Large area triple GEM chambers for muon tracking in CBM experiment at FAIR

Ajit Kumar[1,*], A. K. Dubey[1], S. K. Prasad[2] , J. Saini[1], V. Singhal[1] , V. Negi[1], E. Nandy[1] , C. Ghosh[1] and S. Chattopadhyay[1], for the CBM Collaboration

[1] *VECC, Kolkata, INDIA,* [2] *Bose Institute, Kolkata, INDIA*

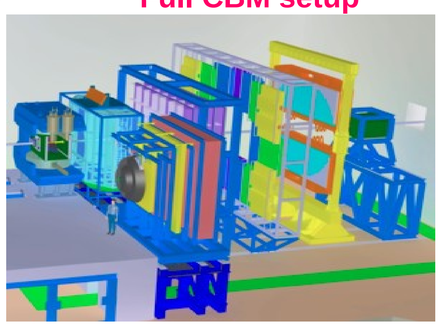
* *Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 400085, India*

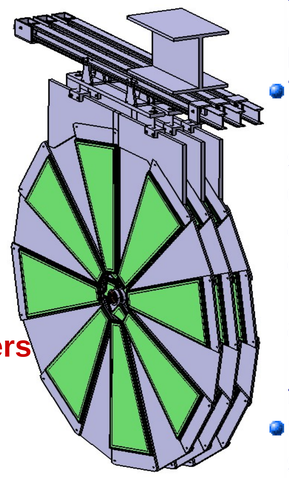
CBM

Compressed Baryonic Matter experiment at FAIR

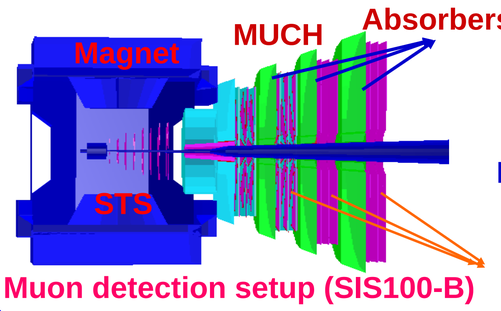
Muon detection setup

Full CBM setup





Mounting scheme for the MUCH

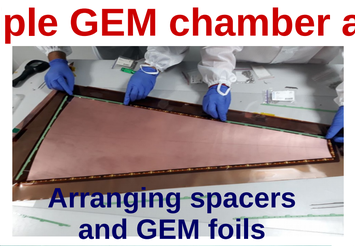


Muon detection setup (SIS100-B)

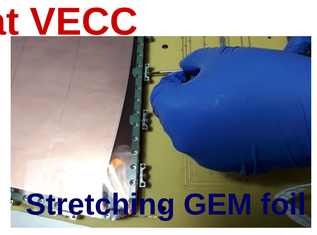
- Aim is to detect di-muon originating from LMVM and J/ψ.
- The novel feature for muon detection system for this experiment is that the absorbers are sliced and chambers are placed in between the absorbers to identify momentum dependent tracks.
- System comprises of segmented absorbers and detector stations.
- For the first two stations, GEM based detector technology will be used.

Fabrication and test (with Fe^{55}) of large size triple GEM chamber at VECC

GEM foil leakage current test



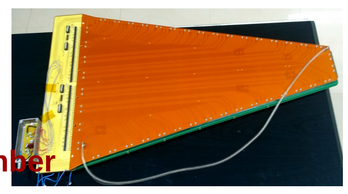
Arranging spacers and GEM foils

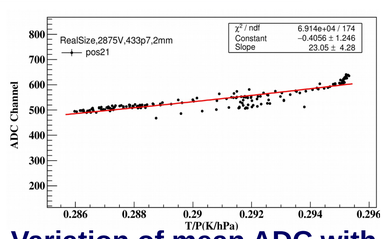


Stretching GEM foil

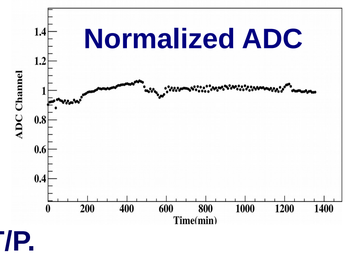
Three GEM foils in drift board

Complete chamber





Variation of mean ADC with T/P.

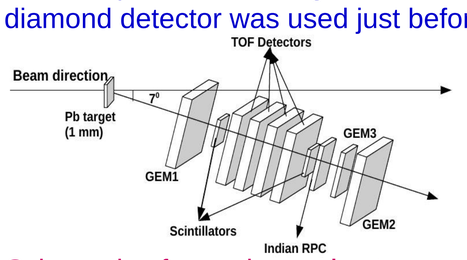


Fabrication of large size chamber using NS-2 technique

Normalized ADC Channel with time. Maximum variation of around ~10%

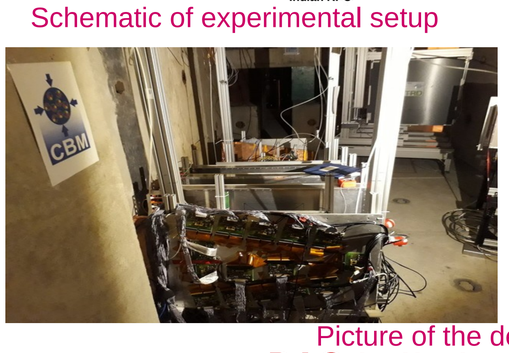
Testing large size GEM with Pb+Pb collision at CERN SPS

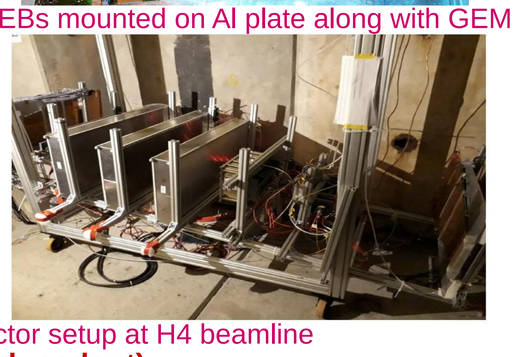
- Two large size (~1m x 0.5m) ,Mv1 - one assembled at RD51 lab CERN and second one assembled at CPDA lab of VECC India, and one small (10 cm x 10 cm, GSI GEM) chambers were tested along with CBM-TOF detectors
- A 10 mm thick Al plate with water channels grooved inside was used for cooling n-XYTER chips and mounting the GEM chambers.
- A diamond detector was used just before the target for beam monitoring



Schematic of experimental setup

FEBs mounted on Al plate along with GEM

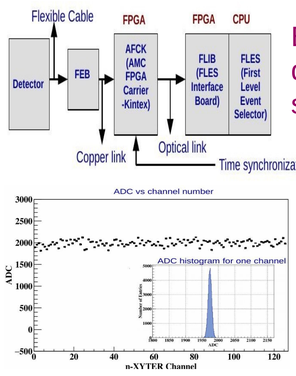




Picture of the detector setup at H4 beamline

DAQ (Self-Triggered readout)

- Data were processed by FPGA based Data Processing Board (DPB)[1].
- LVDS flat ribbon cables, 6 meters in length were used as signal cables from the back end of FEBs to the front-end of DPB boards.
- An optical cable of 50 meter in length was used from back-end of the DPB to the FLIB (FLES Interface Board) board which was mounted on FLIB-PC.
- Time-synchronization for the two systems was carried out via two dedicated AFCK (master and slave)



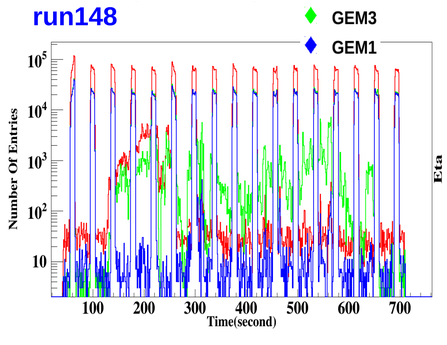
Block diagram of data acquisition system

This shows the variation of baseline ADC channel with n-XYTER channel number.

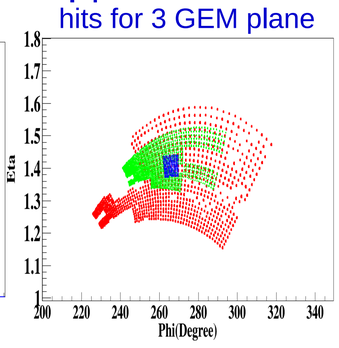
Test beam results and discussion

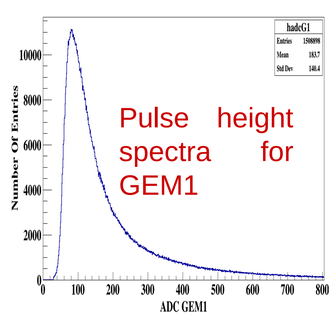
1. Spill structure, η-φ and pulse height distribution

Phase4 (150AGeV), run148



η-φ distribution of hits for 3 GEM plane

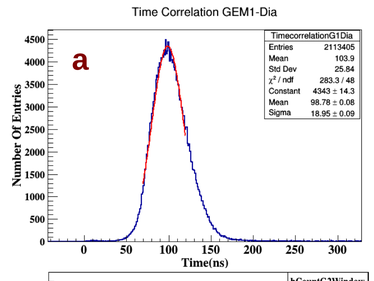


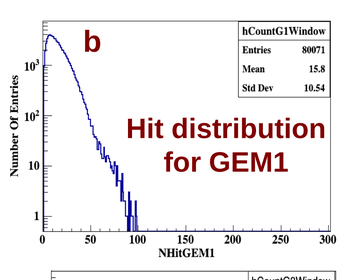


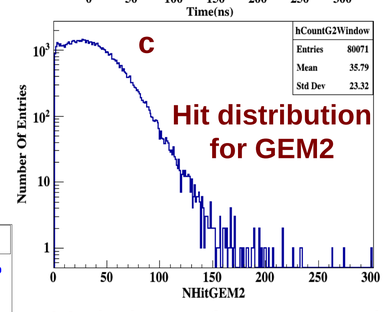
Pulse height spectra for GEM1

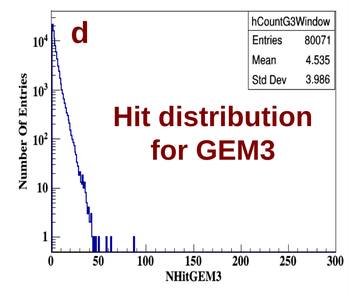
2. Event Reconstruction

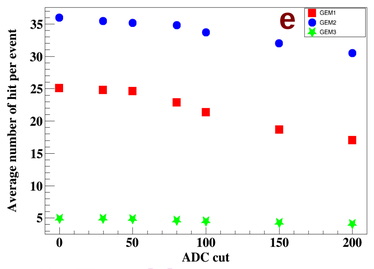
- Events were reconstructed using diamond detector. We used GEM hits which lie between two consecutive diamond hit time.
- Time correlation spectra of GEM1 with diamond (a) and hit distribution per (b,c,d) event for three GEMs plane are shown.









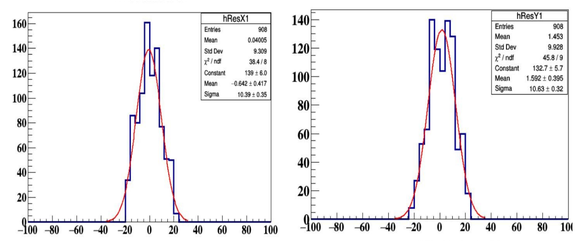


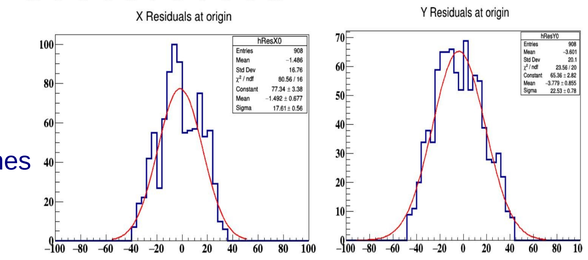
- Variation of average hit per event with ADC threshold for three planes are shown in the figure (e). Variation remains unchanged up to adc ~80 and decrease afterwards.

3. Tracking

- A straight line track fitting algorithm has used for calculating the residuals.
- Straight line track fitting has been done using three GEM planes within η-φ window . Tracking in another zone of η-φ has been also performed and the residual in both the case remains same.

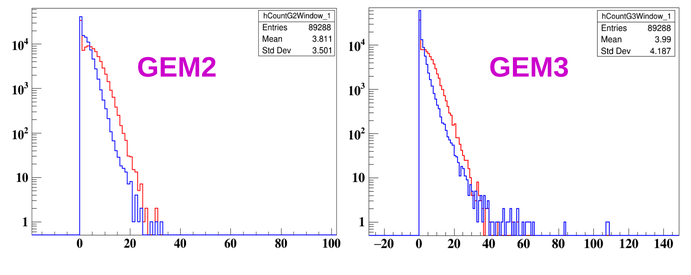
ADC cut:	η-φ selection
GEM1 : 50 adc channel	η-φ cut for all planes
GEM2 : 100 adc channel	1.37<**η**<1.40
GEM3 : 100 adc channel	264<**φ**<266





4. Effect of 20 cm thick Fe absorber on detector multiplicity

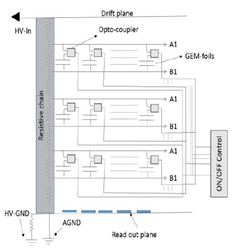
- Variation of number of hit per event with and without 20 cm Fe (placed before GEM2 and GEM3) absorber for 1.37<η<1.44 and 262<φ<272 is shown here.
- A reduction in average number of hits with absorber seen.
  - Similar trend observed in the simulation (not shown here) as in the data. Details simulation is under process

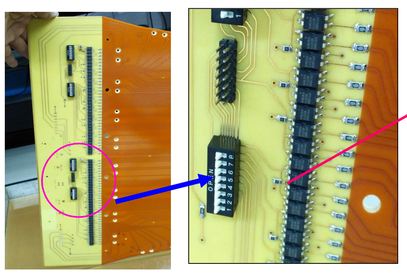


Red->Without absorber
Blue->With absorber
Adc cut = 40

Opto-coupler based high voltage scheme

- A opto-coupler (cost effective) based high voltage design will be used for powering the GEM foils.
- We fabricated and tested two real size triple GEM chamber using this high voltage scheme.





Opto-coupler based HV distribution for GEM detectors[3]

- The picture of the opto-couplers are shown in the right figure. Three Mv2 (larger in size with Mv1) chamber will be used in mCBM experiment.

Outlook

Reference

1. W. Zabolotny, et.al., “Towards the Data Processing Boards for the CBM experiment”, CBM Prog. Rep. (2014) 97
2. An Introduction to Charged Particles Tracking – Francesco Ragusa
3. http://www.sympnp.org/proceedings/61/G30.pdf

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