Measurement of branching-ratios in the β decay of ^{38}Ca

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We have been making steady progress towards our goal of being able to measure the branching ratios for superallowed transitions with a precision of ~0.1%. This report documents our progress on such measurements for the decay of ^{38}Ca. In these measurements, ^{38}Ca was produced with the same reaction and primary beam energy used in the half-life measurement for ^{38}Ca [1], and the activity was collected on, and transported by, our fast tape-transport system. In our first test measurement, we used a *collect-move-count* cycle of 1.5-0.180-1.5 s, and measured time-tagged β-γ coincidence events with a 1-mm-thick plastic scintillator for β particles and our well-calibrated 70% HPGe detector for γ rays. In a five-day run, approximately 2.5-million β-γ coincidence events were recorded, which corresponded to about 100-million β singles. Although the overall statistics were insufficient to achieve our targeted precision, the analysis of these data showed that the measured relative γ-ray intensities were consistent with the values previously measured in Ref. [2].

After this measurement, improvements were made in the experimental equipment, which allowed us to measure the electronic dead times and the source-to-detector distance cycle by cycle. The former was achieved by pulser signals from a constant frequency pulse generator measured in coincidence with gating signals from β-singles events, γ-singles events, and β-γ coincidence events. The addition of a laser triangulation device into our system also allowed us to determine the source-to-detector distance accurate to ±0.1 mm in the range from 9 to 19 cm [3]. With this upgraded system, every detection cycle is now tagged with its own source-to-detector distance. This increases the precision we can achieve in a branching-ratio measurement to the limit defined by the precision of the absolute efficiency of the γ-ray detector. These improvements were implemented into a second measurement of the branching-ratio of ^{38}Ca.

The second measurement involved a seven-day run, in which we collected approximately 7 million β-γ coincidence events from over 300 million β singles in 50 separate runs, including 3 runs used as room-background measurements. However, our analysis revealed that, of the total number of events that triggered β-γ coincidences, approximately 20% were not recorded as complete events in our data-acquisition system because either the β or γ energy (or both) was below the threshold of the corresponding ADC. To resolve this problem, we are currently implementing various improvements to our data-acquisition electronics. One of our major focuses is to ensure that all events causing a β-γ trigger have β and γ energies that are in the range of our ADC's; and to independently measure dead-times by recording the number of β-γ coincidence triggers in the data stream on a cycle-by-cycle basis. We are also planning to employ the pulser method for measuring pile-up losses in the coincident γ rays. Once these improvements have been made, we will be one step closer to the 0.1% precision we seek for the branching-ratio measurement of ^{38}Ca.

[1] H.I. Park, J.C. Hardy, V.E. Iacob, A. Banu, L. Chen, V.V. Golovko, J. Goodwin, V. Horvat, N. Nica, E. Simmons, L.Trache, and R.E. Tribble, *Progress in Research*, Cyclotron Institute, Texas A&M University (2010-2011), p. XXX.

[2] B.D. Anderson, A.R. Baldwin, P. Baumann, B.A. Brown, F. Didierjean, C.C. Foster, L.A.C. Garcia, A. Huck, R. Madey, D.M. Manley, G. Marguier, M. Ramdhane, H. Ravn, C. Richard-Serre, G. Walter and J.W. Watson, Phys. Rev. C **54**, 602 (1996).

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