Two-Dimensional Investigation of Neutron-Yield Performance in Direct-Drive, Low-Adiabat, Cryogenic D$_2$ Implosions on OMEGA

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Summary

Trends in experimental neutron-yield degradation are reproduced in DRACO simulations of low-\(\alpha\), cryogenic D\(_2\) implosions on OMEGA

- We have systematically investigated the neutron yield performance in direct-drive, low-adiabat, cryogenic D\(_2\) implosions on OMEGA using two-dimensional, radiation-hydrodynamics code—DRACO.

- Our simulation results indicate that the low-mode perturbations (target offset and ice roughness) can generally explain the observed yield-over-clean (YOC) degradation in thin (\(\sim 5\text{-}\mu\text{m}\)) CD-shell implosions.
Collaborators


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This study focuses on the neutron-yield performance of low-adiabat ($\alpha \approx 2 \sim 3$) cryogenic D$_2$ implosions.

**Typical targets imploded on OMEGA**

- **D$_2$ gas** (~330 $\mu$m)
- **D$_2$ ice** (~95 $\mu$m)
- **CD shell** (~5 $\mu$m)

**A low-adiabat ($\alpha \approx 2$ to 3) pulse shape**

**DRACO**
- Full 3-D ray tracing
- 12 radiation groups (AOT)
- SESAME EOS
- $f = 0.06$ (flux limiter)

This target design is not sensitive to laser imprints. Low-mode perturbations (target-offset, ice roughness, and laser-power imbalance) effects on neutron yield will be examined.
Target offset alone cannot fully account for the observed YOC degradation in experiments

- The target offset imposes a dominant $\ell = 1$ mode perturbation to a uniform (no ice roughness) target implosion
YOC is found to be sensitive to the phase between the target offset and the ice roughness

\[ \Delta R(\theta) = \Delta R_0 + \sum A_\ell \times \cos(\ell \theta) \]
The combined target offset and low-mode ice roughness are the main causes of YOC degradation.

The YOC range at each target offset has been obtained by averaging different explored rms phases.
Compared to experiments, our simulation results reproduce the trends in the observed YOC degradation.

Experimental shots ($1.8 < \alpha < 3.0$)
- $I = 2.5 \sim 6 \times 10^{14} \text{ W/cm}^2$
- $\langle \rho R \rangle_{\text{exp}} / \langle \rho R \rangle_{1-\text{D}} \geq 60\%$
- $\langle \rho R \rangle_{\text{exp}} \geq 100 \text{ mg/cm}^2$
Summary/Conclusions

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- Our simulation results indicate that the low-mode perturbations (target offset and ice roughness) can generally explain the observed yield-over-clean (YOC) degradation in thin (~5-\(\mu\)m) CD-shell implosions.