Measurement of Runaway Electron Beam Composition and Estimate of Resulting Collisional Decay of Runaway Electron Currents in DIII-D*

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High current (0.1–0.5 MA), long-lived (>100 ms) runaway electron beams are created in DIII-D by rapidly shutting down discharges with small (D = 2.7 mm) argon pellet injection. Analysis of visible line emission, interferometer data, and visible synchrotron emission indicate that this runaway phase plasma consists of two components: a cold ($T \approx 1.6$ eV), dense ($n_e \approx 5-15\times10^{13}$ cm^{-3}) background plasma co-existing with a very energetic ($T_e \approx 20$ MeV), tenuous ($n_R \approx 4-18\times10^{9}$ cm^{-3}) electron beam. The ion composition is estimated to be dominantly D^+ plus approximately 10%–20% Ar^+ and <1% C^+. The neutral content of the plasma is thought to be smaller than the ion content. From this plasma composition, it is possible to estimate the effect of collisional drag on the runaway electron beam. For applied toroidal electric fields ranging from 1.5 V/m in the accelerating direction to –1.5 V/m in the opposite direction, the runaway electron current is observed to decay significantly faster than expected from collisions. The 10/s excess in dissipation rate above collisional is presently believed to be due to losses of runaway electrons to the wall, although this has not been confirmed experimentally yet.

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