

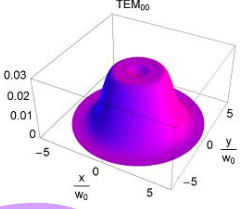
# The Mesa Beam

## Initial Results



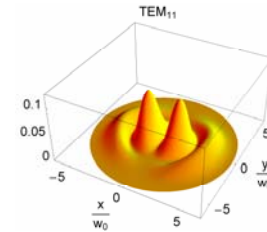
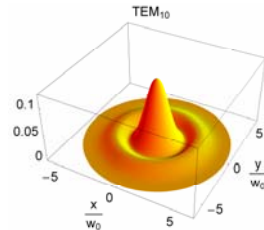
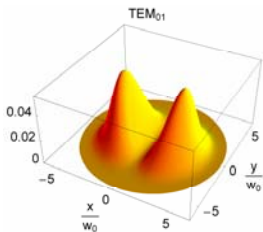
UNIVERSITY  
of  
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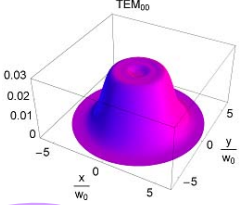
Juri Agresti<sup>1</sup>, Erika D'Ambrosio<sup>1</sup>, Riccardo DeSalvo<sup>1</sup>,  
Danièle Forest<sup>2</sup>, Patrick Ganau<sup>2</sup>, Bernard Lagrange<sup>2</sup>,  
Jean-Marie Mackowski<sup>2</sup>, Christophe Michel<sup>2</sup>, **John  
Miller**<sup>1,3</sup>, Jean-Luc Montorio<sup>2</sup>, Nazario Morgado<sup>2</sup>,  
Laurent Pinard<sup>2</sup>, Alban Remillieux<sup>2</sup>, Barbara Simoni<sup>1</sup>,  
Marco Tarallo<sup>1</sup>, Phill Willems<sup>1</sup>



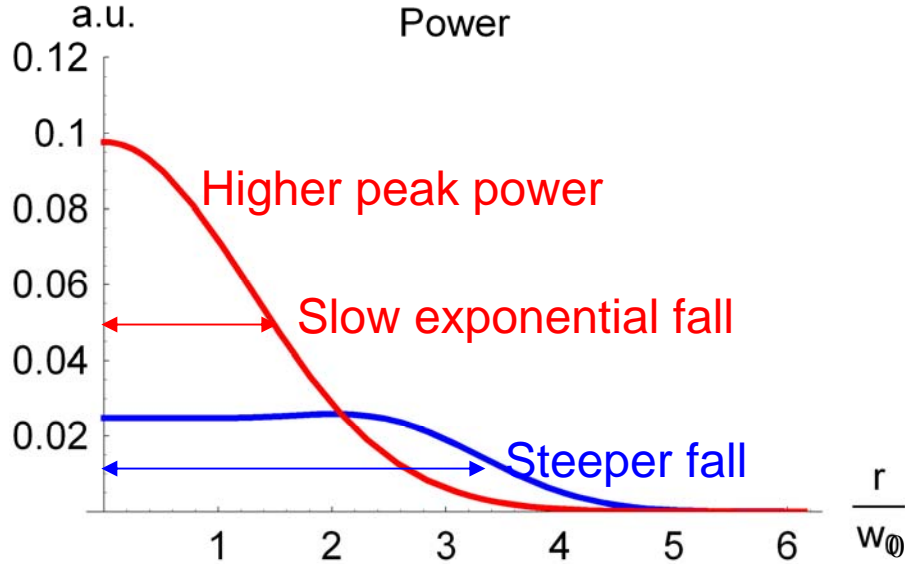
## Introduction

- Thermal noise shall be a limiting factor for AdvLIGO
- Flat-topped beams reduce thermal noise
- A cavity has been constructed to generate and characterise the mesa beam



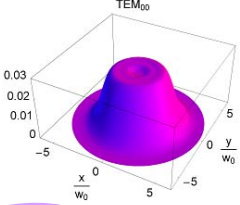


# Profiles



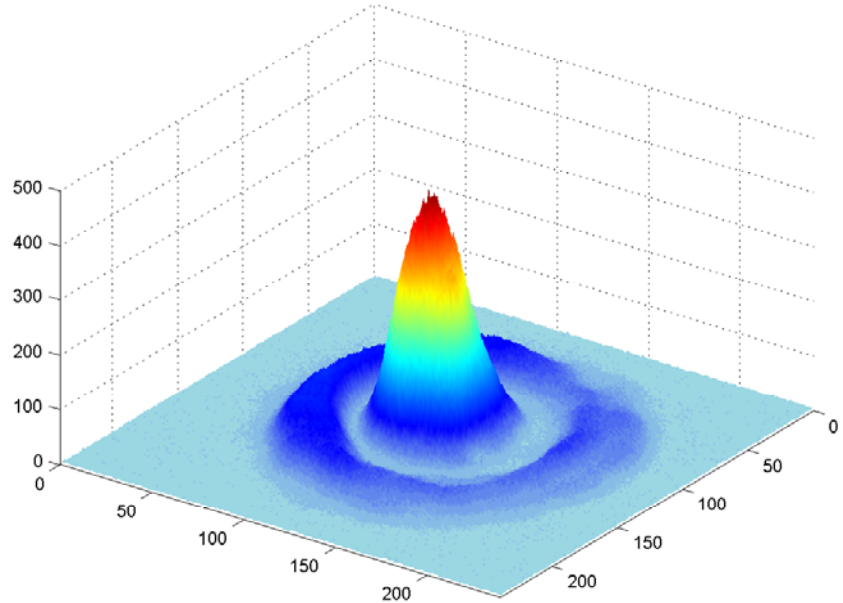
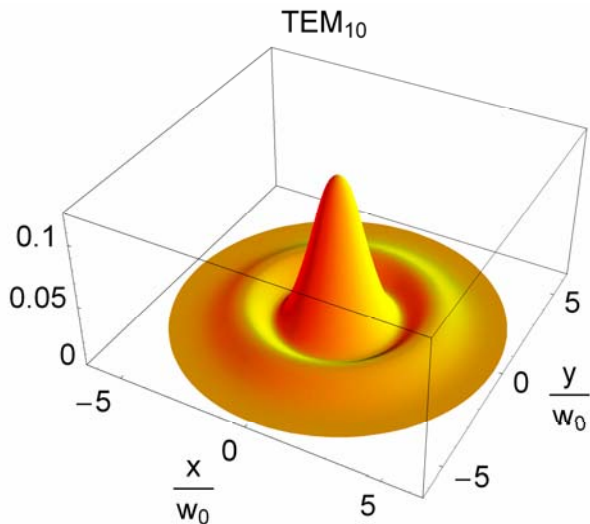
- Profiles normalised for same integrated power
- Same diffraction losses

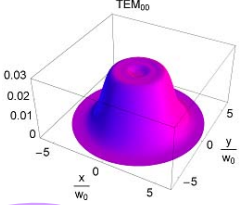
## Results



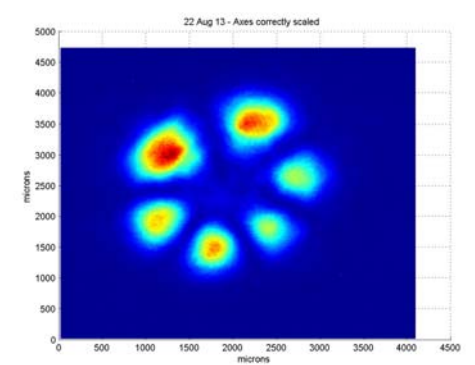
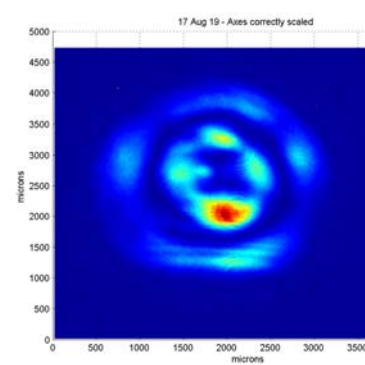
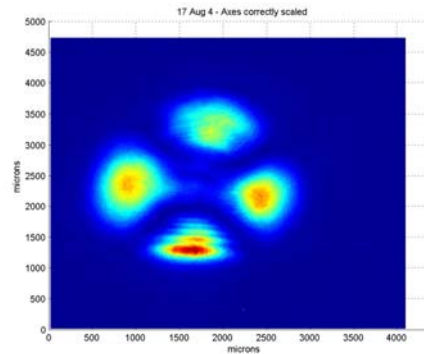
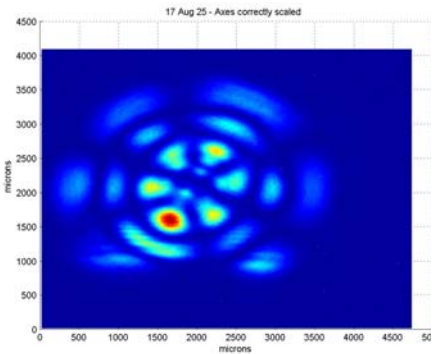
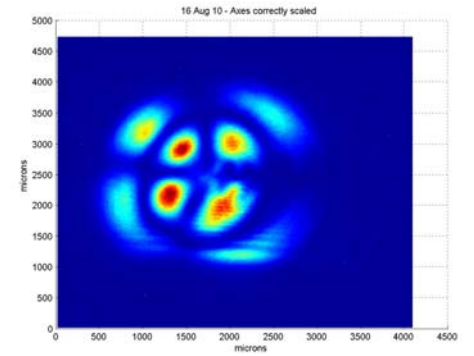
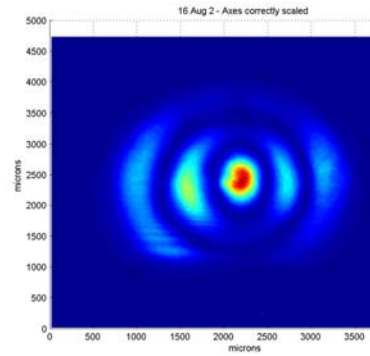
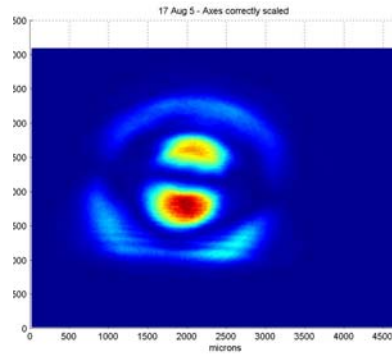
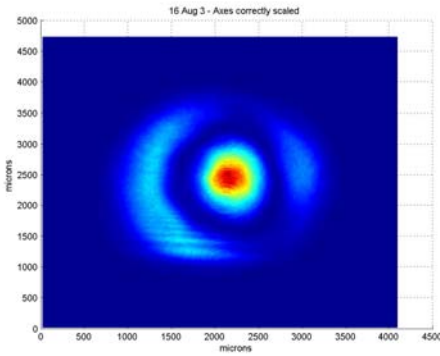
TEM<sub>10</sub>

- We have been able to lock to higher order modes
- These modes exhibit good agreement with theory

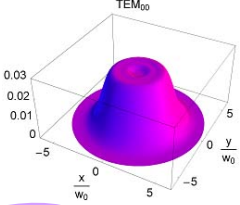




## Results - HOM

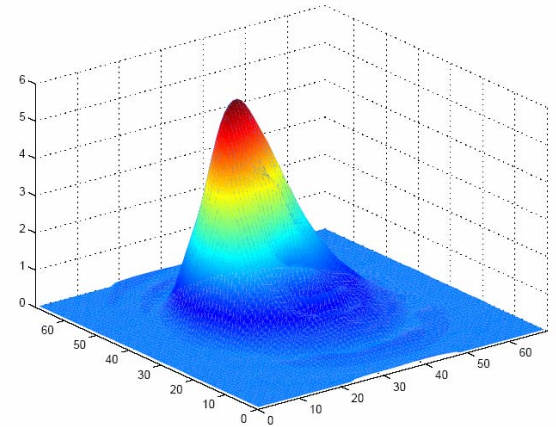


Diffraction around beam baffle eliminated

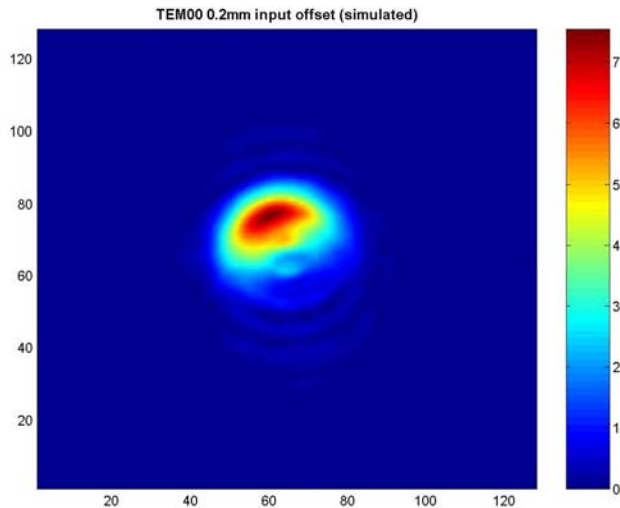


## The Fundamental?

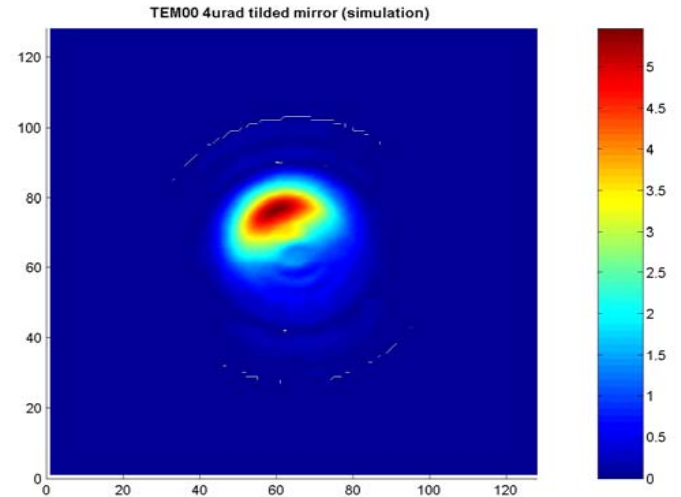
- Alignment is taxing
- We are unable to distinguish between translations and tilts of the input beam

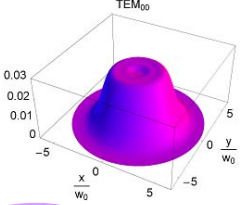


0.2 mm  
offset



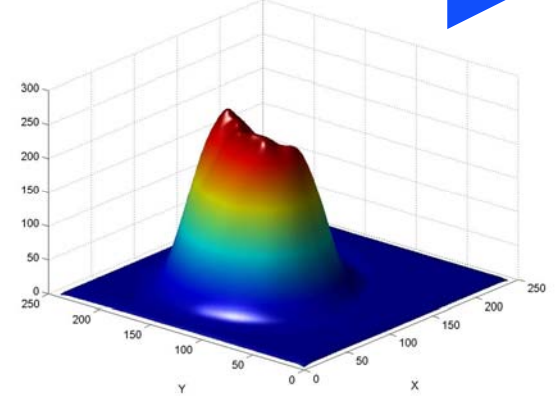
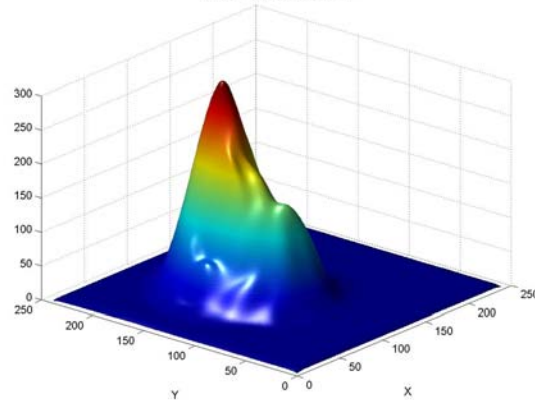
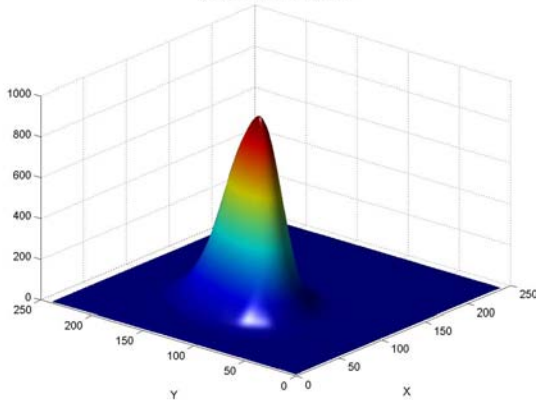
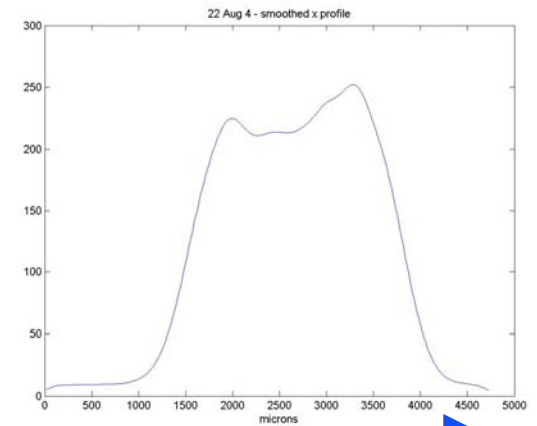
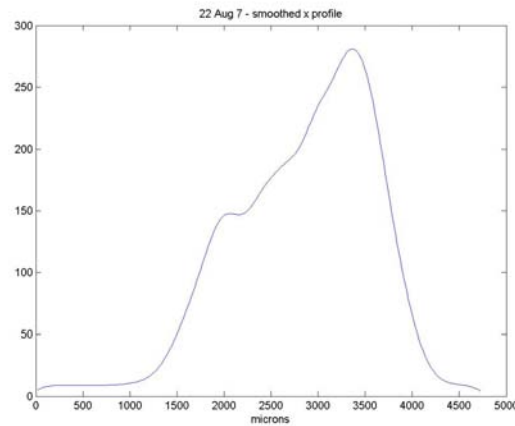
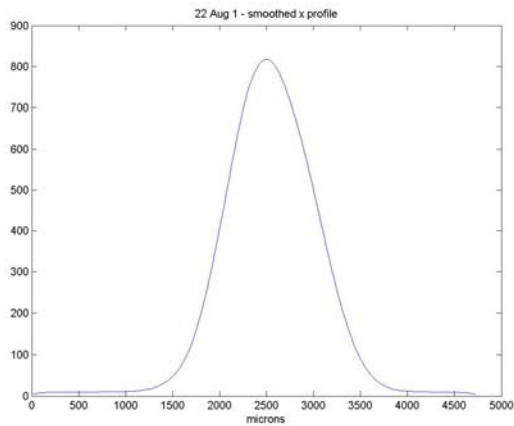
4  $\mu$ rad  
tilt



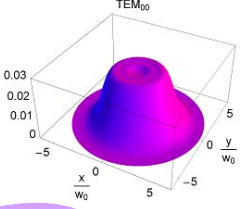


## Improving Alignment

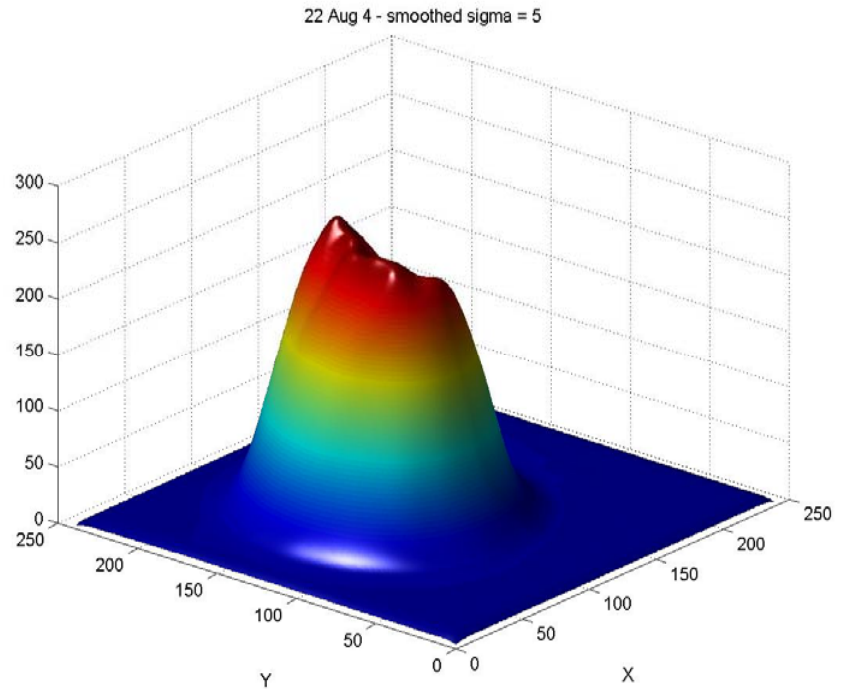
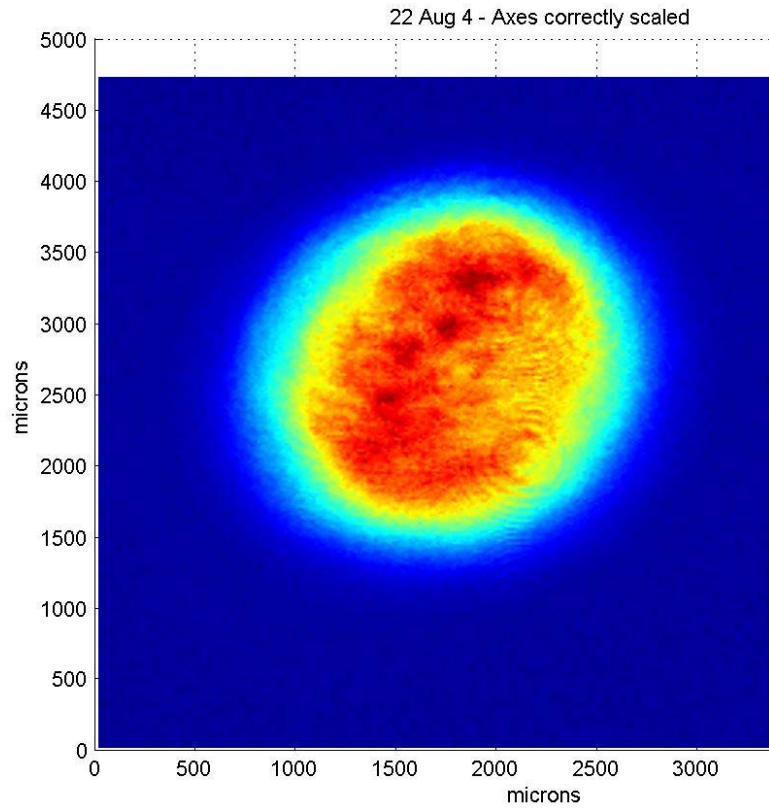
- The reference during alignment was changed from the intensity profile to the transverse mode spectrum



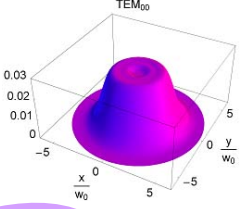




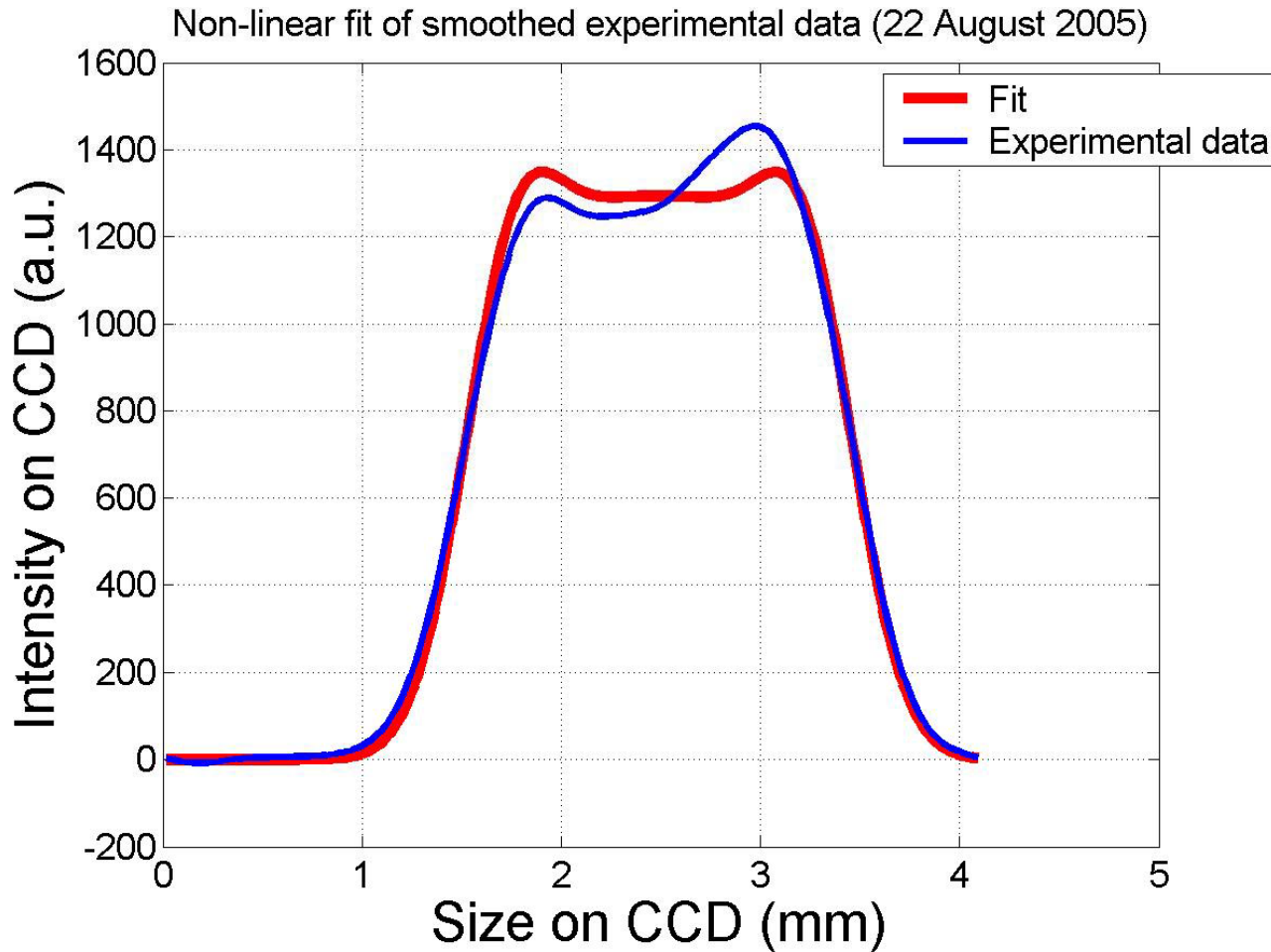
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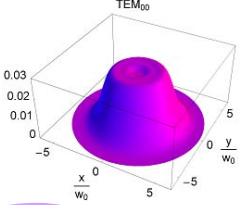




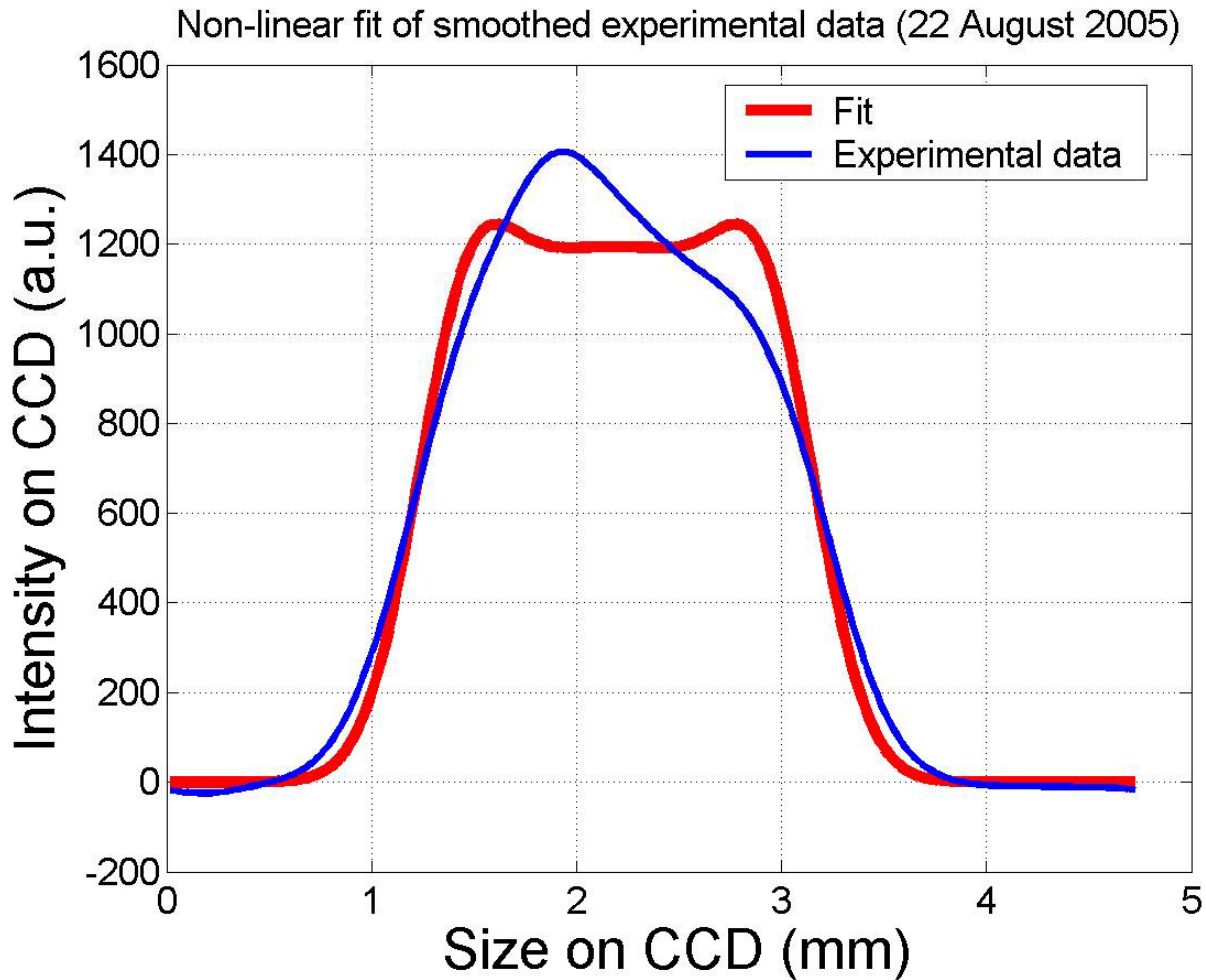


# Non-Linear Fit X

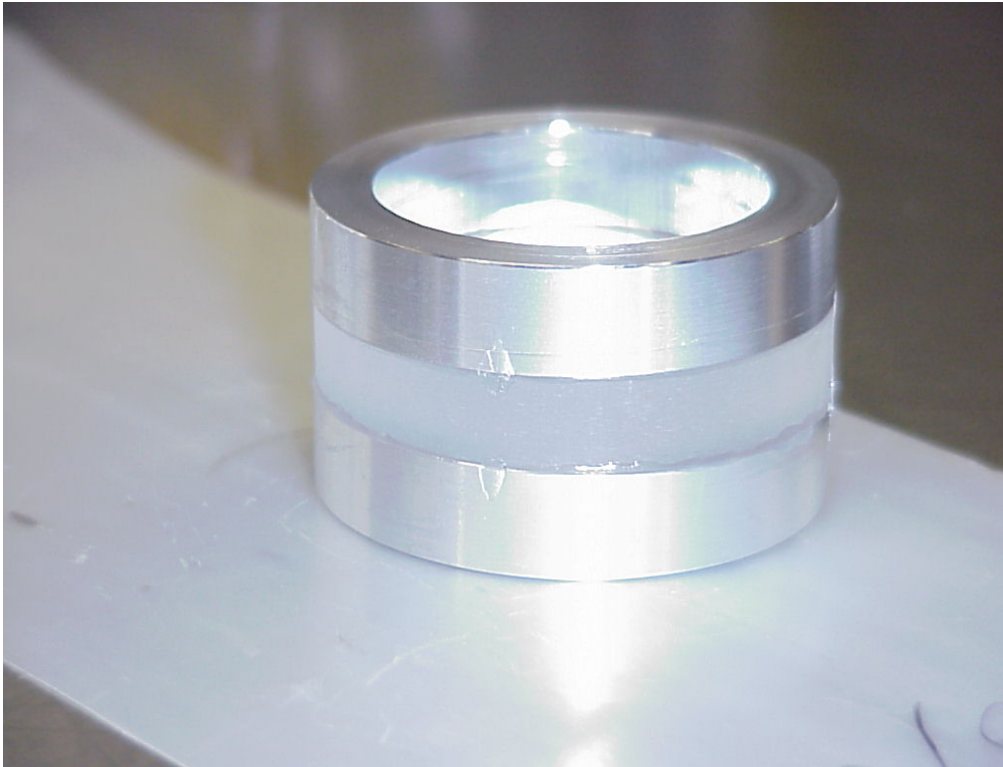
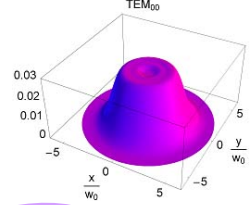




# Non-Linear Fit Y

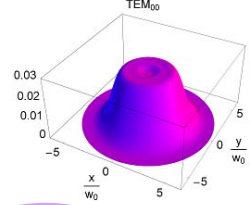


# How Was This Achieved?

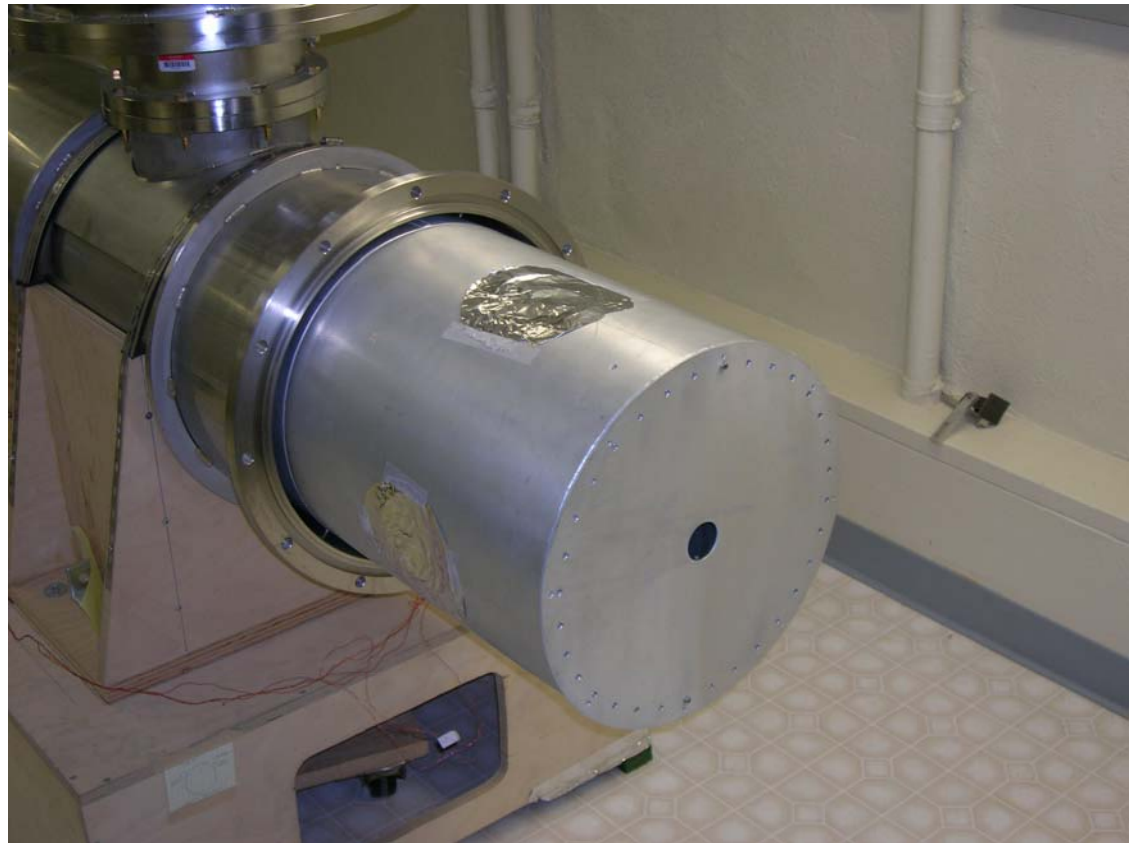


- We have reinforced flexible mirrors with aluminium rings
- Thicker substrates have been ordered

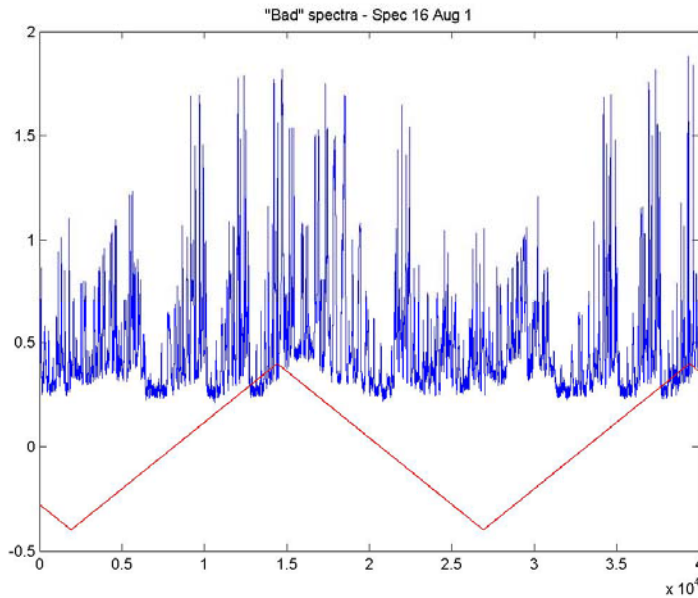
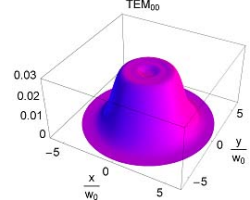
# How Was This Achieved?



- Improved atmospheric isolation
- Better stability 'in lock'

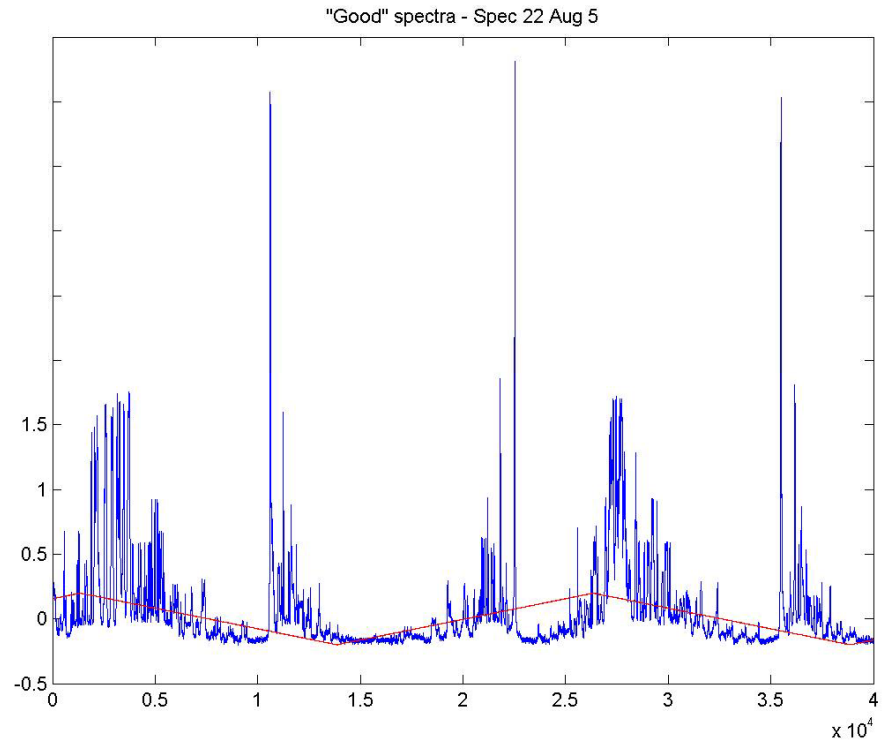


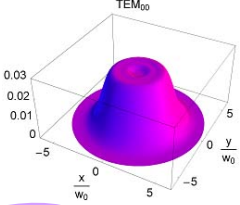
# How Was This Achieved?



- Improved spectrum

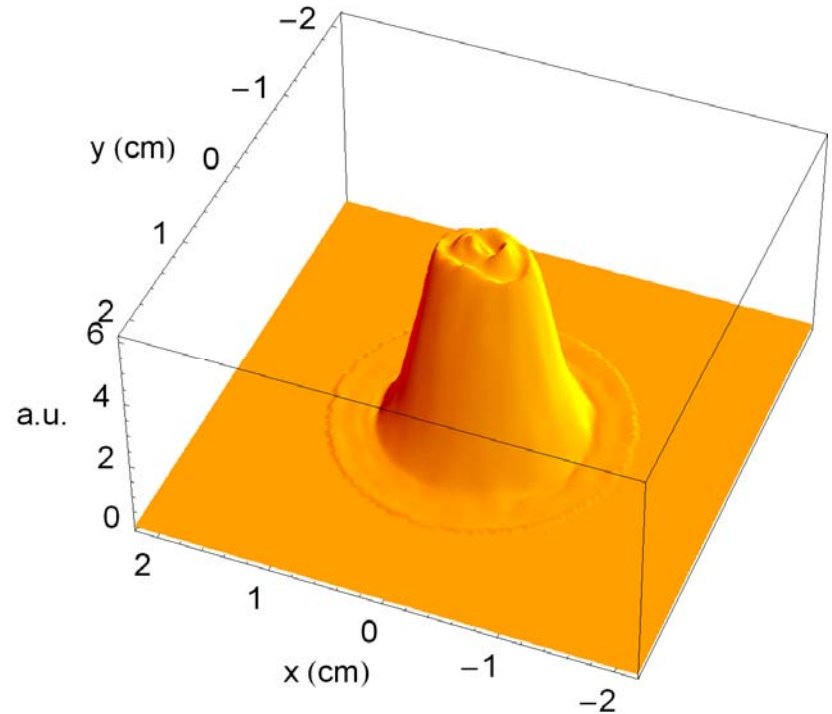
- More power in the fundamental mode



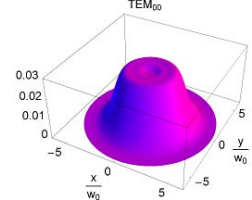


# Optimal Profile

- Even with aluminium rings the flat mirrors are far from perfect
- Thicker flat mirrors have been ordered
- New mounts being designed



# Further Work With This Set Up



- Improve profile using new flat mirrors
- Repeatability/ stability
- Quantify alignment/ mirror figure error tolerances – cf. theory
- Test other two MH mirrors
- Characterise high order modes
- Long term – design and build half of a nearly concentric MH Cavity