Fast X-ray imaging of the NSTX plasma with a Micro Pattern Gas Detector based on GEM amplifier

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An innovative fast system for X-ray imaging has been developed at ENEA Frascati (Italy) and successfully tested on the National Spherical Tokamak Experiment (NSTX) at Princeton Plasma Physics Laboratory (PPPL), in collaboration with the Johns Hopkins University (JHU). It is a pinhole camera, whose detector is a Micro Pattern Gas Detector (MPGD) having a Gas Electron Multiplier (GEM) as amplifying stage. This detector (2.5 cm * 2.5 cm active area), operating in single photon counting mode, is equipped with a true 2-D read-out printed circuit board with 128 pixels, each one connected to an independent electronic channel for pulse conversion, shaping and fast acquisition. This device is able to get X-ray images of the plasma at very high framing rate (up to 100 khz) in a selectable X-ray energy range, with different magnifications or views of the plasma.

Time resolved, two-dimensional X-ray images, in the range 2.5 – 8 keV, of the NSTX plasma core will be shown, with different plasma magnifications and with different orientations of the optical axis of the pinhole camera, along a tangential view. Differences in the shaping of the X-ray emissivity of the plasma in the cross section appear, depending on the regime of the plasma: ohmic, L-mode with NBI (1.5 MW) and H-mode with NBI (5 MW). With a sampling rate of 10 khz it has been possible to get the images of a plasma motion appearing as rotation on the poloidal plane. Fast acquisitions, performed up to 100 khz of framing rates, allowing the study of the plasma evolution and the 2-D shaping during MHD activity, will be presented. This system, thanks to its 2-D imaging capability, and the energy discrimination, allowing a fine tune-up of the plasma region of interest, is particular adapt to be used for spherical tokamaks and for real time measurements.