Numerical Investigation of Initial Low-Adiabat OMEGA Polar-Drive Implosions

Saturn target

Ring improves equatorial drive

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Concurrence of measured and simulated framed x-ray radiographs demonstrate control of OMEGA low-adiabat polar-drive* implosion symmetry

- Work continues on the verification of the NIF polar-drive (PD) ignition design on OMEGA.
- Earlier experiments optimizing high-adiabat PD implosions were successful in recovering the yield of symmetric implosions done with identical targets.
- Improved numerical sliding-grid algorithm allows better resolution around the Saturn ring and at the ablation surface within the target.
- Experiments are being designed that will demonstrate that low-adiabat PD implosions recover symmetric-illumination yields.

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Related Talk:
F. J. Marshall (NO5.00001).
Collaborators

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Previously high-adiabat PD experiments on OMEGA achieved near-symmetric-illumination yields*

Square laser pulse
\(~15 \text{ kJ}, \alpha \sim 7\ to \ 8\)

\begin{align*}
\text{Laser power (TW)} & \quad \text{Time (ns)} \\
15 & \quad 0.5 \quad 1.0 \quad 1.5 \\
0 & \quad 0 \\
\end{align*}

\begin{align*}
\text{Saturn ring radius scan} & \quad \text{Fraction of symmetric yield} \\
0.9 \quad 1.1 \quad 1.3 \quad 1.5 & \quad 0.00 \quad 0.25 \quad 0.50 \quad 1.00 \\
\text{Saturn ring radius (mm)} & \quad 0 \quad 10^9 \quad 10^10 \quad 10^{11} \\
\text{Standard target } D_2 \text{ yields} & \quad \text{Shell thickness (\textmu m)} \\
14 \quad 18 \quad 22 & \quad 0 \quad 10^9 \quad 10^{10} \\
\end{align*}

Initial low-adiabat PD experiments were performed with two-beam repointing configurations.

LA1501 laser pulse
~13 kJ, $\alpha \sim 3$

X-ray framing camera, $\theta_V = 63^\circ$

<table>
<thead>
<tr>
<th>Ring</th>
<th>Pointing 1 offset</th>
<th>Pointing 2 offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta r_1$</td>
<td>90 $\mu$m</td>
<td>90 $\mu$m</td>
</tr>
<tr>
<td>$\Delta r_2$</td>
<td>150 $\mu$m</td>
<td>120 $\mu$m</td>
</tr>
<tr>
<td>$\Delta r_3$</td>
<td>150 $\mu$m</td>
<td>120 $\mu$m</td>
</tr>
</tbody>
</table>
Eulerian 2-D DRACO simulations with 3-D laser ray trace resolve plasma flow and laser refraction around the ring

- High-resolution Godunov-type scheme
- Nonuniform spherical grid with improved sliding-grid algorithm
- Multigroup radiation-diffusion transport

Mass density (log scale)

![Mass density plot]

$X (\mu m)$

$Z (\mu m)$

$t = 800$ ps
The first beam-pointing case (90, 150, 150-\(\mu\)m offset) is more appropriate for driving standard PD targets.

**OMEGA shot 49331 standard target**

- \(t = 2.21\) ns
- \(2.40\) ns
- \(2.46\) ns

**DRACO/Spect3D**

- \(t = 2.40\) ns
- \(2.60\) ns
- \(2.70\) ns

**400 \times 400-\(\mu\)m regions**

Ti backlit images (~4.7 keV)

View angle \(\theta_v = 63^\circ\)

**Opacity**

- \(-1\) to 2
- (<0 is emission)

**Mass density at peak of UV production (DRACO)**

**TC8375**

*Spect3D: Prism Computational Sciences, Inc., Madison, WI*
The first beam-pointing case (90, 150, 150-\(\mu m\) offset) overdrives the Saturn target equator, producing a prolate implosion.

**OMEGA shot 49333 Saturn target**

\(t = 2.27\) ns  2.51 ns  2.57 ns

**DRACO/Spect3D**

\(t = 2.35\) ns  2.63 ns  2.70 ns

400 \(\times\) 400-\(\mu m\) regions
Ti backlit images (~4.7 keV)
View angle \(\theta_v = 63^\circ\)

Mass density at peak of UV production (*DRACO*)

Opacity

\(<0\) is emission

\(\rho\) (g/cm\(^2\))

*Spec3D: Prism Computational Sciences, Inc., Madison, WI*
The second beam-pointing case (90, 120, 120-μm offset) underdrives the standard target equator, producing an oblate implosion.
The second beam-pointing case (90, 120, 120-μm offset) produces a more-uniform Saturn target implosion.
Summary/Conclusions

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