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# Development of a backscatter-free beta spectrometer for determination of weak magnetism recoil terms in allowed transitions

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Nuclear beta decay experiments for precision studies of the weak interactions are searching for new types of interactions, such as scalar and tensor components of the weak currents. The beta-neutrino correlation, the beta-asymmetry parameter, and the ft-values of the superallowed pure Fermi transitions have high sensitivity for scalar and/or tensor contributions [Sev2006]. A significant progress in the accuracy for each of these variables has been reached in the last decades. For example, for different nuclei the beta-neutrino correlation is determined with a precision of 0.5% to 1.1% [Gor2005] and the beta-asymmetry parameter with an accuracy of 1.4% [Wau2009a]. Various groups are currently improving their experimental setups and methods while new experiments are in preparation, which allows to expect that precision levels below 0.5% are to be reached in the near future. At such precision, higher order effects in the vector and axial-vector currents should be taken into account [Sev2006]. In the Standard Model the most significant higher order corrections are related to the form factors - b, the weak magnetism, and - d, the induced tensor, both originating from the hadronic structure of the nucleons. The contributions of these "recoil" terms, scaling with E/M, cause small changes (typically of the order of 0.1% to 0.5%) to the values of the correlation coefficients, which may mask the effects of new physics.

Our goal is to investigate in detail the recoil effects both theoretically and experimentally. Recent advances of computational techniques allow to calculate matrix elements which determine the recoil terms based on the theoretical formalism developed by B. R. Holstein [Hol1974]. For the experimental determination of the recoil terms a new compact beta spectrometer is being developed. Its main purpose is to measure shapes of beta spectra with corrections for the energy dependent backscattering. The shape of the beta spectrum can be used to determine the weak magnetism term, b [Cal1976]. In addition, backscattering data from the measurements will be used to improve GEANT4 based simulations, which are used for reduction of the systematical errors in beta asymmetry measurements [Wau2009b]. The final version of the spectrometer is planned to suit as a portable backscatter-free detector for future use in beta decay experiments. The spectrometer consists of two main parts: a solid state detector for energy measurements and a multi-wire drift chamber [Loj2009] for detection and suppression of the backscattered electrons. This spectrometer design allows achieving up to 100 times higher efficiencies compared to the magnetic spectrometers used in the past.

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