Studies on position resolution & gain mapping of Gas Electron Multipliers (GEM) using Scalable Readout System (SRS)

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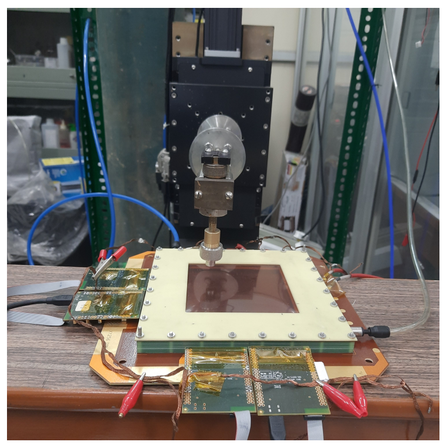
Motivation

The Gas Electron Multipliers (GEM) [1] are among one of the well known MPGDs that are used for tracking applications and are highly efficient even at high rates [2].

Our aim is to determine the spatial resolution and gain uniformity of these detectors as they play an important role in tracking experiments, using resources available in a small laboratory.

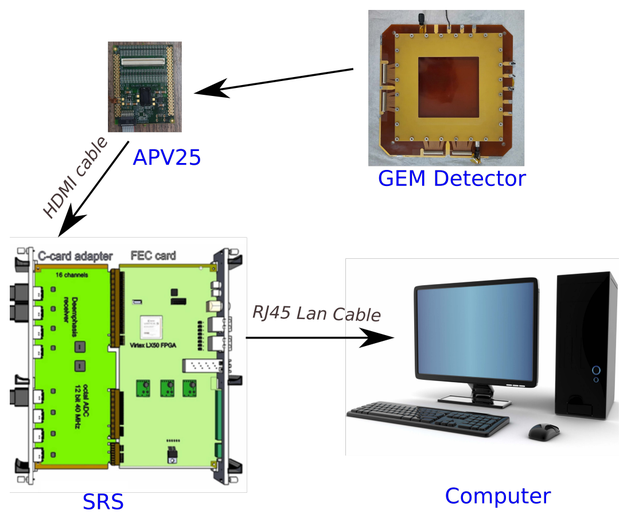
Experimental Setup

Experiments have been conducted at SINP, Kolkata by placing the GEM detector on a test bench. An ^{55}Fe X-ray source placed above it is mounted on an Aerotech XYZ Linear Stage [3].



Experimental setup

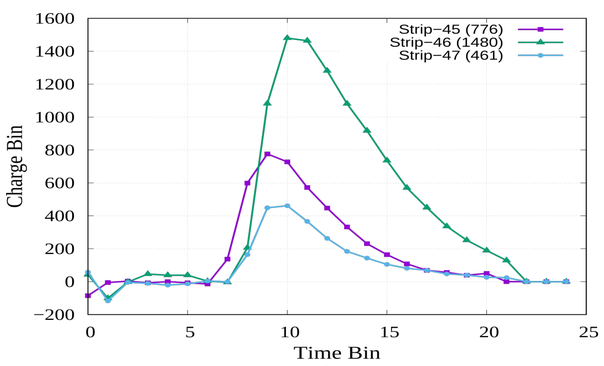
Instrumentation



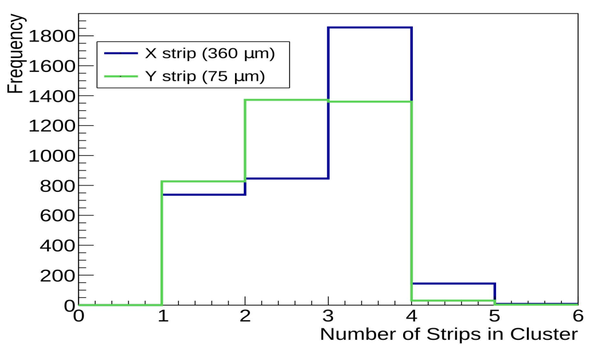
The GEM readout consists of 256 strips running across X and Y-directions, connected to an APV25 Front-end board [4] by 130 pin Panasonic connector. The APV25 has an in-built pre-amplifier and shaper. The charge signals are then sent to Scalable Readout System (SRS) [5] for digitization, zero suppression and further processing. The FEC card present on the SRS handles all the communication, data processing and transfer processes.

Methodology

An external trigger of 2 kHz (NIM signal) has been used to collect data from the APVs. The data recorded contains the charge information of individual strips within a small time window.

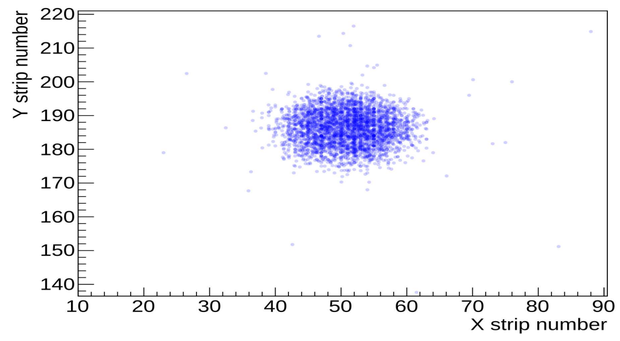


Charge signal from individual strips

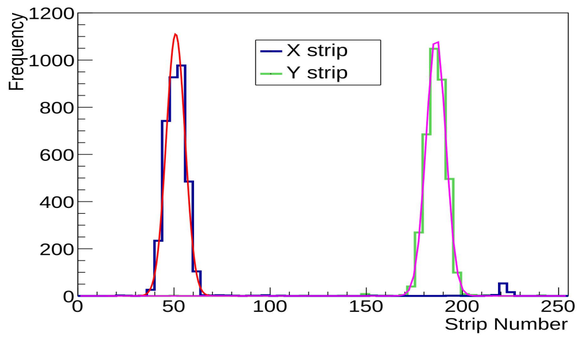


Strip multiplicity from x and y plane

The event positions are calculated using Centre of Gravity (CoG) method for multiple strip hits. Data from the x and y-sense planes are used for scattered plot of individual events.

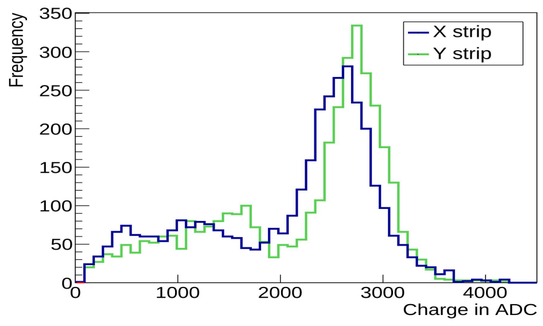


Scatter plot of a typical event

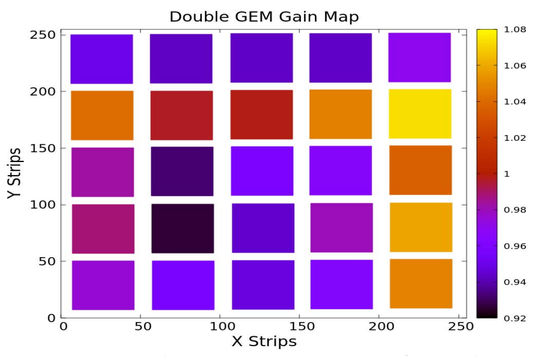


Histogram of positions obtained from x and y plane data

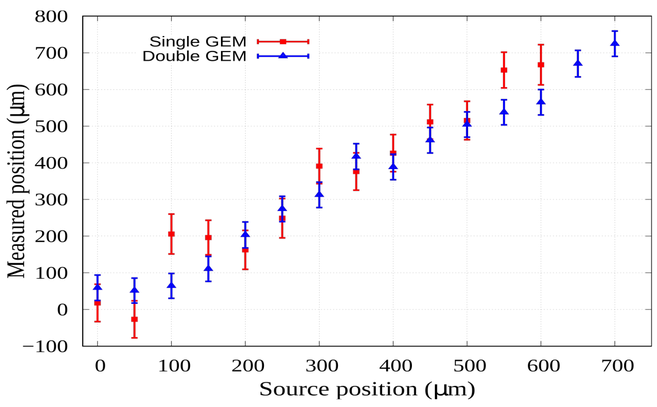
Results & Conclusions



Energy spectra from charge collected in x and y planes



Gain values at center of each 2 by 2 cm block



Position information obtained by moving the source in step of 50 μm in x direction.

GEM Geometry	ΔV_{GEM1} (Volts)	ΔV_{GEM2} (Volts)	Spatial Resolution σ_X & σ_Y (μm)
Single	480	------	66.47 , 88.86
Double	380	400	36.76 , 54.56

- This new approach of using a fine precision positioning system to estimate position resolution and gain uniformity of GEM detectors is found to work satisfactorily.
- Due to charge spread, the spatial resolution for double GEM geometry is better than single GEM giving better position information by CoG method.
- The gain is almost uniform with a variation of ± 8%.

Acknowledgments

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References

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