Anomalies

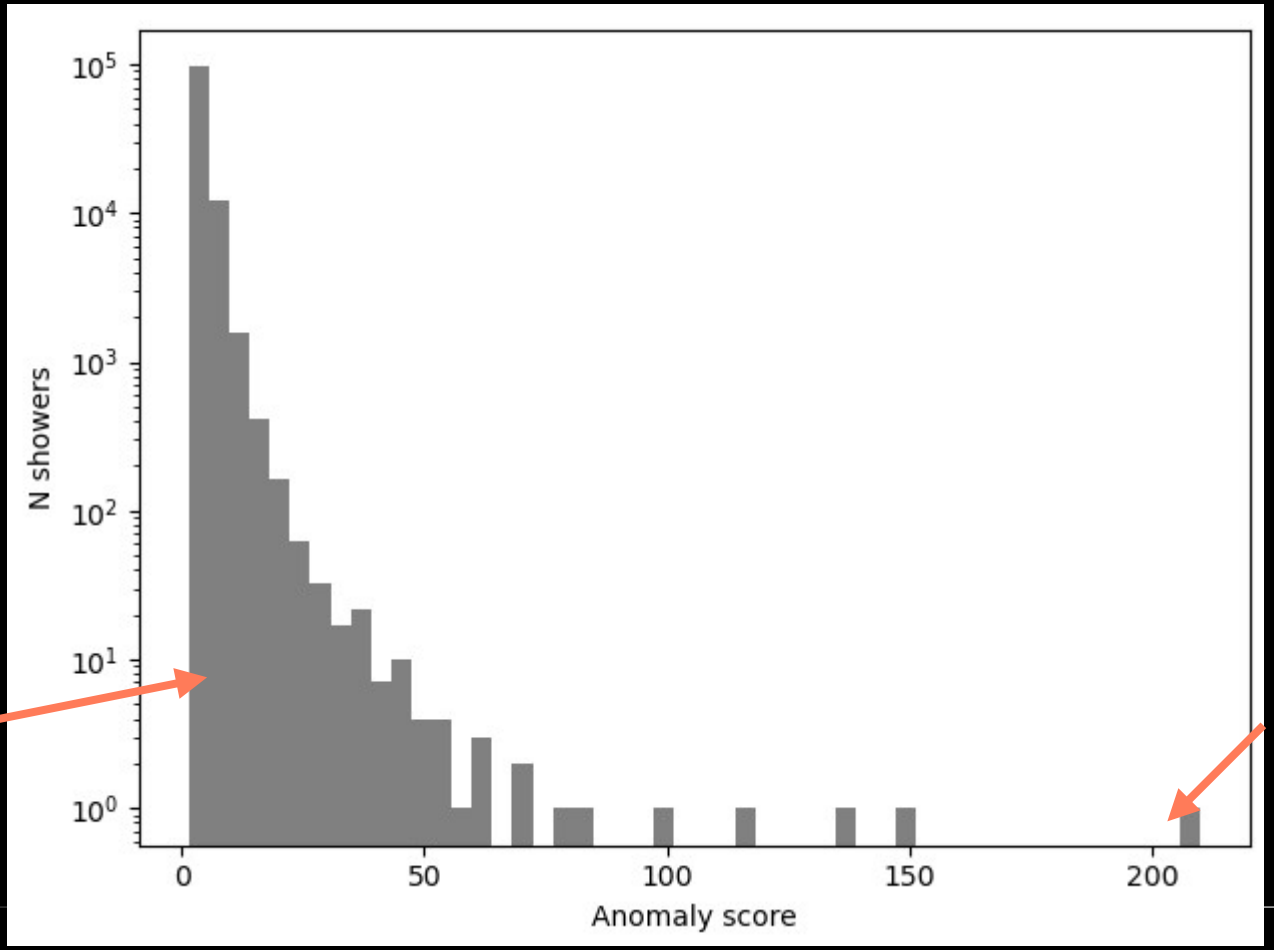
Basic anomaly detection

- Start from the downsampled ECal data. (High granularity)
- Dataset contains 110000 events.
- Represent each event as a graph.
  - Making connections between points so that events take on a roughly tree like shape.
- Feed this to a graph autoencoder. The autoencoder aims to guess the features on the points given the shape of the graph.

Features on the points are

- X
- Y (layer)
- Z
- Point energy
- Incident energy
- N children 1 layer forward
- N children 2 layers forward
- N children 3 layers forward
- N children 4 layers forward
- N children 5 layers forward.

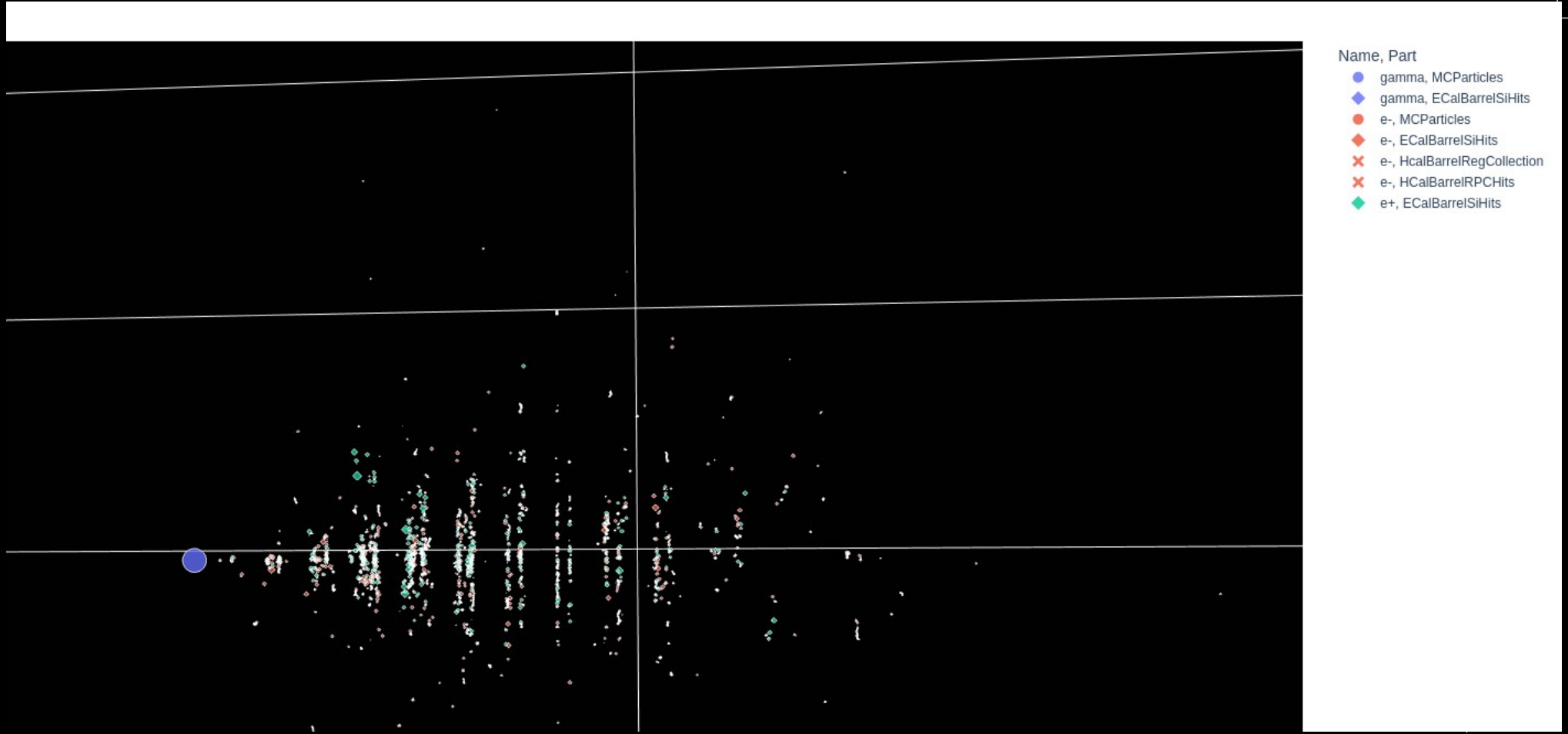
Anomaly detector is working



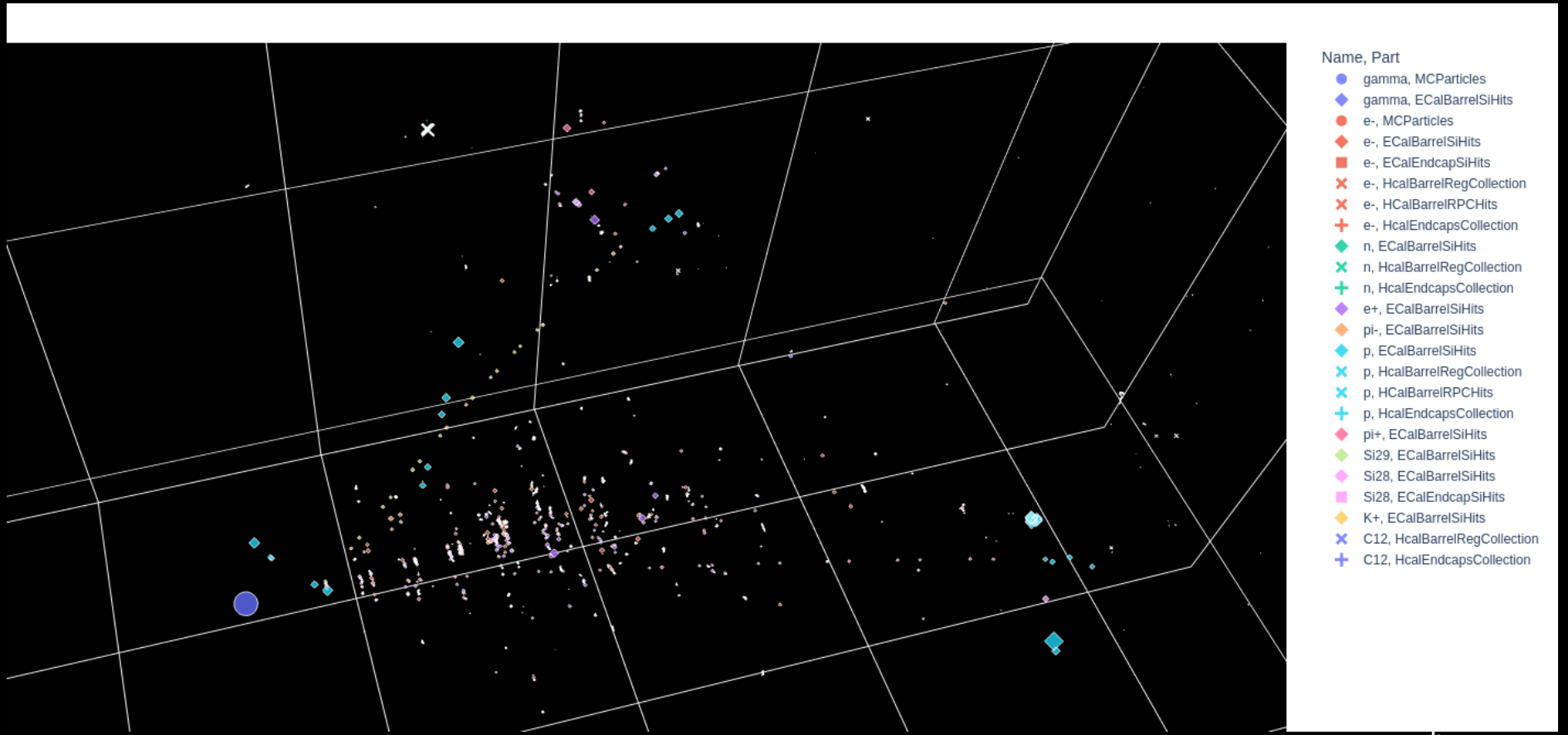
Easy to reconstruct, Probably normal

Hard to reconstruct, probably odd.

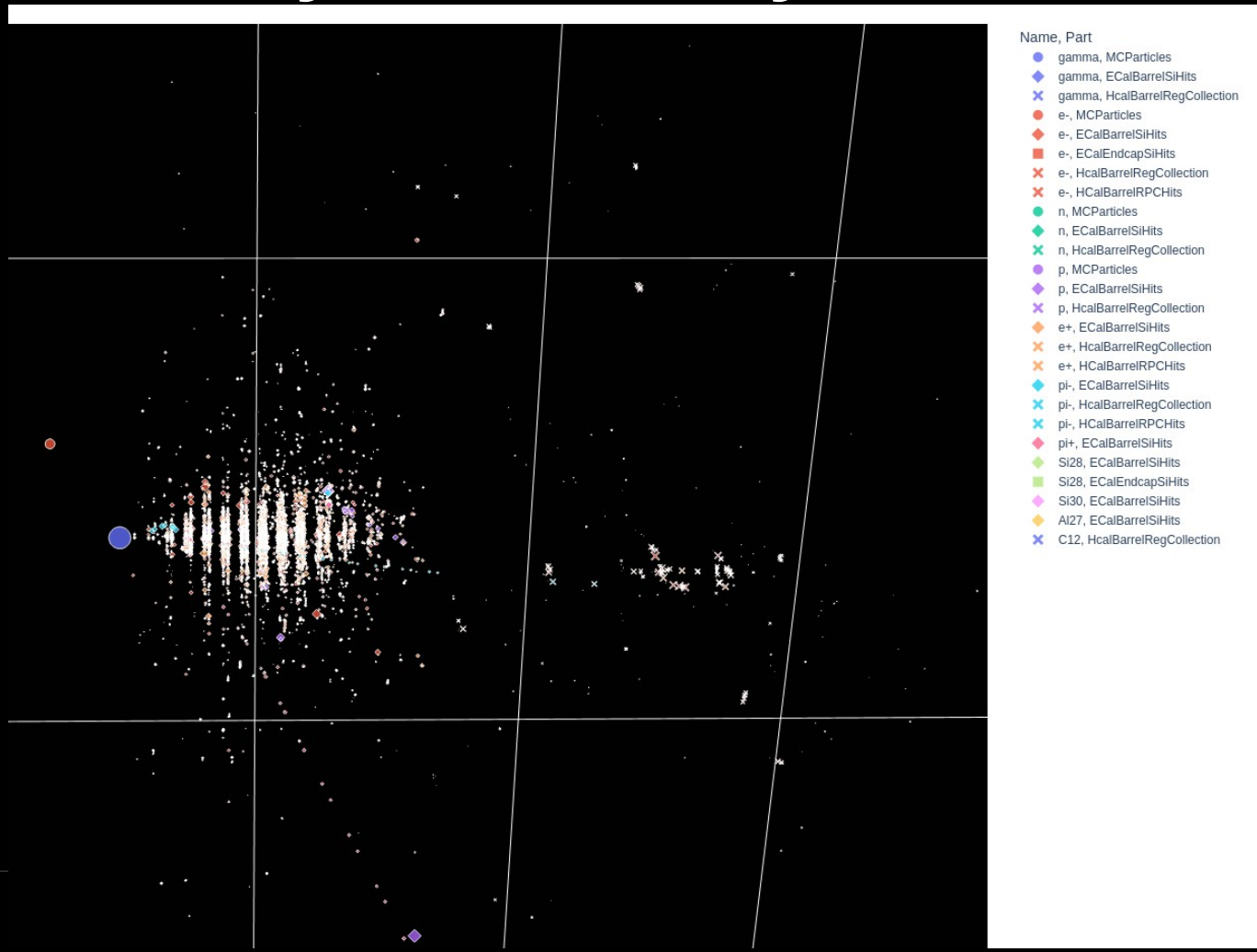
Most normal event; Anomaly score 1.8



Strangest event; Anomaly score 209.7



Isolated oddity; Anomaly score 63.3

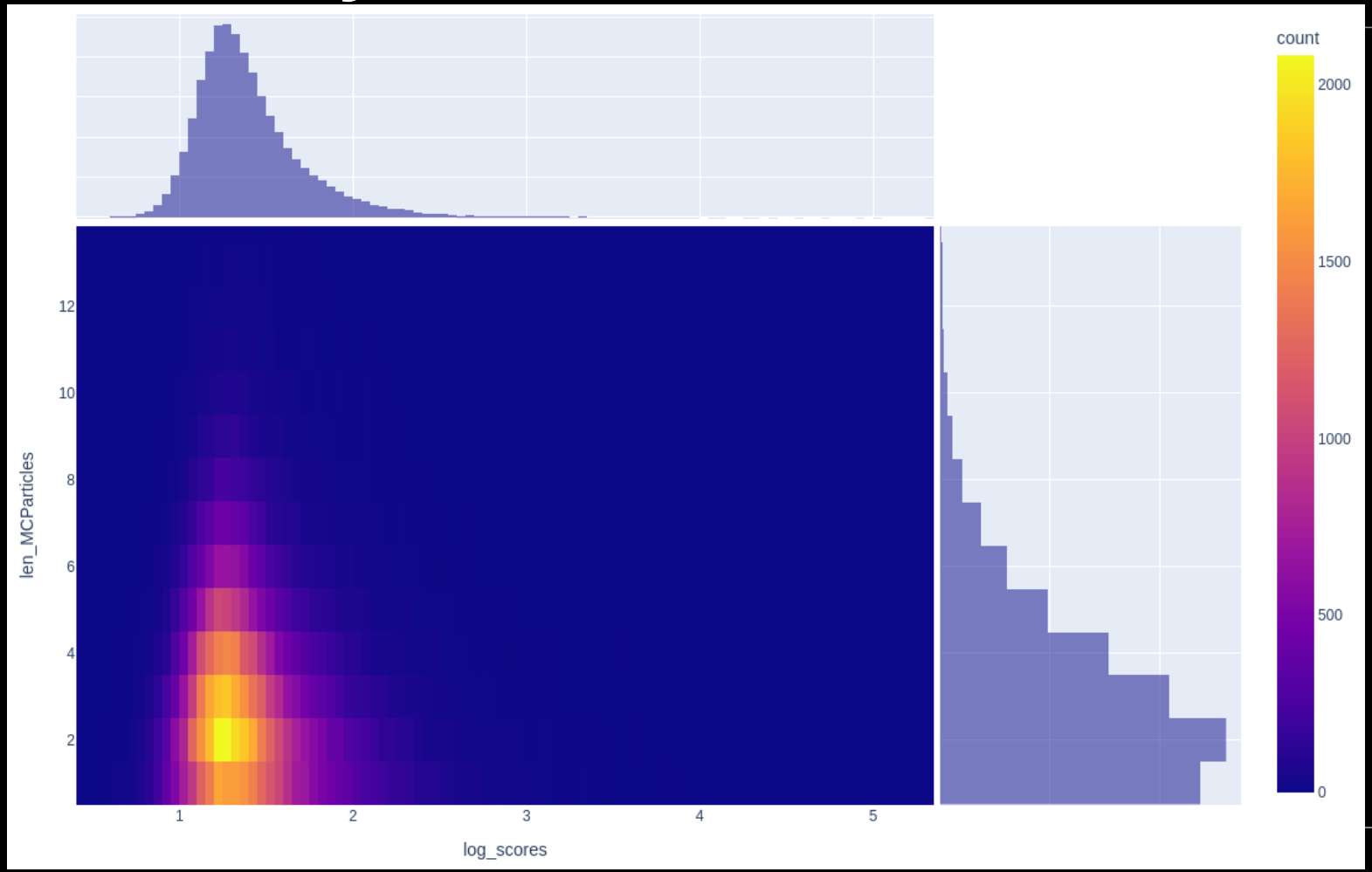


Short MCParticles

- Standard root files produced in edm4hep format have a short list of MCParticles.
- These have been filtered down from the much longer list that's present the "verbose" variation. Filtered so it's quicker to produce and smaller on disk.
- I don't know all the rules on the filter.
- It's about 1 to 15 particles.

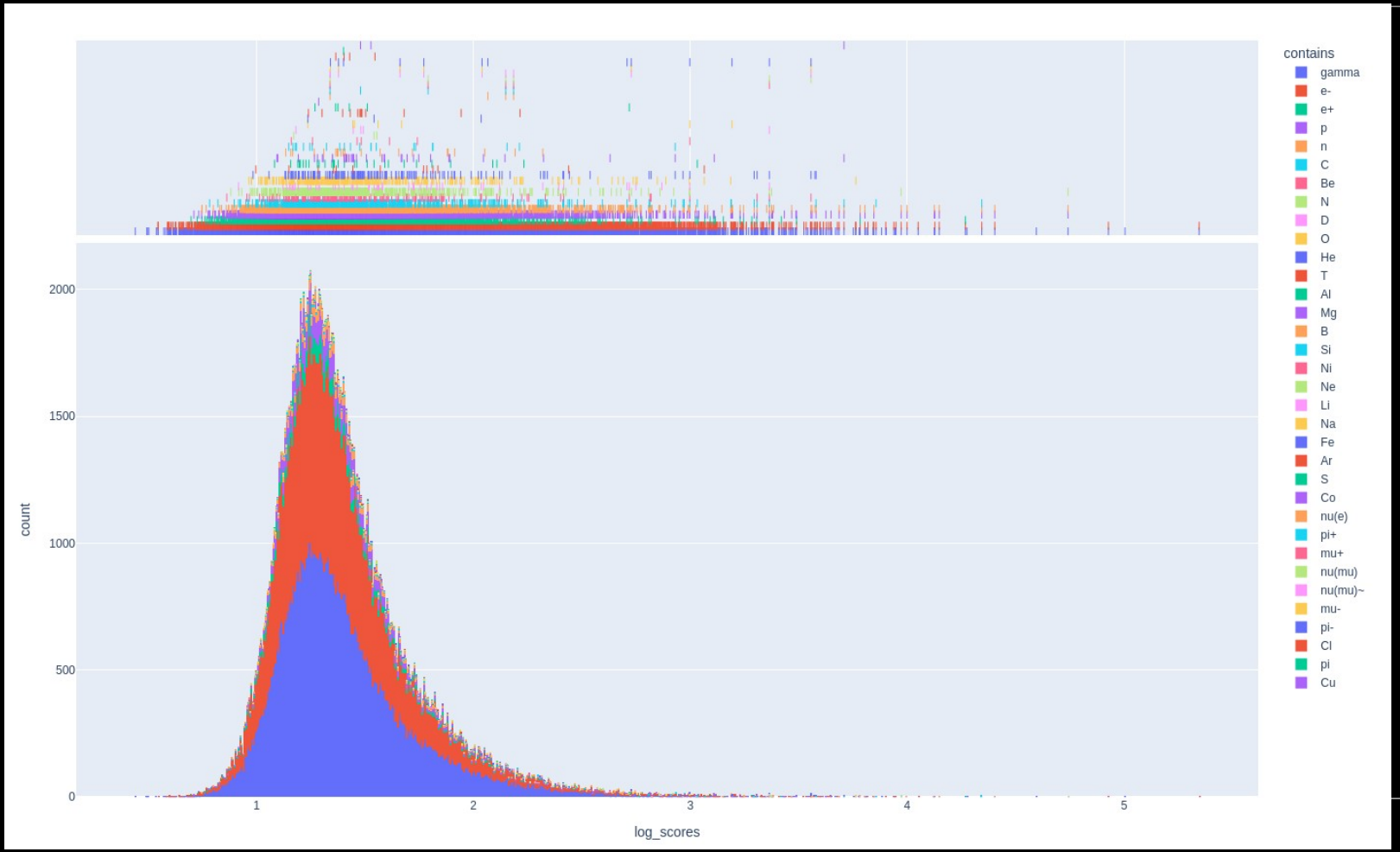
- I had hoped that I'd be able to understand the anomalous events just by looking at this list.
- It doesn't seem to contain enough information.

Anomaly score v.s. number of MC



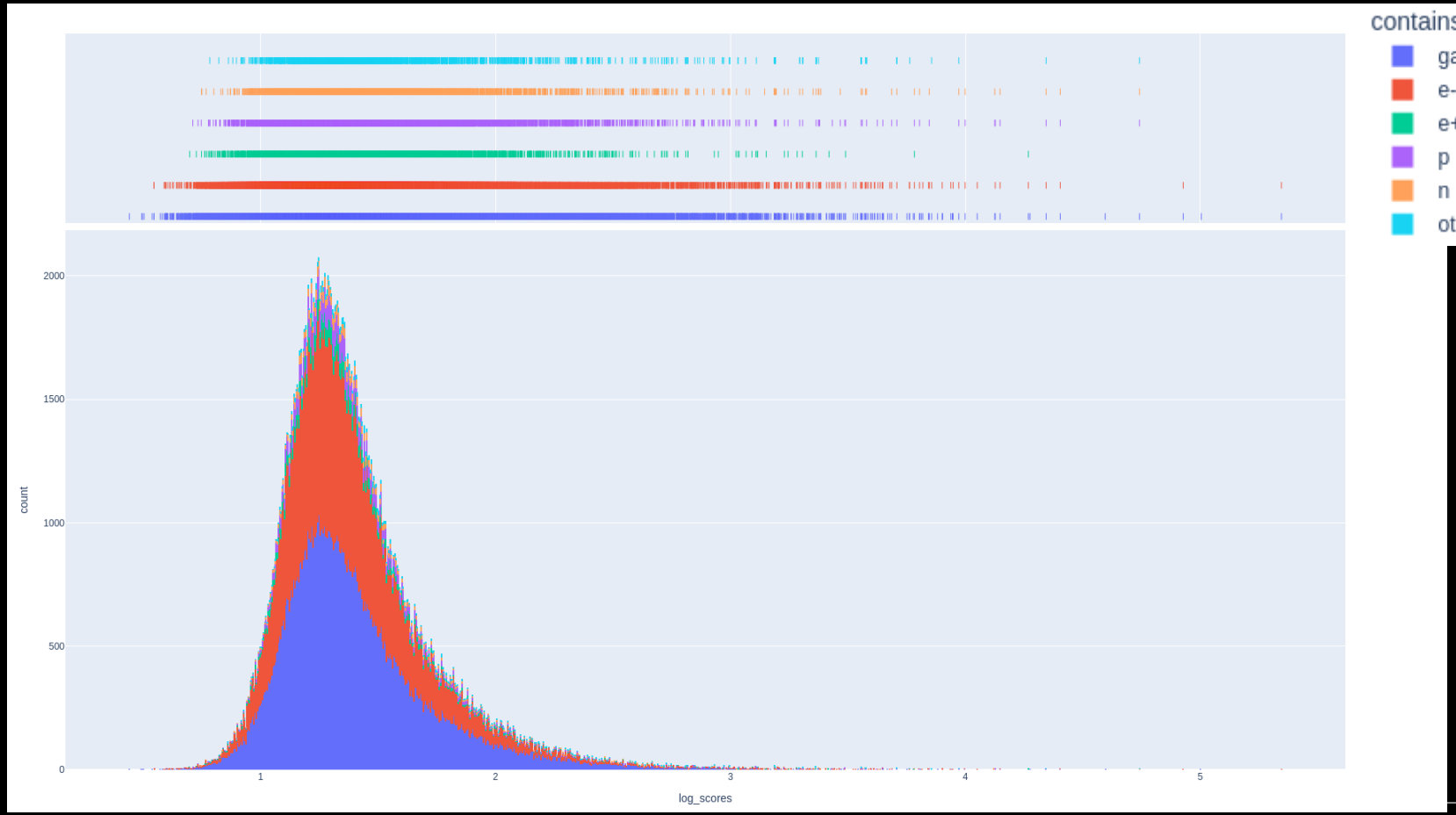
No clear connection.

Anomaly score v.s. types in MC



No clear connection.

Anomaly score v.s. types in MC



No clear connection.

> python3 scripts/plotting/event_3d.py ../point-cloud-diffusion-data/anomalies/*root

Explore interactively

Perhaps….

- We can see some pi+ pi- pair production occurring seemingly spontaneously.
- Sometimes there are also proton tracks.
- Occasionally e+ e- pairs.
- Calorimeter materials like Silicon and Aluminum appear as random scatters (not tracks). See event with anomaly score 138.0609.
- Sometimes there are other MC particles, with comparable energy to the particle gun. They do get parent child relations to the gun, but it isn't clear when and how that interaction took place.

- Could it all just be the hadronic cross section of the photon?