GTH-3.6-1.75FA GAUSS-TO-TOP-HAT BEAM SHAPING LENS

Working distance is given by focal length of additional lens which is always needed. Top Hat appears always at focal plane of additional lens.

For instance if an additional lens f = 100 is used, Top Hat appears at 100 mm behind additional lens. So GTH-3.6-1.75FA could be easily put in front of objectives for example.

The distance between GTH-3.6-1.75FA and additional lens is not critical (up to several tens of centimeters).

The full fan angle of Top-Hat generation for GTH-3.6-1.75FA is 1.75 mrad. This leads to Top-Hat sizes:

– 88×88 µm for lens with f = 50 at 50 mm distance
– 175×175 µm for lens with f = 100 at 100 mm distance
– 1.75×1.75 mm for lens with f = 1000 at 1000 mm distance

GTH-3.6-1.75FA OPERATION SPECIFICATIONS

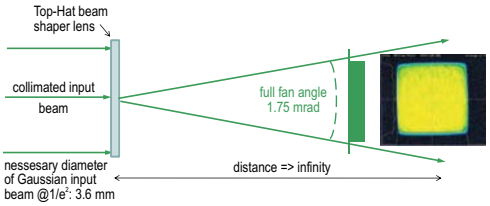
Recommended operation wavelength range	400-1550 nm
Necessary free aperture	always 2.2x beam diameter @ 1/e², along total beam path
Input beam	TEM_{00}, diameter (1/e²): 3.6 ± 0.15 mm
Achievable Top Hat size @ 1/e²	5x diffraction limited @ 1064 nm, 10x diffraction limited @ 532 nm
Full fan angle of Top-Hat generation	1.75 mrad
Beam energy distribution efficiency	> 95% of input energy within Top Hat profile
Beam homogenity	± 5 % (rel. to average intensity within Top Hat)
Lens diameter	12.0 +0.0/-0.1 mm
Lens thickness	2.0 ± 0.1 mm

Catalogue number	Description	Price, EUR
GTH-3.6-1.75FA	uncoated lens	450
GTH-3.6-1.75FA-VIS	VIS coated lens (400-700 nm (R<1% per face))	495
GTH-3.6-1.75FA-IR	IR coated lens (700-1300 nm (R<1% per face))	495

Other specific laser wavelengths are available on request.

GTH-3.6-1.75FA OPERATION INSTRUCTIONS

General function of Top-Hat beam shaper GTH-3.6-1.75FA



The Top-Hat beams haper GTH-3.6-1.75FA generating a square Top-Hat profile with a full fan angle of 1.75 mrad. To get best results it is necessary to use a Gaussian TEM_{00} input beam with a diameter of 3.6 mm @ 1/e².

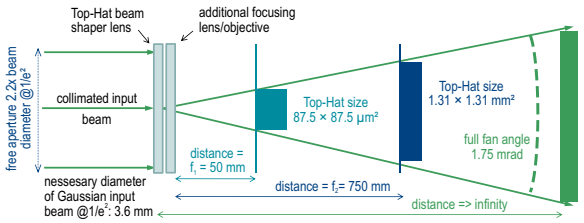
For all setups using GTH beam shaper the user have to consider that the free aperture along the total beam path have to be at least 2.2 (better 2.5) times bigger than the beam diameter @ 1/e².

Optical setup for Top-Hat beam shaper GTH-3.6-1.75FA

There are different possibilities to integrate the GTH-3.6-1.75FA beam shaper into an optical setup.

1. Beam shaper directly in front of focusing optic/objective (Top Hat size @ 1/e² > 90 µm).

Top Hat size is determined by focal length (f) of focusing optic/objective and can be calculated as follows: $\frac{1.75}{1000} \cdot f$



By introducing the GTH-3.6-1.75FA into the beam path in front of a lens/objective the initial diffraction limited Gaussian spot will be transformed into a square homogeneous Top-Hat profile.

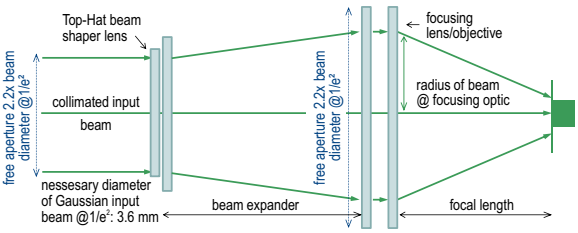
The necessary beam diameter at the position of GTH-3.6-1.75FA is 3.6 mm @ 1/e².

The resulting Top-Hat size is given by: $\frac{1.75}{1000} \cdot$ focal length, for example with f = 50 mm => 87.5 µm.

2. Beam shaper in front of beam expander (Top Hat size @ 1/e² < 90 µm).

Top Hat size is determined by numerical aperture (NA) of focused beam and is given by:

$$\approx \frac{3.2\ \mu m}{NA} \Rightarrow \approx \text{ 5x diffraction limited @ 1064 nm (10x @ 532 nm)}$$



To realize Top Hat sizes smaller than 90 µm it's recommended to introduce the GTH-3.6-1.75FA into the beam path in front of a beam expander. Initially the necessary input beam diameter of 3.6 mm @ 1/e² is passing the GTH. Afterwards the beam is expanded and focused on working plane. The initial diffraction limited Gaussian spot at focal plane will be transformed into a square homogeneous Top-Hat profile. The resulting Top-Hat size is given by:

$$\approx \frac{3.2\ \mu m}{NA} \Rightarrow \approx \text{ 5x diffraction limited @ 1064 nm (10x @ 532 nm)}$$

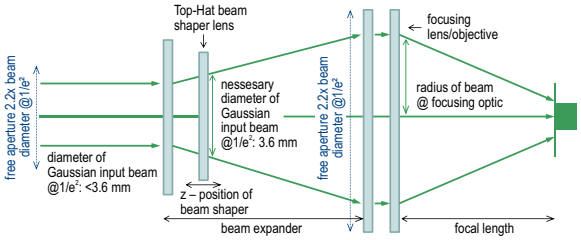
NA represents the numerical aperture of focused beam and is given by:

$$NA = \frac{\text{beam radius @ focusing optic}}{\text{focal length of focusing optic}}$$

3. Beam shaper within beam expander (Top Hat size @ 1/e² < 90 µm).

Top Hat size is determined by numerical aperture (NA) of focused beam and is given by:

$$\approx \frac{3.2\ \mu m}{NA} \Rightarrow\approx$$ 5x diffraction limited @ 1064 nm (10x @ 532 nm)



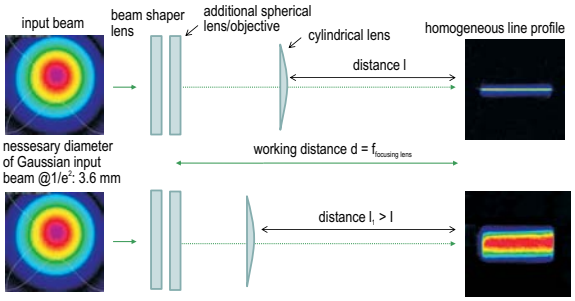
A further and even more flexible possibility is to introduce GTH-3.6-1.75FA into the beam path within a beam expander. The user has the possibility for an easy "fine tuning" of beam diameter at the position of GTH-3.6-1.75FA by shifting shaper along z-axis. It's just necessary to consider that the beam diameter at the position of GTH is 3.6 mm @ 1/e². The resulting Top-Hat size is given by:

$$\approx \frac{3.2\ \mu m}{NA} \Rightarrow\approx$$ 5x diffraction limited @ 1064 nm (10x @ 532 nm)

NA represents the numerical aperture of focused beam and is given by:

$$NA = \frac{\text{beam radius @ focusing optic}}{\text{focal length of focusing optic}}$$

Homogeneous line generation with additional cylindrical lens



If an additional cylindrical lens is used, one can generate homogeneous line profiles. By varying the distance l the width of line profile (short axis) can be changed from near diffraction limited size to several millimeters. We recommend the use of a cylindrical lens or lens system with a focal length of = 1.8 m.

FBS — TOP HAT BEAM SHAPING LENS

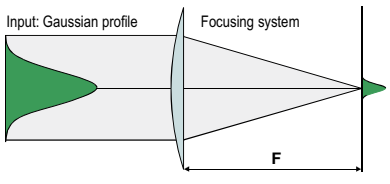
- **New Diffractive Beam Shaping Concept ! based on Fourier methods**
- **Transforming Gaussian TEM_{00} beam into square or round homogeneous Top-Hat profile**
- **Top Hat size is near diffraction limited and is given by: ~λ /NA**
- **Achievable Top Hat sizes: 1 µm – 200 µm**

SPECIFICATIONS

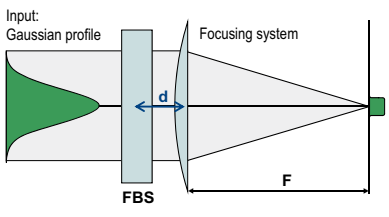
Material	fused silica	
Diameter	25.4 mm	tolerance ±0.1 mm
Input Beam	TEM_{00}, different models for diameter@1/e²: 2.0 ... 10.0 mm with 0.5 mm step	tolerance ±5%
Necessary Free Aperture	2.2x (or better 2.5x) beam diameter@1/e²	along total beam path
Top Hat Size	1.5x diffraction limited Gaussian spot	square form (round optional)
Homogenity	+/- 2.5%	rel. to average intensity within tophat
Wavelength	different models for: 1064 nm, 532 nm or 355 nm	others on request
Transmission	> 99%	AR/AR coating
Efficiency	> 95%	of input energy within tophat profile
Damage Threshold	4 J/cm² @ 532 nm, 10 ns	
Free Aperture	23 mm	

FBS OPERATION INSTRUCTIONS

FBS – Top-Hat Fundamental Beam Mode Shaper



Without FBS Beam Shaper: Gaussian-profile at focal plane



With FBS Beam Shaper: Top-Hat-profile at focal plane

- FBS works together with focusing system (FS)
- Top Hat size just depends on wavelength (λ) and numerical aperture (NA) of focused beam
- Distance d between FBS and FS up to several meters