Contribution ID: **768** Type: **Poster**

4P07 - Monte-Carlo modelling of parallel electron transport in the Proto-MPEX linear plasma device

Thursday 27 June 2019 16:00 (1h 30m)

The Prototype Material Plasma Exposure eXperiment (Proto-MPEX) is a linear plasma device located at Oak Ridge National Laboratory which serves as a test-stand to develop the plasma source concept for the Materials Plasma Exposure eXperiment (MPEX). Recent experiments have demonstrated the heating of electrons via Electron Bernstein Waves (EBW) in this linear configuration using 28 GHz microwaves. Moreover, experimental observations suggest that the magnetic ripple adversely affects the parallel transport of the heated electrons toward the target where material samples are to be exposed to the plasma. To understand the transport process during microwave application, a test-particle Monte-Carlo (MC) code has been developed that incorporates the effects of Coulomb collisions, magnetic mirror kinetic trapping and electron cyclotron interaction via a quasilinear RF operator.
In this work, we describe the MC code and its application to Proto-MPEX. We observe that test electrons relax to a Maxwell-Boltzmann distribution when interacting with the low-temperature (4 eV) high-density (4e19 m^{-3}) helicon-generated background plasma. Upon injection of microwaves, electron cyclotron interactions produce high energy electrons. Depending on the conditions, such as the shape of the magnetic ripple and the location of the cyclotron resonance, anisotropic distributions characteristic of kinetic trapping are observed. We find that injecting microwaves in magnetic wells with significant asymmetry assists in releasing kinetically-trapped heated electrons. This reduces the adverse effects of magnetic ripple on parallel electron transport. Moreover, we observe that the location of the cyclotron resonance affects whether a particle experiences multiple RF "kicks"and becomes trapped or it experiences a single RF "kick"and exits the magnetic well towards the target section. Results are compared with experimental measurements. Finally, the implications of the results are discussed in the context of the upcoming MPEX device.

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Session Classification: Poster - Charged Particle Beams and Accelerators and High Energy Density Plasmas and Applications

Track Classification: 3.1 Plasma, Ion and Electron Sources