Non-solenoidal Startup via Local Helicity Injection on Pegasus: Progress and Plans

J.A. REUSCH, J.L. BARR, G.M. BODNER, M.W. BONGARD, M.G. BURKE, R.J. FONCK, E.T. HINSON, B.T. LEWICKI, J.M. PERRY, D.J. SCHLOSSBERG, University of Wisconsin-Madison — Non-solenoidal plasma startup via local helicity injection (LHI) at the Pegasus toroidal experiment now provides routine operation at \( I_p \approx 0.17 \text{MA} \) with \( I_{\text{inj}} \approx 5 \text{kA} \) and \( V_{\text{inj}} \approx 1 \text{kV} \) from four active arc injectors. Experiments in the past year have advanced the understanding of the governing physics of LHI and its supporting technology. Injector impedance scales as \( V_{\text{inj}}^{3/2} \) and is governed by two effects: a quasineutrality constraint on electron beam propagation, related to the tokamak edge density, and double-layer sheath expansion, related to \( n_{\text{arc}} \). Injector design improvements permit operation at \( V_{\text{inj}} \geq 1 \text{kV} \) without deleterious PMI or impurity generation. Discharges with varied shape, \( I_p(t) \), and helicity input test a predictive 0D power-balance model for LHI startup. Anomalous, reconnection-driven \( T_i > 800 \text{ eV} \) and strong MHD activity localized near the injectors are observed during LHI. Preliminary core Thomson scattering measurements indicate surprisingly high \( T_e > 300 \text{ eV} \), which if verified may indicate the dominance of high-energy electron fueling from the injector current streams. A new divertor injector system has been designed to substantially increase the available helicity input rate and support critical studies of confinement during LHI and reconnection activity at high \( I_p \). A proposed upgrade to the Pegasus experiment will extend these studies to NSTX-U relevant parameters.

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