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Beta spectrum shape measurements using a multi-wire drift chamber

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Beyond Standard Model (BSM) theories are typically probed in two types of experiments. In collider experiments, such as those carried out at LHC, exotic bosons are directly produced in high-energy proton - proton collisions. Another way to test BSM's, is by studying low-energy observables. This is facilitated by the small effects/currents of the same exotic bosons on these observables[1]. The shape of the beta spectrum, which is the topic of this research, is sensitive to two exotic currents, scalar and tensor, both prohibited in the SM weak interaction. For allowed transitions, these currents introduce a correction term in the spectrum, called the Fierz term bFierz , which is inversely proportional to the energy.
In addition to BSM's, the beta spectrum shape is a useful tool to probe SM effects. One of those effects is called Weak Magnetism (WM) and is induced by QCD interactions between quarks in the nucleon. For some particular transitions, a measurement of WM can provide a good test for the Conserved Vector Current hypothesis (CVC). Furthermore, the knowledge of WM for high-mass neutron-rich nuclei is crucial in the analysis of reactor anti-neutrino experiments[2].
With this in mind, an attempt is made to measure the spectrum shape of the pure Gamow-Teller decay In114 -> Sn114, at the precision level of 10-3. To obtain a spectrum cleared from undesired systematic contributions, a plastic scintillator in combination with a multi-wire drift chamber was designed to measure the beta spectrum shape. The purpose of the drift chamber is to identify certain type of events , e.g. electrons that are backscattered from the scintillator surface, or cosmic muons. In addition to event pattern recognition, the setup allows for several filtering and calibration methods. For example, by requiring coincidence between detector and drift chamber, noise and gamma particles can be filtered. Furthermore, in order to correct for non-uniform light propagation in scintillator and light guide, tracking conversion electrons from a calibration source enables the real-time generation of a 2D-detector surface gain map.

The current results and progress with respect to detector calibration and efforts to tackle systematics in the measured 114In-spectrum will be presented. In addition, the results are compared with Monte-Carlo simulations, mainly based on Geant4 and Garfield++, as the analysis is depending on it. Finally, the preliminary results for WM extraction are shown.

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[2] A. C. Hayes and P. Vogel. Reactor neutrino spectra. Annual Review of Nuclear and Particle Science, 66(1):219–244, 2016.
[3] L. De Keukeleere (2021), PhD Thesis, KU Leuven.

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