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Validation of Extended MHD Models using MST RFP Plasmas[1]

C.M. JACOBSON, B.E. CHAPMAN, D. CRAIG, K.J. MCCOLLAM, C.R. SOVINEC, University of Wisconsin-Madison — Significant effort has been devoted to improvement of computational models used in fusion energy sciences. Rigorous validation of these models is necessary in order to increase confidence in their ability to predict the performance of future devices. MST is a well diagnosed reversed-field pinch (RFP) capable of operation over a wide range of parameters. In particular, the Lundquist number S, a key parameter in resistive magnetohydrodynamics (MHD), can be varied over a wide range and provide substantial overlap with MHD RFP simulations. MST RFP plasmas are simulated using both DEBS, a nonlinear single-fluid visco-resistive MHD code, and NIMROD, a nonlinear extended MHD code, with S ranging from 10^4 to 5×10^4 for single-fluid runs, with the magnetic Prandtl number $Pm = 1$. Experiments with plasma current I_P ranging from 60 kA to 500 kA result in S from 4×10^4 to 8×10^6. Validation metric comparisons are presented, focusing on how magnetic fluctuations $\tilde{b}$ scale with S. Single-fluid NIMROD results give $S \sim \tilde{b}^{-0.21}$, and experiments give $S \sim \tilde{b}^{-0.28}$ for the dominant $m = 1$, $n = 6$ mode. Preliminary two-fluid NIMROD results are also presented.

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