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The BAND-GEM detector: An improved efficiency GEM-based solution for thermal neutrons detection at spallation sources

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New high count rate and large area detectors are needed for future spallation neutron sources. Indeed, the 3He-shortage limits the use of 3He tubes in present and future applications where large areas (several m2) and high efficiency (>50%) detectors are envisaged. In this framework, GEM (Gas Electron Multiplier) is one of the explored detector technologies. GEMs feature good spatial resolution (< 0.5 cm) and timing properties. Moreover they have an excellent rate capability (MHz/mm2) and can cover large areas (about 1 m2) at low cost. The GEM technique is well established for charged particle measurements in high energy physics applications at CERN and elsewhere. The new development concerns the neutron conversion to charged particles. In the BAND-GEM (Boron Array Neutron Detector) approach a 3D geometry for the neutron converter was developed that is expected to provide an average efficiency >50% in the wavelength of interest for SANS (Small Angle Neutron Scattering) measurements at spallation sources, while meeting the spatial resolution requirements for these specific instruments. A system of thin lamellas (250 µm) of dielectric material coated with 1 µm layer of boron carbide (on both sides) has been built and positioned in the first detector gap, orthogonal to the cathode. By properly tilting the lamellas system with respect to the beam, there is a significant increase of effective thickness of the borated material crossed by the neutrons. As a consequence, the interaction probability, as well as the detection efficiency, is increased while keeping the beam perturbation small due to the reduced volume of non-active material. A first experiment with this new detector, performed at the JEEP 2 reactor (Norway), measured a detector efficiency of about 20% for 7° tilting to the incoming 1.54 Å neutron beam . The results of this experiment in terms of efficiency (as a function of tilting angle), gamma-ray insensitivity, stability and uniformity will be presented. Based on these results, which are in agreement with the simulations, a new detector with improved parameters is being designed at the moment and will be tested in the near future.

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