

Title: Electron plasma diagnostics in ELTRAP by electron cyclotron resonance heating method

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Abstract: Electron cyclotron resonance heating method of Particle-in-Cell code was used to analyze heating phenomena, axial kinetic energy, and self-consistent electric field of confined electron plasma in ELTRAP device by hydrogen and helium background gases. The electromagnetic simulations were performed at a constant power of 3.8 V for different RF drives (0.5 GHz– 8 GHz), as well as for 1 GHz constant frequency at these varying amplitudes (1 V—3.8 V). The impacts of axial and radial temperatures were found maximum at 1.8 V and 5 GHz as compared to other amplitudes and frequencies for both background gases. These effects are higher at varying radio frequencies due to more ionization and secondary electrons production and maximum recorded radial temperature for hydrogen background gas was 170.41 eV. The axial kinetic energy impacts were found more effective in the outer radial part (between 0.03 and 0.04 meters) of the ELTRAP device due to applied VRF through C₈ electrode. The self-consistent electric field was found higher for helium background gas at 5 GHz RF than other amplitudes and radio frequencies. The excitation and ionization rates were found to be higher along the radial direction (r-axis) than the axial direction (z-axis) in helium background gas as compared to hydrogen background gas. The current studies are advantageous for nuclear physics applications, beam physics, microelectronics, coherent radiation devices and also in magnetrons.

Keywords: Electron cyclotron resonance heating; Particle-in-Cell simulation; Confined electron plasma; ELTRAP device; Radiofrequency heating; Axial kinetic energy; Radial temperature; Self-consistent electric field; Hydrogen and helium background gases; Plasma ionization dynamics

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