Investigating the Role of High-Frequency Magnetic Activity in Local Helicity Injection Dynamics

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Local Helicity Injection (LHI) uses biased plasma arc sources at the plasma edge for non-solenoidal tokamak startup. Understanding the magnetic activity present in LHI and its scaling could prove crucial for applying this technique to future devices. Internal magnetic measurements on the Pegasus ST show three main features are present in LHI: a ~20–40 kHz peak from $n = 1$ line-tied kink motion of the injector current streams; an intermediate region near 0.6 MHz with higher fluctuation power; and broadband turbulence for $f < 3$ MHz. A novel LHI regime is found at low $B_T \leq 0.075$ T where the $n = 1$ activity is suppressed, power at frequencies $f > 0.1$ MHz increases, and current drive efficiency is improved. This suggests that high-frequency activity could play a critical role in the current drive process. To investigate this, experiments to characterize and identify the observed activity are underway. Discharges with only the LHI current streams isolate the ~0.6 MHz feature to the injector arc and show sensitivities to injector voltage and/or current and magnetic field strength, suggestive of arc and/or kinetic instabilities. Experiments to determine the characteristic length and time scales of the broadband turbulence are underway.

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