OMEGA Cryogenic DT Implosion Performance: Cryogenic DT implosion performance on OMEGA has been shown to depend strongly on the in-flight aspect ratio and the fuel adiabat α (Ref. 1). The dependence was explained by isolated surface perturbations that grow at the ablation front and eventually penetrate the fuel shell, injecting ablator material (carbon) into the core. The explanation was supported by the observation of enhanced continuum emission (relative to 1-D predictions) and the behavior of the primary performance scalars (ρR, Y, and T_i) relative to 1-D predictions. The measured values for low-α (2 to 3) implosions were lower, relative to predictions, than for higher-α (3 to 4) implosions.

A potential perturbation source was identified as contaminant gases (CH_x, CO_2, N_2,…) in the DT fuel supply that freeze onto the outer surface of the capsule (see the *April 2012 LLE Monthly*). A palladium-silver filter was recently installed in the DT filling system to eliminate all of the contaminant gases except ^1H. Implosion performance since the installation of the filter has improved significantly. Table I compares the performance scalars as well as derived metrics from two implosions (shots 68790 and 68951) after the filter was installed with one of the best-performing targets prior to the installation (shot 67290). The higher yields and ion temperatures are the result of improved shell stability and higher implosion velocities (up to 370 km/s). All three shots used the same four-shock drive pulse with 26 kJ on target.

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On 28 February an NLUF team headed by Princeton University conducted the experiment "Study of Astrophysical Collisionless Shocks" on the OMEGA EP laser. The team included (from left to right, above): A. Spitkovsky (Princeton), D. Caprioli (Princeton), G. Fiksel (LLE), D. Barnak (UR/LLE graduate student), C. Huntington (LLNL), D. Froula (LLE), P.-Y. Chang (UR/LLE graduate student), H.-S. Park (LLNL), A. Elsholz (LLNL), and D. Ryutov (LLNL).

The dimensionless ICF Lawson criterion χ is defined as the ratio of $P\tau$ (the pressure in the core times the confinement time of the plasma at that pressure) and the $P\tau$ required for ignition (~25 atm-s at 5 keV) (Refs. 2 and 3). In Ref. 3, $P\tau$ is cast in terms of the experimentally measured performance scalars (given in columns 2–4) plus the mass of the fuel. The values of $P\tau$ and χ for these three OMEGA implosions are shown in columns 5 and 6, respectively. The value of χ required to demonstrate ignition hydro-equivalent performance on OMEGA[3] is 0.16 (nominally a ρR of ~0.3 g/cm^2 and a yield of 4×10^{13}). The value of χ scaled to a 1.8-MJ symmetric implosion is given in column 7. Column 8 is the scaled experimental ignition threshold factor[4] (ITFx) for OMEGA,[1] where a value of 1 implies a 50% probability of igniting.[4] Note that the χ and ITFx include an estimated 2× improvement in the yield at the 1.8 MJ scale. This is motivated by the expected similarity in ice-roughness and laser smoothing at NIF-scale but an increase in the target size.

Table I: Performance metrics for three recent cryogenic DT implosions on OMEGA.

Shot	Yield	ρR (g/cm^2)	T_i (keV)	$P\tau$ (atm-s)	Ignition parameter $\chi = P\tau/P\tau(\text{ign})$	χ scaled to 1.8 MJ symmetric	ITFx scaled to 1.8 MJ symmetric
67290	1.4×10^{13}	0.18	2.7	3.10	0.075	0.50	0.12
68790	2.7×10^{13}	0.18	3.7	3.25	0.100	0.64	0.23
68951	3.4×10^{13}	0.16	3.4	3.50	0.100	0.66	0.23

Omega Facility Operations Summary: The Omega Facility conducted 137 target shots in February with an average experimental effectiveness (EE) of 96%. There were 103 shots taken on OMEGA with an EE of 96.1% and 34 shots on OMEGA EP with average EE of 95.6%, respectively. The ICF program accounted for 15 target shots, while 32 shots were carried out for the HED program for experiments led by LANL and LLNL. Five NLUF experiments led by UC San Diego, New Hampshire University, UC Berkeley, Rice University, and Princeton University accounted for 51 target shots and the LBS program carried out 39 target shots for experiments led by LLNL and LLE.

(1) T. C. Sangster *et al*., "Improving cryogenic DT implosion performance on OMEGA," to be published in Physics of Plasmas; (2) R. Betti *et al*., Phys. Plasmas **17**, 058102 (2010); (3) R. Betti, presented at the 24th IAEA Fusion Energy Conference, San Diego, CA, 8–13 October 2012; (4) S. W. Haan *et al*., Phys. Plasmas **18**, 051001 (2011).