Study of the CDC background

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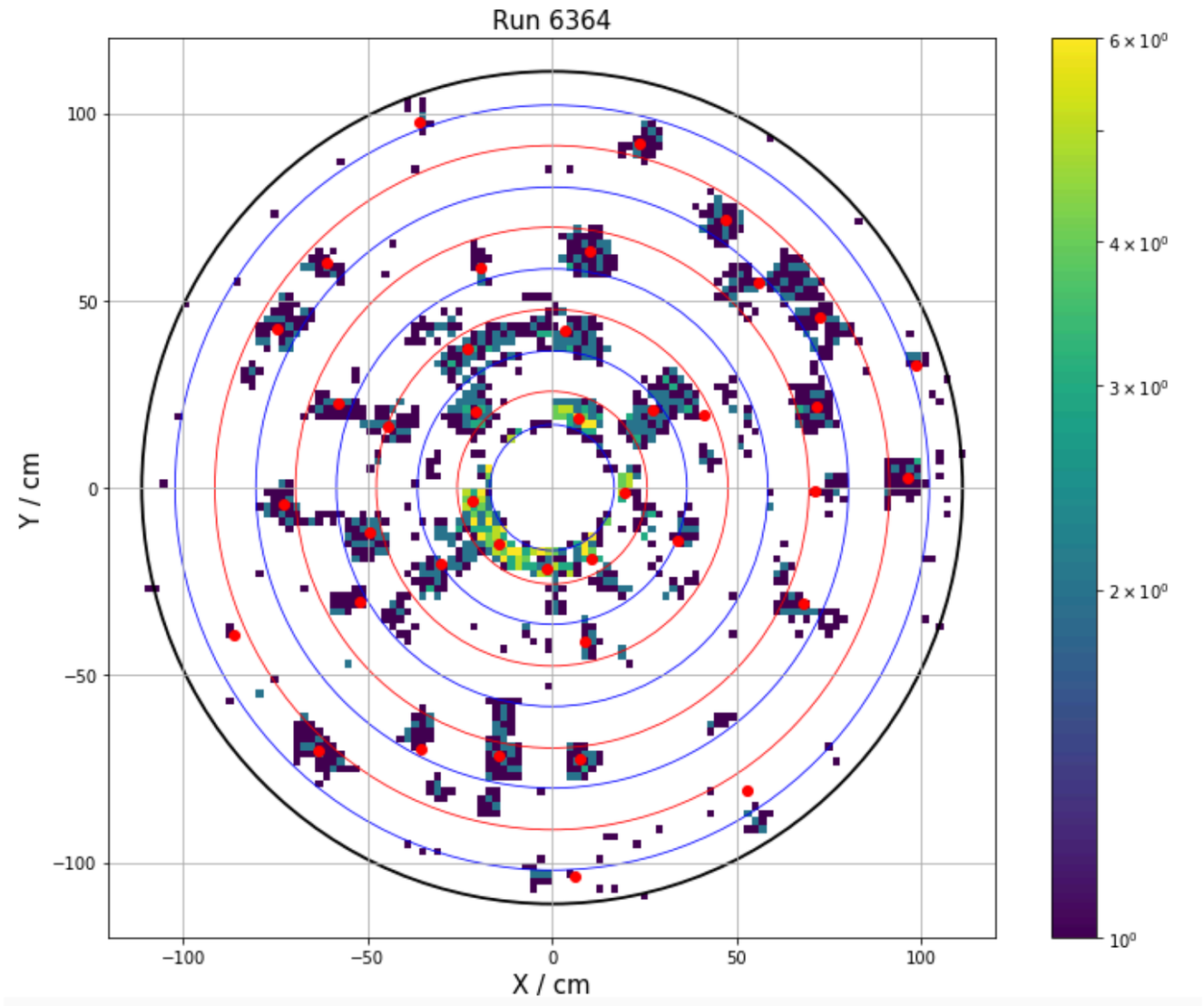
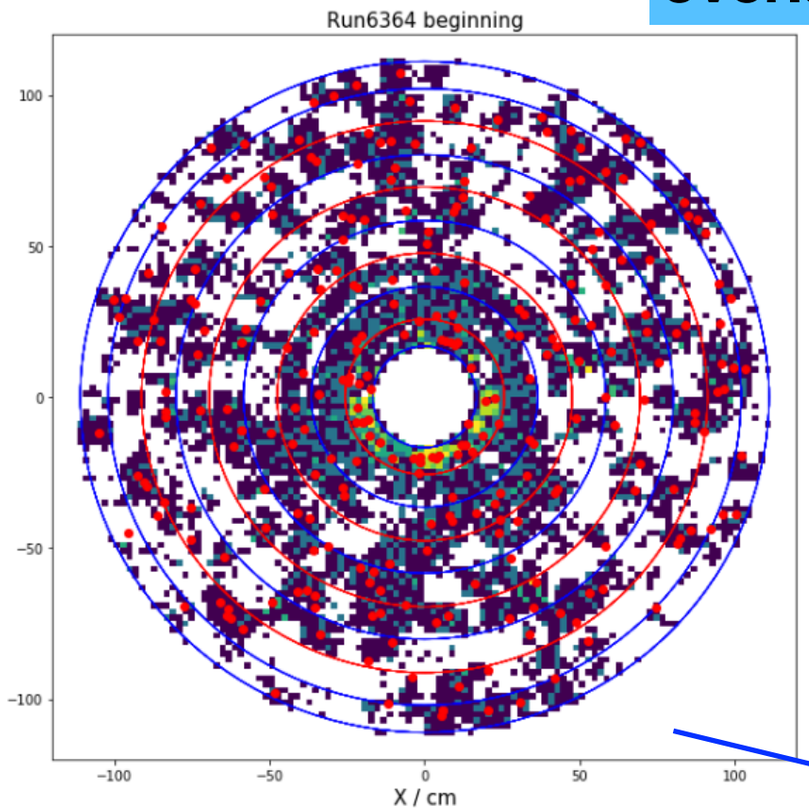
Clusters in random trigger data

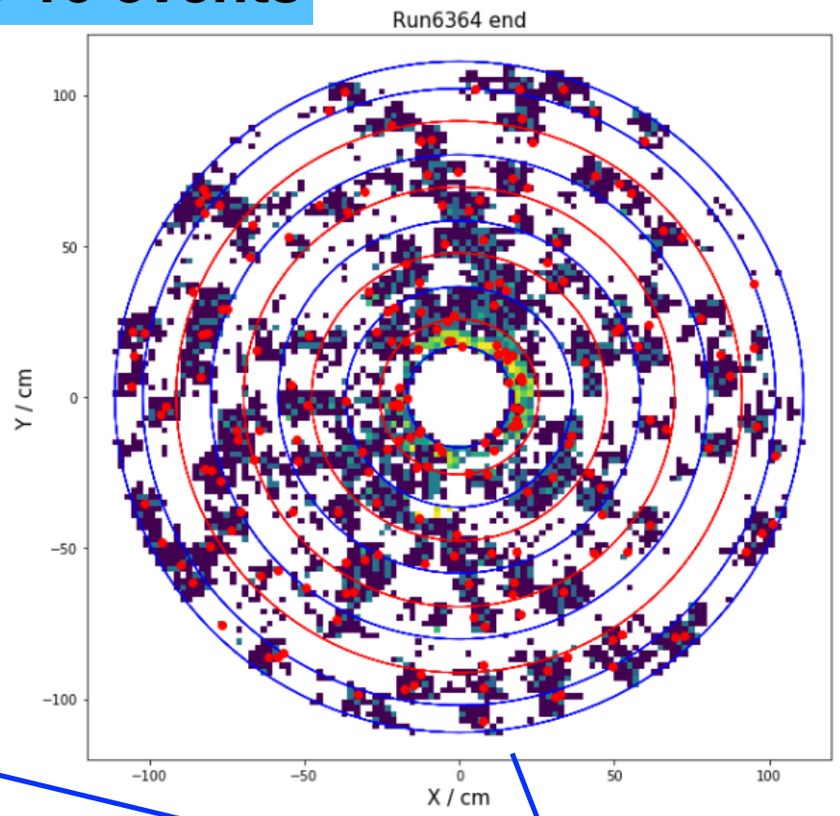


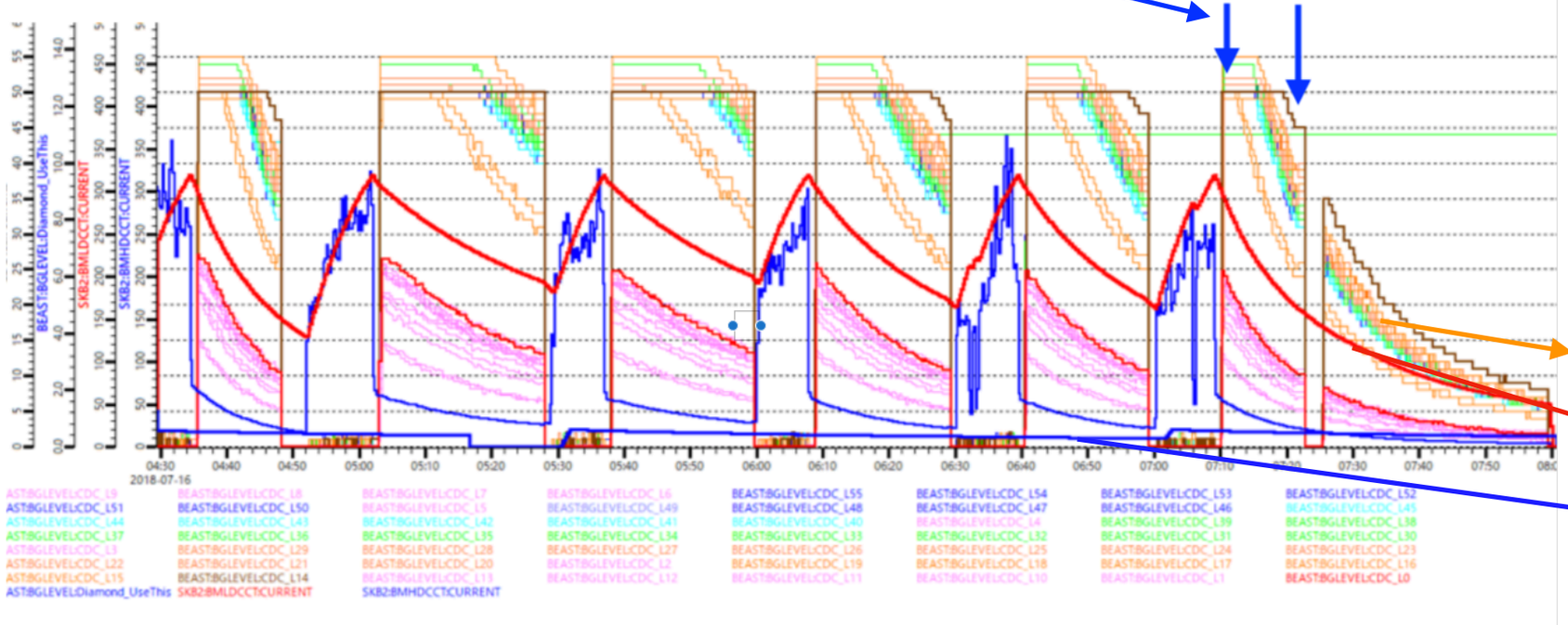
- From CDC hits distribution, Cluster-like backgrounds are found in the LER random trigger data
- The background also seen in HER-only and collision data.
- The cluster sizes are around 20cm (diameter) and seem distributed homogeneously in most of CDC area.
- The clusters mostly confined in single super- layer - almost no overlaps .
- Increased background in innermost super-layer, probably due to the additional beam-wall background close to IP

Clusters in random trigger data

overlay 10 events







- The number of cluster is beam current related
- Some time dependent pattern is observed. The hits distribution is more homogeneously at the end of the run.
- This pattern is consistent with the currents in each layer during the data taking.
- At beginning of the run, the currents of outer layers reach the limits, so the hits are suppressed.

CDC current in each Layer

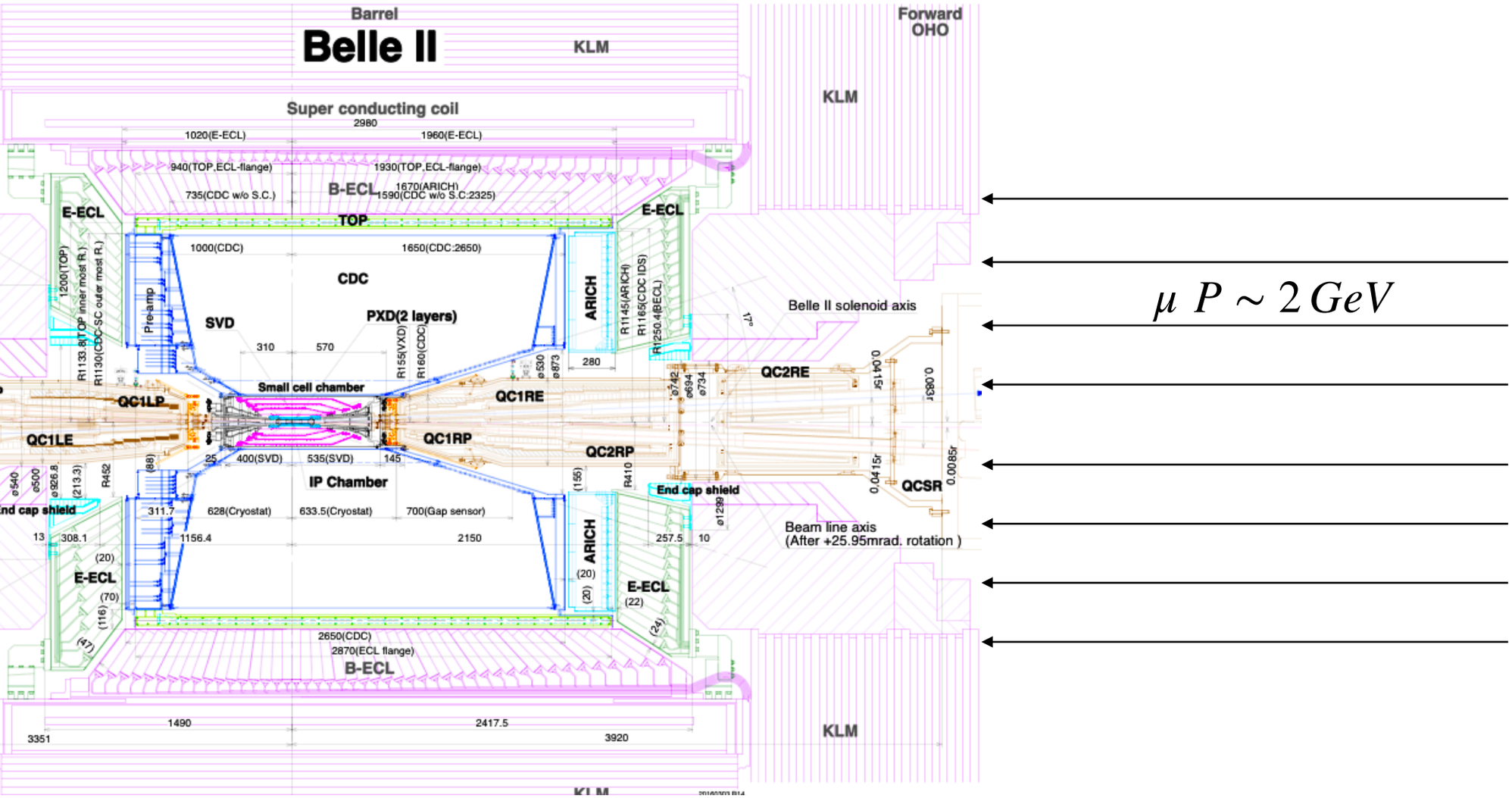
LER current

HER current

Possible source of BG.

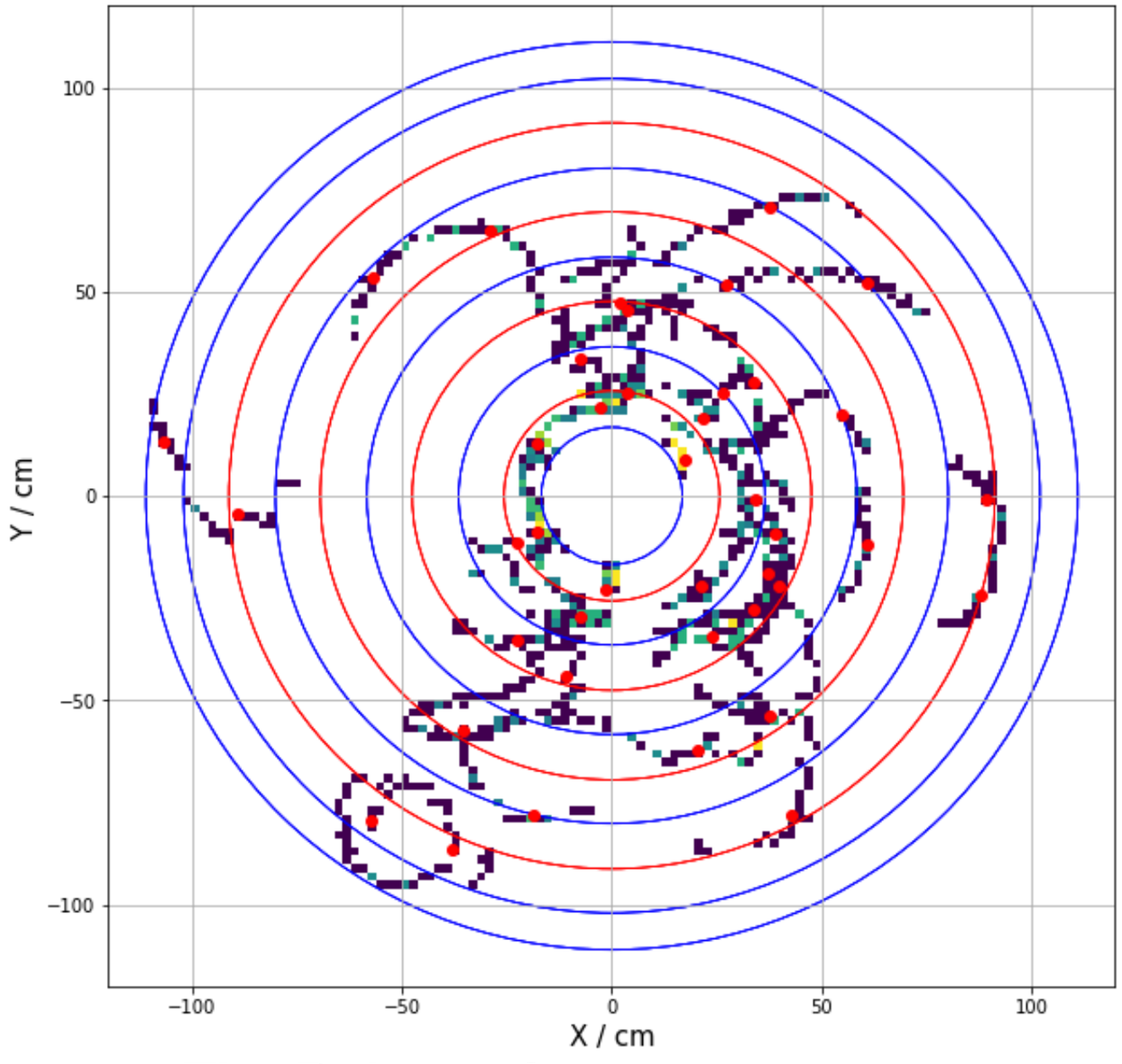
- General idea:
  - Clusters come from tracks with small Pt.
  - The original particles come from outside of the detector since the spatial distribution is almost homogeneous. .
- Possible candidates:
  - muon: long life, small cross section with material, pick up transverse momentum due to multiple scattering in the iron, (>75 MeV for 1-1.5m @ 2 GeV)
  - photon: conversions in the CDC end plate. For LER we in fact identified a hole in the shielding
  - neutron: interactions with the CDC gas, lead to highly ionizing and very short tracks
- We can simulate these background to reproduce the clusters.

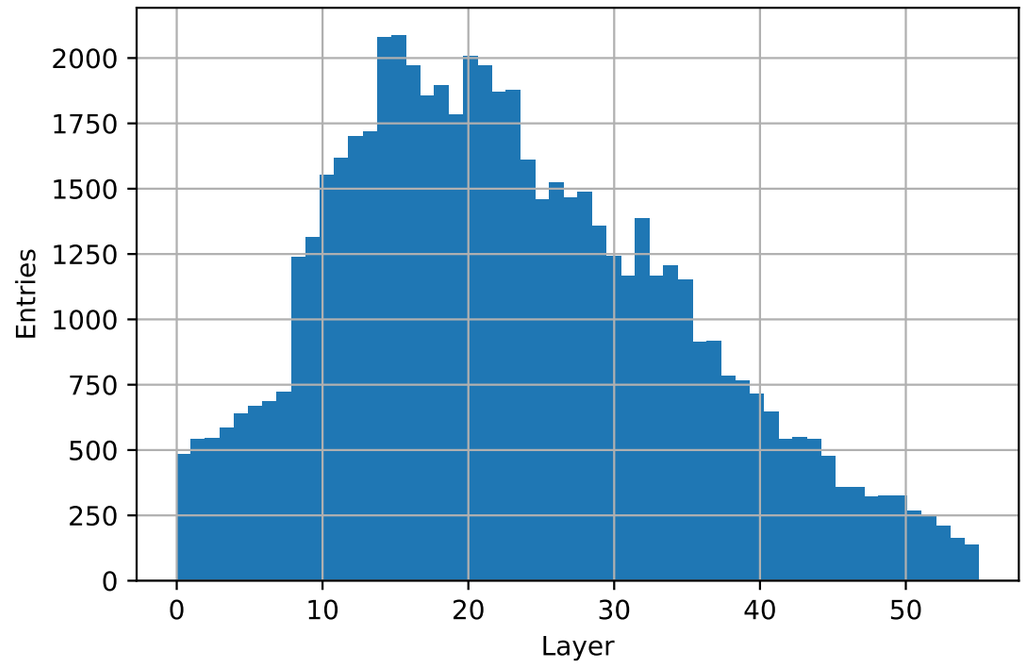
Halo muon BG.

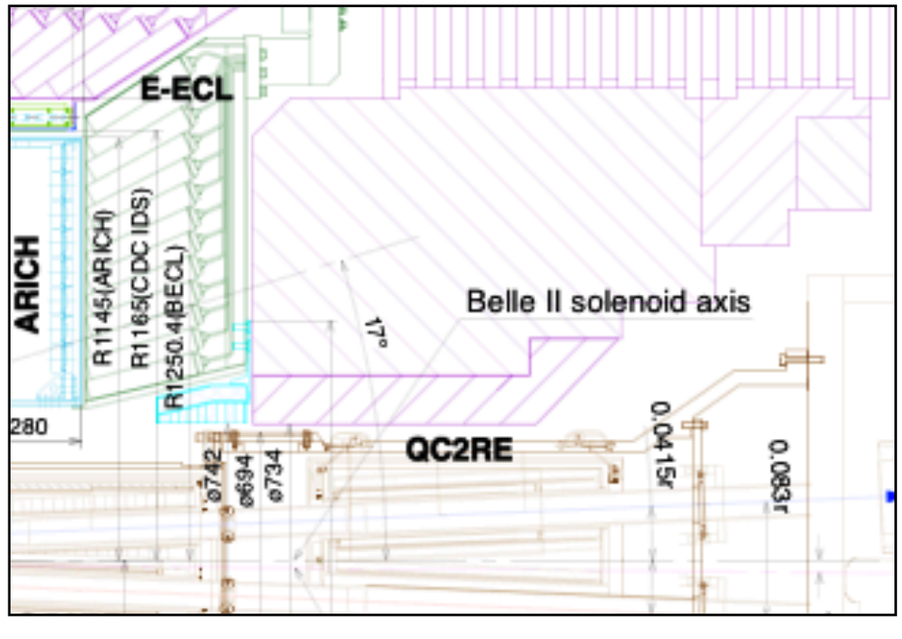


μ $P \sim 2\,GeV$

Simulated BG. in CDC

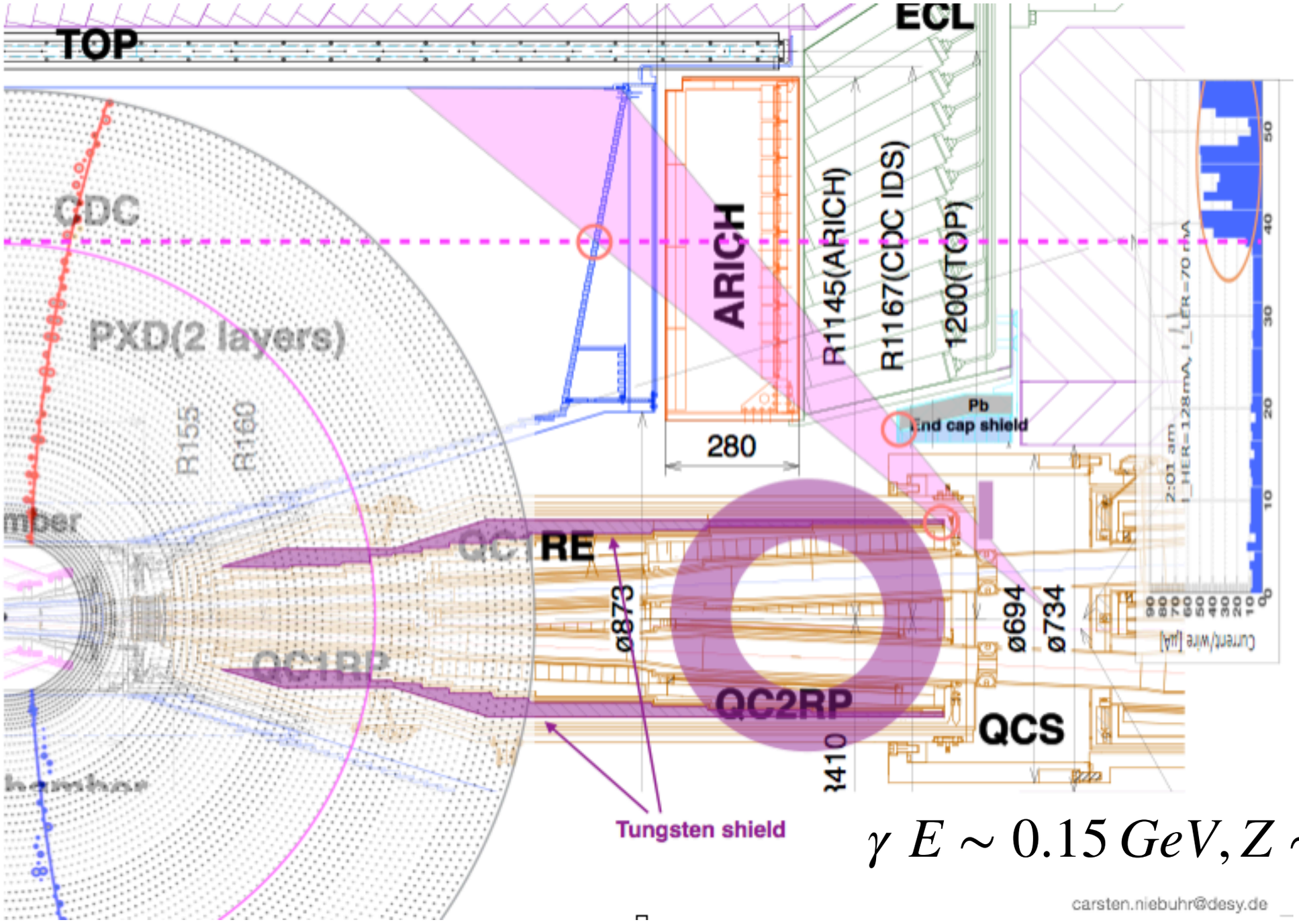






- **The Pt is too large**
- **Hit number should be R dependent**
- **Data distribution ~flat**

Photon from LER



$\gamma\ E \sim 0.15\,GeV, Z \sim 250\,cm$

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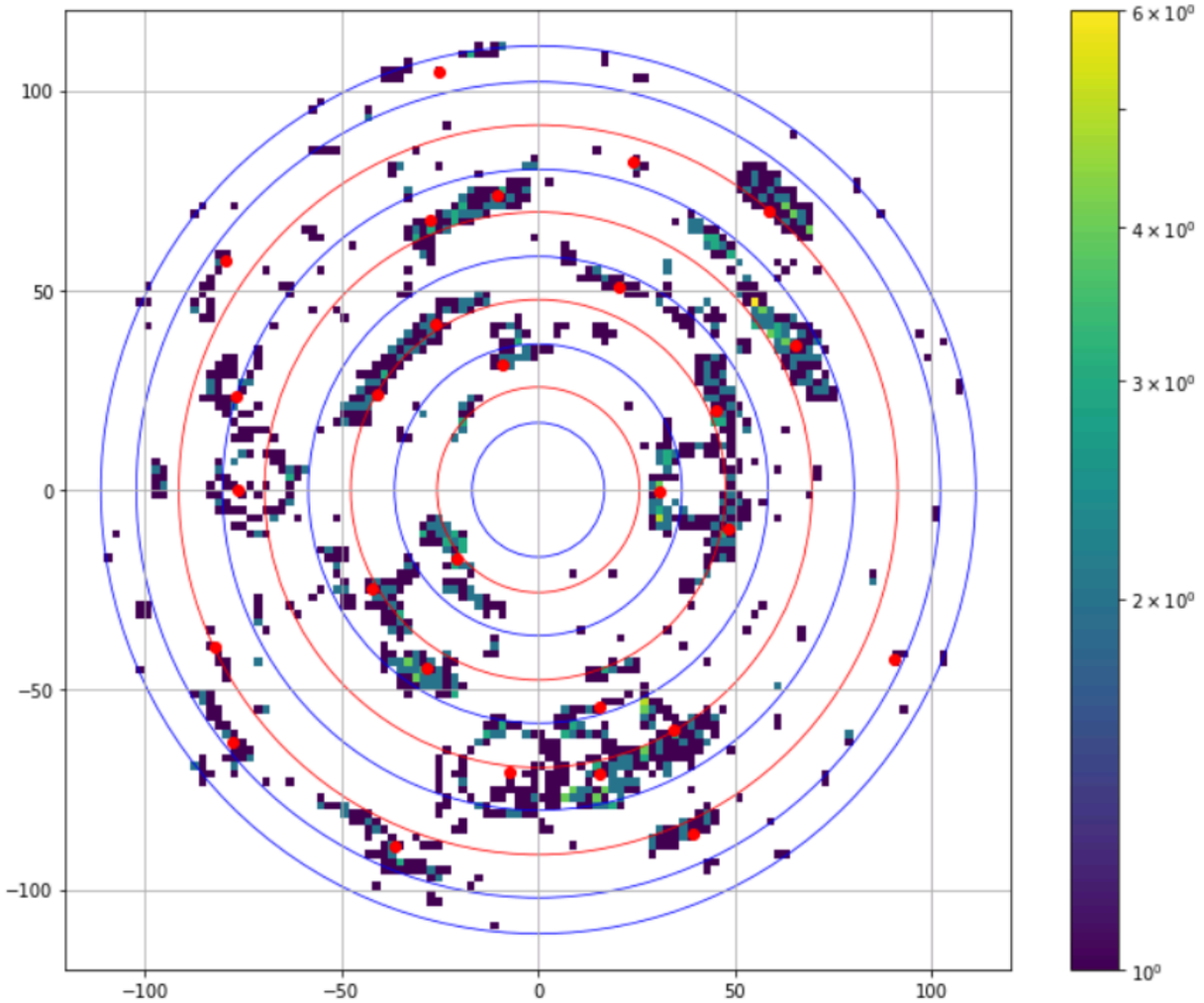
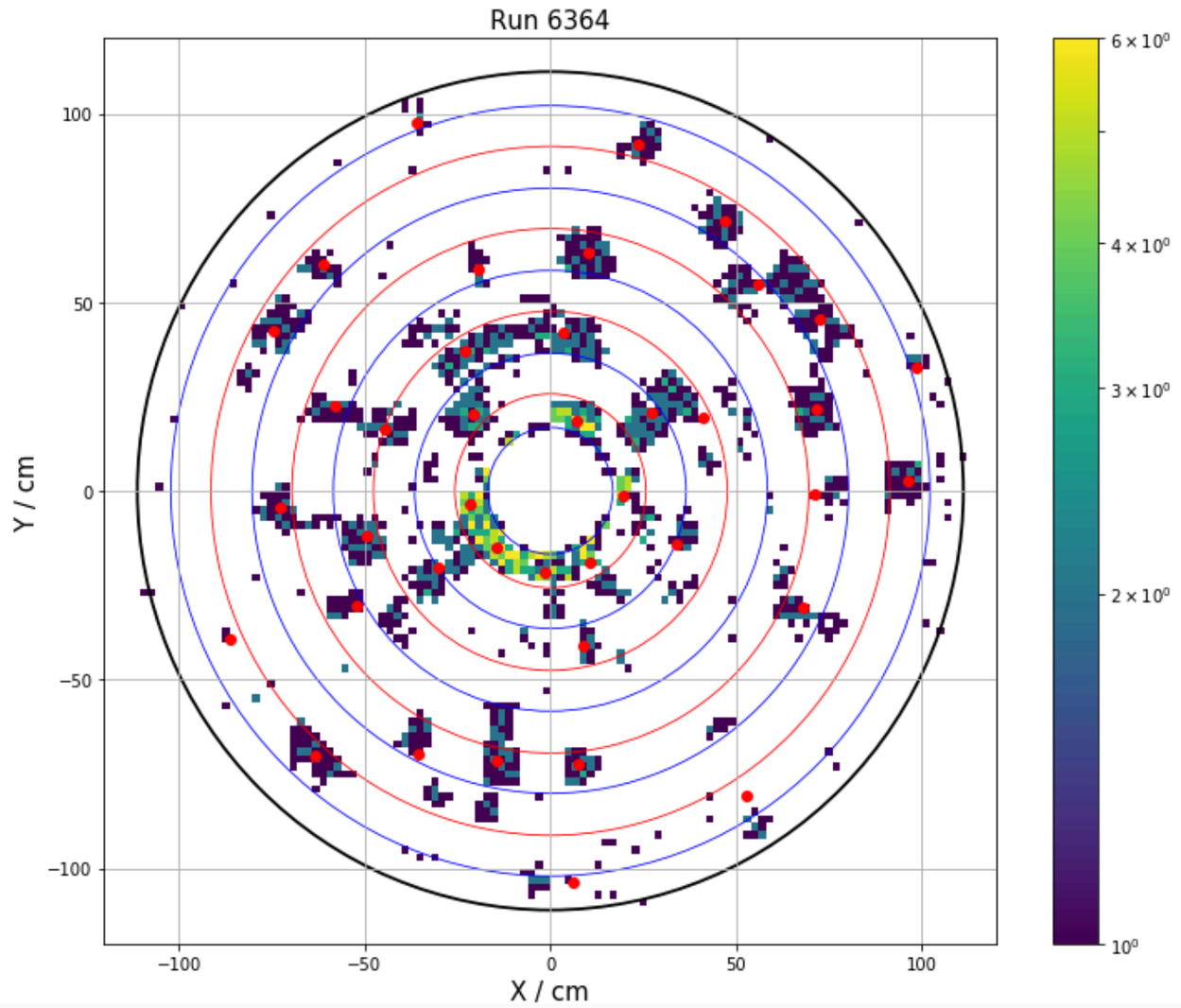
Simulated BG.

MC

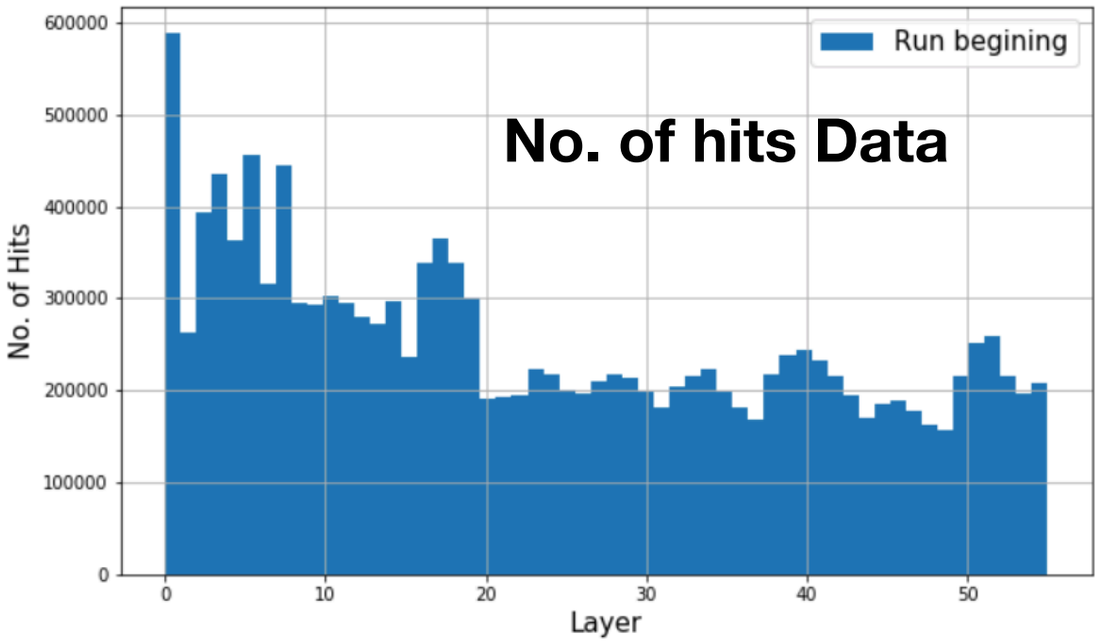


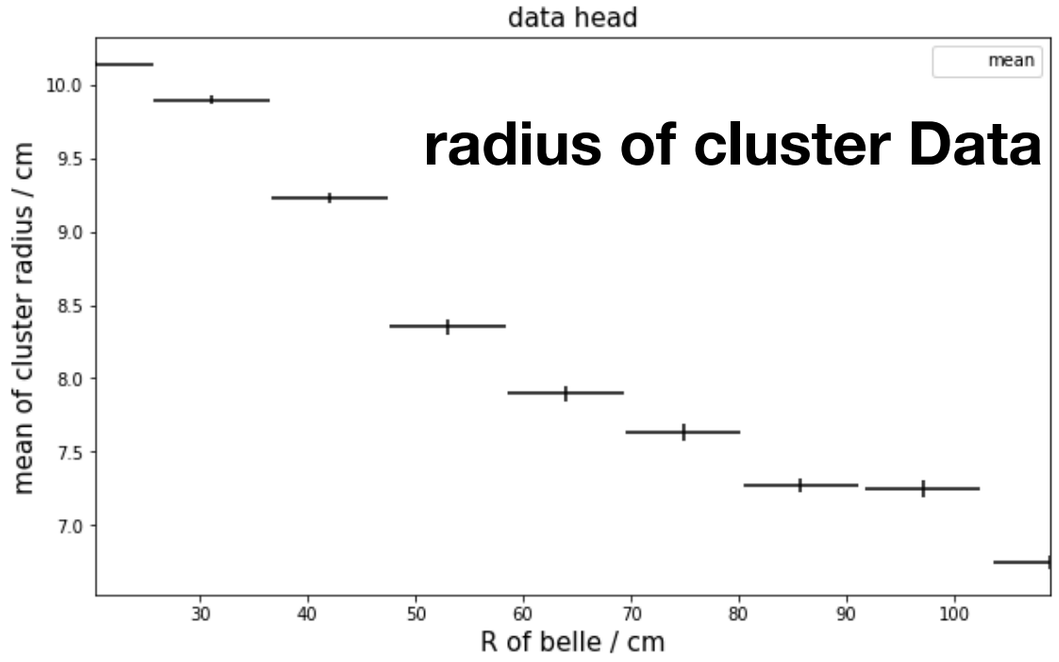
Data

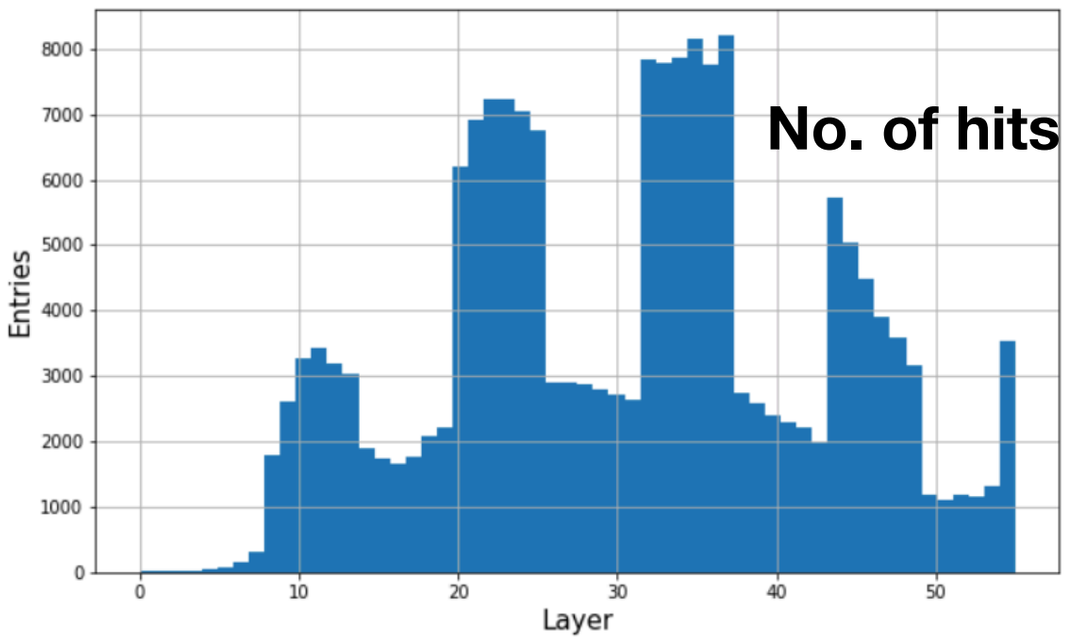


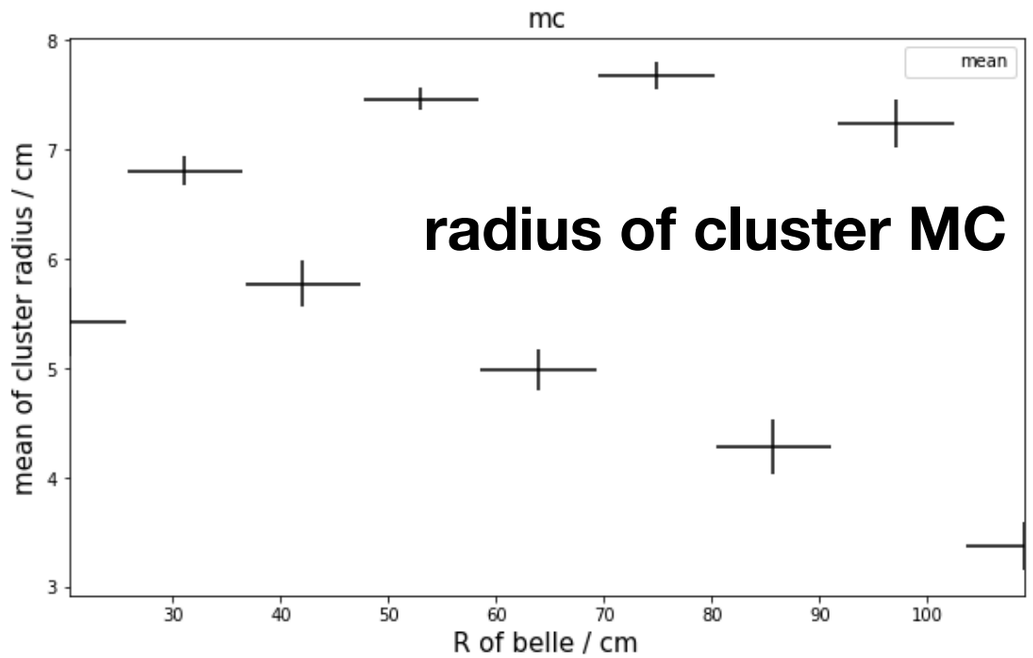
- On first glance looks similar than data

Is it the true BG.?





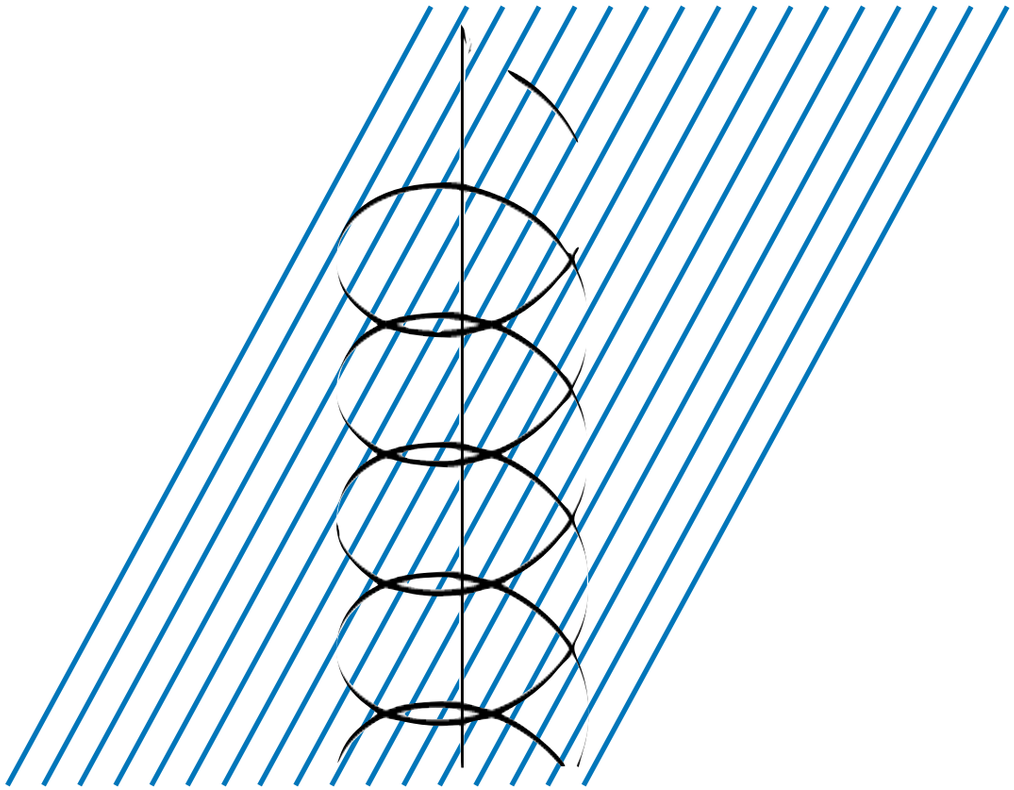


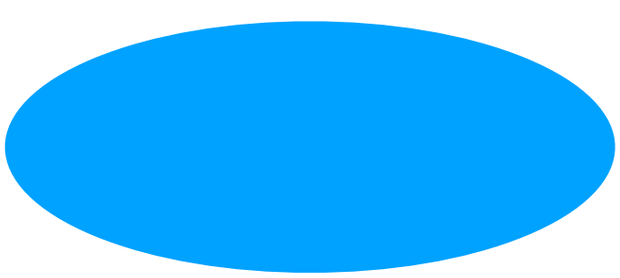


The hits number and cluster size in stereo layer is much larger than that of axial layer

Why the shape is different?

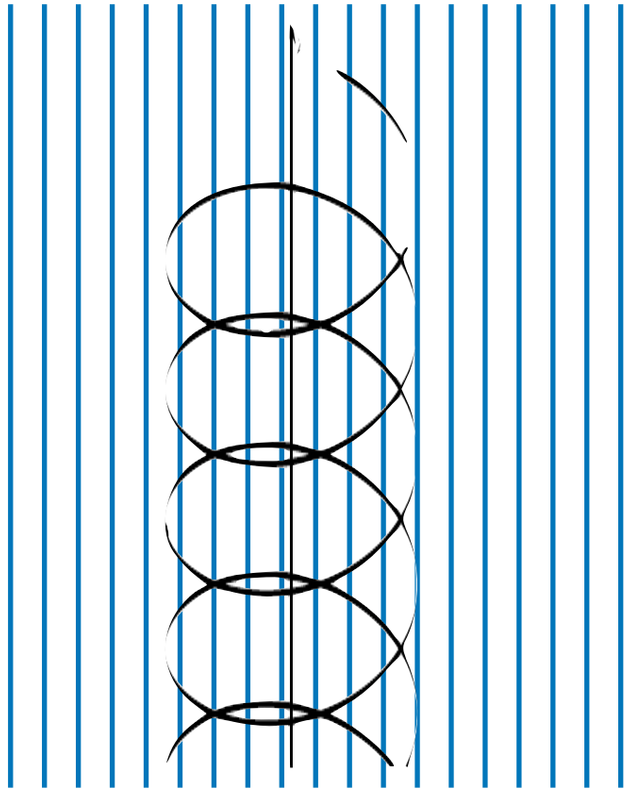
stereo layer

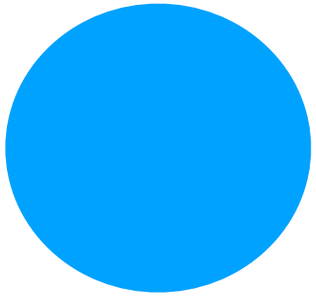




cluster shape

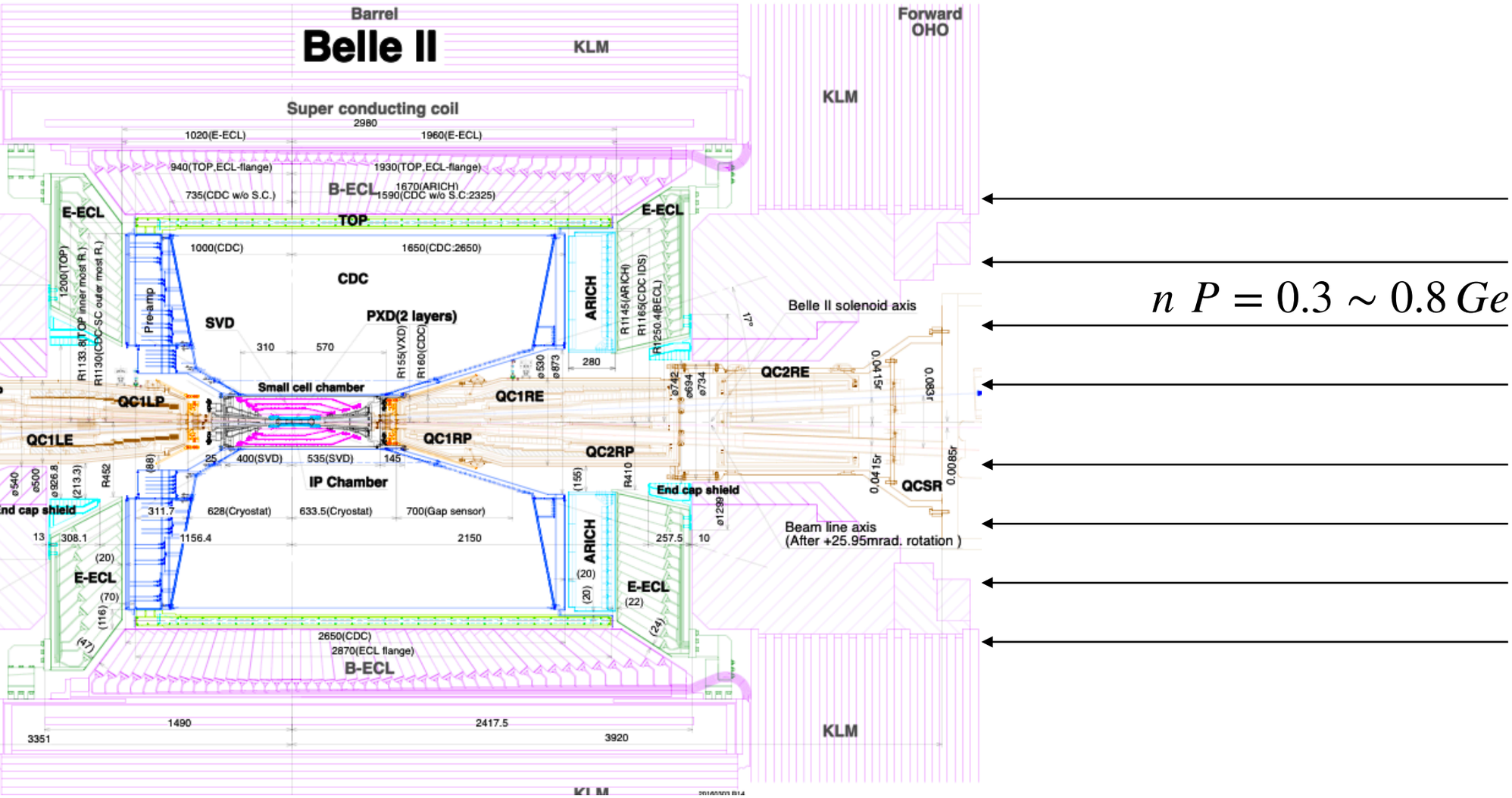
axial layer





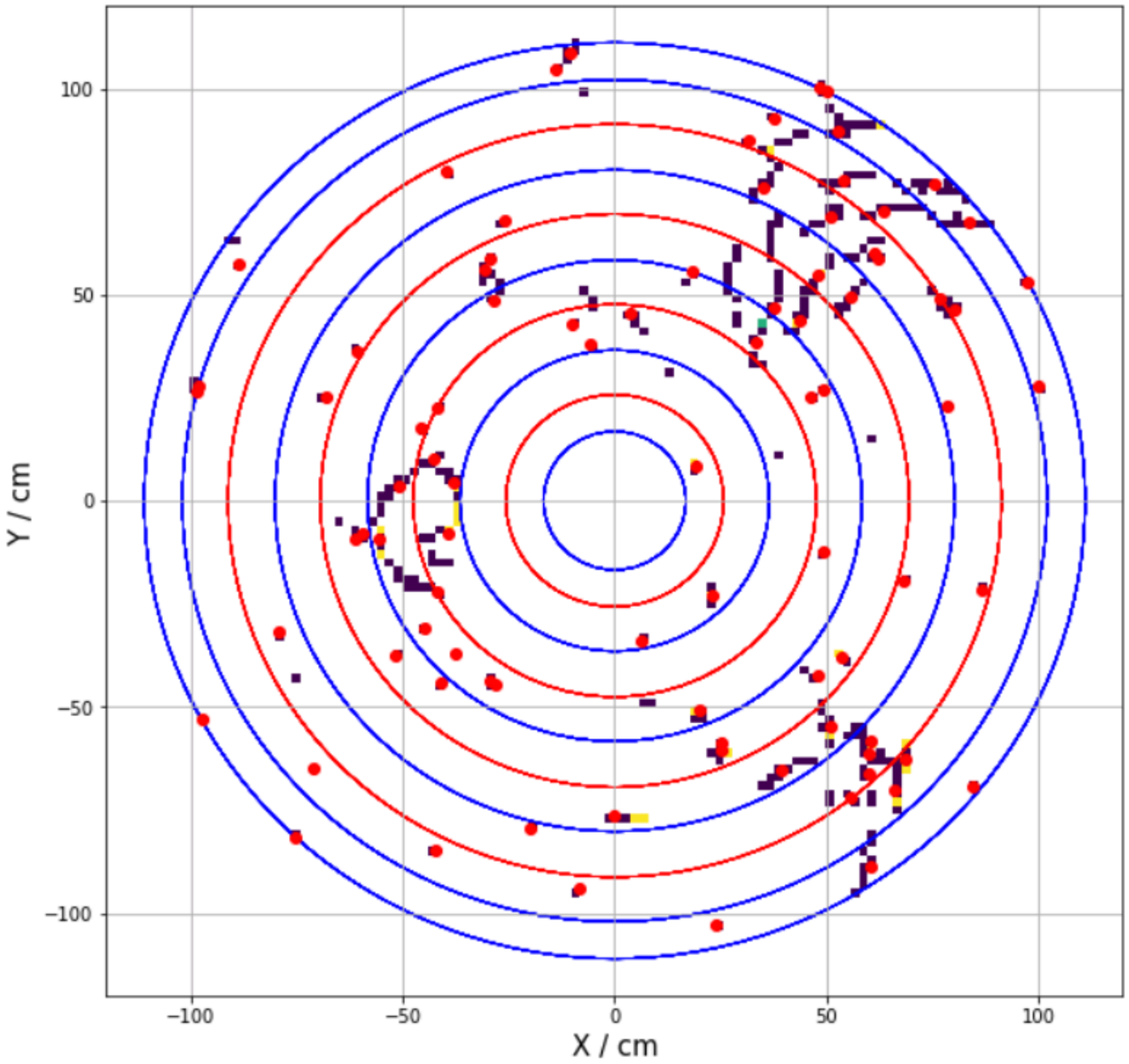
cluster shape

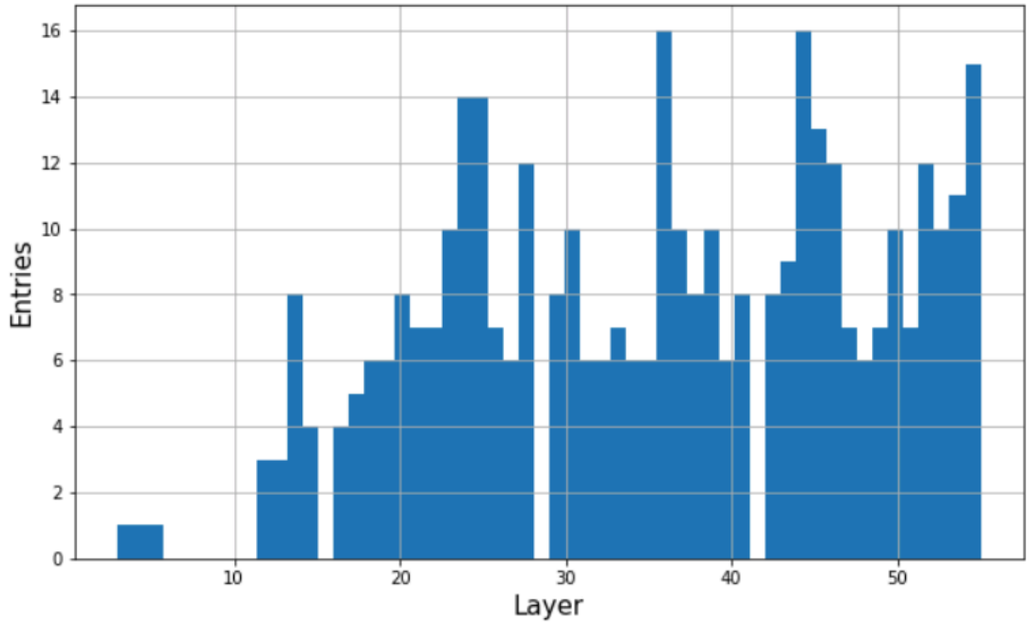
Halo neutron BG.



$$n \;\; P = 0.3 \sim 0.8\, GeV$$

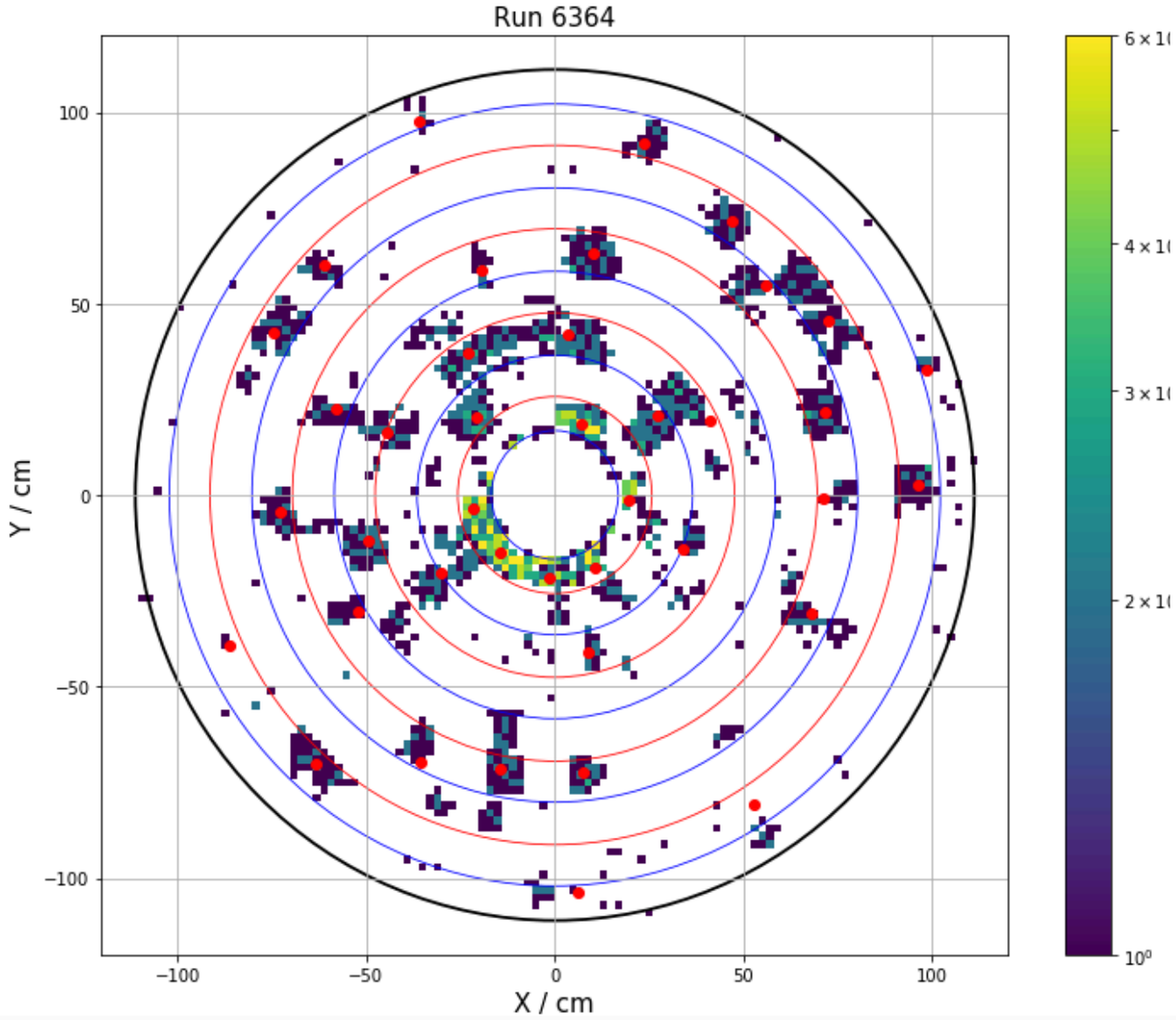
Simulated BG.

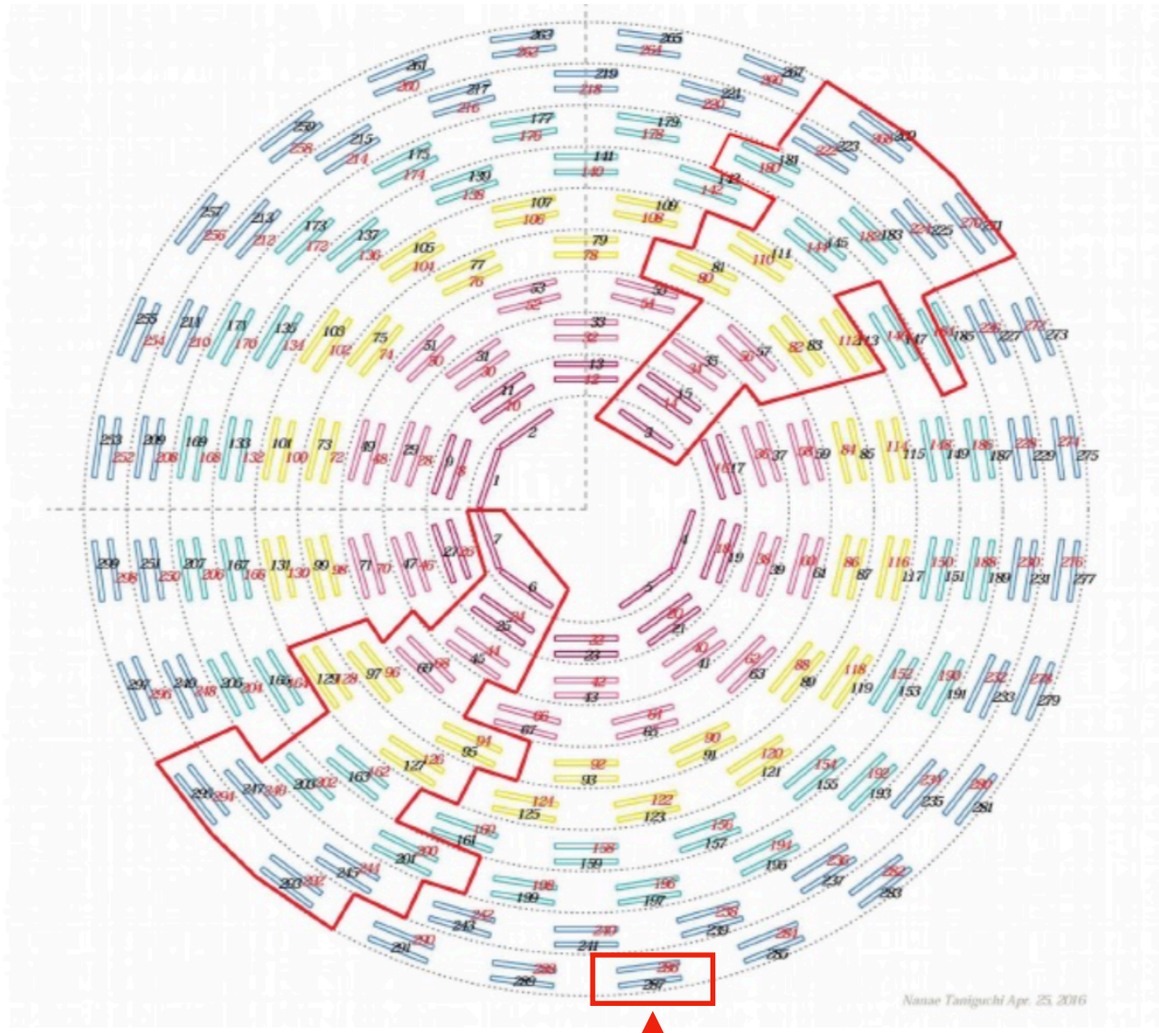




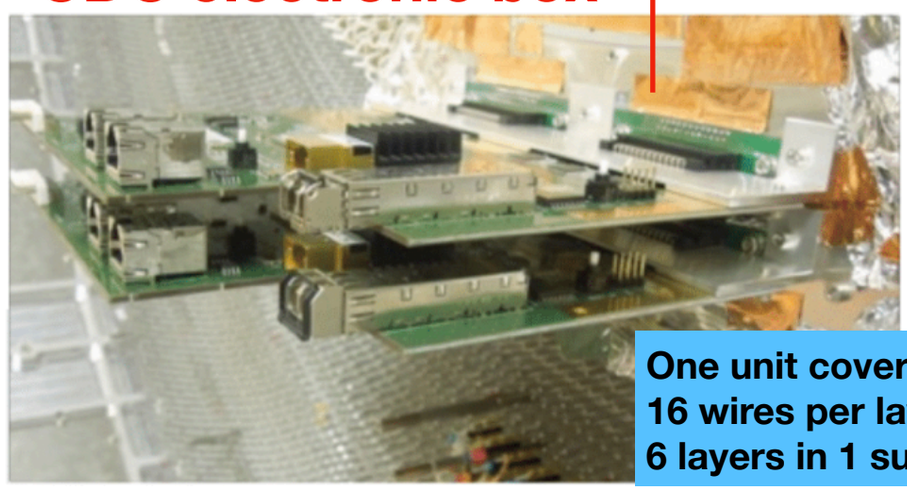
the cluster is different with the data

Is it cross talk?





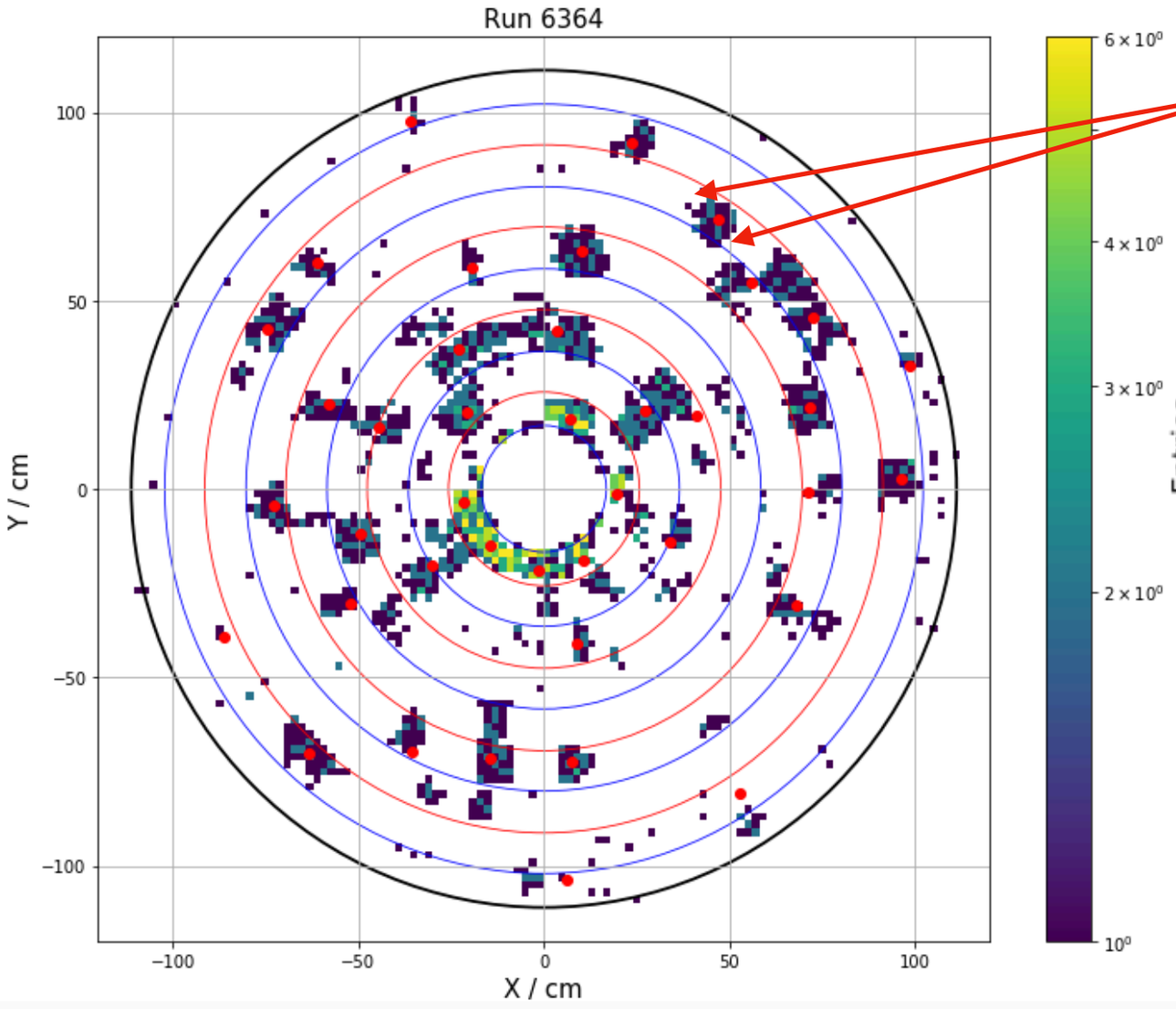
CDC electronic box



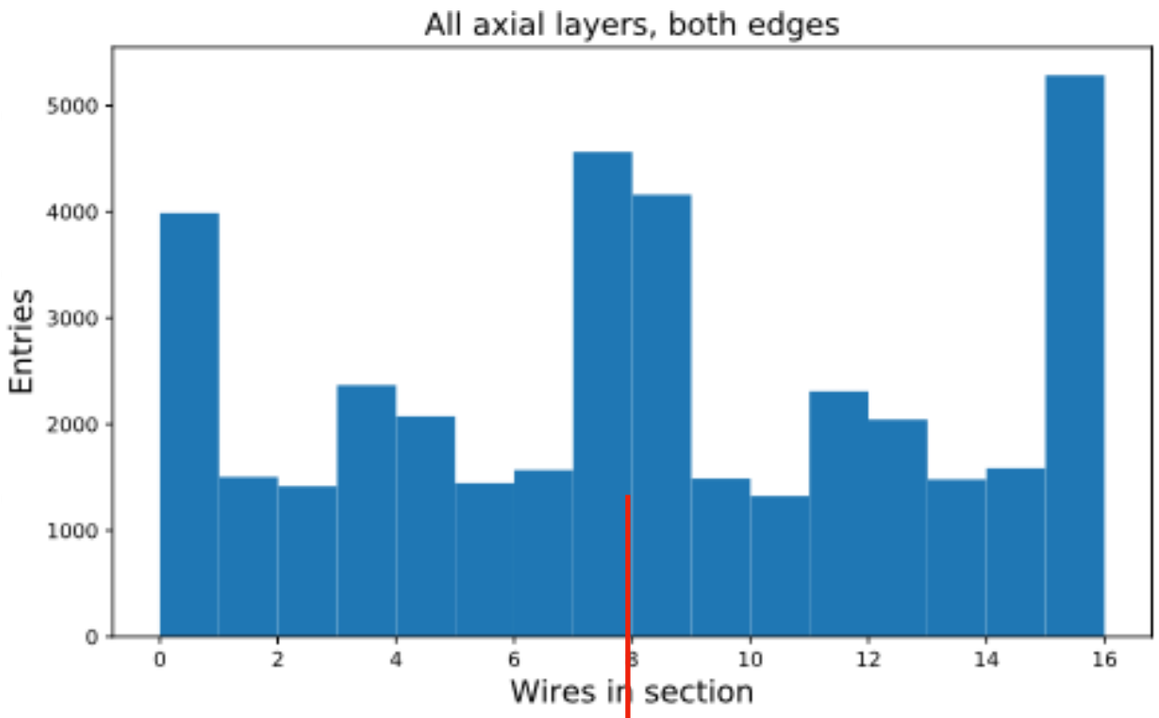
One unit cover
16 wires per layer
6 layers in 1 super layer

The hits of cluster confined in super layer suggest it probably due to cross talk by Uno san

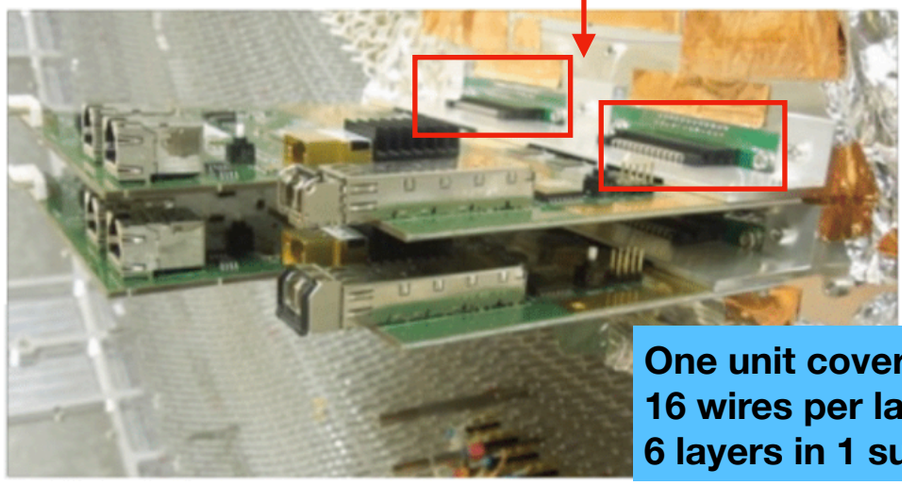
Is it cross talk?



Left and right edges of each cluster



CDC electronic box



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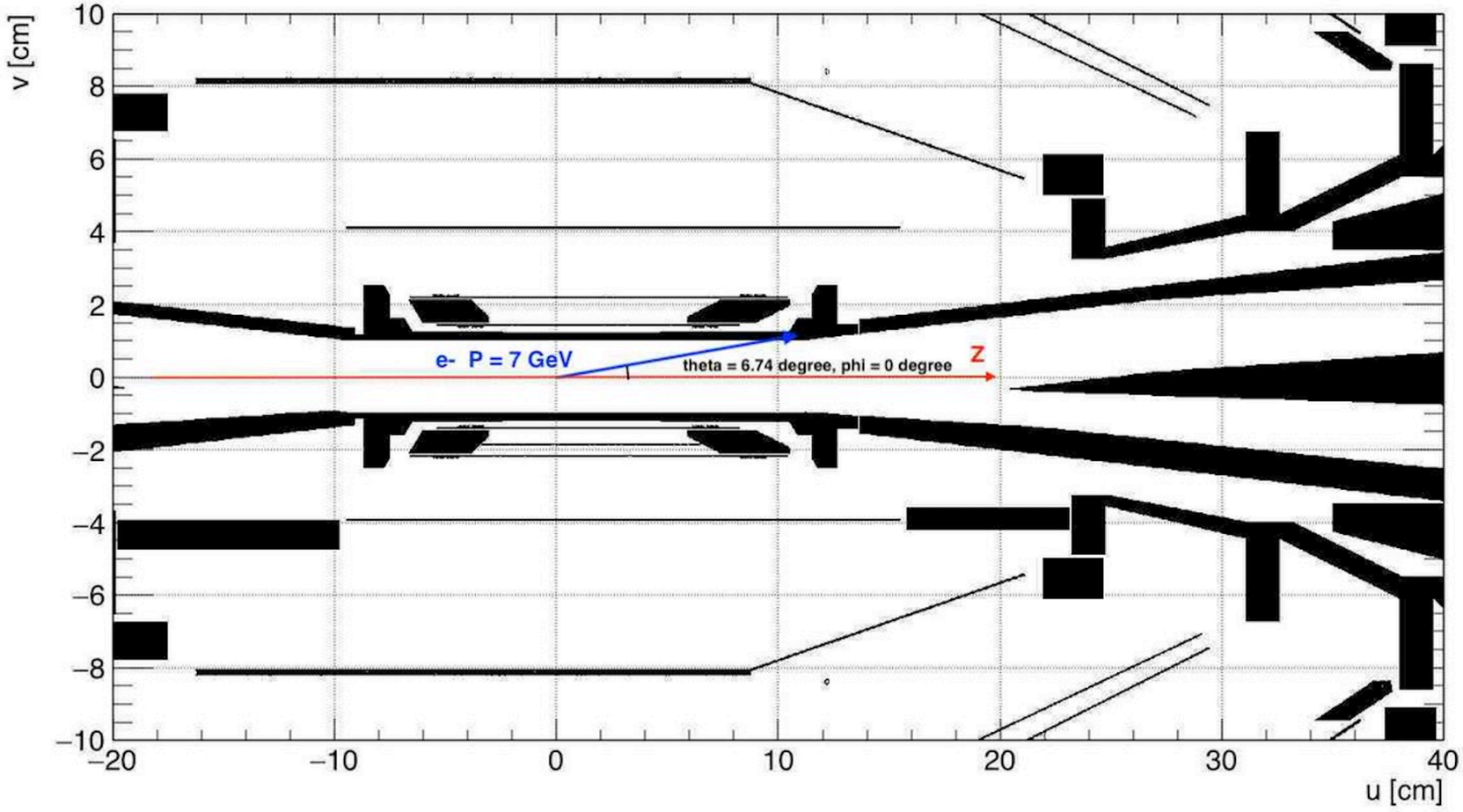
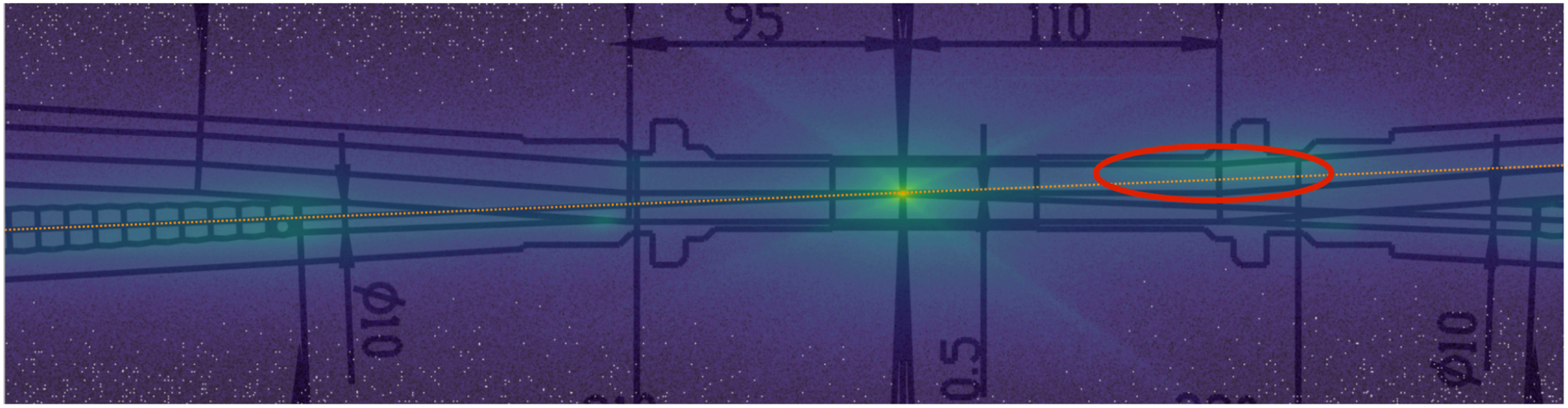
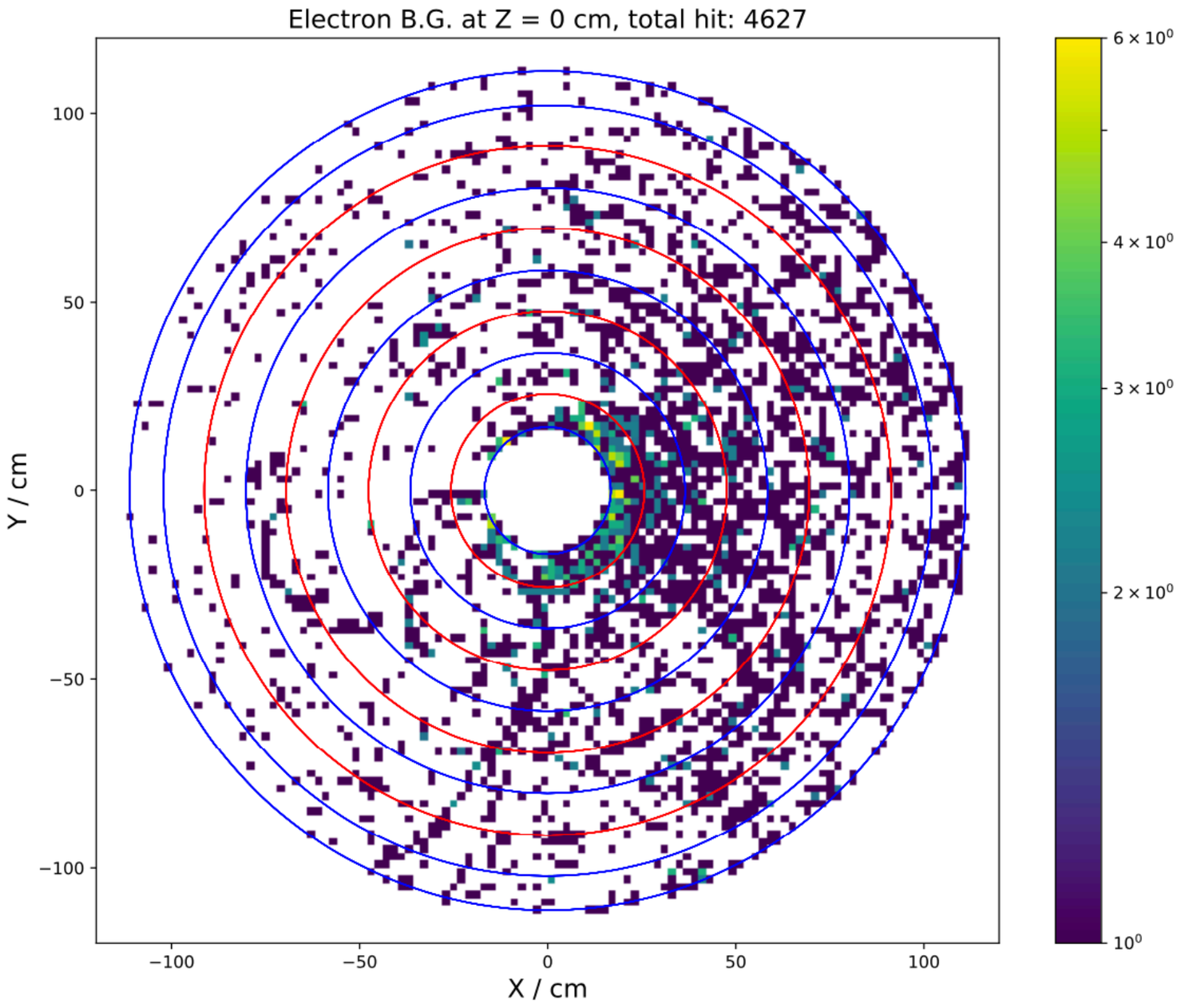
the recent progress



- inspired by the vertex distribution in tracking study



the recent progress

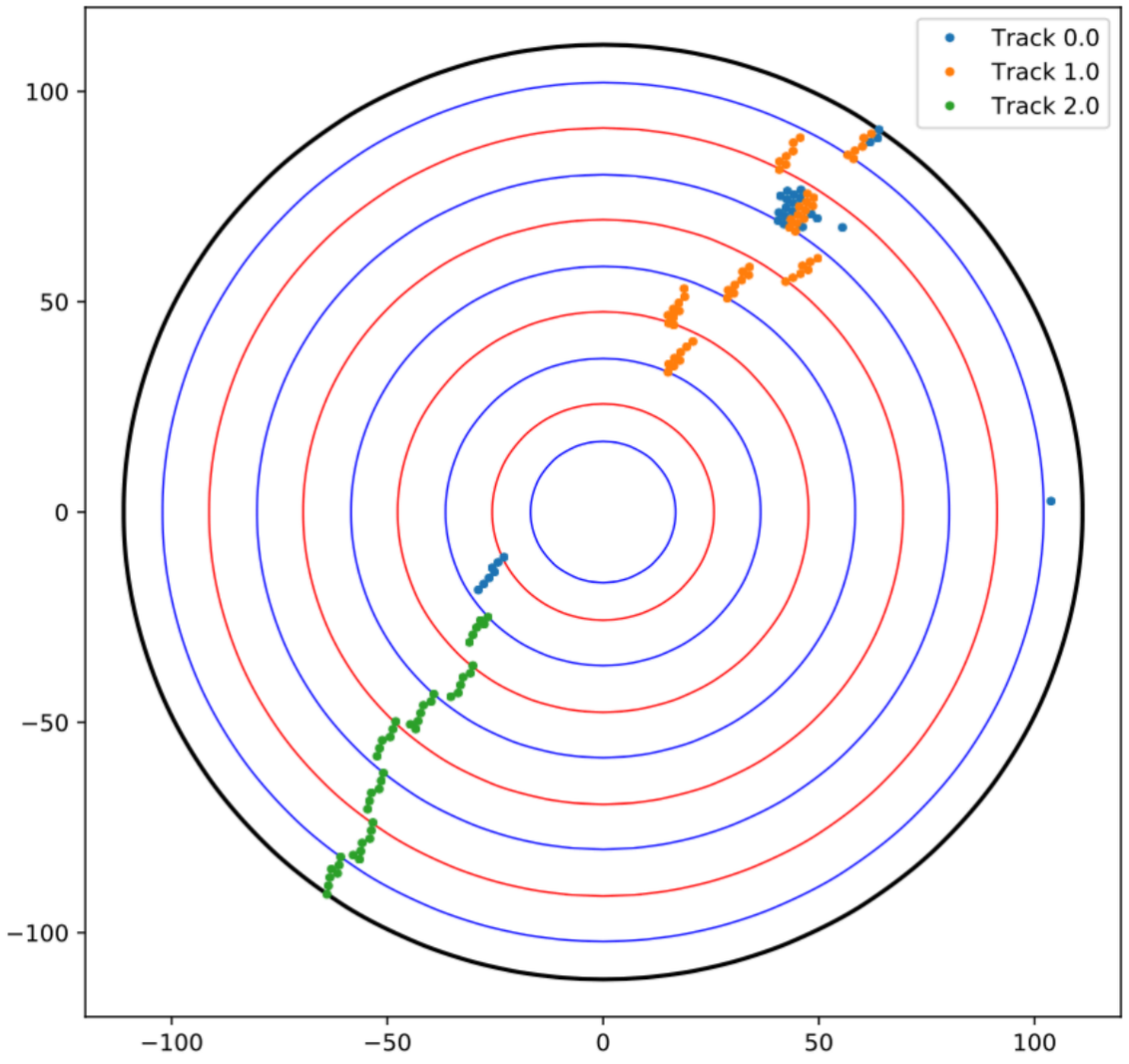


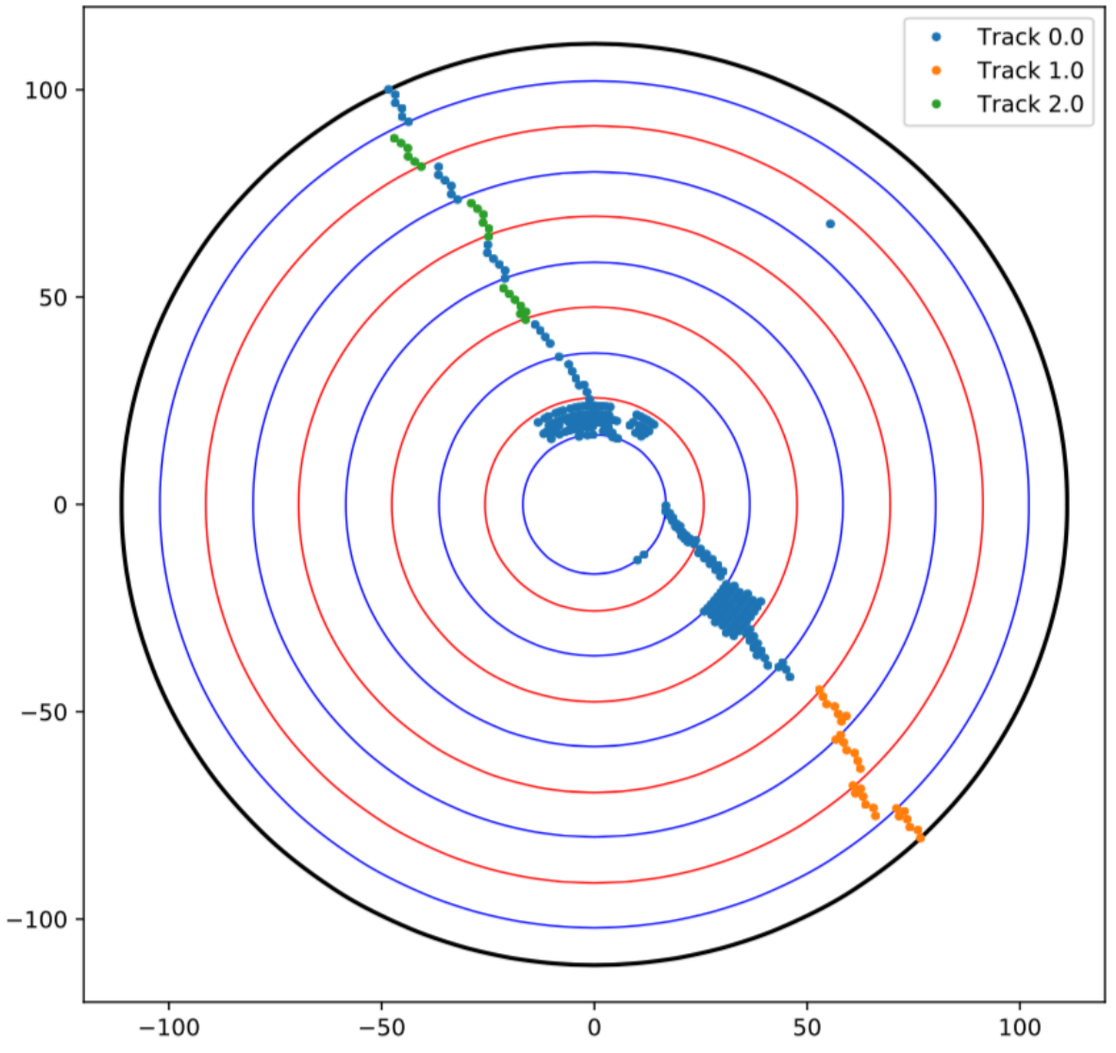
- this background together with electronic cross talk probably produce the clusters in data

- further study is ongoing

The clusters in physics data

Cosmic ray

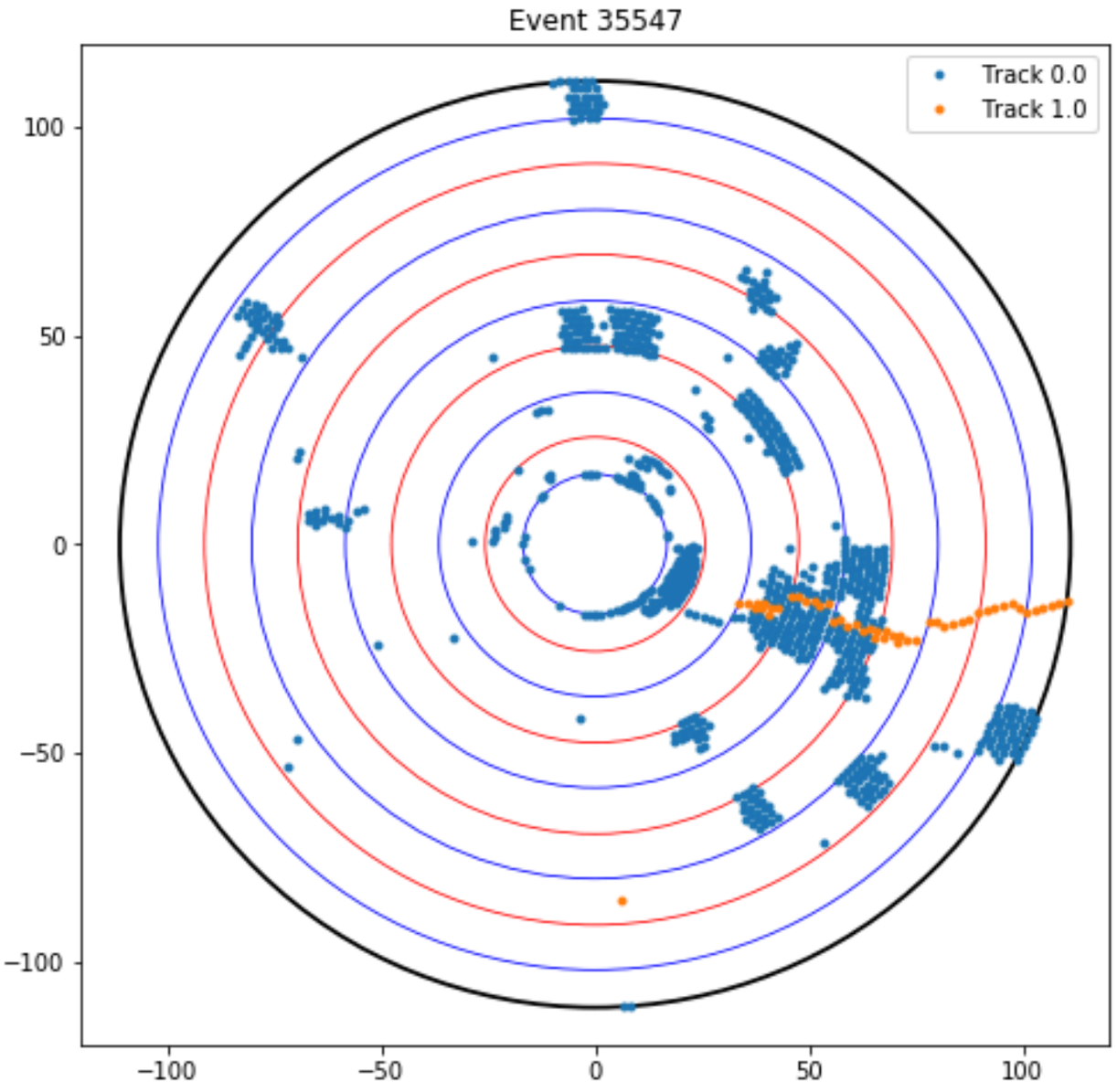


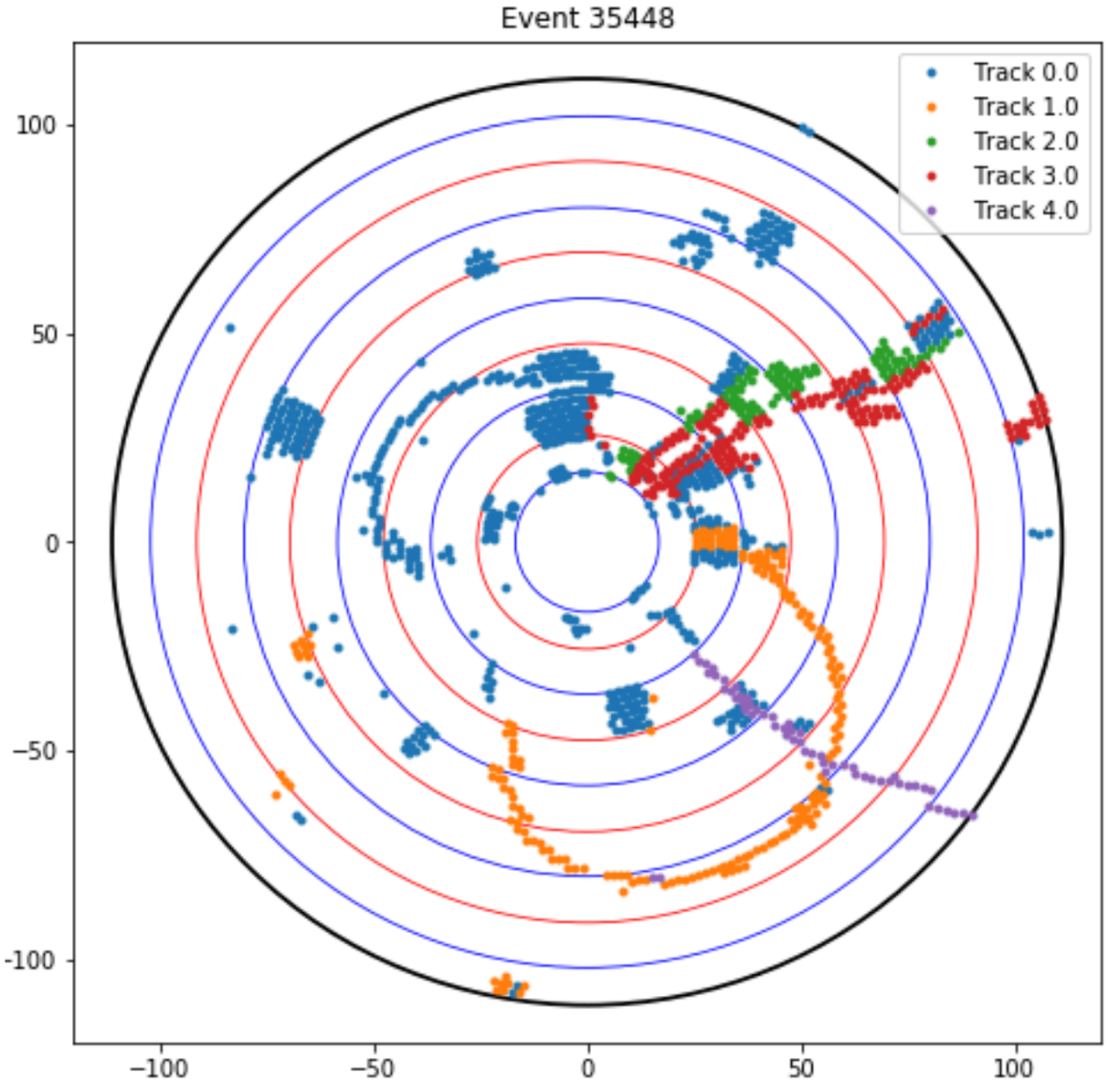


- In some case, the clusters are harmless, some time, it will break the track

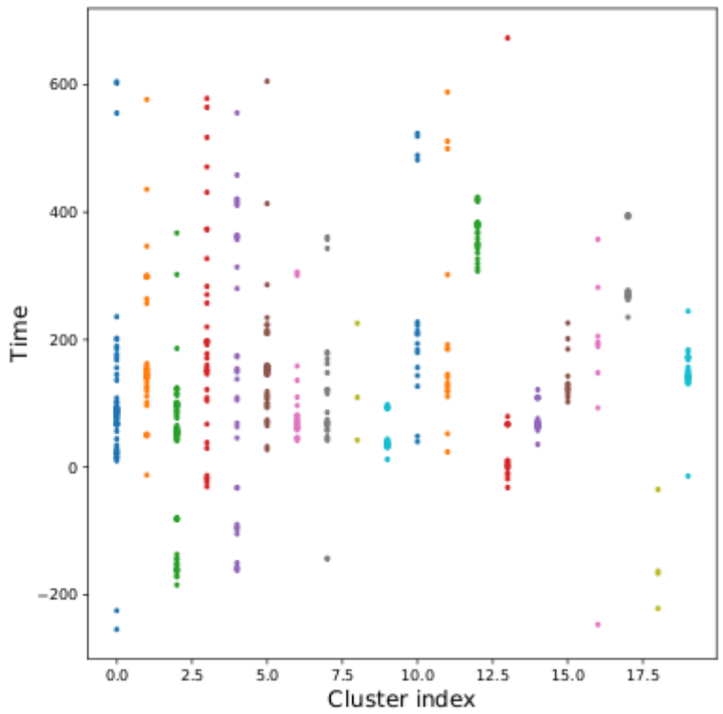
The clusters in physics data

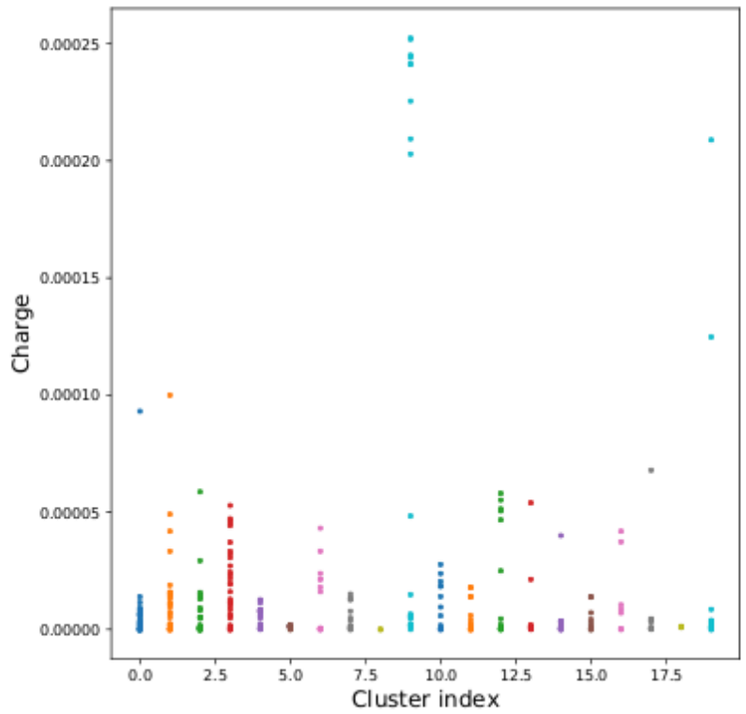
Collision data

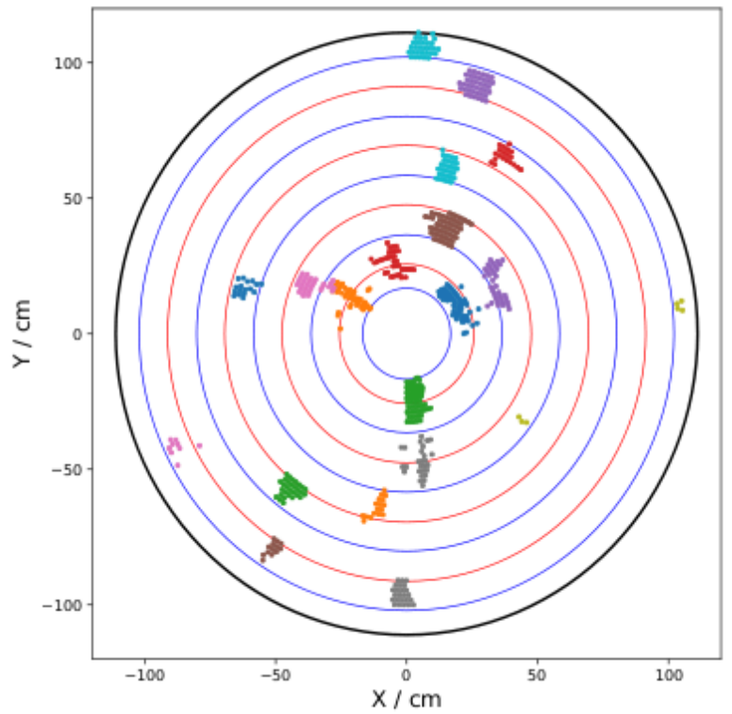


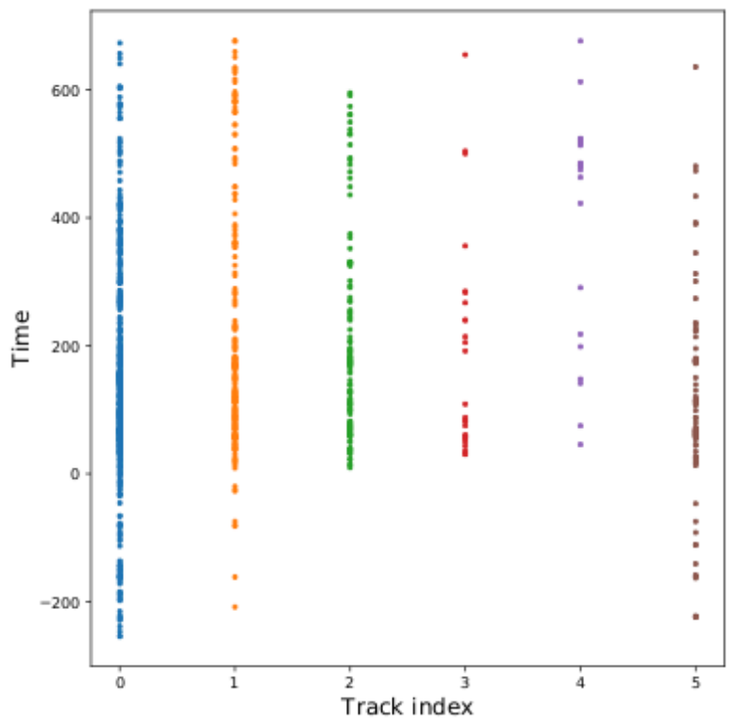


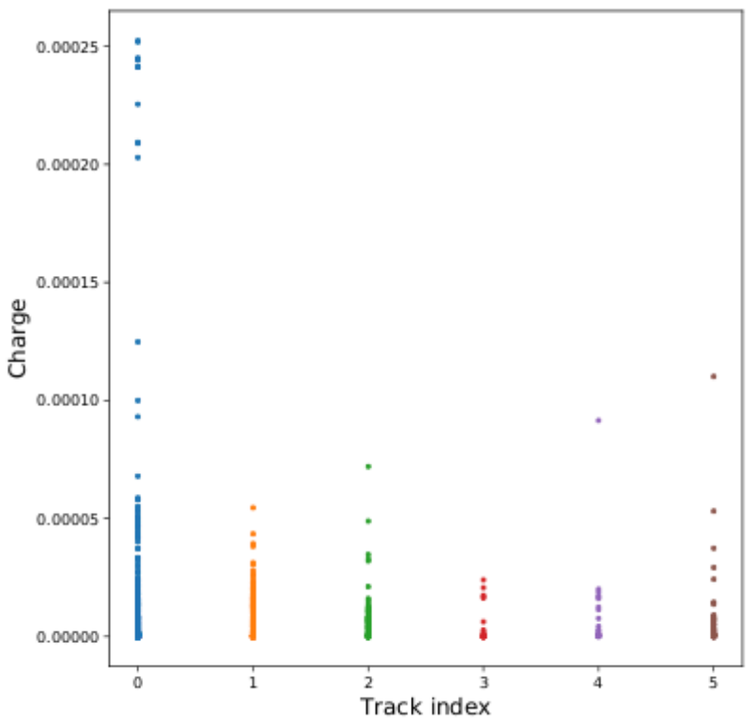
Time and Charge info.

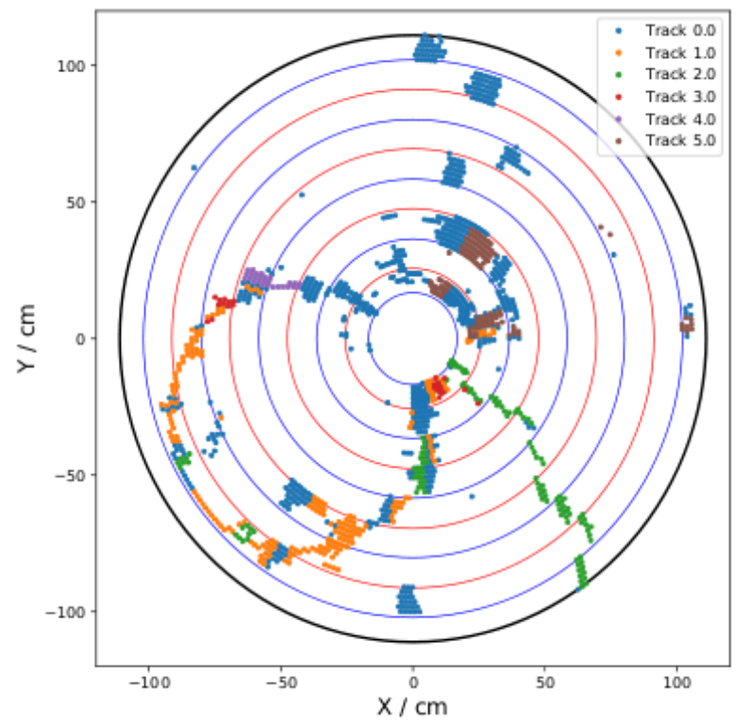




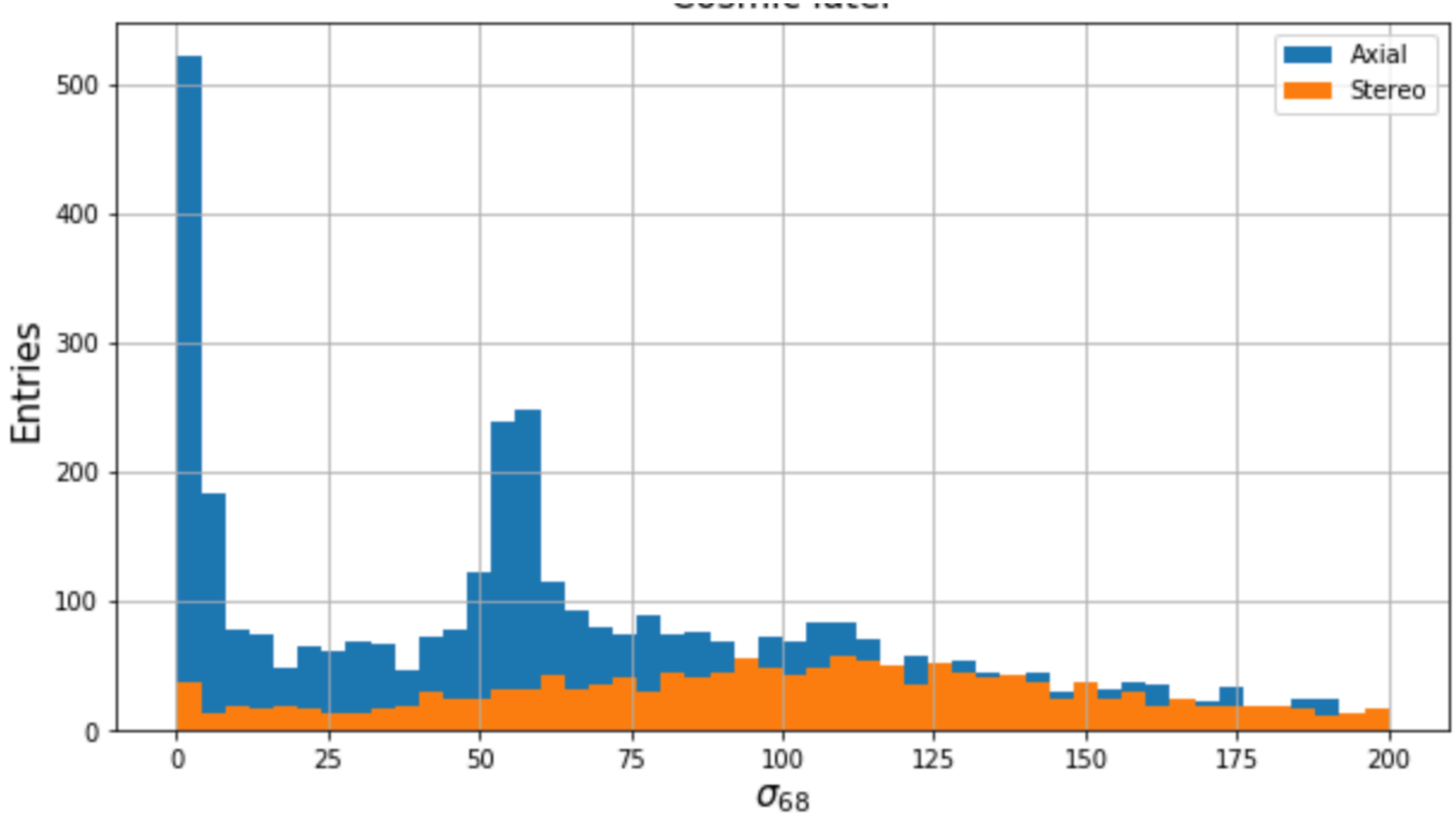








Time spread of cluster



- Time spread of the cluster probably will be helpful to suppress background.

- The peak around 50 is unclear and it only happens in axial layer

Summary

- To understand the CDC background, several hypotheses are checked by MC:
  - Halo muons from far away upstream
  - Photon conversions in the CDC end plate
  - Neutron interactions with the CDC gas
- Although all their behavior in simulation differ from the cluster shown in data, photon or neutron probably can produce the cluster together with electronic cross talk effect.
- It is still unclear which source trigger the cross talk.
- The clusters will affect tracking. Further study is necessary to discard this effect.