Measurement of the half-life of the *T=1/2* mirror decay of ^{29}P

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The consistency of *ft* values of pure Fermi transitions are well-known to demonstrate the conserved vector current and to determine the value of V_{ud} for probing the standard model via a test of the unitarity of the CKM matrix. Mixed Fermi and Gamow-Teller transitions between $T = 1/2$ mirror nuclei are being studied as a complementary and independent measure of V_{ud}. As these decays are mediated by both the vector and axial-vector component of the weak interaction, in addition to the *ft* value, (any) one of the angular-correlation coefficients must be measured to determine V_{ud}. The mirror decay of ^{29}P is one of five candidates of *T=1/2* mirror nuclei which has been used as an independent measure of V_{ud} [1]. The relatively large uncertainty of its contribution is dominated by the precision of ρ, the ratio of Gamow-Teller to Fermi matrix elements, which was obtained from a ±12% measurement of the beta asymmetry parameter, A_β [2]. The ft value [3] is known much better, to ±0.4%, with the largest contribution to its uncertainty being the lifetime of the decay: 4.142(15) s [4]. The aim of the present work is to improve the lifetime of ^{29}P so that it no longer dominates the uncertainty in the deduced ft value.

The half-life of ^{29}P was measured using the Momentum Achromatic Recoil Spectrometer (MARS) and a fast-tape-transport system equipped with a 4π continuous-gas-flow proportional counter. The secondary beam of ^{29}P was produced via the $p(^{30}\mathrm{Si}, 2n)\ ^{29}\mathrm{P}$ reaction in inverse kinematics at a primary beam energy of 24 MeV/u. MARS was used to produce a secondary beam of ^{29}P with a purity of 99.8%, with impurity levels of ^{27}Si and ^{25}Al both at the 0.1% level. The total data set was divided into several runs with different settings of the experimental parameters: bias voltage, discriminator threshold and dominant dead-times. The initial activity of ^{29}P for each cycle was in the range of 4000 − 9000 cps. All runs were composed of 100 − 200 cycles with ≈4×10^6 counts in each run. In addition, a background measurement was performed where all of the experimental conditions were the same as for normal data taking except that the tape motion was disabled.

The selection of data for final analysis was made according to following criteria. First, cycles with too few counts – less than 5000 – were rejected. Second, the number of βs recorded in each cycle was compared to the corresponding number of heavy ions recorded in the scintillator at the exit of MARS. If their ratio was abnormally low, it meant that the tape did not stop with the activity positioned correctly within the 4π proportional gas counter. In that case, the cycle was rejected. The decay data from accepted cycles are currently being analyzed by summed analysis method. In this analysis method, the first step is to correct the measured decay spectrum in each cycle channel-by-channel for deadtime, based on the measured rate in each channel. Next, the cycles of a given run are summed into two decay curves, one for each imposed dominant deadtime. Finally, these spectra are fitted to function composed of an exponential and flat background. Fig. 1 show a typical deadtime-corrected decay curve for one cycle.

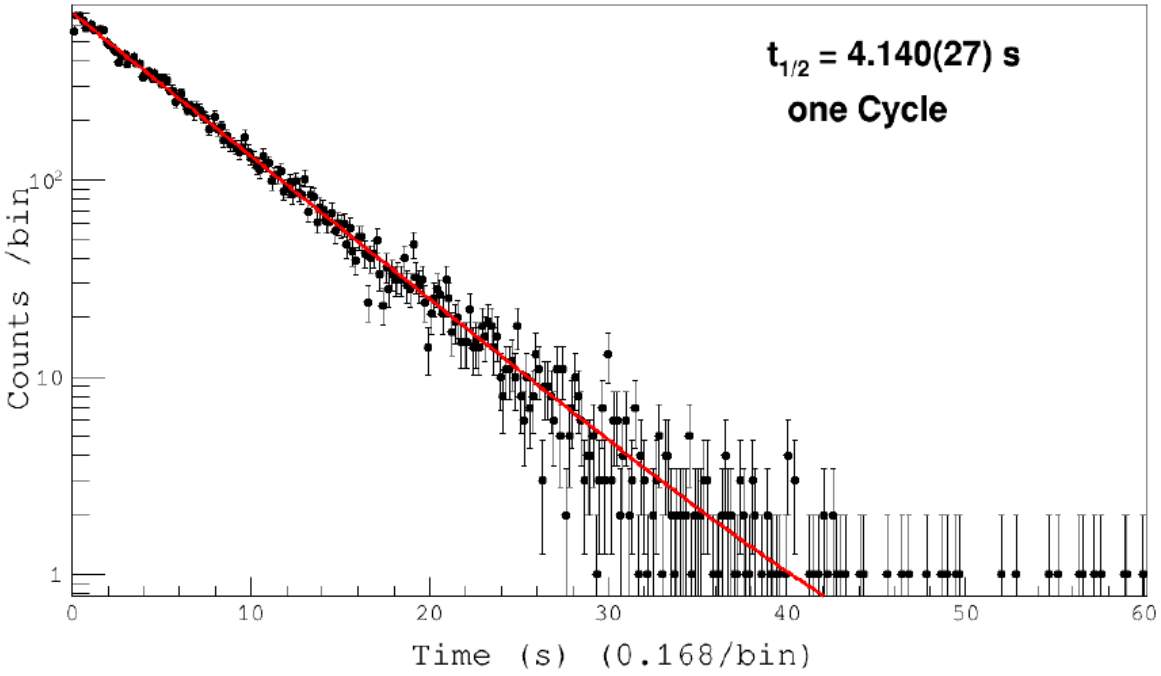

Fig. 1. Typical deadtime-corrected β-decay curve for ^{29}P from one cycle. The reduced χ^2 of the fit is 1.02.

The preliminary analysis indicates that the statistical uncertainty is at the 0.015% level. The analysis is in progress to extract the final value of the half-life along with an associated systematic error budget.

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