CFD MODEL OF A SPINNING PIPE GAS LENS

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SAIP

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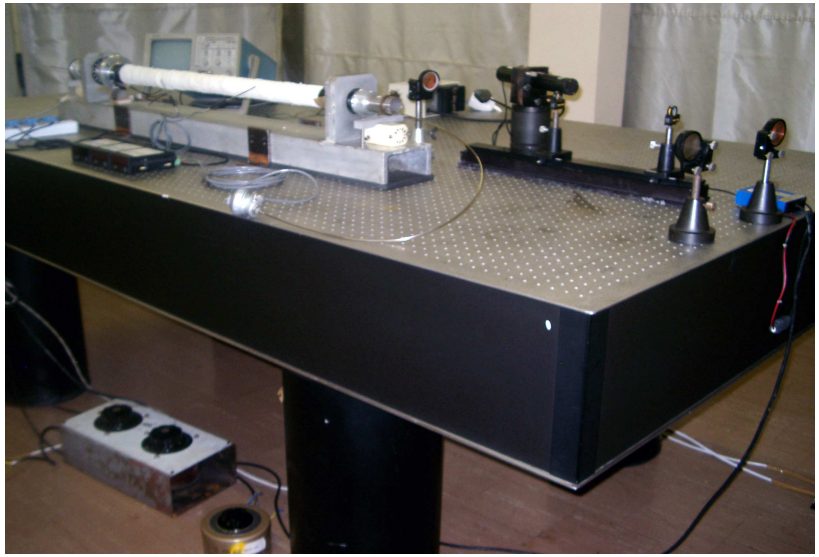
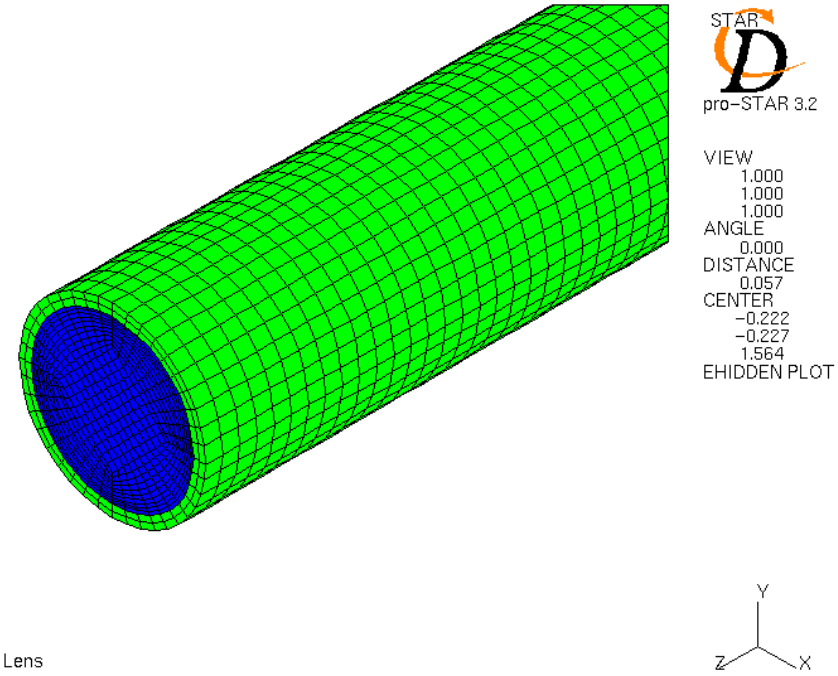
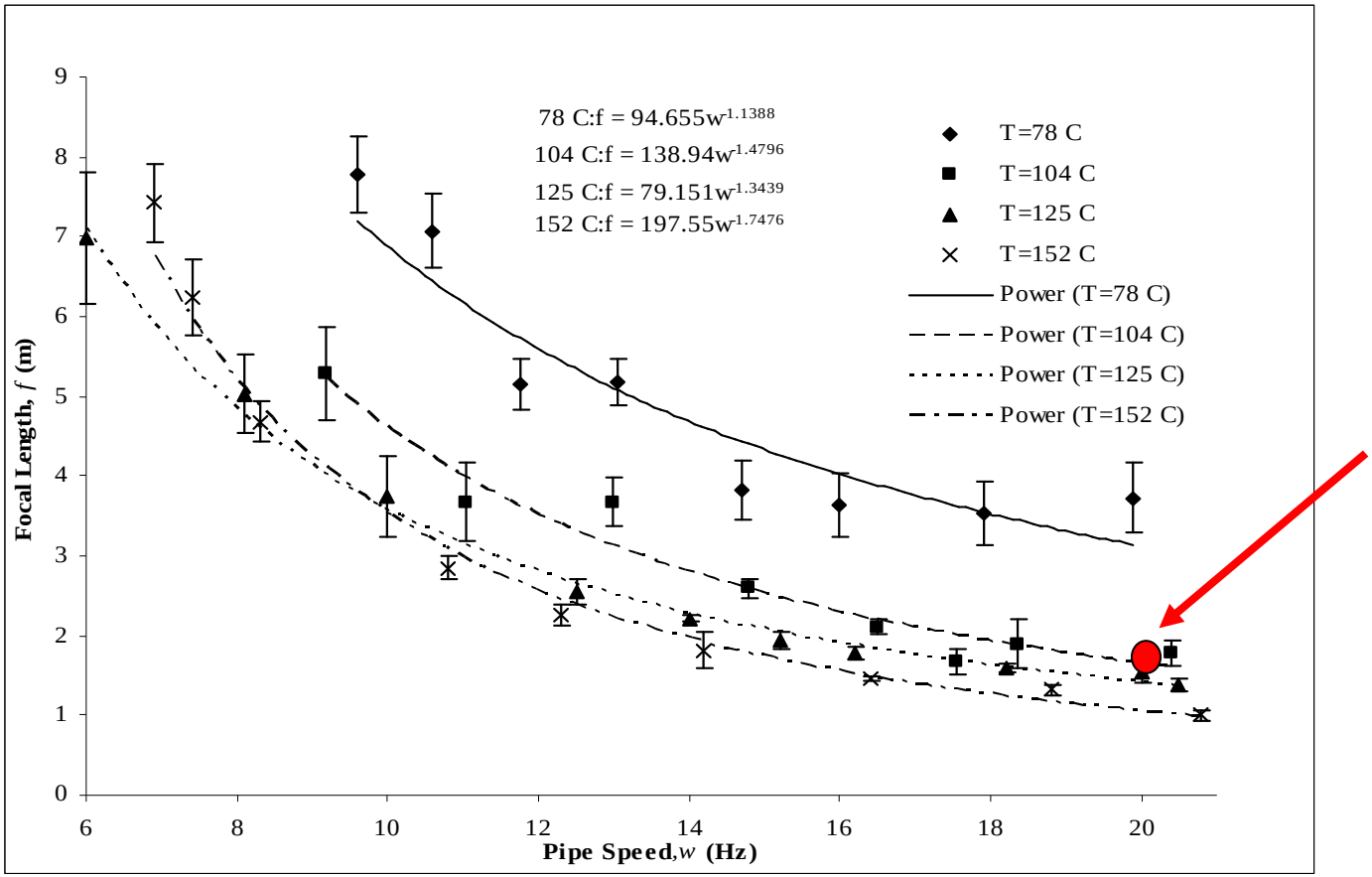
Spinning Pipe Gas Lens



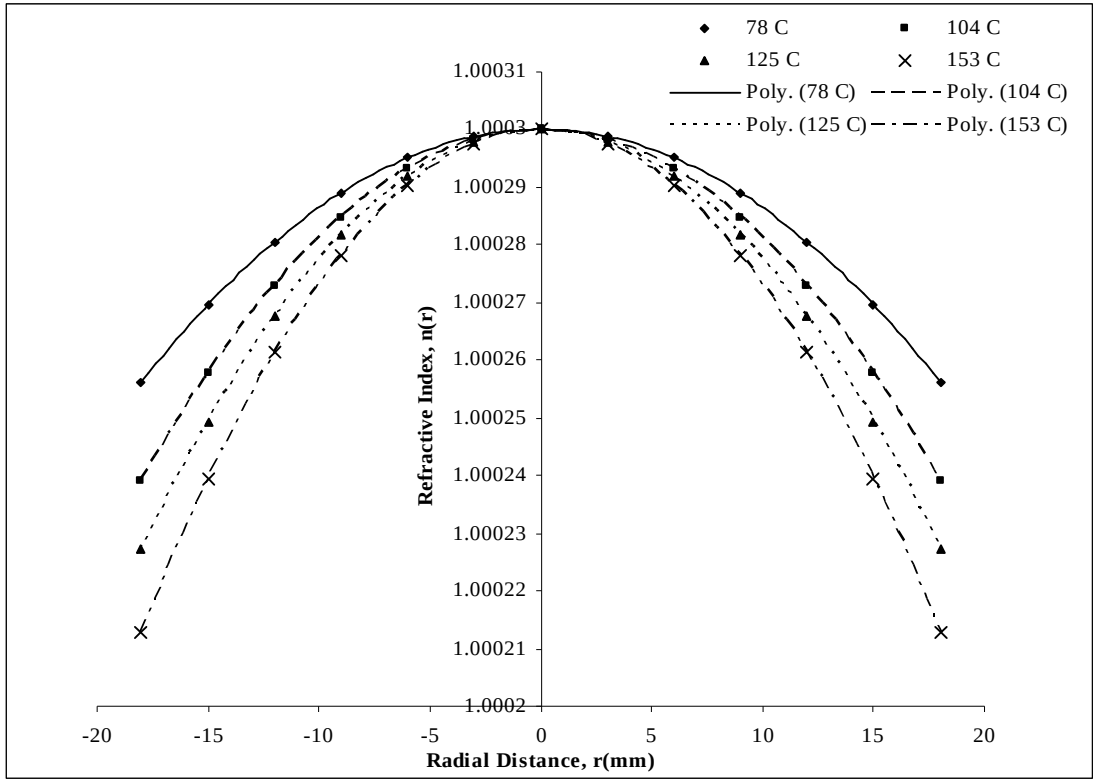


Gas Lens

Focal Length

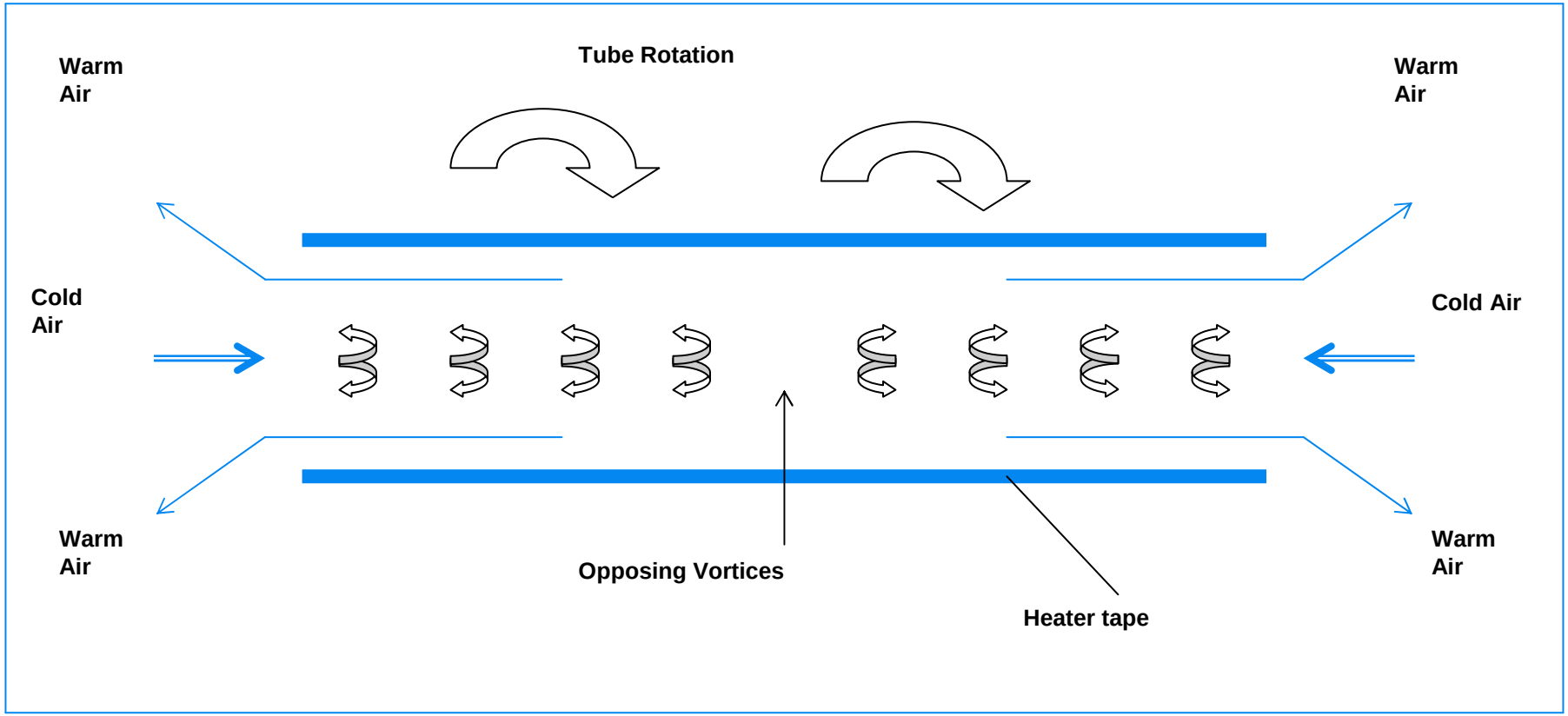


Refractive Index

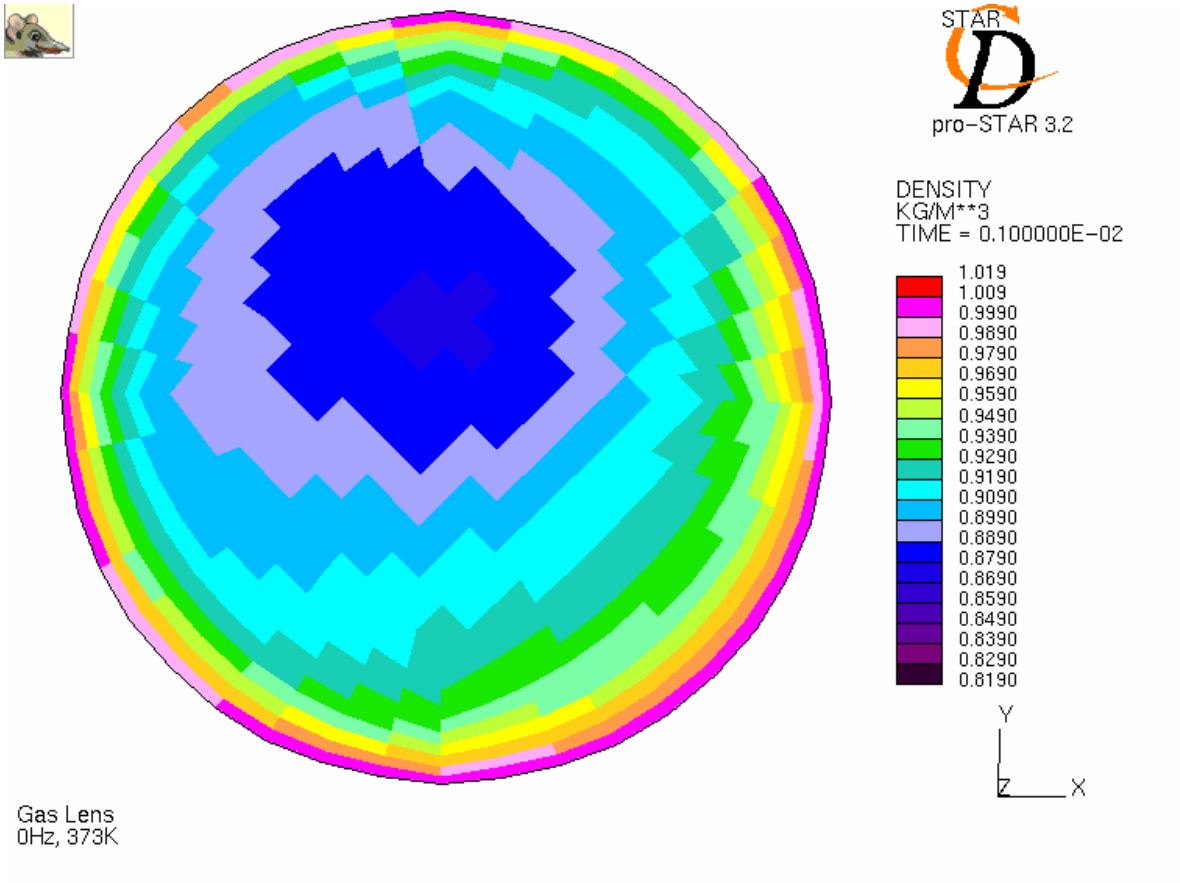


Gas Dynamics

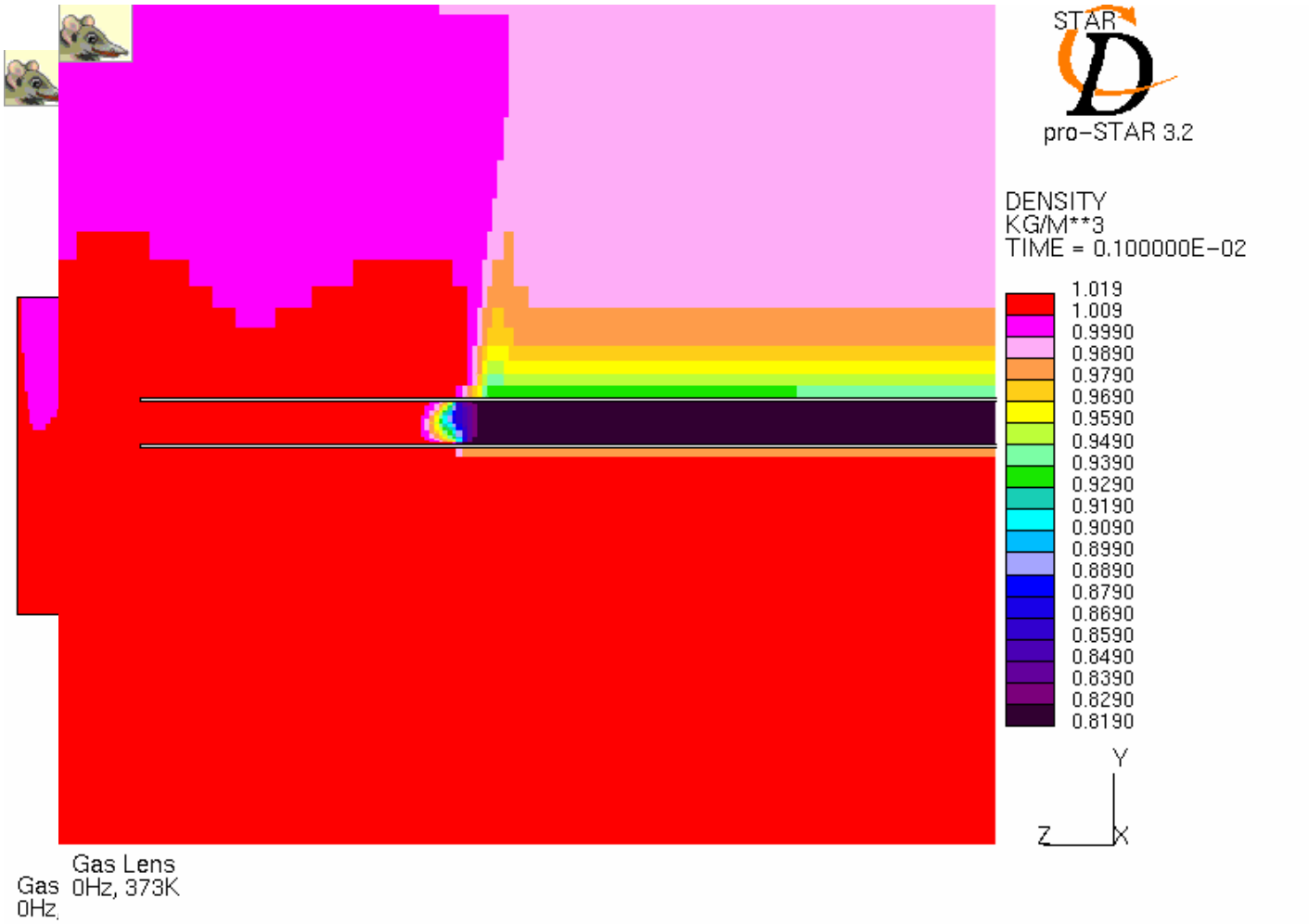
Guess at the gas dynamics



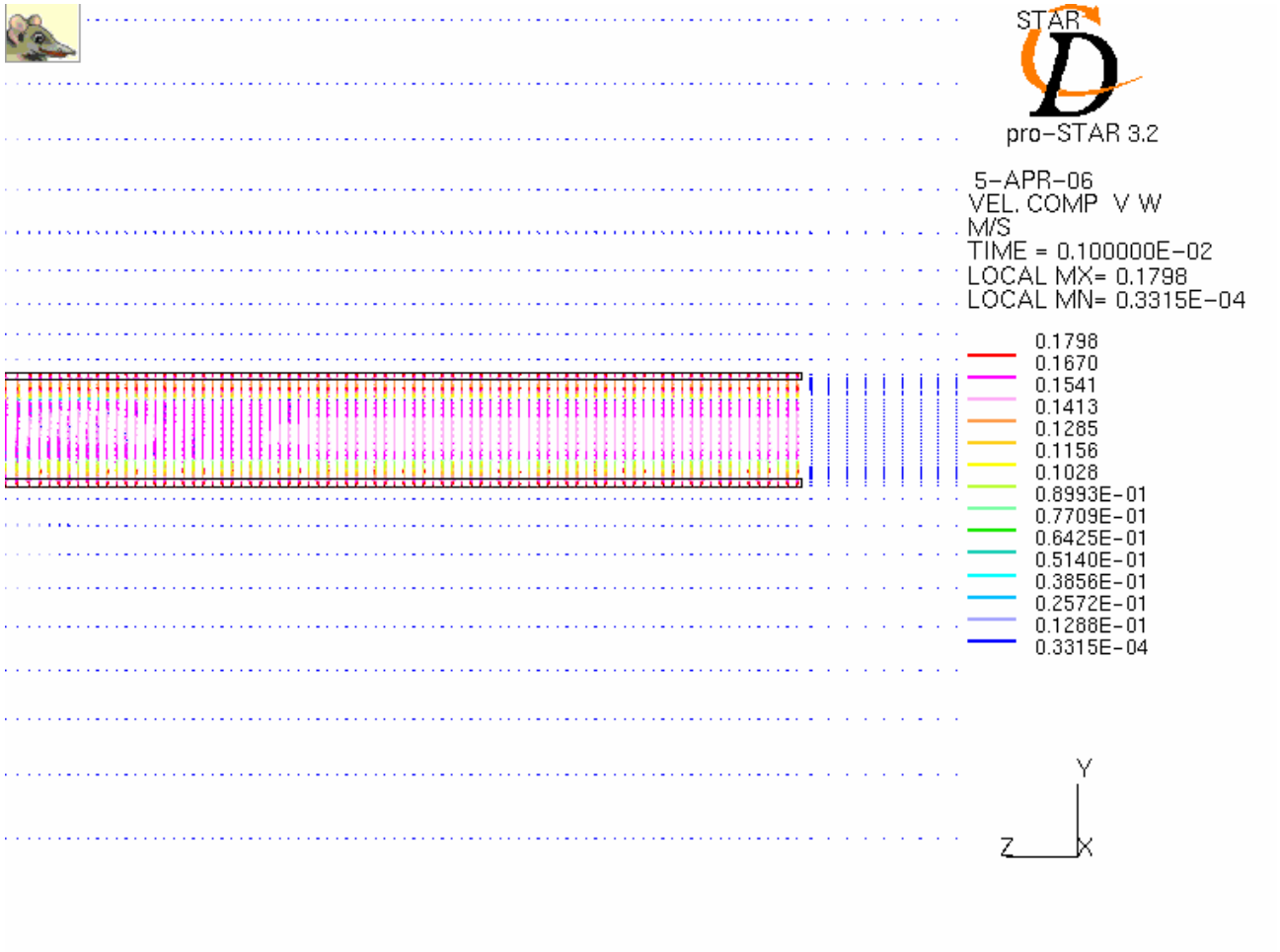
Density Profile



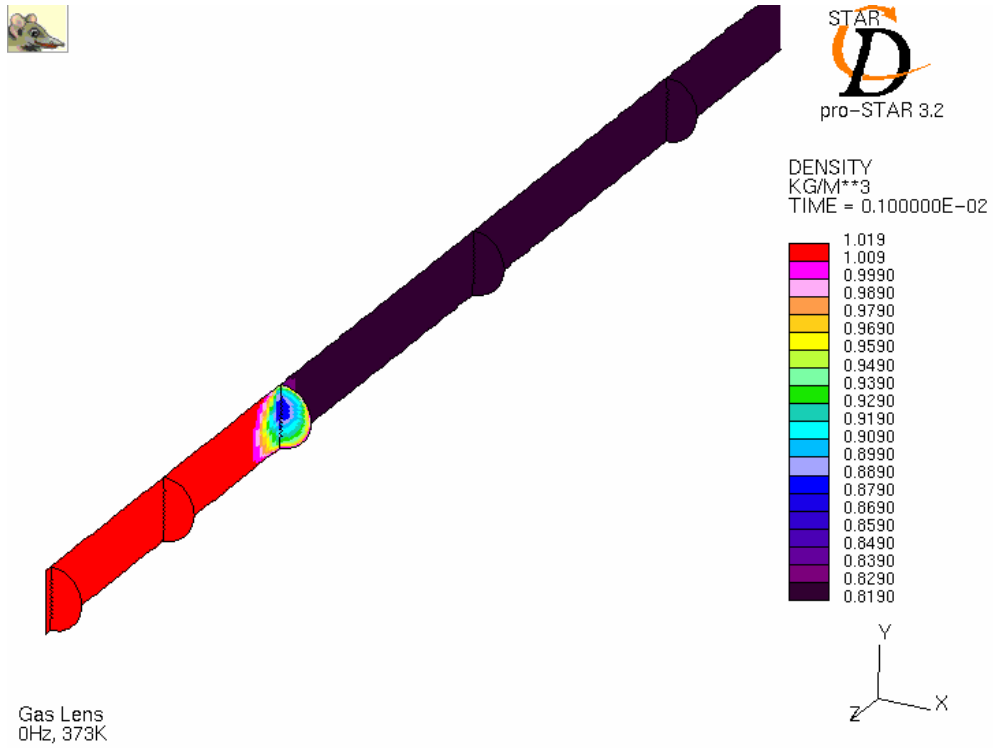
Density Profile



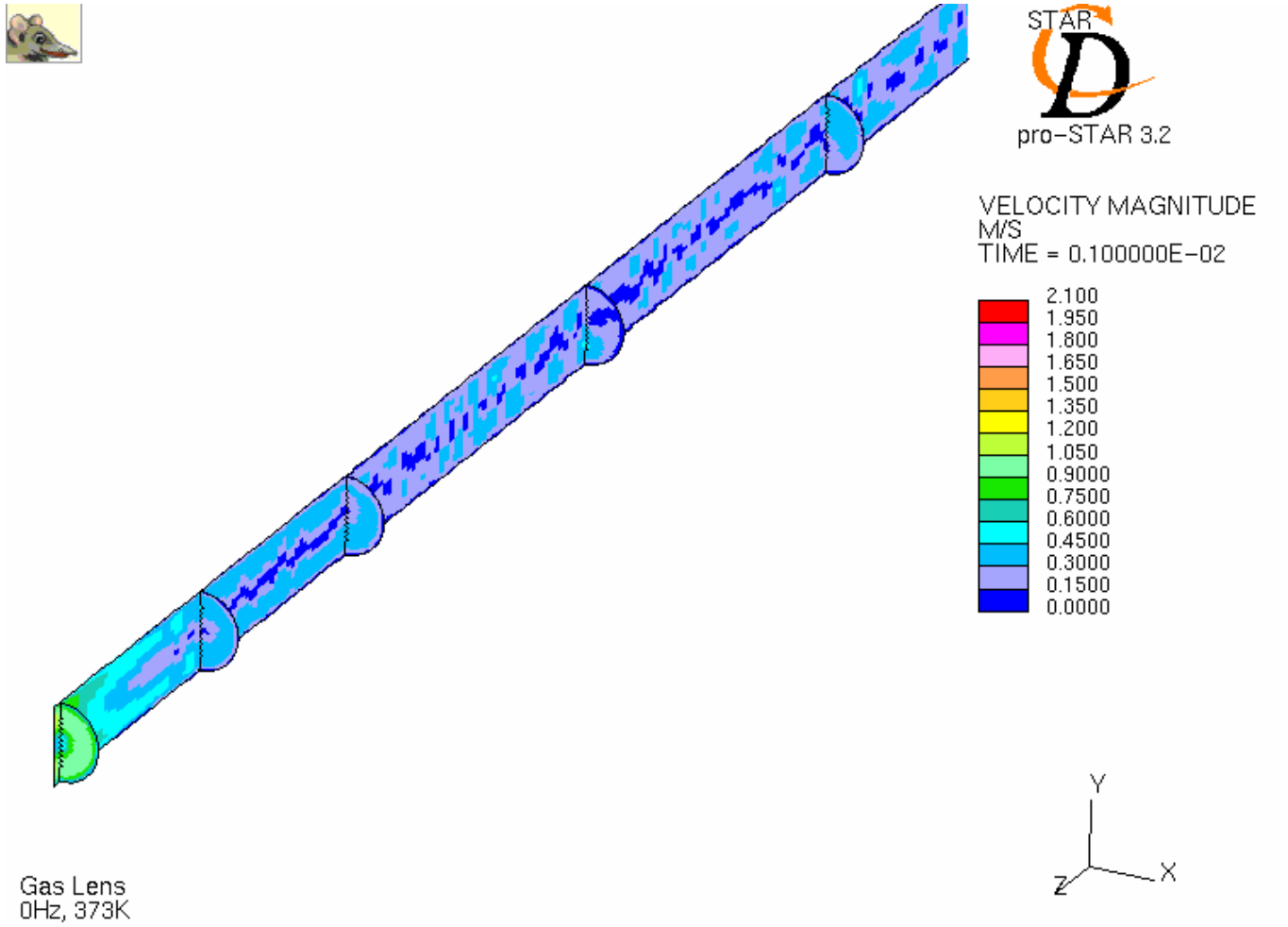
Flow Profile



Rosby Waves

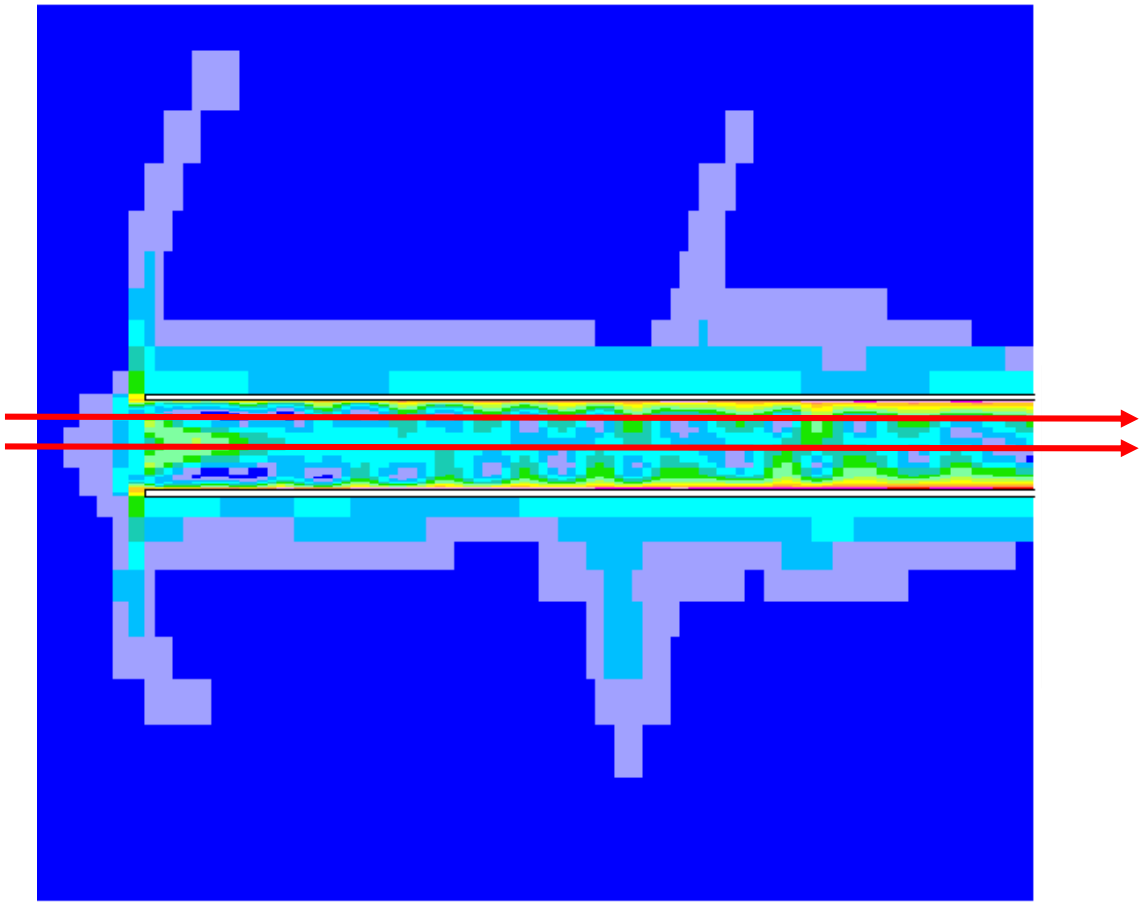


Rayleigh–Taylor Instabilities



Future Work

Instabilities near the boundary



Wavefront Measurement & Control

$$\Phi(\rho,\theta) = \sum_{n=0}^{\infty}\sum_{m=0}^{n}[A_n^m U_n^m(\rho,\theta) + B_n^m V_n^m(\rho,\theta)]$$

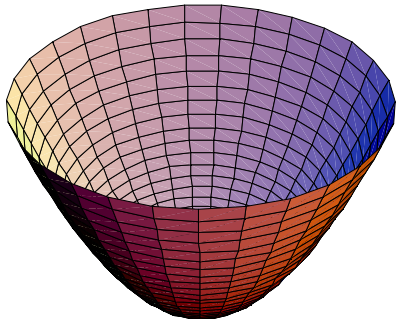
$$R_n^m(\rho) = \sum_{k=0}^{\frac{n-m}{2}} \frac{(-1)^k (n-k)!}{k!\left(\frac{n+m}{2}-k\right)!\left(\frac{n-m}{2}-k\right)!}\rho^{n-2k}$$

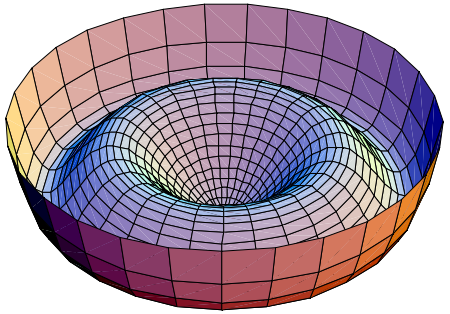
$$A_n^m = K(m)\frac{n+1}{\pi}\int_0^{2\pi}\int_0^1 \Phi(\rho,\theta)U_n^m(\rho,\theta)\rho d\rho d\theta$$

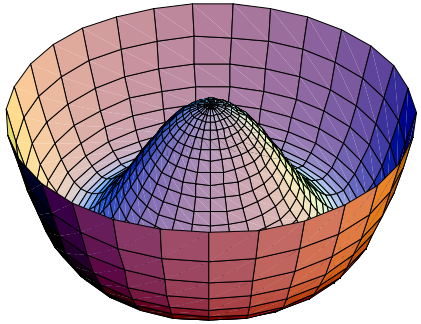
$$\sigma_{nm}^2 = N_{nm}\left(D/r_0\right)^{5/3} \qquad r_0 = \left[0.423k^2\int_{h_{min}}^{h_{max}} C_n^2(h)dh\right]^{-5/3}$$

$$N_{nm} = \frac{0.15337(-1)^{n-m}(n+1)\Gamma(14/3)\Gamma(n-5/6)}{\Gamma(17/6)^2\Gamma(n+23/6)}$$

$$\phi(\kappa) = 0.033C_n^2\kappa^{-11/3}$$

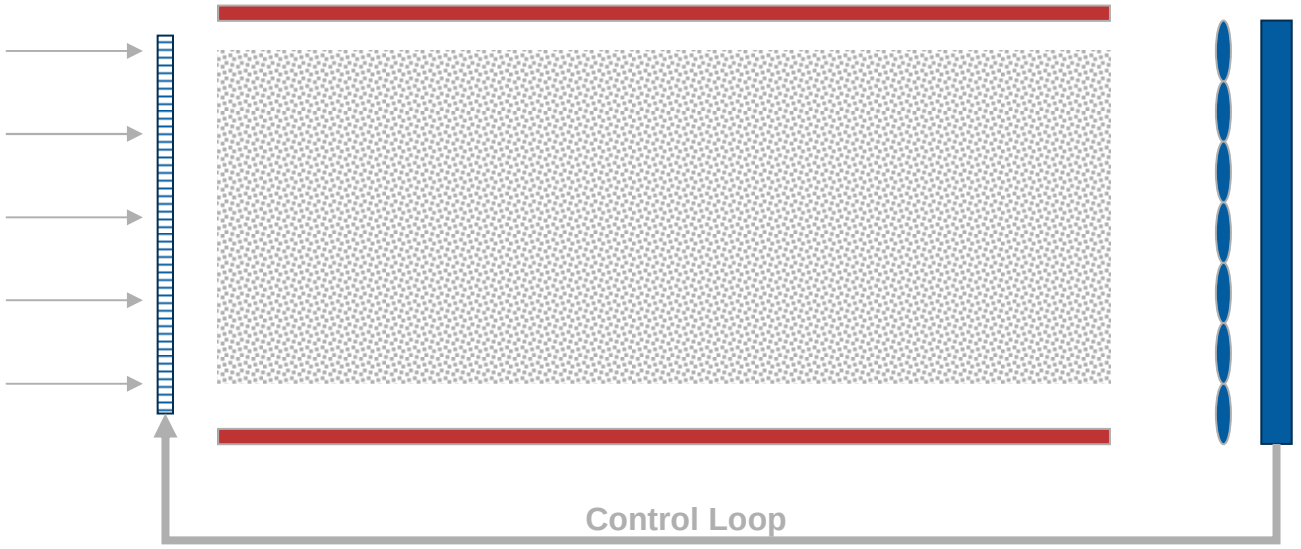






Adaptive optics for turbulence correction

- SLM acts as an adaptive optic
  - Measure wavefront distortion,
  - Feed result back into SLM to create conjugate phase,
  - Propagate conjugate phased beam through medium.



Conclusion

- CFD model of gas lens
  - Shows Rosby waves and Rayleigh–Taylor instabilities
- Propagation model in preparation
  - Full Fresnel propagation through GRIN system
- Future work
  - Adaptive optics theory and experiment

Questions