Preliminary study of Electron reconstruction In LArIAT

LArIAT collaboration meeting
July 11th, 2014

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The idea

✔ *"Borrow" from Microboone the latest reconstruction tools and test them on electrons simulated in the LArIAT geometry.*

✔ *Check the performance of these reconstruction tools on e-m showers in the energy range of interest for LArIAT (200 MeV – 1 GeV):*

- *What's already in place?*
- *What needs to be done?*
- *Need for different approaches for low energy VS high energy e-m showers?*
- ...

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PRELIMINARY STUDY/RESULTS!!!!

Procedure

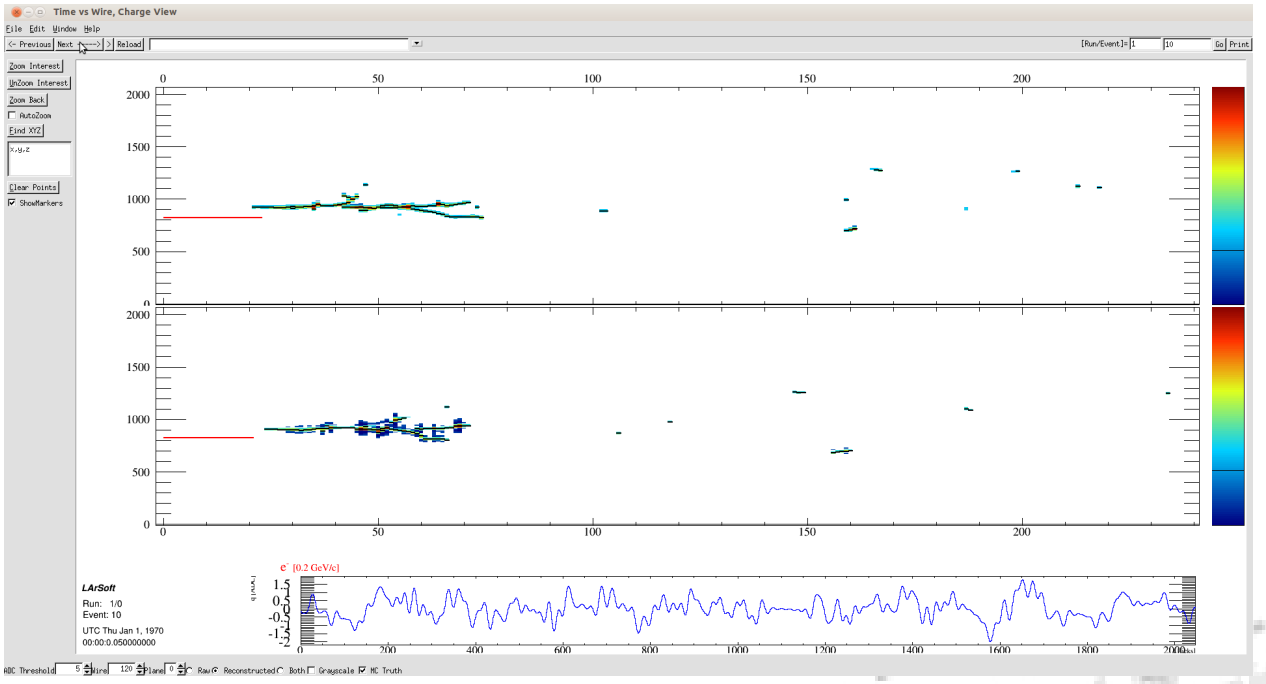
- *Four energies considered: 0.25±0.15 GeV, 0.50±0.15 GeV, 0.75±0.15 GeV, 1.00±0.15 GeV.*

- *For each energy, 300 electrons starting OUTSIDE the cryostat have been simulated.*

- *The simulation has been done twice: with and without the presence of a ~1 X_0 pre-shower disk.*

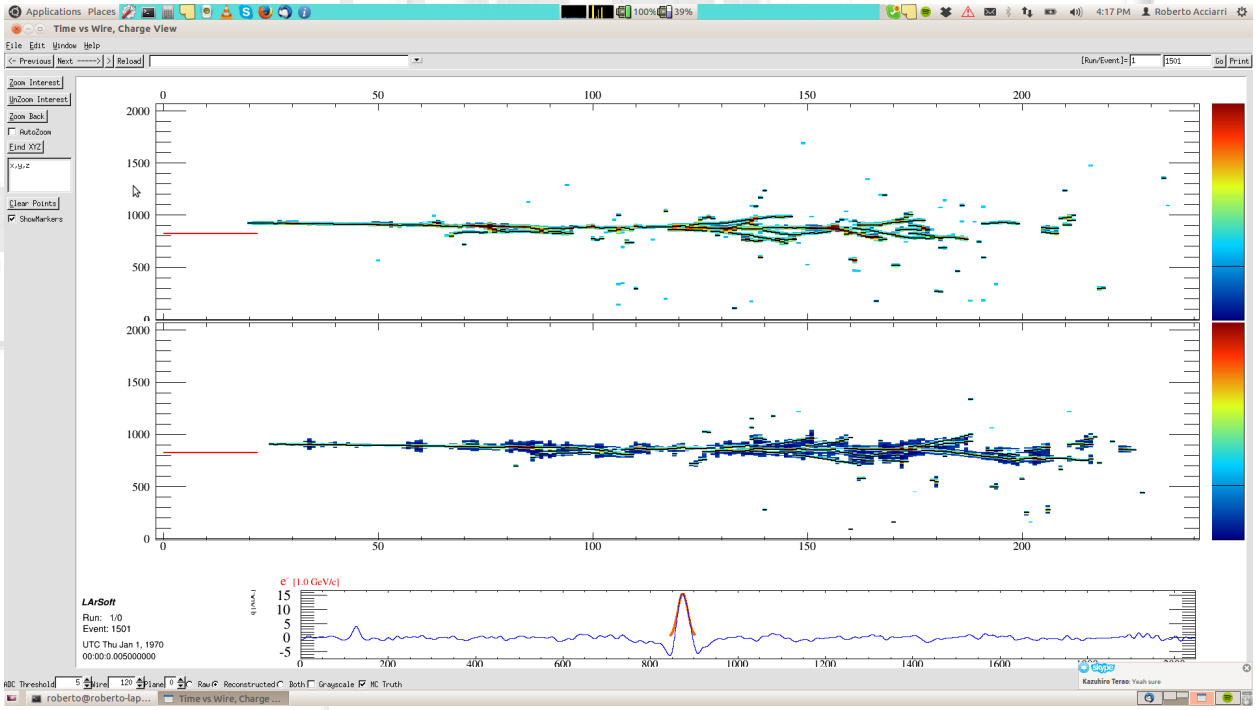
In total, 1200 electrons with energies ranging from 0 to ~1.4 GeV have been simulated both with and without the presence of a pre-shower disk.

Ben Carls Fuzzy Cluster has been applied to the simulated events and plots of # clusters VS initial energy, energy deposited/lost VS initial energy produced…

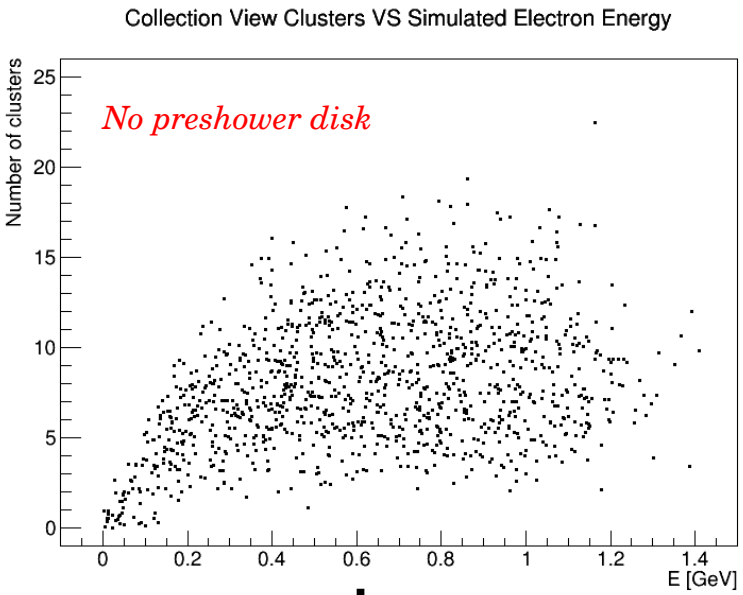


200 MeV electron

1 GeV electron

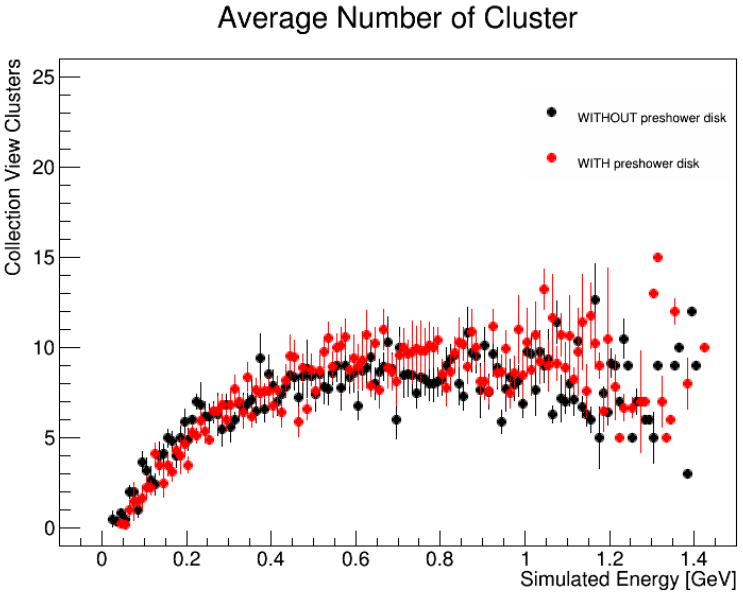


Number of Cluster VS Simulated Electron Energy

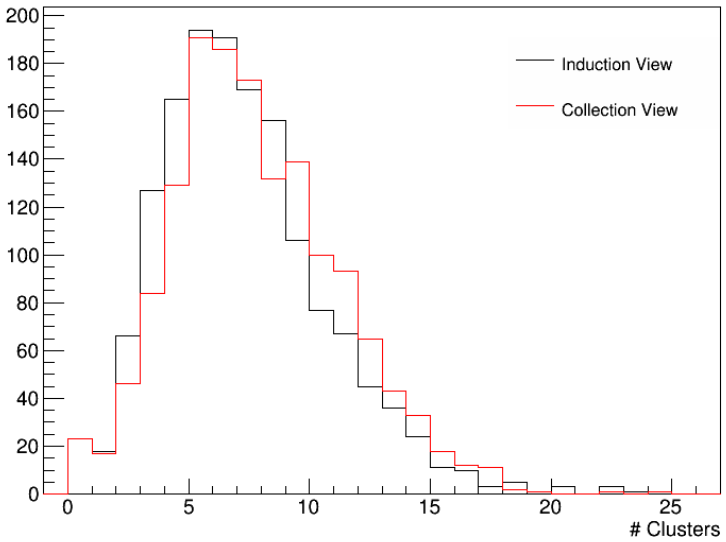


Profile

Histogram



Projection onto Y axis



Both in induction and collection view, both with and without preshower disk, the e-m shower generated by an electron is broken into several small clusters (on average, about 8 clusters).

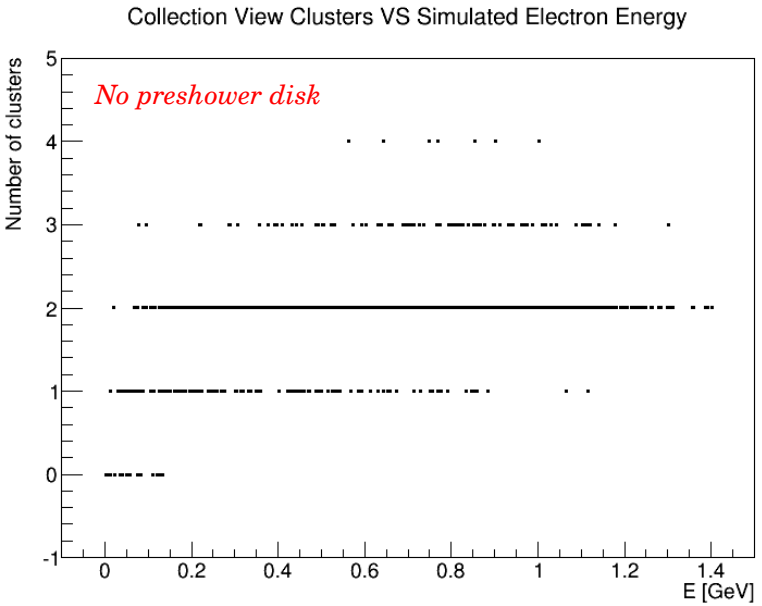
Energy reconstruction from such clusters would be really hard and affected by a large uncertainty.

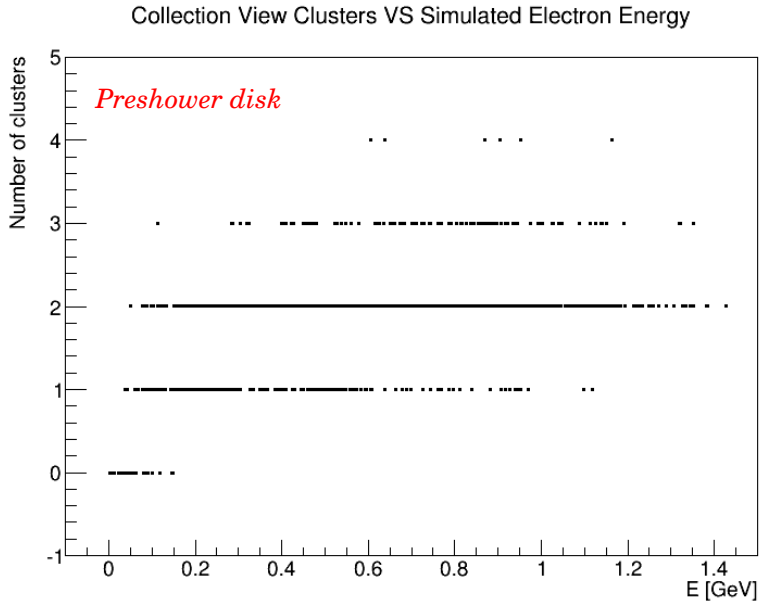
Some Remarks...

✔ *This clustering algorithm is developed for Microboone, with the idea to reconstruct multiple particles present in nu interactions (as opposite from LArIAT, where we expect ~ 1 particle at a time in the detector).*

✔ *This study aims at investigate whether we can tune the parameters of the existing Microboone algorithms to make them suitable to LArIAT, or whether we need to develop our own for LArIAT's case of single particle tracking.*

Solution #1: Fuzzy Cluster Tweak

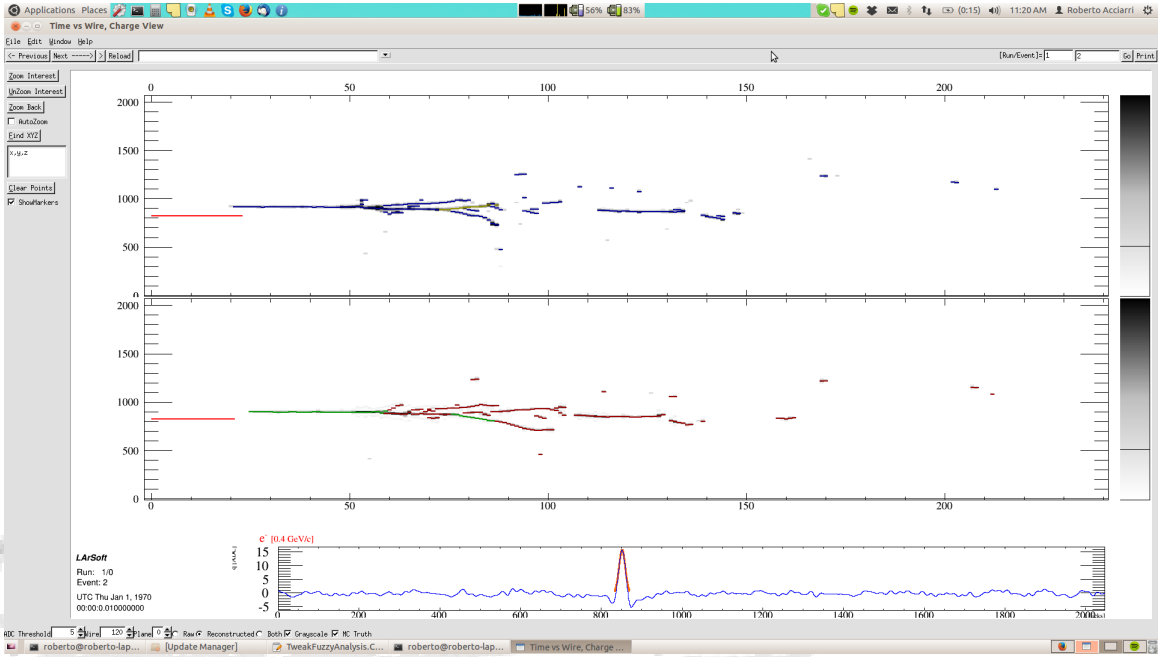


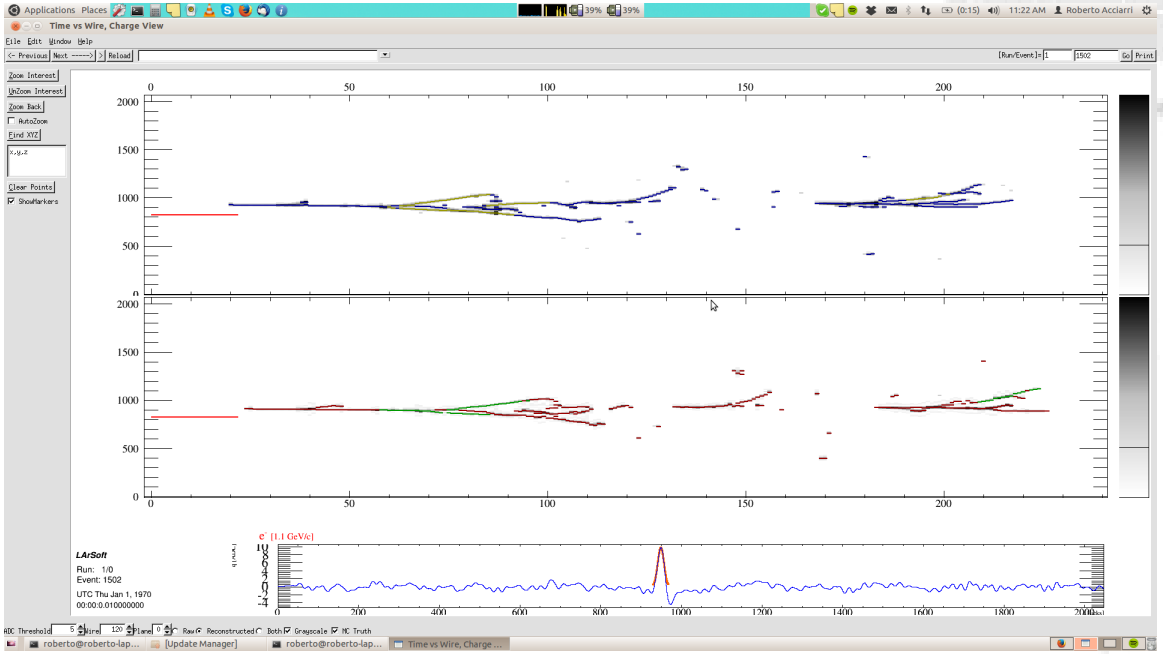


- ✔ *Change Fuzzy Cluster parameters (max clustering angle, distance between clusters..) to merge everything in one single cluster.*
- ✔ *Quite an improvement, but not there yet. Especially because the clustering becomes "random" (see next slide).*
- ✔ *Speaking about with Ben C: "Fuzzy cluster is made to break up things. DB Cluster would work better in your case" (cit).*

Solution #1: Fuzzy Cluster Tweak

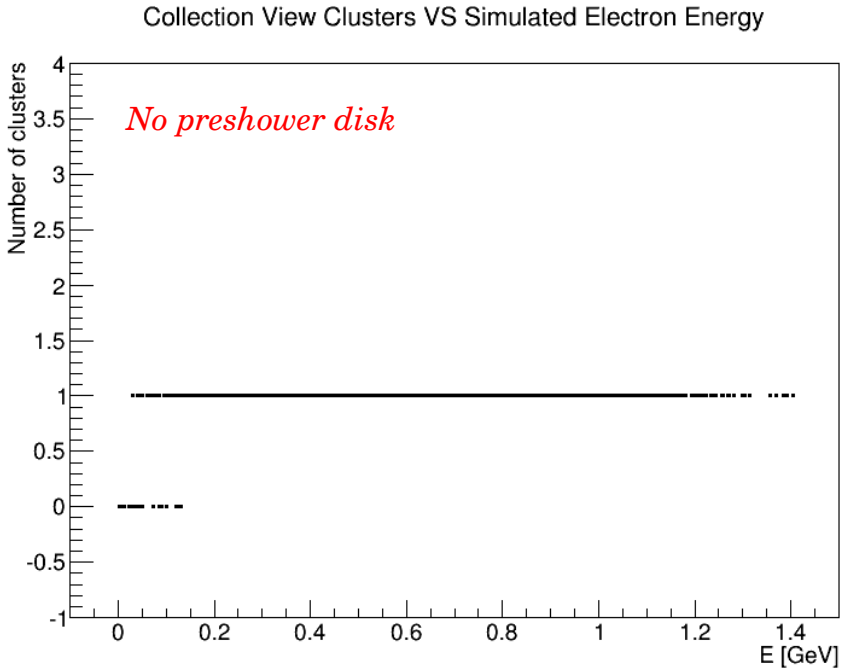
400 MeV electron





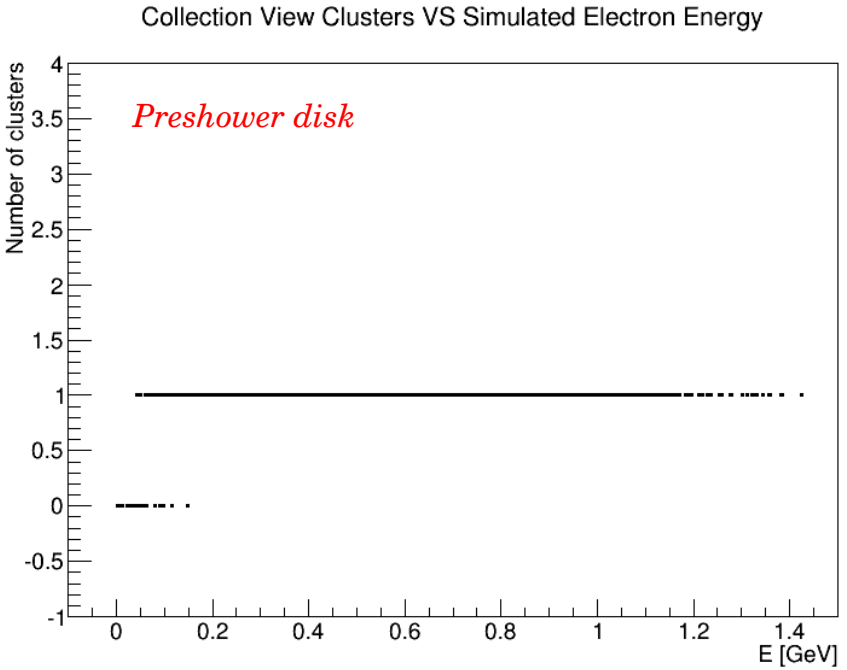
1.1 GeV electron

Solution #2: DB Cluster Tweak



✔ *Change DB Cluster parameters to merge everything in one single cluster.*

✔ *Works! No need to create a specific LArIAT clustering algorithm (yet).*



✔ *DB Cluster slow (but can be made fast enough for our purposes)*

✔ *Cluster merging can be done at shower reconstruction level.*

✔ *Decide whether go to shower reconstruction with one cluster per view or not.*

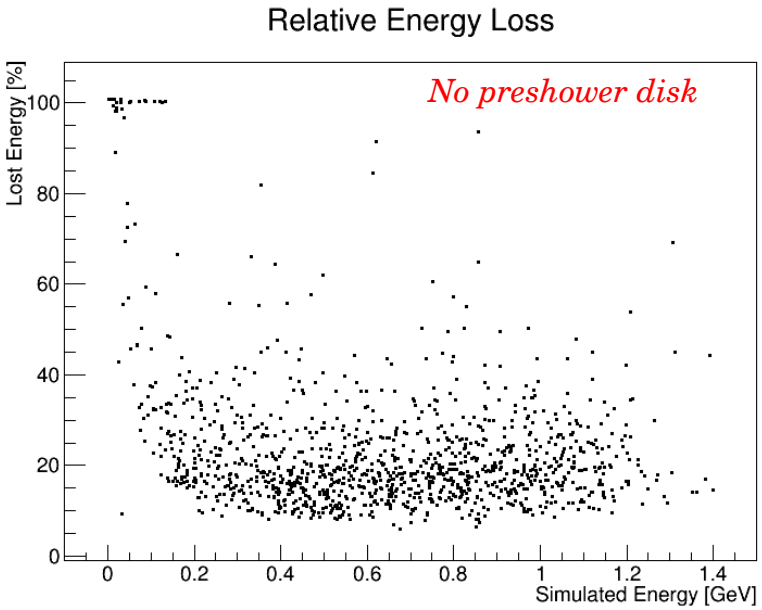
From Clustering to Energy Containment

✔ *Once found a (some) clustering algorithm suitable for LArIAT electron events, we need to test its (their) performance.*

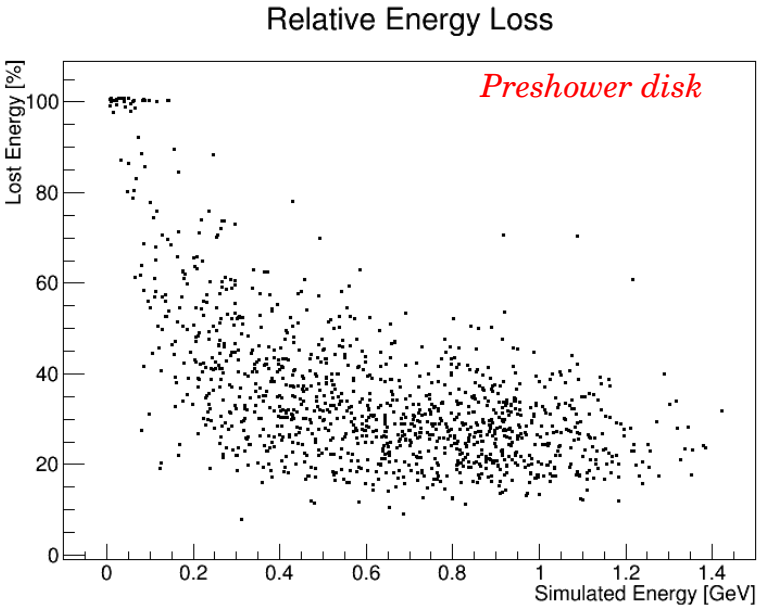
✔ *That is, determine what fraction of the electron energy deposited in the TPC is successfully reconstructed.*

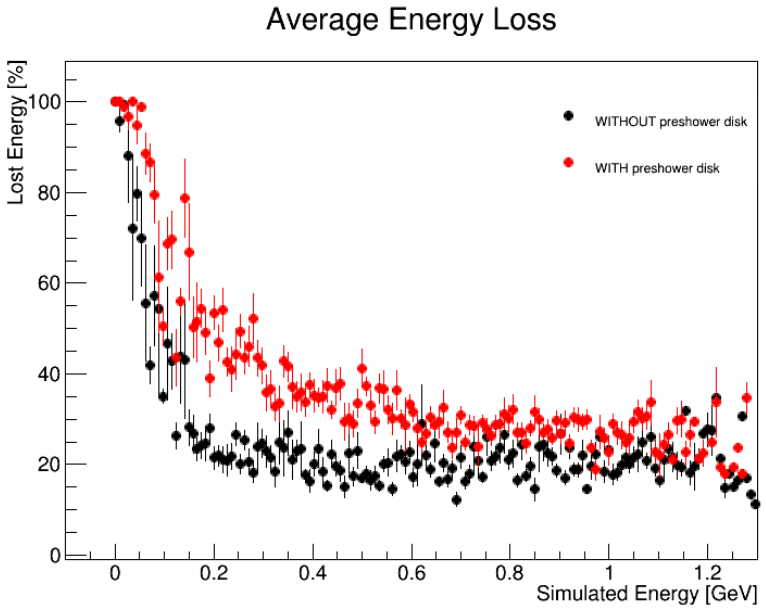
✔ *To be able to do this, we first need to know how much of the electron shower energy (MC Truth) is contained in the TPC, as a function of the electron initial energy.*

Energy Lost VS Simulated Electron Energy



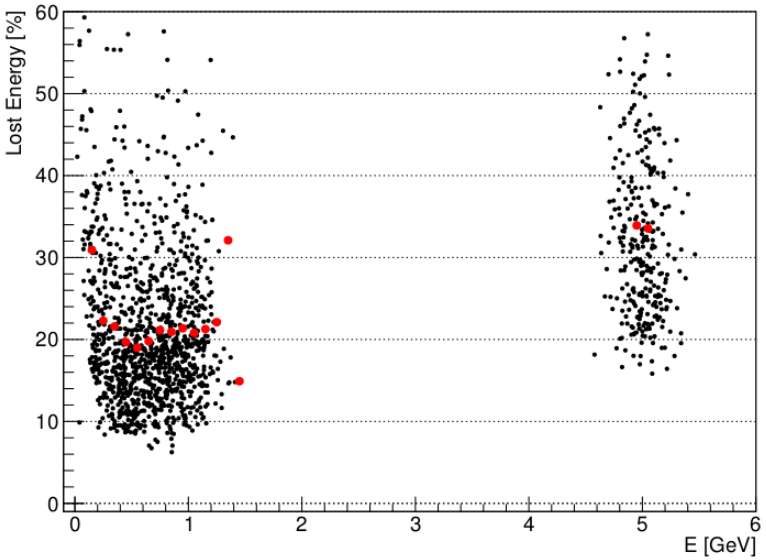
- ✔ *Energy lost both upstream and downstream the TPC.*
- ✔ *Bunch of events at 100% E Loss gives an indication of the amount of energy lost before entering the TPC.*
- ✔ *Flat part for E>0.5 GeV suggests events may be largely contained.*



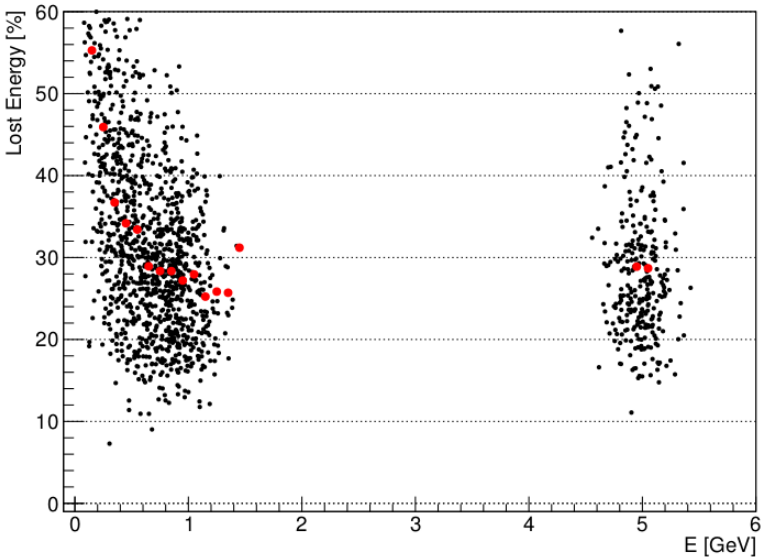


Energy Lost VS Simulated Electron Energy: Cross Check 1

No preshower disk



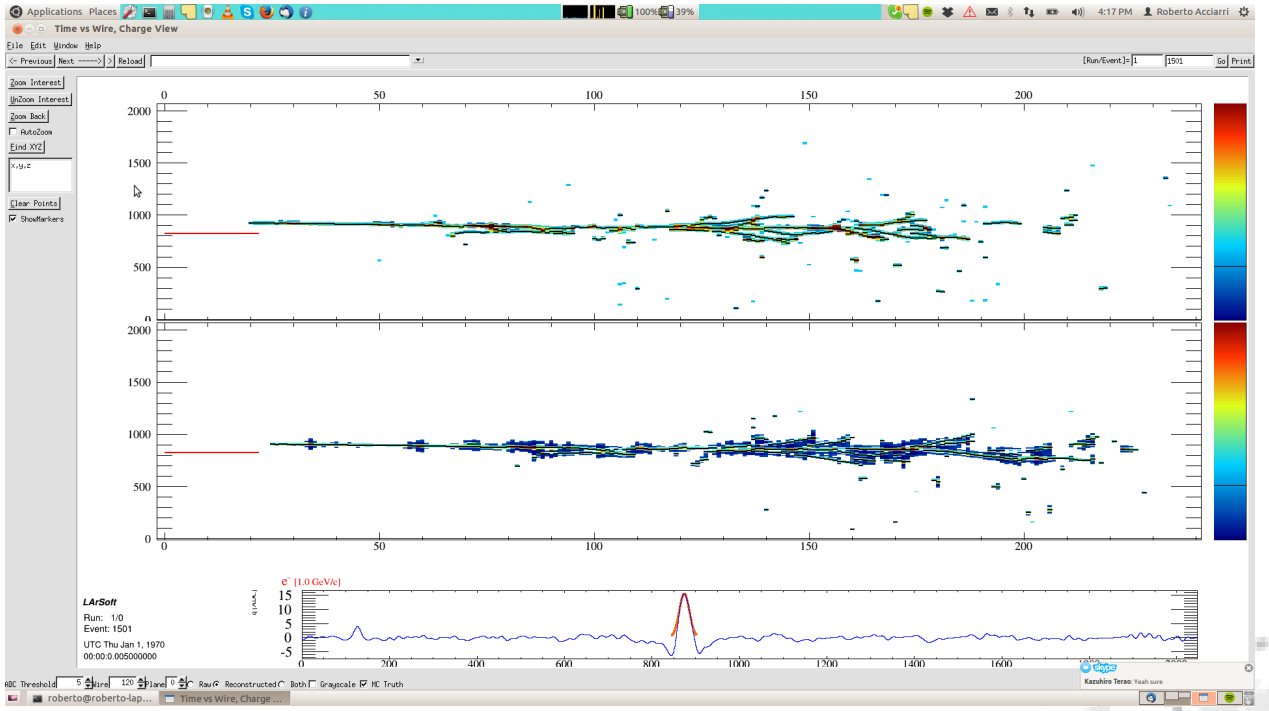
Preshower disk



✔ *300 5 GeV electron events have been simulated both with and without preshower disk.*

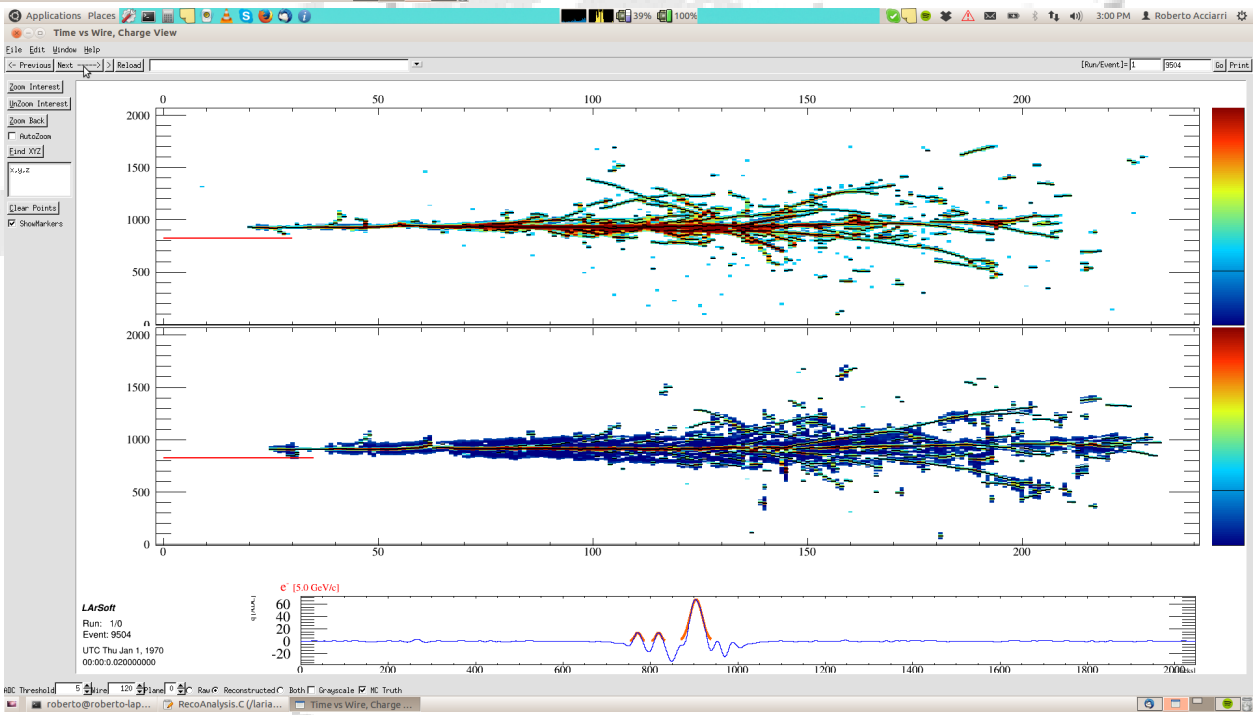
✔ *Check whether the flat trend on the energy loss is due to particle containment or to a bug in the analysis code.*

✔ *Average energy loss for 5 GeV events higher than for 1 GeV. We can therefore assume we have some degree of containment for 1 GeV electrons.*

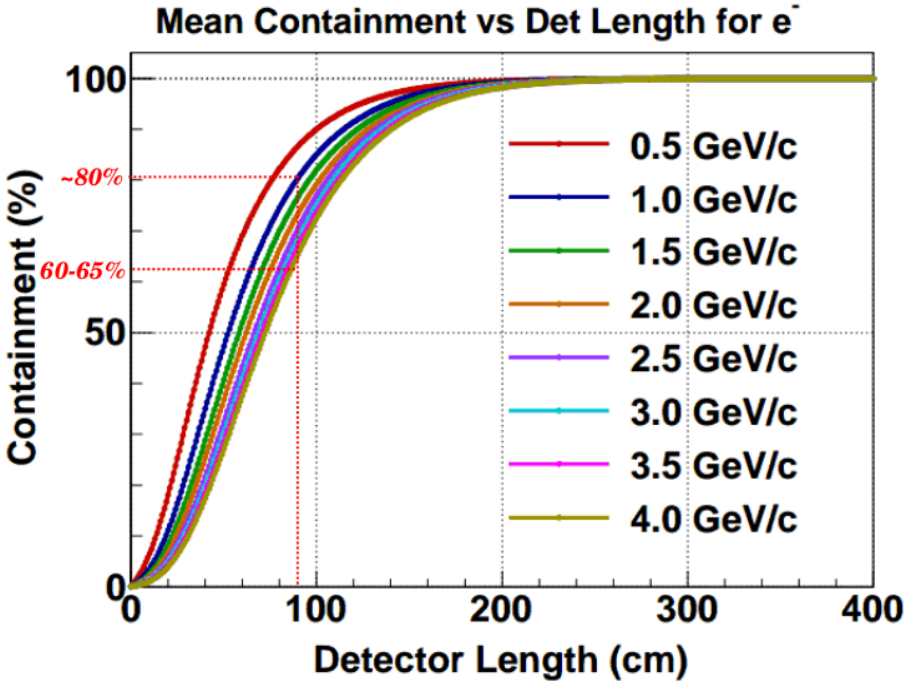


1 GeV electron

5 GeV electron



Energy Lost VS Simulated Electron Energy: Cross Check 2



✔ *~20-22% energy lost @ 1 GeV and ~33-35% energy lost @ 5 GeV.*

✔ *Good agreement (for a qualitative check).*

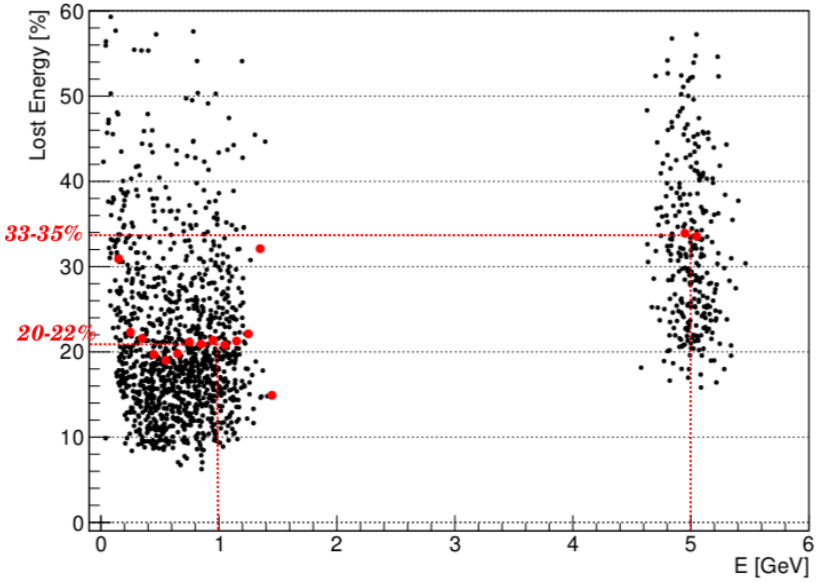
✔ *"Flat trend" in the 0.5-1 GeV range given by the small size of containment changes with E.*

✔ *Plot of e- containment from a study by Junting Huang on 2012 (docDB 847-v3).*

✔ *Particles start INSIDE the LAr volume – energy lost upstream the TPC is not considered.*

✔ *~80% containment @ 1 GeV and ~60-65% containment @ 5 GeV.*

No preshower disk



Final Remarks: Clustering Algorithms

Identified a clustering algorithm potentially suitable for energy reconstruction.

BUT

Simulation done using warm ArgoNeuT electronics: noise level in LArIAT will likely be quite different.

- ***Need to implement in the simulation a reliable noise and electronic response.***
- ***A re-test of the clustering algorithms with the new simulation (when available) may be necessary.***
- ***Additional clustering algorithms may be considered.***

Final Remarks: Energy

✔ *Energy studies shown here are based on MC Truth: not affected by the electronic.*

✔ *Determined the fraction of electron shower energy contained in LArIAT, as a function of electron energy.*

✔ *There are indications minimum energy lost by electrons before entering the TPC is of the order of few tens of MeV.*

✔ *The next step in the chain – shower reconstruction – has been put in hold for some issues found adapting the 3 wire planes Microboone version to a LArIAT-friendly 2 wire planes version. Issues are mostly solved and soon it will be possible to proceed to the next steps:*

➢ ***Look at the reconstructed energy VS MC true contained energy to define the performance of the clustering algorithm.***

➢ ***Define whether or not different algorithms are needed at different energies.***

Thank You!!!