Recent Advances in the Transport Modeling of Two-Plasmon–Decay Electrons in the 1-D Hydrodynamics Code *LILAC*

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Summary

*LILAC* simulations using an improved fast-electron transport model reproduce the timing of the hard x-ray (HXR) emission in OMEGA experiments

- Improvements have been added to the fast-electron straight-line transport model to study the effect of two-plasmon–decay (TPD) fast electrons
  - random departure from specular reflection at the target outer boundary
  - source divergence
- Two spherical OMEGA implosions with different shell materials (CH and a Si layer) were simulated
  - the relative HXR emission levels are well reproduced
  - the threshold parameter is lower for the Si-layer target than for the CH target, leading to a lower HXR emission
Collaborators

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The source of fast electrons is based on the measured HXR emission from intensity sweep experiments

- The HXR emission depends on the threshold parameter: \( \eta = I_{14} \) (at \( n_{c}/4 \)) \( L(\mu m)/[233 \times T \text{ (keV)}] \)*
- The source function was designed to follow the same dependence as the HXR emission

\[ S(\eta) = \exp(16.6 \eta - 21.1) \]

*\( I_{14} \) is the measured HXR intensity in units of pC. The threshold parameter \( \eta \) is defined in terms of the plasma density \( n_c \), the characteristic length \( L \), and the electron temperature \( T \). A. Simon et al., Phys. Fluids 26, 3107 (1983).
Target performance is not sensitive to random deflection of electrons above 4°

- Specularly reflecting an electron at the target boundary sends it along the same path until it stops.
- To model the fact that the sheath is not smooth and E and B fields are present in the corona,* a random Gaussian angle is added to the reflected angle.

Target performance is insensitive to the source divergence angle above the 60° half-angle.

Simulations used a 90° half-angle source divergence.
Various ablator designs are being studied to evaluate the mitigation of fast-electron production*

The simulations were carried out with cross-beam energy transfer (CBET) and nonlocal thermal transport in the 1-D hydrocode LILAC using the same fast-electron source parameters.

*D. H. Froula et al., NO5.00001, this conference.
The threshold parameter for the multilayer target is reduced even though intensities at $n_c/4$ are identical

Threshold parameter: $\eta = I_{14} \text{ (at } n_c/4) \cdot L(\mu m)/[233 \cdot T(\text{keV})]$
The source model gives good agreement with experiment in the timing and relative levels of the HXR emission.

The HXR emission is very sensitive to the steep source function; a 1% error in the threshold parameter leads to a 17% difference in the HXR emission.
Summary/Conclusions

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- Improvements have been added to the fast-electron straight-line transport model to study the effect of two-plasmon–decay (TPD) fast electrons
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Replacing the SG4 phase plate with SG5 plates increased the HXR emission.

Detailed ray-trace simulations showed no difference in the TPD gain between the two shots.
The source intensity and the HXR emission is narrower in time when CBET is included.
The threshold parameter in the case with CBET is below unity because of the lower intensity at the $n_c/4$ surface.

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**27-μm-thick CH target at $10^{15}$ W/cm$^2$**

<table>
<thead>
<tr>
<th>Incident intensity ($\times 10^{14}$ W/cm$^2$)</th>
<th>Threshold parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without CBET</td>
<td>With CBET</td>
</tr>
<tr>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>2.0</td>
<td>1.5</td>
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<tr>
<td>8.0</td>
<td>6.0</td>
</tr>
<tr>
<td>10.0</td>
<td>7.5</td>
</tr>
</tbody>
</table>

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**Graphs:**

- **Intensity at $n_c/4$:**
  - Incident, Without CBET, With CBET

- **Threshold parameter:**
  - Incident, Without CBET, With CBET
For the multilayer target, the lower scale lengths and higher temperatures compared to the CH target give a smaller threshold parameter.