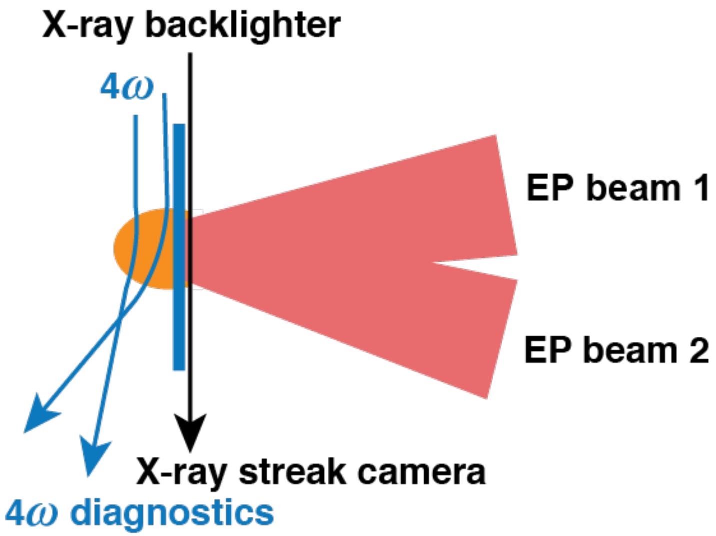
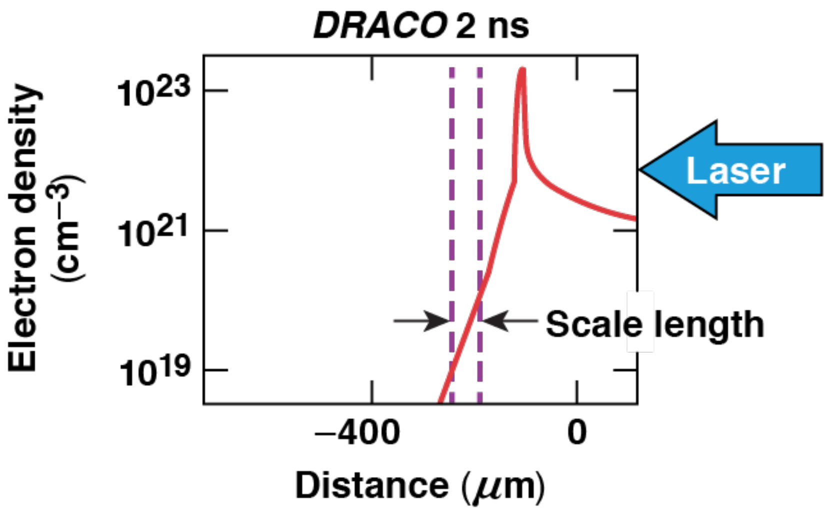
Shock-Release Experiments on OMEGA EP





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Radiation transport strongly affects the expansion of the rarefaction wave formed by the shock released from the laser-driven CH foil

- **Experiments using VISAR* showed early expansion (before the shock release) of the back surface of the CH foil**
- **The buried Au layer reduced the extent and scale length of the density profile in the rarefaction wave, consistent with radiation preheat hypothesis**
- **The Al layer on the laser side of the target did not affect the release, which ruled out the laser shinethrough as the early expansion mechanism**

* D. Haberberger *et al.*, Phys. Rev. Lett. 123, 235001 (2019).
VISAR: velocity interferometer system for any reflector

Collaborators

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T. C. Sangster, R. Boni, P. M. Nilson, V. N. Goncharov, and D. H. Froula**
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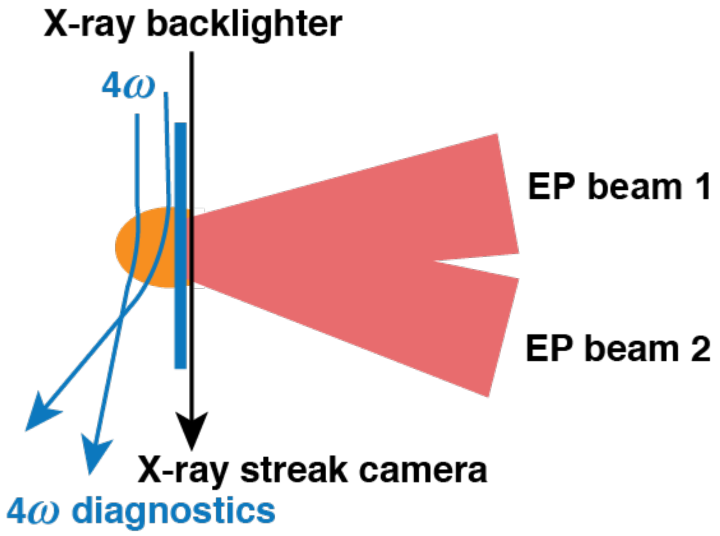
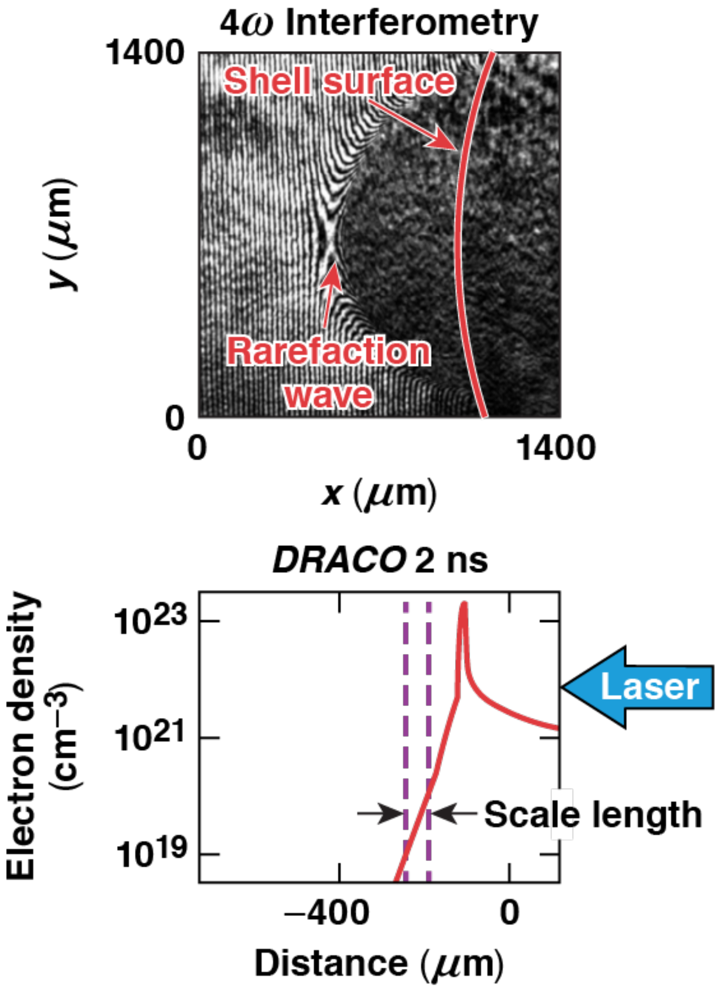
Lawrence Livermore National Laboratory

The shock-release experiments used a 4ω probe to measure the low-density plasma profile and side-on x-ray radiography to measure the shell trajectory



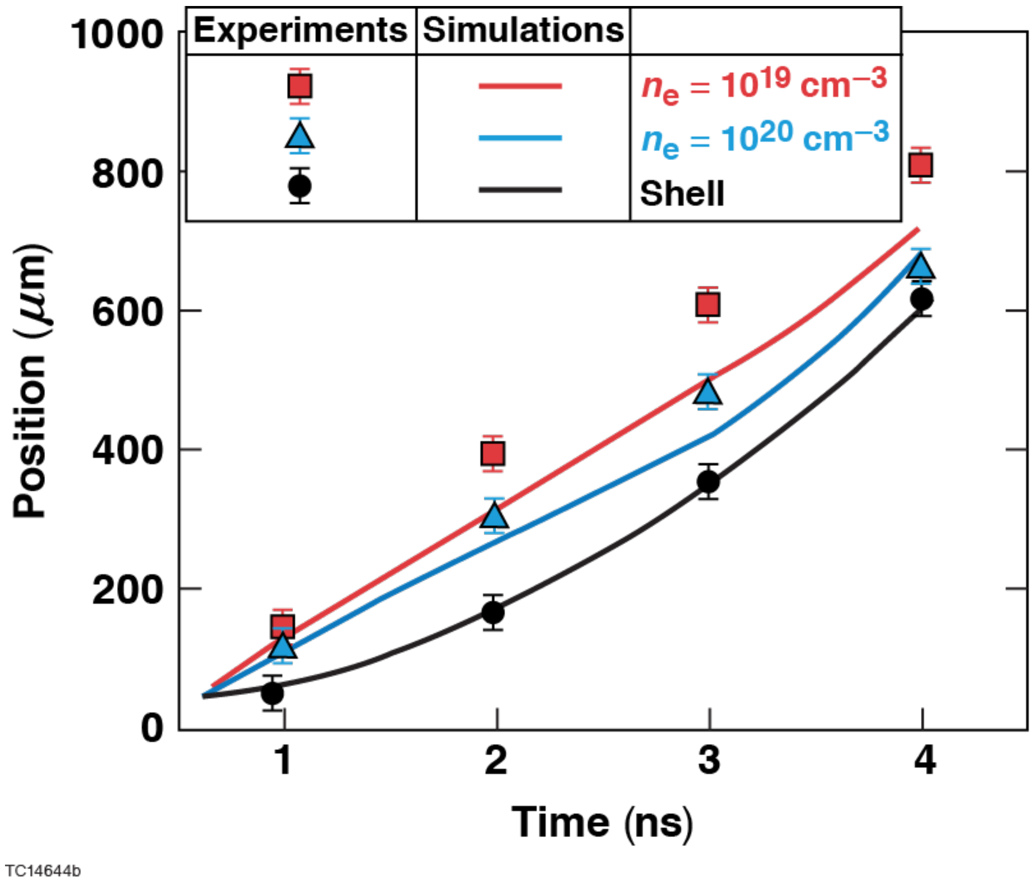
TC14640b

- 37 μm CH
- 4.1-mm-diam spherical cap or flat
- 5-ns square pulse
- 3×10^{14} W/cm^2



TC14642b

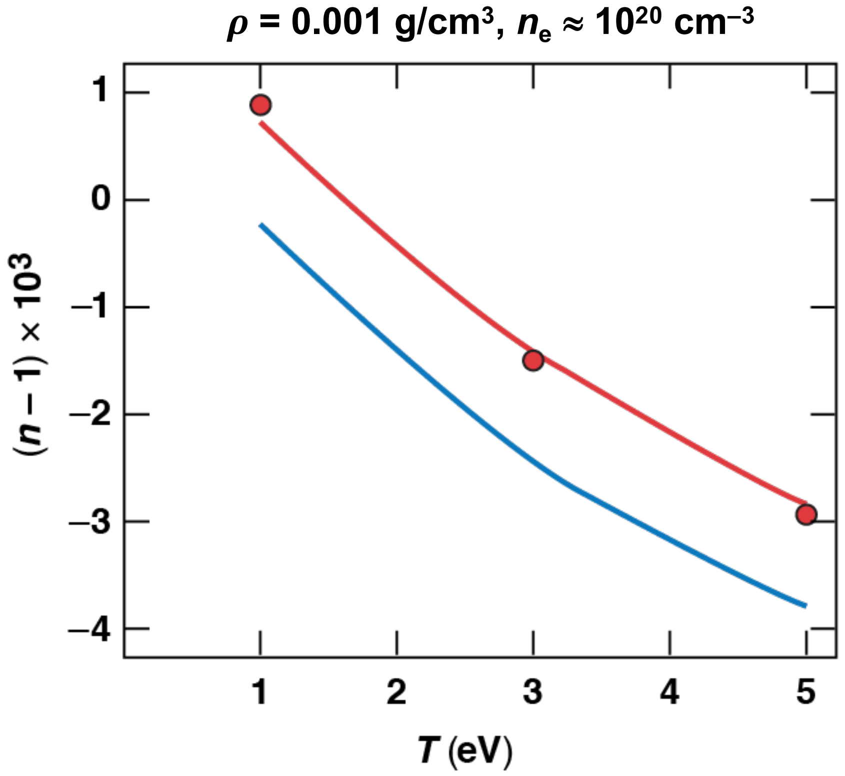
The experimentally measured extent and scale length of the electron density profiles in the rarefaction wave are significantly longer than those predicted by standard radiation-hydrodynamics simulations

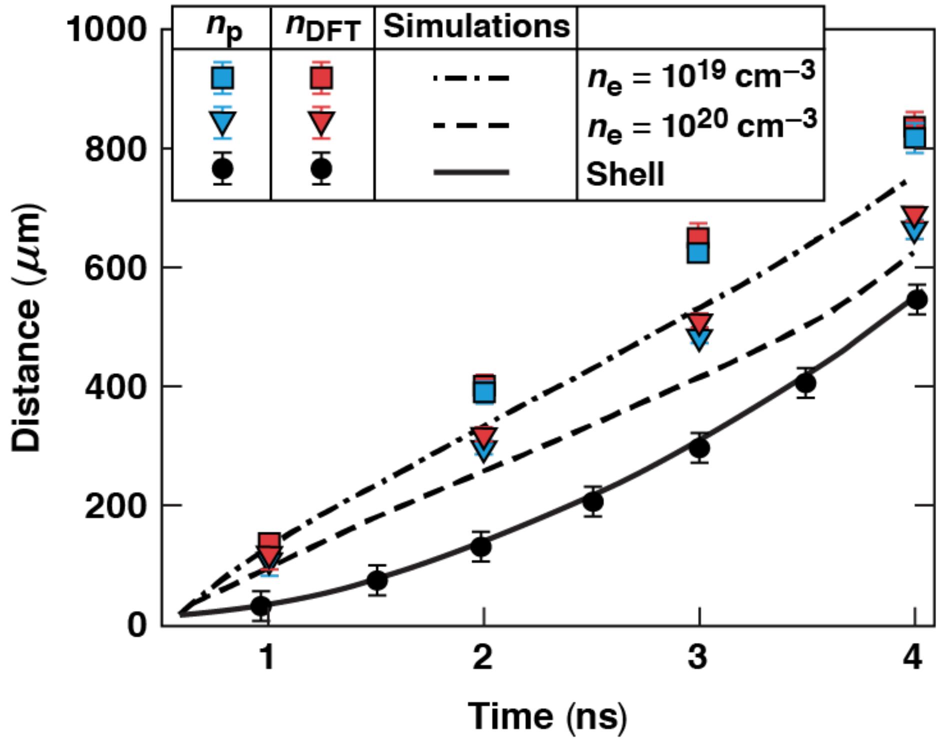


The reasons for the difference

- The way we infer the electron density using a textbook plasma index of refraction is wrong
- Some physics is missing from or incorrect in the simulations

Using a more-accurate index of refraction from *ab-initio* calculations* does not significantly change the electron density profiles obtained from 4ω probe images



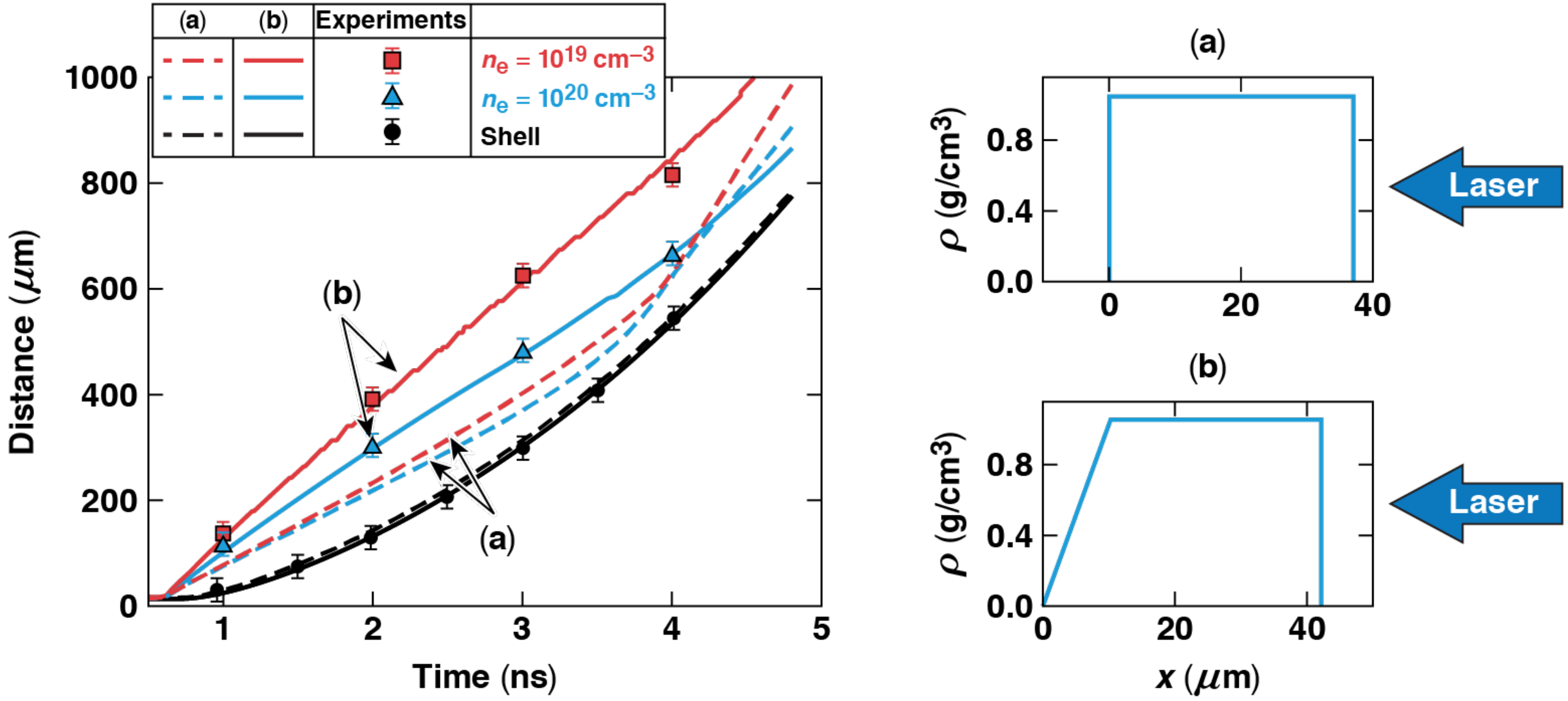


$n_{DFT} = \sqrt{1 + 4\pi(1.7\,\text{Å}^3 \times ni - 4.9\,\text{Å}^3 \times n_e)}$ – DFT *ab-initio* calculations

$n_p = \sqrt{1 - 4\pi\, 4.9\,\text{Å}^3 \times n_e}$ – plasma dielectric constant $n_p = \sqrt{1 - n_e/n_c}$

* A. Shvydky, A. V. Maximov, V. V. Karasiev, D. Haberberger, and V. N. Goncharov, "Ionization State and Dielectric Permittivity in Cold Rarefied CH Plasmas of Inertial Confinement Fusion," to be submitted to Physical Review E.

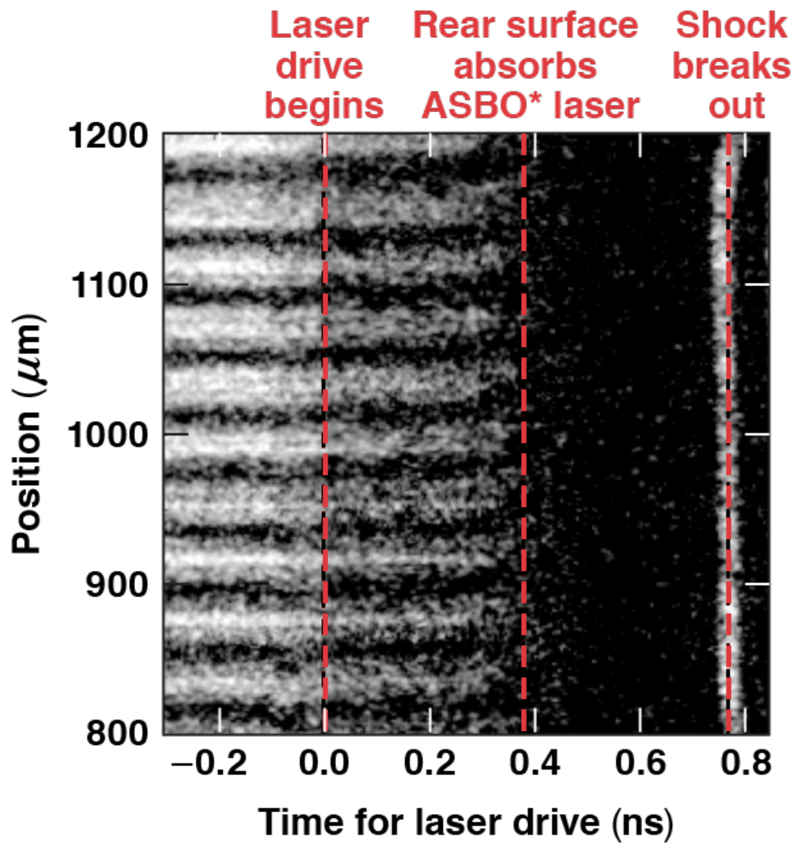
The density profile on the back side of the shell before the shock breakout strongly affects the rarefaction wave expansion

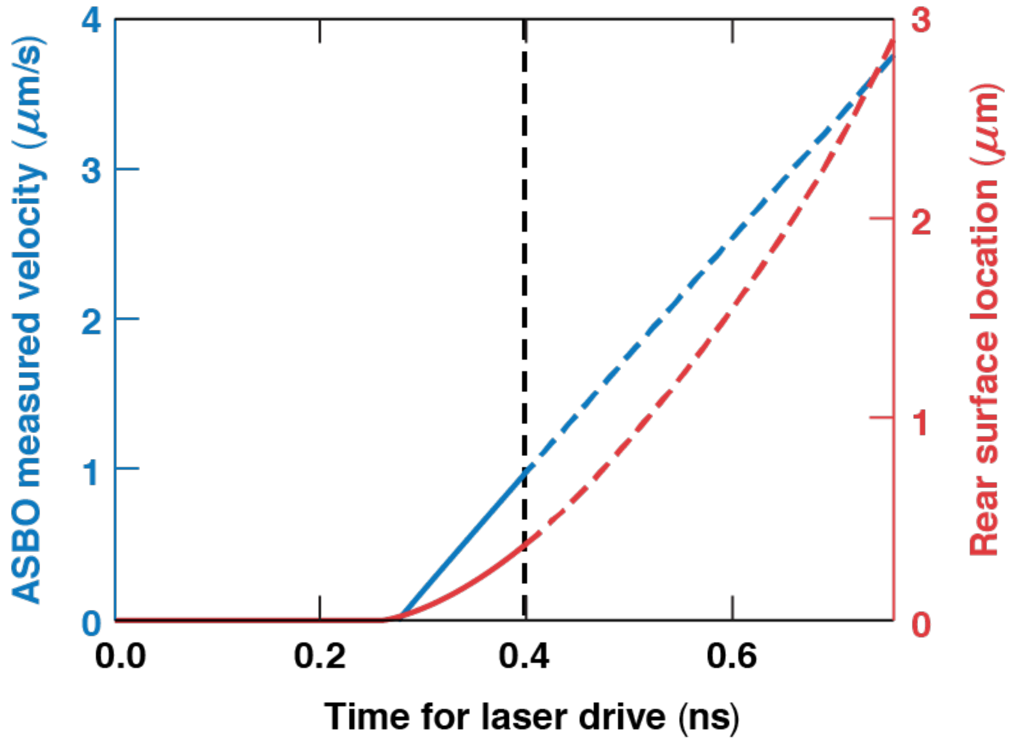


TC15202a

D. Haberberger *et al.*, Phys. Rev. Lett. 123, 235001 (2019).

VISAR shows movement of the back side of the CH foil before the shock breakout



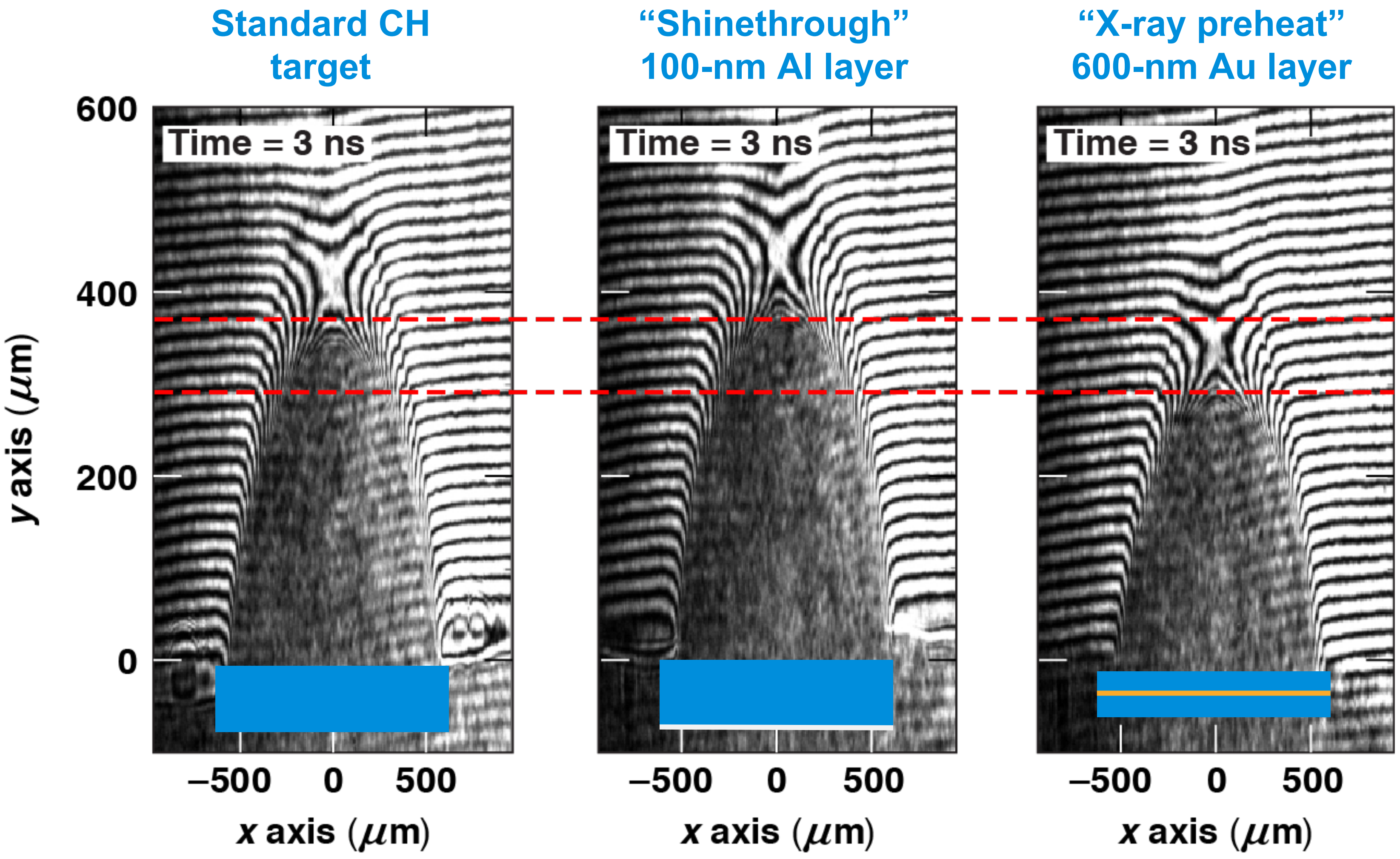


TC15601

Coronal x-ray preheat or laser shinethrough?

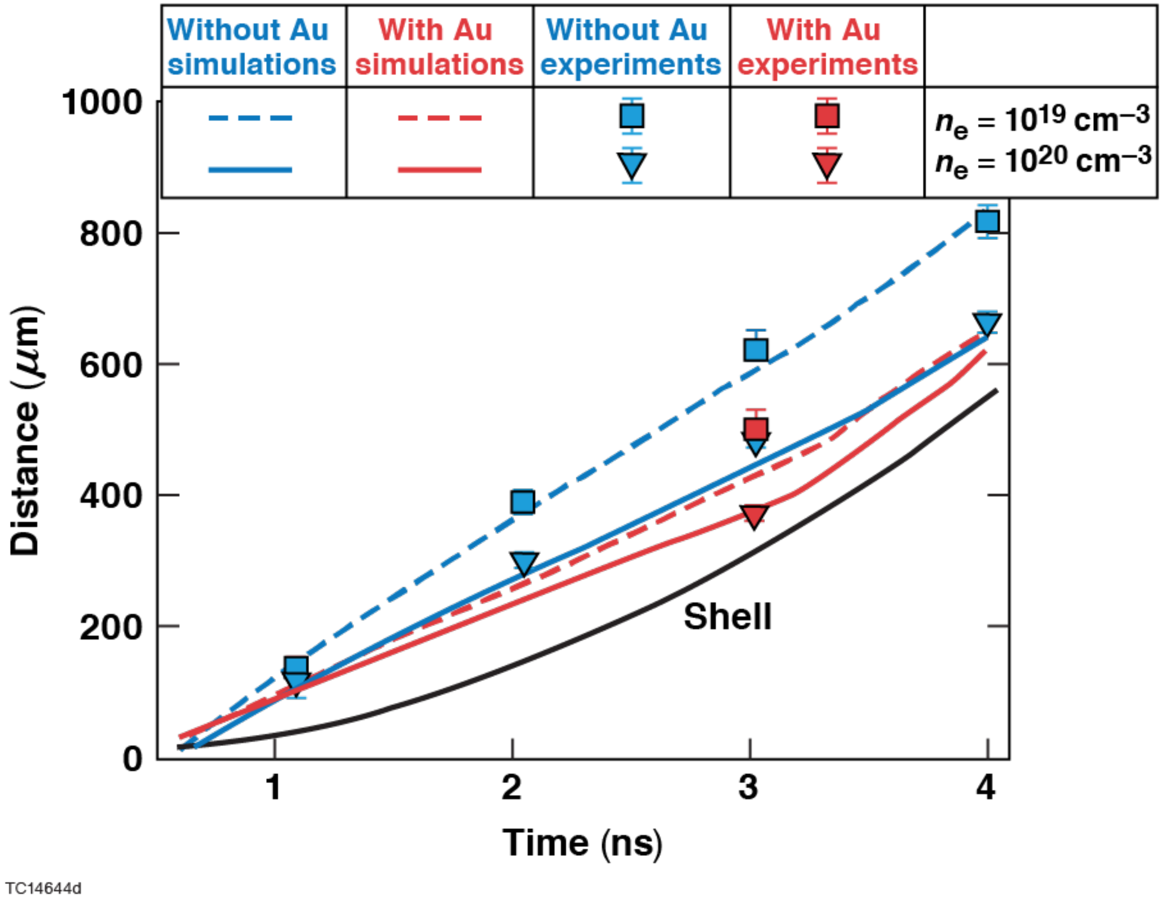
* ASBO: active shock breakout

The latest experiments were aimed at testing x-ray preheat as well as shinethrough as the culprit for pre-expansion of the rear side of the target

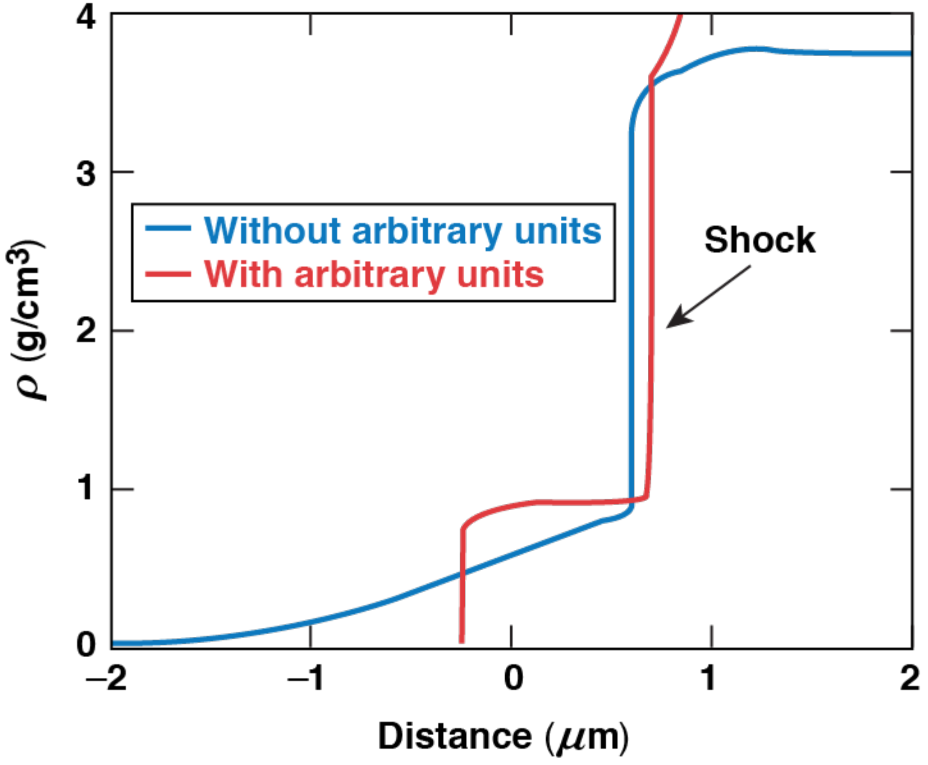


TC15602

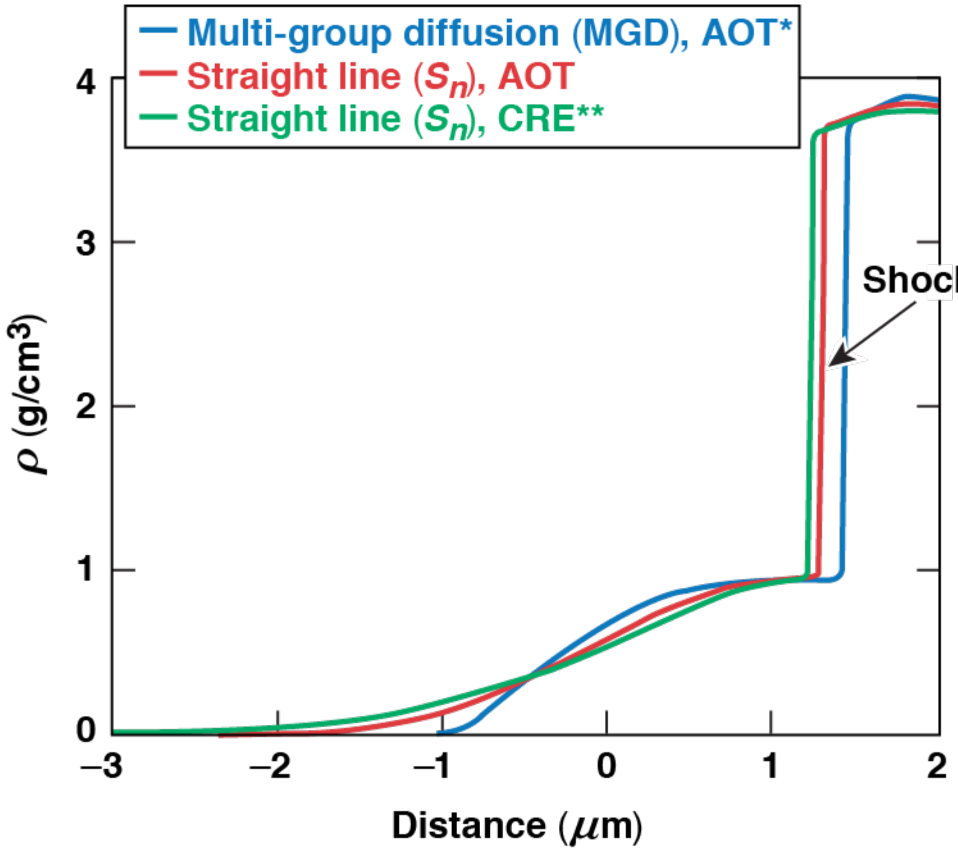
The buried Au layer significantly affects the position of the rarefaction wave



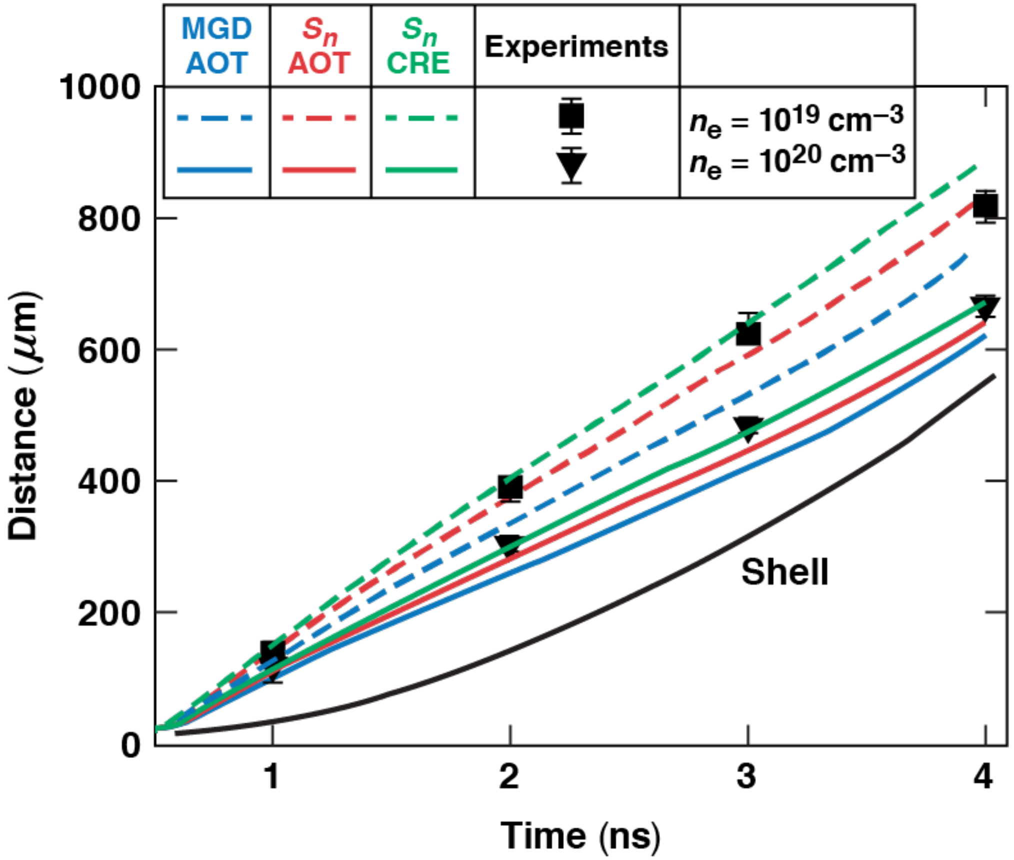
LILAC simulations



The early expansion and therefore the release strongly depend on the radiation transport models used in the simulations



TC14644e



W. F. Huebner *et al.*, Los Alamos National Laboratory, Los Alamos, NM, Report LA-6760-M (1977);
* AOT: astrophysical opacity tables
R. Epstein *et al.*, Bull. Am. Phys. Soc. 43, 1666 (1998);
** CRE: collisional radiative equilibrium

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