

mRICH Beam Test Update

Deepali Sharma (May 9th, 2022, EIC-PID Consortium Meeting)

Outline

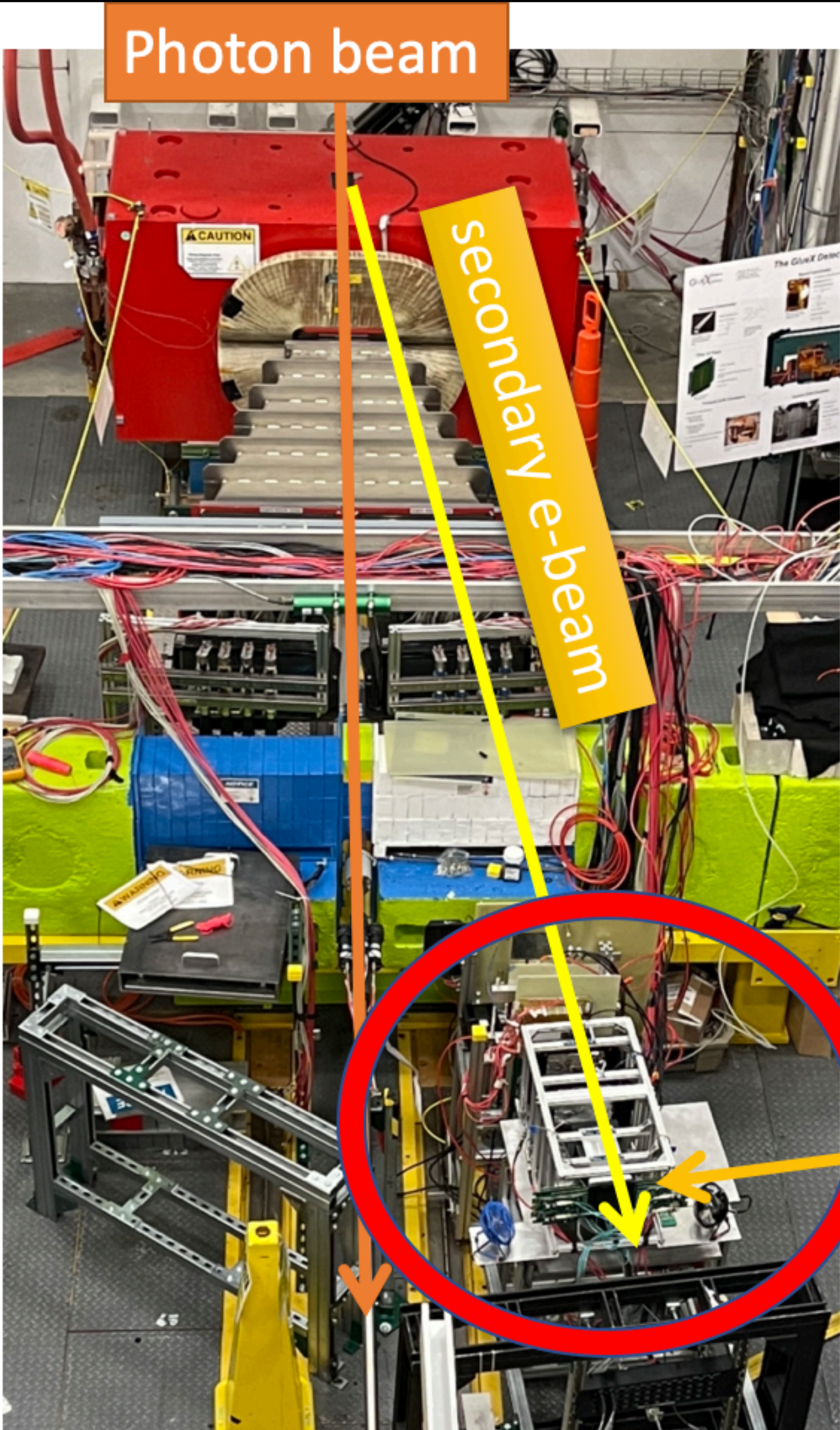
- **JLAB Test Beam Set-up**
- **Status of analysis**
 - **Correlation of Beam Position Hits in Detectors**
 - **mRICH Rings as a Function of Position Scan**
- **Summary and Outlook**

JLAB Beam Test

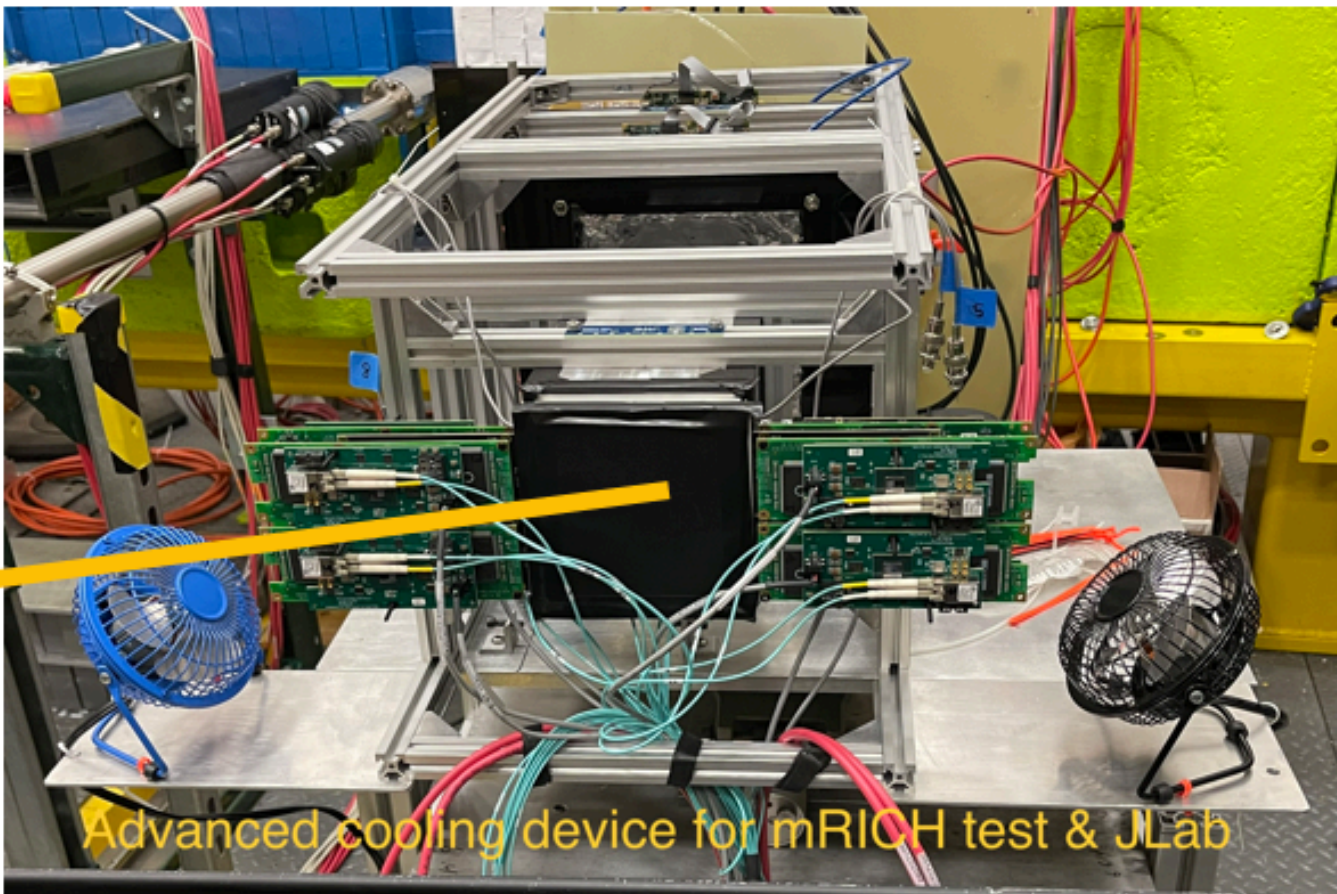
- Major goal of the beam test is to determine the single photon angular resolution.
- Set-up consisted of two GEM Trackers and mRICH that will provides tracking and ID (analogous of small section of EIC experiment)
- Collected a good amount of data (~ 470 M triggered events)

Beam Test -Set-up

Area view of the setup



Kondo and Bishnu working on GEM tracking setup



Viewed from back

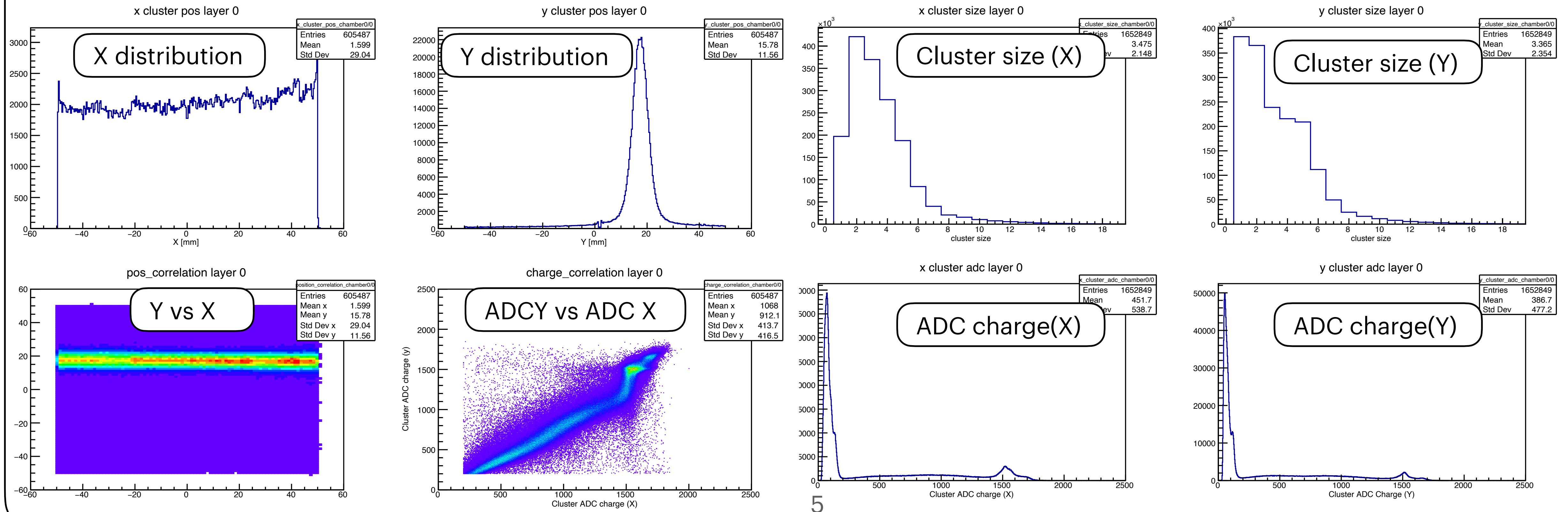


GEM Trackers

GEM Tracker QA Distributions (GEM 0)

Run#1935

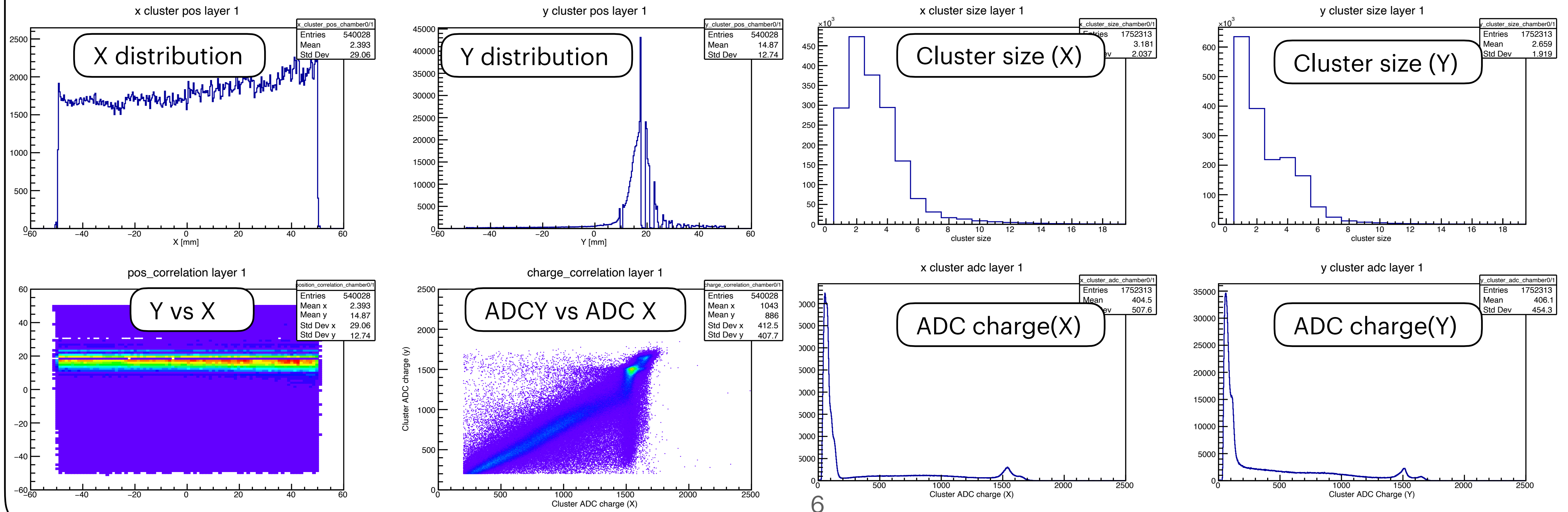
- Pedestal cuts of 5 sigma applied
- The analysis uses an ADC charge cut of (>200) and cluster size (>2) to suppress the noise and cross-talks!



GEM Tracker QA Distributions (GEM 1)

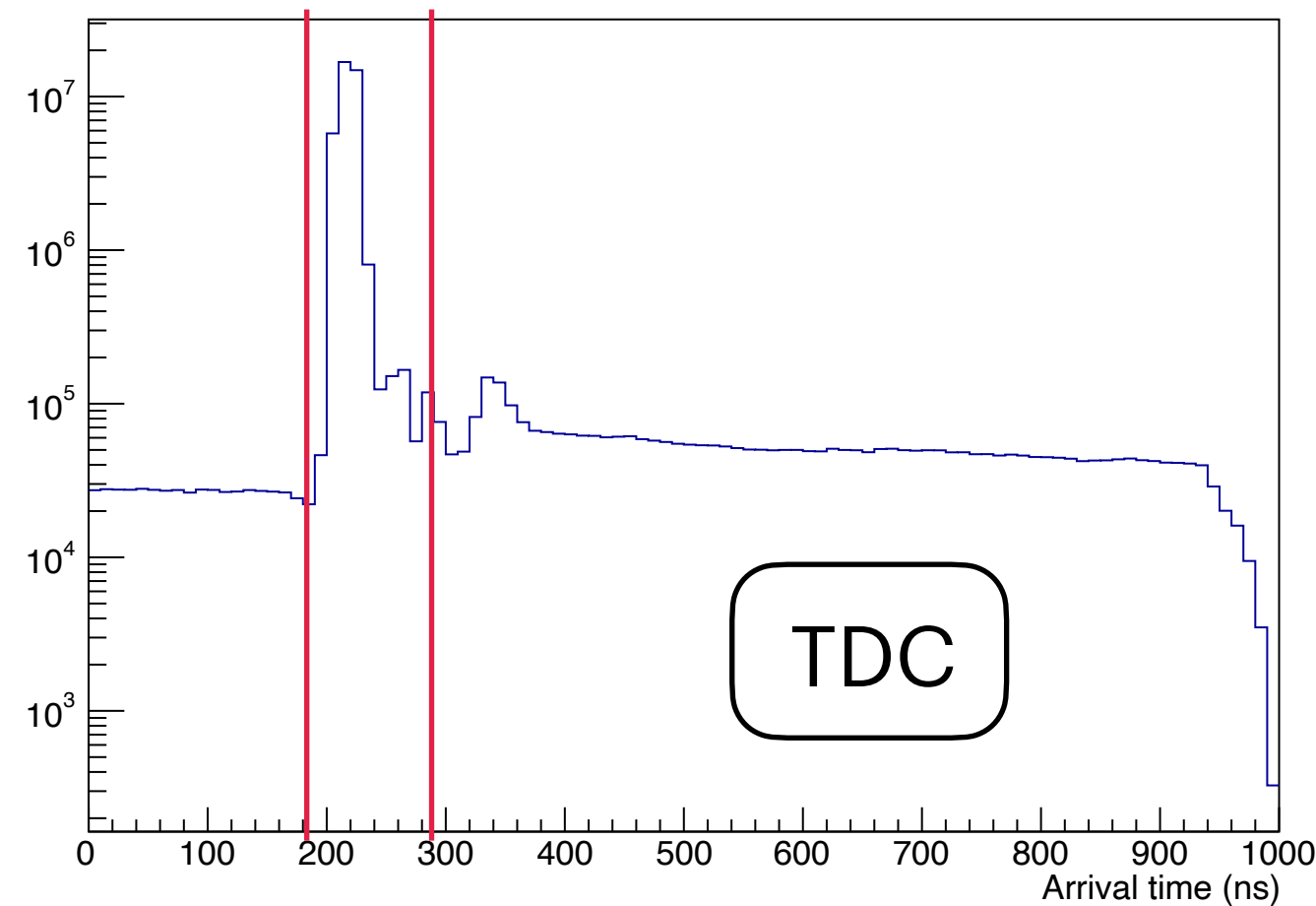
Run#1935

- Pedestal cuts of 5 sigma applied
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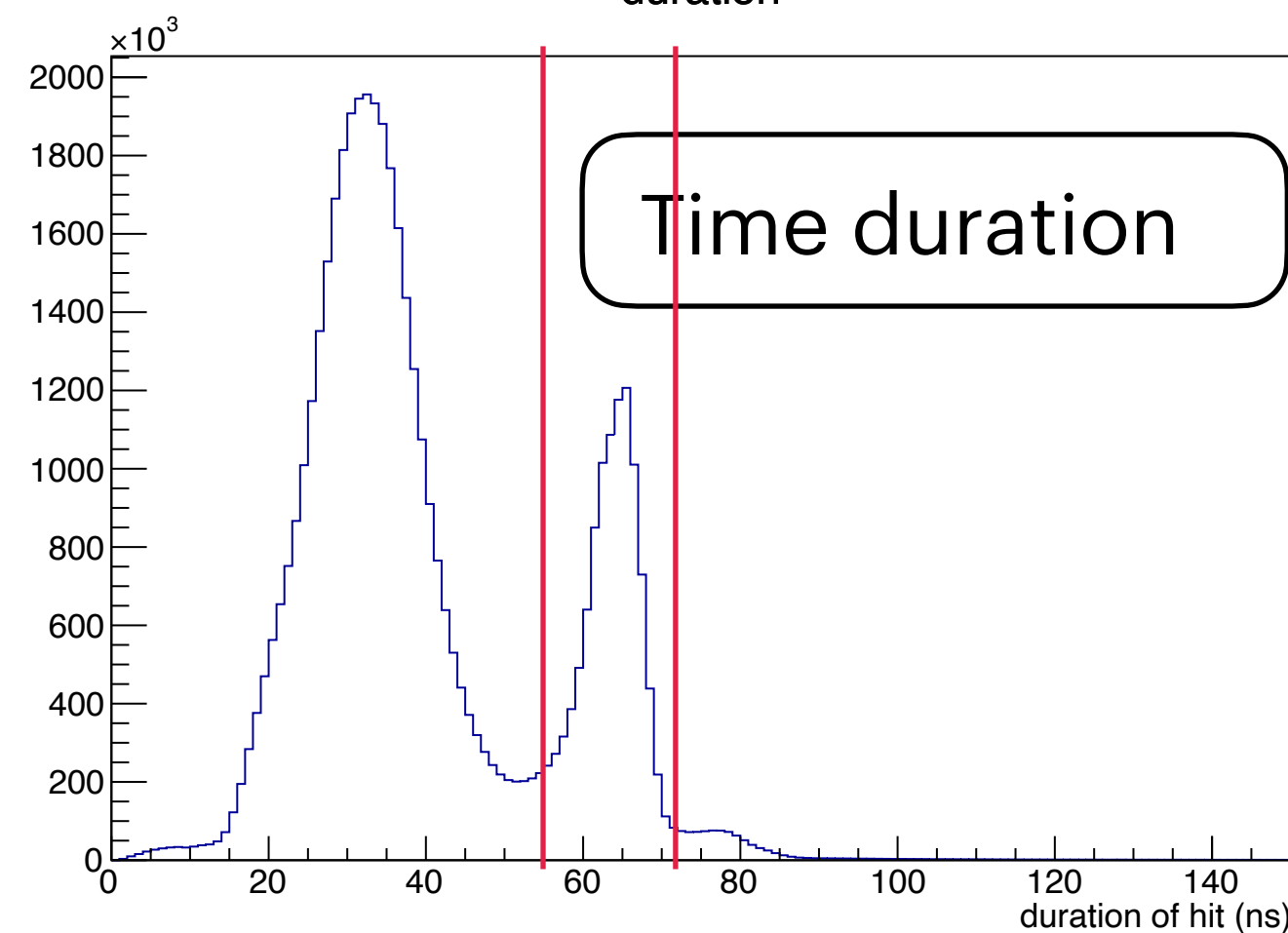


Distributions of TDC, time duration and mRICH display

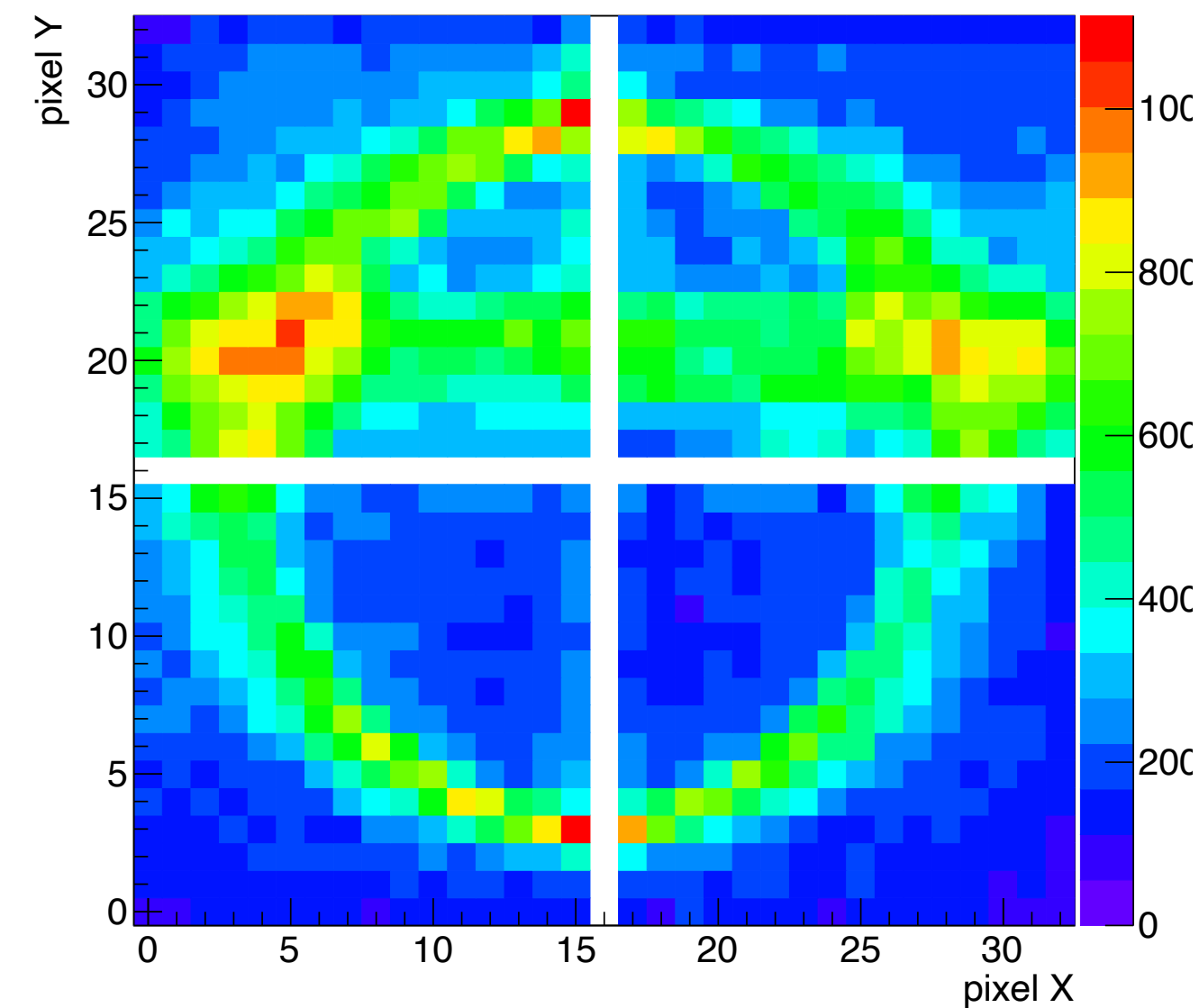
TDC time distribution



duration

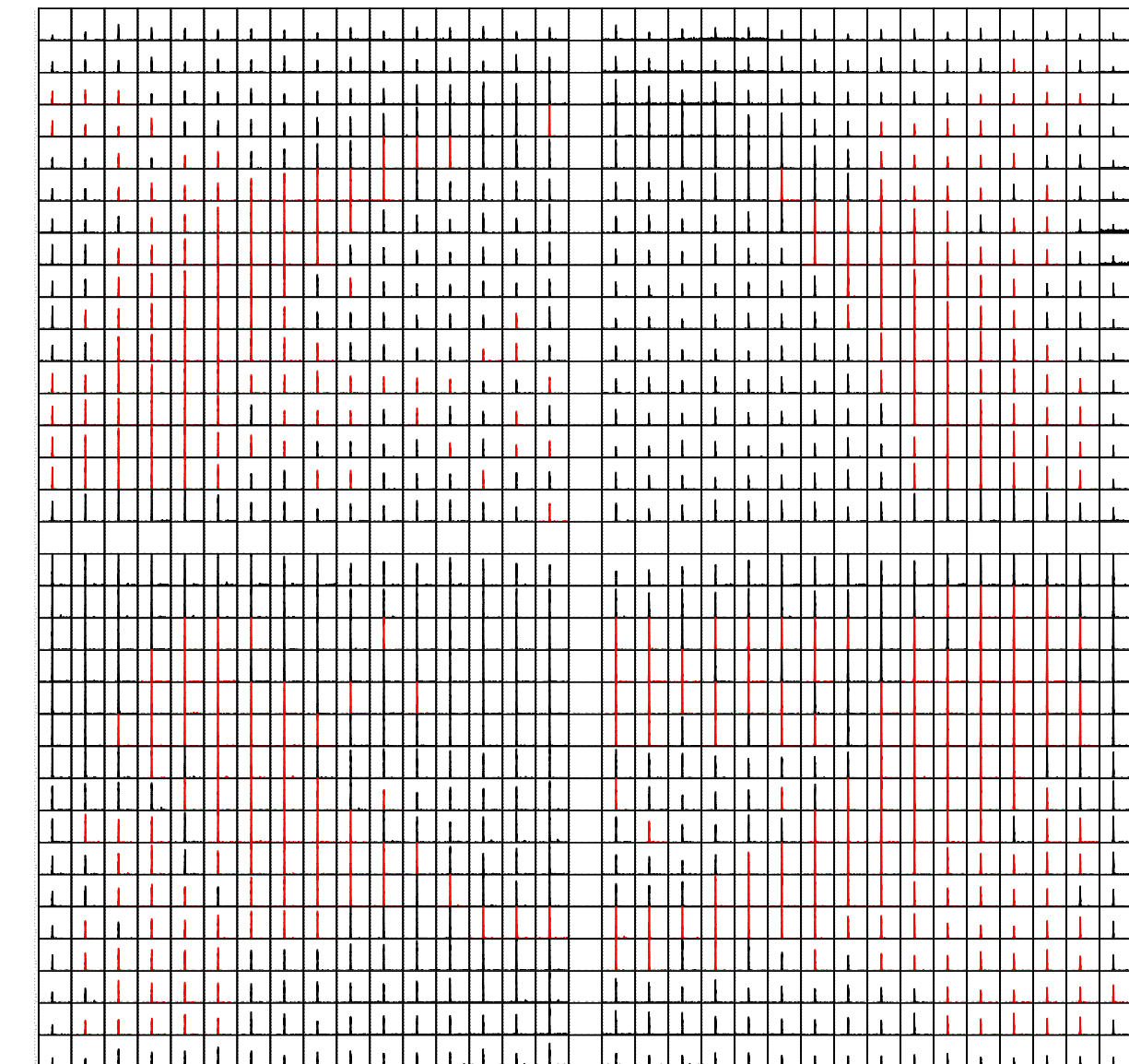


Run1935(190 < TDC < 230) and (55 < Tduration < 70.0)



Cumulative ring display

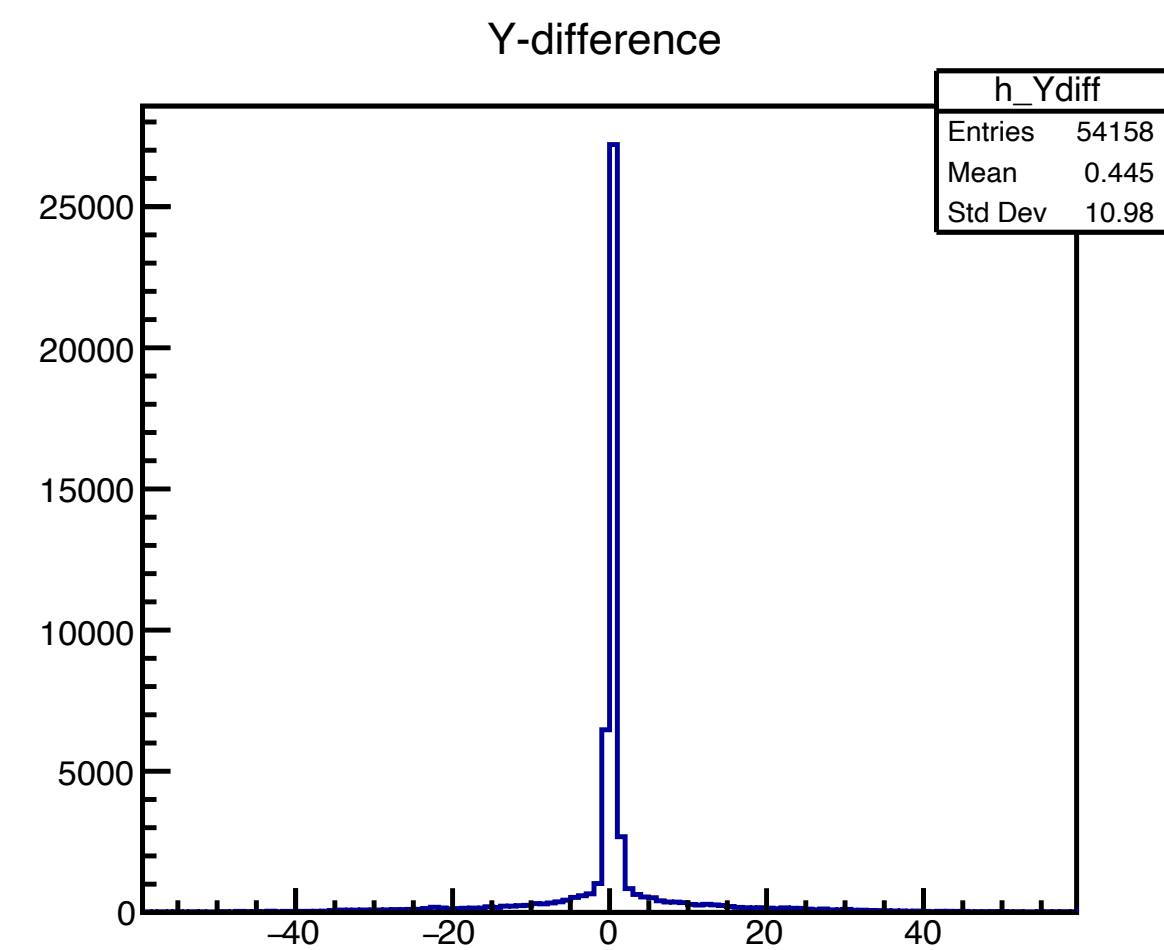
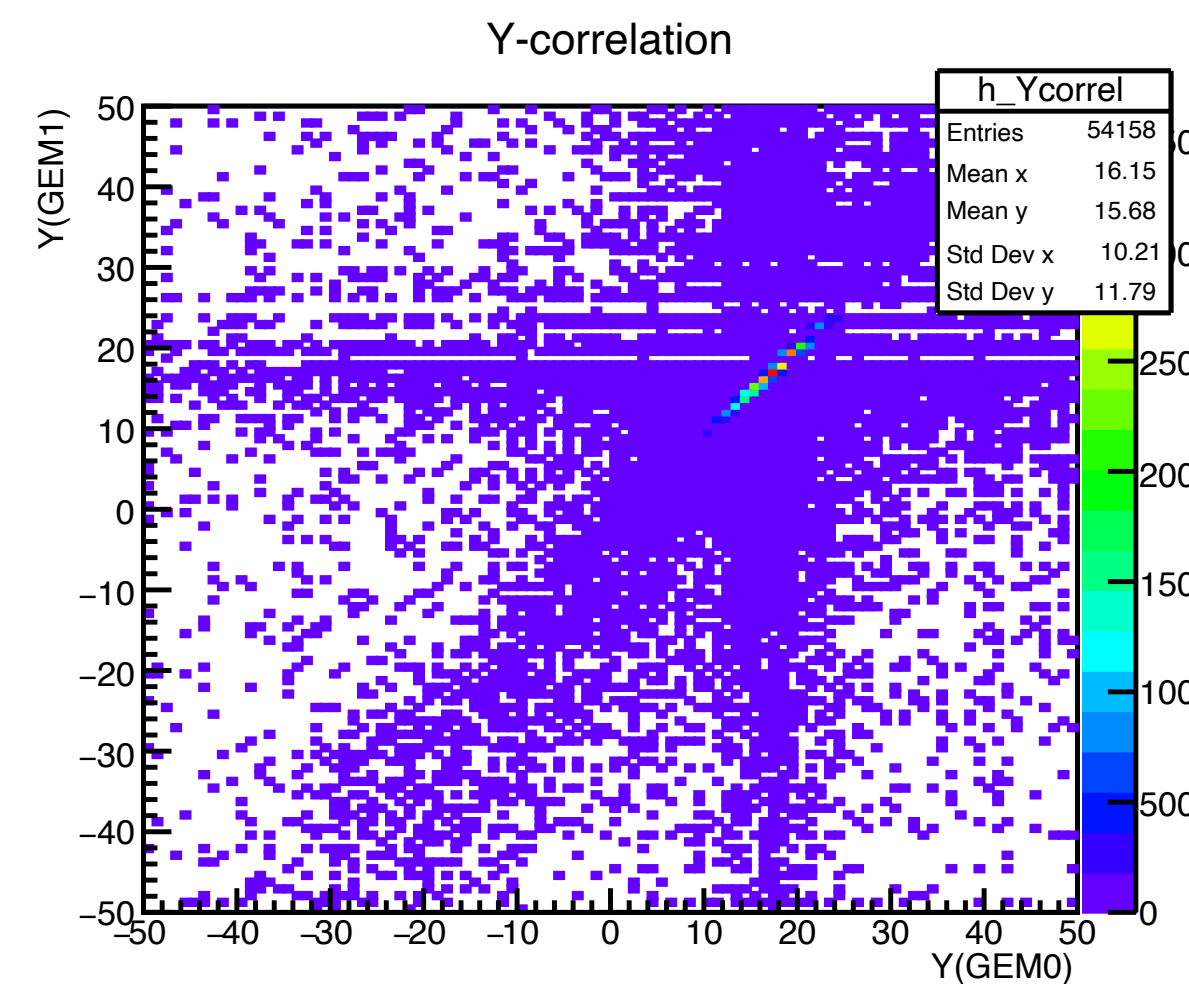
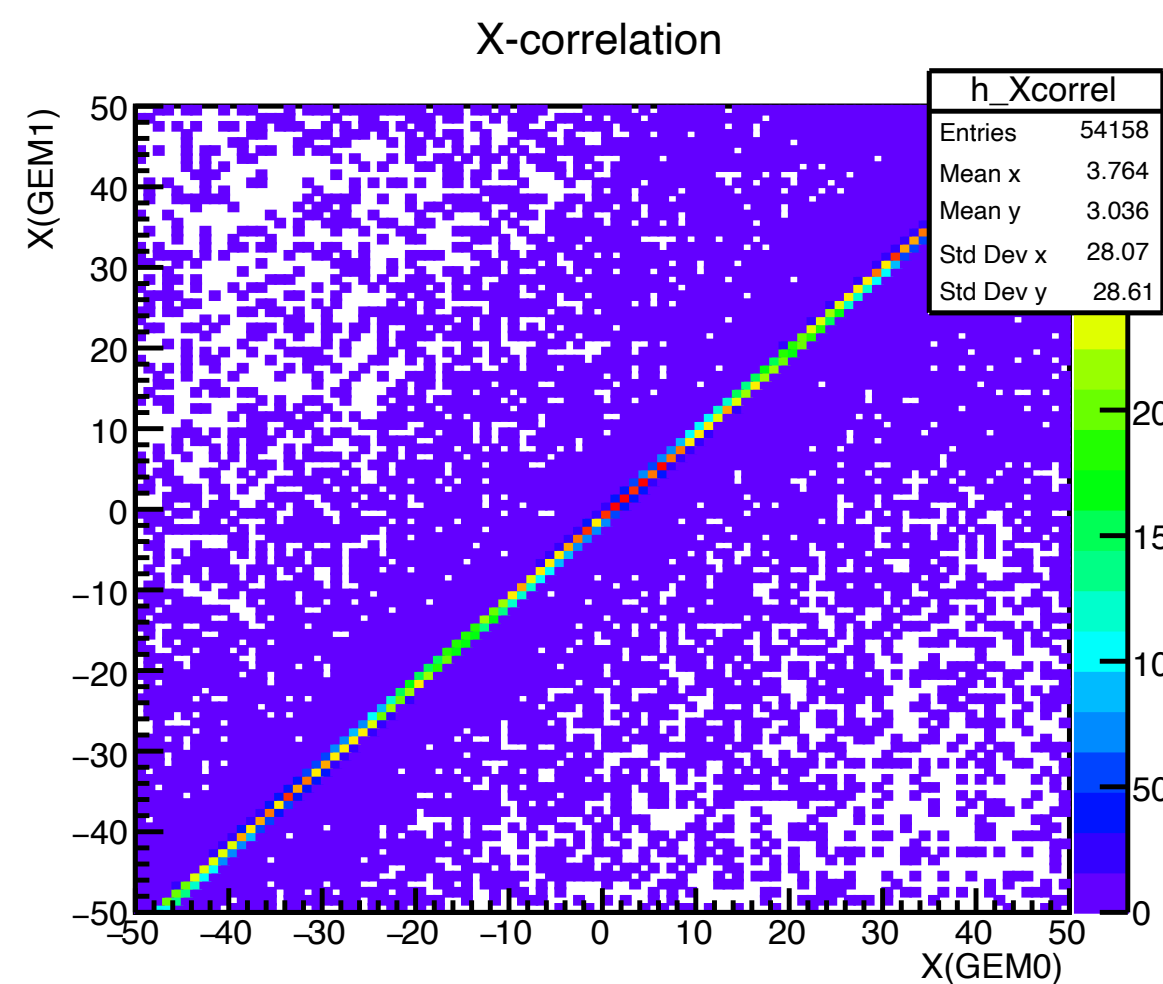
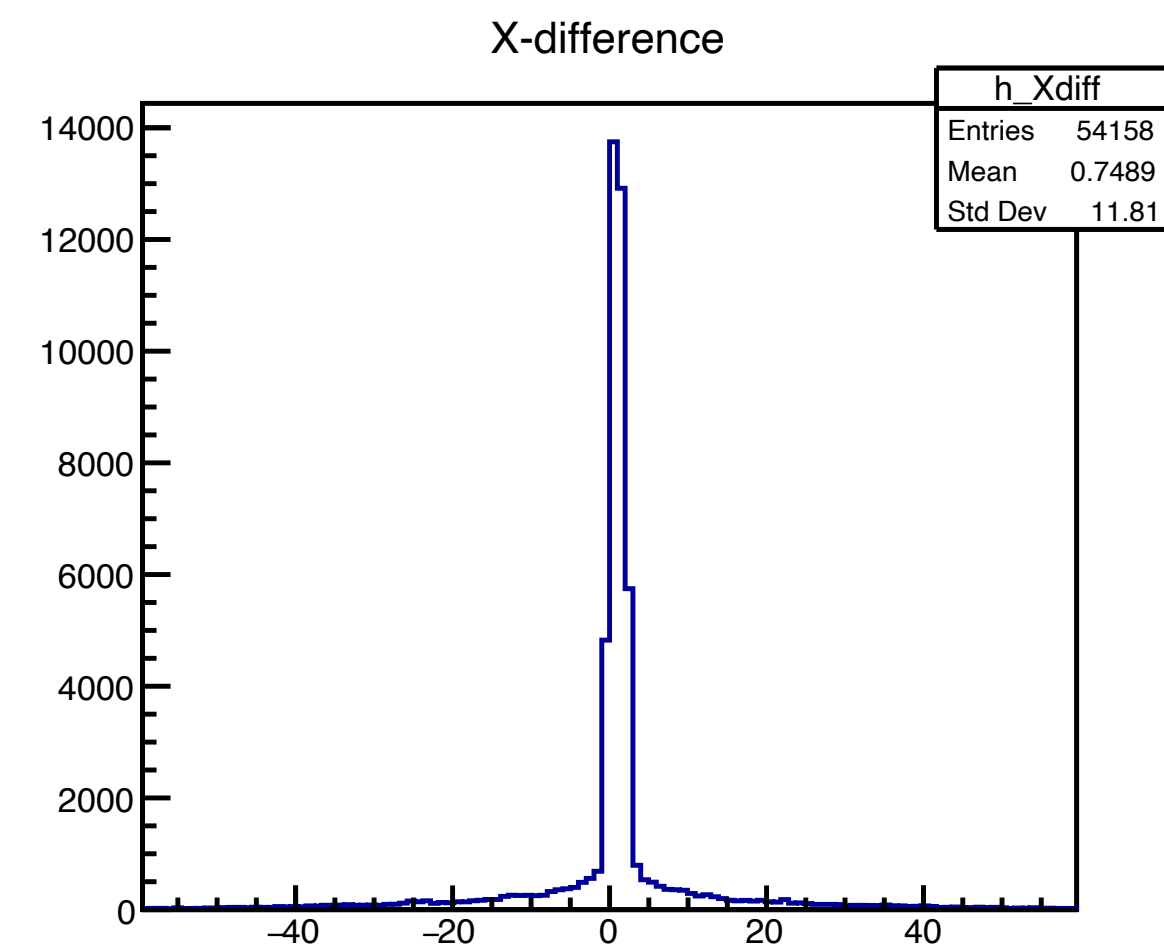
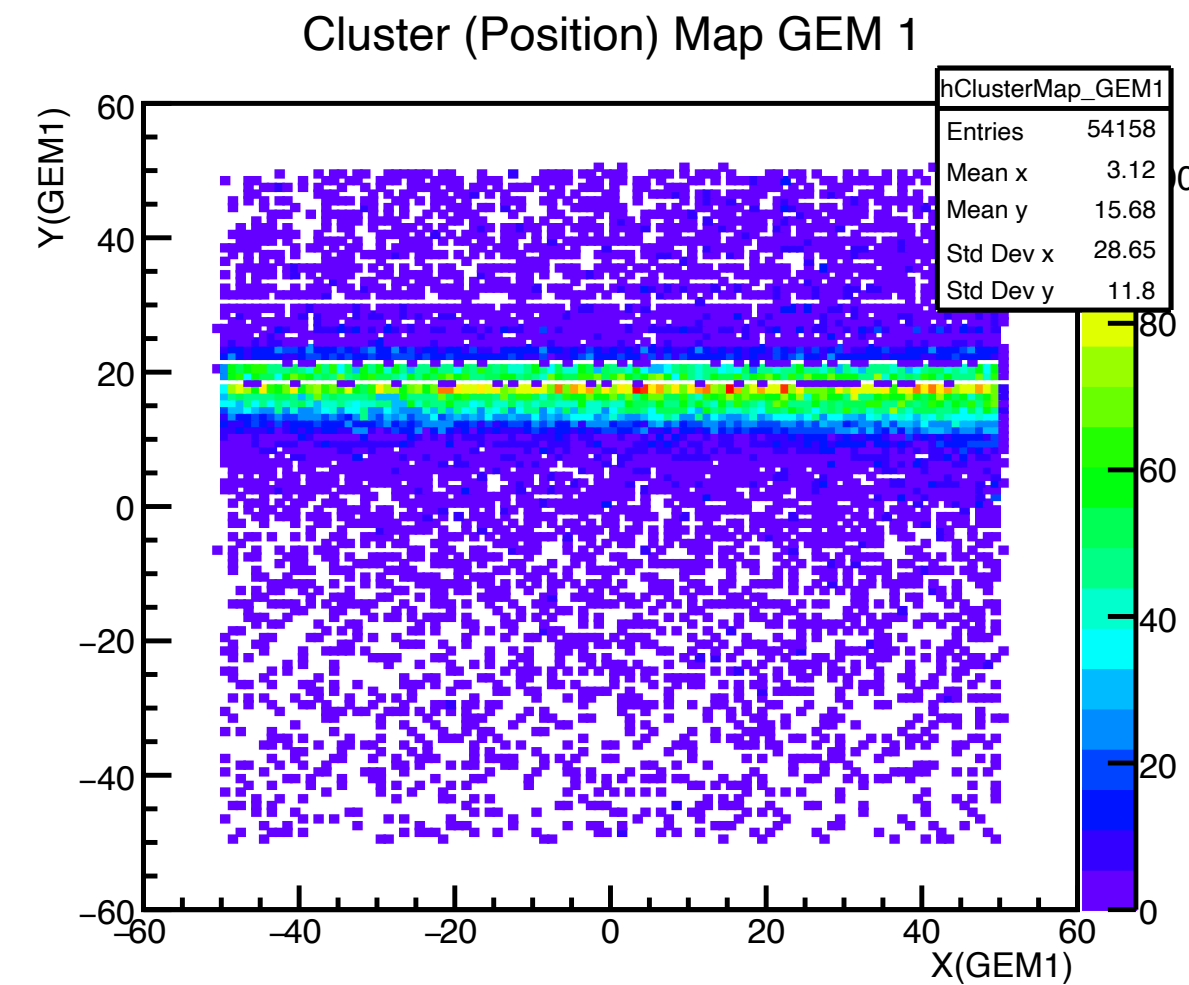
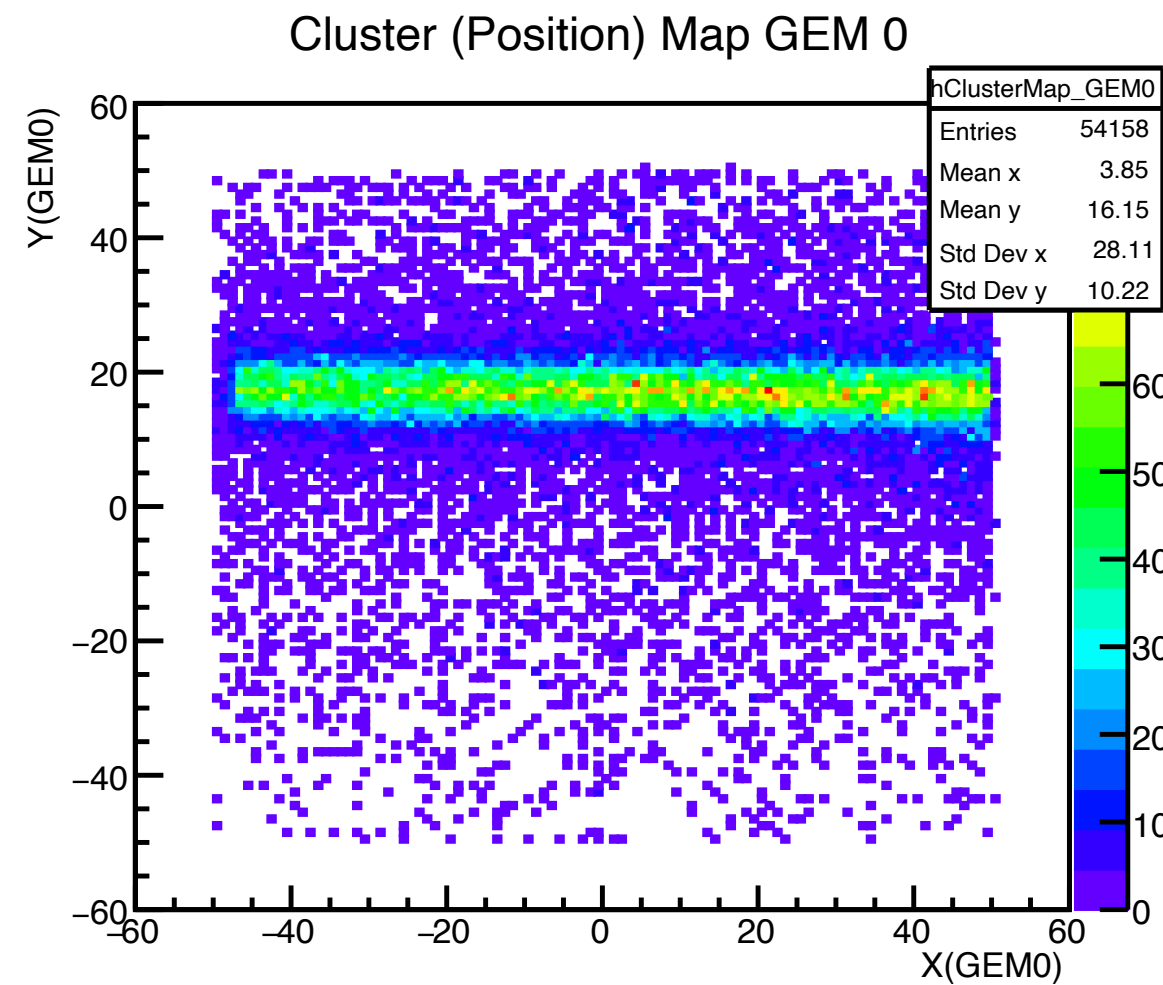
- **Run 1935**
- **PMT Threshold 200**
- **PMT HV 1000 V**



- TDC signal for each pixel
- Pixels with hits above a threshold on signal-to-noise are plotted in Red
- signal is defined as counts in the TDC distribution around the peak region within $\pm 3\sigma$
- Background is the total integral of the TDC distribution

Beam Position Determination (GEM0 vs GEM1)

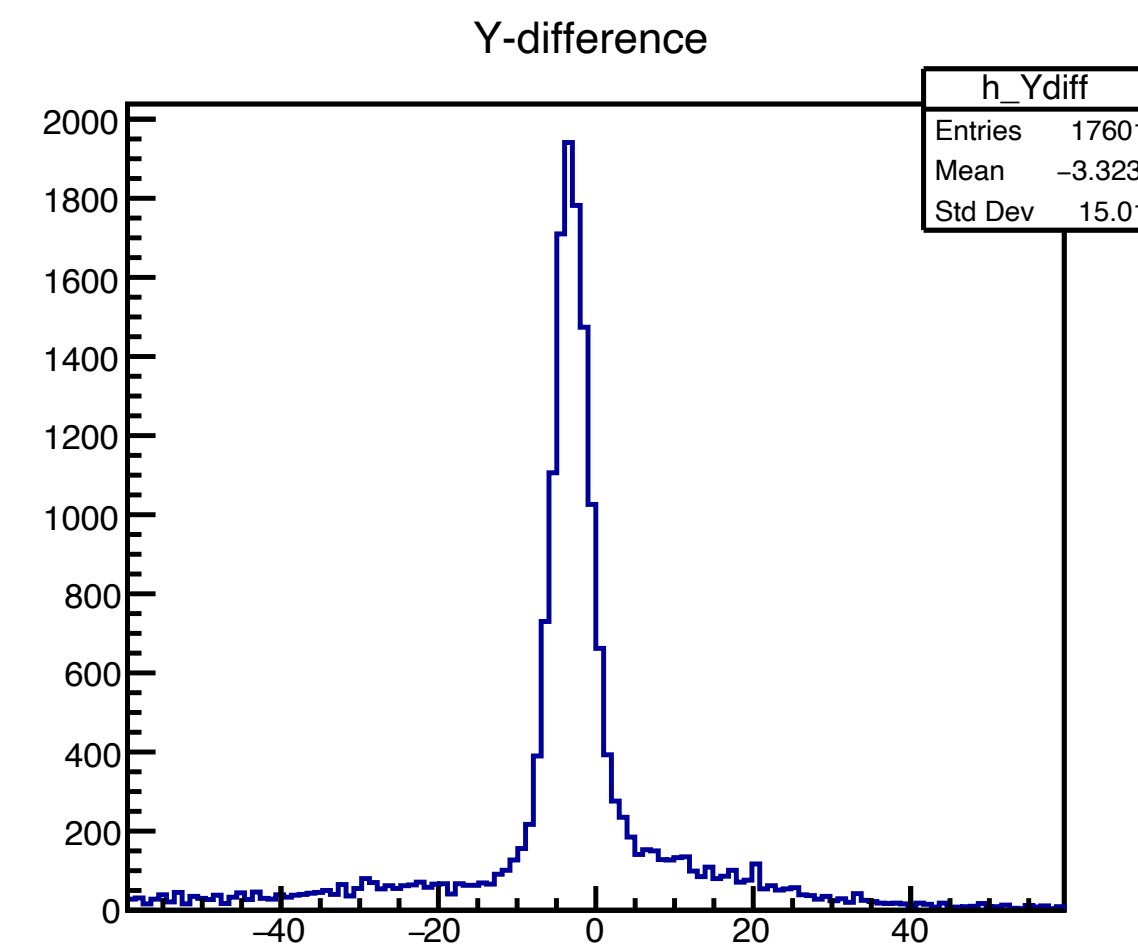
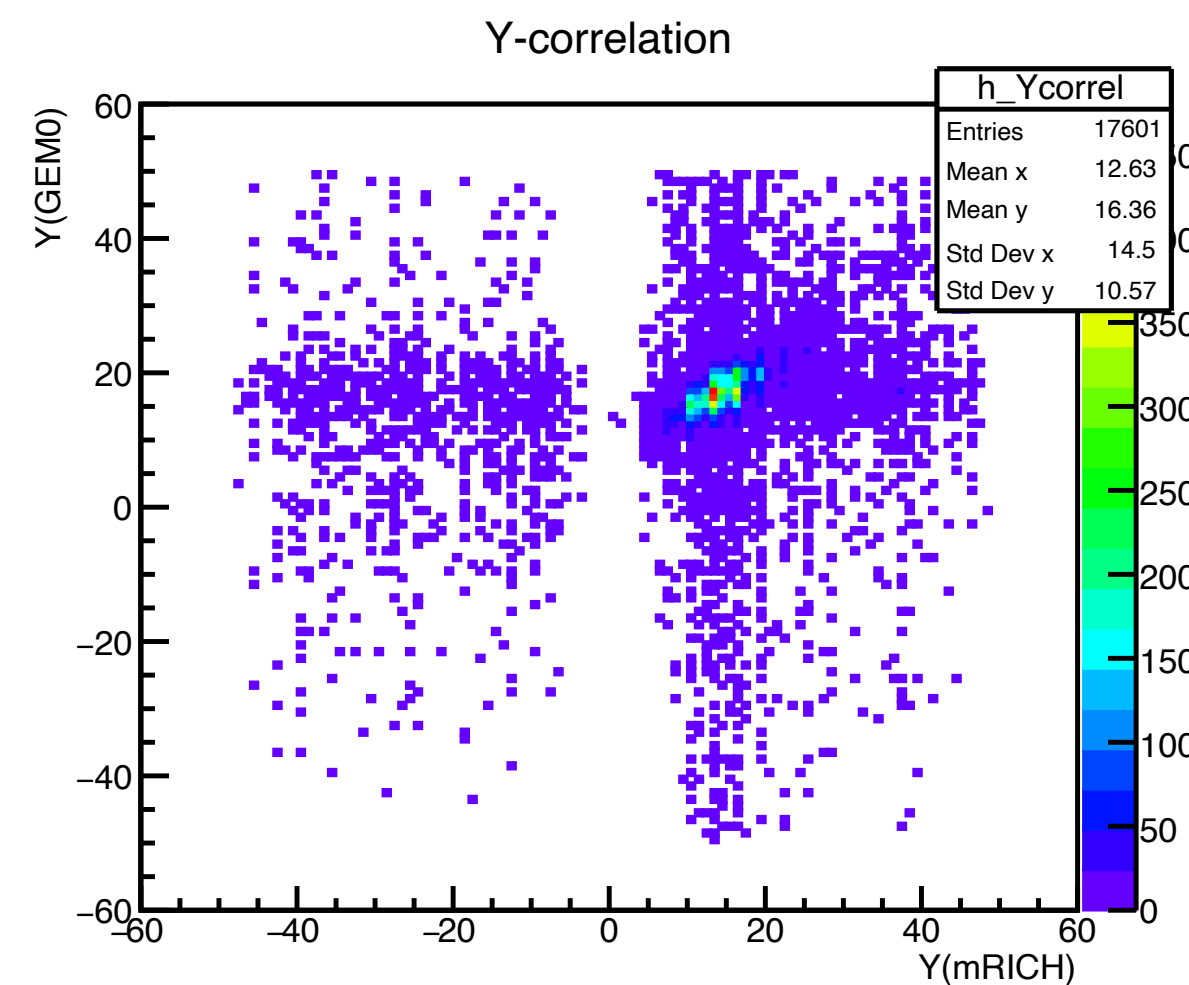
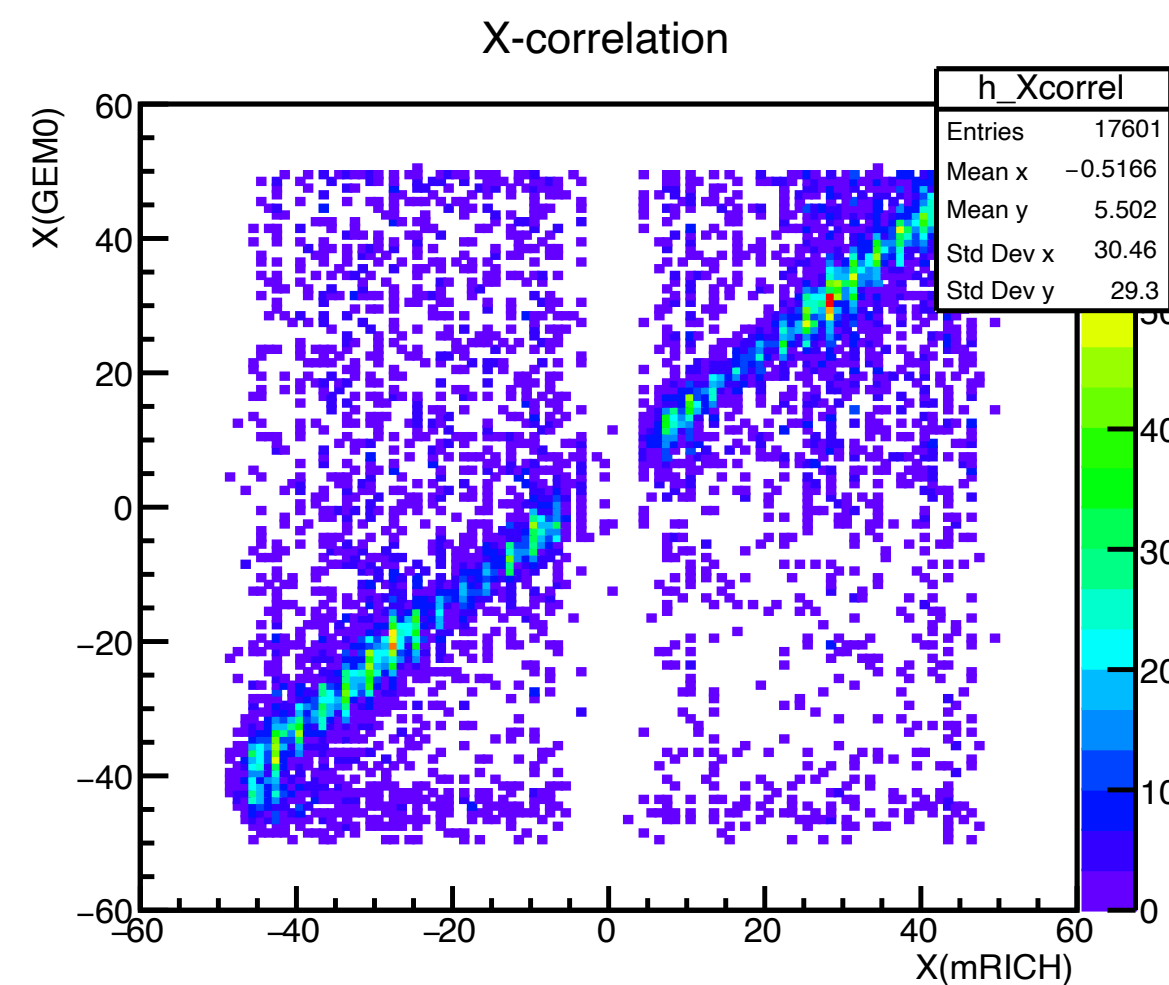
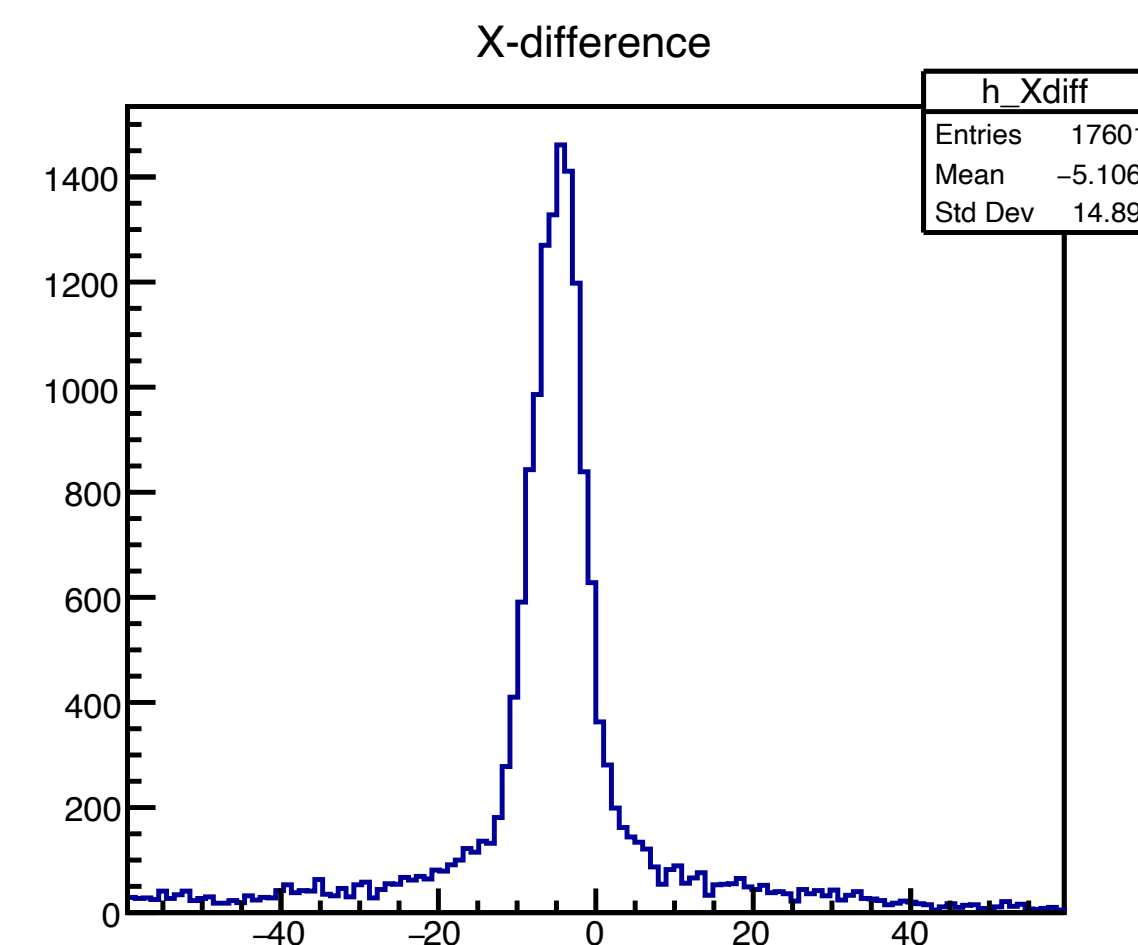
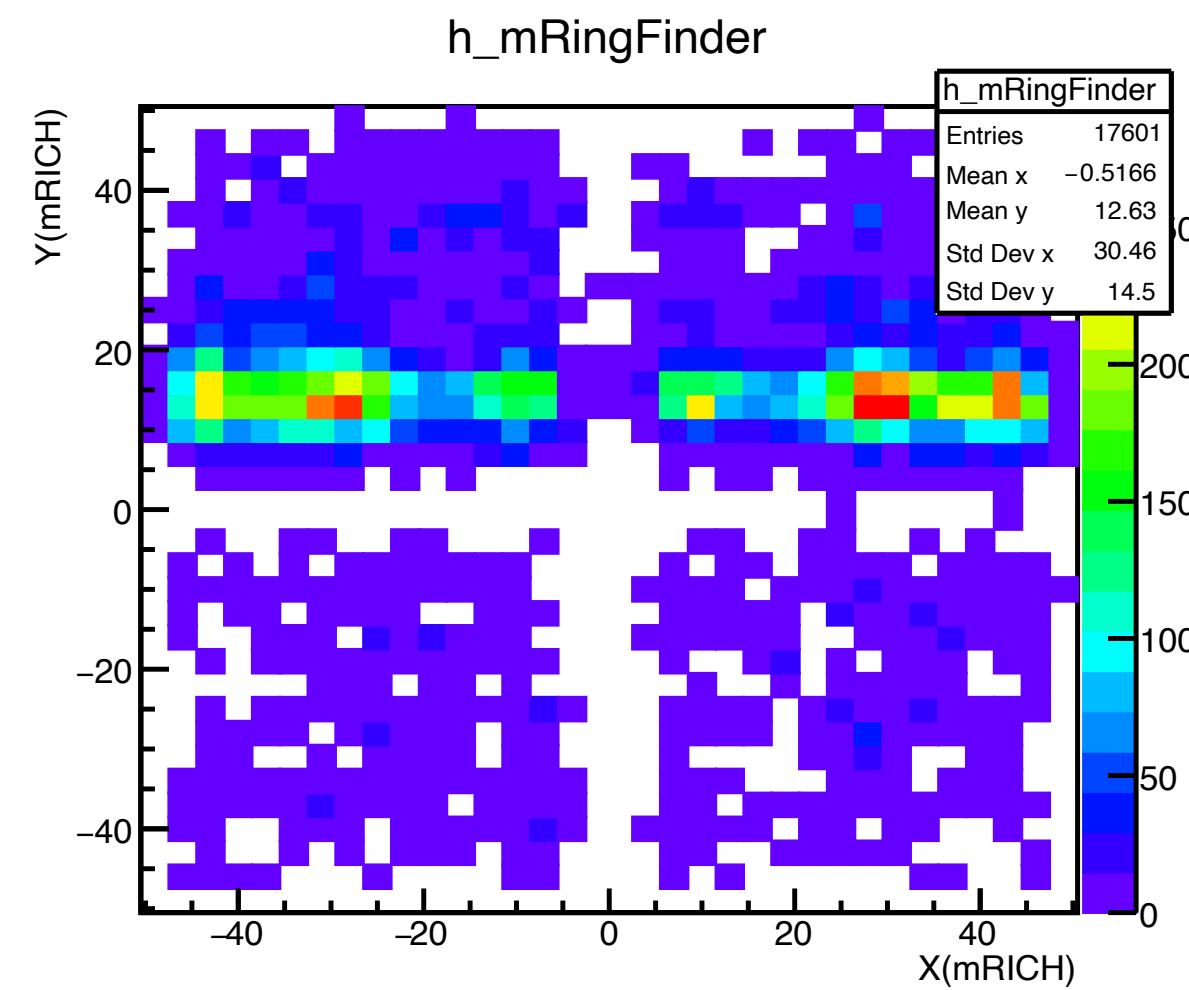
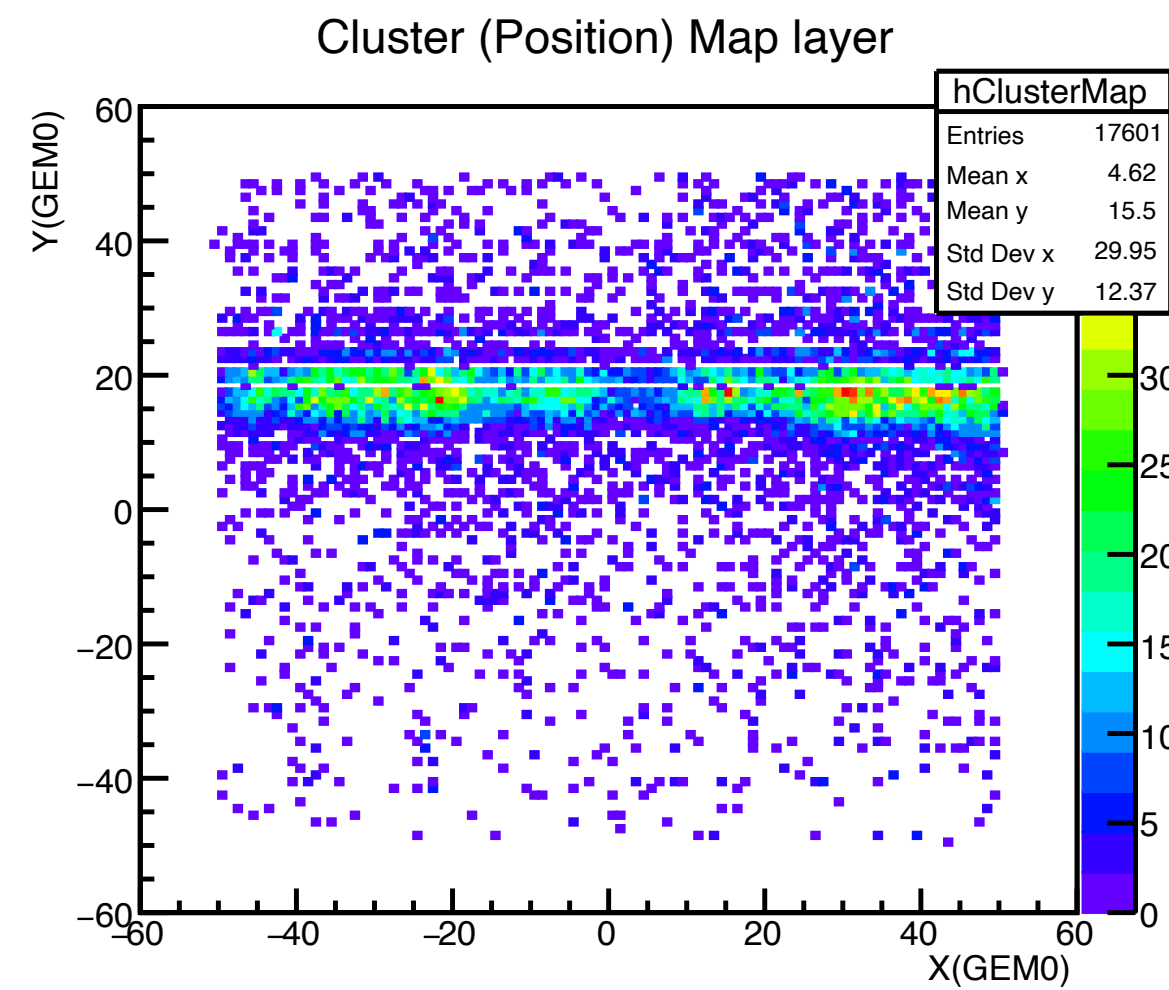
Run#1935



- The band seen between 10 to 25 mm corresponds to the incident electron beam
- Clear nice correlation seen in both X and Y directions, determined by the two GEMs

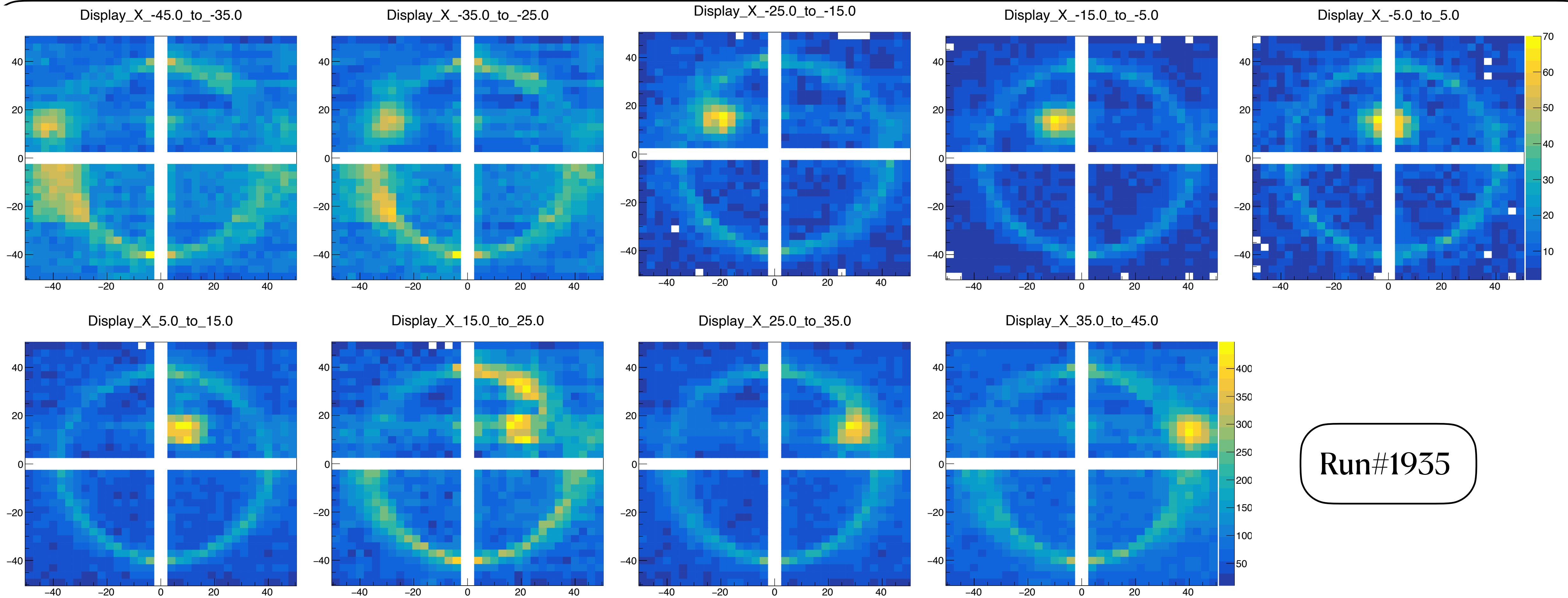
Beam Position Correlation (GEMs vs mRICH)

Run#1935



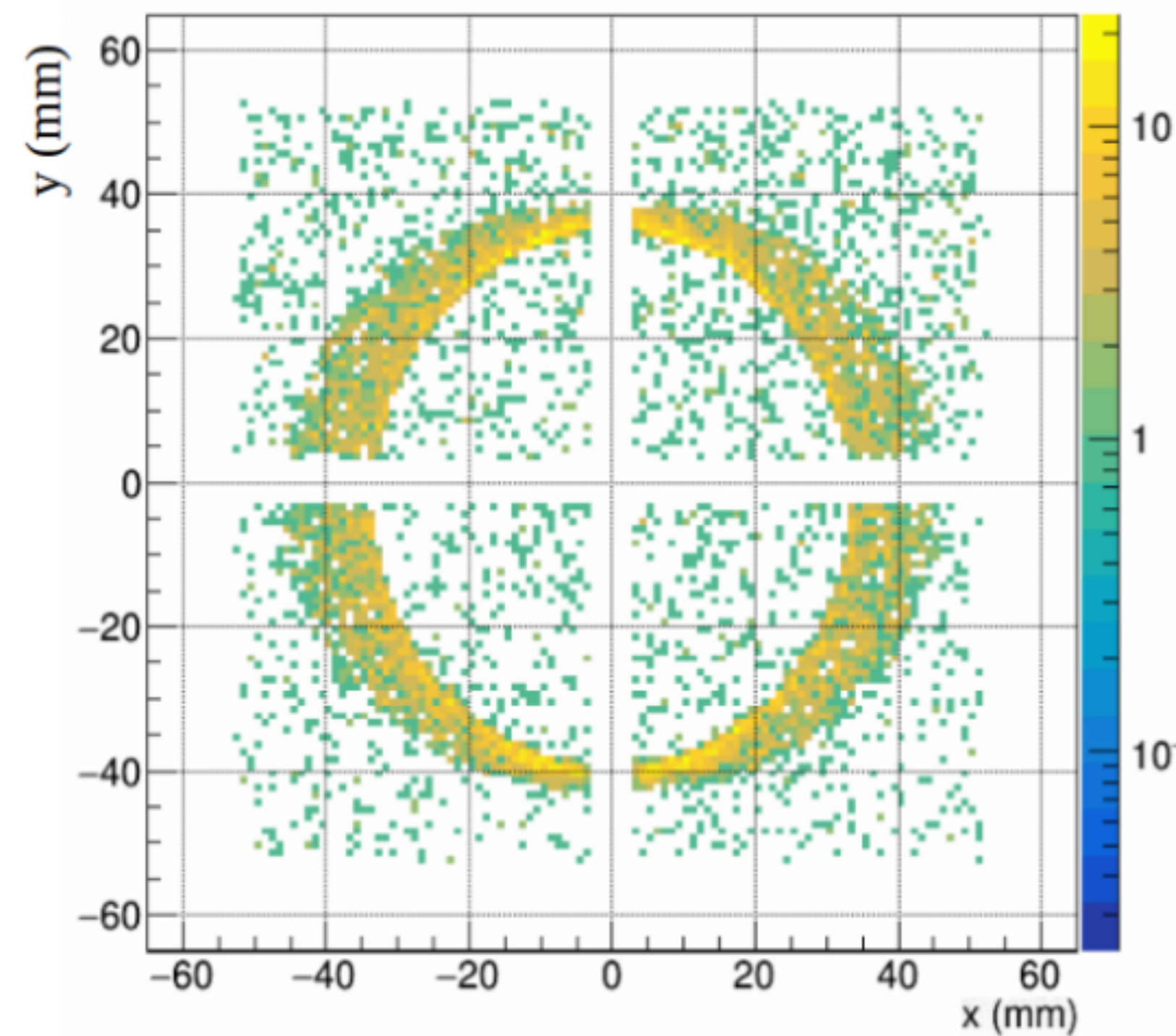
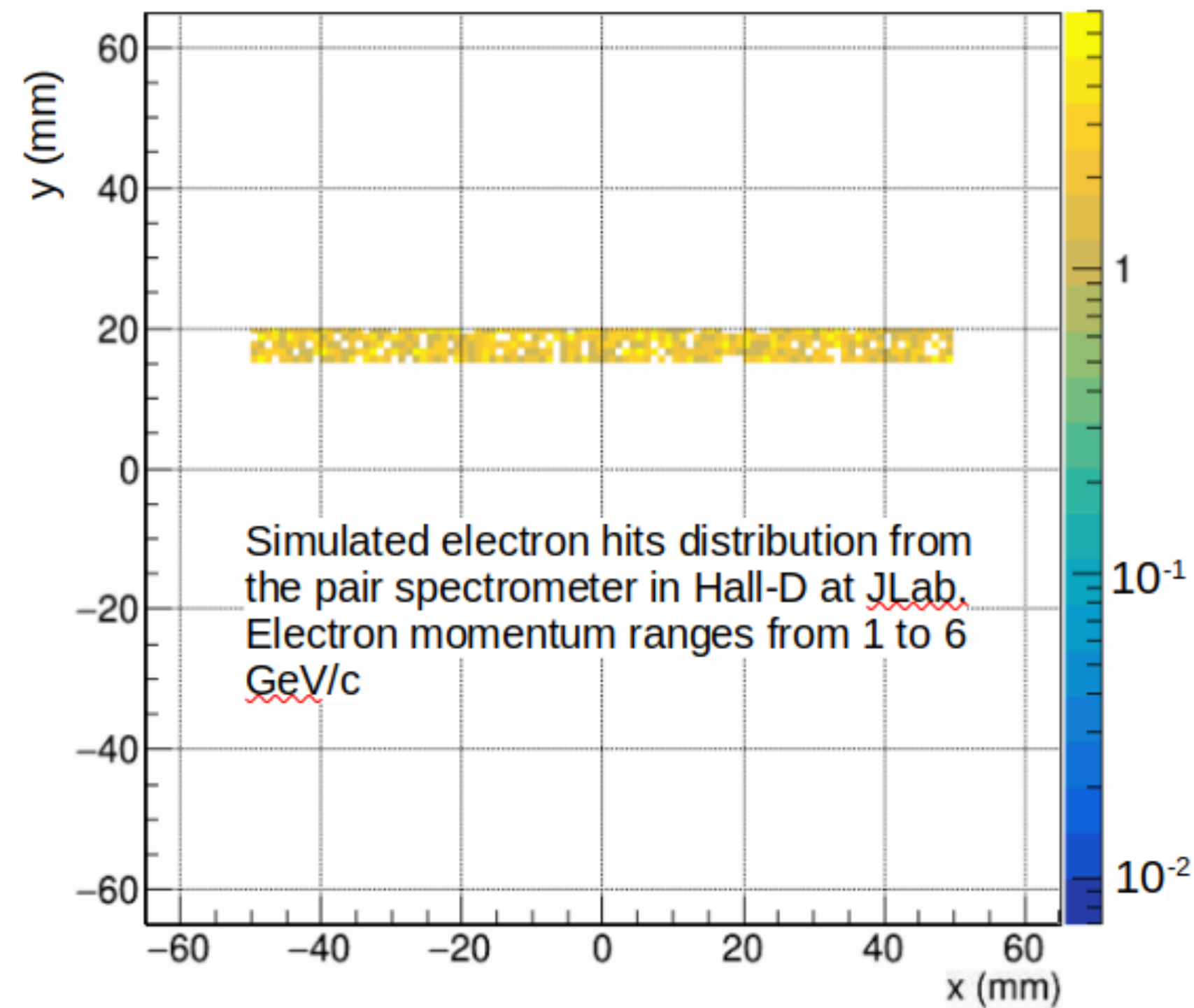
- We can see a nice correlation between Beam Positions as seen in GEMs vs mRICH.

Rings as a Function of Incident Beam Position



•One can see the slight shift in the rings as we move from left to right, with a nicely centered ring when the beam position aligns with the center of mRICH

mRICH Rings in Simulation



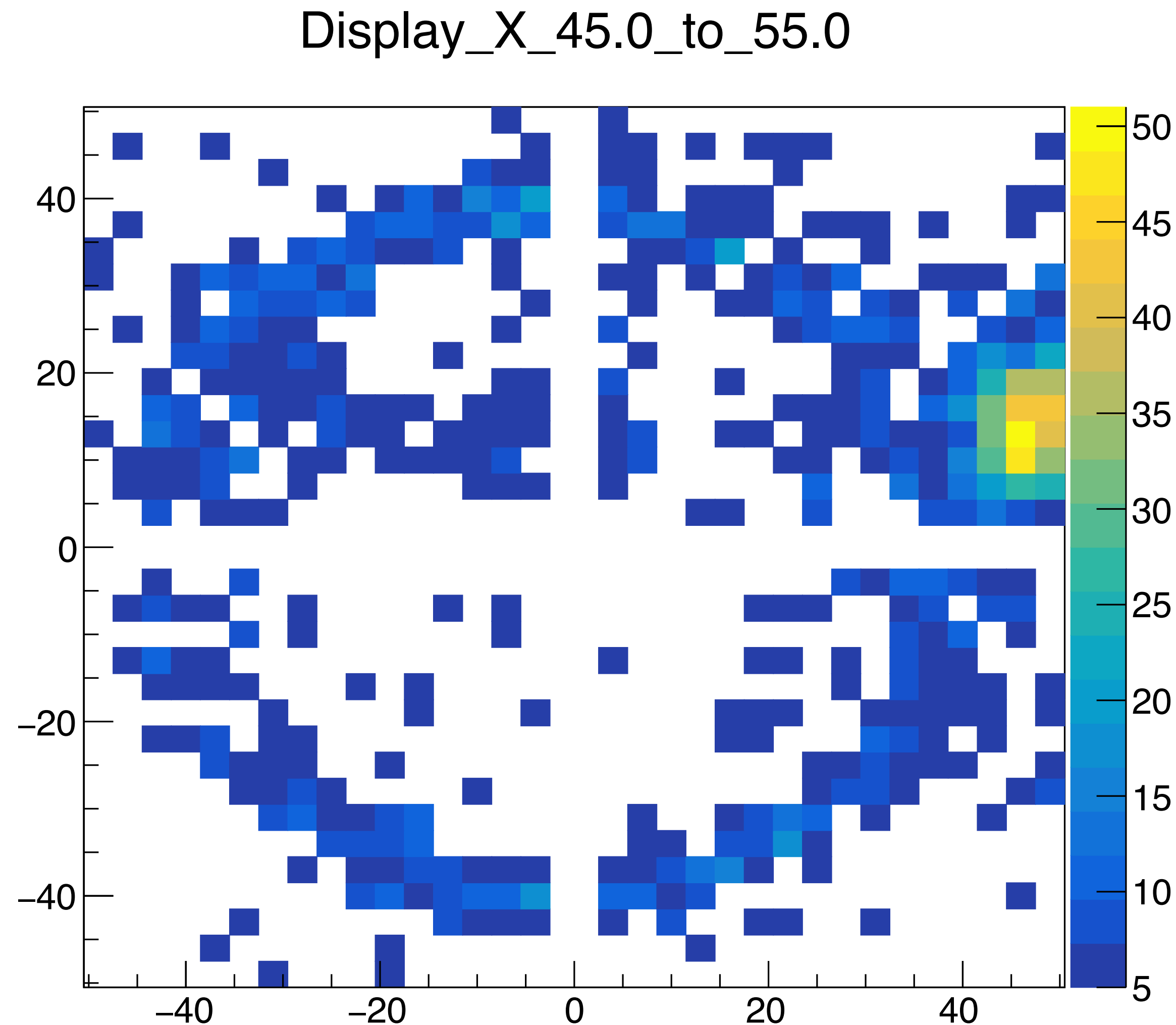
- GEANT4 Simulation provided by Murad
- We are working to get more fine-tuned simulations using input from data.

Summary and Outlook

- So far we have done:
 - QA for both mRICH and GEMs
 - We see a very nice correlation between GEMs and mRICH for the beam position.
 - First look at the ring images as a function of beam position.
- Next steps will include:
 - Determination of mRICH and GEMs efficiencies as a function of different cuts
 - Calculate the number of photons, ring radius and single photon angular resolutions

Back-Ups

Rings as a Function of Incident Beam Position

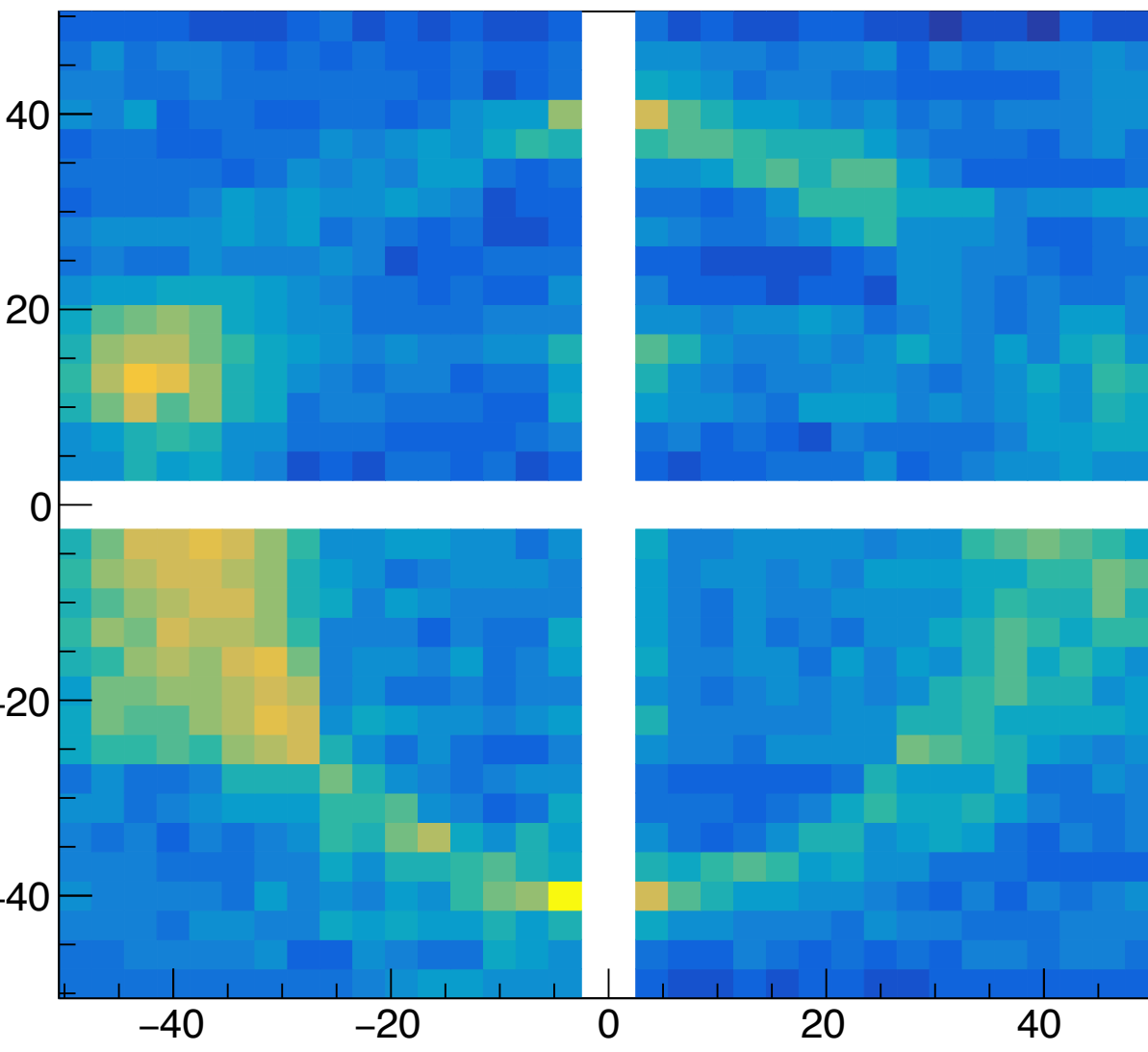


- One can see the slight shift in the rings as we move from left to right, with shortest and circular ring when the beam aligns with the center of mRICHBackground is the total integral of the TDC distribution.

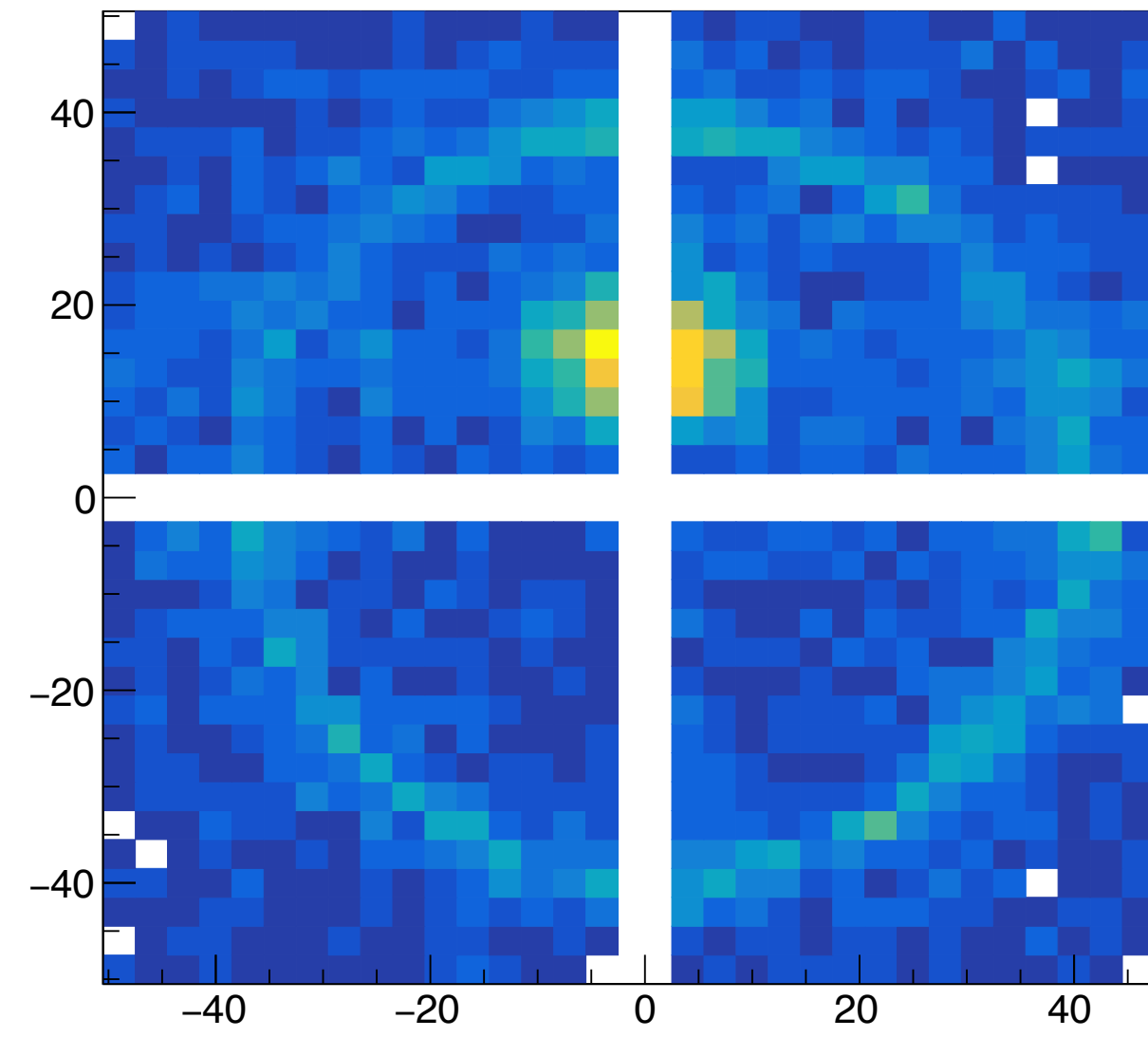
Run#1935

Rings as a Function of Incident Beam Position

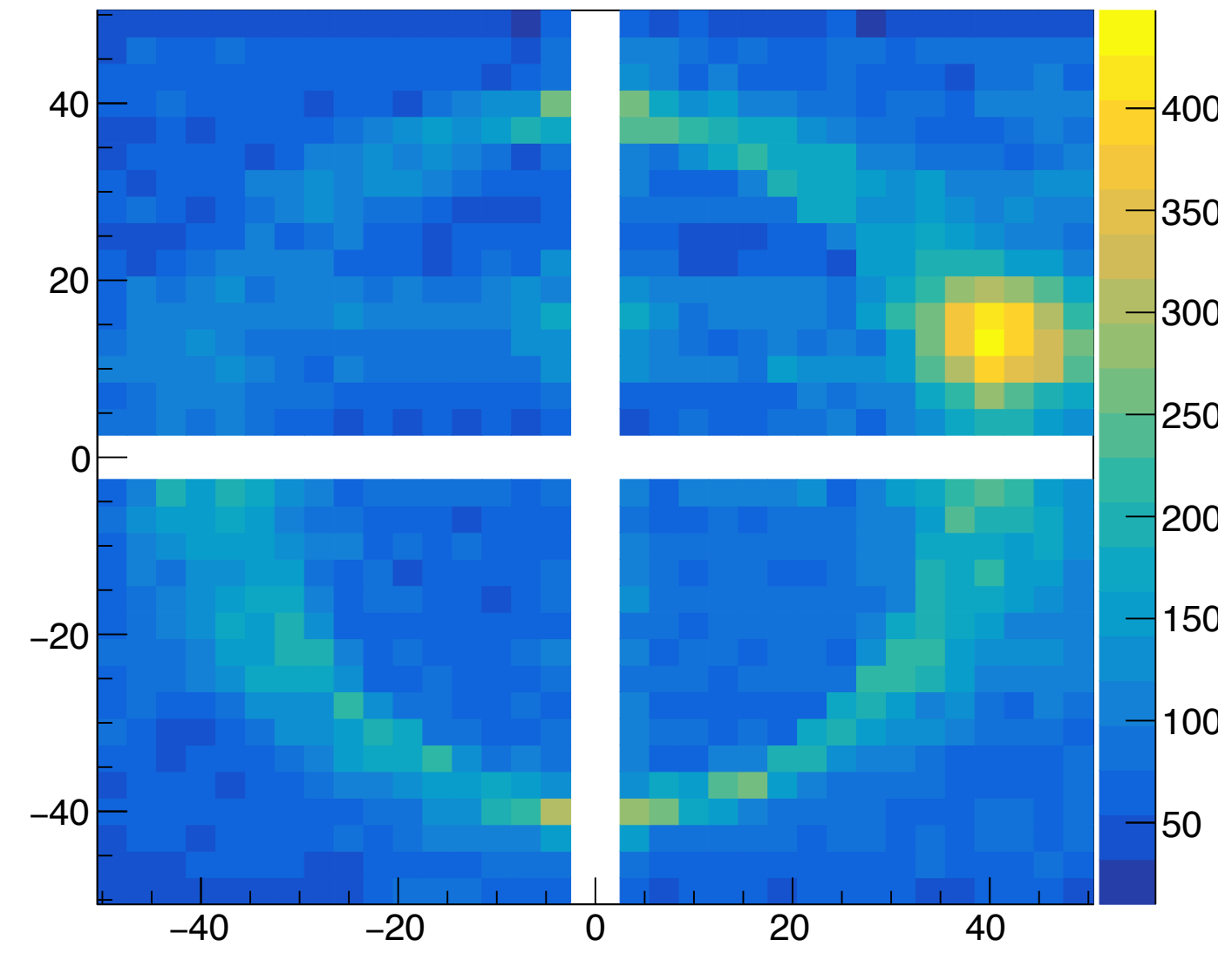
Display_X_-45.0_to_-35.0



Display_X_-5.0_to_5.0



Display_X_35.0_to_45.0



Run#1935

GEM Tracker set-up

- The set-up consisted of two GEMs
- Four APV cards are mounted on each GEM, so in total there are 8 APVs
- Each APV card has 128 channels chips that read data from GEMs and transmit the analog signal



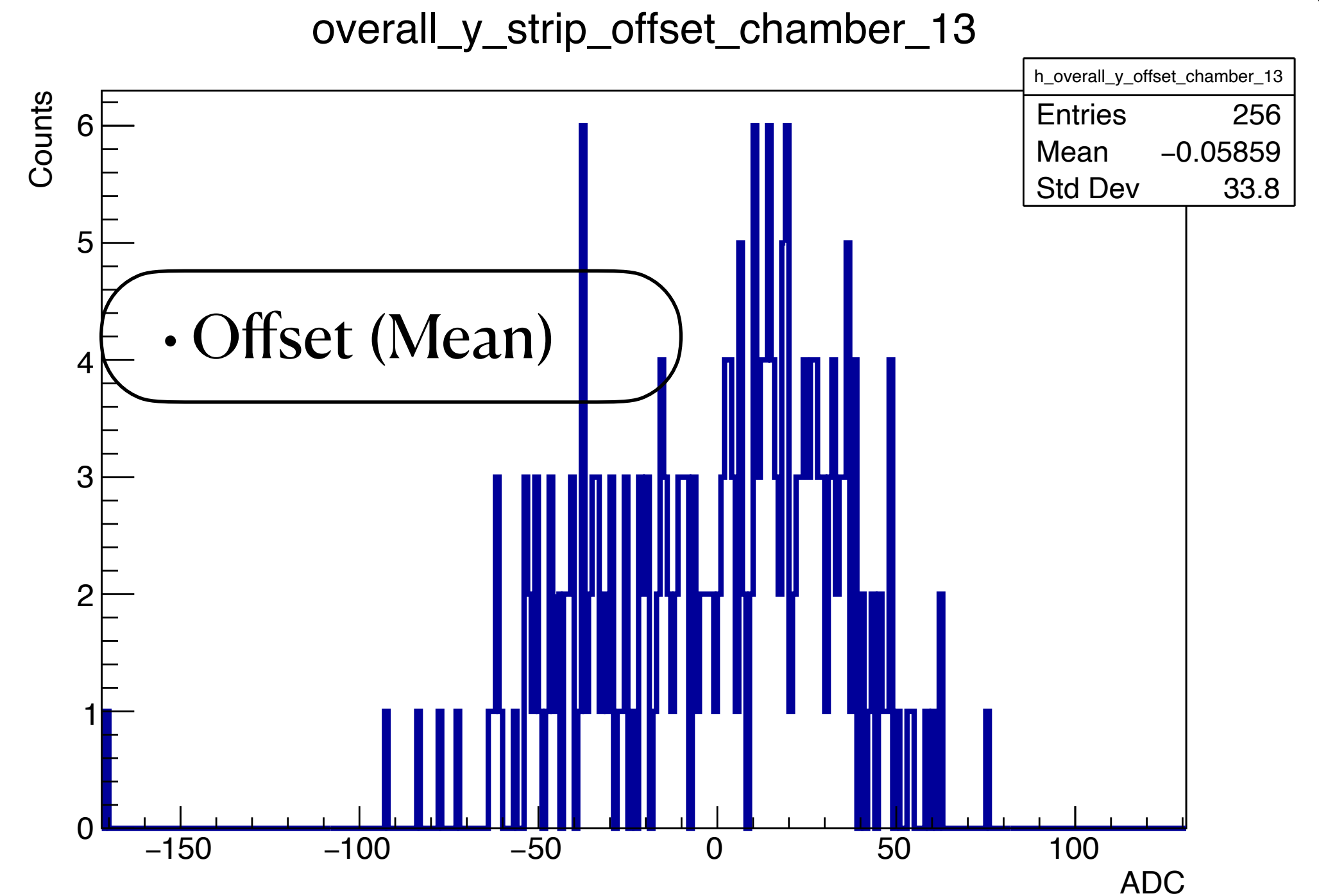
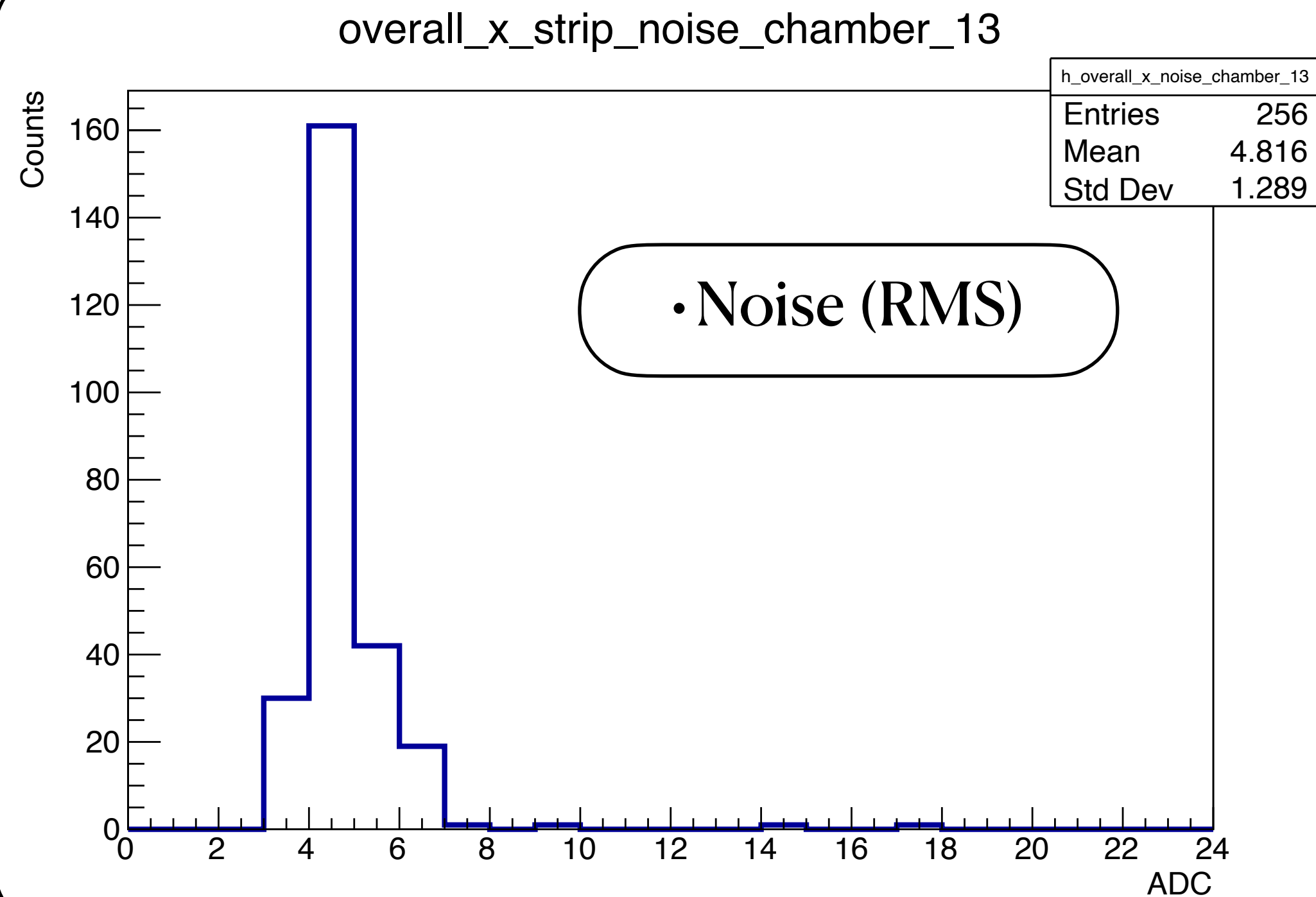
Total data accumulated

Triggered Events	PMT Threshold	HV (V)	Events (with mRICH cuts)
~290 M	200	1000	104 M
~154 M	220	1000	57 M
5 M	250	1000	1.95 M
5 M	220	850	1.95 M
5 M	220	900	1.95 M
5 M	220	950	1.95 M

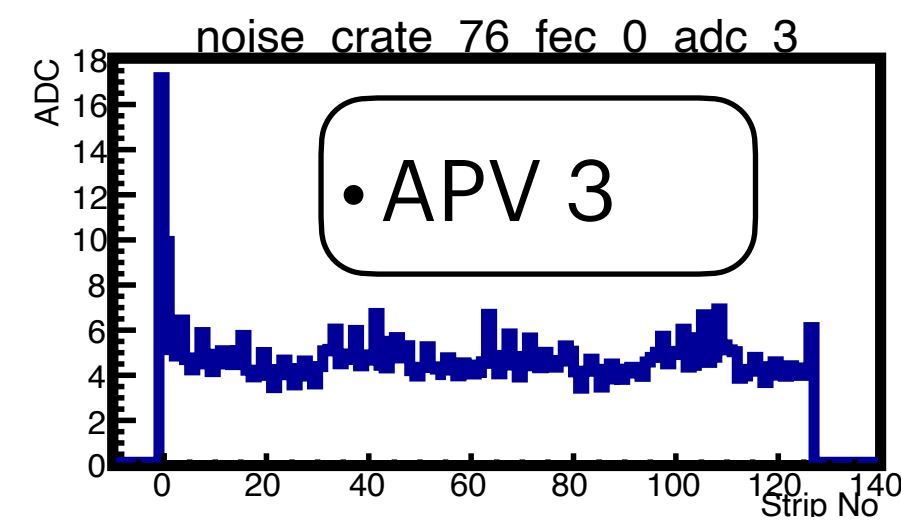
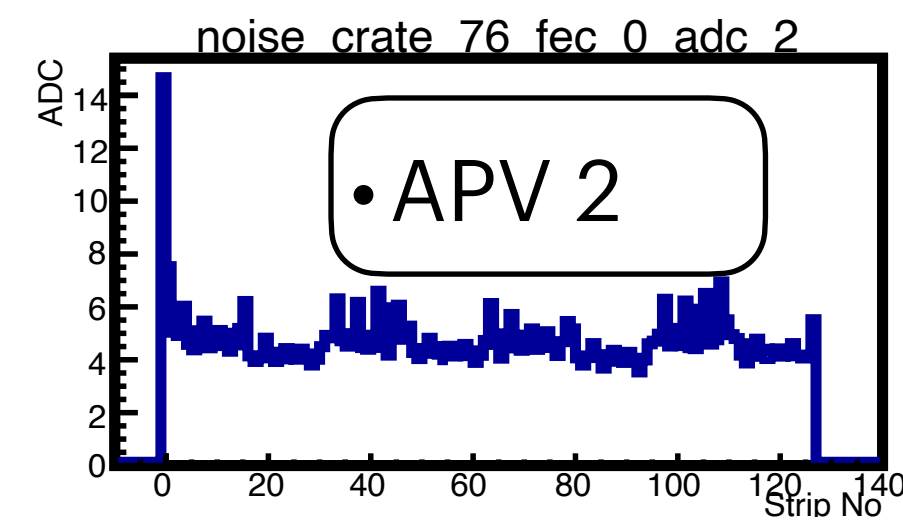
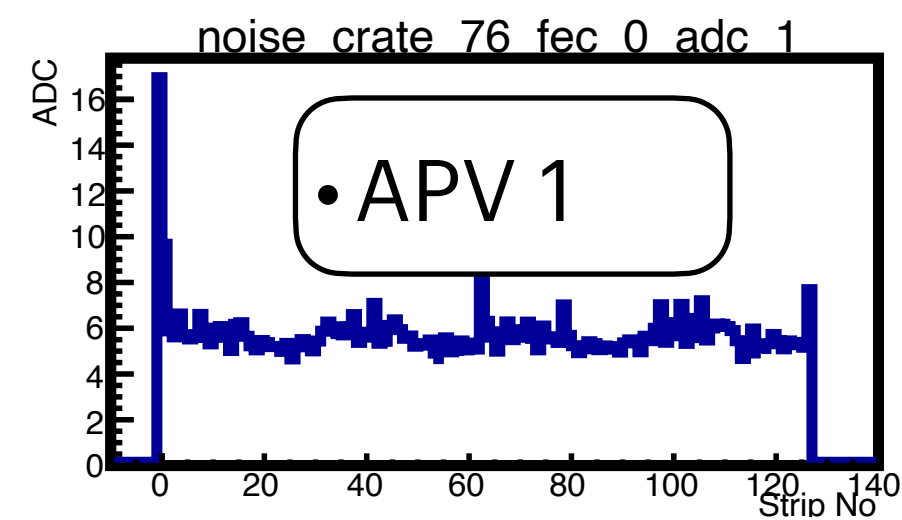
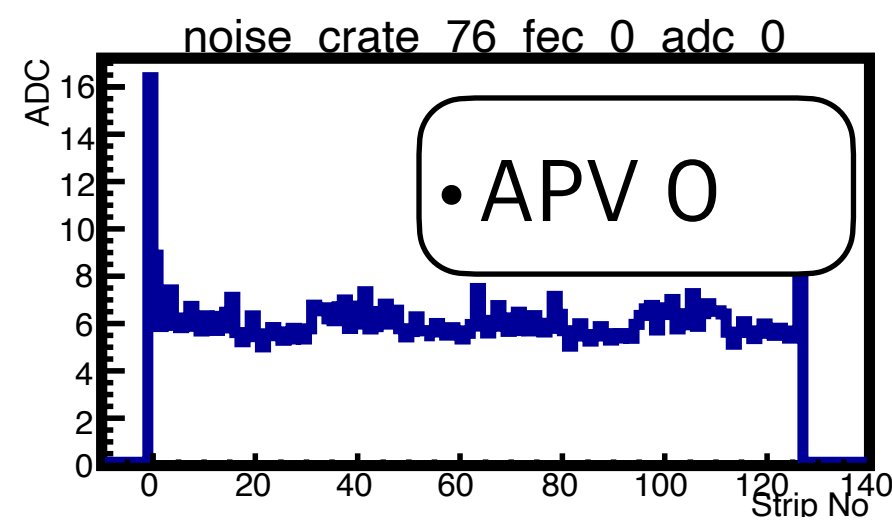
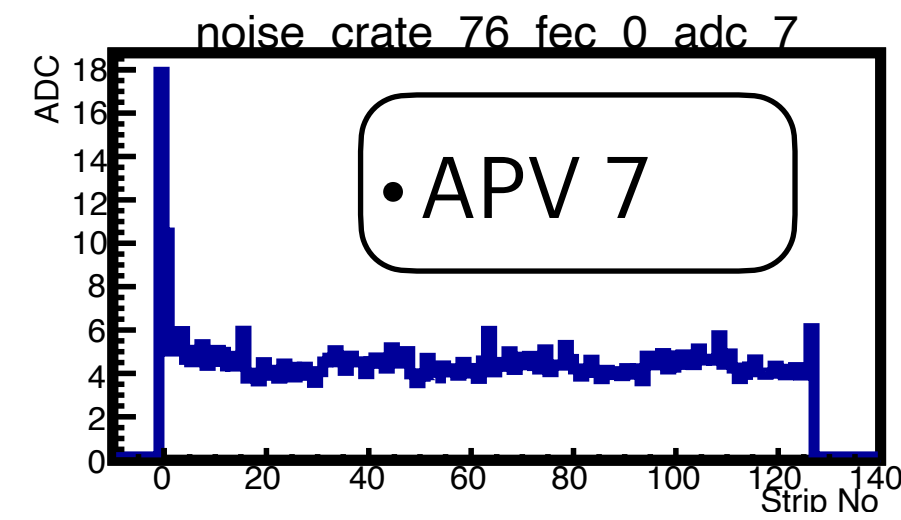
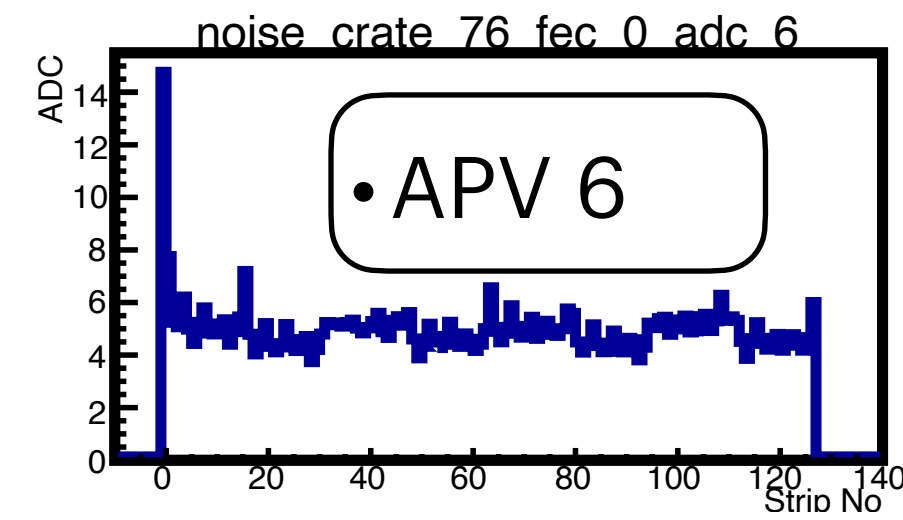
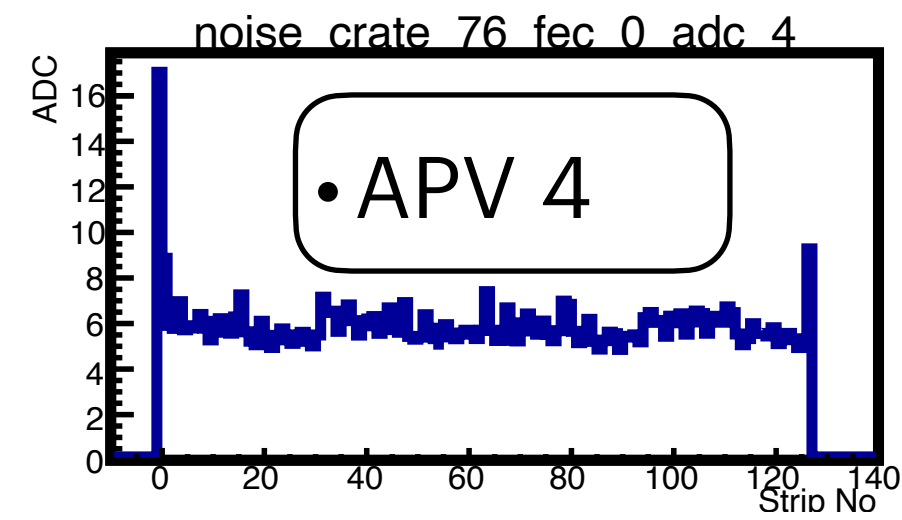
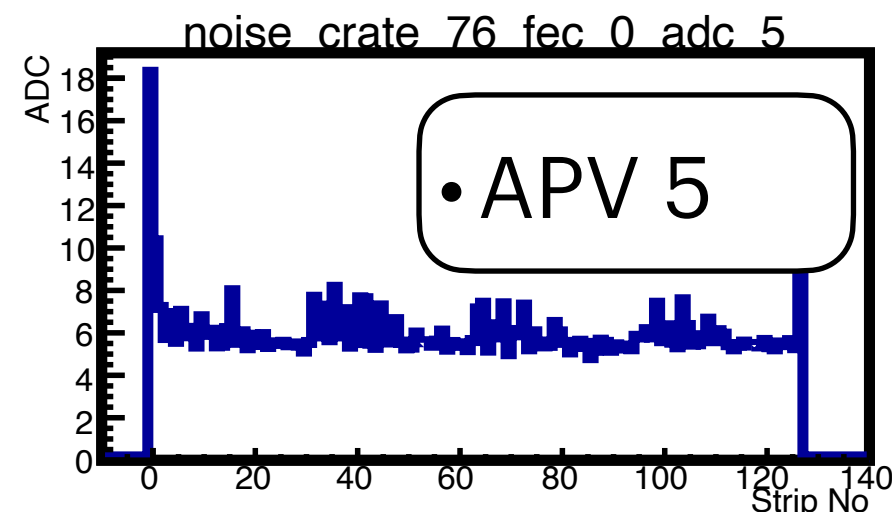
- GEM trackers have 97% efficiency (as per Kondo), with 1/3rd of triggered events resulting hits in GEMs
- Understanding mRICH and GEM trackers efficiency will be a part of this analysis

Pedestal calculation

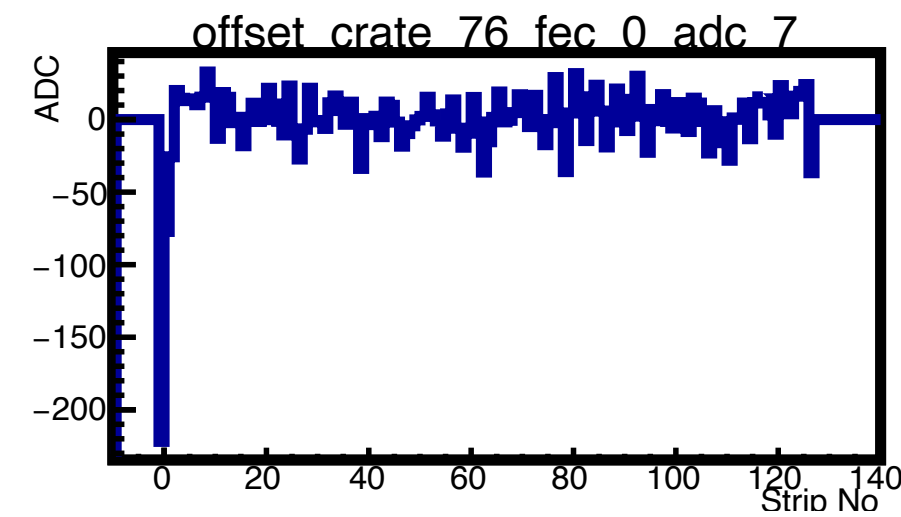
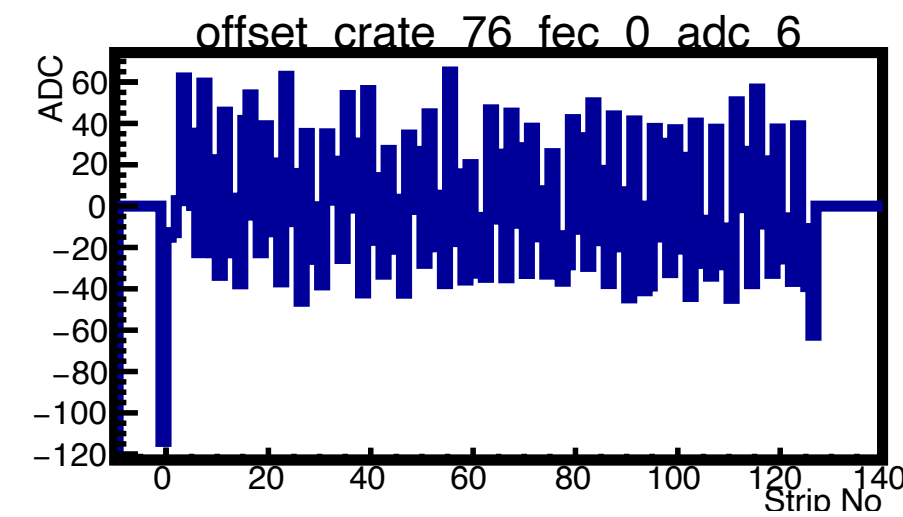
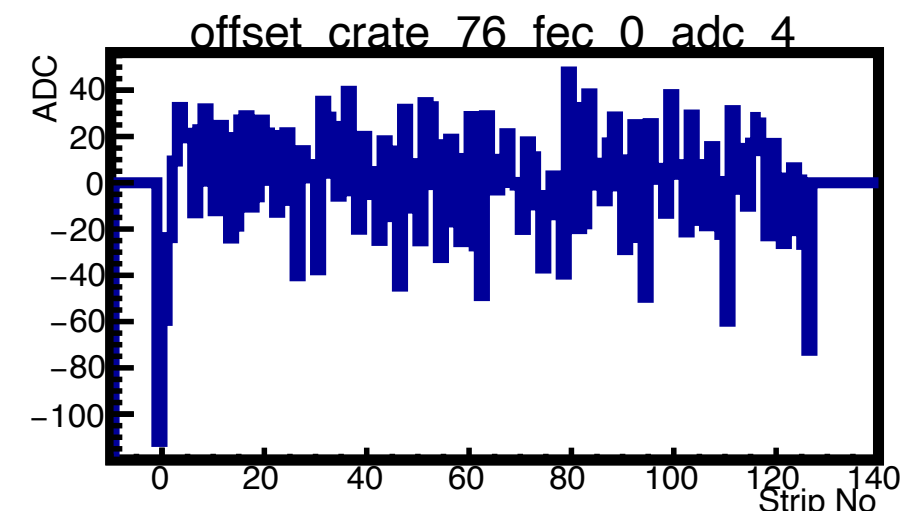
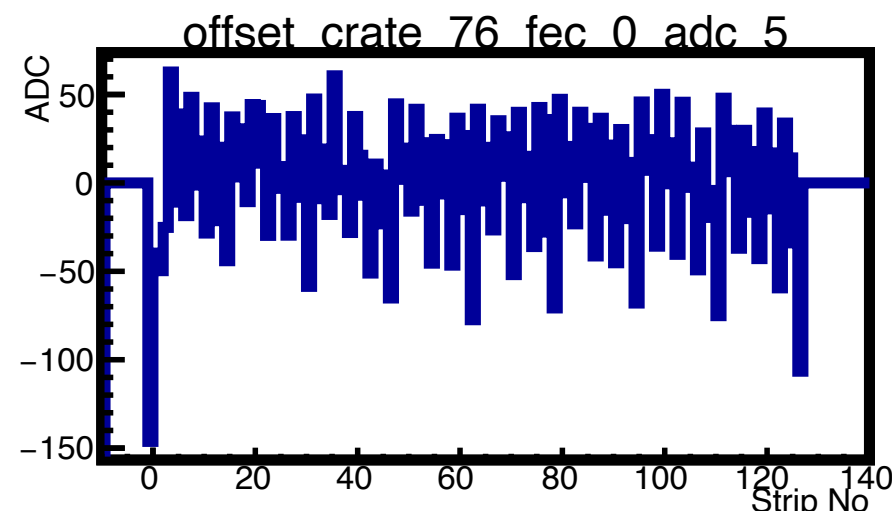
- For each ADC channel/Strip, the mean and RMS of ADC distribution is determined.
- These are then used as underlying noise values for each event and are subtracted.
- Shown below is the cumulative distributions for Mean and RMS for 256 strips. The individual distributions are shown in the next slide



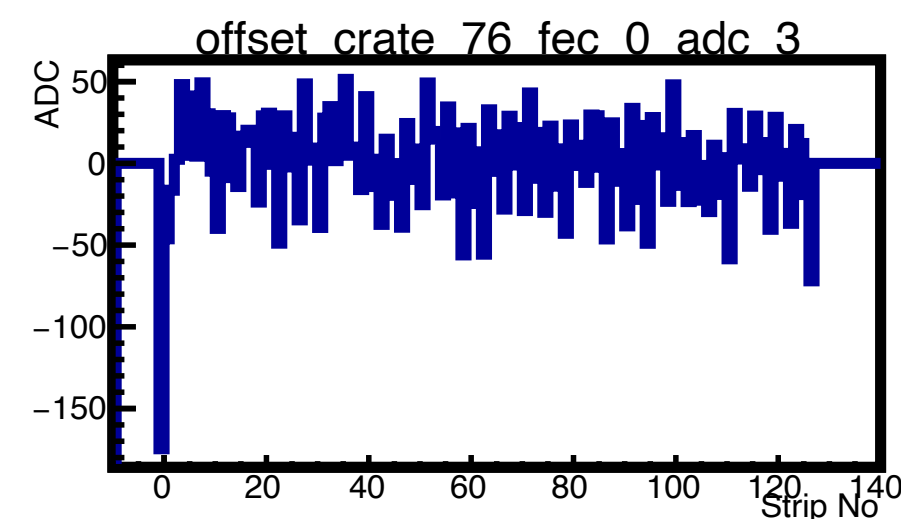
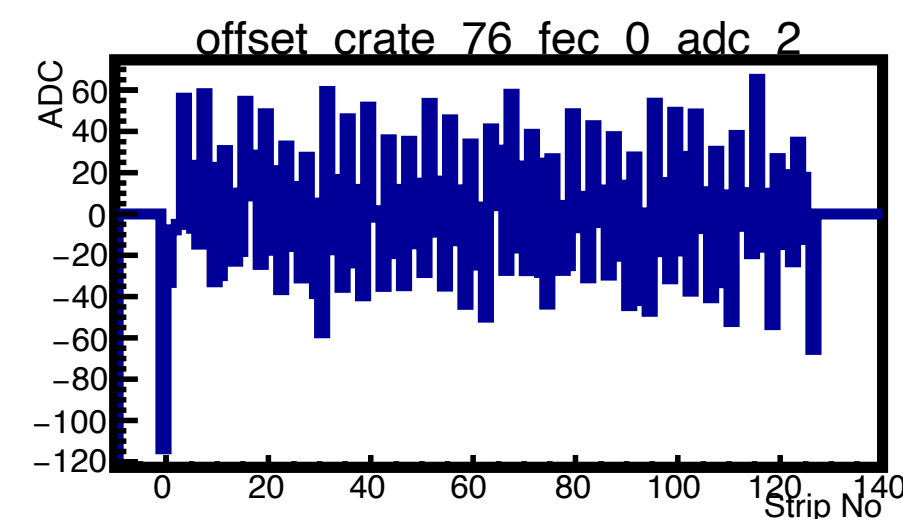
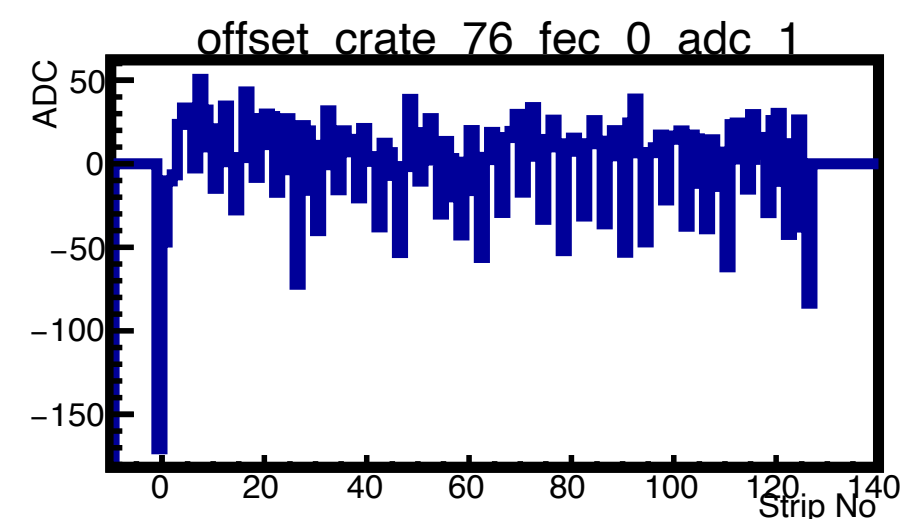
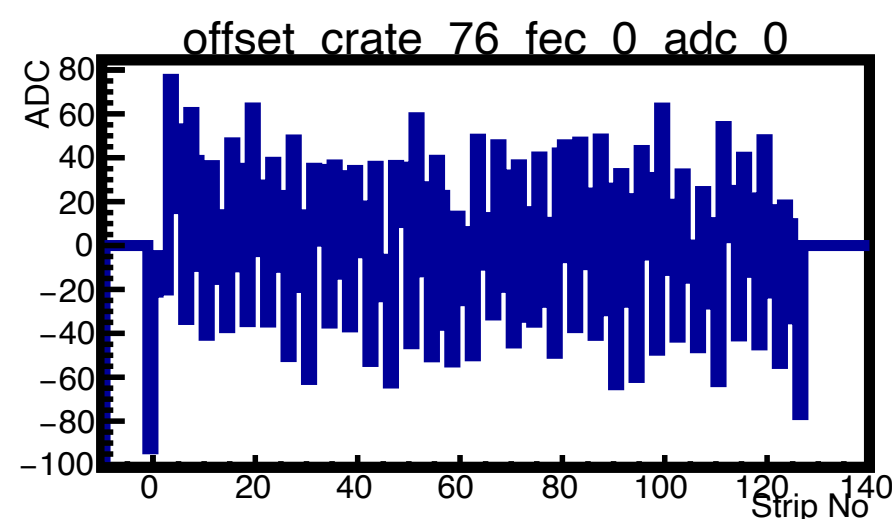
Pedestal calculation



• Noise (RMS)

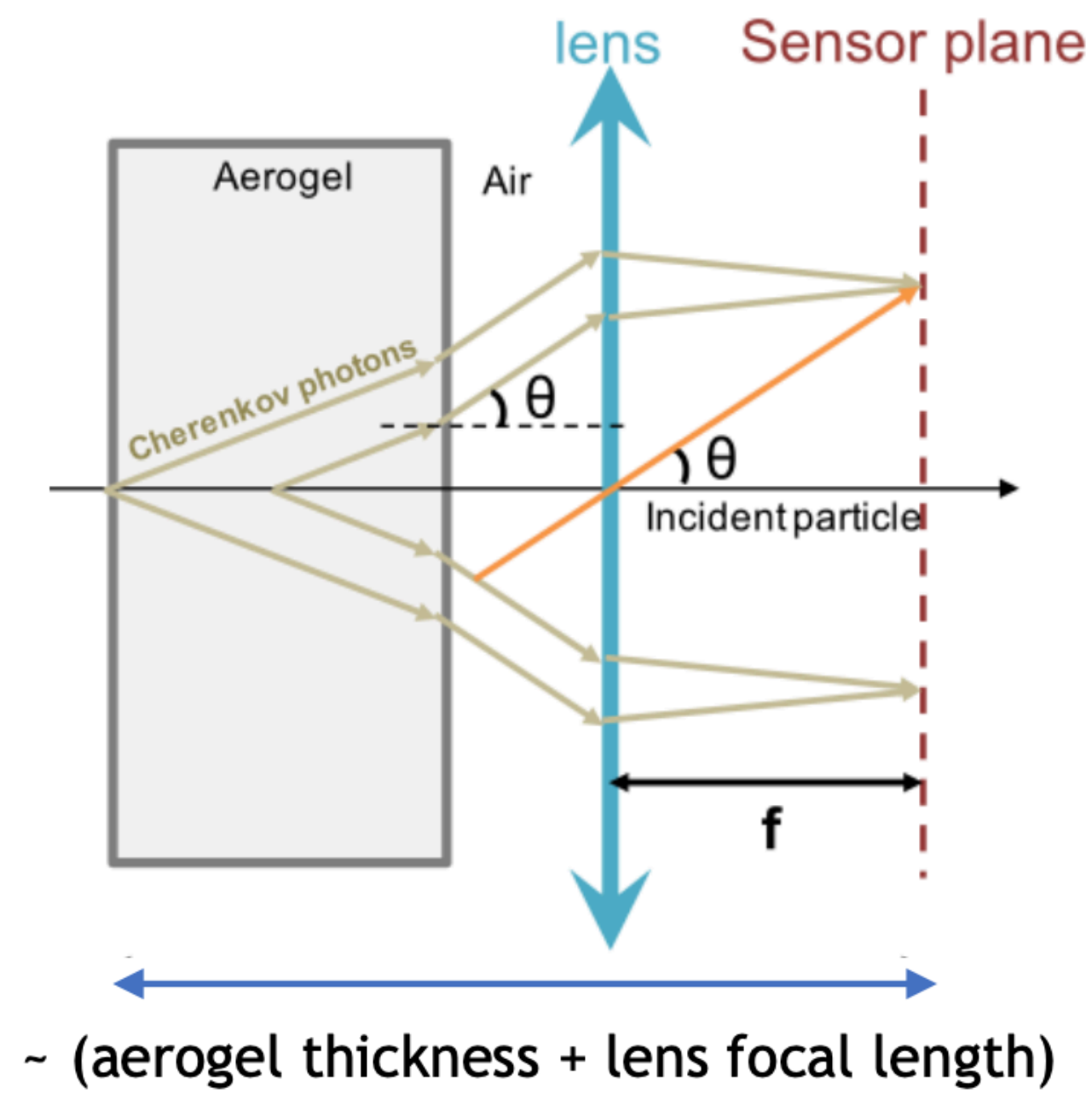


• Offset (Mean)

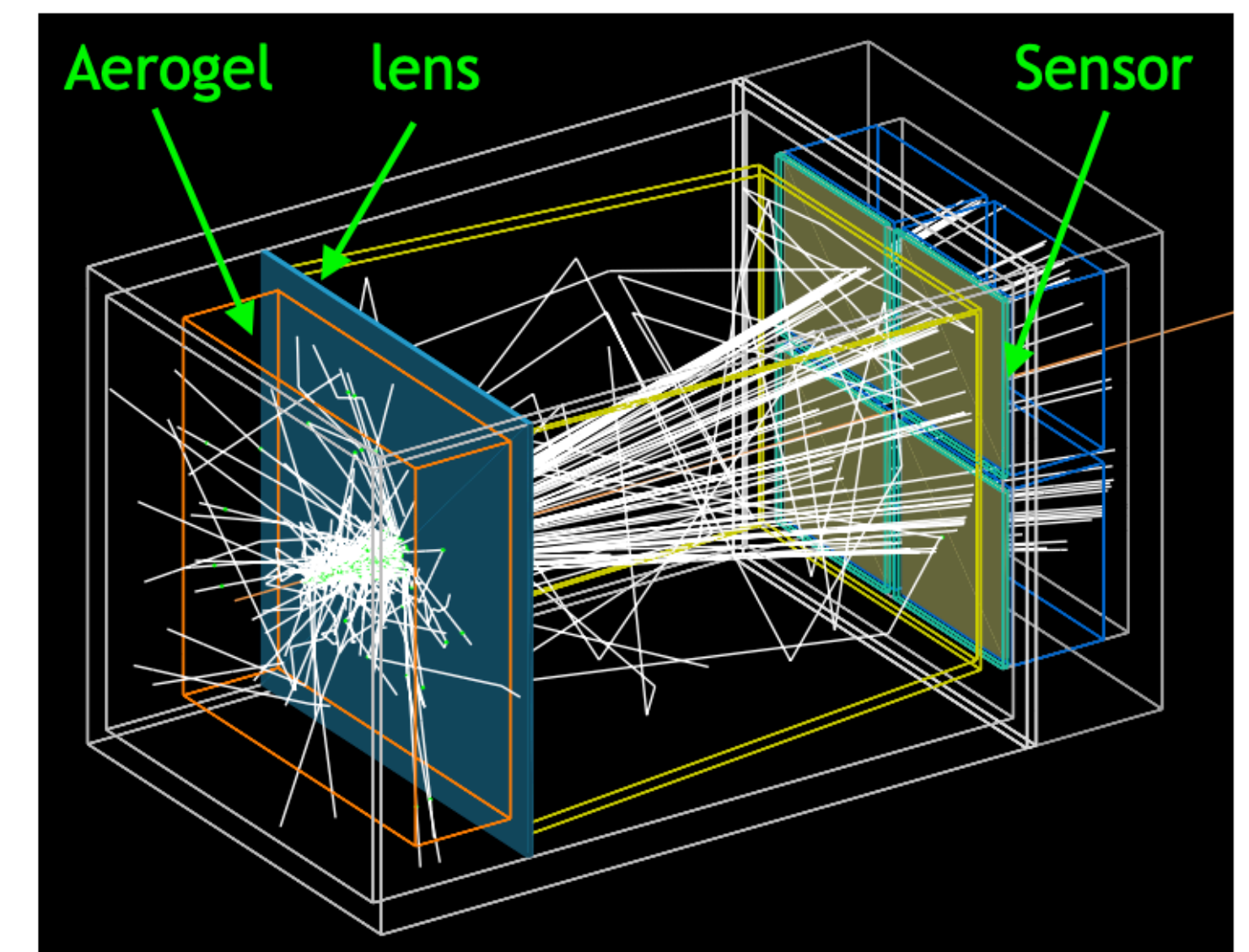
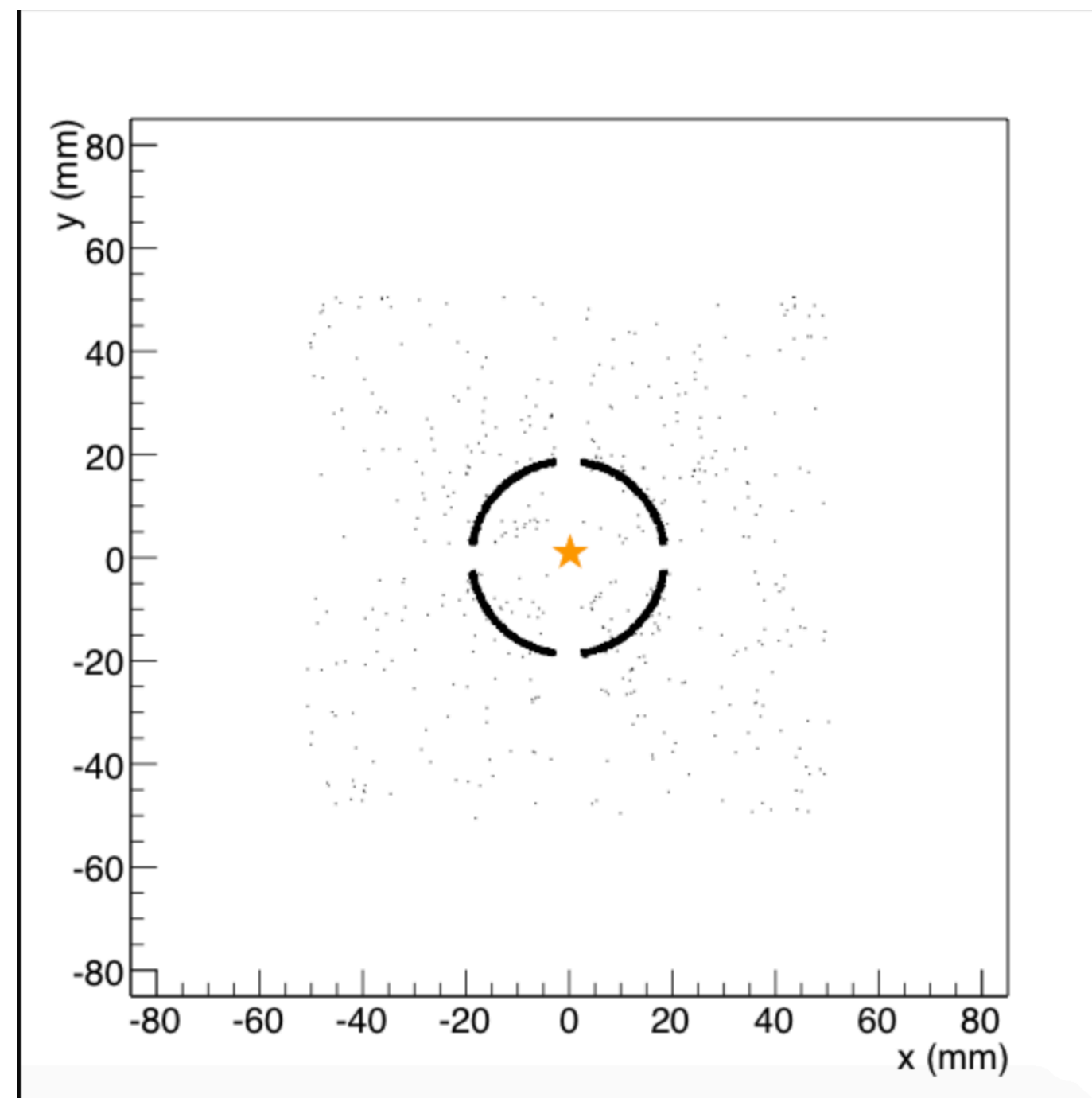


mRICH-Modular, Compact and Projective

- mRICH stands for compact and modular Ring Imaging Cherenkov detector, which is designed for K/pi separation in a momentum range of 2 to 8 GeV/c and e/pi separation below 2 GeV/c for the future EIC experiment



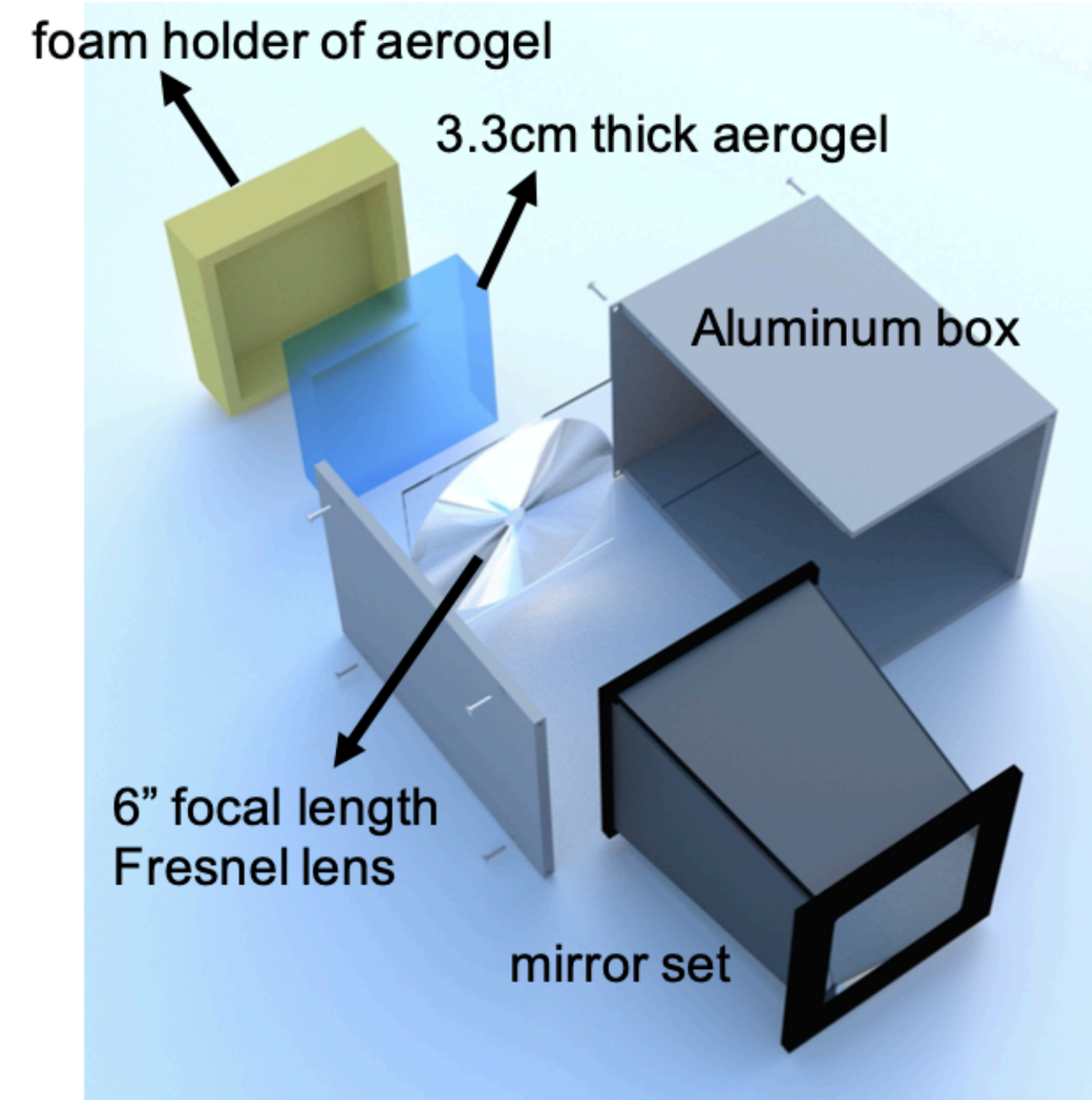
(Not to scale, for illustration purpose only)



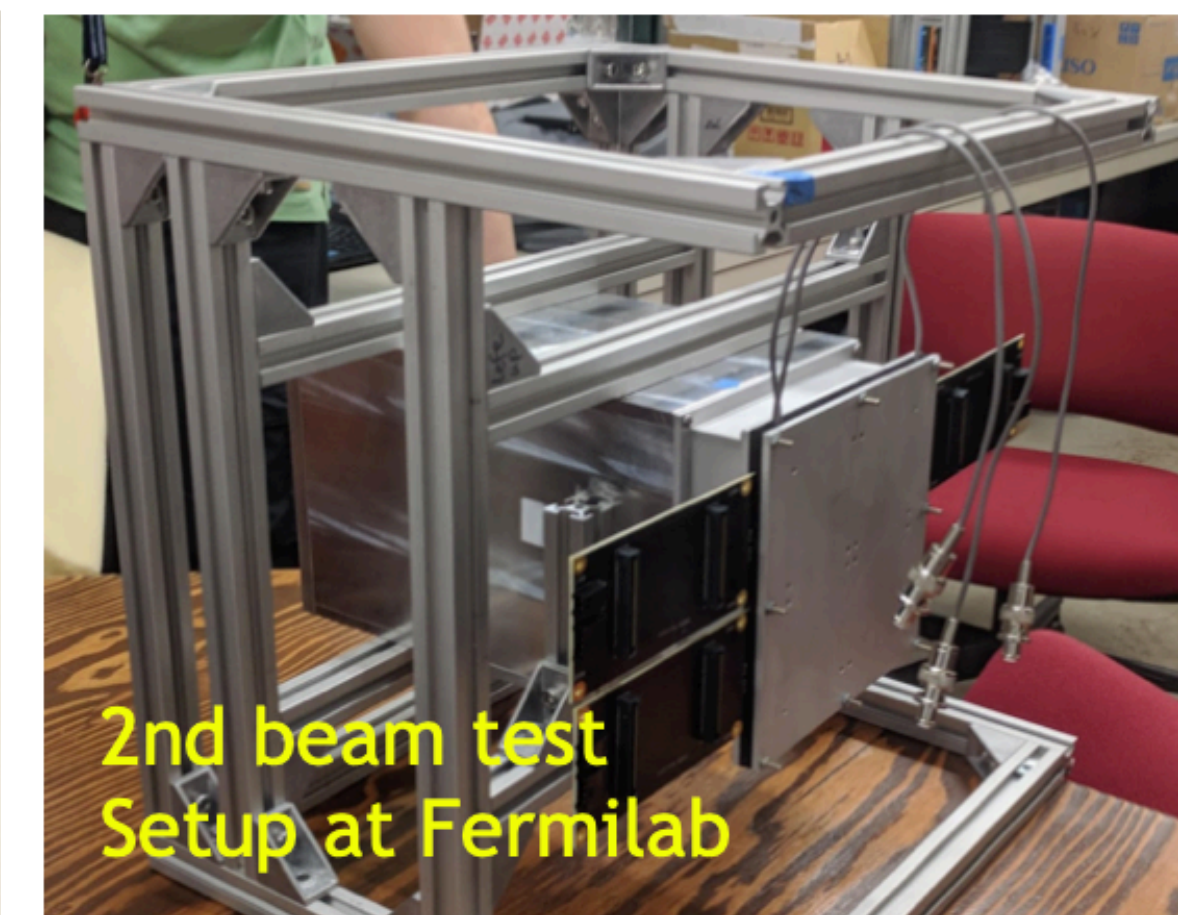
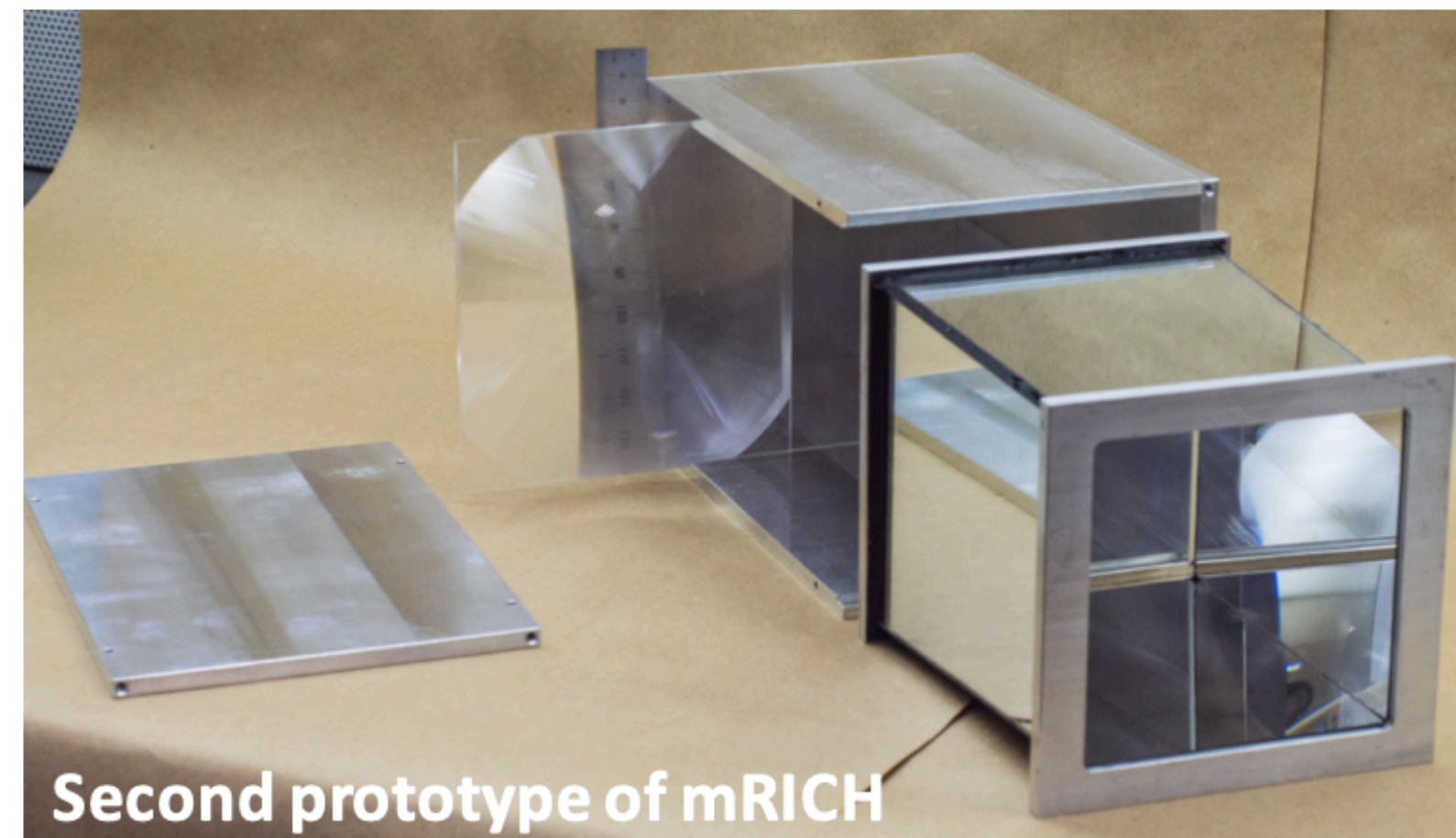
Geant4 Simulation

With realistic material optical properties

mRICH Prototype - Optical Component Design



Different photosensors and readout can be attached at the back of mRICH.



2nd and 3rd beam tests have same mRICH design

Analysis Flow Chart

