Role of the avalanche source in wall heating during an unmitigated runaway electron final loss event in DIII-D

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The leading candidate for disruption and runaway electron (RE) mitigation in ITER and future devices is massive material injection (MMI). However, MMI often precipitates a current quench that generates a large inductive electric field. Large electric fields increase secondary RE generation from large-angle collisions of primary REs with the background plasma, known as the avalanche source. In addition to its role during the initial MMI used for disruption mitigation, the avalanche source takes effect following secondary MMI used to mitigate the RE beam. The present study improves recent modeling of RE mitigation in Ref. [1] by including an avalanche RE source [2] in the KORC code. We model DIII-D discharge 177031, where an unmitigated RE beam undergoes a rapid final loss event. Our simulations evolve a distribution of tracer RE guiding center orbits using a time series of axisymmetric experimental reconstructions of the electromagnetic fields, ignoring contributions from non-axisymmetric MHD modes. To calculate the plasma-facing-component (PFC) surface heating due to RE deposition, we have generalized the 1D analytic model from Ref. [3] to include energy-dependence of the deposition length scale into the PFCs. Due to the decreased drift orbit effects of secondary REs relative to primary REs, secondary REs are often promptly lost, remain at low energies, and deposit their energy near the PFC surface. We find that REs produced by the avalanche source are the primary contributor to transient high heat loads observed at PFC surfaces, and qualitative features of the simulated PFC surface heating agree with infrared imaging of the first wall tiles in DIII-D only when the avalanche source is included.

[1] Beidler et al., *Phys. Plasmas* **27**, 112507 (2020)
[2] Aleynikov et al., IAEA FEC Paper TH/P3-38 (2014)
[3] Martín-Solís et al., *Nucl. Fusion* **54**, 083027 (2014)

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