UNIVERSIDADE FEDERAL DE JUIZ DE FORA

PPEE
Programa de Pós-Graduação em Engenharia Elétrica UFJF

Directional-iDBSCAN

a proposal to CYGNO

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Last presentation

- It was agreed in the last meeting that the next step should be to look for quantitative results using the DDBSCAN.

  - The analysis was inspired by the DBSCAN article (^{55}Fe based analysis).
    - DOI: 10.1088/1748-0221/15/12/T12003

  - Selected runs: 2054 (EN), 2156 (NRAD) and 2163 (ER).

Quantitative analysis

- In order to measure the algorithm performance, two *reco files* will be created and compared, one using DBSCAN and another using DDBSCAN.

- The analysis will be done by checking the cluster energy distributions and scatter plots containing energy and size.

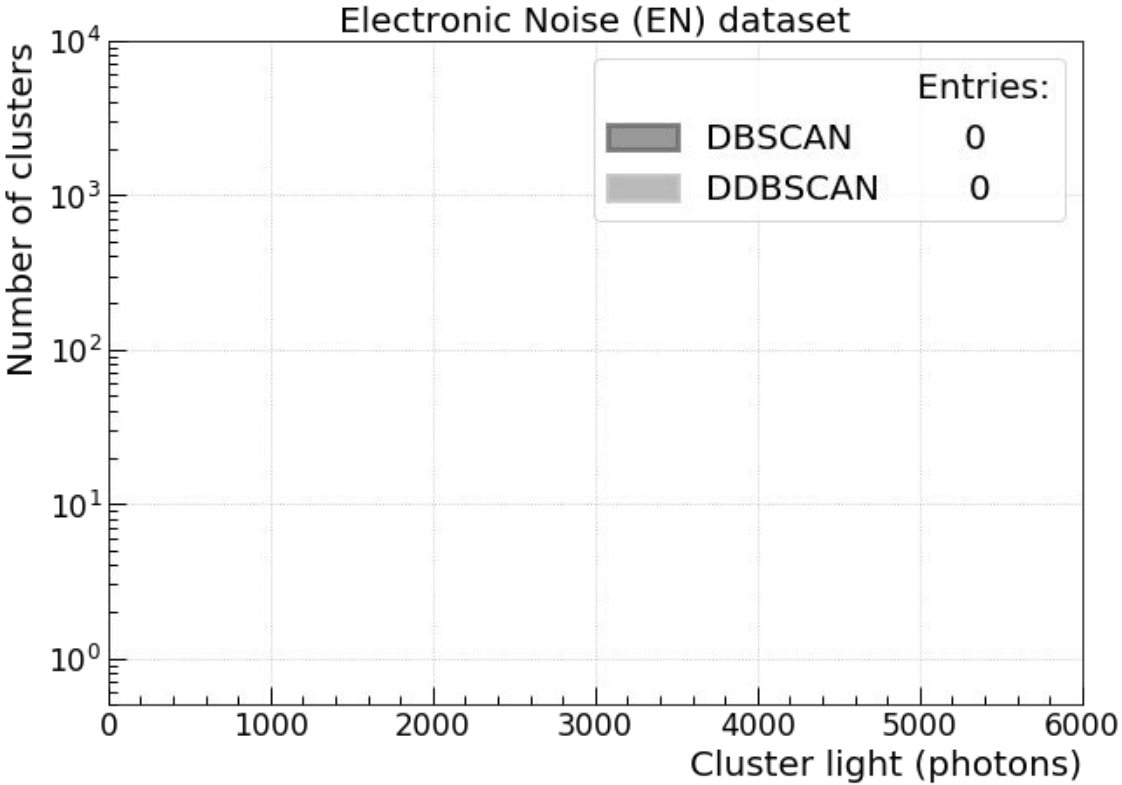
- Similar to the article, the clusters far from the center of the image will not be considered and an extra analysis using a slimness cut will be made.

DBSCAN and DDBSCAN Parameters

- DBSCAN:
  - eps = 5.8
  - min_pts = 30

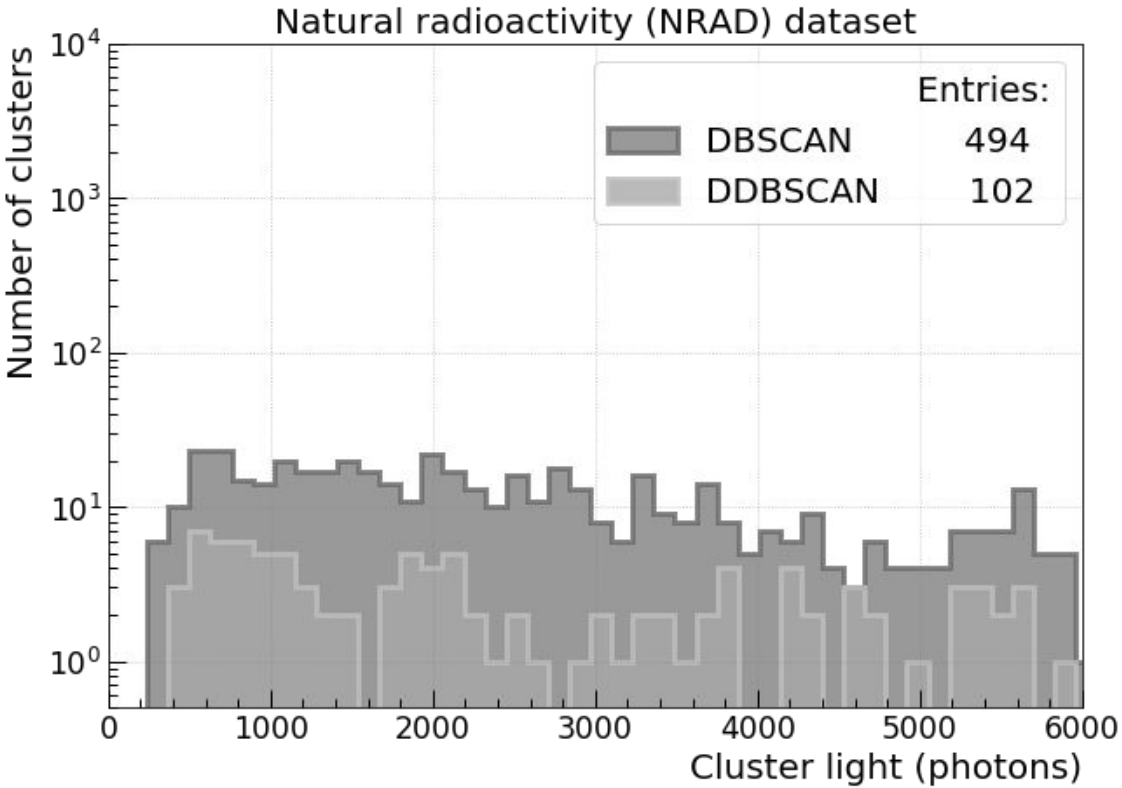
- DDBSCAN:
  - eps = 5.8
  - min_pts = 30
  - dir_radius = 15.5
  - dir_min_accuracy = 0.8
  - dir_minsamples[1] = 50
  - dir_thickness[2] = 5.5
  - max_attempts = 13
  - isolation_radius[3] = 5
  - expand_noncore = True

Electronic Noise (**EN**)



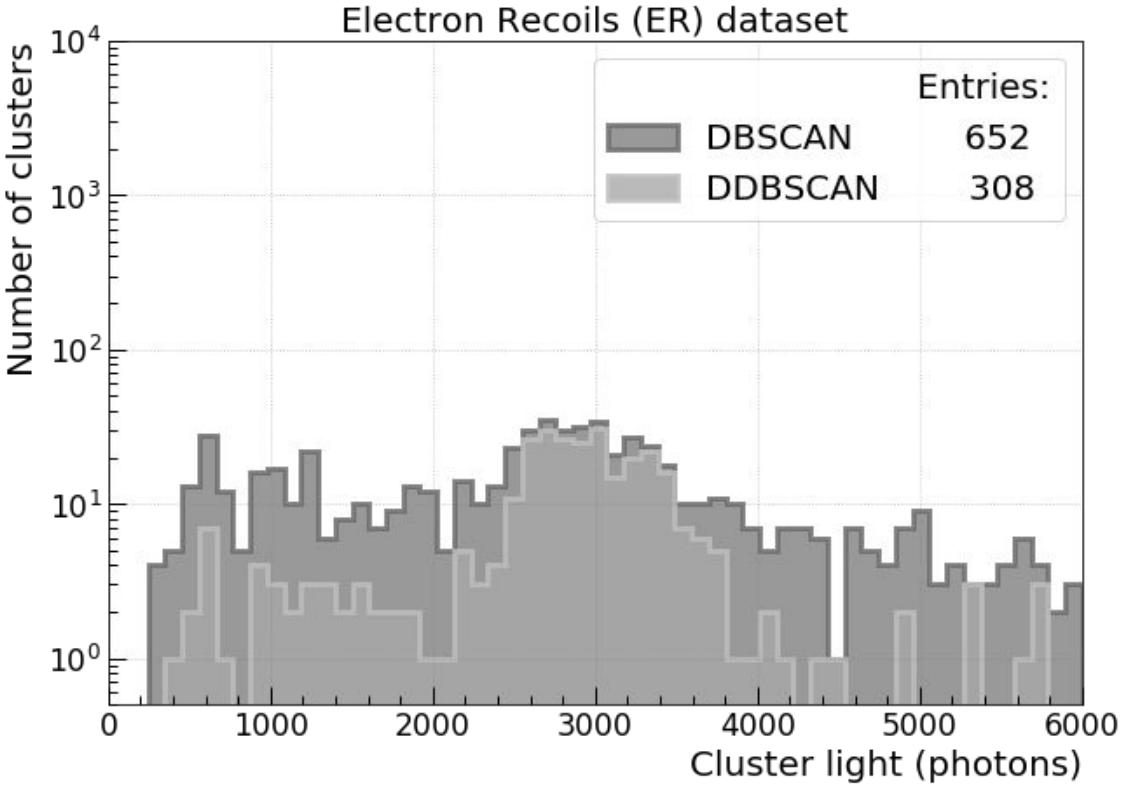
- Actually, 2 clusters were found in the entire run, but they were discarded for being far from the center of the image.

Natural Radioactivity (**NRAD**)



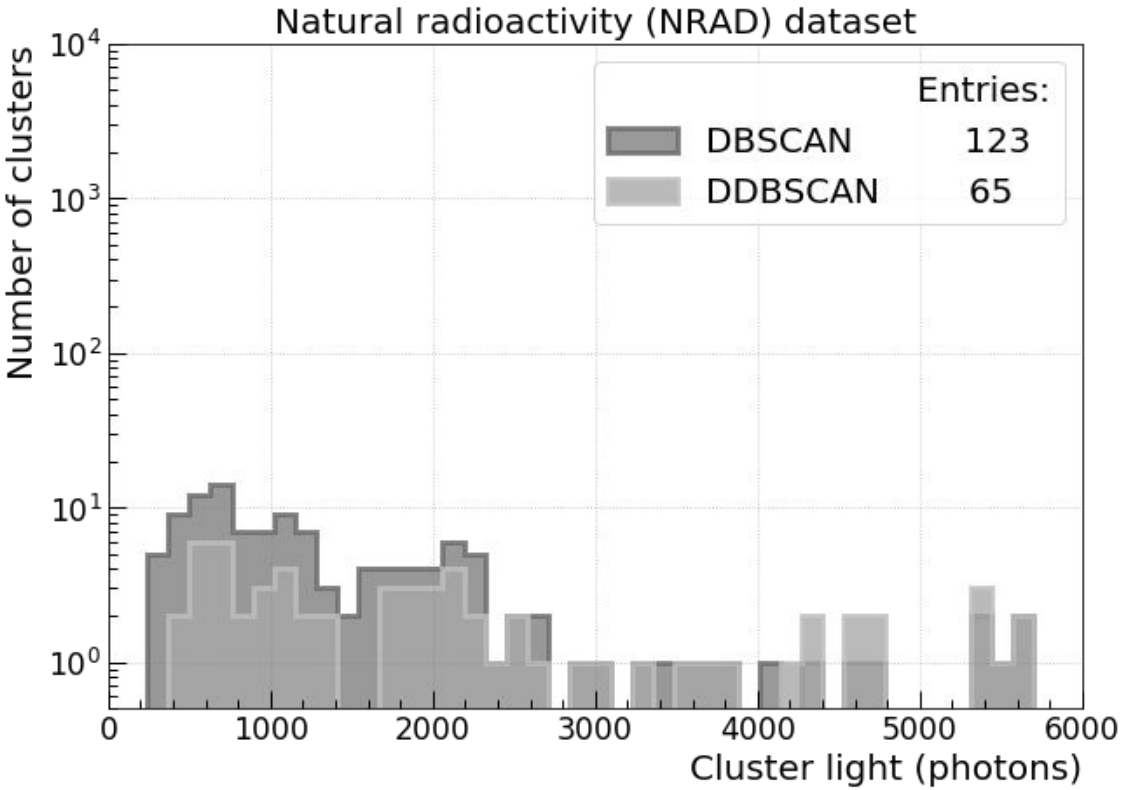
- The DDBSCAN found fewer clusters than the DBSCAN in the low energy region (^{55}Fe energy region and below).

Electron Recoils (**ER**)



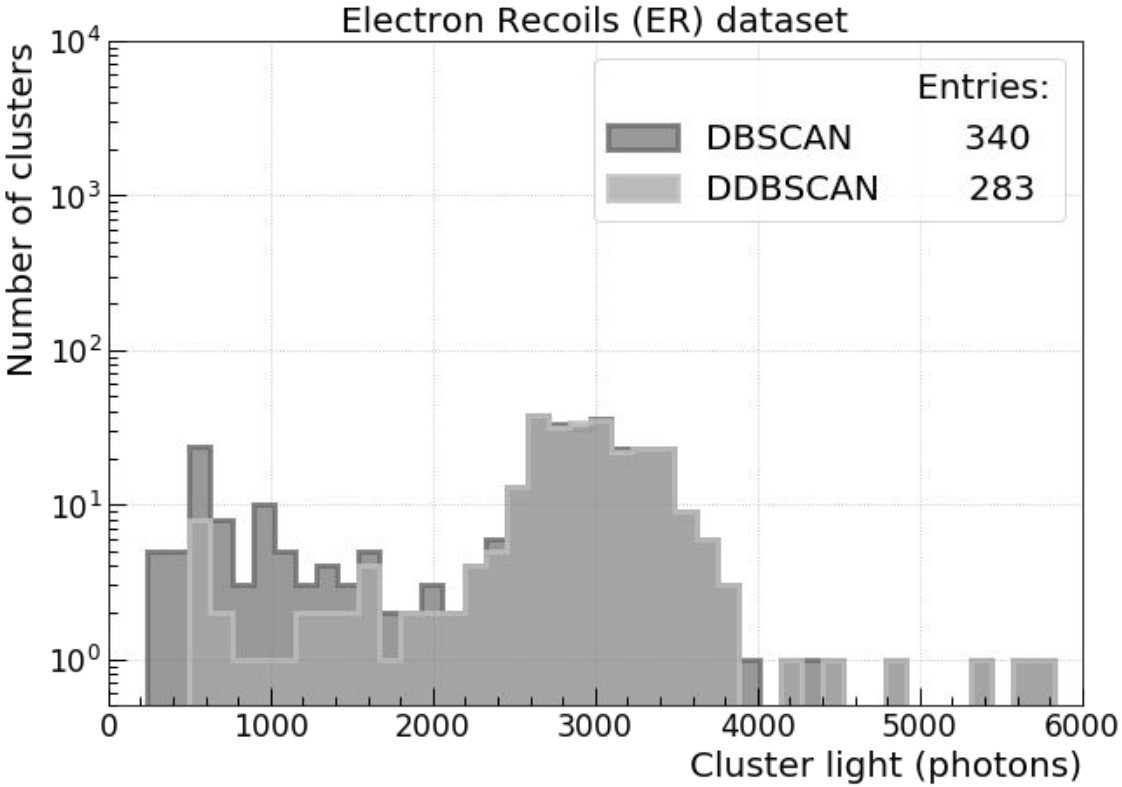
- Both histograms have a ^{55}Fe peak around 3000 photons.

NRAD - slimness cut



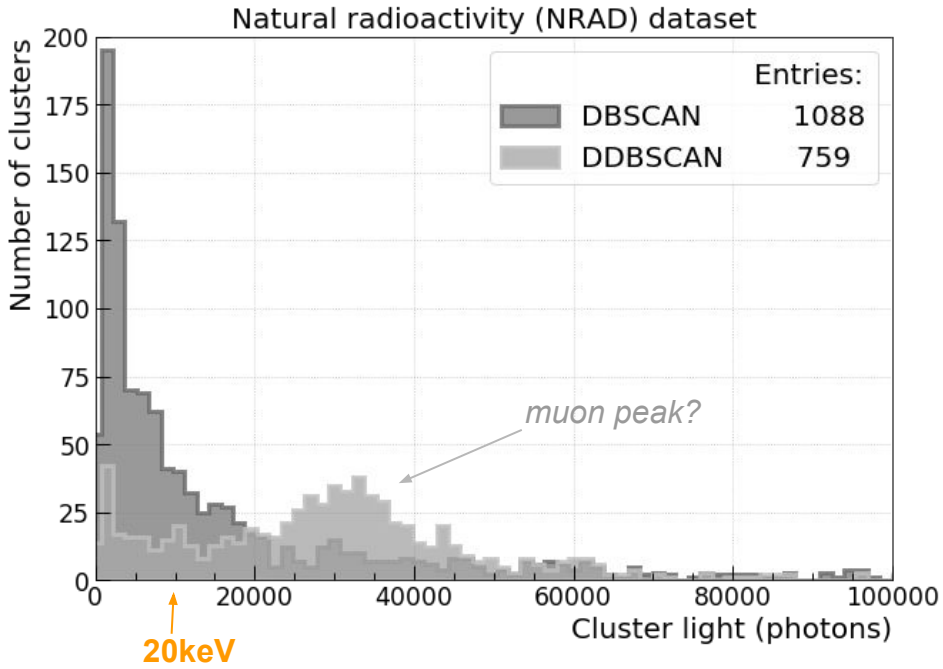
- This is the same run of the slide 7, but considering only the cluster with slimness higher than 0,4.
- The impact on the DBSCAN is higher making it to get closer to DDBSCAN.
- In the very low energy, DDBSCAN seems to have less clusters.

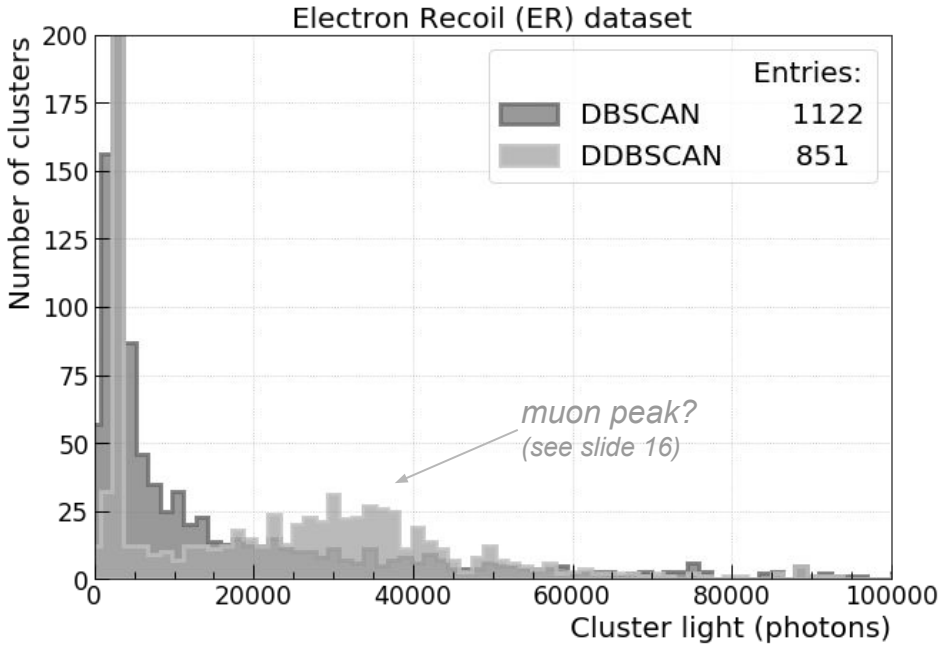
ER - slimness cut



- This is the same run of the slide 8, but considering only the cluster with slimness higher than 0,4.
- Again, the impact on the DBSCAN is higher making it to get closer to DDBSCAN around the ^{55}Fe peak.

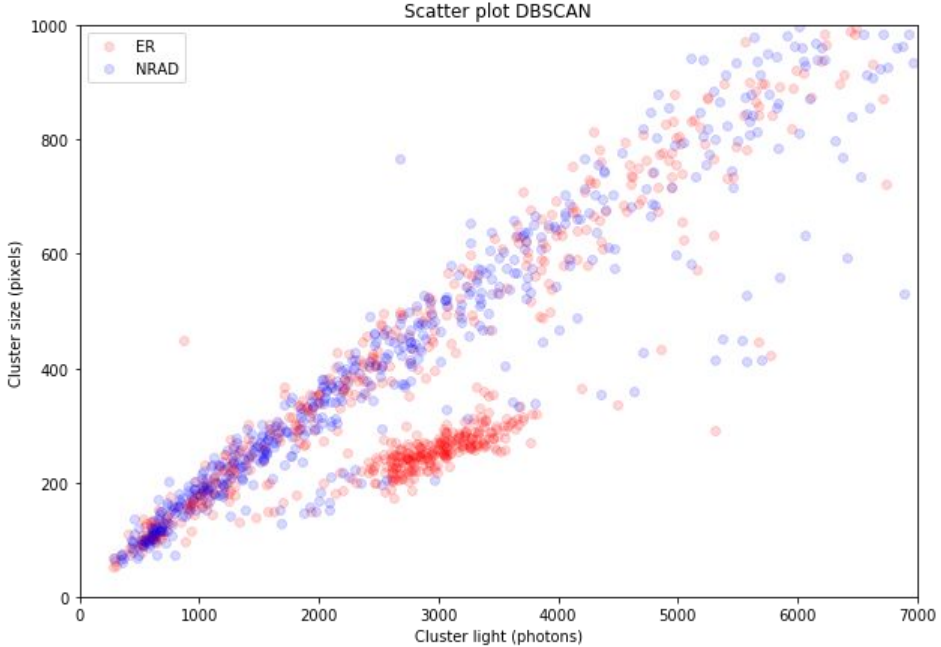
NRAD and ER - High Energies

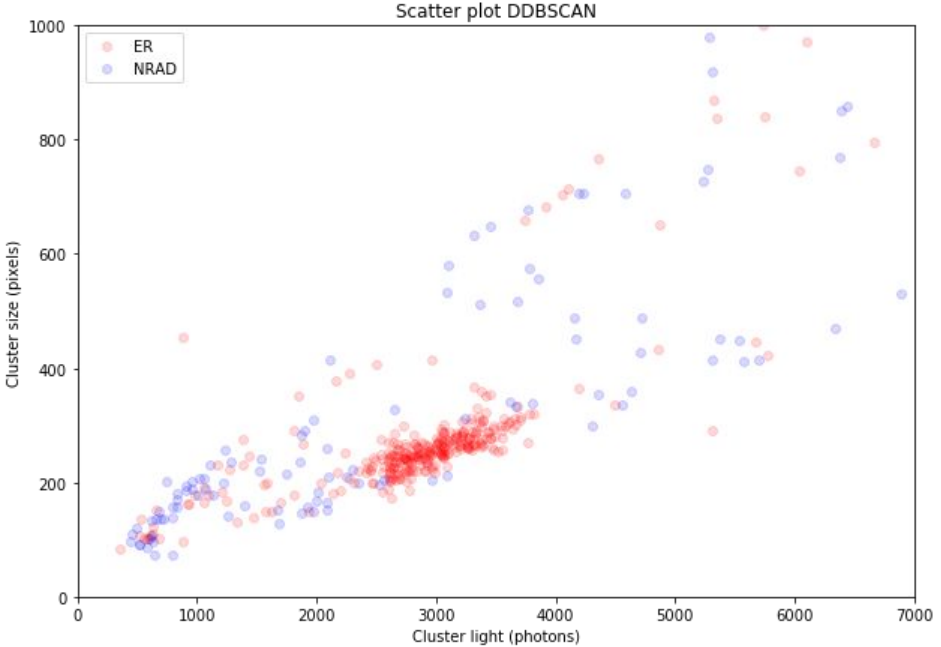




- **Many small clusters were reconstructed as long tracks, rising the cluster energies to form a peak around ~30000 photons and to clean up the low energy region < 40keV.**

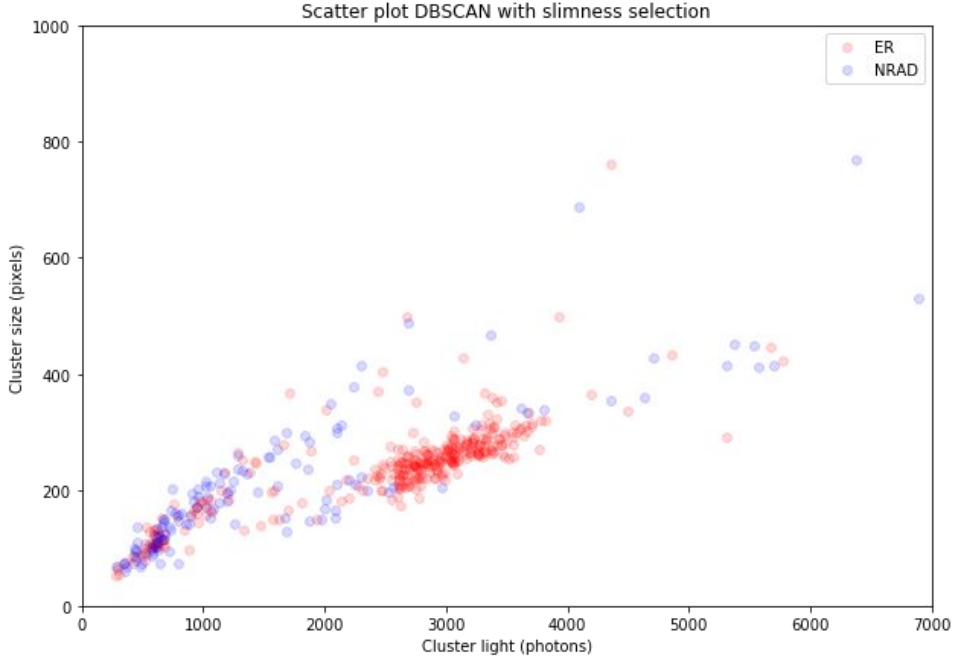
Scatter plot

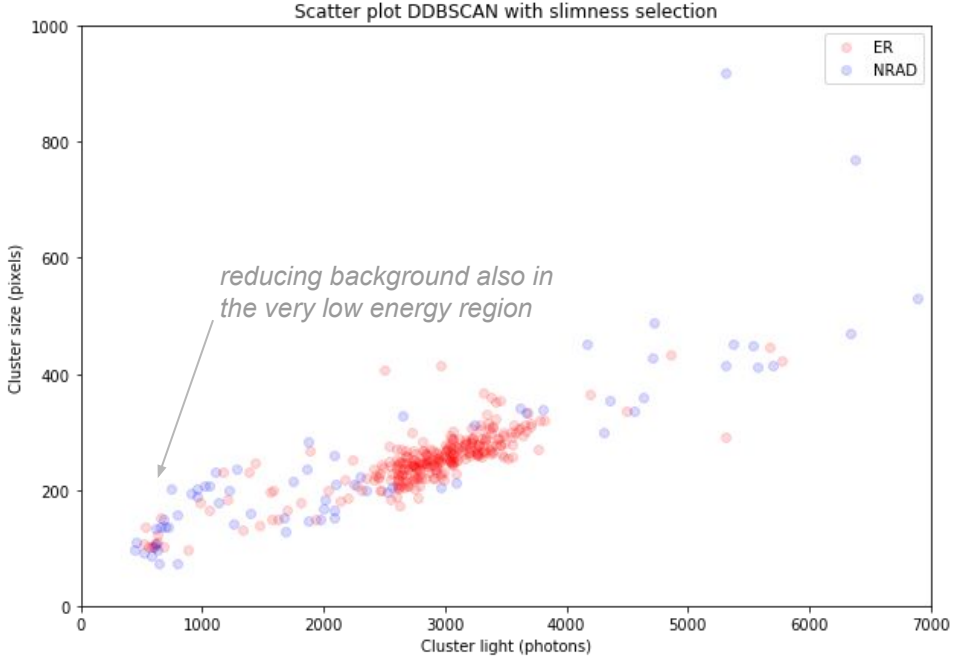




- **DDBSCAN clears many points from the surroundings without removing points from the ^{55}Fe spot area.**

Scatter plot with slimness selection





- ***Slimness* cut has high impact on DBSCAN.**
- ***Slimness* mostly cut off chunks of long tracks.**

Conclusions

- DDBSCAN seems to be able to reduce background noise in the low energy region (by reconstructing short, medium and long tracks)
  - DDBSCAN is doing its job without modifying the ^{55}Fe clusters.

- Once directional search is applied, *slimness* cut becomes less important in reducing background noise.
  - *slimness* mostly cut off chunks of long tracks. To detect circled spots it might work well but for other low energy particles DDBSCAN could be useful.

- The energy peak at ~30000 photons seems to be a physical signal which is possible to see when DDBSCAN is applied.
  - just as another indication that DDBSCAN is doing what it is supposed to.

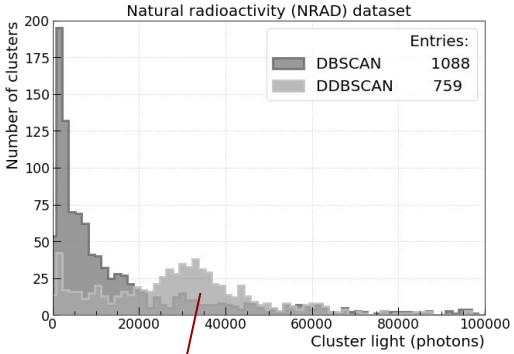
Next steps

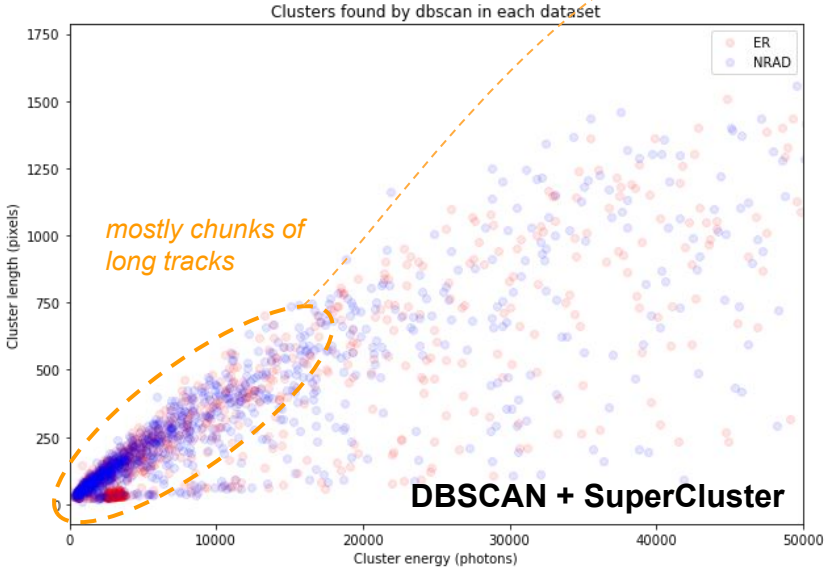
- Look into another datasets?
  - real or simulated data? what would be the motivation?

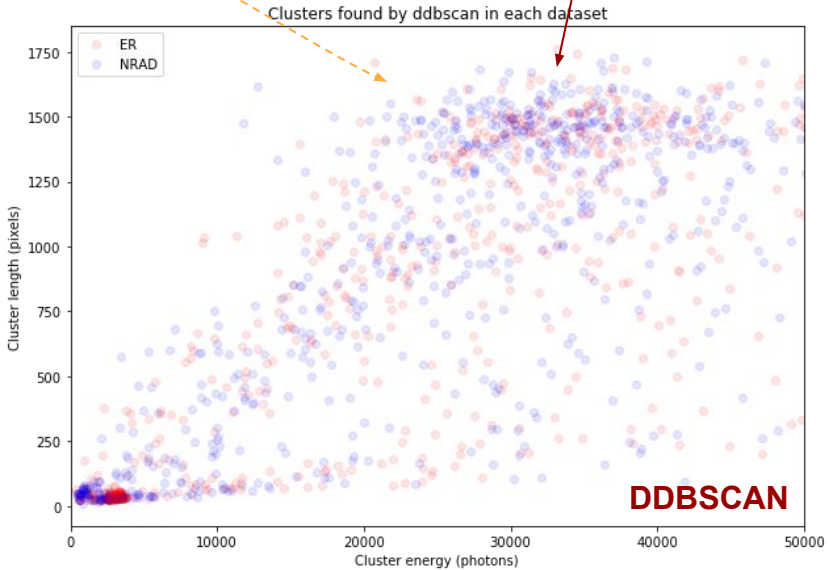
- Use quantitative results to tune the DDBSCAN parameters?
  - real or simulated data? and how?

Backup Slides

Scatter plot - cluster length versus energy

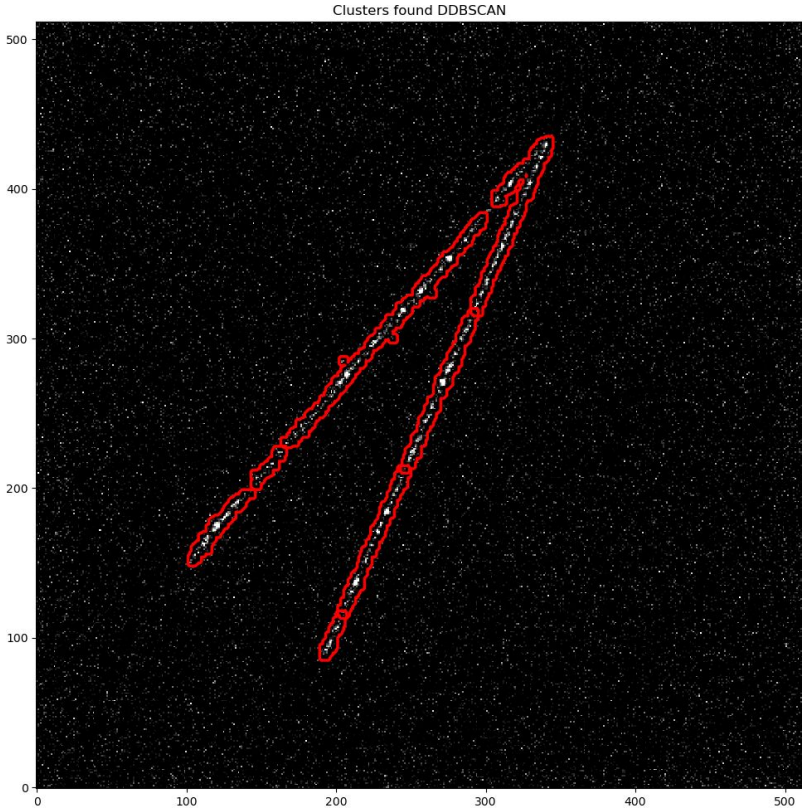






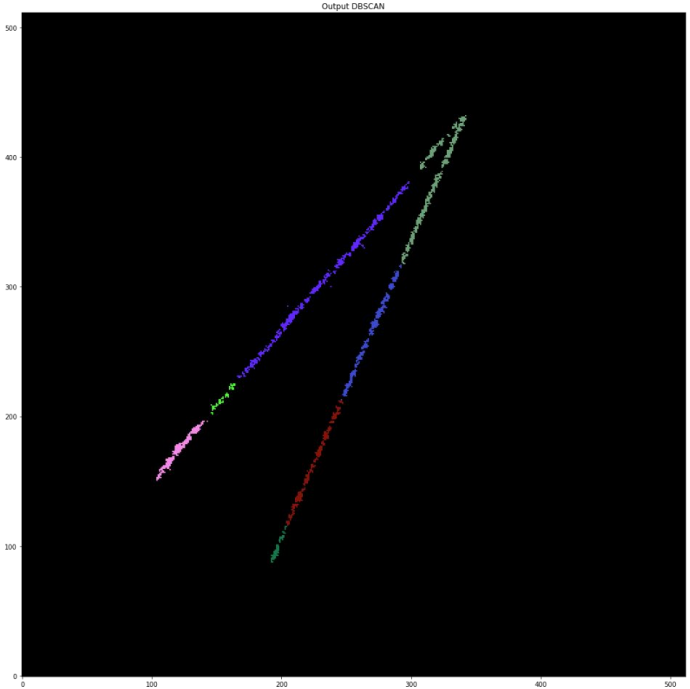
Example of tracks with 38k and 33k photons

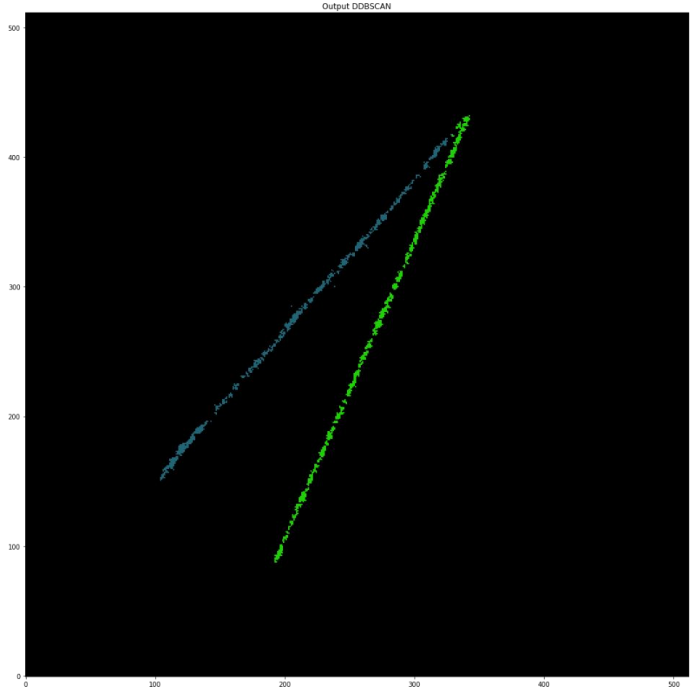
Run 2156 - Event 108



Example of tracks with 38k and 33k photons

Run 2156 - Event 108





Run 2156 - Event 108.

obs: This does not mean that all the tracks in the 30k photons peak are like these, this is just an example.

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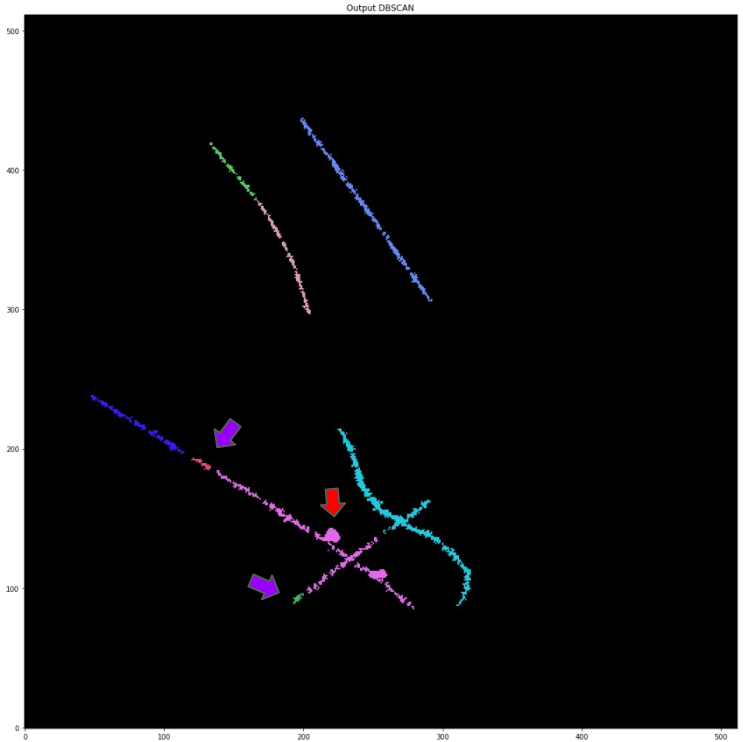
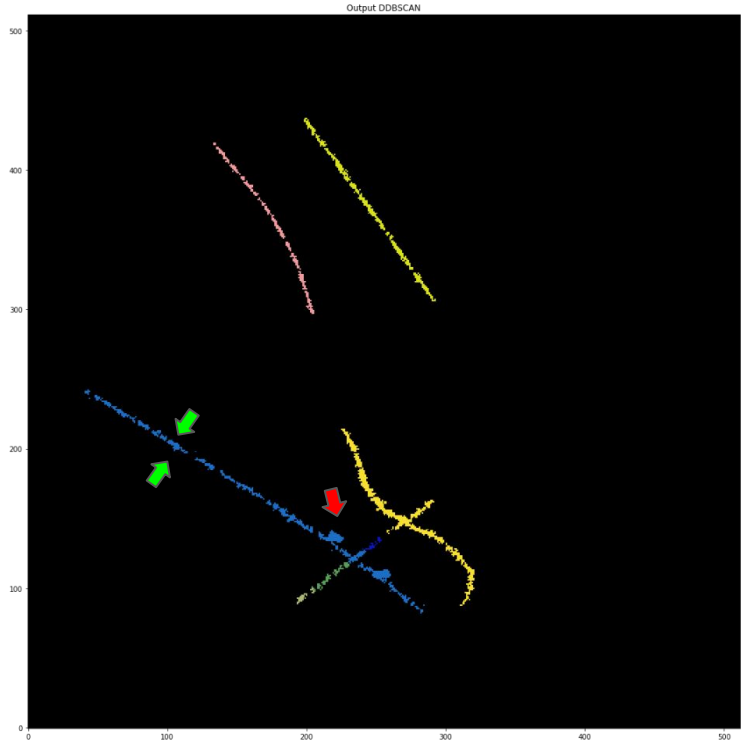
DBSCAN and DDBSCAN Parameters (Run 2156 - Event 27)





Dir_minsamples (purple arrow): Clusters with size smaller than that are not tested by the ransac; Dir_thickness (green arrows): Related with the width of the track; Isolation_radius (red arrows): Prevent the creation of *halos*. (check that some points found in the DBSCAN are not in the DDBSCAN result)