Controlled-Prepulse Rayleigh–Taylor Experiments: Direct-drive, high-gain laser fusion targets require that the fuel entropy be as close as possible to the Fermi-degenerate entropy during the implosion. In contrast, mitigation of Rayleigh–Taylor (RT) growth of surface and illumination imperfections requires higher entropies in the ablator region. Recently, a series of OMEGA experiments have begun to address this issue using a controlled prepulse. This prepulse precedes the main acceleration pulse. One- and two-dimensional hydrodynamic simulations indicate that the optimum prepulse for planar-foil experiments has half the intensity of the drive pulse and a width of 300 ps (see Fig. 1). The main drive pulse has a Gaussian leading edge rising to a pleateau at 2×10^{14} W/cm^2. This pulse mimics the drive pulses for future cryogenic-target experiments on OMEGA and the NIF. The peak of the prepulse precedes the maximum intensity of the drive pulse by 1.8 ns.

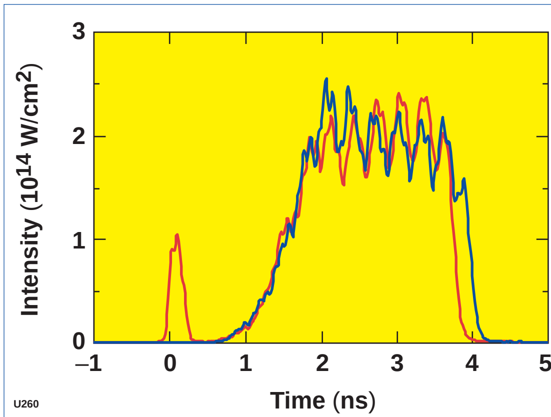

Figure 1. Pulse shapes that were used during the experiments to study the effect of controlled prepulses on the RTI growth rate of directly driven foils. The red line follows the shape that was used for measurements with a prepulse. The blue line shows the pulse shape that was used for experiments without a prepulse.

The RT growth of preimposed target perturbations was measured for laser illumination with and without the prepulse. Perturbations of 60-, 30-, and 20-μm wavelengths with initial amplitudes of 0.25 μm were imposed on the surface of 20- to 28-μm-thick CH foils that were directly driven by the laser. The RT growth of these perturbations was measured using x-ray radiograms (see Fig. 2). The red squares and blue diamonds are the measured modulations in optical depth of the x rays as a function of time for targets accelerated with and without a prepulse, respectively. The actual drive pulse shapes were used in 1-D hydrodynamic simulations (*LILAC*) to compute the target acceleration, ablation velocity, and density scale length as functions of time for detailed comparison with experimental measurements. The expected RT growth rate was calculated using the Betti dispersion formula.[1] The growth rate (see Fig. 2) is significantly reduced by the prepulse (for the 20-μm-wavelength perturbation, the growth rate is ~5 ns^{-1} without a prepulse versus ~2 ns^{-1} with a prepulse). Figure 2 also demonstrates the good agreement between the hydrodynamic code predictions and the experimentally observed RT growth rates. The turnover of the experimental data is due to saturation of the radiographic measurement.

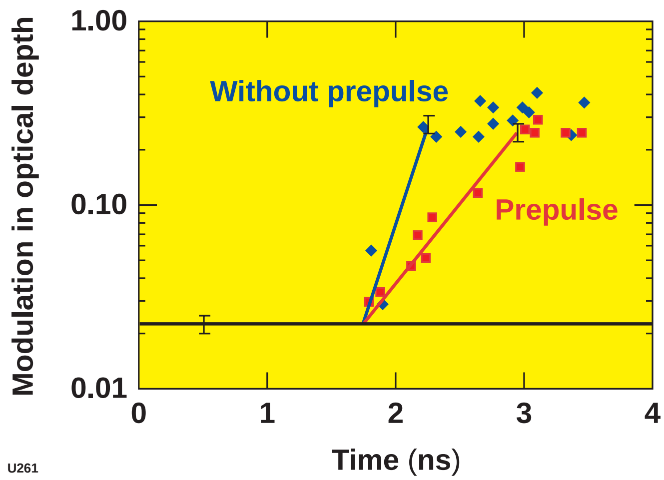

Figure 2. Measured growth of a 20-μm-wavelength perturbation with an initial amplitude of 0.25 μm. The blue diamonds are data from measurements without prepulse. The blue line represents the expected growth from 1-D hydrodynamic simulations and the Betti dispersion formula. The red squares are measured data with prepulse, and the red line is the expected growth from the 1-D simulations. The black line indicates the initial perturbation amplitude in "modulation of optical depth."

OMEGA Operations Summary: During March, 14 days were devoted to target shots, resulting in 131 target shots allocated among 12 users. The largest campaign was for LLE's integrated spherical experiments (ISE), which totaled 61 shots over six days. Some of these ISE shots were used to characterize x-ray yield from the focal spot of each of the 60 beams on Au-coated spheres. Data from these shots were fed back into the power settings of the beams to investigate the reduction of residual power balance errors. Also in March, six days were dedicated to shots for national laboratory investigators and 1/2 day to shots for scientists from Commissariat à L'Énergie Atomique (CEA). The total breakdown of shots during March was LLE-ISE (61), LLE-SSP (15), LLNL (38), LANL (10), and CEA (7) for a total of 131.

[1] R. Betti, V. N. Goncharov, R. L. McCrory, R. Sorotkin, and C. P. Verdon, Phys. Plasmas **3**, 2122 (1996).

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