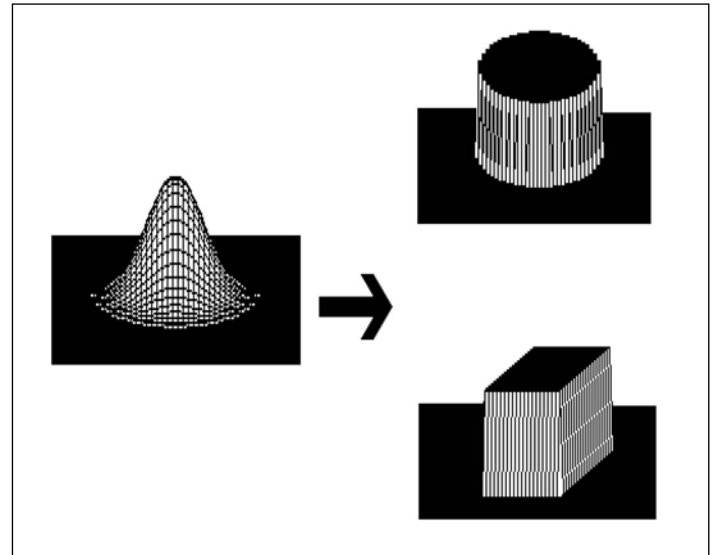


# Top Hat Beam Shaper

## UNIFORM SPOTS ENABLE LASER PROCESSES WITH A HIGHER QUALITY

Experienced material processing teams know that most laser processing jobs will perform better with a Top Hat shape. This shape applies a uniform intensity well-defined spot to the material and enables sharp and accurate transitions in the material under process. This offers considerable advantages in laser heat treatment, annealing of surfaces in machinery and microelectronics, optical heads of laser writer and optical information processing.

A Top Hat DOE produces a so-called Top Hat beam profile in the working plane with a steep slope from a Gaussian-shaped beam. The beam profile can have almost any type of cross section, round or square are the most popular.

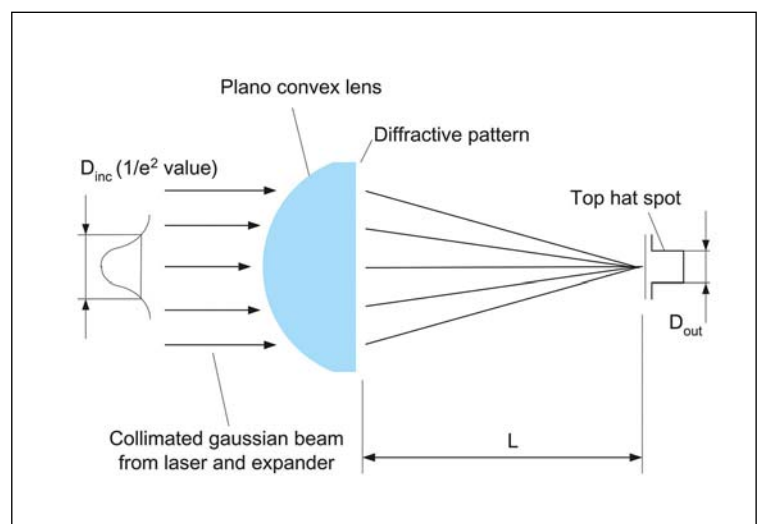


Top hat beam shaper:  
Transforms a gaussian beam into a top hat profile.

## DESIGN DETAILS

The optical scheme for of the top hat beam shapers should use collimated Gaussian incident beam, as presented on the right figure. Only TH-002 and TH-041 require a converged input beam.

The input diameter of the beam on the lens should be  $D_{inc}$  at the level of about  $1/e^2 \approx 13.5\%$  of intensity normalized to maximum intensity (not total power).



Optical setup for top hat beam shaper.



- The diffractive structure is usually located on the plane surface of a plano-convex lens.
- The Top Hat beam profile is reached exclusively in the working plane.
- A well-defined incident beam ( $M^2 < 1.3$  recommended; defined diameter) is necessary to obtain an optimally homogeneous and steep-edged Top Hat.
- The Top Hat profile depends on the exact x and y positioning of the DOEs in relation to the incident laser beam.
- The working distance L is measured from the planar surface of the plano-convex lens or window.
- Intensity distribution at distances  $< L$  should feature an intensity decrease at the edges of the spot (a bit similar to Gaussian beam).
- Intensity distribution at distances  $> L$  should feature intensity increase at the edges of the output spot (overcorrected).
- It is recommended that the position L of the top hat plane will be fine tuned for each laser system experimentally.

### OUTPUT SPOT

- Round with diameter  $D_{out}$  defined at  $1/e^2$ . Except for TH-008, TH-009 and TH-032 that are defined at FWHM
- Rectangular or squares with dimensions width x length defined at  $1/e^2$
- A rectangular or round angle at infinity at  $1/e^2$

### TYPICAL PERFORMANCE

The performance will depend on the design. In the table below one can see a range of typical performance for various parameters. Below that a table with selected design is displayed.

Performance <sup>1</sup>	Energy in desired Spot ( $1/e^2$ )	Ripple / Uniformity	Working distance	Transition region	Input Dia	Wavelength	Spot size
From	75 %	+/- 0.5 %	25 mm	5 $\mu$ m	0.8 mm	266 nm	15 $\mu$ m
·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·
Till	98 %	+/- 20 %	Infinity	100 $\mu$ m	35 mm	10600 nm	100 x 100 m

<sup>1</sup> Depends on design



## PART NUMBER NOMENCLATURE

TH –	001 –	A –	x –	A
function	design description	wavelength code	coating code	grade
TH: Top Hat ST: Stable Top		A: 10.6 $\mu\text{m}$ I: 1064 nm Q: 532 nm U: 355 nm W: 266 nm	Y: with AR coating N: uncoated for 10.6 $\mu\text{m}$ typically always with coating, for other wavelengths to customer need	A to E typ. A



## STANDARD PARTS

Selected designs	Part No.	Function	Diameter Component	Wave-length [μm]	Diameter Input beam (1/e <sup>2</sup> ) [mm]	Working distance	Spot size (1/e <sup>2</sup> )	Note	Spot Shape
	TH-001-A-Y-A	Top-Hat	1.5"	10.6	25	250 mm	3 mm		Round
	TH-002-A-Y-A	Top-Hat	1.1"	10.6	12	250 mm	6 mm	Converging	Square
	TH-003-A-Y-A	Top-Hat-1D	0.5"	10.6	3.7	42.5 mm	0.3x0.1mm		Line
	TH-004-A-Y-A	Top-Hat	1.1"	10.6	12	63.5 mm	0.39 mm		Round
	TH-006-A-Y-A	Top-Hat	1.5"	10.6	25	125.4mm	15x1mm		Rectangular
	TH-009-A-Y-A	Top-Hat	1.1"	10.6	12	63.5 mm	0.28 mm	FWHM	Square
	TH-205-A-Y-A	Top-Hat	1.0"	10.6	4 mm	100 mm	1.5 mm		Round
	TH-202-A-Y-A	Top-Hat	20 mm	10.6	14.5 mm	80.2 mm	230 mm	1/e <sup>2</sup>	Round
	TH-205-A-Y-A	TopHat	1.0"	10.6	4 mm	100 mm	1.5 mm		Round
	TH-208-A-Y-A	Top-Hat 1-d	1.1"	10.6	13 mm	150 mm	5 mm x 0.18 gauss		Line
	ST-201-A-Y-A	Stable Top-Hat	1.5"	10.6	16.5 mm	190.5 mm	360 μm		Round
	TH-005-C-Y-A	Top-Hat	1.1"	9.25	12	63.5 mm	0.35 mm		Round
	TH-007-C-Y-A	Top-Hat	1.5"	9.25	25	121.0 mm	14.2x1.7 mm		Rectangular
	TH-008-C-Y-A	Top-Hat	1.1"	9.25	12	62.9 mm	0.26 mm	FWHM	Square
	ST-200-C-Y-A	Stable Top-Hat	1.1"	9.25	12 mm	63 mm	0.26 x 0.26 mm		Square
	TH-203-D-x-A	Top-Hat	11 mm	2.936	4.0 mm	80 mm	200 μm		Round
	TH-012-H-x-A	Top-Hat	20 mm	1.319	7.0	43.2 mm	0.17mm		Round
	TH-013-l-x-A	Top-Hat	1.0"	1.064	7.0	infinity	1x1 deg		Square
	TH-014-l-x-A	Top-Hat	20 mm	1.064	7.0	42.52 mm	0.190 mm	Sharp edge	Round
TH-015-l-x-A	Top-Hat-1D	1.0"	1.064	5.1	infinity	0.83 deg x input		Line	
TH-017-l-x-A	Top-Hat	50 mm	1.064	39.0	20 meter	635 x 5.3 mm		Rectangular	
TH-018-l-x-A	Top-Hat	1.5"	1.064	13.0	20 meter	635 x 635 mm		Square	
TH-019-l-x-A	Top-Hat	1.0"	1.064	3	100 mm	210 x 210 μm		Square	
TH-101-l-x-A	Top-Hat	1.0"	1.064	3	100 mm	150 μm		Round	
TH-102-l-x-A	Top-Hat	1.0"	1.064	6	100 mm	150 μm		Round	
TH-103-l-x-A	Top-Hat	1.0"	1.064	9	1000 mm	10 x 10 mm		Square	
TH-104-l-x-A	Top-Hat	1.0"	1.064	7 mm	100 mm	210 x 210 μm		Square	
TH-016-K-x-A	Top-Hat	1.0"	0.980	7.0	infinity	0.94 x 0.94 deg		Square	
TH-033-M-x-A	Top-Hat	1.0"	0.80	6.0	200.3 mm	3.0 mm		Round	
TH-031-Q-x-A	Top-Hat	1.0"	0.532	5	52.4 mm	0.1 mm		Round	
TH-032-Q-x-A	Top-Hat	1.0"	0.532	10.9	200 mm	2 mm	FWHM	Round	
TH-034-Q-x-A	Top-Hat	1.0"	0.532	2.5	99.5 mm	100 x 100 μm		Square	
TH-035-Q-x-A	Top-Hat	1.0"	0.532	2.5	99.5 mm	90 μm		Round	



Selected designs	Part No.	Function	Diameter Component	Wave-length [μm]	Diameter Input beam (1/e <sup>2</sup> ) [mm]	Working distance	Spot size (1/e <sup>2</sup> )	Note	Spot Shape
	TH-036-Q-x-A	Top-Hat	1.0"	0.532	3.5 mm	100 mm	200 x 200 μm		Square
	ST-201-Q-x-A	Stable top-hat	1.0"	0.532	3.5 mm	100 mm	200 x 200 μm		Square
	TH-201-Q-x-A	Top-Hat	1.0"	0.532	3.5 mm	100 mm	0.2 x 0.2 mm		Square
	TH-041-U-x-A	Top-Hat	1.0"	0.355	2	100 mm	0.1 mm	Converging	Square
	TH-042-Q-x-A	Top-Hat	1.0"	0.355	2.5	50 mm	0.05 mm		Round
	TH-043-U-x-A	Top-Hat	20 mm	0.355	8.0	49.8 mm	0.015 mm		Round
	TH-045-U-x-A	Top-Hat	0.5"	0.355	1.65	94 mm	170 x 170 μm		Square
	TH-046-U-x-A	Top-Hat	0.5"	0.355	2.5	95 mm	80 x 80 μm		Square
	TH-209-U-x-A	Top-Hat	1.0"	0.355	9x6 mm	200 mm	0.1 mm		Round
	TH-207-U-x-A	Top-Hat	1.0"	0.355	3.5 mm	100 mm	200 x 200 μm		Square
	TH-044-V-x-A	Top-Hat	20 mm	0.337	8.0	49.4 mm	0.020 mm		Round
TH-051-W-x-A	Top-Hat	1.0"	0.266	5	42 mm	0.015 mm		Round	

**Note:**

Holo/Or is very flexible to tailor elements to very narrow defined requests of a customer. After having your detailed needs we can clarify what is possible.

If you look for a more robust solution a stable top or a homogenizer could be a suitable solution. These can work with beam that have a larger M<sup>2</sup> and are less well aligned and defined, please contact us for further details.

