Correcting the heat load induced performance degradation on a XUV beamline

ACTOP08

Correcting the heat load induced performance degradation on a XUV beamline

- Source
- Beamline Optical Design
- Ray Traces
- Resolution and Flux
- Heat Load
- Summary

ACTOP08

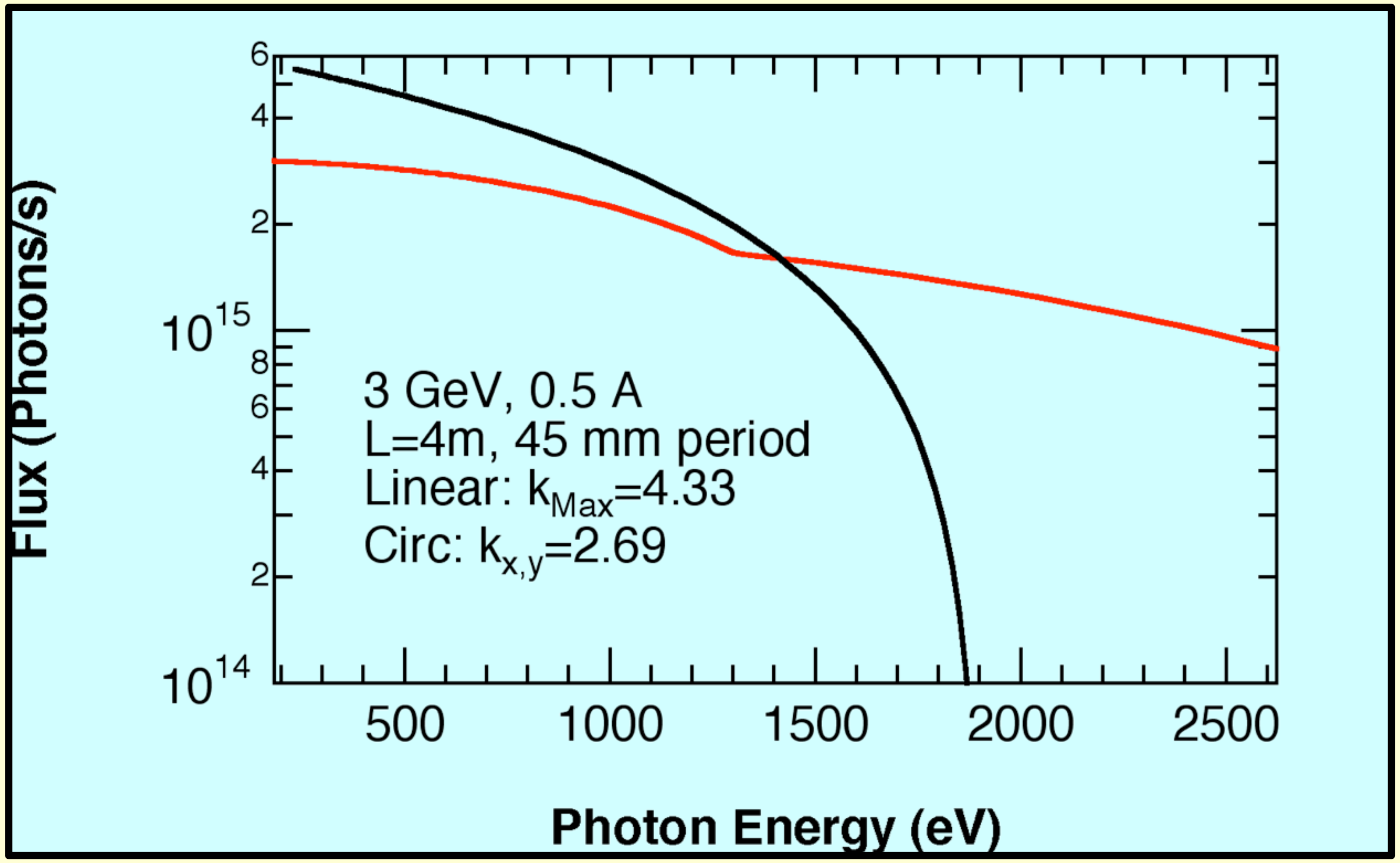
Correcting the heat load induced performance degradation on a XUV beamline

- Source
- Beamline Optical Design
- Ray Traces
- Resolution and Flux
- Heat Load
- Summary

S. Hulbert, NSLS
C. Sanchez-Henke, NSLS
D. Arena, NSLS
K. Kriesel, PSL
R. Reininger, SAS-SRC

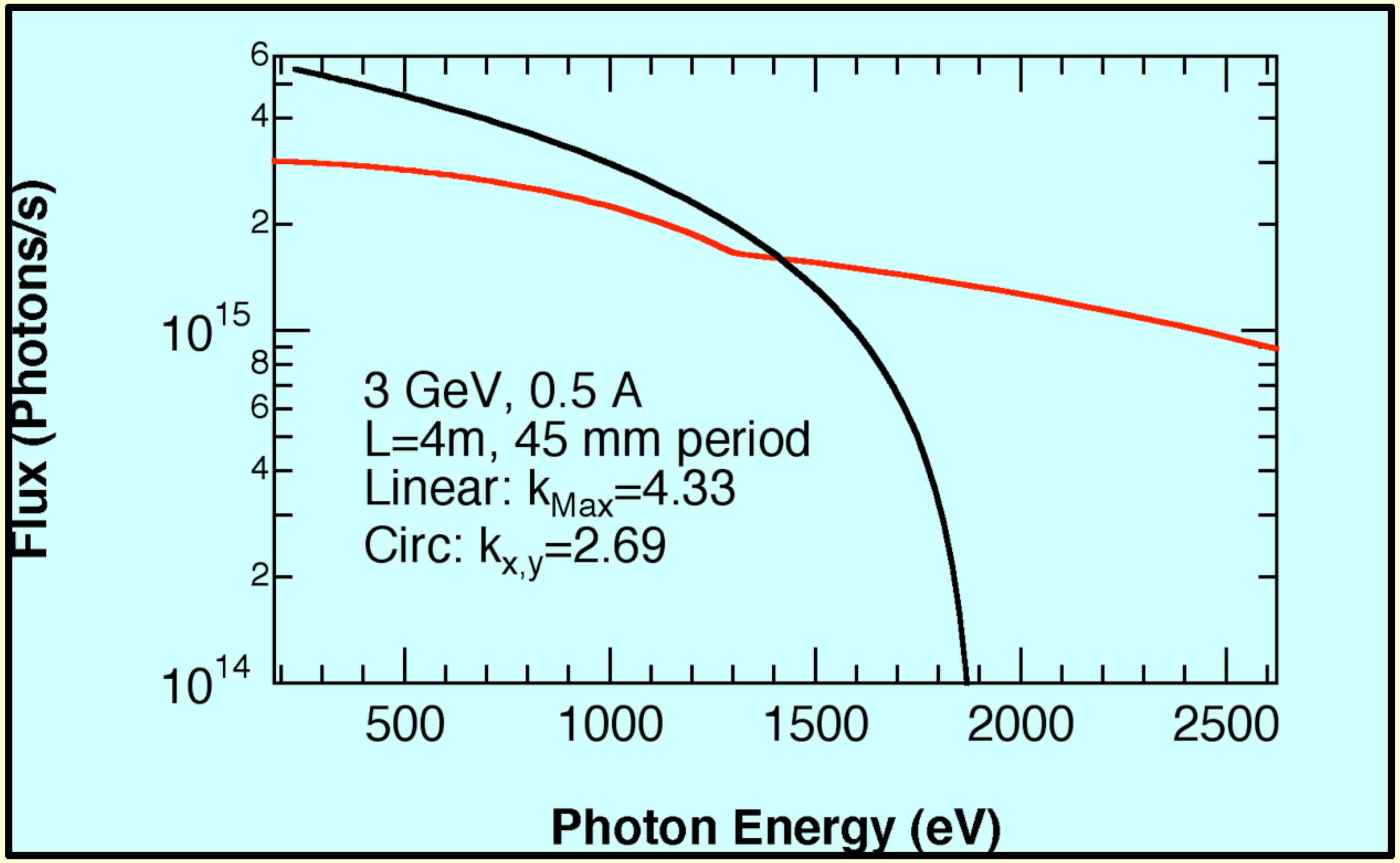
ACTOP08

Source: NSLS II, EPU 45



No need to focus horizontally

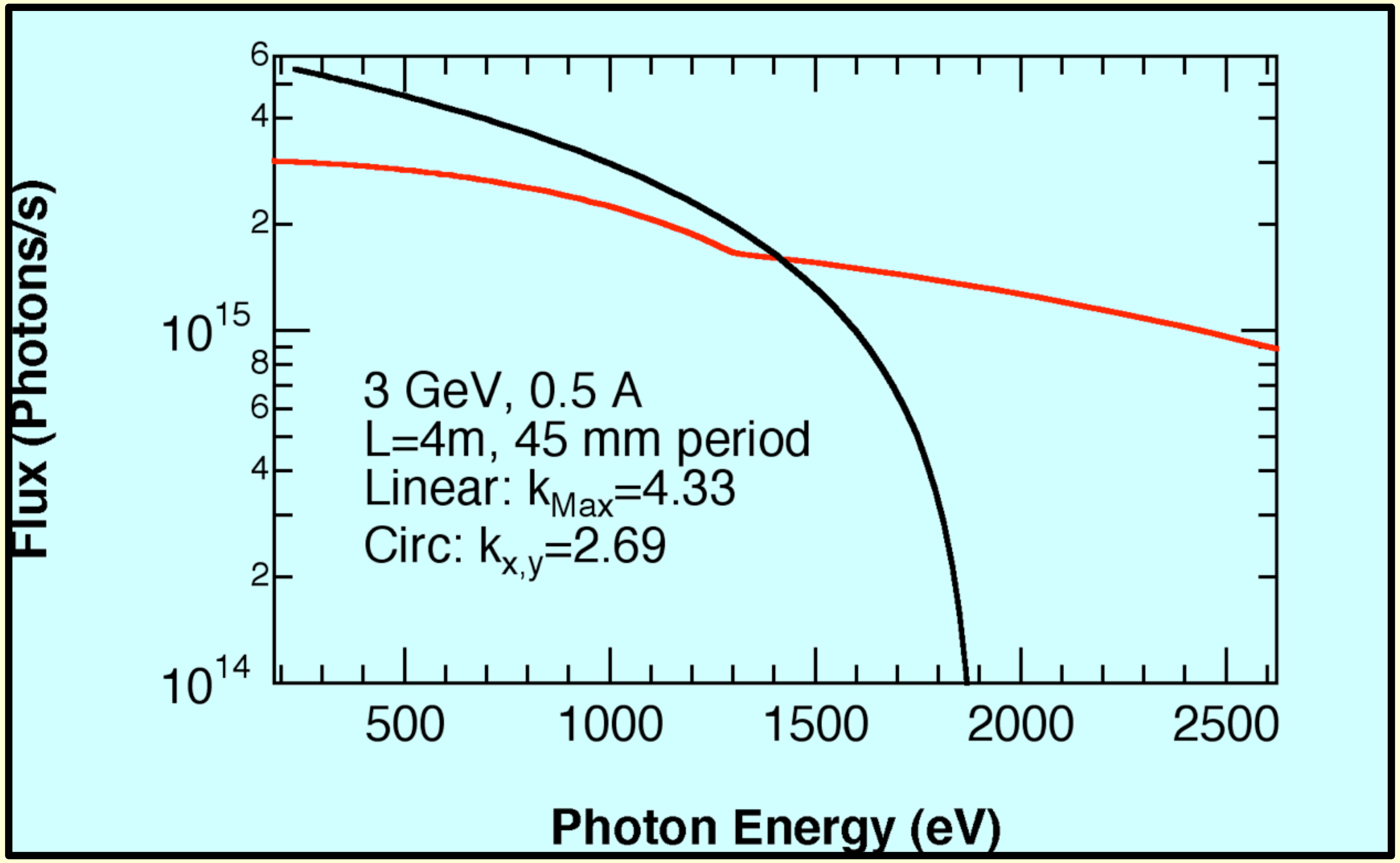
Source: NSLS II, EPU 45



	200 eV	1000 eV
σ_{hor} (μm)	45	32
σ_{ver} (μm)	36	16
σ'_{hor} (μrad)	34	23
σ'_{ver} (μrad)	28	13

No need to focus horizontally

Source: NSLS II, EPU 45



	200 eV	**1000 eV**
σ_{hor} (μm)	45	32
σ_{ver} (μm)	36	16
σ'_{hor} (μrad)	34	23
σ'_{ver} (μrad)	28	13

200 eV at 50 m, σ=1.7 mm

No need to focus horizontally

VLS-PGM

$$k(w) = k_0(1 + 2b_2 w + 3b_3 w^2 \ldots)$$

$$f_{20} = \frac{\cos^2\alpha}{r_1} + \frac{\cos^2\beta}{r_2} + 2b_2 n k \lambda$$

$$f_{30} = \sin\alpha \frac{\cos^2\alpha}{r_1^2} + \sin\beta \frac{\cos^2\beta}{r_2^2} + 2b_3 n k \lambda$$

Collimated beam $r_1 \rightarrow \infty$

VLS-PGM

$$k(w) = k_0(1 + 2b_2 w + 3b_3 w^2 \ldots)$$

$$f_{20} = \frac{\cos^2\alpha}{r_1} + \frac{\cos^2\beta}{r_2} + 2b_2 n k \lambda$$

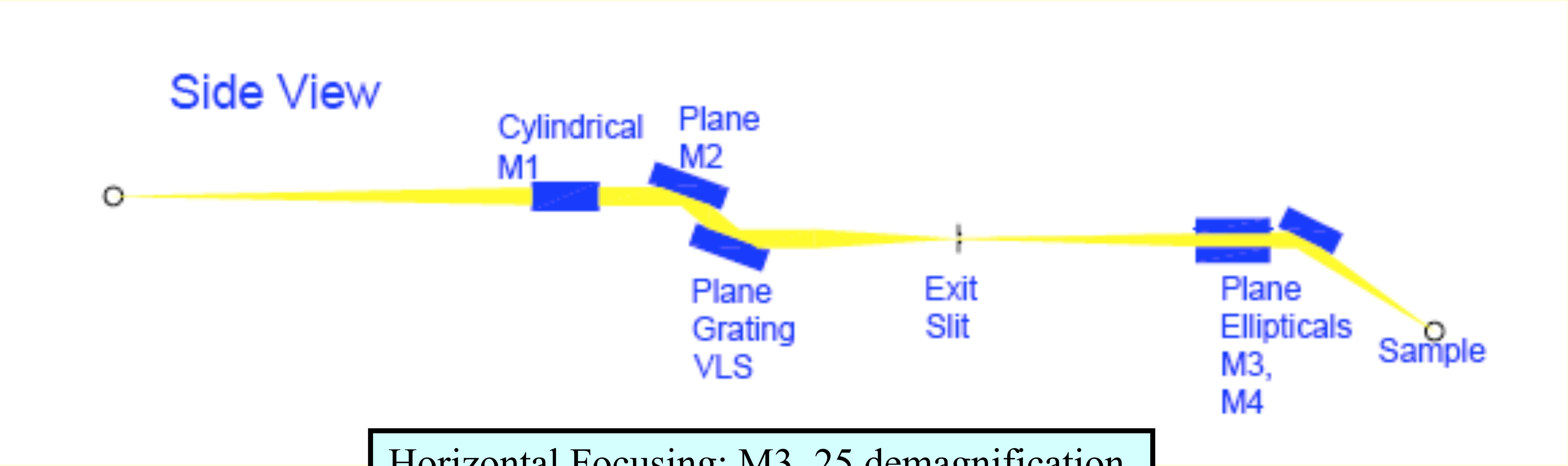
$$f_{30} = \sin\alpha \frac{\cos^2\alpha}{r_1^2} + \sin\beta \frac{\cos^2\beta}{r_2^2} + 2b_3 n k \lambda$$

Collimated beam $r_1 \to \infty$

PM : $\gamma = \dfrac{\alpha - \beta}{2} \Rightarrow f_{20} = 0, n k \lambda = \sin\alpha + \sin\beta$

$$c = \frac{\cos\beta}{\cos\alpha}$$

Beamline

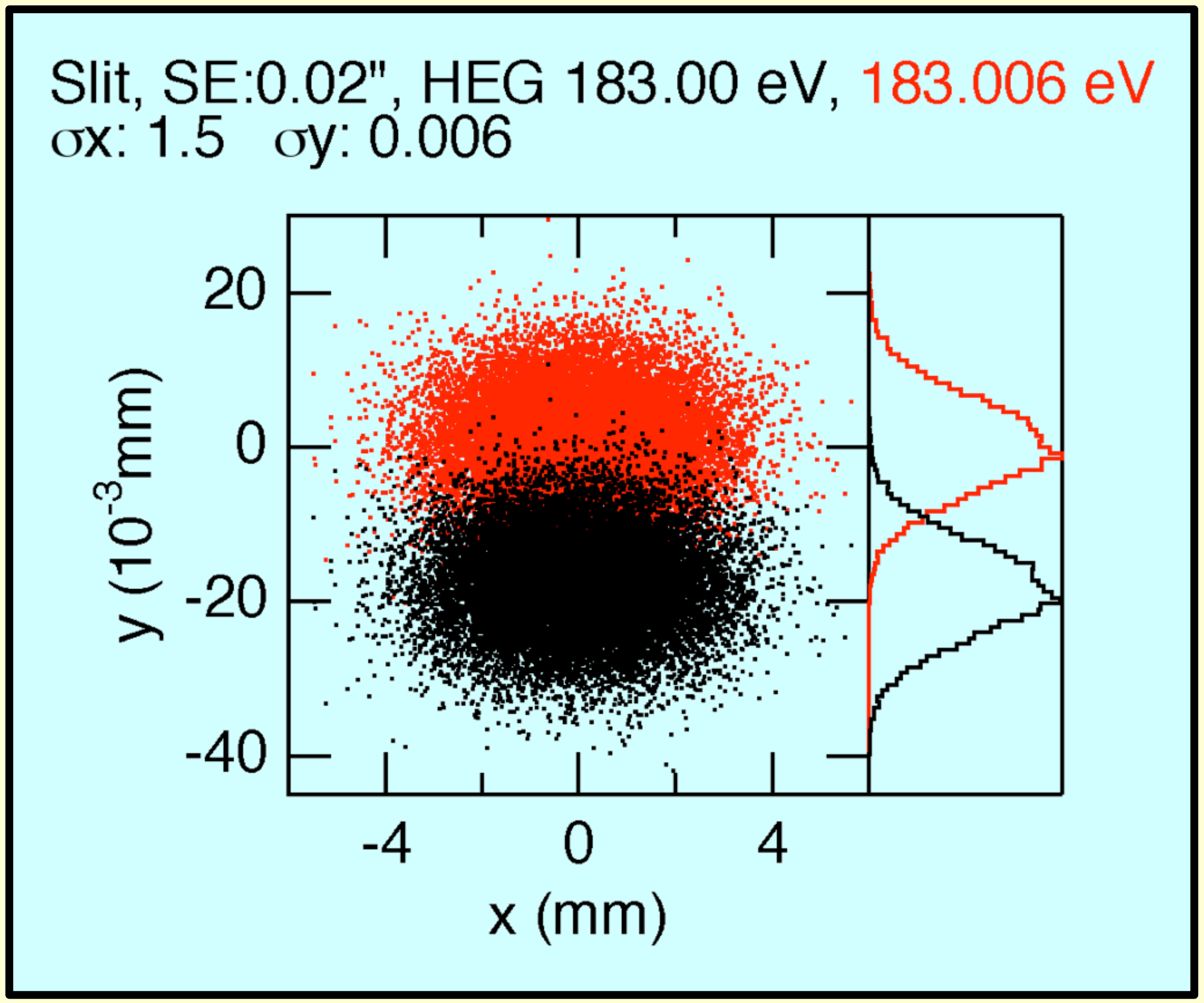


Horizontal Focusing: M3, 25 demagnification

Element	Distance (mm)	Angle (°)	Deflection	4σ×4σ (mm²)
M1- Sagittal Cylinder	29500	88.75	Horizontal	190×3.5
M2- Plane	31929[a]	84.0[a]	Vertical	380(70)×5
Gr - Grating	32000[a]	86.2[a]	Vertical	180×5
Slit	42000			
M3 - Plane Elliptical	43200	88.75	Horizontal	280×1
M4 - Plane Elliptical	43950	88.75	Vertical	48×4
Sample	44950			

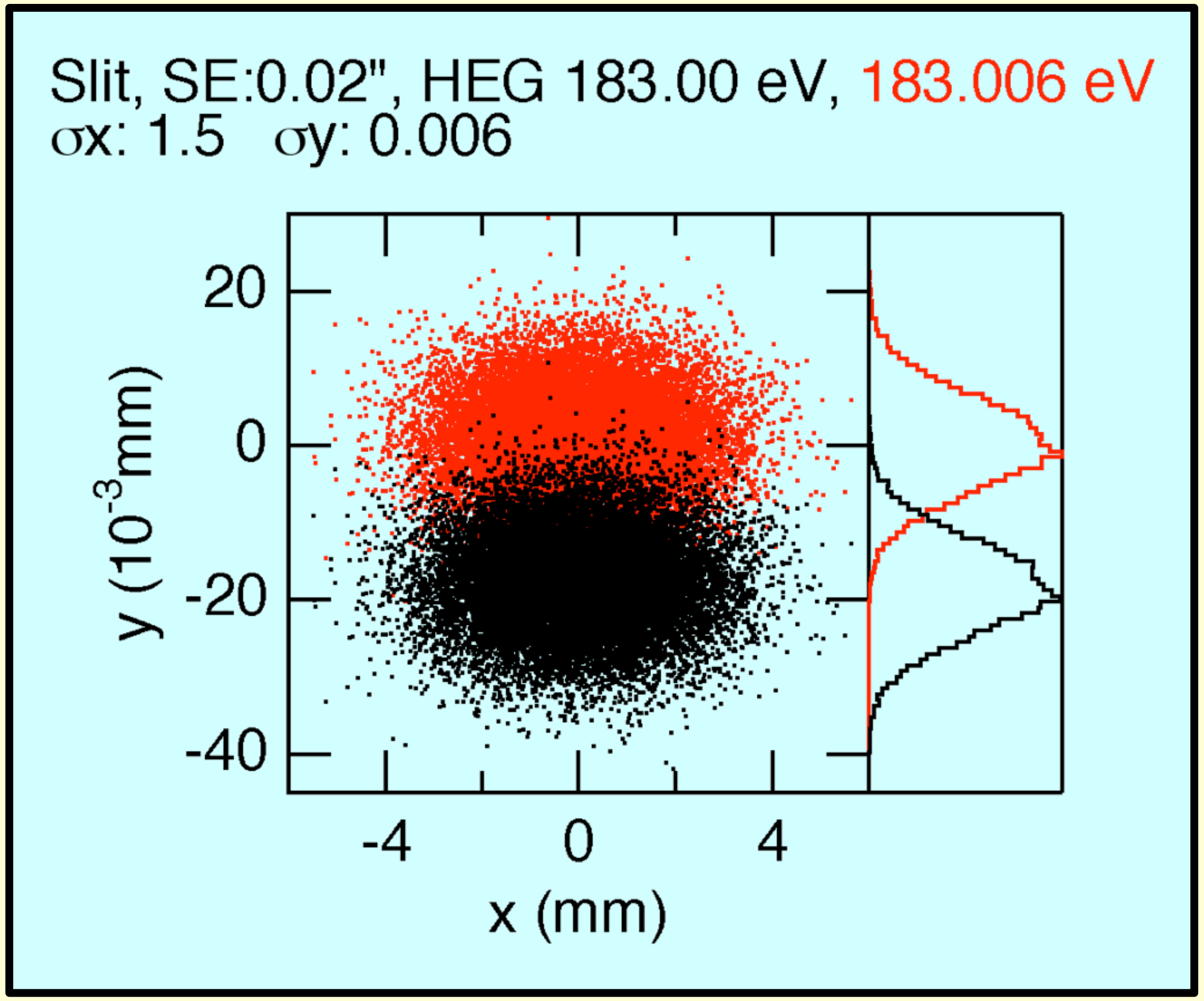
[a] For 183 eV

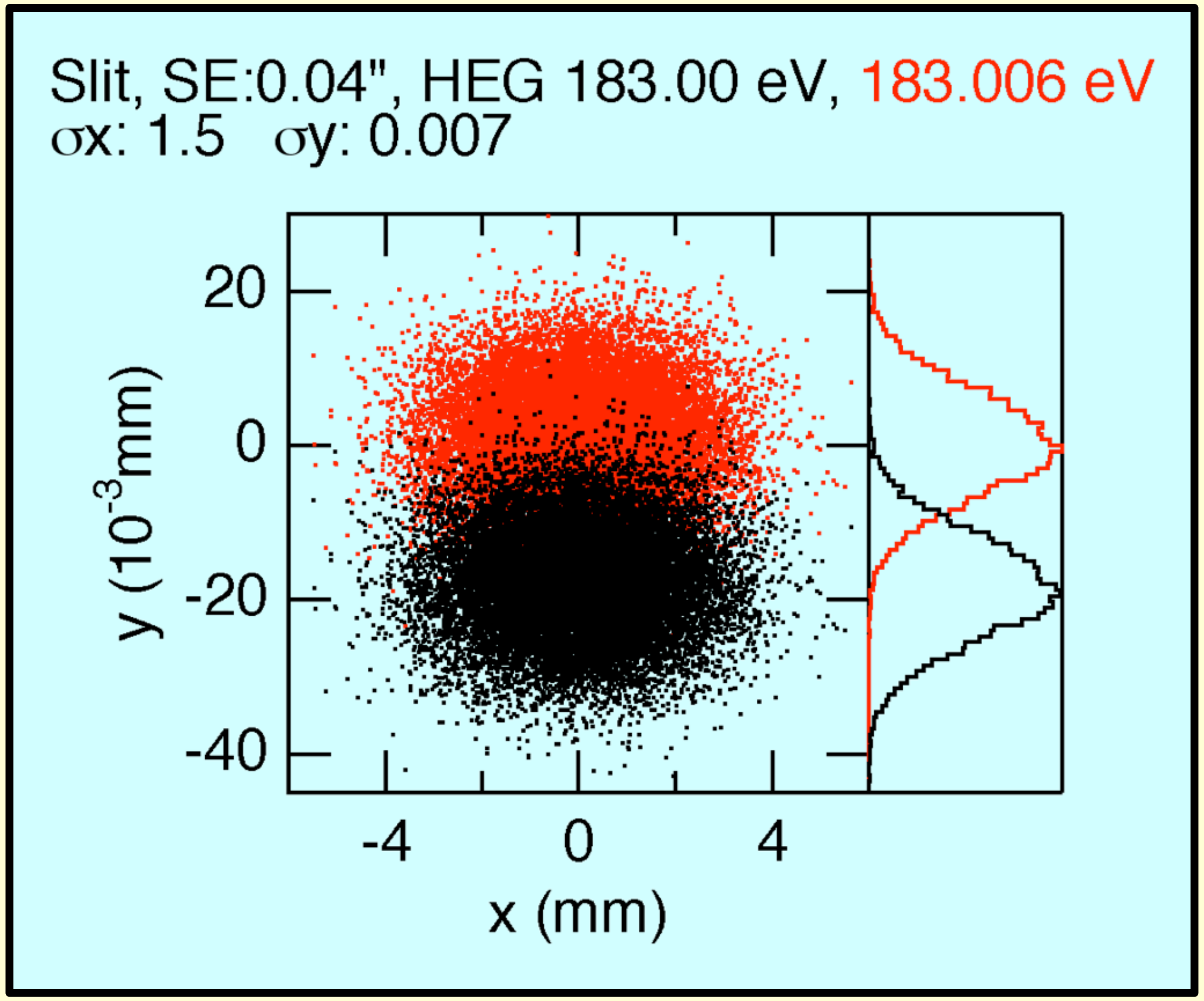
Ray Traces at Slit, 183 eV



RP >30000

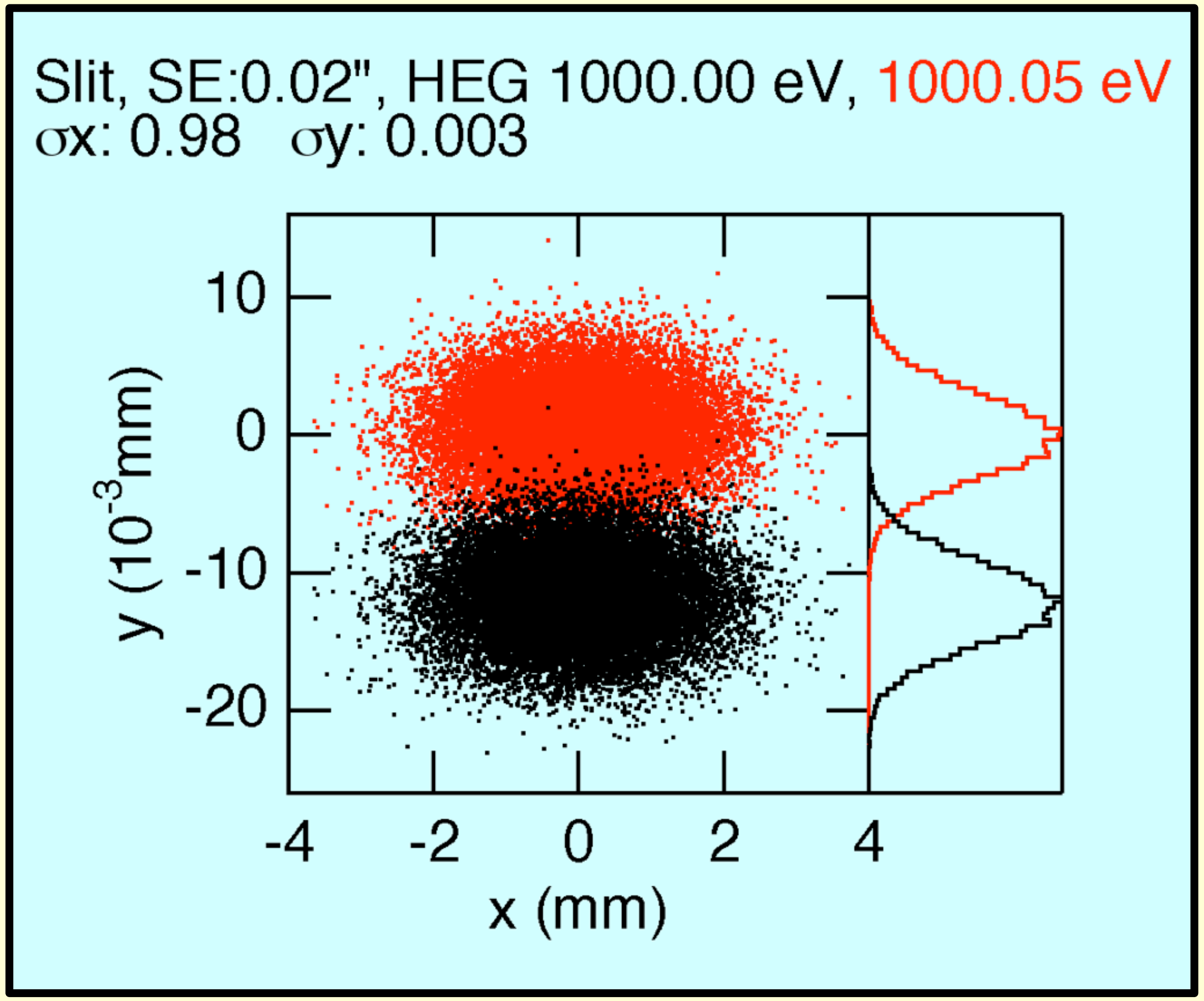
Ray Traces at Slit, 183 eV



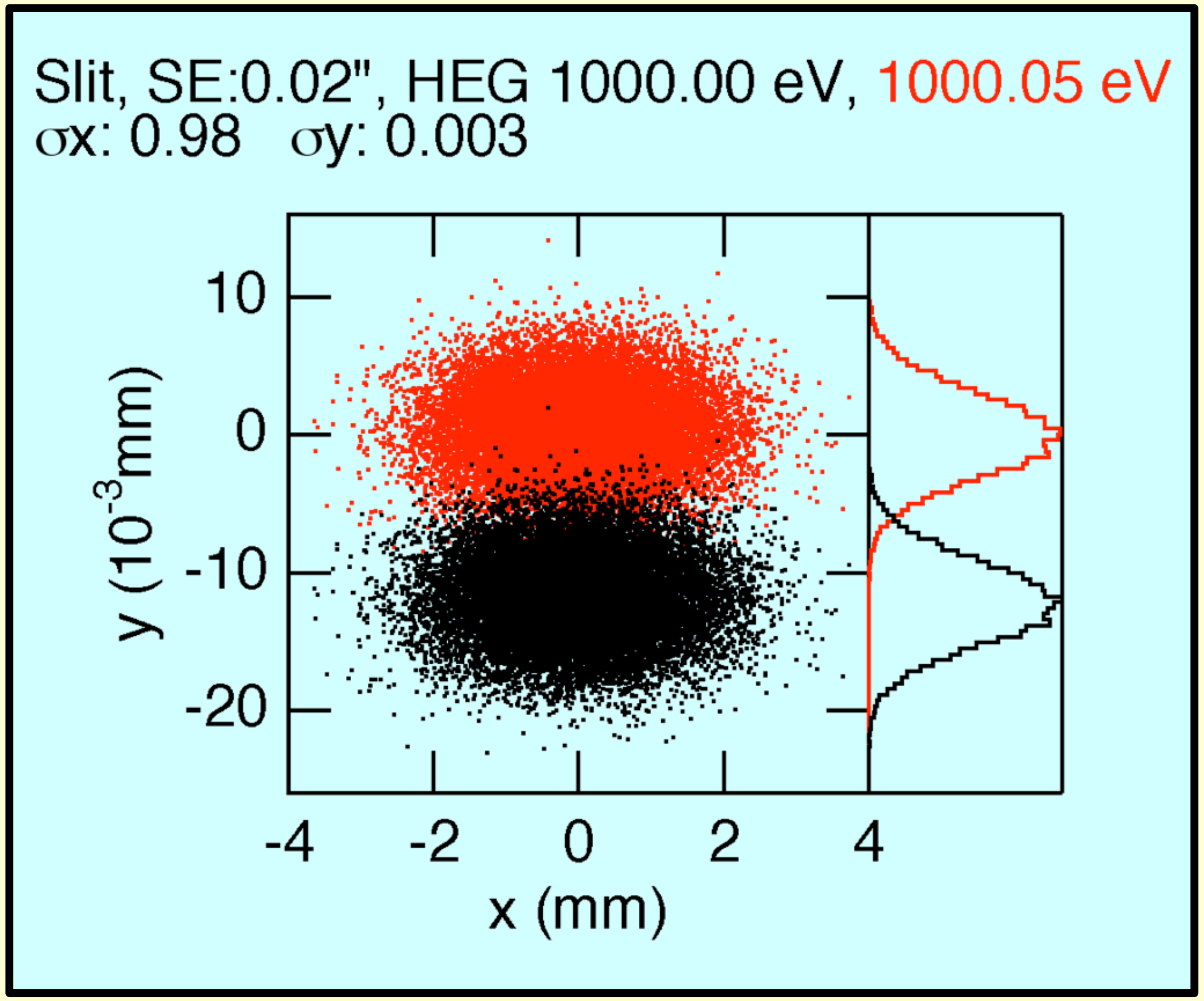


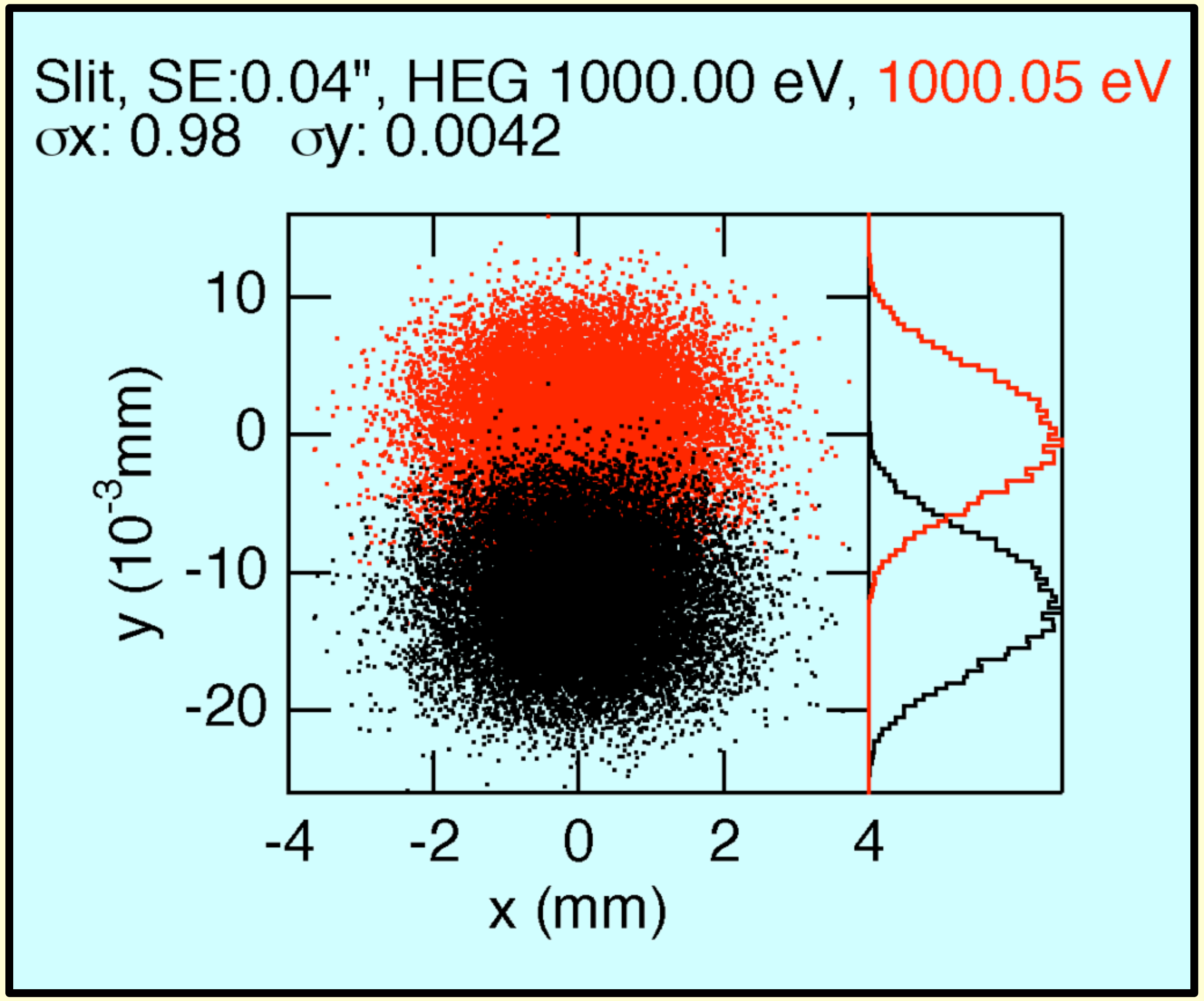
RP >30000

Ray Traces at Slit, 1000 eV

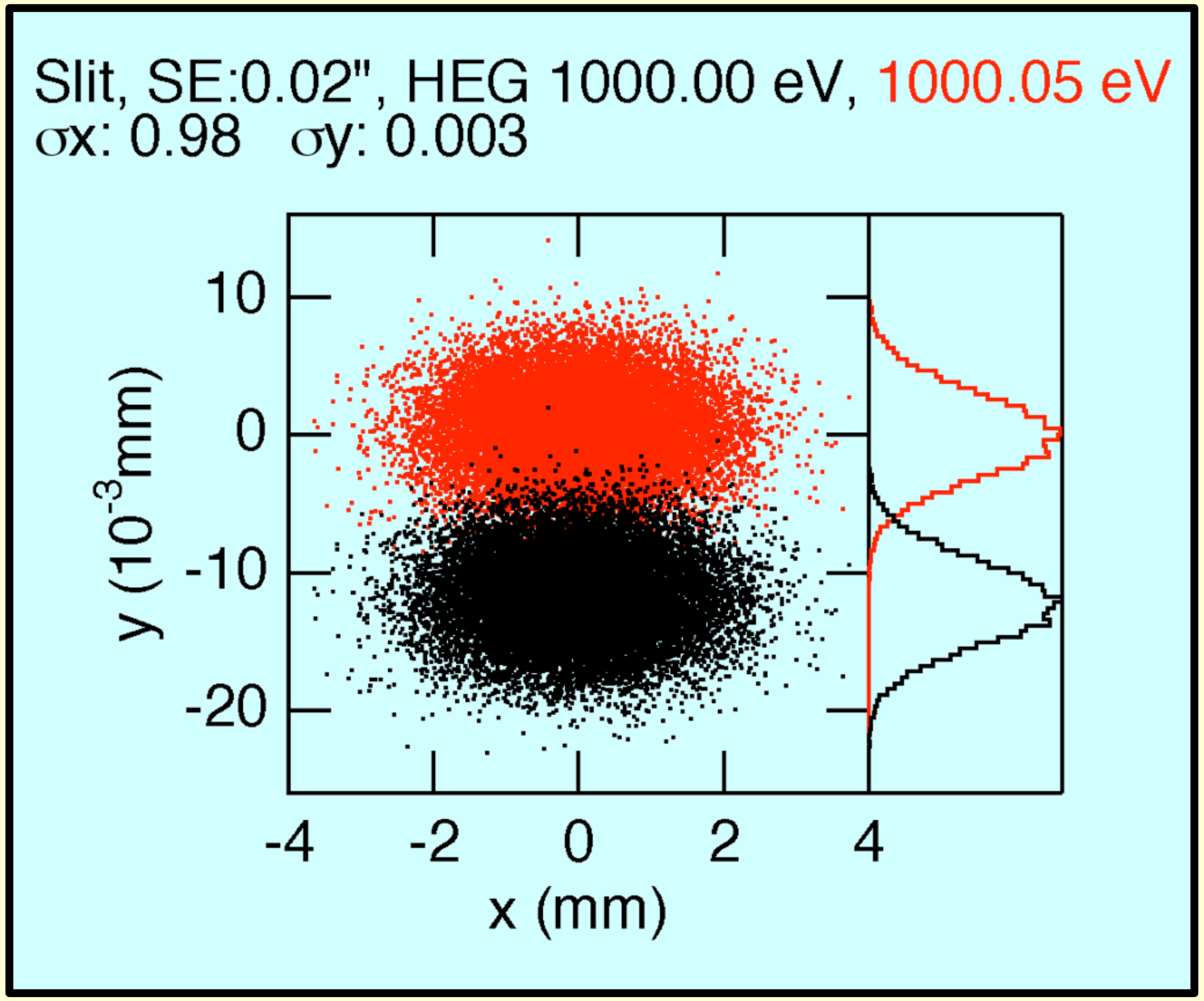


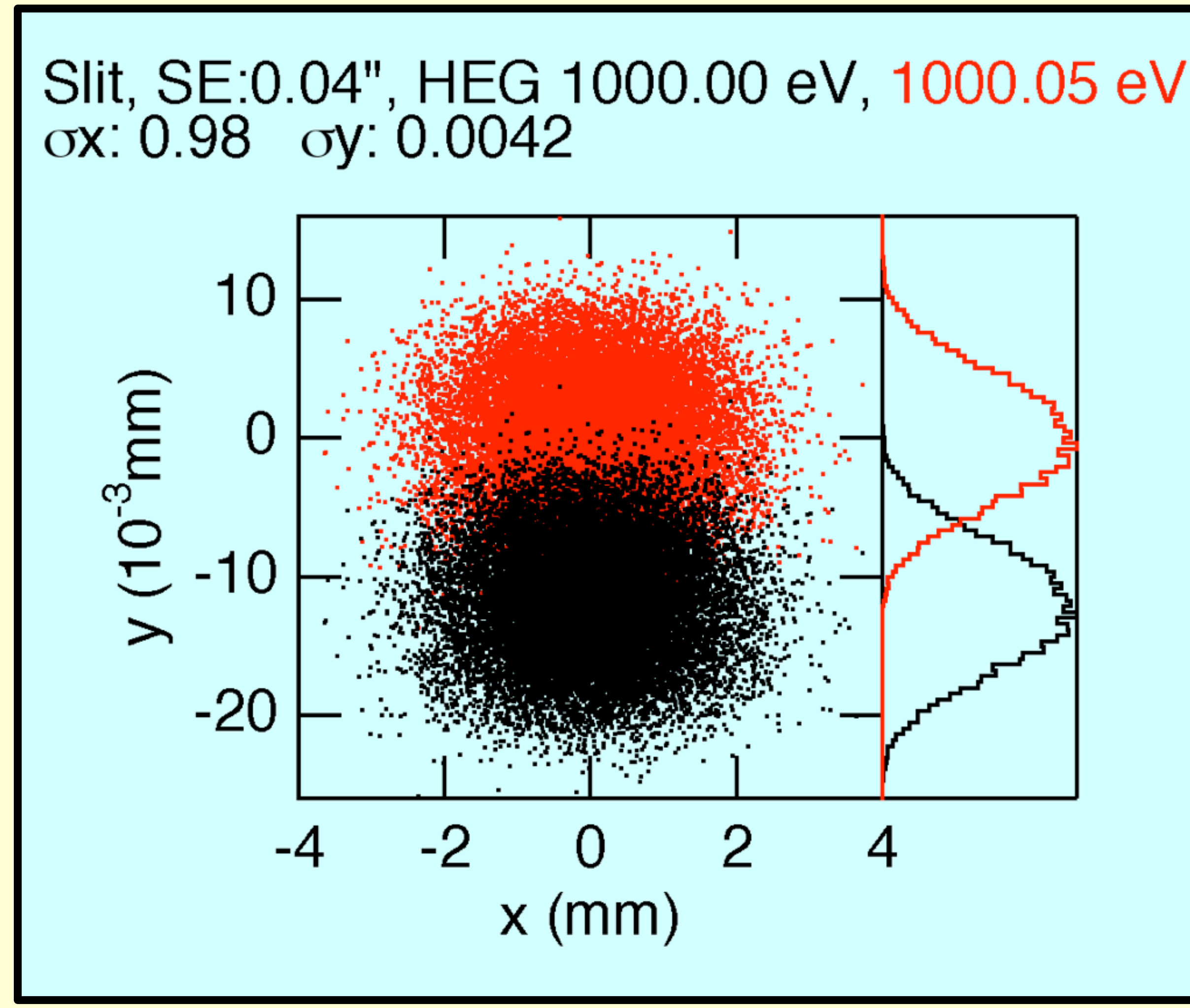
Ray Traces at Slit, 1000 eV





Ray Traces at Slit, 1000 eV

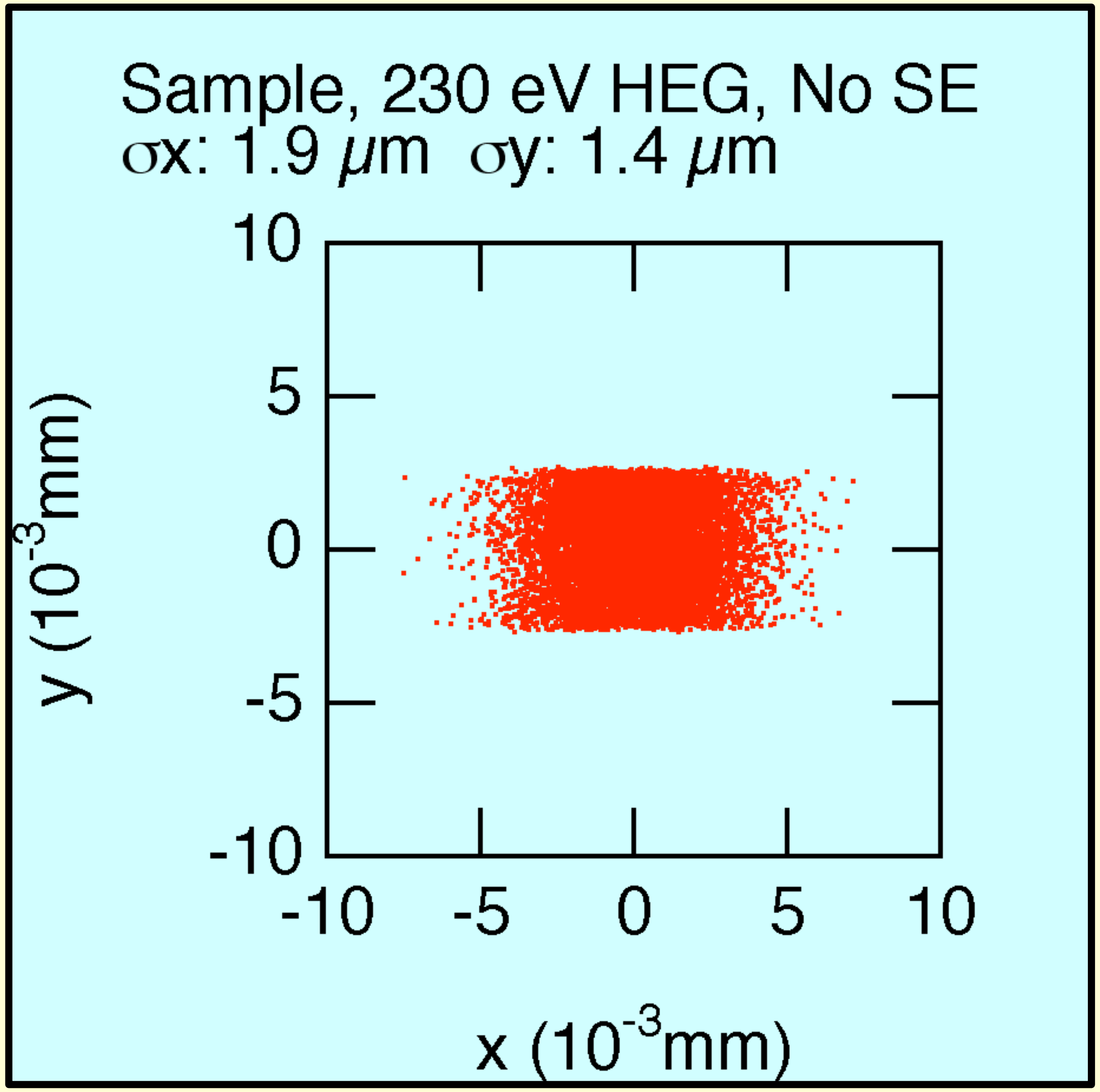




RMS Slope Errors ≈ 0.02”

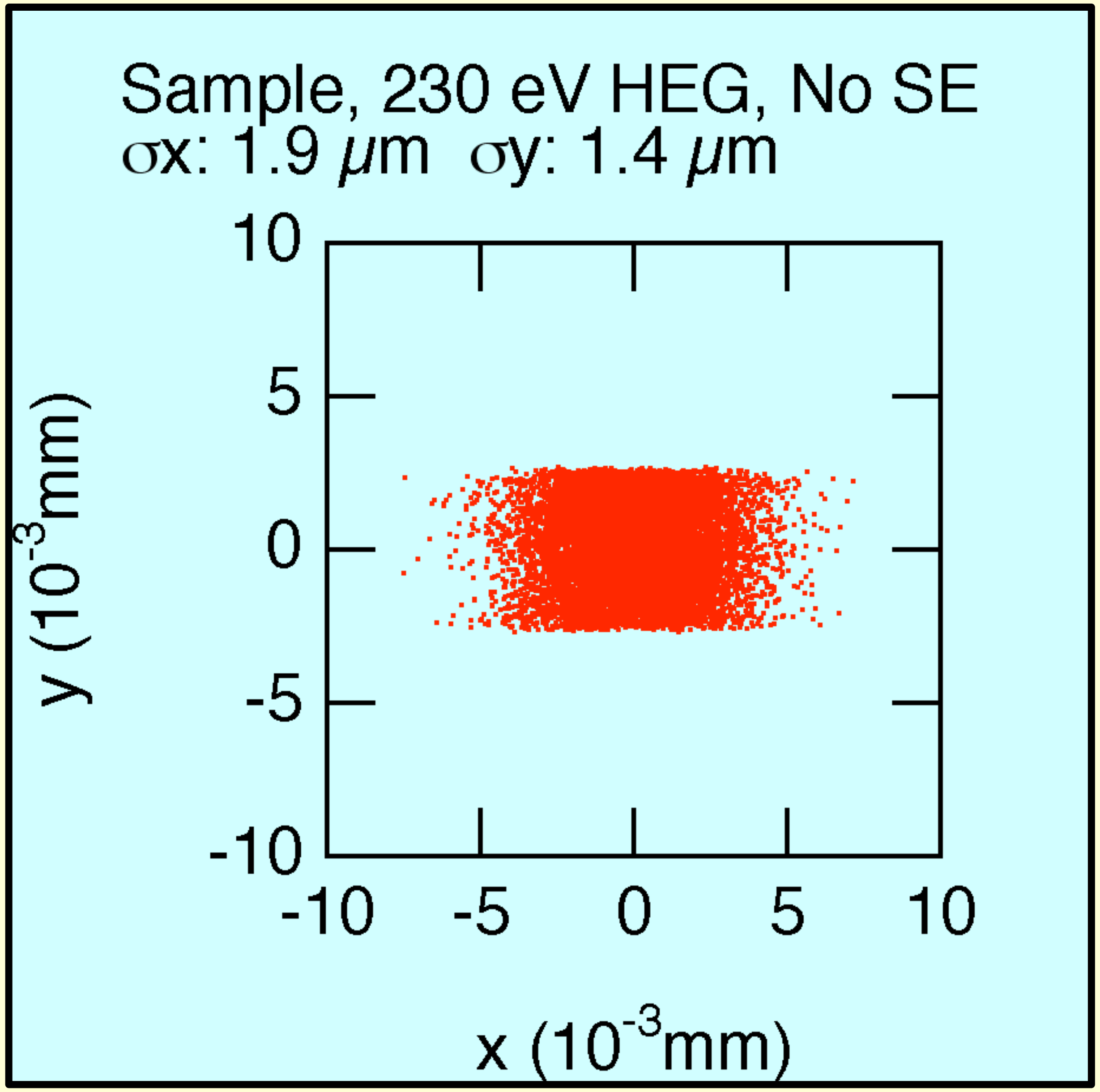
Size at Sample

230 eV, HEG, Linear, 10 μm slit



Size at Sample

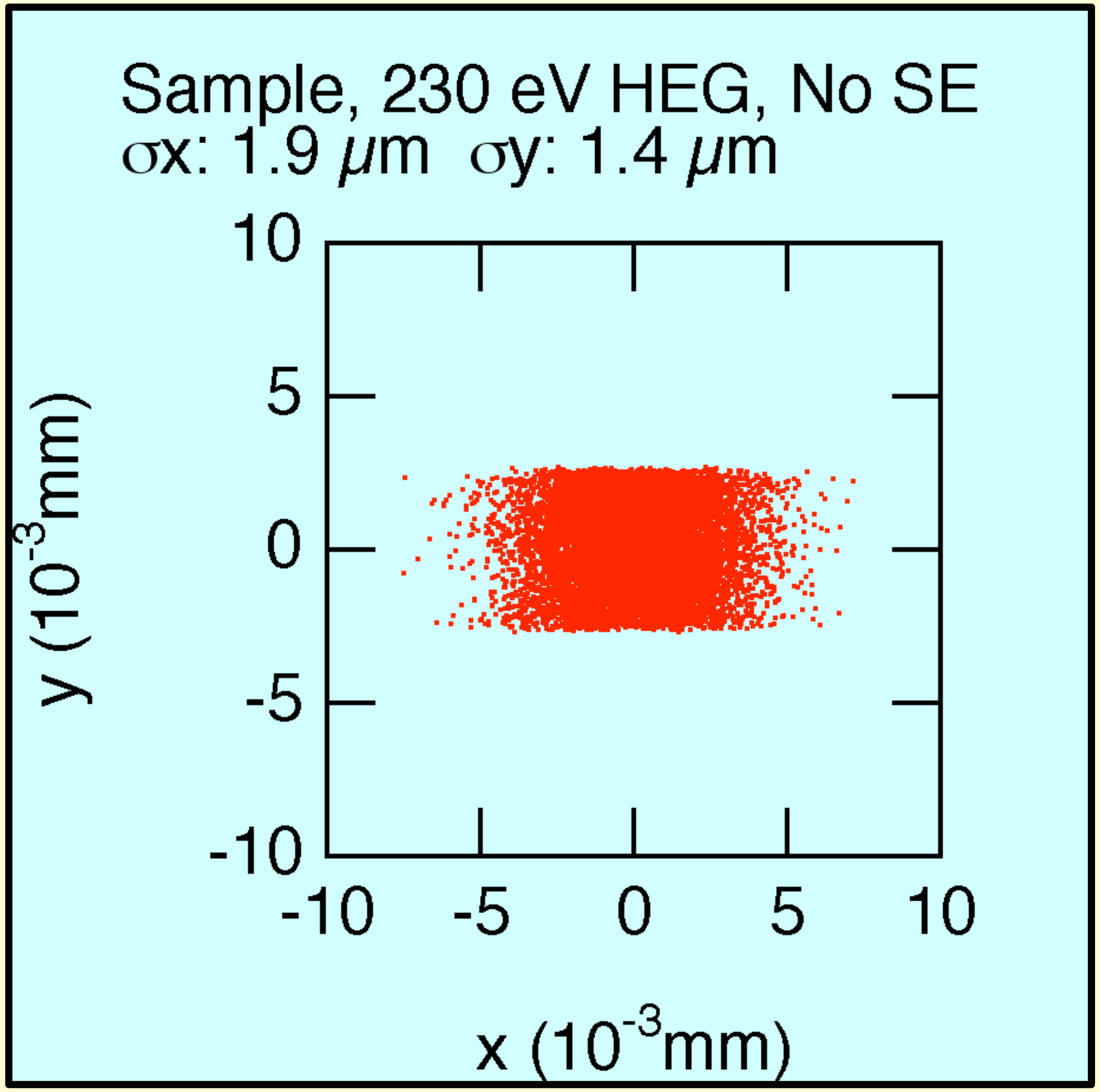
230 eV, HEG, Linear, 10 μm slit

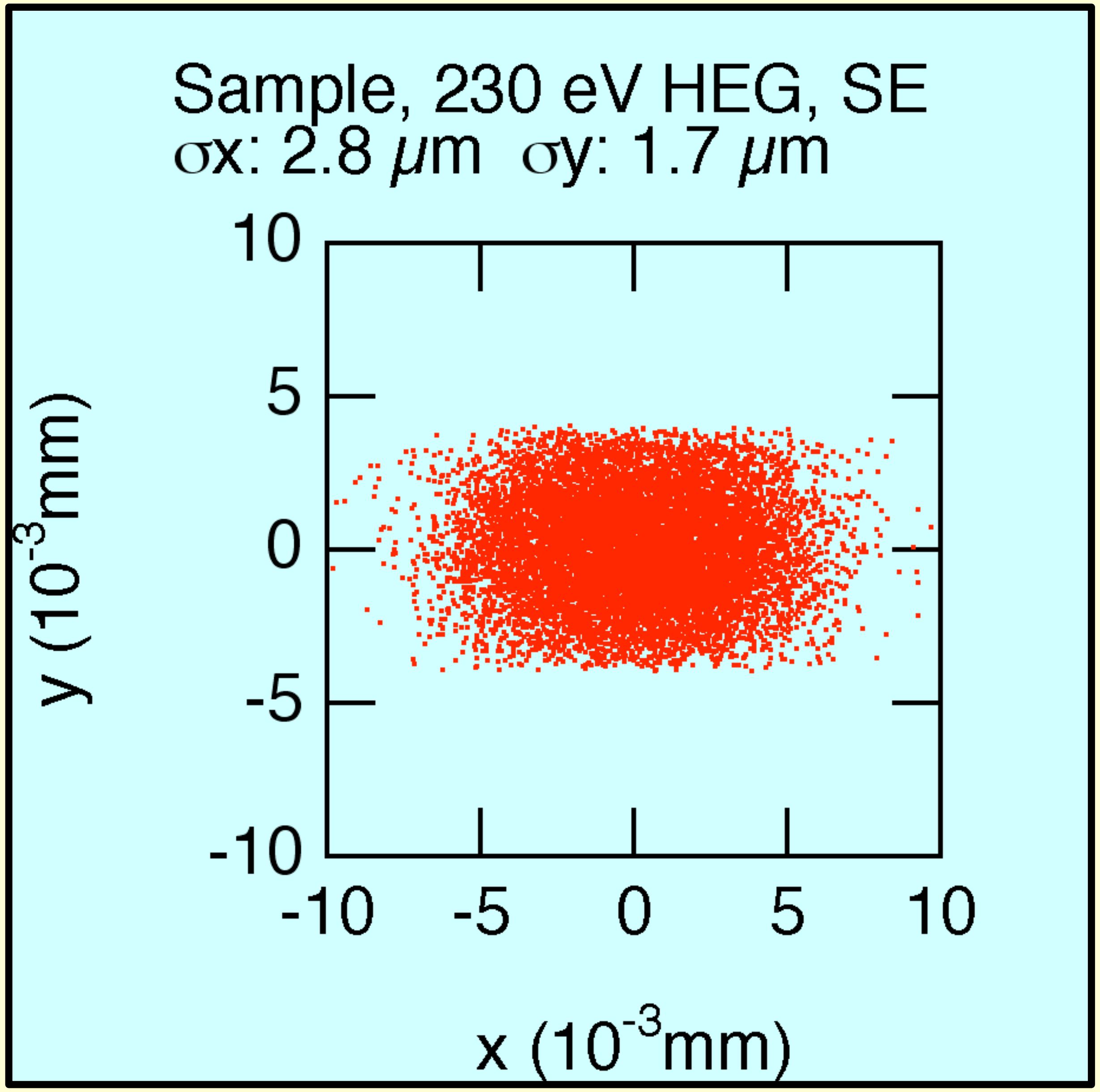


SE 0.1” meridional M1, M3, M4

Size at Sample

230 eV, HEG, Linear, 10 μm slit

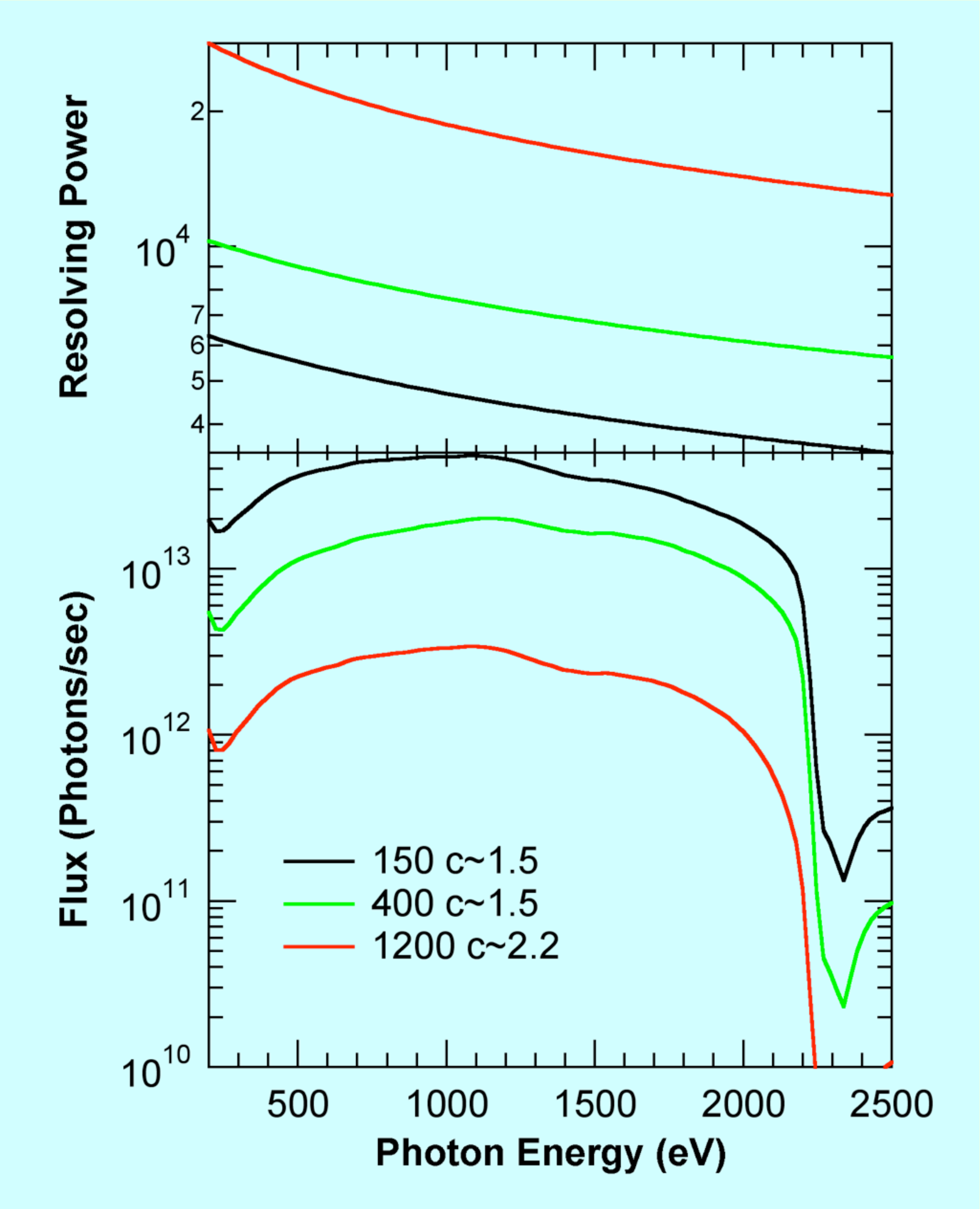




SE 0.1” meridional M1, M3, M4

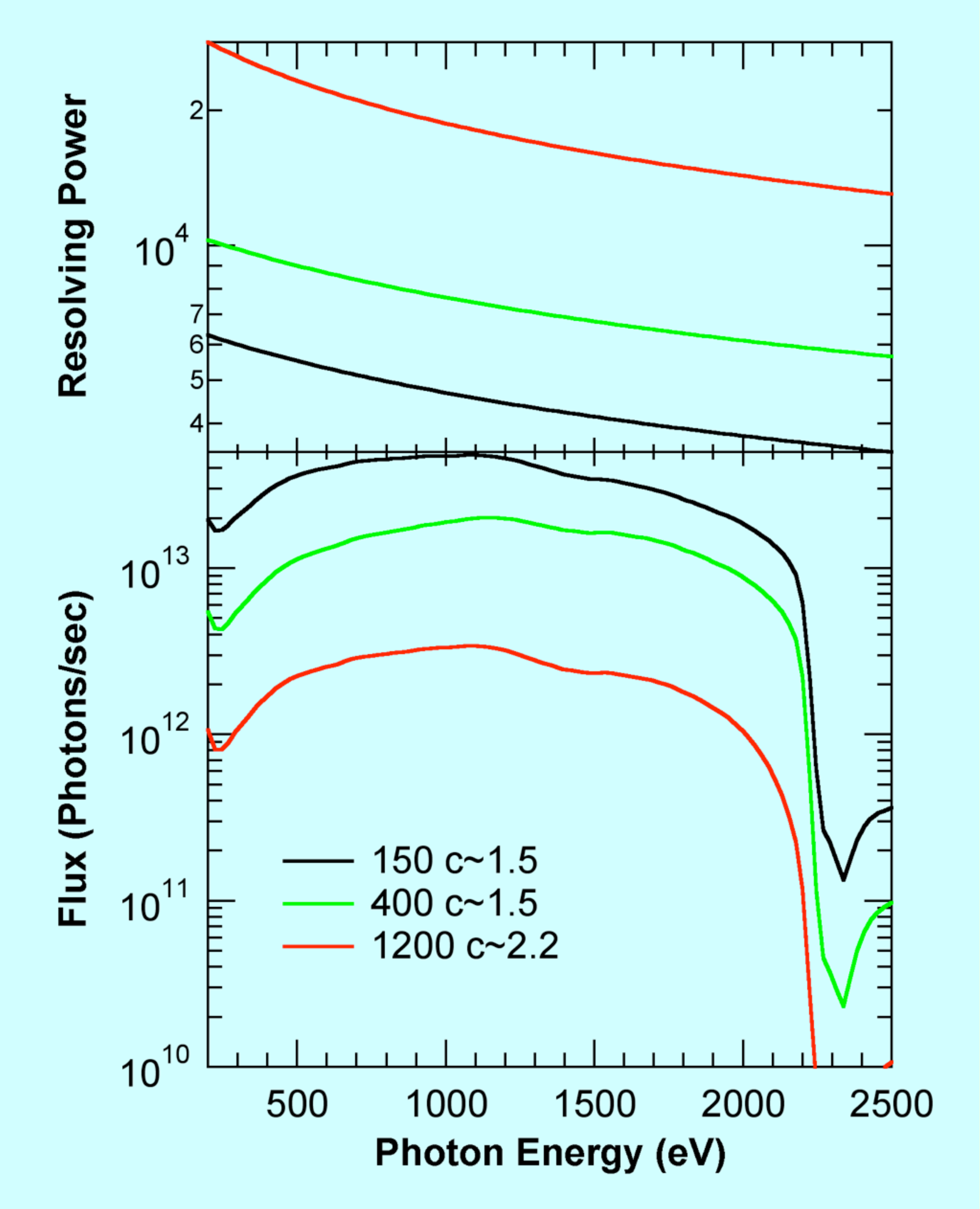
Resolution & Flux (linear)

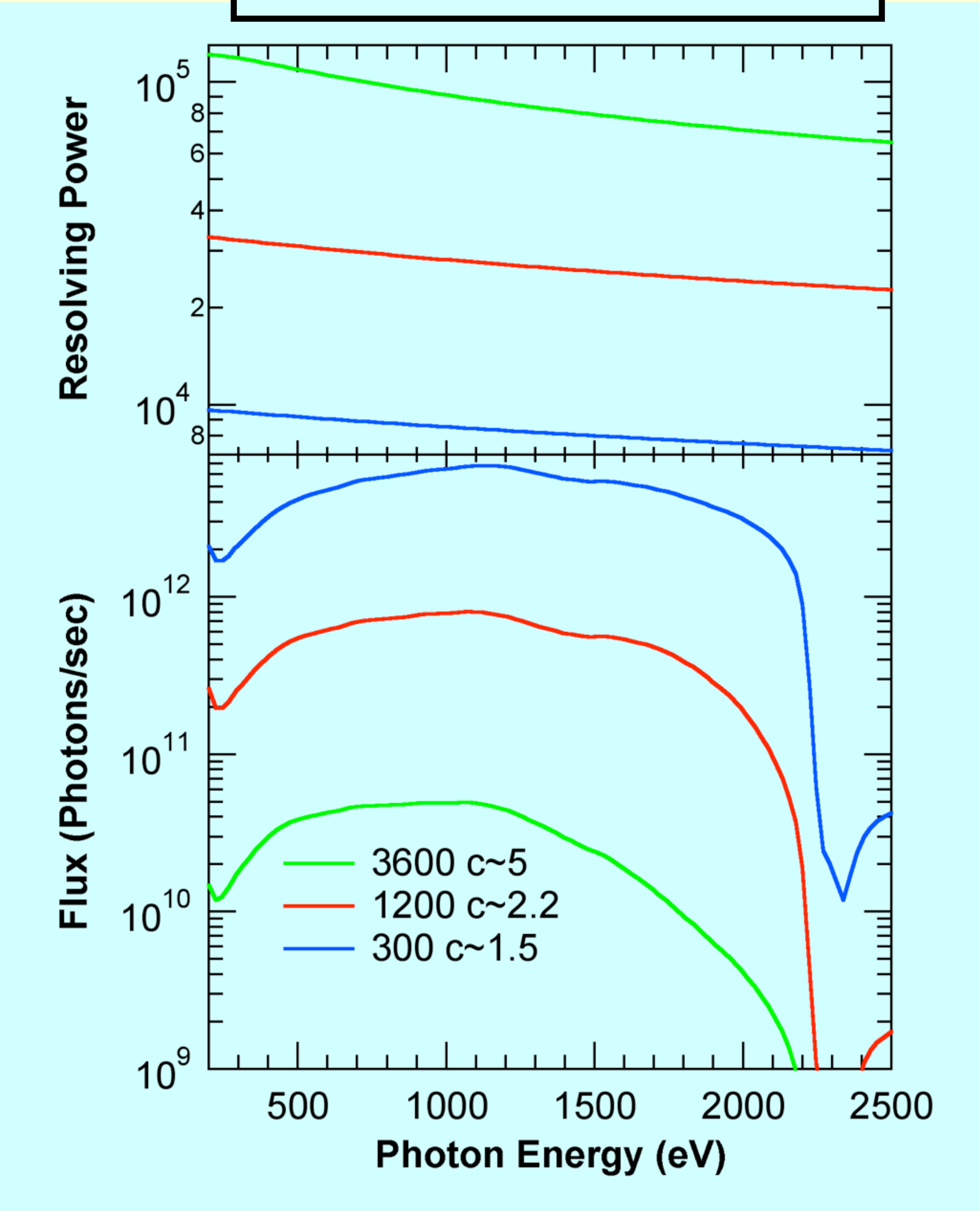
Source, Grating efficiencies, Reflectivity, 10 μm Slit, Slope errors.



Resolution & Flux (linear)

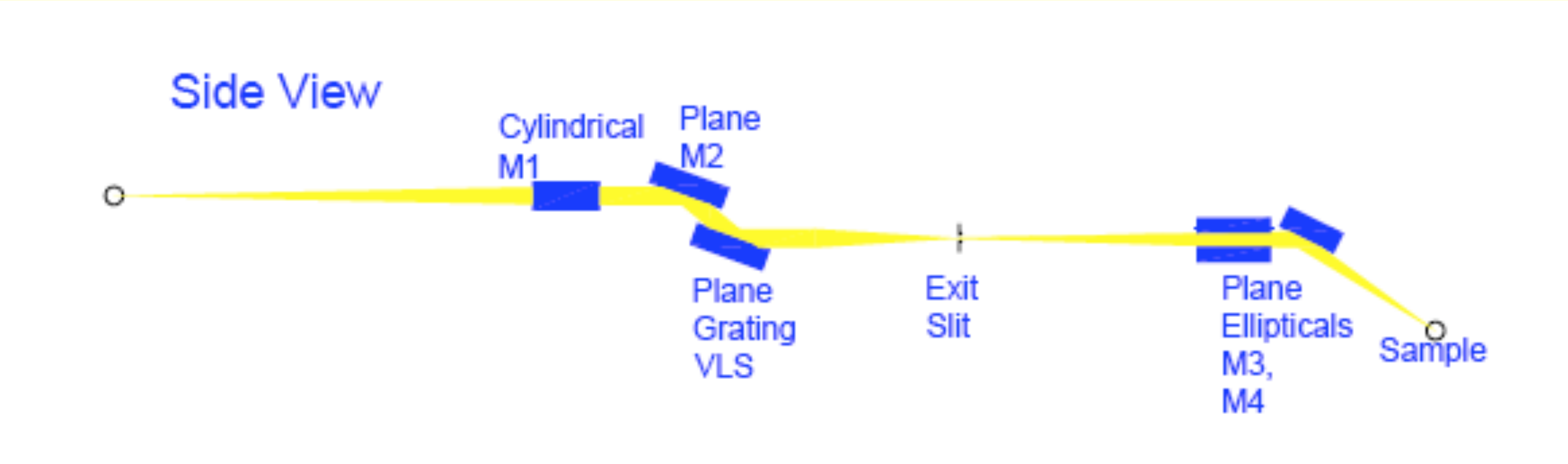
20 m Grating-Slit, 5 µm slit





Heat Load Deformation Correction

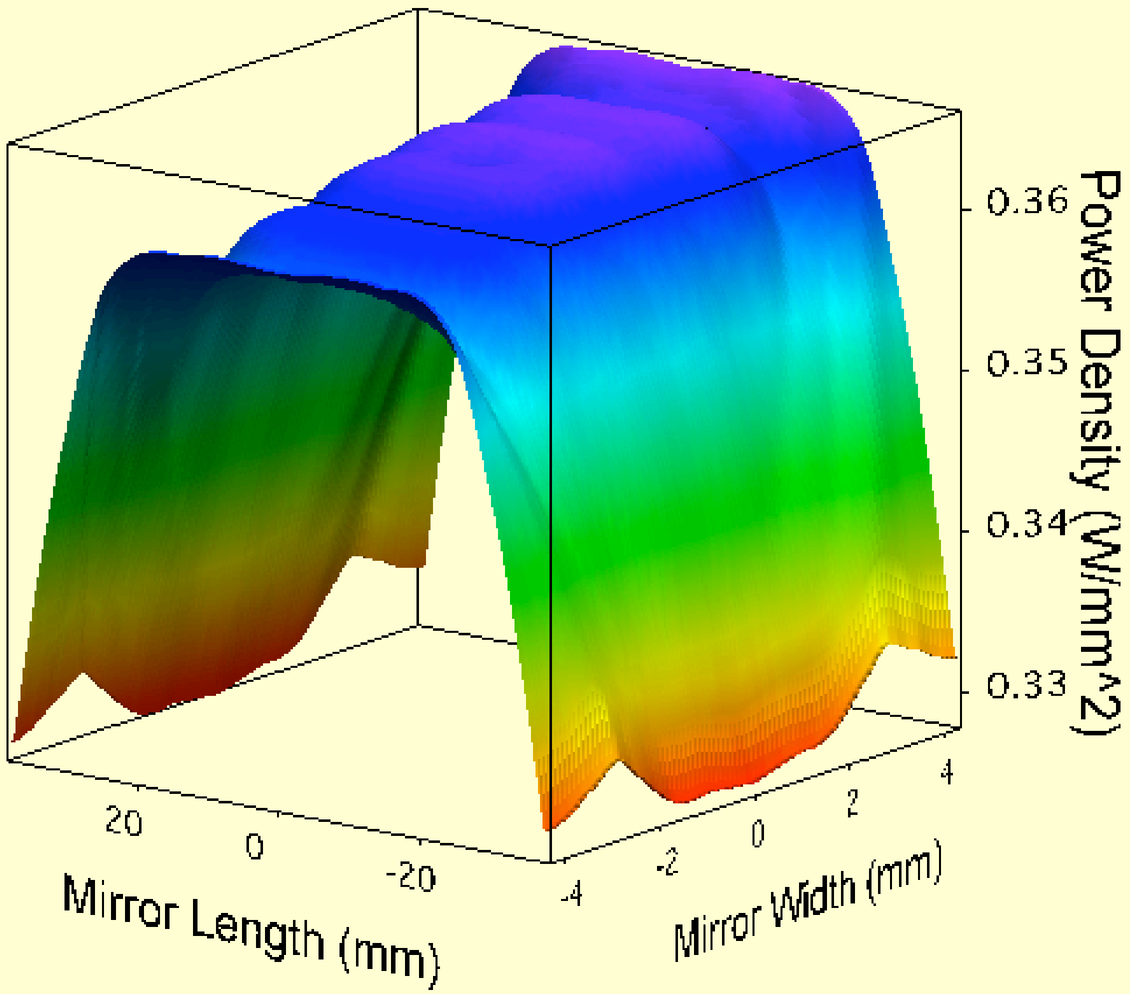
- 3 GeV, 0.5 A
- Linear mode: 12 kW total at 183 eV
- 0.27×0.27 mrad^2 only 2.15 kW
- 1.9 kW absorbed on M1. Deformation ➠ blow up horizontal at sample
- 0.24 kW on M2 ➠ Resolution



Rev. Sci. Instrum. **79**, 033108, 2008

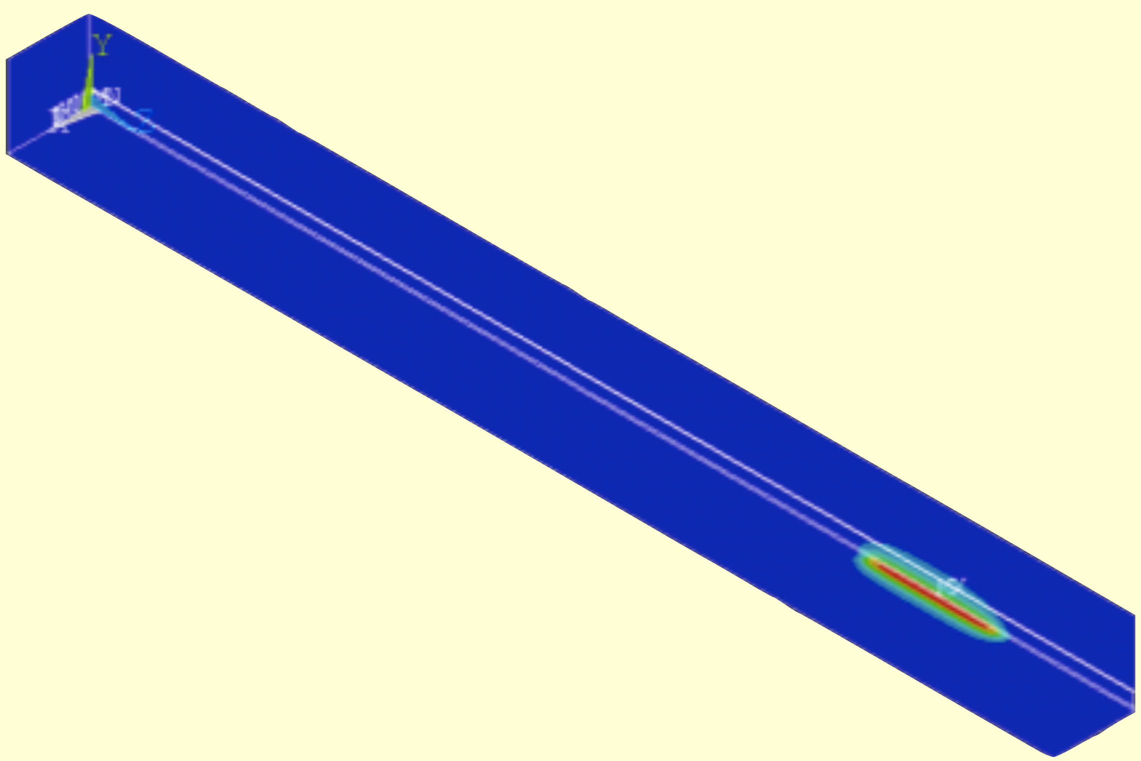
Power on M2

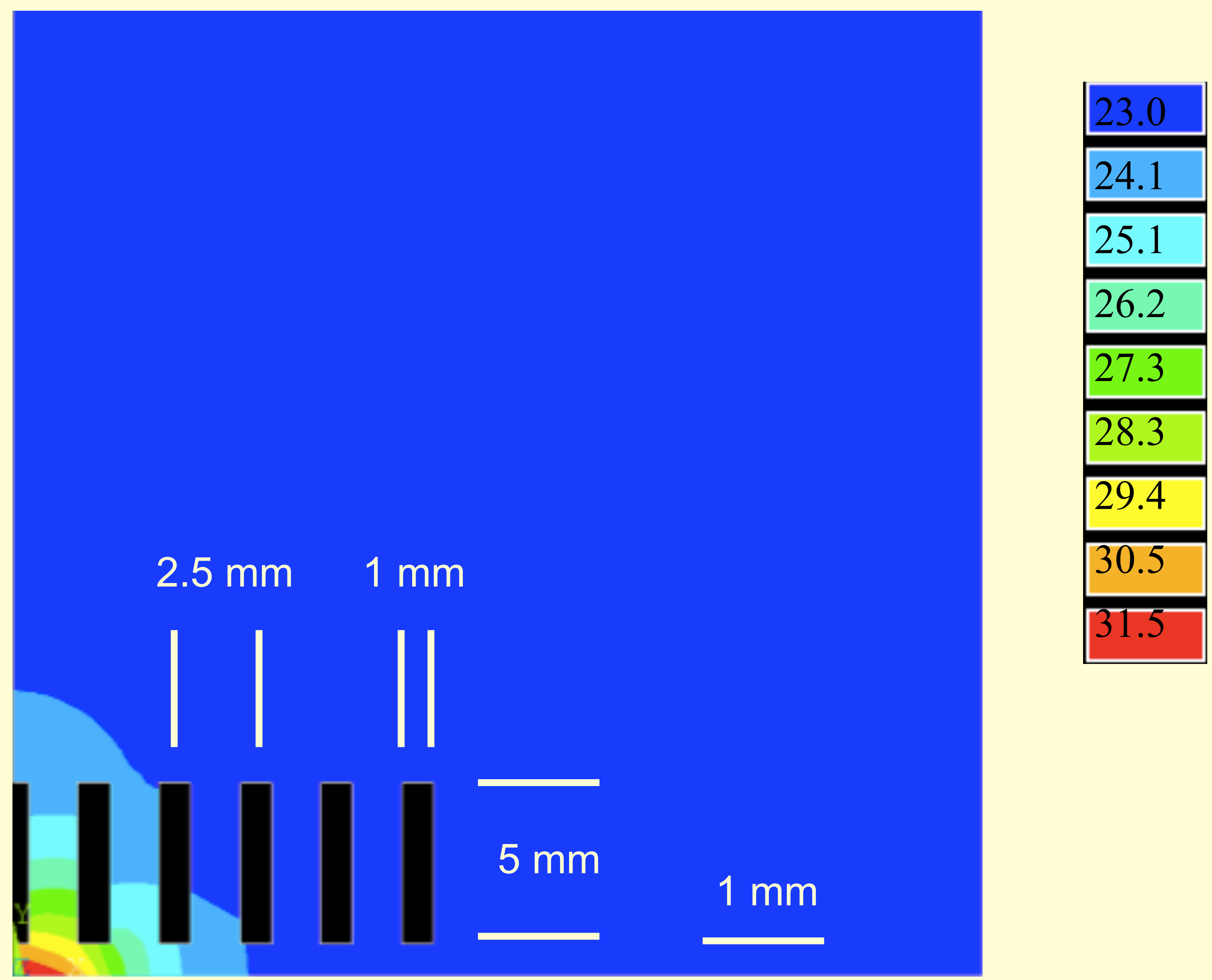
- Total absorbed 236 W



Finite Element Analysis, M2

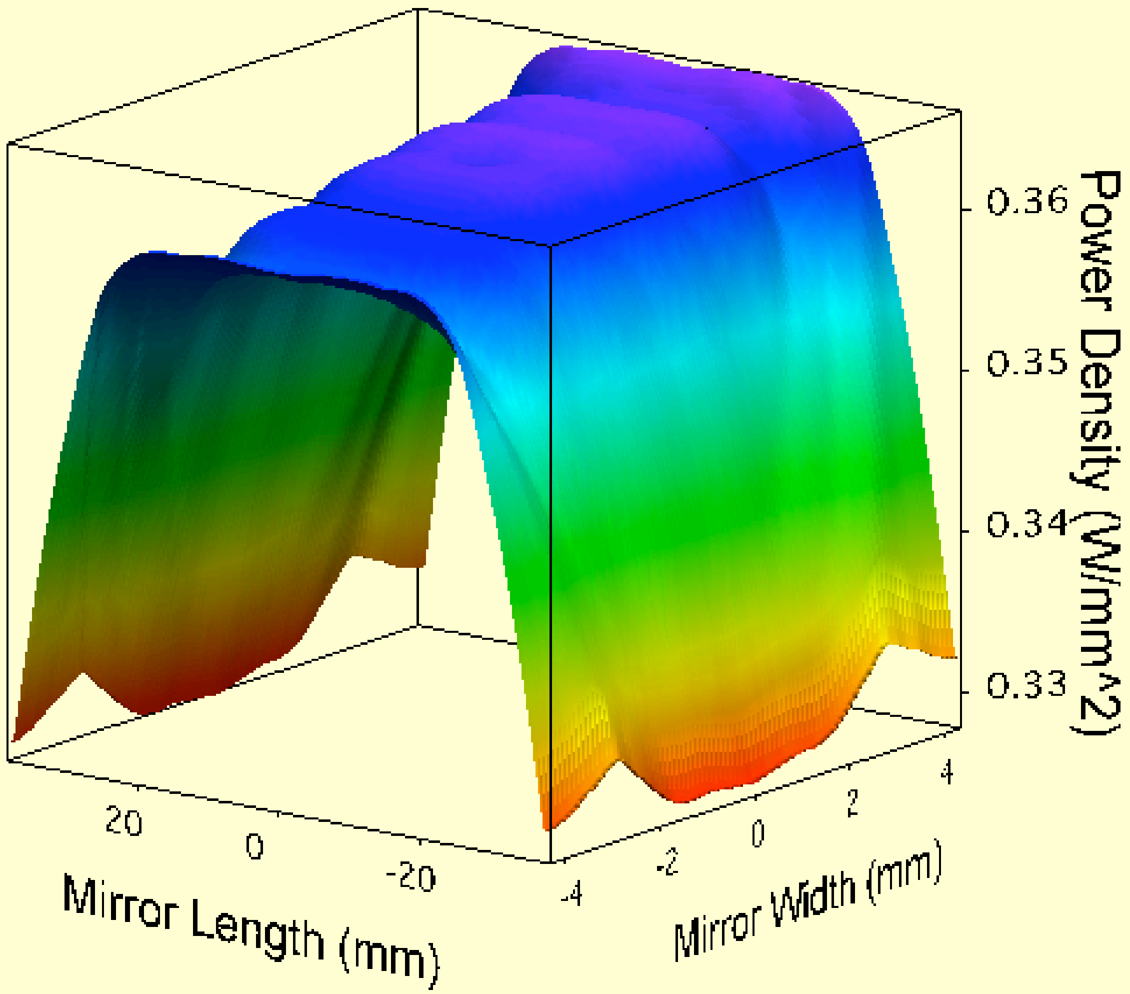
Parameters used FEA, SC Si	
Density (g/mm^3)	2.3310^{-3}
Young Modulus (N/mm^2)	1.3105
Poisson's ratio	0.28
CTE (ppm/°C)	-0.33 to 3.25 over 100 to 400K
Conductivity, *K* (W/mm/K)	0.913 to 0.105 over 100 to 400K
Water Bulk Temp (°C)	20
Convection coeff., (W/mm^2/C)	0.01





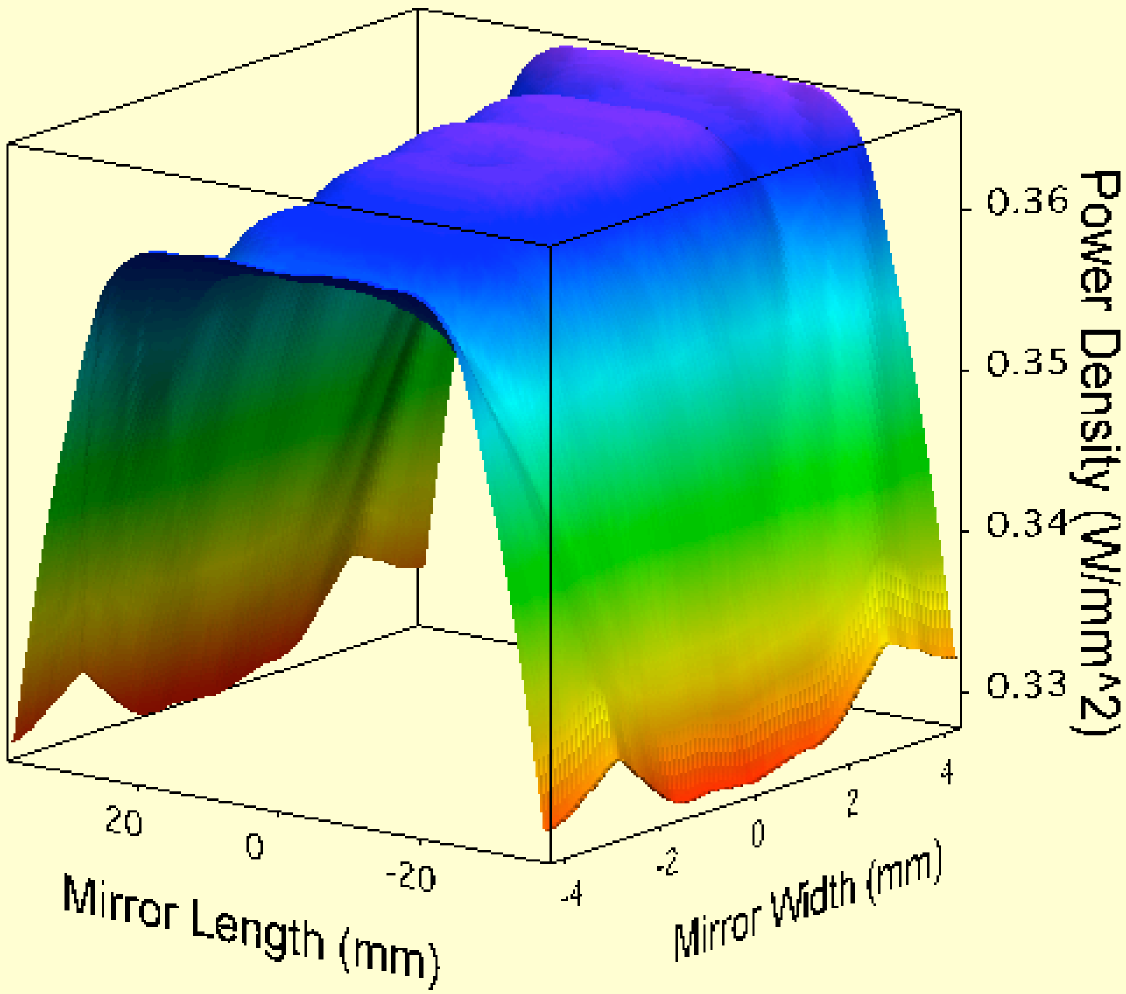
Power on M2

- Total absorbed 236 W

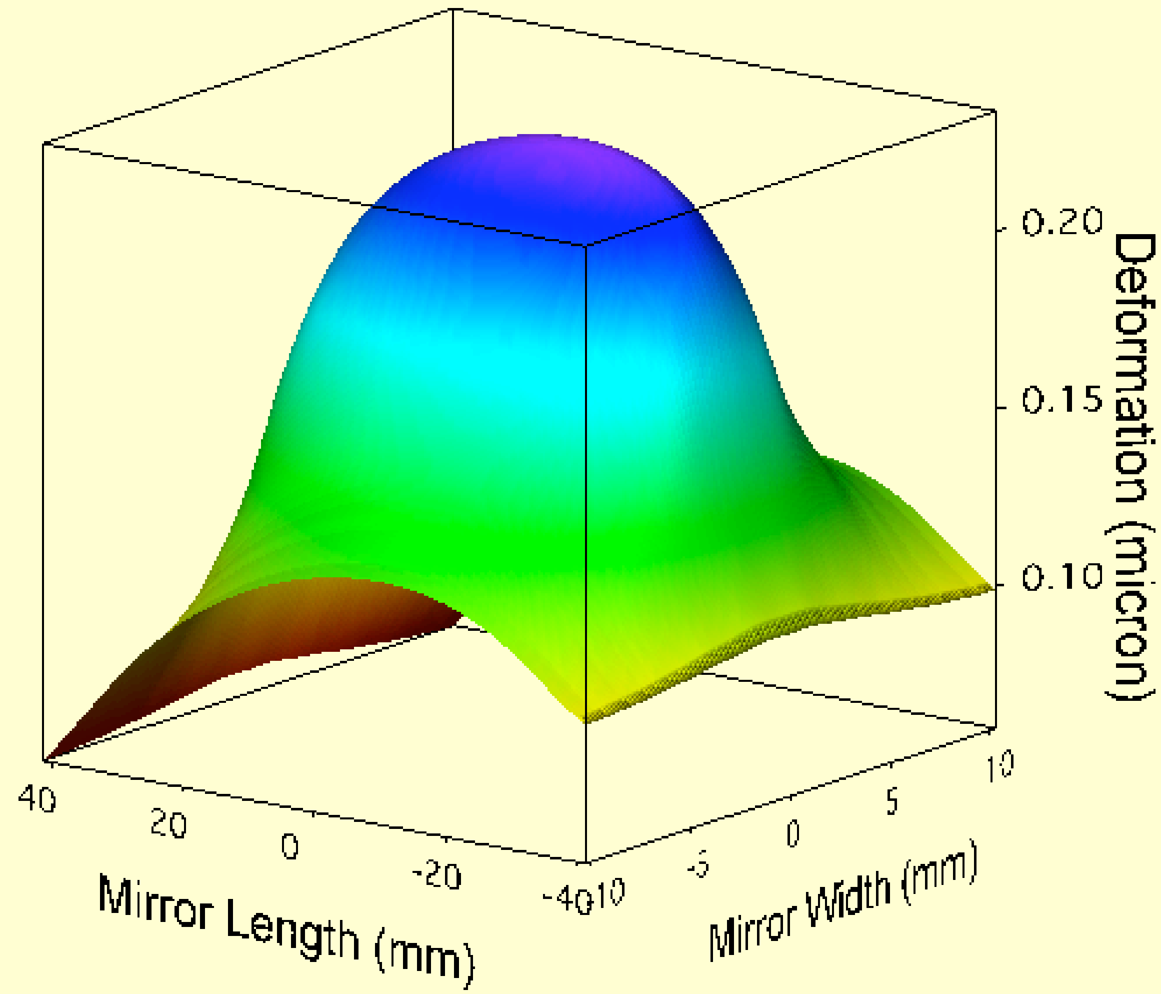


Power on M2

- Total absorbed 236 W

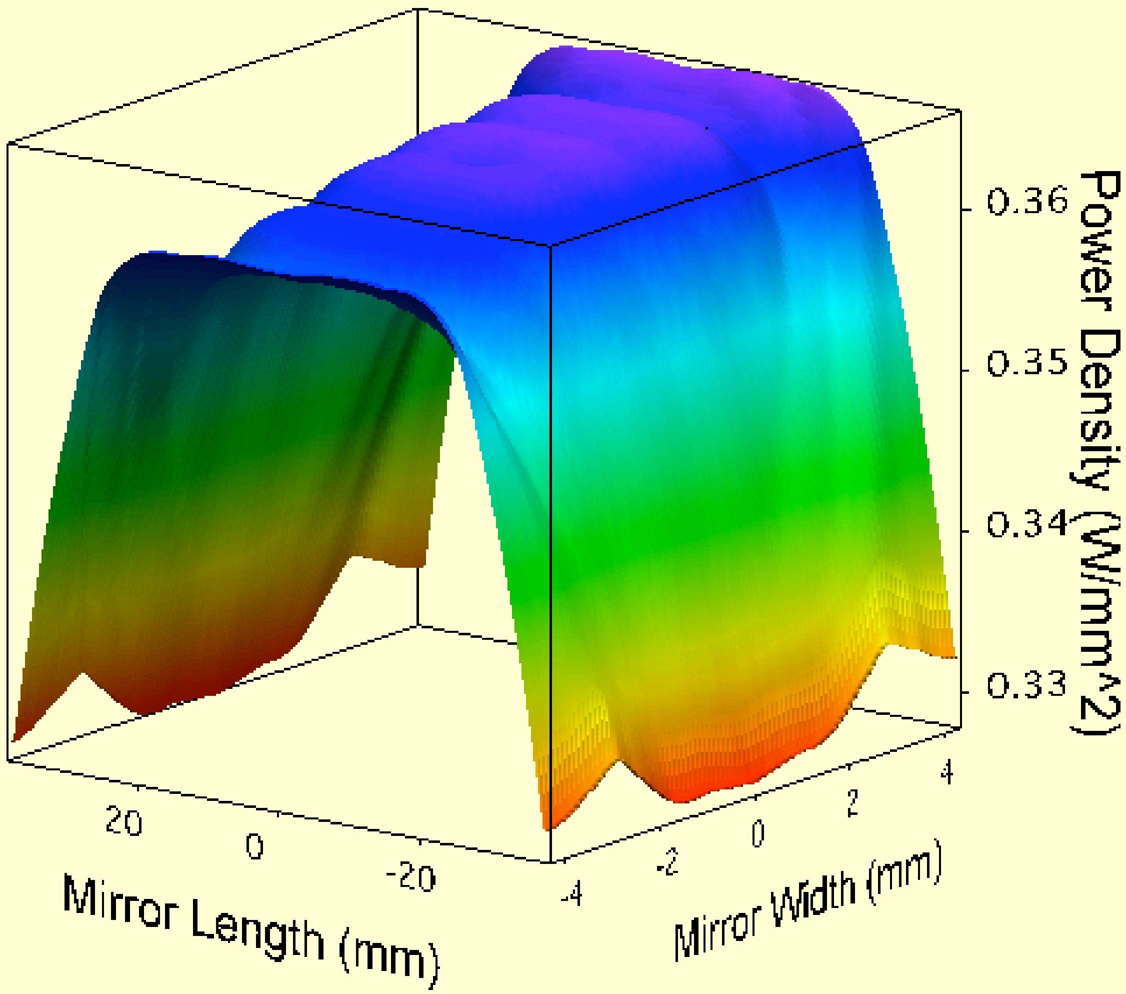


- Internally water cooled

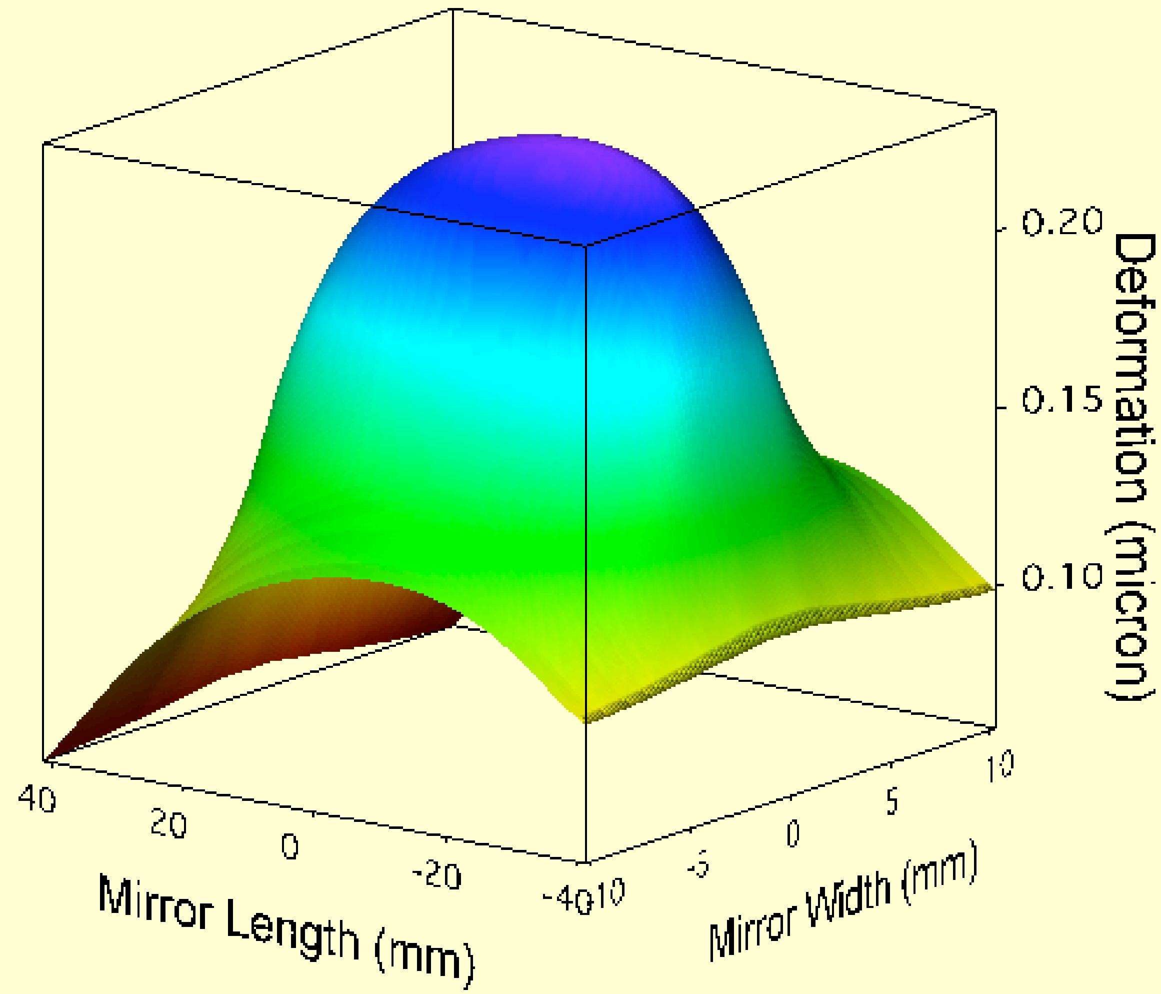


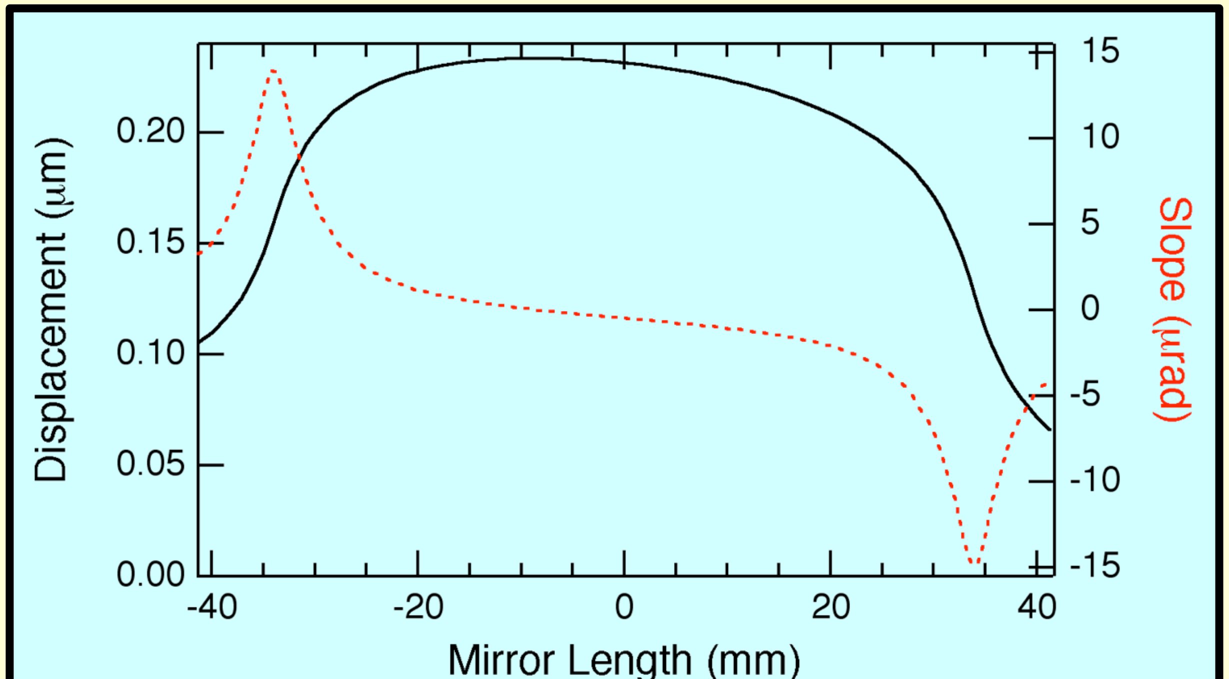
Power on M2

➡ Total absorbed 236 W



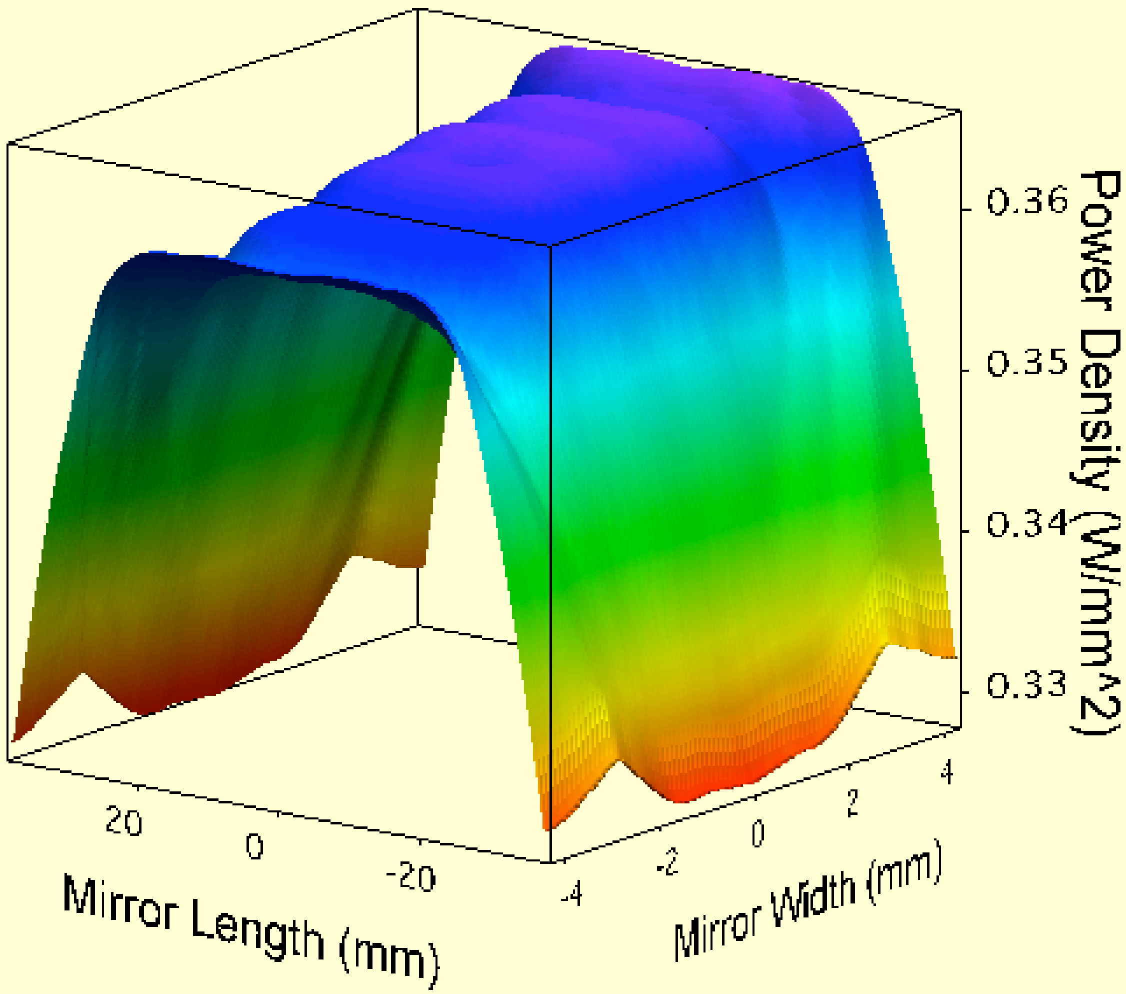
➡ Internally water cooled



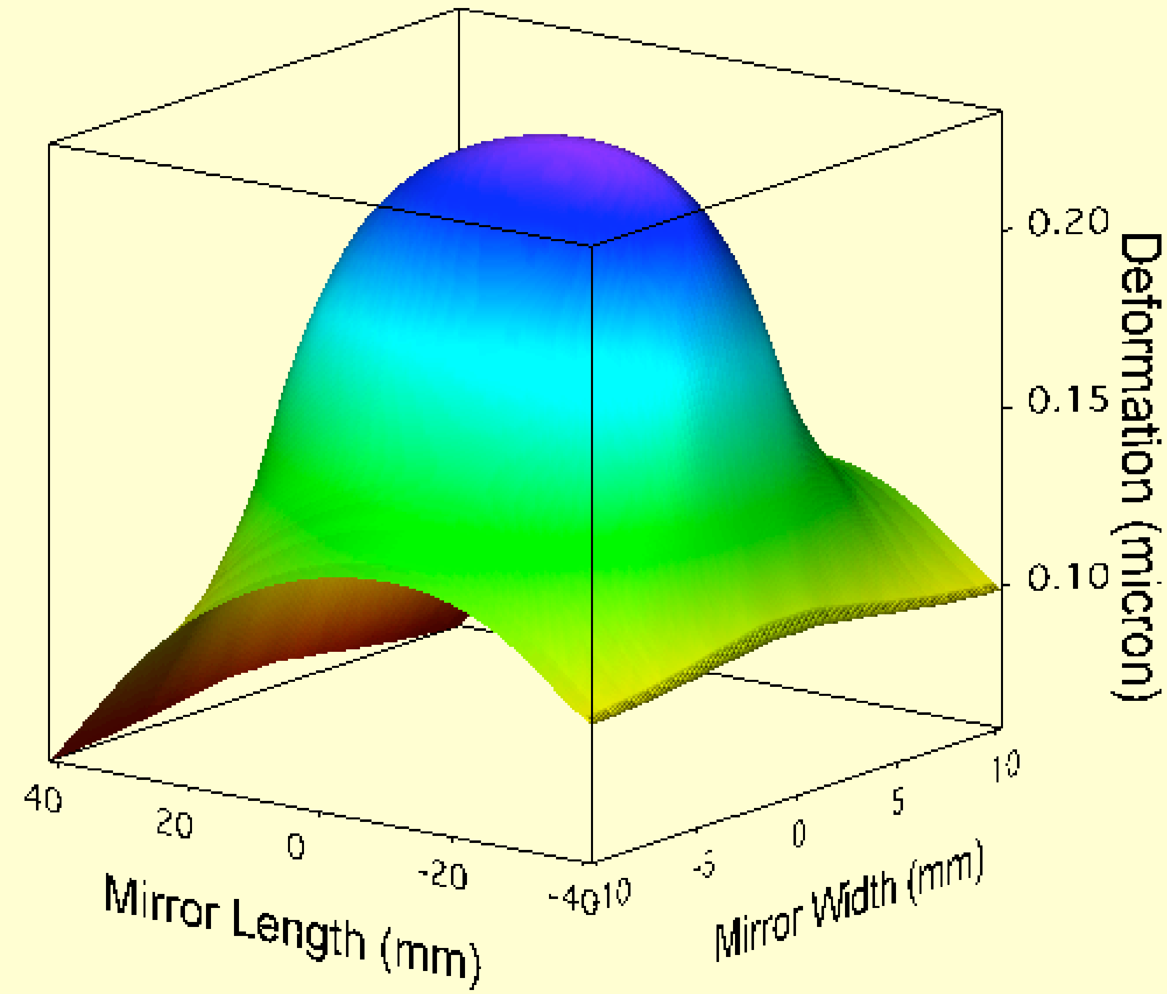


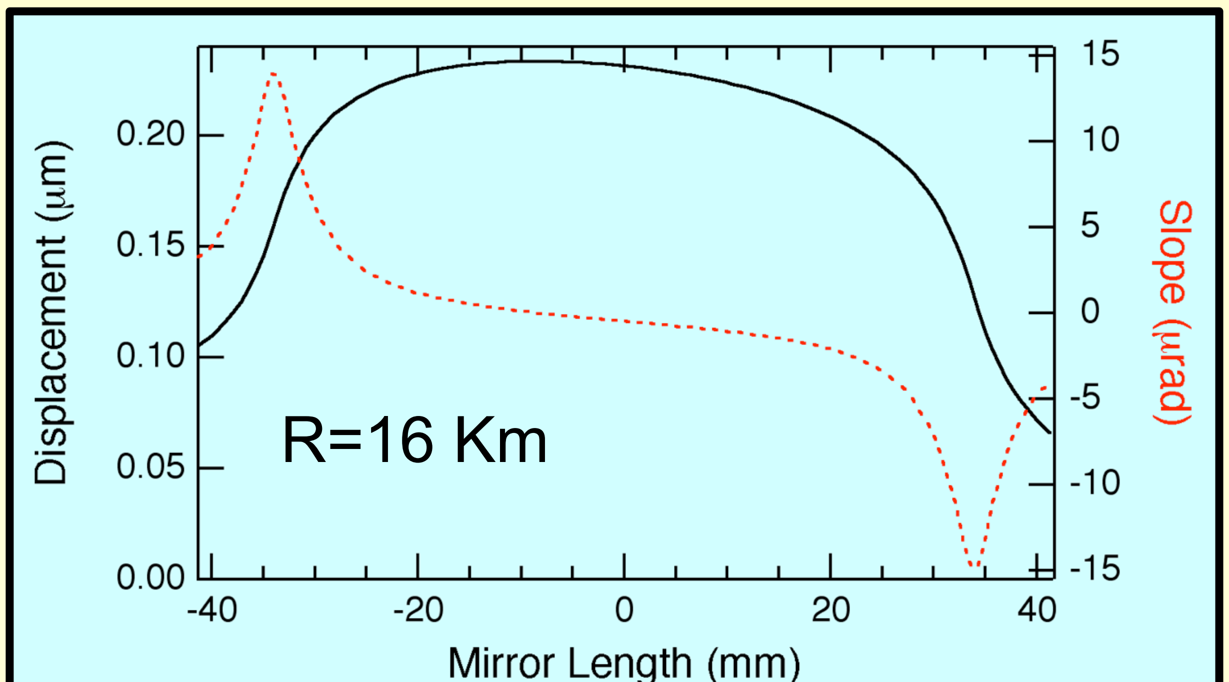
Power on M2

- Total absorbed 236 W



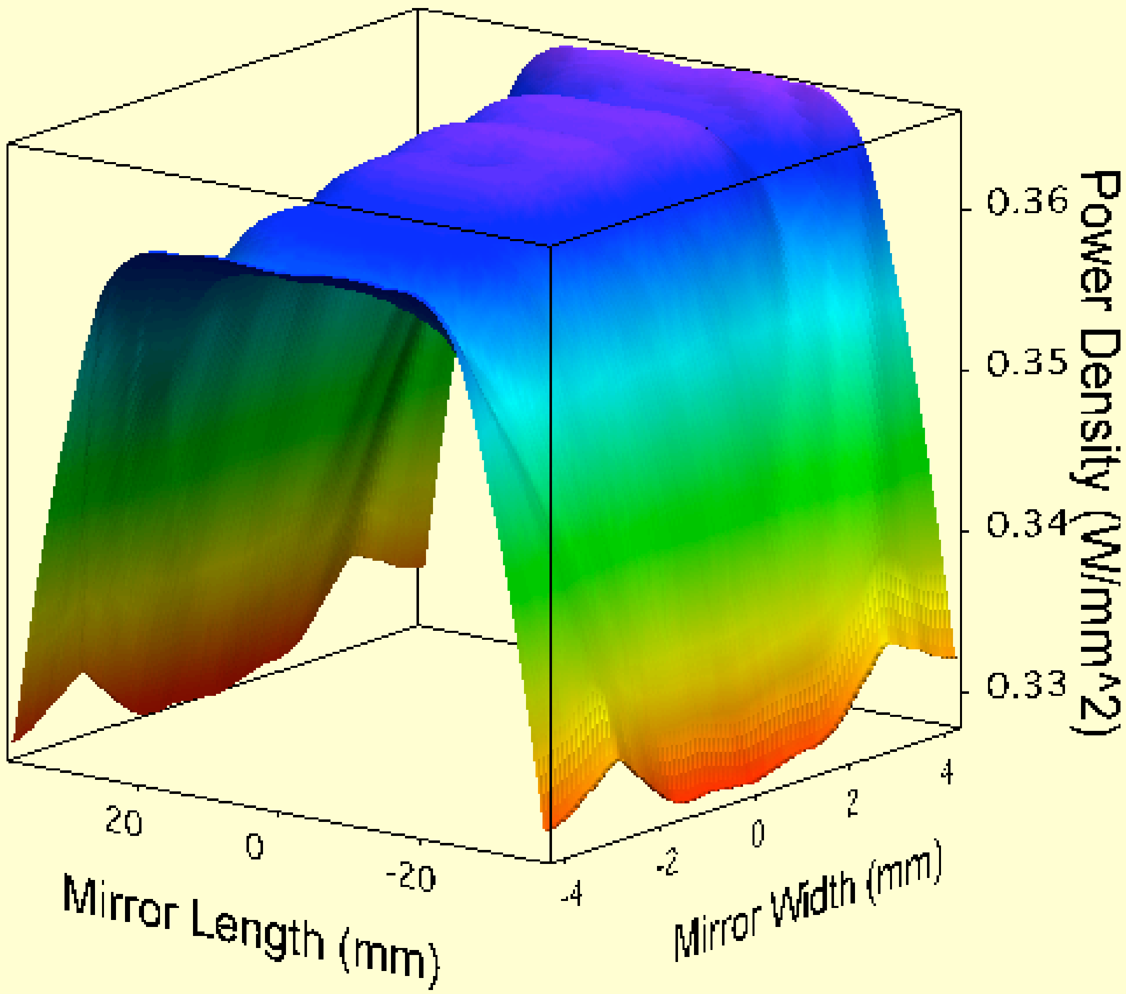
- Internally water cooled



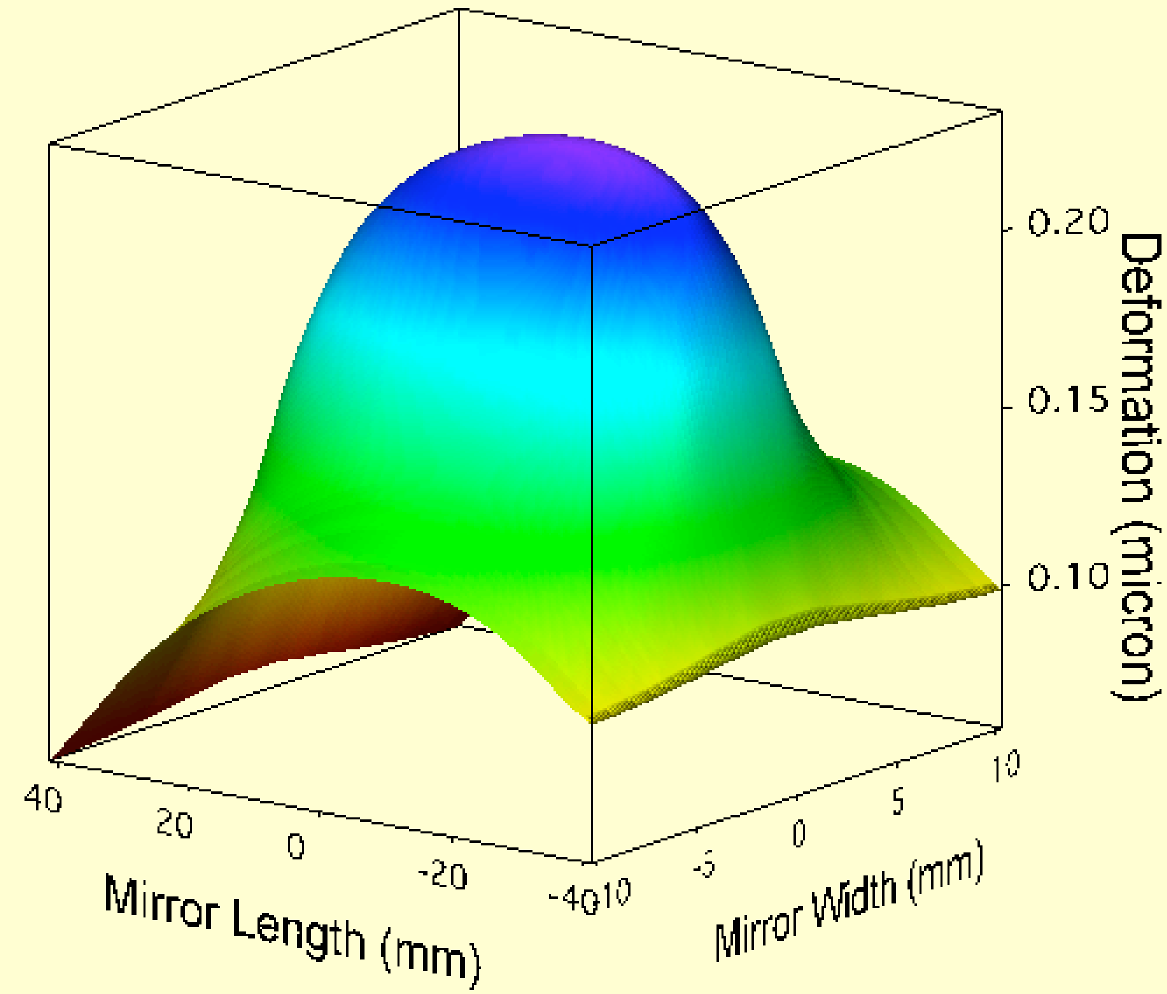


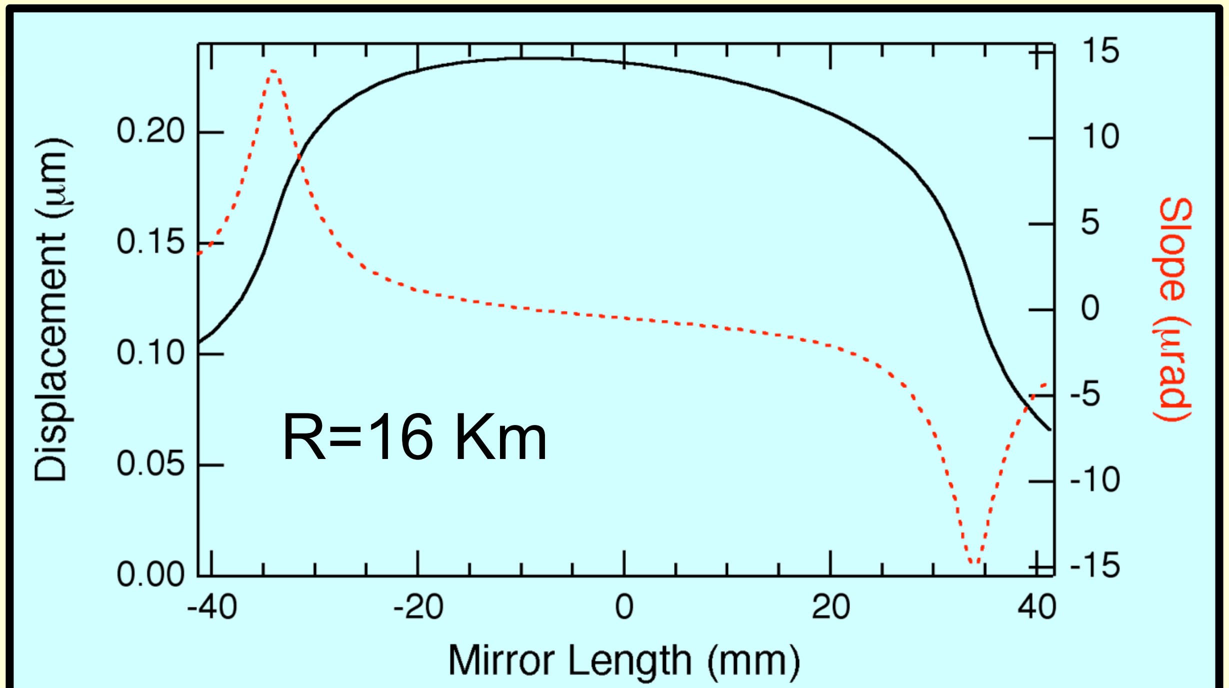
Power on M2

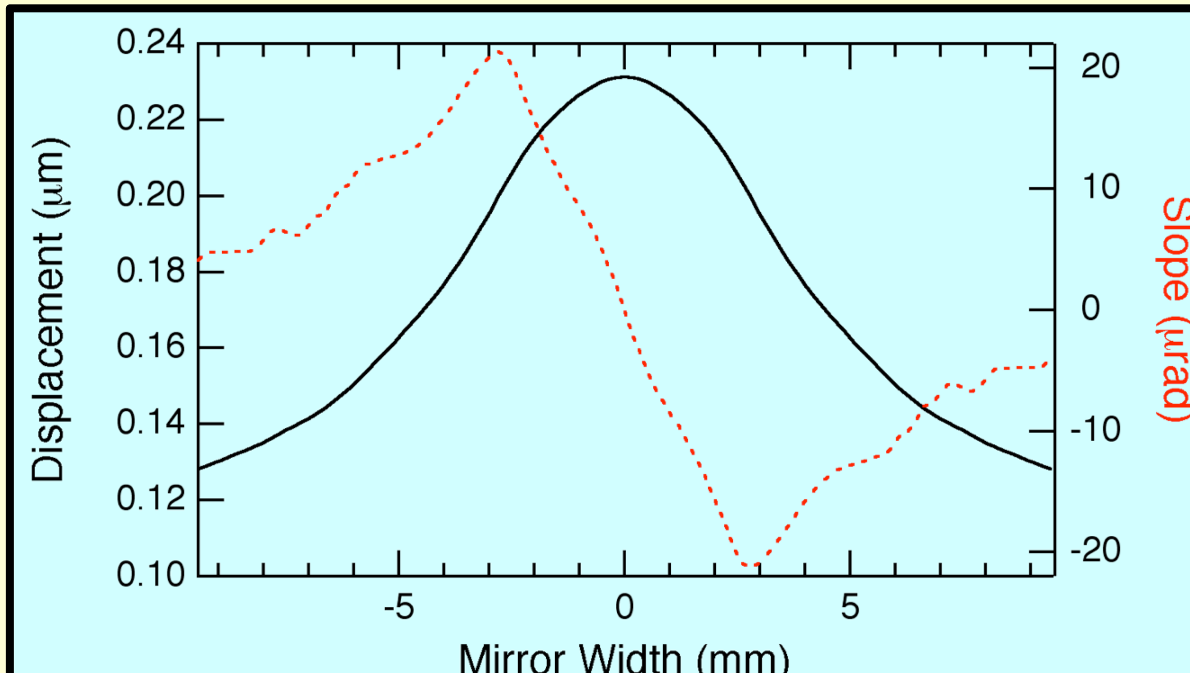
- Total absorbed 236 W



- Internally water cooled

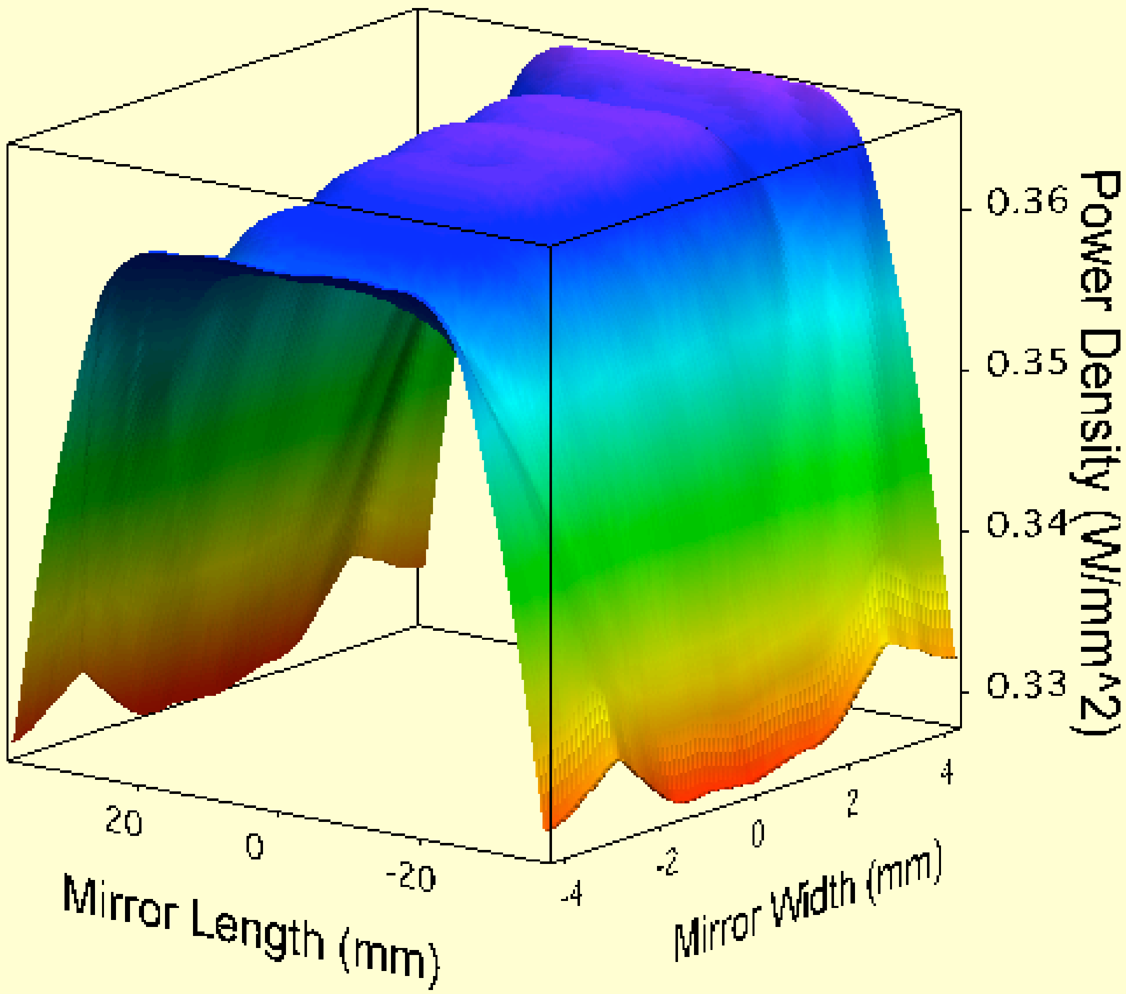




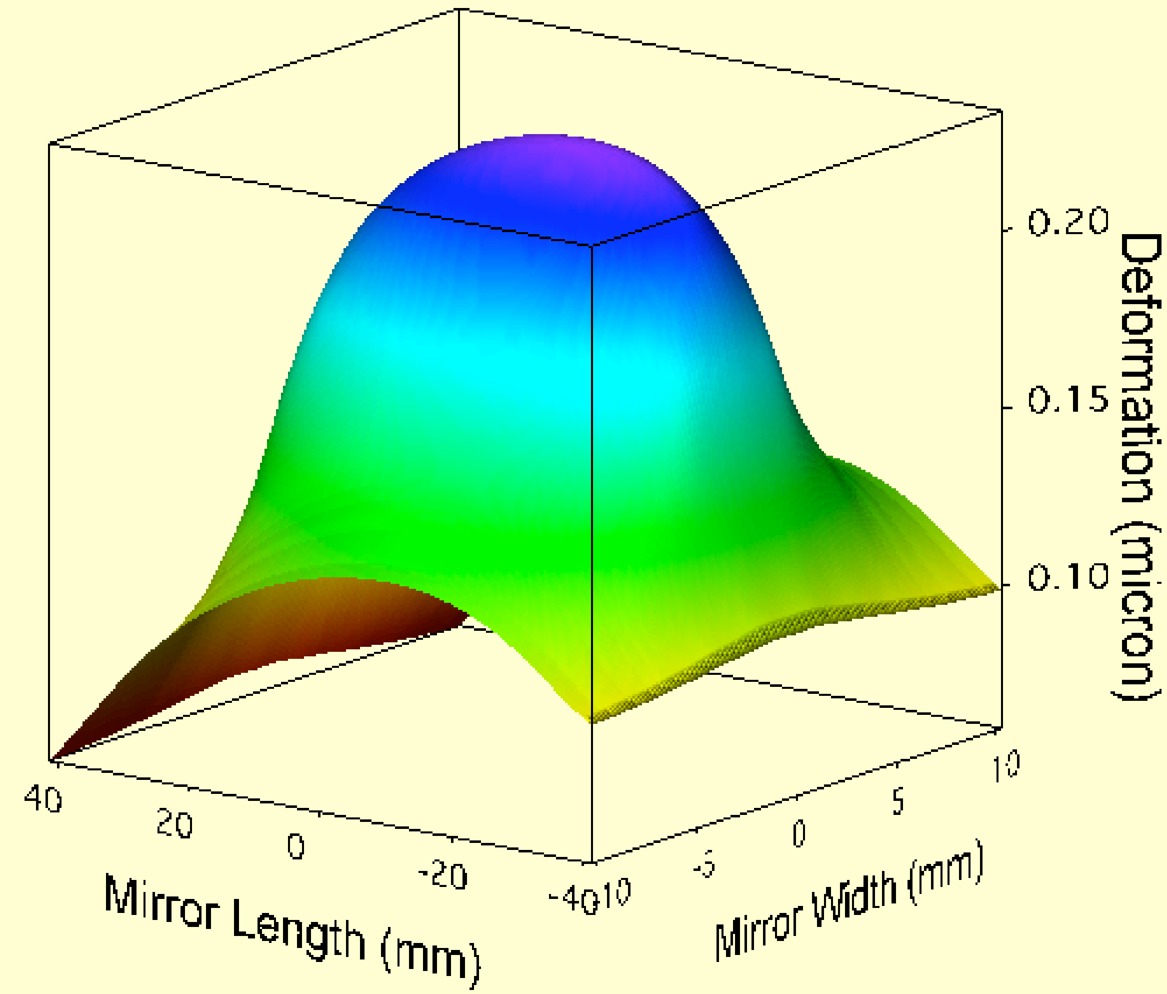


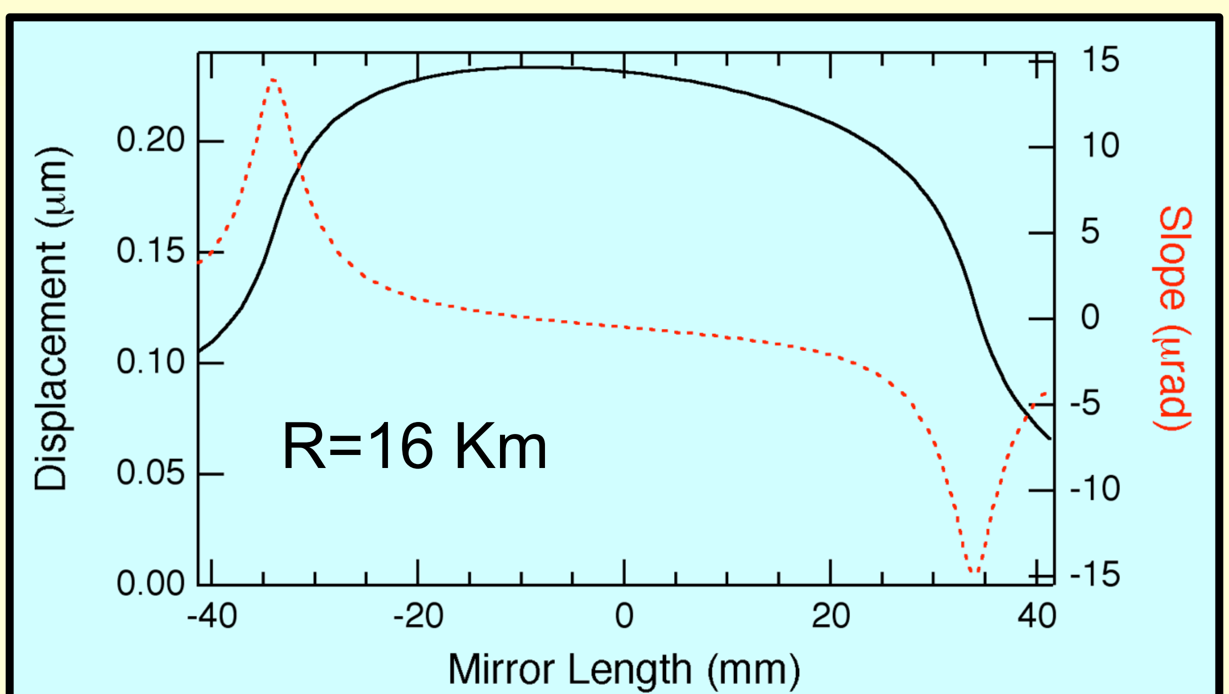
Power on M2

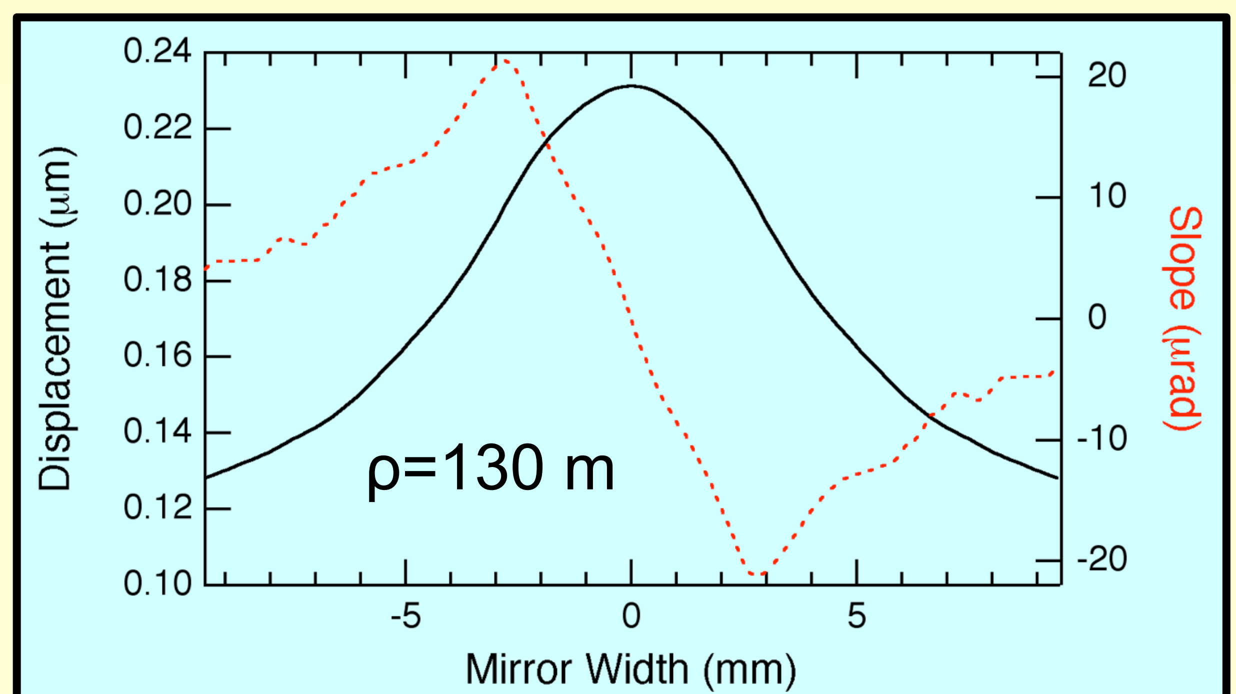
- Total absorbed 236 W



- Internally water cooled

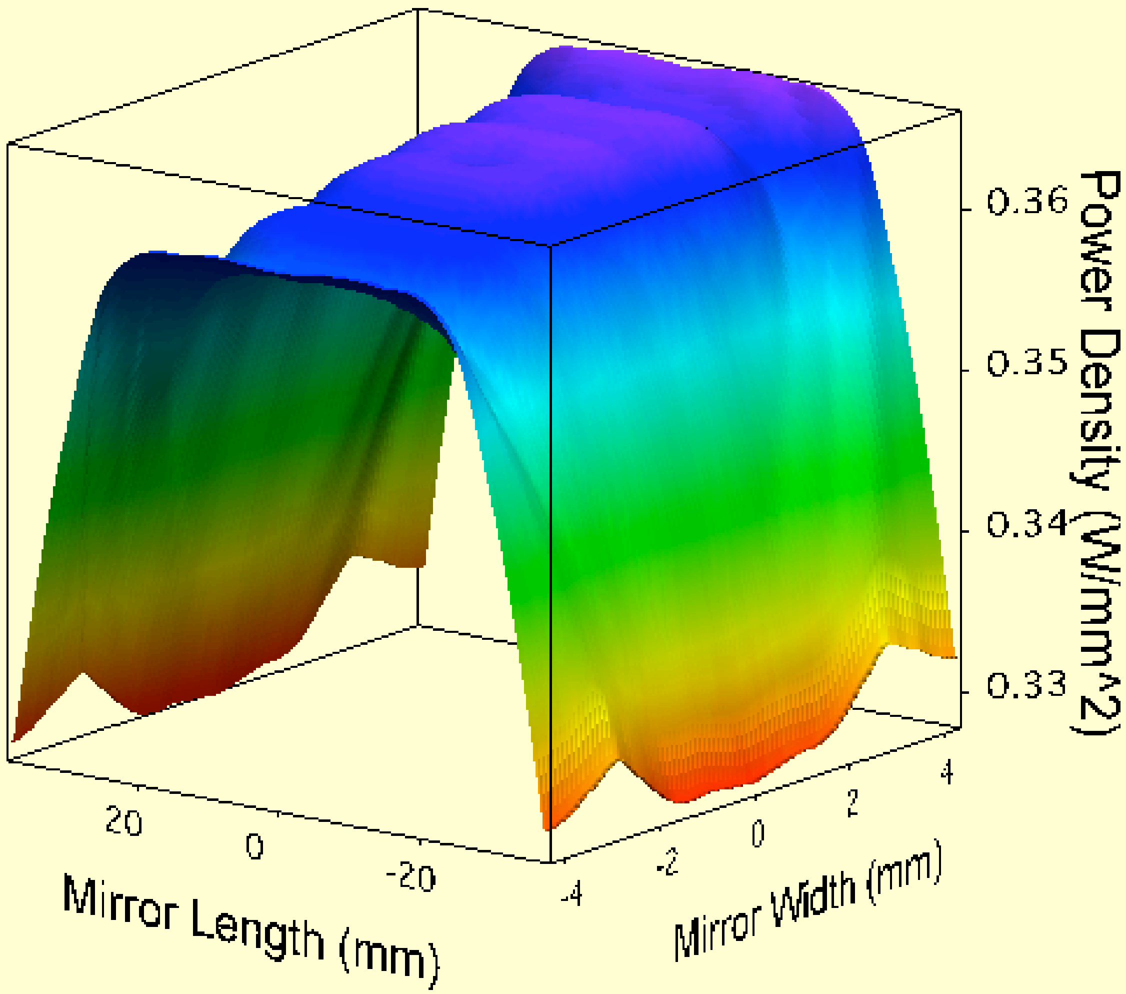


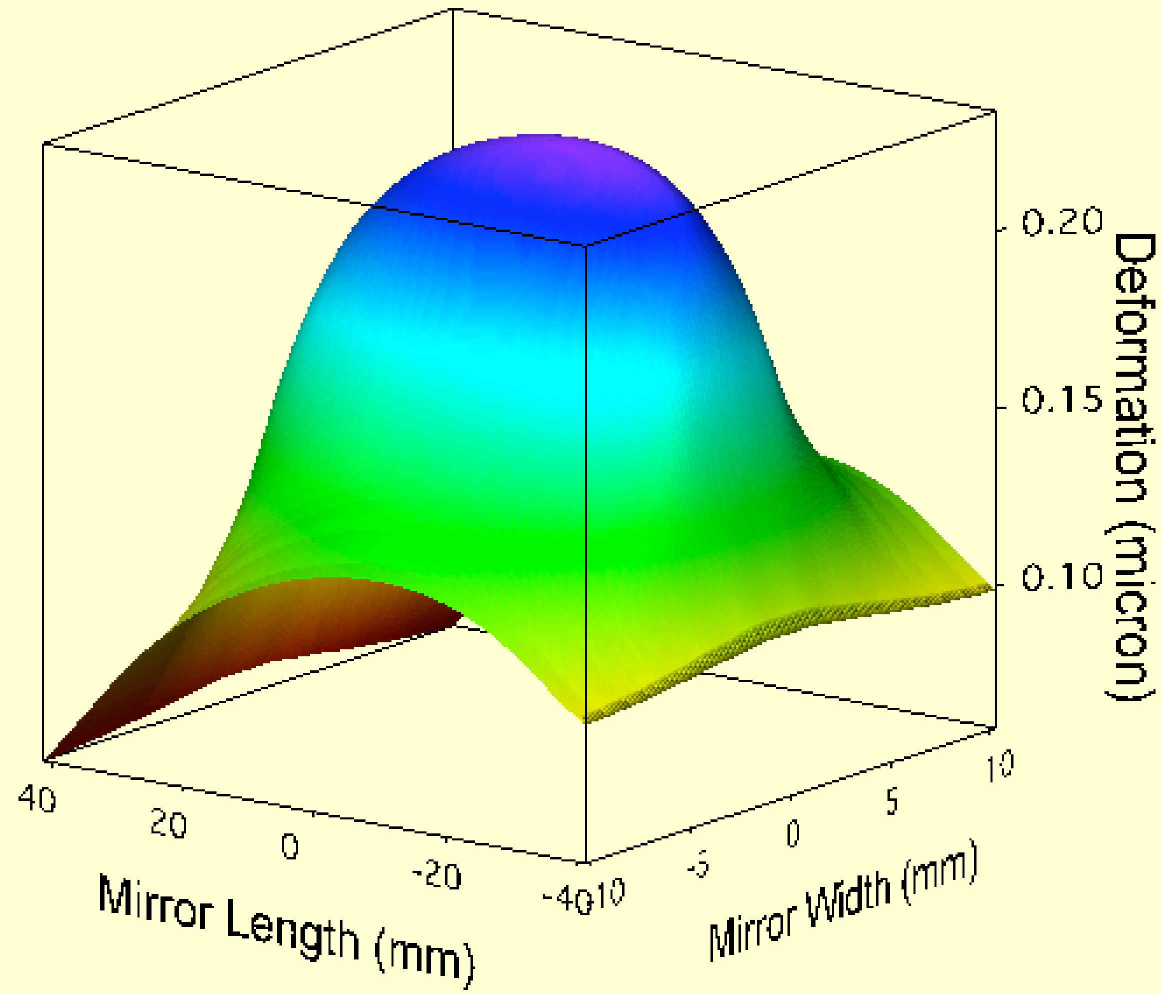


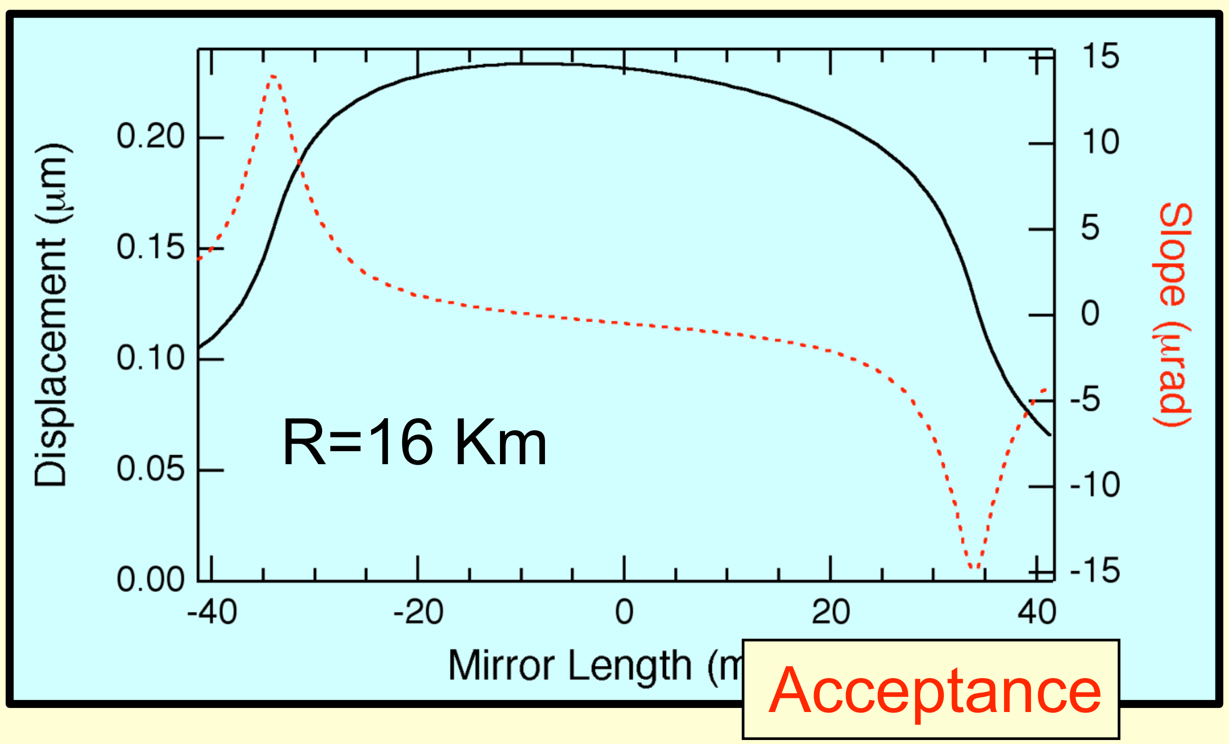


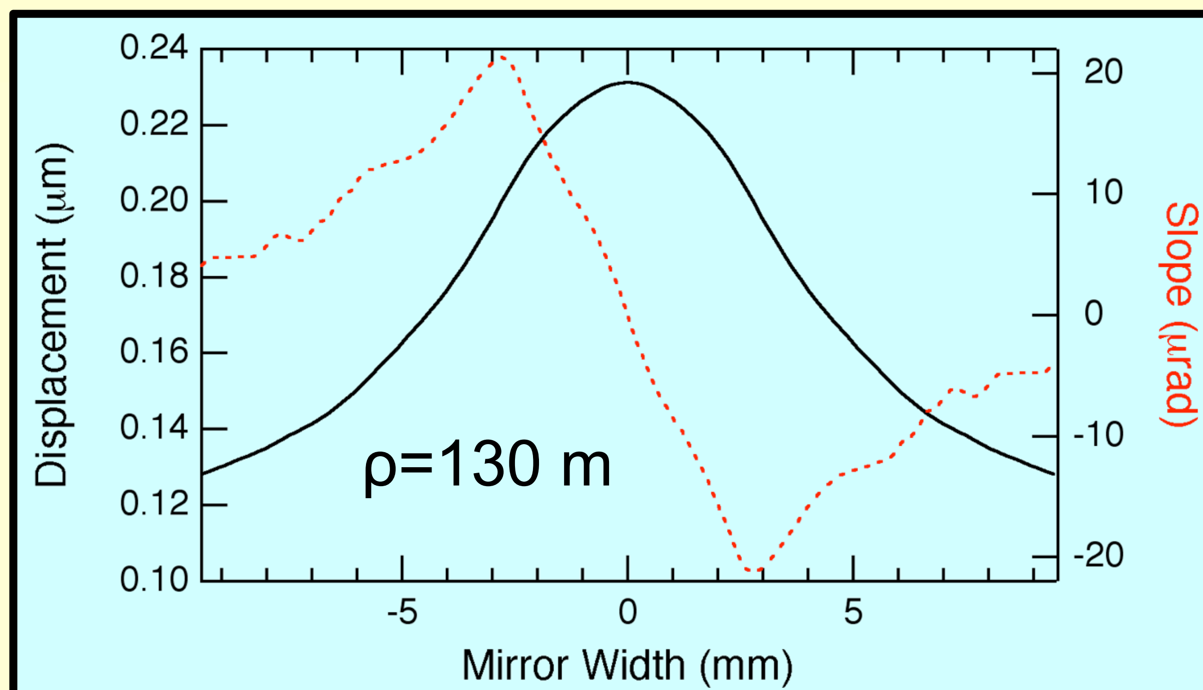
Power on M2

- Total absorbed 236 W
- Internally water cooled



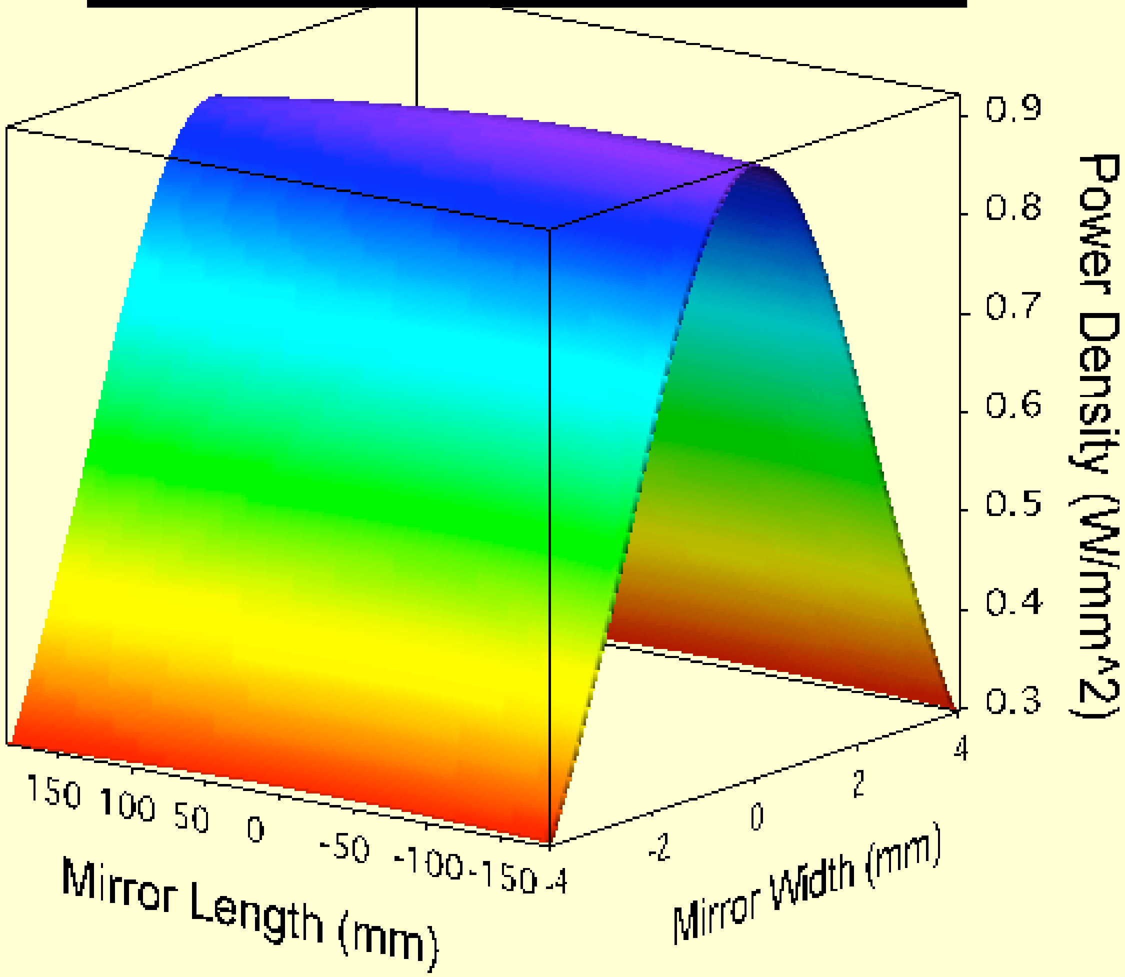






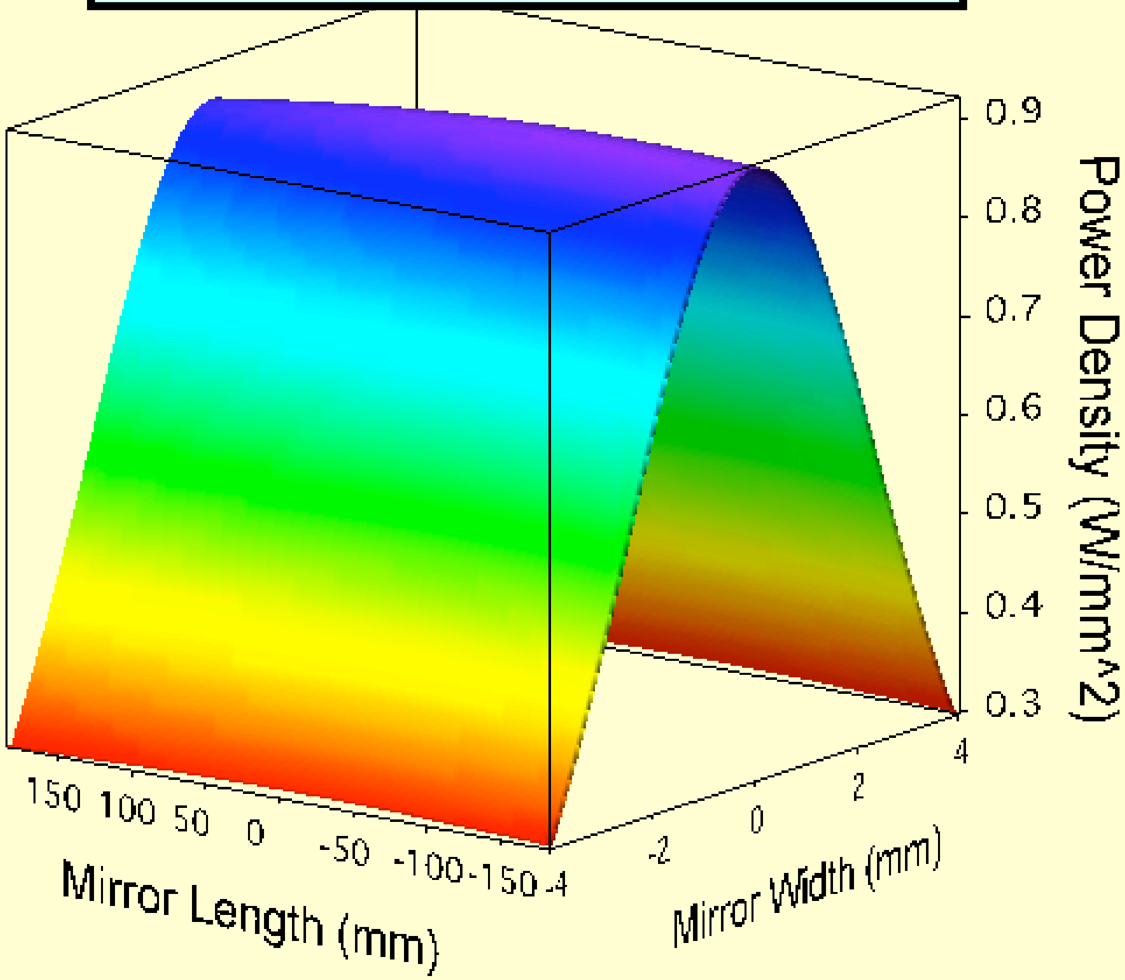
Power on M1

- Total absorbed 1.9 kW

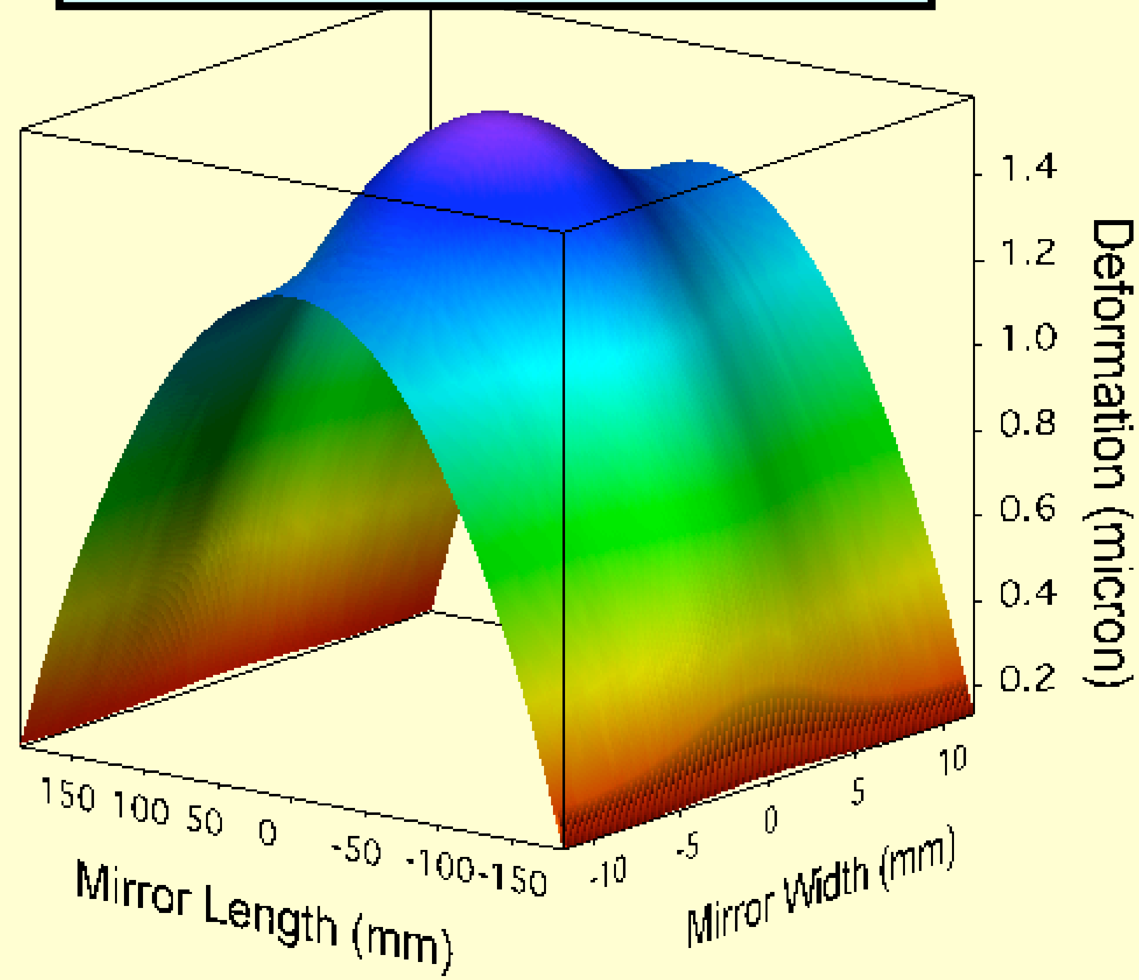


Power on M1

- Total absorbed 1.9 kW

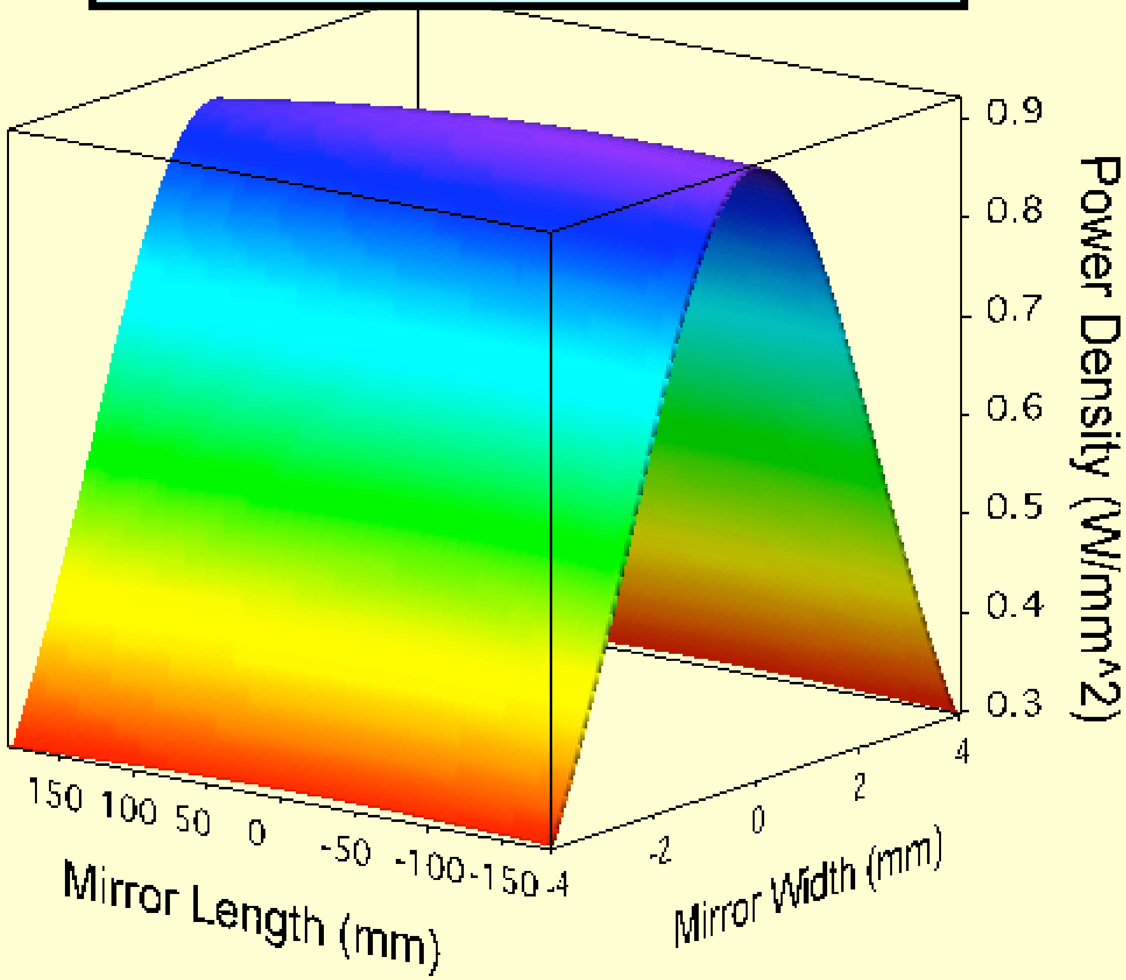


- Internally water cooled

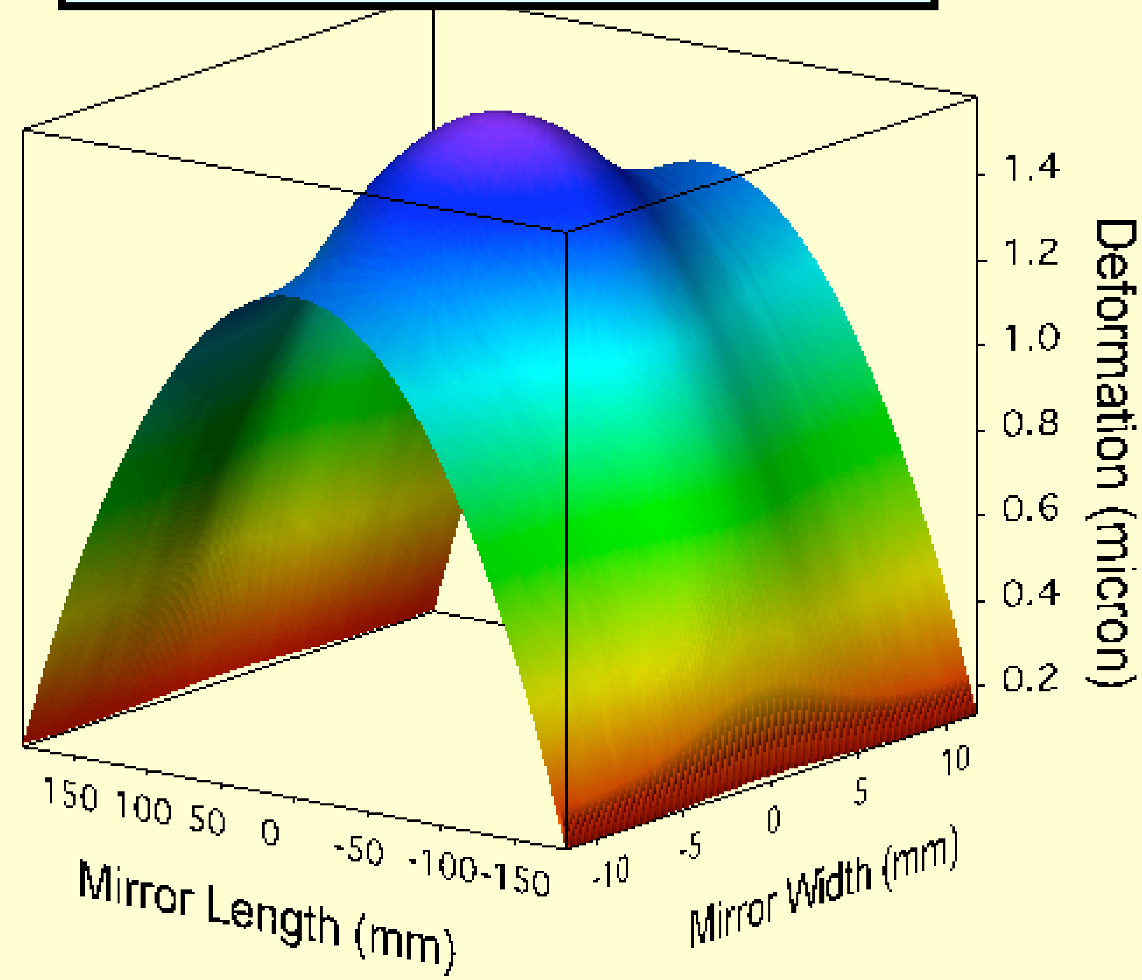


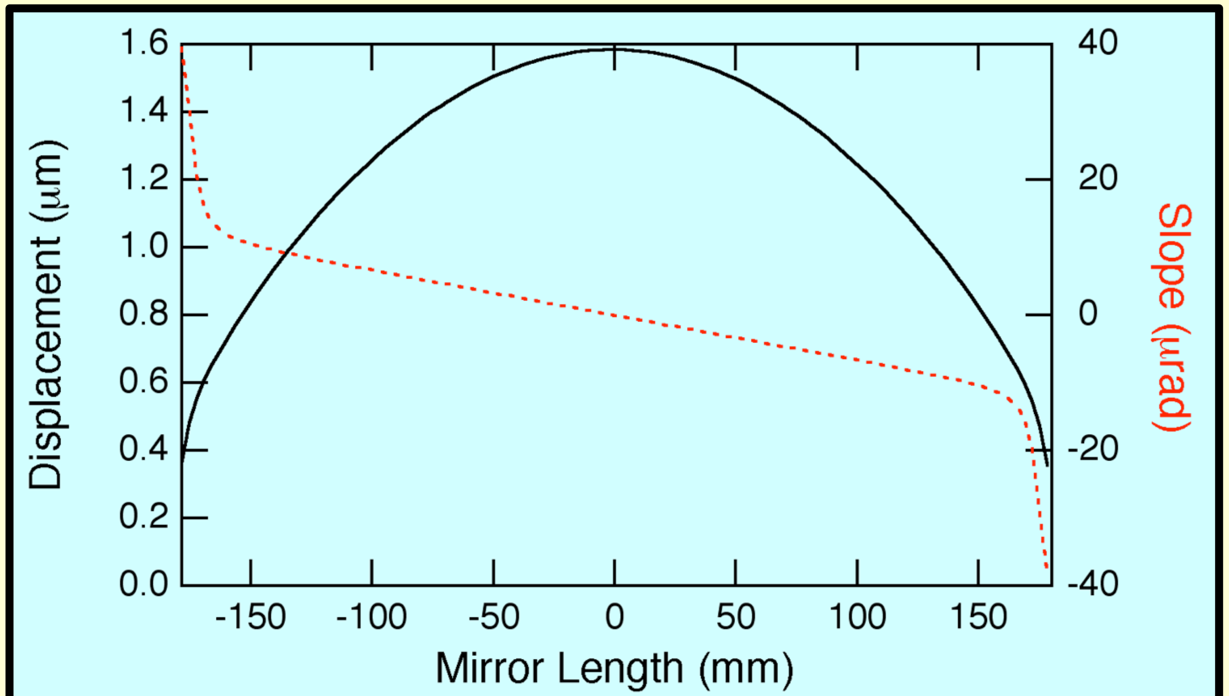
Power on M1

- Total absorbed 1.9 kW



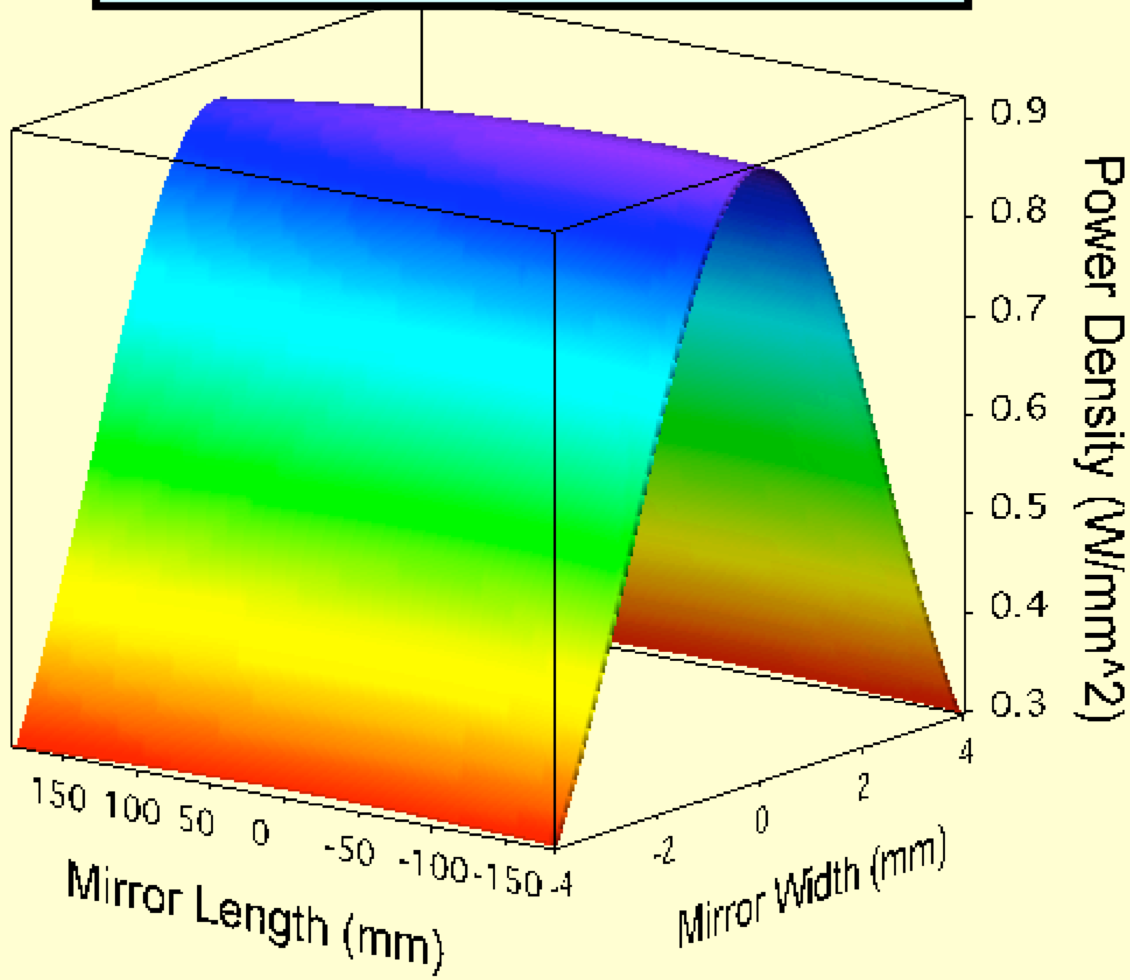
- Internally water cooled



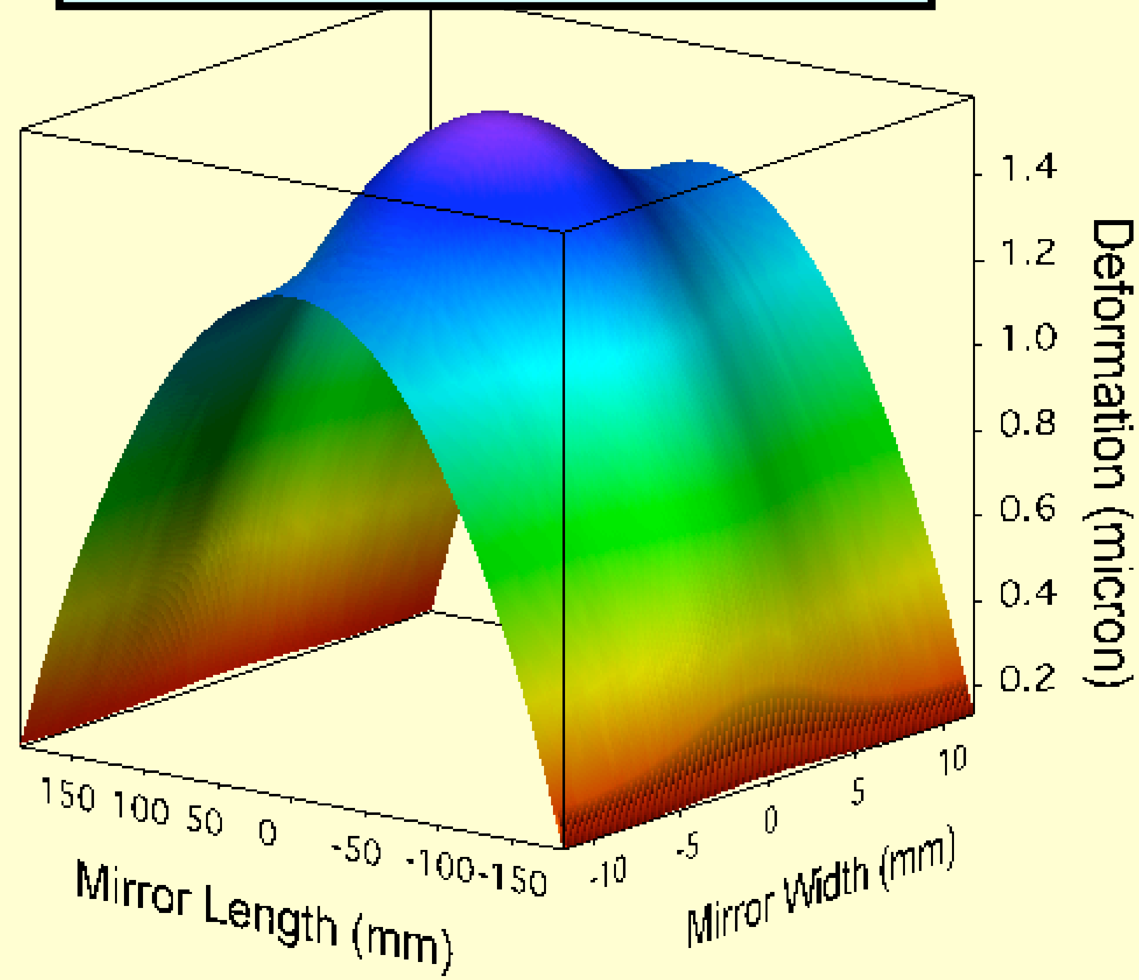


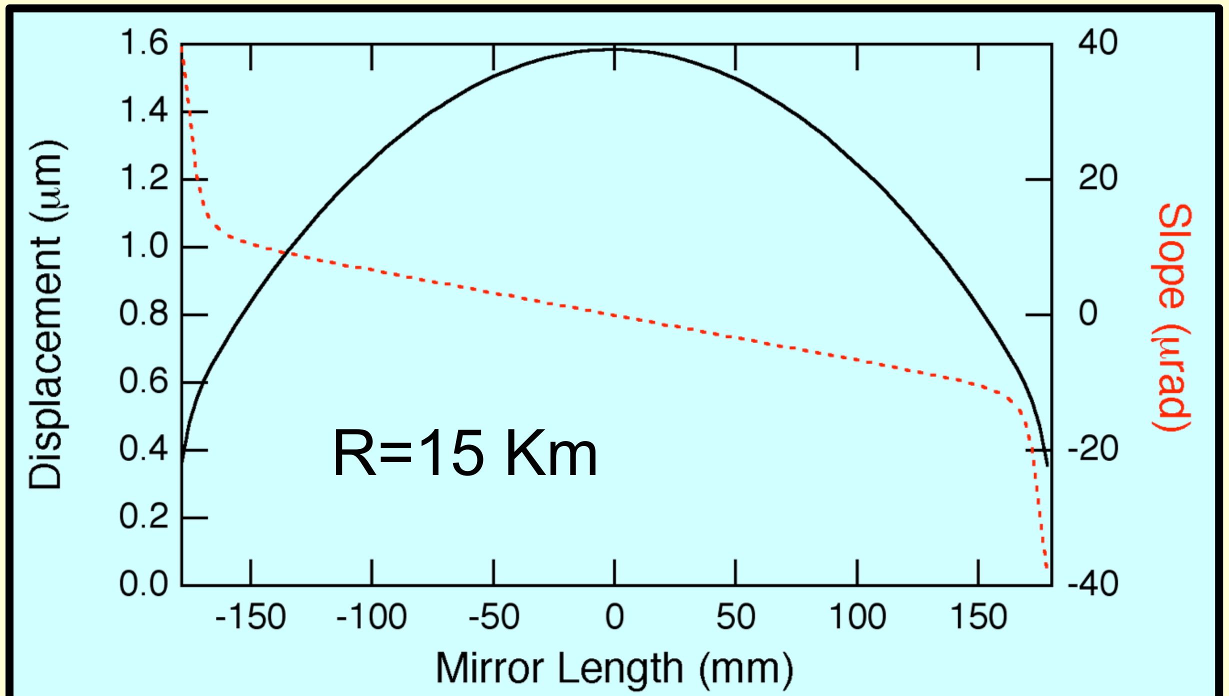
Power on M1

- Total absorbed 1.9 kW



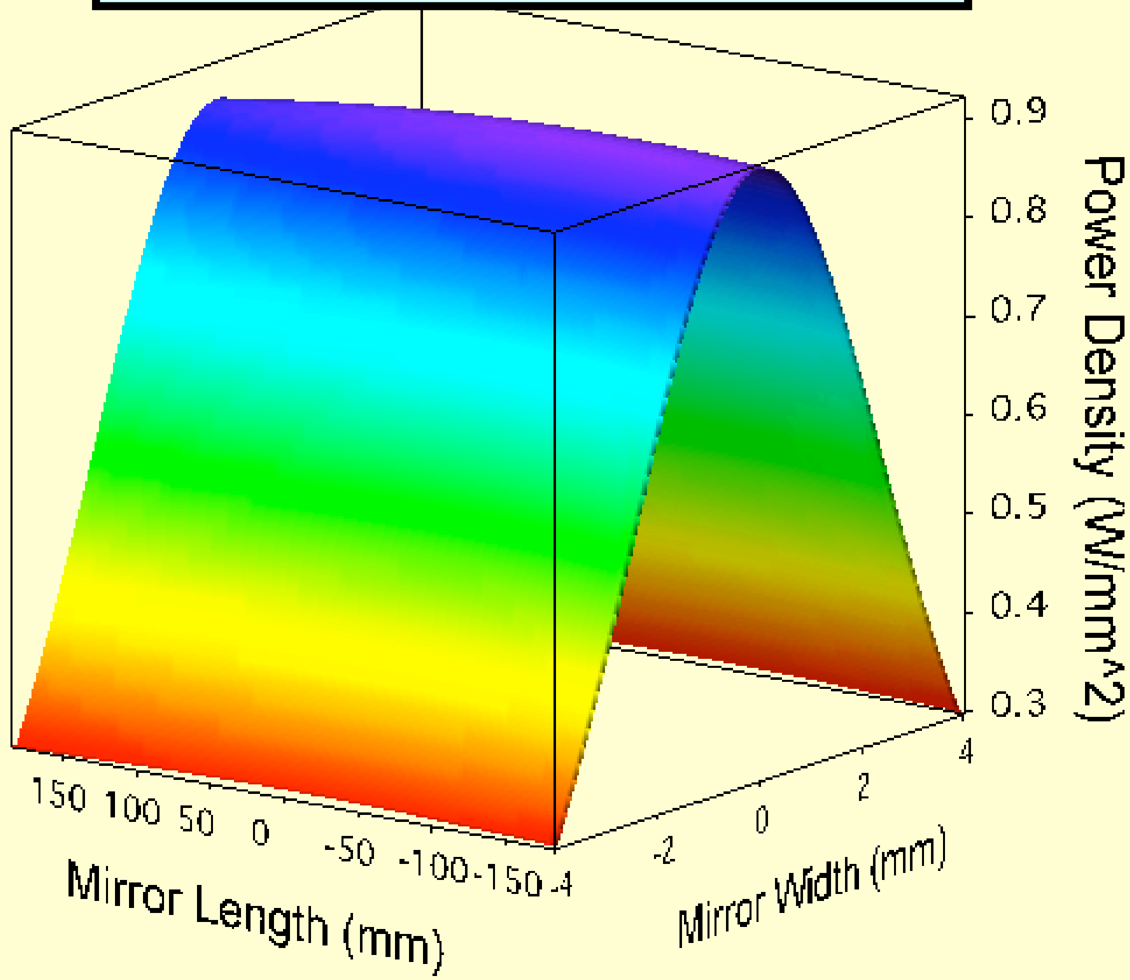
- Internally water cooled



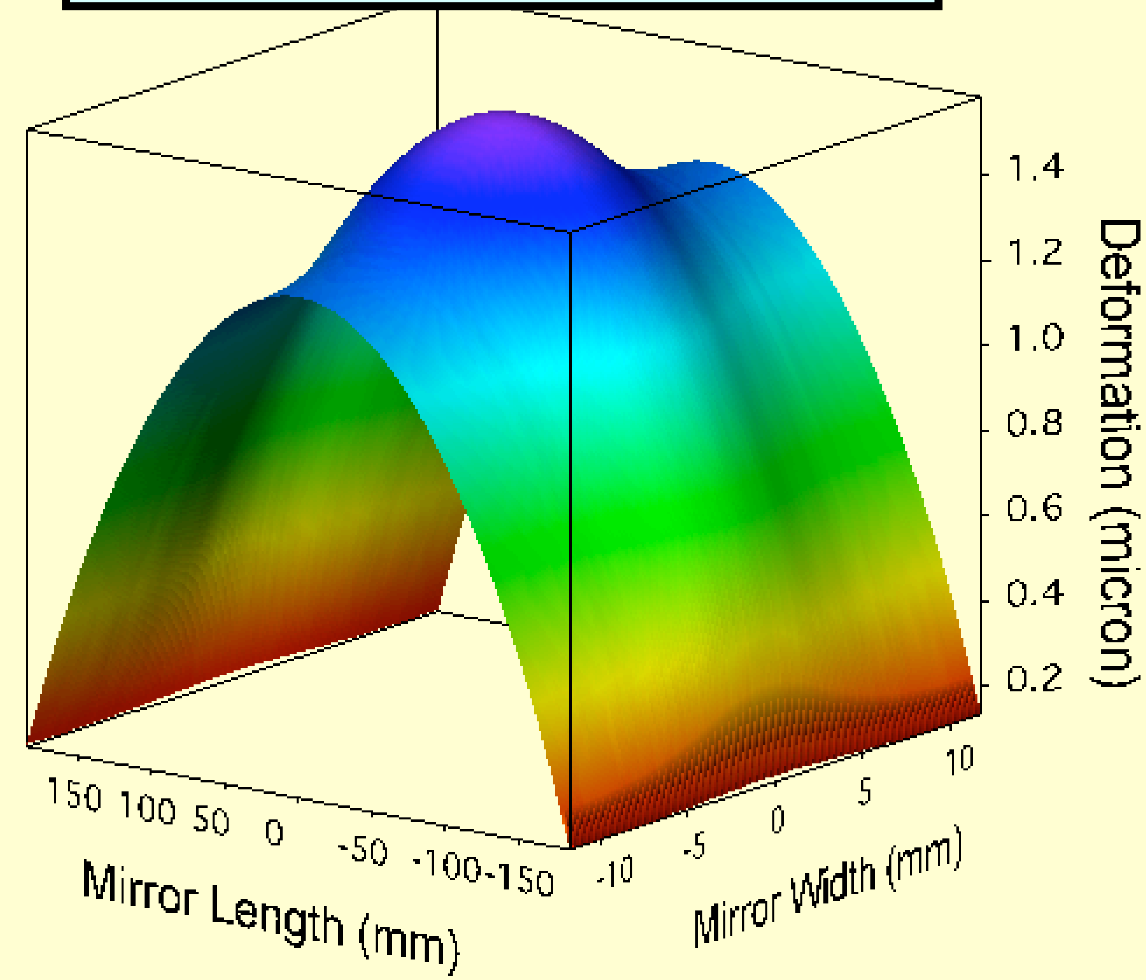


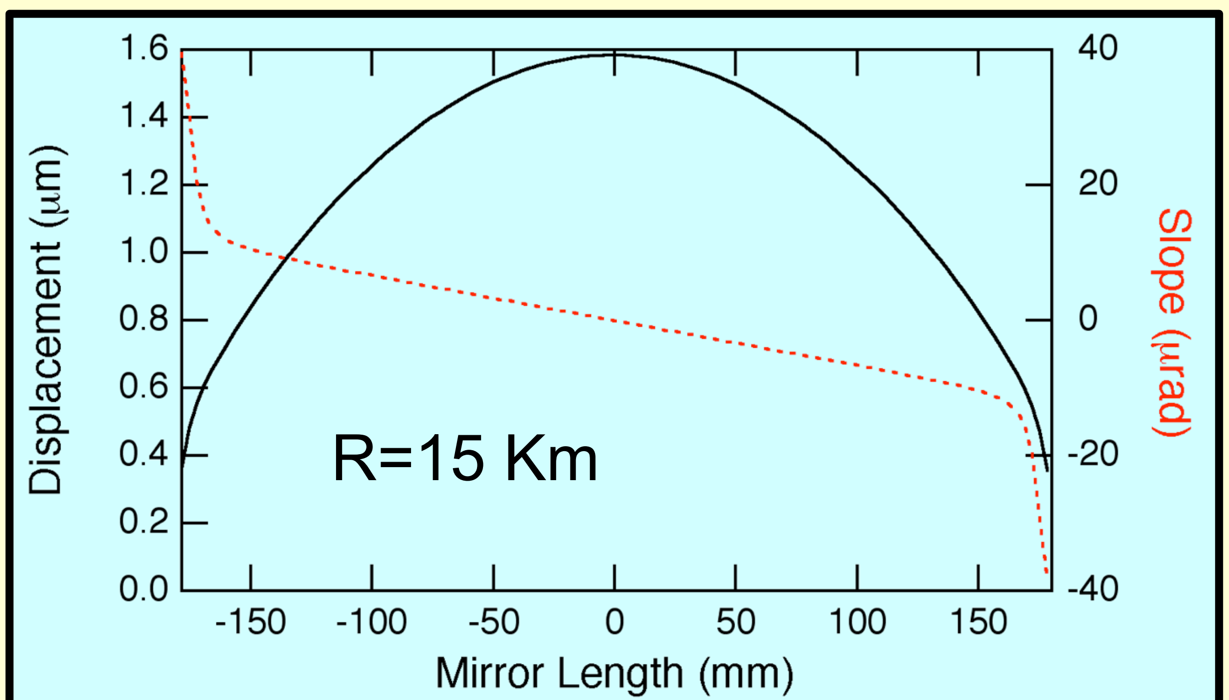
Power on M1

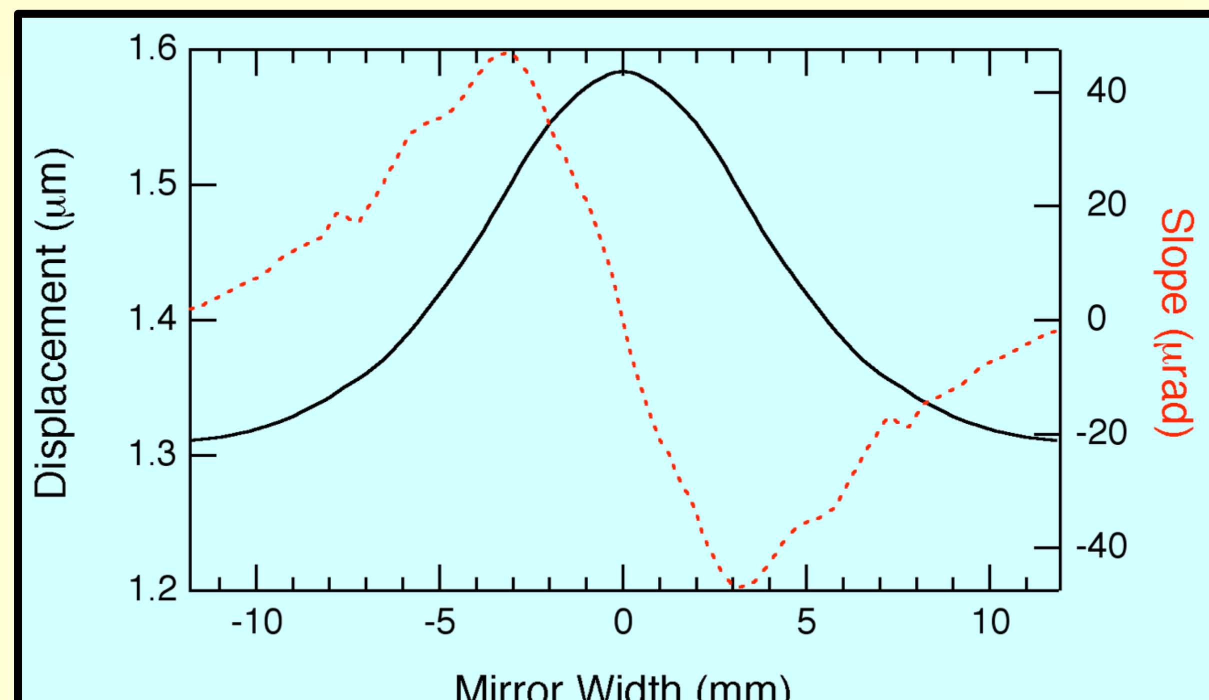
- Total absorbed 1.9 kW



- Internally water cooled



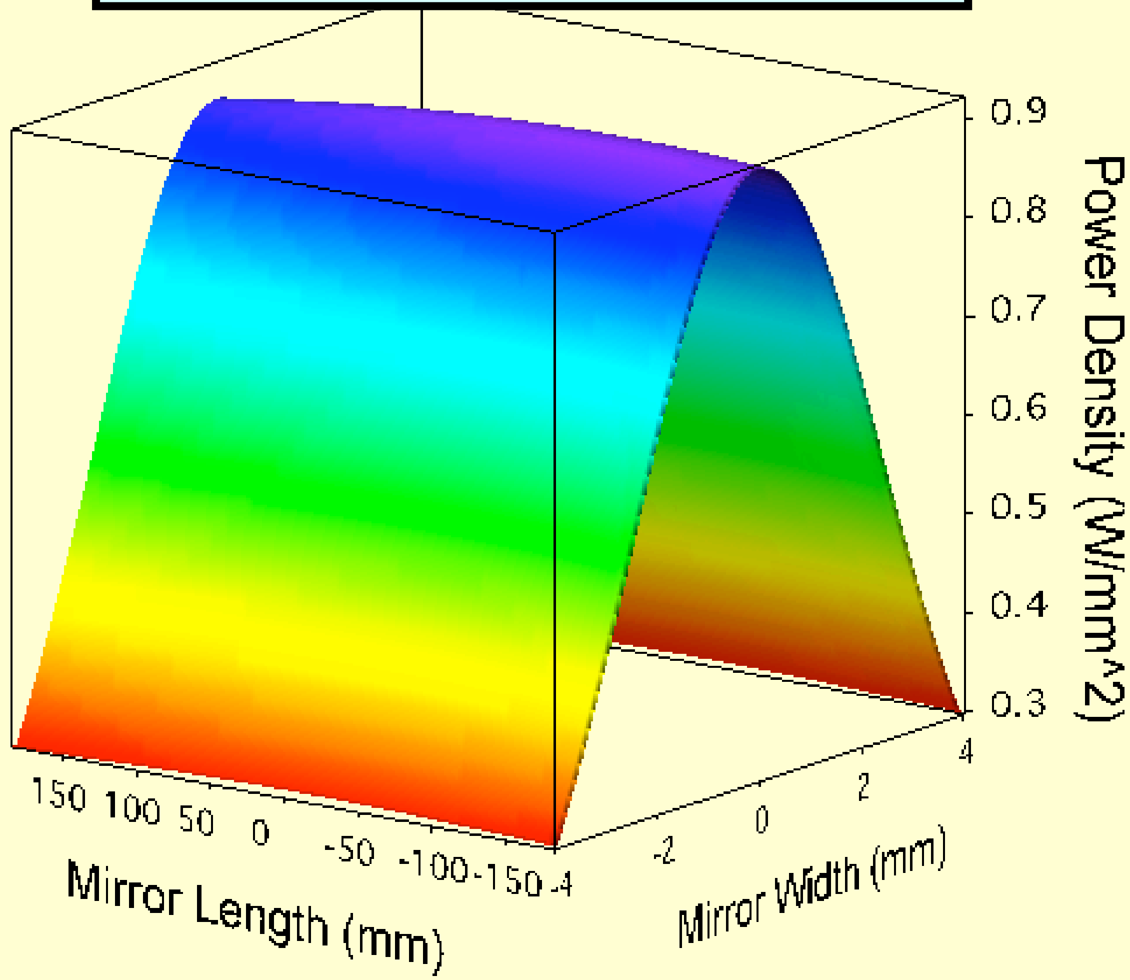


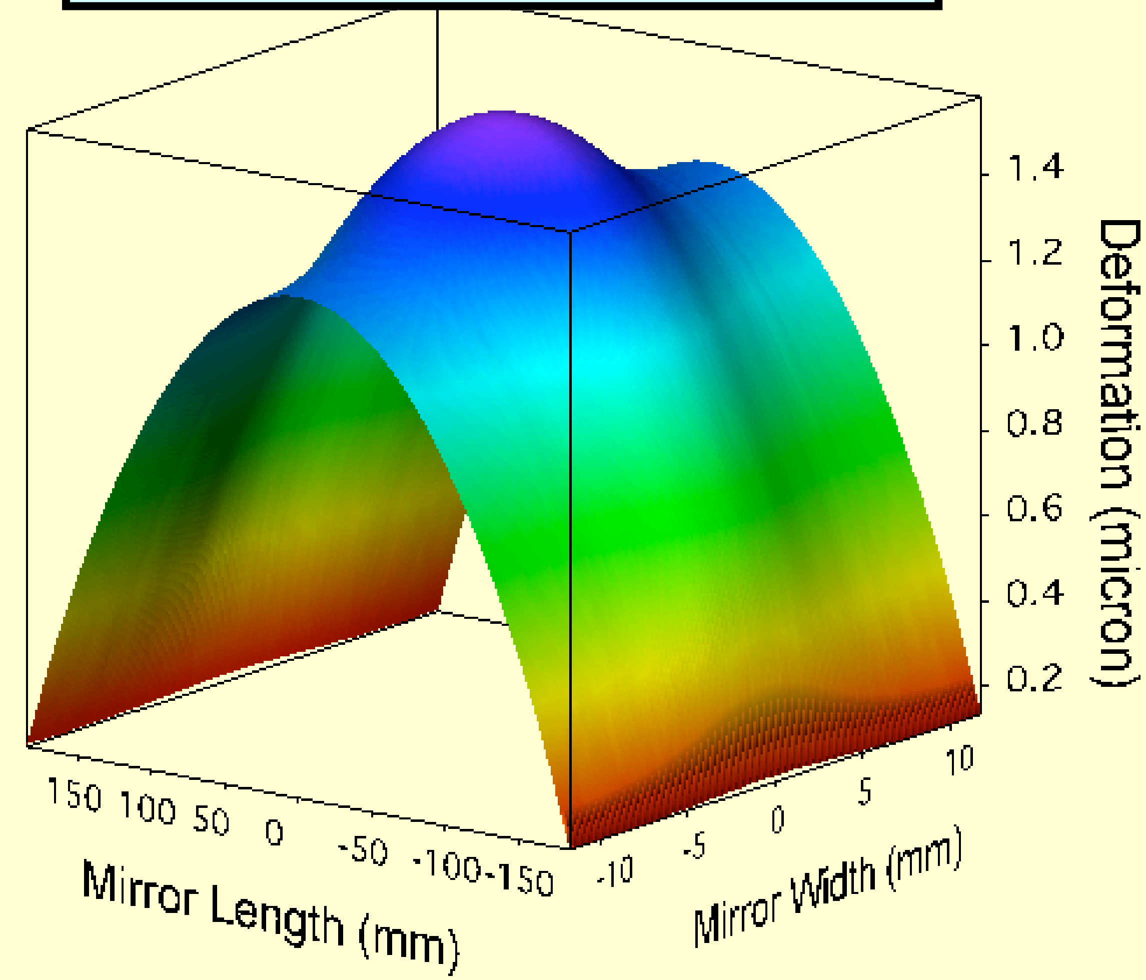


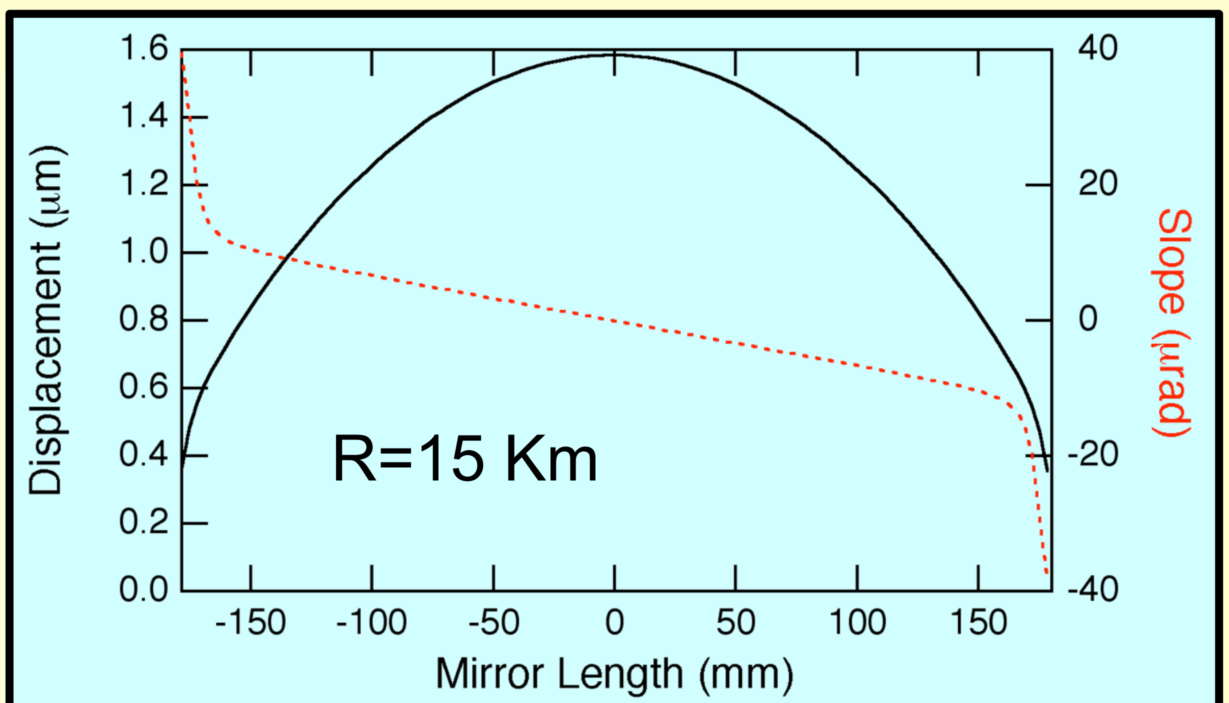
Power on M1

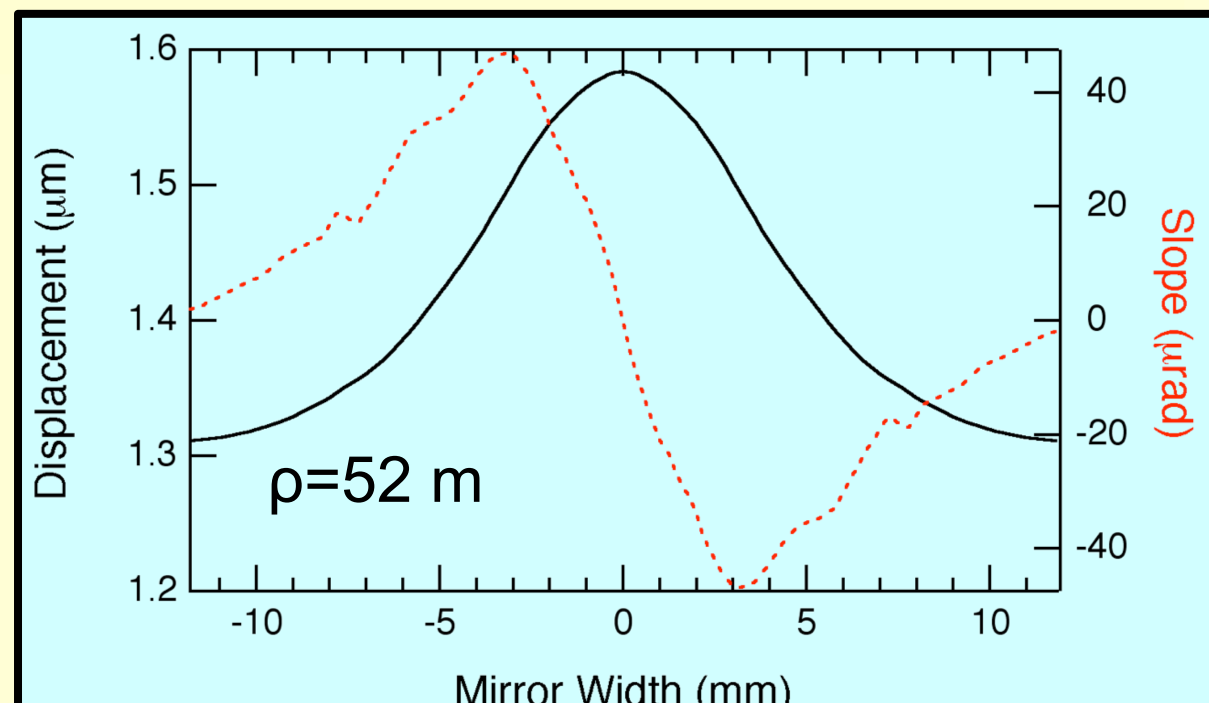
Total absorbed 1.9 kW

Internally water cooled



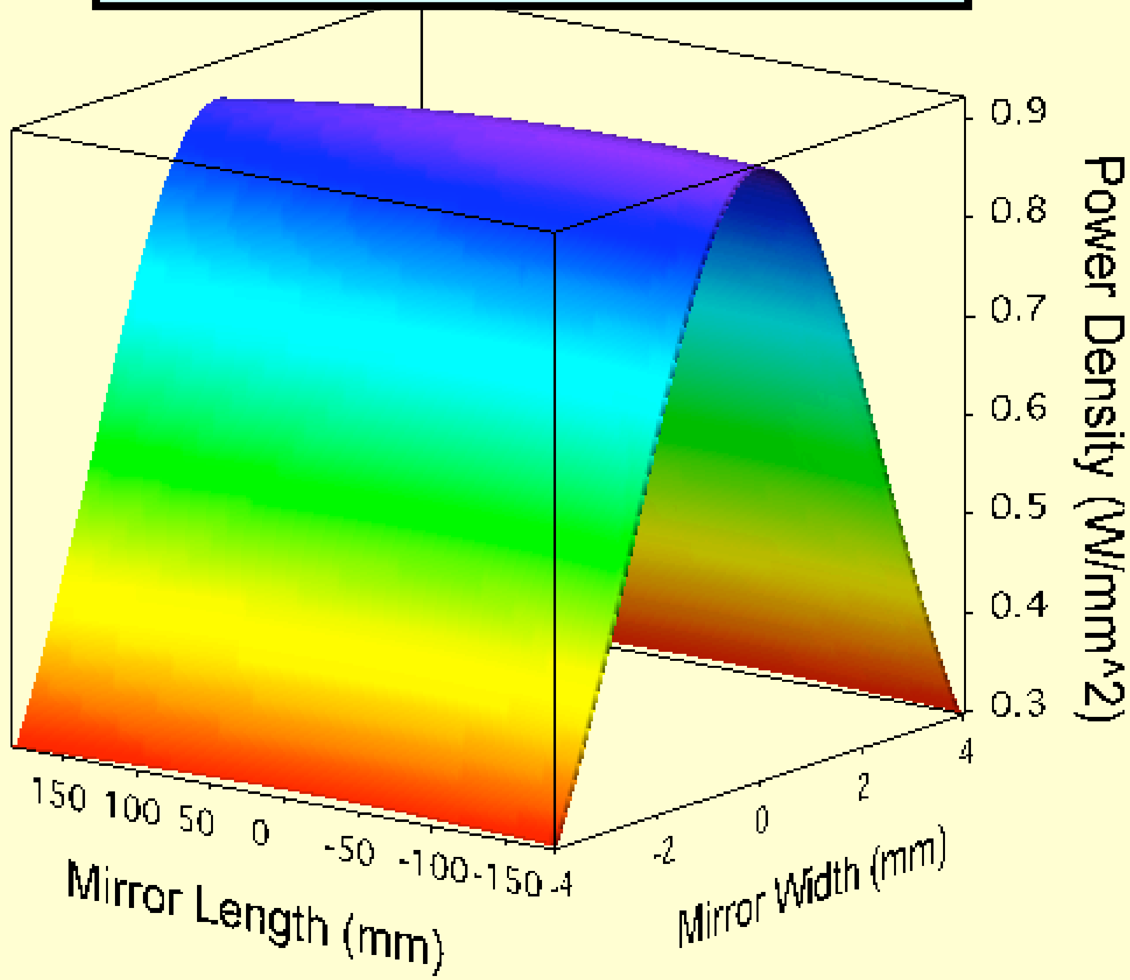


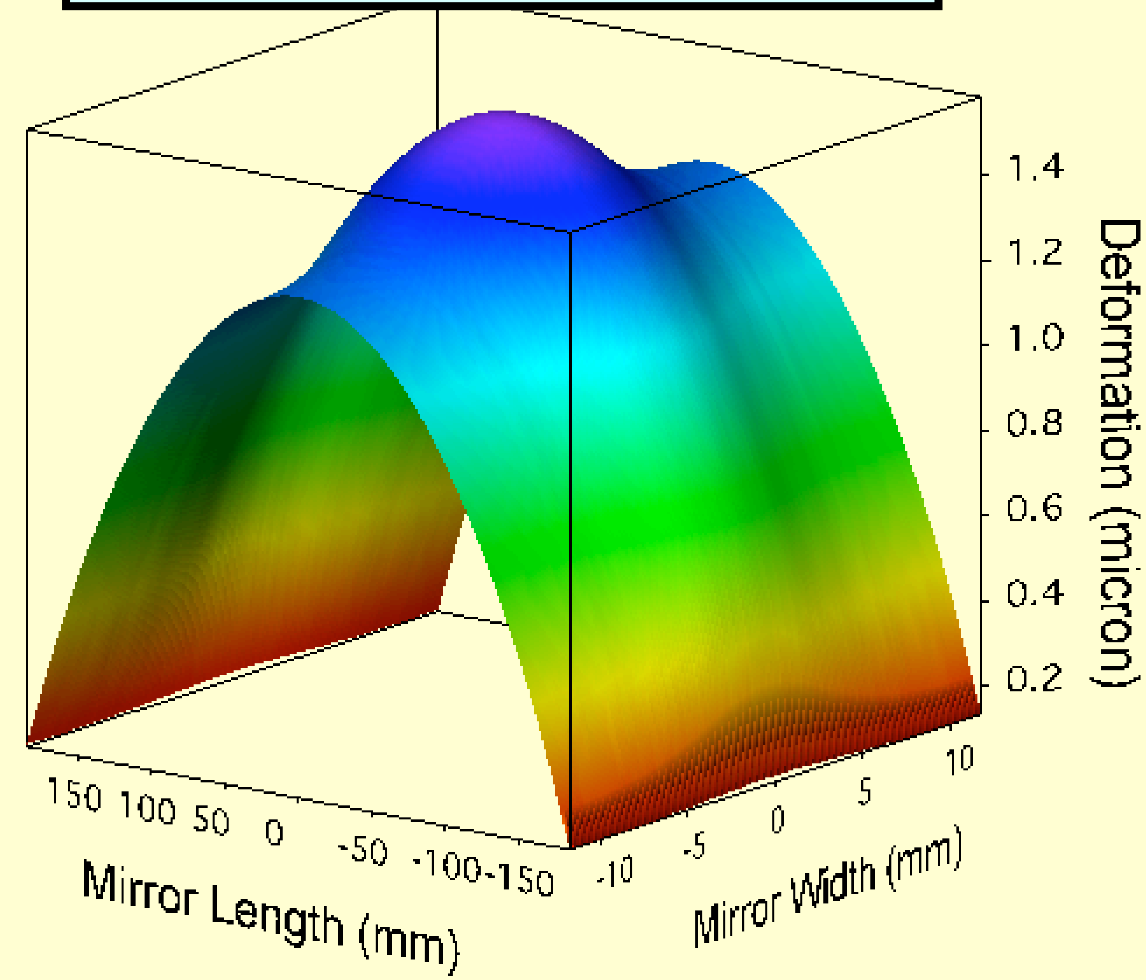


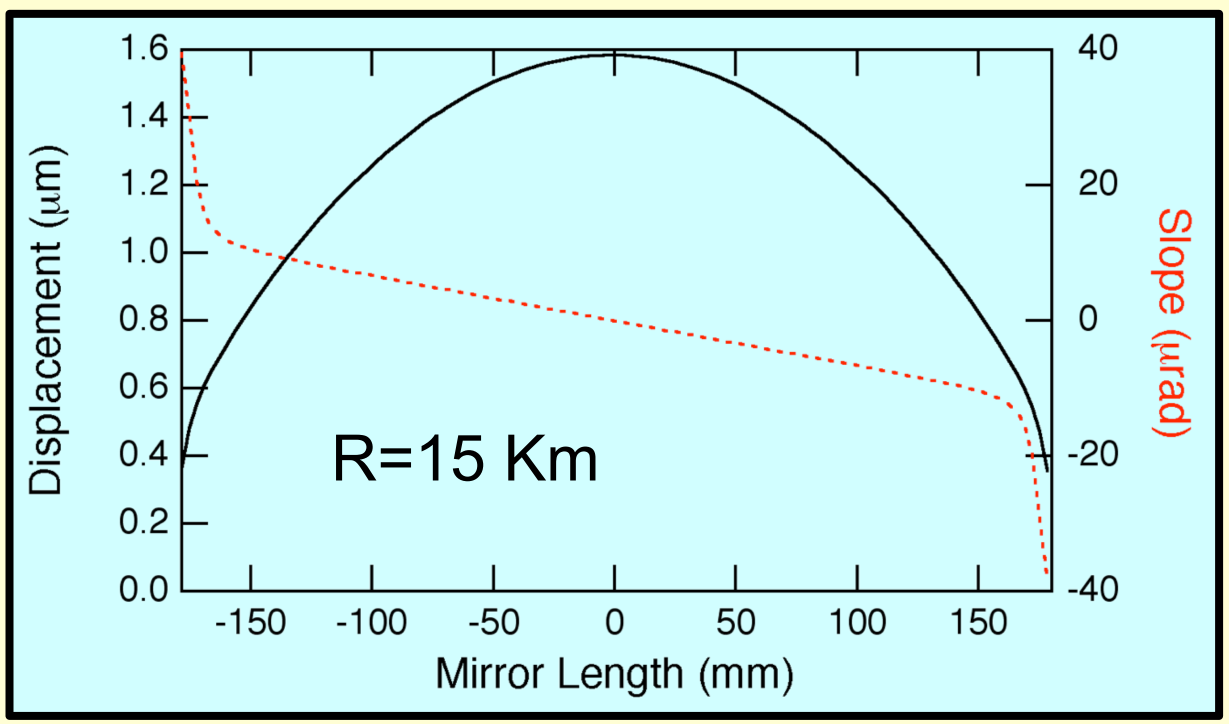


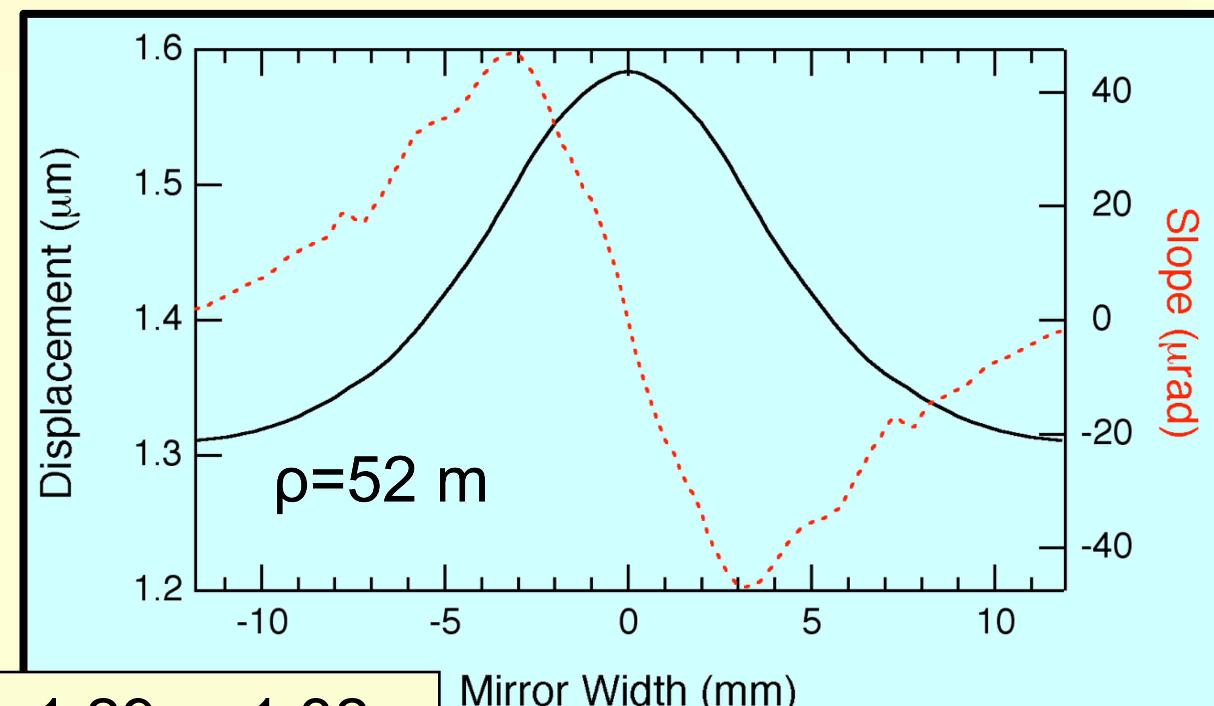
Power on M1

- Total absorbed 1.9 kW
- Internally water cooled





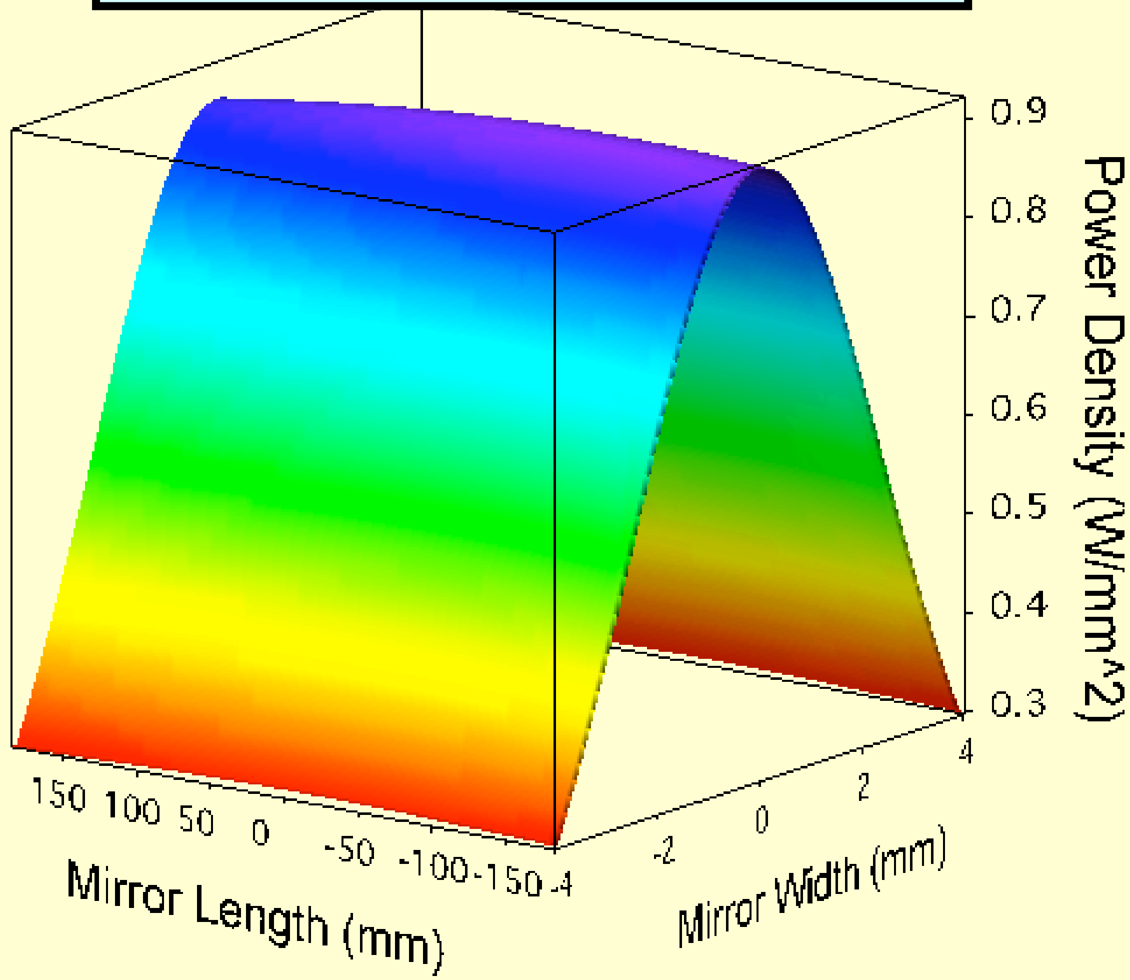




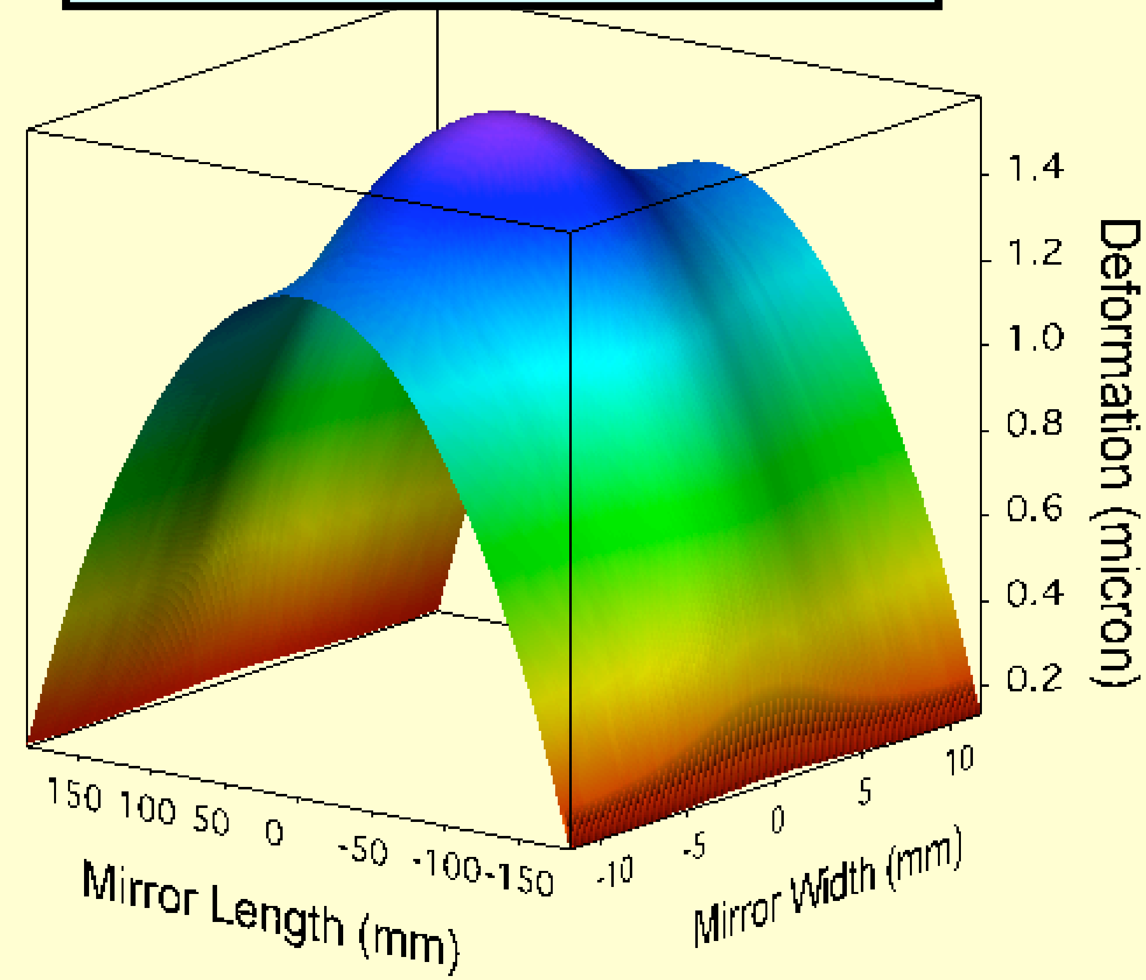
ρ=1.29 m 1.32m

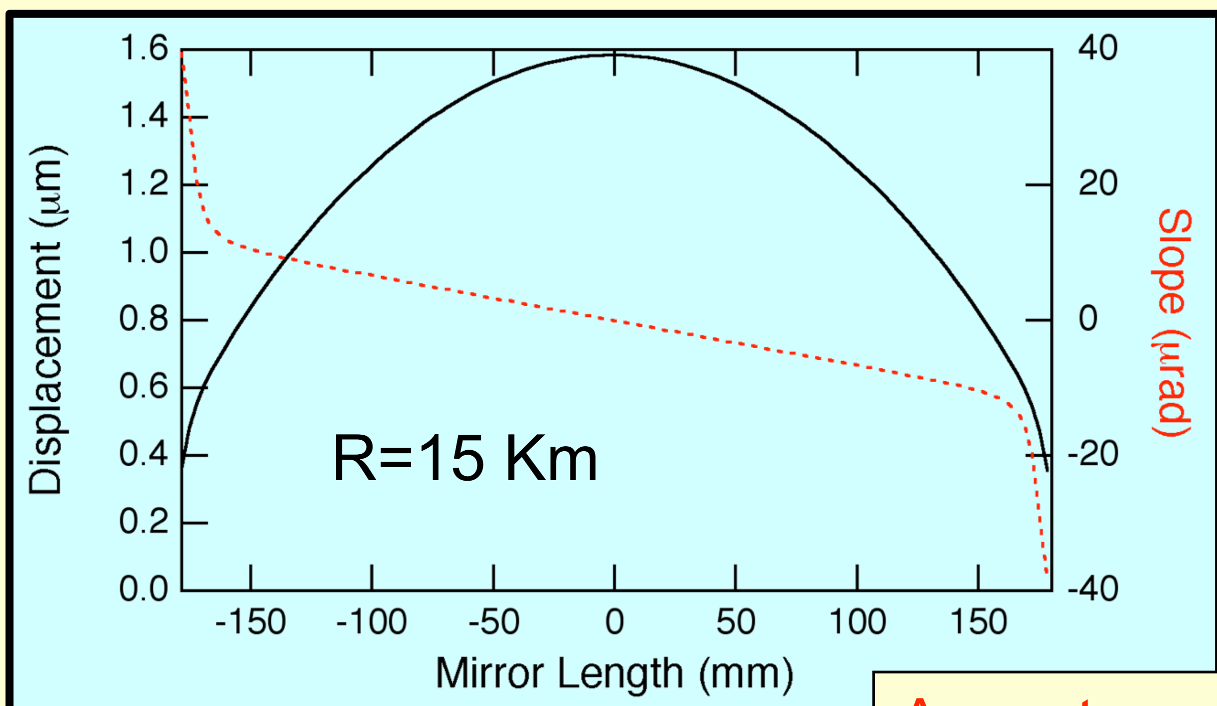
Power on M1

➡ Total absorbed 1.9 kW

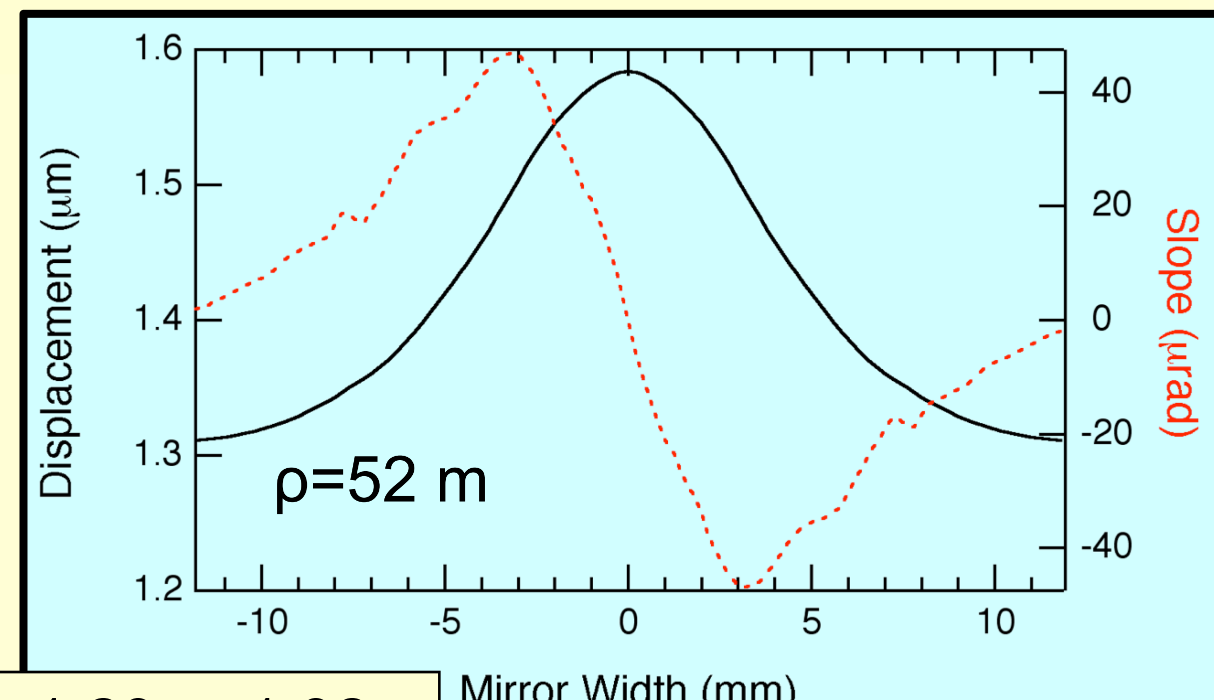


➡ Internally water cooled





Acceptance

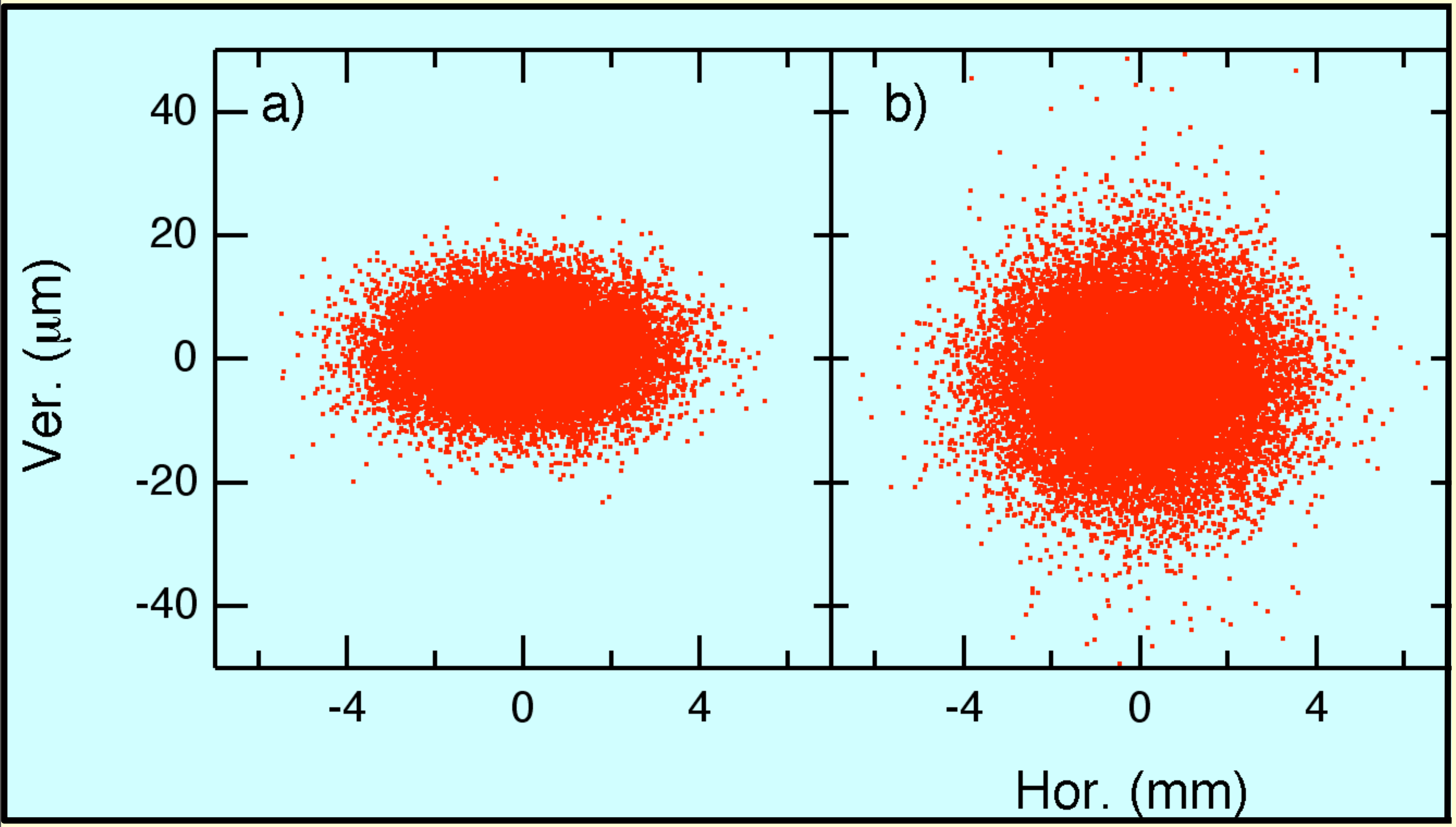


ρ=1.29 m 1.32m

Ray Traces Slit

Ideal

+Heat

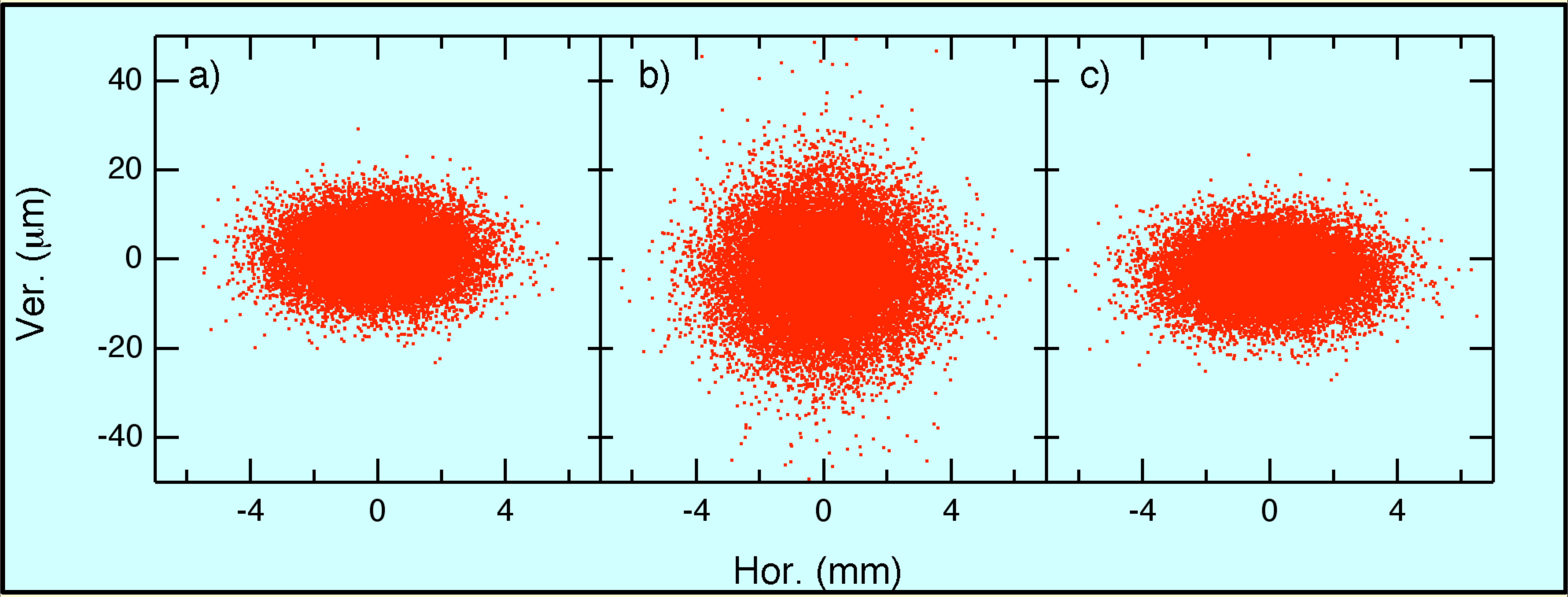


Ray Traces Slit

Ideal

+Heat

+Heat+change c



c value

2.183 to 2.201

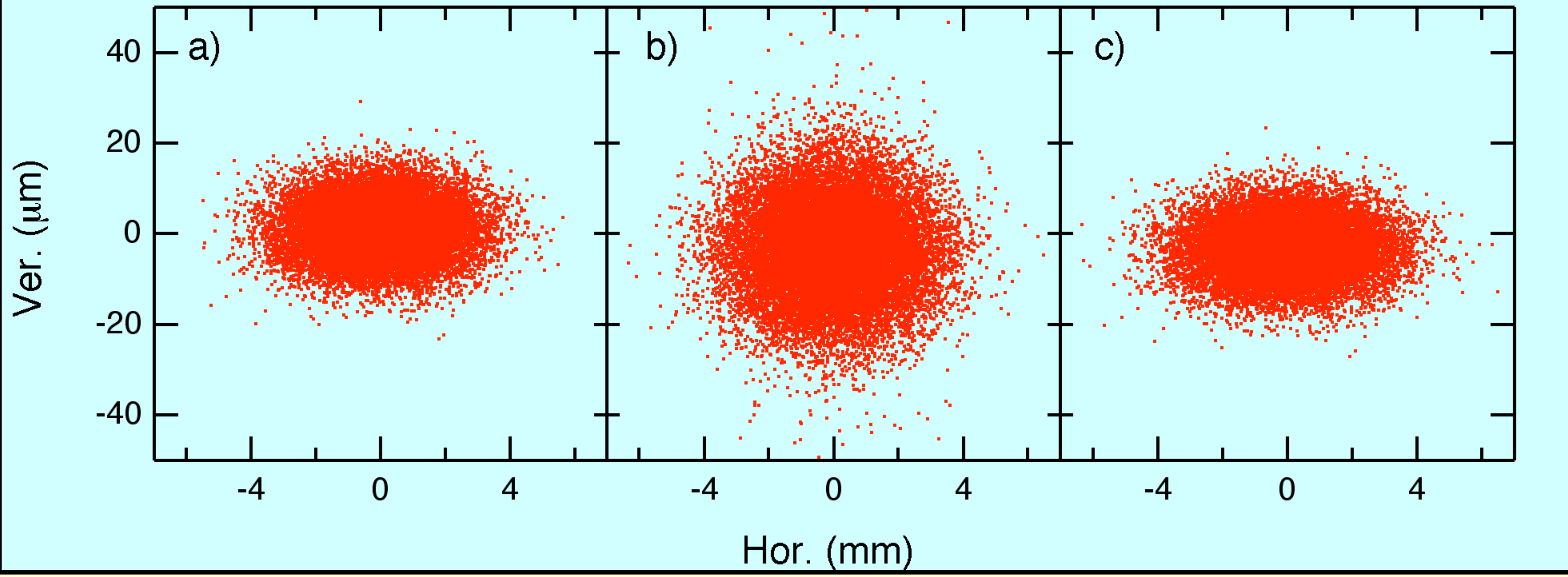
93% beam

Ray Traces Slit

Ideal

+Heat

+Heat+change c



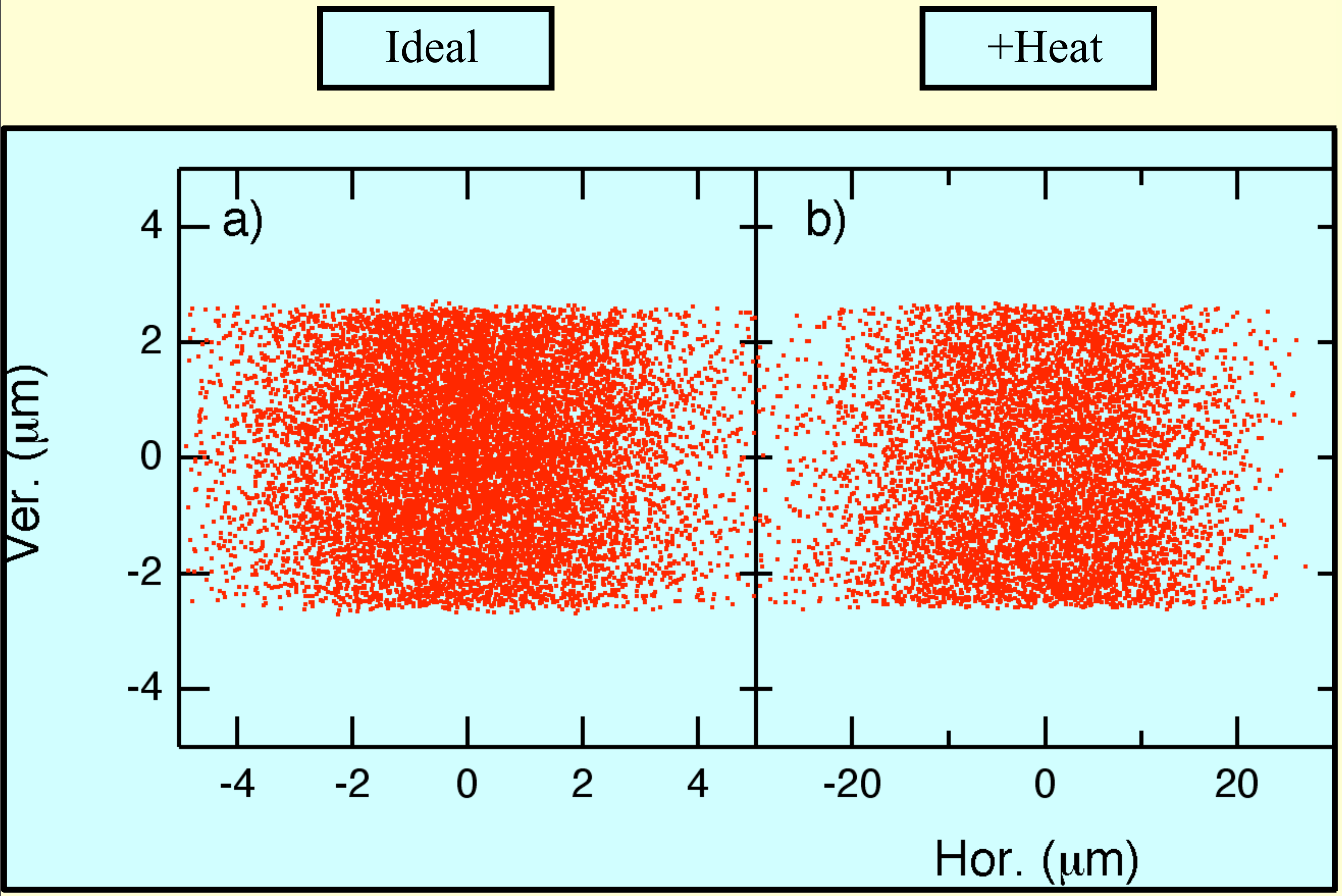
Could be achieved in the collimated PGM by moving slit

c value

2.183 to 2.201

93% beam

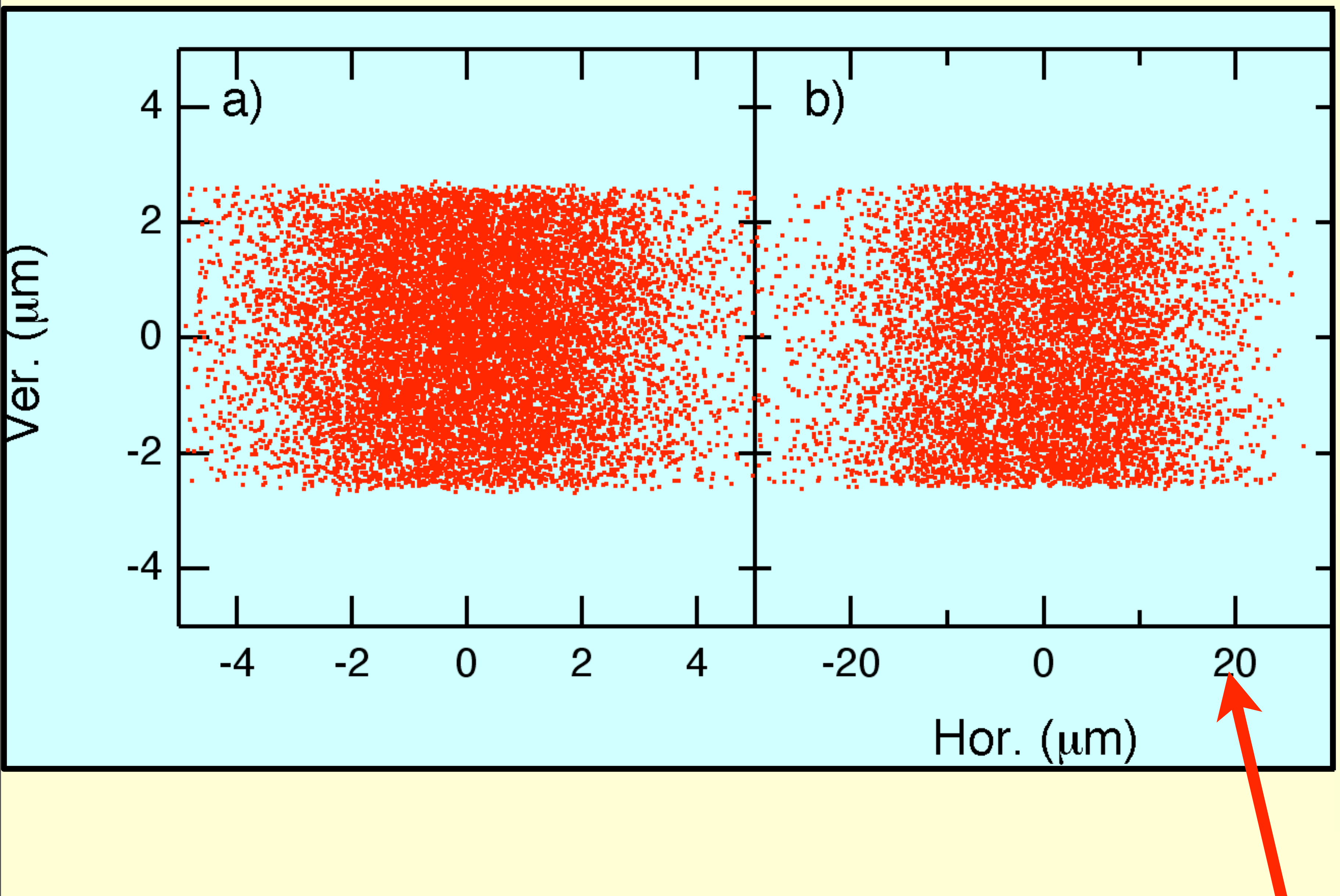
Ray Traces Sample



Ray Traces Sample

Ideal

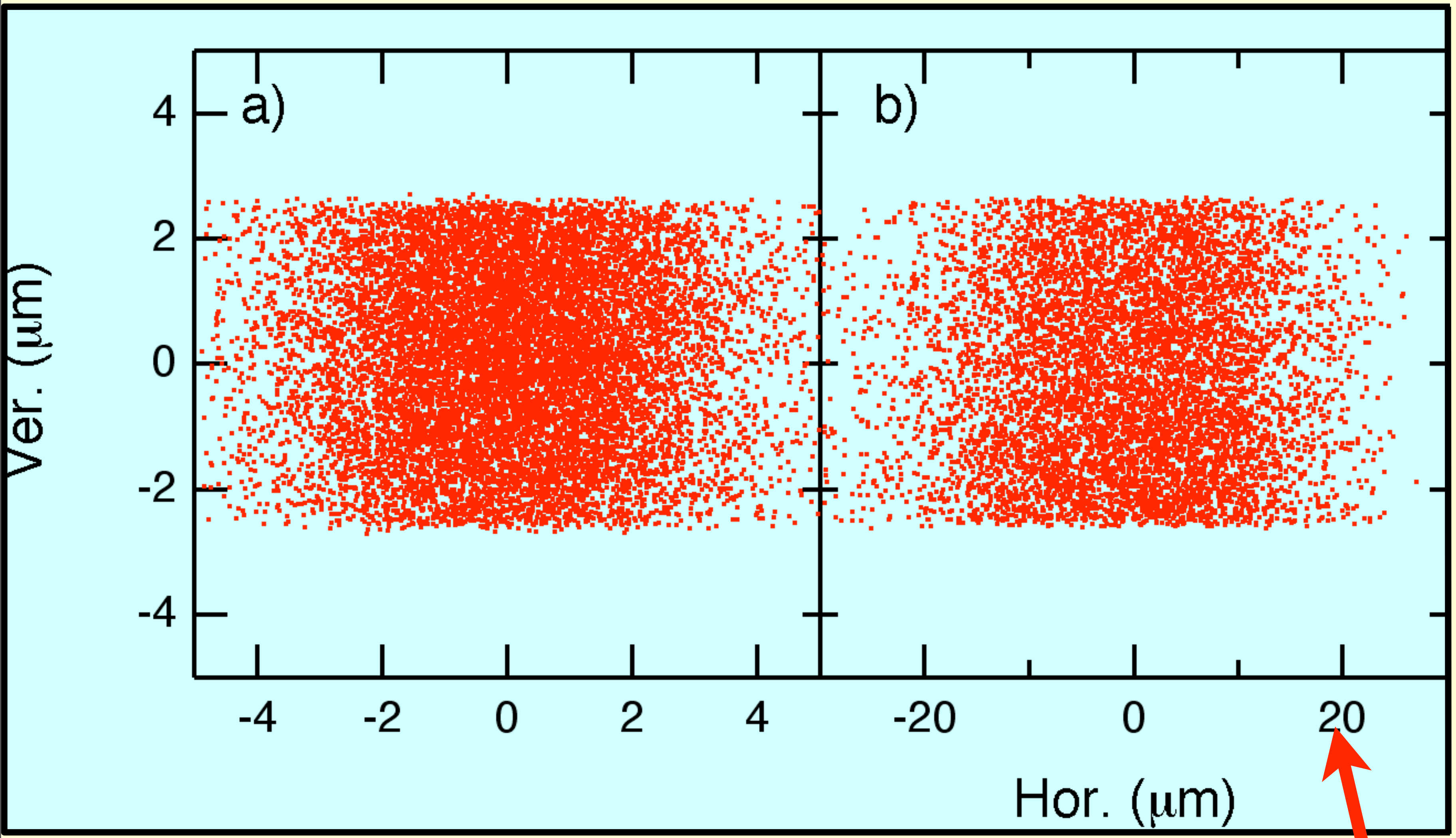
+Heat



Ray Traces Sample

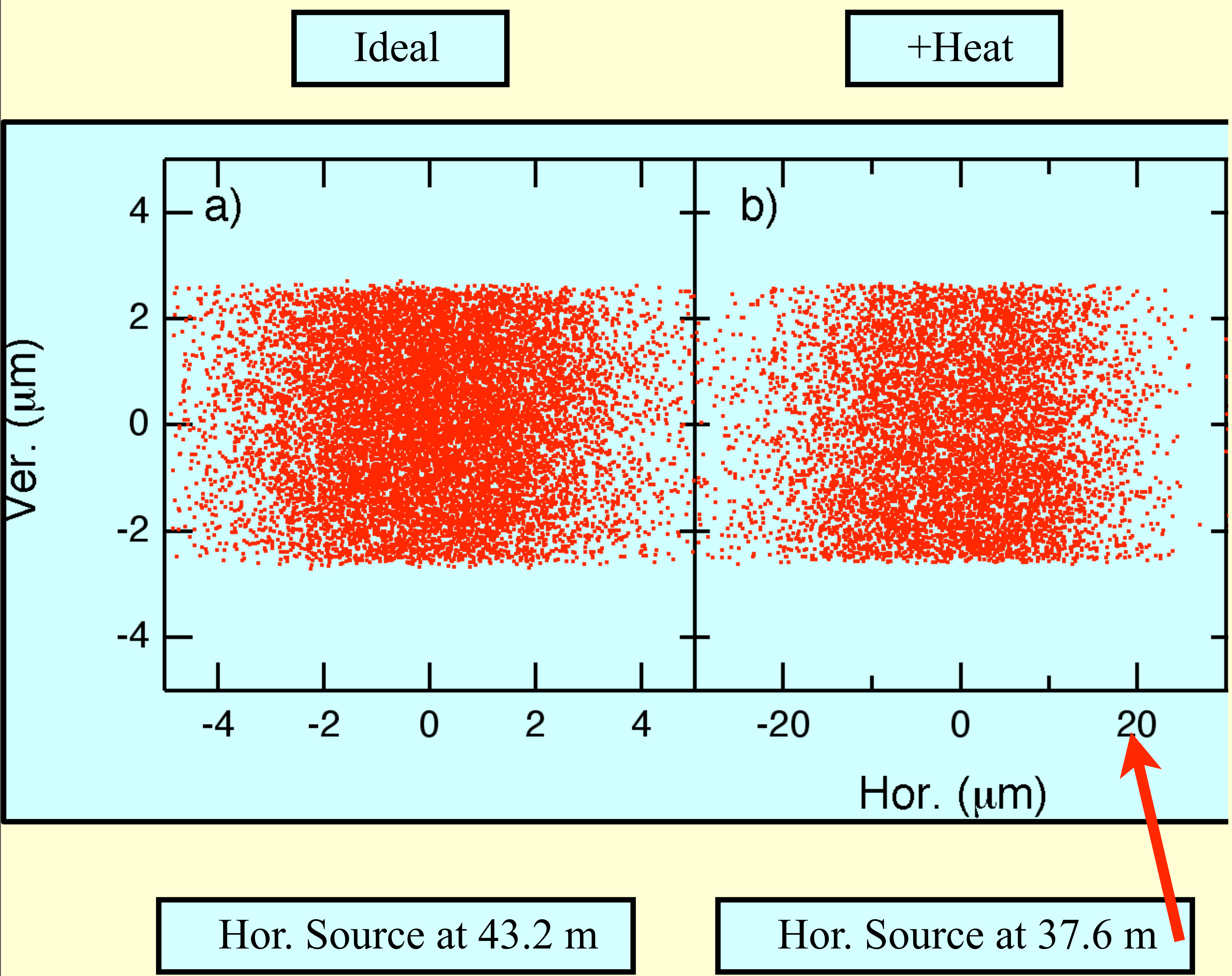
Ideal

+Heat



Hor. Source at 43.2 m

Ray Traces Sample

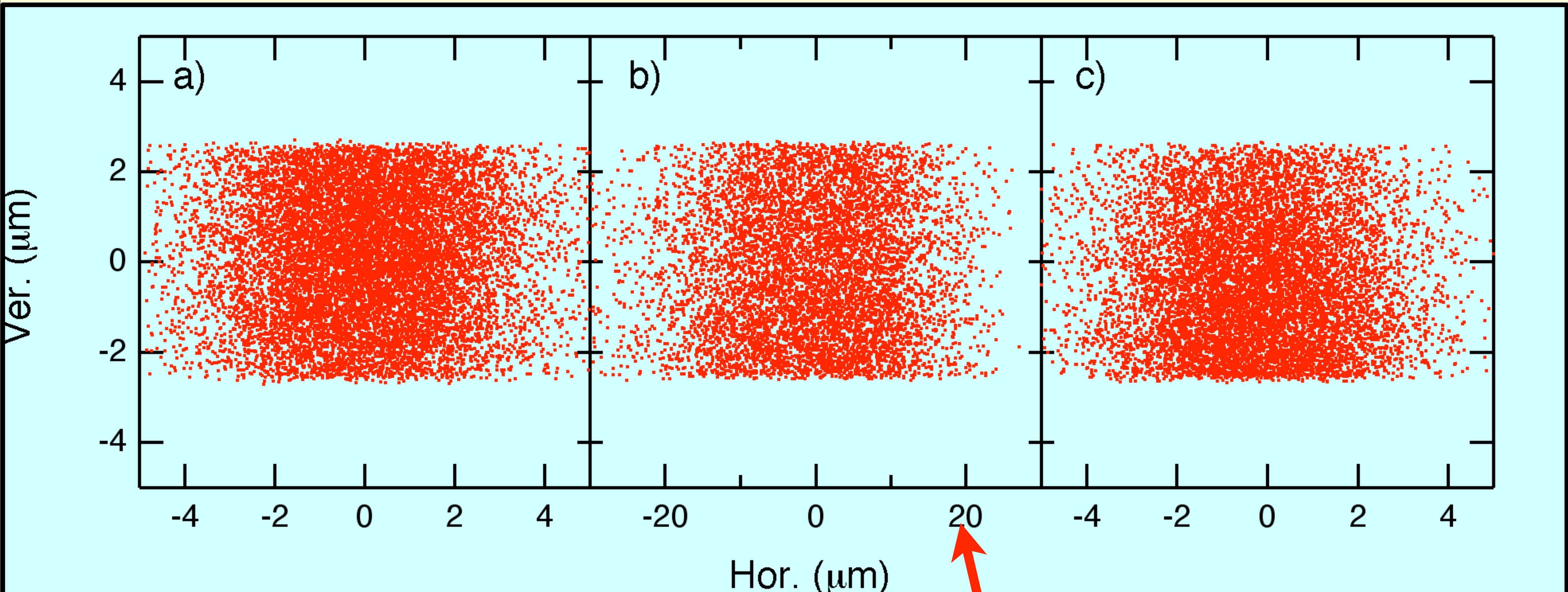


Ray Traces Sample

Ideal

+Heat

+Heat+bending mirror



Hor. Source at 43.2 m

Hor. Source at 37.6 m

Will It Work?

- Resolution recovered by changing c
- Spot at sample (hor.) by changing M3 (ellip. cyl.)
- Top-up mode
- No ID scan or very limited energy range
- Generate a working table
  - Gap
  - Resolution
  - Spot size
  - Temperature
- On line measurements radius curvature and resolution ➠ Real time correction.