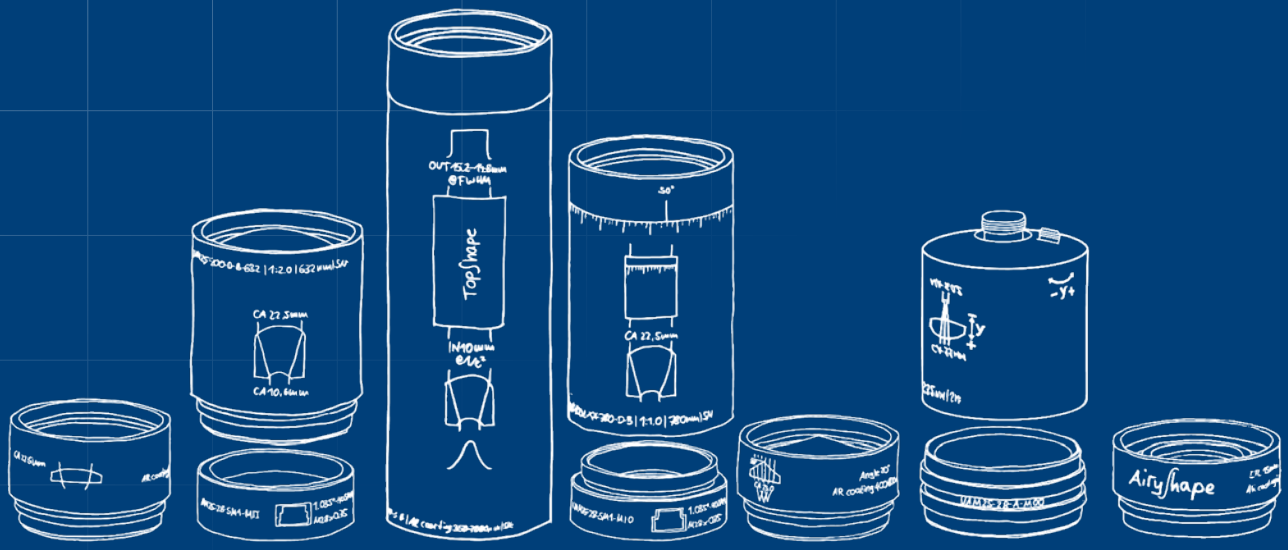
asphericon

BeamTuning

Beam expansion and **Beam shaping** at the next level



Discover plug and play perfection.

asphericon BeamTuning

asphericon BeamTuning for beam expansion, fiber collimation and beam shaping at the next level. Discover a comprehensive range of laser beam processing elements, the various possible combinations and compile your own individual product selection.

BEAMEXPANSION

The world's first aspheric beam expansion system is the right choice when it comes to beam expansion or reduction with outstanding quality.

BEAMEXPANSION PRODUCTS:

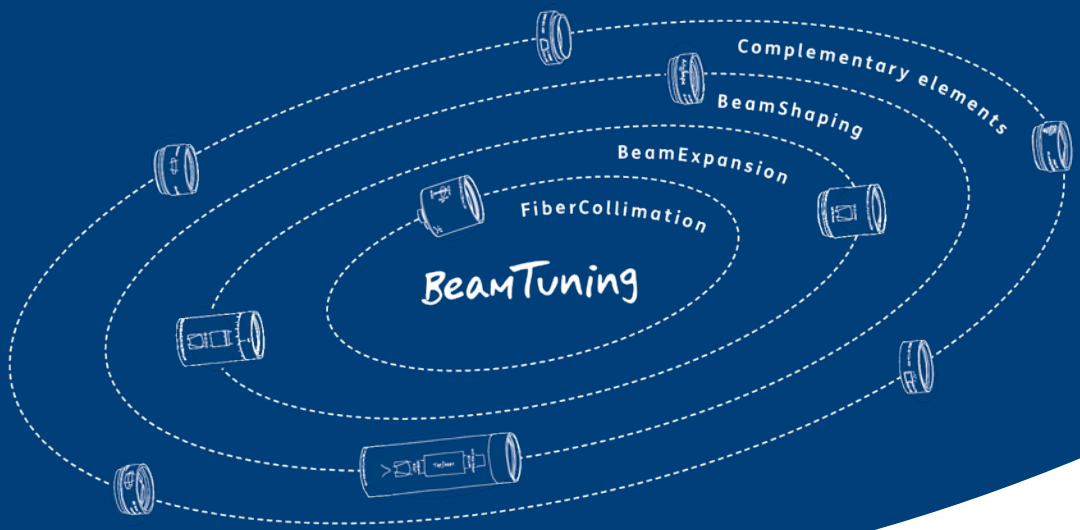
= a|BeamExpander (p. 6)
= a|Wavelλdapt (p. 8)

FIBERCOLLIMATION/FIBERCOUPLING

Use our adjustable fiber collimation package to easily combine all BeamTuning elements directly to your fiber coupled laser source.

FIBERCOLLIMATING PRODUCT:

= a|AspheriColl (p. 10)



BEAMSHAPING

Simply transform collimated Gaussian laser beams into collimated and focused Top-Hat beams and take advantage of the easy handling.

BEAMSHAPING PRODUCTS:

a|TopShape (p. 12)
a|AiryShape (p. 14)

COMPLEMENTARY ELEMENTS

Connect all elements or combine them with other systems. Matching adapters and MountedOptics allow for 100% flexibility.

COMPLEMENTARY PRODUCTS:

a|MountedAspheres/Axicons/Acylinders (p. 16)
a|Adapters cross-system & intra-system (p. 18)

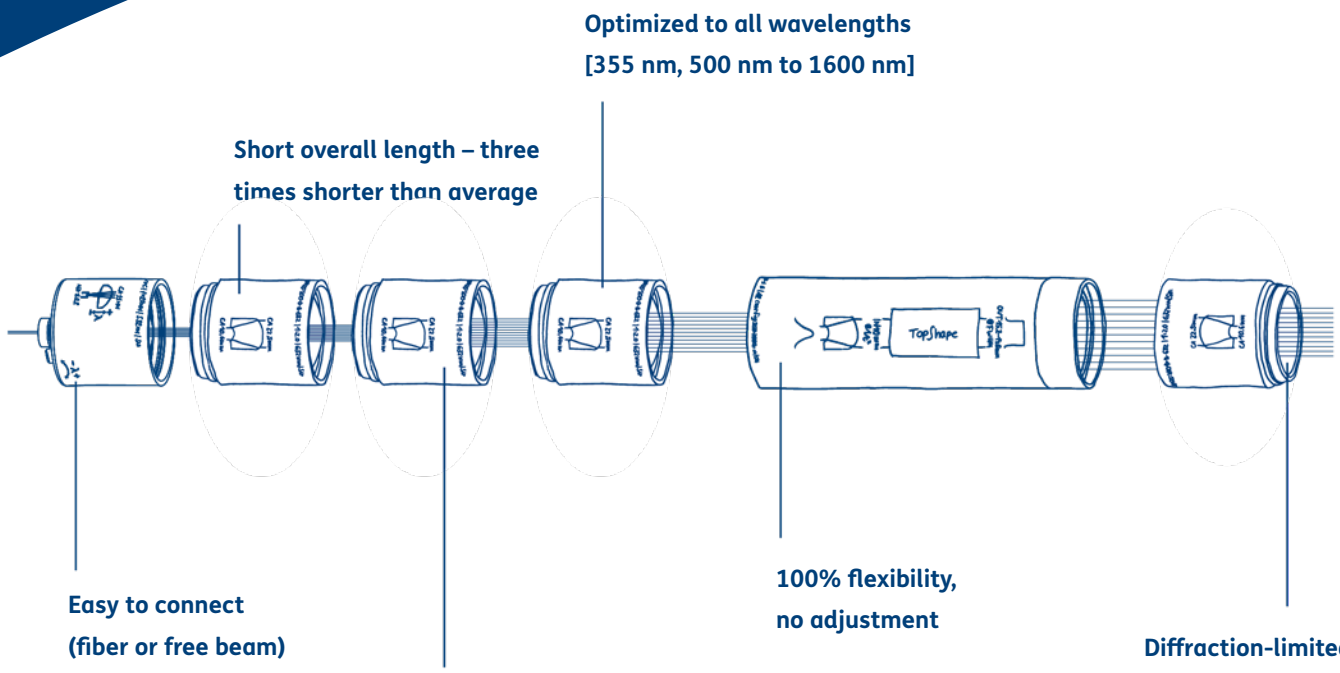
tu·ning [‘tju:nIŋ],
to adjust something for maximum usability or performance

= Flexible choice of input and output beam diameter

= Economical to use – Simple integration into any optical system by an intelligent mounting concept

= Low contamination due to tightly sealed mountings

= Easy and timesaving handling



Application areas

Discover the wide application range of our BeamTuning products. Flexible in use, with the highest quality, ideal for your specific needs. Below you find some selected examples. Need help with an individual solution? Let us know!

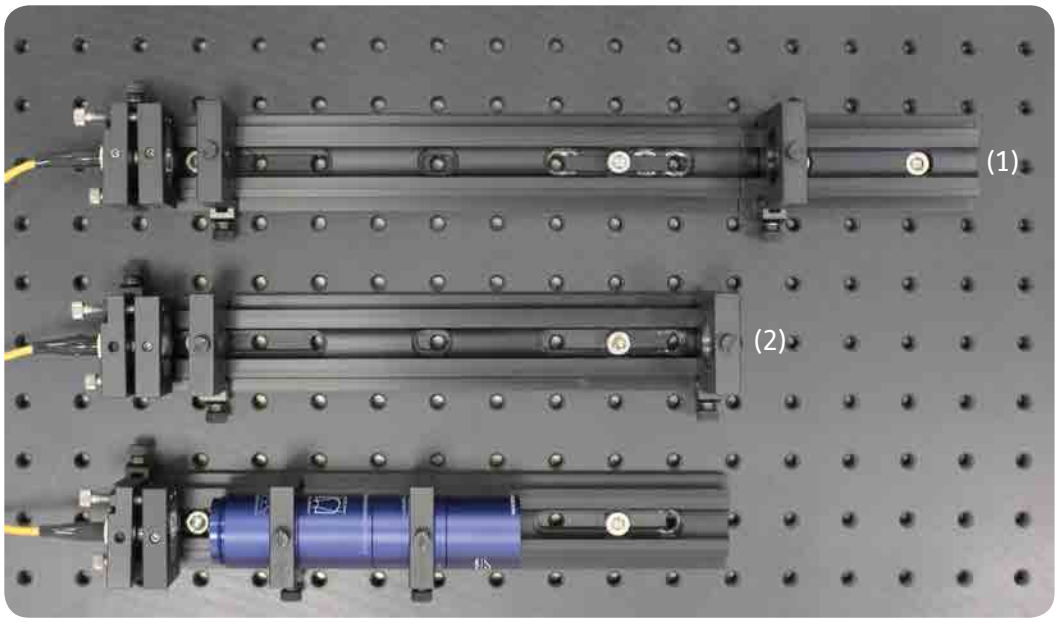
LABORATORY

Beam expansion and beam shaping systems are used for optimum beam adaption between light sources (i.e. laser) and a following optical element. Accurate illumination of the optically effective surfaces is especially essential for beam shaping and focusing with high numerical apertures. Conventional systems can only be adapted with high effort, are relatively large and only suitable for a certain wavelength.

BeamTuning by asphericon covers a wide wavelength range with just a few products, enables flexible adjustments and saves you a lot of time.

Discover, for example, how the a|BeamExpander can help you reduce the overall length of your beam expansion system and still achieve outstanding performance results.

→ *Learn more on page 6/7.*



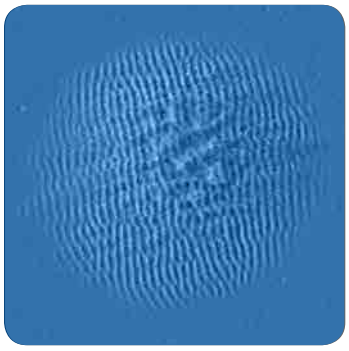
Magnification (M = 10) with a|BeamExpander compared to conventional systems (1) Kepler and (2) Galilean.

High-end BeamTuning solutions for your application.

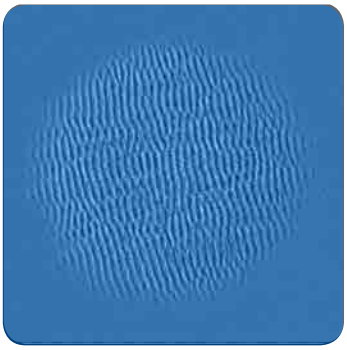
MATERIAL PROCESSING

If a laser beam with a Gaussian intensity profile is used, e.g. for drilling or cutting, the energy loss at the edge of the beam affects the cutting edge quality of the workpiece. Good results require further cuts, which influence the efficiency of the process. In the case of surface functionalization, a Gaussian distribution is also disadvantageous, since uneven melting of the surface prevents homogeneity. Discover how BeamTuning elements easily generate homogeneous intensity distributions (e.g. Top-Hat or Donut). The latter allows for a uniform heat input into the material, which results in smooth profiles.

→ *Learn more on page 14/15.*



Surface functionalization with conventional system (Gaussian Beam)



Surface functionalization with a|AiryShape (Top-Hat)

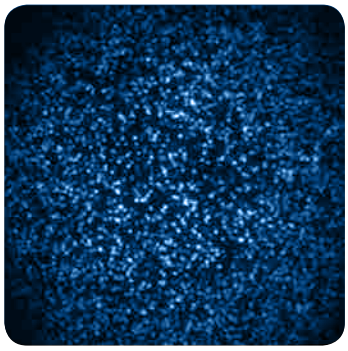
Surface functionalization with a|AiryShape (Donut)

Image reference: Otto Schott Institute of Materials Research (OSIM) at the Friedrich Schiller University of Jena

IMAGING/ILLUMINATION

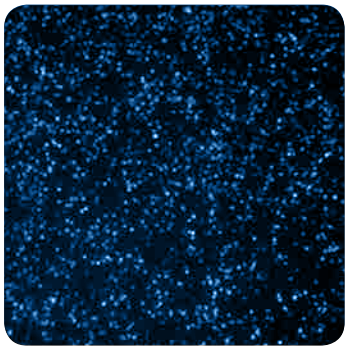
The uneven illumination of Gaussian intensity profiles makes quantitative analysis in laser-based wide-field fluorescence microscopy highly challenging. One disadvantage of non-uniform illumination is the uneven activation of molecules. Those being closest to the center of the beam fluoresced more strongly than those near the periphery. Discover how BeamTuning by asphericon allows to achieve uniform illumination (homogeneity > 95%) while remaining tolerant to variations in size of the incoming laser beams.

→ *Learn more on page 12/13.*



Conventional illumination system

Paper Download:



Illumination with a|TopShape

Image reference: I. Khaw, B. Croop, J. Tang, A. Moehl, U. Fuchs, K. Y. Han: „Flat-field illumination for quantitative fluorescence imaging“, In: OPTICS EXPRESS, Vol. 26, No. 12, 11 Jun 2018, pp. 15276-15288

a|BeamExpander

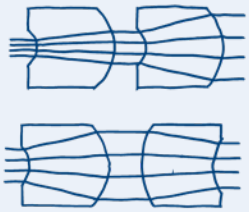
Discover the world's first aspheric and diffraction-limited beam expander. The a|BeamExpander is a monolithic laser accessory with just one aspheric lens for the highest level of precision. Experience nearly endless possibilities with up to 32× beam magnification and optimized performance for different design wavelengths – individually measured and certified.

- = Available in five design wavelengths [355 nm / 532 nm / 632 nm / 780 nm / 1064 nm]
- = Max. input aperture 10.6 – 14.7 mm, max. output aperture 22.5 mm
- = Available with magnifications of 1.5 | 1.75 | 2.0
- = Possibility of combining up to five expander for up to 32 times beam expansion and over 230 intermediate stages
- = Completely diffraction-limited – individually measured and guaranteed by an original asphericon certificate
- = Laser induced damage threshold (Coating): 12 J/cm², 100 Hz, 6 ns, 532 nm
  Please be aware of the material damage threshold of your set-up!

Also available as UV version, made of Suprasil and optimized for Nd:YAG-Laser [355 nm], which enables diffraction-limited beam expansion in the UV range.

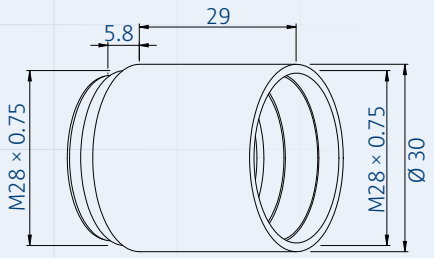
APPLICATION

A beam expander is used to increase or decrease the diameter of a collimated input beam to a larger or smaller collimated output beam.
Use the a|BeamExpander for applications such as interferometry, telescopes, or microscopy.

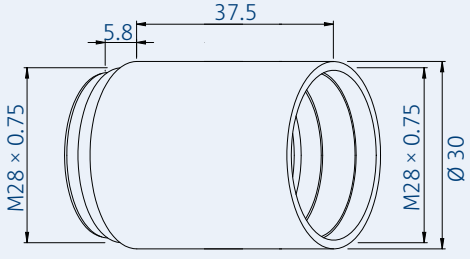


TECHNICAL DIMENSIONS

a|BeamExpander [532 – 1064 nm]

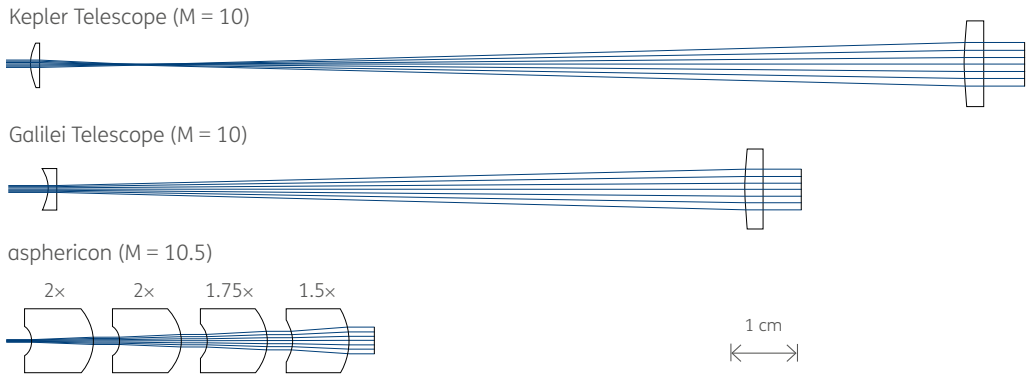


a|BeamExpander UV [355 nm]



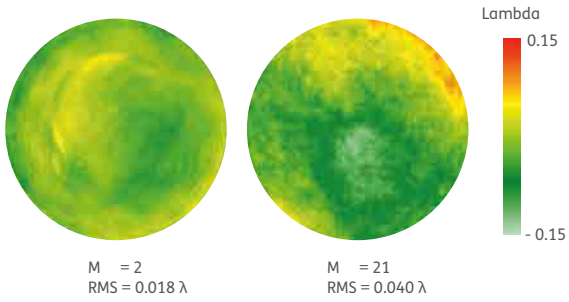
LENGTH

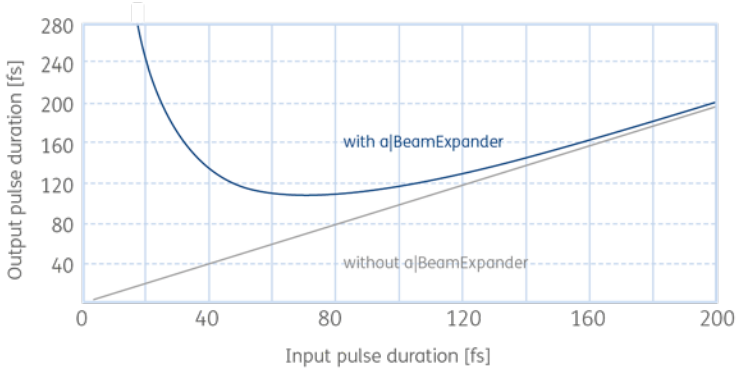
The a|BeamExpander, based on the use of aspheric and monolithic beam expansion elements, achieves overall lengths up to 50% shorter than those of conventional systems – even when used in a cascade. Shown are a Kepler and Galilean telescope with 10× magnification (M = 10) in comparison with our beam expansion system.



PERFORMANCE

Its high performance is particularly evident regarding the wavefront measurements. Depicted are the measured wavefront maps of an a|BeamExpander with a magnification M = 2 (left) and a five element set of a|BeamExpander with M = 21 (right) at 532 nm. The aspheric element is made of glass by grinding and polishing the surface. Having values of wavefront RMS = 0.018 λ (left) and RMS = 0.040 λ (right) prove the exceptional precision of the lenses and its well-suited use in a cascade system.





FLEXIBILITY

The a|BeamExpander can also be used flexibly in the wavelength range from 500 nm to 1600 nm for ulta short pulse laser applications. Please be aware of the pulse broadening effect. In the chart on the left, you can see how your input pulse changes by propagating through an optical element such as the a|BeamExpander.

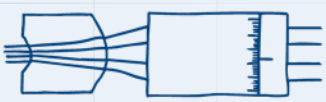
a|Waveλdapt

Using an a|BeamExpander at a wavelength, which differs from its design wavelength? No problem with the a|Waveλdapt. It covers the complete spectral range from 500 nm to 1600 nm, corrects wavefront deformation and adjusts divergence while retaining the beam diameter. This laser device is very flexible in usage – especially, since the overall length of the system is very short compared to conventional systems. Due to it's metric fine thread the a|Waveλdapt, like all BeamTuning elements, can be easily integrated into any optical system.

- = Available for the four a|BeamExpander design wavelengths [532 nm / 632 nm / 780 nm / 1064 nm]
- = Optimized adaptation to wavelength range from 500 nm to 1600 nm
- = Compensation of divergent incoming beams up to 1 mrad
- = Combinable with up to five BeamTuning elements – completely diffraction-limited
- = Preservation of adjusted magnification
- = Max. input aperture 22.5 mm, max. output aperture 22.5 mm
- = Easy and flexible handling

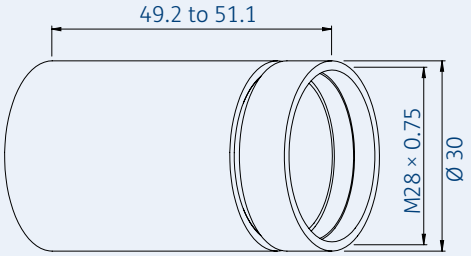
APPLICATION

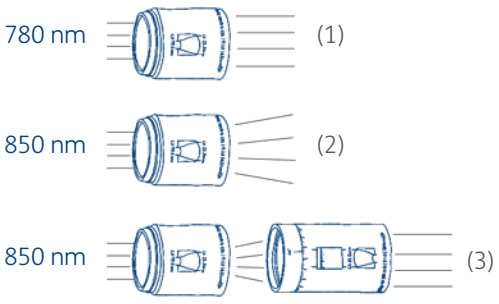
The a|Waveλdapt allows the use of an a|BeamExpander with wavelengths other than its design wavelength.



wavelength adaption

TECHNICAL DIMENSIONS





FLEXIBILITY

The outgoing beam is either divergent or convergent, when an a|BeamExpander is used at a different wavelength than the design wavelength. Additionally, higher order wavefront aberrations occur since the asphere and the center thickness do no longer match the design intention.

A suitable a|Wavelλdapt can easily set these problems within its range of use and thus increases the flexibility of the a|BeamExpander. By using a 780 nm a|Wavelλdapt, for example, beams with a wavelength of 850 nm can be collimated by an a|BeamExpander 780 nm. The diffraction-limited performance is achieved by collimating the outgoing beam at the new wavelength.

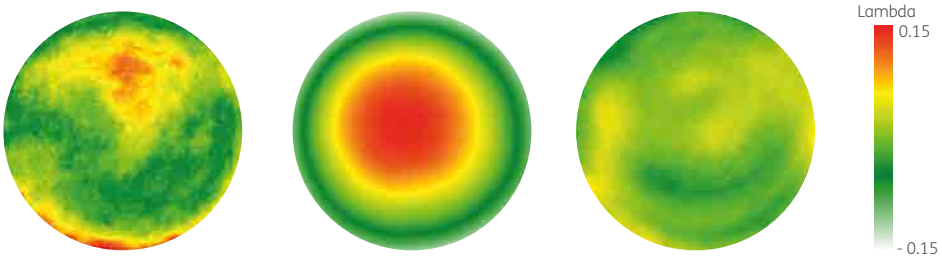
PERFORMANCE

Shown are the measured wavefront maps for two different wavelengths using a cascade with three a|BeamExpander at 780 nm and a corresponding a|Wavelλdapt.

(1) shows the measurement of a cascade with three a|BeamExpander with M = 8 at 780 nm having RMS = 0.042 λ.

(2) illustrates what happens when using the „wrong“ wavelength. The obvious effect is a resulting defocus and consequently divergence of the beam. The measurement showing an a|BeamExpander cascade at 850 nm with a defocus of 2.9 λ PV (RMS = 0.78 λ).

(3) demonstrates how the problem from (2) can be easily solved, when adding the 780 nm a|Wavelλdapt to the set-up. A RMS = 0.024 λ underlines the strong performance (which is even better in the example shown than with a single a|BeamExpander) and high quality of the element.



(1) (2) (3)

The optical design of an a|Wavelλdapt is meant to compensate the right amount of aberrations resulting in a diffraction-limited wavefront in real world when obtaining a collimated beam. Therefore, the a|Wavelλdapt has to be placed at the position of the largest beam diameter to perform as desired.

a|AspheriColl

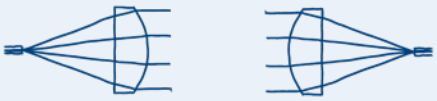
Next Generation

Now even easier to adapt: the a|AspheriColl, an adjustable fiber collimation device, which enables the perfect connection of FC/PC patch fibers to your set-up. Combine the world's smartest off-the-shelf fiber collimator for NA's from 0.12 to 0.275 with BeamTuning or other beam shaping elements to obtain any desired output beam while maintaining a diffraction-limited wavefront.

- = Fiber collimator covering for NA's from 0.12 to 0.275
- = Focal length: f = 20 mm, with $Ø_e$ = 13 mm
- = Optimized for wavelength range 500 nm - 1600 nm
- = Simplified wavelength adaption by setting adjustment unit with SW2 allen key
- = Perfectly aligned lateral position
- = Completely diffraction-limited performance (Strehl > 0.95) when used with FC/PC patch fibers
- = Thanks to matching adapters also usable for APC fibers
- = No truncation effects compared to other available fiber couplers
- = Thanks to bigger output beam diameters, no additional expansion might be needed (shorter system length)

APPLICATION

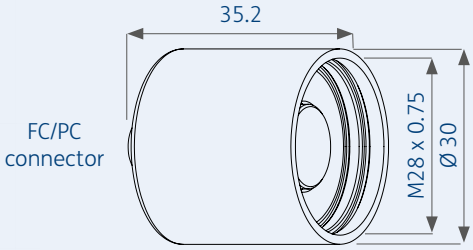
Easily use a|AspheriColl to collimating or coupling fibers.



fiber collimation

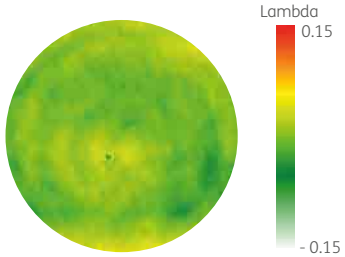
fiber coupling

TECHNICAL DIMENSIONS



PERFORMANCE

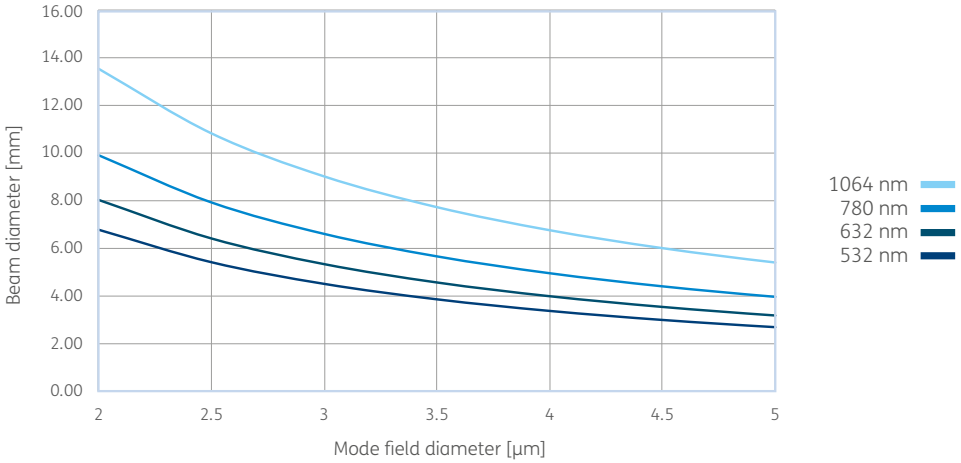
The map on the right shows the measured wavefront of an a|AspheriColl at 632 nm. The diameter of the collimated output beam, which depends on your fiber's numerical aperture (NA) and mode field diameter (MFD), is already in a usable range. It is already perfectly aligned to the design wavelength. If needed, it can also be adjusted in a certain wavelength range. Due to its outer diameter of 30 mm the a|AspheriColl fits into any standard holder (e.g. from OWIS). By simply pluging in the fiber the a|AspheriColl is ready to use.

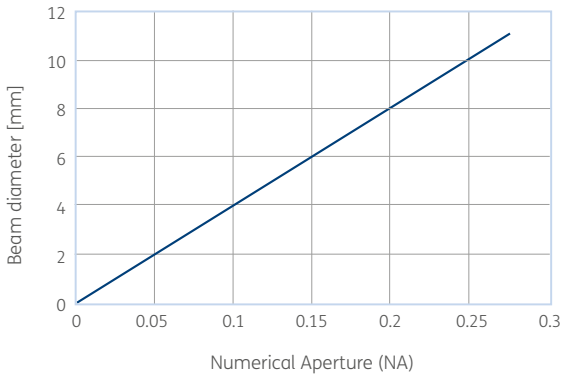


FLEXIBILITY

The diameter of the collimated output beam generated by an a|AspheriColl depends on the NA and MFD of the fiber. Both are functions of the wavelength.

Due to fiber manufacturing process, the MFD might deviate from its nominal value. The figure shows collimated output beam diameter as a function of MFD for a|AspheriColl. The large output beam diameter is advantageous, since there are no truncation effects compared to other available types of fiber couplers.





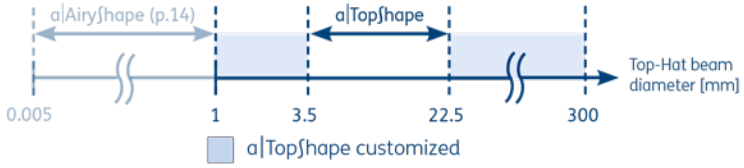
The basic diameter is set as shown in the graph on the left. Pre-aligned for the wavelengths [nm] 532, 632, 780 and 1064, the a|AspheriColl collimates the output of single mode fibers with NA's between 0.12 and 0.275.

a|TopShape

Discover the a|TopShape, an innovative beam shaper, which easily transforms collimated Gaussian beams into collimated Top-Hat beams. This laser device convinces with its very compact design and unbeatable optical performance. Covering a large spectral range, the a|TopShape accepts varying input beam diameter and generates a stable beam profile for at least 300 mm.

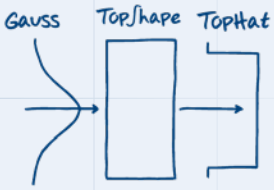
Coming soon: TopShape for stable beam profiles at long distances of up to 4.5 meters!

- = Unbeatable optical performance (homogeneity > 95%) without any power losses
- = Large spectral range (350 nm to 2500 nm) and ideal for multi-wavelength applications
- = Accepts varying input beam diameter (± 10%)
- = Extremely short overall length (92.3 mm)
- = Stable beam profile for at least 300 mm (with inhomogeneity < 10%)
- = Input beam diameter @ $1/e^2$ = 10 mm; output beam diameter @ FWHM = 14.7 mm (@ 632 nm)
- = Laser induced damage threshold: 12 J/cm², 100 Hz, 6 ns, 532 nm
- = Suitable for highest laser power (customized coatings on request)
- = Usable for applications in the following beam diameter range:

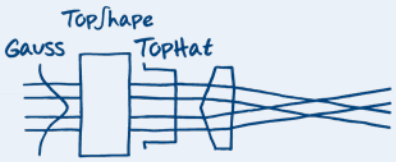


APPLICATION

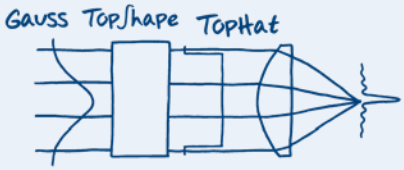
a|TopShape is the perfect support for your application, e.g. in the fields of metrology, microscopy or material processing.



flat TopHat-profile

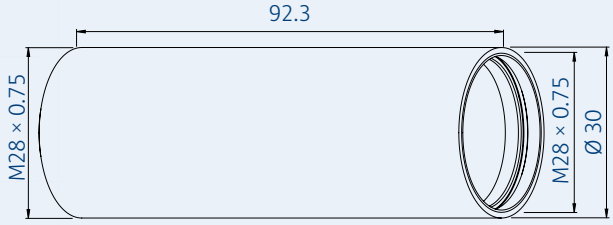


homogeneous Bessel beam



Airy-focus

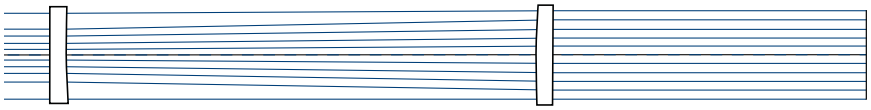
TECHNICAL DIMENSIONS



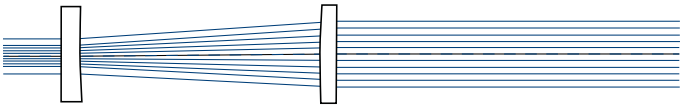
LENGTH

The principle layout of a conventional afocal beam shaping system compared to our system is shown in the following figure. The incoming Gaussian beam having an input beam diameter of 10 mm @ $1/e^2$ is redistributed in a way that the output beam has a uniform intensity distribution with a diameter of about 15 mm (FWHM) depending on the wavelength. The length could be reduced by half as compared with most systems available on the market.

CONVENTIONAL SYSTEM



ASPHERICON



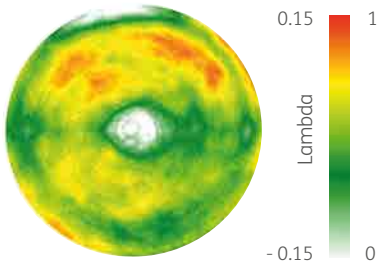
1 cm

PERFORMANCE

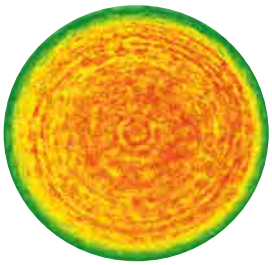
The following figures show the measured wavefront after passing 14 surfaces, including seven aspheres (left) and the beam profile after passing 12 surfaces, including six aspheres, at a working distance of 100 mm (right). The resulting RMS wavefront error of 0.05 λ, which corresponds with a Strehl value of 0.9, proves the very high optical quality. The resulting ISO Plateau Uniformity of 0.133 and the ISO Edge Steepness of 0.4 emphasizes this.

Measurement equipment:
Phasics SID4-HR-307c,
300x400 pts
Wavelength: 632 nm
Wavefront RMS: 0.05 λ
Strehl: 0.9

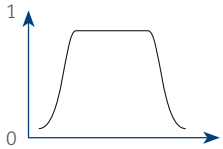
Wavefront



Intensity



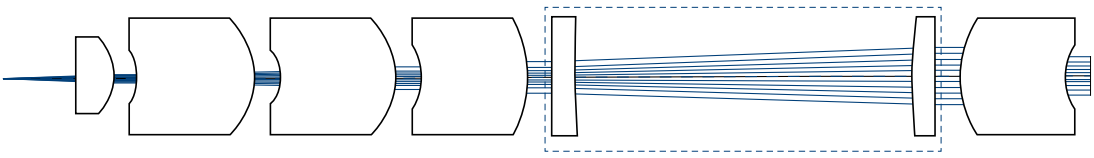
λ = 635 nm
Beam Uniformity = 0.97
ISO Edge Steepness = 0.4
Beam Profile:



FLEXIBILITY

Easily combine the a|TopShape with other BeamTuning elements including a perfect fiber coupling solution. High flexibility is guaranteed by matching adapters *(→ see p. 18)* - use this beam shaper also with other common systems. For more possible combinations or an individual solution contact us!

Example Set-up



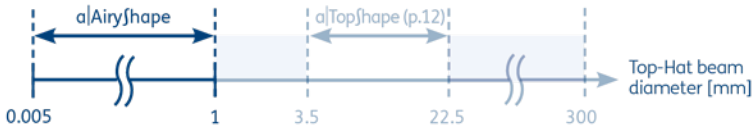
a|AspheriColl | a|BeamExpander | a|TopShape | a|BeamExpander (optional)

... or use your individual set-up!

a|AiryShape

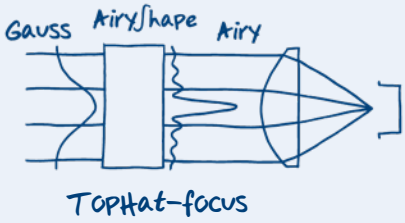
Another beam shaper optimized for wavelengths from 300 nm up to 1600 nm is the a|AiryShape. This beam shaping element enables, in combination with a focusing lens, the transformation of collimated Gaussian beams into different focused beam profiles (e.g. Top-Hat, Donut).
Thanks to its compact design, the a|AiryShape can be easily integrated into existing set-ups.

- = Generation of different beam profiles
- = Profile size easily scalable by focal length
- = Optimized for wavelengths from 300 nm to 1600 nm
- = Easy integration into existing set-ups
- = Perfect alignment by high-precision mounting
- = Compact design
- = Input beam diameter @ $1/e^2$ = 10 mm; output beam diameter d_{Airy} = 10 mm
- = Laser induced damage threshold: 12 J/cm², 100 Hz, 6 ns, 532 nm
- = Usable for applications in the following beam diameter range:

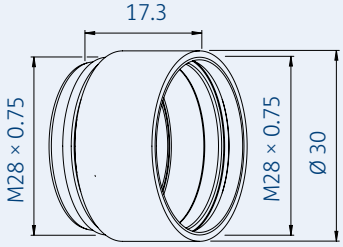


APPLICATION

Conveniently use this perfectly aligned BeamTuning element for your application, e.g. in the fields of material processing or medical applications.

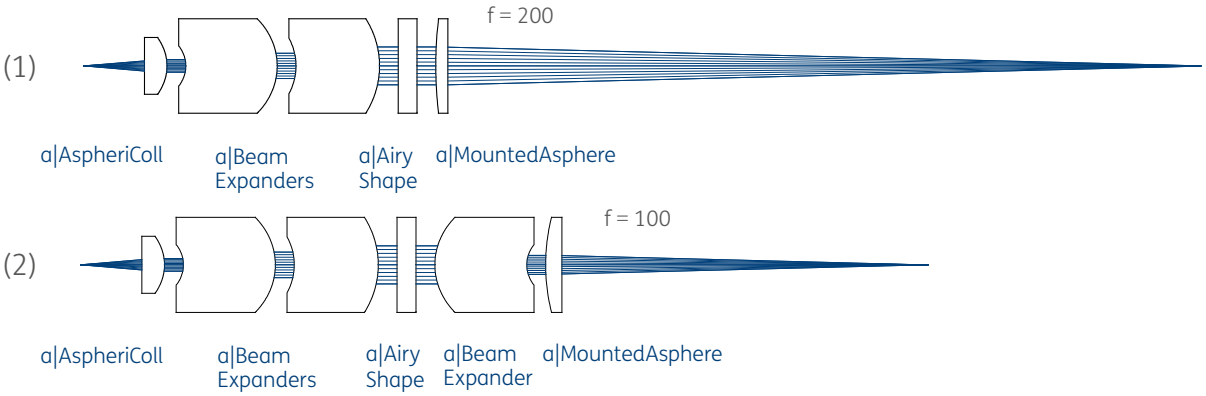


TECHNICAL DIMENSIONS



LENGTH & FLEXIBILITY

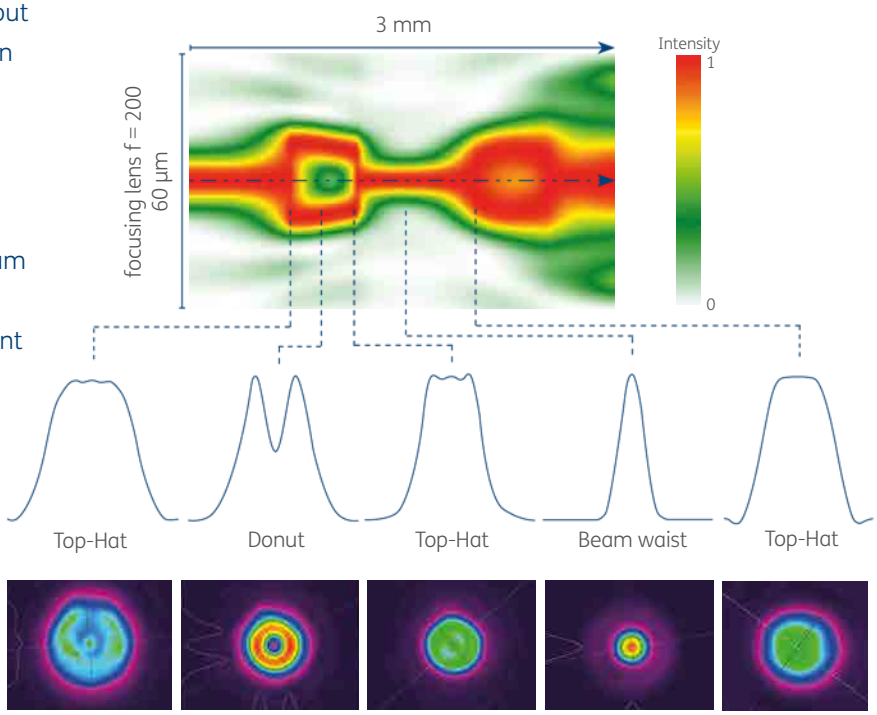
One feature of a|AiryShape is its extremely compact design. With a length of only 17.3 mm, it can easily be integrated into existing set-ups. Thanks to its optical design, it may also reduce the working distance.
The example system (1) has an overall length of 290 mm. By using another a|BeamExpander (2), the length can already be reduced by 25%, since shorter focal lengths can be used. With more a|BeamExpanders total system reductions of up to 75% are possible.



PERFORMANCE & FLEXIBILITY

In the figure below, normalized beam profile sections along its propagation direction (z-axis) are summarized in one diagram. The detected range is ± 1.5 mm around the waist location. Furthermore, the corresponding most interesting intensity profiles in the different working planes are shown as 2D and cross-sectional plots. Both plots of the characteristic beam profiles are generated with the a|AiryShape (λ = 635 nm). According to the working principle of the a|AiryShape, it is possible, not just to generate one Top-Hat beam profile in the focal plane of a focusing lens but also to create various profiles in different working distances for your flexibility.

The generation of the shown beam profiles depends on the input beam quality. For optimum results a perfect collimated beam with minimized wavefront aberrations is required.

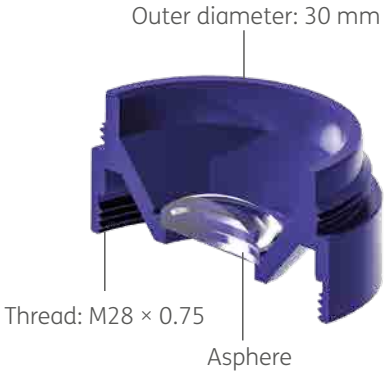


MountedOptics

Expand your laser application with the attractive selection of pre-aligned a|Aspheres, a|Axicons and a|Acylinders from the StockOptics product line in high-precision mounts. All aspheres and axicons with diameters from 12.5 mm to 25.4 mm, as well as all acylinders with diameters from 10 mm to 18 mm are perfectly aligned with < 10 µm decentration of the optical and mechanical axis. Using the a|Adapters a very simple integration into any optical system is guaranteed.

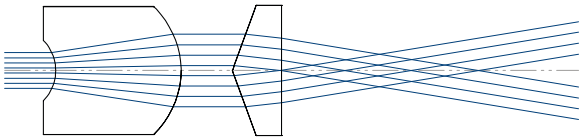
- a|MountedAspheres, a|MountedAxicons, a|MountedAcylinders
- Especially designed mounts, engraved with lens specifications
- Perfect alignment (< 10 µm decentration)
- Tilt-reduced for optimal focusing
- Modular design for high compatibility to all asphericon products and common optical systems
- Comfortable and timesaving handling

TECHNICAL DIMENSIONS

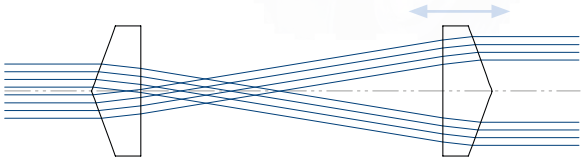


Maximum usability
from asphericon.

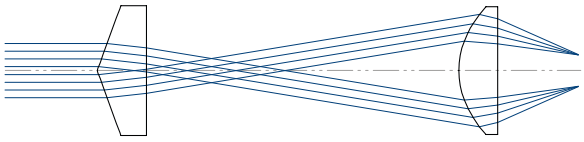
APPLICATIONS



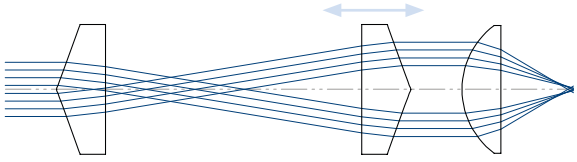
Optimizing the illumination of the axicon to adjust the length of the Bessel Beam.



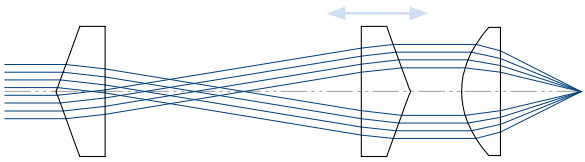
Generation of a collimated ring-shaped beam by altering the distance between the two axicons.



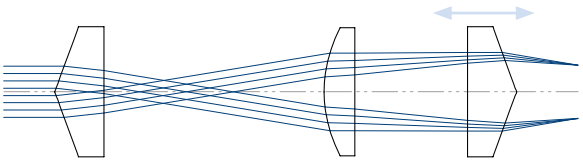
Generation of a ring focus - Distance changing through focal length of the lens, diameter changing through axicon angle.



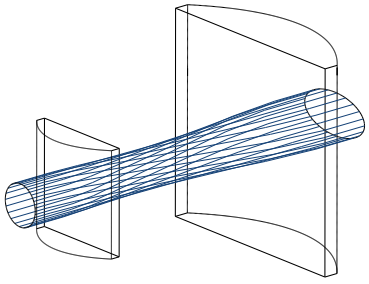
Changing the focal length of a sphere by altering the distance between the axicons and improving the performance.



Changing the focus width of an asphere by altering the distance between the axicons - Focusing under the diffraction limit.



Generation of adjustable ring foci by shifting the last axicon to vary the ring diameters.



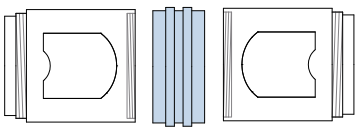
Generate an elliptical beam by using two acylinder in an anamorphic telescope.

a|Adapter

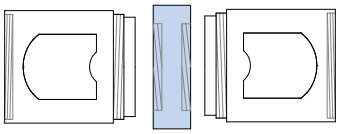
Cross-system and intra-system a|Adapters conveniently connect all BeamTuning elements to any optical set-up - without additional adjustment.

INTRA-SYSTEM

Intra-system a|Adapters allow to combine all BeamTuning elements, e.g. to use a|BeamExpander in both functional directions, to expand or reduce the beam diameter.



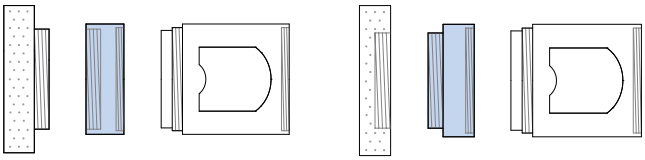
a|Adapter intra-system



a|Adapter 1.2" circumference

CROSS-SYSTEM

Easy integrate all BeamTuning elements into any optical system (e.g. Qioptiq, OWIS or Edmund Optics) through a variety of mounting concepts by using the cross-system a|Adapters (C-Mount, SM1). Thanks to its outer diameter, the 1.2" circumference can be used both as intra-system and as cross-system a|Adapter.



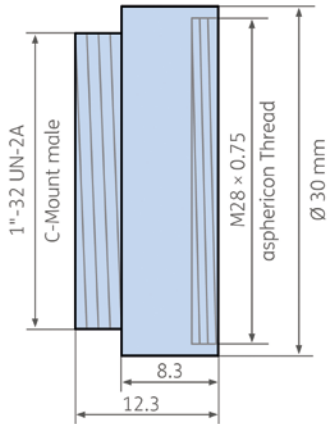
a|Adapter cross-system (female/female, male/female)

PRODUCT OVERVIEW ADAPTER TYPES

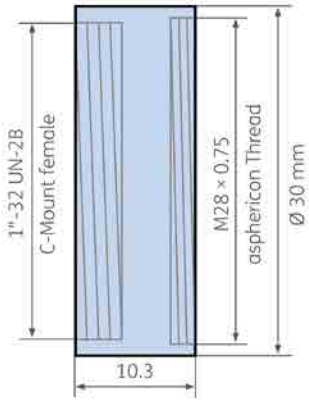
Adapter type	Product code	Thread type
C-Mount male	UAM25-28-C-MIO	male/female
C-Mount female	UAM25-28-C-MII	female/female
SM1 male	UAM25-28-SM1-MIO	male/female
SM1 female	UAM25-28-SM1-MII	female/female
1.2" circumference	UAM25-28-1.2in-MII	female/female
Intra-System	UAM25-28-A-MOO	male/male

TECHNICAL DIMENSIONS

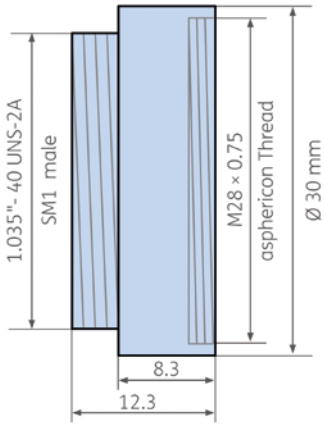
C-MOUNT MALE



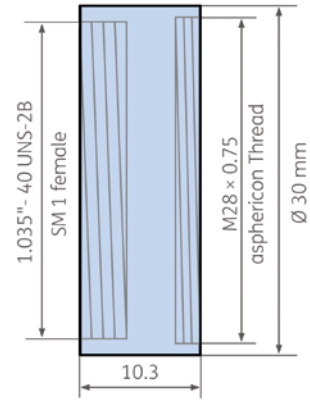
C-MOUNT FEMALE



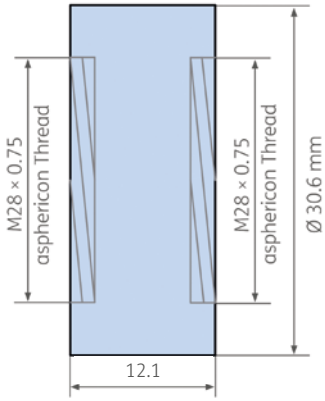
SM1 MALE



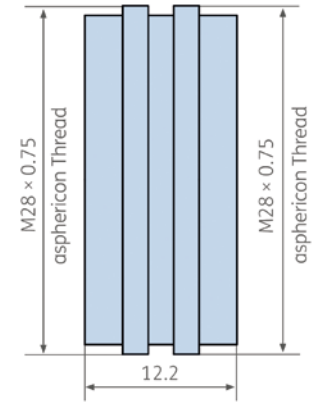
SM1 FEMALE



1.2" CIRCUMFERENCE (DUAL USE)



INTRA-SYSTEM



a|BeamBox

Regardless whether you need beam expansion, fiber collimation or beam shaping components: simply choose and combine them in one convenient a|BeamBox.

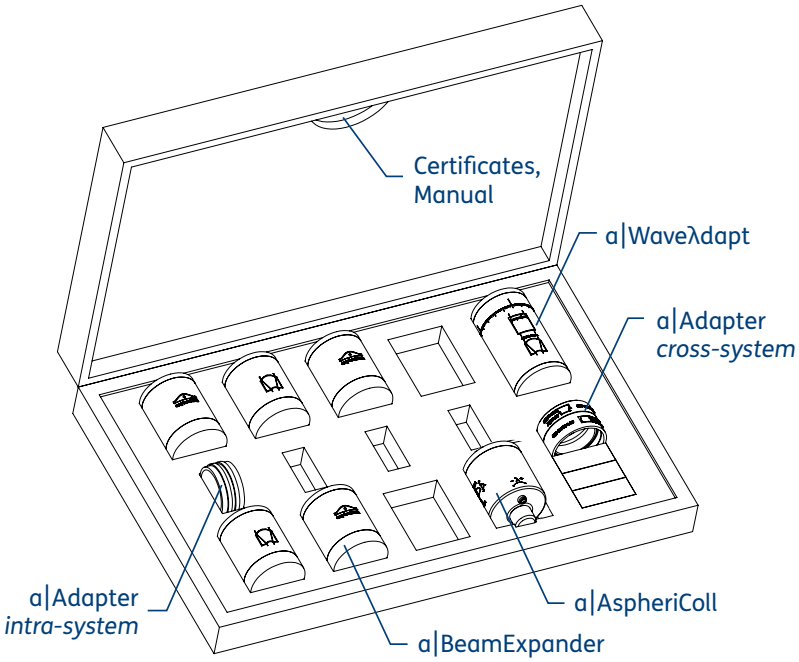
The following boxes are available:

- Essential series: Including beam expansion elements for different wavelengths
- TopShape/AiryShape series: Including beam expansion and shaping elements for different wavelengths

VARIATIONS

BeamBox	Possible content
a|BeamBox Essential 355	1 – 8 BeamExpander 355 nm, Adapter
a|BeamBox Essential 532	1 – 8 BeamExpander 532 nm, AspheriColl, Wavelλdapt, Adapter
a|BeamBox Essential 632	1 – 8 BeamExpander 632 nm, AspheriColl, Wavelλdapt, Adapter
a|BeamBox Essential 780	1 – 8 BeamExpander 780 nm, AspheriColl, Wavelλdapt, Adapter
a|BeamBox Essential 1064	1 – 8 BeamExpander 1064 nm, AspheriColl, Wavelλdapt, Adapter
a|BeamBox TopShape	1 – 5 BeamExpander, TopShape, AspheriColl, Adapter, MountedAspheres/Axicons
a|BeamBox AiryShape	1 – 6 BeamExpander, AiryShape, AspheriColl, Adapter, MountedAspheres

a|BEAMBOX ESSENTIAL



a|BEAMBOX TOPSHAPE

a|BEAMBOX AIRYSHAPE

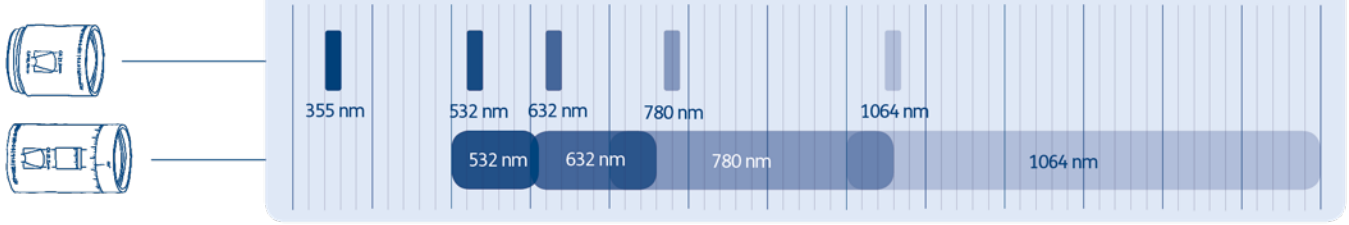
Mix & match, any combination is possible - For your individual a|BeamBox, please contact us!

asphericon BeamTuning

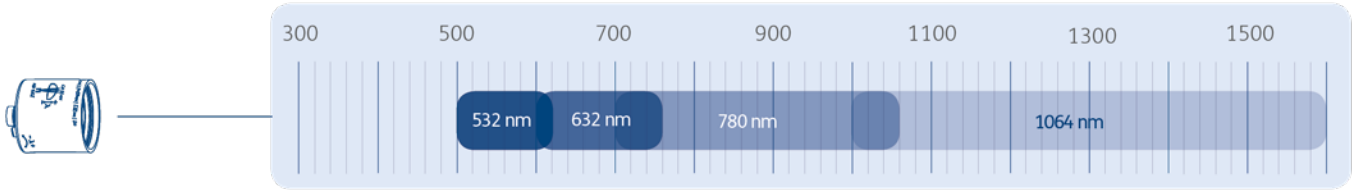
Mix & Match

BeamTuning products by asphericon cover an enormous wide range of wavelengths. The right solution for every application.

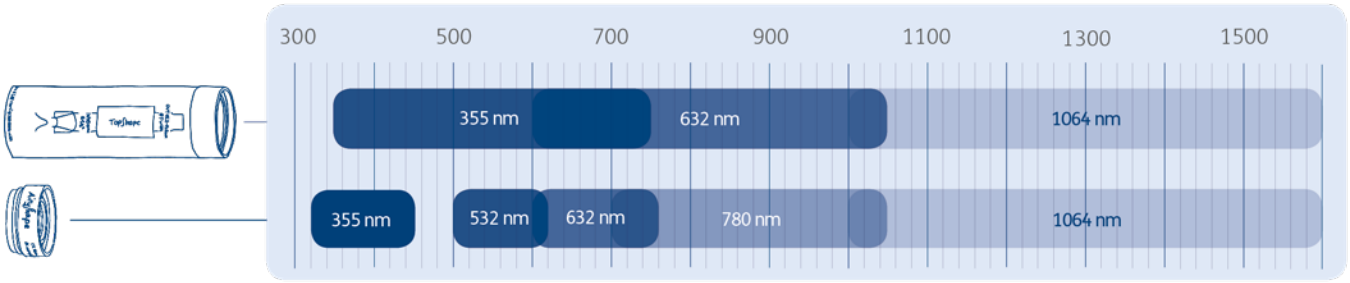
BEAMEXPANSION



FIBERCOLLIMATION



BEAMSHAPING



COMPLEMENTARY ELEMENTS

MountedOptics

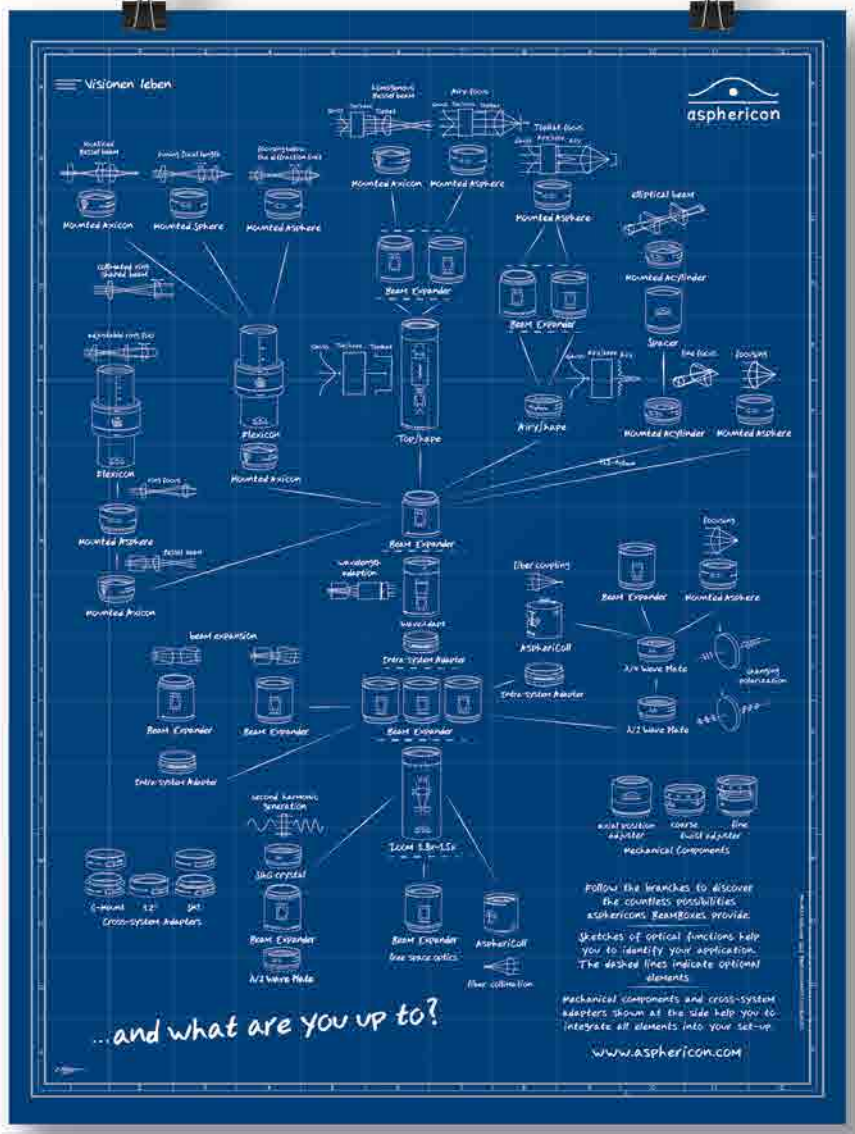
- a|MountedAspheres
- a|MountedAxicons
- a|MountedAcylinders

Adapters

- C-Mount male
- C-Mount female
- SM 1 male
- SM 1 female
- 1.2" circumference
- Intra-System

BeamTuning Poster

Discover our BeamTuning Poster. It sketches will help you to identify applications by showing optical functions. Interested in getting one? We will gladly send you a poster free of charge.



Get your free Poster:

Order all elements online:

Blog:

BeamTooling App

asphericon BeamTooling is the ultimate tool for the perfect usage of BeamTuning products. Whether for applications in the lab or in the field, with this app you will find quickly and easily solutions at any time. The app is now available in the Apple and Google App Stores.

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