Establishing Low-Field-Side to High-Field-Side Local Helicity Injection Startup Scenarios

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Local Helicity Injection (LHI) is a non-solenoidal startup technique that utilizes electron current injectors to initiate a tokamak-like plasma. LHI startup in Pegasus employs a low-field-side (LFS) injector set on the outboard midplane, and/or a high-field side (HFS) injector set in the lower divertor region. HFS injection is of interest due to the dominance of helicity drive in sustaining I_p. This drive term increases with decreased injector radius (R_{inj}). To evaluate scalability of LHI to larger machines, operation at full field ($B_{T,0}$ = 0.15 T) is necessary. Previous HFS-only operation at full B_T (R_{inj} = 27 cm) was restricted due to stream pitch angle constraints impeding relaxation. Additionally, increased susceptibility to cathode spots that markedly reduce LHI drive was observed. These issues are mitigated by first using the LFS injectors to initialize the plasma and then handing off to the HFS system for I_p growth and sustainment. $I_p \sim 0.2$ MA is achieved at full B_T with this new scenario. Thomson scattering measurements in these plasmas show centrally-peaked pressure, with $T_e \sim 125$ eV and $n_e \sim 1\times10^{19}$ m^{-3}. This LFS to HFS handoff scenario enables HFS injection at lower R_{inj}, and thus increased current drive potential.

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