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High-resolution, detailed simulations of low foot and high foot implosion experiments on the National Ignition Facility[1]

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In order to achieve the several hundred Gbar stagnation pressures necessary for inertial confinement fusion ignition, implosion experiments on the National Ignition Facility (NIF) require the compression of deuterium-tritium fuel layers by a convergence ratio as high as forty. Such high convergence implosions are subject to degradation by a range of perturbations, including the growth of small-scale defects due to hydrodynamic instabilities, as well as longer scale modulations due to radiation flux asymmetries in the enclosing hohlraum. Due to the broad range of scales involved, and also the genuinely three-dimensional (3-D) character of the flow, accurately modeling NIF implosions remains at the edge of current radiation hydrodynamics simulation capabilities. This talk describes the current state of progress of 3-D, high-resolution, capsule-only simulations of NIF implosions aimed at accurately describing the performance of specific NIF experiments. Current simulations include the effects of hohlraum radiation asymmetries, capsule surface defects, the capsule support tent and fill tube, and use a grid resolution shown to be converged in companion two-dimensional simulations. The results of detailed simulations of low foot implosions from the National Ignition Campaign are contrasted against results for more recent high foot implosions. While the simulations suggest that low foot performance was dominated by ablation front instability growth, especially the defect seeded by the capsule support tent, high foot implosions appear to be dominated by hohlraum flux asymmetries, although the support tent still plays a significant role. Most importantly, it is found that a single, standard simulation methodology appears adequate to model both implosion types and gives confidence that such a model can be used to guide future implosion designs toward ignition.

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