Pseudorapidity Response of MuCh Detector in FAIR-CBM Experiment

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Introduction

The proposed Compressed Baryonic Matter (CBM) experiment at FAIR is designed to explore the QCD phase diagram in the region of high baryon densities [1]. It is expected that the FAIR-CBM experiment will open up a new era in nuclear matter research by observing rare diagnostic probe that has never been explored before. The CBM experiment has thus a unique discovery potential. In order to obtain a complete picture a comprehensive set of observables will be measured in p-p, p-A and A-A collisions over E_L = 10 – 40 AGeV. The observables include particles containing charm quarks (D-mesons and charmonia) [2], low mass vector mesons decaying into lepton pairs (rho , omega and phi mesons) and omega hyperons (consisting of 3 strange quarks), the measurement of even-by-event fluctuations , correlations and of collective flow of hadrons. These observables will provide important new information on the dynamics of the fireball.

The CBM Detector

Considering the pixel detector layout, several optimization studies have recently been performed on various detector systems regarding mainly the numbers, position and dimension of layers [3]. The layout of the CBM detector suitable for dimuon measurement is shown in Fig.1. In the first step of the optimization of the detector layout is to study the hit reconstruction efficiency. In the present study, a CBM muon chamber (MuCh) geometry is used which consists of 9 tracking stations made up of GEM detectors, sandwiched between 3 iron absorber layers of variable thickness (225 cm in total). Events are generated using UrQMD [4] event generator for central Au-Au collisions at 10 GeV and transported through the detector set up using transport code based on GEANT3 in CBMROOT simulation framework. Hits are generated from the pad centre of the GEANT3 Monte Carlo (MC) points.

Segmentation

Since the detector is not homogeneous, it is expected that the efficiencies will depend on where the muon pass through the detector. Thus efficiencies may depend on the variables p_T, η and φ. However, due to approximate azimuthal symmetry of the detector with respect to the beam axis it is expected that efficiencies might not depend on the azimuthal angle φ. Further, efficiency drops are expected for all those eta values at a particular layer which corresponds to the gap to be kept for support system etc. Moreover, considering the high luminosity of the proposed FAIR facility the clustering effect of the pads will have a considerable influence on the efficiency of the detector. Hence for a realistic detector design and optimization of detector layout with respect to the physics signals, the detectors are to be segmented and a simple and flexible segmentation scheme is needed to be developed. In the present investigation an attempt has been made to study the pseudorapidity (eta) coverage of the detector in terms of the matching of the reconstructed hits with the MC points. The pad dimension is shown in the table. The minimum pad dimension is 2mm x 2mm which is well suited for GEM detectors. The above parameter is calculated for different eta by choosing two scenario with and without clustering. Here the nearest neighbour clustering algorithm (i. e. clusters are made up of set of neighbouring fired pads) is considered.

And in the clustering scenario itself the above parameter (Hit-efficiency = No. of Hits/No. Of MC Points) is calculated for different eta and different spot radius.

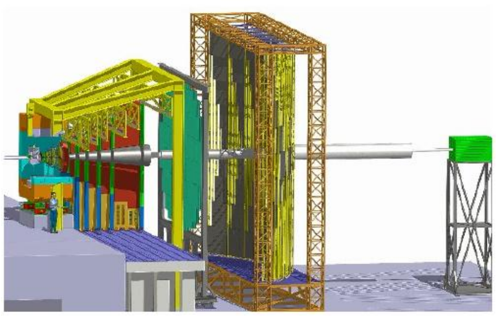

Fig.1 Proposed CBM detector set up

Table 1: Different Segmentation Scheme

Scheme	Station #1 (cm)	Station #2 (cm)	Station #3 (cm)	Total Pads
Seg1	0.2X0.2	1.5X1.5	4.0X4.0	2793144
Seg2	0.4X0.4	2.0X2.0	5.0X5.0	780576
Seg3	0.6X0.6	2.5X2.5	5.5X5.5	367728
Seg4	0.8X0.8	3.0X3.0	6.0X6.0	222648

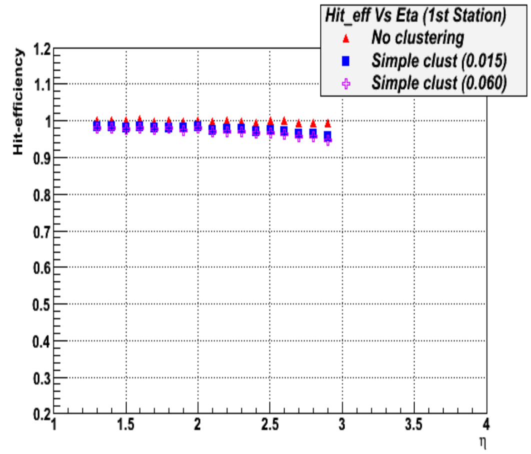

Fig. 2 Hit-efficiency vs eta (seg1)

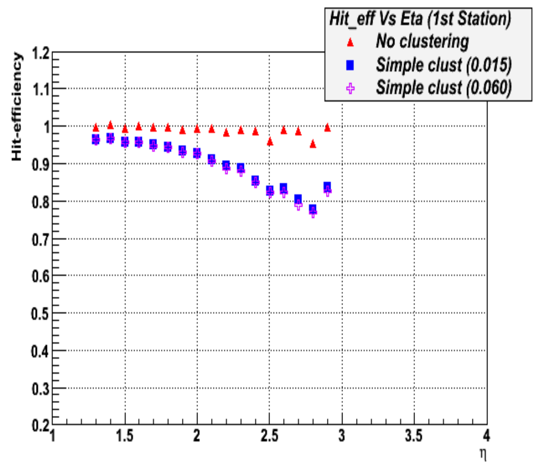

Fig. 3 Hit-efficiency vs eta (seg4)

Results

From Fig.2 it is clear that the hit reconstruction efficiency decreases towards higher pseudorapidity with clustering (for station 1). It is also evident that the as the pad size increases this decrease is found to be severe (Fig.2). But for the case without clustering the hit-efficiency remains same for all eta. This might be due to the good matching between the hit produced with the MC points without clustering . It is also noted from the Fig.2 and Fig. 3 that there is no difference found in terms of hit-efficiency with eta for different spot radius.

References

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