ABLATIVE HYDRODYNAMIC RICHTMYER-MESHKOV AND RAYLEIGH-TAYLOR INSTABILITIES AT ABLATION FRONT IN DIRECT-DRIVE SHOCK IGNITION SCHEME

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Shock Ignition (SI) [1,2] is a promising approach to Inertial Confinement Fusion. The strength of SI relies in decoupling the phase of fuel compression from the phase of ignition. The compression stage of a spherical millimetre target is driven by a ramped nanosecond laser pulse that causes shell implosion at about 300 km/s. Ignition is triggered by a second intenser laser pulse (spike) launched toward the end of the first laser pulse. The spike is tailored to produce an inward shock that reaches the rebouncing one coming from the centre causing the additional heating and fuel compression needed to ignite.

The continuous shock launching as well as the shell implosion are a natural place where both hydrodynamic ablative Richtmyer-Meshkov instability (RMI) and ablative Rayleigh-Taylor instability (RTI) are seeded and grow [3,4]. Hydrodynamic instabilities quickly degenerate, e.g. hot-cold material mixing, causing fuel degradation and so aborting ignition.

Our numerical investigation begins assuming that the outer target surface is corrugated. Simulations are carried out with the 2D radiative hydrodynamic code DUED. Our studies show that during the first phase of the ramped profile surface, the perturbations below a given threshold are damped by vorticity, above the RMI is excited [3]. Most importantly the RTI develops toward the end of the pulse, when the shell takes up moving, and its initial amplitude conditions are given by the late phase of the RMI. The two instabilities are sequential (one follows and seeds the other) and thus they are strictly correlated. We deduce that instability control can be traced back up to the original surface manufacturing perturbations. For this reason we have investigated techniques such as an 'adiabat shaping picket', giving promising results. Simulations verify that RMI and RTI behave similarly if we impose shell density inhomogeneity [3] or whether we consider target positioning error [4,5].

Non-local electron transport effects [6,7] are also included, they become important in ablative regions to reproduce all the thermal flow features. Nonetheless we showed that for very intense lasers ($I>10^{16}\,W/cm^2$) non-local transport smooths out pressure profiles reducing dis-uniformities [7].

During the RTI the involved geometry, density and electron temperatures ranges are suitable to self induce a magnetic field. The underlying physics is investigated adding the magneto hydrodynamic induction equation with the baroclinic source term to our model (DUED-B). A toroidal magnetic field forms around the sinusoidal density profile slightly changing the overall evolution, modifying the evolution times and influencing the non linear phase.

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