UNIVERSIDADE FEDERAL DE JUIZ DE FORA

PPEE
Programa de Pós-Graduação em Engenharia Elétrica UFJF

Directional-iDBSCAN

Paper

Igor Pains

Igor Abritta and Rafael A Nobrega

Proposal

- An analysis inspired on the iDBSCAN article (^{55}Fe based analysis) was done using the iDDBSCAN algorithm.

- Selected datasets:
  - Run 5862: NRAD.
  - Run 5890: ER.
  - Cosmic: 216 hand-selected cosmics tracks from 100 events.
  - ^{55}Fe: 703 hand-selected iron tracks from 50 events.

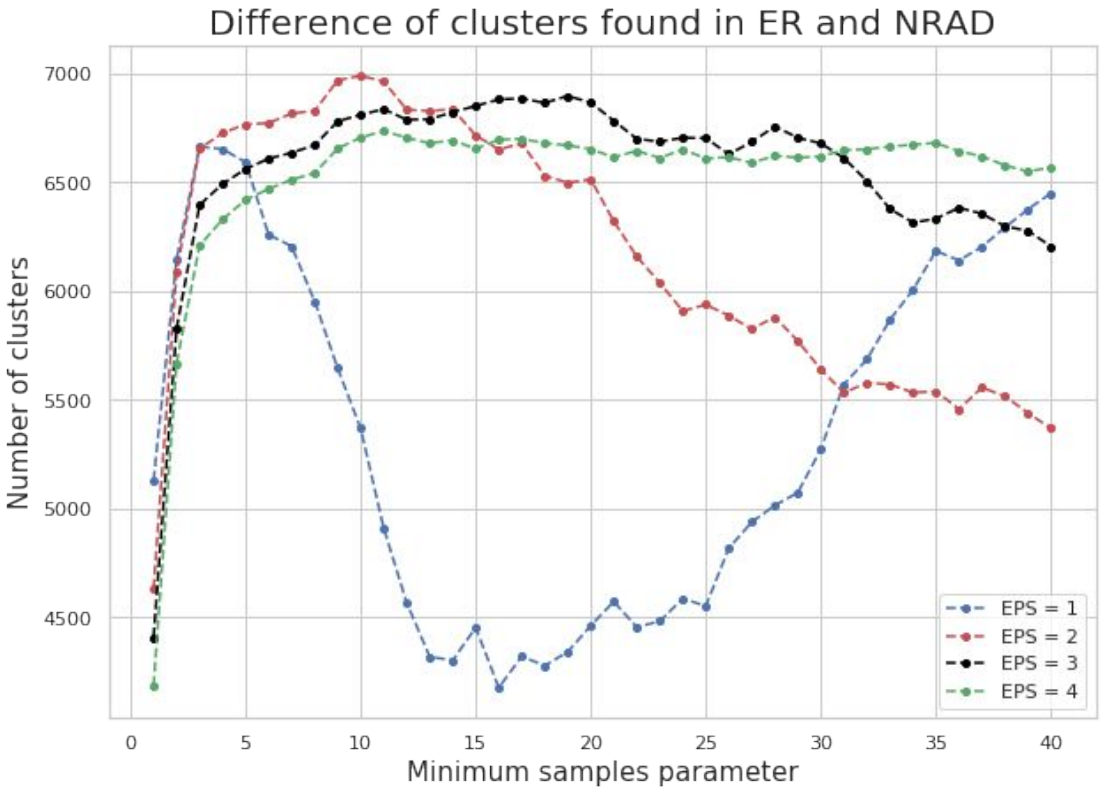
- Reconstruction version:
  - Autumn21 branch updated on Feb 11th.

Paper Structure

- Introduction[1]
- Measurement setup
  - LIME detector[1], acquired datasets[2] and expected signals[2].
- Data Anlysis
  - Reconstruction algorithm[2], iDBSCAN and iDDBSCAN explanations[2].
  - Parameter validation (ε, N_{min}, ω_{dir}, ε_{dir}, $\rho_{isolation}$)[2].
- Clustering algorithms comparison
  - Energy spectra[2], slimness optimization[2], scatter plots[2] and polya fit[2].
- Summary[1]

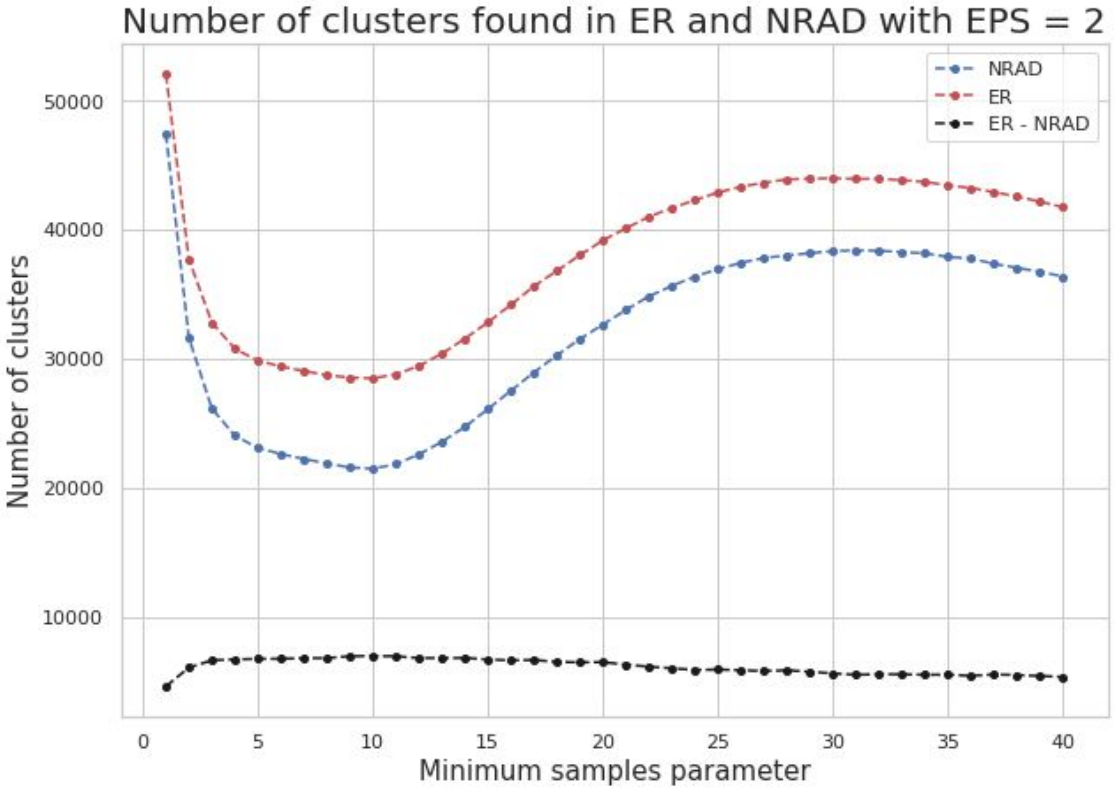
1 - On going
2 - Done.

Parameter Validation: ε and N_{min}



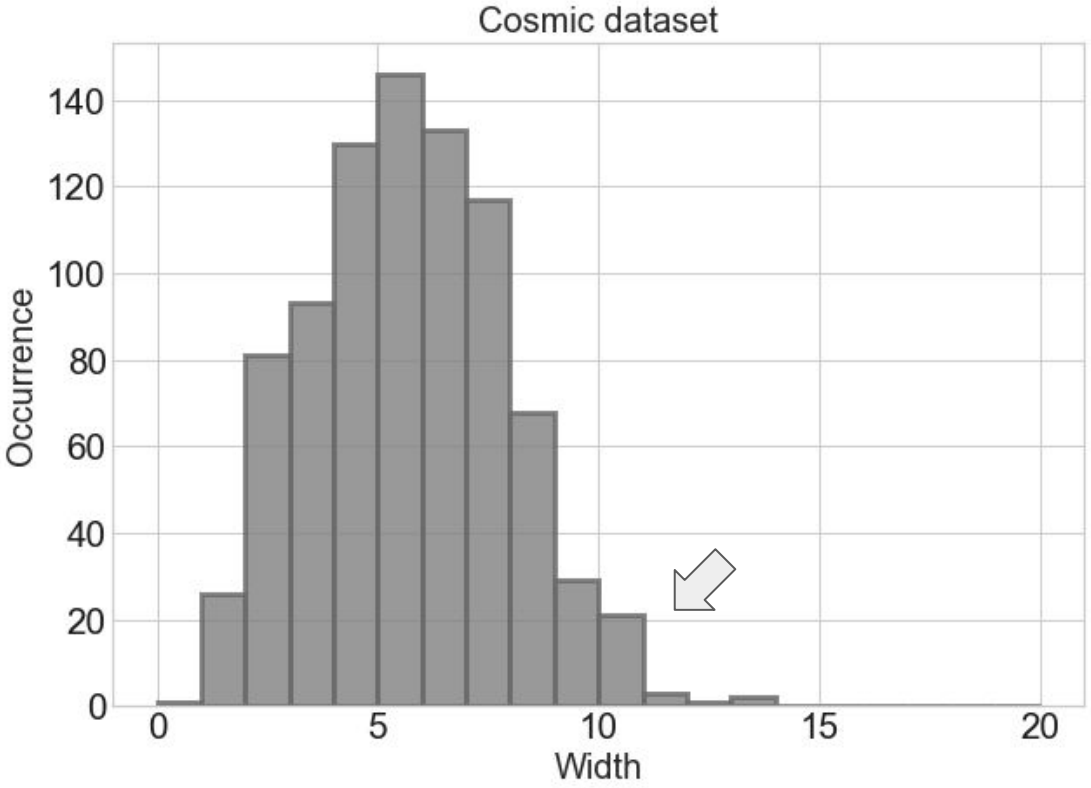
- Number of detected clusters by sweeping the parameters.
- The peak of ER - NRAD clusters is desired.
- ε = 2; N_{min} = 10.

Parameter Validation: ε and N_{min}



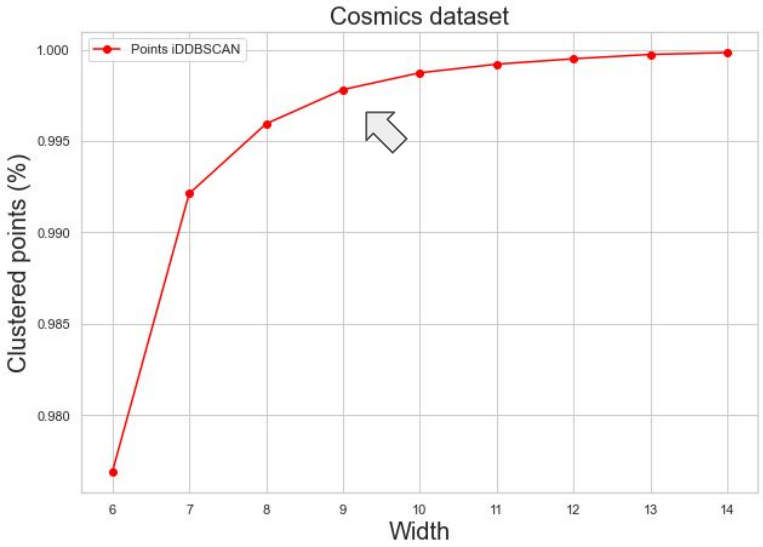
- Sweeping N_{min} for the fixed value of ε provides a good understanding of the data.
- N_{min} = 10 is also the valley of both ER and NRAD plots.

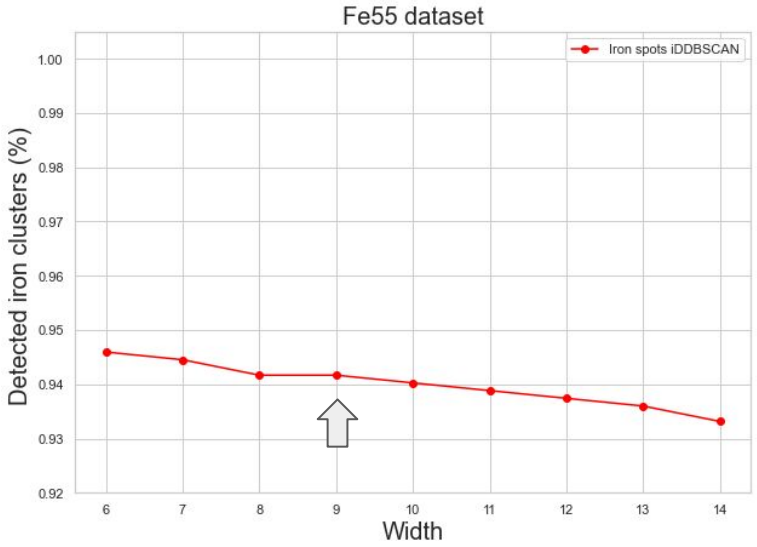
Parameter Validation: ω_{dir}



- The iDBSCAN was used on the cosmic dataset to measure the width of each cluster.
- The ideal ω seems to be close to 10.
- A scan using the iDDBSCAN was done by sweeping ω from 6 to 14 on cosmic and ^{55}Fe datasets.

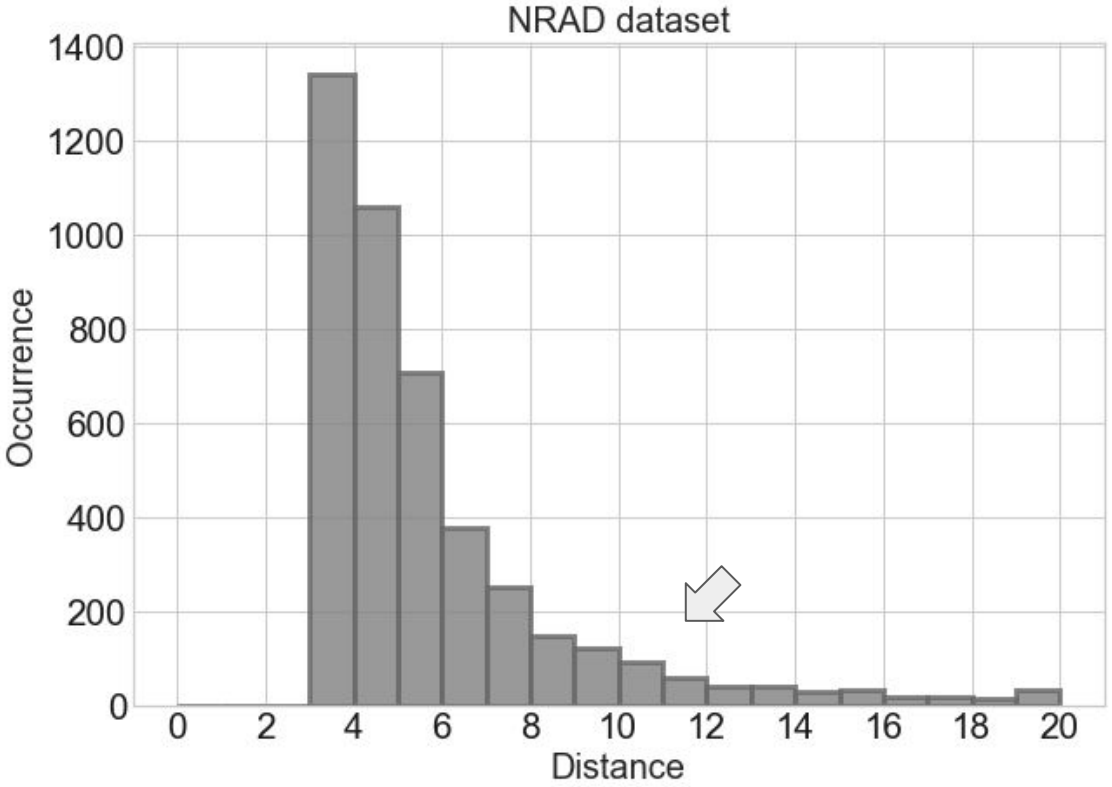
Parameter Validation: ω_{dir}





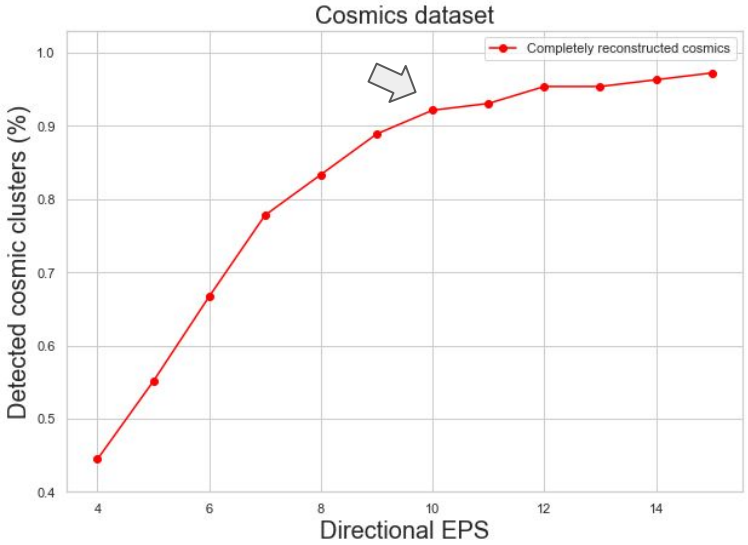
- Cosmics are better reconstructed as ω grows whereas more ^{55}Fe tracks are lost.
- The value 9 was chosen for this parameter.

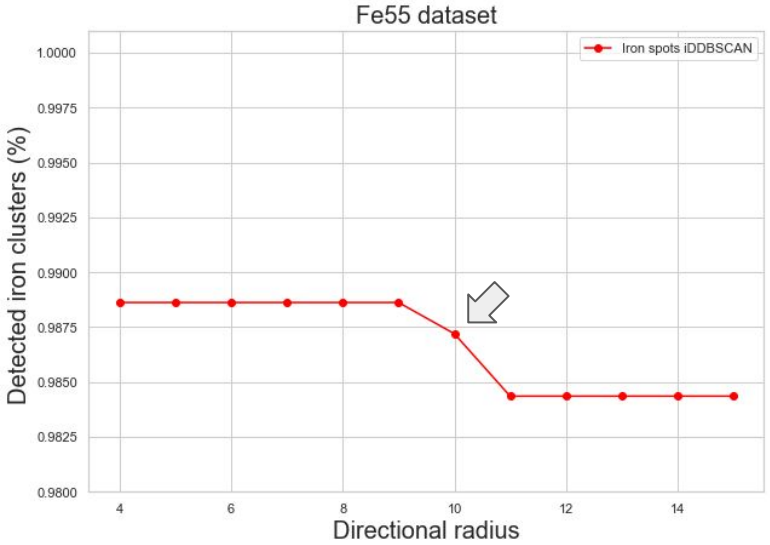
Parameter Validation: ε_{dir}



- The iDBSCAN was used on the NRAD dataset to measure the distance between the unidirectional clusters.
- The ideal ε_{dir} seems to be close to 10.
- A scan using the iDDBSCAN was done by sweeping ε_{dir} from 4 to 15 on cosmic and ^{55}Fe datasets.

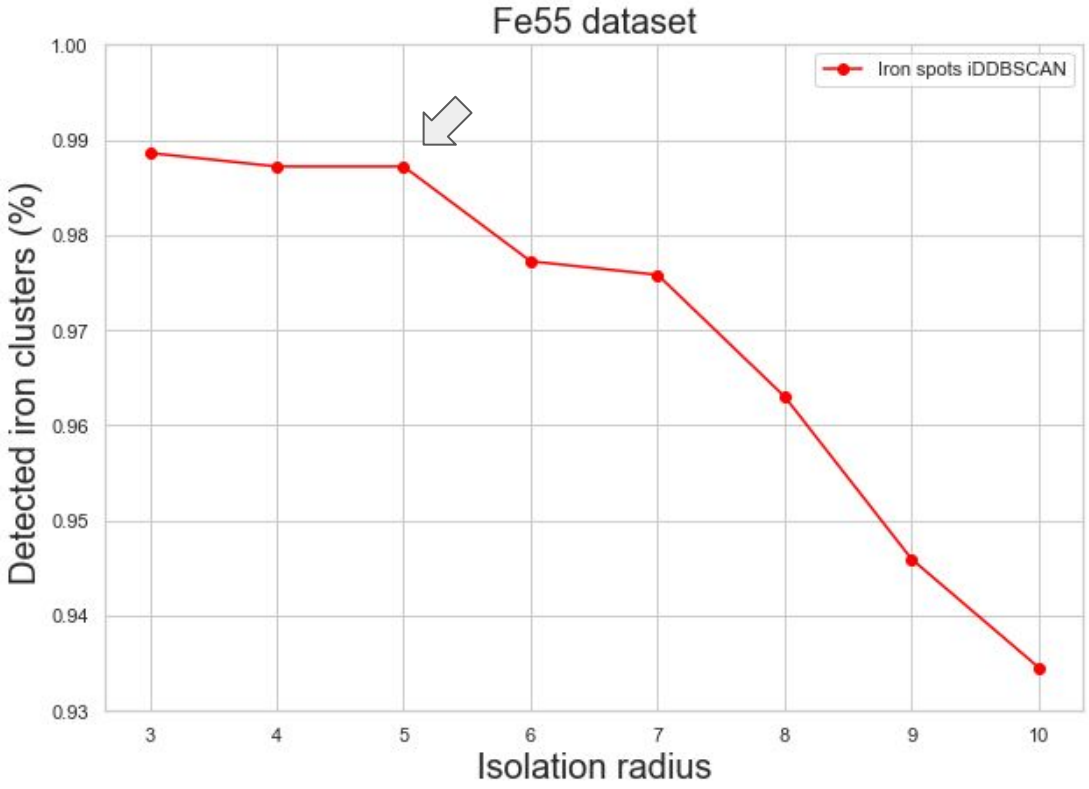
Parameter Validation: ε_{dir}





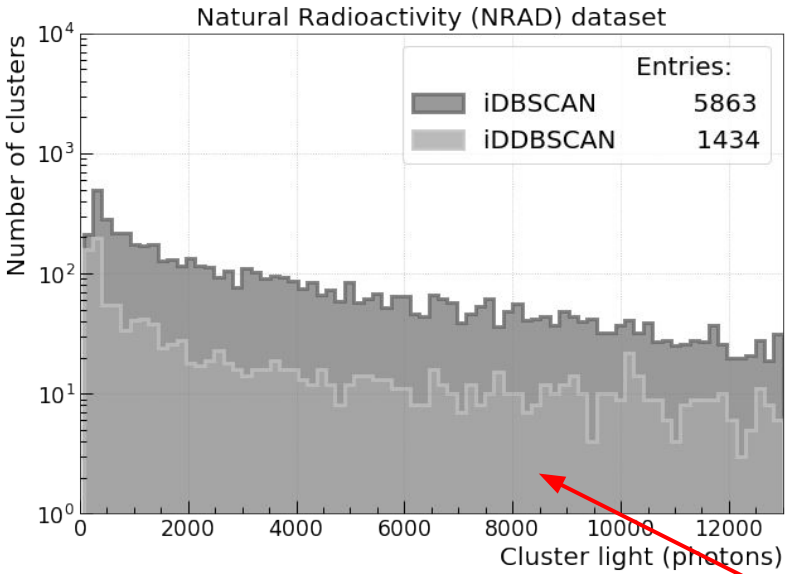
- Cosmics are better reconstructed as ε_{dir} grows whereas more ^{55}Fe tracks are lost.
- The value 10 was chosen for this parameter.

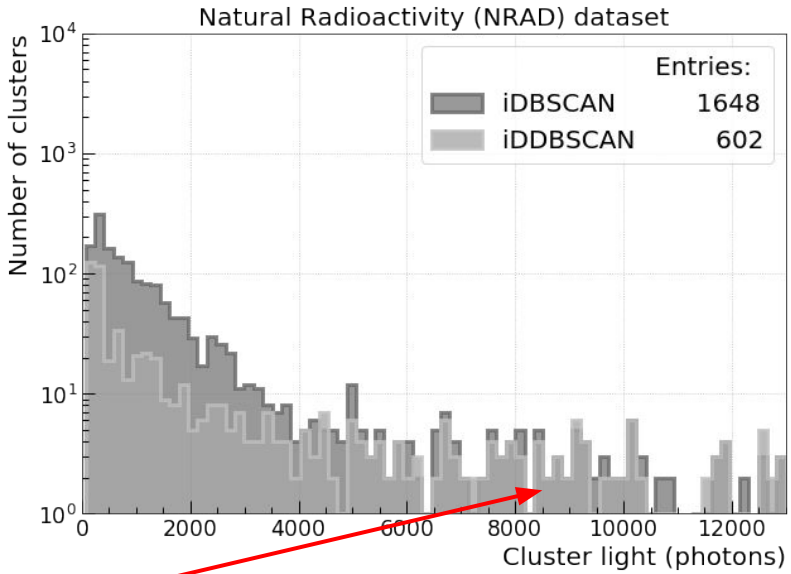
Parameter Validation: $\rho_{isolation}$



- This parameter should be slightly higher than ε to avoid the halos.
- A scan on the ^{55}Fe dataset was done to check the iron loss based on this parameter.
- The value 5 was chosen for this parameter.

Low energy analysis

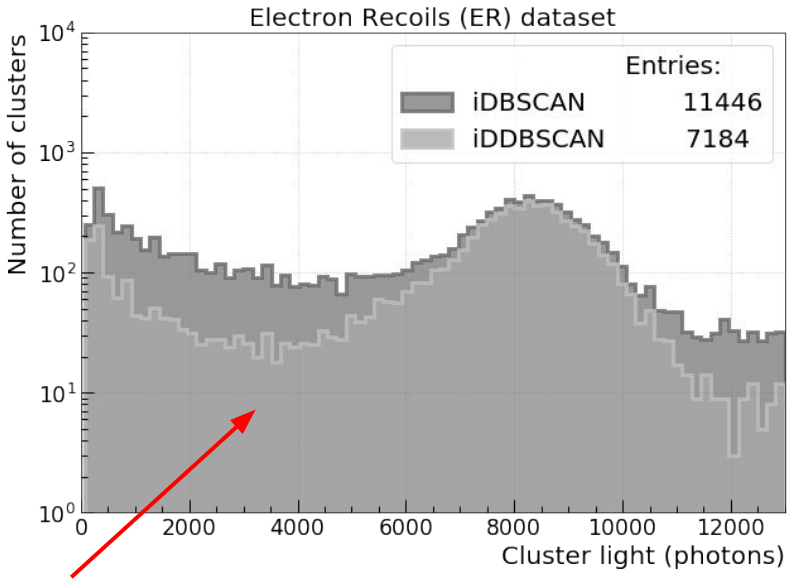


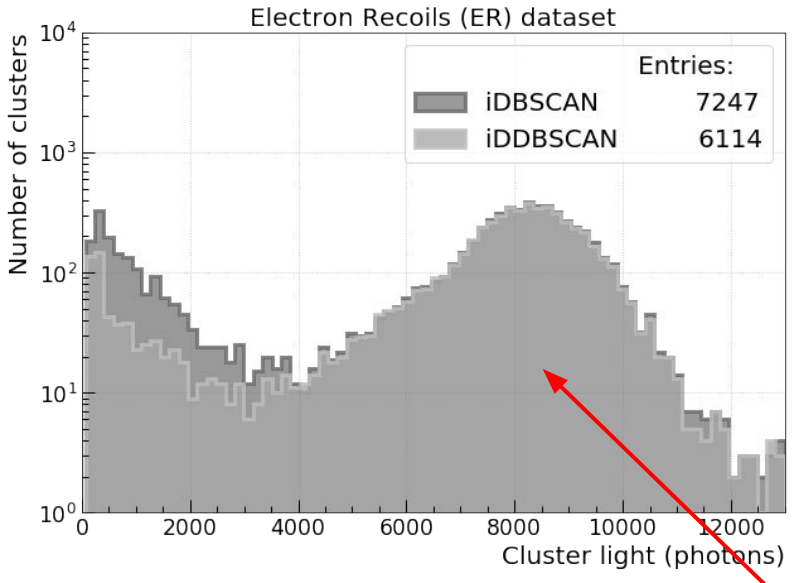


Less contamination

NRAD clusters energy comparison between iDBSCAN and iDDBSCAN without (left) and with (right) selection on the slimness.

Low energy analysis



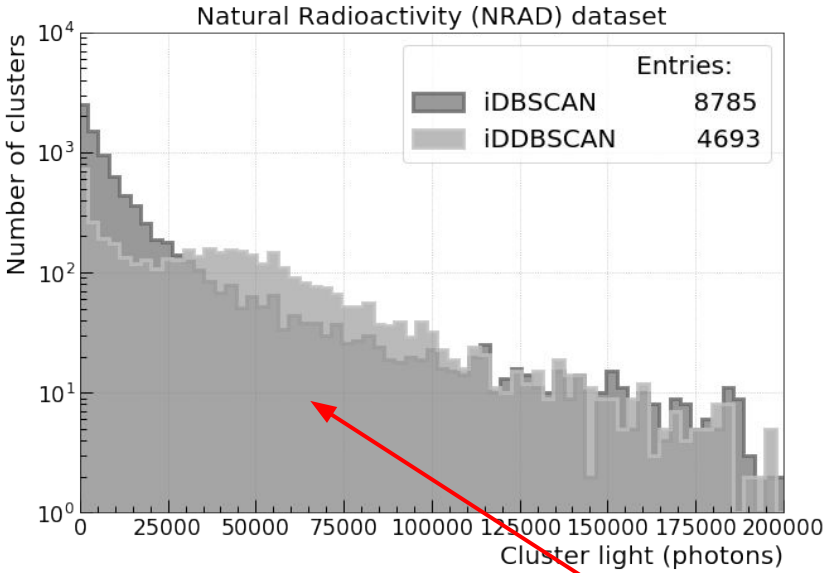


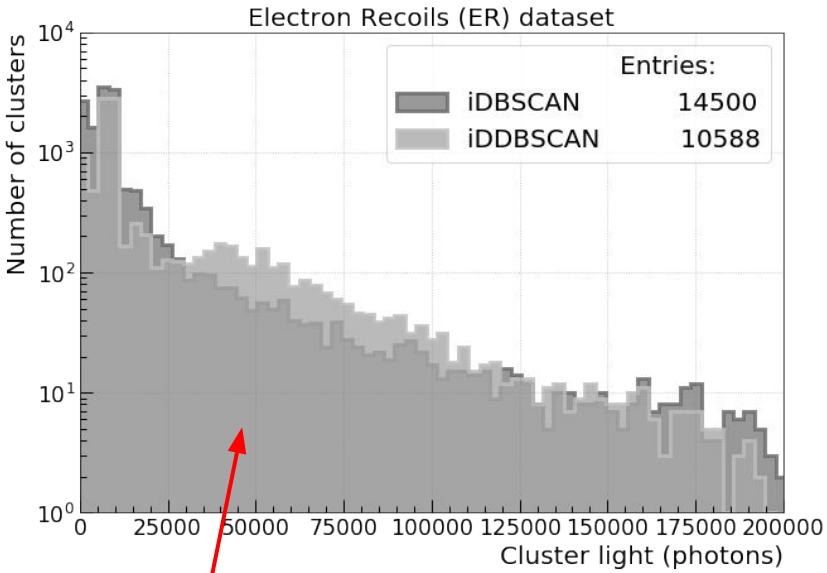
Cleaner neighborhood

Similar peak

ER clusters energy comparison between iDBSCAN and iDDBSCAN without (left) and with (right) selection on the slimness.

High energy analysis

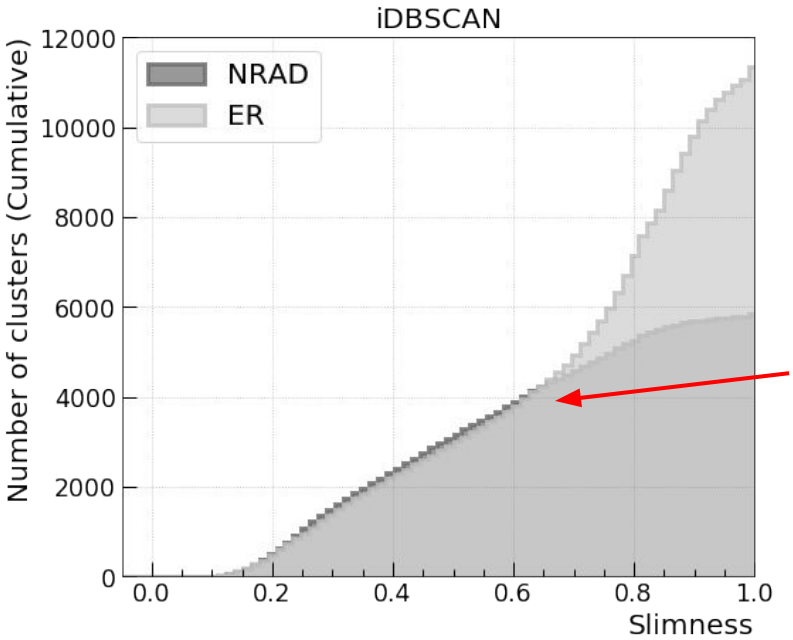




More cosmics reconstructed

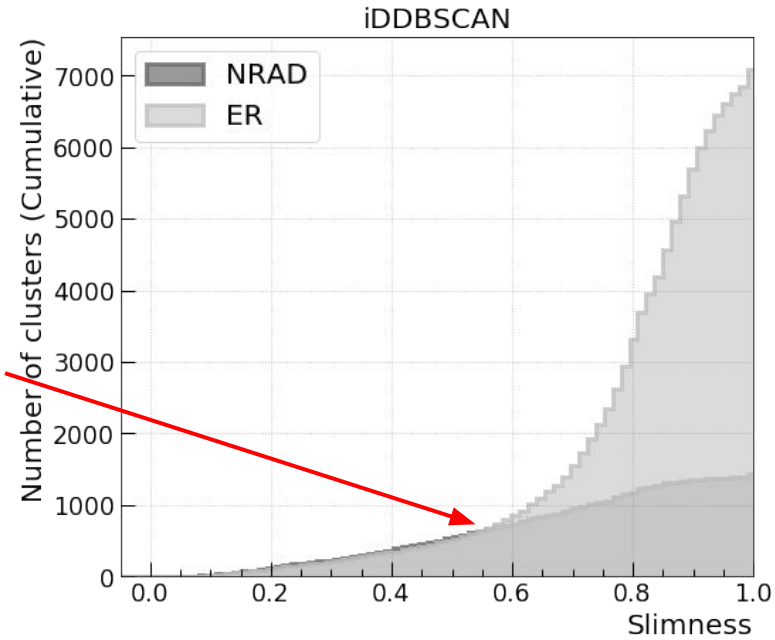
Comparison between iDBSCAN and iDDBSCAN on NRAD (left) and ER (right) datasets considering all the energies.

Slimness selection optimization



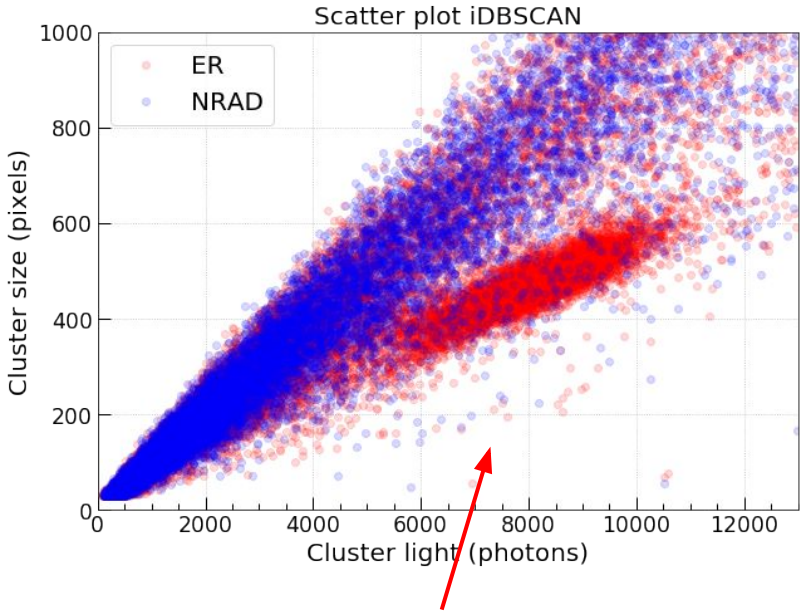
Separation

Slimness 0.65 chosen.

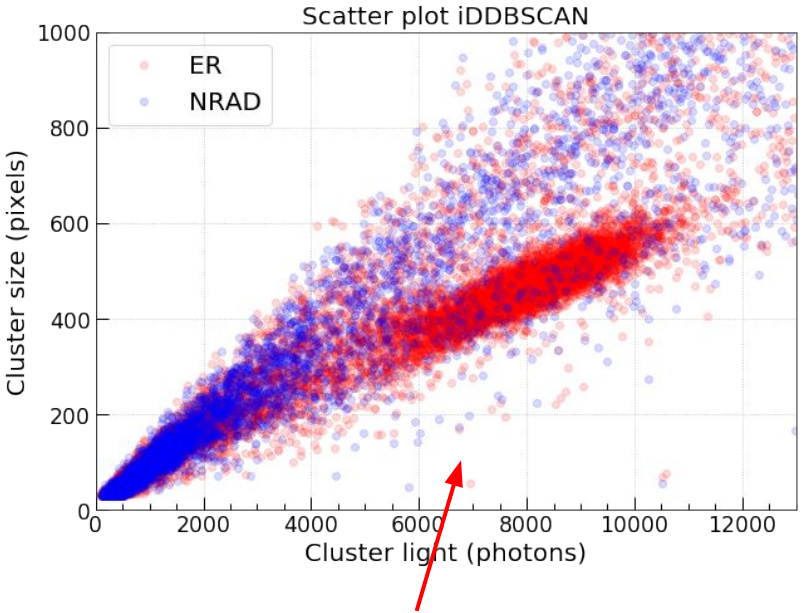


Slimness cumulative distribution on NRAD and ER datasets using the iDBSCAN (left) and iDDBSCAN (right).

Scatter plot



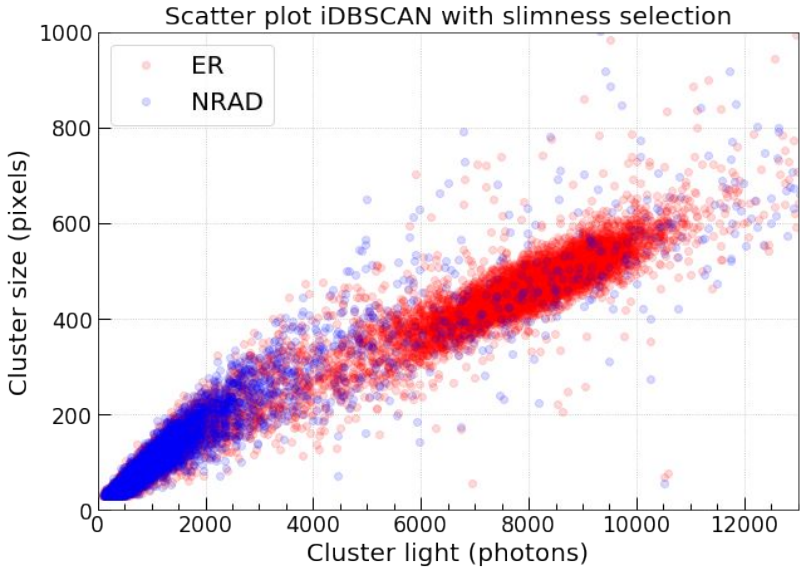
Iron region's neighborhood overcrowded

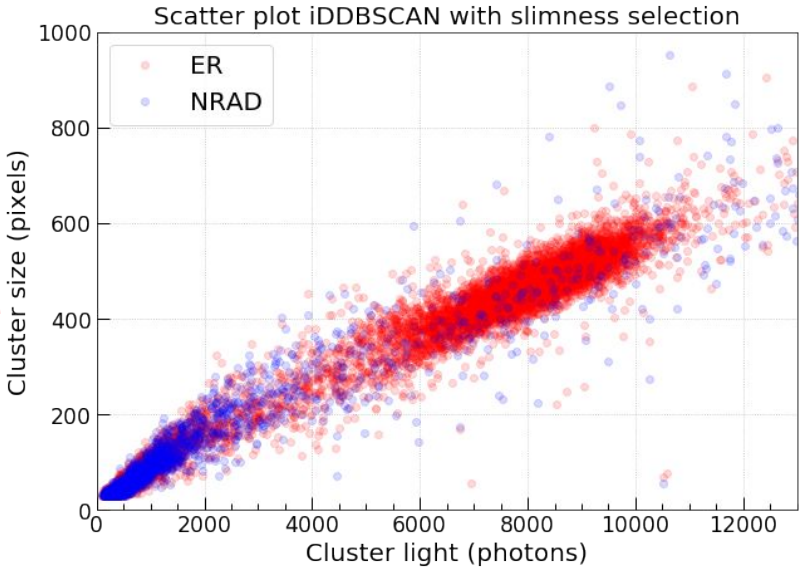


Iron region's neighborhood cleaner

Scatter plot of cluster integral versus cluster size o ER and NRAD datasets using the iDBSCAN (left) and iDDBSCAN (right)

Scatter plot with slimness selection

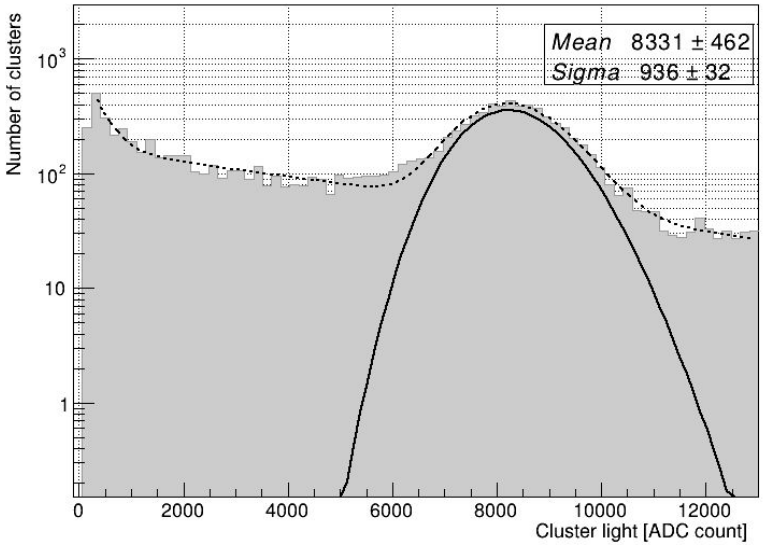


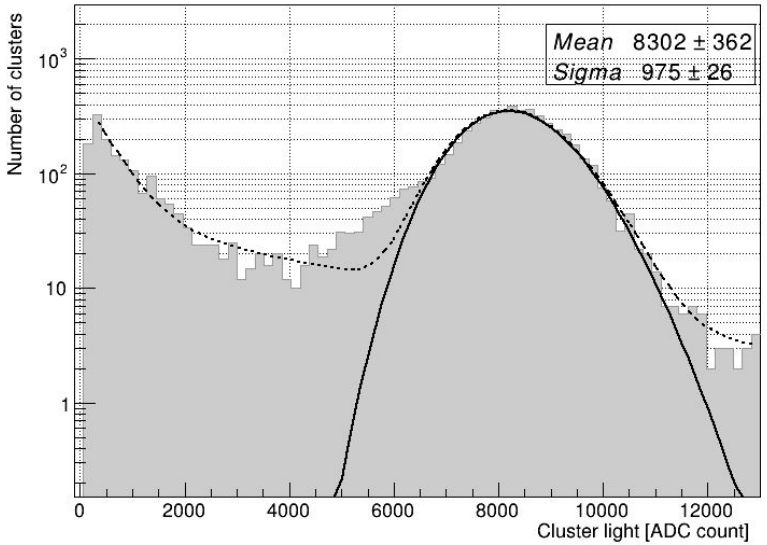


Similar result

Scatter plot of cluster integral versus cluster size o ER and NRAD datasets using the iDBSCAN (left) and iDDBSCAN (right) and selection on the slimness.

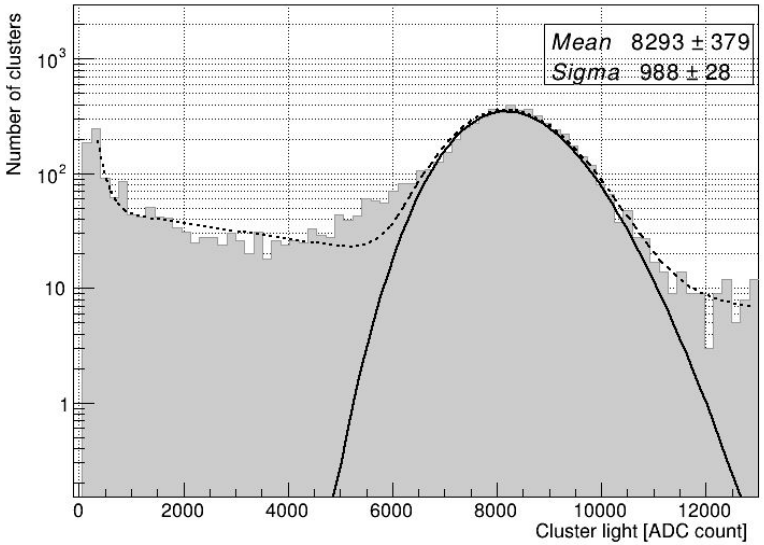
iDBSCAN polya fit

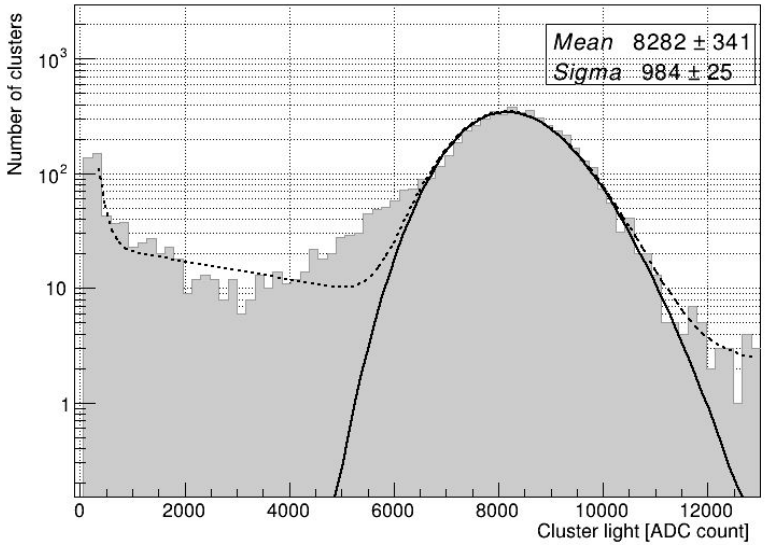




Polya fit on the ER dataset's cluster energy histogram using the iDBSCAN without (left) and with (right) a selection on the slimness

iDDBSCAN polya fit





Polya fit on the ER dataset's cluster energy histogram using the iDDBSCAN without (left) and with (right) a selection on the slimness

Light yield resolution

Parameter	iDBSCAN	iDDBSCAN
Resolution (%)	**(11.2±0.73)**	**(11.9±0.64)**
Resolution (%) slimness > 0.65	**(11.7±0.6)**	**(11.8±0.57)**

Conclusion

- The iDDBSCAN is able to perform a better reconstruction of cosmic tracks without significantly affecting the energy resolution, which indicates that the loss of ^{55}Fe tracks is minimal.

- Therefore, background rejection has been improved whereas signal detection remained close.