Cryogenic DT Implosions with a Laser-Shinethrough Barrier: The goal of cryogenic DT implosion experiments on OMEGA is to demonstrate ignition hydro-equivalent performance.[1] The primary metric to assess implosion performance is the average core pressure during the fusion burn. The highest peak pressure measured with current targets is ≲40% of that needed for ignition hydro-equivalence (≥100 Gbar) (Ref. 2). The pressure deficit is primarily caused by energy-coupling losses from cross-beam energy transfer (CBET).[3] In addition, hydrodynamic instabilities seeded by target-surface imperfections and laser imprint limit the minimum fuel adiabat (α) for stable implosions to ~4 (at implosion velocities above 370 km/s). Despite significant improvements in the target-surface quality during 2012 and 2013 (Refs. 1, 2, and 4) near 1-D (with CBET losses included) target performance at $\alpha < 4$ has been elusive.

In addition to high spatial frequency surface imprint resulting from laser speckle, LLE is currently studying imprint mechanisms that include beam-to-beam mistiming and energy variations in the leading picket as well as volumetric etching of the fuel and ablator material caused by laser shinethrough.[5] Shinethrough was identified several years ago as a potential seed source for hydrodynamic instabilities.[5] Mitigation experiments at the time were inconclusive because of the poor quality of the target surface. Cryogenic DT implosion experiments in November used a thin (~70-nm) Si overcoat to prevent shinethrough. The choice of silicon as the 3ω barrier layer was motivated by material properties—the thin layer of Si is permeable to DT (the targets can be filled) and optically thin (the layers can be characterized with the existing systems). Attempts to permeation fill the targets were initially unsuccessful. This problem was eventually overcome by reducing the fill rate of the targets. Reducing the fill rate to a half atm/s resulted in 100% survival of the capsules during the fill. This fill rate lengthened the fill time, relative to uncoated targets, by ≳48 h.

The initial series of implosions with the silicon overcoat was performed with an established design (to ensure there were no adverse effects from the overcoat). The yields normalized to 1-D predictions are consistent with the yields from uncoated capsule implosions under similar drive conditions [both sets of data are plotted in Fig. 1 as a function of the calculated in-flight aspect ratio (IFAR)]. Experiments in January and February 2014 will systematically lower the fuel adiabat and increase the IFAR to determine whether or not shinethrough is limiting higher-performance cryogenic DT implosions.

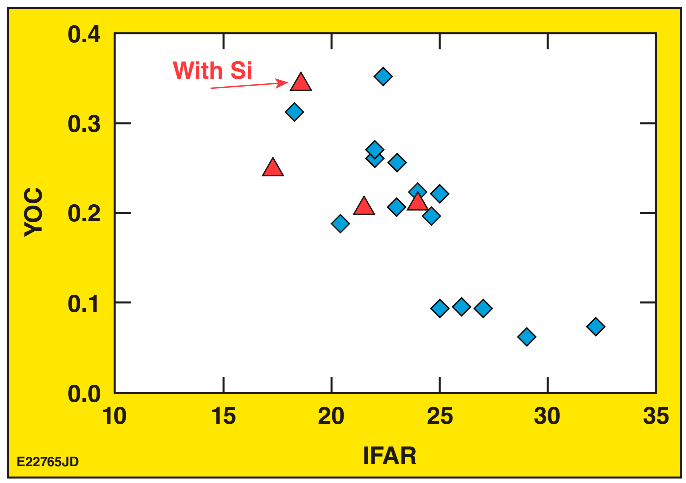

Figure 1. The yield ratio with 1-D prediction [yield over clean (YOC)] is plotted as a function of the calculated in-flight aspect ratio (IFAR) for triple-picket cryogenic DT implosions in 2013. The red triangles are the Si-coated CD shells, which perform similarly to uncoated CD shells (blue diamonds). This suggests that shinethrough is not the dominant source for hydro-instability seeds.

Omega Facility Operations Summary: During December, the Omega Laser Facility conducted 123 target shots with an average experimental efficiency of 96.7%. These target physics shots included 86 on the OMEGA laser (experimental effectiveness of 95.3%) and 37 on OMEGA EP (experimental effectivness of 100%). The ICF campaign accounted for 63 target shots led by LANL, LLNL, and LLE teams, while 36 target shots were taken for the HED campaign by LLNL and LLE. One NLUF experiment led by the University of California, Berkeley accounted for 7 target shots, while the LBS program received 17 shots in experiments led by LLNL. In addition, 21 OMEGA EP system shots were taken in support of beam co-propagation activation.

1. T. C. Sangster *et al.*, Phys. Plasmas **20**, 056317 (2013).
2. V. N. Goncharov *et al.*, "Improving the Hot-Spot Pressure and Demonstrating Ignition Hydrodynamic Equivalence in Cryogenic DT Implosions on OMEGA," to be published in Physics of Plasmas.
3 I. V. Igumenshchev *et al.*, Phys. Plasmas **19**, 056314 (2012); *October 2012 Progress Report on the Laboratory for Laser Energetics.*
4. *April 2012, August 2012, and February 2013 Progress Reports on the Laboratory for Laser Energetics.*
5. D. H. Edgell *et al.*, Phys. Plasmas **15**, 092704 (2008).