

Comparison of time-walk compensation methods for Leading Edge Discriminators

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Purpose

Timing resolution of leading edge discriminators is affected by the time-walk caused by the uncertainty of interaction energy, thus several methods for time-walk compensation have been proposed. Most of the correction methods use the integral of the signal as a parameter for energy, while some studies tried amplitude or slew rate as a parameter for energy. In this study, we tested time-walk corrections using different parameters of energy to obtain optimal coincidence timing resolution.

Methods

We obtained the coincidence data using Hamamatsu R9800 PMT coupled with LYSO ($4 \times 4 \times 10$ mm³) with SiPM coupled with LGSO ($3 \times 3 \times 20$ mm³). Whole signals were digitized using digitizers (DT5742B; CAEN, Italy). To compensate for time walks, time differences were expressed as functions of parameters (integral, amplitude, and slew rate of signals). Linear fitting, quadratic fitting, and logarithmic fitting were tested. For linear fitting and quadratic fitting, the difference of parameters was used, while the logarithmic value of the ratio between parameters was used for logarithmic fitting. We performed principal component analysis on data, then divided them into 10 groups with the same numbers, selected median points for each group, then used them for curve fitting.

Results

With a 30 keV energy window, the detector pair showed 272 ps CTR. With time-walk correction using logarithmic fitting between energy and time, FWHM was reduced from 433 ps to 356 ps for the dataset obtained with a 500 keV energy window. Slew rate, amplitude, and energy showed similar performance in time-walk compensation.

No significant differences between linear, quadratic, and logarithmic functions were observed.

Conclusion

The log relationship between energy and timing was well known, but the amplitude and slew rate with appropriate curve fittings also showed similar time-walk compensation capability.

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