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Computational Studies of Magnetohydrodynamic Phenomena in the Reversed Field Pinch During PPCD*

Jim Reynolds and Carl Sovinec

Center for Plasma Theory and Computation, University of Wisconsin
1500 Engineering Drive, Madison WI 53706

Abstract

Magnetohydrodynamic phenomena present during application of Pulsed Poloidal Current Drive (PPCD) in the reversed-field pinch (RFP) configuration are investigated numerically with the 3D nonlinear simulation code NIMROD [1]. Preliminary simulations have demonstrated the global experimental observations of magnetic fluctuation reduction [2], increased instantaneous energy confinement time [2], and reduced magnetic stochasticity [3]. Recent simulation efforts focus on improving our understanding of the current profile evolution and the suppression of core-resonant tearing modes through numerical diagnostics and analysis.

Experimentally, probe measurements [4] near the plasma edge of the Madison Symmetric Torus (MST) [5] and equilibrium fits using data from Faraday rotation polarimetry [6] show migration of parallel current toward the core during the PPCD pulse. Through simulation and numerical diagnostics, we are able to track individual terms in Ohm's law, poloidal and toroidal flux evolution, and other effects related to the current profile evolution at various times during the electric field pulse. In addition, the role of the MHD fluctuations during the profile evolution is studied by varying the number of toroidal harmonics in different simulations. The results expose the relative roles played by the MHD pinching effect, reduced magnetic fluctuations, and resistive current diffusion in the parallel current profile temporal evolution. To demonstrate the sensitivity with respect to the initial state, we consider a parameter study with varied states of toroidal field reversal. Finally, a comparison of RFP simulations with PPCD in cylindrical and toroidal configurations examines geometric effects.

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