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Axisymmetric studies of Avalanche generation and Termination mechanisms for Runaway Electrons in ITER

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Runaway electrons (RE) are generated post-disruption in ITER and results in formation of RE beam due to avalanche effect and are potentially more severe than electromagnetic loads [1,2,3]. The avalanche gain depends on the Ne injection and exponentially increases with higher Ne [4]. Earlier studies barely considered the effect of injection of various neon and hydrogen concentrations during the vertical motion of plasma on avalanche gain and RE beam termination [5]. In this report 2D axisymmetric study is performed to investigate the RE avalanche generation and termination in mitigated ITER major disruptions using a non-linear runaway model in JOREK. Various H and Ne concentrations are injected to estimate the avalanche gain during the runaway generation in ITER. It has been noticed that with lower Ne injection and higher H simultaneously, CQ time could go beyond 150 ms (above the previous CQ mitigation limit) without compromising EM load mitigation. Also, the poloidal halo current remains in range of 1.8 - 2.2 MA throughout the simulations. The potential avalanche gain can be reduced from 10^{20} to 10^{10} by minimizing Neon injection while still sustaining a significant radiated power fraction during the CQ. Multiple RE beam terminations are expected in high-current devices, driven by cycles of RE losses after crossing MHD stability limits, followed by re-avalanching in the subsequent ohmic plasma. To mimic the magnetic stochasticity and termination of RE beam in these 2D simulations, the perpendicular RE diffusion coefficient is surged when q_{95} reduces to 2. With initial RE current of 9.8 - 11.2 MA and post-termination RE current of 350 kA [6], a total of 6-8 terminations is observed for 5×10^{18} - 5×10^{19} m^{-3} Ne densities. Total RE kinetic energy deposited on wall has also been calculated and varies from 54 - 56 MJ for the chosen 2 injections of Ne mainly dissipating on FW panels 9 and 8 while terminating during a VDE.

References:

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