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Large high-efficiency thermal neutron detectors based on the Micromegas technology

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Due to the so-called 3He shortage crisis, many detection techniques used nowadays for thermal neutrons are based on alternative converters. Possible ways to increase the detection efficiency for thermal neutrons, using solid neutron-to-charge converters, 10B or 10B4C, implemented the micromegas technology are examined. The micro-pattern gaseous detector Micromegas has been developed for several years in Saclay and is used in a wide variety of neutron experiments combining high accuracy, high rate capability, excellent timing properties and robustness. We propose here a large high-efficiency Micromegas-based neutron detector with several 10B4C thin layers mounted inside the gas volume for thermal neutron detection. The principle and the fabrication of a single detector unit prototype with overall dimension of ˜ 15 x 15 cm2 and a flexibility of modifying the number of layers of 10B4C neutron converters are described and simulated results are reported, demonstrating that typically five 10B4C layers of 1-2 μm thickness can lead to a detection efficiency of 20-40% for thermal neutrons and a spatial resolution of sub-mm. The design is well adapted to large sizes making possible the construction of a mosaic of several such detector units with a large area coverage and a high detection efficiency, showing the good potential of this novel technique [1]. An alternative way is to use this multiplayered micromegas equipped with GEM-type meshes coated with 10B4C both sides and resulting on a robust and large surface detector. Another additional innovative and very promising concept for a cost-effective, high-efficiency, large scale neutron detector is to use a stack of microbulk micromegas coated with 10B4C. Simulations show that by placing four back to back microbulk micromegas detector units, efficiencies of˜ 40% at 1.8 Å can be recorded. A prototype was designed and built and the tests so far look very encouraging.

[1] G. Tsiledakis et al, JINST, 12 P09006 (2017)

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