Status & Plans for Reco Efforts

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Outline

- Part I, Status Briefing: SDHCAL PFA Analysis on Single Particle Events

- Part II, Discussion: Plans & Perspective

- Part III, Technical: how to play with Pandora

Part I: SDHCAL PFA Study: Single Particle Event Analysis

Outline

- **Introduction**
  - SDHCAL reco soft status
  - Observation: UDS jet reconstruction with SDHCAL

- **Single pion event:**
  - Performance at SDHCAL barrel
  - Comparison to Endcap and Corner region
  - Comparison to AHCAL

- **Single Klong event**
  - AHCAL/SDHCAL Comparison

- **Summary and Plan**

Introduction

- **Finer granularity...**
  SDHCAL: 1 by 1 cm
  AHCAL: 3 by 3 cm

- **SDHCAL reconstruction software status**

  - PandoraPFA based reconstruction chain:

    – Preliminary RPC digitization (*with 3 thresholds: 0.5, 2, 10 mips*): to be upgraded with multiplicity effects: R.Han et.al: http://ilcagenda.linearcollider.org/getFile.py/access?contribId=19&sessionId=8&resId=1&materialId=slides&confId=4776

    – PandoraPFA: learning phase -> optimize the parameters & orders of different modules

  - SDHCAL based algorithms: under development
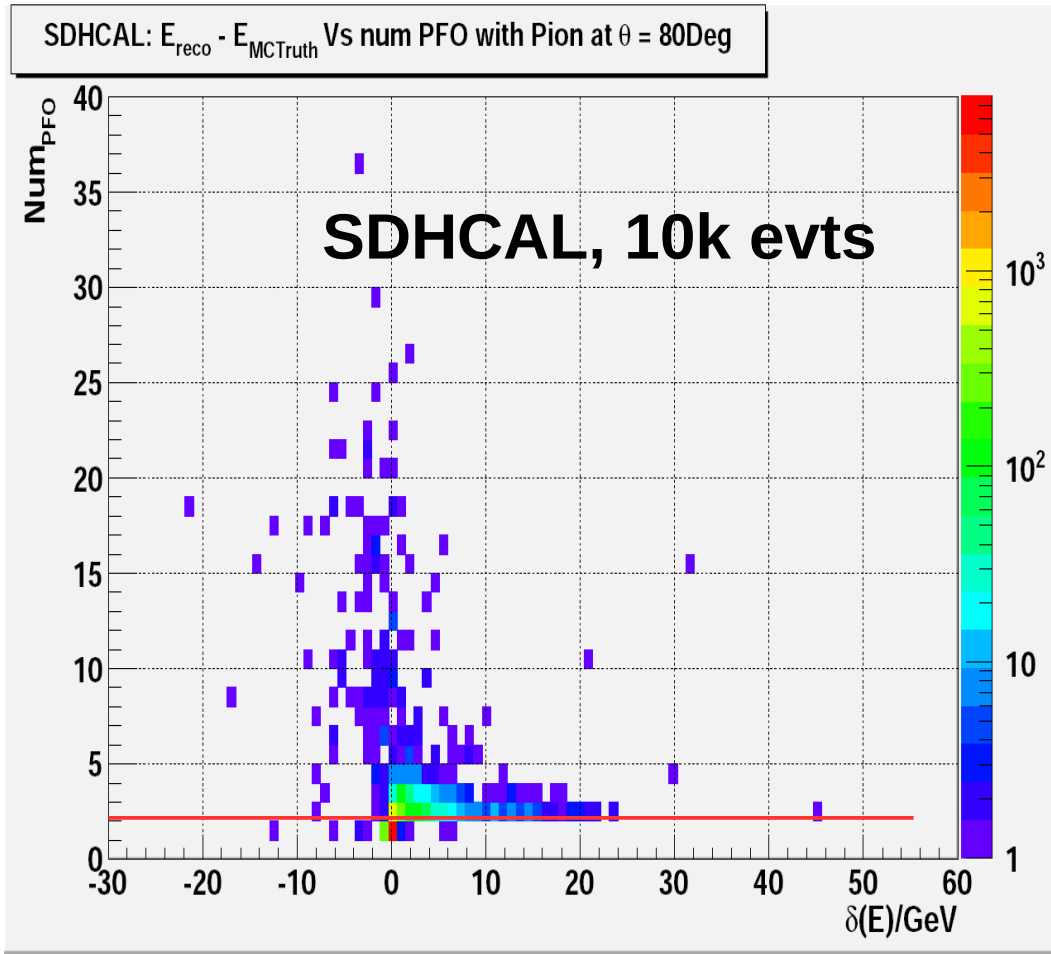
    – Density & NN analysis, Kalman filter, Hough transform...

    – Dedicated clustering + shower energy estimator: to be developed and integrated

 - Event Display: heavily employed to understand the performance

Pandora: learning phase
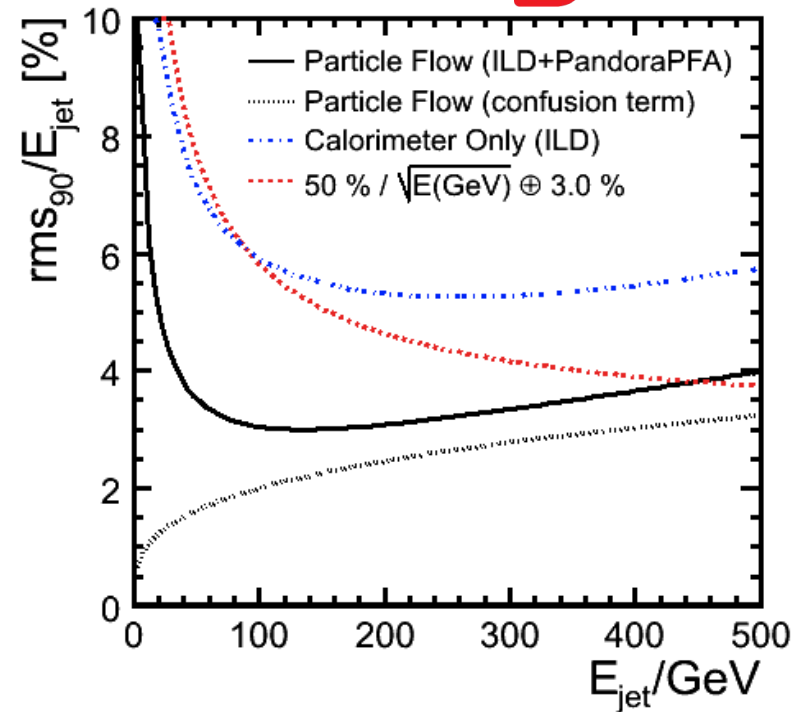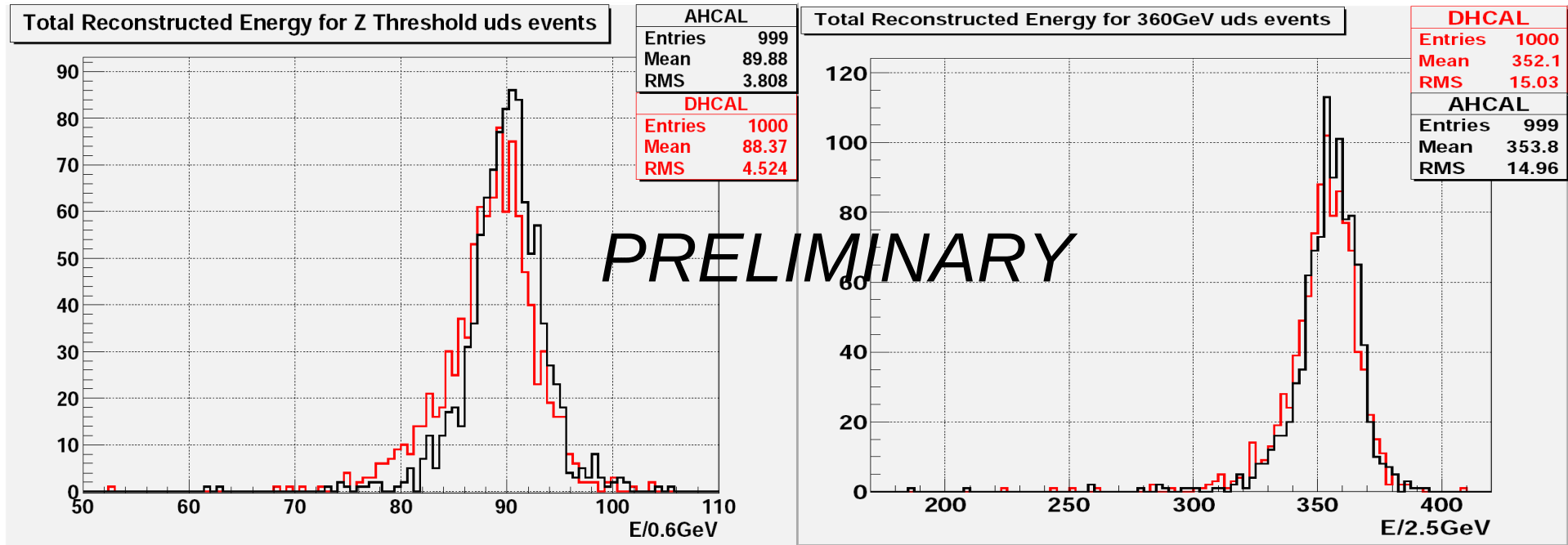
- For SDHCAL: treated Pandora as black box

  - Pandora + Preliminary Digitization + Calibration constant tuning

  - Performance with uds evts: slightly worse @ Zthreshold, much closed @ 360GeV

- To achieve better understanding: Single Particle events

  - Single Pion, Klong and Tau

  - Statistic: ~300k each. 1k ~ 2k * 10 energies (10 ~ 100GeV) * 9 polar angles * 2 concepts

  - Simulation (with grid & mokka 06-07) almost finished. Analysis on going.

SDHCAL, Pion at θ = 80º

SDHCAL: $E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 80Deg

SDHCAL, 10k evts

$\delta(E)$ of events with only 1 PFO. θ = 80Deg, Pion

$\delta(E)$ Vs MCEnergy of events with only 1 PFO. θ = 80Deg, Pion

81% evts (8097) has single PFO
Low energy tail in delta(E) spectrum, correlated
with MCEnergy: energy loss

$E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 80Deg
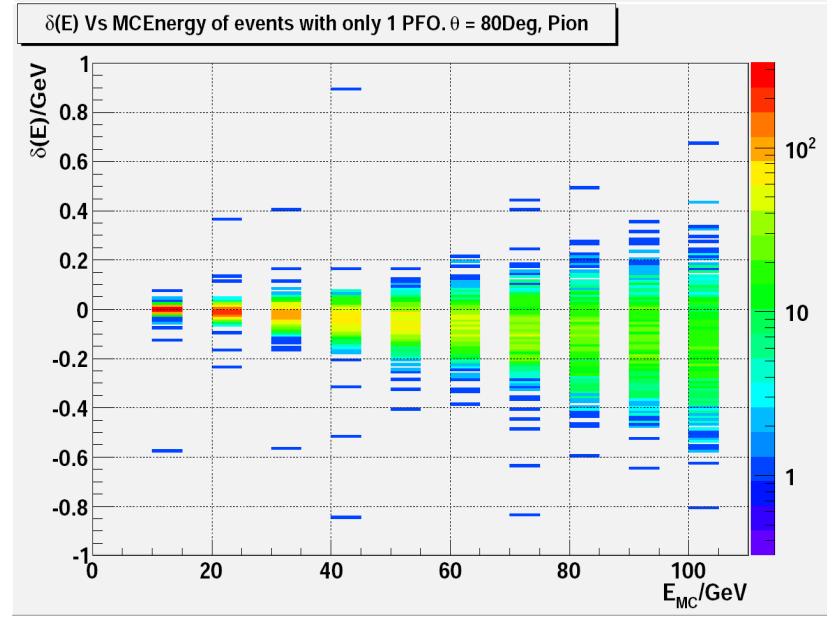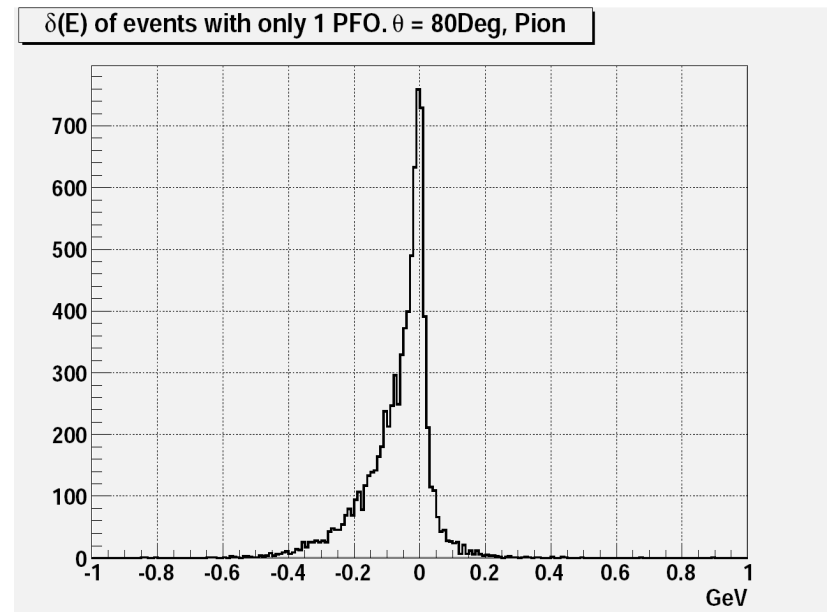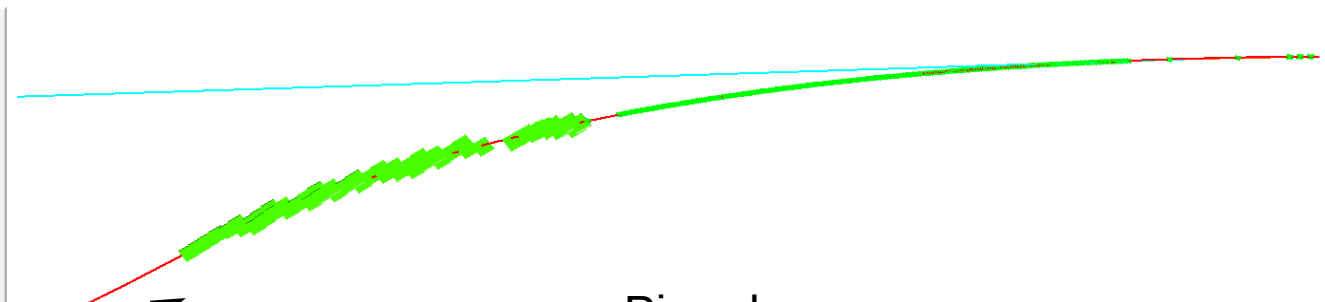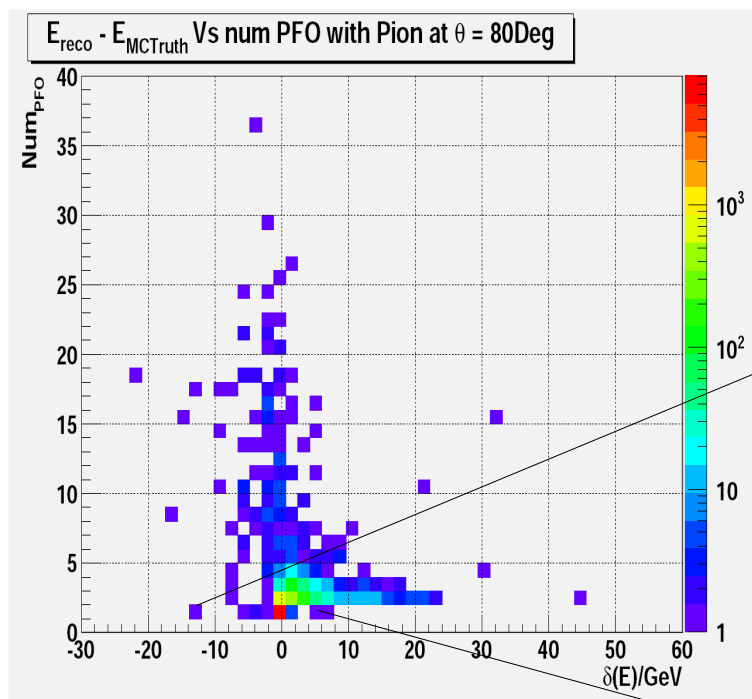
Pion decay:
40GeV Pion ~ 12GeV neutrino + 28GeV muon...

Evt 821,
40GeV Pion at MCTruth
Identify as 46.6GeV PFO
with 38GeV cluster

Failure of track energy
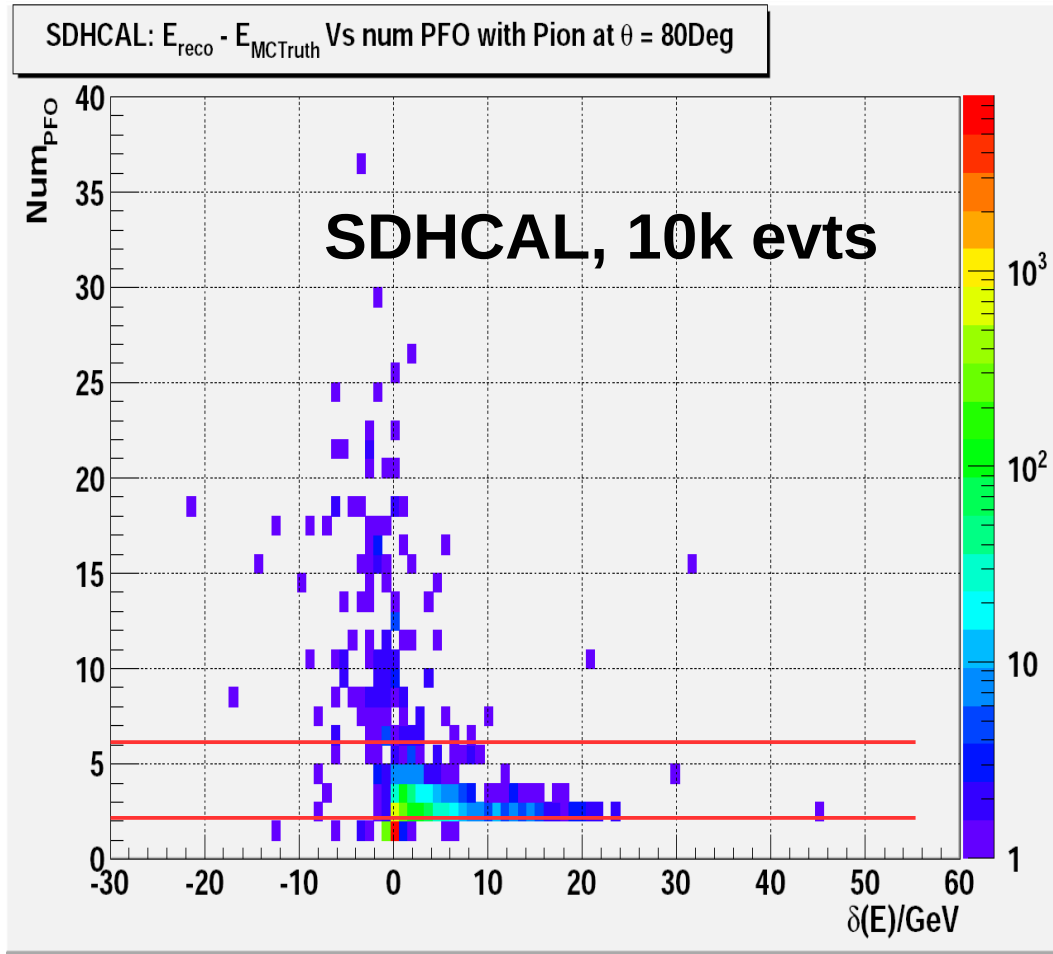Reconstruction?
Rare... but happens
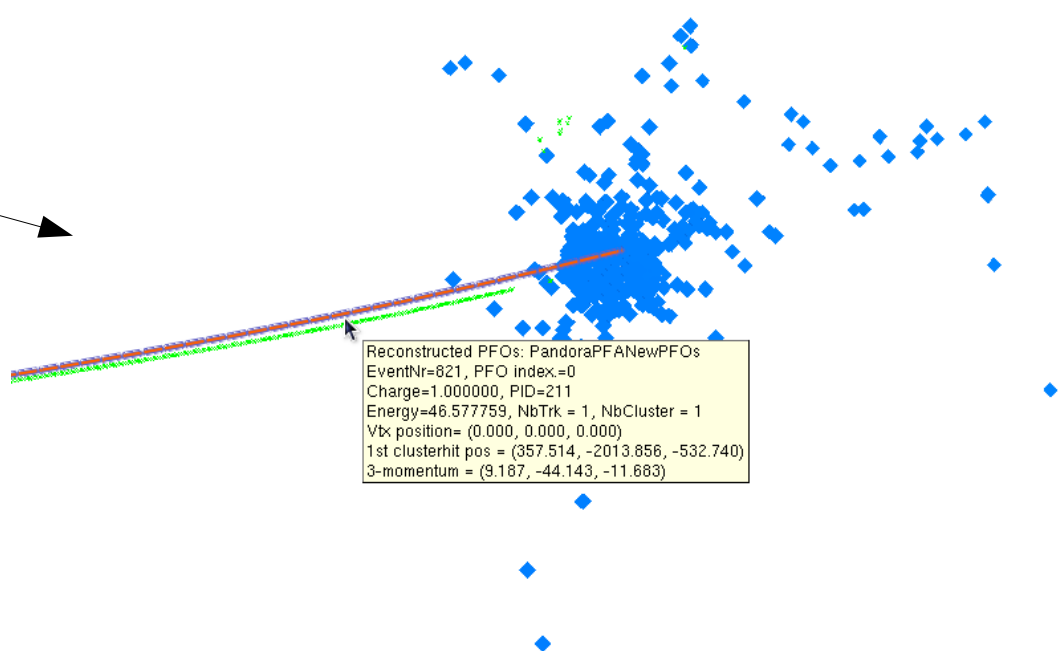
Reconstructed PFOs: PandoraPFANewPFOs
EventNr=821, PFO index.=0
Charge=1.000000, PID=211
Energy=46.577759, NbTrk = 1, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (357.514, -2013.856, -532.740)
3-momentum = (9.187, -44.143, -11.683)

SDHCAL: $E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 80Deg

SDHCAL, 10k evts

δ(E) events with 1<N_{PFO}<6. Pion at θ = 80Deg, SDHCAL

δ(E) Vs MCEnergy events with 1<N_{PFO}<6. Pion at θ = 80Deg, SDHCAL

~ 18% (1766) events has 2 - 5 PFOs
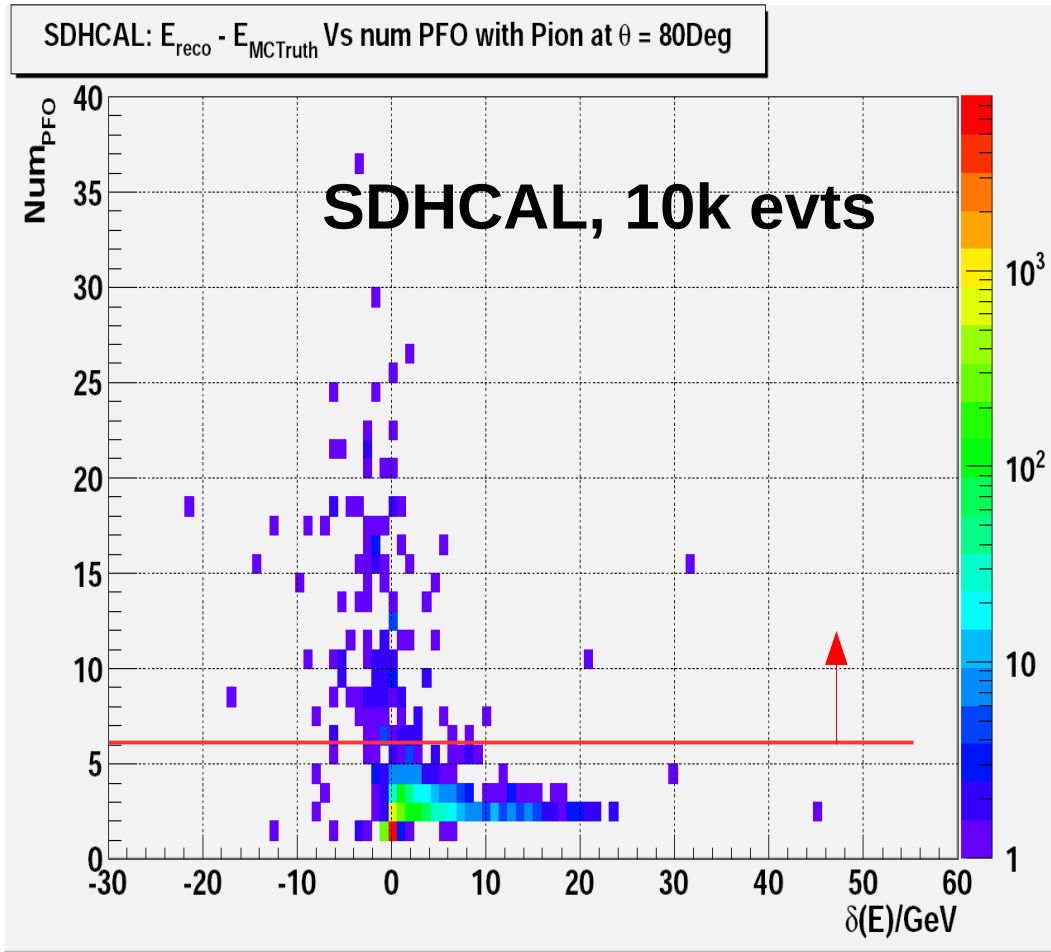Higher estimated energy
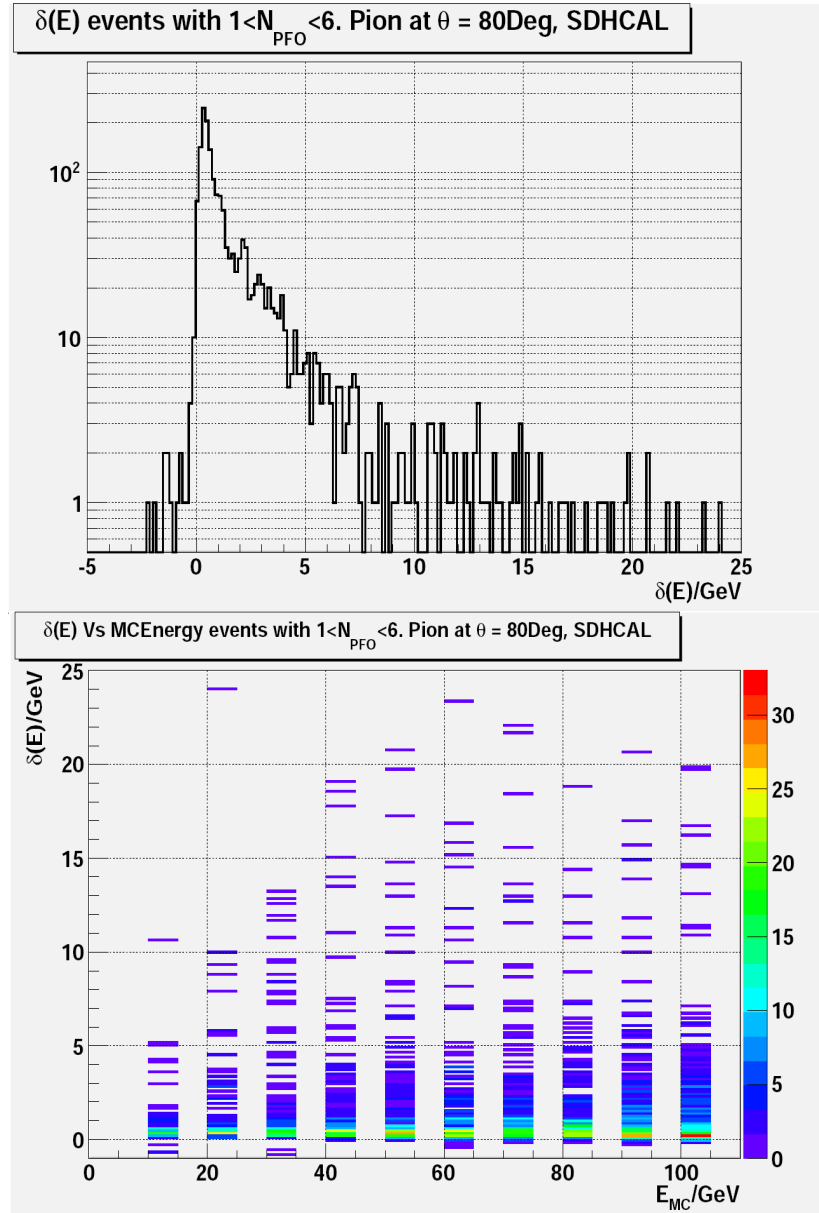
Events with 2 - 5 PFOs

(Evt 286) 2 PFOs, Identify as
100GeV Pion (80.7GeV cluster) +
45GeV Neutron (45.4GeV)
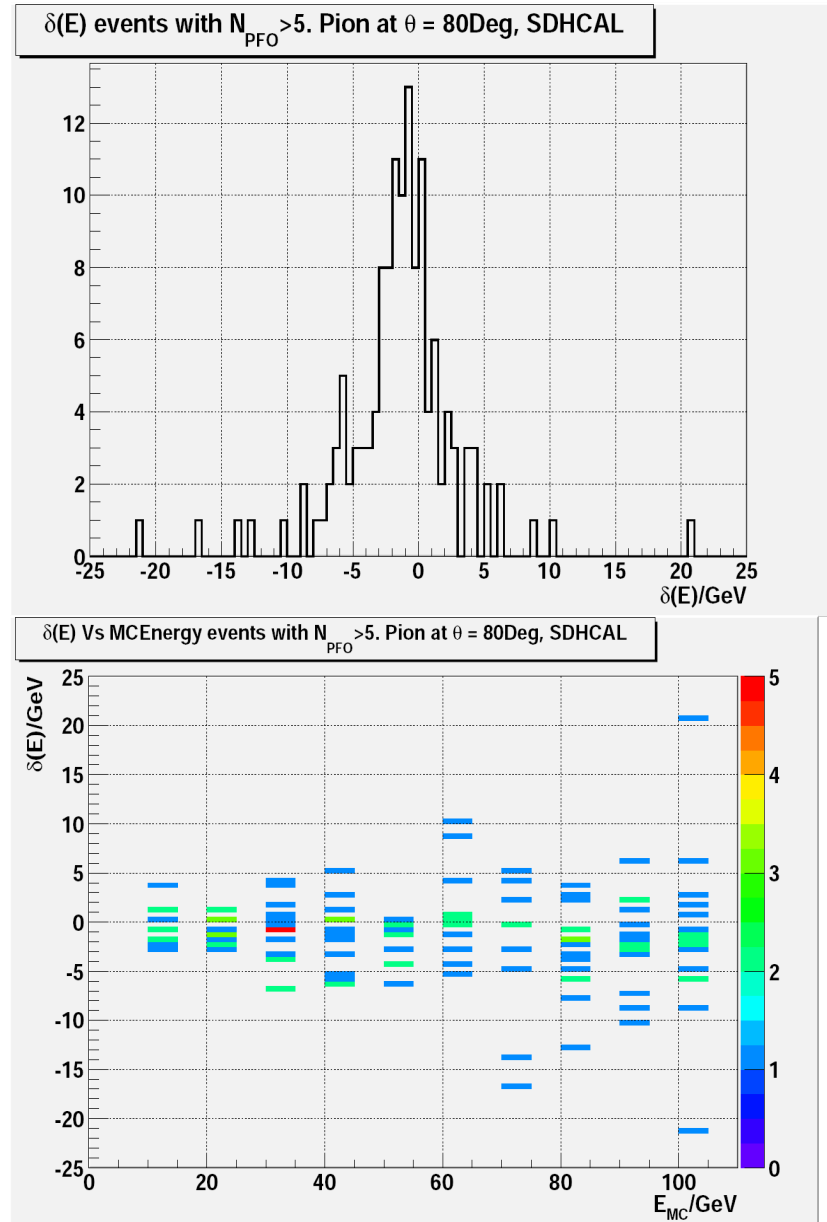Total PFO energy = 145GeV
Seed at deep ECAL Layer...

Evt 216
Simulation level

Reconstruction: 4 PFOs:
100GeV Pion (86.3GeV) +
28GeV Neutron (24.4GeV) + ...
Total PFO energy = 130GeV

Double counting! To be improved...

Events: more than 5 PFOs

SDHCAL: $E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at $\theta = 80Deg$

SDHCAL, 10k evts

$\delta(E)$ events with $N_{PFO} > 5$. Pion at $\theta = 80Deg$, SDHCAL

$\delta(E)$ Vs MCEnergy events with $N_{PFO} > 5$. Pion at $\theta = 80Deg$, SDHCAL

~ 1.4% (137) events have more than 5 PFOs
Large smearing in measured energy
(*Smearing amplitude increase with MC energy*)

Evt 346,
Interaction at TPC
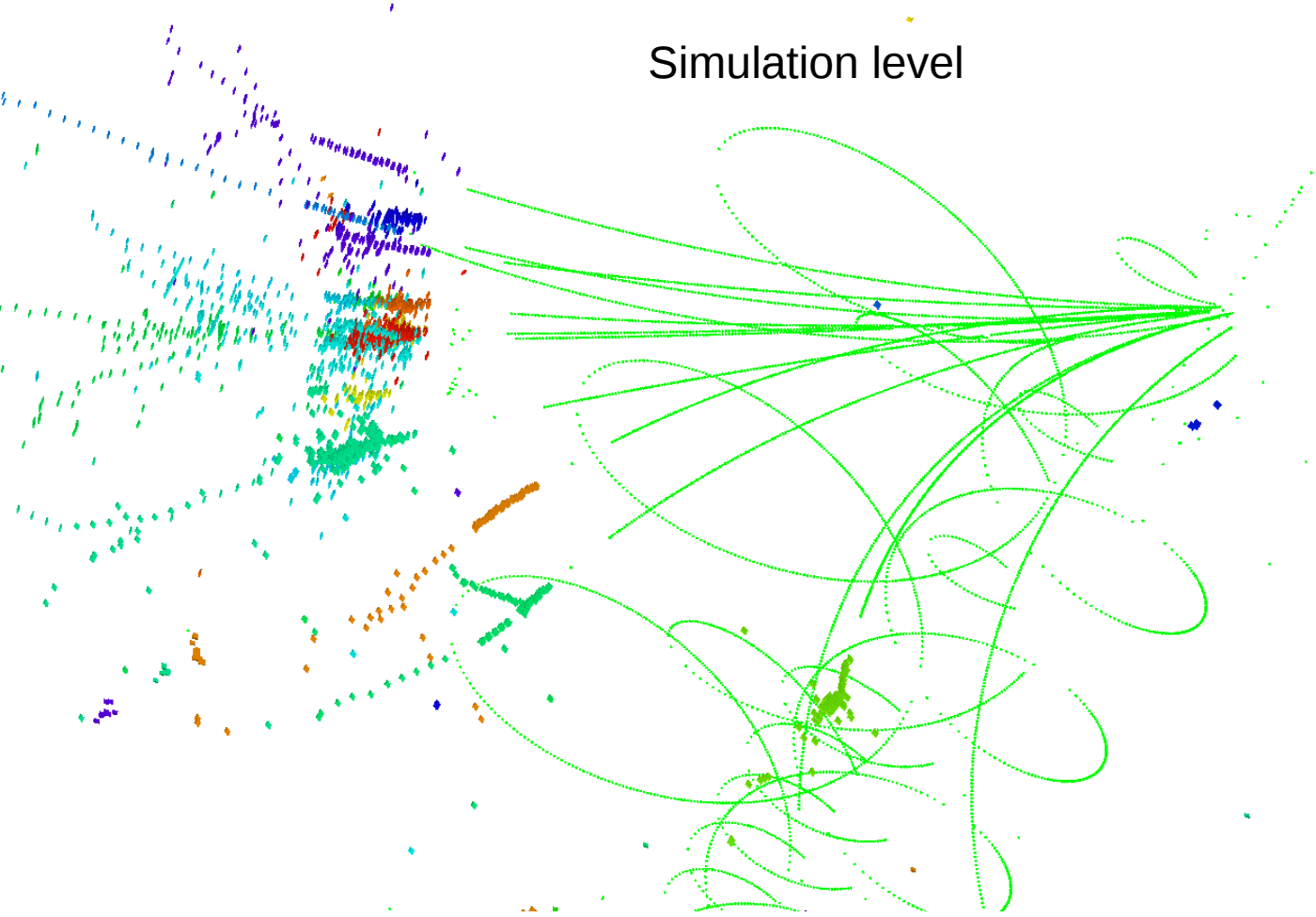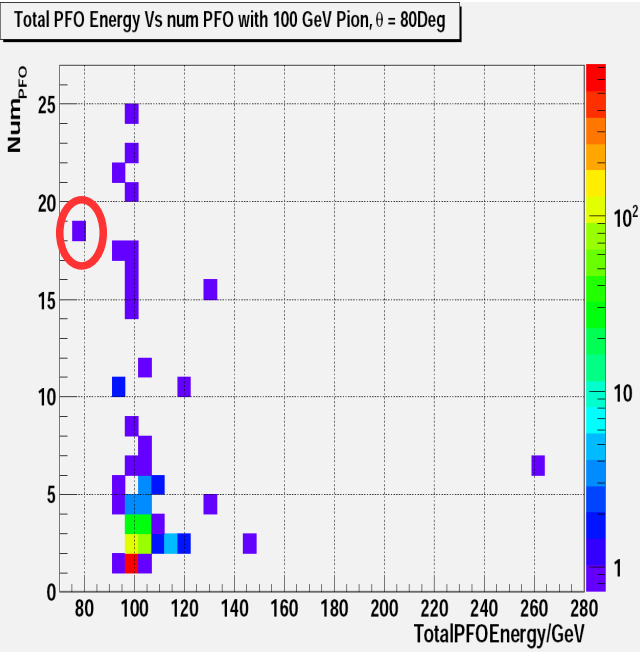entrance

18 PFOs,
Total Energy 79GeV

Simulation level

Total PFO Energy Vs num PFO with 100 GeV Pion, θ = 80Deg

dude... you are a pion?

Higher estimated energy for NPFO > 5 events

(Evt 867)
Simulation level
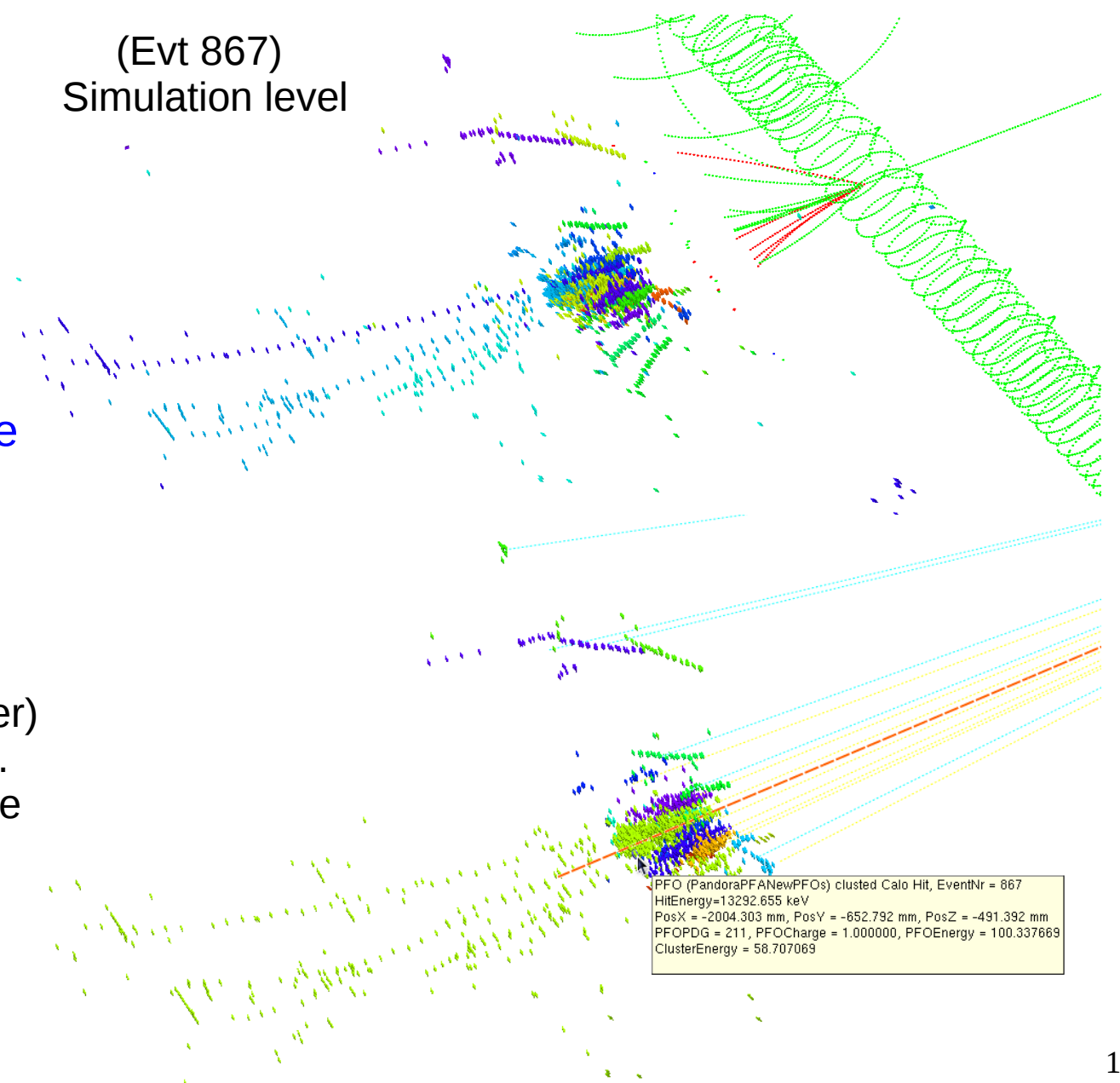
Interaction based double counting

Reconstruction level:

15PFOs
Leading PFO (54GeV cluster)
identified as 100GeV pion.
Others contribute to double
counted 32GeV...

PFO (PandoraPFANewPFOs) clusted Calo Hit, EventNr = 867
HitEnergy=13292.655 keV
PosX = -2004.303 mm, PosY = -652.792 mm, PosZ = -491.392 mm
PFOPDG = 211, PFOCharge = 1.000000, PFOEnergy = 100.337669
ClusterEnergy = 58.707069

Tough case... interaction near the end of Tracker!

Even more crazy...
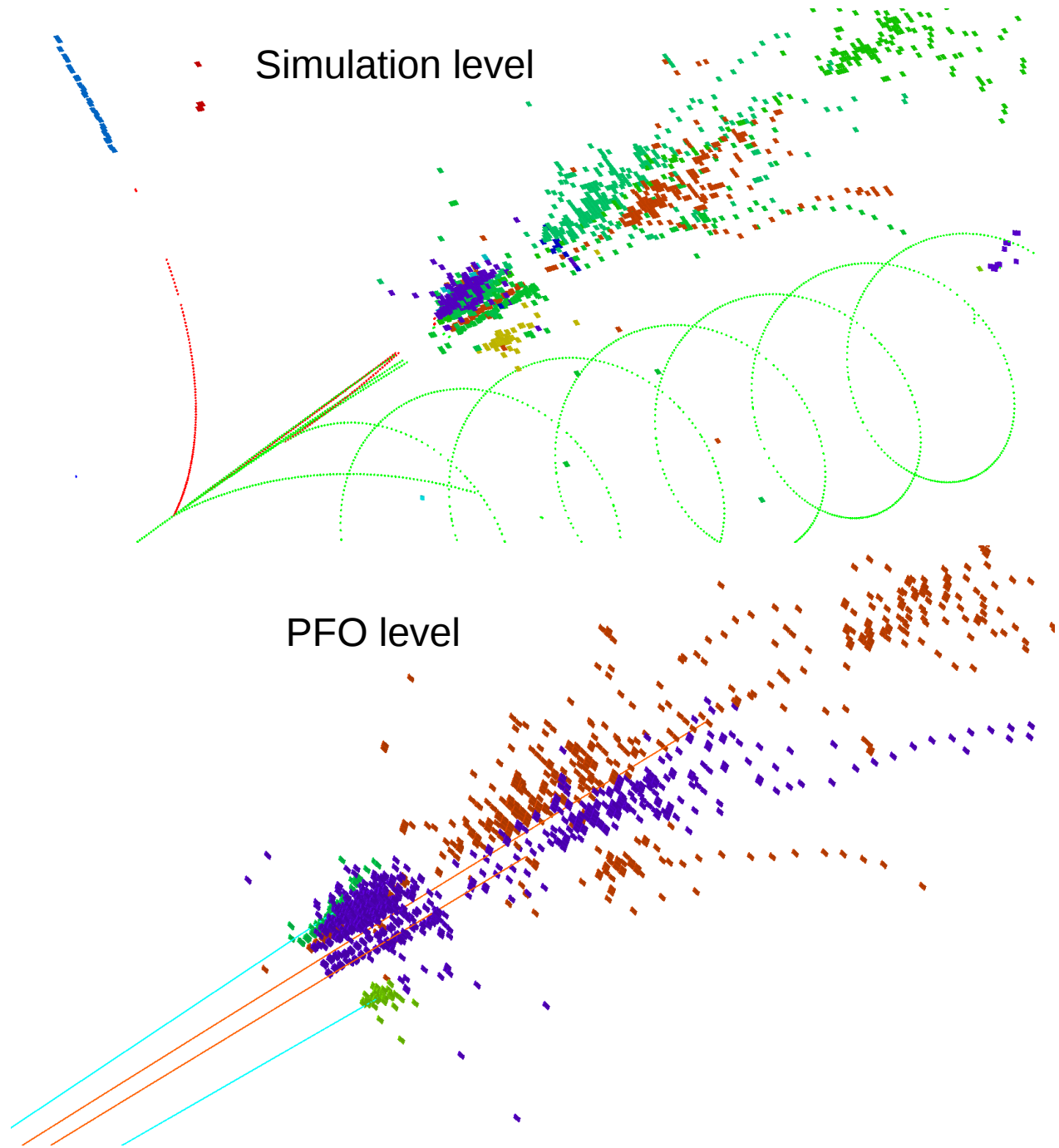
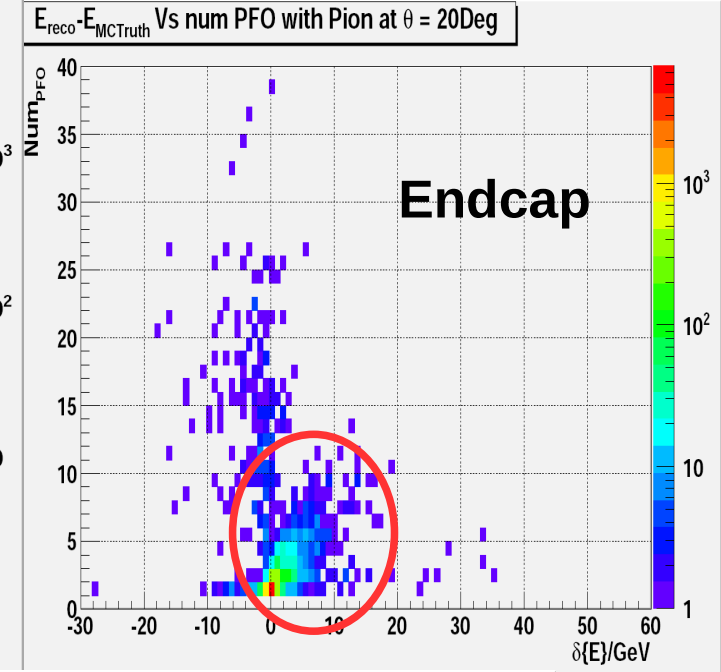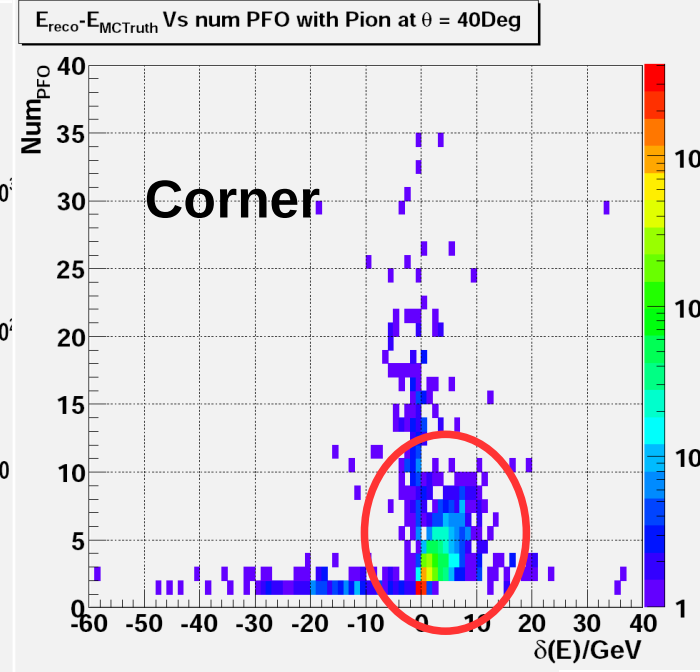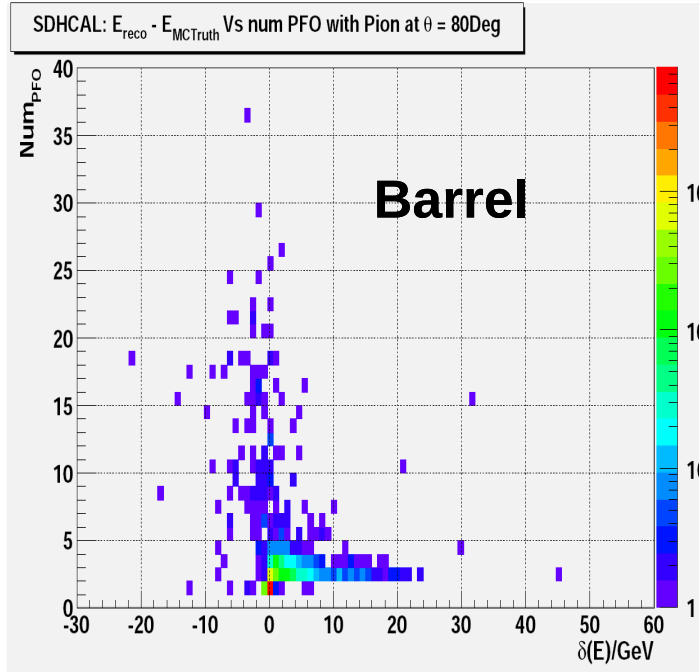Evt 646: Interaction Inside TPC (1/3 of the radius)

Confused tracker: 3 LDCTrack found

6PFOs:
2 leading PFO assigned with tracks + cluster, with energy 110GeV (40GeV cluster) and 148GeV (55GeV cluster)

Totally reconstructed energy: 264GeV

Judgement on trk quality?
Flag on those kind of evts
Rely more on cluster info?

Simulation level

PFO level

Compare to corner & endcap

SDHCAL: $E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 80Deg — **Barrel**

$E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 40Deg — **Corner**

$E_{reco} - E_{MCTruth}$ Vs num PFO with Pion at θ = 20Deg — **Endcap**

- For single PFO events:

  - Large low energy tail in Corner (also for 2-PFO events)

  - Large energy smearing in Endcap region (track smearing)

- Corner & Endcap: More material near the end of tracker

  - More Interactions

  - Linear dependency of delta(E) and NPFO ~ interaction based double counting?

Number of reconstructed PFOs (Normalized to 10k evts)

	SDHCAL_80Deg	
Entries	13746	
Mean	1.871	
RMS	1.534	
	SDHCAL_40Deg	
Entries	16909	
Mean	1.72	
RMS	2.1	
	SDHCAL_20Deg	
Entries	15579	
Mean	1.55	
RMS	2.253	

Low energy tail at θ = 40º

Simulation level

PFO level

Failed to link the track

(Track reconstructed: LDCTrack Number = 1):

100GeV Pion at 40Deg:

Above: Evt 427, Single PFO

Left: Evt 872, Double PFOs Neither linked to track...
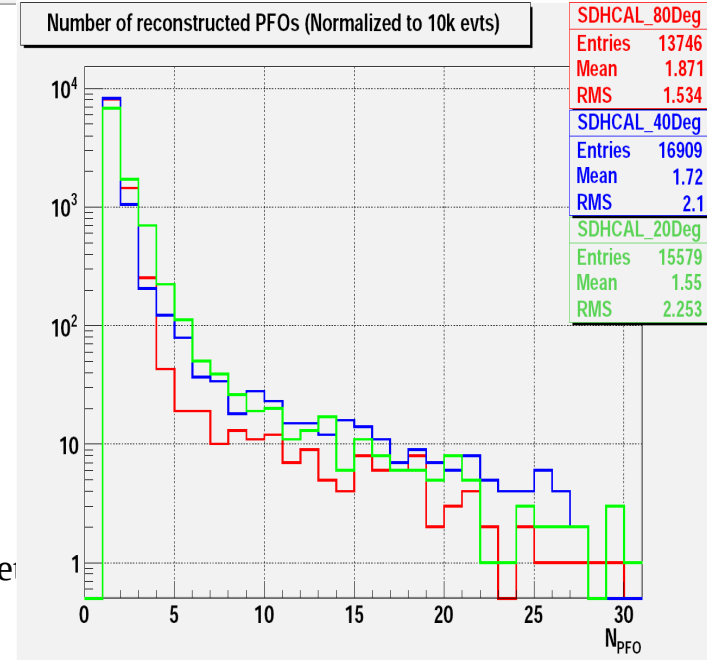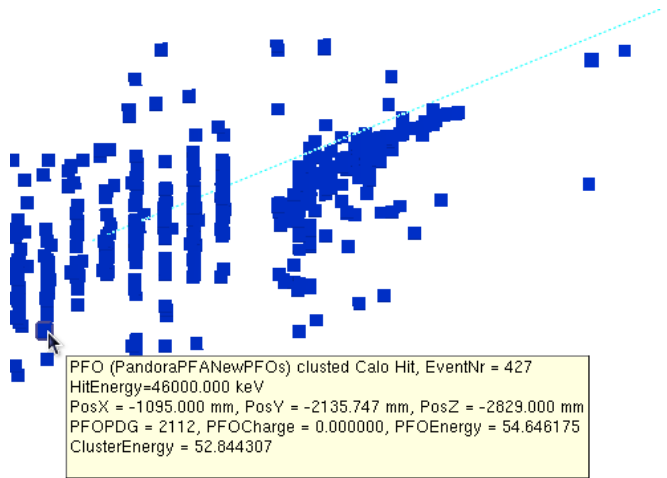
PFO (PandoraPFANewPFOs) clusted Calo Hit, EventNr = 427
HitEnergy=46000.000 keV
PosX = -1095.000 mm, PosY = -2135.747 mm, PosZ = -2829.000 mm
PFOPDG = 2112, PFOCharge = 0.000000, PFOEnergy = 54.646175
ClusterEnergy = 52.844307
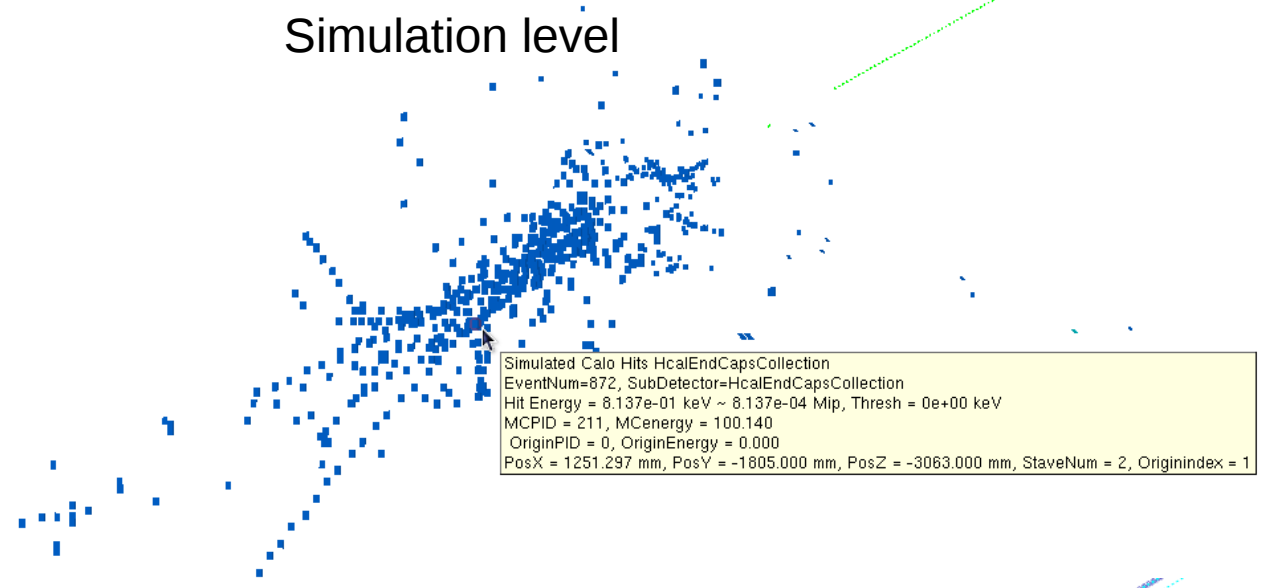
Simulated Calo Hits HcalEndCapsCollection
EventNum=872, SubDetector=HcalEndCapsCollection
Hit Energy = 8.137e-01 keV ~ 8.137e-04 Mip, Thresh = 0e+00 keV
MCPID = 211, MCenergy = 100.140
OriginPID = 0, OriginEnergy = 0.000
PosX = 1251.297 mm, PosY = -1805.000 mm, PosZ = -3063.000 mm, StaveNum = 2, Originindex = 1

Reconstructed PFOs: PandoraPFANewPFOs
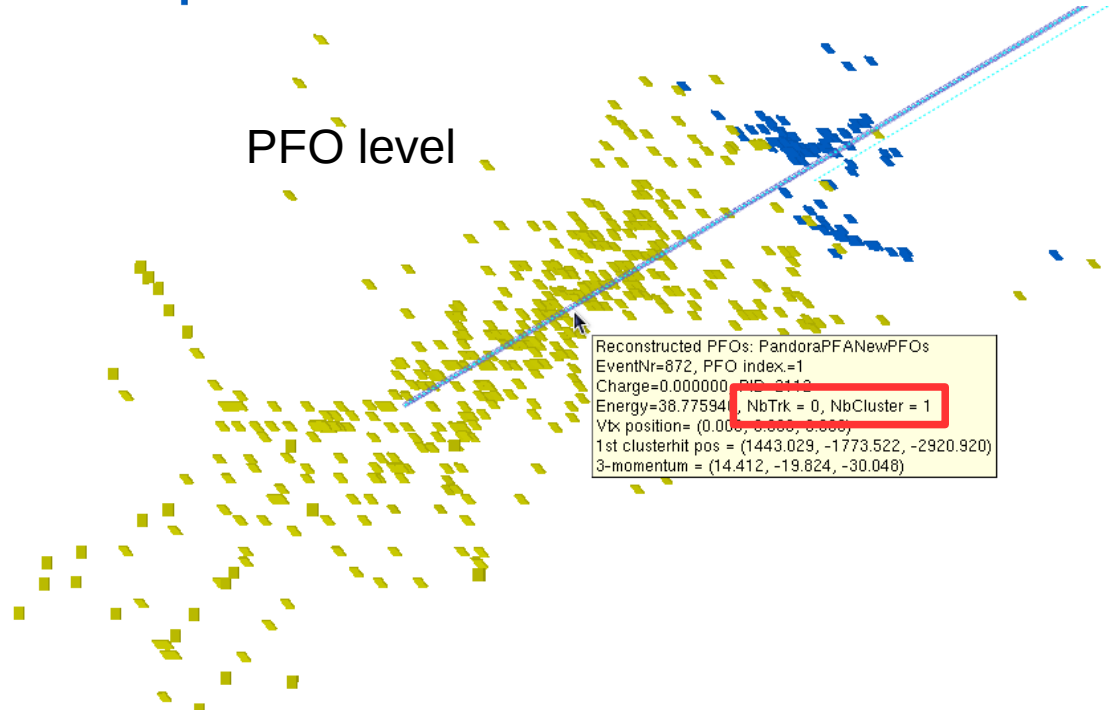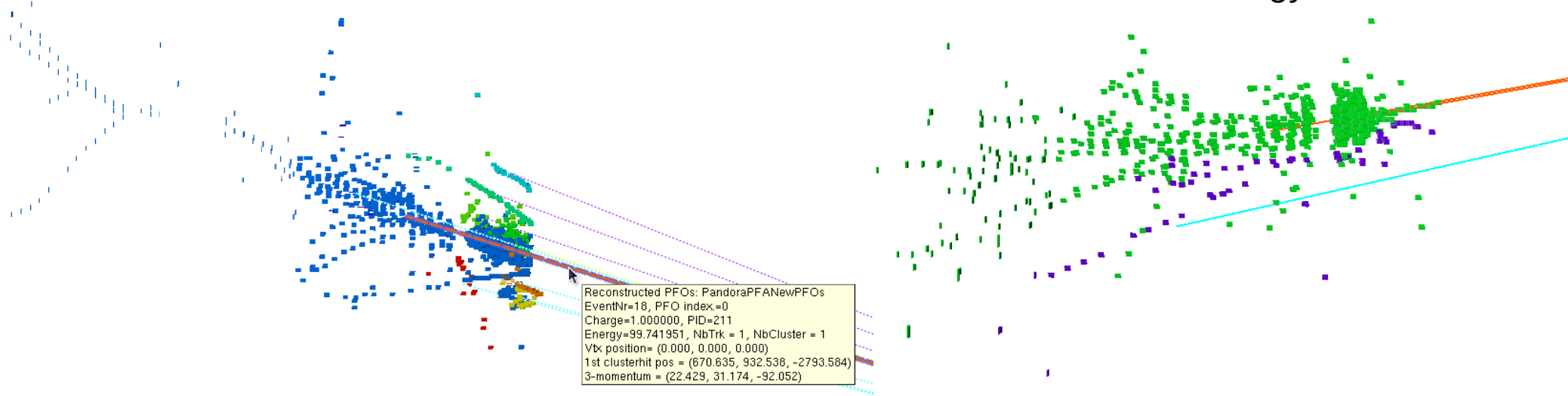EventNr=872, PFO index.=1
Charge=0.000000, PID=2112
Energy=38.775940, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (1443.029, -1773.522, -2920.920)
3-momentum = (14.412, -19.824, -30.048)

Higher estimated energy at θ = 20º

Double counting: 2 PFOs,
Total measured energy = 105GeV

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=18, PFO index.=0
Charge=1.000000, PID=211
Energy=99.741951, NbTrk = 1, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (670.635, 932.538, -2793.584)
3-momentum = (22.429, 31.174, -92.052)

Interaction based double counting...

PFO (PandoraPFANewPFOs) clusted Calo Hit, EventNr = 119
HitEnergy=46000.000 keV
PosX = -665.000 mm, PosY = -959.830 mm, PosZ = -2673.000 mm
PFOPDG = 211, PFOCharge = 1.000000, PFOEnergy = 217.064896
ClusterEnergy = 87.619408

Single PFO
Crazy track energy ~ 217GeV
Cluster Energy = 87GeV

"Lower" energy at θ = 20º

Theta = 20 deg
Smearing of Track energy resolution
Track energy = 91.2GeV
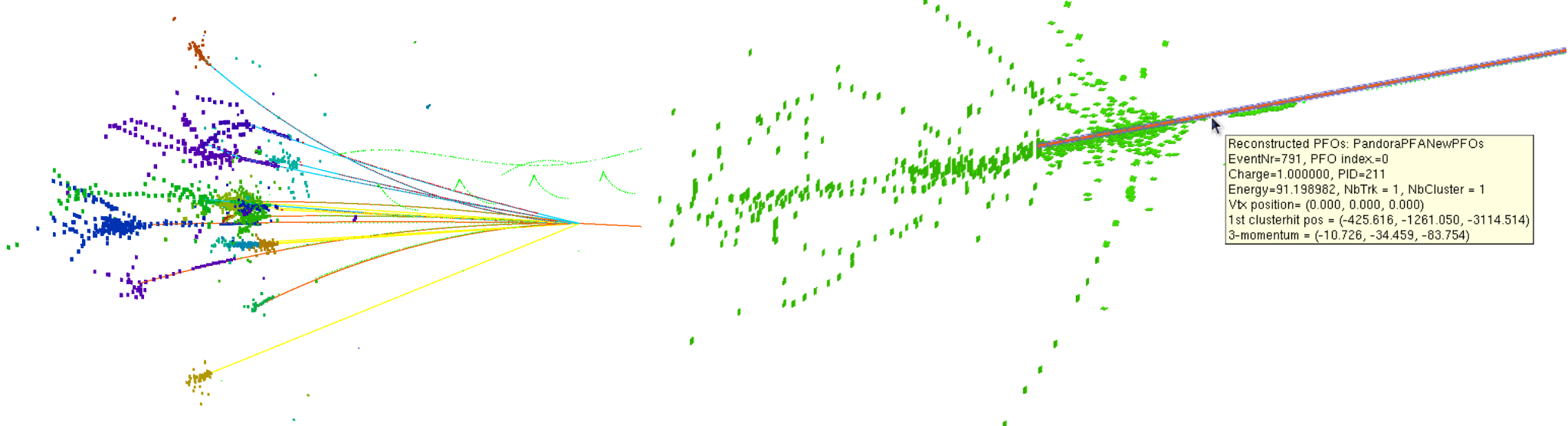
Reconstructed PFOs: PandoraPFANewPFOs
EventNr=791, PFO index.=0
Charge=1.000000, PID=211
Energy=91.198982, NbTrk = 1, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (-425.616, -1261.050, -3114.514)
3-momentum = (-10.726, -34.459, -83.754)

Interaction before Calo +
Cluster energy resolution uncertainty

Pion decay: 42GeV neutrino + 58GeV muon...
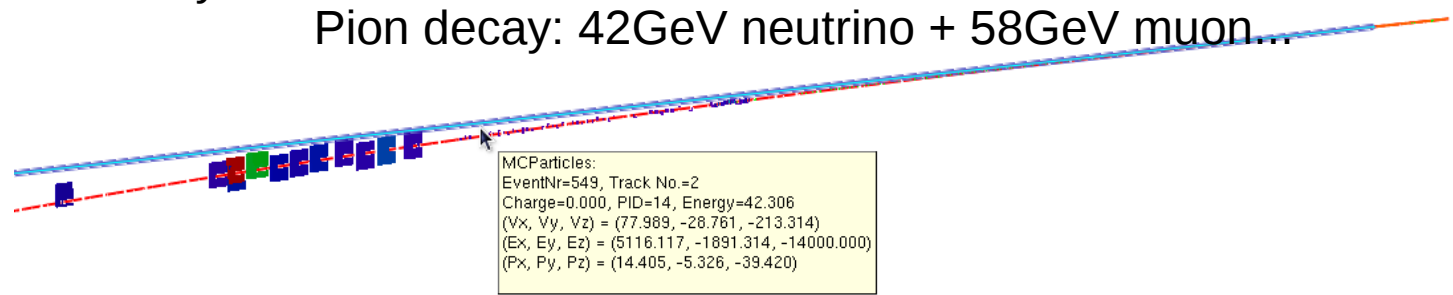
MCParticles:
EventNr=549, Track No.=2
Charge=0.000, PID=14, Energy=42.306
(Vx, Vy, Vz) = (77.989, -28.761, -213.314)
(Ex, Ey, Ez) = (5116.117, -1891.314, -14000.000)
(Px, Py, Pz) = (14.405, -5.326, -39.420)

Comparing with AHCAL

SDHCAL, 10k evts

Barrel:
AHCAL
20k evts

Corner
18k evts
No 30GeV Run

Endcap
20k evts
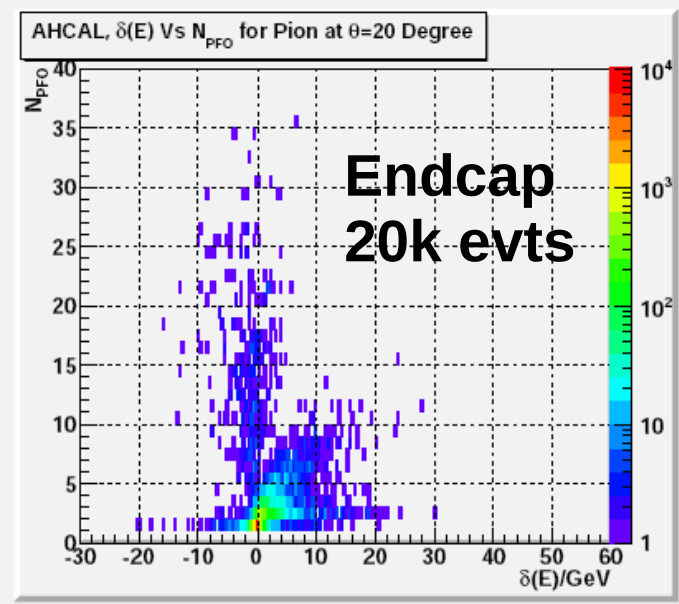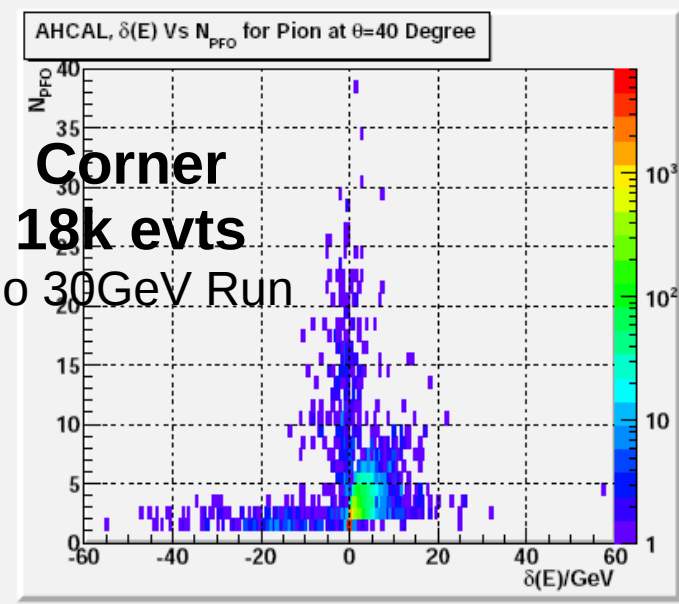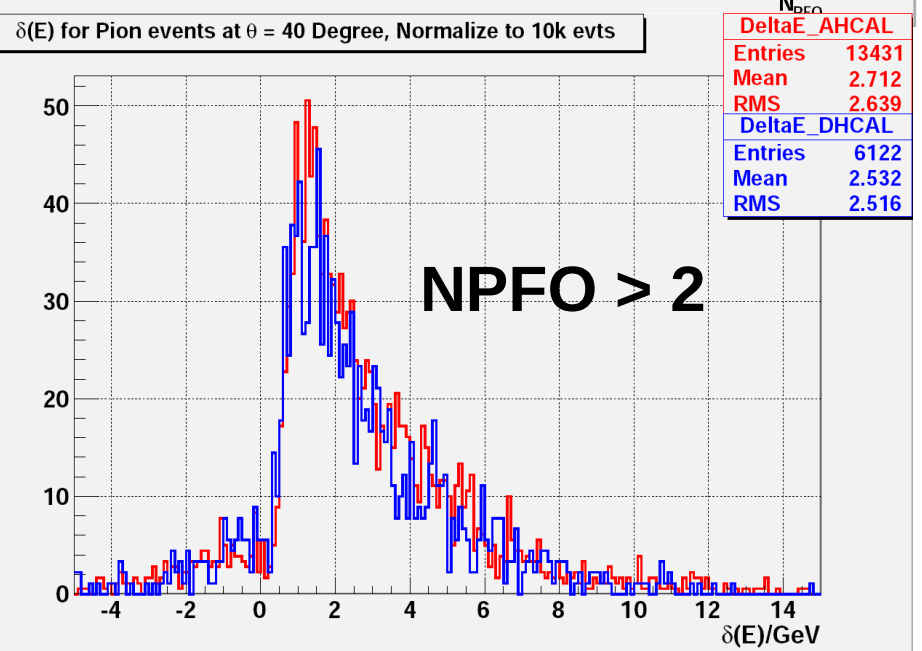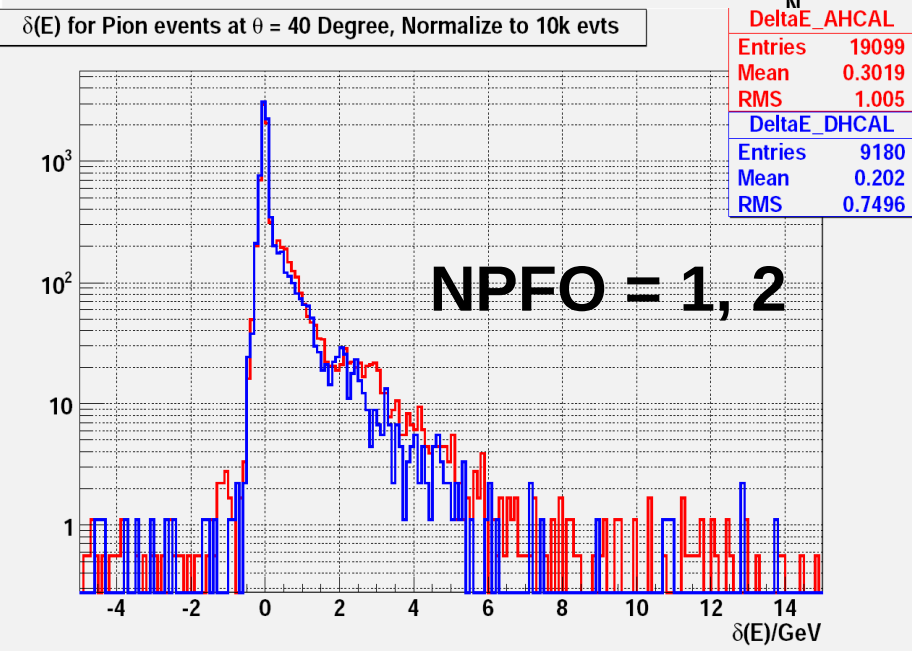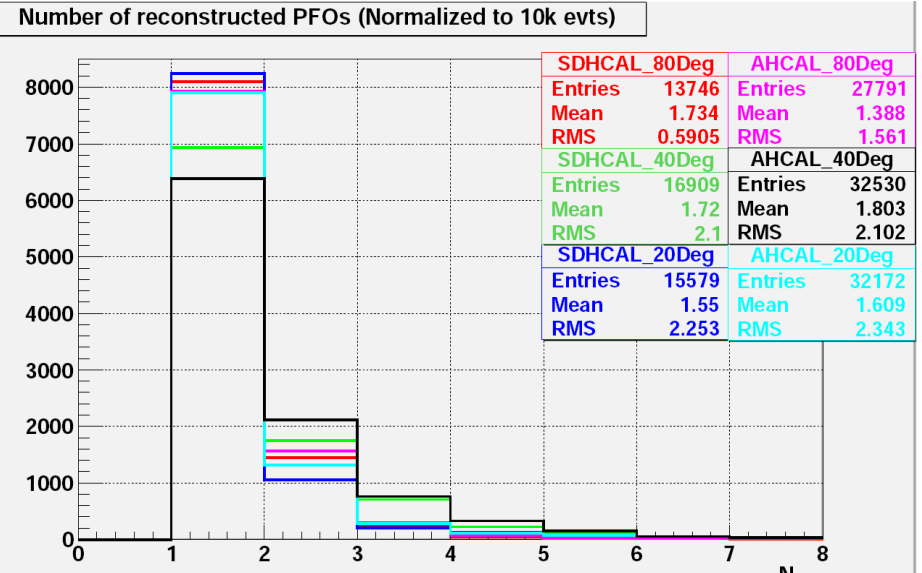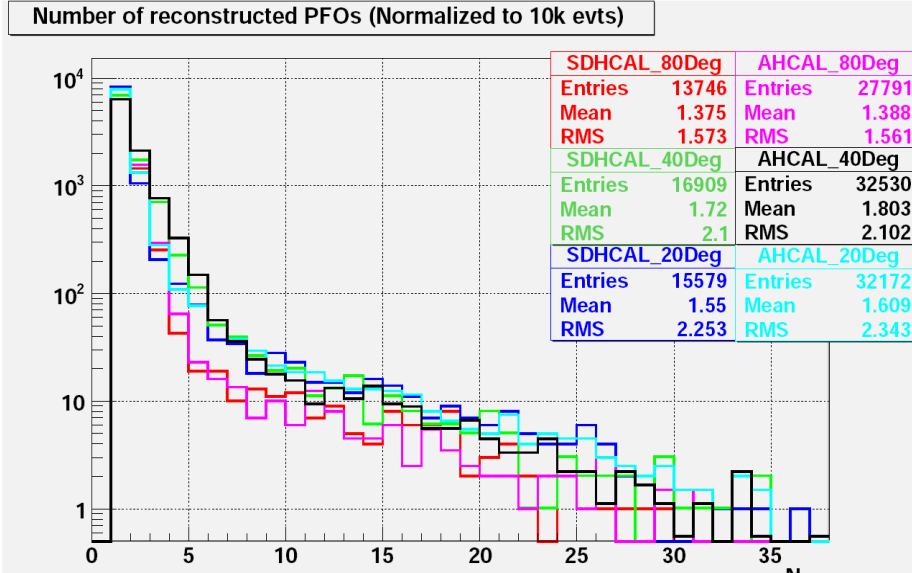
A little surprising: AHCAL has more double PFO events, especially in corner region: Geometrical effects? Neutron effect?

Summary on Pion analysis

- SDHCAL Barrel Region

  - More than 80% events has only one PFO:

    - Lower estimated energy: energy loss, pion decay and track energy resolution smearing

    - Higher estimated case. Very rare. Due to Failed track energy resolution?

  - ~18% events with 2-5 PFOs, most of which coming from wrong cluster splitting, and result in double counted energy. Where we might improve.

  - ~1.4% events has heavy interaction inside the tracker (could happen even at the entrance of TPC), caused lots of uncertainty. Some more dedicated treatment?

- (SDHCAL) Endcap and corner:

  - More interactions, more double counting observed

  - Corner: linking of track – cluster need to be improved (1% ~ 2% events fails, $\theta = 35^\circ - 45^\circ$)

  - Endcap: Larger track energy resolution smearing. Rely more on cluster info?

- Comparing to AHCAL:

  - Similar behaviour

  - More single PFO event in SDHCAL: Geometrical/Neutron effects?

Klong events (SDHCAL)

Klong (90GeV)
can be really penetrate
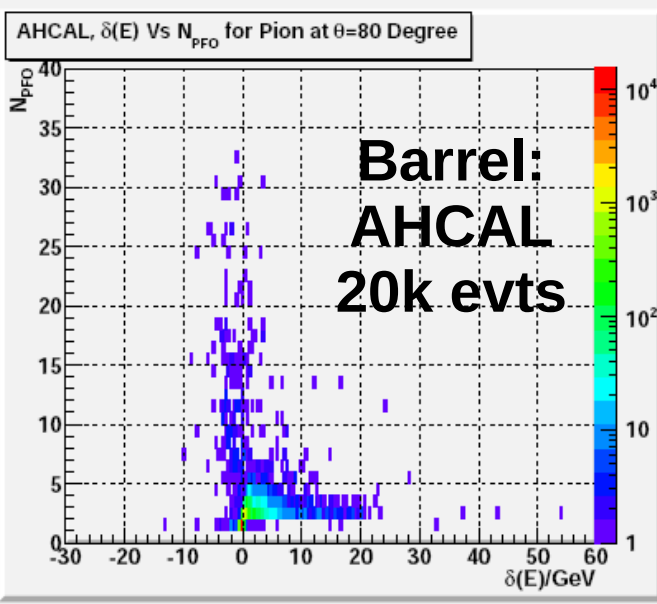deposit only 11GeV energy
in the end of Calo
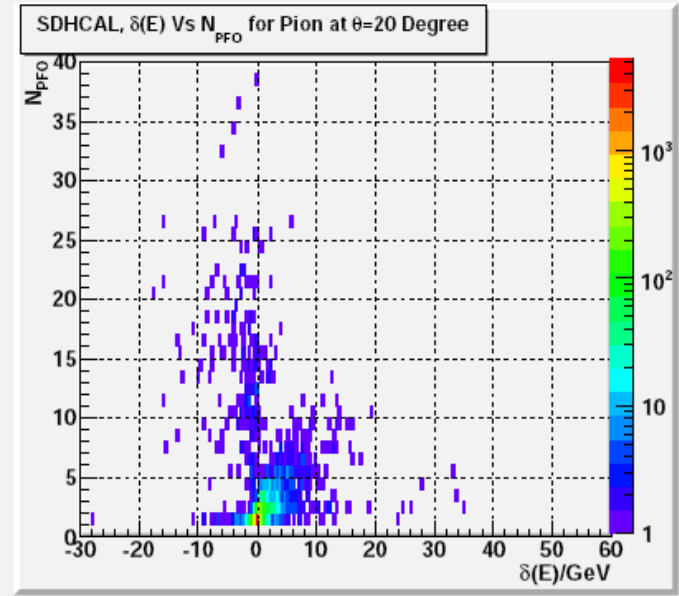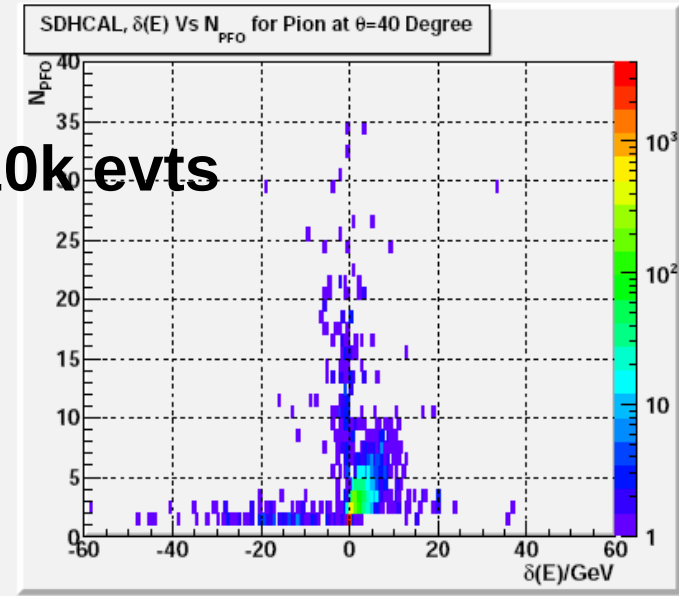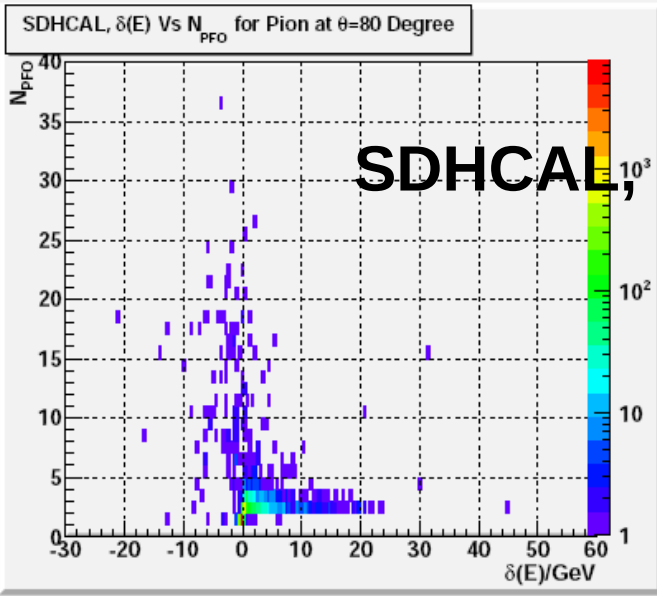
Or create a huge cluster...

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=309, PFO index.=0
Charge=0.000000, PID=2112
Energy=113.645325, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (-1404.870, -2115.811, 290.946)
3-momentum = (-60.302, -94.703, 17.613)

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=1152, PFO index.=0
Charge=0.000000, PID=2112
Energy=11.204000, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (-3307.260, -570.133, 357.817)
3-momentum = (-11.019, -1.522, 1.335)

80GeV Pion, create 127GeV
cluster in the Endcap
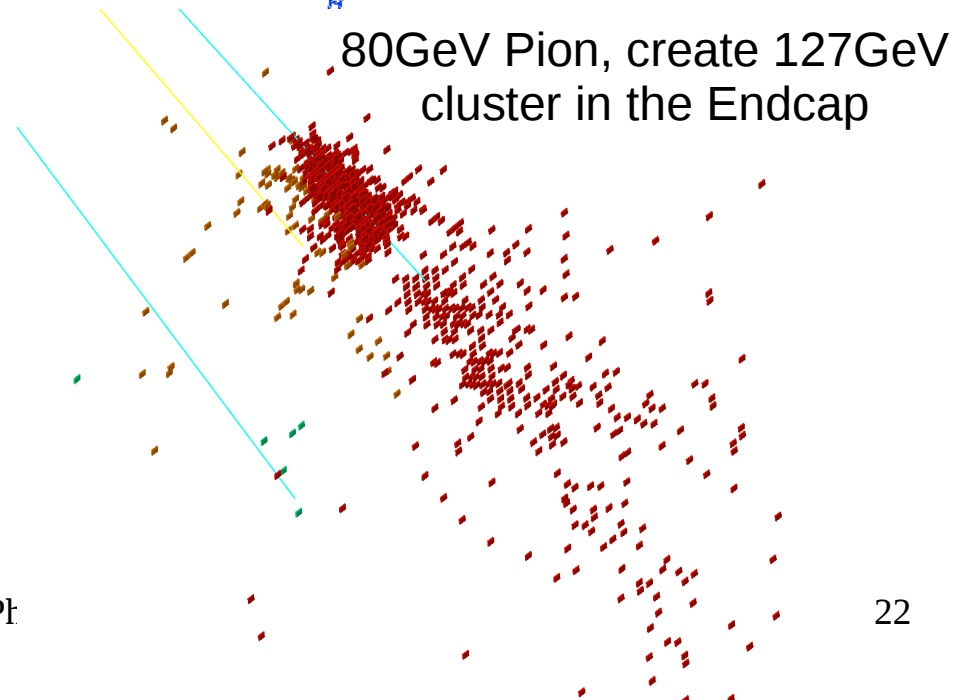
Multiply PFO Klong events
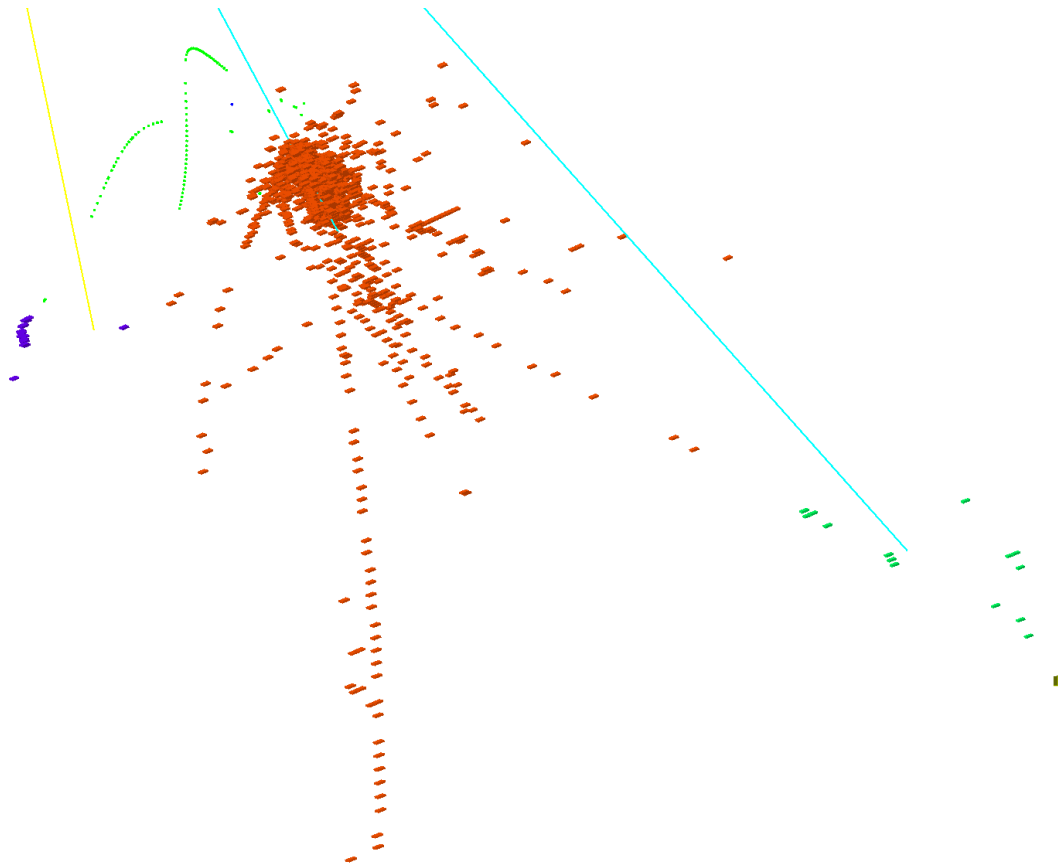
3PFOs: Back scattering + wide HCAL Shower
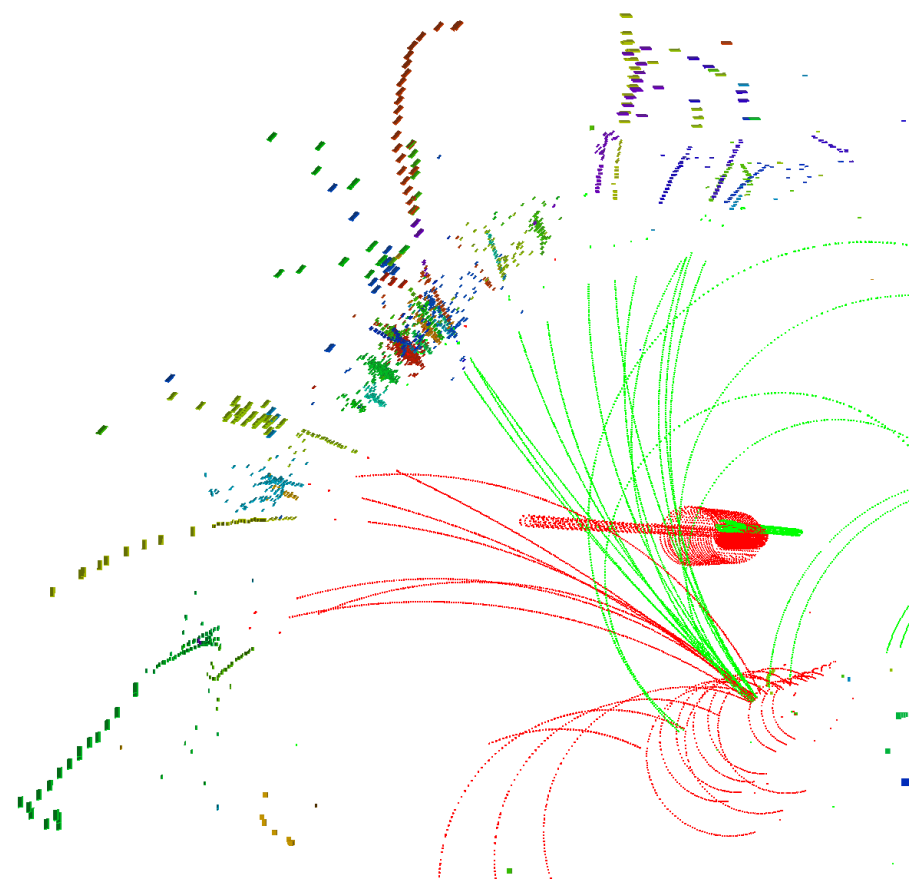
Interaction inside tracker

SDHCAL, Klong
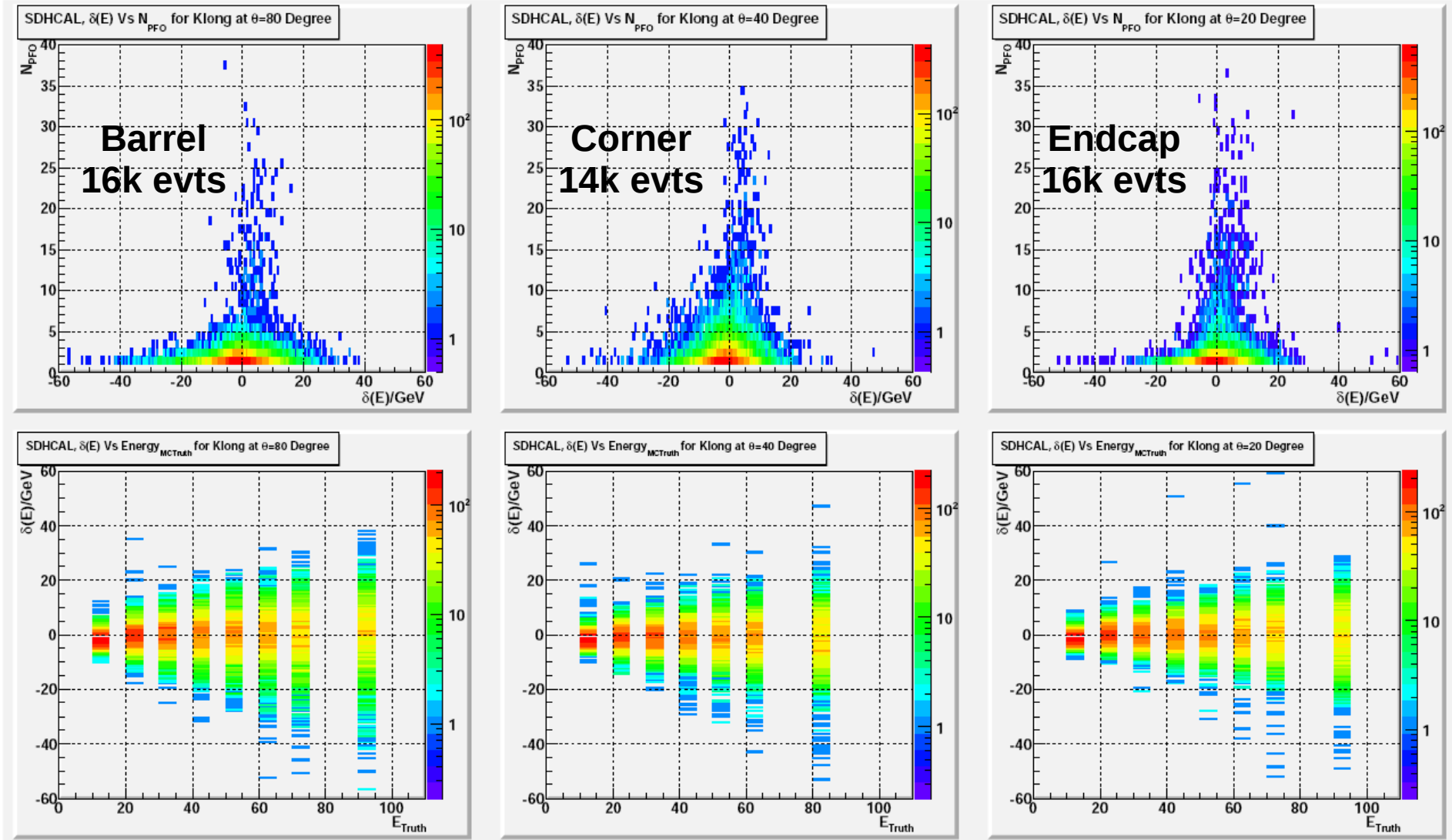
- NPFO(Barrel) < NPFO(EndCap) < NPFO(Corner)

- Large smearing in energy resolution: better energy estimator and correction needed...

AHCAL, Klong
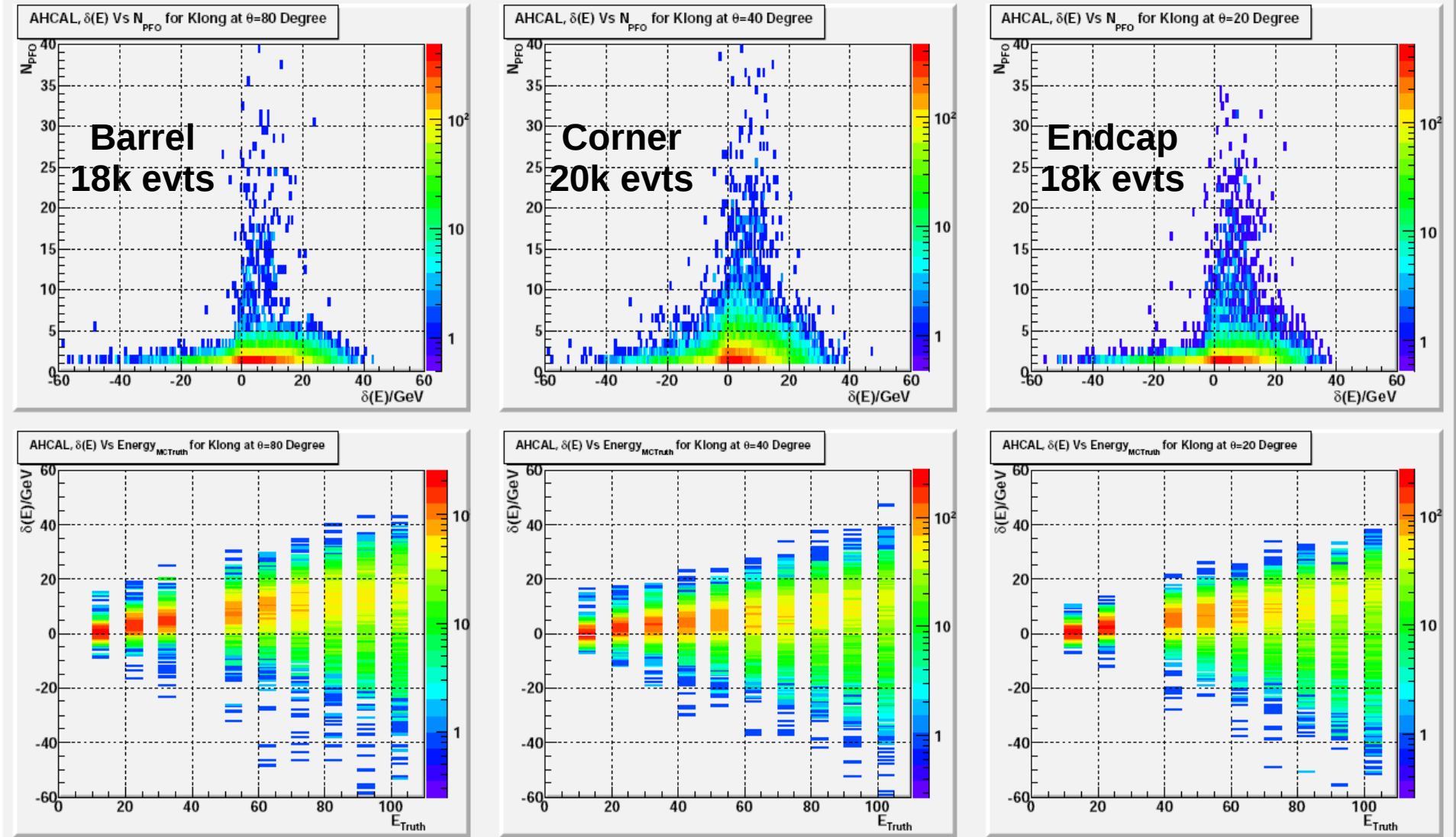
- Energy measurement: biased (Correction included?)

- Asymmetry low energy tail – Leakage

SDHCAL/AHCAL Comparison
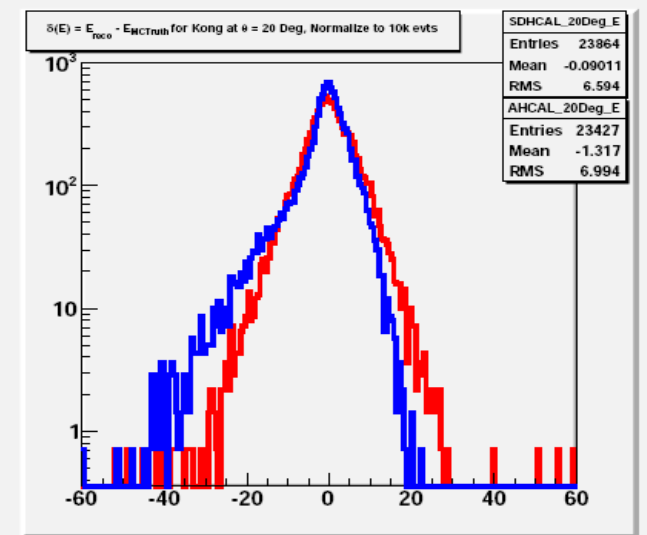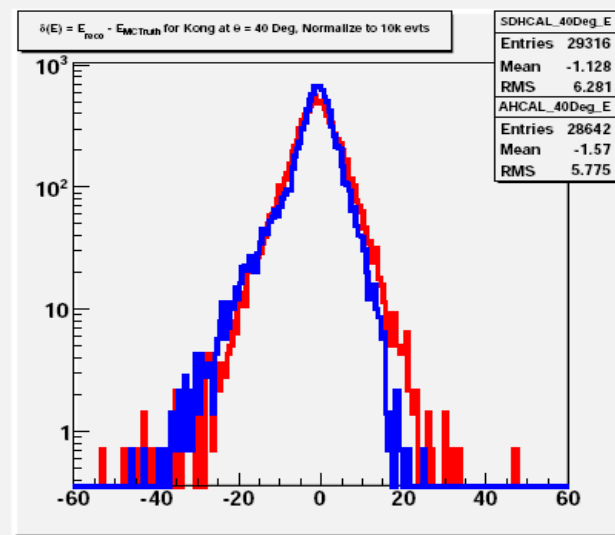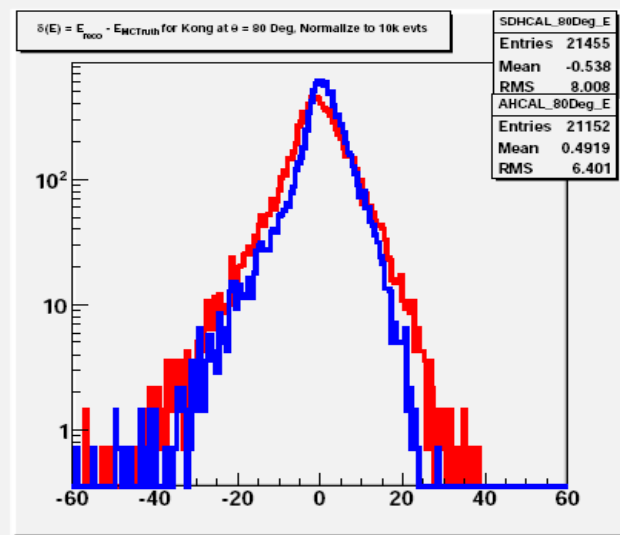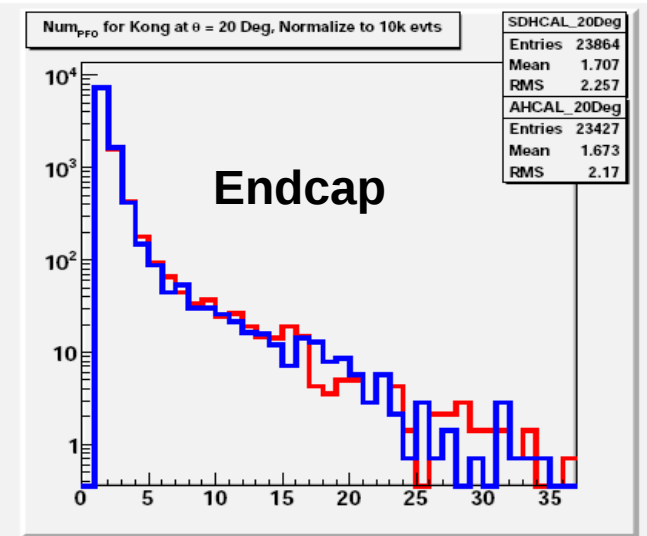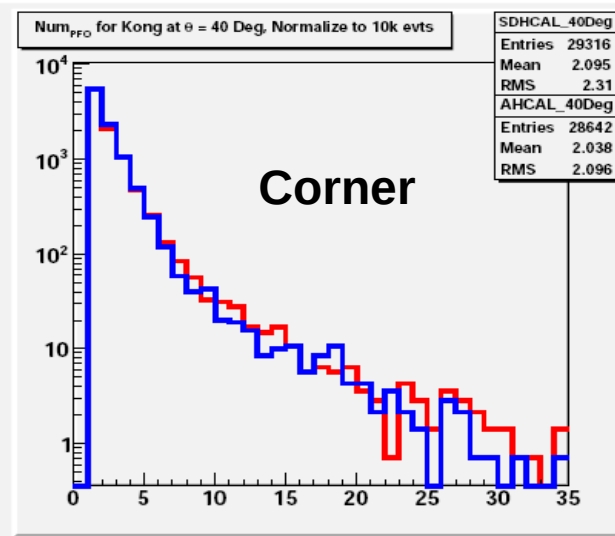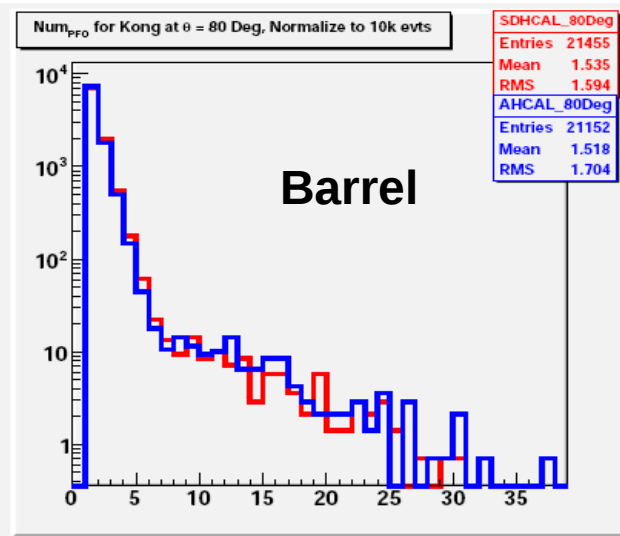
- Similar NPFO distribution (with data files with same set of energies)

- AHCAL has better energy resolution – but larger lower energy tail in Endcap

Summary and Plans

- Study of single particle reconstruction with Pandora:

  - Pion:

    - AHCAL & SDHCAL has similar behaviour. SDHCAL has slightly more Single PFO event, might be geometrical effect: to be distinguished

    - Possible to improve on double counting (~ 10% - 20% of events), track cluster linking in corner, identification and specialized treatment on pre-interaction pion

  - Klong:

    - Similar NPFO for AHCAL & SDHCAL, Leakage correction is needed.

    - Better energy estimator for SDHCAL

- To do: analysis tau (neutron, electron), jet events, disentangle geometrical/sensor effects

- SDHCAL Reco software is progressing in various directions with Looooooong to do list

  - **Identify man power**

  - Parameters & order optimization of PandoraPFA

  - SDHCAL energy estimator & clustering development and integration

  - Testing on benchmark processes at different energy *(qq, ZZ, ZH, ttbar, multiple jet SUSY events...)*

Part II: Plan & Perspective

P & P

- **Simulation:**
  - Validate different concepts in Mokka & cubic model(Gabriel, Ran), Xcheck
  - Central MC generation & data handling (Manqi, Gerald? To make the data accessible for everyone: GRID, CALICE/ILC VO?)

- **SDHCAL Digitization:**
  - Almost there (+ cleaning & validation: Ran, Gerald, Manqi)

- **Reco package based on PandoraPFA:** workable but far from optimized
  - Current Clustering:
    - From Single Pion/Klong event: reasonably good comparing to AHCAL, by sense of double counting, but sure has the potential to improve
    - Further investigation for tau, soft/heavy jet event @ different concepts (Manqi)
    - Optional: improve pre-interaction case (mainly to cooperate with ECAL/Tracker people, play together with Garlic... Manqi, Daniel...?)

P & P

- Reco package based on PFA: Energy Estimation
  - Status: ~ 80%/sqrt(E) ~ **huge potential** to be improve
    - Worse than AHCAL (< 50% after S.C) and even SiD DHCAL (~ 60%)
  - First step: find optimized thresholds/Calibration constants with current clustering
    - Target samples: single pion/klong events *after digitization and clustering* (Imad, Sameh, Manqi)
    - Goal: reach **at least ~ 60%**
  - Second step: using density. etc, to separae the EM cluster & MIP trackers
    - MIP tracks: Kalman Filter + dE/dx (Vincent, Khaled)
  - Iteration with More dedicated clustering
    - Optimize order & parameters for current Pandora (Manqi...)
    - Minimal spanning tree, density analysis & NN (Gerald)
    - Hough transform (Imad, Manqi...)

P & P

- Advanced application:
  - Muon id (Manqi)
  - Physics channel analysis
  - ...

- Task list:
  - To be extended. But first let's focus on the energy estimation with thresholds & calibration constant optimization study
  - Welcome to add your name to any of the listed task

- Organization:
  - Bi weekly meeting, maybe together with the sdhcal analysis meeting
  - Contact us if need any kind of technical support

Part III: How to play with Pandora

Outline

- **Introduction:**

  - (MarlinReco) Reconstruction chain

  - PandoraPFA: Splitted

    – Marlin Pandora: PandoraPFA Plugin to MarlinReco

    – PandoraPFANew: PFA algorithm manager

- **Using Pandora**

  - Installation

  - Setting steering file

  - Accessory

Reconstruction chain

Input: (Mokka) Simulated data

```
<!-- Example steering file for MarlinPandora -->
<marlin>

<execute>
    <processor name="MyMaterialDB"/>
    <processor name="MyTPCDigiProcessor"/>
    <processor name="MyVTXDigiProcessor"/>
    <processor name="MyFTDDigiProcessor"/>
    <processor name="MyETDDigiProcessor"/>
    <!--processor name="MyNewLDCCaloDigi"/-->
    <processor name="MyRPCDHCALCaloDigi"/>
    <processor name="MySimpleMuonDigi"/>
    <processor name="MySimpleLCalDigi"/>
    <processor name="MySimpleLHCalDigi"/>
    <processor name="MyLEPTrackingProcessor"/>
    <processor name="MySiliconTracking"/>
    <processor name="MyFullLDCTracking"/>
    <processor name="MyV0Finder"/>
    <processor name="MyKinkFinder"/>
    <processor name="MyMarlinPandora"/>
    <processor name="MySatoruJetFinderProcessor"/>
    <processor name="MyLCIOOutputProcessor"/>
</execute>
```

User analysis module, LCIO Output module...

LCIO Collections

MCParticle + Detector Hits

Digitization: + Digitized Hits collection

Convert MC energy deposition information to electronic signal, and estimate real physics signal from estimated electronic signal, with systematical effects...

Tracking: + track collection from digitized tracker Hits

Pandora: + Reconstructed Particle collection: PandoraPFO(New) from tracks & Calo Hits

PandoraPFA

- PandoraPFANew: a dependency free PFA algorithm Manager, with lots of pre-defined PFA algorithms.

- MarlinPandora: MarlinReco Plugin. IO & Calibration constants setting

  Dependency: LCIO, PandoraPFANew, Marlin, MarlinUtil, GEAR

```
<processor name="MyMarlinPandora" type="PandoraPFANewProcessor">
  <parameter name="PandoraSettingsXmlFile" type="String">PandoraSettings.xml</parameter>
  <!-- Collection names -->
  <parameter name="TrackCollections" type="StringVec">LDCTracks</parameter>
  <!--parameter name="ECalCaloHitCollections" type="StringVec">ECALBarrel ECALEndcap ECALOther ECALBarrelP
reShower ECALEndcapPreShower ECALOtherPreShower</parameter-->
  <parameter name="ECalCaloHitCollections" type="StringVec">ECALBarrelPreShower ECALBarrel ECALEndcapPreSh
ower ECALEndcap ECALOtherPreShower ECALOther</parameter>
  <parameter name="HCalCaloHitCollections" type="StringVec">HCALBarrel HCALEndcap HCALOther</parameter>
  <parameter name="LCalCaloHitCollections" type="StringVec">LCAL</parameter>
  <parameter name="LHCalCaloHitCollections" type="StringVec">LHCAL</parameter>
  <parameter name="MuonCaloHitCollections" type="StringVec">MUON</parameter>
  <parameter name="MCParticleCollections" type="StringVec">MCParticle</parameter>
  <parameter name="RelCaloHitCollections" type="StringVec">RelationCaloHit</parameter>
  <parameter name="RelTrackCollections" type="StringVec">LDCTracksMCP</parameter>
  <parameter name="V0VertexCollections" type="StringVec">V0Vertices</parameter>
  <parameter name="KinkVertexCollections" type="StringVec">KinkVertices ProngVertices SplitVertices</param
eter>
  <parameter name="PFOCollectionName" type="String">PandoraPFANewPFOs</parameter>
  <!-- Calibration constants -->
  <parameter name="ECalToMipCalibration" type="float">160.0</parameter>
  <parameter name="HCalToMipCalibration" type="float">34.8</parameter>
  <parameter name="ECalMipThreshold" type="float">0.5</parameter>
  <parameter name="HCalMipThreshold" type="float">0.3</parameter>
  <parameter name="ECalToEMGeVCalibration" type="float">1.0</parameter>
  <parameter name="HCalToEMGeVCalibration" type="float">1.0</parameter>
  <parameter name="ECalToHadGeVCalibration" type="float">1.16></parameter>
  <parameter name="HCalToHadGeVCalibration" type="float">1.0</parameter>
  <parameter name="AbsorberRadiationLength" type="float">0.2857</parameter>
  <!--<parameter name="NEventsToSkip" type="int">0</parameter>-->
</processor>
```

Setting PandoraPFA

- Select algorithms, define orders & parameters with PandoraSetting.xml

```xml
<!-- Pandora settings xml file -->

<pandora>
    <!-- Global pandora settings -->
    <IsMonitoringEnabled> true </IsMonitoringEnabled>
    <ShouldUseSimpleIsolationScheme> false </ShouldUseSimpleIsolationScheme>
    <ShouldDisplayAlgorithmInfo> false </ShouldDisplayAlgorithmInfo>

    <!-- Plugin helper functions -->
    <HadronicEnergyCorrectionFunctions> CleanClusters ScaleHotHadrons MuonCoilCorrection MyHadronicEnergyCorrection</HadronicEnergyCorrectionFunctions>
    <PhotonFastFunction> PhotonFastDefault </PhotonFastFunction>
    <ElectronFastFunction> ElectronFastDefault </ElectronFastFunction>
    <MuonFastFunction> MuonFastDefault </MuonFastFunction>

    <!-- Select the tracks to use for clustering -->
    <algorithm type = "TrackSelection"/>

    <!-- Muon clustering -->
    <algorithm type = "PrimaryClustering">
        <algorithm type = "Clustering" description = "ClusterFormation">
            <TanConeAngleHCal>0.75</TanConeAngleHCal>
            <AdditionalPadWidthsHCal>12.5</AdditionalPadWidthsHCal>
            <SameLayerPadWidthsHCal>45</SameLayerPadWidthsHCal>
            <ShouldUseTrackSeed>false</ShouldUseTrackSeed>
            <MaxTrackSeedSeparation>0</MaxTrackSeedSeparation>
            <MaxLayersToTrackSeed>0</MaxLayersToTrackSeed>
            <MaxLayersToTrackLikeHit>0</MaxLayersToTrackLikeHit>
            <TrackPathWidth>0</TrackPathWidth>
        </algorithm>

        <InputCaloHitListName> Muon </InputCaloHitListName>
        <RestoreOriginalCaloHitList> true </RestoreOriginalCaloHitList>
        <ClusterListName> MuonClusterList </ClusterListName>
        <ReplaceCurrentClusterList> false </ReplaceCurrentClusterList>
    </algorithm>

    <!-- Primary clustering algorithm runs Clustering algorithm -->
    <algorithm type = "PrimaryClustering">
        <algorithm type = "Clustering" description = "ClusterFormation" instance = "mainClustering"/>

        <algorithm type = "TopologicalAssociation" description = "ClusterAssociation" instance = "mainTopologicalAssoc">
            <associationAlgorithms>
                <algorithm type = "LoopingTracks"/>
                <algorithm type = "BrokenTracks"/>
                <algorithm type = "ShowerMipMerging"/>
                <algorithm type = "ShowerMipMerging2"/>
                <algorithm type = "BackscatteredTracks"/>
                <algorithm type = "BackscatteredTracks2"/>
                <algorithm type = "ShowerMipMerging3"/>
                <algorithm type = "ShowerMipMerging4"/>
                <algorithm type = "ProximityBasedMerging">
                    <algorithm type = "TrackClusterAssociation"/>
                </algorithm>
                <algorithm type = "ConeBasedMerging">
                    <algorithm type = "TrackClusterAssociation"/>
```

Optimized for AHCAL

Installation

- Pre-installed cmake tool is mandatory (eg, cmake 2.6.4)

- PandoraPFANew:

    cd $PandoraPFANew

    mkdir build

    cd build

    cmake ../

    make install

- MarlinPandora: need pre-installed LCIO, PandoraPFANew, Marlin, MarlinUtil, GEAR. Specify corresponding path in BuildSetup.cmake

    cd $MarlinPandora

    mkdir build

    cd build

    cmake -C ../BuildSetup.cmake ..

    make install

To use PandoraPFA

- Pre installed MarlinReco (cmake, LCIO, Marliln, MarlinUtil, GEAR... can be all installed by ilcinstall) : define Digitization & Tracking algorithms

- Replace DHCAL digitization module with our digitization

- Load corresponding libraries by setting MARLIN_DLL (. loadLDD.sh)

```bash
#!bin/bash

unset MARLIN_DLL

export MARLIN_DLL=/home/manqi/Softwares/ilcsoft/v01-08-01/MarlinUtil/v00-14-01/lib/libMarlinUtil.so:/home/manqi/Softwares/ilcsoft/v01-08-01/gsl/1.8/lib/libgsl.so:/home/manqi/Softwares/ilcsoft/v01-08-01/MarlinReco/trunk/lib/libMarlinReco.so

export MARLIN_DLL=$MARLIN_DLL:/home/manqi/Softwares/PFA/PandoraPFA/Official_1/PandoraPFA/lib/libPandoraPFANew.so

#export MARLIN_DLL=$MARLIN_DLL:/home/manqi/Softwares/PFA/PandoraPFA/Official_1/MarlinPandora/lib/libMarlinPandora.so
export MARLIN_DLL=$MARLIN_DLL:/home/manqi/Softwares/PFA/PandoraPFA/Official_1/MarlinPandoraManqi/lib/libMarlinPandora.so

#For Digitization
export MARLIN_DLL=$MARLIN_DLL:/home/manqi/Softwares/MarlinTools/DHCALMIPDigi/lib/libRPCDHCALCaloDigi.so

export MARLIN=/home/manqi/Softwares/ilcsoft/v01-08-01/Marlin/v00-11
export LCIO=/home/manqi/Softwares/ilcsoft/v01-08-01/lcio/v01-12-02
export PATH=$PATH:$MARLIN/bin:$LCIO/bin

echo $MARLIN_DLL


#export MARLIN_DLL=/opt/exp_soft/ilc/LOCAL_LLR/ilcsoft//v01-06/MarlinUtil/v00-13/lib/libMarlinUtil.so:/home/llr/ilc/reinhard/ILC
Soft/MarlinReco/lib/libMarlinReco.so:/opt/exp_soft/ilc/LOCAL_LLR/ilcsoft//v01-06/gsl/1.8/lib/libgsl.so:/home/llr/ilc/reinhard/IL
CSoft/GARLIC_v1-5/lib/libGARLIC.so:/home/llr/ilc/ruan/PFA/tag-1.22/lib/libPandoraPFANew.so
```
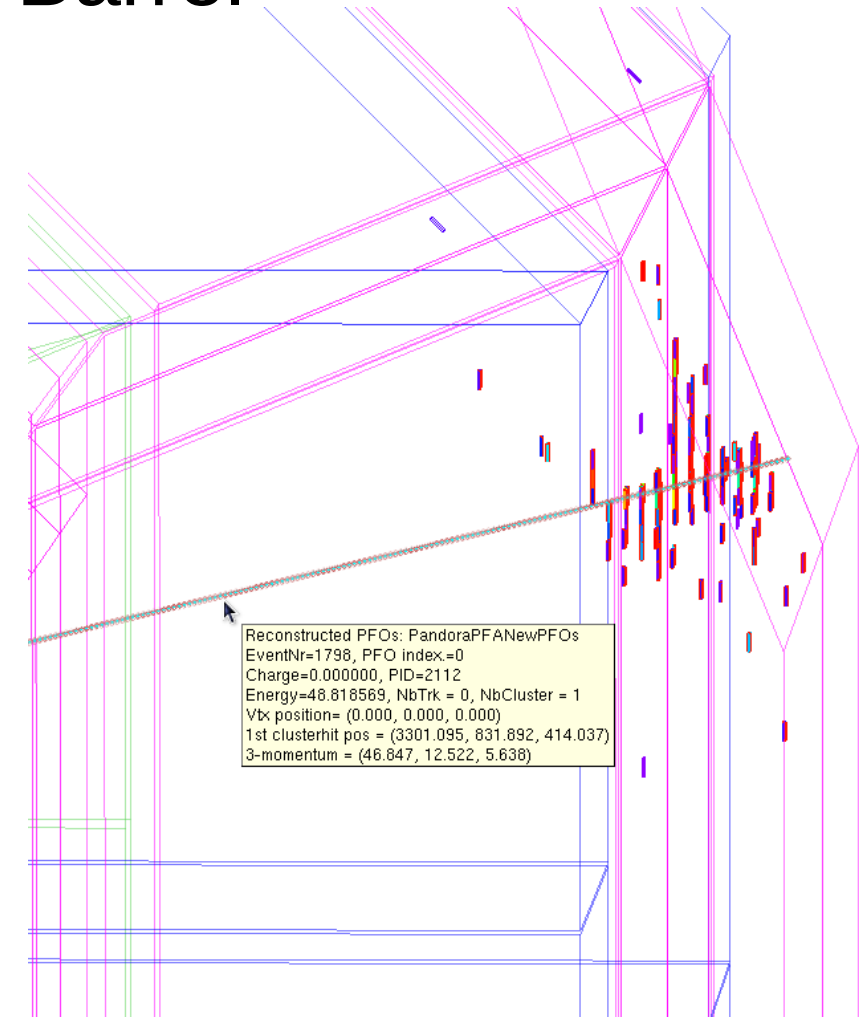
- To use PandoraPFA : straight forward

  – Specify IO, reference files (gear file, PandoraSetting) in steering file

  – To run: Marlin *.xml

Accessory

- **Official SVN (latest version)**
  - https://svnsrv.desy.de/public/PandoraPFANew/MarlinPandora/tags/v00-03/
  - https://svnsrv.desy.de/public/PandoraPFANew/PandoraPFANew/tags/v00-04/

- **My webpage (old version) http://polywww.in2p3.fr/~ruan/PFATutorial**
  - Tar ball of source file for PandoraPFA, MarlinPandora
  - Example steering file and data file for Klong @ ILD00, ILD00_Dhcal
  - Reference gear file, Pandorasetting.xml
  - Example digitization module

- **If needed, example analysis code based on lcio information could be released.**

BK Slides

Lower estimated energy in AHCAL Barrel

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=623, PFO index.=0
Charge=0.000000, PID=2112
Energy=42.726776, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (3404.531, -1263.613, 715.168)
3-momentum = (38.933, -14.697, 9.684)

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=1798, PFO index.=0
Charge=0.000000, PID=2112
Energy=48.818569, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (3301.095, 831.892, 414.037)
3-momentum = (46.847, 12.522, 5.638)

100GeV Klong at θ = 80º. High penetrating events, interact deep inside HCAL.

Left (evt 623), Reconstructed Energy 42.7GeV.
Right (evt 1798), Reconstructed Energy 48.8GeV

Reconstructed PFOs: PandoraPFANewPFOs
EventNr=47, PFO index.=0
Charge=0.000000, PID=2112
Energy=44.300461, NbTrk = 0, NbCluster = 1
Vtx position= (0.000, 0.000, 0.000)
1st clusterhit pos = (204.613, 1270.960, 4054.333)
3-momentum = (1.653, 13.122, 42.280)
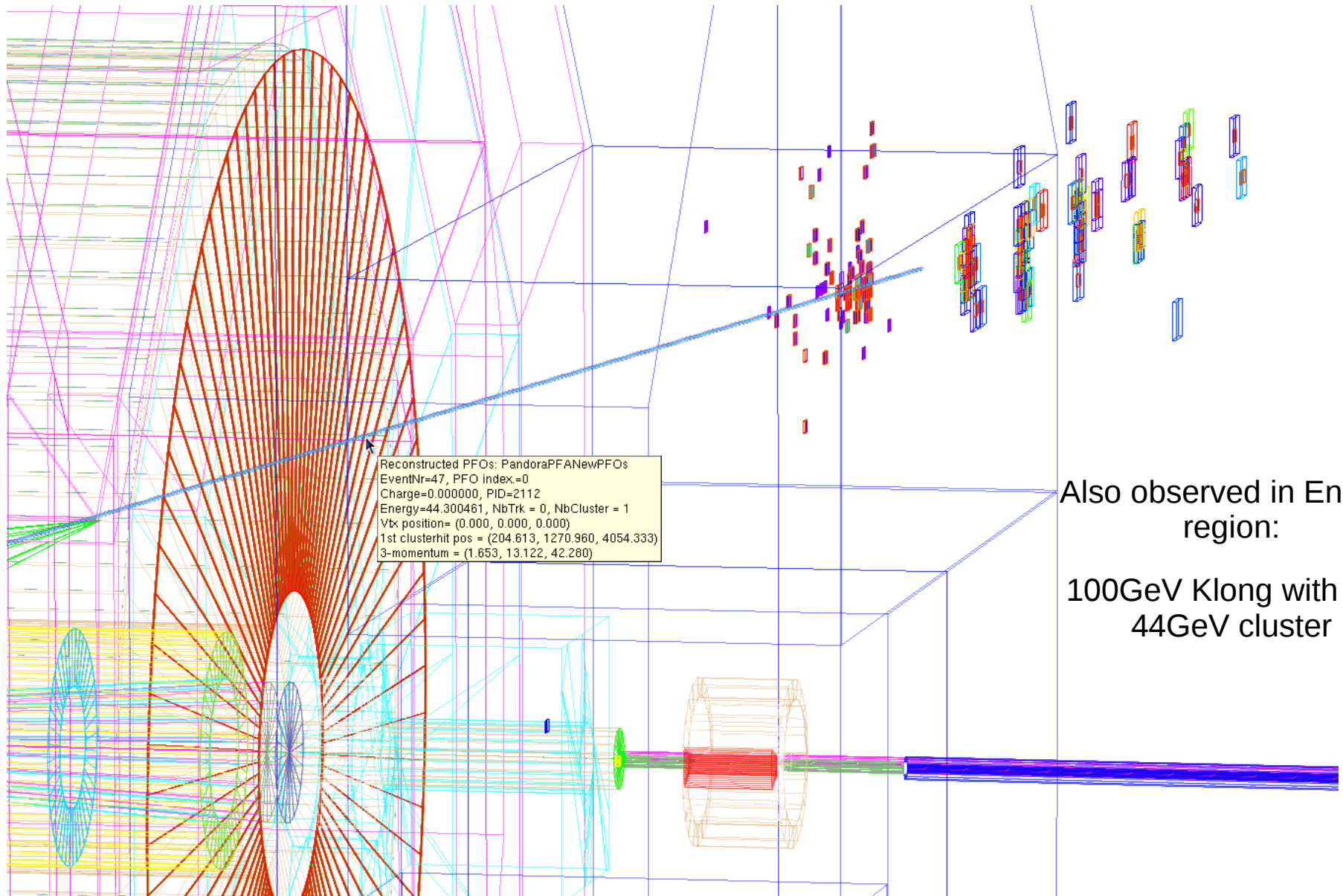
Also observed in Endcap region:

100GeV Klong with only 44GeV cluster
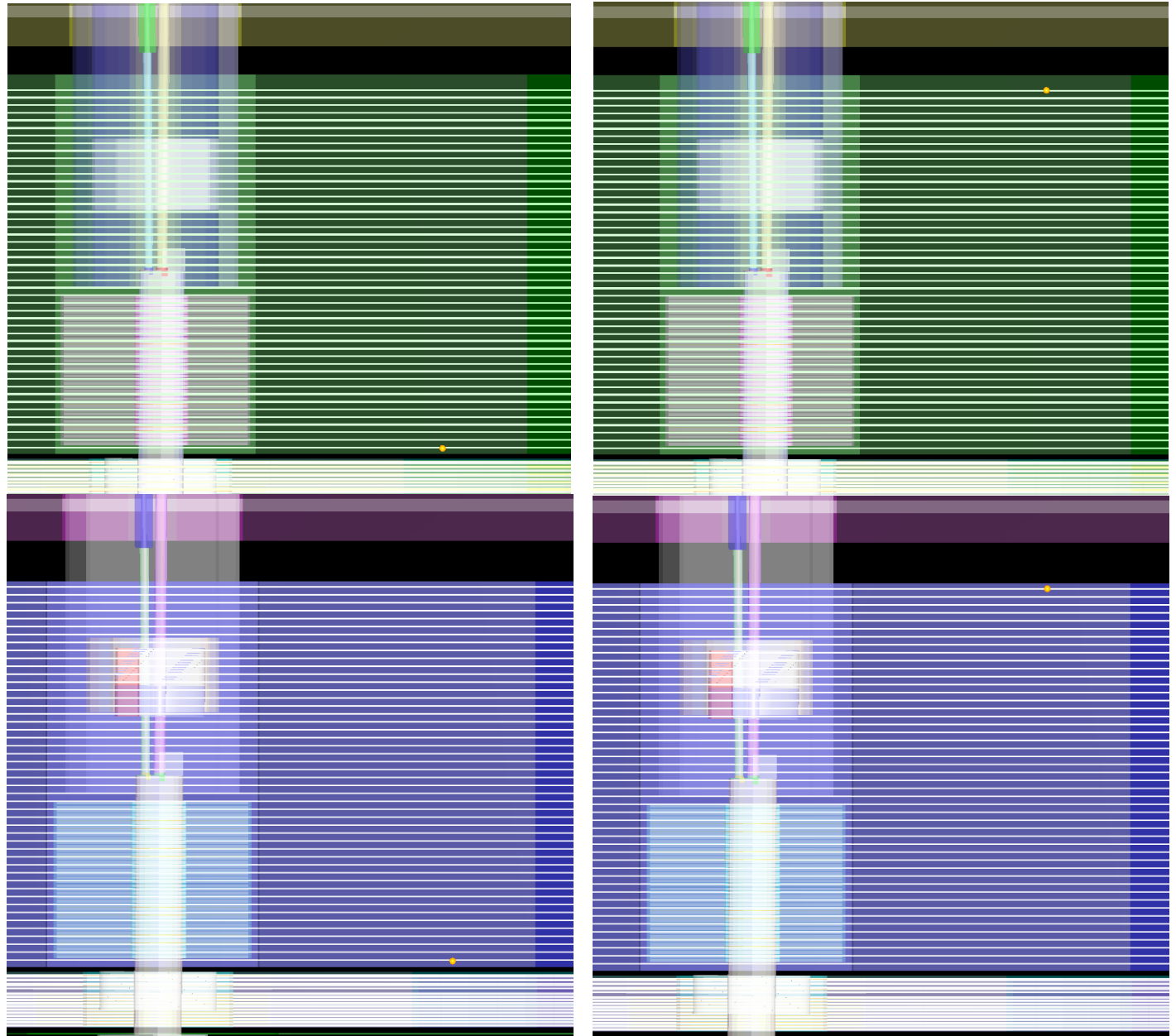
Checking geometry

Checking from gdml

Above: SDHCAL
below: AHCAL

Reference points (cm):
(100, 0, 267), (100, 0, 392)

Sensor layer location is the
same, but has more iron
(~3cm) in the SDHCAL
Endcap back...

Digitization & calibration

- Preliminary DHCAL Digitization module based on latest cosmic ray experiment: convert the energy deposition information into the induced charge

- Specify thresholds (0.6pC, 15pC and 30pC, corresponding to 0.2, 5 and 10 mips) on induced charge. Calibration constant fixed by Klong samples.

< 0.6 pC, inefficient hit
(~98.3% of overall efficiency)
<0.6 - 15pC> = 5.73 pC ~ 32 MeV
<15 - 30pC> = 20.93 pC ~ 145 MeV
< > 30 pC> = 94.8 pC ~ 560 MeV