XII International Workshop on Ring Imaging Cherenkov Detectors - RICH2025

Contribution ID: **13** Type: **Talk**

Experiences with series produced Microchannel-Plate PMTs for the PANDA Barrel DIRC

Wednesday, September 17, 2025 10:30 AM (20 minutes)

The PANDA experiment at FAIR will use two DIRC detectors for charged particle identification via Cherenkov light. Given the harsh radiation environment and the placement of the photosensors in magnetic fields of ~1 Tesla, Microchannel Plate Photomultiplier Tubes (MCP-PMTs) were selected as the designated sensors to fulfill the stringent requirements for the DIRCs. For the Barrel DIRC, 155 MCP-PMTs of type XP85112-S-BA were ordered from PHOTONIS. These sensors feature a 2×2 inch^2 active area and MCPs with 10 µm pore diameter. To meet the experiment's lifetime requirement of about 5 C/cm^2 integrated anode charge over ten years, all MCPs were treated with atomic layer deposition (ALD) coatings of Al_2O_3 and MgO to improve their lifetime.

Before deployment of the sensors in PANDA a comprehensive and systematic quality control program is conducted at the University of Erlangen. It includes a wavelength scan of the quantum efficiency (QE) and the measurement of the gain curve, as well as scans of the spatial homogeneity of QE and gain. The collection efficiency, the time resolution and the rate capability are also measured. Using the DiRICH/TRB DAQ system from GSI additional parameters such as the dark count rate (DCR), afterpulse probability (AP) and its time-of-flight (TOF) distribution, and crosstalk are assessed as a function of the active area. The large amount of tested MCP-PMTs allows insights in the quality of the production and provides a high statistics sample of the various performance parameters.

While the complex process of ALD coating enhances the lifetime of MCP-PMTs, it also introduces unwanted side effects regarding some key parameters in a fraction of the sensors. Some MCP-PMTs show characteristic peaks in AP TOF spectra most likely corresponding to Mg and Al ions, suggesting that the AP ions originate from the ALD layers. Furthermore, a subset of tubes exhibits a phenomenon referred to as "escalation", where massive photon rates are emitted from within the MCP. In some cases, escalation occurs only in local regions of the sensor. Tubes with higher DCR and AP levels tend to enter escalation at lower gain values, suggesting a correlation between ALD-induced impurities and this behavior.

Despite the observed issues, the large dataset from more than 90 tested sensors enables a detailed analysis of correlations among sensor parameters, such as the MCP resistance and rate capability. Tubes with lower MCP resistance generally perform better under high-rate conditions, maintaining stable gain at photon rates up to 10^6 photoelectrons/s/cm^2. However, no direct correlation was found between MCP resistance and the occurrence of escalation.
These and more findings will be presented.

- Funded by BMBF and GSI -

Author: GUMBERT, Katja (Universität Erlangen(UErl))

Co-authors: LEHMANN, Albert (Universität Erlangen(UErl)); MIEHLING, Daniel (Universität Erlangen(UErl)); Mr COSTI, Gabriele; BÖHM, Merlin (Universität Erlangen(UErl)); KRAUSS, Steffen (Universität Erlangen(UErl)); FOR THE PANDA CHERENKOV GROUP

Presenter: GUMBERT, Katja (Universität Erlangen(UErl))

Session Classification: Photon sensor techniques for Cherenkov imaging counters

Track Classification: Photon sensor techniques for Cherenkov imaging counters