HK 1: Computing I

Time: Monday 16:45–18:30 Location: HBR 14: HS 1

HK 1.1 Mon 16:45 HBR 14: HS 1

Volunteer computing in HEP: PoUW blockchain for CBM — •Felix Hoffmann and Udo Kebschull — Goethe Universität Frankfurt

HEP experiments rely on computational power for conducting Monte Carlo simulations and analyzing real-world data collected from experiments. These calculations are traditionally done on large computing clusters like the WLCG or on locally managed servers. In the past, there have also been volunteer computing approaches, such as BOINC projects, in which anyone can participate and donate computational power to support a scientific experiment.

This talk explores the idea of a novel blockchain consensus algorithm in which miners run MC simulations for CBM with a given set of parameters instead of wasting energy spamming hashing functions like SHA256. The goal is to bring the blockchain community and the HEP community together: The blockchain community has available computational power and needs some form of blockchain consensus to secure the underlying blockchain, and the HEP community is in need of computational power. To make this possible, a libp2p application is currently being implemented in Golang and is expected to be completed before the end of 2024. This talk will give an overview of the general idea and provide implementation details.

HK 1.2 Mon 17:00 HBR 14: HS 1

Brute-force Minimization Approach for Alignment in CBM — •Nora Bluhme for the CBM-Collaboration — FIAS, Goethe University Frankfurt am Main, Germany

The CBM experiment (Compressed Baryonic Matter), which is planned at the future FAIR facility (Facility for Antiproton and Ion Research), will be used to investigate heavy-ion collisions at high interaction rates. In such high-energy physics experiments, the track-based software alignment of the detectors is a generic and crucial task. By determining the exact detector geometry, the alignment provides the required accuracy to utilise the high intrinsic resolution of the measurements. This is typically achieved by minimising a χ^2 cost function for a set of reconstructed tracks with respect to the alignment parameters in question.

To complement the available alignment tools, an alignment approach based on brute-force minimisation is developed. Potential advantages of this method are tighter parameter handling and the use of more constraint types for more accurate alignment results.

In this contribution, recent progress in applying the brute-force minimisation approach for alignment in the CBM setup is presented.

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HK 1.3 Mon 17:15 HBR 14: HS 1

Exploring the Effects of Longitudinally Polarized Electrons on the Degree of Linear Polarization of Crystalline Bremsstrahlung — •Leoniedas Reschke for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Nussallee 14-16, 53115 Bonn

The baryon excitation spectrum is probed with a real photon beam at several experimental facilities. In the case of single pseudoscalar meson photoproduction, a complete analysis of the process requires the measurement of not only the unpolarized cross section but also various single and double-polarization observables. Certain polarization observables require the use of linearly or circularly polarized photons. Typically, non-polarized electrons in combination with a diamond radiator, are employed to generate linearly polarized bremsstrahlung, while longitudinally polarized electrons in combination with an amorphous radiator, are employed to generate circularly polarized bremsstrahlung. The combination of longitudinally polarized electrons with a crystalline radiator, such as a diamond, results in elliptically polarized photons. The software package Diracxx offers a tool for computing the partial differential cross-section corresponding to a specific recoil momentum transferred from the incoming electron to the atomic nucleus of a radiator material. This package enables the swift and sufficiently precise computation of polarization spectra arising from the combination of a diamond crystal with longitudinally polarized electrons. This presentation shows results derived from these computational studies.

HK 1.4 Mon 17:30 HBR 14: HS 1

Simulating ultra cold neutron storage and lifetime measurement in a fully magnetic trap — •Sylvain Vanneste for the tauSPECT-Collaboration — Johannes Gutenberg University, Mainz, Germany

The accurate determination of the free neutron lifetime is of special interest in today's precision physics era. Its value is tightly connected to quarks mixing, and to the ratio of hydrogen to helium produced during the early Universe. As of today, the two existing distinct measurement techniques provide non-compatible results, giving rise to the so-called neutron lifetime puzzle.

With the aim of reducing experimental systematic uncertainties due to neutron absorption by material walls, the τSPECT experiment is a fully magnetic trap for Ultra Cold Neutrons (UCNs). In order to precisely understand and characterise the behaviour of UCN after production, guidance, storage, and finally detection inside τSPECT, a tailored simulation is being developed using the PENTrack software. The framework includes UCN dynamics via gravity; transmission trough, and reflection from, material surfaces; moving geometries; and interactions with magnetic fields. This work presents the results of such end-to-end simulations, comparisons with actual data measurements, and possible improvements for UCN magnetic storage experiments.

HK 1.5 Mon 17:45 HBR 14: HS 1

Applying TGeoArbN based tessellation in CBM geometry description* — •Simon Neuhaus — Bergische Universität Wuppertal, Wuppertal, Deutschland

Tessellation is a method to describe any volume using a triangle-based surface mesh. Tessellation of detector geometries offers promising new possibilities to efficiently create ROOT/GEANT detector geometries for simulation directly from CAD output (e.g. step files). This enables more rapid iteration cycles in detector design and lowers the risk of potential discrepancies in the generated simulation geometry. The sole disadvantage might be a significant increase in computing time using this new method of geometry creation.

TGeoArbN is a software tool for tessellation, developed at the University of Bonn for the Panda experiment. This tool is independent from tessellation implemented in GEANT. This has the benefit that TGeoArbN runs with both, GEANT3 and GEANT4 based simulations. This talk discusses first studies using TGeoArbN to generate parts of the RICH detector of the CBM experiment.

The application of PANDA TGeoArbN in CBM is a good example of the synergy effects generated by the exchange between different detector groups and universities within the NRW FAIR Network.

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HK 1.6 Mon 18:00 HBR 14: HS 1

Multi-particle Reconstruction in Detector Data using object-centric Machine Learning — •Sara Aumiller[1], Nicole Hartman[1], Lukas Heinrich[1], Florian Kaspar[1], Karina-Sânziana Stelea[1], Stefan Wallner[1], Dominik Ecker[1], Luise Meyer-Hetling[1], Andrii Maltsev[1], and Thomas Pöschl[2] — [1]Technical University of Munich, Germany — [2]CERN, Geneve, Switzerland

High-energy physics experiments require high performance on separation and reconstruction of multi-particle signals in detector data. This task gets especially challenging if signals of multiple, quasi-simultaneous particles overlap. Such events occur in various forms like calorimetric clusters, Cherenkov light rings or track patterns. Traditional reconstruction methods of particle-detector data are regularly pushed to their limits when confronted with this challenge as they require specific development for each task and get computationally expensive.

In this talk, I will explore a universal approach of multi-particle reconstruction using object-centric machine learning. This includes state-of-the-art artificial-neural-network methods like Invariant Slot Attention and Variational Autoencoding which are applied on simulated, particle-detector data. The research holds potential for future application in experiments like COMPASS or AMBER at CERN.

HK 1.7 Mon 18:15 HBR 14: HS 1

Machine Learning Algorithms for Pattern Recognition with the PANDA Barrel DIRC — •Yannic Wolf[1,2], Roman Dzhygadlo[1], Klaus Peters[1,2], Georg Schepers[1], Carsten Schwarz[1], and Jochen Schwiening[1] for the PANDA-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Goethe-Universität Frankfurt

Precise and fast hadronic particle identification (PID) is crucial to reach the physics goal of the PANDA detector at FAIR. The Barrel DIRC (Detection of Internally Reflected Cherenkov light) is a key detector for the identification of charged hadrons in PANDA. Several reconstruction algorithms have been developed to extract the PID information from the measured location and arrival time of the Cherenkov photons. In comparison to other Ring Imaging Cherenkov detectors, the hit patterns observed with DIRC counters do not appear as rings on the photosensor plane but as complex, disjoint 3D-patterns.

Using the recent advances in machine learning (ML) algorithms, especially in the area of image recognition, we plan to develop new ML PID algorithms for the PANDA Barrel DIRC and compare the results to conventional reconstruction methods. First network implementations show a performance comparable to conventional methods on a limited phase space. As a next step, we are investigating ways to extend the phase space, while also experimenting with different data input structures to optimize the training process and increase PID performance.