Sintec Optronics

Diffractive Optic Elements (DOE)

Contents

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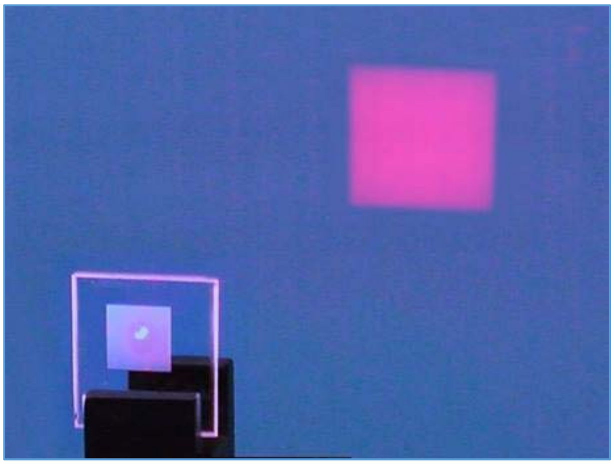
Beam Shaper

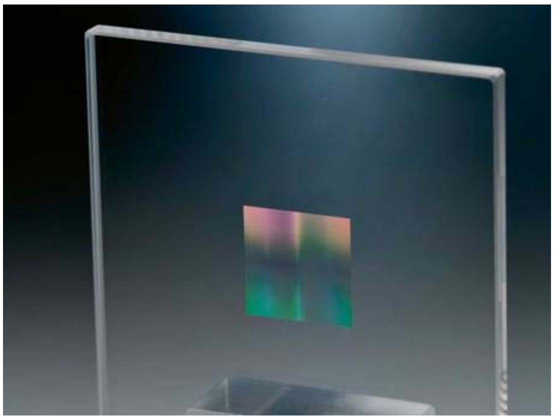
A diffractive beam shaper allows you to modify the intensity and phase profiles of spatially coherent lasers. Through in-phase manipulation of the input beam, you can achieve virtually limitless and, most importantly, speckle-free intensity profiles in the output beam. This requires reliable and accurate knowledge of the input beam and phase profile.



You can optimize the performance and overall efficiency of your system, which could be in the application of laser material processing, in the field of lithography and holographic lighting as well as for biomedical devices and optical sensors.

With our high-performance beam shapers, you can create uniform top-hat, circular rectangular, or linear intensity profiles as well as all manner of distributions and geometries – all according to your own specific requirements and applications. We design our beam shapers to be perfectly compatible with single-mode (TEM00) input beams. We also produce refractive or diffractive diffusers and homogenizers for use with multi-mode lasers to integrate the multi-mode beam. These cover a wavelength range from DUV to LWIR.

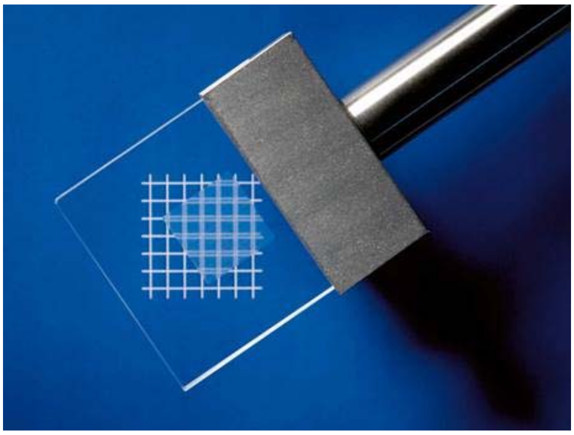
Diffractive Line Generators



Single-mode lasers such as solid-state lasers, fiber lasers, diode lasers, gas lasers and frequency-doubled or -tripled lasers feature a Gaussian beam profile. These Gaussian profiles can´t be readily used for optimal for uniform lighting applications.

Diffractive line generators from Sintec use a single surface element without additional optics to convert a Gaussian laser beam into a uniform, one-dimensional top-hat profile. Uniform and speckle-free lines are ideal for material processing applications, such as annealing or recrystallization of semiconductors and thin layers. This type of illumination can be designed to create lines at normal incidence or even on highly tilted planes.

Beam Splitter

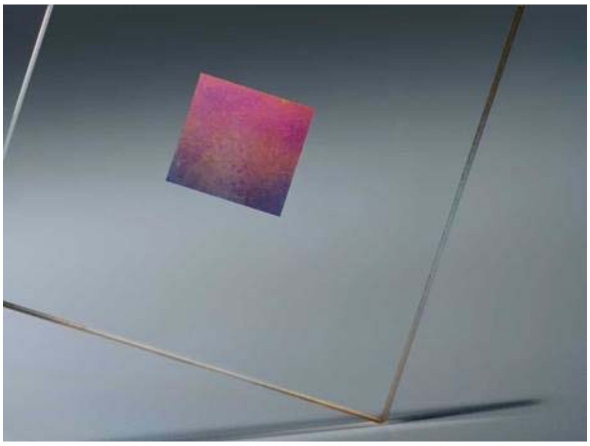


Diffractive beam splitters from Sintec effectively separate a single incident laser beam into multiple non-overlapping beams. The intervals, intensity ratios and symmetrical distribution of the beams are freely selectable and are set by the periodic microstructures of the beam splitter with great accuracy and high repeatability. At the same time, the divergence angle, diameter and polarization of the incident beam remain unchanged.

As a result, the energy emitted by the laser is better distributed for multiple channel processing, thus enhancing both efficiency and performance. This makes our high-precision diffractive microoptics ideal for LIDAR applications involving color separation, material processing for surgical procedures as well as in the field of metrology, as a few examples. You can also achieve better results during laser welding by using multiple laser beams with fixed angular separation and power ratios, thereby optimizing the transfer of heat into the material, for instance.

For your specific applications, Sintec also offers polarizing beam splitters, which allow you to separate the s and p polarization and adjust their intensity ratio.

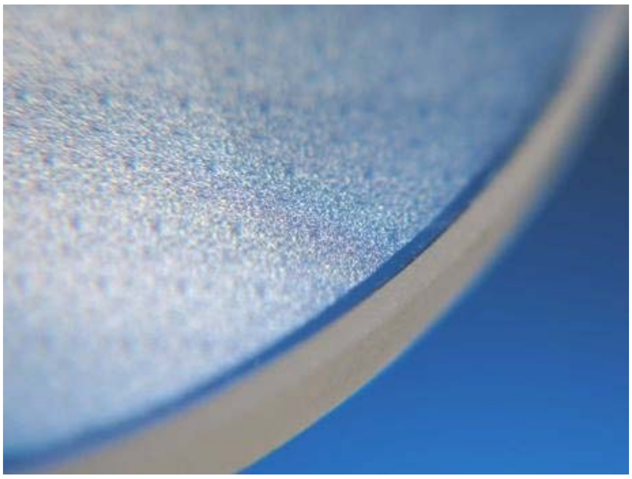
Diffractive Diffuser



You use diffractive diffusers from Sintec to absorb a monochromatic laser beam and scatter the light into any imaginable pattern. Like the diffractive beam splitter, the diffuser converts an input beam into a multitude of output beams, the angle and intensity of which can be controlled. However, in contrast with the beam splitter, these beams overlap and interfere, generating a new, homogenized distribution.

Diffractive diffusers are therefore ideal for laser applications, in which a specific laser beam shape is required, similarly to refractive homogenizers. They also allow you to realize uniform performance for a specific range at a defined distance from the light source. The optical elements achieve a uniformity of 3 to 5%, whereby the shape of the light distribution can be round, rectangular or freely selectable.

Our diffractive diffusers feature a strictly controlled beam angle, which guarantees you particularly high levels of efficiency. The diffusers are not alignment sensitive and have no impact on the polarization of the input beam. This makes the diffractive diffusers ideal for applications requiring rapid sensing of large areas, in the fields of remote sensing or LIDAR/LADAR, for example. The diffusers cover the wavelength range from DUV to infrared.



Gaussian Generator

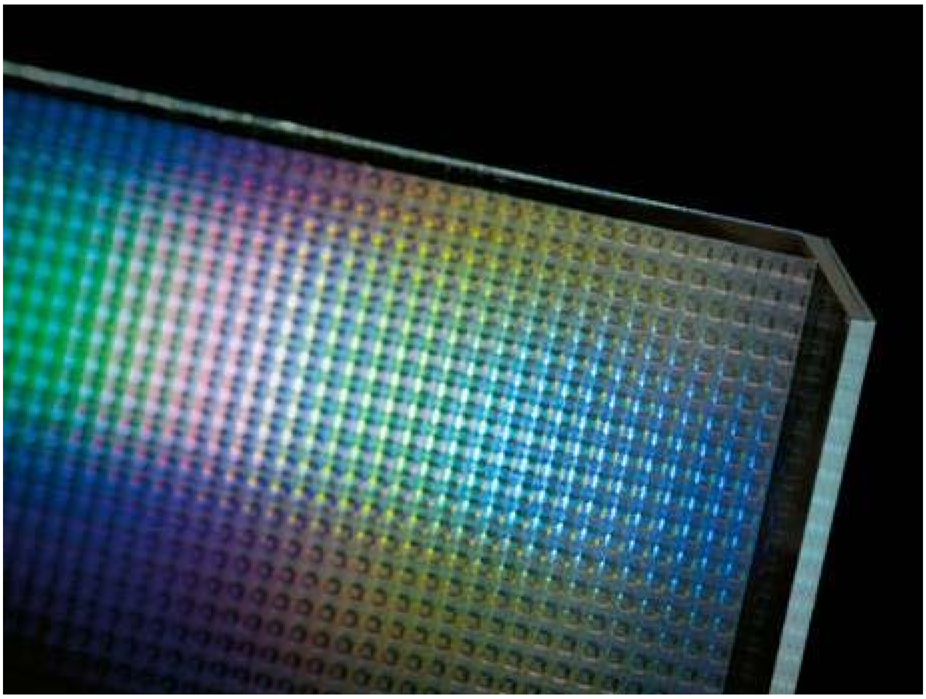
The diffractive Gaussian generators from Sintec represent a special type of diffractive diffuser and are ideally suited for high-power lasers such as excimer, nitrogen or diode lasers. They convert non-Gaussian laser beams into accurately defined, reproducible Gaussian far-field profiles.

Such intensity profiles are ideal for overlapping laser beam processing – for example, during material processing and medical laser treatment or for printing technology and measuring systems. We can provide you with DOEs for wavelengths ranging from UV to NIR.

Diffractive elements for Off-axis Illumination

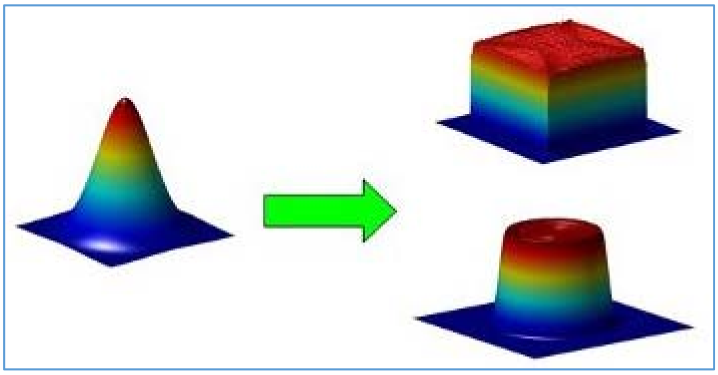
Multi-pole pupil illumination is required to achieve maximum resolution in mask projection systems. Diffractive optical elements (DOE) from Sintec effectively produce such distributions with high accuracy and uniformity both within and between the individual poles.

We use high-quality materials for all our diffractive elements. This ensures a long service life, even in the case of intensive UV laser irradiation.



Beam Shaper / Top-Hat

A Top-Hat beam shaper converts a Gaussian input laser beam into a uniform intensity beam of any shape and size requested by the customer.

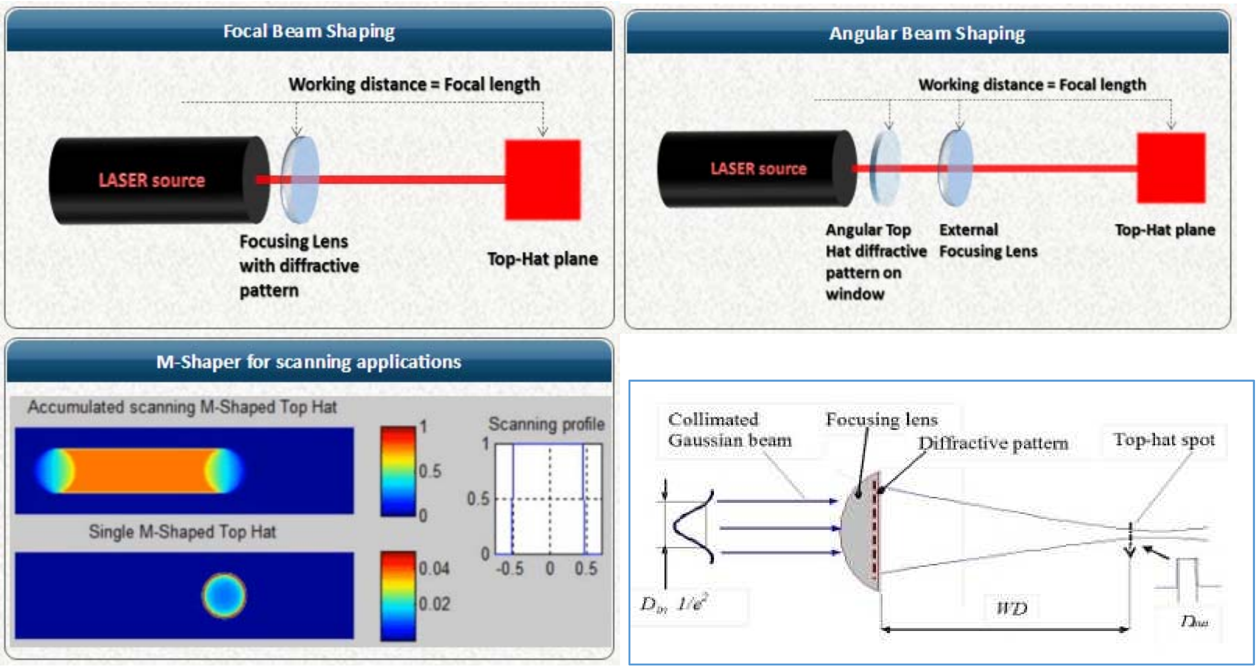


The beam shaping element is a diffractive optical element (DOE) used to transform a near-gaussian incident laser beam into a uniform-intensity spot of either round, rectangular, square, line or other shape with sharp edges in a specific work plane.

A uniform spot enables equal treatment to a surface, excluding over/under-exposure of specific areas. In addition, the spot is characterized by a sharp transition region that creates a clear border between the treated and untreated area. The beam shaping can be a:

Focal Beam Shaping: Hybrid element (lens) or module which give a Top-Hat intensity distribution at a specific working distance (BFL of the lens or distance from exit location of the module to Top-Hat plane).
Angular Beam Shaping: Optical element (window) which gives a Top-Hat intensity distribution at infinity or focal length of aberration free customer's lens.

M-Shaper: Optical element (window) which gives a uniform exposure over scanned lines.



Focal Beam Shaper standard elements

PN	Wavelength [nm]	Beam Dia [mm]	WD [mm]	Spot Size	Element Size [mm]	Image Shape
TH-042-U-Y-A	355	2.5	50	50 um	25.4	Round
TH-245-U-Y-A	355	12	50	45x10um	25.4	Rectangular
ST-202-U-Y-A	355	14	50	50x6 um	25.4	Rectangular
ST-203-I-Y-A	1064	6	52	50x50 um	25.4	Square
ST-204-Q-Y-A	532	6	52	30 x 30 um	25.4	Square
TH-241-W-Y-A	266	8	200	1mm	25.4	Line
TH-235-U-Y-A	355	12	700	10mm	27.94	Line
ST-209-Q-Y-A	532	2	104.76	150x200um	12.7	Rectangular
ST-211-A-Y-A	10600	11	38	125x200um	27.94	Rectangular
ST-215-U-Y-A	355	14	47.8	6x34um	25.4	Rectangular
ST-216-U-Y-A	355	14	47.8	6x38um	25.4	Rectangular
ST-217-U-Y-A	355	14	47.8	6x42um	25.4	Rectangular
TH-234-A-Y-A	10600	14	95	250um	27.94	Round
TH-233-A-Y-A	10600	12	63.5	0.25x2.5mm	27.94	Rectangular
TH-223-A-Y-A	10600	2.4	565	27.8x27.8mm	15	Square
TH-222-Q-Y-A	532	2.9	40	200um	12.7	Line
TH-219-A-Y-A	10600	12	63.5	0.25x1.5mm	27.94	Rectangular
TH-217-U-Y-A	355	2	100	100x100um	12.7	Square
TH-009-A-Y-A	10600	10	63.5	280x280 um	27.94	Square
TH-011-A-Y-A	10600	25	250	3 mm	38.1	Round
TH-216-Q-Y-A	532	12	720	10x10mm	25.4	Square
TH-014-I-Y-A	1064	7	42.52	190 um	20	Round
TH-017-I-Y-A	1064	39	20000	635x5.3 mm	50	Rectangular
TH-018-I-Y-A	1064	13	20000	635x635 mm	38.1	Square
TH-019-I-Y-A	1064	3.5	100	210x210 um	25.4	Square
TH-209-U-Y-A	355	9x6	200	100 um	25.4	Round

TH-208-A-Y-A	10600	13	150	5 mm	27.94	Line
TH-207-U-Y-A	355	3.5	99.35	200x200 um	25.4	Square
TH-034-Q-Y-A	532	2.5	99.5	100x100 um	25.4	Square
TH-035-Q-Y-A	532	2.5	99.5	90 um	25.4	Round
TH-036-Q-Y-A	532	3.5	100	200x200 um	25.4	Square
ST-201-A-Y-A	10600	16.5	187.5	360um	38.1	Round
TH-043-U-Y-A	355	8	49.8	15 um	20	Round
TH-205-A-Y-A	10600	4	100	1.5mm	25.4	Round
TH-045-U-Y-A	355	1.65	94	170x170 um	12.7	Square
TH-046-U-Y-A	355	2.5	95	61x61um	12.7	Square
TH-051-W-Y-A	266	5	42	15 um	25.4	Round
TH-101-I-Y-A	1064	3	100	150 um	25.4	Round
TH-102-I-Y-A	1064	6	100	150 um	25.4	Round
TH-103-I-Y-A	1064	9	1000	10x10 mm	25.4	Square
TH-202-A-Y-A	10600	14.5	79.5	370um	20	Round
TH-203-D-Y-A	2940	4	80	200 um	11	Round
TH-204-Q-Y-A	532	3.5	105	200x200um	25.4	Square
ST-200-C-Y-A	9250	12	63.5	260x260um	27.94	Square
TH-032-Q-Y-A	532	10.9	200	2mm @FWHM	25.4	Round
TH-031-Q-Y-A	532	5	52.4	100 um	25.4	Round
TH-005-C-Y-A	9250	12	62.9	350 um	27.94	Round
TH-226-A-Y-A	10600	4	100	3x3mm	20	Square
TH-231-I-Y-A	1064	5	100	0.2x0.6mm	12.7	Rectangular
TH-004-A-Y-A	10600	12	63.4	390 um	27.94	Round
TH-003-A-Y-A	10600	3.7	41	650um	12.7	Line
TH-244-U-Y-A	355	12	50	35x13um	25.4	Rectangular
TH-033-X-Y-A	800	6	200	3 mm	25.4	Round
TH-012-H-Y-A	1319	7	43.2	170 um	20	Round
TH-008-C-Y-A	9250	10	62.9	260x260 um	27.94	Square
TH-232-X-Y-A	1070	12	150	300x300um	38.1	Square
TH-007-C-Y-A	9250	25	121	14.2X1.7 mm	38.1	Rectangular
TH-006-A-Y-A	10600	25	125	15X1 mm	38.1	Rectangular
ST-208-X-Y-A	1070	14	75	500x500um	30	Square
ST-205-I-Y-A	1064	7	100	210x210um	25.4	Square
TH-044-1-Y-A	337	8	49.4	20 um	20	Round
TH-224-X-Y-A	1070	14	75.76	1x1mm	38.1	Square

Angular Beam Shaper

PN	λ [nm]	Beam Dia [mm]	θf [mRad]	Image size*** [um] for EFL=100mm	Element Size [mm]	Image Shape	Remarks
TH-238-I-Y-A	1064	3	6	600	11	Round	
ST-206-I-Y-A	1064	10	2.7	270	25.4	Line	
ST-219-I-Y-A	1064	4	0.52	52	11	Round	Binary TH
ST-225-I-Y-A	1064	4.5	0.47	47	25.4	Square	Binary TH
ST-234-I-Y-A	1064	7	0.3	30	25.4	Square	Binary TH
ST-237-I-Y-A	1064	9	0.23	23	25.4	Round	Binary TH

ST-241-I-Y-A	1064	10	0.2	20	25.4	Round	Binary TH
PT-001-I-N-A	1064	6	0.56	56	30	Square	
TH-258-I-Y-A	1064	10	0.48	48	25.4	Square	
ST-212-I-Y-A	1064	7	1	100	20	Square	
ST-277-I-Y-A	1064	7	0.3	30	25.4	Line	Binary TH
TH-227-I-Y-A	1064	3	13.3	1330	11	Round	
ST-283-I-Y-A	1064	12	0.36x1.80	36.0x180.0	25.4	Rectangular	
TH-215-I-Y-A	1064	6	1	100	25.4	Round	
ST-286-I-Y-A	1064	12	0.35x2.70	35.0x270.0	25.4	Rectangular	
TH-015-I-Y-A	1064	5.1	14.5	1450	25.4	Line	
TH-013-I-Y-A	1064	7	17.5	1750	25.4	Square	
ST-303-I-Y-A	1064	7.5	0.28	28	25.4	Round	Binary TH
ST-221-I-Y-A	1064	4.7	0.44	44	25.4	Round	Binary TH
ST-238-I-Y-A	1064	10	0.2	20	25.4	Square	Binary TH
ST-239-I-Y-A	1064	6	0.35	35	25.4	Round	Binary TH
ST-240-I-Y-A	1064	8	0.26	26	25.4	Round	Binary TH
ST-222-I-Y-A	1064	5	0.41	41	25.4	Round	Binary TH
PT-002-I-Y-A	1064	7.5	45.18x2.64	4518.8x264.0	40x40	Rectangular	
ST-259-I-Y-A	1064	2	1.04	104	11	Round	Binary TH
ST-260-I-Y-A	1064	3	0.69	69	11	Round	Binary TH
PT-001-I-Y-A	1064	6	0.56	56	30	Square	
ST-289-I-Y-A	1064	3.5	0.6	60	11	Round	Binary TH
TH-249-I-Y-A	1064	3.2	0.74	74	12.5	Line	Binary TH
TH-246-I-Y-A	1064	6	4.2	420	25.4	Round	
TH-239-I-Y-A	1064	4.7	0.51	51	12.5	Line	Binary TH
ST-227-I-Y-A	1064	4	2	200	11	Frame	Binary TH
ST-267-I-Y-A	1064	2	1.04	104	11	Line	Binary TH
ST-268-I-Y-A	1064	3	0.69	69	11	Line	Binary TH
ST-269-I-Y-A	1064	4	0.52	52	11	Line	Binary TH
ST-270-I-Y-A	1064	5	0.43	43	11	Line	Binary TH
ST-271-I-Y-A	1064	2	1.3	130	11	Round	Binary TH
ST-272-I-Y-A	1064	3	0.87	87	11	Round	Binary TH
ST-273-I-Y-A	1064	5	0.52	52	25.4	Round	Binary TH
ST-275-I-Y-A	1064	8	0.26	26	25.4	Line	Binary TH
ST-276-I-Y-A	1064	10	0.21	21	25.4	Line	Binary TH
ST-228-I-Y-A	1064	4	24	2400.1	11	Frame	Binary TH
ST-278-I-Y-A	1064	9	0.23	23	25.4	Line	Binary TH
ST-229-I-Y-A	1064	4	12	1200	11	Square	Binary TH
TH-221-I-Y-A	1064	2.2	3.2	320	11	Square	Binary TH
ST-281-I-Y-A	1064	6	0.34	34	25.4	Line	Binary TH
ST-282-I-Y-A	1064	6	0.34	34	25.4	Square	Binary TH
ST-230-I-Y-A	1064	7	0.29	29	20	Round	Binary TH
TH-220-I-Y-A	1064	1.125	6.2	620	11	Square	Binary TH
ST-231-I-Y-A	1064	3	8.7	870	11	Line	Binary TH
ST-232-I-Y-A	1064	3	17.67	1767	11	Line	Binary TH
ST-220-I-Y-A	1064	4	0.53	53	11	Square	Binary TH
ST-235-I-Y-A	1064	8	0.26	26	25.4	Square	Binary TH

ST-315-I-Y-A	1064	1.5	1.39	139	11	Square	Binary TH
ST-290-I-Y-A	1064	3.5	0.6	60	11	Square	Binary TH
ST-291-I-Y-A	1064	2	1.02	102	11	Square	Binary TH
ST-292-I-Y-A	1064	2.5	0.81	81	11	Square	Binary TH
ST-293-I-Y-A	1064	3	0.68	68	11	Square	Binary TH
ST-294-I-Y-A	1064	2.5	0.83	83	11	Line	Binary TH
ST-295-I-Y-A	1064	3.5	0.59	59	11	Line	Binary TH
ST-296-I-Y-A	1064	4.5	0.46	46	11	Line	Binary TH
ST-297-I-Y-A	1064	2.5	0.84	84	11	Round	Binary TH
ST-298-I-Y-A	1064	4.5	0.47	47	11	Round	Binary TH
ST-299-I-Y-A	1064	5.7	0.4	40	11	Round	Binary TH
ST-300-I-Y-A	1064	5.7	0.49	49	11	Round	Binary TH
ST-301-I-Y-A	1064	5.7	0.37	37	12.5	Round	Binary TH
ST-302-I-Y-A	1064	5.7	0.48	48	12.5	Round	Binary TH
ST-236-I-Y-A	1064	9	0.23	23	25.4	Square	Binary TH
ST-307-I-Y-A	1064	1	2.08	208	11	Round	Binary TH
ST-308-I-Y-A	1064	1	2.08	208	11	Square	Binary TH
ST-312-I-Y-A	1064	1	2.08	208	11	Line	Binary TH
ST-313-I-Y-A	1064	1.5	1.39	139	11	Line	Binary TH
ST-314-I-Y-A	1064	1.5	1.39	139	11	Round	Binary TH
ST-263-I-Y-A	1064	12	0.36x2.39	36.0x239.0	25.4	Rectangular	
ST-207-I-Y-A	1064	10	0.6	60	25.4	Round	
ST-288-I-Y-A	1064	12	0.36x3.30	36.0x330.0	25.4	Rectangular	
ST-287-I-Y-A	1064	12	0.35x2.99	35.5x299.0	25.4	Rectangular	
ST-285-I-Y-A	1064	12	0.36x2.40	36.0x240.0	25.4	Rectangular	
ST-284-I-Y-A	1064	12	0.36x2.10	36.0x210.0	25.4	Rectangular	
ST-280-I-Y-A	1064	12	0.36x3.30	36.5x330.0	25.4	Rectangular	
TH-225-I-Y-A	1064	1.2	23.7	2370.1	11	Dollar	
ST-279-I-Y-A	1064	12	0.36x3.00	36.0x300.0	25.4	Rectangular	
TH-228-I-Y-A	1064	3	10	1000	11	Round	
TH-236-I-Y-A	1064	6	7.2	720	25.4	Grid 10x10 cells	
TH-237-I-Y-A	1064	6	7.2	720	25.4	11 lines	
ST-266-I-Y-A	1064	12	0.37x2.40	36.9x239.5	25.4	Rectangular	rounded corners
ST-265-I-Y-A	1064	12	0.37x2.09	37.2x209.1	25.4	Rectangular	rounded corners
ST-264-I-Y-A	1064	12	0.36x2.69	36.5x269.0	25.4	Rectangular	
TH-248-I-Y-A	1064	5	5.60x0.94	560.0x94.0	25.4	Rectangular	
TH-002-I-Y-A	1064	12	2.4	240	27.94	Square	
TH-252-I-Y-A	1064	6	20	2000.1	25.4	Round	
TH-253-I-Y-A	1064	12	0.65x2.97	65.0x297.0	25.4	Rectangular	
TH-254-I-Y-A	1064	12	0.81x2.36	81.0x236.0	25.4	Rectangular	
TH-255-I-Y-A	1064	12	1.10x1.77	110.0x177.0	25.4	Rectangular	
TH-256-I-Y-A	1064	12	0.40x4.79	40.0x479.0	25.4	Rectangular	
TH-257-I-Y-A	1064	12	0.36x5.39	36.0x539.0	25.4	Rectangular	
ST-262-I-Y-A	1064	12	0.36x2.10	36.0x210.0	25.4	Rectangular	
TH-259-I-Y-A	1064	6	3.19	319	25.4	Square	
TH-260-I-Y-A	1064	6	1.71	171	25.4	Square	

TH-105-I-Y-A	1064	7.5	0.54	54	25.4	Round	
ST-261-I-Y-A	1064	12	0.36x1.78	35.8x178.0	25.4	Rectangular	
ST-258-I-Y-A	1064	10	3.9	390	25.4	Line	
ST-223-I-Y-A	1064	6	3	300	25.4	Line	
PT-003-I-Y-A	1064	3.2	22.77	2277.1	12.7x12.7	Line	
PT-005-I-Y-A	1064	5	3.29	329	25.4	Round	
PT-006-I-Y-A	1064	2	40.30x57.10	4030.5x5711.6	12.7	Elliptical	

Small Angle Top Hat standard

Small Beam Shaper for scanning application (~1.5X Diffraction Limit)

Laser beams with Top-hat energy distribution are being used for different applications in the laser material processing industry. Most systems in this industry include scanners and F-θ lenses in order to direct and focus the beam on the substrate. HoloOr is proud to introduce a new design for ~1.5x(Diffraction limit) beam shapers DOEs (Diffractive Optical Element) which is considerably cheaper than regular Top-hats. Those DOEs are specially designed to operate with scanners/F-θ lenses under high power lasers. Placing the beam shaper DOE before the scanner will create a top-hat energy distribution at the F-θ lens working plane. The use of this beam shaper does not affect the focal length of the system.

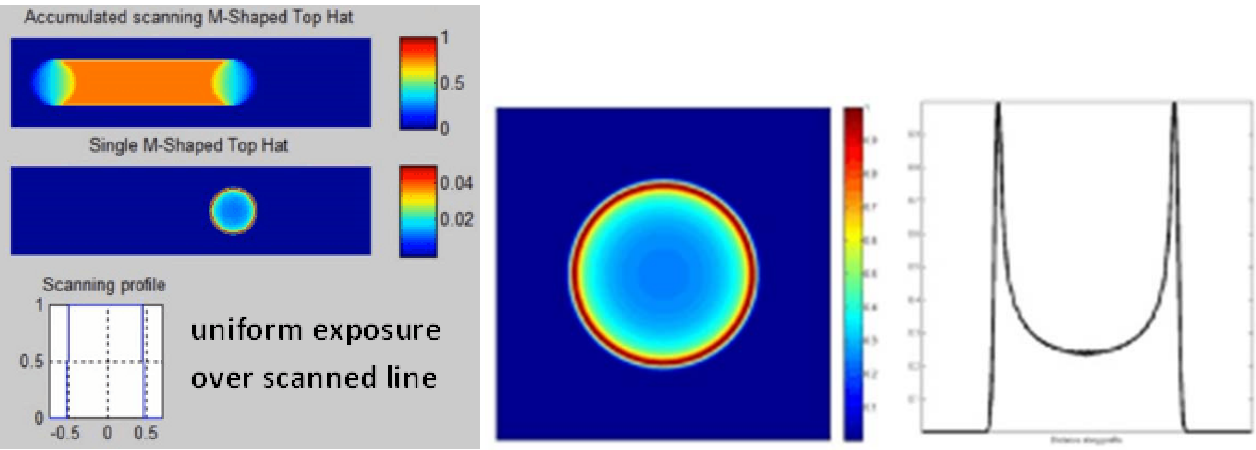
M-Shaper

M-Shaper, is a diffractive optical elements (DOE) used to create a unique 2D M-shaped intensity profile, with sharp edges in a specific work plane. The M-Shaper optical function is not possible by conventional reflective or refractive optical elements. The typical application is to create a uniform exposure over scanned lines. That is, when scanning a line with a regular Gaussian or even Top-Hat spot the center gets over exposed (influencing the heat distribution during laser material processing). The M-Shape is the mathematical shape that gives a uniform exposure over the line when scanned. This provides higher quality of the process & enables more flexibility in the system configuration. For example, it allows optimization of the intensity profile, and image size, without changing the laser, fiber cable and/or scanning optical head.

The benefits of our optimized M-shaped intensity profile include:

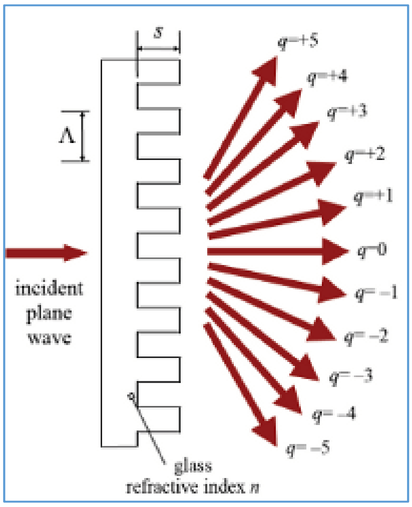
- Uniform exposure over the scanned line
- "Cleaner" results with scanned lines in almost any process
- Enables very strong weld seams

The most M-Shape DOE's listed below require a Single Mode (TEM00) input beam. However, some M-Shape DOE's had been designed for Multimode lasers (with MM in remarks column). Please feel free to contact us on this or any other custom request you may have.



PN	λ[nm]	Beam Diameter (mm)	Image Shape	θf [deg]	Image size*** [mm] for EFL=100mm
MR-003-I-Y-A	1064	5.3	Round	0.43	43
MR-004-I-Y-A	1064	5.7	Round	0.4	40
MR-006-I-Y-A	1064	10.2	Round	0.23	23
MR-009-I-Y-A	1064	11.3	Round	0.21	21
MR-010-I-Y-A	1064	2.3	Round	1.02	102
MR-013-I-Y-A	1064	4.2	Round	13.32	1332
MR-015-I-Y-A	1064	4.2	Round	6.06	606
MR-002-I-Y-A	1064	4.5	Round	0.52	52
MR-005-I-Y-A	1064	7.9	Round	0.29	29
MR-007-I-Y-A	1064	6.8	Round	0.34	34
MR-008-I-Y-A	1064	9	Round	0.26	26
MR-011-I-Y-A	1064	3.4	Round	0.69	69
MR-001-I-Y-A	1064	8.5	Round	4.26	426
MR-012-I-Y-A	1064	8.4	Round	1.03	103
MR-014-I-Y-A	1064	4.2	Round	10.13	1013
MR-017-I-Y-A	1064	8.4	Round	0.47	47
MR-018-I-Y-A	1064	6	Round	3.21	321
RD-232-I-Y-A	1064	>1.5	Round	34.9	3490.4
RD-247-I-Y-A	1064	>6	Round	8.73	873
RD-254-I-Y-A	1064	>4	Round	17.45	1745
MR-016-I-Y-A	1064	7	Round	3.32	332

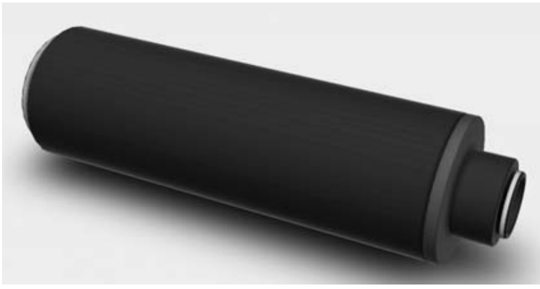
Gratings



Diffraction gratings are Binary Phase Gratings. These are a special case of a 1D Damman grating with a duty cycle of 50% within a period. Our gratings are transmission gratings, but can be offered in reflective versions as desired. In this section, we present our standard list of gratings with custom etching depth (modulation depth).

In addition to standard gratings, we can offer gratings with custom specifications (duty cycle, modulation depth, period, reflection or transmission grating).

Lens for Thick Glass Cutting

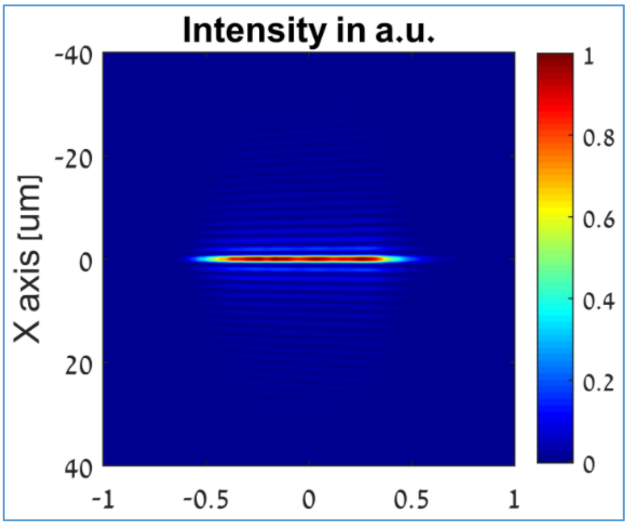


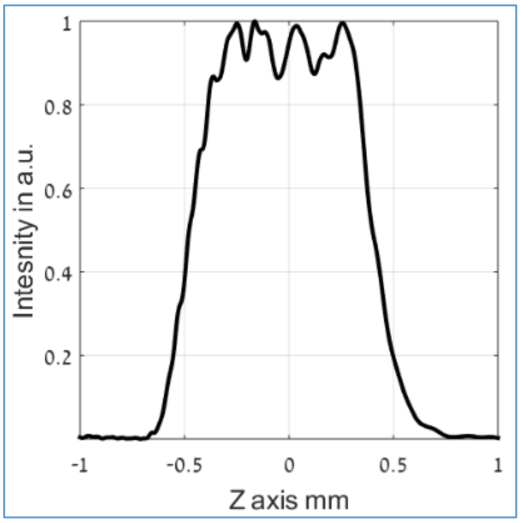
Our special designed Lens for Thick Glass Cutting focuses an incident single mode laser into a tight spot with 1.8 μm waist size along the entire Depth of Focus range (1-2mm typical range) .The focused spot is equivalent to 0.35 objective NA and is ideally suited for thick glass cutting, such as flat panels. This module is a complete optical solution for cutting applications. There are no need for additional high NA objectives or other high cost optics. The Lens for Thick Glass Cutting module differs from standard EF elements by constant peak power along the focus region and requires low M^2 and accurate input beam size.

Main features:

- Full depth glass cut from single pulse
- Complete solution in a single module
- Very low aberrations level- spot diameter <2µm
- Easy to integrate into existing opto-mechanics

Elongated Focus with uniform intensity:





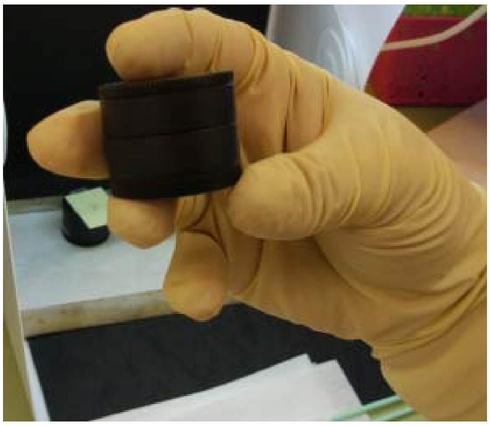
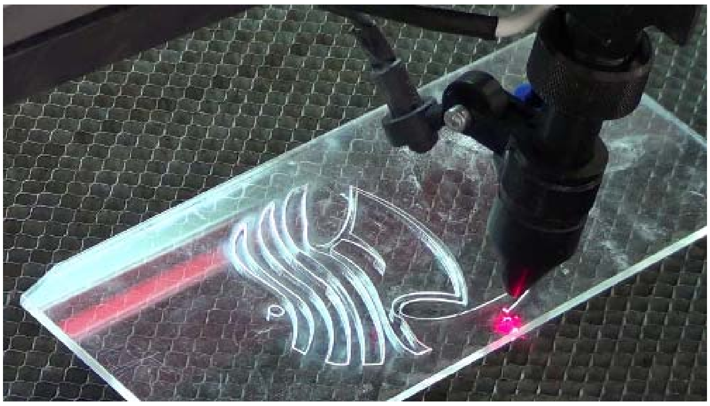
Technical specifications:

Wavelengths	1030nm, 1064nm, others by request
Required laser input	Single mode M^2<1.3
Input Beam Diameter (exp^{-2})	6mm (±10%)
Depth of Focus in Air	~1mm
Waist Diameter (exp^{-2})	1.8µm
Working Distance	7.4mm
Dimensions	30.5mm diameter x106 mm length
Mounting Threads	SM1, SM05 external
Optical elements Material	Fused Silica
Efficiency	>93%

* Depth of focus can be customized according to customer need.

Multifocal Lens for Glass Cutting

Diffractive Multifocal (MF) lenses are widely used for glass cutting applications. **In this process, multiple foci are formed along the cutting path, thus increasing the speed and accuracy of the process.** To achieve optimal performances, small separation distances between neighbour foci and high-power densities are required. This is usually achieved with a high NA objective lens. However, the majority of off-the-shelf high-power objectives does not meet the application requirements and result in degraded performance. To address this issue, we have developed a tailored focusing module for glass cutting applications, by using a Multifocal lens. Our Multifocal module maintains diffraction limited spots size at all foci.

Main features:
- Complete solution – no need to purchase the components from separate vendors
- Enhanced performance – very low aberrations level, Diffraction limited spot size
- Accepts large input beam diameter (15mm or more), enabling smaller spots
- Tailored per customer's parameters
- Achieves more accurate results and increases process throughput

Technical specifications:

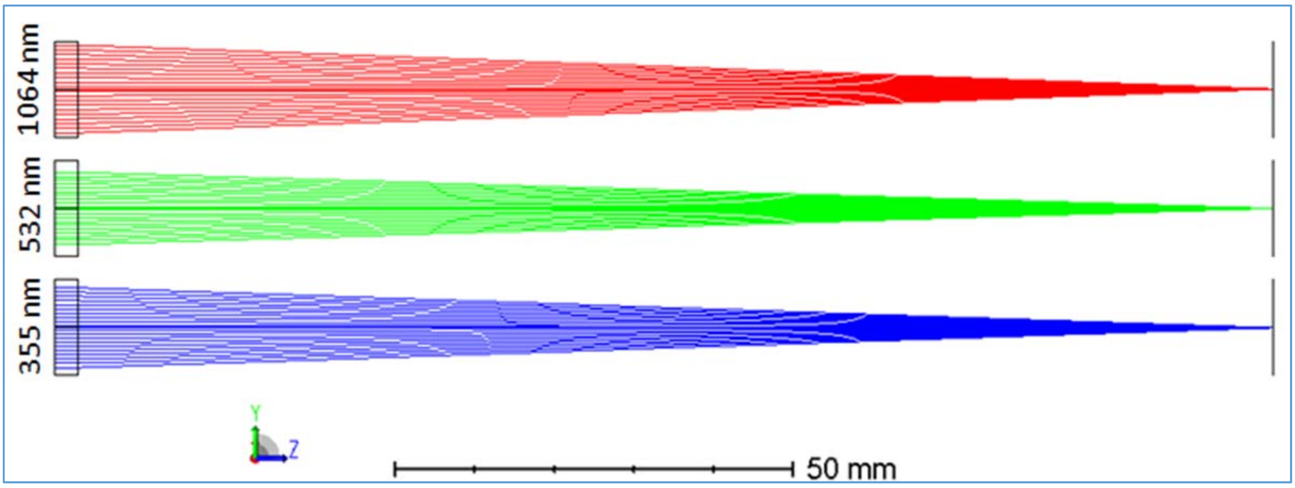
Focal Length	20mm
Clear Aperture	20mm
NA	0.45
Focusing performance	Diffraction limited
Operating Wavelength Range	700-1100nm
Focal function	Any multi / elongated focus
Dimensions	30mm dia. x 25mm length

Diffractive achromatic lens

We offer diffractive Achromat lenses that have the same focal length for 3 harmonies of Nd:YAG lasers (355nmm 532nm and 1064nm).

These Triple Wavelength (TW) lenses are ideally suitable for high power applications, where standard Achromats made by using lenses with different refractive indices often suffer from limited laser damage threshold. Due to the high accuracy of the manufacturing methods of diffractive optical elements, our lenses are aberration-free at all 3 design wavelengths, enabling tighter focusing and higher power density at focus compared to standard Achromat lenses.

All TW elements are planar, light and thin windows that are easy to integrate into limited spaces in high power systems. These diffractive lenses are also called Multi-Order Diffractive Lenses ("MOD lenses").



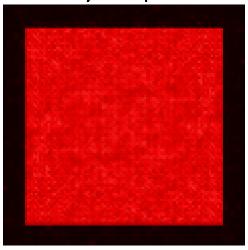
We currently offer the Triple Wavelength TW-001-UQI-Y-A, with a focal length of 150mm and diffraction limited spot size performance for 355, 532 and 1064nm wavelengths. Other element sizes and EFL values are available on demand.

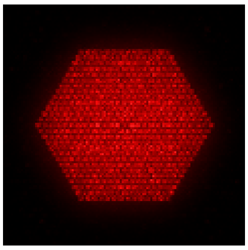
PN	Focal Length [mm]	Thickness [mm]	Diameter [mm]	Clear Aperture [mm]	Material	Wavelengths [nm]
TW-001-UQI-Y-A	150	3	15	12	Fused Silica	355,532 and 1064

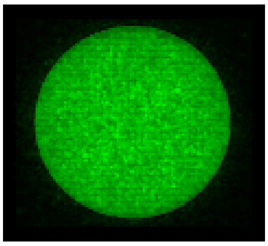
Homogenizer / Diffuser

Homogenizer product line flexibly converts any collimated input laser beam into a well-defined beam with homogenized intensity and desired shape.

Using our Beam Homogenizer product, you can convert any collimated input beam profile into a well-defined beam with homogenized intensity. Any desired shape, for any wavelength can be achieved.A Beam Homogenizer is very useful in many applications requiring a well-defined beam shape with a randomly-diffused intensity profile. The output of the Beam Homogenizers will depend on the input beam profile: A multi-mode laser beam actually has an advantage when used with beam homogenizer, as their degraded coherence will reduce the visibility of speckles and therefore create a more uniform intensity profile than with single mode laser input.


Square Homogenizer


Hexagonal Homogenizer


Round Homogenizer

PN	λ[nm]	θf [deg]	Image size*** [mm] for EFL=100mm	Element Size [mm]	Image Shape	Remarks
HM-260-I-Y-A	1064	2	3.49	25.4	Line	
DF-200-I-Y-A	1064	0.50x0.50	0.87x0.87	11	Square	replaced by HM-283
HH-209-I-Y-A	1064	20.00x20.00	35.27x35.27	10x10	Square	High Homogeneity
HH-214-I-Y-A	1064	2.00x2.00	3.49x3.49	11	Square	High Homogeneity
HM-200-I-Y-A	1064	0.50x0.50	0.87x0.87	11	Square	replaced by HM-283

HM-201-I-Y-A	1064	0.50x0.50	0.87x0.87	25.4	Square	replaced by HM-212
HM-203-I-Y-A	1064	2.00x2.00	3.49x3.49	25.4	Square	replaced by HM-271
HM-208-I-Y-A	1064	2.75x2.75	4.80x4.80	25.4	Square	
HM-210-I-Y-A	1064	2.00x2.00	3.49x3.49	11	Square	replaced by HM-284
HM-211-I-Y-A	1064	2.00x2.00	3.49x3.49	25.4	Square	replaced by HM-271
HM-212-I-Y-A	1064	0.50x0.50	0.87x0.87	25.4	Square	
HM-213-I-Y-A	1064	1.00x1.00	1.75x1.75	22	Square	High Efficiency
HD-200-I-Y-A	1064	2.15	3.75	18	Hexagonal	
HM-271-I-Y-A	1064	2.00x2.00	3.49x3.49	25.4	Square	
HM-273-I-Y-A	1064	10.00x10.00	17.50x17.50	10x10	Square	
HM-274-I-Y-A	1064	20.00x20.00	35.27x35.27	10x10	Square	
HM-283-I-Y-A	1064	0.50x0.50	0.87x0.87	11	Square	
RH-215-I-Y-A	1064	4	6.98	25.4	Round	High Homogeneity
RD-204-I-Y-A	1064	2	3.49	25.4	Round	
RD-206-I-Y-A	1064	2	3.49	11	Round	
RD-211-I-Y-A	1064	0.5	0.87	11	Round	replaced by RD-228
RD-215-I-Y-A	1064	4	6.98	25.4	Round	
RD-216-I-Y-A	1064	1.6	2.79	25.4	Round	
RD-228-I-Y-A	1064	0.5	0.87	11	Round	
HM-263-I-Y-A	1064	0.5	0.87	11	Line	
HM-264-I-Y-A	1064	0.60x0.60	1.05x1.05	25.4	Square	
HM-267-I-Y-A	1064	8	13.99	48	Line	
ED-204-I-Y-A	1064	1.71x0.84	2.98x1.47	25.4	Elliptical	
HM-272-I-Y-A	1064	0.55x0.55	0.96x0.96	25.4	Square	
ED-205-I-Y-A	1064	2.76x1.87	4.82x3.26	25.4	Elliptical	
ED-206-I-Y-A	1064	3.80x2.92	6.63x5.10	25.4	Elliptical	
HM-276-I-Y-A	1064	1.00x1.00	1.75x1.75	25.4	Square	
HM-281-I-Y-A	1064	2	3.49	11	Line	
RH-220-I-Y-A	1064	4	6.98	20	Round	High Homogeneity
HM-284-I-Y-A	1064	2.00x2.00	3.49x3.49	11	Square	
HM-285-I-Y-A	1064	0.36x0.66	0.63x1.15	25.4	Rectangular	
RH-218-I-Y-A	1064	2	3.49	18	Round	High Homogeneity
HM-288-I-Y-A	1064	0.54x0.54	0.94x0.94	38.1	Square	
HM-289-I-Y-A	1064	1	1.75	11	Line	
HM-290-I-Y-A	1064	4.00x4.00	6.98x6.98	11	Square	
HM-291-I-Y-A	1064	4	6.98	11	Line	
HM-303-I-Y-A	1064	3.60x14.40	6.29x25.27	15	Rectangular	
RH-217-I-Y-A	1064	2	3.49	25.4	Round	High Homogeneity
RH-224-I-Y-A	1064	4	6.98	15	Round	High Homogeneity
RH-206-I-Y-A	1064	2	3.49	11	Round	High Homogeneity
RD-254-I-Y-A	1064	1	1.75	20	Round	M-Shape
RD-253-I-Y-A	1064	5.27	9.2	15	Round	
ED-201-I-Y-A	1064	1.23x0.79	2.15x1.38	15	Elliptical	
RD-252-I-Y-A	1064	3.44	6.01	15	Round	
RD-251-I-Y-A	1064	6.87	12	15	Round	
RD-247-I-Y-A	1064	0.5	0.87	25.4	Round	M-Shape
HM-320-I-Y-A	1064	5.78x1.44	10.10x2.51	15	Rectangular	

RD-246-I-Y-A	1064	3	5.24	15	Round	
HM-322-I-Y-A	1064	2.06x7.55	3.60x13.20	18	Rectangular	
HM-323-I-Y-A	1064	0.3	0.52	25.4	Square	
HM-327-I-Y-A	1064	3	5.24	11	Line	
HM-328-I-Y-A	1064	5.00x5.00	8.73x8.73	11	Square	
RD-237-I-Y-A	1064	4	6.98	11	Round	
RD-231-I-Y-A	1064	1	1.75	20	Round	
RD-203-I-Y-A	1064	0.5	0.87	25.4	Round	
HH-208-I-Y-A	1064	2.75x2.75	4.80x4.80	25.4	Square	High Homogeneity
ED-202-I-Y-A	1064	1.23x0.79	2.15x1.38	11	Elliptical	
RD-208-I-Y-A	1064	16	28.11	11	Round	
HH-211-I-Y-A	1064	2.00x2.00	3.49x3.49	25.4	Square	High Homogeneity
RD-213-I-Y-A	1064	0.5	0.87	11	Round	
HM-217-I-Y-A	1064	2.06x7.55	3.60x13.20	18	Rectangular	
ED-203-I-Y-A	1064	1.23x0.79	2.15x1.38	25.4	Elliptical	
RD-220-I-Y-A	1064	0.33	0.58	11	Round	
RD-221-I-Y-A	1064	0.16	0.28	11	Round	
RD-222-I-Y-A	1064	0.16	0.28	15	Round	
RD-232-I-Y-A	1064	2	3.49	11	Round	M-Shape
RD-227-I-Y-A	1064	1	1.75	25.4	Round	
HM-262-I-Y-A	1064	0.5	0.87	25.4	Line	
HM-315-I-Y-A	1064	25	44.34	10x10	Line	
RD-226-I-Y-A	1064	27.4	48.75	15x15	Round	
RH-221-I-Y-A	1064	27.4	48.75	15x15	Round	High Homogeneity
HM-286-I-Y-A	1064	22.9	40.51	7.25x7.25	Line	
HM-307-I-Y-A	1064	0.50x0.50	0.87x0.87	25.4	Square	High Efficiency
HM-312-I-Y-A	1064	10	17.5	10x10	Line	
HM-321-I-Y-A	1064	5	8.73	15x15	Line	
HM-319-I-Y-A	1064	45	82.84	10x10	Line	
HM-318-I-Y-A	1064	40	72.79	10x10	Line	
HM-317-I-Y-A	1064	35	63.06	10x10	Line	
RD-202-I-Y-A	1064	0.75	1.31	25.4	Round	High Efficiency
HM-314-I-Y-A	1064	20	35.27	10x10	Line	
HM-313-I-Y-A	1064	15	26.33	10x10	Line	
HM-316-I-Y-A	1064	30	53.59	10x10	Line	
RD-256-I-Y-A	1064	0.5	0.87	14.1x14.1	Round	
RD-255-I-Y-A	1064	1	1.75	14.1x14.1	Round	
RD-245-I-Y-A	1064	0.19	0.33	12.7x12.7	Round	High Efficiency
RD-239-I-Y-A	1064	13.86	24.31	15x15	Round	
RD-238-I-Y-A	1064	11.9	20.84	15x15	Round	
ED-207-I-Y-A	1064	1.71x0.84	2.98x1.47	25.4x25.4	Elliptical	
ML-001-I-Y-A	1064	81.59x81.59	172.60x172.60	20x20	MultiLines	15 Lines

Sintec Optronics

Beam Splitter MultiSpot

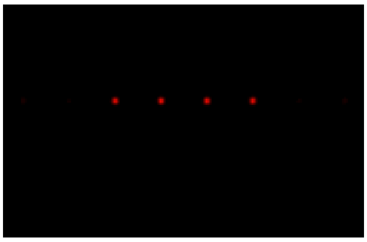
A Beam splitter element converts input laser beam into a 1 or 2-dimensional array of beamlets according to custom parameters.

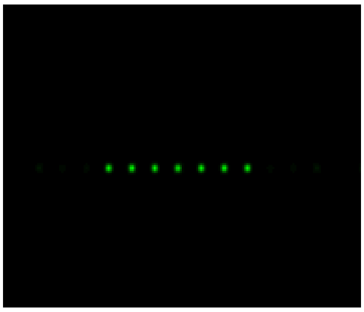
The Diffractive Beam Splitter is a diffractive optical element used to split a single laser beam into several beams, each with the characteristics of the original beam (except for its power and angle of propagation).

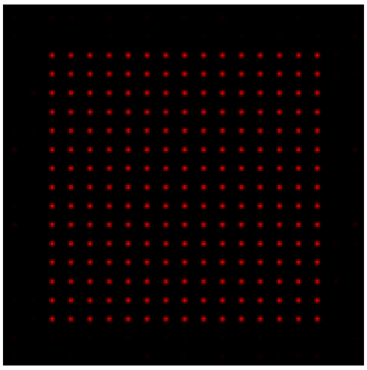
A diffractive beam splitter can generate either a 1-dimensional beam array (1xN) or a 2-dimensional beam matrix (MxN), depending on the diffractive pattern on the element. The diffractive beam splitter is used with monochromatic light such as a laser beam, and is designed for a specific wavelength and angle of separation between its output beams.
In this section, we present our standard list of 1D, 2D, and custom diffractive beam splitters.

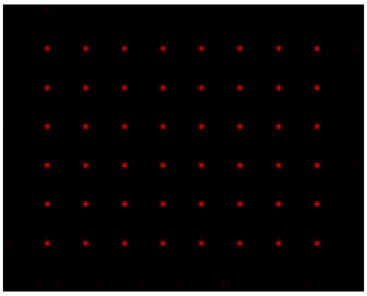
We offer, in addition to standard diffractive beam splitters, the possibility to choose the number of spots and their locations, as a part of its custom design and manufacturing capability.

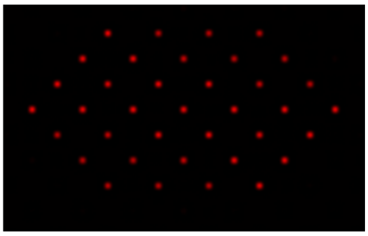
We also offer Binary Phase Gratings, which is a special case of 1D Damman grating with a duty cycle of 50% within a period. The gratings are transmission grating. In addition to standard gratings, We offer gratings with custom specifications (duty cycle, modulation depth, period, reflection or transmission grating).

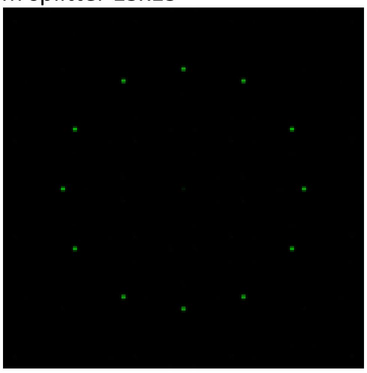

Beam Splitter 1x4


Beam Splitter 1x7


Beam splitter 15x15


Beam splitter 6x8


Hexagonal Beam Splitter


Round beam splitter

1D diffractive beam splitters

PN	Number Spots	λ[nm]	θs [deg]	Element Size [mm]	Remarks
MS-268-I-Y-A	19	1064	0.15	25.4	
TS-008-I-Y-S	3	1064	1.27	25.4	inclined DOE
DS-212-I-Y-A	2	1064	0.25	38.1	
DS-216-I-Y-A	2	1064	1.52	11	
DS-217-I-Y-A	2	1064	0.27	25.4	
DS-224-I-Y-A	2	1064	0.12	20	

DS-238-I-Y-A	2	1064	1.42	25.4	
MS-107-I-Y-X	7	1064	0.29	25.4	
MS-214-I-Y-A	6	1064	0.57	25.4	
MS-233-I-Y-X	7	1064	0.7	25.4	
MS-245-I-Y-A	10	1064	0.57	25.4	
MS-255-I-Y-X	101	1064	0.057	25.4	
MS-257-I-Y-A	51	1064	0.057	25.4	
DS-006-I-Y-A	2	1064	2.54	25.4	
MS-269-I-Y-X	25	1064	0.11	25.4	
MS-272-I-Y-N	7	1064	0.19	15	
MS-385-I-Y-A	6	1064	0.76	25.4	
MS-398-I-Y-X	5	1064	0.3	25.4	
MS-399-I-Y-A	4	1064	0.14	25.4	
MS-400-I-Y-A	8	1064	0.14	25.4	
MS-401-I-Y-A	16	1064	0.14	25.4	
MS-455-I-Y-A	19	1064	0.38	20	
MS-475-I-Y-A	6	1064	0.4	25.4	
TS-225-I-Y-A	3	1064	0.072	25.4	
TS-008-I-Y-D	3	1064	1.27	25.4	
MS-333-I-Y-A	10	1064	0.76	11	
DS-198-I-Y-A	2	1064	7.63	25.4	
DS-199-I-Y-A	2	1064	8.72	11	
DS-207-I-Y-A	2	1064	0.15	15	
DS-208-I-Y-A	2	1064	0.27	11	
DS-209-I-Y-A	2	1064	0.15	11	
DS-210-I-Y-A	2	1064	0.29	11	
DS-001-I-Y-A	2	1064	0.14	27.94	
DS-213-I-Y-A	2	1064	0.038	38.1	
DS-215-I-Y-A	2	1064	3.39	11	
DS-025-I-Y-A	2	1064	0.15	27.94	
DS-026-I-Y-A	2	1064	0.099	27.94	
DS-218-I-Y-A	2	1064	14.38	11	
DS-222-I-Y-A	2	1064	2.18	11	
DS-223-I-Y-A	2	1064	1.35	27.94	
DS-029-I-Y-A	2	1064	0.099	15	
TS-269-I-Y-A	3	1064	0.11	25.4	
TS-268-I-Y-A	3	1064	0.23	27.94	
TS-261-I-Y-A	3	1064	1	25.4	
TS-259-I-Y-A	3	1064	0.71	25.4	
TS-258-I-Y-A	3	1064	9.21	15	
TS-256-I-Y-A	3	1064	0.016	27.94	
DS-233-I-Y-A	2	1064	0.68	11	
DS-234-I-Y-A	2	1064	5.42	11	
DS-235-I-Y-A	2	1064	1.79	27.94	
DS-237-I-Y-A	2	1064	18.41	15	
DS-033-I-Y-A	2	1064	10.17	25.4	
DS-239-I-Y-A	2	1064	2	25.4	

DS-241-I-Y-A	2	1064	0.41	25.4	
DS-242-I-Y-A	2	1064	0.11	25.4	
DS-243-I-Y-A	2	1064	0.084	25.4	
TS-255-I-Y-A	3	1064	0.016	25.4	
TS-254-I-Y-A	3	1064	0.019	38.1	
TS-253-I-Y-A	3	1064	0.038	27.94	
TS-252-I-Y-A	3	1064	0.047	20	
TS-251-I-Y-A	3	1064	0.059	20	
DS-255-I-Y-A	2	1064	0.064	38.1	
DS-256-I-Y-A	2	1064	0.45	27.94	
DS-257-I-Y-A	2	1064	0.23	25.4	
DS-258-I-Y-A	2	1064	0.046	25.4	
DS-261-I-Y-A	2	1064	0.14	27.94	improved side lobs
TS-250-I-Y-A	3	1064	0.072	20	
TS-249-I-Y-A	3	1064	0.073	11	
DS-034-I-Y-A	2	1064	0.038	38.1	
DS-180-I-Y-A	2	1064	0.032	27.94	
MS-226-I-Y-X	5	1064	0.5	25.4	
DS-181-I-Y-A	2	1064	0.032	25.4	
MS-243-I-Y-A	8	1064	1.48	25.4	
MS-244-I-Y-A	10	1064	0.76	25.4	
DS-182-I-Y-A	2	1064	0.076	27.94	
DS-183-I-Y-A	2	1064	0.076	25.4	
MS-257-I-Y-X	51	1064	0.057	25.4	
DS-184-I-Y-A	2	1064	0.094	25.4	
MS-263-I-Y-A	4	1064	1.5	11	
MS-268-I-Y-X	19	1064	0.15	25.4	
DS-185-I-Y-A	2	1064	0.14	20	
DS-186-I-Y-A	2	1064	0.14	25.4	
MS-271-I-Y-X	7	1064	0.7	11	
MS-272-I-Y-X	7	1064	0.19	15	
DS-187-I-Y-A	2	1064	0.18	27.94	
MS-278-I-Y-X	7	1064	0.95	11	
MS-279-I-Y-X	7	1064	0.88	11	
MS-291-I-Y-X	9	1064	0.11	27.94	
MS-298-I-Y-X	7	1064	0.19	15	Without SideLobs
MS-304-I-Y-A	8	1064	0.045	27.94	Minimum Beam size 8mm
TS-248-I-Y-A	3	1064	0.13	38.1	
MS-316-I-Y-X	11	1064	1.2	11	
MS-320-I-Y-A	8	1064	0.045	25.4	Minimum Beam size 8mm
MS-322-I-Y-A	4	1064	3.4	20x20	
TS-247-I-Y-A	3	1064	0.15	11	
TS-246-I-Y-A	3	1064	0.67	27.94	
TS-245-I-Y-A	3	1064	0.67	25.4	
MS-331-I-Y-A**	10	1064	0.76	19	
MS-332-I-Y-A	4	1064	1	11	
DS-002-I-Y-A	2	1064	0.27	27.94	

MS-338-I-Y-A	6	1064	0.57	11	
TS-244-I-Y-A	3	1064	0.76	11	
MS-357-I-Y-A	6	1064	0.21	25.4	
TS-243-I-Y-A	3	1064	1.09	11	
DS-188-I-Y-A	2	1064	0.18	25.4	
TS-238-I-Y-A	3	1064	1.69	11	
DS-189-I-Y-A	2	1064	0.5	15	
DS-190-I-Y-A	2	1064	0.92	27.94	
DS-191-I-Y-A	2	1064	0.92	25.4	
DS-192-I-Y-A	2	1064	0.96	27.94	
TS-235-I-Y-A	3	1064	2.07	25.4	
MS-438-I-Y-X	9	1064	0.11	11	
MS-439-I-Y-X	19	1064	0.15	11	
MS-454-I-Y-X	15	1064	0.44	20	
MS-455-I-Y-X	19	1064	0.38	20	
DS-193-I-Y-A	2	1064	0.96	25.4	
MS-456-I-Y-X	35	1064	0.17	20	
MS-457-I-Y-X	51	1064	0.17	20	
MS-453-I-Y-X	9	1064	1.05	25.4	
MS-463-I-Y-X	7	1064	0.29	15	
TS-233-I-Y-A	3	1064	7.19	11	
MS-474-I-Y-A	6	1064	1.2	25.4	
DS-194-I-Y-A	2	1064	1.05	27.94	
MS-499-I-Y-X	5	1064	1	25.4	
MS-501-I-Y-A	6	1064	2.59	25.4	
TS-232-I-Y-A	3	1064	0.34	11	
TS-230-I-Y-A	3	1064	0.25	15	
MS-506-I-Y-A	4	1064	0.5	25.4	
MS-512-I-Y-X	33	1064	0.036	25.4	
MS-513-I-Y-X	321	1064	0.036	25.4	
MS-519-I-Y-X	7	1064	0.14	11	
DS-195-I-Y-A	2	1064	1.05	25.4	
MS-545-I-Y-A	6	1064	0.054	25.4	
TS-224-I-Y-A	3	1064	0.46	20	
TS-216-I-Y-A	3	1064	0.46	25.4	
TS-213-I-Y-A	3	1064	2.54	11	
TS-212-I-Y-A	3	1064	4.36	11	
TS-211-I-Y-A	3	1064	3.81	25.4	
MS-557-I-Y-X	7	1064	0.047	27.94	
MS-560-I-Y-A	4	1064	0.1	38.1	
TS-205-I-Y-A	3	1064	0.091	27.94	
MS-575-I-Y-A	32	1064	0.26	25.4	
MS-579-I-Y-A	6	1064	0.064	38.1	
TS-204-I-Y-A	3	1064	2.44	25.4	
MS-589-I-Y-X	11	1064	0.57	11	
MS-590-I-Y-X	11	1064	0.23	11	
MS-592-I-Y-X	11	1064	0.11	11	

TS-003-I-Y-A	3	1064	0.068	27.94	
TS-004-I-Y-A	3	1064	0.14	27.94	
TS-008-I-Y-A	3	1064	1.27	25.4	
DS-196-I-Y-A	2	1064	4.13	25.4	
DS-197-I-Y-A	2	1064	5.08	11	
TS-027-I-Y-A	3	1064	0.076	27.94	
TS-028-I-Y-A	3	1064	0.05	27.94	
TS-031-I-Y-A	3	1064	5.09	25.4	
TS-200-I-Y-A	3	1064	0.53	27.94	
TS-201-I-Y-A	3	1064	0.48	27.94	
TS-203-I-Y-A	3	1064	0.14	25.4	
TS-270-I-Y-A	3	1064	0.023	25.4	
MS-364-I-Y-A	4	1064	0.053	38.1	High Efficiency
DS-225-I-Y-A	2	1064	3.67	15x15	
DS-226-I-Y-A	2	1064	3.39	15x15	
DS-227-I-Y-A	2	1064	3.13	15x15	
DS-228-I-Y-A	2	1064	2.9	15x15	
DS-229-I-Y-A	2	1064	2.71	15x15	
DS-230-I-Y-A	2	1064	2.44	15x15	
MS-542-I-Y-X	131	1064	0.062	10x10	
MS-505-I-Y-X	85	1064	0.25	20x20	
MS-502-I-Y-A	6	1064	2.59	20x20	
MS-021-I-Y-X	15	1064	0.044	25.4	High Efficiency
MS-408-I-Y-A	12	1064	2.44	15x15	
TS-236-I-Y-A	3	1064	1.83	15x15	
TS-237-I-Y-A	3	1064	1.69	15x15	
MS-396-I-Y-X	9	1064	0.03	25.4	High Efficiency
TS-239-I-Y-A	3	1064	1.56	15x15	
TS-240-I-Y-A	3	1064	1.45	15x15	
TS-241-I-Y-A	3	1064	1.35	15x15	
TS-242-I-Y-A	3	1064	1.22	15x15	
MS-022-I-Y-X	15	1064	0.028	25.4	High Efficiency
MS-355-I-Y-A	4	1064	1.33	20x20	
MS-307-I-Y-A	4	1064	5.11	20x20	
MS-323-I-Y-X	5	1064	0.046	25.4	High Efficiency
MS-327-I-Y-X	11	1064	1.52	9.8x9.8	
MS-327-I-Y-S	11	1064	1.52	9.8x9.8	
MS-572-I-Y-X	5	1064	0.42	17x17	
MS-473-I-Y-A	6	1064	2.43	12.7x12.7	
DS-252-I-Y-A	2	1064	2.54	14x14	
DS-251-I-Y-A	2	1064	2.71	14x14	
DS-250-I-Y-A	2	1064	3.05	14x14	
DS-249-I-Y-A	2	1064	3.21	14x14	
MS-580-I-Y-X	15	1064	0.54	17x17	
MS-548-I-Y-X	7	1064	0.14	14x20	
TS-220-I-Y-A	3	1064	7.64	9.8x9.8	
MS-549-I-Y-A	8	1064	0.5	14x20	

MS-551-I-Y-A	10	1064	0.3	14x14	
MS-555-I-Y-X	5	1064	0.54	17x17	
MS-556-I-Y-X	11	1064	0.54	17x17	
DS-248-I-Y-A	2	1064	3.59	14x14	

2D diffractive beam splitters

PN	Number Spots	λ[nm]	θs [deg]	Element Size [mm]	Remarks
MS-288-I-Y-A	3x7	1064	1.27x0.42	25.4	
MS-377-I-Y-L	9x9	1064	0.50x0.50	20	
MS-027-I-Y-L	9x9	1064	0.50x0.50	25.4	
MS-027-I-Y-N	9x9	1064	0.50x0.50	25.4	
MS-030-I-Y-A	2x2	1064	1.00x1.00	25.4	High Efficiency
MS-049-I-Y-A	7x7	1064	0.70x0.70	25.4	
MS-201-I-Y-A	7x7	1064	0.70x0.70	11	
MS-202-I-Y-A	4x4	1064	1.39x1.39	25.4	
MS-203-I-Y-A	2x2	1064	4.00x4.00	25.4	
MS-204-I-Y-A	2x2	1064	0.25x0.25	25.4	
MS-211-I-Y-A	7x7	1064	0.19x0.19	25.4	
MS-215-I-Y-A	5x5	1064	1.00x1.00	11	
MS-216-I-Y-A	4x4	1064	1.39x1.39	11	
MS-231-I-Y-A	7	1064	0.23x0.13	25.4	hexagonal
MS-237-I-Y-A	7x7	1064	2.11x2.11	11	
MS-254-I-Y-A	9x9	1064	0.21x0.21	25.4	
MS-261-I-Y-A	3x3	1064	0.57x0.57	11	
MS-267-I-Y-A	4x4	1064	0.94x0.94	25.4	
MS-285-I-Y-A	3x3	1064	1.27x1.27	25.4	
MS-286-I-Y-A	3x4	1064	1.27x0.85	25.4	
MS-287-I-Y-A	3x5	1064	1.27x0.64	25.4	
MS-027-I-Y-A	9x9	1064	0.50x0.50	25.4	
MS-289-I-Y-A	5x5	1064	2.20x2.20	11	
MS-290-I-Y-A	5x5	1064	2.61x2.61	11	
MS-299-I-Y-A	7x7	1064	2.11x2.11	25.4	
MS-305-I-Y-X	5x5	1064	0.64x0.64	25.4	
MS-306-I-Y-A	5x6	1064	0.64x0.51	25.4	
MS-341-I-Y-A	4x4	1064	0.85x0.85	50	
MS-342-I-Y-A	7x7	1064	1.40x1.40	11	
MS-377-I-Y-A	9x9	1064	0.50x0.50	20	
MS-377-I-Y-A	9x9	1064	0.50x0.50	20	
MS-025-I-Y-A	5x5	1064	1.00x1.00	25.4	
MS-377-I-Y-N	9x9	1064	0.50x0.50	20	
MS-476-I-Y-A	7x7	1064	2.11x2.11	15	
MS-429-I-Y-A	5x5	1064	1.00x1.00	18	
MS-429-I-Y-L	5x5	1064	1.00x1.00	18	
MS-429-I-Y-N	5x5	1064	1.00x1.00	18	
MS-430-I-Y-A	9x9	1064	0.50x0.50	18	
MS-430-I-Y-L	9x9	1064	0.50x0.50	18	

MS-430-I-Y-N	9x9	1064	0.50x0.50	18	
MS-516-I-Y-S	10x10	1064	0.93x0.93	14.1x14.1	
MS-500-I-Y-S	10x10	1064	0.93x0.93	20	
MS-254-I-Y-X	9x9	1064	0.21x0.21	25.4	
MS-201-I-Y-X	7x7	1064	0.70x0.70	11	
MS-254-I-Y-N	9x9	1064	0.21x0.21	25.4	
MS-259-I-Y-X	9x9	1064	0.12x0.12	15	
MS-260-I-Y-A	4x4	1064	0.57x0.57	11	
MS-261-I-Y-X	3x3	1064	0.57x0.57	11	
MS-211-I-Y-X	7x7	1064	0.19x0.19	25.4	
MS-027-I-Y-X	9x9	1064	0.50x0.50	25.4	
MS-273-I-Y-X	7x7	1064	0.70x0.70	25.4	
MS-274-I-Y-X	9x9	1064	0.50x0.50	25.4	
MS-277-I-Y-X	19x19	1064	0.12x0.12	25.4	
MS-280-I-Y-X**	3x3	1064	0.36x0.36	19	
MS-281-I-Y-X**	9x9	1064	0.50x0.50	19	
MS-284-I-Y-X	3x3	1064	0.36x0.36	11	
MS-285-I-Y-X	3x3	1064	1.27x1.27	25.4	
MS-212-I-Y-X	15x15	1064	0.50x0.50	25.4	
MS-286-I-Y-X	3x4	1064	1.27x0.85	25.4	
MS-215-I-Y-X	5x5	1064	1.00x1.00	11	
MS-287-I-Y-X	3x5	1064	1.27x0.64	25.4	
MS-201-I-Y-L	7x7	1064	0.70x0.70	11	
MS-288-I-Y-X	3x7	1064	1.27x0.42	25.4	
MS-201-I-Y-N	7x7	1064	0.70x0.70	11	
MS-289-I-Y-X	5x5	1064	2.20x2.20	11	
MS-217-I-Y-X	5x5	1064	1.94x1.94	11	
MS-290-I-Y-X	5x5	1064	2.61x2.61	11	
MS-218-I-Y-X	9x9	1064	0.50x0.50	11	
MS-292-I-Y-X	9x9	1064	0.061x0.061***	27.94	Frame
MS-299-I-Y-X	7x7	1064	2.11x2.11	25.4	
MS-220-I-Y-X	5x5	1064	1.39x1.39	11	
MS-300-I-Y-A	8x8	1064	0.57x0.57	11	
MS-303-I-Y-X	5x5	1064	2.20x2.20	10	with cut-off
MS-221-I-Y-X	7x7	1064	0.19x0.19	15	
MS-306-I-Y-X	5x6	1064	0.64x0.51	25.4	
MS-225-I-Y-X	9x9	1064	0.12x0.12	15	
MS-319-I-Y-A	2x2	1064	13.58x13.58	25.4	
MS-321-I-Y-X	5x5	1064	3.23x3.23	11	
MS-583-I-Y-X	15x15	1064	0.50x0.50	25.4	
MS-581-I-Y-X	3x3	1064	0.57x0.57	15	
MS-576-I-Y-A	2x2	1064	0.50x0.50	25.4	
MS-573-I-Y-X	29x29	1064	0.0075x0.0075	34	MS round
MS-337-I-Y-X	77	1064	5.73x5.73***	11	MS X-Men
MS-339-I-Y-X	3	1064	0.35x0.47	25.4	Triangle MS (not equal power)
MS-340-I-Y-X	21x21	1064	0.080x0.080	11	

MS-229-I-Y-X	5x5	1064	0.30x0.30	15	
MS-342-I-Y-X	7x7	1064	1.40x1.40	11	
MS-231-I-Y-X	7	1064	0.23x0.13	25.4	hexagonal
MS-353-I-Y-A	16x16	1064	0.33x0.33	12.5	
MS-354-I-Y-A	2x2	1064	0.50x0.50	11	
MS-356-I-Y-X	12	1064	9.15x9.15***	25.4	MS Circle
MS-358-I-Y-X	9x9	1064	1.09x1.09	11	
MS-359-I-Y-X	11x11	1064	0.10x0.10	11	
MS-360-I-Y-X	99x99	1064	0.10x0.10	11	Not standard MS
MS-571-I-Y-X	7x7	1064	0.074x0.074	25.4	
MS-567-I-Y-A	2x2	1064	0.29x0.29	11	
MS-367-I-Y-X	21x21	1064	0.090x0.090	11	
MS-566-I-Y-A	2x2	1064	0.68x0.68	11	
MS-376-I-Y-X	9x9	1064	0.21x0.21	20	
MS-377-I-Y-X	9x9	1064	0.50x0.50	20	
MS-049-I-Y-X	7x7	1064	0.70x0.70	25.4	
MS-232-I-Y-X	9x9	1064	0.15x0.15	15	
MS-235-I-Y-X	5x5	1064	2.68x2.68	11	
MS-587-I-Y-X	7	1064	0.23x0.13	20	hexagonal
MS-382-I-Y-A	2x2	1064	7.63x7.63	25.4	
MS-383-I-Y-X	76	1064	0.50x0.50	25.4	Hexagonal Lattice
MS-384-I-Y-A	8x8	1064	0.57x0.57	25.4	
MS-386-I-Y-X	5	1064	13.58x13.58	25.4	MS Dice
MS-387-I-Y-X	9x9	1064	0.50x0.50	15	
MS-388-I-Y-X	76	1064	0.50x0.50	11	Hexagonal Lattice
MS-393-I-Y-X	9x9	1064	0.70x0.70	11	
MS-394-I-Y-X	9x9	1064	0.19x0.19	11	
MS-395-I-Y-X	37	1064	0.19x0.33	15	hexagonal (head 120deg)
MS-397-I-Y-A	16x16	1064	0.33x0.33	25.4	
MS-402-I-Y-X	11x11	1064	0.32x0.32	11	
MS-403-I-Y-X	11x11	1064	0.32x0.32	11	
MS-565-I-Y-A	2x2	1064	1.52x1.52	11	
MS-562-I-Y-A	2x2	1064	0.41x0.41	25.4	
MS-409-I-Y-A	10x10	1064	0.93x0.93	18	
MS-410-I-Y-A**	18x18	1064	0.49x0.49	19	
MS-561-I-Y-A	2x2	1064	2.00x2.00	25.4	
MS-550-I-Y-X	3x5	1064	2.67x2.01	25.4	
MS-546-I-Y-A	2x2	1064	7.96x7.96	25.4	
MS-414-I-Y-X	15x15	1064	0.50x0.50	11	
MS-415-I-Y-A	6x6	1064	0.40x0.40	11	
MS-416-I-Y-X	3	1064	0.90x1.04	11	Triangle MS (h x b angle)
MS-544-I-Y-X	7x7	1064	0.70x0.70	15	
MS-237-I-Y-X	7x7	1064	2.11x2.11	11	
MS-476-I-Y-X	7x7	1064	2.11x2.11	15	
MS-426-I-Y-A	6x6	1064	1.15x1.15	11	
MS-427-I-Y-A	6x6	1064	0.80x0.80	11	

MS-429-I-Y-X	5x5	1064	1.00x1.00	18	
MS-025-I-Y-X	5x5	1064	1.00x1.00	25.4	
MS-586-I-Y-A	4x4	1064	2.90x2.90	11	
MS-239-I-Y-X	9x9	1064	0.21x0.21	11	
MS-430-I-Y-X	9x9	1064	0.50x0.50	18	
MS-240-I-Y-A	2x2	1064	13.58x13.58	11	
MS-241-I-Y-A	8x8	1064	1.09x1.09	25.4	
MS-585-I-Y-X	3x3	1064	0.30x0.30	25.4	
MS-434-I-Y-X	5	1064	1.00x1.00	25.4	MS Dice
MS-437-I-Y-X	5x4	1064	0.98x1.01	25.4	
MS-440-I-Y-X	19x19	1064	0.12x0.12	11	
MS-441-I-Y-X	13x13	1064	0.33x0.33	11	
MS-443-I-Y-X	3x3	1064	0.060x0.060	25.4	
MS-443-I-Y-N	3x3	1064	0.060x0.060	25.4	
MS-444-I-Y-X	2x3	1064	0.90x0.52	11	
MS-445-I-Y-A	2x2	1064	1.42x1.42	25.4	
MS-446-I-Y-A	8x8	1064	1.09x1.09	20	
MS-452-I-Y-X	3x11	1064	0.033x0.11	25.4	
MS-458-I-Y-X	3x3	1064	0.50x0.50	25.4	
MS-459-I-Y-A	4x4	1064	1.94x1.94	25.4	
MS-460-I-Y-A	6x8	1064	0.50x0.50	25.4	
MS-461-I-Y-X	15x15	1064	0.31x0.31	11	
MS-462-I-Y-X	5x33	1064	1.18x0.59	11	
MS-249-I-Y-X	9x9	1064	0.50x0.50	27.94	
MS-516-I-Y-A	10x10	1064	0.93x0.93	14.1x14.1	
MS-471-I-Y-X	3	1064	2.60x3.00	20	Triangle MS (h x b angle)
MS-472-I-Y-X	2x3	1064	2.60x1.50	20	
MS-515-I-Y-X	32	1064	5.00x5.00***	11	MS Circle
MS-478-I-Y-A	2x2	1064	2.77x2.77	11	
MS-479-I-Y-A	8x8	1064	0.69x0.69	11	
MS-480-I-Y-X	3	1064	0.18x0.21	25.4	Triangle MS (h x b angle
MS-500-I-Y-A	10x10	1064	0.93x0.93	20	
MS-250-I-Y-X	37	1064	0.16x0.092	25.4	hexagonal
MS-514-I-Y-X	31x31	1064	0.17x0.17	11	MS round
MS-591-I-Y-A	6x6	1064	0.23x0.23	11	
MS-504-I-Y-A	16x16	1064	0.20x0.20	20x20	
MS-477-I-Y-A	4x4	1064	0.21x0.21	25.4	High Efficiency
MS-465-I-Y-X	25x25	1064	0.016x0.016	14.1x14.1	MS round
MS-464-I-Y-X	13x13	1064	0.015x0.015	14.1x14.1	MS round
MS-424-I-Y-X	61x61	1064	18.37x18.37***	2.45x2.45	random MS
MS-423-I-Y-X	41x41	1064	18.41x18.41***	2.45x2.45	random MS
MS-532-I-Y-A	128x128	1064	0.24x0.24	10x10	
MS-534-I-Y-A	64x64	1064	0.044x0.044	10x10	
MS-536-I-Y-A	10x10	1064	1.87x1.87	14.1x14.1	
MS-541-I-Y-A	64x64	1064	0.066x0.066	10x10	
MS-422-I-Y-X	21x21	1064	18.38x18.38***	2.45x2.45	random MS
MS-413-I-Y-A	64x64	1064	0.48x0.48	10x10	

MS-412-I-Y-A	128x64	1064	0.060x0.033	10x10	
MS-236-I-Y-X	5x5	1064	2.68x2.68	11x11	
MS-553-I-Y-A	2x2	1064	9.21x9.21	25.4x25.4	
MS-238-I-Y-X	7x7	1064	2.11x2.11	11x11	
MS-559-I-Y-A	2x2	1064	28.52x28.52	20x20	
MS-411-I-Y-A	128x64	1064	0.16x0.16	10x10	
MS-503-I-Y-A	2x2	1064	8.72x8.72	20x20	Intensity 100/50
MS-563-I-Y-A	2x2	1064	1.41x1.41	25.4	High Efficiency
MS-564-I-Y-A	2x2	1064	0.29x0.29	25.4	High Efficiency
MS-404-I-Y-X	81x81	1064	18.37x18.37***	2.5x2.5	random MS
MS-375-I-Y-A	10x10	1064	0.069x0.069	25.4	High Efficiency
MS-363-I-Y-X	101x101	1064	40.66x40.66***	10x10	random MS
MS-568-I-Y-A	2x2	1064	1.08x1.08	11	High Efficiency
MS-569-I-Y-A	2x2	1064	0.48x0.48	11	High Efficiency
MS-570-I-Y-A	2x2	1064	0.21x0.21	11	High Efficiency
MS-362-I-Y-X	3x3	1064	3.27x5.68	33x33	
MS-324-I-Y-X	5x5	1064	3.81x2.87	9.8x9.8	
MS-574-I-Y-A	2x2	1064	0.35x0.35	15	High Efficiency
MS-326-I-Y-X	3x3	1064	7.64x5.75	9.8x9.8	
MS-325-I-Y-A	4x4	1064	5.08x3.81	9.8x9.8	
MS-405-I-Y-X	119x119	1064	18.37x18.37***	2.5x2.5	random MS
MS-578-I-Y-X	11x11	1064	0.26x0.26	5x5	
MS-328-I-Y-X	19x13	1064	0.85x0.95	9.8x9.8	Cross MS
MS-246-I-Y-X	29x29	1064	1.43x1.43	25.7x25.7	
MS-558-I-Y-A	2x2	1064	28.52x28.52	20x20	MS Dice
MS-552-I-Y-X	3x5	1064	2.67x2.01	22x22	

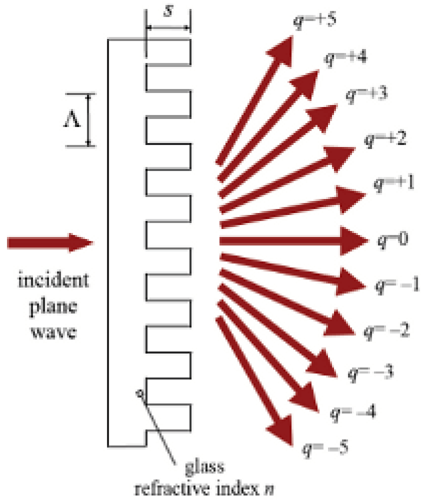
Custom Beam Splitters

PN	Number Spots	λ [nm]	θs [deg]	Element Size [mm]	Remarks
MS-231-I-Y-A	7	1064	0.23x0.13	25.4	hexagonal
MS-231-I-Y-X	7	1064	0.23x0.13	25.4	hexagonal
MS-250-I-Y-X	37	1064	0.16x0.092	25.4	hexagonal
MS-292-I-Y-X	9x9	1064	0.061x0.061***	27.94	Frame
MS-514-I-Y-X	31x31	1064	0.17x0.17	11	MS round
MS-337-I-Y-X	77	1064	5.73x5.73***	11	MS X-Men
MS-339-I-Y-X	3	1064	0.35x0.47	25.4	Triangle MS (not equal power)
MS-356-I-Y-X	12	1064	9.15x9.15***	25.4	MS Circle
MS-480-I-Y-X	3	1064	0.18x0.21	25.4	Triangle MS (h x b angle)
MS-383-I-Y-X	76	1064	0.50x0.50	25.4	Hexagonal Lattice
MS-386-I-Y-X	5	1064	13.58x13.58	25.4	MS Dice
MS-388-I-Y-X	76	1064	0.50x0.50	11	Hexagonal Lattice
MS-395-I-Y-X	37	1064	0.19x0.33	15	hexagonal (head 120deg)
MS-515-I-Y-X	32	1064	5.00x5.00***	11	MS Circle
MS-471-I-Y-X	3	1064	2.60x3.00	20	Triangle MS (h x b angle)
MS-416-I-Y-X	3	1064	0.90x1.04	11	Triangle MS (h x b angle)
MS-434-I-Y-X	5	1064	1.00x1.00	25.4	MS Dice

MS-423-I-Y-X	41x41	1064	18.41x18.41***	2.45x2.45	random MS
MS-424-I-Y-X	61x61	1064	18.37x18.37***	2.45x2.45	random MS
MS-422-I-Y-X	21x21	1064	18.38x18.38***	2.45x2.45	random MS
MS-464-I-Y-X	13x13	1064	0.015x0.015	14.1x14.1	MS round
MS-465-I-Y-X	25x25	1064	0.016x0.016	14.1x14.1	MS round
MS-405-I-Y-X	119x119	1064	18.37x18.37***	2.5x2.5	random MS
MS-363-I-Y-X	101x101	1064	40.66x40.66***	10x10	random MS
MS-503-I-Y-A	2x2	1064	4.36x4.36	20x20	Intensity 100/50
MS-404-I-Y-X	81x81	1064	18.37x18.37***	2.5x2.5	random MS
MS-328-I-Y-X	19x13	1064	0.85x0.95	9.8x9.8	Cross MS

Binary Phase Grating – Diffractive Grating

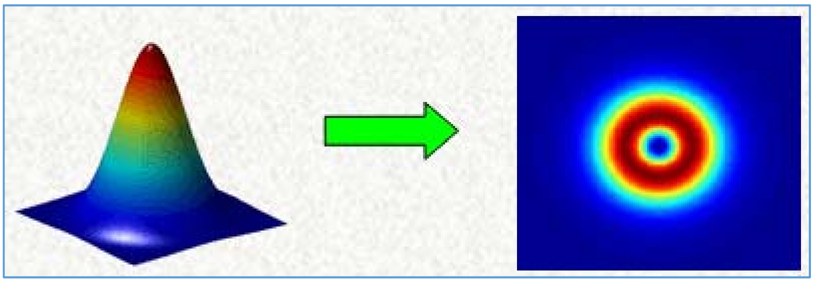
Period [um]	Lines/mm
2	500
4	250
6	166.667
8	125
11.25	88.889
12	83.333
14	71.429
16	62.5
18	55.556
19	52.632
22.5	44.444
24	41.667
25	40
25.75	38.835
27	37.037
29.5	33.898
33.25	30.075
36	27.778
39	25.641
42	23.81
45	22.222
47	21.277
48	20.833
50	20
56	17.857
61	16.393
80	12.5
86	11.628
90.375	11.065
115.75	8.639
132.5	7.547
225	4.444
243	4.115
415	2.41
450	2.222
478.25	2.091
673.125	1.486

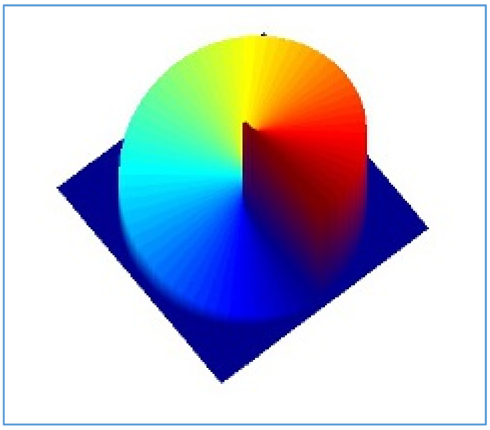


800	1.25
830	1.205
848	1.179
847.875	1.179
890	1.124
1230	0.813
1598	0.626
1907	0.524
3231	0.31
3869	0.258

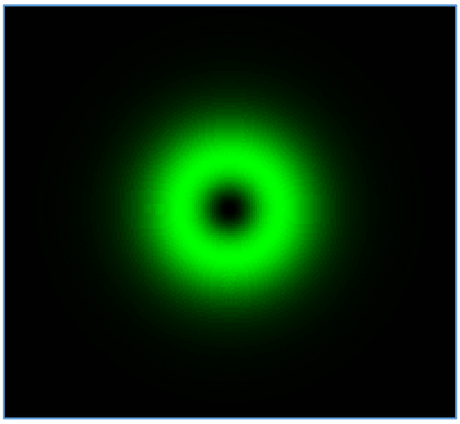
Vortex Lens

Vortex lenses convert a Gaussian input laser beam into a donut-shaped energy ring.
A Vortex lens is a unique optic, whose structure is composed of spiral or helical phase steps.
A Spiral phase plate converts a Gaussian input profile into a donut-shaped energy ring.
The spiral phase plate is a unique optic, whose structure is composed entirely of spiral or helical phase steps, whose purpose is to control the phase of the transmitted beam.
The topological charge, denoted in the literature as m, refers to the number of 2π cycles (i.e. "staircases") etched around 360° turn of diffractive surface. One main effect of a higher topological charge is an increase in the angular momentum of the vortex beam by a factor of m. Another effect is the dimensions magnification of the ring intensity pattern, by a factor of m.





Spiral phase plate (Vortex)



Donut Shaped energy ring

PN	λ[nm]	Element Size [mm]	Typical Efficiency [%]	Topological charge	Outer ring size [um]	Remarks
VL-209-I-Y-A	1064	25.4	95	1	54.73	
VL-215-I-Y-A	1064	25.4	95	3	111.36	
VL-216-I-Y-A	1064	25.4	95	2	81.55	
VL-217-I-Y-A	1064	25.4	90	1	54.73	Square donut
VL-218-I-Y-A	1064	25.4	92	4	142.79	
VL-227-I-Y-A	1064	11	92	3	111.36	

VL-204-I-Y-A	1064	11	92	1	54.73	
VL-214-I-Y-A	1064	25.4	95	1	54.73	
VL-208-I-Y-A	1064	25.4	92	1	54.73	
VL-219-I-Y-A	1064	25.4	95	3	111.36	
VL-220-I-Y-A	1064	25.4	95	2	81.55	
VL-221-I-Y-A	1064	25.4	37***	1	54.73	1mRad separation
VL-222-I-Y-A	1064	25.4	37***	1	54.73	7.5mRad separation
VL-224-I-Y-A	1064	25.4	37***	1	54.73	5mm sep @f=100mm
VL-225-I-Y-A	1064	25.4	92	6	209.44	
VL-226-I-Y-A	1064	11	95	3	111.36	
VL-206-I-Y-A	1064	11	95	1	54.73	
VL-228-I-Y-A	1064	11	92	6	209.44	
VL-229-I-Y-A	1064	11	92	2	81.55	
VL-230-I-Y-A	1064	25.4	95	6	209.44	
VL-231-I-Y-A	1064	25.4	95	4	142.79	
VL-232-I-Y-A	1064	11	95	6	209.44	
VL-233-I-Y-A	1064	11	95	12	411.57	
VL-234-I-Y-A	1064	11	95	2	81.55	
VL-235-I-Y-A	1064	11	95	4	142.79	
VL-236-I-Y-A	1064	25.4	95	12	411.57	
VL-237-I-Y-A	1064	11	92	5	175.3	
VL-238-I-Y-A	1064	11	95	5	175.3	
VL-239-I-Y-A	1064	25.4	92	12	411.57	
VL-240-I-Y-A	1064	11	92	12	411.57	
VL-241-I-Y-A	1064	25.4	92	8	276.09	
VL-242-I-Y-A	1064	11	92	8	276.09	
VL-243-I-Y-A	1064	11	92	4	142.79	

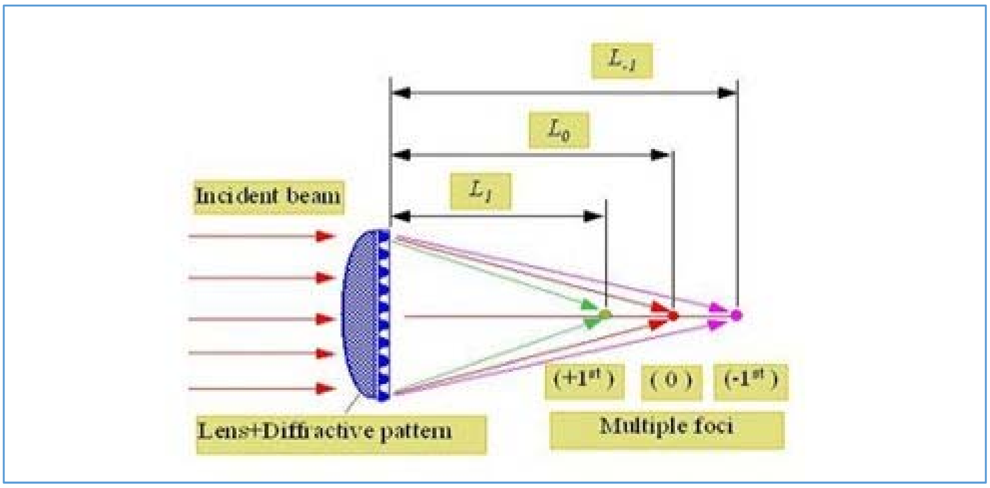
Multifocal Lens

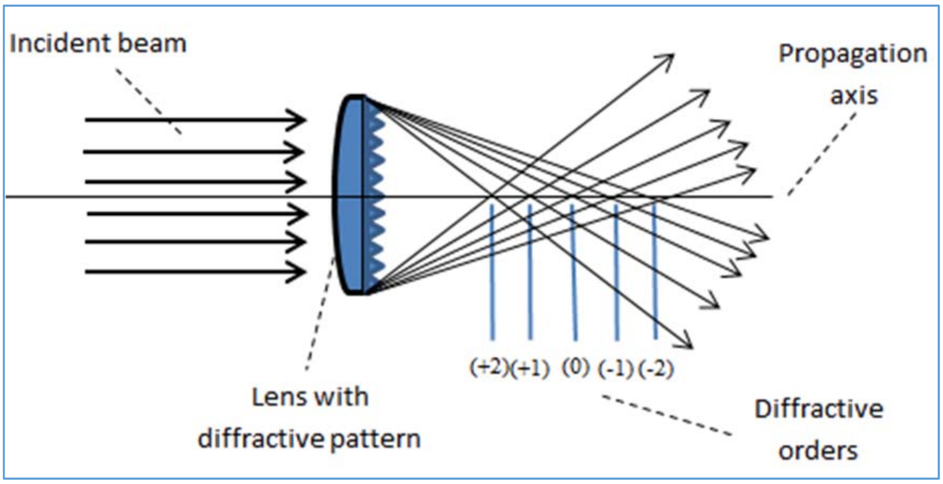
Multi-focal Diffractive Optical Element (DOE) allows to focus a single incident beam simultaneously at several focal planes along the propagation axis.

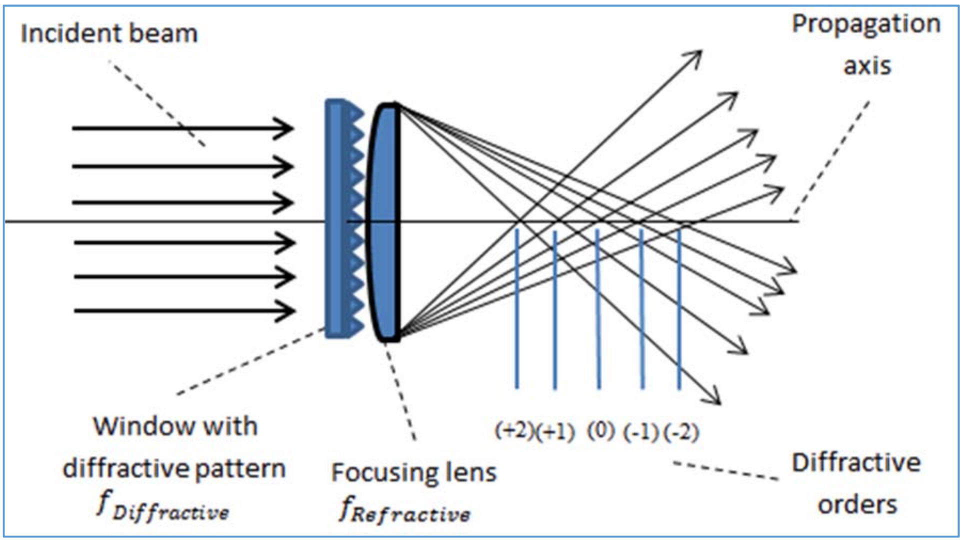
We have a vast variety of solutions for multiple foci along the optical axis: The Multifocal Diffractive Optical Elements (DOE's) allow a single incident beam to focus simultaneously at several focal lengths along the propagation axis. From a collimated input beam (single mode or multi-mode), the output beams focussed at a fixed number of focal lengths, predetermined during the design of the Multifocal DOE based on the customer's system requirements. The Multifocal DOE comes in two configurations: A DOE consisting of a Plano-convex lens with predetermined focal length, and a diffractive pattern, etched on its Plano side. For more flexibility, a window DOE, thus, to get the foci spots at certain distances, the user adds a regular focusing lens after the DOE. The lens focal length determines the working distance (WD).

The Multifocal DOE can also be used as quasi elongated focus elements, increasing effectively the depth of focus in applications such as laser glass cutting and laser micro machining.

Sintec Optronics





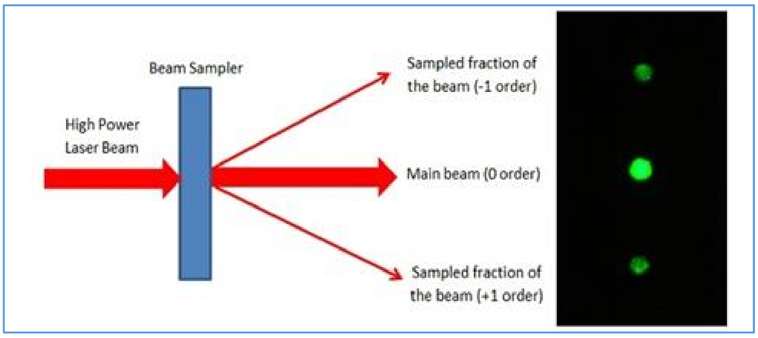


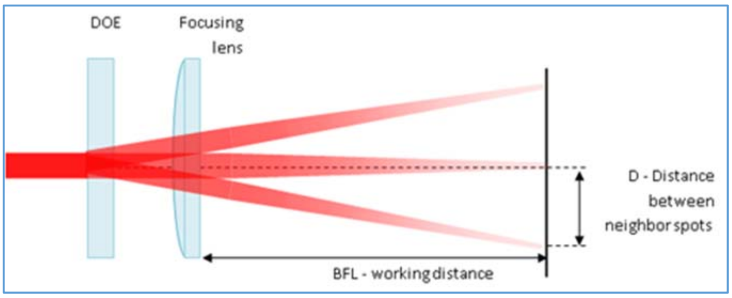
PN	λ[nm]	Number of Foci	Element Size [mm]	Average separation between foci [um]	Remarks
BF-005-I-Y-A	1064	2	25.4	598	
MF-001-I-Y-A	1064	5	15	112.8	
MF-002-I-Y-A	1064	7	25.4	95.3	
MF-005-I-Y-A	1064	4	11	549	
MF-006-I-Y-A	1064	15	11	610.4	
MF-007-I-Y-A	1064	5	11	146.6	High Efficiency

BF-006-I-Y-A	1064	2	11	1995	
BF-014-I-Y-A	1064	2	11	301	
BF-015-I-Y-A	1064	2	25.4	31	
TF-008-I-Y-A	1064	3	11	535.7	
MF-003-I-Y-A	1064	9	15	68.5	
MF-004-I-Y-A	1064	11	25.4	121.3	
TF-004-I-Y-A	1064	3	11	150.5	
TF-005-I-Y-A	1064	3	25.4	15.5	
TF-010-I-Y-A	1064	3	11	667.4	
TF-011-I-Y-A	1064	3	11	414.7	
MF-009-I-Y-A	1064	6	15	94.5	
MF-011-I-Y-A	1064	5	11	238.1	orders 0,-1,-2,-3,-4
MF-012-I-Y-A	1064	15	25.4	125.6	
MF-013-I-Y-A	1064	5	11	192.3	
TF-012-I-Y-A	1064	3	11	226	
BF-021-I-Y-A	1064	2	38.1	5429.9	
BF-016-I-Y-A	1064	2	25.4	13.3	
BF-008-I-Y-A	1064	2	11	1071.5	
BF-017-I-Y-A	1064	2	11	1334.8	
BF-018-I-Y-A	1064	2	11	829.4	
BF-019-I-Y-A	1064	2	11	452	
TF-003-I-Y-A	1064	3	25.4	299	
TF-009-I-Y-A	1064	3	11	997.5	
BF-020-I-Y-A	1064	2	11	1602.6	
MF-008-I-Y-A	1064	5	15	112.8	High Efficiency

Beam Sampler

Diffractive beam samplers are used to monitor high power lasers where optical losses and wavefront distortions of the transmitted beam need to be kept to a minimum. In most applications, most of the incident light must to continue forward, "unaffected," in the "zero order" while a small amount of the beam is diffracted into a higher order, providing a "sample" of the beam. By directing the sampled light in the higher order(s) onto a detector, it is possible to monitor, in real time, not only the power levels of a laser beam, but also its profile. A Laser Beam Sampler allows the high power beam (zero order) to propagate undisturbed along the optical axis, but produces two side beams with low energy. These two sample beams are located to the left and right of the main beam (-1 and +1 orders), and are characterized by a given separation angle between them and by a sample power ratio. It is relatively easy to modify the sampling ratio upon a request of the customer.



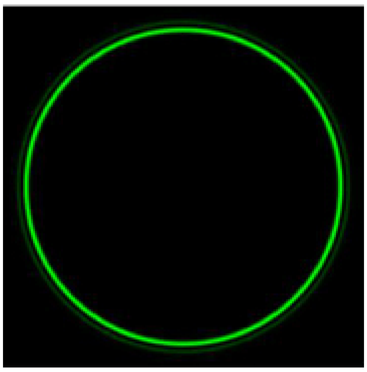
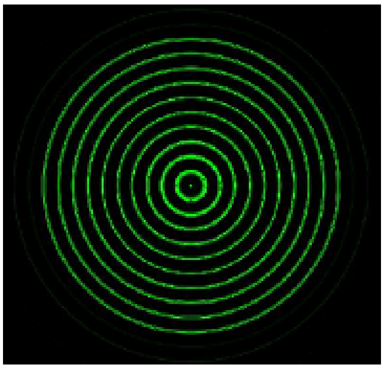


PN	λ[nm]	Sampled Energy [%]	Sampled Angle [deg]	Element Size [mm]
SA-010-I-Y-A	1064	0.4	15.43	12x12
SA-014-I-Y-A	1064	0.4	15.43	25.4
SA-022-I-Y-A	1064	1.22	2.07	25.4
SA-220-I-Y-A	1064	0.5	10.21	11
SA-020-I-Y-A	1064	1	1.27	27.94
SA-021-I-Y-A	1064	1	1	25.4
SA-219-I-Y-A	1064	0.5	2.44	25.4
SA-204-I-Y-A	1064	0.5	2.07	25.4
SA-206-I-Y-A	1064	1	2.07	25.4
SA-207-I-Y-A	1064	2	10	15
SA-218-I-Y-A	1064	0.5	1	25.4
SA-217-I-Y-A	1064	0.5	2.84	25.4
SA-216-I-Y-A	1064	0.5	3.81	25.4
SA-213-I-Y-A	1064	0.5	9.21	15
SA-215-I-Y-A	1064	0.5	5.09	25.4
SA-208-I-Y-A	1064	2	5.09	15
SA-211-I-Y-A	1064	1	20.77	10x10
SA-209-I-Y-A	1064	3.8	15.43	10.7x10.7
SA-011-I-Y-A	1064	1.6	15.43	12x12
SA-012-I-Y-A	1064	3.8	15.43	12x12
SA-214-I-Y-A	1064	0.5	7.64	9.8x9.8

Ring Generator

A Ring generator transforms a laser beam into a ring (Diffractive axicon) or into a multi-rings (Multi-Circles). A laser concentric circles pattern transforms a laser beam into multiple circles. A concentric circles light pattern can be used for certain 3D mapping applications, especially within pipe/tube objects. A concentric circles pattern was recently proved to be the most appropriate light pattern for certain 3D mapping applications, especially with pipe/tube objects.

Each laser concentric circles is defined by its full angle and its number of rings. We offer, in addition to its standard products, the possibility to design and manufacture a number of circles, separation angle between the circles and full angle as requested by the customer, as a part of its custom design and manufacturing capability. We also design and manufacture diffractive axicon which is a DOE that splits an input beam to a single ring. An Axicon transforms a laser beam into a ring shape (a Bessel intensity profile). The ring's thickness will be equivalent to the diffraction-limited-spot size (of the input laser beam). An Axicon also images a point source into a line along the optical axis and increases the Depth Of Focus (DOF). Each diffractive Axicon product is defined by its ring propagation angle.

Axicon for single ring shape

PN	λ[nm]	Element Size [mm]	Ring Angle [deg] P2P(+)	Ring Dia(+) [mm] for EFL=100mm	Remarks
DA-004-I-Y-A	1064	25.4	8.14	14.231	
DA-011-I-Y-A	1064	25.4	0.061	0.106	
DA-003-I-Y-A	1064	25.4	0.3	0.524	
DA-017-I-Y-A**	1064	34	1.52	2.653	
DA-006-I-Y-A	1064	11	0.24	0.419	
DA-032-I-Y-A	1064	25.4	3.6	6.285	
DA-008-I-Y-A	1064	11	0.49	0.855	
DA-009-I-Y-A	1064	11	0.98	1.71	
DA-010-I-Y-A	1064	25.4	0.081	0.141	
DA-033-I-Y-A	1064	25.4	7.2	12.583	
DA-012-I-Y-A	1064	11	2	3.491	
DA-031-I-Y-A	1064	25.4	1.8	3.142	
DA-014-I-Y-A**	1064	34	0.19	0.332	
DA-015-I-Y-A**	1064	34	0.38	0.663	
DA-016-I-Y-A**	1064	34	0.76	1.326	
DA-005-I-Y-A	1064	11	0.12	0.209	
DA-018-I-Y-A	1064	11	1.72	3.002	
DA-019-I-Y-A	1064	11	2.29	3.997	
DA-020-I-Y-A	1064	11	0.057	0.099	
DA-021-I-Y-A	1064	11	0.086	0.15	
DA-029-I-Y-A	1064	11	1.39	2.426	
DA-028-I-Y-A	1064	11	0.7	1.222	
DA-027-I-Y-A	1064	11	0.35	0.611	
DA-026-I-Y-A	1064	11	0.17	0.297	
DA-025-I-Y-A	1064	11	0.35	0.611	High Efficiency
DA-024-I-Y-A	1064	11	0.17	0.297	High Efficiency
DA-023-I-Y-A	1064	11	0.24	0.419	High Efficiency
DA-013-I-Y-A	1064	34	0.19	0.332	High Efficiency
DA-007-I-Y-A	1064	11	0.12	0.209	High Efficiency
DA-002-I-Y-A	1064	7.25x7.25	30.85	55.183	

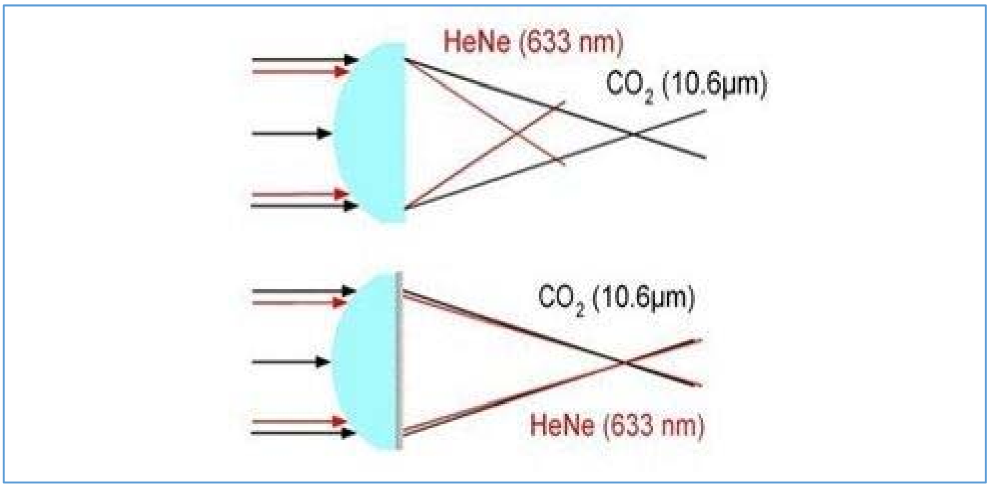
Concentric Circles Pattern

Part Number	λ (nm)	number of rings	Full Angle (Deg)	Dimensions(mm)	Material	Coating
MC-006-I-Y-A	1064	2	1.83	11	Fused Silica	AR V-Coating

MC-005-I-Y-A	1064	2	3.66	11	Fused Silica	AR V-Coating
MC-017-1-Y-A	808	12	5.9	11	Fused Silica	AR V-Coating

Dual Wavelength

Dual wavelength beam combiners are diffractive optical elements used to combine two incident beams with different wavelengths into the same focal point.
In multi-wavelength light beams the dual wavelengths are diffractive optical elements used to combine two incident beams with different wavelengths into the same focal point.
In particular, this focus combiner is used for combining CO2 laser focus and visible aiming beam focus into a single focal point.
The Dual wavelength corrects the strong chromatic aberrations between a CO2 laser and its visible aiming beam.
This hybrid element,is based on a Plano convex lens with corresponding diffractive pattern on its Plano side.
The focal length for both wavelengths is determined during the design, according to the customer's application



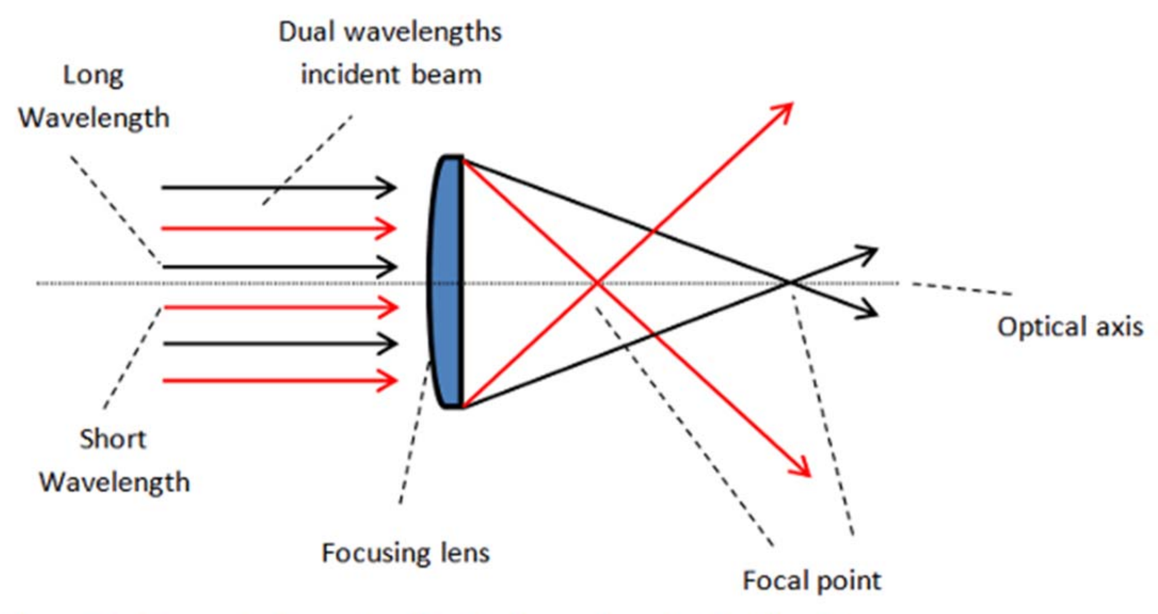
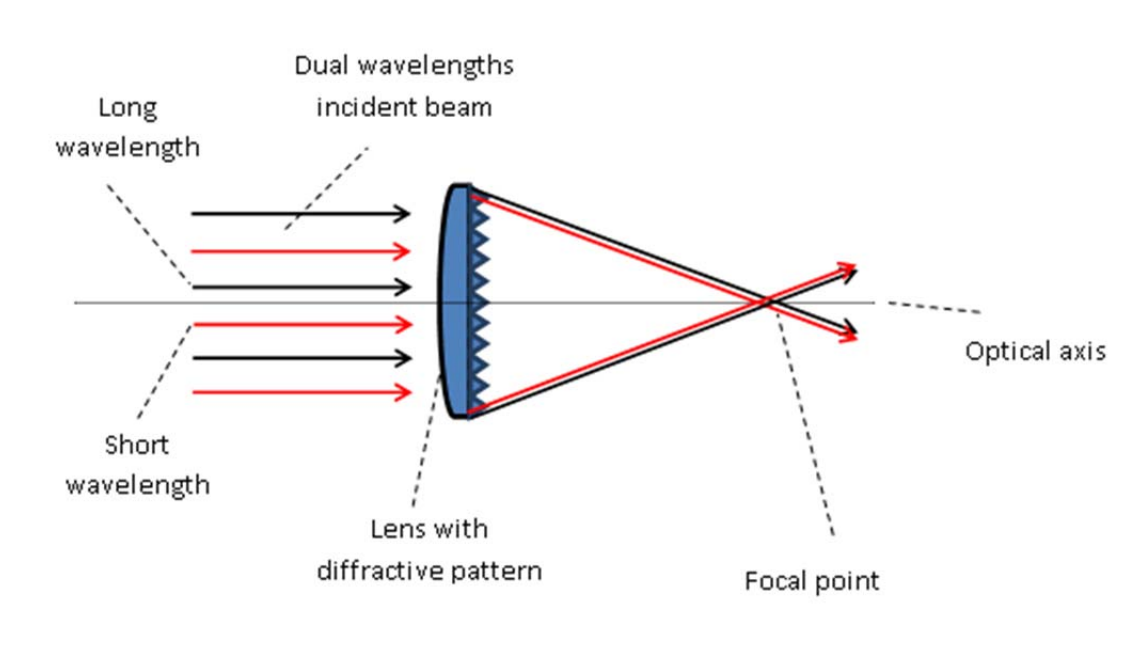


Figure 1– Chromatic aberration for dual wavelengths incident beam



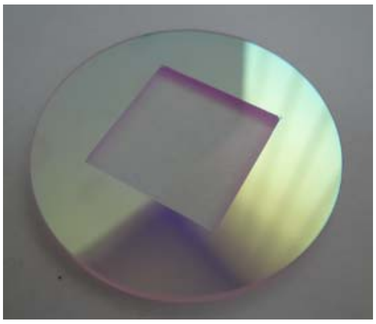
Dual Wavelength – focus combiner of CO2 laser and aiming beam

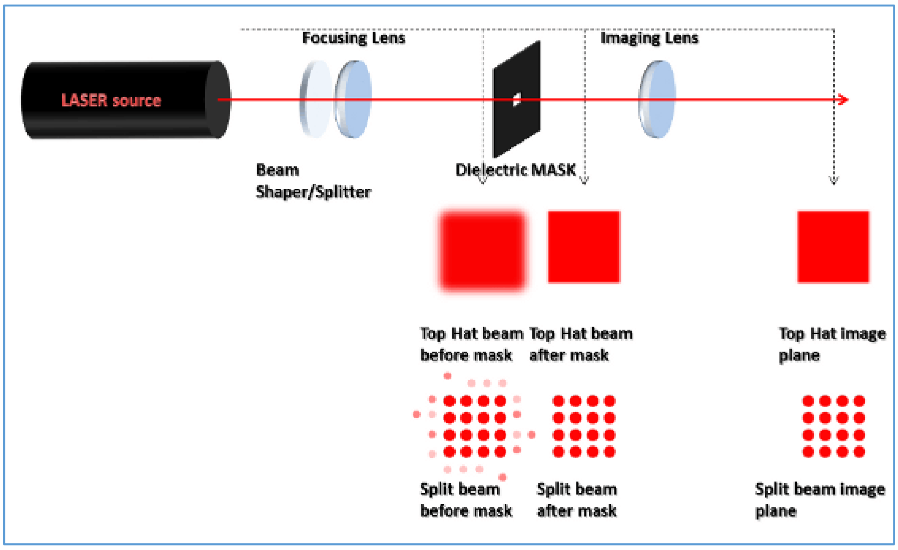
Part Number	λ (nm)	Input Beam 1/e2@633nm (mm)	Working Distance (mm)	Dimensions (mm)	Material	Coating
DW-201-AP-Y-A	10600, 633	4-8.8	125	15	ZnSe	AR-V Coating
DW-208-AP-Y-A	10600, 633	4-13.3	100	38.1	ZnSe	AR-V Coating
DW-202-AP-Y-A	10600, 633	4-12	20	19	ZnSe	AR-V Coating

Dielectric Mask

Dielectric masks are glass substrates that have a very thin (~1um) reflective patterned coating. The coated part reflects the incoming beam while the uncoated part transmits the beam. The output in the near field will be very close to the shape of the pattern. In the far field some diffraction patterns may appear. One should not see significant diffraction, if one projects with a lens the output of the mask to an image plane, as shown in the figure below.

Application:
One can narrow the transition region from a beam-shaper by using the Dielectric mask as in the figure below. One can also create any pattern that will be imaged with a lens. One cannot manage the intensity profile within a spot.

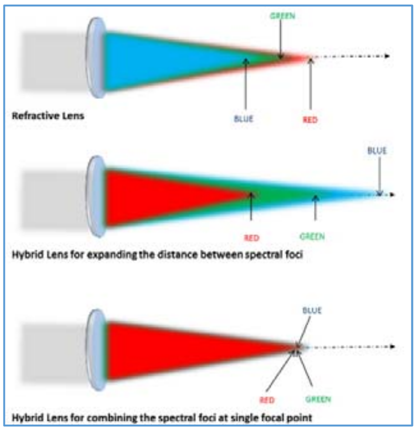




Dielectric (Projection / Imaging) Mask – Precision aperture for high power laser

Part Number	Diameter (mm)	Aperture Size (um)	Aperture Shape	Material
DM-017	85	50.075	Square	Fused Silica
DM-010	25.4	5680	Round	Fused Silica
DM-004	25.4	1750	Square	Fused Silica
DM-009	25.4	6200	Round	Fused Silica
DM-019	25.4	300	Square	Fused Silica
DM-007	25.4	10838	Round	Fused Silica
DM-006	25.4	7000	Square	Fused Silica
DM-005	25.4	3500	Square	Fused Silica
DM-008	20	8428	Round	Fused Silica
DM-016	11	5400	Round	Fused Silica
DM-015	11	3000	Round	Fused Silica
DM-014	11	4214.9	Round	Fused Silica
DM-013	11	2408	Round	Fused Silica
DM-012	11	3612	Round	Fused Silica
DM-011	11	4817	Round	Fused Silica
DM-003	11	165	Square	Fused Silica
DM-002	11	65	Square	Fused Silica

Custom Solutions



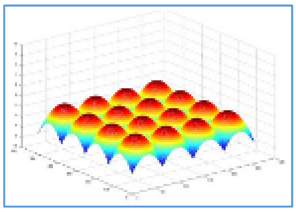
We offers customers the opportunity to obtain custom solutions such as:

DOE for spectral dispersion of focal plane

In applications requiring multi-spectral focal dispersion, we offer a flexible and compact diffractive solution. A refractive lens alone has a small dispersive component, due to slight spectral dependence of the lens material optical index. As a result, the spectral foci are discreet

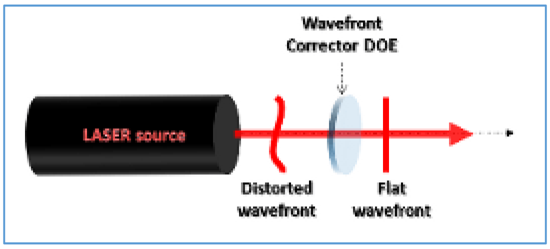
but very close to one another. A diffractive surface is a compact effective solution for "stretching out" or expanding the inter-focal distance between two or more spectral foci.
On the other hand, a diffractive surface is also an effective solution for combining foci of assorted wavelengths to a single focal point.

Lenslet array



Diffractive lenslet arrays are substrates covered with a set of micro diffractive lenses. The arrays perform as diffusers or for local focusing and sampling. A diffractive lenslet array has the advantage of 100% fill factor, much higher than refractive lenslet array. Aberration corrected micro lenses for imaging systems are easily designed and fabricated.
We also offer 1-D micro lens arrays, lenslet arrays with shifted center.

Wavefront corrector (i.e. for aberrations correction)



When the wavefront is different from the desired shape, a DOE element can be used to correct the deviation. The wavefront deviation from desired shape must be constant in time, because each part of the element introduces a specific phase correction

Diffractive lens and Zone Plate Lens [ZPL]

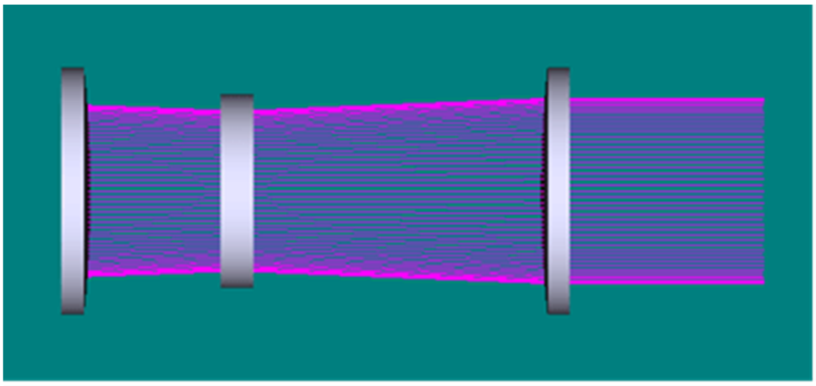
Diffractive lenses are used to focus monochromatic light (often laser light). A diffractive lens consists of a series of radial rings or "zones" of decreasing width (known also as Fresnel zones). The diffractive lens is a perfect lens which include spherical aberration correction. As a general rule, diffractive elements work best at a single wavelength. At any other wavelength the efficiency as well as image contrast are reduced. However, the diffractive lens can be used also as chromatic aberration corrector and, in this case, the image contrast will not be reduced. The diffractive lens can be used also to reduce the number of elements in a system.

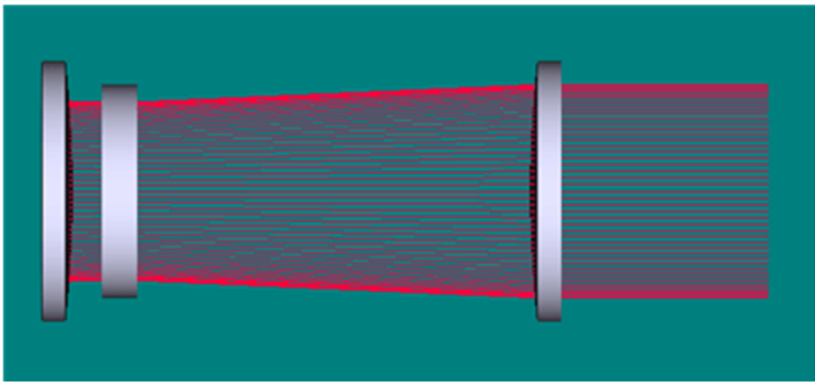
Customize etching / lithography for non optical devices
Intraocular lenses (IOL)
Waveguide

DOE Accessories

DOE Tuner for wavelengths range from 266nm to 1064nm

To answer the demand for fine-tuning abilities of various output parameters when using a DOE, as: shape/spot size, separation/divergence angle, etc. our designed a variable beam tuner, optimized for use with Top-Hat beam shaper, Homogenizer, MultiSpot, and other DOE products. Another application is the fine-tuning of incident beam size before DOE for Top-Hat application, where precision of incident beam size is important.



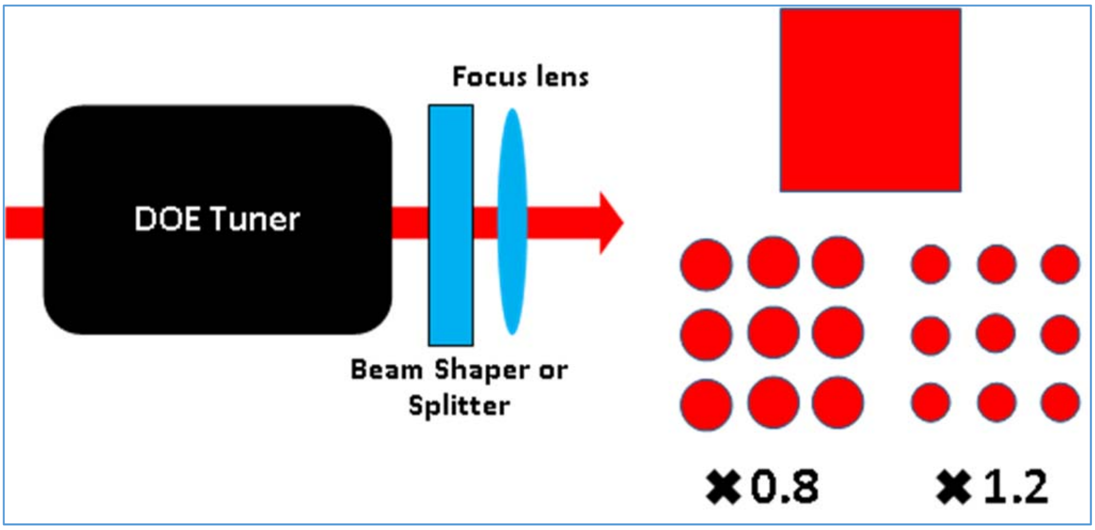


The DOE tuner presents the following features:
Very low wavefront error
Beam expander x0.8-x1.2
No need to change module direction
Sliding lenses
Constant mechanical size
Fused Silica lens material
Input and output clear aperture = 23 [mm]
Module length = 120 [mm]
Max. Input Beam Diameter (1/e2): Ø8.4 mm (0.8X), Ø7.0 mm (1.2X)
Max. output beam size = 8.4 [mm]
*Max. incident angle = 0.5o
Wavelength range = 266-1064 [nm]
Other wavelengths upon request
*Defines angular limitation for Top Hat Beam Shaper or Beam Splitter usage.
Different configurations for using the DOE-Tuner module:

Placing the DOE-Tuner before a DOE
Purpose – Fine tuning for input beam size
Benefit:
For Top-Hat beam shaper – achieves nominal beam size
For Beam-Splitters, Multi-Focal and Vortex phase plate – controls spot size
Key parameters:

Parameter:	Magnification < 1	Magnification > 1
Spot size:	Increases	Reduces
Separation angle:	No change	No change

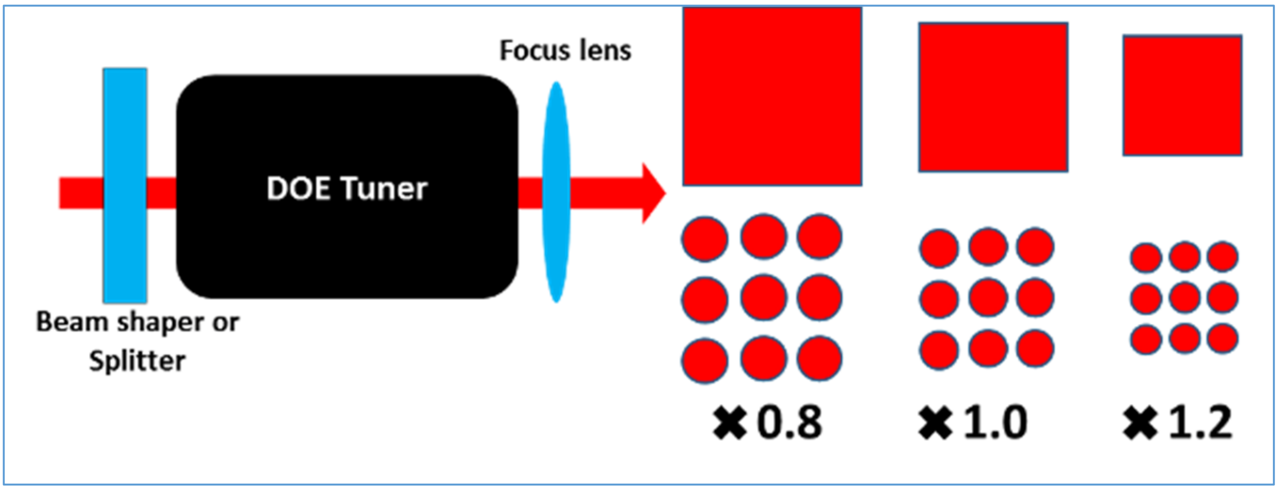
Figure 1: DOE-Tuner module placed before DOE



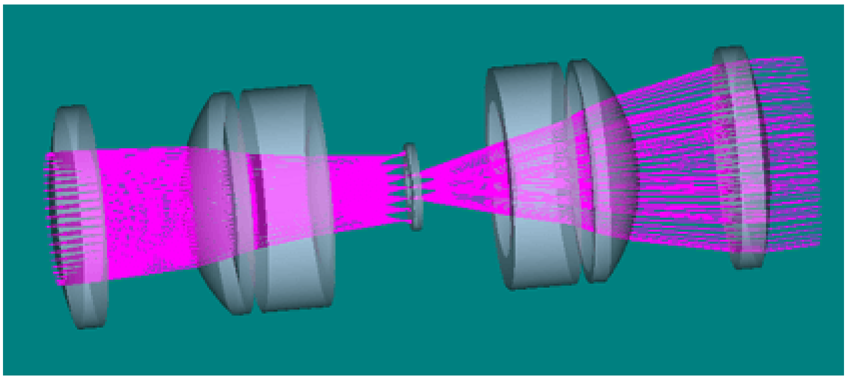
Placing the DOE-Tuner after a DOE
Purpose – controlling divergence of the output beam, allows to vary key parameters of DOE in range of 80-120 %
Benefit:
Multi-Spot – controls the separation angle
Multifocal – controls the separation between foci
Top-Hat , Homogenizer & others – controls the image size
Key parameters:

Parameter:	Magnification < 1	Magnification > 1
Spot size:	Increases	Reduces
Separation angle:	Increases	Reduces

Figure 2: DOE-Tuner module placed after DOE and before focus lens (or objective)

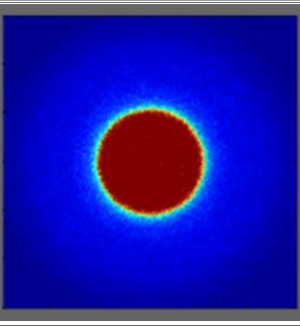
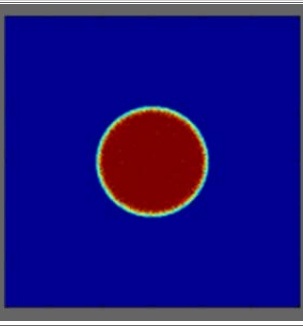
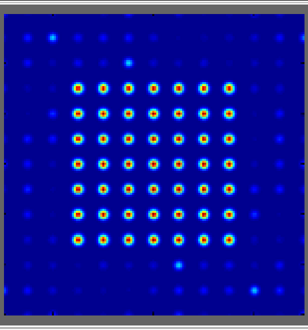
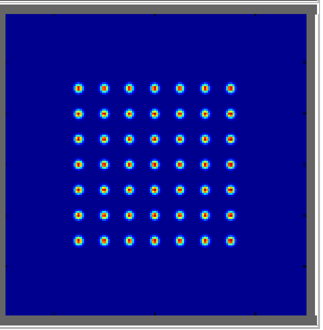


Module for blocking unwanted spots \ energy



For applications as metrology and sensitive material processing, our designed a compact universal module for blocking undesired spots of Multi-Spots or parasitic energy of Homogenizers.
The module contains 6 lenses and a mask/aperture in the middle.
Each DOE design requires a certain mask/aperture according to customer's specs.

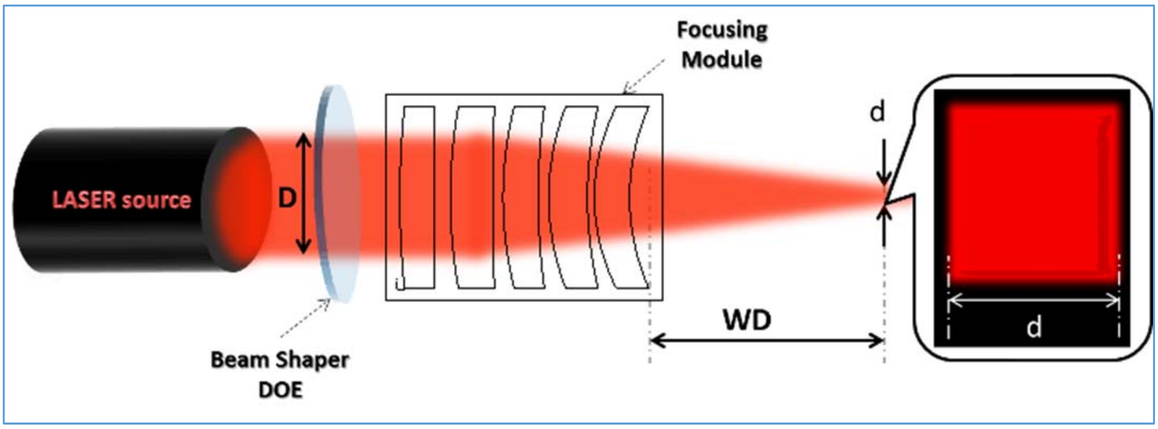
Parameters and features of the module:
Max input beam diameter = 12 [mm]
Max full angle of DOE for 12 [mm] input beam dia = 5 [deg]
Input beam smaller than 12[mm] enables larger than 5 [deg] full angle for DOE
Module length = 90 [mm] (not includes DOE and focusing lens)
Outer diameter of module = 30.5 [mm] (lens diameter = 25.4 [mm])
Lenses material = N-SF11
Simulation results of two DOEs with the module (right) and without (left):

	No module	**With module**
Round Diffuser		
Multi-Spot		

Focusing Module Optimized for Beam Shaper

For applications requiring an aberration-free image in focus plane, with a high precision, we developed a new optimized focusing module to be used with our Beam Shapers. A standard focusing lens (or objective) is normally optimized for focusing a Gaussian beam and is not optimized to work with a Beam Shaper. Thus, the use of standard focusing lens with Beam-Shapers often causes aberrations of the Top-Hat image and requires special design of a focusing lens or module. These aberrations will normally occur at small focal lengths, short wavelength and large input beam. In order to solve this problem, we designed a focusing module (with focal length 50 [mm]) adapted to our Beam Shaper working at 355 [nm]. The module contains 5 lenses, and the Top-Hat output is obtained at the back focal length of the module. We offers customization of the module for other wavelengths and focal length. The focusing module presents the following features:
Free-aberrations module
Focal lengths: 30 and 50 [mm]
Wavelength (optimized): 355 [nm]
Material: Fused Silica
Max. input beam size = 12 [mm]
Optional - Objective correction collar

Typical set-up



Comparison between Square Top-Hats result at image plane obtained by different focusing elements:

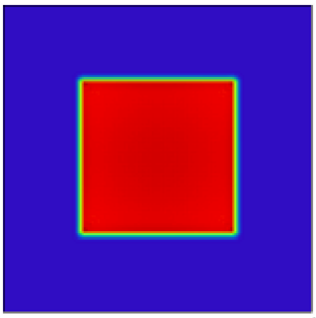
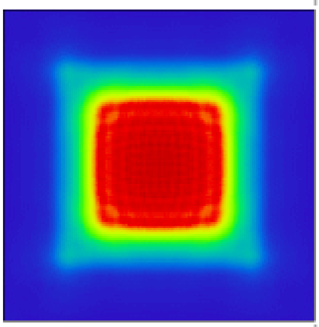
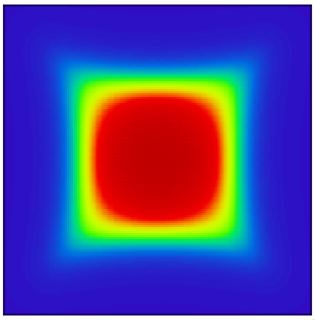
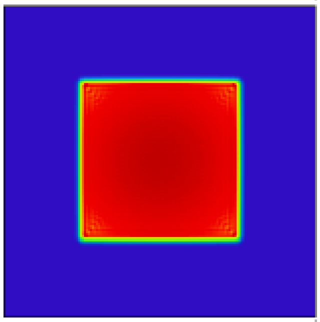
Ideal Lens (Theoretical)	Aspheric lens	Standard Focusing	Our Focusing Module
			
Simulation results for a Square Top-Hat 100x100[μm2] in size, with (from left to right): perfect lens (not real lens) for ideal spot, aspheric lens, standard focusing module not optimized for use with a Beam Shaper and our focusing module optimized for use with Beam Shapers.			

Table parameters of Beam Shaping Focusers:

Part Number	Focal Length (mm)	Outer Diameter (mm)	Max input beam (mm)	Material	module length(mm)	Zemax Black Box
Objective-001-U	50	45	12	Fused Silica	38.5	

Part Number	Focal Length (mm)	Outer Diameter (mm)	Max input beam (mm)	Material	module length(mm)	Zemax Black Box
Objective-002-U	30	45	12	Fused Silica	31	

DOE Expander

We introduce a new module for modifying certain output parameters of a Diffractive Optical Element (DOE).
The module reduces or expands the full angle of a DOE output by a magnification factor.
Unlike standard beam expander, our module takes into considerations the characteristics of our beam shaping, beam splitting and beam foci elements, thus achieving superb results with minimal aberrations.
The module can be beneficial/suitable in the following cases:
Using the module together with a DOE, to create an overall function that would be hard to manufacture by a single element
Adding our module to a standard, semi-standard or in-stock DOE with specific full angle to change the full angle of the DOE thus avoiding any NRE payment, and shortening delivery time
our is also able to customize the module according to the customer's system and request.

Specifications:

Material:	Fused Silica
Transmission:	≥ 97%
Fixed Expansion factor:	x5 and x9.4
Product categories to be used with the DOE expander:	Beam Splitter, Homogenizer / Diffuser, Top-Hat Beam Shaper, Vortex Spiral Phase Plate, Diffractive Axicon, Multi-Circles
DOE expander optimized for:	Square shape beam (as Top-Hat square or Beam Splitter 2D square [9x9 spots for example])
Suitable for:	266nm to 1550nm

Typical set-up:

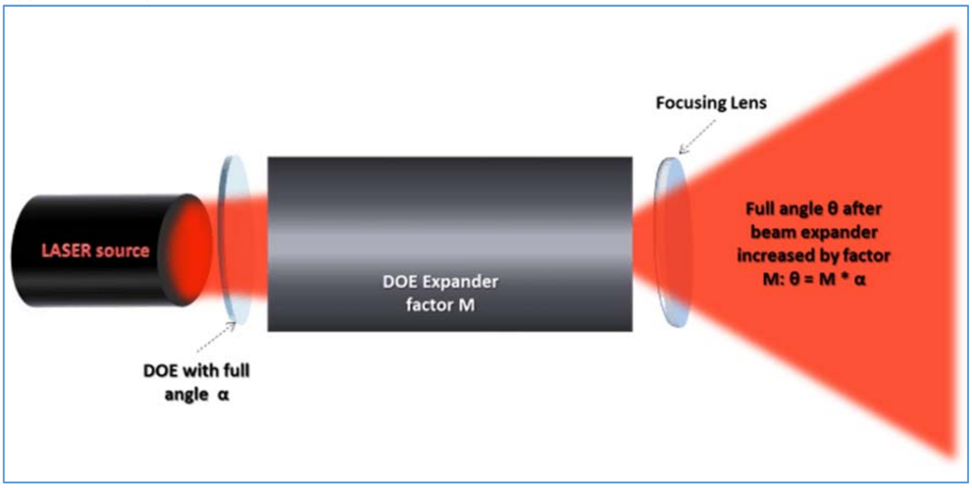
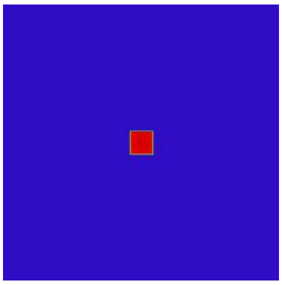
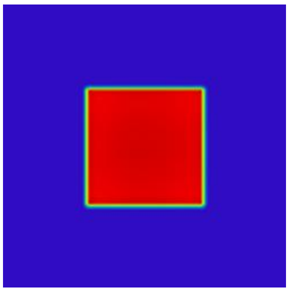
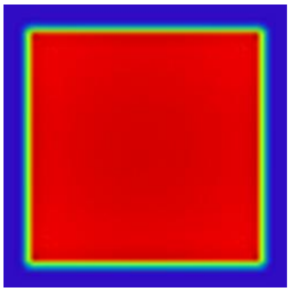


Table parameters of DOE expanders:

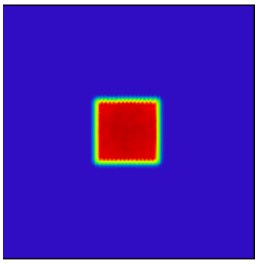
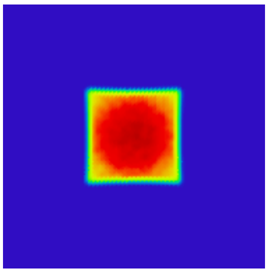
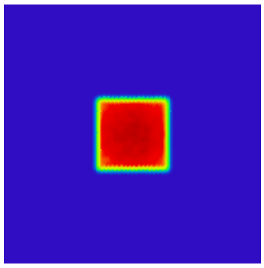
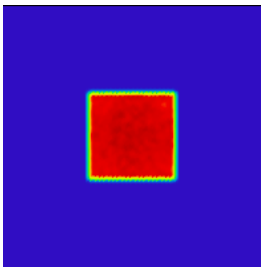
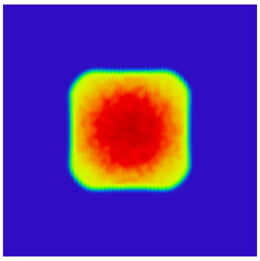
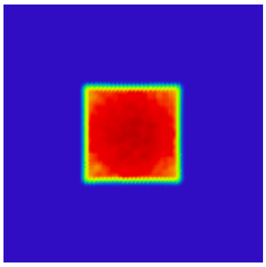
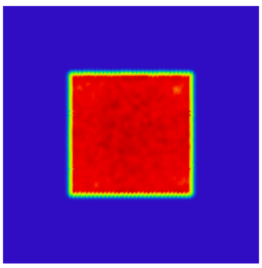
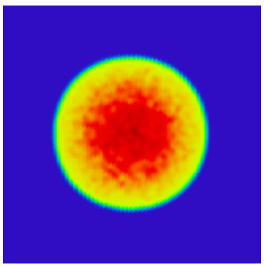
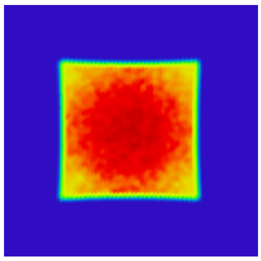
Part Number	Magnification	Max entrance and exit aperture (mm)	Max input beam (mm)	Max input angle (deg)	module length*	Outer diameter
DOE_Expander_x10	x9.4	23	14	3	130	35
DOE_Expander_x5	x5	23	14	3	110	35

*: not including the DOE and optional focusing lens

Results:

Without DOE Expander	With DOE Expander x5	With DOE Expander x9.4
		
Far-field simulation results for a Square Top-Hat, from left to right, without DOE expander 1.5x1.5[deg], with DOE expander x5 7.5x7.5[deg] and with DOE expander x10 ~14x14[deg].		

Comparison between Square Top-Hats result at image plane obtained by different expander module elements:

Ideal Lens (Theoretical only)	Standard Beam Expander	Our DOE Expander
		
Simulation results for a Square Top-Hat 1.6deg in size, with (from left to right): perfect beam expander (not real lens) for ideal output spot, standard beam expander not optimized for use with a DOE and our DOE Expander optimized for use with a DOE and additional focusing lens after the module. Simulation input parameters: Wavelength 532nm and input beam diameter 8mm.		
		
Simulation results for a Square Top-Hat 2.0deg in size, with (from left to right): perfect beam expander (not real lens) for ideal output spot, standard beam expander not optimized for use with a DOE and our DOE Expander optimized for use with a DOE and additional focusing lens after the module. Simulation input parameters: Wavelength 532nm and input beam diameter 6mm.		
		
Simulation results for a Square Top-Hat 2.86deg in size, with (from left to right): perfect beam expander (not real lens) for ideal output spot, standard beam expander not optimized for use with a DOE and our DOE Expander optimized for use with a DOE and additional focusing lens after the module.		

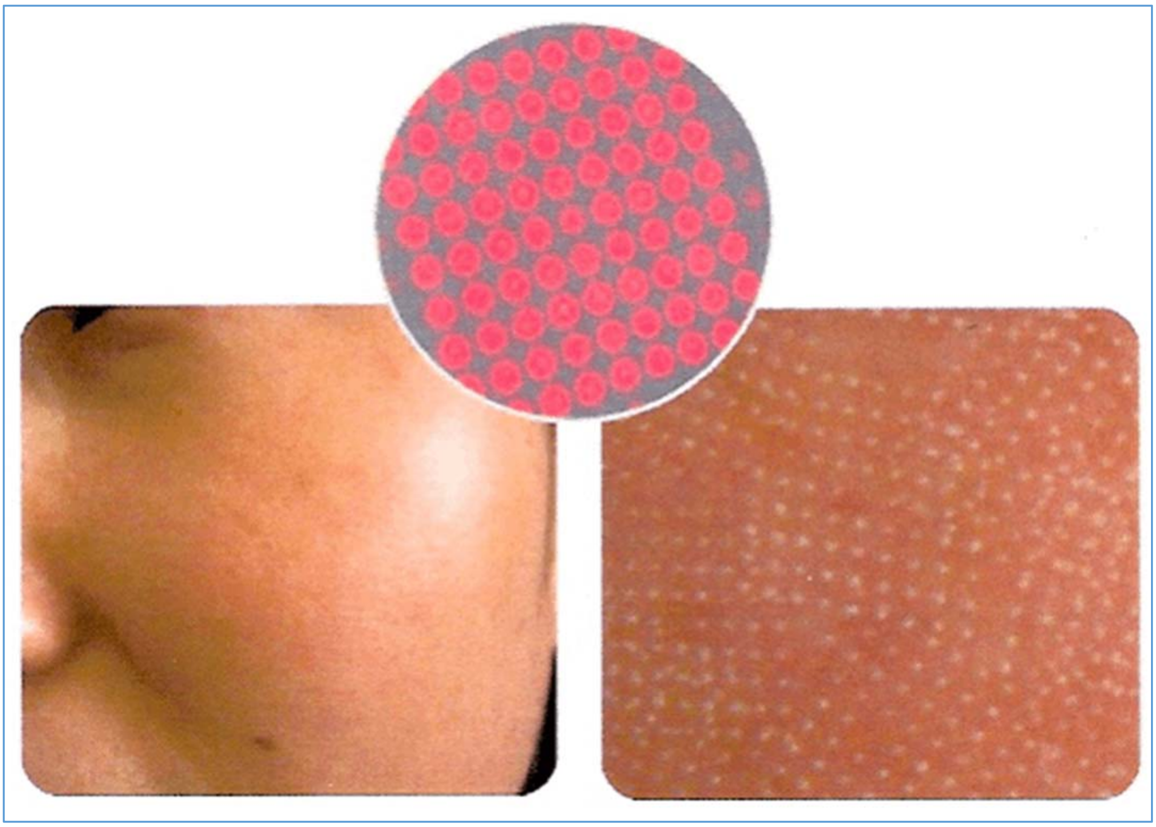
Ideal Lens (Theoretical only)	Standard Beam Expander	Our DOE Expander
Simulation input parameters: Wavelength 532nm and input beam diameter 6mm.		

Applications notes for DOEs

Aesthetics Treatments with Diffractive Optics

Introduction

As the use of laser technology becomes a more integral tool in the field of aesthetic treatments, the ability to manipulate the output of the laser is increasingly important. Diffractive Optical Elements (DOE) provide a unique solution by allowing for the beam to be manipulated in a myriad of ways, and at the same time are thin and compact.



Skin resurfacing

Skin resurfacing includes a wide range of treatments meant to rejuvenate the appearance of the skin from imperfections caused by many factors, including acne, scarring, and excessive sun exposure. Multispot elements have proven to be effective in assisting with more efficient skin resurfacing procedures. Creating a 2D matrix of smaller laser beams covers more area of the skin than a single laser beam, thus reducing procedure time. Moreover, healing time is shorter and more effective because the laser affects the skin in an even pattern, and the uneffected skin between spots allows for a shorter migration path for epidermal stem cells to develop and rejuvenate the skin.

Relevant products: Beam splitter
Common wavelengths: 10600 nm (CO_2), 2940 nm (Er:YAG)

Figure 1. A gaussian input beam split into a 9x9 array.

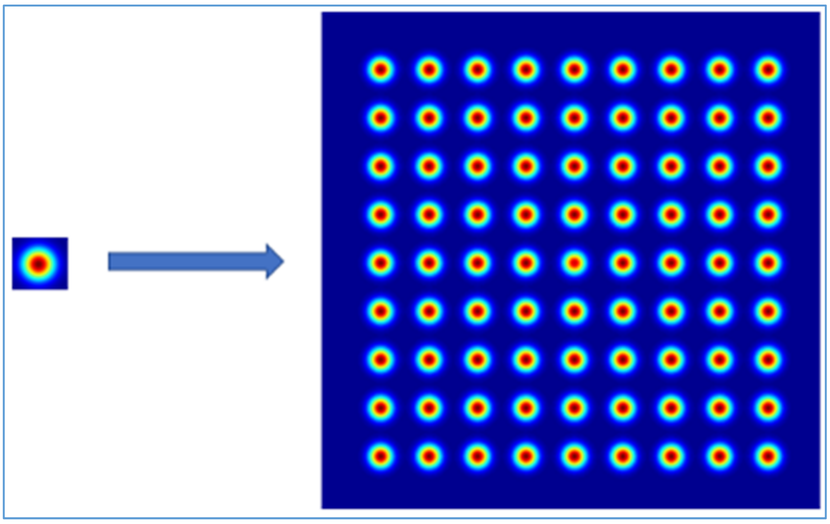
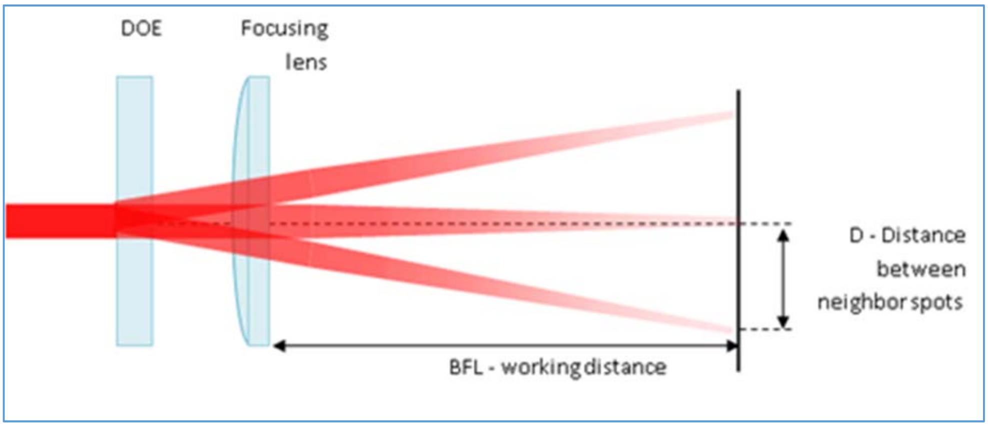
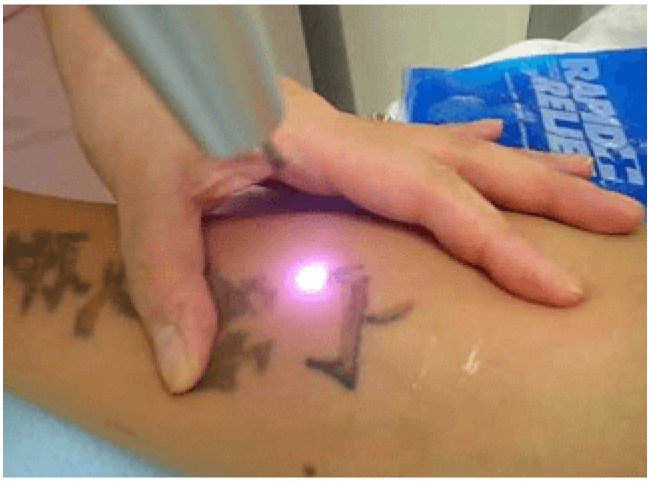


Figure 2. Multispot set-up.



Tattoo removal



When using a non-uniform, or gaussian, beam when performing tattoo removal, this can cause "hot spots" on the skin of the patient since such a small area is so highly concentrated with laser power. This has several disadvantages, including increased healing time, increased procedure difficulty due to overlap of the laser pulses, and longer procedure duration. Using a top-hat beam shaper or homogenizer DOE creates a uniform beam that decreases the presence of hot spots, allowing for a shorter healing time; this is thanks to the less concentrated and more uniform energy distribution on the skin. Also, a homogenizer DOE makes it easier for the technician to perform the procedure in an effective way that provides uniform treatment on the entire effected area and minimal overlap between pulses. Moreover, the duration of the procedure is shortened because the DOE provides a larger effective area on the skin than an uneven beam profile.

Relevant products: Diffuser, Top Hat
Common wavelengths: 1064 and 532 nm (Nd:YAG), 694 nm (Ruby), dependent on tattoo ink color.
Figure 3. A gaussian input beam converted into a round or square homogenized spot.

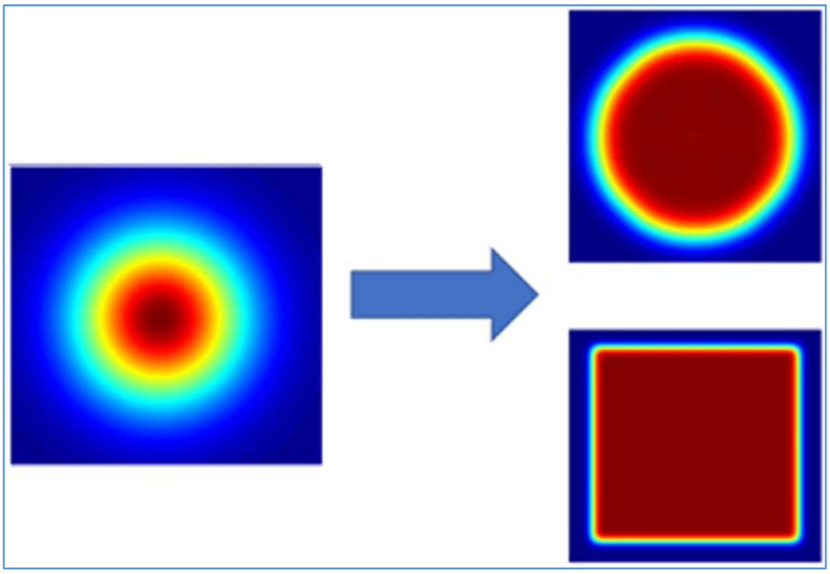
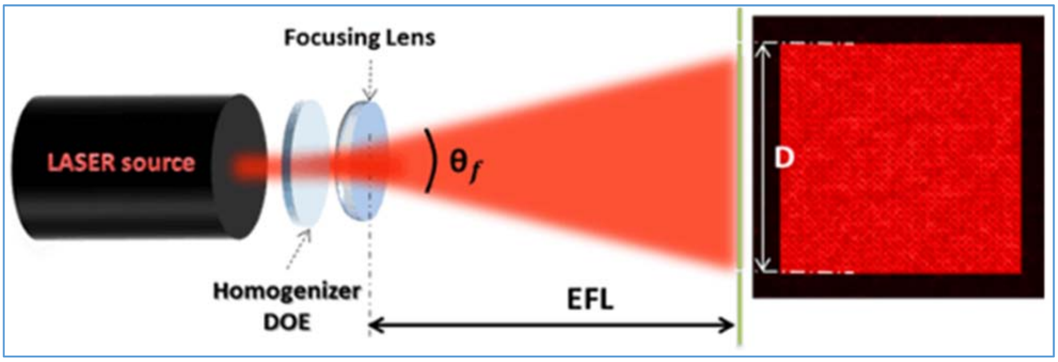
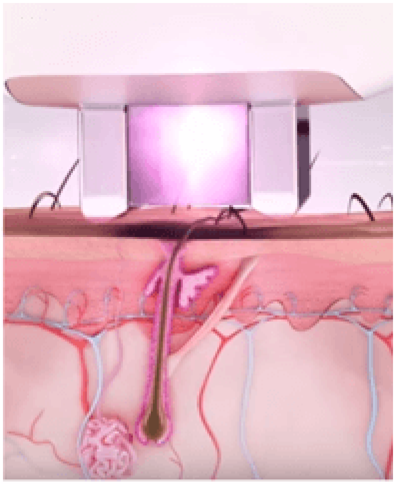


Figure 4. Homogenizer set-up.



Hair removal



Hair removal is another area of aesthetics where laser homogeneity provides a big advantage. Laser hair removal utilizes a technique called selective photothermolysis (SPTL), where targeted tissue is heated with minimal effect on adjacent tissue. The hair follicles in the target area are damaged, and the hair growth stunted. Using a non-uniform beam decreases the effectiveness of the SPTL; it becomes more difficult to know which part of the target area was affected and which was not. Also, due to the larger transfer region of a non-uniform beam, unintentional overlapping of the beam can occur, thus damaging the skin and causing uneven results. The use of a homogenizer DOE allows for a uniform beam profile which makes it easier to discern between affected regions and unaffected regions, and its narrow transfer region reduces the chance of unintentional overlapping. Additionally, the increased effected area of the beam on the skin causes a reduction in procedure time.

Relevant products: Diffuser, Top Hat
Common wavelengths: 694 nm (Ruby), 755 nm (alexandrite laser), 800 nm (diode laser), 1064 nm (Nd:YAG)

Body contouring

Laser body contouring is performed by shrinking subcutaneous fat cells with laser radiation. The use of a homogenizing DOE can assist in this treatment, and it can decrease unwanted side effects, such as skin blemishes and hyperpigmentation. By using a more uniform beam that covers a larger effected region on the body, procedure time is reduced, thus creating a more favorable experience for the patient and a more economical solution for the health care provider. Moreover, the even intensity distribution lowers the risk of burning and hyperpigmentation because the laser radiation is not so heavily concentrated in such a small area like with a regular gaussian beam.

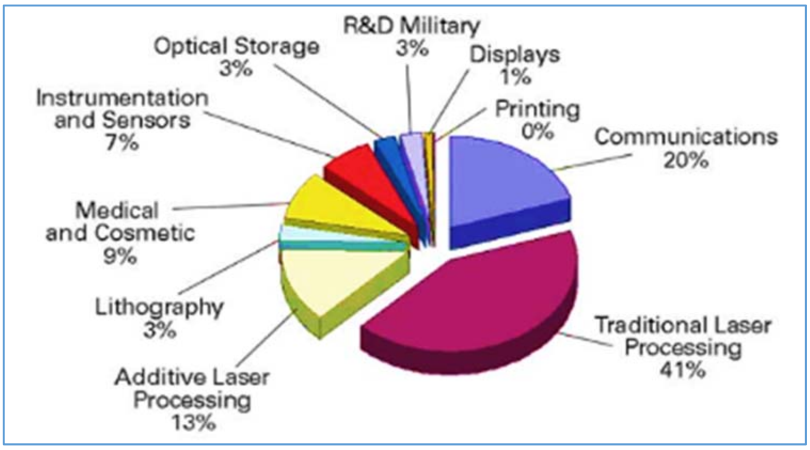
Relevant products: Diffuser, Top Hat
Common wavelengths: 635 nm, 658 nm, 915 nm, 940 nm

Laser Material Processing - Diffractive Optics

Introduction

Recently, the development of new laser systems for industrial needs has increased. Many new processes were developed, and many traditional industrial processes were replaced by laser additive systems. Material processing accounts for a significant share of the total laser market, as shown in the figure below:

Figure 1. Worldwide laser applications[1]



Diffractive optical elements (DOEs) play an important role in provision of the process-adapted laser beam shaping. This has made laser beam shaping and homogenization techniques essential to optimize many laser-material processing applications.

Usually, laser systems start from utilizing the laser, and performance is upgraded by adding a DOE.
The key parameters achieved are:

- Multiplying process speed and throughput
- Process precision
  - Wall steepness
  - Heat affected zone
  - Process effectiveness

Ablation & Structuring

Laser ablation is the process of removing material from a solid (or occasionally liquid) surface by irradiating it with a laser beam. Ablation is achieved by applying high energy short pulses on a small area.
Laser ablation has been considered and used for many technical applications, including: the production of Nano materials, deposition of thin metallic and dielectric films, fabrication of superconducting materials, routine welding and bonding of metal parts, and micromachining of MEMS structures.
Our Top-Hat and Vortex-Lens produce shaped spots with sharp, defined edges that will produce a precise material removal in the ablation process. Multi-Spot elements enable parallel processing, thus increasing throughput.
Relevant products: Top Hat, Vortex lens, Multispot

Figure 2. Laser ablation[2]

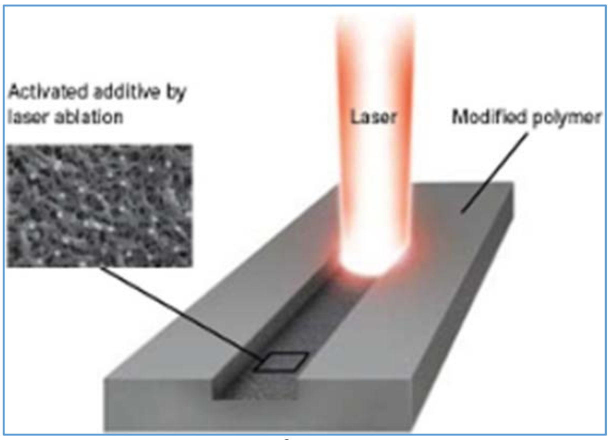
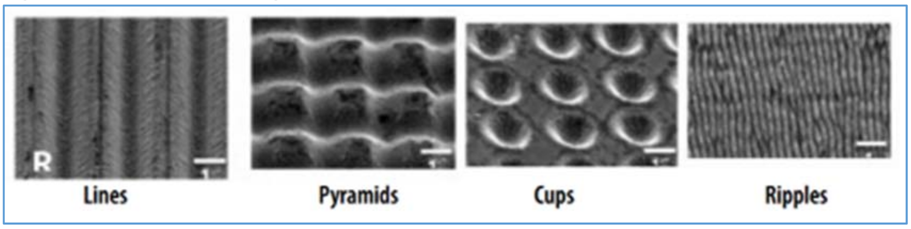


Figure 3. Laser structuring[3]



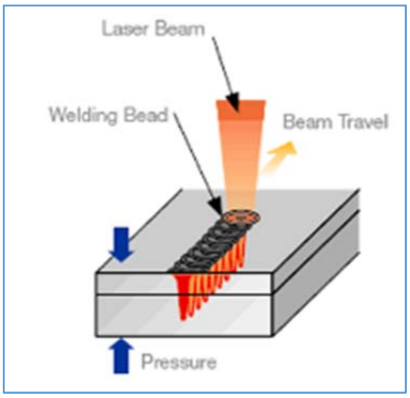
Welding

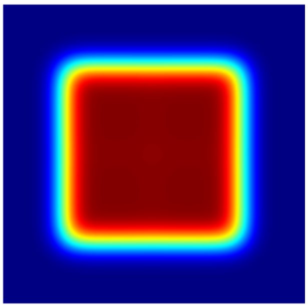
Laser welding techniques are used to join multiple pieces of metal or plastic with a laser. The beam provides a concentrated heat source, allowing for narrow, deep welds and high welding rates. The process is frequently used in high volume applications using automation, such as the automotive industry. In conjugation with cutting techniques, lasers are ideally suited for many types of welding (spots, line, soldering).
Our Homogenizer elements have uniform, flat intensity profiles regardless of non-homogeneity in the input, and can be designed to give shaped distributions that are tailored for specific welding profiles. Using a trailing spots multi spot profile, one can pre-heat the weld area and then post-treat it.

Relevant products: Homogenizer/Diffuser, Multispot

Figure 4. Laser welding[4]

Figure 5. Homogenizer energy distribution





Brazing

In laser brazing applications, two metal sheets are joined by a laser melted solder wire. The join quality has been proven to improve when the metal surfaces are cleaned and pre-heated before the brazing wire is melted. Typical applications are found in the automotive industry.
For this purpose, we have developed a special Homogenizer element that creates two small leading beams for cleaning/preheating and one large uniform beam that equally distributes the energy over the brazing wire to achieve better melting and cleaner edges.

Relevant products: Custom Homogenizer -- please contact us for more information

Figure 6. Laser ablation process[5]

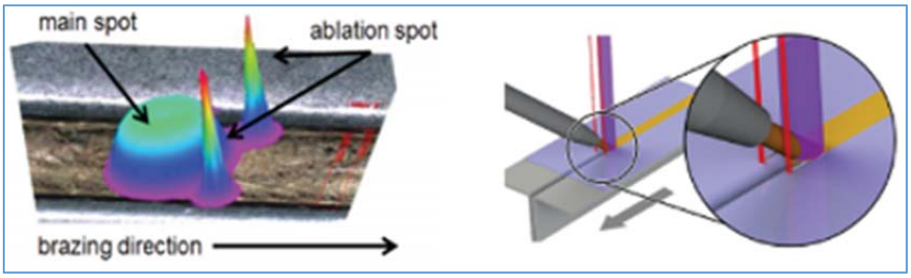
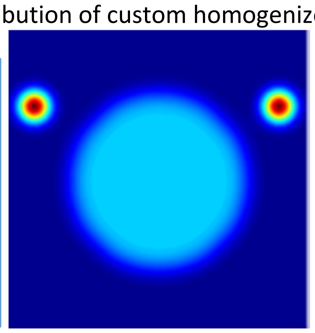


Figure 7. Energy distribution of custom homogenizer



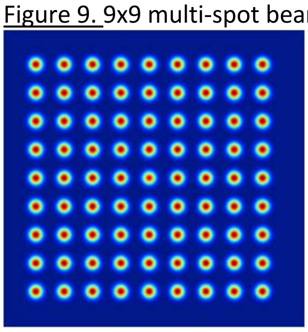
Perforation

A perforation is a small hole in a thin material or web. Laser perforation is typically used for sheet materials such as cigarette-tip paper or packaging foil for the food industry (prolongs the freshness and quality of perishable goods). Such applications require precise microscopic holes of a desired pattern with equal distances. This is why our beam-splitter DOE are the obvious solution.

Relevant products: Multispot

Figure 8. Laser perforation for food packaging[6]

Figure 9. 9x9 multi-spot beam splitter



Cutting

Laser cutting works by directing the output of a high-power laser, usually through an optical system & moving stage, to scan the focus on a workpiece and cut it. It is typically used in industrial manufacturing applications. The goal is to

extend the depth of focus of the system, without increasing the focal length of the focusing optic, or to improve cut quality and reduce exfoliation and material re-melting in the cut area.
Metal laser cutting is performed by locally heating the material at the focal point of a focused laser beam above its melting point. The resulting molten material is ejected by a gas flow, so that an open cut is formed.
Glass laser cutting or laser dicing is usually done with high powered lasers in the IR regime. Because glass has a weak absorption of light in most wavelengths, more powerful lasers are needed to cut glass. By using a focal DOE, the energy is spread in the bulk of the glass wafer. This enables one-pass cuts, without the need of adjusting the focal depth of the spot and z-movement during the cut. This is especially useful for stealth dicing, where the laser light modifies the glass to make it brittle, instead of ablation cutting, and then the glass is mechanically separated along the laser process line.

Relevant products: for metal cutting -- Vortex Lens, Top Hat; for glass cutting -- Elongated Focus, Multi-focal Lens

Figure 10. Laser metal cutting[7]

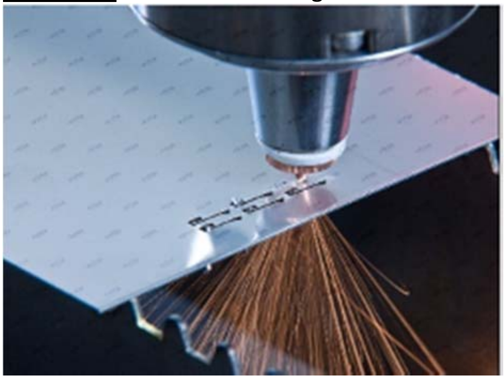


Figure 11. Vortex lens energy distribution

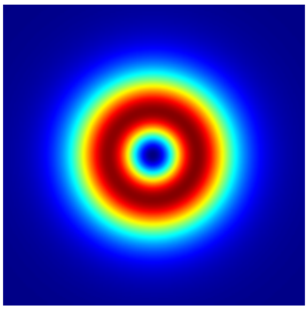


Figure 12. Laser glass cutting[8]

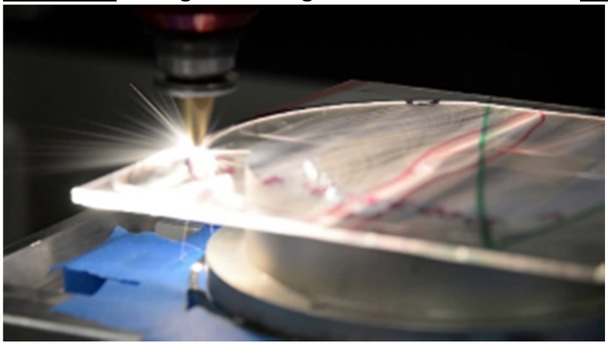
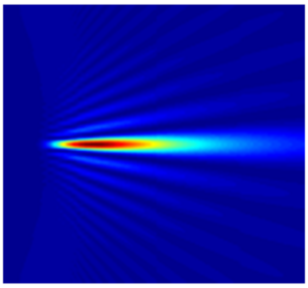


Figure 13. Elongated focus energy distribution along optical axis



Drilling

Laser drilling is the process of creating thru-holes by repeatedly pulsing focused laser energy on a material and evaporating the melted material. The greater the pulse energy, the more material is melted and vaporized. Over the years, several laser drilling techniques have evolved, including signal pulse, percussion, trepanning and helical drilling. Laser-drilled holes are used in many applications, including drilling of silicon wafers and rubber.

For higher throughput and more productive processes, Holo/Or's Multi-Spot beam-splitters have been proven to provide accurate results. Top-Hat beam shapers can improve the edge quality and diameter accuracy of the holes, while vortex phase plates enable drilling of ring shapes.

Relevant products: Multispot, Top Hat, Vortex lens

Figure 14. Different laser drilling techniques[9]

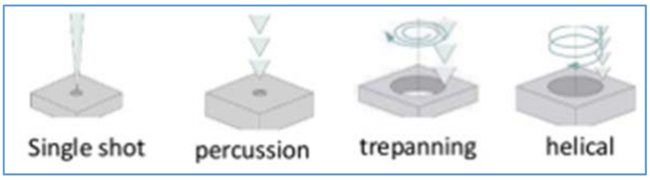
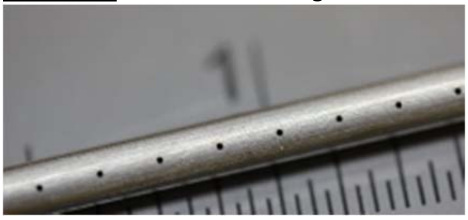


Figure 15. Laser micro-drilling of stainless steel tube[10]



Laser Lift-Off

Laser Lift Off (LLO) is a technique to selectively remove one material from another. A laser beam is projected through a transparent material and absorbed in an adjacent material on the backside, such as GaN on Sapphire. The laser lift-off separation process allows processing large area devices with the required finesse and reproducibility. For this reason, it is very common in the LED industry for separating light-emitting films and also in displays for television and mobile devices.

LeanLine™ is our innovative solution for transformation of a Multi-Mode round input beam into a narrow laser line, especially in UV and green wavelengths (343, 355, and 532 nm). Our solution is based on proprietary diffractive beam shaping concepts and can be tailored to any wavelength from 193nm deep UV to 1600nm IR lasers. By utilizing our solution, one can use lower cost Multi-Mode lasers to achieve an efficient power density in a thin line.

Figure 16. LeanLine module

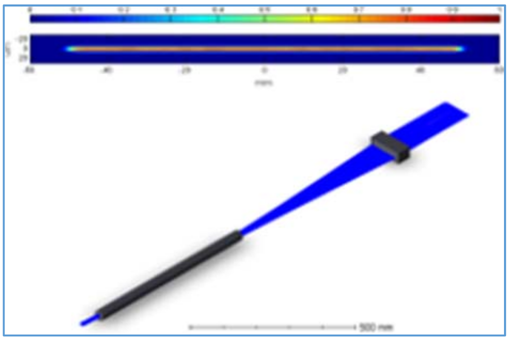
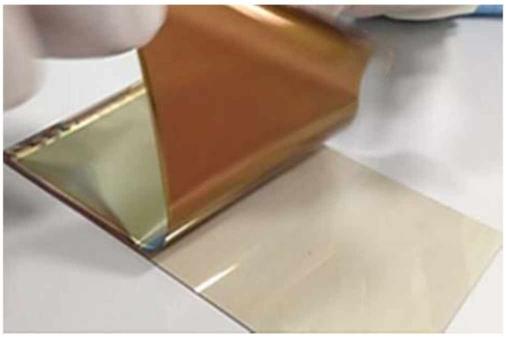


Figure 17. Separation of a substrate from a glass panel[11]



Surface treatment (hardening & remelting)

The principle of laser surface treatment is the modification of a surface as a result of interaction between a beam of high power density coherent light and the surface within a specified atmosphere (vacuum, protective or processing gases). Some of the typical uses of laser surface treatment are laser hardening and laser re-melting.

Laser hardening is a thermal surface hardening process in which the material is heated up for a short time above the critical temperature and is then rapidly cooled down, preventing the metal lattice from returning to its original structure and producing a very hard metal structure.

Laser re-melting is another thermal method of surface treatment. The component surface is briefly heated above the melting temperature. The melt then solidifies and re-crystalizes without major changes in the chemical composition.

Relevant products: Homogenizer/Diffuser, Top Hat

Figure 18. Laser hardening[12]

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3. Jens Bliedtner et. al, "Ultrashort Pulse Laser Material Processing", Laser Technik Journal

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7. http://www.acsys.de/en/laser-cutting/laser-fusion-cutting.html
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12. http://www.lasertherm.com/offered-services/laser-hardening/

Structured Light laser DOEs

Features

- Complex structured light laser patterns
- High efficiency
- High laser damage threshold (glass)
- Coated elements
- Compact size, light-weight
- Small to Large angle

Applications

- 3D Mapping / sensing
- Machine Vision
- Volume and movement tracking
- High-End Alignment
- Life Sciences (Confocal Microscopy, Bio-Detection)

As cutting-edge technology explodes in the direction of autonomous driving and machine vision, structured light has become an integral part of the development and implementation of these innovative fields. Structured light is a common method in which a known pattern is projected onto an object or scene, and by measuring the returning deformed pattern (resulting from the geometry of the surface of the object), a vision system can calculate depth, movement, and several other parameters.

We have the capability to design and manufacture complex structured light laser patterns according to the customer's request and application. These patterns can vary in many ways--including shape, texture, and angle--according to the customer's application. Complex structured light laser patterns can be easily obtained by using diffractive optical elements (DOEs).

Structured light is a common method in which a known pattern is projected onto an object or a scene, and by measuring the deforming pattern, a vision systems can calculate: depth, movement, etc. This technology is applied in the currently widespread 3D mapping / sensing, shape measurements and machine / computer vision. The light patterns can have various shapes, textures and periods.

Specifications	
Materials	Fused Silica, ZnSe, Plastics
Wavelength range	193nm to 10.6um
DOE design	Binary and up to 16-level
Element size	Up to 100mm
Diffraction efficiency	75%-98%

Coating (optional)	AR/AR
Custom Design	Tailored shape, texture and period
Pattern angles@532nm	Few mRad to 160°

LiDAR

LiDAR, or Light Detection and Ranging, describes the method with which distances can be measured with pulsed laser light. The laser source illuminates the target from some distance, and a sensor measures the reflected pulses of light. Small differences in the pulses' return times and wavelengths allow for 3D mapping of the target.

Another technique for measuring unknown distances is triangulation. In this approach, a triangle is formed between a laser measuring system, a camera or optical sensor, and the target object. With the known distance between the camera and the laser, and the measured distance between the laser and the target, the third side of the triangle (target to camera) can be easily calculated.

LiDAR applications are endless, ranging from machine vision and autonomous driving to aerial and satellite mapping. Compact LiDAR systems can be mounted on drones for discrete and inexpensive surveying. In many LiDAR applications, multiple laser beams are used simultaneously to scan the examined area. We have an entire line of multi-spot beam splitters and shapers that effectively transform a beam from a single laser source into multiple laser beams or lines. Custom designs can be tailored to fit specific output shapes and sizes, as well.

Relevant products: Multi Spot, Multi Lines, Plastic DOE

Figure 1. Aerial LiDAR image of a bridge.[1]

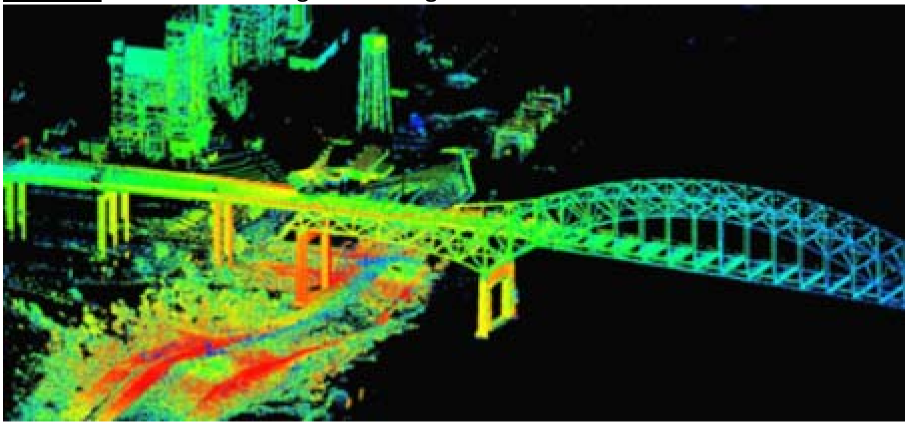
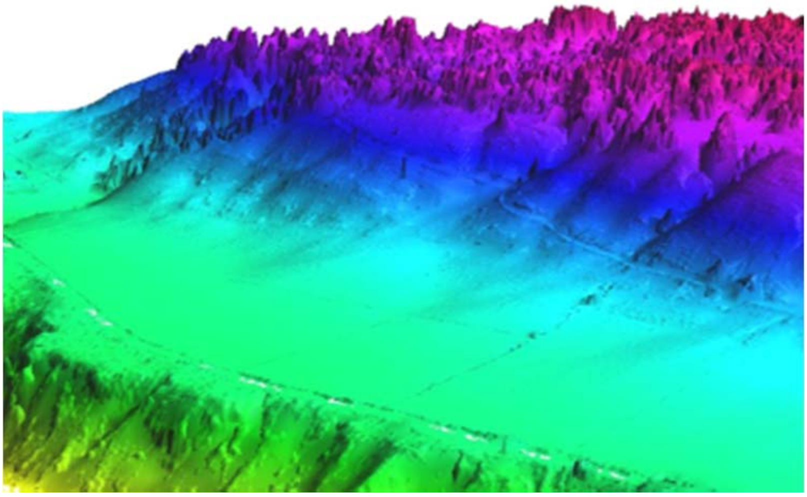


Figure 2. Elevation mapping using LiDAR.

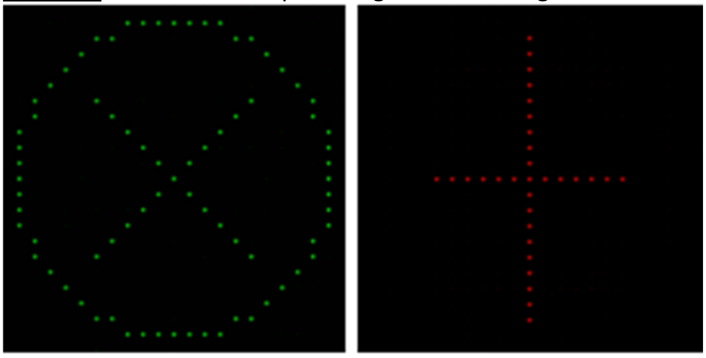


Projection Marking

For certain applications it is useful to create a projection marking system instead of physical marking. This way, markings can be instantly changed or turned off without physically attending to the marked object. For example, road markings that change with the hour or floor markings in a warehouse that change with current inventory. Projection marking is crucial for several medical treatments, such as radiation therapy, to make sure the target area is being treated with high accuracy. We can create a custom structured light pattern for projection marking in almost any shape or design.

Relevant products: Custom design, Plastic DOE

Figure 3. Custom Multi Spot designs for marking.



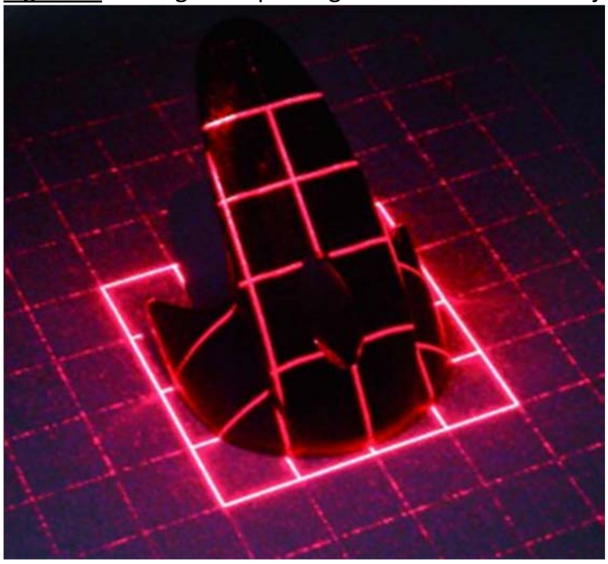
Surface Inspection

Applying a structured light pattern for the use of surface inspection is an efficient way to accurately assess a large area for cracks and imperfections. A 2D light pattern is illuminated on a surface, and the reflection of the light back into a detector is then processed and analyzed (by the triangulation method). Places of imperfection on the surface will not reflect as expected, and the location and magnitude of the imperfection can then be measured based on this discrepancy.

A custom structured light pattern can be designed to fit the inspection needs, varying in illumination pattern features and divergence angle to modify the inspected surface area.

Relevant products: Multi Spot, Multi Lines, Plastic DOE, Custom grid design

Figure 4. Laser grid inspecting the contours of an object.



Cylindrical/Tube Mapping

Structured light has several important fucntions, such as detecting the location of a leak in a gas pipe, identifying cracks in a freeway tunnel early on that can prevent expensive future structural repairs, for endoscopy and colonoscopy diagnostics, and accurate measurements inside both narrow and wide cylindrical structures. Specifically, a structured light pattern of concentric circles can be used for 3D mapping of the tube walls. This type of light pattern has recently been proven to be most appropriate for these mapping applications. A concentric circles pattern is defined by its full angle and number of rings, which can be tailored to fit the application needs.

Relevant products: Diffractive Axicon, Multi Circles

Figure 5. Pipe inspection.[2]

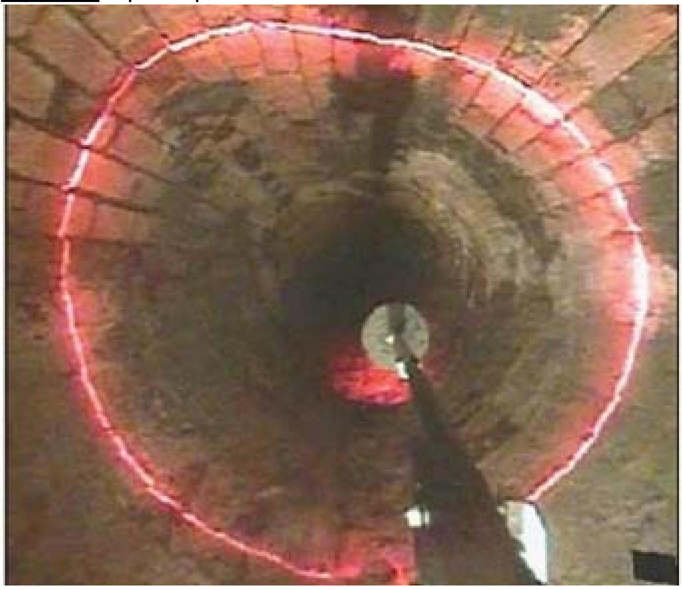
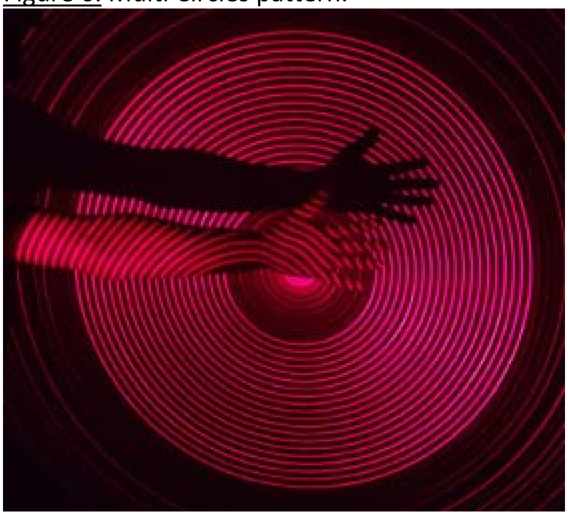


Figure 6. Multi Circles pattern.



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Contact us for more information on structured light laser DOEs or for a custom DOE solution

Fiber Coupling

Diffractive beam splitters (Multispots) can be used fvor effective coupling of light from a laser into fiber bundles. Use of Multispots can uniformly distribute energy into channels of a fiber bundle, improving the coupldingefficiency. HOLO/OR released new Multispot designs in hexagonal of 7, 19, and 37 spots.

Typical applications of fiber bundles include:

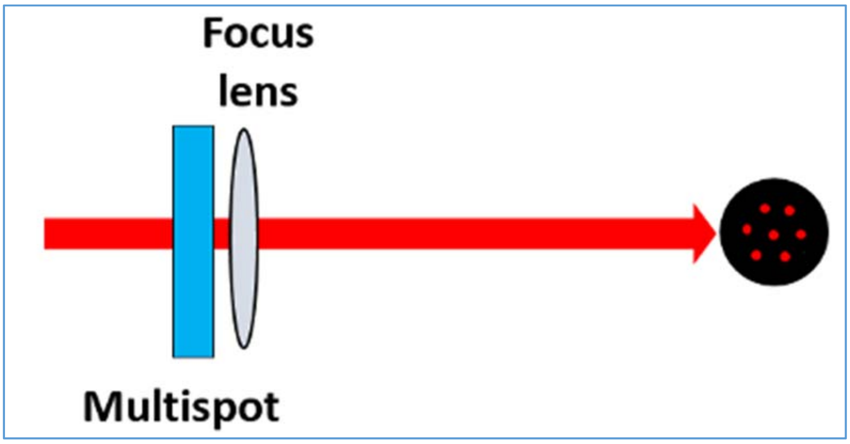
- Spectroscopy
- Fluorescence microscopy
- Particle detection scanning
- Colorimetry
- Illumination

Bundle of 7

Bundle of 19

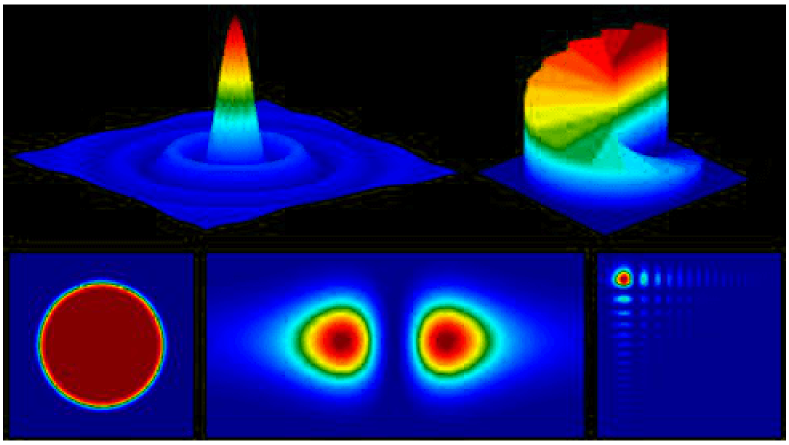
Bundle of 37

A typical optical setup would include a Multispot and a lens, as in the below figure:



You can find our standard elements on the 2D beamsplitter products page with the remark "hexagonal".

Other Research & Scientific Applications - Diffractive Optics



Introduction

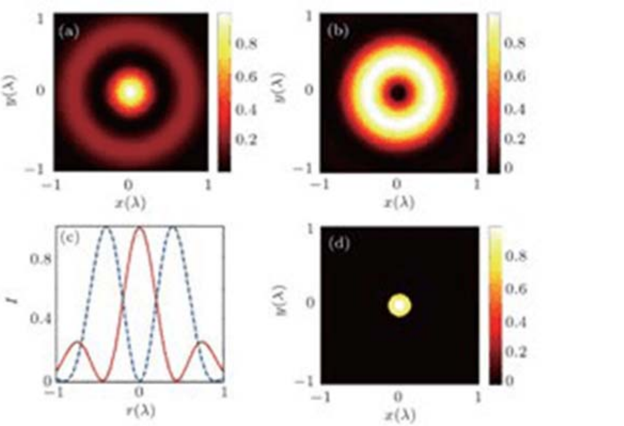
Many of our customers use DOE in their scientific research fields – for both academic research purposes and advanced industrial application development.
In this application section, you will find a review of DOE usage in several selected applications, based on inquiries from our customers over time.
For more information, please contact our sales.

STED Microscopy

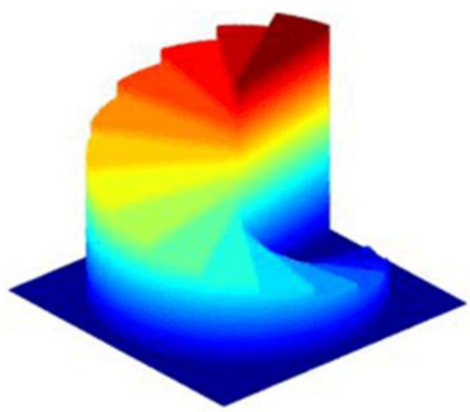
In recent years, Stimulated Emission Depletion (STED) microscopy has become a popular method due to its unique microscopic properties and advanced performance, such as higher imaging speed and super-resolution imaging capacity, and has wide applications in many fields.
STED microscopy is based on depleting fluorescence in specific regions of the sample, while leaving a center focal spot active to emit fluorescence. This is done by using two overlapping beams which act as excitation and depletion laser consecutively.
In this configuration, the STED laser must possess zero-fields in the center and maximum in the periphery which exhibits a doughnut-shaped phase pattern. The most common means is to use diffractive optical elements (DOE) to get a doughnut shape – hence a vortex phase plate is the obvious solution.
Other possibilities for 3D imaging are round p phase plates.

Relevant products: Vortex Lens, p Phase-Plate

Figure 1. Spiral Phase Plate used in STED microscopy[2]



Formation of excitation spot (a), doughnut-shape de-excitation spot (b), the line scan of intensity distributions (c), remaining focal area allowing fluorescence (d) [2]



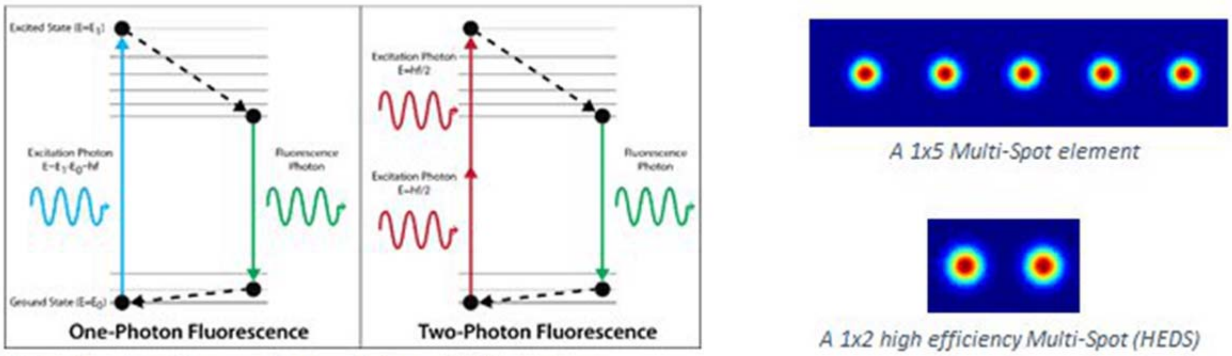
A Vortex Lens phase profile with m=1

Two-Photon Fluorescence Microscopy

Similar to the standard confocal microscopy, two-photon microscopy uses a laser to excite a fluorescent tag within a sample and measures the emitted light. However, unlike the lasers used for confocal microscopy (which provide single-photon excitation), the lasers used in two-photon microscopy excite by using near simultaneous absorption of two long wavelength (~800 nm) photons. Longer wavelengths are scattered to a lesser degree than shorter ones, which is a benefit to high-resolution imaging.
In addition, these lower-energy photons are less likely to cause damage outside the focal volume and penetrate more deeply into tissues.
Typical applications include living cells and tissue imaging.
By using our 1D multi-spot elements, one can project several spots with desired separation distance and excite multiple particles at the same time.

Relevant products:1D Multi-Spot, HEDS

Figure 2. Beam Splitter used in Fluorescence microscopy[4]



Jablonski energy diagram of a one-photon excitation vs. two-photon excitation process [4]

A 1x5 Multi-Spot element

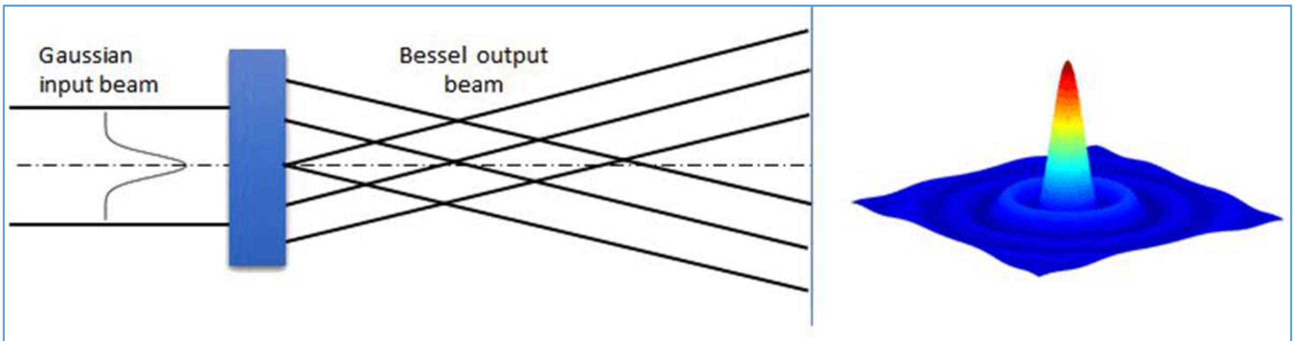
A 1x2 high efficiency Multi-Spot (HEDS)

Bessel-Like Beam Generation

Bessel-Like beams are unique beams which have some immunity to diffraction – as it propagates, it does not diffract and spread out (as oppose to usual light waves). The description of such a beam is by using a Bessel function, which leads to a predicted cross-sectional profile of a set of concentric rings.
When focused, Bessel beams have a far longer depth of focus compared to a Gaussian beam, with a corresponding decrease of energy density at focus.
Typical applications include imaging and increased depth of focus for non-linear frequency conversion. One method of generating a Bessel-like beam is by using a Diffractive Axicon.

Relevant products: Diffractive Axicon, Elongated Focus

Figure 3. Bessel Beam Generation



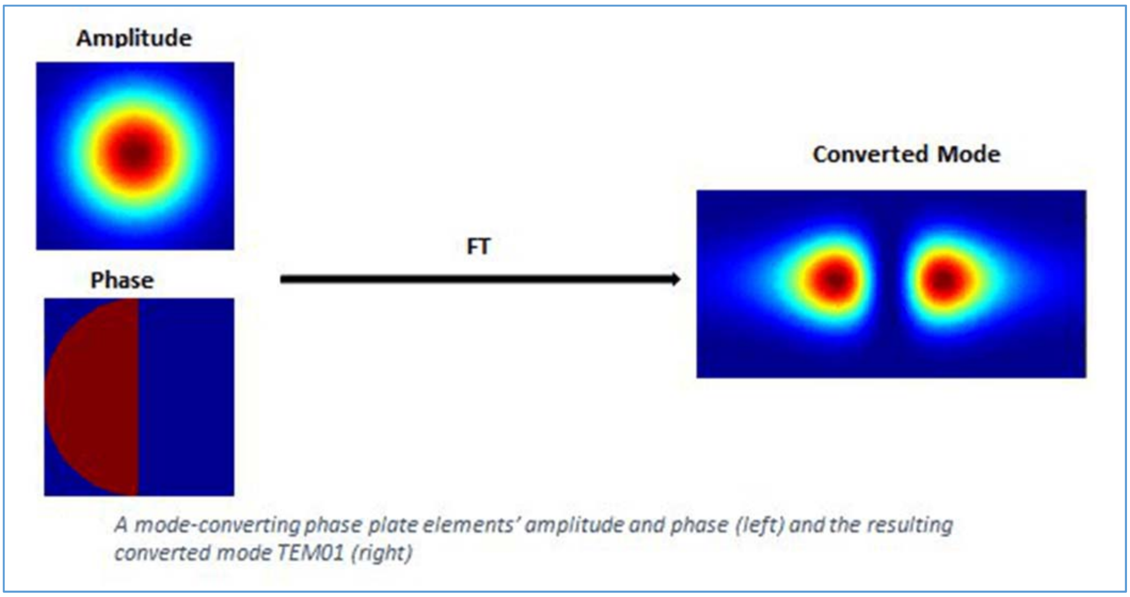
Bessel-like beam generation using a Diffractive Axicon element (left) and a closer look on the output beam distribution (right)

Optical Mode Generation & Conversion

For many applications, it is useful to convert the fundamental laser mode TEM00 to a higher order of Hermite-Gaussian beams modes (whose amplitude profiles are separable in x and y using Cartesian coordinates) or Laguerre-Gaussian beam modes (which are circularly symmetric).
Typical uses include flow cytometry, optical communications, biological cell microscopy and scanning applications.
We have developed a new product line for Hermite-Gaussian mode conversion and p-phase plates that generates higher Hermite-Gaussian modes (any mode is possible).
For Laguerre-Gaussian modes the relevant products are Spiral Phase Plates (i.e. Vortex Lens).

Relevant products: mode-conversion DOEs, Vortex Lens

Figure 4. Mode Convertor[16]

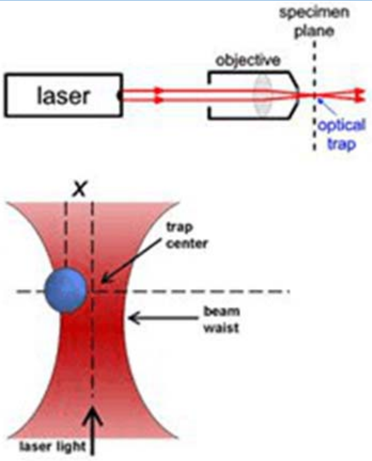


Optical Tweezing / Atomic Traps

Optical Tweezers are the use of light to manipulate microscopic objects as small as a single molecule or atom. A laser beam, usually a high-power IR light, is focused by a high-quality microscope objective to a spot in the specimen plane. This spot creates an "optical trap" which is able to hold the small particle at its center.
Typical applications include biological and nanotechnological fields - tracking of movement (e.g. of bacteria) and measurement of small forces.

Relevant products: Diffractive Axicon, Vortex Lens

Figure 5. Optical Tweezing with Axicon and Vortex Spiral phase[10,11]



Typical optical trap set-up (up) [10], single beam optical tweezers (down) [11]

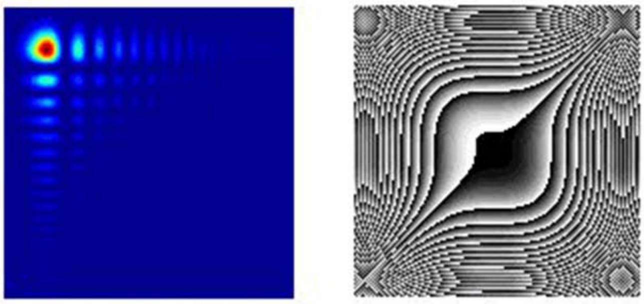
A diffractive Axicon shaped spot

Airy Beams Generation

An Airy beam is a non-diffracting waveform which doesn't spread out as the beam propagates and gives the appearance of curving as it travels.
The Airy beam also has the characteristic of freely accelerating. As it propagates, it bends so as to form a parabolic arc.
A cross section of an ideal Airy beam would reveal an area of principal intensity, with a series of adjacent, less luminous areas trailing off to infinity. Typical applications include manipulation of small particles such as microfluidic engineering and cell biology.

Relevant products: special phase elements

Figure 6. Airy Beam[14]



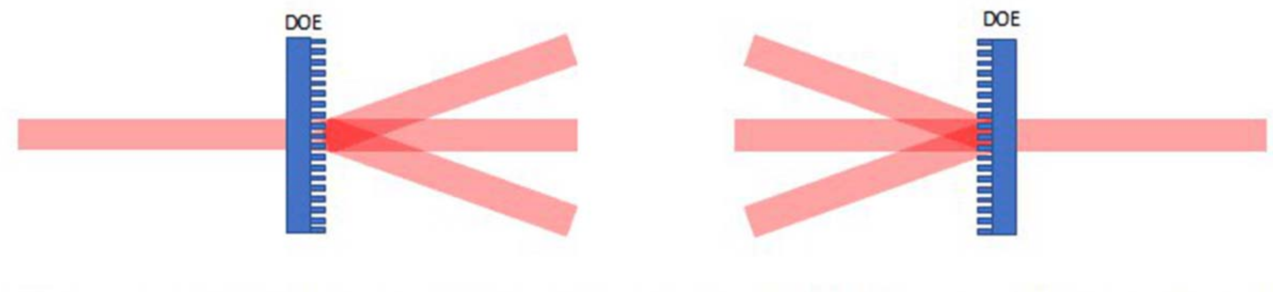
2D Airy beam intensity distribution (left) and the corresponding phase (right)

Coherent Beam Combining

In coherent beam combining applications, the goal is to combine several low-power laser beams into a single high-power beam with not only correspondingly higher power, but also with preserved beam quality. This technique allows to increase the power of the laser far beyond what it is possible to obtain from a single conventional laser.
Let us consider a triple-spot element (1x3 spots) for example: an incoming Gaussian beam will lead to three beamlets exiting the DOE with pre-designed separation angles and intensities. While reversing the orientation of the DOE, making the beams enter the un-diffracted side, a single output can be obtained if the incoming beams are mutually coherent and adjusted such that they enter the element at the same angles and have the same amplitudes.
This combination can be repeated as required for several incoming beams.
Typical applications are military/defense: anti-missile and other directed-energy laser weapons.

Relevant products: Multi-Spot

Figure 7. Beam Combining



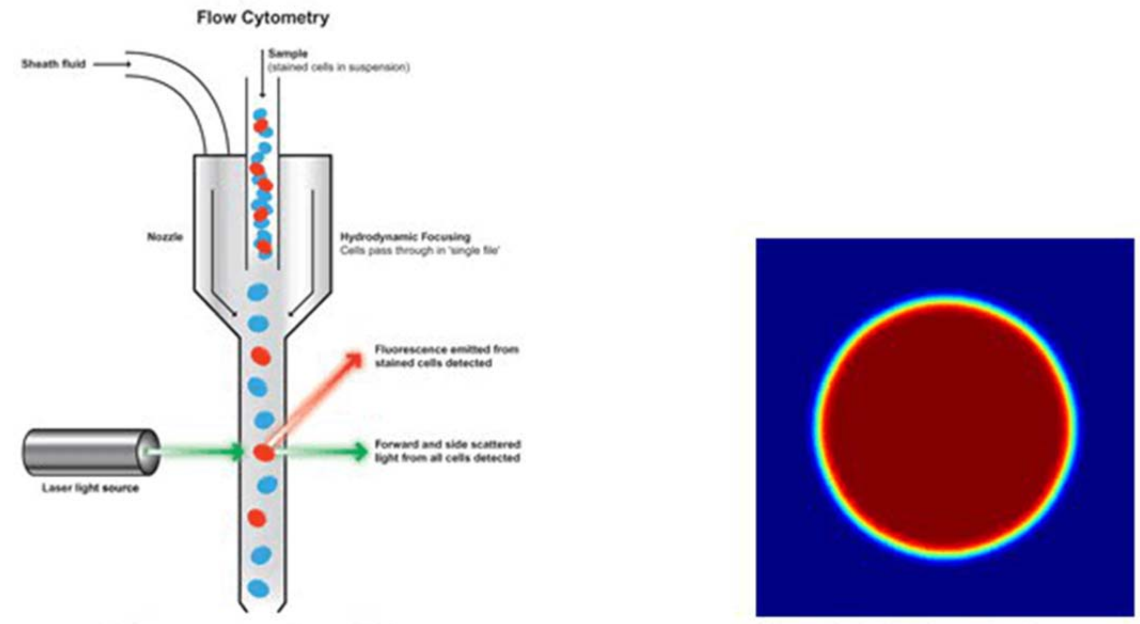
Typical operation of a 1x3 Multi-Spot element for beam splitting (left), reverse operation of a 1x3 Multi-Spot element for beam combining (right)

Flow Cytometry Analysis

Flow cytometry is a technology that is used to analyze the physical and chemical characteristics of particles in a fluid as it passes through a laser light. When labeled cells are passed by a light source, the fluorescent molecules are excited to a higher energy state. Upon returning to their resting states, the fluorochromes emit light energy at longer wavelengths, allowing measurement of cell size and internal complexity of the structure.
Flow cytometry is a widely used to technique to study many aspects of cell biology and is routinely used in the diagnosis of disease (especially blood cancers) and in basic and clinical research.

Relevant products: 1D Multi-Spot (for parallel channel cytometry), Top-Hat

Figure 8. Flow Cytometry with Top-Hat[24]



A flow-cytometer scheme [24]

A round Top-Hat shaped spot