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Highly nonlinear ablative Rayleigh-Taylor experiments on the National Ignition Facility

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Cryogenic indirect-drive implosions on NIF have evidenced that the ablative Rayleigh-Taylor Instability (RTI) is an important driver of hot spot mix [1]. This motivates the switch to a higher adiabat implosion design [2]. Academic tests in physical regimes not encountered in ICF will help to build a better understanding of hydrodynamic instabilities. Under the NIF Discovery Science program, indirect drive experiments were performed to study the ablative RTI in transition from weakly nonlinear to highly nonlinear regime [3]. The unique capabilities of the NIF are harnessed to accelerate planar samples over much larger distances ($\sim$ 2 mm) and longer time periods ($\sim$ 10 ns) than previously achieved. The existence of a turbulent-like regime at ablation front is in fact not precluded by theory. This question is crucial for laboratory astrophysics and supernova of type Ia explosions based on the analogy between the flame front and the ablation front. A modulated package is accelerated by a 180 eV radiative temperature plateau created by a room temperature gas-filled platform irradiated by 64 NIF beams. Simultaneous trajectory and RTI growth measurements are performed. We present measurements made for various two-dimensional patterns (single-mode and broadband multimode modulations) and compare our results with weakly nonlinear analytical theory and FCI2 hydrocode simulations. The dependence of RTI growth on initial conditions and ablative stabilization is emphasized, as well as the possibility of measuring RTI bubble-merger for the first time in indirect-drive. In collaboration with D. Martinez, V.A. Smalyuk, B. Remington (LLNL), L. Masse, S. Liberatore, P. Loiseau (CEA).

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