

Experiment settings and results

Introduction

Solid scintillation detector is one of the most commonly used devices for high energy photon and particle detection, due to its high detection efficiency, fast operation speed, low cost, production capability and radiation hardness. Fast scintillation detection systems, event energy measurement is a crucial task, nuclear medical imaging equipments like positron emission tomography (PET) and single photon emission computer tomography (SPECT) energy information is used to resolve Compton scatter and events not generated by the isotopic tracer. Moreover, energy information is even utilized in Argon logic algorithm to localize an event's position. PET systems equipped with position-sensitive photomultiplier tubes (PMTs)

Semiconductor detectors are usually considered as a linear system, which produces a current signal with amplitude proportional to the energy of the incident particles and independent of the number of single events. The detector's accuracy is severely affected when no more than a few pulses are produced. Such pile-up events are usually caused by high source activities, long pulse duration and etc. Pulse processing is important in the energy measurement.

The proposed method is a simple energy measurement method, which processes the signal with a digital signal processor (DSP). The proposed method applies MLE method to determine the digital signal processing pulse and then integrates the voltages of the resulting take signals to obtain the energy. The experiments showed that the proposed method provided encouraging performance in terms of energy resolution and count rate recovery. For single energy pulses of 10^4 counts per second, the energy resolution was found to be 1.5% at 10 keV and 12.8% at 100 keV. In the case of pulses with burst of 10^5 counts per second, the energy resolution was 1.5% at 10 keV and 12.8%. The count rate recovery was 100% at 10 keV and 95% at 100 keV. The energy resolution and count rate recovery were measured for the ER produced by DOI for single shots. Meanwhile, the energy resolution and count rate recovery were measured for the ER produced by DOI with a 2×10^4 counts per second. The energy resolution was 1.5% at 10 keV and 12.8% at 100 keV. The count rate recovery was 100% at 10 keV and 95% at 100 keV. The energy resolution and count rate recovery were measured for the ER produced by DOI with a 2×10^5 counts per second. The energy resolution was 1.5% at 10 keV and 12.8% at 100 keV. The count rate recovery was 100% at 10 keV and 95% at 100 keV.

Methods and Materials



Figure 3. (a) The LYSO scintillation crystal is in the size of $16.5 \times 16.5 \times 10$ mm³. (b) The detector consists of an LYSO crystal coupled to a Hamamatsu R9800 photomultiplier tube. (c) The pileups data experiment setup. Only one channel of oscilloscope was used.

The real world experiments showed that the proposed method provided encouraging performance in ER and count rate recovery. For single data measurement, the proposed method can obtain better results than the traditional methods.

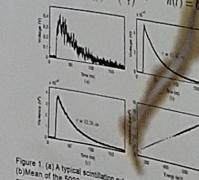


Figure 1. (a) A typical scintillation pulse sample.
 (b) Mean of the 5000 acquired pulses after non-exponential fitting result shows the distribution of 5000 acquired pulses.

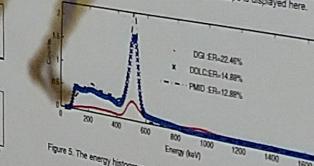


Figure 5. The energy histogram.

Discussion

Summary and Conclusion
 Based on the mean pulse of scintillation signals, we constructed a linear model for scintillation detection systems and thus transferred the measurement of event energy to a deconvolution (Poisson) problem. We proposed a pulse model based iterative reconstruction (PIR) method, which can provide pulsed events with accurate position and adaptive forth-moment signal pulse shapes. The proposed method was compared with digital-pulse-height analysis (DPA) and digital-delay-line (DDL) methods using world experimental data. For singles data, the clipping (DOLC) method performed best than DPA and DDL. For pulses, the energy resolution (ER) produced by PIR method was better than DOLC. In addition, the energy resolution of PIR method was better than DDL and DOLC in ER and count recovery. The encouraging results suggest that the PIR method has great potentialities in applications like photon-counting systems and pulse height spectrometers, in which multiple-event pluses are common.

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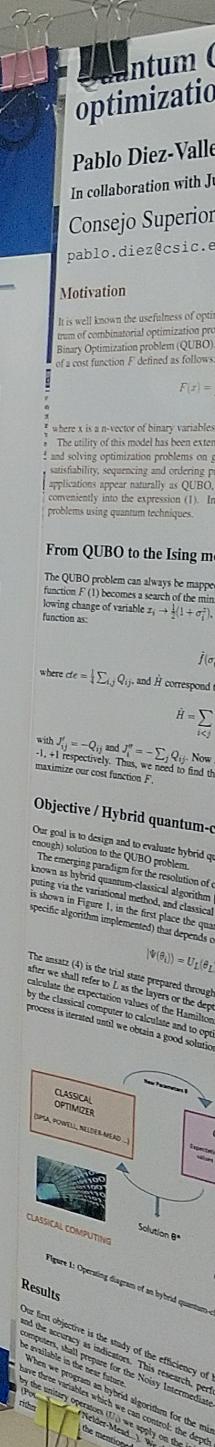
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100% of the energy consumed by the U.S. economy is derived from fossil fuels.



Results

Our first objective is the study and the accuracy as in computers, the

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useful intermediate variables which we can control; the unitary operations (U_i) we apply.