DT Implosions Meet Requirements for Scattered Neutron Spectroscopy: LLE has begun imploding an increasing number of high-performance DT-cryogenic targets in anticipation of having the new Magnetic Recoil Spectrometer[1] (MRS) available in December 2008, which will infer areal densities by measuring the fraction of the primary neutron yield scattered to lower energies in the dense fuel shell surrounding the hot spot. The primary MRS design requirements are an areal density of at least 100 mg/cm^2 and a primary neutron yield of 5×10^{12} (to give a statistical accuracy of ±10% in the down-scattered fraction). High implosion velocities (V_{imp} at least 3×10^7 cm/s) with good shell stability (minimal ice roughness and drive asymmetry) are required to achieve these yields. The first of these targets was imploded in November.

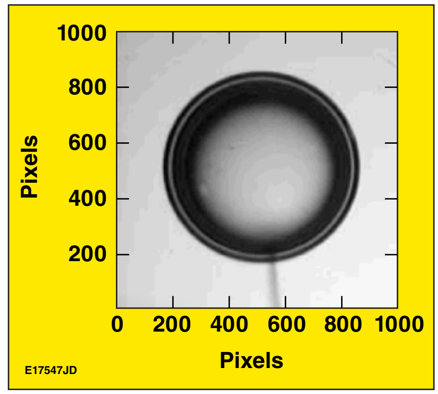

Figure 1. A shadowgraph of a stalk-mounted DT-cryogenic target that produced a yield of 5.6×10^{12} using the 21-kJ drive pulse shown in Fig. 2. This yield meets the requirements for using the Magnetic Recoil Spectrometer to infer the areal density in the DT-fuel shell.

Stalk-mounted targets are under development to improve shell stability in these high V_{imp} implosions. Recent experiments suggest that the perturbations associated with the standard mount (4× spider silks attached to the thin outer-CD shell with a cryogenic-compatible glue) may lead to significant degradation in target performance.[2] The most difficult aspect of the stalk-mounted targets is the opposing requirements of a mechanically and thermally robust stalk, and a minimal mass perturbation at the stalk–shell joint. LLE's Target Fabrication Group has designed a stalk that combines a 17-μm silicon carbide fiber with a stainless steel tube. This is the same fiber used to mount warm gas-filled cryogenic-surrogate targets. Figure 1 shows a shadowgraph of a stalk-mounted DT target in the Characterization Station. The ice roughness of these targets has averaged approximately 2-μm rms in all modes, with the dominant perturbation associated with the stalk–shell joint (the stalk acts as a heat sink causing the ice to be slightly thicker). To date, none of the stalk-mounted DT-cryogenic targets have been lost during transfer to the Moving Cryostat or insertion to target chamber center.

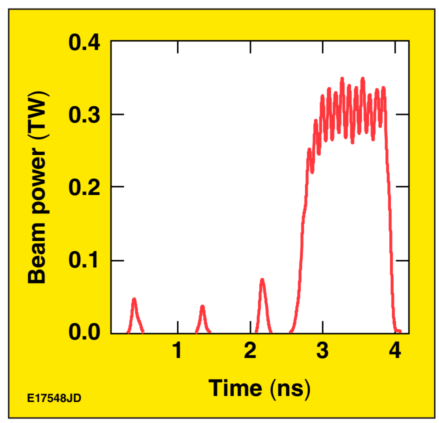

Figure 2. The multiple-shock drive pulse used to implode the targets shown in Fig. 1. The energy of this pulse is approximately 21 kJ.

The implosion velocity has been achieved (based on the measured bang time) by thinning the DT ice to approximately 65 μm (with a CD shell thickness of 10 μm). November's shots achieved the highest ever cryogenic-DT yields on OMEGA—up to 5.6×10^{12} using the multiple-shock drive pulse shown in Fig. 2 (see the July 2008 DOE report for a discussion of the shock-timing aspects of these drive pulses). A measurement of the knock-on deuteron spectrum from one of these implosions indicates that the areal density for this series is between 150 and 200 mg/cm^2 (the knock-on deuteron measurement saturates at these areal densities). This yield and areal density meet the requirements for areal density measurements using the MRS on high-performance cryogenic-DT implosions. Using the MRS to infer the areal density is an important milestone because the down-scattered fraction technique (the areal density is proportional to the ratio of the down-scattered fraction and the primary yield) will be the primary basis for areal density measurements on the initial THD and ignition campaigns in 2010 at the NIF.

OMEGA Operations Summary: The OMEGA Facility conducted a total of 116 target shots in November; 81 of these shots were taken on OMEGA and 35 shots were conducted on OMEGA EP, including joint shots. The overall experimental effectiveness averaged 95.7% (96.3% for OMEGA and 94.3% for OMEGA EP). NIC and NIC-support shots totaled 84 (39 on OMEGA and 35 on OMEGA EP). These shots were taken by teams led by scientists from LLNL (25), SNL (7), and LLE (52). Shots for HED programs were taken by LLNL (11) and LANL (12). There were also 9 shots conducted for AWE (UK).

1. J. A. Frenje *et al*. Rev. Sci. Instrum. **72**, 854 (2001).
2. F. J. Marshall *et al*., "Plasma Density Determination from X-Ray Radiogrphy of Laser-Driven Spherical Implosions," submitted to Physical Review Letters.