Status of GEM QC activities at SINP

Prasant Kumar Rout, Supratik Mukhopadhyay, Nayana Majumdar, Satyaki Bhattacharya

Saha Institute of Nuclear Physics, HBNI, Kolkata

24th GEM Workshop, CERN, 30/09/2019

QC studies of GE1/1 triple GEM detectors:

- To validate the GEM technology in the hight eta region(GE1/1), Quality control studies have been performed.

- We try to perform 3 QC activities at SINP.

Quality Control	Test
QC3	GEM Chamber Gas Leak rate Test
QC4	HV and Spurious Signal Test
QC5	Gain & response Uniformity test (X-ray Station)

Manpower situation :

1) Site manager : supratik Mukhopadhyay, Nayana Majumdar
2) P.hd student : 2 students joined recently . They can help for the Studies.

QC3 Test: GEM Chamber Gas Leak rate Measurement

- The QC3 gas leak test determines the gas leak rate of a GE1/1 detector by monitoring the drop of internal over pressure as a function of the time.

Components	Required	Quantity	Components at SINP Lab
Gauge Pressure Transducer	CTEM9200GQ4X	2	Buy
Atmospheric Pressure Senser	MPXA6115AC7U	3	purchased
Temp Senser	LM335Z	5	purchased
4-Digit 7-Segment Digital Display	LDQ-M284RI	6	purchased
Arduino Board	MEGA 2560	2	One is available,
Crimp Connector	22 Gauge (AWG)	200	Buy
Ethanol bottle (Pure)	Pure	2 bottle	availble
Painting Brush		2	available
Flex Cable Wire (Red, Black, Yellow)	0.25 mmsq cross section	1 Bundle each color	purchased
Flow meter (Variable area flow meter) for Gases	Input & output Height- 10 cm log scale	2 input 2 output	Buy
Valves T & L, manually close/open	Both 6 mm	3L and 6T	Buy
Heat Gun (Hot air Tool)	Plastic welding	1	Buy
Plastic Spiral Wrap	Minimum 4 mm, Maximum 20 mm	2 bundle	purchased
Plastic pipe (bendable), Transpare	Inner diameter 1/2 inch	3m	purchased
PCB Connector	Spacing 2.54 mm, Height 6.3 mm	50	Buy
Resistors	500 ohm and 100 ohm	50 and 100	purchased
shrink cable	Sleeve(Max) 3mm, Minimum 1 mm	1 bundle	purchased
Soldering Wire	Thickness 0.25 mm	1 bundle	availble,
Stainless Steel Pipe	Inner diameter 4 mm Outer diameter 6mm	1m, 10 pieces	purchased
SS gas connector	Ineer diameter 6 mm	50	purchased

- 2 Gauge pressure transducer and 1 flow meter have been purchased recently.
- Almost all components are bought and Gas leak test stand is being fabricated in the workshop.

Access to 2 clean rooms in the institute : Class 100 & class 10000

Components bought recently

Input flow meter(Q-flow) (0 - 120 mm scale)

Pressure transducer CTEM9200GQ4X

Megger for Insulation test

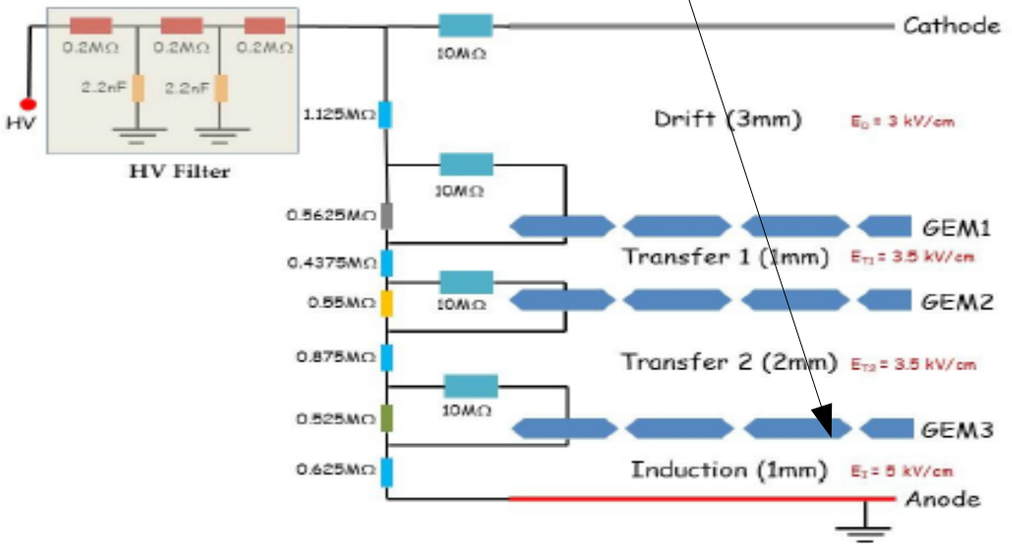
QC4 Test : HV Linearity and spurious signal Measurement

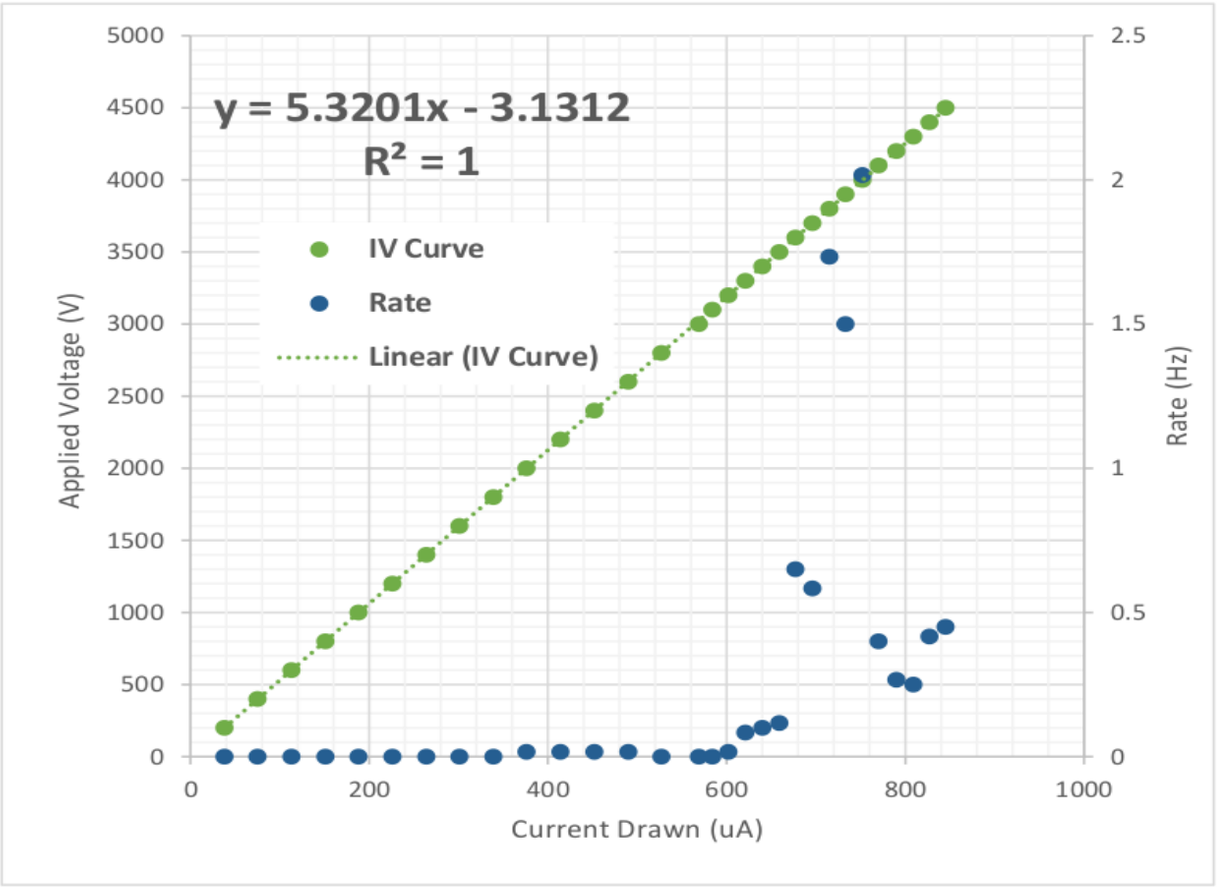
- The QC4 study aims to determine the I vs. V curve of a GE1/1 detector and identify possible malfunctions, defects in the HV circuit and spurious signals.
- Gas : CO_2

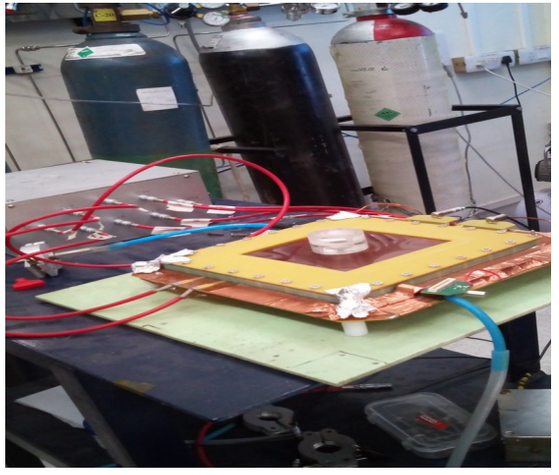
QC4 Components	Suggested	Components at SINP Lab
HV Power Supply	CAEN N1470	CAEN N471, SY 4527. working
Charge sensitive Preamplifier	CAEN A422A	CAEN A422A, ORTEC 142IH Available and working
Shaping amplifier (TFA)	ORTEC 474	Not available. ORTEC 672 Spectroscopy Amp is Available and working.
Discriminator	Lecroy 623A	ORTEC 473A CFD, LTD Available . working
Scalar & Counter	CAEN N1145	CAEN N1145 Scalar and Counter. working
Oscilloscope	Yes	Available and working

QC4 Test with 10X10 GEM : I ~ V curve and rate

- Gas : CO_2
- Signal : GEM3 bottom
- Discriminator Threshold : 60 mV







10 X 10 Triple GEM detector

QC5 : Effective gain and Response uniformity study

- The QC5 gain calibration includes the measurement of the effective gain as a function of the voltage applied on the divider and the measurement of the response uniformity of the detector.
- Both tests are performed in a specific radiation box containing an X-ray generator.

QC5 Components	Suggested	Components at SINP Lab
X – ray Generator	Amptek mini X-ray Ag Target	Moxtek X- ray with Cu Target. Working
Large Cu shield Box	Required to house the X-ray gun	Ready.Equipped with necessary Connectors. Working
Pico-ammeter	Keithley 6487	Keithley 64857. Alternative :Danfysik Current Integrator. Working
Dual Timer(Trigger)	CAEN N39B	CAEN Mod V993 Available. Working.
SRS System	Yes	SRS with FEC V6 available, configured and Working
DAQ System	Yes	Configured. working

QC5 X-ray station : Radiation shield Cu box

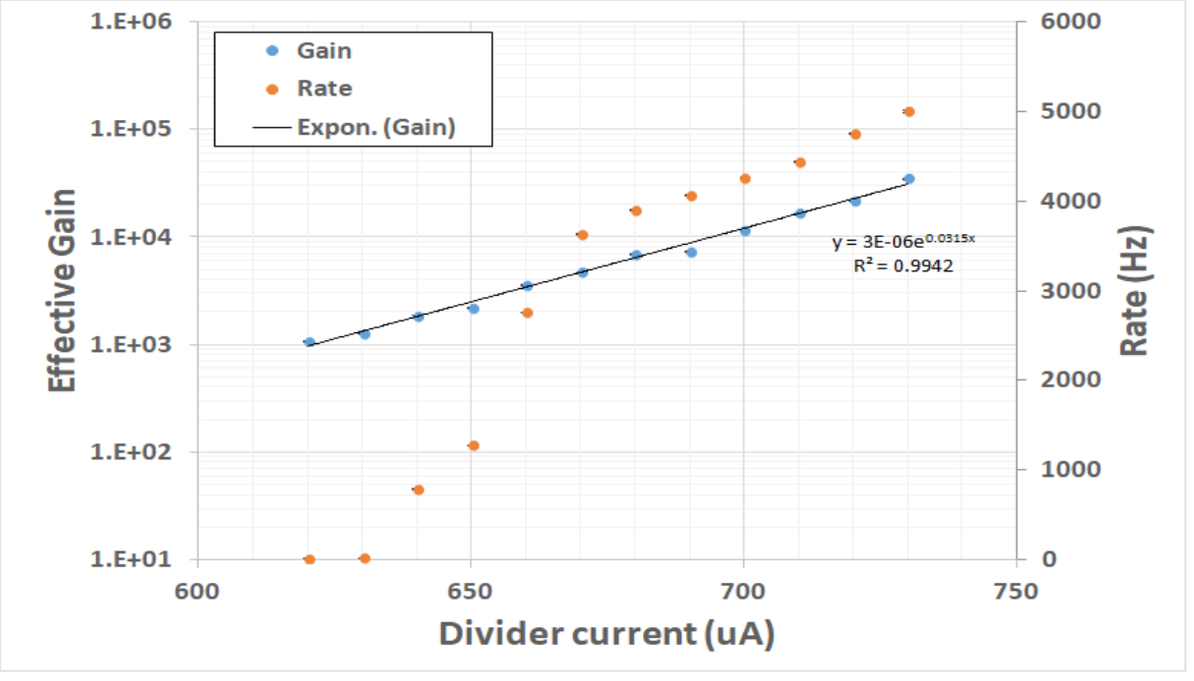
- Completed, configured with necessary connectors and working.

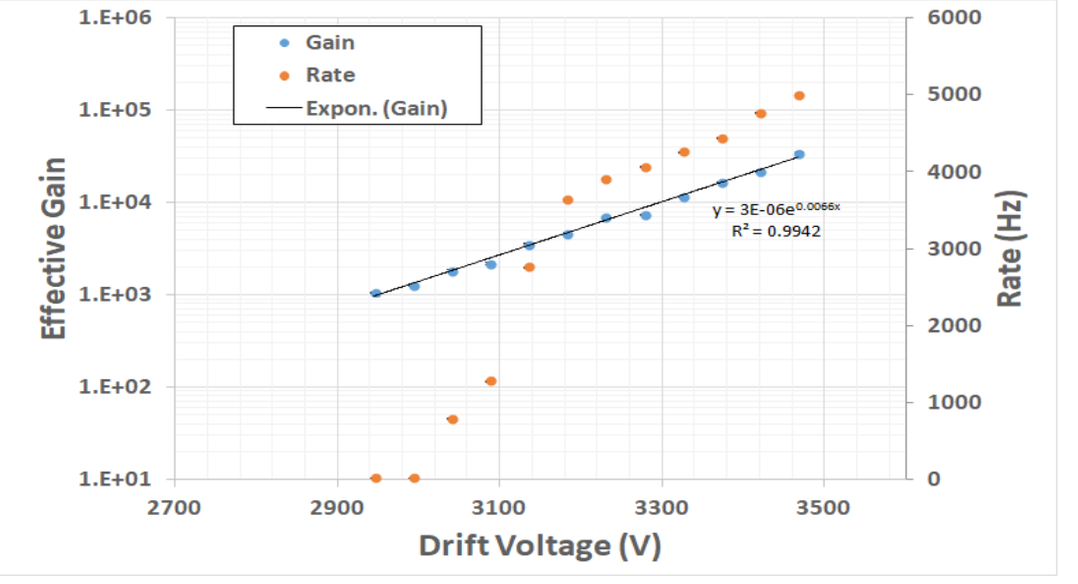
QC5 Gain results : 10 X 10 Triple GEM

- Gas Mixture : Ar + CO_2 (70:30)
- Source : ^{55}Fe (emits 5.9 keV photon)
- Effective Gas Gain (G) = I (nA) / (R * N_p * e)

  I = Anode current , R = rate, N_p = number of Primary Ionizations,

  e = charge of an electron

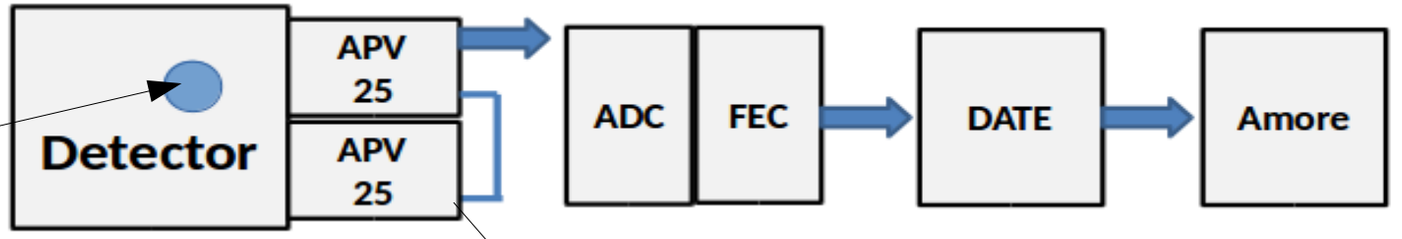




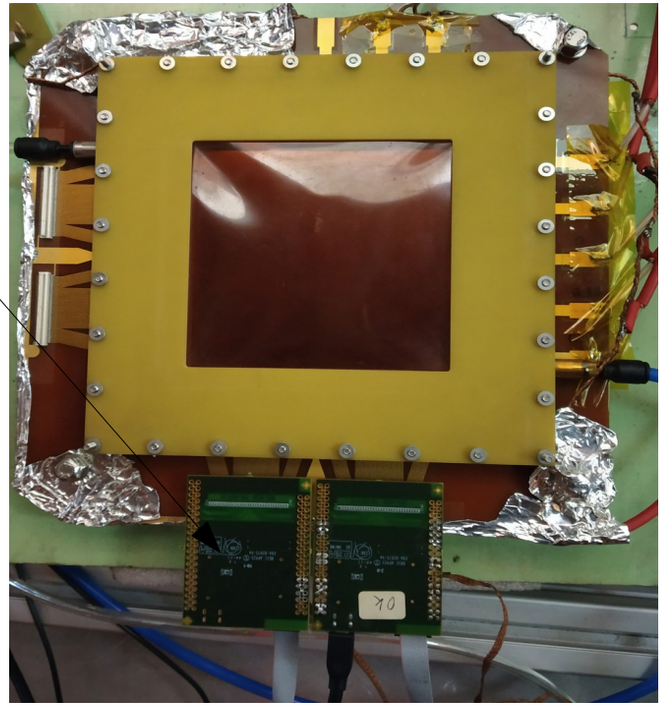
Gain uniformity Studies on 10 X 10 GEM detector using SRS System :

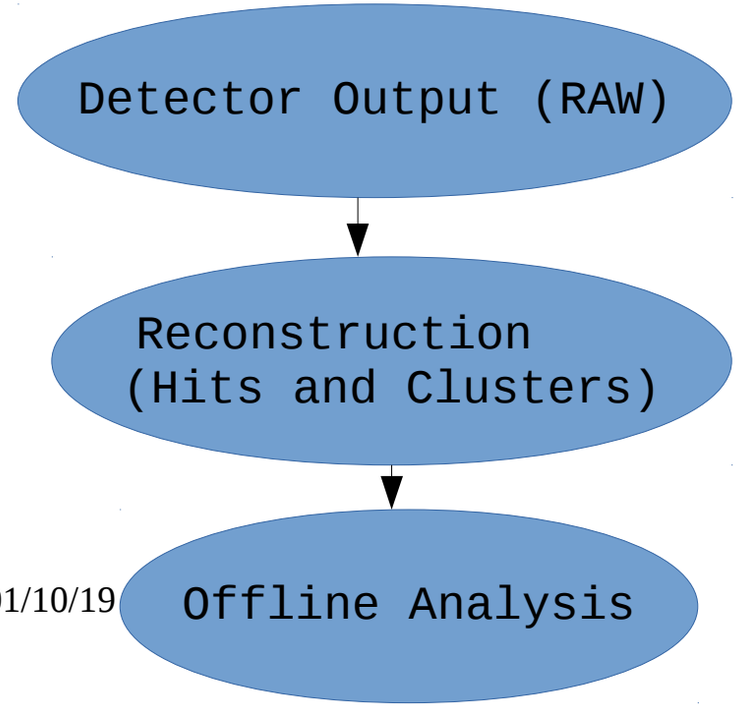
Readout strips : 512
(X-strips, Y-strips)

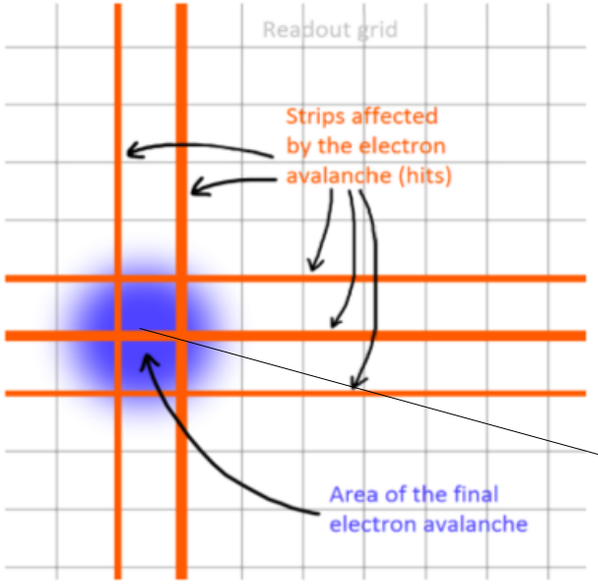
Fe-55 source



- APV 25 chip reads the amplified signal (Analog) from detector readout strips
- ADC convert analog signal to digital
- FEC sends data to the computer
- DATE collect all data
- Amore visualize the data and perform analysis

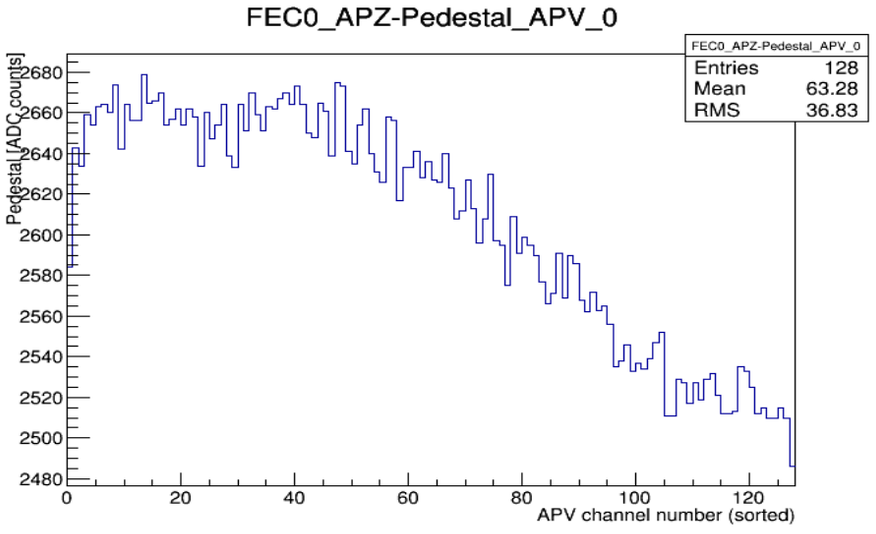


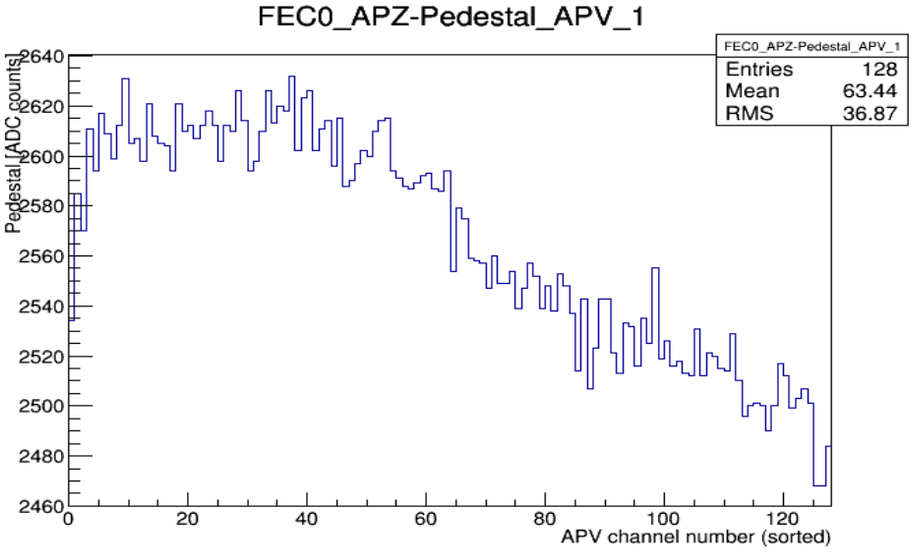


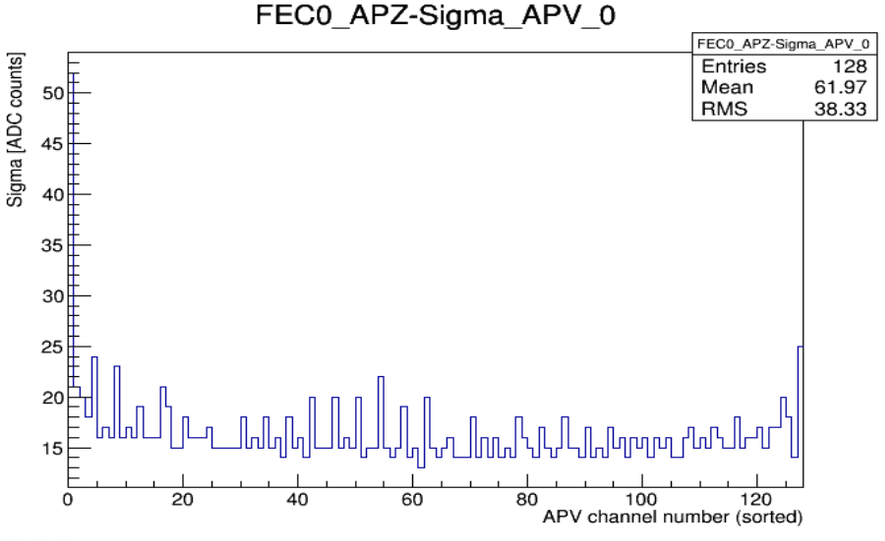


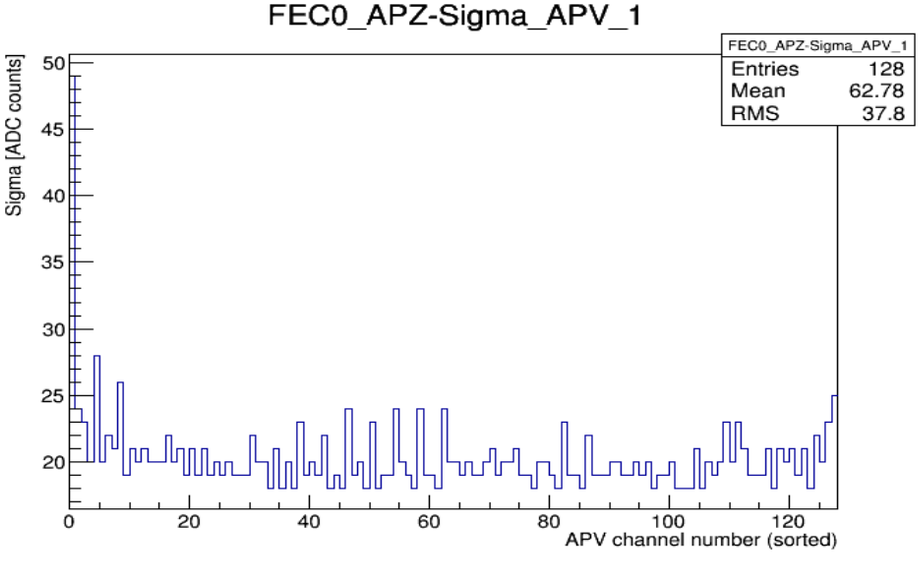
Hit: induced signal in readout strips

Pedestal and Sigma measurement : Zero level of measurement without any radiation source

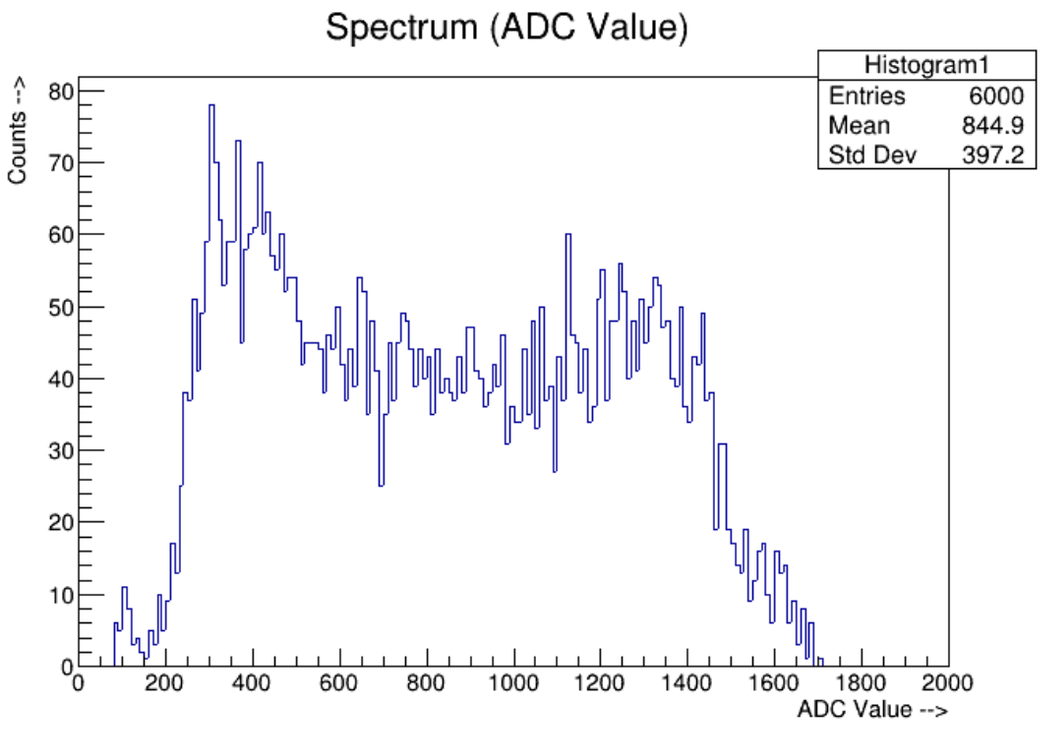




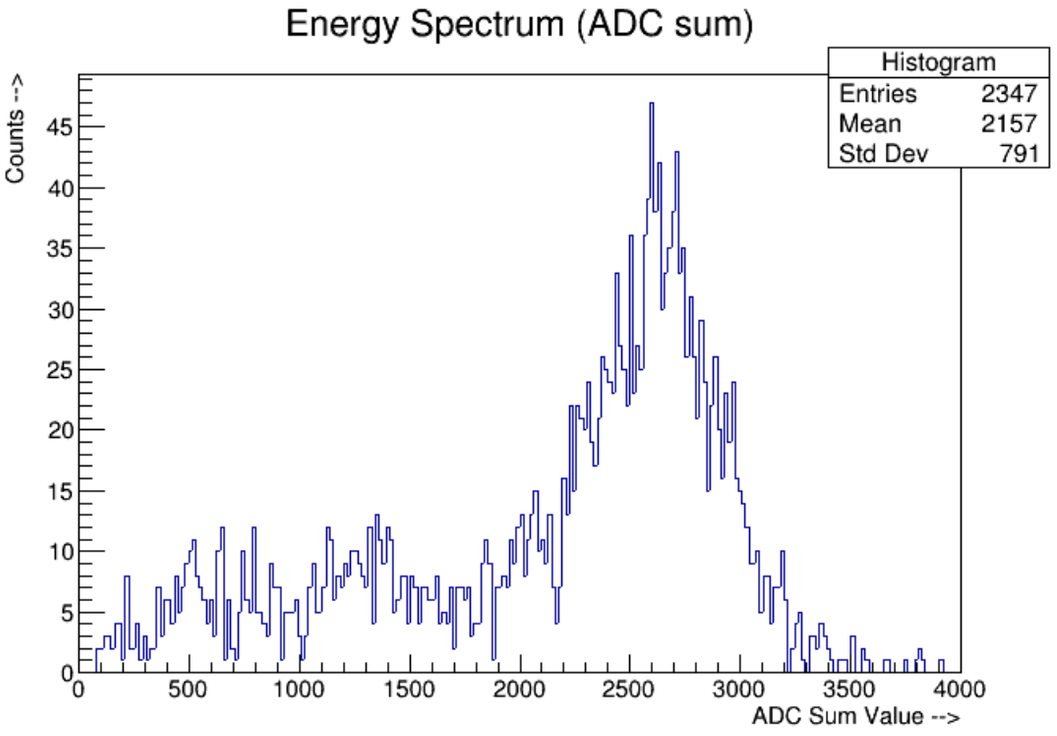




Energy spectrum : Fe – 55 Source, HV = 3450 Volt



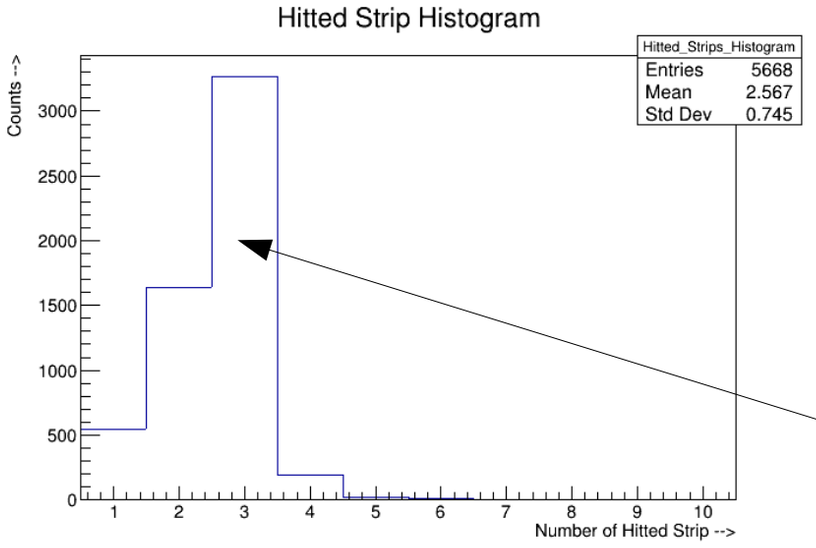
Hit ADC



Cluster ADC

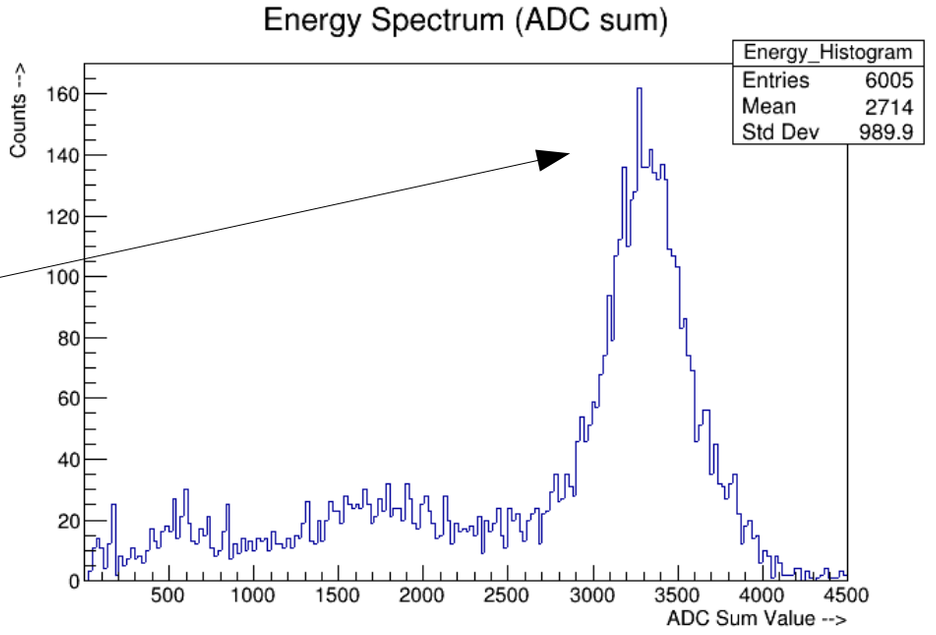
- Each channel of APV reads a particular strip in 30 time bins giving rise to 30 ADC values
- Charge is proportional to ADC values
- **HitADC** : Peak ADC value of 30 time bins
- **ClusterADC** : Total charge in an event. Sum of peak ADC values in an event for multiple strips fired in that event.

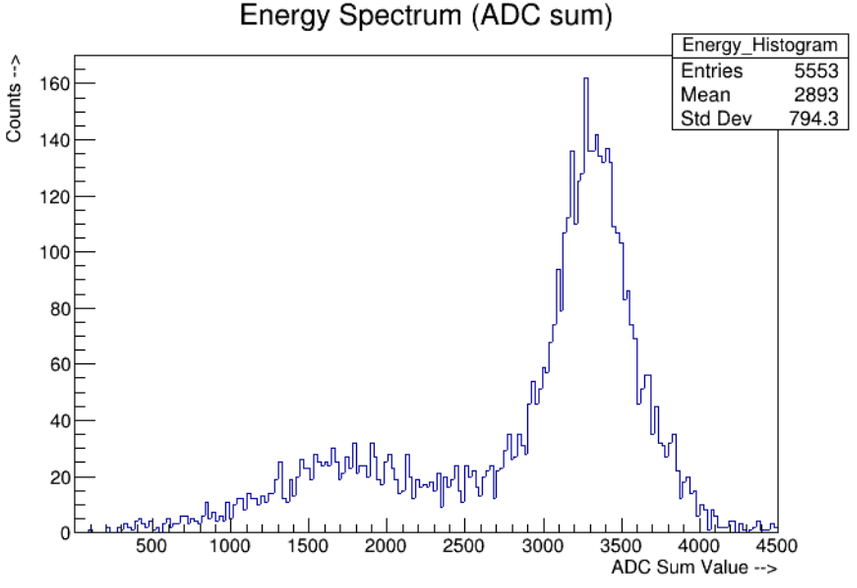
Strip multiplicity : Number of strips hit in an event



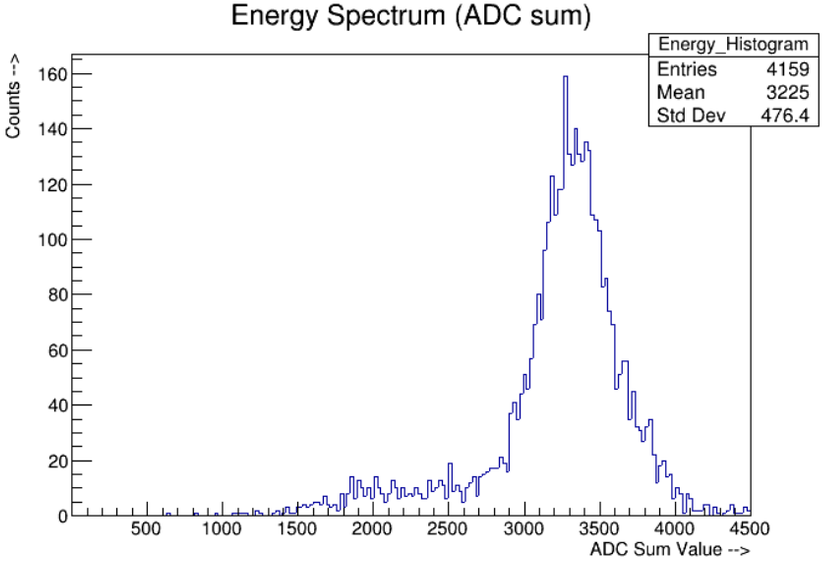
Cluster Size

Cluster ADC
With all hits





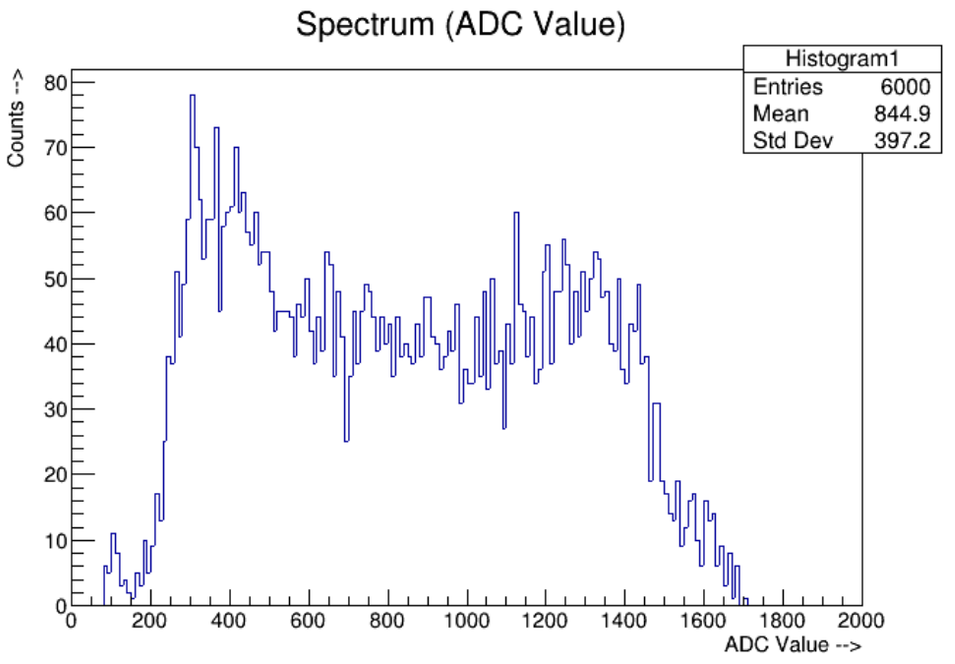
Strip hits > 1



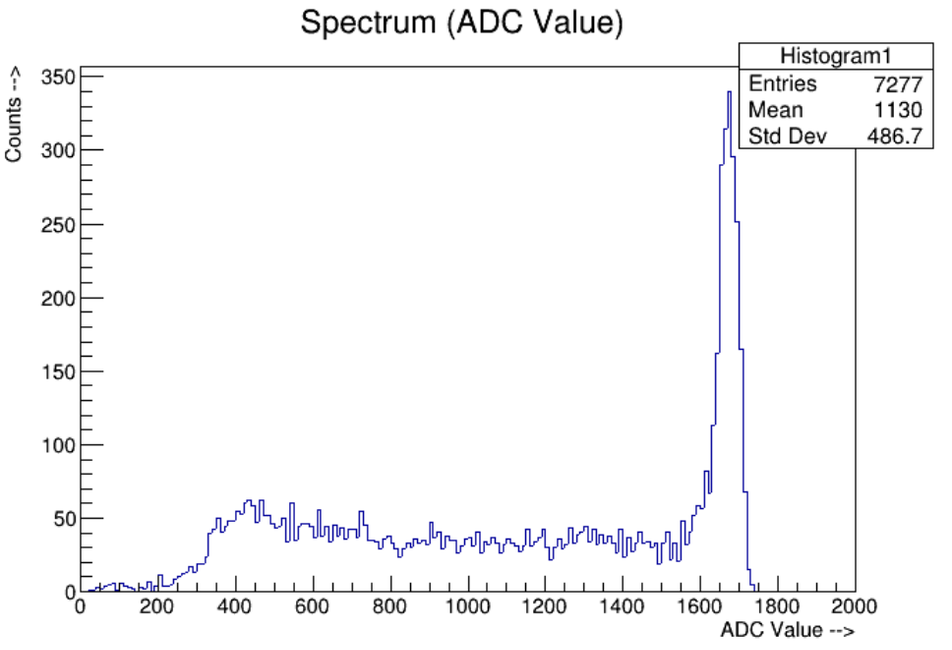
Strip hits > 2

Strip multiplicity : Variation with detector High Voltage

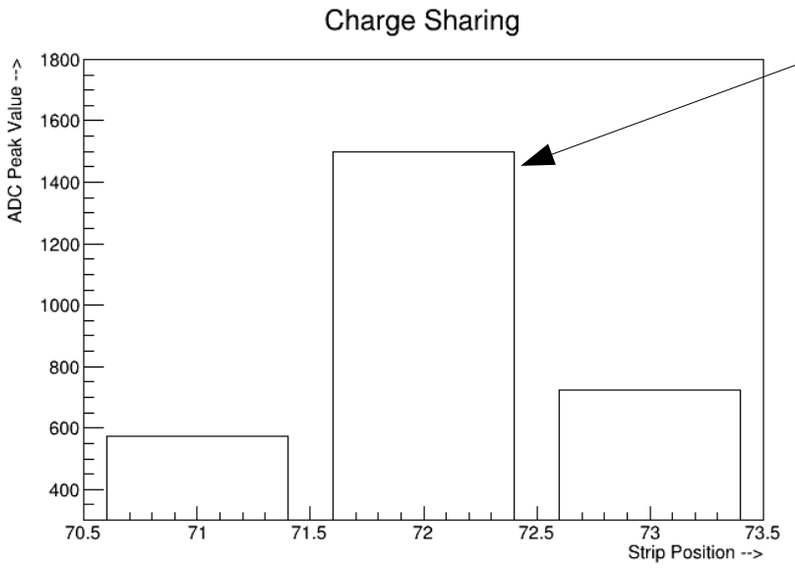
HV at 3450 Volt

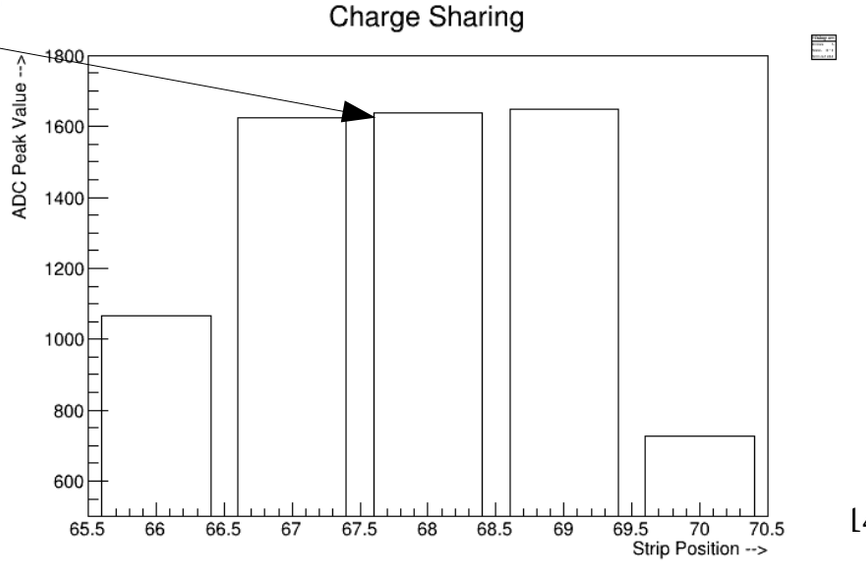


HV at 3550 Volt (Saturation)



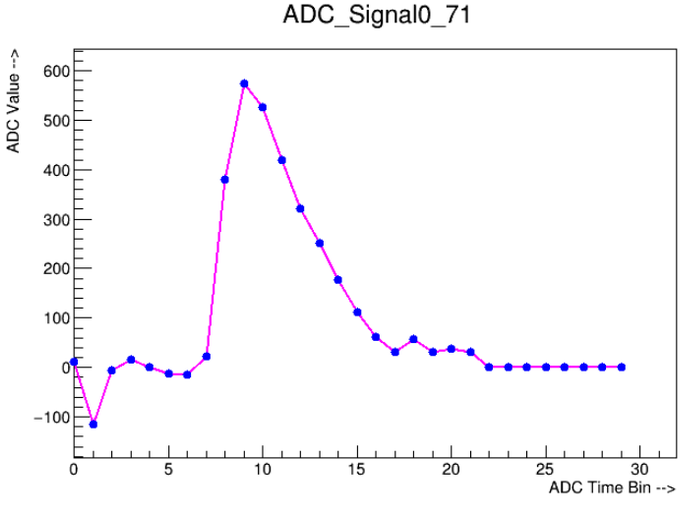
Single event

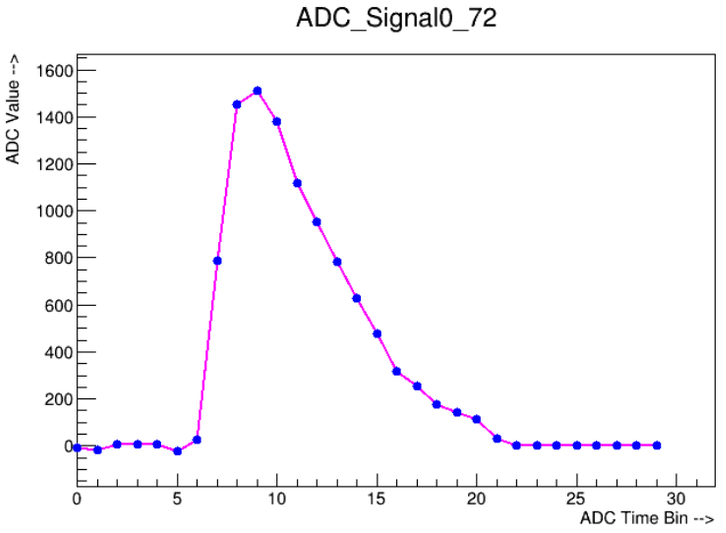


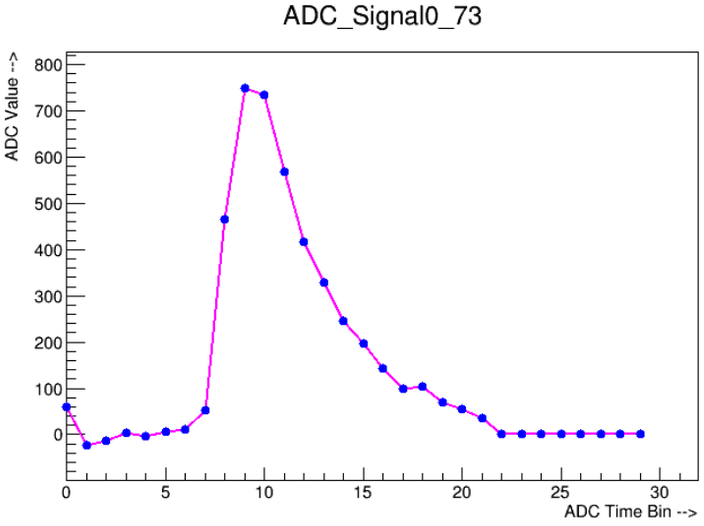


Time evolution of charge in strips: for a single event

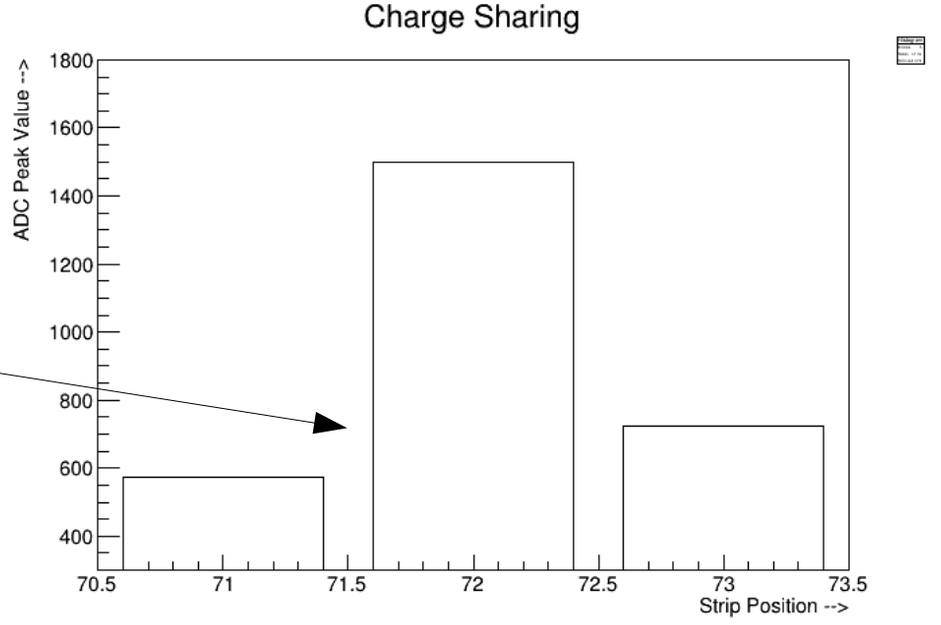
- A single event where 3 strips are fired .



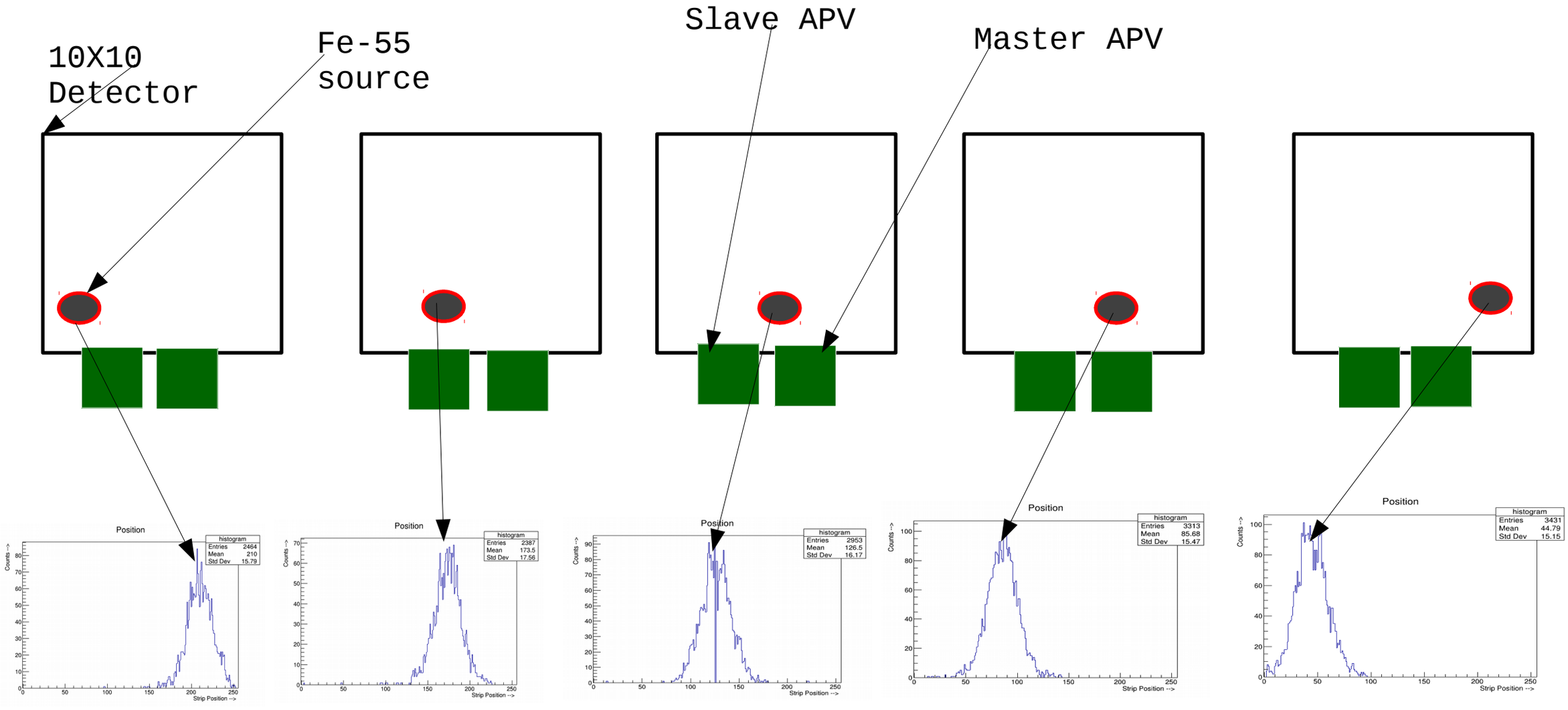




Charge sharing among strips

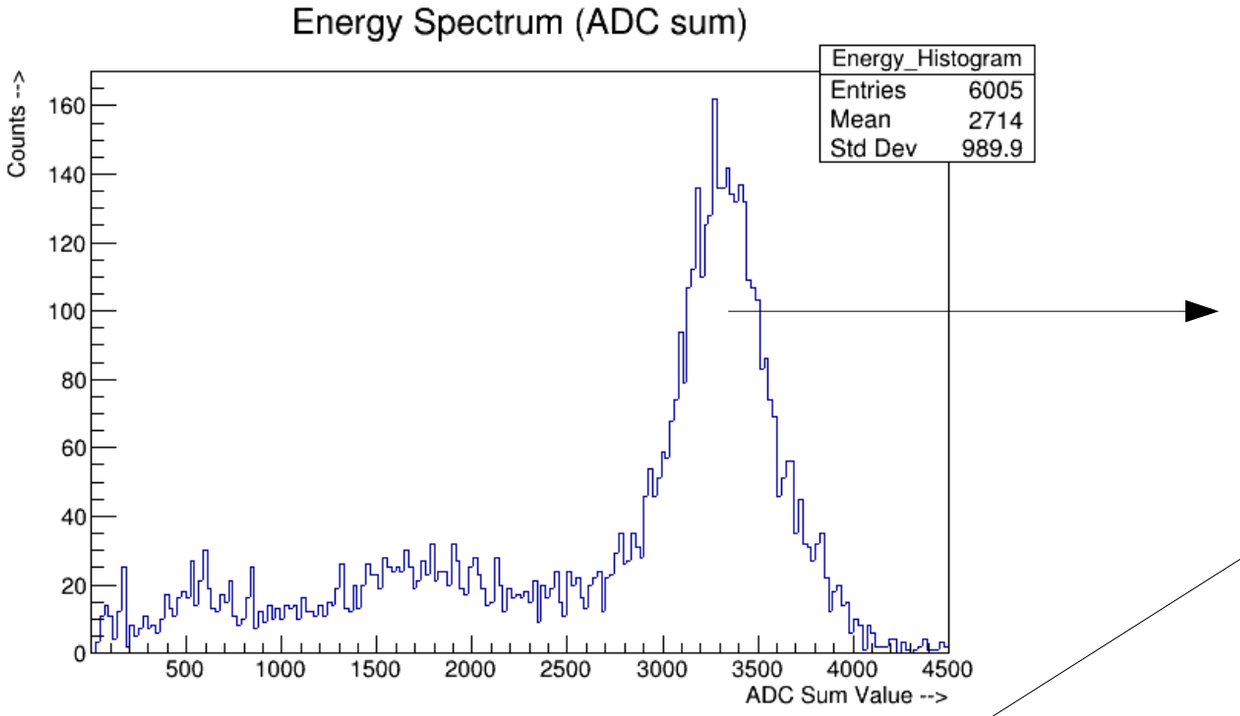


Source Position change: shift of energy spectrum

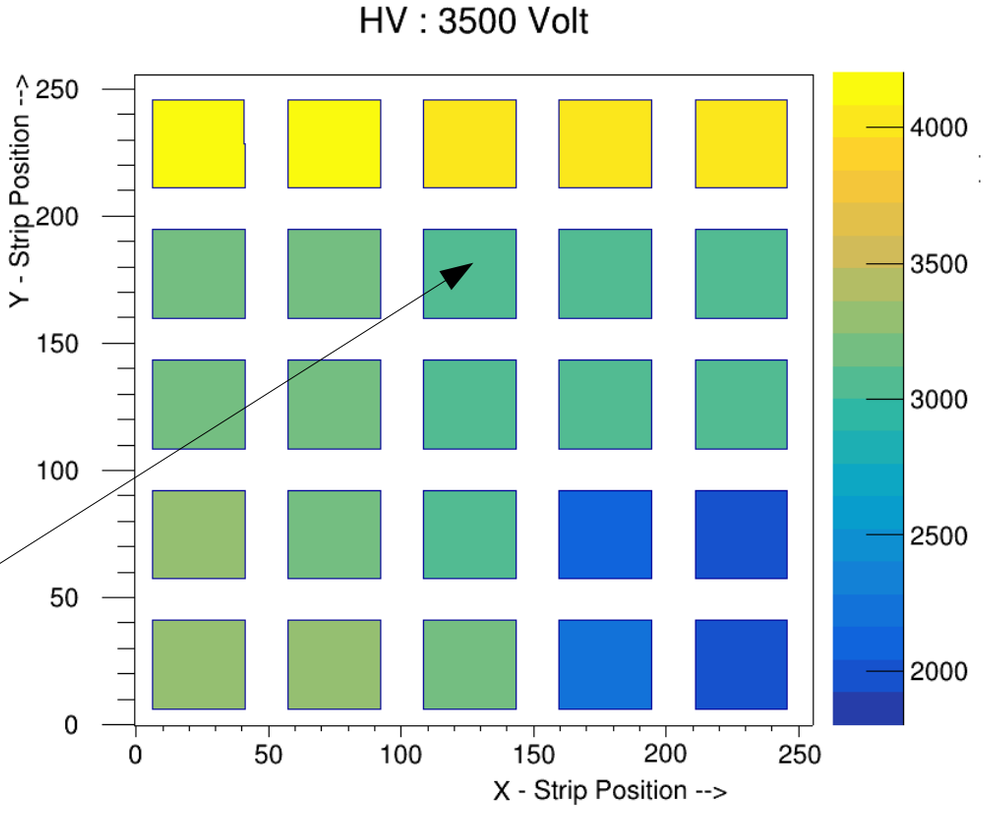


Gain Map : variation of gain across GEM detector

- Radiation Source : Fe – 55
- Each square corresponds to the position of source and photo peak
- Uncertainties come from various sources : variation in GEM hole-diameter, variation in gaps, variation in GEM foil thickness, etc.



Cluster ADC



Mean photo peak of cluster ADC spectrum

Summary :

- Presented status of QC studies for 10X10 triple GEM at SINP.
- Almost all the components are available in the lab. QC3 gas leak rate measurement will be performed soon. Currently, the test stand is being fabricated in the workshop.
- QC4 Test is configured and working.
- QC5 gain measurement is performed with Keithley Picoammeter and results are shown.
- Complete SRS system has been procured last year. It is configured and working.
- The gain variation study has been attempted with 10X10 Triple GEM detector with the SRS-APV system and the results are shown.

**********Thank you**********

Back up