Control And Dissipation Of Runaway Electron Beams Created During Rapid Shutdown Experiments In DIII-D

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Abstract. DIII-D experiments on rapid shutdown runaway electron (RE) beams have improved the understanding of the processes involved in RE beam control and dissipation. Improvements in RE beam feedback control have enabled stable confinement of RE beams out to the volt-second limit of the ohmic coil, as well as enabling a ramp down to zero current. Spectroscopic studies of the RE beam have shown that neutrals tend to be excluded from the RE beam center. Measurements of the RE energy distribution function indicate a broad distribution with mean energy of order several MeV and peak energies of order 30-40 MeV. The distribution function appears more skewed toward low energies than expected from avalanche theory. The RE pitch angle appears fairly directed ($\theta \sim 0.2$) at high energies and more isotropic at lower energies ($\varepsilon < 100$ keV). Collisional dissipation of RE beam current has been studied by massive gas injection of different impurities into RE beams; the equilibrium assimilation of these injected impurities appears to be reasonably well described by radial pressure balance between neutrals and ions. RE current dissipation following massive impurity injection is shown to be more rapid than expected from avalanche theory – this anomalous dissipation may be linked to enhanced radial diffusion caused by the significant quantity of high-Z impurities (typically argon) in the plasma. The final loss of RE beams to the wall has been studied: it was found that conversion of magnetic to kinetic energy is small for RE loss times smaller than the background plasma ohmic decay time of order 1–2 ms.