Comparison of Triple-to-Double Coincidence Ratio Liquid Scintillation Counting Activity Determinations of Co^{60} Using FPGA and List-Mode Acquired Data

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Triple-to-double coincidence ratio (TDCR) liquid scintillation counting (LSC) is a primary method for the measurement of activity. TDCR is particularly suited to measuring activity for beta and positron emitters, since their relatively low LET leads to lower counting efficiency. A three-photomultiplier tube (PMT) system is used, with an LS vial containing activity and LS solution placed in the center, and emitted scintillation light collected by the PMTs. Logic circuitry is used to record the collected light as a triple coincidence (light pulse detected by all three PMTs) or a double coincidence (light pulse collected by two PMTs). The ratio of triple coincidence and double coincidence count rates is the TDCR, which allows an absolute measurement of the collection through a free-parameter efficiency model. Using various filters, the efficiency of light collection is manually changed to provide a range of TDCR values. Currently, NIST employs two modes of data collection in their TDCR system: a field programmable gate array (FPGA) based system that has been used in the past, and list-mode acquired data collected using a newly implemented Caen 5724 digitizer. In this work, TDCR activity measurements were performed for a ^{60}Co source using these two different methods of data collection. Activity calculations were done using both TDCR data sets in addition to two different MICELLE2 TDCR simulations. The two MICELLE2 simulations differed in the beta spectrum of ^{60}Co used: one using the classical ^{60}Co spectra and the other using the BetaShape calculated spectrum from Kossert et al (2018). Using MICELLE2 simulated TDCR and efficiency values, a plot of the efficiency versus the TDCR was made, and a linear fit was applied. This fit equation and the experimental TDCR values were used to solve the double coincidence counting efficiency. This efficiency and the experimentally measured count rate were used to get the value of the activity in becquerel. Comparisons were made between the activity computed using both TDCR data sets to assess differences in the data acquisition methods.

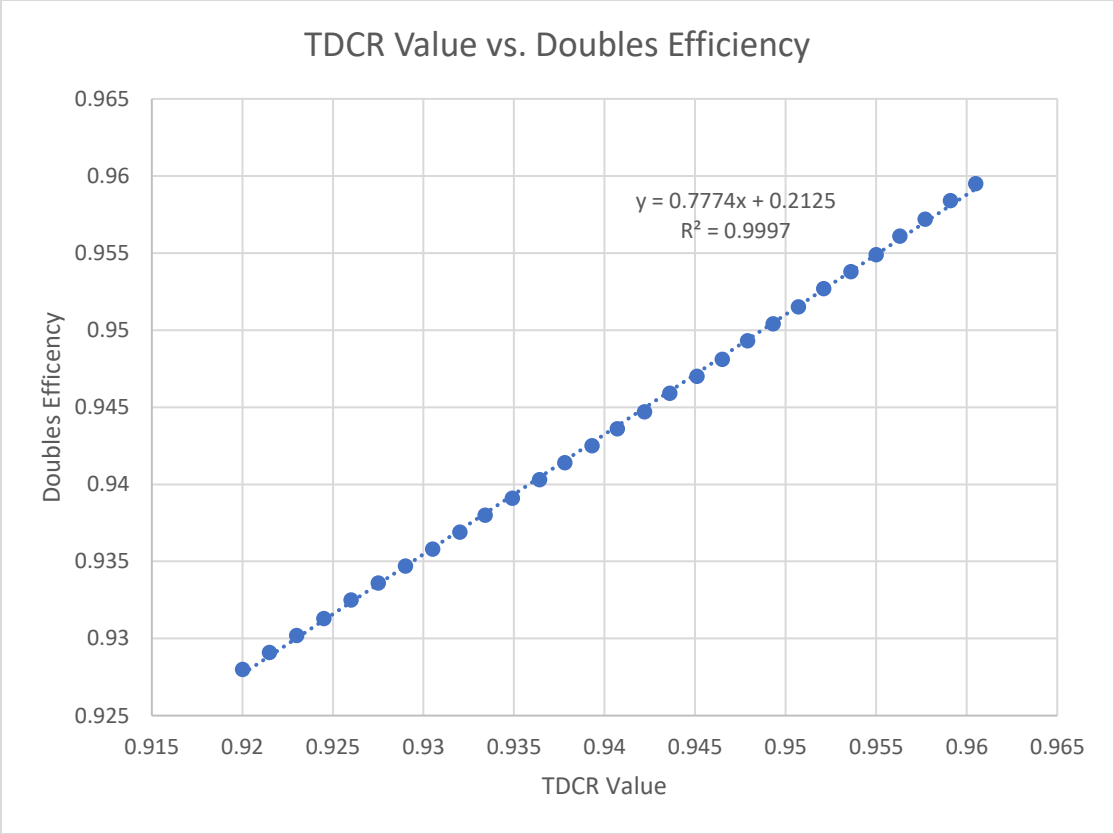

Figure 1. Plot of the MICELLE2 calculated TDCR values versus the MICELLE2 computed collection efficiency of double coincidences. The linear fit equation of this plot was used to calculate the experimental collection efficiency of double coincidences. This MICELLE2 simulation was done using the BetaShape computed ^{60}Co spectrum by Kossert et al (2018).