Precise Half-Life Measurement of ^{22}Mg

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As part of our program [1] to test CKM unitarity via superallowed ∃-decays, we reported in last year's Progress Report [2] that we were well advanced in making a measurement of the half-life of ^{22}Mg. At that time we had obtained a preliminary result but had not yet fully explored all possible systematic errors. Subsequently, an additional experiment was performed at the MARS spectrometer with our fast tape-transport system. It was carried out under similar conditions to those reported previously [2], but incorporated a variety of parameter changes focused on exposing unexpected systematic effects if they are present.

As before [2], a beam of 23 *A*MeV ^{22}Mg (pure to better than 99.6%) exited the MARS spectrometer, was degraded and then implanted in mylar tape. The purity of the collected sample was enhanced further by the implantation, since any impurities have a different range and, thus, for the most part, do not stop in the tape. After a suitable collection time, the beam was turned off and the tape moved to convey the collected activity, within 190 ms, to the center of a 4B proportional gas counter, from which the ∃-decay signals were multi-scaled. Since dead-time is an important consideration in any precise half-life determination, we introduce into the circuit a fixed, non-extendable and well-determined dead-time that is chosen to be larger than any of the other dead-times present there. This dominant dead-time can be changed from measurement to measurement. Data were collected under two different collect-time/count-time conditions: 8s/80s and 60s/160s. The first setting was optimized for the measurement of the ^{22}Mg decay and is similar to the previous experiment [2]: about 20 million ∃-decay events were recorded in a sequence of measurements, each with a different setting of the detector bias, discriminator level, and/or dominant dead-time. The latter could be set to 8, 10, or 12:s. No systematic effects on the measured half-life could be detected.

The second collect-time/count-time setting, 60s/160s, was optimized towards the detection and measurement of any possible impurity of comparable half-life present in our experiment: in particular, we were looking for ^{21}Na ($t_{1/2}$ = 22.48 s). About 5 x 10^5 events were collected in this configuration; these data revealed the presence of ^{21}Na in the collected samples at a level of about 2 x 10^{-4} times that of ^{22}Mg. Even though this might seem to be a small contamination, its effect on our result for the ^{22}Mg half-life exceeds our statistical error and it certainly must be accommodated.

With this result in mind, we have also revisited the previous measurements. The particle spectra recorded in the July 2000 run showed that the ^{21}Na impurity in that measurement was about four times smaller than in the 2001 run (consistent with a narrower slit-setting of the MARS spectrograph for the July 2000 run). With the effects of ^{21}Na accounted for, there is complete agreement between our results from the measurements in 2000 and in 2001. Combining both, we obtain a final value for the ^{22}Mg half-life of $t_{1/2}$ = 3.8749(12) s.

References

[1] J. C. Hardy *et al., Progress in Research*, Cyclotron Institute, Texas A&M University (2001-2002), p. I-21.

[2] V. E. Iacob *et al., Progress in Research*, Cyclotron Institute, Texas A&M University (2000-2001), p. I-30.