

## 4.1 Condenser lens assemblies

Customise 

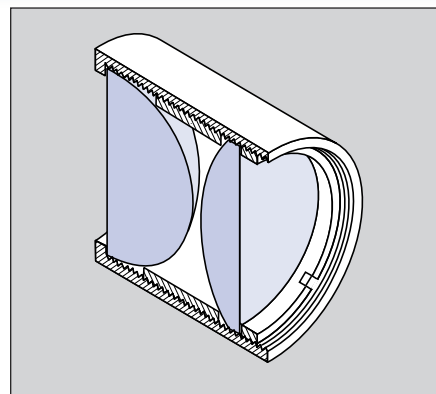
These systems comprise an aspheric condenser (see p.15) and either a second aspheric or a planoconvex lens, all mounted in a black anodised aluminium cell from our TubeMount range (p.53). Usually the aspheric will be used to collect light from a source and the second lens to form an image of the source on the required target area. The object-to-lens distance is shown for each lens as 'WD' (working distance) and the lens-to-image distance as 'Throw'. Measurements are to the metal mount rather than the glass surface.

## Technical data available

Request our note 'Design of illumination systems' for further information on system design

## See also:

For details of mounts used (MB type) p.54



Catalogue No.	Length x dia. (mm)	WD (mm)	Throw (mm)	Mag.	Accept. angle	Lenses included (see pp.4-5, 15)
01 TA 16	20 x 19	9.5	7.3	1.0	59°	15 AF 16/15 AF 16
02 TA 16	16 x 19	9.5	25	2.1	59°	15 AF 16/32 PQ 16
04 TA 16	16 x 19	9.5	57	4.2	59°	15 AF 16/63 PQ 16
01 TA 25	25 x 28	8.9	7.7	1.0	90°	16 AF 25/16 AF 25
02 TA 25	25 x 28	8.9	24	1.9	90°	16 AF 25/32 PQ 25
04 TA 25	20 x 28	8.9	56	3.8	90°	16 AF 25/63 PQ 25
01 TA 40	50 x 43	17.1	12	1.0	91°	29 AF 40/29 AF 40
02 TA 40	40 x 43	17.1	48	2.2	91°	29 AF 40/63 PQ 40
04 TA 40	40 x 43	17.1	112	4.4	91°	29 AF 40/125 PQ 40
01 TA 50	50 x 53	24.6	23	1.0	82°	39 AF 50/39 AF 50
02 TA 50	40 x 53	24.6	65	2.0	82°	39 AF 50/80 PQ 50
04 TA 50	40 x 53	24.6	147	4.1	82°	39 AF 50/160 PQ 50

## Options available

Only a small selection of the possible 2-lens systems can be listed. Almost any two catalogue lenses (max. 50mm dia.) can be supplied in a similar mount. To order use code TA followed by the lens catalogue numbers, e.g.:

TA/20 PQ 16/50 PQ 16

Please enquire for pricing.

## 4.2 Achromatic relay lenses

Customise 

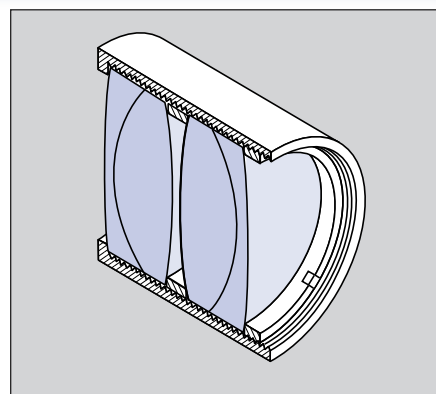
A pair of doublet lenses forms a well-corrected system for imaging at finite conjugates. This range comprises lenses from our achromatic doublet range (p.17) in a black anodised aluminium cell.

The object-to-lens distance is shown for each lens as 'WD' (working distance) and the lens-to-image distance as 'Throw'. Measurements are to the metal mount rather than the glass surface.

## Options available (see p.3)

To order special types see box in Section 4.1 above but use code TT followed by doublet catalogue numbers required from p.17.

Catalogue No.	Length x dia. (mm)	WD (mm)	Throw (mm)	Mag.	FL (mm)	Clear aper. (mm)	Lenses included (see p.17)
01 TT 25	25 x 28	58	53	1.0	32.4	23.2	63 DQ 25/63 DQ 25
02 TT 25	20 x 28	96	92	1.0	50.7	23.2	100 DQ 25/100 DQ 25
03 TT 25	16 x 28	156	153	1.0	80.5	23.2	160 DQ 25/160 DQ 25
04 TT 25	20 x 28	58	95	1.59	39.6	23.2	63 DQ 25/100 DQ 25
05 TT 25	20 x 28	58	153	2.54	45.7	23.2	63 DQ 25/160 DQ 25
06 TT 25	20 x 28	58	243	3.97	50.8	23.2	63 DQ 25/250 DQ 25
01 TT 40	25 x 43	94	94	1.0	51.0	38.2	100 DQ 40/100 DQ 40
02 TT 40	25 x 43	155	150	1.0	80.8	38.2	160 DQ 40/160 DQ 40
03 TT 40	20 x 43	245	243	1.0	125.7	38.2	250 DQ 40/250 DQ 40
04 TT 40	25 x 43	94	153	1.6	62.7	38.2	100 DQ 40/160 DQ 40
05 TT 40	25 x 43	94	243	2.5	72.5	38.2	100 DQ 40/250 DQ 40
06 TT 40	20 x 43	94	396	4.0	80.5	38.2	100 DQ 40/400 DQ 40



## See also:

For lens details p.17  
For mount details (MB) p.53

www.gmp.ch

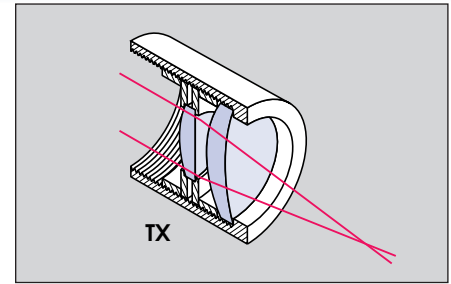
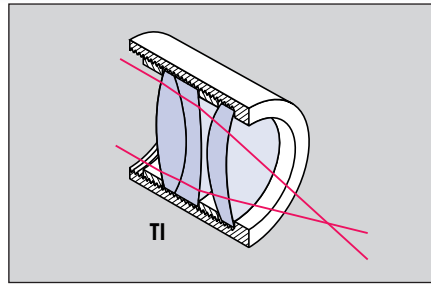
## 4.3 Focusing/collimating lens combinations

≡Customise 

These lens systems, incorporating high-index meniscus supplementary lenses (see p.6), are ideal for laser focusing and collimation, offering good correction at large apertures. They are supplied ready-mounted in black anodised TubeMount cells (p.53).

The TI series comprise a doublet and a meniscus lens and are diffraction-limited over almost the entire aperture.

The TX series comprise two high-index singlets (planoconvex and meniscus). They are suitable for high powers (having no cemented interfaces), have higher transmittance and lower cost, but of course are not quite so well corrected.



Catalogue No.	Length x dia. (mm)	FL (mm)	WD (mm)	Aperture (mm)	NA	Lenses included (see pp.6, 17)
<b>Doublet + meniscus</b>						
05 TI 04	16 x 19	5.4	0.6	4.3	0.40	10 DQ 06/10 IX 04
08 TI 06	16 x 19	8.2	2.6	6.4	0.39	16 DQ 08/16 IX 06
12 TI 09	16 x 19	12.7	6.6	8.8	0.35	25 DQ 10/25 IX 10
20 TI 14	16 x 19	20.4	13.4	14.2	0.35	40 DQ 16/40 IX 16
<b>Planovex + meniscus</b>						
05 TX 03	10 x 19	5.0	0.9	3.3	0.33	10 PX 04/10 IX 04
08 TX 05	10 x 19	8.0	2.8	5.3	0.33	16 PX 06/16 IX 06
12 TX 05	10 x 19	12.5	6.8	5.3	0.21	25 PX 06/25 IX 10
20 TX 09	10 x 19	20.0	13.8	8.8	0.22	40 PX 10/40 IX 16

**See also:**

Similar combinations in objective mounts p.20

## 4.4 UV condenser lens

≡Customise 

This 3-element f/1 lens offers excellent spherical-aberration correction, with a spot diameter of around 0.2mm. Being entirely in UV silica (see p.2) it can be used down to 170nm.

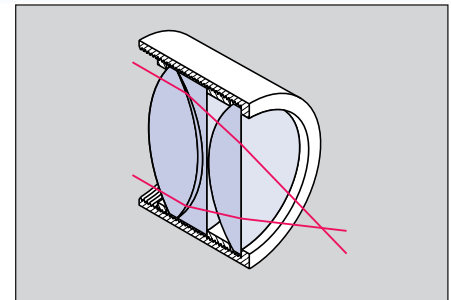
Catalogue No.	Length x dia. (mm)	FL (mm)	Clear aper. (mm)
10 TS 25	25 x 28	25	23.2

**Specification**

Working distance	13.9mm
Collection angle	53°
Numerical aperture	0.45
Note: Data given for 400nm	

**Options available (see p.3)**

- AR coating
- Special mounting



## 4.5 Projector lenses

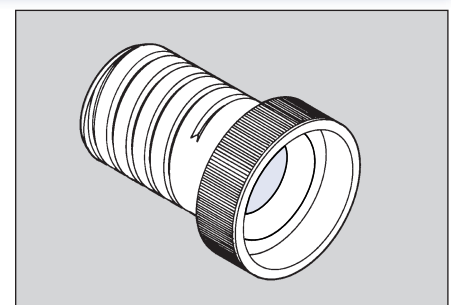
These 35mm projector lenses are useful in any optical system requiring good definition of a projected image over a large angle.

The 85mm FL lens is particularly low-cost, owing to mass production, and is useful in illumination systems where the area to be illuminated must be precisely defined.

**Specification**

Object size	43mm diagonal
Barrel dia.	42.5mm

Catalogue No.	Focal length (mm)	F/No.
60 TQ 21	60	2.8
85 TQ 30	85	2.8
180 TQ 51	180	3.5

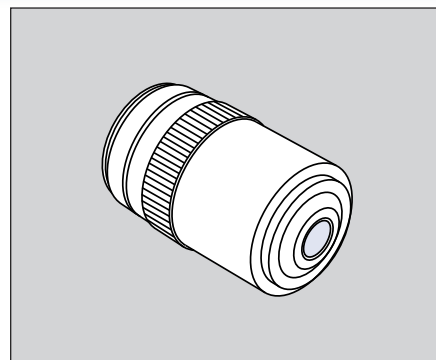


## 4.6 Microscope objectives

We offer a standard range of high-quality achromats; long-working-distance achromats for viewing objects with restricted access; metallurgical achromats for surface inspection and

planachromats for flatter field.

Microscope objectives are widely used for laser focusing in spatial filters etc. but those listed in Section 4.7 below will often be better for this purpose.



## Specification

Optical tube length (shoulder to image)	150mm
Cover glass correction (not critical on low powers)	0.17mm
Parfocal distance	45mm

## Accessories available

05 Q0 06	Immersion oil, 6-7ml
10 Q0 00	Tap for thread
Adaptors	see p.58
Holders	see p.81

Catalogue No.	Mag.	NA	WD (mm)	FL (mm)	Length (mm)	Parfocal	Type
04 OA 10	4	0.1	18.5	30.7	26.5	yes	achromat
06 OA 10	6	0.1	18.5	22.6	26.5	yes	achromat
10 OA 25	10	0.25	6.5	16.9	38.5	yes	achromat
20 OA 40	20	0.4	1.7	9.01	43.3	yes	achromat, sprung
40 OA 65	40	0.65	0.6	4.51	44.3	yes	achromat, sprung
60 OA 85	60	0.85	0.3	2.91	44.7	yes	achromat, sprung
100 OA 125	100	1.25	0.15	1.69	44.85	yes	achromat, sprung, oil
01 OL 04	1	0.04	125	73	23.5	no	long-WD achromat
02 OL 05	2	0.05	68	53	23.5	no	long-WD achromat
03 OL 07	3	0.07	26	38	23.5	no	long-WD achromat
10 OL 18	10	0.18	15	17	30	yes	long-WD achromat
20 OL 30	20	0.3	5.8	8.19	39.2	yes	long-WD achromat
04 OS 10	4	0.1	20	31	25	yes	planachromat
10 OS 25	10	0.25	7.3	15.9	37.7	yes	planachromat
40 OS 65	40	0.65	0.7	4.5	44.3	yes	planachromat
05 OM 10	5	0.1	18.0	26.98	26.9	yes	met. achromat
10 OM 25	10	0.25	5.5	16.56	38.6	yes	met. achromat
20 OM 40	20	0.40	1.8	7.84	43.3	yes	met. ach. sprung
40 OM 65	40	0.65	0.6	4.52	44.7	yes	met. ach. sprung
100 OM 125	100	1.25	0.15	1.69	44.7	yes	met. ach. sprung, oil

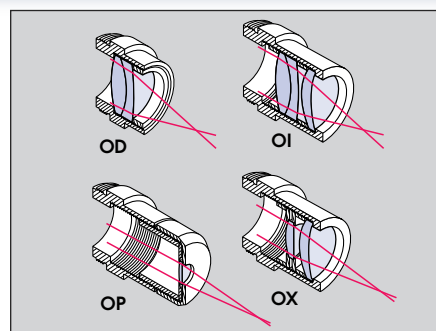
## 4.7 Laser objectives

≡Customise

Conventional microscope objectives are not ideal for laser focusing, being designed for finite conjugates and usually having more elements and higher reflection losses than necessary for this application. We therefore offer here several ranges of laser lenses in standard objective mounts, parfocal at 45mm where possible, to fit directly into spatial filters etc.

The doublets (OD series) give diffraction-limited performance and being achromatic can also be used for microscopy. See p.17 for more details. The

OI series have larger aperture with similar performance (not achromatic) by adding a supplementary meniscus lens (see TI series, p.19). The singlets (OP series) are suitable for high powers, having no cemented interfaces, and have very high transmittance. Owing to the high-index glass used they still have a useful diffraction-limited aperture; see p.6 for further details. The OX series are also cement-free and comprise a singlet focusing lens with supplementary meniscus for greater NA (as TX combinations, p.19).



Catalogue No.	FL (mm)	Aper. (mm)	WD* (mm)	Mag.†	NA*	Similar to lens type
<b>Doublets (see p.17)</b>						
04 OD 026	4	2.6	2.1	47	0.32	04 DQ 03
05 OD 03	5	3.3	2.8	37	0.33	05 DQ 04
06 OD 03	6.3	3.15	4.0	29	0.25	06 DQ 04
10 OD 05	10	5.3	7.0	17	0.26	10 DQ 06
16 OD 06	16	6.4	13.0	10	0.20	16 DQ 08
25 OD 09	25	8.8	22.2	5.7	0.18	25 DQ 10
40 OD 14	40	14.2	32.9	2.7	0.18	40 DQ 16
63 OD 14‡	63	14.2	55.1	1.42	0.11	63 DQ 16
100 OD 14‡	100	14.2	92.5	0.52	0.07	100 DQ 16
<b>Doublet/meniscus combinations (see p.19)</b>						
05 OI 04	5.4	4.3	1.7	33	0.40	05 TI 04
08 OI 06	8.2	6.4	3.7	21	0.39	08 TI 06
12 OI 09	12.7	8.8	7.7	13	0.35	12 TI 09
20 OI 14	20.4	14.2	12.0	7.2	0.35	20 TI 14

Catalogue No.	FL (mm)	Aper. (mm)	WD* (mm)	Mag.†	NA*	Similar to lens type
<b>High-index planovex singlets (see p.6)</b>						
025 OP 02	2.5	2.0	1.3	76	0.43	025 PX 025
04 OP 02	4	2.0	2.9	47	0.26	04 PX 025
06 OP 03	6.3	3.3	4.5	29	0.27	06 PX 04
10 OP 03	10	3.3	8.3	17	0.17	10 PX 04
16 OP 05	16	5.3	13.9	10	0.17	16 PX 06
25 OP 05	25	5.5	23.0	5.8	0.11	25 PX 06
40 OP 09	40	8.8	33.1	2.9	0.11	40 PX 10
63 OP 14‡	63	14.2	57.1	1.4	0.11	63 PX 16
100 OP 14‡	100	14.2	94.2	0.52	0.07	100 PX 16
<b>Planovex/meniscus singlet combinations (see p.19)</b>						
05 OX 03	5	3.3	2.0	37	0.33	05 TX 03
08 OX 05	8	5.3	3.8	22	0.33	08 TX 05
12 OX 05	12.5	5.3	7.8	13	0.21	12 TX 05
20 OX 09	20	8.8	12.2	7.6	0.22	20 TX 09

\*For infinite conjugate † For 150mm optical tube length ‡ Not parfocal

## 4.8 Microscope eyepieces

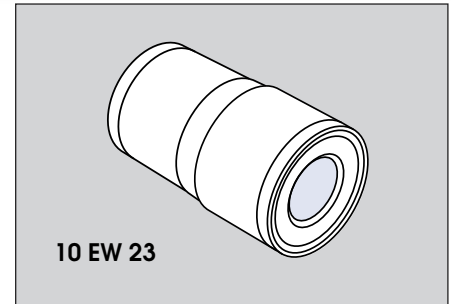
These eyepieces fit most standard microscopes (23.2mm fitting) and can be incorporated in other optical systems, especially where a graticule is required for measurement or alignment. The **12 EW 23** is a low-cost type without provision for a graticule. For incorporation in instruments the astronomical eyepieces listed below should also be considered.

For regular use with a graticule we recommend the focusing eyepiece **10 EF 23** which allows adjustment for individual users' sight.

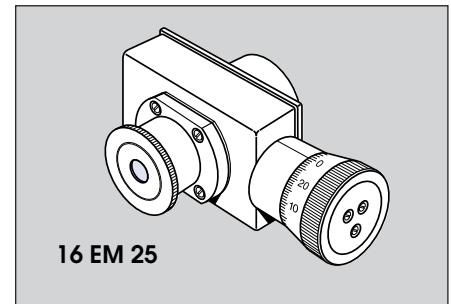
The filar micrometer eyepiece **16 EM 25** allows very accurate measurements of position, having a crosshair driven by an external micrometer head and reading to 10 microns. This unit clamps on the outside of an eyepiece tube (25mm dia.).

- Focusing eyepiece for comfortable viewing
- Zoom for variable magnification
- Filar micrometer for precise measurements

Catalogue No.	Mag.	Field dia. (mm)	Graticule dia. (mm)	Type
<b>10 EW 23</b>	10	18	19	widefield
<b>12 EW 23</b>	12	16	–	widefield
<b>15 EW 23</b>	15	11	19	widefield
<b>20 EW 23</b>	20	8	19	widefield
<b>10 EF 23</b>	10	18	19	widefield, focusing
<b>16 EM 25</b>	16	11	–	filar micrometer
<b>20 EZ 23</b>	10-20	7.5-10	–	widefield, zoom



**10 EW 23**



**16 EM 25**

**See also:**

Graticules

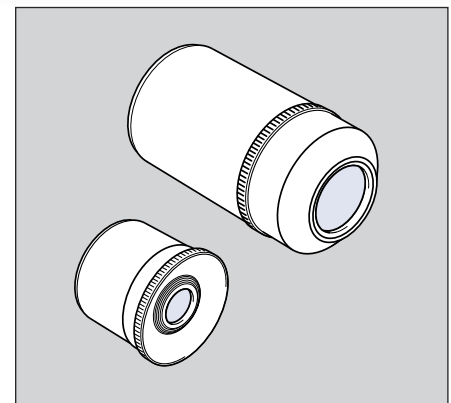
[p.47](#)

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## 4.9 Telescope/instrument eyepieces

These eyepieces, primarily intended for astronomical telescopes, are very suitable for incorporation into other optical instruments for viewing or projecting an image. They are of high optical quality and available in a wide range of powers. The image plane is external to the optics and can be accessed by unscrewing the fitting tube, for use with an independently-mounted graticule etc.

The Kellner (**EK**) series is roughly equivalent to microscope widefield eyepieces, at a very competitive price. The orthoscopic (**EO**) series has similar field size but better correction and a flatter field, while the Erfle (**EE**) offers a much wider field.



Catalogue No. 24.5mm dia.	Catalogue No. 31.7mm dia.	Focal length (mm)	Field dia. (mm)	Field angle	Equiv. mag.	Eye relief (mm)	No. of elements	Type
<b>06 EK 24</b>	–	6	4.2	42°	42	4.8	3	Kellner
<b>09 EK 24</b>	–	9	7.1	44°	28	7.2	3	Kellner
<b>12 EK 24</b>	–	12	8.5	40°	21	9.6	3	Kellner
<b>18 EK 24</b>	–	18	15.0	45°	14	15.0	3	Kellner
<b>25 EK 24</b>	–	25	17.8	42°	10	19.5	3	Kellner
<b>04 EO 24</b>	–	4	2.8	41°	63	3.5	4	orthoscopic
<b>06 EO 24</b>	<b>06 EO 32</b>	6	4.2	43°	42	4.8	4	orthoscopic
<b>09 EO 24</b>	<b>09 EO 32</b>	9	7.2	42°	28	7.2	4	orthoscopic
<b>12 EO 24</b>	<b>12 EO 32</b>	12.5	8.5	44°	20	10.0	4	orthoscopic
<b>18 EO 24</b>	<b>18 EO 32</b>	18	13.1	44°	14	14.4	4	orthoscopic
<b>25 EO 24</b>	<b>25 EO 32</b>	25	17.0*	45°*	10	20.0	4	orthoscopic
–	<b>20 EE 32</b>	20	20.0	62°	12.5	11.0	6	Erfle

\*25 EO 32 has field dia. 17.5mm, angle 47°

**Magnification calculation**

For convenience we list the equivalent magnification of each eyepiece, given by 250mm/FL; this is the magnification when used as a simple magnifier or in a microscope. The magnification of a telescope is given by the ratio of the focal lengths of the objective and eyepiece.

## 4.10 Microscope tubes

**Customise**

These visual and camera microscopes are convenient for building a wide range of industrial vision and inspection systems. We list both empty tubes accepting standard microscope optics (pp.20, 21) and ready-made systems. All tubes are 28mm diameter.

The **visual** systems use 10x widefield eyepieces, which accept 19mm dia. graticules (p.47). Those with focusing eyepiece allow the focus on the graticule to be adjusted to suit individual users' sight and are recommended if a graticule is to be frequently used. For accurate measurements, scale graticules quoted are approximate only.

The **camera** systems have the standard 1"-32 thread to screw directly into any C-mount or CS-mount camera.

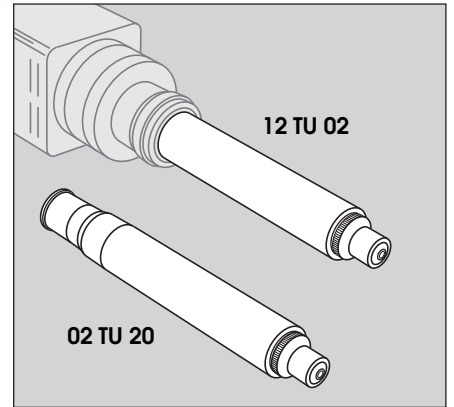
These units do not, of course, include adjustments for focusing on the object, which should be placed at the approximate working distance shown and adjusted for best focus.

### Options available

Many different configurations can be made up from our TubeMount system - see pp.53-59 or contact us to discuss your application

### See also:

Objectives to fit	p.20 (all items)
Eyepieces to fit	p.21 (Section 4.8 only)
Graticules and stage graticules	p.47
Rack and pinion focusing units	p.65
Holders for tubes	pp.81,82



Visual microscopes

Catalogue No. with focusing eyepiece	Catalogue No. with non-focusing eyepiece	Mag.	Field of view (mm)	Overall length (mm)	Working distance (mm)	NA
02 TU 10	04 TU 10	10	18	212	125	0.04
02 TU 20	04 TU 20	20	9	212	68	0.05
02 TU 30	04 TU 30	30	6	212	26	0.07
02 TU 40	04 TU 40	40	4.5	215	18.5	0.1
02 TU 100	04 TU 100	100	1.8	227	6.5	0.25
Tube without eyepiece or objective						
02 TU 00	-	-	-	160	-	-

Camera microscopes

Catalogue No.	Mag.	Field of view (1/2" camera)* (mm)	Overall length (mm)	Working distance (mm)	F/No. (image side)
12 TU 01	1	6.4 x 4.8	154	125	13
12 TU 02	2	3.2 x 2.4	154	68	20
12 TU 03	3	2.1 x 1.6	154	26	22
12 TU 04	4	1.6 x 1.2	157	18.5	20
12 TU 10	10	0.64 x 0.48	169	6.5	20
Tube without optics					
12 TU 00	-	-	130	-	-

\*For 1/3" multiply by 0.75; for 2/3" by 1.375 and for 1" by 2

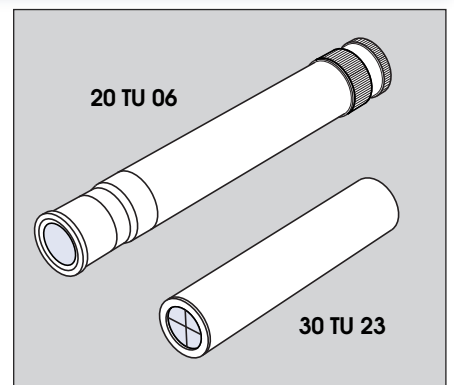
## 4.11 Telescopes and collimators

**Customise**

Simple telescopes are widely used for alignment, remote scale reading etc. Our standard unit has a 160mm f.l. 23mm aperture doublet objective with screw movement focusing from 2m to infinity. It is offered complete with eyepiece and crosshair graticule giving 6.4x magnification, or alternatively as a tube accepting any standard microscope

eyepiece (with graticule if required). Many other systems can readily be constructed from our TubeMount system (pp.53-59) - we shall be very happy to advise on your specific application.

Collimators comprise a crosshair mounted at the focus of an achromatic objective and are useful for various measurement and alignment applications.



Catalogue No.	Overall length (mm)	Tube diameter (mm)	Objective lens (see p.17)	Description
20 TU 06	216	28	160 DQ 25	Telescope 6.4x
20 TU 00	188	28	160 DQ 25	Telescope without eyepiece
30 TU 23	170	28	160 DQ 25	Collimator 23mm aperture
30 TU 38	170	43	160 DQ 40	Collimator 38mm aperture

### See also:

Eyepieces to fit (Section 4.8 only)	p.21
Graticules	p.47
Holders for tubes	pp.81,82

## 4.12 Laser beam expanders

Customise 

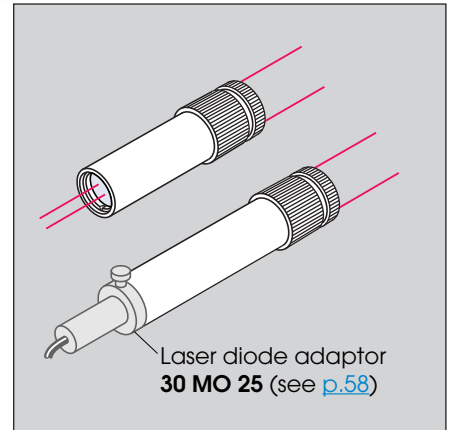
Expansion of a laser beam reduces the divergence in the same ratio, and so is desirable for use over long distances. These expanders have a focusing movement of 16mm on the output lens and so can be used to produce a converging beam.

Our **Standard** range have very high transmittance and aberration correction within the diffraction limit. For the smaller apertures we use high-index singlet lenses

(see pp.6,10) allowing these expanders to handle high laser powers. To maintain correction for larger output apertures we use cemented-doublet output lenses.

The **UV silica** range can be used from 170nm to 2500nm, and is suitable for high powers.

The **Achromatic** range uses doublet lenses (see p.17) for both input and output and is useful for multi-line lasers.



### Options available

Many other configurations possible - please enquire

### See also:

Adaptors to connect to lasers [p.58](#)  
Mounting rings [p.81](#)

### Standard range

Catalogue No.	Mag.	Input aperture (mm)	Length x dia. (mm)
<b>Singlet optics</b>			
01 TE 016	1.6	9.1	71 x 28
01 TE 025	2.5	5.7	71 x 28
01 TE 04	4	3.6	95 x 28
01 TE 06	6.4	3.6	156 x 28
01 TE 10	10	2.3	156 x 28
01 TE 16	16	1.45	171 x 28
<b>Doublet/singlet optics</b>			
11 TE 10	10	3.8	192 x 43
11 TE 16	16	2.4	192 x 43
11 TE 25	25	1.9	192 x 53

### UV silica range

Catalogue No.	Mag.	Input aperture (mm)	Length x dia. (mm)
02 TE 016	1.6	14.5	71 x 28
02 TE 025	2.5	9.1	111 x 28
02 TE 04	4	5.8	132 x 28
02 TE 06	6.4	3.6	157 x 28
02 TE 10	10	2.3	157 x 28
02 TE 16	16	1.45	172 x 28

### Achromatic range

Catalogue No.	Mag.	Input aperture (mm)	Length x dia. (mm)
03 TE 016	1.6	9	86 x 28
03 TE 025	2.5	7.2	111 x 28
03 TE 04	4	5.8	146 x 28
03 TE 06	6.3	3.7	132 x 28
03 TE 10	10	2.3	131 x 28
03 TE 16	16	1.45	191 x 28
13 TE 10	10	3.8	194 x 43
13 TE 16	16	2.4	207 x 43
13 TE 25	25	1.9	219 x 53

## 4.13 Zoom beam expanders

Customise 

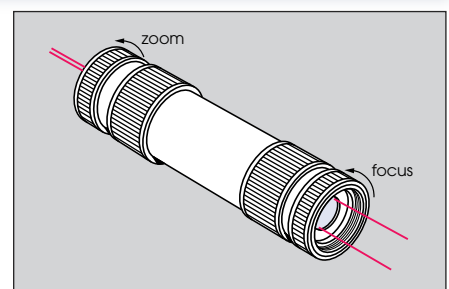
The expansion ratio of these beam expanders can be varied over a range of approximately 2:1 by a simple rotation of the input lens. A similar motion of the output lens provides for focusing.

Two ranges are offered. The 01 TZ series

are most suitable for high power, having no cemented components. The 11 TZ range achieve better correction (normally diffraction-limited) and larger apertures by use of a cemented-doublet output lens.

### Technical data sheet

Available on request



### Expanders with singlet output lens

Catalogue No.	Mag.	Input aper. at max. mag. (mm)	Length (mm)	Body dia. (mm)
01 TZ 02	1-2	2.65	128	28
01 TZ 03	1.6-3.2	1.7	140	28
01 TZ 05	2.5-5	1.76	114	28
01 TZ 08	4-8	1.83	141	28
01 TZ 12	6.3-12.5	1.15	141	28
01 TZ 20	10-20	1.16	216	28

### Expanders with doublet output lens

Catalogue No.	Mag.	Input aper. at max. mag. (mm)	Length (mm)	Body dia. (mm)
11 TZ 03	1.6-3.2	2.8	140	28
11 TZ 05	2.5-5	2.9	122	28
11 TZ 08	4-8	2.9	141	28
11 TZ 12	6.3-12.5	1.9	141	28
11 TZ 20	10-20	1.9	232	43
11 TZ 32	16-32	1.2	296	43