Control of post-disruption runaway electron beams in DIII-D

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Abstract

Recent experiments in the DIII-D tokamak have demonstrated real-time control and dissipation of post-disruption runaway electron (RE) beams. In the event that disruption avoidance, control, and mitigation schemes fail to avoid or suppress RE generation, active control of the RE beam may be an important line of defense to prevent the rapid, localized deposition of RE beam energy onto vulnerable vessel sections. During and immediately after the current quench, excessive radial compression of the runaway beams is avoided by a combination of techniques, improving the likelihood of the beams surviving this dynamic period without a fast termination. Once stabilized, the runaway beams are held in a steady state (out to the ohmic flux limit) with the application of active plasma current and position controls. Beam interaction with the vessel wall is minimized by avoiding distinct thresholds for enhanced wall interaction at small and large radii, corresponding to inner wall and outer limiter interaction, respectively. Staying within the "safe zone" between those radial thresholds allows for the sustainment of long-lived, quiescent runaway beams. The total beam energy and runaway electron population are then dissipated gradually by a controlled ramp-down of the runaway current.