Optimized Irradiation Uniformity: The on-target irradiation uniformity for direct-drive spherical capsules depends on several factors, including beam-to-beam energy and power balance, beam-pointing precision, target-positioning accuracy, and the on-target beam shape and beam-to-beam variations. The OMEGA irradiation uniformity was recently improved by implementing several changes, including a new set of distributed phase plates (DPP's), designated SG4, that produce a flatter intensity distribution on target (see Fig. 1) than the previous set (SG3). The on-target shape with 1-THz SSD and polarization smoothing (PS) is characterized with a super-Gaussian profile $I = I_0 e^{-(r/r_0)^n}$. The average on-target fit values determined from x-ray images of the beam spots on 4-mm Au-coated pointing spheres are r_0 = 308 μm, n = 2.3 for the SG3 DPP's, and r_0 = 380 μm, n = 3.7 for the SG4 DPP's. Associated target diameters that intercept ~95% of the energy are 930 μm for the SG3's and 865 μm for the SG4's. In addition to producing a larger effective beam area on target, the SG4 DPP's have a smaller beam-to-beam shape variation than their predecessors (see Fig. 2).

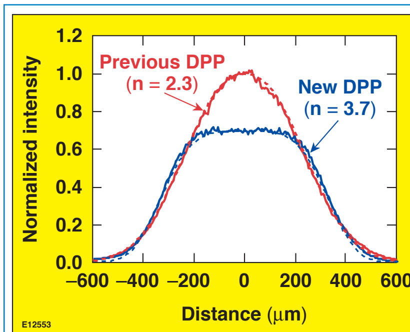

Figure 1. On-target intensity distribution for OMEGA beam with SG3 and SG4 DPP's.

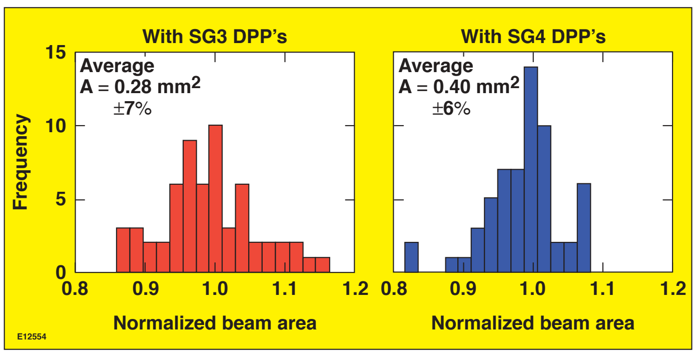

Figure 2. Comparison of the beam-to-beam size variation with the old SG3 and new (SG4) DPP's.

The overall OMEGA irradiation uniformity on target has also been improved by using active repointing. Active repointing consists of evaluating the actual beam positions on target using x-ray images of the beam spots on a 4-mm-diam Au-coated pointing target and then repointing individual beams that appear to be incorrectly pointed (see Fig. 3). Use of this procedure requires additional system shots. Table 1 is a summary of all the irradiation-uniformity improvements recently implemented on OMEGA, which reduced the overall on-target irradiation nonuniformity from the previous σ = ±3.3% to a current level as low as ±1.3%. Initial data from direct-drive implosion experiments confirm the expectations that these improvements reduce the low-ℓ-mode nonuniformities on target and result in more-symmetric direct-drive implosions.[1]

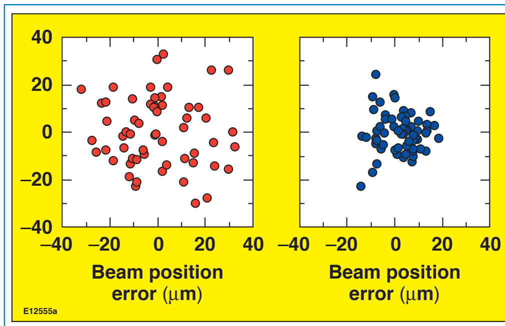

Figure 3. Pointing location of beam centers relative to ideal location as derived from eight x-ray images on OMEGA: (a) before correction, the pointing error is ±23 μm rms; (b) after repointing, the pointing error is reduced to ±11 μm rms.

Table I: On-target nonuniformity contributions; σ_{total} is the quadrature sum of the individual nonuniformity contribution.

	ℓ mode	SG3 n = 2.3	SG4 n = 3.7
Beam imperfections	1–5, 10, 20	1.1	0.6
Size variations	1–6	1.5	0.6
Pointing	1–6	2.2	0.7
Target position	1, 2	<1.0	<0.4
Beam balance	1, 2, 3	1.3	0.6
	σ_{total}	3.3%	1.3%

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OMEGA Operations: During October, a total of 136 shots were taken on OMEGA. Of the total, 42 target shots were carried out for LLNL experiments including NEL-hydro, gas–wall interface, gas-hydro, 2ω laser–plasma interaction, hohlraum development, high-Z EOS, x-ray Thomson scattering, and gas-bag experiments. Eighty-four shots were dedicated to LLE experiments including shots for the following campaigns: long-scale-length plasma interaction (LPI), cryogenic target (CRYO), Rayleigh–Taylor instability (RTI), integrated-spherical (ISE), SSP, and power balance. Four shots were also taken for an NLUF collaboration led by the University of California, Berkeley, and six shots were dedicated to CEA experiments.

1. F. J. Marshall, J. A. Delettrez, R. Forties, R. Keck, J. H. Kelly, P. W. McKenty, S. P. Regan, and L. J. Waxer, "Direct-Drive Implosion Experiments with Enhanced-Fluence Balance on OMEGA," to be published in Physics of Plasmas.

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