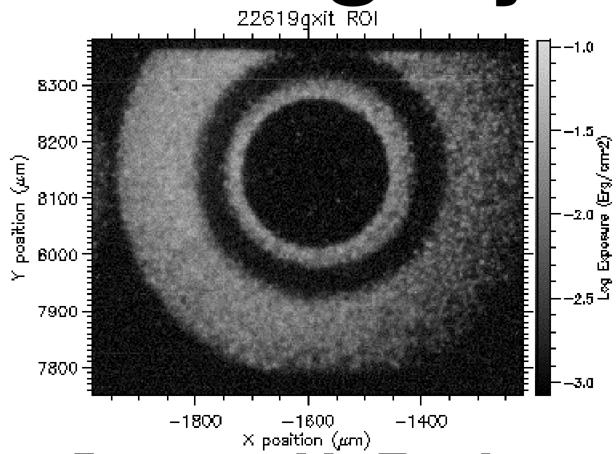
LA-UR-01-6658

Mixing Between Two Compressing Cylinders



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***LANL, #AWE**

8th International Workshop on Compressible Turbulence and Mix

Poster E5; Pasadena, CA December 11, 2001

Abstract

- **Foam-filled cylinders have been imploded by the OMEGA laser at the University of Rochester. A marker layer of heavier material is placed between the foam and the outside ablator. The marker layer is hydrodynamically unstable when a strong shock passes through both these interfaces and the marker layer material mixes into the foam and the ablator.**
- **These experiments thus measure mix in the compressible, convergent, miscible, strong-shock regime. These experiments are being extended by placing a solid cylinder at the center of the foam, forming a set of concentric cylinders separated by foam. The initial shock converges on the central cylinder and then rebounds and expands. The shock is predicted to create even more mixing of the marker layer as it traverses the previously mixed region. We present experimental measurements of this configuration.**

- **LA-UR-01-2575:** ***This document was produced by the Los Alamos National Laboratory under the auspices of the United States Department of Energy under contract no. W-7405-ENG-36.***

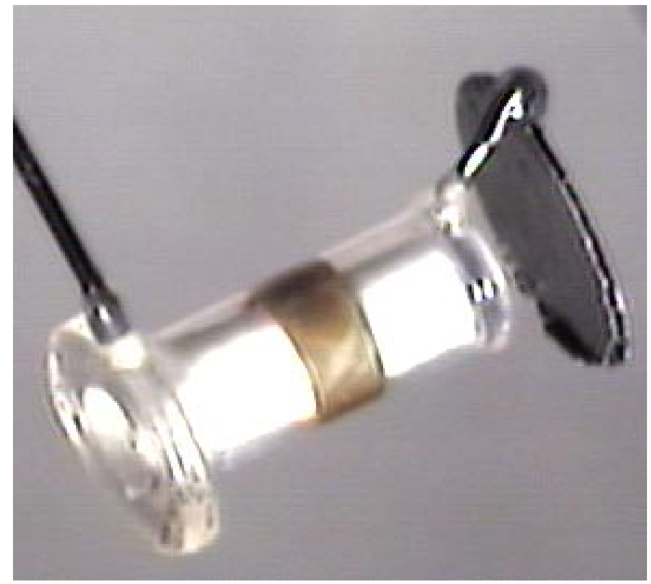
Why direct-drive cylindrical implosions?

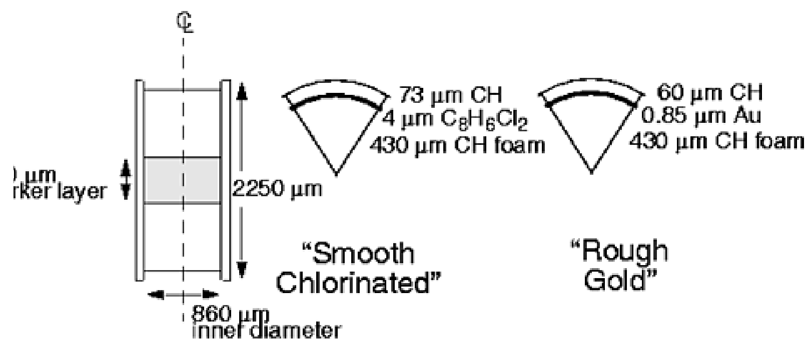
- **Purpose**
  - Study Richtmyer-Meshkov (RM) instability in *compressible, convergent, miscible* systems undergoing *strong shocks*
  - *Examine mixing due to reflectance of a shock from the center (reshock)*
- **Method**
  - Implode cylinder with an unstable interface and measure resulting mix
  - Diagnostic advantages, fewer ends to affect experiment, convergent

- **This poster presents initial experimental results**
- **See Kenny Parker's poster for design information**
  - "Computational Modeling of 2 – Shell Cylindrical Implosions with Mix" for design information

We have established a useful, laser-based test bed for mix experiments

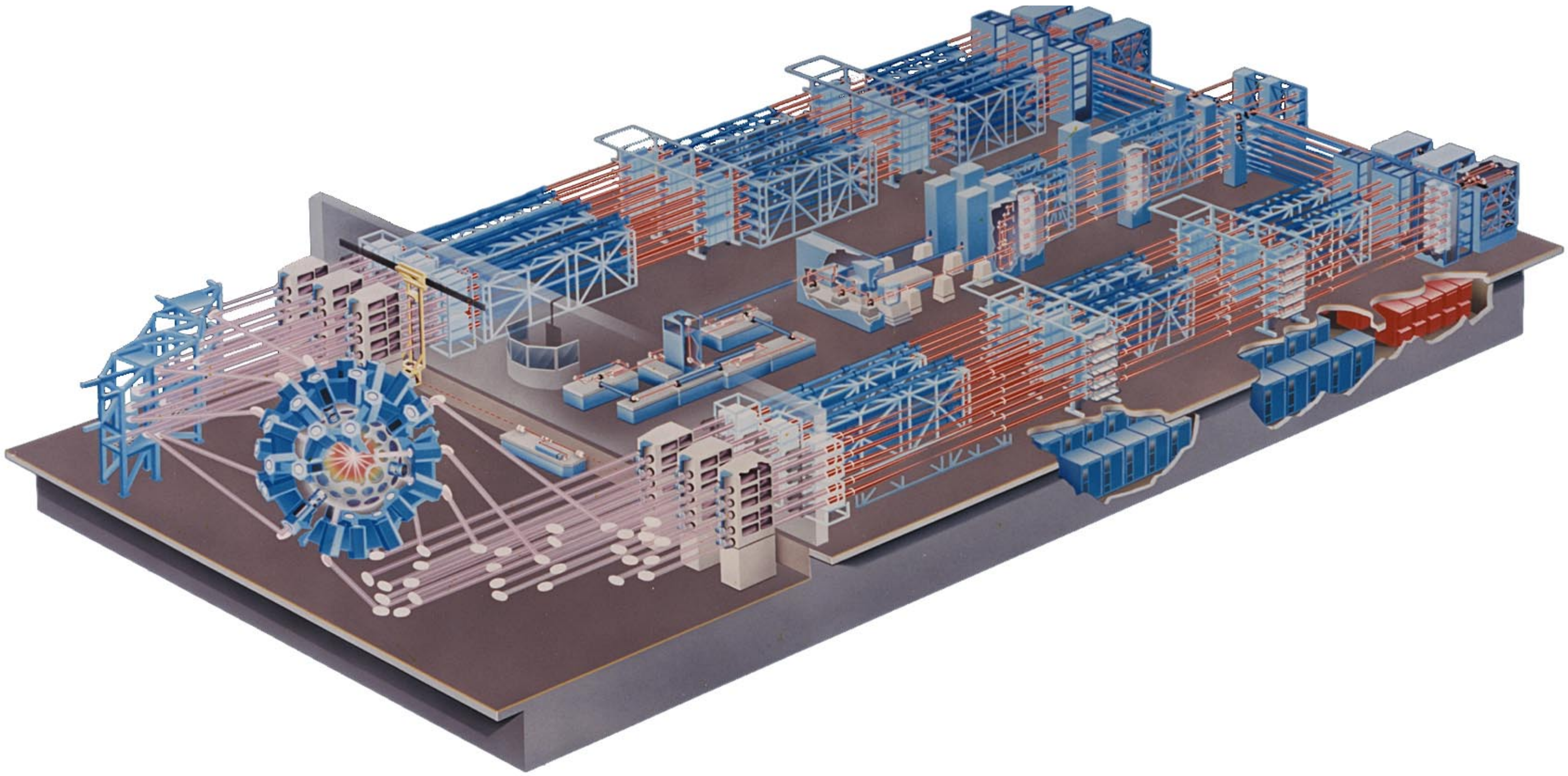
- Implode cylinder with thick ablator with 1-ns square pulse direct laser irradiation
- Hydrodynamically unstable at plastic/Au and Au/foam interfaces
- Backlight with x rays through cylinder
- Measure radial extent of "mix layer" of Au into adjacent materials
- 1D convergent experiment with Mach number ≈ 20 (pre-shock; Mach ≈ 5 post-shock), convergence ≈ 4, Pressure > 45 Mbars, Reynold's number ≈10^6*





*Galmiche and Gauthier, *Jpn. J. Appl. Phys.* 35 (1996) 4516

We use the Omega laser at the University of Rochester

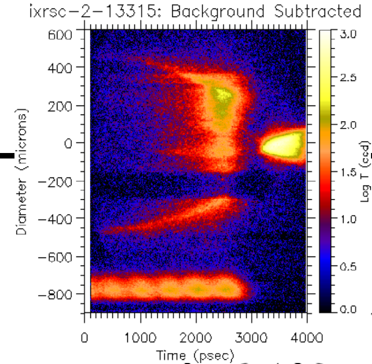


- 60 beams
- >30 kJ UV on target
- 1%–2% irradiation nonuniformity
- Flexible pulse shaping
- Short shot cycle (1 h)

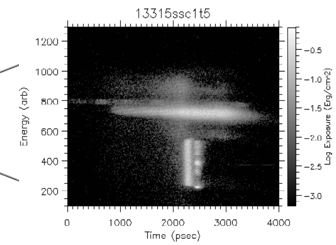
Complete Diagnostic Coverage Available

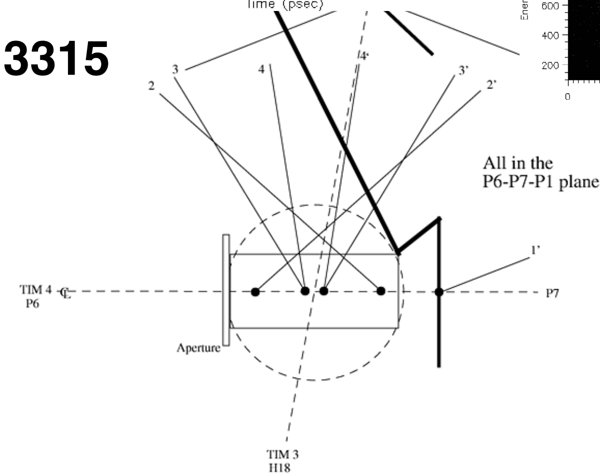
- **Diagnostics for shot 13315**

Imaging X-Ray Streak Camera

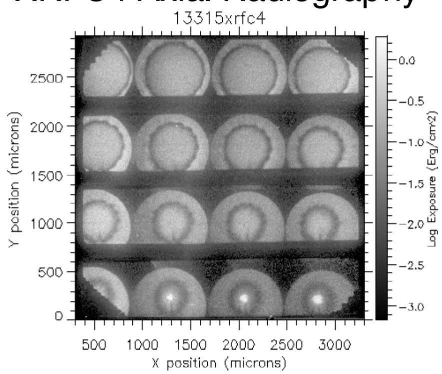


SSC1 Streak of Backlighter

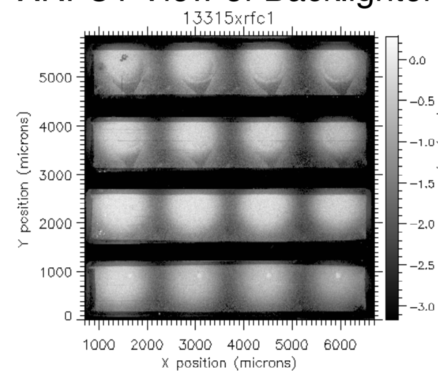




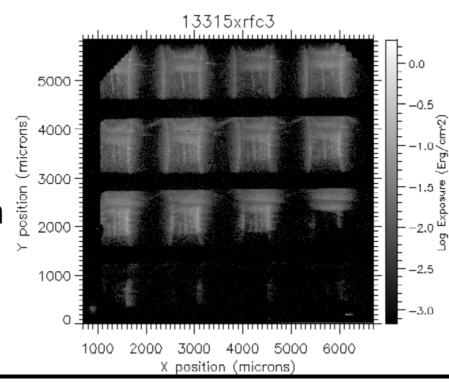
XRFC4 Axial Radiography



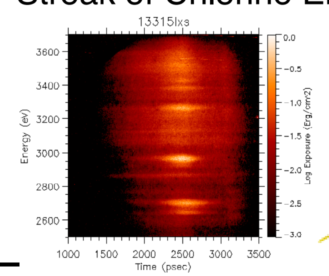
XRFC1 View of Backlighter



XRFC3 Transverse
View of Self-Emission

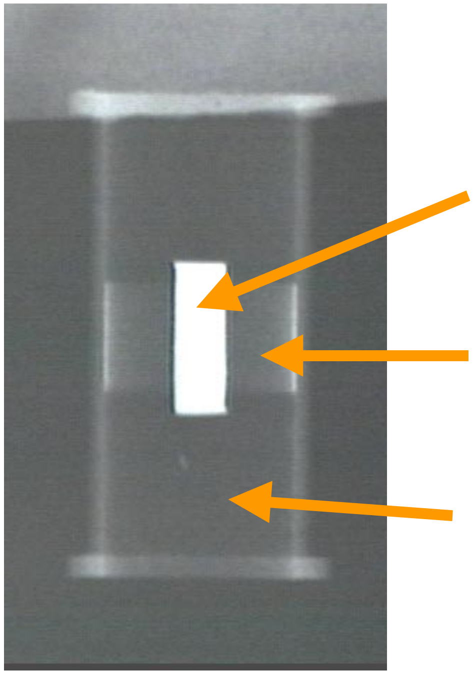


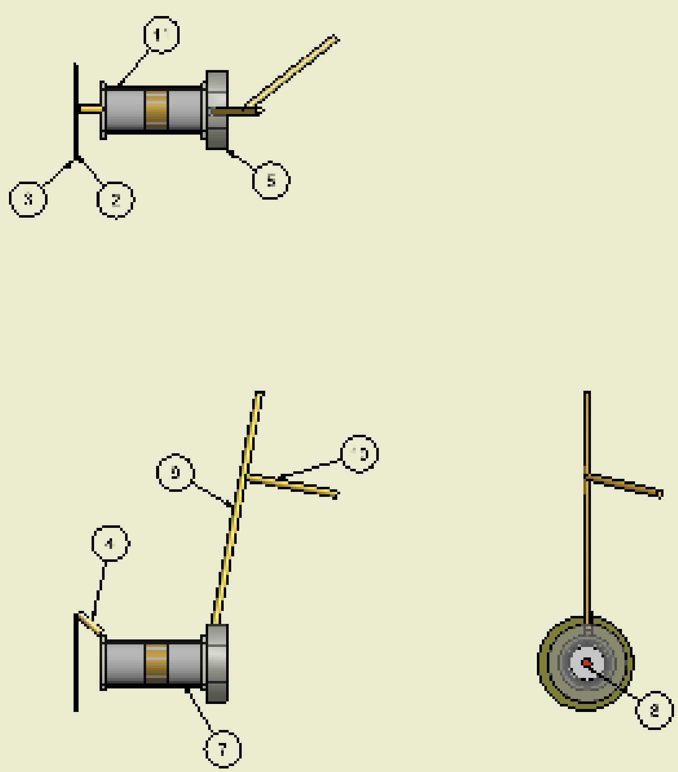
LLE X-Ray Spectrometer
Streak of Chlorine Emission



Double cylinder adds an inner shell

- **Al or Cu wire in center provides a hard reflector for the main shock**
- **Wire: 700 μm long**
- **Marker layer: 500 μm long**





Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
2	1	CYLMIX Be backlighter disc	
3	1	CYLMIX Iron backlighter disc	
4	1	CYLMIX backlighter mounting stalk	
5	1	CYLMIX leaded acrylic aperture	
6	1	CYLMIX gold marker band	
7	1	CYLMIX gold double shell foam	100 mg/cc
8	1	CYLMIX gold double shell inner shell	
9	1	CYLMIX mounting stalk	
10	1	CYLMIX rotation fiber	
11	1	CYLMIX [illegible] ablator	

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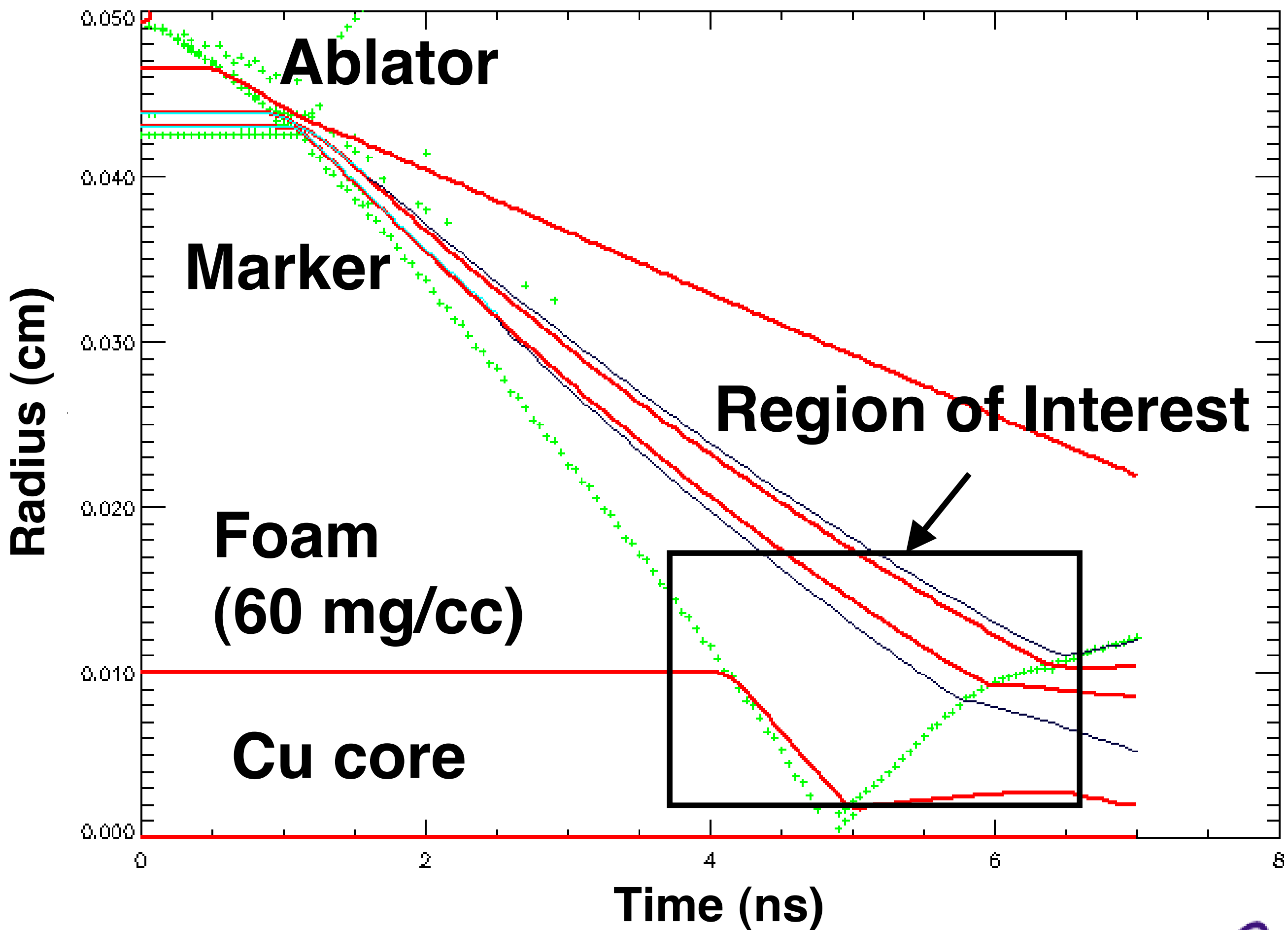
Gold Double Shell Assembly

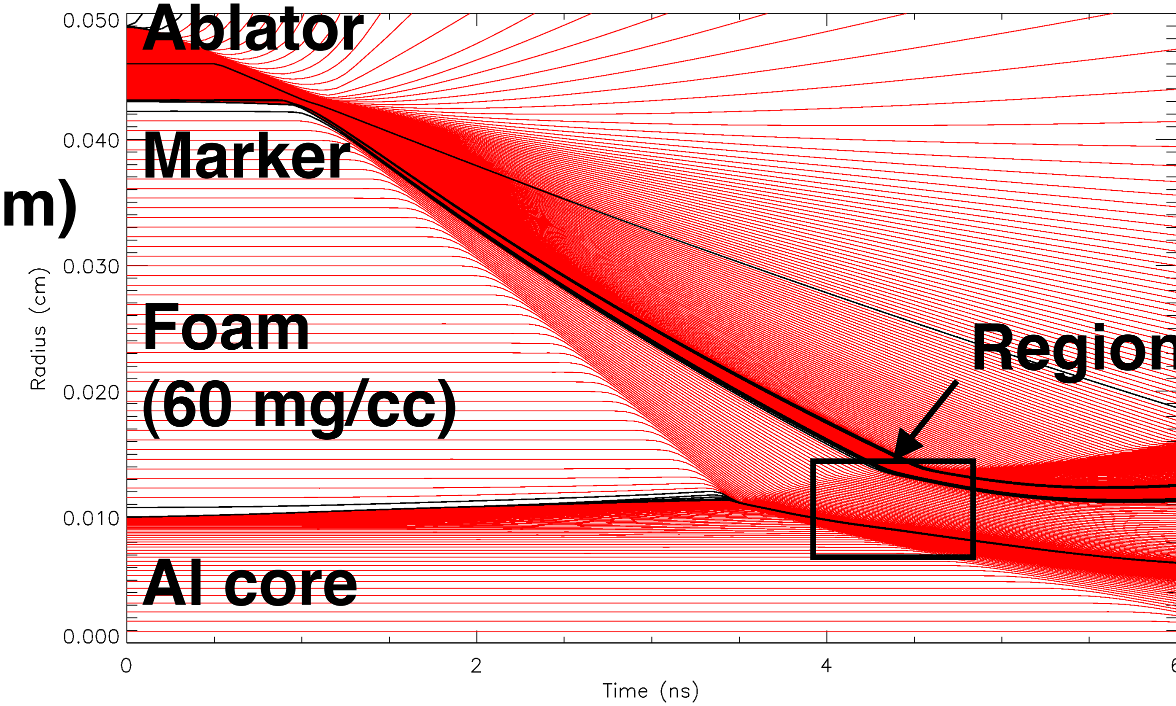
CYLMIX gold double shell assembly detail drawing

Intershell region undergoes strong shocks and mix

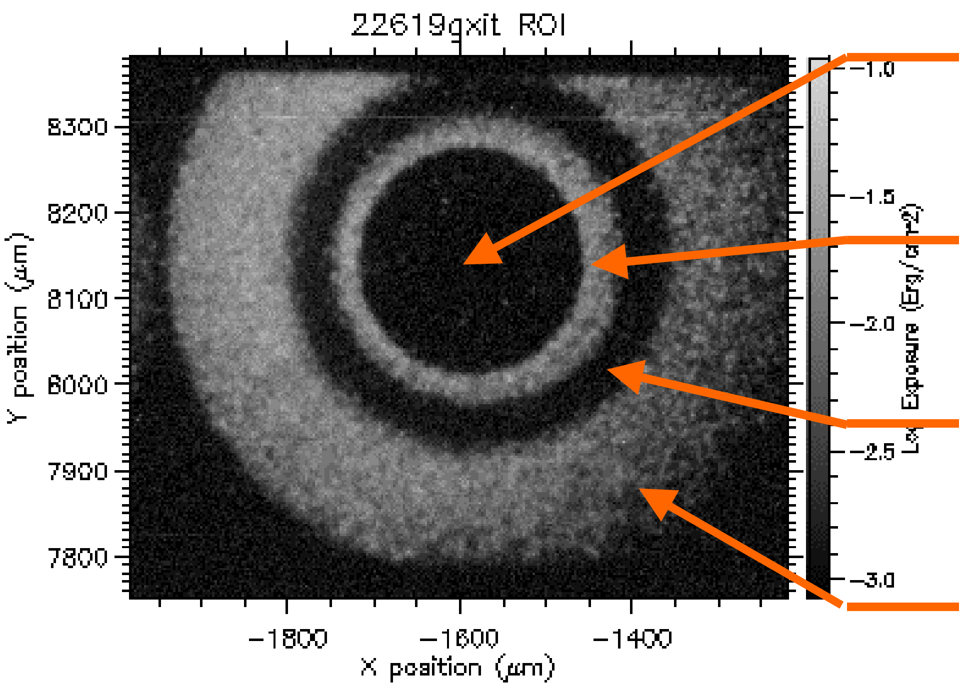


Time/space regions of interest

- Proof-of-principle experiment based on low-mix design
- Solid, centered Al “shell”
- Want to diagnose mix between shells



Intershell region clearly visible



Cu center shell (opaque)

Foam between shells (transparent)

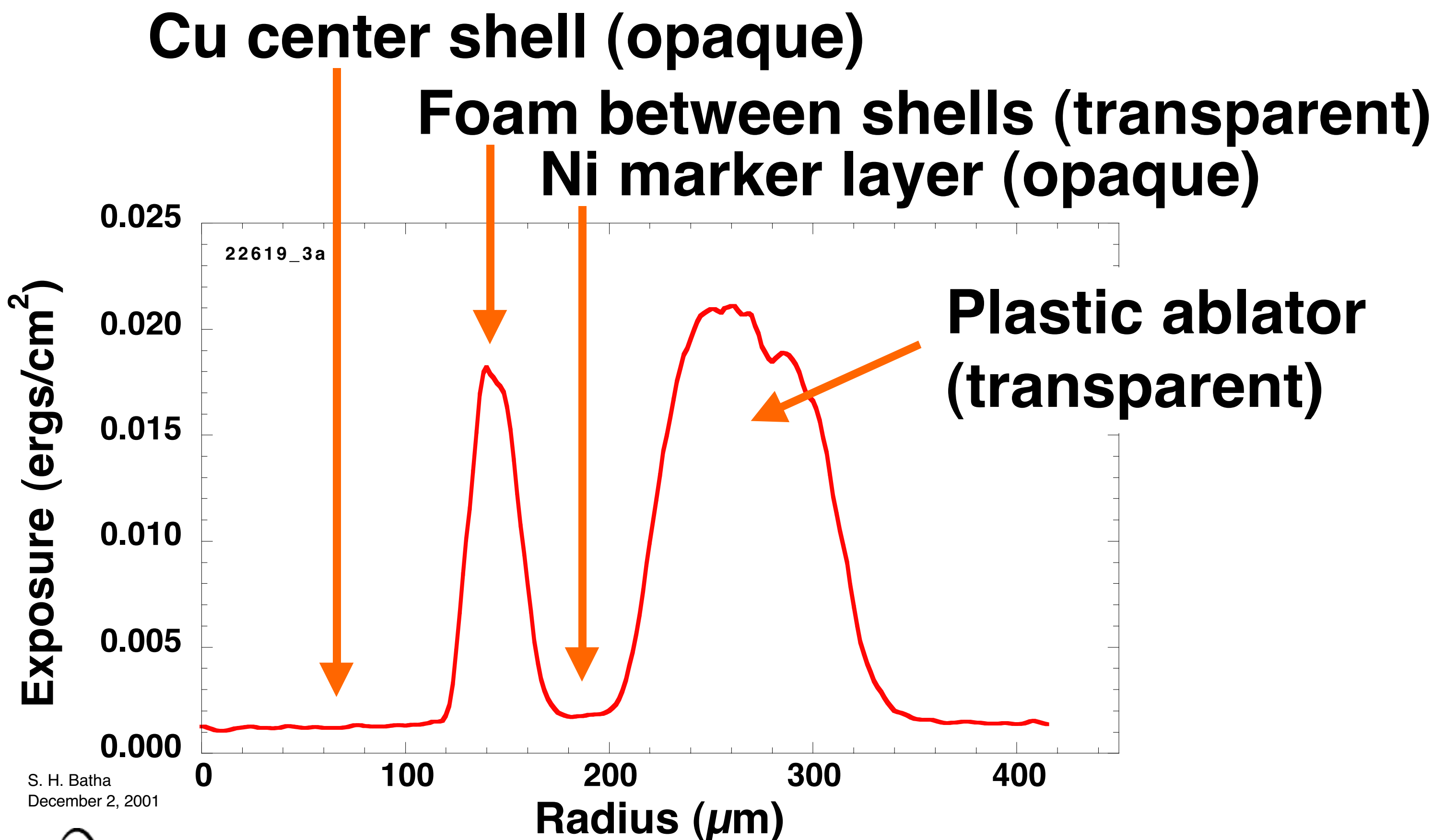
Ni marker layer (opaque)

Plastic ablator (transparent)

- **Marker mixes into foam and ablator**
- **Radiograph at 6.9 keV (Fe K-shell)**
- **Backlighter intensity varies smoothly across image**

Radial lineout shows different regions

- **Average radial transmission profile**



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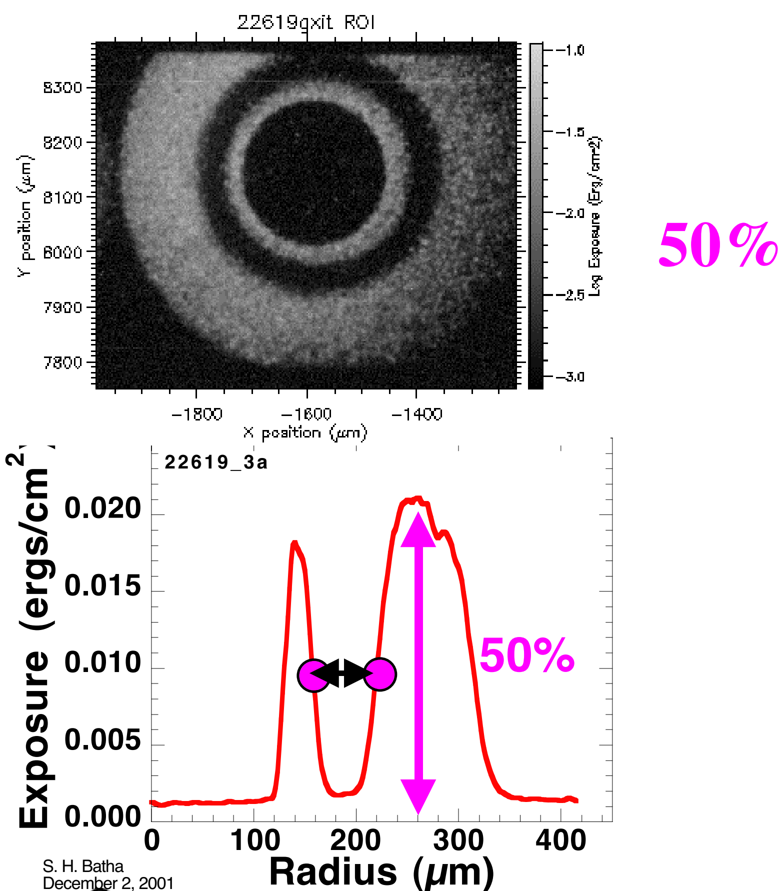
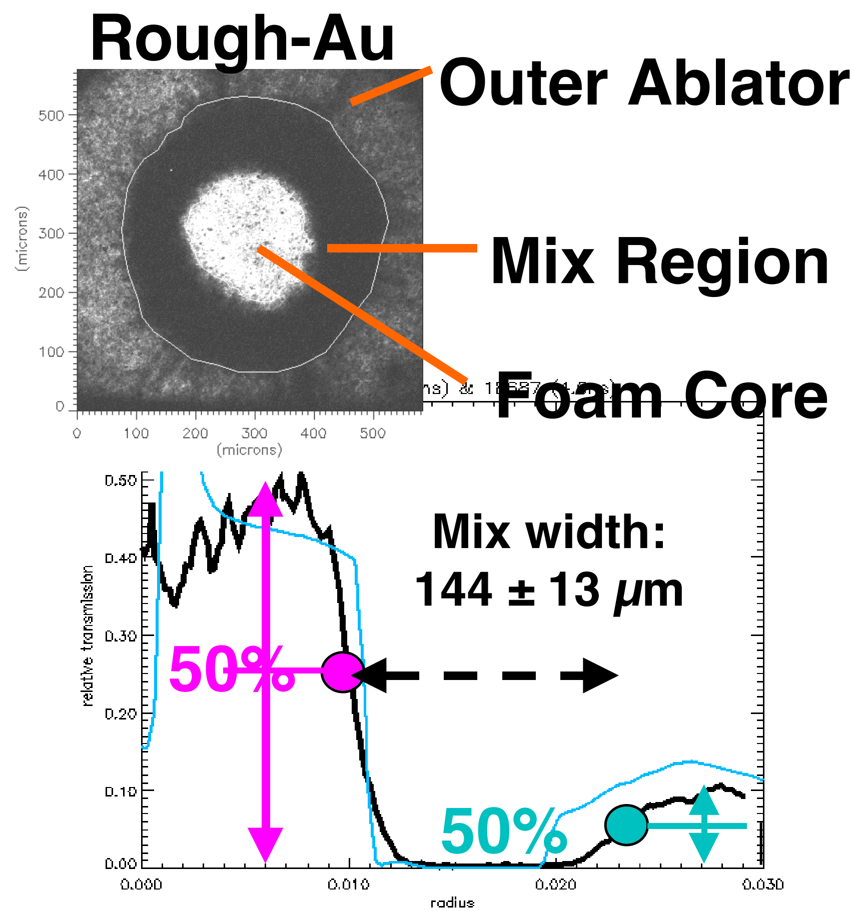
Compare double to single cylinders





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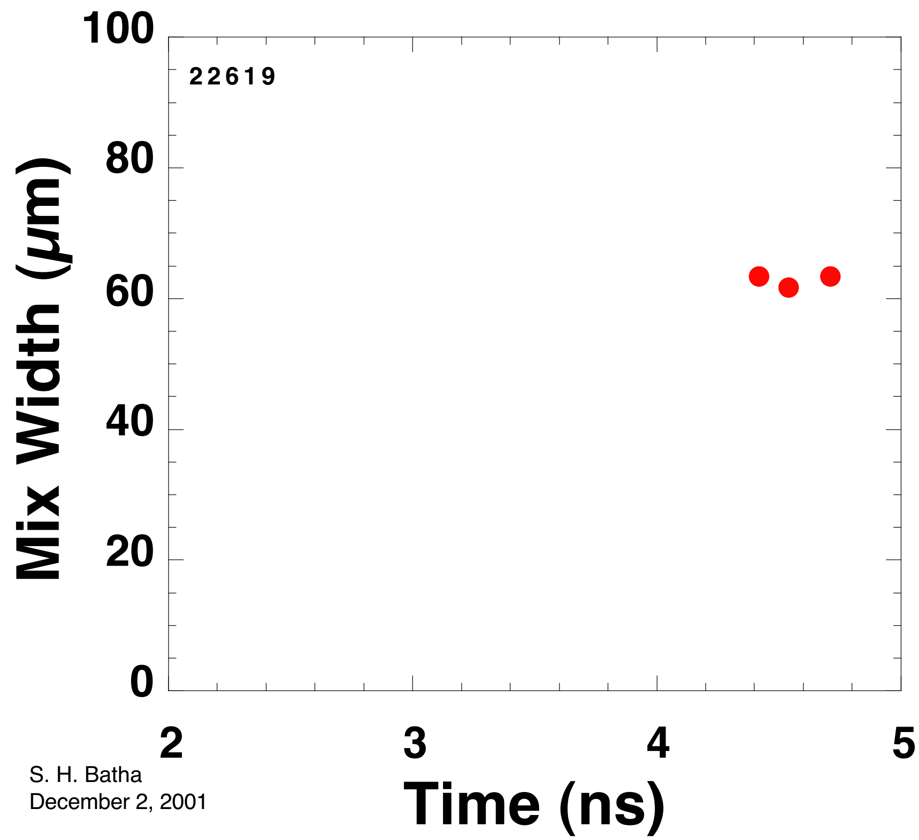
Marker layer has expanded near peak compression

- **Marker/inner shell separation initially 290 *μ*m**
- **4-*μ*m-thick Ni marker**
- **Mix width ≈ 65 *μ*m**



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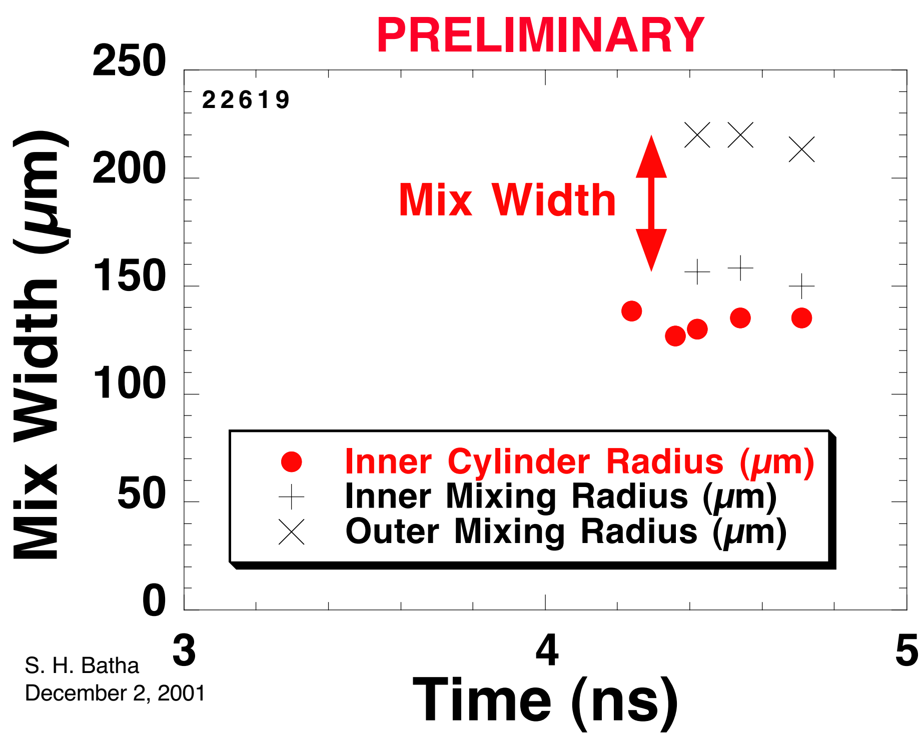
Dynamics of implosion as expected

- Little change in outer-shell radius seen over 400 ps
- Central shell has not expanded (initial radius ≈ 140 μm)



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Conclusions

- Double-cylinder targets can be built and fielded

- Excellent radiographic data of intershell region obtained

- Central shell does not expand during experiment

- Mixing observed

- See Kenny Parker's poster (C28)