Calibration and simulation of $LaBr_3$:Ce scintillator for analyzing $^{8}Li(\alpha, n)^{11}B$-reaction data

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We performed an experiment[1)] using $LaBr_3$:Ce scintillators[2)] at CRIB in 2018 for investigating controversial large differences among the previously reported[3–9)] cross-section data of the $^{8}Li(\alpha, n)^{11}B$ reaction. In order to resolve the discrepancies among them, it is essential to obtain an accurate γ-ray spectrum of ^{11}B; therefore, accurate energy calibration and precise efficiency estimation play a crucial role. We performed off-line measurements for energy calibration using radiation sources, as listed in Table 1. Figure 1 presents the calibration plot, in which the horizontal and vertical axes correspond to the time-to-digital converter (TDC) channel reduced by a charge-to-time converter (QTC) and the expected γ-ray energy, respectively; the plot shows sufficiently good linearity. On-line measurements using ^{16}N beams were also performed at CRIB. In the studied reaction, ^{16}N decays to $^{16}O^*$, which emits γ-rays with E_γ = 6130 keV. GEANT4 simulations were also performed for each type of γ-rays. One example is shown in Fig. 2, which is the preliminary result of the γ-ray energy spectrum of $^{16}N(\beta\gamma)$. The histogram with error bars and filled histogram are measured and simulated spectra, respectively. The measured peaks of full energy, single escape and double escape are consistent with the simulated ones. By applying the results of our precise energy calibration, we can proceed to the data analysis for solving the discrepancies among the previous results.

Table 1. Gamma-ray sources used for off-line calibration and their energies.

Source	Energy (keV)
^{137}Cs	662
Am/Be($^{12}C^*$)	4440
Cm/C($^{16}O^*$)	6130
Am/Be+Al	7724

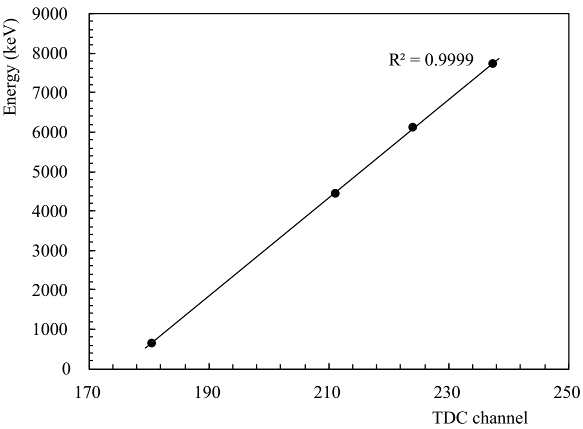

Fig. 1. Calibration plot obtained by off-line measurements.

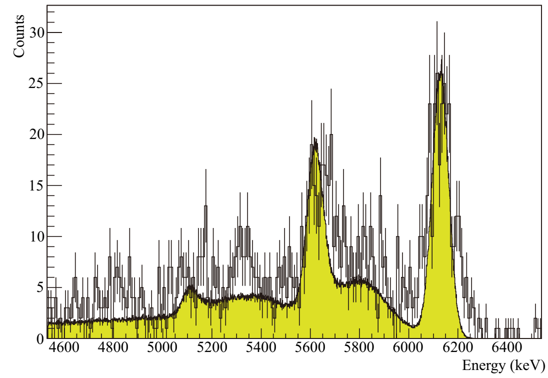

Fig. 2. Energy spectrum of γ-rays from $^{16}N(\beta\gamma)$.

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