Performance study of MUCH detector for low mass vector mesons at 8 A GeV

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The Facility for Anti-proton and Ion Research (FAIR) is a newly contructing facility at GSI, Darmstadt Germany. It will provide high intenisty beams upto 10^9 Au ions/second to 10^{13} protons/second. FAIR consists of two superconducting synchrotrons SIS100 and SIS300 in the same tunnel placed one above the other, having the circumference of 1084 meters.

The Compressed Baryonic Matter (CBM) experiment is one of the main experiment which will be operating in FAIR. It is a fixed target experiment that explores the properties of QCD matter especially first order deconfinement and QCD critical point under high net baryon density, which has not been yet examined properly both experimentally as well as theoretically.

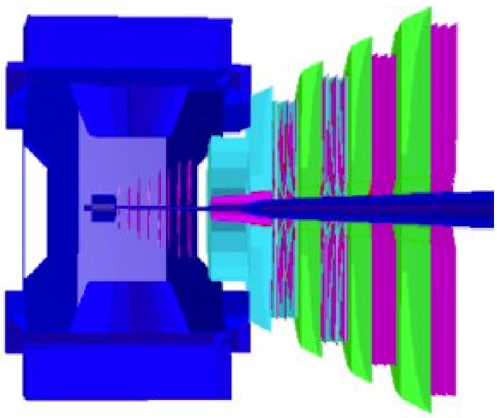

FIG. 1: Muon Chamber in CBM experiment at 8 A GeV energy.

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The CBM detection system consists of different detectors like Micro Vertex Detector (MVD), Silicon Tracking Stations (STS), Dipole magnet, Ring Imaging Cherenkov Detector (RICH), Tranisiton Radiation Detector (TRD), Muon Chamber (MUCH), Electomagnetic Calorimenter (ECAL) and Projectile Spectator Detector (PSD). We demonstrate the performance of the CBM muon detection system for low mass vector mesons at 8 A GeV. We have used the latest geometry of various modules in our work. We have used the Standard SIS100 Muon Chamber (MuCh) detector system geometry consisting of 4 absorbers and 4 stations with first absorber made of 28 cm low-density graphite and 30 cm concrete, and subsequent three iron absorbers with thickness 20 cm, 20 cm, and 30 cm. A triplet layer detector station is present behind each absorber.
Gas Electron Multiplier (GEM) detector which is insensitive to neutrons, have been used in the first two stations of the MuCh system. It is a gaseous detector which uses mostly a gas mixture of Ar and CO_2 with Ar being 70 % and CO_2 30 %. The main advantage of this detector is to face very high particle rate and harsh environment of radiations. So it acts as a baseline for the first two stations of SIS100. Resistive Plate Chamber (RPC), the most advanced detector with high resolution and better efficiency for the purpose of tracking and trigger in high energy physics [1] [2], has been used in third and fourth stations.

The CBM muon detection system is optimized by simulating muon pairs from the decay of low mass vector mesons (η, ω, ρ, ϕ) and charmonium (J/ψ) produced in heavy-ion collisions by using the cbmroot framework at FAIR energies. We simulate the background by using the UrQMD event generator. The

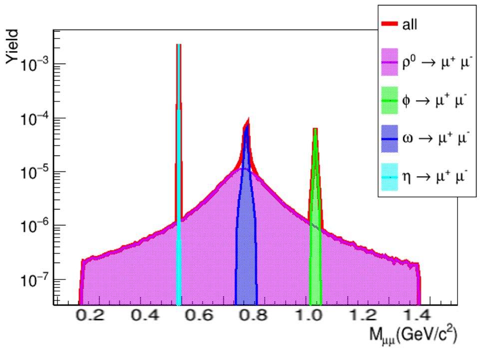

FIG. 2: Invariant dimuon mass distribution of PLUTO from low mass vector mesons for central Au Au at 8 A Gev energy.

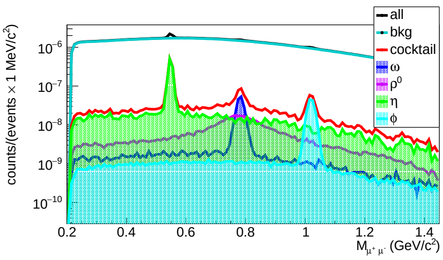

FIG. 3: Invariant dimuon mass distribution decaying from low mass vector mesons with the combinatorial background simulated for central Au + Au collisions at 8 A GeV.

calculation of the phase space distribution of the low mass vector mesons and their decay particles are done by thermal source generator PLUTO which generates the signal event by event. Particle multiplicities have been taken from the HSD and branching ratio from PDG [3] database for proper normalisation. Fig. 2 shows input cocktail of lmvm sources used in our work. Muon pairs from signal sources have been embedded into UrQMD events and are transported by the GEANT3 tranport code to the detector setup.

For increasing the statistics the combinatorial background has been calculated from UrQMD events with the superevent technique. Cellular automation method has been used for finding the primary tracks and reconstructing at the STS level and the Kalman Filter has

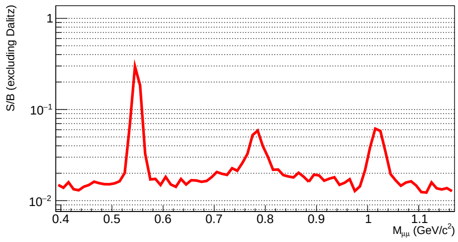

FIG. 4: Signal to background ratio of the low mass dimuon invariant mass spectra for central Au+Au collisions at 8 A GeV.

been used for track and vertex fitting while propagating through the MUCH detector. For reducing the background, conditions on the quality of the number of hits in MUCH, STS and TRD, on the quality of the primary vertex, and on the quality of the tracks in the MUCH were required in the analysis (much hits ≥ 11, chi^2 much ≤ 2.0, sts hits ≥ 7 , chi^2 STS ≤ 2.0, chi^2 vertex ≤ 3.0, TRD cut of 1 and ToF cut of 2.0). Fig. 3 shows the invariant mass distribution of the muon pairs reconstructed from low-mass vector mesons together with the combinatorial background.

The reconstructed efficiencies for the muon pairs are 0.37, 2.02, 0.67 and 1.67 for η, ρ^0, ω, and ϕ respectively. Finally Fig. 4 shows the Signal/Background ratio between cocktail of these 4 sources with background.

We can conclude that MUCH reconstructs all lmvm sources fairly well even at 8 A GeV.

References

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