TRIUMF E-823: Measurements of the ^{37,38m}K half-lives

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The E-823 experiment was a collaboration between scientists from TRIUMF, Lawrence Berkeley National Laboratory, Simon Fraser University, Argonne National Laboratory, Queen's University and Texas A&M. It was designed to perform measurements of half-lives and branching ratios for superallowed $0^+ \rightarrow 0^+$ β decays in medium-mass (A>60) nuclei produced by the ISAC1 radioactive beam facility at TRIUMF. These data were to be used in testing the Standard Model via the unitarity of the Cabibbo-Kobayashi-Maskawa (CKM) matrix [1].

In its initial phase, more than eight years ago, we were testing the half-life detection equipment (electronics and tape-transport-system) and the fitting programs used to extract the half-lives. The experimental apparatus comprised a 4π proportional gas-counter and a tape-transport system similar to the one in use by us at the Cyclotron Institute at Texas A&M. However, because of the low energy of the radioactive beam at TRIUMF, the ions were implanted in the mylar tape in vacuum, an arrangement that required two sets of slits with differential pumping between them for the tape to be withdrawn from the vacuum en route to the detector.

The test cases chosen were the decays of ^{37,38m}K, nuclei readily available at the ISAC1 facility in its initial production phase. After our initial analysis of the ^{38m}K data [2] we reported results consistent with previous measurements, thus confirming the reliability of our equipment and the data reduction techniques. Since ^{38m}K ($t_{1/2}$=0.924 s) was generated along with ^{38}K ($t_{1/2}$=7.63 min), the counting rate stayed at levels above the background for the whole detection cycle. However, in the case of ^{37}K ($t_{1/2}$=1.235 s), no other significant components were present in the radioactive beam so the counting rate had returned to background level during the 25-s counting period. Thus, for the ^{37}K half-life, special care needed to be taken for the channels with few counts in them.

In preparing to publish these results, we have recently revisited the ^{37}K data. The data-filtering procedure we used in the original analysis [2] included rejection of cycles that showed non-statistical noise anywhere in the spectrum. We have more recently come to realize that this filtering procedure has a bias: noise is more easily detected in the low rate region (at the end of the decay spectrum) than in the high rate region (at the beginning). This means that, after filtering, the data will tend to yield a fitted half life that is too short. In our new analysis we removed this filter and used only one that tested the χ^2 value of the fit of each individual cycle, rejecting those cycles with a confidence level below 10^{-4}. In the new fits we found:

- a very small scatter associated with the detector bias – see Fig 1, in which χ^2/ndf = 0.5; but
- a higher scatter associated with the discriminator threshold – see Fig 2, in which χ^2/ndf = 2.6.

It should be noted however that the values obtained in these fits have no provision for any ^{37}Ca impurity in the collected samples. The extent of this contribution needs to be assessed by our colleagues at TRIUMF and then incorporated into the final data analysis. We anticipate this work to be completed within a few months.

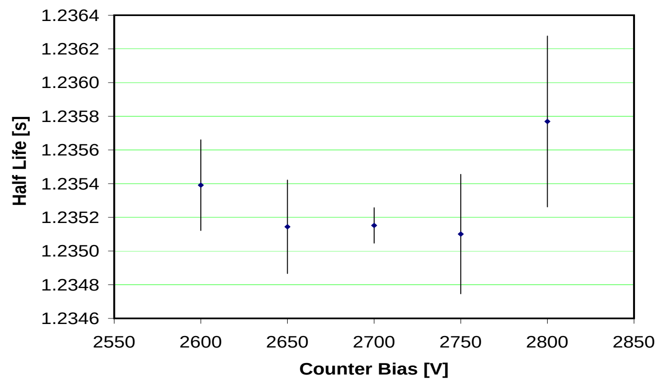

Figure 1. Half-life results for ^{37}K from separate runs, plotted as a function of detector bias.

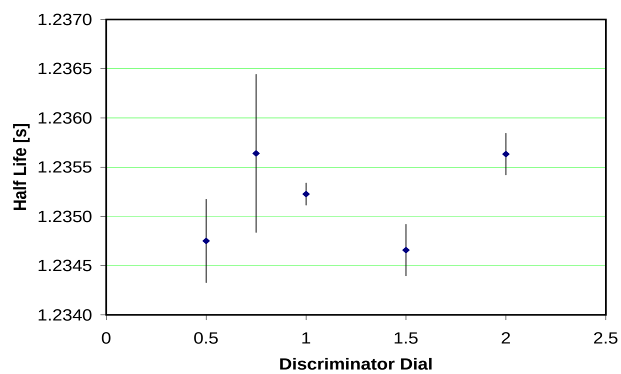

Figure 2. Half-life results for ^{37}K from separate runs, plotted as a function of discriminator threshold.

[1] J. C. Hardy and I. S. Towner, Phys. Rev.C **71**, 055501(2005) and Phys. Rev. Lett. **94**, 092502 (2005).

[2] J. C. Hardy and V. E. Iacob, *Progress in Research*, Cyclotron Institute, Texas A&M University (1998-1999), p. I-30