TEST PERFORMED ON TRIPLE-GEM DETECTOR BUILT USING COMMERCIALLY MANUFACTURED GEM FOILS

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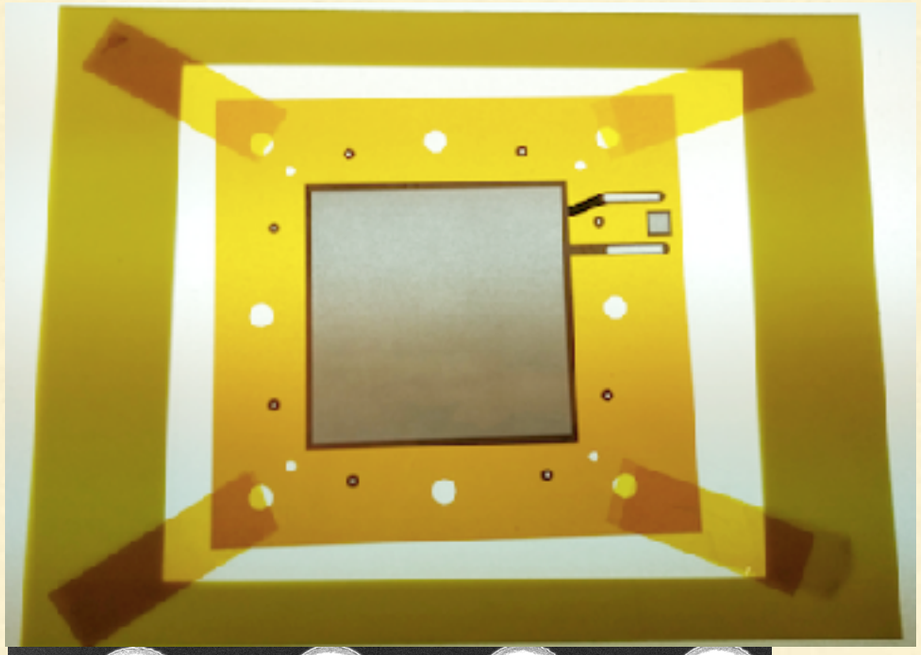
MOTIVATION

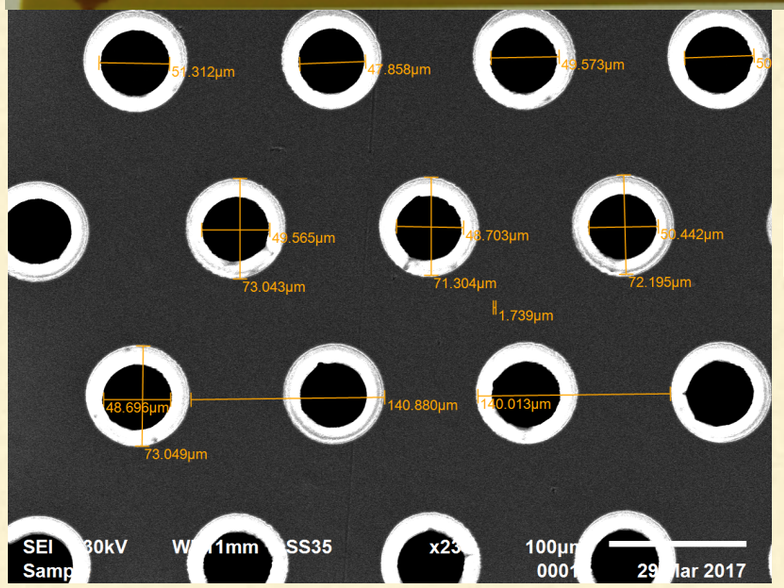
- Gas Electron Multiplier (GEM) is the new age detector for nuclear and particle physics experiments, which was first developed by CERN.
- From that point forward just CERN has been the main provider of the foils and it is difficult for CERN to cope up with the increasing demand of the GEM foils. So, there is a need for commercially available GEM foils to help fulfill the surge in demand.
- Recently few private companies started manufacturing GEM foils under the transfer of technology (ToT) from CERN.
- However it's a long process to validate the foils delivered by these companies to claim that the GEM detectors made from these foils are compatible with the high scientific standards.

INTRODUCTION

"Development, characterization and qualification of first GEM foils produced in India", Nucl. Instrum. Meth. A, 2018, 892: 10-17

- Along these lines, an India based company Micropack Pvt. Ltd. acquired a license from CERN under ToT to produce GEM foils.
- The University of Delhi (DU) then began collaborating with Micropack to help them establish a consistent manufacturing procedure for GEM foils.
- The primary focus of producing these foils to use them for the GE2/1 and ME0 upgrades of the CMS-GEM Muon upgrade.
- Micropack has been successful in realizing the 10cm x 10cm & 30cm x 30cm using both single and double mask techniques.
- Optical inspection and electrical testing were done on the first batch of 10cm x 10cm foil and it was confirmed to satisfy the standards.





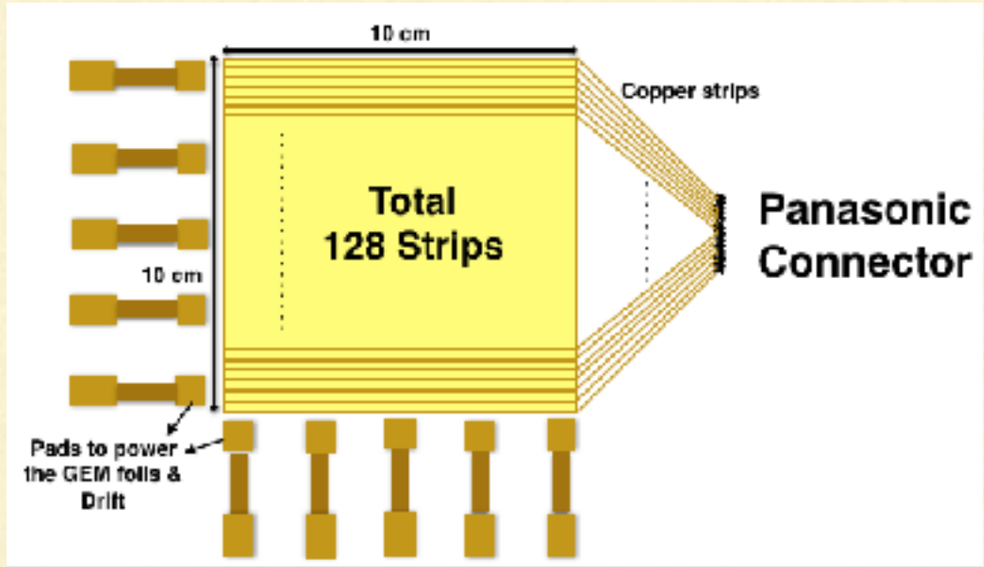
SEM IMAGE

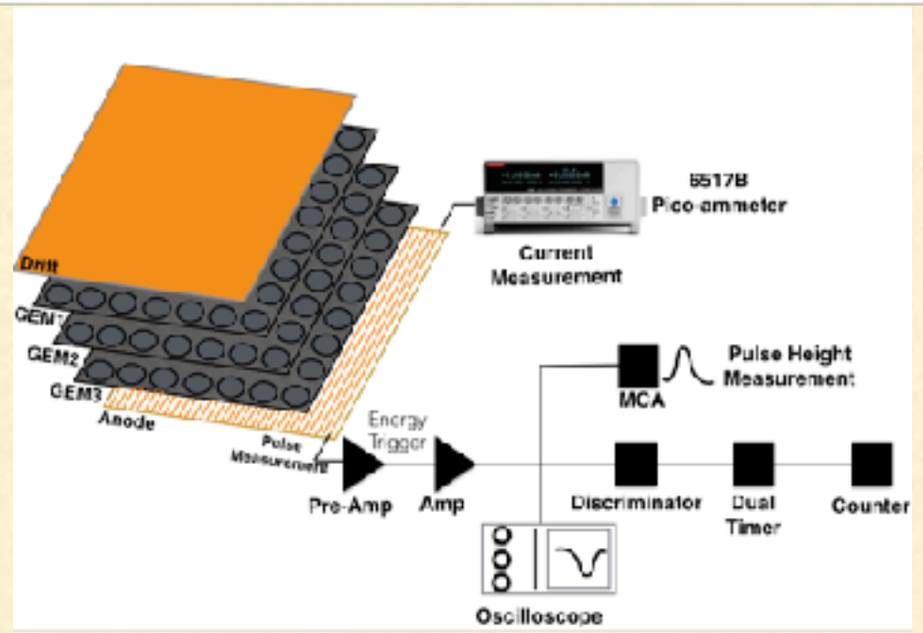
TRIPLE-GEM DETECTOR

- A triple GEM detector was built using these foils with the same gap configuration used by CMS i.e. Drift/ transfer1/transfer2/induction gap of 3mm/1mm/2mm/1mm.

- 1-D readout board with an active area of 10cm x 10cm was used to pick up the signal.

- The Current measurement was done using pico-ammeter, and pulse measurement was processed using the NIM electronics.





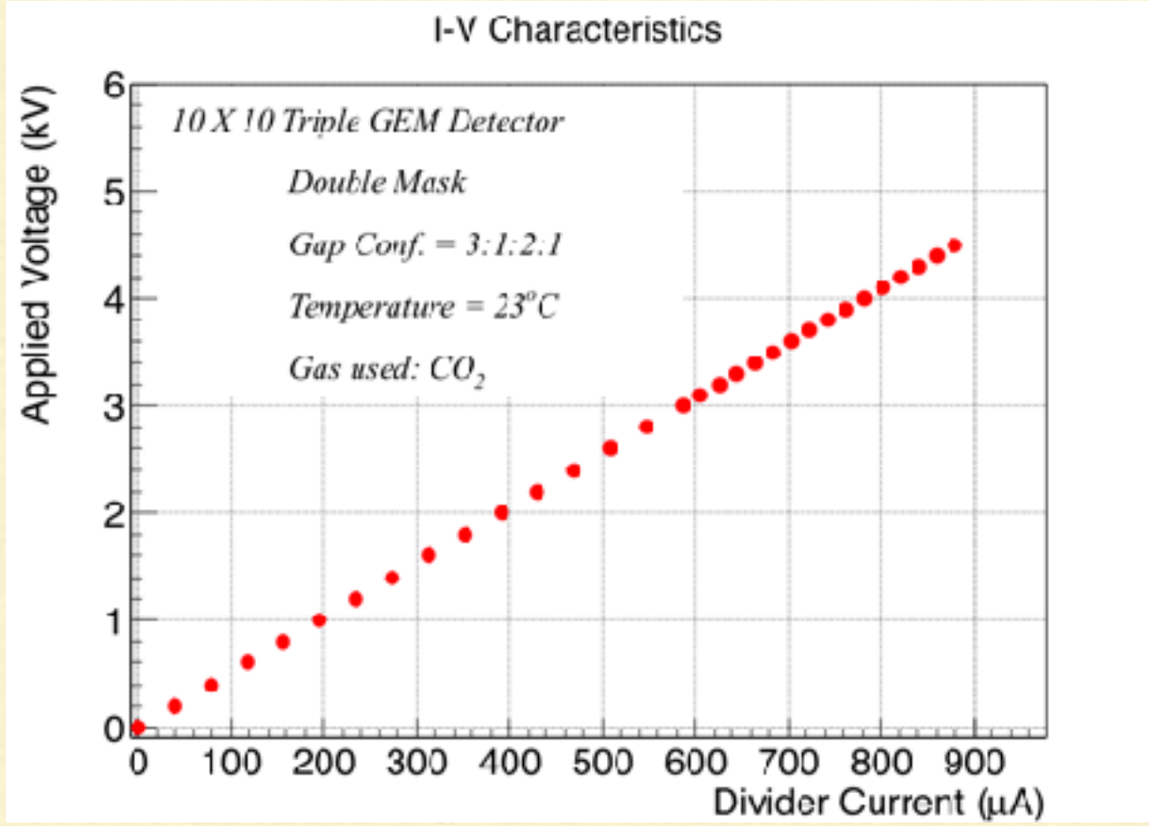
QUALITY CONTROLS

"Muon Chamber Endcap Upgrade of the CMS Experiment with Gas Electron Multiplier (GEM) Detectors and Their Performance", XXII DAE High Energy Physics Symposium, Springer Proceedings in Physics 203, *doi* : 10.1007/978 – 3 – 319 – 73171 – 1139.

- In order to avoid any damage to the readout electronics as well as detector, it is very important to ascertain the behavior of high voltage distribution which uses a resistive divider to ground to power up the GEM detector.

- The test has been performed under the constant flushing of CO_2

- The detector shows the ohmic behavior during the operation and no strange effect was observed.



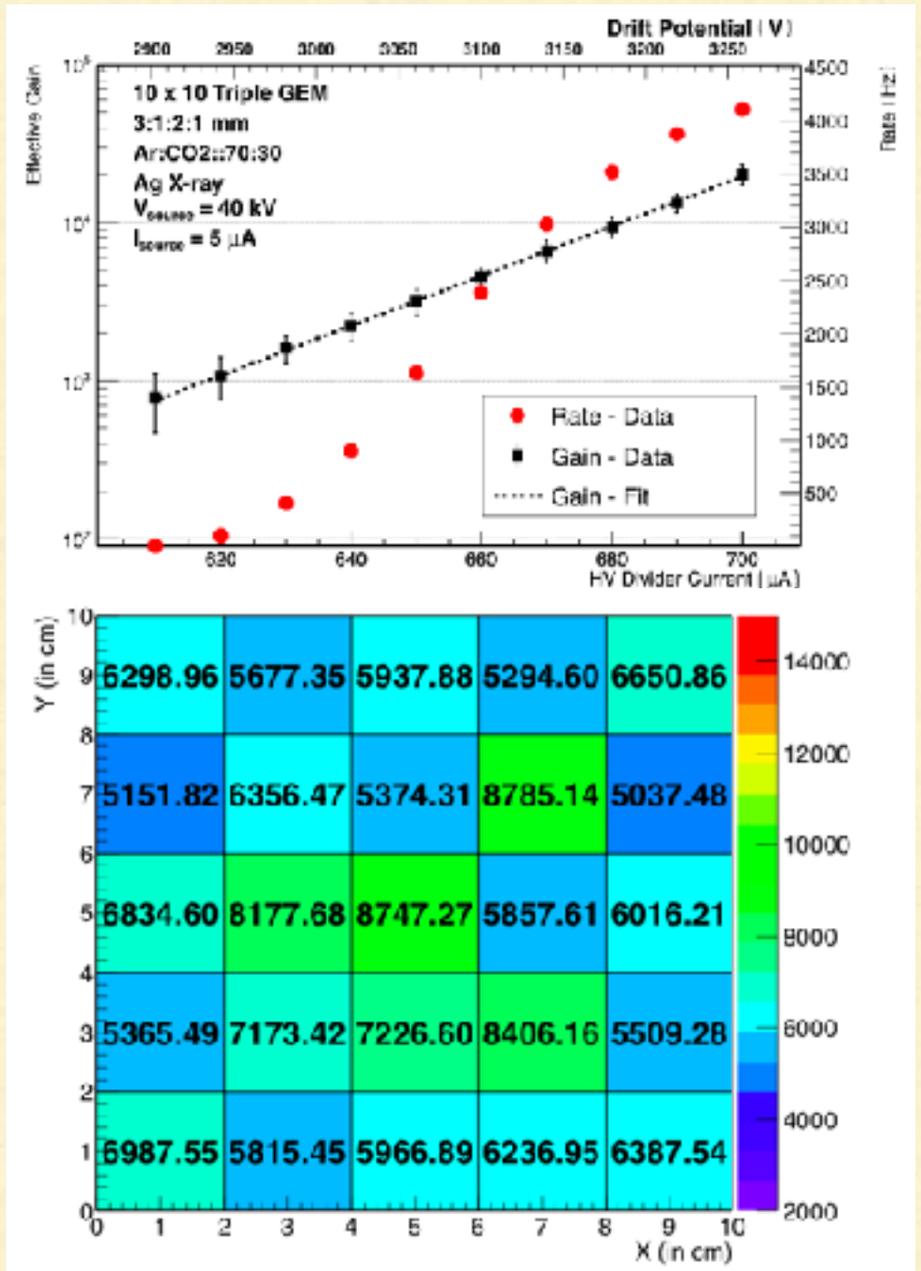
QUALITY CONTROLS

"Performance of the triple-GEM detector built using commercially manufactured GEM foils in India"; arXiv:1806.05016, 2018

- One of the important parameter of any gaseous detector is the gain which explains the geometrical as well as the optical properties of the detector.

- It is important to measure the value of the gain with respect to the input voltage to check the any non-linearity in the performance of the detector.

- Also the uniformity of the gain has been measured over the active area of the GEM foils.



HYSTERESIS EFFECT

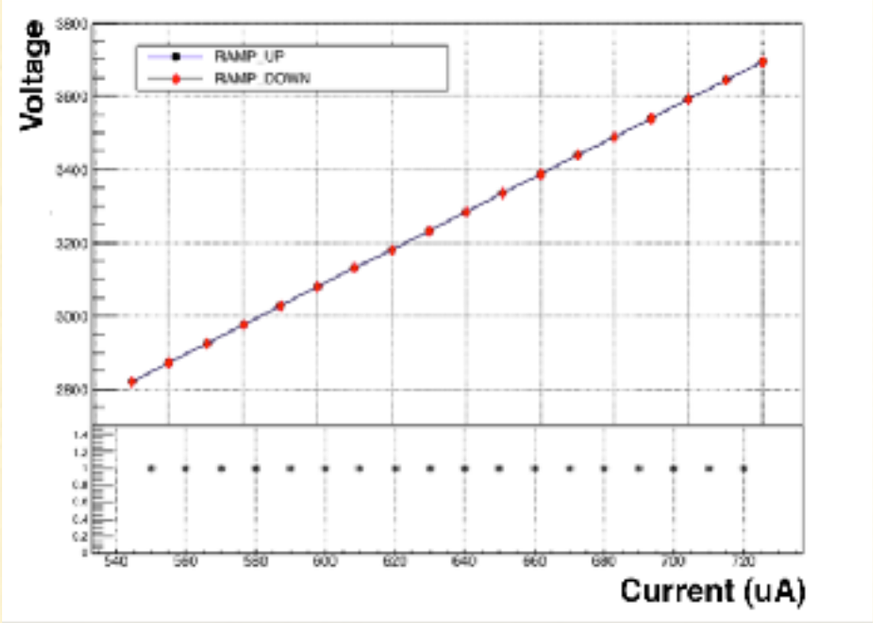
. The WELL detector, ELSEVIER, Volume 423, issue 1, 1999, Pages 125-134.

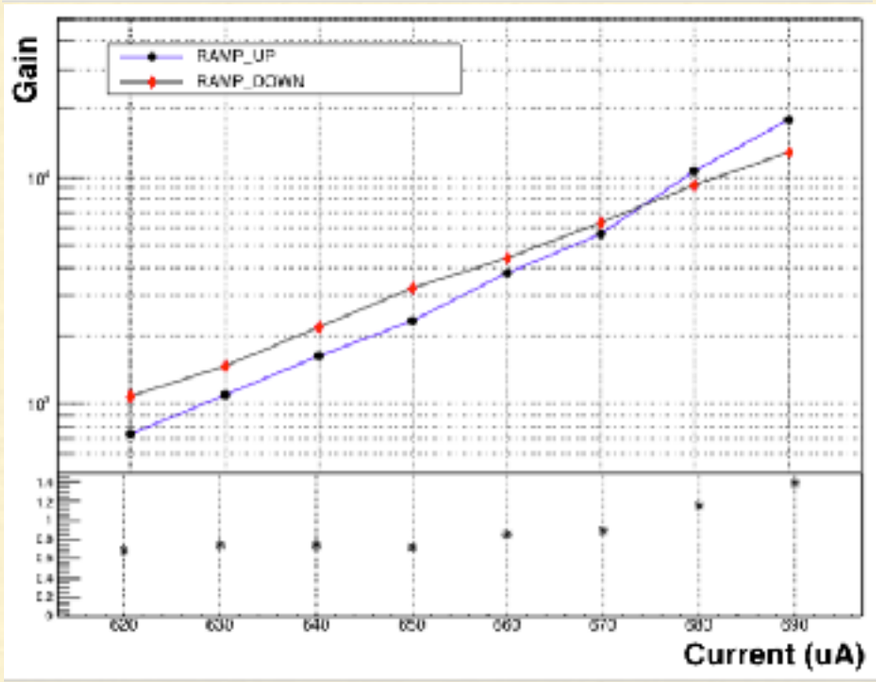
- The stability of gain is very important for gaseous detector because any un-wanted variation in gain can cause the loss in efficiency.

- The IV characteristics of the detector was measured when the voltage is first ramped up and then ramped down the detector.

- Also the measurement of the effective gain was done while ramping up and ramping down the detector.

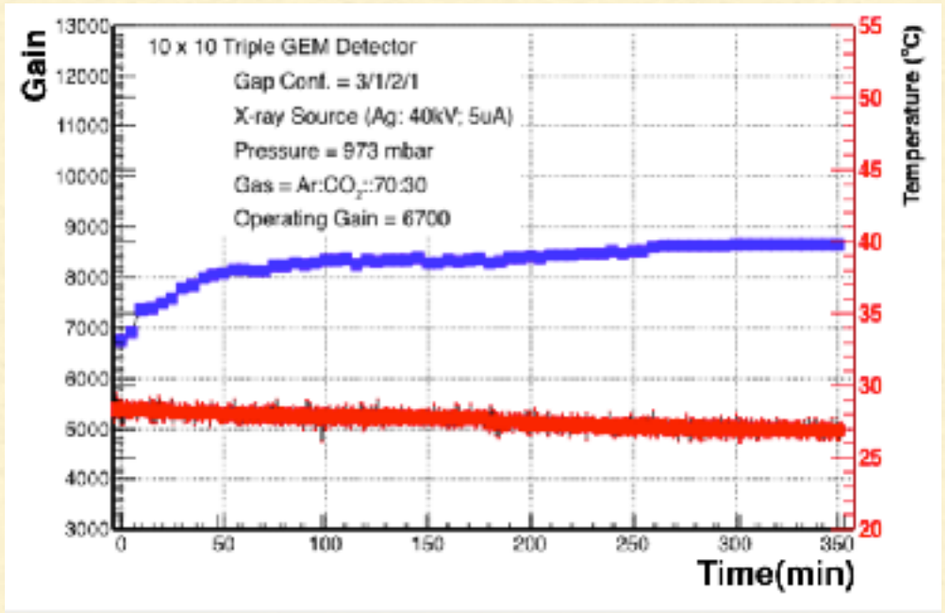
- Two curve shows the different slope on the log scale and this is the clear manifestation of the hysteresis effect.

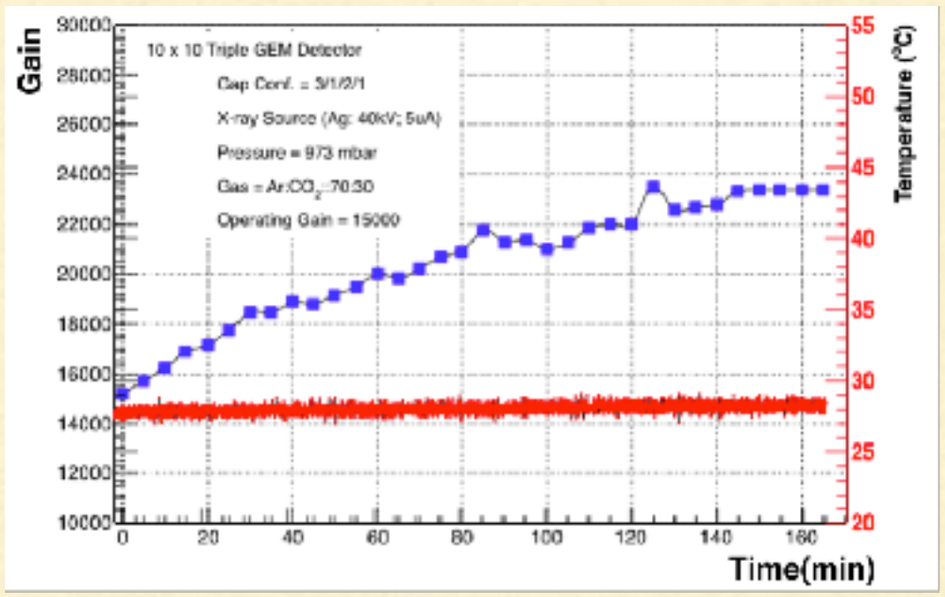




POLARIZATION EFFECT

- The stability of the gain is mainly affected by two effects charging up or polarization effect.
- The charging up effect is due to the trapping of the charge, on the other hand polarization is due to the movement of the electron inside the polyimide.
- To estimate the gain stability in time and variation in gain due to the polarization effect, a series of measurements were carried out for several hours.
- The effective gain amplitude and stability time was measured while exposing with the silver target Mini-X Ray.





RATE CAPABILITY

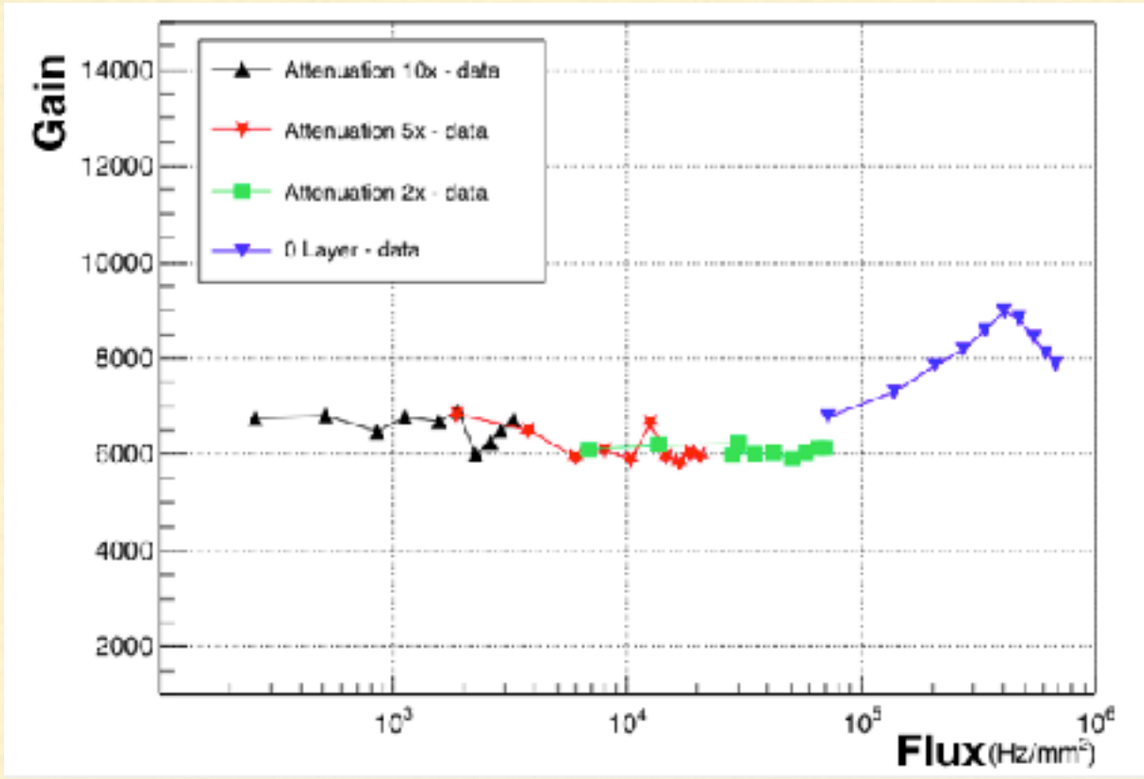
Stability tests performed on the triple GEM detector built using commercially manufactured GEM foils in India; 2019 *JINST* **14** P08004

- The MPGD technologies were mainly introduced in response to the limited rate capability of the MWPC.

- Reducing the amplifying structure to the microscopic scale helps quickly mitigate the effect of the space charge effect.

- GEM detectors are known for the stable operation even at very high incoming flux. And three possible regions can be distinguished depending upon the incoming flux.

- The detector gain is stable from lowest flux used up to about 50 kHz/mm^2. For higher fluxes, up to approximately 0.4 MHz/mm^2, the effective gain increases as a function of flux. Further increasing the flux results in a decrease of the effective gain.



SUMMARY AND CONCLUSION

- Due to limited GEM foil manufacturing capacity of CERN, there is need to produce these foils commercially.
- Micropack Pvt. Ltd. an India based company started producing GEM foils under the ToT from CERN.
- First batch of double mask 10cm x 10cm foils from Micropack tested for optical and geometrical test.
- A triple-GEM detector has been assembled using these foils and tested for basic quality controls and compared with the CERN foils.
- Stability of the gain in time and the rate capability measurement were carried on the detector built using these foils.
- Commercially manufactured GEM foils are tested and validated to claim that the detector produced using these foils are meeting the high scientific standards.
- Micropack has produced the GE2/1 M1 size (~600mm x 400mm) foils and is going through various qualification tests.

Thanks