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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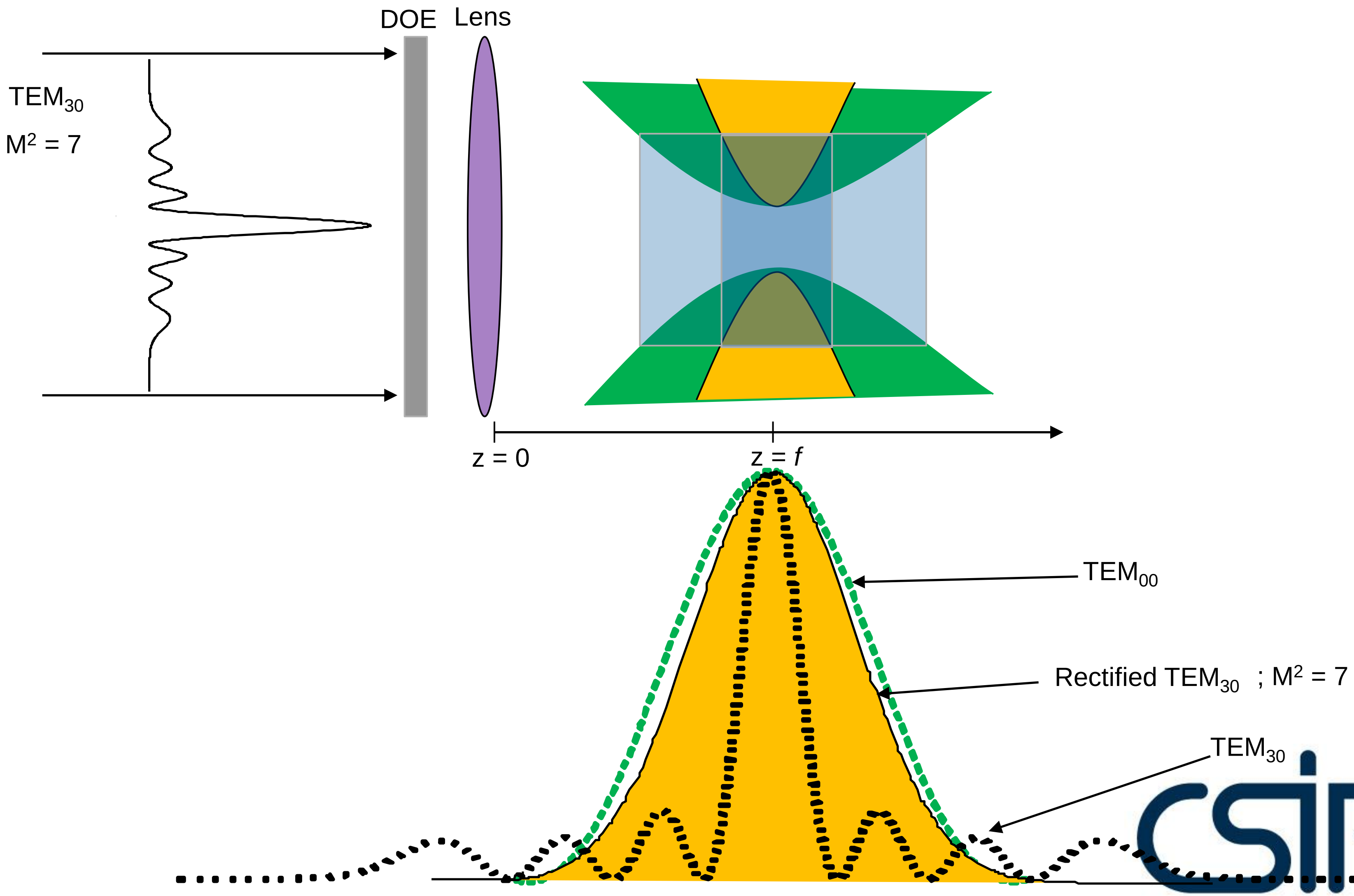
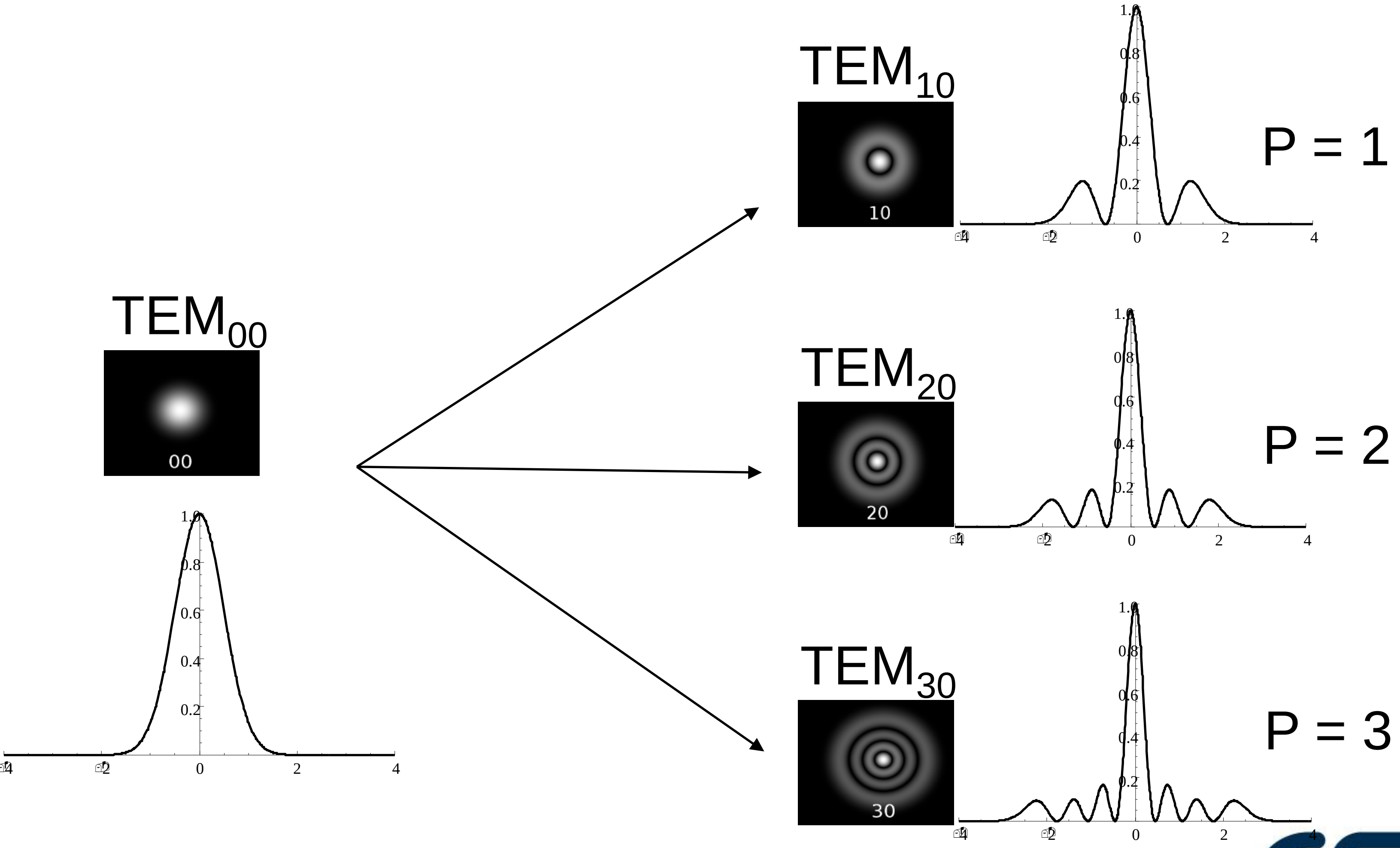
ABSTRACT

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.

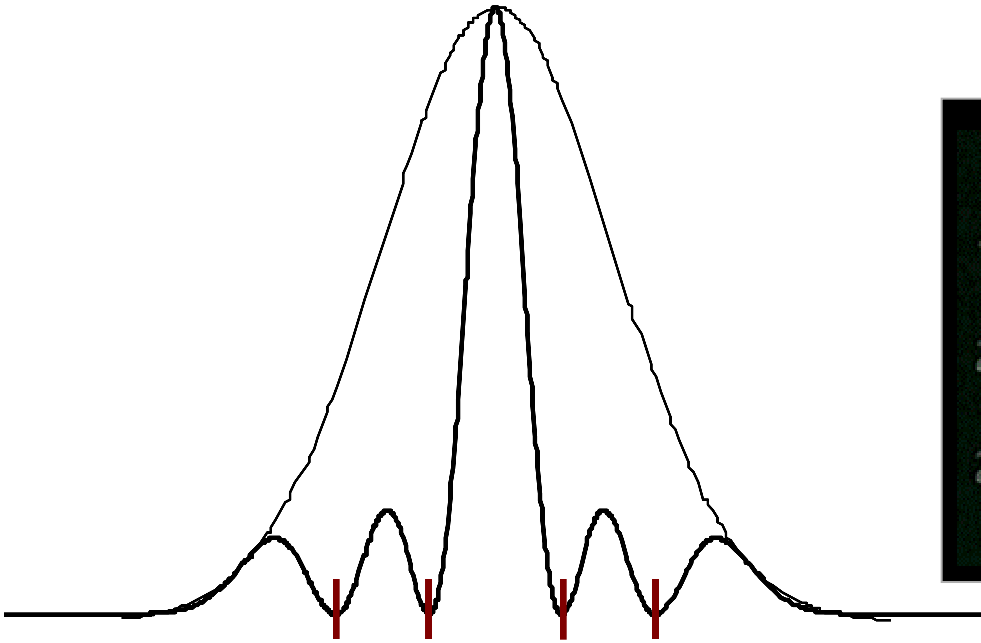
Concept of creating high resolution beams



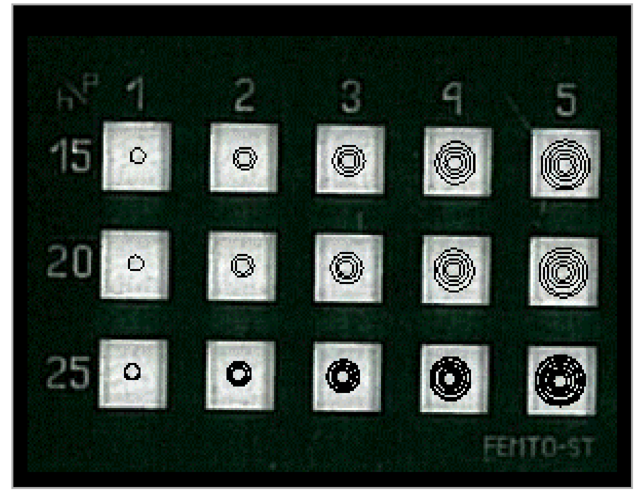
Step 1: Transform a TEM_{00} to a TEM_{p0} beam



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



DOE Plate



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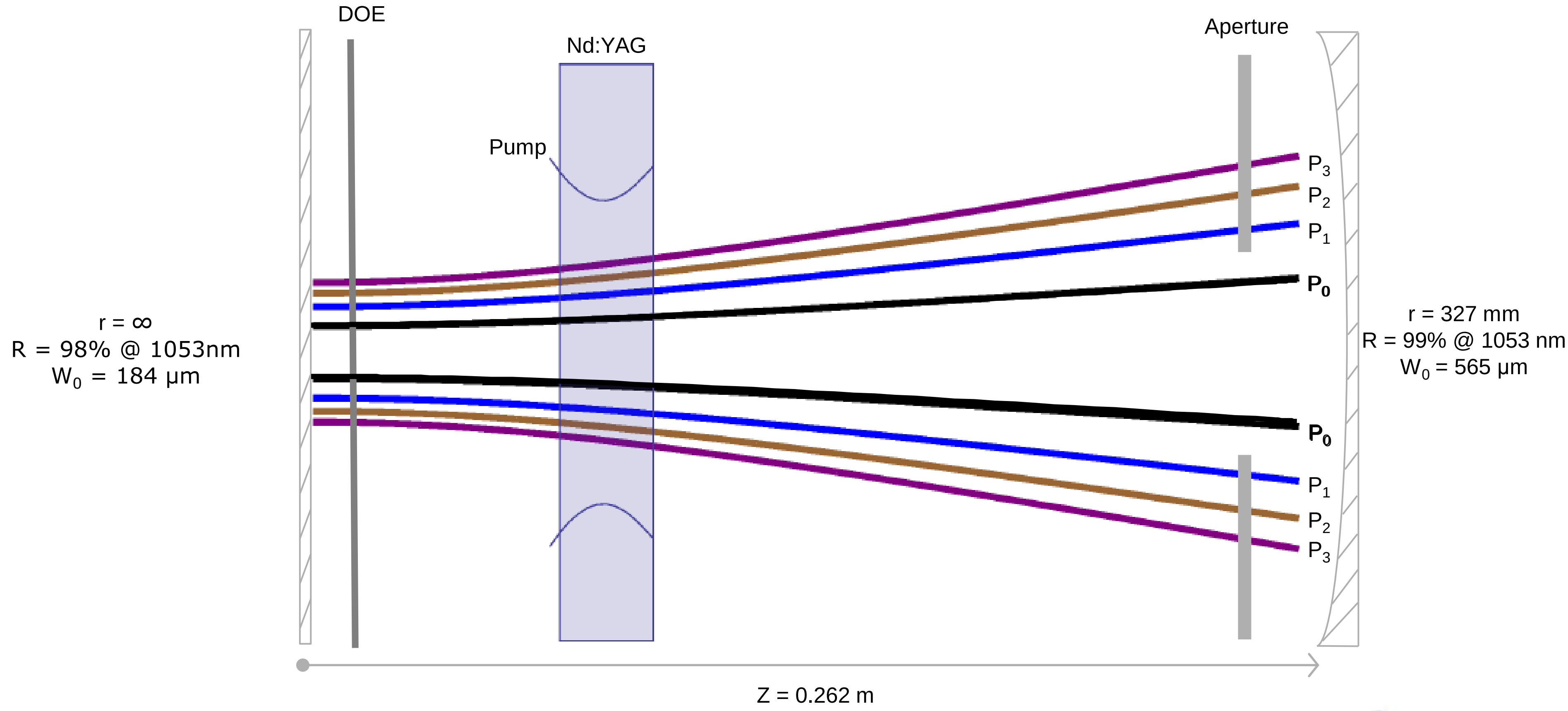
Resonator design



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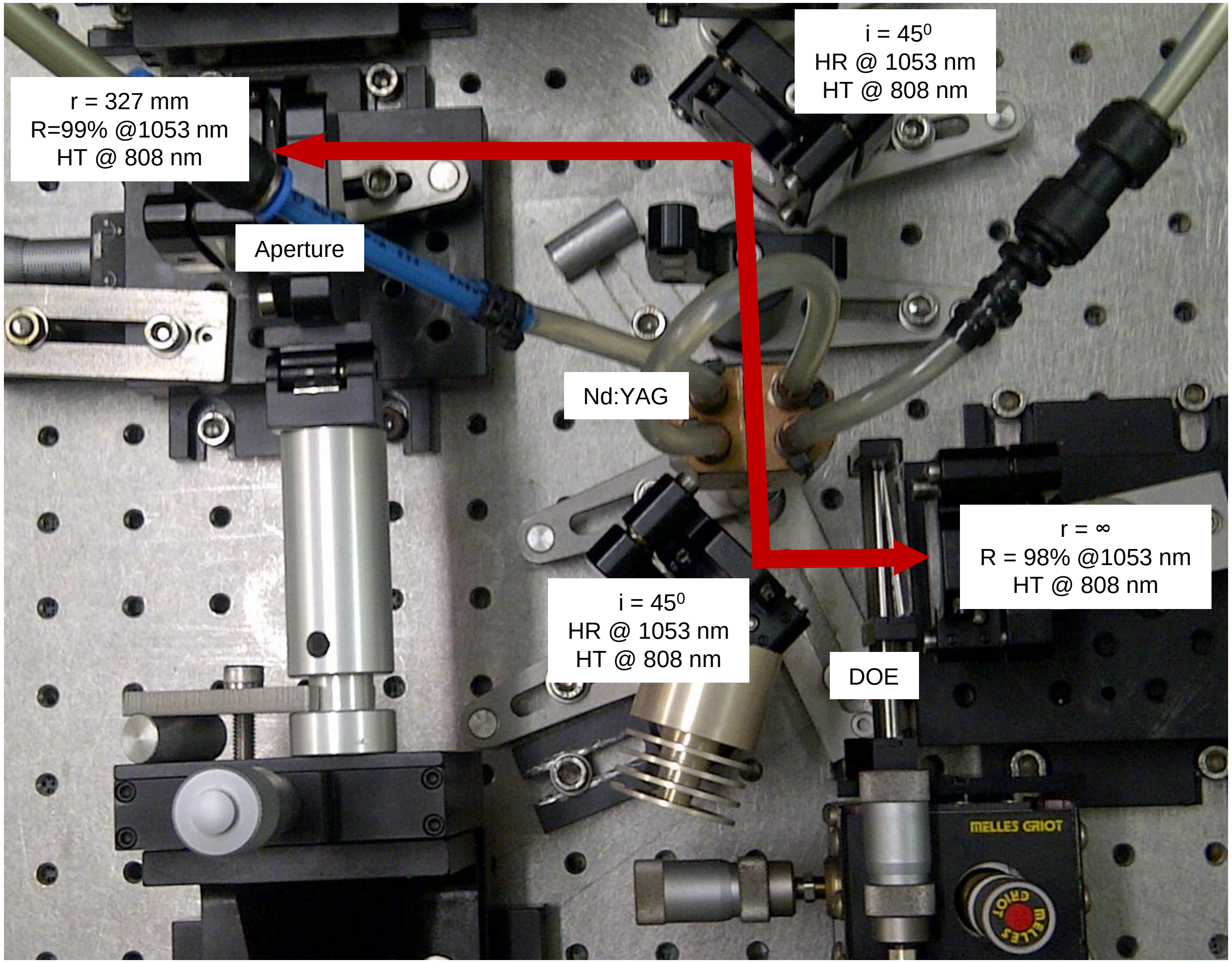
Tested the concept on an Nd:YAG system



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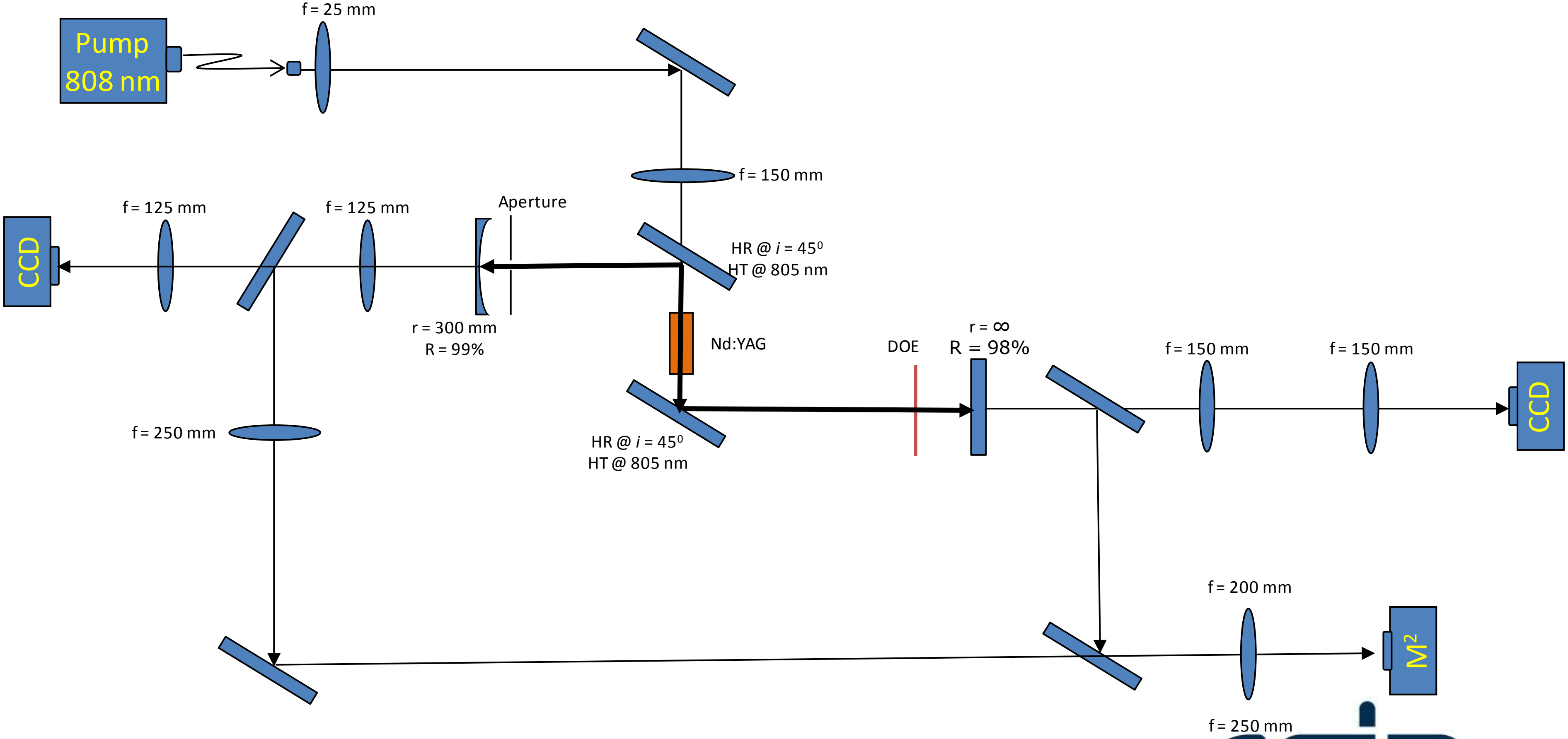

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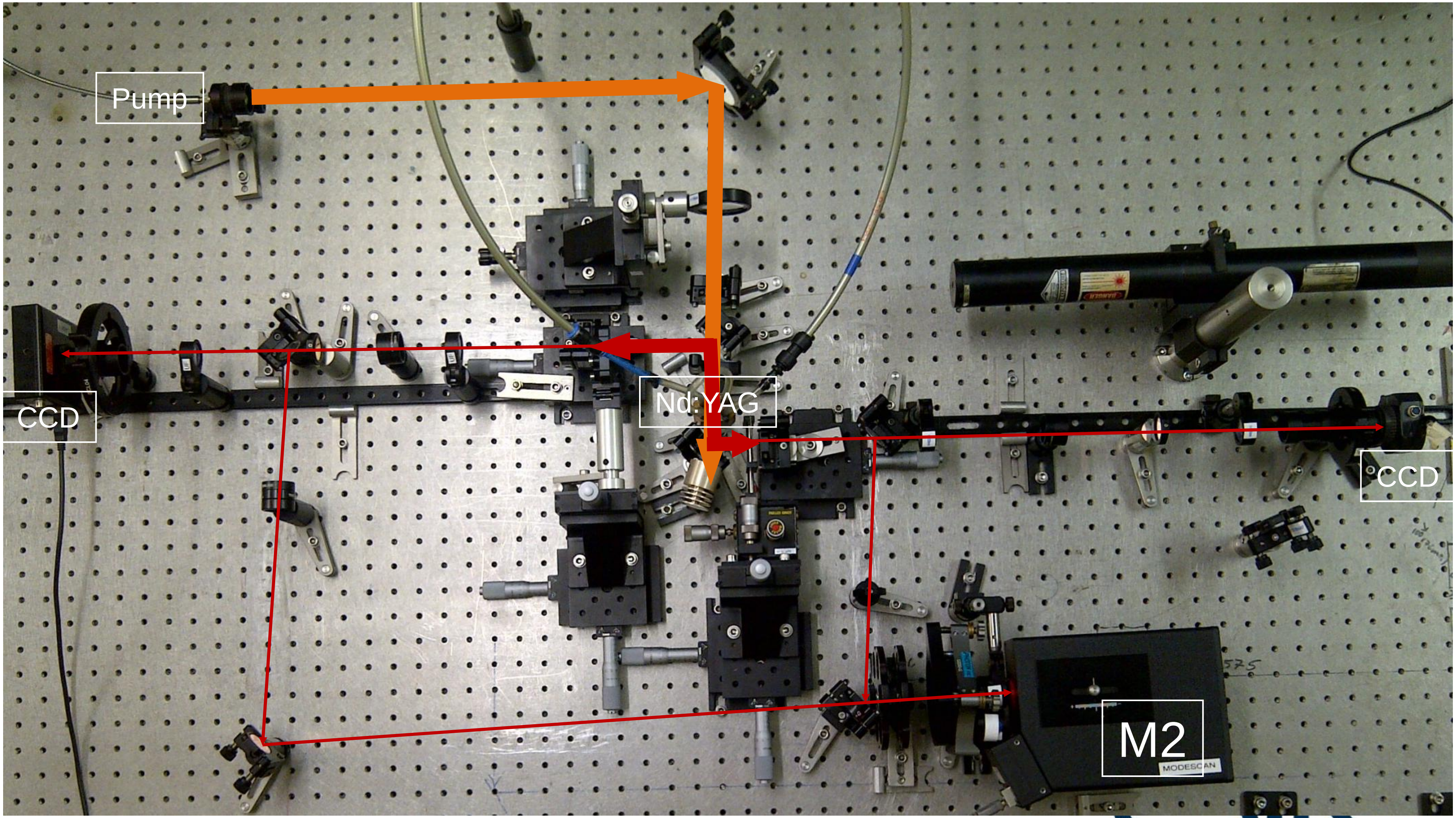
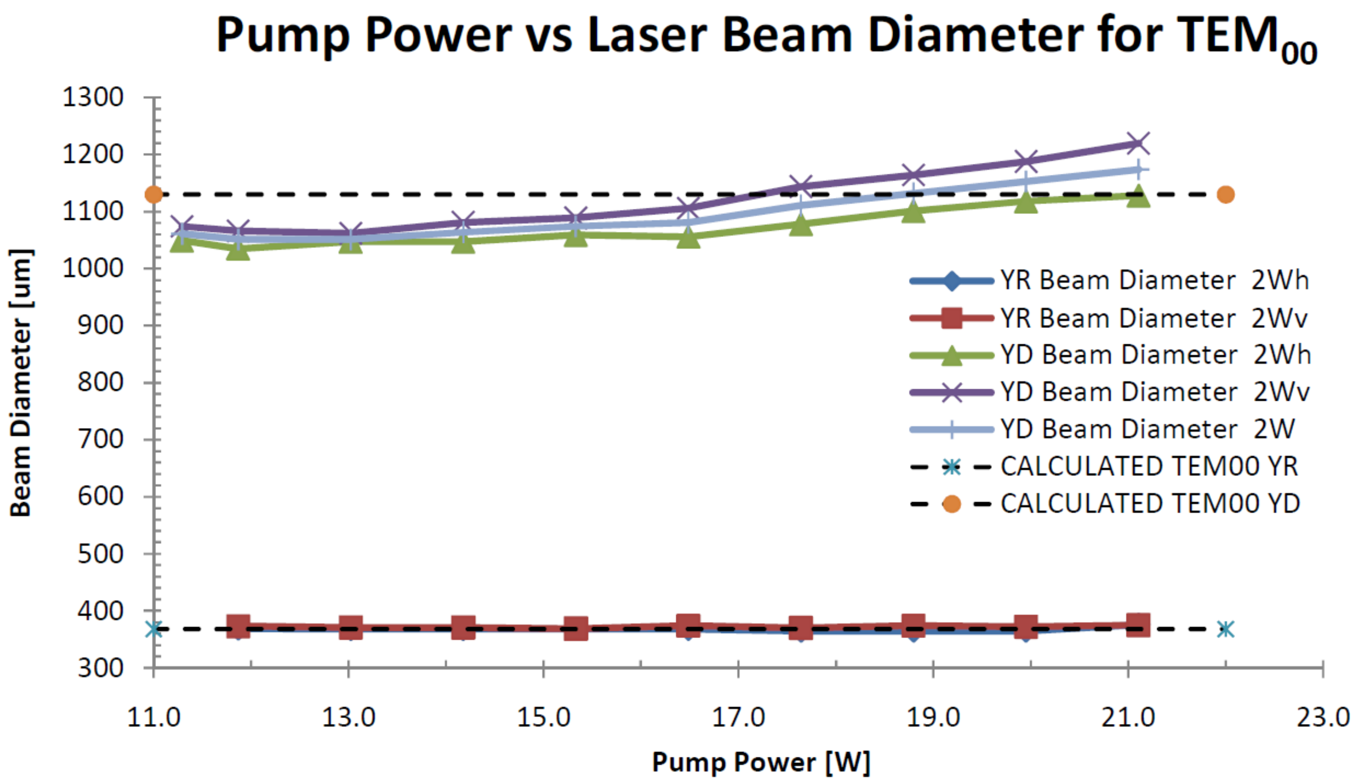
Tested the concept on an Nd:YAG system



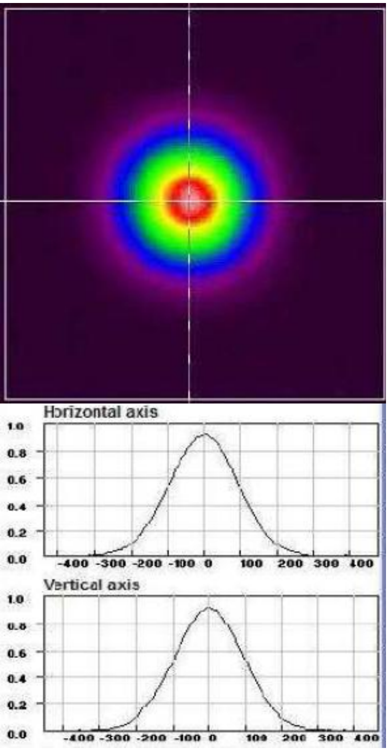
Check TEM_{00} Stability



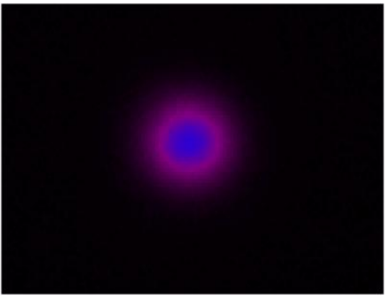
TEM_{00}	Beam Diameter on Flat Mirror [YR]		Beam Diameter on Curved Mirror [YD]		
	2Wh (um)	2Wv (um)	2Wh (um)	2Wv (um)	2W (um)
Measured Average	368	373	1072	1119	1095
Calculated	368	368	1130	1130	1130
Difference (%)	0	1	5	1	3

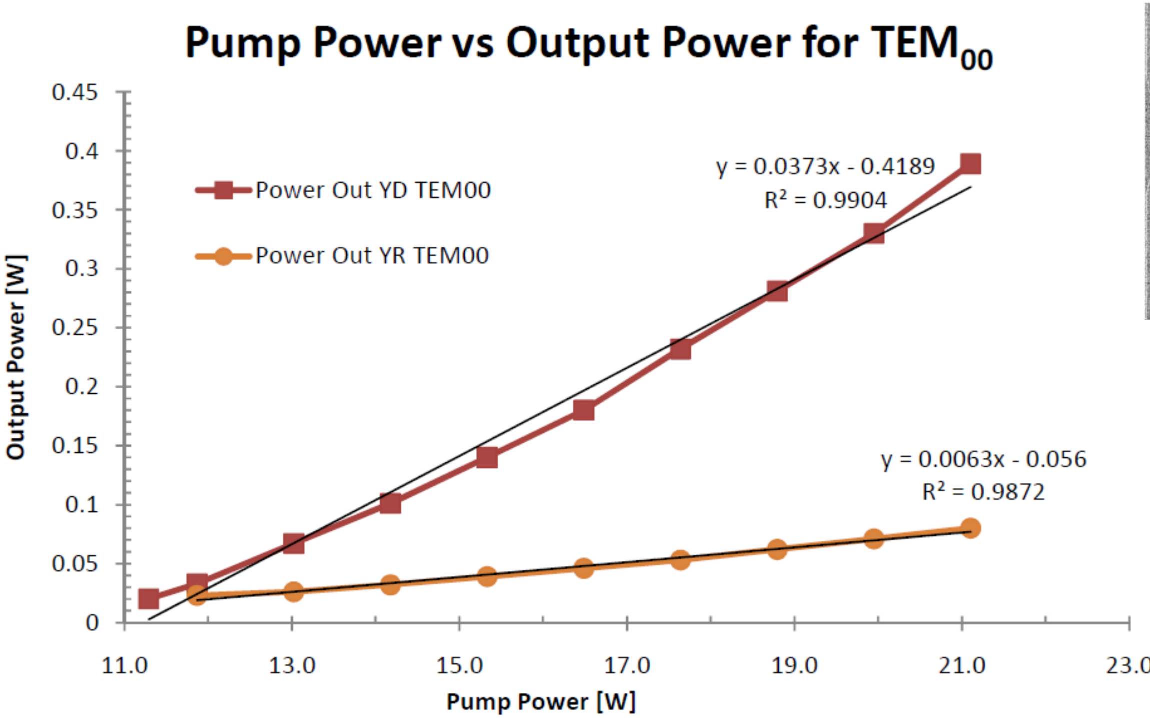
Check TEM_{00} Stability

Flat Mirror
Near Field

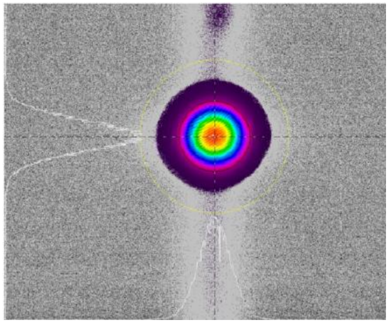


Far Field

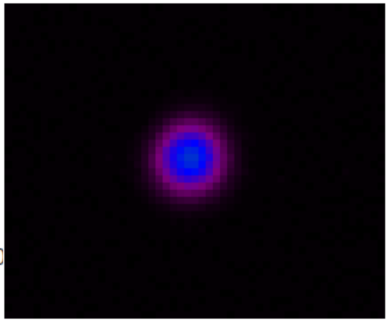




Curved Mirror
Near Field



Far Field



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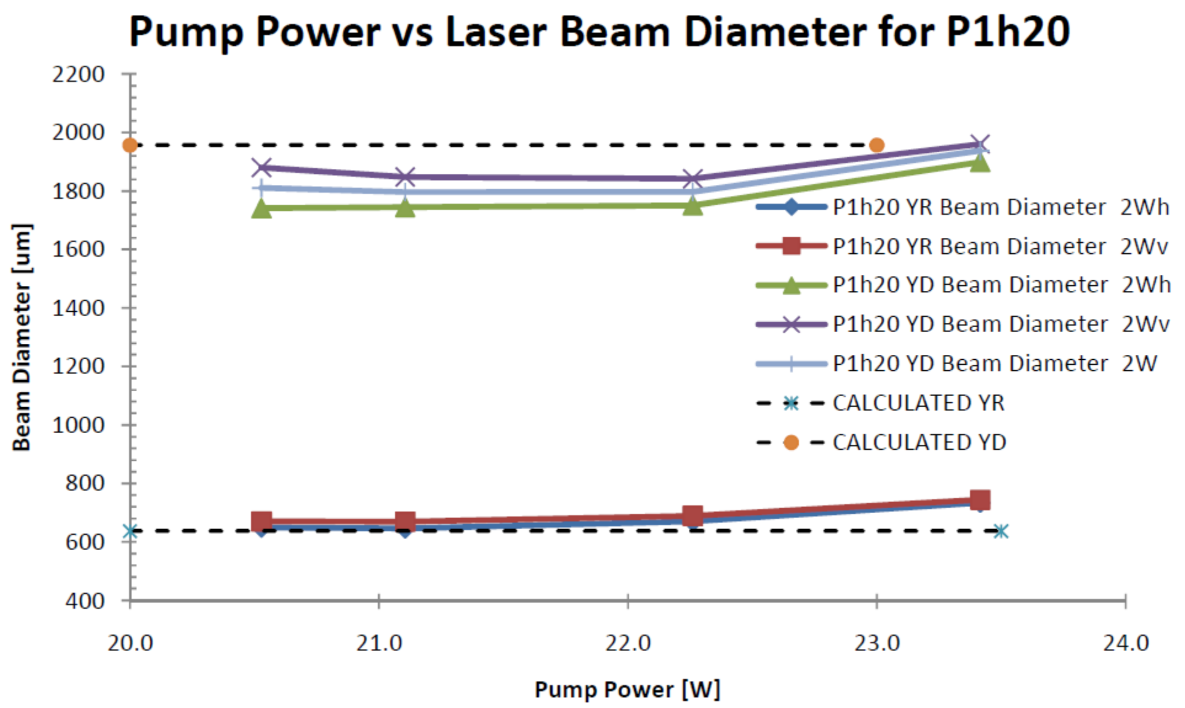
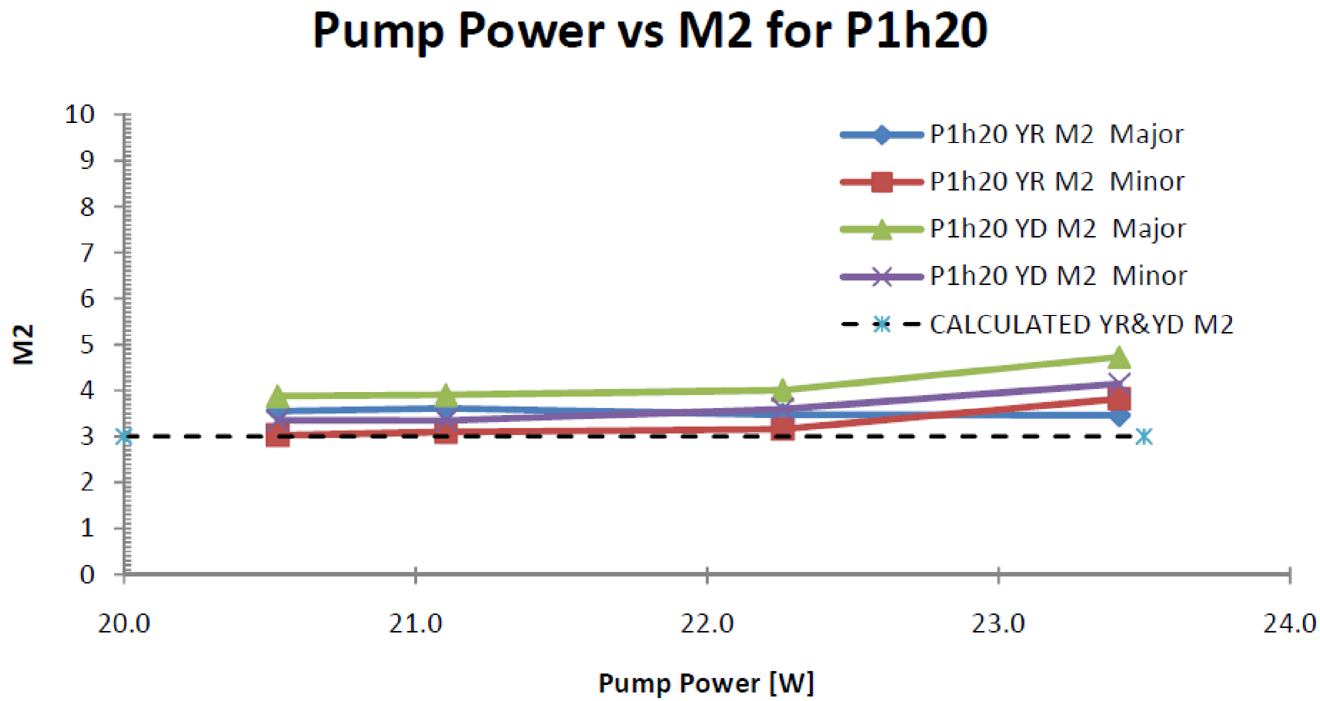
Insertion of a DOE plate, we find a p = 1 mode



P1h20	Beam Diameter on Flat Mirror [YR]		Beam Diameter on Curved Mirror [YD]		
	2Wh (um)	2Wv (um)	2Wh (um)	2Wv (um)	2W (um)
Measured Average	675	693	1784	1883	1836
Calculated	637	637	1957	1957	1957
Difference (%)	6	9	9	4	6

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



P1h20	M2 on Flat Mirror [YR]		M2 on Curved Mirror [YD]	
	Major	Minor	Major	Minor
Measured Average	3.52	3.28	4.13	3.61
Calculated	3	3	3	3
Difference (%)	17	9	38	20

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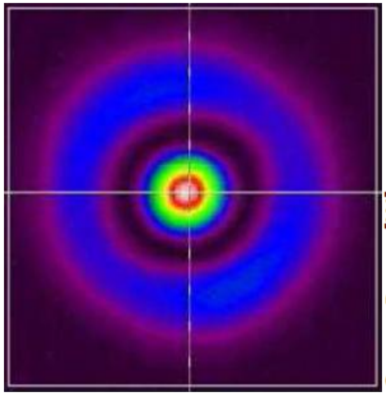
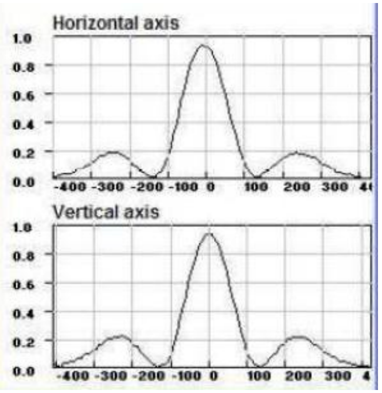
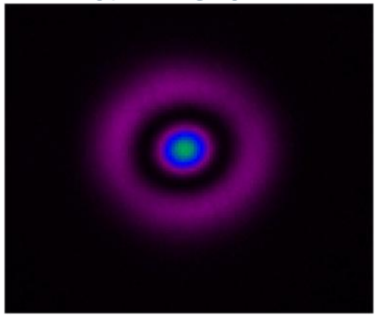
Insertion of a DOE plate, we find a p = 1 mode

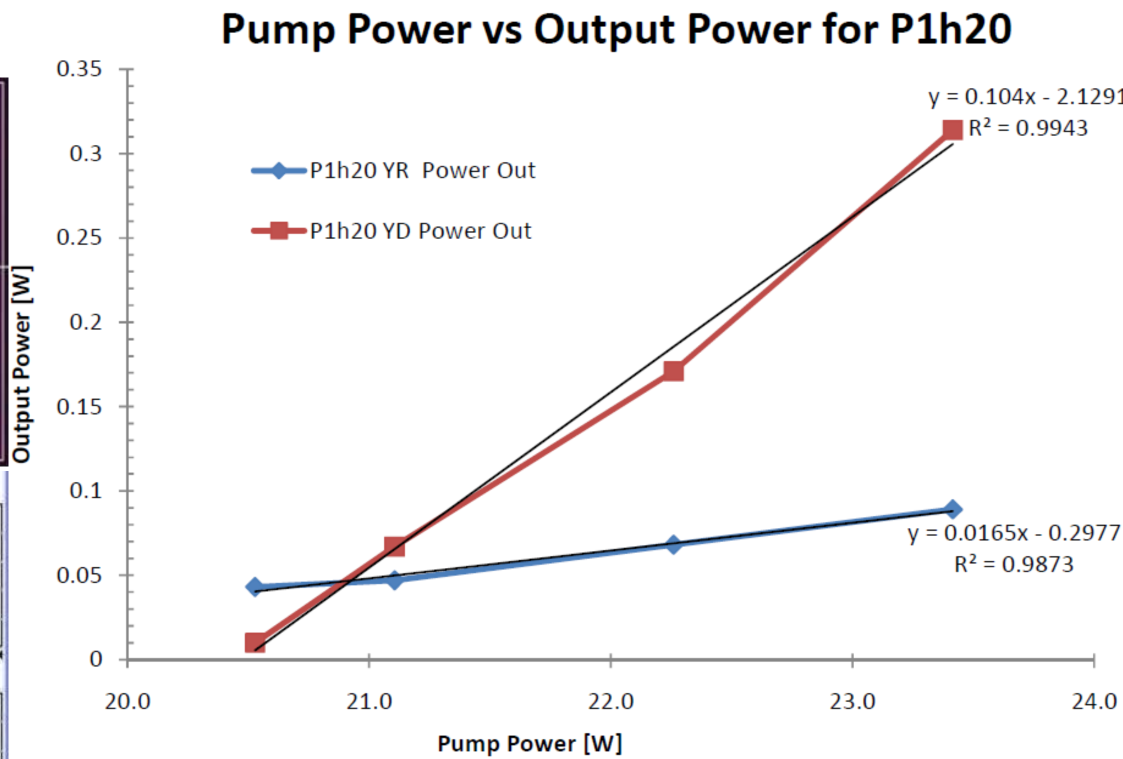
Flat Mirror [YR]
Near Field



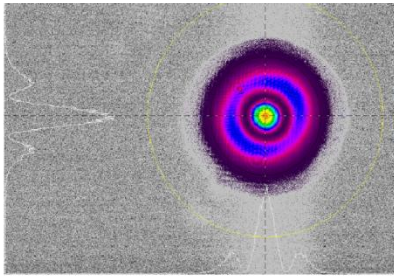


Far Field

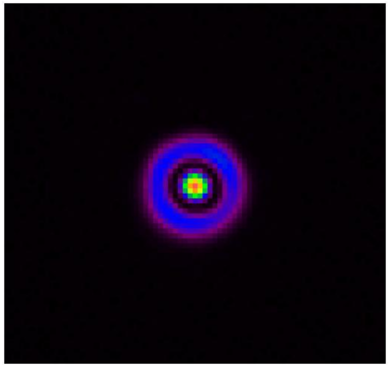




Curved Mirror [YD]
Near Field



Far Field



Mode	Flat Mirror [YR]	Curved Mirror [YD]
	Slope Efficiency (%)	Slope Efficiency (%)
TEM_{00}	0.63	3.73
P1h20	1.65	10.4
Power Increase	262	279

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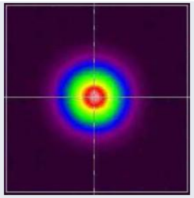
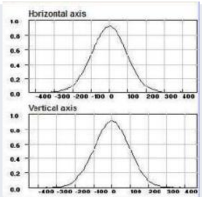
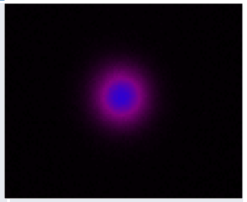
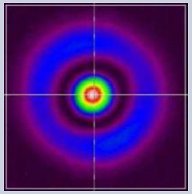
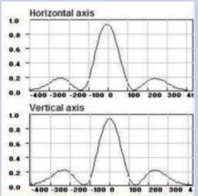
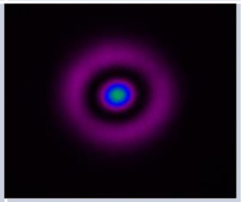
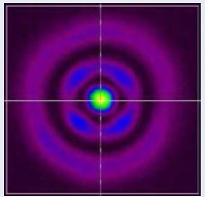
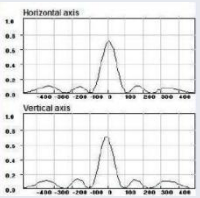
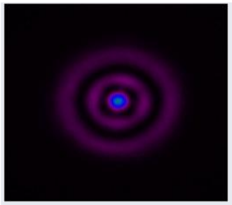
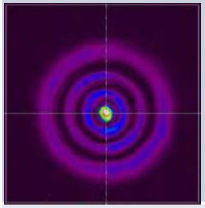
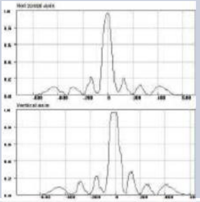
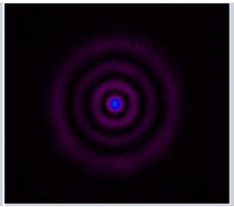
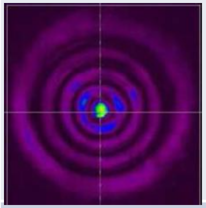
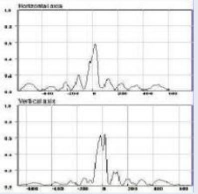
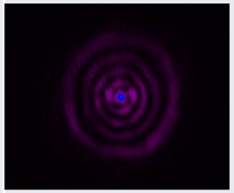
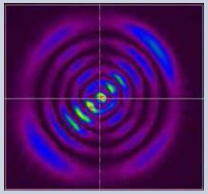
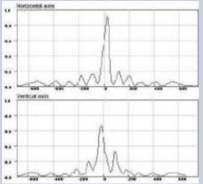
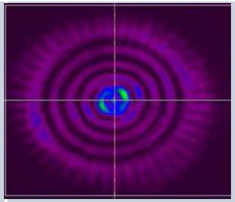
P	Near Field Beam Shape	Near Field Horizontal & Vertical Beam Profile	Beam Diameter on Flat Mirror			Beam Diameter on Curved Mirror			Far Field Beam Shape
			Measured (um)	Calculated (um)	Difference (%)	Measured (um)	Calculated (um)	Difference (%)	
0			370	368	0.5	1119	1130	1	
1			675	637	6	1883	1957	4	
2			825	823	0.2	2527	2527	0	
3			977	974	0.3	3005	2990	0.5	
4			1110	1104	0.5	3304	3390	3	
5			1239	1221	1	3533	3748	6	

Conclusions

- Achieved to generate LGB of high order
- Proven the theory

Future Work

- Rectify high order LGB

THANK YOU

THE END