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Analysis of Variability in Pre-Disruption Plasma Parameters and their Effect on Runaway Electron Generation using the JET data-base on RE

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Analysis of Variability in Pre-Disruption Plasma Parameters and their Effect on Runaway Electron Generation using the JET data-base on RE

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The generation of runaway electrons (RE) during major disruptions in International Thermonuclear Experimental Reactor (ITER) is unacceptable. Disruption Mitigation System (DMS) designed in ITER is based on massive injection of impurities, gaseous (MGI) or solid state pellets (SPI). Such injections should provide an intense radiation of the plasma stored energy in order to mitigate the damaging effect of the heat and mechanical loads and to provide reliable suppression of RE. Despite a significant progress in studies relevant to the ITER DMS design, the set of physical and technology problems remains unsolved. In particular, they concern to understanding of the mechanisms for mixing and assimilation of injected impurities during the rapid shutdown and to the physics of RE, their formation, interaction with surrounding plasma and injected gases (fuel and impurities, frozen and gaseous) and dissipation. Comprehensive analysis of the existing experimental database on RE in JET and other tokamaks, as well as planned new experiments should stimulate further advances in understanding of the physics of RE generated in major disruptions.
This report presents the results of the mapping of RE parameters depending on pre-disruption and post-disruption JET plasma parameters (electron temperature and density, internal plasma inductance, current quench (CQ) rates, etc.). Despite the plasma parameters are poorly known during and after disruptions, this approach enables establishing links between plasma parameters before thermal quench and during CQ, allowing the calculation of accelerating electric fields and RE parameters. Using known models for RE generation: primary mechanism ("Dreicer-Gurevich-Connor/Hastie…") and Putvinski/Rosenbluth the parameters of RE were calculated and compared to those measured in experiments for a wide range of disrupted JET currents (up to 6.25 MA). Note, that in certain cases the simulations yielded the data, which was in contrary to experimentally observed trends. Study of current quench (CQ) stages revealed different, accelerating and constraining effects of initial plasma configurations (circular (limiter) or X-point) on CQ rates, RE generation and value of current conversion ratio (Ipl/IRE). Analysis of MGI effect from different Disruption Mitigation Valves revealed different effects on disruption dynamics and RE generation.

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