

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.

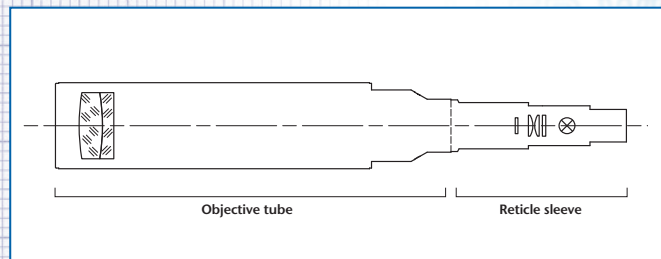
The main components of a collimator are:

- 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 built 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

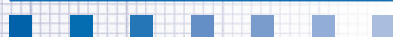
Numerical example:

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"



Adjustable Focus

Collimators with adjustable focus are available in addition to those with fixed focus. Adjustable focus collimators vary the distance between reticle and objective.

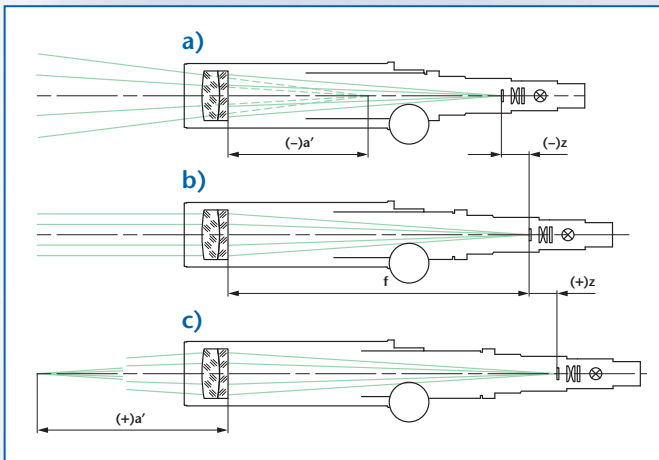
If the reticle is displaced from the focal plane by a distance z , then the collimator is focused at a distance a' according to:

$$a' = \frac{f^2 + zf}{z}$$

$z < 0$ corresponds to a decrease of the distance between objective and reticle. The resulting image distance is negative (virtual object position) (a).

$z > 0$ corresponds to a real image with positive object distance (c).

$z = 0$ produces an image at infinite distance (b).



Selection criteria

Long or short focal length?

A longer focal length leads to small field angles. As the focal length increases the field of view decreases proportionally. For resolution testing choose a collimator with equal or slightly larger focal length than the optics under test. When used in conjunction with a testing telescope choose the same focal length. Additionally, the intensity of the light bundle emitted from the collimator decreases with increased focal length. A longer focal length affects the mechanical extension of the tube, as well.

Small or large objective aperture?

Light conditions are more favourable when large apertures are used, and the evaluation of the results is easier and more accurate. A long distance between test specimen and collimator demands a relatively large free aperture (or aperture ratio). For these measurements a relatively large aperture diameter should be used.

Fixed or variable distance setting?

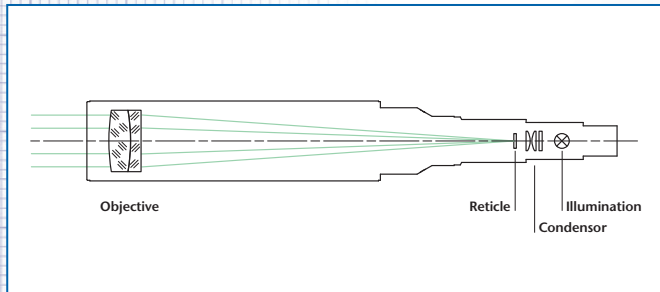
Fixed, infinity focus collimators are generally the best choice when testing systems adjusted to infinity. Fixed focus tubes set at other than infinity can be ordered.

Measuring tasks requiring different wavelengths of light, or measurements requiring focus other than infinity are best accomplished using focusable collimators.

COLLIMATORS

Description:

For a general description of the operating principle of collimators see page 6.



Application examples:

- Measurement of angular displacements (in conjunction with a telescope)
- Testing of the infinity setting of camera objectives
- Testing of the imaging properties of optical elements and systems

Notes on ordering:

- One reticle, 6V/5W illumination w/cord are included in the delivery.
- If not specified otherwise, the collimator is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- The nomenclature of the collimators is as follows:

Example:

K 50/ 40

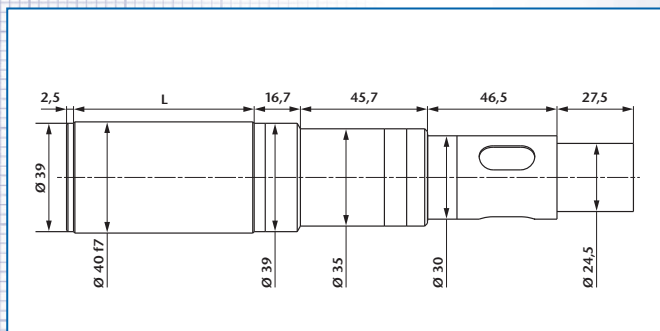
Collimator

Focal length

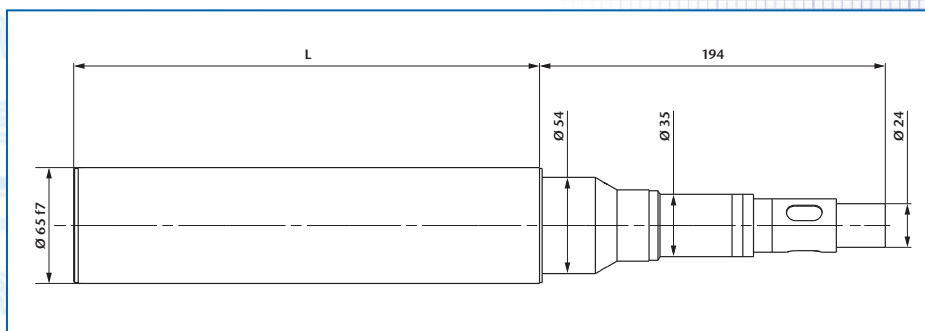
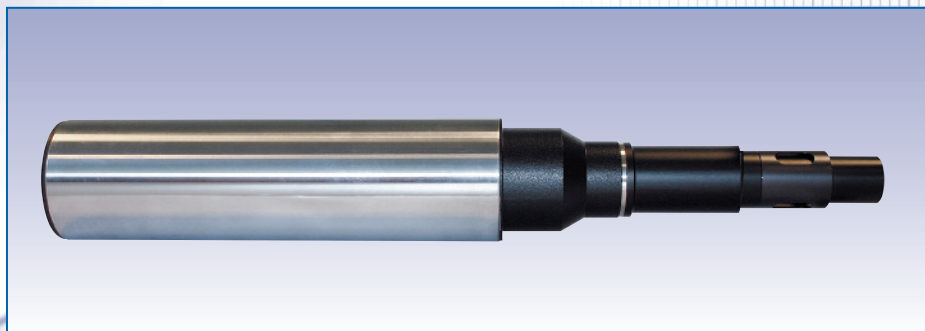
Tube diameter

Important:

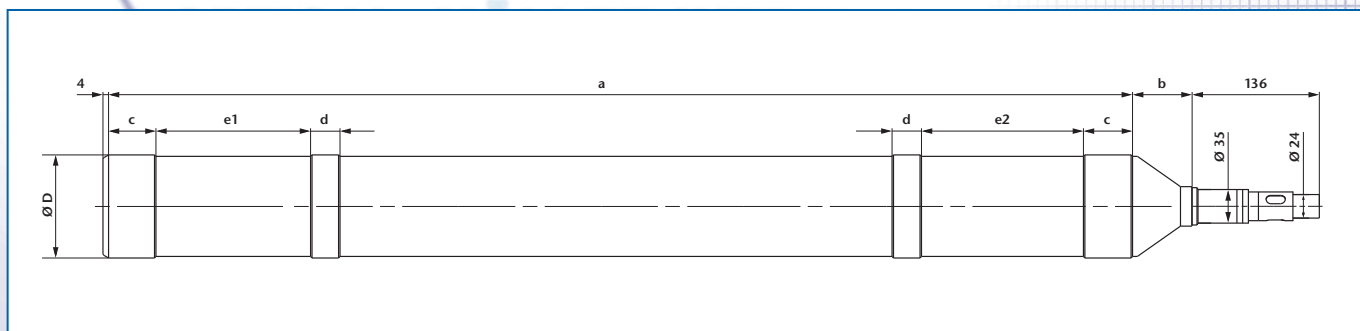
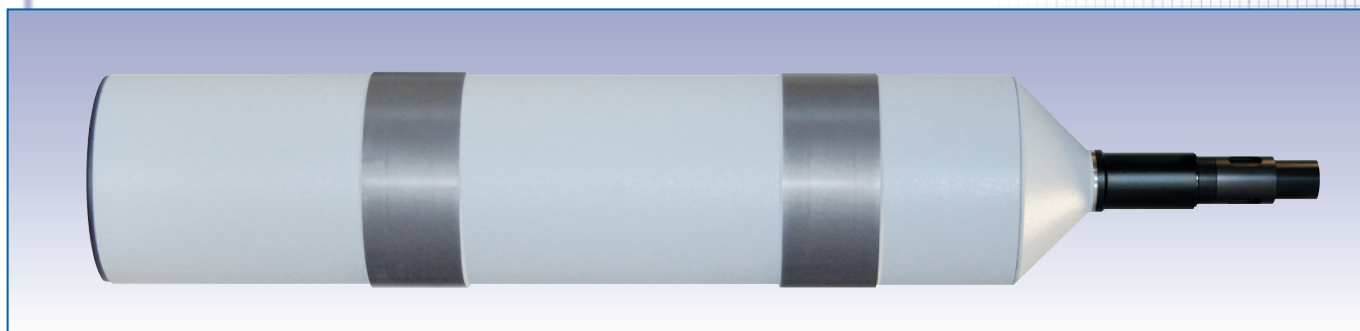
Please specify illumination (LED-, bulb or cold light, see page 81) and reticle (see page 82) when ordering.



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
225 004	K 50/40	50	10	10,0°	65
225 005	K 90/40	90	16	6,0°	65
225 006	K 140/40	140	28	4,0°	118
225 007	K 200/40	200	28	3,0°	173
225 008	K 300/40	300	28	2,0°	274
225 009	K 500/40	500	28	1,0°	474



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
225 010	K 300/65	300	50	2,0°	233
225 011	K 500/65	500	50	1,0°	415
225 012	K 500T/65	500	50	1,0°	233



Ord.-No.	Description	Focal length	Free aperture	Field of view	D	a	b	c	d	e1	e2
225 015	K 600/128	600	100	0,8°	Ø 128 f7	530	46	—	58	154	78
225 016	K 1100/105	1100	78	0,5°	Ø 105 f7	1045	66	50	30	165	100

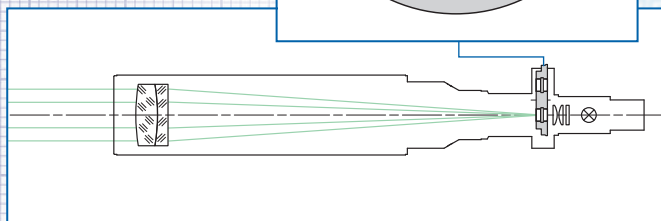
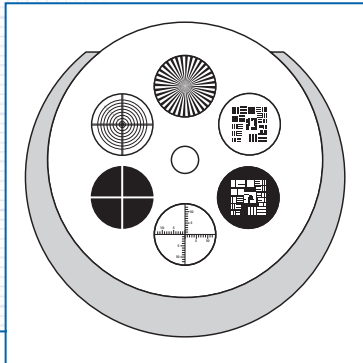
COLLIMATORS

WITH RETICLE TURRET

Description:

For a general description of the operating principle of collimators see page 6.

A collimator with a reticle turret provides 6 selectable collimator reticles. The reticle turret allows a quick change of reticles for different measurement tasks.



Application areas:

- Measurement of angular tilt (in conjunction with a telescope)
- Testing of the infinity setting of camera objectives
- Qualitative testing of the imaging properties of optical elements and systems

Notes on ordering:

- Six reticles and 6V/5W illumination w/cord are included.
- In contrast to collimators with one reticle the optical axis of the collimator with reticle turret can not be adjusted to be co-linear with the mechanical axis.
- If not specified otherwise, the collimator is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or other wavelengths is also possible on demand.
- The nomenclature of the collimators with reticle turret is as follows:

Example: K 50/ 40 SW

Collimator

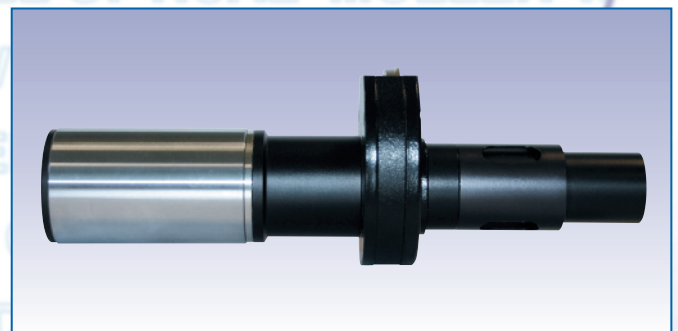
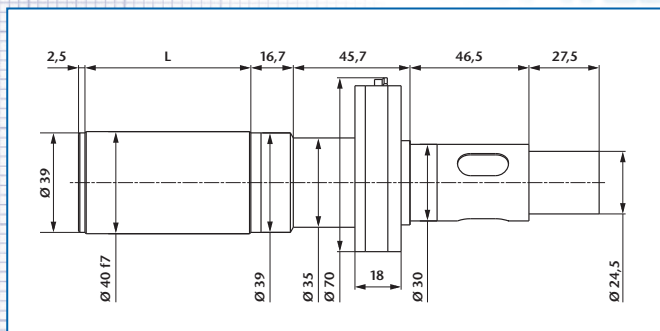
Focal length

Tube diameter

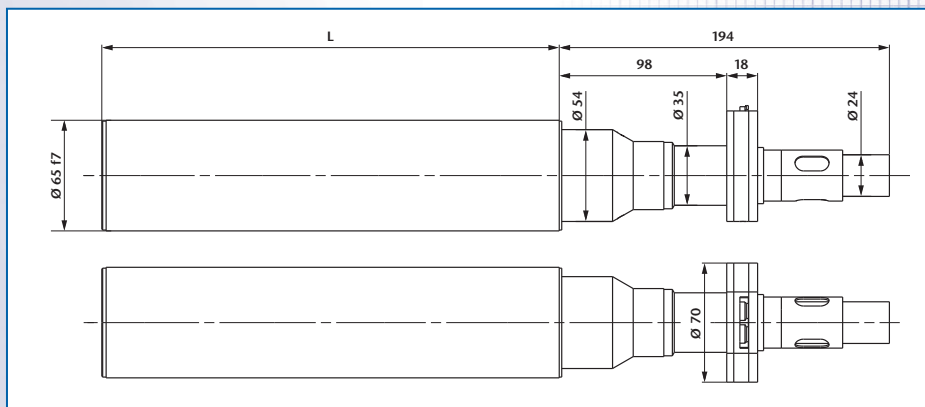
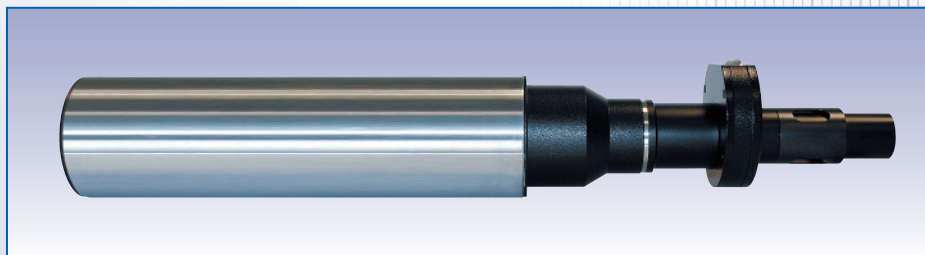
Reticle turret

Important:

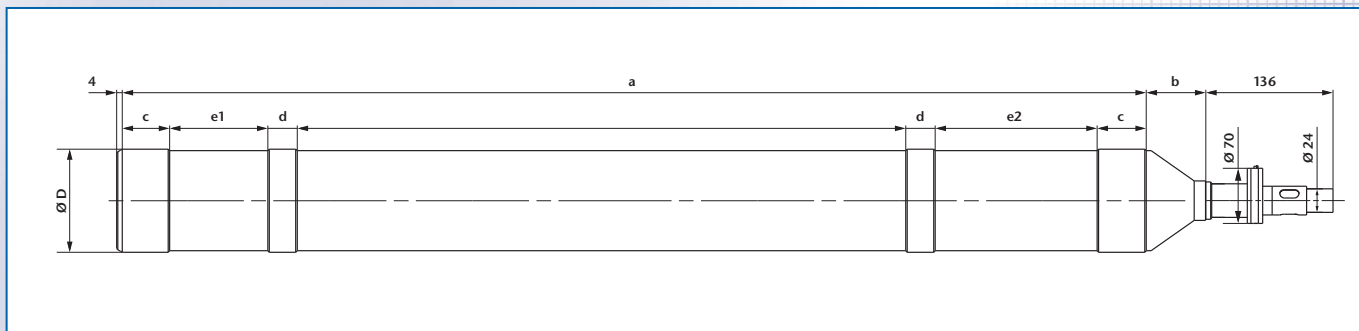
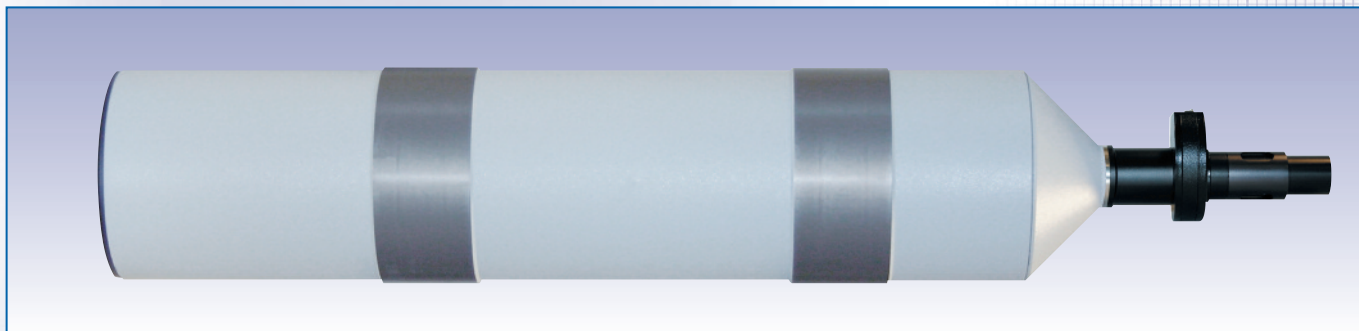
Please specify up-to six reticles (see page 82) and illumination (LED-, bulb- or cold light, see page 81).



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
225 201	K 50/40 SW	50	10	10,0°	65
225 202	K 90/40 SW	90	16	6,0°	65
225 203	K 140/40 SW	140	28	4,0°	118
225 204	K 200/40 SW	200	28	3,0°	173
225 205	K 300/40 SW	300	28	2,0°	274
225 206	K 500/40 SW	500	28	1,0°	474



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
225 207	K 300/65 SW	300	50	2,0°	233
225 208	K 500/65 SW	500	50	1,0°	415
225 209	K 500T/65 SW	500	50	1,0°	233



Ord.-No.	Description	Focal length	Free aperture	Field of view	D	a	b	c	d	e1	e2
225 212	K 600/128 SW	600	100	0,8°	Ø 128 f7	530	46	—	58	154	78
225 213	K 1100/105 SW	1100	78	0,5°	Ø 105 f7	1045	66	50	30	165	100

COLLIMATORS

WITH DOUBLE MICROMETER

Description:

For a general description of the operating principle of collimators see page 6.

A collimator with double micrometer allows the setting of defined image angles in two directions.

The movement of the reticle in x- and y-direction in the focal plane is measured with measuring drums. The scale division (SD) is 5 μm .

Application areas:

- Measurement of angular tilt (in conjunction with a telescope)
- Qualitative testing of the imaging properties of optical elements and systems

Notes on ordering:

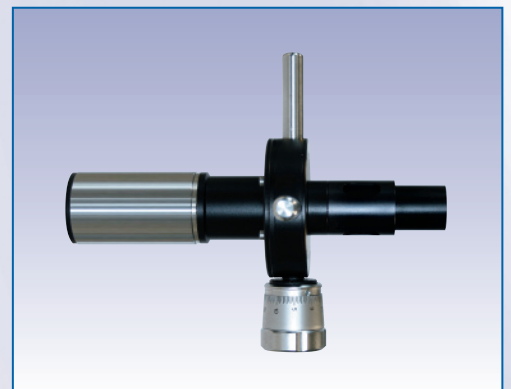
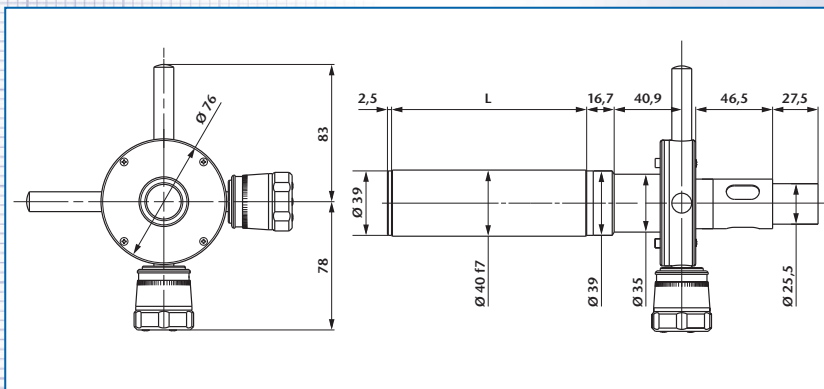
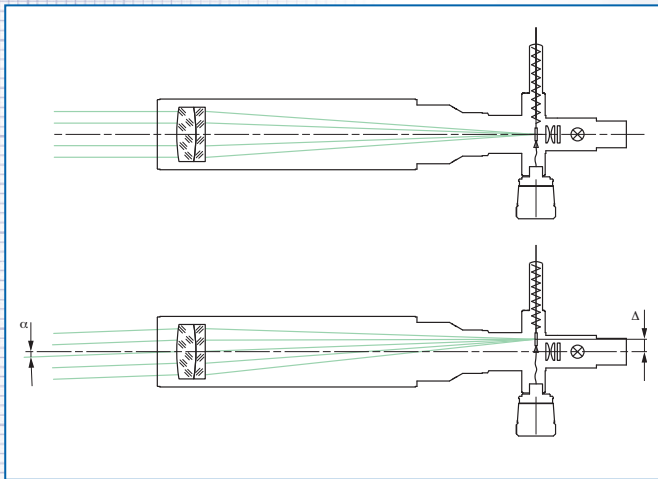
- One reticle and 6V/5W illumination w/cord are included.
- If not specified otherwise, the collimator is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or other wavelengths is also possible on demand.
- The nomenclature of the collimators with double micrometer is as follows:

Example: K 50/ 40 MD

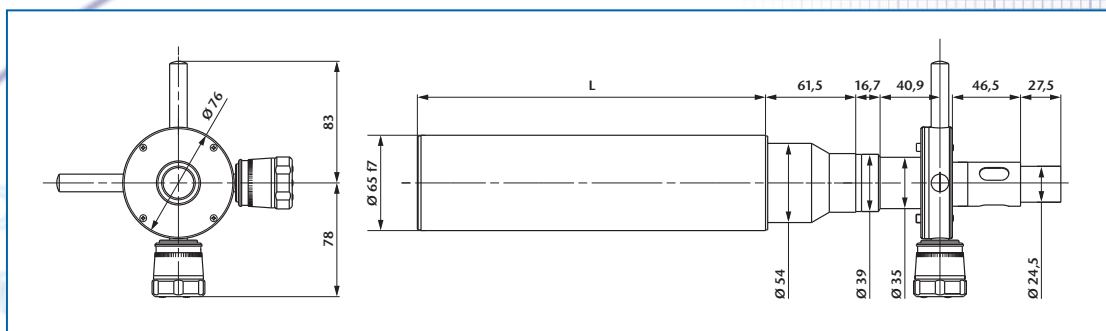
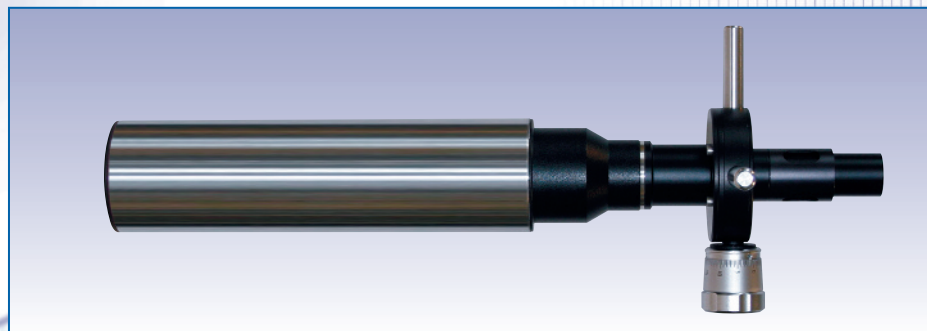
Collimator ———
Focal length ———
Tube diameter ———
Double micrometer ———

Important:

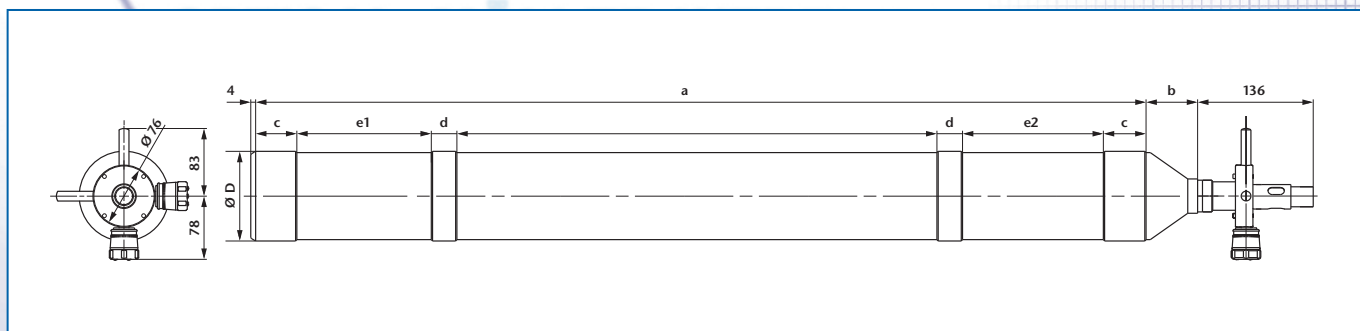
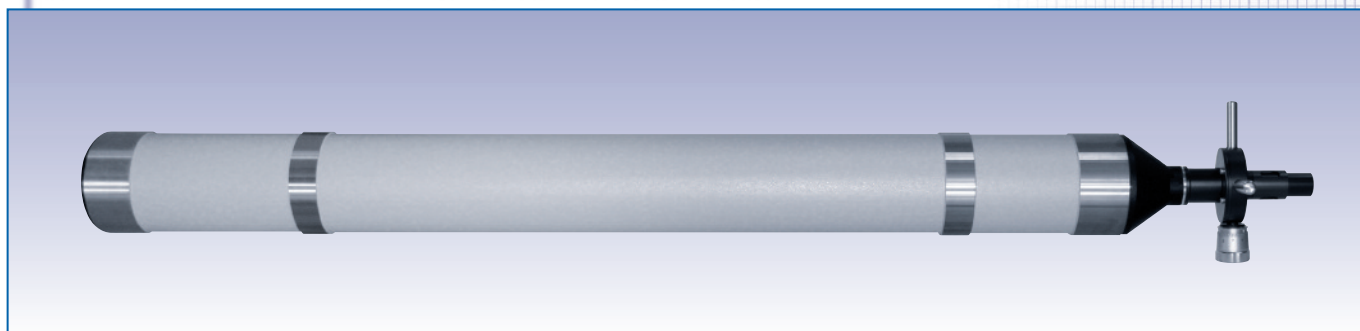
Please specify the reticle (see page 82) and illumination (LED-, bulb- or cold light, see page 81) when ordering.



Ord.-No.	Description	Focal length	Free aperture	Setting range	SD	L
225 281	K 50/40 MD	50	10	3,2°	20,0"	65
225 282	K 90/40 MD	90	16	2,0°	11,5"	65
225 283	K 140/40 MD	140	28	1,2°	7,5"	118
225 284	K 200/40 MD	200	28	0,8°	5,0"	173
225 285	K 300/40 MD	300	28	0,6°	3,5"	274
225 286	K 500/40 MD	500	28	0,4°	2,0"	474



Ord.-No.	Description	Focal length	Free aperture	Setting range	SD	L
225 287	K 300/65 MD	300	50	0,6°	3,5"	233
225 288	K 500/65 MD	500	50	0,4°	2,0"	415
225 289	K 500T/65 MD	500	50	0,4°	2,0"	233



Ord.-No.	Description	Focal length	Free aperture	Setting range	SD	D	a	b	c	d	e1	e2
225 292	K 600/128 MD	600	100	0,30°	1,7"	Ø 128 f7	530	46	—	58	154	78
225 293	K 1100/105 MD	1100	78	0,16°	1,0"	Ø 105 f7	1045	66	50	30	165	100