Understanding the Performance of Low-Adiabat Cryogenic Implosions on OMEGA

V. N. Goncharov
University of Rochester
Laboratory for Laser Energetics

56th Annual Meeting of the American Physical Society
Division of Plasma Physics
New Orleans, LA
27–31 October 2014
Several degradation mechanisms are considered to explain the performance of low-adiabat cryogenic implosion on OMEGA

- While the moderate-adiabat ($\alpha > 3.5$) implosions are well understood using multidimensional-hydrocode simulations,* the performance of $\alpha < 3$ implosions is degraded relative to code predictions.
- Degradation mechanisms include hydrodynamic-instability growth, ablator and cold-fuel mix, and 1-D dynamics.
- The effect of reduced hydroefficiency observed during the main pulse rise is studied using slow-rise pulses.
- The agreement of the predicted ablation-front trajectories and scattered-light spectra with the data is improved in slow-rise pulses.
- The observed red-shifted feature in the scattered light indicates a potential importance of the stalk on target performance.

Collaborators


University of Rochester
Laboratory for Laser Energetics

J. A. Frenje and M. Gatu Johnson
Plasma Science and Fusion Center, MIT
Reduced yields, areal densities, and hot-spot pressures are observed as the adiabat is reduced.*

Typical drive pulses are predicted to produce fast plasma expansion at the beginning of the main drive.
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$LILAC$ simulation

$3\omega$ spectrum for shot 72083

Density and velocity plateau travel through corona

$L_n$ ($\mu$m)

$\frac{dR_c}{dt}$ (km/s)
Shell trajectories are delayed during the rise of the main pulse.

Shot 72083

Early-trajectory delay

Faster acceleration at later time

Data

Simulation
Shell trajectories are delayed during the rise of the main pulse.

Ablation-pressure deficiency during the rise and a faster pressure increase later in the pulse may lead to secondary shocks and adiabat degradation.

* A. K. Davis et al., JO4.00014, this conference.
Reducing the rate of intensity rise eliminates the blue-shifted feature, bringing simulation results closer to the data.
Reducing the rate of intensity rise eliminates the blue-shifted feature, bringing simulation results closer to the data (cont.)
The agreement of the predicted shell trajectories and mass-ablation rate with the data improves in slow-rise pulses.

*D. T. Michel et al., JO4.00009, this conference.
The early red-shifted feature in the scattered light suggests premature release of ablated DT into the plasma corona.
The red-shifted feature is observed in detectors close to the target bottom, suggesting a correlation with the stalk.

No red-shifted feature

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>351.4</td>
</tr>
<tr>
<td>351.2</td>
</tr>
<tr>
<td>351.0</td>
</tr>
<tr>
<td>350.8</td>
</tr>
</tbody>
</table>

Time (ns) | 0 | 1 | 2 | 3
---|---|---|---|---

FABS = full-aperture backscatter station
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*V. N. Goncharov et al., Phys. Plasmas 21, 056315 (2014).*