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Three-Dimensional Hybrid Simulations of Field-Reversed Theta-Pinch Discharges YURI OMELCHENKO, Trinum Research, Inc, HOMA KARIMABADI, SciberQuest, Inc — The field-reversed theta-pinch discharge is a well-known method for creating the field-reversed configuration (FRC) considered to be one of the most promising candidates for an economical fusion reactor. Using an asynchronous parallel hybrid code, HYPERS, we have conducted first-ever 3D simulations of such discharges under realistic physical conditions that include applied magnetic flux coils, ion-ion collisions and the Chodura resistivity. Unlike all other existing hybrid codes, HYPERS does not step spatially distributed variables synchronously in time but instead performs numerical time integration by executing asynchronous discrete events: updates of particles and fields carried out as frequently as dictated by local physical time scales. As a result, not only HYPERS produces robust and accurate results with speedups of several orders of magnitude compared to traditional simulations but for the first time this code made it possible to study end-to-end kinetic dynamics of 3D laboratory plasma systems under experimental plasma conditions that make application of other codes very difficult if not altogether impossible. We discuss physical properties of FRCs obtained in simulations and mechanisms responsible for their spontaneous toroidal spin-up.

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