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Closed-loop, non-linear feedback control simulations of beam-driven field-reversed configurations (FRCs) N. RATH, M. ONOFRI, D. BARNES, J. ROMERO, Tri Alpha Energy, THE TAE TEAM — The C-2U device has recently demonstrated sustainment of an advanced, beam-driven FRC over time scales longer than the characteristic times for confinement, fast ion slow-down, and wall current decay. In anticipation of further advances in plasma lifetime, we are developing feedback control techniques for major FRC parameters and resistive instabilities. The LamyRidge code solves the time-dependent extended MHD equations in axisymmetric geometry. In the Q2D code, LamyRidge is combined with a 3-D kinetic code that tracks fast ions and runs in parallel with LamyRidge. Periodically, the background fields in the kinetic code are updated from the MHD simulation and the averaged fast particle distribution is integrated into the fluid equations. Recently, we have added the capability to run Q2D simulations as subordinate processes in Simulink, giving us the ability to run non-linear, closed-loop simulations using control algorithms developed in Simulink. The same Simulink models can be exported to real-time targets (CPU or FPGA) to perform feedback control in experiments. We present closed-loop simulations of beam-driven FRCs under magnetically-actuated feedback control. Results for positionally unstable FRCs are compared with the predictions of a linearized rigid-plasma model. Plasmas predicted to be passively stabilized by the linear model are found to exhibit Alfvenic growth in several cases. Feedback gains predicted to be stabilizing in the linear model are generally found to be insufficient in non-linear simulations, and vice versa. Control of separatrix geometry is demonstrated.

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