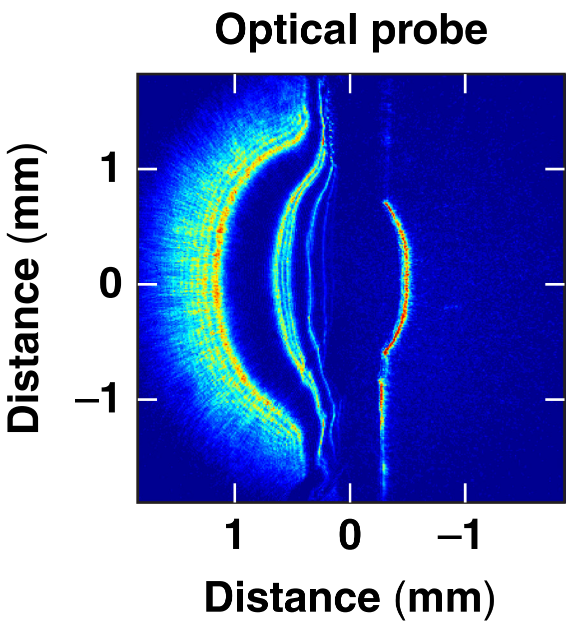
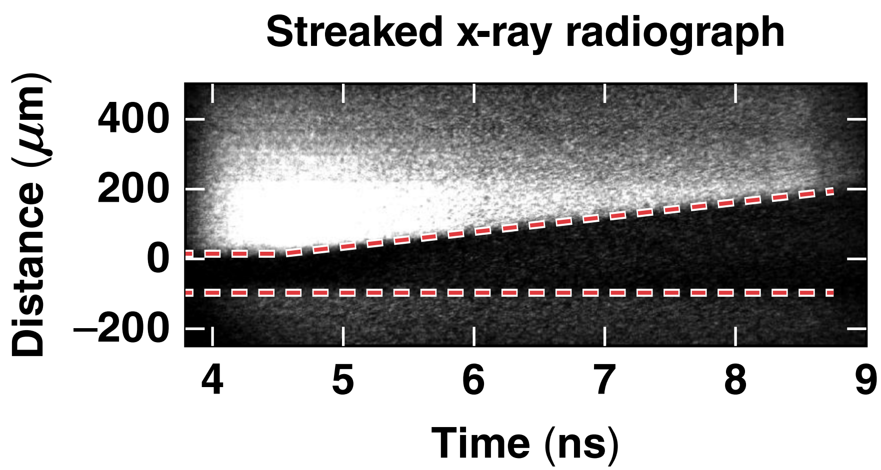
Probing the Release of Shocked Material





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The release behavior of shocked material is critical to equation-of-state (EOS) measurements and inertial confinement fusion (ICF) target designs

UR LLE

- When a shock encounters a lower impedance, it adiabatically "releases" to lower pressure and density
- The impedance-match technique relies on knowing the behavior of that release
- National Ignition Facility (NIF) shock-timing measurements revealed inconsistencies in the predicted release of the ablator into deuterium fuel
- The release of shocked materials into vacuum is studied using 266-nm and x-ray probes of the release plume
- Data for shocked polystyrene shows that the release isentrope from LEOS 5111 models the velocity well

Collaborators

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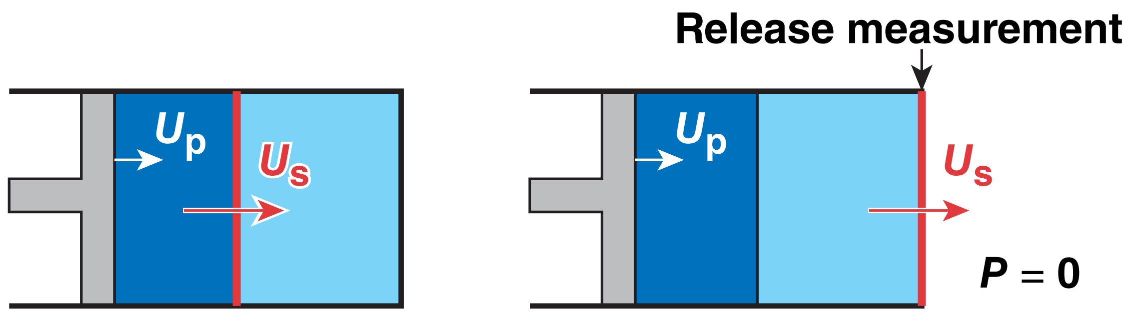
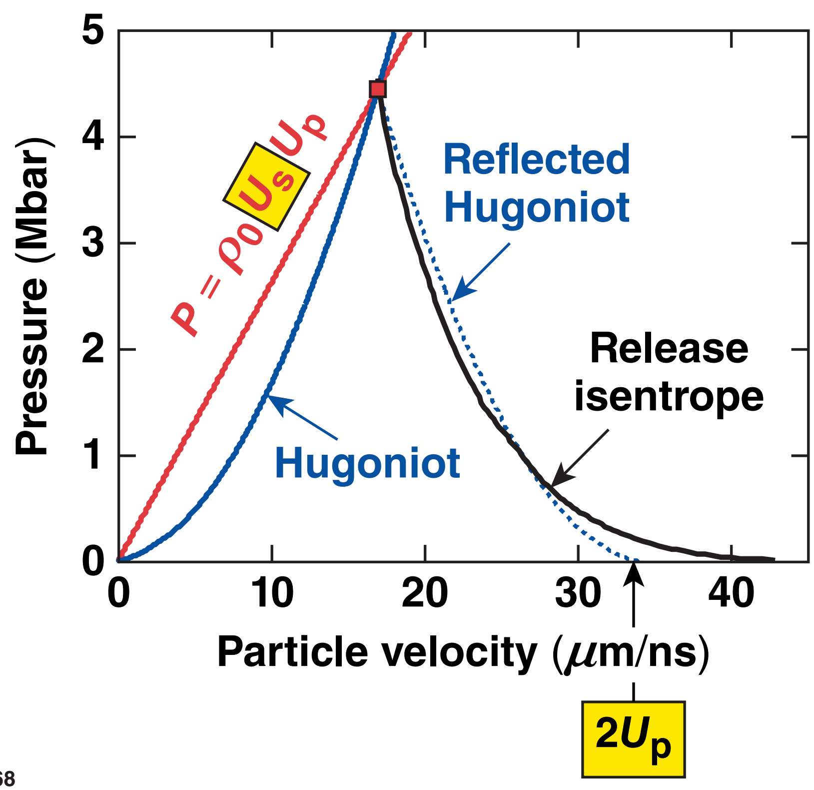
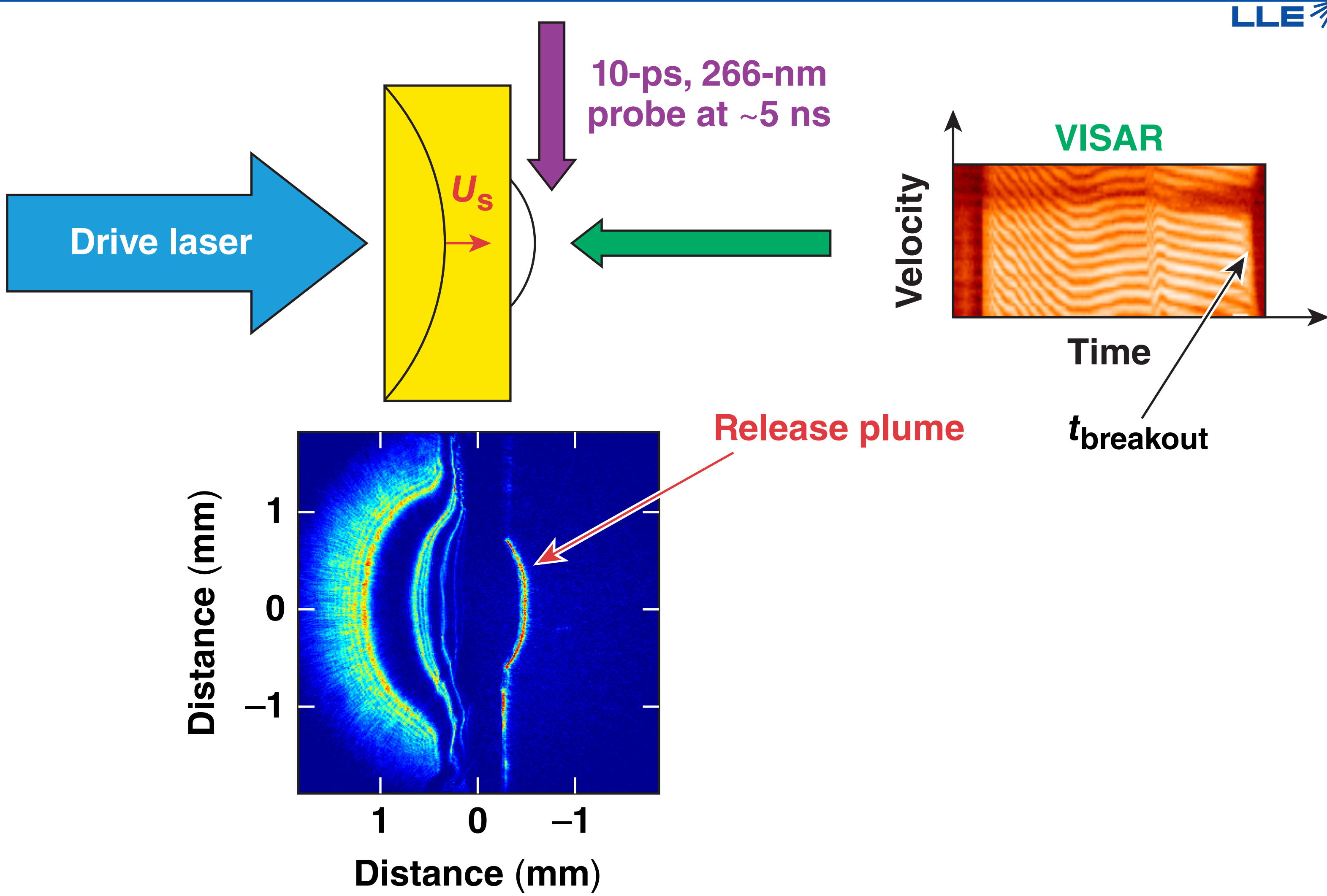




- For weak shocks, release velocity is ~$2U_p$ (reflected Hugoniot)
- Strong shocks produce higher entropy and the release is described by the isentrope
- Strong shocks ($\gtrsim$Mbar) produce velocities >2*U*p

E23568

A UV beam probed the release plumes of shocked materials and a velocity interferometer system for any reflector (VISAR) provided initial conditions



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When shocked to ~15 Mb, CH is released at ~90 km/s; 2.7× the initial particle velocity (U_p)

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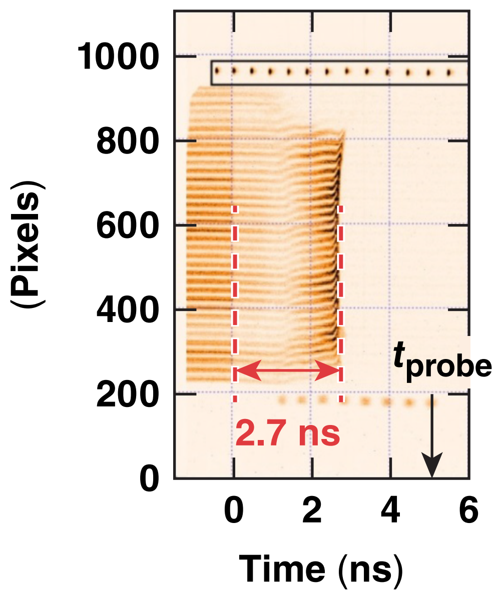
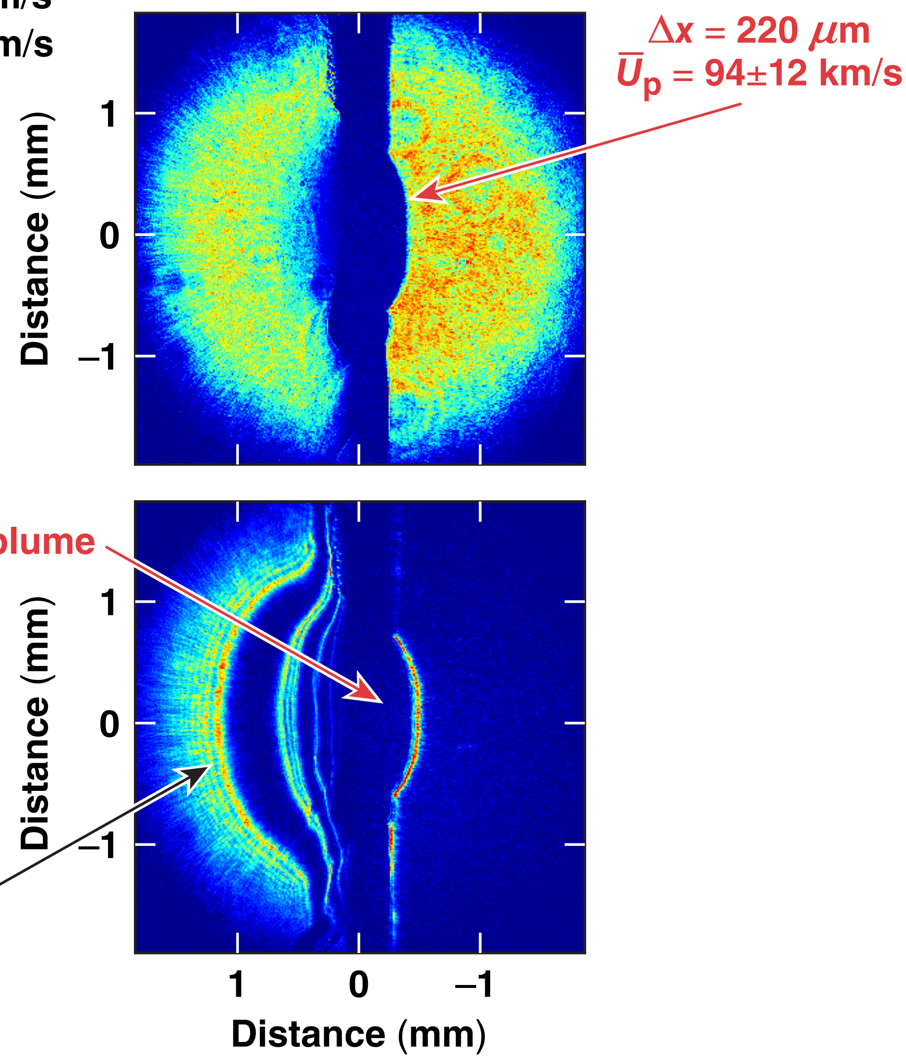
VISAR provides the breakout time and initial conditions



U_s = 50 km/s
U_p = 35 km/s
~15 Mbar
>5 eV



Release plume

Refractometry image (schlieren-type imaging with angular filters)

Coronal plasma

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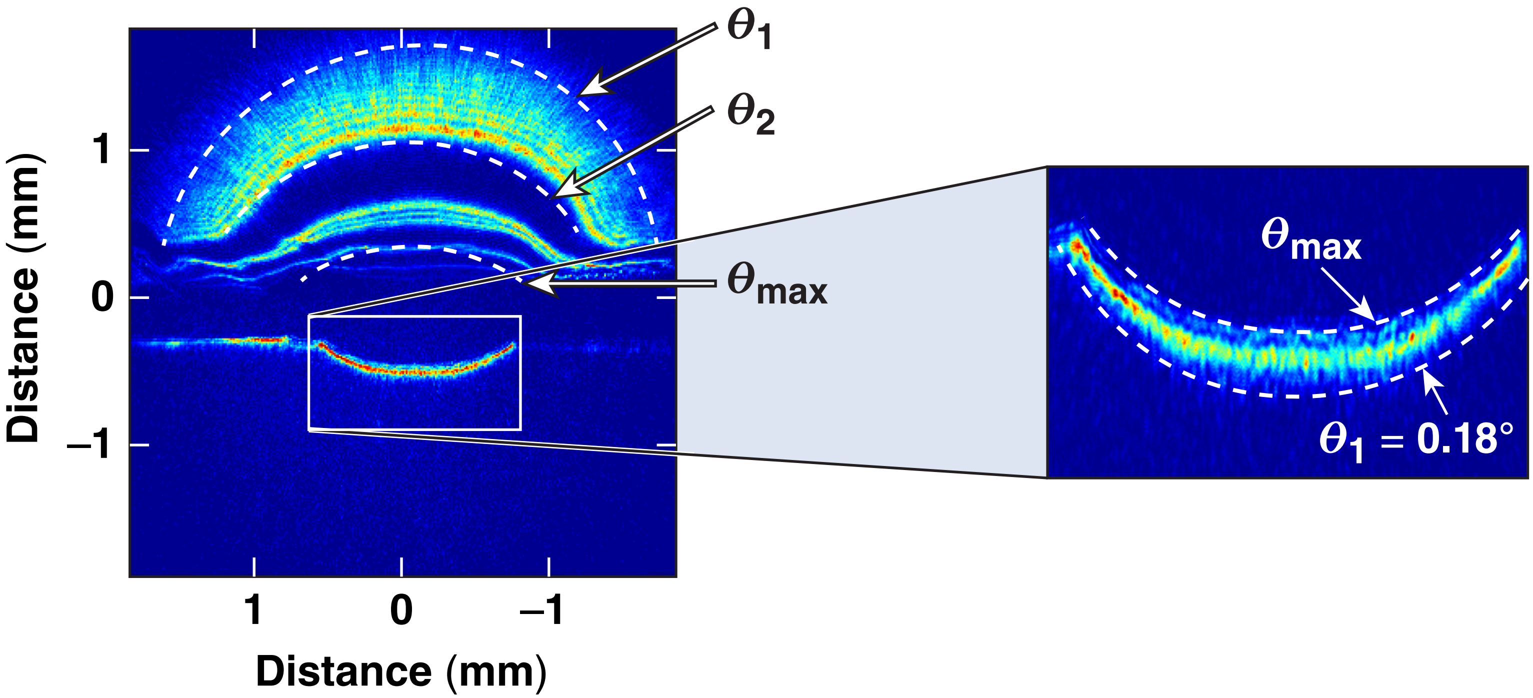
E23570

D. Haberberger *et al.*, Phys. Plasmas 21, 056304 (2014).

Refractometry can provide the electron density at the leading edge of the release plume



- Electron density
  - 3×10^{20} cm^{-3} ($\theta_1 = 0.18°$, $\theta_{max} = 8.0°$)

Assuming plasma model

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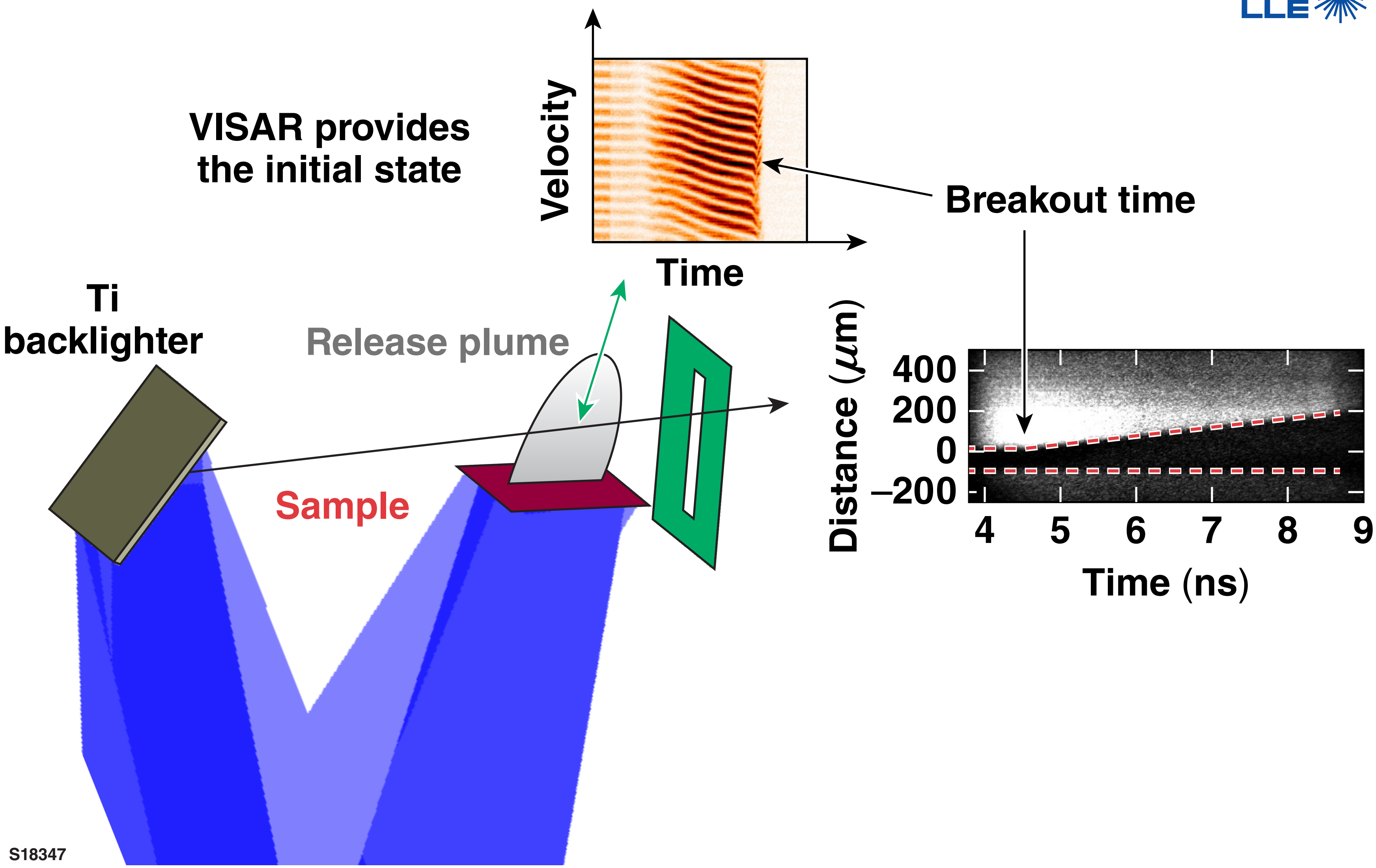
Streaked x-ray radiography tracks the expansion of shocked material released from the rear surface



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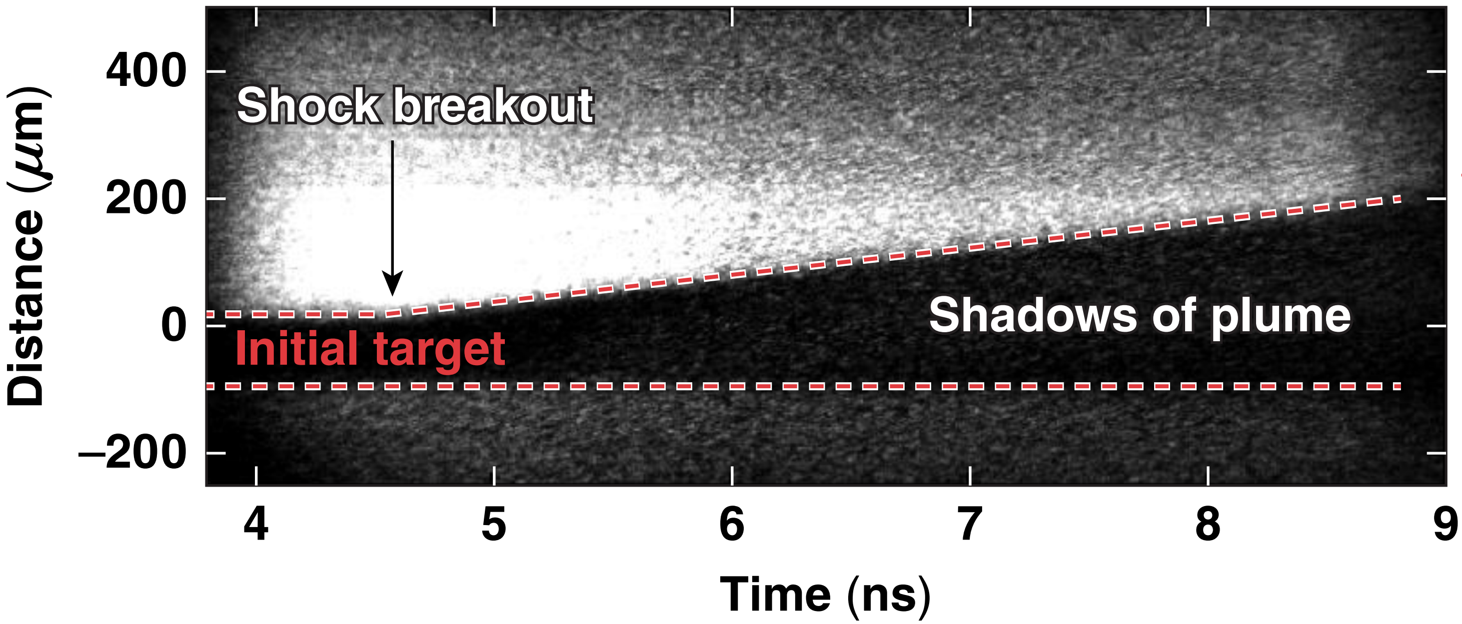
The release velocity is obtained from the trajectory of the time-resolved shadows of plume

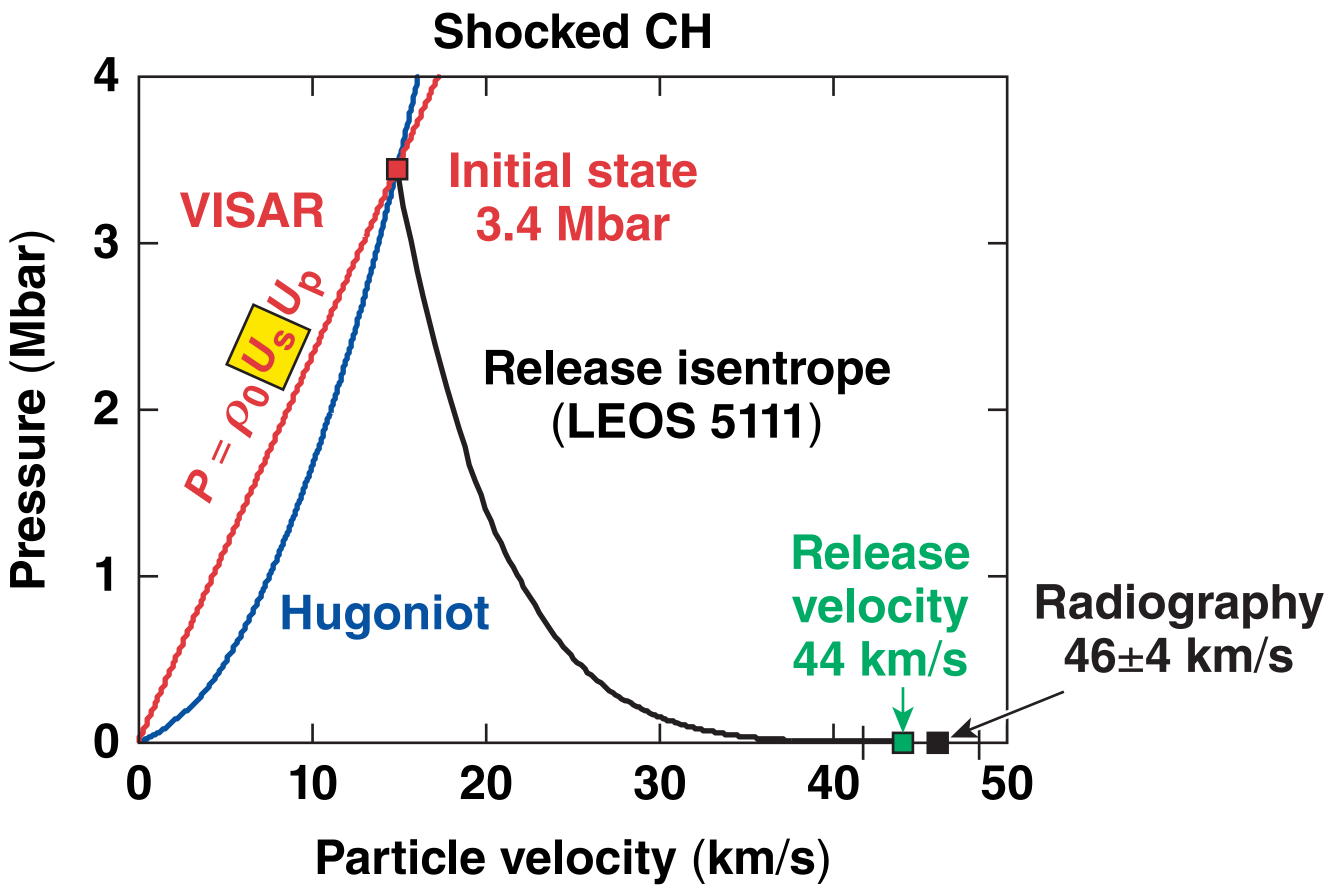


$$\frac{\Delta x}{\Delta t} = 46 \pm 5 \text{ km/s}$$

S18347

E23574

Radiography shows the expansion velocity of 3.0 U_p for CH shocked to 3.4 Mbar



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Summary/Conclusions

The release behavior of shocked material is critical to equation-of-state (EOS) measurements and inertial confinement fusion (ICF) target designs

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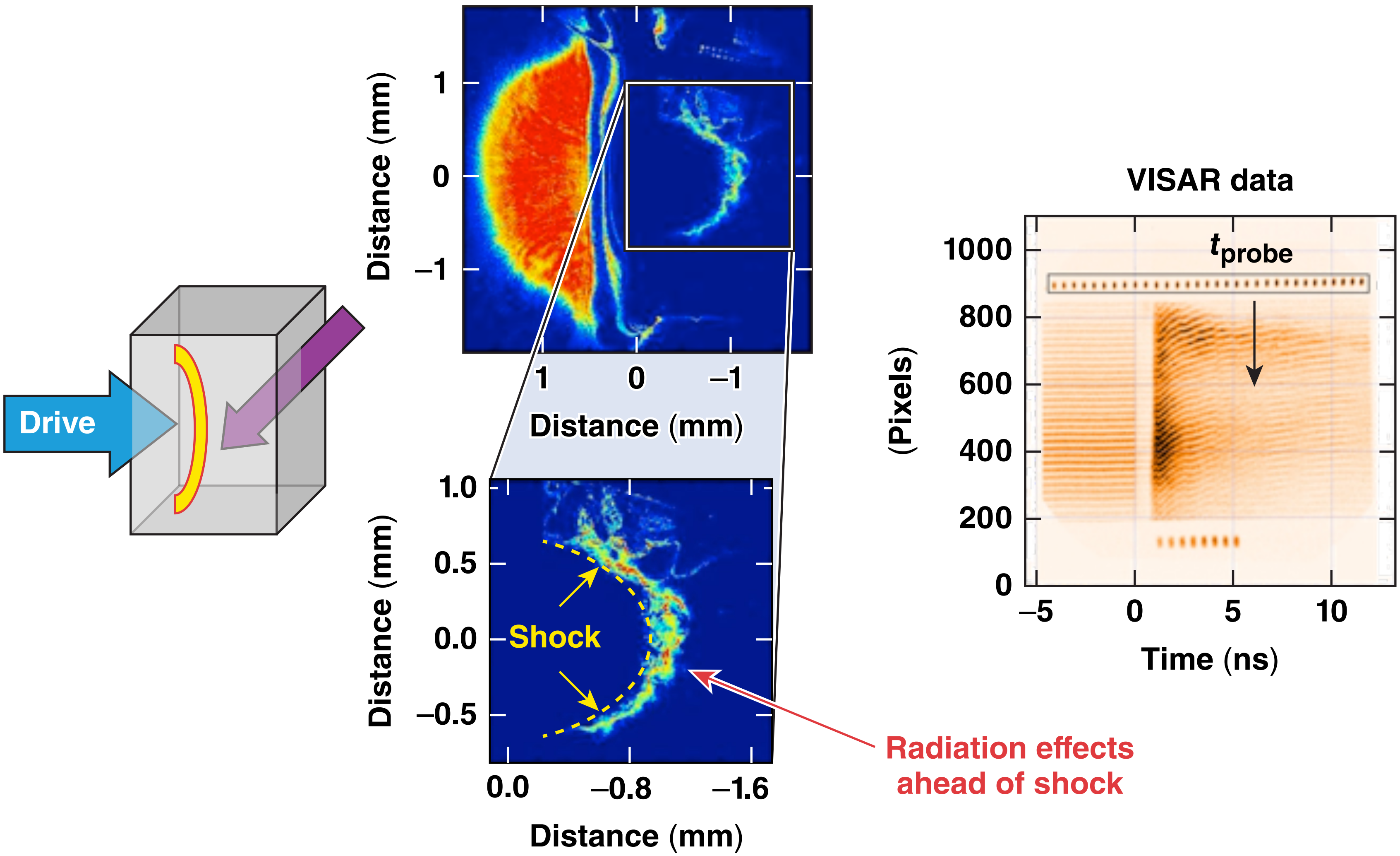
Images of a shock in fused silica show perturbations in the optical properties ahead of the shock



E23572