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ITR/P1-12: Modelling of ITER Plasma Shutdown with Runaway Mitigation Using TSC

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Fast shutdown of an ITER plasma discharge without generating large runaway current has been an area of active research over the past several years. In ITER, during the thermal quench preceding the current disruption, the toroidal electric field can resistively grow to values about 50 times the critical electric field for runaway current generation, which can give rise to avalanche generation of runaway electrons with energies up to 15MeV and currents of unprecedented magnitude of more than 10MA, causing potential damage to the ITER first wall. Such a scenario can be avoided by rapidly increasing the plasma electron density by about 50-60 times, close to Rosenbluth density values, by which the toroidal electric field remains lower than the critical electric field. In this case, the runaway electrons are slowed down through collisional processes, suppressing the runaway current. In this paper we have carried out simulations for ITER plasma shutdown using both impurity doped deuterium pellets using the TSC code. The pellet model of TSC is also extended to approximately model massive gas injection into ITER plasmas. Using pellet initial radius of 5mm and initial pellet velocity of 500m/s and repetition frequency of around 100 Hz launched from the outboard mid-plane, we have explored possibilities of safe plasma shutdown without large runaway current generation. The MGI is modeled in TSC by a train of 3-5 large pellets of pure neon with total number of atoms equal to that in a gas jet cartridge is injected with velocity of 500m/s. The major difference between a pellet and a gas jet in the low ablation rate of the pellets, especially at low target Te, is overcome by artificially increasing the ablation rate to such an extent that the entire pellet atoms are ablated by the time it crosses the q=2 surface. We are carrying out detailed parametric study of the ITER plasma shutdown in the wide parameter space of pellet impurity content, number of injected pellets, radius of the pellets etc. The relative merits and issues with the different options will be discussed.

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