Distribution Runaway Electron Dissipation and Energy Distribution 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. The decay rate of the plasma current $I_p^{-1}dI_p/dt$ in this runaway electron "plateau" appears to dissipate at a rate significantly faster (about 10/s faster) than expected due to electron-electron collisional drag. At present, it is not understood if this apparent anomalous loss is due to drift-orbit losses to the outer wall, diffusion into the inner wall, excess collisional drag, or shrinking of the current profile. Reconstructions of the runaway electron beam radial profile are performed using soft x-ray and interferometer measurements; these indicate that the runaway electron beam current and kinetic energy is dominantly concentrated in a narrow $a \sim 0.2\,\mathrm{m}$ beam surrounded by a larger $a \sim 0.4\,\mathrm{m}$ diffuse halo. The diffuse halo seems to support the presence of a slow diffusion of runaway electrons to the wall, although a loss rate has not yet been obtained. A coarse reconstruction of the runaway electron energy distribution is obtained by combining measurements of soft x-ray (2–10 keV), medium x-ray (20–150 keV), and hard x-ray (1–50 MeV) brightnesses with visible synchrotron emission spectra. The energy distribution appears to be more shifted toward lower energies than expected from avalanche theory, possibly due to terms typically neglected in avalanche theory, such as pitch-angle scattering off high-Z impurity ions. These results may be encouraging for ITER in that the resulting total post-disruption runaway electron amplification rate may be lower than expected from avalanche theory.

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