Results on Pisa Calibration

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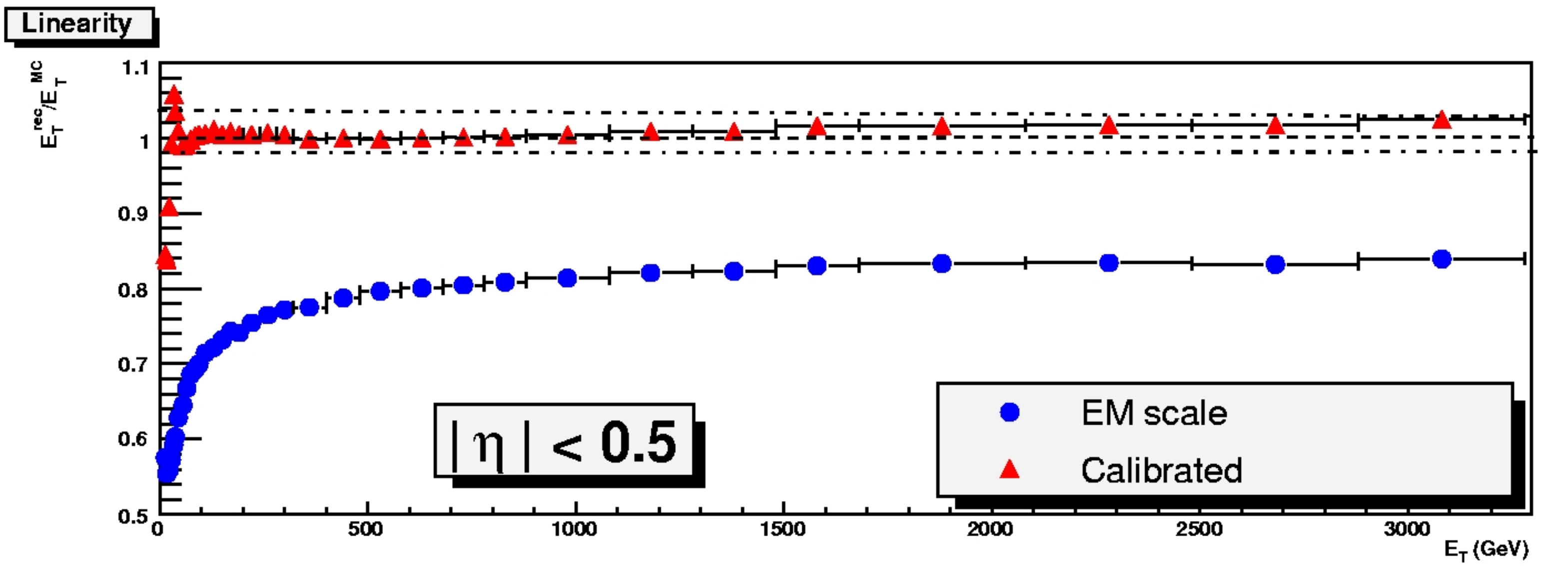
Outlook

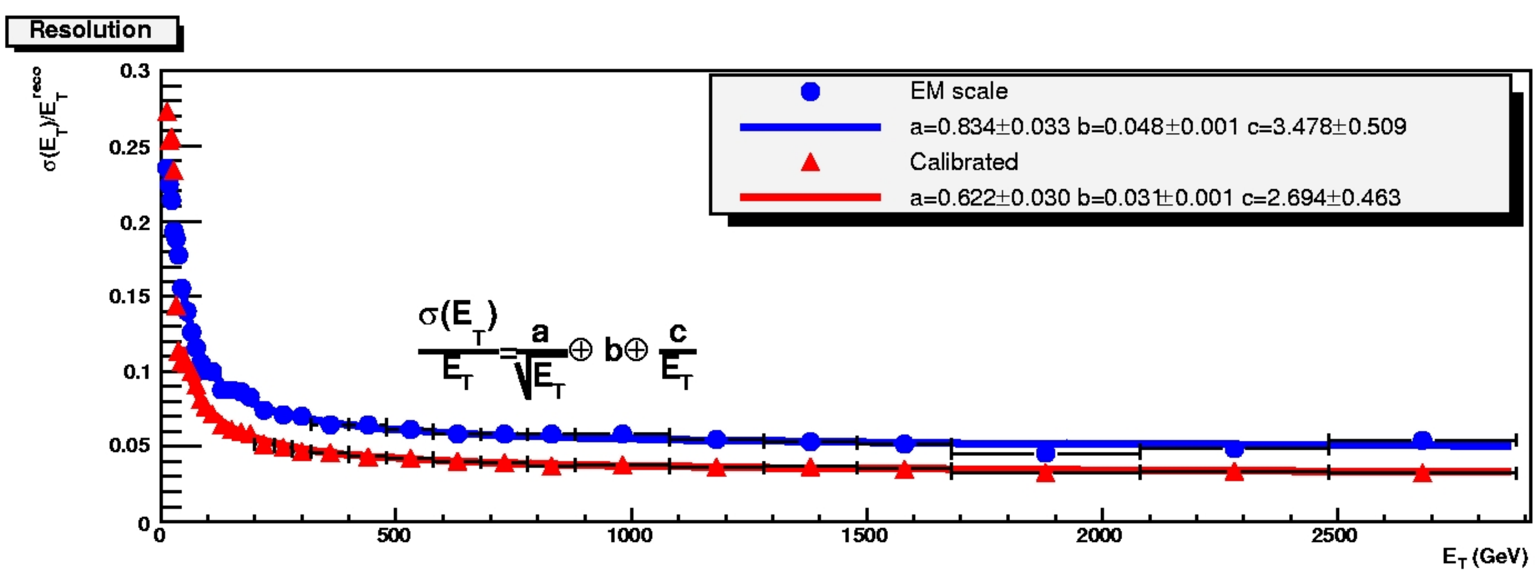
- Introduction
- Results on Rome data
  - Linearity and resolution for Cone0.7 and Con0.4 jets
  - Comparison with TDR and std Athena jetrec
- Preliminary results on mc11 sample and rome ttbar sample
- Timing issue
- Conclusions and work for Barcellona

Introduction

- Jets are reconstructed using TopoClusters
- Weighting functions are extracted comparing reconstructed jet (with Cone0.7) with MC jet (ParticleInCone truth), with the linear constrain: $E_{rec} = E_{MC}$
- Calibration weights are applied to cells belonging to TopoClusters
- Weights depend on cells and jet energies
- Jet Calibration is performed with iterative procedure

Linearity and resolution: results Cone0.7





- Linerity ($E_T$rec/E_TMC) recovered at the level of 2% from 30 GeV up to 3 TeV
- Good improvement in resolution
- More in the following for “low” E_T

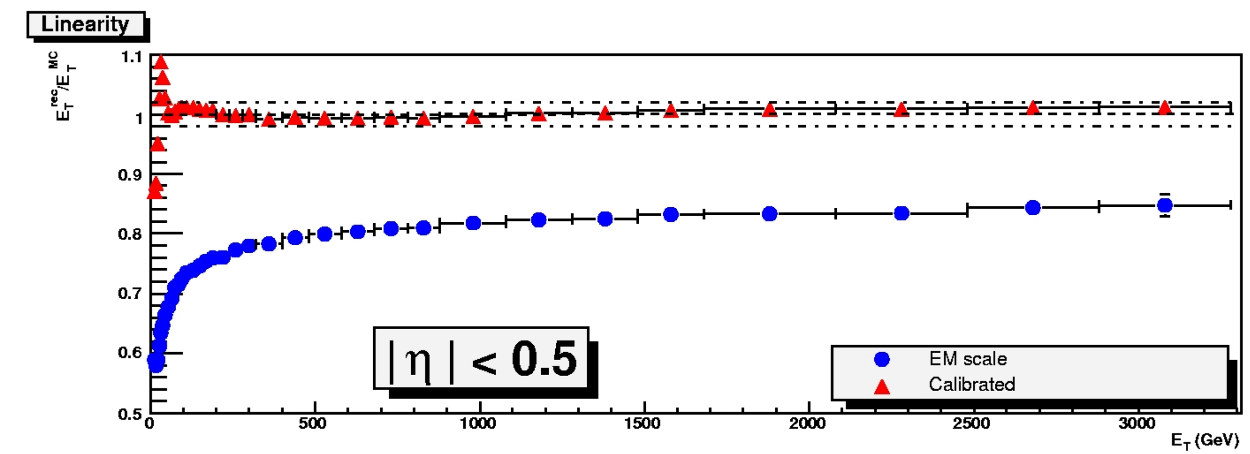
Results for Cone0.7

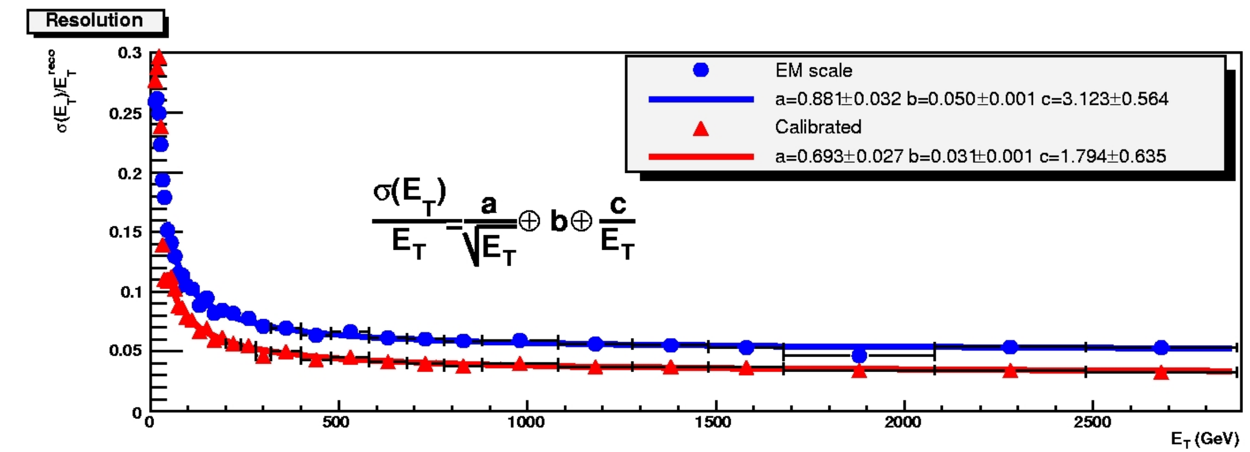
Eta		EM			Calib	
	a (GeV$^{1/2}$)	b	c (GeV)	a (%GeV$^{1/2}$)	b	c (GeV)
0 – 0.5	83%	4.8%	3.5	62%	3.2%	2.7
0.5 – 1.3	79%	5.3%	3.5	65%	3.5%	3.6
1.3 – 1.8	80%	6.0%	2.4	42%	4.6%	3.6
1.8 – 2.3	52%	3.8%	3.2	36%	2.7%	2.9
2.3 – 2.9	43%	3.8%	2.3	27%	3.5%	3.1
2.9 – 3.4	73%	7.7%	1	59%	4.8%	2.7
3.4 – 5.0	67%	1.4%	-	50%	4.0%	-

stochastic term in resolutions $\sigma(E_T)/E_T$ improves of about 30%

Linearity and resolution: results Cone0.4

- Linearity recovered at the level of 2% from 30 GeV up to 3 TeV
- Resolution improves, both EM and Calibrated resolutions are worse than Cone0.7 (expected)





Calibration weights extracted from Cone0.7 jets and applied to Cone0.4

We recover linearity: we correct for detector effects (crack, e/h, ...)

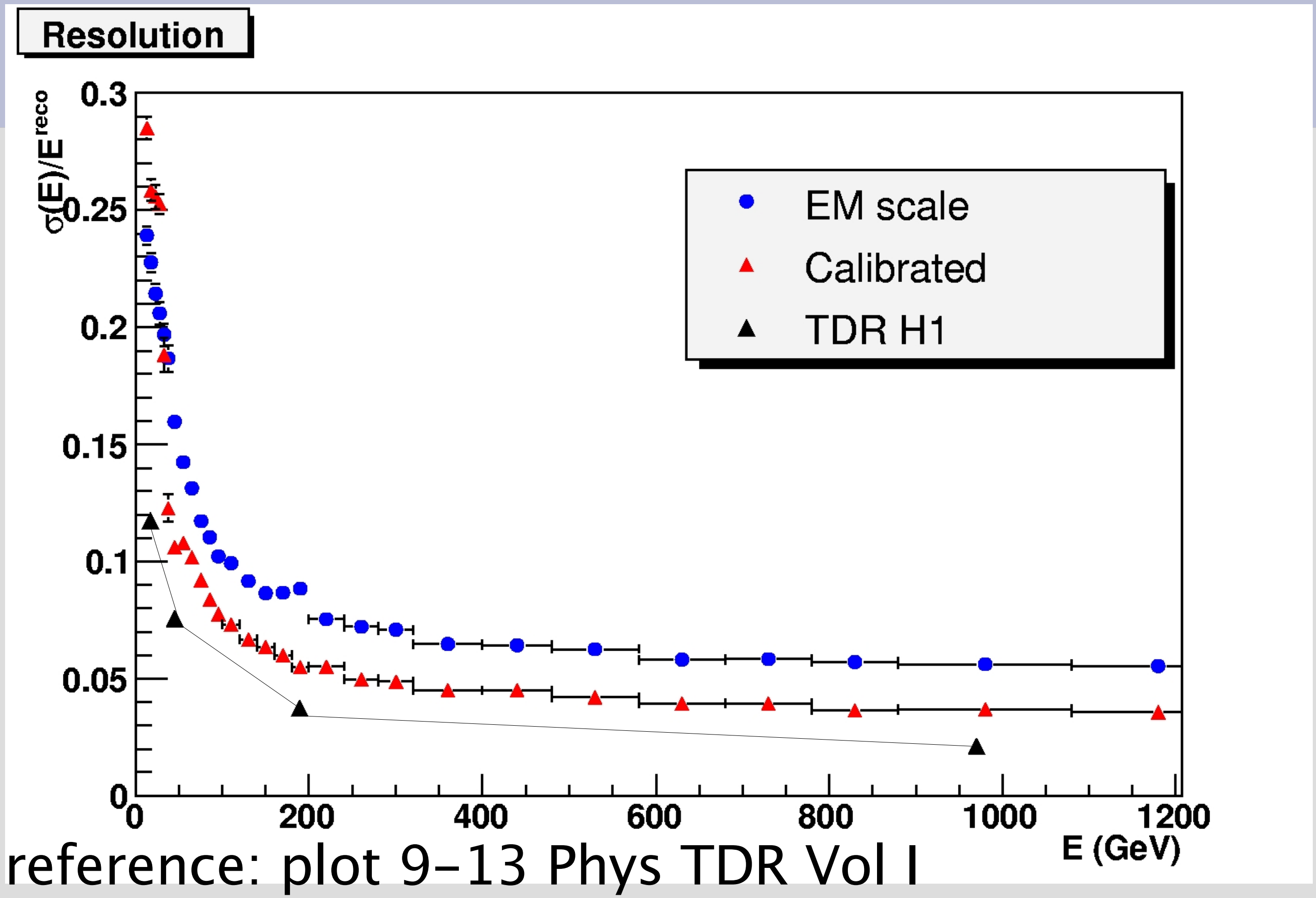
Important result: many physics studies (example ttbar) use Cone0.4 jets

Results for Cone0.4

Eta		EM			Calib	
	a ($GeV^{1/2}$)	b	c (GeV)	a (%$GeV^{1/2}$)	b	c (GeV)
0 – 0.5	88%	5.0%	3.1	70%	3.1%	1.7
0.5 – 1.3	87%	5.3%	3.2	66%	3.5%	4.4
1.3 – 1.8	85%	6.3%	3.1	55%	4.6%	3.9
1.8 – 2.3	59%	3.9%	2.4	41%	2.7%	2.6
2.3 – 2.9	47%	4.4%	3.4	21%	4.1%	4.2

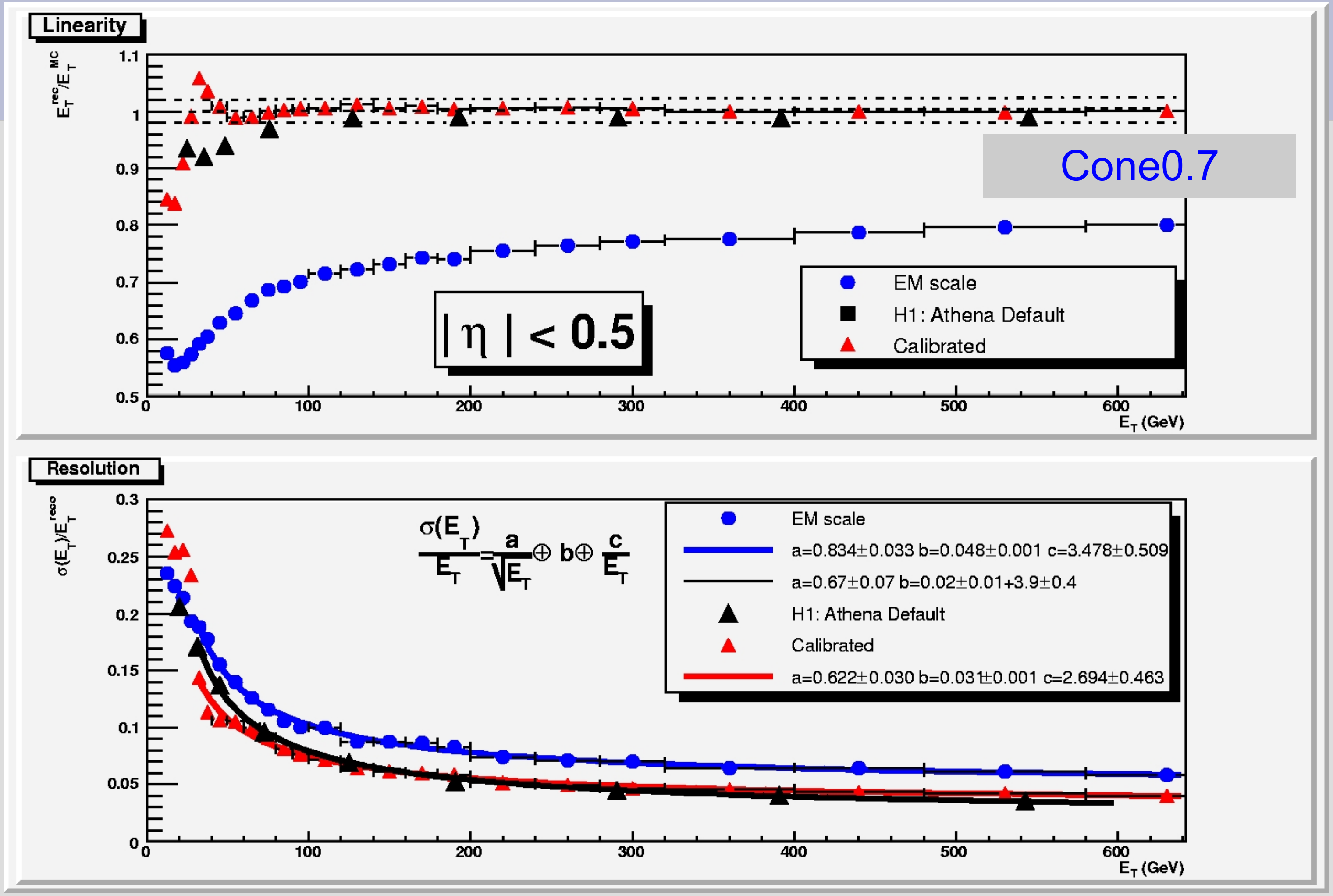
Still working on data with $|\eta| > 2.9$
Resolution and linearity are improving on all eta ranges

Comparison with TDR results



- TDR reference: plot 9-13 Phys TDR Vol I
  - Single jet gun, H1 method, CaloTower
- Rome sample: di-jet, TopoCluster
- Resolution for Calibrated jets is worse than TDR (E=200GeV +2%)

Comparison with standard Athena Reconstruction

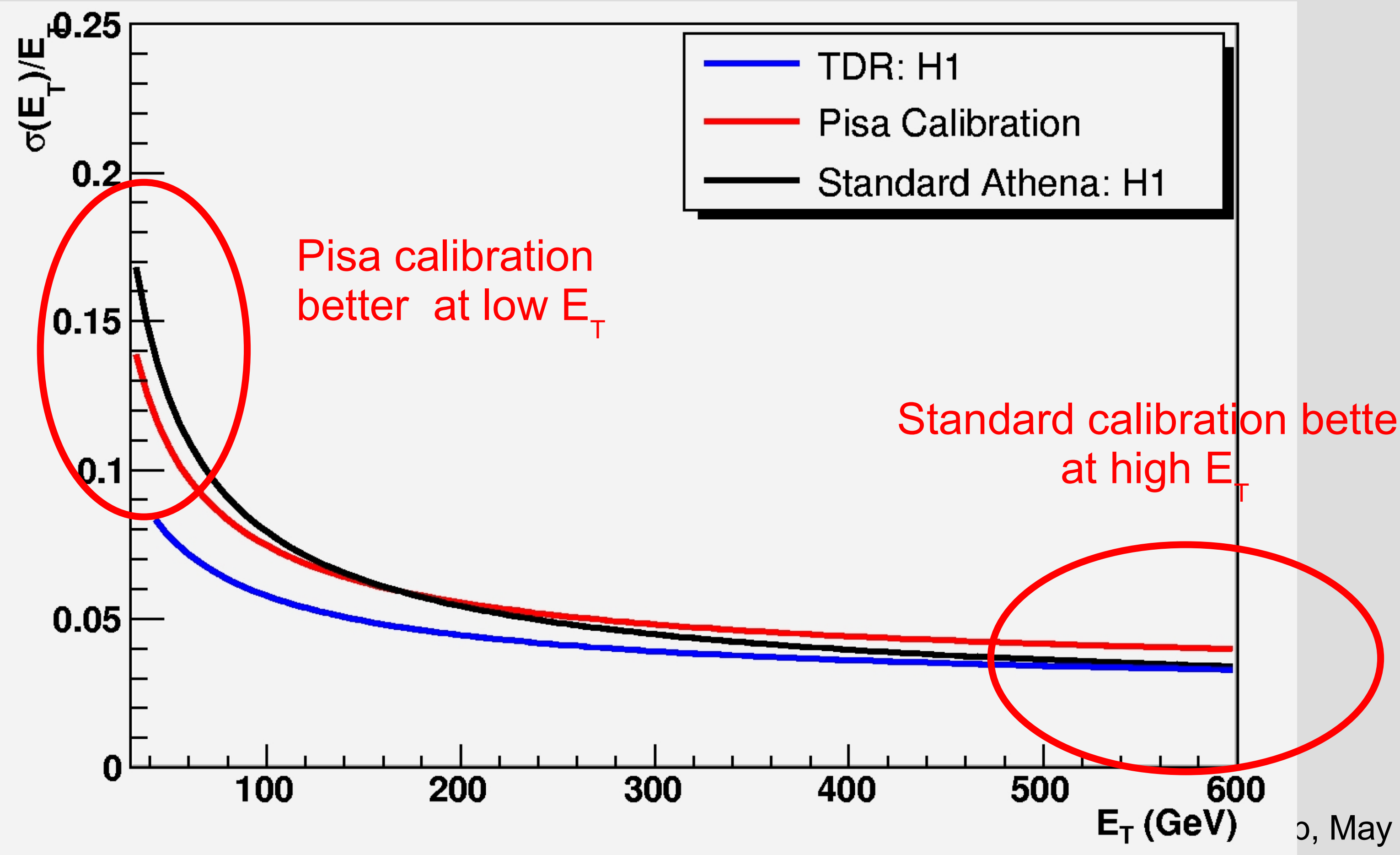


Standard Athena Jet Calibration (H1) and Pisa calibration give similar results (caveat: standard calibration uses CaloTowers, Pisa TopoClusters)

Pisa Calibration: better sampling term

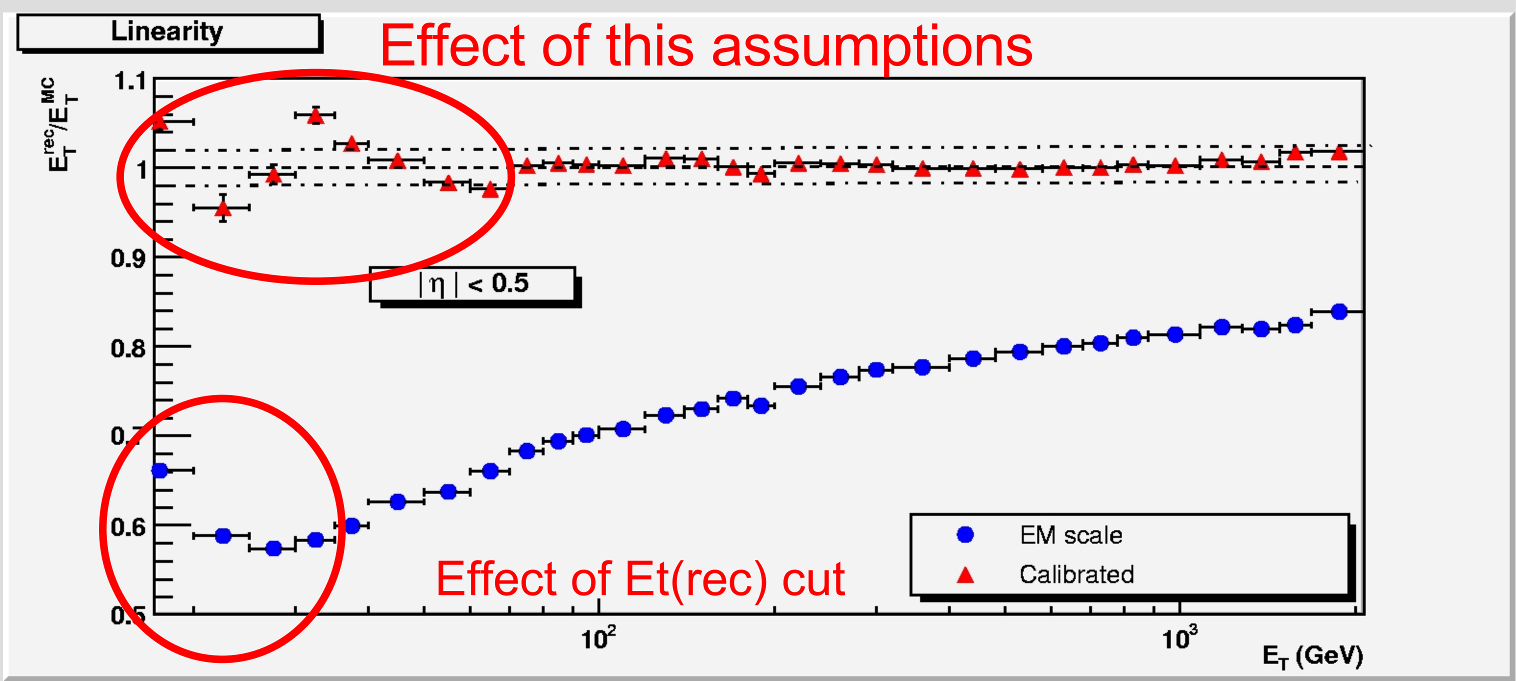
Resolutions: Central Region

- Pisa Calibration a little bit better at low E_T
- Standard calibration approaching TDR resolution at high E_T
- Athena Standard and Pisa give similar results
- Both worse than TDR results



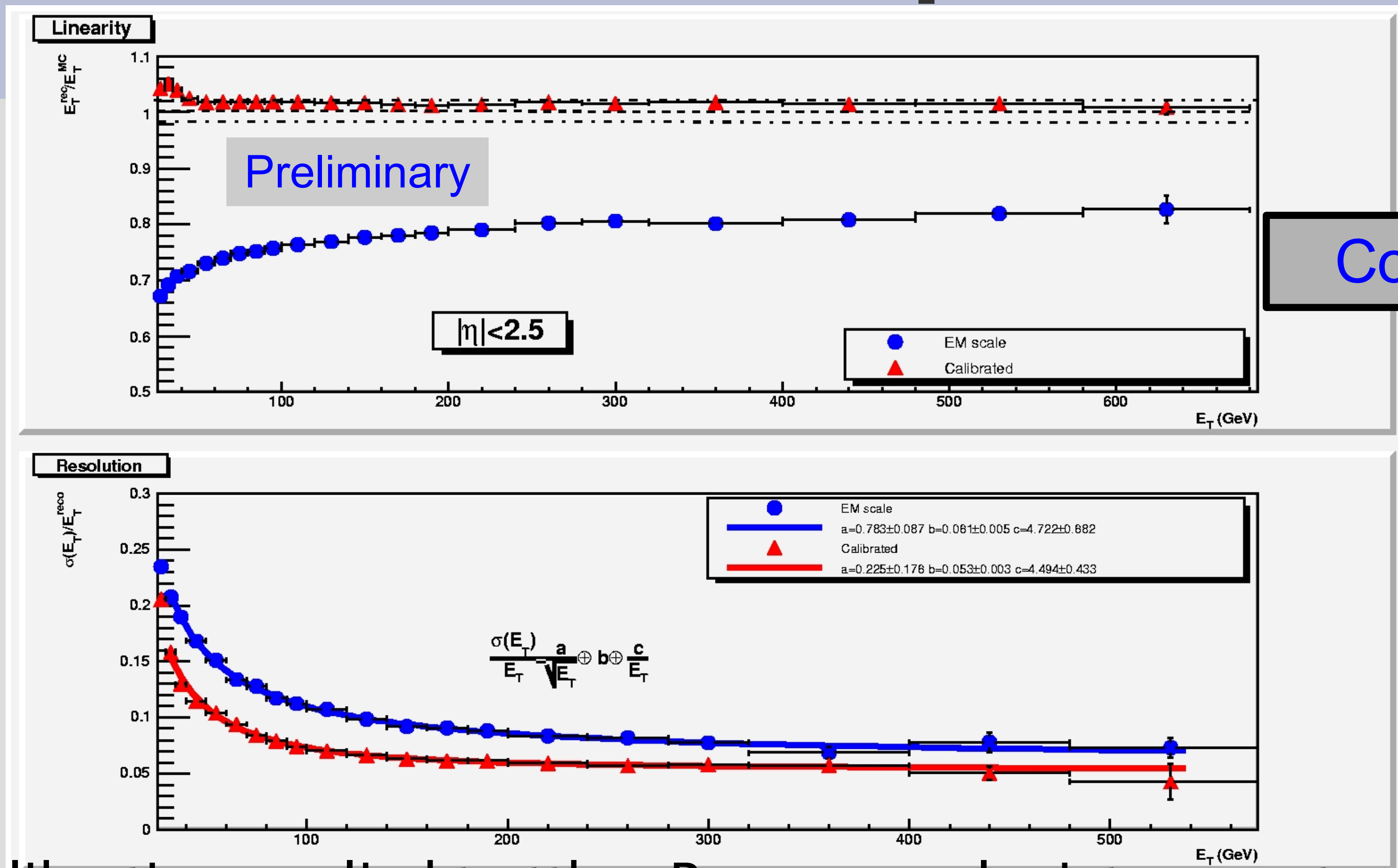
Weights at low energy

- Current calibration strategy:
  - Calibrate only jets with $E_T > 10$ GeV
  - Jets with $10 < E_T < 20$ simplified parametrizations



Still working to improve linearity at low E_T

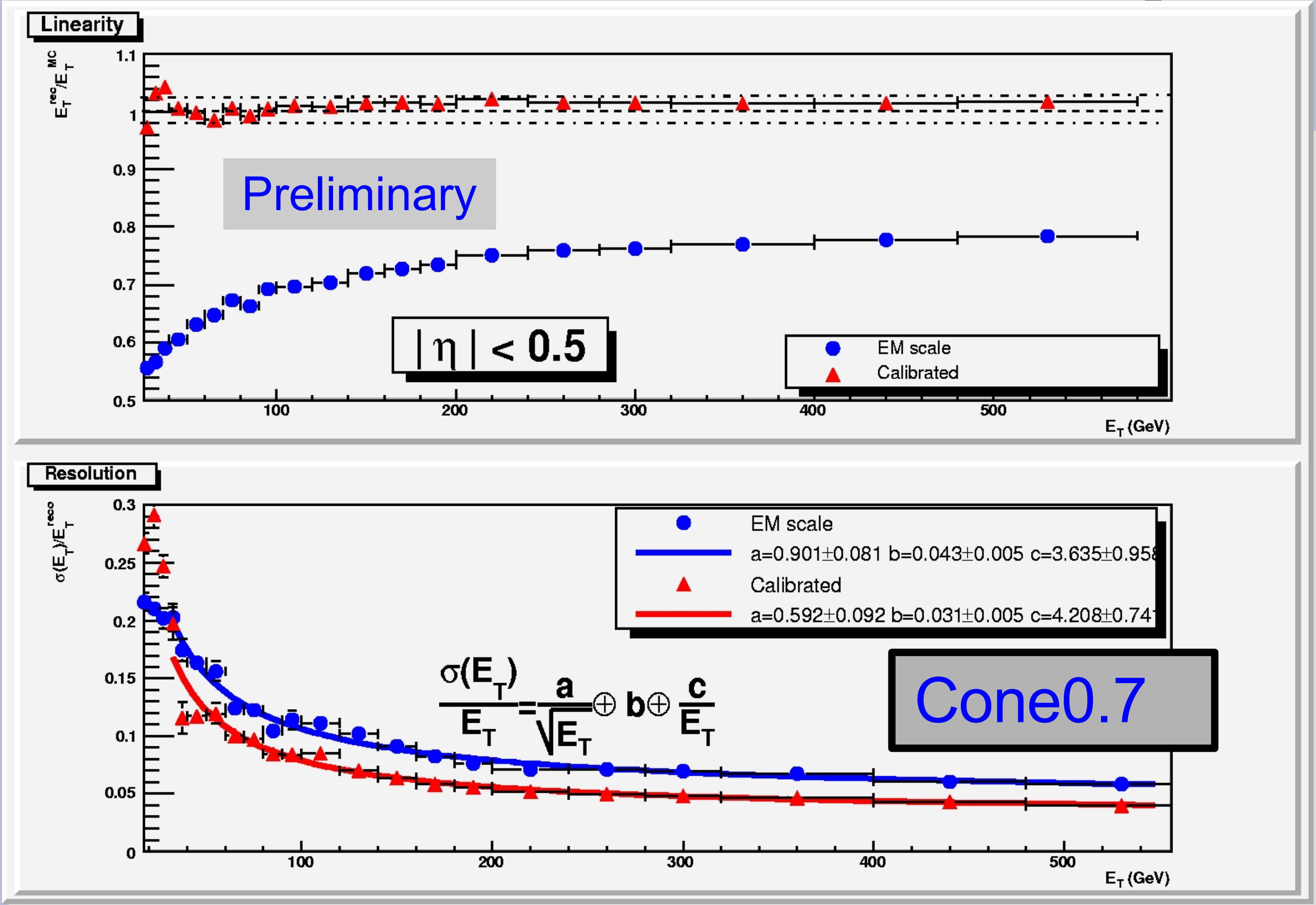
Preliminary results on rome ttbar sample



Cone0.4

- Pisa calibration applied to ttbar Rome sample, jet reconstructed with Cone0.4
- Linearity recovered in ±3% (40–600 GeV) but systematically higher than 1
- Resolution lower than expected: under investigation

Preliminary results on mc11 data sample



- Ad-Hoc fudge factors applied to take into account TileCal sampling fraction and budget material
- Linearity recovered at the level of 2%
- Resolution comparable with rome data

- Weighting functions extracted from Rome applied to mc11 J2 and J5 samples
- mc11: same Pythia events, but: different version of G4, different budget material in Forward region different TileCal sampling fraction

mc11 data: resolution

Eta		EM		Preliminary	Calib	
	a ($GeV^{1/2}$)	b	c (GeV)	a (%$GeV^{1/2}$)	b	c (GeV)
0 – 0.5	90%	4.3%	3.6	60%	3.1%	4.2
0.5 – 1.3	88%	4.8%	3.8	69%	3.3%	3.7
1.3 – 1.8	73%	6.0%	4	50%	3.9%	3.6
1.8 – 2.3	58%	3.9%	2.9	40%	2.8%	2.6
2.3 – 2.9	46%	4.6%	2.8	41%	3.6%	3.2

- Resolutions compatible with the Rome data
- Still working on high eta regions
- Important result: fudge factors are enough (no need to extract new weights)

Timing issue: can help to know...

- At first our code was slow compared to Std Calib: 5 s/evt (Pisa) Vs 0.9 s/evt (H1)
- We have found that the problem was in the statement:

```
StatusCode Algo::execute() {
    for (....)  { // some big loop over all cells
        SomeF();
        }
    }
StatusCode Algo::SomeF() { /* ... */
    retrun StatusCode::Success;
    }
```

- The problem is the destructor of StatusCode (trying to write to a file)
- Returning a bool in our internal function imporved timing to 40ms!

Conclusions 1/2

- Linearity is recovered at 2% level over a wide energy range (30 GeV – 3 TeV)
- Method works with Cone0.7 and Cone0.4 jets with the same weighting functions
- Method works for E_T>30 GeV and some studies have started to decrease this limit
- At the moment the most time consuming (form physicist point of view) part of the procedure is the extraction of the calibration weights (currently done outside athena): need to study a better/faster strategy
- Results has been compared with TDR results and standard Athena reconstruction
- The method gives similar results as standard Athena

Conclusions 2/2

- Preliminary results on ttbar (rome data) and mc11 J2+J5 samples have been shown, consistent performances have been obtained
- Fudge factors have been applied to cope with simulation and reconstruction differences between mc11 and rome data
- We will put our calibration scheme in Athena release, integration started (now testing full reco: from digits to AODs)
- Solved timing problem (found quite a tricky reason)
- We intend to participate in CSC note for calibration comparison
- We plan to work (with Ambreesh and anybody else that is interested) on systematic and detailed comparisons with other calibration method: developing of standard analysis tools ongoing

Future work:

- Barcellona plan:
  - Use current calibration schemes
  - Compare systematically the performances
  - Validate on physics samples (already using Pisa calibration for top analysis)
  - Study impact of calibration on start-up detector (commissioning with top events)
  - Start integration DM and ClusterID to our approach

Backup

Introduction: the method 1/2

"Binned" energy for sample s and bin b (sum of all energies of cells belonging to s with energy between $\langle E_{b-1} \rangle$ and $\langle E_b \rangle$)

$$E_{s,b} = \sum_{\langle E_{b-1} \rangle < E_c < \langle E_b \rangle,\, c \in s} E_c$$

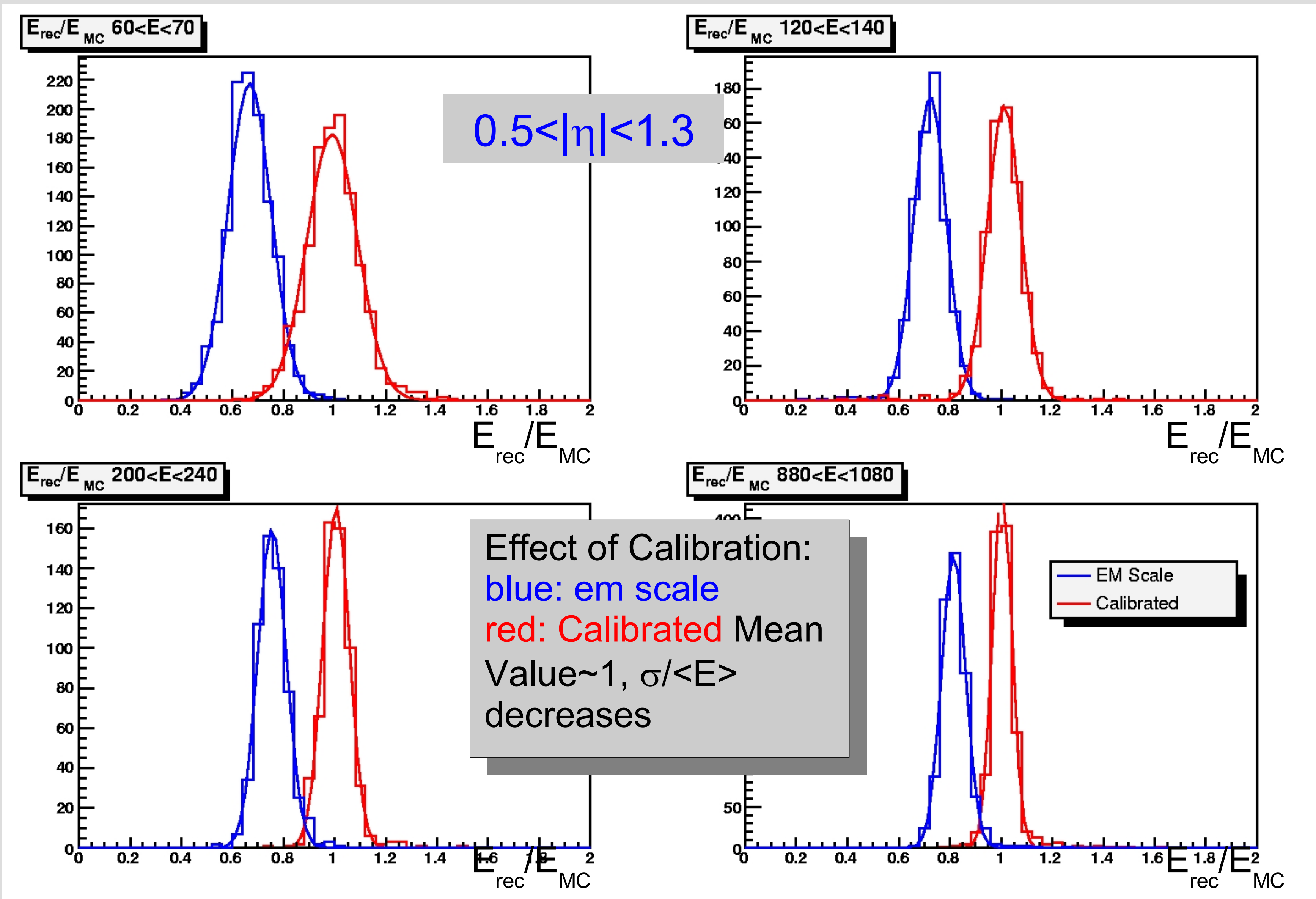
$$E_{rec}(em) = \sum_{s,b} E_{s,b}$$ Jet at EM scale

$$E_{jet}^{cal} = \sum_{s,b} W_s(E_{jet}^{cal}, E_{s,b}) E_{s,b}$$ Calibrated jet

$$W_s(E_{jet}^{cal}, E_{s,b}) = A_s(E_{jet}^{cal}) + \frac{B_s(E_{jet}^{cal})}{\langle E_b \rangle}$$

- Different weights for different eta regions and longitudinal samples (s)
- Weights depending on "true" energy of the jet (E_{jet}^{cal}) and on energy in cells (bin value $\langle E_b \rangle$)

Result on Rome data: Cone0.7

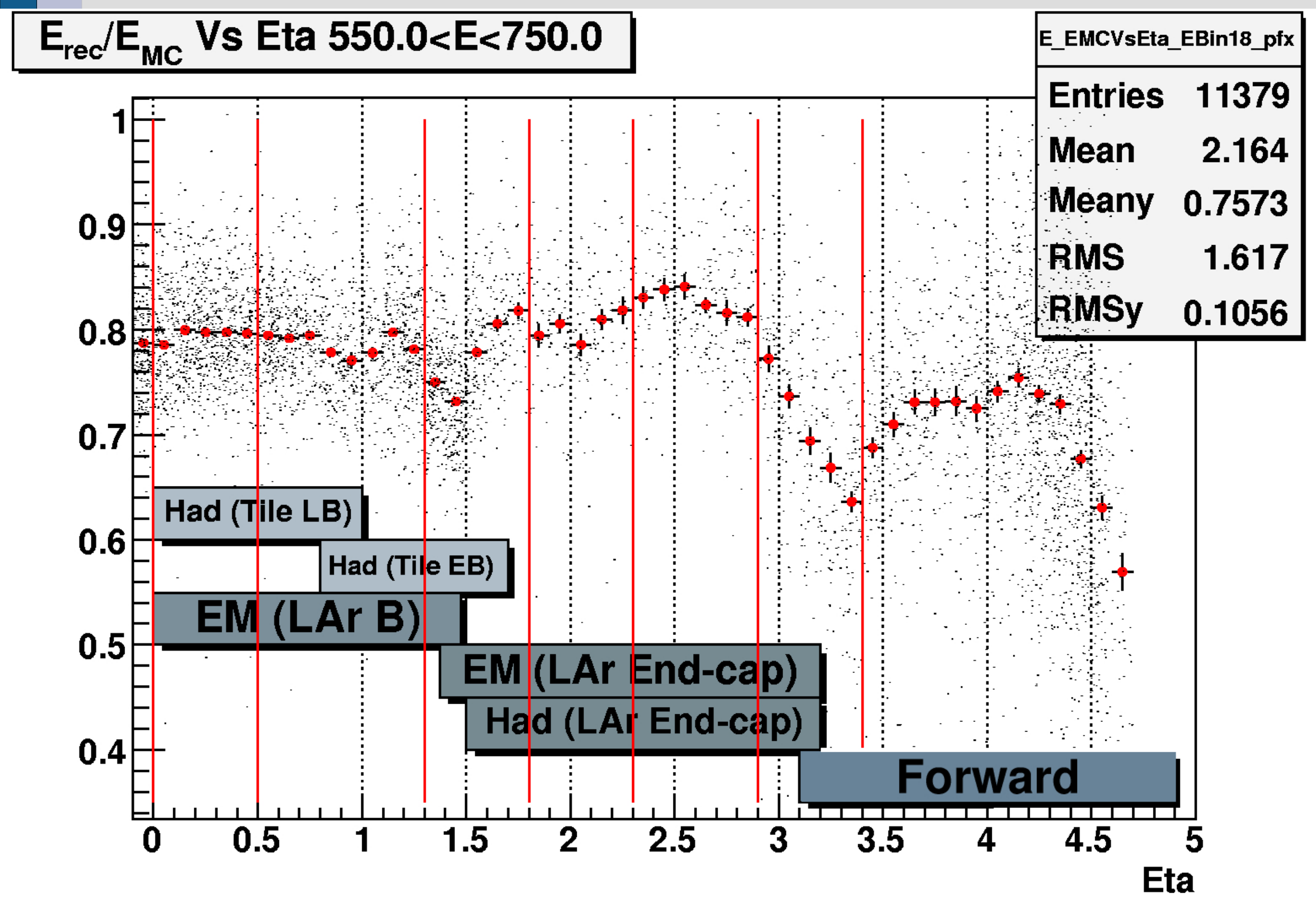


0.5<|η|<1.3

Effect of Calibration:
blue: em scale
red: Calibrated Mean Value~1, σ/<E> decreases

Introduction: eta regions

- The calorimetric system is divided in 7 eta regions and this zones are calibrated separately



- Cracks and subsystems are well visible and correspond to the divisions

$|\eta|<0.5$ – $0.5<|\eta|<1.3$

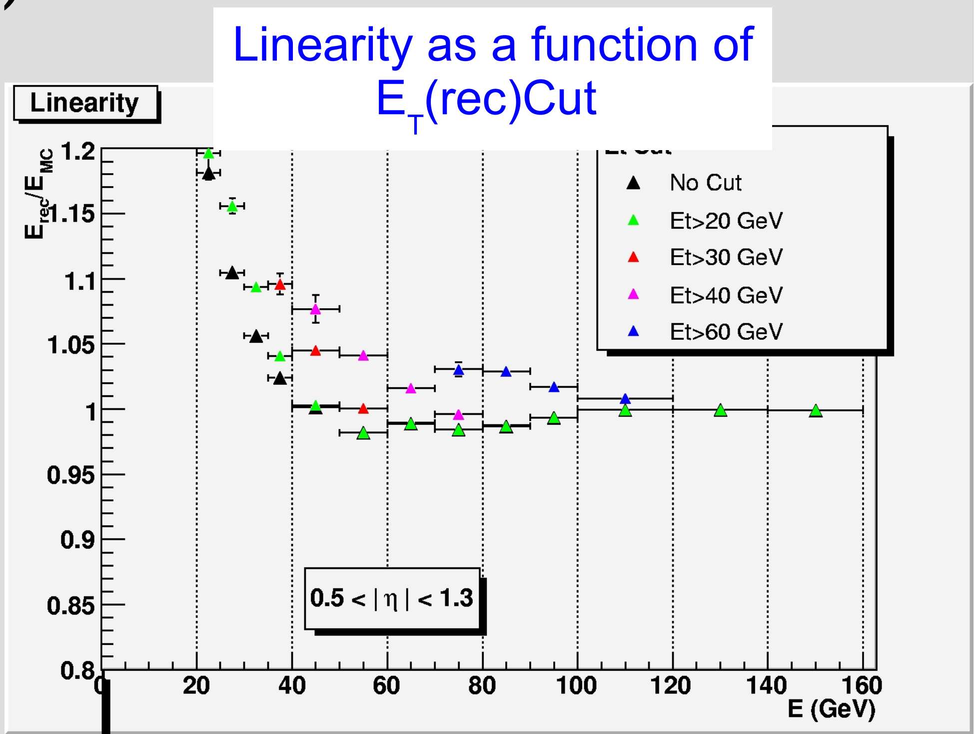
$1.3<|\eta|<1.8$ – $1.8<|\eta|<2.3$

$2.3<|\eta|<2.9$ – $2.9<|\eta|<3.4$

$3.4<|\eta|<5.0$

Weights at low energy

- This is probably due to a different factors:
  - Shower Shape, at low energy the shower shape of a jet can be different (i.e. energy all contained in one sample)
  - Bias introduced by Jet reconstruction (and following matching with truth)



Again on Validity: mathematical aspect

- Given an equation: E=f(E) sufficient condition that the iterative method will converge to the exact (and unique) solution is that |df/dE|<1 (in an interval)
- Given the functional behaviour of our weights (1/E) it will exist a lower energy limit for which this condition is no more satisfied
- Under this limit the solution can be wrong (incresed spread in E_{rec}/E_{MC})
- The results are good approximations only above this limit