Precise half-life measurement of ^{42}Ti

H.I. Park, J.C. Hardy, V.E. Iacob, V. Horvat, M. Bencomo, L. Chen, N. Nica, B.T. Roeder, and A. Saastamoinen

We repeated the half-life measurement of ^{42}Ti after dealing with the problems [1] we encountered in the previous experiment. Again we used the ^{4}He(^{40}Ca, 2n)^{42}Ti reaction in inverse kinematics to produce ^{42}Ti at a primary ^{40}Ca beam energy of 32 MeV/nucleon. With extraction slits on the MARS recoil spectrometer set tight, the ^{42}Ti samples were deposited near the back of the collection tape, thus ensuring that most of the produced impurities passed through the tape without stopping, leaving behind a rather pure ^{42}Ti sample. In addition to acquiring data from the proportional gas counter with our standard analogue electronics, we also ran a TDC-based system in parallel so that we could record the absolute time information event-by-event for the same data. The use of this second data-taking method offers a means to test for possible systematic effects in the measurement, as well as an opportunity to improve our data-acquisition techniques for all half-life measurements.

At the beginning of the experiment, we observed an unphysical structure in the middle of cumulative time-decay spectrum recorded at the lowest discriminator setting. The structure was more pronounced as the tape reel on the take-up deck of the tape-transport system became heavier as more tape wound onto it. This led us to conclude that the cause must be noise pickup arising from the servo-motors that control the tape reels. We assessed the effect of this pickup by measuring a background spectrum, without beam but with the tape-transport system operating normally. Under these conditions we found that for the first 300 cycles the background rate remained at less than 1 count/s, the normal rate with the gas counter in our experimental area; but as the cycles increased beyond 300 the pickup appeared. When we recorded the background spectrum with the 300-cycle restriction, there was no sign of the structure caused by unwanted noise signals from the servomotors. Consequently, throughout the experiment, we rewound the tape manually after every 300 cycles from the beginning of the tape roll, and routinely took 300-cycle cumulative background spectra to ensure the data were free of pickup for the various combinations of detector settings (bias / discriminator level / dead-times) used.

Our current analysis focuses on comparing the ^{42}Ti half-life result determined from two different approaches, one in which the linkage between the parent and daughter activities is enforced and the other in which their activities are treated as two independent decays.

[1] H.I. Park *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2016-2017), p. I-15.