Materials studies and beam physics with intense ion beams

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Helium ions in the Neutralized Drift Compression Experiment (NDCX-II) are accelerated and compressed in an induction accelerator [1], making high perveance ion beams and low emittance, attractive for exploring basic beam physics of general interest, and relevant to the high-current, high-intensity ion beams needed for heavy-ion-driven inertial fusion energy [2,3]. By choosing the ion mass and kinetic energy to be near the Bragg peak, dE/dx is maximized and a thin target may be heated with high uniformity [4,5].

In the past year we have integrated particle-in-cell simulations with experimental measurements at NDCX-II to enable higher dose rates [6]. The detailed comparison of PIC to the beam diagnostics from the experiment informed iterations and improved the beam focusing properties at the entrance to the drift compression section. As a result, we have doubled the peak ion current delivered to the target to >2 Amperes of He^+ with 7×10^{10} He^+ ions/pulse, and a peak fluence of 2×10^{20} ions/cm^2/s.

In beam-target experiments, we are comparing the dynamics of rapidly heating thin tin samples to a 3D multi-physics multi-material code including the effect of surface tension [7]. In order to measure ion energy loss in materials, including while driving phase-transitions during the ion pulse, we have implemented a time-of-flight (TOF) ion transmission energy loss capability. We note that our 1 MeV He^+ pulses implement Bragg-peak heating with uniform energy deposition across the foil within 2% (SRIM).

References

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