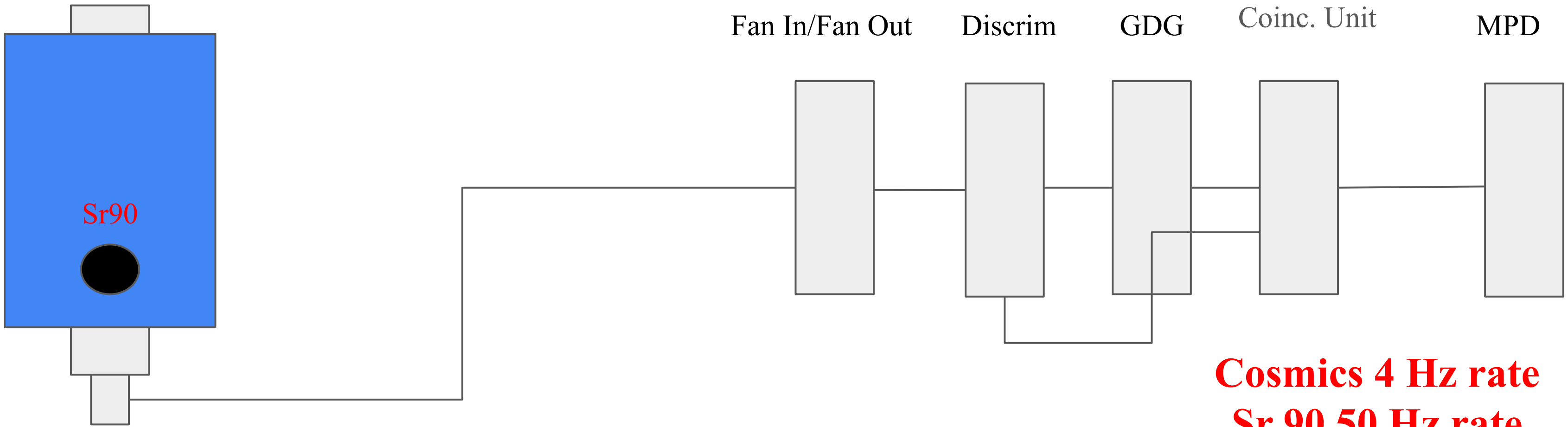
GEMs at LERF Status

March 6, 2024

Setup

GEM active area 400 x 250 mm^2

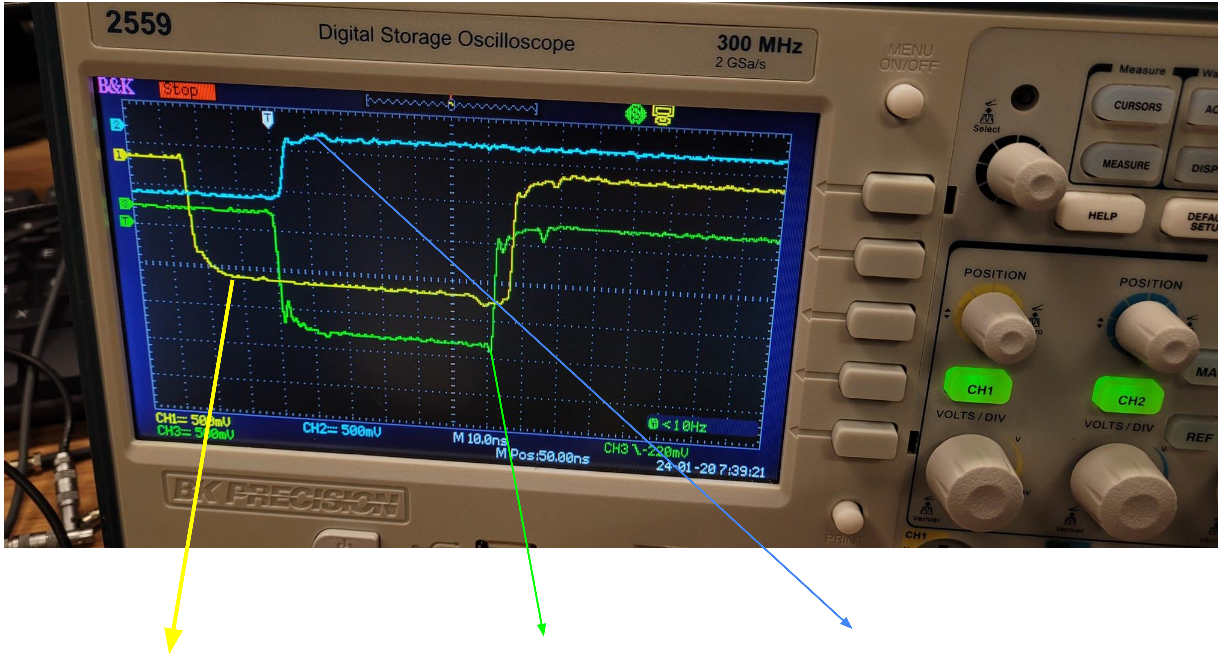


Cosmics 4 Hz rate
Sr 90 50 Hz rate

Scintillator + PMT
Active area of scintillator ~ 200 mm^2

- Raw PMT signal input to FIFO.
- Output from FIFO to input of discriminator.
- One copy of the output from discriminator to input of gate/delay generator, which creates 2 ms latch output
- Take the NOT gate output from the GDG and other copy of discriminated signal as inputs to the coincidence module to form AND signal
- Output AND signal is sent to the MPD.

Timing



Discriminated signal

AND output

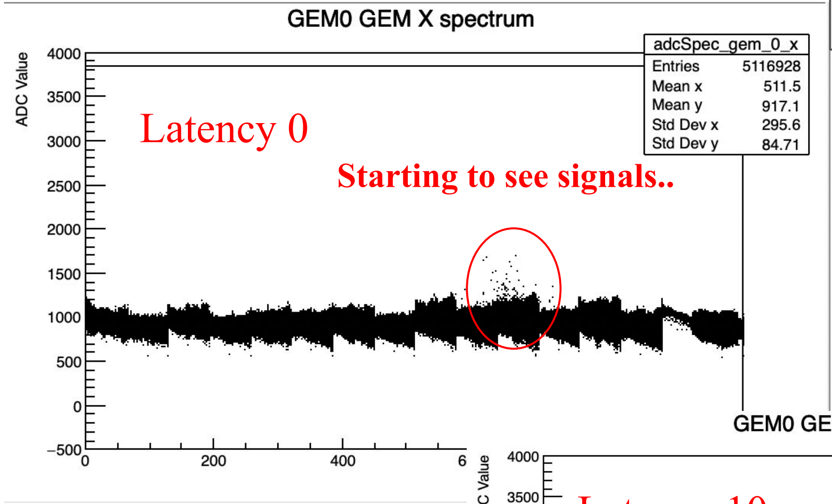
NOT Gate (Not BUSY signal)

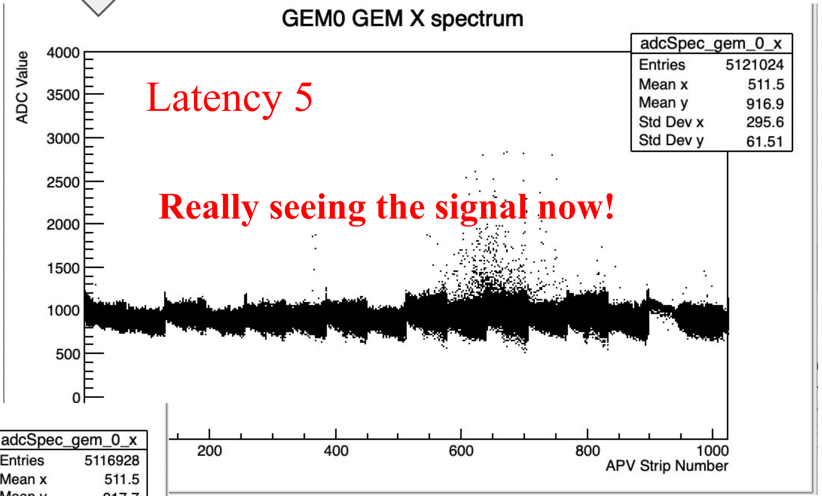
- Using the NOT gate output in coincidence with the discriminated output so that we can allow the first trigger to be sent to the MPD.
- The output from the gate/delay generator is produced roughly ~ 25 ns after the discriminated signal so that the first trigger can indeed pass through.
- The AND coincidence output has to be at least 50 ns long and be a negative NIM signal for the MPD to recognize it.

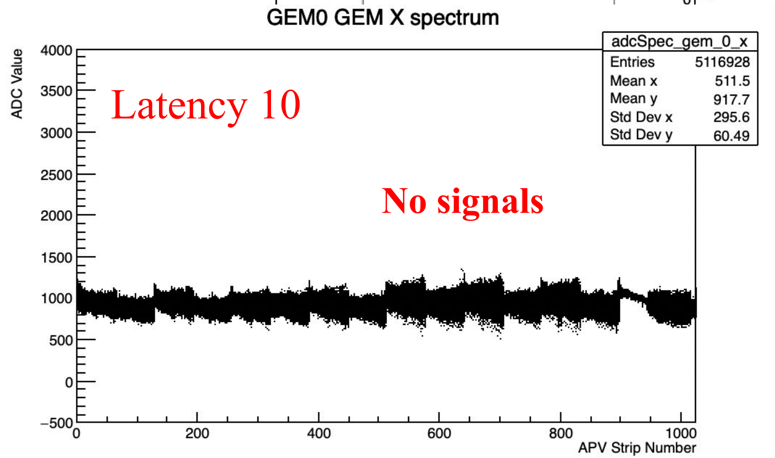
Latency and HV Scan

- The APVs have a 4 μs buffer. The latency refers to how far back one has to go in order to probe the buffer. If the trigger takes a long time to create, then the farther in time we must go back to probe.
- One latency unit is 25 ns, so 160 latency channels in the buffer.
- First started with finding the optimal latency (a parameter that is changed in a file) at fixed HV. Started with HV = 3700 V.
- Scanned the latency from 0 to 10 with this HV.
- After finding the optimal latency, scan at different HVs. We did from 3700-4000 V in steps of 50. Needed to find the optimal conditions for running the GEM.

Finding the Latency (HV = 3700)

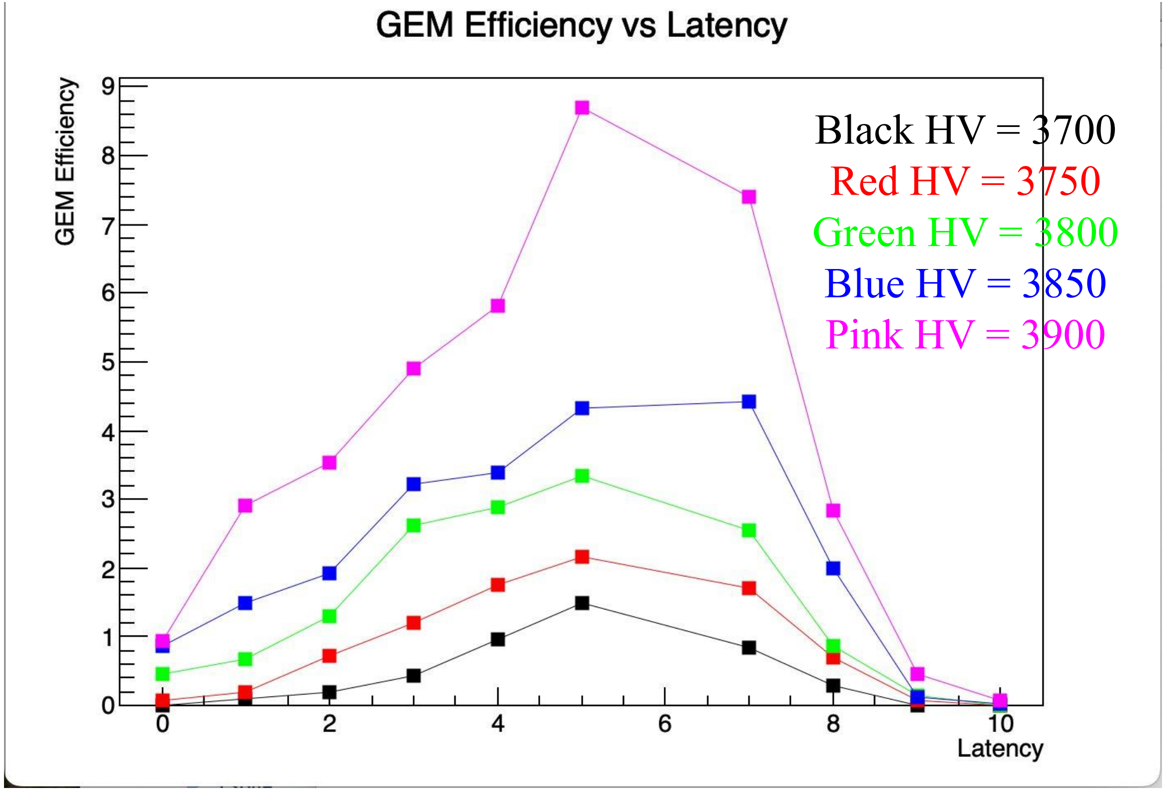






We chose latency 5 to be optimal…

GEM Efficiency vs Latency



Latency = 6 omitted…One problematic run…

- We initially defined the efficiency as the ratio of clusters found over the number of events. The number of events was renormalized to account for the fact the trigger had both Sr90 and cosmics.
- This used 2D cluster finding, which may not be efficient. So 1D clustering was implemented.
- In the software, there is a minimum ADC threshold which is used to identify possible cluster candidates. This threshold was set to 500 for this plot. So, we now have another parameter to scan but this is software driven
- **The future plots will be using 1D cluster information**

New thoughts on GEM efficiency

- Take the latency 5 runs and look at the cluster multiplicities per event. Then the efficiency ε is then

>1 multiplicity indicative of noise present. Should be 1 cluster/event for Sr90 (cosmics)

$$\varepsilon = \text{\# single cluster events/\# of events}$$

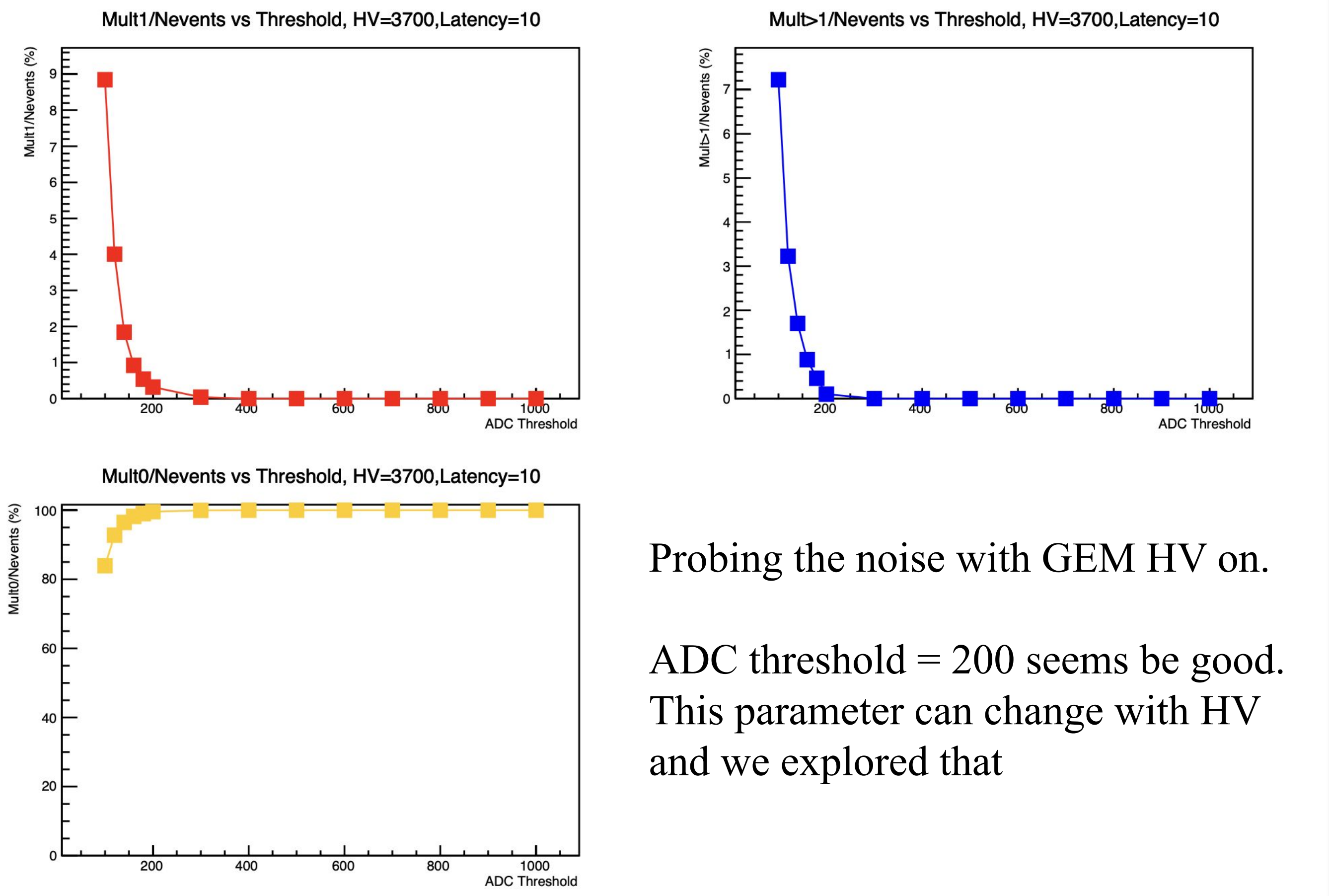
$$(1 - \varepsilon) = \text{\# no cluster events/\# of events}$$

Right now using all events in denominator. We can correct for that later

- This works if S/N i.e., signal to noise ratio is big and noise is the same for all strips. We scan the peak finding threshold to suppress the multi cluster events. We can use the latency 10 data to probe the noise distribution and find the minimum peak threshold that suppresses the noise.

I have omitted the HV = 4000 data, saw a FIFO buffer bull error which tended to correct itself but increased the deadtime substantially. Our trigger rate is 50 Hz but the event rate being read by MIDAS only 20 Hz!

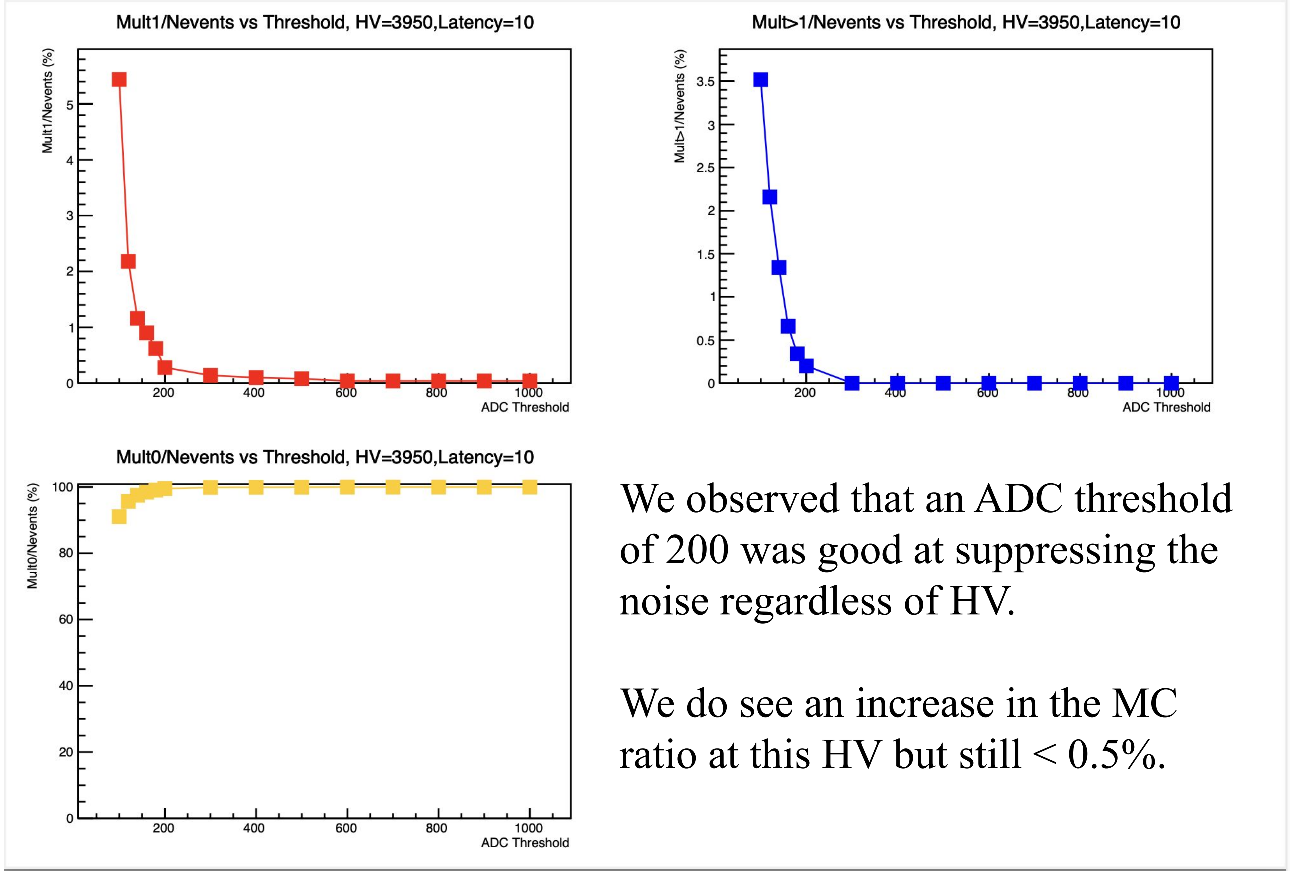
ADC Threshold Scan (HV = 3700, Latency 10)



Probing the noise with GEM HV on.

ADC threshold = 200 seems be good. This parameter can change with HV and we explored that

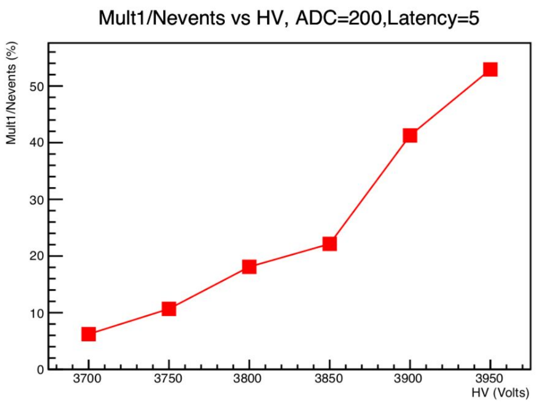
ADC Threshold Scan (HV = 3950, Latency 10)

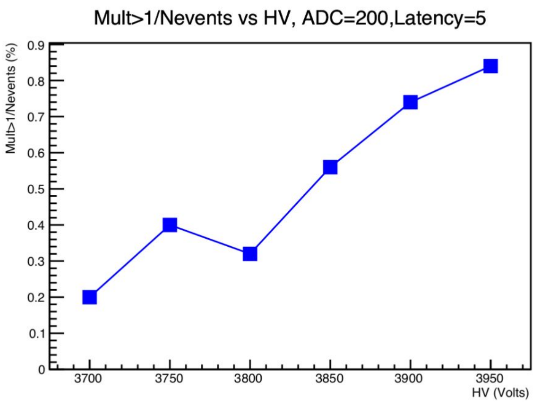


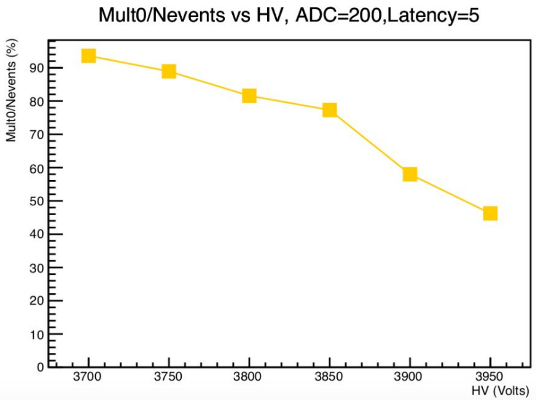
We observed that an ADC threshold of 200 was good at suppressing the noise regardless of HV.

We do see an increase in the MC ratio at this HV but still < 0.5%.

GEM Efficiency vs HV (Latency 5)





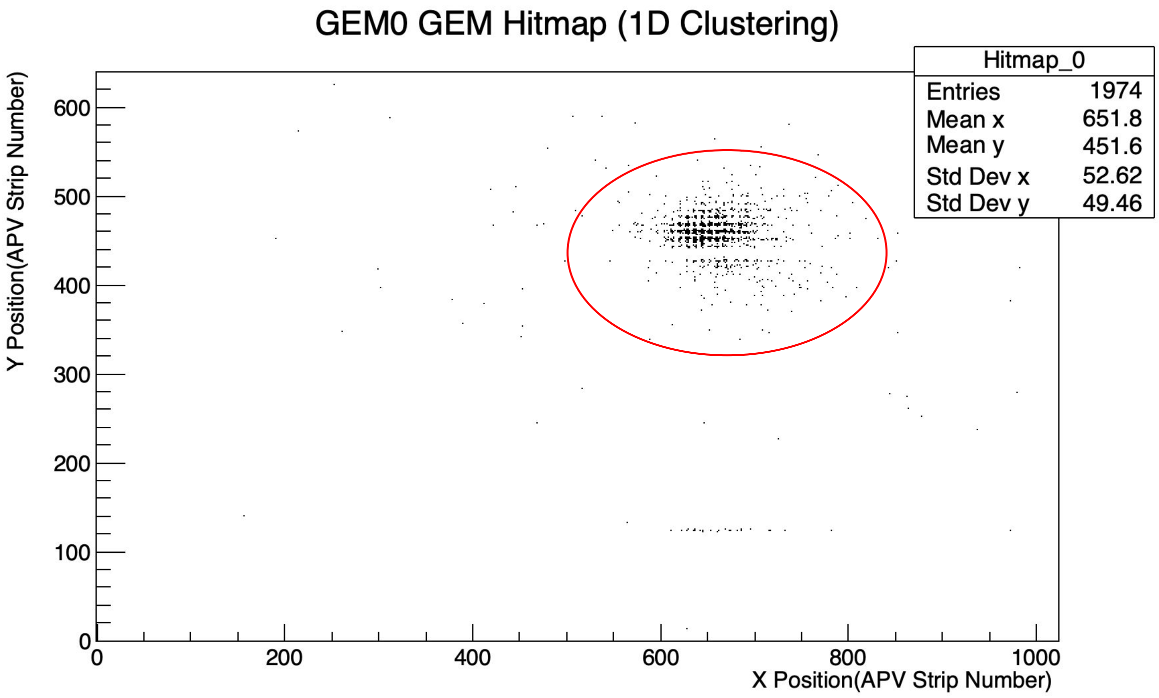


Still looking for plateau…

Would like to do this for cosmics since source is localized. We can then see if the efficiency changes where you are on the GEM

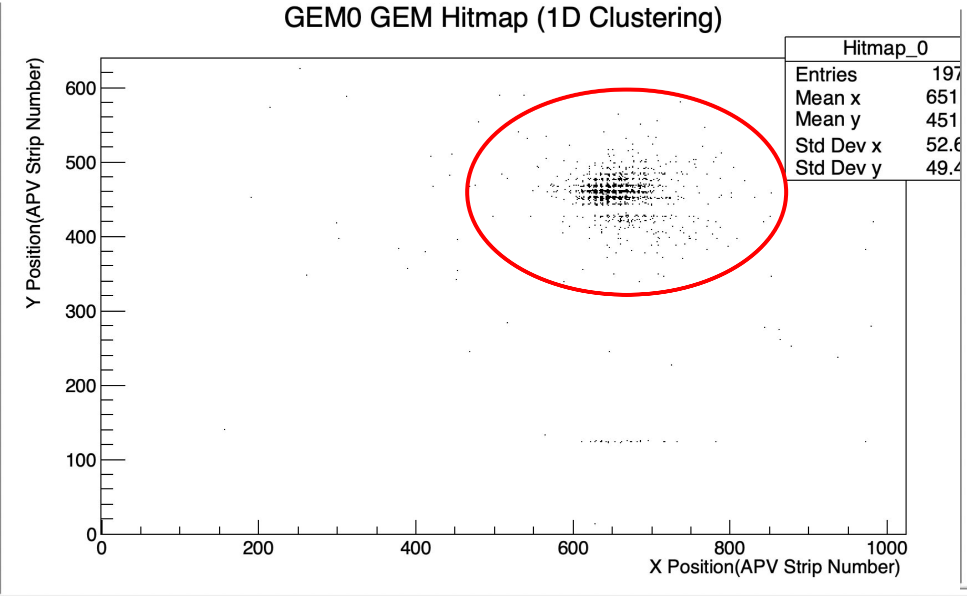
- ADC threshold of 200 suppresses the noise (<1%). Now this threshold is applied to all strips. We would like to apply a threshold at the strip level. We can recover some efficiency that way. There is still a question about the mapping from APV electronics to strips. We've started taking the data.
- We have also taken runs with GEM HV on/off, to look at the spectrum for each channel on each APV. We have done the same with different triggers (i.e., Sr90 vs pulser).

Issues

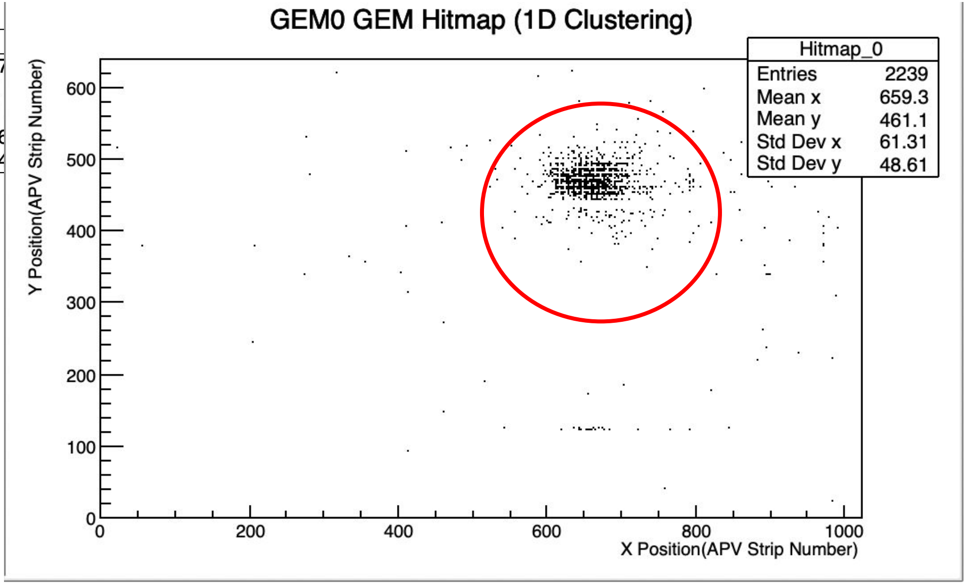


- Observe the chess like pattern in the hitmap. Gain variation? Issue with ADC? Firmware? Mapping issue? Software? Encoding/Decoding?
- We have firmware test
- This MPD has Oct 2018 firmware. We have another MPD in a different slot with the same firmware. Also have another MPD in a different slot than both, with Aug 2018 firmware (used at PSI)

Firmware Test



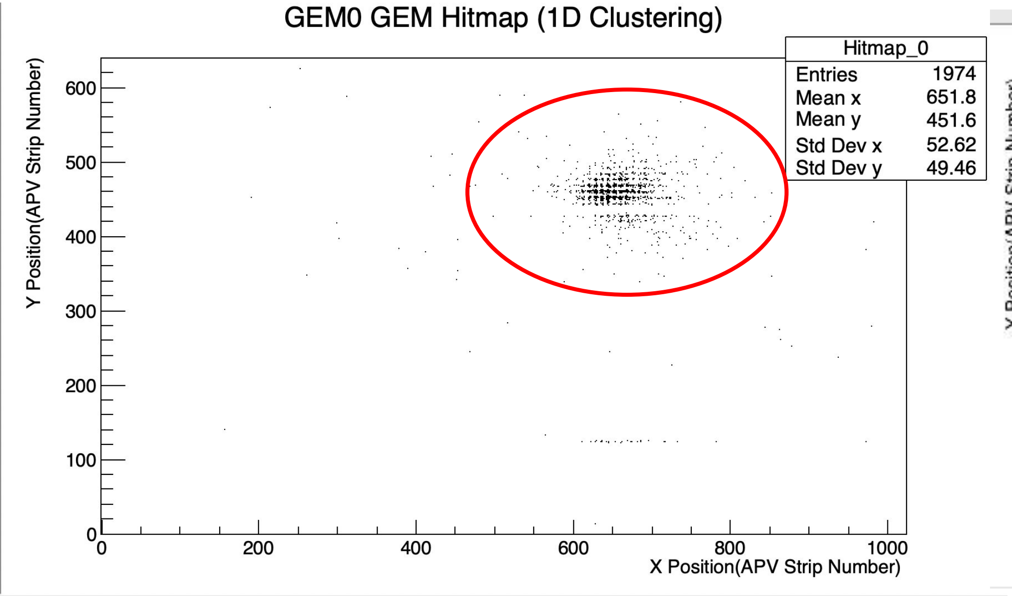
MPD 316 slot 3, Oct 2018 Firmware



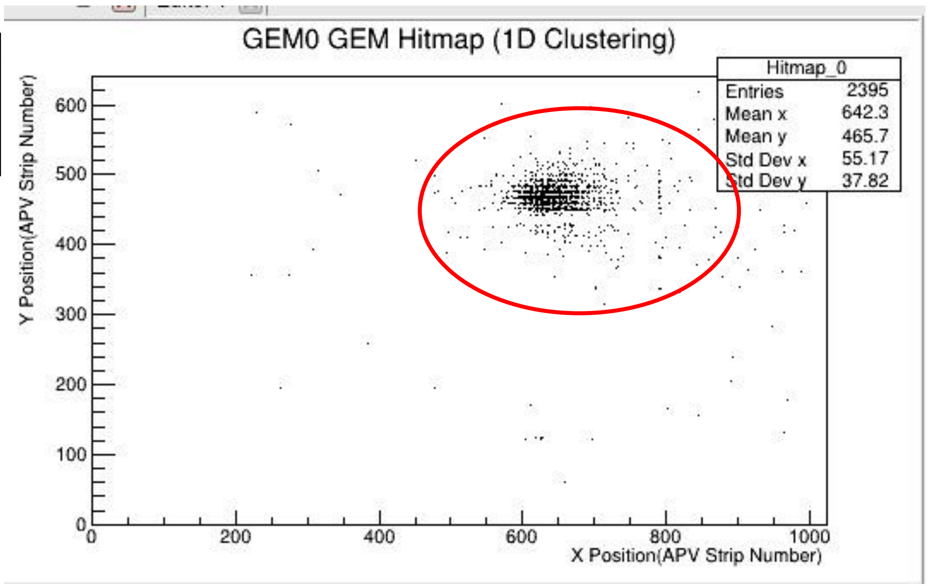
MPD 310 slot 4, same Oct 2018 Firmware

Chess like pattern remains!

Firmware Test



MPD 316 slot 3, Oct 2018 Firmware



MPD 104 slot 5, Augustt 2018 Firmware

Chess like pattern remains!

Outlook

- We have started the mapping studies. Move Sr90 around to known positions for mapping from electronics channels to strips.
- We do get false triggers at times, engage the V262 for the trigger. We have ideas on how to proceed with this.
- We should clean up the trigger some. Noise triggers still present but we would need another scintillator for that.
- We'd like to branch off of MUSE master so we can test the encoding/decoding using the PSI readout on a 2x2 APV subset.
- Repeat the same procedure for the second GEM.