Implementation and verification of a high performance PET triggering unit and global clock distribtuion scheme

Master thesis project description

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January 12, 2011

Introduction

COMPET is novel pre-clinical small animal PET (Positron Emission Tomography) detector. The comPET detector has an inventive geometry with a total of 600 LYSO scintillation crystals and 480 wavelength shifters. The object of this master thesis is timplement and verify the Central Trigger Unit (CTU) and the global clock distribution for the read-out chain. The main task of this CTU is to monitor the activity in the detector through the read-out cards and trigger data acquisition when a coincidence occurs [1] . The CTU will also be the provider a synchronized clock domain to an arbitrary number of readout cards.

Motivation

A synchronized time-domain is needed to separate and compare interactions in time-domain, so event building across multiple readout cards is made possible. Since there can be an arbitrary number of read-out cards this is not a trivial task. The bottleneck for the system throughput (as it is now) is the network communication with the data storage facility. Filtering out the uninteresting events at the front-end will put less strain on the communication with the back-end, and is therefore seen as a crucial part of the read-out chain.

Methods

By first implementing a synchronous CTU scheme it will be possible to analyse the performance gains given. This can then be compared with more complex designs where we try to balance out ease of implementation versus scalability.

[1] A coincidence is when you detect something which originated from the radioisotope in use (back-to-back gammas from β^+ decay)

And the distributed clock domain needs to be measured and adjusted with accuracy in the nS range. The implementation will happen on purpose-bought development cards made by avNET for Xilinx which include cutting edge processing and communication units [2]. The comPET development is driven out by the Experimental Particle Physics group at UiO in collaboration with Rikshospitalet/Radiumhospitalet in Oslo and the Small Animal Unit at UiO.

Outline

- Get an in-depth understanding of general PET principles, and from that, study the inner workings of the comPET. The focus of the study will be on how the efficiency and throughput of the system can be optimized with the implementation of a Central Trigger Unit.
  This work will be done by the beginning of 2011.

- Instrumentation of the CTU will happen in generations. By starting out with a simplistic synchronized trigger scheme and from that experimenting with more novel complex designs while documenting the performance gains. The development will mainly happen with an HDL on a FPGA situated on a purpose bought development board. A design report will document the process and findings of this study.
  This a continuous effort throughout the entire project time.

References

[1] Jo Inge Buskenes. Master's thesis.

[2] J.G. Bjaalie J.I. Buskenes O. Dorholt O. Rohne A. Skretting S. Stapnes E. Bolle, M. Rissi. Compet - high resolution and high sensitivity pet scanner with novel readout concept: Setup and simulations. In *Nucl. Instr. and Meth. A*.

[2] Xilinx Virtex-5 LXT/SXT PCI Express Development Kit, http://www.em.avnet.com/