Performance of the HADES-RICH Photon Detector ◇

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In the past year the readout electronics of the ring imaging Cherenkov detector (RICH) for HADES [1] was completed. A preliminary version of the RICH mirror was installed and equipped with float glass substrates (4 sectors only). The new gas supply system [2] including a refined VUV transmission monitoring went into routine operation. The RICH was succesfully operated in 2 beam times at GSI with light and medium heavy ions. We report here on first results and improvements of the photon detector performance. Some of the measurements have also been performed with a detector module in our laboratory.

The photon detector is a thin-gap (d = 5.5 mm) MWPC with CaF_2 entrance window and a pad cathode (28.272 pads) covered by a solid CsI photon converter. The chamber is operated with purified CH_4 at atmospheric pressure and read out with a GASSIPLEX based front end circuitry. The excellent VUV transmission ($T \simeq 100\%$) of the gas down to the absorption cutoff at $\lambda = 146\,nm$ was continuously monitored. From the very beginning, the MWPC was run under stable conditions with an anode voltage of 2500 V and typical leakage currents $I < 20nA$ in each of the six sectors even at beam intensities $N_{beam} = 1{\cdot}10^6 s^{-1}$. Cherenkov photons generated by beam ions in solid radiators [3] have been used to liberate single photo electrons from the detector cathode and to measure pulse height distributions for each pad. A Polya function analysis results in a visible gas gain $q_{mean} \geq 1{\cdot}10^5$ for all channels.

The detection efficiency ϵ^{se} for single photo electrons was optimized in a systematic study of electronic noise for all pads. Offset amplitudes (Q_{off}) and variances (σ) as a measure for the noise were obtained for each pad from pulse height distributions registered with random trigger and zero threshold. The resulting distribution of variances for all pads in one sector is shown in Fig. 1. After installation of additional grounding shields on the rear of the pad plane the significant dependance on pad position and wire length seen before [4] is not visible any longer. The average sigma could be reduced from $\sigma_{old} = 8560e^-$ to $\sigma_{new} = 1120e^-$. For the given q_{mean}, an integration of the Polya function from the lower threshold (pedestal) $P = Q_{off} + 3 \cdot \sigma$ to infinity then results in single electron efficiencies $\epsilon^{se}_{old} = 74\%$ and $\epsilon^{se}_{new} = 94\%$, respectively.

The pad multiplicity per event depends on the number of photon hits and on background hits due to charged particles and noise. It has strong influence on the recognition efficiency for Cherenkov rings and on the achievable event rate capability. Measurements with ion beams show in one sector (4712 pads) multiplicities as low as $< M > \simeq 50\,pads/event \simeq 1\%$ for readout rates up to $5 \cdot 10^3 s^{-1}$. At higher rates an increase of cross talk on the frontends leads - although with low probability - to very large multiplicities and hence to data rates exhausting the readout bandwidth.

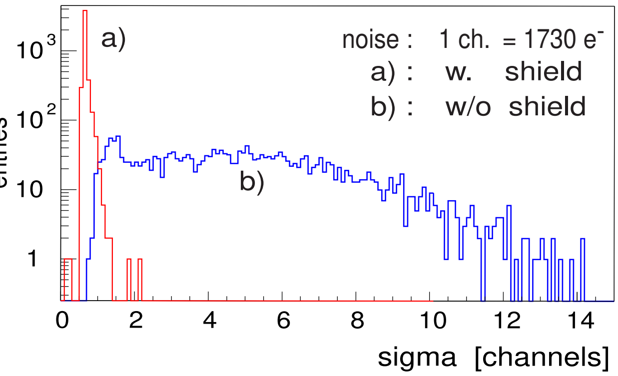

Fig. 1: Distribution of pad pulse height variances (σ) in units of channels before (b) and after (a) installation of grounding shields.

In C+C collisions at 1.5 AGeV the photon detector is hit by charged particles with a rate of about one per 1000 first level trigger events. From a first analysis of the detector response to these charged particles we find that the large energy deposition triggers in about 5% of all such events spontaneous discharges. Due to a current limitation circuitry these discharges do not develop to sparks but to short HV drops which are well localised to a few anode wires. In this way the in beam detector operation is not seriously affected. However, these mini discharges are accompanied by a few mV shift of the pad pedestals and lead in the respective area only to a reduced photo electron efficiency. Fig. 2 shows as an example a cosmic muon track as it was recorded with one detector module in our laboratory.

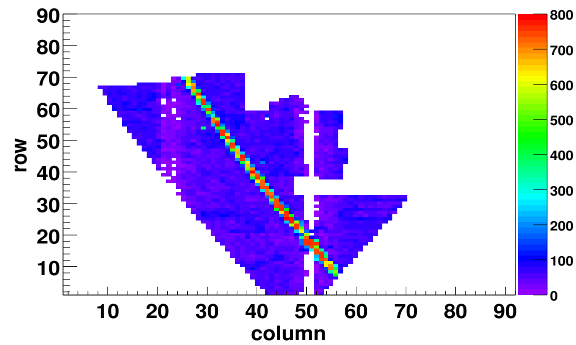

Fig. 2: Track of a single cosmic muon parallel to the cathode surface. Note the large charge disposal on individual pads. The upper right corner was not equipped with electronics.

In summary, the photon detector is operational and ready for data taking in physics runs. Presently we continue to increase the rate capability to the design value.

References

[1] K. Zeitelhack *et al.* , Nucl. Instr. Meth. **A433** (1999) 201, and Jahresbericht 1999, p. 95
[2] J. Friese *et al.*, this report, p.79, and Jahresbericht 1999, p. 94
[3] S. Schröder, diploma thesis, TU München, 2001, and this report, p.81
[4] M. Böhmer *et al.*, Jahresbericht 1999, p. 96

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