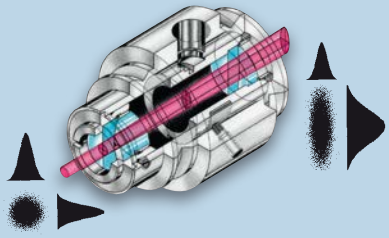
ANAMORPHIC OPTICS

Anamorphic Beam-Shaping Optics transforms a collimated laser beams from elliptical into circular.
Faraday isolators protect laser sources from back-reflection.



Anamorphic Beam-Shaping Optics and Faraday Isolators

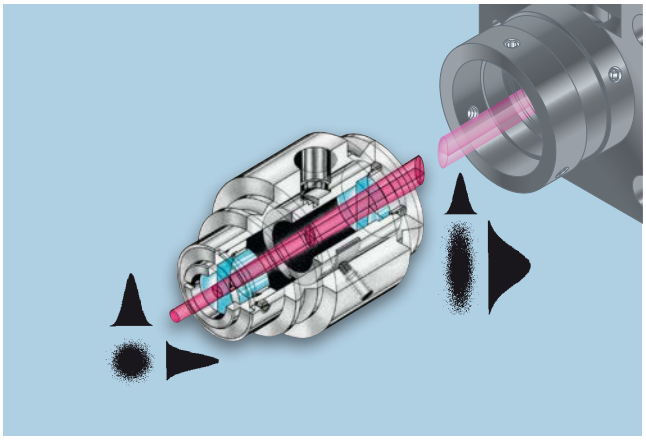
Anamorphic Beam-Shaping Optics 5AN

Transforms a Collimated Laser Beams with Elliptical Cross-section into a Circular beam or Vice Versa

A circular beam profile may be preferred over the elliptical profile usually provided by laser diodes. Anamorphic optics act one-dimensionally on the elliptical profile of the collimated beam and adjust the larger beam diameter to the dimension of the smaller one, producing a radially symmetric beam.

The anamorphic beam-shaping optics type 5AN are cylinder lens systems and, therefore, can be additionally used to correct the astigmatic difference ΔAs of the laser diode through a refocusing of the optical system. Coupling efficiencies to singlemode fibers of 80% or more are possible when using anamorphic beam-shaping optics (depending on the beam characteristics of the laser diode).

- Radially symmetric output beam achieved by down scaling of the longer elliptical axis (beam-shaping factor 0.33 – 0.63)
- Integrated astigmatism correction
- No lateral beam shift or beam deviation as with anamorphic prism pairs
- Various optics UV-IR
- Clear aperture 5 mm
- Diffraction-limited optics pair
- Ø19.5 mm system mount: Full integration with multicube™ system/30 mm cage system, collimators and adapters



Form Factor

The anamorphic effect is described by the **form factor F**, which indicates the relative diameter change of the parallel beam.

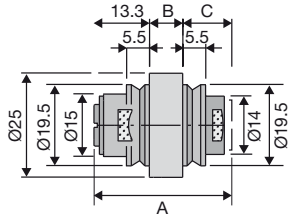
The target value is calculated from the ratio of the beam divergences $\theta_\perp$ and $\theta_\parallel$ of the laser diode or the beam diameters $Ø_\perp$ and $Ø_\parallel$ of the collimated beam.

Technical Data

Dimensions A	Dimensions B	Dimensions C	Form factor F	Wavelength range [nm] λ	Order Code
26.8	8	5.5	0.63	600 - 1020	5 AN-1.6-V-05
31.8	10	8.5	0.5	390 - 620	5 AN - 2- V-35
31.8	10	8.5	0.5	600 - 1020	5 AN - 2- V-05
31.8	10	8.5	0.5	980 - 1550	5 AN - 2- V-08
31.3	8	10	0.4	600 - 1020	5 AN-2.5-V-05
31.3	8	10	0.4	980 - 1550	5 AN-2.5-V-08
36.8	15	8.5	0.33	390 - 540	5 AN - 3- V-35
36.8	15	8.5	0.33	600 - 1020	5 AN - 3- V-05
36.8	15	8.5	0.33	980 - 1550	5 AN - 3- V-08
36.8	15	8.5	0.33	1500 - 2100	5 AN - 3- V-19

Dimensions

B Anamorphic beam-shaping optics Type 5AN

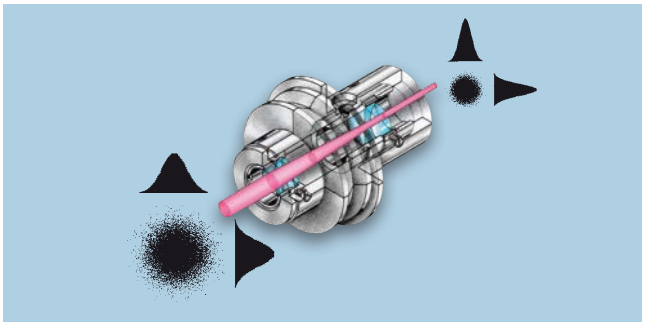


Expansion Optics Type 48EO

Expands the beam diameter of the collimated beam

The best fiber coupling efficiency for beam diameters <0.4 mm is achieved when the laser beam is expanded in advance.

This is done using the Schäfter+Kirchhoff beam expander type 48EO allowing lenses of longer focal length to be used, which improves polarization extinction, makes adjustment easier and increases coupling efficiencies.

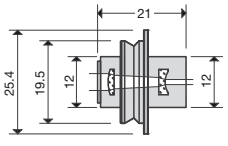


Order Options for Expansion Optics 48EO

Order Code 48EO - 3 - 26

- Spectral range
  - 26 = 420 – 700 nm
  - 02 = 600–1050 nm
- Expansion factor
  - 3 = Standard

Dimensions



Clear aperture 5 mm

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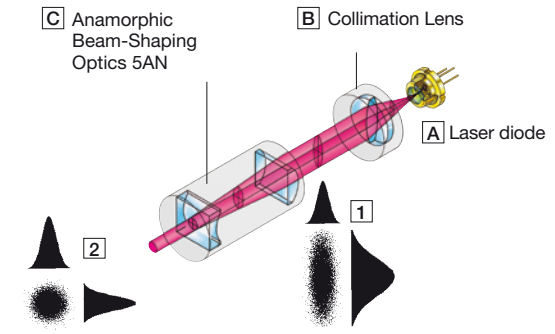
Laser diodes A have large aperture angles vertically (*s*) and smaller aperture angles in parallel (*p*) with the light-emitting layer. Additionally, some laser diodes have two virtual emission sources from the *s*- and *p-directions*, i.e. astigmatism, characterized by the axial displacement, ΔAs.

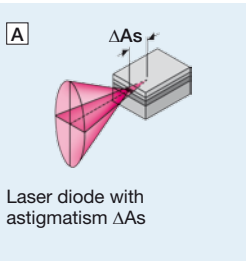
The collimating lens B produces a collimated elliptical beam with a Gaussian intensity profile 1. If there additionally is an astigmatic difference, ΔAs, the beam is collimated in only one of the directions and is diverging in the other.

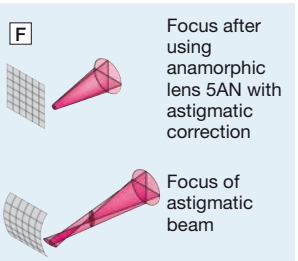
The anamorphic beam-shaping optics C contains a positive and a negative cylinder lens, scaling down the longer elliptical axis to that of the shorter axis. To compensate for divergence induced in the *s-direction*, the distance between the elements of the cylinder lens is increased (astigmatism correction).

The output beam profile 2 of the anamorphic beam-shaping optics is circular and the beam is collimated (if the anamorphic form factor is chosen correctly). After astigmatism correction, the wave fronts are planar.

When this beam is refocused, the spot is not only circular but also has plane wave fronts F. Without astigmatism correction (e.g. when beam shaping is performed using anamorphic prism optics), the focus shows astigmatism and the wave fronts are curved.







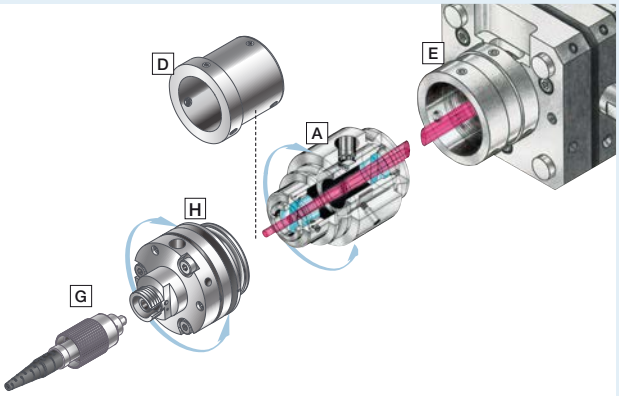
Beam-Shaping and Coupling into Singlemode Fibers

The optically active axis of the anamorphic beam-shaping optics A is orientated in parallel with the longer elliptical axis of the collimated laser beam.

The circular V-groove at the anamorphic optics input provides a positive, rotatable and lockable connection with the laser diode collimator E .

When coupling into polarization-maintaining fibers G, the (slow) polarization axis of the fiber together the laser beam coupler H beam must be aligned with the polarization axis of the laser beam.

The alignment of the polarization axis is facilitated by the rotatable and lockable adapter flange **19.5AM25-L** D on the output side of the anamorphic optics.

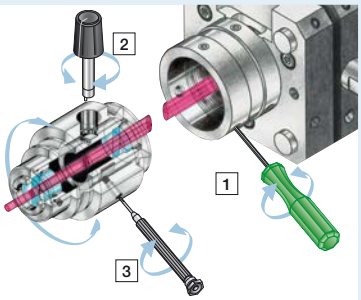


Assembly and adjustment tools

1 **Orientation and attachment of anamorphic beam-shaping optics to e.g. an adapter**
Tool: Hex screwdriver WS 1.5 mm Order-Code **50HD-15**

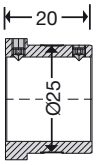
2 **Astigmatism correction by adjusting the optics pair**
Tool: Eccentric key Order-Code **60EX-5**

3 **Locking of optics adjustment setting**
Tool: Screwdriver WS 1.2 mm Order-Code **9D-12**



Dimensions

D **Adapter 19.5AM25-L**



Order Options for Adapter 19.5AM25-L

Order Code **19.5AM25-L**

The adapter 19.5AM25-L enables the laser beam coupler 60SMS to be positively and reproducibly locked into the beam-shaping optics.

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Faraday Isolators 48FI

to protect laser sources from back-reflection

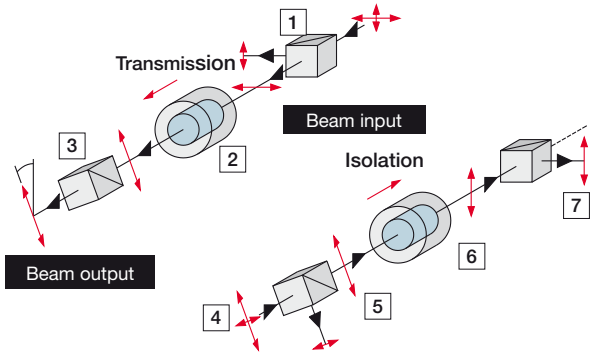
Faraday Isolators are used to protect laser sources from back-reflection (optical diode), which causes mode hopping, laser noise, frequency instability and a shorter laser lifetime.

Main features:

- High isolation >30 dB
- Low insertion loss <0.5 dB
- Aperture Ø 5 mm
- Compatibility with multicube™ and microbench / cage systems
- Through-holes for mounting rods
- Standard wavelengths in a range of 400 to 1080 nm
- Bandwidth: center wavelength ±20 nm

Working Principle

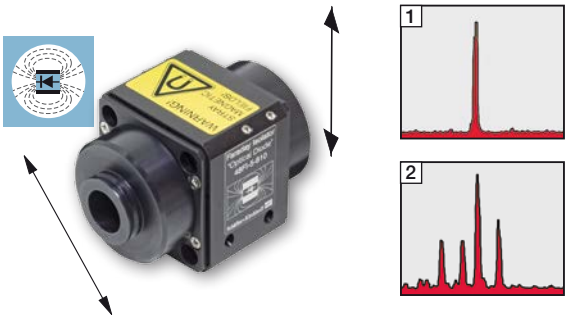
1 Polarizing beam splitter eliminates the *s*-polarized portion (typically 1 %) of the laser (diode) radiation
2 Faraday crystal in a strong magnetic field rotates the input polarization plane 45°
3 Polarizing beam splitter exactly aligned with the output polarization plane, i.e. by 45° with respect to the input polarization
4 Reflective or scattering surfaces cause polarized or depolarized reflected signals
5 Polarizing beam splitter 3 eliminates the *s*-polarized portion of the reflected signal
6 Faraday rotator 2 rotates the polarization plane by a further 45° so that the polarization plane of the reflected signal is now rotated by 90° from the polarization plane of the input beam
7 Polarizing beam splitter 1 blocks the reflected signal



Benefits of using a Faraday Isolator

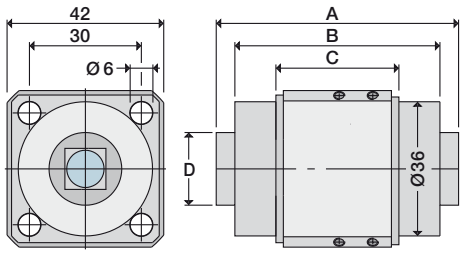
A Faraday Islolator protects the laser diode from back-reflection. If light is back-reflected into the laser source, it causes mode hopping. A typical spectrum is shown for an undisturbed and a laser beam source disturbed by back-reflected light. The disturbed spectrum shows multiple excited modes that change stochastically over time. This mode hopping results in laser noise, frequency instability and ultimately causes the laser lifetime to be decreased significantly.

Please note that because of its working principle the polarization of the beam passed by the Faraday isolator is rotated by 45° degrees in comparision with the input polarization.



1 Spectrum of an undisturbed laser beam source
2 Disturbed spectrum because of back-reflections (mode hopping)

Dimensions



Dimension [mm]					Aperture [mm]			Center Wave-length λ [nm]	Order Code
row	A	B	C	D	2	3	5		
1	80	70	48	19.5			x	400	48FI-5-400
2	39	27	20	18	x			532	48FI-2-532
3	65	55	33	19.5			x	532	48FI-5-532
4	39	27	20	18	x			633	48FI-2-633
5	65	55	33	19.5			x	633	48FI-5-633
6	91	70	32	19.5			x	660	48FI-5-660
7	80	70	48	19.5			x	670	48FI-5-670
8	65	55	33	19.5			x	780	48FI-5-780
9	65	55	33	19.5			x	810	48FI-5-810
10	65	55	33	19.5			x	850	48FI-5-850
11	100	90	68	19.5			x	980	48FI-5-980
12	92	82	60	19.5		x		1064	48FI-3-1064
13	100	90	68	19.5			x	1080	48FI-5-1080

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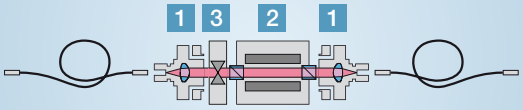
Application: Fiber-coupled Faraday Isolator

The fiber-to-fiber coupler with Faraday isolator from Schäfter+Kirchhoff supresses back-reflection and also offers - as an option - attenuator and shutter functionalities.

A fiber-to-fiber coupler with Faraday isolator is used to protect laser beam sources where the attached fiber connectors cannot be removed (e.g. a fiber pigtail) or when back-coupling to the fiber is a desirable and discriminating characteristic (e.g. in interferometry).

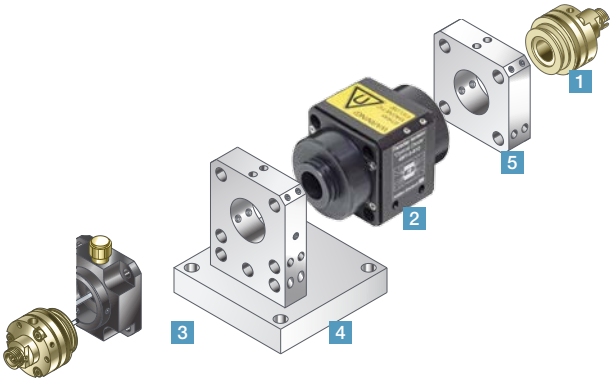
They are used in combination with polarization-maintaining fiber cables.

Optical Scheme



Set-up / Order Codes

1	Laser beam coupler		
	Order Code	60SMS-1-4-	for out and for in-coupling, adjustable
2	Faraday isolator		
	Order Code	48FI-	avoids back-coupling of laser radiation into the fiber
3	Attenuator/Shutter		
	Order Code	48AT-A/ 48AT-S	Option: Attenuator or shutter mechanism
4	Console		
	Order Code	48MB-19.5-60	
5	Mounting Plate		
	Order Code	48MC-MP-19.5	



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