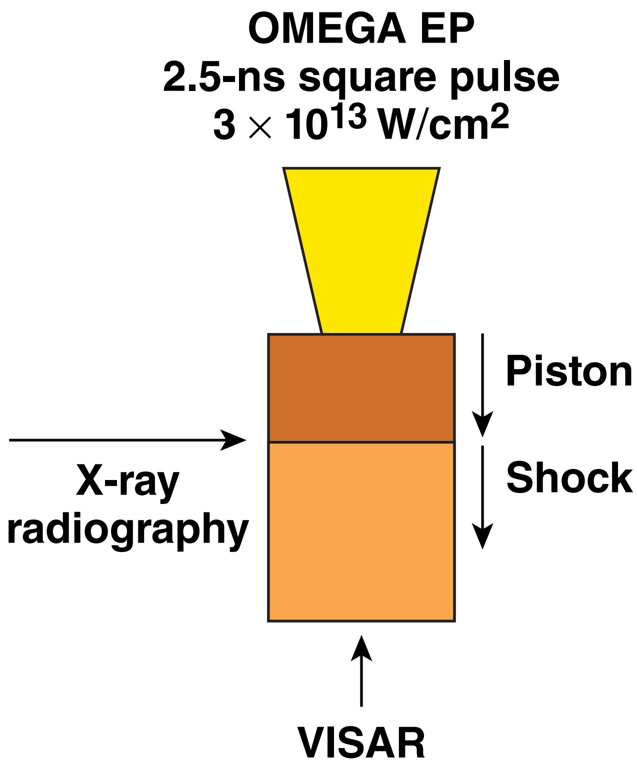
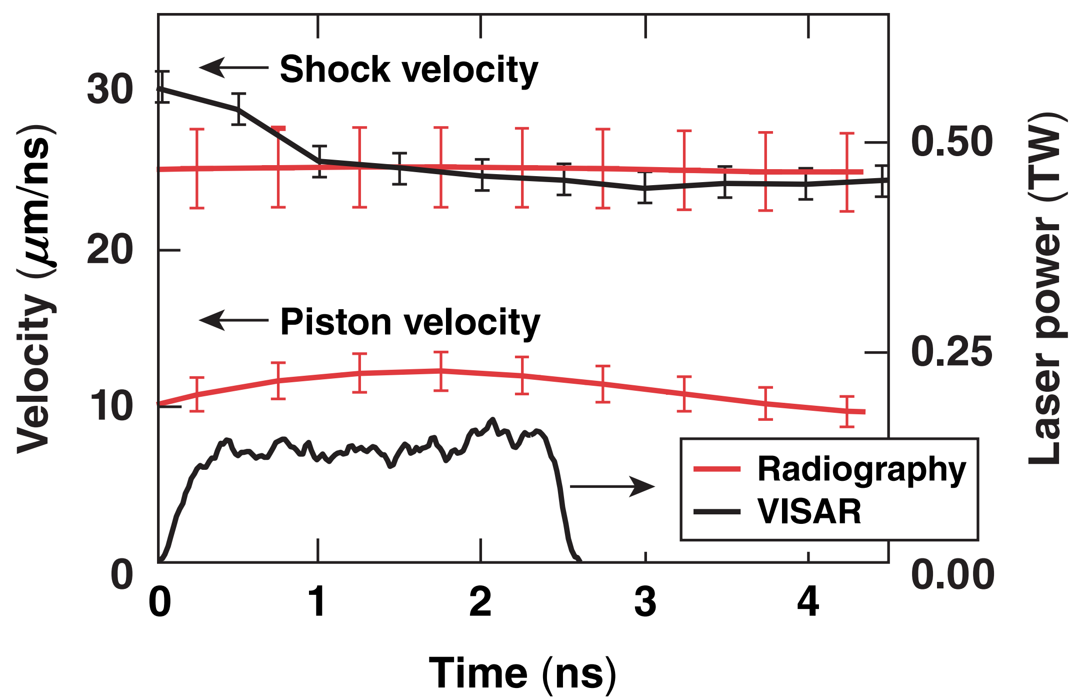
Direct Measurements of Shock-Wave Propagation in CH Using Streaked X-Ray Radiography and VISAR





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Summary

Techniques are being investigated to improve the precision in absolute equation-of-state (EOS) data in CH

- Absolute EOS data for CH were obtained using directly driven shocks on OMEGA EP
- Piston (u_p) and shock (u_s) velocities were measured with streaked x-ray radiography and VISAR (velocity interferometer system for any reflector)
- Combining these techniques improves the precision of the inferred material compression and pressure to ~10%

Experiments are planned to extend these measurements to higher densities and pressures.

Collaborators

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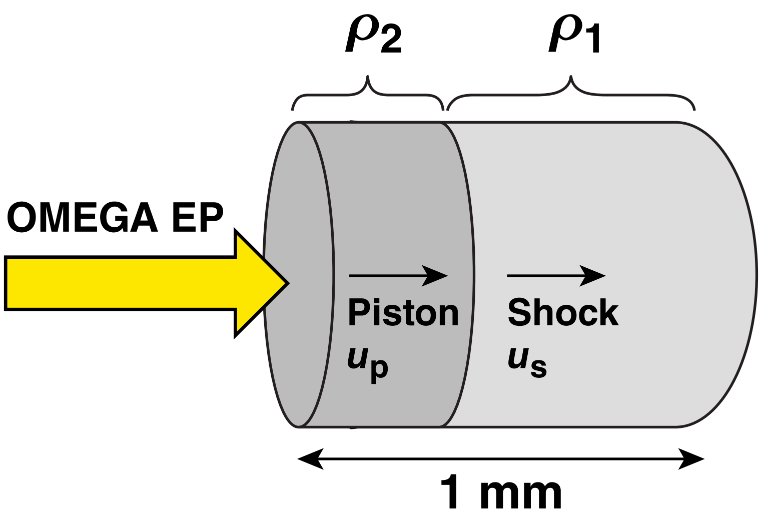
Conservation laws require two independent parameters be measured to obtain absolute EOS data



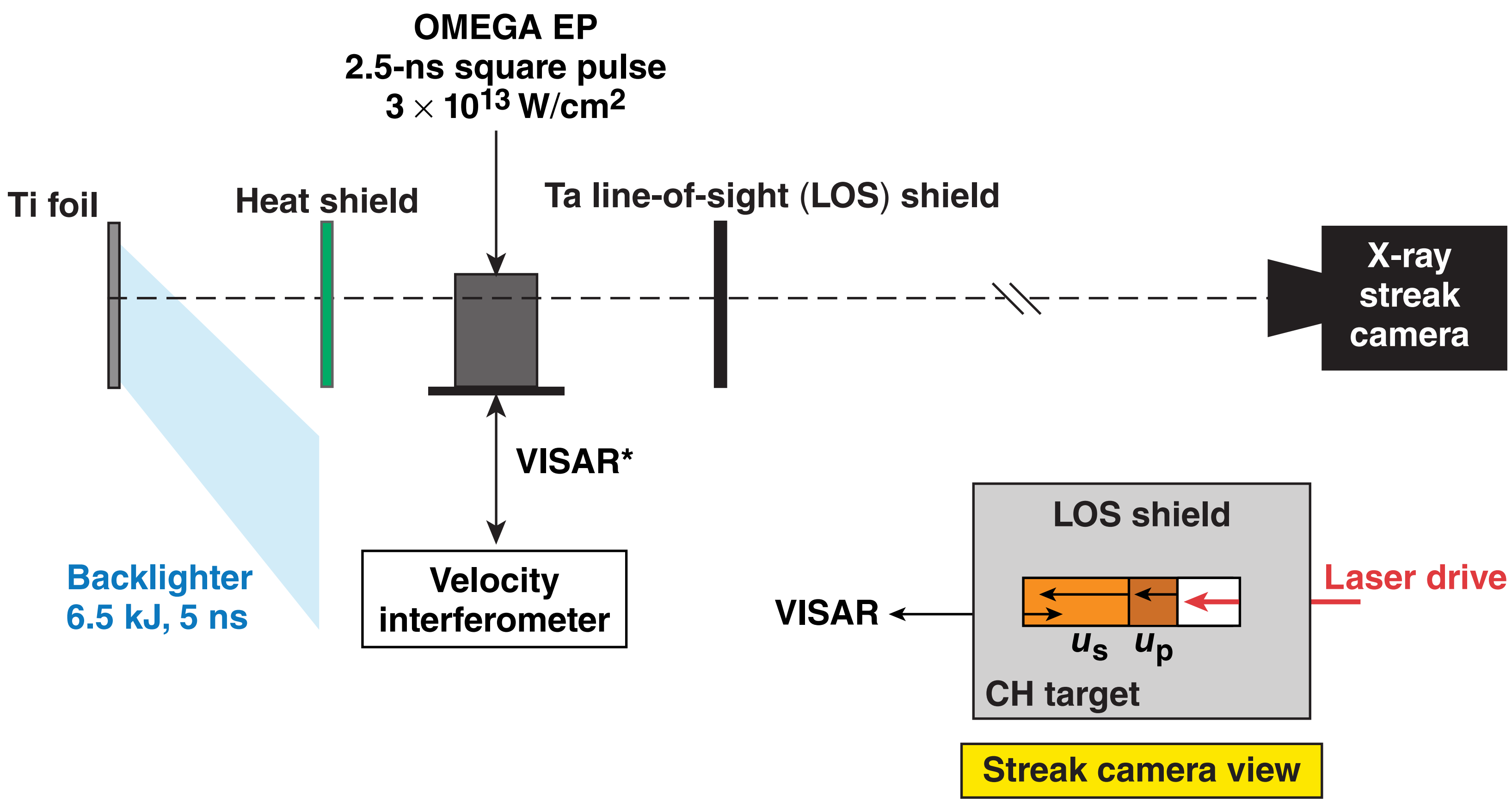
Rankine–Hugoniot equations

$$P = \rho_1 u_s u_p$$

$$\frac{\rho_2}{\rho_1} = \left(1 - \frac{u_p}{u_s}\right)^{-1}$$

Radiography only: $\delta\rho/\rho = 30\%$, $\delta P/P = 14\%$
Radiography and VISAR: $\delta\rho/\rho = 20\%$, $\delta P/P = 10\%$

Shocks in CH were diagnosed with streaked x-ray radiography and VISAR



P. M. Nilson, NO6.00014, this conference.

*L. M. Barker and R. E. Hollenbach, J. Appl. Phys. 45, 4872 (1974).

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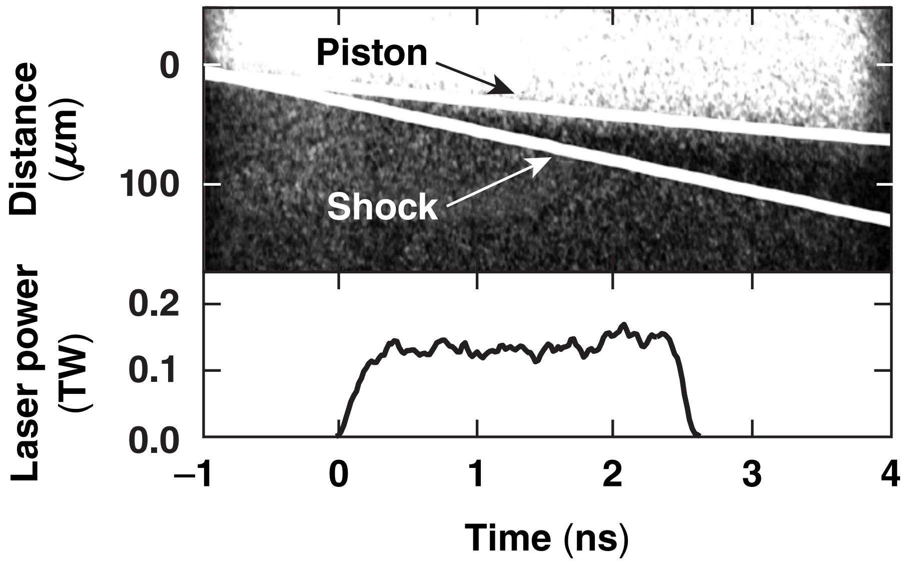
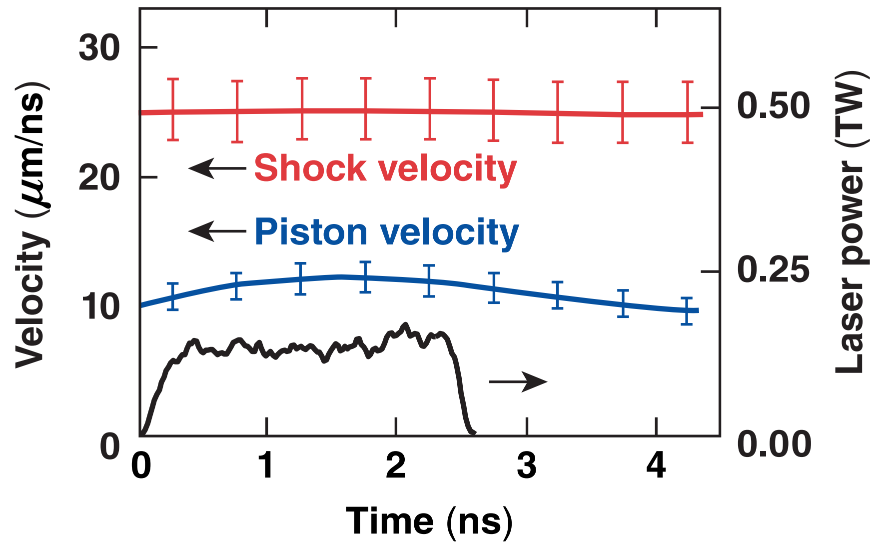
X-ray radiography tracks the piston and shock trajectories

Shot: 19439
Target: CH
Laser: 350 J, 2.5 ns
Intensity: 3×10^{13} W/cm^2





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VISAR measures the shock velocity to within a few percent

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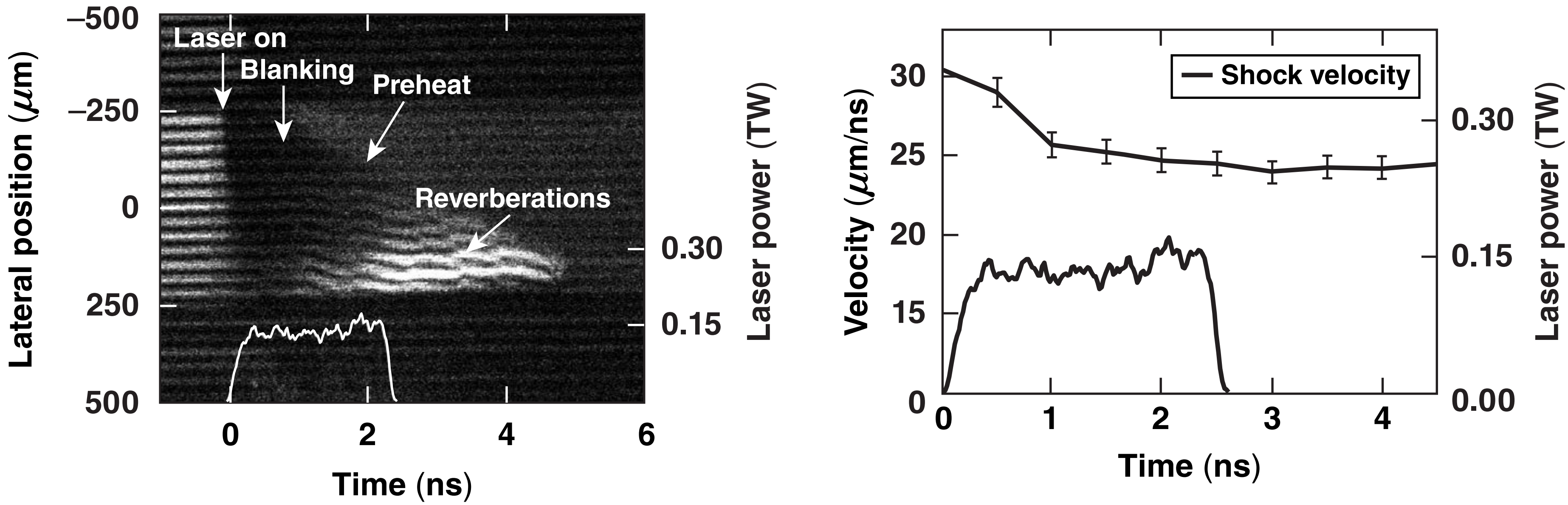
Shot: 19441
Target: CH
Laser: 350 J, 2.5 ns
Intensity: 3×10^{13} W/cm^2



Asymmetric-drive conditions give rise to deviations from 1-D behavior.

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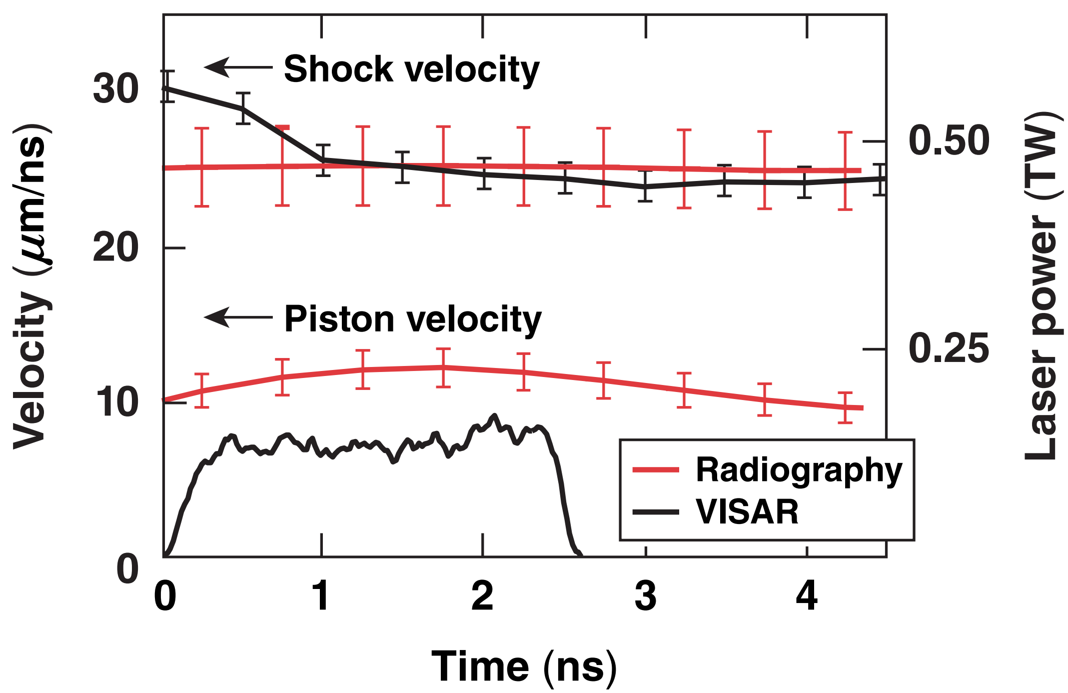
The shock velocities measured with x-ray radiography and VISAR agree to within experimental error



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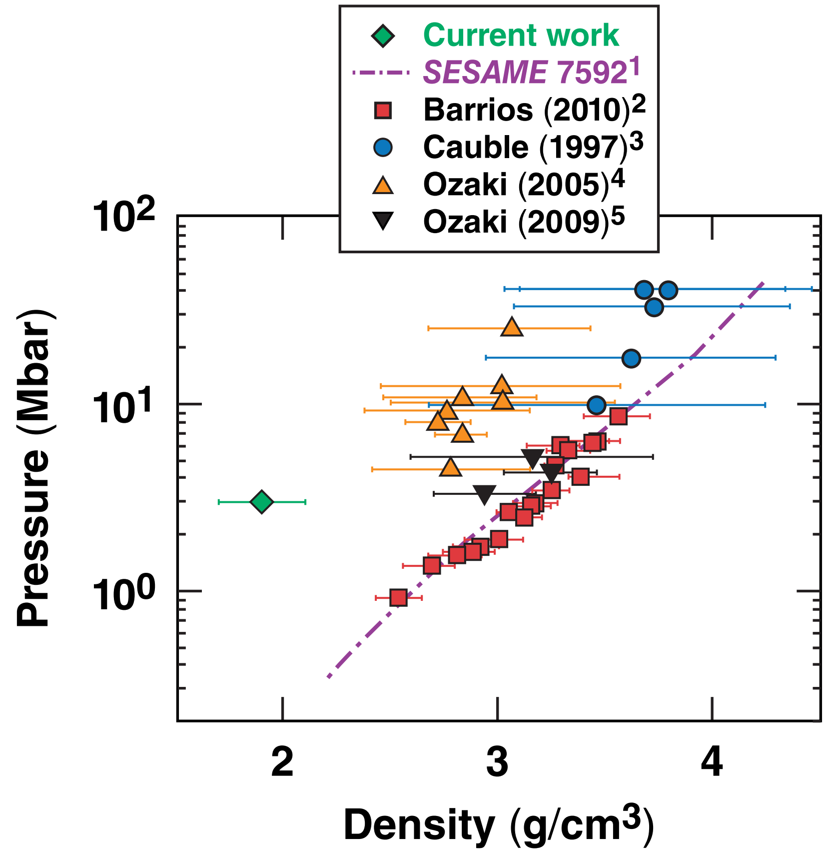
Combining these techniques reduces the error in the inferred material compression and pressure

	u_s (μm/ns)	u_p (μm/ns)	$\frac{\rho}{\rho_0}$	P (Mbar)
Radiography	25±3	12±1.5	1.9±0.3	3±0.4
Radiography and VISAR	25±0.5	12±1.5	1.9±0.2	3±0.3

Future studies will improve the drive symmetry, shock planarity, and steadiness.



[1]S. P. Lyon and J. D. Johnson, Los Alamos National Laboratory, Los Alamos, NM, Report LA-CP-98-100 (1998).
[2]M. A. Barrios Garcia, Ph.D. thesis, University of Rochester, 2010.
[3]R. Cauble *et al.*, Phys. Plasmas 4, 1857 (1997).
[4]N. Ozaki *et al.*, Phys. Plasmas 12, 124503 (2005).
[5]N. Ozaki *et al.*, Phys. Plasmas 16, 062702 (2009).

Summary/Conclusions

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