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GEM based fast neutron detector for fusion and spallation sources experiments

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The fast neutron GEM detectors (nGEM), i.e. GEM detectors equipped with a cathode that also serves as neutron-proton converter foil, represent a new frontier of beam monitor devices in the new fast neutron beam lines in the spallation sources experiments, such as ChipIR at ISIS, or in the future fusion experiments such as the ITER neutral beam injector. The GEM detectors are particularly suited to these applications due to their good spatial resolution and timing proprieties, excellent rate capability, radiation hardness and possibility to cover large areas. A series of nGEM detectors is foreseen in the framework of the ITER neutral beam test facility under construction in Padova (PRIMA) that will host two experimental devices: SPIDER, a 100 kV negative H/D RF source, and MITICA, a full scale, 1MeV deuterium beam injector.
One nGEM detector will be mounted in a detection system called Close-contact Neutron Emission Surface Mapping (CNESM) with the aim to resolve one of the eight beamlet groups in SPIDER. This is achieved by the evaluation of the map of the neutron emission due to interaction of the deuterium beam with the deuterons implanted in the beam dump surface. Due to the physics of the process (deuterium implantation on the beam dump and fusion neutron transport up to the CNESM system) the minimum required space resolution in order to resolve the single beamlet is equal to 15(x) x 25(y) mm2. The nGEM detector of the CNESM system has an active area of 35.2 x 20 cm2 and the readout anode is composed by 256 PAD, each with dimensions equal to 13(x) x 22(y) mm2. This PAD dimension allows measuring the intensity of each single beamlet. Future improvement of the spatial resolution, that can allow a better beamlets reconstruction precision in SPIDER or a better reconstruction of the beam profile in the fast neutron beam lines, could be obtained by fine moving the detector in small steps in each direction. This paper describes the test of a fine scanning technique implemented during a measurements campaign held at the ROTAX fast neutron beam-line at the ISIS spallation source. The nominal FWHM of the ROTAX beam is about 40 (x) x 35 (y) mm. The aim of the measurement was the precise reconstruction of the beam profile by scanning it in steps of 2 mm in each direction: a total of 750 x-y positions were recorded. This allows improving the resolution of about 60% in the x direction and of about 80% in the y direction. The fine results obtained with the nGEM detector are than compared with those obtained with a series of diamond detectors mounted on the same beam-line. This work was set up in collaboration and financial support of Fusion for Energy.

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