SUPERRESOLUTION BEAMS

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Outline

- Introduction
- Concept of superresolution beams
- Transformation of TEM_{00} to TEM_{10}
- Resonator design and experimental setup
- Results
- Conclusions
- Future work

Introduction

- Small laser focal spots are of particular importance for many application when focusing a laser beam.
    - Optical Tweezers - Probing and manipulation of atoms
    - Lithography
    - Laser cutting
    - 3-D laser prototyping Non-linear microscope.

- Continuation of the theoretical work published

Creation of a sharper focus by using a rectified TEM_{p0} beam

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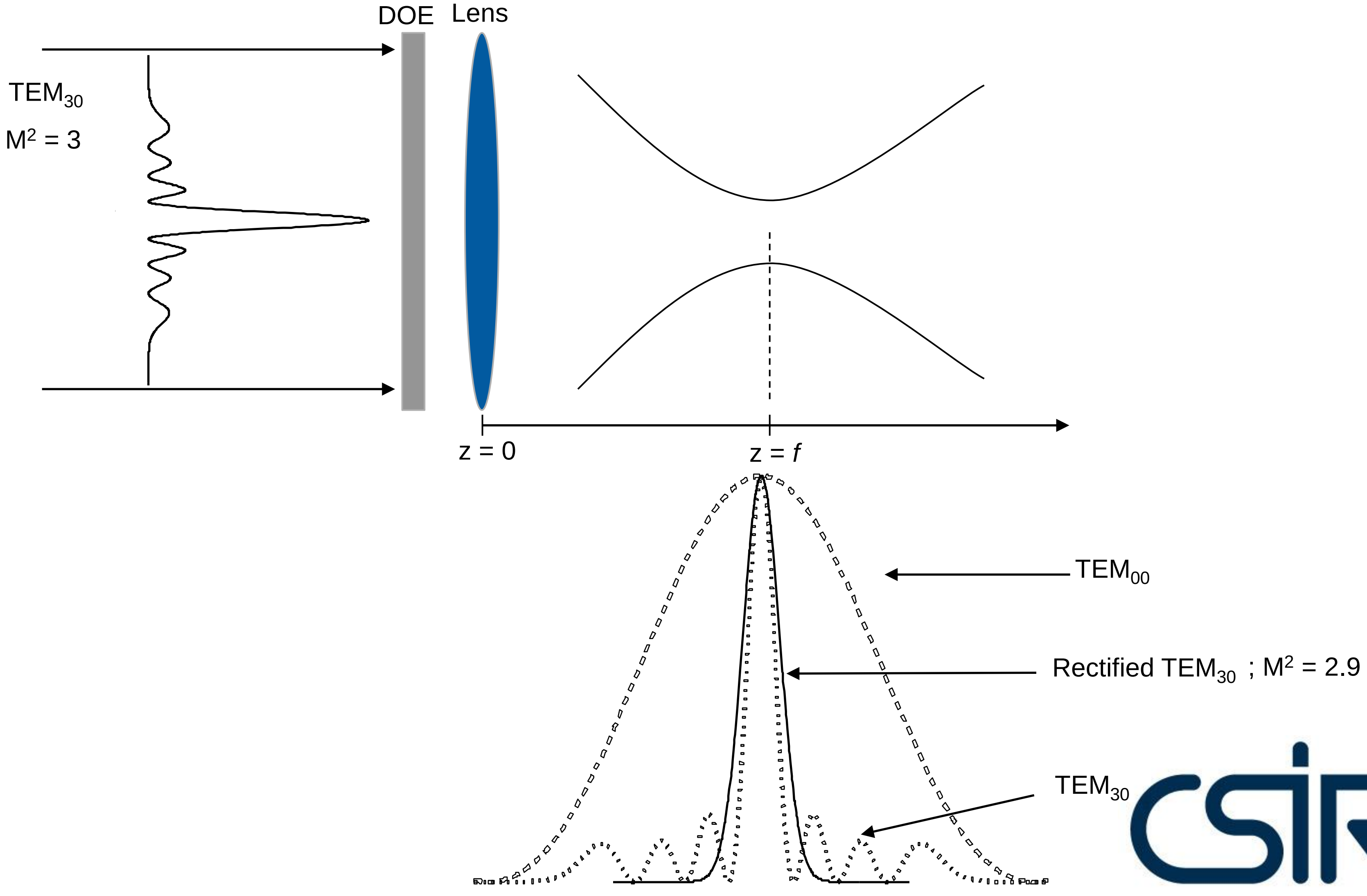
ABSTRACT

The superresolution technique is usually used in optical imaging for its ability to make the central diffractive spot smaller than the Airy spot. In this paper, we apply the superresolution technique for transforming a symmetrical TEM_{p0} Laguerre–Gauss beam into a Gaussian intensity distribution in the plane of a converging lens. The beam shaping is achieved by an annular binary Diffractive Optical Element having a transmittance, alternatively equal to -1 or $+1$, modelled on the p light rings of the incident beam. It is observed that the rectified TEM_{30} beam at focus has a focal volume 170 times smaller than that of a Gaussian beam.

Concept of creating high resolution beams



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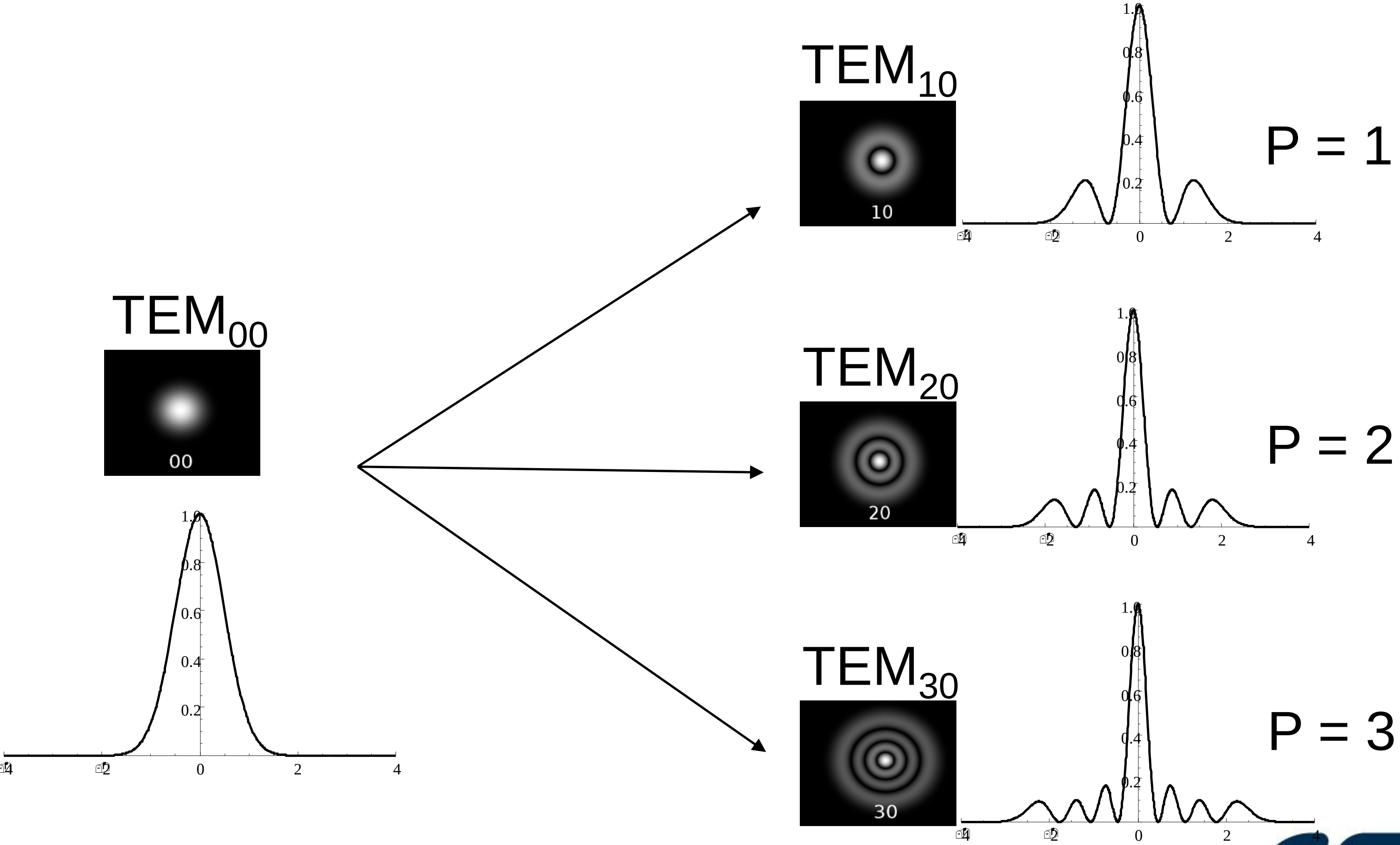
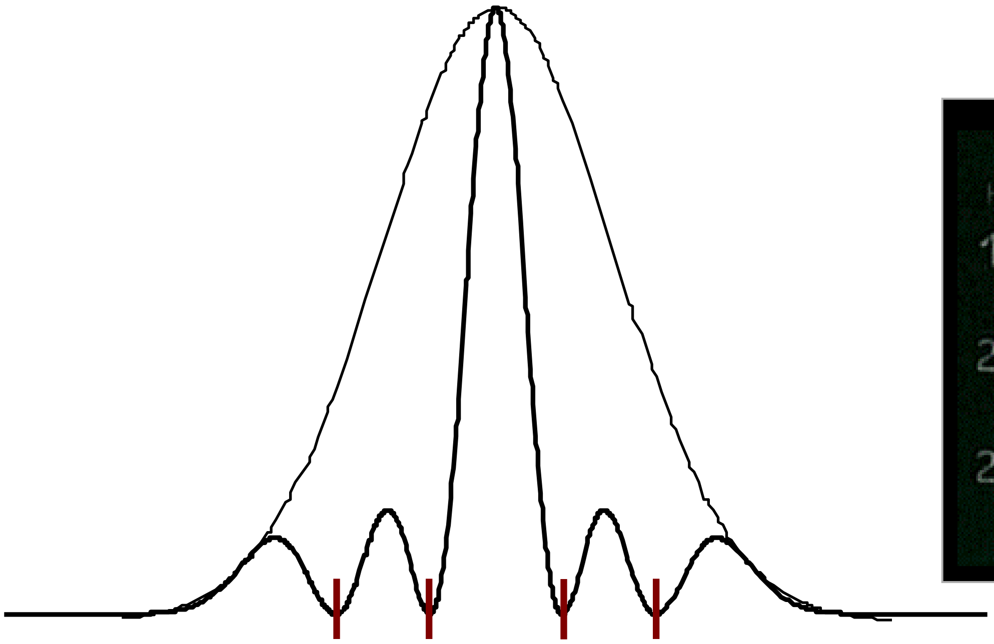
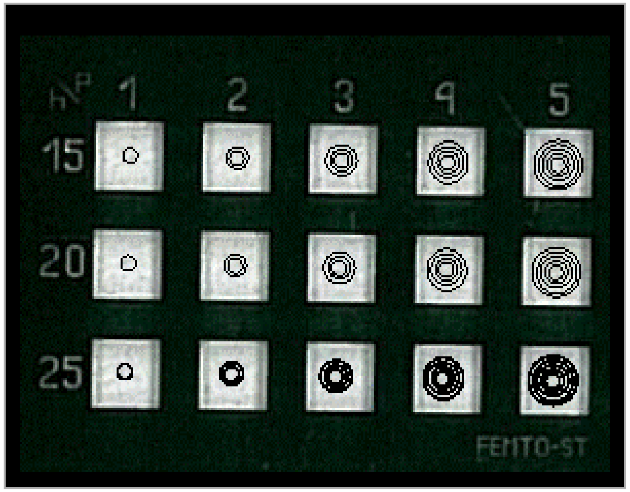
Step 1: Transform a TEM_{00} to a TEM_{p0} beam



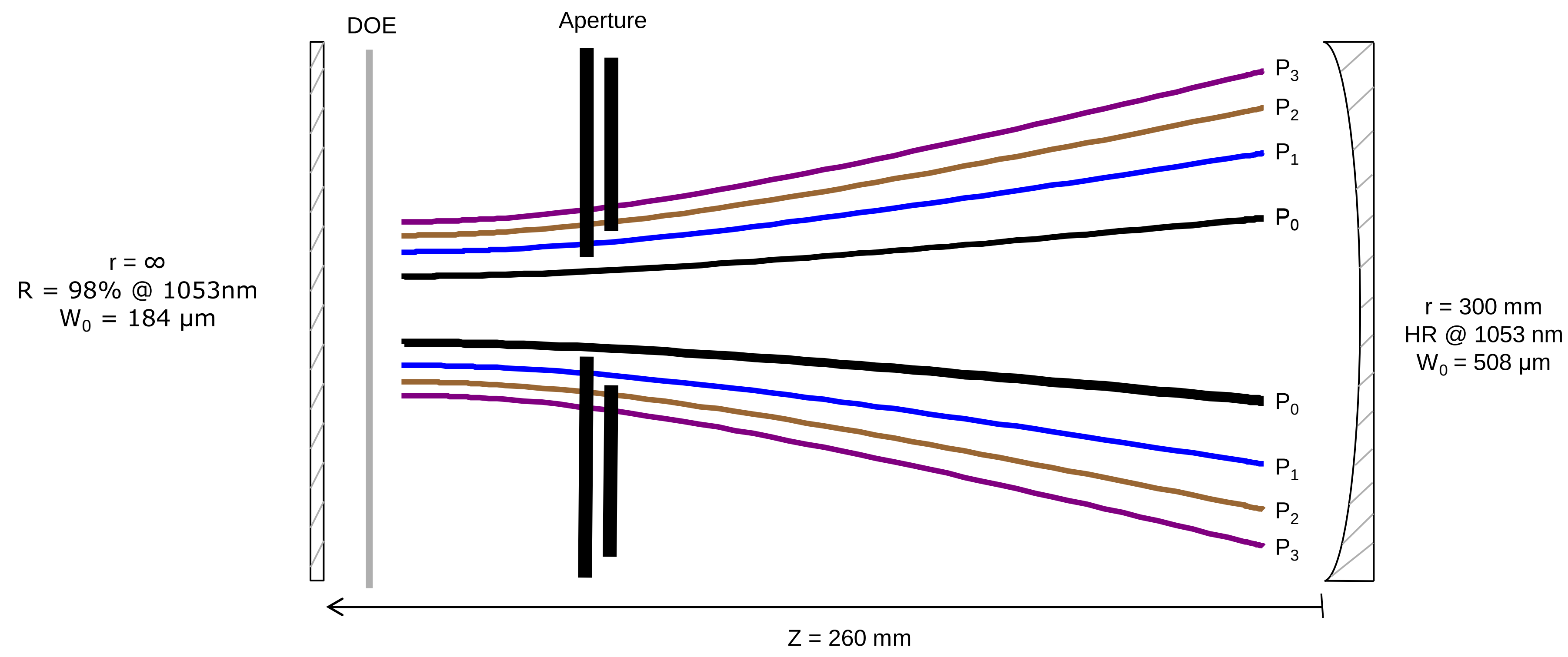
Tranformation of a TEM_{00} to a TEM_{p0} beam



DOE Plate



Resonator design



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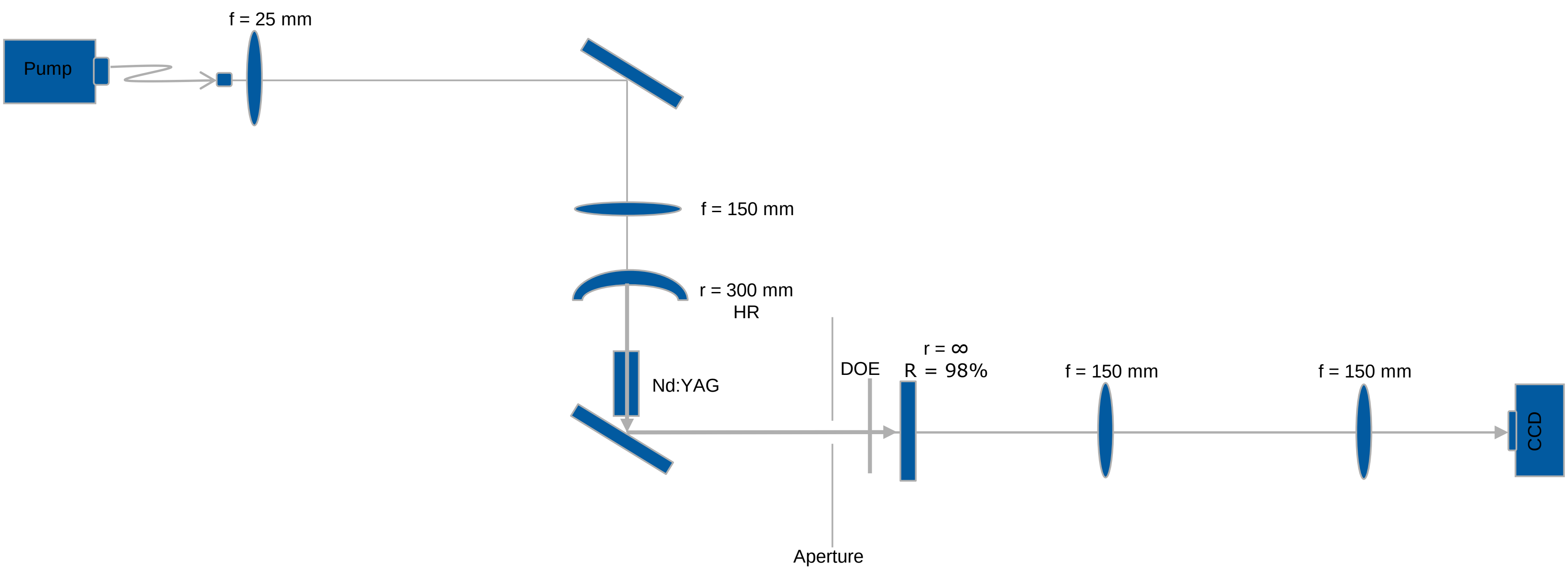
Tested the concept on an Nd:YAG system



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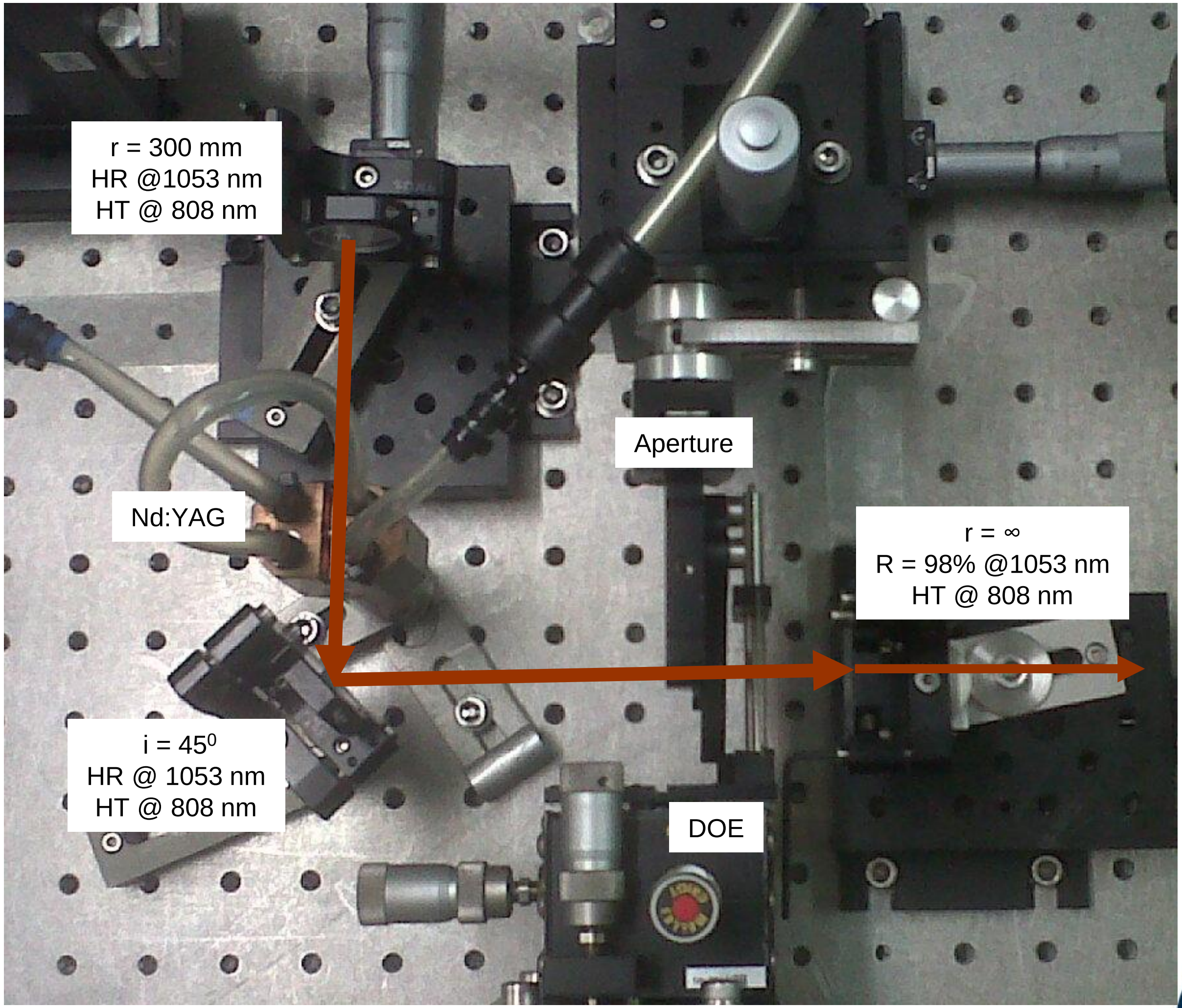

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Sanity Check

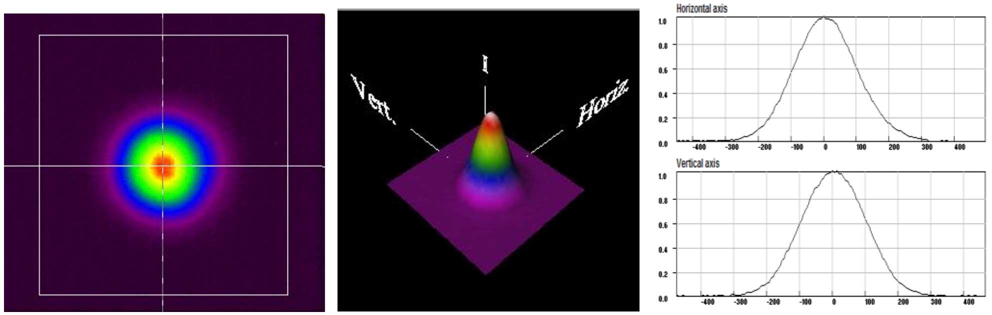
- Calculated Gaussian Beam profile:

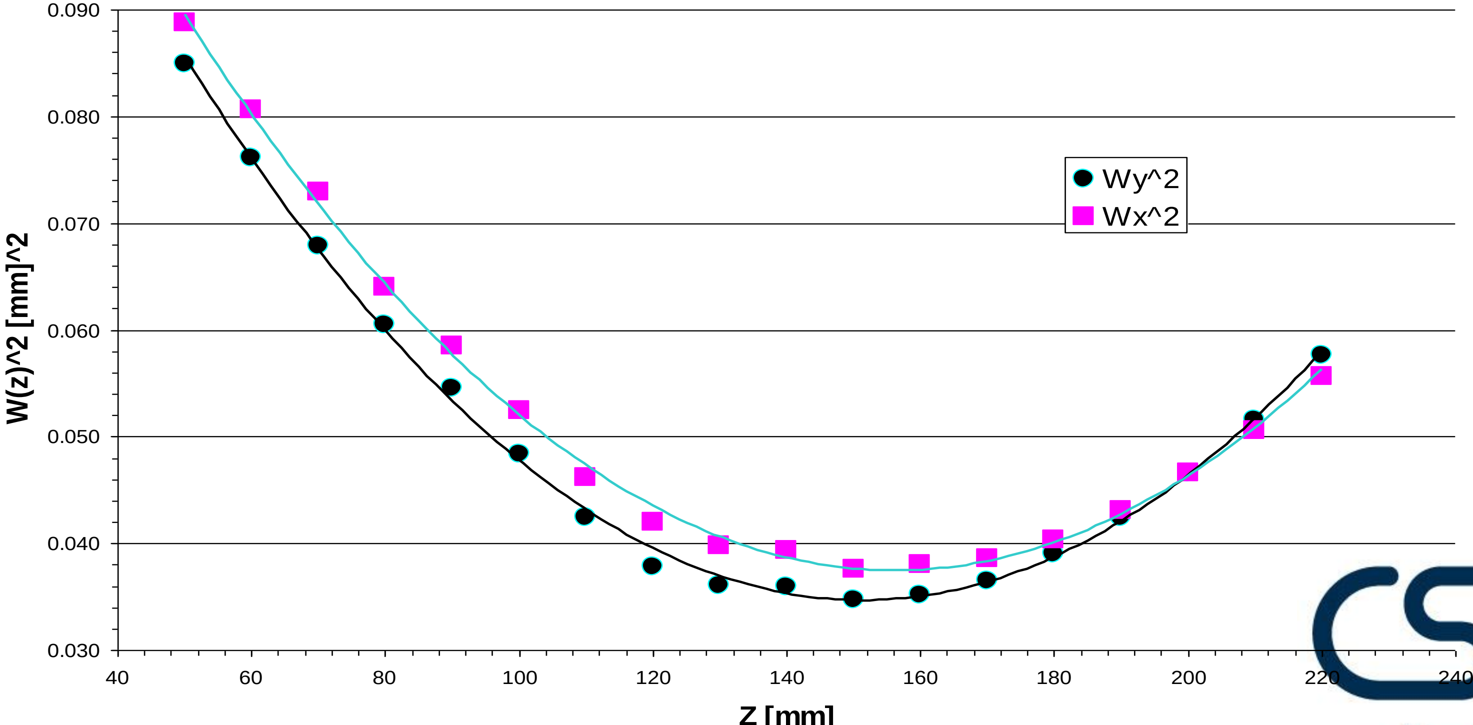
  $W_0 = 184\ \mu m$ and $M^2 = 1.0$

- Measured Gaussian Beam profile:

  $W_{0x} = 194\ \mu m$ and $W_{0y} = 186\ \mu m$

  $M^2_x = 1.24$ and $M^2_y = 1.23$





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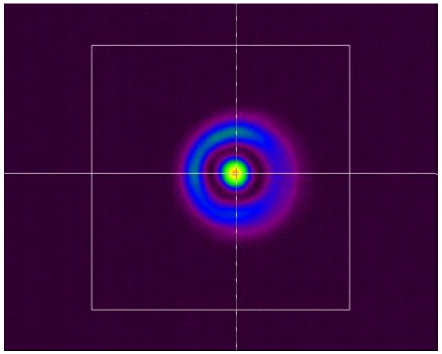
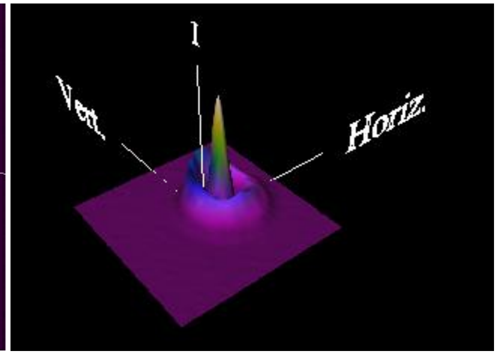
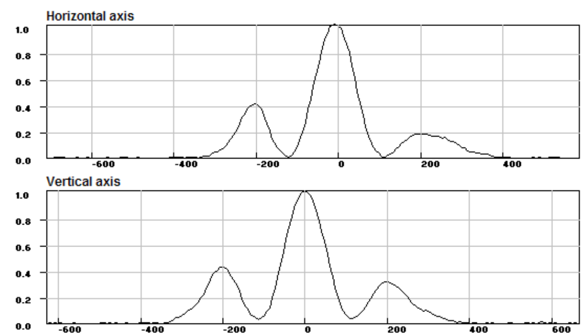
Insertion of a DOE plate, we find a p = 1 mode

- LGB profile of order p = 1:

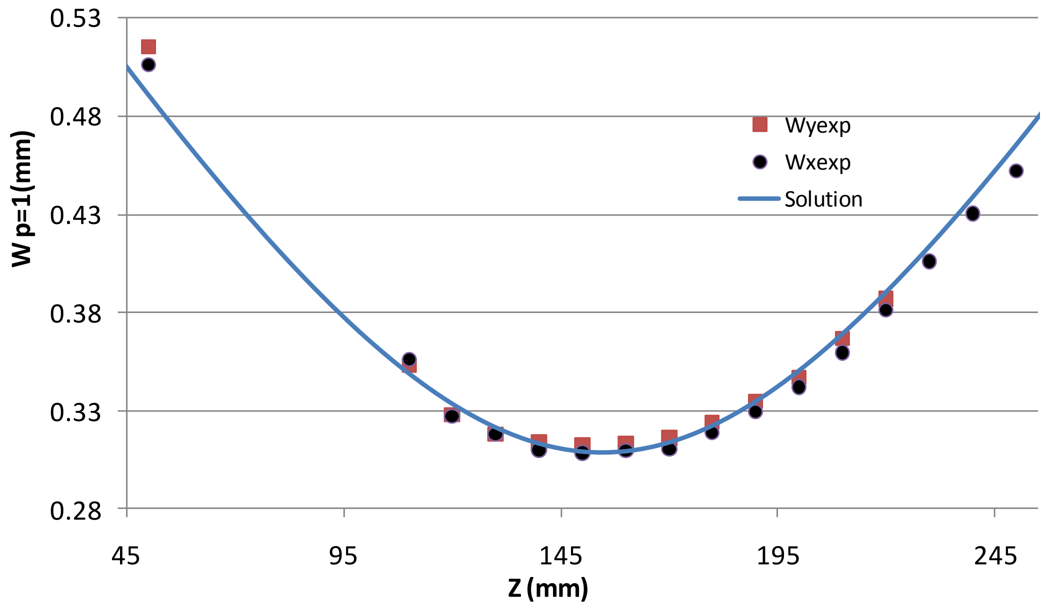





$$W_p = W_0\sqrt{2p+1}$$

$$M_p^2 = 2p+1$$

Calculated : W_{1x} = 319 µm and W_{1y} = 319 µm ; M^2_{1x} = 3.00 and M^2_{1y} = 3.00
Experiment: W_{1x} = 301 µm and W_{1y} = 304 µm ; M^2_{1x} = 3.21 and M^2_{1y} = 3.29
% Difference: 5.6 % 4.7 %



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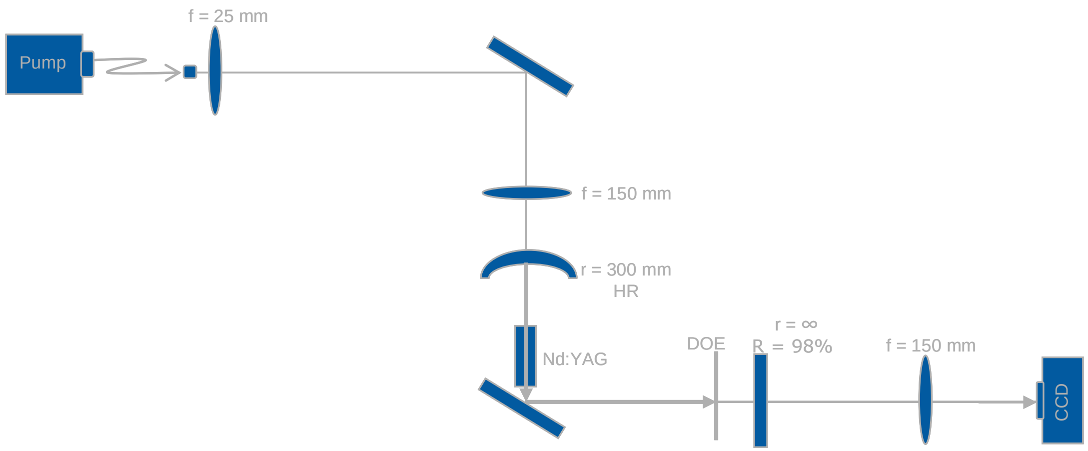
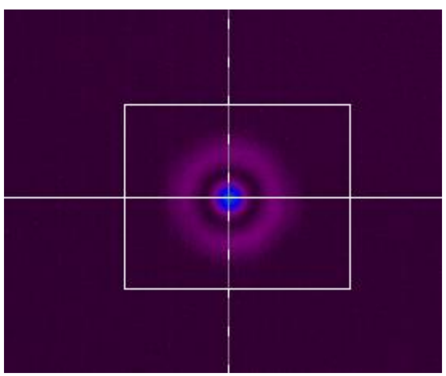
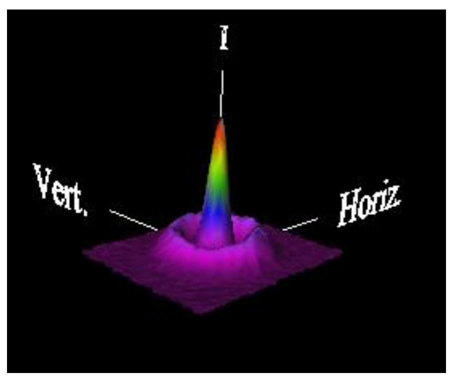
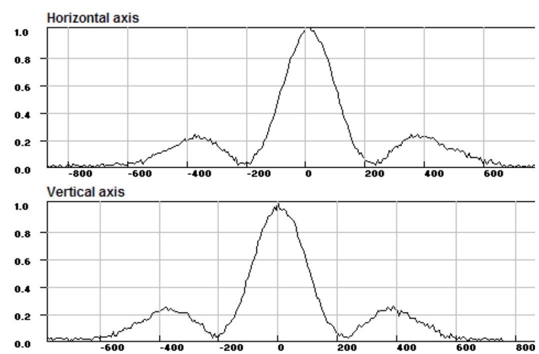
But is it really a mode?

- Test: Fourier Transform of LGB is a LGB









- Yes it is a laser mode

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Conclusions

- Achieved to generate LGB of high order p = 1
- Proven the theory

Future Work

- Generate LGB of high order p>1

THANK YOU

THE END