

Truth Association Information in Simulation Campaign Datasets

Analysis goal

- Study $\pi^0 \rightarrow \gamma\gamma$ reconstruction and cluster merging probability.
- Identify which photon contributes to each reconstructed cluster.

Observation

- For the reconstructed based on **HepMC input**,
 - the `SimCalorimeterHit` truth association can be traced back to the individual photons from
$$\pi^0 \rightarrow \gamma\gamma,$$
 - allowing each reconstructed cluster (or hit) to be matched to its corresponding photon.
- For the **simulation campaign single- π^0 datasets**,
 - the `SimCalorimeterHit` truth association points only to the parent π^0 ,
 - the intermediate photon information is not available through the stored truth association for the single simulation campaign.

Thus,

- Both photon showers are associated with the same parent π^0 .
- It is therefore not possible to determine which reconstructed cluster (or hit) originated from each photon using the stored truth association.

Current truth association : `SimCalorimeterHit` $\longrightarrow \pi^0$

For $\pi^0 \rightarrow \gamma\gamma$ studies, the desired association would be :

`SimCalorimeterHit` $\longrightarrow \gamma$

or more generally,

`SimCalorimeterHit` $\longrightarrow$ shower-initiating particle.

Suggested Association :

1. Start from the particle contributing to each `SimCalorimeterHit`.
2. Traverse the particle ancestry toward the generator particle.
3. Continue traversing across prompt decays according to a configurable criterion, for example
 - decay length,
 - last particle in the tracking volume,
4. Stop once the selected criterion is no longer satisfied.
5. Store the last particle before this condition (the shower-initiating particle) in the truth association.

Now, with this change, for $\pi^0 \rightarrow \gamma\gamma$ the stored association would become:

`SimCalorimeterHit` $\longrightarrow \gamma$,

while the parent π^0 would remain accessible through the `MCParticle` parent links.

For the π^0 case, a criterion based on the shower-initiating particle (e.g. the last particle before detector interactions) would select the daughter photon rather than the parent π^0 .