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In-Trap Decay Spectroscopy for Electron Capture Branching Ratios using TITAN at TRIUMF

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A novel technique to measure weak electron capture branching ratios (ECBRs) in a set of odd-odd nuclei involved in double beta decay (ββ) using ion traps has been developed at TRIUMF, Canada's National Laboratory for Nuclear and Particle Physics located in Vancouver, Canada. The aim of this program is to extract the nuclear matrix elements (NME) involved in the EC process, and benchmark the theoretical calculations for both 2νββ- and 0νββ-decay modes. These calculations are used to predict the rate of the neutrinoless (0νββ) decay process, which if observed, can elucidate the nature of the neutrino. This is one of the pressing questions in contemporary physics.

The EC often compete with a strong beta-decay component that hinders the observation of characteristic low-energy photons emitted in EC decay, and they are also altered by the attenuation of the x-rays in the implantation environment of the sample. To overcome these problems encountered in past experiments, this program takes advantage of an electron-beam ion trap (EBIT) part of the TITAN ion trap facility, and up to seven custom-made Si(Li) detectors to observe low-energy photons from daughter nuclei involved in EC decay [1]. The high-intensity radioactive beams provided by the ISAC facility at TRUMF decay in the backing-free environment of the trap, with the trap's high magnetic field guiding the electrons from the competing beta decay outside the trap, and thus allowing for a low background in the region of interest for x-rays.

The set-up for ECBR measurements has been designed, implemented, and commissioned with an A = 124 cocktail beam [2], and was followed by subsequent experiments with a 116In beam [3]. In the fall of 2015 an experiment to measure the 0.3% ECBR of 110Ag will be performed. In anticipation of such weak ECBRs measurements numerous updates and Monte Carlo simulations have been implemented to enhance the sensitivity and monitor the performance of the experimental set-up [4]. In this talk the updates of the TITAN facility, the obtained results and milestones, and future directions of the program will be presented.

References

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