

# Implementation of Primary Particle ID for Jet Studies

*Gennady Pospelov*

MPI für Physik, München

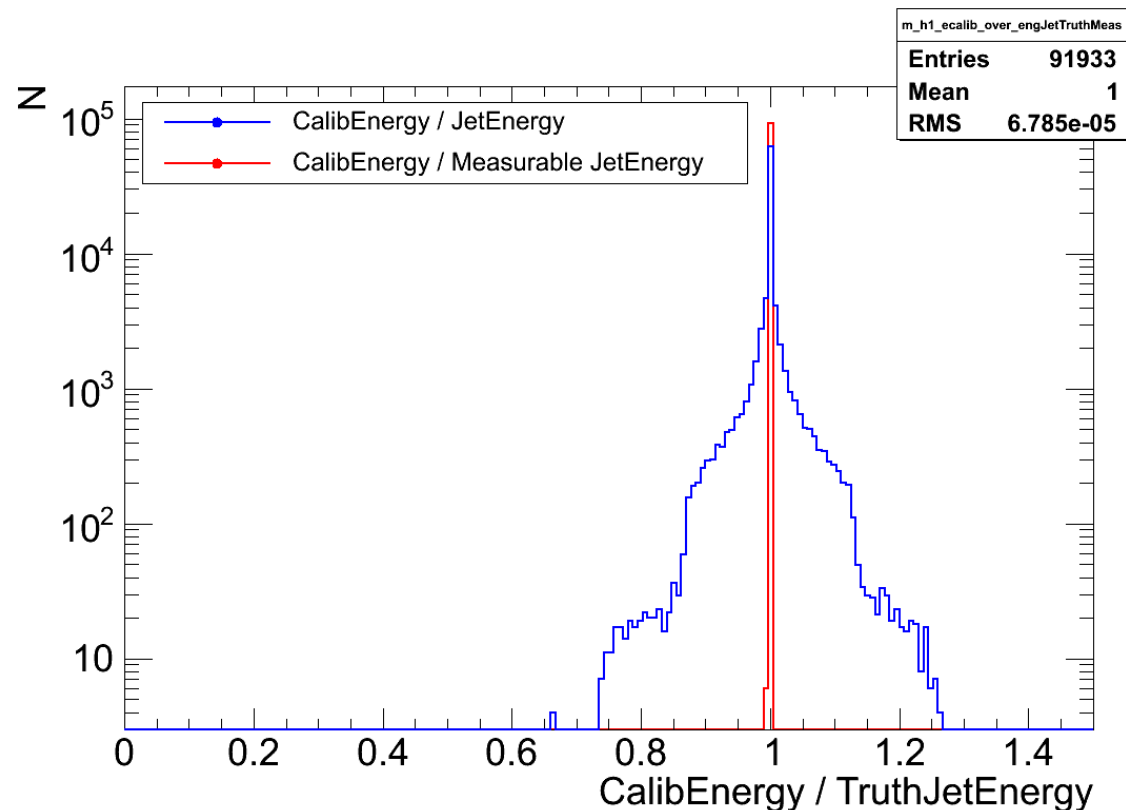
ATLAS Hadronic Calibration Workshop  
Portugal, 23-27 June, 2009

# Introduction

- Primary particle ID implementation has been developed to establish unique correspondence between primary particles and energy deposits in the calorimeter and in the dead material.
- It allows to study in unambiguous way different aspects of jet calibration
  - out-of-jet correction, lost particles, truth energy flow, etc
  - no matching anymore – separate access to energy deposits of different primary particles
- Based on calorimeter calibration hits machinery
  - ➔ Calibration hits:
    - provide access to the truth energy deposition in the calorimeter readout and virtual dead material cells
    - access to *em*, *nonem*, *invisible*, *escaped* energy components
  - ➔ Enhanced calibration hits with primary particle ID:
    - New attribute – *barcode* of primary particle which caused given hit
    - If *N* particles deposited in given calorimeter cells, then *N* calibration hits will be found in the container for this cell, each with different primary particle *barcode*
- Available since release 15.0.0
- More information  
<https://twiki.cern.ch/twiki/bin/view/AtlasProtected/PrimaryParticleID>

# Calibration energy of Truth Jet

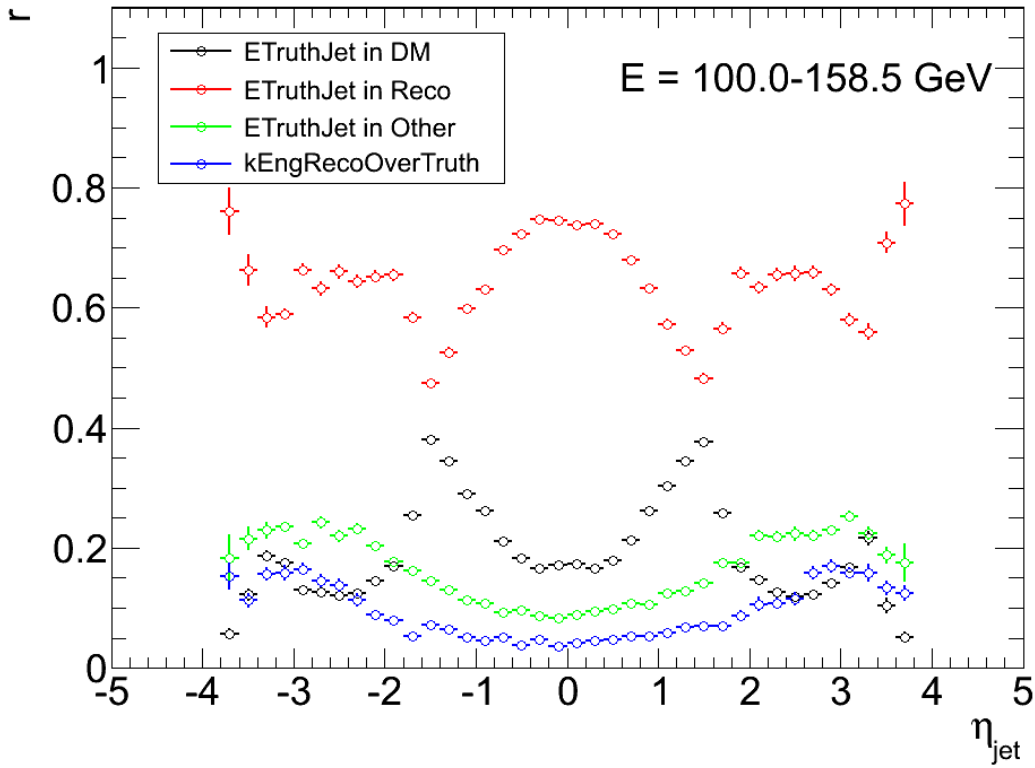
- for each jet in `Kt4TruthJet` collection calculate calibration energy of the jet as a sum of calibration energies of constituents (i.e. truth particles)
- plot shows ratio of jet calibration energy to the jet energy before (●) and after (●) correction for rest masses of stable particles



- implementation works well – calibration energy of truth jet is consistent with initial energy of the jet corrected for rest masses of constituents

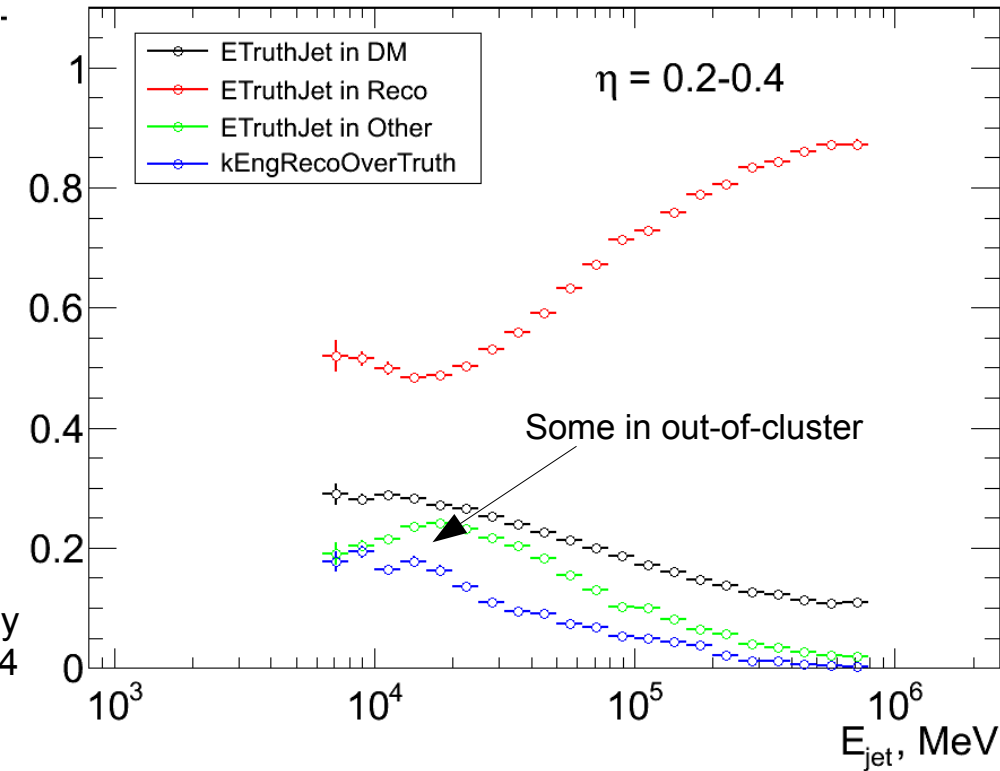
# KT4 Truth and Reco matched (0.3) jets: Friend-or-Foe jet energy components

- (●) - Truth jet energy deposited in matched Reco jet
- (●) - Truth jet energy deposited in dead material
- (●) - Truth jet energy deposited in clusters/cells not belonging to the matched Reco jet
- (●) - Reco jet energy caused by particles not belonging to the Truth matched jet



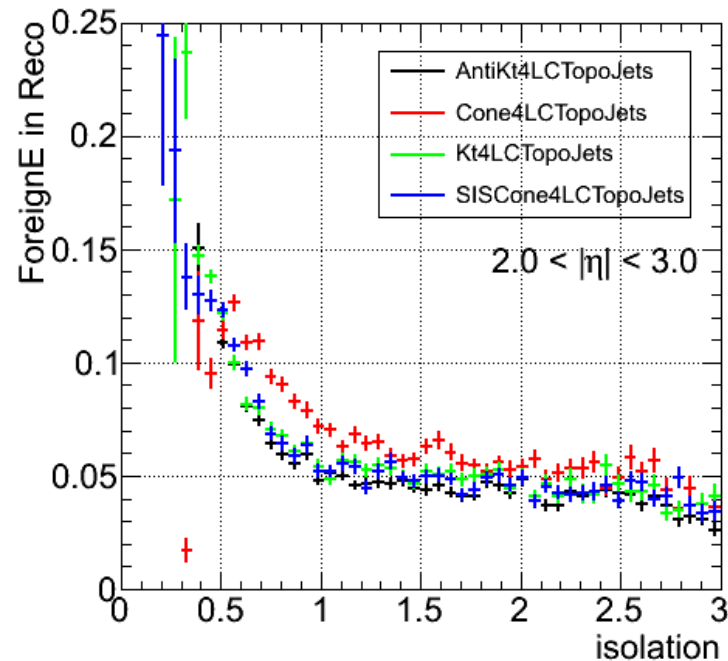
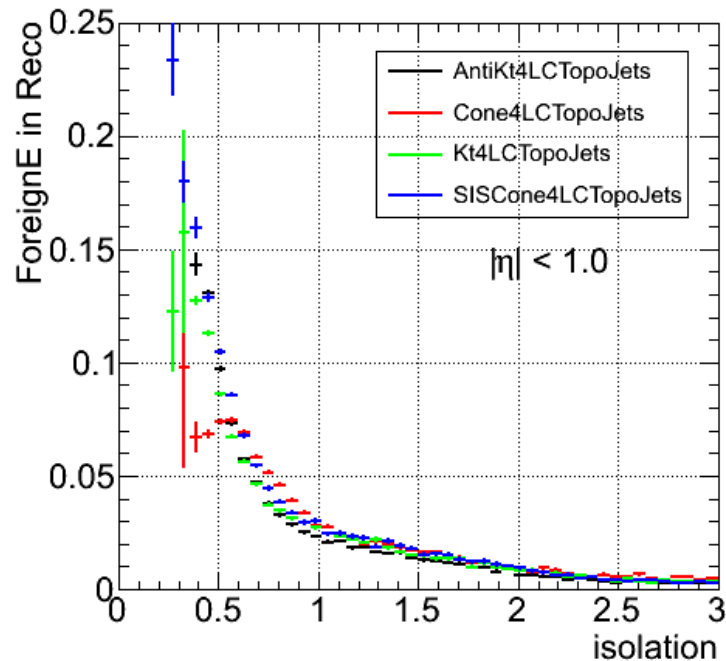
Ratio (r) of energy components to the jet total calibration energy as a function of jet energy for  $0.2 < \eta < 0.4$

Ratio (r) of energy components to the jet total calibration energy as a function of jet  $\eta$  for [100, 160] GeV jets



# Foreign energy in reconstructed jet as a function of isolation

- Ratio of Reco jet energy caused by particles not belonging to the Truth matched jet to the jet total energy, as a function of isolation parameter for different jet algorithms
  - matching criteria  $\Delta R < 0.3$ ,  $E_t(\text{truth}) > 20\text{GeV}$ ,  $E_t(\text{reco}) > 12\text{GeV}$



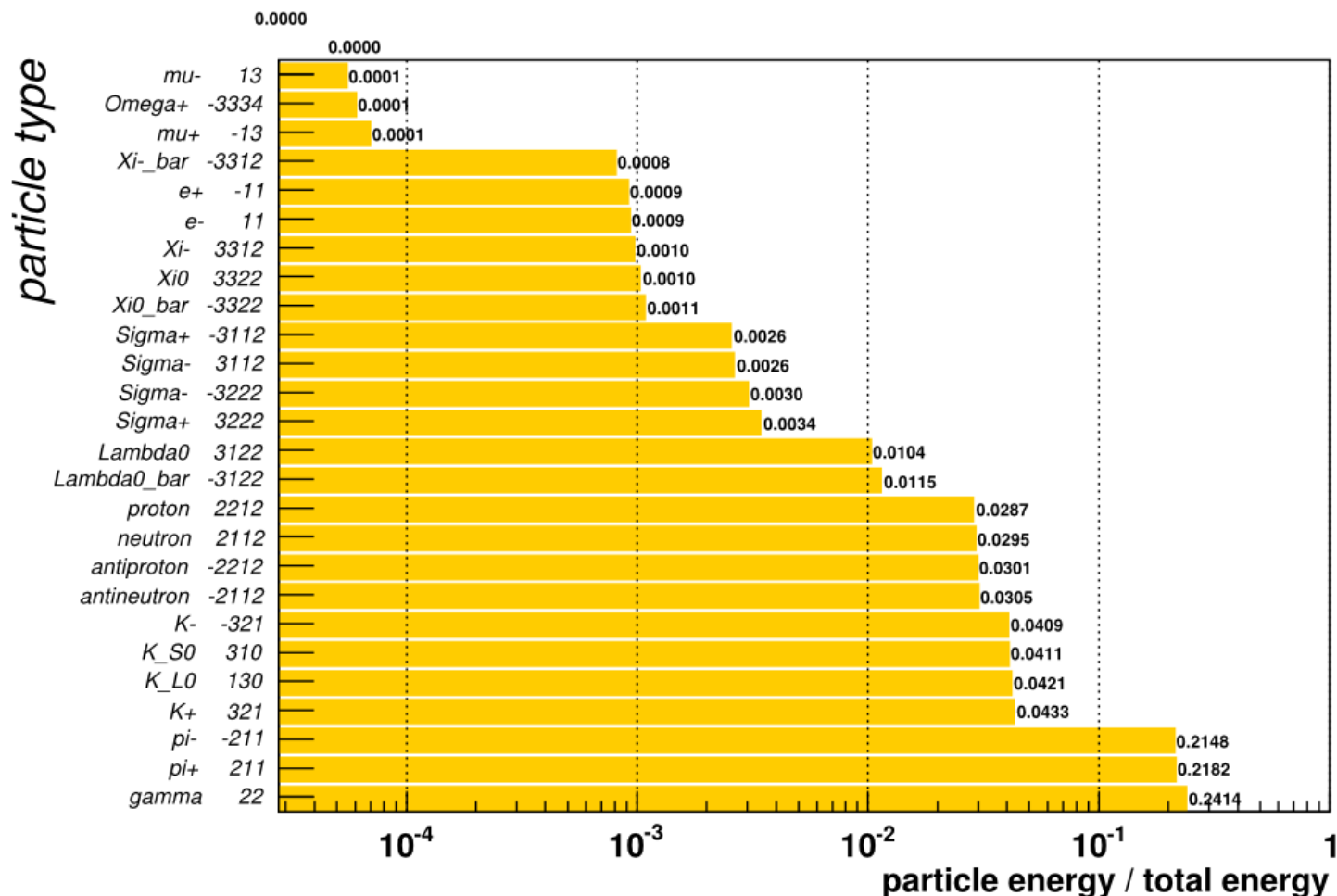
- Jets have large foreign energy contribution even at large isolation (long tail)
  - primary particles across the detector not belonging to any Truth jet (7GeV cut?)
- Usage of isolation criteria
  - As a quality cut to discard “bad” jets (?)
  - Not to use isolation as quality cut, but make correction aware of isolation (?)

# Summary

- ◆ Primary particle ID implementation for calorimeter calibration hits is ready for use.
- ◆ It establishes unique correspondence between primary particles and their energy deposits in the calorimeter and in the dead material on the calibration hit level.
- ◆ Possible application: out-of-cluster, out-of-cone corrections, lost particles, jet algorithms validation, truth energy flow studies, jet energy scale Part I- IV, etc.
- ◆ ~50k of J4+J5+J6 events are available now on the Grid to give a try.
- ◆ See details <https://twiki.cern.ch/twiki/bin/view/AtlasProtected/PrimaryParticleID>
  - accessible via Jet/Etmiss WG wiki page

# Which primary particles could be traced?

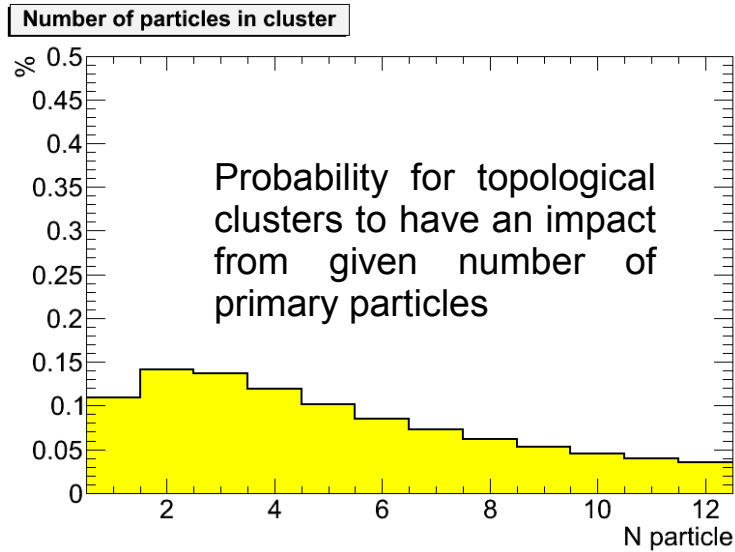
- ◆ All particles from generator passing *isGenStable* criteria (these are particles whose energy sum is equal to 10 TeV)
  - ... except beam particles with initial  $|\eta| > 5.0$  which do not give rise of a signal in the detector
- ◆ All calibration hits have known origin (if not, i.e. *barcode*==0, than implementation is off in simulation)



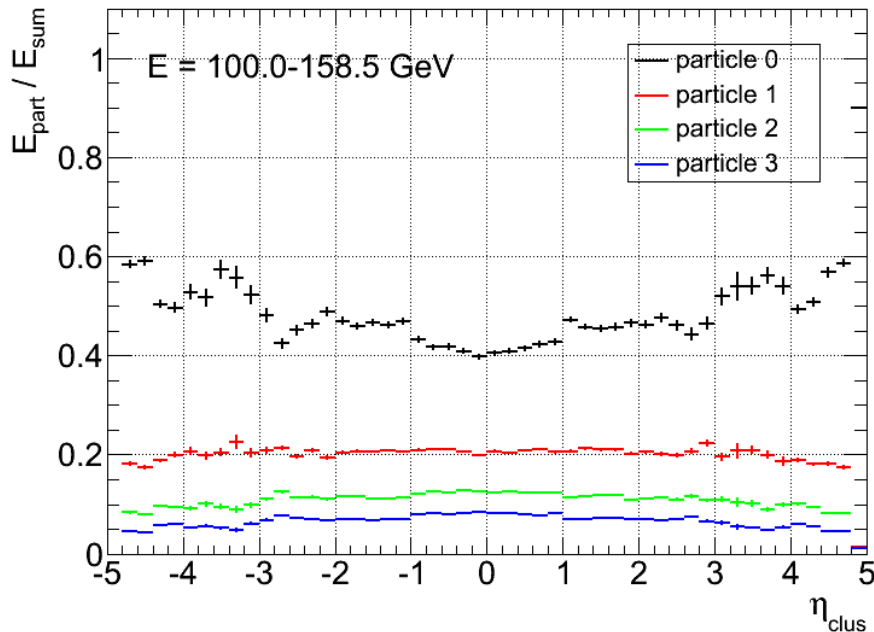
Ratio of energy deposited in active cell volume by particles of different type in J4 di-jet sample

Thus, fractional energy carried by different particle types in CaloCell is similar to one in the Truth jet

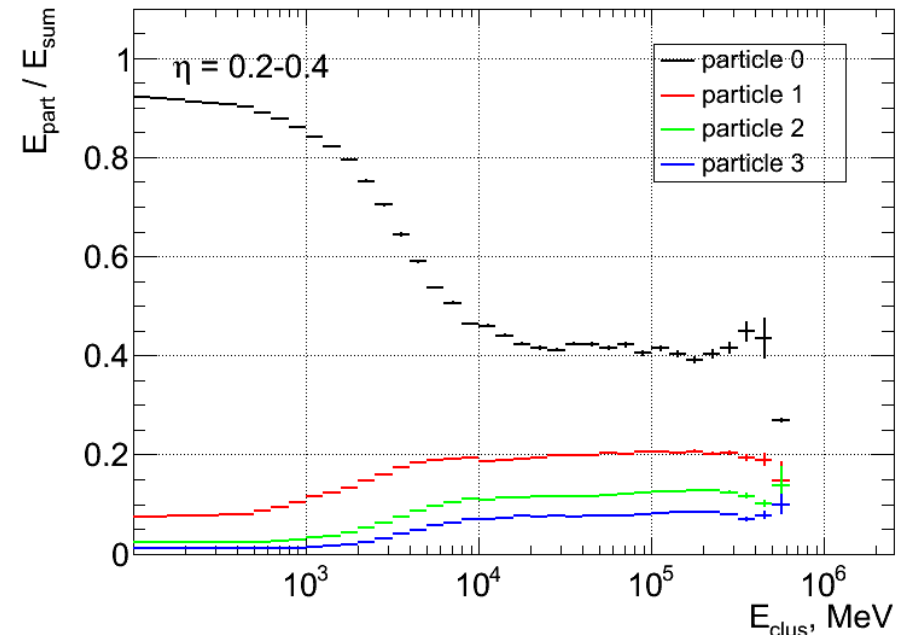
# Backup: primary particle impact on \*TopoJets constituents



- For high energetic ( $>10$  GeV) clusters in J4 environment only 50% of cluster energy is caused by most energetic particle, the rest of cluster energy is due to other particles
  - Corrected for extra particles from  $\pi_0 \rightarrow \gamma\gamma$ : photons with same vertex are accounted as single particle



Primary particles impact on topological cluster as a function of cluster  $\eta$



Primary particles impact on topological cluster as a function of cluster energy