Precise half-life measurement of ^{42}Ti

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We have made a second attempt to measure the half-life of ^{42}Ti to high precision. The critical change from our first measurement [1] was that we removed the time delay between the beginning of each count period, as defined by the fast tape-transport system, and the actual start time when data are recorded with our standard analog electronics. This was a feature we had introduced for our branching ratio measurements and had inadvertently left connected for the first half-life measurement of ^{42}Ti.

Once again we produced ^{42}Ti using the ^{4}He (^{40}Ca, 2n) ^{42}Ti reaction in inverse kinematics, with a primary ^{40}Ca beam energy of 32 MeV/nucleon. With extraction slits on the MARS recoil spectrometer set tight, by depositing the ^{42}Ti samples near the back of the collection tape we could ensure 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.

Unfortunately, our second measurement suffered from a failure of the fast tape-transport system to place the collected source consistently into the center of the detector. This newly encountered instability significantly decreased the overall statistics we could obtain during the seven days of beam time. Another issue arose from the operation of the gas counter. In all such measurements we intend to operate the detector in a flat "plateau" region. In this case, as usual, we determined the plateau region in advance by using a ^{90}Sr/^{90}Y beta source and measuring the count rate as a function of applied detector voltage at the three different thresholds (50, 100, and 150 mV) used in our half-life measurement. Since count rate is nearly independent of detector bias in the plateau region, this operating condition ensures that our detection efficiency, which is close to 100%, is essentially independent of count rate. We repeated the ^{90}Sr/^{90}Y source measurement at the end of the experiment to confirm that our operating range for the detector bias voltage had remained unchanged. To our surprise, the plateau region was somewhat narrower than that obtained before the experiment began, indicating that the settings used during the measurement might not all have been safely within the plateau region. Thus we are concerned that our ^{42}Ti half-life measurement might have been compromised by a rate-dependent detection efficiency. Our analysis is currently progressing but with great attention being paid to possible rate-dependent effects.

In the meantime, the tape-transport system has been repaired and the gas-counter repeatability has been (re)established. An additional measurement with all systems in prime operating condition is planned for late summer.

[1] H.I. Park *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2015-2016), p. I-17.