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Simulating a Scintillator Array for the GRIFFIN Decay Station

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The study of neutron rich nuclei far from the valley of stability has become an increasingly important field of research within nuclear physics. One of the decay mechanisms that opens when the decay Q value becomes sufficiently large is β-delayed neutron emission. This decay mode is important when studying the astrophysical r-process as it can have a direct effect on theoretical solar abundance calculations [1]. The utilization of large-scale neutron detector arrays in future experiments is therefore imperative in order to study these β-delayed neutron emitters and gain more insight into these astrophysical processes.
At the TRIUMF ISAC facility, β-delayed neutron spectroscopy experiments are being performed. This is done using the GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigation of Nuclei) spectrometer [2] coupled to DESCANT (DEuterated SCintillator Array for Neutron Tagging) [3]. Since DESCANT was originally intended to be a neutron-tagging array for fusion evaporation reactions, a precise measurement of the neutron energy was not considered a priority over the neutron detection efficiency. Therefore, the use of thin plastic scintillators is being investigated to improve the current obtainable precision on the neutron energy, allowing a more in-depth analysis of β-delayed neutron emitters at the GRIFFIN decay station. Plastic scintillators are ideal for this enhancement due to their timing properties, customizability, and overall cost effectiveness. The energy of the neutrons can then be determined via the time-of-flight technique. To investigate the viability of this augmentation, GEANT4 is being used to simulate and optimize the experimental design, the progress of which will be discussed.
[1] Mumpower, M. et al., Prog Part Nucl Phys 86 (2016), 86-126.
[2] Garnsworthy, A. B., Svensson, C. E., et al., Nucl Instrum Meth A, 918 (2019) 9-29.
[3] Garrett, P.E., Hyperfine Interact, 225 (2014) 137-141.

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