**Space Resolved Electron Density and Temperature Evaluation by X-Ray Pinhole Camera in ECR Plasma**

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X-ray space-resolved emission characterization can provide relevant features of plasmas in terms of local distribution of electron density and temperature.

In the PANDORA project [1] framework and in the context of the collaboration between ATOMKI and INFN-LNS laboratories, a high resolution full-field X-ray pin-hole setup was developed. It consists of a 400 μm hole in a lead disk coupled with a 1 MP X-ray CCD camera (sensitive in~ 1 – 20 keV energy range) and a multi-layered Pb collimator. Advanced analysis techniques for single-photon-counted (SPhC) and high-dynamical-range (HDR) analysis [2] were developed, allowing X-ray imaging and space-resolved spectroscopy at high energy and spatial resolution (560 μm and 230 eV @ 8.1 keV respectively).

We here present the first quantitative evaluation of local warm electron density and temperature of an Electron Cyclotron Resonance (ECR) Argon plasma heated by 200 W microwave power in the 14 GHz ECR ion source (ATOMKI, Debrecen).

Thermodynamic parameters have been extracted by the analysis of the local fluorescence and bremsstrahlung spectra, according to the theoretical emissivity model [3,4] in the approximation of local Maxwell-Boltzmann distribution of electron energies (LTE – local thermodynamic equilibrium).

The technique is then supported by the comparison with a properly developed theoretical model [4], which gives a further constraint on fitted parameters by considering the fluorescence emission from plasma ions.

Several regions of interest (ROIs) of the image were selected, studying the non-homogeneity of plasma parameters inside the ECR plasma volume, comparing temperature and density maps in the plasma core ROI vs the peripheral regions.

The analysis method is a powerful tool to investigate the confinement of magnetic plasmas and heating dynamics, with relevant implications about R&D of ECR Ion Sources as well as for fundamental plasma physics and nuclear physics research in these setups.

***References***

[1] D. Mascali et al. Universe, 8(2), 80 (2022)

[2] E. Naselli et al JINST 17 C01009 (2022)

[3] A. Gumberidze et al. Rev. Sci. Instrum. 81, 033303 (2010)

[4] B. Mishra et al. Physics of Plasmas 28, 102509 (2021)