Upgrade of the ^{37}K asymmetry measurment experiment

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β decay experiments have played a significant role in the development of the Standard Model (SM), starting with the classic experiment of C.S Wu *et al*. [1] that first provided experimental confirmation of parity violation in weak force interactions.

Low-energy nuclear physics experiments continue to play a critical role in testing predictions of the SM. β decay experiments are sensitive to new physics via the angular distribution of the decay; for example, the asymmetry in the emission of β's along the polarization axis is given by [2]:$(N_+-N_-)/(N_++N_-)$ $=PA_\beta v_e/c$ where P is the average nuclear polarization, v_e is the positron's velocity and N_+ (N_-) is the number of observed β's emitted along (opposite to) the initial nuclear spin. The value of the correlation parameter, A_β, is sensitive to the form of the weak interaction; it will differ from the SM prediction if, for example, right-handed currents do in fact exist and have only escaped observation so far because they are heavily suppressed relative to the dominant *(V-A)* form of the weak interaction.

Our planned experiment will observe the decay of ^{37}K initially cooled and confined in a magneto-optical trap, with its nuclear spin polarized by optical-pumping. The experiment will be carried out at the ISAC/TRIUMF facility in Vancouver BC. Three ΔE-E β detectors will be placed around the trap with two in a back-to-back geometry along the axis of polarization, and a third monitor detector at 90º. Fig. 1 shows this geometry as viewed by the monitor detector. The Figure also shows the additional two micro-channel plates (MCPs) used to collect the recoiling ions and the shake-off electrons. Using this geometry, we will first perform a precision measurement of A_β, followed by further measurements of other correlation parameters.

We are in the process of upgrading our experimental setup that will allow us to make a precision measurement of A_β which was not possible in our first attempt due to large systematics [3]. The dominant systematic was found to be atoms which were lost from the trap, implanted onto the mirrors in front of the β detectors and depolarized before decaying. The key feature of the re-design is the addition of the shake-off electron MCP which will give us an extra coincidence condition which will ensure we only count decays which originated from the trapping region. Additional improvements include increasing the solid angle coverage of the β detectors by ~2× from the current setup (improving statistics) and replacing our DC-MOT with a novel AC-MOT [4] which will greatly reduce eddy currents while turning off the anti-helmholtz coils (needed for trapping) before polarizing and counting. The upgraded system will hopefully be in place to take data shortly after the facility shutdown during the 2010 winter Olympics in Vancouver.
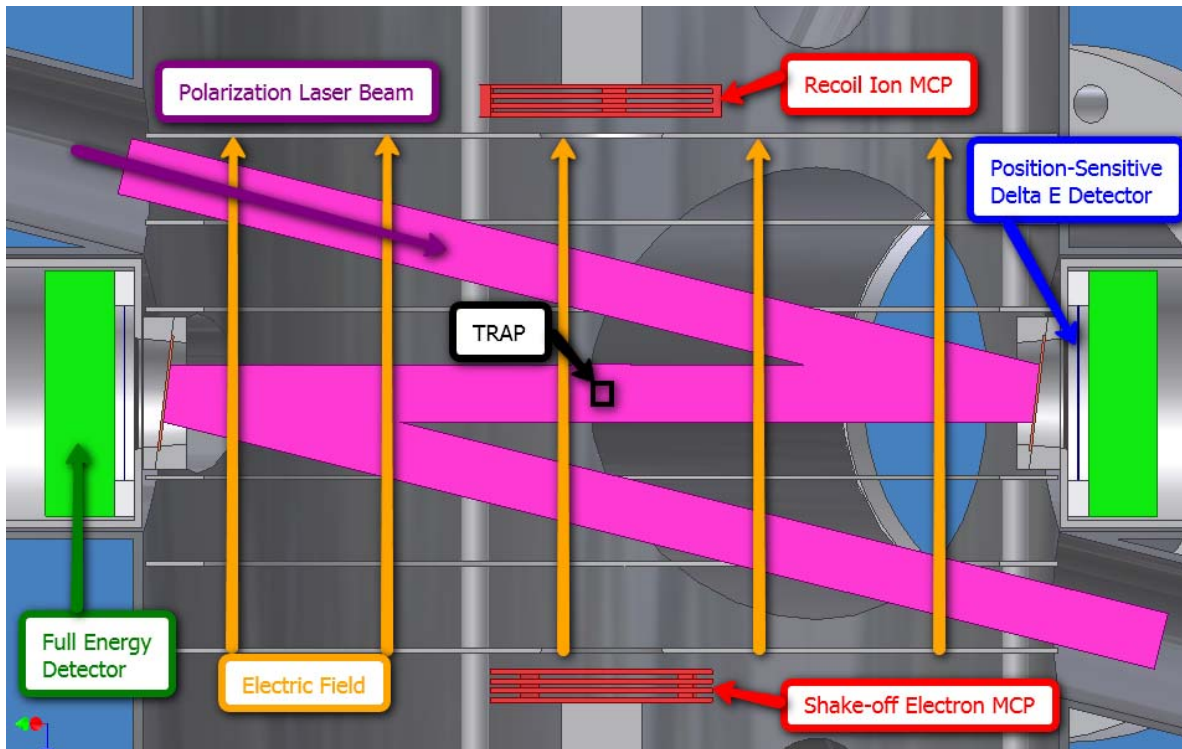
FIG. 1. A cut away view of the inside of the chamber from the point of view the 90° detector. The electrostatic hoops shown along the back wall produce the electric field shown in orange. The purpose of this field is to sweep the recoiling daughter (positive) ions towards one MCP, and the (negative) shake-off electrons into the opposite MCP. By requiring a signal in the shake-off electron MCP, we will ensure the β's observed in the ΔE-E detectors were polarized and decayed from the trapping region. The asymmetry in the observed rates of the two β detectors is proportional to the correlation parameter A_β.

[1] C. S. Wu *et al.*, Phys. Rev. **105**, 1413 (1957).

[2] J. D. Jackson, S. B. Treiman, and H. W. Wyld, Phys. Rev. **106,** 517 (1957).

[3] D. Melconian *et al.*, Phys. Lett. B **649**, 370 (2007).

[4] M. Harvey and A. J. Murray., Phys. Rev. Lett. **101**, 173201 (2008).