Absolute EOS Measurements: Many equation of state (EOS) studies rely on impedance matching to determine the behavior of a sample by comparing it to a known standard. At very high pressures (>5 Mbar), uncertainties in the EOS of that standard material ultimately limit the accuracy of this technique. Previous efforts to perform absolute EOS measurements using time-resolved x-ray radiography were limited by the extreme precision required to measure shock and particle velocities (from trajectories) in materials at high compressions. Recent LLE–LLNL collaborative experiments on the OMEGA Laser System investigated a new technique designed to achieve direct *density* measurements in a shock wave. Side-on radiography with point-projection imaging using ~5-keV x rays produces snapshots of the expanding shock wave. These 2-D images are then tomographically "inverted" to determine the density profile behind the shock front. The density determination and the simultaneous measurement of the shock velocity (using VISAR), yield absolute equation of state measurements.

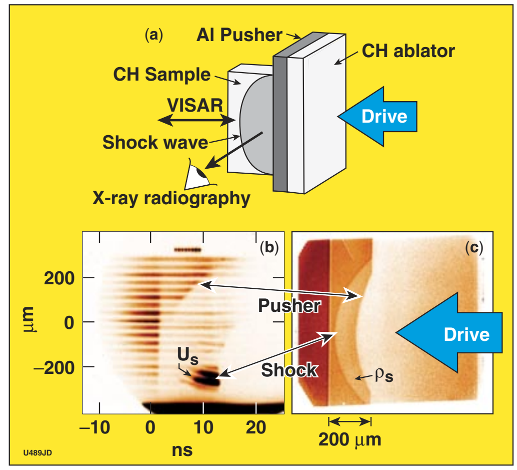

Figure 1. (a) Schematic illustrating the experimental configuration for simultaneous VISAR and radiography. (b) The VISAR record yields a measurement of shock velocity U_s, and (c) the simultaneous x-ray radiographic record yields a measurement of shocked density ρ_s.

Figure 1 shows data from an experiment that demonstrates this technique. The target [Fig. 1(a)] comprises a CH ablator and an aluminum pusher that drives a shock into a 400-μm-wide CH sample. X rays from a vanadium backlighter traverse a 10-μm-diam pinhole to produce a "point projection" image of the shock as it traverses the sample. Figure 1(b) shows the VISAR record for this shot and shows the fringe shifts observed from the leading edge of that spherical shock. Figure 1(c) is the radiograph obtained on a single-strip x-ray framing camera. Note that both the shock and the Al-CH interface are visible in this image. The shock is deliberately spherical in shape to facilitate the tomographic inversion to extract the density of the shocked CH. Figure 2 illustrates the use of this technique; the figure shows a pressure-density plot for polystyrene depicting various gas-gun data at low pressures and Nova radiography data at higher pressures. The Nova data[1] used inferred pusher and shock velocities and therefore had sizeable errors in estimates of ρ_s. The black point, with preliminary error bars, is the result from the OMEGA data ($U_s \rho_s$) depicted in Fig. 1. Full analysis and refinement of the technique should reduce these errors considerably. This technique conveniently scales to measurements of higher-Z and opaque materials using harder x rays from an intense short-pulse laser.

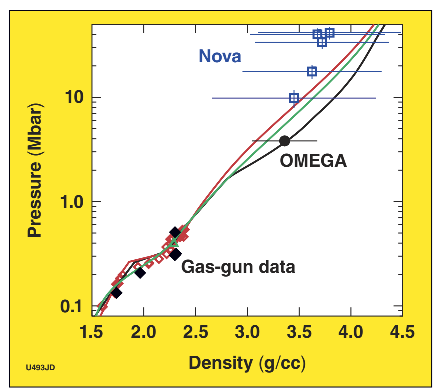

Figure 2. Polystyrene Hugoniot results from gas guns (<1 Mbar), Nova (>10 Mbar), and new OMEGA data point. The results are compared to *SESAME* EOS tables (solid lines) from Ref. 1 and references therein.

OMEGA Operations Summary: During April, OMEGA conducted 148 target shots for LLE, LANL, and NLUF experiments. The LLE experiments included a total of 50 shots for ASTRO, EXAFS, CRYO, diagnostic development, fast ignition, ISE, and focus scan testing. In addition, 40 shots were conducted for LANL campaigns, 41 for LLNL, and 17 for several NLUF campaigns. The focus scans are part of an integrated process to ensure adequate beam-to-beam energy and power balance. Balancing the beam energies on OMEGA includes monthly checks of each beam's energy transmission to target, and replacement and refurbishment of the beam blast shields to assure adequate average transmission and minimum deviation of the beam energy to the target. During a typical month, the average transmission-to-target is reduced by ~4% to 5%. Refurbishment and replacement of blast shields and power balancing (by gain tuning) help to maintain the overall energy balance on target at $\lesssim$5% rms. The beams' focus characteristics are also checked periodically. The measured beam focus positions typically vary by less than 0.5 mm compared to the effective focal depth with phase plates of several millimeters. Such variations have a negligible effect on the irradiation uniformity for 60-beam spherical target irradiation.

1. R. Cauble *et al.*, Phys. Rev. Lett. **80**, 1248 (1998).

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