Building and testing of the first real size prototype chamber of CBM MUCH

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A triple GEM (Gas Electron Multiplier) based tracking system will be a part of the Muon Chamber (MUCH) system in the Compressed Baryonic Matter(CBM) experiment at the upcoming FAIR facility at GSI [1]. The actual layout of the GEM based station consists of three layers of detectors. Each layer consists of trapezoidal shaped modules arranged azimuthally around the beam-pipe in a staggeredmanner.The active area and the granularity of the detector has been optimized using realistic simulations in CBM framework. In this paper we report for the first time the fabrication and assembly of a real size prototype GEM chamber.

Fabrication of detector components

The sector shaped module consists of three main components, the GEM foils, the drift plane and the readout plane. The other components included FR4 based the edge frames and the inner frames, O-rings, and several small brass pillars for support. Sector shaped foils designed at VECC, extending upto about 80 cm in length and 40 cm in breadth, were fabricated at CERN. A picture of such a GEM foilis shown in Fig. 1

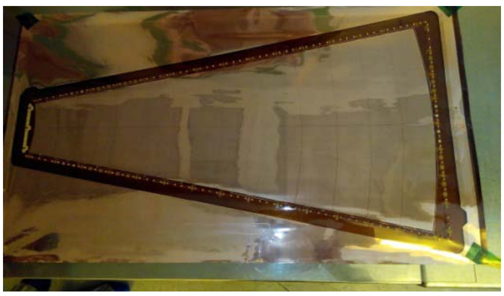

Fig. 1 Picture of the trapezoidal shaped GEM foil

The raw materials available to produce these foils have a maximum width of about 60 cm, hence the constraint on the width of the GEM foils.The top surface of each GEM foil was segmented into 24 HV sections, the innermost four segments having an area of 25 sq. cm and the rest having 100 sq. cm. The inner segments, facing higher particle density are made smaller, so as to withstand a high pulsed current, which is expected to be about 0.4 micro Amps per 100 sq. cm. A surface-mounted protection resistance of 1 MΩ was used acrosseach segment. The readout plane consisted of progressively increasing pad sizes. This 8 layered PCB board was built locally in India.

Assembling and testing

The readout board consisted of 1920 pads having 15 nXYTER based FEB connectors on the outer side. Soldering for all these thirty 68 pin ERNI connectors along with 10Ω resistance at every channel was carried out at VECC. Soldering was also done to seal the PTH at every pads.The final assembly of the detector was carried out at RD51 lab at CERN.

Fig. 2. Picture of the brass supports and inner frames being fixed on the PCB plane.

All the three GEM foils were thoroughly inspected segment by segment. The raw foils were initially mounted on large FR4 supports.
During all these years so far, we have used the thermal stretching technique for gluing and framing of the GEM foils[2] for our prototype detectors. This technique is complex and very

time consuming. Instead, for the present case, a glue-less approach called "NS2" has been adopted.In such a scheme no cross grids are used, thus eliminating any dead region due to these in the active area of the foils. This was not the case for the intermediate 31 cm x 31 cm detector built previously [2]. In the "NS2" techniques, all the three GEM foils wereclamped together at the boundaries between FR4 spacers (inner frames) shown in Fig. 2 and the entire inner frame structure was stretched using edge screws supported by metallic brass pieces which were fixed at regular intervals on the drift plane, as shown in the figure. The triple GEM stack was stretched simultaneously with the help of these supports.

Fig. 3 picture of the HV contact pins soldered on the PCB.

These inner FR4 frames also had appropriate holes foraccommodating spring contact metallic pins(Fig. 3) through which the individual foil segments were connected to the bias voltage.

To start with, brass pieces were first fixed on the drift plane, which was followed by soldering of the HV contact pins. The inner frames or the spacers were laid along with GEM foil one by one. Appropriate guiding pins were inserted inside the frames to hold the foils and the stack together. This was followed by the stretching of the foils. Then the outer edge frame was placed on the drift plane. The readout plane was then mounted on top of this assembly, thus sealing the chamber.Figure 4 shows the picture of the final chamber ready for tests. A separate PCB forsoldering HV resistive chain was later fixed on the top side as shown in the picture.Figure 5 shows the response of the detector to ^{55}Fe X-ray source, and a clear 5.9 keV major peak was obtained, indicating the satisfactory working of the detector.The detailed fabrication and assembly procedure along with the lab test results will be presented and discussed.

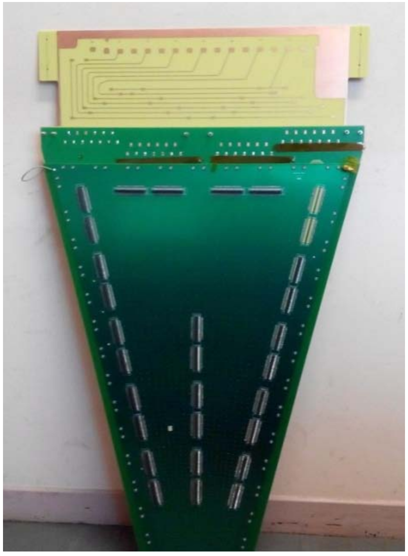

Fig. 4. Picture of the first Real size prototype after assembly.

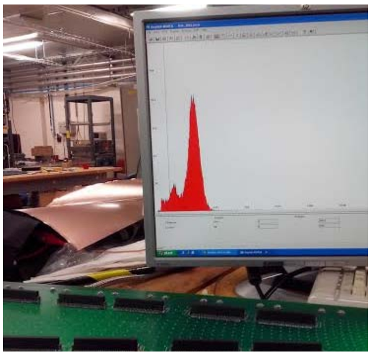

Fig. 5 Test with Fe55 source. The screen shows the pulse height spectra with the major peak.

Acknowledgement

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References

[1] DAE Symp. On Nucl.Phys. **57,** 132 (2012).
[2] DAE Symp. On Nucl.Phys. **59**,956 (2014) .