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COMPARATIVE STUDY OF POSITION RESOLUTION AND GAIN MAP OF SINGLE AND DOUBLE GEM

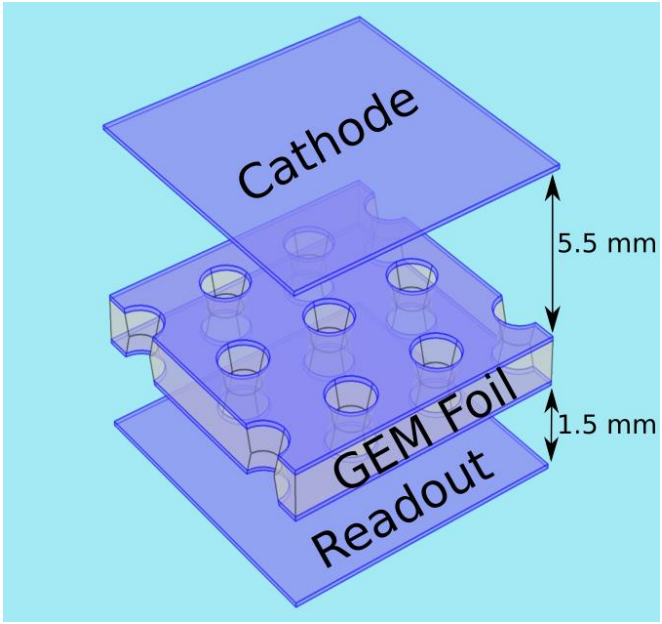
Vishal Kumar
Applied Nuclear Physics Division
Saha Institute of Nuclear Physics, Kolkata,
Homi Bhabha National Institute, Mumbai

Motivation

- Gas Electron Multipliers (GEM) are well know for their operation in high flux with high efficiency and position resolution.
- Optimization of GEM for various applications like muon tomography, particle tracking, medical imaging, etc.
- Study of charge spread and position information obtained from GEM readout for various configurations.

Single GEM Setup

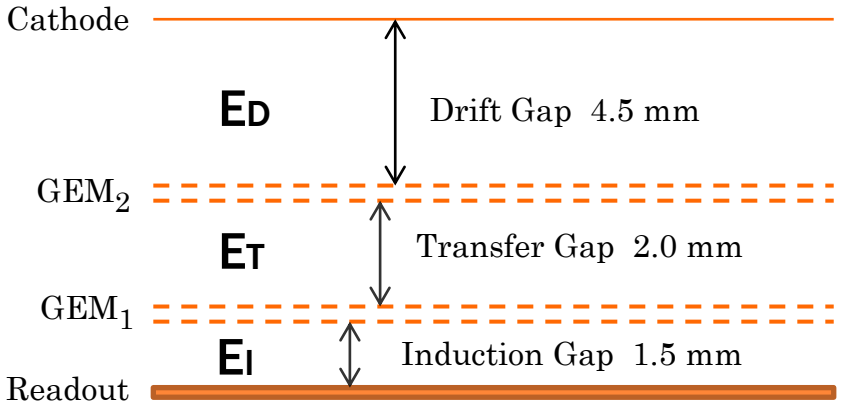
- 50 μm Kapton sheet sandwiched between two Copper layers of 5 μm
- Biconical holes with inner and outer diameter of 50 and 70 μm respectively
- Etched out by double mask lithographic technique in a hexagonal pattern



Schematic diagram of single GEM

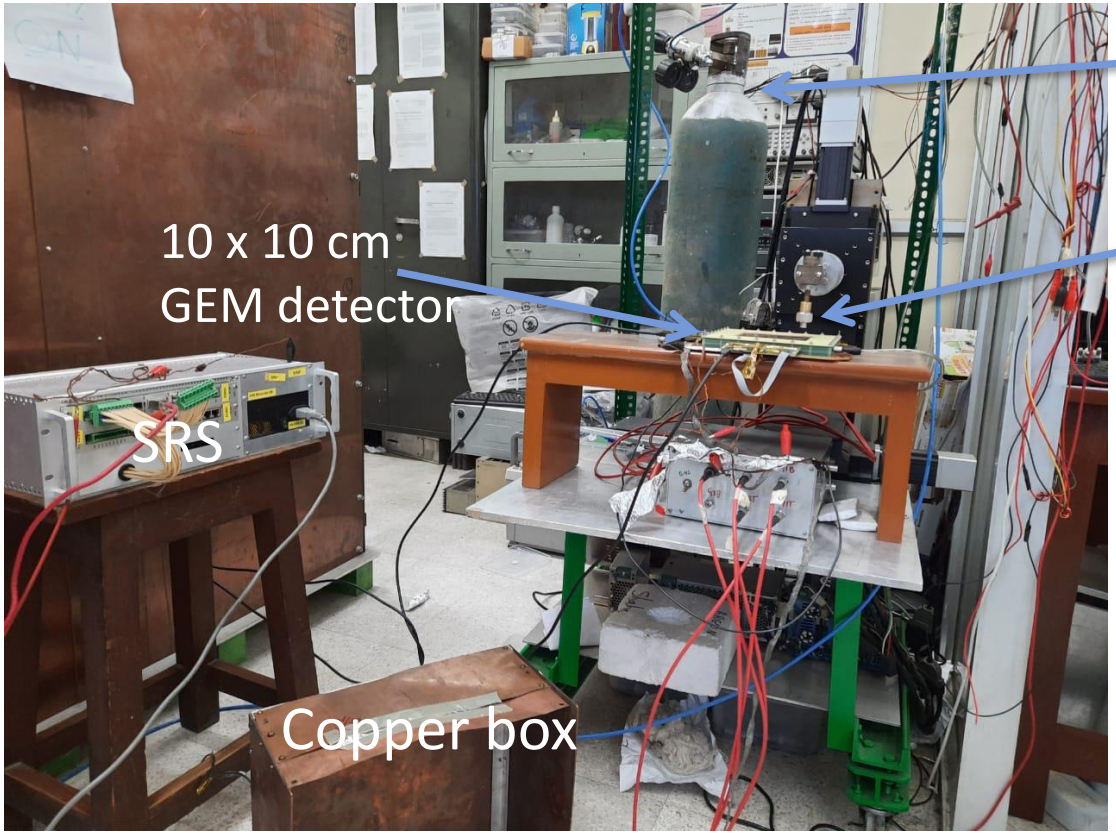
Double GEM setup

- Consists of two GEM foils
- Lower operating voltage
- Increases Gain
- Increases Efficiency
- Increases charge spread



Detector Config.	E_D kV/cm	E_T kV/cm	E_I kV/cm	GEM_1 Volts	GEM_2 Volts
S-GEM	2.76	-	3.33	480	-
D-GEM_1	2.0	2.5	3.0	380	380
D-GEM_2	2.0	2.5	3.0	380	400

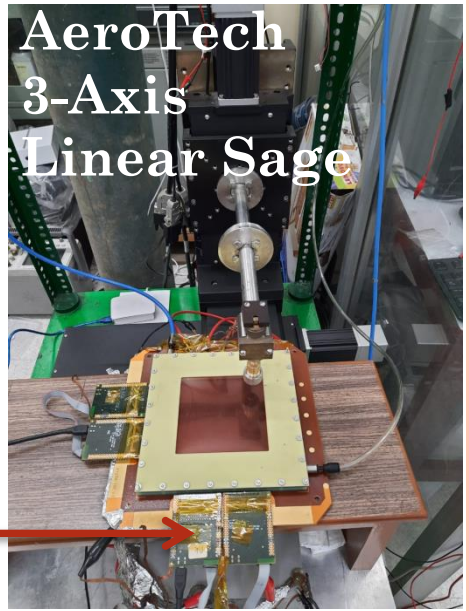
Experimental setup



$Ar:CO_2$
80 :20

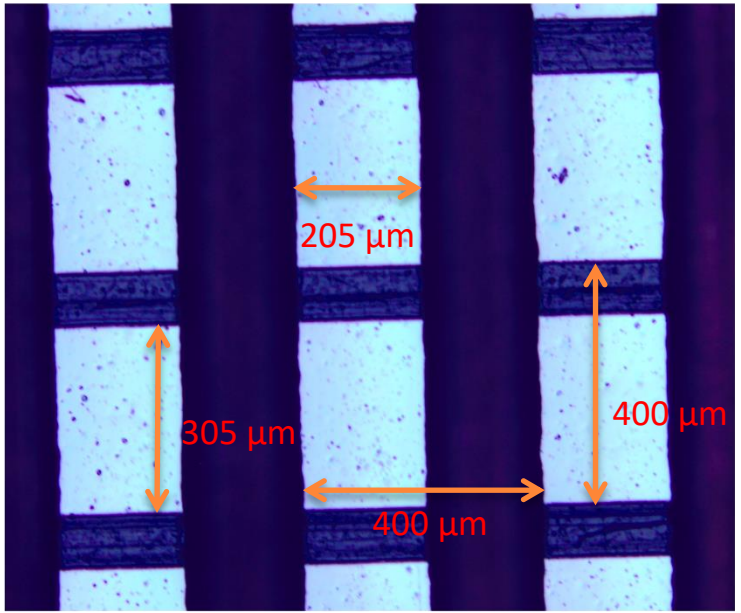
^{55}Fe

APV



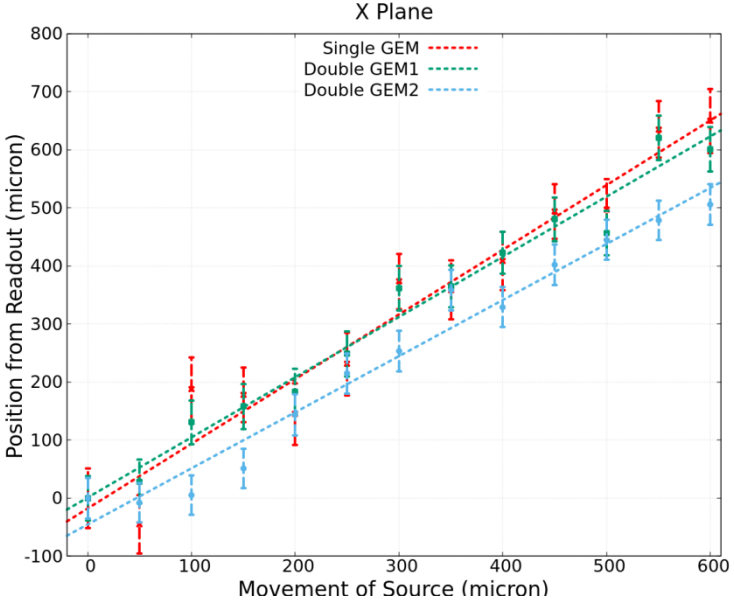
Readout design

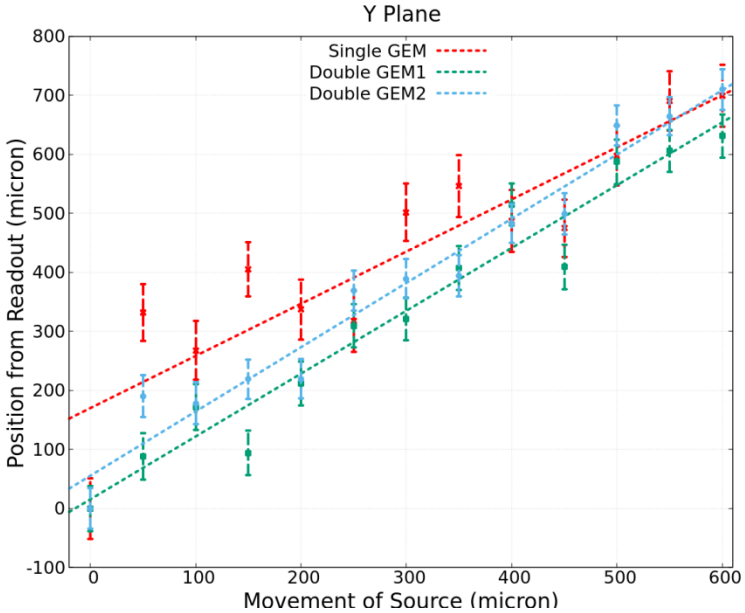
Image of readout panel with Panasonic connectors



Microscopic Image of readout plane

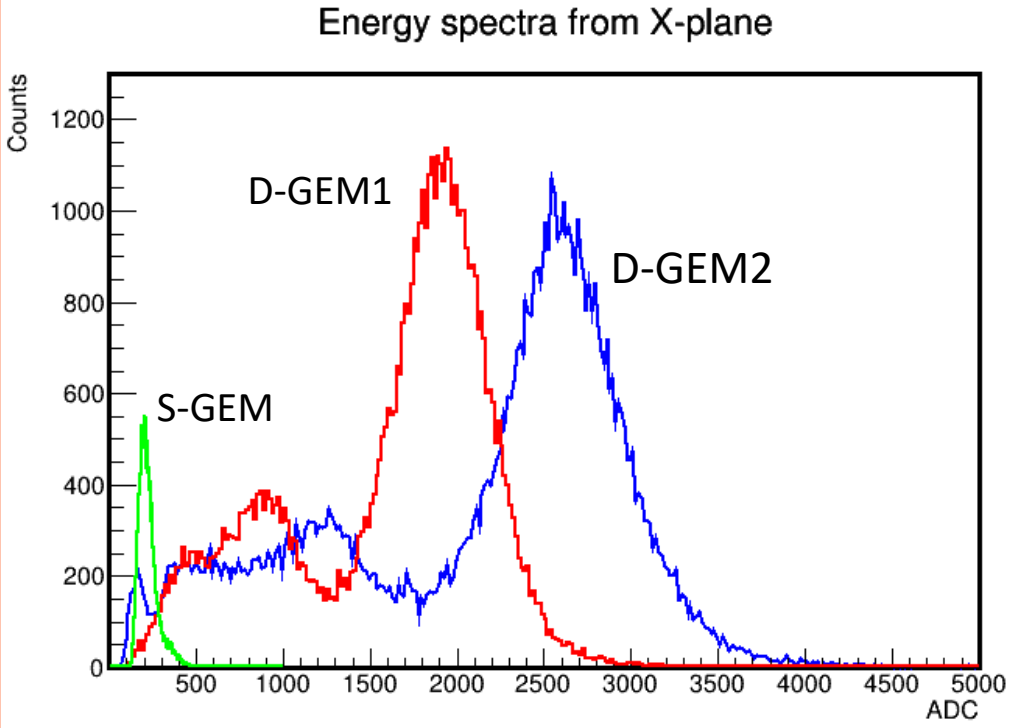
OBSERVATIONS





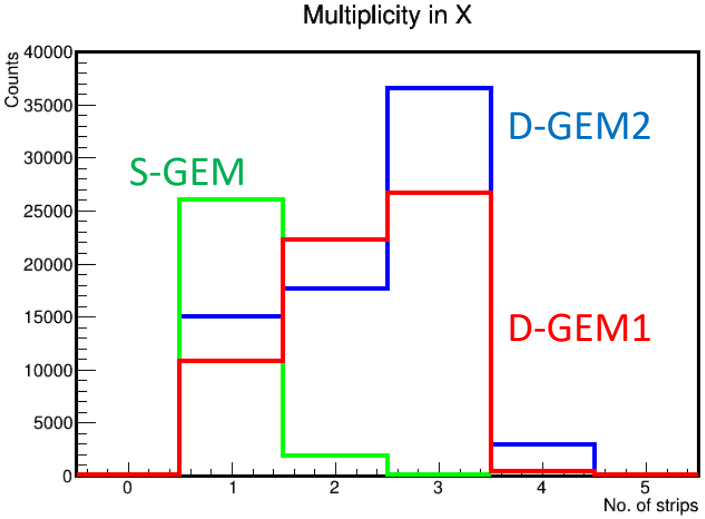
Detector	X-plane rms of residuals	Y-plane rms of residuals
S-GEM	51.016	84.816
D-GEM$_1$	32.387	48.673
D-GEM$_2$	33.737	43.563

Energy Spectra



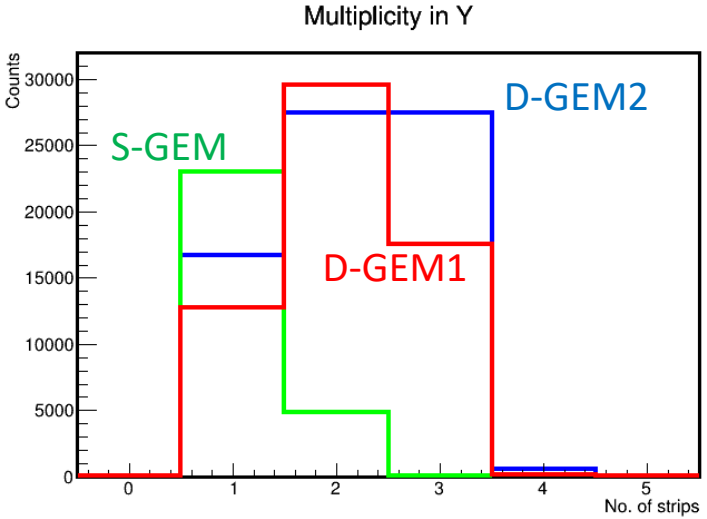
Detector	Mean	Sigma	ΔE/E
S-GEM	210.2	39.24	0.186
D-GEM1	1917.4	260.93	0.136
D-GEM2	2604.4	323.36	0.124

Charge Spread

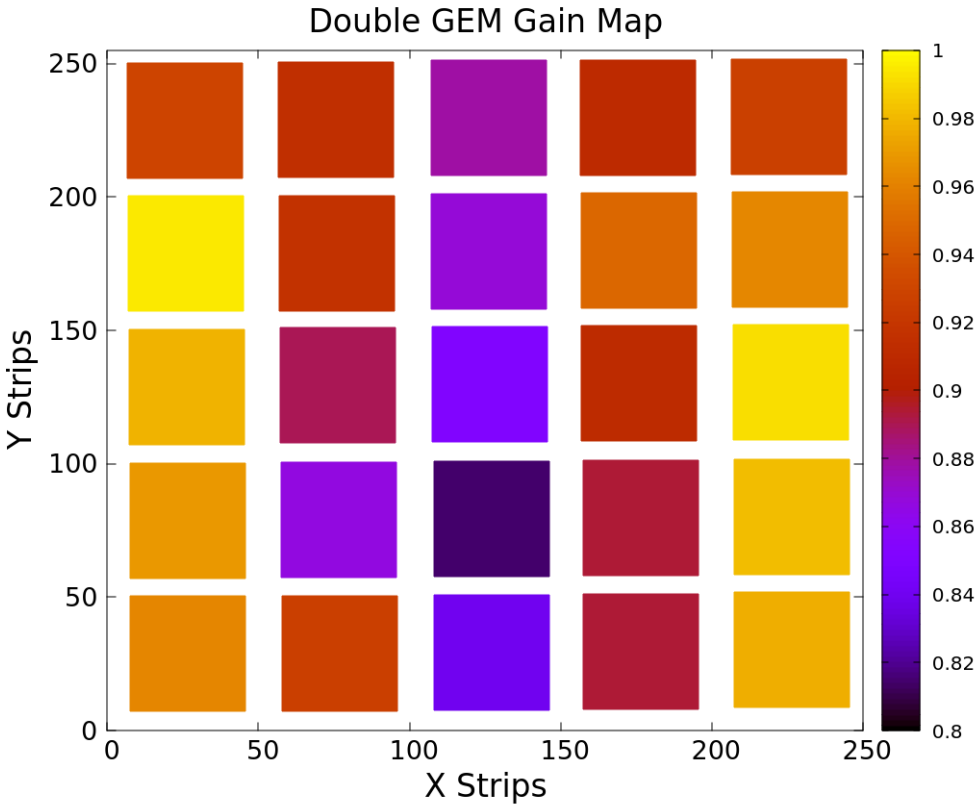


- Double GEM
  - 2 to 3 strips per even
  - CoG works better
  - Multiplicity increase with gain

- Single GEM
  - Mostly one strip is hit
  - Difficult to use CoG method
  - Efficiency is low



Gain Mapping



- Difference in gain from max to min is within 20%
- Gain value reduces at centre
- Sagging or bulging of GEM foils.

Conclusion & Future goal

- Double GEM increases gain as well as charge spread of the detector.
- Gain increases exponentially with GEM voltage.
- Position resolution of double GEM is higher than single GEM.
- Charge spread increase with increase in gain.

- The study of position resolution in triple GEM.
- Validate our results with numerical calculations using GEANT4.

Collaborators

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- Supratik Mukhopadhyay
- Nayana Majumdar
- Sandip Sarkar

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Thank you