JOREK simulations of runaway electron beam generation in DTT

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Unforeseen magnetohydrodynamic (MHD) instabilities or failures of the control systems can trigger plasma disruption, which have the potential to significantly reduce the lifetime of large fusion machines. While injecting impurities into the plasma can be an effective mitigation strategy, the quick radiation of most of the plasma thermal energy (thermal quench) increases the electrical resistance of the plasma, resulting in large toroidal electric fields that can accelerate electrons up to relativistic velocities. Such highly energetic electrons are called runaway electrons (REs) and they can carry a significant fraction of the pre-disruption plasma current, potentially damaging the plasma-facing components by applying thermal loads of several tens of MJ per square meter.

This study investigates RE formation during a mitigated disruption in the Divertor Tokamak Test (DTT), using the non-linear magnetohydrodynamic code JOREK, coupled with the vacuum-field code STARWALL. JOREK includes a RE fluid model coupled with MHD equations which treats REs as a distinct population within the plasma, self-consistently coupling RE population with the plasma. In order to lower the computational cost, we treat the thermal quench phase in a simplified way in 2D by increasing transport coefficients. This allows us to focus the analysis on the RE formation in the successive current quench phase. With this study, we aim to aid in the design of effective disruption mitigation strategies in DTT, contributing to enhancing its operational safety and reliability.