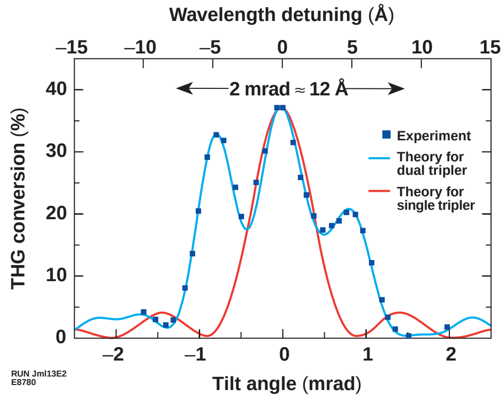
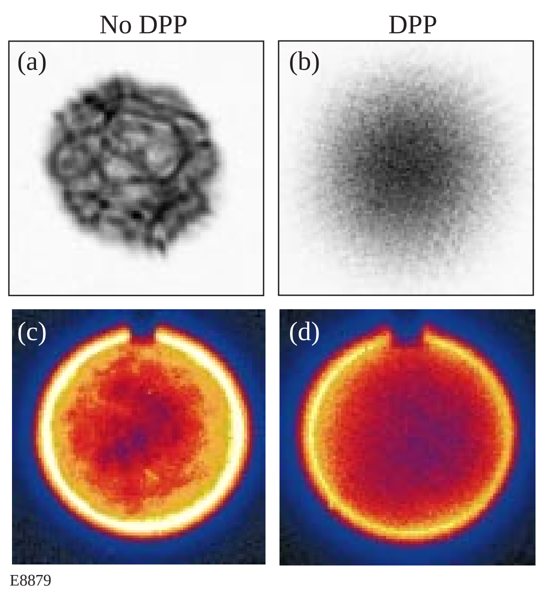
December 1997 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Summary: We report on recent experiments that validate an efficient large-bandwidth frequency-tripling scheme; the installation and preliminary full system tests of new, damage-resistant distributed phase plates (DPP's) on OMEGA; and the design of DPP's for flat-foil experiments.

High-Bandwidth Frequency Tripling: Recent experiments at LLE verified an efficient high-bandwidth frequency-tripling scheme recently proposed by D. Eimerl *et al.* [Opt. Lett. **22**, 1208 (1997)]. The scheme uses two properly detuned tripling crystals and allows conversion of 1-μm radiation to its third harmonic with an overall energy conversion efficiency ≥80% and a UV bandwidth of ~1 THz. Broad bandwidth is simulated by varying the angle of incidence on the crystals (6-mm and 9-mm thickness). The accompanying figure shows the experimentally measured dual-crystal tripling conversion efficiency along with the predicted conversion efficiency for this particular tripler configuration (the standard single-tripler performance is shown for comparison). The close agreement between theory and experiment provides confidence that the predicted 70%–90% conversion of an optimized design can be attained.



Distributed-Phase-Plate Installation: During the reporting period, 60 new distributed phase plates were installed on OMEGA. These fully continuous DPP's are designed to irradiate 900- to 1000-μm-diam targets without significant energy loss. The new phase plates were used in a series of shots to determine the best focus for all beams and to obtain preliminary irradiation uniformity information. Figure (a) shows the equivalent-target-plane (ETP) intensity distribution of one of the UV OMEGA beams without using phase plates. Figure (b) shows the more symmetric ETP intensity distribution obtained with one of the new phase plates. To assess the overall irradiation uniformity on spherical targets, 1-mm-diam plastic spheres coated with Au were irradiated with 60-beams. The x-ray emission from these targets is recorded with x-ray pinhole cameras as shown in Figs. (c) and (d). Figure (c) shows the typical x-ray emission recorded from a target irradiated with normal OMEGA beams without phase plates. Figure (d) shows the emission typical of target irradiation with the new phase plates. In both photographs, the target support stalk is at the north pole of the target and creates a dark region characteristic of low x-ray emission. These photographs qualitatively show a significant improvement in the x-ray emission uniformity with the use of the phase plates. Analysis is underway to quantitatively assess the improvement in irradiation uniformity. Spherical implosion experiments with this smoother intensity distribution are scheduled for January 1998.



Distributed Phase Plates for Flat-Foil Experiments: The Optics and Imaging Sciences group at LLE has completed design work for a new distributed phase plate (DPP) to be used in flat-foil experiments on the OMEGA laser system. This new DPP is designed to phase convert an OMEGA laser beam, producing an envelope of irradiance that is mathematically described as a 12th-order super-Gaussian. Research and development of continuous lithographic masks will be carried out over the next three months with the goal of realizing this high-order profile with in-house-manufactured DPP's.

OMEGA Operations Summary: In addition to installing a new set of 60 ion-etched DPP's on OMEGA in December, 38 target shots were taken. Eighteen shots were dedicated to characterization of the new DPP's on spherical targets, and 20 shots were taken in support of the S2 "beam-imprinting" campaign. The remainder of the system time was dedicated to enhancing the laser amplifier's small-signal-gain diagnostic and installing a new Schlieren IR far-field diagnostic to characterize SSD.

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