Runaway electron mitigation in ITER disruptions by injection of high-Z impurities

The effect of the injection of high-Z impurities (Ar or Ne) on the runaway electrons (REs) during disruptions has been investigated:

• Injection before the thermal quench (TQ): to avoid the formation of the RE seeds. The amount of impurities is constrained by the condition that the resulting CQ times must be acceptable for tolerable mechanical loads. Lower RE currents are found for the shortest CQs (particularly for Ne) whereas RE beams up to ~10 MA can be found for the longest CQs. Mixed Ar or Ne +D injection might be efficient in controlling the RE formation for a sufficient amount (~14 kPa·m^3) of D_2

• Injection during the CQ: to avoid the avalanche multiplication of the RE seeds. Early CQ injection of Ne could be effective if the amount of Ne injected is large enough and consistent with the range of acceptable CQ times (close to ~6 kPa·m^3)

• Injection onto the plateau RE current: to yield the dissipation and decay of the RE current and energy. The RE distribution function shows a depletion at low energies mainly due to collisions and a steepening in the high energy region because of the radiation losses (bump formation). Extrapolations to ITER suggest that injection of a few kPa·m^3 of Ar could be efficient for RE dissipation. However, the fast VDE of the plasma when the impurities are injected can lead to the interaction of the REs with the wall structures, the scraping-off of the beam increasing the amount of impurities required for an efficient dissipation.