HK 22: Instrumentation

Zeit: Montag 16:45–19:00 Raum: HSZ-405

Gruppenbericht HK 22.1 Mo 16:45 HSZ-405

A background veto system for GERDA based on scintillation of liquid argon — •Nuno Barros for the GERDA-Collaboration — Technische Universität Dresden, Dresden, Germany

Gerda is an experiment to search for the neutrinoless double beta decay on ^{76}Ge, where bare germanium detectors are operated in a cryostat with 65 m^3 of liquid argon (LAr). A light instrumentation system installed in the LArGe test facility demonstrated that the detection of argon scintillation light can be used to effectively suppress background events in the germanium, that simultaneously deposit energy in LAr. The results from LArGe demonstrated that this method could significantly contribute to reach the goal in background index of 10^{-3} cts/(keV·kg·yr) for the Phase II of Gerda. Based on these results, several options are being pursued for the light instrumentation of LAr, which have to comply with the stringent radio-purity requirements of the experiment and should provide a significant suppression of the background signals in the region of interest around $Q_{\beta\beta}$ of ^{76}Ge at 2039 keV. This talk gives an account of the different design options under investigation by the Gerda collaboration. Results from the LArGe test facility are presented, demonstrating the feasibility of the method. The designs including photomultipliers (PMT) and silicon photomultipliers (SiPM) are discussed, along with their performance expectations from MC simulations. The progress in the development of these options is also reported, along with the design criteria for the use of light instrumentation in Gerda . This work is funded by the DFG, the BMBF and supported by the HPC@ZIH Dresden.

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Identifying Surface Background Events in the COBRA-Experiment — •Matthew Fritts[1] and Jan Tebrügge[2] for the COBRA-Collaboration — [1]Institut für Kern- und Teilchenphysik (IKTP), Technische Universität Dresden — [2]Lehrstuhl Experimentelle Physik IV, Technische Universität Dortmund

The COBRA-Experiment searches for neutrinoless double beta decay in CdZnTe semiconductor detectors. In the R&D setup at Gran Sasso Underground Laboratory coplanar grid detectors are investigated. Intrinsic to the detector design is the ability to calculate interaction depth, which makes it possible to veto surface events at the anode and cathode side. Furthermore the details of charge induction due to the grid geometry cause distortions in pulse shapes for interactions near the other surfaces. The COBRA collaboration has developed an improved depth reconstruction technique as well as new methods for identifying events near the lateral surfaces using pulse-shape analysis. Alpha radiation at the surface of the detectors is currently the major source of background in the energy region of interest, so using pulse shape analysis offers promising possibilities for background reduction, which is a crucial issue for the COBRA-Experiment.

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Modellierung des CIMBI-Detektors — •Mario Cappellazzo — Institut für Kernphysik der Universität zu Köln, Köln, Deutschland

Das elektrostatische Abbildungssystem des Cologne Ion Monitor for Beam Imaging (CIMBI) wurde in ein Computermodell übersetzt, um daran Untersuchungen zum räumlichen und zeitlichen Auflösungsvermögen durchzuführen. Der CIMBI ist ein "beam tracking detector", welcher als Hilfsdetektor für HISPEC/DESPEC am FAIR entwickelt wird. In einer dünnen Konversionsfolie lösen passierende Ionen Sekundärelektronen aus, welche durch das elektrostatische Abbildungssystem auf einen ortssensitiven Messaufbau, bestehend aus einer Micro Channel Plate und Dual Delay Lines, außerhalb der Ionenflugbahnen abgebildet werden.

Zur Modellierung des Detektors musste die Laplace-Gleichung mit inneren Randbedingungen gelöst werden. Die inneren Randbedingungen ergaben sich, da die Kapazitäten der Komponenten des Abbildungsystems unbekannt waren. Diese wurde nach der Methode der finiten Differenzen diskretisiert und das daraus entstehende lineare Gleichungssystem mit numerischen Methoden gelöst. Es war notwendig, feine Details in der Größenordnung von 0,1mm zu diskretisieren. Durch die Detektorausmaße in der Größenordnung von 0,1m musste ein Gleichungssystem mit rund 1 Milliarde Unbekannten gelöst werden. Dazu wurde das Successive-Over-Relaxation-Verfahren und ein für diesen Zweck modifiziertes Mehrgitterverfahren verwendet.

Mit dem berechneten Potentialverlauf ließen sich Elektronenflugbahnen vorhersagen und Messungen mit verschiedenen Masken simulieren.

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Simulation and reconstruction for the PANDA Barrel DIRC — Klaus Götzen[1], •Maria Patsyuk[1,2], Klaus Peters[1,2], Carsten Schwarz[1], Jochen Schwiening[1], and Marko Zühlsdorf[1,2] for the PANDA-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [2]Goethe Universität Frankfurt

The PANDA experiment at the new Facility for Antiproton and Ion Research in Europe (FAIR) at GSI, Darmstadt, will study fundamental questions of hadron physics and QCD. Efficient Particle Identification (PID) for a wide momentum range and the full solid angle is required for reconstructing the various physics channels of the PANDA program. Hadronic PID in the barrel region of the detector will be provided by a DIRC (Detection of Internally Reflected Cherenkov light) counter. The design is based on the successful BABAR DIRC with important improvements, such as focusing optics and fast photon timing.

A detailed detector simulation of the Barrel DIRC, including a number of design options, was performed using Geant. A reconstruction algorithm was developed to quantify the performance in terms of single photon Cherenkov angle resolution and photon yield. Simulation and performance of the design options will be discussed in this contribution.

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Triplet Based Online Track Finding in the PANDA-STT — •Marius C. Mertens, James Ritman, and Peter Wintz for the PANDA-Collaboration — Forschungszentrum Jülich GmbH

The PANDA-Experiment at the future FAIR-Facility in Darmstadt will implement a Straw Tube Tracker (STT) as its central tracking subdetector within a 2 T solenoidal magnetic field. The STT is a gas based detector for charged particle tracking which is comprised of 4636 cylindrical drift chambers (straw tubes) of 1 cm diameter and 150 cm length, surrounding a cylindrical volume from 16 cm up to a radius of 42 cm around the silicon based micro vertex detector.

At PANDA a continuous readout mode of the detectors is required due to the broad range of different event topologies and the very high interaction rate of $2 \cdot 10^7$ annihilations per second. As a consequence of this mode of operation the drift start time will not be given by the trigger time but it has to be extracted from either other detector hits or the signature of hit patterns in the STT itself.

One method of track finding without initial knowledge of the drift start time is based on the identification of hit triplets within a certain time window. It is then particularly simple to analytically calculate the circle parameters of the track helix' projection into the xy-plane. We will present the triplet method in detail as well as studies on its applicability under the PANDA operating conditions.

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ALICE TRD GTU Online Tracking Performance in $\sqrt{s} = 7-8$ TeV pp collisions — •Rettig Felix, Kirsch Stefan, and Lindenstruth Volker for the ALICE-Collaboration — Frankfurt Institute for Advanced Studies, University of Frankfurt

The Transition Radiation Detector provides fast trigger contributions for electron and jet signatures to the ALICE experiment at CERN.

More than 65,000 custom multi-processor modules on-detector identify and parametrize short stiff track segments for a total of 1.2 million analog channels. Within 3μs up to several thousand track segments per event are forwarded to the TRD Global Tracking Unit (GTU).

The GTU consists of 109 FPGA-based processing nodes arranged in three levels. 90 nodes receive data at an aggregate bandwidth of up to 2.16 TBit/s. They perform an online 3D track reconstruction and p_T estimation within 1.2μs. Track information is pushed to 18 sector-level nodes, which run trigger algorithms for single electrons and jets. A top-level node provides the TRD trigger contributions to the central ALICE trigger system within 6μs.

In the past years of continuous operation the TRD online tracking performance was studied for pp and Pb-Pb collisions. A p_T resolution of better than 15-20% over the range from 2 to 10 GeV/c was achieved. In 2012 the jet trigger was put into operation, later two single-electron triggers for heavy flavor and quarkonia studies. Based on the data from pp collisions at $\sqrt{s} = 7 - 8$ TeV we present the performance of the online tracking and a technical overview of the triggers.

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FPGA helix tracking algorithm for PANDA — •Yutie Liang, Martin Johannes Galuska, Thomas Gessler, Jifeng Hu, Wolfgang Kühn, Jens Sören Lange, David Münchow, and Björn Spruck for the PANDA-Collaboration — II. Physikalisches Institut, Giessen University, 35392, Germany

The PANDA detector is a general-purpose detector for physics with high luminosity cooled antiproton beams, planed to operate at the FAIR facility in Darmstadt, Germany. The central detector includes a silicon Micro Vertex Detector (MVD) and a Straw Tube Tracker (STT). Without any hardware trigger, large amount of raw data are streaming in the data acquisition system. The data reduction task is performed in the online system by reconstruction algorithms programmed in VHDL (Very High Speed Integrated Circuit Hardware Description Language) on FPGAs (Field Programmable Gate Arrays). One important part in the system is the online track reconstruction. In this presentation, an online tracking finding algorithm for helix track reconstruction in the solenoidal field using conformal transformation and Legendre transformation is shown. The MVD and STT are used in this algorithm.

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GPU Implementations of Online Track Finding Algorithms at PANDA — •Andreas Herten[1], Tobias Stockmanns[1], James Ritman[1], and Mohammad Al-Turany[2] for the PANDA-Collaboration — [1]Institut für Kernphysik, Forschungszentrum Jülich GmbH — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The PANDA experiment is a hadron physics experiment that will investigate antiproton annihilation in the charm quark mass region. The experiment is now being constructed as one of the main parts of the FAIR facility.

At an event rate of $2 \cdot 10^7$ /s a data rate of 200 GB/s - 1 TB/s is expected. A reduction of three orders of magnitude is needed in order to save the data for further offline analysis. Since signal and background processes at PANDA have similar signatures, no hardware-level trigger is forseen for the experiment. Instead, a fast online event reconstruction is substituting this element. We investigate the possibility of using graphics processing units (GPUs) for this task.

This talk shows advances in the implementations of fast tracking algorithms for GPUs to be used at PANDA.