Contribution ID: **53** Type: **not specified**

Search for Weak Exotic Currents with Nuclear Beta Decay

Abstract:
Beta decay correlation coefficients and the beta spectrum shape are 2 powerful observables to constrain the existence of Physics beyond the Standard Model of particles in the weak sector.
New constraints on deviations from the standard expected value of the angular correlation coefficient are currently being set at WISArD, ISOLDE, with a precision of 0.1-0.2% that will allow us to bring constraints on exotic scalar currents competitive with the expected next generation constraints from LHC. The WISArD experiment relies on the measurement of the kinematic shift of the beta-delayed proton group of the IAS of 32Ar. The kinematic shift is proportional to the angular correlation coefficient of interest. This shift is increased in lighter nuclei and 20Mg has been identified as the best candidate to perform such a measurement with increased sensitivity to scalar currents by a factor 10-20%. Such a measurement requires the development of a new setup at DESIR, which includes a superconducting magnet reaching 4 to 5T, and must rely on the purification set-ups of the beam (HRS, PIPERADE), to suppress 20Na contamination.

Beta shape measurements are used to set new constraints on exotic tensor currents by extracting the Fierz interference term from a direct comparison of the expected shape (simulations) to the data. This extraction is possible to the required level of precision when the standard recoil order corrections, namely weak magnetism, are unambiguously known and sufficiently high statistics can be reached. These conditions are met in mirror nuclei and decays with $\Delta T3=\pm1$, pointing to a few short-lived candidates: 6He, 17F, 20F etc. Beta shape measurements are currently being performed in the WISArD magnet with long-lived isotopes using Si(Li) detectors. Feasibility studies will be carried out to assess the possibility to reach high level of precision with stacked Si(Li) detectors, in preparation of beta-shape measurements with short-lived isotopes for which the Q values are higher than 2 MeV at DESIR, i.e 6He or 20F. Such measurements also require the installation of a superconducting magnet at DESIR, with a large enough bore to fit Si(Li) and gamma detectors for beta and Bremsstrahlung escape detection. Beam purity is essential to avoid superposition of beta spectra in the detectors hence the need for the purification set-ups of DESIR.

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