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Limiting Currents of Pegasus Helicity-Injection Sources[1] E.T. HINSON, R.J. FONCK, B.T. LEWICKI, A.J. REDD, G.R. WINZ, University of Wisconsin-Madison — DC helicity injection start-up and current growth schemes call for sources of current injection at the tokamak edge. Since helicity injection rate scales with injection voltage, knowledge of the physics governing the impedance of the current injectors is needed for a predictive model of the helicity injection rate. In Pegasus, two types of injector are implemented – a plasma cathode electron gun, and a bare molybdenum electrode. The electron gun operates immersed in plasma, and draws current densities J $\sim$1 kA/cm^2 from an arc discharge of similar current density. It manifests two regimes of operation, one with I $\propto$ V$^{3/2}$, and a higher-power mode where I $\propto$ V$^{1/2}$ holds. At voltages and currents below $\sim$100 V / 1 kA, the three-halves power mode manifests a perveance of $\sim$1 A/V$^{3/2}$. At higher currents and voltages, the I $\propto$ V$^{1/2}$ characteristic has the magnitude of a few Alfvén currents, I_A. It is hypothesized that the low-power mode is a space-charge limited current mode, due to a $\sim$10 μm thick double layer at the 2 cm^2 gun aperture. The transition into the half-power mode is indicative of a change from a space-charge limited to a magnetically limited regime. Current in both regimes is observed to increase linearly with neutral fueling to the gun. The electrode in Pegasus also manifests a space-charge limited, I $\propto$ V$^{3/2}$ mode when the plasma is decoupled from the electrode. This current roughly scales with electrode area, as expected.

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