Off-axis runaway electron seed formation, growth and suppression in MST tokamak plasmas

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New observations of the seed formation and dynamics of the birth conditions of runaway electrons (REs) in quiescent density ramp-down experiments have recently been carried out at the Madison Symmetry Torus (MST). The formation of an off-axis RE seed with linear growth rates has been resolved for low energies, a hollow streaming parameter and large electric fields in agreement with theory and simulations; the emergence of the seed population in the plasma periphery instead of that in at the magnetic axis is consistent with a lower electron-density and Dreicer fields. Secondary exponential growth rates have also been spatially resolved for the first time and are consistent with a convective transport of the order of the Ware pinch and energies up to $1000\times T_{e,0}$. The use of a newly developed versatile multi-energy soft x-ray (SXR) pinhole camera provides unprecedented improvement in throughput and signal-to-noise-ratio thus enabling early-detection, imaging and low-energy discrimination; the latter is of great advantage over conventional REs studies conducted in large tokamaks with electron temperatures of few keV and electron energies up to 1-60 MeV. Seed calculations using a newly developed Backward Monte Carlo code computing the RE generation in space and time dependent dynamic scenarios including radial transport will also be presented. Numerical simulations are shown to reproduce the experimental observations including the off-axis runaway electron generation, radial transport and exponential growth at the core, as well as suppression due to *m=3* resonant magnetic perturbations even in regions with large electric fields.

References.

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