Polar-Direct-Drive Experiments: Progress made over the last year in direct-drive target designs has greatly increased the probability of achieving moderate to high direct-drive target gain on the National Ignition Facility (NIF). LLE is exploring the feasibility of using the beams of the NIF in the indirect-drive configuration for directly driven target implosions. This concept, polar direct drive (PDD), uses beams that are clustered around the two poles of the NIF target chamber and, hence, the target surface. The theoretical basis of PDD was presented as an invited paper in November 2003 at the 45th Annual Meeting of the APS Division of Plasma Physics.[1] PDD has the potential of coupling more energy to the fuel than x-ray drive, and the compressed fuel core can be more easily accessed for high-ρR diagnostic development and fast-ignitor studies.

Initial target experiments simulating the NIF PDD illumination condition were performed recently on the OMEGA facility using 40 of its 60 beams (Fig. 1). The 40 drive beams were repointed to achieve a more uniform beam irradiation. Figure 2 shows time-integrated x-ray images of target implosions driven with 40 beams in the PDD configuration [Fig. 2(a)], compared to a 60-beam implosion [Fig. 2(b)]. Reductions in both absorbed energy (expected) and fusion yield (as a result of lower absorbed energy and reduced drive uniformity) for the PDD cases were noted when compared to 60-beam normally incident target chamber center (TCC) illumination.

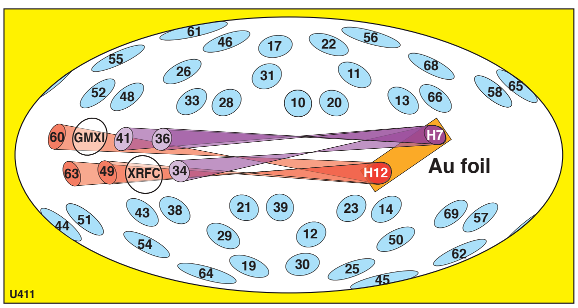

Figure 1. Arrangement of 40 beams of OMEGA used to simulate direct-drive illumination conditions on the NIF, when beams in the indirect-drive configuration are used to directly drive the target implosion. Additional beams used to produce x-ray backlighter spots are indicated.

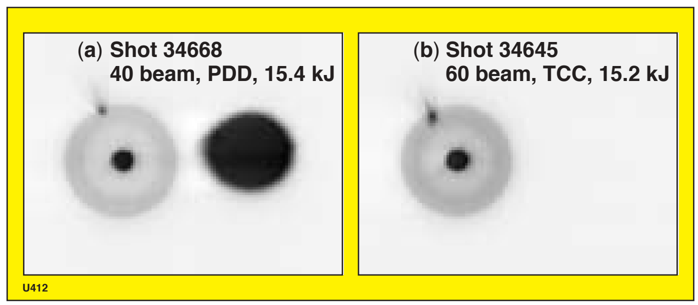

Figure 2. Time-integrated x-ray images of the implosions of 15-atm-D_2-filled, 20-μm-thick CH shells with (a) 40 full-energy beams in the PDD configuration, compared to (b) a 60-beam implosion with all beams at 2/3 full energy and pointed at TCC. The dark region to the right of the target in (a) is an x-ray backlighter source.

Time-framed x-ray backlighting was used to study the final stages of the implosion. For PDD implosions, 6 of the 20 beams not used for target drive were used to produce two x-ray backlighter sources (Fig. 1). For simplicity, a single piece of gold foil was used to allow backlighting of two framed x-ray imagers [a TIM-based x-ray framing camera (XRFC) and the gated monochromatic x-ray imager (GMXI)]. Both were configured to be sensitive to the gold *M*-band emission region (2 to 3 keV). Figure 3 shows a selection of radiographs taken late in the target implosion history (from $t = 1.25$ to 1.75 ns for a nominally square, 1-ns-long drive pulse) before maximum compression (roughly $t = 2.0$ ns). The radiographs reveal structure in the imploding shell resulting from the asymmetries in the effective drive. Theoretical simulations and analysis of these implosion experiments and planning for future PDD experiments are in progress.

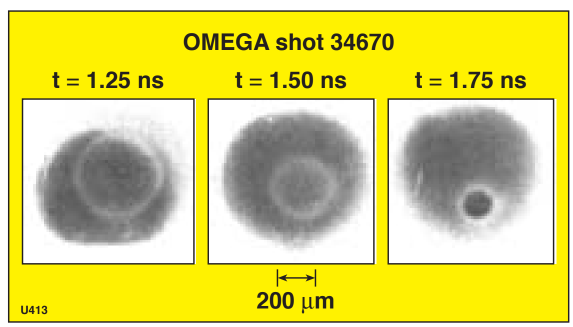

Figure 3. X-ray radiographs of the late stages of a PDD-illuminated target implosion. The initial target diameter was 865 μm. The "hexagonal" shape of the imploding shell is due to the imposed PDD irradiation uniformity.

OMEGA Operations Summary: OMEGA supported 130 target shots during the month of February. This included 12 shots for an NLUF collaboration led by the University of California at San Diego, 35 shots for LLNL campaigns, and 83 shots for LLE experiments.

1. S. Skupsky *et al.*, "Polar Direct Drive on the National Ignition Facility," submitted to Physics of Plasmas.

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