HK 11: Instrumentation IV

Time: Monday 16:45–18:15 Location: SR Exp1B Chemie

HK 11.1 Mon 16:45 SR Exp1B Chemie

Detailed Study of Afterpulses in MCP-PMTs — •Gabriele Costi, K. Gumbert, S. Krauss, A. Lehmann, and D. Miehling — ECAP, Universität Erlangen-Nürnberg

The PANDA experiment at FAIR uses two DIRC detectors for pion/kaon separation by Cherenkov light detection. Central to their performance are Microchannel-Plate Photomultipliers (MCP-PMTs), which were chosen for their excellent time performance and suitability in high magnetic fields ($\gtrsim 1$ T). Recent quality control tests of PHOTONIS XP85112-S-BA tubes has provided new insights into performance parameters such as lifetime, quantum efficiency, gain stability, dark count rates, and afterpulses (APs).

APs triggered by feedback ions are suspected to be the main cause of photocathode aging; therefore, it is crucial to understand how, where and how many APs are created in the MCP-PMT. To study this effect in more detail, various measurements and analyses of time-of-flight (TOF) spectra were performed with a TRB/DiRICH DAQ system and compared to simulations. By analyzing the TOF the origin in the PMT and the type of the feedback ions were investigated. In this contribution, we present the results obtained on APs in MCP-PMTs, including comparative data from prototype and series production models.

- Funded by BMBF and GSI -

HK 11.2 Mon 17:00 SR Exp1B Chemie

Performance and problems of the latest series production MCP-PMTs for the PANDA Barrel DIRC — •Steffen Krauss, K. Gumbert, A. Lehmann, and D. Miehling — ECAP, Universität Erlangen-Nürnberg

The PANDA experiment at GSI's Facility for Antiproton and Ion Research (FAIR) in Darmstadt will use DIRC detectors to separate pions and kaons in the 0.5 to 4 GeV/c momentum range. The DIRC focal planes will be located inside the PANDA solenoid magnet. This exposes the photon sensors to a magnetic field of $\sim$1 T. For this and other reasons, microchannel plate photomultipliers (MCP-PMTs) were the only viable option to efficiently detect the few Cherenkov photons.

A barrel DIRC surrounds the interaction region and consists of 16 radiator sectors, each equipped with 8 MCP-PMTs. The selected PMTs, type PHOTONIS XP85112-S-BA with 10 μm pores, have an area of 2x2 inch^2 with 8x8 anode pixels and an ALD coating to increase the lifetime. A total of 165 (128 + 37 spare) tubes are quality evaluated in Erlangen to fulfill the key requirements for the Barrel DIRC.

Essential requirements for the MCP-PMTs are gains of $> 10^6$ in a 1 T field, high detective quantum efficiency (QE*CE), high rate capability, ultra-fast time response and good spatial homogeneity of QE and gain. Internal parameters such as dark count rate, crosstalk and afterpulse fractions are measured with a TRB/DiRICH DAQ system. The main conclusions for meanwhile >80 surveyed PMTs are presented, as well as some severe PMT issues encountered during the evaluation process.

- Funded by BMBF and GSI -

HK 11.3 Mon 17:15 SR Exp1B Chemie

SiPM based neutron detectors for the lifetime experiment τSPECT — •Julian Auler[1], Martin Fertl[1], and Dieter Ries[2] for the tauSPECT-Collaboration — [1]Institute of Physics, Johannes Gutenberg University Mainz, Mainz, Germany — [2]Paul Scherrer Institute, Villigen PSI, Switzerland

The neutron storage experiment τSPECT aims to measure the free neutron lifetime by confining ultracold neutrons (UCNs) in a three-dimensional magnetic trap. A key aspect of this experiment is the detection of UCNs at various locations and times. For this purpose, a multilayer structure consisting of a conversion layer and a scintillator layer on a polyester carrier foil is employed. This design enables flexible coupling to light guides of detectors with diverse geometries. Silicon photomultipliers (SiPMs) are used as photosensors, which are particularly well suited for in-situ detection in τSPECT due to their compatibility with high magnetic fields.

This talk will give an overview of UCN detectors already implemented in τSPECT and discuss recent developments. In particular, we will present our approach to determine the energies of stored UCNs by combining a spatial resolving detector with the magnetic field gradient of the UCN trap. Additionally, a complementary detector in the beamline is employed to monitor fluctuations of the UCN source performance and to normalize measurements in τSPECT accordingly. Lastly, the so-called leakage detector will be introduced, which is intended to investigate systematic effects related to magnetic storage by detecting UCNs that may escape the trap.

HK 11.4 Mon 17:30 SR Exp1B Chemie

Dual sided PMT Readout Studies for the DarkMESA Calorimeter — •Lukas Reitz for the MAGIX-Collaboration — Johannes Gutenberg Universität, Mainz

At the Institute for Nuclear Physics in Mainz, the MESA accelerator will be operational shortly, producing a high-energy beam (150 MeV, 15 mikro Ampere). This beam will be used in the P2 experiment and subsequently absorbed in a beam dump, making the P2 experiment ideally suited for a parasitic dark sector experiment — DarkMESA.

The goal of this experiment is the detection of Light Dark Matter (LDM), which in simple models couples to the dark photon. This dark photon can potentially be produced in the P2 beam dump through a process analogous to bremsstrahlung and may then decay into a dark matter particle pair. A fraction of these dark matter particles will scatter off electrons or nuclei within the DarkMESA calorimeter, generating detectable Cherenkov light.

The Phase A calorimeter consists of 5x5 PbF2 crystals due to their high density and is surrounded by a hermetic veto system made of two layers of plastic scintillators and a 1 cm thick lead shield. For the Phase B calorimeter, SF6 and BGO are also considered as potential calorimeter materials.

This contribution will focus on the feasibility of reading out a BGO calorimeter from both sides using PMTs. A dual-sided readout would enable time-of-flight measurements, allowing for more precise determination of an Event's location and propagation within the calorimeter while also drastically reducing background noise of the detector.

HK 11.5 Mon 17:45 SR Exp1B Chemie

A Look Inside mRICH: Exploring Timing and Performance of a RICH Prototype* — •Abhishek Anil Deshmukh for the CBM-Collaboration — Bergische Universität Wuppertal, Wuppertal, Deutschland

The CBM (Compressed Baryonic Matter) experiment to be built at the future FAIR facilities in Darmstadt, Germany aims to investigate the QCD phase diagram at high-net baryon densities and moderate temperatures. The FAIR accelerator will provide high-intensity heavy-ion beams for this fixed target experiment. To ensure the best operability of CBM at day one, a prototype of CBM is set up already now, including scaled-down versions of almost all the detectors later to be employed in the final CBM setup. One main goal of this prototype, called mini-CBM (mCBM), is to establish the free-streaming readout scheme envisioned for CBM. To test this scheme a dedicated test beam time was carried out at the beginning of 2024.

This contribution will focus on the mRICH detector, being part of mCBM. The mRICH is a proximity-focusing RICH detector that utilizes the same readout electronics as the RICH detector planned for the final CBM experiment. Particular emphasis is placed on the RICH ring matching with tracks from other detector systems. The discussion also covers the detector's overall performance, which primarily depends on the aerogel radiator that has been in operation for over four years.

*Work supported by BMBF (05P24PX1)

HK 11.6 Mon 18:00 SR Exp1B Chemie

A SiPM-based Ring Imaging Cherenkov detector at CBM. — •Jesus Peña-Rodríguez, Christian Pauly, Jörg Förscн, and Karl-Heinz Kampert for the CBM-Collaboration — Fakultät für Mathematik und Naturwissenschaften, Bergiche Universität Wuppertal, Gausstrasse 20, 42119 Wuppertal, Deutschland

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will study the phase diagram of strongly interacting matter at high densities and moderate temperatures. CBM features a Ring Imaging Cherenkov (RICH) detector for electron detection. The RICH detector will have two photon cameras comprised of Multi-Anode Photomultipliers (MAPMTs), two spherical glass mirrors as focusing elements, and a CO2 radiator gas. In recent years, Cherenkov detectors have been moving toward new photodetection technologies to improve timing, spatial, and amplitude resolutions. Silicon photomultipliers (SiPMs) measure single-photon light intensities with picosecond timing precision, photodetection efficiencies up to 50%, and magnetic field immunity. However, SiPM drawbacks, such as a strong temperature dependence and high dark count rates, make their use challenging in RICH detectors featuring low-rate single-photon signals. We present the implementation and characterization of an 8x8 SiPM (AFBR-S4N66P024M) array adapted to the readout electronics of the CBM RICH. In addition, we evaluate the SiPM radiation hardness under different doses taking into account the radiation levels expected in the CBM photon cameras.