# HK 20: Instrumentation III

Time: Tuesday 17:00–18:30 Location: J-HS C

HK 20.1 Tue 17:00 J-HS C

**Optimization of a PANDA track finding algorithm based on the Apollonius problem** — •Anna Scholl, Tobias Stockmanns, and James Ritman — Forschungszentrum Jülich

This work presents a track finding algorithm for the barrel part of the PANDA Straw Tube Tracker (STT). It consists of over 4200 gas-filled drift tubes arranged in a dense packing. The STT hits are not point-like, but tubes (isochrones) around the center of the straw tubes resulting from the measured drift time of the electrons to the anode. The track of the charged particle must pass tangentially to the isochrone. Algorithms based on two or three dimensional hitpoints usually do not use the additional isochrone information. For the STT, however, a tracking algorithm is needed that finds tracks that are tangential to every isochrone. To deal with this challenge, this work presents an approach based on the Apollonius problem, which is a mathematical solution to find a circle that is tangential to three other circles. This mathematical description is the basis for a Hough transformation to find the track of the charged particle.
To improve the performance of the Hough transform, the results from several different data preselection methods will be presented. Another challenge the algorithm needs to deal with is that the particle tracks are not perfectly continuous, but there may also be losses of hits or noise. Therefore a merging algorithm was implemented to combine different tracklets to a track. A more detailed description and first results of the algorithm described above will be shown.

HK 20.2 Tue 17:15 J-HS C

**Machine learning approaches for multi-neutron detection with NeuLAND** — •Jan Mayer and Andreas Zilges for the R3B-Collaboration — Institute for Nuclear Physics, University of Cologne

Upcoming experiments featuring Reactions with Relativistic Radioactive Beams ($R^3B$) at the Facility for Antiproton and Ion Research (FAIR) require precise multiplicity and energy information of the emitted neutrons. NeuLAND, the New Large Area Neutron Detector, is dedicated to the detection of up to five high-energy neutrons.

Reconstruction of the multiplicity and the first interaction points from the complex, superimposed hit patterns is challenging. As an alternative to classical methods, we study modern machine learning methods ranging from simple scikit-learn classifiers to deep neural networks with keras.

Here we give an overview of challenges, solutions, and results obtained with a diverse set of approaches and ideas for integration in a data analysis pipeline.

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HK 20.3 Tue 17:30 J-HS C

**Position reconstruction methods for the CBM-TRD** — •Felix Fidorra for the CBM-Collaboration — Institut für Kernphysik, Universität Münster

The Compressed Baryonic Matter (CBM) experiment will be a fixed target heavy-ion experiment at FAIR. The CBM Transition Radiation Detector (TRD) is one of the key detectors to provide electron identification and charged particle tracking. The TRD will be built based on a Multi-Wire Proportional Chamber (MWPC) with a 5 mm drift region, and an irregular foam foil radiator. Concerning reconstruction of detector data, currently different methods are being evaluated and will be discussed in this talk. The application of the discussed methods on testbeam data from DESY electron beam will be shown. This work is supported by BMBF grant 05P19PMFC1.

HK 20.4 Tue 17:45 J-HS C

**Machine Learning Approach for Track Finding Using Language Models** — •Jakapat Kannika, James Ritman, and Tobias Stockmanns — Forschungszentrum Jülich, Jülich, Germany

In the particle physics experiments, track finding is a pattern recognition task in which input hits are clustered into different groups of output tracks. The hits are signals of the particles traveling through the detectors, and the tracks are groups of trajectories of those particles. This study is focusing on implementing a track finding algorithm using language models for straw tube based tracking systems. The language model is a probability distribution which is used in order to recognize the sequences of data. The model is widely used in the field of natural language processing, where applications such as speech recognition, handwriting recognition, word prediction also use the language models. In the current study, we extract features from the hit data and treat them as discrete values similarly to words, then do a language modeling. The obtained language model is used in the same way as in the word prediction applications, but in this case, it predicts the next hits. The algorithm is now able to learn how to distinguish between true hit and noise, and it can also recognize tracks with long dependency patterns. The current status and an outlook on the overall performance will be presented.

HK 20.5 Tue 18:00 J-HS C

**Analysis plane optimization for background reduction in the KATRIN experiment** — •Benedikt Bieringer for the KATRIN-Collaboration — Institut für Kernphysik, Uni Münster, Germany

The Karlsruhe Tritium Neutrino experiment (KATRIN) aims at determining the electron antineutrino mass with a sensitivity of 0.2 eV (90% CL). Two spectrometers, electrostatic filters of MAC-E filter type, are used to measure the integral energy spectrum of Tritium $\beta$ decay electrons from a windowless gaseous tritium source. To reach the specified sensitivity, it is crucial to reduce experimental backgrounds as far as possible. Two main sources of background in the main spectrometer are assumed to be highly excited Rydberg atoms ionized by thermal radiation, and secondary electrons produced by trapped Radon-219 decay electrons. By optimization of the electric and magnetic fields inside the main spectrometer, the volume dependent Rydberg background can be drastically lowered. In this talk, the effort of field optimization with real time field calculations is presented. This work is supported under BMBF contract number 05A17PM3.

HK 20.6 Tue 18:15 J-HS C

**Event reconstruction for dark photon searches at the NA64 experiment at CERN** — •Srijan Sehgal, Nabeel Ahmed, Michael Hösgen, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The NA64 experiment is an active beam-dump experiment at CERN, searching for possible vector particles as a portal to a hypothetical dark matter sector. High-energy beam electrons are tracked and then stopped in a hermetic calorimeter, which acts as an active target. Interesting events are those, where not the full energy has been deposited in the calorimeter.

The presentation describes the event reconstruction for the 2017 and 2018 data for the invisible mode. In this mode some energy is lost by producing a dark photon, which then flies through the detector without interacting. For the alignment of the tracking detectors, we use the principle of least-squares minimization that takes into account both global (e.g. positional correction) and local (e.g. slope of track) parameters. The talk will also cover the Monte-Carlo reconstruction of particle tracks and the energy deposited in the calorimeter for the 2018 visible mode data. In the visible mode the dark photon is produced in an additionally placed tungsten calorimeter and decays into an $e^-e^+$ pair, which is detected by the downstream detectors.

These studies advance the implementation of the data analysis in the CORAL and PHAST frameworks, providing a more flexible and more modular environment than the monolithic code presently used by the NA64 collaboration.