Branching ratio of the superallowed positron emitter ^{10}C

V.E. Iacob, D. Melconian, N. Nica, D. McClain, G. Morgan, M. Holloway,
M. Valdez-Calderon, and B. Roeder

Among superallowed beta emitters, ^{10}C has the highest chance to make an impact on setting tighter limits on the possible contribution of a scaler current to Fermi transitions [1]. Since the 1995 measurement by Savard *et al.* [2], several attempts have been made to improve its precision, most recently by Blank *et al.* [3]; while consistent with the accepted value, the new measurements did not match the precision of the 1995 experiment.

We report here a test run in which we tested our ability to measure the superallowed branch in the ^{10}C decay. The experiment requires to determine the intensity of the 1021.65-keV relative to the 718.34-keV gamma. The challenge comes from the relatively strong contribution to the 1021.65-keV line of the pile-up of two annihilation rays. In our approach, we try to take advantage of the dependence of the pile-up amplitude on the difference between the arrival times of the annihilation rays: the farther in time, the lower the amplitude of the sum. For this, we fine-tuned our beta-gamma coincidence setup, taking particular attention to the time-responses in the beta and gamma signals. In our setup, we consider β- and γ-ray signals arriving within 4 μs of each other as coincident. For each such event we recorded the deposited energies E_β and E_γ, the time difference between the detection of the two signals, $t_{\beta\gamma}$, and the absolute time of the coincidence. Using the 2D representation of $t_{\beta\gamma}$ versus E_γ, we can separate events related to the 1021.65-keV gamma from those related to piled-up annihilation rays. Fig. 1 presents the relevant part of the 2D histogram $t_{\beta\gamma}$-vs-E_γ. Obviously, the 1021.65-keV gammas generate a vertical, straight ridge, while piled-up annihilation rays generate a curved, parabolic ridge, extending from ~900 keV for $t_{\beta\gamma}$=0, to 1022 keV for $t_{\beta\gamma}$=2400ns. This clean separation into pile-up and genuine 1021.76-keV gammas allows us to extract the correct gamma intensities without the need of any additional calibration experiments.

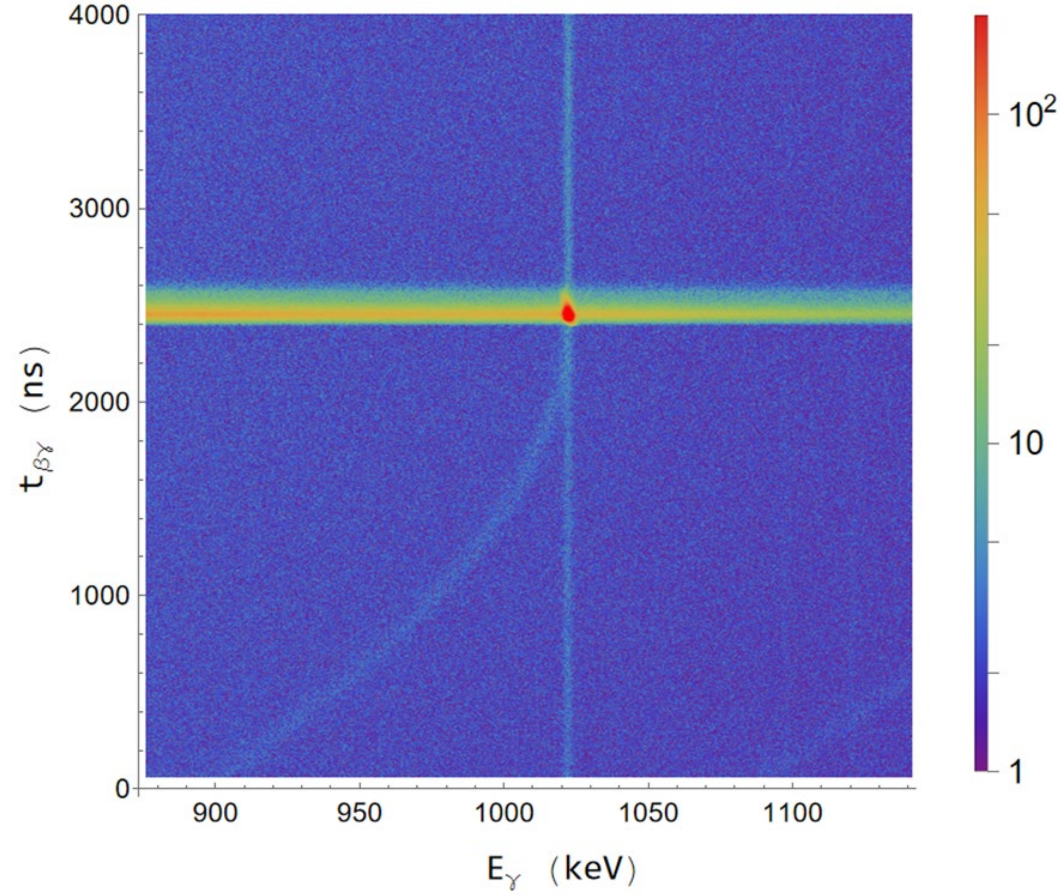

Fig. 1. Histogram coincidence-time versus gamma energy around E_γ=1021.65 keV.

[1] J.C. Hardy and I.S. Towner, Phys. Rev. C **91**, 025501 (2015).
[2] G. Savard *et al.*, Phys. Rev. Lett. **74**, 1521 (1995).
[3] B. Blank *et al.*, Eur. Phys. J. A 56, 156 (2020).56:156.