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Title: RADIATION DRIVE WITH A COMPOSITE LASER PULSE SHAPE

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Radiation Drive with a Composite Laser Pulse Shape

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Outline

- Motivation
- Pulse Shapes
- Synchronization – timing of the pulses
- Hohlraums
- Radiation Temperature
  VISAR
  DANTE
- Cork Popping – the ejection speed of a sample!
- Au Influx – the filling of the target
- Front Lighting – face-on imaging of the samples
- Summary

Motivation

- NIF experiments will be ~20 ns in duration.

- A host of concepts for successful ignition must be tested in NIF-relevant regimes:

  LPI control
  Be anisotropy
  cryogenic systems
  beam phasing and pointing
  energy balance…

- **Objective: to Develop a 6-ns Hohlraum Environment on Omega for Be Anisotropy Studies**

In particular, we are seeking an environment for Be isotropy studies with enough growth times to assess the suitability of Be for NIF ignition capsules.

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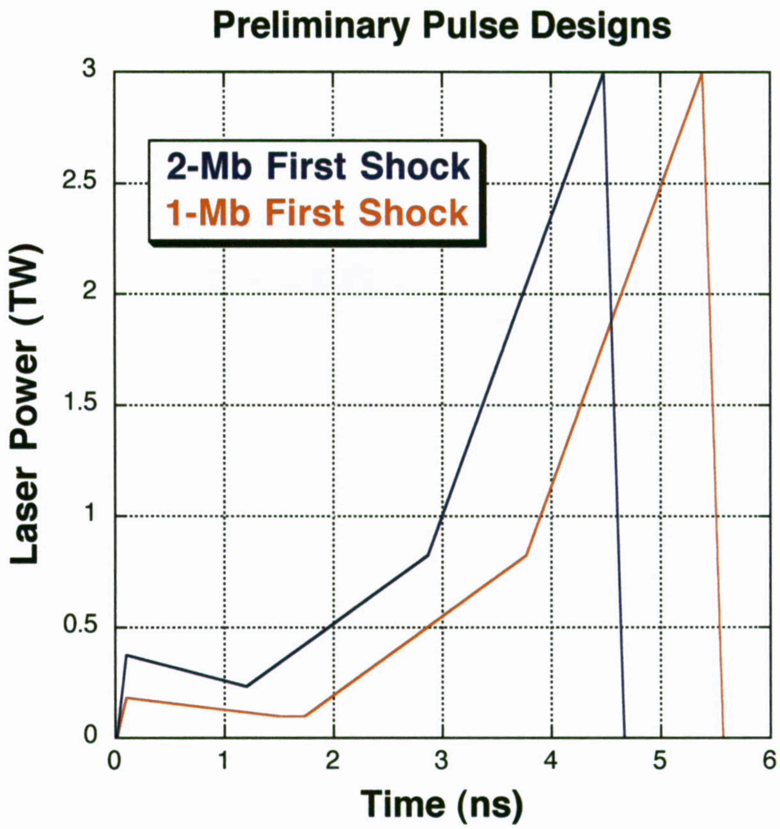
Pulse Shapes

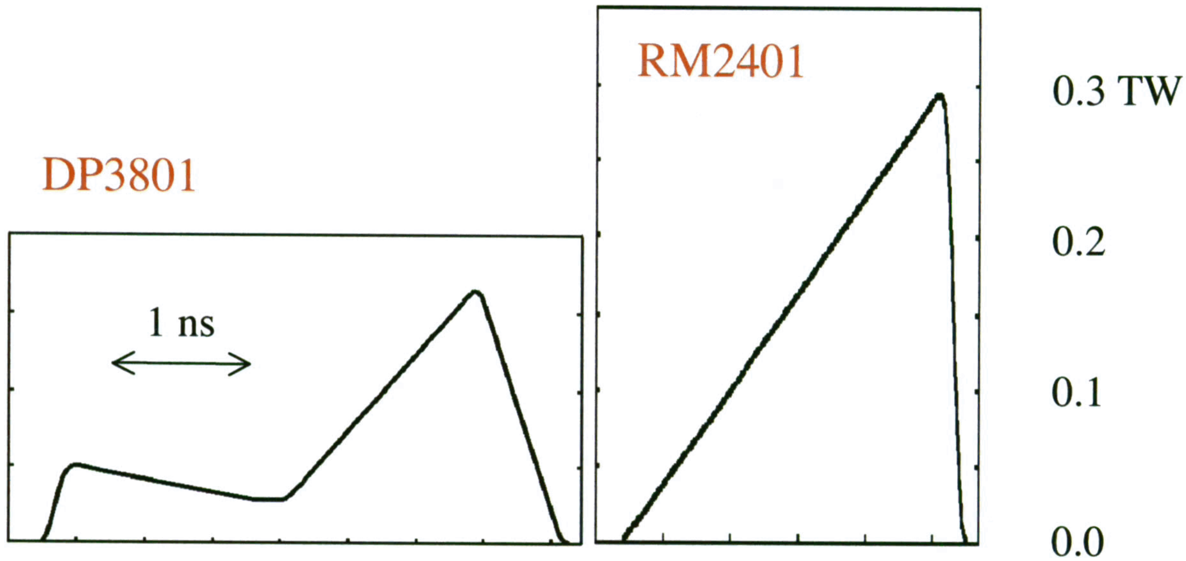


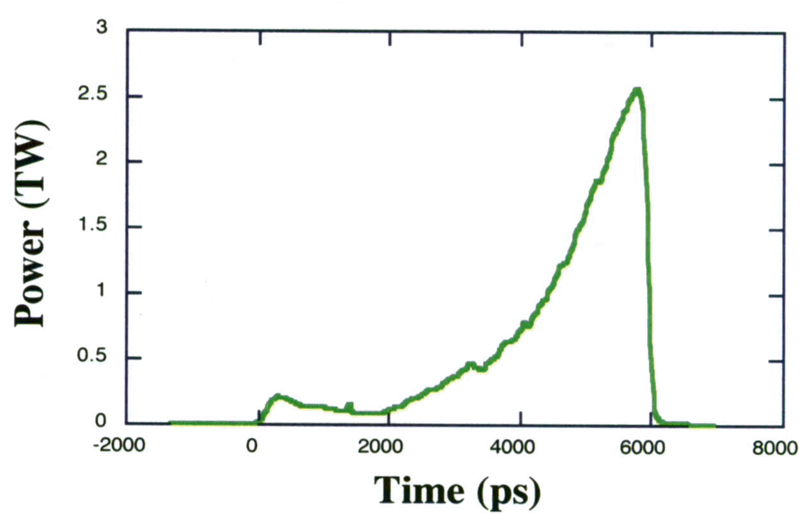
- The problem is that typically the Omega laser runs out of gain for such long pulses.

- We decided to compose an integrated hohlraum drive out of separate pulse shapes – one to represent the foot of the drive for ~3.5 ns and one to carry the bulk of the drive at the end of the pulse.

The Composite Pulse!

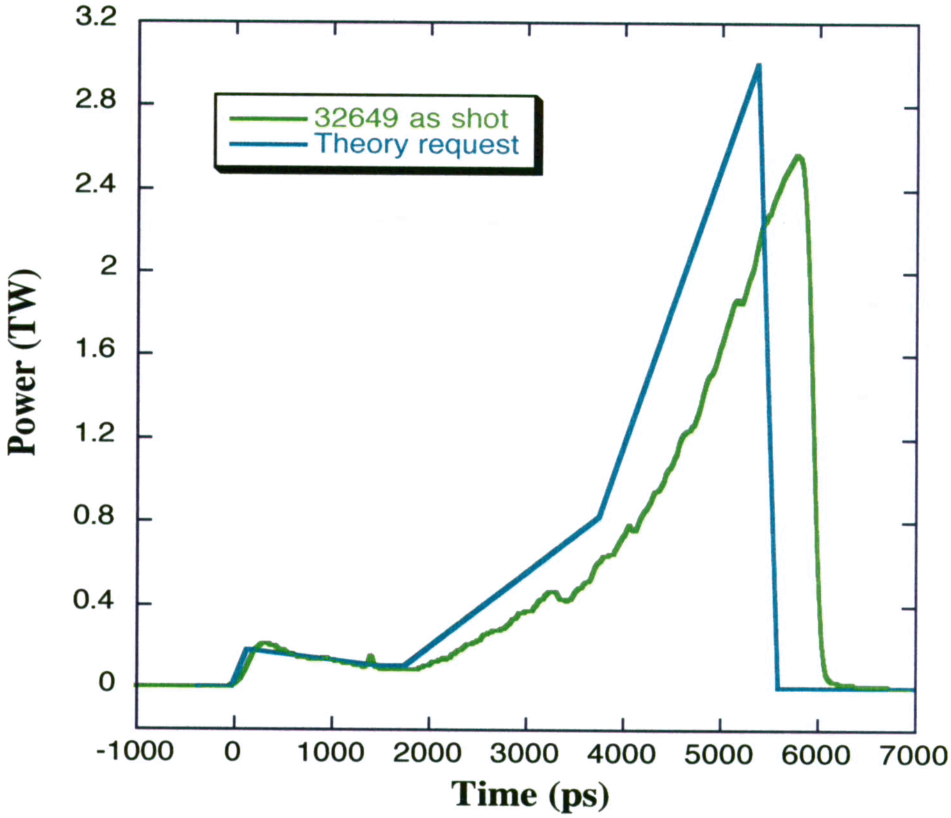
- Two new Omega pulse shapes were specially fabricated under the direction of Keith Thorp and John Marciante of the University of Rochester: DP3801 and RM2401. A third alternate 'foot' pulse, DP2801 was also constructed.





Three 'foot' beams and **ten** 'drive beams' were employed.

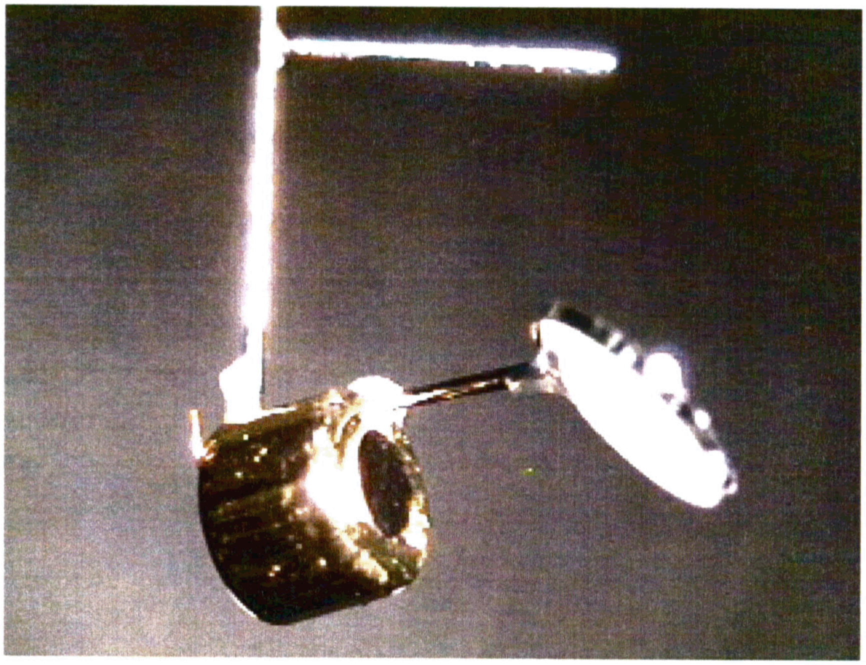
First Attempt at the '1-MB' Pulse



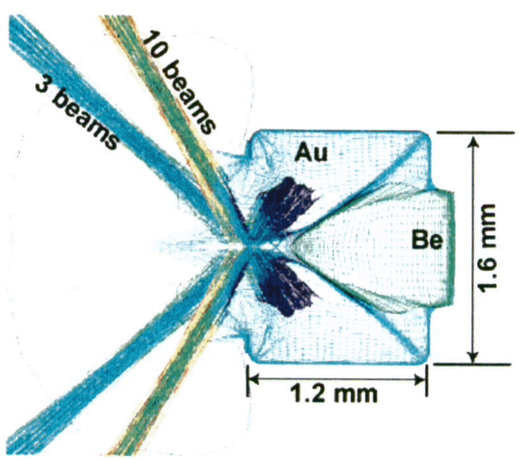
Energy budget: Foot -- > 700 J, ramp -- > 3.5 kJ
Total energy on target > 4.2 kJ

Synchronization was accomplished by varying the timing between the two pulse shapes and monitoring with a streak camera. (Thanks to Bill Donaldson, LLE.) In addition, the lowest energy Dante channel (35 – 75 eV) was useful for observing 'discontinuities' in the x-ray record.

Hohlraums



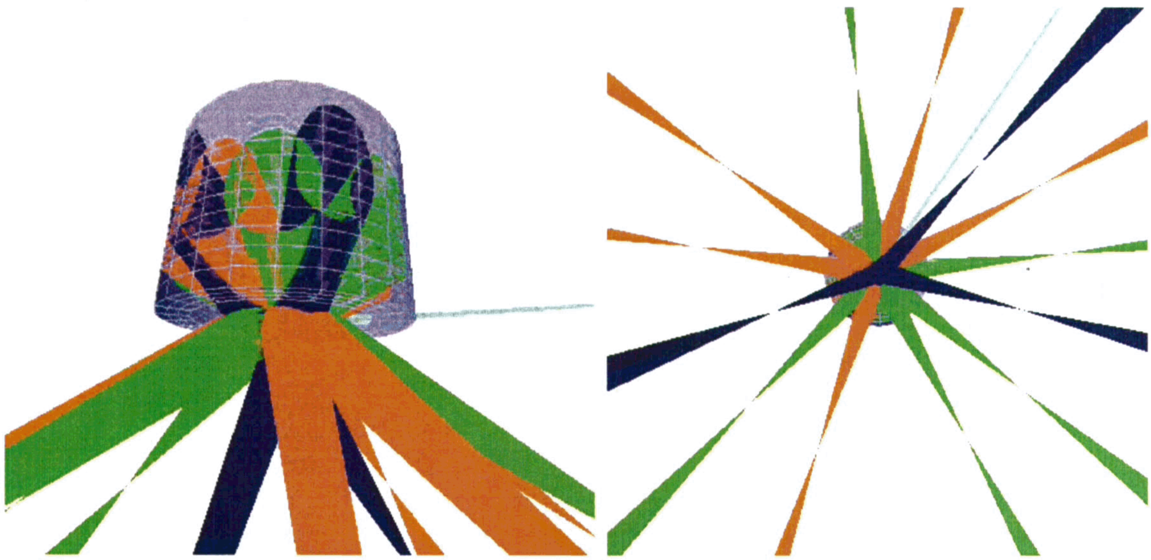
This shows a standard Au 'halfraum' with a VISAR mirror for alignment with TIM 5.



- Be package diameter – 0.8 mm, single LEH – 1.2 mm
  Packages:
  Wedges (25 – 60 μm thick)
  Sinusoids: 100 μm period, 5 μm peak to peak

Laser Input to Halfraums

- The P-6, P-7 alignment was used at Omega.



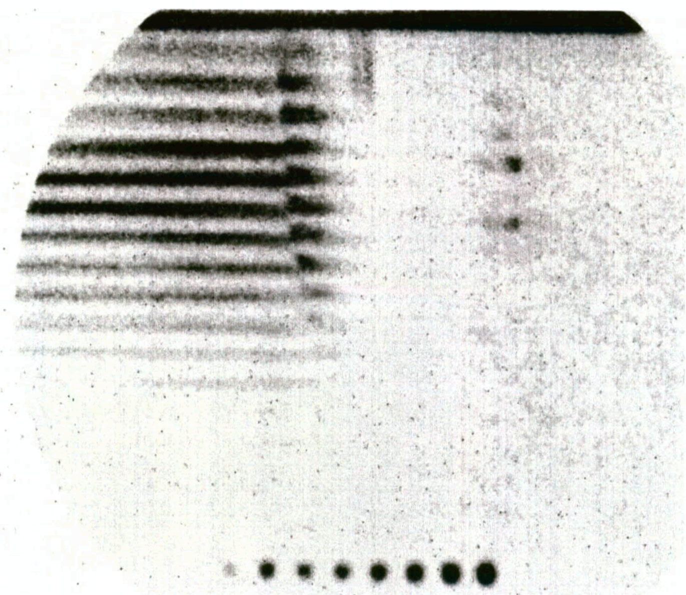
Side-on view of halfraum End-on view

- The dark blue show the three 'foot' beams. Red and green are the ten main 'drive' beams.

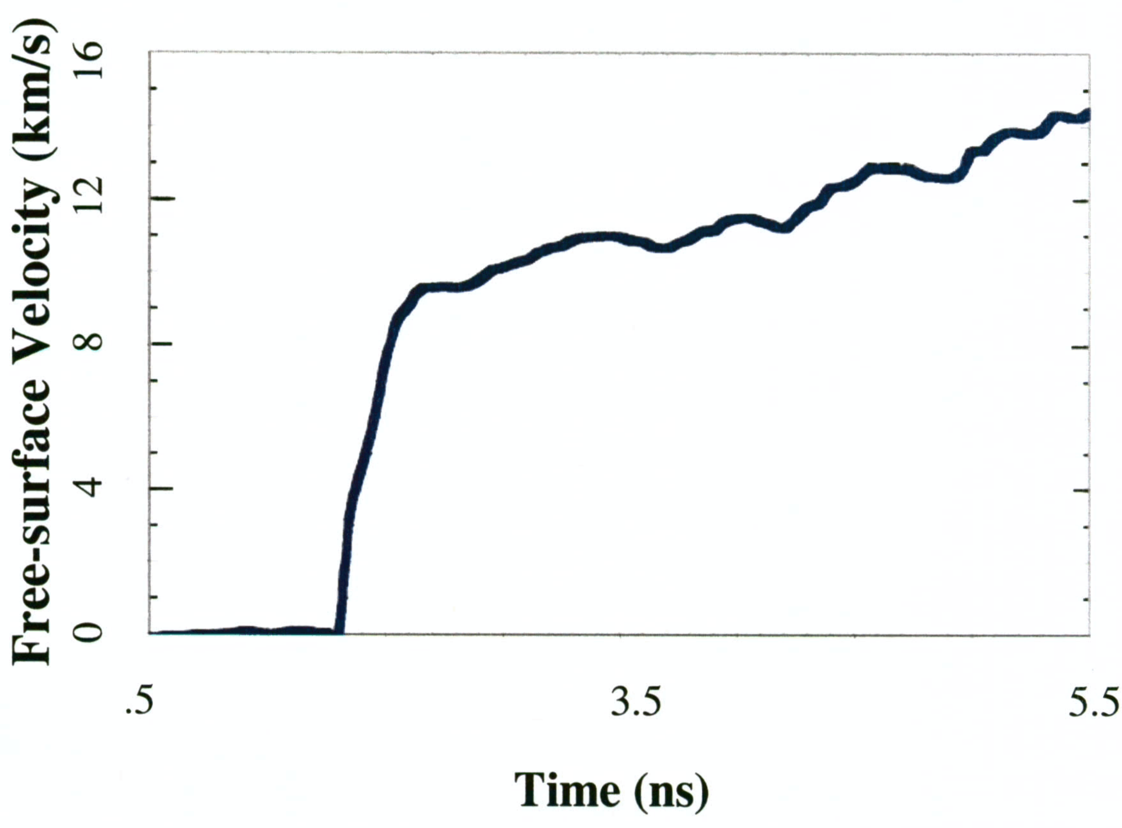
- Symmetries – The foot beams show a quasi-3-fold symmetry. The drive beams, except for one pair, tend to be gathered into a 5-fold symmetry.

- Highest average laser irradiance of the foot beams at the wall is ≤ mid 10^{13} W/cm^2 – below the threshold for M-band emission $\Rightarrow$ preheat mitigation!

VISAR with Al Mirror

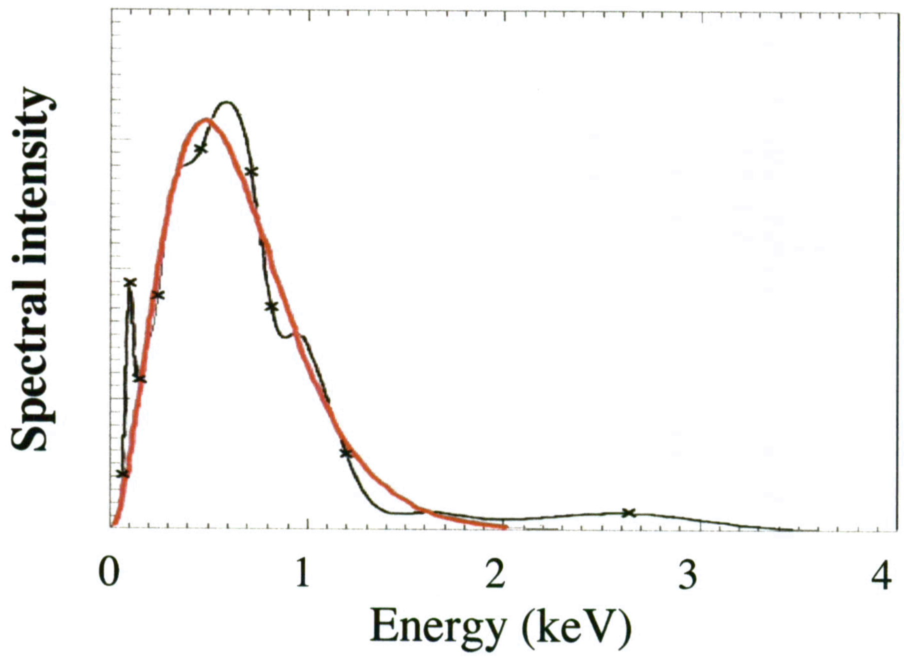


Raw VISAR data showing shock breakout

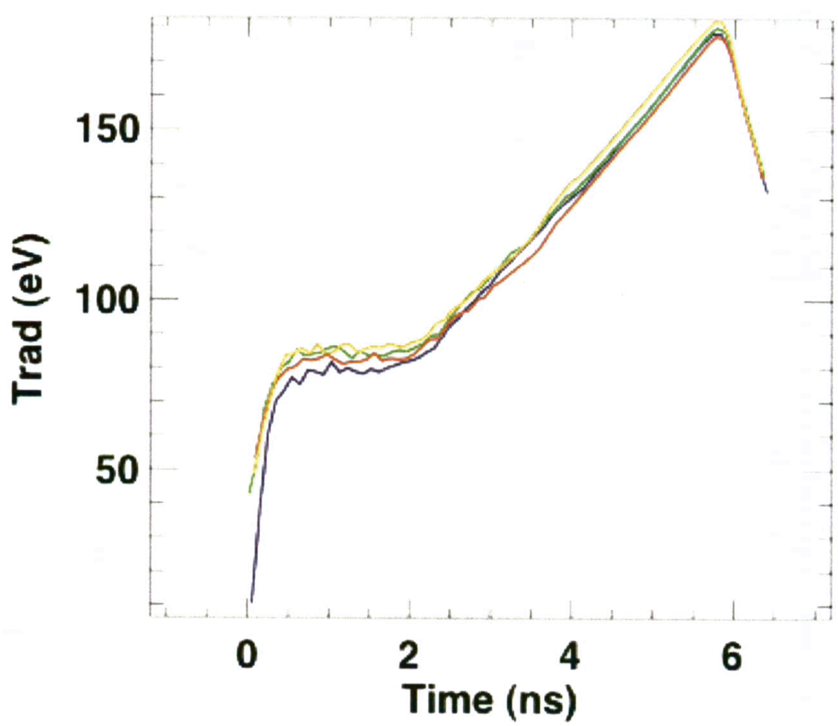


Remember 10 – 12 km/s…

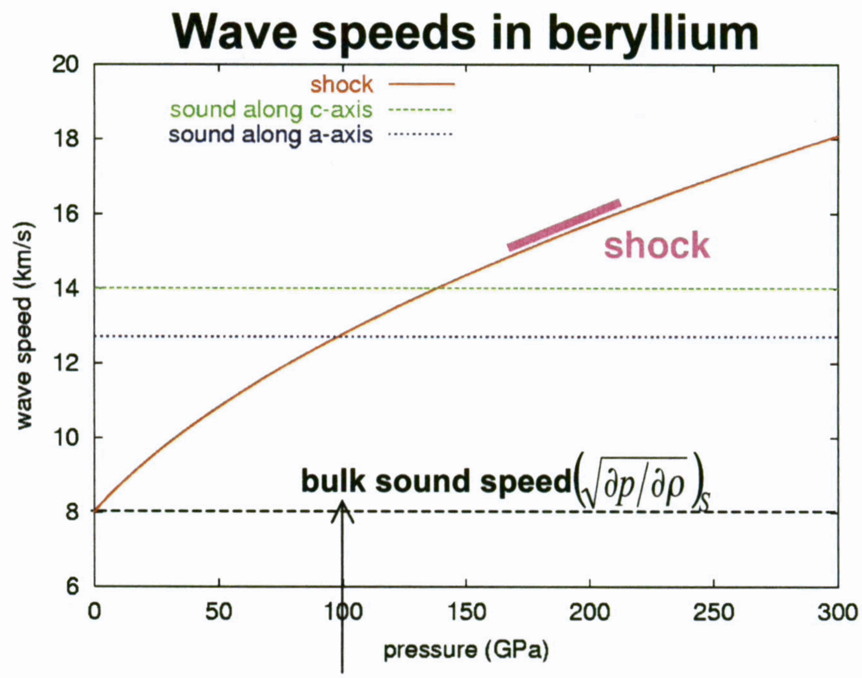
Dante Records



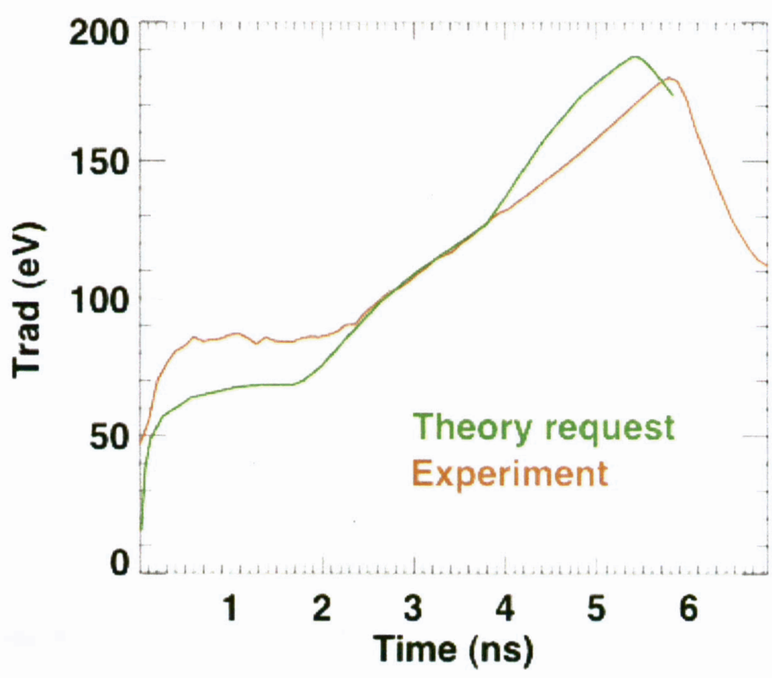
- Dante unfold @ 5.8 ns – 170 eV



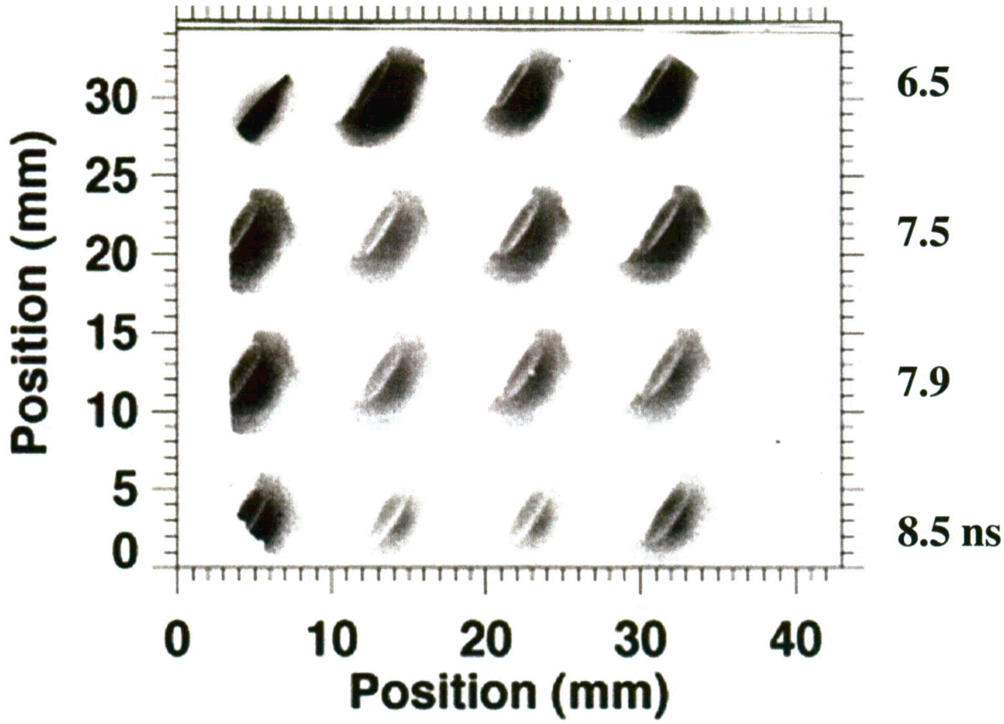
How good is the drive?



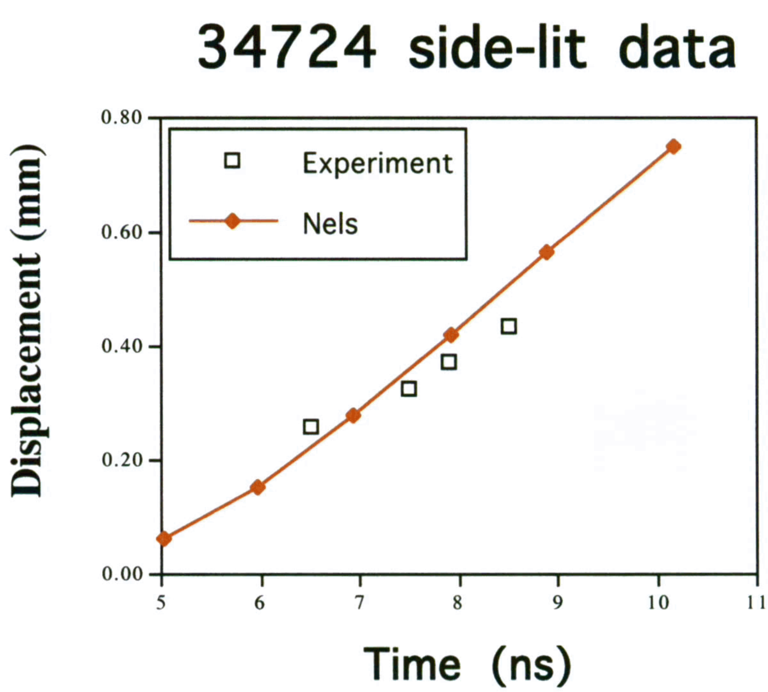
- VISAR data ⇒ 1 Mbar ~ 100 GPa @ ~4.5 ns.



Corking Popping

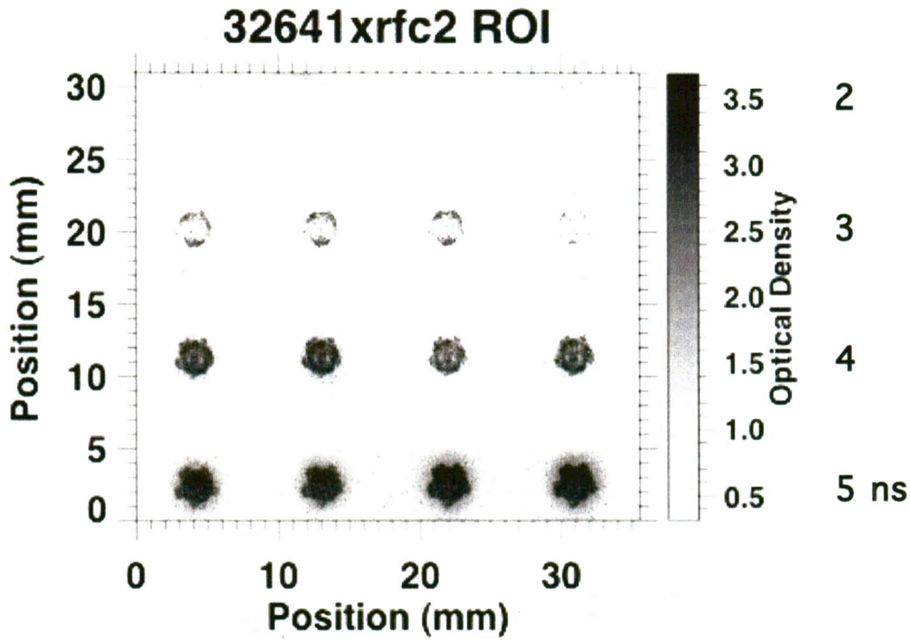


Sidelighting @ 1.6 keV



Velocity ~ 9 x 10^6 cm/s ± 20%

Au Influx from Wall

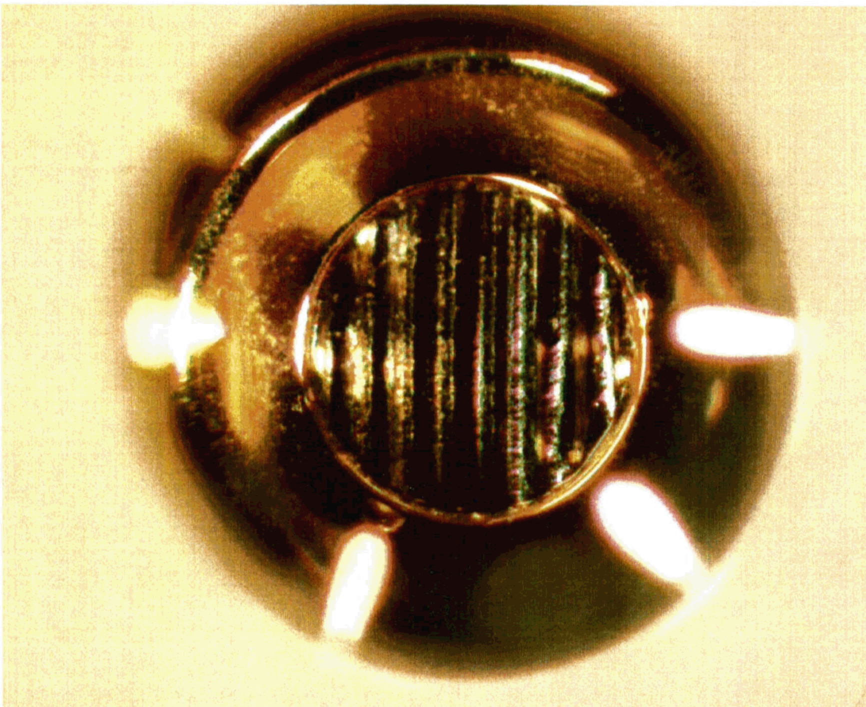


- In about 1 ns (between 3 and 4 ns), the slowest component of the Au has moved ~300 μm at a speed of ~3 x 10^7 cm/s.

- The fastest Au ions already appear to have stagnated on axis by the third ns of the drive as evidenced by the tiny black dot in the centers of the images.

- By 5 ns, the emission from the LEH is heavy and uniform. We have not yet resolved whether this is 'inside' or at the LEH of the halfraum.

Face-on Radiography

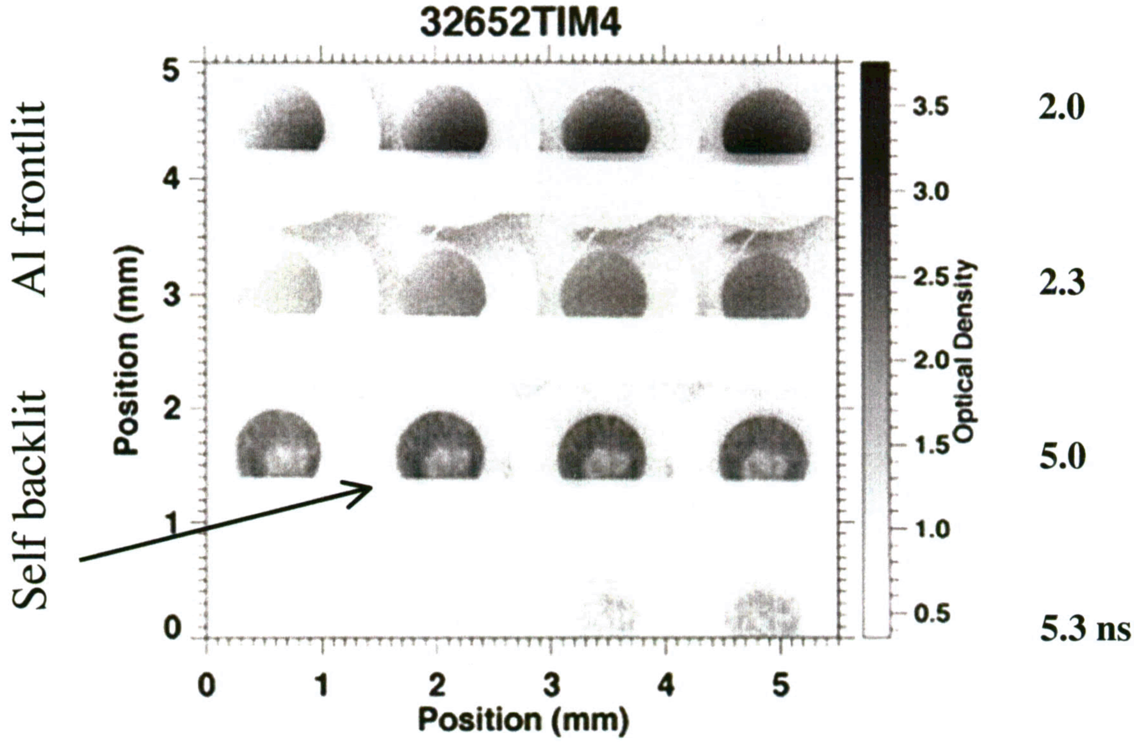


Sinusoidal Be target

λ ~ 100 μm

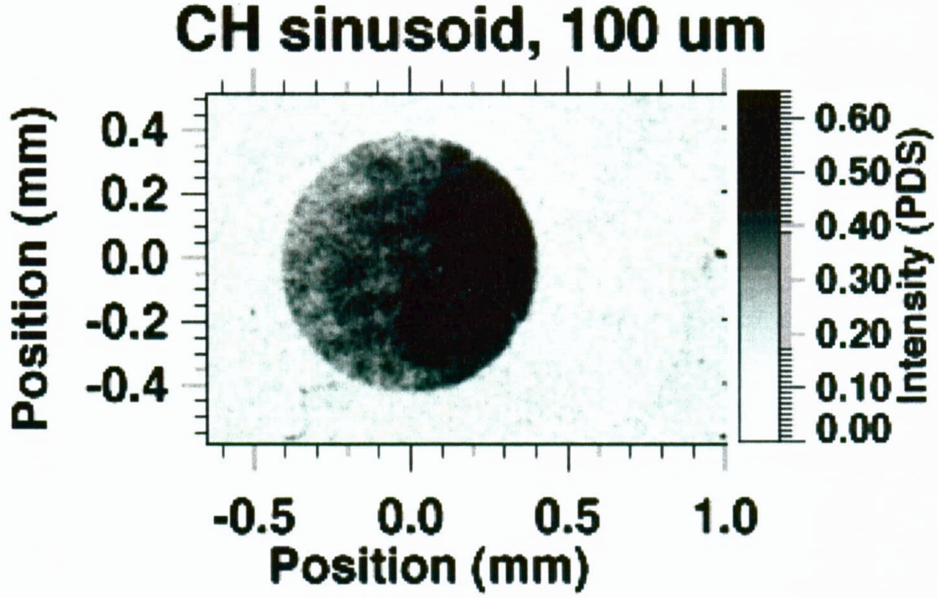
A ~ 2.5 μm

φ ~ 800 μm



Gated images of sinusoids

Backlighter Optimization: an Unfinished Task



#34727 100-μm CH with few μm amplitude
Time: ~ 3.6 ns Notice the low film exposure.

- The need to address the Au migration problem suggests gas-filled targets, which implies a drive penalty.

- This summer, we will test both the 1- and 2-MB drives with both 3 and 6 foot beams.

Summary

In 20 shots to date, we have:

- synchronized 2 laser pulse shapes at Omega to obtain a smooth halfraum drive for ~6 ns,
- characterized the drive with Dante (~180 eV peak),
- obtained high quality VISAR data (using a mirror),
- measured ejected Be sample velocity ,
- made the first estimates of Au migration to the axis of the vacuum halfraum, and
- collected the first face-on x-ray images of sinusoidally perturbed Be samples.

The immediate objective is to qualify a target for the Be studies. To that end, we hope:

- to explore alternate foot drives
- optimize the radiography, and
- to field and characterize gas-filled targets within the next 6 months.

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