

Update On PRex/CRex GEM detector analysis

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(on behalf of PREX/CREX collab)

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The logo of Jefferson Lab, featuring a red swoosh above the text 'Jefferson Lab'.
Jefferson Lab
Thomas Jefferson National Accelerator Facility

Talk Overview

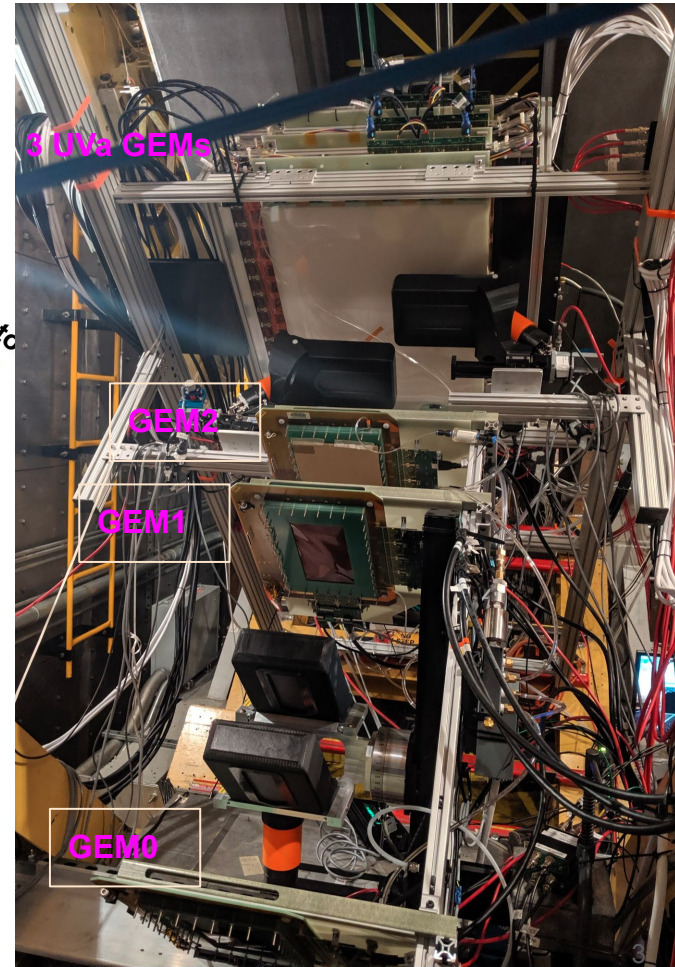
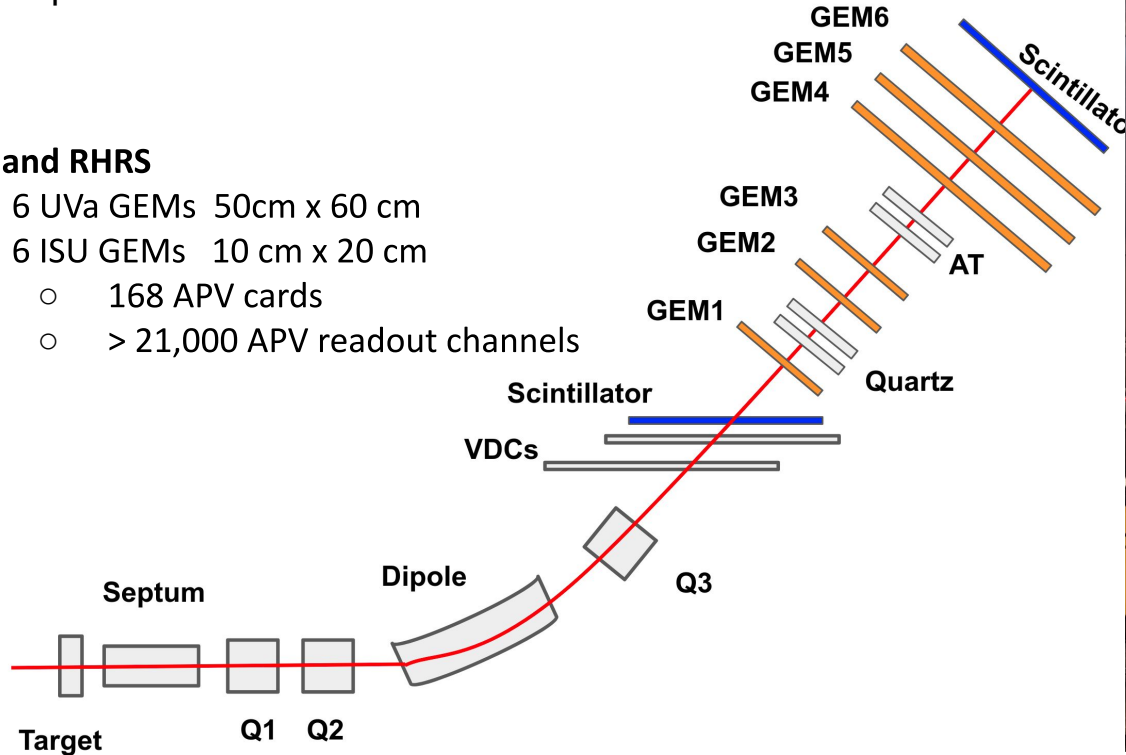
- **The Layout of GEM Detectors in PRex/CRex**
- **GEM Pedestal Distribution**
- **GEM Tracking and Efficiency Analysis**

Layout of GEM detectors in PRex/CRex

- VDC efficiency drops when rate goes Higher
- Good Opportunity to test the SBS GEMs in real experiment

LHRS and RHRS

- 6 UVa GEMs 50cm x 60 cm
- 6 ISU GEMs 10 cm x 20 cm
 - 168 APV cards
 - > 21,000 APV readout channels



Pedestal Distribution

All the GEM and the APV cards noise level look good

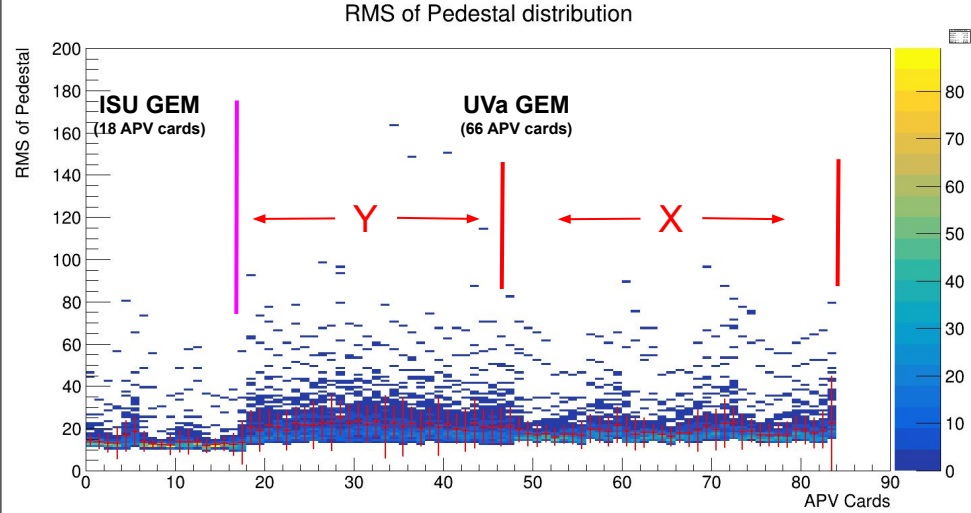
- 1. The RMS distribution is around 20~30 ADC value
- 2. All cards are working fine

- UVa GEM have a little bit higher noise level
 - Area for UVa-GEM is much larger than that of ISU GEMs
 - UVa-GEM strip length is much longer
 - Higher capacitance -> Higher noise
- Y-axis noise level is a little bit larger than that of X-axis
 - The readout strips on Y-axis is wider than the strips on X-axis ->Higher noise
- First few channels on each APV cards have higher noise level because of crosstalk.
- larger noise level on L-HRS
 - Grounding issue

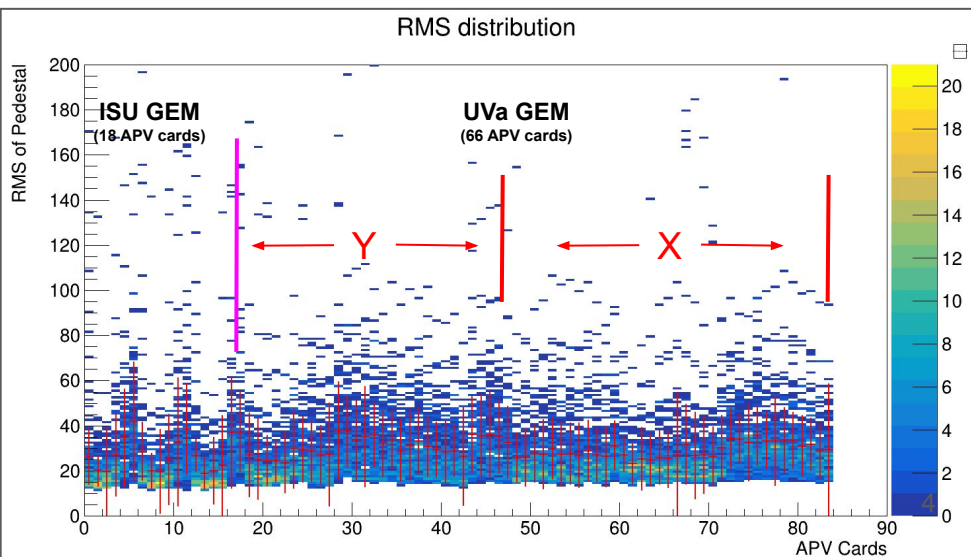
RMS distribution for All APV Cards

X : APV Card.
On each bin, It have 128 points which is the pedestal RMS of the 128 channels on each APV Card.
Y : RMS of Pedestal

RHRS-GEMs



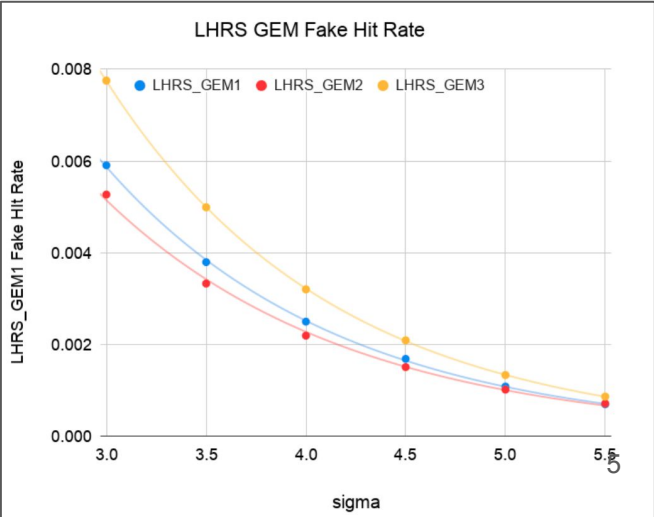
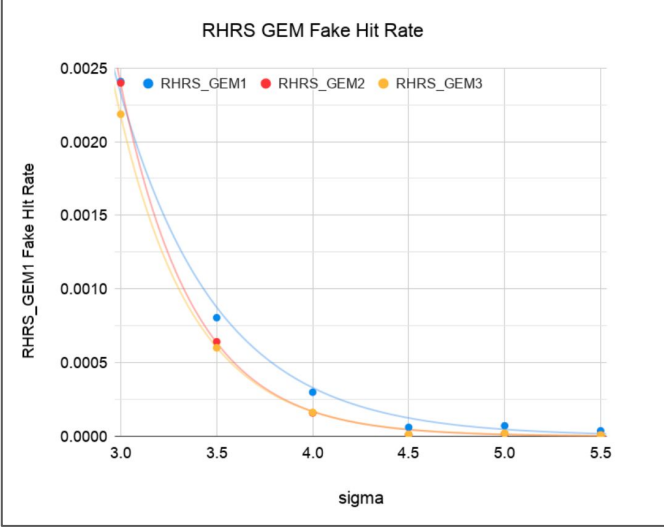
LHRS-GEMs



Pedestal Distribution

GEM Fake Hit Rate

- Pedestal Run for each GEM Chamber
 - No real signal Hit, all the channels are pedestals
- Scan on the Pedestal Noise Sigma Cut
 - Threshold to peak signals from the pedestals



GEM Fake Hit Rate

X : # of sigma cut

Y : Percentage of Fake Hit
percentage of GEM strips that passed the sigma cut
in the Pedestal run

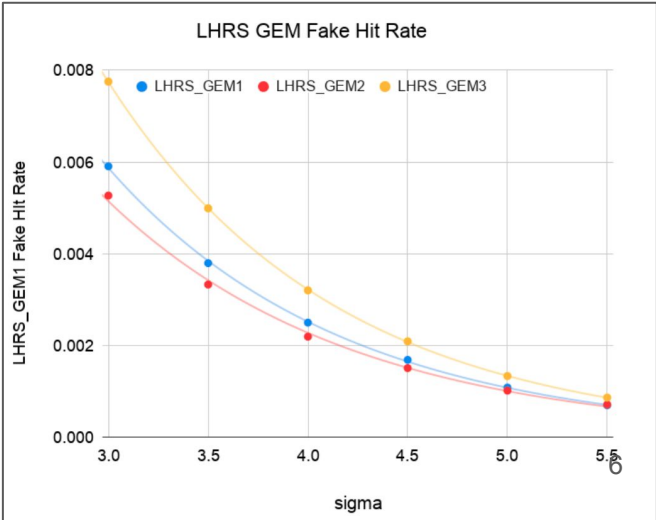
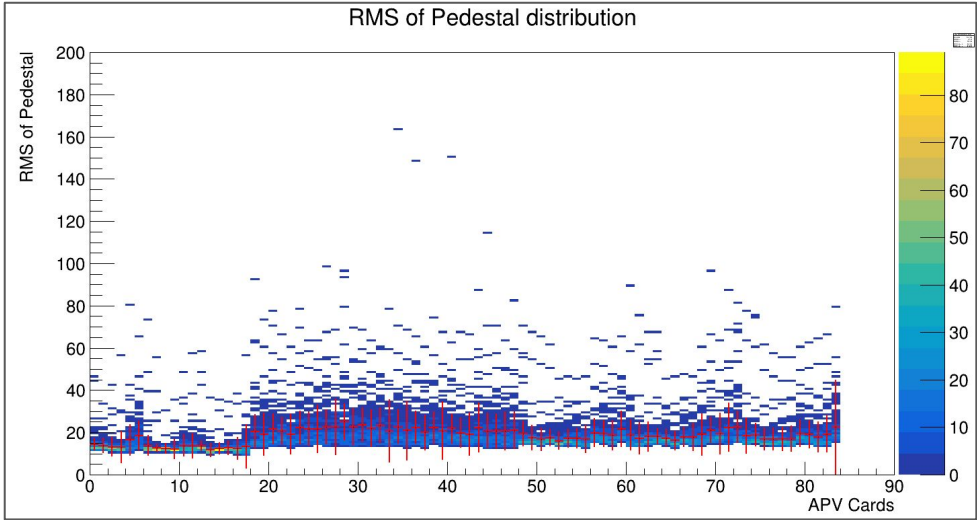
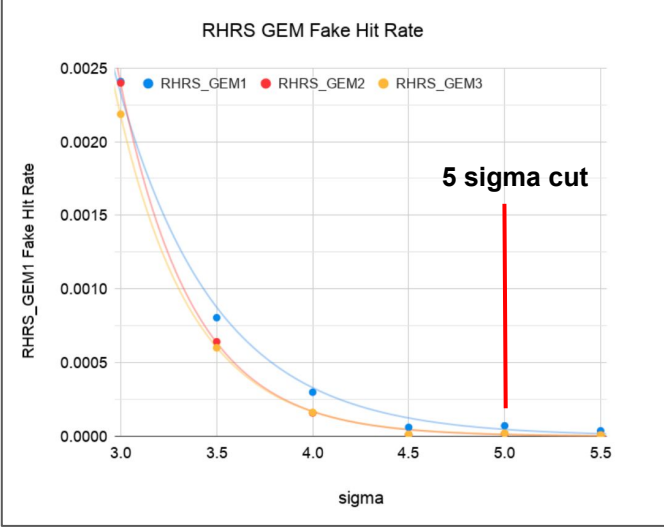
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RHRS Fake Hit Rate

- Less noisy on RHRS
- 3-sigma : 0.2% fake rate
- 5-sigma :0.05% fake rate



Pedestal Distribution

GEM Fake Hit Rate

RHRS Fake Hit Rate

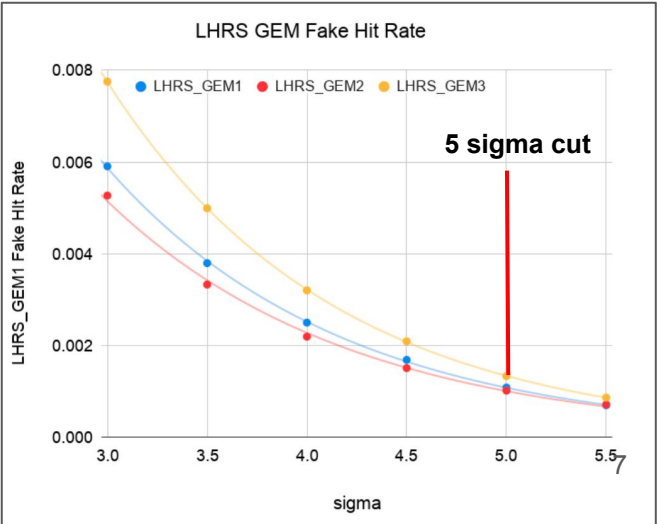
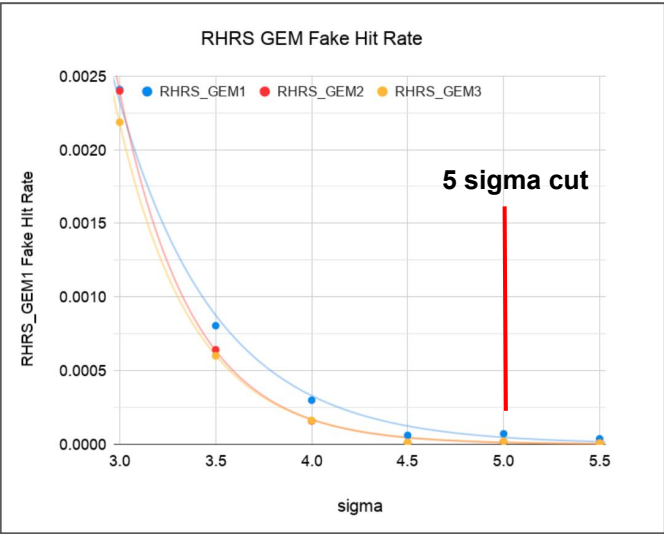
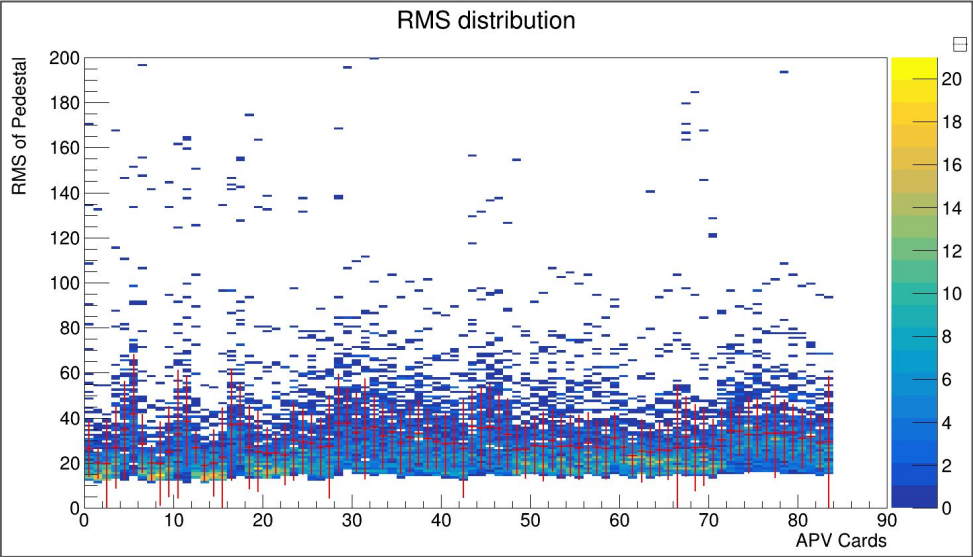
- Less noisy on RHRS
- 3-sigma : 0.2% fake rate
- 5-sigma : 0.05% fake rate

LHRS Fake Hit Rate

- 3-sigma: 0.8% fake rate
- 5-sigma: 0.1% fake rate

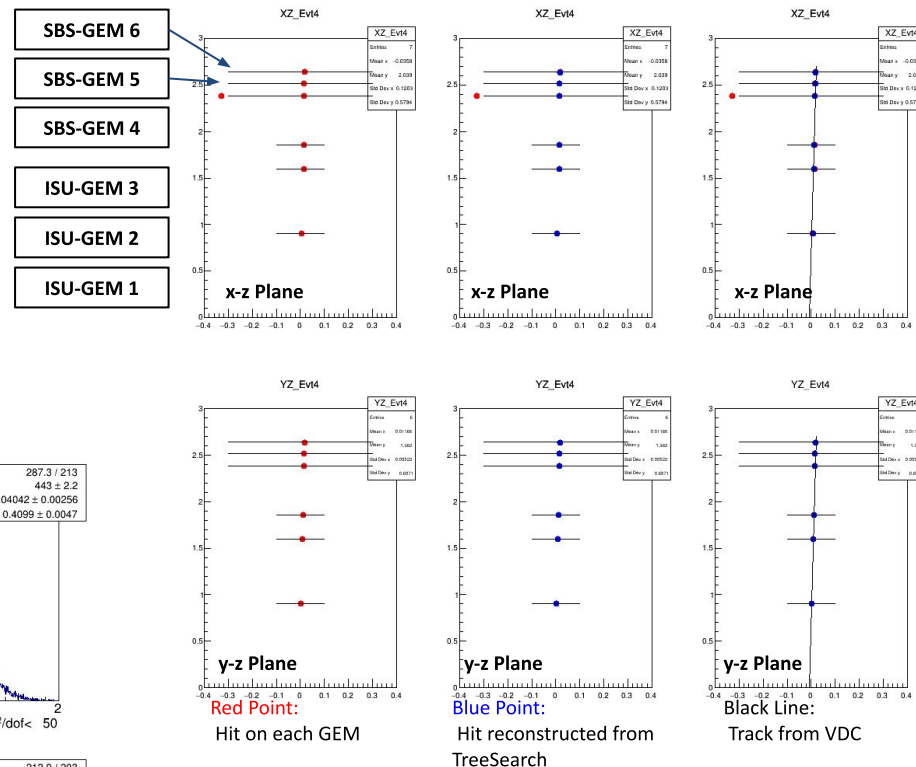
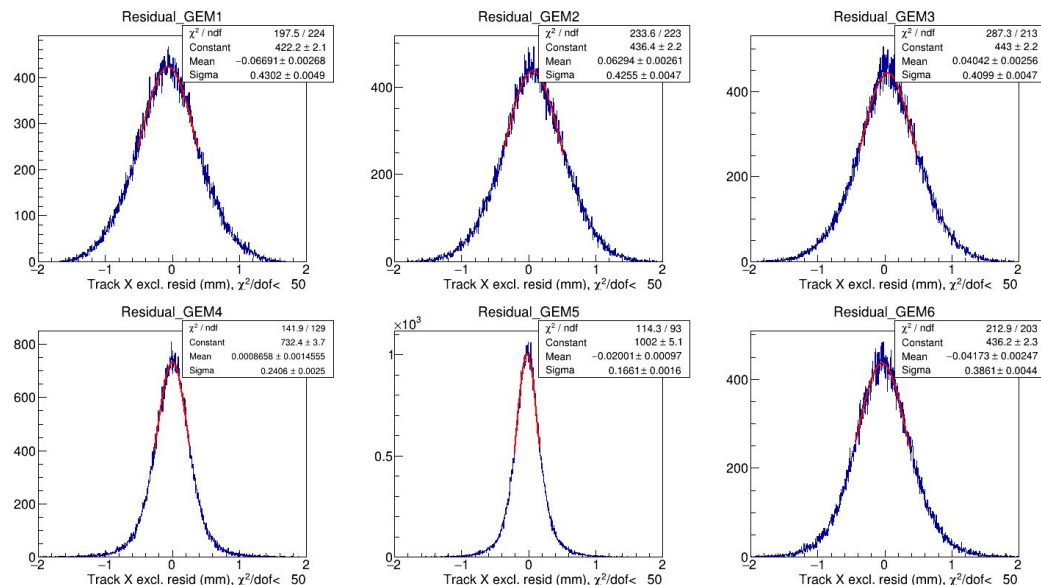
In experiment
Threshold: 5 sigma
RHRS: 99.9%
LHRS: 99%

Xinzhan Bai is working on ground issue



Track Based Alignment

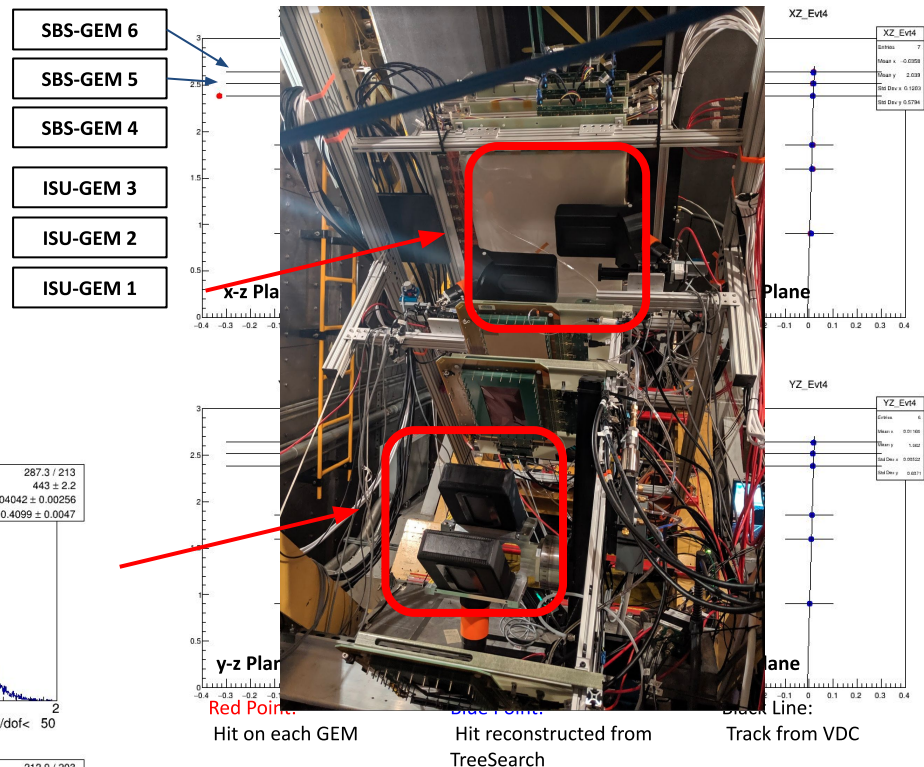
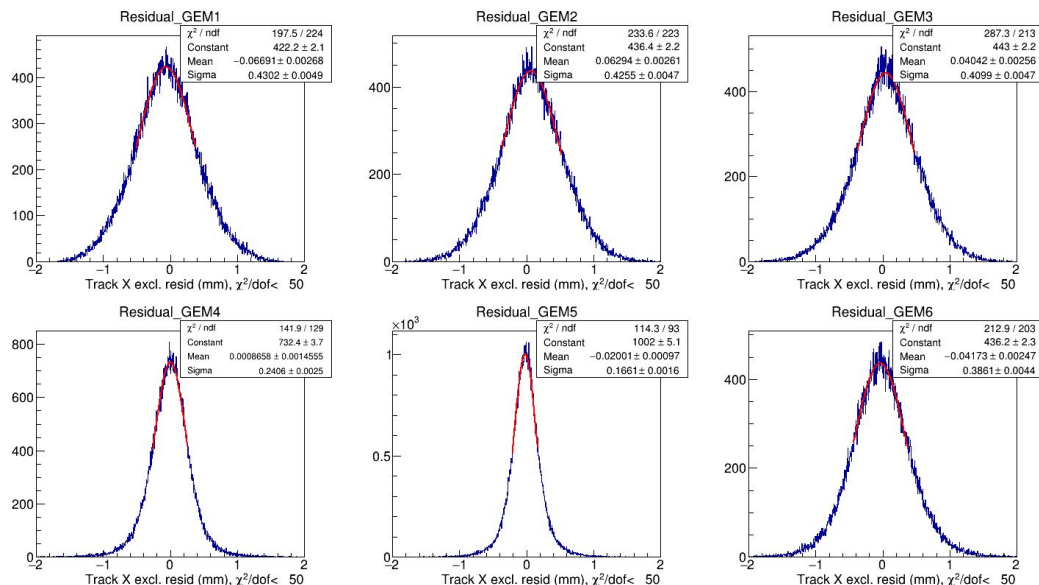
- Track Event Viewer
 - Hit on each GEM
 - Hit reconstructed from TreeSearch
 - track reconstructed from VDC
- Pre-align with VDC
- Track based alignment with [SBSGEM_standalone](#)(Andrew Puckett)
- Residual
 - ISU GEMs: 400 um (preliminary)
 - UVa GEM: 200 um (preliminary)



- The residuals are dominated by the multiple-scattering of electrons in the protection cover and travelling through ~3m of Air
- Will use a G4 simulation to extract GEM resolution

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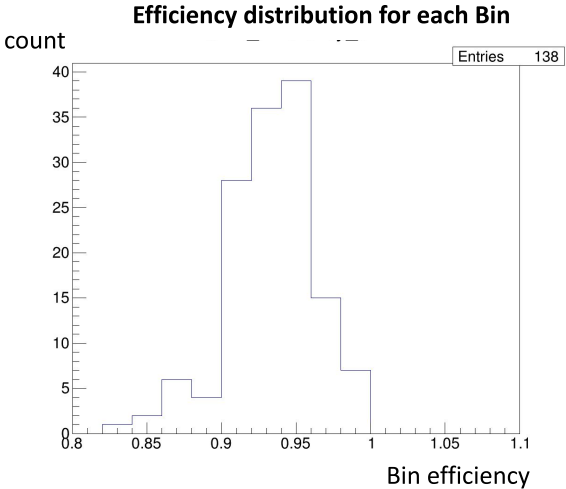
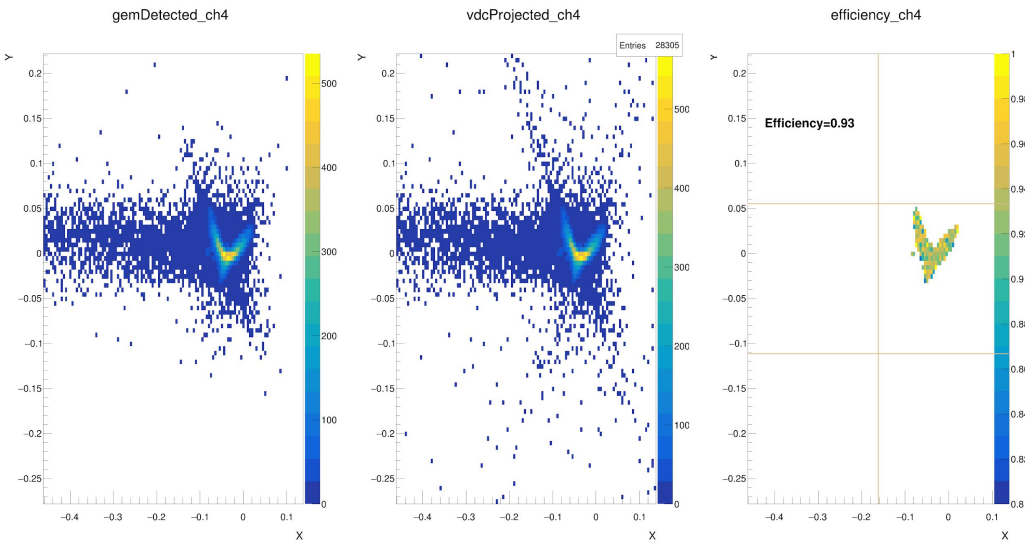


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GEM efficiency study

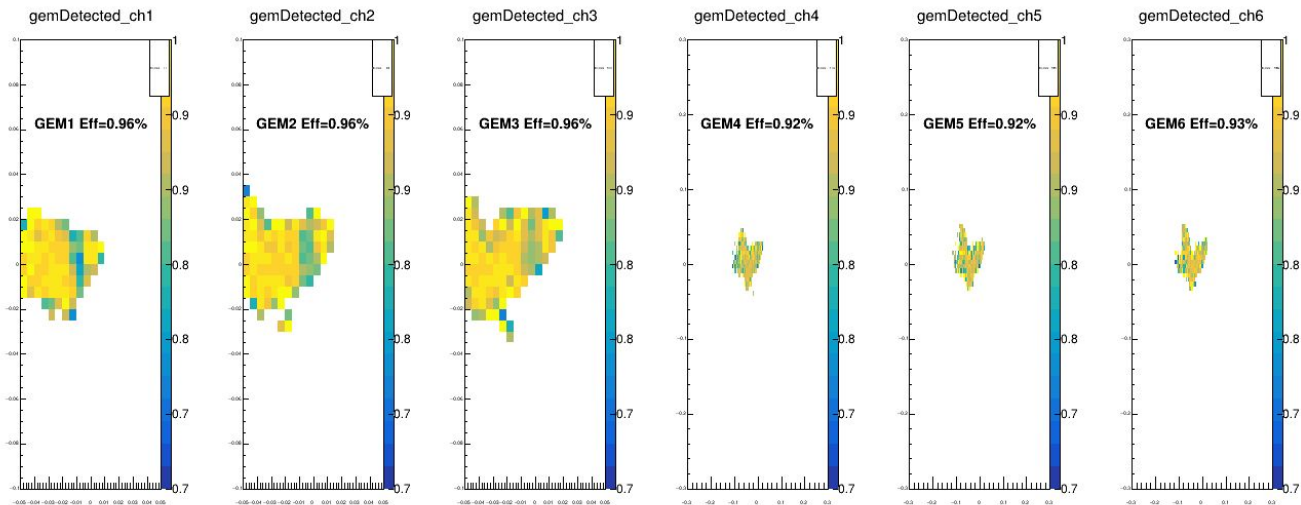
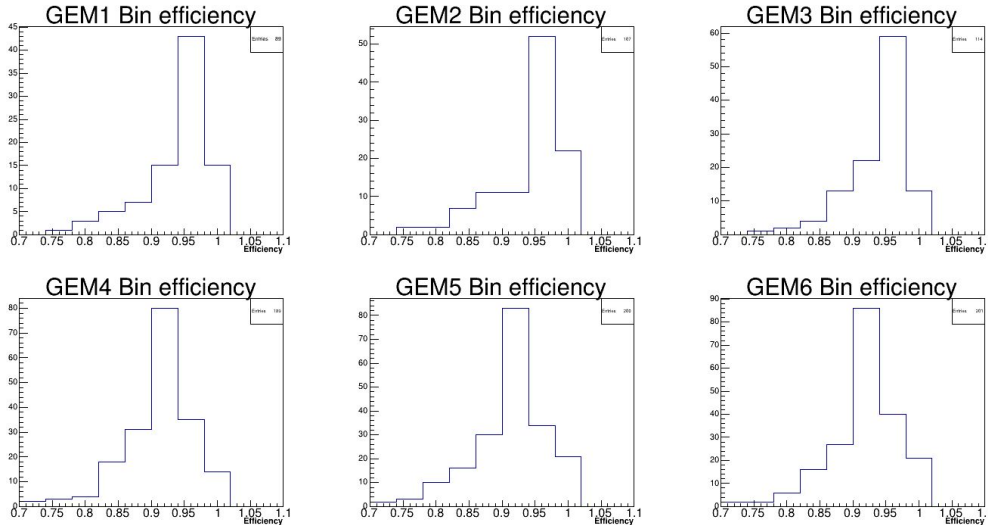
GEM Detected Hit : Project VDC to GEM plane and search for GEM Hit within 4cm² area
VDC Projected Hit : Project VDC to GEM plane

- Event cut on each Bin(1cm x 1 cm) ≥ 30
 - background caused by cosmic etc
 - fake hit caused by VDC ghost hit combinations at high rates
- Efficiency quoted for each Bin (1cm x 1 cm)
- GEM High voltage: 4050



'V' shape is due to the the PRex optics tune.

- Distribution of efficiency of each Bin
 - Cut bins > 30
 - Most if the bin efficiency > 90%

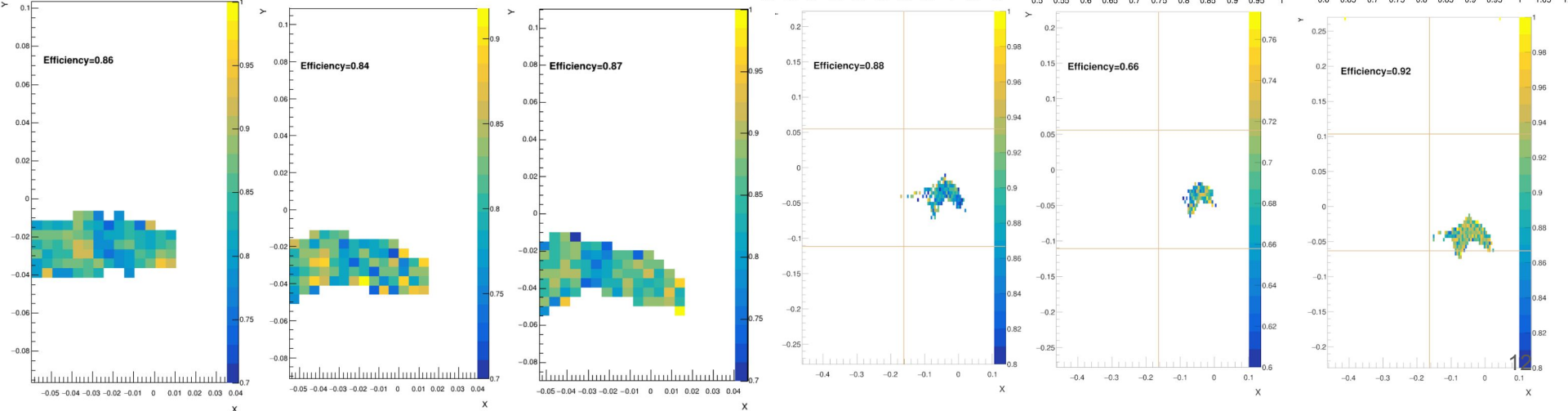
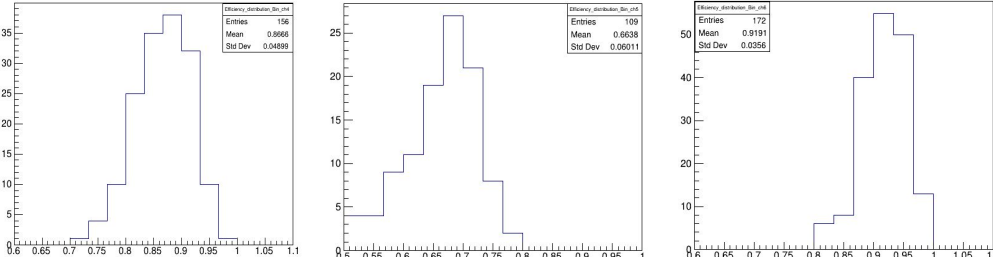
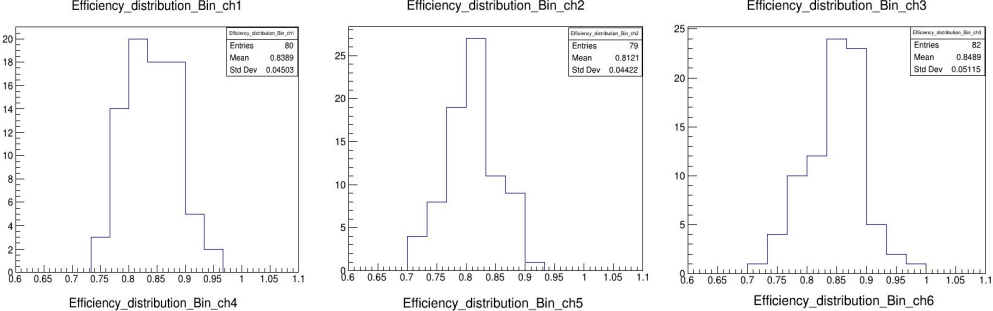


Efficiency
distribution for
1cm x 1cm bin

GEM efficiency study

LHRS GEMs

- Distribution of efficiency of each Bin
 - Cut bins > 30



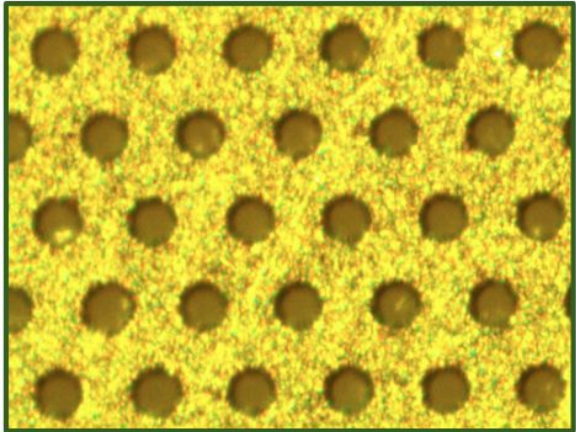
Overall efficiency of RHRS Detectors

GEM1	GEM2	GEM3	GEM4	GEM5	GEM6
96%	96%	96%	92%	92%	92%

Overall efficiency of LHRS Detectors

GEM1	GEM2	GEM3	GEM4	GEM5	GEM6
86%	84%	87%	88%	66%	92%

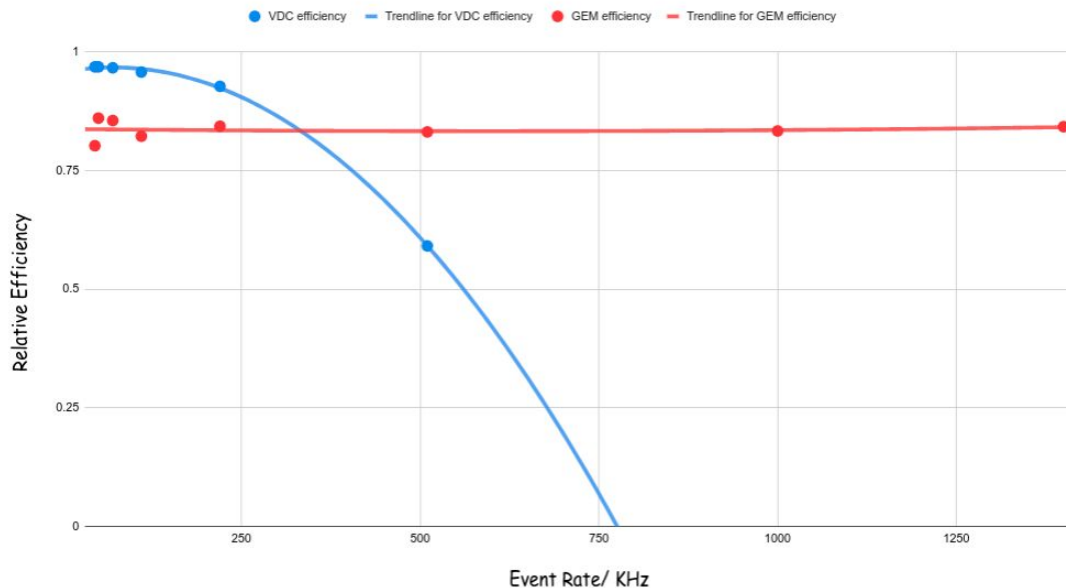
- SBS GEM
 - In experiment 4050V. Did not optimize the operating voltage before experiment.
 - Optimize operating voltage have been done since then, all the GEMs have efficiencies > 92%
- GEM 5
 - Larger GEM foil holes
 - Higher Working voltage



GEM Efficiency vs. Rate (Relative Efficiency)

- For safety concern, the VDC are switched off when event rate larger than 500K
- GEM efficiency presented here is relative efficiency obtained with tree search algorithm
- VDC efficiency drop down when the event rate larger than 200k
- GEM efficiency shows good stability in the range (20k-1.4M).

VDC efficiency and GEM efficiency



Summary:

- All GEMs, both UVa and ISU operated highly stably with no issues throughout the experiment
- Run up to rates four times higher than the VDC max rates.
- GEMs can go another factor of 5-10 higher in luminosity
- Preliminary analysis gives excellent agreement with VDC tracks.
- High GEM efficiency > 90%

Work To Do:

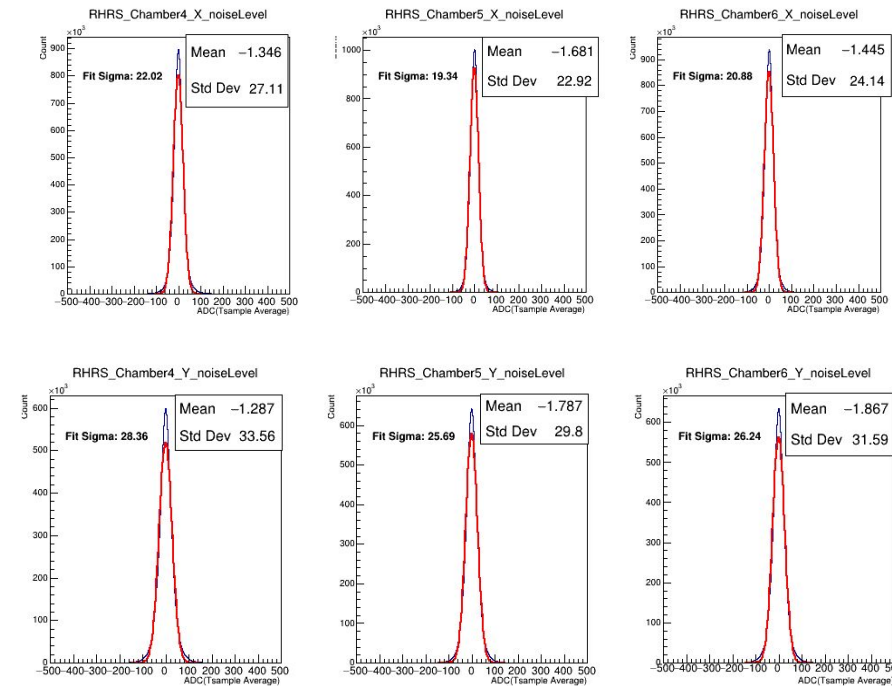
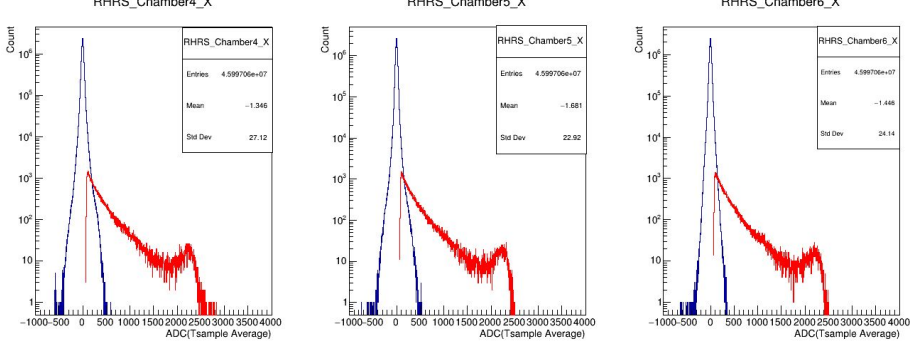
- Higher accuracy Alignment
- GEM simulation to extract the Resolution
- Reconstruct the Target Variable with GEM track only

The End!
Thank you



GEM detector Noise Level

- GEM Signal/background distribution (log scale)
 - Blue line: strip ADC did not pass the 5-sigma cut
 - Red line: strip ADC passed the 5-sigma cut (hit candidate)
 - Y dimension strip is wider -> higher noise level



GEM Signal/background distribution

