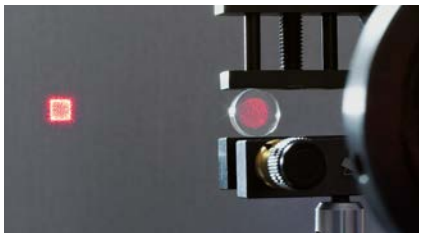
TOP HAT BEAM SHAPING LENSES – FBS

Features

- Transforms Gaussian beams into flat-top beams
- Different shapes of Top Hat spots - round, square, line
- Easy to integrate into existing beam paths

FBS Series beam shapers are designed to transform collimated Gaussian beams into small and homogeneous Top Hat spots of square, round or line shapes. FBS beam shapers should be used in setup with focusing optics, and the working distance of a Top Hat beam shaper is determined by the focal length of the focusing optics.



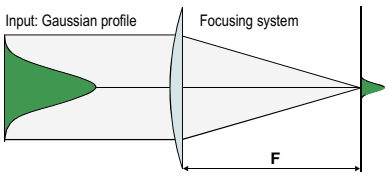
Specifications

Material	UV Fused Silica
Transmission	>99%
Diameter	25.4 mm
Thickness	3 mm
Laser Damage Threshold	10 J/cm^2 @ 1064 nm, 10 ns 5 J/cm^2 @ 532 nm, 10 ns 3 J/cm^2 @ 355 nm, 10 ns

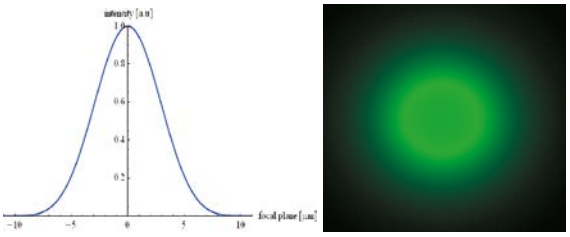
Operation Requirements

Input beam	Gaussian beam (TEM$_{00}$), $M^2 < 1.4$
Input beam diameter	Fixed, ±5% tolerance
Operation wavelength	Fixed
Optical setup	Clear apertures along beam path at least 2.2x larger than the beam size @ 1/e^2

Without FBS Beam Shaper

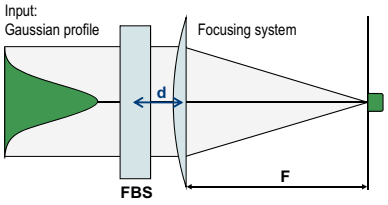


Gaussian-profile at focal plane

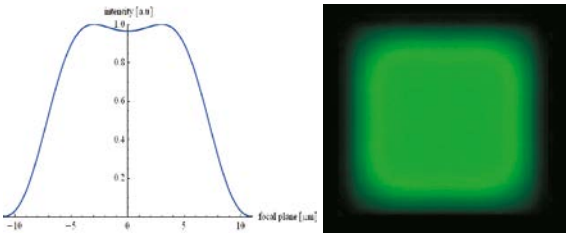


Diffraction limited Gaussian profile

With FBS Beam Shaper

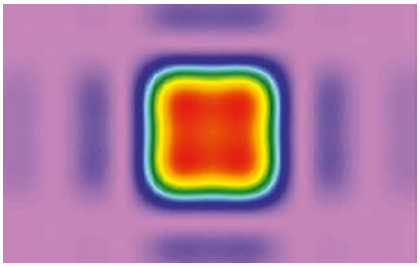


Top-Hat-profile at focal plane



Near diffraction limited Top Hat profile

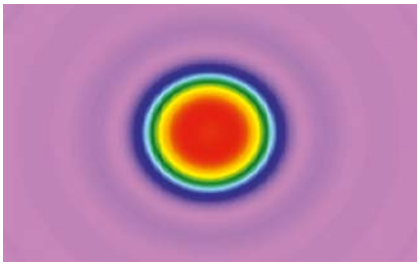
FBS2 – Square Top Hat Profile



Spot Geometry

Top Hat width	approximately 2 × λ ×(f/d), with f = focal length, d = beam diameter @ 1/e²
Efficiency	up to 90%
Homogeneity	ca. ± 2.5% (rel. to average intensity of the Top Hat plateau)
Side modes (strongest)	~16.5x weaker than line plateau (< 1.5% of input energy)
Depth of focus (DOF)	~60% of the Rayleigh length

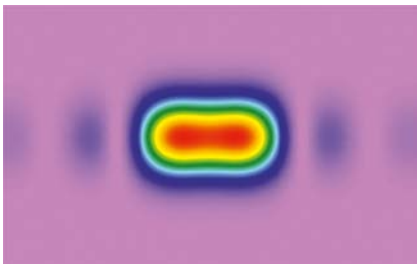
FBSR – Round Top Hat Profile



Spot Geometry

Top Hat diameter	approximately 2 × λ × (f/d), with f = focal length, d = beam diameter @ 1/e²
Efficiency	up to 95%
Homogeneity	ca. ± 2.5% (rel. to average intensity of the Top Hat plateau)
Side modes (strongest)	~70x weaker than line plateau (< 1.5% of input energy)
Depth of focus (DOF)	~30% of the Rayleigh length

FBSL – Line Top Hat Profile



Spot Geometry

Line length (Top Hat)	approximately 2 × λ × (f/d), with f = focal length, d = beam diameter @1/e²
Line width (Gaussian)	Similar to the diameter of Gaussian spot in the same optical configuration
Efficiency	up to 92.5%
Homogeneity	ca. ± 2.5% (rel. to average intensity of the Top Hat plateau)
Side modes (strongest)	~15x weaker than line plateau (< 1.7% of input energy)
Depth of focus (DOF)	~50% of the Rayleigh length

Ordering information

FBS2-1064-1.0

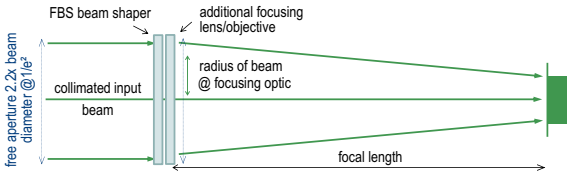
Model name:
- FBS2 – Square profile
- FBSR – Round profile
- FBSL – Line profile

Operation wavelength:
- 1064 nm
- 1030 nm
- 532 nm
- 515 nm
- 355 nm
- 343 nm

Input beam diameter (@ 1/e²):
- From 1.0 to 6.0 mm, increment: 0.5 mm

There are different possibilities to integrate the FBS beam shaper into an optical setup.

1. Beam shaper directly in front of a focusing optic/objective

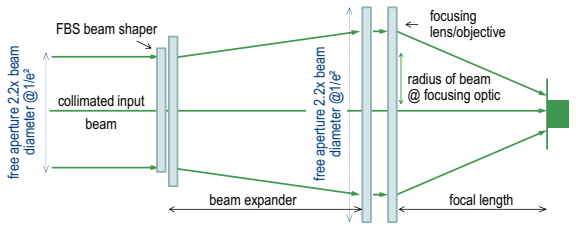


By introducing the FBS beam shaper into the beam path in front of a lens/objective the initial diffraction limited Gaussian spot will be transformed into a homogeneous Top-Hat profile.

When a Gaussian TEM_{00} input beam with a diameter of 5 mm @ $1/e^2$ is used the diameter of the free aperture along the total beam path have to be at least 11 mm (better 13 mm).

If for example a wavelength with 532 nm, a Gaussian TEM_{00} input beam with a diameter of 5 mm@$1/e^2$ and a focusing lens with f=160 mm is used, ones will get a homogeneous Top Hat profile with a diameter of 34 µm.

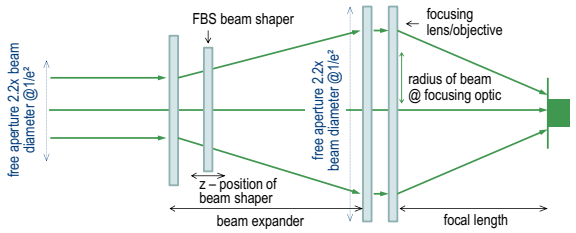
2. Beam shaper in front of a beam expander



There is also the possibility to introduce the FBS beam shaper into the beam path in front of a beam expander. This leads to a higher numerical aperture of the focused beam and to a smaller Top Hat profile.

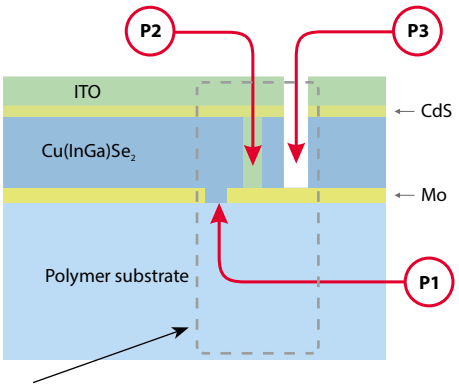
Example: A Gaussian beam with a diameter of 5 mm@$1/e^2$ illuminates the FBS beam shaper and is afterwards increased by a beam expander to a beam diameter of 8 mm. With an focusing optic with f=50 mm the user can generate a Top Hat with a diameter of 7 µm. The needed free aperture increases with the expanded beam. For a beam with a diameter of 8 mm the free aperture has to be at least 18 mm.

3. Beam shaper within a beam expander



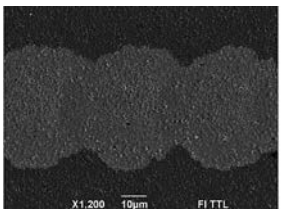
A further and even more flexible possibility is to introduce the FBS beam shaper into the beam path within a beam expander. The user has the possibility for an easy "fine tuning" of beam diameter at the position of FBS beam shaper by shifting shaper along z-axis.

Scribing of CIGS-solar cells

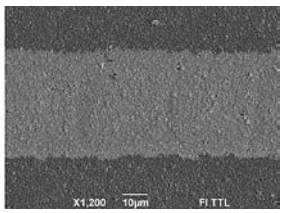


- Wasted area, reducing efficiency → need of smallest scribing lines
- Cut quality influence efficiency → need of small HAZ, no debris, smooth edges
- High scanning speed for high throughput → need of small pulse overlap

P1 – „Scribing"



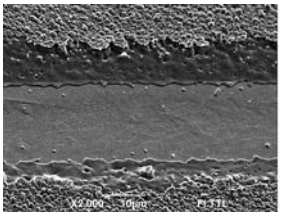
Gaussian Profile



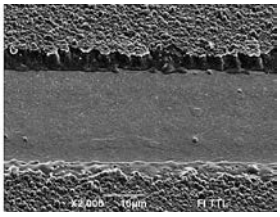
FBS-Top-Hat Profile
small overlap, smooth edges

Removal of a front contact in ZnO(1 µm)/CIGS/Mo/PI structure. Laser PL10100/SH, 10 ps, 370 mW, 100 kHz, 532 nm; scanning speed 4.3 m/s, single pass.

P3 – „Scribing"



Gaussian Profile



FBS-Top-Hat Profile
small HAZ, smooth edges

Tilted SEM pictures of the P3 scribe in ZnO(1 µm)/CIGS/ Mo/PI structure. Laser PL10100/SH, 10 ps, 370 mW, 100 kHz, 532 nm; scanning speed 60 mm/s, single pass.

Raciukaitis et. al, JLMN-Vol. 6, No. 1, 2011

Recommended Accessories

Zoom Beam Expander
See page 5.4

Two Axes Translation Polarizer Holder
840-0240
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