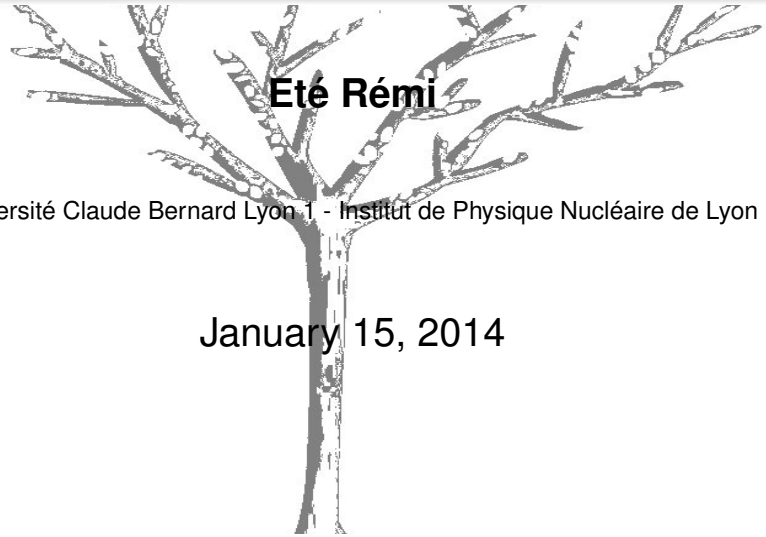
Arbor PFA approach
Reconstruction purity/efficiency of single and overlaid particles



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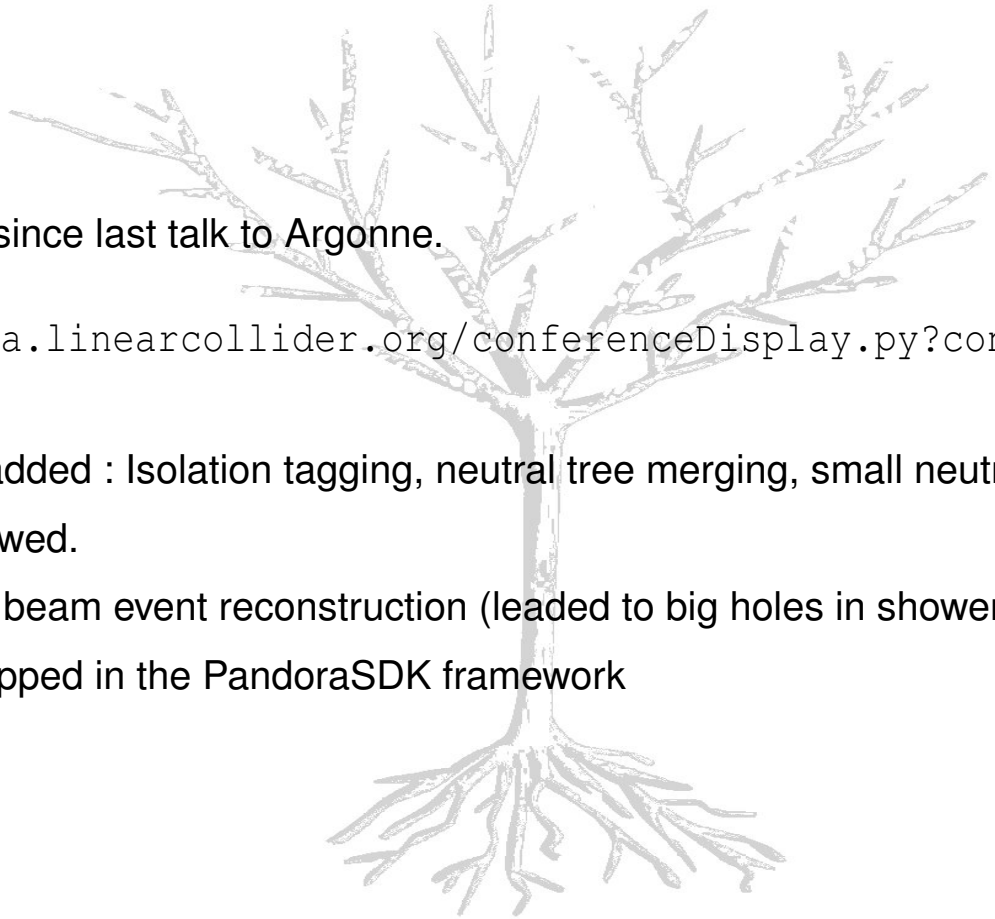
Arbor status

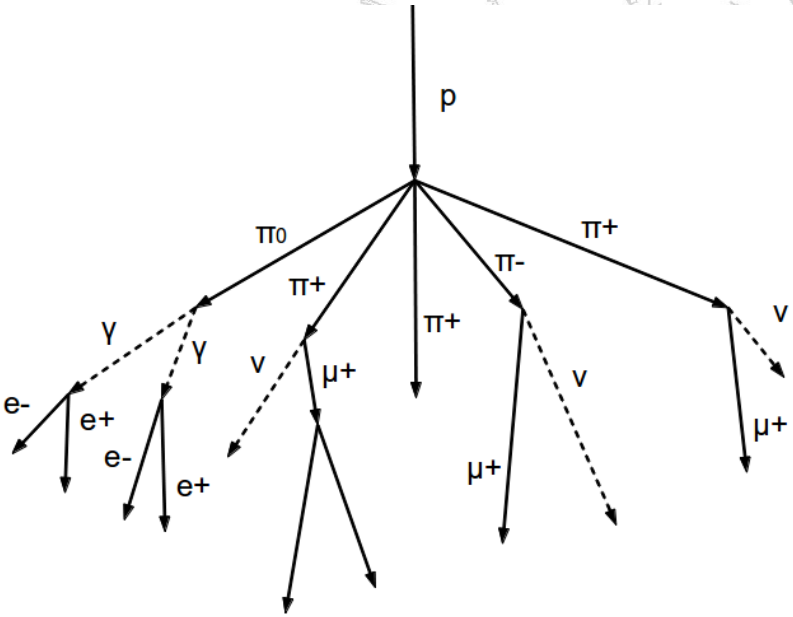


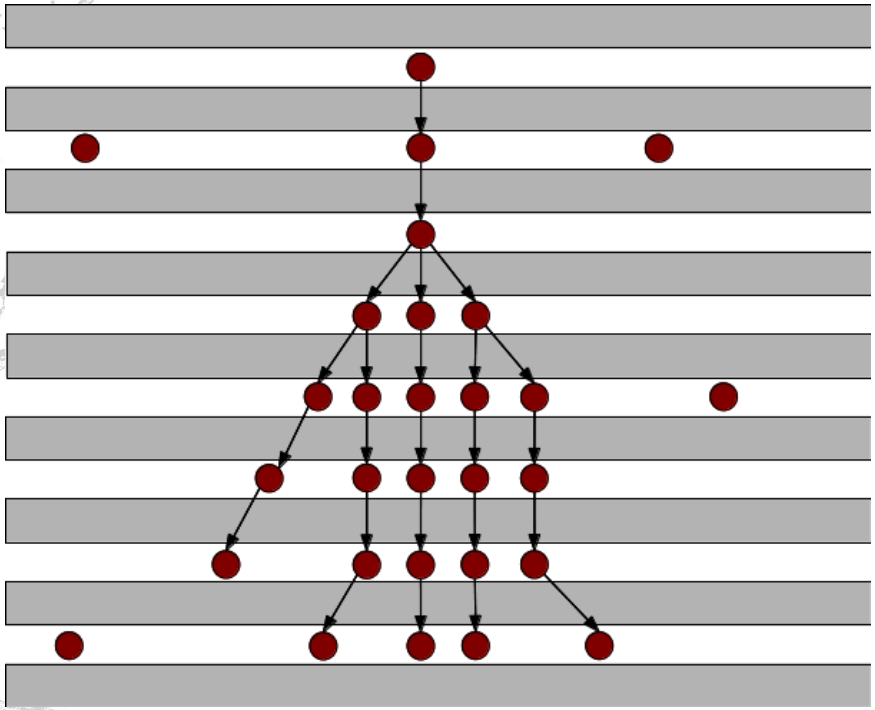
Many things changed since last talk to Argonne.

See : `https://agenda.linearcollider.org/conferenceDisplay.py?confId=6341`

- New algorithms added : Isolation tagging, neutral tree merging, small neutral cluster merging.
- Parameters reviewed.
- Bug fixed on test beam event reconstruction (leaded to big holes in showers).
- Arbor API developped in the PandoraSDK framework

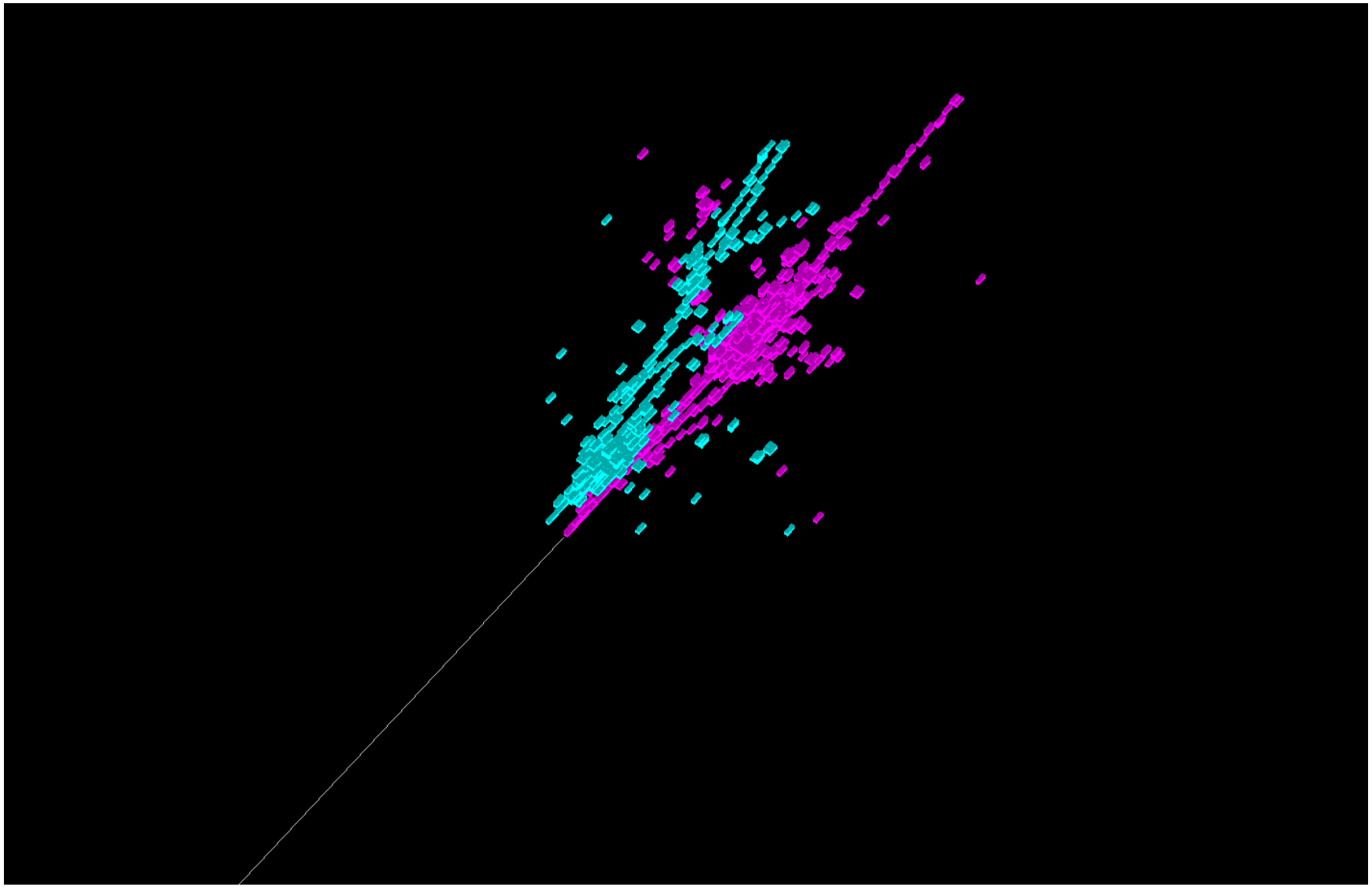
Remind on Arbor principle





Clustering algorithm that uses connectors between calo hits.
Build clusters in an oriented tree topology.
Key point : **The reconstruction follows the underlying physics principle of the shower !**

Event display



Neutral π^- of 30 GeV overlaid with a charged π^- of 50 GeV at 5 cm distance.

For this study

Studying

- the reconstruction efficiency for single particle energies [10,20,30,40,50,60,70,80] GeV
- the reconstruction efficiency/purity for overlaid particles energies [10,20,30,40,50] GeV

Particle flow config

In Arbor :

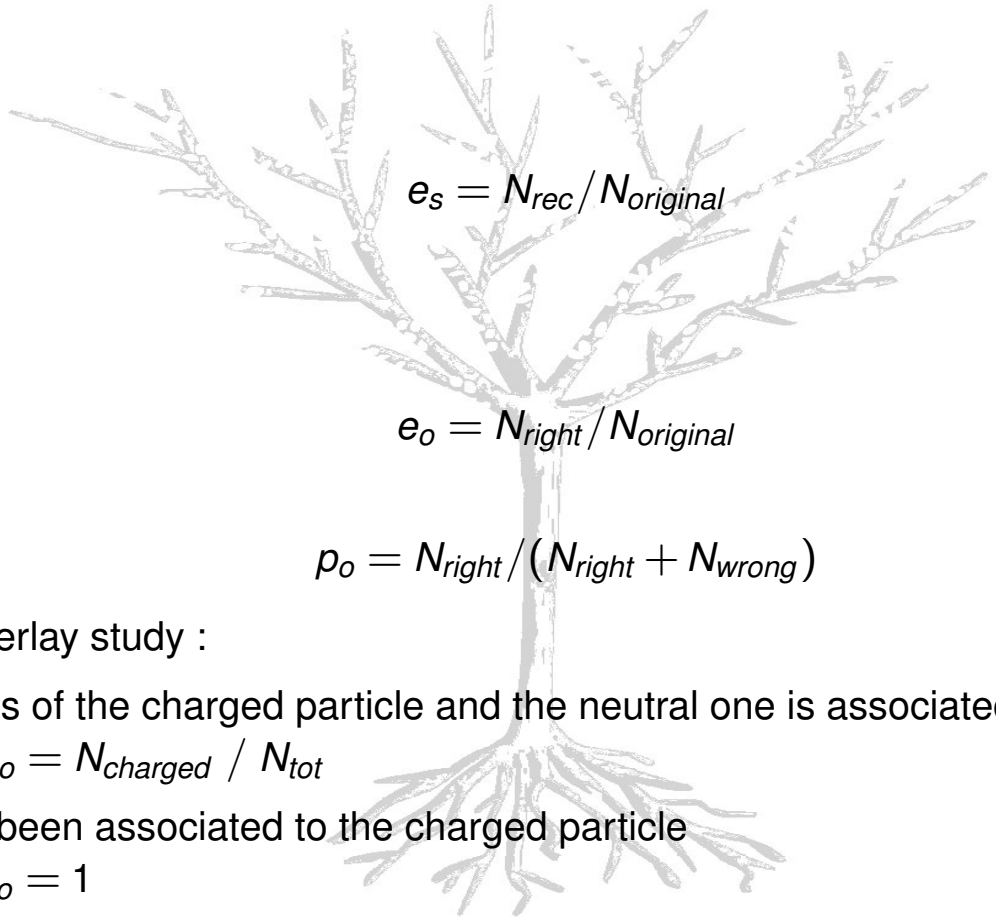
- No energy information is used in algorithms
- A track association is done using only topology
- A few association algorithms run (neutral tree, small neutral merging)
- Particle object flow formation : cut on E_{pfo}> 1 GeV

In Pandora (v00-12) :

- Specific algorithms not run (MuonReconstruction, PhotonReconstruction, etc ...)
- Energy information used : usual quadratic energy function plugged in PandoraPFA framework.
- Particle object flow formation : cut on E_{pfo}> 1 GeV
- Statistical re-clustering run (χ^2 minimization using many clustering algorithms)

PFO Analysis

Definitions



Single particle

Efficiency :

$$e_s = N_{rec} / N_{original} \tag{1}$$

Overlaid particles

Efficiency :

$$e_o = N_{right} / N_{original} \tag{2}$$

Purity :

$$p_o = N_{right} / (N_{right} + N_{wrong}) \tag{3}$$

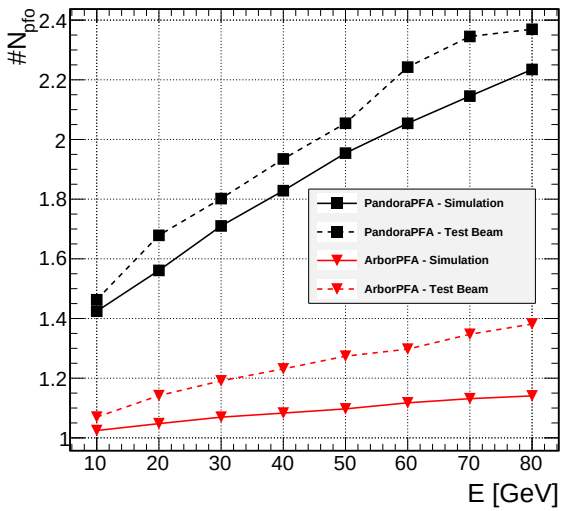
Particular cases for overlay study :

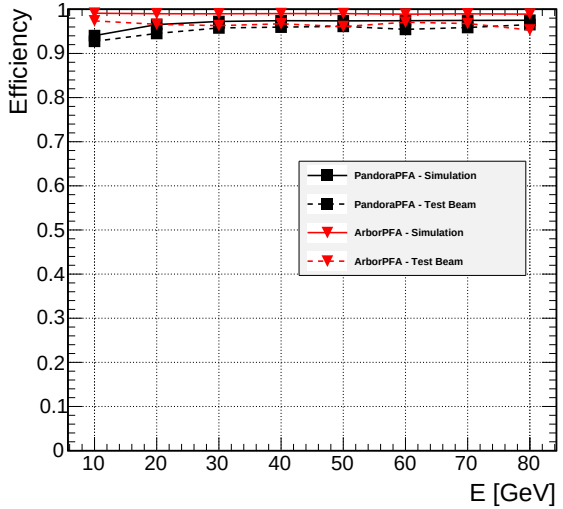
- All the original hits of the charged particle and the neutral one is associated to the charged
  $\rightarrow$ $e_o = 1$ *and* $p_o = N_{charged} \ / \ N_{tot}$
- Only one hit has been associated to the charged particle
  $\rightarrow$ $e_o \sim 0$ *and* $p_o = 1$
- Particles perfectly reconstructed
  $\rightarrow$ $e_o = 1$ *and* $p_o = 1$

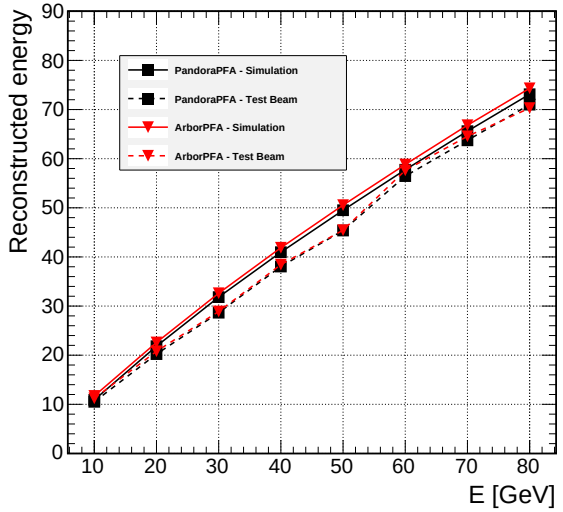
Interpretation of results should be done carefully ...

PFO Analysis

Single particle study







Pandora :

- Splitting of single particle showers.
- Efficiency plot shows that Pandora splits the main cluster in one big plus small ones.

Arbor :

- Very small shower splitting due mostly to neutral fragment.
- Good efficiency

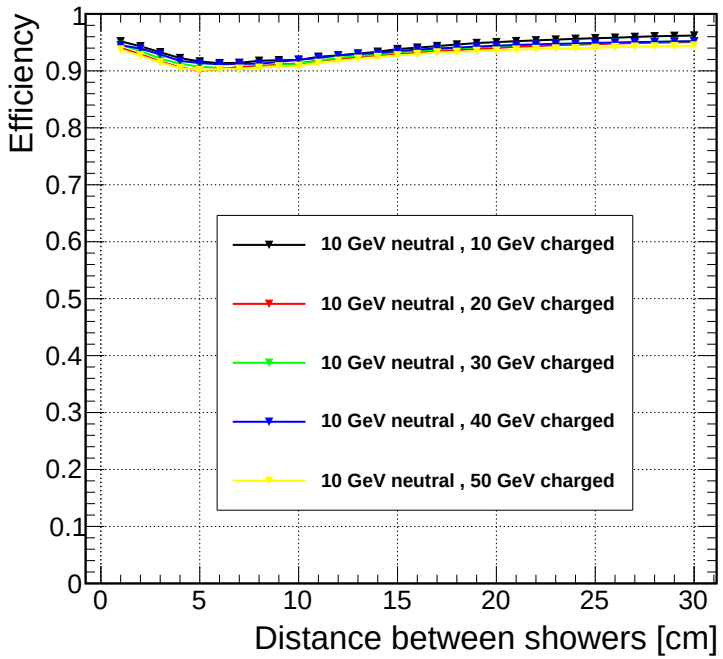
Remark :

Energy calibration is not optimal and will impact the PandoraPFA reconstruction since it uses energy information in algorithms ! !

PFO Analysis

Overlay study - 10 GeV neutral + charged pi-

Overlaying two particles from test beam : a 10 Gev charged pion simulating a neutral hadron and a X GeV charged pion with a fake generated track with a momentum of X GeV.



In the following slides, efficiency and purity of the charged X GeV pion are displayed as a function of the separation distance between the two particles.

PFO Analysis

Overlay study - 10 GeV neutral + charged pi-

For a 10 GeV + 10 GeV overlay, at 0 cm distance, we expect :

- Pandora efficiency tends to 0.5 and purity to 0.5
- Arbor efficiency tends to 1 and purity to 0.5

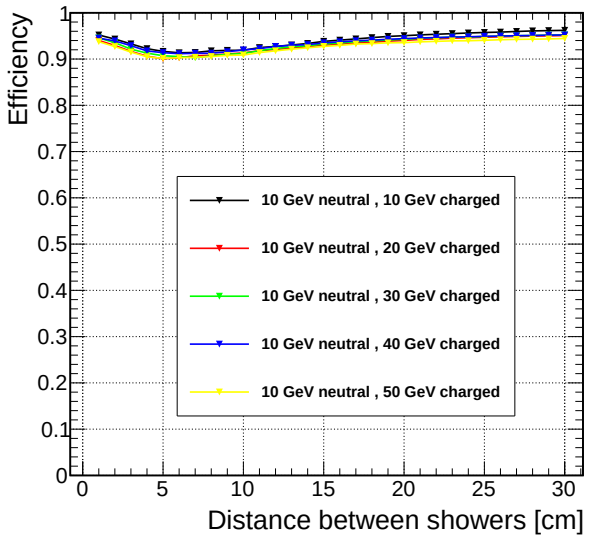
Arbor :

- No EFlow approach
- Better for higher separation distance

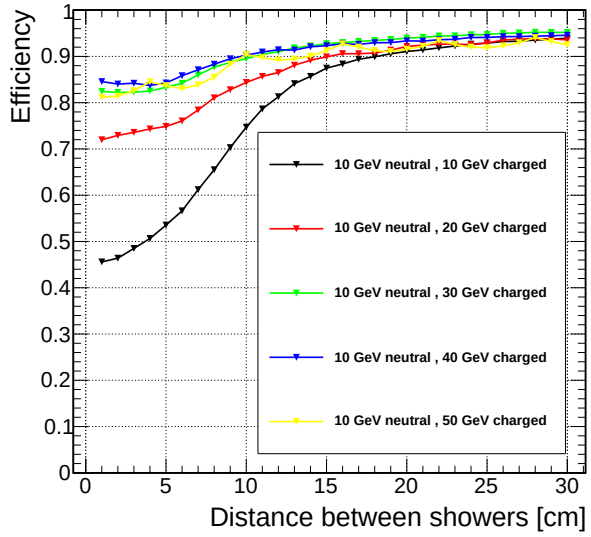
Pandora :

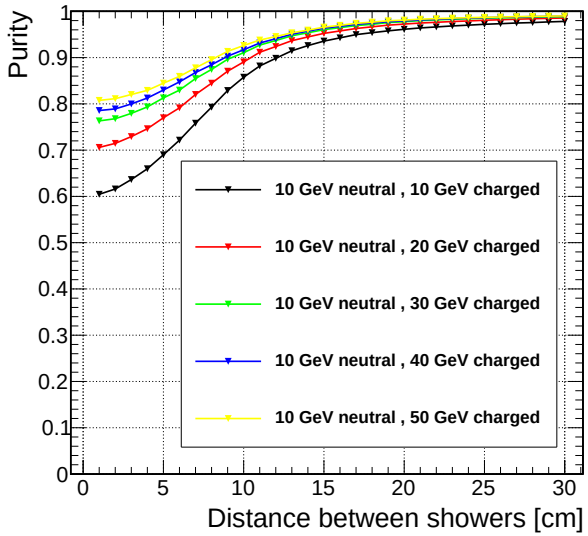
- EFlow used to force shower splitting for small distances
- This effect is sensitive to the energy calibration

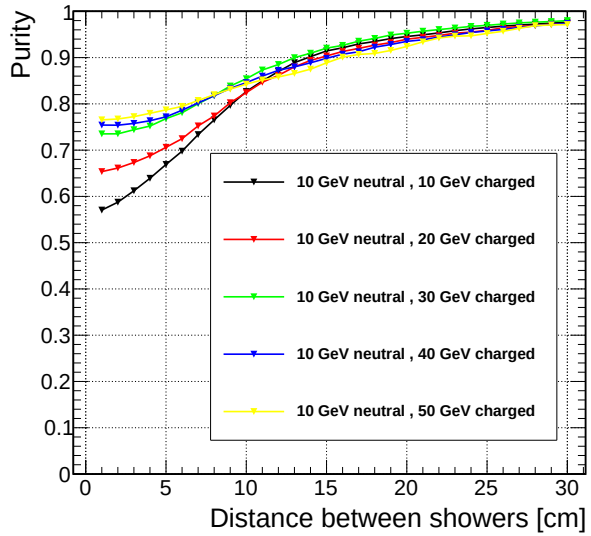
Arbor



Pandora

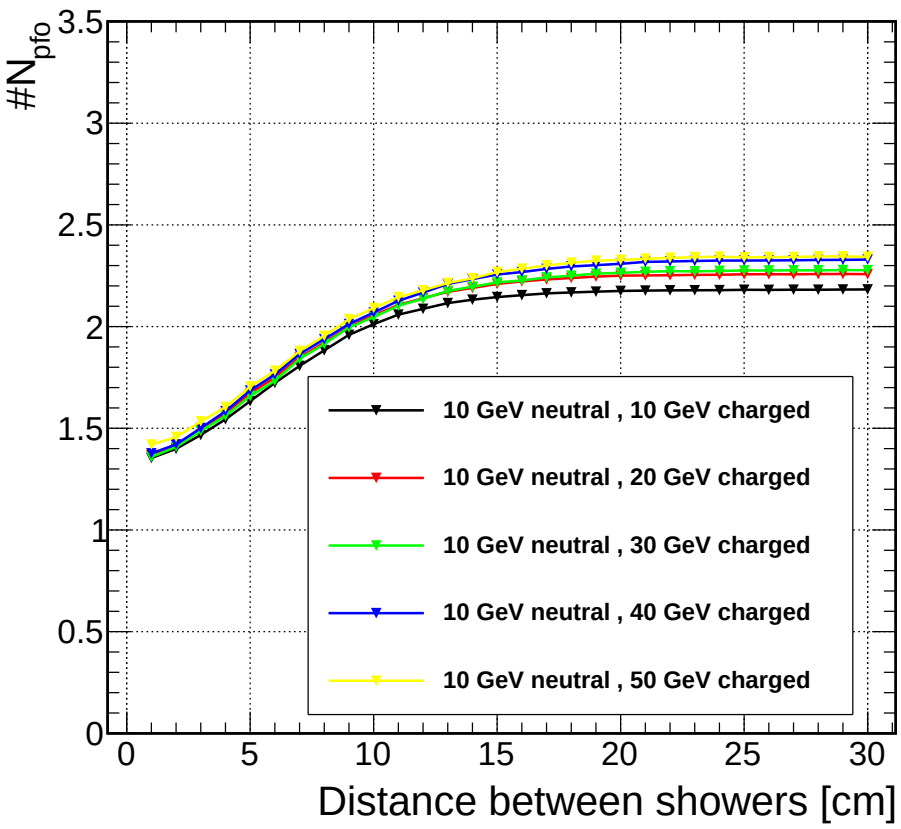


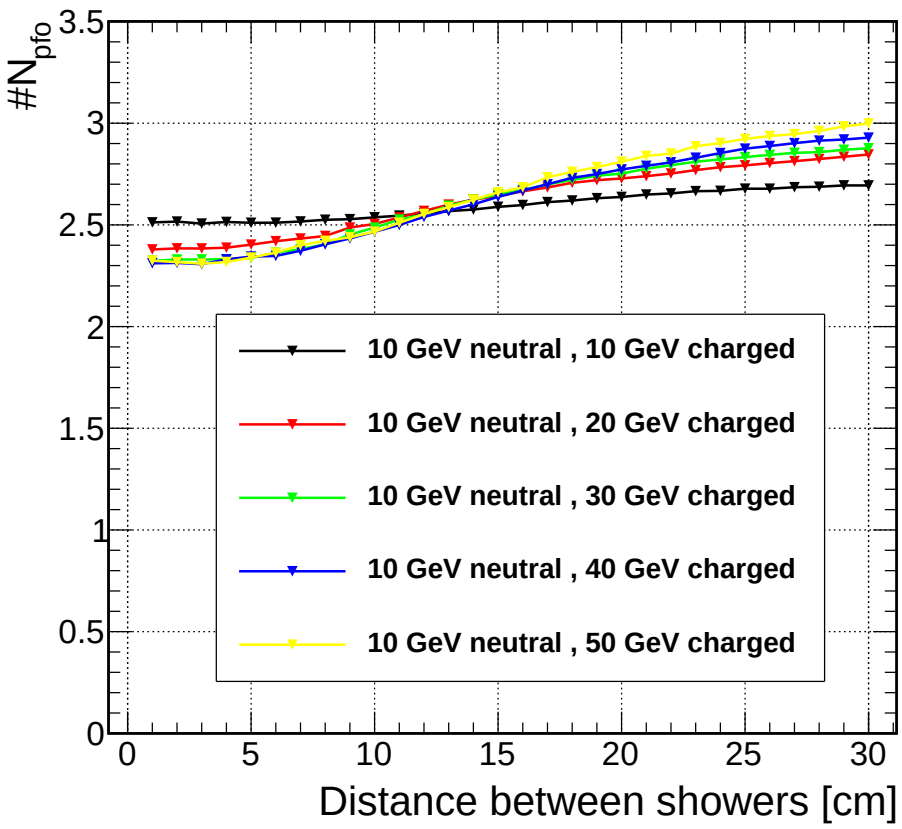




PFO Analysis

Overlay study - 10 GeV neutral + charged pi-





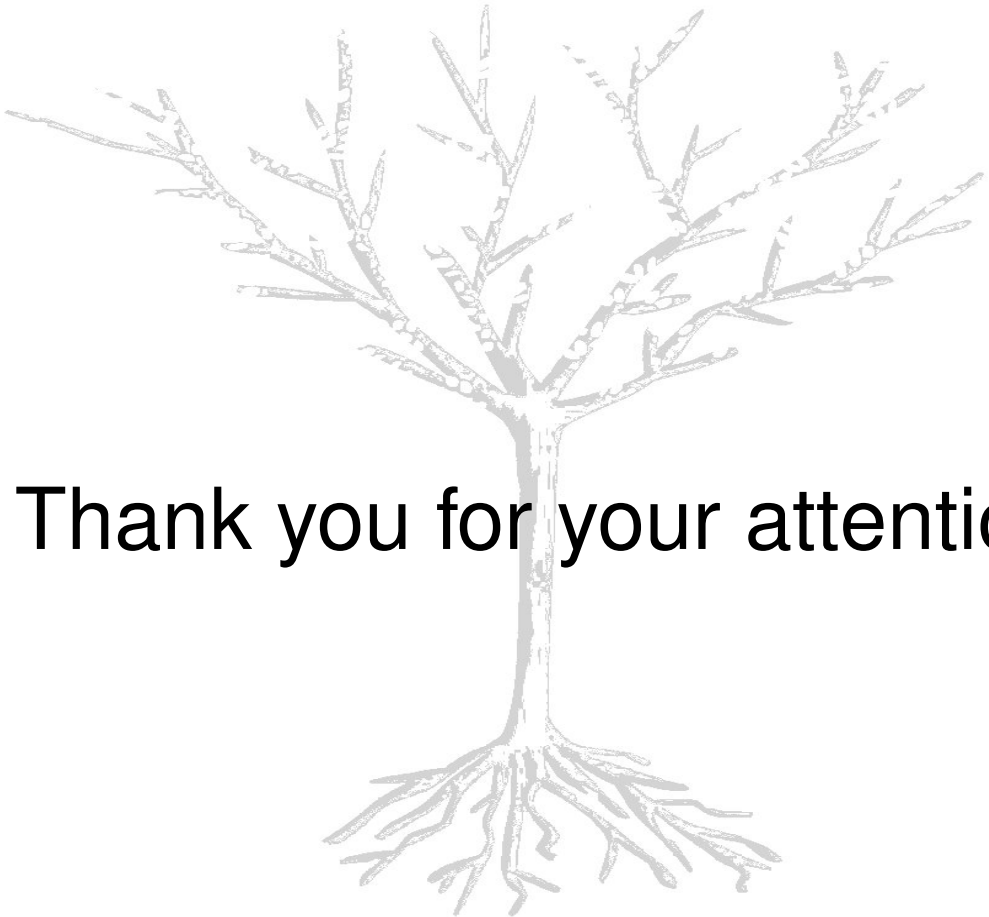
Conclusions and plans

Conclusions :

- ArborPFA algorithms are well understood. By using only topological information, it shows good results for single particle reconstruction and overlaid particle until small distances ($\sim$ 5cm).
- PandoraPFA shows a very important dependence on energy calibration in terms of efficiency. EFlow part of Pandora tends to improve the purity/efficiency for small separation distances.

Plans :

- Study the impact of the energy calibration in PandoraPFA reconstruction.
- Study the single shower topology with Arbor ; TB/MC comparison.
- Starting to write a Calice Analysis Note on ArborPFA.
- Start to work on a combined ECAL + HCAL detector setup in the ILD framework (link between ECAL and HCAL).
- Prepare a working version for ECAL + HCAL test beam configuration for next incoming test beams.



Thank you for your attention !