

PFA Studies:
Reconstruction of the charged
energy

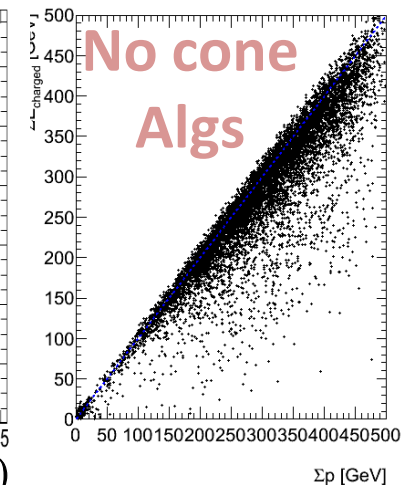
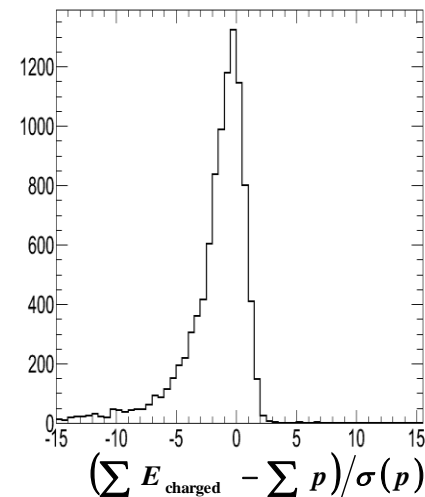
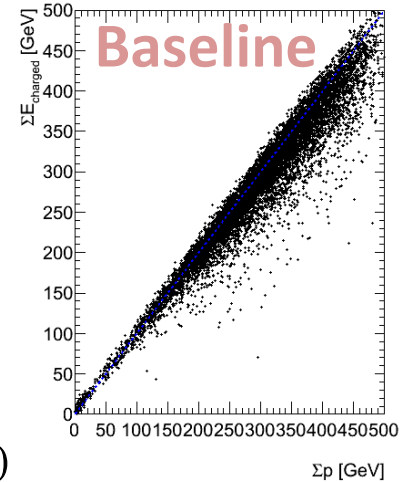
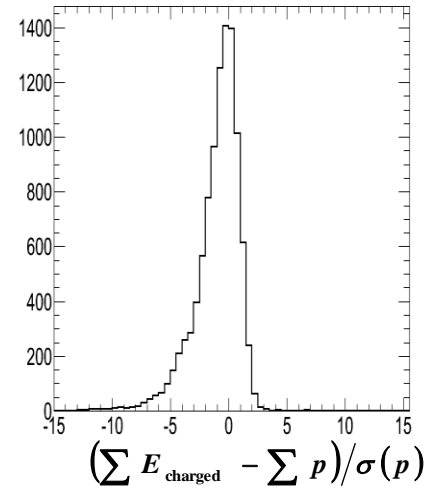
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Introduction

- The idea:
 - Factorize the study of the PFA performance.
 - Start by studying the performance of the PFA on events with purely charged energy.
- The implementation:
 - Wrote a hit filter which remove hits generated by neutral particles (photons and hadrons).
 - The reconstruction then runs on the filtered hit container.
- The studies:
 - Look at Energy/Momentum balance at event level.
 - Look at a random selection of event displays (~100 events) and identify common features.
 - Study in particular the cone algorithms (first and second) and the “jet” merging.

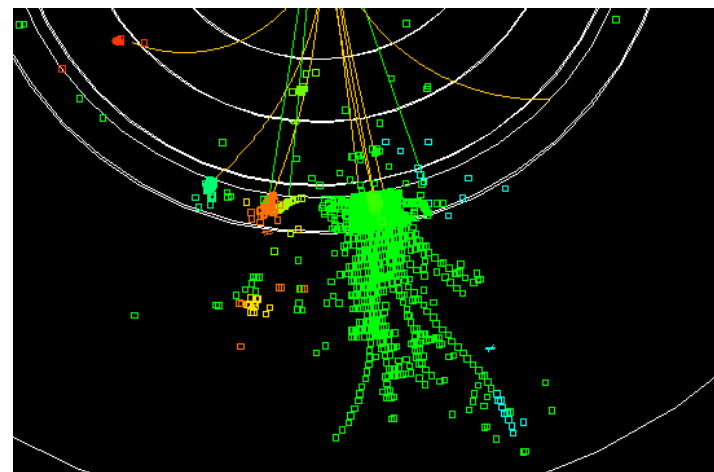
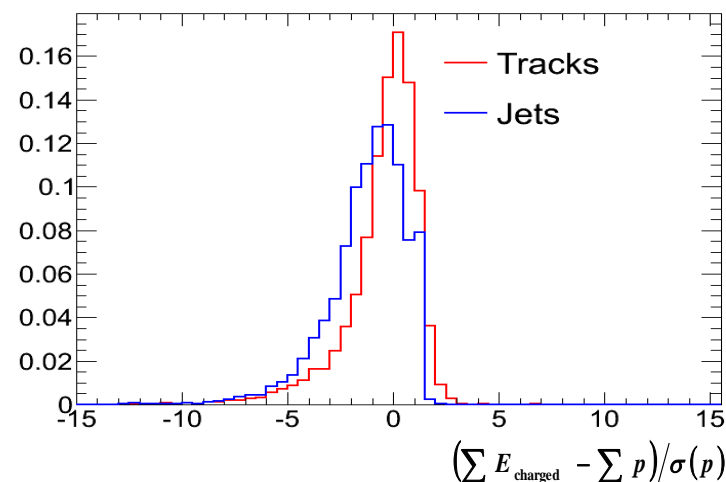
Event energy reconstruction

- Compare total momentum to total reconstructed charged shower energy:
 - Would expect in the ideal case to have same distribution except for calorimeter resolution.
- Reconstructed energy is systematically lower:
 - Charged \rightarrow Neutral confusion.
 - Leakage.
 - Worse when not applying the cone algorithms.



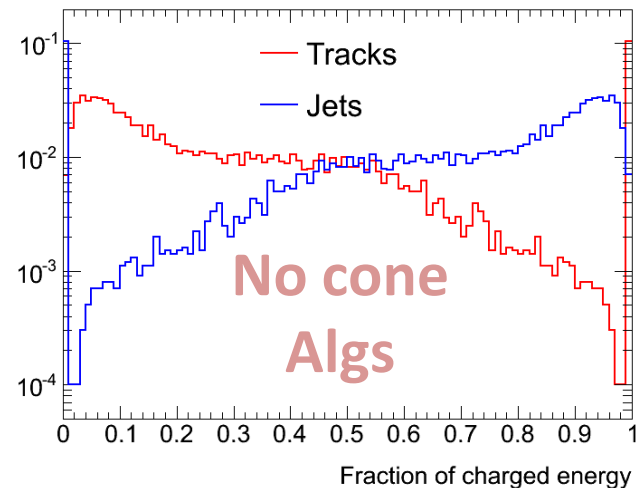
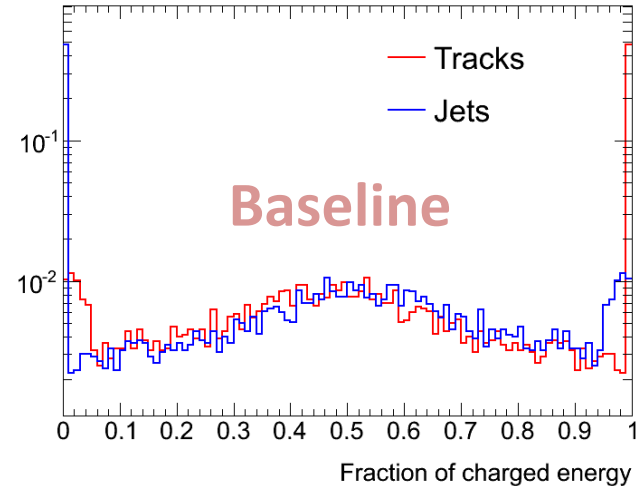
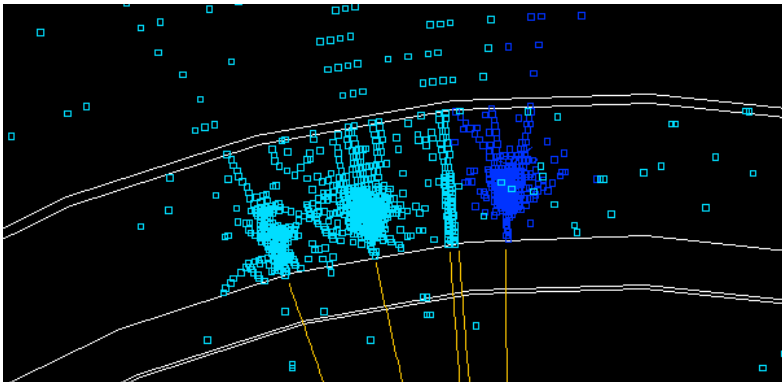
Jet Merging

- Tracks that are close enough so that the shower pieces overlap, are merged into “Jets”:
 - “Jets” are almost always associated with mistakes.
 - Left-over pieces gets reconstructed as neutral particles.
- The causes that lead to jet merging are not always proximity of the tracks!



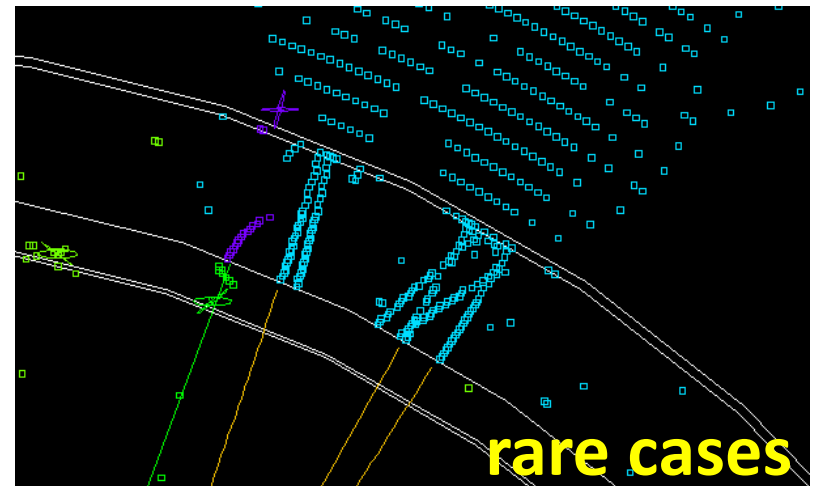
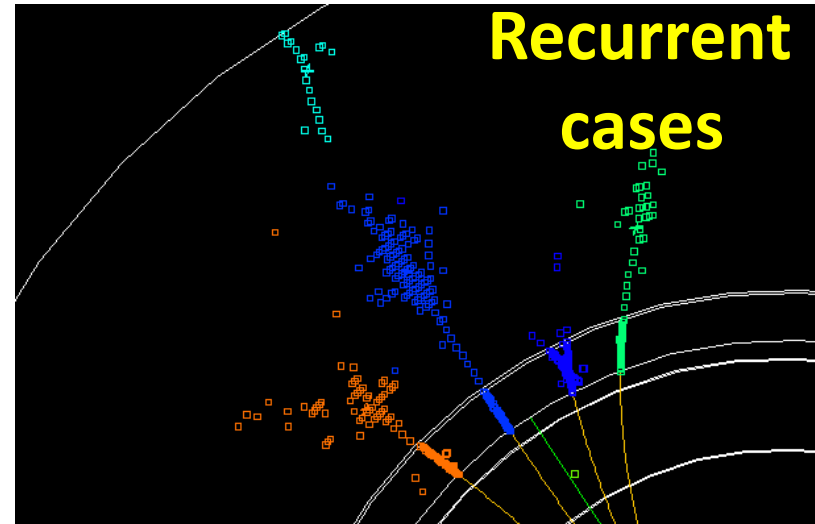
Jet Merging vs First Cone Alg.

- When turning off the first cone algorithm, “Jet” merging is almost the rule!!
- Most common cause: Tracks that start their shower very early in the Ecal have very short seeds (< 4 hits)
 - ➔ Score calculation to link a cluster to the seed is affected
 - ➔ The PFA find a track with too low energy and tries to fix by merging it with nearby tracks
- **The first cone algorithm updates the score which actually hides this problem!**



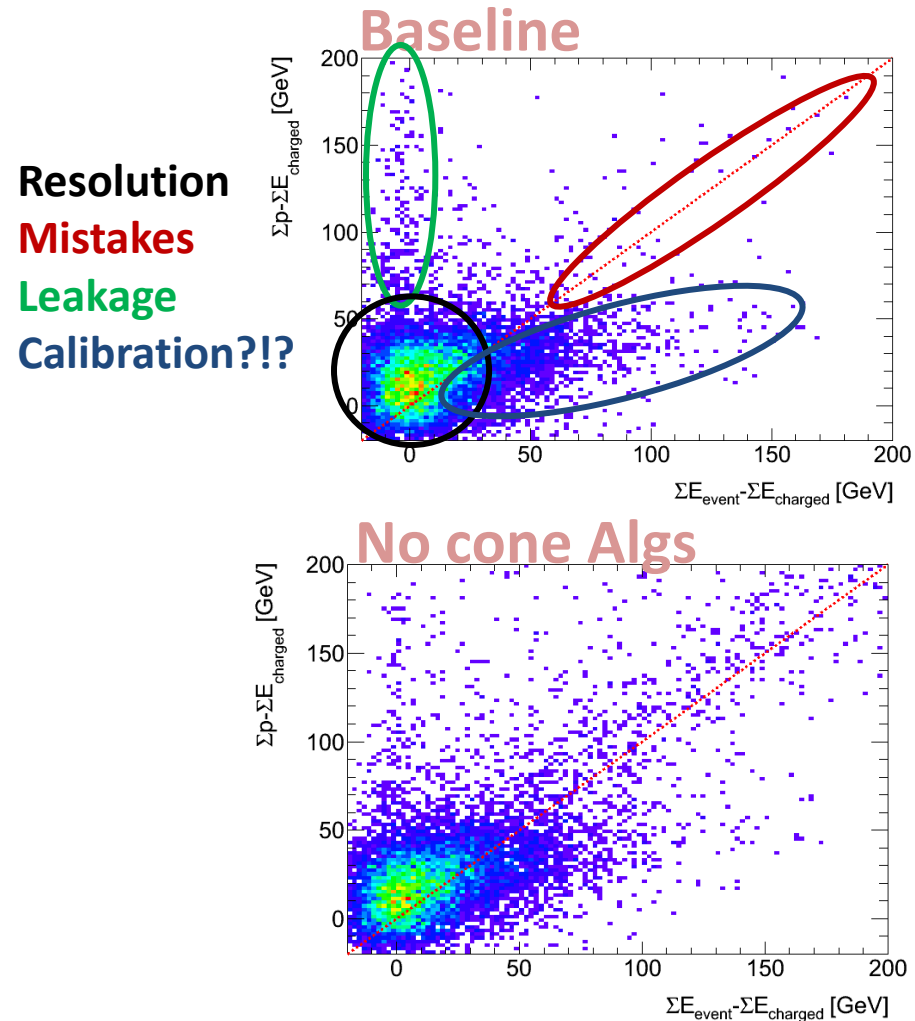
Other mistakes...

- Detached pieces of shower essentially from secondary neutrals:
 - Fixed by the first cone algorithm.
 - This is not the main problem that appear when we turn off the cone algorithm!!!
- Tracking failure:
 - Triggers “Jet” merging, probably because the extra energy tend to become more tolerable when merging into a “jet”.
 - Rare cases, not the first thing to try to fix!



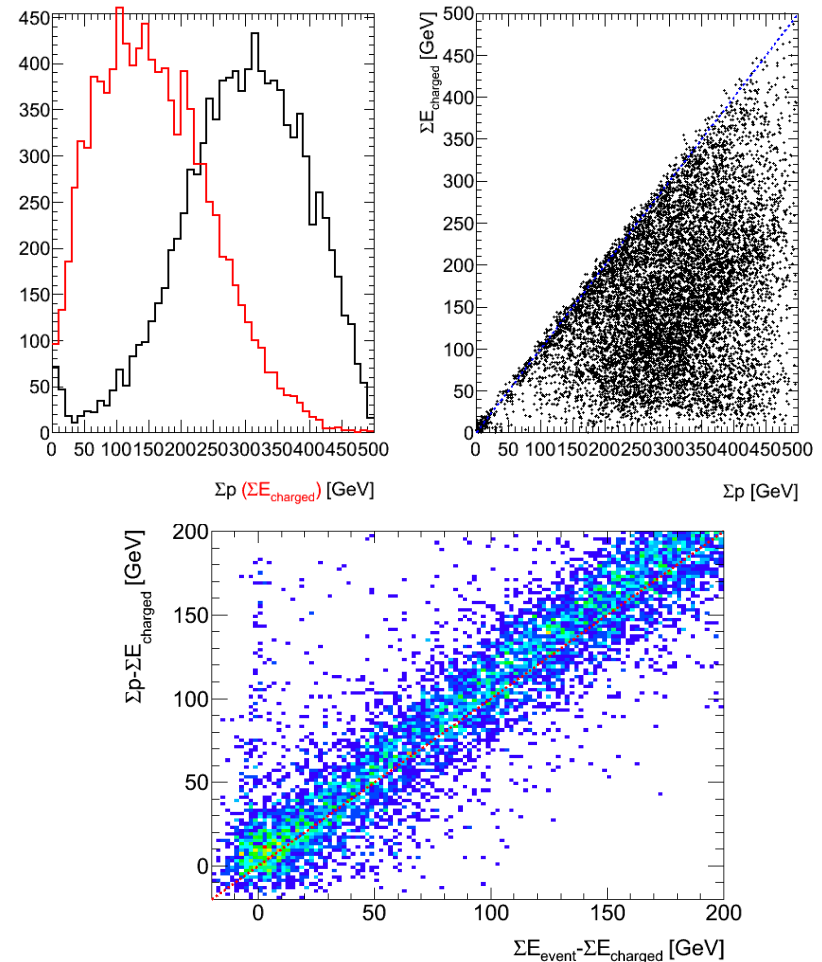
Trying to quantify different effects

- Plot the momentum/charged energy balance vs. total/charged energy balance:
 - Total event energy is computed from hits while charged energy is computed from showers
→ Different calibration!
 - Different components show up in different regions of the plot.



What if we turned off both Cone algorithms and Jet merging?

- Real catastrophe!!!
- This is a problem in my opinion since both the “jet” merging and the cone algorithms were created to fix rather secondary problems!!



Conclusion

- The PFA is doing mistakes even when no neutral energy is present in the event.
- I have spent some time to spot problems and do a diagnostic of the causes.
- Cone Algorithm and Jet merging are hiding (and not fixing) the real problems of the PFA.
- Next step is to start implementing and testing solutions:
 - I am now working of modifying the score calculations for the cases where the seed is too small to have a reliable directional information:
 - The idea is to use track direction at the Ecal entrance instead of the seed direction when the shower point is in the first few layers of the Ecal.