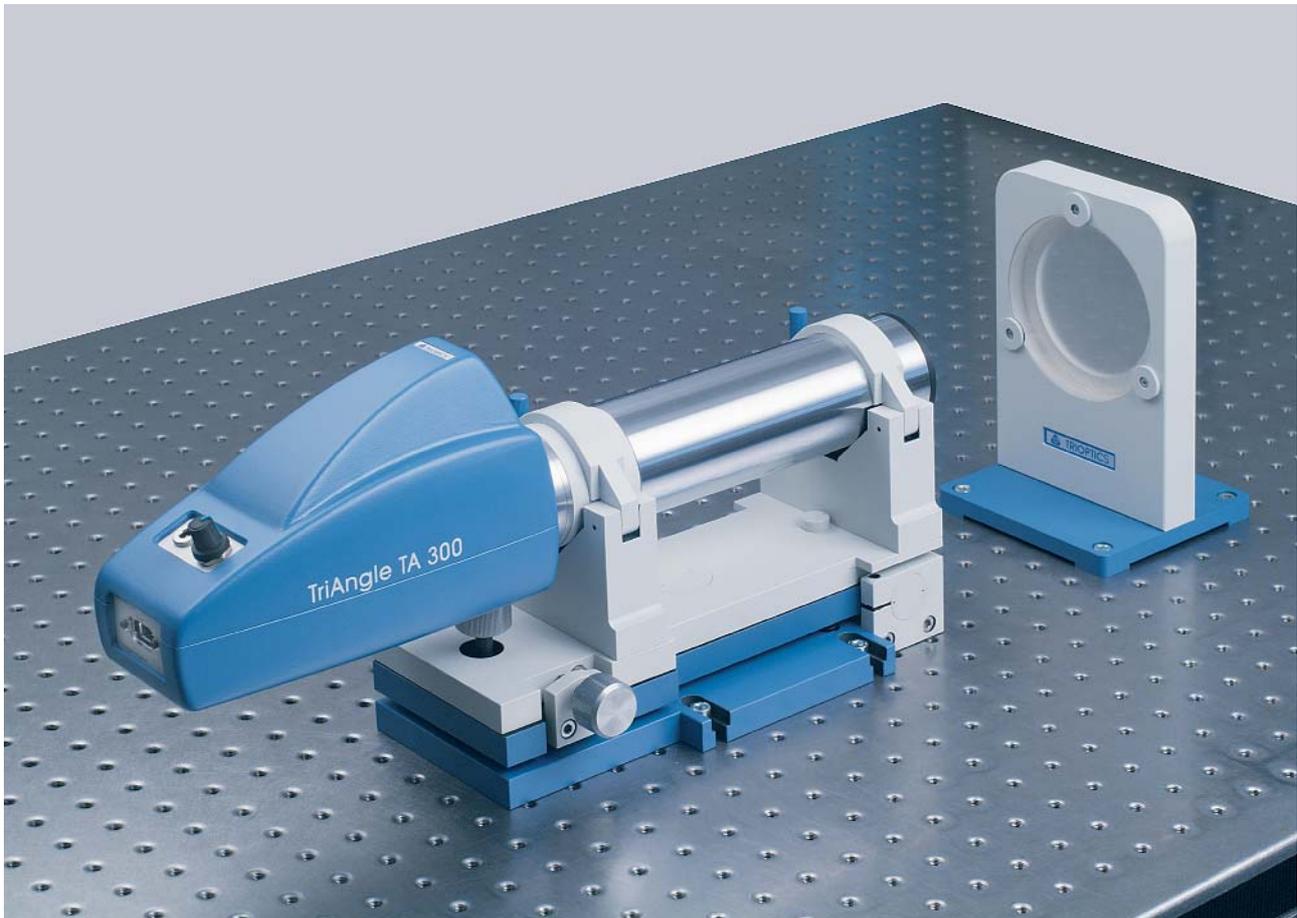
$n$  = refractive index of the wedge glass

$f$  = focal length of the autocollimator

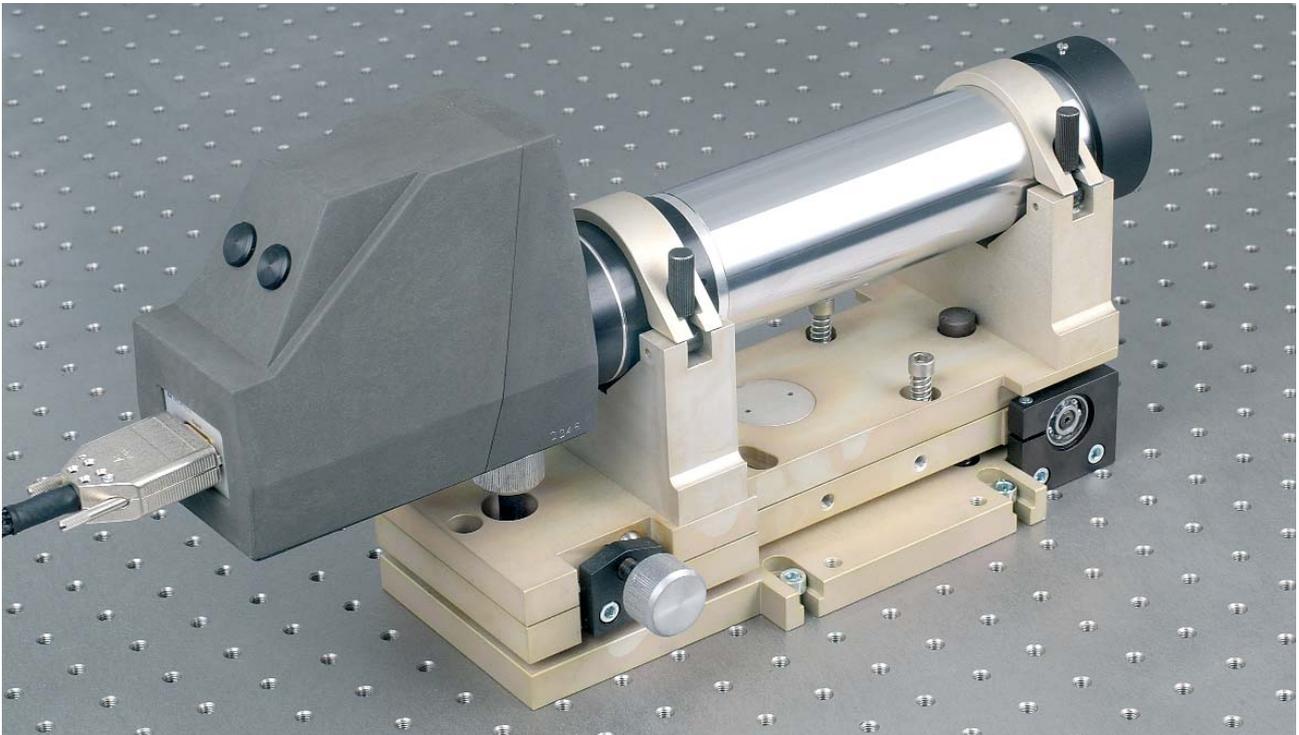
The software further includes programs for the wedge measurement in transmission.



Measurement of optical wedges with TriAngle®



TriAngle® TA 300 in 2-axis adjustable holder with reference mirror



Vacuum compatible TriAngle® TA 300 HiSpeed

**SPECIFICATIONS**

	<b>TriAngle®</b>	<b>TriAngle® HS</b>
Sensor	CCD Camera Analog /Digital (IEEE1394, GigE)	Position Sensitive Detector
Light Source	LED (Standard), LASER, Halogen Lamp	LASER
Interface	Analog Video or Digital Camera Interface	Analog X, Y, Intensity Voltage Signal or USB (optional)
Clear Aperture	TA ...-38: . . . . .30 mm TA ...-57: . . . . .50 mm TA ...-115: . . . . .100 mm TA ...-140: . . . . .125 mm	

The delivery kit includes:

- TriAngle® Electronic Autocollimator
- Frame Grabber or PCI interface card
- OptiAngle® Software Package on CD
- Interface Cables
- Individual Certificate of Calibration traceable to PTB angle standard

**TriAngle® TA Series**

Order Code	Type	Field of View* hor.(x)/vert. (y) (°)	Resolution (arcsec)	Repeatability (arcsec)	Accuracy (arcsec)
3-103-061	TA 100-38	1.8° × 1.4°	0.1	0.3	2.5
3-103-062	TA 150-38	1.2° × 0.92°			1.7
3-103-063	TA 200-38	0.92° × 0.69°	0.01	0.2	1.3
3-103-064	TA 300-38	0.61° × 0.46°		0.1	0.75
3-103-065	TA 300-57	0.61° × 0.46°			
3-103-066	TA 500-57	0.37° × 0.28°		0.05	0.4
3-103-068	TA 1000-115	0.18° × 0.14°		0.025	0.2
3-103-069	TA 1000-140	0.18° × 0.14°			

\* for 1/2" CCD, other sensor sizes available upon request

**TriAngle® HiSpeed (HS) Series**

Order Code	Type	Field of View* (°)	Resolution (arcsec)	Linearity (%)	Bandwidth (-3dB)
3-103-061 HS	TA HS 100-38	1.0°	0.40	0.8	10 kHz
3-103-062 HS	TA HS 150-38	0.69°	0.30		
3-103-063 HS	TA HS 200-38	0.52°	0.20		
3-103-064 HS	TA HS 300-38	0.34°	0.15		
3-103-065 HS	TA HS 300-57	0.34°	0.15		
3-103-066 HS	TA HS 500-57	0.21°	0.10		
3-103-068 HS	TA HS 1000-115	0.10°	0.05		
3-103-069 HS	TA HS 1000-140	0.10°	0.05		

\* larger sensors for increased field of view available

**CONTACT**

Please ask for more information  
on TriAngle® electronic autocollimators  
and their applications:

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