Combined Longitudinal Weight Extraction and Intercalibration

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with
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and input from
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Physics Plennary, CERN, Nov-4-2004

Some References

- Atlas LAr Group, NIM A500 (2003) 202, NIM A500 (2003) 178.
- Atlas LAr Group, Linearity and Uniformity LAr EMC Test-Beams (in preparation)
- G.Graziani, ATL-LARG-2004-001
- N.Kerschen, "New Results from e/γ", Freiburg ATLAS Overview Week Oct-5-04
- F.Djama, ATL-LARG-2004-008
- D.Fournier, M.Kado, L.Serin (talks in LAr weeks)
- ATL-COM-CAL-2004-002
- M.Boonekamp: Drell-Yan talk in this plennary.
- Our note to be submitted (ATL-LARG Nov/04)

A short overview of cell and e/γ corrections

EMC Cell Energy Reconstruction

G.Unal: Overview of Calibration and Reconstruction in Athena, LAr week, 6-Sep-04

$$E_{rec} = c \cdot \sum_{i=1,5} \left[\mathrm{OF}_i \cdot \mathrm{ADC}_i - \overline{\mathrm{PEDESTAL}} \right]$$

C = (ADC_to_DAC)* (from ramps)

(DAC_to_Volts)* (17bit ADC-> 38.147μV/digit)

(Volts_to_μA)* (from injection resistor)

(μA_to_MeV) $(t_{drift}*W)/e$ * 1/SF

Energy Deposited = (1/SF)*(visible Energy)

From Geant 4 (averaged Sampling Fractions):
Accordion: SF = 0.167, |η|<0.8
Presampler: SF = 0.05

Corrections at the cell level

- non-linear corrections to ADC->DAC (not in Athena)
- Intercalibration Weights (not in Athena)
  - 1 weight per region (~0.2x0.4) is expected
- HV corrections (skeleton in Athena)
- Capacitance variation in EMEC (not in Athena)
- Lead thickness corrections (not in Athena)
- LAr purity and Temperature Variation corrections (not in Athena)

Corrections at the cluster level 9.0.0

- S-shape correction
  - Corrects the reconstructed position of a cluster along η
- ϕ-modulation
  - Corrects the energy as a function of the cell impact point in ϕ
- offset in ϕ
  - Corrects the cluster position along ϕ
- η-modulation
  - Corrects the energy as a function of the cell impact point in η
- out-of-cone correction
  - Corrects the energy for losses in the lateral direction
- Correction for upstream material effects
  - Through: $E_{rec} = \lambda\left(b + W_0 E_{pres} + E_1 + E_2 + W_3 E_3\right)$

Some of these corrections are being re-evaluated

- New Energy parametrizations (upstream effects),
  D.Fournier, L.Serin, M.Kado, T.Carli

- out-of-cone will be absorbed in overall scale

- Longitudinal leakage correction can be done through a mean shower depth parametrization which is η dependent (Graziani, Orsay group)
- Soft electrons (see Derue+Kaczmarska's talk)

- Photons? the expectation is that an overall few % scale factor (η dependent) is needed on top of the existing weights and should be obtained from MC (tested against TBeam). Detailed studies are needed (K. Loureiro, Slovakia meeting).

LAr upstream material effects and Intercalibration

e/gamma: two serious problems

- **Upstream Material Corrections:** extraction of EMC longitudinal weights which correct the e/γ energy for effects due to the material upstream of the EM Calorimeter
- **Intercalibration:** equalization of response of different physical regions of the EM Calorimeter
- **Monte Carlo: several effects not included**
  - LAr purity and temperature variations
  - Mechanical and Electronics effects
  - High Voltage (i.e. missing lines, gap variations etc)
  - other
- Such effects (even after correcting for them at the cell level), affect the resolution constant term, giving rise to the problem of intercalibration and its in-situ monitoring during ATLAS data taking.

InterCalibration

- ATLAS Requirement: 0.3% uniformity in 448 regions ($\Delta\eta \times \Delta\phi$ = 0.2 x 0.4) of the EMC
- This gives a 0.7% resolution constant term
- First Intercalibration with cosmic muons (ATL-GEN-2004-001 and L.Serin et al, LAr week, Sep-2003)
  - Use middle layer -> S/B = 7, peak E=250MeV, large fluctuations
  - Expect a uniformity better than 0.5% but,
  - Need high statistics (~10k muons per cell?)
  - Need to control response with time (months)
  - Assume it works: we need to monitor it during Physics Runs.

In-situ intercalibration using Z->ee

- In-situ, people propose Z->ee (F.Djama+TDR)
- But, to extract LAr weights (LW) which correct for upstream material effects also need electrons.
- The two problems (LW+IC) are coupled !
- For PDF uncertainties and E-scale issues, see M.Boonekamp, Mass and Energy Scale using Z events, Atlas Week June 2004. Also at this plennary.

LAr Longitudinal Weights
(assume Intercalibrated EM Calorimeter)

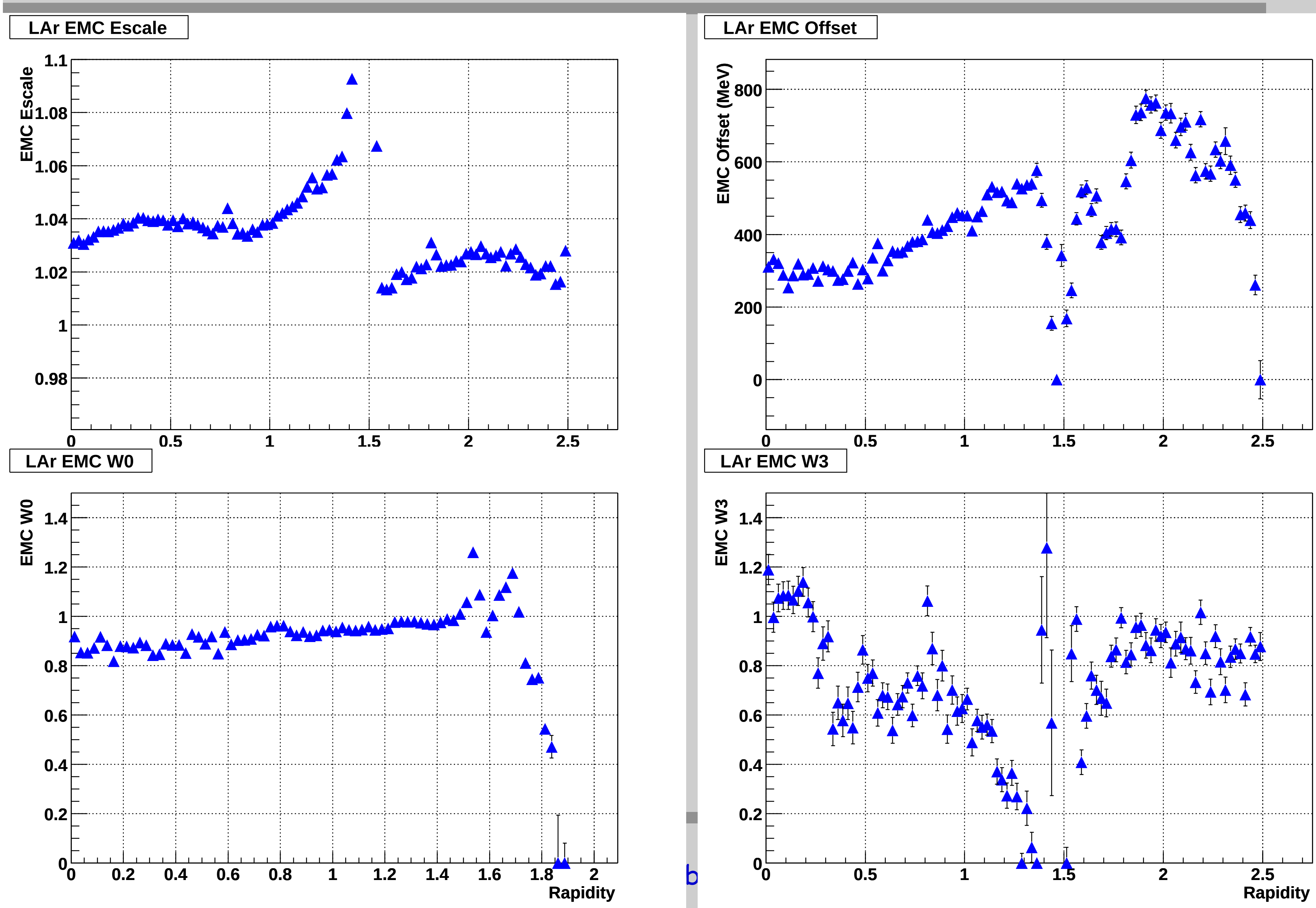
e-based Longitudinal EMC weights

- Longitudinal weights calculated using:

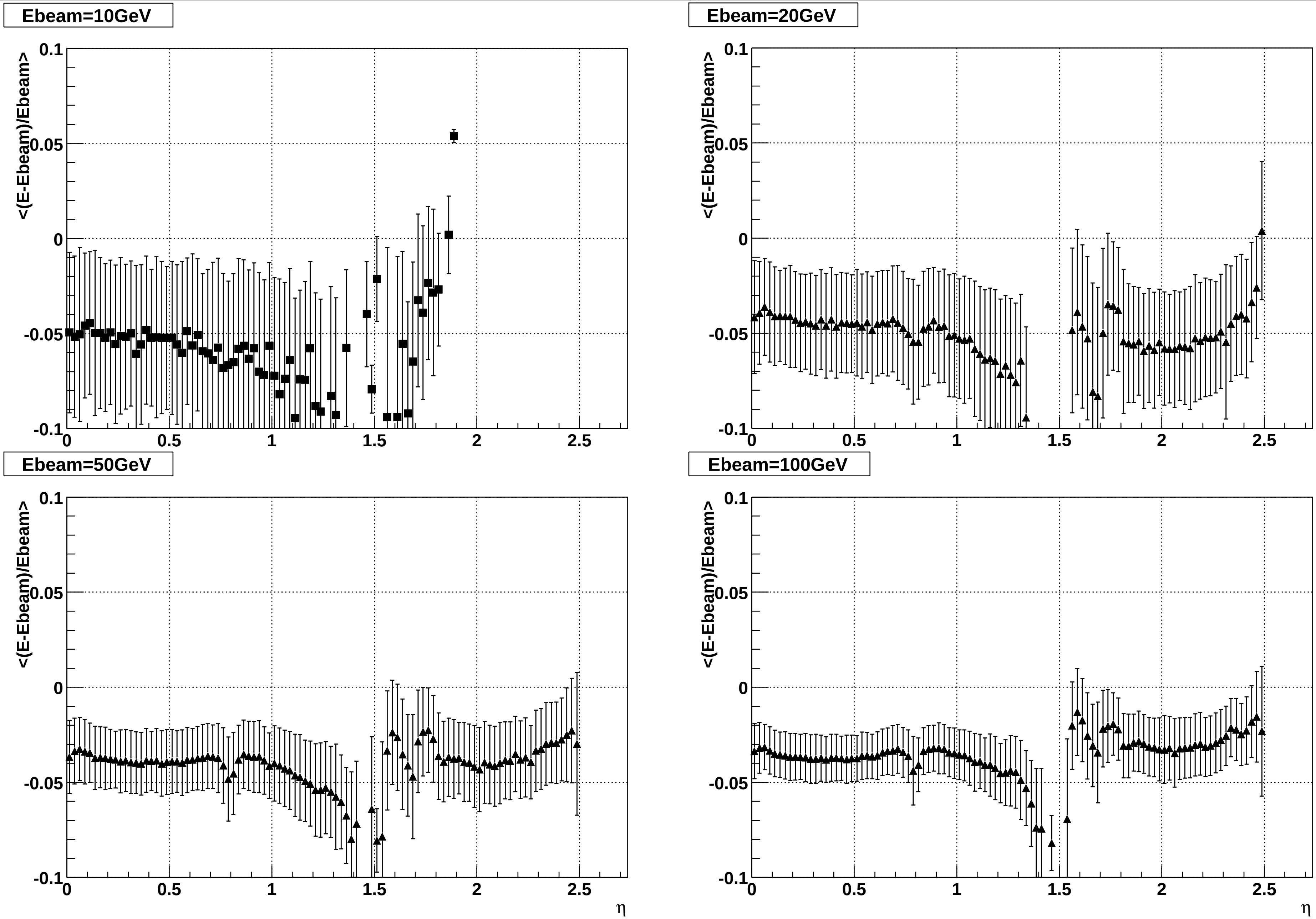
$$E_{rec} = \lambda\left(b + W_0 E_{pres} + E_1 + E_2 + W_3 E_3\right)$$

- In 100 η bins from 0 to 2.5
- Currently through single electrons
  - First step, But not just an academic exercise: study the parametrizations found in TBeam; find the weights that give optimum linearity and resolution.
- 8.2.0: sim+dig+rec (already out-of-date!)
- In-situ: from Z (1 per sec), W (10/s)
- CAUTION: the MC doesn't simulate miss- inter-calibration (must also be solved in situ)

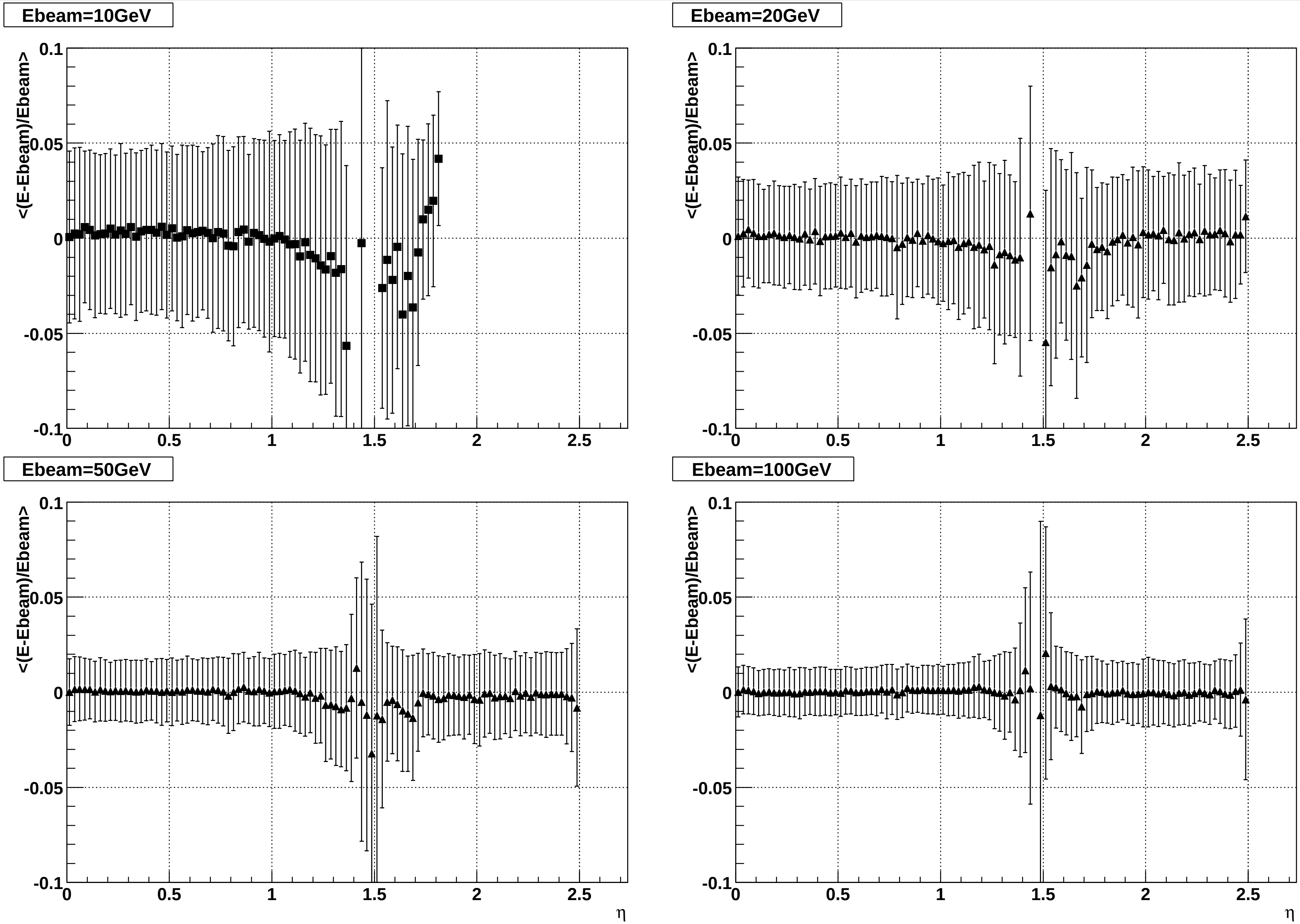
EMC Longitudinal Weights (8.2.0 Recon)



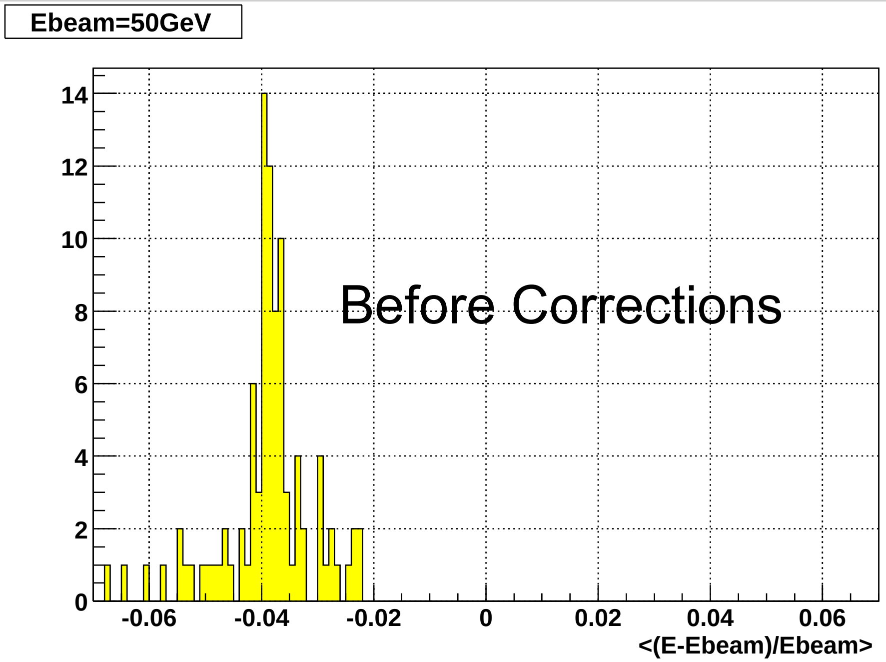
Calorimeter without upstream material corrections

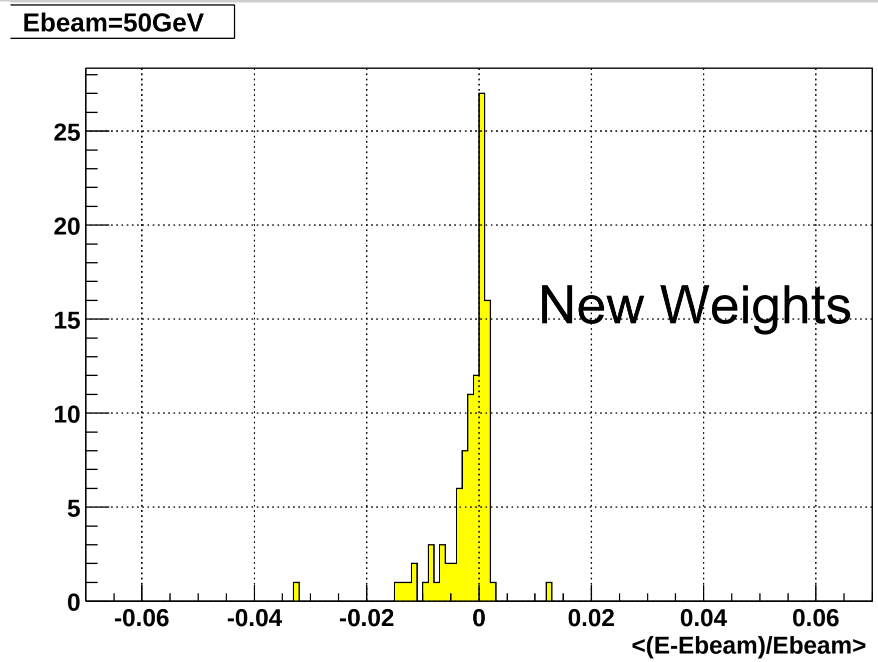


Calorimeter after application of Long. Weights

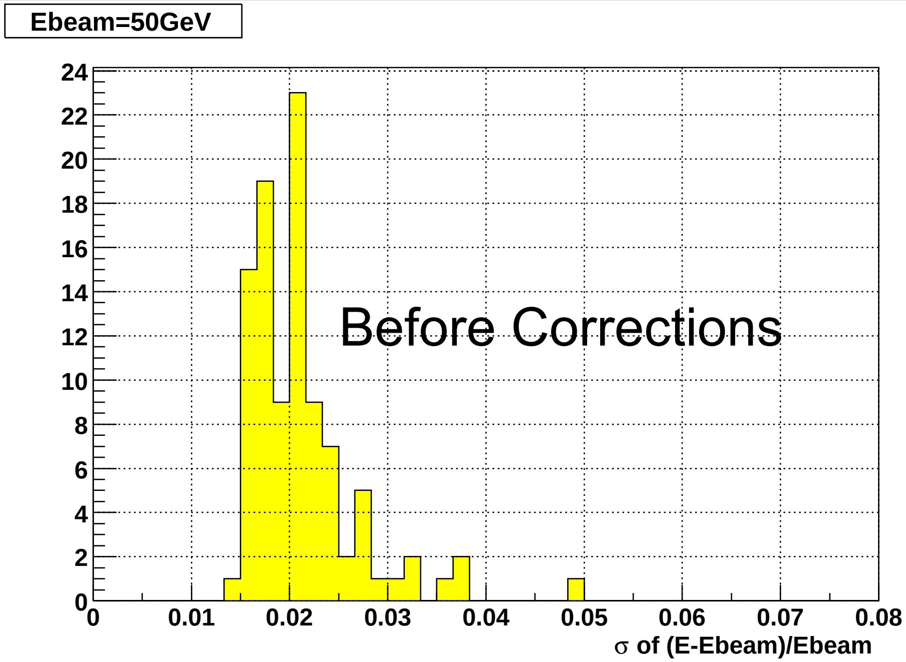


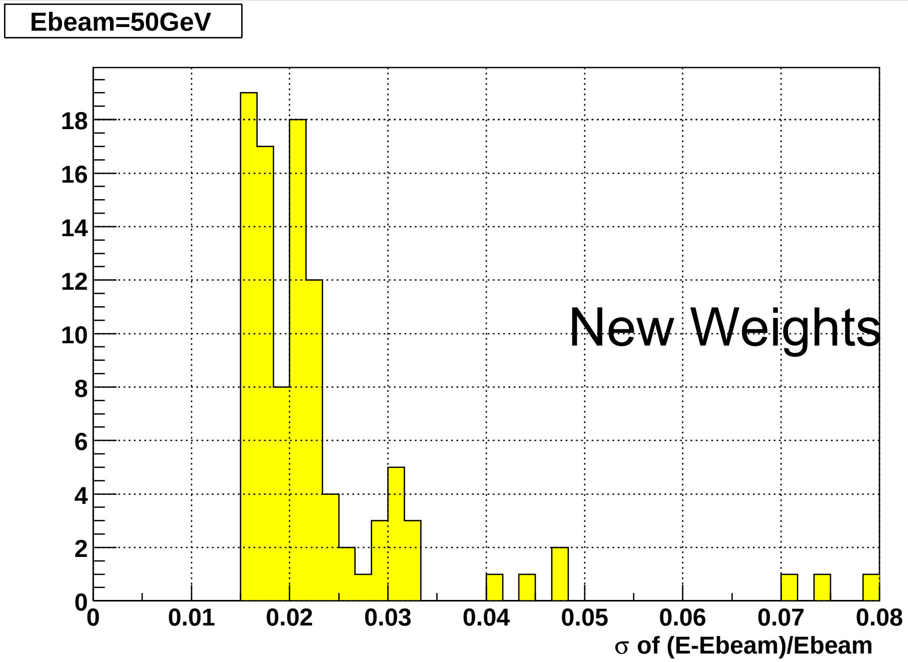
Scale and Uniformity for 50GeV electrons





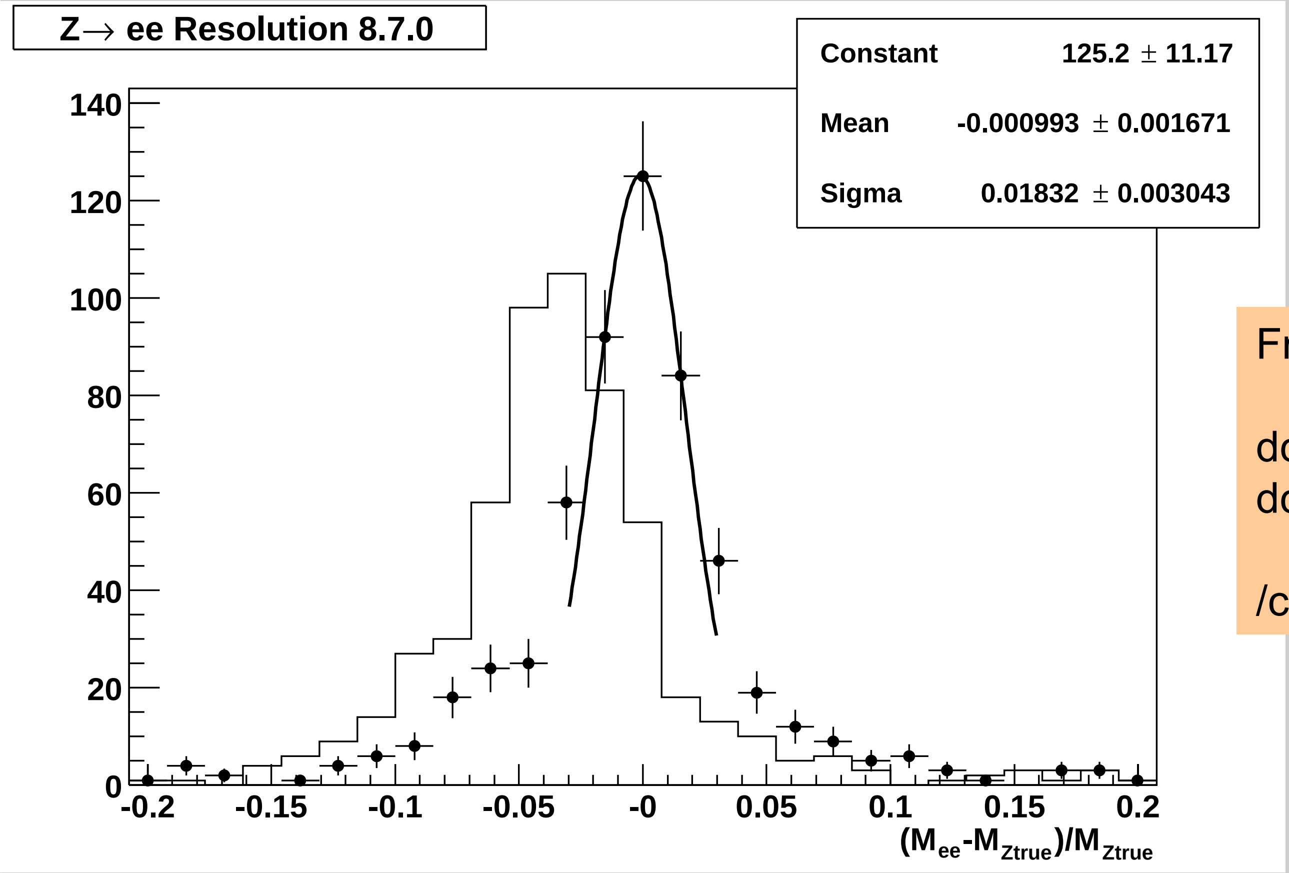
Energy Resolution for 100 η bins





A small improvement per η bin is seen
Eresol = 1.6% In the central barrel region
Eresol = 1.5% in the Test-Beam 2002
(1X0 of upstream material)

Effect on Z->e^+e^-



From DC2 Samples

dc2.002896.pyt_h130_4l
dc2.002896.pyt_h180_4l

/castor/cern.ch/atlas/project/dc2/

Combined Longitudinal Weight Extraction and Intercalibration

Combined Method

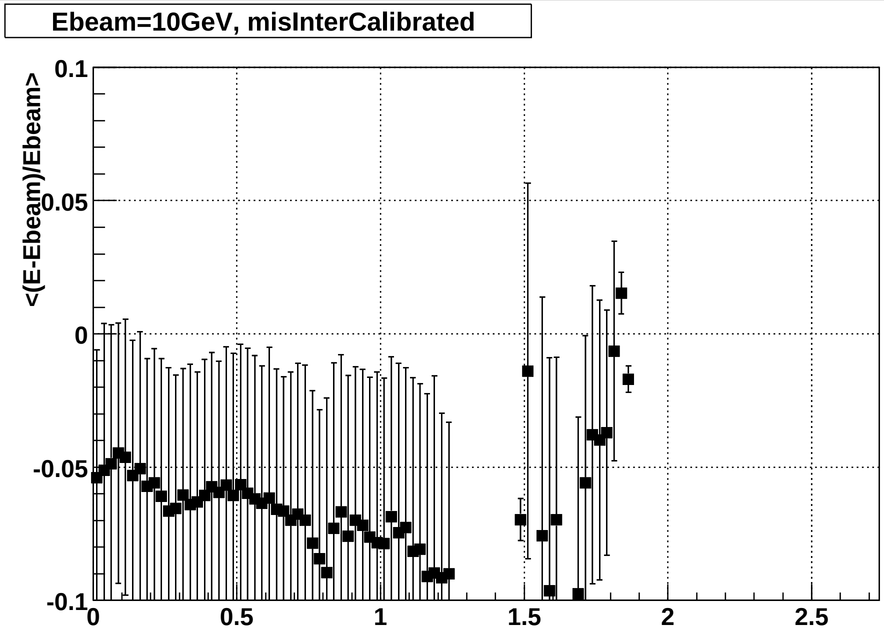
- Expect the intercalibration weights α to be absorbed in the overall scale:

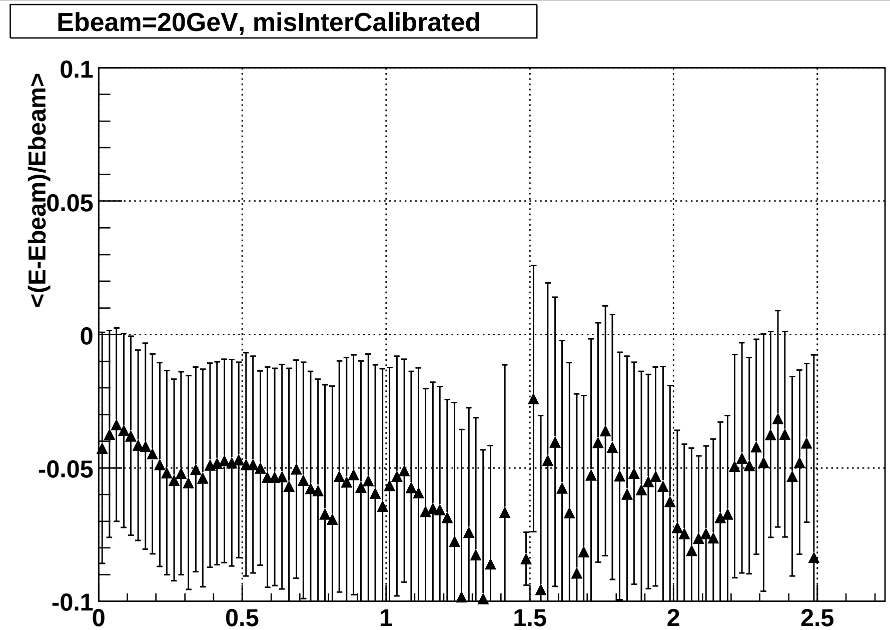
$$E_{rec} = \lambda\left(b + W_0 E_{pres} + E_1 + E_2 + W_3 E_3\right)$$

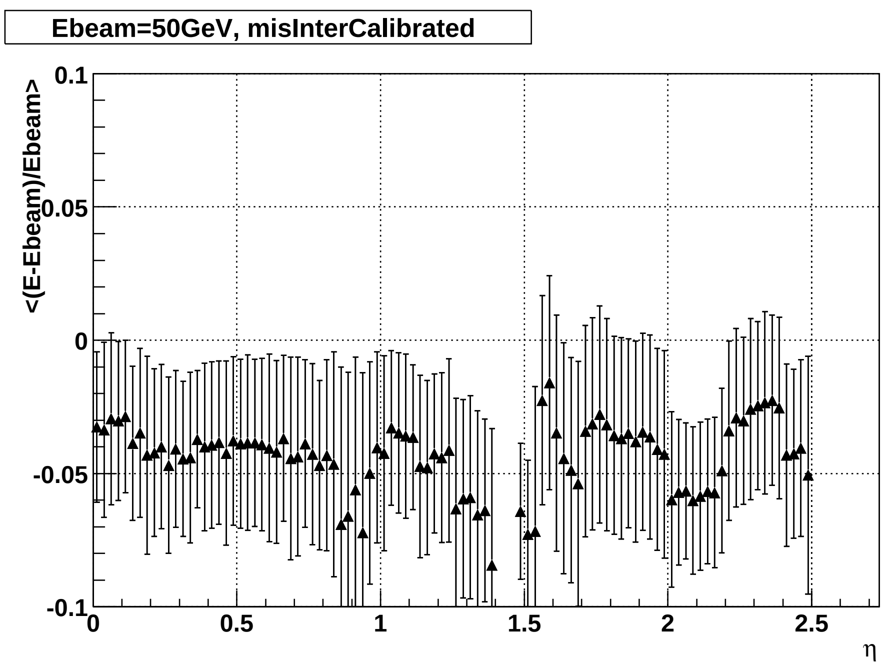
- To do this we can extend the long. weights to be φ dependent.

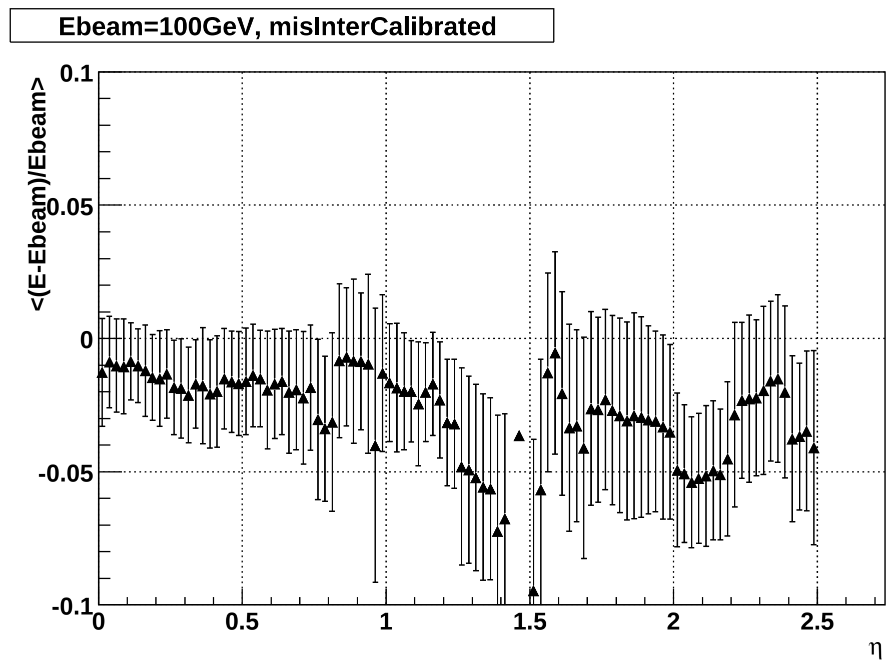
- In the following we apply a ±5% miscalibration in (ΔηxΔφ=0.2x0.4) regions of the calorimeter and recalculate the weights in ~800 η,φ bins.

electrons: Miscalibrated Calorimeter (±5%)



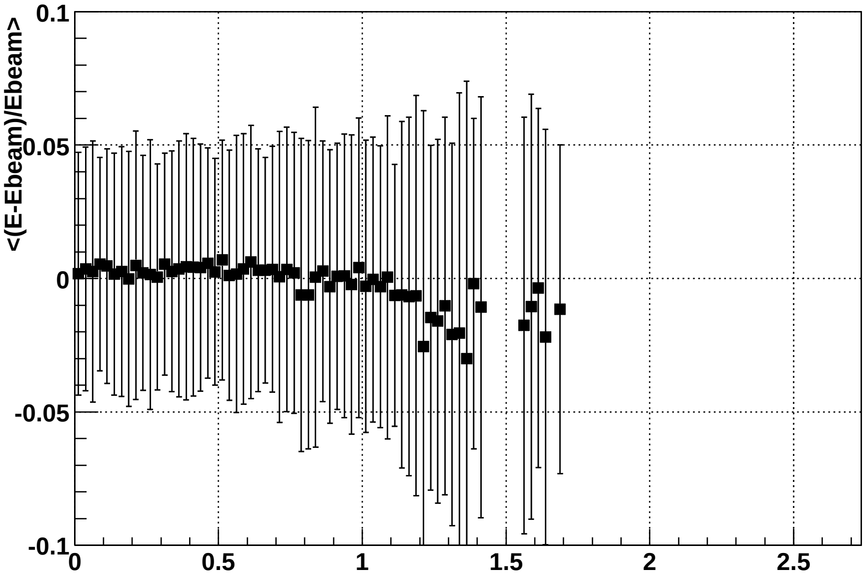




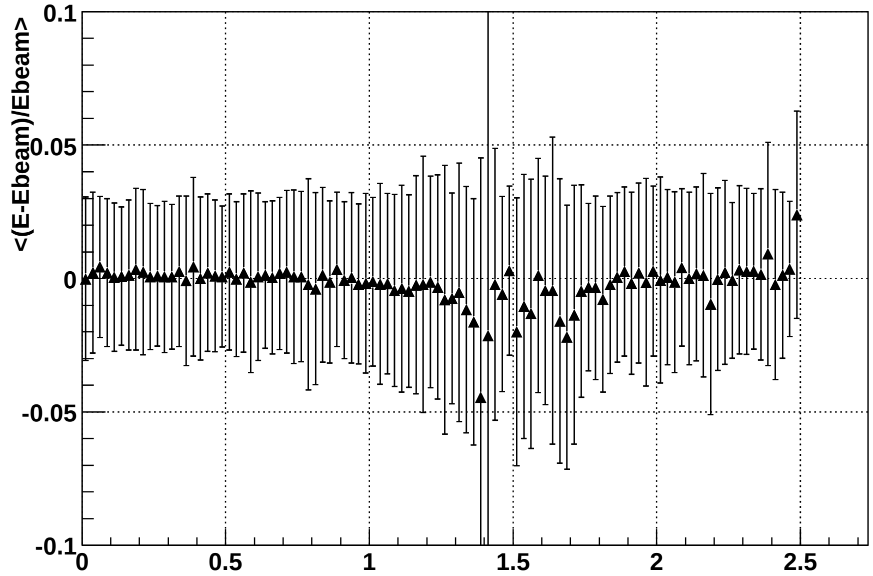


electrons: Response after combined method

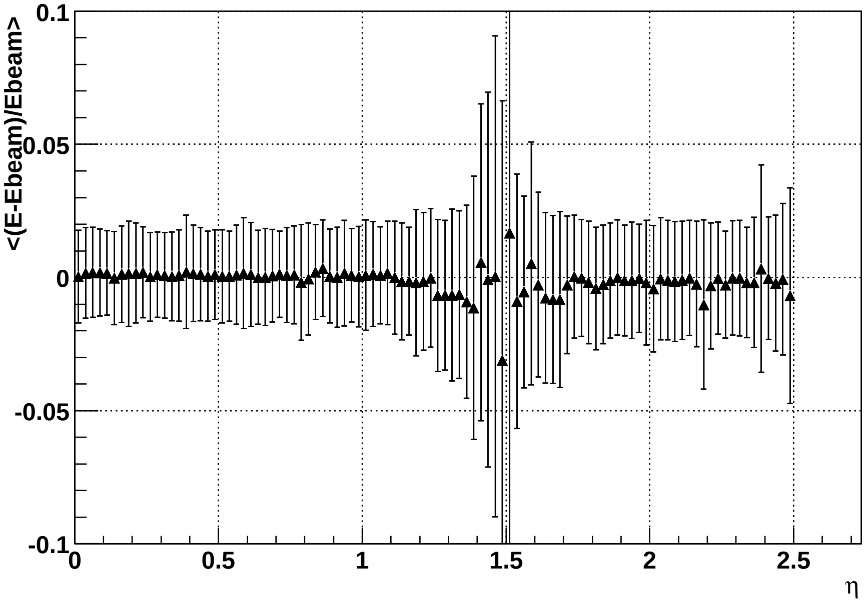
Ebeam=10GeV, InterCalibration



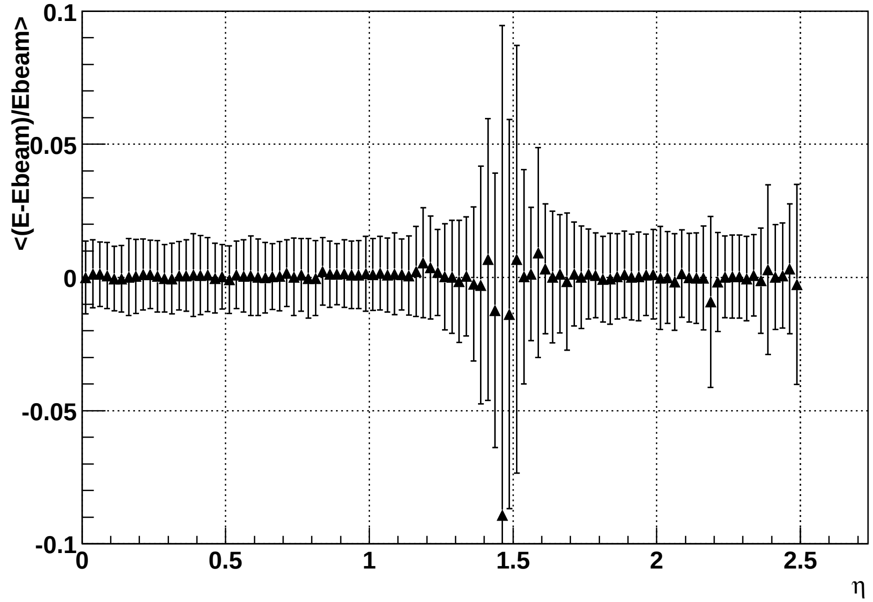
Ebeam=20GeV, InterCalibration



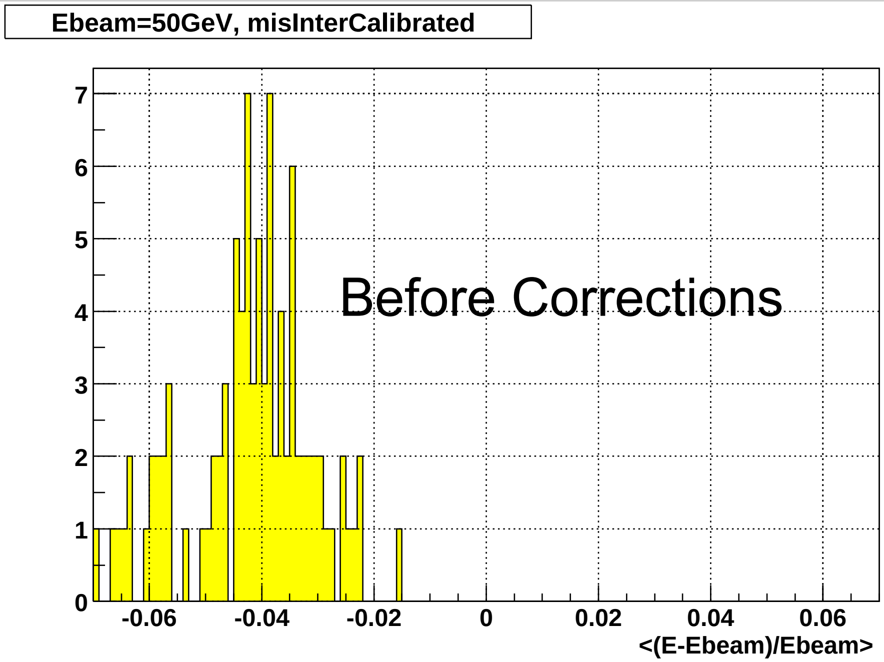
Ebeam=50GeV, InterCalibration

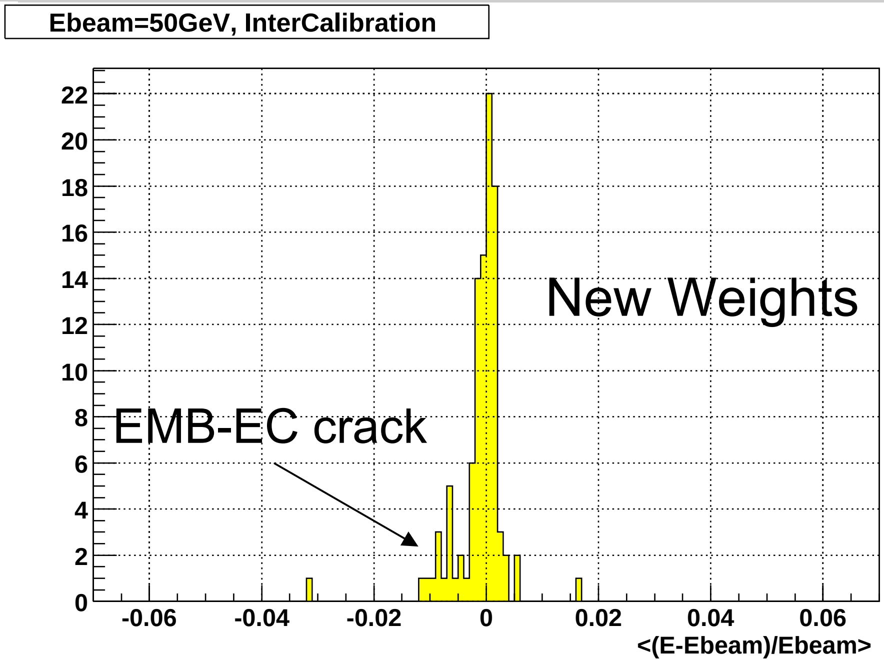


Ebeam=100GeV, InterCalibration



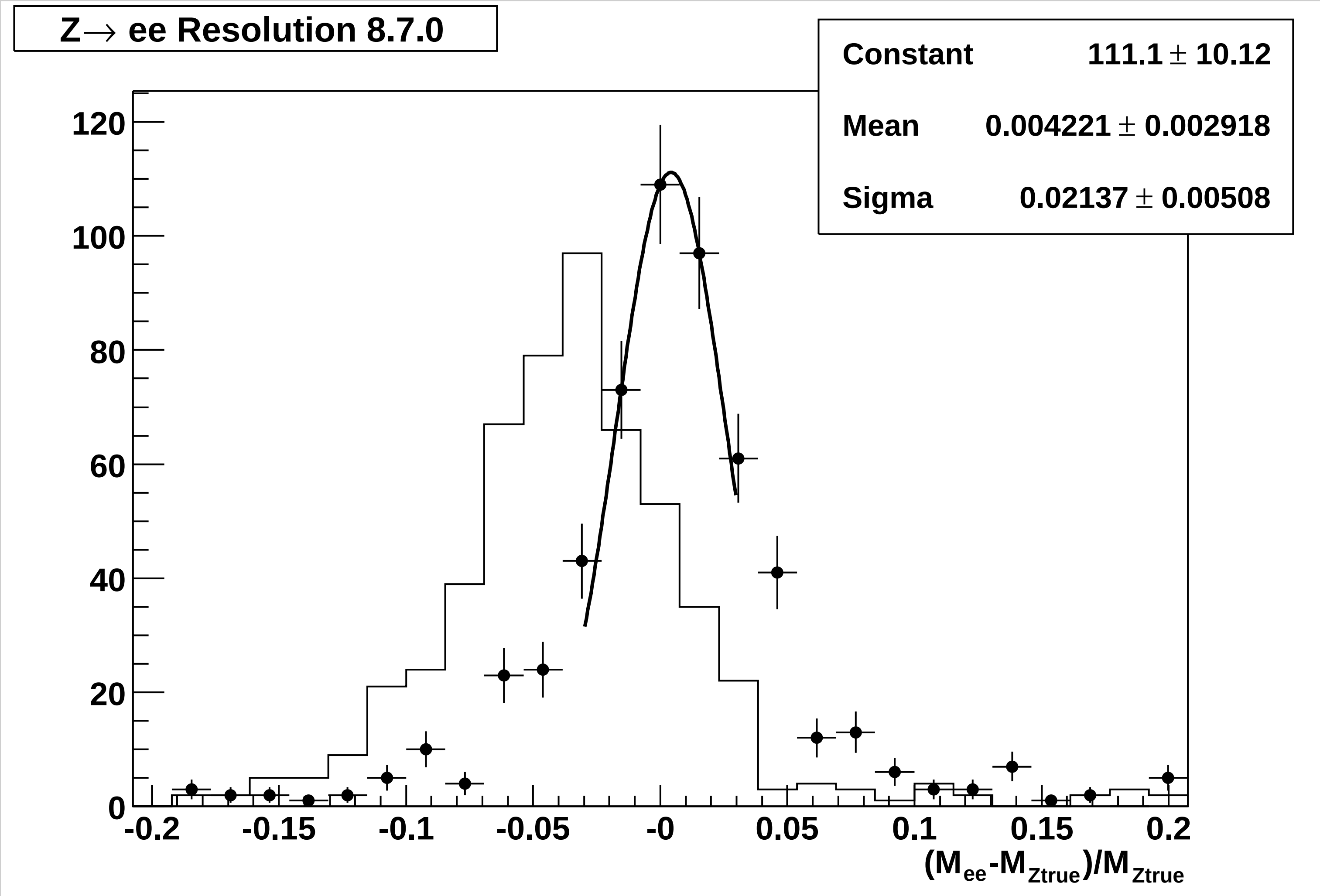
Look at 50GeV: uniformity





A better than 0.2% Uniformity is found (crack region excluded)

Effect on $Z \to e^+e^-$



Caveats: how well can we do this with W->eν and Z->ee ?

- Method possible with single electrons of known energy
- pp->Z+X->ee+X, with Z mass constrain
- pp->W+X->e+X, where e isolated relies on tracking

- To be done:
  - Recalculation of the weights for versions 9.x.x
  - Weights for all cluster types (3x7, 5x5, etc)

Summary

- We discussed two important problems that EM Calorimetry has to deal with during data taking: intercalibration and corrections for losses in upstream material. When electrons are used, the two problems are coupled.

- An extension of the LAr Calorimeter weights to include intercalibration effects was studied using electrons.

- A better than 0.2% uniformity was found, excluding the Barrel-EndCap crack region.

- In-situ, the method has the advantage of using a single data-sample for both corrections, however its performance must be tested with pp->Z+X->ee+X events.