Density Profile of a Foil Accelerated by Laser Ablation

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Streak-camera radiograph

PSF-convolved DRACO radiograph

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Summary

Simulated radiographs of accelerated foil qualitatively agree with measured radiographs

- Release of excess material into the hot spot reduces peak compression of inertial confinement fusion (ICF) implosions
- Simulated acceleration of foil agrees with data to within the errors of the measurement
- Shape of rear-surface blowoff is modeled well early in time
- Rear-surface scale length is smaller in the simulation at the end of the laser drive
  - material may have a higher speed-of-release off rear surface
- Measured data do show a wider foil than the simulation after the laser has turned off
  - target is decompressing more than simulated when ablation pressure is released
Collaborators

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Release of excess material into the hot spot reduces peak compression of ICF implosions

- Material added to the hot spot
  - indicates a higher adiabat
  - reduces compressibility
  - reduces hot-spot pressure

Shell density in higher-adiabat designs adds material to the hot spot.
OMEGA EP experiments to measure accelerated foil-density profiles use the x-ray streak camera to measure an edge-on radiograph versus time.

<table>
<thead>
<tr>
<th>Thickness μm</th>
<th>30</th>
<th>20</th>
<th>25</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>CH 4% Ge</td>
<td>CH 4% Si</td>
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Laser

- λ = 351 nm
- Width = 5 ns
- Power = 1.1 TW
- Intensity = $2.5 \times 10^{14}$ W/cm²

Total thickness = 80 μm
0.9-mm high × 0.2-mm wide
Streak-camera data are analyzed to determine the density profile of the accelerated target

- Compute streak-camera point-spread function (PSF) from resolution data
  - calculate for radiographic system
  - measure system magnification
- Streak-camera data
  - data averaged to reduce noise
  - backlighter shape fit with a fourth-order polynomial
  - position versus time determined from outer diameter (OD) peak
- Simulation data
  - streak-camera PSF convolved with simulation output
  - convolved simulation data analyzed with the same method as the experimental data
  - equivalent times compared to experimental OD
Resolution targets were used to measure the magnification and PSF of the x-ray streak camera.

Si radiograph of two-wire resolution target

25-\(\mu\)m-diam Ta wires
Separation = 155 \(\mu\)m
Early time data were used to measure the streak-camera PSF.

Late-time data show that the Ta wires expand because of x-ray absorption.

PSF $\sigma \, 12.0^{-0.5}_{+0.5} \, \mu m$
The **DRACO** simulation agrees with the measured foil position as measured to within errors.

\[ \chi^2/\text{degree-of-freedom} = 1.0 \text{ for a distance error of } 7 \ \mu m. \]
The simulation OD profile agrees with the measured data at time = 1.65 ns after the start of the laser pulse.
**DRACO** simulations show good agreement with the target rear profile for time = 3.0 ns

![Graph showing optical density vs. distance and time](image)
The *DRACO* simulation rear scale length is smaller than the measured data at the end of the laser pulse (time = 5 ns).
The DRACO simulation is narrower than the measured data after the laser has turned off (time = 5.4 ns)
Simulated radiographs of accelerated foil qualitatively agree with measured radiographs

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DRACO simulations show qualitative agreement with the data for foil acceleration and shape