Predictive Modelling and Helicity Dissipation Scaling Studies for Local Helicity Injection Non-Solenoidal ST Startup

J.D. Weberski, G.M. Bodner, M.W. Bongard, R.J. Fonck, and J.A. Reusch

Department of Engineering Physics, University of Wisconsin-Madison, Madison, WI 53706

A 0D power balance model is being tested on the Pegasus ST to develop predictive capability, interpret experiments, and inform future system design for Local Helicity Injection (LHI). The model calculates $I_p(t)$ by balancing LHI effective drive (V_{LHI}), helicity dissipation, and inductive effects while enforcing the Taylor relaxation current limit. Experimentally constrained drive inputs (plasma geometry, ℓ_i, β_p, injector parameters) allow for prediction of upper bounds on I_p. Namely, predictive modeling suggests nonlinear increases in achievable I_p are possible by higher B_T and/or I_{inj} to increase the early-phase Taylor limit. This motivates a new injector design and facility enhancements to further test LHI scalability. However, proper treatment of the helicity dissipation term is still a model uncertainty. Thus far, helicity dissipation has been attributed to neoclassical resistivity. This has been challenged by experiments showing I_p scales linearly with V_{LHI} while Thomson scattering indicates a variety of T_e profiles (from hollow to peaked, $40 < T_{e,0} < 150$ eV) depending on B_T, n_e, and injector parameters. Systematic scaling studies of T_e with discharge parameters are underway to resolve this model uncertainty.

Work supported by US DOE grants DE-FG02-96ER54375 and DE-SC0006928.