Planar Shock-Ignition Studies on OMEGA

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Planar-target, high-intensity laser–plasma interactions with relevance to shock ignition have been performed on OMEGA

- Experimental data exhibit hot-electron generation at $T_e \sim 150$ keV with conversion efficiencies of up to $\sim 6\%$

- Scaled 1-D LILAC simulations suggest spike laser-generated pressures of at least 100 Mbar

- 2-D DRACO simulations are currently in progress to fully evaluate the experimental conditions
Collaborators


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Shock ignition uses a non-isobaric fuel assembly to achieve a lowered ignition condition*

Crucial issues for shock ignition:

- Demonstrate hot-electron temperatures \(\leq 150\) keV generated by spike**

- Demonstrate 400-Mbar spike-generated pressure


**See K. S. Anderson et al., BO5.00009
A laser–plasma interaction experiment was performed in planar geometry with overlapping beams.

- Shock propagation in quartz is observed with SOP and VISAR.
- Hot-electron component is inferred from Mo Kα and x rays.

Pre-plasma pulse: \( \sim 2 \times 10^{14} \text{ W/cm}^2 \)
900-μm spot diameter

Shock pulse: \( \sim 1 \) to \( 5 \times 10^{15} \text{ W/cm}^2 \)
250- to 600-μm spot diameter

Legend:
- 22 μm CH
- 30-μm Mo
- 138 μm quartz
- VISAR SOP

Intensity (10^{14} \text{ W/cm}^2)

Time (ns)
2-D DRACO simulations suggest a laser-generated shock pressure in the plastic of up to 300 Mbar.

Simulations exhibit shock-ignition-relevant laser-generated pressures.
Up to 6% of the high-intensity laser energy is converted into hot electrons

- Measured hot-electron temperature is a factor ~3 higher than in spherical geometry*
- This is probably due to significantly larger plasma scale length in planar experiments
- >150-keV electrons can be detrimental to target performance

*See M. Lafon et al., XP9.00044
The shock propagation in quartz was observed with streaked optical pyrometry and VISAR.
Because of blanking, the decaying shock front in the SiO$_2$ can be observed for only $t > 4.2$ ns.

- We have extracted temperature and velocity data from the shock propagation in quartz (Shot 57529).

Straight early features suggest 1-D treatment of hydrodynamics is sufficient.
1-D LILAC simulations are used to estimate a lower limit for the spike-generated shock pressure.

- The spike absorption is varied to match the shock-breakout time (~6.1 ns, Shot 57529)
- Simulations suggest that at $1 \times 10^{15}$ W/cm² laser-generated pressures of at least ~110 Mbar are achieved
Summary/Conclusions

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