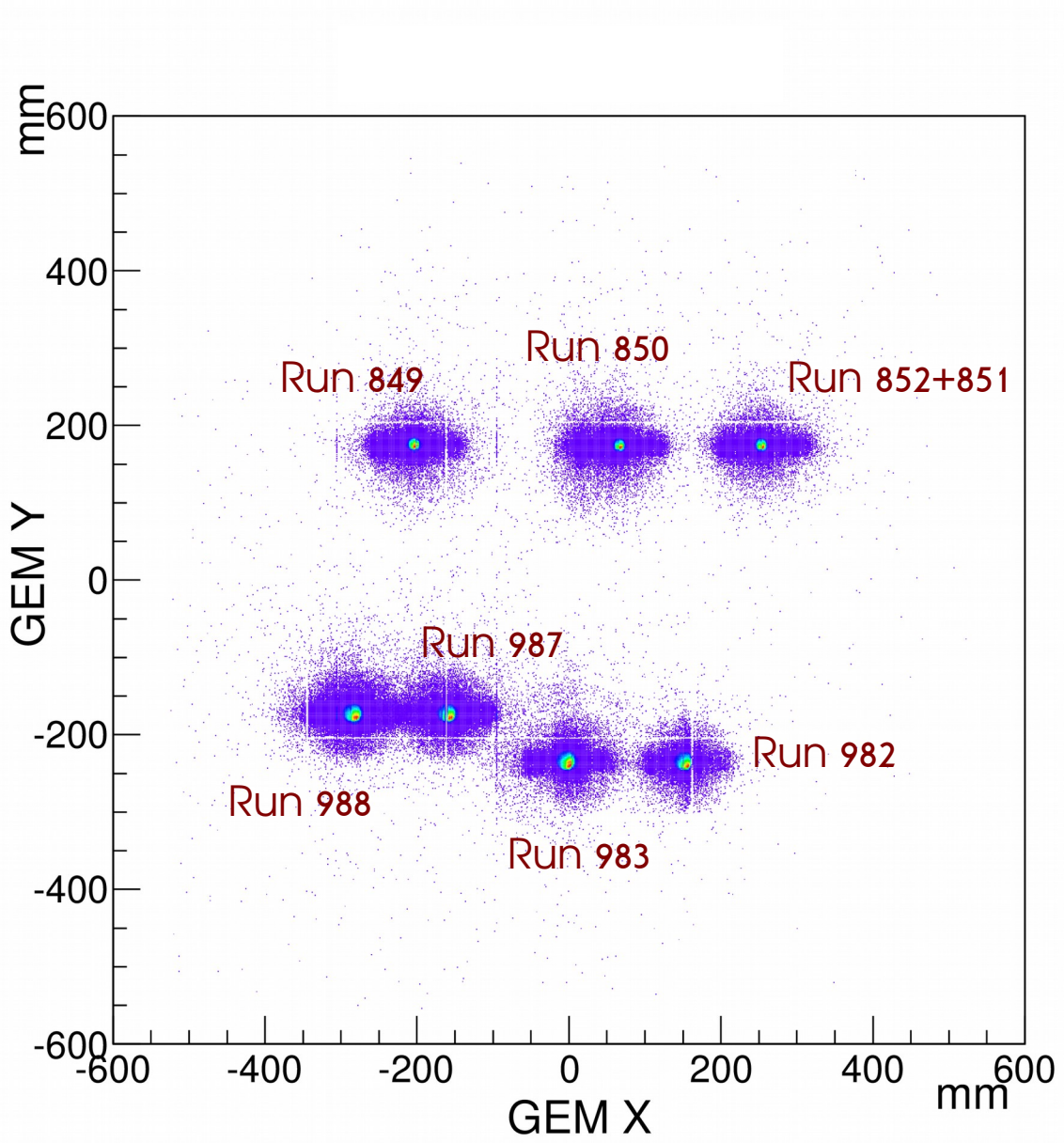
Contents

- Update on GEM efficiency from calibration.
- Cross talk removal

GEM scanning spots during calibration run

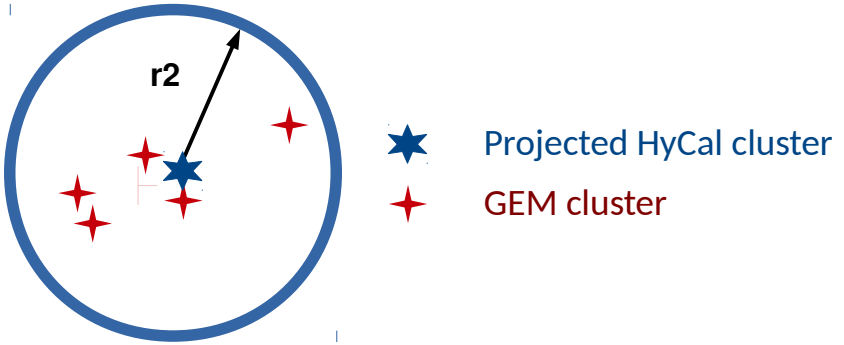
reminder



GEM HyCal Matching

reminder

- Project HyCal Cluster to GEM
- Draw a circular area around the projected points,
- Find the closest points within this area.



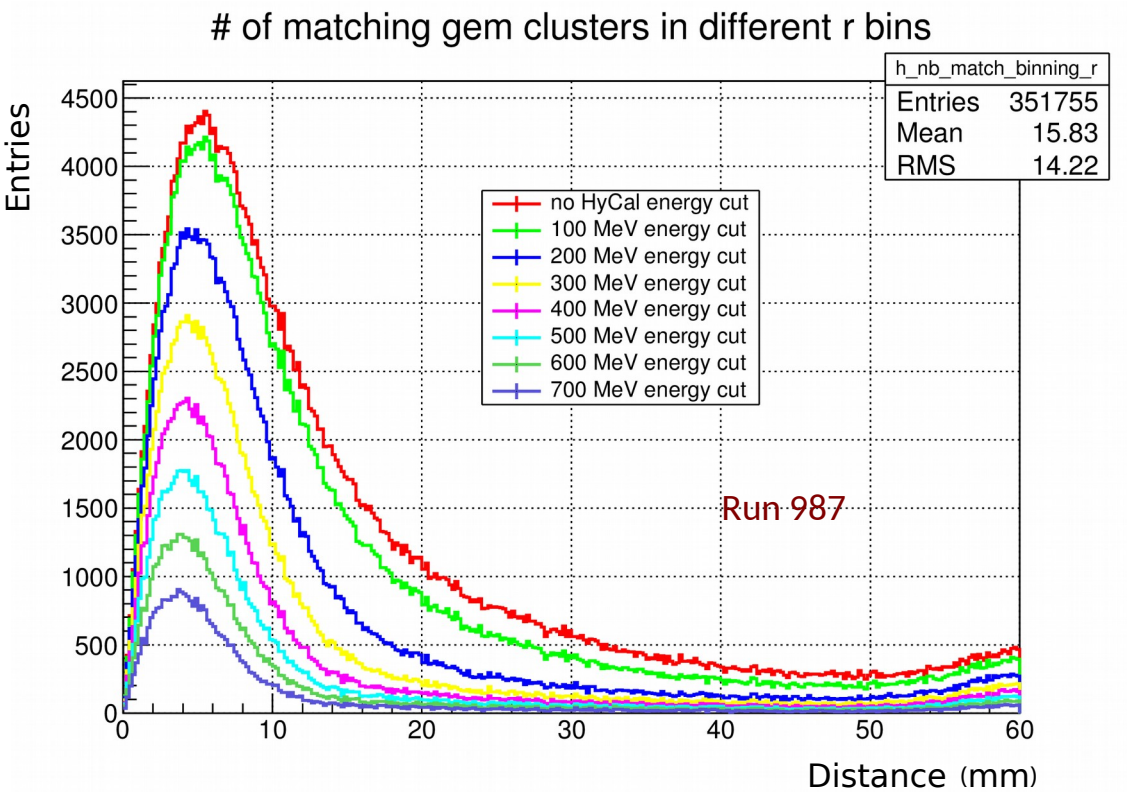
HyCal GEM Matching on GEM detection Plane

Searching Radius Binning

Bin size: 0.2mm. Intent: find the proper searching radius for calibration data.

Meaning of this Plot:

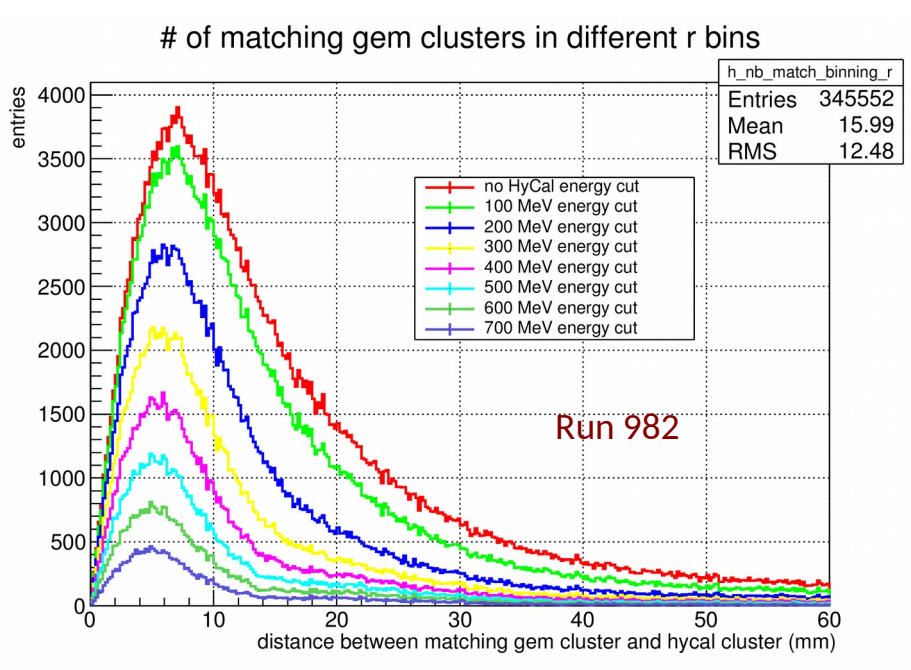
- Find all GEM clusters within that searching area (r = 60mm).
- Get the distance for each GEM cluster relative to projected HyCal cluster.

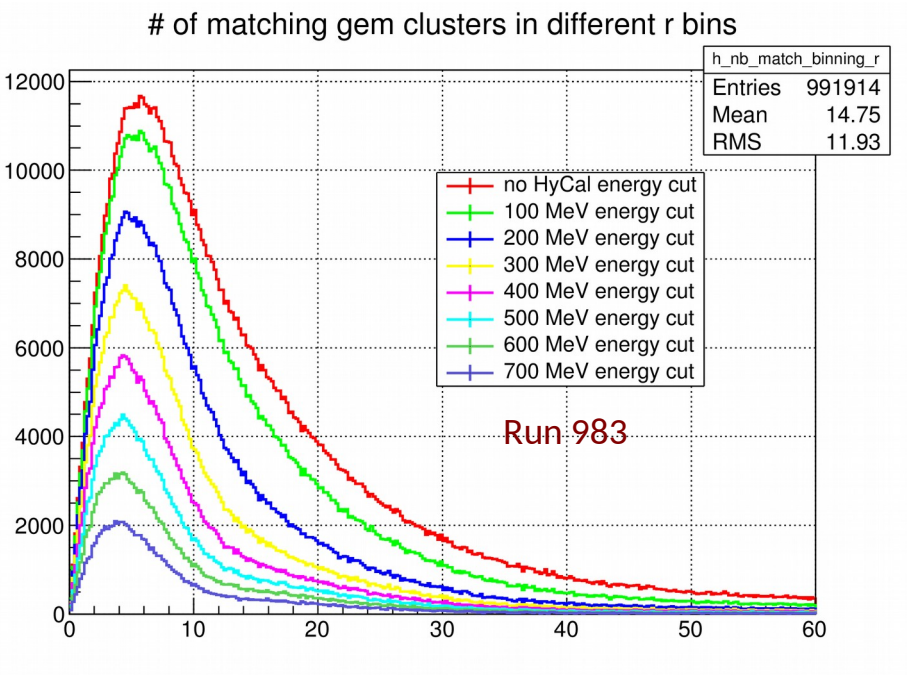


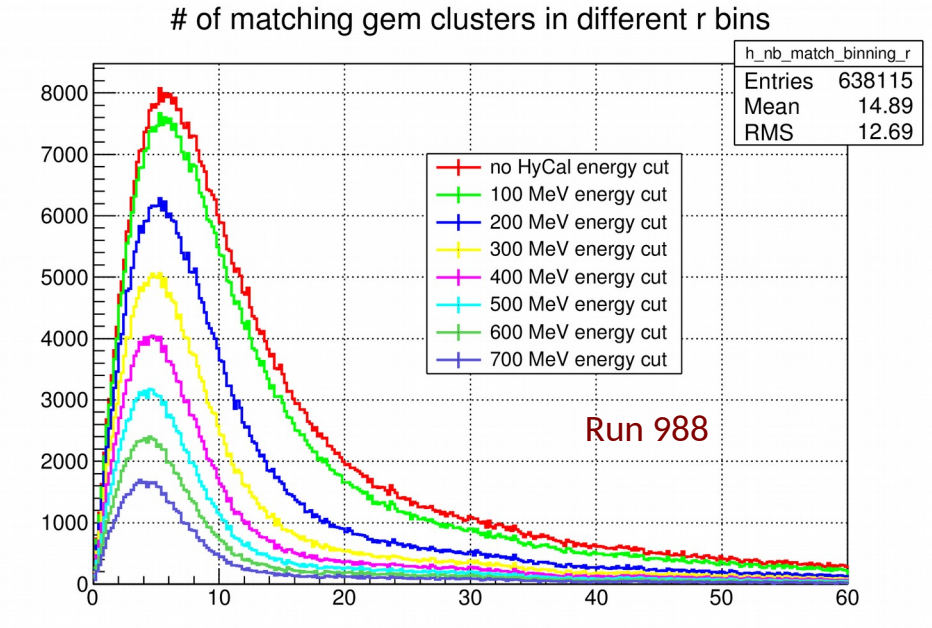
This plot shows that for most of GEM clusters: how far are them away from the projected HyCal cluster.

Searching Radius Binning

Bin size: 0.2mm. Intent: find the proper searching radius for calibration data.

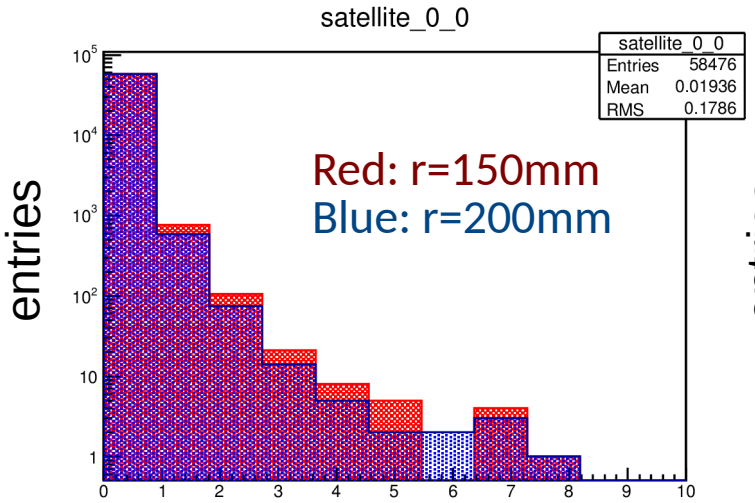




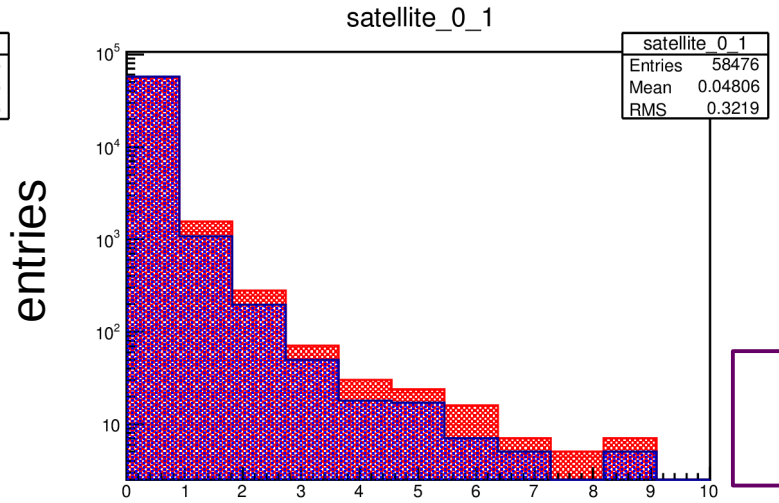


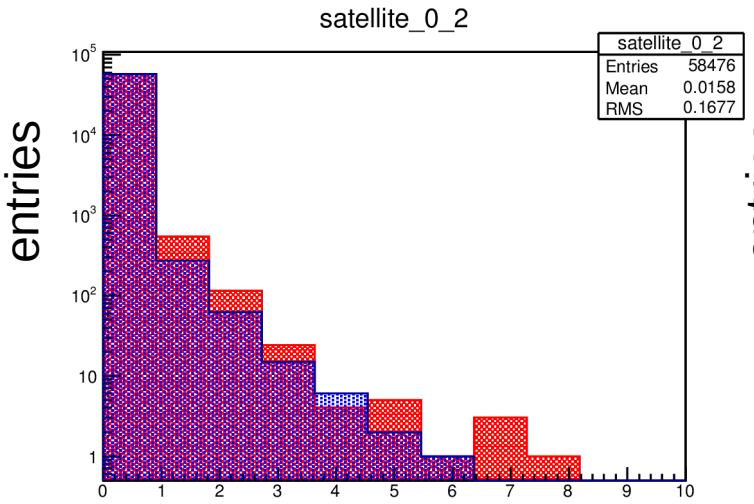
Nb matching gem cluster in satellite areas

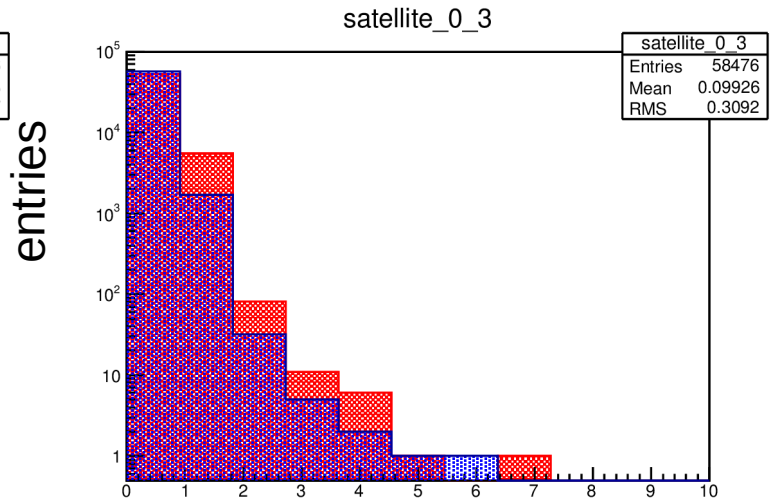
Co-incidentals estimation.

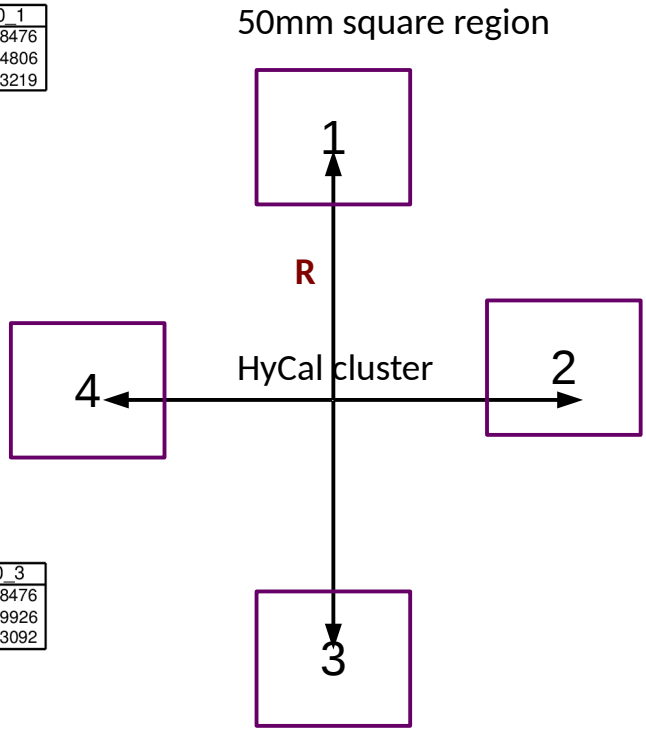


Red: r=150mm
Blue: r=200mm







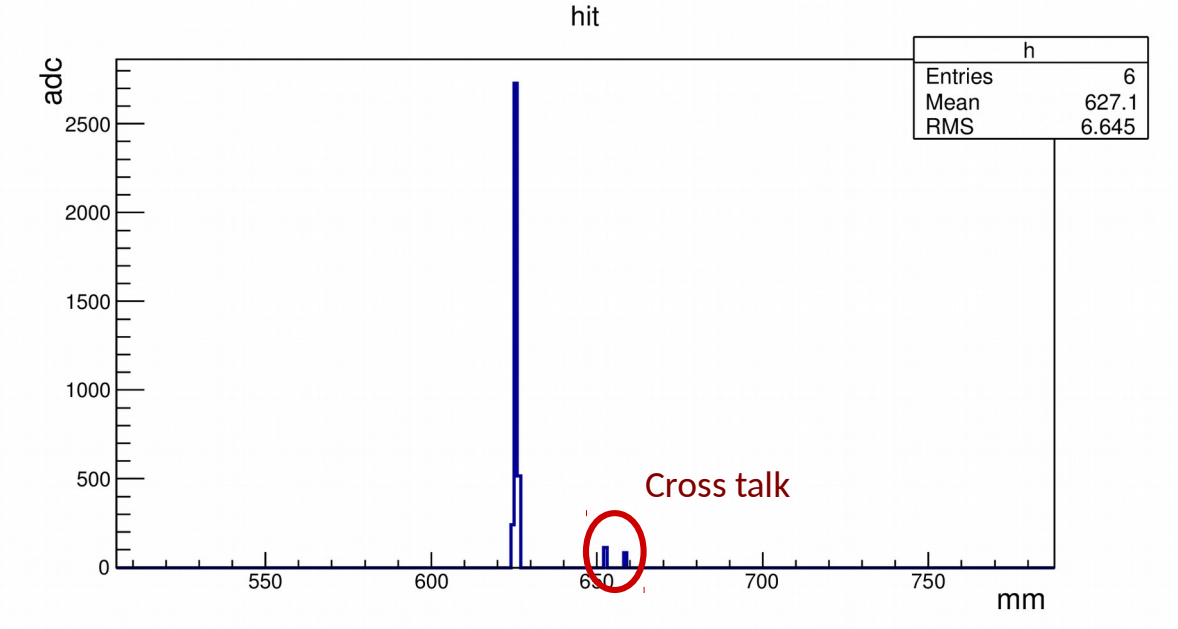


Number of GEM clusters

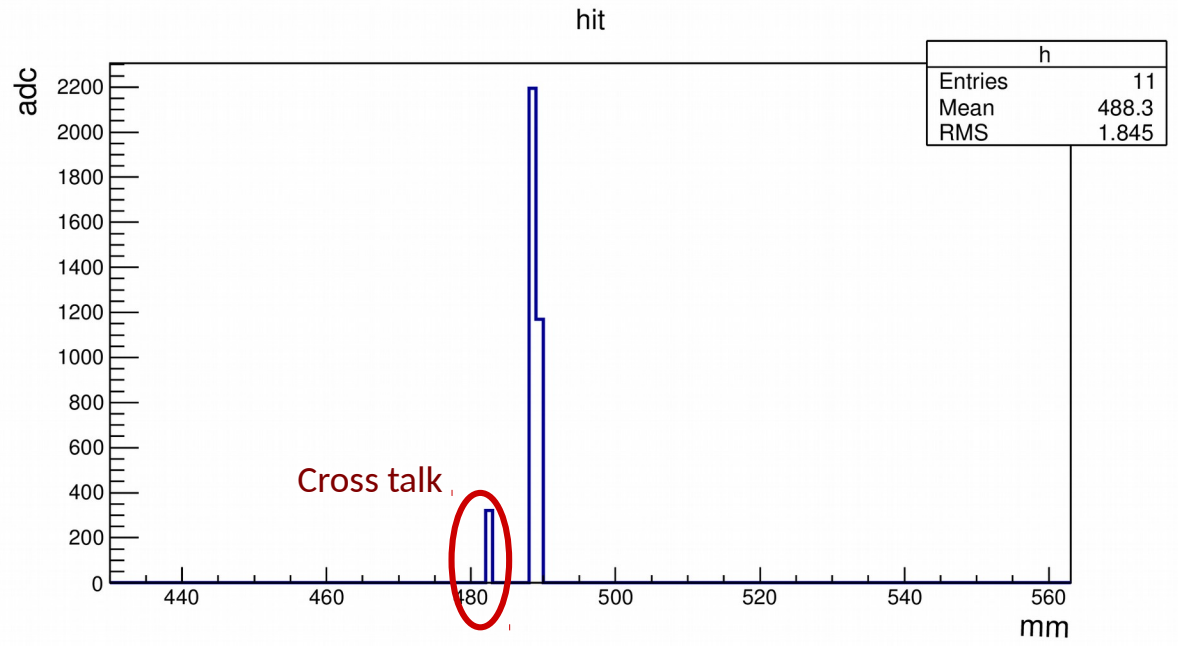
Cross-talk problem:

How cross talk signals look like?

Sample signal 1



Sample signal 2



Cross-talk problem:

Where cross talk comes from?

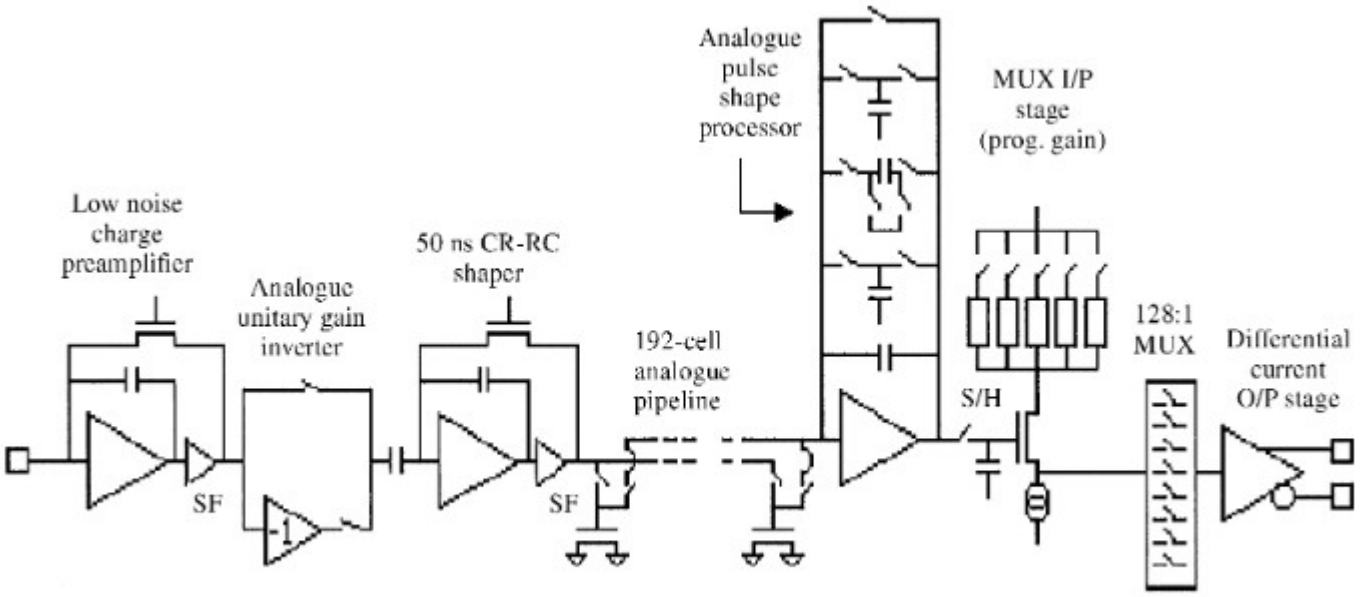


Fig. 1. Block diagram of one channel of the APV25.

APV: Analogue Pipeline Voltage mode

- Happens inside the APV25 chip.
- Between two neighboring channels.

[reference]: http://www.desy.de/~kapishin/bst/H1silicon/APV25chip_NIMA466.pdf

Cross-talk problem:

What are the characteristics of cross talk signals?

- APV25 channel order:

  "*Due to the tree structure of the analogue multiplexer, the order that channels are read out through the analogue output is non-consecutive. The multiplexer is constructed in three stages, if 'n' is the order in which the channels appear (starting at 0,1,2,3,4 etc), then the physical channel number is defined by:*"

  $$\text{Channel No.} = 32 * (n \bmod 4) + 8 * \text{INT}(n / 4) - 31 * \text{INT}(n / 16)$$

- cross talk happens between two-adjacent channels inside the APV chip.
- Detector strip order:

  strip 1 → strip 128 usually follows detector (X/Y) plane direction.
- Detector strips are connected to APV channels

  (Usually they are NOT by strip 1 → channel 1, strip 2 → channel 2, … etc. This depends on detector R/O board design pattern. Different detector have different mapping relationships.)
- Two channels neighbor inside APV chip, will not be neighbors on detector.
- For PRad GEM detector: If two channels neighbor inside APV, the strips they connected on detector can be separated by:

6.4mm, 17.6mm, 24.4mm, 24.8mm, 25.2mm, 25.6mm, 26mm, 26.4mm, 26.8mm, 33.6mm, 44.8mm

Ref[1]: https://indico.cern.ch/event/77613/contributions/2088496/attachments/1056875/1506927/MMW_20101214_Cross_talk.pdf
Ref[2]: https://cds.cern.ch/record/1069892/files/cer-002725643.pdf

Cross-talk problem:

`How to fix ...`

- Fix 1):

  1), Inside the APV chip level.

  2), for each channel, check if it has adjacent channels.

  3), if it has, find out which channel has bigger ADC value.

  4), see if the other strip has **<10%** of bigger ADC value,

  5), if it has, discard this channel, otherwise leave it and keep its ADC untouched.

- Fix 2):

  1), Reconstruct clusters using all strip information.

  2), Check the distance between each cluster, if separated by a cross-talk distance, then remove the smaller one.

  3), Not very reliable,

  a), b/c they can have many different distance configurations,

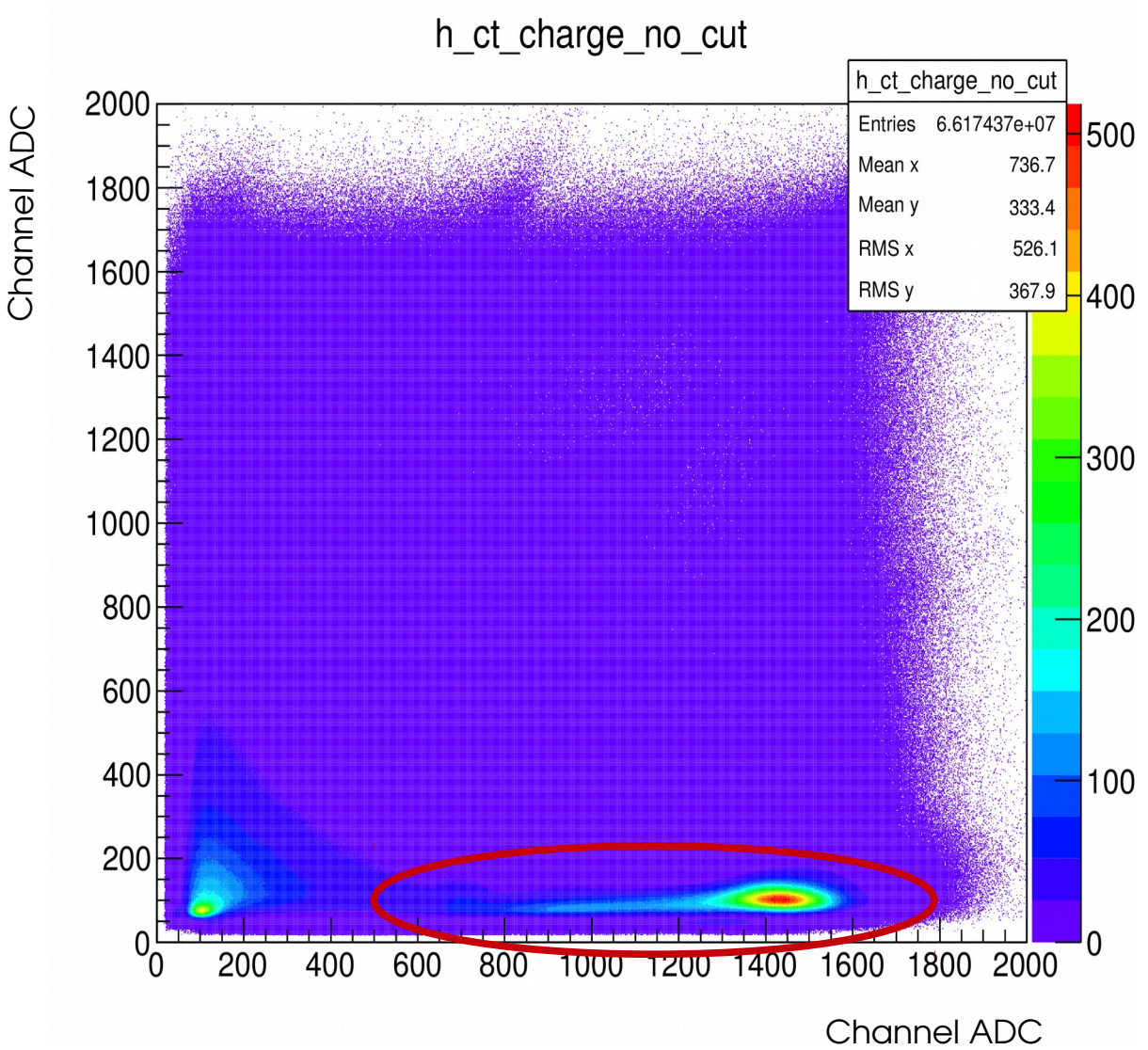
  6.4mm, 17.6mm, 24.4mm, 24.8mm, 25.2mm, 25.6mm, 26mm, 26.4mm, 26.8mm, 33.6mm, 44.8mm

  b), reconstructed cluster position can have variations.

Cross-talk problem:

Verification: exist or not? And how bad it is.

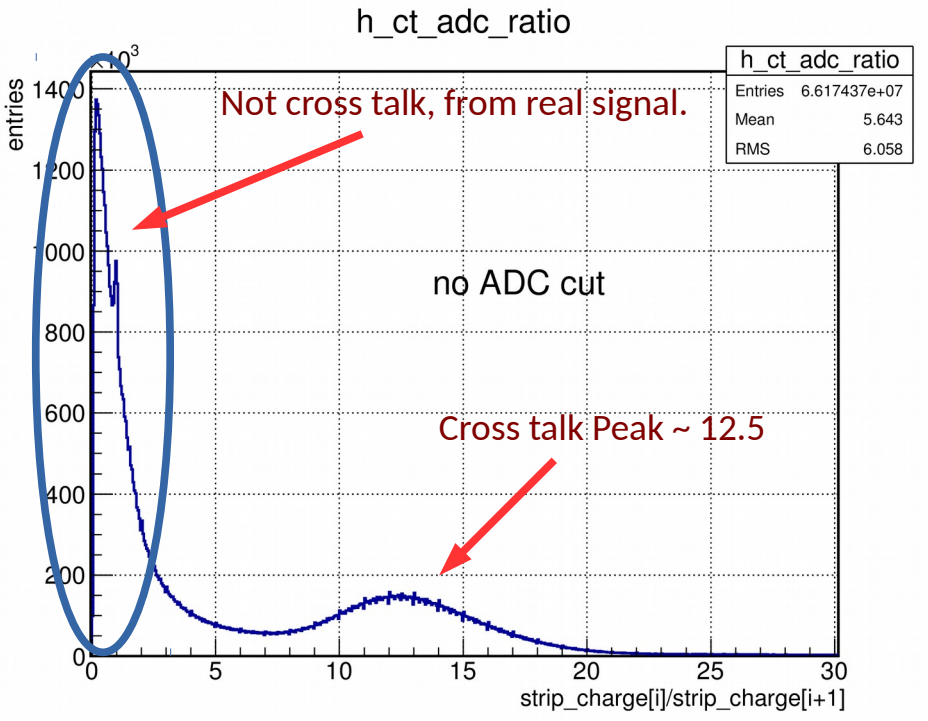
- Find all adjacent channels inside APV chip.
- Fill charge in channel n to x-axis, fill charge in channel n+1 to y-axis.

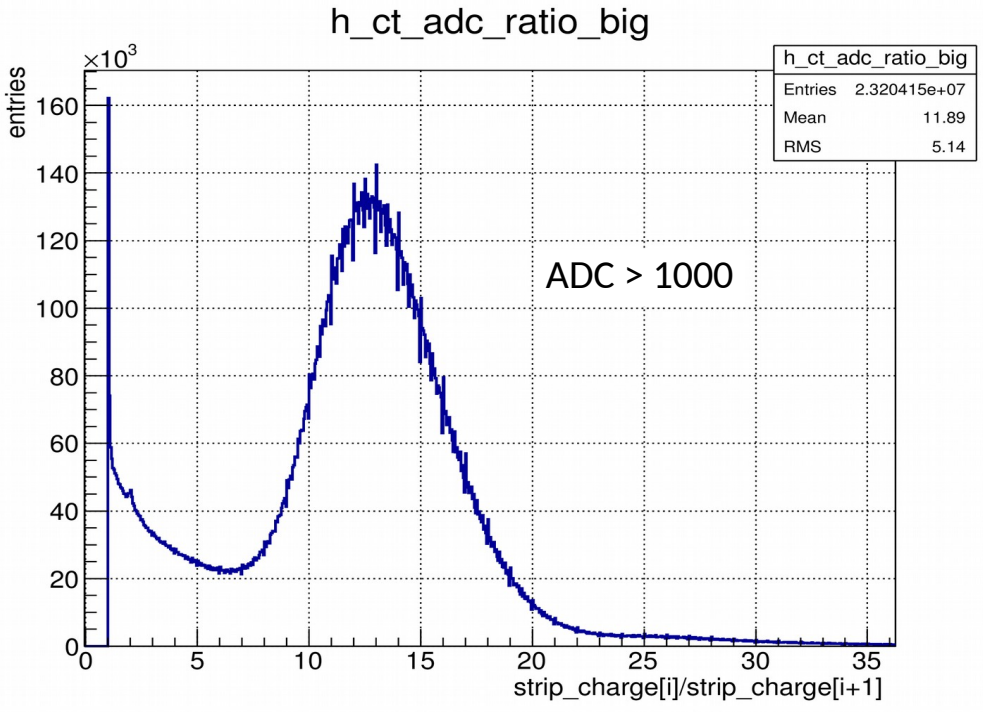


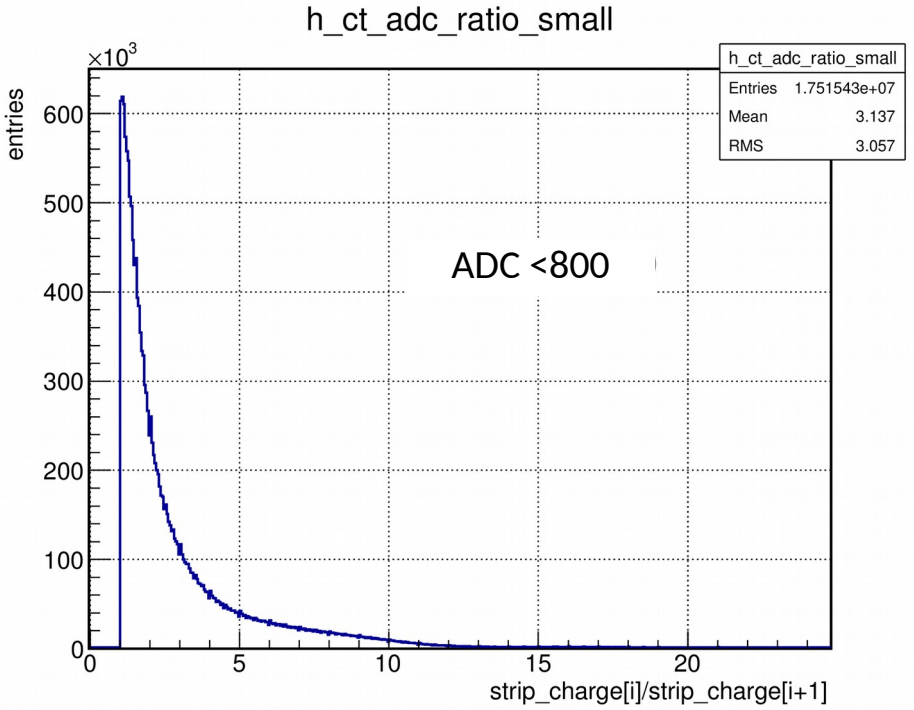
This plot is different with charge ADC 2-d correlation, this plot show channel ADC correlation, charge ADC usually contains 2-5 channels ADCs.

Cross-talk problem

- Find two adjacent channels (n, n+1), these are suspected cross-talk channels.
- Compute the charge ratio of the two channels.
- Among the two channels, one channel has bigger ADC, the other one has samller.
- APV noise level ~ 14 ADC.



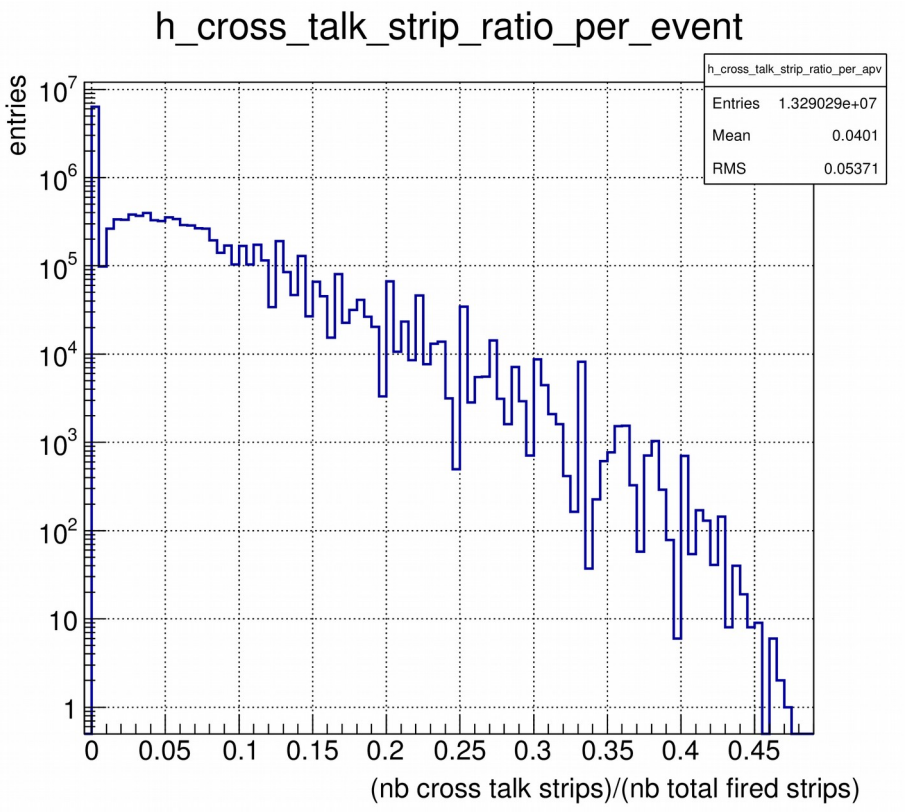




Cross-talk problem:

Verification: exist or not? And how bad it is.

- This plot shows in each event, the number of suspected cross-talk strips / total number of fired strips.
- This plot intends to show how bad the cross talk situation is.
- Roughly estimates the percentage of cross talk strips.

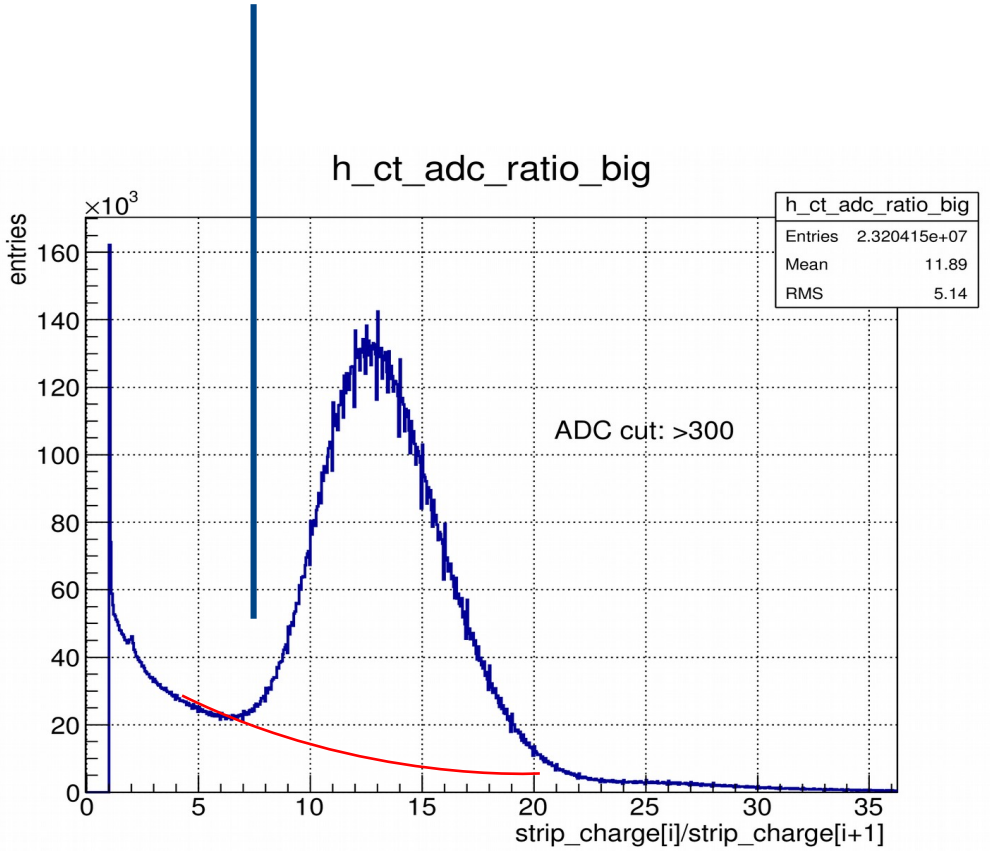


Cross talk channels are always induced by a physical channel, so the ratio should be always < 50%.

Cross-talk problem:

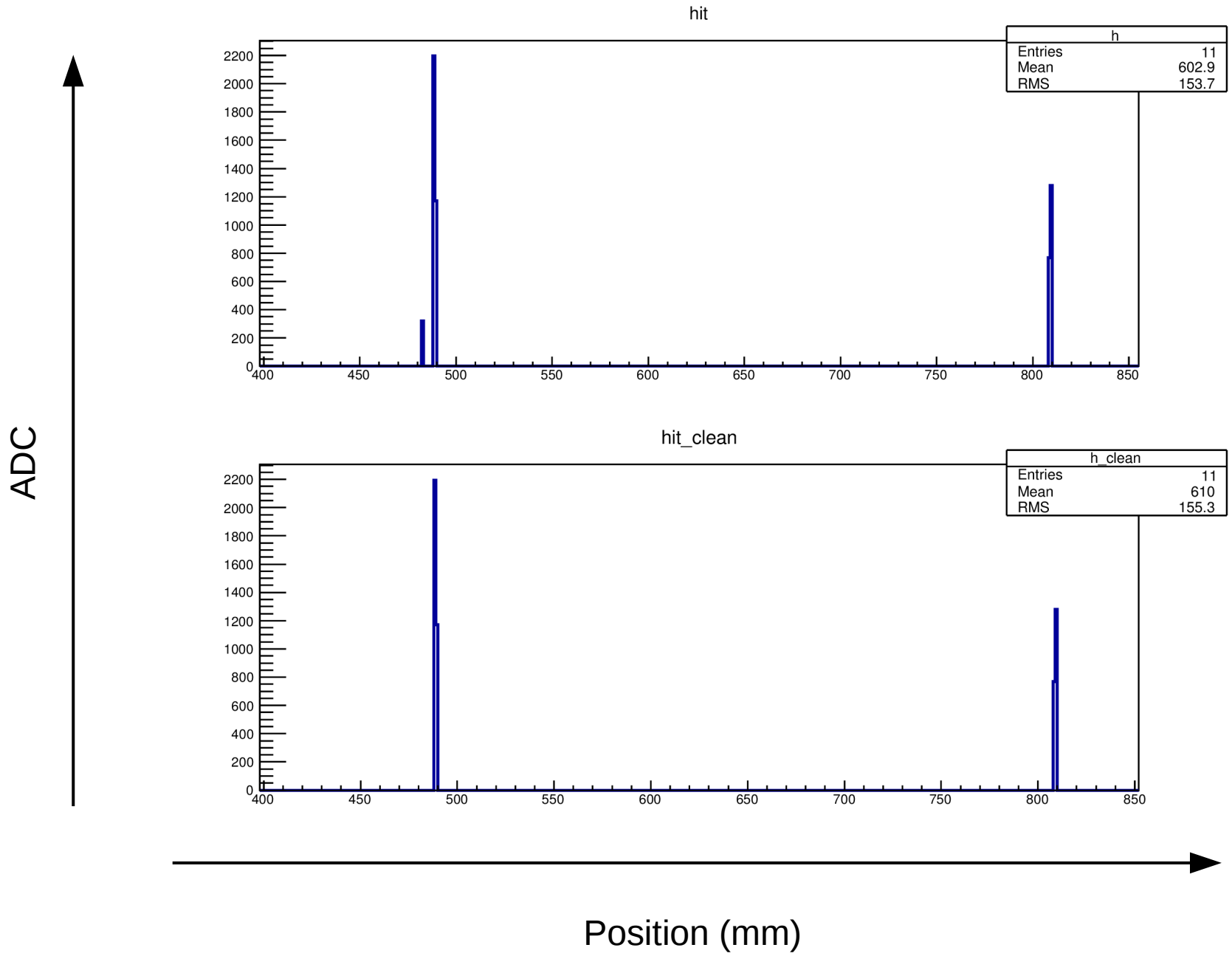
Find the optimum fix.

Where to cut
8, 10, etc

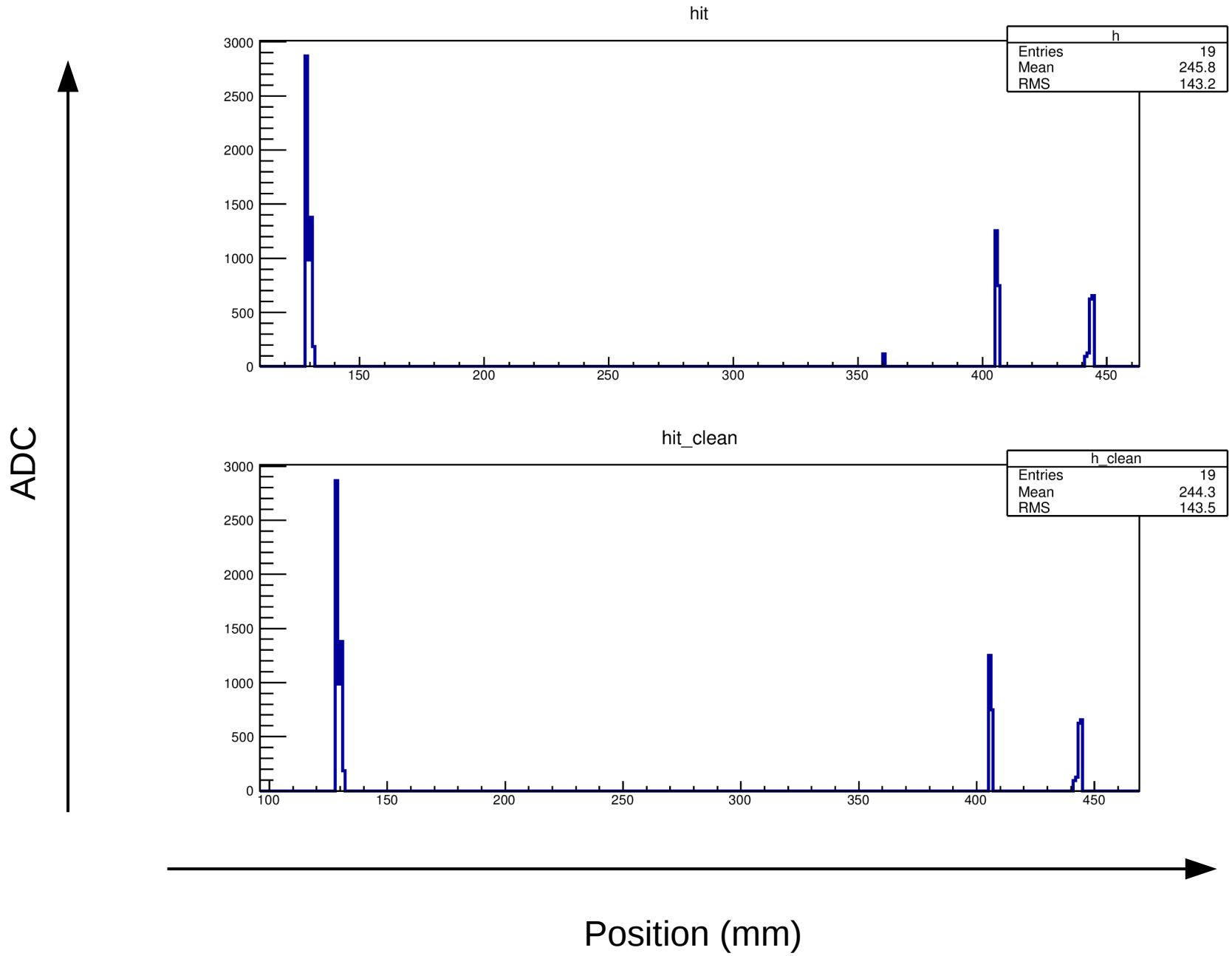


- Want to cut away this peak.
- Hard to assure that real signals are not cut.

Cross Talk problems removal



Cross Talk problems removal



Summary

- Remove cross talk strips in APV channel level.
- In 13M total events, there are ~7M events have suspected cross-talk strips, ~ 52%.

Next:

- Apply this cross talk removal code piece to GEM reconstruction.
- Simulation for GEM efficiency from calibration data under going.
- Use HyCal island clustering method on some part of GEM calibration data.