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Measurements of Neutron and Nuclear Beta Decay Using Highly-Segmented Silicon Detectors In a Magnetic Spectrometer

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High precision measurements of the beta spectrum from neutron and nuclear decay are a sensitive probe for beyond standard model physics. In particular, exotic scalar and tensor couplings can produce Fierz terms which introduce a characteristic distortion to the standard model spectrum, inversely proportional to the beta energy. Employing silicon detectors, with understood charge collection and linearity, allows for precision measurements at low energies to probe the most sensitive regions of the decay spectra. As a part of the Nab experiment at the Spallation Neutron Source in Oak Ridge and an R\&D program for the UCNB experiment at the Los Alamos Neutron Science Center, we have developed a magnetic beta spectrometer system which features 4π collection of the emitted betas from our fiducial volume, and reconstruction of the beta decay spectra using highly segmented silicon detectors. Our Si detectors are uniquely tailored to beta decay measurements, being 1.5 to 2 mm thick, having an active diameter of roughly 11.5 cm read out in 127 separate pixels, with $\sim$3 keV FWHM energy resolution and thresholds below 10 keV. We present an overview of recent measurements in neutron and nuclear decay, including measurements of ^{45}Ca decay made in collaboration with the Weak Interactions group at KU Leuven University, and focus on some of the expected sources of systematic uncertainty for high precision measurements planned or underway. In particular, by simulating the expected measured signal, we can get a handle on the transport effects as well as the systematics associated with the energy deposition and charge collection effects in our detectors. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, the National Science Foundation, the Los Alamos National Laboratory LDRD program, and the Office of Workforce Development for Teachers and Scientists.

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