February 1998 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

***X-Ray Diagnostics*:** A novel x-ray imager was implemented, consisting of an array of several hundred pinholes in front of a flat-crystal x-ray spectrometer. The instrument yields 2-D quasi-monochromatic images over a wide range of photon energies. This enables the imaging of the target on a single spectral line and the subtraction of the image at a nearby photon energy. A particularly useful application of this device is imaging the cold, compressed target shell by observing the Kα fluorescence radiation from a doped shell (which is excited by the strong continuum radiation from the compressed core), thus providing an image of the cold, compressed shell at peak compression. A titanium-doped layer was inserted within the target shell and shot on OMEGA. Figure 1 shows part of the array images from this test shot. The Ti-Heα line and its satellites around 4.75 keV are emitted by the laser burnthrough to the titanium-doped layer and are found to be emitted only during the laser irradiation. On the other hand, the Kα emission around the core is found to be emitted mostly during peak compression. The Kα image in the dispersion direction is limited because the Kα line here is narrow, but lineouts in the vertical direction show the average dimensions of the cold shell. This is shown in Fig. 2, where the difference between vertical lineouts through the image at the Kα line and through adjacent images indicates a doped shell of mean radius ~130 μm and thickness ~90 μm. From here, using the shell areal density (derived from the measured Ti *K*-edge absorption), its density can be determined. The importance of this novel method is the ability to measure the cold, compressed shell without backlighting.

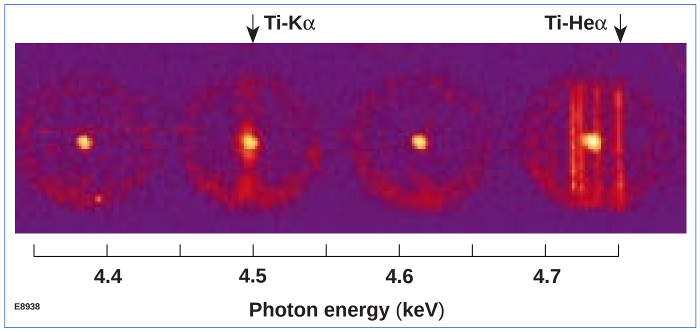

Fig. 1. Array of x-ray images obtained on an imploding shell containing a Ti-doped layer.

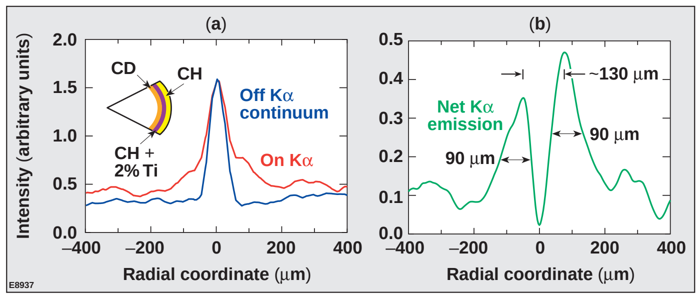

Fig. 2 Target construction (inset); lineout of intensity of contimuum emission off the Kα line and on the Kα line (left); net Kα-line emission profile (right).

***Laser–Plasma Interactions*:** Laser–plasma interactions were investigated in exploding-foil plasmas with density-gradient scale lengths comparable to those expected in direct-drive NIF coronal plasmas. The plasmas are created by exploding a 19-μm-thick CH foil with 18 OMEGA beams for 2 ns. The plasmas are then heated with 20 additional OMEGA beams for 1 ns. This creates plasmas with a density-gradient scale length of ~ 1 mm, a peak on-axis density of n/n_{cr}~ 0.18, temperatures in excess of 3.5 keV, and a velocity-gradient length of ~1500 μm. A single phase-converted beam at intensities of ~6×10^{14} W/cm^2 (near the NIF cluster intensity) and ~1.5×10^{15} W/cm^2 was used to interact with this plasma. The plasma temperature was diagnosed with iso-electronic line ratios of Ca and Ti and found to be in excess of 3.5 keV. The peak density was determined by stimulated Raman scattering (SRS) for the underdense plasmas. The SRS scattered signal is shown in Fig. 3. The prominent feature is the SRS from the peak of the density profile beginning at 2 ns, indicating that the peak density is approximately 18% of the critical density. For laser intensities up to ~1.5×10^{15} W/cm^2 no stimulated Brillouin backscattering (SBS) was observed in these plasmas when DPP's were used.

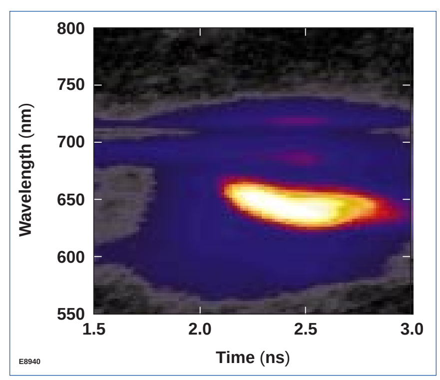

Fig. 3. Color-enhanced streak photograph of the stimulated Raman scattering spectrum.

***OMEGA Operations Summary*:** February '98 target shots were allocated between NLUF (spherical implosions), PP2, and S1/S2 campaigns. Dr. C. Hooper and his team (NLUF users) from the University of Florida conducted hydrodynamic mix and burnthrough experiments on spherical targets using time-resolved x-ray instrumentation for the first week of February. LLE campaigns filled out the remainder of the month: 20 shots for the PP2 (convergence ratio scans), 16 shots for the S1 (RT growth rates, flat foils), and 14 shots for the S2 (beam imprinting, flat foils) campaigns. In total, 72 target shots were taken during the month of February.

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