HK 15: Instrumentation V

Time: Monday 16:00–17:30 Location: HK-H4

Group Report HK 15.1 Mon 16:00 HK-H4

A new high level filter system for the AMBER experiment at the CERN SPS — •Benjmain Moritz Veit for the AMBER-Collaboration — Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz

AMBER is a new experiment at the European Organization for Nuclear Research (CERN) dedicated to study fundamental questions related to the emergence of hadron mass from QCD. Therefore a variety of measurements with muon and hadron beams, which will cover a wide range in the squared four-momentum transfer Q2, at the M2 beam line of the Super Proton Synchrotron (SPS) are forseen. One of the first measurements in AMBER phase 1 is the elastic scattering of high-energy muons off protons to precisely determine the proton charge radius. For this experiment, it is planned to transform the current classical DAQ approach to a streaming DAQ scheme, in which detectors deliver continuous time-stamped data streams with data rates of up to 20GB/s to the DAQ. This data streams will be concentrated by a system of FPGA-based multiplexers and a timeslice builder switch before the full data stream is stored by readout computers on a temporary local storage. The local storage allows for extraction and validation of calibration information before the final processing. The newly developed asynchronous running high level filter system (HLT) use this information to partially reconstructed, analyse, and eventually reduced the amount of data. The goal of the filter system is to reduce the data rate below 500MB/s before it is written to permanent storage. An overview of the design of the filter system will be presented.

HK 15.2 Mon 16:30 HK-H4

NuDAQ - A flexible and extendable data acquisition system for above-small size nuclear physics setups — •Michael Weinert, Christoph Fransen, Andreas Harter, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The increasing number of channels in modern day nuclear physics experiments led to a redesign of the digital data acquisition system (DAQ) and the overall approach to setting up experiments at the Institute for Nuclear Physics in Cologne. While a high channel count and low dead times are welcomed features of modern digital acquisition systems, the highest achievable spectral resolution is mandatory for experiments that depend on the analysis of e.g. γ-ray energies well below 1 keV precision or direct lifetime measurements in the ps regime. A new DAQ system was built around the commercially available V1730 and V1782 digitizer modules by CAEN SpA, which are used to process signals from semiconductor detectors as well as photomultiplier-based detectors. A centralized server station, connected to each setup via fibre channel, builds the heart of the DAQ system that does not have to be moved between experiments, is accessible even when beam is on target, and benefits from an independent power supply and a fast uplink. An online-coincidence filter module has been implemented on the CAEN V2495 FPGA module which also allows to process veto signals per detector. This contribution presents the new system and improved workflow and display the high performance available for local experiments. Supported by the BMBF (05P21PKEN9).

HK 15.3 Mon 16:45 HK-H4

A Cost-Effective Modular Data Logger for Detector Laboratories — •Philip Hauer, Mario Engel, Oliver Adam, Thomas Block, Jan Paschek, Tobias Rudolph, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik – Universität Bonn

Many important parameters of a gaseous detector (e.g. the gas gain) depend on environmental parameters such as pressure and temperature. For the operation of gaseous detectors it is therefore crucial to monitor these parameters precisely and reliably. In order to fulfil this task, a modular logger for environmental parameters in laboratories was developed. In addition, the used temperature and pressure sensor is so small that it can be placed inside the gas system such that it can measure the temperature and pressure of the gas directly.

The logger is based on different sensors that are connected to a micro-controller which has a built-in WiFi chip. The micro-controller connects to a local wireless network which is created by a Raspberry Pi. Via the MQTT protocol, the recorded data are sent to the Raspberry Pi which forwards the data to a remotely accessible database for long-term storage.

On this poster, the setup is described in more detail. Some exemplary data and how they are used to correct gain fluctuations are also shown.

Supported by BMBF.

HK 15.4 Mon 17:00 HK-H4

Developing Feature Extraction Algorithms with Vivado HLS for the CBM-TRD — •David Schledt — 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 Baryonic 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 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 CBM Transition Radiation Detector (TRD) is equipped with the SPADIC front-end ASIC. The SPADIC allows for an oscilloscope-like sampling of the detector signals. From the sampled signal several different features can be extracted, such as the deposited charge or a time resolution above the pure sampling frequency. In this talk I will present how different feature extraction algorithms were implemented in the FPGA with Vivado HLS.

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HK 15.5 Mon 17:15 HK-H4

Firmware improvements for the FPGA-based Sampling-ADC readout of the Crystal Barrel Calorimeter — •Benedikt Otto for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The CBELSA/TAPS experiment investigates the photoproduction of neutral mesons. Since June 2021, the experiment's main calorimeter is equipped with a new Sampling-ADC (SADC) readout, based on 14bit@80MS ADCs and Kintex7 FPGAs. The firmware taking care of feature extraction and UDP/IP communication is currently developed further and improved.

Part of these enhancements is the resource-efficient implementation of a finite-impulse-response (FIR) filter to perform effective noise reduction. Additional improvements to the feature-extraction algorithms themselves are presented as well. To furthermore accommodate multihit-features and a custom waveform compression method, the packet structure had to be adapted.

As integral part of the firmware development, a comprehensive test suite was implemented using python and cocotb which allows convenient and automated testing of firmware components.