X-Ray Thomson Scattering from Strong Shocks in Carbon Foams: Shocked foams are important design elements in many inertial confinement fusion and high-energy-density applications. Shocked foams are challenging to simulate because of uncertainty in the equation of state (EOS) of plasma that is close to solid density and temperatures of several tens of eV. An experiment was recently performed on the OMEGA EP laser to infer the spatial profiles of temperature and density and the shock velocity of compressed carbon foams using the spectrally and spatially resolved x-ray Thomson-scattering experimental platform.[1] The imaging x-ray Thomson spectrometer[1] diagnostic recorded the scattered x rays at different probe delay times. The experiment was designed to infer the EOS of the foam from the measured data and to compare it to current EOS tables. The experimental configuration optimized the platform previously demonstrated.[2] A schematic of the experiment is shown in Fig. 1. One UV OMEGA EP beam (4.5 kJ, 10 ns) drove a shock into the foam package, consisting of a 50-μm-thick plastic ablator and a 2-mm-thick carbonized resorcinol formaldehyde (CRF) foam with an initial density of 97 mg/cm^3. At a specified delay after the start of the drive beam, the remaining three UV OMEGA EP beams (3.75 kJ, 1 ns) irradiated a nickel foil to generate 7.8-keV Ni He$_\alpha$ x rays to probe the shocked material. Figure 2 shows spatial profiles of the elastic x-ray scattering peak measured[2] at different probe times. A shock velocity of ~70 km/s is estimated from the progression of the shock front across the different probe times. Ray-tracing analysis will be used to deconvolve the profile to obtain a more-accurate measurement of shock-front location and compression. The scattering regime is noncollective for this geometry and probe wavelength and is dominated by scattering from individual electrons.[2] The x rays are elastically scattered from bound electrons and inelastically scattered from free and loosely bound valence electrons. The intensity of the elastic scattering peak is proportional to the density of the shocked foam, but is also modified by the attenuation of the probe radiation through different regions of the shocked foam. A density compression of ~4 is estimated by taking the ratio of the scattering peaks in the shocked and unshocked regions. The measured spectrum is compared to theoretical scattering spectra to obtain a fit for the plasma conditions. Preliminary analysis yields a temperature $T = 30$ (+20/–10) eV. Future experiments will investigate the effect of changing the initial density of the CRF foam and expanding to other materials.

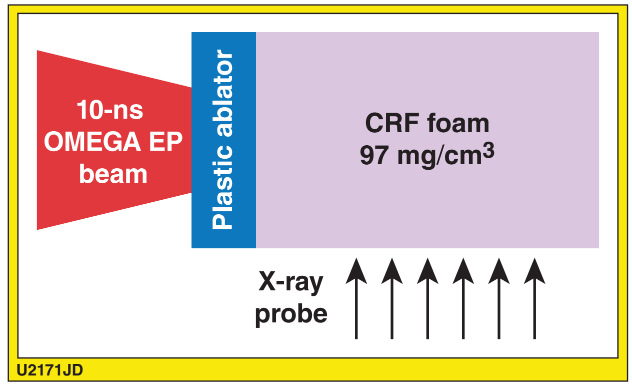

Figure 1. Schematic of the x-ray scattering experiment. One OMEGA EP beam is used to drive a shock into the carbonized resorcinol foam (CRF), while the remaining three UV beams are used to generate the x-ray probe. The detector (imaging x-ray Thomson spectrometer) is located outside of the page.

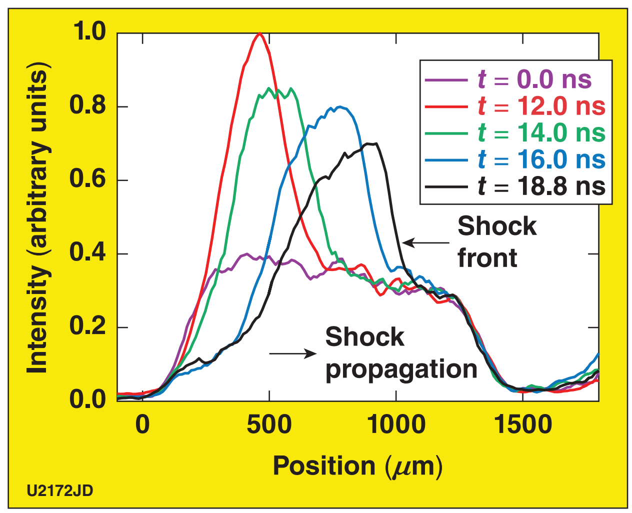

Figure 2. Spatial profiles of the elastic scattering peak at different probe times.

Omega Facility Operations Summary: During January, 158 target shots were conducted on the Omega Laser Facility with an average experimental effectiveness (EE) of 98.1% (the OMEGA laser had 93 shots with EE = 98.9% and OMEGA EP had 65 shots with EE = 96.9%). ICF experiments carried out by LLNL, LLE, and SNL accounted for 84 target shots and HED experiments accounted for 35 shots. Two NLUF experiments led by the University of Michigan had 14 target shots and two LBS experiments led by LLE and LANL conducted 25 target shots.

1. E. J. Gamboa *et al.*, Rev. Sci. Instrum. **83**, 10E108 (2012).
2. P. X. Belancourt *et al.*, Rev. Sci. Instrum. **87**, 11E550 (2016).