Wave aberrations in a spinning pipe gas lens

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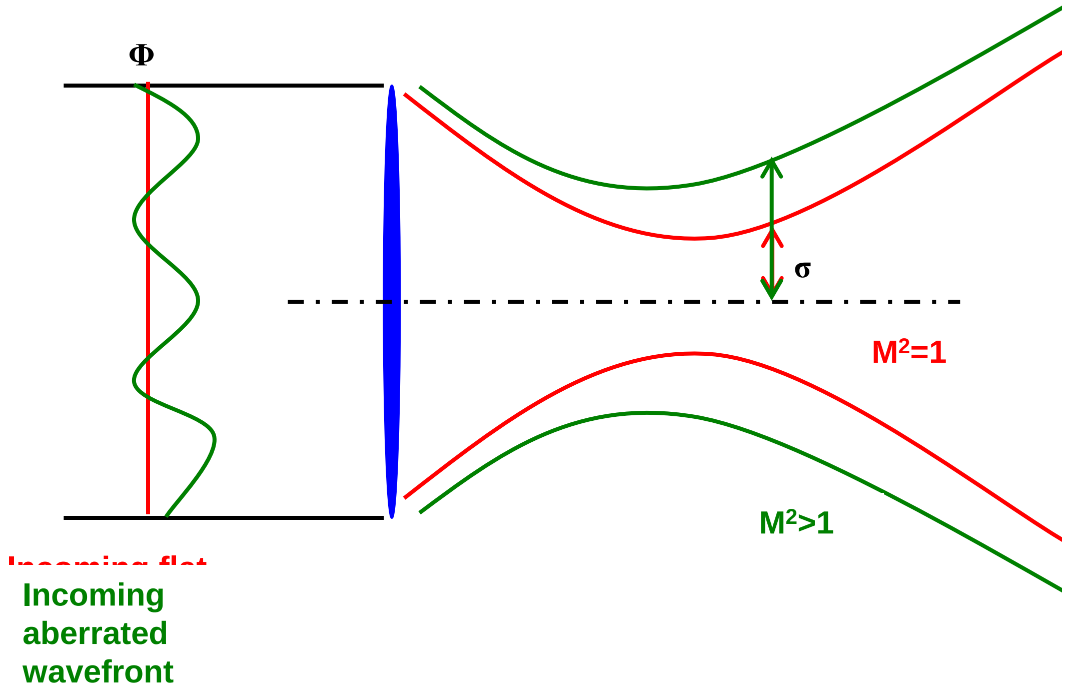
Aberrations and M^2



Shack–Hartmann wavefront sensor

- Model CLAS 2D
- Properties
  - 248 nm – 1100 nm
  - CW or pulsed
  - 69 x 69 microlenses
  - 7.4 mm x 7.4 mm array
- Outputs
  - M^2, ω_0, z_0, θ_0
  - Zernike coefficients
  - Phase map
  - Intensity map
  - Fringe/vector

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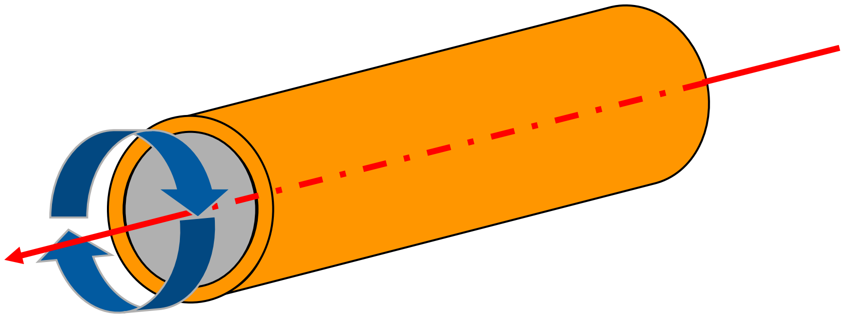
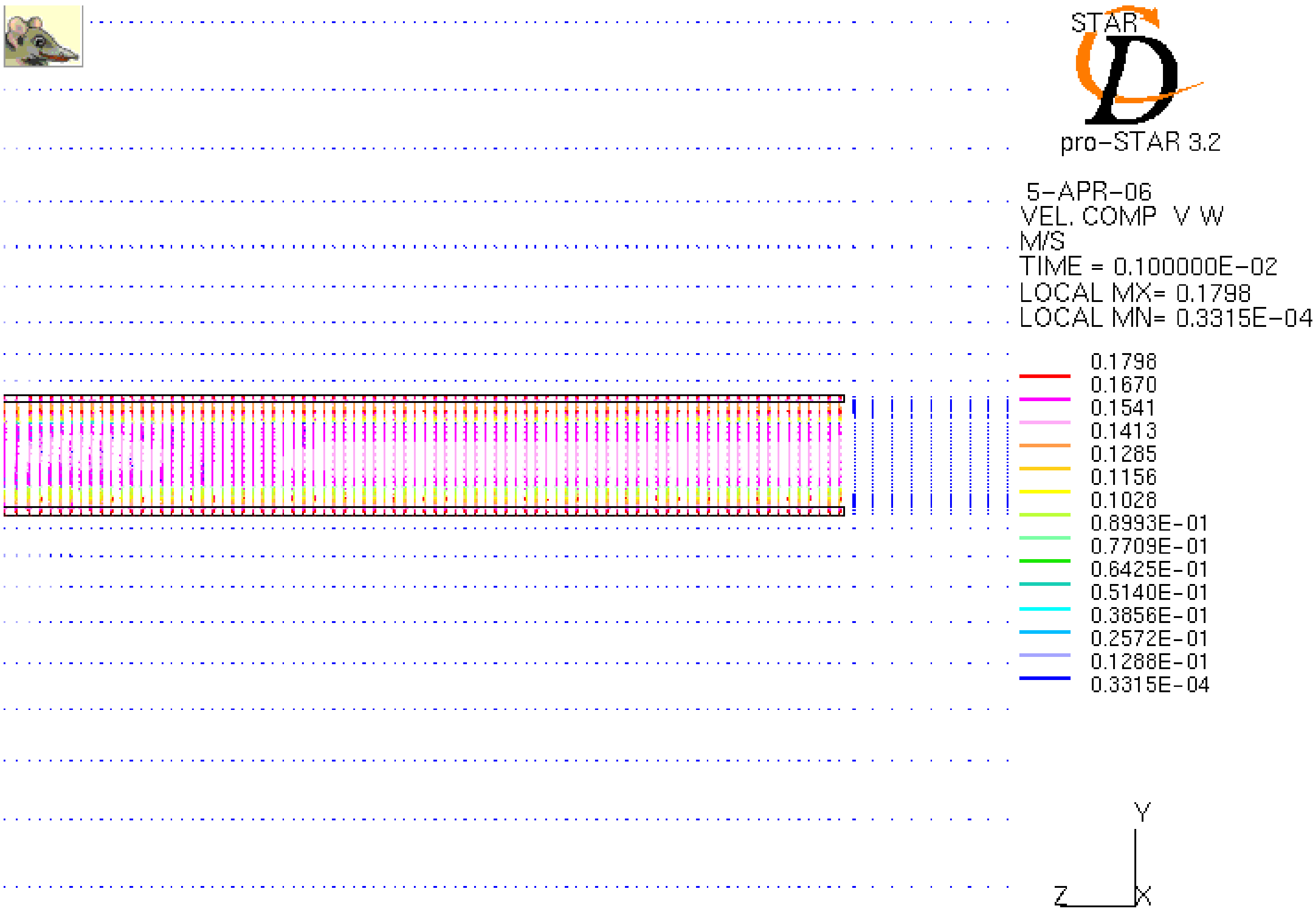
Spinning Pipe Gas Lens (SPGL)



- An non-isolated steel pipe with heated walls and then rotated along its axis
- Viscosity of air increases with temperature which determines the boundary layer thickness
- 4 types of flow
  - 2D crescent flow (natural convection)
  - 2D oscillatory flow (forced convection)
  - 2D multicellular flow (forced convection)
  - 3D spiral flow (forced convection)
- 3D spiral flow is responsible for the air exchanges which are responsible for the graded density distribution

CFD Models – velocity vectors



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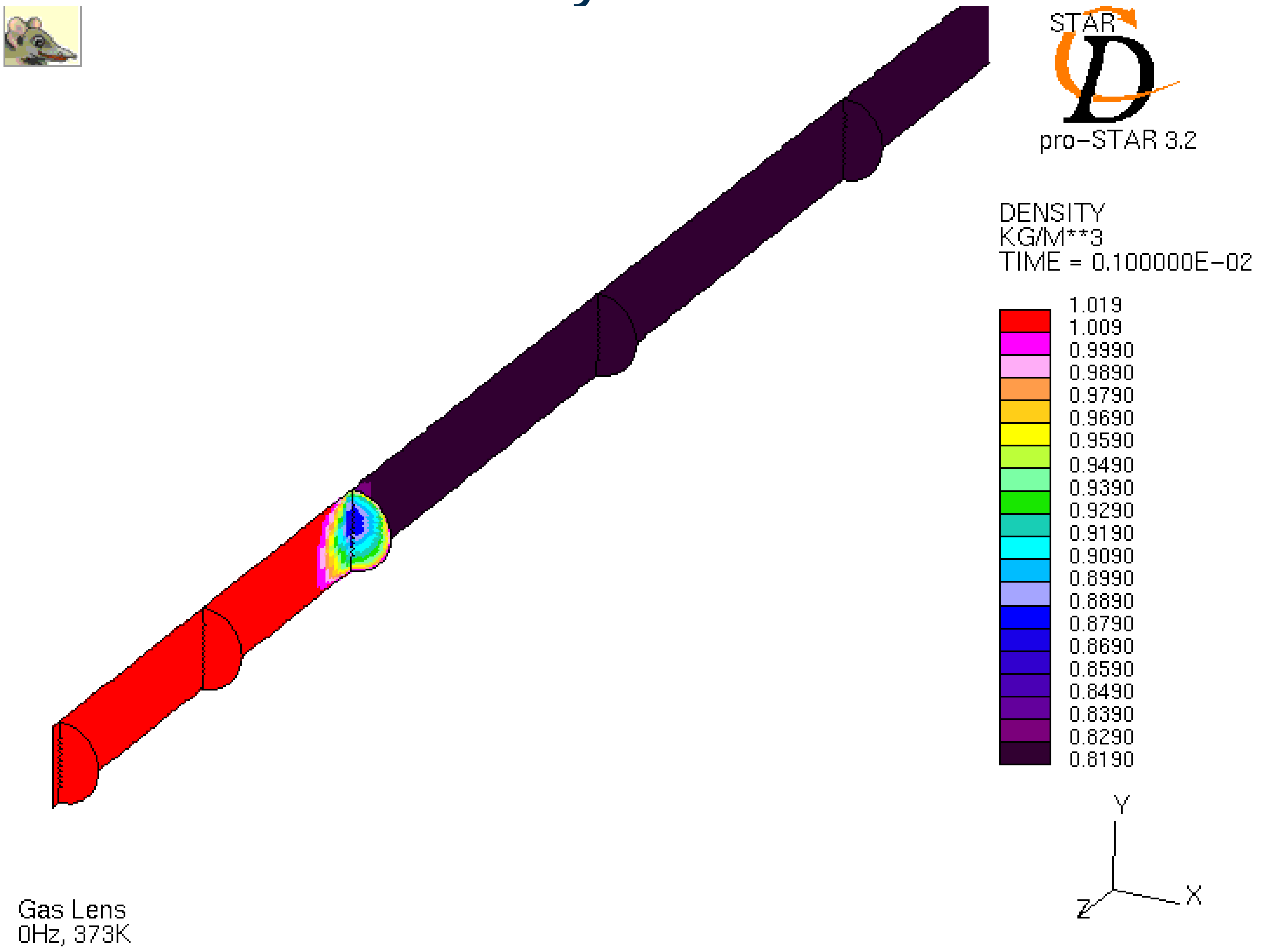
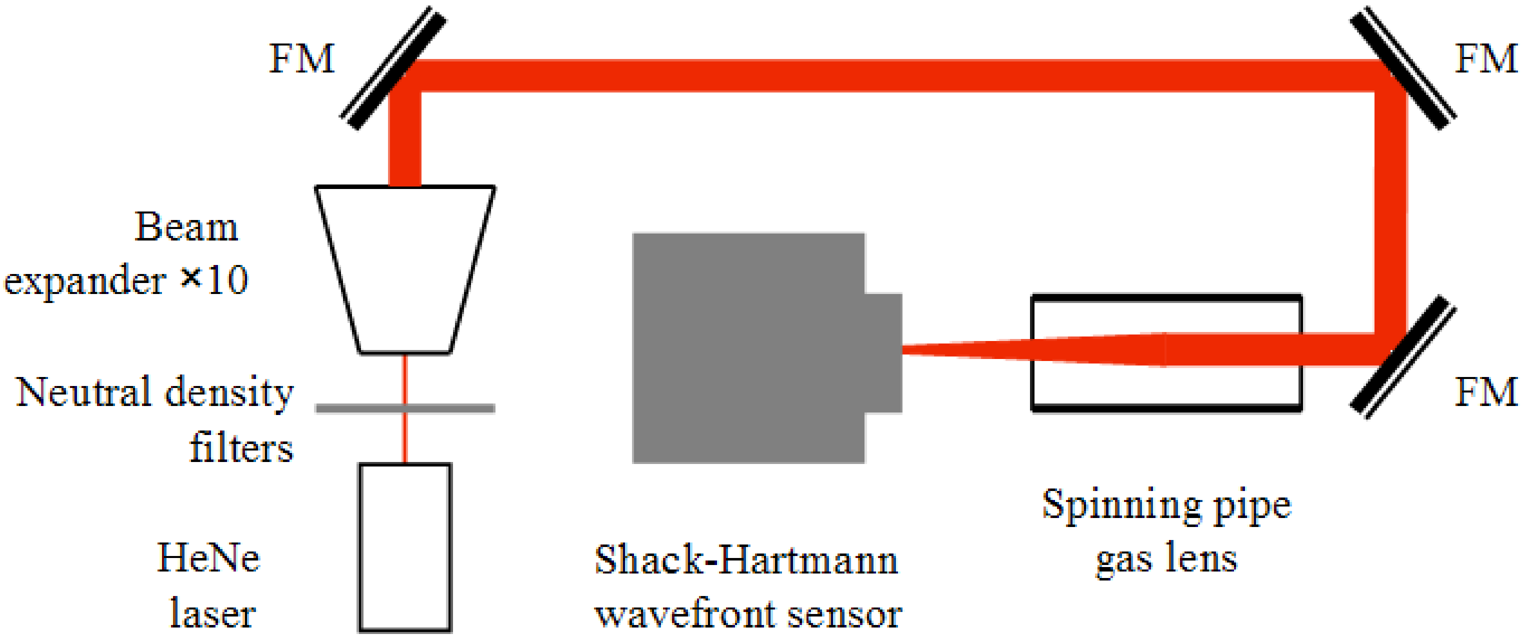
CFD Model - density

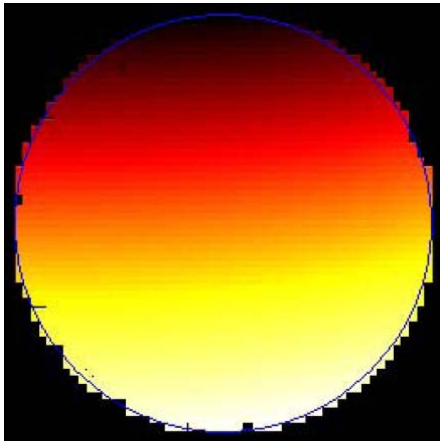


Experimental set-up

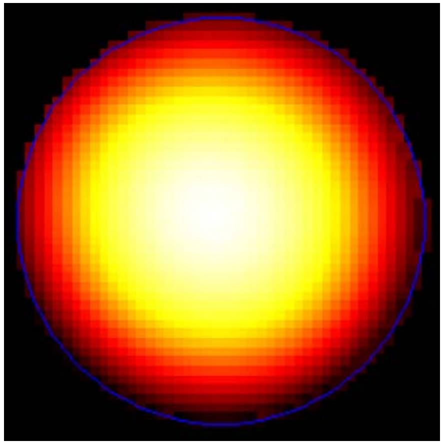


Phase

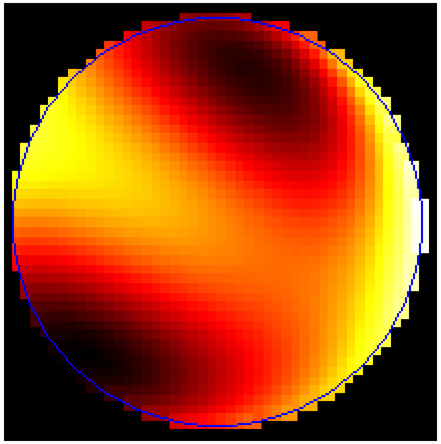
Heated but stationary- y-tilt dominant

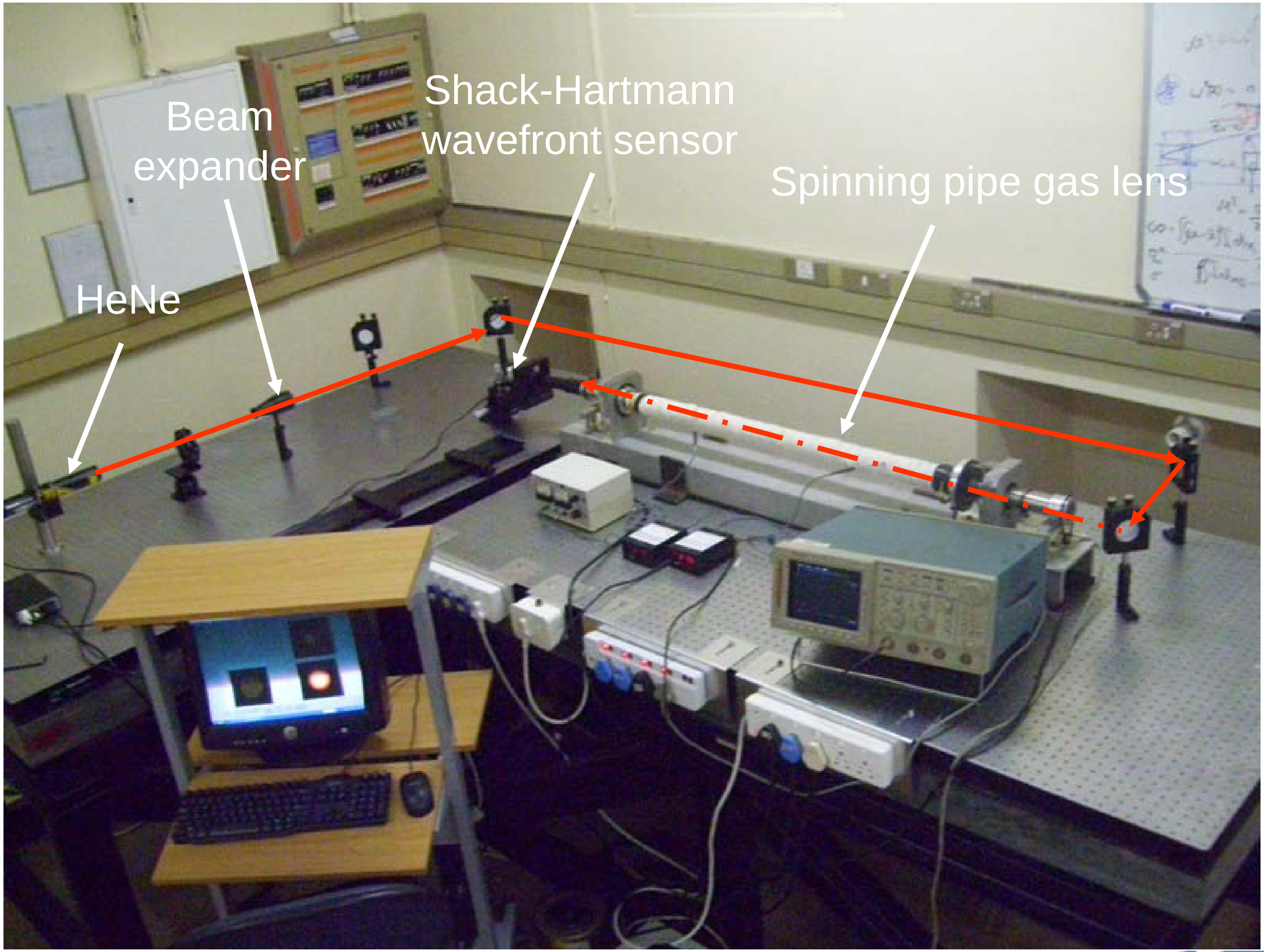


Steady state rotation- defocus dominant

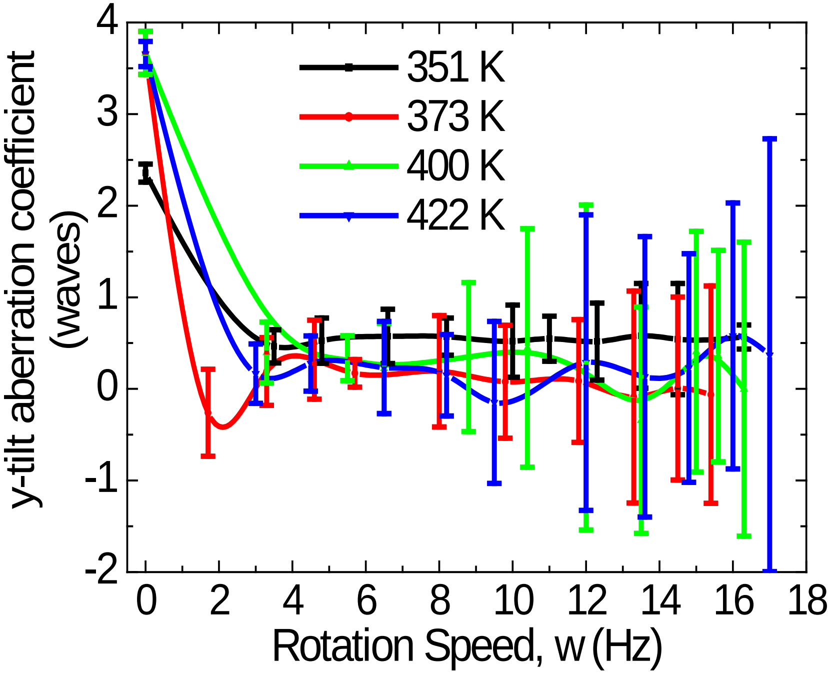


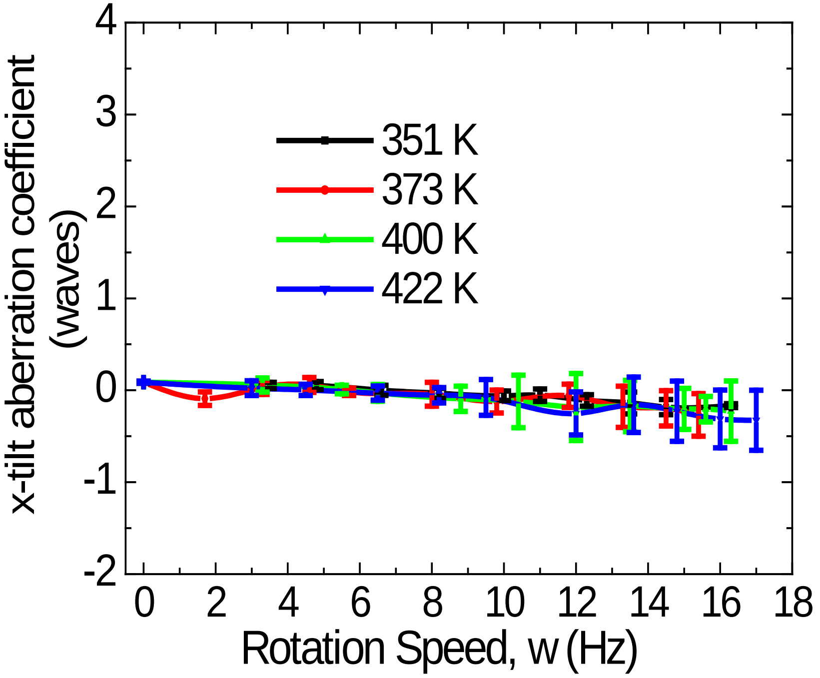
Phase minus defocus + tilt




Beam
expander
Shack-Hartmann
wavefront sensor
Spinning pipe gas lens
HeNe

Tilt





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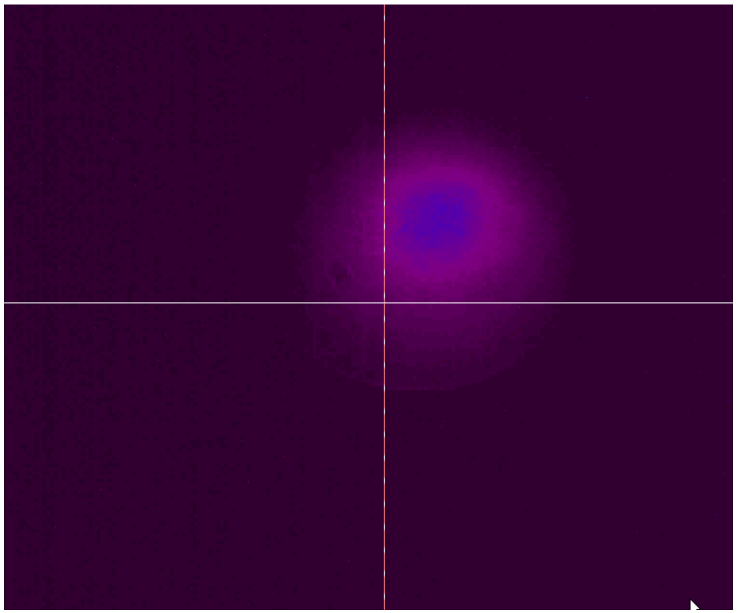
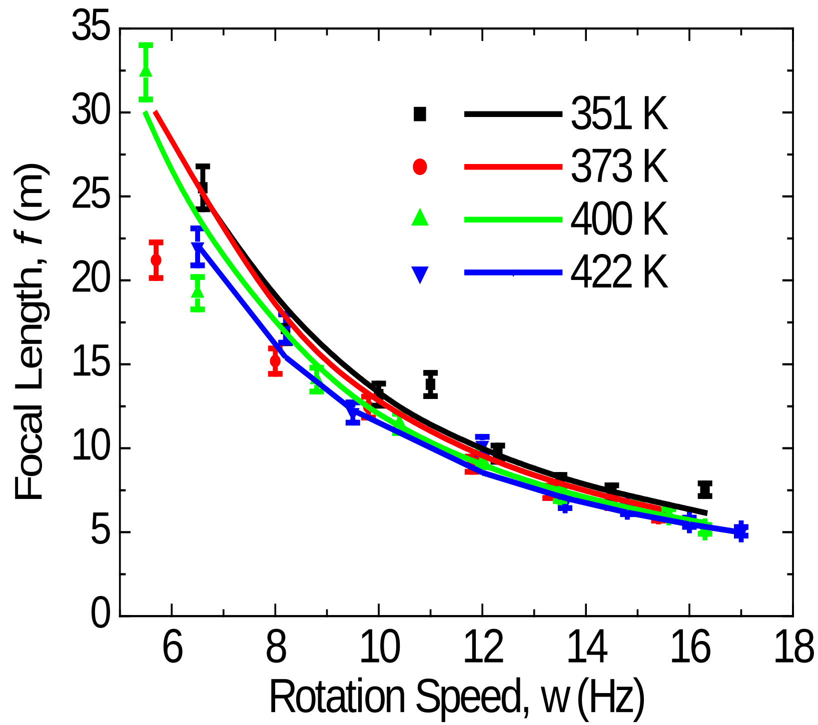
Lensing





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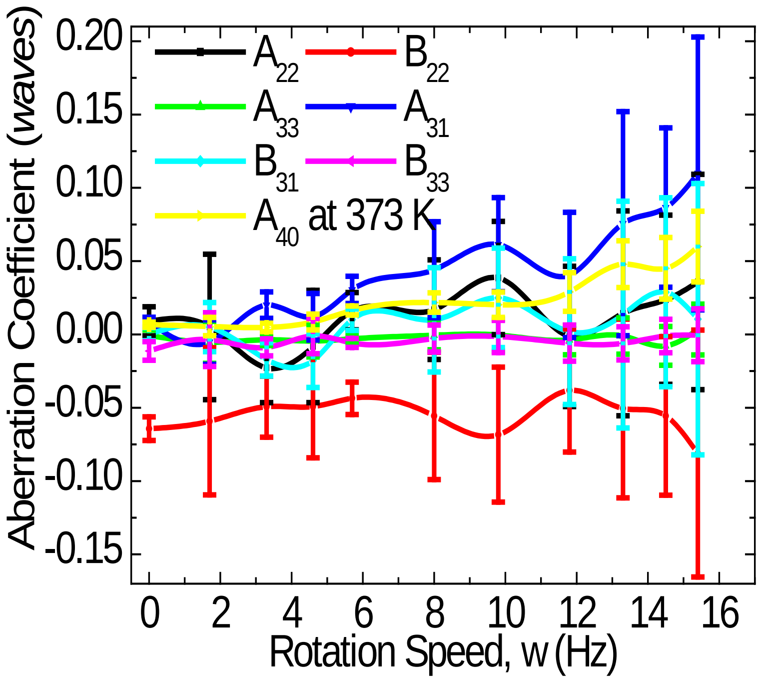
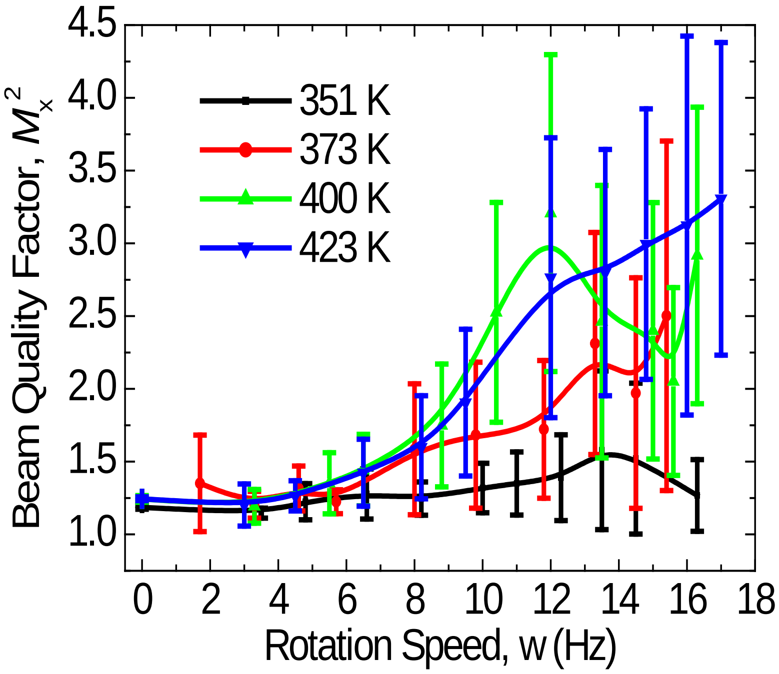
Aberrations and M²



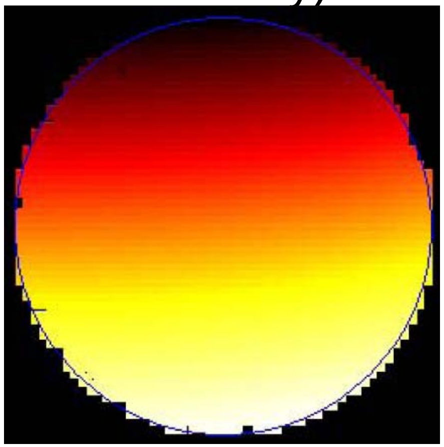


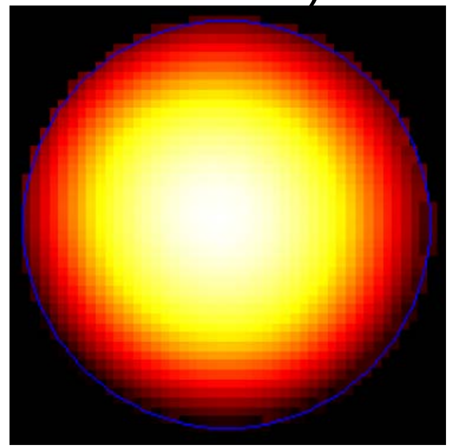
Model and experiment

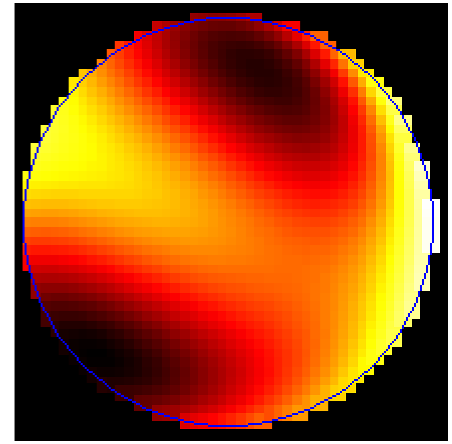
Tilt (heated but stationary)

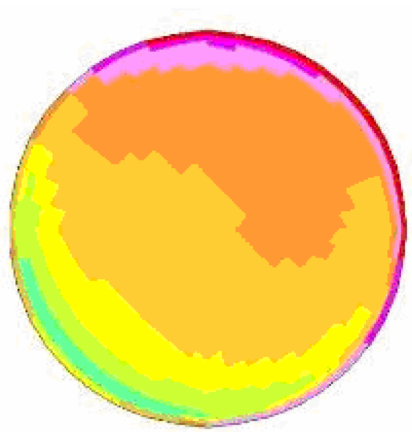
Defocus (steady state rotation)

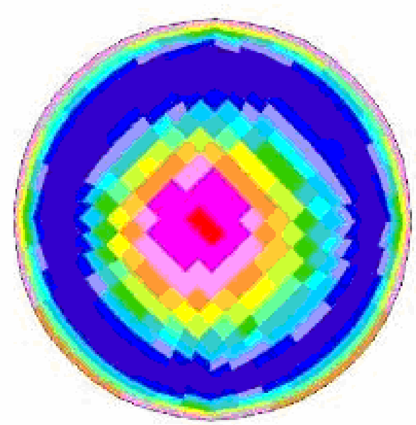
Phase minus defocus + tilt











C. Mafusire *et al*. Optics Express **16**(13), pp. 9850–9856 (2008).

Future work

- Higher order aberrations leads to loss of beam quality which means we can improve M^2 by eliminating aberrations
- Measurement of changes to M^2 caused by selected amounts of specific aberrations
- Presently-available option – Phase only SLM with no real time
- Ideal solution – adaptive optics methods

Thank You

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