HK 27: Computing I

Time: Wednesday 14:00–15:15 Location: SR Exp1A Chemie

HK 27.1 Wed 14:00 SR Exp1A Chemie

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. 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 areas of image recognition and generative AI, we have studied ML PID algorithms for the PANDA Barrel DIRC. Several network implementations were found to be capable of reaching a performance comparable to conventional methods, but only if the network is trained for each particle angle and momentum. To make a trained network usable for different points in phase space, and to optimize the training process and PID performance, we varied the data input structures, increased the parameter space, and included normalizing flow-based generative models in the study. We will show a comparison of the performance of different ML methods to conventional algorithms and discuss the impact on the PANDA Barrel DIRC.

HK 27.2 Wed 14:15 SR Exp1A Chemie

Neutron-Gamma Multiplicity and Discrimination in ^{252}Cf Fission: GEANT4 Simulations and Machine Learning Approaches — •Annesha Karmakar[1,4,5], Frederik Uhlemann[2], Heinrich Wilsenach[3], Anikesh Pal[4], Christoph Scheidenberger[1,2], G. Anil Kumar[5], Mohit Tyagi[6], Timo Dickel[1,2], and Wolfgang.R Plass[2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]II. Physikalisches Insti- tut, Heinrich-Buff-Ring 14, Giessen, Germany — [3]FRS Ion Catcher Collaboration, Tel Aviv University, Isreal — [4]Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India — [5]Department of Physics, Indian Institute of Technology Roorkee, India — [6]Technical Physics Division, Bhabha Atomic Research Centre, Mumbai ,India

This study examines neutron and gamma-ray distributions from ^{252}Cf fission, linking them to specific prompt release events using GEANT4 and GEF simulations. The neutron energy spectrum peaks at 2 MeV and extends up to 15 MeV, with event-by-event correlations analysed using plastic scintillation detectors. Pulse Shape Discrimination (PSD) is crucial for accurate neutron-gamma identification, traditionally achieved through charge integration methods but requiring manual optimization. Machine learning techniques, such as deep neural networks (DNN) and convolutional neural networks (CNN), provide faster and more reliable PSD, particularly at low energies, enhancing our understanding of neutron-gamma multiplicity.

HK 27.3 Wed 14:30 SR Exp1A Chemie

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

Tessellation is a method to describe an arbitrarily shaped volume using a triangle-based surface mesh. This offers promising possibilities to efficiently create ROOT/GEANT detector geometries for simulations directly from CAD output (e.g. STEP files). It facilitates faster iteration cycles in detector design and reduces the risk of potential discrepancies in the generated simulation geometry. However, a notable disadvantage of using tessellated objects for simulation is an increase in simulation time.

TGeoArbN is a software tool that enables the use of tessellated geometries in GEANT3- and GEANT4-based simulations. By employing its own navigation functionality, TGeoArbN operates completely independent of the ROOT-native TGeoTesselation library. Additionally, it features an inbuilt octree-based partitioning method for runtime optimization. Developed at the University of Bonn for the PANDA experiment this tool is now also utilized for simulations within the CBM experiment. This contribution will present the appplication of TGeoArbN and octree-based partitioning for certain components of the CBM experiment.

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HK 27.4 Wed 14:45 SR Exp1A Chemie

TGeoArbN in combination with T.Stockmanns STEP-to-ROOT converter — •Ben Salisbury for the PANDA-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

In particle physics precise simulations are vital. For this accurate detector geometries are required. Simulateable triangle-meshes can be of great help to increase the automation of converting Computer-Aided-Design (CAD) detector models to simulatable geometries. However, the ROOT geometry package lacks the implementation of such a triangle-mesh. To address this capability gap in the ROOT framework, TGeoArbN, a ROOT compatible geometry class, was implemented allowing the use of triangle meshes (analog to G4TessellatedSolid) in Virtual Monte Carlo (VMC)-based simulation. To improve simulation speed partitioning structures in form of an Octree or bounding volume hierarchy can be used. TGeoArbN in combination with a STEP-to-ROOT converter (based on [1]) allowed for a high level of automation for the conversion of the FwEndcap geometry of the PANDA electromagnetic calorimeter. A short overview over TGeoArbN and a modified STEP-to-ROOT converter version will be given.

[1] T. Stockmanns, "STEP-to-ROOT -from CAD to Monte Carlo Simulation", Journal of Physics: Conference Series 396 (2012) 022050, url: https://doi.org/10.1088/1742-6596/396/2/022050

HK 27.5 Wed 15:00 SR Exp1A Chemie

Simulation Comparison of the mSTS Geometry based on Primitive ROOT/TGeo Solids and Tessellated Solids — •Mehulkumar Shiroya for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Silicon Tracking System (STS) is the core tracking detector of CBM, tasked with achieving high-precision measurements of particle tracks and momentum. Currently, a prototype system, comprising several detector subsystems, including a scaled version of the STS called mSTS is undergoing extensive testing in the miniCBM (mCBM) experiment at the existing SIS-18 accelerator at GSI, Helmholtzzentrum für Schwerionenforschung, Darmstadt.

The direct conversion of Computer-Aided Design (CAD) based geometry model to Geometry Description Markup Language (GDML), XML-based format using different software toolkits has attracted considerable attention. Solids extracted from CAD models and represented in GDML format typically consist of triangular or quadrilateral facets. `TGDMLParser` in ROOT and `G4GDMLParser` in GEANT facilitate the reading of different volumes from the GDML file and the creation of volume assemblies.

We will present a simulation analysis study of two representations of the mSTS geometry: one employing simplified primitive ROOT/TGeo solids and the other utilizing Tessellated solid-based geometry. The study includes secondary particle production, the significance of passive volumes, and computation time.