Cylindrical implosion for validating hydrodynamics and scaling of inertial confinement fusion implosions

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Achieving Inertial Confinement Fusion (ICF) requires spherically compressing DT fuel filled capsules by a factor of 15-35 in radius. These system are inherently hydrodynamically unstable with perturbation growth due to shocks crossing interfaces (Richtmyer-Meshkov) or growth of perturbations from a density mismatch at an accelerated surface (Rayleigh-Taylor). In addition, perturbation growth occurs due to convergence effects know as Bell-Plesset growth. The combination of these effects leads to large scale mixing of ablator materials into the DT fuel reducing performance in ICF. Validating models is important for predicting performance and determining how much driver energy is needed to reach ignition. While measurements of these combined hydrodynamics can be done in spherical implosions, they are not direct measurements and are inferred from x ray self-transmission. We have been developing cylindrical implosions as a means to validate our modeling with direct measurements of perturbation growth while including convergence effects. Using both the Omega laser facility and the National Ignition Facility, we have demonstrated hydrodynamic scaling of implosions for a factor of 3x increase in size and are planning to test this scaling at convergence ratios of ~10. These convergences are relevant for laser direct drive ICF implosion. As part of the platform development, we implemented a Bayesian analysis to quantify uncertainties and include three dimensional effects to improve precision for validating models. These experiments hope to untangle the combined effects of RM, RT, and BP for ICF implosions.