Arbor PFA
Separation of overlaid shower studies - CAN summary

Eté Rémi

Université Claude Bernard Lyon 1
Institut de Physique Nucléaire de Lyon

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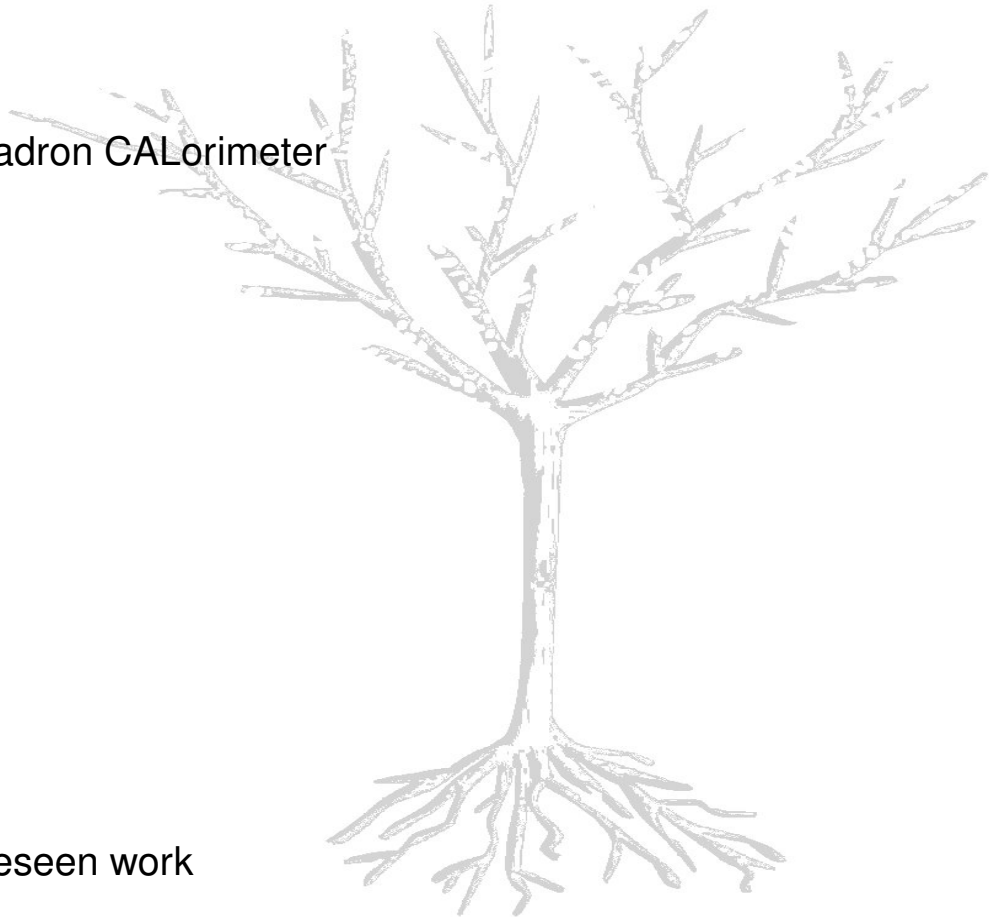
CAN Summary

- Summary of the future CAN-054 : *Close-by showers separation within SDHCAL prototype detector using ArborPFA*
- Submitted to editorial board last Monday

Abstract

A new reconstruction algorithm called ArborPFA is developed to separate close-by hadronic showers in the SDHCAL prototype. This intends to demonstrate the capability of high granularity hadronic calorimeters such as the SDHCAL to apply efficiently the Particle Flow Algorithms in the future ILC experiments. The reconstruction algorithm we present here uses the tree structure features of the hadronic showers, that high granular calorimeters reveal, to associate clusters belonging to each hadronic shower and to reduce the confusion between two close-by showers. The results of these studies indicate a good single particle efficiency and powerful separation down to 5 cm of separation distance.

Summary



The Semi Digital Hadron CALorimeter

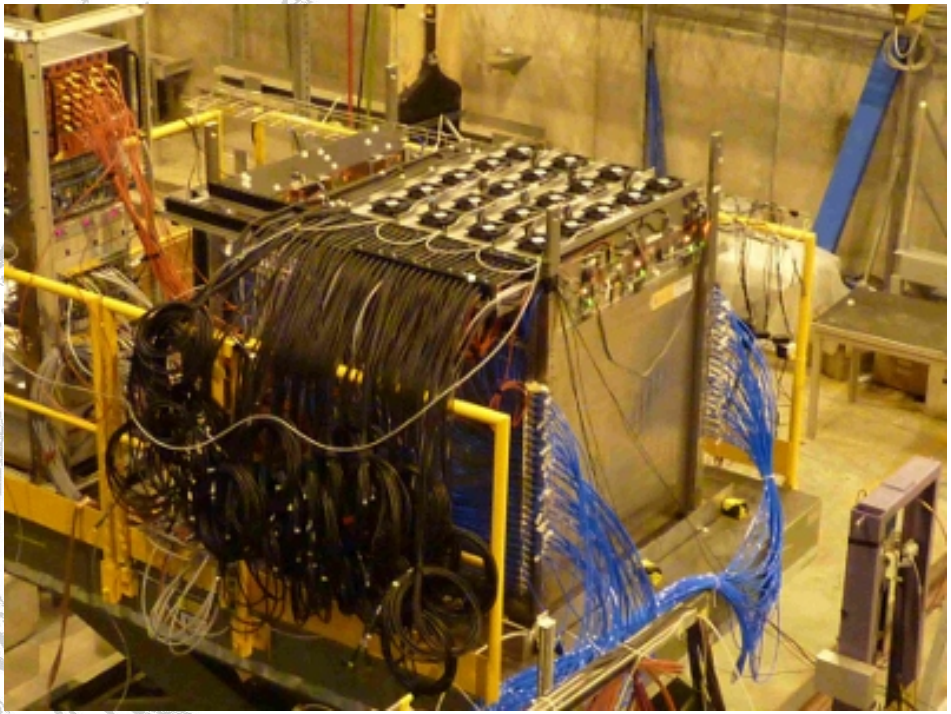
Semi Digital Hadron CALorimeter
$\sim$ 48 GRPC layers ($\sim$ m^3)
3 charge thresholds

Energy reconstruction :

$$E_{rec} = \alpha(N_{hit}).N_1 + \beta(N_{hit}).N_2 + \gamma(N_{hit}).N_3$$

χ^2 minimization from 10 GeV to 80 GeV.

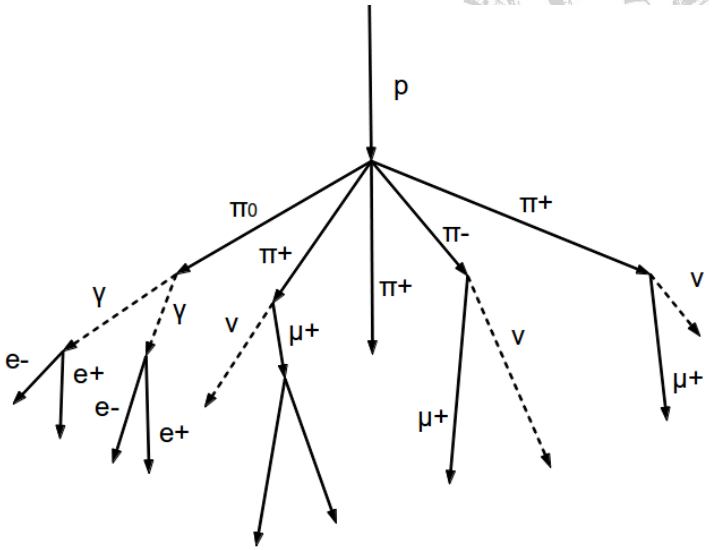
Event reconstruction, pion event selection according to SDHCAL prototype construction note.

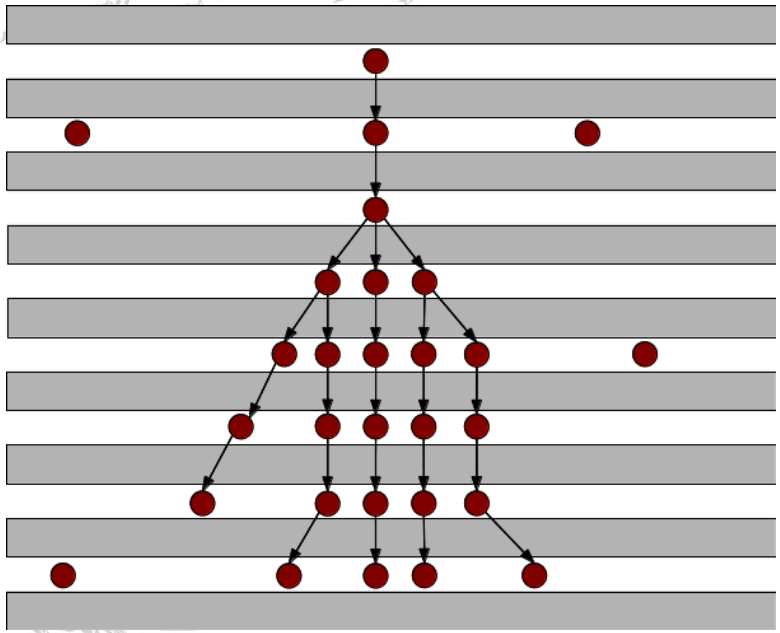


ArborPFA

Principle

Shower $\Longleftrightarrow$ Tree structure





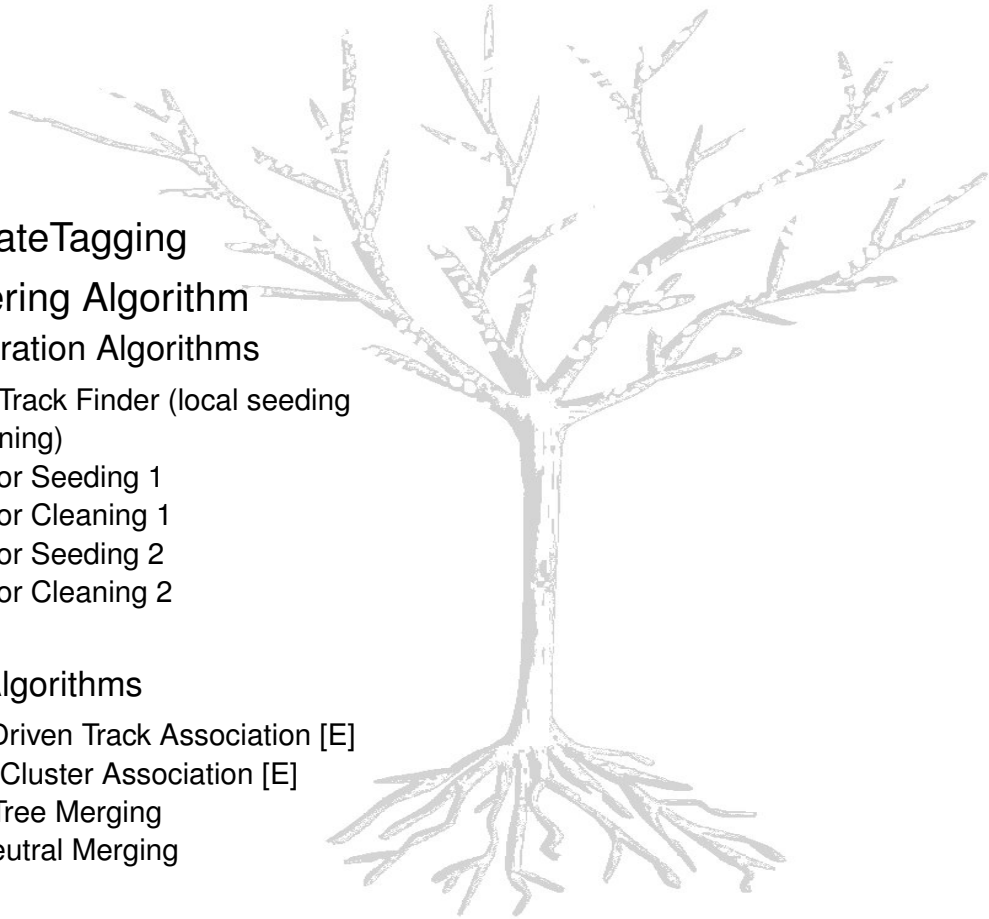
IPNL homemade ArborPFA release v01-04-00

→ `https://github.com/SDHCAL/ArborPFA`

Uses **PandoraSDK** as development toolkit and **Marlin** as running framework.

ArborPFA

Arbor algorithms



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2. Mip track CandidateTagging
3. Connector Clustering Algorithm
    1. Connector Iteration Algorithms
        1. Primary Track Finder (local seeding and cleaning)
        2. Connector Seeding 1
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    2. Tree Building
    3. Association Algorithms
        1. Energy Driven Track Association [E]
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        3. Neutral Tree Merging
        4. Small Neutral Merging
4. Pfo Creation

ArborPFA

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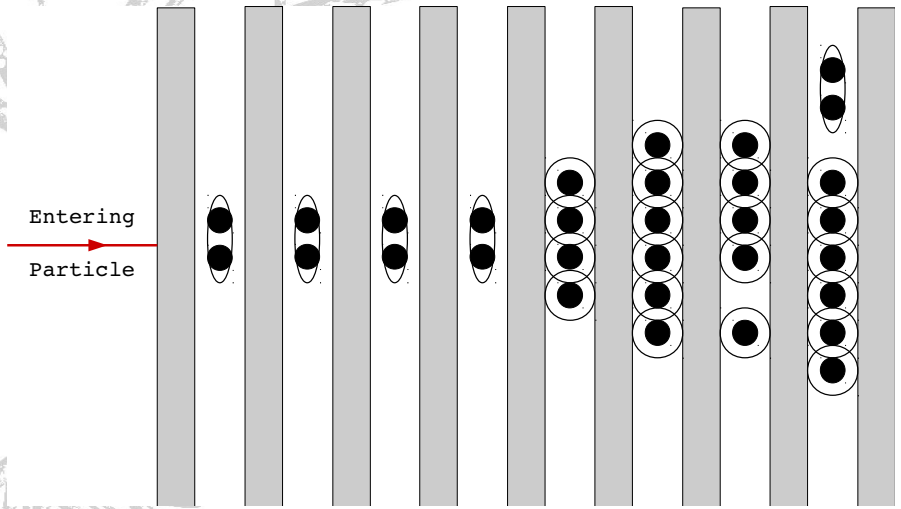

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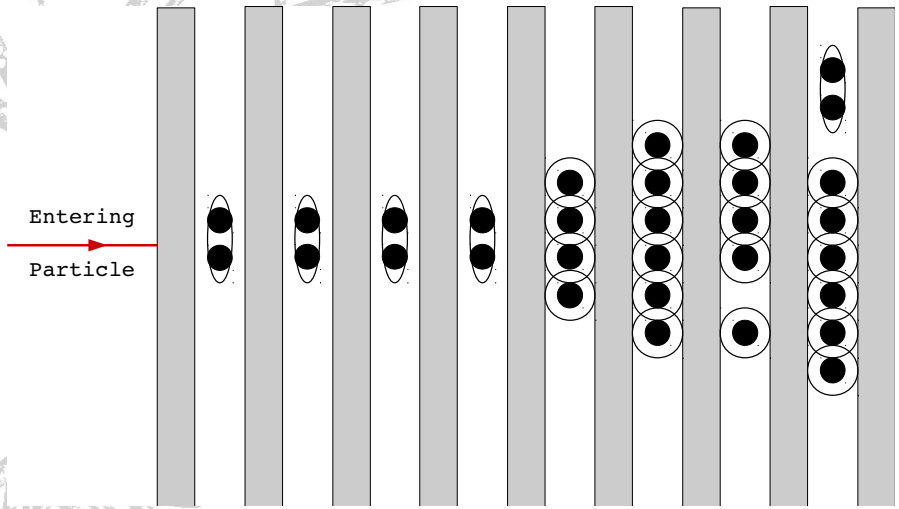
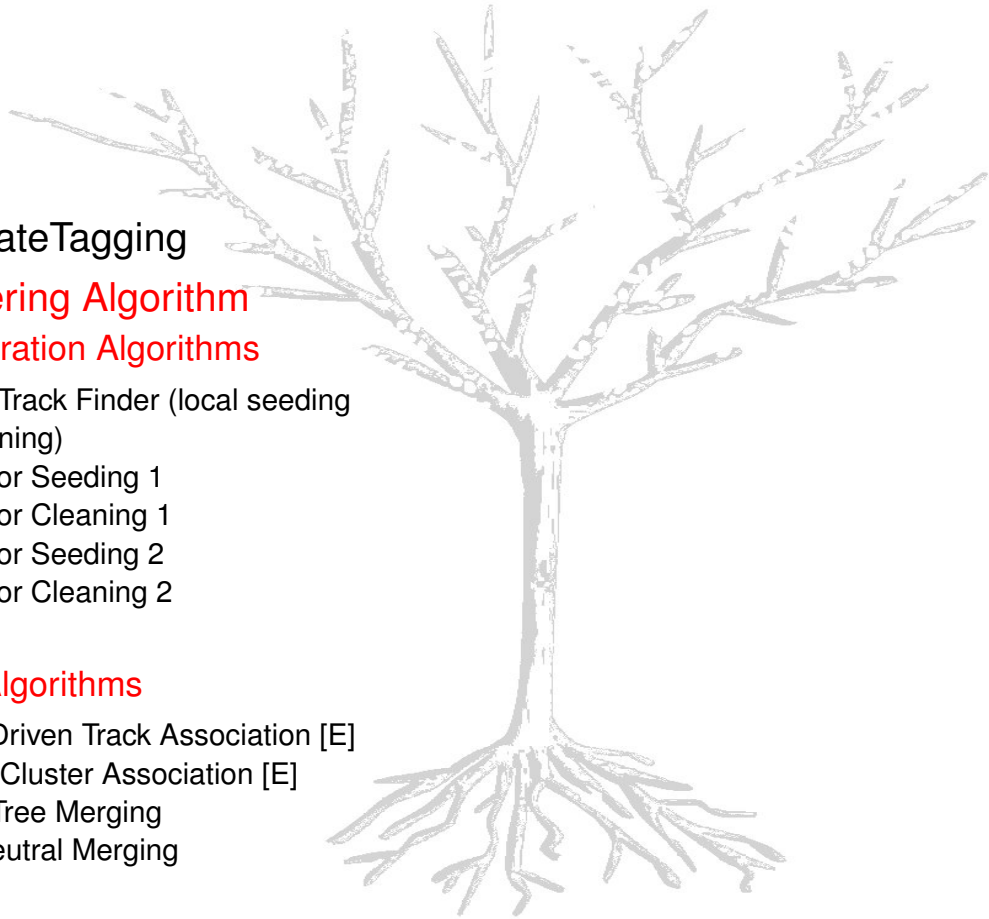


ArborPFA

Arbor algorithms



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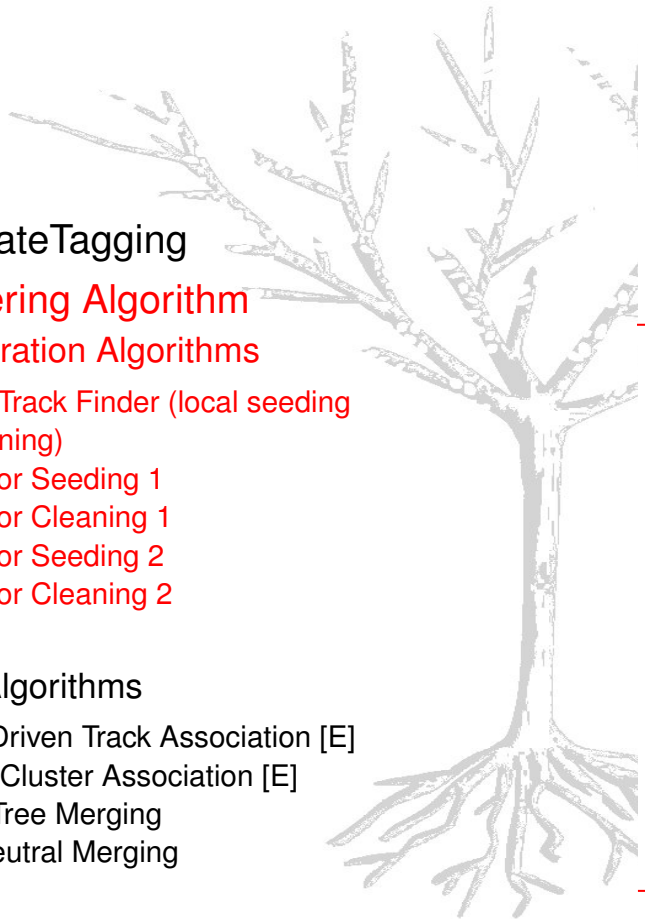

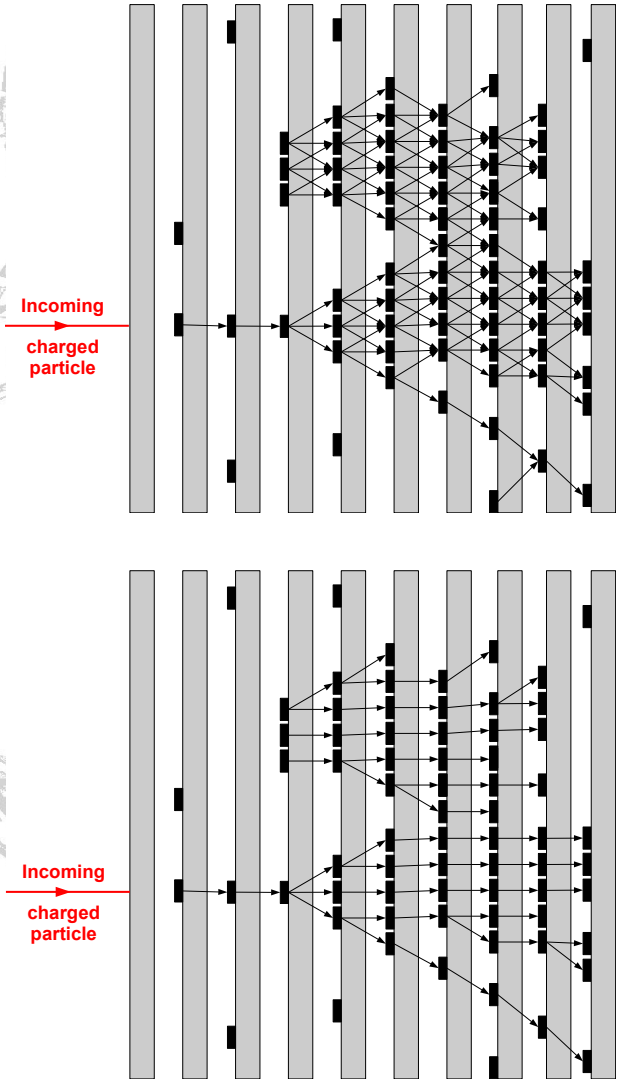

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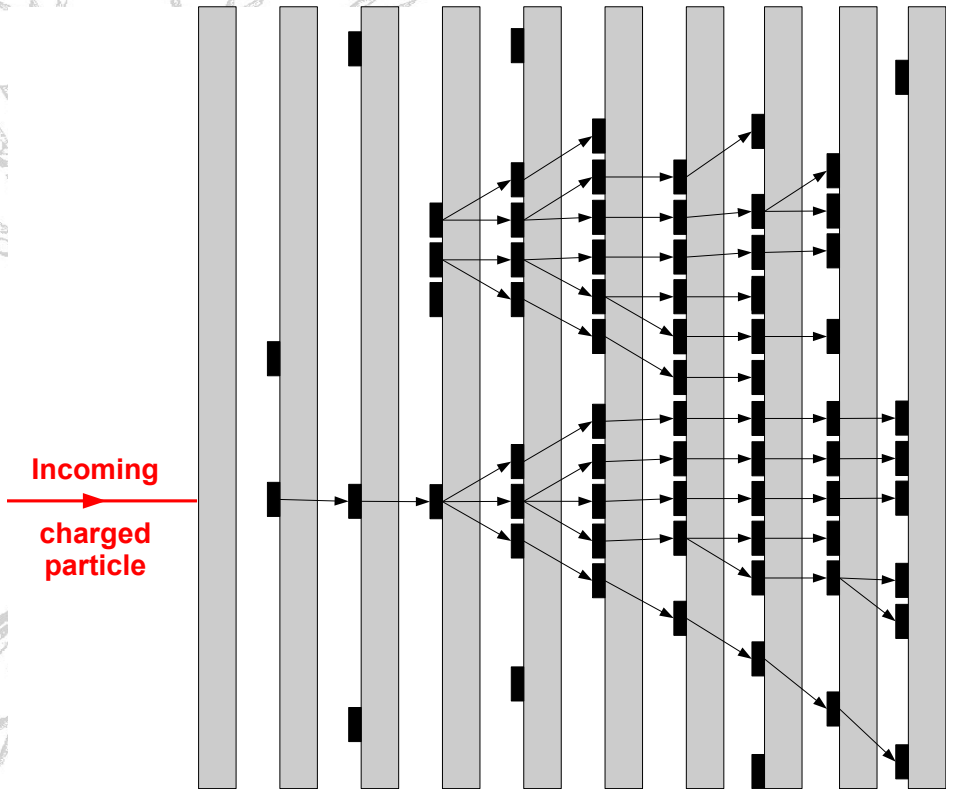

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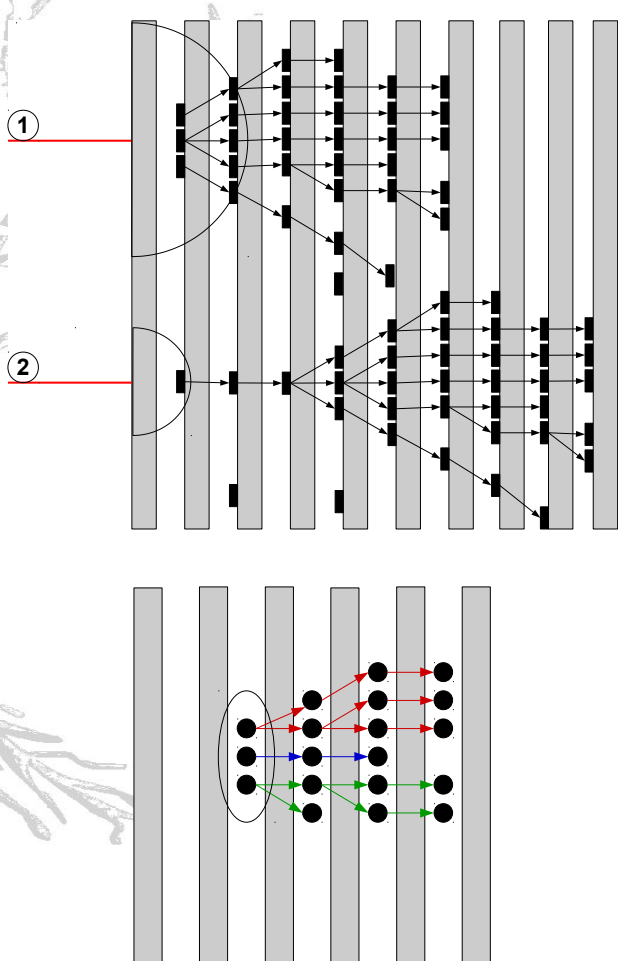

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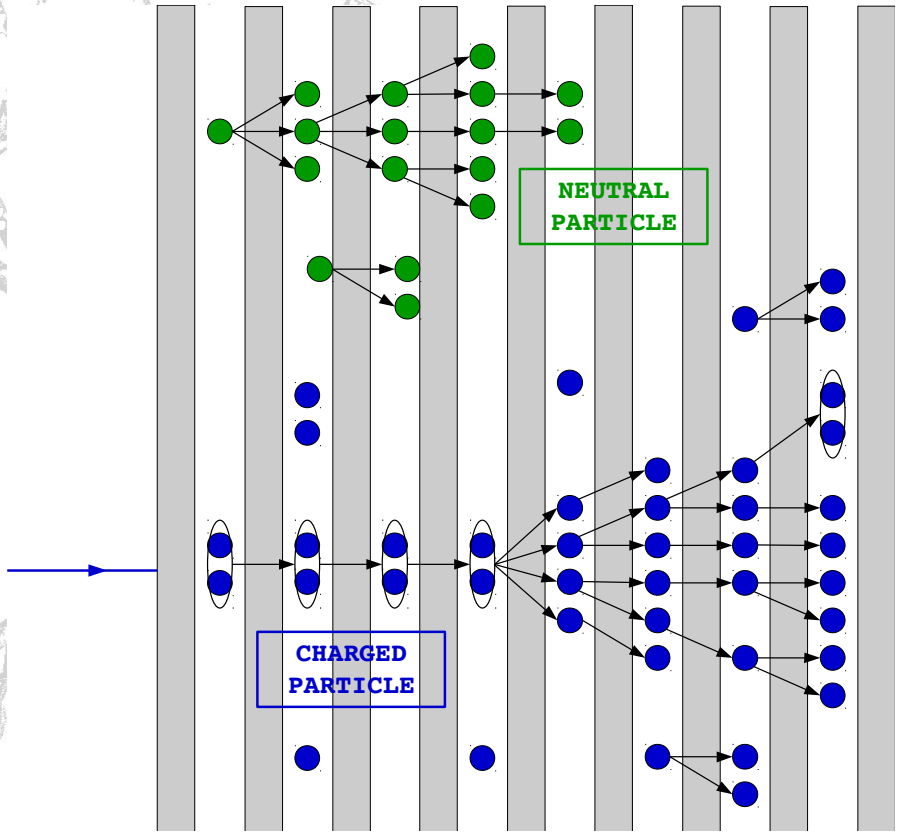
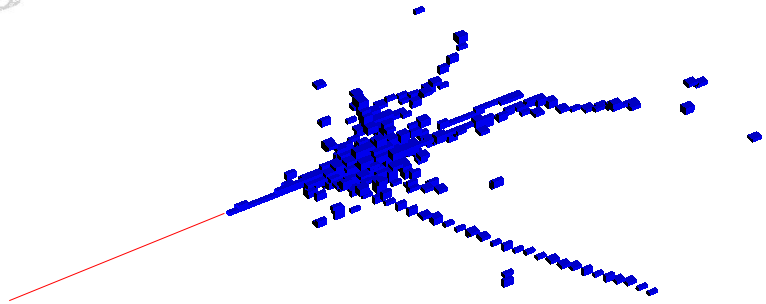


Analysis

Single particle

Loading SDHCAL pion hits in the PandoraSDK framework

Generating straight track in front of the SDHCAL

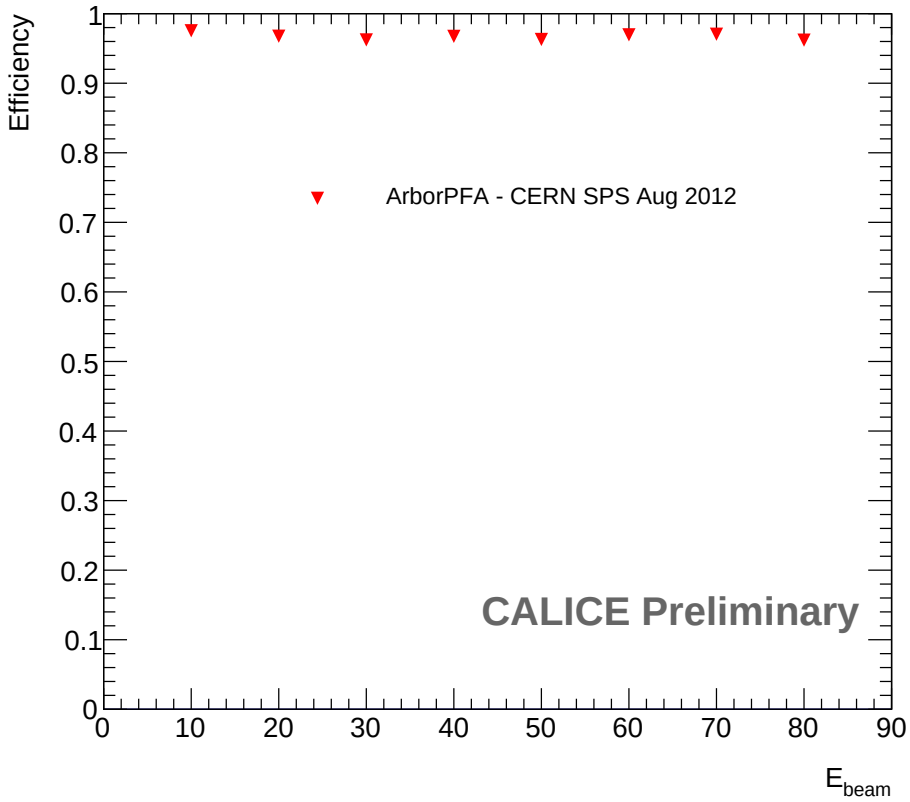


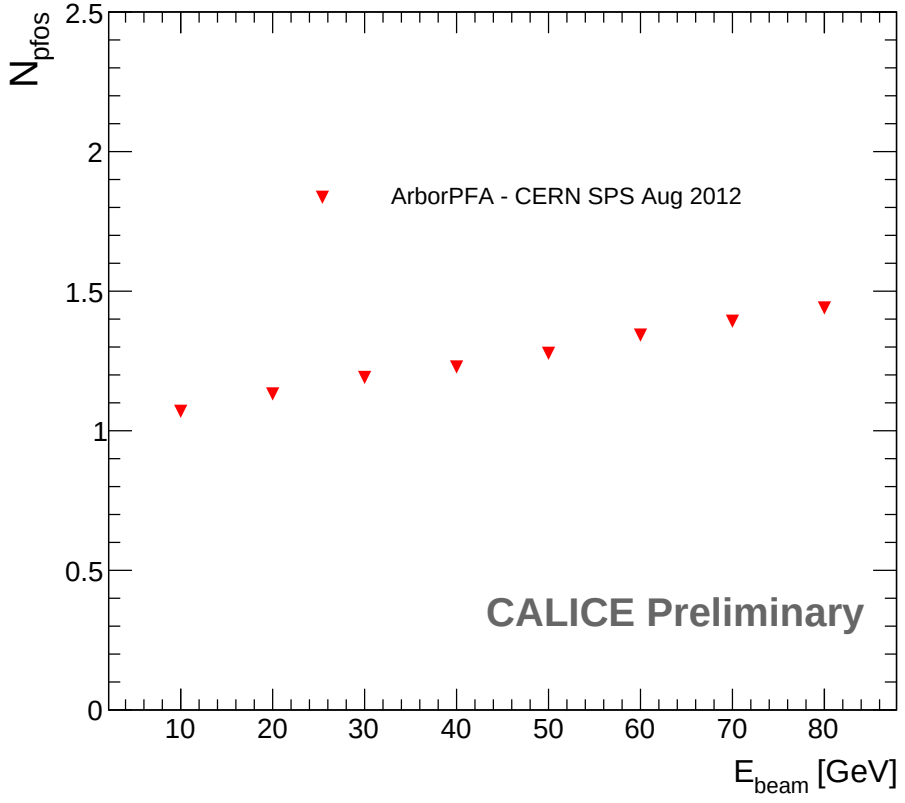
Simple observables as performance estimator :

- Efficiency
- N_{pfos}
- E_{rec}
- E_{resol}

Analysis

Efficiency. N PFOs



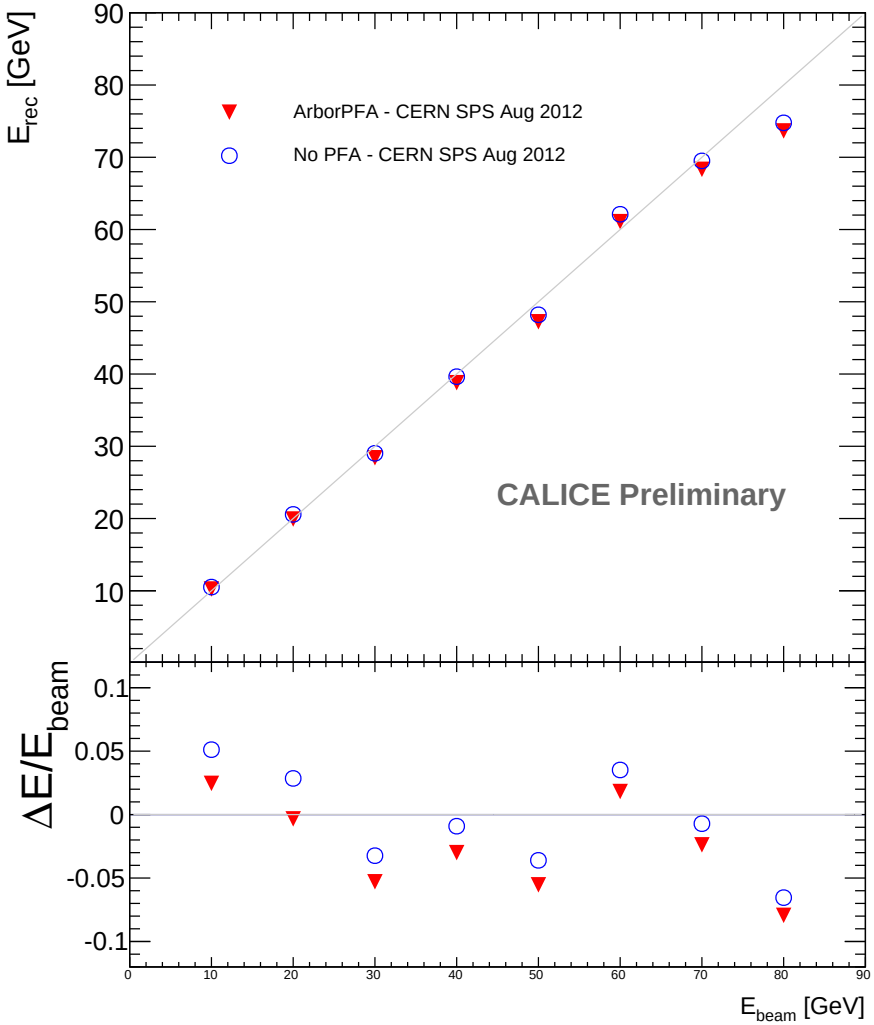


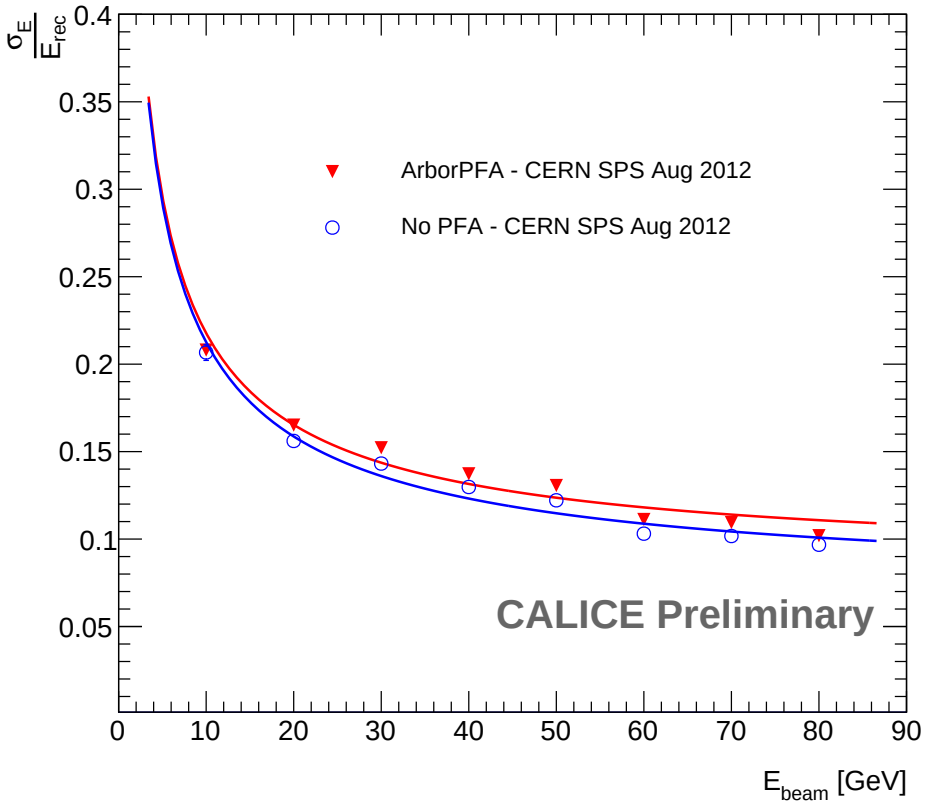
Efficiency $\rightarrow$ OK.

NPfos $\rightarrow$ A bit of splitting but OK.

Analysis

Rec energy. Energy resolution





ERec → Effect of pfo splitting visible in deviation (rather small).
EResol → Effect of deviation visible

Analysis

Overlay event

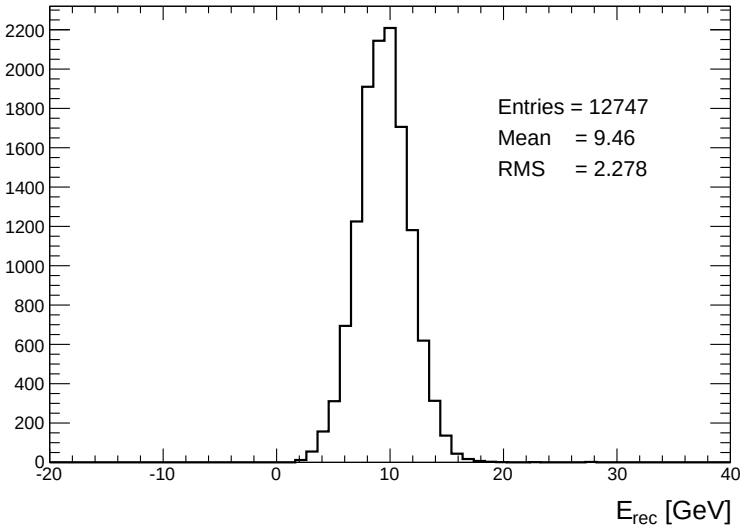
Overlay pion shower events :

- Find entering point of both showers
- Shift the shower in Y direction by $\pm$d wrt calorimeter center
- Identify track segment hits of one of the two pions and remove them (neutral)
- Merge hits in the same collection + tag hits by shower id
- Overlaid hits : highest threshold chosen

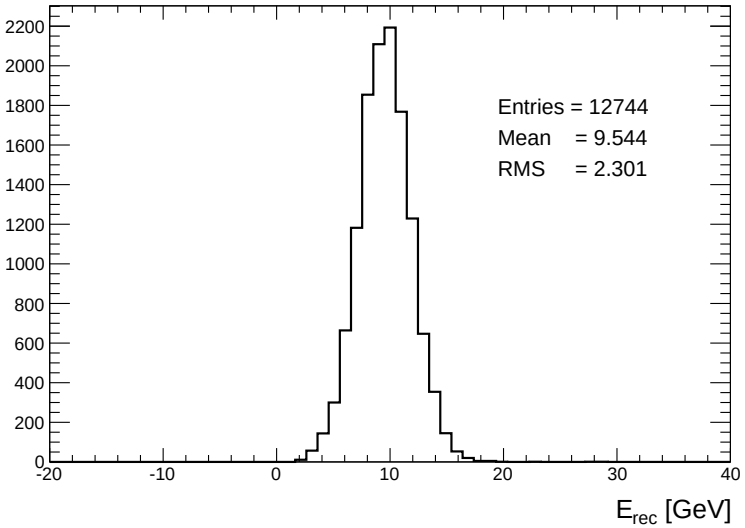
10 GeV neutral + 50 GeV charged pion
Neutral ERec before and after overlay $\Longrightarrow$

Track generation similar to single particle.
Observables as performance estimator :

- Efficiency
- Purity
- N_{pfos}
- $P_{n>0}$
- Mean E_{rec}-E_{meas}

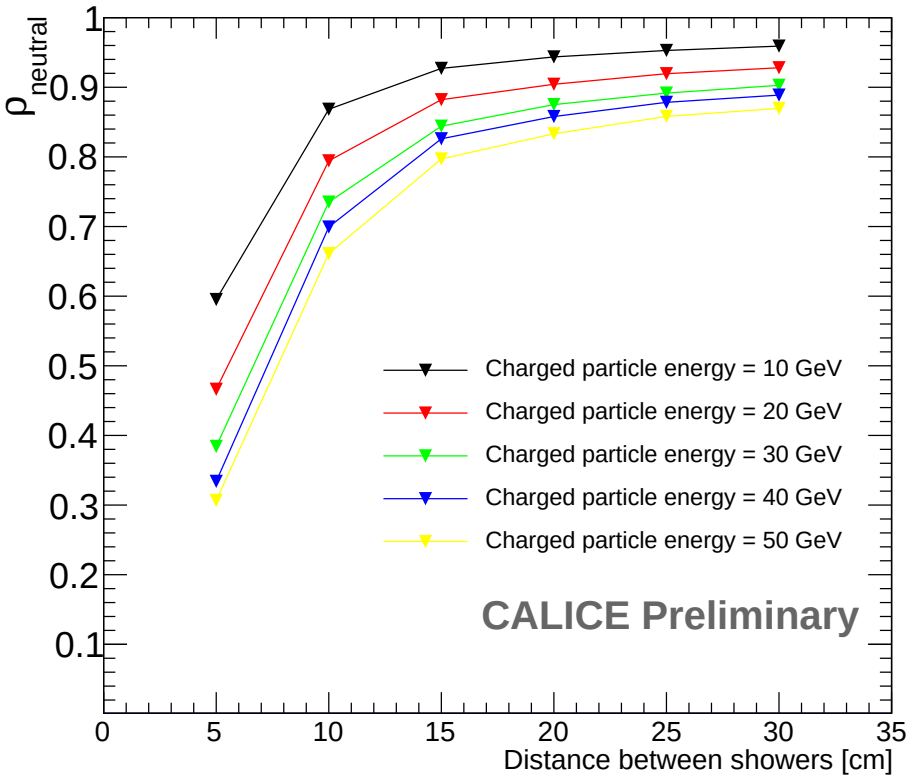


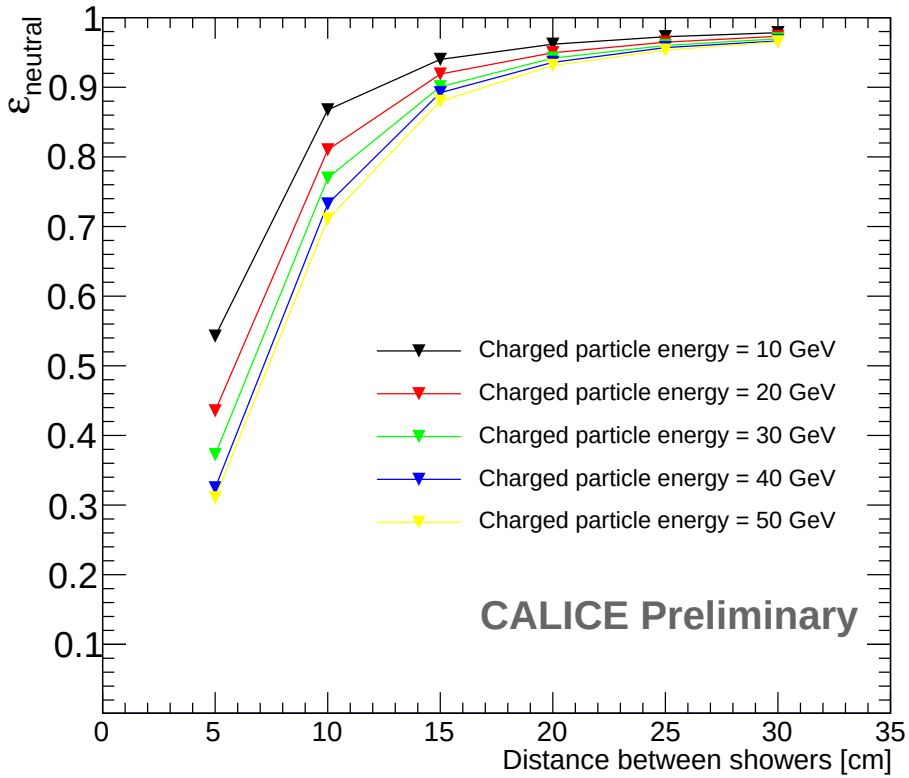
After $\Downarrow$



Analysis

Overlay event



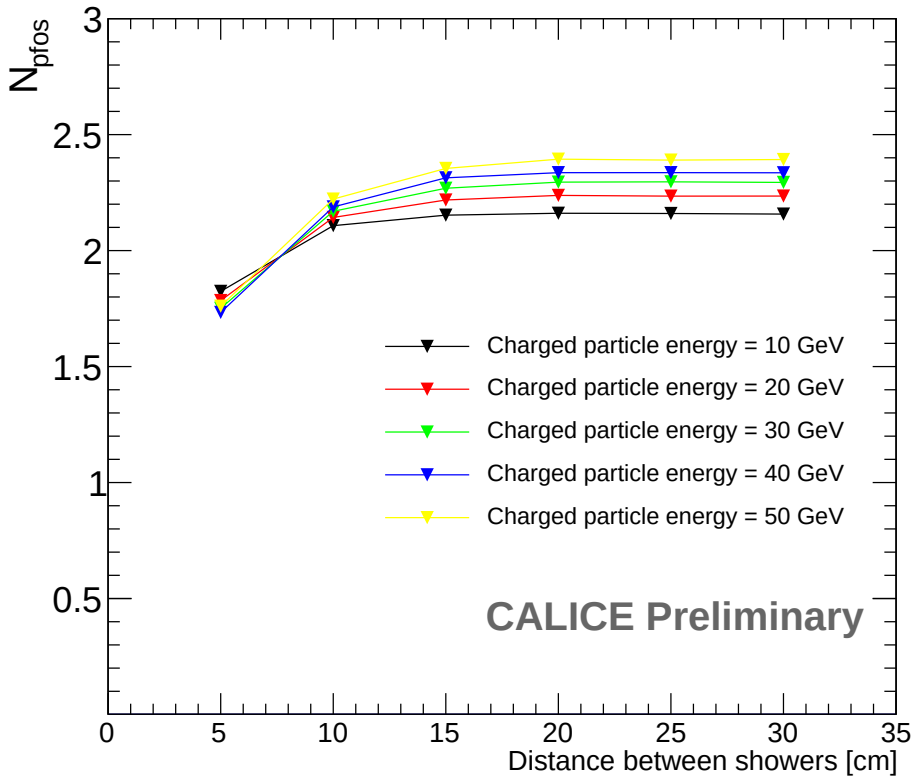


SmallNeutralTreeMerging effect on purity.

Using the distance between parent and daughter trees, no energy information (that should be used here !)

Analysis

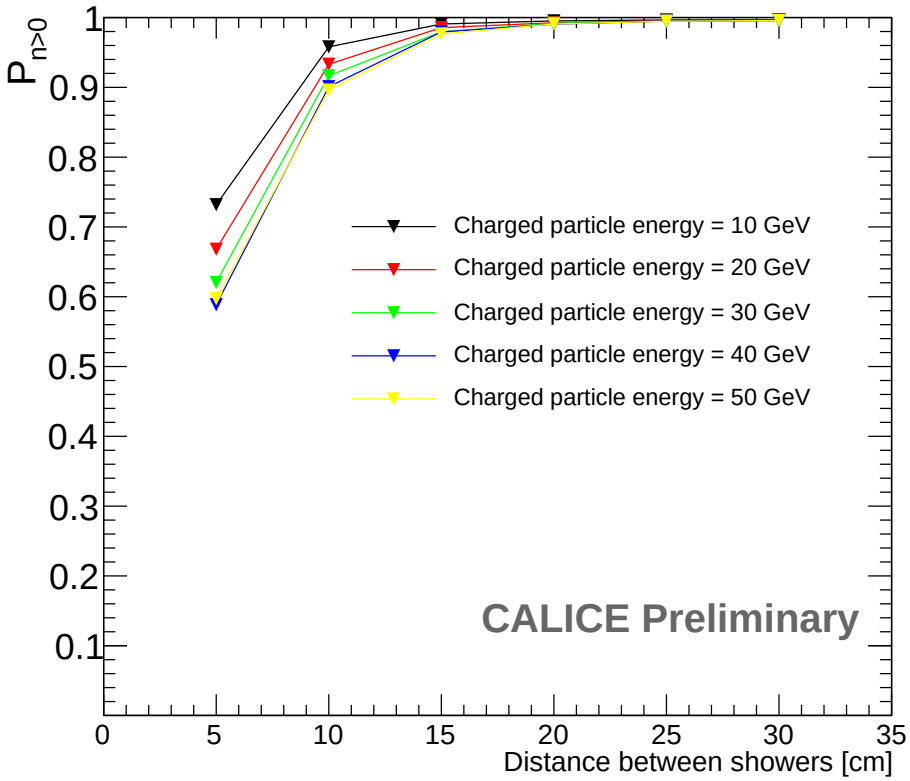
Overlay event

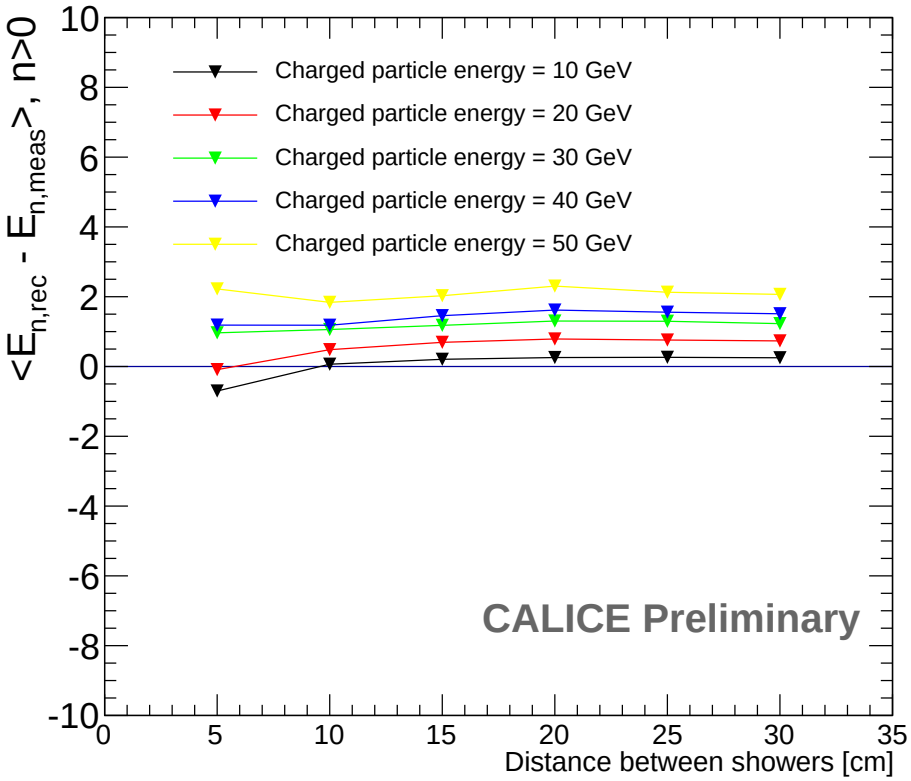


Compatible with $N_{pfo,n,single} + N_{pfo,ch,single}$ at large distance.
As expected decreasing with the separation distance

Analysis

Overlay event





- 10 GeV neutral + 50 GeV charged : still 60% of neutral recovery
- Binary-like behavior at small separation distances : good separation or complete merging (event topology)

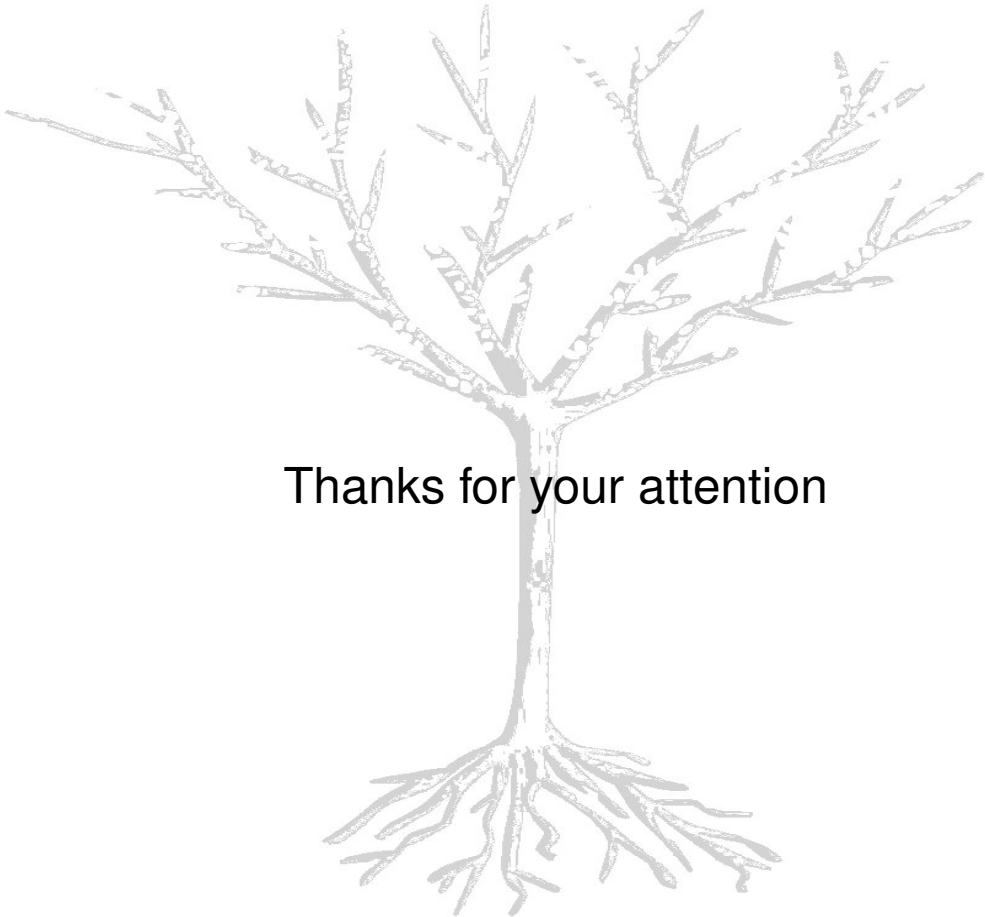
Conclusion and foreseen work

Conclusion :

- Algorithm development within PandoraSDK
- Single particle understood and showed very good result
- Overlaid particles separation understood and showed good results until 5 cm. At this distance the separation power is binary-like (well separated or completely merged).

Current and foreseen work :

- Correct the small neutral tree merging by using energy weight
- Starting to look at ILD reconstruction (ILD_02_v05) :
  - Implementation in ECal for hadronic interactions
  - Connection between ECal-HCal
  - High θ angle region
- Implements a re-clustering ?
  - Statistical loop (a la Pandora)
  - Branch cutting and switching (a la Arbor)
- Garlic in ECal
- ECal+SDHCAL energy estimator and calibration



Thanks for your attention