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Modeling HIF Relevant Longitudinal Dynamics in UMER

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A unique challenge for heavy ion fusion drivers is achieving sufficiently low emittances and small energy spread in the presence of intense space-charge to achieve the high deposition densities necessary for pellet ignition. The University of Maryland Electron Ring (UMER) uses intense low-energy electron beams to access the scaled physics of HIF drivers. In particular the long path length propagation in UMER presents a unique opportunity to study, at realistic scales the longitudinal beam dynamics and manipulations required for such a driver. With the use of induction modules, as in the ion machines such as NDCX-II, the resulting bunch dynamics show evidence of space-charge waves excited by an initial mismatch between the detailed initial beam distribution at the bunch ends and the applied focusing waveforms, persisting with multiple damped reflections propagating along the bunch flat-top. With sufficient amplitude, we have also been able to demonstrate steepening and the formation of solitary waves from initial modulations. With the use of sufficiently fast diagnostics we have been able to measure the dispersive transverse effects dependent on the longitudinal dynamics from both edge erosion as well as space-charge wave dynamics. This experimental work has also been very closely coupled with a simulation effort that has shown excellent agreement when the detailed longitudinal dynamics of the experiment are carefully incorporated into the model.

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