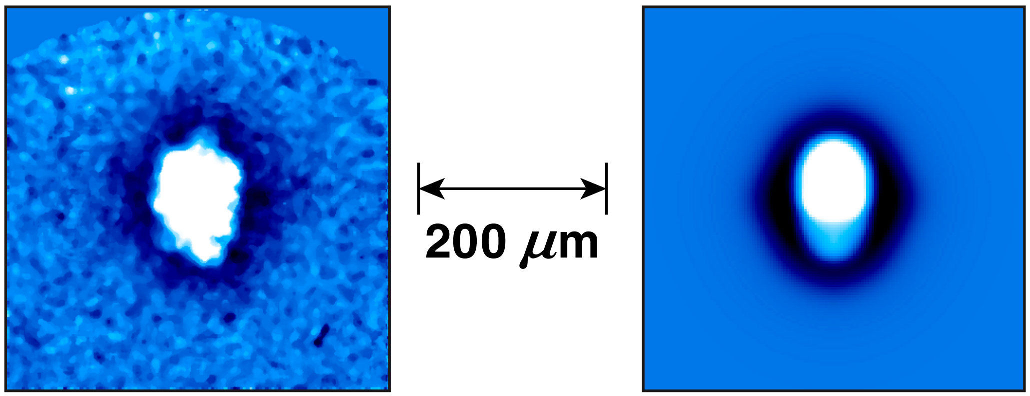
Low-Adiabat, Polar-Drive-Implosion Experiments on OMEGA

OMEGA shot 52136, Saturn target, 15-atm-D_2-filled, 24-μm CH shell, LA1501 pulse shape



Experiment — ***DRACO*/Spect3D**

Ti backlit images
~4.7 keV
View angle θ_v = 63°

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Summary

Low-adiabat, polar-drive experiments on OMEGA are validating the NIF designs

- Shaped pulses are used to keep the main fuel layer on a low adiabat (~3).
- Beam repointing is used to optimize the implosion symmetry on both standard and Saturn-type targets.
- Measurements of implosion core size and shape determined from framed x-ray radiographs compare favorably to 2-D *DRACO* simulations.
- Inferred areal densities agree with values determined from D^3He proton spectra.

Recent publications:
F. J. Marshall *et al.*, J. Phys. IV France 133, 153 (2006).
J. A. Marozas *et al.*, Phys. Plasmas 13, 056311 (2006).

Related Talk:
A. Shvydky (TO5.00007).

Collaborators

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Massachusetts Institute of Technology
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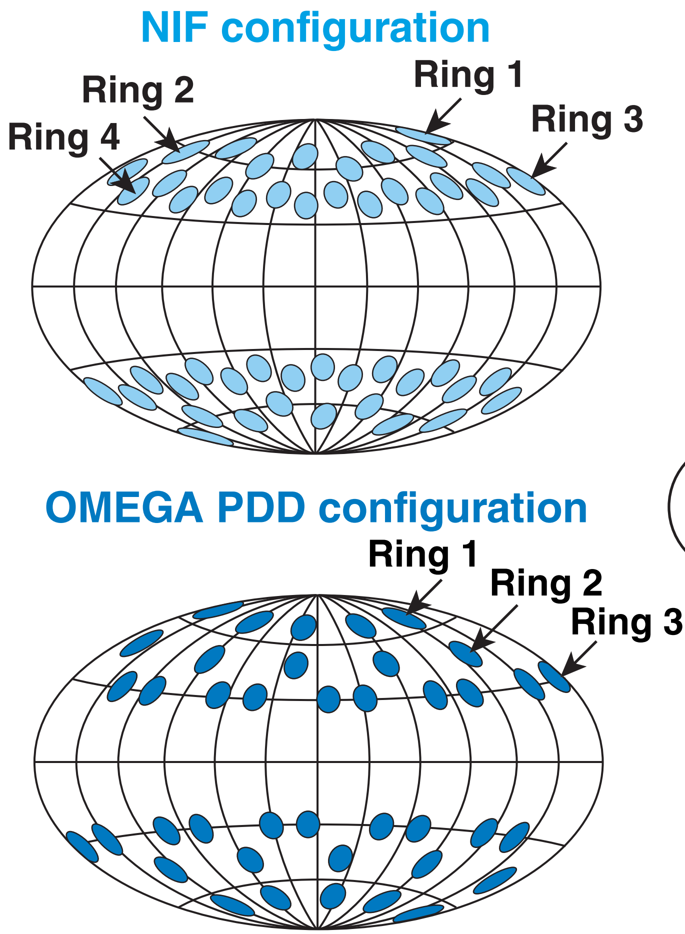
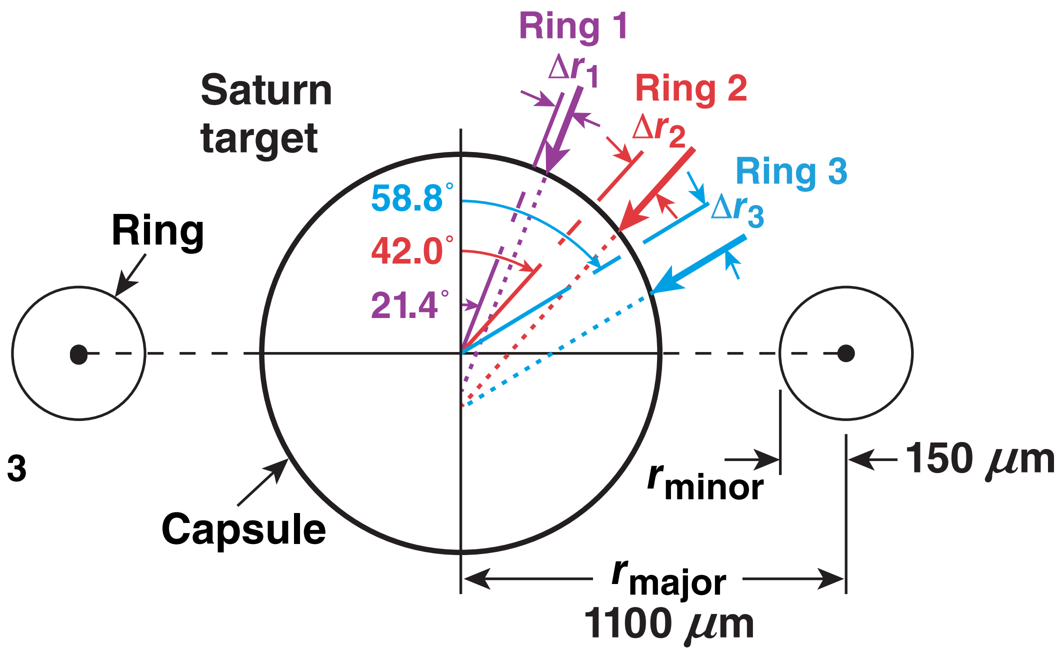
Forty OMEGA beams are used to emulate the NIF 192 beam (48 quad) indirect-drive configuration





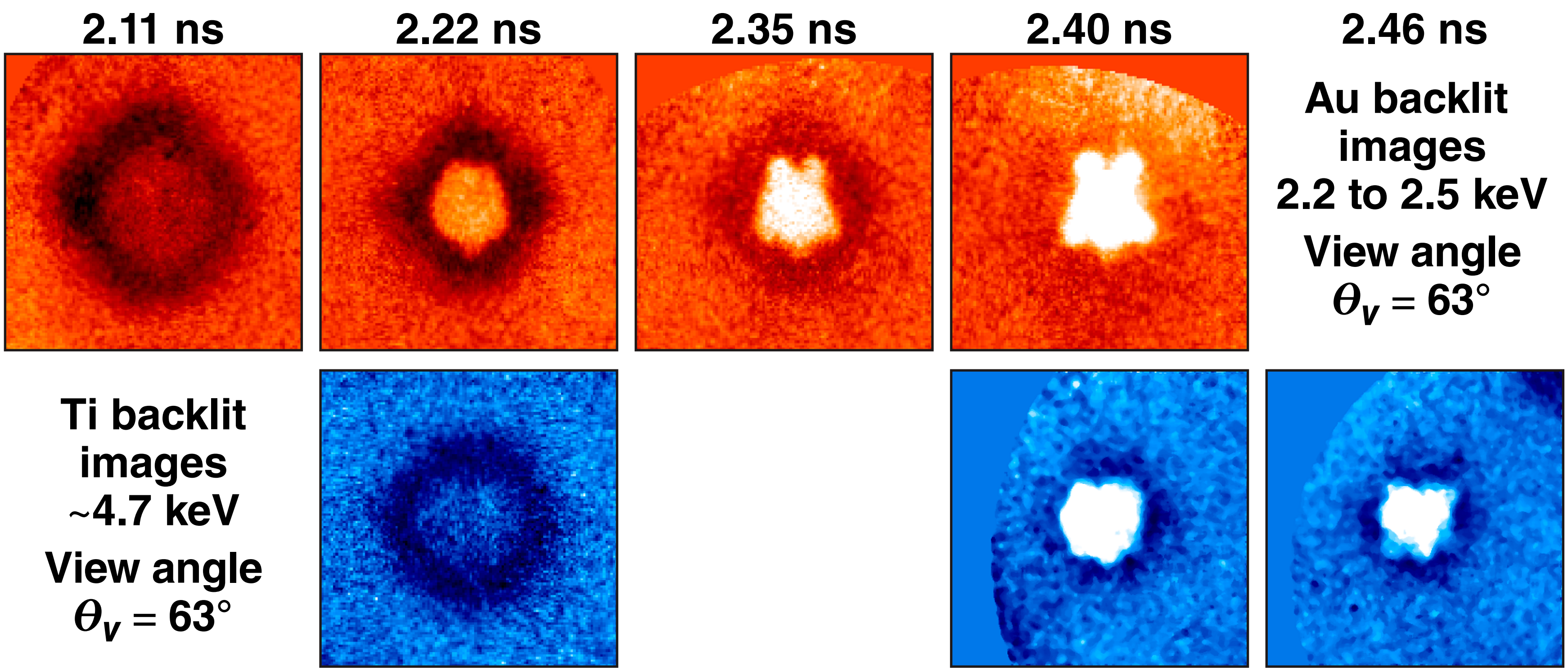
- The OMEGA beams, in six rings from 21° to 59°, are used to emulate the NIF geometry.
- Additional OMEGA beams are used for x-ray backlighting.

E14113

Comparison of low- and high-energy backlit images reveals details of the evolution of the fuel and shell

UR LLE

OMEGA shot 49331, polar-driven standard target, 15-atm-D_2-filled, 24-μm CH shell, LA1501 pulse shape



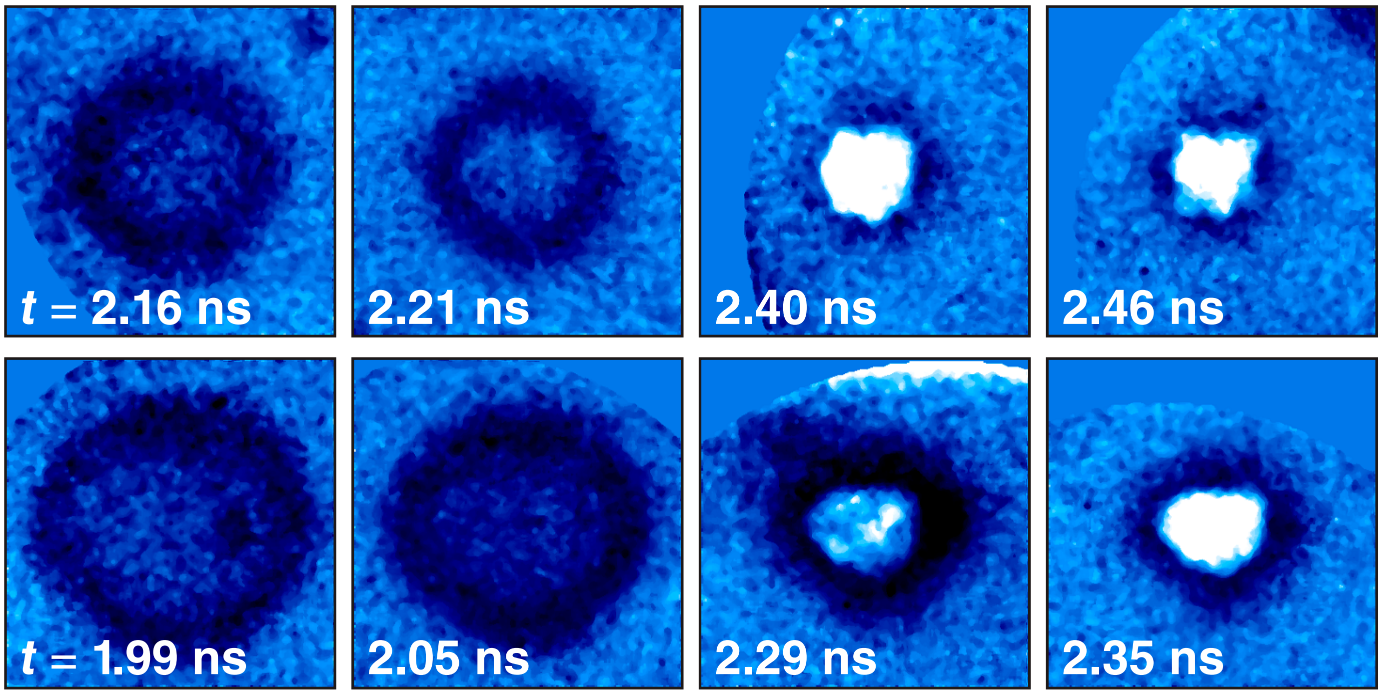
The higher-energy backlighter more clearly delineates the shell and fuel at stagnation.

E17402

Standard targets require a larger beam offset to optimize implosion symmetry *

UR LLE

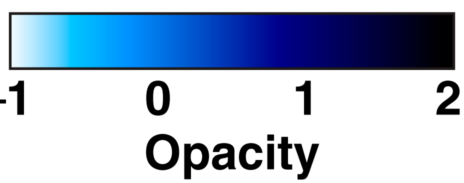
Polar-driven standard target, 15-atm-D_2-filled, 24-μm CH shell, LA1501 pulse shape



Shot 49331
90,150,150-μm offset pointing
Ti backlit images
~4.7 keV

Shot 52135
90,120,120-μm offset pointing
Sc backlit images
~4.3 keV

400 × 400-μm regions



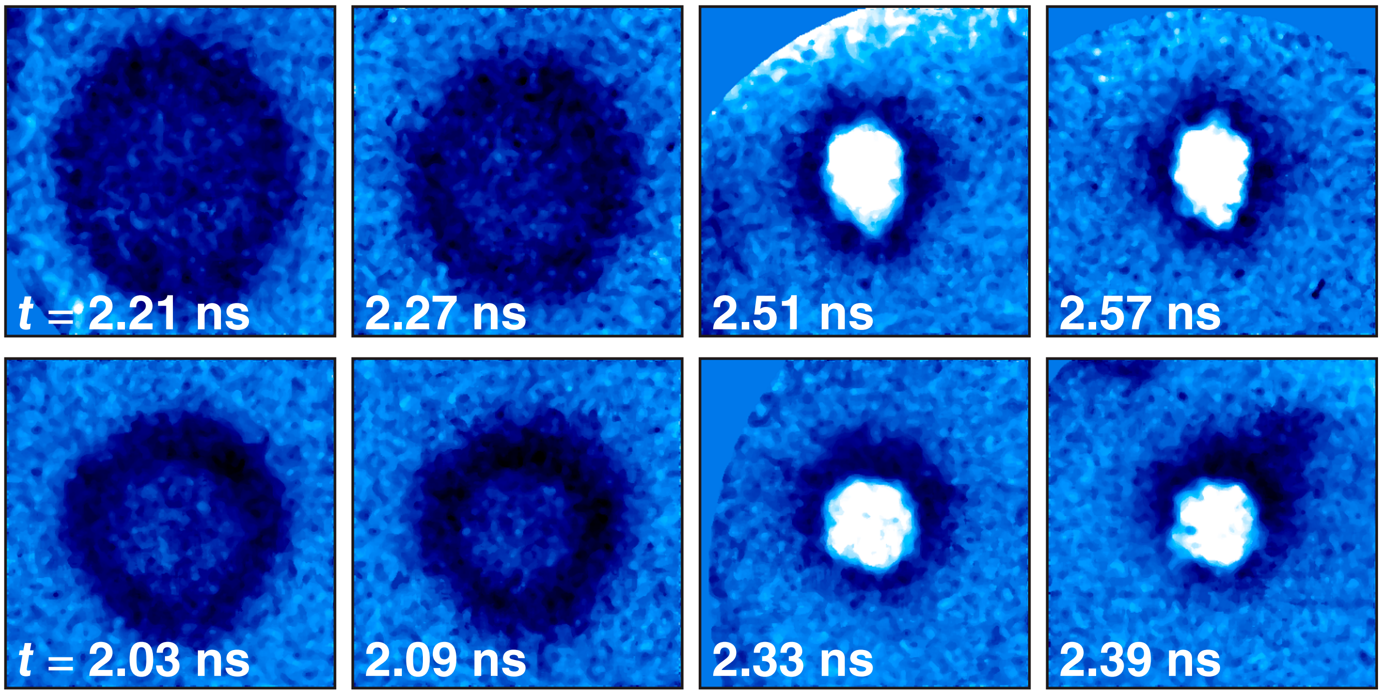
(<0 is emission) View angle θ_V = 63°

E17403

*F. J. Marshall *et al*., J. Phys. IV France 133, 153 (2006).

Saturn-target implosion symmetry is achieved with a smaller beam offset relative to standard targets*

Polar-driven Saturn target, 15-atm-D_2-filled, 24-μm CH shell, LA1501 pulse shape



Shot 49333
90,150,150-μm offset pointing
Ti backlit images
~4.7 keV

Shot 52136
90,120,120-μm offset pointing
Sc backlit images
~4.3 keV

400 × 400-μm regions

(<0 is emission)

View angle $\theta_v = 63°$

E17404

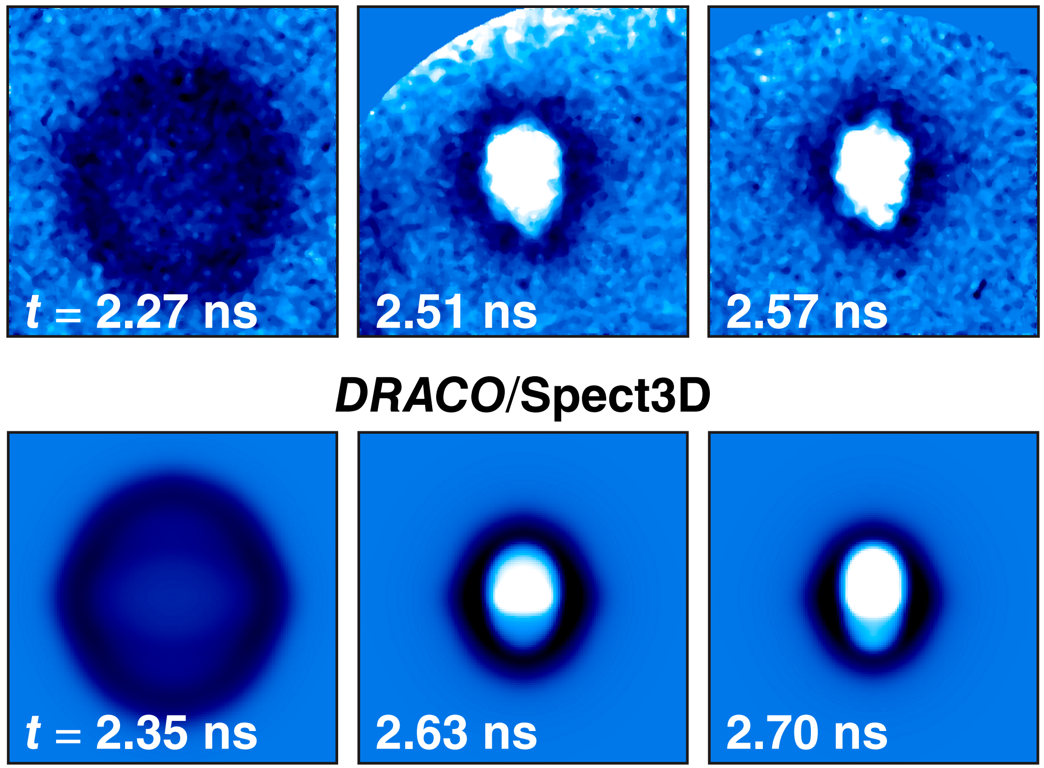
*R. S. Craxton *et al*., Phys. Plasmas 12, 056304 (2005).

X-ray radiographs and 2-D *DRACO* simulations* show good agreement of both shape and size of the core

OMEGA shot 49333, polar-driven Saturn target, 15-atm-D_2-filled, 24-μm CH shell, LA1501 pulse shape

400 × 400-μm regions

View angle θ_v = 63°



Ti backlit images ~4.7 keV

Simulated backlit images

–1 0 1 2

Opacity

(<0 is emission)

Prolate implosion

E17405

*A. Shvydky (TO5.00007).

Identifing the fuel/shell interface and the outer edge of the shell allows the areal density to be estimated from the x-ray radiographs

$$\rho R_{\text{shell}} = 3\,\rho_0 r_0^2 \frac{\left(\Delta r_0 - \Delta r_{\text{abl}}\right)}{\left(r_{\text{out}}^3 - r_{\text{in}}^3\right)} \times \left(r_{\text{out}} - r_{\text{in}}\right)$$

$$\rho R_{\text{fuel}} = \rho_0 \left(\frac{r_0}{r_{\text{in}}}\right)^3 r_{\text{in}},$$

r_0 = initial radius
ρ_0 = initial density
Δr_0 = initial shell thickness
Δr_{abl} = ablated shell thickness
r_{in} = final fuel/shell interface radius
r_{out} = final shell outer radius

Determination of ρR from radiographs compares favorably with values determined from proton spectra

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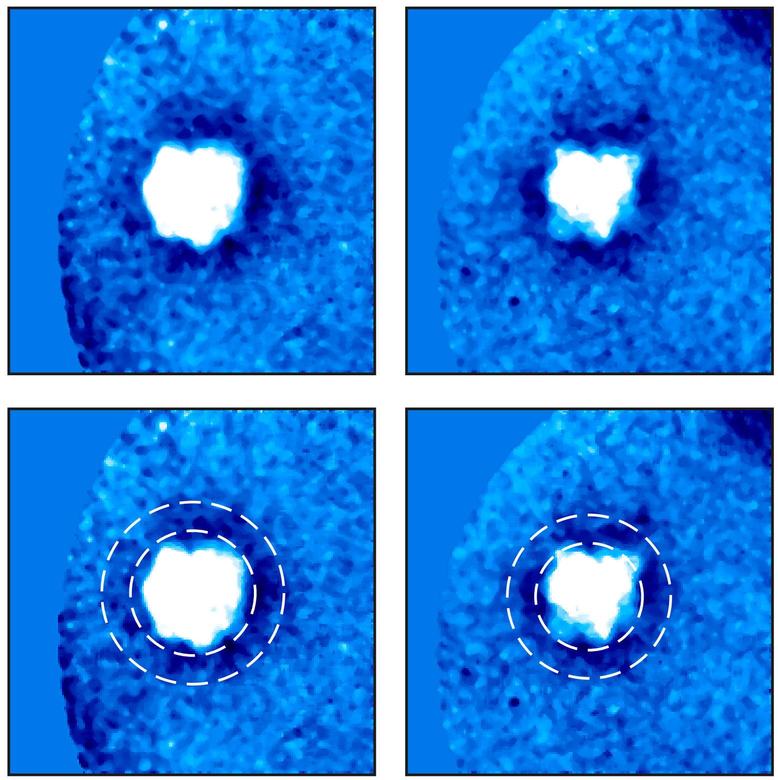
OMEGA shot 49331, polar-driven standard target

ρR values (mg/cm^2)

t = 2.40 ns
$\rho R_{CH} = 50 \pm 5$
$\rho R_{D_2} = 5 \pm 1$
$\rho R_{total} = 55 \pm 5$

$\langle \rho R \rangle_p = 58 \pm 7$
$\rho R_{LILAC} = 88$



ρR values (mg/cm^2)

t = 2.46 ns
$\rho R_{CH} = 54 \pm 5$
$\rho R_{D_2} = 7 \pm 1$
$\rho R_{total} = 61 \pm 5$

$\langle \rho R \rangle_p = 58 \pm 7$
$\rho R_{LILAC} = 88$

The values determined at the two times bracket the value determined from D^{3}He protons.*

E17407

*F. H. Séguin *et al.* Rev. Sci. Instrum. 74, 975 (2003).

Summary/Conclusions

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- Shaped pulses are used to keep the main fuel layer on a low adiabat (~3).
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