SHORT-PULSE ION BEAMS AT BERKELEY LAB*

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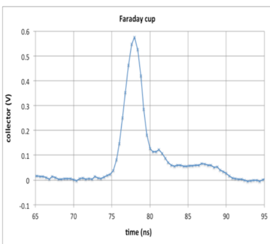
We have commenced experiments with intense short pulses of ion beams on the Neutralized Drift Compression Experiment (NDCX-II) at Lawrence Berkeley National Laboratory, by generating r < 1 mm beam spots within 2.5 ns FWHM. The Li^+ ion kinetic energy is 1.2 MeV. To enable the short pulse durations and mm-scale focal spot radii, the beam is neutralized in a 1.5-meter-long drift compression section following the last accelerator magnet. An 8-Tesla short focal length solenoid focuses the beam in the presence of the volumetric plasma that is near the target.



The beam current measured at the end of the accelerator and drift compression section is shown in the figure. In the accelerator, the line-charge density increases due to the velocity ramp imparted to the beam bunch in the accelerator [1,2]. The transverse distribution is characterized by a thin scintillator and gated image-intensified CCD camera, which shows that the beam distribution is peaked with 80% of the charge within a radius of 0.8 mm. The charge in the compressed bunch is presently 1-2 nC and is expected to ultimately reach over 30 nC per pulse while maintaining a small focal spot and bunch duration. These results show that the induction accelerator components are functioning as designed. The 28 pulsed accelerator solenoids operate at up to 3 Tesla. Lumped-element networks or Blumleins create the compression and acceleration waveforms of the 12 active induction acceleration cells.

Diagnostics for studying the transient conditions of the bombarded targets include probe laser transmission and reflection, time resolved spectroscopy of beam-induced emission, and time of flight and energy analysis of the transmitted and backscattered ions.

The scientific topics to be explored are warm dense matter, the dynamics of radiation damage in materials [4], and intense beam and beam-plasma physics including select topics of relevance to the development of heavy-ion drivers for inertial fusion energy [5]. Since the ion range is short, such beams will push micron-thick targets into the warm-dense matter state on a ns timescale. Below the transition to melting, the short beam pulses offer an opportunity to study the multi-scale dynamics of radiation-induced damage (ionization cascades) in materials with pump-probe type experiments.

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[3] P.A. Seidl et al., Phys. Rev. ST – Accel. Beams 15 (2012) 040101; A.I. Warwick, IEEE NS 32 (1985) 1809.
[4] T. Schenkel et al., Nucl. Inst. Meth. B V315 (2013) 350–355
[5] R.O. Bangerter, A. Faltens, P.A. Seidl, Rev. Accel. Sci. & Tech. V6, 85-116 (2013).

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