Contribution ID: **26** Type: **not specified**

AI Tools for Plasma Diagnostics by X-ray Imaging and Spectroscopy in the PANDORA Project Frame

Wednesday, 18 June 2025 13:00 (20 minutes)

PANDORA (Plasmas for Astrophysics, Nuclear decay Observation and Radiation for Archaeometry) is a multidisciplinary project aimed at investigating β decays in stellar-like ECR plasmas, representing a breakthrough for fundamental studies on weak interactions in astrophysical contexts. The facility will rely on an extended diagnostic system. Among which, the X-rays diagnostic and spectroscopy will be one of the most relevant to measure and to monitor the emission of magnetically confined plasmas, their thermodynamic parameters, the confinement dynamics and its overall structure. The same techniques apply for plasma-based ion sources, such as ECR devices.

The diagnostics setup consists in an X-ray pin-hole camera, sensitive in the soft X-ray energy domain (0.5-30 keV). An innovative algorithm for X-ray imaging in Single-Photon Counting (SPhC) mode was developed by a sophisticated suite of post-processing routines which enabled this technique to reach 500 μm and 240 eV of spatial and energy resolution respectively, in HDR mode. Preliminary results will be hereby shown about the AI-based machine learning algorithm development and optimization.

Data have been acquired from several datasets, under different plasma conditions in two magnetic traps: the B-minimum ion source at ATOMKI Laboratories (Debrecen) and the simple mirror Flexible Plasma Trap (FPT) at INFN-LNS. The detected photons were labelled in terms of geometrical and intensity-related features. Through the AI tool encoded in MATLab, clusters of data exhibiting similar features were identified, highlighting parameters that allow the characterization of single-photon events. Then a feed forward neural network is used to discriminate and exclude spurious pile-up events, via a labelling procedure of the dataset. This approach aims to retrieve, in a much shorter time, plasma emission spectra with higher energy and spatial resolutions, maximize the signal-to-noise ratio, and provide unprecedented rapidity and accuracy in characterizing soft X-ray fluorescence and bremsstrahlung emissions from such plasmas.

The AI tools, including the ongoing stage of neural-network implementation, and the first results, obtained through systematic measurements, will be presented in this contribution.

Primary author: PERI, Bianca (Istituto Nazionale di Fisica Nucleare)

Co-authors: Dr PIDATELLA, Angelo (Istituto Nazionale di Fisica Nucleare); Dr MISHRA, Bharat (Istituto Nazionale di Fisica Nucleare); Dr MASCALI, David (Istituto Nazionale di Fisica Nucleare); Dr SANTONOCITO, Domenico (Istituto Nazionale di Fisica Nucleare); Dr NASELLI, Eugenia (Istituto Nazionale di Fisica Nucleare); Mr FINOCCHIARO, Giorgio (Istituto Nazionale di Fisica Nucleare)

Presenter: PERI, Bianca (Istituto Nazionale di Fisica Nucleare)

Session Classification: X-ray Applications