9th CERN Patatrack Hackathon @TUE

GROUP 3, 14 JULY 2021

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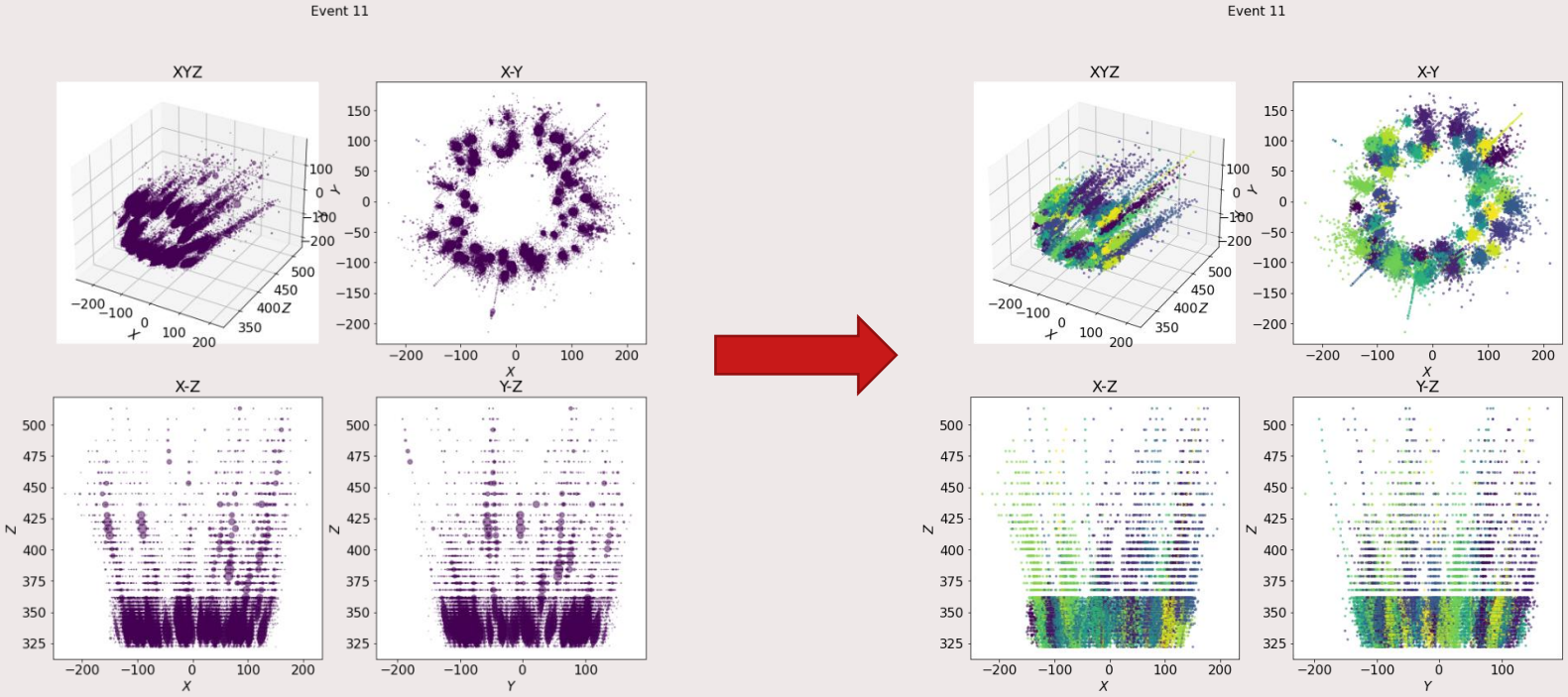
Goal

Identifying tracksters and the points belonging to them



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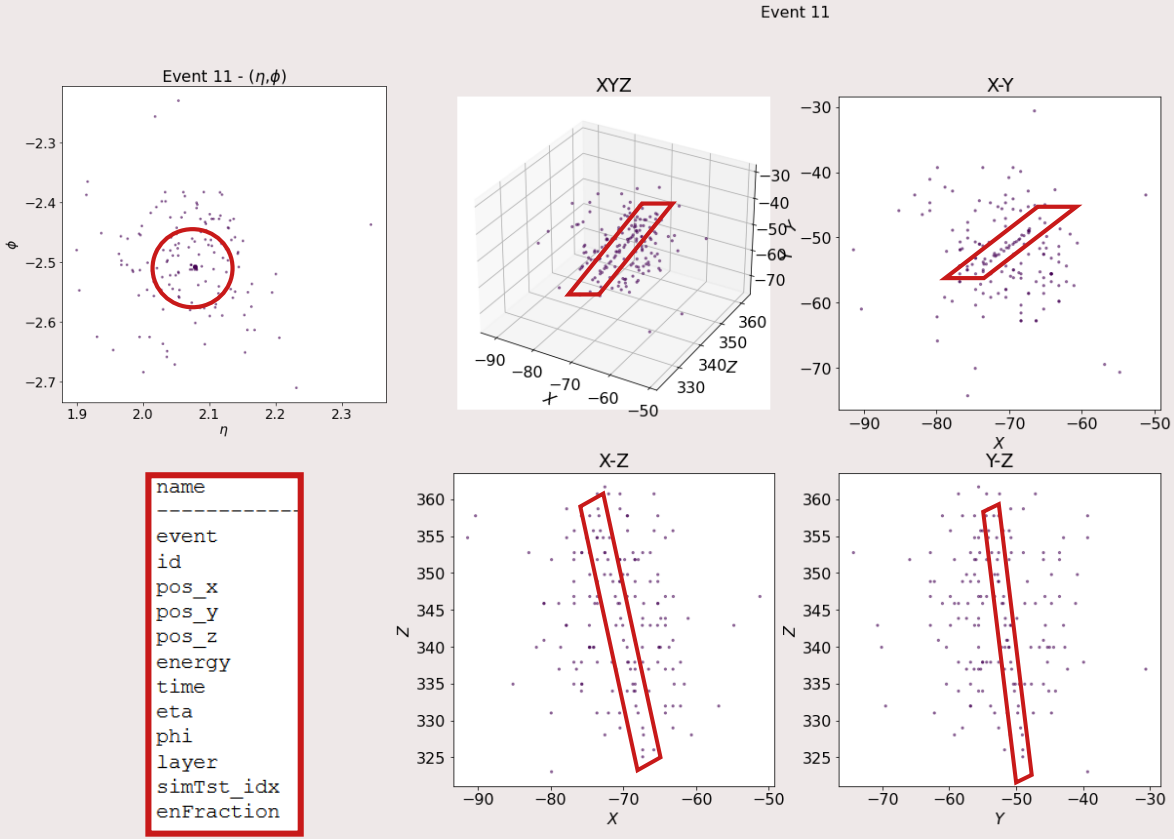
Datasets

- Contains information about positions, energy, time, and layers
- Intuitively, there are areas that are more **densely** populated
- Some **pattern intuition** involving **Z**



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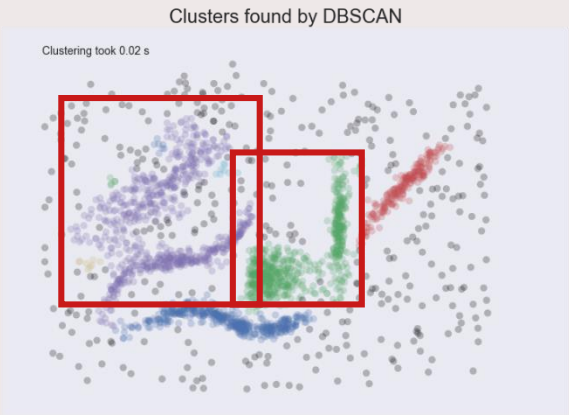
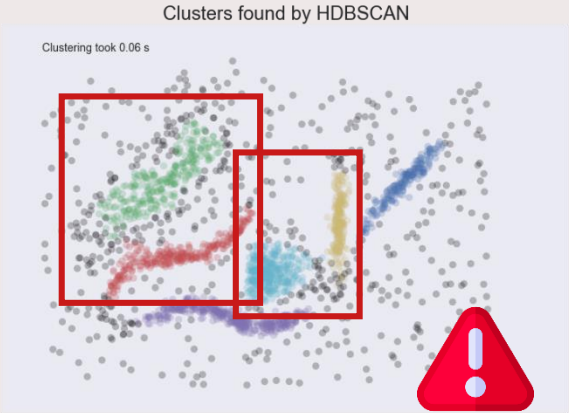
Main idea

- Focusing on **density-**> DBSCAN algorithm
- DBSCAN uses **core samples** to build the clusters around them -> More **energetic points**
- HDBSCAN = DBSCAN + varying density clusters





Source

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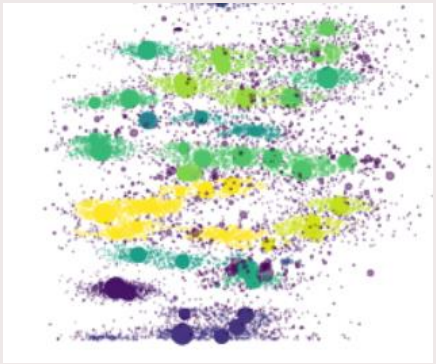
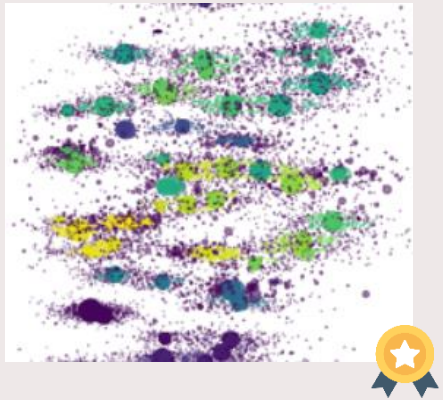
Findings

```
clusterer = hdbscan.HDBSCAN(min_cluster_size=15,
                            min_samples=7,
                            cluster_selection_epsilon=0.002)
```

```
labels = clusterer.fit_predict(df[['eta','phi']])
```

- Clustered on density based on η and ϕ
- You can fine-tune HDBSCAN with these parameters
  - min_cluster_size and min_samples -> # to consider a cluster
  - cluster_selection_epsilon -> minimum separation between clusters





ε=0.02

ε=0.002

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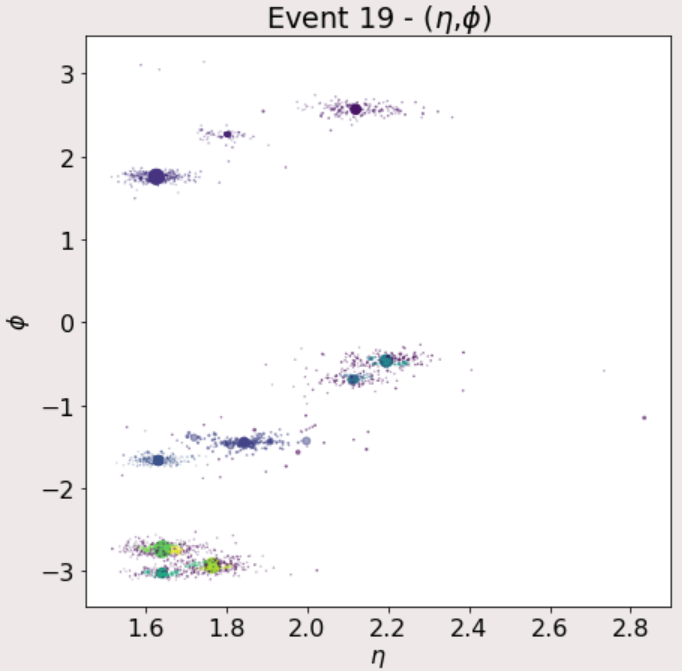
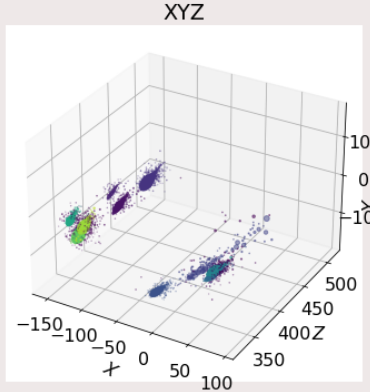
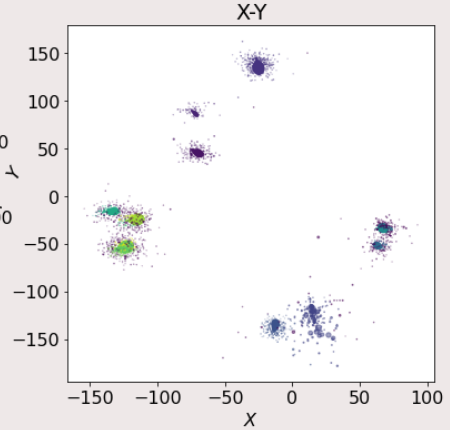
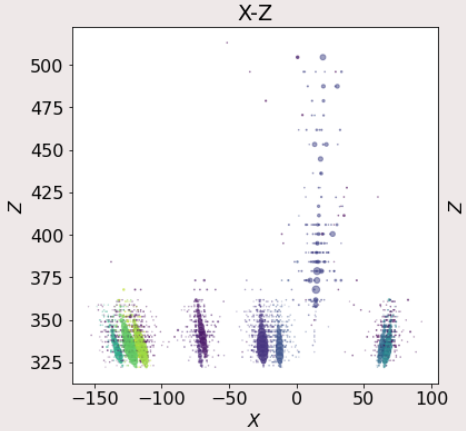
Results (I)

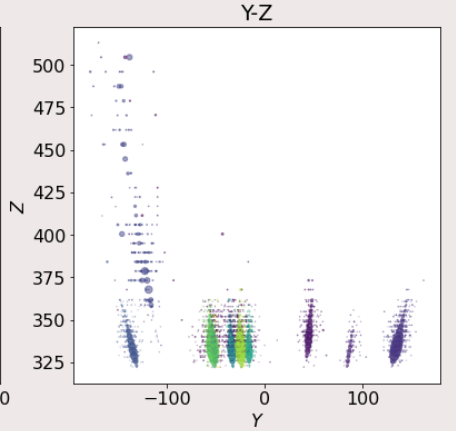



```
The total clusters are:  21
```









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Classifying outliers

- KDTree on the classified points
- For the not classified:
  - Find the nearest point in the classified tree
  - Take the cluster from that point
  - Assign that cluster to the unclassified point

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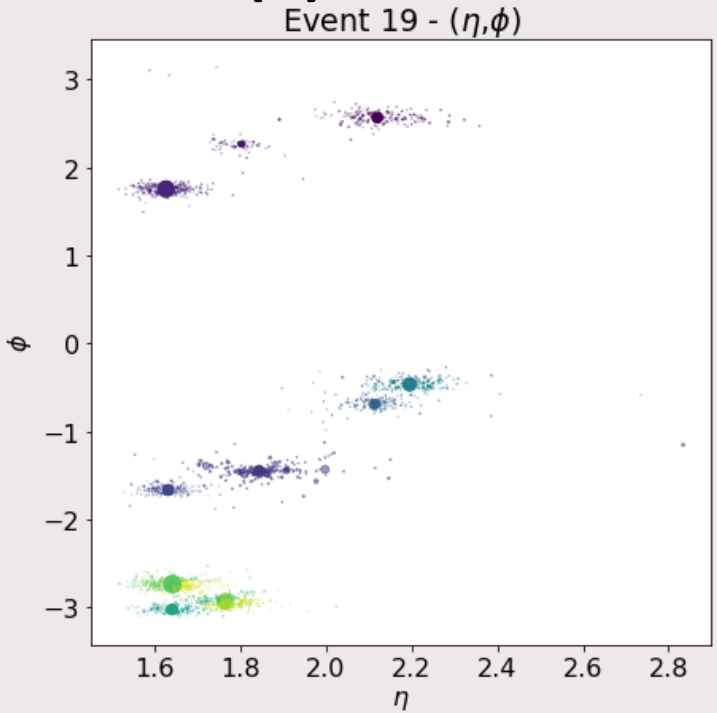
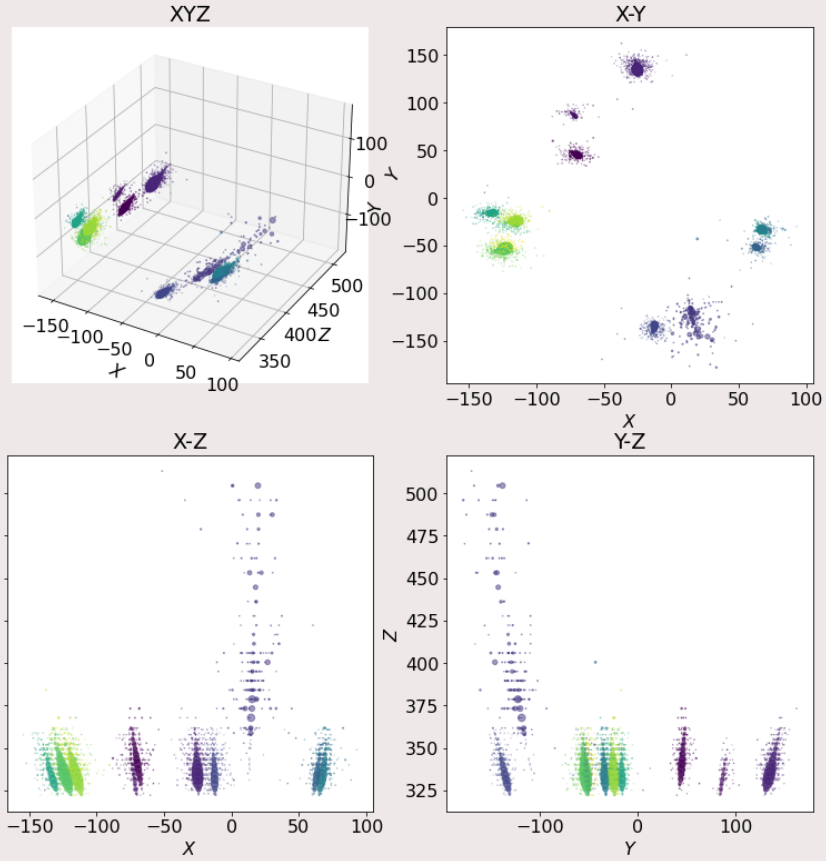
Results (II)




```
The total clusters are:  21
```



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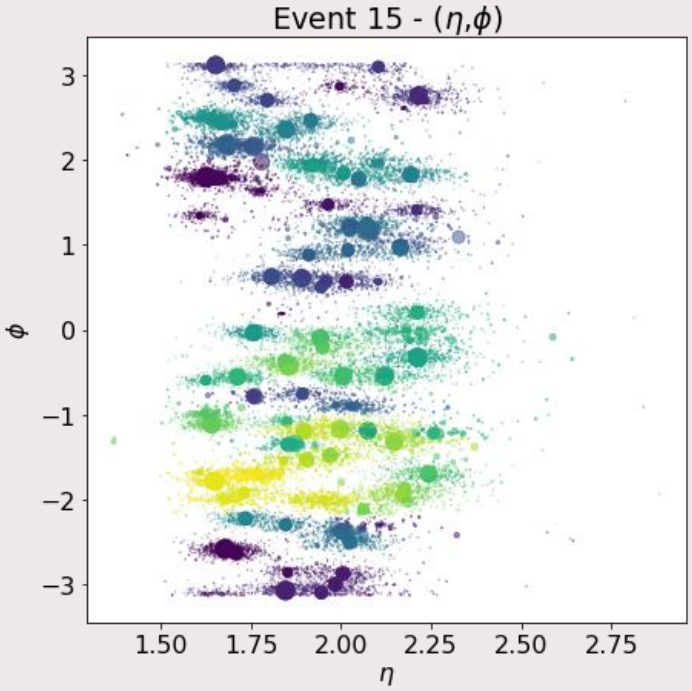
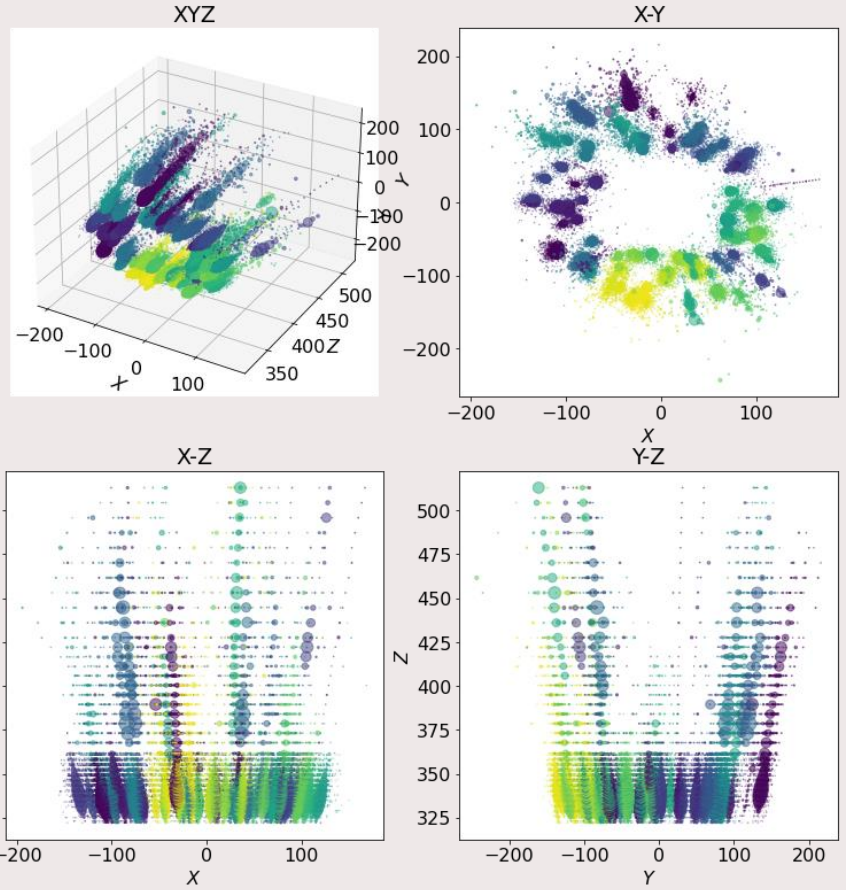
Results (II)



The total clusters are: 210



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Future possible improvements

Best approach is raw clustering to get the number of clusters following with precise (density-based) clustering method such as:

1. Flatten the image in each clusters' angle and use a stricter cluster algorithm based on the energy density
2. Use HBDSCAN to create a tree based on energy density and pick the appropriate level contour that matches to expected energy of the particles
3. Create circles around points and expand until it includes n points, the radius of each circles corresponds whether it is a core point, boundary point or noise point (the outliers)
4. **Extra:** Use temporal dependencies to distinguish different particle showers for files with overlapping showers