HK 6: Instrumentation I

Zeit: Montag 16:45–19:00 Raum: F 072

HK 6.1 Mo 16:45 F 072

Pulse Shape Analysis with AGATA using coincident γ-ray detection after e^+/e^- annihilation — •Lars Lewandowski and Peter Reiter for the AGATA-Collaboration — Institut für Kernphysik Köln

The γ spectrometer AGATA is a tracking array consisting of position sensitive, highly segmented HPGe detectors. The gamma ray tracking GRT is based on the pulse shape analysis PSA of the digital signals of the 36 segments and the central electrode. The PSA provides the interaction position within the segments by comparing the measured signals with simulations. To investigate and improve the position resolution a reliable method to determine the performance of the PSA is necessary. Therefore, a measurement with ^{22}Na, that decays by emission of a positron, was performed. The two 511 keV γ rays, that are emitted in an angle of 180 degree after e^+/e^- annihilation, were detected in coincidence. In combination with the known annihilation position this provides a measure for the position resolution of the two detected γ rays. This method was used to improve the performance of the PSA, including a new way to calculate the figure of merit that is used to compare measured and simulated signals. Supported by the German BMBF (05P12PKFNE TP4)

HK 6.2 Mo 17:00 F 072

Numerical correction methods of neutron damage in position-sensitive HPGe detectors — •R. Hetzenegger, B. Birkenbach, B. Bruyneel, P. Reiter, J. Eberth, H. Hess, R. Hirsch, L. Lewandowski, and A. Vogt — IKP, Universität zu Köln

The Advanced GAmma Tracking Array (AGATA) is a major γ-ray spectrometer mainly for nuclear structure studies. AGATA is based on the novel technique of γ-ray tracking in electrically segmented high-purity Ge crystals. The array is currently employed at the Grand Accélérateur National d'Ions Lourds (GANIL, France) in stable-beam experiments with high count rates. Fast neutrons are emitted after almost any nuclear reaction with projectile energies above the Coulomb barrier. These neutrons generate crystal defects by dislocating Ge atoms. Dislocations act as hole traps within the HPGe material, causing a reduced charge collection efficiency, observed as a left tailing in the energy-peak shapes. The crystals can recover from neutron damage by annealing. However, for practical reasons, this treatment cannot be applied after every experiment. Recently, two software-based methods were developed employing pulse-shape analysis (PSA) to minimize the trapping effects between consecutive scheduled annealings of the HPGe crystals. Both approaches employ the position sensitivity of the HPGe detectors and determine the neutron trapping contribution for charge collection after individual γ-ray interactions. Energy resolution and line shape of neutron-damaged detectors are improved dramatically. Results and perspectives on neutron-damage corrections are presented. Supported by German BMBF 05P12PKFNE TP4 and 05P15PKFN9.

HK 6.3 Mo 17:15 F 072

Characterisation and pulse shape discrimination of a SAGe Well detector for future germanium based double beta decay experiments — •Thomas Wester for the GERDA-Collaboration — Institut für Kern- und Teilchenphysik, TU Dresden

The search for the neutrinoless double beta ($0\nu\beta\beta$) decay is a very active field in modern neutrino physics. An observation would come hand in hand with lepton number violation and provides valuable information about the neutrino mass mechanism.

The GERDA experiment searches for the $0\nu\beta\beta$ decay in ^{76}Ge by operating an array of isotopically enriched germanium detectors in a liquid argon cryostat. The background level achieved in Phase II of about 10^{-3} cts/(keV·kg·yr) is the lowest in the field of $0\nu\beta\beta$ experiments. By employing BEGe detectors with a small anode geometry, a big improvement in background reduction was achieved with respect to Phase I. They provide an excellent pulse shape discrimination of surface and high energetic gamma ray background.

Small Anode Germanium (SAGe) Well detectors as manufactured by Canberra combine the small anode technology of BEGe detectors with a much larger volume. This makes them an excellent choice for future germanium based $0\nu\beta\beta$ experiments with source masses exceeding 100 kg.

This talk presents the characterisation and pulse shape discrimination potential of a SAGe detector currently operated in the Felsenkeller underground laboratory in Dresden.

HK 6.4 Mo 17:30 F 072

Status of the Development of a HPGe-BGO Pair Spectrometer for ELI-NP — •Ilja Homm, Alexander Ignatov, Stoyanka Ilieva, and Thorsten Kröll — Technische Universität Darmstadt, Darmstadt, Germany

At the moment, the new european research facility called ELI-NP (The **E**xtreme **L**ight **I**nfrastructure - **N**uclear **P**hysics) is being built in Bucharest-Magurele, Romania. It is one of three parts of the ELI project and offers applications for the investigation of questions concerning nuclear physics. ELI-NP offers unprecedented opportunities for photonuclear reactions with high intensity, brilliant and fully polarized photon beams at energies up to 19.5 MeV.

The 8 HPGe (**H**igh-**P**urity **Ge**rmanium) CLOVER detectors of ELIADE (**ELI**-NP **A**rray of **DE**tectors) with four crystals each and high resolution are important components for the gamma spectroscopic study of photonuclear reactions. These detectors are surrounded by standard anti-Compton shields (AC shield). We investigate the possibility to operate for two of the ELIADE CLOVERS an advanced version of an AC shield as escape γ-rays pair spectrometers to extend the high-resolution spectroscopy to photon energies of several MeV where the pair production process dominates. The main tasks in this work are to develop and test such an AC shield: a pair spectrometer with BGO and CsI(Tl) crystals with APD (avalanche photodiode) or SPM (silicon photomultiplier) readout. The results of prototype testing are reported.

This work is supported by the German BMBF (05P15RDENA).

HK 6.5 Mo 17:45 F 072

First performance results of the BGO prototype for the MINIBALL spectrometer — •Dawid Rosiak, Peter Reiter, Jürgen Eberth, Herbert Hess, Iolanda Matea, and Christine LeGalliard — Institut für Kernphysik, Universität zu Köln

The successful HIE-ISOLDE upgrade at CERN with higher beam energies and intensities increases the experimental potential for reaccelerated radioactive ion beams. Direct- and fusion-evaporation reactions will allow access to states at high excitation energies and higher angular-momentum. The existing MINIBALL γ-ray spectrometer was designed for best solid-angle coverage, resulting in high γ-ray efficiency for low-multiplicity events. In order to cope with higher γ-ray multiplicities the MINIBALL triple cluster detectors will be surrounded with BGO Compton-suppression detectors to reject events from scattering of γ radiation between detectors from high energetic γ-rays and multiple hits. After advanced Monte-Carlo studies a BGO prototype was developed and built in collaboration with the IPN Orsay. Mechanical test of the BGO detector as well as for the PMTs and the electronics started in Orsay. A prototype BGO shield was mounted around a MINIBALL triple cluster in Cologne. First results, especially for the crucial Peak-to-total ratio, were obtained from measurements with γ-ray sources.

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Bayes-Tracking – A new Approach to Gamma-Ray Tracking — •Philipp Napiralla[1], Christian Stahl[1], Herbert Egger[2], Michael Reese[1], and Norbert Pietralla[1] — [1]Institut für Kernphysik, TU Darmstadt — [2]AG Numerik und wissenschaftliches Rechnen, TU Darmstadt

A new mathematical approach to the Gamma-Ray tracking with position-sensitve HPGe detectors using Bayesian inference is presented and the necessary mathematical background is explained. Using data from a simple HPGe detector simulation, the performance of this new Gamma-Ray Tracking algorithm, called Bayes-Tracking, is shown. A comparison between tracked and raw detector data is given. In addition, all necessary improvements of the current version of the Bayes-Tracking are illustrated. Supported by BMBF 05P15RDFN1 - TP9 (Experiment).

HK 6.7 Mo 18:15 F 072

Radiation Damage Caused by Neutron Capture in Boron Doped Silicon Pixel Sensors — •Benjamin Linnik, Tobias Bus, Michael Deveaux, Dennis Doering, and Ali Yazgili for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

CMOS Monolithic Active Pixel Sensors (MAPS) are considered as an emerging technology in the field of charged particle tracking. They will be used in the vertex detectors of experiments like STAR, CBM and ALICE and are considered for the ILC and the tracker of ATLAS. In those applications, the sensors are exposed to sizeable radiation doses. While the tolerance of MAPS to ionizing radiation and fast hadrons is well known, the damage caused by thermal neutrons was so far not studied in detail. Those neutrons initiate nuclear fission of ^{10}B dopants found in the P-doped silicon forming the active medium of MAPS. This effect can be expected to increase radiation damage beyond the predictions of the NIEL (Non Ionizing Energy Loss) model for pure silicon.
We estimate this effect by calculating the additional NIEL created by the fission fragments. Moreover, we show first measured data for CMOS sensors, which were irradiated with cold (1.8 meV) neutrons. The empirical results contradict the prediction of the updated NIEL model both, qualitatively and quantitatively: The sensors irradiated with slow neutrons show an unexpected and strong acceptor removal, which is not observed in sensors irradiated with 1 MeV neutrons.

*This work has been supported by BMBF (05P15RFFC1), GSI and HIC for FAIR.

HK 6.8 Mo 18:30 F 072

Aging of recent lifetime enhanced Microchannel-Plate Photomultipliers — •Markus Pfaffinger, Merlin Böhm, Rafael Frytz, Albert Lehmann, Daniel Miehling, Samuel Stelter, and Fred Uhlig for the PANDA-Collaboration — Physikalisches Institut , Universität Erlangen-Nürnberg

At the PANDA experiment at the new FAIR facility two DIRC detectors will be used for particle identification. The focal plane of the detectors will be located inside a magnetic field of >1 Tesla. Microchannel-Plate Photomultipliers (MCP-PMTs) are the favored sensors for the detection of the Cherenkov photons. As the lifetime is a known caveat this has has to be carefully tested and optimized. The quantum efficiency (QE) is an indicator of the MCP-PMT lifetime. The QE may decrease because of aging processes taking place at the photo cathode (PC) till the sensor is "blind". The aging process is mainly caused by feedback ions from the residual gas in the MCP-PMT, which may damage the PC on impact. The QE degradation is correlated to the integrated anode charge (IAC) having been measured in the sensor. With the Erlangen lifetime setup new MCP-PMTs are being illuminated and their IAC is monitored. In time intervals of a few weeks the spectral QE is measured and full surface QE scans are made every few months. This talk will present the current status of the measurement systems and the latest results, especially of the most recent 2 inch MCP-PMTs from Hamamatsu and Photonis. IACs of >>5 C/cm^2 were obtained with no or only minor declines of the QE. This is sufficient for the PANDA DIRCs. - Funded by BMBF and GSI -

HK 6.9 Mo 18:45 F 072

Read-Out Resilience in Radiation Environments — •Andrei-Dumitru Oancea and Udo Kebschull for the CBM-Collaboration — IRI , Geothe-Universität Frankfurt, Germany

In a radiation environment it is only a question of time until single-event effects cause an alteration in the firmware of Read-Out Board FPGAs, which ultimately leads to data loss due to the malfunction of the affected boards. To combat this, we are developing an autonomous concept that ensures that all boards are continuously monitored, quickly repairs errors in the firmware, and re-integrates boards that needed a reset into the read-out chain to minimize the downtime caused by radiation effects. The approach is furthermore free of flash technology, since flash memories will limit the longevity of the involved electronics due to low Total Ionizing Dose.

The developed approach works for Xilinx 7-Series FPGAs and is based on the GBTX chain (CERN), which was designed for radiation-hard data and slow control links in high-energy physics experiments. It utilizes the GBT-SCA, which is a slow control adapter ASIC for programming FPGAs and repair erroneous FPGA configuration frames via selective frame scrubbing on-demand, but only in case the errors cannot be fixed via the internal autonomous SECDED mechanism, which is the advantageous feature of 7-Series FPGAs. The developed concept is scalable for multiple firmwares running on multiple FPGAs.