December 1999 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

1-THz, 2-D SSD on OMEGA: Broadband beam smoothing was implemented on OMEGA with a two-dimensional SSD (2-D SSD) system generating infrared bandwidths of 1.5 × 11 Å and nominally 1 × 1 color cycles. A measurement of this infrared bandwidth using a spectrometer that disperses the bandwidth from each phase modulator in orthogonal directions is shown in Fig. 1(a). Efficient frequency conversion to the ultraviolet with dual-tripler frequency-conversion crystals (FCC's) yields approximately 1-THz bandwidth, as shown in Fig. 1(b). Dual-tripler FCC's are presently installed on the OMEGA beams used for planar-target experiments. Imprinting experiments utilizing broadband smoothing have already commenced to quantify the improved smoothing performance. For near-term spherical-target experiments requiring all 60 OMEGA beams, the 2-D SSD system can be converted back to a three-color-cycle configuration producing 1.5 × 3.0 Å and nominally 1 × 3 color cycles.

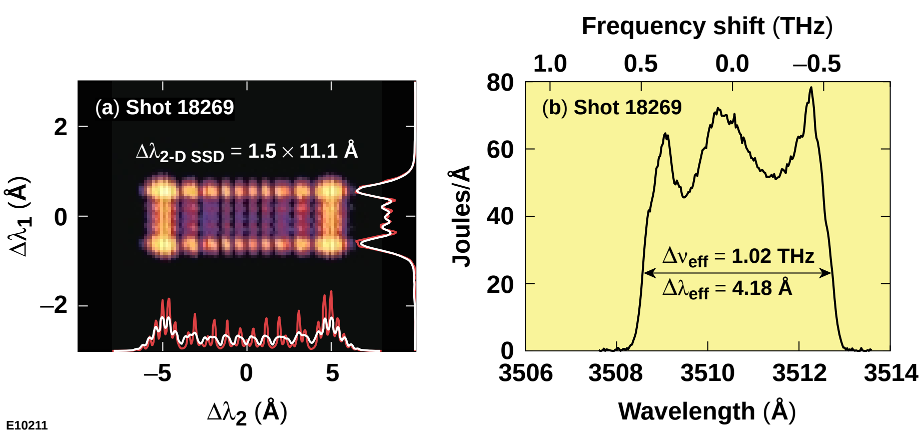

Figure 1. Measured infrared and ultraviolet spectra from an OMEGA target shot demonstrate the broadband smoothing capability installed in November. (a) A far-field image of the 2-D SSD beam injected into OMEGA is analyzed to measure the FM bandwidth produced by each SSD modulator. The white-line spectra shown on the bottom and right side of Fig. 1(a) are the vertical and horizontal sums of the 2-D spectrum. The red lines are simulated spectra and include the instrumenal resolution. (b) The UV spectrum is measured using a double-grating spectrometer, and the spectra indicate that the design goal of 1.0 THz has been achieved.

Two-Plasmon-Decay Instability: In a recent set of OMEGA implosion experiments, hard x-ray emission was temporally correlated with the three-halves harmonic (of the laser wavelength) signature ($3\omega/2$) from the two-plasmon decay (TPD) instability. The hard x rays were recorded on the neutron temporal diagnostic (NTD) equipped with an aluminum nose cone that transmits x rays above 15 keV. The time resolution of both instruments is better than 50 ps. Figure 2 shows a record of the laser pulse, hard x rays, and $3\omega/2$ light on a common time scale for a 60-beam CH capsule implosion. From the very good temporal correlation between $3\omega/2$ light and the hard x rays, it is most probable that hot electrons, which give rise to hard x rays, are produced by the TPD instability. Simultaneous measurements of backscattered light from stimulated Raman scattering (SRS), which can also produce hot electrons, showed no detectable signal. Earlier time-integrated experiments confirm these measurements, showing the same correlation in the energy of the hard x-ray signal and the $3\omega/2$ light.

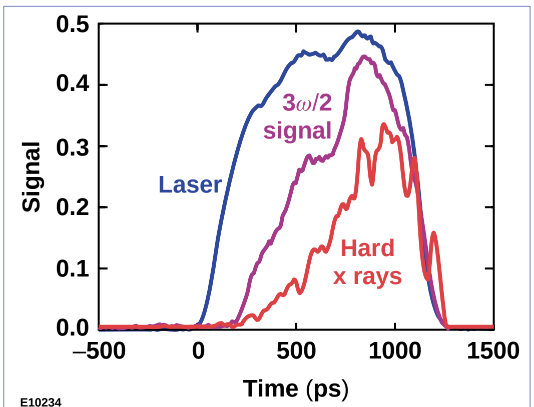

Figure 2. Record of laser pulse (blue), $3\omega/2$(violet), and hard x-ray (red) signals from the implosion of a 20-μm-thick, 1-mm-diam, CH shell irradiated with a 1-ns square UV pulse at an intensity of 8×10^{14} W/cm^2.

OMEGA Operations Summary: During December eight shot days were dedicated to six target campaigns. A total of 76 target shots were taken: 16 shots for the Rayleigh–Taylor instability experiments (RTI), 11 shots for the Commissariat à L'Energie Atomique (CEA) of France, 18 shots for Lawrence Livermore National Laboratory (LLNL), 11 shots for the National Laser Users' Facility (NLUF), 10 shots for LLE's integrated spherical experiments (ISE) campaign, and 10 shots for LLE's power balance (PB) campaign. Two weeks were dedicated to the PB campaign. The system was characterized for on-target focus, UV transport, beam timing, and amplifier small-signal gain. All 60 blast window assemblies were replaced, and the system lens swaps and FCC installations continued. This end-of-the-year "tune up" will feed into early-January '00 direct-drive uniformity experiments.

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