T 14: Experimental methods I

Time: Monday 16:30–18:05 Location: H-HS XV

Group Report T 14.1 Mon 16:30 H-HS XV

Track reconstruction for the Mu3e experiment — •Alexandr Kozlinskiy for the Mu3e-Collaboration — Institut für Kernphysik Johannes Gutenberg-Universität Mainz

The *Mu3e* experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with the aim to reach a branching ratio sensitivity of 10^{-16}. The first phase the experiment will be performed at an existing beam line providing 10^8 muons per second at the Paul-Scherrer Institute (Switzerland) which will allow to reach a sensitivity for the branching fraction of 10^{-15}. The muons will stop on a target and decay at rest. The decay products (positrons and electrons) with energies below 53 MeV are measured by a tracking detector consisting of two double layers of 50 μm thin High-Voltage Monolithic Active Pixel Sensors (HV-MAPS). The high granularity of the pixel detector with a pixel size of 80×80 μm allows for a precise track reconstruction in the high occupancy environment of the *Mu3e* experiment. The *Mu3e* track reconstruction uses a novel fit algorithm that in the simplest case takes into account only the uncertainty due to multiple scattering, which allows fast online tracking on a GPU based filter farm. The implementation of the 3-dimensional multiple scattering fit based on hit triplets is described. An extension of the fit that takes into account energy losses and pixel size is used for offline track reconstruction. The algorithm and performance of the offline track reconstruction based on a full Geant4 simulation of the *Mu3e* detector are presented.

T 14.2 Mon 16:50 H-HS XV

ATLAS track reconstruction developments for LHC Run 3 and 4 — •Fabian Klimpel[1,2], Andreas Salzburger[2], and Stefan Kluth[3] for the ATLAS-Collaboration — [1]Technische Universität München — [2]CERN — [3]Max Planck Institut für Physik

Reconstructing trajectories of particles in high-energy physics experiments require the dominant amount of hardware resources used for the total reconstruction. With the start of the high luminosity LHC the combinatorial complexity of this task will increase. In order to handle future track reconstruction challenges the ATLAS collaboration put much effort into the revision of existing code and the development of new software. In this context an optimisation of the current track reconstruction chain has been performed. An overview over the results and this study will be presented within this talk. In addition to the code changes and optimisations in the reconstructions algorithms ATLAS is deploying a new multi-threaded AthenaMT framework in order to improve the memory/thread scaling. This change requires a thread-safe implementation of the track reconstruction components. Since it represents a major conceptual change compared to a single-core optimised software as used in LHC Run 1 and 2 the ATLAS project ACTS was created. The track reconstruction project is by design thread-safe and serves as detector independent R&D project for future improvements in track reconstruction algorithms. We will present the improvements and prospects of the ATLAS track reconstruction for Run 3 and 4 and give an overview of the status of the ACTS project.

T 14.3 Mon 17:05 H-HS XV

Combinatorial Kalman Filter for the Belle II Experiment — Florian Bernlochner[1], Jochen Dingfelder[1], Alexander Glazov[2], Simon Kurz[2], and •Christian Wessel[1] for the Belle II-Collaboration — [1]Physikalisches Institut, Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Deutsches Elektronen-Synchrotron DESY

Kalman filters are a widely used tool in HEP to identify charged particle trajectories with a high efficiency and purity. The Belle II Combinatorial Kalman Filter (CKF) implementation is instrumental in achieving the physics goals of the experiment and is successfully being used in first emerging physics measurements. In this talk, I will summarize the key elements of the CKF implementation, show first results with data and give an outlook on future optimizations and extensions we have been working on.

T 14.4 Mon 17:20 H-HS XV

Reconstruction of B mesons using machine learning methods — Florian Bernlochner[2], •Tobias Böckh[1], Jochen Gemmler[1], Pablo Goldenzweig[1], and James Kahn[1] for the Belle II-Collaboration — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

The Belle II experiment records events of two B mesons decaying, via intermediate resonances, into final state particles. This work presents a deep learning approach to reconstruct a B meson. For this purpose, a network is trained to predict for each final state particle from which B meson it originated. Subsequently, particles from a common mother are combined to predict properties of the B meson.

T 14.5 Mon 17:35 H-HS XV

Demonstrating learned particle decay reconstruction with graph neural networks at Belle II — •Ilias Tsaklidis[1], James Kahn[2], Tobias Boeckh[2], and Pablo Goldenzweig[2] for the Belle II-Collaboration — [1]Institut Pluridisciplinaire Hubert CURIEN (IPHC), Strasbourg, France — [2]Karlsruher Institut für Technologie, Germany

The clean environment within Belle II, with decay processes originating from an electron-positron pair without the presence of partons, allows for the reconstruction of the entire collision event. This is a unique advantage to the Belle II experiment in that it allows for direct measurements of decay processes involving neutrinos or few detectable particles in the final state. This does, however, require a catch-all reconstruction algorithm which is able to reconstruct those particles not associated with the signal process being investigated. The current Full Event Interpretation algorithm at Belle II requires the reconstructed sub-decay processes to be hard-coded. This both restricts the total branching fraction coverage of the algorithm and relies on intuition to decide which decay processes to reconstruct. In this work we introduce a method for learning which processes to reconstruct and how to reconstruct them from example using graph neural networks.

T 14.6 Mon 17:50 H-HS XV

Track reconstruction with ACTS — Florian Bernlochner, Jochen Dingfelder, and •Ralf Farkas for the Belle II-Collaboration — University of Bonn

The reconstruction of trajectories of charged particles is a crucial task for most HEP experiments. The ACTS (A Common Tracking Software) aims to be a generic, framework- and experiment-independent toolkit for track reconstruction, initially started from the ATLAS tracking software. My talk will summarise recent developments of a combinatorial Kalman filter for the ACTS project and the possibilities of integrating ACTS into the Belle II track reconstruction.