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Development of the BAND-GEM detector solution for the SANS experiments

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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 features good spatial resolution (< 0.5 cm) and timing properties. Moreover they have an excellent rate capability (MHz/mm2) and can cover large areas (⊠ 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 >40% in the wavelength of interest for SANS (Small Angle Neutron Scattering) measurements at spallation sources, while meeting the spatial resolution requirements for SANS. A system Aluminium grids with thin walls (200 µm) coated with 0.6 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 grid 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 (with an active area of 5x10 cm2), performed at EMMA-ISIS neutron beamline measured a detector efficiency of about 40% for tilting angles > 3° for neutron wavelength of 4 Å. Based on these results, which are in agreement with the simulations, a full-module (trapezoidal shape with an area of 860 cm2) for a SANS experiment is being realized at the moment and will be tested in the near future.

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