Position sensitive GEM-based thermal neutron detector prototype with $^{10}B_4C$ converter

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In the last decade, several efforts have been made by the scientific community to find alternatives to ^{3}He, the most effective gas used for thermal neutron detection, which is virtually extinct [1]. Common alternatives make use of isotopes such ^{157}Gd, ^{10}B, and ^{6}Li, due to their high neutron capture cross-section [2].

We present in this work our detector prototype: a 10 cm × 10 cm double GEM stack with an aluminum cathode, coated with a 2.2 µm thick $^{10}B_4C$ layer deposited by the European Spallation Source (ESS). The detector operates under $ArCO_2$ (90/10) open flow at atmospheric pressure. The neutrons are detected through the gas ionization charges created by the outcomes of the ^{10}B(n,α)^{7}Li capture reaction. These charges are collected in a 256×256 strip readout plane produced by CERN, connected to resistive chains we designed for this project and produced in the local industry. We tested the prototype in the IPEN IEA-R1 nuclear reactor with a 1.4 Å monochromatic neutron beam.

We will report experimental measurements showing that the prototype presented high stability, position sensitivity with spatial resolution better than 3 mm (obtained by 2 methods), detection efficiency of 2.66(30) %, and good agreement with simulated results regarding the energy spectrum of the neutron capture products. We will finally discuss further methods to be adopted for enhancing detection efficiency.

References

[1] R. T. Kouzes, J. H. Ely, L. E. Erikson, W. J. Kernan, A. T. Lintereur, E. R. Siciliano, D. L. Stephens, D. C. Stromswold, R. M. V. Ginhoven, and M. L. Woodring, "Neutron detection alternatives to ^{3}He for national security applications," *Nucl. Instr. Meth. A*, vol. 623, no. 3, pp. 1035 – 1045, 2010.

[2] A. Pietropaolo, M. Angelone, R. Bedogni, N. Colonna, A. Hurd, A. Khaplanov, F. Murtas, M. Pillon, F. Piscitelli, E. Schooneveld, and K. Zeitelhack, "Neutron detection techniques from µeV to GeV," *Physics Reports*, vol. 875, pp. 1–65, 2020.