Detection of low mass vector mesons with realistic Muon Detector system at 8 AGeV Au+Au collisions in CBM experiment at FAIR

Ekata Nandy[1*] and Subhasis Chattopadhyay[1]
[1] *Variable Energy Cyclotron Centre, Kolkata-700064 INDIA*

Introduction

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in GSI, Germany is a future fixed target experiment which will perform the precision measurement of dilepton pairs in the full mass region (low mass to charmonium) in the energy range 4-40 AGeV using very high-intensity (∼10MHz) heavy-ion beams. Leptons being weakly interacting, remain unaffected by final state interactions, and act as one of the cleanest probes to explore the fireball created in heavy ion collisions. The objective of the MUon CHamber(MUCH) detector in the CBM experiment is to study the di-muon spectra at different mass regions. One of the major experimental challenges of the CBM experiment in the FAIR energy regime is the identification of low momentum muons, originating from the decay of low-mass vector mesons (LMVM), in a very high particle density environment [1]. At low invariant masses, dileptons provide information on the in-medium modification of vector mesons which is a promising observable for the chiral symmetry restoration. Till date, no dilepton measurements are available for heavy-ion collisions in the FAIR energy range.

MUCH Geometry and Simulations

The CBM experimental set-up including the muon system has gone through several modifications as per the requirements from mechanical, radiations, etc points of view. Here

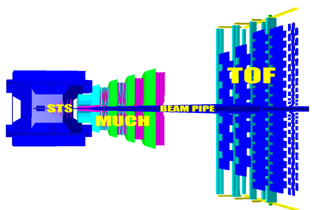

FIG. 1: MUCH set-up with 4 stations and 4 absorber for LMVM detection.

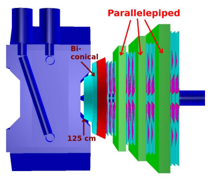

FIG. 2: New configuration.

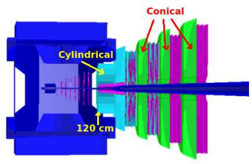

FIG. 3: Old configuration.

we report the performance of the latest CBM MUCH detector, characterized by the detection efficiency for LMVM (ρ, ω, ϕ, η). The performance of MUCH detector system for the LMVM set up, shown in fig 1, has been reviewed for the realistic geometry. In the latest geometry, absorber shape and dimensions have been re-defined. The conical shaped absorbers used earlier have been replaced by parallelepiped, except the first one. The first absorber has a bi-conical shape and divided in two parts- one inside the magnet and other outside. The absorber inside the magnet has been modified to conical shape instead of a cylindrical geometry used earlier. The dimensions of the 1^{st} absorber has also been changed, 1st part of 1st absorber is now 24cm and 2nd part is 36cm which was earlier 40 cm and 20 cm, respectively.The entire MUCH set-up has been shifted by 5 cm downstream. The

*Electronic address: ekatanandy@gmail.com

Z-position of the 1st absorber has been shifted to 125 cm, which was at 120 cm in the previous geometry. Magnet geometry has been modified to avoid overlap with the MUCH. The magnet shielding bars are also removed. Simulations were performed with the new MUCH geometry (as shown in Fig.2) to study the detection efficiency of LMVM. The work has been carried out with CbmRoot framework using GEANT3 transport code to transport the particles through the detector set-up. Embedded events (signal+background) was used for central Au+Au collisions at 8 AGeV. To generate background particles UrQMD event generator was used and PLUTO [2] generates signal LMVM particle with one di-muonic decay per event. LMVM are detected from those di-muonic decay channels. For proper normalization multiplicities have been taken from the HSD, and branching ratios from PDG. Here the major background contributions are uncorrelated decay muons from different sources. To identify muon candidates from reconstructed tracks and to reduce background, optimized selection cuts are applied The selection cuts used here are, for hits : STS hits $\geq$ 7, MUCH hits $\geq$ 11 , on tracks : $\chi^2_{Vertex} \leq 2.0$, $\chi^2_{MUCH} \leq 1.3$ and TOF mass cut ≤ 0.05. In simulation TOF mass cut is also used to reduce background with minimum signal loss. The reconstructed positive and negative muon candidates are combined to obtain invariant mass spectra.The background mass spectra is calculated by the super-event technique.

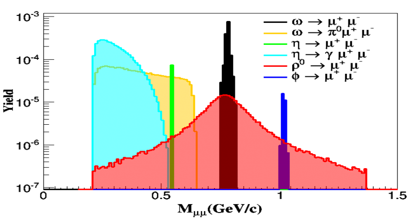

FIG. 4: Input Cocktail from PLUTO at 8 AGeV.

Results And Discussion

Fig.4 shows the input cocktail obtained from the PLUTO used in our simulation studies for central Au+Au collisions at 8 AGeV. In Fig.5, the invariant mass distribution of the reconstructed muon pairs in new MUCH detector for LMVM is shown together with the combinatorial background. The detection efficiencies and S/B for different LMVM particles are tabulated below: Fig.6 shows comparison

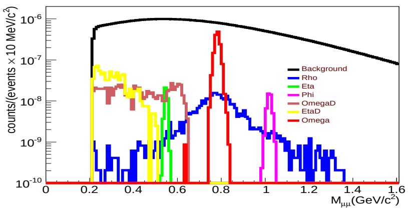

FIG. 5: Reconstructed cocktail sources superimposed over background

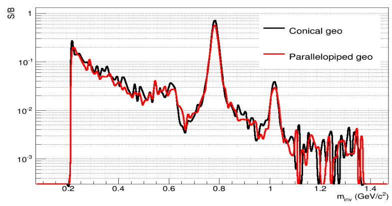

FIG. 6: Signal to background ratio.

TABLE I: Table for efficiency and S/B for different LMVMs for latest geometry.

	ρ^0	ω	ϕ	η	η^D	ω^D
Efficiency(%)	0.63	0.65	1.00	0.3	0.16	0.23
S/B	0.006	0.24	0.008	0.005	0.004	0.007

of S/B ratio of latest MUCH geometry with the previous one. With the implementation of realistic geometry, it is seen that the reconstruction efficiency is reduced to some extent. Detailed investigation has revealed that the degradation in the efficiency is because of the latest Silicon Tracking Station geometry and not the effect of new MUCH geometry.

References

[1] MUCH, Technical Design Report.
[2] I. Froehlichet, et al.,Journal of Physics: Conference Series 219 (2010) 032039