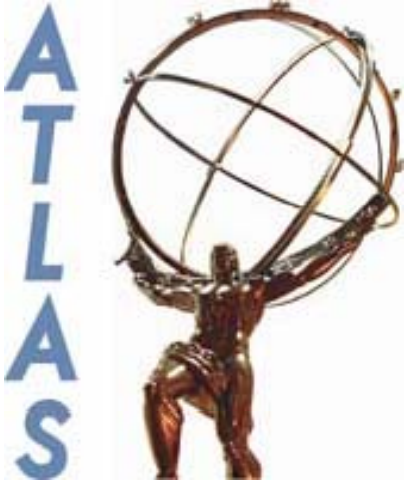


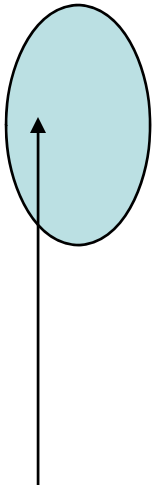
CaloTopoCluster Based Energy Flow and the Local Hadron Calibration

Mark Hodgkinson

June 2009

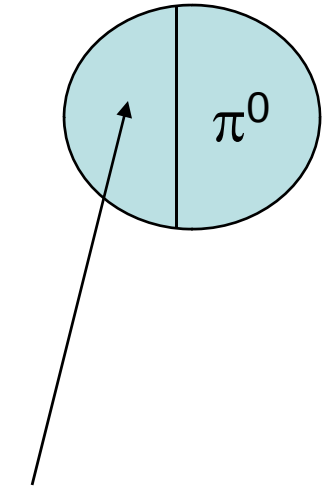
Hadronic Calibration Workshop

Main Scenarios for Hadronic Energy Flow



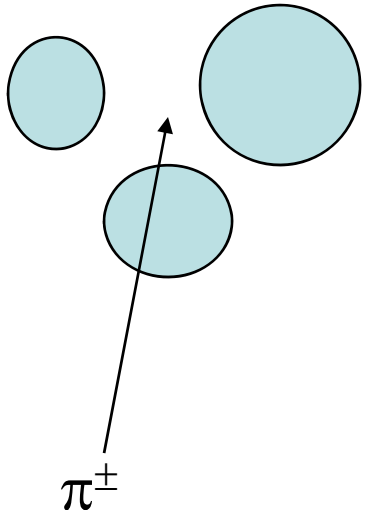
$\pi^{\pm}$

(1)



$\pi^{\pm}$

(2)



(3)

(1) Relatively trivial - remove cluster, use track energy

(2) Need to remove charged shower from CaloTopoCluster and identify remaining shower as em/hadronic and then calibrate

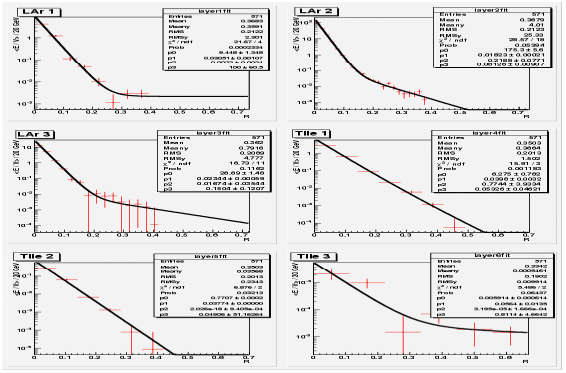
- in principle can start with CaloCalTopoCluster and only adjust cluster energy, not worry about cells, but then how is correct calibration possible for this mixed case? Cluster is tagged EM or HADRONIC in LHC Scheme.

(3) Need to find rest of charged pion shower OR do not use track energy in this case - latter via comparing E/P with that from control sample of charged pions

(4) Scenario (2) and (3) at same time - presumably rather problematic to cope with…..

Scenario 2

- In single pion control sample plot radial energy density profiles relative to track axis
-Ordering principle by ordering all cells in all layers in descending energy density.
-Bin in energy, eta,calo layer of first interaction
- Use this order principle in physics events to remove cells around track axis starting at EM core of shower
- Call this Method (B)

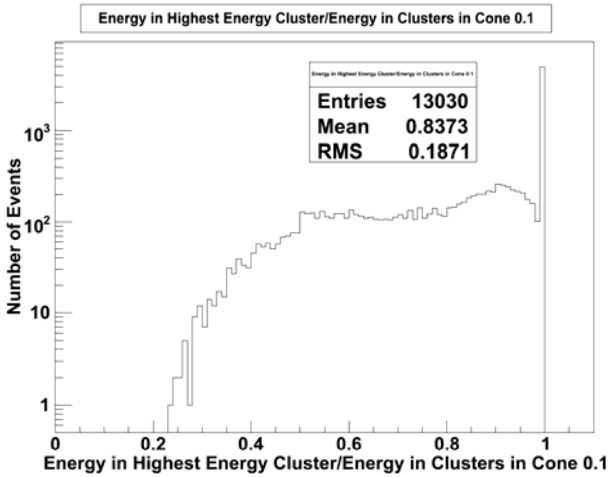


(A) Subtract average energy of hadronic shower from cells relative to track axis
- suffers from large energy fluctuations
- useful when core of pi+ shower overlaps with core of pi0 shower in *same* cell

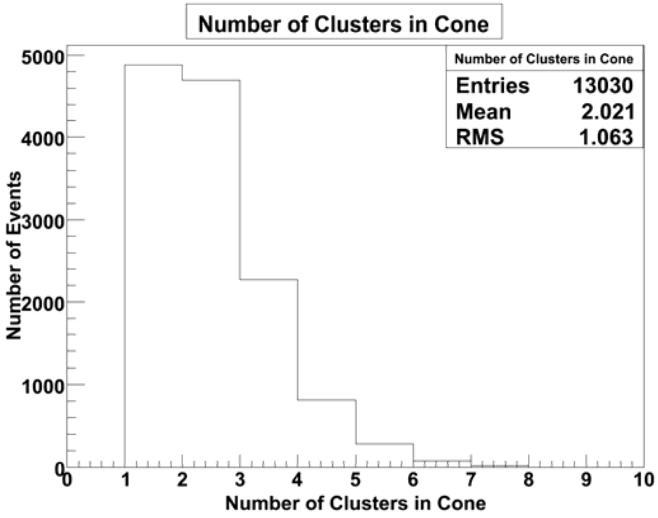
(B) Subtract full energy from cells relative to track axis
- not affected by shower energy fluctuations since you keep going until summed cell energy is consistent with E/P
- cannot deal (well) with core of pi+ shower overlaps with core of pi0 shower in *same* cell

- Reconstruction/eflowRec (M. Hodgkinson, D.Tovey, R Duxifield) package uses method (B) and produces “eflowObjects” for input to combined reconstruction (Jet algorithms, new PanTau package by Bonn Atlas group etc)
- Method (A) is also implemented in athena as part of the tau reconstruction to remove hadronic energy prior to pi0 reconstruction algorithm, see tau meetings if interested in that.
- Since eflowRec starts with EM scale topoclusters, Local Hadron Calibration fits in naturally to provide calibration (as far as I understand just taking the jet-derived H1 weights would not be appropiate for example) to provide set of calibrated (as far as hadronic scale) eflowObjects (tracks, clusters at hadronic scale, clusters at em scale).

Scenario 3

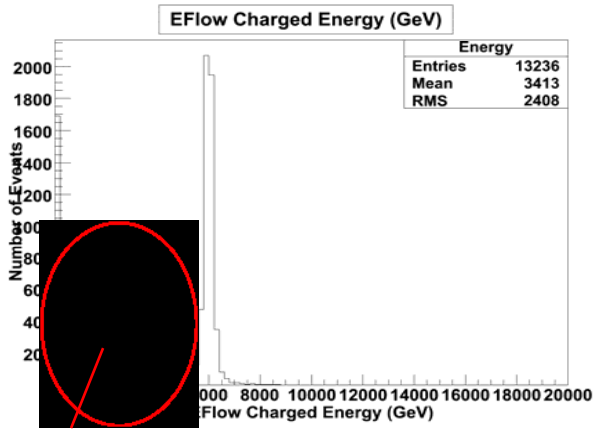


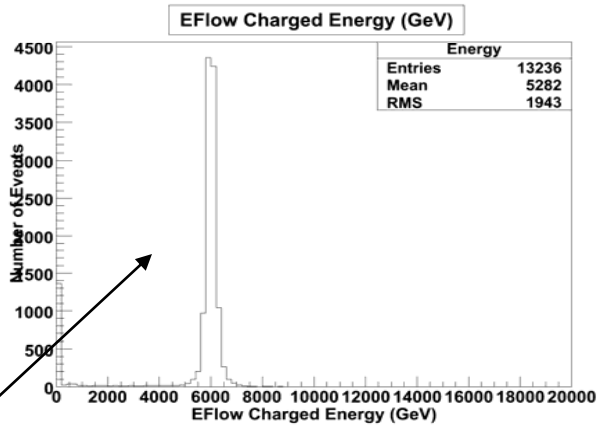
6 GeV E Pions
Eta < 2.5



- Shower often prefers to split into multiple clusters - almost one third have less than 80% of energy in leading cluster in R=0.1 cone around extrapolated track coords (6 GeV pions)
- So how do we subtract hadronic energy for this case?
- Just place a cone around track coordinates in calorimeter?
- Do we need to be more intelligent - search for combinations of clusters consistent with expected E/P?
- But would that work in presence of additional particles (i.e. scenario (2) + (3))?

6 GeV Energy Pions

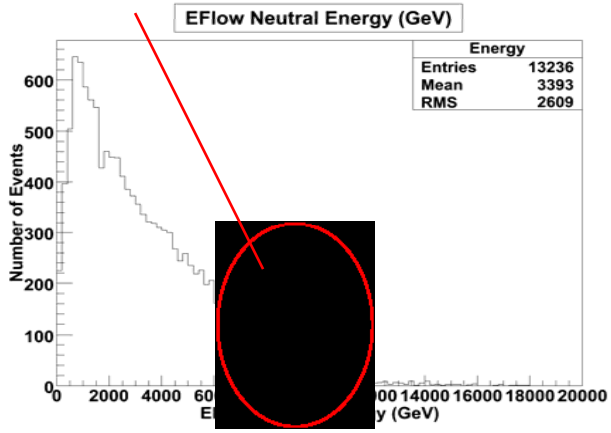


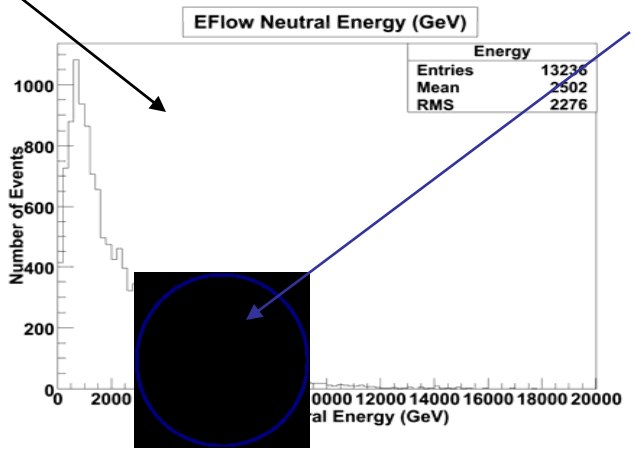


Cluster energy not consistent with expected E/P of track (i.e scenario 3) - charged object uses cluster energy, not track energy

Use cone (0.2) around these tracks

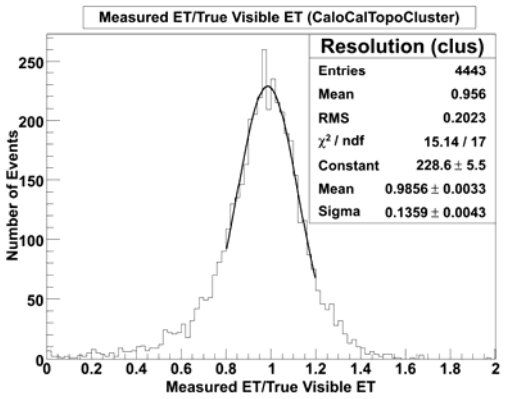
Work underway with Bonn group to understand this residual neutral energy

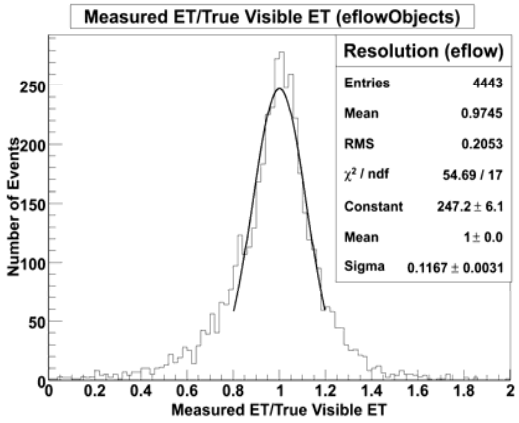


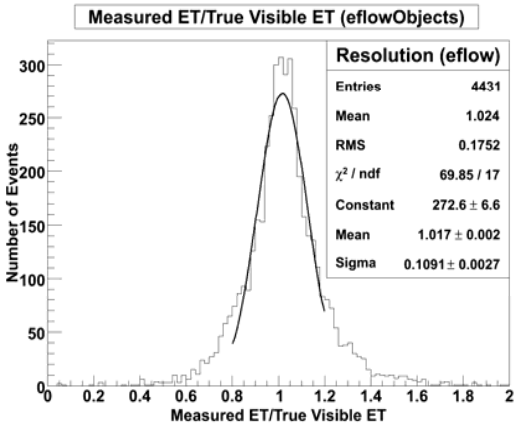


- Excluded events where track does not match to cluster (~10% of these single pion events) - different problem to solve

20 GeV Pt Taus (All to PiPi0)

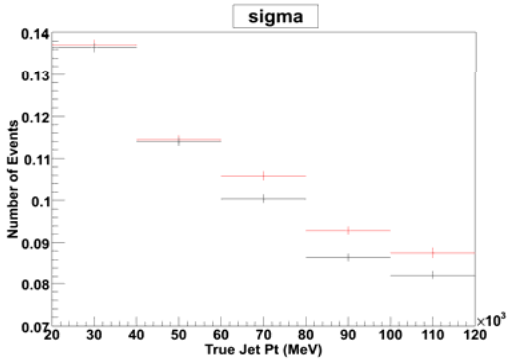




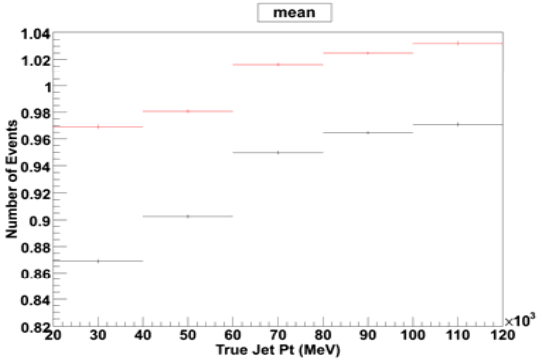


- Single Pions extremely useful for understanding energy flow algorithm limitations
- Also useful to look at more complex scenario - single particle taus and QCD jets (latter on next slide)
- Not looking at fully realistic tau reconstruction here - that work is done by Bonn group with PanTau package - see e.g. recent tau workshop few months ago
- Only take events with true pi+- Pt > 6 GeV + place 0.4 cone around extrapolated track coordinates - reco energy is then defined as all measured energy (CaloCalTopoCluster or eflowObjects) in this cone
- Observe central peak does narrow with extra scenario 3 algorithm (right hand plot) in addition to default eflowRec algorithm, also observe energy scale shifts to 1.5% too high….in both cases narrower than calotopocluster only.
- Have written prototype functions to not just use cone, but try and pick sets of clusters consistent with E/P, also another one tries to use calorimeter layer information - haven’t really tested these yet…
- Of course maybe other better ideas to try…
- Started to remake these samples with primary particle ID calibration hits. Should be very educational for energy flow to better understand/identify scenarios when the algorithm is not optimal.

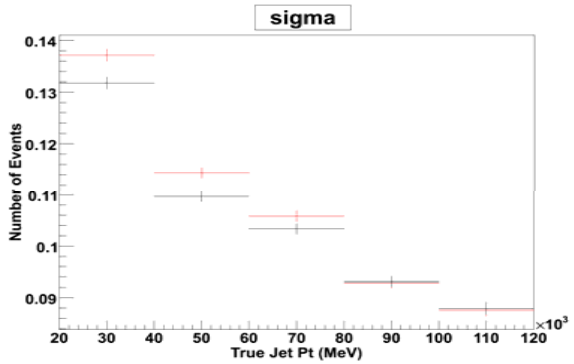
QCD Jets (Pythia J1-3)



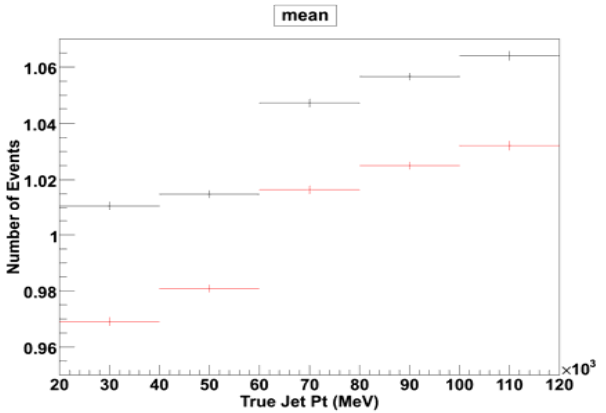
Black - Local Hadron Jets,
Red - default energy flow Jets



- Cone 0.7 jet algorithm
- Require highest pt eflow jet with |eta| < 1.8
- Require Local Hadron TopoJet within DeltaR < 0.1 of highest pt eflow jet
- Require truth jet with DeltaR < 0.2 to both reco jets
- Fit Gaussian to RecoE/TrueE for jets in true jet pt bins (0-40 GeV,40-60,60-80,80-100,100-120)
- Turning on extra part of eflow algorithm to cope with scenario 3 appears to result in improved width, but again see too much jet energy (below plots) - feature of dealing with scenario 3 OR enhancement of existing affect, which is present in default eflow, when performing energy flow for the extra tracks which failed E/P consistency check?
- Eventually somehow one must quantify what fraction of jet energy is due to double counting effects , which is well known issue in energy flow approaches, in order to have a correction procedure? Can such an effect ever be reduced to negligible level for jets?



Black - energy flow (with new Cone based eflow) jets
Red - default energy Flow Jets



Extra Details

Some Technical Details

- Single particle samples generated in 14.2.20.1, simulated in 14.2.10.1 (QSP_BERT), digitised in 14.2.20.3, ESD made in 14.2.20.3 - all steps using identical job transforms options as used for the 10 TeV production
- ESD were used in 15.1.0 where I reran CaloTopoCluster reconstruction (ESD only contain CaloCalTopoCluster) + reconstructed energy flow objects with tag eflowRec-00-02-27 (15.1.0 contains eflowRec-00-02-22) - difference is 3 or 4 relatively minor bug fixes
- QCD dijets are official e344_s479_r541 samples