Direct-Drive Late Time 3D Rayleigh-Taylor Instabilities on the NIF

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High-power laser facilities such as the National Ignition Facility (NIF) or the Laser Megajoule (LMJ) provide unique conditions to study the physics of nonlinear and turbulent mixing flows [1]. In order to do so, we need to accelerate millimeter-large samples over a long time (tens to hundreds nanoseconds of drive) with velocities of a few tens $\mu m.ns^{-1}$. However those conditions seem difficult to achieve with hohlraum generated X-drive.

Here we report on the results of the Long Duration Planar Direct Drive Discovery Science campaign on the NIF. We commissioned a 20-30ns long duration direct-drive platform for future academic experiments. Planar plastic samples are irradiated by 300 to 500kJ of 3w laser irradiation distributed over a 2-mm wide flat laser spot customized by adequate beams repointing. It is first shown that a shock can be sustained for 30ns with almost no curvature on a 2mm central area. These novel results and their benchmark against two-dimensional radiative hydrocode simulations will pave the way for future experiments requesting long duration drive on NIF [2].

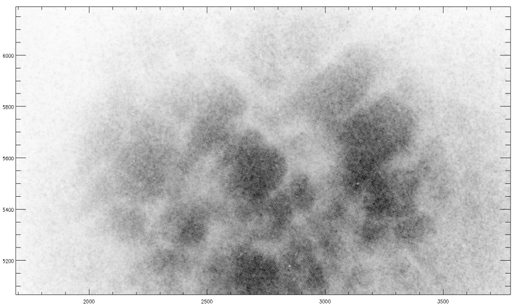

Figure 1: Radiography of 3D-imprinted perturbations after 23ns of laser drive

We used the platform to study Rayleigh-Taylor growth of 2D preimposed ripple and 3D imprinted pattern. These growths are quantified through face-on radiography and in-flight trajectory of the foil is measured through side-on radiography.

During 3D Rayleigh-Taylor growth the perturbation is composed of bubbles and spikes. Those bubbles are growing and merging together as the the biggest ones are fed by the others. We had been able here to measure several generations of bubbles between 10 to 23 nanoseconds of drive and also to reach an auto-similar regime of growth [3] until the size of the bubbles is equivalent to the size of the initial sample. Those results will provide further benchmarking of theoretical and numerical 3D non-linear Rayleigh-Taylor growth.

References

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