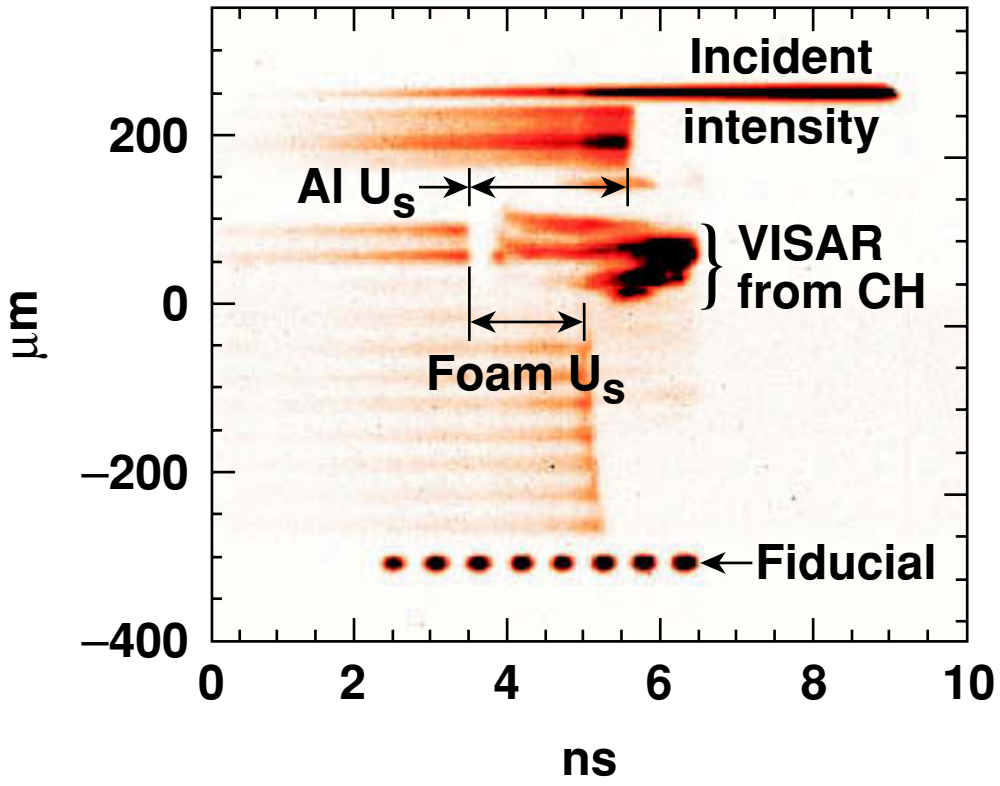
Measurements of the Equation of State of Carbon Foams



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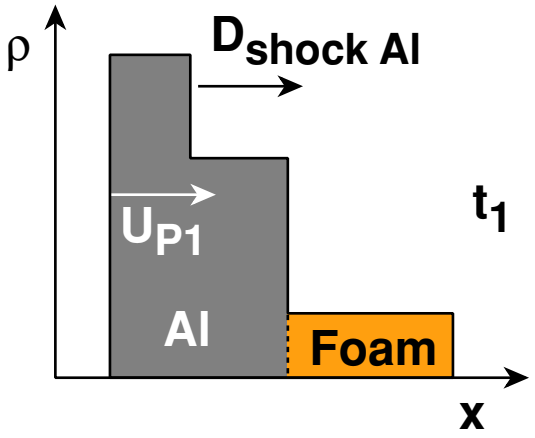
Summary

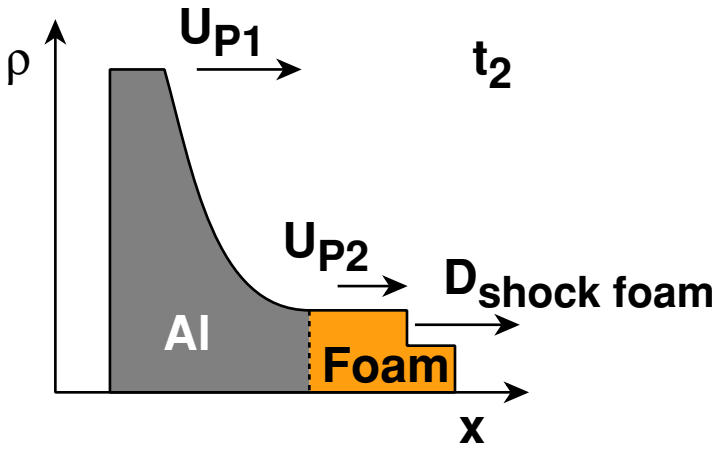
LLE has begun a program to study the equation of state of various materials at high pressures (> 1 Mb)

UR LLE

- Initial experiments concentrate on carbon resorcinol foam (CRF); a material used in high-energy-density studies.
- Pressures are produced by a single shock; the EOS is obtained using impedence-match technique.
- Shock velocities are measured using a VISAR system developed and installed on OMEGA by LLNL.
- Preliminary results are promising, have validated target designs, and will be used for EOS models.
- Other materials, including liquid and solid deuterium, will be studied.

Impedance match method relies on the shock and release behaviors of a known standard





Rankine–Hugoniot equations:

$$\frac{\rho}{\rho_0} = \frac{D_s}{(D_s - U_P)}$$

$$P - P_0 = \rho_0 D_s U_P$$

$$E - E_0 = \frac{1}{2}(P + P_0)\left(\frac{1}{\rho_0} - \frac{1}{\rho}\right)$$

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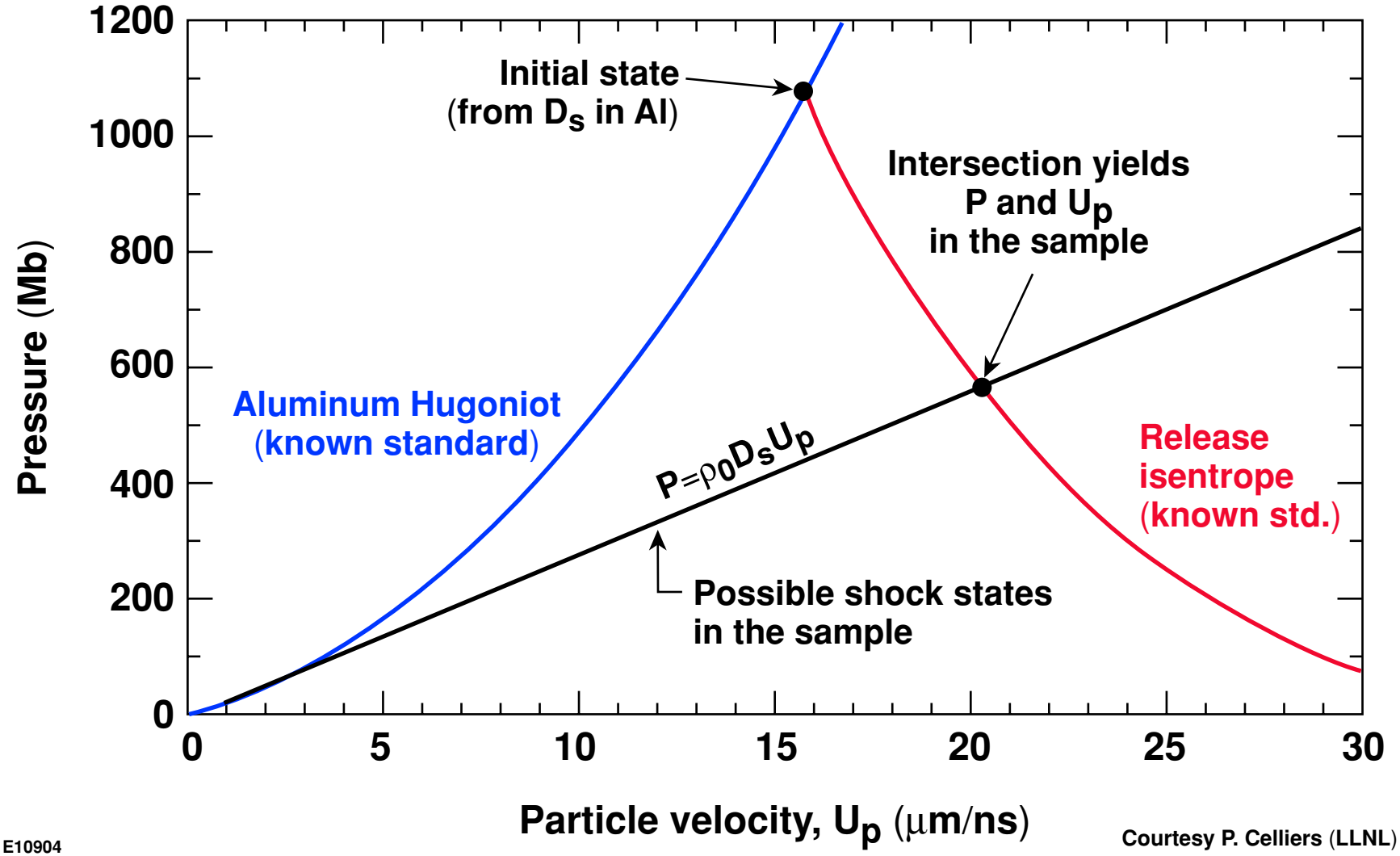
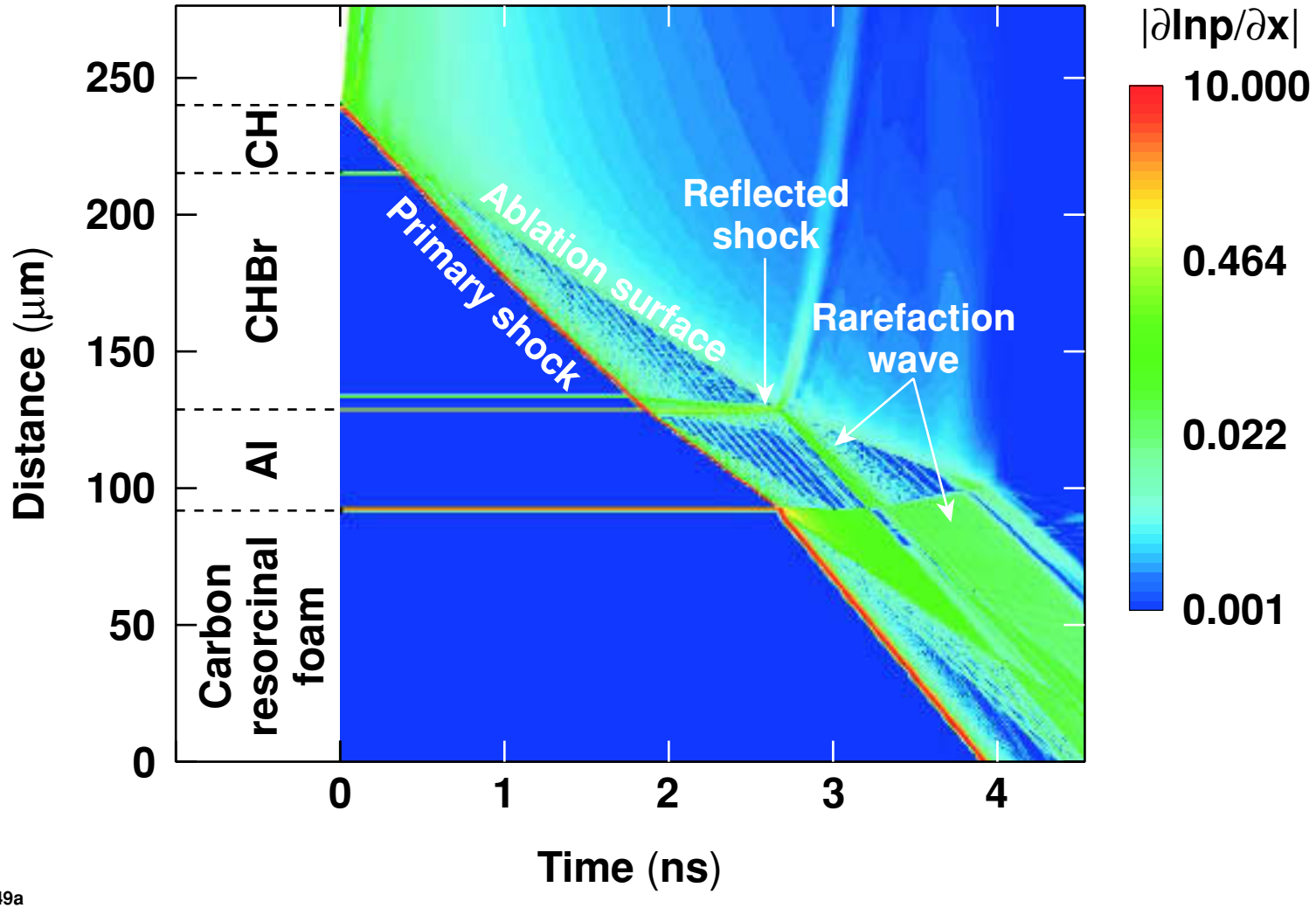
Hugoniot measurements are determined by impedance matching using the known EOS of aluminum



E10904

Courtesy P. Celliers (LLNL)

Simulations are used for target design to ensure only the primary shock is measured



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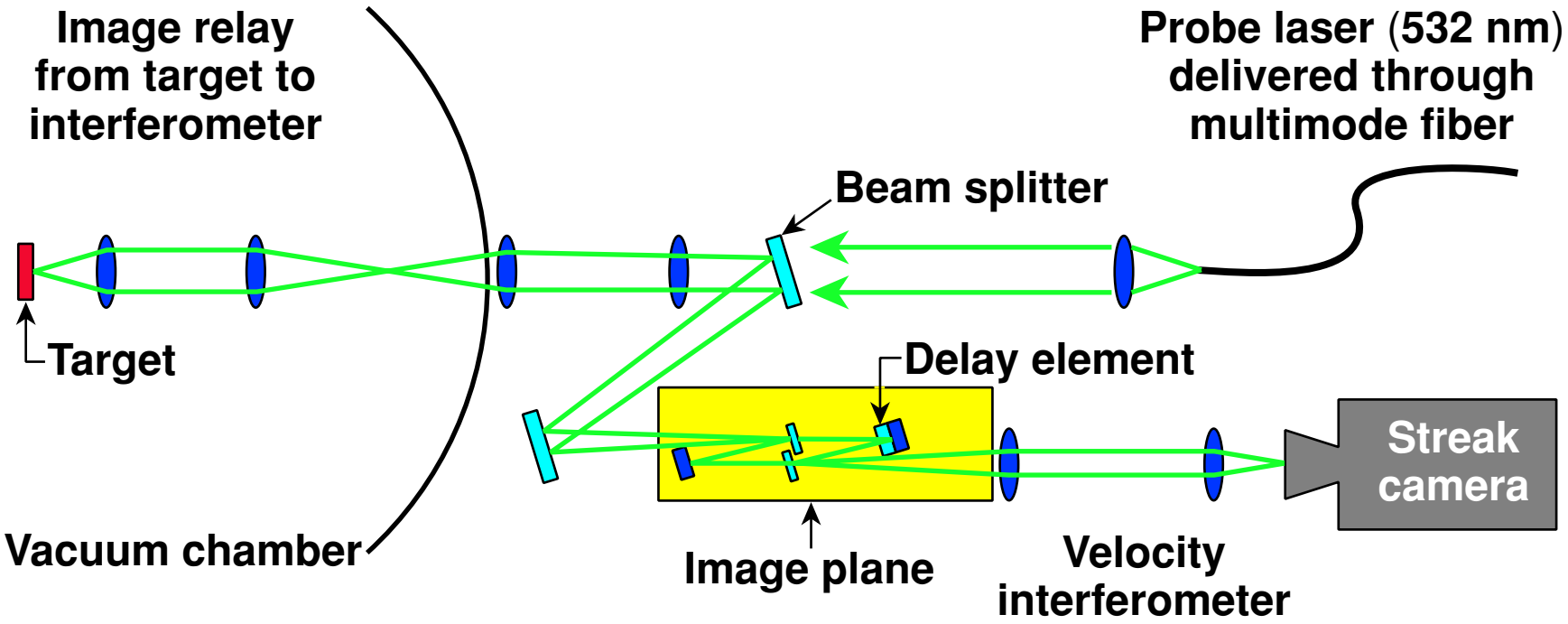
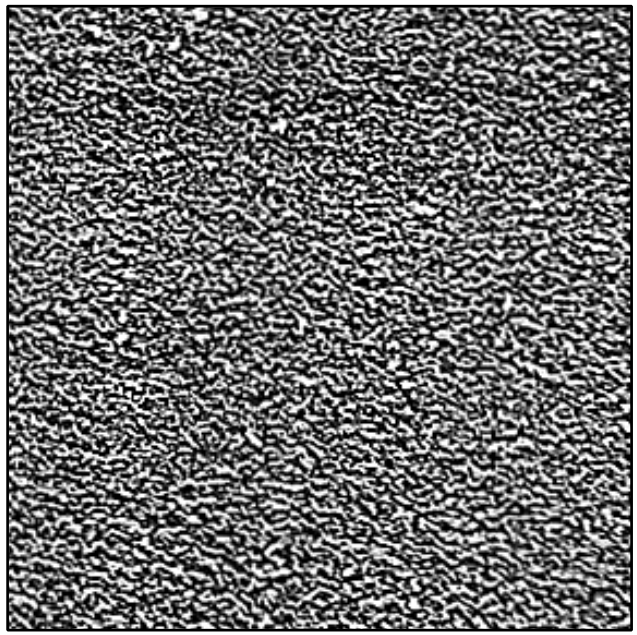
Shock velocities were measured using time-resolved VISAR*

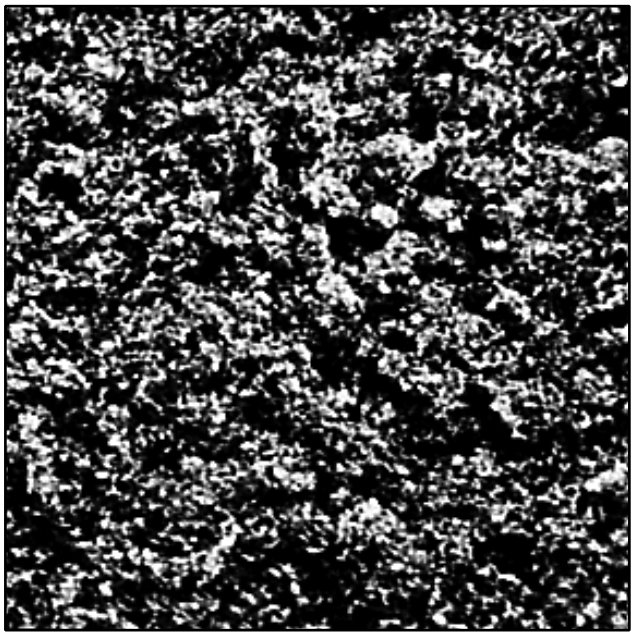


*Velocity Interferometry System for Any Reflector (designed and implemented by LLNL); Barker and Hollenbach, J. Appl. Phys. 43, 4669 (1972).

The CRF ($C_{20.7}$ $H_{2.7}$ O) foams have small cells (30 nm to 50 nm) and smooth surfaces



30 μm

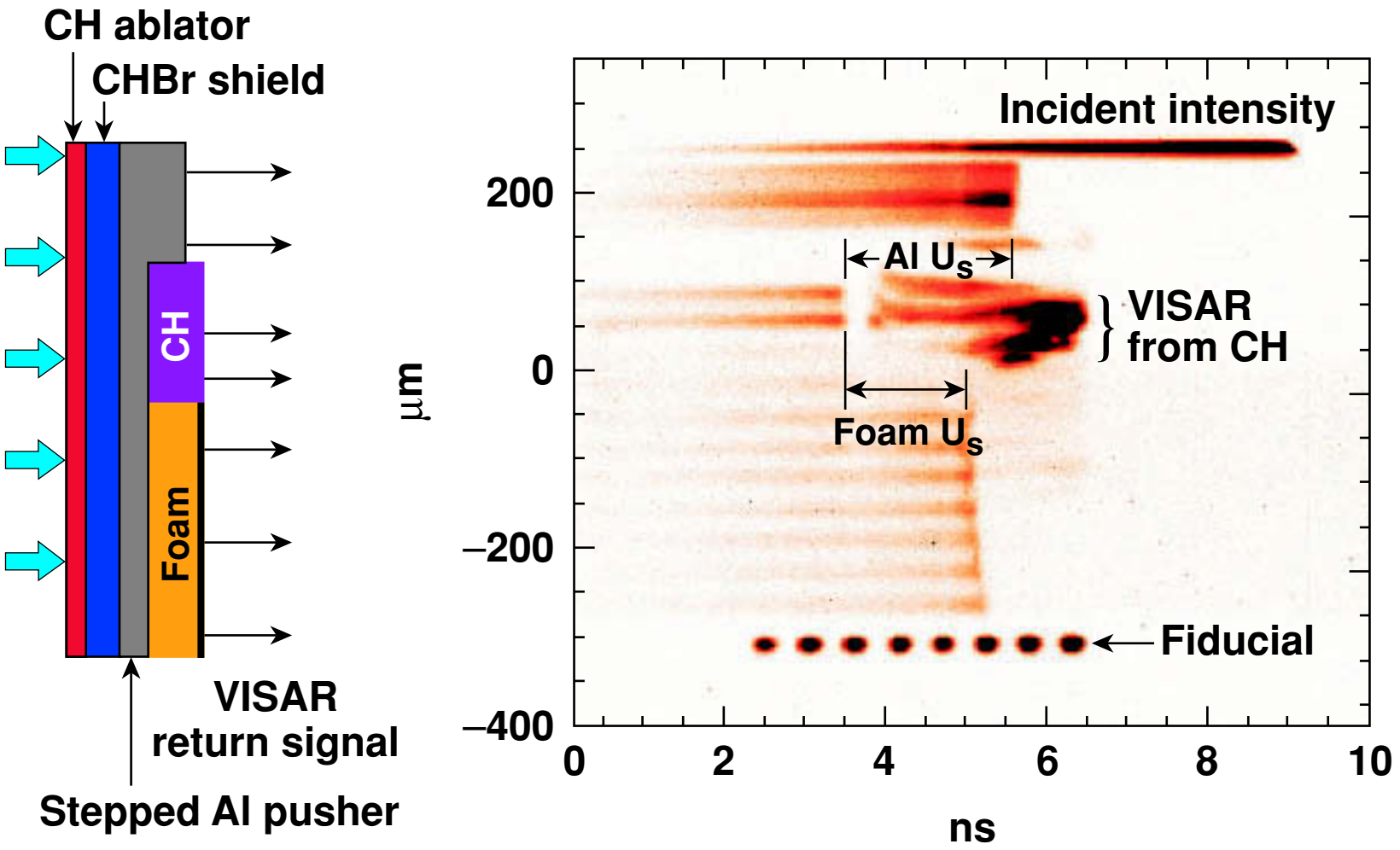


3 μm

SEM micrographs of 0.1 g/cc foam

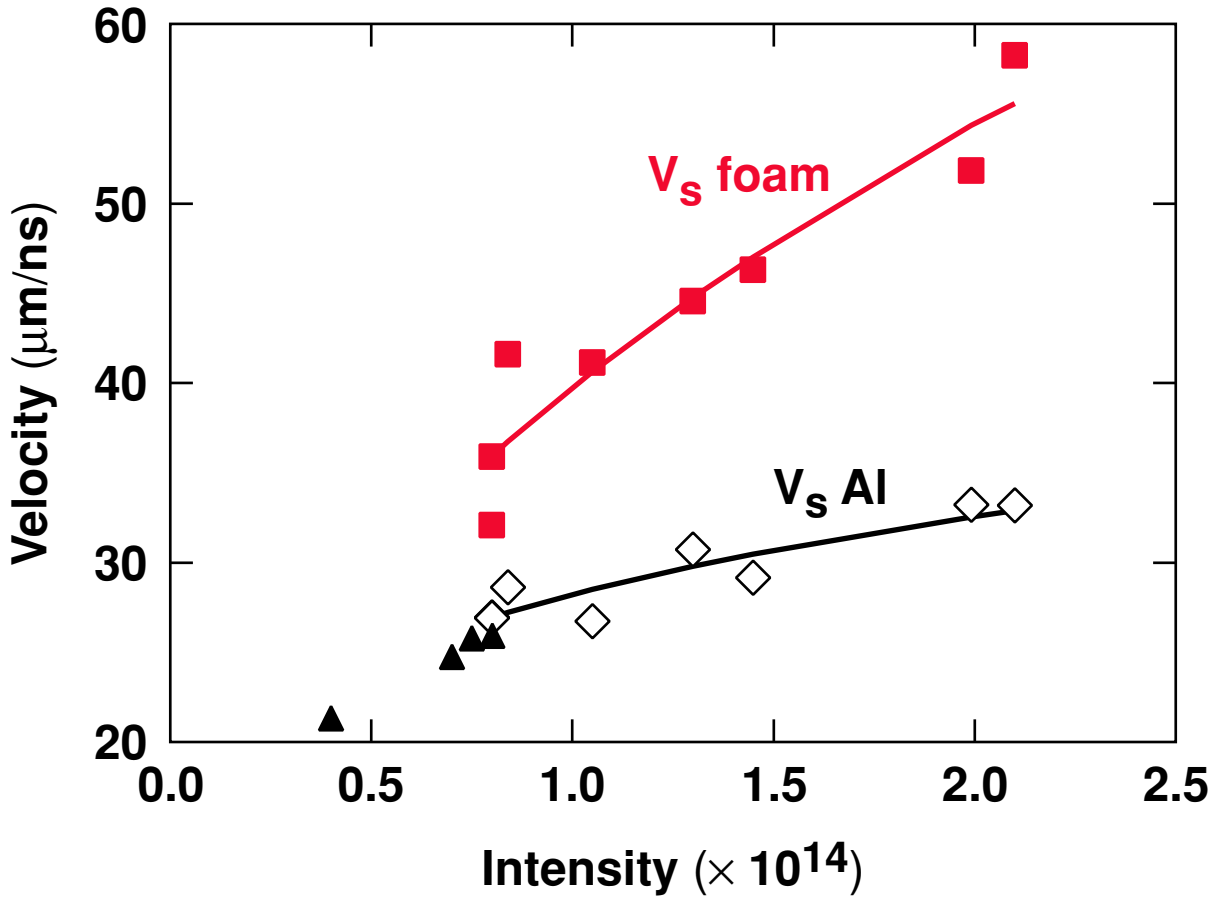
E11270

EOS experiments provide breakout times and VISAR signals yielding shock speeds in Al, CRF-foam, and a witness material



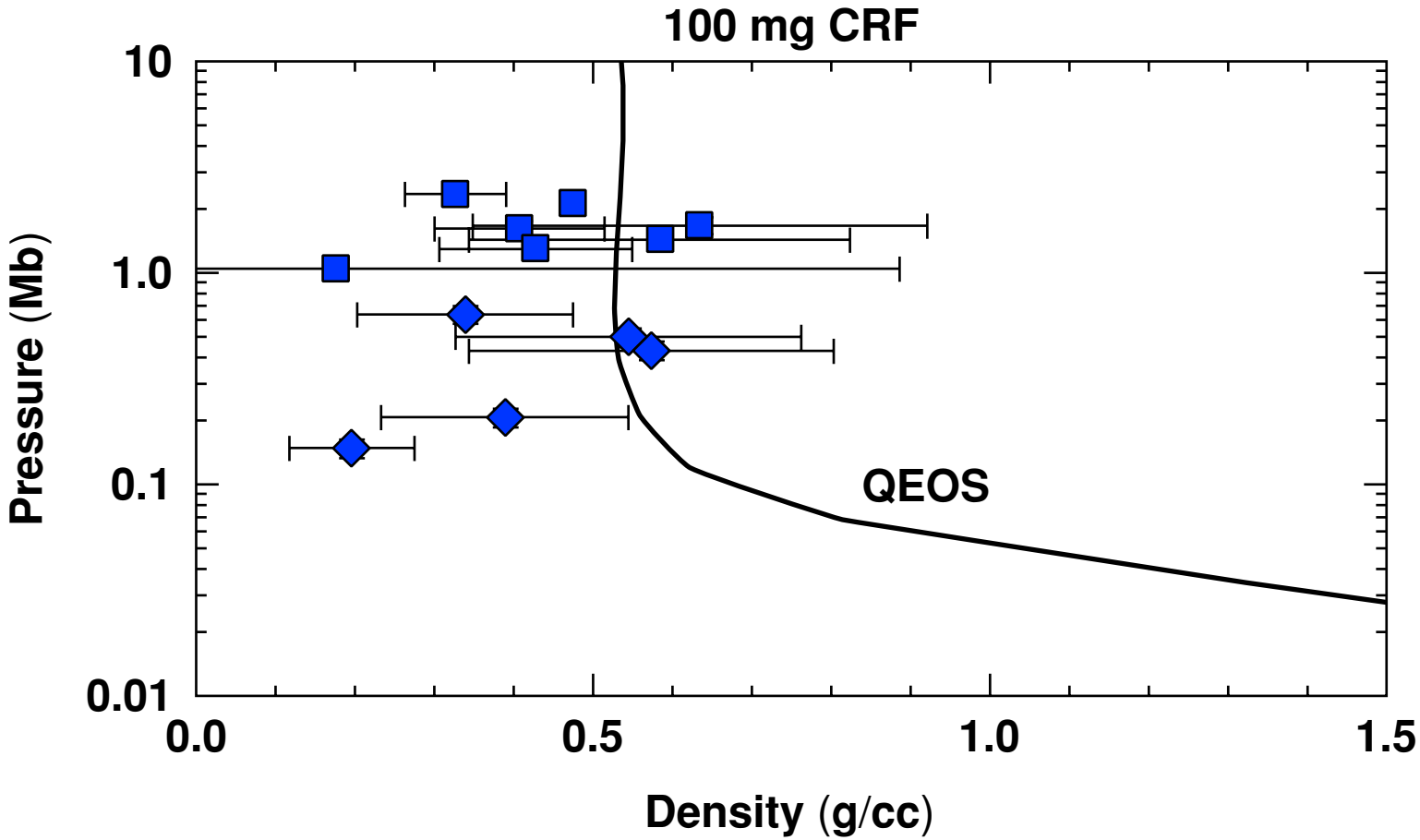
Shot 23860
E11040

Shock velocities in Al and CR foam have been measured over a range of drive intensities



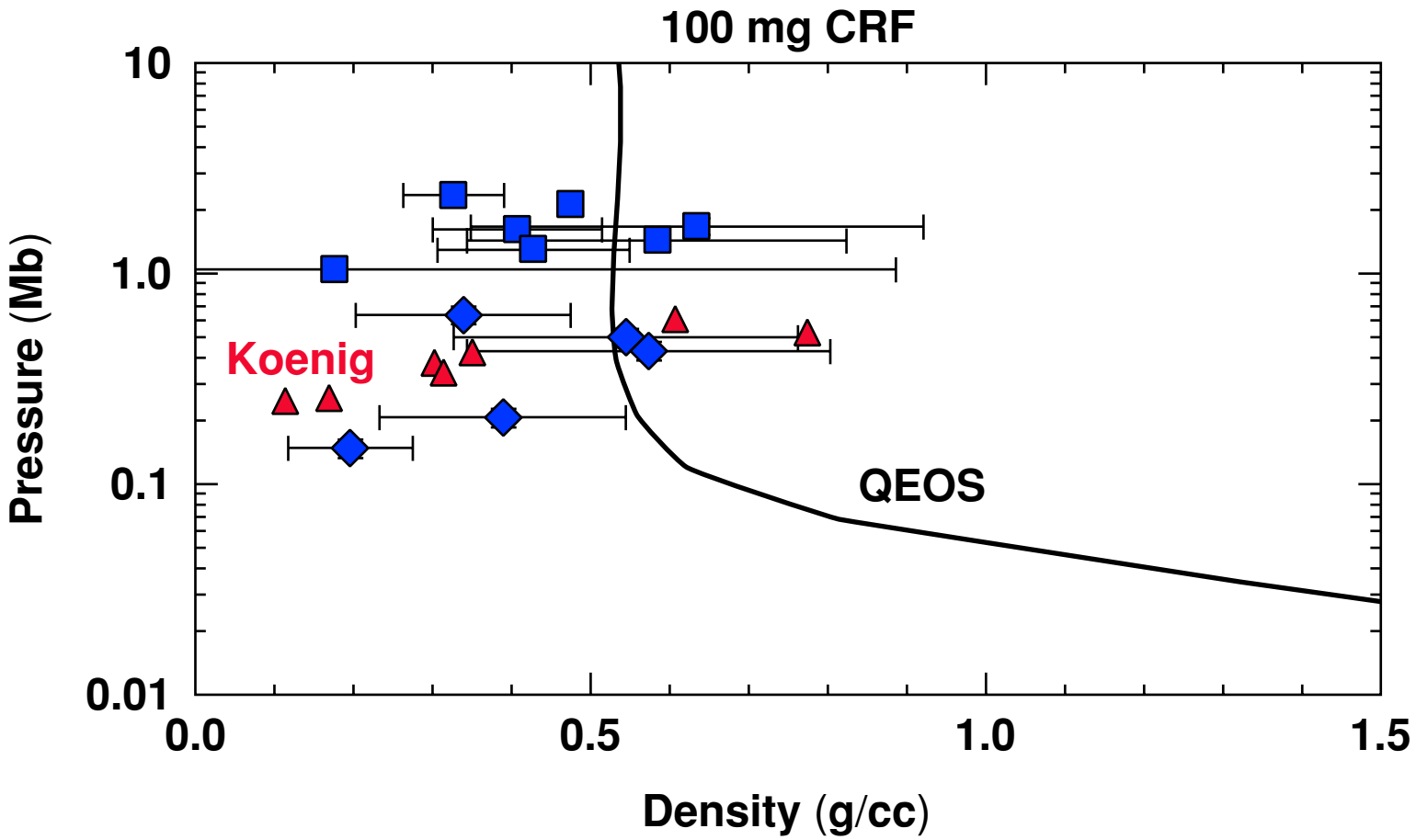
E11214

Preliminary results indicate that CRF does not exhibit the “anomalous” Hugoniot predicted by QEOS



E11216

Preliminary results indicate that CRF does not exhibit the "anomalous" Hugoniot predicted by QEOS



E11216a

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