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Non-linear interaction of runaway electrons with resistive MHD modes in an ITER VDE

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Uncontrolled termination of post-disruption runaway electron (RE) current can cause deep localized melting of the first wall and this poses a serious challenge to the successful operation of fusion grade tokamaks, including ITER. Since the deconfinement of REs depends on the timescale of flux surface reformation and the plasma stability itself is affected by the runaway current, the interaction between REs and MHD is highly non-linear and has important consequences. This is the motivation of the present work, that complements the tracer particle approach for REs. The final goal is the self-consistent modeling of REs in a disrupted plasma through non-linear MHD simulations of disruption.

In this contribution, we present results that focus on the interaction of resistive MHD modes with runaway electron growth. This is modeled by extending the non-linear MHD code JOREK by including a fluid model for the evolution of runaway electron density. Runaway generation due to Dreicer as well as the avalanche sources are included (with an option for initializing an arbitrary RE seed profile), with advection contributions from parallel runaway velocity and an $E \times B$ drift. The first studies shown here are based on pseudo thermal quenches that are obtained by artifically increasing the perpendicular thermal conductivity $k_\perp$ of the plasma in equilibrium, which in turn triggers the generation of REs.

The JOREK model with REs is applied to analyse the interaction of the $(1,1)$ resistive internal kink with runaway electrons, given that the resistive kink is naturally destabilized due to the peakedness of the RE current profile that can lead to the central safety factor q_0 dropping below unity. A numerical study of this problem was carried out recently using the spectral MHD code EXTREM , where several simplifying assumptions were made, such as an independent thermal decay, decoupling RE current from perpendicular $E \times B$ dynamics and the neglect of parallel fluid velocity $V_{||}$. In our study, an attempt is made towards a more comprehensive treatment of the problem. The effect of the mode growth on the RE seed redistribution and the final RE profiles will be discussed in addition to the influence of REs on the mode excitation and dynamics.The effects of pre-disruption q_0 and the thermal quench rates will be studied.

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