The half-life of ^{46}V

H. I. Park, J. C. Hardy, V. E. Iacob, J. Goodwin, V. Horvat, N. Nica, E. Simmons,
L. Trache, and R. E. Tribble

A recent Penning-trap Q_{EC} measurement of the superallowed β decay of ^{46}V [1, 2] raised the $\mathscr{F}$t value by nearly three standard deviations from the average of all other well-known superallowed transitions. This anomaly stimulated questions about the possible presence of systematic effects for all reaction-based Q-value measurements [3] and led to a theoretical reexamination of the isospin-symmetry-breaking corrections for the ^{46}V transition, as well as for a number of other cases [4]. These new corrections resulted in the restoration of CVC consistency and brought the CKM matrix into better agreement with unitarity. Throughout these changes, it was always assumed that the half-life of ^{46}V was completely correct although the accepted Q_{EC} value had been found to be flawed. Therefore, we are measuring a new precise half-life of ^{46}V to see if this assumption is correct.

Essential to this experiment was the development of a ^{47}Ti beam to produce ^{46}V. For our first attempt in the summer of 2007, the ^{1}H(^{47}Ti, 2n) ^{46}V reaction was used at a primary beam energy of 30A MeV. Although some ^{47}Ti beam was accelerated with natural titanium source material, we were not able to collect any data because of the extremely low beam intensity. However, the observed production rate of ^{46}V indicated that the experiment would be possible with a beam current of as little as 25 nA from the cyclotron. More recently, with enriched ^{47}Ti and the same ^{1}H (^{47}Ti, 2n) ^{46}V reaction at primary beam energy of 30A MeV, enough beam was produced to allow us to conduct a test run on the half-life of ^{46}V. The main purpose of this test was to optimize MARS settings and to verify the presence of ^{46}V with our detection system. These results indicated that we could improve the experimental conditions by increasing the primary beam energy to 32A MeV because the maximum cross section for ^{46}V was predicted at this energy.

We tried the experiment again on October 2008. It turned out that the production of a ^{47}Ti beam at 32A MeV was a real challenge for the accelerator. For most of the time, the beam current was less than 10 nA, which barely met the minimum β-particle counting rate required from a statistics point of view. Furthermorer, we were able to obtain data for only one third of the seven-day requested beam time. Our experimental arrangement was the same as for the half-life measurement of ^{38}Ca [5]. With repeated cycles of 1 s/0.192 s/10 s collect/move/count times, over 30 million β events were recorded for one set of dominant dead times. Unfortunately, the useful beam time was not sufficient for us to check for systematic errors. However, our result for the half-life, 0.4226(1) s, agrees with the average of all previous measurements, 0.4225(1) s.

Another five-day run followed in December 2008 to improve the overall statistics of the data and to check for any possible systematic errors. Unfortunately, our analysis revealed a small systematic effect on half-life in this measurement. The main cause has now been identified and eliminated. The final experiment is scheduled in June 2009 to complete the precise half-life measurement of ^{46}V.

[1] G. Savard, F. Buchinger, J. A. Clark, J. E. Crawford, S. Gulick, J. C. Hardy, A. A. Hecht, J. K. P. Lee, A. F. Levand, N. D. Scielzo, H. Sharma, K. S. Sharma, I. Tanihata, A. C. C. Villari, and Y. Wang, Phys. Rev. Lett. **95**, 102501 (2005).

[2] T. Eronen, V. Elomaa, U. Hager, J. Hakala, A. Jokinen, A. Kankainen, I. Moore, H. Penttilä, S. Rahaman, A. Saastamoinen, T. Sonoda, J. Äystő, J. C. Hardy and V. Kolhinen, Phys. Rev. Lett. **97**, 232501 (2006).

[3] J. C. Hardy, I. S. Towner, and G. Savard, Int. J. Mass Spectrom. **251**, 95 (2006).

[4] I. S. Towner and J. C. Hardy, Phys. Rev. C **77**, 025501 (2008).

[5] H. I. Park *et al*., *Progress in Research*, Cyclotron Institute, Texas A&M University (2007- 2008), p. I-30.