Thin Shell Adiabat-Shaped Designs for High-Foot Implosions with Improved Stability on the National Ignition Facility

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The High Foot (HF) campaign on the National Ignition Facility (NIF) has improved the neutron yield by an order of magnitude as compared to the implosions reported during the National Ignition Campaign (NIC) while dramatically lowering the ablation-front instability growth. However, this yield increase came at the expense of reduced fuel compression due to higher fuel adiabat. Thinner shell adiabat-shaped HF implosions have been designed to combine the ablation front stability benefits of the current HF pulses with the demonstrated high fuel compressibility of the NIC implosions and increased implosion velocity. This is accomplished by using an adiabat-shaping technique which lowers the laser power between the first and second pulses to enhance the ablative stabilization at early times. However, while weakening the growth of the low mode numbers, this approach also introduces large negative lobes to the growth factor spectra at high mode numbers. Several methods such as altering the picket strength and shape and precisely tuning the rise-to-peak radiation drive are then investigated to minimize the negative lobes and the increase of the fuel adiabat by preventing undesired shocks from propagating in the fuel and depositing additional entropy. Ablation front growth factor spectra are generated from two-dimensional simulations with the FCI2 radiation hydrodynamics code. Linear analysis of the instability growth demonstrates that adiabat-shaped pulses provide a path to control and reduce ablation front instability growth while achieving the alpha-heating-dominated regime. Finally, introducing high-Z dopants in the ablator and adiabat-shaped pulses without picket are also investigated as potential ways to enhance the stability of the capsule and the hohlraum walls at early times.