Crosstalk between neighbouring channels in multianode PMTs *

J. Kopfer[1], *K.-H. Becker*[1], *K.-H. Kampert*[1], *C. Pauly*[1], *J. Pouryamout*[1], *S. Querchfeld*[1], *J. Rautenberg*[1], *and S. Reinecke*[1]

[1]Bergische Universität Wuppertal, Germany

The photo-detector of the CBM-RICH detector is foreseen to be built from multinanode photomultiplier tubes (MAPMTs). The usage of MAPMTs has the advantage of good time and spatial resolution and a very low dark rate. Up to now, R&D was focussed on the Hamamatsu metal channel dynode type PMTs H8500 and R11265. The H8500 has 64 pixels of 5.8 x 5.8 mm^2 each. The R11265 has 16 pixels with the same pixel size. The suitability of the H8500 for single Cherenkov photon detection has been demonstrated in laboratory tests [1] and in beam tests [2, 3].

In a RICH detector the number of registered photons per Cherenkov ring is important for the efficiency of ring finding and the quality of the ring fitting. In order to evaluate the number of registered photons, crosstalk has to be taken into account. There are two different sources of crosstalk: firstly optical crosstalk from the incident light spread in the front window and from photo electrons travelling on a curved trajectory from photo cathode to first dynode and secondly electrical crosstalk from the splitting of the electron avalanche between the dynodes during secondary electron multiplication and on the segmented anodes. Optical crosstalk will mainly cause a smearing of position information and does not influence the number of registered photons whereas electrical crosstalk generates additional hits in the neighbouring pixels.

Crosstalk measurements for the H8500 have already been done by illuminating one pixel with a pulsed 350 nm LED/tungsten lamp with the help of an aperture mask or optical fibre [4, 5]. Here, we present measurements of additional hits caused by crosstalk on single photon level at a wavelength of 275 nm.

The measurement is based on a homogeneous single photon illumination of the MAPMT without usage of an aperture mask or light fibre which has the advantage that the photons hit the pixel not only at the central part but homogeneously distributed over the whole surface as it will be the case in the RICH detector. Single photons hitting the outer parts of a pixel will create more crosstalk than those hitting the centre. Data readout is done as described in [3]. In order to estimate the number of additional hits in neighbouring pixels due to crosstalk, the distribution of the geometrical distance of hits in events with exactly 2 hits per MAPMT (2-hit-events) is compared to a simulation without crosstalk (Fig. 1). The normalized excess of entries in the bin corresponding to direct and diagonal neighbours in the data compared to the simulation quantifies the crosstalk.

* supported in part by GSI project WKAMPE1012 and BMBF grant 06WU9195I

The crosstalk extracted by this method depends on the threshold applied to the ADC signal. Figure 2 shows the additional hit fraction (crosstalk) as function of MAPMT gain for 12 H8500 and 7 R11265. It can be seen that for a common threshold for all MAPMTs the crosstalk rises with gain. This is expected as for high-gain MAPMTs the relatively small ADC values of the crosstalk hits more likely pass the threshold. If, however, individual thresholds for every MAPMT at 10 % of the single photo electron peak are applied, the crosstalk is fairly constant. When averaging the values we see that for H8500 (6.8 ± 1.2) % additional crosstalk hits are found and (3.2 ± 0.7) % for R11265.

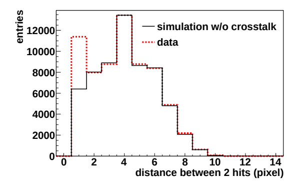

Figure 1: Geometrical distance of hits in 2-hit-events within one MAPMT in simulation (continuous) and data (dashed). Because of crosstalk, simulation and data differ in the second bin (”neighbour bin”).

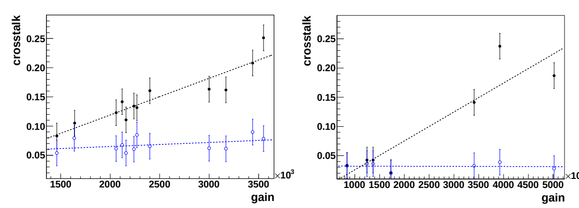

Figure 2: Crosstalk as function of gain for common threshold (filled black circles) and for threshold at 10 % of the single photon peak (open blue circles) for H8500 (left) and R11265 (right). Linear fits to the data are shown as dashed lines. Every data point corresponds to one MAPMT. HV of all MAPMTs was set to the same nominal value of 1000 V.

References

[1] C. Pauly et al., CBM Progress Report 2010, p. 26

[2] J. Eschke et al., CBM Progress Report 2010, p. 24

[3] J. Kopfer et al., CBM Progress Report 2011, p. 32

[4] J. Eschke et al., CBM Progress Report 2010, p. 28

[5] Hamamatsu Photonics K.K., Photomultiplier Tubes: Basics and Applications, Word Technical Writing Inc., 2007