Investigation of crosstalk in multi-anode photomultipliers for the CBM-RICH photodetector

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A key item of the CBM physics programme is the precise measurement of low-mass vector mesons and charmonium in their leptonic decay channel. In CBM, electrons will be identified using a gaseous RICH detector combined with several TRD detectors positioned behind a system of silicon tracking stations [1]. The concept of the RICH detector foresees an array of multi-anode photomultipliers (MAPMTs) for the photodetector covering an area of 2.4 m^2.

Beam tests at GSI (2009) and CERN (2010) and measurements with LEDs in the laboratory could demonstrate that the Hamamatsu H8500 with 64 pixels with a pixel size of 5.8×5.8 mm^2 is very well suited for the detection of single Cherenkov photons and therefore very likely will be used for the CBM RICH photodetector [2, 3]. In all these tests, the signals of the MAPMT were attenuated by a factor of 50 in order to be compatible with the self-triggered readout electronics based on the n-XYTER ADC chip.

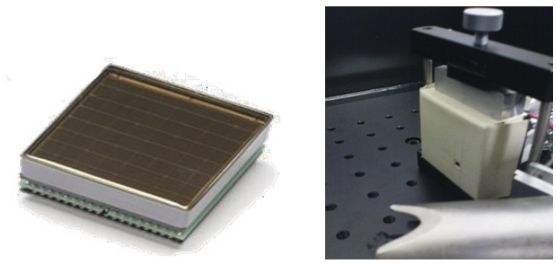


Figure 1: Single-photon illumination of a single pixel of the MAPMT with a LED

An important feature of H8500 MAPMT to be investigated is the crosstalk between neighbouring pixels. For its determination, a light-emitting diode (LED) with a wavelength of 350 nm was pulsed with ≈10 ns signals of ≈4.5 V amplitude. The distance between the LED and the MAPMT of ≈20cm in combination with the voltage at the operating threshold of this particular LED assured that not more than one photon per pulser signal reached one MAPMT pixel. Figure 1 shows the Hamamatsu H8500 covered by an aperture with a 3×3 mm^2 hole. Only the central part of a single pixel was illuminated at a time.

A clear separation of uncorrelated, low-amplitude noise events from signals of single photons with higher amplitude was achieved by a cut on the time difference between the pulser signal and the hits in the MAPMT. Figure 2 shows the event-integrated yield of MAPMT hits in linear and loarithmic scale. The uncovered pixel shows the largest number of hits. However, the 8 direct neighbour pixels, but also the 16 second neighbour pixels, exhibit an non-negligible signal yield, even though they could not be directly excited by photons.

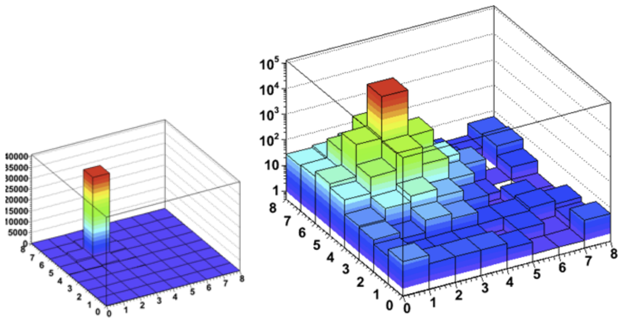
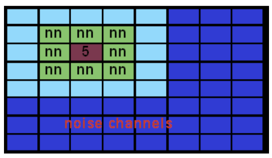


Figure 2: Yield of fired MAPMT cells from single-photon illumination of one pixel



$$\bar{n} = \sum_{n.c.} N_{hits}/39$$

Figure 3: Calculation of average noise ($\overline{n}$)

For a quantitative determination of this crosstalk, the average noise level in the 39 non-neighbouring MAPMT pixels was calculated (see Fig. 3) and subtracted. The fraction of cross talk in the 8 direct neighbour pixels

$$x = \frac{\sum_{nn} N_{hits} - 8\bar{n}}{N_{central} - \bar{n}}$$

compared to the central, illuminated pixel was determined by measurements on four different pixels of this MAPMT to be 7.7% on average. The measurement will be repeated by single-photon illumination with a template of the same size as the MAPMT pixels. It is expected that these measurement will reveal a crosstalk of more than 10%.

References

[1] C. Höhne, *CBM Progress Report 2007*, Darmstadt 2008, p. 17

[2] J. Eschke, K. Todoroki and C. Höhne, *CBM Progress Report 2009*, Darmstadt 2010, p. 21; J. Eschke *et al.*, this report

[3] J. Kopfer *et al.*, *Quantum efficiency and gain homogeneity measurements of H8500 MAPMTs for the development of a CBM RICH prototype camera*, this report