Efficiency measurement for the HADES-RICH Detector ◇

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The ring imaging Cherenkov detector (RICH) [1,2] 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 number of Cherenkov photons N_{phot} registered for each ring by the MWPC type photon detector. 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.
We have used light and medium heavy ion beams to determine the effective photon detection efficiency in the RICH making use of the good photon statistics expected for $Z > 1$ particles. A slightly displaced beam was focused to a set of two solid radiator discs located close to the regular target station inside the RICH and generated for each incident ion two large Cherenkov rings of precisely calculable photon yield. The setup is depicted in Fig. 1). The light from the upstream SiO_2 disc is transmitted through the downstream MgF_2 disc. The standard radiator gas C_4F_{10} was replaced by purified and highly VUV transparent N_2. Velocities and nuclear charge of the beam ions were chosen such that both superring patterns could be recorded simultaneously and that individual photon hits could be identified on the ring area. A typical ring pattern for about 600 ^{12}C ions is shown in Fig. 2.

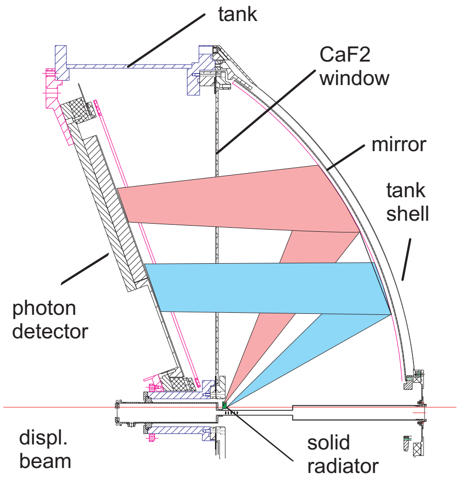

Fig. 1: Schematic view of the RICH setup with a stack of MgF_2 and SiO_2 discs used as Cherenkov radiators for relativistic ions.

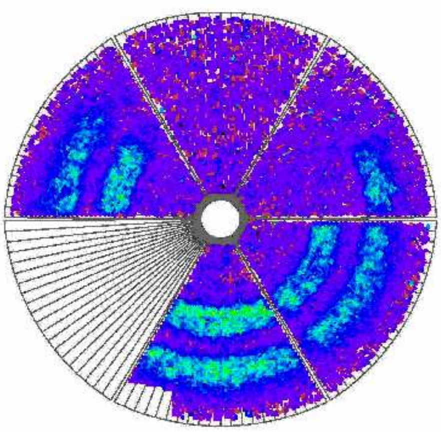

Fig. 2: Superposition of $\simeq$ 600 Cherenkov rings from ^{12}C ions (E = 600 AMeV, $\beta = 0.794$) impinging on a MgF_2 and a SiO_2 radiator. The upper sectors are in the shadow of the beam pipe; one lower sector was not equipped with mirrors and readout electronics.

The number of detected photons per ion of charge Z is given by $N_{det}^{Ph} \approx N_0 \cdot Z^2 \cdot \Delta d \cdot \sin^2 \Theta_C$ for a radiator thickness d and Cherenkov angle Θ_C and allows to calculate the figure of merit N_0 which contains all optical and detector properties. Due to the CsI cathode, the photon detector is sensitive to Cherenkov light in the spectral region $146\,\mathrm{nm} < \lambda < 210\,\mathrm{nm}$, whith the short wavelength limit given by the transmission cutoff of the detector gas CH_4. For optimum detector parameters we expect $N_0 \simeq 110$.
Energy loss in the radiator and optical dispersion lead to a broadening of the rings. Hence, the width and shape of the radial photon distribution reflects also spectral information of the optical properties. The polar angle distribution is shown for one sector in Fig. 3 in comparison to simulation results, for which measured transmissions, an optimum mirror reflectivity, and the high CsI quantum efficiency [3] were taken as input. For three of six sectors we extract experimental figures of merit $90 \leq N_0 \leq 105$ which are slightly below the optimum (design) value. A more detailed analyis can be found in [4]. With the permanently installed radiators these measurements can be easily repeated for each HADES run and allow a continuous monitoring of the RICH performance.

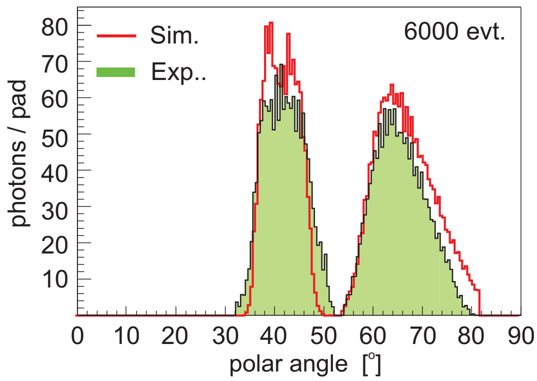

Fig. 3: Polar angle distribution for both ring segments in 1 sector compared to a simulation using optimum detector parameters.

References

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[2] A. Elhardt *et al.*, this report, p.80
[3] J. Friese *et al.*, Nucl. Instr. Meth. **A438** (1999) 86; Jahresbericht 1996, p. 99
[4] S. Schroeder, diploma thesis, TU München, 2001

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