HK 41: Instrumentation 13

Time: Wednesday 14:30–16:30 Location: M/HS1

Group Report HK 41.1 Wed 14:30 M/HS1

Development and Verification of a Compact TDC-Based Data Acquisition System for Space Applications — •Martin Losekamm[1,2], Dominic Gaisbauer[1], Igor Konorov[1], Stephan Paul[1], and Thomas Pöschl[1] — [1]Physics Department E18, Technische Universität München — [2]Institute of Astronautics, Technische Universität München

The advances of solid-state detectors and in particular those for the detection of photons have made their application in space systems increasingly attractive in recent years. The use of, for example, silicon photomultipliers (SiPM) paired with a suitable scintillating material allows the development of compact and lightweight particle detectors. The Antiproton Flux in Space experiment (AFIS) intends to measure the flux of antiprotons trapped in Earth's magnetosphere aboard a nanosatellite using an active target tracking detector, consisting of plastic scintillating fibers read out by SiPMs. In order to implement a large number of detector channels while adhering to the given space, mass and power constraints, the development of a compact TDC-based data acquisition system was proposed. This talk will present a current prototype featuring 900 channels, real-time multi-channel temperature measurement and bias regulation. Possible alternative applications as well as the next steps in the development will also be discussed. This work is supported by the Excellence Cluster 'Origin and Structure of the Universe'.

HK 41.2 Wed 15:00 M/HS1

A new FPGA-based Time-over-Threshold System for the Time of Flight Detectors at the BGO-OD Experiment — •Oliver Freyermuth for the BGO-OD-Collaboration — Physikalisches Institut, Nussallee 12, D-53115 Bonn

The BGO-OD experiment at the ELSA accelerator facility at Bonn is built for the systematic investigation of meson photoproduction in the GeV region. It features the unique combination of a central, highly segmented BGO crystal calorimeter covering almost 4π in acceptance and a forward magnetic spectrometer complemented by time of flight walls.

The readout of the ToF scintillator bars was upgraded to an FPGA-based VME-board equipped with discriminator mezzanines including per-channel remotely adjustable thresholds. A firmware was developed combining a time-over-threshold (ToT) measurement by implementing a dual-edge TDC, a configurable meantimer trigger logic including a special cosmics trigger, adjustable input delays and gateable scalers, all inside a single electronics module.

An experimentally obtained relation between ToT and slope of a PMT signal can be used for a time walk correction to achieve time resolutions comparable to a classical chain of CFD and standard TDC. Additionally, the time-over-threshold information can be exploited for gain matching and allows to monitor online the gain-stability and check for electronics problems such as pulse reflections or baseline jitter.

The system is well-suited for a wide range of PMT-based fast detectors with many channels and further applications foreseen.

This work is supported by the DFG (SFB/TR-16).

HK 41.3 Wed 15:15 M/HS1

FPGA-Based Upgrade of the Read-Out Electronics for the Low Energy Polarimeter at the Cooler Synchrotron — •Nils Hempelmann for the JEDI-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich

The Cooler Synchrotron (COSY) is a storage ring used for experiments with polarized proton and deuteron beams. The low energy polarimeter is used to determine the vector and tensor polarization of the beam before injection at kinetic energies up to 45 MeV for protons and 75 MeV for deuterons. The polarimeter uses scintillators to measure the energy of both outgoing particles of a scattering reaction and the time between their detection. The present read-out electronics consists of analog NIM modules and is limited in terms of time resolution and the capability for online data analysis. The read-out electronics will be replaced with a a new system based on analog pulse sampling and an FPGA chip for logic operations. The new system will be able to measure the time at which particles arrive to a precision better than 50 ps, facilitating better background reduction using coincidence measurement. In addition to measuring the beam polarization, the system will be used to precisely determine the vector and tensor analyzing powers for deuteron scattering off carbon at a kinetic energy of 75 MeV.

HK 41.4 Wed 15:30 M/HS1

FPGA-based calibration and monitoring system for the HADES Electromagnetic Calorimeter. — •Alessandra Lai for the HADES-Collaboration — University of Turin, Italy — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The High Acceptance Di-Electron Spectrometer (HADES) at GSI was designed to measure dileptons and strangeness in elementary and heavy-ion collisions. An upgrade of HADES with an Electromagnetic Calorimeter (ECAL) has started and will be ready for beam in 2017. The goal is to measure π^0 and η meson yields together with the dielectron data in pion and proton-induced reactions as well as in heavy ion collisions. Moreover, photon measurement is important for Λ^0 (1405) and Σ^0 (1385) spectroscopy.

It is essential to precisely calibrate all the lead-glass crystal modules individually in order to achieve the required ECAL performances. Continuous monitoring with a light pulser system is required. It is foreseen to use blue light from an LED source, driven by short signals from a flexible pulse generator and distributed with optical fibers to each module of the ECAL. Due to their great flexibility, Field Programmable Gate Arrays (FPGA) have been chosen to implement the mentioned monitoring system. In this contribution an FPGA-based calibration system for commissioning as well as long term stability of the ECAL modules will be presented.

This work has been supported by BMBF (05P12RFGHJ), VH-NG-823, EMMI, GSI and HIC for FAIR.

HK 41.5 Wed 15:45 M/HS1

Read-out concepts for FPGA-based sub-systems within the CBM detector — •Jan Michel for the CBM-Collaboration — Goethe-Universität Frankfurt

The Compressed Baryonic Matter experiment (CBM) to be built at FAIR consists of several individual sub-detectors. Some are based on custom ASICs as front-ends. Others employ FPGA based modules where extensive slow control features can be implemented to ease the recording of data and to allow for fast detection of any kind of error condition. Being designed as a free-running data acquisition, the demands also include a synchronized read-out, i.e. distribution of a common clock signal to all modules. To reduce the complexity of wiring, this is to be done sharing the same optical fibers as the data transport. During the past years, TrbNet has been designed and is used in various experiments, initially for the HADES experiment at FAIR. This protocol can now serve as a platform for the CBM read-out. In several steps, synchronous links with deterministic latency, as well as a free-streaming data transport can be included. At the same time, modifications to improve bandwidth and provide compatibility to the CERN GBTx links used for ASIC based sub-systems are to be developed. This contribution shows the planned steps as well as the current status of development. This work has been supported by BMBF (05P12RFFC7), GSI and HIC for FAIR.

HK 41.6 Wed 16:00 M/HS1

Upgrade of the Data Acquisition System for the A2 Experiment at MAMI — •Andreas Neiser and Wolfgang Gradl — Institut für Kernphysik, Johann-Joachim-Becher-Weg 45, Mainz

The A2 collaboration at the electron accelerator MAMI in Mainz uses energy-tagged photons to produce light mesons off the nucleon. Its current data acquisition system is the major performance bottleneck under typical trigger conditions. Furthermore, the availability of spare parts is limited, which renders the maintainability for the next decade difficult. Thus, an upgraded system is desirable for A2 to achieve the upcoming experimental goals. For this upgrade, an FPGA-based solution using the TRB3 is being considered.

The TRB3 is a multi-purpose $4+1$ FPGA board, where four peripheral FPGAs communicate with one add-on board each. The central FPGA provides data readout via standard gigabit Ethernet and interconnection to other TRB3s via optical links. The TRB3 collaboration currently provides flexible TDC-in-FPGA firmwares with various discrimination front-ends as well as a 48 channel ADC add-on board with 60 MHz sampling rate and 10 bit resolution. Additionally, an extensive software framework for slow control and readout is available.

We present energy and timing measurements with the ADC add-on board at the Crystal Ball NaI(Tl) calorimeter and compare the performance to the currently used COMPASS data acquisition system. Furthermore, we give an outlook on possible feature extraction firmwares and estimate the costs for a complete upgrade of the system.

HK 41.7 Wed 16:15 M/HS1

A FPGA based DAQ for the COMPASS experiment — •Stefan Huber — Technische Universiät München

In this contribution the deployment and first results of the new FPGA-based data acquistion system (DAQ) of the COMPASS experiment is presented. Since 2002, number of channels increased from 190000 to approximately 300000, trigger rate increase from 5 kHz to 30 kHz; the average event size remained roughly 35 kB. In order to handle the increased data rates, it has been decided to develop a new DAQ system during technical shutdown of CERN accelarator in 2013-2014. The new system replaces the old computer based event building network with custom FPGA based data handling cards (DHC). The DHC cards use two different versions of firmware: multiplexer and switch. The multiplexer card can combine 15 incoming links into one outgoing, whereas the switch combines 8 data streams from multiplexers and using information from look-up table sends the full events to the readout engine servers equipped by spillbuffer PCI-Express cards that receive the data. Both types of DHC cards can buffer data which allows to distribute the load over the cycle of accelerator. As the DHC cards perform data flow control and event building, the software serves only for configuration, run control, and monitoring. For these purposes, we have developed software tools. The new DAQ system has been deployed for the pilot run starting from the September 2014. In the paper, we present preliminary performance and stability results of the new DAQ, we compare it with the original system in more detail.