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The impact of low-mode areal-density non-uniformities in indirect-drive implosions at the National Ignition Facility[1]

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To achieve hotspot ignition, inertial confinement fusion (ICF) implosions must achieve high hotspot pressures that are inertially confined by a dense shell of DT fuel. This requires high inflight shell velocity and high areal-density at stagnation. The size of the driver and scale of capsule required can be minimized by keeping a high efficiency of energy coupling from the imploding shell to the hotspot. However, significant 3D low mode asymmetries are commonly observed in indirect-drive implosions limiting the coupling of shell kinetic energy to the hotspot. To better quantify shell density asymmetry magnitudes and impacts, we have developed new analysis techniques [Casey et al., RSI 87, 11E715 (2016)] and analytic models [Hurricane et. al., POP 2020] that have been cross compared to data and simulation and recently extended beyond mode-1. We developed an analytic neutron transport model to cross-compare two independent measurements of asymmetry. They are in good agreement and show that the level of these asymmetries is significant. Recent analysis [MacGowan et al., HEDP 2020] has shown that there are multiple causes for the observed asymmetries, namely percent-level beam-to-beam laser power fluctuations and hohlraum diagnostic window losses. We will present evidence that non-uniformity in the ablator shell thickness in high-density carbon (HDC) experiments is also a significant cause for observed 3D implosion asymmetries. We will also discuss planned extensions of analysis techniques to mode 2-4 asymmetries using fluence compensated down-scattered neutron images and arrays of neutron activation detectors.

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