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Simulations of NDCX-II Targets for Warm Dense Matter and Heavy Ion Fusion Physics*

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The Neutralized Drift Compression Experiment II (NDCX II) is an induction accelerator now being constructed at Lawrence Berkeley National Laboratory and scheduled for project completion in March 2012. The baseline design calls for a 1.2 - 3 MeV, ~30 A Li+ ion beam, delivered in a bunch with sub ns pulse duration, and transverse dimension less than ~1 mm [1]. The purpose of NDCX II is to carry out experimental studies of material in the warm dense matter regime (WDM), and ion beam and hydrodynamic coupling experiments relevant to heavy ion based inertial fusion energy (HIF). In preparation for NDCX-II, we have carried out hydrodynamic simulations [2] of ion-beam-heated, porous and solid, metallic and non-metallic, targets. We have calculated the temperature and velocity at the critical surface [3], to estimate the predicted optical intensity and laser interferometer inferred velocity time profiles based on the simulated density, temperature, and velocity of the target. We have shown the sensitivity of these observables on two equations of state (QEOS and LEOS). Pulse formats include single pulses of fixed ion energy (fig. 1), and pulses with varied energy to create shocks and investigate ion-coupling efficiency. An increasing ion energy over the course of the pulse allows ions with larger range later in the pulse to keep pace with a shock wave initiated by ions earlier in the pulse. Thus, over the course of the pulse, energy is deposited close to the shock front, resulting in better coupling efficiency than for a mono-energetic pulse, relevant to direct drive HIF targets. Simulated target geometries include spherical [4] and cylindrical [5] bubbles (to create enhanced regions of higher pressure and temperature), in addition to planar solid and planar foam targets [6]. In addition, we have begun exploration of droplet evolution [7],[8] produced in NDCX-II targets.

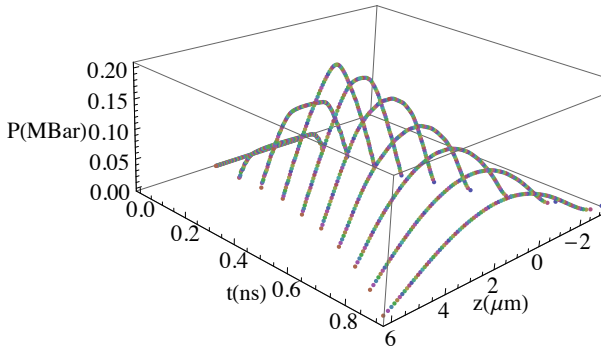

Figure 1: HYDRA [9] simulation of longitudinal pressure profile at the radial center of a 3.5 μ thick aluminum target heated by NDCX-II beam, for ten different times (with each curve separated by 0.1 ns) during the beam heating. Simulation assumed 20 kJ/g, delivered over 1 ns by 2.8 MeV Li+ ion beam.

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