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Control of Post-disruption Runaway Electron Beams in the DIII-D Tokamak[1]

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Recent experiments on DIII-D have demonstrated real-time control of post-disruption runaway electron (RE) beams, presenting the possibility for slow, controlled dissipation of the beam energy. RE beams will present a greater challenge to ITER than present tokamaks due to ITER's high RE avalanche gain constant [Nucl.Fusion **37**, 1355-62 (1997)] and the difficulty repairing potential damage to its first wall. In the rare event that disruption control and mitigation schemes fail to suppress RE generation, active control of the RE beam may be an important line of defense to prevent rapid, localized deposition of RE beam energy on the first wall. Initially, sustaining a RE beam plateau requires avoiding radial collapse of the beam into the inner wall during the first 1-2 wall penetration times following the current quench (CQ). This collapse is caused by attractive induced currents in the wall and a lack of radial equilibrium with slow vertical field coils. The collapse is avoided by slewing the inner PF coils to push the RE beam off the wall while reducing the outer PF coil currents. Beam survival through this phase requires sufficient RE plateau current (I_{RE}) and power supply slew rates to re-establish equilibrium. Following that transient period, RE beam vertical position was dynamically controlled, and stabilization was maintained in an elongated ($\kappa \leq 1.8$) DND configuration for up 250 ms. Most controlled RE beams end in a rapid vertical displacement event (VDE), indicating that the profiles evolve even as the position is controlled. Experimental radial evolution and VDE onset are shown to be consistent with theoretical calculations of controllability boundaries. However, ohmic regulation of I_{RE} has been shown to delay VDEs to the pre-programmed ramp-down time, indicating that steady-state control may be achievable.

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