Propagation of Porro 'petal' beams through a turbulent atmosphere

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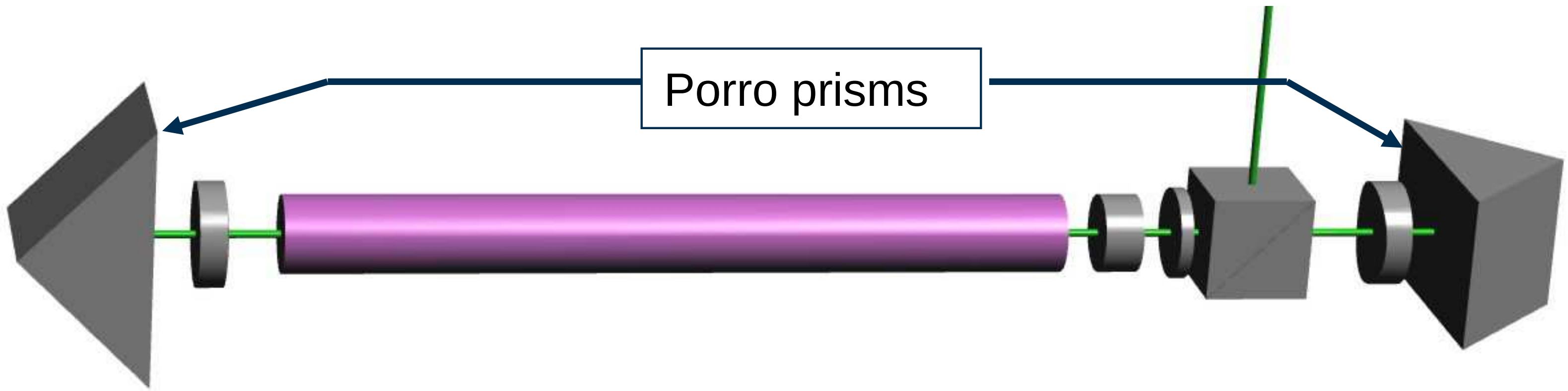
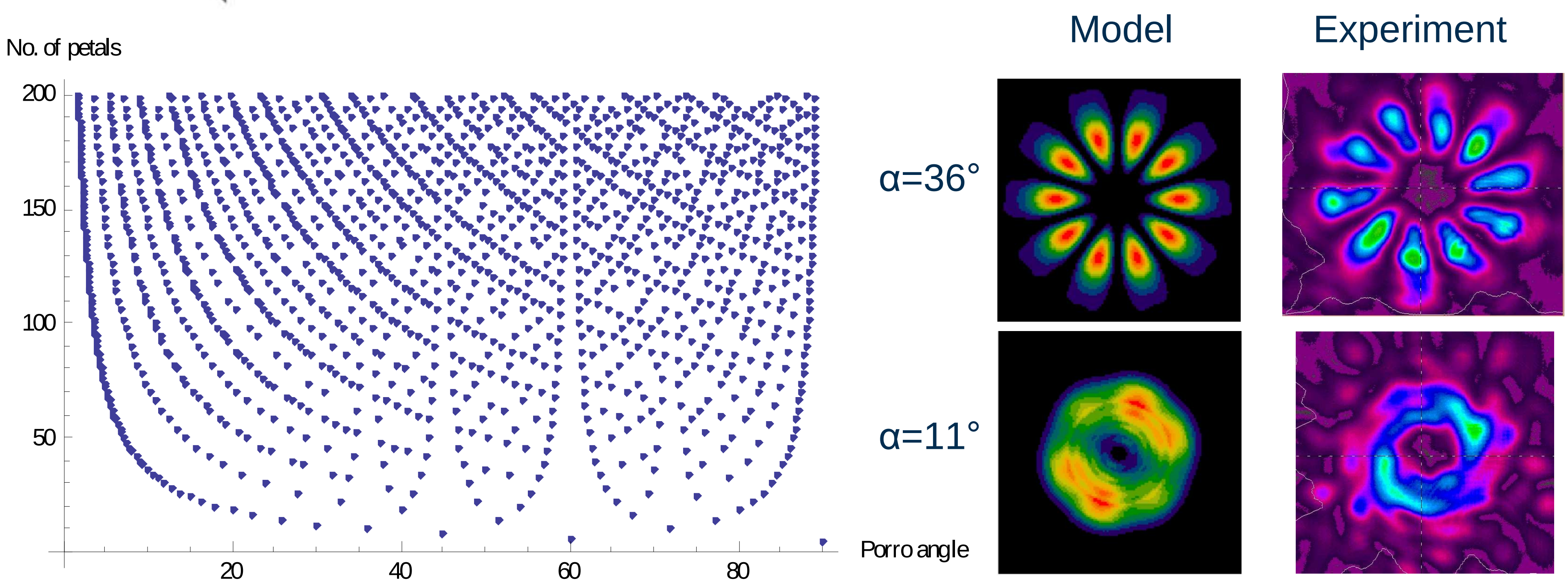
6-10 July 2009

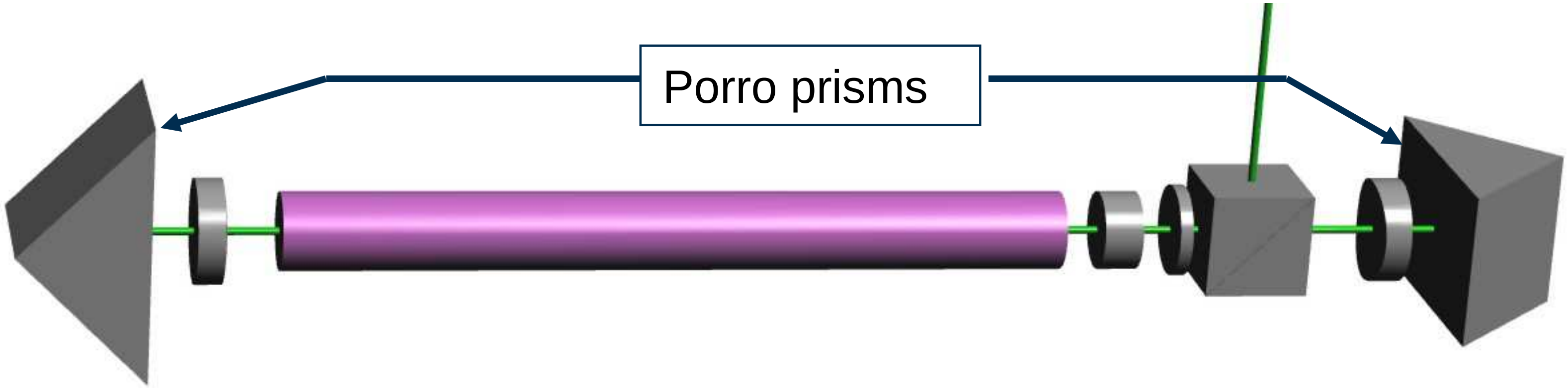
our future through science

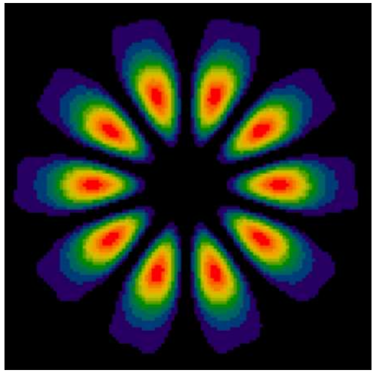
Nd:YAG laser with Porro prism resonator

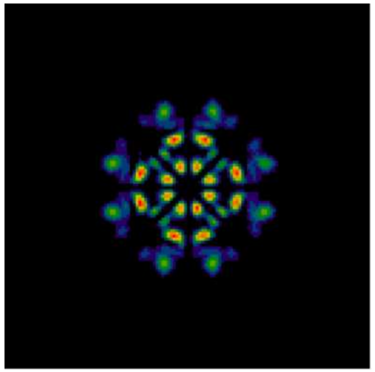


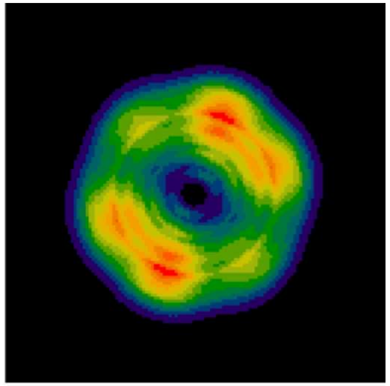


Nd:YAG laser with Porro prism resonator





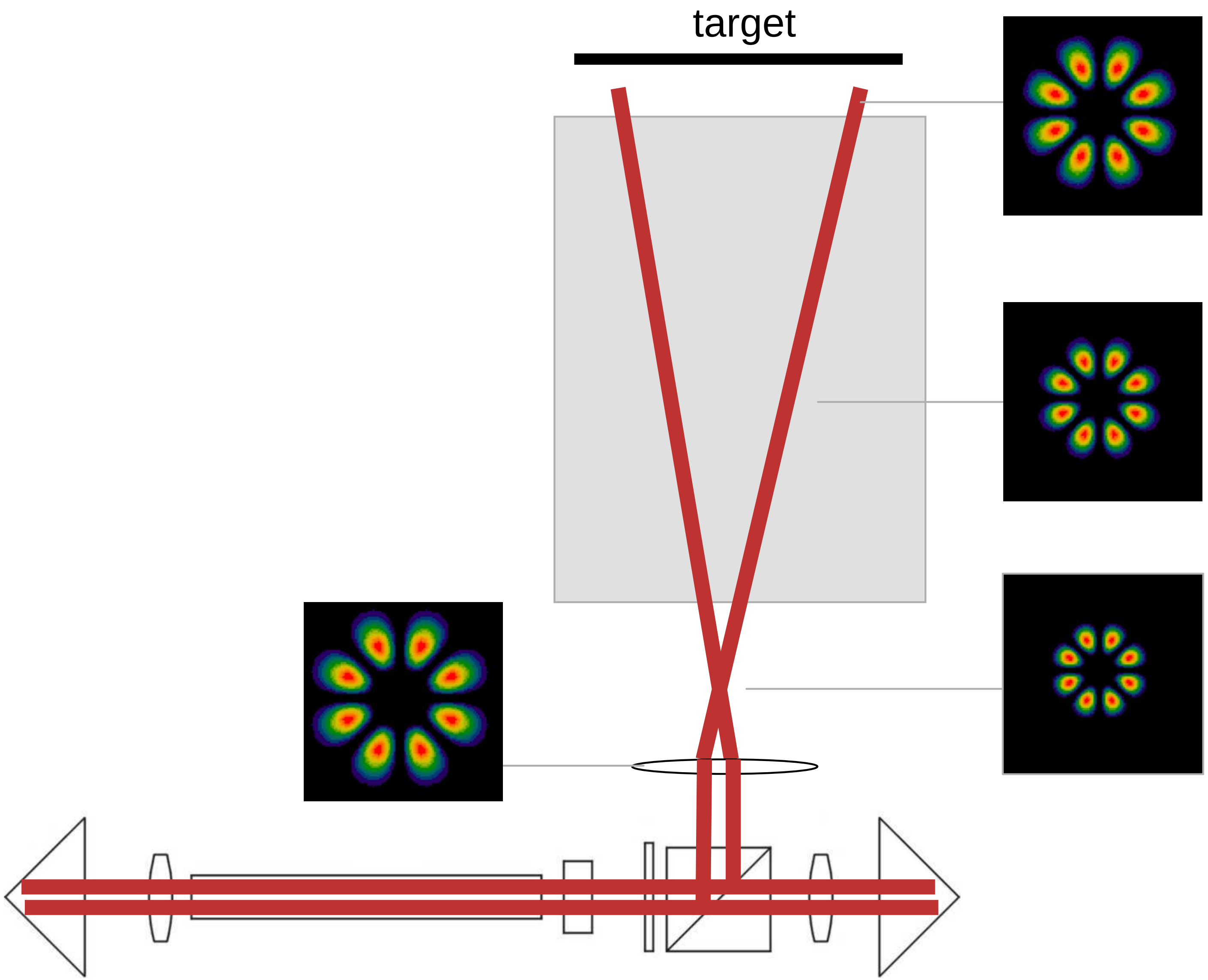




Optics Express **15**(21), 14065-14077, 2007

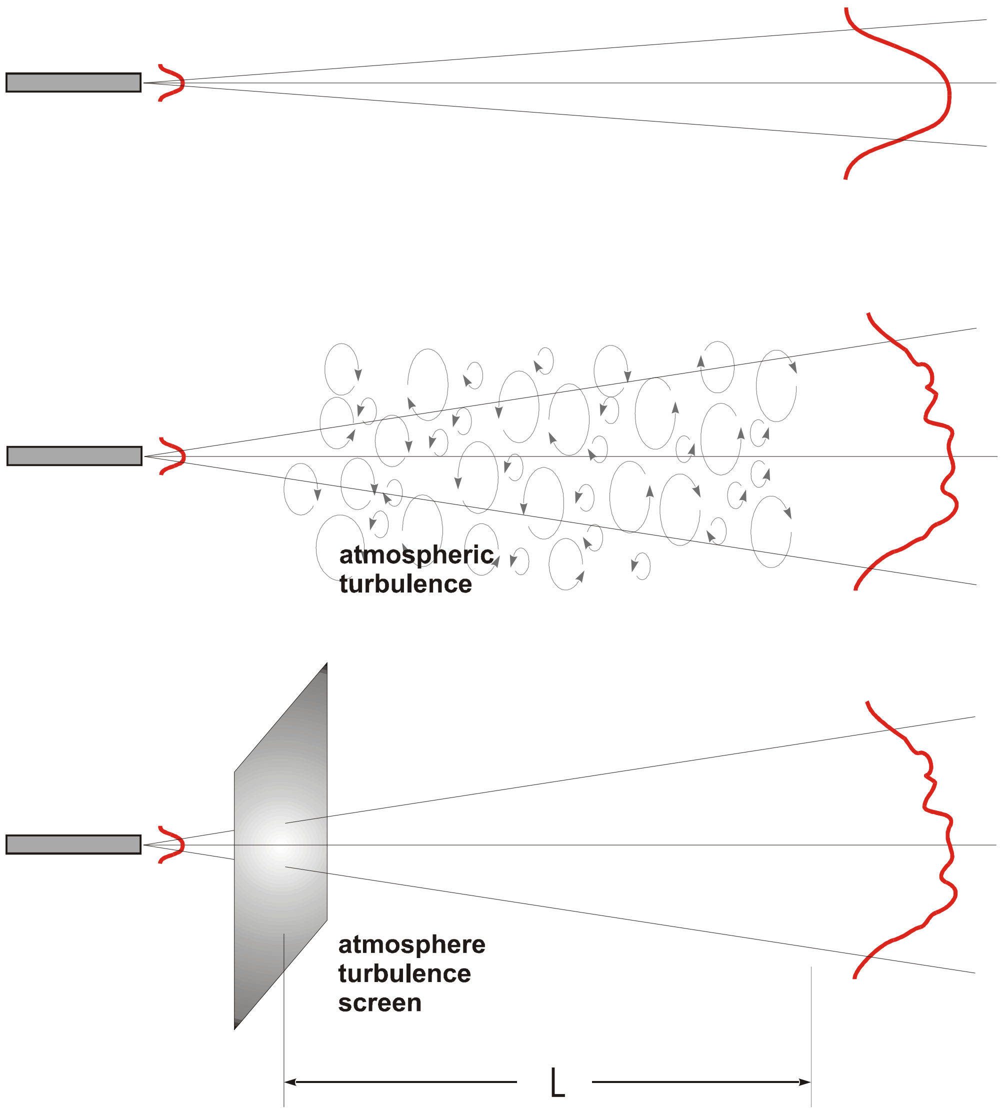
Optics Express **16**(17), 12707-12714, 2008

Porro prism resonator



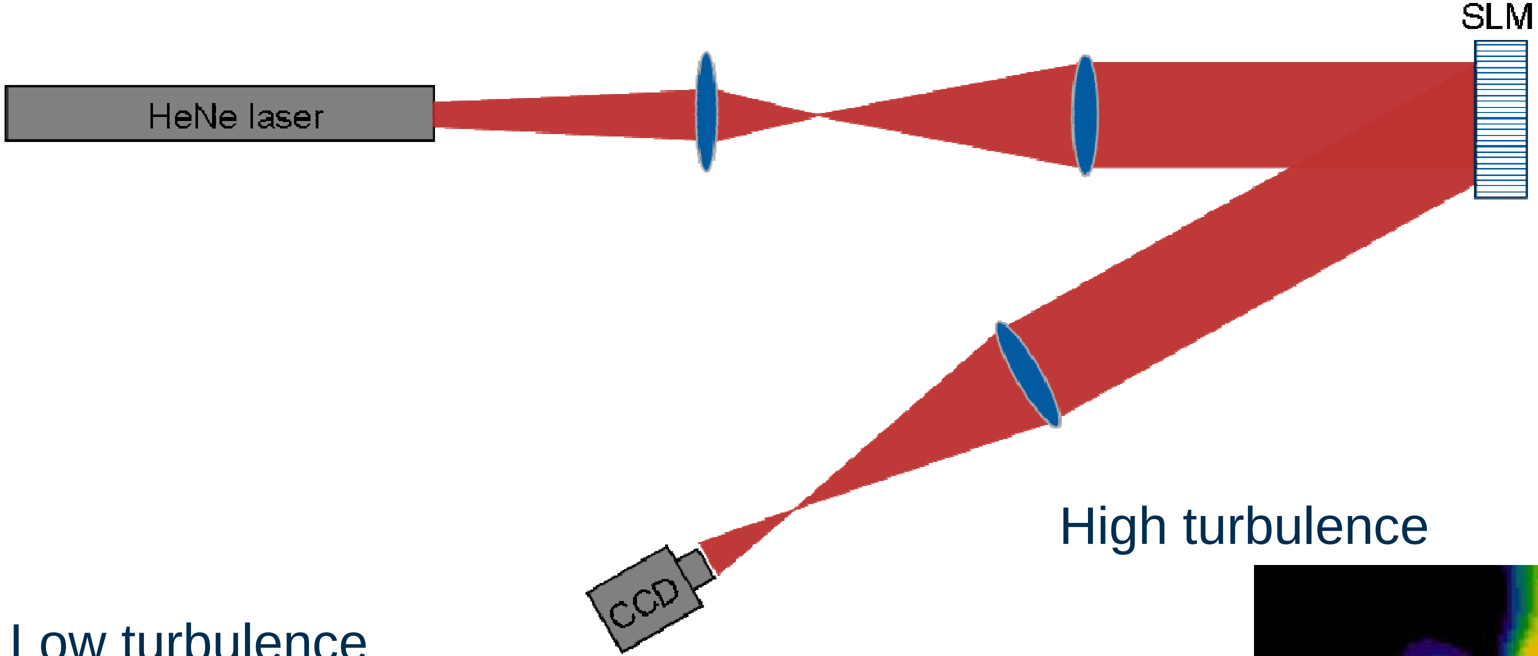
Atmospheric propagation

Transmission through turbulence



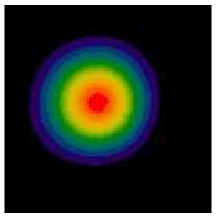
Atmospheric propagation

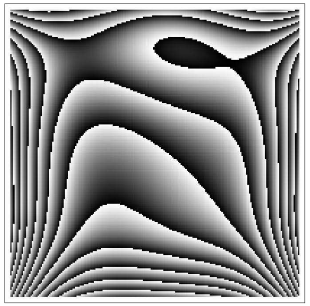
Laboratory simulation using a SLM

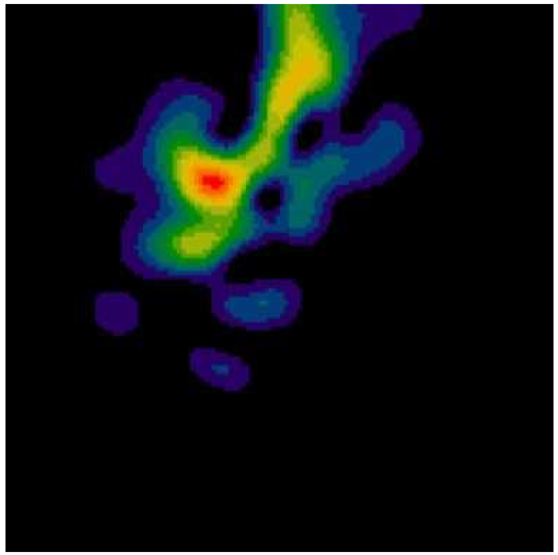


High turbulence

Low turbulence

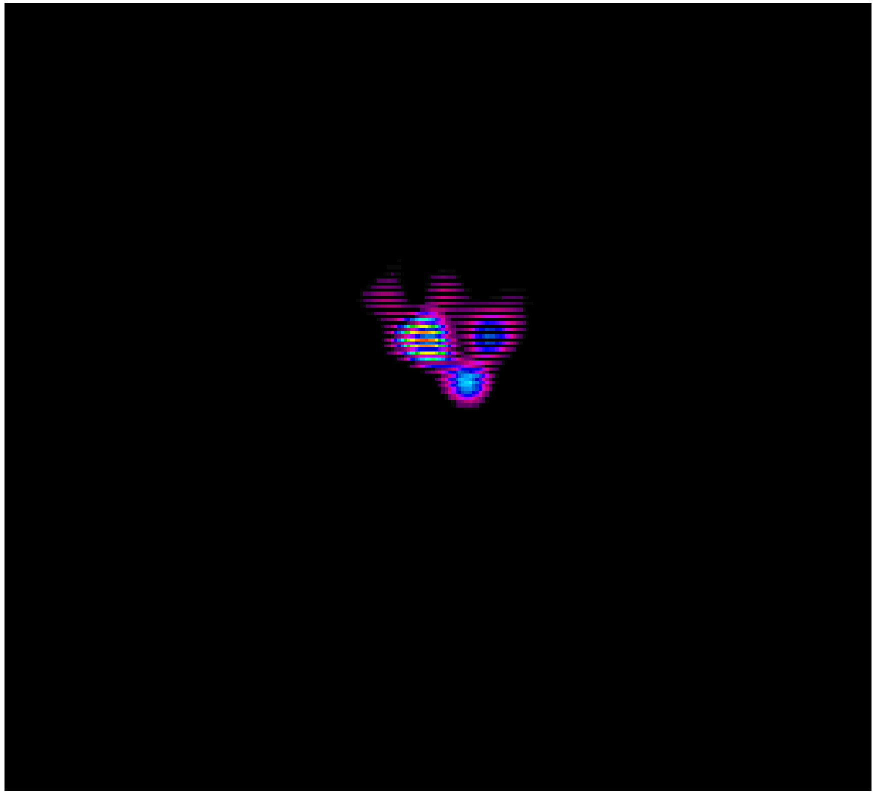






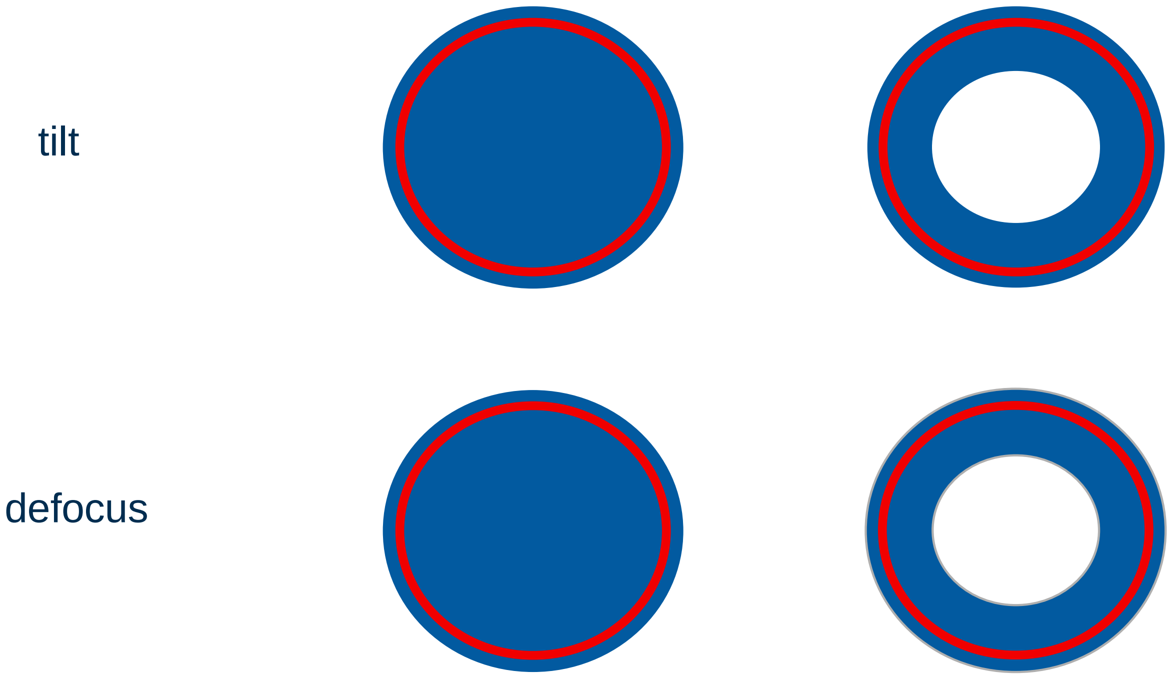
South African Journal of Science **104**(3-4), 129-134, 2008

Experimental results



Atmospheric propagation

Hypothesis – the effect of turbulence of centred and off-centre beams



Atmospheric propagation

Kolmogorov Turbulence Model

Fried's scale parameter (r_0) is the turbulence coherence length:

$$r_0 = \left[0.423 k^2 \int_{h_{\min}}^{h_{\max}} C_n^2(h) dh \right]^{-3/5}$$

C_n^2 is the refractive index structure constant
h is height asl
k is the wave number

For a fixed height:

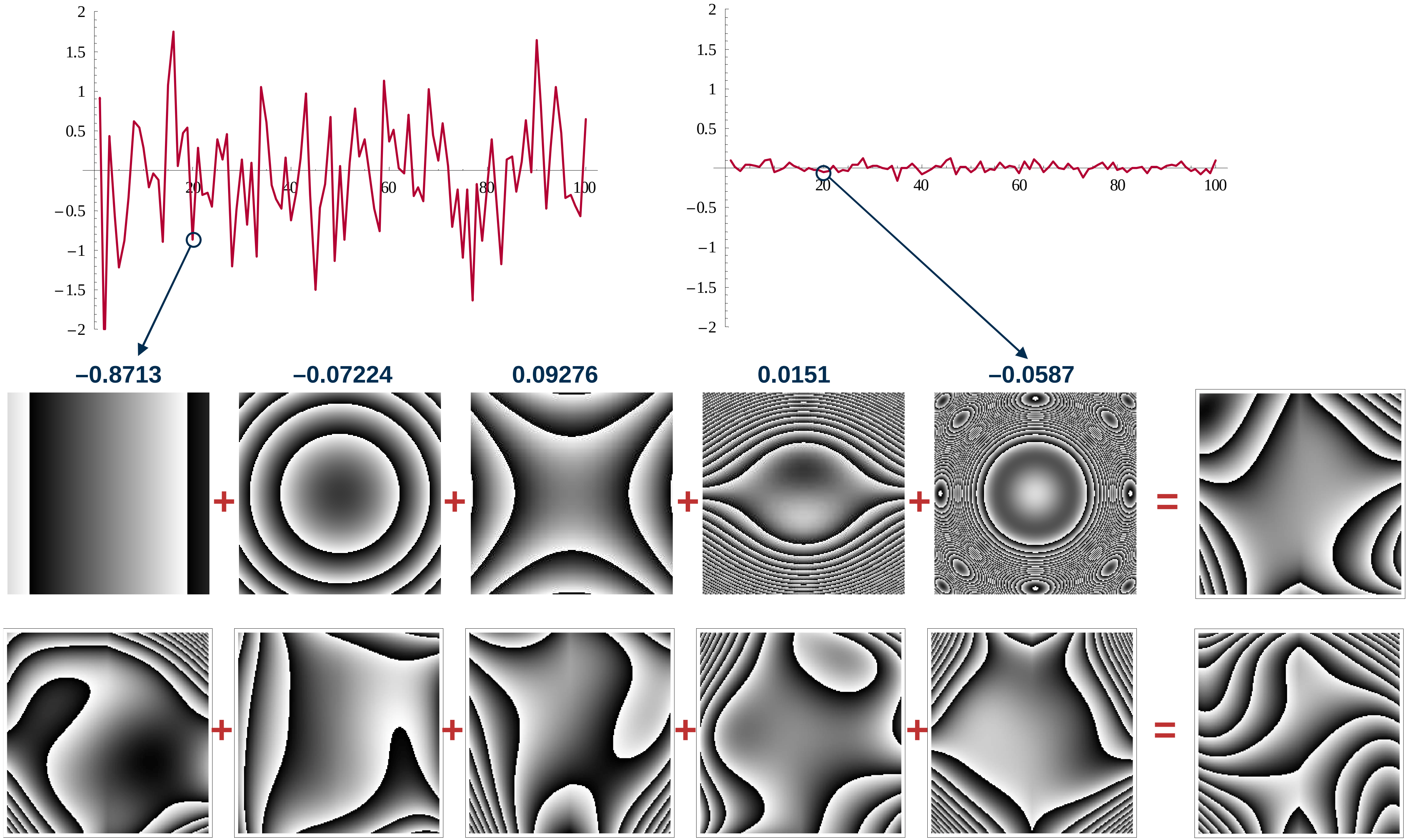
$$r_0 = 1.68 \left(C_n{}^2 L k^2 \right)^{-3/5}$$

Atmospheric propagation

How to measure turbulence

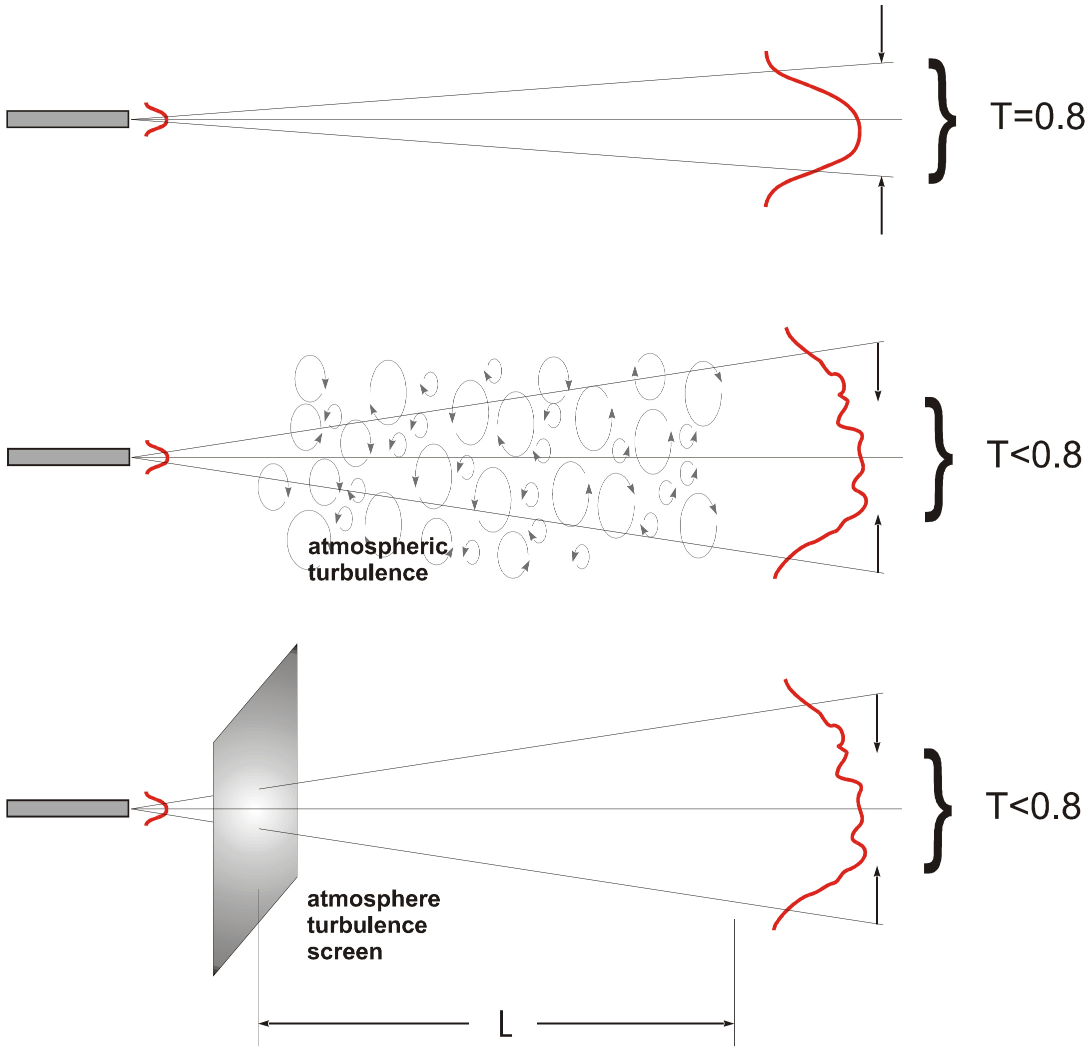
1. Decompose the turbulence model into a series of orthogonal functions (basis set).
2. Construct a series of pseudo–random phase screens from the basis.
3. Implement optical wavefront changes from the pseudo–random phase screens.
4. Propagate the resulting beam to the far field and measure ….

Phase screen construction



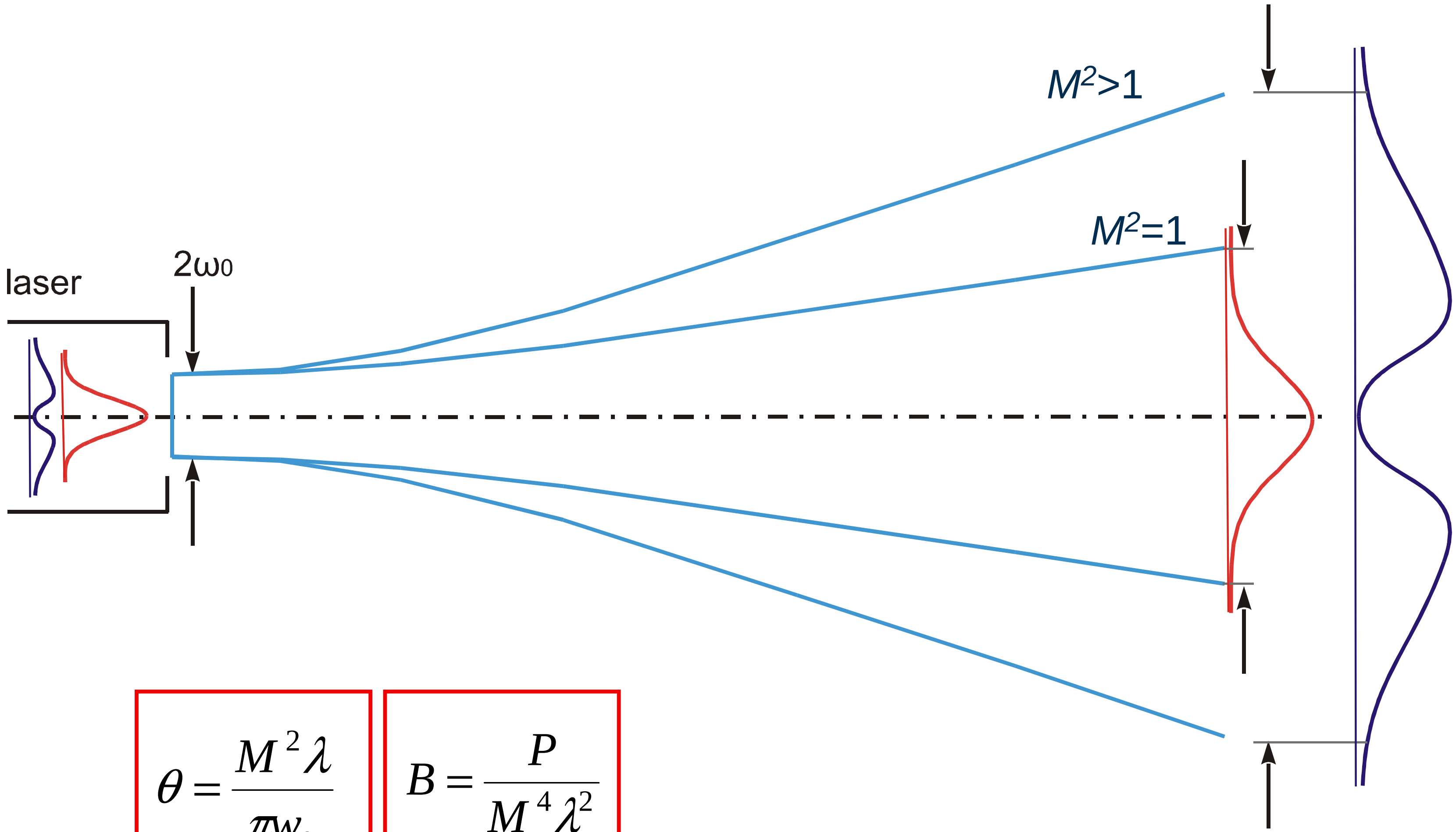
Atmospheric propagation

Transmission through turbulence



Atmospheric propagation

*M*² considerations



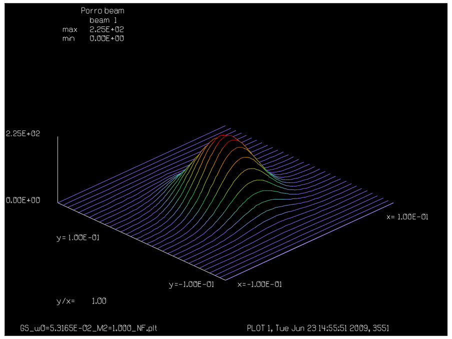
$$\theta = \frac{M^2 \lambda}{\pi w_0}$$

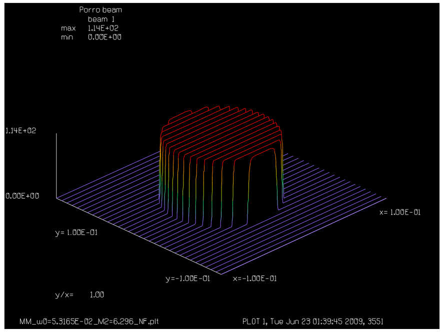
$$B = \frac{P}{M^4 \lambda^2}$$

Proc. of SPIE **6290**, 62900M-1 - 8, 2006

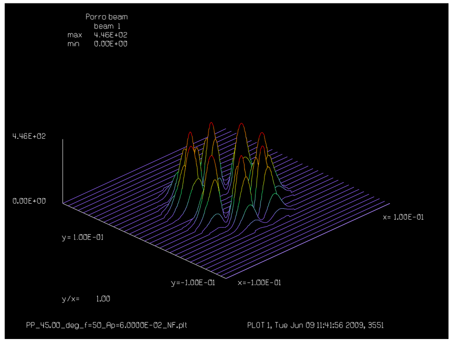
Atmospheric propagation

80% radius



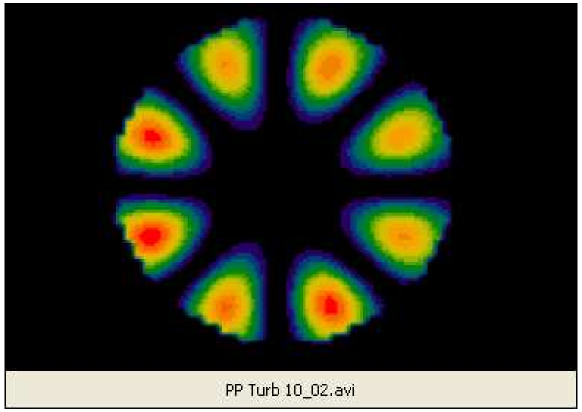


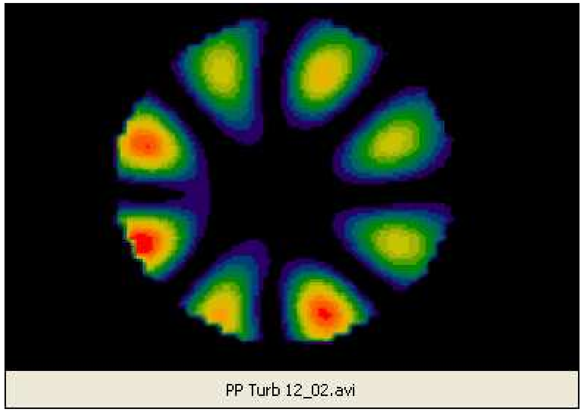
	w_0 (mm)	M^2	r_{80} (cm)
Gaussian	0.53	1	578
Multimode	0.53	6.3	911
Porro petal beam	0.53	6.3	2614

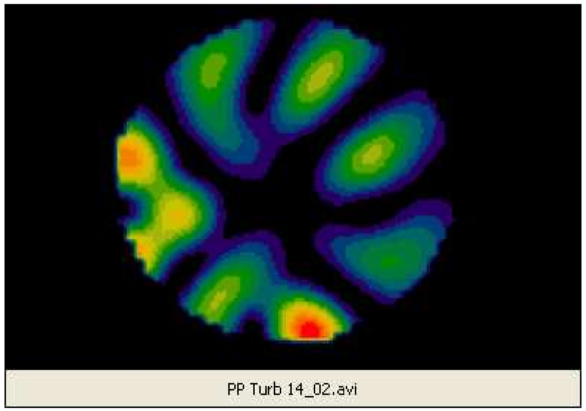


Atmospheric propagation

Results

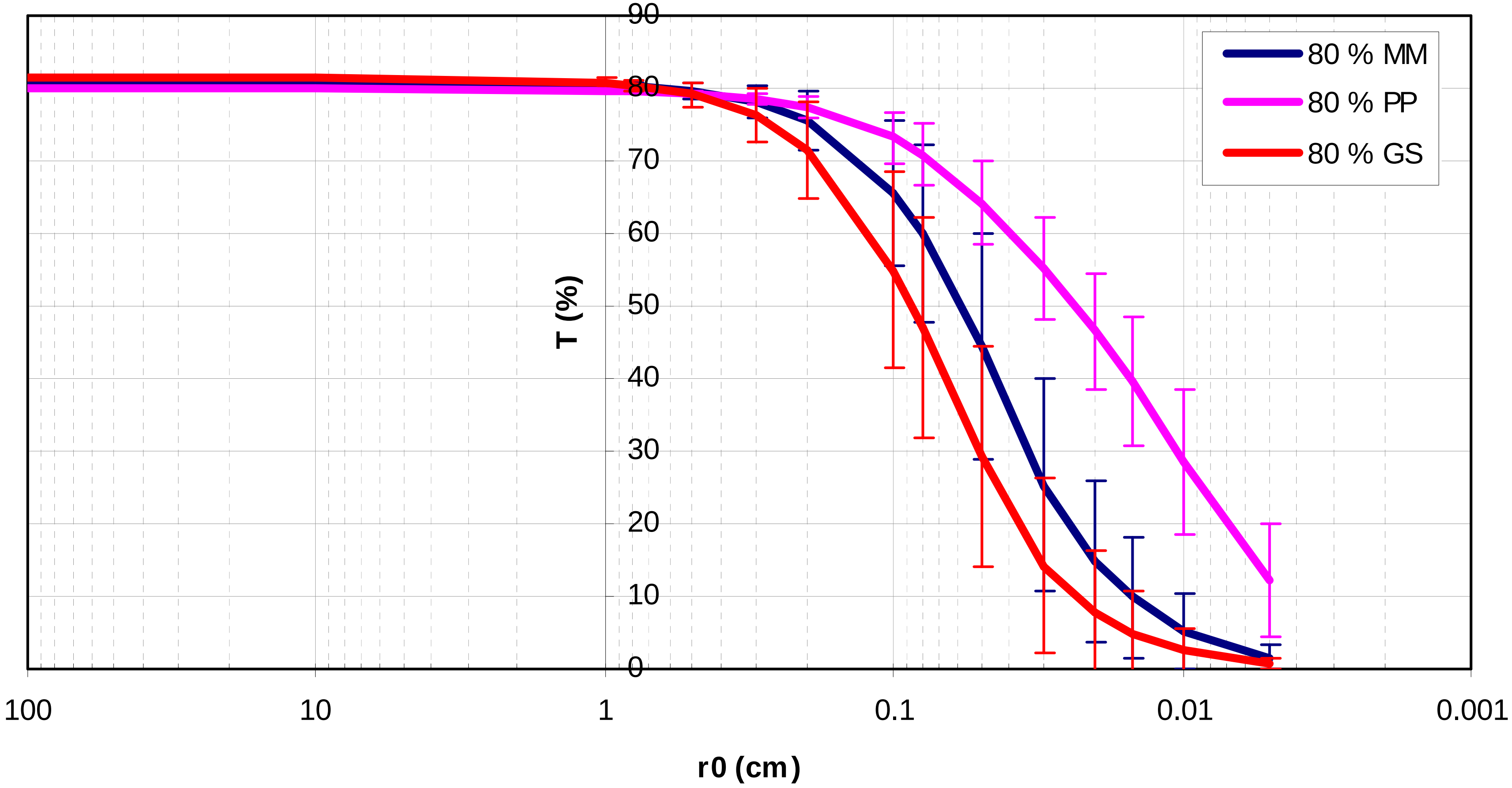






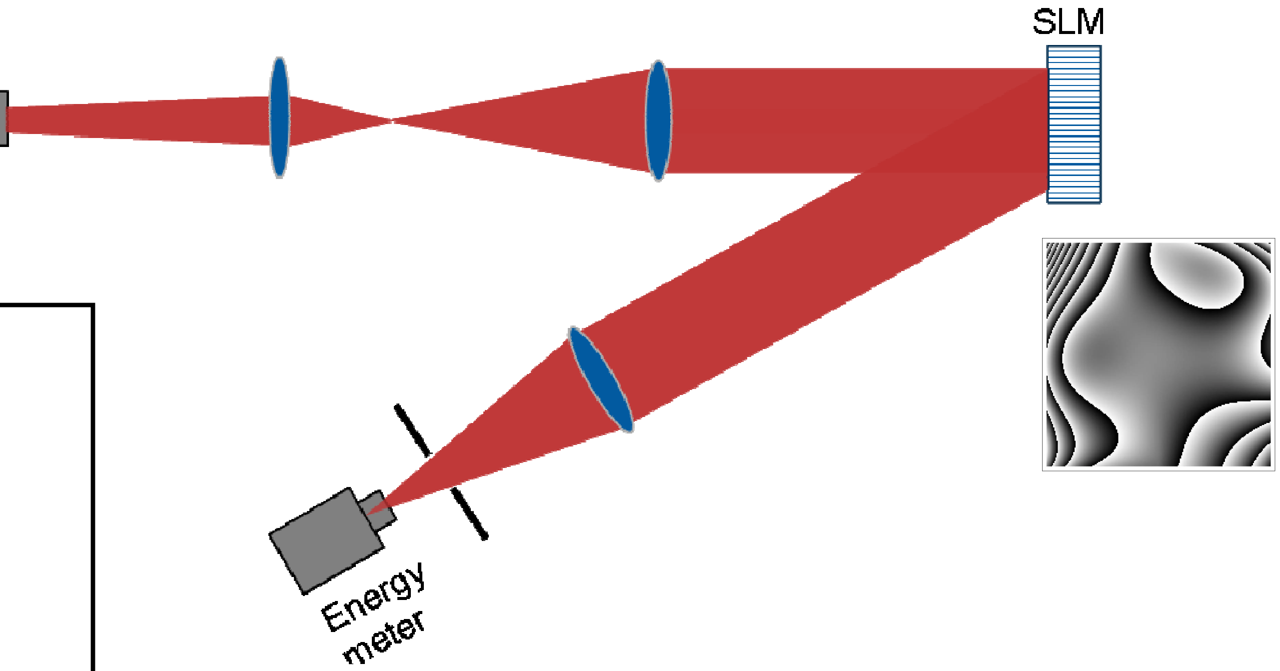
Atmospheric propagation

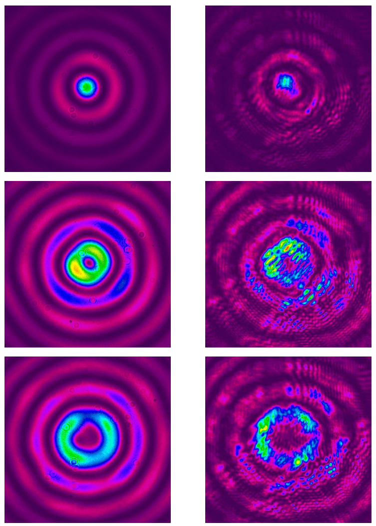
Results



Atmospheric propagation

Laboratory experiment using an SLM





Laboratory experiment using a turbulence phase screen

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