Cherenkov photon detection with the HADES RICH in Au + Au collisions*

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In the past years, the HADES experiment has undergone a mayor upgrade of the detector readout and DAQ system [1] to enhance its performance stability and count rate capabilities also for collision systems like Au + Au. Within this enterprise, the GASSIPLEX based frontend electronics of the gaseous MWPC type **R**ing **I**maging **Ch**erenkov detector has been replaced by readout cards utilizing the APV25S1 amplifier chip [2]. The photon detector is operated with CH_4 at normal pressure and equipped with a CsI photo cathode sensitive in the wavelength region 150 nm < λ < 200 nm. Consequently, we have performed a dedicated study of the MWPC response to single photo electrons and updated the detector modelling in the HADES analysis and simulation framework Hydra such as to allow for proper electron and positron identification in the recent Au + Au experimental runs.

In an off-line experiment we have used ^{241}Am α-particle induced xenon excimer emission around λ ~ 170 nm to illuminate the whole detector plane with a photon areal density 10^{-3} cm^{-2} < ρ < 10^{-1}cm^{-2} per emission event. Events triggered by correlated α-particles were recorded with rates 0.1 kHz < R < 30 kHz for various MWPC anode voltages 2200 V < U_{an} < 2500 V. Up to ~10^4 photo electron induced signals have been recorded for each of the 28272 pads allowing for a systematic study of the detector response to single VUV photons.

The zero bias pulse height distribution for each pad exhibits for nearly all voltages a clear single photo electron signal at higher amplitudes. A sample spectrum is shown in the left panel of Figure 1. Recorded photon signals with

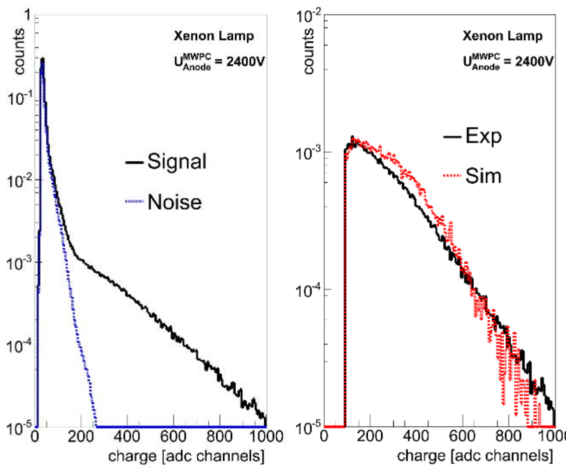

Figure 1: Pulse height spectra with noise contribution (left) and for single photon signals after noise subtraction in comparison to detector simulations (right).

noise suppressing 3σ thresholds (Figure 1, right panel) show after noise subtraction for each photon a pad cluster size ranging from 1 to 4 pads with an average multiplicity $\langle M_{pad} \rangle$ = 1.3. Simulations with tuned detector model parameters reproduce amplitudes and pad coupling in all aspects reasonably well. The photo electron detection efficiency varies in the range 0.88 < ε_{se} < 0.94 across the whole pad plane. With a preliminary calibration of the emitted photon yield per trigger we extract a ~ 20% reduction of the overall photon detection efficiency compared to values determined in experimental runs before.

Cherenkov photons radiated by electrons and positrons from reconstructed π^0 – Dalitz e^+e^- pair decays were then used to verify the photon detector response in Au + Au reactions at E = 1.23 AGeV. In spite of the high charged particle multiplicity environment and significant background in the photon detector, Cherenkov rings could be identified and analysed. The observed signal distributions of the ring and pad patterns show reasonably good agreement with the VUV lamp data and the detector model simulations. Figure 2 shows as an example the pad multiplicity per ring (left panel) and the relative cluster type abundances attributed to single and multiple photon hits in the ring (right panel).

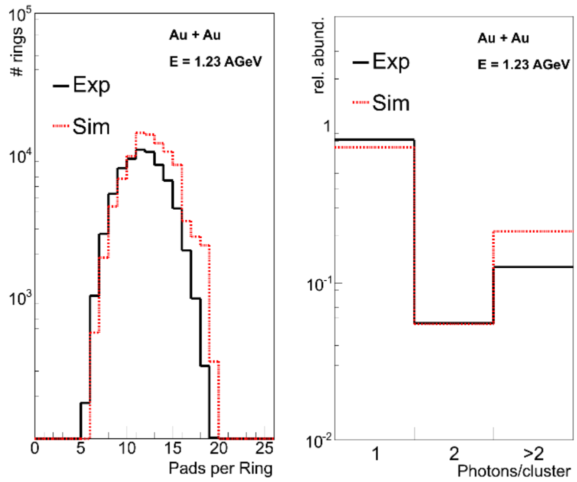

Figure 2: Pad multiplicity and cluster type abundance distributions in identified Cherenkov rings measured and simulated for reconstructed e^+/e^- tracks in Au + Au collisions.

After more than a decade of operation, the MWPC photon detector with the new frontend electronics is still capable to detect Cherenkov rings even in Au + Au collisions, albeit with a somewhat lower overall efficiency.

[1] J. Michel et al., IEEE Trans. Nucl. Sci. 58 (2011)
[2] L.L. Jones et al., CERN/LHCC/99-09 162

* Work supported by BMBF 05P12WOGHH, GSI TMLFRG316
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DOI:10.15120/GR-2015-1-MU-NQM-HADES-14