Revolver Designs for the National Ignition Facility Using Current and Optimized Phase Plates

Current phase plates ($\Delta v/v = 2.5\%$)

- Center-of-mass variations after 400-$\mu$m travel

Custom phase plates ($\Delta v/v = 1.2\%$)

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The drive uniformity of Revolver designs can be improved using custom phase plates

- The implosion velocity uniformity is improved using beam spots that are stretched in the azimuthal direction
  - $\Delta v/v \sim 2.5\%$ for current phase plates
  - $\Delta v/v \sim 1.2\%$ for custom phase plates
- The Revolver target operates in a regime with nearly 100% inverse-bremsstrahlung absorption
Collaborators

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The *Revolver* design proposed by Molvig *et al.* was used for this work

- Only the interaction of the laser pulse with the Be shell was modeled

Designs were generated for the current phase plates and custom phase plates

**Current phase plates (3.5-cm defocus)**
- Rings 1 and 2
  \( \theta = 23.5^\circ, 30^\circ \)
  - 1 mm

**Custom phase plates (best focus)**
- Ring 3
  \( \theta = 44.5^\circ \)
  - 1 mm

- Ring 4
  \( \theta = 50^\circ \)
  - 1 mm

- Current phase plates
  - Rings 1 and 2
  - Ring 3
  - Ring 4
The laser–plasma interaction appears to be very classical

- Very high absorption (~99%)
- 50% of the laser energy is deposited by quarter critical
- The overlapped intensity at quarter critical is only $1 \times 10^{14}$ W/cm²
- The standoff distance between quarter critical and the ablation front is large (~350 μm)

Rays are not drawn after 50% deposition.

Run Y1363
TC14482

P. W. McKenty et al., CO4.00002, this conference.
At the end of the laser pulse (6.7 ns), the azimuthally averaged center-of-mass radius is very uniform in both cases.

\[ \sigma_{\text{rms}} = 2.1 \ \mu m \quad \Delta v/v = 0.54\% \]

\[ \sigma_{\text{rms}} = 4.4 \ \mu m \quad \Delta v/v = 1.1\% \]
The azimuthally averaged deposition patterns exhibit modulations that appear to be smoothed out by thermal conduction.
With the current NIF phase plates at 3.5-cm defocus, there are significant azimuthal nonuniformities in the deposited energy.
With the custom phase plates, the azimuthal nonuniformities are greatly reduced.

- Time-integrated deposited energy

Fraction of maximum

Run Y1363
TC14486
With the current NIF phase plates, variations in the center-of-mass radius are \( \pm 10-\mu m \) (rms) after 400 \( \mu m \) of travel.

- Center of mass variations at \( t = 6.7 \) ns
- \( \frac{\Delta v}{v} = 2.5\% \)
With the custom phase plates, variations in the center-of-mass radius are $\pm 4.7\,\mu\text{m (rms)}$ after 400 $\mu\text{m}$ of travel.

- Center of mass variations at $t = 6.7$ ns
- $\frac{\Delta v}{v} = 1.2\%$
The $m$-mode spectra of center-of-mass variations (summed over $\ell$) are dominated by $m = 0, 4,$ and $8$
Summary/Conclusions

The drive uniformity of *Revolver* designs can be improved using custom phase plates

- The implosion velocity uniformity is improved using beam spots that are stretched in the azimuthal direction
  - $\Delta v/v \sim 2.5\%$ for current phase plates
  - $\Delta v/v \sim 1.2\%$ for custom phase plates
- The *Revolver* target operates in a regime with nearly 100% inverse-bremsstrahlung absorption

NIF experiments using scaled-down *Revolver* targets would be interesting.