^{26}Si half-life measurement

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If ^{26}Si is to yield an *ft*-value with sufficient precision to contribute meaningfully to the evaluation of V_{ud} from superallowed β decay, experimental precision must be improved from the world-average results given in the most recent, 2009 survey [1]. Since that survey closed, a significantly more precise Q_{EC}-value result has already been published [2], thus providing considerable incentive for improving both the half-life and branching-ratio values. This report describes progress on our measurement of the ^{26}Si half-life, which aims at a precision of better than 0.1%.

The experimental set-up was similar to the one described in [3] except that, for the first time, the time profile of the deposited activity was recorded contemporaneously with the decay data [4]. An ^{27}Al beam accelerated to 30 *A* MeV impinged on a hydrogen gas target kept at liquid-nitrogen temperature and at a pressure of at 2 atmospheres. The ejectiles recoiling from the target passed through the MARS spectrometer, from which a pure beam of ^{26}Si at 25 *A* MeV was obtained with an intensity of more than 40×10^3 particles/s. This beam was then extracted into air, passed through a 0.3-mm-thick plastic scintillator as well as Al degraders, and eventually was implanted in the 76-μm-thick mylar tape of our fast tape-transport system. The measurement consisted of repeated computer-controlled cycles, in which the activity was collected for a few seconds; then the beam was turned off and the collected activity was moved in 188 ms to the center of a 4π proportional gas counter, where the decays were detected and multiscaled for 45 s (about 20 half-lives of ^{26}Si). These collect-move-detect cycles were repeated until the desired statistics had been acquired. Typically an individual run would record 4×10^6 decay events at one choice of experimental parameters. These parameters would then be changed and another 4×10^6

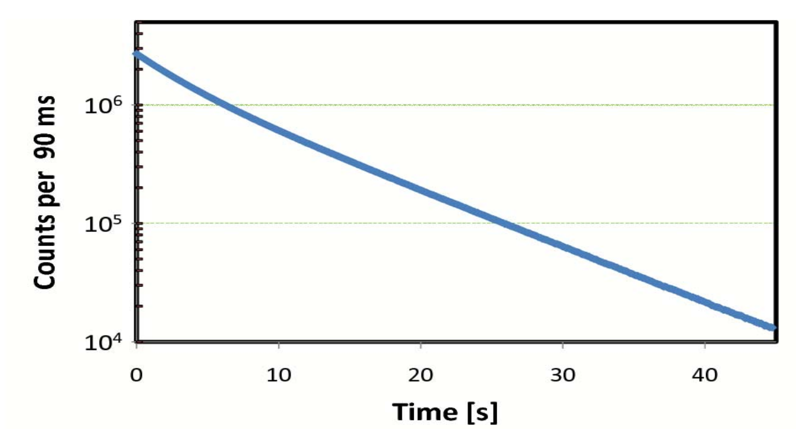

FIG. 1. Total decay spectrum of the combined β^{+}-decays of ^{26}Si and its daughter ^{26}Al.

decay events recorded, after which another change would be made and a new run begun … and so on. In total, more than 260×10^6 decay events were recorded for ^{26}Si and its daughter ^{26}Al. The total time-decay spectrum obtained is presented in Fig. 1.

Special care was given to checking the consistency of the results. Using the same techniques as described in [3], we split the experiment into separate runs and, from one to another, we changed the parameters that are critical in the electronic setup: dead-times (3, 4, 6 and 8 μs), discriminator thresholds (150, 200 and 250 mV) and detector bias (2550, 2650, 2750 and 2850 V). As the signal generated by the detector is split in two chains, each of which has a different pre-set dominant dead-time, in our analysis we first compared the two data-streams within each run. After correction for the different dead times, no difference was observed in the fitted half-life, as one would expect for events originating from the same data stream but differing only in dominant dead time. We than tested the stability of the fitted results from run to run, thus testing for any systematic dependence on the three critical parameters. As seen from the results displayed in Fig. 2, no systematic bias was observed.

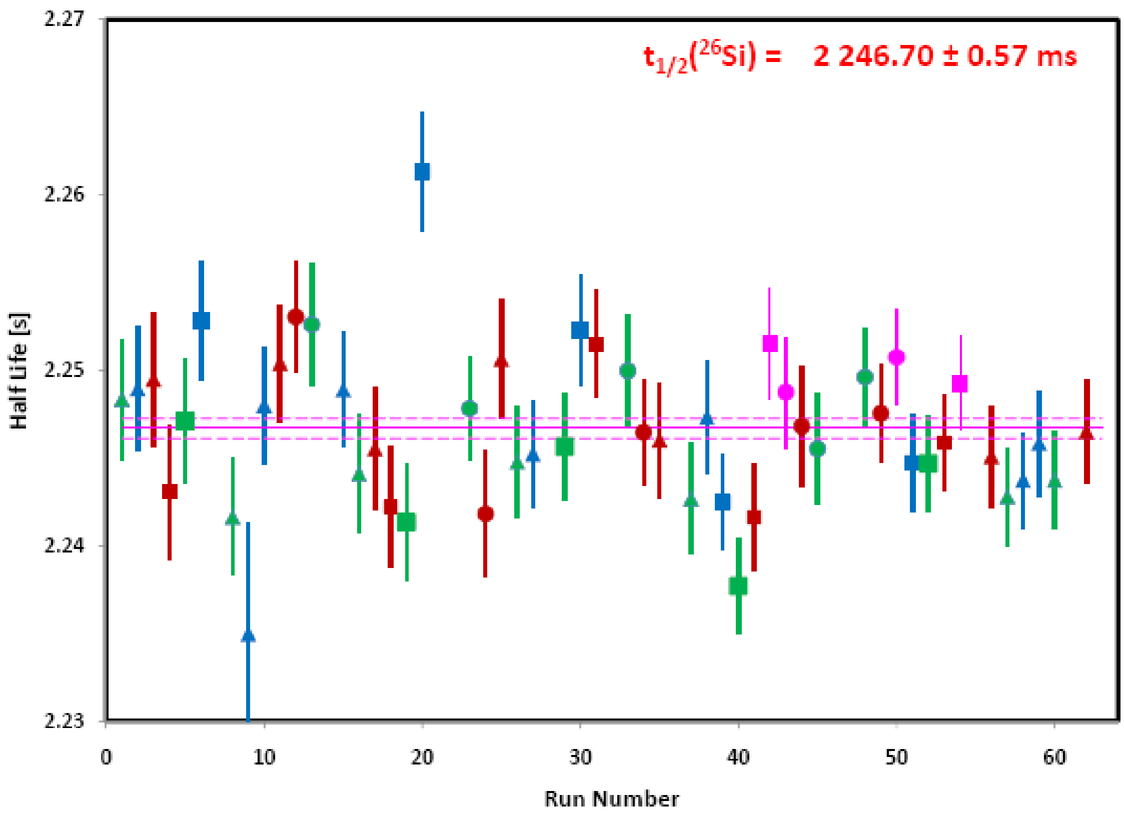

FIG. 2. Search for possible systematic errors in the half life of ^{26}Si. The data points are identified by color and symbol: triangles/squares/circles correspond in order to 150mV/200mV/250mV discriminator settings while blue/green/maroon/purple correspond to detector-bias settings of 2550V/2650V/2750V/2850V.

Our preliminary result for the ^{26}Si half-life, $t_{1/2}$ = 2246.70(57) ms (statistical uncertainty only), disagrees with the current world average [1], a number that is dominated by a recent measurement by

Matea *et al.* [5], $t_{1/2}$ = 2228.3(27) ms. We have carefully studied the experimental arrangement described by Matea *et al.* and conclude that the difference between their result and ours is a consequence of their neglecting the difference in detection efficiency between the parent and daughter nuclei, ^{26}Si and ^{26}Al, respectively. For the scintillation detector used in [5] the detection efficiency for β's originating from ^{26}Si is considerably higher than that for the β's originating from ^{26}Al, which has a lower end-point energy. While this is an important correction for the Matea *et al.* scintillator detector, it only has a minor contribution in our set-up with a high-efficiency proportional gas counter; nevertheless we do make the correction. Using the efficiencies as we obtain them from an approximate Monte Carlo simulation of the Matea *et al.* experimental set-up [5], we conclude that a proper correction to their measured data would bring their reported half-life into agreement with our new result.

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