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Neutron Spectroscopy on the National Ignition Facility

J.P. KNAUER, Laboratory for Laser Energetics, U. of Rochester

The performance of cryogenic fuel implosion experiments in progress at the National Ignition Facility (NIF) is measured by an experimental threshold factor[1] (ITFX) and a generalized Lawson Criterion.[2] The ITFX metric is determined by the fusion yield and the areal density of an assembled deuterium-tritium (DT) fuel mass. Typical neutron yields from NIF implosions are greater than 10^{14} allowing the neutron energy spectrum to be measured with unprecedented precision. A NIF spectrum is composed of neutrons created by fusion (DT, DD, and TT reactions) and neutrons scattered by the dense, cold fuel layer. Neutron scattering is used to determine the areal density of a NIF implosion and is measured along four lines of sight by two neutron time-of-flight detectors, a neutron imaging system, and the magnetic recoil spectrometer. An accurate measurement of the instrument response function for these detectors allows for the routine production of neutron spectra showing DT fuel areal densities up to 1.3 g/cm^2. Spectra over neutron energies of 10 to 17 MeV show areal-density asymmetries of 20% that are inconsistent with simulations. New calibrations and analyses have expended the spectral coverage down to energies less than the deuterium backscatter edge (1.5 MeV for 14 MeV neutrons). These data and analyses are presented along with a compilation of other nuclear diagnostic data that show a larger-than-expected variation in the areal density over the cold fuel mass. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No DE-FC52-08NA28302. In collaboration with NIC.

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