Contribution ID: **156** Type: **Poster presentation only**

A recoil-proton track imaging detector for fast neutrons

Neutron detectors are an essential tool for the development of many research fields, as nuclear, particle and astroparticle physics as well as radiotherapy and radiation protection. Since neutrons cannot directly ionize, their detection is only possible via nuclear reactions with nuclei constituting the matter. In particular, the study of fast neutrons is often based on the neutron-proton elastic scattering reaction. In this two-body reaction, the ionization caused by recoil protons in a hydrogenous material constitutes the basic information for the design and development of neutron detectors. So far, proposed recoil-proton imaging systems detectors using n-p elastic scattering show clear limits in terms of detection efficiency, complexity, cost, and final implementation [1,2]. To address this deficiency, we propose a novel recol-proton track imaging detector (RIPTIDE) in which the light output of a fast scintillation signal is used to perform a complete reconstruction in space and time of the event. It is worth mentioning that the challenging aspects of the proposed technique related to the dE/dx track analysis, could enable the reconstruction of the neutron momentum as well as straightforward background rejection capability.
In this contribution, Geant4 Monte Carlo simulations of the RIPTIDE demonstrator will be presented. In particular, the demonstrator consists of a cubic active volume of BC-408/EJ-200 plastic scintillator, which has been widely characterized in the literature [3] in terms of detection efficiency and interactions with neutrons (see for instance Fig. 1, where the measured and simulated neutron attenuation lengths are reported as function of neutron energy).
In addition, several options for imaging devices and electronic readout of the signal will be discussed.

[1] J. Hu, J. Liu, Z. Zhang, et al., Sci. Rep. 8, 13363 (2018)
[2] S.M. Valle, et al., Nucl. Instrum. & Methods A 845, 556 (2017)
[3] W.F. Rogers, et al., Nucl. Instrum. & Methods A 943, 162436 (2019)

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Session Classification: Poster session 1

Track Classification: Applications