T 18: DAQ und Trigger I

Zeit: Montag 16:00–18:35 Raum: ST 2

Gruppenbericht T 18.1 Mo 16:00 ST 2

FTK system and online monitoring — •Marta Czurylo and André Schöning — Physikalisches Institut, Universität Heidelberg, Germany

The FTK system is currently being commissioned at ATLAS and its main goal is to add the capability of obtaining the full tracking information at the High Level Trigger which will allow to select events with interesting kinematic properties and will help to further reduce the event rate. This will be beneficial during the LHC Run III while during Run II only the tracking information obtained in the Regions of Interest (around trigger objects) was available. An overview of the FTK system is given in the first part of the talk. In order to quickly and efficiently recognise errors occurring in the system, the functioning of hardware and software needs to be monitored. In this talk, the currently developed central online application is presented.

T 18.2 Mo 16:20 ST 2

Adapting the ATLAS Fast Tracker track fit constants to new detector conditions — •Emily Thompson — DESY

During the Run 3 of the LHC, the number of simultaneous proton-proton collisions is expected to rise to an average of 80 events per bunch crossing. This poses a significant challenge for the trigger system of ATLAS, which aims to select interesting signal events with high purity at a rate of only 1 kHz.

The ATLAS Fast Tracker (FTK) is a hardware based track finding system which is designed to provide full tracking information at an early stage of the ATLAS trigger system. The FTK is a highly parallelized system which performs pattern matching between hits in the silicon trackers and one billion simulated patterns stored in ASIC Associative Memory chips, allowing to exploit tracking information in the ATLAS trigger system.

Once a track is found, track parameters are estimated using a linear approximation with pre-calculated constants. The generation of these fit constants is a time consuming process which utilizes 300 million single muon tracks. This presentation addresses the current progress for developing strategies to quickly adapt the FTK fit constants to changing module positions and orientations in the tracking detectors.

T 18.3 Mo 16:35 ST 2

Rückblick auf den ATLAS Level-1 Kalorimeter-Trigger in Run-2 des LHC — •Martin Klassen — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Run-2 war bisher die mit Abstand erfolgreichste Periode der Datennahme am LHC mit 158 fb^{-1} gelieferten Daten, von denen der ATLAS Detektor bei stetig steigender Effizienz 149 fb^{-1} aufgezeichnet hat. Wichtig dafür war die zuverlässige Funktion des Triggers, insbesondere des Level-1 Triggers, welcher während des langen LHC Betriebsstopps (LS1) verschiedensten Upgrades unterzogen wurde, um dies auch bei einer höheren Anzahl an gleichzeitig stattfinden Interaktionen gewährleisten zu können.
Ein wesentlicher Bestandteil des Level-1 Triggers ist der Kalorimeter-Trigger, in dem einzelne Kalorimeterzellen zu sogenannten Triggertowern zusammengefasst werden. Die so analog summierten Signale werden im PreProcessor in transversale Energien umgewandelt, um in Echtzeit Elektron-, Photon-, Tau- und Jetkandidaten als auch globale Ereigniseigenschaften wie fehlende transversale Energie zu identifizieren. Ereignisse werden akzeptiert, wenn diese Objekte bestimmte Schwellen in transversaler Energie überschreiten. Dazu sind beispielsweise eine gute Energiekalibrierung oder die Bestimmung der korrekten Strahlkreuzung in der Gegenwart von signifikanter Hintergrundaktivität von besonderer Bedeutung. In diesem Vortrag werden die wichtigsten Änderungen im Level-1 Kalorimeter-Trigger und dessen Leistungsfähigkeit während Run-2 vorgestellt.

T 18.4 Mo 16:50 ST 2

A control system for the Mu3e DAQ — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz, Germany

The Mu3e experiment will search for the lepton flavour violating decay $\mu^+ \rightarrow e^+e^-e^+$ and is aiming for a sensitivity of one in 10^{16} muon decays. Since this decay is highly suppressed in the Standard Model to a branching ratio of below $\mathcal{O}(10^{-54})$, an observation would be a clear sign for new physics.

In the Mu3e detector, four thin layers of silicon pixel sensors will be used to track electrons and positrons. The overall detector is expected to produce a data rate from 80 Gbit/s (Phase I) to 1 Tbit/s (Phase II), which will be processed in a three-layer, triggerless DAQ system using FPGAs and a GPU filter farm for online event selection.

The talk will focus on the control system for the first two DAQ layers and their connections to the Maximum Integrated Data Acquisition System (MIDAS) as well as the clock and reset distribution system.

T 18.5 Mo 17:05 ST 2

Data flow in the Mu3e filter farm — •Marius Köppel — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany.

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \rightarrow e^+e^+e^-$. This decay violates the lepton flavour conservation - so observation would be a clear indication for Physics Beyond the Standard Model. The Mu3e experiment aims for an ultimate sensitivity of one in 10^{16} μ decays. To this end, more than one billion μ tracks per second need to be detected and reconstructed.

Since the corresponding data of about 1 TB/s cannot be saved to disk, a trigger-less on line readout system needs to be designed which is able to analyze the data while running. A farm with PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction. The talk presents the Field Programmable Gate Array (FPGA) based system which is used to preprocess, sort and transport the data from the detector to the filter farm.

T 18.6 Mo 17:20 ST 2

Mu3e electrical readout chain — •Lars Olivier Sebastian Noehte for the Mu3e-Collaboration — Physikalisches Institut, Heidelberg

The Mu3e experiment is going to search for the charged lepton-flavour violating decay $\mu^+ \rightarrow e^+e^-e^+$ with a sensitivity of 1 in 10^{16} decays in phase II. The pixel tracker is based on HV-MAPS and creates an untriggered continuous data stream with a total data rate of approximately 1 Tbit/s. The tracker is read out via 3060 differential links running at 1.25 Gbit/s. To minimise multiple Coulomb scattering ultra-thin tracking layers, consisting of monolithic pixel sensors with a thickness of $50\,\mu m$ and high density interconnects made out of aluminum and polyimide are used. The tracking layers are designed to have a total radiation length of about $X/X_0 = 0.115\,\%$ per layer.
This talk focuses on the Mu3e electrical readout chain between the sensor chips and FPGA-frontend boards. It is going to cover high density interconnects being aluminum polyimide flexprints as well as micro twisted pair cables and high-speed interposer arrays. Results of the commissioning tests are presented and discussed.

T 18.7 Mo 17:35 ST 2

Status der lokalen DAQ des Belle II Pixel Detektors — •Florian Lütticke, Jochen Dingfelder, Norbert Wermes, Carlos Marinas und Botho Paschen für die Belle 2-Kollaboration — Physikalisches Institut, Universität Bonn

Der Super-KEKB Beschleuniger am KEK Forschungszentrum in Tsukuba, Japan wurde bis zum Jahr 2017 aufgerüstet, um zukünftig eine instantane Luminosität von 8×10^{35} $\mathrm{cm}^{-2}\mathrm{s}^{-1}$ zu liefern, 40 mal mehr als der Vorgänger KEKB. Um die dadurch erzeugte höhere Datenrate ausnutzen zu können, wird der Belle Detektor zu Belle II aufgerüstet. Dabei werden die innersten beiden Lagen des neuen Vertexdetektors aus DEPFET Pixelsensoren bestehen, die näher an den Interaktionspunkt verschoben, um eine höhere Vertexauflösung zu erreichen. Daten dieser Sensoen werden über zwei FPGA Systeme (DHE und DHC) ausgelesen.

In diesem Vortrag wird die lokalen Datenaquisition (DAQ) des Pixeldetektors vorgestellt und die Erfahrungen mit der DAQ während der Kommisionierung von Belle II präsentiert.

T 18.8 Mo 17:50 ST 2

Online Datenreduktion für das Belle II-Experiment mit dem FPGA-basierten DATCON System — •Christian Wessel, Bruno Deschamps und Jochen Dingfelder für die Belle 2-Kollaboration — Universität Bonn, Physikalisches Institut

Das Belle II-Experiment in Japan ist für eine instantane Luminosität von $8 \cdot 10^{35}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ ausgelegt. Für präzise Messungen von zeitabhängigen Effekten ist Belle II mit einem Pixel Detektor (PXD) mit 8 Millionen Pixeln auf DEPFET-Basis ausgestattet. Durch die Kollisionsrate von 509 MHz wird im PXD eine hohe Datenrate erzeugt, die zu großen Teilen aus Strahluntergründen besteht, welche online aus dem Datenstrom entfernt werden müssen, um so die Datenmenge zu reduzieren. Diese Online-Datenreduktion soll mit dem FPGA-basierten „Data Acquisition Tracking Concentrator Online Node“ (DATCON) System bewerkstelligt werden. Der DATCON sucht im den PXD umgebenden Streifendetektor nach Spursegmenten. Diese werden in den PXD extrapoliert, um dort „Regions of Interest“ (ROI) zu definieren. Nur die Daten der Pixel innerhalb einer ROI werden offline gespeichert. Auf diesem Weg soll eine Reduktion der Daten des PXD um einen Faktor von 10 erfolgen. In vorläufigen Simulationsstudien mit $\Upsilon(4S)$-Ereignissen und Strahluntergründen liegen sowohl die Spurrekonstruktionseffizienz als auch die Effizienz der ROI-Berechnung bei über 96%.

In diesem Vortrag werde ich den aktuellen Status der Entwicklung des DATCON darlegen mit Fokus auf die Simulationsergebnisse.

T 18.9 Mo 18:05 ST 2

Online data reduction with FPGA-based track reconstruction for the Belle II DEPFET Pixel Detector — •Bruno Deschamps, Christian Wessel, Jochen Dingfelder, and Carlos Marinas for the Belle 2-Collaboration — University of Bonn

The innermost two layers of the Belle II vertex detector at the KEK facility in Tsukuba, Japan, will be covered by high-granularity DEPFET pixel sensors (PXD). The large number of pixels leads to a maximum data rate of 256 Gbps, which has to be significantly reduced by the Data Acquisition System. For the data reduction the hit information of the surrounding Silicon strip Vertex Detector (SVD) is utilized to define so-called Regions of Interest (ROI). Only hit information of the pixels located inside these ROIs are saved. The ROIs for the PXD are computed by reconstructing track segments from SVD data and extrapolating them to the PXD. The goal is to achieve a data reduction of up to a factor of 10 with this ROI selection. All the necessary processing stages, the receiving, decoding and multiplexing of SVD data on 48 optical fibers, the track reconstruction and the definition of the ROIs will be performed by the Data Acquisition Tracking and Concentrator Online Node (DATCON). The planned hardware design is based on a distributed set of Advanced Mezzanine Cards (AMC) each equipped with a Field Programmable Gate Array (FPGA). In this talk, the recent PHASE2 results as well as the plans for the upcoming PHASE3 are presented.

T 18.10 Mo 18:20 ST 2

Arduino-based Readout Electronics for Particle Detectors — •Markus Köhli[1,2], Jannis Weimar[1], Fabian Allmendinger[1], Fabian Schmidt[2], Klaus Desch[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Universität Heidelberg,Heidelberg, Deutschland — [2]Physikalisches Institut, Universität Bonn, Bonn, Deutschland

With the Arduino open source electronics platform microcontrollers have become a comparably easy-to-use tool for rapid prototyping and implementing creative solutions. Yet, running at 16 MHz, the capabilities can be extended to data taking and signal analysis at decent rates. Such devices in combination with dedicated frontend electronics can offer low cost alternatives for student projects and independently operating small scale instrumentation. We present two projects, which cover the readout of helium-3 and boron-10 proportional counters and of scintillators or wavelength shifting fibers with Silicon Photomultipliers. With the SiPMTrigger we have realized a small-scale design for triggering or vetoing in combination with a photon counter. It consists of a custom mixed signal frontend board featuring signal amplification, discrimination and a coincidence unit for rates up to 200 kHz. The nCatcher board transforms an Aruino Nano to a proportional counter readout with pulse shape analysis - time over threshold measurement and a 10-bit analog to digital converter for pulse heights. This makes the device suitable for low to medium rate environments, where a good signal to noise ratio is a crucial.