HK 11: Instrumentation IV

Time: Tuesday 14:00–16:00 Location: H4

Group Report HK 11.1 Tue 14:00 H4

A new free running DAQ for future measurements at the M2 beamline at CERN — •Benjamin Moritz Veit for the AMBER DAQ-Collaboration — Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz

Several new measurements with muon and hadron beams at the M2 beamline of the CERN SPS were approved. For the experiments, it is planned to transform the current classical DAQ approach to a free running (streaming) DAQ scheme, which is based on a trigger-less readout of all detectors with local data processing and later online and offline data reduction stages based on FPGA and X86 filter technologies (High-Level Triggers). Few levels of FPGA multiplexers perform real-time tasks of processing timestamped hit information from the detectors, buffering, merging, and distributing data between read-out computers. The read-out computers transfer data to a local storage system. From this storage, an asynchronous running HLT system is fetching the data. On the HLT system, the data will be partially reconstructed, analyzed, and eventually reduced before it is written to permanent storage. One of the approved experiments is the measurement of the proton charge radius by elastic muon proton scattering. For this experiment, two data taking phases are foreseen. For the first phase, with a low-intensity muon beam, a full, not reduced data sample will be written to disk. This allows a complete unbiased data analysis and the validation of the filtering scheme. An overview of this novel DAQ and filtering approach will be presented.

HK 11.2 Tue 14:30 H4

Recent developments of the slow-control of the barrel part of the PANDA EMC front-end bus system* — •Christopher Hahn for the PANDA-Collaboration — II. Physikalisches Institut, Gießen,Deutschland

One of the main components of the upcoming PANDA experiment at the future FAIR complex in Darmstadt will be an Electromagnetic Calorimeter (EMC) inside a 2 T solenoid. Due to the required energy resolution, timing and spacial constraints, the individual high-voltage adjustments for the Large Area Avalanche Photodiodes (LAAPDs) that read out the EMC crystals demand innovative and specialized electronics, such as, for example, the individual bias voltage adjustments for the Photodiodes need to be accurate down to 0.1V. At the same time, space constraints in the inner detector volume limit options for individual cable routing and connections for the LAAPD bias voltage. The key elements of the high voltage adjustment concept will be described, with a special focus on the first and the second iteration of the dedicated control ASICs for the front-end bus system, the so-called SerialAdapter ASICs (SAA). The SAAs are also utilized for the communication and control of the APFEL preamplifier ASICs, which read out the APD photodetectors. The different versions of the SerialAdapter ASICs were utilized in the preproduction versions of the High-voltage control for the LAAPDs. The results of these preproduction tests will be presented. *gefördert durch das BMBF, GSI und HFHF.

HK 11.3 Tue 14:45 H4

Implementation of a MiniTAPS Trigger Board for the CBELSA/TAPS Experiment — •Lisa Richter, Annika Thiel, Janis Hoff, Peter Klassen, and Christian Honisch for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The nucleon excitation spectrum is probed by the CBELSA/TAPS experiment by studying different photoproduction reactions using real photon beam on a polarized or unpolarized target. The experimental setup comprises mainly two electromagnetic calorimeters, the Crystal Barrel and the MiniTAPS detector, focusing on neutral mesons in the final state that decay to photons. Since the CBELSA/TAPS is a fixed target experiment, many decay particles are boosted in forward direction.

Here, the MiniTAPS detector is located, which consists of 216 hexagonal BaF2 crystals which are read out via photomultiplier tubes. It covers the forward angle between 1° and 12° and can capture photons with energies between 10 MeV and 2.0 GeV. To avoid wrong trigger information due to overlapping clusters, the crystals are arranged in four sectors and the number of hits in a sector in one event is determined by the trigger. The new MiniTAPS trigger replaces the old MCU (multiple coincidence unit) electronics. It is realized by a single FPGA in a VME module. This not only simplifies the electronics but also allows for more sophisticated trigger algorithms including e.g. a fast cluster finder. The new setup of the trigger and the current status of the analysis will be presented in this presentation.

HK 11.4 Tue 15:00 H4

Designing FPGA Readout Firmware with the help of Vivado HLS — •David Schledt for the CBM-Collaboration — Infrastructure and Computer Systems in Data Processing, Frankfurt, Deutschland

Traditionally FPGA firmware was developed solely with Hardware Description Languages (HDL) like verilog or VHDL. However, with the steady improvements of tools like Vivado HLS (High Level Synthesis) it is now possible to write parts of the firmware with higher level languages like C++. Using HLS allows faster development cycles, easier code reuse and, most importantly, to efficiently write complex algorithms for the FPGA.

The Compressed Baryionic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will investigate the QCD phase diagram at high net-baryon densities. The experiment employs a free streaming data acquisition with radiation hard self-triggered front-end electronics (FEE). At interactions rates of up to 10 MHz the readout firmware has to process very high data loads. The detector data is marked with timestamps by the FEE, which has to be sorted in time to speed up the online event finding. This requires complex data processing inside the FPGA. In this talk I will present how the readout firmware for the CBM Transition Radiation Detector (TRD) was developed aided by Vivado HLS.

This work is supported by BMBF-grant 05P19RFFC1.

HK 11.5 Tue 15:15 H4

HLS C++ Template Library for Detector Readout and Data-Preprocessing using FPGAs — •Thomas Janson and Udo Kebschull — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, 60438 Frankfurt am Main, Germany

In this talk, we discuss a methodology of implementing massive parallel algorithms using the C++ high-level synthesis. We show that the methodology is applicable for preprocessing in FPGA based detector readout widely used in high-energy physics experiments. The focus is on feasibility for this field by using modern C++ programming techniques with the help of generic template programming. It has been shown that with this methodology the resource consumption remains acceptable low compared to an HDL implementation. The Intel HLS compiler and C++17 language features are used to implement algorithms in the style of data flow programming, which are particularly well suited for processing data streams. The idea is to present an algorithm as a data flow graph and implement it as a deep pipeline on an FPGA. For this we are developing an HLS C++ template library for detector readout and data pre-processing targeting FPGAs. A first draft of this library is shown in this talk.

HK 11.6 Tue 15:30 H4

The HADES electromagnetic calorimeter upgrade: Current status and future perspectives* — •Adrian Rost for the HADES-Collaboration — FAIR GmbH, Darmstadt, Germany — TU Darmstadt, Darmstadt, Germany

The HADES spectrometer at GSI Helmholtzzentrum für Schwerionenforschung GmbH in Darmstadt was recently upgraded with a new electromagnetic calorimeter (ECAL). In March 2019 a four week physics production beam time with an "Ag+Ag" beam at 1.58A GeV was carried out. In this contribution the performance of the new detector system under beam conditions will be presented. Particular emphasis will be put on its FPGA-TDC based read-out electronics and the performance.

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HK 11.7 Tue 15:45 H4

Low Gain Avalanche Diodes for timing applications in

HADES — •Wilhelm Krueger[1], Tetyana Galatyuk[1,2], Vadym Kedych[1], Sergey Linev[2], Jan Michel[3], Jerzy Pietraszko[2], Adrian Rost[1,4], Michael Traeger[2], Michael Traxler[2], and Christian Joachim Schmidt[2] — [1]TU Darmstadt, Germany — [2]GSI GmbH, Darmstadt, Germany — [3]Goethe-Universität Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

A reaction-time (T0) determination with a precision of $\sigma_{T0} < 50$ ps is required by the HADES physics program in order to ensure e.g. an excellent particle identification via Time-of-Flight measurements. In addition, monitoring of beam properties such as position, width and time structure is necessary. In order to fulfill these tasks, the recently emerged Low Gain Avalanche Diode (LGAD) technology seems to be a fitting candidate. A timing precision of $\sigma_t \approx 47$ ps was demonstrated with an LGAD based prototype T0 detector at COSY (Juelich), with a 1.92 GeV proton beam. Therefore, it is planed to use LGADs in upcoming experiments with proton, pion and possibly ion beams. The so far reached results will be presented in this contribution. In addition, future plans on development of dedicated ASICs capable of dealing with high rates and a high number of read-out channels will be mentioned. This work is supported by F&E, TU Darmstadt and HGS-HIRe.