An ATHENA package for jet performance studies

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Main purposes of a Jet Performance Package

- Provide a reproducible set of plots to check the performance of the jet calibration algorithm
  - follow evolution of the performances
  - compare/validate new calibration strategies with existing ones

- Athena package
  - configurable with jobOptions
  - can be installed in a standard way

- Provide plots for the CSC ATLAS note

Requested plots for ATLAS Detector Paper

- Jet collections
  - Jets built from **Tower** and **Topological clusters**,
  - Clustering with **cone 0.4** and **cone 0.7**
  - Calibration with **H1 method**

- Linearity and energy resolution vs E
  - vs Energy : **central region** ($0.2 < |\eta| < 0.4$) and **forward region** ($2.35 < |\eta| < 2.55$)
  - vs η : $30 < E_T < 40$ GeV and $480 < E_T < 640$ GeV

- Spatial resolution vs η
  - η(rec)-η(truth) and φ(rec)-φ(ruth) for $30 < E_T < 40$ GeV and $480 < E_T < 640$ GeV

- Efficiency and purity vs E_T and η of the truth jet
  - 3 eta regions : $0 < |\eta| < 0.5$; $1.7 < |\eta| < 2.5$; $3.7 < |\eta| < 4.2$
  - 2 E_T regions : $30 < E_T < 40$ GeV; $480 < E_T < 640$ GeV

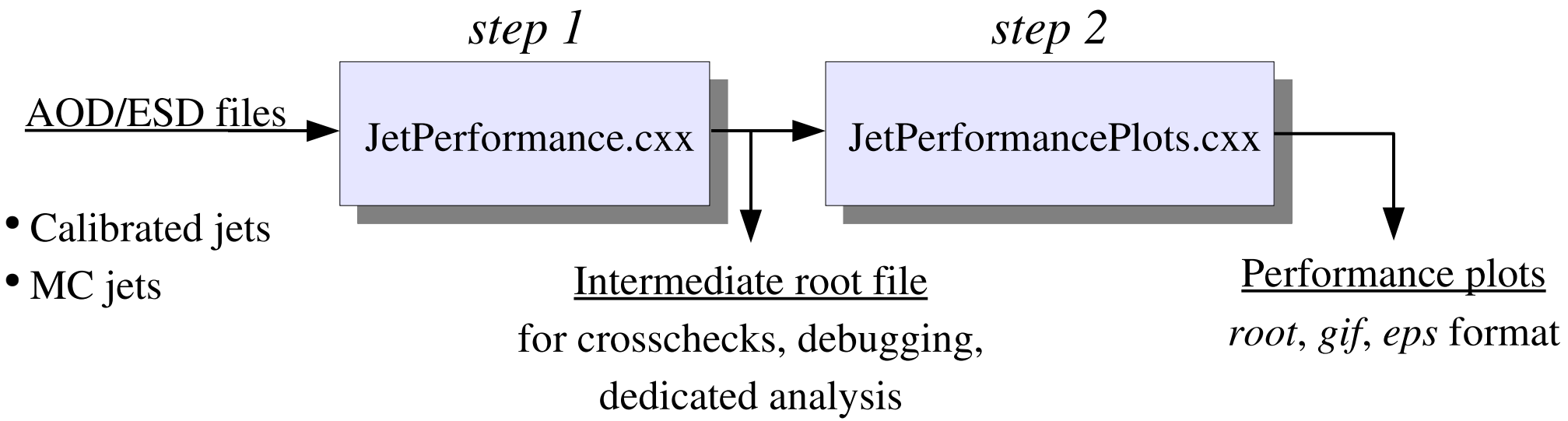
General structure of the JetPerformance package

(still under development)

- CVS : Reconstruction/Jet/JetPerformance

- Data set used so far
  - Official QCD dijet samples
  - Misaligned geometry with material distortion

- Structure of the Jet Performance algorithm



The JetPerformance algorithm

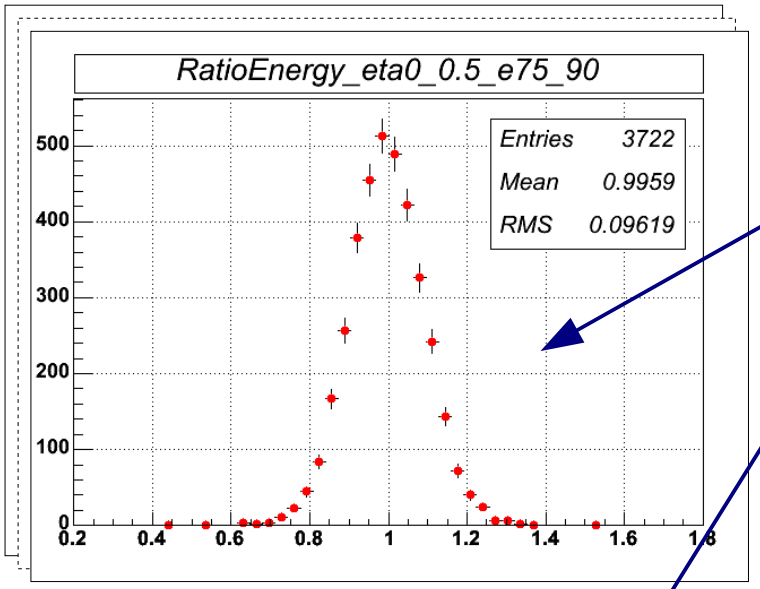
- Input file : AOD/ESD files containg jet collections (reco jets, MC jets)
- Performs the matching between **MC jets** and **reconstructed jets**
  - matching cone ΔR, set in jobOptions file
- For each bin (in η, φ, E_T or E) save 1-D and 2-D histograms
  - E^{Reco}/E^{Truth} (if $E_T^{Truth} >$ TrueJetCut and $E_T^{Reco} >$ RecoJetCut)
  - $\eta^{Reco} - \eta^{Truth}$ (same cuts on E_T)
  - $\varphi^{Reco} - \varphi^{Truth}$ (same cuts on E_T)
  - Number of true jets vs E_T and eta (no cuts on E_T)
  - Number of reconstructed vs E_T and eta (no cuts on E_T)
  - Number of true matched jets vs E_T and eta (no cuts on E_T)
  - Number of reconstructed jets vs E_T and eta (no cuts on E_T)
- Output file : ROOT histogram file

The intermediate output root file : structure

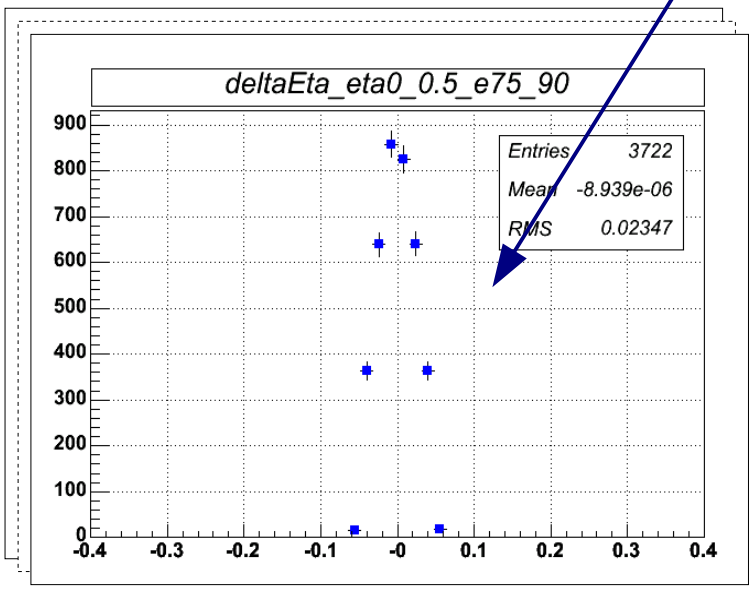
For each jet collection the following info is available :

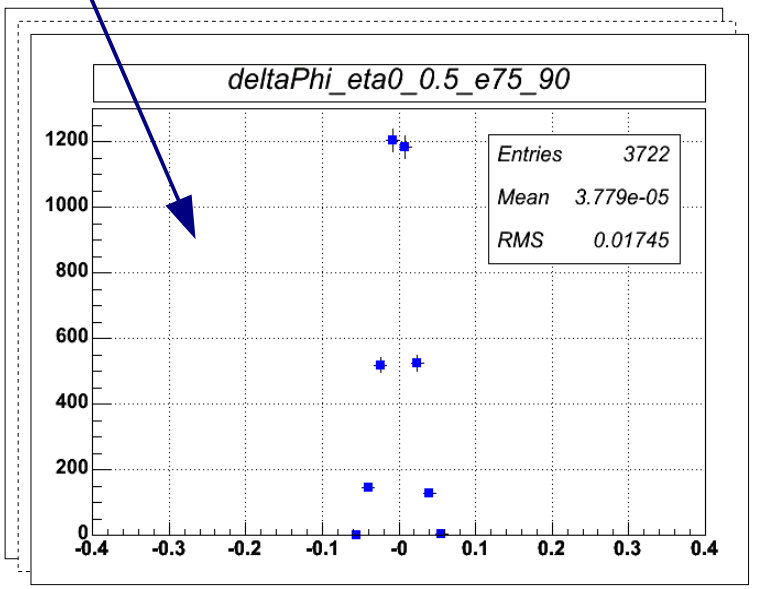
- Backup of the histograms conditions
  - matching cone, E_T^{truth} cut, E_T^{reco} cut
  - Number of Energy, Eta, Phi bins
  - Size of the bining in E, Eta, Phi
  - ...
- Histograms (1D, 2D)
  - E(rec)/E(truth) for each bin
  - Spatial resolution in **eta** for each bin
  - Spatial resolution in **phi** for each bin
  - Number of **MC Jets** vs ET and eta
  - Number of **reconstructed Jets** vs Et and eta
  - Number of **matched MC Jets** vs Et and eta
  - Number of **matched MC Jets** vs Et and eta

The intermediate output root file : example



- For $0 < \eta^{Truth} < 0.5$ and $75 < E^{Truth} < 90$ GeV
  - Distribution of E^{Reco}/E^{Truth}
  - Distribution of $\eta^{Reco} - \eta^{Truth}$
  - Distribution of $\varphi^{Reco} - \varphi^{Truth}$





Drawing performance plots

- Linearity and resolution
  - For each bin in $\eta/\varphi/E_T/E$, fit E(Reco)/E(Truth) distributions with a Gaussian function ($\pm 2\sigma$ range) $\Rightarrow$ get ***μ*** and ***σ***
  - *Linearity* : Plot μ vs E(Truth) and η
  - *Energy resolution* : Plot σ/μ vs E(Truth) and η + fit with 2 or 3 parameters :

$$\frac{\sigma}{E} = \frac{a}{\sqrt{E}} \oplus b \qquad \frac{\sigma}{E} = \frac{a}{\sqrt{E}} \oplus b \oplus \frac{c}{E}$$

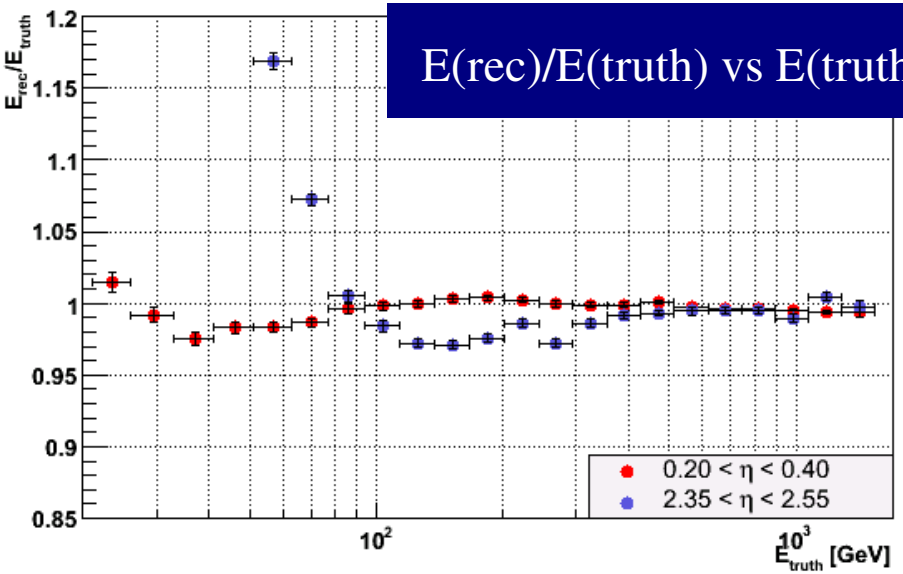
  - Spatial resolution : For each bin in η fit η(Reco)-η(Truth) and φ(Reco)-φ(Truth) distributions with a Gaussian ($\pm 2\sigma$ range) $\Rightarrow \mu$

- Efficiency
  - Plot (Number of matched reco jets) / (Number of reco jets)

- Purity
  - Plot (Number of matched true jets) / (Number of true jets)

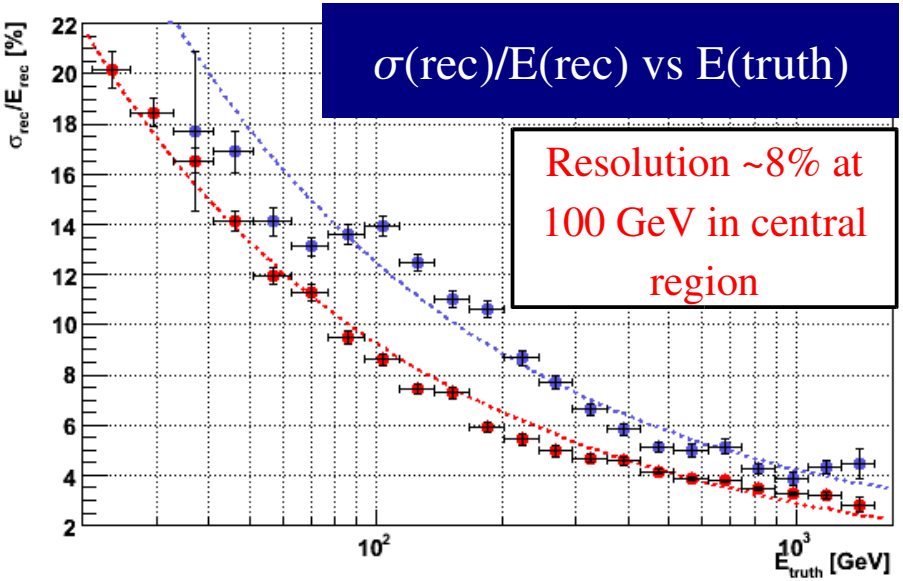
Some example plots : linearity and energy resolution

E(rec)/E(truth) vs E(truth)

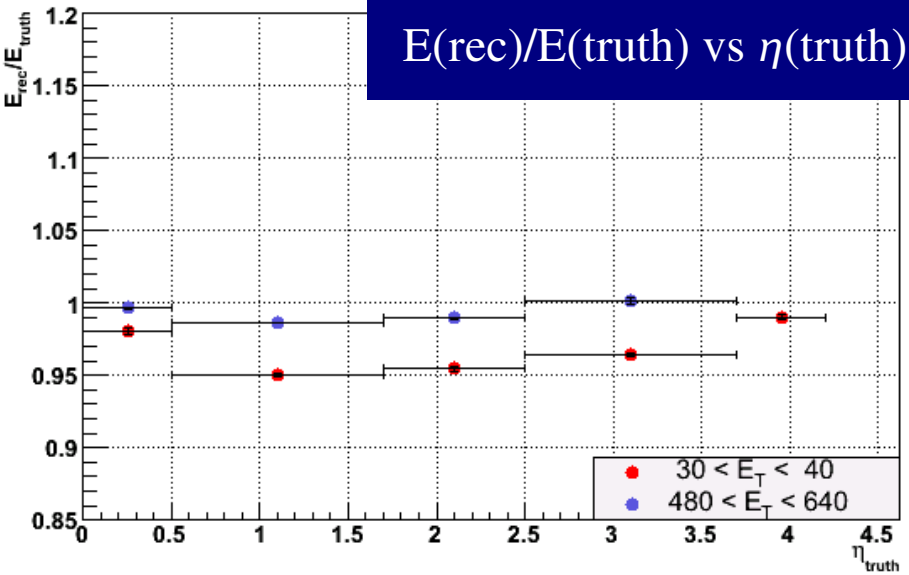


σ(rec)/E(rec) vs E(truth)

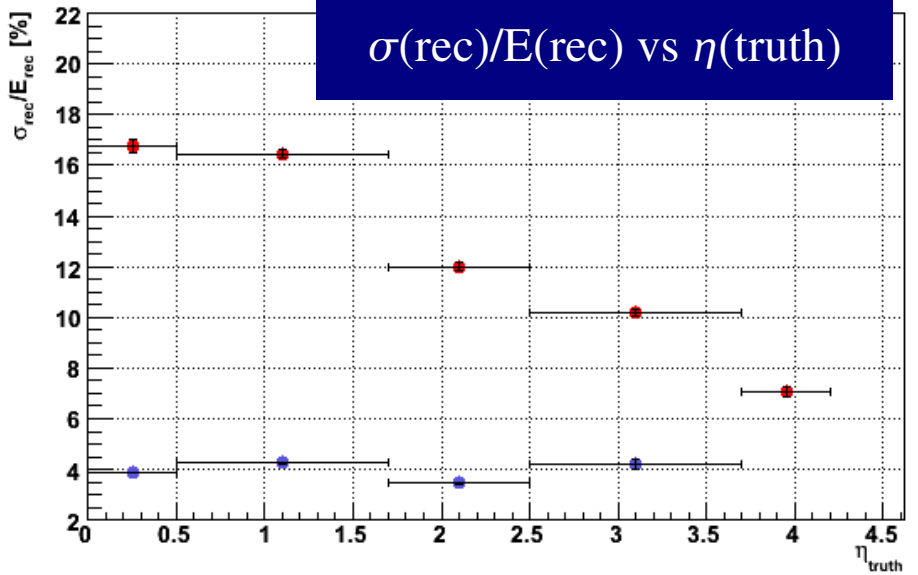
Resolution ~8% at 100 GeV in central region



E(rec)/E(truth) vs η(truth)

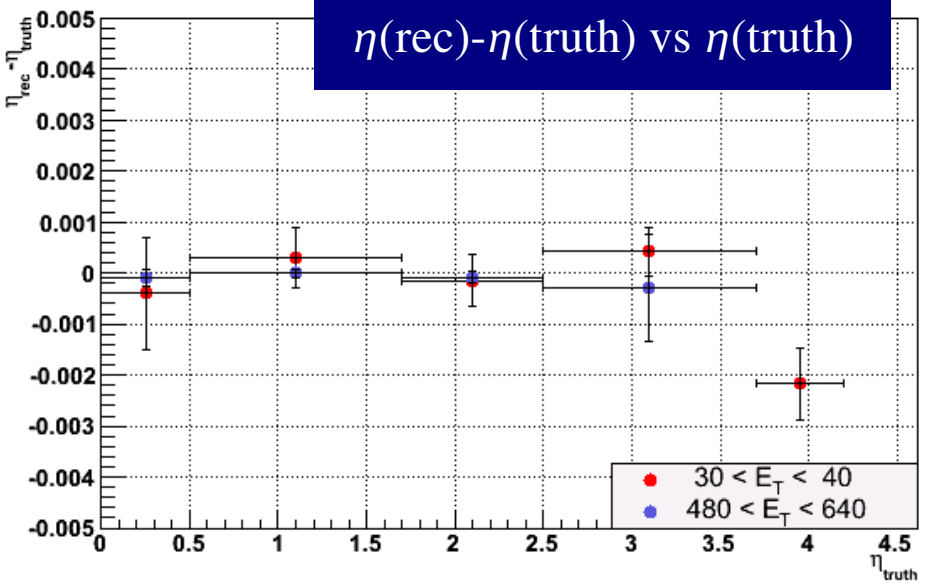


σ(rec)/E(rec) vs η(truth)

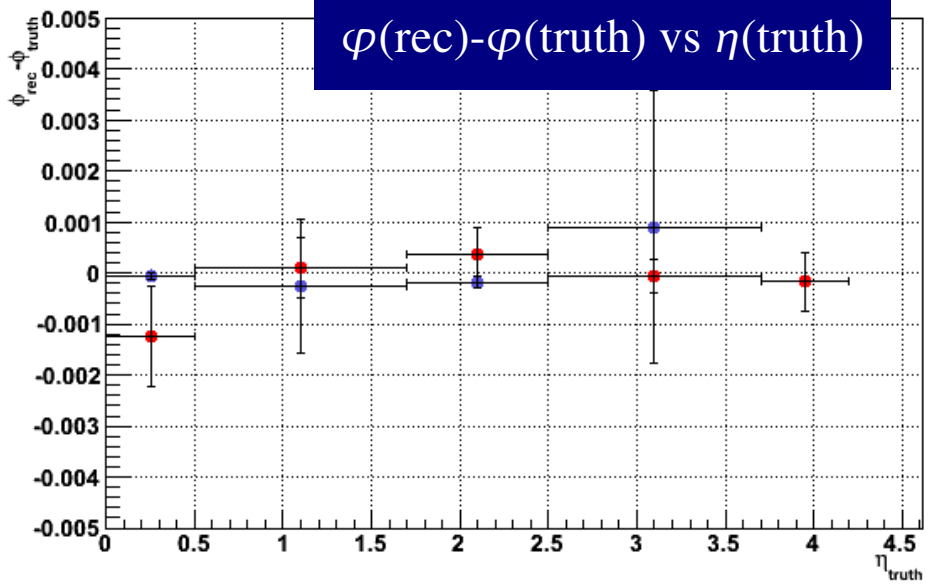


Some example plots : spatial resolution

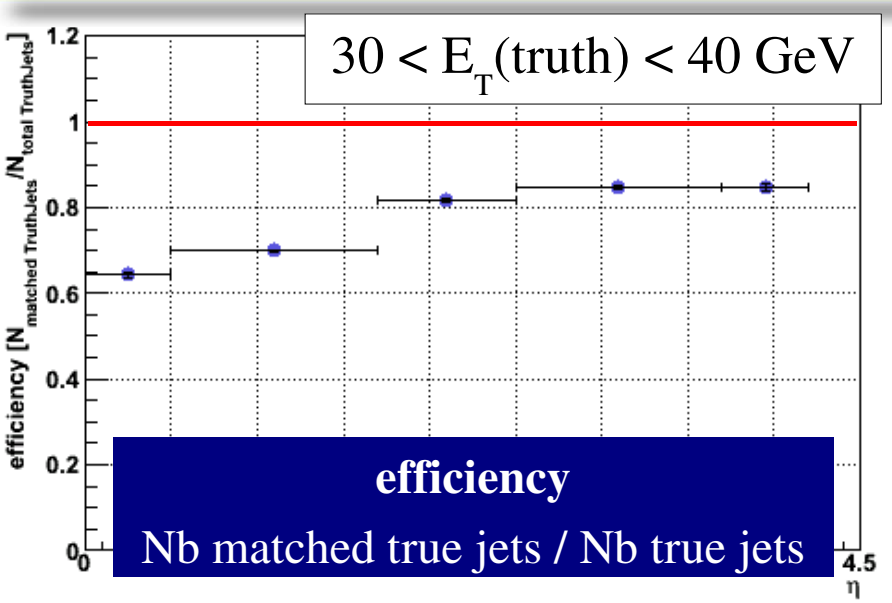
η(rec)-η(truth) vs η(truth)

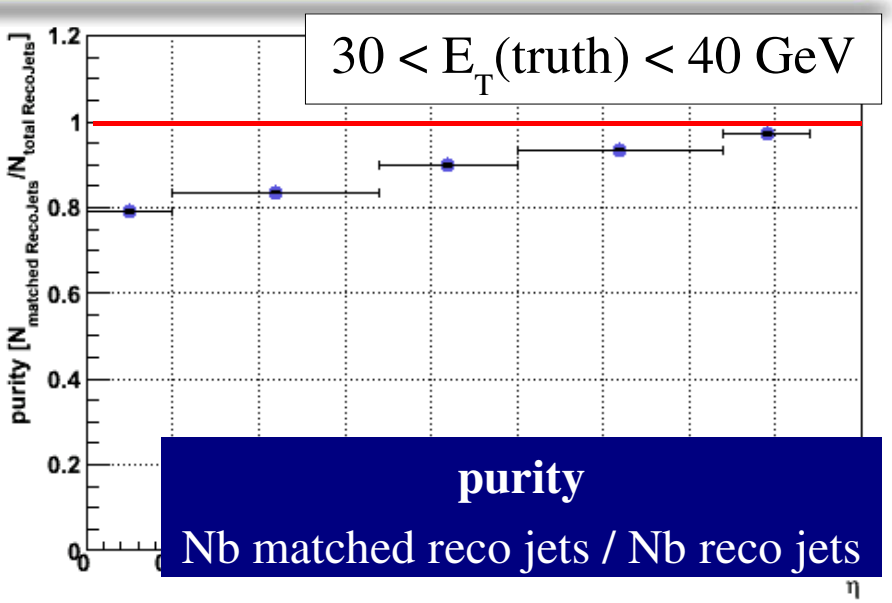


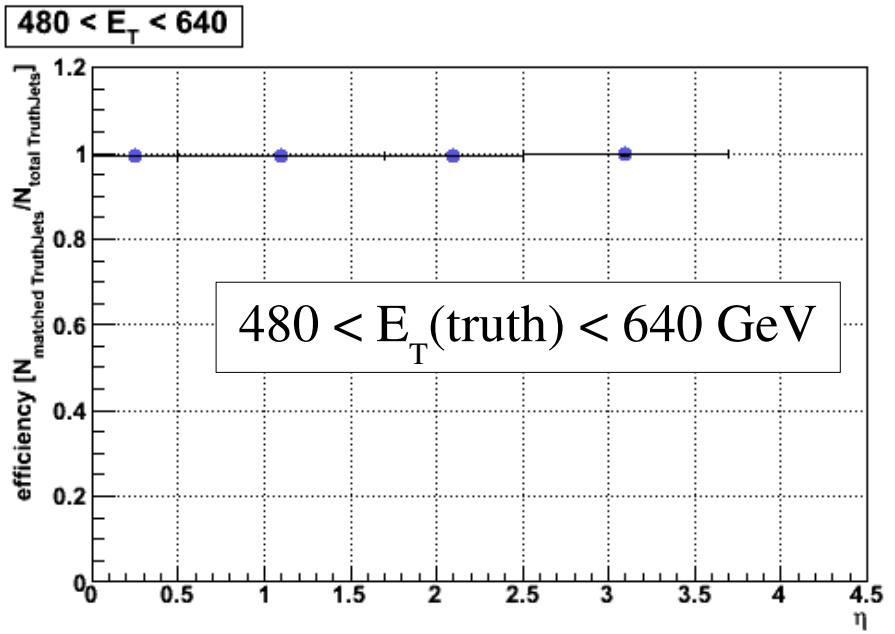
φ(rec)-φ(truth) vs η(truth)

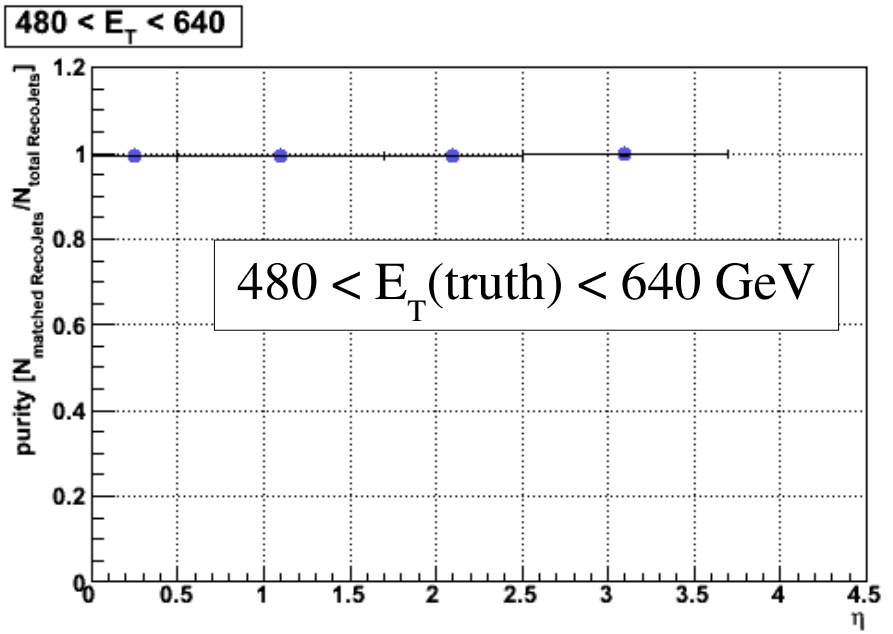


Some example plots : Efficiency & purity vs eta









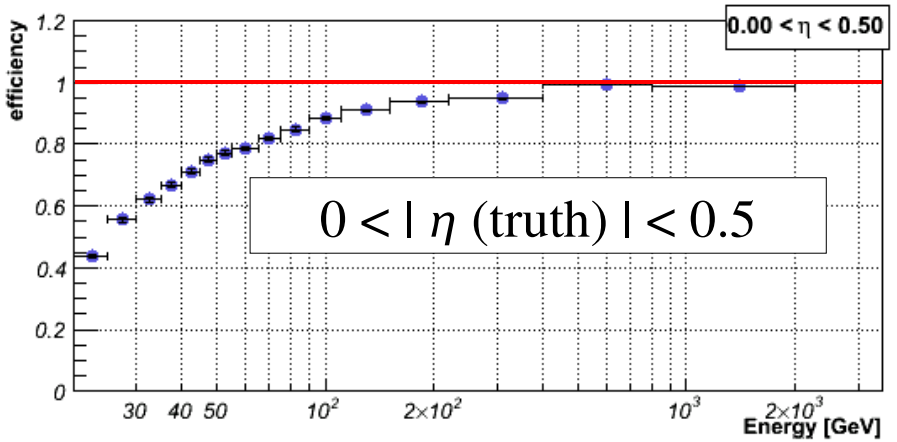
Some example plots : Efficiency & purity vs E(truth)

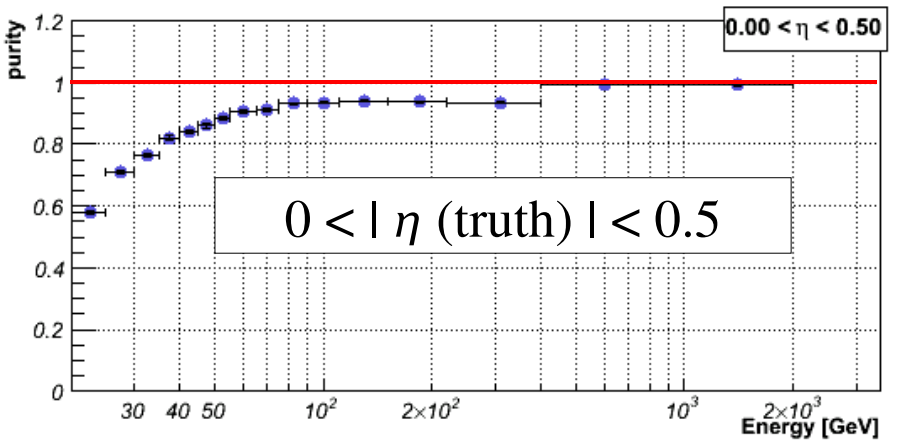
efficiency

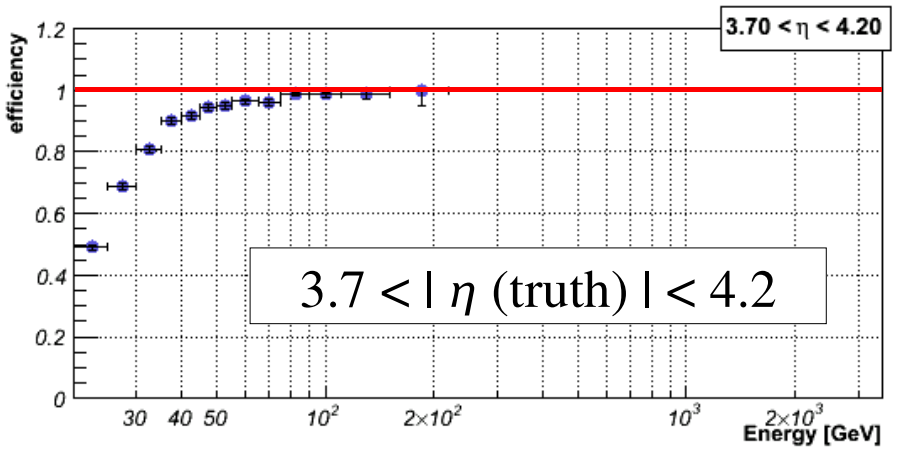
Nb matched true jets / Nb true jets

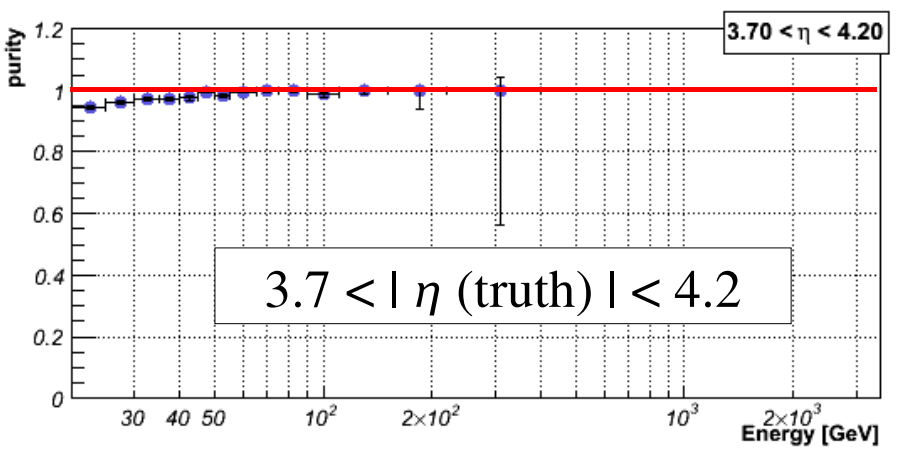
purity

Nb matched reco jets / Nb reco jets









Conclusions...

- Official Jet Performance package under development
  - meant to be easy and flexible to use
  - still some efforts to make it conform to ATHENA coding rules
  - will be soon put into release 13.X.X
- First plots for the ATLAS CSC note have been provided using this tool
- Any suggestion for improvment are welcome

Backup : calibration methods

Energy resolution minimization (with linearity constraint) to obtain weights W() :

- W(Jet Energy) x Sample energy
- W(Cell Energy density) x Cell energy
- W(Cell Energy, Jet Energy) x Cell energy

Simple and fast but less performant, useable at trigger level ? (A.Gupta)

Default in Athena, used in all physics analysis up to now and for ETMiss. Indicated with H1 (F.Paige)

Use global jet scale, See A.Dotti presentation, (Pisa groups)

All weights are also function of eta.
Different functions are assumed to describe the weight energy dependence.