Mitigating Crossed-Beam Energy Transfer in Implosion Targets: Scattered-light and bang-time measurements conducted on recent OMEGA implosion experiments using large-diameter plastic-shell targets (1400-μm-diam) irradiated with beams smaller than the target diameter demonstrated increased laser absorption. The increased absorption is caused by the reduction of the crossed-beam energy transfer[1] when drive laser beams smaller in diameter than the target are employed. Crossed-beam energy transfer is caused by stimulated Brillouin scattering and appears to reduce the absorption in OMEGA direct-drive implosion experiments by 10% to 15%. Simulations show that the most energetically efficient transfer occurs between incoming light, which is directed almost perpendicular to the target surface and is located near the laser beam center, and outgoing light, which is inclined to the target surface and is located at the beam edges. The intensity of the former light is reduced, whereas the intensity of the latter is increased during the transfer. The transferred light bypasses the highest absorption region near the critical surface, reducing the total absorption. Varying the shape of laser beams, for example, by reducing the light intensity at beam edges (i.e., narrowing the beams) can mitigate the crossed-beam energy transfer.

The experiments compared the measured absorption with narrow- and wide-drive laser beams to determine the difference in absorption fraction and bang timing caused by the crossed-beam energy transfer. In the "narrow-beam" configuration, SG4 phase plates are used and the target surface is at the best focus position (corresponding to beams with 95% of the energy within a diameter of 860 μm). The wide-beam configuration is obtained by defocusing the OMEGA beams by 0.55 cm to nearly match the target diameter. The implosions were driven by a 1-ns-square, 27-kJ laser pulse. Figure 1 compares the predicted absorption fraction (using a nonlocal electron heat-transport model) as a function of the ratio of the beam radius to target radius for two cases: with no crossed-beam energy transfer (dashed line) and with crossed-beam energy transfer (solid line). In the latter case, a simplified model[2] for the saturation of ion-acoustic waves was used assuming that the saturation occurs for electron density perturbations $\delta n/n_e > 10^{-3}$.

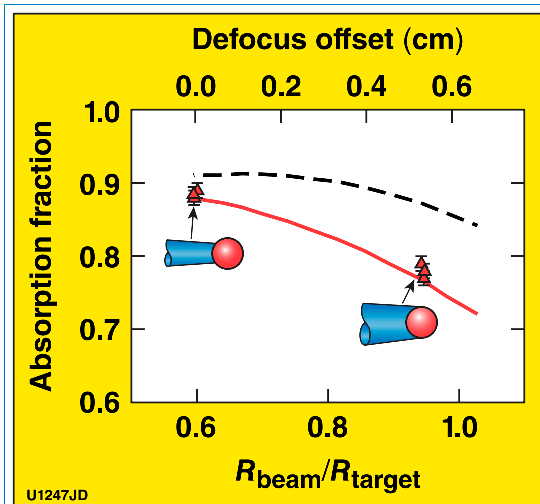

Figure 1. Absorption fraction plotted versus the ratio of the laser beam radius (taken at the 5% power level) to target radius for implosions of 1400-μm-diam plastic-shell targets. The solid line shows the simulated absorption fraction including the crossed-beam energy transfer and the dashed line shows the absorption fraction without the transfer. The red triangles represent experimental results for implosions driven by narrow (focused on target) and wide (defocused by 0.55 cm) OMEGA laser beams. The upper axis indicates the defocus offset.

The larger-diameter beams result in reduced absorption fraction caused by more-efficient crossed-beam energy transfer. In Fig. 1, triangles show the experimental results, which confirm the predicted effect of the crossed-beam transfer. Bang-time measurements from these experiments show a delay of ~550 ps for the bang time of implosions with wide drive beams compared to narrower beams. The implosions driven by narrow beams demonstrate earlier bang time because of the reduced crossed-beam transfer and more-efficient drive. The observed time delay is in a good agreement with that predicted by simulations.

Omega Operations Summary: The Omega Laser Facility conducted 169 target shots in February (124 on the OMEGA laser and 45 on the OMEGA EP laser) with an average experimental effectiveness of 95% (96% for OMEGA and 92.2% for OMEGA EP). The NIC program accounted for 51 of the target shots in experiments led by LLE scientists. Sixty-one shots were taken for the HED program by teams from LLNL and LANL. The NLUF program accounted for 25 shots taken by a team led by the MIT-PSFC. Nine target shots were taken by a team from the University of Michigan Center for Radiative Shock Hydrodynamics (CRASH).

1. I. V. Igumenshchev *et al*., Phys. Plasmas **17**, 122708 (2010).
2. I. V. Igumenshchev *et al*., "Mitigating Crossed-Beam Energy Transfer in Direct-Drive Implosions," to be submitted to Physics of Plasmas.