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Formation and termination of runaway beams during vertical displacement events in ITER disruptions

Large amounts of runaway electrons can be generated during ITER disruptions which could lead to severe damage and limit the lifetime of the plasma facing components (PFCs). Indeed, the control and mitigation of the runaway electrons constitute one of the priorities of the disruption mitigation system (DMS) in ITER [1], the injection of high-Z impurities by Shattered Pellet Injection (SPI) actually constituting the most promising candidate. Evaluation of the runaway current formation during the disruption has been often carried out without including self-consistently the vertical motion of the plasma eventually hitting the wall. In this paper, a simple 0-D model which mimics the plasma surrounded by the conducting structures [1] and including self-consistently the vertical plasma motion and the generation of runaway electrons during the disruption is used for an assessment of the effect of vertical displacement events on the runaway current formation. The total plasma current and runaway current at the time the plasma hits the wall will be estimated and the effect of injecting impurities into the plasma will be evaluated. In the case of ITER, with a highly conducting wall, although the total plasma current when the plasma touches the wall is always the same, however the runaway current can significantly decrease for large enough amount of impurities. The plasma velocity is larger and the time to hit the wall shorter for lower runaway currents, when larger amounts of impurities are injected. When the plasma reaches the wall, the scraping-off of the runaway current occurs. During this phase, the plasma velocity and electric field can substantially increase leading to the deposition of a noticeable amount of energy on the runaway electrons [3]. It is found that an earlier second impurity injection reduces the amount of energy deposited on the runaways. Also larger temperatures during the scraping-off might be efficient in reducing the power fluxes onto the PFCs.

[1] M. Lehnen et al., Fusion Energy 2018 (Proc. 27th Int. Conf., Gandhinagar, 2018) (IAEA) CD-ROM file EX/P7-12
[2] D.I. Kiramov, B.N. Breizman, Phys. Plasmas 24, 100702 (2017)
[3] S. Konovalov et al., Fusion Energy 2016 (Proc. 26th Int. Conf., Kyoto, 2016) (IAEA) CD-ROM file TH/7-1

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