

WedM07

Electron Density and Temperature measurements in Electron Cyclotron Resonance Ion Source plasma by means of X-ray spectroscopy and X-ray imaging

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An experimental campaign aiming to investigate ECR plasma X-ray emission has been recently carried out at the ECRIS laboratory of ATOMKI based on a collaboration between the Debrecen and Catania ECR teams. In a first series, the X-ray spectroscopy was performed through SDD and HpGe detectors, characterizing the volumetric plasma emission. The on-purpose developed collimation system was suitable for direct plasma density evaluation, performed “on-line” during beam extraction and CSD characterization. A campaign for correlating the plasma density and temperature with the output charge states and the beam intensity for different pumping wave frequencies, different magnetic field profiles and single-gas/gas-mixing configurations was carried out. The ion source in most cases was tuned to maximize the Ar⁴⁺ production. The microwave frequency was swept in the 12.8-13.5 GHz range with steps of 40 MHz and the forwarded power was 30 W at each step. The results reveal a surprisingly very good agreement between warm-electrons density fluctuations, output beam currents and the calculated electromagnetic modal density of the plasma chamber. In a second series, a new setup based on a CCD camera coupled to a small pin-hole allowing X-ray imaging was installed and numerous X-ray photos were taken in order to study the peculiarities of the ECRIS plasma structure (overall shape, density distribution, response to tuning parameters like frequency and magnetic field). Preliminary results of the 2D X-ray-imaging will be presented.