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Initiatives in Non-Solenoidal Startup and H-mode Physics at Near-Unity A[1] M.W. BONGARD, J.L. BARR, M.G. BURKE, R.J. FONCK, E.T. HINSON, B.T. LEWICKI, J.M. PERRY, A.J. REDD, D.J. SCHLOSSBERG, K.E. THOME, G.R. WINZ, University of Wisconsin-Madison — Research on the $A \sim 1$ Pegasus ST is advancing the physics of non-solenoidal tokamak startup and the H-mode confinement regime. Local helicity injection (LHI) uses current sources in the plasma edge to initiate and drive I_p via DC helicity injection, subject to constraints from helicity conservation and Taylor relaxation. To date, $I_p \sim 0.18$ MA has been initiated with $I_{inj} \sim 6$ kA. A predictive 0-D power balance model of LHI $I_p(t)$ evolution matches present discharges with strong PF induction. It projects $I_p \sim 0.3$ MA operation in Pegasus will achieve the LHI-dominated physics regime expected for 1 MA NSTX-U startup. Ohmic H-mode plasmas are routinely attained, due to the low P_{th} at the low B_T of $A \to 1$ plasmas. However, both limited and favorable ∇B SN plasmas have $P_{th} \sim 11$ times higher than expected from high-A scalings. They have improved τ_e ($H_{98} \sim 1$) and a quiescent J_{edge} pedestal between edge localized modes (ELMs). Unique $J_{edge}(t)$ measurements through a single Type I ELM show a complex, multimodal pedestal collapse and filament ejection. A proposed Pegasus-U initiative will upgrade the centerstack assembly and LHI injector systems, increasing B_T to 1 T, Ohmic V-s by $\times 6$, and pulse length to 100 ms at $A = 1.2$. This allows the physics and technology of LHI to be validated at NSTX-U relevant parameters, supports studies of nonlinear ELM dynamics, and will test high-β_T tokamak stability.

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