



Pandora PFA : Status report and Plans

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Goals



- **Develop the necessary tools in order to :**
 - Reconstruct electrons, photons, π_0 , jets and study their characteristics (energy and angular resolutions, gamma separation etc.).
 - Make full use of the high granularity of the proposed electromagnetic and hadronic calorimeters.
 - Be in a position to make a first crude full reconstruction chain running by early Spring, and make more details studies in the Summer.



Tools



- Since the proposal is to build a high granularity calorimeter should be focusing on continuing to explore and develop further the Particle Flow Technique.
 - Have a custom made (CMS) PF code with an excellent performance so far. Code very much designed and tuned around current CMS detector. (*There is already ongoing work in CMS to develop it for the upgrade detectors, do not know if timescale matches ours.*)
 - There is large community of experts and expertise developed during the past years on high granularity calorimeters for an LC. Many tools and code developed and tested, one (the best) of which is PandoraPFA.



Pandora PFA



PandoraPFA is a very elaborate reconstruction package using the particle – flow technique / idea. It is developed and maintained by the Cambridge Group (M. Thomson, J. Marshall et al):

<http://www.hep.phy.cam.ac.uk/~thomson/pandoraPFA/>

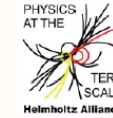
- It is a very well developed and documented package that is widely now used in HEP experiments:
 - CALICE collaboration (Particle flow calorimetry)
 - MicroBOONE (neutrino experiment)
 - ATLAS (internally only, not public yet)
- Since it is a generic software package build for high granularity calorimetry that does not depend or is build around a specific detector technology it is ideal for our purposes.



Pandora PFA : Performance

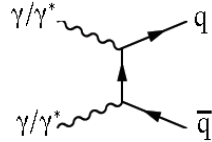


Its not just calorimetry

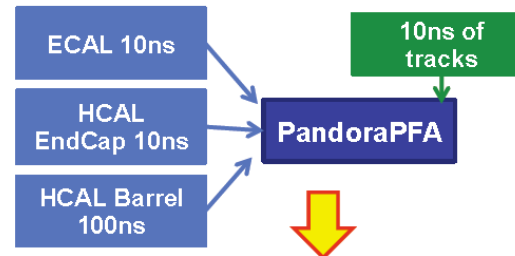


★ Working at **reconstructed particle** level brings other benefits:

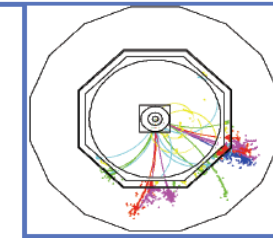
- e.g. at CLIC energies (or ILC at 1 TeV) background from $\gamma\gamma \rightarrow \text{hadrons}$



1. CLIC 3 TeV: input to reconstruction

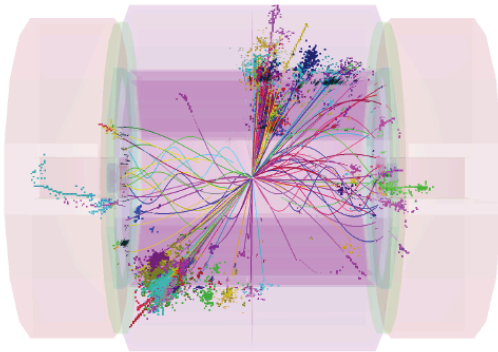


ILC-like energies



Clear separation of W/Z di-jet mass peaks

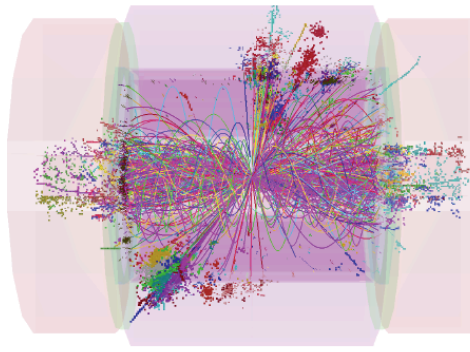
3. Selected particles, total energy 85 GeV



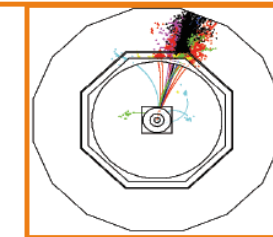
Apply timing cuts to reconstructed particles



2. Reco. particles, total energy 1.2 TeV



CLIC-like energies



W and Z still resolved from monojet invariant mass

- Very powerful tool!!



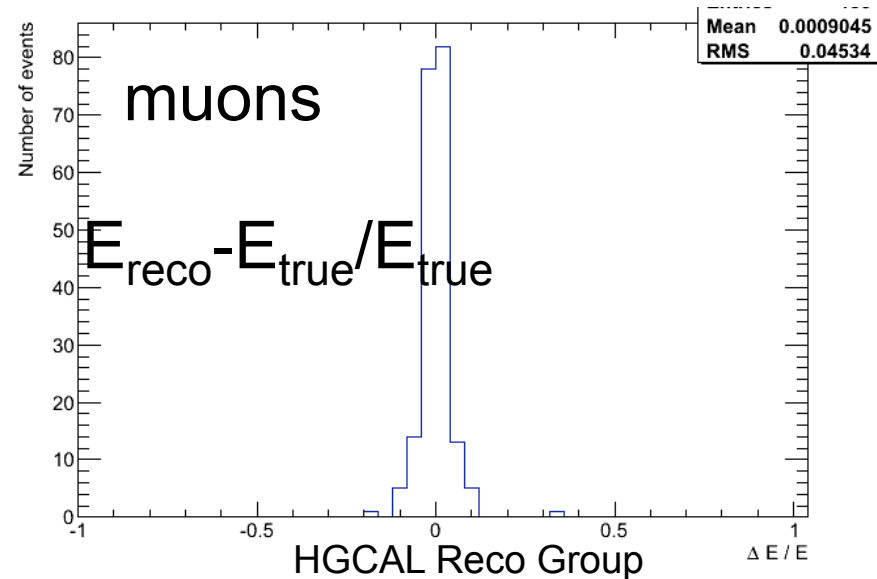
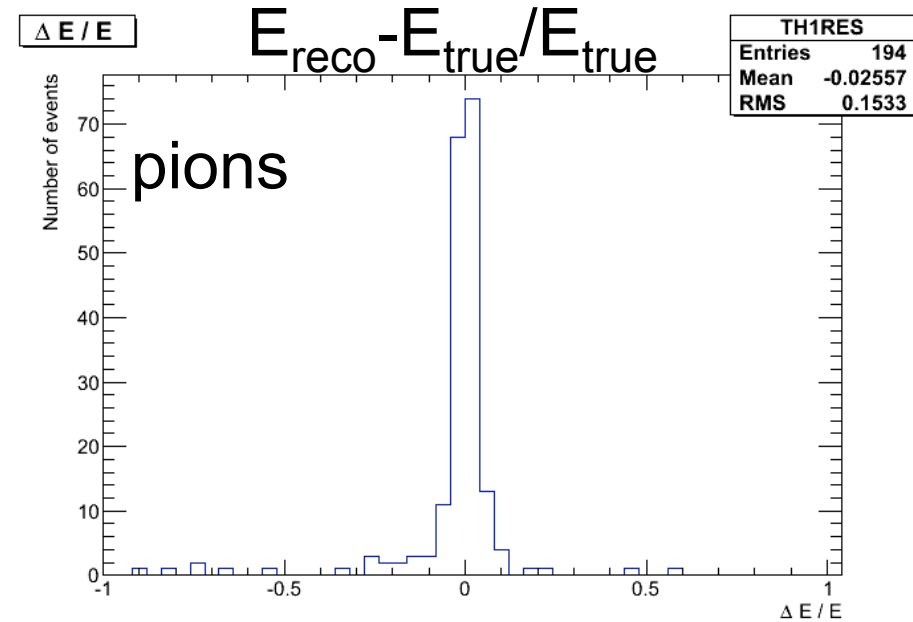
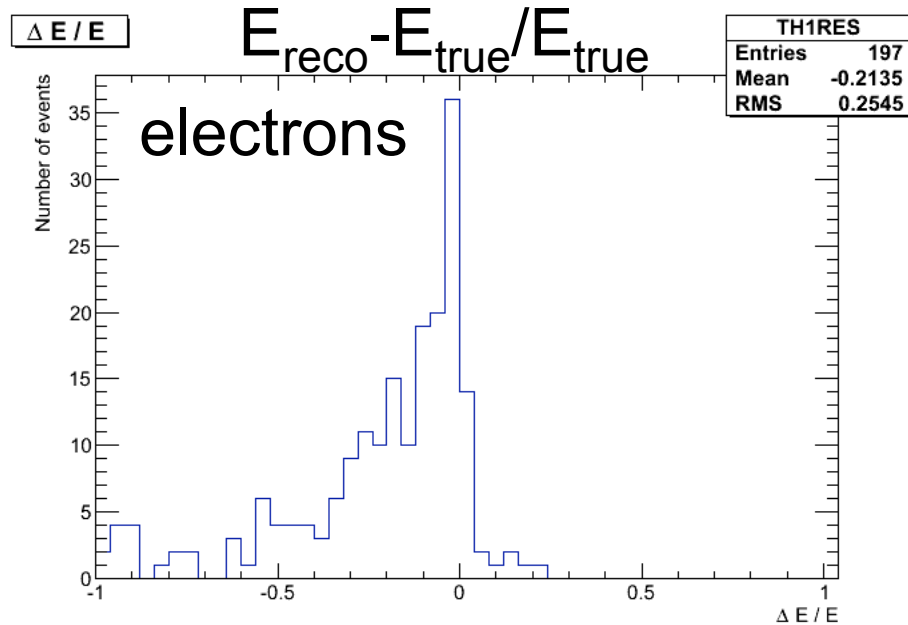
Pandora PFA : Status of our implementation

- Have established a productive communication with Pandora Authors (Mark Thomson and John Marshall). Got very useful examples of Pandora PFA code used for ATLAS and other experiments.
- Have understood what are the needed inputs to Pandora PFA and what the outputs would be, and have also established a clear step-approach.
- Decided, in order to speed up things, to start with the current CMS detector (and not wait until HGCal SIM-DIGI-RECO is in CMSSW) **only to have the technical aspects of the code worked out.**
- **Have a working implementation of Pandora PFA:**
 - Ported to CMSSW with an elaborate Monitoring (Event Display) working as well:
<https://twiki.cern.ch/twiki/bin/view/CMS/PFCaIPandoraAlgorithm>



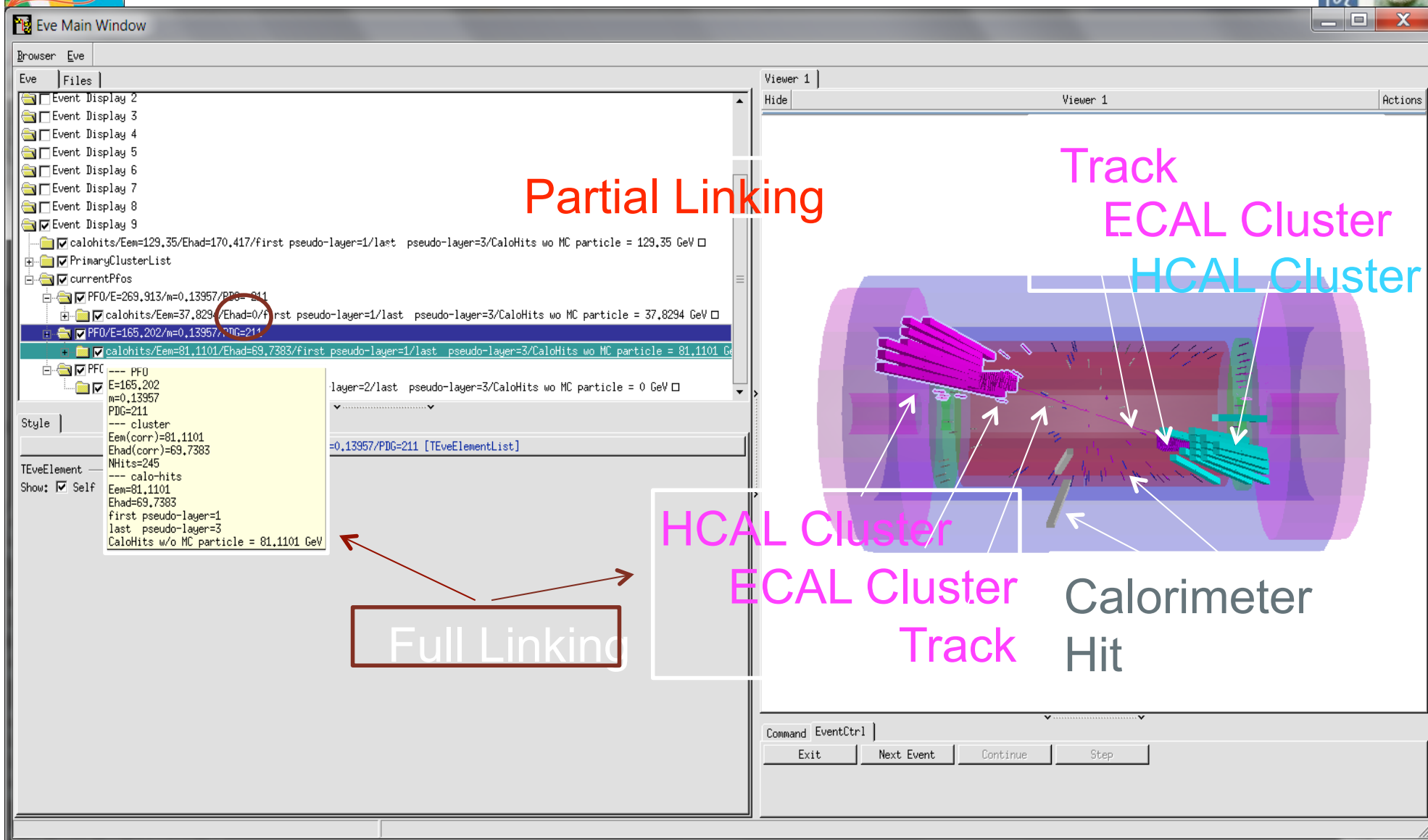
PandoraPFA : First results

- No tuning has been applied, code as it works out of the box!

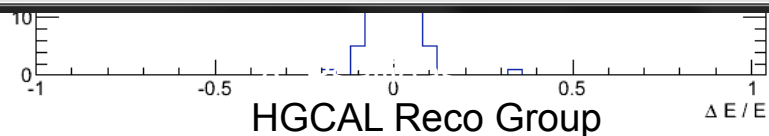




PandoraPFA : First results



HEP 2014
10/05/2014





Pandora PFA : Status so far



- **PandoraPFA is a very elaborate, well documented and widely used PF reconstruction package.**
- **Have successfully implemented PandoraPFA in CMSSW as an external package.**
- **A fully working PandoraPFA version is now available and has been tested with 800 events (muons, electrons, pions) of the current CMS detector, without problems from the technical point of view and with “reasonable” first results.**
- **Have also established a working version of the elaborate Pandora Monitoring within CMSSW and have just began debugging and tuning studies**



Pandora PFA : Ongoing work



- Timeline :
 - Have a full working code (technical aspect) by early Spring (**already done**)
 - Have a well understood-debugged version of the pandoraPFA code **with the current CMS detector by May** with a few pending issues we have already identified figured out.
 - Start performing **physics studies with the HGCAL detector by early Summer : June-July** would be the goal.
- Progress on tuning of the various PandoraPFA algorithms and debugging for the HGCAL detector **will require and depend upon** a full SIM-DIGI-RECO chain in CMSSW. Currently the RECO step is being worked on.
- Could establish synergies between this work and the one happening within the CMS reconstruction group so that we could both benefit.

Thank you!

BACKUP