Geometry optimization for dimuon detection system in CBM Experiemnt at FAIR

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Introduction

The goal of the Compressed Baryonic Matter (CBM) experiment[1] at the FAIR is to explore the phase diagram of strongly interacting matter in the region of high baryon densities.The scientific program will address problems like equation of state of baryonic matter, the deconfinement phase transition and its critical endpoint, chiral symmetry restoration at high baryon densities and the in medium modification of hadrons. Among the key observables are Low Mass Vector Meson (LMVM) and charmonium decaying into dilepton pairs which do not participate in strong interaction thus providing information on early dense phase of collision.The CBM Indian group holds the responsibility of designing and building the Muon Chamber for the CBM experiment. In this paper,we discuss the investigations made for optimizing the detector granularity by using the variables like efficiency and signal to background ratio for LMVM and charmonia at various beam enegies available at FAIR energies.

CBM Detector Concept

The proposed layout is shown in figure 1 with the setup for muon identification.It consists of a Silicon Tracking System (STS) inside a magnet as the primary tracking device.The muon detection system which will track the particles after STS will consist of series of iron absorbers, for hadron absorbtion and a number of tracking detectors sandwhiched between them. The present design includes 6 iron absorbers and 18 detector layers (3 behind each absorber). The total absorber length in the current design amounts to 2.25 m of iron. The detection procedure is to continuously track all charged particles through the complete absorber, starting with the tracks measured by the Silicon tracker (which defines the momentum). This will ensure high tracking efficiency even for low momentum muons which are required for the low mass vector meson measurement. An additional shielding is used around the beam pipe in order to reduce the background of secondary electrons produced in the beam pipe.[2].

Feasibility Studies

The signals such as LMVM and J/ψ decayed into dimuon channels are generated by PLUTO[3] event generator are embeded on background events generated by the URQMD[4] event generator.Both the signal and background tracks are transported through detector setup using GEANT3[5] within the CBMROOT[6] simulation framework.The track should be reconstrcuted both in STS and Muon Chamber for being classified as a muon track. We have segmented the detector into pads of varying size from 4mm X 4 mm to 3.2cm X 3.2 cm for track reconstruction. The reconstruction efficiency of ω and signal to background ratio were calculated in a$\pm 2\sigma$ window around the signal peak and are presented in Table 1 for central Au-Au collisions at 8,25 and 35 AGeV beam energies.

We also explored the possibility to perform muon detection with reduced (9 layer) and intermediate(12 layer) geometry.The reduced geometry consists of 3 hadron absorber layers(iron plates of thickness 30cm,95cm and 100cm) and 9 layers(made of GEM) located in triplets behind each absorber. Here the definition of LMVM track is that it should

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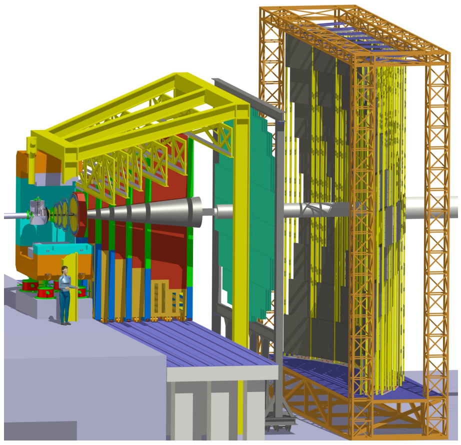

FIG. 1: Experimental setup of CBM

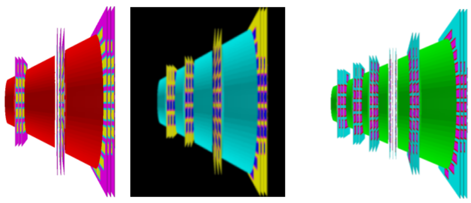

FIG. 2: Geometry:Reduced,Intermediate and Standard

pass through 2 layers of absorber(125cm). The intermediate geometry consists of 4 hadron absorber layers(iron plates of thickness 30cm,30cm 65cm and 100cm) and 12 detector layers made of a micropattern detector technology known as GEM and is located in triplets behind each absorber. Here the definition of LMVM track is that it should pass through 3 layers of absorber(125cm). The signal to background and reconstruction efficiency for both cases were similarly calculated as for 18 layer case and are shown in Table 1.

TABLE I: Reconstrcution Efficiency and Signal to Background ratio of ω in central Au-Au collision at 8,25 and 35 AGeV beam energies (Input events: 10k UrQMD+PLUTO)

Energy (A GeV)	Efficiency			S/B		
	9	12	18	9	12	18
8	0.94	0.91	0.86	0.05	0.088	1.41
25	1.77	1.95	0.58	0.00098	0.0003	0.49
35	1.85	2.13	1.82	0.00059	0.00162	0.34

Summary

As far as measurement of Low Mass Vector Meson are concerned mainly from S/B point of view there seems to be no choice other than standard geometry(ie.18 layers).Segmentation with minimum pad size 4mm x 4mm is a suitable choice.

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