The impact of tokamak geometry on runaway electron formation in a disrupting plasma.

Tokamak disruption mitigation continues to be a broadly pursued effort, specifically in the context of runaway electron (RE) damage to plasma facing components (PFCs). The formation of a RE beam occurs through an avalanching process, where the current carried by near bulk electrons is converted to current carried by REs. The present work evaluates the efficiency of the avalanche mechanism in a disrupting plasma, with particular emphasis on the impact of tokamak geometry. It is found that the collisionality at the critical energy for an electron to run away ν^*_{crit} determines the impact of tokamak geometry on the efficiency of the avalanche mechanism, where for $\nu^*_{crit} \ll 1$ tokamak geometry significantly reduces the efficiency of RE formation due to particle trapping, whereas for $\nu^*_{crit} \gtrsim 1$ the impact of tokamak geometry is largely negligible. To evaluate which of these two regimes applies to a tokamak disruption, an idealized but self-consistent model of a disruption is employed. Here, a power balance between Ohmic heating and radiative losses is used to evaluate the electron temperature, where Ohm's law is employed to evaluate the resulting electric field. It is found that for plasmas with a substantial quantity of high-Z impurities such as Neon or Argon, ν^*_{crit} is robustly greater than one, implying trapping effects are negligible leading to a more efficient RE avalanche. In the opposite limit of a deuterium dominated plasma, ν^*_{crit} is found to be asymptotically small, indicating that trapping effects will significantly reduce the efficiency of the avalanche mechanism. These findings are subsequently verified by carrying out direct simulations of the avalanche growth rate using the relativistic drift kinetic RE code RAMc, where the value of ν^*_{crit} is shown to modify the avalanche growth rate by up to a factor of two in the outer half of the plasma, as well as the overall efficiency of RE avalanching.