July 2003 Progress Report on the Laboratory for Laser Energetics
Inertial Confinement Fusion Program Activities

Shock-Timing Experiments: Direct-drive ICF target designs based on "adiabat shaping"[1] require a short ($\lesssim$100-ps) laser pulse ahead of the main drive pulse to condition the target shell. Adiabat shaping can potentially reduce the rates of Rayleigh–Taylor instability growth, thus stabilizing the capsule implosion. The success of these designs relies on accurately timing the arrival of the shocks produced by the laser pulses at the inner surface of the cryogenic layer. An important step to demonstrate adiabat shaping is the validation of the predictive capability for shock timing using hydrodynamic simulation computer codes.

Recent experiments on OMEGA were designed to test shock-timing predictions in direct-drive targets. Figure 1(a) illustrates the experimental configuration. Two OMEGA laser pulses with pulse widths of ~90 ps produced shocks in a planar CH foil. The pulses were separated by 1.5 to 2 ns [Fig. 1(b)], and the laser beams had angles of incidence to the target normal of 23° and 48°. The shock velocity, breakout (at the back of the foil), and relative timing were measured using a VISAR interferometer. These experiments test the coupling of laser light to a solid target (first pulse) and to a preformed plasma (second pulse); the propagation of decaying (unsupported) shocks in cold and shocked material; the effect of the angle of incidence; and various two-dimensional effects. Figure 1(c) shows the VISAR record for shot 32213, where a 130-μm-thick CH target was irradiated by a 90-ps laser pulse at an irradiance of 3×10^{14} W/cm^2 at a 48° angle of incidence and 2 ns later by a pulse of half that intensity at 23°. The fringe positions are proportional to velocity and show the decaying velocity of the first shock from ~0.5 to 4 ns. At 4 ns, the second shock catches up with the first, and an abrupt change in fringe position (and intensity) is observed. The white areas coincident with the laser pulses occur because the VISAR probe laser is absorbed in the target bulk, which is ionized by x rays from the coronal plasma. The signal is restored after the laser pulses, and electron–ion recombination results in the recovery of the laser transmission. At about 6 ns, the shock reaches the rear side of the target and the fringes turn off abruptly.

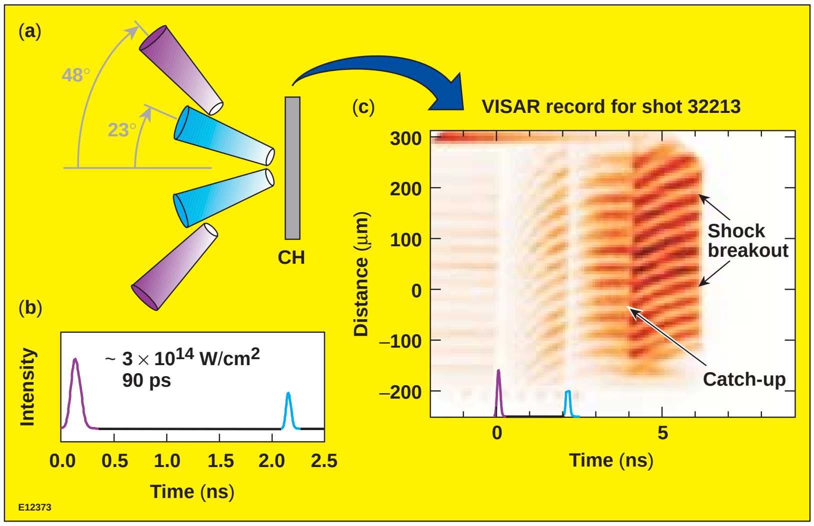

Figure 1. (a) Schematic of shock-timing experiment; (b) pulse configuration for these experiments; and (c) VISAR data from a typical shock-timing experiment (shot 32213) for a pulse separation of ~2 ns.

Experiments with varying pulse intensities and relative pulse timing were performed and provide essential data for comparison with simulations and the success of adiabat shaping in future ICF direct-drive target designs.

OMEGA Operations Summary: During July, OMEGA provided 139 shots for experiments by LLNL, LANL, CEA, NLUF, and LLE. A total of 29 OMEGA shots were taken for LLNL for experiments on direct-drive implosions, laser–plasma interactions, and equation-of-state measurements. Twenty-nine (29) shots were also conducted in July for LANL for ACE B, ACE D, and beryllium-ablator microstructure (BAMS) experiments. LLE carried out 41 target shots for the ISE, cryo, SSP, and RTI campaigns. An NLUF team led by Polymath Research, took 21 target shots for experiments to study a means of controlling scattering instabilities in laser–plasmas; another NLUF team led by the University of Michigan took 8 shots for laboratory astrophysics experiments. Finally, CEA had 11 target shots for experiments to study ablator physics and hohlraum symmetry.

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1. "Improved Performance of Direct-Drive ICF Target Designs with Adiabat Shaping Using an Intensity Picket," Laboratory for Laser Energetics LLE Review **93**, 18–32, NTIS document No. DOE/SF/19460-478 (2002). Copies may be obtained from the National Technical Information Service, Springfield, VA 22161.

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