A 3D dynamic model to assess impacts of low-mode asymmetry, aneurysms, and mix induced radiative loss on capsule performance at NIF, Omega, and Z

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A simple 3D dynamic model for implosions has been developed and used to assess impacts of low mode asymmetry, aneurysms, and mix-induced radiative loss on capsule performance across all ICF platforms. The model, while benchmarked against radiation hydrodynamics simulations, benefits from its simplicity and speed to allow rapid assessment of possible sources of degradation as well as help build intuition about the relative importance of different effects. Degradations in the model result from 3D rho-r perturbations that grow under deceleration from a radial stagnation flow, resulting in reduced convergence, stagnation pressure, and temperature. When available, experimental data is used as input to seed 3D perturbations in the model so that the actual observed hotspot and shell rho-r properties and asymmetry at stagnation are accurately reproduced, as well as impact of mix induced radiative loss. This model is applied to a broad range of implosion data from the NIF, Omega and Z, including examples from three ICF approaches: Indirect Drive (ID), Direct-drive (DD), and Magnetic Drive (MD). We can reproduce the performance trends by accounting for the impacts of shell rho-r asymmetry, impact of thin regions in the shell, and mix-induced radiative loss enhancements. As an example, for the high-foot series, model predicts up to a 30 to 100 -fold reduction in yield from low mode asymmetry and tent aneurysm leaks. The model is then used to examine a modified ignition criterion accounting for the presence of 3D perturbations and thin regions that increase the expansion PdV work.

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