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Dynamics of Runaway Electron Generation and Loss in Tokamaks

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Of all electrons, runaway electrons (REs) have long been recognized as a distinctive population. It is important to understand the RE dynamics as they have the potential to seriously damage the tokamak. In this talk, we will present identification of several mechanism of RE generation and loss from EAST, TEXTOR and J-TEXT tokamaks, including the hot-tail mechanism of runaway production, runaway avalanche onset, RE transport in presence of magnetic fluctuations, and kinetic-instabilities driven by REs.

RE generation: During tokamak disruptions, RE plateau are easily obtained with higher electron temperature, supporting the hot-tail mechanism of runaway production has been identified [1]. Increasing the RE generation by increasing the temperature, an obvious RE plateau is observed even with low toroidal magnetic field (1.2 T). In the flattop of ohmic discharges, two different threshold electric fields, characterizing a lower field required for significant seed RE generation and sustainment via primary generation and a higher field required for the RE avalanche onset, have been observed [2]. The threshold electric field for the RE avalanche onset is 1.2-fold higher than the RE detection onset field required for the primary generation.

RE loss: RE suppression has been achieved when magnetic turbulence at the beginning of the current quench is larger than a certain threshold [3]. Below this threshold, the generated RE current is inversely proportional to the level of magnetic turbulence. The magnetic turbulence originates from the background plasma and the amplitude depends strongly on the toroidal magnetic field and plasma electron density. During the RE plateau phase, large MHD activities cause significant RE loss covering the entire energy range whilst kinetic instability enhances RE loss only in the relatively medium-energy region [4].

References
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