Implementation of a model for the non-linear interaction between runaway electrons and background plasma

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Disruptions in tokamaks are caused by large scale instabilities, that eventually lead to the loss of plasma confinement. During a disruption, the plasma cools down significantly over a short timescale, leading to the generation of a large electric field along the toroidal direction. This leads to the free acceleration of electrons to relativistic speeds, giving rise to a significant runaway electron (RE) current. Understanding the dynamics of runways interacting with the disruption is essential to enable robust disruption mitigation strategies for reactor size tokamaks like ITER.

The goal of this work is the numerical simulation of the non-linear effects of runaway electron currents in the course of a disruption. This is done by extending the non-linear MHD code JOREK [1,2]. Runaway electrons are currently modelled in JOREK as a seed particle population, that evolves spatially in a passive manner [3]. However, in the present work, in order to include the effects of a back-reaction on the background plasma, a fluid model for runway electrons is implemented. The model describes the evolution of the runaway electrons as a fluid species interacting with the background plasma. It includes the generation of REs due to the Dreicer mechanism [4] and their subsequent growth through the secondary avalanche [5] process. A self-consistent primary generation mechanism is important, as the location of initial RE seed could determine the final profile of the current in an RE dominated plasma [6]. Preliminary results of the JOREK simulations will be presented along with first comparisons to one-dimensional runaway electron codes [7] for validation purposes.

References

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