Cryogenic Implosion Performance: The 1-D Cryogenic Implosion Campaign is being used to develop a predictive model for direct-drive cryogenic DT implosions. The model includes a statistical mapping of the experimental results onto a simulation database of high-adiabat implosions ($\alpha \sim 5$) having convergence ratios of ~11 to 13. The nonlinear regression formula from the mapping is used to bridge the gap between experiments and simulations. The combination of simulation outputs and statistical mapping is then used to design the next implosion series. This technique can overcome the present limitations of the physics models in the current codes and enable progress in improving the implosion performance. It also provides a new and powerful tool to interrogate the experimental data to identify the 1-D deficiencies in the 1-D physics models.

One example of mapping relations is from the nonlinear regression on experimental yields from 1-D campaign implosions up to 31 January 2017 $\text{Yield}_{\text{exp}} = 4.3 \times 10^{14} \left(V_{\text{imp}}^{LILAC}/400\right)^{4.03} \left(M_{\text{stag}}^{LILAC}/0.014\right)^{0.69}$, where V_{imp}^{LILAC} and M_{stag}^{LILAC} are the implosion velocity in km/s and stagnating mass in mg from 1-D simulations. This formula was used to design the 4 April and 11 July implosions using larger-diameter shells up to 910 μm in outer diameters and ice layers of ~42 μm in thickness. Prior cryogenic targets had diameters ~860 μm.

Figure 1 shows the predictive capability of the statistical mapping. The circles are the yields from the 1-D campaign shots up to 31 January used to generate the mapping relation. The triangles are the yields from the 4 April and 11 July shots that are accurately predicted in advance by the mapping relation (blue line). The mapping formula shows that the 1-D campaign yields are dominated by the effect of implosion velocity despite the record IFAR's (in-flight aspect ratios) reached in these implosions (IFAR $\lesssim$ 44). Therefore, increasing the implosion velocity will increase the neutron yield even though the stability properties are degraded through higher IFAR's. The implosion velocity can be further increased by using larger-diameter shells up to 1000 μm in outer diameter, which couples more energy to the target. Cryogenic implosions performed on 11 July 2017 were designed with a calculated implosion velocity reading of 500 km/s.

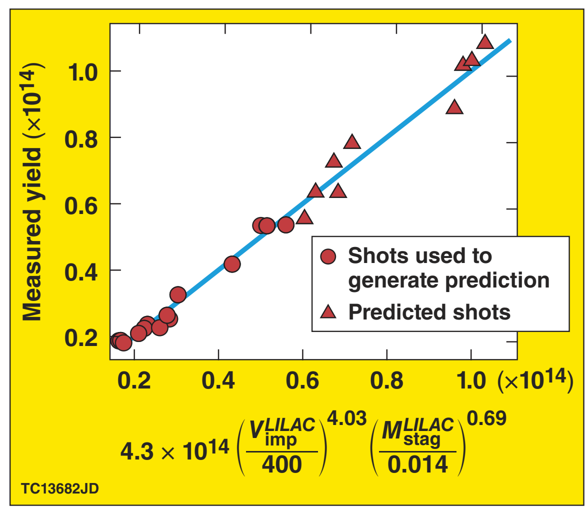

Figure 1. Measured neutron yields versus mapping relations from the nonlinear regression. The circles are shots used in the mapping. The triangles are shots designed and executed based on the mapping predictions.

Figure 2 shows the measured neutron yield as a function of the implosion velocity as calculated by *LILAC*. Data from the July implosion set are the points with implosion velocities from 486 to 497 km/s and yields from 0.87 to 1.1×10^{14}. The measured yield of 1.1×10^{14} neutrons is the highest recorded for an OMEGA cryogenic implosion. The line is a power law fit to the points that shows an implosion velocity exponent of 4.2±0.2. The areal densities achieved in these implosions were in the range of 100 to 120 mg/cm^2.

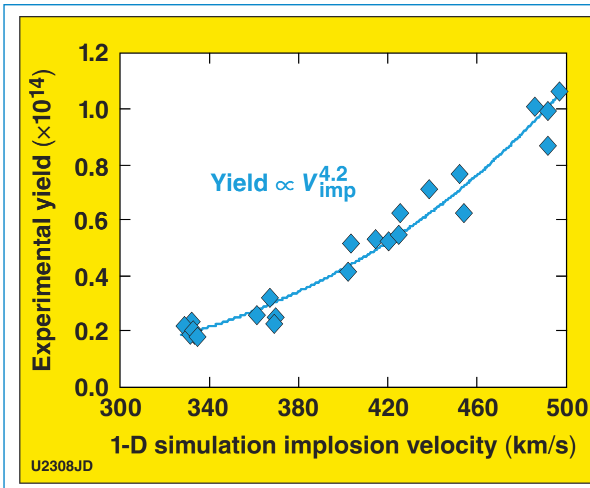

Figure 2. Plot of the neutron yield versus implosion velocity. The latest July implosion data are the four points at the top right of the graph.

Omega Facility Operations Summary: During July 2017, 165 target shots were taken at the Omega Laser Facility with an average experimental effectiveness (EE) of 98.5% (the OMEGA laser had 112 shots and an EE of 97.8% while the OMEGA EP laser had 53 shots with an EE of 100.0%). LLNL and LLE conducted 48 shots for ICF experiments, while HED experiments led by LANL, LLNL, and LLE accounted for 45 target shots. Five NLUF teams led by the University of Nevada, Reno, the University of Michigan, MIT, Princeton University, and the University of California, Berkeley, conducted 47 shots. Two LBS program experiments led by LLNL and LLE, respectively, had 19 target shots. One experimental campaign from the Centre Lasers Intenses et Applications (CELIA) of the University of Bordeaux, France, accounted for six of the target shots.

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