Study of Photon Detector Response of the HADES-RICH Detector ◇

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The ring imaging Cherenkov detector (RICH) [1] of the dilepton spectrometer HADES at GSI, Darmstadt, is used as a second level trigger device for events containing e^+/e^- pairs. The efficiency for electron identification and hence the trigger efficiency depend strongly on the efficiency to detect a single photon. Its determination requires a precise knowledge of all relevant optical properties of the RICH, where the quantum efficiency of the CsI photo cathode used in the MWPC is the most sensitive parameter [2]. The detector properties are represented by a figure of merit N_0 which determines the number of detected photons $N_{det}^{Ph} \approx N_0 \cdot Z^2 \cdot \Delta d \cdot \sin^2 \Theta_C$ for a given particle charge Z, a radiator thickness d and Cherenkov angle Θ_C. For optimum parameters we expect $N_0 \simeq 110$.
We have focused light and medium heavy ion beams (Z$\gg$ 1) of E=600 AMeV to a set of two solid radiator discs (MgF2, SiO2) in order to produce a well defined amount of Cherenkov light and to determine the effective photon detection efficiency in the RICH. Each incident ion generated two large Cherenkov rings of well separated individual photons. An example of 2 ring segments measured in one of the 6 sectors is shown in Fig. 1. A detailed description of this methode is given in ref. [3].

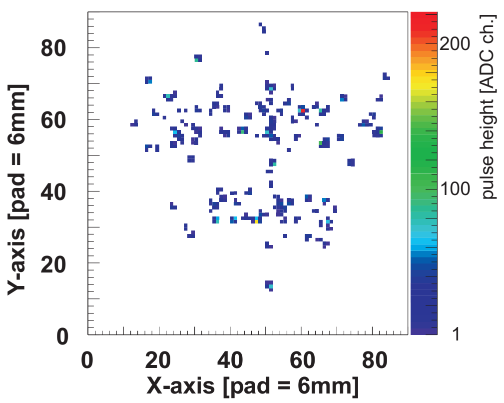

Fig. 1: Single event from ^{12}C ions (E = 600 AMeV, β = 0.794) impinging on a MgF_2 and a SiO_2 radiator.

The measured pulse height distributions and hit patterns on the detector padplane induced by individual photons were used to develop a parametrisation for the pad response (digitizer) which is applicable for the HADES full system simulation code (HYDRA). Each single photon induces signals distributed typically over an area of $3 \cdot 3$ pads with the central pad getting most of the charge. A considerable fraction of the total charge is induced to neighbouring pads due to electric coupling and cross talk. Simulation results based on our parametrisation are shown in Fig. 2 in comparison to experimental data and exhibit a good quantitative agreement of the distribution profiles.

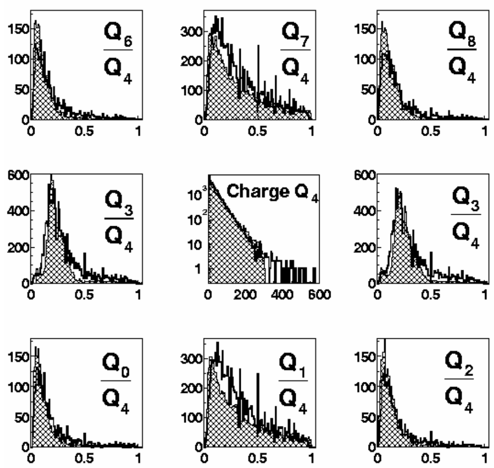

Fig. 2: Charge coupling to neighbouring pads for 1000 single photons hitting the central pad. Plotted are charge ratios (Qi/Q4) with respect to the charge on the central pad (Q4). Solid curves correpond to simulated data, hatched aereas to experimental data.

In addition we have analyzed the polar angle distribution of detected photons. Fig. 3 shows a comparison to simulation results for optimun detector parameters. The optical dispersion of the radiator leads to a broadening of the rings. Hence, the width and shape of the radial photon distribution reflect also spectral information of the optical properties. From the comparison for four out of six sectors we extract experimental figures of merit $90 \leq N_0 \leq 110$ which are close to the design value.

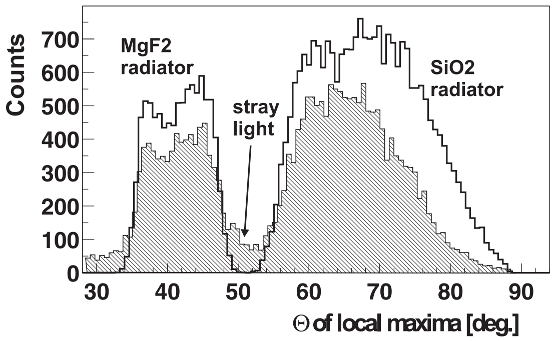

Fig. 3: Polar angle distribution of the detected photon candidates in 1 sector compared for simulated and real data; the same number of event has been accumulated. White histograms correpond to simulated data, hatched histograms to experimental data.

References

[1] K. Zeitelhack *et al.*, Nucl. Instr. Meth. **A433** (1999) 201
[2] J. Friese *et al.*, Nucl. Instr. Meth. **A438** (1999) 86; Annual report 1996, p. 99
[3] S. Schroeder, diploma thesis, TU München, 2001

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