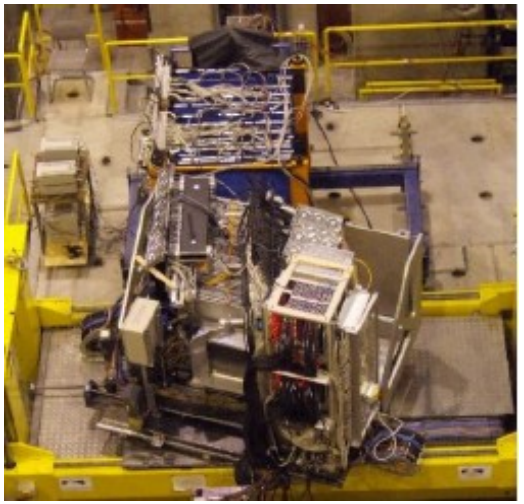
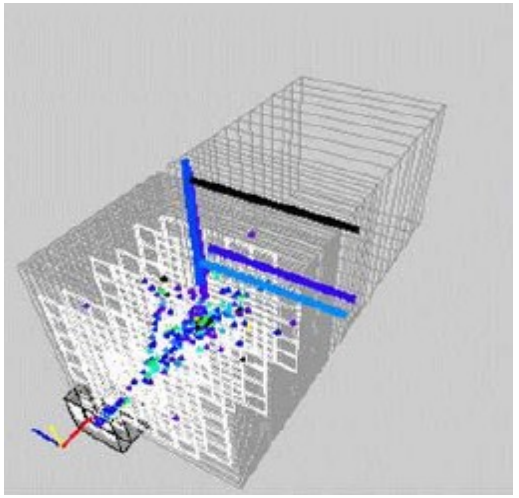
Multiparticle jet simulation with CALICE Testbeam data samples for PandoraPFA analysis

Sergey Morozov DESY, Hamburg





Universität Hamburg

DESY

CALICE Calorimeter for ILC

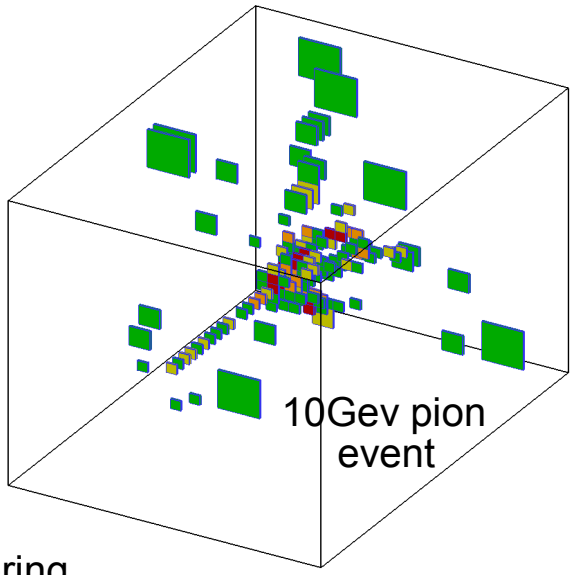
Multiparticle jet simulation

PandoraPFA tests using only 2 overlapped pion data from CALICE testbeam have been done..

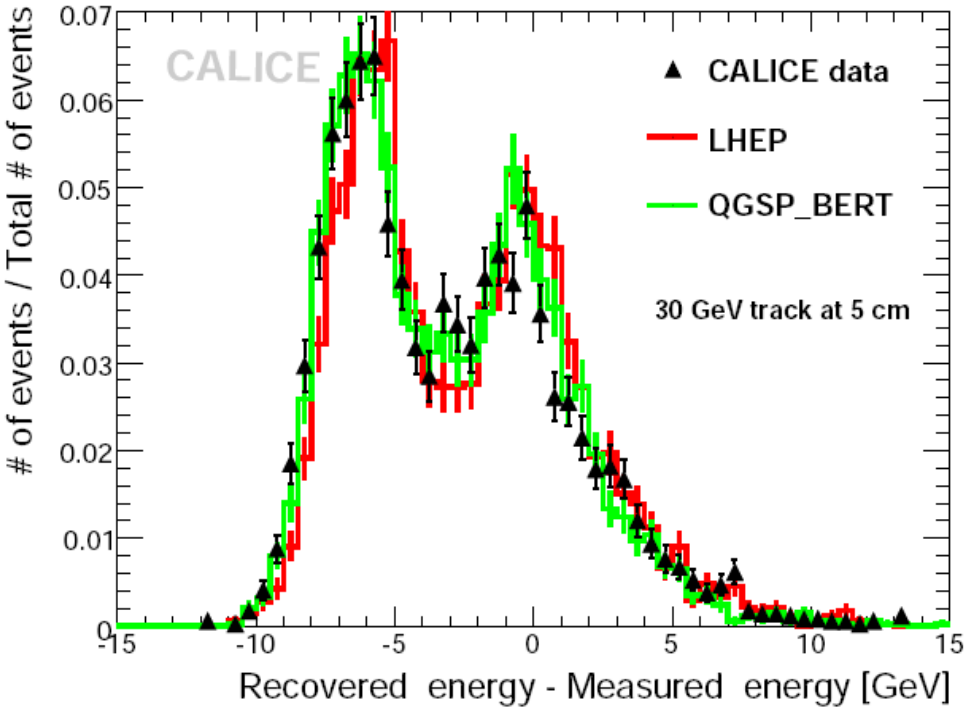
(O.Markin on behave of CALICE collaboration, CAN-24)

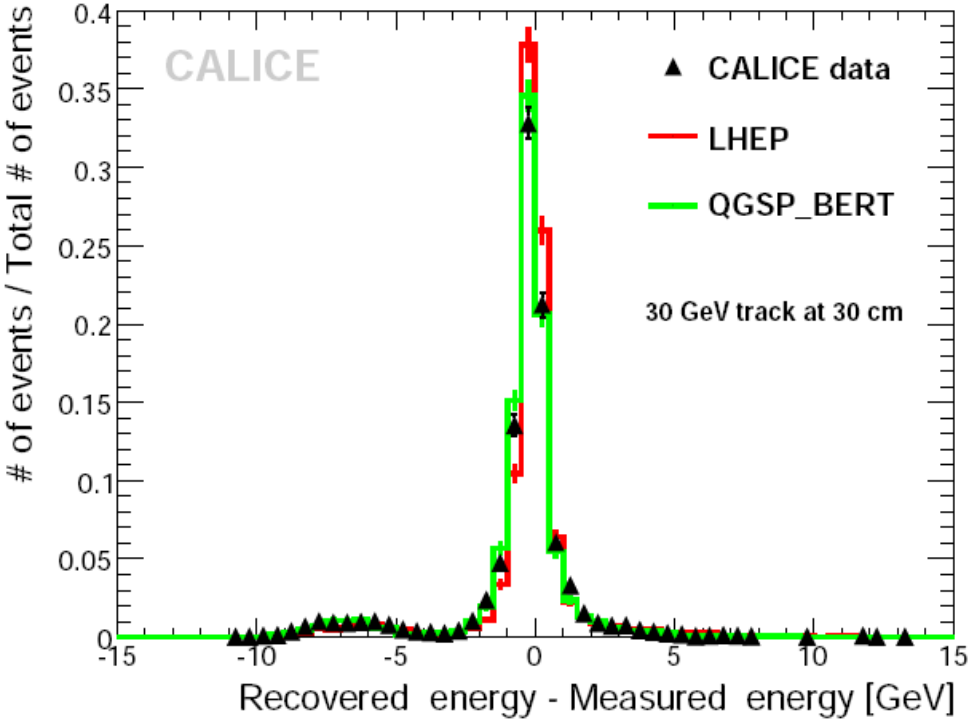
..and show a very good agreement in data and MC!

Can we construct the n-particle jets with testbeam data events?



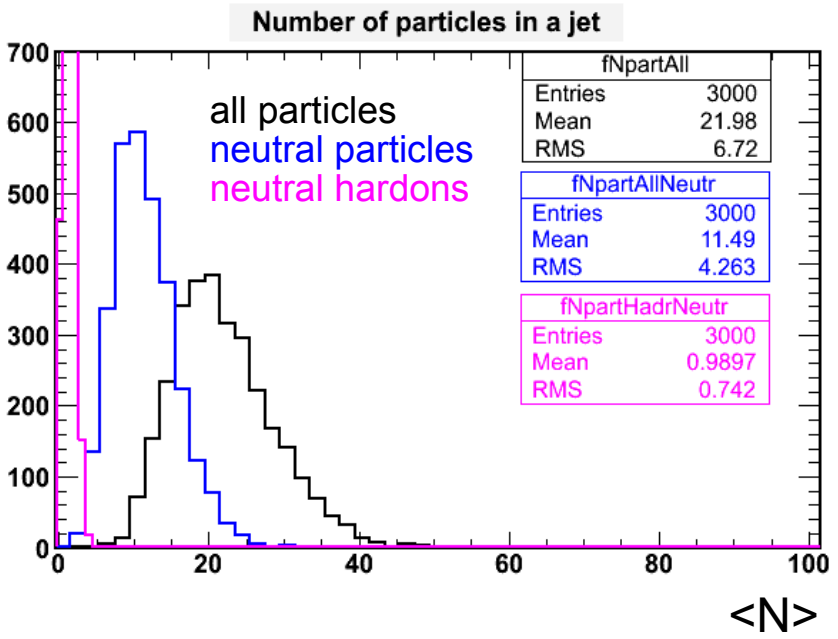
Result for 30 GeV “neutral” shower recovering

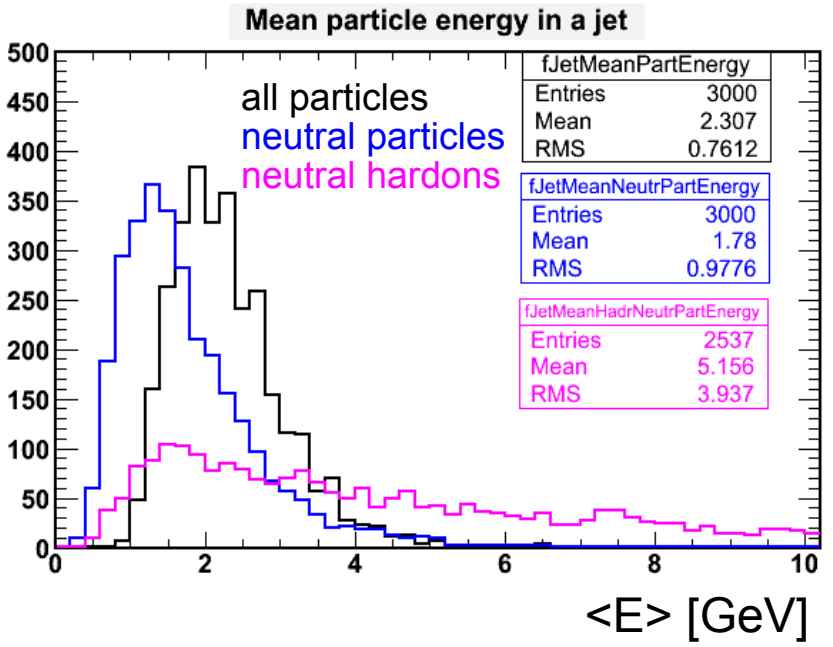


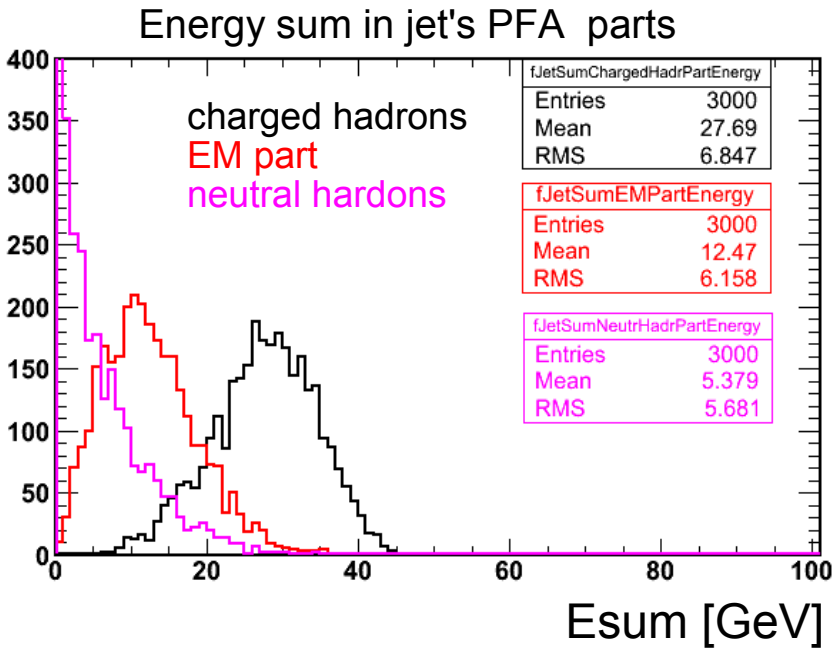


Multiparticle jet simulation

Typical jet composition for Z(91.2GeV) -> uds







Energy sum:

27.69 + 13.47 + 5.38 = 46.54 GeV

59.5% 28.9% 11.6%

(this is consistant with 60%+30%+10%)

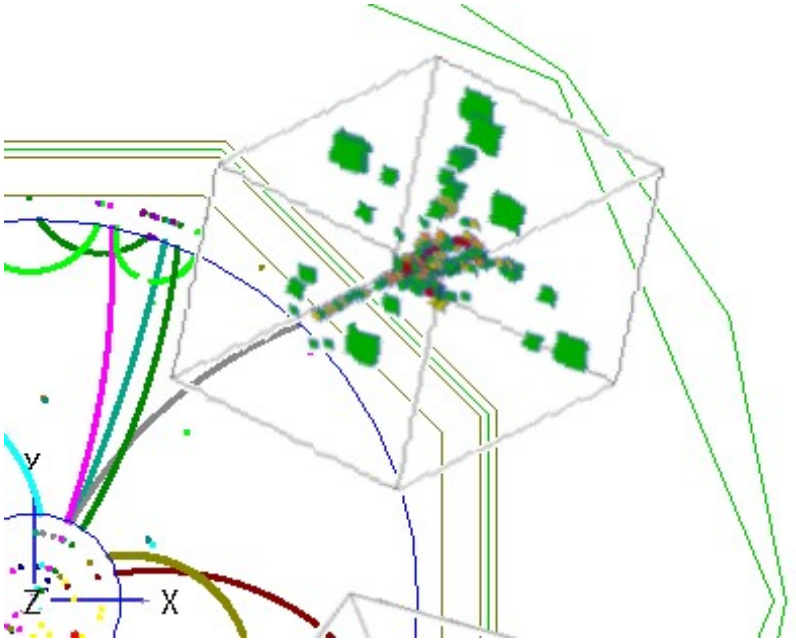
Testbeam data:

- energies 1-80 GeV
- variety of beam compositions

Multiparticle jet simulation

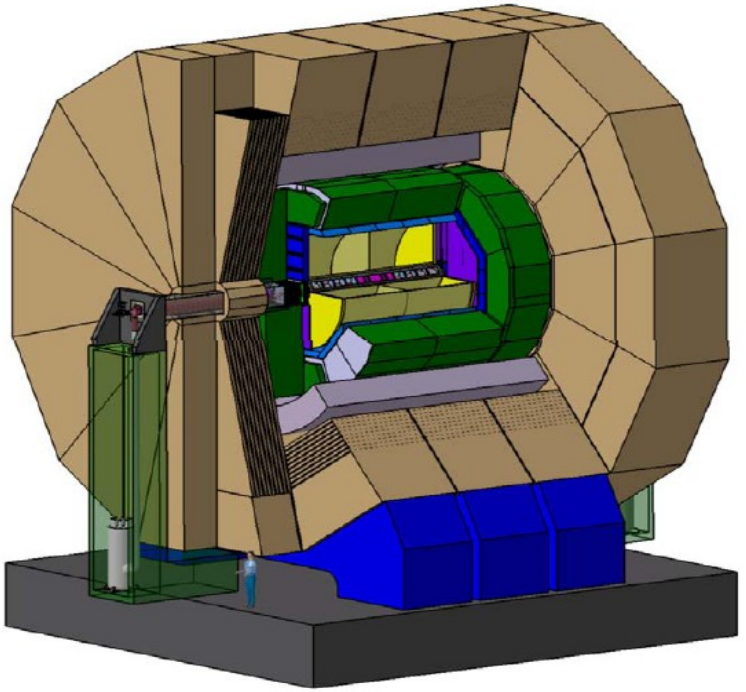
The goal: construct the jet with testbeam data events..

The tool is: EasyJetProcessor.cc

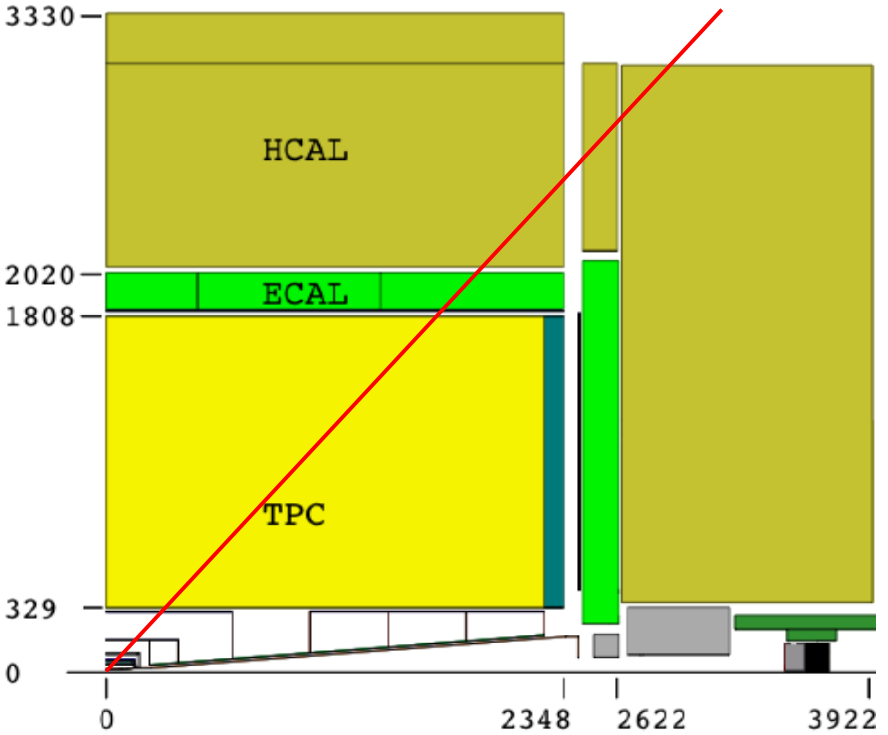


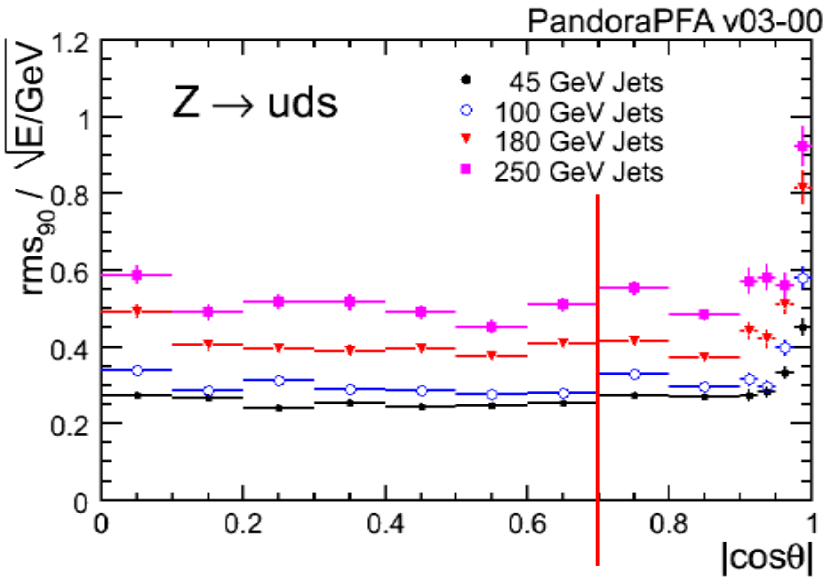
- analyzes the input collections from Mokka (GEANT4) ILD geometry
- finds the primary particle (generatorStatus == 1) “tree” and spot the “very last daughter” ones
- extrapolates the “very last daughter” to the calorimeter entrance and locate the calorimetry entry point (coordinate + momentum)
- removes all SimCalorimeterHits connecting to the “very last daughter” found
- connects prepared *.slcio files from CALICE testbeam data
- overlaps calorimeter hits to ILD geometry

Multiparticle jet simulation



Some simplifications..





$|\cos(\theta)| < 0.7$

- to be sure the particle to replace is crossing the Barrel part of the ECAL-HCAL

CALICEOverlayPreparationProcessor is used for selection of CALICE testbeam events

- makes particle selection for: electrons, pions, protons

- has an alignment applied (reference coordinate system based on beam particles)

- finds primary track and keep the hits in separate collection (very useful for neutral particle event simulation and overlapping)

In this talk files have been generated from CALICEOverlayPreparationProcessor:

electr010_330777_01.slcio (electromagnetic particles: e+ e- gamma)

pionmi010_330777.slcio (hadron light: pions, kaons..)
pionmi012_330849.slcio
pionmi015_330848.slcio
pionmi018_330773.slcio
pionmi020_330797.slcio
pionmi025_330796.slcio

proton030_331298.slcio (hadron heavy: protons, neutrons)
proton040_331339.slcio
proton050_331337.slcio

More files generated => more precisely the jet will be simulated..

Limitations and simplifications of CALICE testbeam event overlapping:

1) not all particles in Mokka is re-placed with CALICE testbeam data samples
   - limited energies (in this talk 10GeV minimum) => energy cut (Ecut) has been applied
   - discreet energy spectrum in testbeam (10,12,15..) => re-scaling of hit energies applied
   Examples (Ecut = 10GeV):

   Calorimeter Entry Particle Energy: 4.5 GeV =>
   energy < Ecut, just keep the MC hits from this particle for PandoraPFA

   Calorimeter Entry Particle Energy: 11.2 GeV =>
   10GeV testbeam event and apply 1.12 correction for all hits

2) neutral particle is re-placed with a charged CALICE testbeam event "–" hits from a track found and the rest hits in "neutral" shower is corrected to compensate the energy

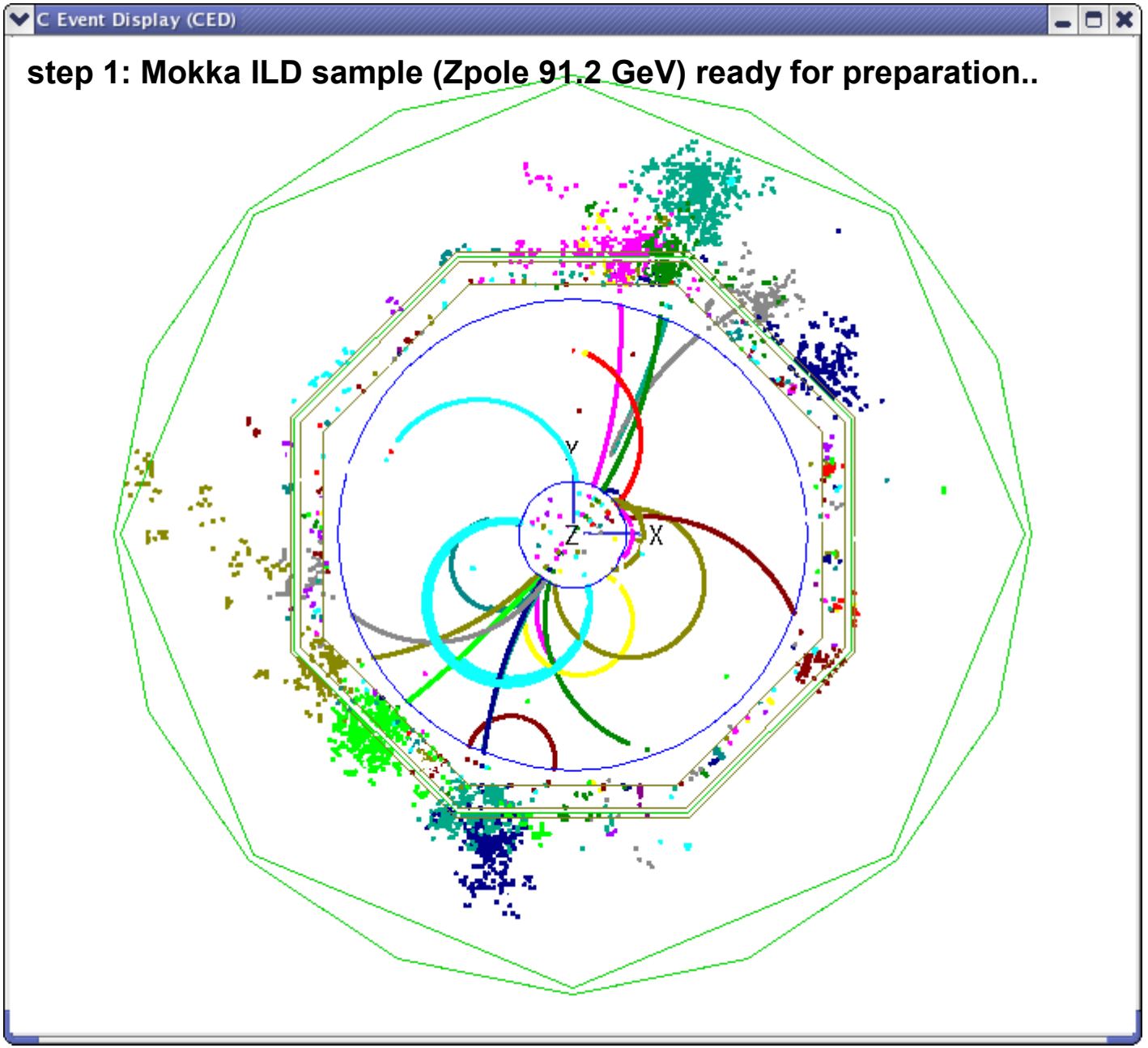
3) ECAL in ILD is not equal to ECAL prototype in CALICE

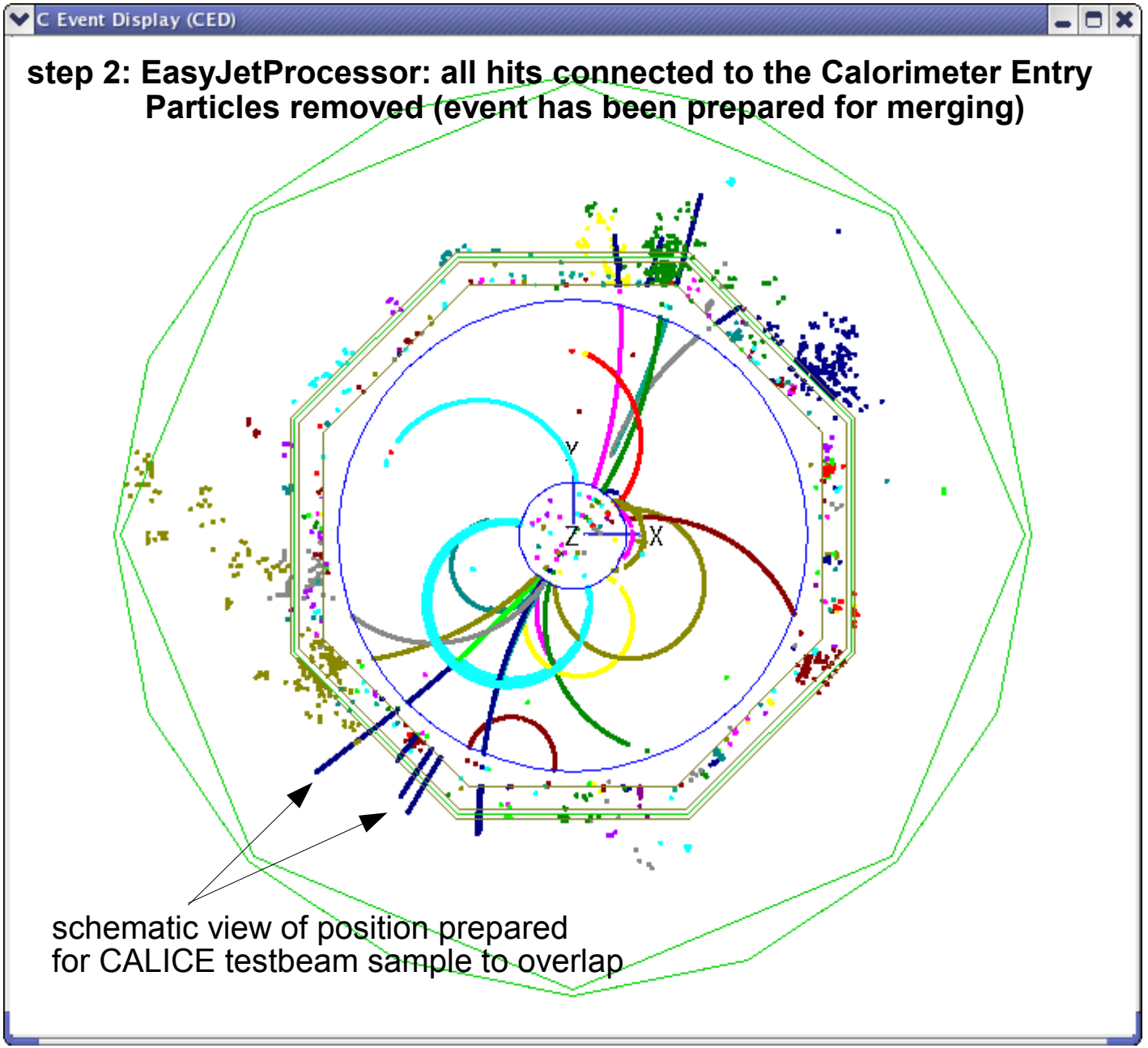
   ILD ECAL: 20 layers of 2.1mm absorber + 10 layers of 4.2mm absorber, 5x5mm2 cells

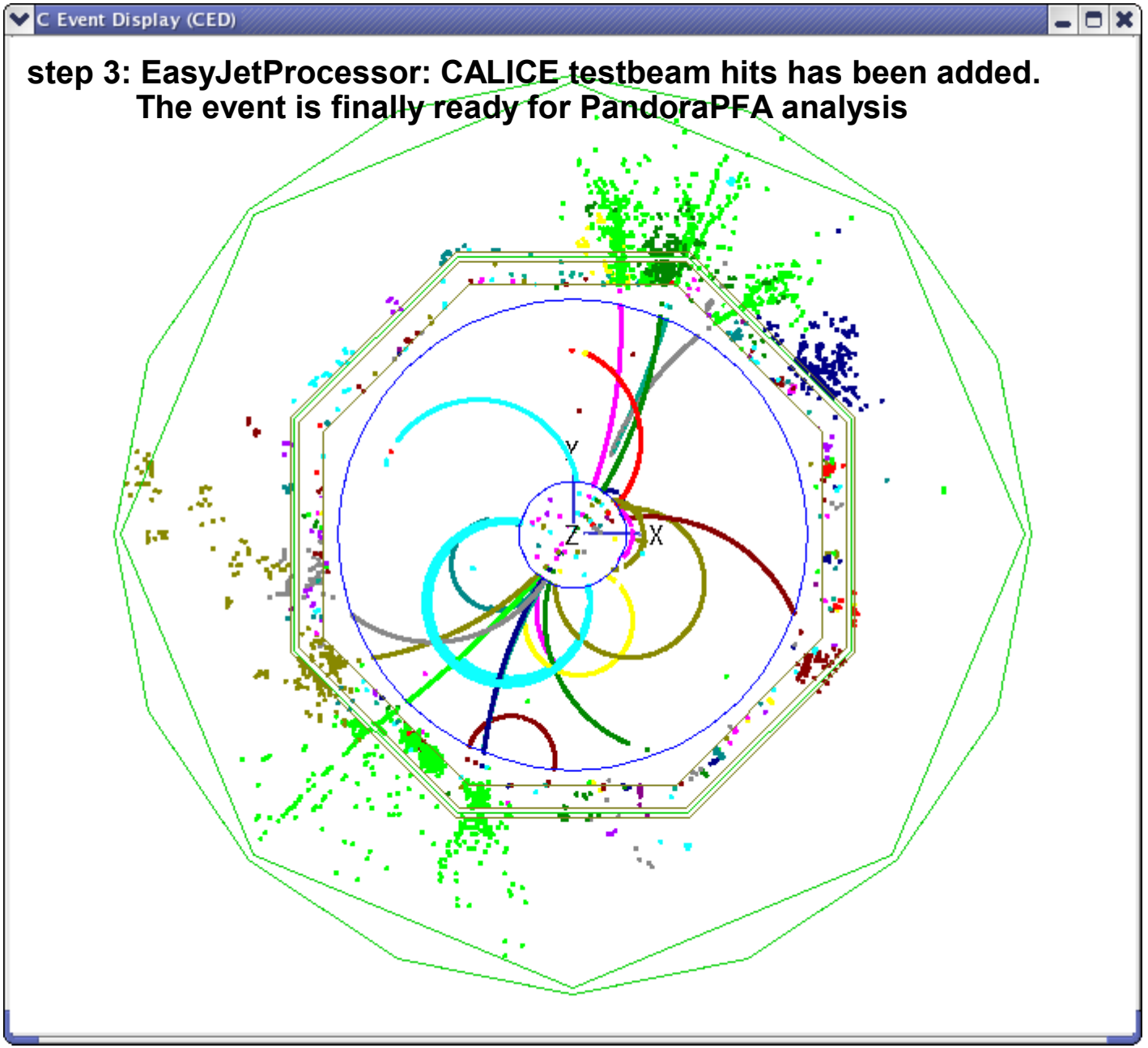
   CALICE ECAL: 10 layers of 1.4 + 10 layers of 2.8 + 10 layers of 4.2 mm absorber,
   10x10mm2 cells

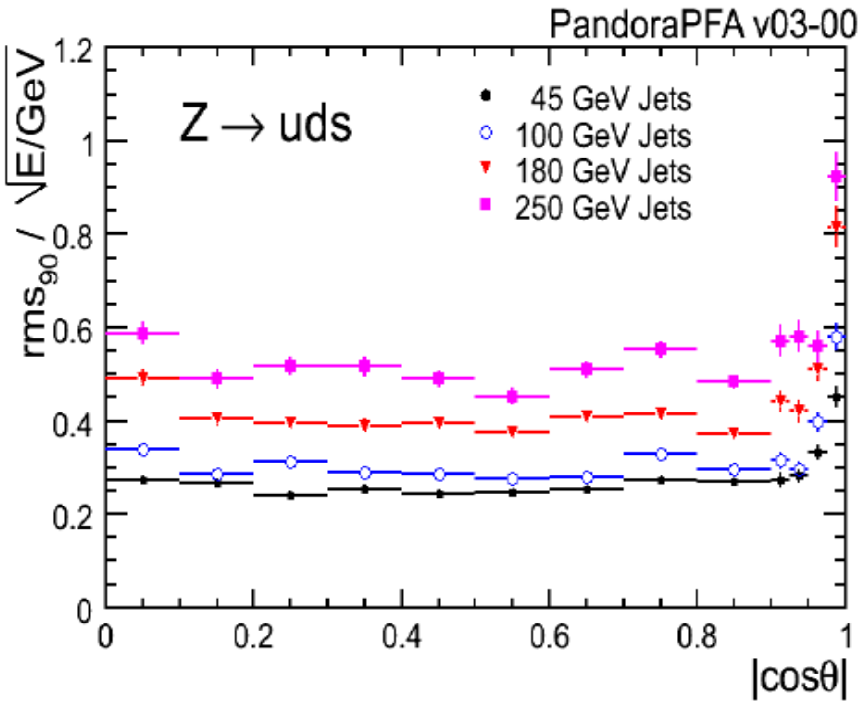
   - re-do the ILD Mokka simulation with CALICE ECAL configuration (need to be validated with PandoraPFA optimization studies!)

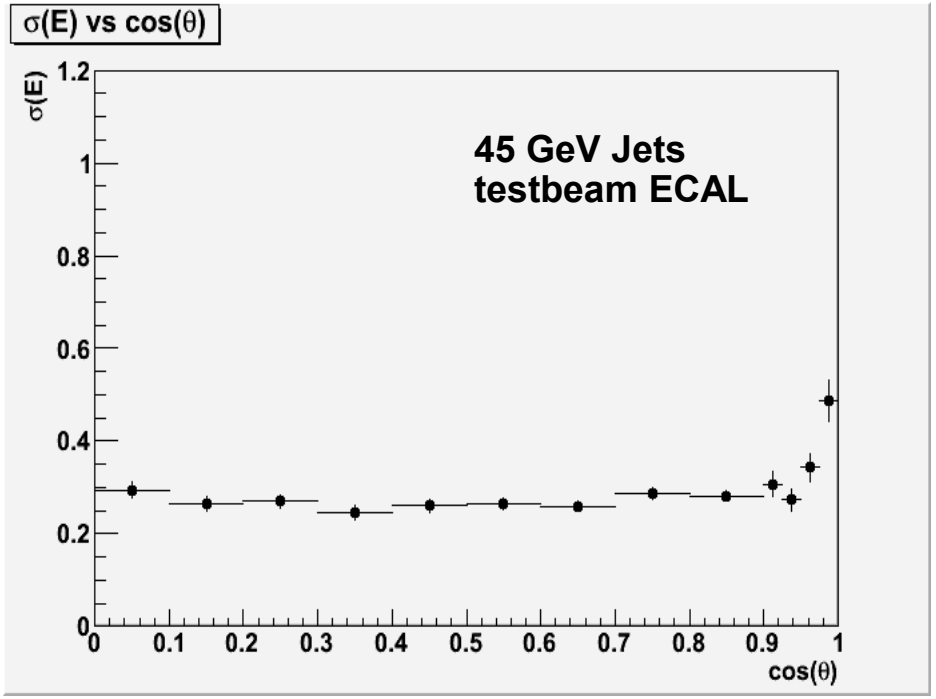
4) hits are placed to the cell structures of ECAL and HCAL => EasyJetProcessor "knows" the ILD geometry and a place where to put a hit (for now just the "closest" cell is used)


C Event Display (CED)
step 1: Mokka ILD sample (Zpole 91.2 GeV) ready for preparation..
Y
Z
X


C Event Display (CED)
step 2: EasyJetProcessor: all hits connected to the Calorimeter Entry
Particles removed (event has been prepared for merging)
Y
Z
X
schematic view of position prepared
for CALICE testbeam sample to overlap


C Event Display (CED)
step 3: EasyJetProcessor: CALICE testbeam hits has been added.
The event is finally ready for PandoraPFA analysis
Y
Z
X

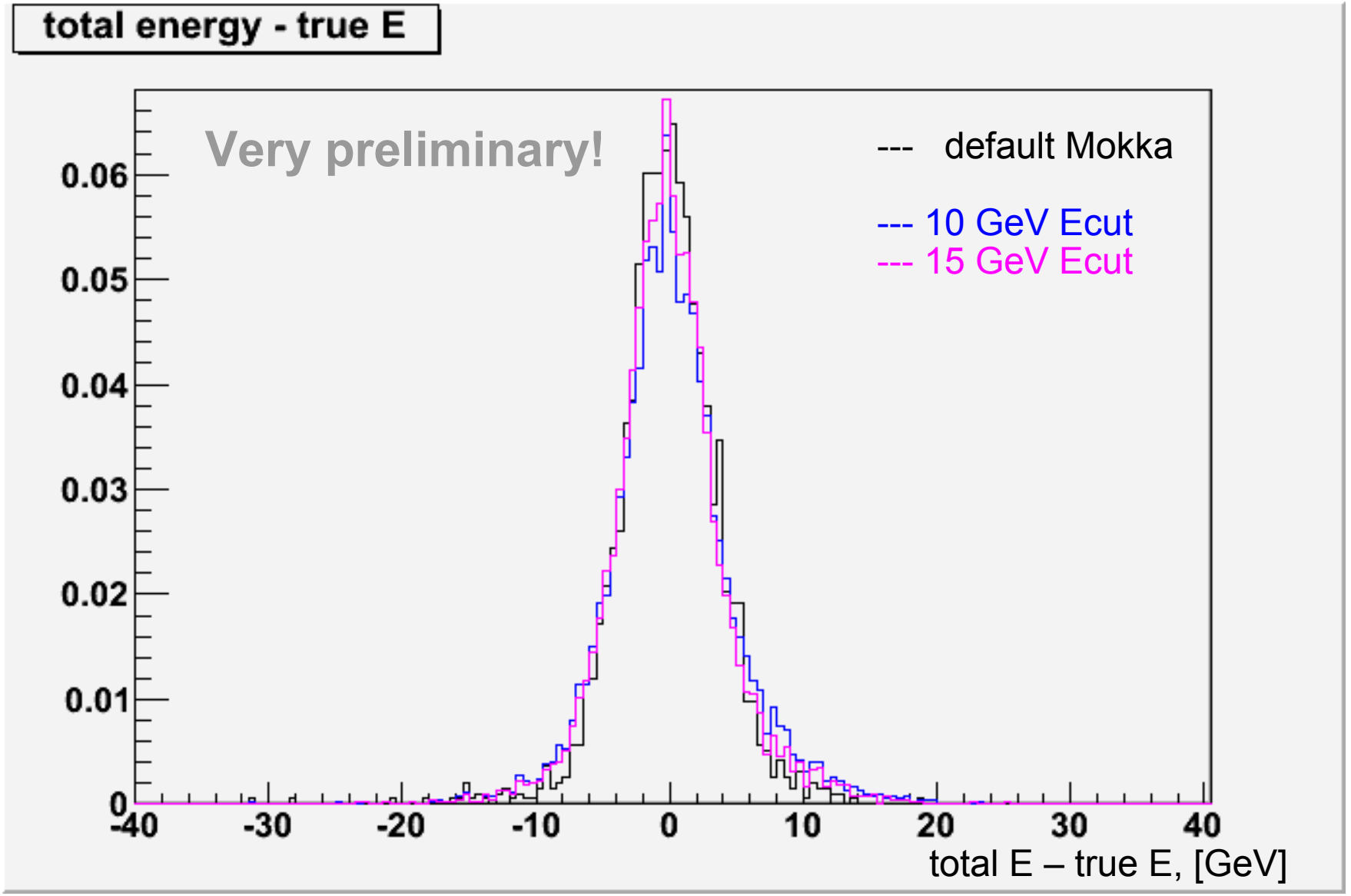




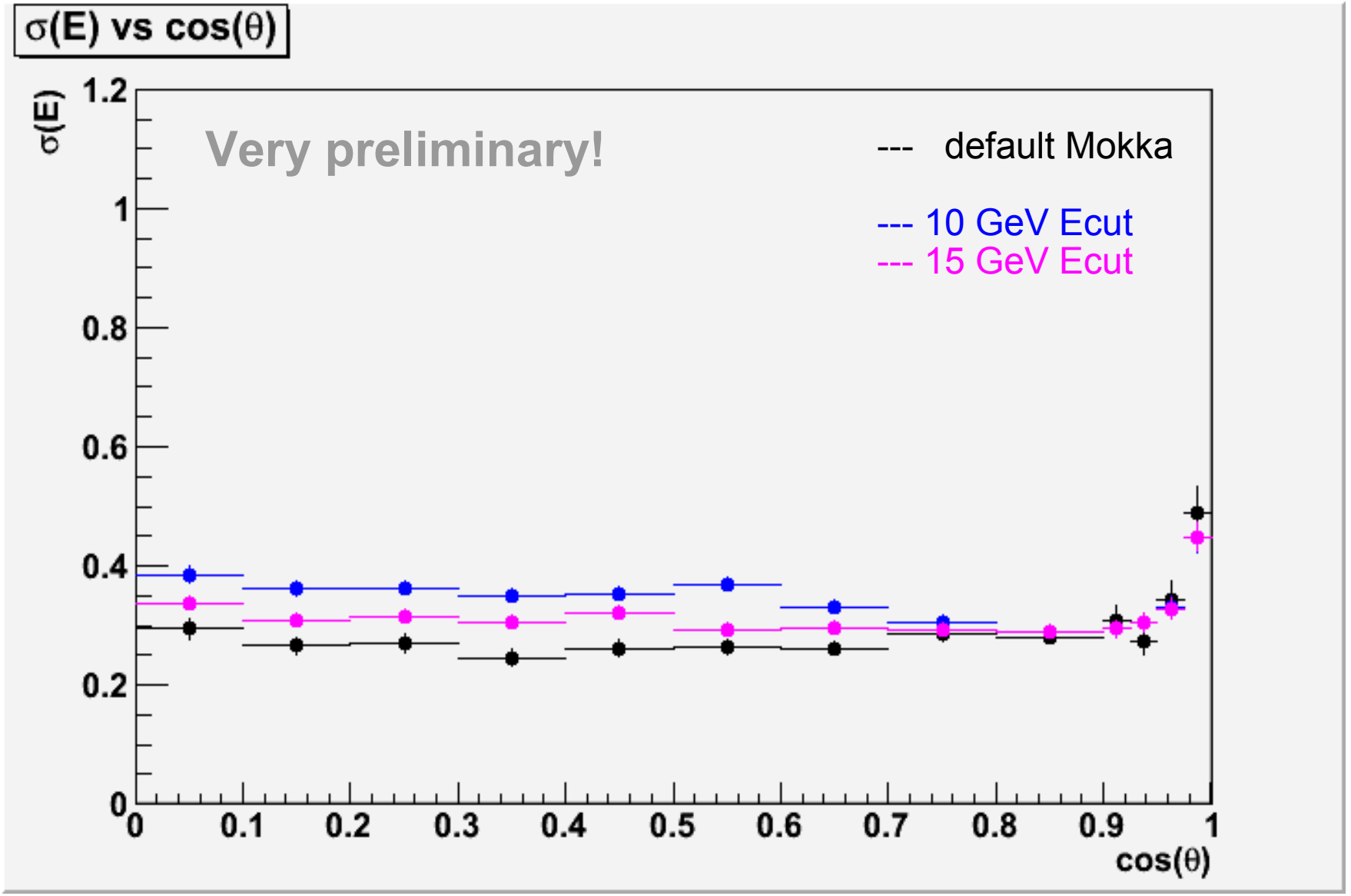
Cross-check of PandoraPFA for CALICE testbeam ECAL configuration =>

Mokka with the testbeam ECAL configuration gives reasonable results

Energy reconstruction with PandoraPFA for 10 GeV and 15 GeV cut in EasyJetProcessor



Energy reconstruction with PandoraPFA for 10 GeV and 15 GeV cut in EasyJetProcessor



Multiparticle jet simulation

Conclusions

- EasyJetProcessor has been developed

- first results with Zpole 91.2 GeV looks reasonable

.. and Outlook

- cross-check with CALICE testbeam MC samples

- more files need to be generated with CALICEOverlayPreparation for more precise jet simulation

- high jet energy simulation to be done