R&D of GEM detector high rate for CBM Experiment at FAIR
Muon Chamber R&D in India

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CBM at SIS 100 (start version/30 GeV/c (protons) and SIS 300 (future/90 GeV/c)

- systematic exploration of high baryon density matter in A+A collisions from 4-90×A/Z AGeV/c beam energy
- explore the QCD phase diagram, chiral symmetry restauration (AGS, SPS, RHIC)
- very high rate (fixed target) HI-experiments (> 10^7 interactions/s), access to rare probes (dileptons, (open) charm....)
The CBM experiment – electron-hadron setup
The CBM experiment – muon setup

- **Muon detection System**
- **Tracking Detector**
- **Silicon Tracking System**
- **Micro Vertex Detector**
- **Dipole magnet**
- **Projectile Spectator Detector (Calorimeter)**
- **Resistive Plate Chambers (TOF)**
Much Layout Studies in Progress

baseline:
6 GEM stations
3 layers per station
30 x 30 cm² GEM foils

other layouts under study

≈35 m² of GEM stations (300 m² of foils)
#pads: > 500 k
pad size: 2.8 mm² and larger (optimization under scrutiny)
Max. Rates in CBM

Typical operation scenario: 6 years $\Rightarrow 10^{13} - 10^{15} \text{n}_{eq}/\text{cm}^2$

$\Rightarrow$ radiation hardness regime of LHC experiments
CBM Muon detector requirements:

Main issues:

- The first plane(s) has a high density of tracks
  -- detector should be able to cope up with high rate. ~ 10 MHz/cm²
- good position resolution
- Should be radiation resistant
- Large area detector – modular arrangement

Institutions:
VECC, India: R&D in GEM, THGEM – Design & Construction
PNPI, Russia: R&D THGEM, Hybrid Micromegas-GEM – Layout studies
VBLHEP, JINR, Russia: Straw Tubes

GSI/University of Tübingen: GEM-ageing in high rate hadronic environment
we have assembled and tested double and triple GEM prototypes based on 10 cm x 10 cm GEM foils.

Idea is to optimize the operating conditions with 10 cm x 10 cm.

In future we would like to go to 30 x 30 cm² and later to larger dimensions.
Schematic of prototype GEM chamber assembly

CERN made GEM foils obtained from Area: 10cm x 10cm

Drift gap: \(~7\text{mm}\)
Induction gap: \(1.5\text{mm}\)
Transfer gap: \(1\text{mm}\)

Drift plane (inner side copper plated)

12 x cm 12 cm x 10 mm
Two triple GEM chambers were fabricated:

**det 01** – with two different pad sizes (shown below)

**det02** -- same size pads but with larger induction gap
GEM chambers – Beam test
MuCh Layout Studies:

- **We have to decide upon:**
  - Total number of stations (layers)
  - Total absorber thickness, total no. of absorbers & the absorber material
  - Number of stations (2/3) in between two absorbers
  - Distance between stations & absorber to station distance
  - TOF station?
  - arrangement of readout electronics

- **Present constraints:**
  - Absorber material (Fe, Pb, W )
  - Layer to layer distance $\geq 10$ cm.
  - Layer to absorber distance $\geq 5$cm.
Several schemes for MuCh are proposed:
- Modular Square Chamber
- Slat type
- Sector type (8 Sectors)

- One module is 30cm x 30cm
- 36 Nos. of Modules in one plane
- Profile is more to reduce dead space
Slat Type

- 20 Chambers
- Width of each chamber 10 cm.

- Profile is less as compared to modular design
- Wastage of chamber space

X-section of chamber

2m
_sector_type

- 8 Nos. of Sectors
- No wastage of chamber space
- Similar type of chamber
- Less profile
Update 2016
Update 2016
Two Real size modules tested with particles from Pb+Pb collisions at SPS
• First test with Realistic DAQ
• The entire active area of the detector was populated with electronics.
• A slotted “rectangular” Aluminum support with water channels used.
• Water based cooling implemented for the first time M2 fabrication: 100 single mask large size GEM foils arrived from CERN for the first station Two Complete sets of all the detector components procured.
• A sample of these already communicated to the Indian Industries,
• Expect to receive the Readout board for M2 by April end and the rest of the components by June. A completely indigenous M2 to be ready in a couple of months.

Next Steps:
building a real-size prototype for second station, feedback from simulation team ? Preparing for COSY/SPS beamtime Work on testing with opto-couplers going on in lab.

Preparation for miniCBM
• 3 modules to be made ready by mid 2018
• A testbeam prior to this with all the realistic electronics and DAQ is important.
Thank you

Interesting to read:

International Programs at FAIR
A window of Opportunities

Pradeep Ghosh
Program Coordinator
Summer Student Program

Eligibility: (Who can apply)
• Bachelor and Master Students
• Science and Engineering (all branches)

Program:
• A scientific or technical project from FAIR and GSI research
• Lectures and hand-on experience with state-of-the-research infrastructure.

Support:
• Scholarship to all selected candidates.
• Accommodation and return travel fare.

Application:
• Announcement in November each year.
• Deadline to apply 15 February.
• Summer School – Around July 15 (for 8 weeks)
GET_INvolved Program

Eligibility: (Who can apply)
• Bachelor Engineering and Master Science Students (all branches)
• PhD Students and Post doctoral researchers.

Program:
• A scientific or technical project from FAIR and GSI research
• hand-on experience with state-of-the-research infrastructure.

Status (Students from these countries already benefiting):
Azerbaijan, China, India, Thailand, Mexico, Romania, Poland and Turkey.
Discussion with institutes in Russia, France, UK, Sweden/Finland, Portugal etc.

Possible Support:
• University Funds/ National funds
• European Funds - ERASMUS+ Program
• German Funds - DAAD Fellowships, DFG /BMBF Fellowships
Contact us

For Summer Student Program:
Please visit: https://theory.gsi.de/stud-pro/

For GET_INvolved Program:
Please visit: www.fair-center.eu

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