

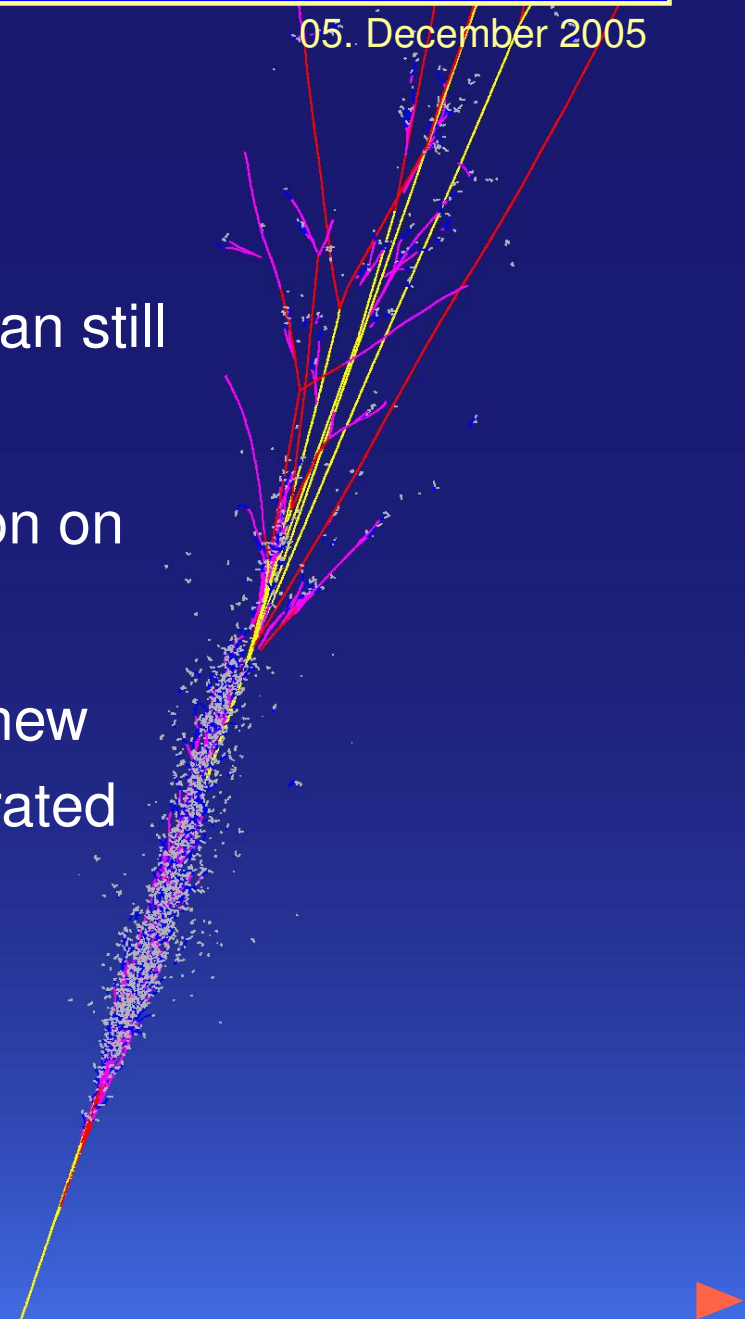
How to make new Jets from Calibrated Topo Clusters

MPI ATLAS Meeting

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05. December 2005

- ▶ What is available on ESD/AOD and what can still be re-done using them
- ▶ What to expect from local hadron calibration on topo clusters
- ▶ Step-by-step example on how to create a new ESD and new AOD with `KtJet` using calibrated `TopoCluster` objects as input



What is available on ESD/AOD

- ▶ check the contents of any pool file (ESD/AOD/TAG) with the following athena commad:

- `athena -c "In=['AOD.pool.root']" AthenaPoolUtilities/EventCount.py`
- replace `AOD.pool.root` with the filename of the pool file you want to check
- typical result for AOD (11.0.2):

```
EventCount      INFO -> 2101 EventInfo (5)
EventCount      INFO - McEventInfo
EventCount      INFO -> 2806 Unknown (40)
EventCount      INFO - CaloTopoCluster
EventCount      INFO - CombinedCluster
EventCount      INFO - EMTopoCluster
EventCount      INFO - LArClusterEM
EventCount      INFO - LArClusterEM33
EventCount      INFO - LArClusterEM35
EventCount      INFO - LArClusterEM37
EventCount      INFO - LArClusterEMSoft
EventCount      INFO -> 133273 Unknown (5)
EventCount      INFO - GEN_AOD
EventCount      INFO -> 9327453 Unknown (10)
EventCount      INFO - VKalPrimVxCollection
EventCount      INFO - VxPrimaryCandidate
EventCount      INFO -> 73891892 Unknown (10)
EventCount      INFO - MET_Base
EventCount      INFO - MET_Calib
EventCount      INFO -> 73891893 Unknown (5)
EventCount      INFO - MET_Truth
EventCount      INFO -> 75817330 Unknown (45)
EventCount      INFO - MET_Base
EventCount      INFO - MET_Calib
EventCount      INFO - MET_Cryo
EventCount      INFO - MET_CryoCone
EventCount      INFO - MET_Final
EventCount      INFO - MET_Muon
EventCount      INFO - MET_MuonBoy
EventCount      INFO - MET_Topo
EventCount      INFO - MET_Truth
EventCount      INFO -> 77883132 Unknown (5)
EventCount      INFO - SpelMC
EventCount      INFO -> 222376821 DataHeader (5)
EventCount      INFO - StreamAOD
EventCount      INFO -> 1073853171 Unknown (10)
EventCount      INFO - MuidMuonCollection
EventCount      INFO - StacoMuonCollection
EventCount      INFO -> 1094973728 Unknown (5)
EventCount      INFO - PhotonCollection
EventCount      INFO -> 1100041527 Unknown (5)
EventCount      INFO - TauJetCollection
EventCount      INFO -> 1118613496 Unknown (30)
EventCount      INFO - Cone4TowerParticleJets
EventCount      INFO - Cone4TruthParticleJets
EventCount      INFO - ConeTowerParticleJets
EventCount      INFO - ConeTruthParticleJets
EventCount      INFO - KtTowerParticleJets
EventCount      INFO - KtTruthParticleJets
EventCount      INFO -> 1163046103 Unknown (5)
EventCount      INFO - BJetCollection
EventCount      INFO -> 1235574503 Unknown (5)
EventCount      INFO - MuonEntryRecordFilter
EventCount      INFO -> 1314707306 Unknown (5)
EventCount      INFO - TrackParticleTruthCollection
EventCount      INFO -> 1324108263 INavigable4MomentumCo
llection (15)
EventCount      INFO - CaloTopoCluster
EventCount      INFO - LArClusterEM
EventCount      INFO - TrackParticleCandidate
EventCount      INFO -> 1334834594 Unknown (40)
EventCount      INFO - MooreTrackParticles
EventCount      INFO - MuTagTrackParticles
EventCount      INFO - MuidCombTrackParticles
EventCount      INFO - MuidExtrTrackParticles
EventCount      INFO - MuonboyMuonSpectroOnlyTrackP
articles
EventCount      INFO - MuonboyTrackParticles
EventCount      INFO - StacoTrackParticles
EventCount      INFO - TrackParticleCandidate
EventCount      INFO -> 1341992142 Unknown (5)
EventCount      INFO - ElectronCollection
EventCount      INFO -> 1667842791 Unknown (60)
EventCount      INFO - BJetCollection
EventCount      INFO - Cone4TowerParticleJets
EventCount      INFO - Cone4TruthParticleJets
EventCount      INFO - ConeTowerParticleJets
EventCount      INFO - ConeTruthParticleJets
EventCount      INFO - ElectronCollection
EventCount      INFO - KtTowerParticleJets
EventCount      INFO - KtTruthParticleJets
EventCount      INFO - MuidMuonCollection
EventCount      INFO - PhotonCollection
EventCount      INFO - StacoMuonCollection
EventCount      INFO - TauJetCollection
```

What is available on AOD

- ▶ short description of the individual lines
 - lines like `EventCount INFO -> 2806 Unknown (40)` show that 40 objects of type 2806 (`clid 2806 = CaloClusterContainer`) are present
 - the following lines list the names of the individual containers – 8 in this case
 - since those 8 are present in each of the 5 events we get 40 in total
- ▶ higher level objects like missing ET, photons, electrons, muons, jets, etc. are on the AOD
- ▶ the lowest level calorimeter object available on the AOD is the `CaloCluster` **BUT** without the `CaloCellContainer`!
 - this means you can use the 4-vector of the clusters and some other pre-calculated quantities (moments) and even make new jets out of the existing clusters.
 - you can not re-calibrate the clusters
 - you can not re-calibrate the jets made out of clusters
 - since all calibrations are based on `CaloCell` content of the jets/clusters

What is available on ESD

► typical contents of ESD in 11.0.2:

```
EventCount      INFO -> 2101 EventInfo (5)
EventCount      INFO - McEventInfo
EventCount      INFO -> 2802 Unknown (5)
EventCount      INFO - AllCalo
EventCount      INFO -> 2804 Unknown (5)
EventCount      INFO - CombinedTower
EventCount      INFO -> 2806 Unknown (40)
EventCount      INFO - CaloTopoCluster
EventCount      INFO - CombinedCluster
EventCount      INFO - EMTopoCluster
EventCount      INFO - LArClusterEM
EventCount      INFO - LArClusterEM33
EventCount      INFO - LArClusterEM35
EventCount      INFO - LArClusterEM37
EventCount      INFO - LArClusterEMSoft
EventCount      INFO -> 3127 Unknown (10)
EventCount      INFO - egammaCollection
EventCount      INFO - softCollection
EventCount      INFO -> 3176 Unknown (5)
EventCount      INFO - MytauContainer
EventCount      INFO -> 133273 Unknown (5)
EventCount      INFO - TruthEvent
EventCount      INFO -> 9327453 Unknown (5)
EventCount      INFO - VxPrimaryCandidate
EventCount      INFO -> 73891892 Unknown (10)
EventCount      INFO - MET_Base
EventCount      INFO - MET_Calib
EventCount      INFO -> 73891893 Unknown (5)
EventCount      INFO - MET_Truth
EventCount      INFO -> 75817330 Unknown (45)
EventCount      INFO - MET_Base
EventCount      INFO - MET_Calib
EventCount      INFO - MET_Cryo
EventCount      INFO - MET_CryoCone
EventCount      INFO - MET_Final
EventCount      INFO - MET_Muon
EventCount      INFO - MET_MuonBoy
EventCount      INFO - MET_Topo
EventCount      INFO - MET_Truth
EventCount      INFO -> 117682415 Unknown (20)
EventCount      INFO - ConvertedMBoyTracks
EventCount      INFO - ConvertedMooreTracks
EventCount      INFO - ConvertedStacoTracks
EventCount      INFO - Tracks
EventCount      INFO -> 222376821 DataHeader (5)
EventCount      INFO - StreamESD
EventCount      INFO -> 1123853143 Unknown (30)
EventCount      INFO - MboyESDMuonContainer
EventCount      INFO - MuidCombinedMuonContainer
EventCount      INFO - MuidCombinedMuonContainerLowPt
EventCount      INFO - MuidExtrCombinedMuonContainer
EventCount      INFO - StacoCombinedMuonContainer
EventCount      INFO - StacoCombinedMuonContainerLowPt
EventCount      INFO -> 1162448536 Unknown (45)
EventCount      INFO - Cone4ParticleJets
EventCount      INFO - Cone4TowerJets
EventCount      INFO - Cone4TruthJets
EventCount      INFO - ConeParticleJets
EventCount      INFO - ConeTowerJets
EventCount      INFO - ConeTruthJets
EventCount      INFO - KtParticleJets
EventCount      INFO - KtTowerJets
EventCount      INFO - KtTruthJets
EventCount      INFO -> 1235574503 Unknown (5)
EventCount      INFO - MuonEntryRecordFilter
EventCount      INFO -> 1236535072 Unknown (5)
EventCount      INFO - TrackTruthCollection
EventCount      INFO -> 1278423365 Unknown (40)
EventCount      INFO - CaloTopoCluster_Data
EventCount      INFO - CombinedCluster_Data
EventCount      INFO - EMTopoCluster_Data
EventCount      INFO - LArClusterEM33_Data
EventCount      INFO - LArClusterEM35_Data
EventCount      INFO - LArClusterEM37_Data
EventCount      INFO - LArClusterEMSoft_Data
EventCount      INFO - LArClusterEM_Data
EventCount      INFO -> 1314707306 Unknown (5)
EventCount      INFO - TrackParticleTruthCollection
EventCount      INFO -> 1324108263 INavigable4MomentumCollection (95)
EventCount      INFO - AllCalo
EventCount      INFO - CaloTopoCluster
EventCount      INFO - CombinedCluster
EventCount      INFO - CombinedTower
EventCount      INFO - Cone4ParticleJets
EventCount      INFO - Cone4TowerJets
EventCount      INFO - Cone4TruthJets
EventCount      INFO - ConeParticleJets
EventCount      INFO - ConeTowerJets
EventCount      INFO - ConeTruthJets
EventCount      INFO - EMTopoCluster
EventCount      INFO - KtParticleJets
EventCount      INFO - KtTowerJets
EventCount      INFO - KtTruthJets
EventCount      INFO - LArClusterEM
EventCount      INFO - LArClusterEM33
EventCount      INFO - LArClusterEM35
EventCount      INFO - LArClusterEM37
EventCount      INFO - TrackParticleCandidate
EventCount      INFO -> 1327319901 Unknown (40)
EventCount      INFO - CaloTopoCluster_Link
EventCount      INFO - CombinedCluster_Link
EventCount      INFO - EMTopoCluster_Link
EventCount      INFO - LArClusterEM33_Link
EventCount      INFO - LArClusterEM35_Link
EventCount      INFO - LArClusterEM37_Link
EventCount      INFO - LArClusterEMSoft_Link
EventCount      INFO - LArClusterEM_Link
EventCount      INFO -> 1334834594 Unknown (40)
EventCount      INFO - MooreTrackParticles
EventCount      INFO - MuTagTrackParticles
EventCount      INFO - MuidCombTrackParticles
EventCount      INFO - MuidExtrTrackParticles
EventCount      INFO - MuonboyMuonSpectroOnlyTrackParticles
EventCount      INFO - MuonboyTrackParticles
EventCount      INFO - StacoTrackParticles
EventCount      INFO - TrackParticleCandidate
```

What is available on ESD, cont'd

- ▶ the ESD contains all the reco objects needed to re-do the AOD
- ▶ for calorimetry we have the (compactified) `CaloCellContainer` with the `StoreGate` key `AllCalo`.
 - the cluster/tower objects on the ESD have pointers to their constituents in this container
 - using the existing clusters already allows for re-doing jets and other higher level objects including calibration
 - but you can even re-do the clusters (and calibrate them on the way) if you want
- ▶ only caveat for calorimetry on using ESD instead of digitized pool files is that the `CaloCellContainer` has compactified information (17 instead of 195 bits) and you might get small (much less than actual resolution) changes in the reconstructed energy

Create new ESD/AOD

- ▶ if you have already an ESD produced with `11.0.X` you can use the ESD and just re-make the topo clusters with calibration
- ▶ if you have only ESD produced with `10.X.X` or earlier you need a new ESD
- ▶ first example is how to make a new ESD with calibrated topo clusters in `athena-11.0.2`:
 - `cmt co Reconstruction/RecExample/RecExCommon`
 - `cd Reconstruction/RecExample/RecExCommon/RecExCommon-*/run`
 - `source ../cmt/setup.sh`
 - `cmt gmake`
 - `source ../share/RecExCommon_links.sh`
 - include in `myTopOptions.py` the line:
`include ("CaloClusterCorrection/CaloTopoLocalCalib_jobOptions.py")`
 - `athena myTopOptions.py`
 - creates ESD, AOD, TAG and CBNT
- ▶ re-doing (calibrated) clusters from an existing ESD in `athena-11.0.2`:
 - include in the beginning of `myTopOptions.py` the lines:
`readESD = TRUE`
`doCaloTopoCluster = TRUE`
 - and somewhere in the end of `myTopOptions.py` the line:
`include ("CaloClusterCorrection/CaloTopoLocalCalib_jobOptions.py")`
 - `athena myTopOptions.py`
 - creates new ESD, AOD, TAG and CBNT from old ESD
- ▶ in general any of the `doSomething` flags will re-make the object `Something` even if it is available on the ESD you read from

Create new KtJet from topo clusters

- ▶ assume that you have ESD with (calibrated) topo clusters and you want to have `KtJets` made and written to new ESD and AOD in `athena-11.0.2`:

- `cmt co Reconstruction/RecExample/RecExCommon`
- `cd Reconstruction/RecExample/RecExCommon/RecExCommon-*/run`
- `source ../cmt/setup.sh`
- `cmt gmake`
- `source ../share/RecExCommon_links.sh`
- create a file `KtTopoJet_jobOptions.py`:

```
-----
#
# jobOptions for JetRec package
#
#
#-----
# DLL Libraries
#-----
theApp.Dlls += [ "JetRec" ]
theApp.Dlls += [ "CaloUtils" ]
#-----
# Algorithm steering
#-----
theApp.topAlg += [ "JetAlgorithm/KtTopoJets" ]
# -- input container
KtTopoJets = Algorithm( "KtTopoJets" )
KtTopoJets.InputCollectionNames = [ "CaloTopoCluster" ]
KtTopoJets.JetCollectionName = "KtTopoJets"

if not 'doJetMonitoring' in dir():
    doJetMonitoring = False

# -- setup with jet monitoring
if doJetMonitoring:
    KtTopoJets.AlgTools = [
        "JetTowerNoiseTool/DoNoise",
        "JetSignalSelectorTool/InitialEtCut",
        "JetPreClusterTool/PreClustering",
        "JetMonitorTool/PreClusterMonitor",
        "JetKtFinderTool/KtFinder",
        "JetMonitorTool/KtFinderMonitor",
        "JetCellCalibratorTool/CellCalibrator",
        "JetMonitorTool/CalibMonitor",
        "JetSignalSelectorTool/FinalEtCut",
        "JetMonitorTool/SelectionMonitor" ]
# -- setup without jet monitoring
else:
    KtTopoJets.AlgTools = [
        "JetTowerNoiseTool/DoNoise",
        "JetSignalSelectorTool/InitialEtCut",
        "JetPreClusterTool/PreClustering",
        "JetKtFinderTool/KtFinder",
        "JetCellCalibratorTool/CellCalibrator",
        "JetSignalSelectorTool/FinalEtCut" ]
#
#-----
# AlgTool steering
#
# -- JetTowerNoiseTool
#KtTopoJets.DoNoise.towerContainer = "CombinedTower"
# -- JetPreClusterTool
#KtTopoJets.PreClustering.OutputLevel = INFO
#KtTopoJets.PreClustering.ClusterRadius = 0.2
#
# -- JetKtFinderTool (defaults)
KtTopoJets.KtFinder.BeamType = "pp"
KtTopoJets.KtFinder.BistsScheme = "DeltaR"
KtTopoJets.KtFinder.RecomScheme = "E"
KtTopoJets.KtFinder.RParameter = 1.0
#
# -- JetCellCalibratorTool (defaults)
KtTopoJets.CellCalibrator.CellCalibratorName = "H1WeightToolAug04"
#
# -- Initial signal selection
KtTopoJets.InitialEtCut.UseTransverseEnergy = True
# FIXME the following cut may need tuning!
KtTopoJets.InitialEtCut.MinimumSignal = 10*MeV
#
# -- Final signal selection
KtTopoJets.FinalEtCut.UseTransverseEnergy = True
# FIXME the following cut may need tuning!
KtTopoJets.FinalEtCut.MinimumSignal = 10.*GeV
#
# -- Monitoring
if doJetMonitoring:
    KtTopoJets.PreClusterMonitor.HistogramPath = "jetprecluster"
    KtTopoJets.KtFinderMonitor.HistogramPath = "jetkt"
    KtTopoJets.CalibMonitor.HistogramPath = "jetcalib"
    KtTopoJets.SelectionMonitor.HistogramPath = "jetsselect"
```

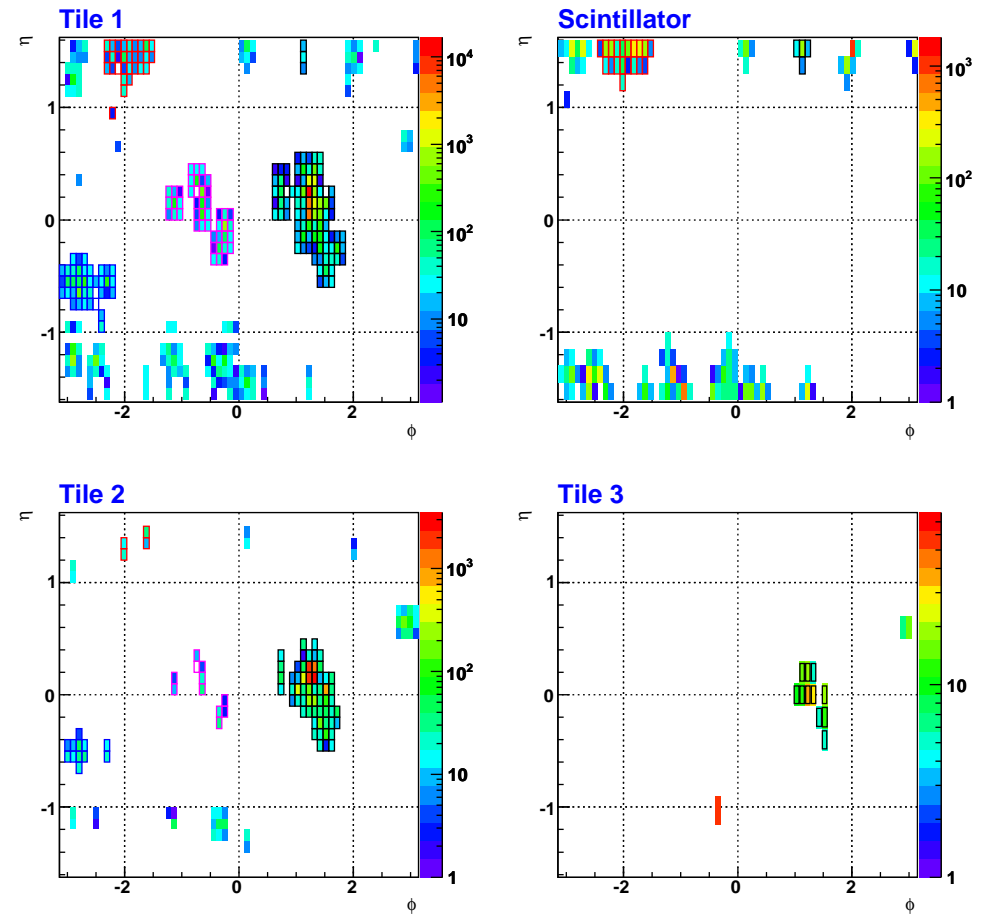
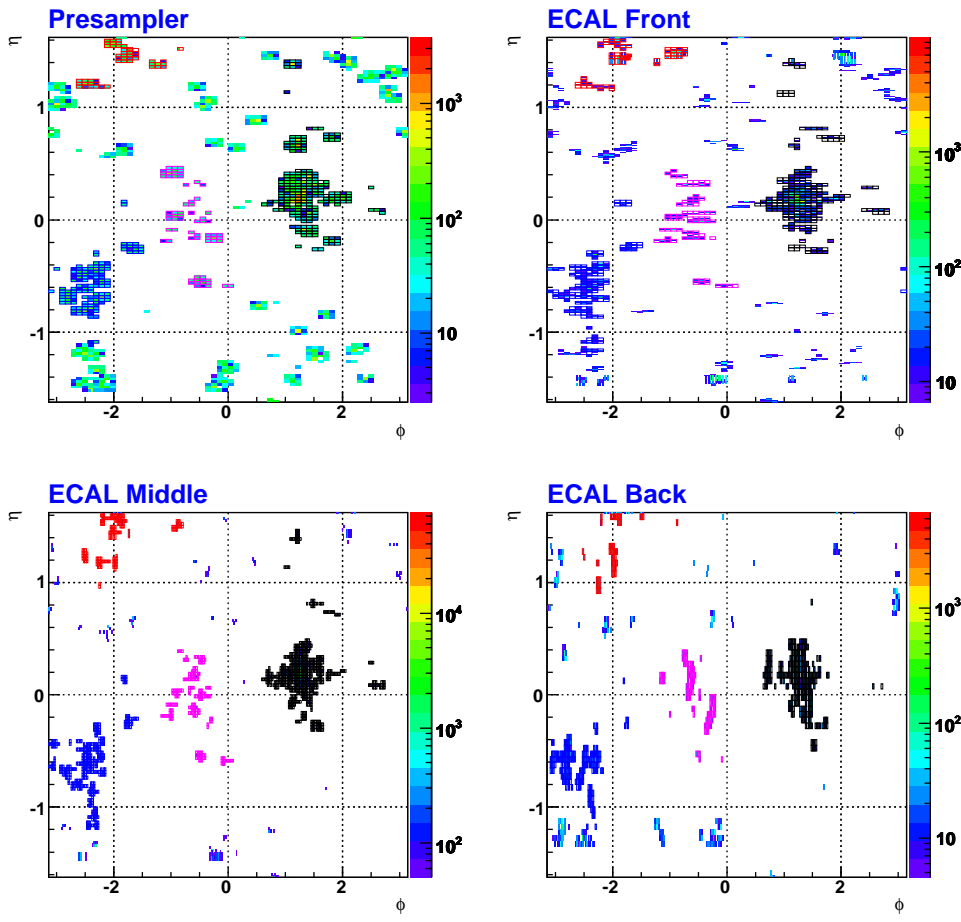
Create new KtJet from topo clusters, cont'd

- add in the file `../share/CombinedRec_config.py` just after the line `include("JetRec/KtTowerJet_jobOptions.py")` the line:
`include("KtTopoJet_jobOptions.py")`
- add in the file `../share/RecExCommon_topOptions.py` just after the line `include("ParticleEventAthenaPool/AOD_Builder_jobOptions.py")` the lines:

```
if AODFlags.ParticleJet:
    theApp.TopAlg += ["ParticleJetBuilder/KtTopoParticleJetBuilder"]
    thisAlg = Algorithm( "KtTopoParticleJetBuilder" )
    thisAlg.JetCollection="KtTopoJets"
    thisAlg.ParticleJetContainer = "KtTopoParticleJets"
    thisAlg.ParticleJetBuilderTool.dataType = EventKernel.ParticleDataType.Full
    # Warning! The next line should agree with the JetRec jobOptions
    # this is ugly, but no other way to get the cryostat weight information
    thisAlg.ParticleJetBuilderTool.CellCalibratorName="H1WeightToolG4"
```
- `athena myTopOptions.py`
- creates ESD, AOD, TAG and CBNT with new `KtTopoJets` and/or `KtTopoParticleJets`

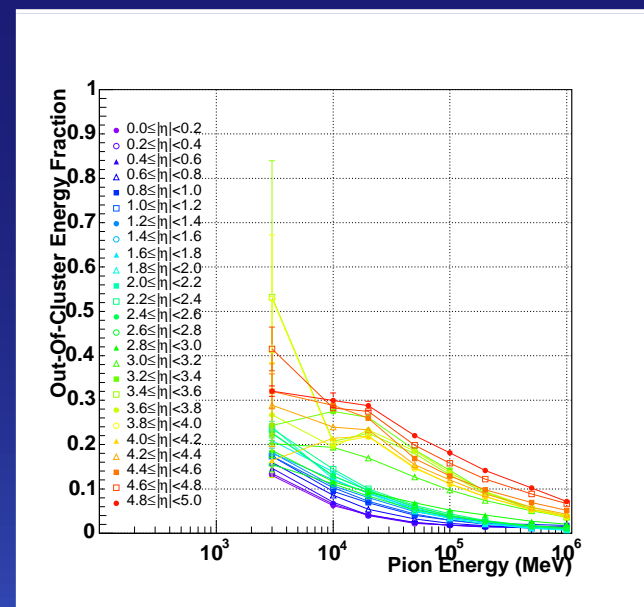
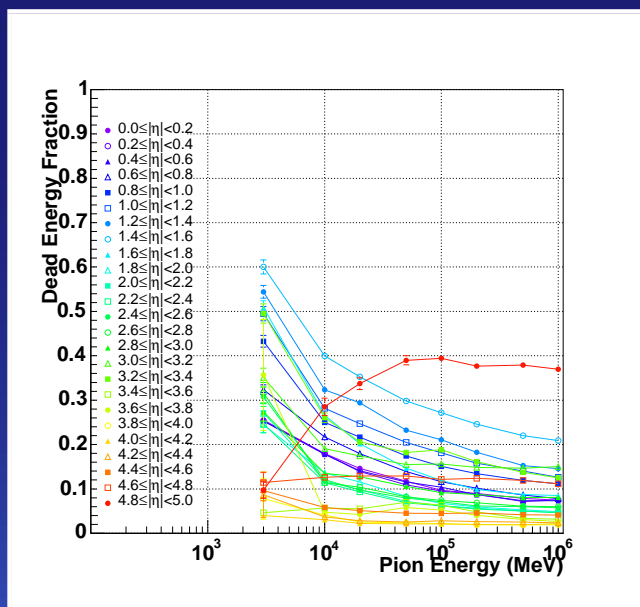
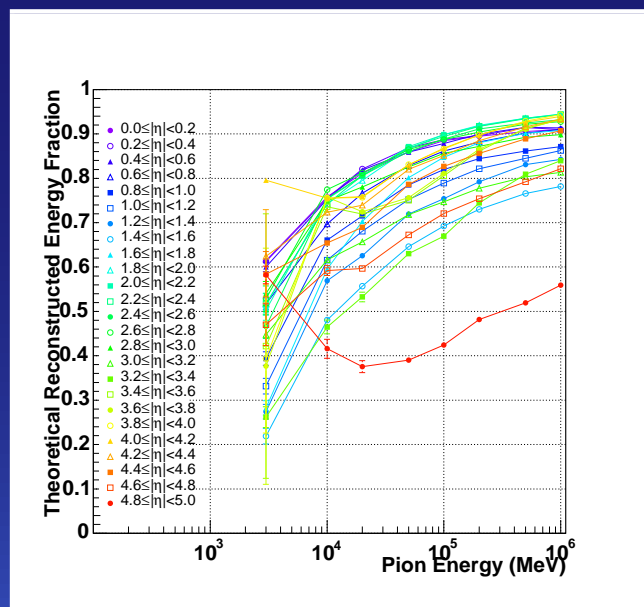
KtJet Example

- ▶ KtJet with $\Delta R < 0.7$, $E_{\perp}^{\text{clus}} > 0$ and E -recombination scheme in dijet events with $140 \text{ GeV} < p_{\perp} < 280 \text{ GeV}$
 - the 6 leading jets in E_{\perp} are shown as colored cell borders
 - left plot shows LArEM, right plot Tile



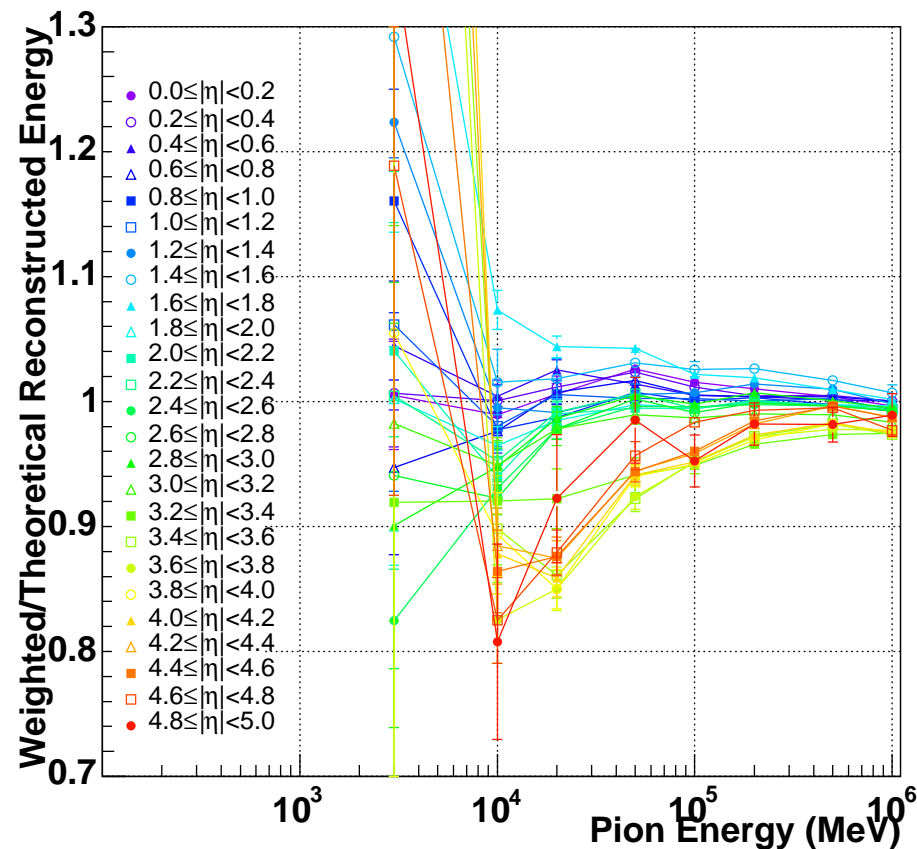
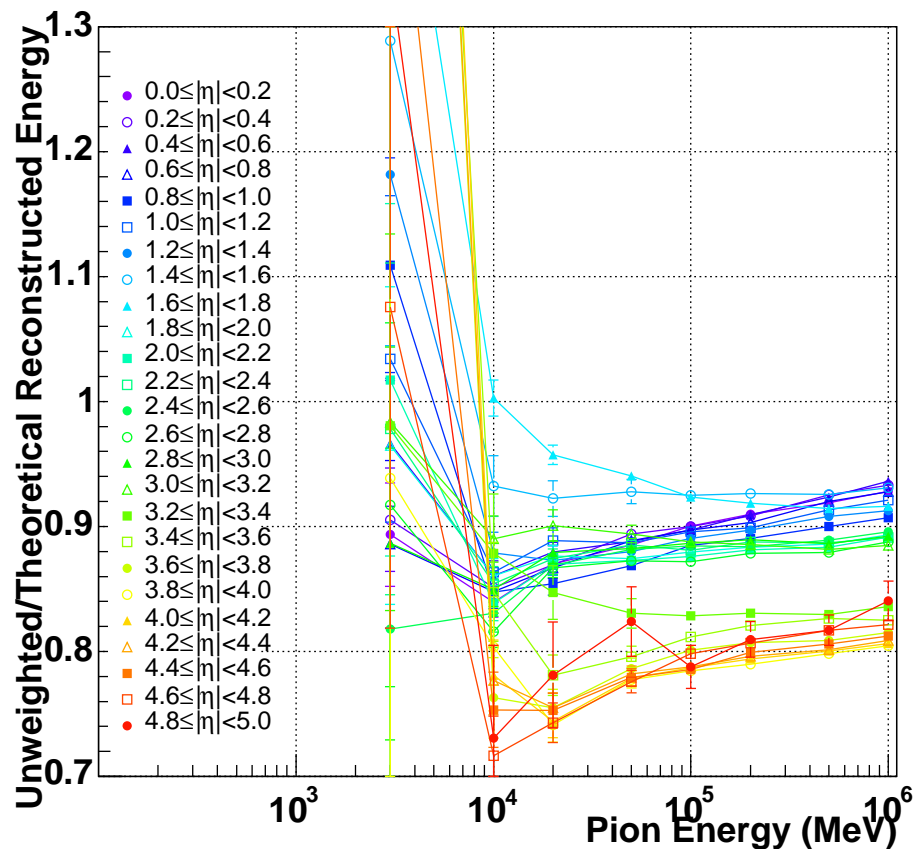
What is done by the calibration?

- ▶ Only the total sum of all calibration hits inside the clusters can be regained by weighting (left plot)
- ▶ Deposits in dead material i.e. outside the calorimeters (middle plot)
- ▶ and inside the calorimeters but outside the clusters (right plot) need additional corrections



Calibration ► Performance on Single Pions

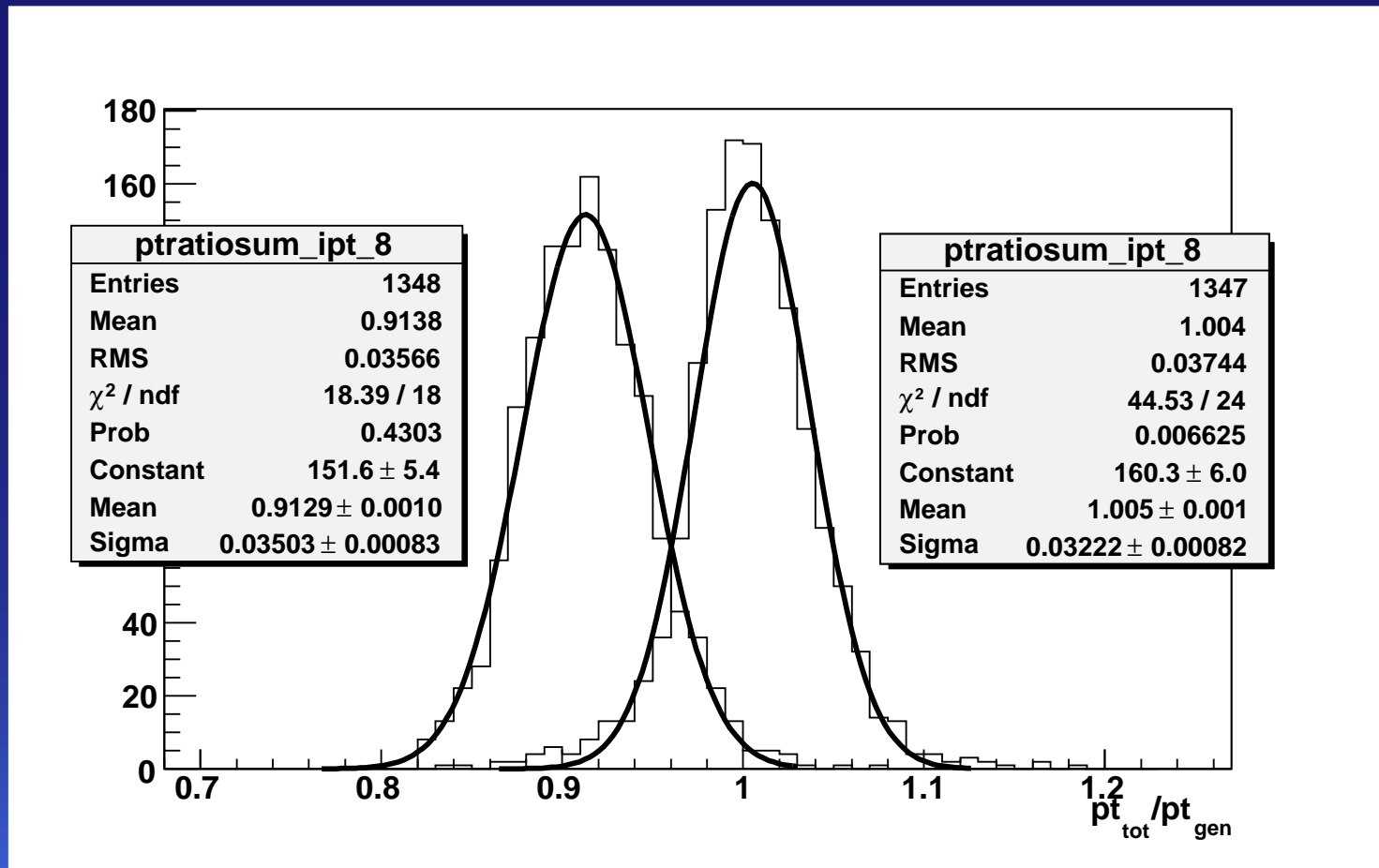
- Plots show ratio of reconstructed over expected energy before (left) and after (right) calibration



- calibration works for energies above 10 GeV
- FCal might need additional weights

Calibration ► Performance on dijets

- First look at results from classification/calibration on the dijet samples made by Pavol (J4)
- K_t Jet with the $\Delta R < 0.7$ distance requirement on calibrated topo clusters
- In J4 this gives around 30 jets per event
- compare the reconstructed energy with the calibration hit energy for calibrated and non-calibrated clusters
- example plot shows jets with $200 \text{ GeV} < p_{\perp} < 240 \text{ GeV}$



Dead Material Corrections and other Plans

- ▶ Alexei Maslennikov and Guennadi Pospelov started to work on Dead Material Corrections from Calibration Hits
 - aim is to include dead material corrections in the local hadronic calibration
 - first step will be to establish correlation between dead material assigned to a cluster inside a given region with the reconstructed energy in adjacent samplings
- ▶ Preparation for DC3
 - the new way of running simulation in a python driven mode required lots of changes to the way calibration hits are simulated
 - we try to get calibration hits working in `11.0.X` such that at least some of the DC3 simulations can be done with them
- ▶ Continue `KtJet` analysis
 - extend to other samples
 - try other cut-off parameters/schemes
 - compare with truth jets

