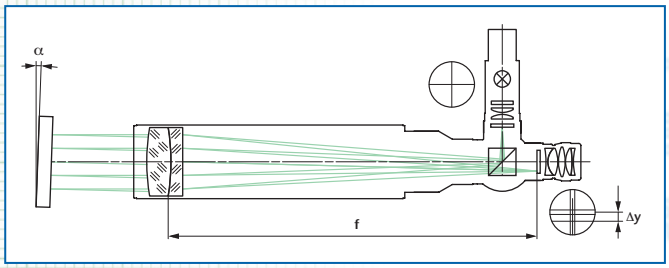
AUTOCOLLIMATORS
INTRODUCTION

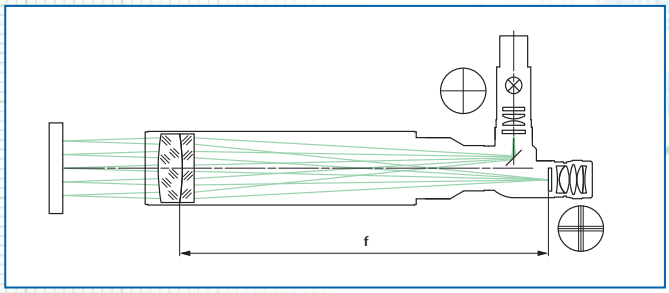
Layout and principle of operation

An autocollimation telescope (autocollimator) combines the function of a collimator and a telescope in one unit. The collimator and telescope share the same optical path, which is accomplished using either a physical or geometrical beam splitter.

The illustration below shows the schematic set-up of an autocollimator with straight viewing, a physical beam splitter and infinity adjustment. The autocollimation telescope projects the image of the collimator reticle to infinity. A target mirror, located in the beam path of the autocollimator objective, returns the projected image into the autocollimator and creates an image of the collimator reticle via the beam splitter in the eyepiece reticle plane (autocollimation image).
The mechanical (objective tube) axis is adjusted to the optical axis with angle accuracy of ±30 µm/*f* for autocollimators with *f*≤300 mm. The reticle adjustment amount ±10 µm.



An autocollimator with geometrical beam splitter is arranged similarly (see illustration below). The collimator reticle is reflected into the beam path by the path-folding mirror which has a small angle in relation to the optical axis. The beam reflected off the target mirror passes below the path-folding mirror and produces an image of the collimator reticle in the eyepiece reticle plane.



Calculation of the angles

An autocollimator can be used to measure the angle of a mirror in two axes with respect to the optical axis of the autocollimator. If the mirror is exactly perpendicular to the optical axis, the beam is reflected upon itself. If the mirror is tilted by the angles α_x and α_y, the reflected beam enters the objective obliquely. Depending on the amount of tilt, the autocollimation image in the eyepiece reticle plane is displaced to a greater or lesser amount. The displacement Δx and Δy of the autocollimation image in X and Y direction provides a measure of the angular displacement of the mirror:

$$\alpha_x = \arctan\left(\frac{\Delta x}{2f}\right) \approx \frac{\Delta x}{2f}$$

$$\alpha_y = \arctan\left(\frac{\Delta y}{2f}\right) \approx \frac{\Delta y}{2f}$$

f: focal length of the autocollimation objective.

Numerical example:
A displacement of the reticle image of 3 mm measured with an autocollimator with 300 mm focal length corresponds to a tilting angle of:

$\alpha \approx 3/2/300 \text{ rad} = 5 \cdot 10^{-3} \text{ rad} = 0{,}2865° = 17'11''$

The image displacement of 10 µm in the reticle plane corresponds to an angular tilt of:

Focal length	Angular tilt
50 mm	21″
90 mm	11″
140 mm	7,4″
200 mm	5,2″
300 mm	3,4″
500 mm	2,1″
600 mm	1,7″
1100 mm	0,9″