Feasibility study for a MAPMT readout of the HADES RICH*

K. Schmidt-Sommerfeld[1], *J. Friese*[†1], *T. Kunz*[1],
[1]Phys. Dept. E12, TU München, Garching, Germany

The HADES RICH is equipped with a MWPC type photon detector and a solar blind CsI photon converter. Operational since 1999, the device starts to suffer from ageing effects in gas amplification, quantum efficiency and hence e^+/e^- - identification power. In view of future experiments with π^- beam and HI induced collisions at SIS and FAIR energies [1] we have studied the feasibility of a MWPC replacement by multi anode photo multiplier tubes (MAPMTs). Driving perspective is an enhancement of the e^+/e^- - identification efficiency and count rate capability. Since commercially available MAPMTs offer pixel sizes similar to the pad dimensions of the present detector, geometrical and granularity effects on ring recognition efficiency are expected to be negligible. Hence, the existing radiator-mirror system may stay unchanged.

We have studied basic RICH performance aspects [2] utilizing the properties (QE and geometry) of Hamamatsu H8500C tubes foreseen also in the CBM RICH [3]. The bi-alkali photo cathodes shift the spectral sensitivity of the present detector from the VUV to the 200 nm < λ < 600 nm region and may lead to additional background effects.

In a first step, we have investigated the scintillation light yields of several purified radiator gases [2]. The gas samples were excited with $^{32}S^{8+}$ beams (E = 90 MeV) and ^{241}Am α-particles. The spectral distributions (Figure 1) show very little emission for C_4H_{10} but a pronounced structure around 300 nm for C_4F_{10}. The total light yield in the MAPMT sensitive region has been estimated for these gases to $Y_{C4H10} < 2 \pm 1$ and $Y_{C4F10} \sim 160 \pm 60$ photons per MeV energy deposit. As known for other cases, a few percent admixture of other gases (O_2, etc.) can quench the scintillation light significantly without affecting the Cherenkov yield.

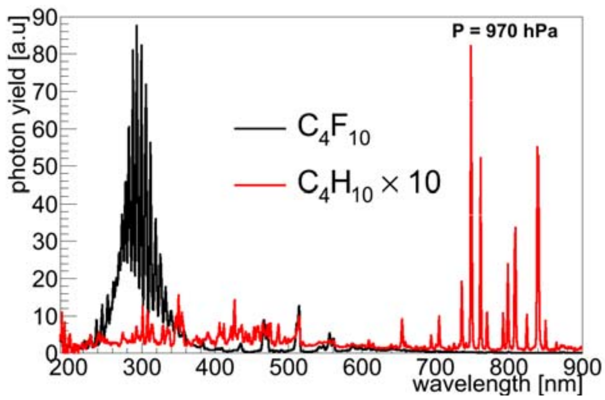

Figure 1: Spectral distributions of scintillation light emitted from purified C_4F_{10} and C_4H_{10} gas samples.

Simulation results for a pure electron sample with homogeneous phase space coverage show a strong increase of recognized rings preferably at lower polar angles and thereby short effective radiator lengths (see Figure 2, left), due to the high MAPMT quantum efficiency. Since scintillation background is negligible for reactions with low track multiplicities, the gain in e^+e^- - pair detection efficiency allows considerable signal enhancement and beam time saving for π-beam experiments. In Au + Au collisions, however, the average energy deposit ΔE ~ 130 MeV/event in the standard radiator gas C_4F_{10} leads to ~ 20.000 scintillation photon hits on the detector plane. Predominantly in the area close to the beam axis they give rise to a substantial amount of fake rings. True Cherenkov rings may, however, still be discriminated to a large extent due to their significantly better ring quality parameters (pattern matrix PM QA, see right panel of Figure 2). Hence, more refined ring finder algorithms and/or selection of different radiator gas mixtures are feasible options easy to realize.

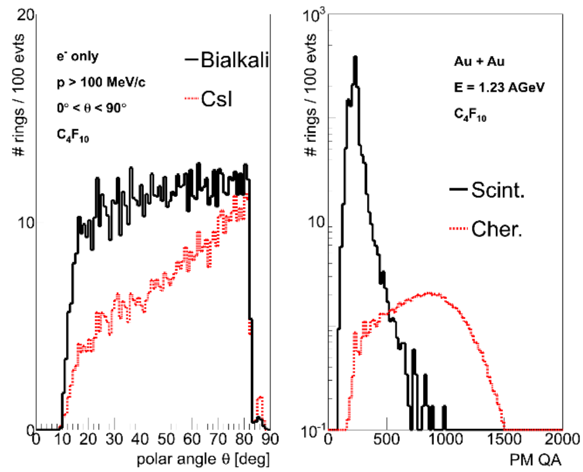

Figure 2: Simulated angular distribution of Cherenkov rings for pure electrons (left) and ring qualities PM of all rings in Au + Au collisions (right) for MAPMT readout.

The MAPMT readout of the HADES RICH has very promising perspectives for the future HADES experimental programme. We have therefore started a joint effort with the CBM RICH collaboration to elaborate on and realize this upgrade scheme within the upcoming two years.

[1] P. Finocchiaro et al., TDR HADES-100, GSI 2013
[2] K. Schmidt-Sommerfeld, Mast. Thes., TUM 2014
[3] C. Höhne et al., TDR CBM-RICH, GSI-2014-00528

* Work supported by BMBF 05P12WOGHH, GSI TMLFRG1316
† juergen.friese@ph.tum.de

DOI:10.15120/GR-2015-1-MU-NQM-HADES-29