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Weak interaction studies with 32Ar

Nuclear beta decay has represented for more than half a century a blooming testing ground for the Standard Model (SM), contributing particularly to the development of the theory of the electroweak interaction. The broad variety of nuclear states and beta transitions provide a highly remarkable tool to be competitive with high-energy physics experiments in searching for the possible presence of non-SM contributions to the firmly established vector - axial-vector (V-A) description of the weak interaction [1]. Particularly, the joined experimental determination of the beta-neutrino angular correlation coefficient ($a_{\beta\nu}$) and the correlated Fierz term (b_F) in pure Fermi and Gamow-Teller transitions tightly allows to set new stringent limits on the existence of scalar and tensor currents, respectively.

The most forthcoming way to retrieve $a_{\beta\nu}$ would be to measure the correlation between the leptons emitted in the decay; yet, as a direct measurement of the neutrino is almost impossible, the $a_{\beta\nu}$ coefficient can be determined from the recoil of the daughter nucleus, which can be measured either directly by means of trap measurements or via the kinematic shift it induces on the energy distribution of the β-delayed particles emitted in case of unstable daughter nuclei, as foreseen in the WISArD experiment at CERN.

The WISArD (Weak Interaction Studies with ^{32}Ar Decay) experiment [2] aims at a precise measurement of both the $a_{\beta\nu}$ and the b_F coefficients for both Fermi and Gamow-Teller transitions by using, differently from previous measurements [3], the kinematic energy shift of the β-delayed protons emitted in the same or the opposite direction to the β-particle from ^{32}Ar. A proof-of-principle experiment, though limited in statistics and performed via a still rudimental experimental set-up, has been successfully accomplished at ISOLDE in November 2018, already leading to the third best measurement of $a_{\beta\nu}$ for Fermi transitions [4]. After determining and estimating the systematic errors, a consistent upgrade of the experimental set-up has been commissioned and realized through the past two years, potentially permitting to reach the aimed precision of the permil level on the determination of both $a_{\beta\nu}$ and b_F. In this talk, the new experimental campaign conduced at ISOLDE in October 2021, along with the enhancements in the newly dedicated detection set-up, will be presented and the first preliminary results will be discussed.

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