Reinvestigation of the TMAE Quantum Efficiency ◇

A. Fräbel, J. Friese, R. Gernhäuser, A. Kastenmüller, M. Knülle, H.-J. Körner, P. Kuschnerus [a], H. Rabus [a], and K. Zeitelhack

[a] Physikalisch-Technische Bundesanstalt (PTB), Abbestr. 2-12, 10587 Berlin

Ring imaging Cherenkov counters (RICH) are widely used in high energy physic experiments for particle identification. Most of these RICH photon detectors are operated with a gaseous photo converter called TMAE (tetrakis(dimethylamino)ethylene). To evaluate the concept of a new type of TMAE detector, we have reinvestigated the quantum efficiency (QE) [1].

The determination of the wavelength dependent QE involves a measurement of the absorption length, which exceeds 25 mm at room temperature. The standard method is to extract the transmittance of a TMAE-filled gas cell at various partial pressures by consecutive irradiation with monochromatic light. The QE can then be determined from a measurement of all charge carrier pairs produced in the sensitive volume of an ionisation chamber. Since TMAE builds films on every surface, i.e. on the windows, the absorption measurement and the QE have large uncertainties.

For this reason we have used a new concept. The anode of the chamber was segmented to allow for a manifold measurement of photoionisation currents with spacial resolution (see fig. 1). The decrease of photoionisation currents then directly reflects the absorption length.

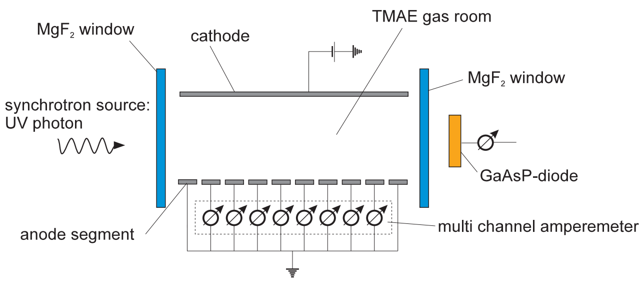

Fig. 1: Schematic view of the TMAE chamber

As the setup allows to measure all parameters simultaneously, systematic error sources like

- photon flux fluctuations between the measurements
- photon scattering at the entrance aperture
- transmission losses due to TMAE films

can either be eliminated or corrected for.

However, this concept requires a very strong VUV source and the possibility to precisely measure lowest photo currents. Therefore the measurements were done in a collaboration with the PTB at the synchrotron radiation source BESSY in Berlin. A nine-channel amperemeter (eight anode segments and the diode) with a resolution of 50 fA was developed [2]. A GaAsP-diode absolutely calibrated (error < 1.2 %) by the PTB [3] allowed an unprecedented precision in photon flux determination.

As the vapour pressure of TMAE is below 0.5 $mbar$ at room temperature, a carrier gas is usually added in a temperature stabilized bubbler. We have measured transmittance and QE of pure TMAE as well as TMAE/methane mixtures. The temperature of the bubbler and thus the concentration of TMAE was varied.

The QE values determined for each of the 28 measurements at various conditions agree well with each other within the errors. This consistency reflects the quality of the experimental setup. The resulting QE is shown in fig. 2 in comparison with literature values [4] and our recent results for the QE of CsI [5].

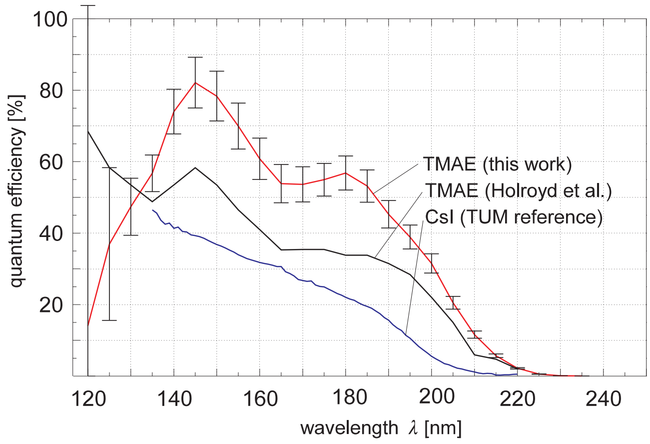

Fig. 2: QE of of TMAE vapour and CsI films in comparison to literature values [4]

While the spectral shape of both TMAE curves is very similar, the absolute QE values obtained by us are considerably higher than those given in the literature. At the same time our extinction coefficients (extracted from the absorption measurement) are about a factor 2 smaller than published data; this fact we attribute to the application of an improved TMAE purification technique [6]. These discrepancies reflect the large impact of systematic errors in all previous measurements.

In a standard RICH photon detector with sufficient conversion gap length and operated at elevated temperatures ($T \approx 50°C$) both effects would nearly compensate and the number of detected photoelectrons should not change dramatically. However, for our new photon detector [1] to be operated at room temperature the low values of the extinction coefficient did influence the detector design and might give improved overall efficiency.

References

[1] A. Fräbel, diploma thesis, TU München, 1996
[2] M. Knülle, private communication
[3] H. Rabus, private communication
and Nucl. Instr. Meth. **A**, in preparation
[4] R. A. Holroyd *et al.*, Nucl. Instr. Meth. **A261** (1987) 440
[5] M. Peter, internal report
[6] S. Ilie, private communication

◇ supported by BMBF (06TM365)