Runaway Electron Beam Control

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Post-disruption runaway electrons (RE) beam mitigation is one of the main concerns for ITER operations. RE beam control algorithms (Tore-Supra [1], DIII-D [2], FTU [3] and TCV [4]) for stabilization and current reduction can be combined with SPI/MGI and provide redundancy and backup in case of SPI/MGI failure. DINA simulations have shown that RE beam control could be effective for Current Quenches (CQ) below 4 MA in ITER. In the first part of the work the RE Control (REC) architecture to stabilize the RE beam position and ramp down its current is presented and experimental results on FTU and TCV are discussed. REC effectiveness is demonstrated by analyzing Hard X-ray (HXR) monitors and the Runaway Electrons Imaging and Spectroscopy (REIS) system. An estimation technique to retrieve the RE energy distribution function from REIS is proposed. RE beam instabilities and their correlation with toroidal electric field and density are discussed. Further, experimental results will be presented from FTU on deuterium pellet and heavy particle injection into steady-state flat-top discharges with runaway electrons and on RE beams. Analyzed data from the fast scanning CO₂-CO interferometer and spectroscopy diagnostics are also reported to help understanding the particle interaction with the RE beam to possibly extrapolate information for ITER predictions. Finally, the REC installation at JET to improve the RE beam stabilization will be introduced.

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References