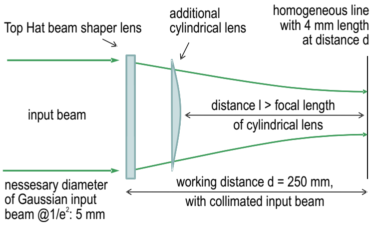
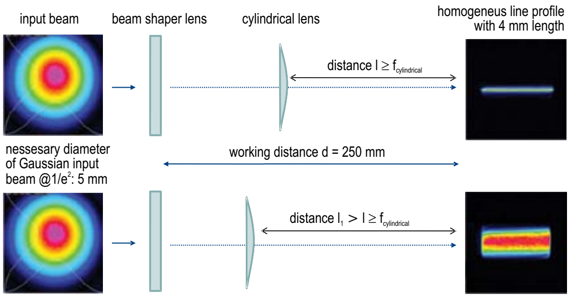
Homogeneous Line Generation with Top Hat Beam Shapper Lens and Additional Cylindrical Lens

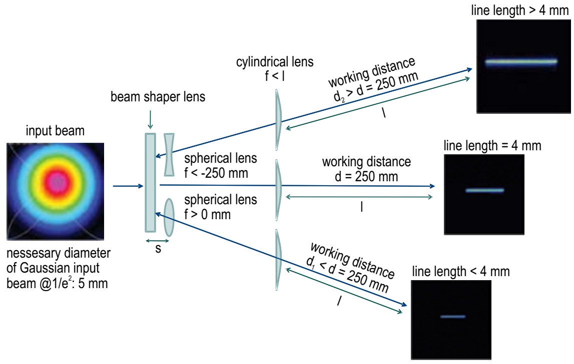


By introducing an additional cylindrical lens behind the Top Hat beam shaper lens (thereby one has to consider that the distance l between cylindrical lens and working plane must be bigger or same as focal length of cylindrical lens) it's possible to generate a line profile at working plane. Along the long axis the intensity profile is homogeneous. Along short axis, which is focused by cylindrical lens, the profile is near Gaussian.



By varying the distance l the width of line profile (short axis) can be changed from near diffraction limited size to several millimeters.

Adjustment of Length of Homogeneous Line by Additional Spherical Lens



GTH-4-2.2FA GAUSS-TO-TOP-HAT BEAM SHAPING LENS

Working distance is given by focal length of additional lens which is needed always. 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-4-2.2FA could be easily put in front of objectives for example.

The distance between GTH-4-2.2FA and additional lens is not critical (up to several tens of centimeters).

The full fan angle of Top-Hat generation for GTH-4-2.2FA is 2.2 mrad. This leads to Top-Hat sizes:

- 110×110 µm for lens with f = 50 at 50 mm distance
- 220×220 µm for lens with f = 100 at 100 mm distance
- 2.2×2.2 mm for lens with f = 1000 at 1000 mm distance
- 4.4×4.4 mm for lens with f = 2000 at 2000 mm distance

GTH-4-2.2FA OPERATION SPECIFICATIONS

Recommended operation wavelength range	400-1550 nm
Input beam	TEM_{00}, diameter (1/e²): 4.0 ± 0.15 mm
Achievable Top Hat size	6x diffraction limited @ 1064 nm, 12x diffraction limited @ 532 nm
Full fan angle of Top-Hat generation	2.2 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	4.0 ± 0.1 mm

Catalogue number	Description	Price, EUR
GTH-4-2.2FA	uncoated lens	450
GTH-4-2.2FA-VIS	VIS coated lens (400-700 nm (R<1% per face))	495
GTH-4-2.2FA-IR	IR coated lens (700-1300 nm (R<1% per face))	495

Other specific laser wavelengths are available on request.

GTH-4-2.2FA OPERATION INSTRUCTIONS

General function of Top-Hat beam shaper GTH-4-2.2FA

The Top-Hat beam shaper GTH-4-2.2FA generating a square Top-Hat profile with a full fan angle of 2.2 mrad. To get best results it is necessary to use a Gaussian TEM_{00} input beam with a diameter of 4 mm @ 1/e².

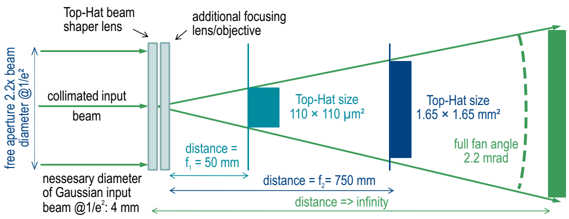
For all setups using GTH beam shaper the user have to consider that the free aperture along the total beam path have to be at least 2.2 (better 2.5) times bigger than the beam diameter @ 1/e².

Optical setup for Top-Hat beam shaper GTH-4-2.2FA

There are different possibilities to integrate the GTH-4-2.2 beam shaper into an optical setup.

1. Beam shaper directly in front of focusing optic/objective (Top Hat size >100 µm).

Top Hat size is determined by focal length (f) of focusing optic/objective and can be calculated as follows: $\frac{2.2}{1000} \cdot f$



By introducing the GTH-4-2.2FA 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.

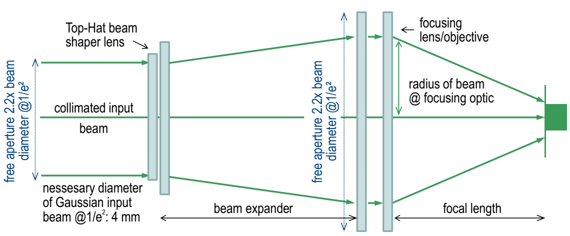
The necessary beam diameter at the position of GTH-4-2.2FA is 4 mm @ 1/e².

The resulting Top-Hat size is given by: $\frac{2.2}{1000} \cdot$ focal length, for example with f = 50 mm => 110 µm.

2. Beam shaper in front of beam expander (Top Hat size <100 µm)

Top Hat size is determined by numerical aperture (NA) of focused beam and can be calculated as follows:

$$\approx \frac{4\ \mu m}{NA} \Rightarrow\approx \text{6x diffraction limited @ 1064 nm (12x @ 532 nm)}$$



To realize Top Hat sizes smaller than 100 µm it's recommended to introduce the GTH-4-2.2FA into the beam path in front of a beam expander. Initially the necessary input beam diameter of 4 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:

$$\approx \frac{4\ \mu m}{NA} \Rightarrow\approx \text{6x diffraction limited @ 1064 nm (12x @ 532 nm)}$$

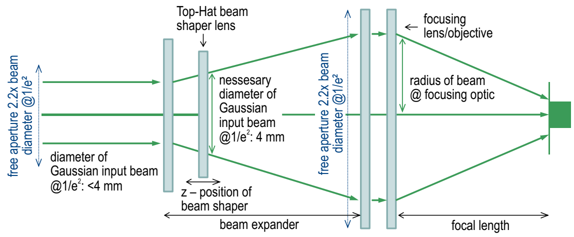
NA represents the numerical aperture of focused beam and is given by:

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

3. Beam shaper within beam expander (Top Hat size <100 µm)

Top Hat size is determined by numerical aperture (NA) of focused beam and can be calculated as follows:

$$\approx \frac{4\ \mu m}{NA} \Rightarrow\approx \text{6x diffraction limited @ 1064 nm (12x @ 532 nm)}$$



A further and even more flexible possibility is to introduce GTH-4-2.2FA 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-4-2.2FA by shifting shaper along z-axis. It's just necessary to consider that the beam diameter at the position of GTH is 4 mm @ 1/e². The resulting Top-Hat size is given by:

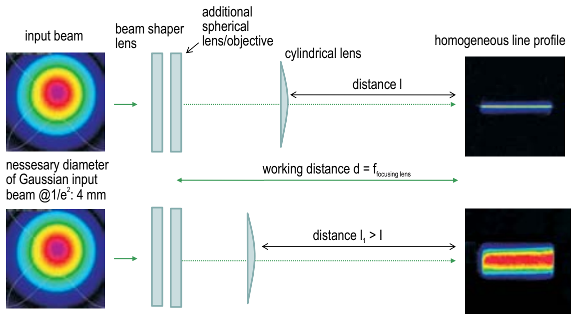
$$\approx \frac{4\ \mu m}{NA} \Rightarrow\approx \text{6x diffraction limited @ 1064 nm (12x @ 532 nm)}$$

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

Line thickness fixed, near diffraction limited.



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 with a focal length of f = 2.25 m.