Abstract Submitted
for the DPP16 Meeting of
The American Physical Society

MHD and Reconnection Activity During Local Helicity Injection[1]

J.L. BARR, M.W. BONGARD, M.G. BURKE, R.J. FONCK, J.A. REUSCH, N.J. RICHNER, University of Wisconsin-Madison — Scaling local helicity injection (LHI) to larger devices requires a validated, predictive model of its current drive mechanism. NIMROD simulations predict the injected helical current streams persist in the edge and periodically reconnect to form axisymmetric current rings that travel into the bulk plasma to grow I_p and poloidal flux. In simulation, these events result in discrete bursts of Alfvénic-frequency MHD activity and jumps in I_p of order $\Delta I_p \sim I_{inj}$, in qualitative agreement with large $n = 1$ activity found in experiment. Fast imaging prior to tokamak formation supports the instability of, and apparent reconnection between, adjacent helical streams. The bursts exhibit toroidal amplitude asymmetries consistent with a kink structure singly line-tied to the injectors. Internal measurements localize this activity to the injector radial location. Pairwise correlations of poloidal Mirnov coil amplitude and phase match expectations of an edge-localized current stream carrying I_{inj}. Prior to tokamak formation, reconnection from both adjacent helical windings and co-injected current streams are shown to strongly heat impurity ions. After tokamak formation, strong anomalous ion heating in the plasma edge is attributed to continuous reconnection between colinear streams. The $n = 1$ bursts occur less frequently as I_p rises, likely caused by increased stream stability as B_v rises and q_{edge} drops. This evidence supports the general NIMROD model of LHI, confirms the persistence and role of the edge current streams, and motivates experiments at higher I_{inj} and B_T.

[1]Supported by US DOE grants DE-FG02-96ER54375, DE-SC0006928.

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Date submitted: 13 Jul 2016 Electronic form version 1.4