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FCCee Vertexing Analysis

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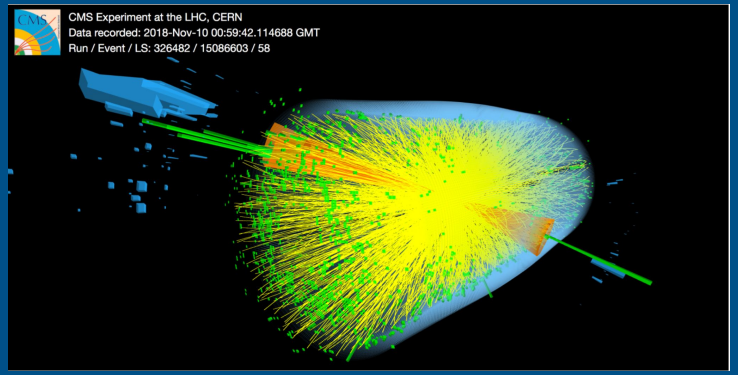
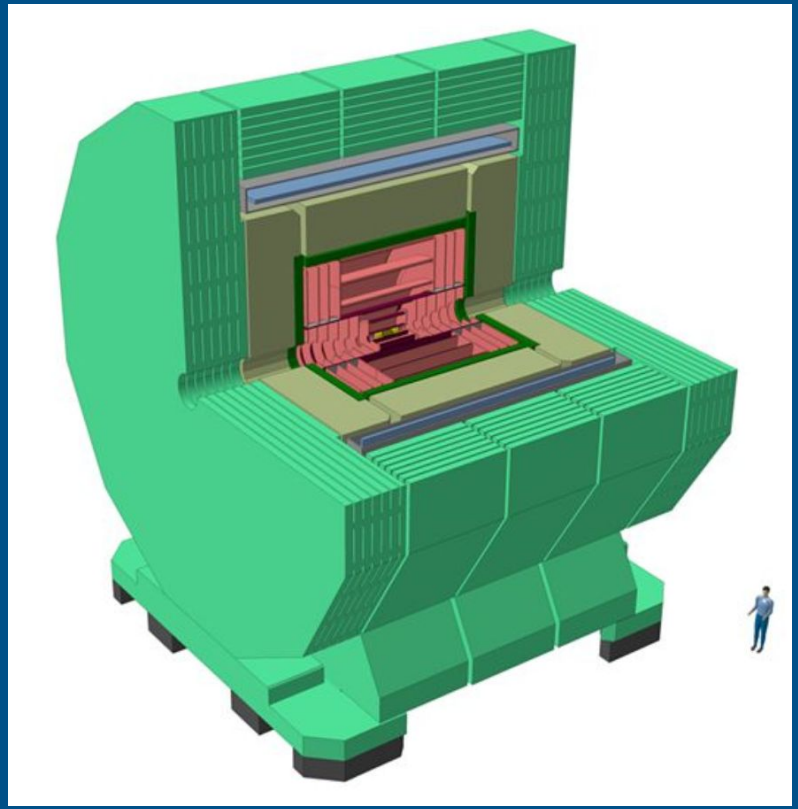
dR vs Energy hitmap:

Motivation:

- Each MC particle in the vertex simulation creates multiple hits shooting out in something like a cone
- Distribution of this cone on the 1st layer of the CLD Vertex Detector.
- Our main focus was creating a set of plots to visualize the distribution of dR and energy deposited.
    - dR being geometric barycenter of all the hits associated to each MCParticle





dR vs Energy hitmap:

Process & Difficulties:

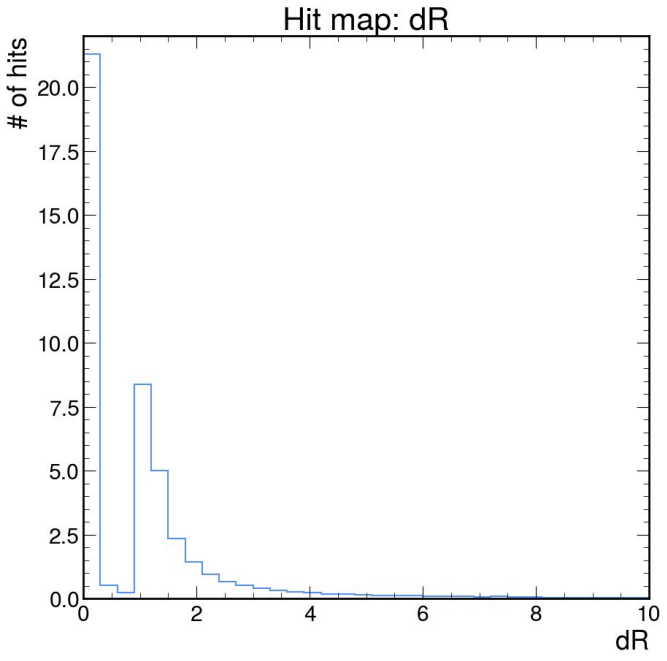
- Step 1: Group particles by MC Particle
- Step 2: Define a center with repect to which we calculate dR
  - Position with highest momentum within hits of each MC
  - Geometric barycenter of all the hits associated with one particle.
- Step 3: Plot the difference in distances against the energy of each hit.

- One issue we encountered was each hit being assigned to a unique MC particle ID, even if they came from the same MC particle. This forces the use of particle energy as an identifier.

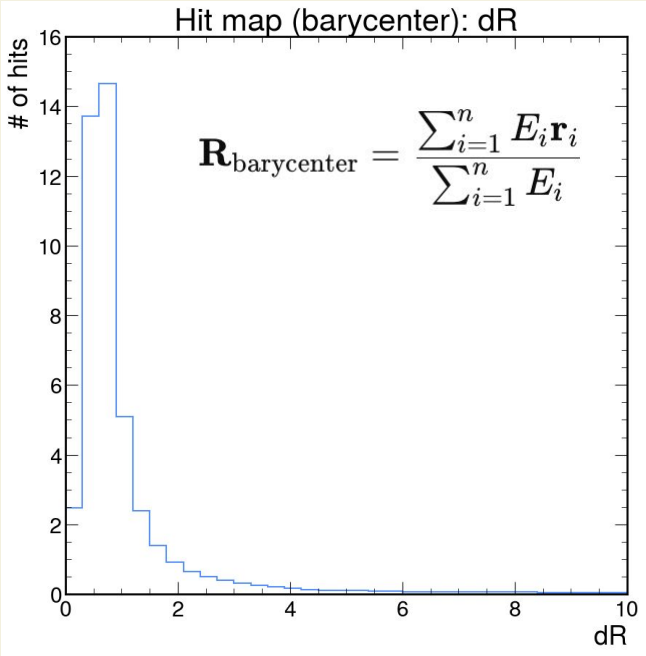
```
hits_by_mc = {}

for hit in good_hits:
    mc = hit.getMCParticle()

    # If mc not already a key, add it
    #for hit in hits_by_mc:

    if mc not in hits_by_mc:
        hits_by_mc[mc] = []

    # Add hit to the list associated with mc
    hits_by_mc[mc].append(hit)
```

```
hits_by_mc = {}

for hit in good_hits:
    mc = hit.getMCParticle()

    # If mc not already a key, add it
    #for hit in hits_by_mc:

    if mc.getEnergy() not in hits_by_mc:
        hits_by_mc[mc.getEnergy()] = []

    # Add hit to the list associated with mc
    hits_by_mc[mc.getEnergy()].append(hit)
```

dR vs. hits



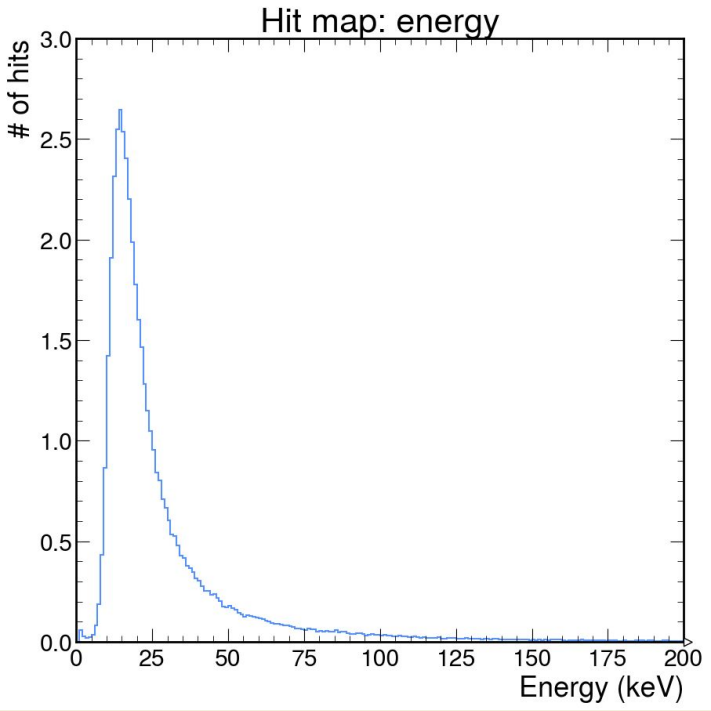
- First peak around dR = 0 implies many hits occur infinitesimally close to the highest energy hit, then almost none, and then a natural looking exponential decay graph.

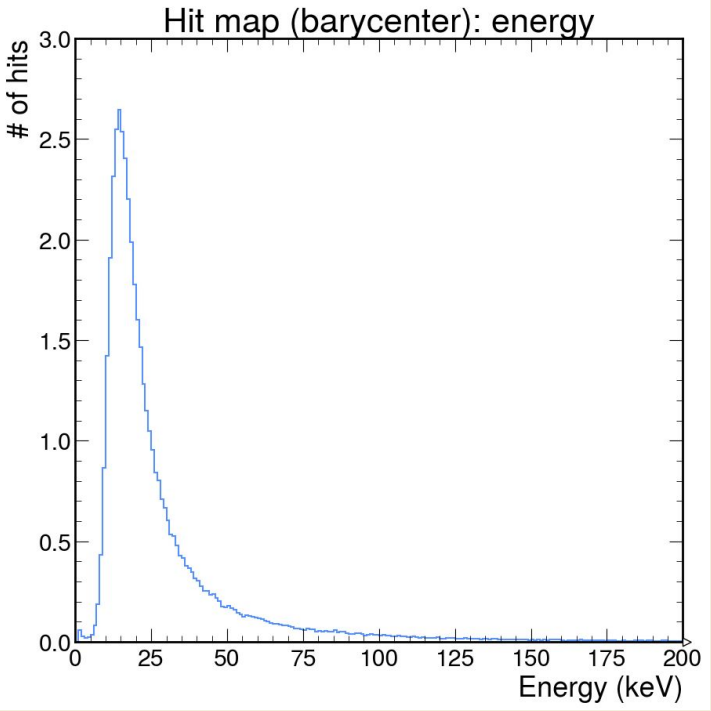


- Peak implies that most events occur a small, but not infinitesimally small, distance away from the centroid, then fall off with distance from the centroid.

Energy vs. hits

- Both centered plots, barycenter or maximum-momentum, result in exactly the same graph, as the summations over dR result in the same total energy



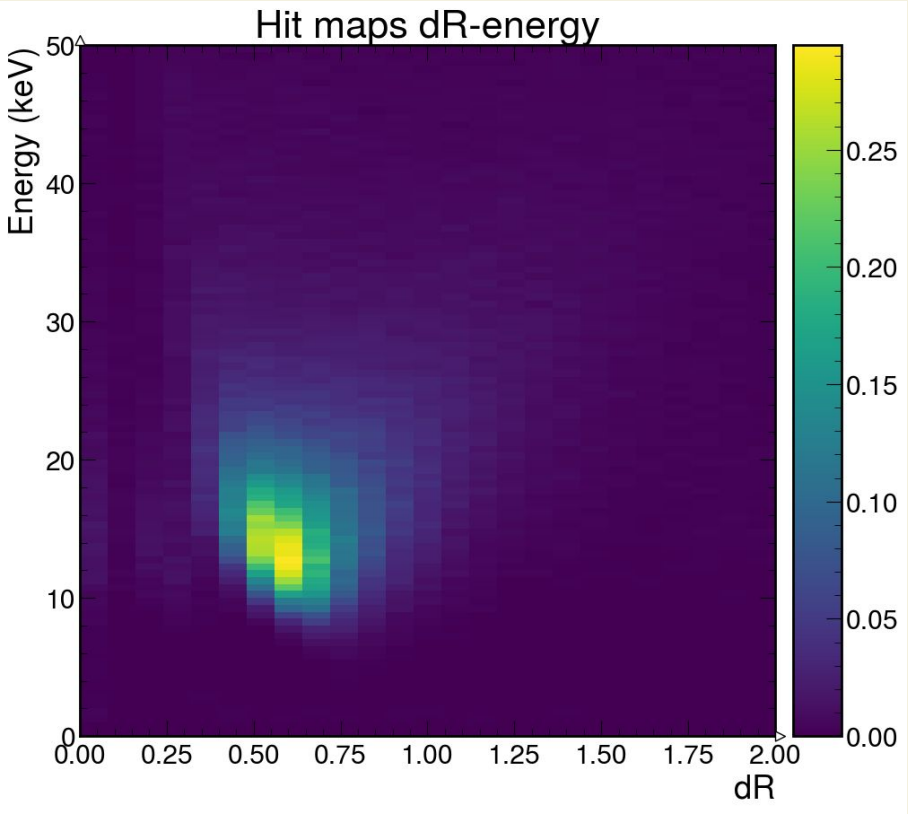


Barycenter Energy/dR hitmap

Analysis: axis (dR): The distance of each hit from its “barycenter,” i.e., from the geometric centroid of all hits produced by the same MC particle in that event.

• y-axis (Energy in keV): The energy deposit of each hit (converted to keV).

• The bin content represents the average number of hits per event falling into each (dR, Energy) bin.



Future Work:

Compute (for layer 1):

- the multiplicity of the combined hits "macro" hists
- a 2D map of the hits in the z-phi plane (same as Nate has, but now with macro hists)

Analyze the spatial distribution and frequency of hits in a detector layer.