Contribution ID: **68** Type: **Short oral in replacement of poster**

Short_Oral_68: Characterisation of an aluminium triple-GEM detector coupled with GEMINI chip for soft X-rays detection in Tokamaks

Tuesday, 7 September 2021 18:00 (10 minutes)

Among other effects of interest for the optimisation of fusion plasma machines, plasma-wall interaction is one of the most investigated. Through plasma-wall interaction, the first wall material may be eroded and impurities enter into the plasma, where they can produce soft X-rays (SXR) from 5 to 20 keV. To study the rate and energy of such SXR emission it is necessary to develop adequate SRX diagnostic devices. One of the best choices is represented by gas detector based on Gas Electron Multiplier (GEM) technology. GEM detectors are very promising thanks to their possibility to cover large areas, good detection efficiency, good spatial resolution (in the order of 5 mm), and capability to sustain high counting rates (>MHz/mm^2). The latter feature, in particular, is possible thanks to the use of a custom electronic readout called GEMINI, an ASIC in 180 nm CMOS. This paper shows the characterisation of a triple GEM detector equipped with GEMINI readout and optimised for SXR detection with Aluminium GEM foils, instead of the standard copper GEM foils. Copper in fact has a prominent 8.04 keV K-alpha line which is in the same energy region of the interesting SXR emission, thus forbidding its use as part of an optimised diagnostic for this application; Aluminium, on the other hand, only emits X-rays at 1.5 keV.
GEMINI ASIC is made of a charge preamplifier (providing an analog signal proportional to the charge deposited into the detector) and a discriminator providing a digital Time-over-Threshold (ToT) signal. Operating in ToT, this digital electronics can sustain rates in the order of MHz per channel. In this paper, a careful study and comparison of digital ToT and analog signals is performed with pulses obtained in realistic conditions (with different X-rays sources). Spectral distribution of the sources (in particular, of Molybdenum and Titanium) have been obtained from both kind of signals; because no significant differences have been found, the two implemented procedures are demonstrated to be equivalent.
In conclusion, we demonstrate that the GEMINI-based electronic readout chosen for GEM detectors is adequate to sustain the high SXR rate from the plasma.

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