A novel real-time radiation detector readout and acquisition system for PET

Detectors:
I. 12 detector panels;
II. A detector panel:
   1. eight 8+8 MPPC arrays;
   2. four 15×15 LYSO arrays.

Electronics:
I. 12 Dlevel boards + 1 Slevel board.
II. Detector level (D-level) board:
    1. Sigma Delta Modulation Method
    2. 64 channels
III. System level (S-level) board:
    1. Event coincidence & buffer
    2. High speed data transferring

Results:
I. Good flood source;
II. Good energy resolution (~18%).
Poster #511

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Introduction

System configuration
1. 12 detector panels;
2. A detector panel;
3. Eight 8×8 MPPCs;
4. Four TDC arrays;

Electronics
1. 12 detector level boards;
2. Sigma-Delta readout;
3. 84 channels;

Level II system board;
1. System control logic;
2. System control logic;
3. System control logic;
4. System control logic;

Fig. 2. The readout electronics system for a detector module is shown in Fig. 3.

Fig. 3. A PET detector module consisted of a 12×12 array of 1×1×30 mm³ XPO cryystals with its two ends optically coupled to two Silicon PhotoMultiplier (SiPM) arrays (Hamamatsu Photonics K.K., 11365, 09064-01) (Fig. 3). To reduce the total number of output channels, a row and column of each input were internally combined to the board to provide eight output signals from four hologrally arranged row and column signals. Therefore, the readout electronics have to provide both negative and positive charge readout capability.

Readout electronics

Fig. 4. Readout circuit for negative charge.

Fig. 5. Readout circuit for positive charge.

The latest 5-bit Sigma-Delta Modulation (SDM) [1] method is used for charge readout. The initial version (Fig. 4) can only accept negative charge, in order to read out positive charge of MPPC array, a stage voltage is introduced in the SDM (Fig. 5).

Summary

- The feasibility of the low-cost, FPGA-based SDM circuit was
devolved and tested in a PET system.
- The improved SDM circuit can process both positive and negative input charge signals.
- The timing performance (±2.0 ns) of the current circuit needs
to be further improved. New readout electronics is under
development.

References: