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P4.1034 Impact of massive material injection on runaway electron generation

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In current carrying fusion devices, the sudden loss of thermal energy, referred to as disruptions, poses a serious threat to the plasma vessel, as relativistic runaway electrons (REs) generated in the process may cause intense localised damage to plasma facing components. In future high-Ip devices such as ITER, the risk of replacing a large fraction of the pre-disruptive current by REs is significantly greater than in present-day devices due to exponentiation of a postdisruption seed. As countermeasure, massive material injection is foreseen in ITER. However in dedicated experiments in present-day devices such as ASDEX Upgrade (AUG), clear correlations between the amount injected material, the plasma response and the runaway behaviour are challenging to observe [1,2].
In this work, their interactions are studied by transport modelling of particles and heat in a realistic magnetic tokamak geometry with the 1.5D transport code ASTRA [3] coupled to the impurity radiation code STRAHL [4], a toolkit previously used for modelling the prethermal quench of AUG MGI experiments [5]. Impurity ionisation states are evolved individually by STRAHL following atomic data based rate equations, thus allowing the simulation of non-equilibrium phenomena. Considering additional impurity electrons and radiation, the background plasma is evolved by ASTRA. The generation of REs is described by fluid equations for small-angle momentum-space diffusion (Dreicer mechanism) [6] and for large-angle knock-on collisions (avalanche mechanism) [7], corrected by the impact of partially ionised impurities on the critical electric field required for runaway generation [8]. Comparison of this toolkit with the disruption code GO [9] shows accurate implementation of these equations in ASTRA. Within this framework, the impact of varying amounts Ninj, type and radial distribution of injected material on RE generation in AUG plasmas is investigated and compared to experimental observations.

References

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