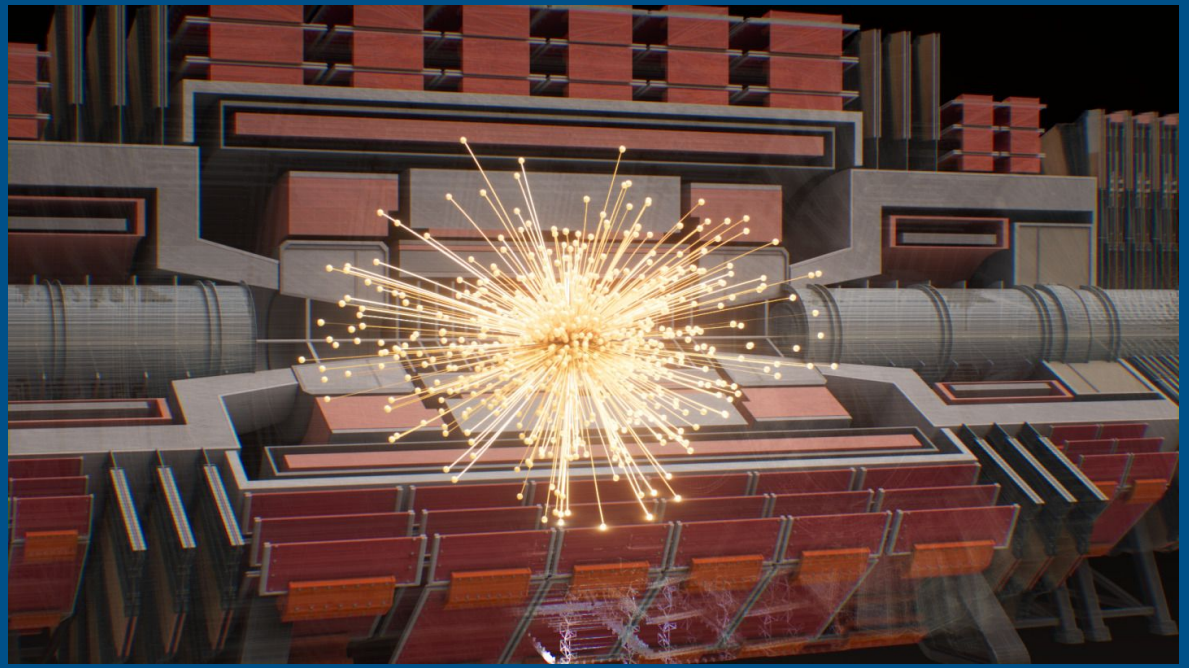
FCCee Geometric Clustering Characterization



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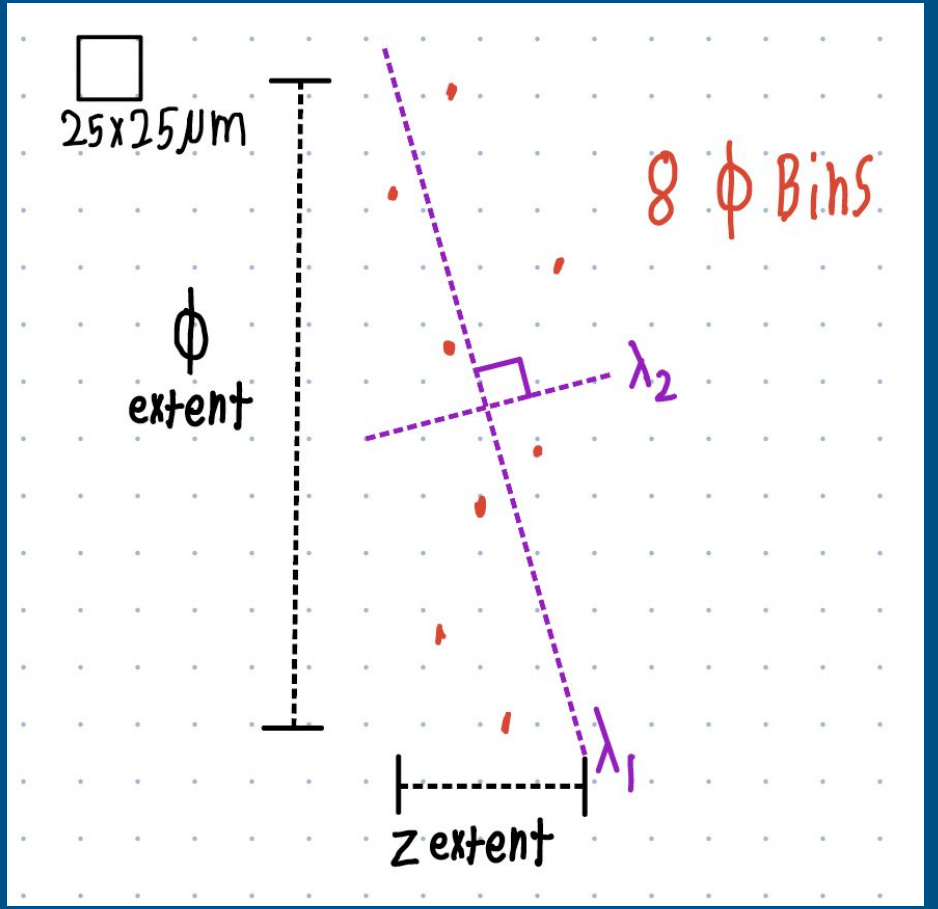
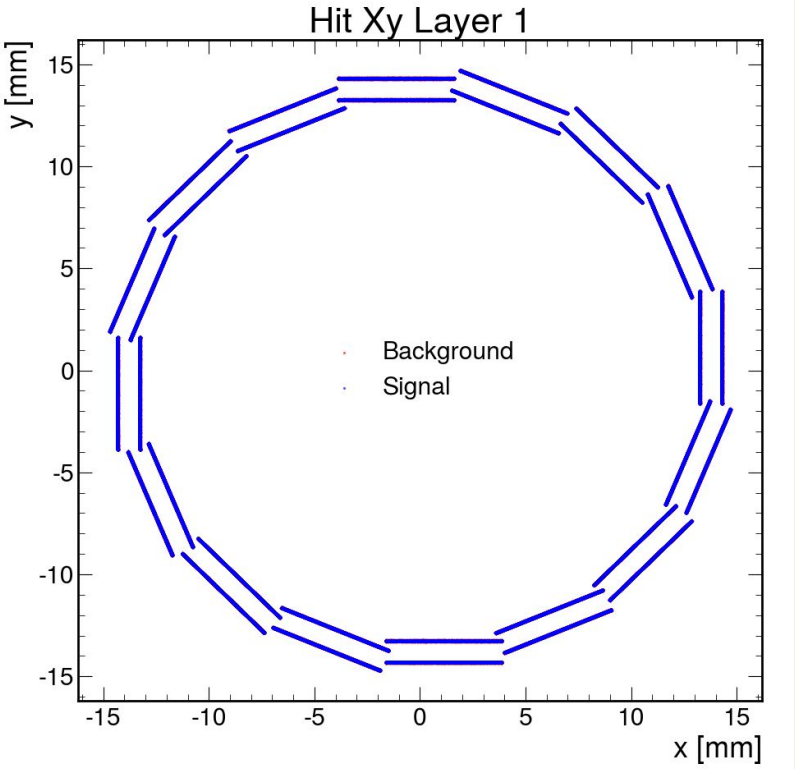
Introduction

- Analyzed hit clusters from a single MC particle in the first layer of the CLD vertex detector using simulation background data.
- Computed a number of geometric descriptors per cluster to study track shapes and detector response: Number of φ rows hit, Z extent, PCA elongation (λ_1/λ_2), cos(theta), energy deposited, etc.

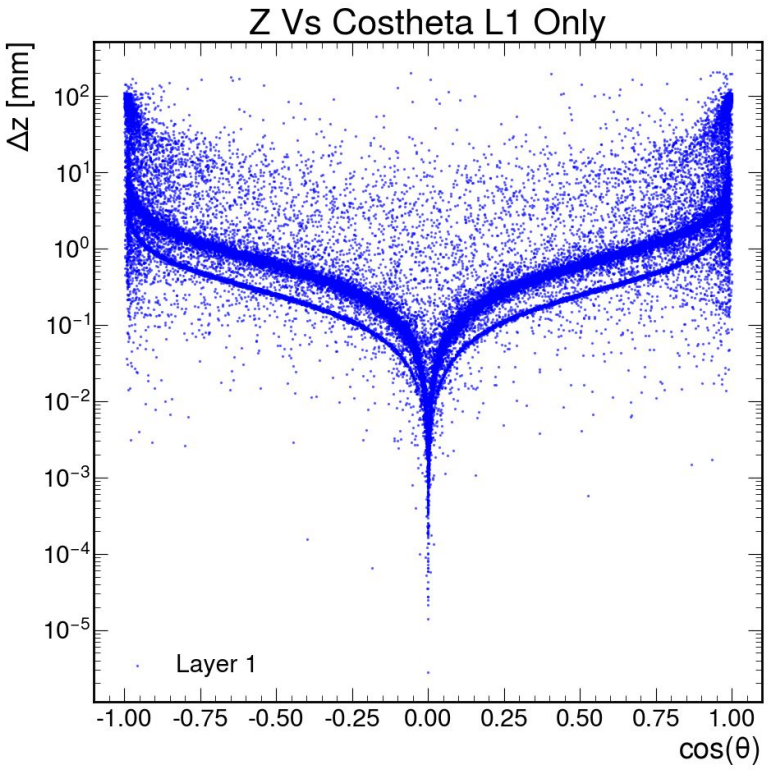


Layer 1 X vs. Y



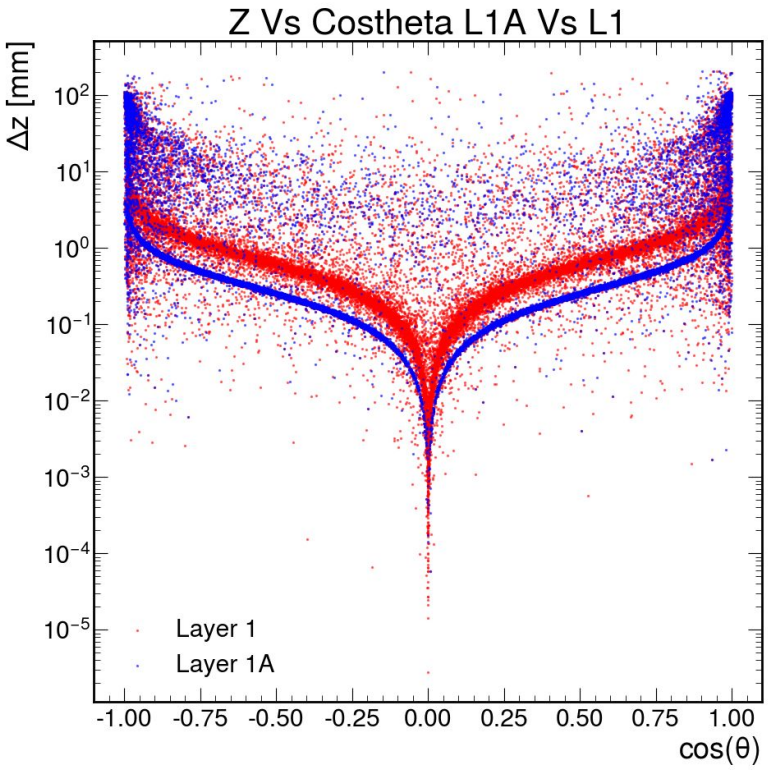
- This plot shows all hits from background and signal on CLD layer 1.
- We see two readout layers. The outer I refer to as, layer 1B, the inner as layer 1A.

Δz vs. Cos(Θ), Layer 1



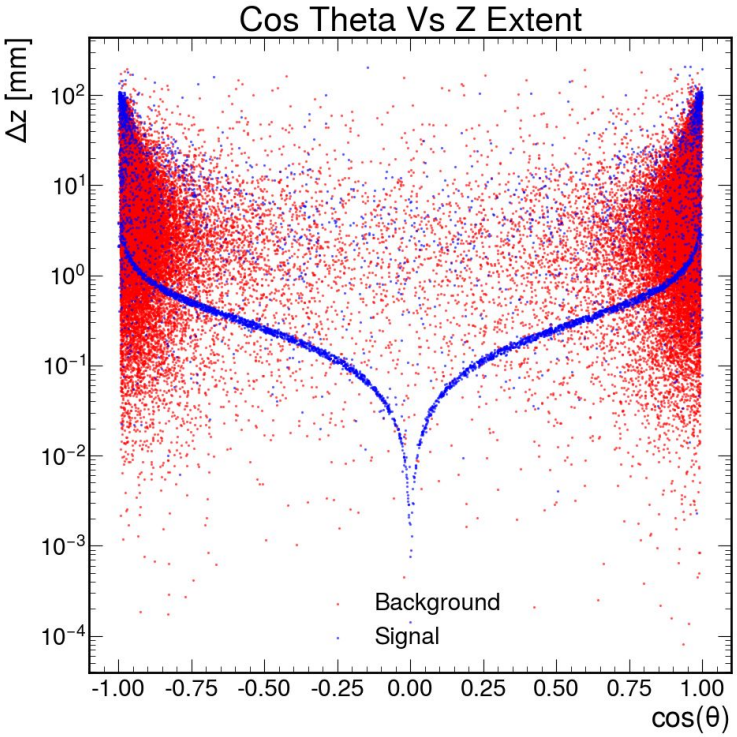
- This plot displays all hits categorized as layer 1, displaying a double band structure in Δz.
- Both bands appear to follow a relationship ln(Δz) = K*ln|cot(Θ)|, with different K values.

Δz vs. Cos(Θ)



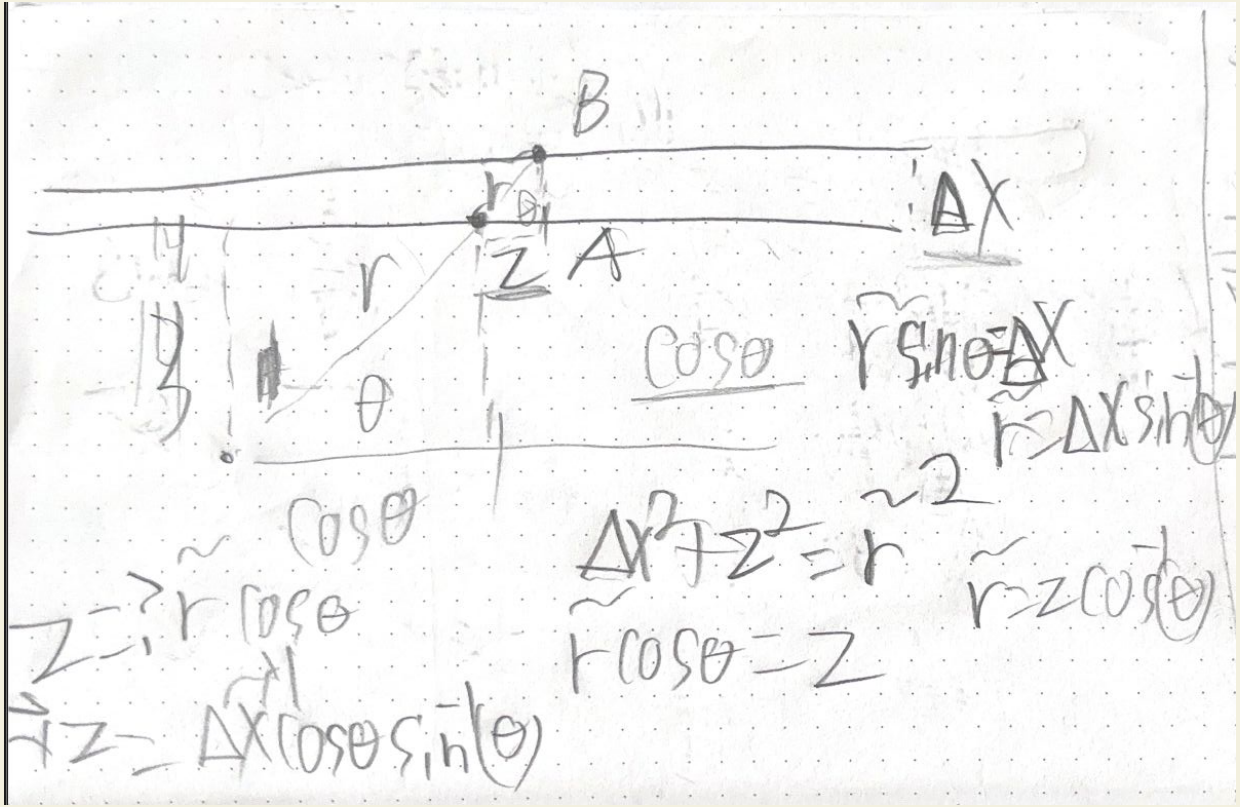
- The cause of this double band relationship is hits being dispersed over two layers, both categorized as layer 1.
- The upper band was created by a cluster with hits on layer 1A and layer 1B.
- Lower band was populated with hits on the same layer, lying on top of the lower band.

ΔZ vs. Cos(Θ), 1B



- This plot displays all the hits shown on the true innermost layer, 1A.
- This plot matches matches multiplicity of three before filtering out layer 1B.
- It follows from trig that $\ln(\Delta z) = K*\ln|\cot(\Theta)|$, where K is some fixed constant.

Double Band Analytically



- My apologies for my handwriting.
- This constant, K, referred to earlier, is actually the difference in radius between two layers.

Next Steps

- Study particle gun of muons at 50 GeV vs. beam background and particle gun vs z->qq, to ensure that any cuts hold across all physics.
- Test cuts separating signal from beam background in signal events.
- Test cuts on transformation of z extent vs. cos(theta) pattern.
- Considering Naives Bayes, Quadratic Discriminant Analysis, SVM.