

COLLIMATORS

INTRODUCTION

Layout and principle of operation

A collimator projects a reticle to a certain distance. Usually the image is at infinity at a wavelength of 546 nm.

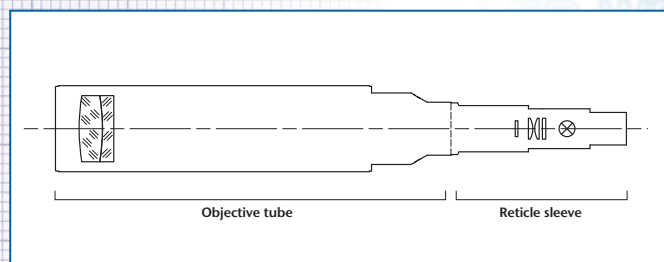
The main components of a collimator are:

- objective tube with objective
- reticle sleeve with reticle, condenser and illumination

The following figure shows the principle set-up of a collimator adjusted to infinity. The reticle is illuminated by an illumination system consisting of a condenser and light source. The reticle is positioned at the front focal point of the objective. Due to this configuration all light beams passing a point in the reticle plane form a parallel light bundle behind the objective.

There is not a real image of the reticle. To get a real image an additional lens, for example a telescope objective, is required.

Mechanical and optical axes of collimators with focal length $f \leq 300$ mm are adjusted with an accuracy of $\pm 30 \mu\text{m}/f$.



A measuring unit for tilt angles can be build by combination of a collimator with a telescope, when there is a need to measure in transmission.

Calculation of the angles

The angles (α_x and α_y) of the parallel beam of a collimator adjusted to infinity in respect to its optical axes can be calculated as follows:

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

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

f : focal length of the collimator objective

Δx : displacement of a point in X-direction

Δy : displacement of a point in Y-direction

Numerical example:

A point with 3 mm distance from the reticle center of a collimator with 300 mm focal length is imaged at an angle of:

$$\alpha \approx 3/300 \text{ rad} = 10 \cdot 10^{-3} \text{ rad} = 0,5730^\circ = 34'23''$$

A displacement of $10 \mu\text{m}$ from the centre of collimator reticle is calculated to have the following angle for the different focal length.

| Focal length | Angle |
|--------------|-------|
| 50 mm | 41'' |
| 90 mm | 23'' |
| 140 mm | 15'' |
| 200 mm | 10'' |
| 300 mm | 6,9'' |
| 500 mm | 4,1'' |
| 600 mm | 3,4'' |
| 1100 mm | 1,9'' |

