Superallowed $0^+ \rightarrow 0^+$ Beta Decay: Precise half-life Measurements

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An important ingredient required for the measurement of an *ft*-value is the total half-life of the parent nucleus. Our program to measure the *ft*-values of superallowed $0^+ \rightarrow 0^+$ transitions using the Texas A&M cyclotron [1] is focusing on the nuclei with $T_z = -1$ and $18 \leq A \leq 38$, initially ^{22}Mg and ^{30}S. The half-lives of these nuclei are not currently known to the required accuracy of ±0.05%, so we are building a system to measure precise beta-decay half-lives. The same system is being used as part of TRIUMF experiment E-823 [2].

Our system is designed to work with the TAMU fast tape-transport system mounted at the end of MARS [3]. It consists of a 4π continuous gas-flow proportional counter, split into two halves, each a separate gas cell, between which the tape passes. A sample of activity collected at the end of MARS can thus be introduced into the middle of this counter within 200 ms of the completion of its collection. The counter itself is a copy of the one developed and used at Chalk River [4] for the same purpose.

The cells were machined from copper and each equipped with anodes of 0.013-mm-diameter gold-plated tungsten wire. In operation, pure methane gas at one atmosphere pressure is continuously flushed through the counter. Initially, aluminized-mylar foils, 0.90-mg/cm^2 thick, are being used to hermetically seal each gas cell and prevent the admixture of air, which is known to alter the gas gain of the detector. Pictures of both halves of the counter are shown in the figures, one showing them opened up, the other with them closed around the transport tape.

Our electronics consists of a fast current amplifier (Phillips Scientific, model 6950), a fast filter amplifier (EG&G Ortec, model 579), a 150 MHz lower-level discriminator (Phillips Scientific, model 711), a non-retriggerable gate generator (LeCroy, model 222) and a CAMMAC-based multichannel scaler (LeCroy/Data Design, model DDCIS10A). To ensure that the filter amplifier recovers quickly from saturating pulses, large pulses are clipped with a Schottky diode inserted after its first stage of amplification. The function of the gate generator is to provide a well-defined, non-extendable pulse width of 3-4 μs, which is measurable and acts as a dominant dead-time, larger than that associated with any preceding electronics.

The characteristics of our counter have been extensively measured off-line and shown to be nearly 100% efficient for the betas emitted from a mixed ^{90}Sr/^{90}Y source. The device was also tested on-line with separated ^{37}K samples produced from the ISAC facility at TRIUMF. Its behavior is similar to the Chalk River counter, which is now in use at TRIUMF, except for the presence of a small number of spurious low-energy signals. These signals are only present when activity is introduced into the counter, but they do not appear under identical conditions with the Chalk River counter. This is a serious problem. They interfere unpredictably with half-life measurements since they appear very near to the subsequent discriminator threshold level. Investigations continue to discover the source of these signals and to find a way to eliminate them.

References

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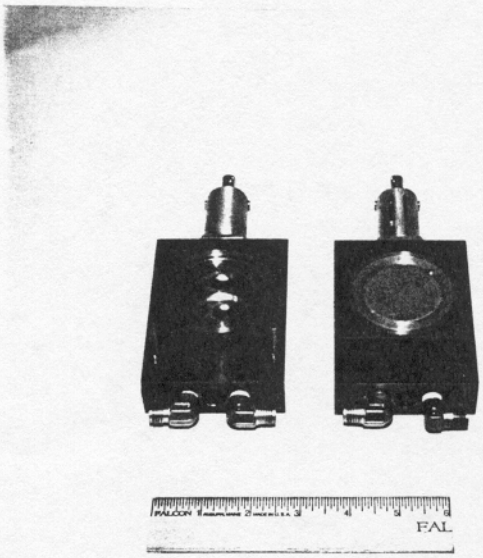

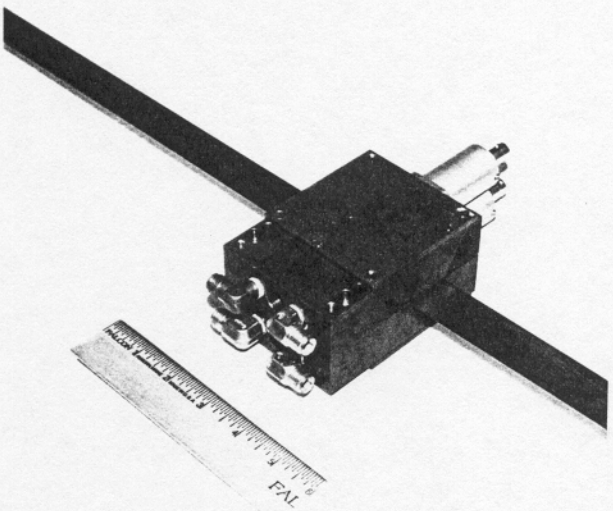

Figures 1 and 2: The 4π proportional counter is shown with the two halves split apart, one half with the window removed to show the inside of the chamber; and under normal operating conditions, with the two halves closed around the tape from the fast tape-transport system, which delivers activity collected from MARS.