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EX/P8-06: Overview of Runaway Electrons Control and Mitigation Experiments on Tore Supra and Lessons Learned in View of ITER

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Runaway electrons (RE) generated during disruption are identified as a major issue for ITER. Mitigation techniques are thus mandatory to suppress RE formation or/and reduce their heat loads. Two ways are explored on Tore Supra:
- Suppress the RE beam formation and avalanche amplification by multiple gas jet injections at current quench (CQ).
- Control the RE beam when it is formed and increase the collisionnality to slow down relativistic electrons.
A RE deconfinement at CQ before their exponential amplification might be achieved by ultra-fast supersonic gas injection. Thus a new concept of injector has been developed and tested on Tore Supra. A high pressure gas cartridge (150 bars), is open by rupture of a bursting disk. Neon or helium gas injections (240 Pam3) were triggered at CQ of disruptive plasma. The propagation of the neutral gas burst in the plasma is followed using a fast camera. The cold gas front travels through the plasma and penetrates at half of gas velocity in vacuum. Despite these observations, no robust perturbations on the current decay and on the loop voltage are recorded. The expected RE suppression has not been observed yet. Moreover, neither indication of an increase of MHD activity nor RE destabilization is observed.
RE beams (hundreds of kA) lasting several seconds are observed on Tore Supra. Such a plateau formation is eased with circular plasma in limiter configuration and develops only when the CFC first wall is depleted of deuterium. Mastering the RE plateau regime is a key to deploy mitigation techniques. Associated to a position control, a several hundred milliseconds RE current control was demonstrated on Tore Supra. Massive gas injection (MGI) was triggered on such a controlled RE plateau to increase the electron collisionnality. A subsequent reduction of high electron energy tail is observed, attributed to a beginning of thermalization. These results are very encouraging for mastering the RE beam regime towards a full thermalization.
The suppression of the avalanching process is the only way to guaranty that RE effects are mastered. Because a reliable suppression technique is not available yet and is still an issue for ITER, RE beam control experiments must be pursued. The aim of a collisionnal thermalization of RE seems feasible but is not achieved yet.

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