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

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In the past year, we have continued to improve our data-acquisition electronics with the goal of achieving 0.1% precision in the branching-ratio measurement of superallowed β transitions. One of our major focuses was to ensure that all events causing a β-γ trigger have β and γ-ray 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. These improvements were strongly motivated by our ^{38}Ca branching-ratio measurement in 2010 [1] in which approximately 20% of all events triggering β-γ coincidences in the ADC did not appear as complete events in the recorded data stream. The improvements we have made to the system are discussed in more detail in the instrumentation section of this report [2].

The improved system was used to measure the branching ratio for the superallowed transition of ^{38}Ca again in the fall of 2011. We produced ^{38}Ca via the reaction ^{1}H (^{39}K, 2n) ^{38}Ca at a primary beam energy of 30*A* MeV. As a collect-move-count cycle was repeated with our fast tape-transport system, the time-tagged β-γ coincidence events were measured with the 1-mm-thick plastic scintillator for β particles and our well-calibrated 70% HPGe detector for the γ rays. Approximately 5 million β-γ coincidence events were collected from over 200 million β singles in 29 separate runs. This experiment allowed us to test the behavior of the upgraded system. On the one hand, we succeeded in reducing the loss of all events triggering β-γ coincidences in the ADC from 20% to 3.5%. On the other, we observed that our system did not record any β-γ coincidence events for the first 45 ms of the 1.6-s count time, possibly because a high counting rate during and immediately after the accelerator beam was present effectively blocked the system. This problem is being investigated in off line tests. Currently, we are making off-line measurements of β-γ coincidences with a ^{22}Na source, using our normal on-line configuration. The branching ratio for ^{22}Na β^+ decay is precisely known and is essentially 100%. These measurements have told us more about the response of our system to positrons and high-energy γ rays comparable to those from ^{38}Ca. A number of improvements have been made, including the reduction of event losses relative to β-γ coincidence triggers to less than 1%.

[1] H.I. Park *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2010-2011), p. I-27.

[2] V.E. Iacob, J.C. Hardy, and H.I. Park, *Progress in Research*, Cyclotron Institute, Texas A&M University (2011-2012), p. V-21.