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Front end, Trigger, DAQ and Data Management

Evaluation of data acquisition system based on FPGA and continuous readout of the J-PET detector

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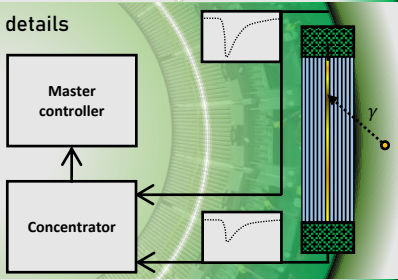
Abstract

Recently, Field Programmable Gate Arrays (FPGAs) have become the best platforms for data acquisition, providing both high capacity of logic resources and unique pipelined processing in real-time capabilities. The poster will present details of the FPGA-based data acquisition system and readout electronics, designed for the Jagiellonian Positron Emission Tomography (J-PET) detector [1-4]. The system works in a continuous readout mode, allowing the collection and pre-processing of all signals registered by the tomograph, which in particular allows for subsequent filtration of the signals for targeted analysis of various types of events like for example multi-photon imaging [5] and positronium imaging [6]. Data processing by programmable logic opens the possibility of initial analysis, coincidence building, as well as on the fly, preliminary image reconstruction [1,2]. It also allows for a significant reduction of data when extracting only the valuable parameters of the collected signals, estimated during processing.

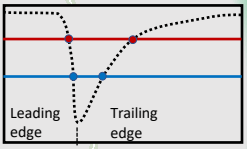
Technical details

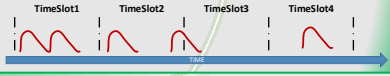
- Digitizing boards Xilinx Artix 7
  - 104 TDC channels
  - 30 ps time resolution
- Concentrator boards Xilinx Virtex Ultrascale
  - 12 links to the digitizing boards
  - 1 link to the controller board
  - 1 10Gb Ethernet data output link
- Controller board Xilinx Zynq MPSOC
  - 4 links to the concentrator boards
  - 1 1Gb Ethernet control and monitoring link



Workflow

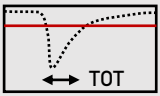
- Digitization:
  - Analog signals discriminated with FPGA buffers
  - Signals probed on multiple thresholds
- Synchronization:
  - Common synchronization pulse from the Controller board delivered to TDCs
- Data readout:
  - Fixed-frequency readout request
  - Data aggregation by the Concentrators

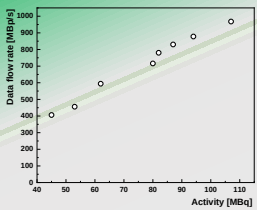




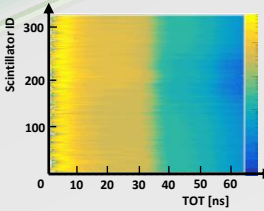
Characteristics

- Signals reconstructed with time resolution of 250 ps
- Energy of the signal estimated from the Time over Thresholds (TOT) value

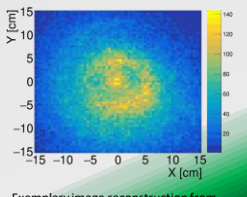




Data flow rate as a function of the source (^{18}F) inside the J-PET detector



TOT spectrum as a function of scintillator ID after synchorization



Exemplary image reconstruction from two-photon coincidences from the J-PET detector for cylindrical phantom

Acknowledgement

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