Contribution ID: **13** Type: **Poster**

Criterion for significant runaway electron generation in activated devices

A disrupting plasma in a high-performance device such as ITER and SPARC may generate large runaway electron (RE) currents that, upon impact with the tokamak wall, can cause serious damage to the device. To quickly identify regions of safe operation in parameter space, it is useful to develop reduced models and analytical criteria that predict when a significant fraction of the Ohmic current is converted into a current of runaway electrons. Such models have previously been developed for Dreicer [1,2] and hot-tail [3] seed currents. In DT experiments however, the contributions to the seed current from tritium decay and Compton scattering may also be significant or even dominant. In this work, we extend previous work and develop a semi-analytic criterion that includes seed currents from tritium decay and Compton scattering. In addition, the avalanche multiplication factor includes effects of partial screening of injected noble gasses [4]. The result is a semi-analytic model that can predict significant RE generation in the next generation of activated devices and is suitable for integrated modeling. The model is validated by fluid simulations using DREAM [5] and is shown to delineate regions in parameter space of significant runaway generation.
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Session Classification: Poster Session #1