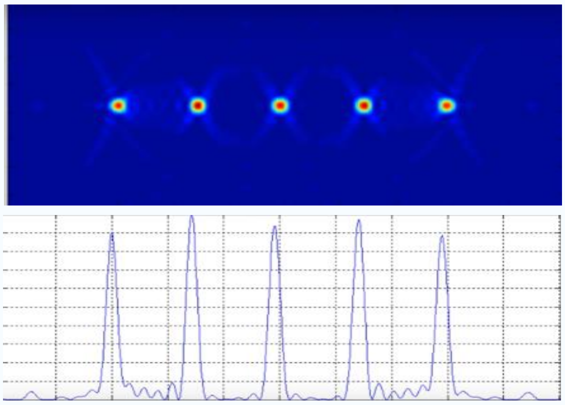
THE EXPERTS IN DIFFRACTIVE & MICRO-OPTICS

Multi Focal Lens

Multi-focal 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 focus at a fixed number of focal lengths, predetermined during the design of the DOE based on the customer's system requirements.



Z Axis

FEATURES

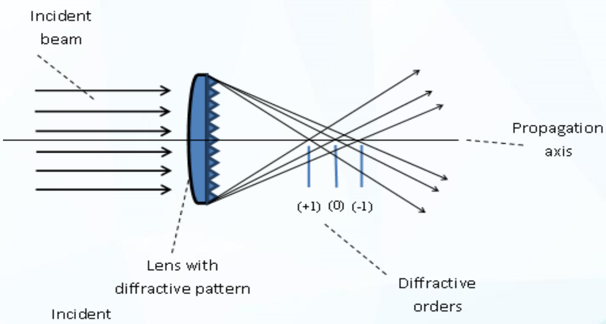
Arbitrary number of foci
Control in the distance between foci
High power threshold

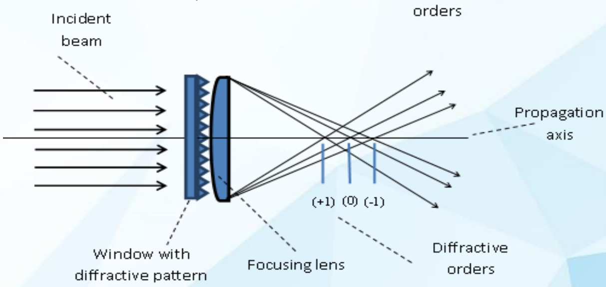
APPLICATIONS

Ophthalmic application
Optical sensors
Parallel zoom systems
Material processing (Laser cutting)

Multi-focal DOE come in two configurations:

1. A DOE consisting of a Plano convex lens with predetermined focal length, and a diffractive pattern, etched on its Plano side.
2. 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).





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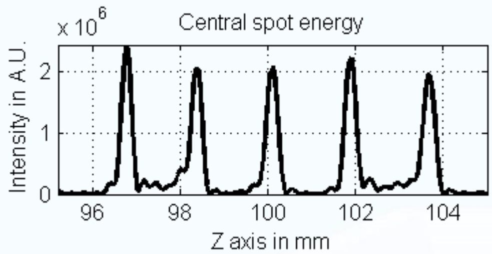
THEORY & DESIGN CONSIDERATIONS

The multi-focal spots location is a function of the refractive focal length, $f_{Refractive}$, and predetermined diffractive focal length, $f_{Diffractive}$. The foci spot at the “zero” order refers to the refractive FL of the used lens. The other diffractive foci spots, orders +/-1,2,3…, appear symmetrically around the refractive “zero” order. The distances between the foci spots are described by the equation below:



$$\frac{1}{f_{\text{"}m\text{"Diffractive}}} = \frac{1}{f_{\text{Refractive}}} + \frac{1 \cdot m}{f_{\text{Diffractive}}} \qquad m = \pm 1, \pm 2, \pm 3 \ldots$$

Where:

$f_{\text{"}m\text{"Diffractive}}$: FL for “m” diffractive order ; $f_{\text{Refractive}}$: FL of a refractive lens ; m : order of multi-focal spot

The Multi-focal spots location can also be calculated by using ***HOLO/OR***’s online optical calculator: https://www.holoor.co.il/optical-calculator/multifocal-lenses/

In the case of a multi-focal DOE with an even number of foci spots, the removal of the Zero-Order spot is achieved by special design and processing.

For binary designs (2 levels pattern structure), power efficiency varies between 75% (for Bi-focal and multi-focal) to 85% (Tri focal).

Each focal spot contains a fraction of the input beam power. In example, for a tri-focal DOE (~85% efficiency), first focal spot will have ~28% of the input beam power at precise diffractive FL, “+1” order. Forward on the propagation axis a focus will appear at the nominal FL of the lens. Here the focus spot will have ~28% of the input beam power. The last focus appears at the “-1” order (diffractive order) and will have the same power. At each order the rest of the power (~56%) will be spread around the focus in the form of a halo.

Multi-focal can also be used as quasi-elongated focus elements, effectively creating a larger depth of focus in material processing operations.

SPECIFICATIONS RANGE

Materials	Fused Silica, ZnSe, Plastic
Wavelength range	193nm to 10.6um
Number of Foci	Custom specific (2-11)
Doe design	Binary, 8-level, 16-level
Diffraction efficiency	75%-98%
Element size	5mm to 38.1mm
Coating (optional)	AR/AR
Custom design	Tailored power distribution, Foci spacing