Contribution ID: **72** Type: **Poster**

Self-Triggering Readout System for the Neutron Lifetime Experiment PENeLOPE

Tuesday, 29 September 2015 17:07 (1 minute)

PENeLOPE is an a neutron lifetime measurement experiment at the Forschungsreaktor Muenchen II aiming to improve a precision of the measurement by one order of magnitude. The experiment employes state-of-the-art readout electronics and high performance data acquisition system.
The system features a continuos noise measurement and pedestal tracking, programmable threshold, high voltage control, cryogenic enviroment and the novel Switched Enabeling Protocol (SEP) developed for passive splitted optical networks. The SEP is a transport level protocol providing access to muplitple slaves connected to a star-topology optical network on a time-division
multiplexing maner.

Summary

The proton detector of the PENeLOPE experiment counts the protons from
the neutron decay and consists of about 1000 Avalanche Photo Diodes (APDs).
A maximum expected proton and background rate is 10ˆ5 Hz. The protons produced by neutron decay
have very low energy therefore in order to detect them a decay volume is placed within an elecrical field which guides the protons
towards the APDs and accelerates them to 30kEv/c. The APDs amplify proton signal to a large amount of electrons.
After that the signals are preamplified again, shaped and digitized by custom designed low noise electronics.
The readout electronics consists of 40 ADC cards carrying 25 channels each, 10 Signal Detection Units(SDU) and one Network Access Controller(NAC) module. Four ADC cards are attached to one SDU. The SDU is an FPGA module which detects signals and transmits
information to the NAC via the Switched Enabling Protocol (SEP).
In order to detect signals efficiently the SDU continuously determines pedestal values and measures
noises which are used by a signal detection logic. The signal is detected when a programmable number of consecutive
samples exceeds a programmable threshold. The threshold is defined as a minimum signal to noise ratio.
The detected signal is tagged by an absolute time provided by the NAC over the SEP protocol.
The signals are sampled at 0.8 MHz rate while the logic runs at 100MHz processing all 100 channels sequentially and thereby
minimizing usage of FPGA resources.

The SEP is a time-division multiplexing transport level protocol developed for a star like optical network topology
with one master and up to 256 slaves. The modules are connected with a single fiber using passive splitter.
The Time-division parameters are programmable and they are a trade-off between buffer sizes and a bandwidth
efficiency utilization. In case of PENeLOPE each slave gets 1 ms time window to transmit detector
information and slow control information. The access window is sequentially moved from one slave to another
in Round-robin manner. The bandwidth utilization efficency is about 98%. The protocol supports
data transmission, slow control interfaces(IPBUS) and distribution of synchronous messages with determinis-

tic latency.
The single fiber optical network simplifies galvanic isolation between the readout electronics(SDU), which stays at
the detector high voltage inside a cryostat, and the NAC module.
The NAC is also an FPGA based module, it combines all data from the different SDUs and sends them to a PC using UDP protocol.
This PC is carrying out all offline analyses and slow control functionality. The maximum expected data rate is about 50MB/s.
The performance of the PENeLOPE detector as well as architecture of the readout system will be presented.

The project is supported by the Maier-Leibnitz-Laboratorium (Garching),
the Deutsche Forschungsgemeinschaft and the Excellence Cluster "Origin and Structure of the Universe".

Primary author: Mr GAISBAUER, Dominic (TU München Physikdepartment E18)

Co-authors: Mr STEFFEN, Dominik (CERN); Mr KONOROV, Igor (TU München Physikdepartment E18)

Presenter: Mr GAISBAUER, Dominic (TU München Physikdepartment E18)

Session Classification: Poster

Track Classification: Systems