Local Hadron Calibration and All Hadronic ttbar channel

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OUTLINE

Three parts

- **Local Hadron Calibration performances for Jet**
  - use of Calibration Hit information as truth reference
  - ability to disentangle effects
- **Local Hadron Calibration performances for MET**
  - results updated to release 14.1.0 reconstruction
- **Top mass measurement in the all hadronic channel**
  - investigation of choices for “weak” classifiers to be combined in a boosted algorithm

Data Used

- **100K event statistics of Jx (no J2 available) Ntuples**
- **simulated with release 12.0.31.01** **KNOWN FCAL PROBLEMS**
- **reconstructed with release 13.0.40** **NO OOC CORRECTIONS YET FOR EM CLUSTERS**

Work based on intensive use of Calibration hits & DM hits info compared to Jet Truth } **no parton jet level studies**

New Algorithm for
- **DM hit truth (DR= 0.3)**
- **NEW**
  OOC CalibHit Truth (DR=0.5)

Calib Hit Jet & Jet Truth

Jet built using true energy of reconstructed clusters and OOC and DM energy near to them

Particle Jet Energy

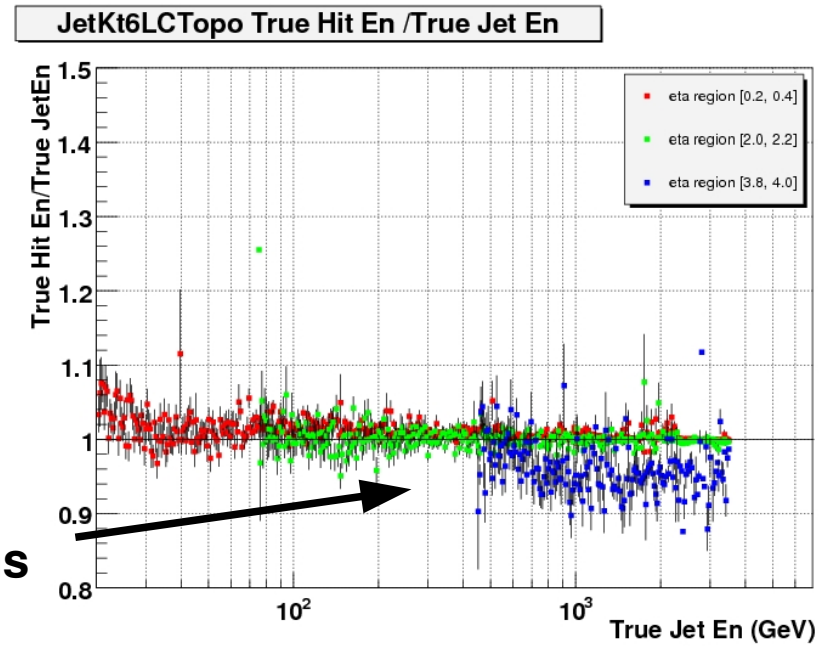
The particles belonging to the jet leave ~ 100% of their energy near to the jet constituents

OOC truth

Simply attaching Calib hits to the more energetic cluster in DR= 0.5

DM truth

Simply attaching DM hits to the more energetic cluster in DR= 0.3



Use of eta/phi space -> Fwd Region problems

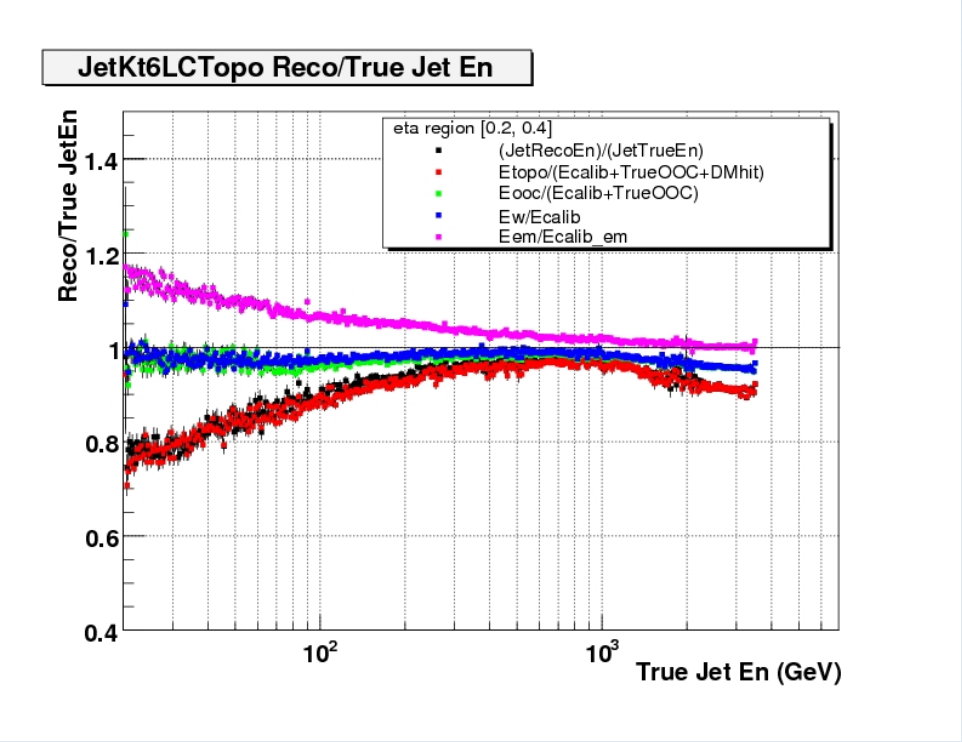
LC steps & Truth Steps

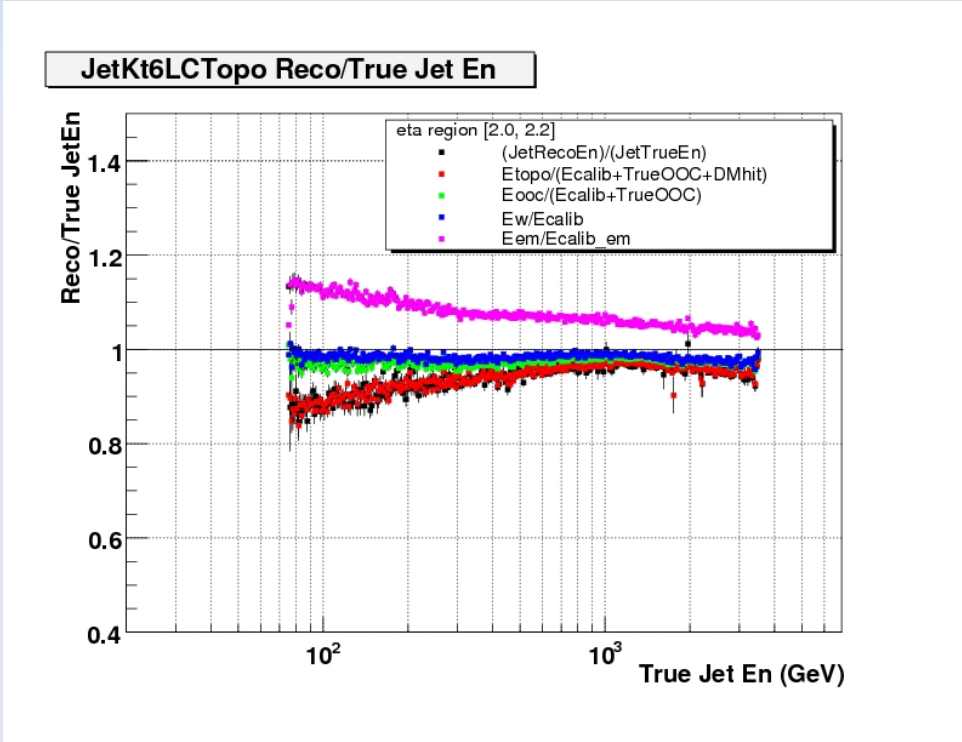
Every LC energy step studied separately

TAKING CARE OF PRESAMPLE OVER-WEIGHT

Compared to CalibHit Step Energy

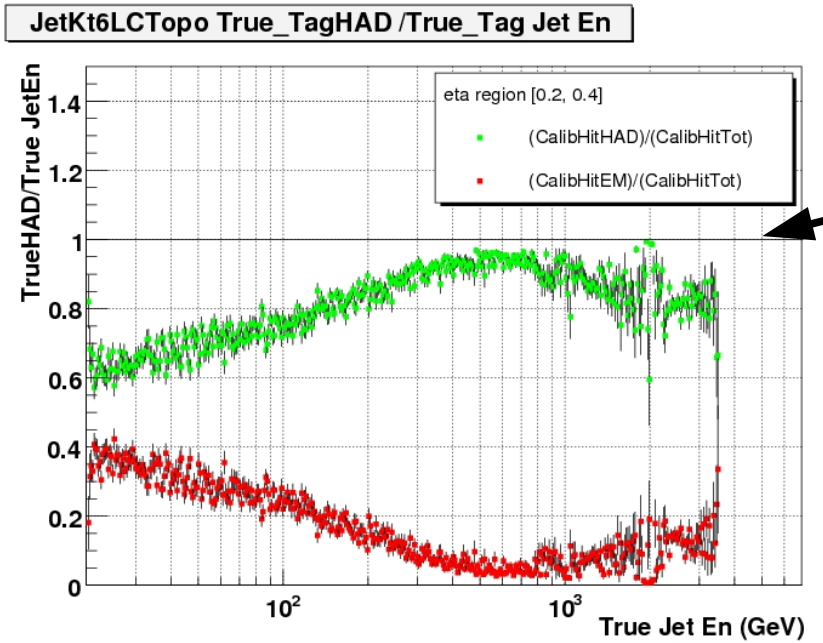
$$\frac{\text{topo}_{\text{step}}}{\text{CaliHit Step}}$$





A part from the EM scale, the ratio should be 1...

LC Steps for EM and HAD

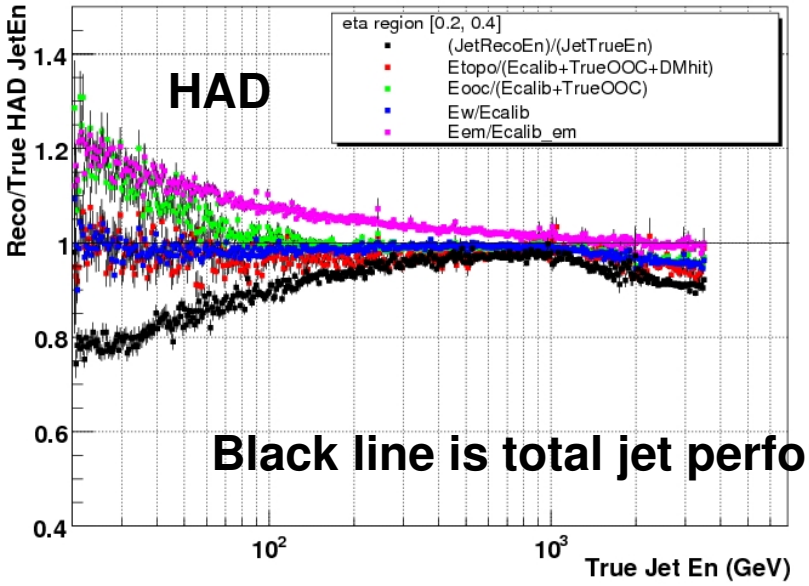


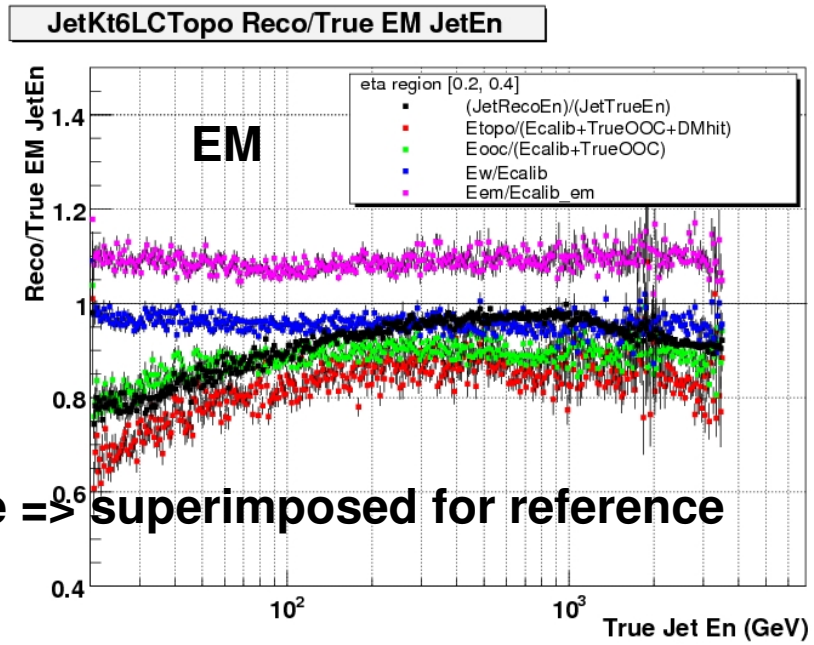
HAD and EM tagged parts of the jets

Relative importance at different Energies

- **Sampling Fraction features**
- **Good Weight Linearity**
- **OOC over estimation for HAD**
- **DM under estimation for EM**

% ?





Black line is total jet performance => superimposed for reference

Hit Step & Jet Truth

LC Energy Step

Jet True En

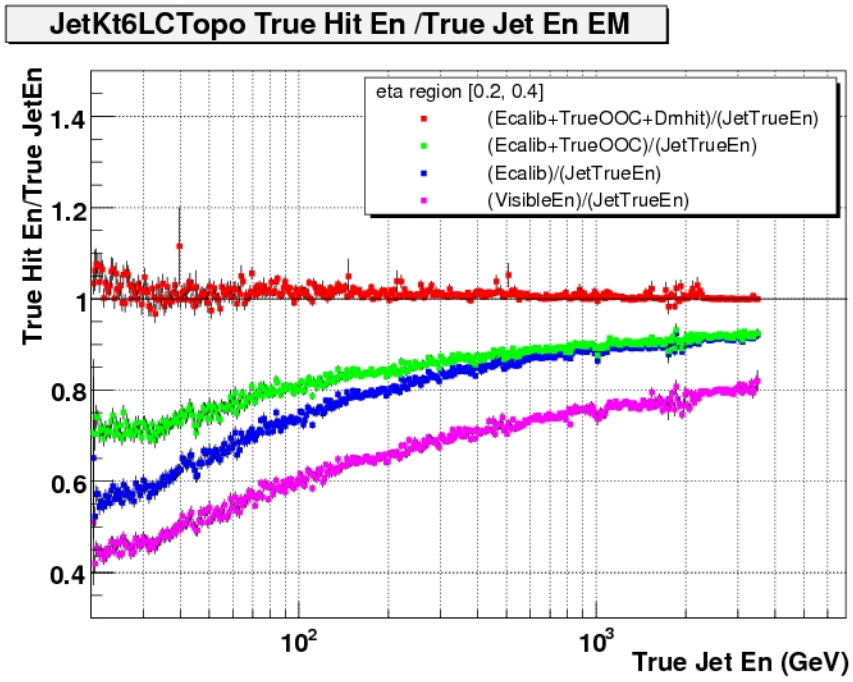
How much do we gain at each step??

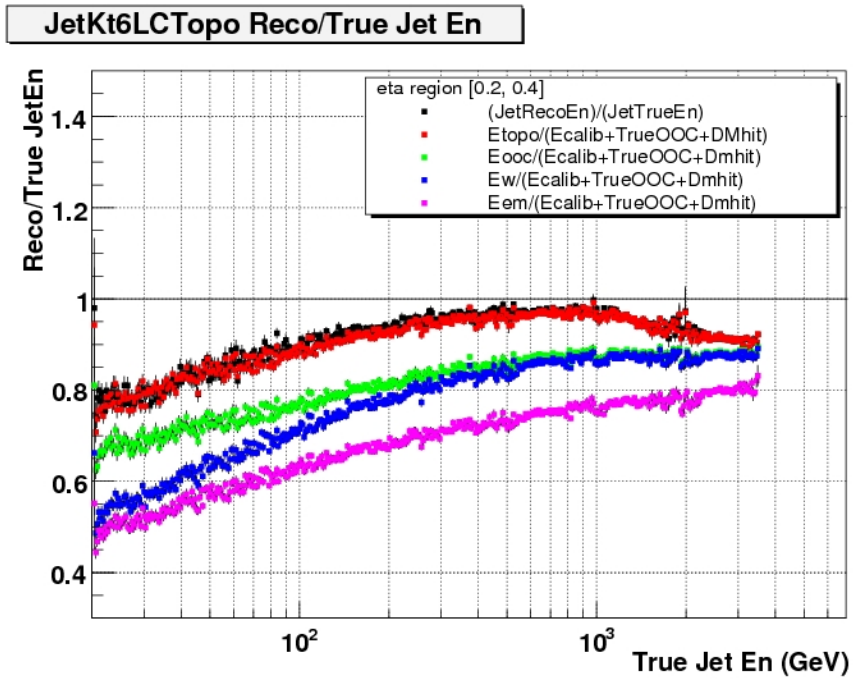
Which is the impact of every step??

Essential Contribution from DM Energy

Big impact of OOC at low energies

True/True → **how we reconstruct** → **Reco/True**





Looking into OOC and DM

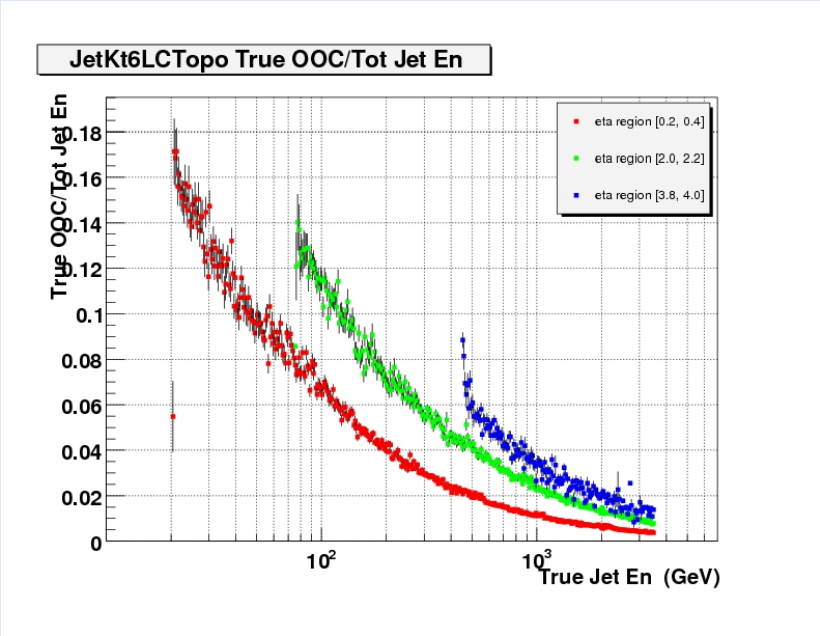
Isolating every LC step $\boxed{\text{topo}_{\text{step}} - \text{topo}_{\text{prevstep}}}$

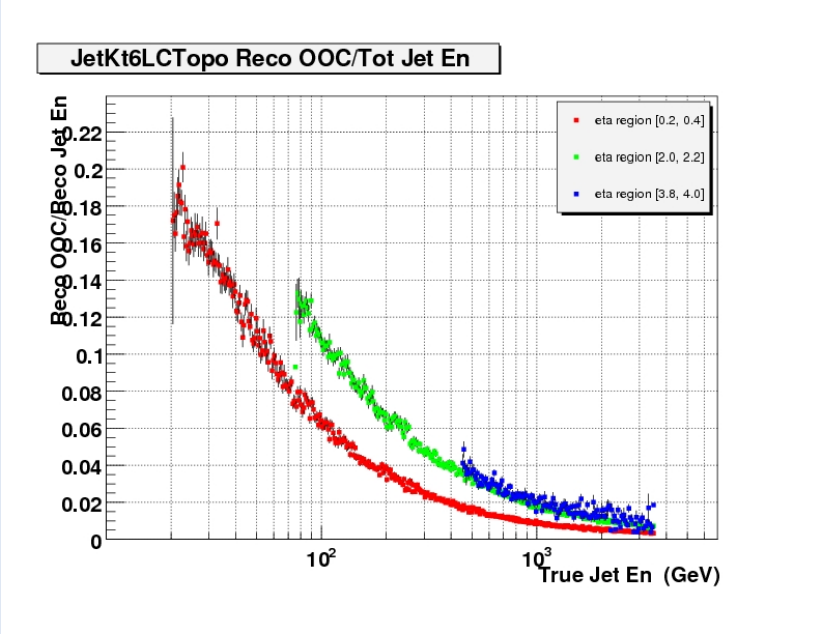
Ambiguous for invisible energy

- **OOC**

It seems that the right amount of OOC gets reconstructed BUT...

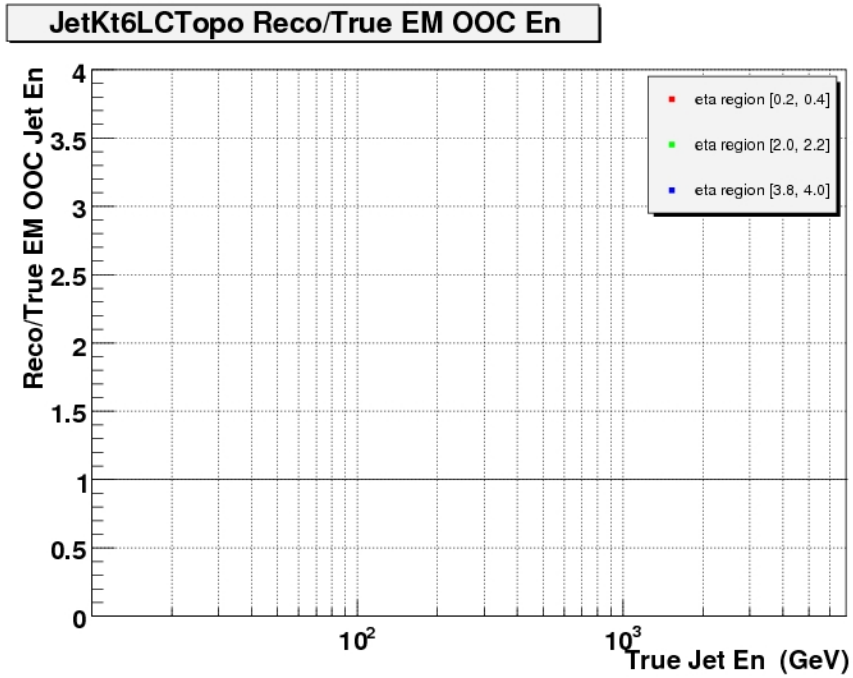
Fraction : OOC Energy/ Jet Energy

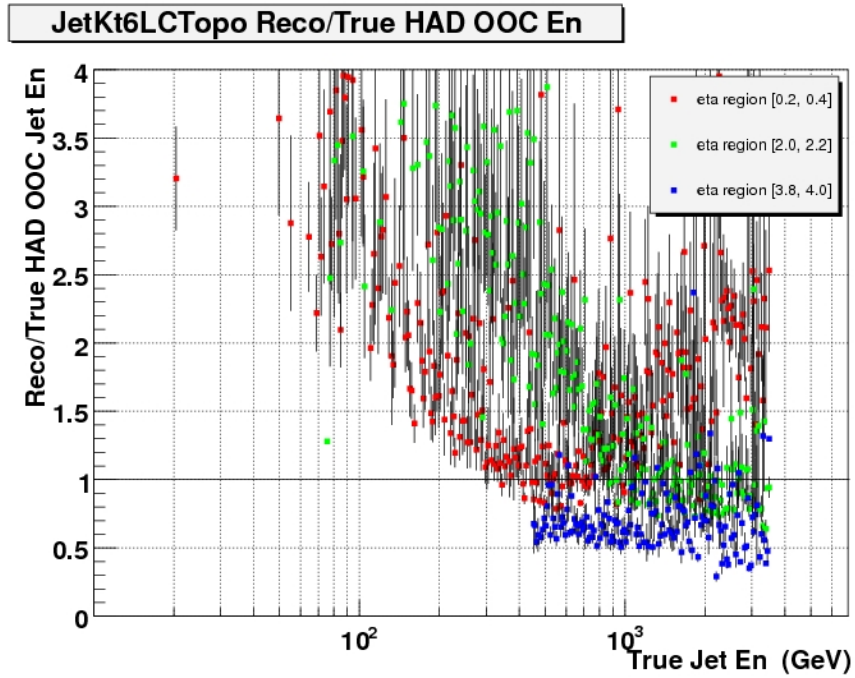




Looking into OOC and DM

Reco OOC / True Hit OOC



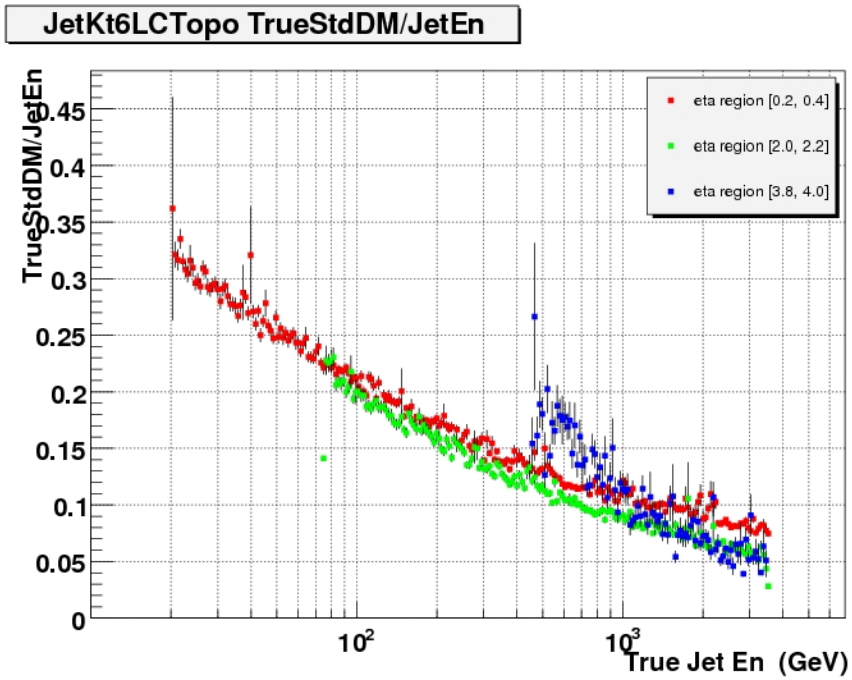


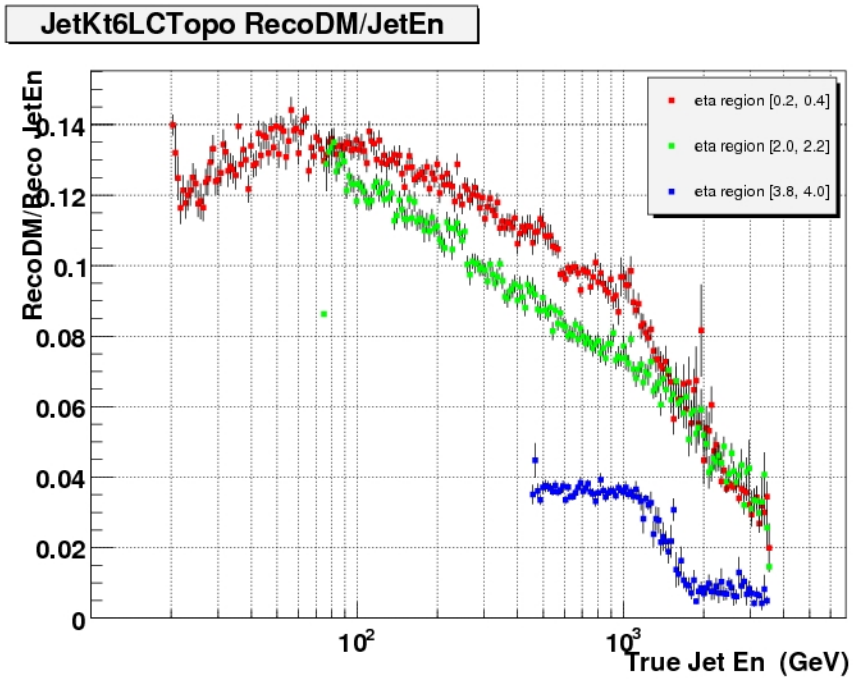
The overall good performance is just a ”release accident”

Looking into OOC and DM

- **DM**

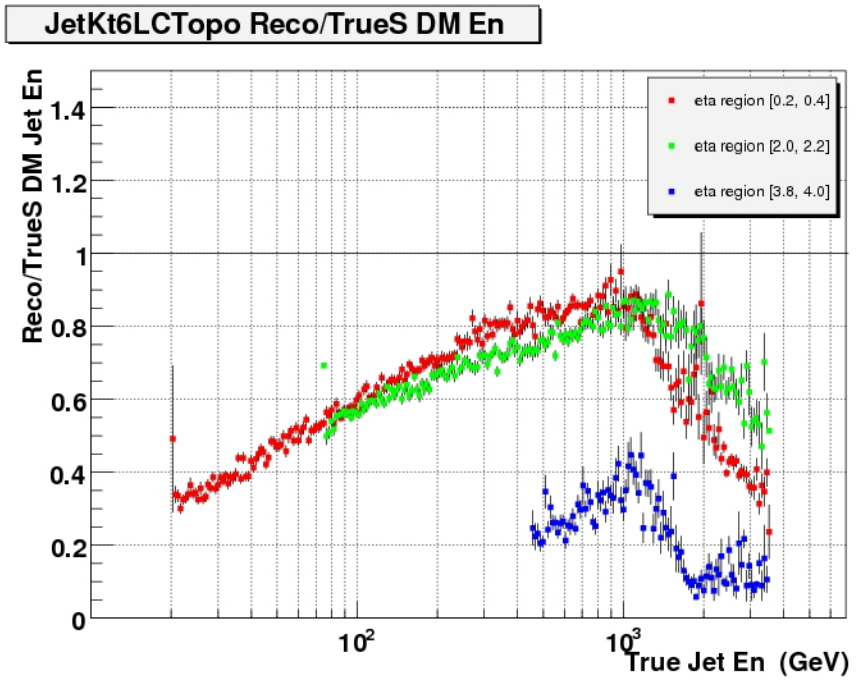
Fraction : DM Energy/ Jet Energy

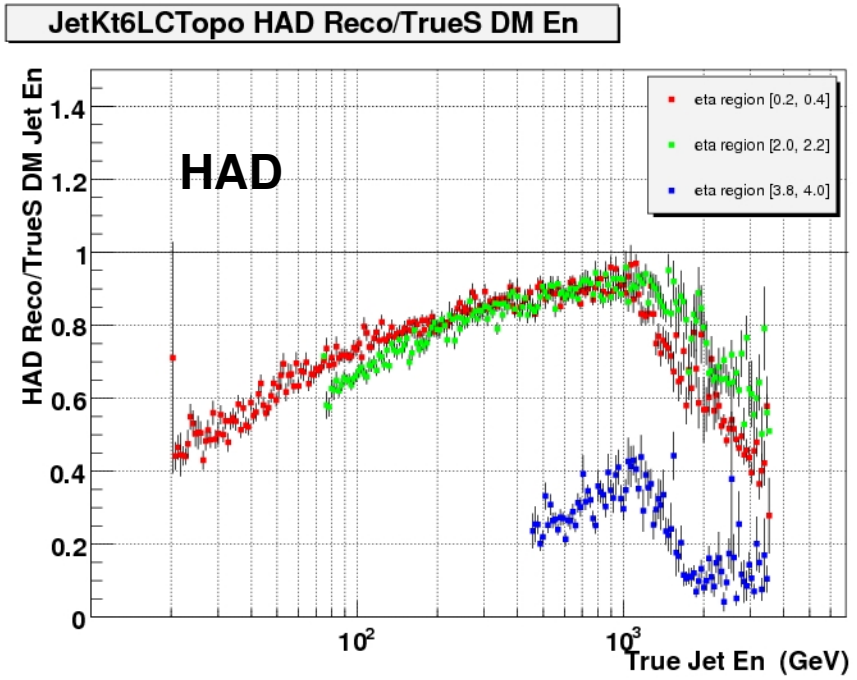




Only 1/3 of the true DM energy is reconstructed .....

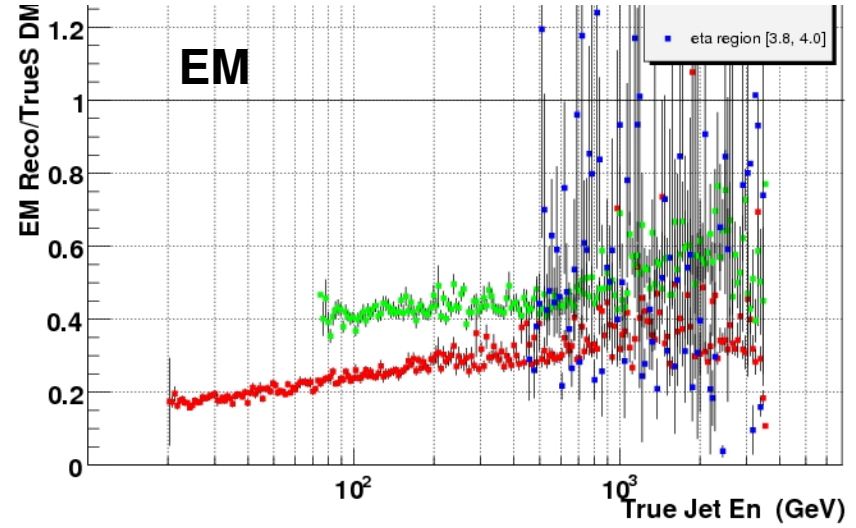
Looking into OOC and DM





Reco DM / True Hit DM

Performance for EM tagged part of the jet is poor (NO OOC dependent)



Jet && Single Particles

NEED to find a good "Truth Jet Reference" for Local Hadron Calibration

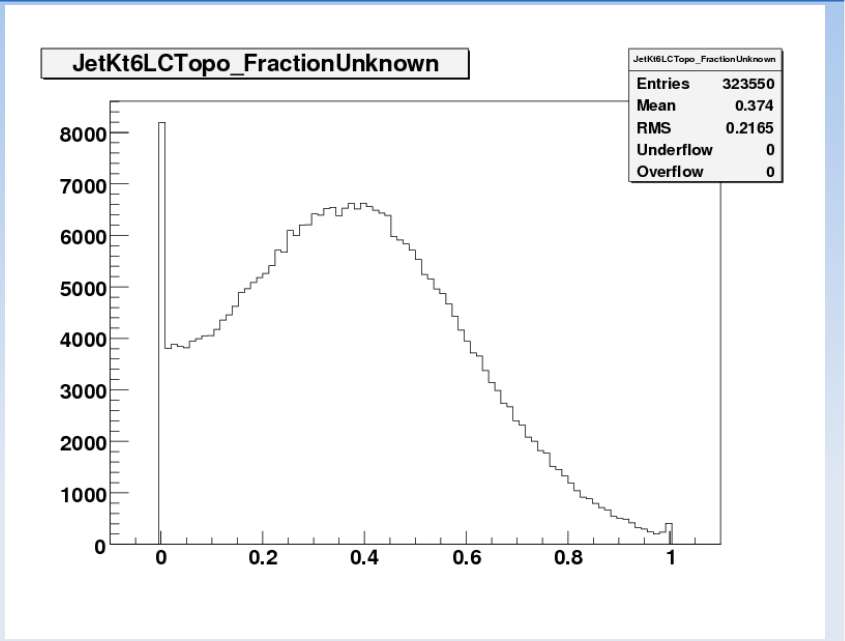
NEED to justify and improve the simple eta/phi approach

- **use of a different metric, as angle in xyz space**
- **new method implemented by Sven in Athena: CaloCalibClusterMomentMaker.cxx**

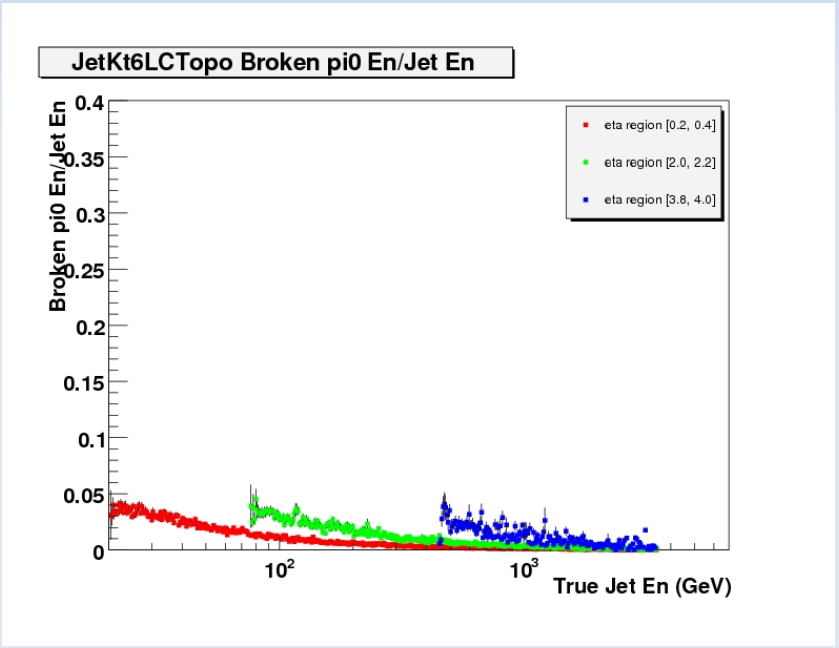
- **use of single particle information==> knowledge of TRUE OOC and TRUE DM**
- **comparison of algorithm performance on single particles where "truth" is known**
- **comparison of algorithm performance on jet and on single particle**

Jet && Single Particle

Jets are not only composed of pion mesons →



There is a fraction of out of jet energy deriving from pi0 decays:



New Single Particle Simulation for:

- K^+ K^-
- K^L
- p anti-p
- n anti-n
- photons (?)

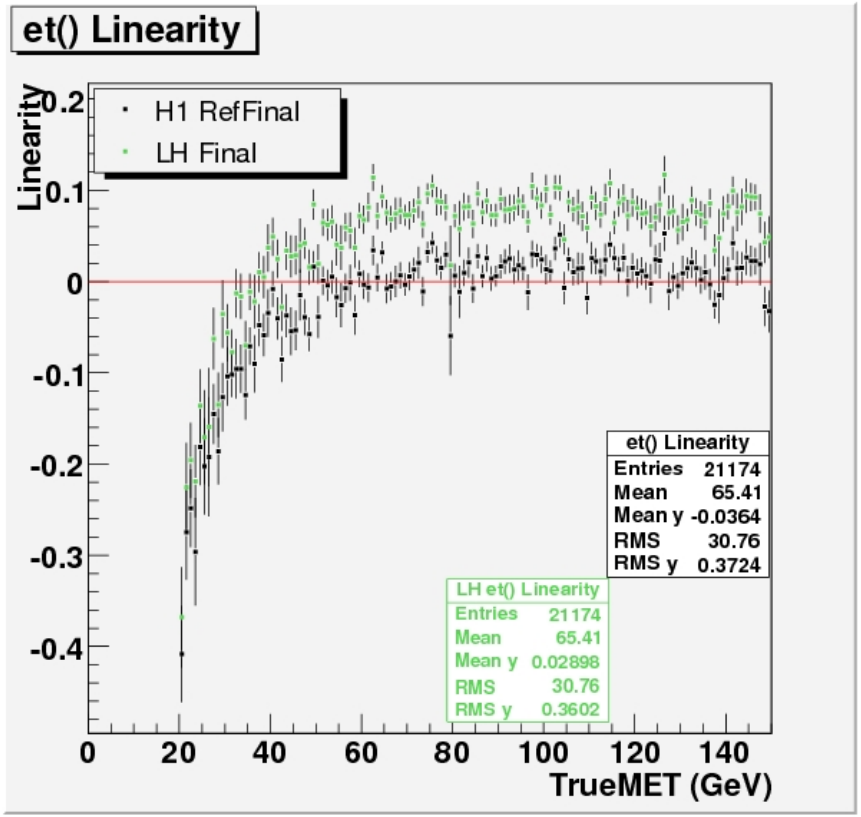
Comparison with jets based on look-up tables in bins of eta, phi and energy

MET from LC

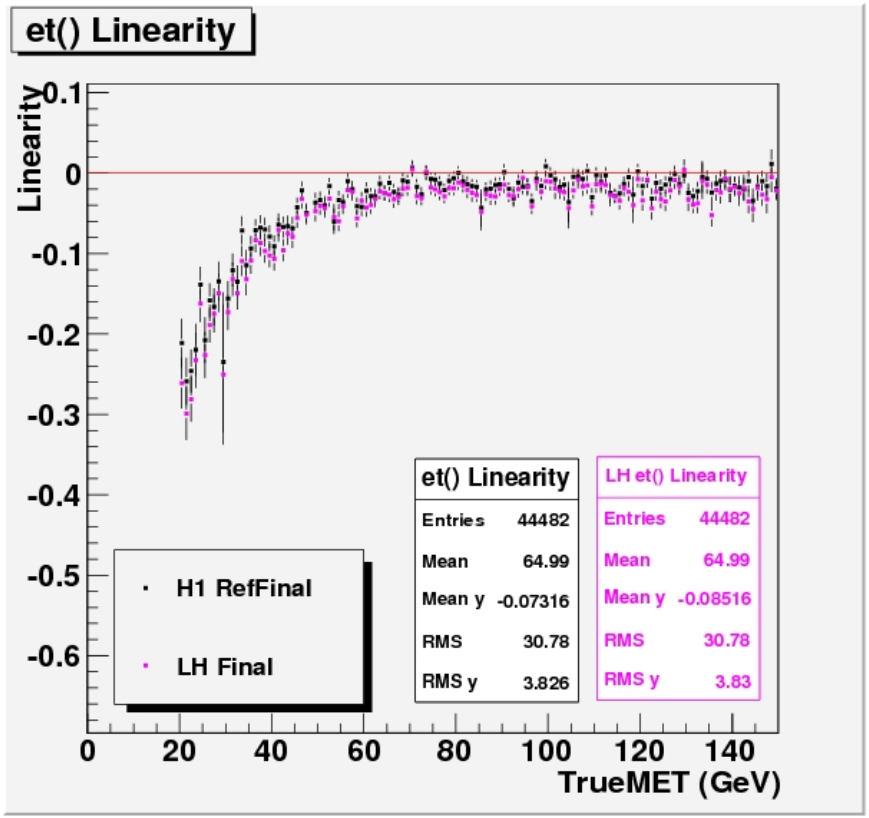
$$\text{MET Linearity} = \frac{\text{TrueMET-RecoMET}}{\text{TrueMET}}$$

Semi-lept ttbar sample

Release 13.0.30



Release 14.1.0



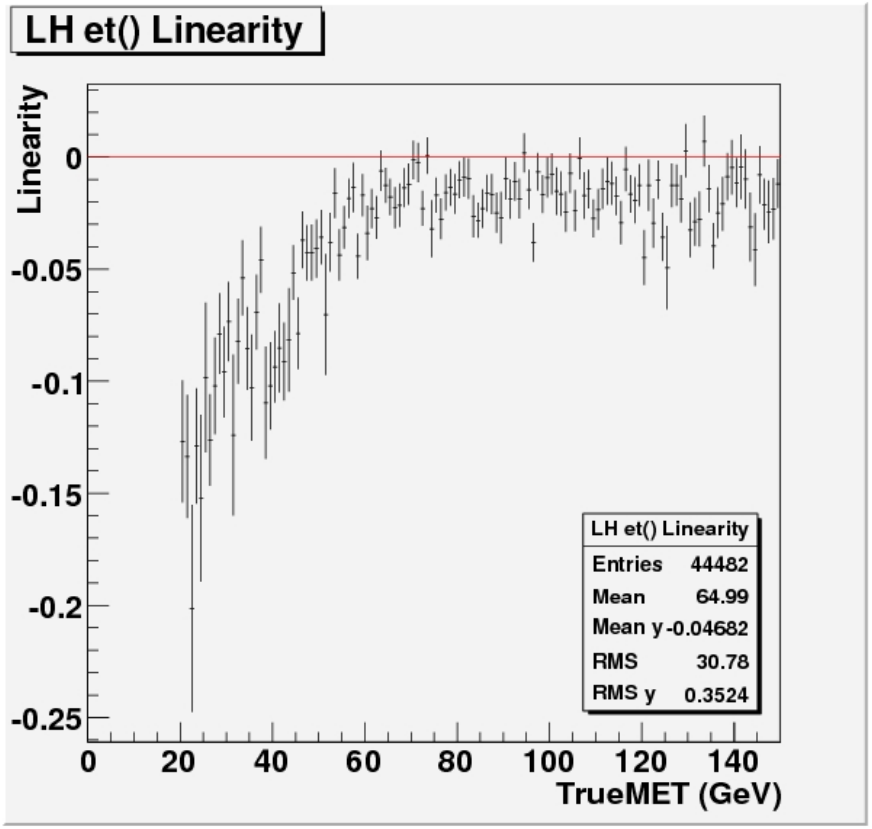
Release 14.1.0

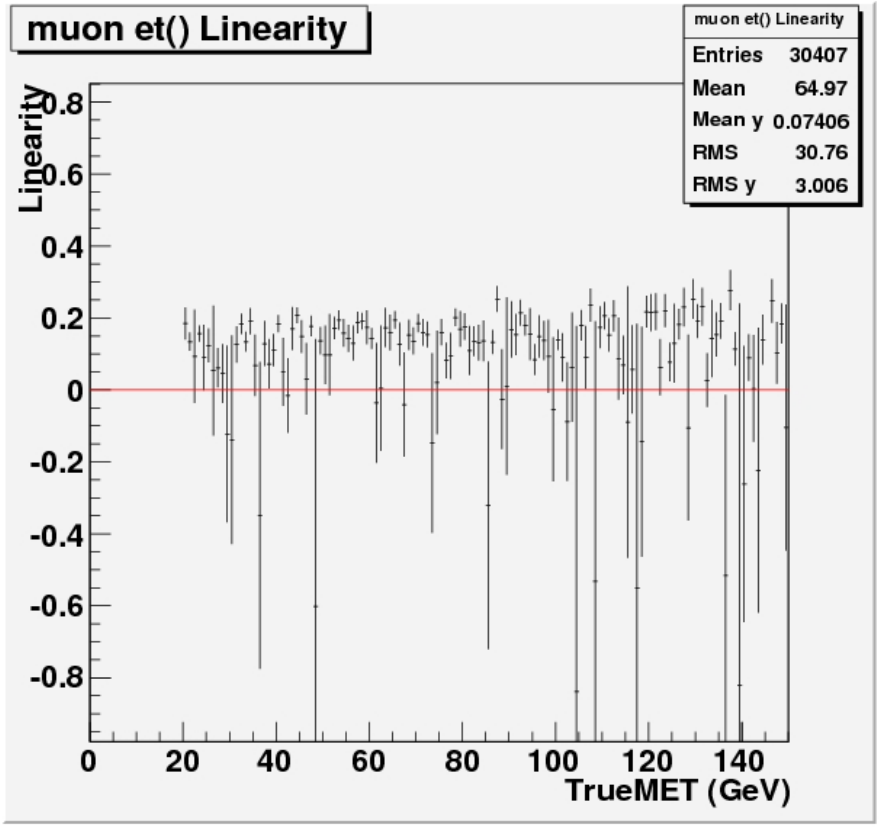
MET from LC

MET_LocHadFinal= MET_LocHadTopoObj + MET_MuonBoy

ONLY LOCAL HADRON CALIB INFO

MUON DETECTOR INFO + REF MUON





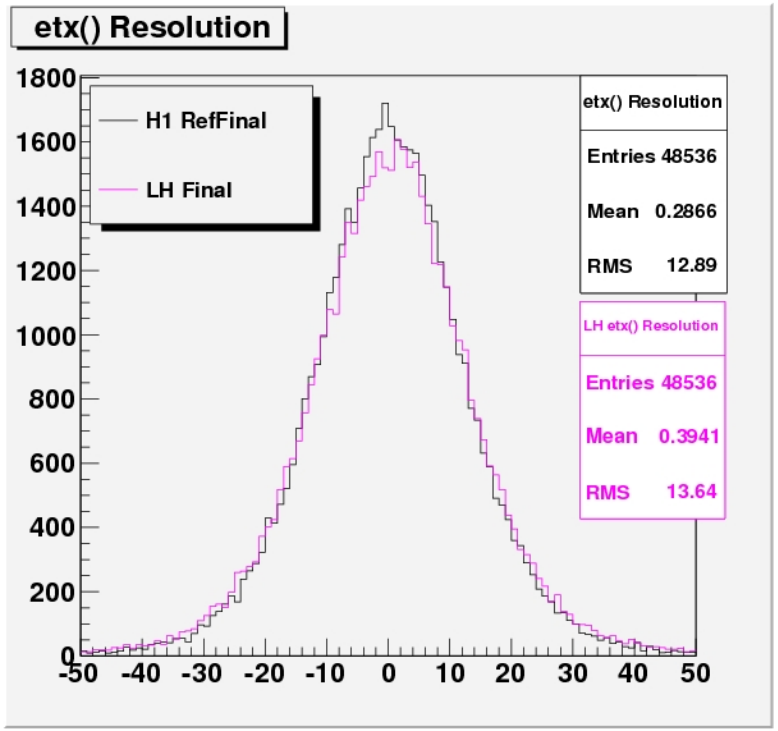
Release 14.1.0

MET from LC

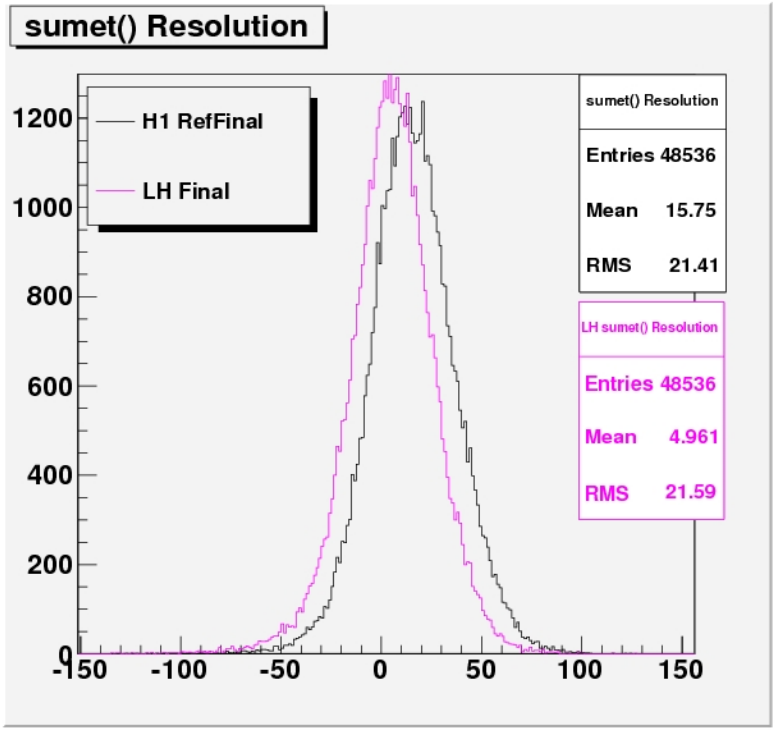
MET Resolution= sigma of the distribution TrueMET_x,y-RecoMET_x,y

Expected to be centered at 0

etx Resolution



sumet Resolution

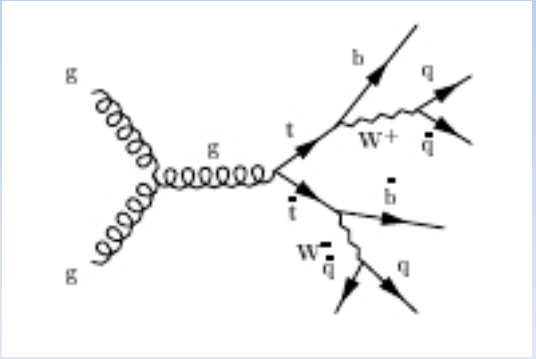


All-had ttbar channel

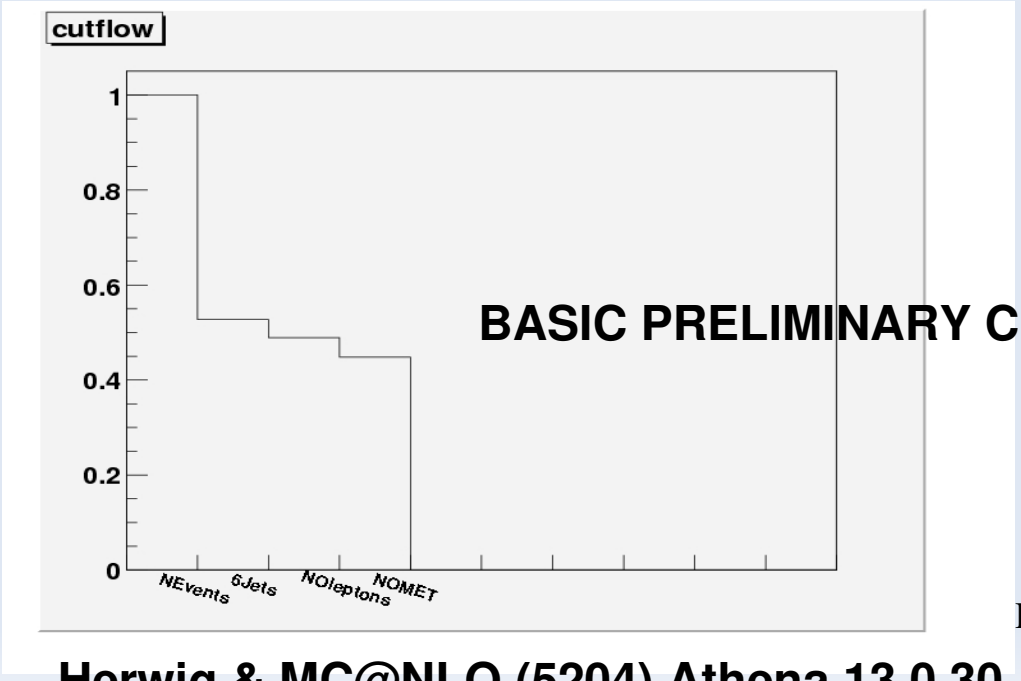
Highest BR 44,4%

ttbar channel where both W decay hadronically:

- **allows for both t and tbar mass reconstruction**
- **low MET content**
- **need to separate from QCD multi-jet background**
- **need to reconstruct the signal in absence of b-tagging**



combinatorial background: 6 jets= 90 combinations per event



BASIC PRELIMINARY CUTS

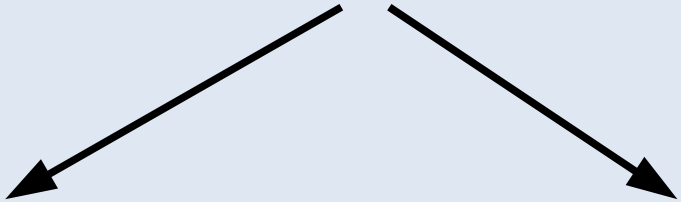
at least 6 jets with
- pT> 20 GeV
- |eta|< 2.5
- not overlapping with an e within DR< 0.2 E(e)> E(jet)/2
- no high pT isolated lepton with pT> 20 GeV |eta|< 2.5
- MET < 40 GeV

Herwig & MC@NLO (5204) Athena 13.0.30

All-had ttbar channel

Previous studies in ATLAS (CSC note T9/V0) show that top mass measurement is very difficult in this channel in absence of b-tagging

NEED to use a technique based on better PID performances than cut analysis => like Boosted Decision Trees or Artificial Neural Networks



Both need to be "trained" on a wide statistics of simulated signal data and simulated background data

LACK OF STATISTICS AT THE MOMENT..

In case of BDT a group of classifier has to be defined to distinguish signal from background

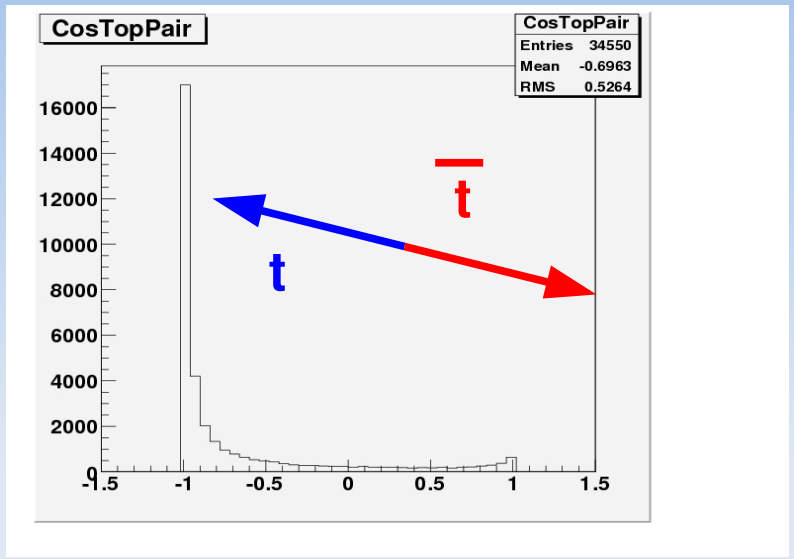
SOME PRELIMINARY STUDIES...

All-had ttbar channel

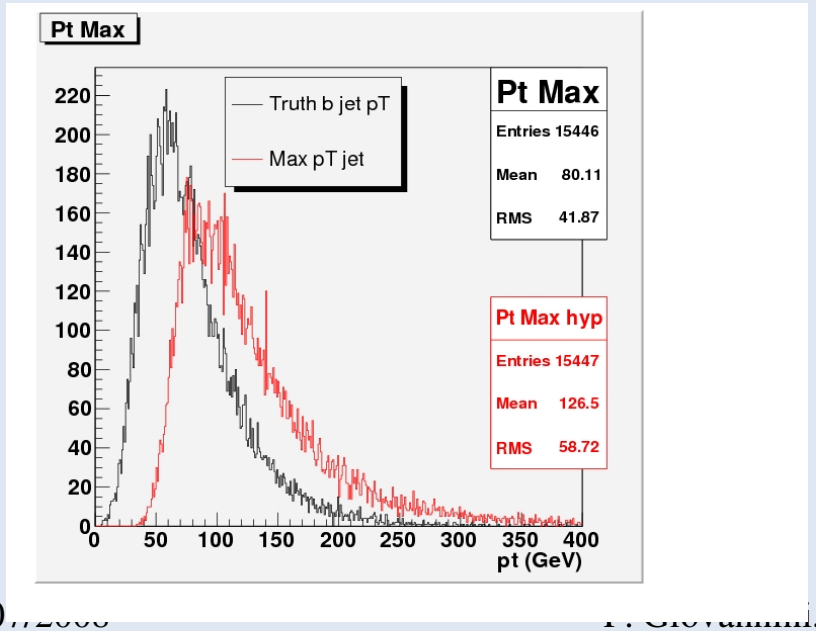
Possible candidates as classifiers:

- **Pt balance method**

MC truth studies



- **Identify b quarks via their high energy**



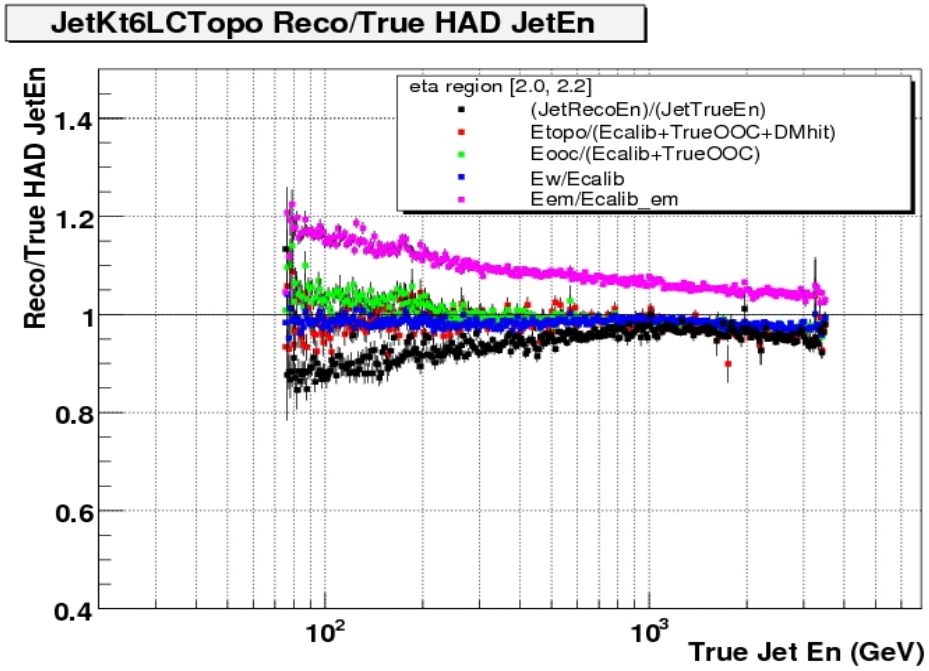
- **Or identify b quark via soft lepton**
- **Identify the W via the closeness of its decay products**

Conclusions

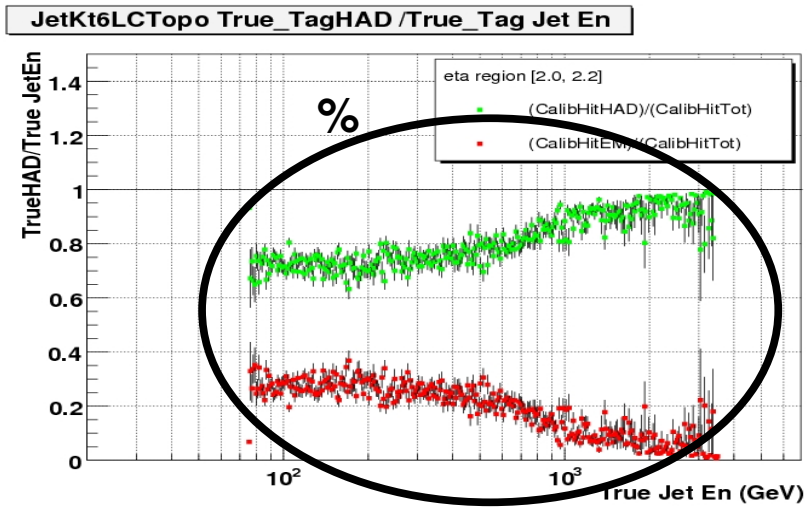
- **JETS**
  - LC performace for jet reconstruction has been studied in detail, exploiting modular approach of the calibration
  - It has been shown that ~ 100% of the true evergy of the particles belonging to the jet is deposited ”near” to the reconstructed jet constituents.... => The problem isn't a ”proximity” problem, but a ”correlation” problem...
- **MET**
  - a Final variable for MET with LC has been studied and is now used in physics analysis
  - need of further corrections at Refined level
  - JES looks very good in release 14.1.0 !
- **ALL HAD**
  - the all hadronic ttbar channel investigation has started
  - need to implement statistical methods such as boosted decision trees
  - lack of QCD multi-jet background Monte Carlo samples could be compensated by private production.

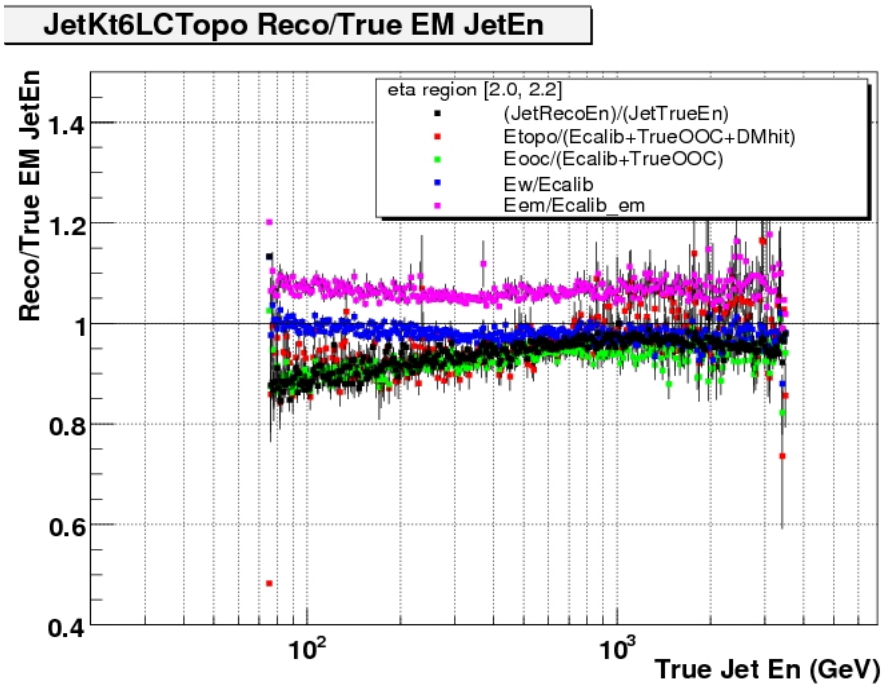
Back -up slides

LC Steps for EM and HAD



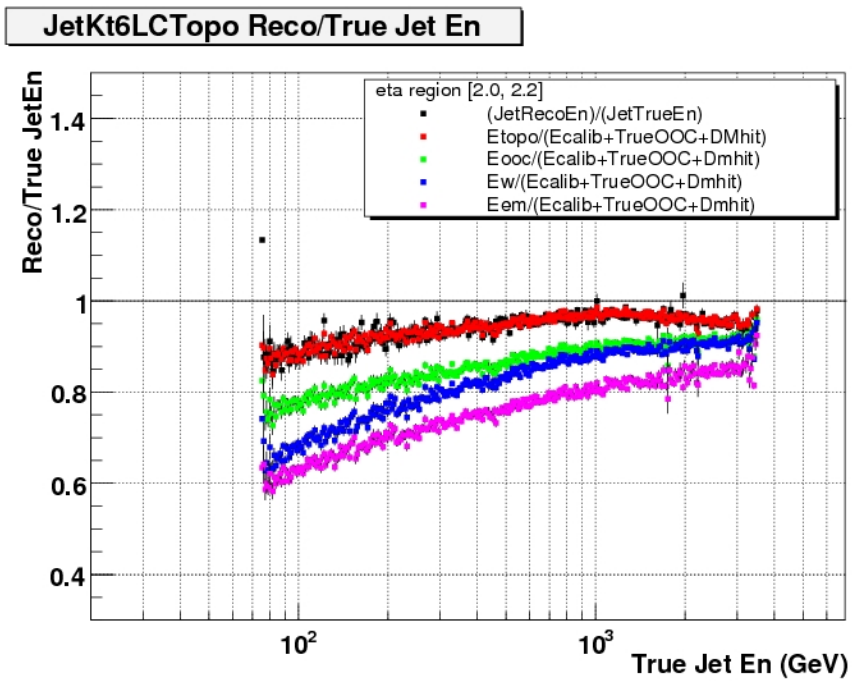
END CAP region

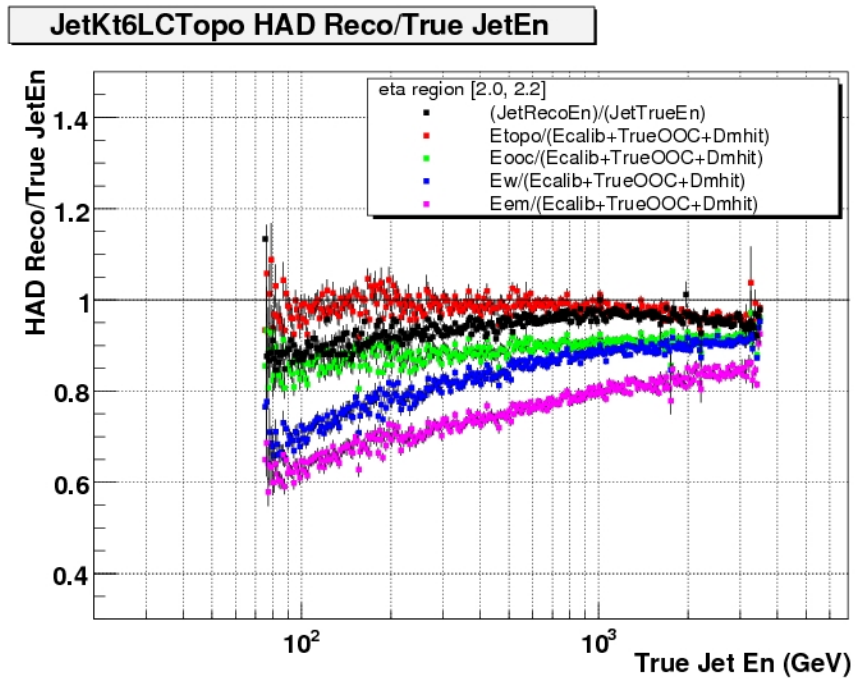


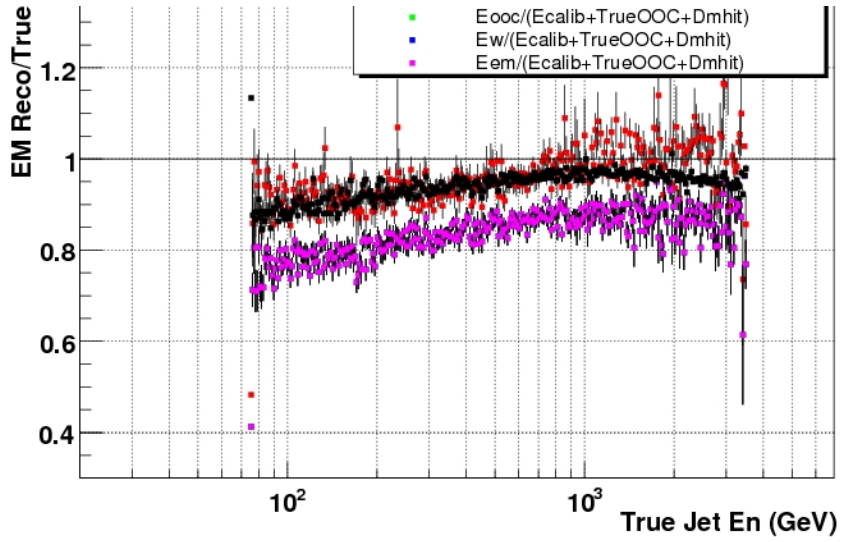


LC Steps & Tot Truth

END CAP region







How we reconstruct

LC Steps & TOT Truth

Every LC energy step → **Compared to Tot CalibHit & DMHit**

TAKING CARE OF PRESAMPLE OVER-WEIGHT