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FCCee Vertexing Analysis

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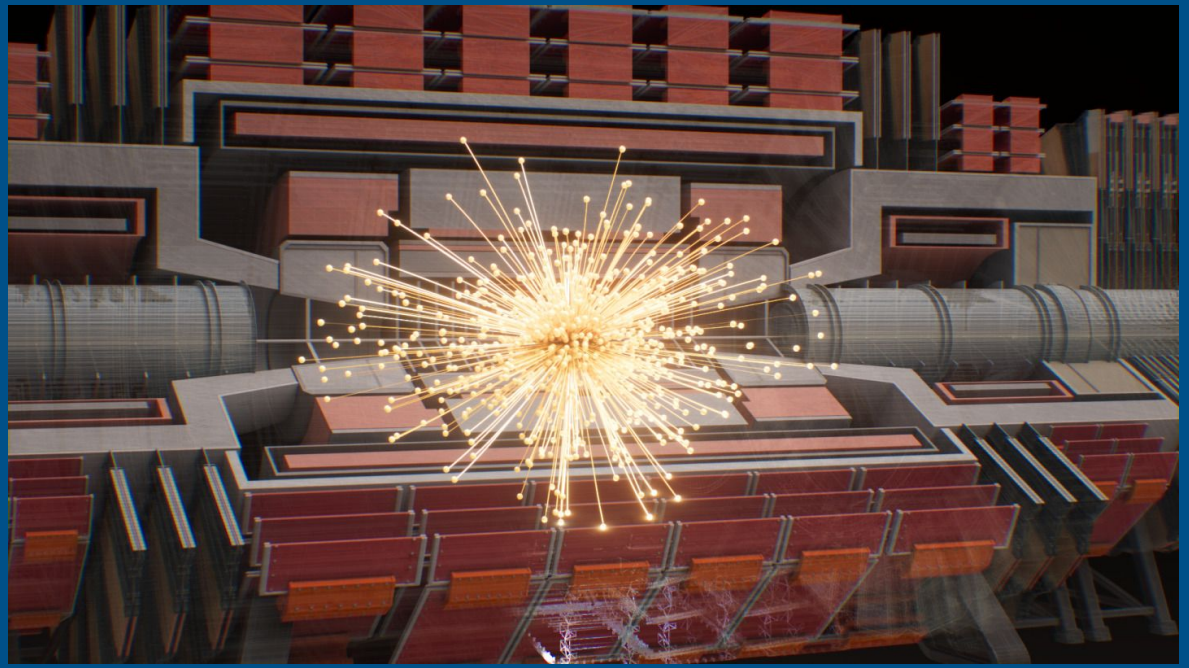
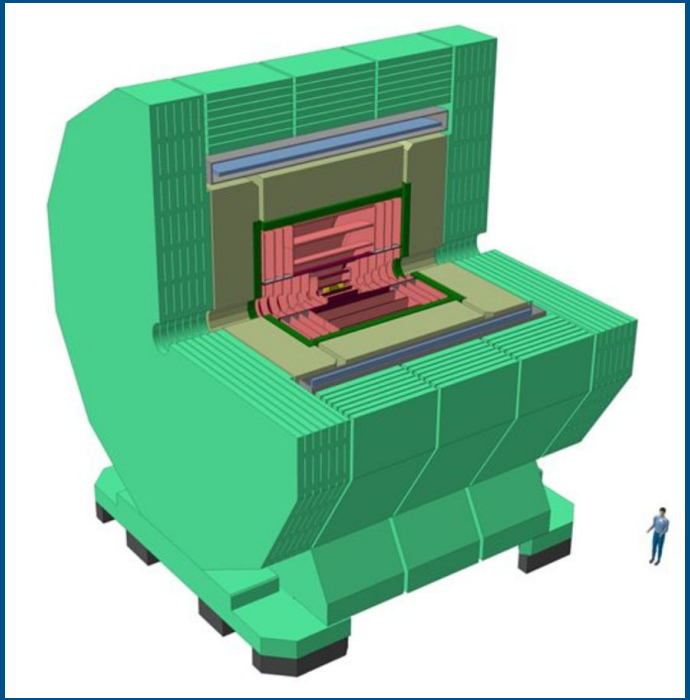
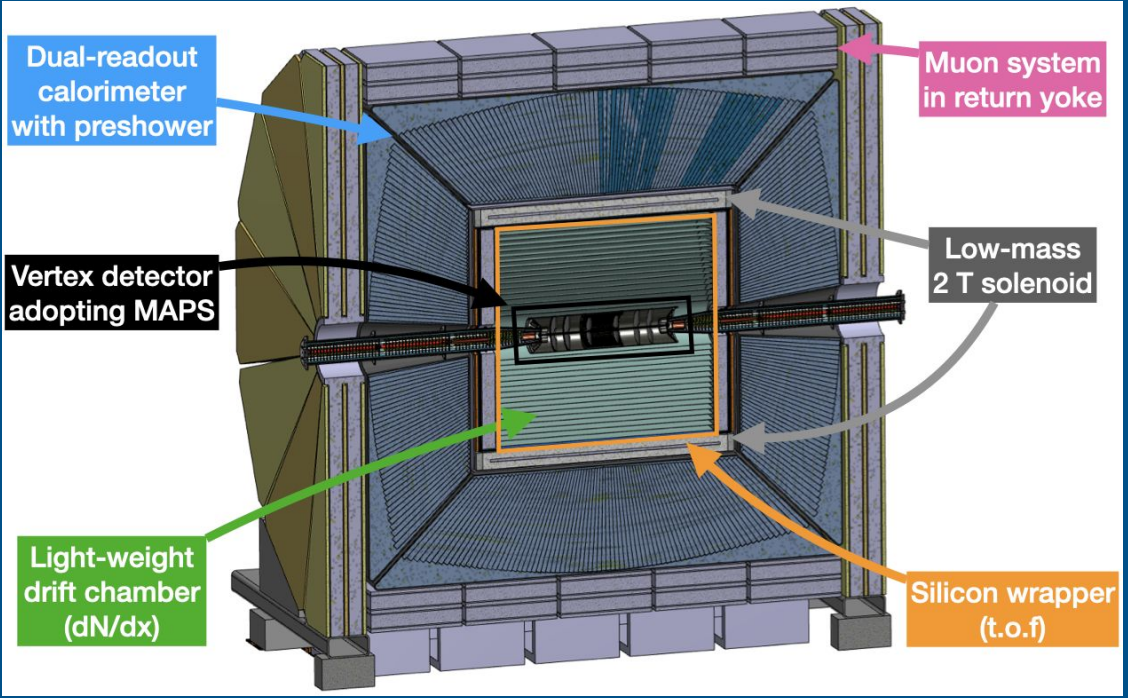


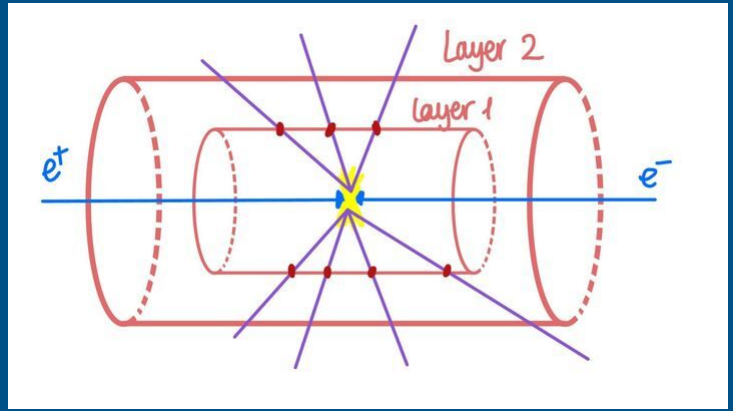
CLD and IDEA Detectors

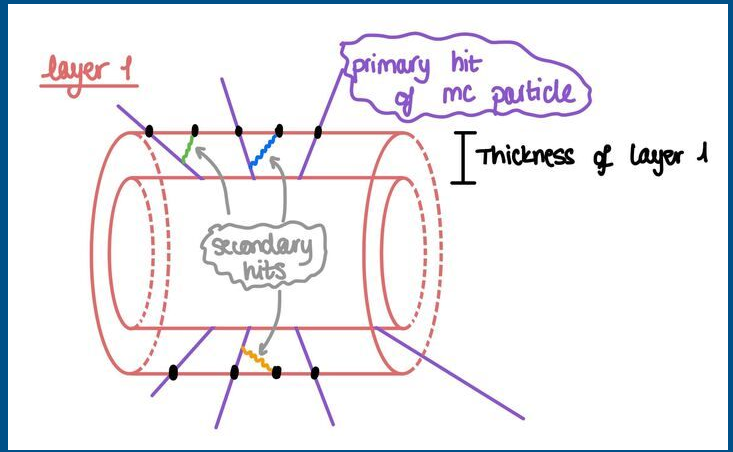




Beam Background

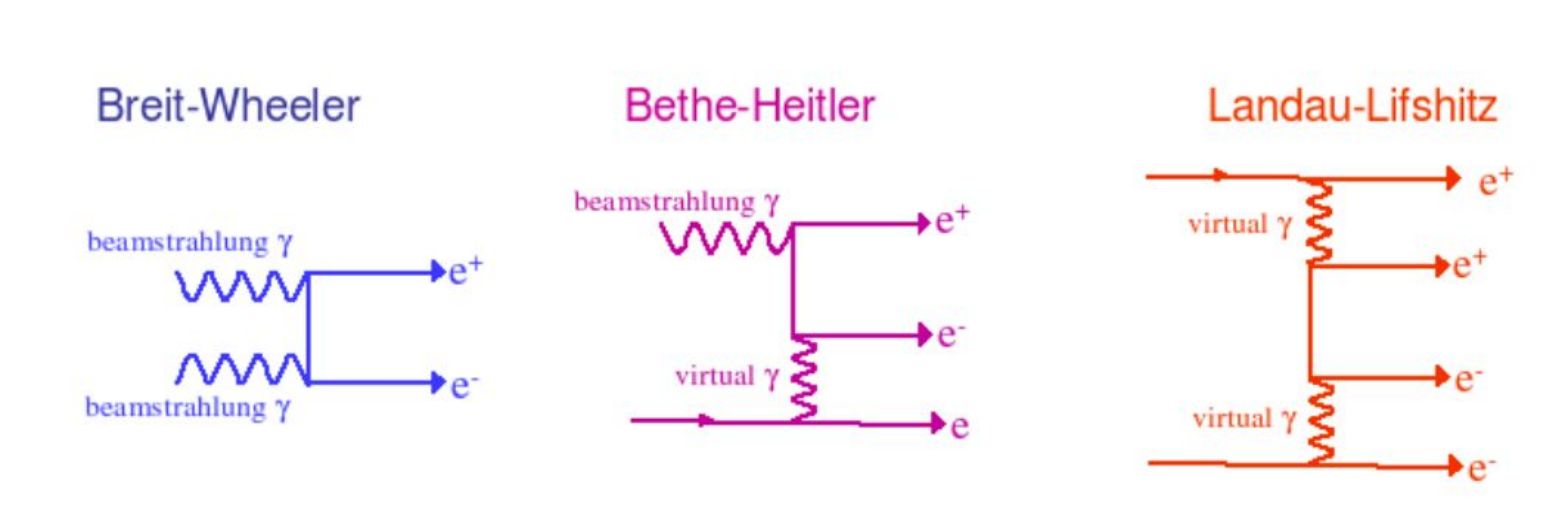
- Beam background: Unwanted particles from interactions not part of the primary collision.
- Secondary hits: Particle interactions outside the beam pipe, in surrounding material.
- Effects: Detector noise, false signals, reduced data quality.





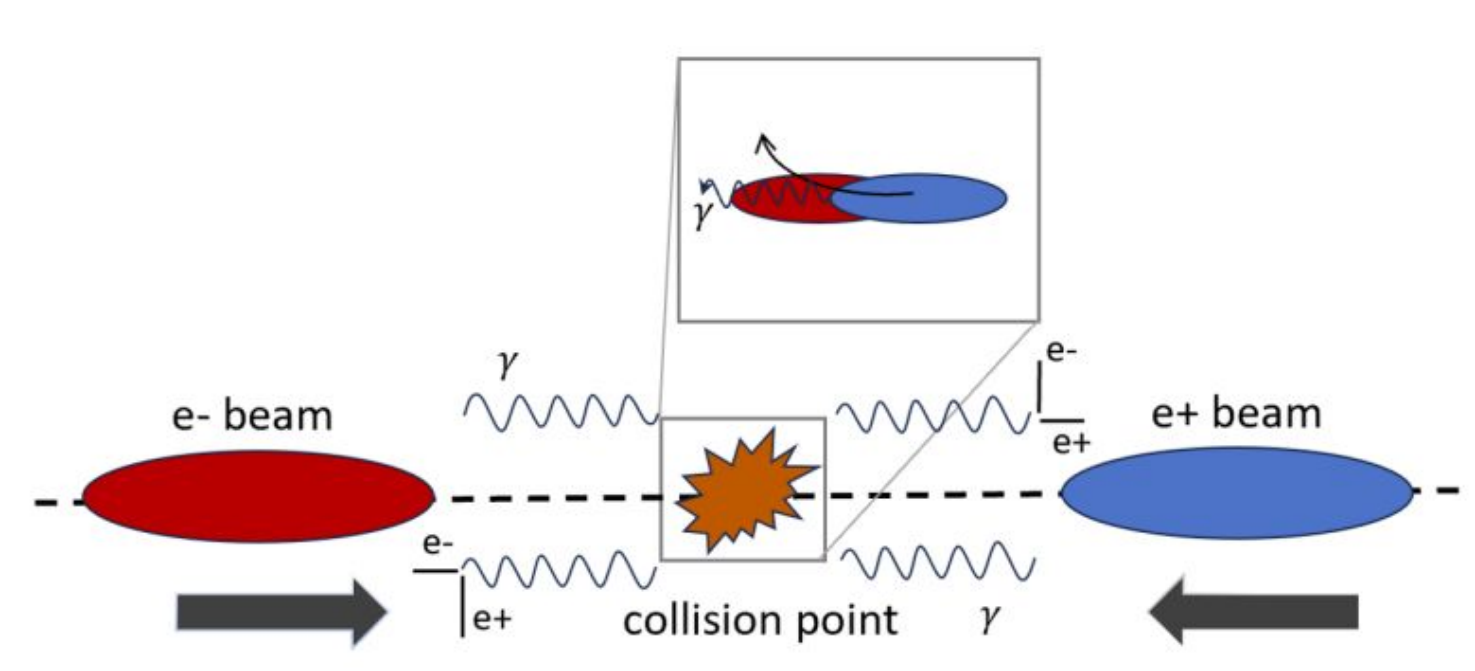
Electron-Positron Pairs

- Breit-Wheeler: Photon-photon collision creates an electron-positron pair.
  - Fundamental test of energy-mass conversion.
- Bethe-Heitler: Photon interacts with a nucleus to produce an electron-positron pair.
  - Nucleus absorbs recoil, common in gamma-ray interactions.
- Landau-Lifshitz: Photon interacts with a strong EM field to create an electron-positron pair.



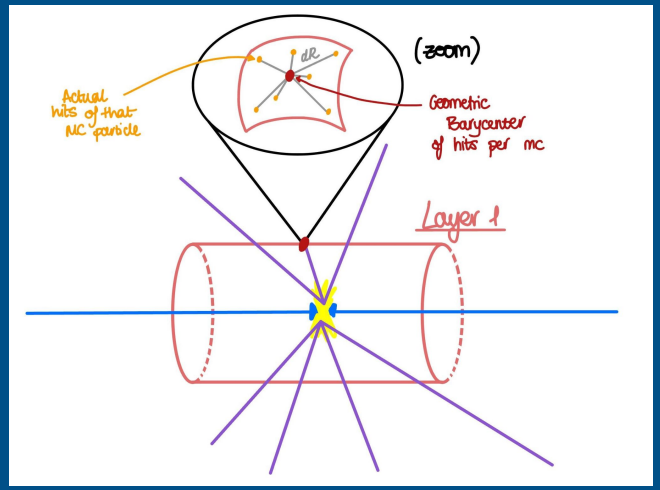
Electron-Positron Pairs

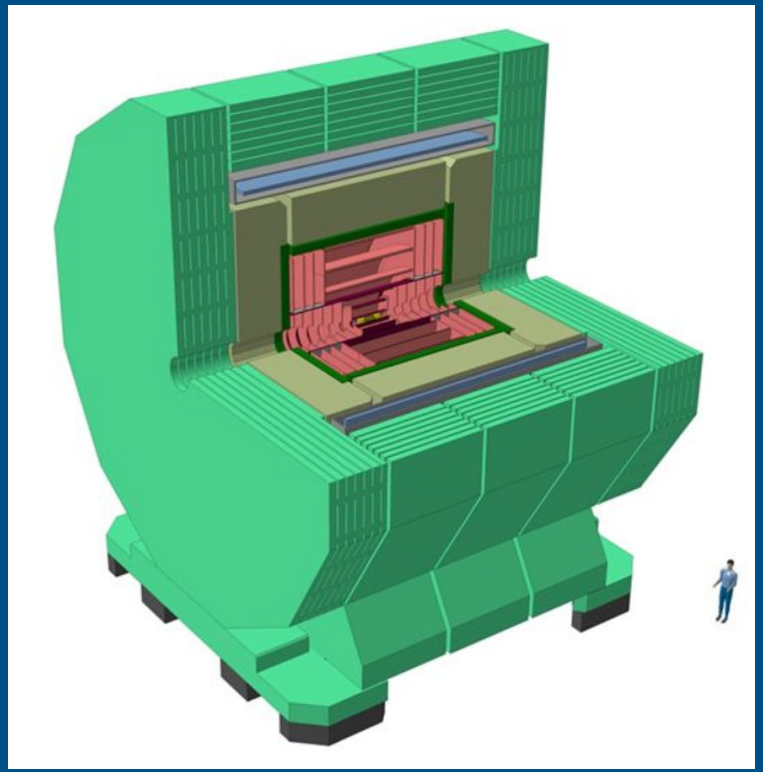
- Electron-positron scattering: Exchange of a virtual photon, no annihilation.
- Electron-positron annihilation to 4e: Virtual photon creates two electron-positron pairs.
  - Higher-order QED process: Extra photon interactions lead to pair production.



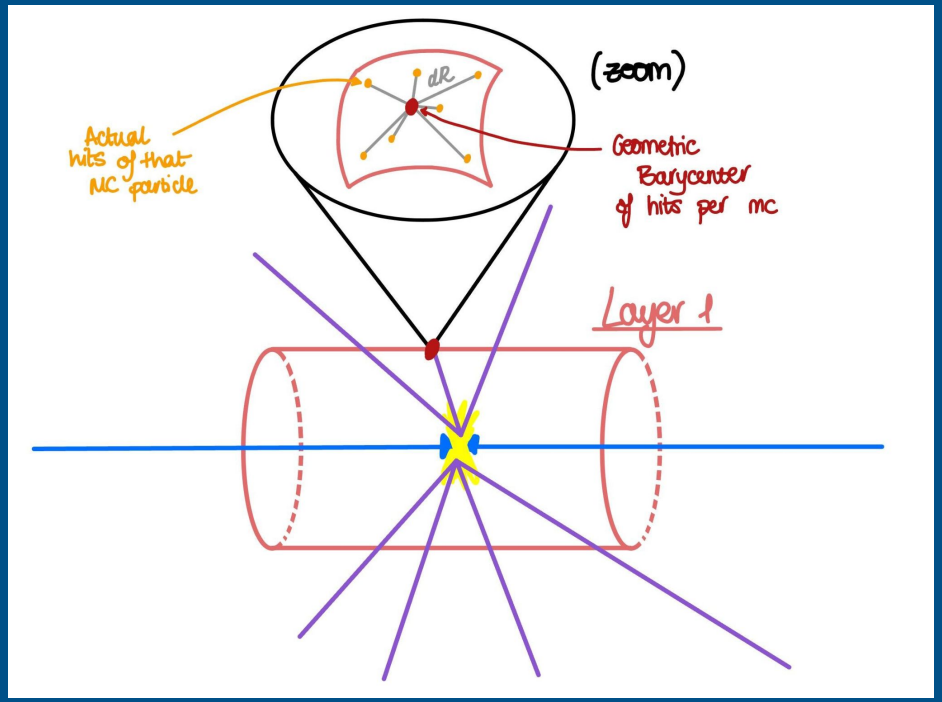
Hit definitions

- Hit: Any impact detected by the first layer of the detector.
- Macrohit: Sum of hits associated with one MC Particle or with its barycenter. Represented as one hit.
- Microhit: Individual hit within a macrohit





Definitions: dR, Barycenter and Multiplicity



- Barycenter: The weighted energy sum of all the hits that come from one MC particle.

$$\mathbf{R}_{\text{barycenter}} = \frac{\sum_{i=1}^{n} E_i \mathbf{r}_i}{\sum_{i=1}^{n} E_i}$$

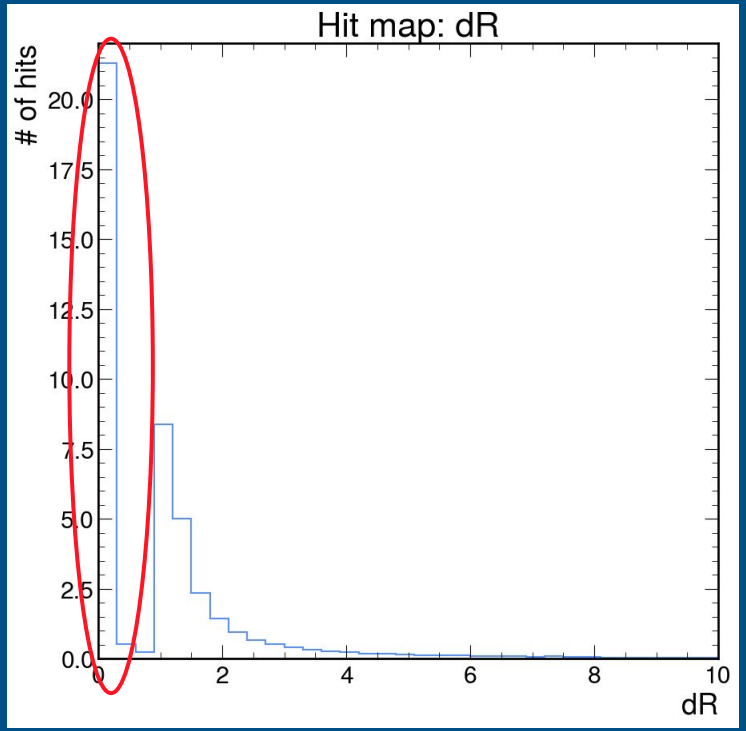
- dR: The distance between one hit from an MC particle and the barycenter

$$dR = \sqrt{dx^2 + dy^2 + dz^2}$$

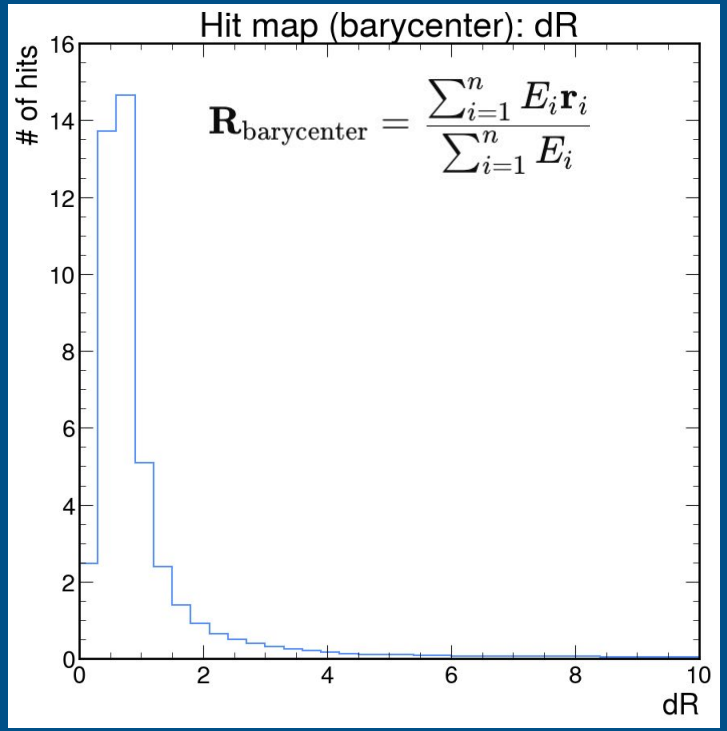
- Multiplicity: The number of hits for each MC particle

dR vs. hits

- dR from position of maximum momentum hit

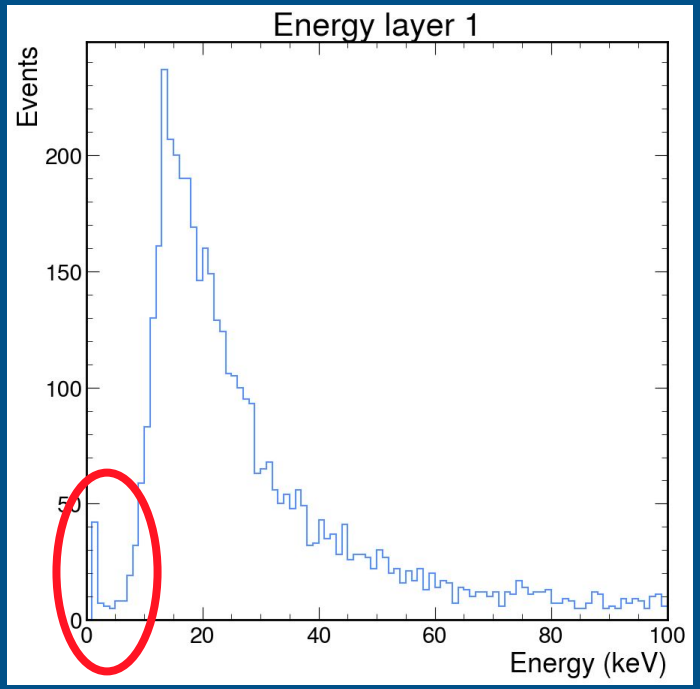


- dR from position of barycenter

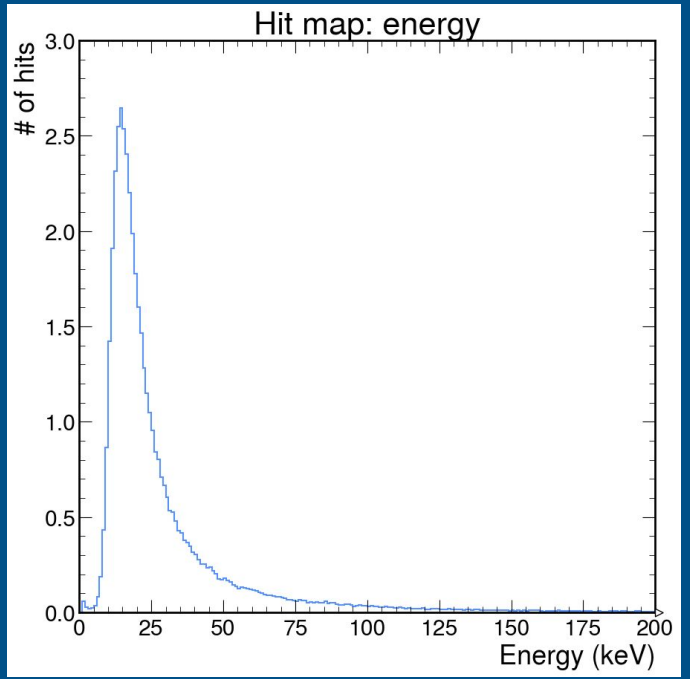


Energy vs. hits

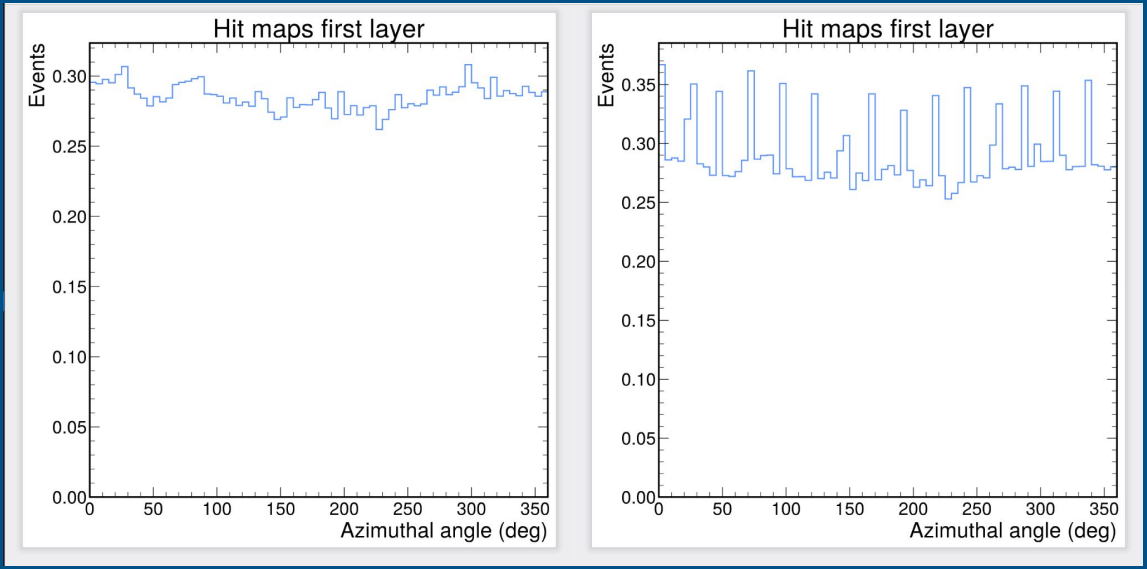
- Energy from individual hits

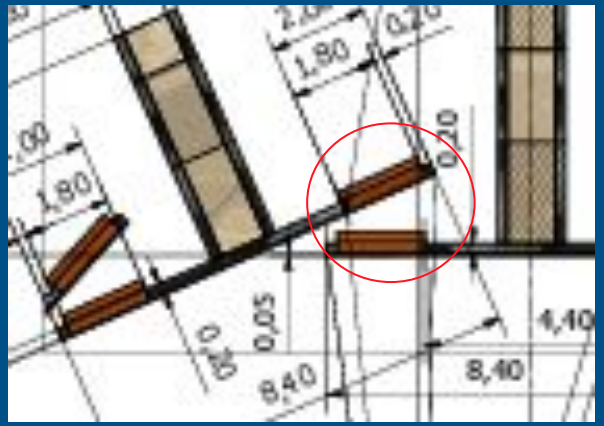


- Energy from macrohits: independent of dR definition



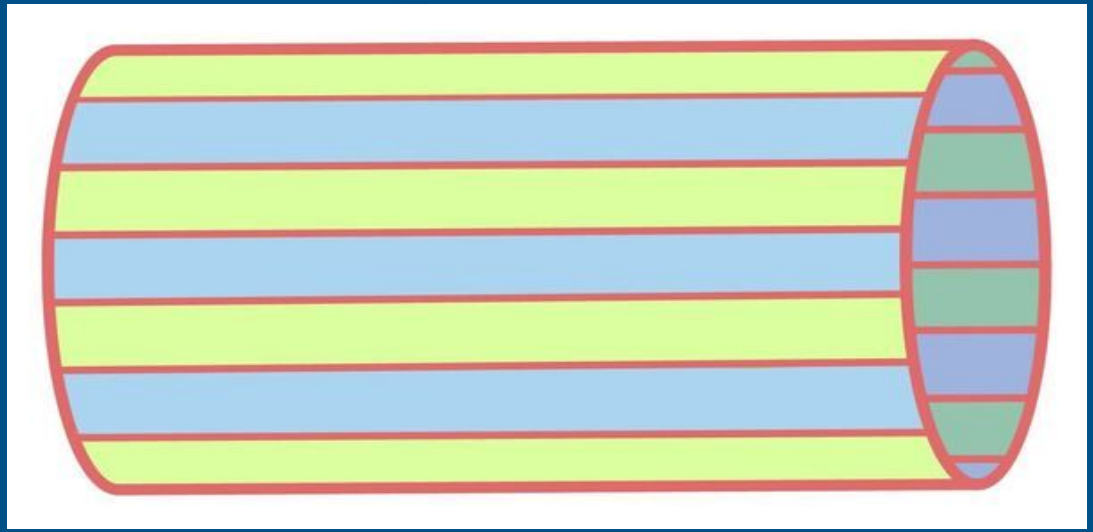
IDEA Detector Phi Hits

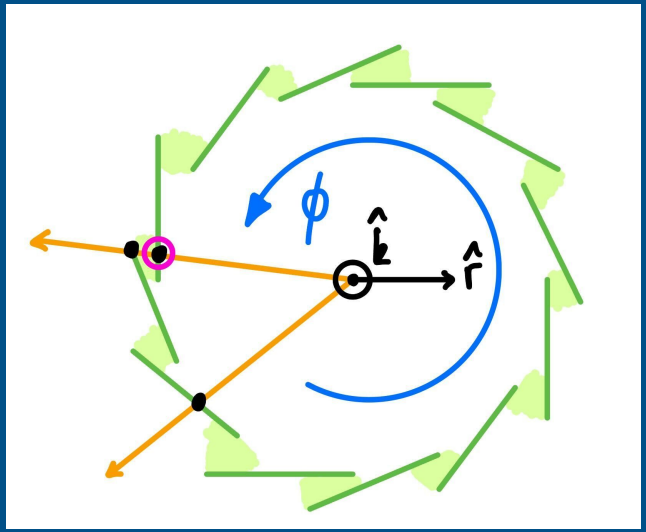




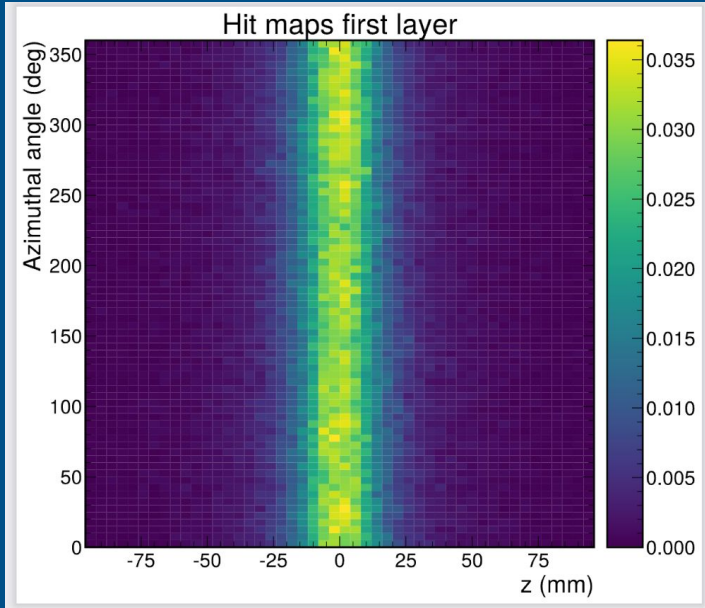
- Previous plot on the right counting multiple hits per MC.
- Updated plot counting one hit per MC particle, smoothing out the sharper peaks.
- Peaks created by overlapping detector segments on IDEA.

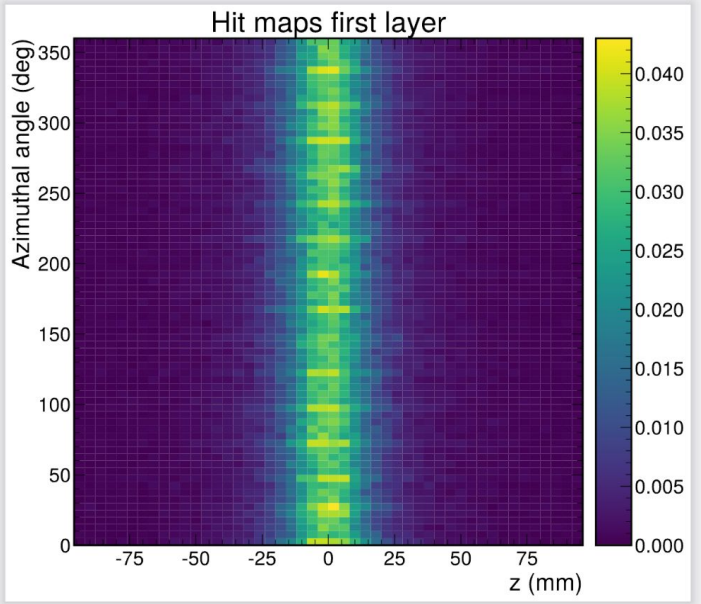
Better visualization of Z-Phi Plot





IDEA Detector Z-phi





- The same peaks present in the previous slide show up again on the right.
- Again, when plotting one hit per MC particle the distribution becomes far more natural.

Updated Occupancy Calculations

Occupancy = #hits/bunch-crossing/per cellID
CellID = readout unit area

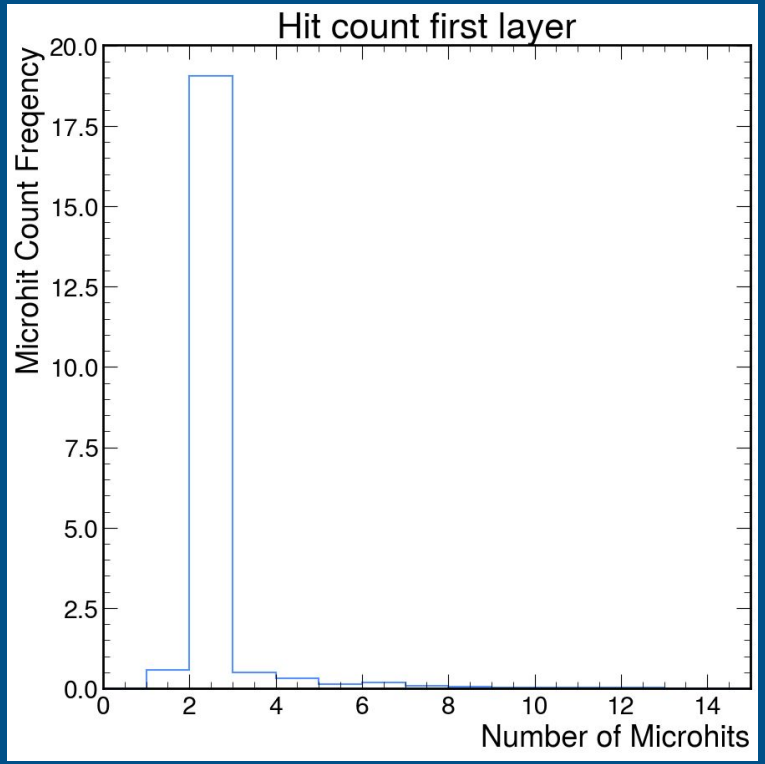
Previous Occupancies:

- IDEA Maximum occupancy: 57.206
- IDEA Average occupancy: 31.920
- CLD Maximum occupancy: 195.000
- CLD Average occupancy: 161.020

New Occupancies:

- IDEA Maximum occupancy: 18.783
- IDEA Average occupancy: 10.555
- CLD Maximum occupancy: 50.588
- CLD Average occupancy: 37.610

The new occupancies are about a third of the previous ones. This results from the corrected calculation with only one hit per MC particle.



Future Work:

- Better understand the physics of beam background and include other sources.
- Vertex detector optimization based on expected (and validated) beam backgrounds.
- Analyze different sources of data besides GuineaPig, possibly comparing simulated LEP data against actual data collected at LEP.