NIF Polar-Drive–Ignition Design: The National Ignition Facility (NIF) polar-drive (PD) ignition point design has been developed to explore the possibility of ignition on the NIF while it is in the x-ray-drive configuration.[1] In PD[2] the indirect-drive beam configuration is used with beams repointed toward the equator. The repointed beams have decreased coupling with the target, requiring higher drive energies and unique pulse shapes to achieve adequate implosion symmetry in conjunction with imposing a compensating ice-layer shim (equator-thinned ice). This design uses several features to improve shell implosion stability: (a) multi-FM 1-D smoothing by spectral dispersion (SSD) only during the picket pulses; (b) optional use of an ice-layer shim; (c) use of a triple-picket pulse; (d) phase plates that produce asymmetric spots for the equatorial beams; and (e) control of shock and shell nonuniformities via beam-group pulse shaping. Along with the use of single-beam polarization smoothing, these features require only modest modifications to the current NIF capabilities.

A new suite of PD ignition designs was developed with lower implosion velocity. This leads to lower in-flight aspect ratios (IFAR's) and decreased acceleration-phase instability. The implosion velocity reduction is accomplished through increased fuel mass. The adiabat was reduced to preserve the ignition margin. The IFAR, which scales as $V_{\text{imp}}/\langle\alpha\rangle^{3/5}$, where V_{imp} is the peak implosion velocity and $\langle\alpha\rangle$ is the average shell adiabat, is reduced to 30 for these designs. These velocities and IFAR's are within the range accessible in cryogenic implosions on OMEGA. One of these designs, with an implosion velocity of 370 μm/ns, has been further optimized in 2-D simulations using *Telios*. *Telios* is an optimization tool employing as its kernel a C++ implementation of a downhill-simplex method. *Telios* was used to maximize the target gain while holding the adiabat, pulse energy, and IFAR constant while varying the beam pointing angles and relative pulse energies. Little variation in target gain (70 < gain < 78) was found, indicating a stability plateau with respect to the polar pointing angles and ring energies (see Fig. 1).

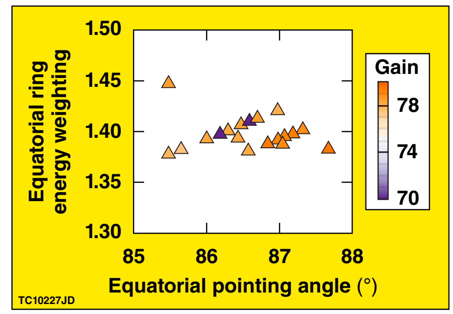

Figure 1. The target gain is shown as a function of the equatorial pointing angle and the relative weighting of beams in the equatorial rings. The optimization for gain was performed in the 5-D space of ring polar angles and relative pulse energies. Each point represents a separate 2-D *DRACO* simulation.

A study of robustness was performed in 1-D using a two-phase spot shape to imitate the decrease in hydrodynamic efficiency after the start of the acceleration phase caused by PD. A grid of designs, scaled from the 370-μm/ns design, was optimized in 1-D using *Telios* over a range of implosion velocities and mass-averaged, end-of-pulse shell adiabats. As was found by Levedahl and Lindl[3] an ignition "cliff" can be seen, largely independent of implosion velocity, in burn-up fraction as a function of ignition margin given by the ratio of the peak shell kinetic energy E_{k} to the minimum energy needed for ignition $E_{\min}$ (Fig. 2). Reduced coupling as a result of cross-beam energy transfer will lower the shell kinetic energy, moving it toward the cliff. Perturbation growth during the deceleration phase will reduce the onset of ignition, having the same effect. In this regime, the survey shows that a robust target design at 1.5 MJ requires a burn-up fraction of at least ~20%. Two-dimensional simulations of the 370-μm/ns PD point design demonstrate a burn-up fraction of ~25%.

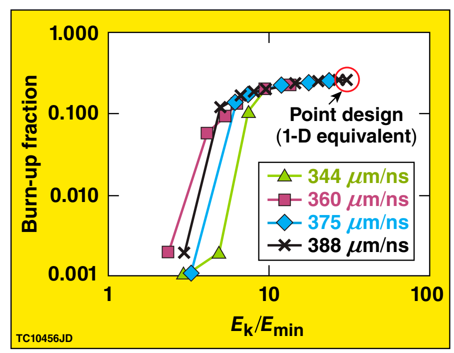

Figure 2. The burn-up fraction is shown as a function of target margin, given by the ratio of the peak shell kinetic energy E_{k} to the minimum energy needed for ignition $E_{\min}$.

Omega Facility Operations Summary: The Omega Facility conducted 146 target shots during the month of December with an average experimental effectiveness of 96.2% (the OMEGA and OMEGA EP lasers conducted 120 and 26 target shots, respectively, with experimental effectiveness ratings of 99.2% and 82.7%, respectively). The ICF campaign accounted for 58 target shots taken for experiments by teams led by LLE and LLNL scientists, while the HED program received 69 target shots. Nineteen target shots were taken for the LBS program by LLNL- and LLE-led teams.

1. T. J. B. Collins *et al.*, Phys. Plasmas **19**, 056308 (2012).
2. S. Skupsky *et al.*, Phys. Plasmas **11**, 2763 (2004).
3. W. K. Levedahl and J. D. Lindl, Nucl. Fusion **37**, 165 (1997).