Shattered pellet injection research on DIII-D in support of ITER Disruption Mitigation System development

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Recent advances in shattered pellet injection (SPI) in the DIII-D tokamak have led to improved understanding of several critical issues for the ITER Disruption Mitigation System. Infrared thermography shows elevated thermal quench heat loads indicative of radiation asymmetries peaked near the injection source. However these elevated heat loads, which are broadly centered around the injection port, indicate a peaking factor of <1.4 and remain below values predicted to cause melting in ITER [1]. Ballistic penetration of solid pellet fragments is thought to play a role in the initial mixing of injected particles, as shown by injecting along a shallow trajectory in which the shattered pellet misses the plasma core. This shallow SPI is observed to have reduced performance, comparable to that of equivalent massive gas injection, suggesting the importance of maximizing the initial penetration of particles, which would favor equatorial injection over upper port injection in ITER. The net particle assimilation from SPI is characterized across a wide range of plasma scenarios, and is found to depend predominantly on the plasma thermal energy, with Ohmic dissipation of the poloidal magnetic energy becoming important for sustaining the electron density later in the current quench (CQ). Increasing injection quantities by firing multiple pellets demonstrates the ability to further increase the density using simultaneous injections. CQ densities initially increase linearly with total injection quantity, indicating constant assimilation fraction, although saturation at higher quantities may occur. These assimilation data are in good agreement with energy balance models which account for ablation shielding of the pellet fragments and non-coronal radiation rates.

References

[1] M. Sugihara et al., Nucl. Fusion **47**, 337 (2007)

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