Studies towards the precise measurement of the half-life 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

Two years ago [1], we reported a successful test measurement of the half-life of ^{42}Ti, which employed a digital-waveform-analysis system. Then last year [2], we added a comparative study of our digital and standard analogue systems based on off-line measurements on calibration sources. The results from the on-line measurement showed that the ^{4}He(^{40}Ca, 2n)^{42}Ti reaction would provide approximately 2000 particles/s of ^{42}Ti with 300 nA of primary ^{40}Ca beam at 32 MeV/nucleon. It was also demonstrated that, with extraction slits on the MARS recoil spectrometer set tight, we could deposit ^{42}Ti samples near the back of the collection tape and thus obtain quite pure ^{42}Ti nuclei by letting most produced impurities pass through the tape without stopping. However, the off-line comparative study reached the unfavorable conclusion that the gain of the digital system was likely insufficient to permit us to detect the lowest energy beta particles, thus compromising half-life measurements by introducing a potentially rate-dependent threshold.

These findings were used to optimize the experimental conditions for a full-fledged measurement of the half-life of ^{42}Ti, which we conducted in the summer of 2015. Compared with our test measurement, we replaced the digital system with our standard analogue electronics and also ran a TDC-based system in parallel to take data from the proportional gas counter. This arrangement allowed us to independently record absolute time information event by event under the same well-controlled conditions. More importantly, the use of an additional, separate method for taking data from the proportional gas counter 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 ongoing data analysis has revealed an unexpected problem. By comparing our standard analogue technique with the TDC-based approach, we found a time delay between the beginning of each count period as defined by the fast tape-transport system and the actual start time when data were recorded with our standard analogue system. This was a feature we had introduced for our branching-ratio measurements and had inadvertently left connected for the half-life measurement. Moreover, the time delay itself was apparently malfunctioning since it was found to vary with time (likely as a function of temperature in the cave). Having identified the cause, we could extract the time delay of the standard analogue system cycle-by-cycle based on the absolute time recorded from the TDC-based system. This made it possible to adjust the time base of the ^{42}Ti decay spectra.

Our next step is to independently determine the ^{42}Ti half-life from the data sets of the two systems and to test for the consistency of their results. All these studies will bring us one step closer to achieving a precise measurement of the ^{42}Ti half-life.

[1] H.I. Park *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2013-2014), p. I-23.

[2] H.I. Park *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2014-2015), p. IV-79.