First Areal Density Measurement Based on Neutron Scattering in Compressed DT-Cryogenic Fuel: In December 2008, the Magnetic Recoil Spectrometer (MRS)[1] accurately measured the spectrum of scattered neutrons from a high-yield cryogenic deuterium–tritium (DT) implosion on OMEGA. The spectrum of <14-MeV neutrons produced by elastic scattering and (n,2n) reactions of 14-MeV neutrons in DT fuel was used to infer burn-averaged fuel areal density. This first-ever measurement of the scattered neutrons from a cryogenic-DT implosion (carried out in collaboration with MIT–PSFC) validates the MRS technique, which will form the basis for diagnosing the areal density in the early THD/DT campaigns on the National Ignition Facility.

The target was a 10-μm-thick CD shell with a 65-μm-thick solid DT fuel layer driven by a multipicket drive pulse (the pulse is shown in Fig. 2 of the November 2008 DOE Progress Report). The implosion produced the highest cryogenic-DT yield to date on the OMEGA laser. For this particular implosion, the MRS was set up with a neutron-to-deuteron conversion foil (deuterated plastic) 10 cm from the target. The measured recoil-deuteron spectrum is shown in Fig. 1(a). The data illustrates a peak at ~11 MeV due to primary neutrons and a low-energy tail between 6 and 9 MeV, caused by scattered neutrons. The broad primary peak is consistent with the expected energy loss of the deuterons in the conversion foil and a forward nD-elastic scattering end-point of 12.5 MeV.

The measured recoil-deuteron spectrum is a convolution of the neutron spectrum from the implosion and the response function of the MRS. This is determined by the solid angles subtended by the conversion foil and aperture in front of the magnet, the thickness of the conversion foil, the cross section for the nD-elastic scattering, and the focusing properties of the bending magnet. The neutron spectrum that gives the best fit to the measured recoil-deuteron spectrum is shown in Fig. 1(b). This spectrum is consistent with an areal density of approximately 150 mg/cm^2, consistent with 1-D predictions and burn truncation for a YOC ~ 10%. For the setup used here, the spectral broadening does not affect the accuracy of the inferred fuel areal density. Subsequent cryogenic-DT implosions will be used to compare areal densities determined from the MRS with areal densities determined for hydrodynamically equivalent cryogenic D_2 implosions.

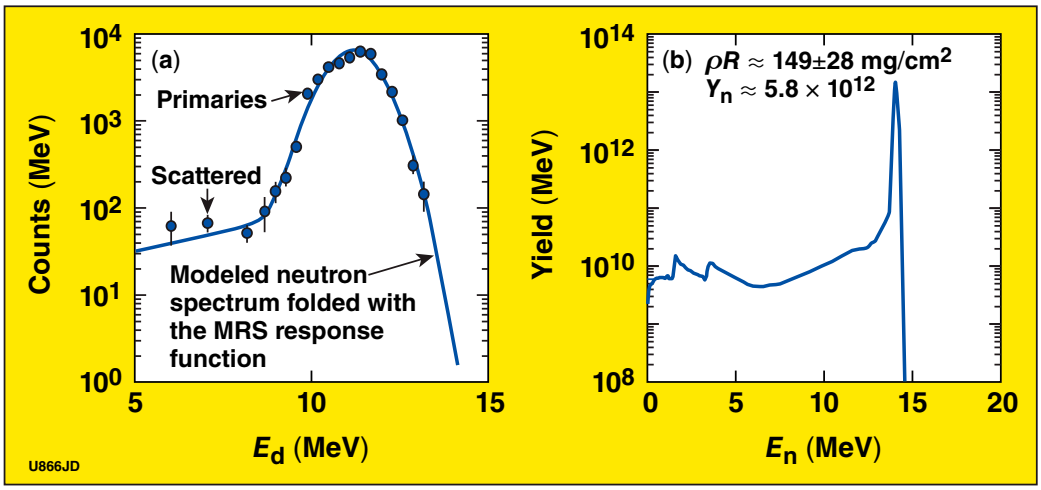

Figure 1: (a) Recoil-deuteron spectrum (blue dots) measured with the MRS. The solid line represents a convolution of the modeled neutron spectrum from the implosion and the MRS-response function. (b) The modeled neutron spectrum that gives the best fit [solid line in (a)] to the measured spectrum. The observed neutron spectrum is consistent with a fuel areal density of approximately 150 mg/cm^2.

OMEGA Operations Summary: The OMEGA Facility conducted 110 target shots during three weeks of operations in December; 81 shots were conducted on OMEGA and 29 on OMEGA EP. The overall experimental effectiveness was 98.2% (97.5% for OMEGA and 100% for OMEGA EP). Eleven of the target shots were joint shots with OMEGA EP firing into the OMEGA target chamber. Seventy-four shots were taken for the NIC program (53 for OMEGA and 21 for OMEGA EP); 28 of the NIC shots were led by LLNL and 25 by LLE. The LBS program accounted for 22 target shots led by LLE. The HED program received 6 shots led by LLNL and CEA conducted 8 target shots.

1. J. A. Frenje *et al.*, Rev. Sci. Instrum **79**, 10E502 (2008).