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Feasibility Study for Local Helicity Injection Startup in the NSTX Upgrade Device[1] A.J. REDD, M.W. BONGARD, R.J. FONCK, University of Wisconsin-Madison, S.C. JARDIN, PPPL — Helicity injection using localized current sources in the tokamak edge region can initiate and sustain plasmas without using a central solenoid. Using this technique, Pegasus Toroidal Experiment plasmas with $I_p \leq 0.17$ MA have been created using $\sim$4 kA of injected current, and the method appears scalable to larger devices. We explore the feasibility of using a local helicity injection system for MA-class startup on the NSTX Upgrade (NSTX-U) device. Two key aspects of this effort are: development of accurate computational models to predictively simulate NSTX-U local helicity injection discharges, through the plasma startup, growth and sustainment phases; and, development of a compact injector assembly and corresponding power supplies appropriate for deployment at NSTX-U. The predictive modeling effort uses the Tokamak Simulation Code (TSC) to test theory-based models of the detailed physics underlying helicity injection discharges against experimental Pegasus results. Effects studied include the effective toroidal current drive, the confinement/dissipation in these plasmas, and neoclassical effects in ultralow aspect ratio Pegasus plasmas. The conceptual NSTX-U injector structure includes a plasma injector with active gas control and a shaped electrode to optimize current drive with respect to the observed helicity balance and magnetic relaxation limits on plasma performance. The existing Pegasus injector is a test of both of these features.

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