Implementing realistic detector layout in GEANT and studying ω-reconstruction using MuCh in the CBM

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Introduction

The Compressed Baryonic Experiment(CBM) [1] aims to study the properties of strongly interacting matter. Since CBM will operate at unprecedented data rates, precise measurement of several rare probes will now be possible. Out of these, leptonic decay modes are of particular interest since they carry undistorted information from within the medium. The Muon Chambers (MuCh) of CBM will study one of the dileptonic signals: The Di-Muons. They consist of alternating detector and absorber layers, enabling measurement of di-muons in a broad momentum range. The major challenges in development of MuCh is selection materials for absorber and detectors to maximise the signal to background ratio. In this paper we shall investigate the effect of material from MuCh on the reconstruction of ω.

Detector Geometry

MuCh consists of several parts like absorbers, detector modules, cooling and support plate etc. The detector alone consists of several small components like supports, Front-end boards etc. which offer significant material budget if taken cumulatively. The complexity of the detectors alone makes it challenging to simulate the detector geometry as realistically as possible. We gladly report that recently most of the major material have been taken into account. Fig. 1 shows a schematic of modified geometry with following improvements:

- Previously missing Steel Studs, Brass supports, Front-end boards (FEBs) and C-Plate have been implemented.
- The active region dimensions are now modified.
- The aluminium cooling plate is now slotted to accommodate FEBs.

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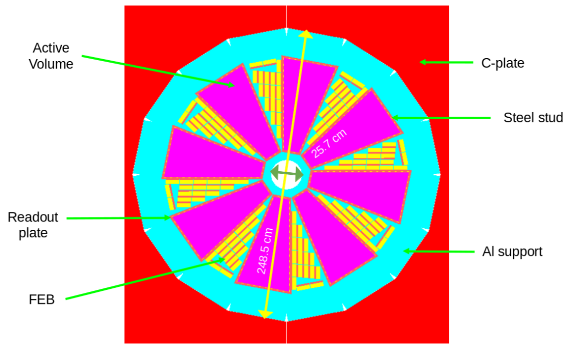

FIG. 1: Schematic of Improved Geometry of Station 1-Layer 1 (tag v21l)

In this paper we compare simulation results for two upgraded geometries with unmodified geometry (tagged v21a): First (tagged v21k) is without C-plate and unchanged active region but with all other modifications implemented while second (tagged v21l) has all the modifications implemented including C-plate and active region.

Simulation and Analysis

Using the improved geometry, we have attempted to reconstruct ω at the highest CBM rates. Background of minimum bias Au-Au collisions at 12 AGeV was generated using UrQMD event generator, whereas for ω signal PLUTO event generator was used. Single ω decaying into μ^+ $\mu-$ was embedded into each background event. The particles are then transported through the upgraded detector setup using the GEANT4 transport engine. The charge deposited is converted to digital signals (digis), which when clustered give hits. The hits are useful in track reconstruction which are finally used to plot the invariant mass distribution.

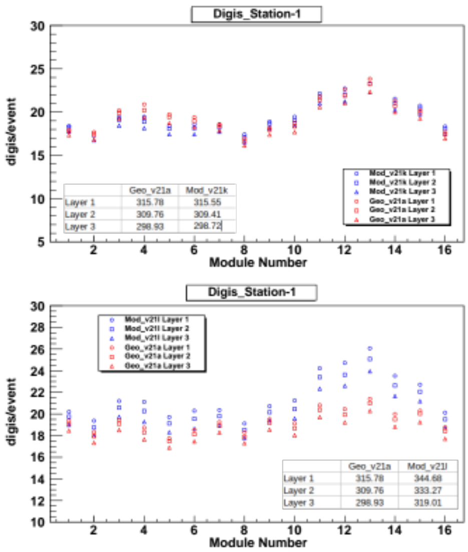

FIG. 2: Module-wise Digi rate comparison with Unmodified Geometry: Without C-plate and acceptance modification (U), With all modifications (D).

Results

Fig. 2 gives a comparison of digi rates (all three layers of Station 1) of two geometries with the unmodified geometry. We notice the following from this plot:

- Digis show a falling trend with layer.
- Due to presence of magnetic field certain modules have more digis. Out of these positively charged tracks are more than negatively charged tracks.
- After Implementing small components like Steel Studs, Brass supports and Front-end boards (FEBs) digi rates are basically unchanged but after acceptance modification the digi rates spiked.

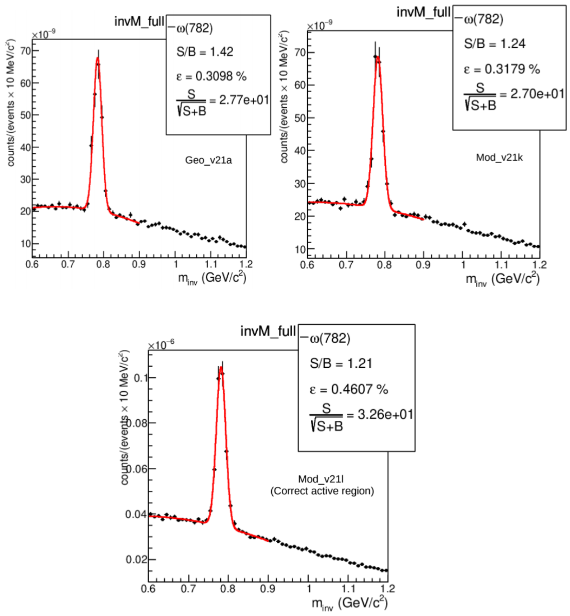

FIG. 3: Comparison of Invariant Mass Spectra of ω-meson from di-muon signals with Unmodified geometry (top-left), without C-plate and acceptance modification (top-right), with all modifications (bottom).

Fig. 3 shows invariant mass reconstruction between three geometries. With implementation of small components only (v21k) the efficiency is basically unchanged but with acceptance modification (v21l) the efficiency has improved significantly. This shows that good amount of dimuon candidates are closer to beam pipe which are now included due to acceptance modification. Further studies on upgrade the of detector geometry and its impact on the physics of CBM will be discussed in the future.

References

[1] Chattopadhyay, S., Viyogi, Y. P., Senger, P., Müller, W. F. J. and Schmidt, C. J. (2015), *Technical Design Report for the CBM : Muon Chambers (MuCh)*. The CBM Collaboration, Ch. 1,2, 7–57.