T 43: Electronics, DAQ, Exp. Methods

Time: Tuesday 17:00–18:30 Location: POT/0106

T 43.1 Tue 17:00 POT/0106

Turning an FPGA into a fast multi-channel ADC — •Dmitry Eliseev, Thomas Hebbeker, Markus Merschmeyer, Carsten Presser, and Erik Ehlert — III. Physikalisches Institut A, RWTH Aachen University, Germany

Electronics for particle detectors nowadays typically deal with a huge number of channels. In a typical detector read-out electronics, the front-end signals are passed through a multi-channel conditioning circuit and meet an FPGA chip at the other end. Modern FPGAs enable good time resolution for such multi-channel acquisition. However, the common solution remains to acquire information on the energy or amplitude of particular events using high-speed multi-channel ADCs. Using ADCs often results in more complex schematics and much higher costs of the electronics for signal acquisition. The presented method makes it possible to waive the ADCs and, to some extent, replace the ADC's functionality with FPGA's internal resources. The method requires a minimal number of additional low-cost external components and can be potentially interesting for many detector applications.

The talk provides a general overview of how to turn a commercially available FPGA device into a multi-channel high-speed ADC. Characterization measurements and calibration methods for the resulting FPGA-based ADC are also given. Possible technical difficulties and ways to overcome them are discussed in an example application: an 8-channel mezzanine PCB for signal acquisition from multiple SiPMs.

T 43.2 Tue 17:15 POT/0106

A Software-Scalable ADC in 28nm CMOS for Detector Readout — •Lukas Krystofiak — Forschungszentrum Jülich

Particle detector experiments rely more and more on advanced integrated circuits to achieve new discoveries. Their development is a lengthy and costly process, that poses a high threat to the overall success of a project. Using a pre-developed software-scalable ADC, adjustable in resolution and sample rate and ultimately in power consumption, catering to many different areas of applications, can decrease this risk substantially. While a generic approach will never reach the same performance as a dedicated development, it facilitates rapid prototyping and verification of readout methods prior to the building of the complete systems without the need to develop a dedicated chip. It also opens up possibilities for projects with smaller budgets. The key driver for this concept is the use of a bulk CMOS 28nm process technology, which allows incorporation of a powerful digital signal processor while analog performance and design is not too restricted. Here, the first iteration of a software-scalable ADC is shown. It features a high-precison mode with 11 Bit resolution and a maximum sample rate of 400 Megasample per second, and a low-power mode with 8 Bit resolution and 800 Megasample per second.

T 43.3 Tue 17:30 POT/0106

High-rate On-Board Drift Tube electronics testing — •Matej Repik, Dmitry Eliseev, Thomas Hebbeker, and Markus Merschmeyer — III. Physikalisches Institut A, Aachen, Germany

A general-purpose detector at the Large Hadron Collider (LHC), the Compact Muon Solenoid (CMS), undergoes changes that are summed up under the Phase 2 Upgrade. As one of the CMS muon-detecting subsystems, the drift tube chambers (DT) also require an upgrade. Among others, the plans foresee new On-Board Drift Tube (OBDT) electronics to replace the previous electronics. OBDTs congregate front-end signals from the DT chambers and stream the acquired data to the CMS back-end. Each OBDT also implements certain slow control routines. As for every complex device, quality assurance is essential for the new OBDT electronics. Consequently, a test system for OBDT is being developed by the DT collaboration with the following requirements: emulate drift tube front-end signals at the expected high hit rates and record the response of OBDT. This talk focuses on the aforementioned test system and its implementation at RWTH Aachen University.

T 43.4 Tue 17:45 POT/0106

Absolute luminosity calibration through van der Meer scans in ATLAS — •Cédrine Hügli for the ATLAS-Collaboration — DESY Zeuthen

Luminosity is a very important quantity for many physics analyses. Its precise knowledge is required for example in cross section measurements. In ATLAS, luminosity is measured by several detectors: the main luminometer is LUCID, located in the forward region and based on Cherenkov radiation. All luminosity detectors need to be absolutely calibrated through so-called van der Meer scans. These are scans where the two beams are scanned through each other, first in the horizontal and then in the vertical plane. In this work, the preliminary analysis of the run 3 13.6 TeV van der Meer scan from 2022 is presented. The analysis precisely measures the part of the inelastic proton-proton interaction cross section visible in the luminosity detectors, which is the absolute luminosity calibration constant. Its value is obtained by fitting the scan curves. During the van der Meer scan analysis several effects need to be corrected to get a precise calibration constant, for example the impact of the electromagnetic interaction of the beams on their separation. The obtained absolute calibration of luminosity is then transferred to physics conditions and used in the early run 3 ATLAS measurements.

T 43.5 Tue 18:00 POT/0106

Emittance Scans at the LHCb Detector in Run 3 — Johannes Albrecht, Elena Dall'Occo, Hans Dembinski, and •Jan Ellbracht — TU Dortmund University, Dortmund, Germany

Precise determination of the luminosity at the LHCb detector is needed for accurate measurements of cross-sections as well as in daily operations. The instantaneous luminosity at LHCb is levelled throughout the fill to optimise the detector performance, which is achieved by tuning the distance between the two colliding beams based on a real-time measurement of the luminosity. The luminosity calibration is performed once per year and per centre-of-mass energy in dedicated van-der-Meer scans. Here, particular beam conditions are used, leading to a maximum number of visible proton-proton interactions $\mu \sim 1$ when the beams are colliding head-on.

In Run 3 the LHCb detector operates at a five times higher instantaneous luminosity compared to the previous runs, with a μ of about 5.5. Therefore, it is planned to perform additional per-fill emittance scans in order to verify linearity from calibration to data taking conditions. This talk will focus on the emittance scan analysis, procedure and first results of Run 3 data.

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T 43.6 Tue 18:15 POT/0106

Estimation of the van-der-Meer factorization bias using the Beam Imaging Method — •Konstantin Sharko and Andreas Meyer — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

At the CMS Experiment at the LHC, van-der-Meer (vdM) scans are used to calibrate the luminosity measurement. The beam imaging (BI) data, a special type of vdM-scan data, are used to estimate and correct biases coming from the assumption of transverse factorization of the proton-bunch densities. In BI scans one of the beams is kept at rest while the other one moves along the x- or y-axis.

In this analysis, the four scans, one for each of the two transverse orientations and two beams, are fit using combinations of Gaussian functions to extract the van-der-Meer factorization bias for LHC Run-2 and Run-3 data.