Distributed Phase Plate Design for Polar-Drive Configuration on the NIF: Distributed phase plates (DPP's) have provided uniform irradiation of fuel capsules in ICF research for more than two decades.[1] For the polar-drive (PD) beam configuration on the NIF, individual beams must be deterministically repointed to increase the irradiation uniformity and total energy on target.[2] To increase the amount of light that is coupled to a target, PD irradiation includes a set of focal spots that are asymmetric in both shape and profile. This scheme represents a significant challenge, requiring several advances in DPP design, manufacturing, and deployment.

Recent advances in DPP design provide promise for successful polar-drive ignition on the NIF. A smoothed random phase is generated to satisfy the basic, azimuthally averaged size, shape, and profile in the focal plane. The 2-D phases are redistributed by tilting the coordinate system in the direction of the asymmetry. The amount of tilt is chosen to produce the required eccentricity. The features along the asymmetric direction contain steeper slopes, corresponding to the shifted peak irradiance of the focal spot. As shown in Fig. 1(a), the focal spot from a phase plate designed for an equatorial beam on the NIF closely approximates the required target profile for polar-drive–ignition experiments (solid contour lines).

A DPP consists of a continuous distribution of phase regions that act as either positive or negative lenses. For the case of a positive lens, light converges and increases the local irradiance on downstream optics, therefore increasing the probability of laser-induced damage. To reduce this effect near the most vulnerable optics at the end of the system, a nonlinear transformation of the phase gradients has been developed. This step process reduces the power of the positive lenses and increases the power of the negative lenses. In addition, local smoothing of the phase is applied at these spots to reduce their focusing power. The histogram of near-field irradiance [Fig. 1(b)], calculated for the disposable debris shield of a NIF beamline, shows the fraction of energy exceeding the input beam fluence (ratio = 1) at a distance of 1 m from the DPP. All hot spots producing irradiances greater than 20% above the average, for the critical surfaces following the DPP, have been eliminated. This successful DPP design results in a significant reduction of the near-field irradiance modulation while maintaining the required focal-spot characteristics for polar-drive ignition on the NIF. The NIF beamlines protection team has accepted this design as meeting their safety requirements.[3]

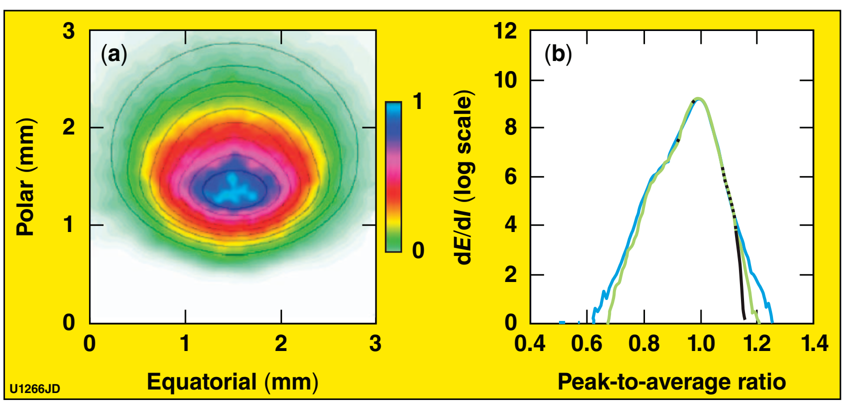

Figure 1. (a) The focal spot from a distributed phase plate designed for an equatorial beam (shown as colored contours) closely approximates the target requirements for polar-drive experiments on the NIF (shown as black contour lines). (b) Phase gradients can be adjusted to limit the irradiance modulation on downstream optics. The blue, green, and black curves show improvement with design iteration as the peak-to-average modulation is reduced to less than 20% after 1 m of propagation (black curve).

Omega Facility Operations Summary: The Omega Laser Facility conducted 195 target shots in August (159 had been planned for the month) with an overall experimental efficiency of 96.9%. The OMEGA laser accounted for 128 of these shots (at an average experimental efficiency of 97.7%), while OMEGA EP conducted 67 target shots with an experimental efficiency of 95.5%. NIC accounted for 54 target shots carried out by teams led by LLE and LLNL scientists and 70 target shots were conducted by LANL and LLNL for the HED program. Six NLUF teams led by scientists from the University of Michigan, Princeton University, General Atomics, Rice University, and the University of California, Berkeley, conducted 51 target shots. Twenty target shots were conducted for the LBS program by three teams led by LLE and LLNL scientists.

1. T. J. Kessler *et al.*, in *Laser Coherence Control: Technology and Applications*, edited by H. T. Powell and T. J. Kessler (SPIE, Bellingham, WA, 1993), Vol. 1870, p. 95.
2. T. J. B. Collins *et al.*, Bull. Am. Phys. Soc. **55**, 25 (2010).
3. K. McCandless, C. Widmayer, and S. Dixit, LLNL, private communication (2011).