DIII-D Research in Support of the ITER Disruption Mitigation System

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Pioneering studies on DIII-D directly support the development and operation of the ITER disruption mitigation system. Recent experiments examined the effects of SPI trajectory orientation and the superposition of multiple SPIs upon mitigation metrics. In experiments, the tangential SPI trajectory increases the current quench duration and halo current impulse compared to a core-directed SPI trajectory. The degraded SPI performance due to the change in injection trajectory implies ballistic transport, in addition to MHD mixing, is an important aspect of SPI mitigation. The superposition of dual toroidally separated SPI is also examined. It is found that when two differently sized pellets (10 torr-L and 400 torr-L) are injected into the plasma simultaneously, the radiation fraction measured near the injector ports is reduced, the current quench duration increases, and the plasma cooling duration decreases relative to injection of the single 400 torr-L pellet, indicating a degradation in the effectiveness of mitigation. Examination of the runaway electron (RE) energy distribution function evolution in the flattop of low-density, Ohmically driven discharges using MeV-scale bremsstrahlung emission provides direct comparison to theoretical models of RE evolution. The observed energy spectra display the predicted energy "bump" indicating the energy attractor predicted by theory, as well as the motion of the bump in energy space as the collisionality (density) is varied. Measured spectra also exhibit a strong dependence of the high-energy tail upon the synchrotron force (varied using B_t) in qualitative agreement with theory. A novel shell pellet technology has been installed on DIII-D to study the deposition of impurities in the core without significantly cooling the edge, and recent experimental results are discussed.

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