Title

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PHYSICS DESIGN FOR NDCX-II, A SHORT-PULSE ION BEAM DRIVER FOR NEAR-TERM WDM AND TARGET PHYSICS STUDIES*

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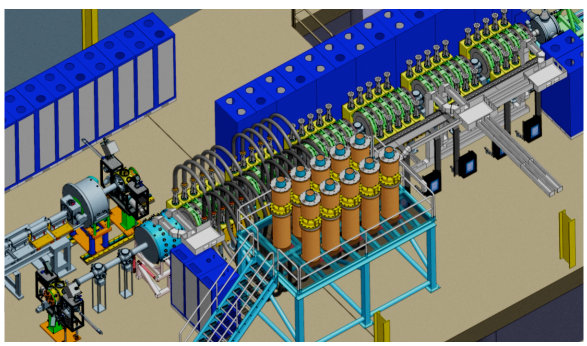
The Heavy Ion Fusion Science Virtual National Laboratory, a collaboration of LBNL, LLNL, and PPPL, is studying Warm Dense Matter (WDM) physics driven by ion beams, and basic target physics for heavy-ion-driven inertial fusion. A low-cost architecture for the next-step facility in this program, NDCX-II, has been enabled by the recent donation of induction cells and associated hardware from the decommissioned Advanced Test Accelerator (ATA) facility at LLNL.

This second-generation Neutralized Drift Compression eXperiment represents a significant upgrade from the existing NDCX-I. NDCX-II is to deliver ~30 nC of ions at ~3 MeV in about 1 ns into a mm-scale spot on a variety of targets. Applications will include studies of the basic physics of the WDM regime using uniform volumetric ion heating of foils at energies near the Bragg peak of deposition; studies of ion energy coupling into an ablating plasma using beams with ramped kinetic energy (relevant to highly efficient heavy-ion direct drive); studies of space-charge-dominated ion beam dynamics; and studies of beam focusing and pulse compression in neutralizing plasma.



We have used a combination of analysis, an interactive one-dimensional kinetic simulation model, and multidimensional Warp-code simulations to develop a physics design for the NDCX-II accelerator section. In this design, the pulse of singly charged Li ions is compressed rapidly using an "energy chirp," that is, by imparting a greater kinetic energy to the latter particles in the beam. This compression brings the pulse duration below 70 ns, at which point the high-voltage blumlein power supplies from ATA are usable. The beam is allowed to stretch spatially as it is further accelerated, and then a final energy chirp is applied, the beam is directed into a neutralizing plasma channel, and finally the accelerated and compressed pulse is focused onto the target. The compression from ~500 ns to ~1 ns requires only ~15 m. We present the novel principles underlying this physics design, and illustrate the beam dynamics using computer-generated videos.

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