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7.2 Reconstruction of the cold fuel shell in ICF experiments using neutron imaging at the NIF

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Neutron, gamma-ray and x-ray imaging are important diagnostic tools at the National Ignition Facility (NIF) for measuring the two-dimensional (2D) size and shape of the neutron producing region, for probing the remaining ablator, and measuring the extent of the DT plasmas during the stagnation phase of Inertial Confinement Fusion (ICF) implosions. Novel analysis tools for primary fusion and down-scattered (neutrons that have scattered off the compressed ICF shell) neutron images observed with the NIF have been developed that allow the forward reconstruction of the fuel density profile. This is extremely important with far reaching impact in this field as this work help fills a critical diagnostic gap in cryogenic DT experiments at NIF, namely the diagnoses of the cold compressed shell. It is currently believed that asymmetries and defects in the shell are leading factors in performance degradation in ICF implosion, and our ability to diagnose them is critical in order to work toward improvements. The recently commissioned second primary neutron image line of sight (there are now a polar and an equatorial primary image) has allowed us to perform a 3D reconstruction of the primary hotspot using these two views. This work promises 3D tomography of both the hot burning plasma and the compressed shell in NIF explosions with additional lines of sight. We present the detailed algorithms used for this characterization, and the resulting reconstructed cold fuel shells from experimental data collected at NIF.

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