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Runaway Electron Generation with the ITER-like Wall and Efficiency of Massive Gas Injection at JET

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Disruptions are a major concern for next generation tokamaks, including ITER. These MHD instabilities lead to the loss of the plasma thermal energy and current on the millisecond timescale. Large electric fields created by the plasma current quench can accelerate several MA of runaway electrons (RE) up to 20 MeV. The influence of the full-metal JET ITER-Like Wall (JET-ILW) on RE is thus a key question for future all-metal PFC machines. Experiments at JET have shown that even though RE are very rare in spontaneous disruptions, they can still be generated during disruptions with fast current quenches induced by argon massive gas injections. The operational domain where runaways appear under those conditions is similar to what it was in carbon wall (JET-C). Hard X-ray spectra show energies up to 10 MeV. Although the boundary location is similar, the runaway generation might be larger in JET-ILW than JET-C inside the domain with higher currents in JET-ILW with like-to-like plasma parameters. Temperatures of up to 900°C have been observed on PFC following beam impact.

Disruptions can also generate excessive heat loads on plasma facing components (PFC) and electromagnetic forces in the machine structures due to halo and eddy currents. Massive Gas Injection (MGI) is presently one of the most promising techniques to mitigate both these effects by radiating away the plasma energy. However, the fraction of energy radiated by MGI at high plasma thermal content as well as the radiation peaking are key questions to ensure good extrapolability of the method to larger tokamaks. Recent experiments at JET-ILW have confirmed that the fraction of the total energy radiated decreases with increasing thermal energy content down to 70% for 10%/90% D2/Ar mixtures. Injections on plasmas with or without a locked mode already present also show different radiation peaking pattern. This suggests that toroidal asymmetries might be strong in case of injections in an already developing disruption.

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