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Simulations of Plasma Disruptions in ITER due to Material Ingress

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Plasma Major Disruptions (MDs), Vertical Displacement Events (VDEs) and associated runaway electron currents in ITER are a major cause of concern in ITER operations. Major R&Ds, both experimental and well as through theory and modeling is underway across the fusion community to understand these events and find suitable amelioration techniques. In the past we have presented detailed predictive simulations of MDs and VDEs in ITER using TSC and benchmarked the results with DINA simulations . Also detailed benchmarking TSC modeling with multi-machine experimental disruptive and VDE shots were carried out to understand and improve the halo current model used in the code to have better match with experiments, which were reported earlier.

However, in the earlier predictive simulations of MDs and VDEs for ITER that were carried out using TSC and DINA [3], the detailed particle and heat transport were neglected and the thermal crash was modelled by artificially specifying the plasma pressure drop in a given time scale (typically 1msec), specifying the pre-crash and post-crash final electron temperature by hand to suit a given plasma current quench time. Thus in the fast current quench cases, post thermal quench Te=6.5eV and in slow current quench cases Te=50eV were specified a priori. Also in these simulations, the generation of the runaway electrons and their effect on the disruption evolution and especially halo currents were generally ignored. In this paper, we present TSC simulations of plasma disruptions initiated by material ingress, mainly in the form of pieces of Beryllium chunk falling into the plasma from the top dome. A spherical piece of Be of radius 1cm is dropped from the top mocking that of a knocked of piece of the Be blanket top dome. The detailed impurity and thermal transport is calculated self consistently along with the evolution of thermal plasma current, halo current and runaway electron current. The impurity transport of the Be ingress and its ablation in the plasma is treated with the pellet injection model in TSC. As expected the piece of Be acts like a very slow pellet and ablates in the outer periphery of the plasma leading to edge cooling and gradual shrinking of the plasma current, finally leading to disruption. Details of this simulation with interplay between plasma current runaway and halo currents will be presented in this paper.

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Author: Dr BANDYOPADHYAY, Indranil (ITER-India, Institute for Plasma Research)

Co-author: Mr SINGH, Amit Kumar (ITER-India, Institute for Plasma Research)

Presenter: Dr BANDYOPADHYAY, Indranil (ITER-India, Institute for Plasma Research)

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