EXPERIMENTAL EVIDENCE OF A BUBBLE-MERGER REGIME FOR THE RAYLEIGH-TAYLOR INSTABILITY AT THE ABLATION FRONT

A.Casner[1], L. Masse[1], D. Martinez[2], S. W. Haan[2], J. Kane[2], S. Liberatore[1], P. Loiseau[1], A.S. Moore[1], R. Seugling[1], M. Farrell[3], E. Giraldez[3], A. Nikroo[3], V.A. Smalyuk[2] and B.A. Remington[2]

[1]CEA, DAM, DIF, F-91297 Arpajon, France
[2]Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[3]General Atomics, San Diego, California 92121, USA
alexis.casner@cea.fr

Under the Discovery Science program, the longer pulses and higher laser energies provided by the National Ignition Facility (NIF) have been harnessed to study for the first time in indirect-drive the highly nonlinear stage of the Rayleigh-Taylor Instability (RTI) at the ablation front. A planar plastic package with pre-imposed two-dimensional broadband modulations is accelerated for up to 12 ns by the x-ray drive of a gas-filled gold radiation cavity with a radiative temperature plateau at 175 eV [1]. This extended tailored drive allows a distance traveled in excess of 1 mm for a 130 µm thick foil, a factor 3x than previously achieved on other laser facilities [2].

As a consequence, we have measured with x-ray radiography the ablative RTI in transition from the weakly nonlinear stage up to the deep nonlinear stage for various initial conditions. The ablative stabilization strength has been varied by changing the plastic dopant material from iodine to germanium. In comparison to previous direct drive experiments [3], the ablation velocity and density gradient scale length are significantly increased with indirect drive leading to cutoff wavelengths large enough, (about 20 microns) to be observable. For the first time we have measured the ablation front RTI growth in a highly non-linear regime for the full unstable spectrum [2]. The results are compared with Haan saturation theory in 2D [4] and other theories [5,6] predicting increased bubble growth due to ablation in nonlinear regime. These results are critical for ICF, and are benchmarked against radiative hydrodynamic simulations performed with FCI2. Most of all, a careful choice of the broadband modulation pattern has allowed us to evidence without doubt a bubble-merger regime for the RTI at the ablation front [7]. This regime was predicted by theory [8] but until now believed unapproachable due to limited acceleration duration.

This paper will therefore provide an exhaustive overview of the Discovery Science Ablaive RTI campaign performed on the NIF since the last IFSA conference.

[1] A. Casner *et al.*, Physics of Plasmas **19**, 082708 (2012).
[2] A. Casner *et al.*, Physics of Plasmas **22**, 056302 (2015).
[3] V.A. Smalyuk *et al.*, Phys. Rev. Lett **95**, 215001 (2005).
[4] S.W. Haan, Phys. Rev. A **39**, 5812 (1989).
[5] J. Garnier et L. Masse, Physics of Plasmas **12**, 62707 (2005).
[6] R. Betti and J. Sanz, Phys. Rev. Lett. 97, 205002 (2006).
[7] D. Martinez *et al.*, submitted to Phys. Rev. Lett.
[8] D. Oron *et al.*, Physics of Plasmas **5**, 1467 (1998).