Development of Shock-Timing Techniques for the National Ignition Facility

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VISAR Data

Shock in D₂
OMEGA experiments have validated the shock-timing technique planned for the NIF

- Ignition targets require precise timing (±50 ps) of the first three shocks for optimal performance

- Optical measurements (VISAR and self-emission) can readily achieve that precision when $T_{\text{rad}} = \sim 170$ eV and $I_{\text{wall}} = 100$ TW/cm$^2$

- OMEGA experiments have demonstrated that optical shock-timing measurements can be performed at and above NIF-relevant x-ray loading (at 1.5 to 4 keV)

- Cryogenic hohlraum experiments on OMEGA have validated the shock-timing technique under NIF-like conditions
Collaborators

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Indirect-drive-ignition capsules use four shocks to achieve ignition

- First three shocks ±50 ps
- Fourth shock ±100 ps
NIF shock timing will be measured through a cone that penetrates the hohlraum and the sphere inside.

Hard x rays from laser spots can blank diagnostic window.
Stacked-pulse experiments show that neither instantaneous nor integrated flux are expected to be problems.
Hohlraum experiments with NIF-sized re-entrant cones demonstrate success at 180 eV
The success of these experiments resulted from a collaboration of four labs for design, construction, fielding

- Parts from GA and LLNL
- Hohlraum-cone assembly at SNL
- Shields and cryo mount at LLE
Cryogenic keyhole target with “thick” ablator succeeded at 135 eV

Hohlraum: 1.6-mm ID 2.55-mm 3/4 LEH 25-μm gold wall

VISAR-2 shot 48881

Distance (μm)

Time (ns)

Au wall
Aperture
Shock in D₂
Au wall
Self-emission agree well with the VISAR shock breakout time—shock arrival at the aperture is also observed.
OMEGA hohlraums produce “hard” x-ray fluxes that are relevant to (or exceed) those expected on the NIF.

OMEGA-scale hohlraums have higher laser-spot intensities than the NIF.
Summary/Conclusions

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- Optical measurements (VISAR and self-emission) can readily achieve that precision when $T_{\text{rad}} \approx 170$ eV and $I_{\text{wall}} = 100$ TW/cm$^2$

- OMEGA experiments have demonstrated that optical shock-timing measurements can be performed at and above NIF-relevant x-ray loading (at 1.5 to 4 keV)

- Cryogenic hohlraum experiments on OMEGA have validated the shock-timing technique under NIF-like conditions
The cryogenic vacuum hohlraum exhibits decreased radiation temperatures compared to warm ones.