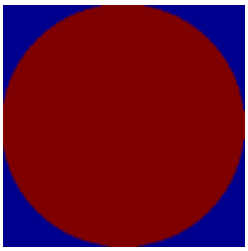
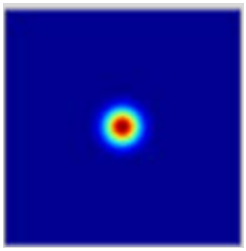
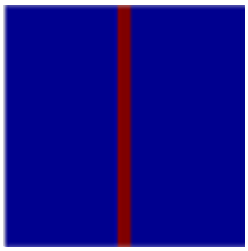
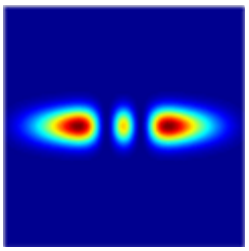
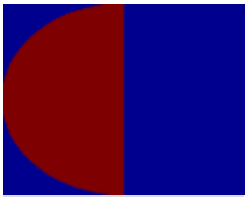
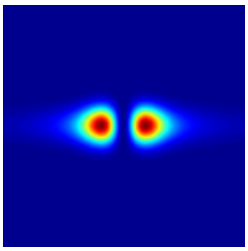
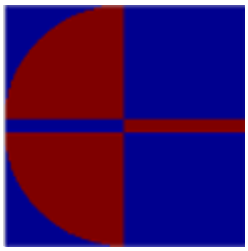
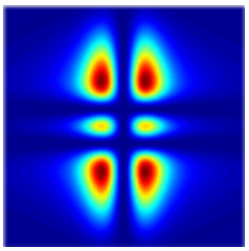
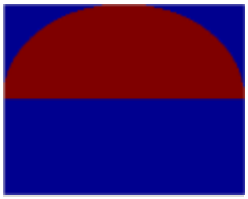
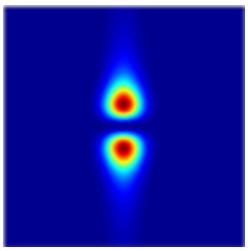
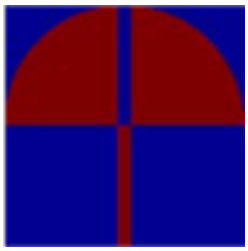
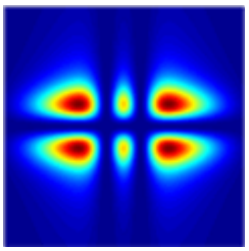
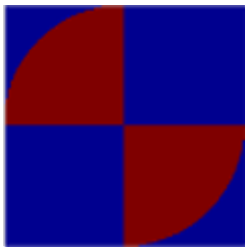
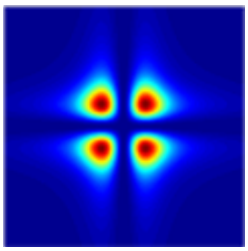
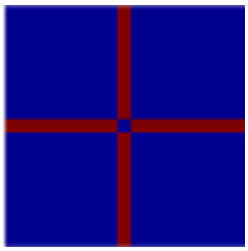
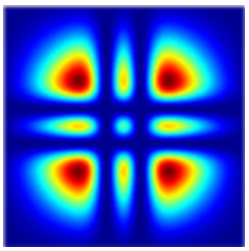
Optical mode converter & π phase-plate

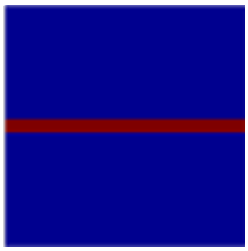
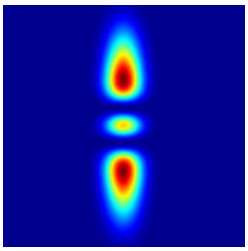
Hermite-Gauss mode conversion

Introduction

Arbitrary solutions of the paraxial Helmholtz equation can be expressed as combinations of Hermite-Gaussian modes (whose amplitude profiles are separable in x and y using Cartesian coordinates).

For many applications, it is useful to convert the fundamental laser mode TEM00 to a higher order of Hermite-Gaussian beams:

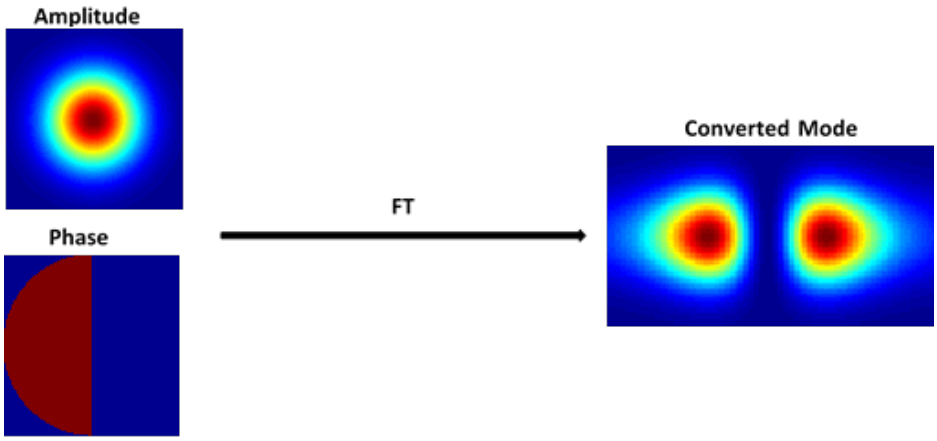
	Phase Element	Output Intensity		Phase Element	Output Intensity
TEM_{00}			TEM_{20}		
TEM_{01}			TEM_{12}		
TEM_{10}			TEM_{21}		
TEM_{11}			TEM_{22}		

TEM_{02}		

Typical Optical set-up:

Typical Operating Principle

The operating principle is quite straight-forward - a Fourier Transform (FT) is applied on the initial field amplitude and phase to obtain the desired field (or intensity) at far-field. In this way, the fundamental Gaussian beam TEM_00 is converted to a higher order of Hermite-Gaussian modes. For example - conversion of TEM_00 to TEM_10:



For the phase-plate element, the height of the step is defined as:

$$h = \frac{\lambda}{2 \cdot (n-1)}$$

where n is the refractive index of the material.

Design Considerations:

For a high-quality performance, the laser output should be Single Mode (TEM00 with an M2 value <1.3. If the M2 is larger, it may still be possible to reduce the M2 value by inserting a spatial filter in between the laser and the DOE lens component.

All optics in the beam path should be of high quality, i.e. have a low irregularity figure, in order not to introdcue wav-front errors which would degrade the diffractive phase element's performance.

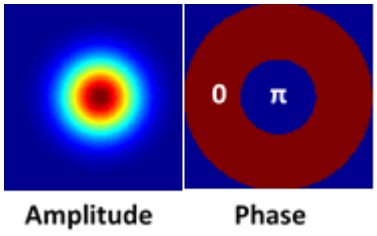
General Specifications:

Materials:	Fused Silica, Sapphire, ZnSe, Plastics
Wavelength range:	193[nm] to 10.6[µm]
DOE design:	Binary (2-level)
Element size:	Few mm to 100 [mm]
Coating (optional):	AR/AR Coating
Custom Design:	Available

π Phase-Plate

Introduction:

For many applications, it is necessary to use a phase element with a π-phase at the center. For imaging purposes using this element will result in an increased depth-of-focus, and for particle manipulation purpose, using this element will result in optical tweezing\trapping.



Standard Products:

Part Number	Diameter [mm]	Aperture size [mm]	Material	Description
PE-202	25.4	23.6	Fused Silica	Half-space π difference mode converter, TEM01 (or TEM10)
PE-230	25.4	23.6	Fused Silica	Quarter-space π difference mode converter, TEM11
PE-215	11	9.2	Fused Silica	Round π phase at the center,diameter 4817 μm
PE-216	25.4	23.6	Fused Silica	Round π phase at the center,diameter 5680 μm
PE-217	20	23.6	Fused Silica	Round π phase at the center,diameter 6200 μm
PE-218	25.4	18.2	Fused Silica	Round π phase at the center,diameter 8428 μm
PE-219	25.4	23.6	Fused Silica	Round π phase at the center,diameter 10838 μm
PE-220	25.4	23.6	Fused Silica	Round π phase at the center,diameter 7224 μm
PE-221	11	9.2	Fused Silica	Round π phase at the center,diameter 3612 μm
PE-222	11	9.2	Fused Silica	Round π phase at the center,diameter 4214 μm
PE-223	11	9.2	Fused Silica	Round π phase at the center,diameter 3000 μm
PE-224	11	9.2	Fused Silica	Round π phase at the center,diameter 5400 μm
PE-225	25.4	23.6	Fused Silica	Round π phase at the center,diameter 6384 μm
PE-226	12.5	10.7	Fused Silica	Round π phase at the center,diameter 6840 μm

PE-227	25.4	23.6	Fused Silica	Round π phase at the center,diameter 8900 μm
PE-228	11	9.2	Fused Silica	Round π phase at the center,diameter 1200 μm
PE-229	11	9.2	Fused Silica	Round π phase at the center,diameter 1800 μm