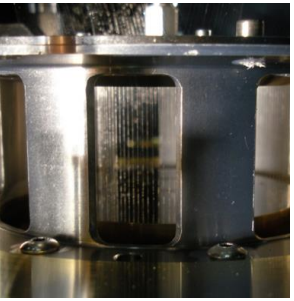

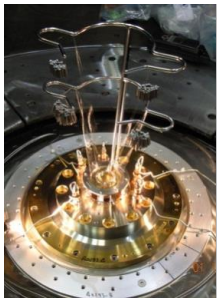

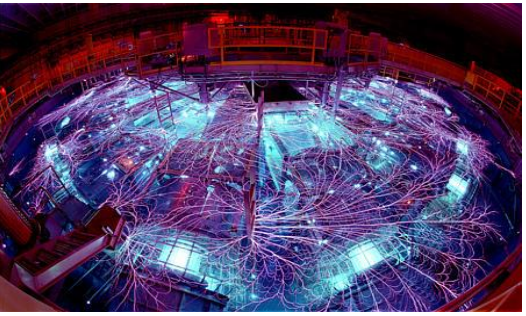

Sandia National Laboratories

Exceptional service in the national interest

11/5/2013

SAND2013-9611C

Computational Modeling of Kr Gas Puffs on Z

C. Jennings

Experimenters:
Dave Ampleford, Brent Jones, Adam Harvey-Thompson, M.E. Cuneo

SITF (gas puff assembly and characterization)
D.C.Lamppa, M. Jobe

Gas Puff Z integration
M. Jones, D. Johnson, T. Strizic

Radiation Physics
S. B. Hansen

Alameda Applied Sciences (Gas Puff)
M. Krishnan, P.L. Coleman

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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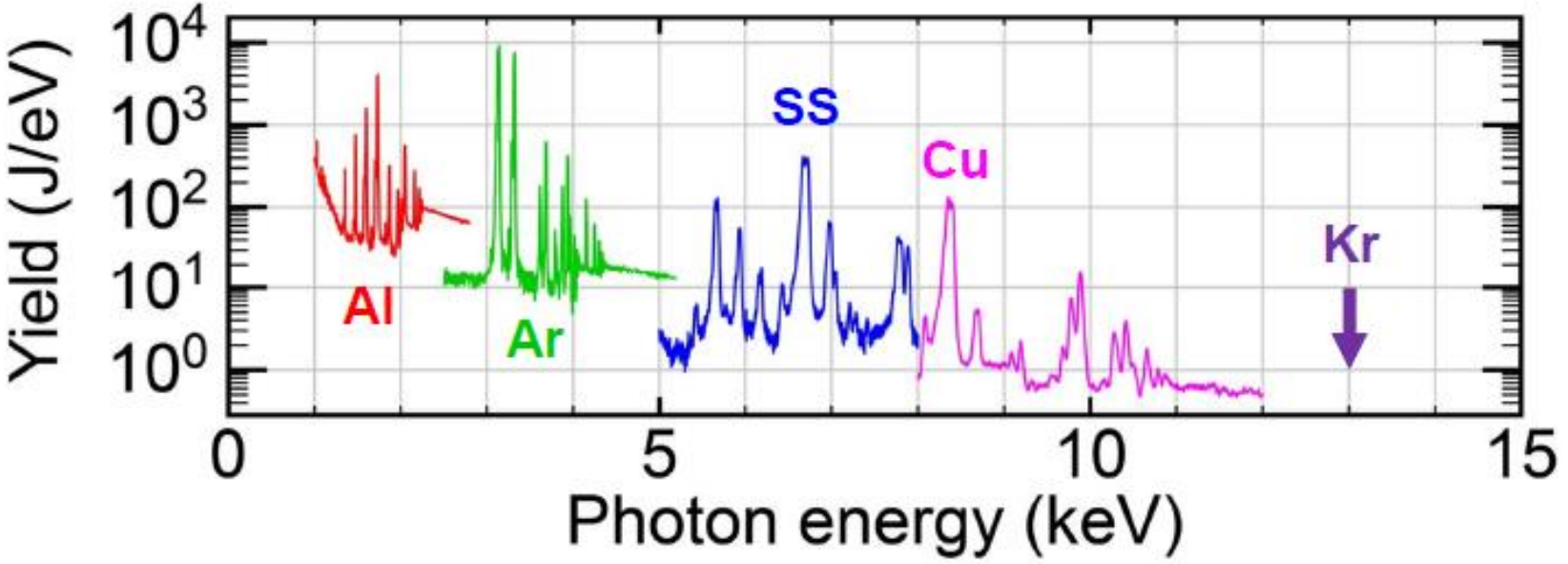
Z Generator ~20MA in ~100ns

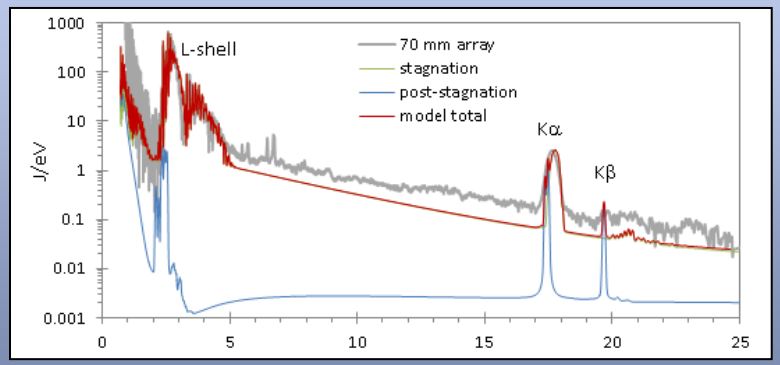
Bright Laboratory Thermal Source of Soft X-rays



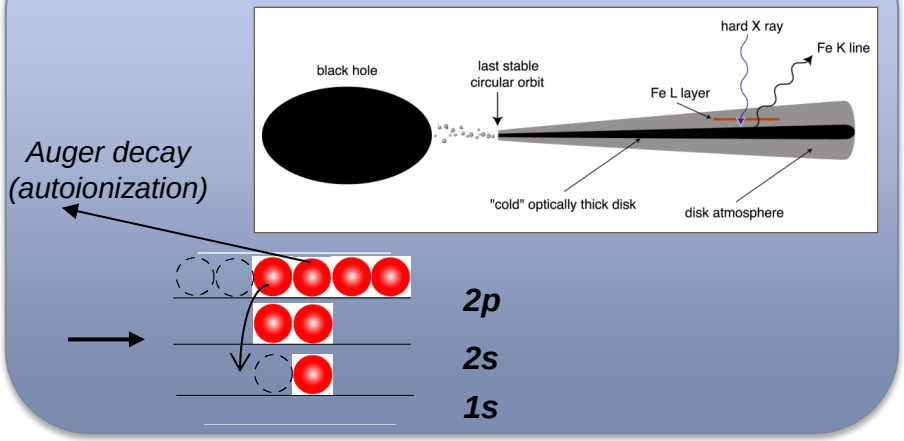
Higher Photon Energies ← **Higher Electron Temperatures** ← **Higher Kinetic Energy Thermalized** ← **Larger Initial Radius**

Large diameter implosions and K-shell x-ray sources can be useful for a number of applications

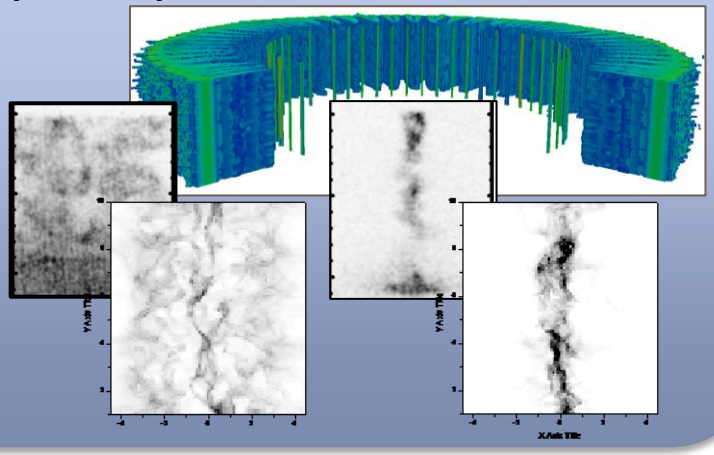
Testing atomic models



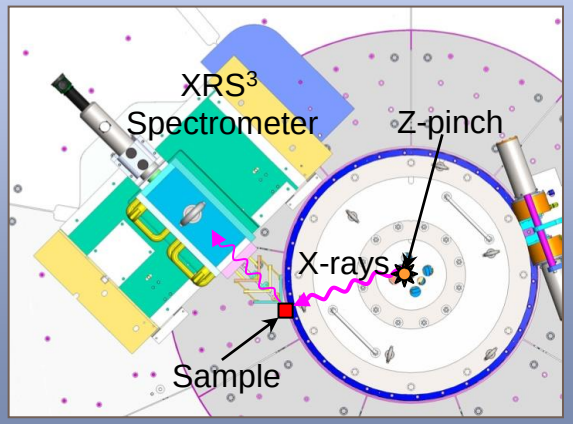
X-ray source for inner-shell photoionization



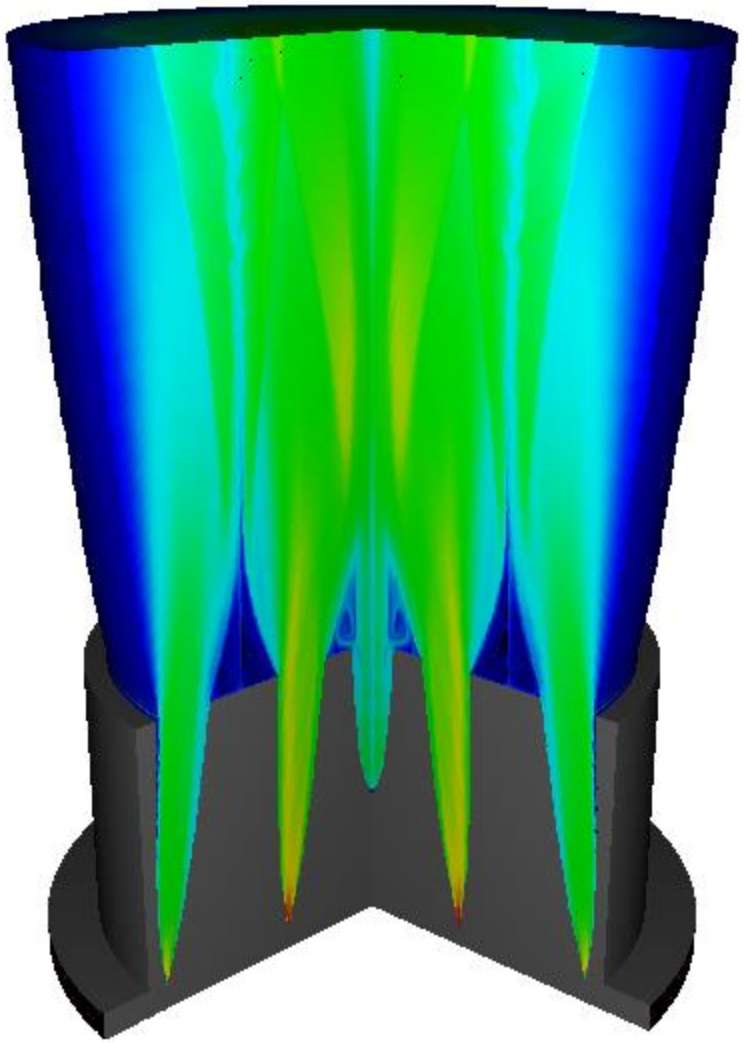
Complex 3D problems for MHD simulations



X-ray source for scattering experiments

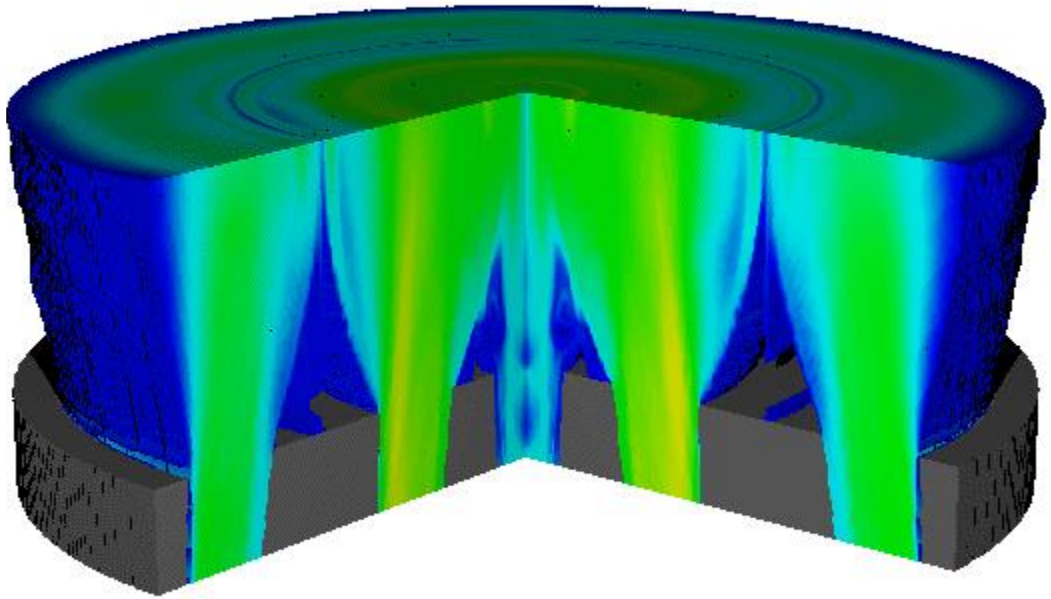


Hydrodynamic Gas Flow



~m second

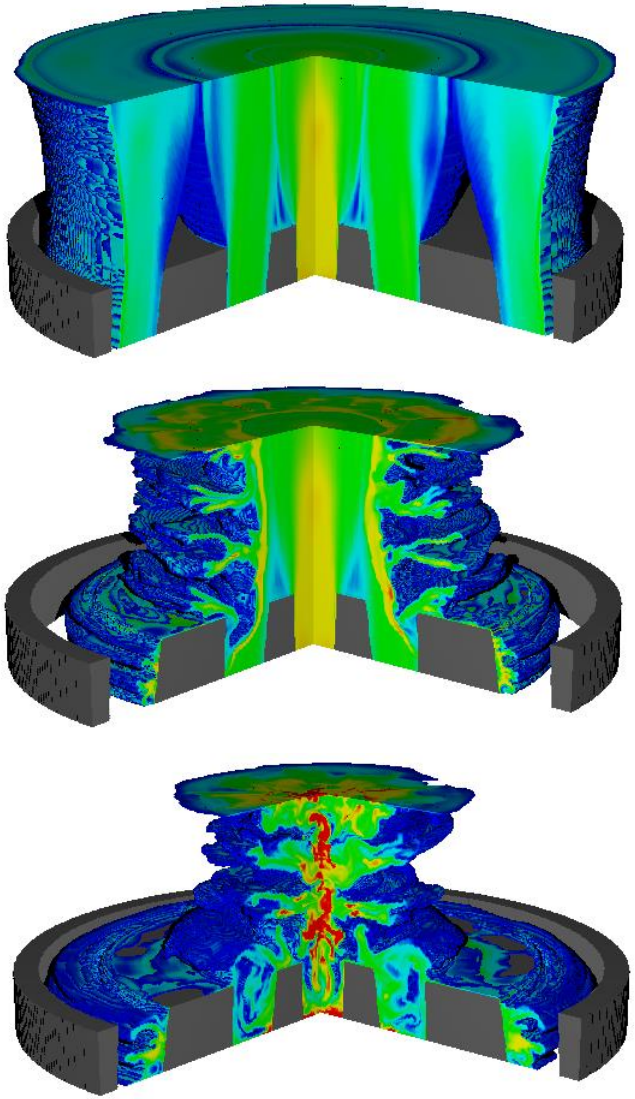
Radiative Magneto-hydrodynamic Implosion



Imploded by ~20MA in ~100ns

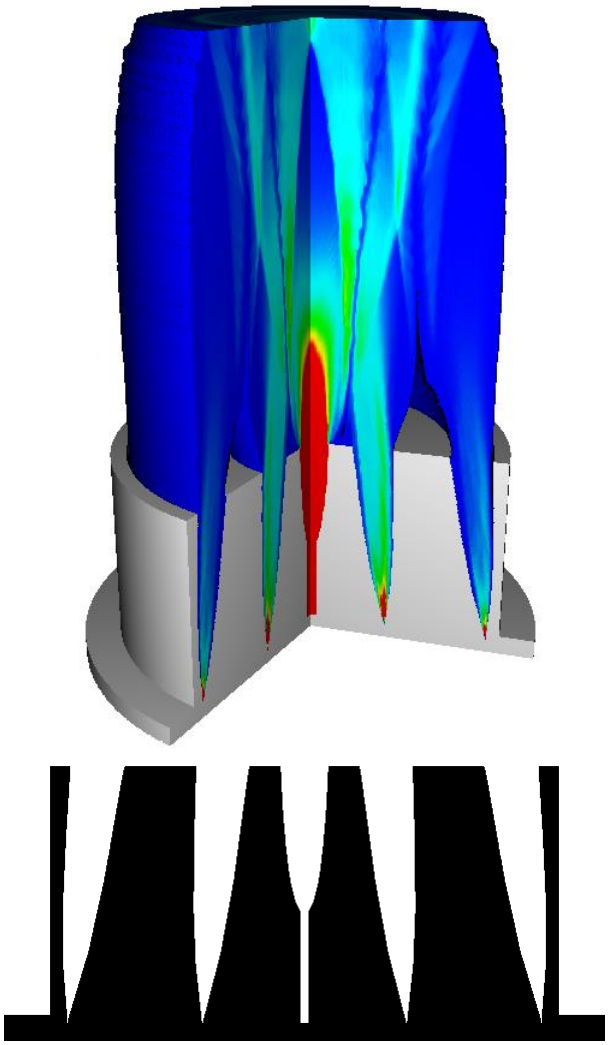
Implosions disrupted by instabilities

8cm or 12cm

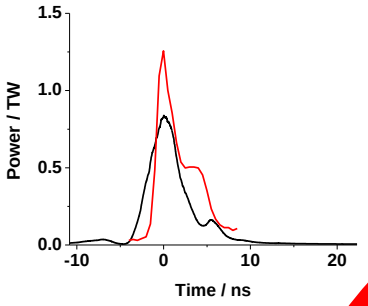


100ns

Can control with mass distribution

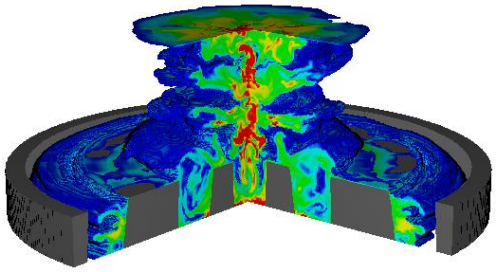


Taking Steps to Get There



Assess Output

GORGON – 3D Radiative-Resistive MHD



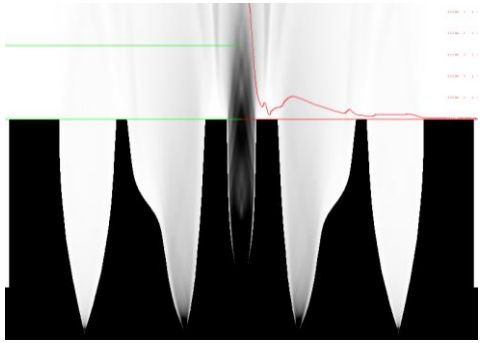
Simulate Implosion

Radiation Model
S.B. Hansen
screened-hydrogenic/
UTA non-LTE model
SCSF

Design Gas Nozzle

Gas profiles measured (SITF)

Simulate Gas Profile

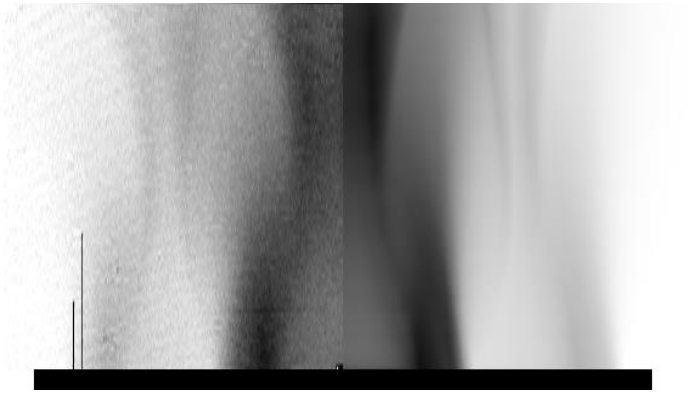


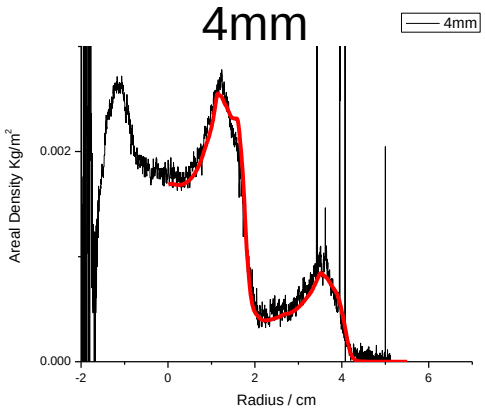
Alameda Applied Sciences (AASC)
DTRA funding instrumental

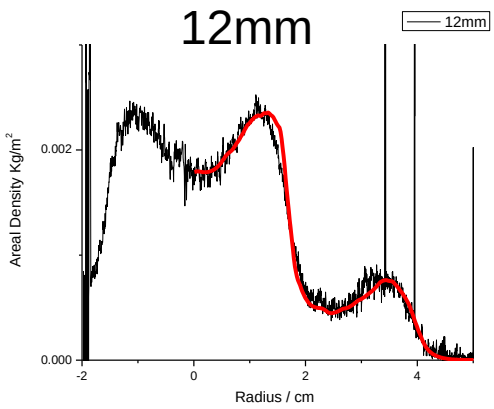
Simulated Areal Density Compared Directly of Measurement

Density Areal Density

Interferometry Simulation





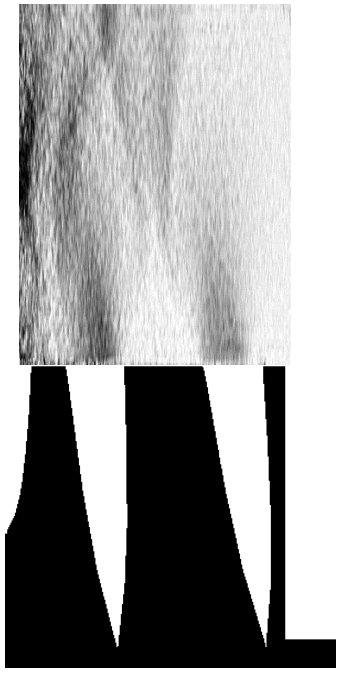


Interferometry / simulation

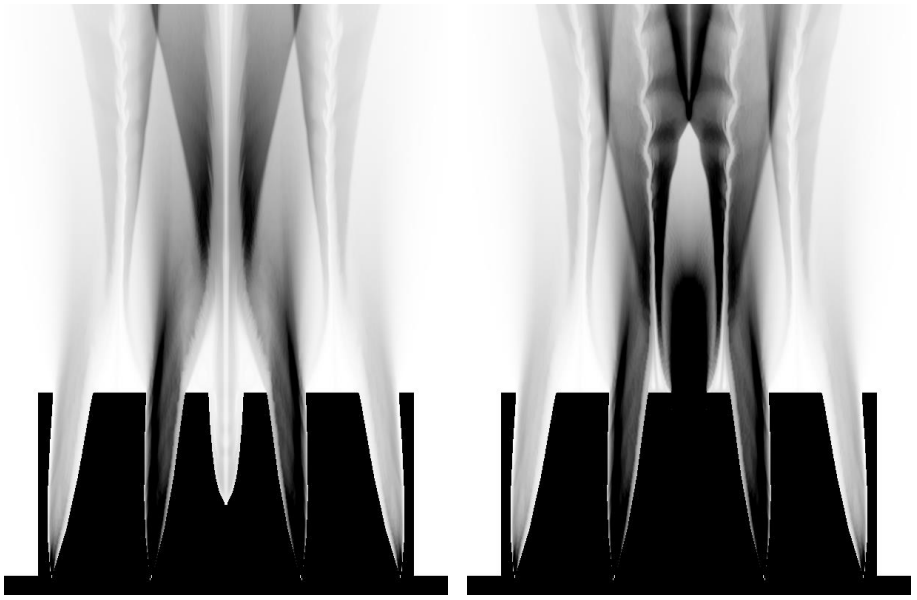
Initial perturbations may be added in controlled way to hydro model, and mass distribution easily varied

Hydo Model

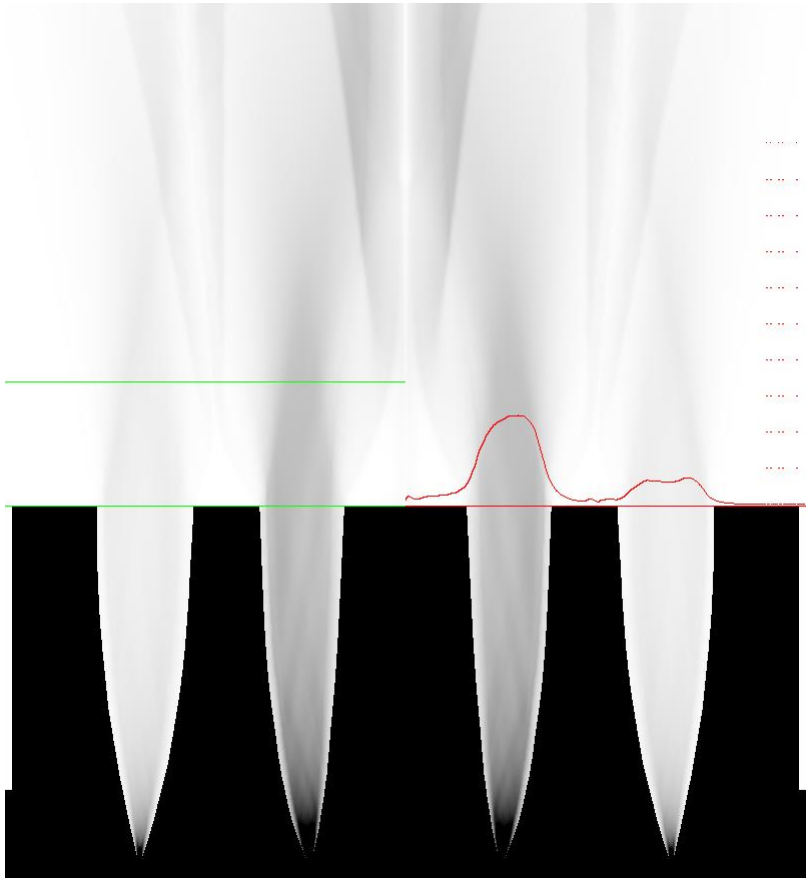
Interferometry

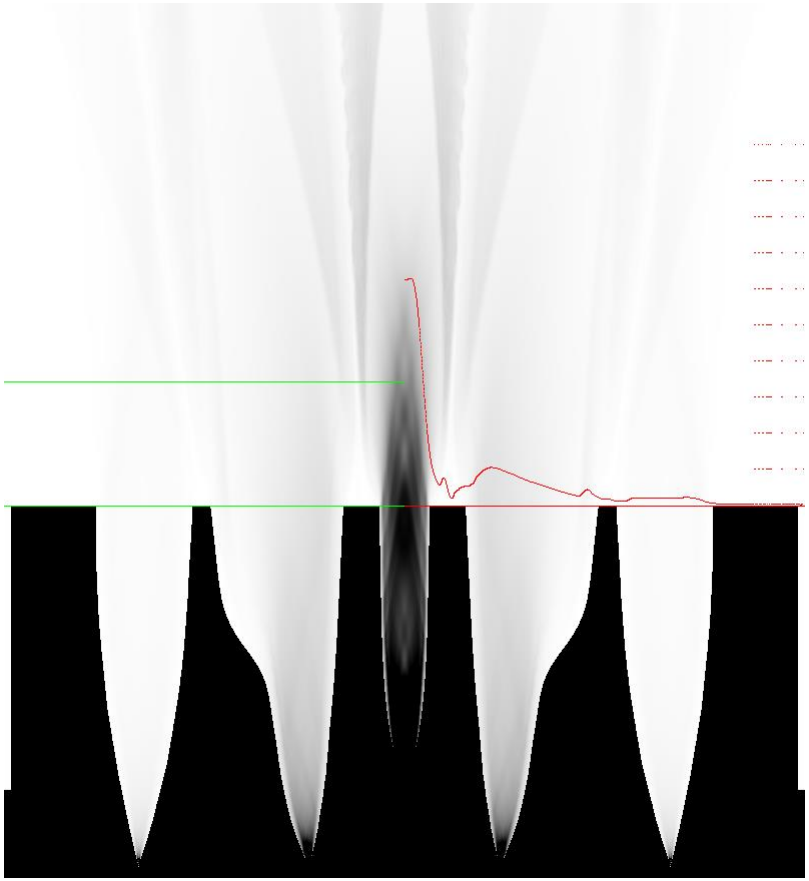


Allows simple testing of different nozzle pressures



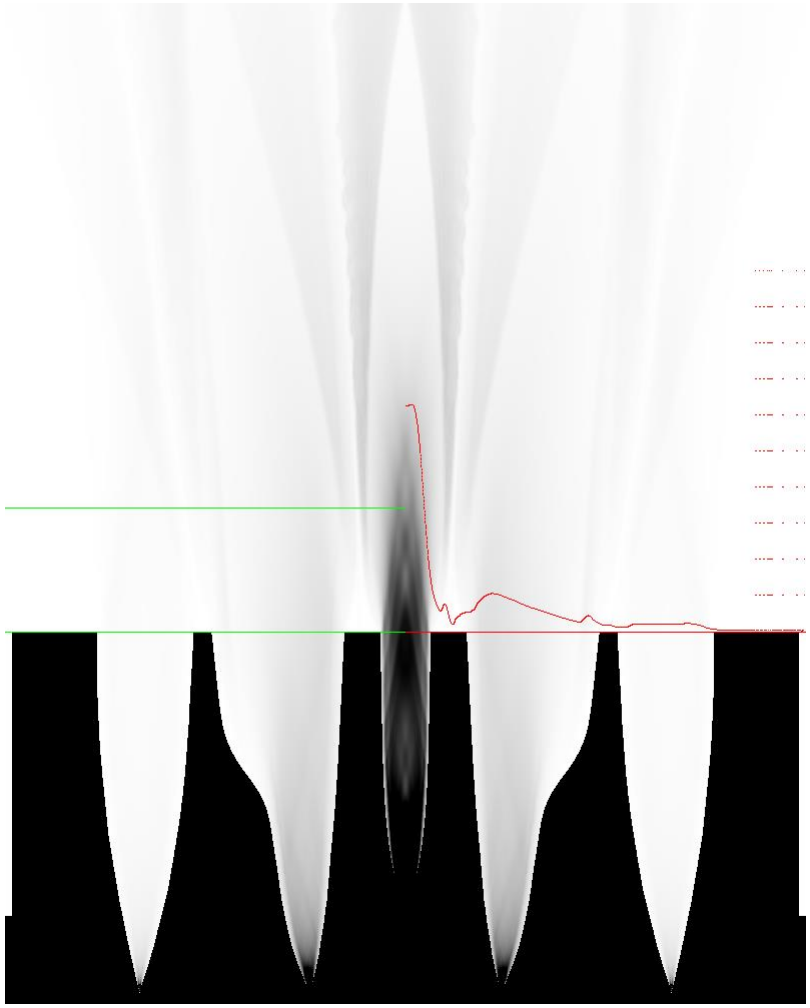
Design 2 12cm nozzles to study shell like vs. ramped density profiles (T. Strizic hardware designer)

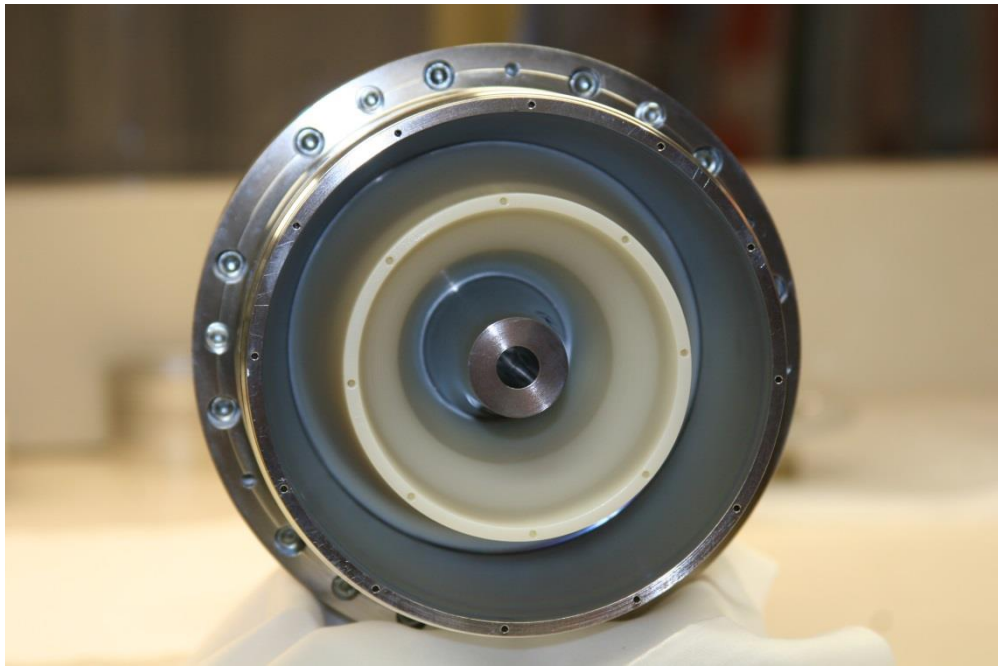


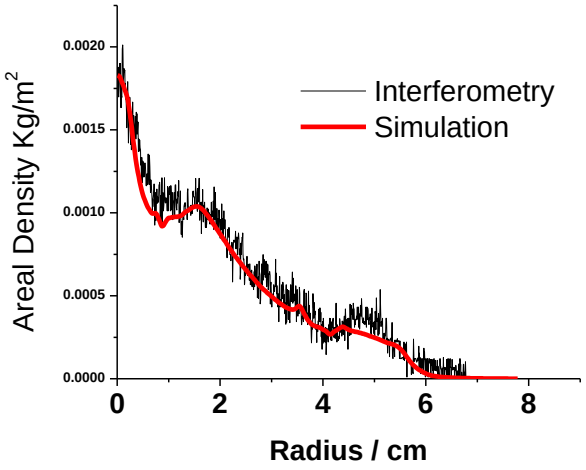


Ramped Density Profiles:
Hammer *et al* PoP 3, 2063 (1996), Velikovich et al., PRL 1996, attached; PoP 1998

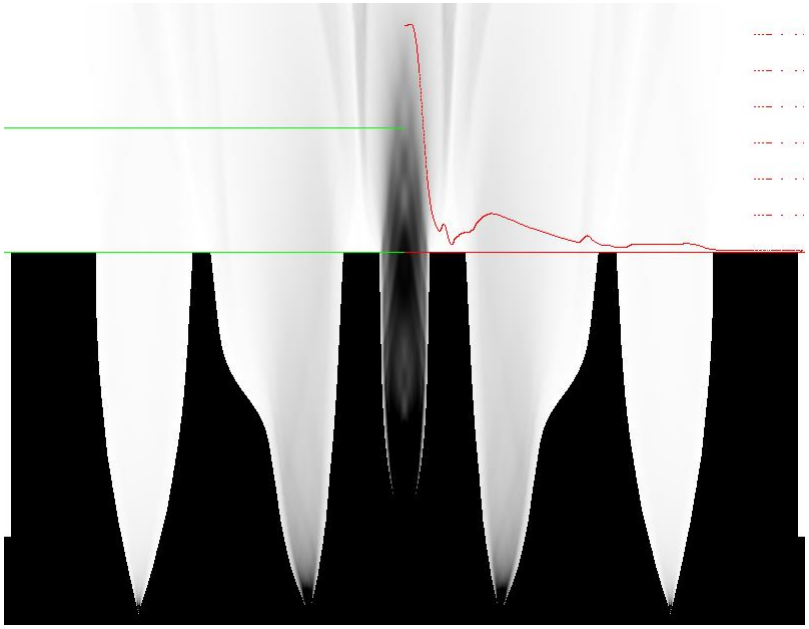
Shaped profile verified with 3D printed components
Thanks SITF team !

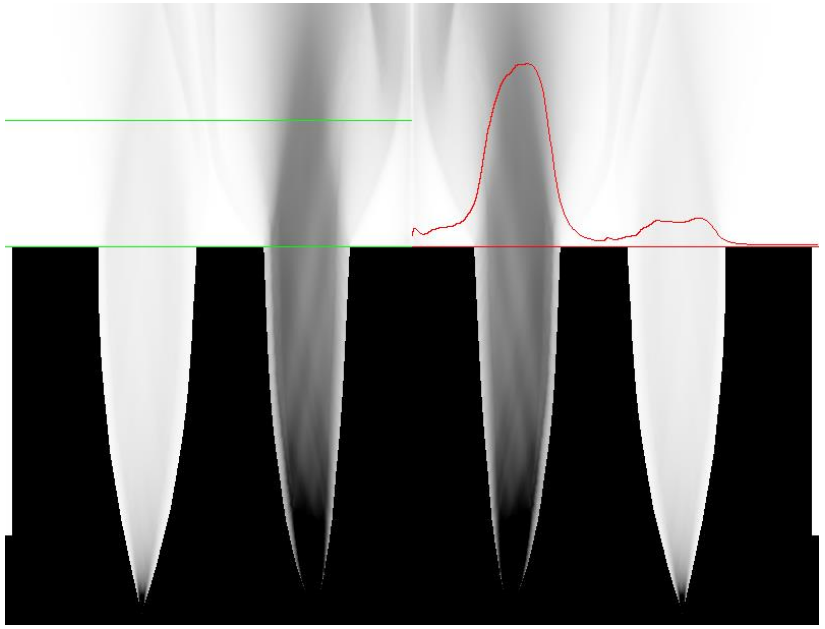


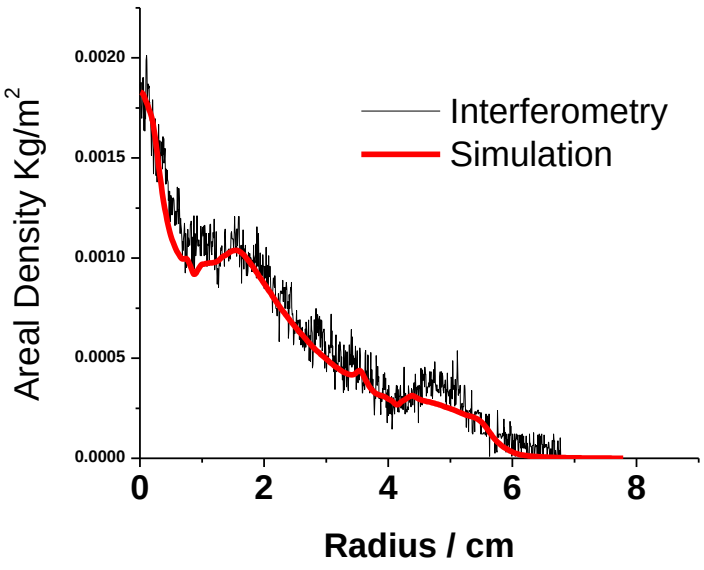


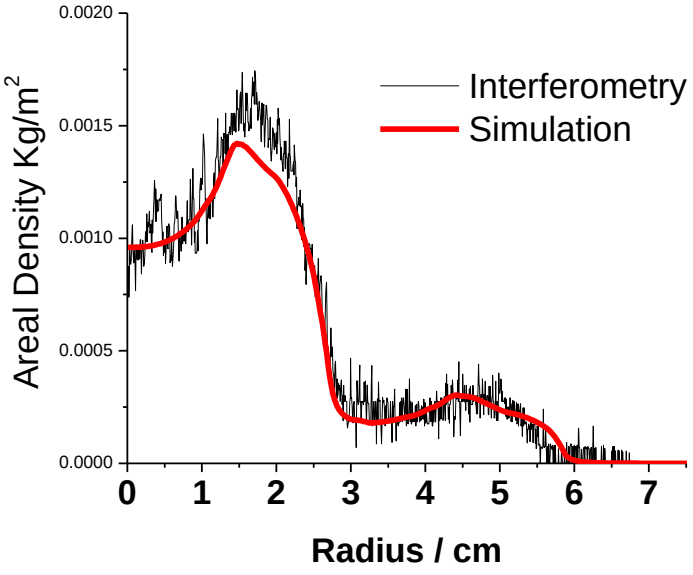


Characterization of new nozzles verify design

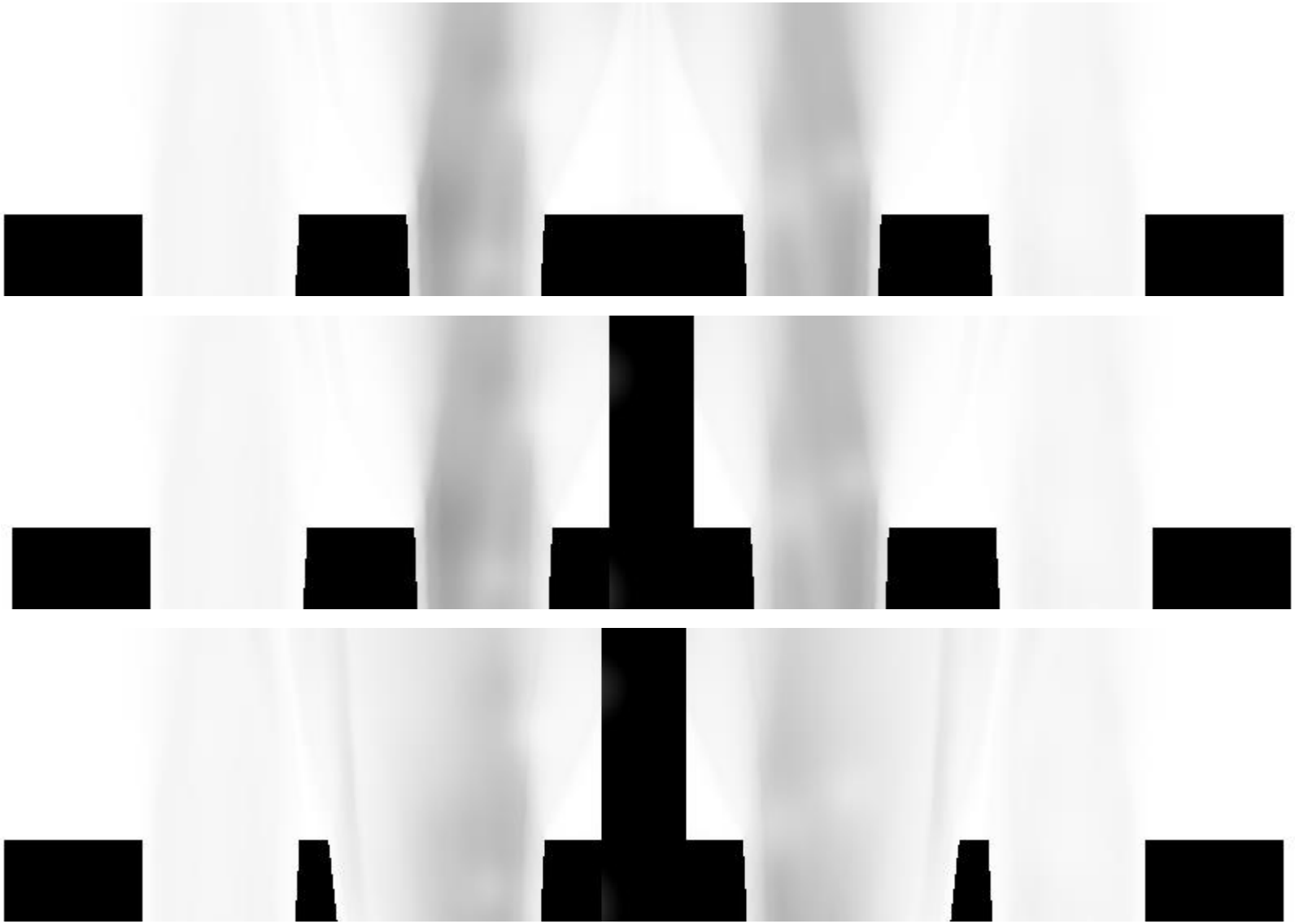








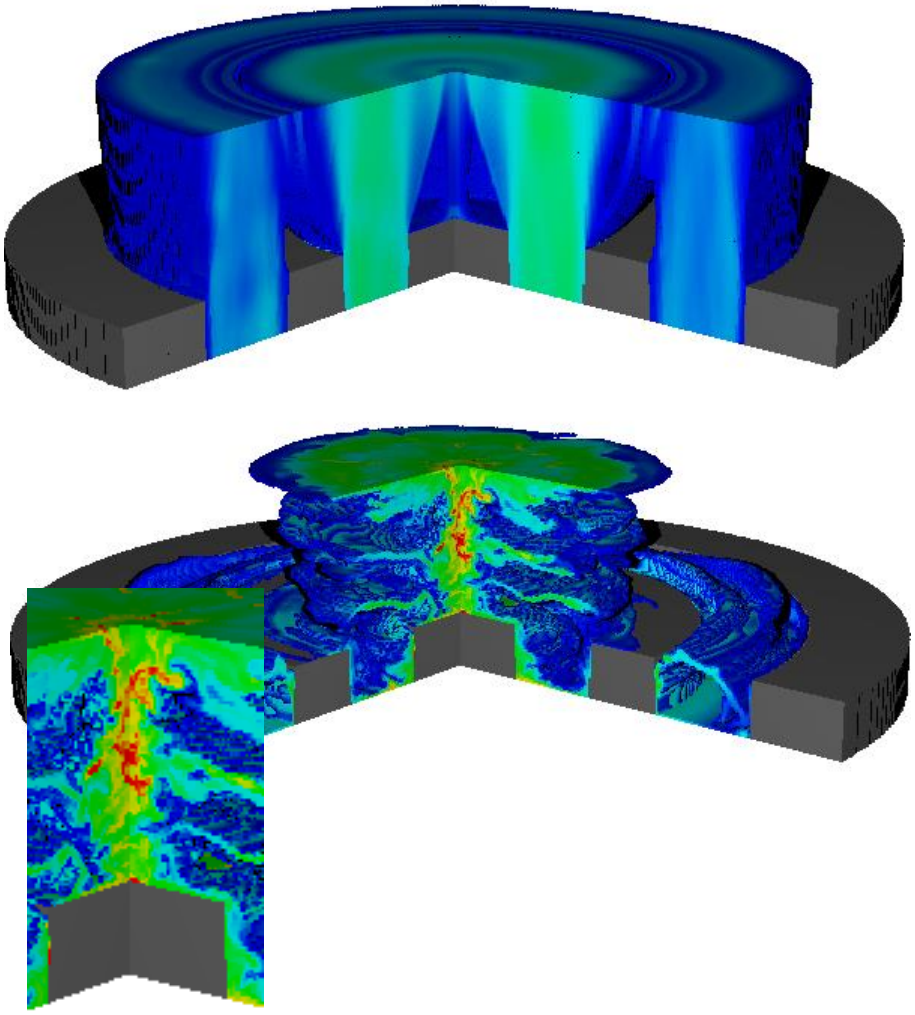
Ramped with jet is expected to perform best



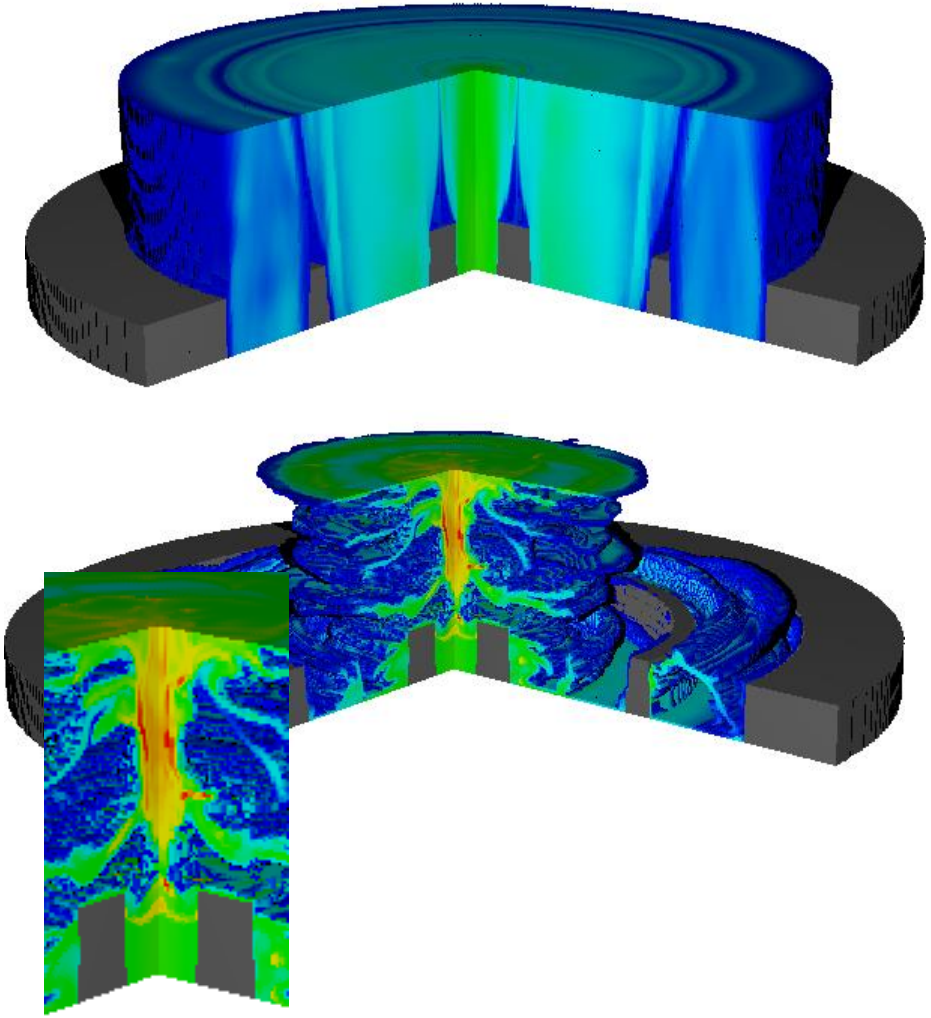
Expectation: Shell like ~ 7kJ Shell like with jet ~16kJ Ramped with jet ~30kJ

Tailoring Density distribution leads to achieve more stable implosion

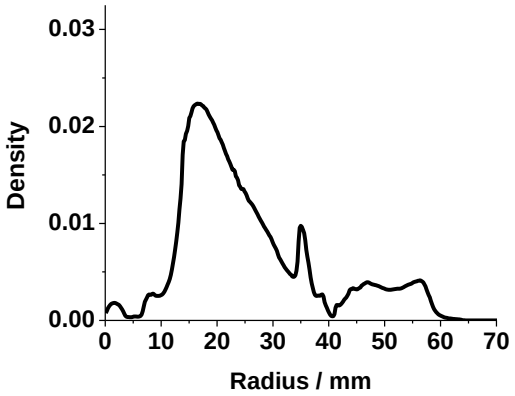
Predicted ~7kJ K-shell



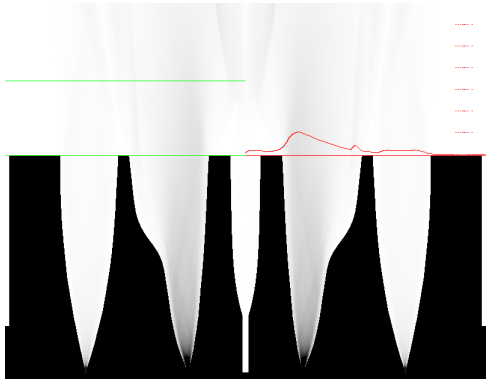
Predicted ~30kJ K-shell



Profile difference successfully predicted, but measured yields were down by a factor of ~3



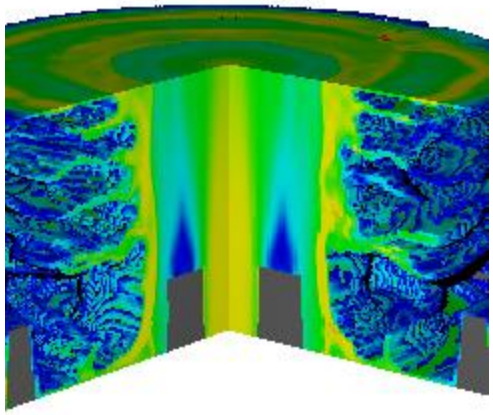
Density Profiles



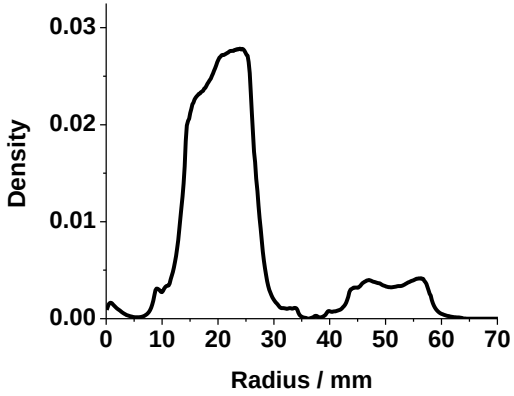
K-shell Yields

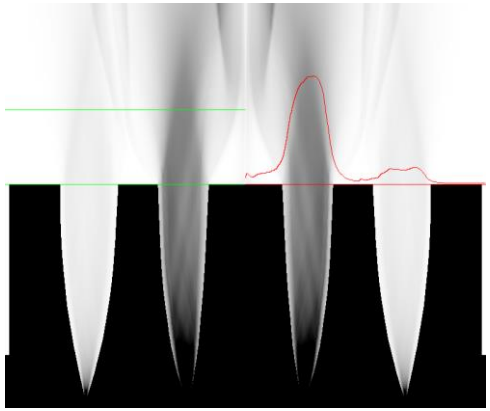
Anticipated ~16kJ

Measured ~5kJ



Log Density Profiles

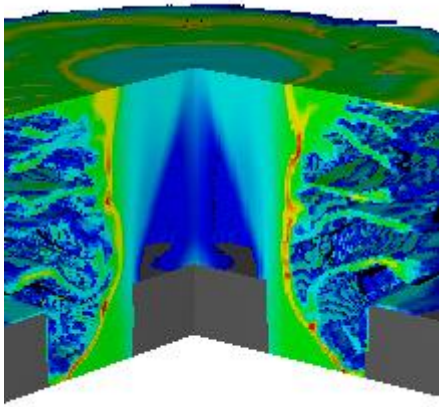




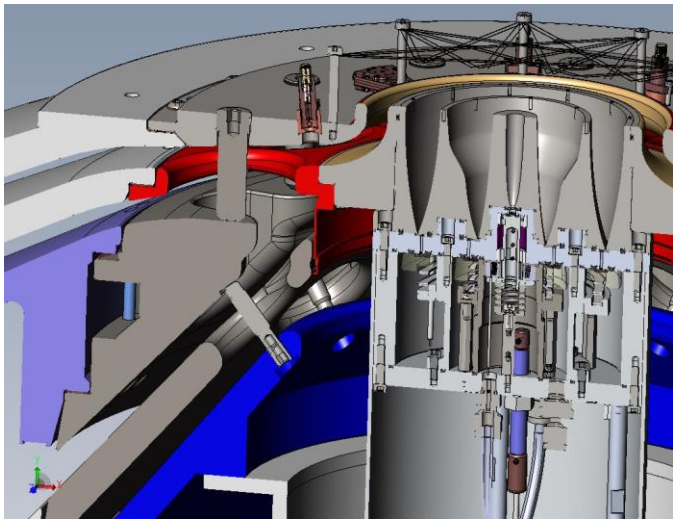
K-shell Yields

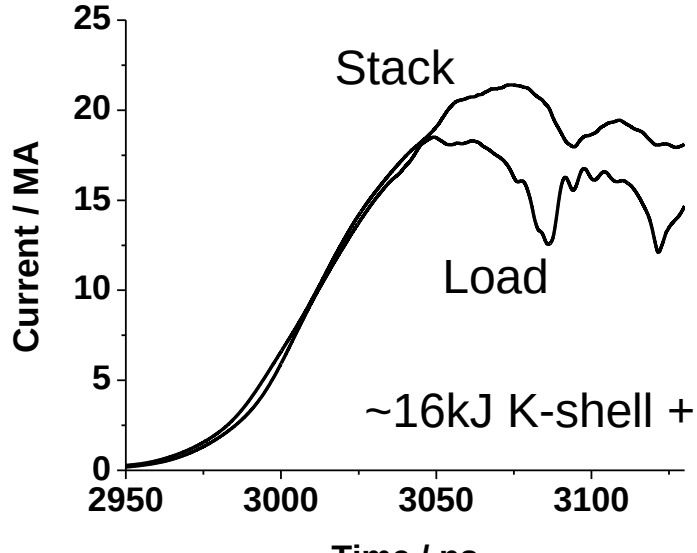
Anticipated ~7kJ

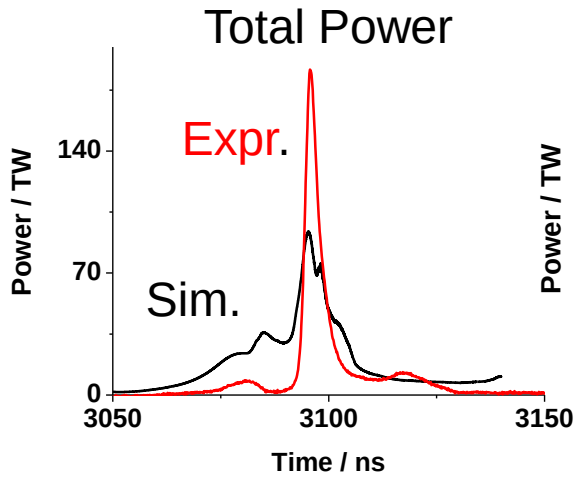
Measured ~2kJ

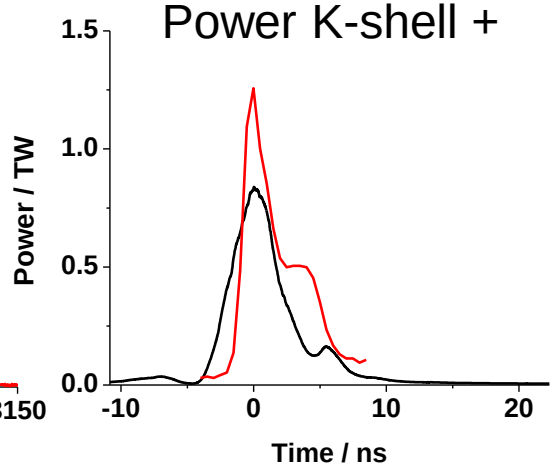


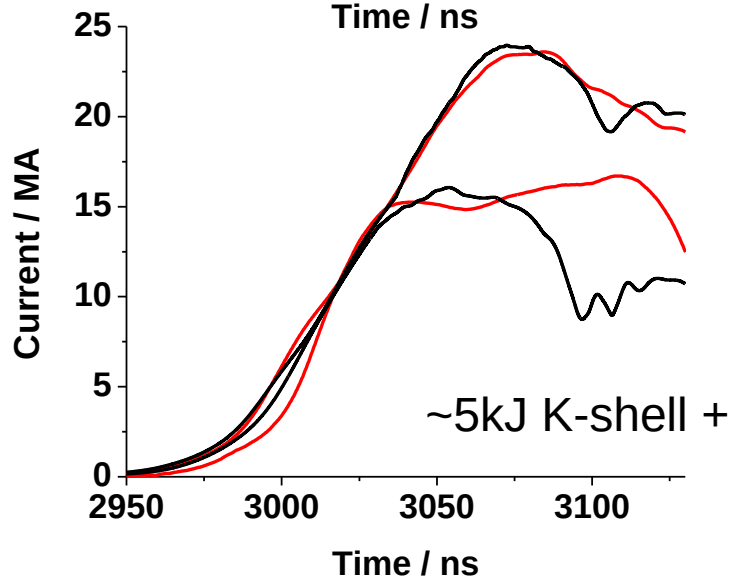
Revising current delivery recovers measured yields, and is consistent with electrical diagnostics











Conclusions

Tools developed and tested to design gas nozzles to shape gas profiles.

Predicted improvement in yield from shaped mass profile was observed in experiments.

Simulations consistent with measured yields under assumptions of reduced current delivery.

Next:

Introduction of central jet predicted to further improve K-shell yield

Gas puffs seem to have anomalously bad current delivery. Understanding why may allow significant improvements in yield.