Target Performance in Low-Adiabat, Warm Implosions on OMEGA

\[ \alpha = 3; \quad I = 5 \times 10^{14} \text{ W/cm}^2 \]

- Experiment
- Simulated

\[ \rho R \text{ (mg/cm}^2) \]

Hot-spot convergence ratio
Warm, plastic shells have been imploded on OMEGA with the goal of identifying the effect of preheat on compression.

- Preheat caused by energetic coronal electrons from two plasmon decay may compromise compression in direct-drive inertial confinement fusion implosions.
- Low-adiabat pulse shapes will be used to irradiate warm plastic shells with varying intensities.
- Observed areal density at low intensities is reduced relative to spherically symmetric simulations, possibly caused by reduced laser-energy absorption.
- A model* that includes energy transfer between beams results in reduced absorption and improves agreement with observed values of areal density, while reproducing time of neutron production.

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Collaborators


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Preheat caused by energetic coronal electrons from two plasmon decay may compromise compression in direct-drive inertial confinement fusion implosions.

\[ \alpha = 2 \text{ to } 5; \text{ CH shell, } I = 0.35 \text{ to } 1.1 \times 10^{15} \text{ W/cm}^2 \]

\[ I = 3.5 \times 10^{14} \text{ W/cm}^2 \]

- \( \alpha = P/P_F \)
- TPD threshold parameter:
  \[ \eta = I_{14} L_{\mu m}/230 T_{\text{keV}} \]

- Energy deposited by these electrons in the cold shell may compromise compression of the imploding shell**

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A series of implosions on warm, plastic targets have been designed to isolate the effect of energetic electrons.

\[ 9 \times 10^{14} \quad 26 \text{ kJ} \]

\[ I = 5 \times 10^{14} \text{ W/cm}^2 \]

16 kJ

\[ \rho R^*_{\text{max}} \sim \frac{E_L^{0.33} v_{\text{imp}}^{0.06}}{\alpha_{\text{inn}}^{0.55}} \]

- These implosions are weakly sensitive to shock mistiming

Decompression of the shell caused by reduced absorption* reduces the areal density achieved in the implosion

\[
\begin{array}{|c|c|c|}
\hline
& f_{\text{abs}} \% & \rho R^1 \text{(scaling)} \text{ (mg/cm}^2) & \rho R \text{ (mg/cm}^2) \\
\hline
\text{No energy transfer between beams} & 83 & 272 & 272 \\
\text{With cross-beam transfer} & 70 & 257 & 217 \\
\hline
\end{array}
\]

For a given adiabat\(^1\):

\[
\rho R \sim (E_L)^{1/3}
\]

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The observed areal density is reduced relative to simulation even at low intensity.

$I = 5 \times 10^{14} \text{ W/cm}^2$

- $\rho R$ (Expt)
- $\rho R$ (Simulated)

Secondary proton spectrum

Normalized yield (MeV)
The time of neutron production is used to set the laser-energy absorption in the simulation.

- X-ray emission, measured through DANTE, also shows delayed core emission.
Better agreement on the areal density can be obtained when bang time is reproduced by the model.
Summary/Conclusions

Warm, plastic shells have been imploded on OMEGA with the goal of identifying the effect of preheat on compression

- Preheat caused by energetic coronal electrons from two plasmon decay may compromise compression in direct-drive inertial confinement fusion implosions
- Low-adiabat pulse shapes will be used to irradiate warm plastic shells with varying intensities
- Observed areal density at low intensities is reduced relative to spherically symmetric simulations, possibly caused by reduced laser-energy absorption
- A model* that includes energy transfer between beams results in reduced absorption and improves agreement with observed values of areal density, while reproducing time of neutron production

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