EXPERIMENTAL STUDY OF THE TRANSPORT LIMITS OF INTENSE HEAVY ION BEAMS IN THE HCX*

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The High Current Experiment (HCX) at Lawrence Berkeley National Laboratory is part of the US program to explore heavy-ion beam transport at a scale representative of the low-energy end of an induction linac driver for fusion energy production. The primary mission of this experiment is to investigate aperture filling factors acceptable for the transport of space-charge-dominated heavy-ion beams at high space-charge intensity (line charge density up to ~ 0.2 μC/m) over long pulse durations (>4 μs) in alternating gradient electrostatic and magnetic quadrupoles. The experiment also contributes to the practical baseline knowledge of intense beam manipulations necessary for the design, construction and operation of a heavy ion driver for inertial fusion. This experiment is testing -- at driver relevant scale -- transport issues resulting from nonlinear space-charge effects and collective modes, beam centroid alignment and beam steering, matching, image charges, halo, electron cloud effects, and longitudinal bunch control. We first present the results for a coasting 1 MeV K^+ ion beam transported through the first ten electrostatic transport quadrupoles, measured with optical beam-imaging and double-slit phase-space diagnostics. This includes studies at two different radial filling factors (60% and 80%), for which the beam transverse distribution was fully characterized. Additionally, longitudinal phase space and halo measurements will be shown. We then discuss the first results of beam transport through four pulsed room-temperature magnetic quadrupoles (located downstream of the electrostatic quadrupoles), where the beam dynamics become more sensitive to the presence of secondary electrons.

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