

## FBS® Top Hat Beam Shaper

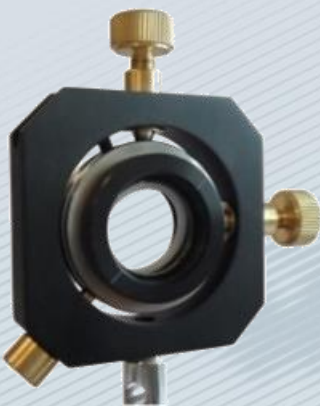
### PRODUCT FEATURES

- ▲ Generation of square Top Hat spots
- ▲ Smallest achievable Top Hat size
- ▲ High efficiency up to 95%
- ▲ Thin single optical element
- ▲ Easy integration in existing beam paths

### APPLICATIONS

- ▲ Micromachining
- ▲ Laser cleaning
- ▲ Thin film laser scribing
- ▲ Microscopy and spectroscopy

### RELATED PRODUCT

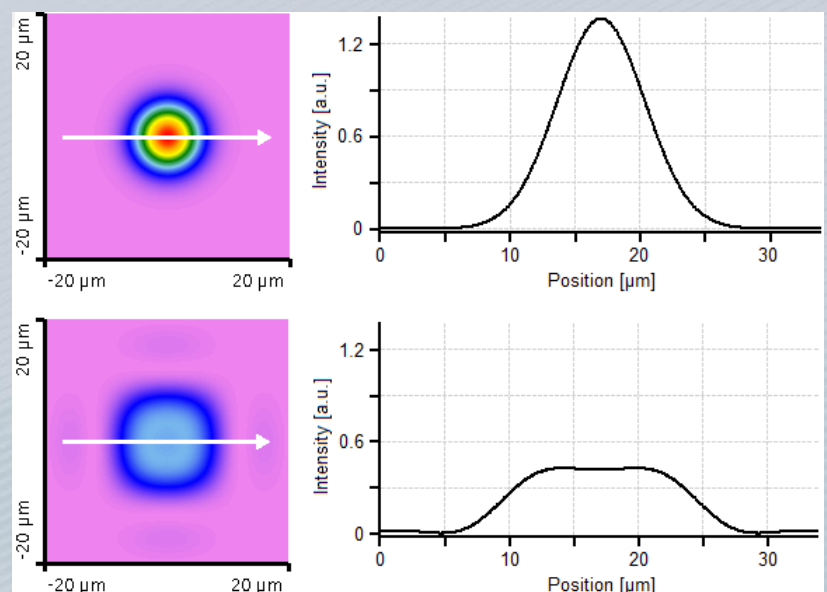


Translation mount HSF02 for the alignment of the FBS in lateral (x, y) directions. It also allows rotating the Top Hat (orientation) in the working plane.

FBS is a beam shaper designed to generate small and homogeneous Top Hat spots in the focal plane. The Top Hat width is approximately 1.5 times larger than the Gaussian spot size.

The small Top Hat size facilitates the use in micromachining, whereby the Top Hat shape leads to more homogeneous ablation and can avoid damage of subjacent layers of layer systems. Furthermore, the homogeneous energy distribution allows a reduction of the pulse-to-pulse overlap. Thereby the processing speed can be increased.

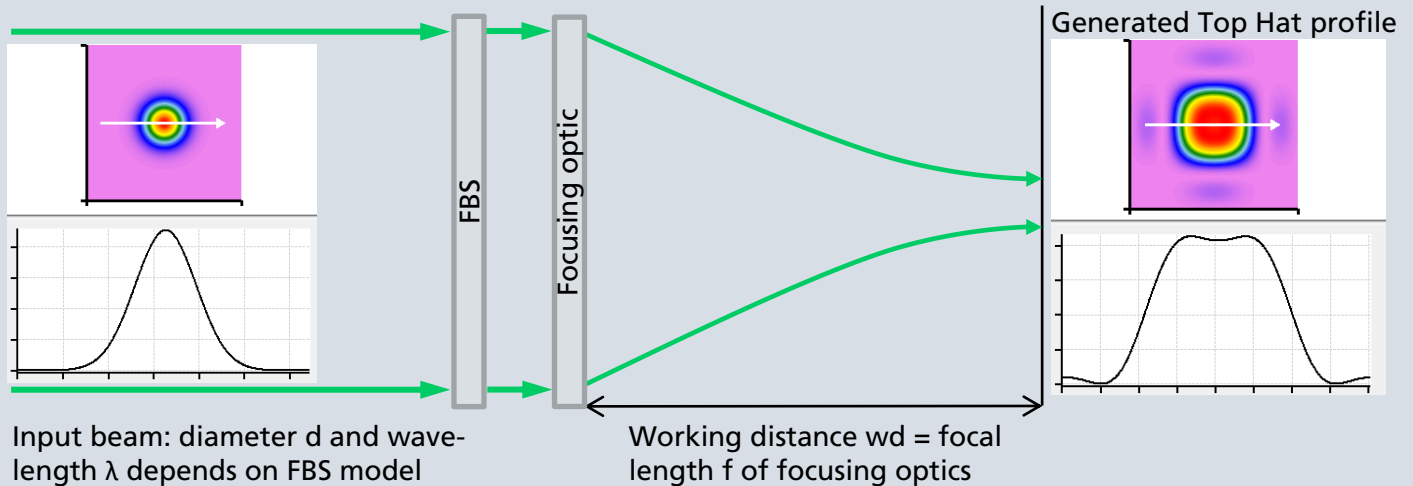
### SPOT PROFILES: GAUSSIAN VS FBS



Above: Spot profile of a focused Gaussian beam in the focal plane (left) and the corresponding line scan (right).

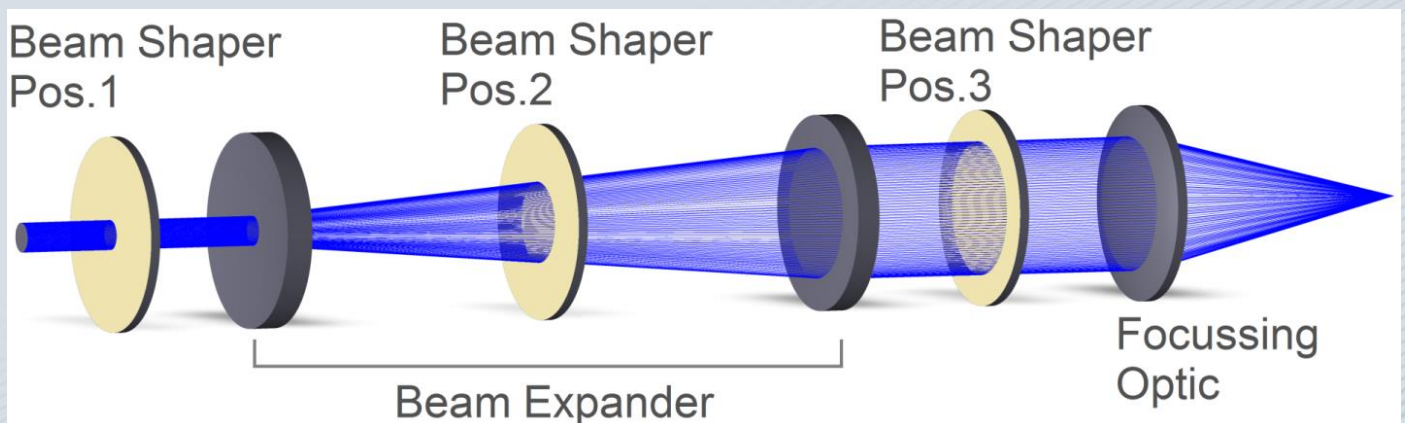
Below: Integration of FBS into the beam path leads to a square Top Hat spot in focal plane (left). Shown results are for  $\lambda = 532 \text{ nm}$ , 5.0 mm beam diameter @ $1/e^2$  and 100 mm focal length.

## BASIC OPTICAL SETUP



FBS beam shaper in combination with any focusing optic and a collimated single mode Gaussian beam (TEM<sub>00</sub> with M<sup>2</sup> of 1.4 or better) delivers a homogeneous Top Hat profile. This Top Hat profile is generated in the focal plane of the focusing optic. The size of the generated Top Hat spot depends on the focal length  $f$ , the input beam diameter  $d$  ( $\text{@}1/e^2$ ) and the wavelength  $\lambda$ . The Top Hat width ( $\text{@}1/e^2$ ) is approximately  $2 * \lambda * f / d$ .

## INTEGRATION



Pos. 1: FBS can be installed in front of a beam expander/telescope into the beam. Advantage of this option is scaling of the spot size in focal plane by changing the magnification of the beam expander.

Pos. 2: If the beam expander is not housed, it is also possible to place FBS between the telescope lenses. This position allows adjustment of the FBS position to match the effective beam diameter.

Pos. 3: FBS can be placed behind the beam expander into the increased beam diameter. Tolerances for the lateral displacement of the FBS and the input beam diameter are proportional to the input beam diameter. In this position, the advantage is the larger lateral displacement tolerance for alignment.

Each beam shaper is designed for a fixed input beam diameter ( $\text{@}1/e^2$ ). Therefore, it is not possible to use the same FBS in front, inside and behind a telescope.

## SPECIFICATIONS

### SPOT GEOMETRY

Top Hat width	approximately $2 * \lambda * f / d$ , with $f$ = focal length, $d$ = beam diameter @ $1/e^2$
Efficiency	up to 95%
Homogeneity	ca. $\pm 2.5\%$ (rel. to average intensity of the Top Hat plateau)
Side modes (strongest)	~ 23x weaker than Top Hat plateau (< 4.5% of Top Hat plateau)
Depth of focus (DOF)	~ 30% of the Rayleigh length

### REQUIREMENTS FOR THE USE OF FBS

Input beam	Gaussian beam TEM <sub>00</sub> , M <sup>2</sup> of 1.4 or better
Input beam diameter <sup>1)</sup>	FBS models are designed for a fixed input beam dia., tolerance $\pm 5\%$ . standard input beam diameters: 1.0 mm, 1.5 mm, ... or 10.0 mm @ $1/e^2$
Standard wavelengths <sup>1)</sup>	1064/1030 nm, 532/515 nm or 355/343 nm
Apertures within the optical setup	clear aperture along the whole beam path should be at least 2.2x larger than the beam diameter @ $1/e^2$

### INTEGRATION OF FBS INTO THE BEAM PATH

Alignment	alignment in lateral direction is necessary (translation). Rotating the shaper around the optical axis is helpful to align the orientation of the Top Hat. We recommend our mount HSF02.
Optical equipment	required: focusing optic to generate the Top Hat in the focal plane of this optic.  useful: beam expander to firstly adjust the effective beam dia. to the design input beam dia. of the FBS and secondly adjust the beam dia. to the desired spot size.  helpful: beam profiler to check profiles while aligning.

### SUBSTRATE SPECIFICATIONS

Material <sup>1)</sup>	fused silica
Transmission	> 99%, with single line AR/AR coating
Damage threshold	@ 10 ns: 10 J/cm <sup>2</sup> @ 1064 nm, 5 J/cm <sup>2</sup> @ 532 nm, 3 J/cm <sup>2</sup> @ 355 nm
Dimension <sup>1)</sup>	unmounted version: dia. 1 inch x 3 mm  mounted version for beam dia. up to 6.0 mm: 16 x 16 x 3 mm <sup>3</sup> in dia. 1 inch x 5.5 mm holder

### ORDER INFORMATION

Product code	FBS - beam diameter - wavelength
Example	FBS-50-532 → 5.0 mm input beam dia. @ $1/e^2$ and $\lambda = 532$ nm

<sup>1)</sup> Others on request