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X-rays spectrum characterization during high voltage conditioning in .vacuum insulated system using high rate detectors

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The characterization of the X-ray energy spectrum during the high voltage conditioning of a multi electrode vacuum insulated system (such as the MITICA electrostatic accelerator) could be useful to understand which stage is causing the micro discharge onset. This technique seems particularly promising for measuring small dark currents (I< 10μA), which are generally difficult to be measured with standard techniques. The X-rays produced during HV experiments are mainly due to bremsstrahlung interaction between the electrons escaping from the HV electrodes (field emission effect) and the background gas or the chamber walls. The X-rays spectrum extends from low energy (˜ keV) up to several hundreds of keV depending on the maximum potential difference applied to the electrodes. During these events high photon flux (about 1 MHz) has been measured in the last years using standard NaI detectors that are not able to cope with high rates. In order to measure this wide spectrum at high rate in single photon counting mode, a diagnostic system that combines a Gas Electron Multiplier (GEM) detector (active area 10x10cm2) and a LaBr3 scintillator (3”x3”active volume) coupled to standard photomultiplier (PMT) is under development. Both are able to stand very high rate (>MHz) in single photon counting mode and results to be complementary with respect to the X-rays energy: GEM is optimized to cover the energy range from 2 up to 50 keV, while LaBr3 extends from 50 keV up to 500 keV. The GEM detector is equipped with anodic pads (256 pads 6x6 mm2), readout with a new data acquisition system called GEMINI, which gives the possibility to obtain information about the energy deposited in the detector by the incoming radiation using the so called Time-Over-Threshold technique on each detector channel, allowing also a spatial reconstruction of the X-rays footprint. This measurement can be performed at several MHz counting rate, due to the very high rate capability of GEM detector (MHz/mm2). The LaBr3+PMT detector has a single readout channel that is routed to a 500 Msample/s ADC. This configuration allows getting a few percent energy resolution at 500 keV at MHz counting rate. This paper describes the system construction and shows preliminary measurements using laboratory source.

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