T 85: DAQ, Data Techniques

Time: Wednesday 17:30–18:45 Location: HSZ/0301

T 85.1 Wed 17:30 HSZ/0301

Simulation and Optimization of Particle Detector Signal Processing using Matlab and Simulink — •Florian Rössing[1], André Zambanini[1], Christian Grewing[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg-Essen

Matlab and Simulink are tools that are widely used in the field of engineering because they provide a flexible tool chain for mixed signal simulation that can be tailored to the specific needs of the user. With these, we model the sensors used in particle detectors and the attached read-out systems, creating a full system view on the electronics component in the chain. This enables studies on the influence of various parameters to obtain a better understanding of relevant factors and optimization potential, for instance for power efficient information extraction.

With this contribution, we will present our modeling approaches, split into three stages: The per channel event modelling, the sensor response to the incident energy, and the analog receiver chain with a front-end and corresponding pre-processing. We will demonstrate how we can model different characteristics in all three stages of the systems, including statistical fluctuations, bandwidth limitations, non-linearity and noise. These models are also used to develop approaches for the digital processing of the signals. The Simulink HDL Coder Toolbox allows us to directly convert the digital domain of our models into HDL, implementable into either an FPGA or an integrated circuit.

T 85.2 Wed 17:45 HSZ/0301

A Simulink Hardware-in-the-Loop Demonstrator Setup for Detector System Analysis — •Aravinda Lasya Indukuri[1], Florian Rössing[1], Christian Grewing[1], André Zambanini[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg- Essen

In our work, we study the influence of different parameters in read-out chains of particle detectors, alongside with studying digital processing methods for feature extraction. As described in our adjacent contribution, we are using Matlab and Simulink to model different aspects of the read-out chain. In order to verify the developed processing methods and setup a demonstrator , we are implementing the digital domain of the models on an FPGA in an FPGA-in-the-loop workflow. Matlab and Simulink provide tools like HDL Coder and HDL Verifier to automatically generate HDL code, select an external simulator to simulate the generated HDL code, implement it on an FPGA, and compare the results with the Simulink reference model. To verify the whole read-out chain model, we are setting up a hardware-in-the-loop model with an arbitrary waveform generator and an ADC along with an FPGA that will be stimulated and verified over Matlab and Simulink. We will also be working on automating the workflow for different event models and signal processing methods. In this contribution, we will present an automated Matlab-Simulink workflow for an FPGA-in-the-Loop demonstrator setup to verify simulink models in hardware, efficiency of HDL coder in comparison to a handwritten HDL code, and our progress on the Hardware-in-the-Loop demonstrator setup.

T 85.3 Wed 18:00 HSZ/0301

Firmware for the Mu3e Filter Farm — •Marius Köppel for the Mu3e-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University, Mainz Germany

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates charged lepton flavour conservation - any 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. The first phase of the experiment, currently under construction, will reach a branching ratio sensitivity of $2 \cdot 10^{-15}$ by observing 10^8 μ decays per second over a year of data taking. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100 Gbit/s of data at these particle rates.

Since the corresponding data cannot be saved to disk, a triggerless online readout system is required which is able to sort, align and 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 developed firmware used to provide the detector data for the GPU reconstruction. The firmware runs on Field Programmable Gate Arrays (FPGAs), which hold Double Data Rate Synchronous Dynamic Random-Access Memory (DDR SDRAM) to buffer the data. It will also show insides of the online analyzer used to perform data quality checks and other system checks.

T 85.4 Wed 18:15 HSZ/0301

Handling systematic uncertainties with the new ATLAS analysis formats — Nikolai Hartmann, Günter Duckeck, Otmar Biebel, and •Alexander Mario Lory — Ludwig-Maximilians-Universität München

Evaluating systematic uncertainties is one of the main elements contributing to CPU usage and processing time of a physics analysis in ATLAS. Frequently, these uncertainties are variations applied during the calibration of physics objects. During Run 2 of the LHC, although a common infrastructure and set of tools were used, the calibration was performed by each analysis group individually. For Run 3, two new small-sized formats have been introduced in order to cope with the increasing amount of data that is expected to be recorded. In one of these formats, the stored physics objects are already calibrated, which allows for a fast processing downstream and potentially new workflows. However, systematic uncertainties need to be revisited in that context, as they can no longer be applied as variations during the calibration step, but need to alter the already-calibrated objects. Can correctionlib, a tool which was developed within CMS to handle the typical correction factors encountered in particle physics, be used for this purpose within ATLAS?

T 85.5 Wed 18:30 HSZ/0301

HS3 - A serialization standard for statistical models in high energy physics — Carsten Burgard[1], Cornelius Grunwald[1], •Robin Pelkner[1], and Oliver Schulz[2] — [1]TU Dortmund University, Department of Physics — [2]Max Planck Institute for Physics, Munich

An important aspect of experimental particle physics, and science in general, is to perform analyses in a reproducible way. In addition to providing the observational data, this also means that the statistical models, which are usually formulated in terms of likelihood functions, must be provided in an accessible form as well. Currently, sharing statistical models between different programs and communities can be cumbersome because there is no standardized exchange format. Different software packages and toolkits usually use fundamentally different ways for representing data and models. We present the "high energy physics serialization standard" (HS3), a proposed standard, which is a language-agnostic and software-independent format for saving statistical models in exchangeable files. HS3 makes it possible to share entire analyses and to use them across software frameworks and methods so results can be cross-checked and models can be reused in new contexts. We give a general introduction to the HS3 standard, its design philosophy and semantics. In addition, we focus on the ongoing implementation of HS3 in ROOT, in Python, and the Julia programming language for use in packages like BAT.jl.