TRIOPTICS

TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

# OptiTest®

## a complete range of Optical Instruments

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TRIOPTICS
TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

# OPTITEST

## A COMPREHENSIVE AND MODULAR OPTICAL TEST EQUIPMENT.

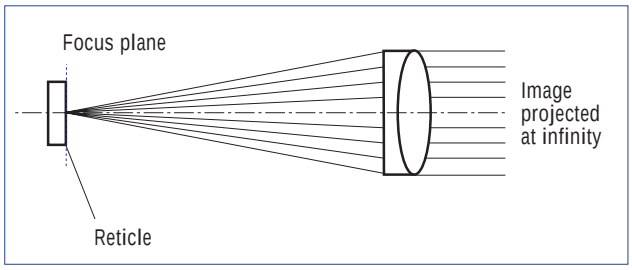
The optical testing usually requires a wide range of configurations specific to the application or the parameters to be measured.
The large variety of the set-ups is, however, a combination of basic optical instruments known as:

- **collimators**
- **telescopes**
- **autocollimators**
- **achromats**
- **mechanical hardware for positionning of the basic optical instruments**

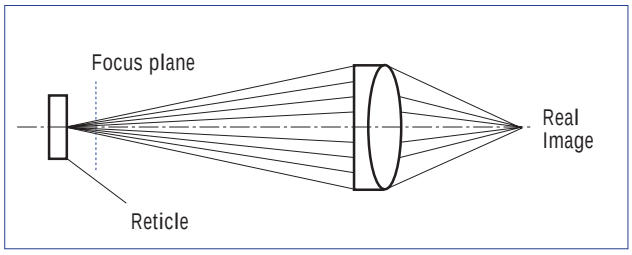
The OPTITEST is a comprehensive line of equipment including the largest range of basic optical instruments and additional mechanical hardware. To cover all conceivable testing set-ups required by fast changing applications, the components of OPTITEST line are design as a modular system.

The OPTITEST components are interchangeable and compatible with each other. This modular approach and the extensive range of instruments belonging to OPTITEST result in significant advantages for the user:

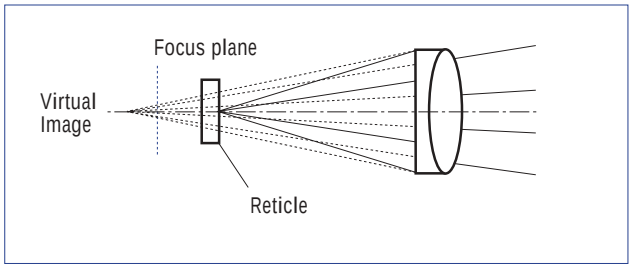
- unlimited flexibility to set up systems to cover present and future applications
- a cost effective solution since the basic components are identical in any configuration
- user freedom to set up the required equipment by himself since everything is already factory adjusted




Standard Collimator
*Infinity setting*




Focusing Collimator
*Finite distance setting-Real image*




Focusing Collimator
*Finite distance setting-Virtual image*

# COLLIMATORS

## TERMS AND DEFINITIONS

The Collimator is an optical instrument consisting of a well corrected objective lens with an illuminated reticle at its focal plane. The emerging beam is parallel (collimated beam), so that the image of the reticle is projected at infinity. The collimator is usually set up in this way known as infinity adjustment (setting).

When moving the reticle out of the focal plane of the objective lens, the shape of the emerging beam will change:

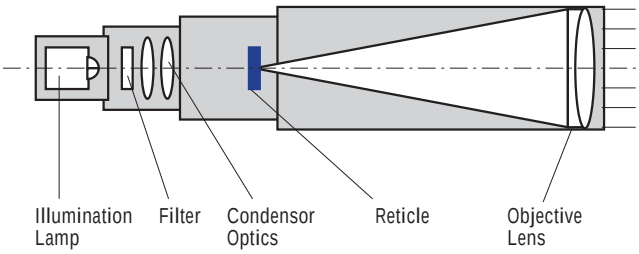
-Moving the reticle away from objective lens will result in a convergent beam. The image of the reticle is real and projected at a finite distance.
-Moving the reticle toward the objective lens will result in a divergent beam. If the beam diverges, a virtual image is produced at the aparent crossing point of the beam rays.This point is also located at a finite distance. This adjustment of the collimator is known as finite distance setting.

## CONSTRUCTION

The main components of a standard collimator (infinity setting) are:

- Tube mounted objective lens
- Reticle adapter
- Illumination device

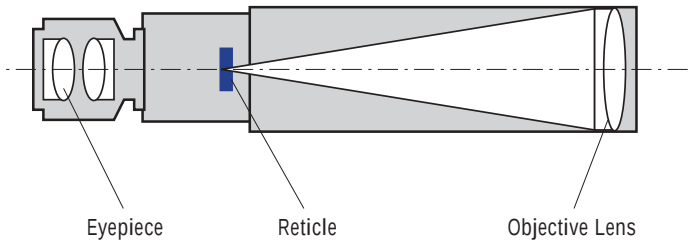
A focusing collimator (finite distance setting) is similary built, however, the reticle adapter is mounted on a draw out tube for focusing adjustment.




# TELESCOPES

## TERMS AND DEFINITIONS

The telescope is a sighting device usually with a magnification greater than unity used for image enlargement or measurement purposes. It consists of a well corrected objective lens, a reticle at its focal plane and an eyepiece.




When the incoming beam is parallel, the image observed through the telescope is located at infinity i.e at a long distance. This set up in is known as infinity setting.

Similar to collimators, the telescopes can be focused at finite distances.Attaching a draw out tube to the reticle adapter to move the reticle out of the focal of the objective lens, the standard telescope becomes a focusing telescope. Depending on the location of the reticle relatively to the focal plane, it results a real or a virtual image at a finite distance.

## CONSTRUCTION

The main components of a standard telescope (infinity setting) are:

- Tube mounted objective lens
- Reticle adapter
- Eyepiece

A focusing telescope (finite distance setting) is similary built, however, the reticle adapter is mounted on a draw out tube for focusing adjustment.

# COLLIMATORS AND TELESCOPES

## OPERATING PRINCIPLE AND APPLICATIONS

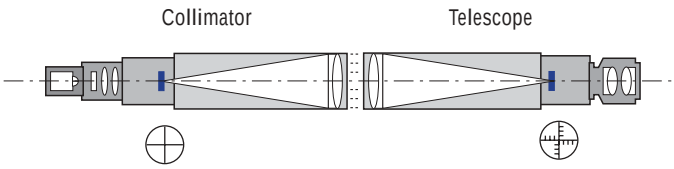
In the optical metrology the collimators and telescopes are mostly used together to measure different optical and geometrical parameters:

### ANGLE MEASUREMENT

A telescope mounted in the front of a collimator enables the simultaneous observation of both collimator and telescope reticle. When a collimator is perfectly aligned to a telescope the reticles are superimposed and no displacement occures.

The presence of an angle „$\alpha$“between the the collimator and telescope axes is shown by a linear displacement „d“ between the two reticles. The displacement „d“ gives the size of the angular disalignment (in radians) of the two instruments:

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




Angle measurement with Collimators and Telescopes

where:
d=linear displacement measured in the reticle plane (focal plane)
f=effective focal length (EFL) of the observing instrument (i.e.telescope)

To ease the angular alignment of equipment with flat surfaces a special type of instruments can be used: the square body collimators and telescopes. The reticles of these instruments are accurately aligned to the outer square body surfaces.

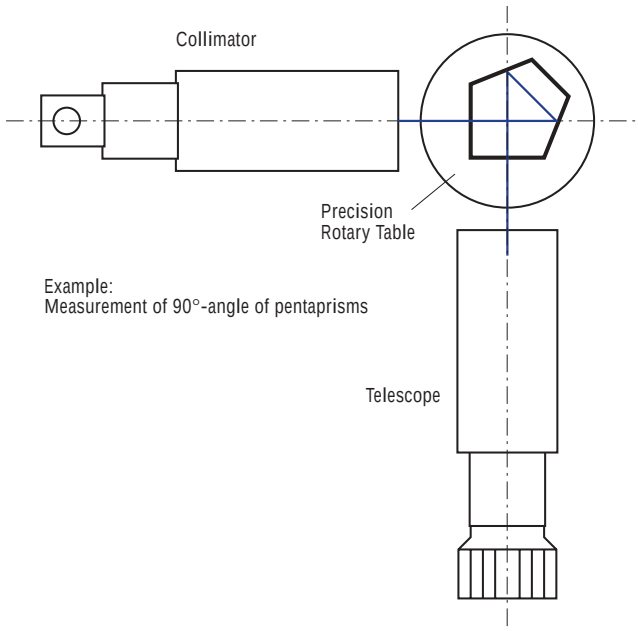
☛ TRIOPTICS Square Body Collimators and Telescopes

Since collimators and telescopes used for angle measurement have a standard infinity setting and therefore the beams of the instruments are parallel, the measurement is not affected:

- when a parallel displacement of the optical axes occures
- when the distance between the instrument i s modified

Typical applications related to angle measurement:

### Measurement of the transmission angle through prisms

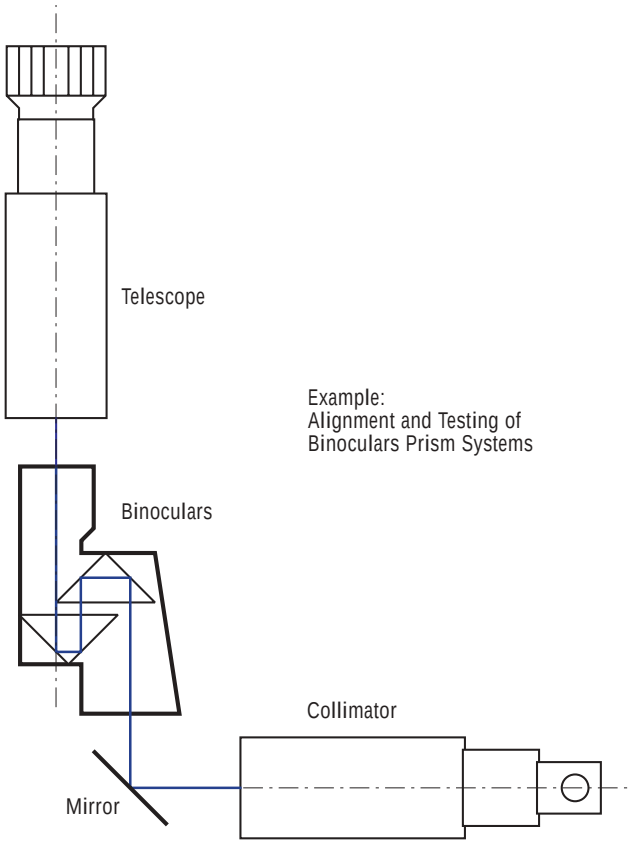



- absolute measurement: The telescope is attached to a precision rotary table with read out:
  First reading: collimator and telescope aligned (without sample)
  Second reading: sample positioned, telescope rotated until the reticles are super imposed. Reading on rotary table.

- relative measurement: a master prisma is used, collimator and telescope rotated until reticles are super imposed and fixed in this position. The sample is placed instead of master prism. Reading on telescope.

☛ TRIOPTICS Goniometer

### Alignment of prism sytems




The collimator and the telescope is strictly aligned. When the binoculars or the prism system only are placed between the collimator and telescope tilt and rotation of prisms can be measured.

☛ TRIOPTICS Binoculars Testing Instrument

## TESTING IMAGE QUALITY

The collimators used for testing the image quality are equiped with reticle containing a resolution pattern (chart) as USAF resolution target, Siemens Star, Foucault Test etc. The telescope or any other sighting devices are pointed to the testing collimator. The limiting number of lines per millimeter that a sighting device is capable to resolve on the collimator reticle is determining the resolution or image quality.

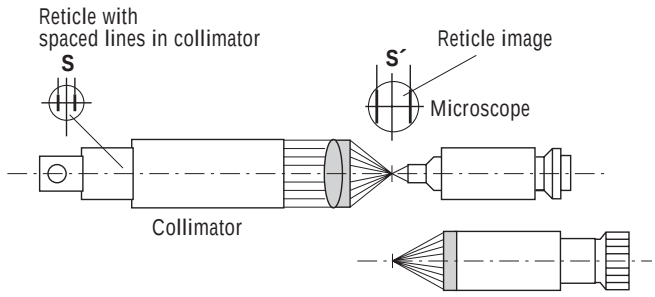
Another typical set up for testing image quality of lenses consists of a collimator which projects a resolution target to the lens under test. The image of the resolution target formed in the focal plane of the sample is observed through a microscope.

☛ TRIOPTICS Master Collimator
☛ TRIOPTICS Optical Bench

## MEASUREMENT OF OPTICAL PARAMETER

### Measurement of focal length

A typical application is the measurement of the effective focal length EFL. A highly corrected collimator set to infinity (emerging beam is parallel) has a reticle with a pair of spaced lines located in its focal plane. The image of the reticle is projected over the lens under test and focused in its focal plane. By means of a




Example:
Measurement of focal length
using collimators and telescopes

Telescope
with supplemantary
achromat lens

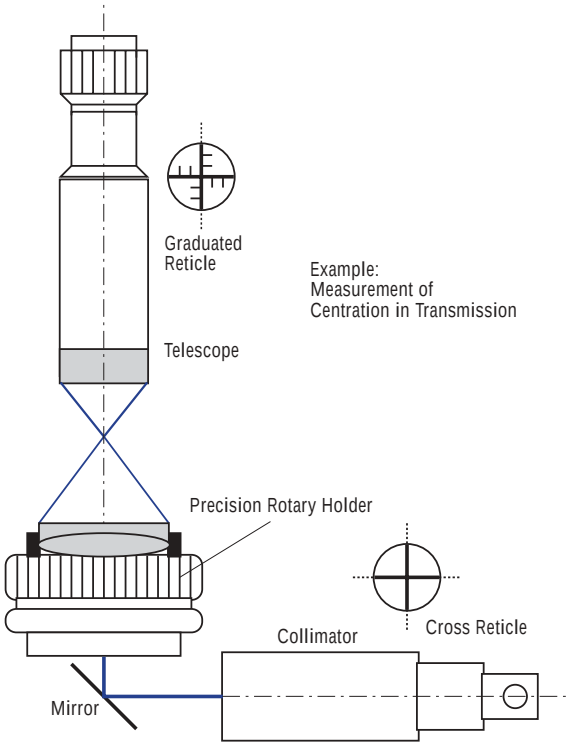
microscope (or a telescope with a supplementary achromat) the size of spaced lines is determined and the EFL calculated:

$$f = fcol \cdot \frac{S'}{S}$$

☛ TRIOPTICS Optomatic
☛ TRIOPTICS OptiAngle

### Measurement of centration errors

A collimator set to infinity contains a reticle with a dark or bright cross. The lens under test is placed in a precision rotary holder. The image of a reticle projected over the lens under test is observed by means of a telescope with additional achromat having a graduated reticle.
While rotating the holder with the lens, the cir-



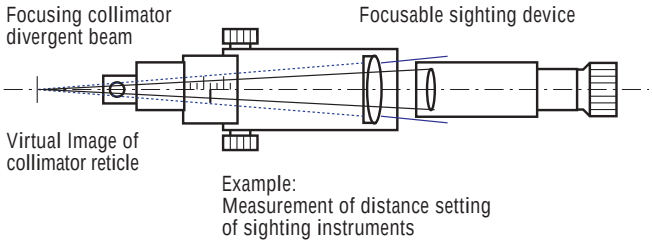

cle described by the reticle image is measured.

☛ TRIOPTICS OptiAngle
☛ TRIOPTICS Ultra-Precision Rotary Holders

## MEASUREMENT OF THE FOCUSING DISTANCES

Many telescopes and sighting devices are designed to to be focused at different distances over a given range. To measure the distance setting of sighting devices a focusing collimator with a accurately graduated draw out tube is focused at the distance to be checked. Through the eyepiece of the sighting device the collimator reticle is observed. If the image of the collimator reticle appears sharp within the required tolerance, the sighting device is correctly adjusted. Deviations are measured and read off on the graduated draw out tube of the collimator.

## TERMS AND DEFINITIONS




# AUTOCOLLIMATORS

The Autocollimator is a single instrument combining the functions of a collimator and a telescope.It detects small angular displacements of a mirror by means of its own collimated light.

The two reticles are positioned in the focal plane of the corrected objective lens, so that the emerging beam is parallel. This usual configuration is known as infinity setting, i.e the autocollimators are focused at infinity.

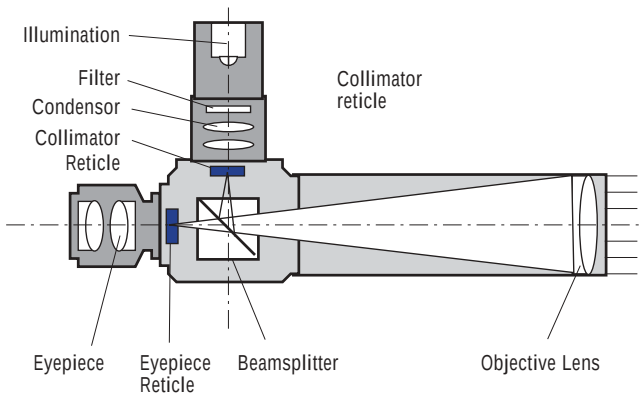
When moving the reticles out of the focal plane of the objective lens, the autocollimator can be focused at finite distances, and the beam becomes divergent (producing a virtual image) or convergent (real image). This results in a focusing autocollimator. The shape of the beam -convergent or divergent-depend on the direction in which the reticles are moved.

## CONSTRUCTION

The main components of a stadard autocollimator i.e. focused at infinity are:

- Tube mounted objective lens
- Beam splitter mount which contains two reticles
- Eyepiece
- Illumination device

The illuminated reticle projected over the beamsplitter towards the lens is known as collimator reticle. The second reticle placed in the focus of the eyepiece is the eyepiece reticle. The beamsplitter mount together with the eyepiece and the illumination device form a main



unit called: Autocollimator Head.

A focusing autocollimator (finite disatnce setting) is similary built. The autocollimator head containing the two reticles is now mounted on a draw out tube for focusing adjustment.

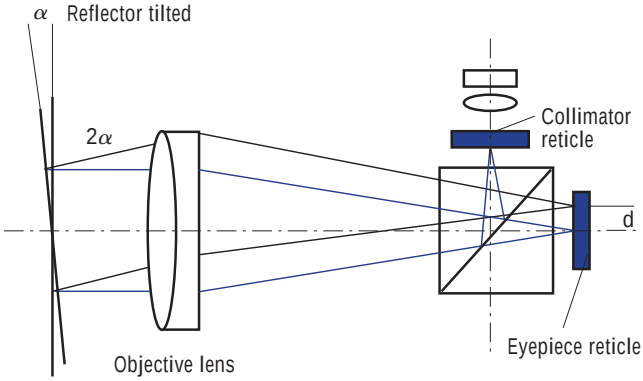
## OPERATING PRINCIPLE

Autocollimation is an optical technique of projecting an illuminated reticle to infinity and receiving the reticle image after reflection on a flat mirror. The reflected image is brought to the focus of the objective lens in which the eyepiece reticle is located. Thus the reflected image of the collimator (illuminated) reticle and the eyepiece reticle can be simultaneously observed. When the collimated beam falls on a mirror which is perpendicular to beam axis, the light is reflected along the same path. Between the reflected image and the eyepiece reticle -which are seen superimposed-no displacement occures.

If the reflector is tilted by an angle $\alpha$ , the reflected beam is deflected by twice that angle i.e. $2\alpha$. The reflected image is now laterally displaced with respect to the eyepiece reticle. The amount of this displacement „d“ is a function of the focal length of the autocollimator and the tilt angle of the reflector: d=$2\alpha$ f. ($\alpha$ in radians).The tilt angle can be ascertained with the formula: where „f“ is the effective focal length EFL of the autocollimator. Since the „f“ is a constant of the autocollimator, the eyepiece reticle can be graduated in angle units and the tilt angle can be directly read off.

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

## APPLICATIONS

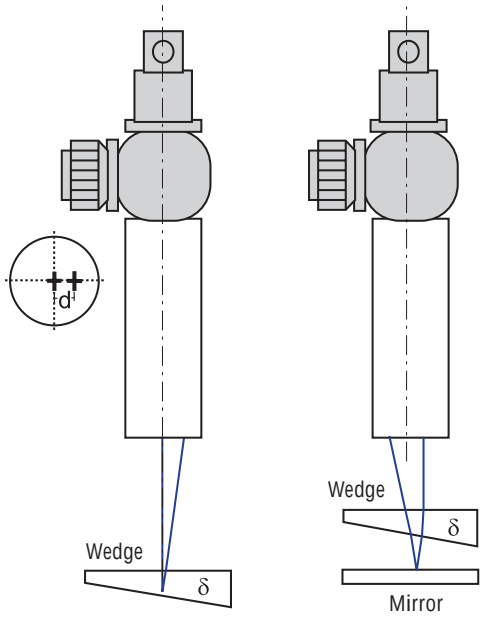


The applications of autocollimators are mainly related to detection and measurement of small angular displacements:

## ANGLE MEASUREMENT OF OPTICAL COMPONENTS

### Measurement of wedge and deflection angle

The parallel beam emerging from autocollimator is reflected from both surfaces of the wedge. The wedge angle δ is given by:



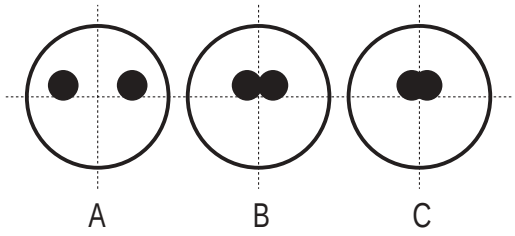

Measurement of wedge and deviation angle with Autocollimators

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

where:
d-displacement of the reflected image
n-refractive index of glass
f-focal length of the autocollimator

For fast measurement in optical manu-facturing, the displacement „d“ for a given angle tolerance and focal length „f“ can be calculated and transfered to the illuminated reticle in form of a pinhole, so that the acertainement of the componenent can be made on a „go“ and „no go“ basis:

A)-Wedge out of tolerance
B )-Wedge at the tolerance limit
C)-Wedge in tolerance




The deflection angle through the wedge γ is given for small angles by:

$$\gamma = \frac{d(n-1)}{2nf}$$

☛ TRIOPTICS Optiangle
☛ TRIOPTICS Autocollimators with pinhole reticles

### Measurement of prisms angles

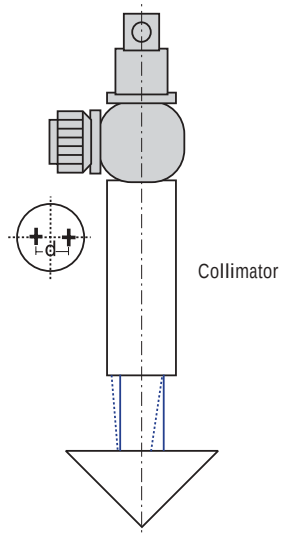
The range of applications in this field is very wide, only some fundamental set ups are presented:

### Internal angle of 90° prisms

The reflected images from the 90° sides (which are insensitive against rotation around the roof edge) are diplaced by an amount „x“, if a deviation from 90° angle „α“is present.

A presence of a displacement in height by the amount „y“ proves a pyramid error „γ“as well:
n-refractive index of glass
f-focal length of the auto-collimator

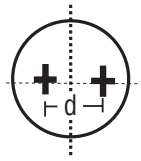
$$\alpha = \frac{x}{4nf} \qquad \gamma = \frac{y}{4nf}$$




Testing the internal angle of prisms

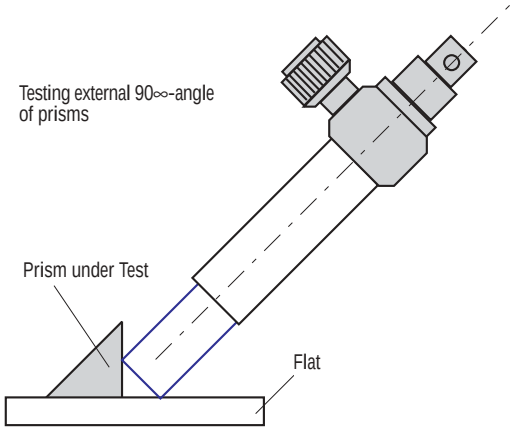
### 90°-Angle of Prisms

The 90° prism is put on a accurate flat surface. The emerging beam of autocollimator is reflected on the prism side and flat and returns along the original path if the angle is exactly 90°. No displacement appears in the eyepiece. Deviations from 90° can be measured in the eyepiece. The error size:




$$\alpha = \frac{d}{4f}$$

where f= focal length of autocollimator. The sign -/+ of the error is determined by defocusing the eyepiece: moving the focal plane of the eyepiece towards objective lens, a negative error results if the distance „d“ becomes smaller.




## 45° Angle of Prisms

a) Relative measurement of 45°-angle

To measure the 45° angle a master prism is used. Both prisms are put on an accurate flat. The 90° angle of the prism under test must be checked first, since the error of this angle will influence the measurement.

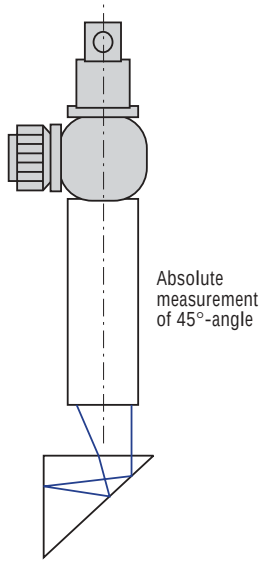
b) Absolute measurement of 45°-angle

The Autocollimator is directed on one side of the 90°-angle. Two images will be produced from both sides of the prism.

The internal reflection within the prism will produce a displacement „d“ depending on the error of the 45° angle „α“:

$$\alpha = \frac{d}{4nf} \pm \frac{\delta}{2}$$

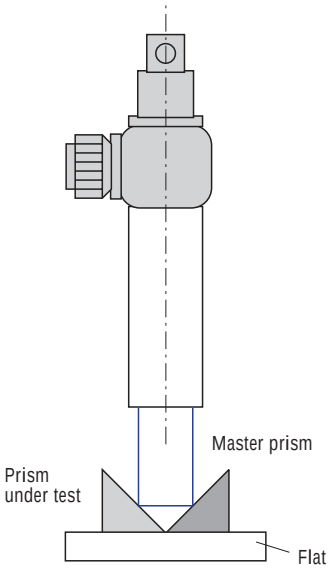
where δ is the error of 90° angle.

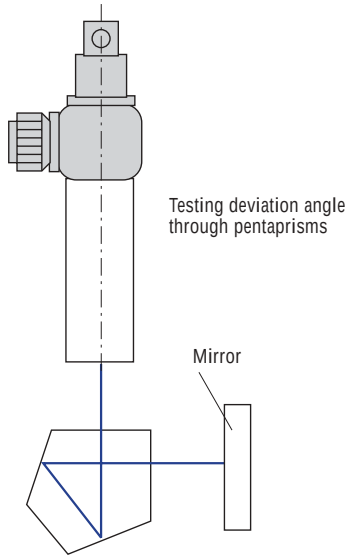



## Measurement of deviaton angle through prisms

The autocollimator is mounted on an adjustable stand and can be tilted at any angle.
A master prism is used to align the autocollimator to the mirror. The master prism is replaced by the prism under test and the angle difference is read off through the eyepiece.

Example: Measurement of deviation angle through pentaprisms.



## CHECKING THE STRAIGHTNESS, SQUARENESS, PARALLELISM AND FLATNESS

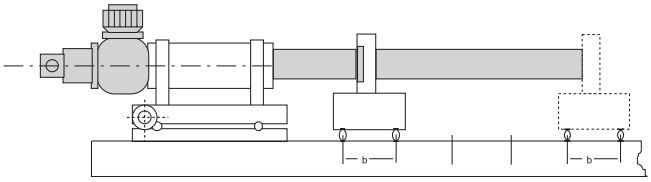
The measurement of geometrical parameters of mechanical parts is a typical application in machine construction, machine tools and aerospace industry.

### Straightness Measurement

A mirror is either moved along the surface or mounted on a movable part of the machine to be measured. The mirror is supported by balls or pins placed at a distance „b“ known as „base length“. Deviations from straightness will result in tilt of the mirror. Deviation from straightness are given by:

$$h = \tan \alpha \; b$$

where:
$\alpha$ = mirror tilt
b = base length

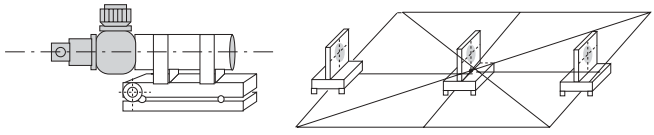


Straightness Measurement
with Autocollimators and Mirrors

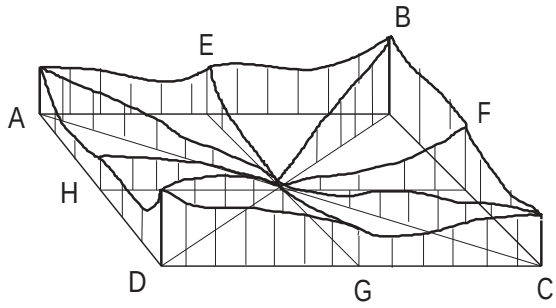
When computerised or electronic autocollimators are used, readings can be automatically entered into computer. The software program permits straightness measurement on machine tool slideways, shafting, stages, rolls etc.

### Flatness Measurement

The „base mirror“ is moved along diagonals and rectangles of the surface to be measured. Along each line a straightness measurement is carried out. The data from surface generators lines are used to calculate the shape of the surface and the deviations from flatness.



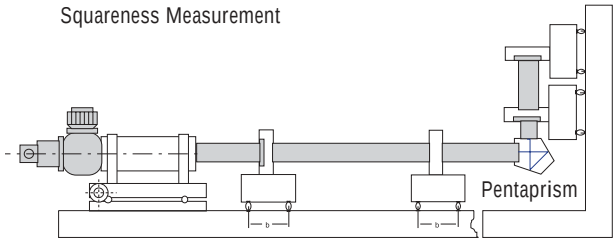
The data can be entered into a computer to produce a topography of the surface under test.




Topography of a surface
measured with Autocollimators

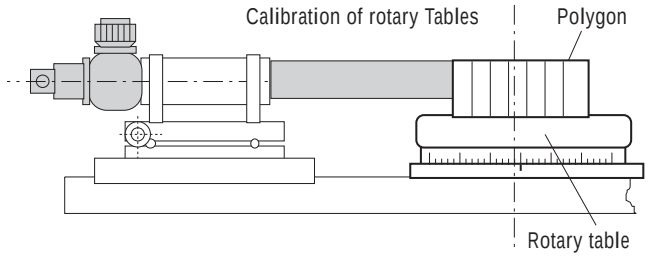
### Squareness Measurement

The procedure is similar with straightness measurement. The measurement of the first surface is made in the same way. Further an accurate pentaprism is used to transfer the autocolimator beam to the second surface. The straightness of the second surface is measured. The data are then combined and corrected for the error of the pentaprism.




## CALIBRATION OF ROTARY TABLES

A reflecting polygon is put on rotary table or dividing head under test. One side of the polygon is squared to the optical axis of the autocollimator. The rotary table is set on zero. The rotary table with the polygon is rotated until next polygon side is square to autocollimator. The graduation of the table is compared with the expected angle.

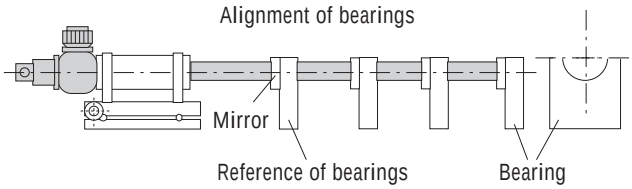


### Measurement of parallelism

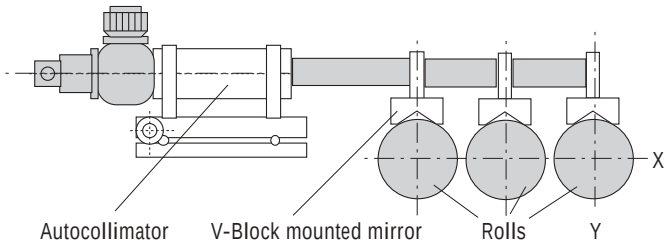
The reference surface is aligned to the autocollimator. The autocollimator is fixed in this position. The mirror is transfered to next surface which is aligned to the same autocollimator:

Example: Parallel alignment of bearings

After the first bearing is squared to autocollimator, the mirror is transfered to the next bearing. Deviation from parallelism is read off and the bearing aligned.




Example: Parallel alignment of rolls.
A mirror mounted on a V-block is put on the first (reference) rolls. After adjustment, the mirror is square to autocollimator. The reference roll is now aligned along X-axis of the autocollimator. The mirror is transfered to the next rolls and the procedure repeated. Two spirit levels mounted on the V-block can be used for levelling the rolls.

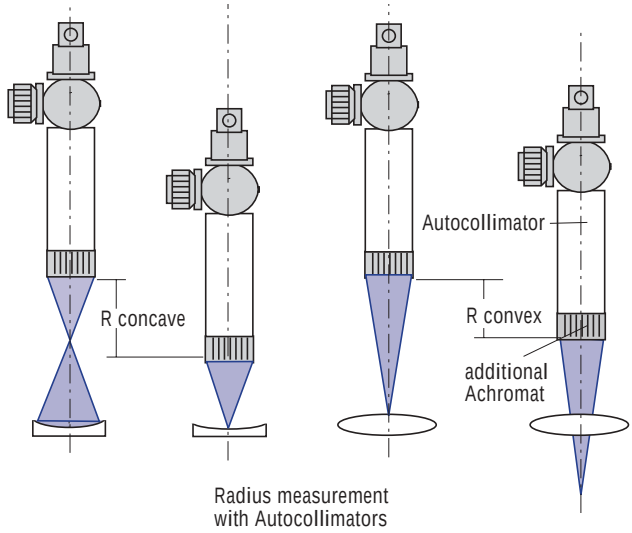


Alignment of rolls

## MEASUREMENT OF OPTICAL PARAMETERS

### Radius of curvature

Aditional achromats are mounted on the one end of the autocollimator tube. The illuminated image of the autocollimator will be projected into the focal plane of the achromat. This image is reflected back from the vertex of the lens and the center of curvature of lens surface. The linear displacement between these two positions - where a sharp image is seen in the eyepiece - gives the radius of curvature. Both concave and convex surfaces can be measured. Spherical and cylindric surfaces can be measured as well. For convex surfaces the back focal length of the achromat must be longer than the radius under test.

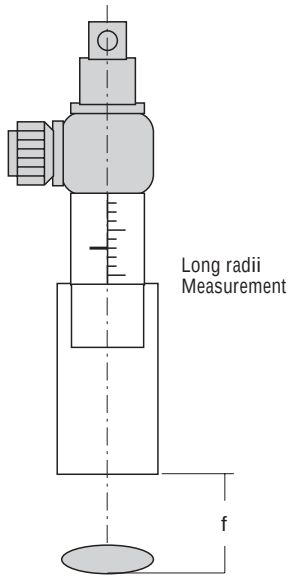


Radius measurement
with Autocollimators

For measurement of very long radii of curvature focusing autocollimators with draw out tubes can be used. Drawing out the tube with the autocollimation head, the autocollimator can be focused on the lens vertex and centre of curvature. Since the nearest focus point for a focusing autocollimator is in a distance of some meters and the focusing on the vertex is practically difficult, following configuration is recommended:
The lens under test is positioned with the vertex at a distance „f“ from autocollimator lens.
(f-effective focal length EFL of the autocollimator).
After focusing in the centre of curvature of the lens, the radius is given by:

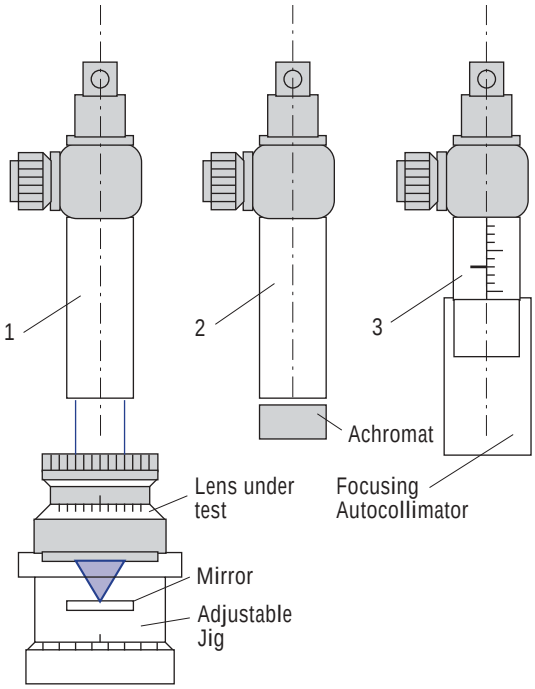
$$R = \frac{f^2}{d}$$

where d=dispacement of the draw out tube read off on its scale



## Measurement and Testing of Flange Focus

The Flange Focus known also as Flange Focal Length (FFL) or Flange Focal Distance (FFD) is the distance between the locating surface of the lens mount and the image plane. Checking and setting of this distance is important especially for camera lenses. The film plane is replaced by a mirror mounted on an adjustable jig.




Testing Flange Focal Distance

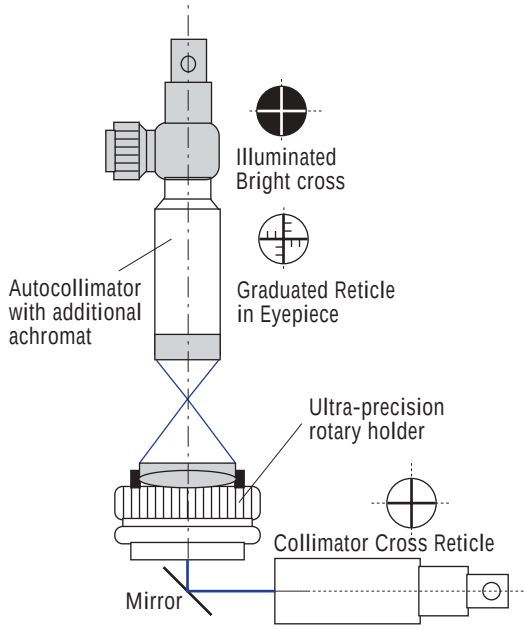
For checking the FFD when the lens under test is set to infinity a standard autocollimator (1) is used. For testing the lens set at other distances as infinity is recommended:

- achromats attached to the autocollimator for short distances (2)
- a focusing autocollimator for infinity and long distances (3)

The reticle normally used is a Siemens Star. When the reticle is sharply seen at the given distance, the camera lens is correctly set. Deviations can be measured with an adjustable jig and the lens correspondingly adjusted.

## Measurement of Centration errors

The autocollimators can be used for measurement of centration errors in transmission (see collimators applications) or in reflection: For measurement in reflection additional achromats are attached to autocollimator. The precision rotary holder is equiped with a chuck runing true to the rotation axis. The spherical surface under test is located on the front surface of the chuck and held in contact by means of a small vacuum device. When rotated, the surface under test will reflect the image reticle. This image describes a circle with a diameter depending on the decentration size.



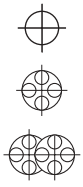

Measuring Centration in Transmission

TRIOPTICS Precision Rotary Holders
TRIOPTICS OptiAngle

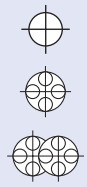
# COLLIMATORS

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View | Reticle Adapter |
|---|---|---|---|---|---|---|
| **COL 100-38** | 3-100-001 | 100 | 38,1 | 30 | 6° | |
| **COL 150-38** | 3-100-002 | 150 | 38,1 | 30 | 4° | |
| **COL 200-38** | 3-100-003 | 200 | 38,1 | 30 | 3° | |
| **COL 300-38** | 3-100-004 | 300 | 38,1 | 30 | 2° | |
| **COL 300-38 RC** | 3-100-014 | | | | | |
| **COL 300-38 RC/FC** | 3-100-114 | | | | | |
| **COL 300-57** | 3-100-005 | 300 | 57 | 50 | 2° | |
| **COL 300-57 RC** | 3-100-015 | | | | | |
| **COL 300-57 RC/FC** | 3-100-115 | | | | | |

## STANDARD COLLIMATORS (CONTINUED)
Infinity Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View | Reticle Adapter |
|---|---|---|---|---|---|---|
| **COL 500-57** | 3-100-006 | 500 | 57 | 50 | 1,2° |  |
| **COL 500-57 RC** | 3-100-016 | | | | | |
| **COL 500-57 RC/FC** | 3-100-116 | | | | | |
| **COL 1000-115** | 3-100-008 | 1000 | 115 | 100 | 0,6° | |
| **COL 1000-115 RC** | 3-100-018 | | | | | |
| **COL 1000-115 RC/FC** | 3-100-118 | | | | | |

## FOCUSING COLLIMATORS
Finite Distance Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View | Focusing range | Reticle Adapter |
|---|---|---|---|---|---|---|---|
| **COL F300-38±25** | 3-101-004 | 300 | 38,1 | 30 | 2° | ∞ to±3,6 m |  |
| **COL F300-38±25 RC** | 3-101-014 | | | | | | |
| **COL F300-38±25 RC/FC** | 3-101-114 | | | | | | |
| **COL F300-57±25** | 3-101-005 | 300 | 57 | 50 | 2° | ∞ to±3,6 m | |
| **COL F300-57±25 RC** | 3-101-015 | | | | | | |
| **COL F300-57±25 RC/FC** | 3-101-115 | | | | | | |
| **COL F500-57±50** | 3-101-006 | 500 | 57 | 50 | 1,2° | ∞ to±5 m | |
| **COL F500-57±50 RC** | 3-101-016 | | | | | | |
| **COL F500-57±50 RC/FC** | 3-101-116 | | | | | | |
| **COL F1000-115±50** | 3-101-008 | 1000 | 115 | 100 | 0,6° | ∞ to±20 m | |
| **COL F1000-115±50 RC** | 3-101-018 | | | | | | |
| **COL F1000-115±50** | 3-101-118 | | | | | | |

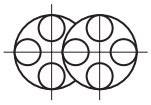
### Delivery Kit

The Collimators are delivered as complete - ready to work-instruments:
- tube mounted objective lens
- reticle adapter incl. reticle
- illumination with green filter and 5W/6V bulb

The reticle adapters which might be included are:

Standard reticle adapter including one reticle at choice

RC-Reticle changer with 4 positions. Four reticles at choice are included.



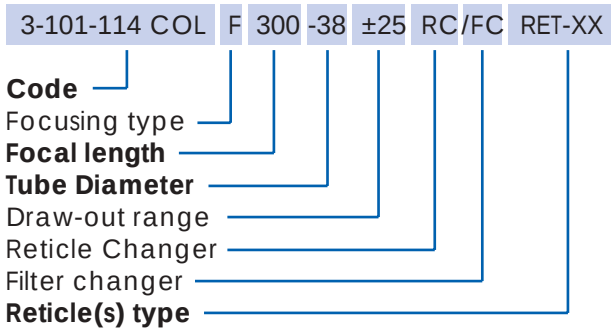
RC/FC-Reticle changer with 4 positions. Four reticle at choice are included. Filter changer with 4 positions. One green and one white difuser are included. Further filters on request.

### Optional Items

- Power supply (Transformer) for illumination
- Holders
- Other illumination devices (cold light source 150W, halogene illumination 20W)

### Ordering Information

To order a collimator please specify:




## TELESCOPES

### PRODUCT RANGE AND SPECIFICATION

STANDARD TELESCOPES
Infinity Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View | Resolution for reticle line width 10 µm |
|---|---|---|---|---|---|---|
| **TEL 100-38**<br>**TEL 100-38 R** | 3-100-021<br>3-100-031 | 100 | 38,1 | 30 | 6° | 20 arcsec |
| **TEL 150-38**<br>**TEL 150-38 R** | 3-100-022<br>3-100-032 | 150 | 38,1 | 30 | 4° | 14 arcsec |
| **TEL 200-38**<br>**TEL 200-38 R** | 3-100-023<br>3-100-033 | 200 | 38,1 | 30 | 3° | 10 arcsec |
| **TEL 300-38**<br>**TEL 300-38 R** | 3-100-024<br>3-100-034 | 300 | 38,1 | 30 | 2° | 7 arcsec |
| **TEL 300-57**<br>**TEL 300-57 R** | 3-100-025<br>3-100-035 | 300 | 57 | 50 | 2° | 7 arcsec |
| **TEL 500-57**<br>**TEL 500-57 R** | 3-100-026<br>3-100-036 | 500 | 57 | 50 | 1,2° | 4 arcsec |
| **TEL 1000-115**<br>**TEL 1000-115 R** | 3-100-028<br>3-100-038 | 1000 | 115 | 100 | 0,6° | 2 arcsec |

## FOCUSING TELESCOPES
Finite Distance Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View | Resolution for reticle line width 10 µm | Focusing range |
|---|---|---|---|---|---|---|---|
| **TEL F300-38±25**<br>**TEL F300-38±25 R** | 3-101-024<br>3-101-034 | 300 | 38,1 | 30 | 2° | 7 arcsec | ∞ to±3,6 m |
| **TEL F300-57±25**<br>**TEL F300-57±25 R** | 3-101-025<br>3-101-035 | 300 | 57 | 50 | 2° | 7 arcsec | ∞ to±3,6 m |
| **TEL F500-57±50**<br>**TEL F500-57±50 R** | 3-101-026<br>3-101-036 | 500 | 57 | 50 | 1,2° | 4 arcsec | ∞ to±5 m |
| **TEL F1000-115±50**<br>**TEL F1000-115±50** | 3-101-028<br>3-101-038 | 1000 | 115 | 100 | 0,6° | 2 arcsec | ∞ to±20 m |

### Delivery Kit

The Telescopes designated by the code mentioned in the table are delivered as complete -ready to work-instruments:

- tube mounted objective lens
- reticle adapter incl. reticle
- standard eyepiece, magnification 16x

### Optional Items

- Eyepieces with magnification 10x, 12x and 25x
- Holders
- Eyepiece micrometers
- Additional achromats in mount fitting on the objective lens tube
- CCD-camera attachment

### Ordering Information

To order a telescope please specify:

| 3-100-036 TEL | 500 | -57 | R | (EPC25) | RET-XX |
|---|---|---|---|---|---|

**Code**
**Focal length**
**Tube Diameter**
Right angle viewing
Non standard eyepiece
**Reticle(s) type**

## AUTOCOLLIMATORS

### PRODUCT RANGE AND SPECIFICATION

## STANDARD AUTOCOLLIMATORS
Infinity Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View/ Measuring Range | Resolution for reticle line width 10 µ | Beam Splitter in Mount with reticles |
|---|---|---|---|---|---|---|---|
| **ACM 100-38** | 3-100-061 | 100 | 38,1 | 30 | 6°/3° | 10 arcsec | |
| **ACM 150-38** | 3-100-062 | 150 | 38,1 | 30 | 4°/2° | 7arcsec | |
| **ACM 200-38** | 3-100-063 | 200 | 38,1 | 30 | 3°/1,5° | 5 arcsec | |
| **ACM 300-38** | 3-100-064 | | | | | | |
| **ACM 300-38 RC** | 3-100-094 | 300 | 38,1 | 30 | 2°/1° | 3,5 arcsec | |
| **ACM 300-38 RC/FC** | 3-100-194 | | | | | | |
| **ACM 300-57** | 3-100-065 | | | | | | |
| **ACM 300-57 RC** | 3-100-095 | 300 | 57 | 50 | 2°/1° | 3,5 arcsec | |
| **ACM 300-57 RC/FC** | 3-100-195 | | | | | | |
| **ACM 500-57** | 3-100-066 | | | | | | |
| **ACM 500-57 RC** | 3-100-096 | 500 | 57 | 50 | 1,2°/0,6° | 2 arcsec | |
| **ACM 500-57 RC/FC** | 3-100-196 | | | | | | |
| **ACM 1000-115** | 3-100-068 | | | | | | |
| **ACM 1000-115 RC** | 3-100-098 | 1000 | 115 | 100 | 0,6°/0,3° | 1 arcsec | |
| **ACM 1000-115RC/FC** | 3-100-198 | | | | | | |

Autocollimator with Reticle Changer (RC) and Filter Changer (FC)

The reticle and filter changer feature 4 locations for reticles and filters respectively

## AUTOCOLLIMATORS
## WITH EYEPIECE MICROMETERS
Infinity Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Measuring range / Micrometer range | Resolution for Micro/ Digi (arcsec) |
|---|---|---|---|---|---|---|
| **ACM 200-38 Micro** | 3-100-073 | 200 | 38,1 | 30 | 1,5°/0,6° | 2,5 |
| **ACM 300-38 Micro**<br>**ACM 300-38 Digi** | 3-100-074<br>3-100-084 | 300 | 38,1 | 30 | 1°/0,4° | 1,7/<br>0,35 |
| **ACM 300-57 Micro**<br>**ACM 300-57 Digi** | 3-100-075<br>3-100-085 | 300 | 57 | 50 | 1°/0,4° | 1,7/<br>0,35 |
| **ACM 500-57 Micro**<br>**ACM 500-57 Digi** | 3-100-076<br>3-100-086 | 500 | 57 | 50 | 0,6°/0,23° | 1/<br>0,2 |
| **ACM 1000-115 Micro**<br>**ACM 1000-115 Digi** | 3-100-078<br>3-100-088 | 1000 | 115 | 100 | 0,3°/0,11° | 0,5/<br>0,1 |

Autocollimator with eyepiece micrometer
Micro-Mechanical Micrometer Digi-Digital Micrometer

## FOCUSING AUTOCOLLIMATORS
Finite Distance Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View/ Measuring Range | Focusing Range | Beam Splitter in Mount with reticles |
|---|---|---|---|---|---|---|---|
| **ACM F 300-38±25** | 3-101-064 | 300 | 38,1 | 30 | 2°/1° | ∞ to ±3,6m | |
| **ACM F 300-38±25 RC** | 3-101-094 | | | | | | |
| **ACM F 300-38±25 RC/FC** | 3-101-194 | | | | | | |
| **ACM F 300-57±25** | 3-101-065 | 300 | 57 | 50 | 2°/1° | ∞ to ±3,6m | |
| **ACM F 300-57±25 RC** | 3-101-095 | | | | | | |
| **ACM F 300-57±25 RC/FC** | 3-101-195 | | | | | | |
| **ACM F 500-57±25** | 3-101-066 | 500 | 57 | 50 | 1,2°/0,6° | ∞ to ±5m | |
| **ACM F 500-57±25 RC** | 3-101-096 | | | | | | |
| **ACM F 500-57±25 RC/FC** | 3-101-196 | | | | | | |
| **ACM F 1000-115±25** | 3-101-068 | 1000 | 115 | 100 | 0,6°/0,3° | ∞ to ±20m | |
| **ACM F 1000-115±25 RC** | 3-101-098 | | | | | | |
| **ACM F 1000-115±25 RC/FC** | 3-101-198 | | | | | | |

Focusing Autocollimator with Reticle Changer (RC)
and Filter Changer (FC)

## FOCUSING AUTOCOLLIMATORS WITH EYEPIECE MICROMETERS

Flinite Distance Setting

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Focusing range | Measuring range/ Micrometer range | Resolution (arcsec) |
|---|---|---|---|---|---|---|---|
| **ACM F 300-38±25 Micro** | 3-101-074 | 300 | 38,1 | 30 | ∞ to ±3,6m | 1°/0,4° | 1,7 |
| **ACM F 300-38±25 Digi** | 3-101-084 | | | | | | 0,35 |
| **ACM F 300-57±25 Micro** | 3-101-075 | 300 | 57 | 50 | ∞ to ±3,6m | 1°/0,4° | 1,7 |
| **ACM F 300-57±25 Digi** | 3-101-085 | | | | | | 0,35 |
| **ACM F 500-57±50 Micro** | 3-101-076 | 500 | 57 | 50 | ∞ to ±5m | 0,6°/0,23° | 1 |
| **ACM F 500-57±50 Digi** | 3-101-086 | | | | | | 0,2 |
| **ACM F 1000-115±50 Micro** | 3-101-078 | 1000 | 115 | 100 | ∞ to ±20m | 0,3°/0,11° | 0,5 |
| **ACM F 1000-115±50 Digi** | 3-101-088 | | | | | | 0,1 |

## LARGE FIELD AUTOCOLLIMATORS

To meet customer requirements for testing optical instruments with large field of view, TRIOPTICS developed a new and unique line of autocollimators, collimators and telescopes providing a significant increase of field of view. Equiped with suitable reticles the Large Field Autocollimators give for the same focal length a field of view larger by 50-100% compared with the standard line.

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View/Measuring range | Resolution for reticle line width 10 µm (arc sec) |
|---|---|---|---|---|---|---|
| **ACM 300-57 LF** | 3-100-265 | 300 | 57 | 50 | 3°/1,5° | 3,5 |
| **ACM 500-57 LF** | 3-100-266 | 500 | 57 | 50 | 2,4°/1,2° | 2 |
| **ACM 1000-115 LF** | 3-100-268 | 1000 | 115 | 100 | 0,9°/0,45° | 1 |

## LED-AUTOCOLLIMATORS

The LED-Autocollimators are light, compact Autocollimators made according MIL-Standards (high and low temperature, shocks, humidity etc). The LED-Illumination enable a practically unlimited life period. The power supply is possible at 12V or 24V or ensured by a battery.

| Type | Code | Focal length (mm) | Tube diameter (mm) | Free Aperture (mm) | Field of View/ Measuring Range | Resolution for reticle line width 10 µ | Beam Splitter in Mount with reticles |
|---|---|---|---|---|---|---|---|
| **ACM 140-40 LED** | 3-100-362 | 140 | 40 | 30 | 4°/2° | 7 arcsec | |

### Delivery Kit

The Autocollimators are delivered as complete -ready to work-instruments including following parts: :

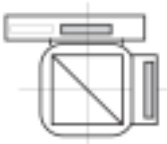
- Tube mounted objective lens
- Beam splitter mount with reticles and eyepiece micrometers*
- Eyepiece
- Illumination device with green filter and 5W/6V bulb

*for Autocollimators with eyepiece micrometers only

### Optional Items

- Power supply (Transformer) for Ilumination
- Eyepieces with magnification 10x, 12x and 25x
- Holders
- Other illumination devices (cold light source 150W, halogene illumination 20W)
- Additional achromats in mount fitting on the objective lens tube
- CCD-camera attachement
- Mirrors

The available Beam **Splitter Mounts** are of different types : Standard Beam Splitter Mount including two reticle at choice



**RC**-Beam Splitter Mount with illuminated Reticle Changer (4 positions for collimator reticles) and one eyepiece reticle. Five reticles at choice are included.

**RC/FC**-Beam Splitter Mount with illuminated Reticle Changer .
Filter Changer with 4 positions. One green and one white difuser are included. Further filters on request.

Large Field Beam Splitter Mount including two reticle at choice

## Ordering Information

To order an autocollimator please specify:

| 3-101-096 ACM | F | 500- | 57 | ±50 | RC | RET-XX |
|---|---|---|---|---|---|---|

**Code**
Focusing type
**Focal length**
**Tube Diameter**
Draw-out range
Reticle Changer
**Reticle(s) type**

| 3-100-088 ACM | 1000 | - | 115 | Digi | RET-XX |
|---|---|---|---|---|---|

**Code**
**Focal length**
**Tube Diameter**
Eyepiece Digital Micrometers (2 pcs)
**Reticle(s) type**

# DIOPTER TELESCOPES

## Operating Principle and Applications

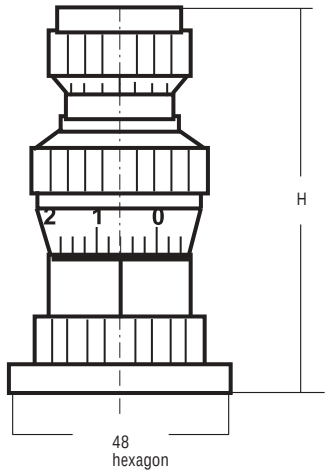
The Diopter Telescope or Dioptometer is a focusing telescope measuring the power of lenses in diopters. The results of the measurement can be read off on a graduated scale.

The Diopter Telescopes have wide applications in the field of optical testing. Most important applications include:

- Testing diopter graduation, focusing range and infinity („zero“) setting of eyepieces.
- Measurement of power of lenses
- Testing the astigmatism of telescopes
- Measuring the field curvature of lenses

The measurements with Diopter Telescopes include following steps:

- the eyepiece of the Diopter Telescope is rotated until its reticle is seen sharp and clear. The focusing ring is set to zero.
- the Diopter Telescope is placed with its supporting flange on the eyepiece or the telescope under test. The eyepiece of the telescope under test is rotated until its reticle is seen sharp and clear. This is the zero setting of the eyepiece.
- Further measurements are made by rotating the eyepiece under test to the next graduation and focusing the Dioptometer correspondingly. The reading is done directly on the diopter graduated scale.



## Product Range and Specification

The supporting flange of TRIOPTICS Dioptometers is hexagonal (48 mm wide) and removable. After removing the flange, the connection thread M 38x1 mm can be used to attach the Dioptometer to custom holders or other devices.

The size of the smallest division is important for accurate reading. All TRIOPTICS Dioptometers (except for 3-100-298) have large graduations and permit easy reading and accurate estimation at half of the smallest division. The eyepieces are interchangeable and can be adapted to custom needs.

| Type | Code | Focal length (mm) | Field of View | Height H (mm) | Measuring range / (Diopter) | Graduation (Diopter) |
|---|---|---|---|---|---|---|
| **DPT-5/+5** | 3-100-295 | 40 | 13° | 75-92 | -5 to +5 | 0,2 |
| **DPT-3/+1** | 3-100-296 | | | 82-90 | -3 to +1 | 0,1 |
| **DPT-1/+3** | 3-100-297 | | | 77-83 | +3 to -1 | 0,1 |
| **DPT-5/+5** | 3-100-298 | | | 75-92 | -5 to +5 | 0,1 |

## DYNAMETER

The Dynameter is used in optical testing for:

- Measurement of the diameter of exit pupil of optical instruments
- Checking the distance between eyepiece and exit pupil
- Measurement of magnification of telescopes

| Type | Code | Magnification | Distance range | Diameter range | Reticle |
|---|---|---|---|---|---|
| **DYN 90** | 3-100-291 | 12 x | 90mm, div. 0,5mm | 10mm | 10mm with div. 0,1mm |

# SQUARE BODY TELESCOPE AND COLLIMATOR

The collimators and telescopes with square body have a cross reticle accurately aligned to the body flat surface i.e.mechanical axis of the instrument. The square body is used as a reference surface in solving alignment problems. The telescope is normally equiped with the standard eyepiece EPC 00-15 (magnification 16x). The collimator includes the standard illumination ILL 5W-6V. Further eyepieces and illumination devices of OPTITEST are available on request.

| Type | Code | Focal length (mm) | Field of View | Free Aperture (mm) | Magnification | Alignment optical/ mechanical axis |
|---|---|---|---|---|---|---|
| **TEL 150-40x40** | 3-100-030 | 150 | 4° | 30 | 9,5 x | >10arc sec |
| **COL150-40x40** | 3-100-010 | 150 | 4° | 30 | - | >10arc sec |

# OPTO-MECHANICAL ASSEMBLIES AND COMPONENTS

The OPTITEST system is configurated from basic opto-mechanical components which are modular, compatible to each other and common to most of the instruments.
The opto-mechanical components are specifically designed to allow instruments reconfiguration on site without any adjustments. The advantages of this modular approach are significant from point of view of flexibility and cost efficiency:

• to adapt the instruments to new applications might be sufficient to buy some components only, avoiding the costly procurement of a complete new instrument.

• setting up a modified instrument is easy and fast, since no adjustments are necessary.

• the OPTITEST system is continuously developed, so that new components and features (e.g. image processing) enhance the utility of existing instruments.

Description and technical data of the opto-mechanical assemblies and components of OPTITESt are presented on the following pages:

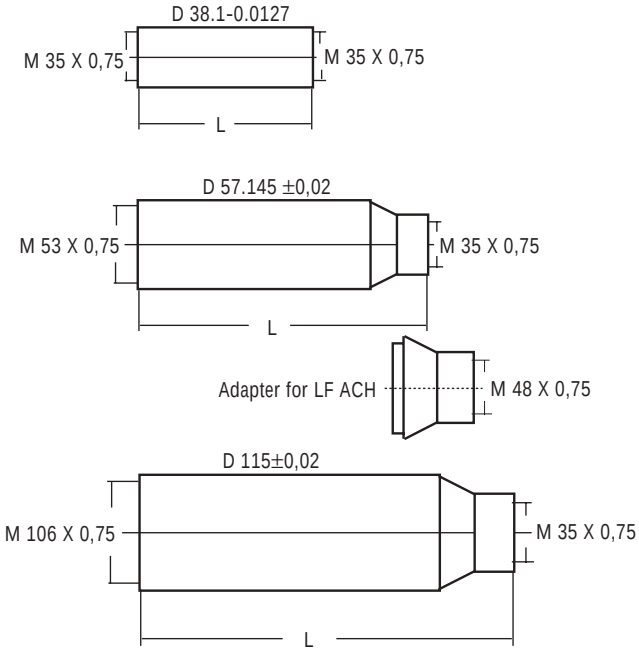
## TUBE MOUNTED OBJECTIVE LENSES

The tube mounted objective lenses represent one of the main components of OPTITEST Autocollimators, Collimators and Telscopes. Typical features of these basic elements are:
• barrel made of hardened steel with hard chrome surface

- front end surface accurately square to optical axis
- front end surface with female thread M35x0.75 mm (for barrels D 38 mm) and M53x0.75 (for barrels D 57 mm) to allow addition of accessories (achromats in mount, beam deflecting mirrors atc.). Similarly with the instruments described before, the tube mounted objective lenses are available in two different types:

## TUBE MOUNTED OBJECTIVE LENS
Infinity setting

| Type | Code | Focal length Diameter (mm) | Length L (mm) | Free aperture (mm) |
|---|---|---|---|---|
| **OBJ-100-38** | 3-200-001 | f = 100 D 38 | 70 | 30 |
| **OBJ-150-38** | 3-200-002 | f = 150 D 38 | 112 | 30 |
| **OBJ-200-38** | 3-200-003 | f = 200 D 38 | 163 | 30 |
| **OBJ-300-38** | 3-200-004 | f = 300 D 38 | 265 | 30 |
| **OBJ-300-57** | 3-200-005 | f = 300 D 57 | 273 | 50 |
| **OBJ-500-57** | 3-200-006 | f = 500 D 57 | 464 | 50 |
| **OBJ-1000-115** | 3-200-008 | f = 1000 D 115 | 980 | 100 |




- The first type represents objective lenses mounted in barrels having fixed length. The barrel length is designed such, that when attaching the reticle adapter to the barrel, the reticle is in the focal plane of the objective lens and the emerging beam is parallel. The reticle image is projected to infinity. This type of adjustment is known as „Infinity Setting“.

- The second type of objective lenses is similarly built, however, a focusing device attached to the tube (barrel) containing the objective lens, allow for variation of the distance between the reticle and lens. The focusing range is normally selected so that in the mid position the reticle is placed in the focal plane of the lens.

- This position which correspondes to the „Infinity Setting“ is engraved on the scale of the focusing device as „0“.

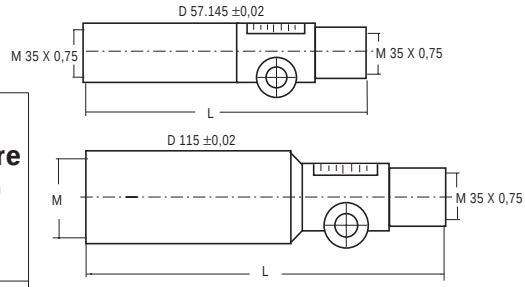
- Moving the reticle away from objective lens will result in a convergent beam. The image of the reticle is real and projected at a finite distance. This region of the scale is marked as „+“ focusing range.

- Moving the reticle toward the objective lens will result in a divergent beam. If the beam diverges, a virtual image is produced at the aparent crossing point of the beam rays.This point is also located at a finite distance. This region of the scale is marked as „-“ focusing range.

  This type of adjustment is known as „Finite Distance Setting“.

## TUBE MOUNTED OBJECTIVE LENSES WITH FOCUSING DEVICE

Finite Distance Setting

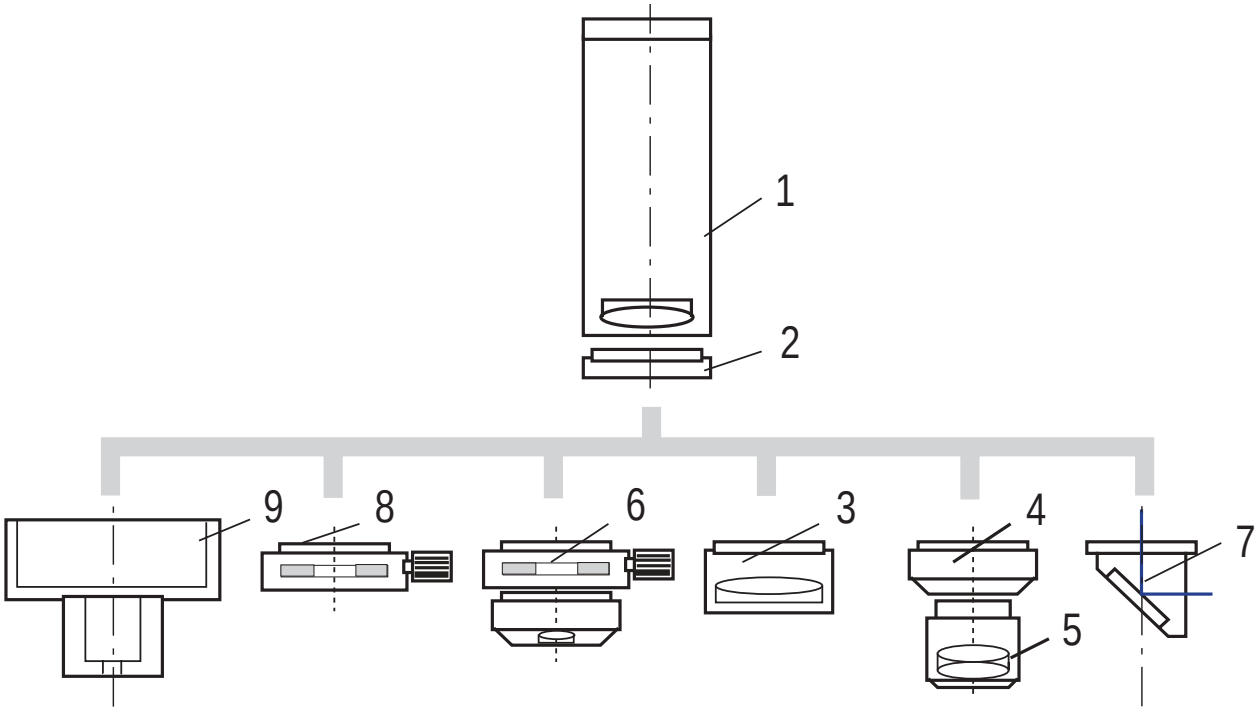



| Type | Code | Focal length Diameter/Draw Out (mm) | Length L (mm) | Free aperture (mm) |
|---|---|---|---|---|
| **OBJ-F300-57** | 3-201-005 | f = 300 D 57±25 | 259 | 50 |
| **OBJ-F500-57** | 3-201-006 | f = 500 D 57±50 | 469 | 50 |
| **OBJ-F1000-115** | 3-201-008 | f = 1000 D115±50 | 948 | 100 |

## ACCESSORIES

for tube mounted objective lenses

For the tube mounted objective lenses of the OPTITEST line a large selection of accessories is available:




1- Tube mounted objective lens D 38mm
2- Front cover ring
3- Achromat in mount
4- Adapter for micro-objectives
5- Micro-objective
6- Dual Adapter
7- Mounted deflecting mirror
8- Iris diaphragm in mount
9- Laser Alignment Attachment

## ACHROMATS IN MOUNT

The OPTITEST achromats are highly corrected objective lenses mounted in a cell having a mechanical interface (thread M 35x0.5 mm) fitting to the end of the objectiv lens barrel. The achromats in mount can be use for gene ral purpose measurements or in connections with the OPTITEST autocollimators, collimators and telescopes.
After removing the front cover ring of the ob jective lens tube, the achromats in mount can be directly screwed on it. The parallel beam emerging from objective lens tube is now fo- cused in the focal plane of the achromat. Ty- pical applications for this set up:

- radius measurement of spherical and cylindrical surfaces (autocolli mators)
- reading or observation of proces ses (telescopes)
- measurement of FFD(flange focal distance) of camera lenses set to short distances (autocollimators)
- MTF measurements, etc.

The range of achromats in mount is presented bellow:

| Type | Code | Focal length Diameter (mm) | Free aperture (mm) |
|---|---|---|---|
| **AMT 50-38** | 3-200-070 | 50/38 | 18 |
| **AMT 100-38** | 3-200-071 | 100/38 | 30 |
| **AMT 150-38** | 3-200-072 | 150/38 | 30 |
| **AMT 200-38** | 3-200-073 | 200/38 | 30 |
| **AMT 300-38** | 3-200-074 | 300/38 | 30 |
| **AMT 500-38** | 3-200-077 | 500/38 | 30 |
| **AMT 300-57** | 3-200-075 | 300/57 | 50 |
| **AMT 500-57** | 3-200-076 | 500/57 | 50 |
| **AMT-1000-115** | 3-101-078 | 1000/115 | 100 |

Further achromats as AMT 140-38, AMT 275-40, etc. can be delivered on request.

## DUAL ADAPTER

## IRIS DIAPHRAGM

The Iris Diaphragm assembly contains an iris diaphragm adjustable between 2...30 mm. The Iris Diaphragm assembly can be attached to any tube munted objective lens of OPTITEST.On the other side the Iris Diaphragm assembly has a mechanical interface fitting to :

- achromat mount of the Dual Adapter
- micro-objectives adapter
- achromats in mount of OPTITEST line

The Dual Adapter assembly incorporates:

- a Iris Diaphragm in mount with a connection thread to the end of objective lens barrel
- an achromat in a mount which has a circu lar (ring shape) aperture around the achro mat.

When mounted on an autocollimator, the Dual Adapter allows for simultaneous observation of the autocollimation image (through the circular aperture around the achromat) and direct viewing of the surface structure (through the achromat) of the plate placed in the front of the autocollimator. For viewing only, the built in iris diaphragm is used. Closing the diaphragm covers the autocollimation beam, so that observation of the surface through the achromat is possible. Applications include the alignment of wafers and lens systems.

The working distance between the Autocollimator and the surface under test depends on the back focal length (BFL) of the achromat mounted in the Dual Adapter. The range of achromats used in the Dual Adapter is from 10 to 200 mm. Further achromats for specific applications are available on request.

The Iris Diaphragm can be used to observe either the autocollimation image or the image on a surface at finite distance. It can be used as well to adjust the illumination intensity when measuring samples with different reflectivities.

## ADAPTER FOR MICRO-OBJECTIVES

The Adapter for Micro-objectives enables the fitting of different micro-objectives to the objective lens barrel of the Autocollimator. In this way it is possible to focuss the autocollimator beam on a surface placed at the working distance of the microobjective.

The Microobjectives have different magnifications and working distances to suit many applications : observation of structure of surfaces, measuring of radii of curvature of spherical surfaces, measuring of BFL, etc.

## DEFLECTION MIRROR IN MOUNT

The Deflection Mirror in Mount is used to deviate the beam of autocollimators, collimators and telescopes by 90°. For this a mirror is mounted at an angle of 45° related to the optical axis of the instrument. The mount of the deflection mirror can be attached to the end of the objective lens tubes.
The Deflection Mirror in Mount increases the versatility of autocollimators and other instruments since these can be used for measurements in horizontal and vertical directions without exchanging the instrument holder.

## LASER ALIGNMENT ATTACHMENT

The alignment of autocollimators to a mirror might be difficult, if the distance is long and the instrument has a long focal length (i.e. small field of view). The TRIOPTICS Laser Alignment Attachment can be easily mounted directly on the end of the objective lens barrel. A small laser diode is mounted inside concentrically with the mechanical interface to objective lens tube. The visible laser beam helps to align quickly the mirror or the autocollimator. The device is supplied complete including power supply.

Laser Alignment Attachment D 57 mm

| | Type | Code | Technical Data |
|---|---|---|---|
| Dual Adapter | **DA 8-38** | 3-200-026 | Outer dia. 38 mm,Achromat dia 8 mm, Diaphragm 2-30 mm |
| Dual Adapter | **DA 10-38** | 3-300-027 | Outer dia. 38 mm,Achromat dia 10 mm, Diaphragm 2-30 mm |
| Iris Diaphragm | **ID 2-30** | 3-300-025 | Range 2-30 mm connection threads M 35 x 0,5 mm |
| Adapter for Microobjectives | **AMO 38** | 3-300-070 | Outer dia. 38 mm thread M 35 x 0,5 mm/ thread 4,5“x 1/36“ |
| Microobjective | **Micro 3,2** | 3-300-073 | Magnification 3,2 X Working Distance 31 mm |
| Microobjective | **Micro 6,3** | 3-300-074 | Magnification 6,3 X Working Distance 12 mm |
| Microobjective | **Micro 10** | 3-300-075 | Magnification 10 X Working Distance 7,5 mm |
| Deflection Mirror | **DMF 38** | 3-300-091 | Mirror dia 36 mm, λ/ 6 |
| Deflection Mirror | **DMF 57** | 3-300-092 | Mirror dia 75 mm, λ/ 5 |
| Laser Alignment Attachment | **LA 57** | 3-300-095 | Max. distance: 25 m |

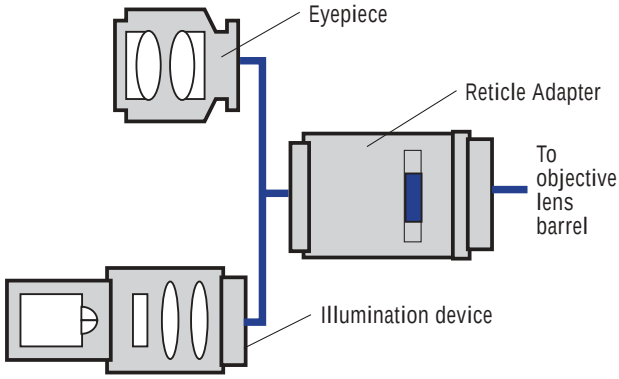
## RETICLE ADAPTERS

A Reticle Adapter is basically an assembly containing :

- one reticle in mount when designated for collimators and telescopes
- a beamsplitter and two reticles in mount for use in autocollimators
- mechanical interface for connection to tu be mounted objective lenses (M35x0.75mm)
- mechanical interface for connection with eyepieces and illumination devices (M27x0.5mm).

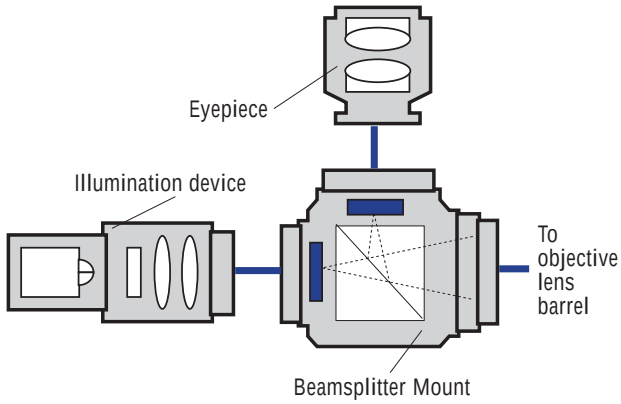
RETICLE ADAPTER FOR COLLIMATORS AND TELESCOPES

The Reticle Adapters for collimators and telescopes as well as the Beamsplitter Mounts for autocollimators come standard with dust covers when ordered separately.




RETICLE ADAPTER FOR AUTOCOLLIMATORS BEAMSPLITTER MOUNTS

The Beamsplitter Mount (BSP) contains a beamsplitter and two reticles in mount for use in autocollimator. The Beamsplitter Mounts with the eyepiece and illumination forms an assembly known as Autocollimation Head. Some Autocollimation Heads (ACH) are illustrated below:




| Type | Code | No. of reticles | Technical Data |
|---|---|---|---|
| **RA** | 3-200-041 | 1 | Standard Reticle Adapter. It contains one fixed reticle. |
| **90°-RA** | 3-200-042 | 1 | 90°-Standard Reticle Adapter. A beamsplitter is used for beam deviation. |
| **RA Micro** | 3-200-043 | 1 | Reticle Adapter with two micrometers. Range for reticle displacement: 4mm. Resolution: 0,005 mm |
| **RA-RC** | 3-200-045 | 4 | Reticle Adapter with Reticle Changer. The four reticles positioned by rotating indexing wheel |
| **RA-RC/FC** | 3-200-046 | 4 | Reticle Adapter with Reticle Changer and Filter Changer. The 4 reticles and 4 filters positioned by rotating indexing wheels. Standard included: one green filter, one diffuser. Two filter locations empty. Filter dia. 20 mm |

Autocollimation Heads From left:
Standard Autocollimation Head (ACH)
90°-viewing
ACH with eyepiece micrometers
ACH with Reticle and Filter Changer
Standard Autocollimation Head (ACH) direct viewing

Large Field ACH / Standard ACH

## Beamsplitters in Mount

| Type | Code | No. of reticles | Technical Data |
|---|---|---|---|
| **BSP** | 3-200-031 | 2 | Standard Beamsplitter Mount with Straight or 90°-viewing. It contains two fixed reticles. |
| **LF BSP** | 3-200-231 | 2 | Large Field Beamsplitter Mount with straight or 90°-viewing. It contains two fixed reticles |
| **BSP Micro** | 3-200-033 | 2 | Beamsplitter Mount with two micrometers. Range for reticle displacement: 4mm. Resolution: 0,005 mm. With straight or 90°-viewing. It contains 1 reticle transleatable in two axes and one fixed reticle (collimator reticle) |
| **BSP Digi** | 3-200-034 | 2 | Beamsplitter Mount with two digital micrometers. Range for reticle displacement: 4mm. Resolution: 0,001 mm. With straight or 90°-viewing. It contains 1 reticle transleatable in two axes and one fixed reticle (collimator reticle) |
| **BSP-RC** | 3-200-035 | 5 | Beamsplitter Mount with Reticle Changer. It contains 1 eyepiece reticle and 4 collimator reticles. The 4 reticles positioned by rotating indexing wheel |
| **BSP-RC/FC** | 3-200-035 | 5 | Beamsplitter Mount with Reticle Changer and Filter Changer. It contains 1 eyepiece reticle and 4 collimator reticles. The 4 reticles positioned by rotating indexing wheels. Standard included: one green filter, one diffuser. Two filter locations empty. Filter dia. 20 mm |

## EYEPIECES

EPC 00-15 (standard)
EPC 00-20
EPC 00-25

The range of eyepieces included in the OPTITEST line provides capabilities for many applications requiring different parameters as :

- large field of view
- large magnification
- facilities for attaching CCD-cameras, etc.

15 is the standard fit for OPTITEST instruments.

- Magnification of the eyepiece:

$$M = \frac{250}{f\ \text{eyepiece}}$$

- Magnification of autocollimators and teles copes

$$M = \frac{f\ \text{lens}}{f\ \text{eyepiece}}$$

The eyeshield is removable. After removal, the thread of the eypiece tube (M 28x0.75) can be used to attach a CCD-camera adapter.

### CCD-CAMERA ADAPTER

This device includes highly corrected imaging optics which transfer the reticle image from the eyepiece on CCD-array. The Camera Adapter has a mechanical interface to CCD-Camera (C-mount) and a threaded mount (M28x0.75) to eyepiece. The imaging optics are interchangeable (factory assembly).

All the eyepiece are focusable and have a long eyepoint which is convenient for spectacle lens wearers. A diopter scale can be used for various measurements like astigmatismus, flatness errors etc. The eyepiece EPC 00-

### Eyepieces

| Type | Code | Focal length (mm) | Magnification | Linear Field | Diopter Scale | Connection Thread |
|---|---|---|---|---|---|---|
| **EPC 00-10** | 3-200-050 | 10,3 | 25 x | 10 | ±5 dpt. | M 27x0,5 |
| **EPC 00-15** | 3-200-052 | 15,8 | 16 x | 10 | ±5 dpt. | M 27x0,5 |
| **EPC 00-20** | 3-200-054 | 20,7 | 12 x | 15 | ±5 dpt. | M 27x0,5 |
| **EPC 00-25** | 3-200-056 | 25,0 | 10 x | 17 | ±5 dpt. | M 41x0,75 |

A complete Video Attachment includes:

- CCD-Camera-Adapter
- CCD-Camera (standardly 2/3“monochro me. On request other types)
- TV-Monitor, monochrome, CCIR
- BNC-Cable to connect camera and monitor
- Power supply for camera

| Type | Code |
|---|---|
| Video Attachment complete | 3-300-060 |
| CCD-Camera Adapter with imaging optics | 3-300-061 |

## ILLUMINATION DEVICES

Standard illumination and Illumination for Large Field Instruments

### STANDARD ILLUMINATION.

The standard illumination device of OPTITEST normally includes:

- condenser optics
- a green filter with a ground side working as difusser
- illuminating lamp in socket
- connection cable to power supply. Length 1 m.

The tube containing the filter is directly screwed on the illumination housing. The standard green filter can be easily exchanged if necessary.

### Standard illumination

| Type | Code | Filter Diameter (mm) | Connection thread | To be used |
|---|---|---|---|---|
| **ILL 5W-6V** | 3-200-150 | 20 | M 27 x 0,5 | Standard Instruments |
| **LF-ILL 5W-6V** | 3-200-151 | 20 | M 41 x 0,75 | Large Field Instruments |

The Power Supply for standard illumination is an adjustable transformer which allow for adapting the light intensity to the specific application. The transformers include the powercable.

### Transformers

| Type | Code | Adjustment range | Power Voltage | |
|---|---|---|---|---|
| **Trafo 220** | 3-200-153 | 2 - 6V | 220V / 50 Hz | |
| **Trafo 110** | 3-200-154 | 2 - 6V | 110V / 50 / 60 Hz | |

## FURTHER ILLUMINATIONS

In some applications the light intensity of the standard illumination might not be sufficient. This is the case in procedures requiring autocollimation with a small (uncoated) reflector or long distances between reflector and autocollimator. A need for more light is also related to collimators with very long focal length or alignment of complex optical systems. For these or similar applications following illumination devices with halogene lamps are recommended.

The fiber optic guide of the Cold Light Source with an effective diameter of 8 mm has an adapter fitting into the housing of standard illumination, so that the filter and condenser of standard illumination are further actively used with this light source.

The Halogene Illumination HAL 20W is delivered with own filter tube and green filter. When exchanging HAL 20W against the standard illumination, the filter tube of standard illumination must be removed and its own filter mounted instead.

Power Supply for Standard Illumination
Cold Light Source with Fiber Optic Guide
Halogene Illumination with Power Supply

| Type | Code | Adjustment range | Features | Power Voltage |
|---|---|---|---|---|
| **CLS 150 W/220V** | 3-200-158 | continuous Range gra fuated in 50 divisions | Cold Light Source, complete incl. power supply, halogene lamp 150W,reflector optimised for range approx. 400-800nm, flexible fiber optic guide 1m length, adapter fitting into the housing of standard illumination | 220V / 50 Hz |
| **CLS 150W/110V** | 3-200-159 | continious Range grafuated in 50 divisions | As above, however power supply voltage 110V | 110V / 50 / 60 Hz |
| **HAL 20 W** | 3-200-160 | continious 10 steps | Halogene lamp 20W in housing, filter tube with green filter fitting on the housing of standard illumination | 220/110V/50/60 Hz |

## RETICLES.

The OPTITEST line offers a comprehensive choice of reticles to meet any conceivable application. Custom glass reticles made to your specification also can be supplied in our instruments. The reticle combination used in an optical instrument is depends on application and the experience of the user. However some general rules and recommandations presented below are intended to help the user to solve this problem.

General rules and recommandations

- A bright cross reticle is especially suitable for applications where the light conditions are not optimal e.g. small reflector for autocollimation, long distance between autocollimator and reflector, AR-coated surfaces, etc. For any other applications a dark cross reticle is prefered.
- For same application, the use of instruments with longer focal length (smaller numerical aperture) will worsen the light conditions. Therefore always use cross reticles with thicker lines when focal length increases.
- The accuracy of reading increases when between two superimposed reticles (in symmetrie position) a small bright gap is left. The thickness of a dark/bright cross or a single/double cross combination should be selected correspondingly.
- The use of bright cross reticles (known also as dark field reticles) in eyepiece is not recommended since the observation of the collimator reticle is difficult.
- In the instruments with 90°-viewing using reticles with scales, the correct (errected) position of the scale numbers depends on the working position i.e. horizontal or vertical assumed by the assembly of the instrument. Therefore the working position of these instruments must be specified when ordering.

Important!
Read always our reccomandations as follows :

- first reticle is eyepiece reticle
- second reticle is collimator reticle.

## 1. CROSS LINE (HAIR) RETICLES

### APPLICATIONS

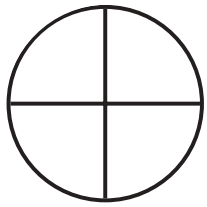
- Alignment of mirrors and optical systems
- Precision measurement of angles in combination with eyepiece micrometers
- Radius measurement of cylindric surfaces
- Measurement of centration errors
- Ideal for PC-controlled angle measurements

☛ TRIOPTICS Optiangle

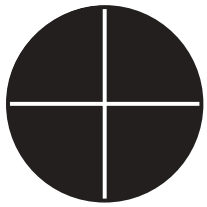
### RECOMMANDATIONS

- Eyepiece reticles: double cross line
- Collimator reticles: single cross line
- Prefered combinations:

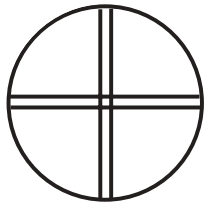
  RET-24/RET-02
  RET-24/RET-12
  RET-24/RET-13
  RET-02/RET-12
  RET-22/RET-01(f <300 mm)



Dark Cross Reticle
(Positive Type)



Bright Cross Reticle
(Negative Type)



Double Cross Reticle
(Positive Type)

Single Cross Line (Hair) Reticles

| Code | Type | Line with (mm) | Dia (mm) |
|---|---|---|---|
| RET-01 | | 0,010 | 12 |
| RET-02 | | 0,020 | 12 |
| RET-04 | | 0,040 | 12 |
| RET-82 | | 0,020 | 25 |
| RET-85 | | 0,050 | 25 |
| RET-11 | | 0,010 | 12 |
| RET-12 | | 0,020 | 12 |
| RET-13 | | 0,030 | 12 |
| RET-15 | | 0,050 | 12 |
| RET-86 | | 0,020 | 25 |
| RET-87 | | 0,050 | 25 |

Double Cross Line (Hair) Reticles

| Code | Type | Clear Spa-ce (mm) | Dia (mm) |
|---|---|---|---|
| RET-22 | | 0,020 | 12 |
| RET-24 | | 0,040 | 12 |
| RET-26 | | 0,060 | 12 |

## 2. RETICLE WITH ANGLE GRADUATED SCALES

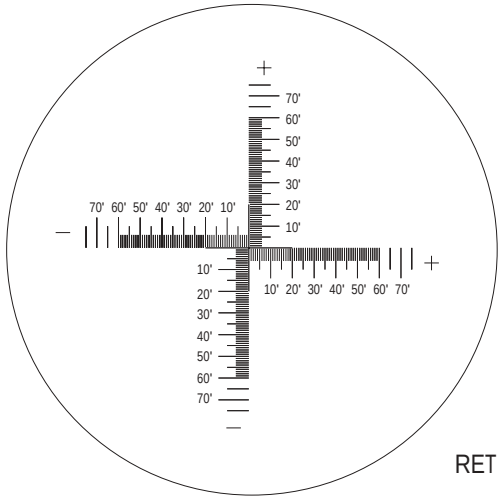
### APPLICATIONS

- Tilt measurement in conjunction with a re flector attached to the object under test
- Angle measurement of optical components like prisms, windows, etc.

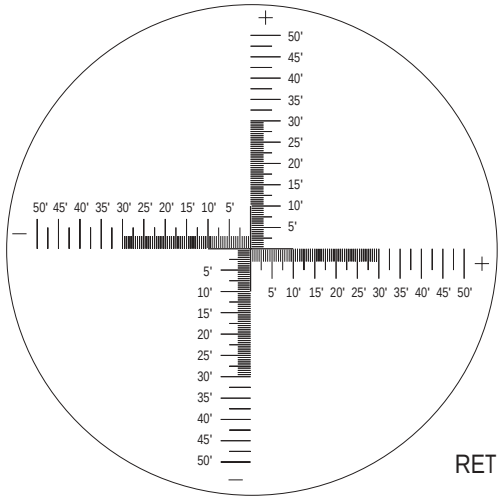
☛ TRIOPTICS AUTOCOLLIMATORS

### RECOMMANDATIONS

- Eyepiece reticles: angle graduated scales
- Collimator reticles: single cross line : RET-02 (RET-01, RET-12, RET-04)
- Prefered combinations: Angle graduated scales/RET-02



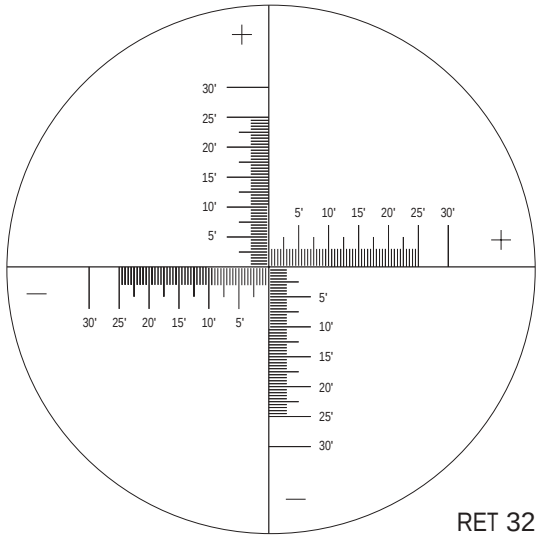

RET 30



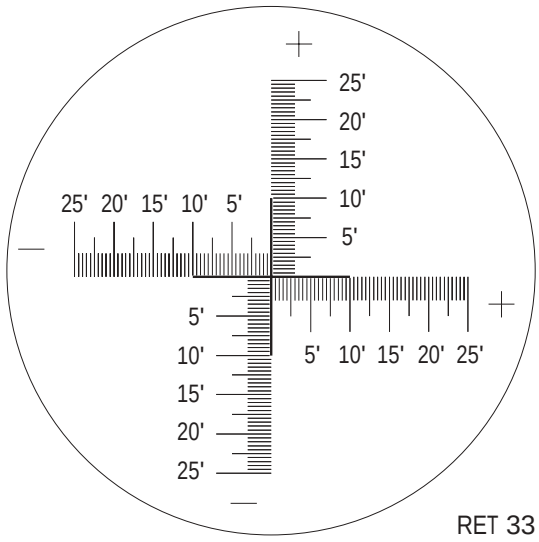

RET 31

## 2. RETICLE WITH ANGLE GRADUATED SCALES
(continued)

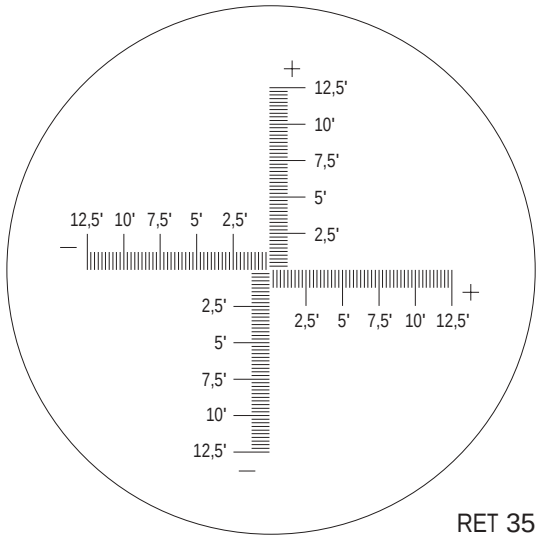
| Angle graduated scales | | | | |
|---|---|---|---|---|
| **Code** | **Range of graduation** | **Smallest division** | **Estimation** | **Designed for instrument** |
| RET-30 | ±75 min | 60 sec | 20 sec | ACM 100 |
| RET-31 | ±50 min | 30 sec | 15 sec | ACM 150 |
| RET-32 | ±30 min | 30 sec | 10 sec | ACM 200 |
| RET-33 | ±25 min | 30 sec | 10 sec | ACM 300 |
| RET-35 | ±12,5 min | 15 sec | 5 sec | ACM 500 |
| RET-39 | ±7,5 min | 5 sec | 1,5 sec | ACM 1000 |
| | | | | |
| **Reticle with special angle graduations** | | | | |
| RET-40 | ±20´ | 1´ | 0,5´ | ACM 100 |
| RET-42 | ±12´ | 0,5´ | 0,2´ | ACM 200 |



RET 32



RET 33

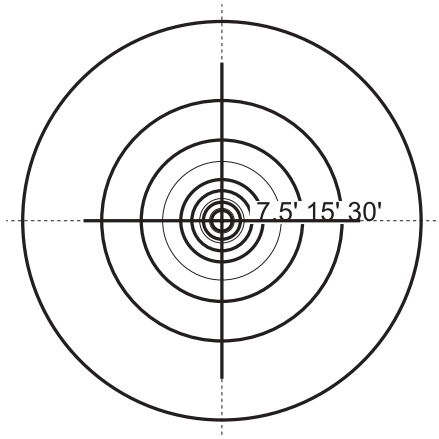


RET 35

## 3. RETICLE WITH ANGLE TOLERANCES

### APPLICATIONS

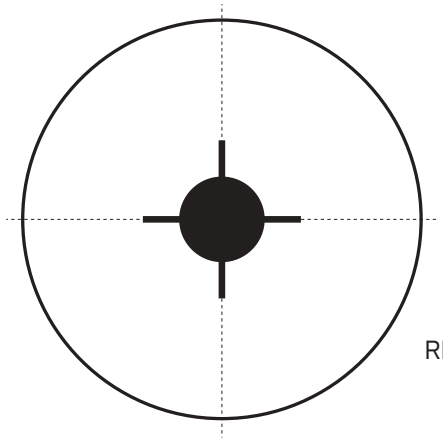
- Fast checking of wedges and plane-parallel plates. Each pinhole allows for checking two angles given by:
- diameter of the pinhole
- cross size (twice the pinhole diameter).
  These reticles are recommended for testing of large production quantities on „go“ „no go“ basis.
- Alignment of optical systems
- Measurement of radii of curvature




RET 50

### RECOMMANDATIONS

- Eyepiece Reticle: RET-50, RET, 51
- Collimator Reticle:pinhole with cross RET-53...59



RET 53...59

### Prefered Combinations

- RET-50/RET-59
- RET-51/RET-53...RET-58

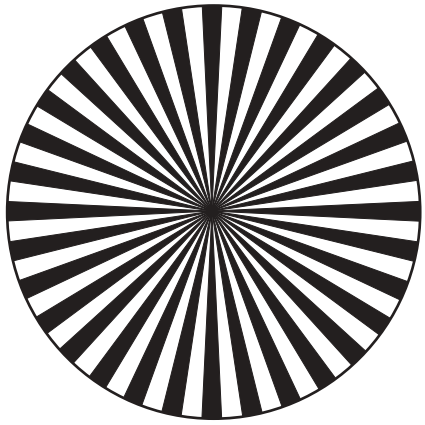
### Reticles with Angle tolerances

| Reticles with angle tolerances | | | |
|---|---|---|---|
| **Code** | **Type** | **Range of graduation** | **Designed for instrument** |
| RET-50 | 9 concentric circles graduated for TILT measurement (positive type) | 1, 2, 3, 4, 5, 7,5, 10, 15, 30, min | ACM 200 |
| RET-51 | 9 concentric circles graduated for WEDGE measurement (positive type) | 1, 2, 3, 4, 5, 7,5, 10, 15, 30, min | ACM 200 |
| RET-53 | pinhole with cross for WEDGE measurement (negative type) | 30/60 | ACM 300 |
| RET-54 | pinhole with cross for TILT measurement (negative type) | 1/2 min | |
| RET-55 | | 1,5/3 min | |
| RET-56 | | 2/4 min | |
| RET-57 | | 2,5/5 min | |
| RET-59 | | 30/60 sec | ACM 200 |

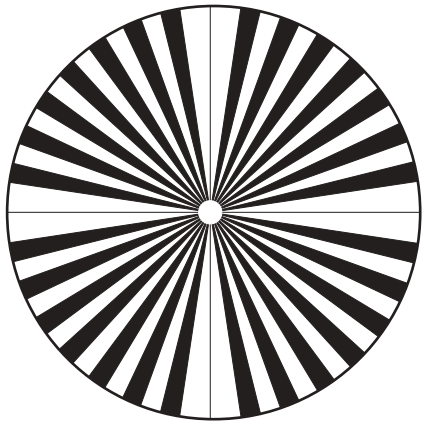
## 4. RESOLUTION TESTS

| Resolution Tests | | |
|---|---|---|
| **Code** | **Type** | **Diameter (mm)** |
| RET-61 | Siemens Star 2 x 36 segments Resolution 8,7 µm | 12 |
| RET 62 | Siemens Star with crossline 0,02 mm 2x30 segments Resoluton10,4µ | 12 |
| RET 63 | USAF Resolution Test lpm (line pairs per mm) 0,504...0,0044 | 12 |
| RET-67 | Siemens Star 2 x 36 segments Resolution 8,7 µm | 25 |
| RET-68 | USAF Resolution Test lpm (line pairs per mm) 0,504...0,0044 | 25 |

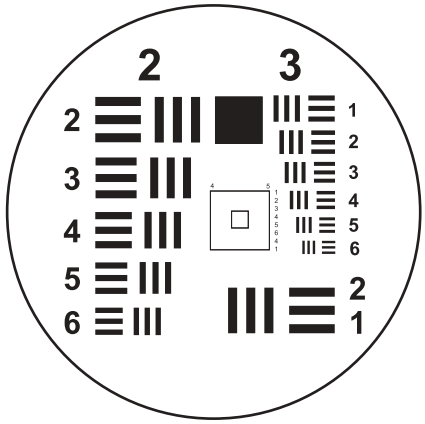
Further resolution tests are available on request



RET 61



RET 62




RET 63

### APPLICATIONS

- Testing image quality of optical systems
- Adjustment and setting of optical instru ments

### RECOMMANDATIONS

- The resolution tests are always used as colli mator reticle. When used in autocollimators, the eyepiece reticle should be a single cross.

## 5. SCALES IN MM AND FURTHER RETICLES USED IN OPTICAL TESTING

### APPLICATIONS

- Measurement of optical parameter : focal length : RET-73, RET-74, RET-91 centration errors: RET-71, RET-90
- Alignment of optical systems: RET-76, RET-77, RET-92

☛ TRIOPTICS OPTI ANGLE / OPTOMATIC

### RECOMMANDATIONS:

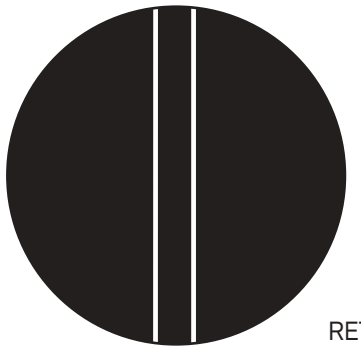
- Eyepiece Reticle: mm scales
- Collimator Reticle: Porro plates, slits patterns, etc.

Prefered combinations:

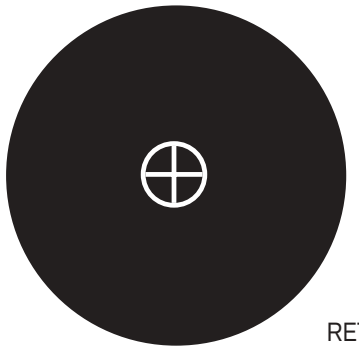
- RET-71/RET-13(RET-02)
- RET-91/RET-13 (RET-02, RET-86)
- RET-02/RET-73

| SCALES IN MM AND FURTHER RETICLES USED IN OPTICAL TESTING | | |
|---|---|---|
| **Code** | **Type** | **Diameter (mm)** |
| RET-71 | Crossed ± 4mm scale. Range ± 4mm Division 0,1mm | 12 |
| RET 73 | Porro plate. Distance between line pairs: 2/4/6/8 | 12 |
| RET 74 | 4 slits pattern, negative type. Width: 0,24/0,8 mm Distance: 2,4/8mm | 12 |
| RET-75 | 2 slits pattern, negative type. Width: 0,08 mm Distance: 0,5 mm | 12 |
| RET-76 | Circle with cross, negative type. Diam. 0,8 mm, crosslines: 0,02mm | 12 |
| RET-77 | Pinhole with positive cross Diam. 0,5 mm, crosslines: 0,01mm | 12 |
| RET 78 | cross with circle, positive. Diam. : 1mm, crossline: 0,02mm | 12 |
| RET 90 | Crossed ± -5mm scale. Range ±5mm Division 0,1mm | 17 |
| RET-91 | 10mm Scale in 500 divisions. 1division 0,02mm | 15 |
| RET-92 | Cross with concentric circles. Diam.:1,2,3,4,5,10,12,5 Linewidth:0,015mm | 25 |

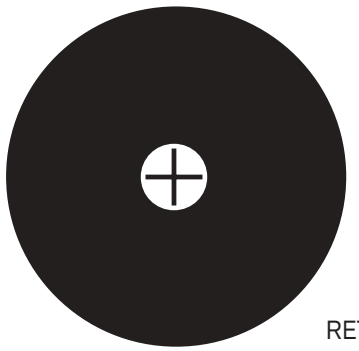
RET 74



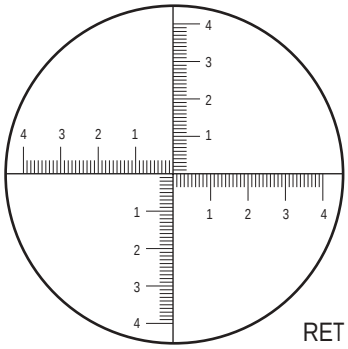
RET 75



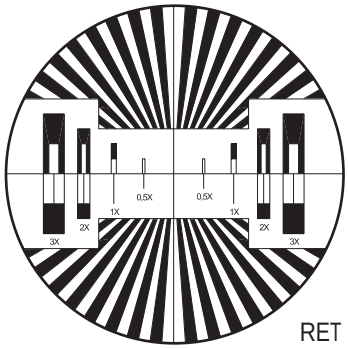
RET 76



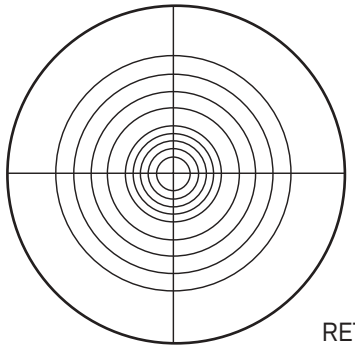
RET 77




RET 71




RET 73



RET 92

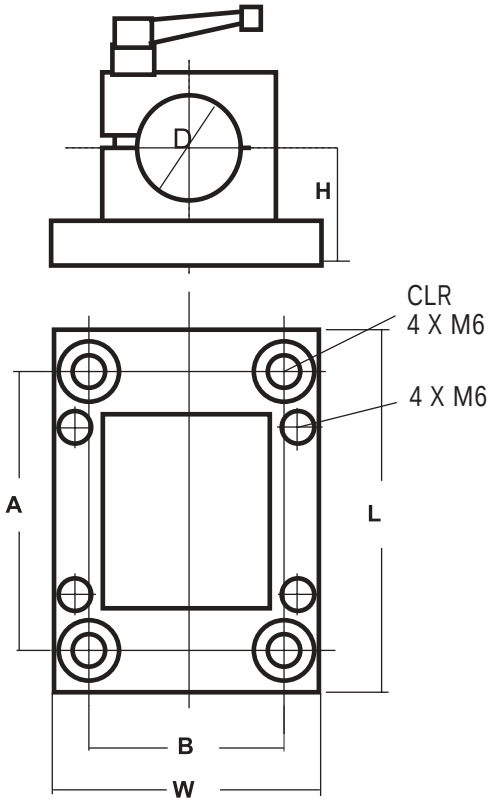
# ACCESSORIES. POSITIONING EQUIPMENT.

The OPTITEST line offers a wide range of accessories to solve positioning and alignment problems. In addition to the standard positioning equipment presented below, TRIOPTICS is supplying special holders and stands made according to specific customers requirements.

## CLAMP FIXTURES

The clamp fixtures are mounted on a base plate with 4 fixing screws and 4 pressure screws. The pressure screws prevent a loosening of the fixing screws and allow a certain levelling within a small range.

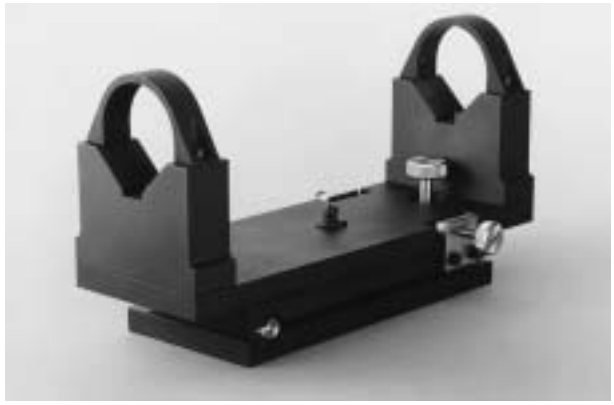
| Code | Diam. D mm | H | L | W | A | B |
|---|---|---|---|---|---|---|
| 3-300-001 | 38 | 40 | 100 | 100 | 75 | 75 |
| 3-300-002 | 57 | 50 | 75 | 120 | 150 | 100 |
| 3-300-003 | 115 | 100 | 75 | 200 | 50 | 175 |




Various Clamp Holders

## TWO AXIS ADJUSTABLE HOLDER

This unit provide two axis fine adjustments for azimuth and elevation. It also incorporates clamping screws to securely hold the autocollimator.



Adjustable Holder D 57 mm

| Code | Diam. D mm | Adjustment range | Sensitivity |
|---|---|---|---|
| **3-300-005** | 38 | ± -1° | < 10 sec |
| **3-300-006** | 57 | ± -2° | < 1 sec |
| **3-300-007** | 115 | ± 1,5° | < 1 sec |

## AUTOCOLLIMATOR STAND

### COARSE TRAVEL STAND (TYPE A)

Features

The Autocollimator Stand A is a simple stand featuring a precision rack and pinion slide mechanism for height adjustment of the autocollimator. The Stand A is equiped with a clamp fixture D 38 mm.
Further provisions are made for mounting of a tilt table D 100 mm. Alternatively a rotary table D 100 mm or a combination of tilt and rotary table can be mounted on the Stand A.

Applications

The Stand A is designated for angle measurements of plano optics as wedges, windows, prisms, etc.

### FINE TRAVEL STAND (TYPE B)

Features

The Stand B has two travel mechanisms: a coarse travel and a coaxial ultra-fine focusing mechanism. The ultra-fine mechanism is especially useful in applications where a smooth, precise motion of optical instruments or subsystems are required. The bottom body of the stand contains a clamp fixture for a collimator D 38 mm and an adjustable mirror for beam deviation. A second clamp fixture D 38 mm attached to the travel mechanisms is used to hold autocollimators and telescopes.
Further accessories can be attached to the Stand B:

- tilt table
- rotary table
- precision self-centering rotary holder for centration measurements

Applications

The Stand B is ideal for measurements in transmission (centration errors) or reflection (radius, centration, etc) of spherical optics. Of coarse angle measurements of plano optics are also possible.

OptiAngle with Stand C

### FINE TRAVEL STAND (TYPE C)

Features

The Stand C is similar with Stand B, however, two transversal translation stages with micrometer are supplimentary provided. One of this stage allows to transversally move the clamp fixture with the optical instruments (mostly autocollimators or telescopes). The second stage is used to translate a reticle (mm scale) mount for measurement purposes.

Applications

The Stand C is ideal for measurements in transmission (centration errors) or reflection (radius, centration, etc) of spherical optics. The two additional micrometer stages are used for focal length measurements. In this case a Porro plate is mounted in the collimator located in the bottom body. The Porro pattern is projected over the sample to be measured. The reading is done using a microscope or telescope mounted on clamp fixture attached to the travel mechanism.

## CONSTRUCTION

### FINE TRAVEL STAND B (C)

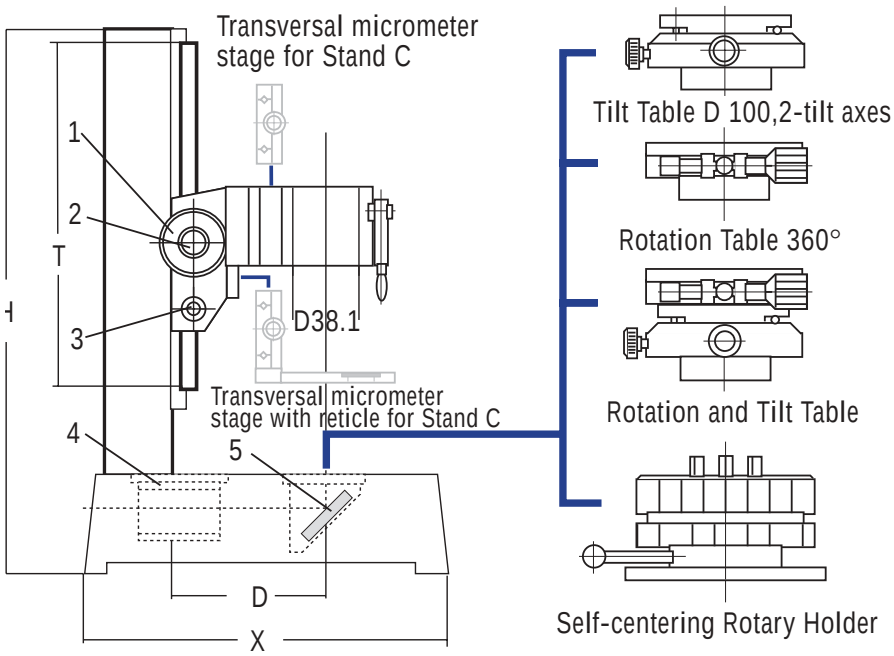
1 - CoarseTravel Knob

2 - Fine Focusing Knob

3 - Clamping Knob

4 - Collimator clamb holder

5 - Deflection Mirror




| Type/Features | Code | Height H mm | Travel coarse/fine range T mm | Distance to optical axis D mm | L x W mm | Approx. Weight Kg |
|---|---|---|---|---|---|---|
| Stand A. Coarse travel only. Sensivity: 50 µm | 3-200-030 | 465 | 225/- | 80 | 225x115 | 6,5 |
| Stand B. Coarse and fine travel. Sensivity: 1 µm | 3-200-032 | 600 | 380/380 | 112,5 | 277x178 | 12 |
| Stand C. Coarse and fine travel. Sensivity: 1 µm. Transversal Stages: ± 10mm, Resolution 0,005 µm | 3-200-034 | 600 | 380/380 | 112,5 | 277x178 | 13,5 |

## TILT AND ROTATION TABLES

### TILT TABLE D 100 MM

Three fine adjustments screws allow the tilt along two axes. Two threaded holes M4 are provided for attaching further accessories. The tilt table designed for measurements in transmission have a central hole D 15 mm.

### ROTATION TABLE D 100 MM

The rotation table features complete 360° rotation. After clamping the table in the selected position, a tangential micrometer enables a fine rotation adjustment.

### TILT AND ROTATION TABLE D 100 MM

The tilt and rotation tables are modular and can be mounted together with the tilt table either on top or at bottom.

Tilt and Rotation Table D 100, Rotation Table D 100, Tilt Table D 100, Wedge and Filter HolderSupporting Tables

## Tilt on Rotation Table

| Type | Code | Tilt Range | Rotation range coarse/fine | Sensitivity | Load Capacity | Approx Weight |
|---|---|---|---|---|---|---|
| Tilt Table D 100 | 3-300-010 | ± 2° | - | 5 sec | 8 Kg | 1,6 Kg |
| Tilt Table D 100/ d 15 | 3-200-011 | ± 2° | - | 5 sec | 8 Kg | 1,5 Kg |
| Rotation Table D 1000 | 3-300-014 | - | 360°/±2,5° | 10 sec | 10 Kg | 1,8 Kg |
| Tilt and Rotation Table D 100 | 3-300-016 | ± 2° | 360°/±2,5° | 5/10 sec | 8 Kg | 3,4 Kg |

## SELF-CENTERING HOLDERS

Trioptics Self-Centering Lens Mounts reliably center and hold optics and cylindrical objects. The centering accuracy is far above the commercially available self-centering mounts. To ensure the precise axial position of lens cells and mounts, the three support rods have an accurately ground step. This secure not only a repeatable radial centration but an exacte axial positioning as well.

| Code | Type | Diam. range mm | Centrati-on mm | Mounting |
|---|---|---|---|---|
| 3-300-018 | SCH 75 | 5-75 | < 0,05 | 3xM4 CLR on Dia.110 mm |
| | | | | |

The Rotary Holders come atandardly with two bell chucks. Further chuck fitting custom lens diameters can be provided on request.

## ULTRA-PRECISION ROTARY HOLDERS

Ultra-precision rotary holders

The Self-Centering Rotary Holders are designed for best possible centration and rotation accuracy required in measurement of centration errors of optical components and systems. The Self-Centering Rotary Holders incorporates an indexing mechanism at 90° for centration measurement with Trioptics automatic optical stations OPTOMATIC and OptiAngle. This indexing mechanism can be simply switched off when used in other applications.

| Type | Code | Diam. range mm | Total error (centration + rotation) |
|---|---|---|---|
| PRH 01 | 2-100-021 | 0,5-13 | 1-3 |
| PRH 02 | 2-100-023 | 13-34 | 1-3 |
| PRH 03 | 2-100-025 | 34-54 | 2-4 |
| PRH 04 | 2-100-027 | 54-75 | 2-4 |