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Beta spectrum shape measurements using backscatter recognition

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Beyond Standard Model (BSM) theories can be 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, 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, caused by the strong interaction and which could mimic effects of new physics. The largest of these is called Weak Magnetism (WM). For some 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 will be made to measure the spectrum shape of the pure Gamow-Teller decay In114 -> Sn114, at the precision level of 10-3. As backscattering is the main source of systematic uncertainty, a scintillation detector 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 electrons that are backscattered from the scintillator and as a result do not deposit their full energy in the detector. In addition to backscatter 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 out. Furthermore, in order to correct for non-uniform light collection, tracking conversion electrons can be used to make a 2D gain map of the detector surface.

The poster will display the current results and progress with respect to calibrations and the first efforts to tackle systematics in the measured 114In-spectrum. In addition, the results will be compared with Monte-Carlo simulations, i.e. Geant4 and Garfield++, as the analysis will be strongly depending on it.

Complementary to this project, an alternative approach, investigated by our research group, is also presented at the conference. Here, two detectors are placed on both sides of the source and a magnetic field is applied to obtain a 4⊠ solid angle, thereby resolving the issue of backscattering[3].

[1] M. González-Alonso, O. Naviliat-Cuncic, N. Severijns. New physics searches in nuclear and neutron β decay. Progress in Particle and Nuclear Physics, 104:165-223, 2019.

[2] A. C. Hayes and P. Vogel. Reactor neutrino spectra. Annual Review of Nuclear and Particle Science, 66(1):219–244, 2016.

[3] S. Vanlangendonck. Unpublished.

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