Optimization of Azimuthal Uniformity in NIF Polar-Drive Implosions

- Deposited energy

Fraction of maximum

0.65 0.75 0.85 0.95

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The azimuthal uniformity of National Ignition Facility (NIF) polar-drive implosions can be calculated using a pseudo 3-D model in SAGE

- The uniformity is improved with azimuthal repointing of the laser beams
- Predictions of the model match many features of self-emission images for LLE polar-drive shots N130128, N130703, and N130731
- The self-emission diagnostic can detect predicted deviations of \( \sim 10 \mu m \) resulting from beam-energy imbalance

See A. K. Davis (UO4.00004, next talk) for detailed modeling of the x-ray images.
Collaborators


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Laboratory for Laser Energetics

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The alternating quad design results in a large $m = 4$ nonuniformity in the deposited energy.

- Deposited energy
- No CBET

Fraction of maximum

0.65 0.70 0.75 0.80 0.85 0.90 0.95
The split-quad design shows improved azimuthal deposition uniformity with an $m = 8$ pattern

- Deposited energy
- Used for LLE shots N121216, N130128

Fraction of maximum

0.65 0.70 0.75 0.80 0.85 0.90 0.95
More improvement is obtained through the addition of azimuthal repointing

- Deposited energy
- Used for LLE shots N130703, N130731

Fraction of maximum

<table>
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<tr>
<th>0.65</th>
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The best uniformity results from the azimuthal repointing design.
Some additional nonuniformity results from actual beam-energy variations

Azimuthal repointing and actual energy variations ($\sigma_{\text{rms}} = 2.2\%$)

Azimuthal repointing ($\sigma_{\text{rms}} = 1.6\%$)

Deposited energy (kJ/sr) vs. Azimuthal angle $\phi$ ($^\circ$)

$\theta = 60^\circ$
For shot N130128, the center-of-mass distribution was estimated from the deposited-energy distribution by applying a simple scaling law to the azimuthal variations.

- Center-of-mass radius
- 192 beams
- Actual energies

\[ t_{\text{NIF}} = 5.8 \text{ ns} \quad \bar{r} = 579 \mu\text{m} \]

\[ \text{Distance} \propto \text{intensity}^{0.72} \]
Framing-camera self-emission images from shot N130128 show features at ±30° from the equator in agreement with simulations.
Shot N130703 used azimuthal repointing but two quads were dropped.

- Deposited energy
  - low near the missing quads

Weak at $\phi = 135^\circ$

$t_{NIF} = 5.9 \text{ ns}$

Fraction of maximum

0.65 0.70 0.75 0.80 0.85 0.90 0.95
Large variations are predicted in the center-of-mass radius

- Center-of-mass radius

$t_{\text{NIF}} = 5.9\ \text{ns}$
The azimuthal variations in the experimental self-emission show the missing quads and the weak drive at 135°.

\[ t_{NIF} = 5.9 \text{ ns} \]

- SAGE center of mass
- Experimental self-emission (shifted 50 \( \mu \text{m} \))
- Missing quads

Azimuthal angle \( \phi \) (°)

Radius (\( \mu \text{m} \))
For shot N130731, the azimuthal variations are $\sim \pm 10 \, \mu m$ and show the predicted strong drive at $\phi = 135^\circ$. 

![Diagram showing azimuthal variations and drive at 135°](chart.png)
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