Disruption Mitigation Studies on DIII-D

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The DIII-D tokamak actively conducts research in many areas of disruption mitigation physics. The robust machine properties and unique combination of mitigation systems and diagnostics allow detailed study of techniques for control and mitigation of thermal quench (TQ) and current quench (CQ) loads, as well as the physics of runaway electron (RE) beams and their dissipation. This lecture will focus on two areas which have seen recent emphasis.

The shattered pellet injection (SPI) technique has been developed on DIII-D, and has now been selected as the primary injection scheme for the ITER disruption mitigation system (DMS). This method allows the rapid injection of a large number of small solid pellet fragments, which provides a number of significant advantages over the more widely studied massive gas injection (MGI) technique. Particle assimilation, impurity penetration, and the resulting heat load mitigation are observed to be more favorable for SPI, and the technique is expected to scale more favorably to large devices such as ITER. The development of SPI, results of direct comparisons with MGI, and the key features of TQ and CQ mitigation by SPI will be described.

DIII-D is also able to create and study REs, both during disruptions caused by high-Z 'killer' pellet injection, as well as during low-density plasma operation. The low-density quiescent-RE (QRE) regime allows detailed scans of the physics mechanisms governing RE evolution, while the post-disruption RE plateau has been used to study dissipation by impurity injection (through MGI or SPI) and the transport of the injected impurities in the runaway beam. The current understanding of RE physics and mitigation strategies will be presented.