Jet performance in FastCaloSim

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Outline

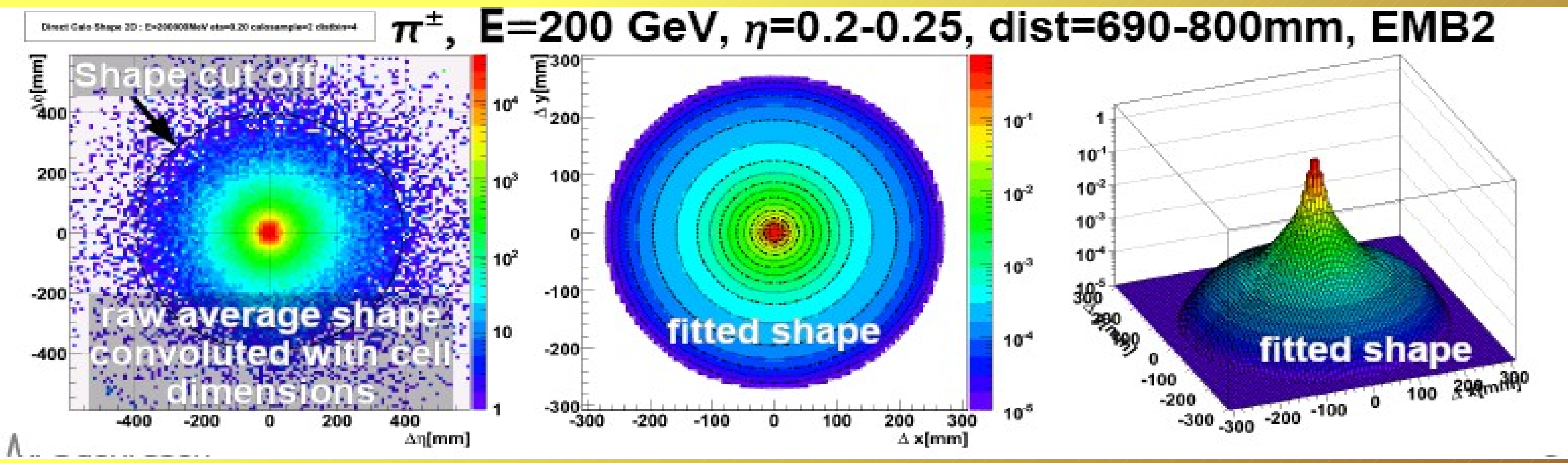
- A very short introduction to FastCaloSim with references
- Overview of electrons, photons and tau reconstruction performance
- Jet performance
- Summary

Toward Atlfast II

- The "standard" Atlfast – ATLAS fast simulation, widely used in the physics analysis, has limitations:
  - The calorimeter is neither simulated nor parametrized. Only final state objects (e/γ, jets) are smeared accordingly to the fullsim resolution
  - The reconstruction efficiencies are parametrized using the truth informations (event dependent)
- A fast calorimeter parametrization (implemented in FastCaloSim) has been developed within the Atlfast task force (mainly M. Duehrssen):
  - An "ATLAS like" calorimeter is filled using the parametrized response. The reconstruction algorithms run straightforward – they are the same as in fullsim.
  - A good reference is Michael Duehrssen's talk at the ATLAS overview week (from which I am taking a lot of material)

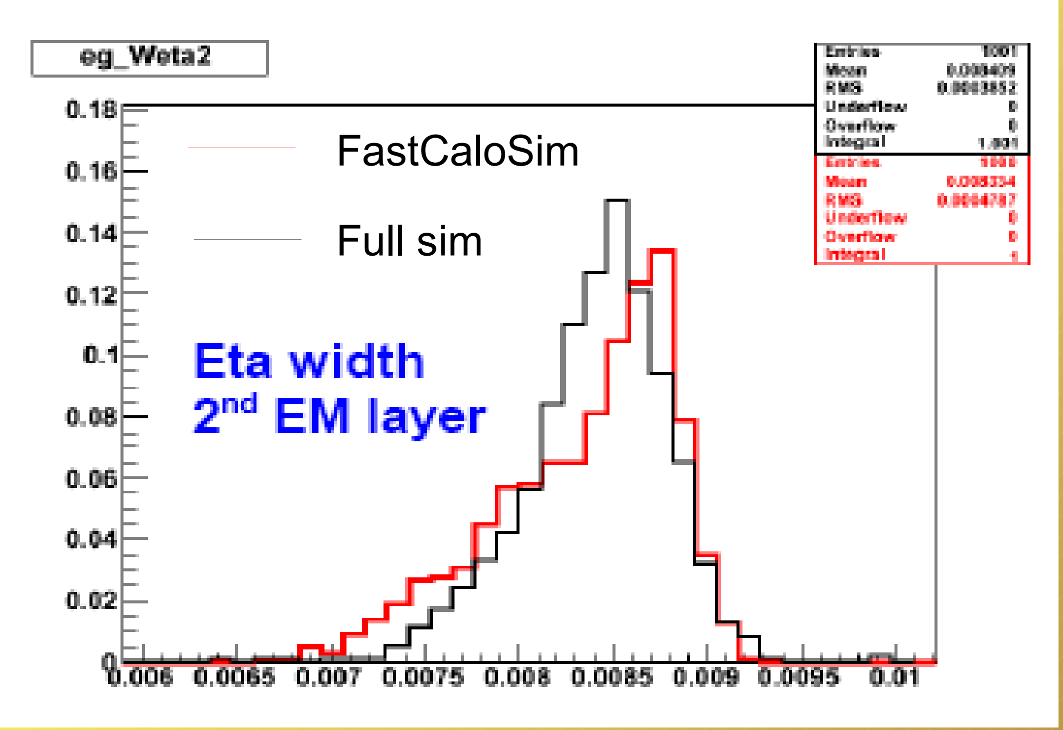
FastCaloSim

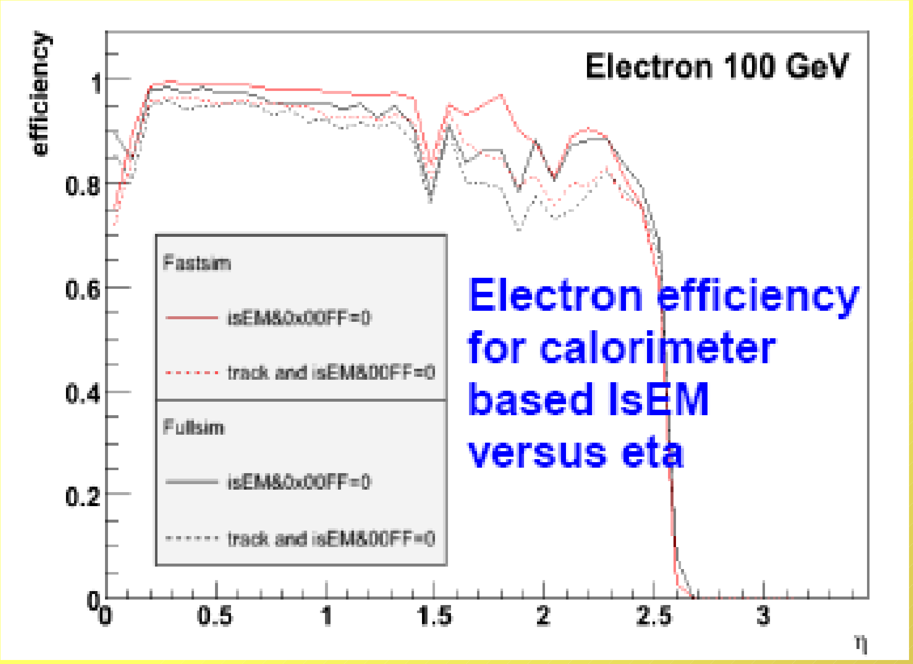
- The calorimeter parametrization is based on single photons and pions (Athena 10.0.1):
  - For details on the shower parametrization please refer to the references I gave.
  - Below an example of the lateral shower shape parametrization
- All the machinary is quite fast:
  - Simulation+Reconstruction with FastCaloSim: of the order of 5 sec (depending of course on the event complexity)



Performance on e and γ

- Generally the photon shower shape is reproduced quite well
- The plot is done with 100 GeV photons, η = 0.2, standard Egamma chain applied

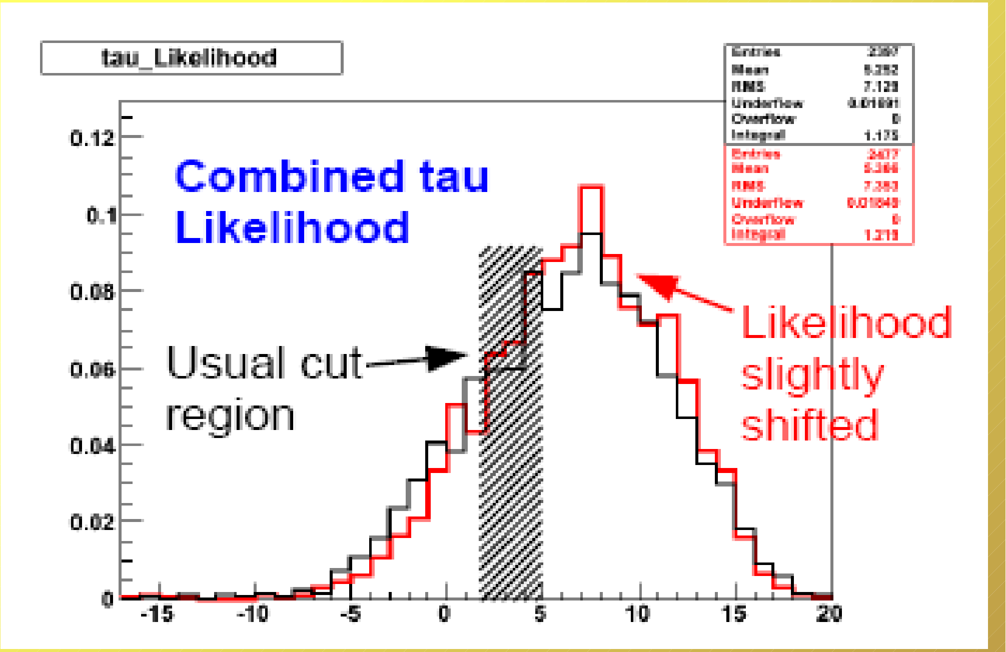


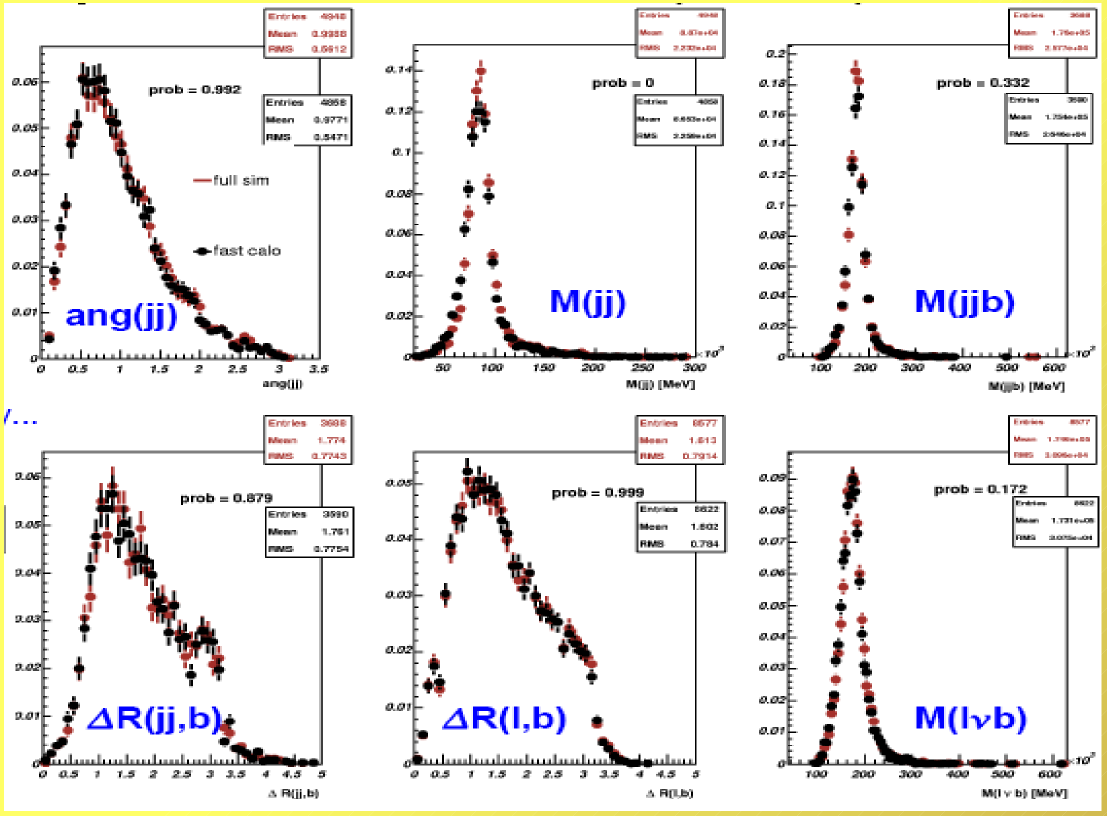


- Also the electron reconstruction efficiencies are reproduced well
- The plot is done with 100 GeV electrons

More on Fast-Full comparison

- tauRec reconstruction – the variables used in the likelihood are all quite well reproduced





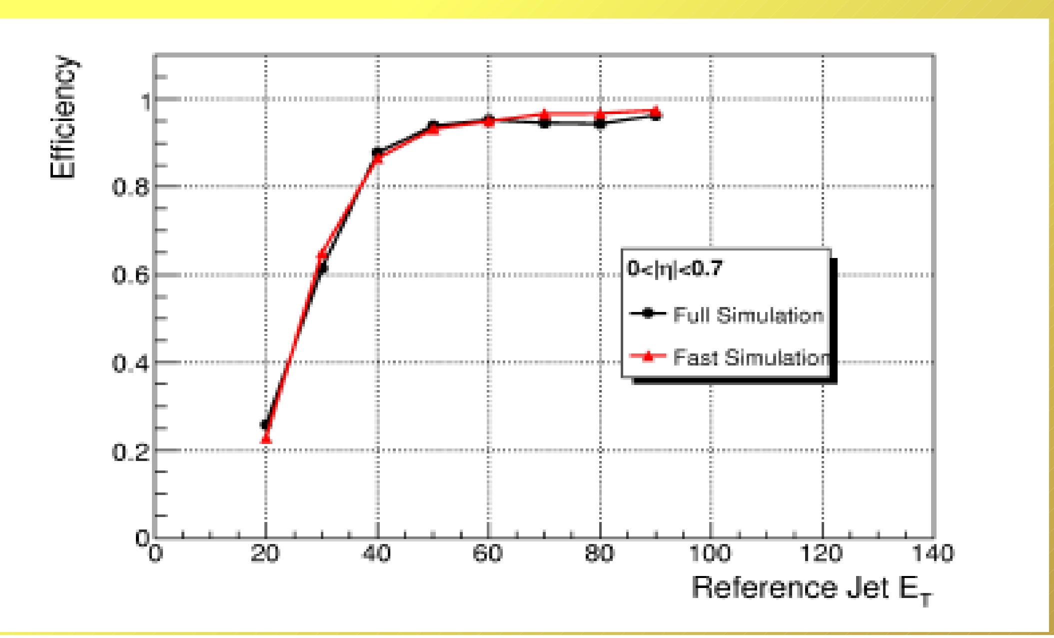
Comparison done also for complex events. An example is ttH (H-->bb) sowed in the picture

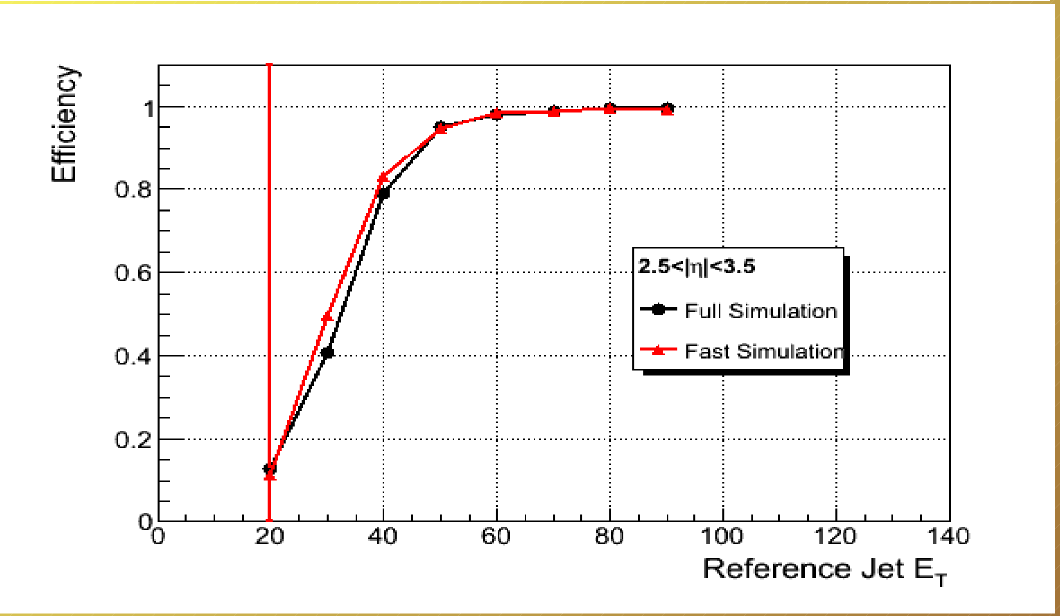
Let's focus on jets

- I was involved in the validation and calibration of the FastCaloSim simulated jets:
  - Since FastCaloSim fills the ATLAS calorimeter with a parametrized response, the JetRec software for the jet reconstruction can just be reused as it is. This means in FastCaloSim we are applying exactly the same algorithms we use in FullSim.
  - FastCaloSim is based on Athena 10.0.1: the most recent FullSim calibration constants are not optimal. They have been rederived using standard Athena software (JetCalib).
  - Thus: the constants differ from the FullSim, the method is identical.
- The weights are derived using jets reconstructed with a seeded cone algorithm ($\Delta R = 0.7$, $E_{seed} = 1$ GeV). The input is calorimeter towers.

Reconstruction efficiency

- A particle (truth) jet is defined as reconstructed if a calorimeter (or atlfast) jet is within a cone of $\Delta R = 0.3$ from the particle jet, regardless of the calorimeter jet P_T
- For each bin in P_T and η of the particle jet, reconstructed particle jets over the number of particle jets is computed
- Reconstruction efficiencies are well reproduced even in "difficult" regions

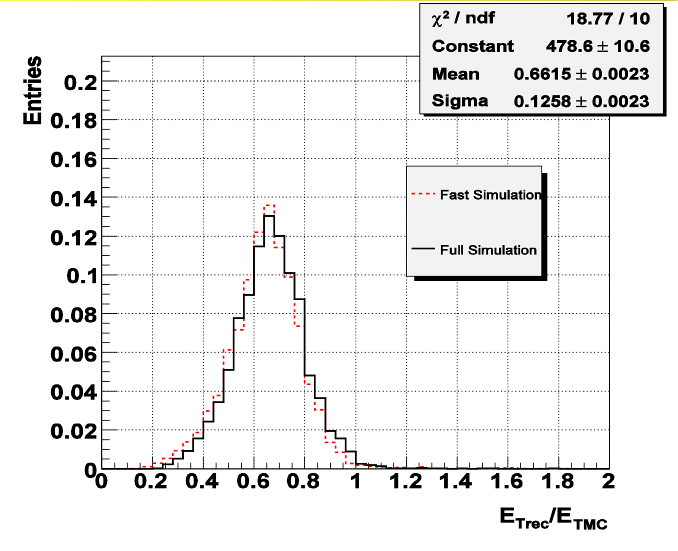


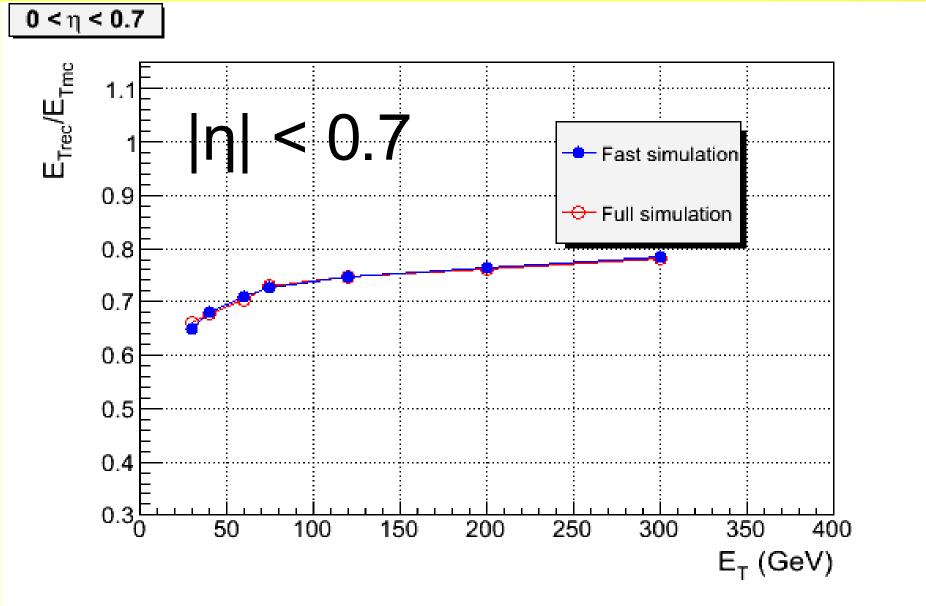


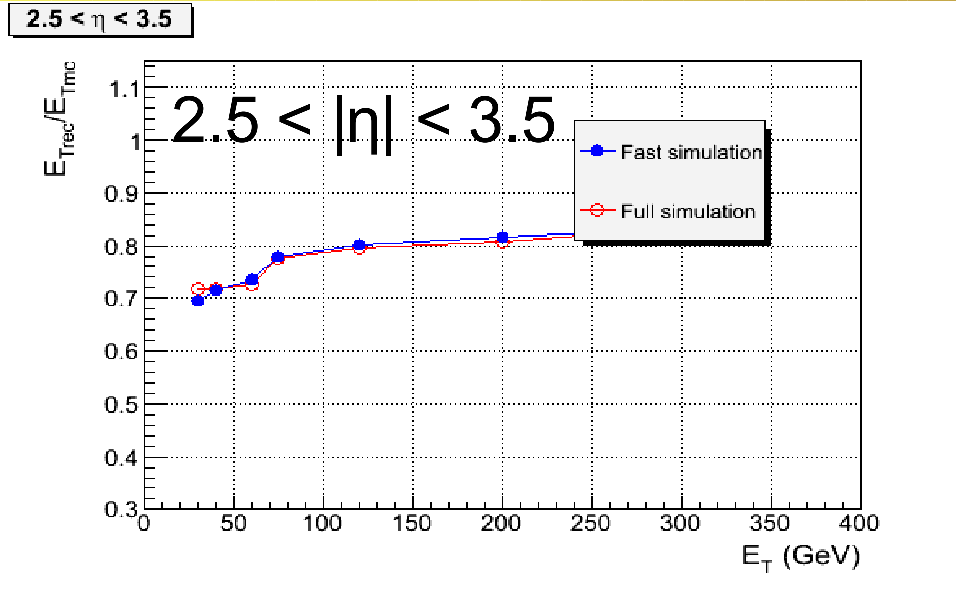
Linearity – EM scale

- First comparison done at the EM scale (the relevant one) with Rome QCD samples.
- Histograms of E_t^{rec}/E_T^{true} filled and fitted with a 2σ gaussian fit.
- Overall very good agreement between fast and full simulation

0<|η|<0.7 – P_T^{truth}~20 GeV

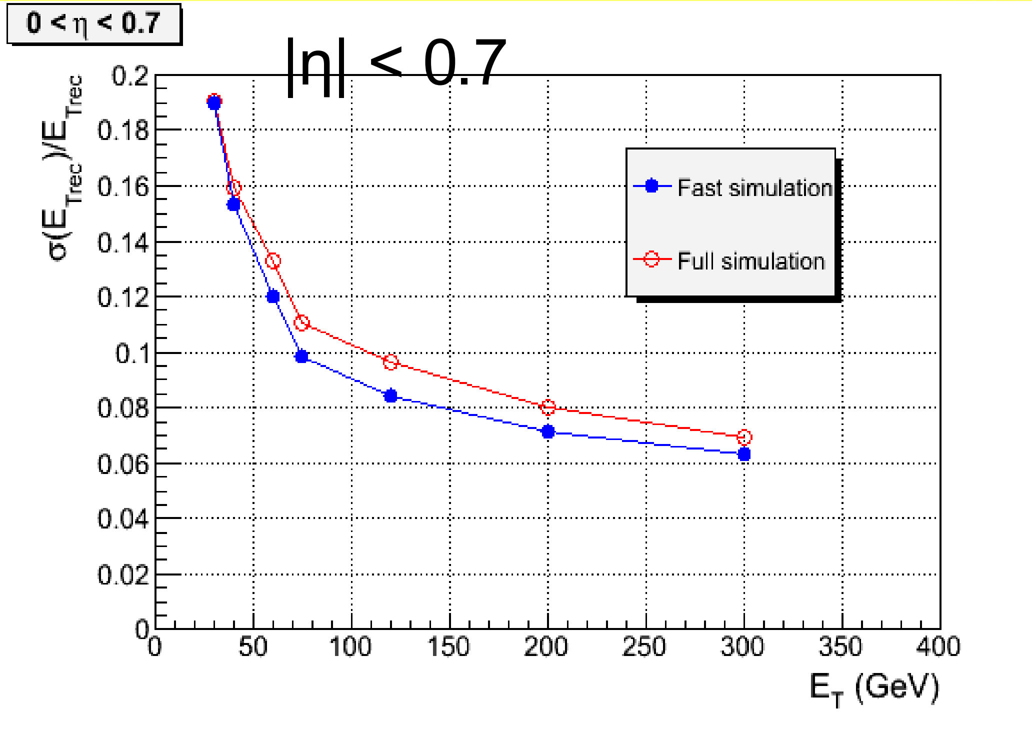


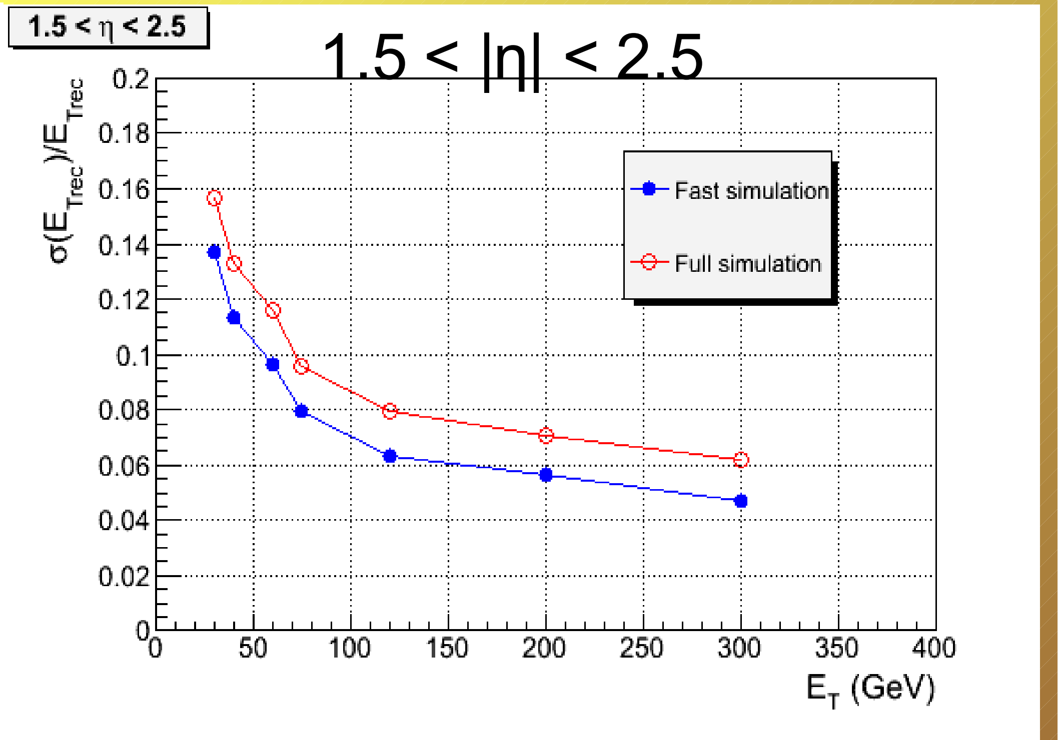




Resolution – EM scale

- The resolution a little bit too good in the fast simulation at the EM scale

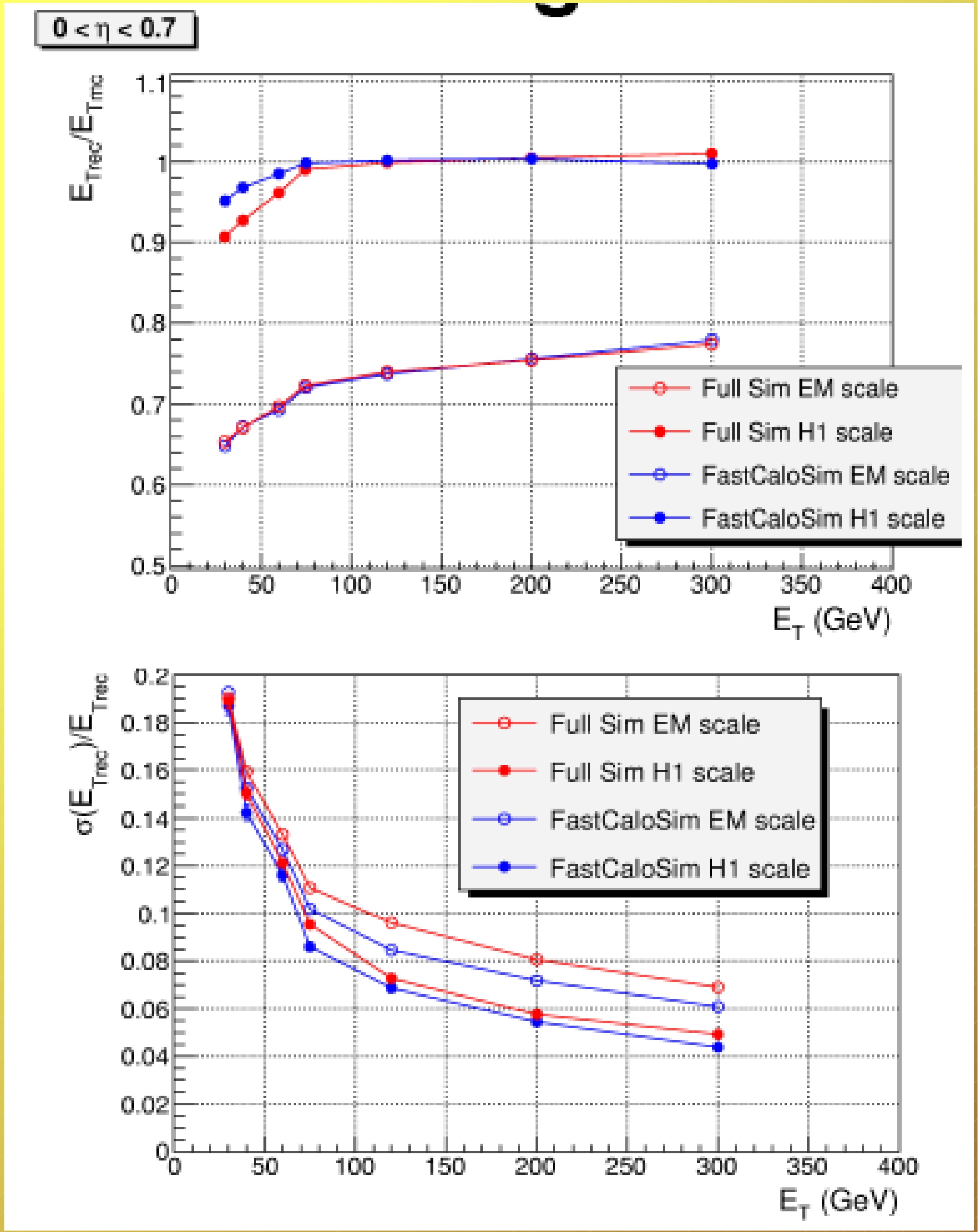




The H1-style calibration in 1 slide

- Jets need to be calibrated because of e/h, dead material, cracks, etc.
- The H1-style calibration (CSC default) is based on the principle that high energy density calorimeter deposits are most likely electromagnetic.
- It has been developed in BNL (F.Paige)
- The energy is reconstructed as $E_{rec}^{jet} = \sum_{i=cells} w_i\left(\frac{E_i}{V_i}\right) E_i$
- The weights are parametrized as $w_i\left(\frac{E_i}{V_i}\right) = \sum_{j=0}^{3} a_j \log \frac{E_i}{V_i}$
- They are obtained minimizing the resolution with respect to the particle (truth) jet $X^2 = \sum_e \left(\frac{\left(E_{rec}^{jet(e)} - E_{truth}^{(e)}\right)^2}{E_{truth}^{a(e)}}\right)$
- More details can be fount on the JetEtMiss WiKi

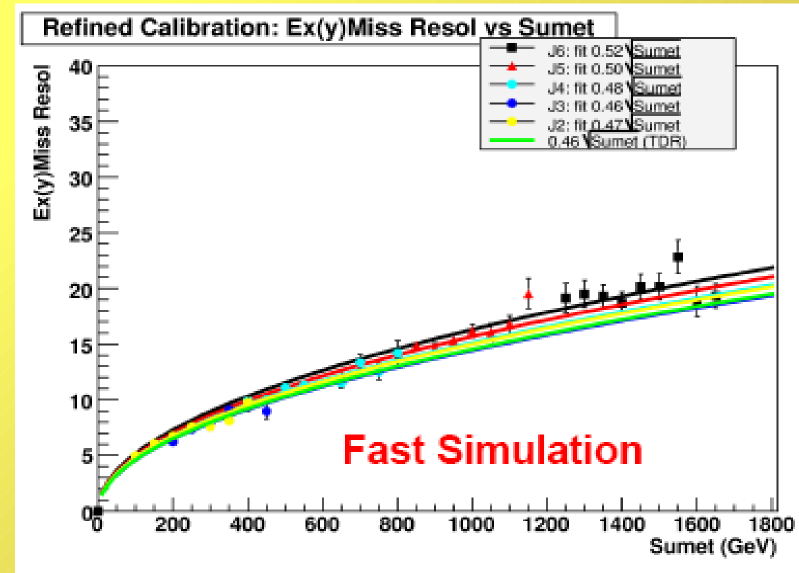
Results – Cal scale

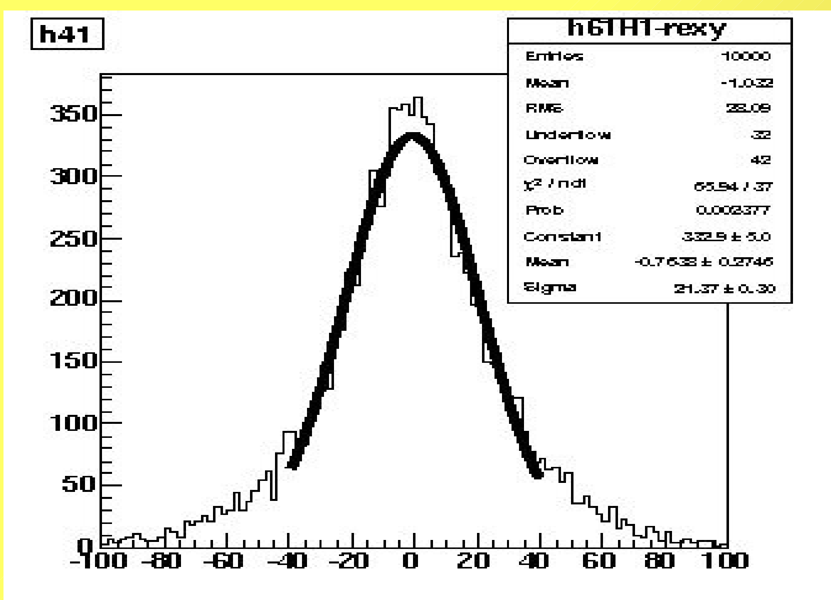


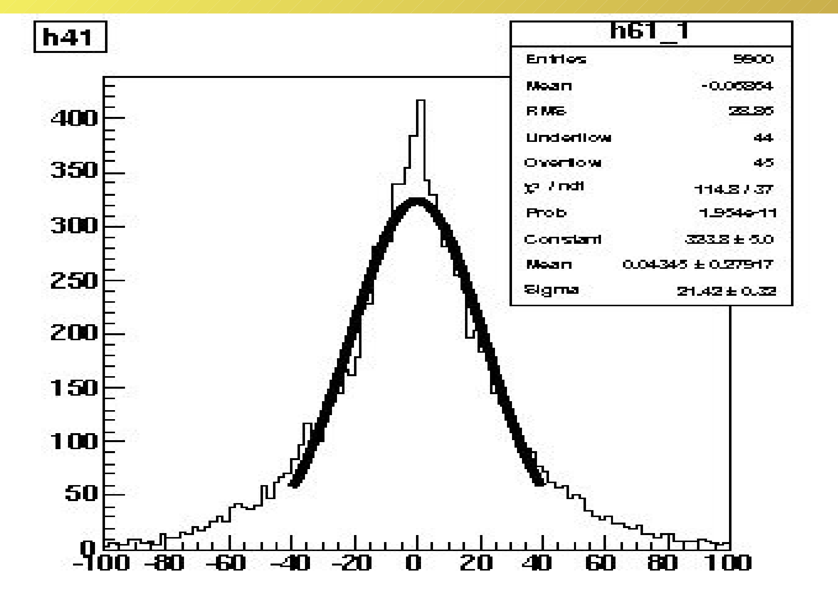
- Same fitting procedure as for the full simulation, slightly different values for the parameters
- The H1 weights recover the linearity of the measurement
- They slightly improve the resolution
- Available in the database as the fullsim constants

Missing E_T

- The H1 weights are used also to reconstruct the missing E_T
- The fast simulation missing E_T resolution is very similar to the fullsim
- The tails are quite well reproduced – more quantitative estimate to come







Summary

- A new fast calorimeter simulation (FastCaloSim) has been developed.
- The relevant variables for the final state object reconstruction are generally well reproduced
- The new simulation is available starting from Athena 13.0.20 (back compatible installation on 12.0.X also possible)
- The evolution can be monitored at FastCaloSim WiKi
- Jets are also well reproduced by FastCaloSim:
  - Specific calibration constants have been derived
- Feedback from the physics group needed