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Hydro Scaling of Direct-Drive Cylindrical Implosions at the OMEGA and the National Ignition Facility[1]

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Deceleration-phase Rayleigh-Taylor instability (RTI) growth during the inertial confinement fusion (ICF) implosions affects the implosion performance significantly as it mixes the cold ablator material into the fuel. Precise measurements of such instability growth are essential for both validating the existing simulation codes and improving our predictive capability. RTI measurements on the inner surface of a spherical shell are limited and are often inferred indirectly at limited convergence. In contrast, cylindrical implosions allow for direct and precise measurements of the inner surface while retaining the effects of convergence, which are known to modify RTI growth rates through Bell-Plesset effects. We have performed direct-drive cylindrical implosions experiments at both the Omega and the NIF laser facilities using scaled targets. RTI growth is demonstrated to be scale-invariant between the cylindrical targets at OMEGA and similar targets at the NIF that are scaled up by a factor of 3 in the radial dimension. Single-mode (m=20) instability growth factors of ˜17 are measured at a convergence ratio CR˜2.5 with nearly identical mode growth at both scales. The measurements are in agreement with RAGE rad-hydro simulations. In addition, we have also developed Bayesian-Inference-Engine (BIE) methods to correct the parallax effects in the measurements allowing a more precise comparison between the experimental data and the simulations. The simulations use an *ad hoc* laser drive multiplier to account for cross-beam energy transfer and laser-plasma interaction physics that are not currently modeled. The same 0.8 multiplier matches both the OMEGA and NIF-scale targets, despite the disparate plasma length scales, with strong implications for scaling of direct-drive ICF implosions. Designs for higher convergence cylindrical implosions, CR˜10-15, are currently underway.

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