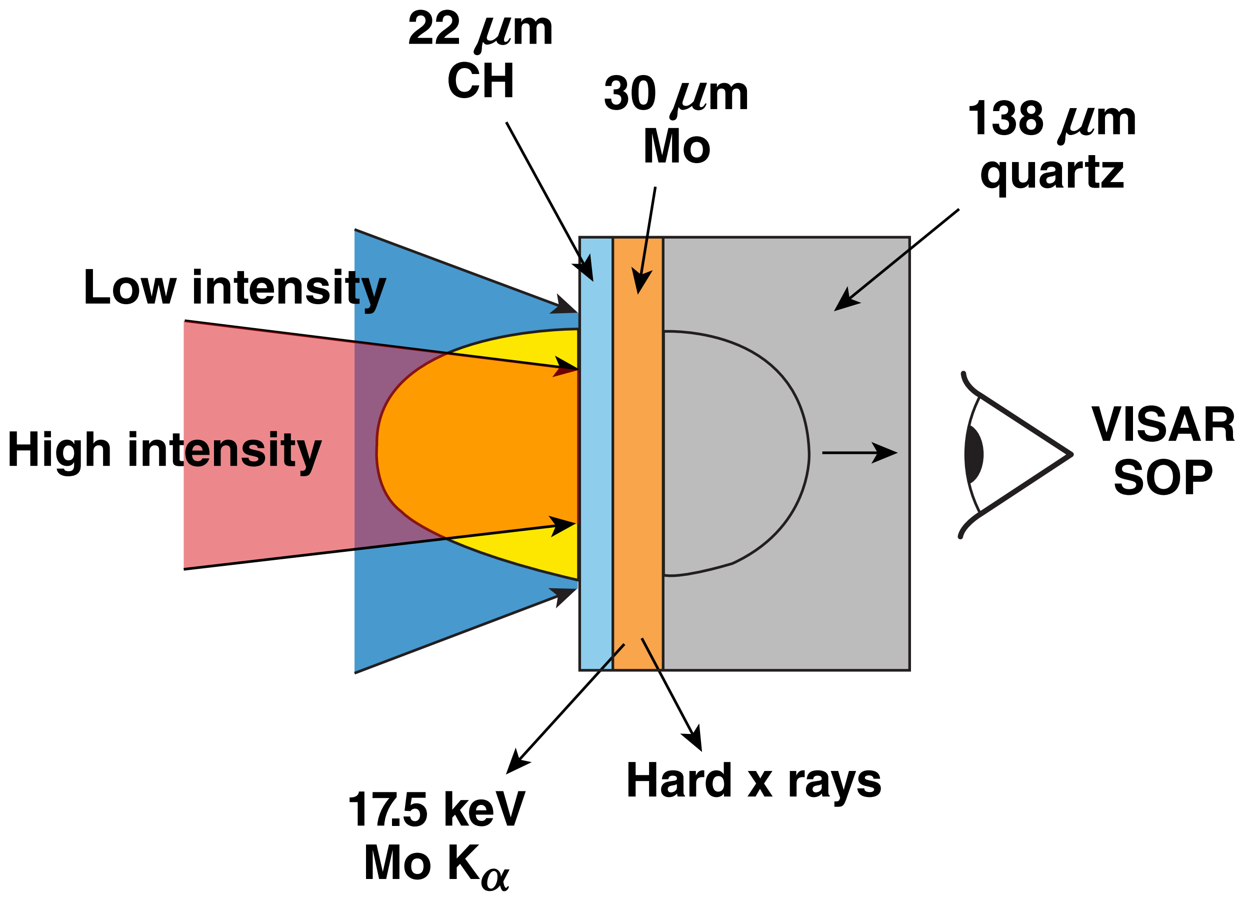
Planar Shock-Ignition Studies on OMEGA



M. Hohenberger *et al.*
University of Rochester
Laboratory for Laser Energetics

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Summary

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 ~150 keV with conversion efficiencies of up to ~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

**W. Theobald, S. X. Hu, K. S. Anderson, C. Stoeckl,
D. E. Fratanduono, T. R. Boehly, D. D. Meyerhofer and R. Betti**

University of Rochester
Fusion Science Center and
Laboratory for Laser Energetics

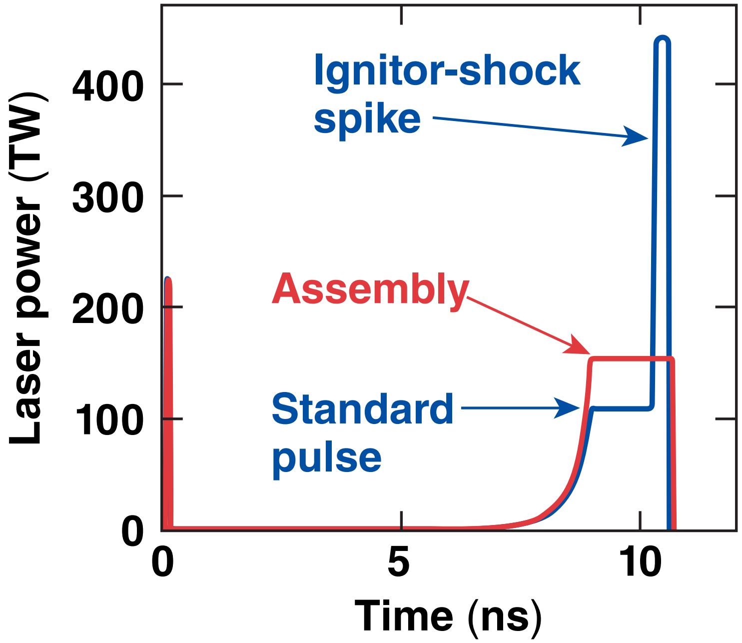
A. Casner

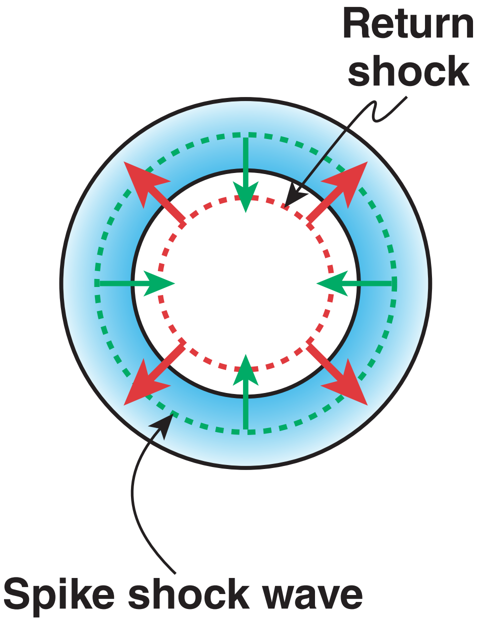
CEA, DAM, DIF, Arpajon, France

X. Ribeyre and G. Schurtz

Centre Laser Intenses et Applications,
University of Bordeaux, France

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





Crucial issues for shock ignition:

- Demonstrate hot-electron temperatures ≤150 keV generated by spike**
- Demonstrate 400-Mbar spike-generated pressure

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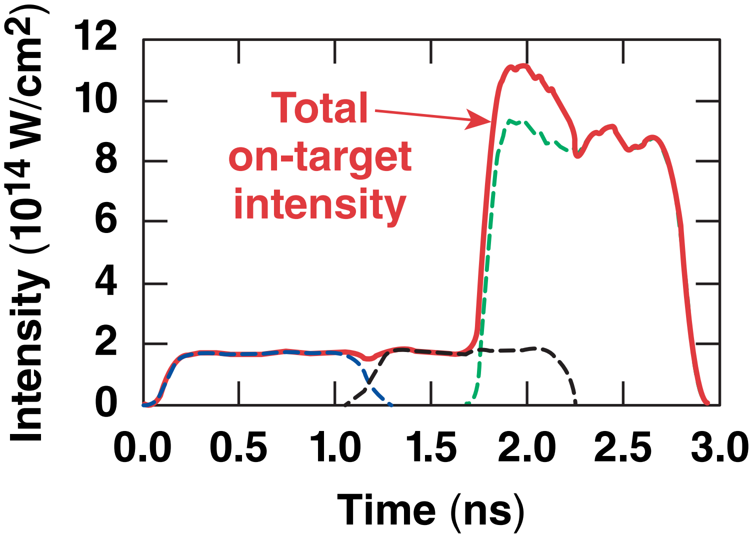
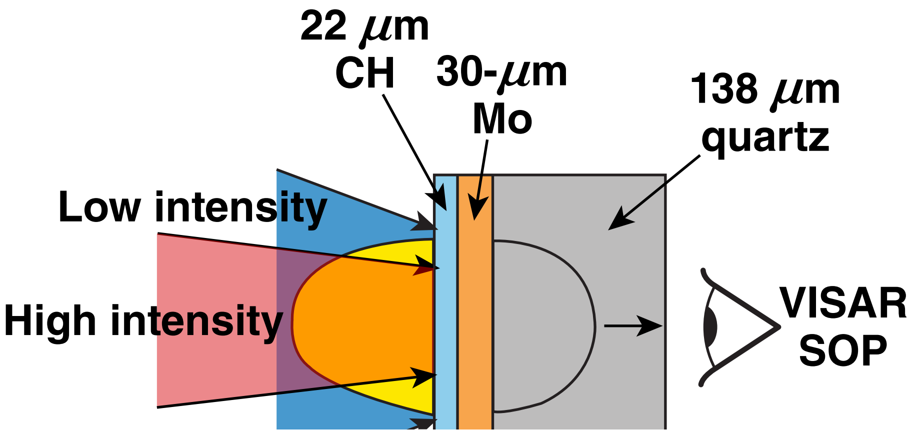
*R. Betti *et al*., Phys. Rev. Lett. 98, 155001 (2007).
**See K. S. Anderson *et al*., BO5.00009

A laser–plasma interaction experiment was performed in planar geometry with overlapping beams



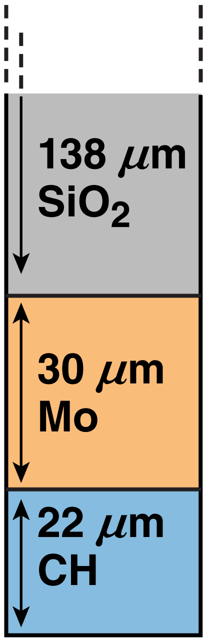
Pre-plasma pulse: ~2 × 10^{14} W/cm^2
900-μm spot diameter

Shock pulse: ~1 to 5 × 10^{15} W/cm^2
250- to 600-μm spot diameter



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

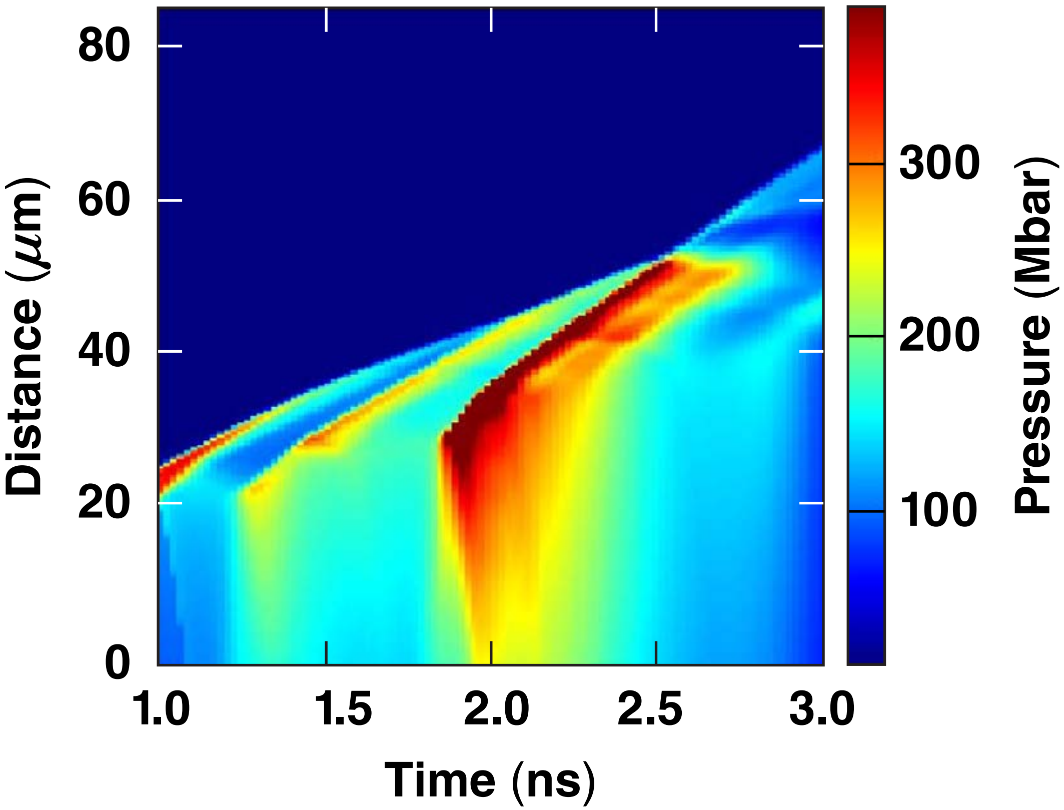
2-D *DRACO* simulations suggest a laser-generated shock pressure in the plastic of up to 300 Mbar



138 μm SiO_2

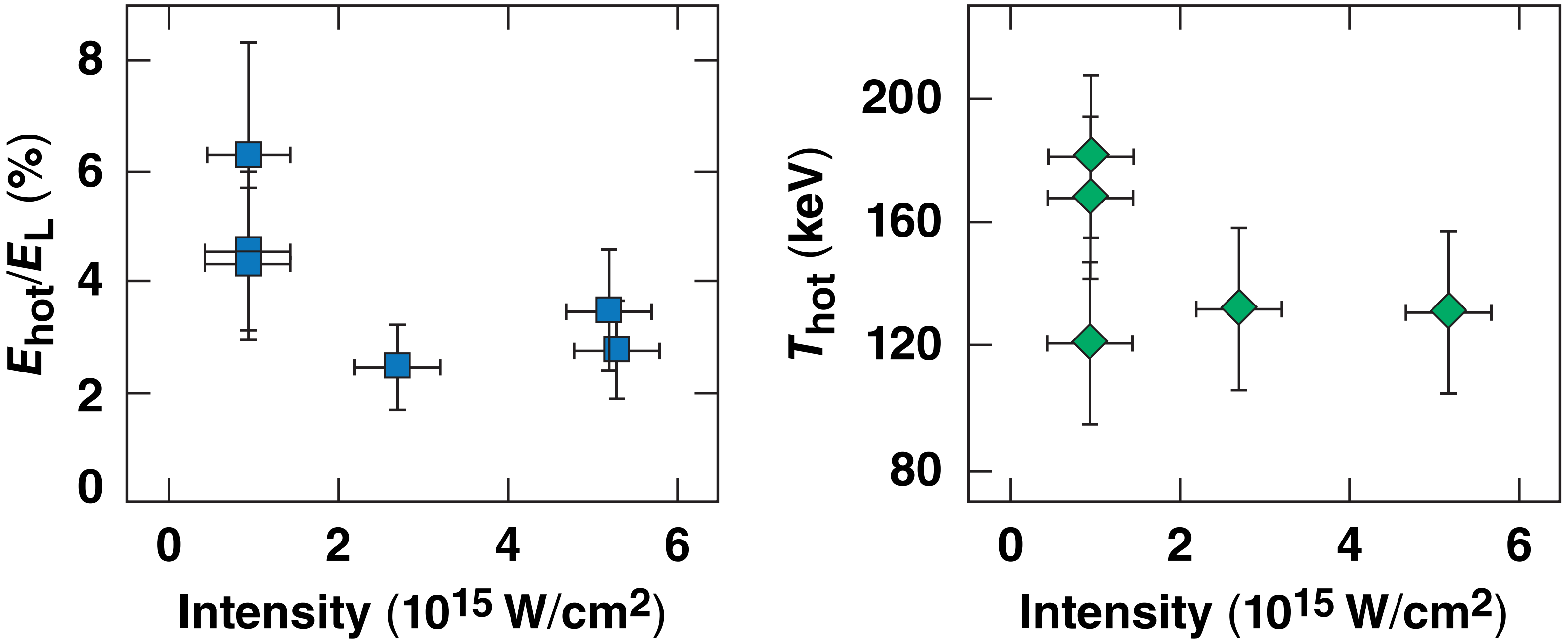
30 μm Mo

22 μm CH



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

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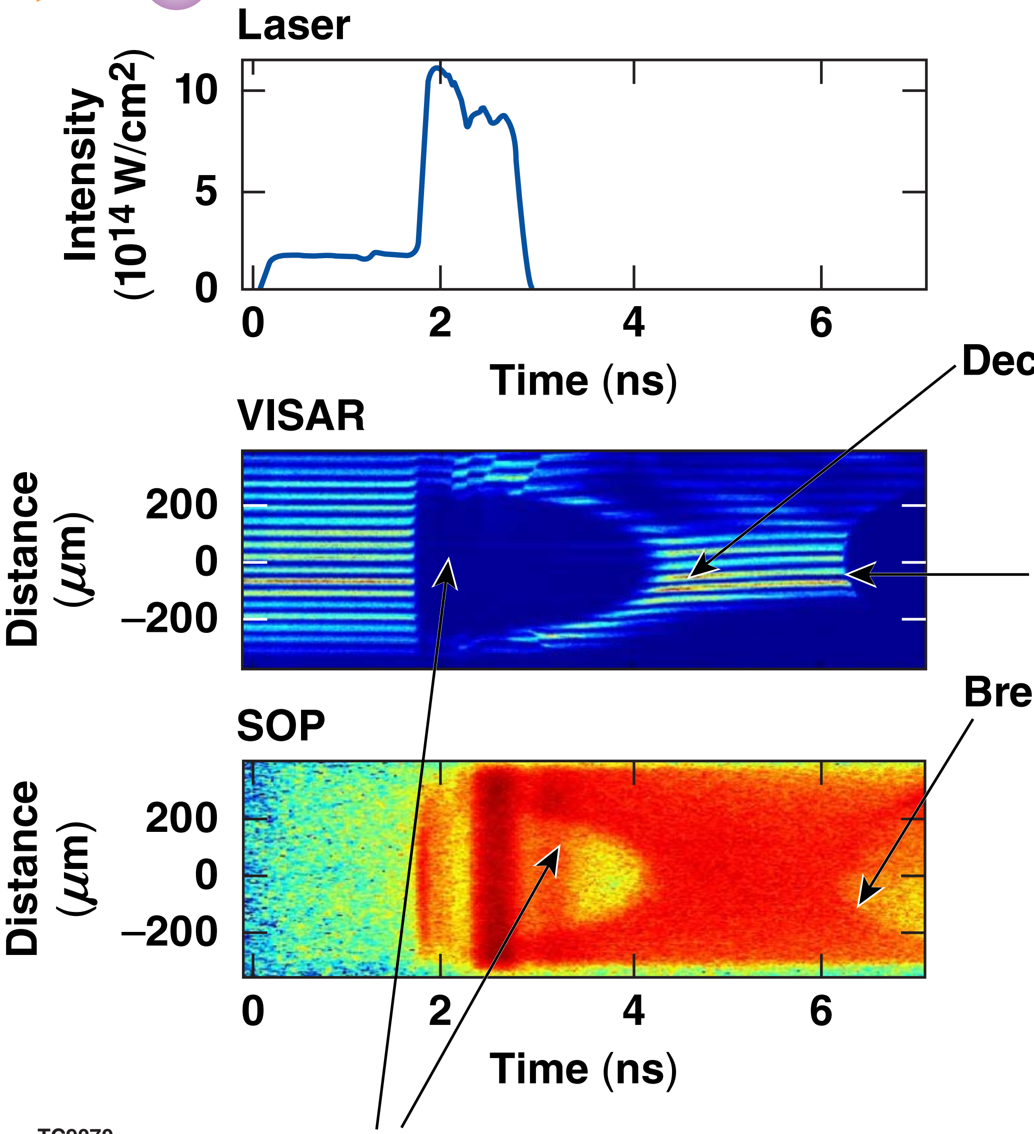
*See M. Lafon *et al*., XP9.00044

The shock propagation in quartz was observed with streaked optical pyrometry and VISAR



Decaying shock

Shock

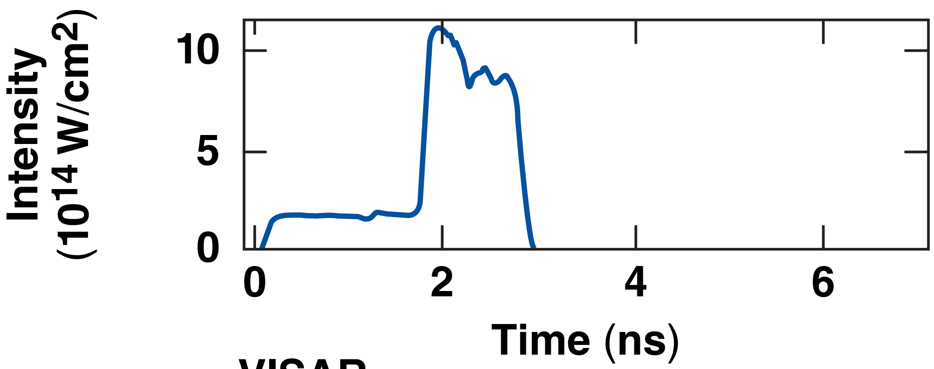
Breakout

Blanking from high-intensity spike

TC9070

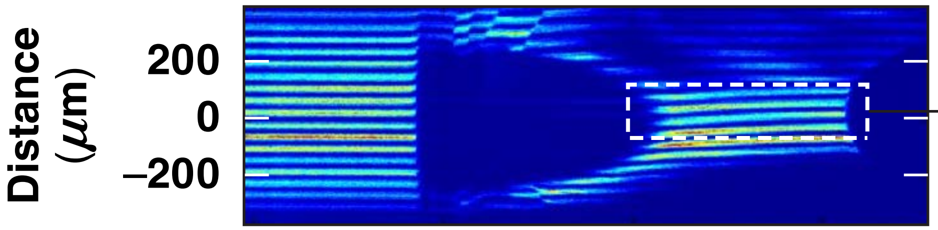
Because of blanking, the decaying shock front in the SiO_2 can be observed for only $t > 4.2$ ns

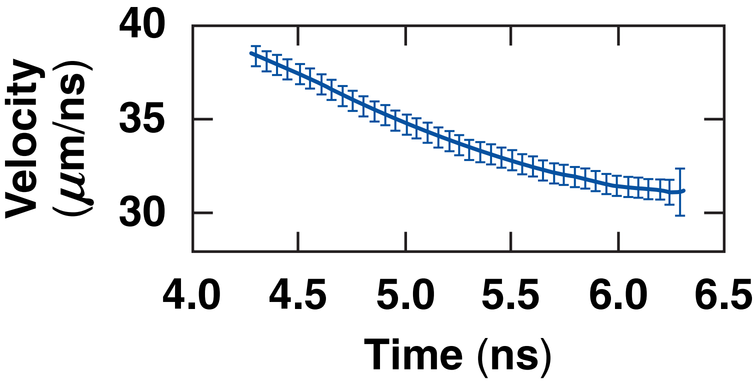
Laser



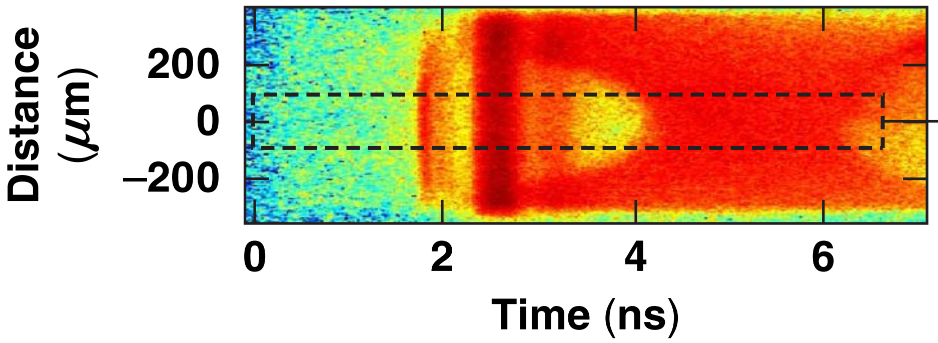
- We have extracted temperature and velocity data from the shock propagation in quartz (Shot 57529)

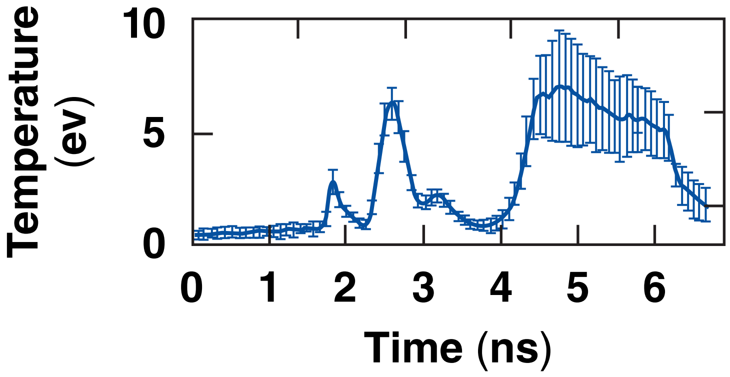
VISAR





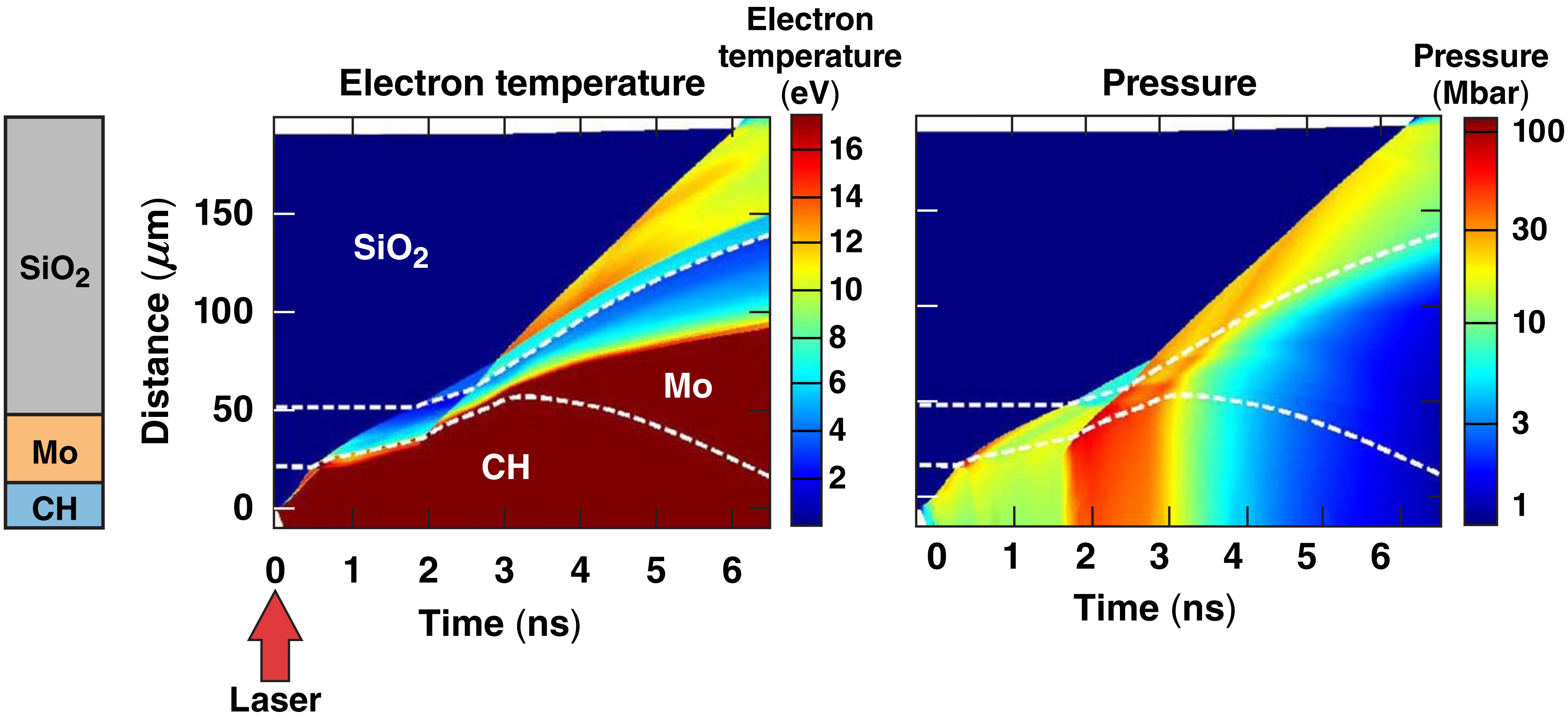
SOP





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 × 10^{15} W/cm^2 laser-generated pressures of at least ~110 Mbar are achieved

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