Polar Direct Drive at the National Ignition Facility

N140612-001 (CR ~ 3)

$t = 7.75$ ns

Simulation
$t = 7.5$ ns

$r = 337 \, \mu m$

$r = 332 \, \mu m$

$1500 \times 1500$-$\mu m$ regions

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Summary

Inferred trajectories from the National Ignition Facility (NIF) polar-direct-drive (PDD) implosion experiments suggest a decompressed shell

- Trajectories from both backlit and self-emission images lag simulations
- Inferred shell thickness is larger than simulated, consistent with a scenario including decompression caused by either nonuniformity or preheat
- A consistent scenario also requires a velocity reduction in addition to that predicted by the current model of cross-beam energy transfer (CBET) in DRACO
- Future experiments should clarify the effect of CBET versus that of nonuniformity in observed trajectories
Collaborators


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Low-adiabat PDD implosions* on the NIF are used to study energetics and preheat

- Existing x-ray drive beam profiles defocused by 1 cm are used in these implosions

\[ E \sim 470 \text{ to } 660 \text{ kJ} \]
\[ \alpha \sim 3 \]
\[ I \sim 8 \times 10^{14} \text{ W/cm}^2 \]
\[ V_{\text{imp}} = 1.8 \times 10^7 \text{ cm/s} \]
\[ \text{IFAR}_{2/3} = 19 \]

M. Hohenberger, CI1.00001, this conference.
Implosion trajectory* and width of emission** region are obtained from self-emission and backlit x-ray images

Trajectories from self-emission and backlighting are delayed when compared to simulation

- Simulations include the effect of CBET* and nonlocal heat conduction**
- CBET reduces the absorption from 93% to 80% and reduces velocity by ~15% compared to a model that includes only collisional absorption


The converging shell is decompressed in the experiment relative to simulation.

- The low measured low areal density indicates decompression:
  \[ \rho R_{\text{meas}} = 125 \pm 25 \text{ mg/cm}^2 \text{ (Ref. 1)} \]
  \[ \rho R_{\text{sim}} = 120 \text{ to } 280 \text{ mg/cm}^2 \]

\[ \text{At 6.9 ns} \]
\[ \Delta_{\text{simulation}} \approx 60 \mu\text{m} \]
\[ \Delta_{\text{experiment}} \approx 110 \mu\text{m} \]

\(^1\)F. H. Séguin et al., Phys. Plasmas 9, 2725 (2002); measured using wedge range filters (WRF’s).
Areal-density measurement is suggestive of decompression

- Areal density is inferred only at the equator
- $\rho R$ measurements at additional locations are important to understand the magnitude of decompression

<table>
<thead>
<tr>
<th>$\rho R$ (mg/cm$^2$)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td>120</td>
<td>280</td>
</tr>
<tr>
<td>Experiment</td>
<td>110±30</td>
<td></td>
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</tbody>
</table>
Consistent trajectories can be recovered with the assumption of reduced drive and a decompressed shell.
Nonuniformity can potentially explain the observed slowing of the self-emission trajectory

- **DRACO PDD simulation** (imprint with $\ell \leq 200$; no target roughness; no additional imprint from beam defocus)

- Nonuniformity sources will be investigated in FY15
  - cone-in-shell imprint experiments*—November and March
  - PDD implosions (smoother targets, 400-Å Au overcoat**)—January

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*A. Shvydky, UO4.00008, this conference.
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