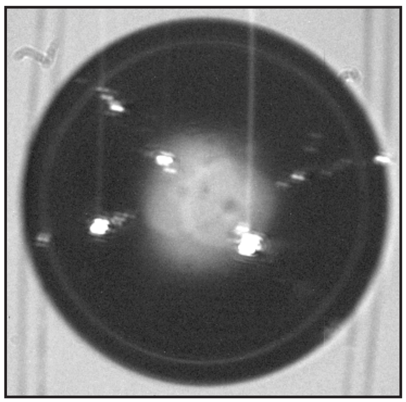
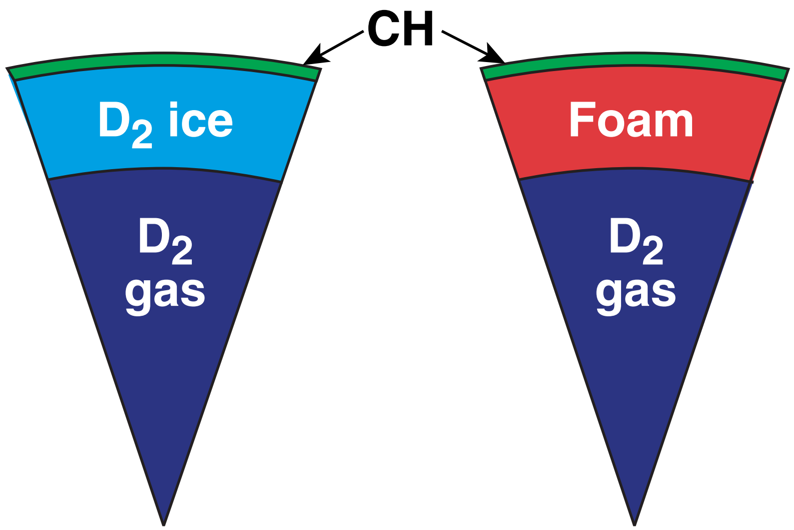
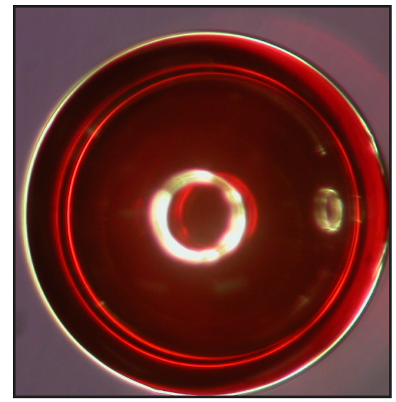
Direct-Drive, Foam-Target ICF Implosions







J. P. Knauer
University of Rochester
Laboratory for Laser Energetics

48th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Philadelphia, PA
30 October–3 November 2006

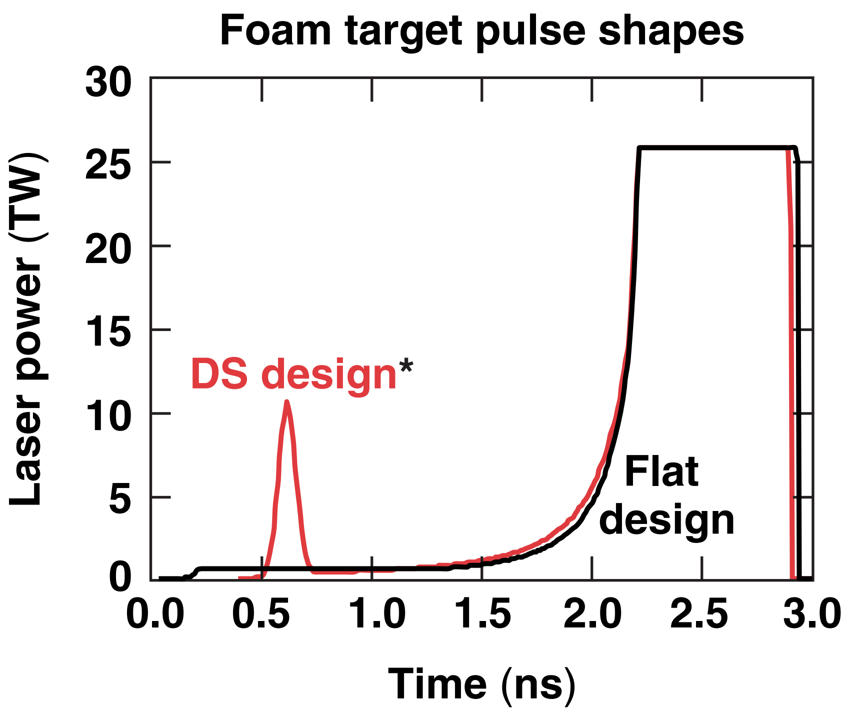
Summary

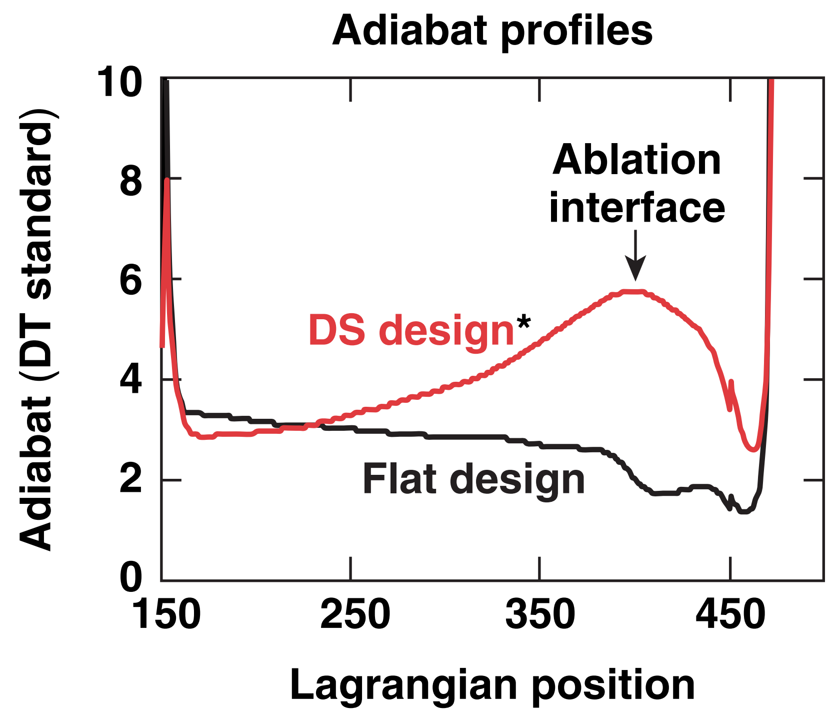
Warm foam cryogenic-surrogate implosions on OMEGA will demonstrate adiabat-shaping techniques

- Foam targets are hydrodynamically equivalent to cryogenic targets.
- Increased radiation from the foam targets does not significantly affect the shell dynamics.
- Current foam targets meet the uniformity specifications but development is needed to show that they can retain D_2.

E15257

Stability of direct-drive targets can be substantially enhanced using adiabat shaping

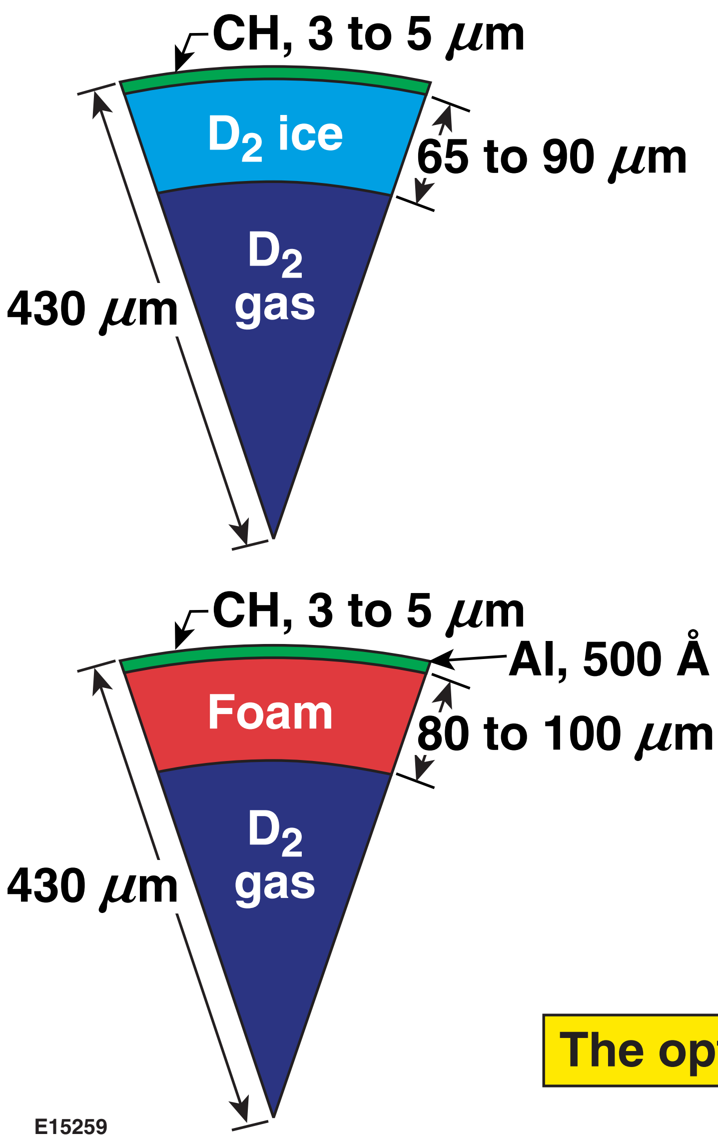




E15258

*V. N. Goncharov *et al.*, Phys. Plasmas 10, 1906 (2003).

Foam targets are proposed as surrogates for cryogenic targets to study adiabat shaping



Requirements for a surrogate:

1. Design should capture early-RT growth
   - overcoat thickness: 3 μm to 5 μm
   - density ratio: overcoat/foam = 3 to 4

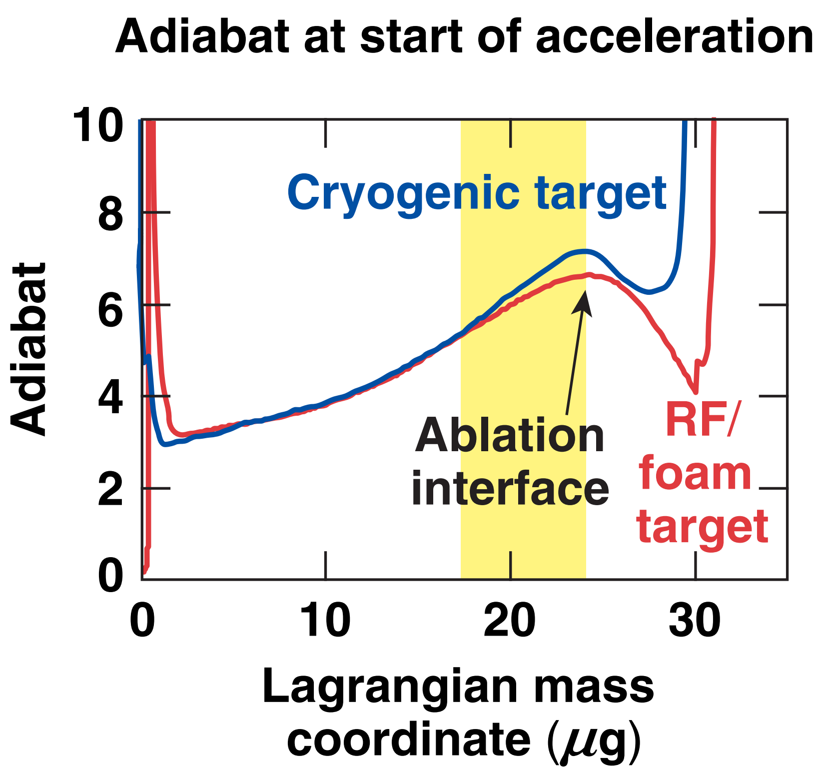
2. Adiabat shaping is not compromised by radiation from corona ($\rho <$ 500 mg/cc, restrictions on high-*Z* constituents)

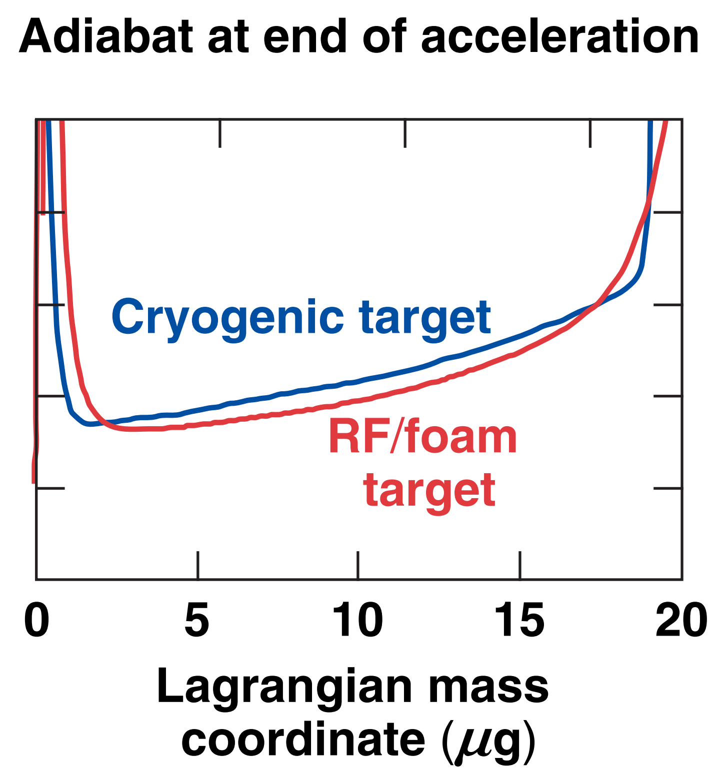
3. No additional instabilities are created ($\rho >$ 150 mg/cc)
   - an unstable radiation ablation front is created in low-density foams

The optimal foam density is 180 mg/cc.

E15259

Foam and cryogenic targets have similar adiabat shapes for the decaying-shock picket-pulse shape

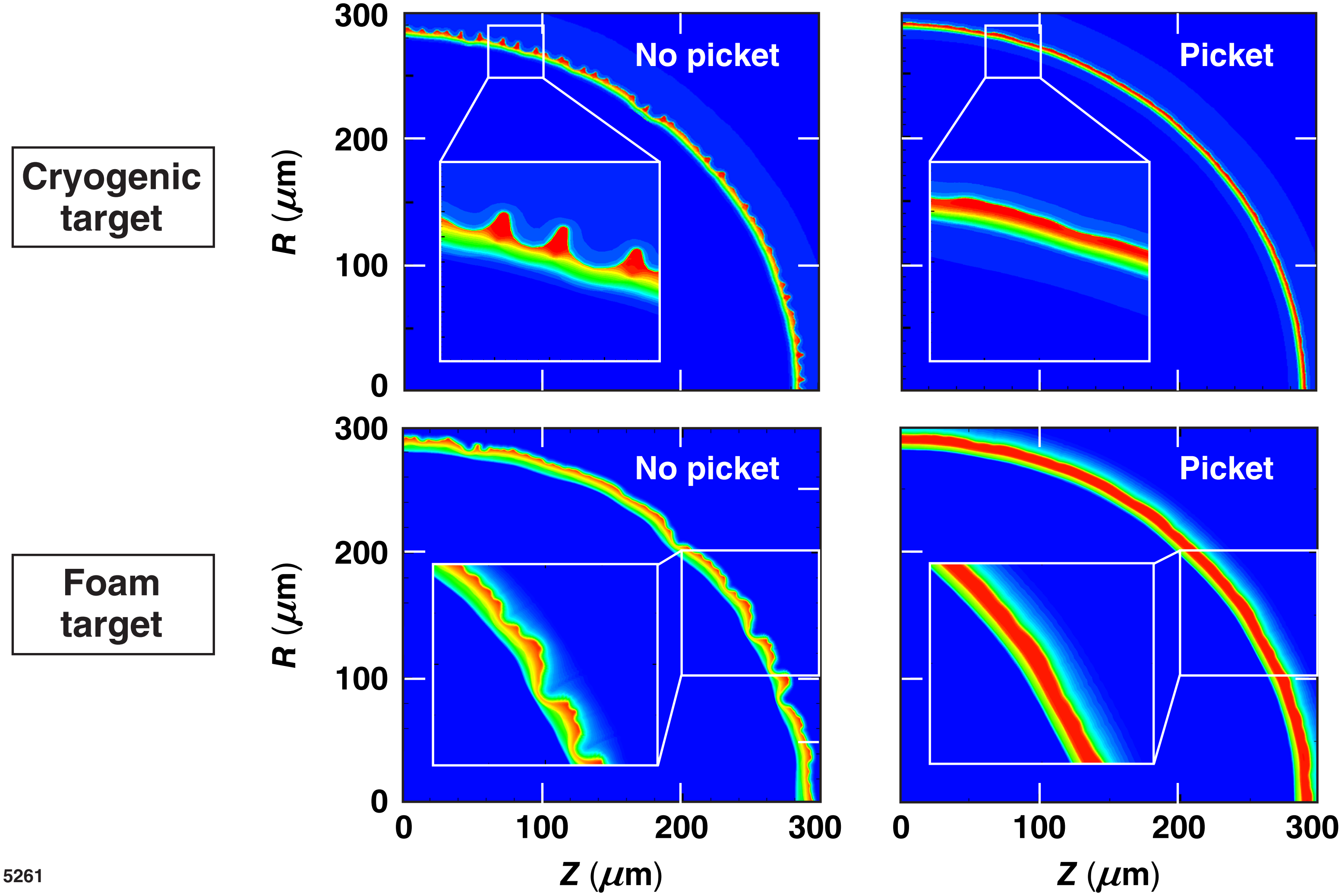




E15260

2-D hydrodynamic simulations show that the "in-flight" shell distortions are analogous

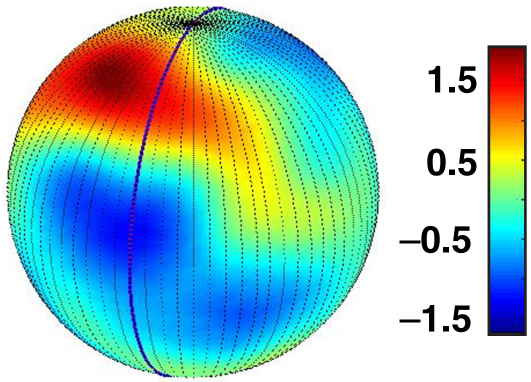
Imprint simulations: ℓ = 2 to 200, DPP + PS, 1-THz SSD



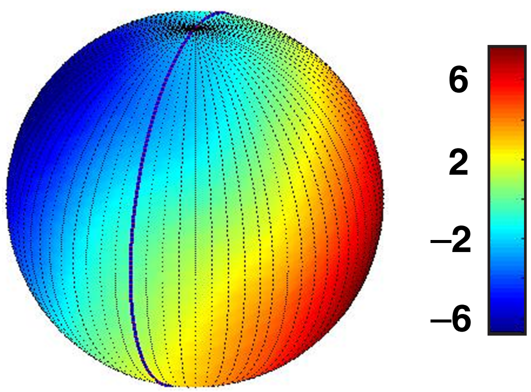
E15261

Foam targets are characterized using the same procedures as the cryogenic targets*

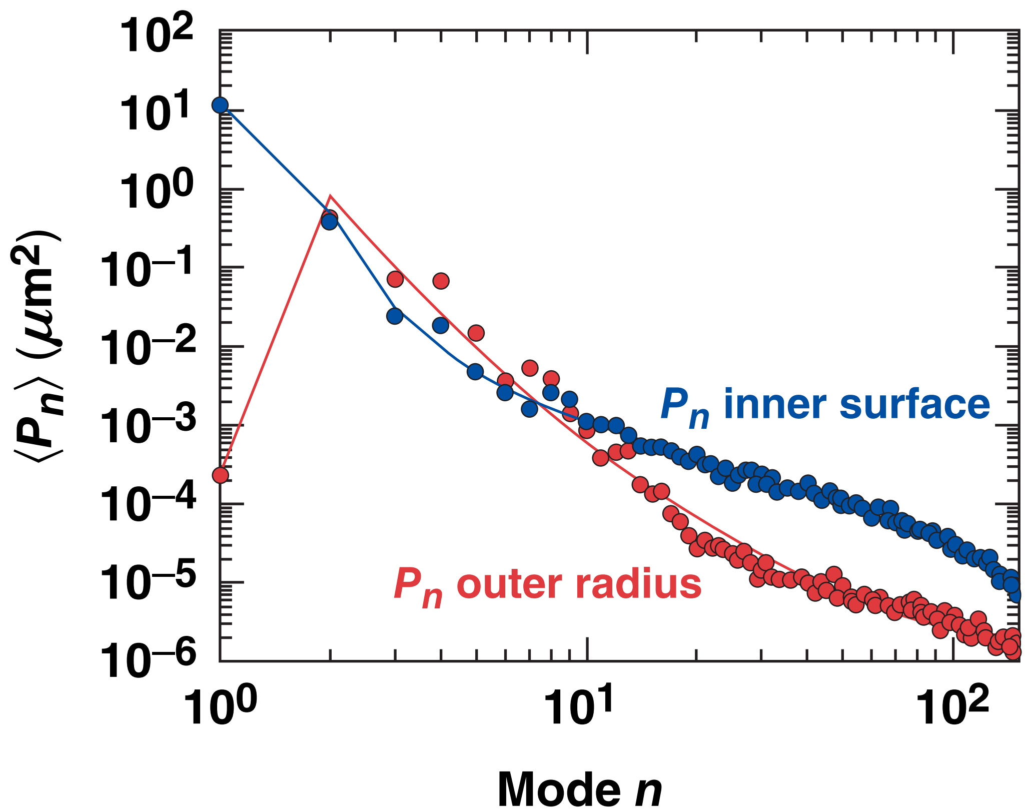
Outer surface



Inner surface



Averaged Fourier power spectrum

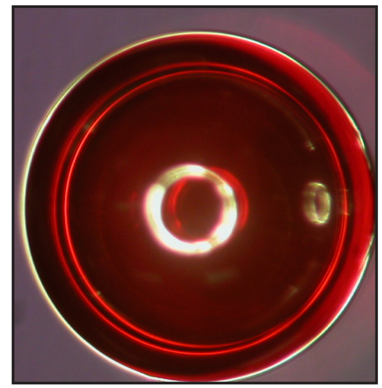


E15262

*D. H. Edgell *et al.*, Fusion Sci. Technol. 49, 616 (2006).

Foam targets have been delivered by GA to LLE for evaluation and implosion

- Foam shell characteristics
  - OD = 857±8.0 μm
  - CH shell thickness = 5.1±0.1 μm
  - rms shell variation = 0.3±0.2 μm
  - foam thickness = 87±3.0 μm
  - rms foam variation = 6±2.0 μm
  - gas time constant = 9±5 hours



- Measured D_2 neutron yields from 2006 foam targets are 10× lower than 2004 foam targets
  - 5-atm targets (2004)
    - neutron yield = $1.5 \pm 0.4 \times 10^{10}$
    - 1-D yield = $7.0 \pm 2.0 \times 10^{10}$
  - 3-atm targets (2006)
    - neutron yield = $1.4 \pm 0.7 \times 10^{9}$
    - 1-D yield = $3.6 \pm 0.9 \times 10^{10}$

E15263

Summary/Conclusions

Warm foam cryogenic-surrogate implosions on OMEGA will demonstrate adiabat-shaping techniques

UR LLE

- Foam targets are hydrodynamically equivalent to cryogenic targets.
- Increased radiation from the foam targets does not significantly affect the shell dynamics.
- Current foam targets meet the uniformity specifications but development is needed to show that they can retain D_2.