Segmentation Optimization for dimuon detection system in CBM Experiment at FAIR

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Introduction

The main goal of Compressed Baryonic Matter experiment [1] at FAIR, upcoming accelerator facility at Darmstadt, Germany is to investigate the phase diagram in the region of higher baryonic densities. The proposed key observables are charmonia and Low Mass Vector Meson (LMVM) via their decays into dileptonic channels. As the produced dileptons do not participate in strong interaction, they provide information on the early dense phase of the collisions. The Indian CBM group is responsible for the design and fabrication of the muon detection system to measure muons [2].

The efficiency of the MUCH detector depend on the variables $p_{T,}$ η and φ. However, due to approximate azimuthal symmetry of the detector with respect to beam axis it is expected that efficiencies may be independent of azimuthal angle φ.Due to gap left for support system the efficiencies is expected to drop. Moreover, considering the high luminosity of the proposed FAIR facility the clustering of the pads will have influence on the efficiency of the detector. Hence for realistic detector design and optimization of detector layout, the detectors layers are to be segmented into smallest detection element called pads and a simple and flexible segmentation scheme has to be developed. The aim of the present work is to search for the optimized MUCH segmentation layout for LMVM and charmonia detection at FAIR energies.

CBM's Detector Concept

The design of the optimized version of muon detection system has already been simulated as shown in Fig. 1. It includes 6 iron absorbers and 18 detector layers (3 behind each absorber). The total absorber length in the current design turns out to be 225 cm. The detection procedure involves reconstruction of the track parameters in the Silicon Tracking system (which determines momenta of particles) and the extrapolation to the muon detecting stations through the absorbers. This will ensure high tracking efficiency even for relatively lower momenta muons, which are required for LMVM measurements. An additional shielding is used around the beam pipe in order to reduce the background of secondary electrons produced in the beam pipe [3].

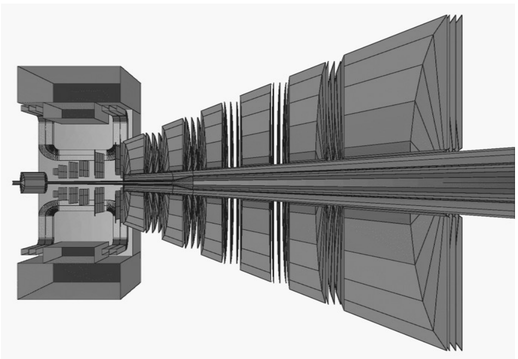

Fig. 1 A schematic view of the presently optimized version of the muon detection system for dimuon measurements in the CBM experiment.

Feasibility Studies

The signals such as LMVM and J/psi which decay into dimuon channels are generated by PLUTO [4] event generator and are embedded on background event generated by the UrQMD [5] event generator. Both the signal and background tracks are transported through detector set up using GEANT3 [6] within the

CBMROOT [7] simulation frame work. The detector layers has been segmented into pads of different azimuthal angles as shown in Fig. 2.

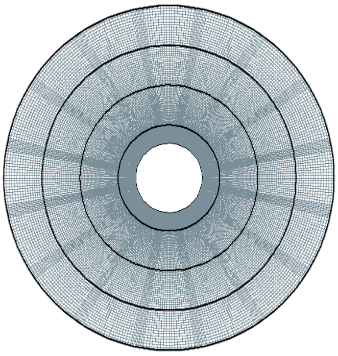

Fig. 2 Segmentation Scheme for detector layer

Fig. 2 exhibits different annular regions segmented into pads by dividing azimuthal angles as given in Table 1.These annular regions are filled with square pads (dr=rΔφ) with the pad size increasing with square size, which increases with radius. This segmentation scheme helps to maintain the occupancy close to a constant which in turn enables to avoid radial dependence of the detector response.

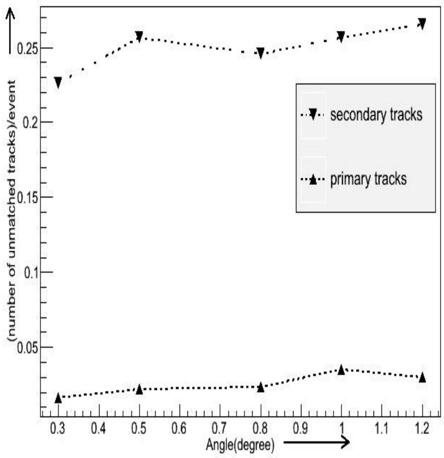

Fig3. Variation of unmatched tracks/event

Table 1: Minimal and maximal pad sizes, occupancy and total number of pads for different segmentation angles for the first station.

dφ (degree)	Min. pad size (cm)	Max. pad size ((cm)	N_{pads}	Occup-ancy (%)
0.3	0.09	0.43	1076400	1.8
0.5	0.14	0.72	375840	3.0
0.8	0.23	1.152	147150	5.0
1.0	0.29	1 1.44	95040	6 .0
1.2	0.34	1.73	65700	7.8

Fig. 3 shows the variation of unmatched background tracks/event for primary and secondary tracks passing through the MUCH detector. Fig. 3 exhibit that mismatching increases with angles for primary and secondary tracks and remain constant for primary tracks.

Summary

The mismatch between the tracks are responsible for increase in background, which is minimum for 1 degree. So**,** segmentation angle of 1 degree is the optimum choice.

References

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