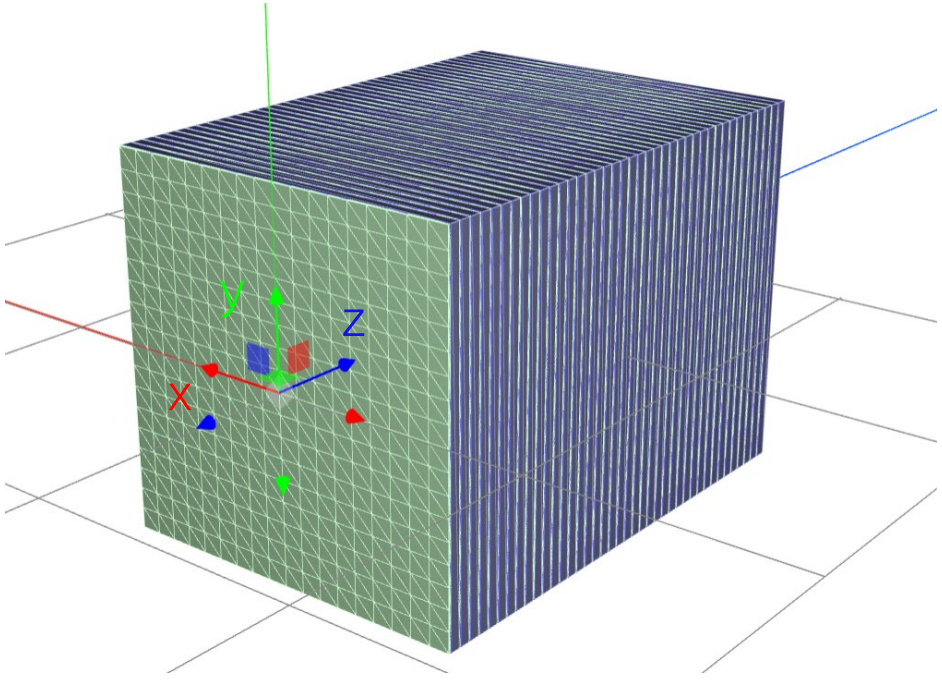
Reconstruction of Shower Radius

Ji-Yuan CHEN, Zhen WANG

23 Feb 2023

Basic Set-up

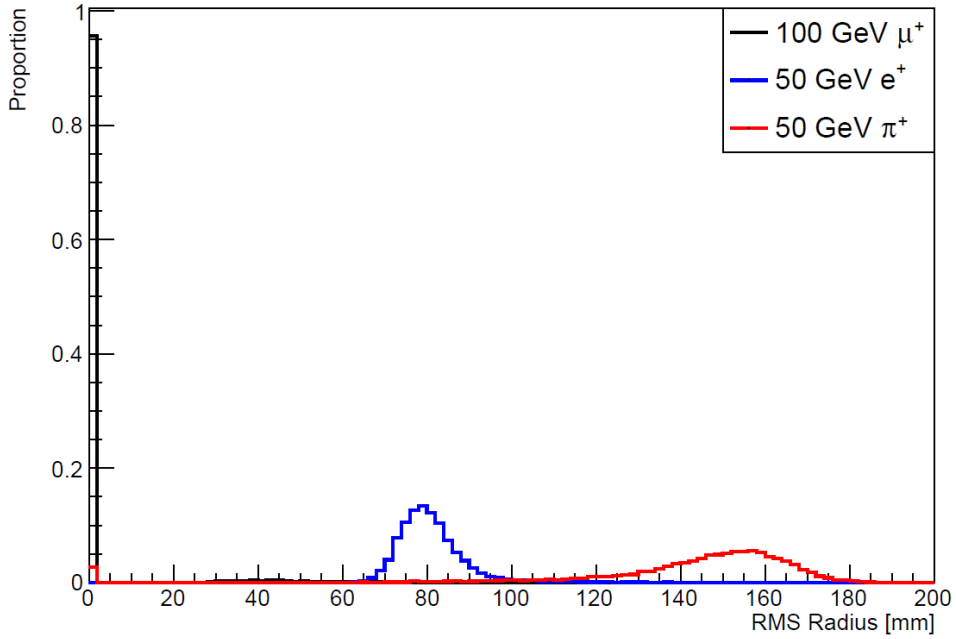
- Particles: μ^+ (100 GeV), e^+ (50 GeV), π^+ (50 GeV).
- Direction: $+z$.
- Detector: Only HCAL (4*4*0.3 cm^3 for scintillator, 72*72*0.2 cm^3 for PCB, 72*72*2 cm^3 for absorber; altogether 40 layers).
- Number of events: 10k each.



Reference: http://116.205.141.144/hcal/

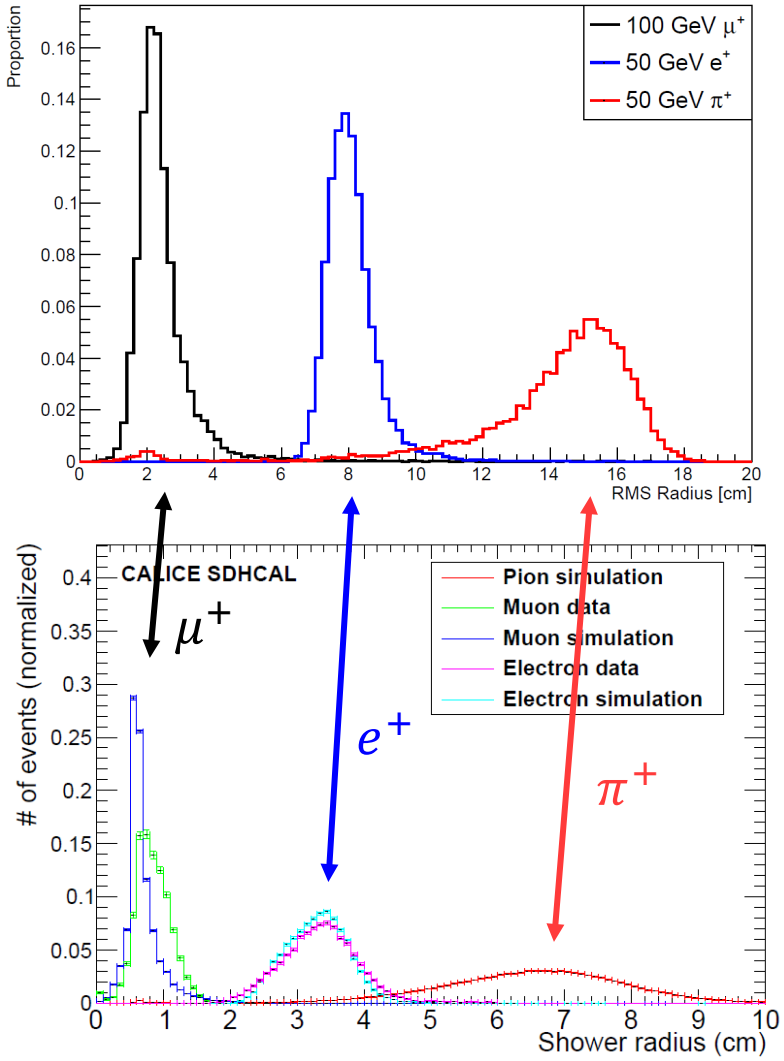
Reconstruction of Shower Radius

- Definition 1:
  - Since the incident particles are in $+z$ direction, we assume that $+z$ is the event axis.
  - Define the beginning and ending layers.
  - Use $r = \sqrt{x^2 + y^2}$ to represent the distance of each hit in these layers with respect to the origin of that layer.
  - Finally, calculate RMS of these distances.
- These three particles can be effectively distinguished.
- (If the incident particles are not in $+z$ direction, performing fit will be a must.)



Reconstruction of Shower Radius

- Definition 2:
  - For each event, use all the hits, regardless of whether it is between the beginning and ending layers or not.
  - Perform fit, and calculate the RMS distance of the hits in each event.
- The result is similar to that in the Reference.
- (Difference in definition: hits in first 10 layers were used to fit in the Reference, while all the hits were used here.)

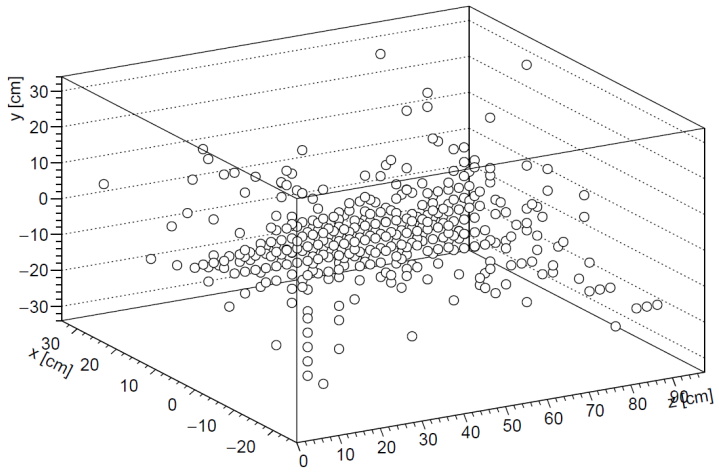


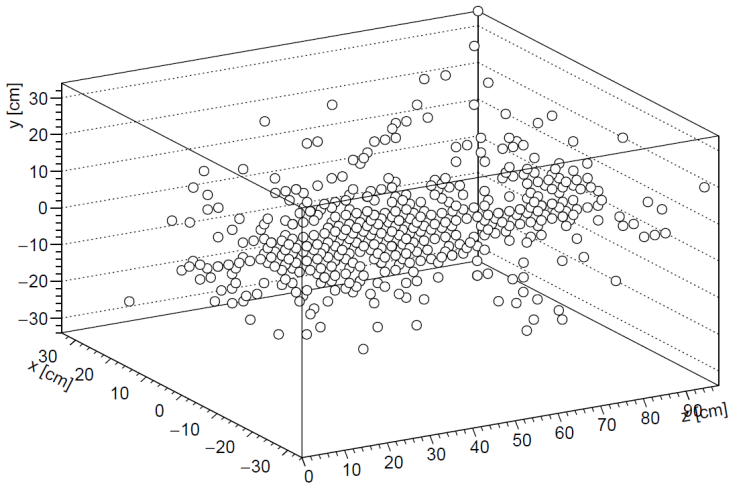
Reference: Particle Identification Using Boosted Decision Trees in the Semi-Digital Hadronic Calorimeter Prototype - IOPscience

Reconstruction of Shower Radius

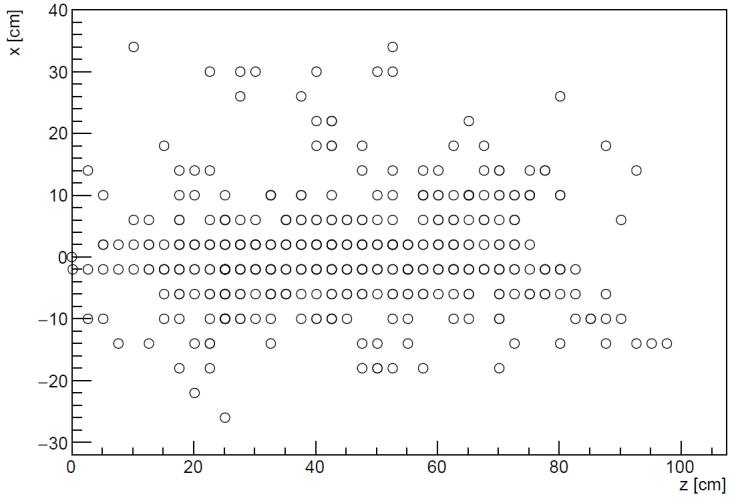
- Definition 3:
  - It is a combination of Definitions 1 & 2, or an improved Definition 1.
  - Define the beginning and ending layers.
  - In between, use the positions of all the hits to perform fit, and obtain the distances between these hits and the fitted line.
  - Finally, calculate RMS of these distances.
- Currently no result is obtained.
- For this set-up, the result is expected to be similar to that obtained from Definition 1.

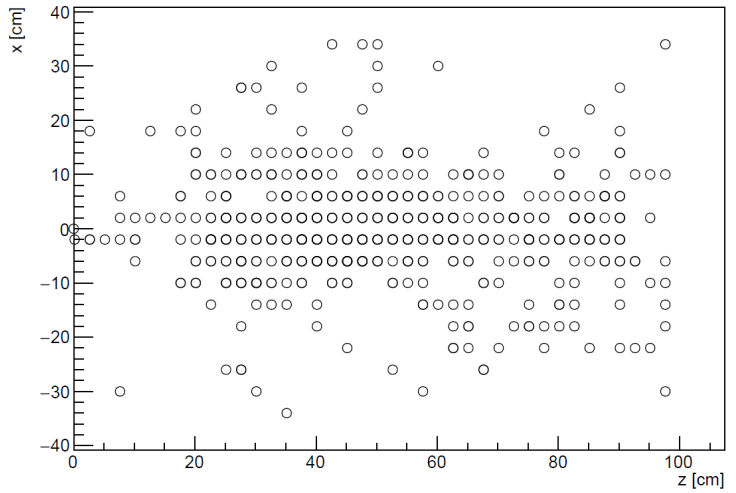
Event Display (50 GeV π^+, All Hits)



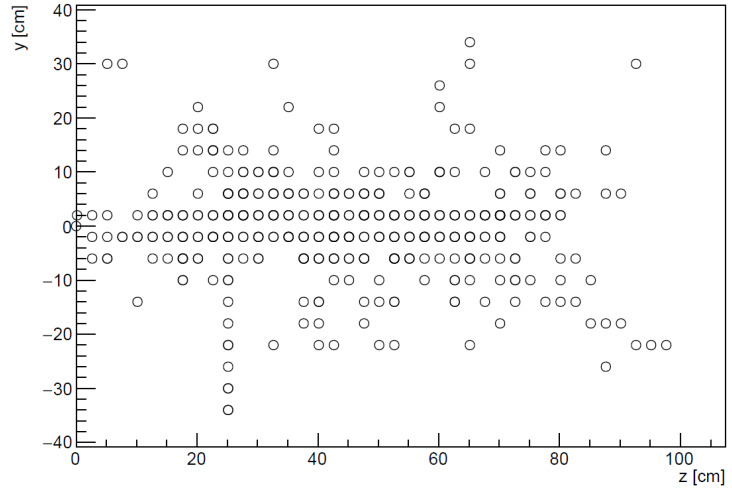


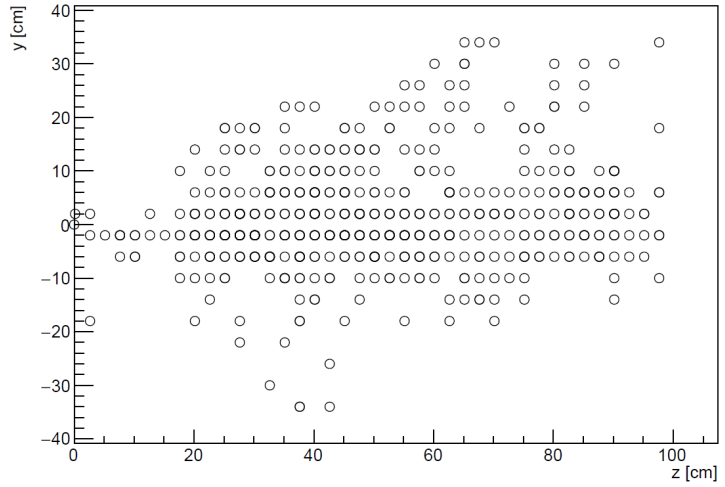
Bird's-eye view





xOz plane





yOz plane

Progress and To-Do

- Currently adding these two definitions to PIDTool (debugging).