Mitigation of Two-Plasmon Decay in Direct-Drive Implosions Using Multilayer Targets

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OMEGA multilayer design

\[ T_e \text{(keV)} \]

\[ n_{cr}/4 \]

\[ R \text{(\(\mu m\))} \]

\[ \frac{P_e}{P_L} \text{(\%) } \]

\[ 1.1 \times 10^{15} \text{ W/cm}^2 \]

\[ \text{Laser power (TW)} \]

\[ \text{Time (ns)} \]

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Summary

Multilayer targets are shown to reduce hot electrons generated by two-plasmon decay (TPD)

- Mitigating cross-beam energy transfer (CBET) is expected to increase the intensity at quarter critical, resulting in more hot electrons from TPD
- A mid-Z layer was added to the target to increase the electron temperature at the quarter-critical surface
- Thomson scattering shows an increased electron temperature around quarter critical
- The increased electron temperature leads to a factor-of-5 reduction in hot electrons
Collaborators


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Reduction of CBET in direct-drive implosions on OMEGA is required to achieve hydrodynamic equivalence.

OMEGA ($\rho R = 300 \text{ mg/cm}^2$, $V_{\text{imp}} = 3.7 \times 10^7 \text{ cm/s}$)

- $R_b/R_t = 1$
- $R_b/R_t = 0.6$
- Current hydro-stability
- No CBET

In-flight aspect ratio vs. Ablation pressure (Mbar)
Mitigating CBET is predicted to increase the hot electrons generated by TPD

![Graph showing hot-electron fraction vs. TPD common-wave gain and ablation pressure.]

\[ G_{MB}^* \approx \frac{I_x L_n}{T_e} \times 10^{-16} \]

Current cryo experiments show no evidence of hot-electron preheat, but simulations suggest a factor-of-2 increase will degrade the areal density.


Multilayer targets have been designed to increase the hydrodynamic efficiency and laser–plasma interaction thresholds while limiting the effects of imprint. The layer thicknesses are optimized to have increased laser absorption at \( n_c/4 \) (Si higher \( T_e \)) and increased ablation in Be (higher \( A/Z \)).

Simultaneous measurements of the collective ion-acoustic and electron plasma wave features provide local plasma conditions in laser-produced plasmas.
Thomson scattering from electron plasma and ion-acoustic waves shows enhanced electron temperatures in multilayer targets compared with CH targets.

Multilayer ablators increase the electron temperature around quarter critical by ~15%.
The increased electron temperature in the multilayer targets reduces TPD gain, resulting in fewer hot electrons.

The hot-electron fraction is reduced by a factor of 8 in multilayer targets compared with CH.

*J. F. Myatt et al., NO5.00002, this conference.
J. A. Delettrez, J. F. Myatt, and B. Yaakobi, NO5.00004, this conference.
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