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# Status of R&D for ITER Disruption Loads, Disruption Mitigation and Runaway Electron Avoidance

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The energy stored during a burning plasma pulse in ITER will significantly exceed that in present devices. Rapid release of this energy during a disruption has the potential to cause surface melting of plasma-facing components (PFCs) and will cause high electromagnetic loads, in some cases close to the design limits. Heat load specifications for ITER, which enter, for example, in the design process for blanket modules and full-W divertor, are based on empirical data on footprint broadening, deposition time and confinement degradation prior to the thermal quench. Runaway electrons (RE) can cause localized high energy deposition and, under some circumstances, up to 300 MJ of magnetic energy could be converted to RE kinetic energy. Electromagnetic loads are quantified in terms of halo current and current quench time, for which a broad database exists. However, understanding the origin of current asymmetries, which can be particularly challenging for the mechanical structures, remains an open issue.
To ensure the required lifetime of PFCs, therefore, reliable disruption prediction will be required to allow action for disruption avoidance or, as a last resort, to trigger the disruption mitigation system (DMS). Three systems are under consideration for the ITER DMS: massive gas injection (MGI), shattered pellet injection (SPI) and Be injection as a back-up option. MGI experiments have shown that electromagnetic and thermal load mitigation is feasible. However, it remains to be confirmed for the latter that 90% radiation efficiency, as envisaged for ITER, can be reliably achieved. RE mitigation remains an open issue. Several options like densification, position control, and destabilization of MHD during RE formation have been tested in recent years and their applicability was shown to be –if at all –limited for ITER. However, more recent experiments indicate that lower densities than predicted by the present theory can already suppress RE formation. Another promising effect is pitch-angle scattering on high-Z impurities, resulting in RE energy dissipation by synchrotron radiation. Simulations including this effect are in qualitative agreement with experimental observations. Overall, achieving mitigation of all disruption loads in ITER is challenging and will need a careful choice of injection technique, injected species, amount of material and injection timing.

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