Design studies for a CBM-RICH prototype

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A RICH prototype is being planned in order to verify the concept of the CBM-RICH detector. This prototype will be scalable to the full detector, and results of the prototype test will be used to evaluate the simulations in the *CbmRoot* framework including tests of ring finding and fitting algorithms on real data. Concepts for the photodetector plane, including the integration of readout electronics, and mirror adjustment and alignment can also be tested. Finally, the results will provide all necessary information for the Technical Design Report.

First tests are foreseen in October 2011 at the T9 testbeam line of the CERN-PS. Here, a secondary beam of hadrons and electrons in the momentum range 1-10 GeV/c is available offering ideal conditions for understanding the electron-pion suppression capability of the RICH detector in the relevant momentum range for CBM. For the simulations shown in this report, the beam conditions were included following the characterization in [1] (polar angle spread, momentum range). The beam focal point in the simulation was placed 1 m in front of the detector; the azimuthal angle is uniformly distributed; the beam in the simulation consists of 50% electrons and 50% negative pions.

In order to have approximately the same amount of Cherenkov photons per electron or pion track, the length of the radiator (1.7 m) and the gas type (CO_2) were kept as in the layout of the CBM-RICH [2]. The positioning and alignment of the mirror and the photomultiplier (PMT) plane were adjusted to achieve focusing of the light cone from Cherenkov radiation of an electron beam passing the detector.

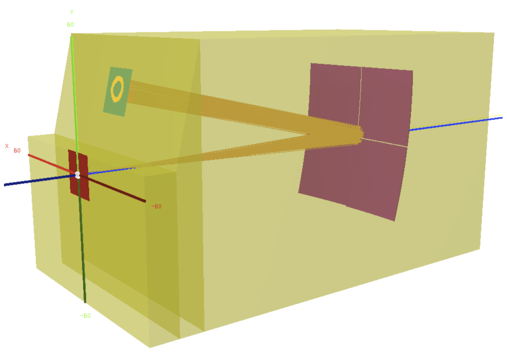

Figure 1: Schematic drawing of the prototype geometry

A schematic view of the prototype layout is shown in Fig. 1. The illustration includes the radiator (transparent yellow), the beam entrance window (left, red), the MAPMT plane (green) and four rectangular mirrors (pink). The beam axis is shown in blue. The transverse dimensions of the gas radiator are 1.2×1.2 m^2, its total length is 2.1 m.

In the event reconstruction, the granularity of the photodetector is implemented as an array of 4×4 MAPMTs with 64 channels each (1024 channels in total). Hits are created from projected photons by applying a tabulated quantum efficiency of the PMTs. In addition 50 channels (5%) are randomly fired in each event, simulating in this way a rather pessimistic noise level. Both the signal and the noise hits were taken as input for the ring finding algorithm [3], which is based on a standard implementation of the Hough transform finder in CbmRoot. As a fitter, the standard Ellipse Fitter is used. The Hough transform ring finding algorithm yields an electron ring reconstruction efficiency of 99.1%.

Applying a simple particle identification, a cut on the main axis a of the reconstructed ellipse was used: ellipses with $a > 4.4$ cm were identified as electrons, those with $a < 4.4$ cm as pions. On average this yields a pion misidentification of 3.3%. Figure 2 shows the distribution of the ellipse main axis versus momentum of the particle (left picture) and pion misidentification as a function of momentum (right picture).

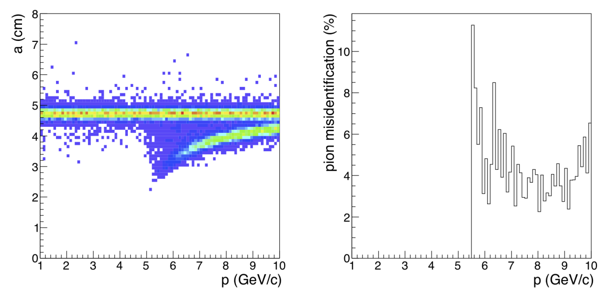

Figure 2: (Left) Distribution of the ellipse main axis versus momentum. (Right) Pion misidentification as a function of momentum.

In summary, the full RICH prototype was successfully implemented and tested in the CbmRoot framework. The testbeam data expected end of 2011 will allow to evaluate these simulations and the concept and performance of the CBM-RICH detector.

References

[1] http://ps-div.web.cern.ch/ps-div/Reports/PA9321/Tables/Table9.html

[2] S. Lebedev, E. Belolaptikova and C. Höhne, *CBM Progress Report 2008*, Darmstadt 2009, p. 20

[3] S. Lebedev *et al*, J. Phys. Conf. Ser. **219** (2010) 032015