The Jet Calibration in the H1 Liquid Argon Calorimeter

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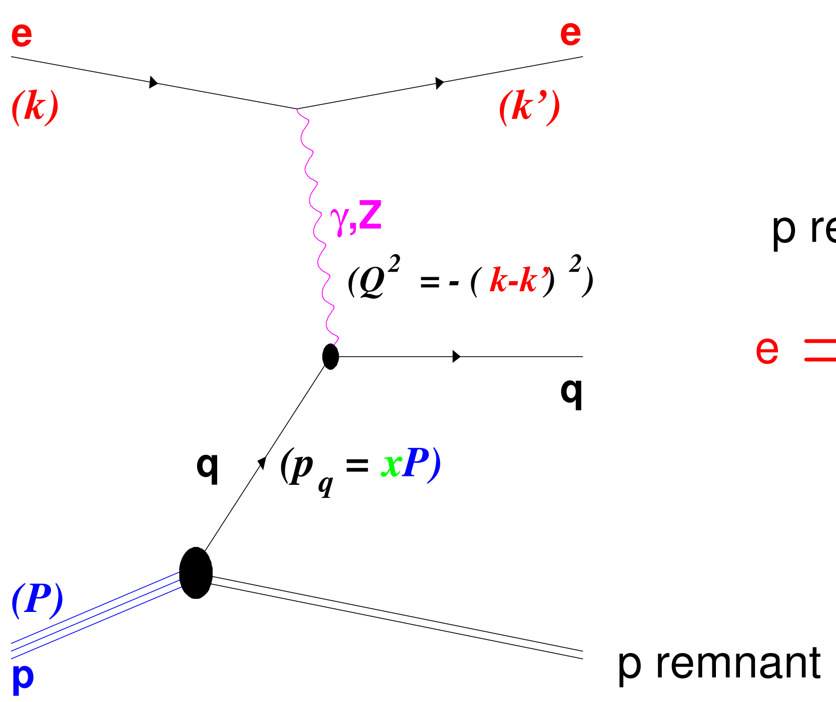
on behalf of the

Collaboration

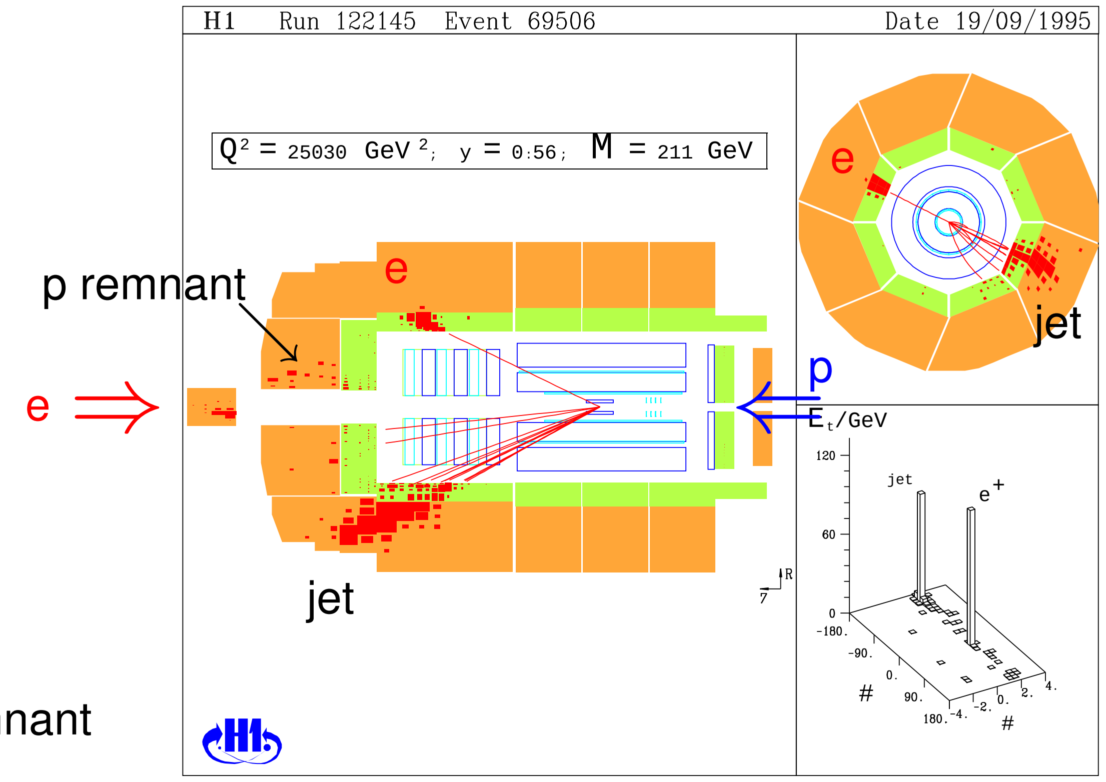
Introduction

physics: ep scattering

e. g. deep inelastic scattering (DIS), neutral current



energy measurement



⇑

calibration of
electromagnetic
and hadronic scale
using DIS data

⇐

software
weighting
NEW approach

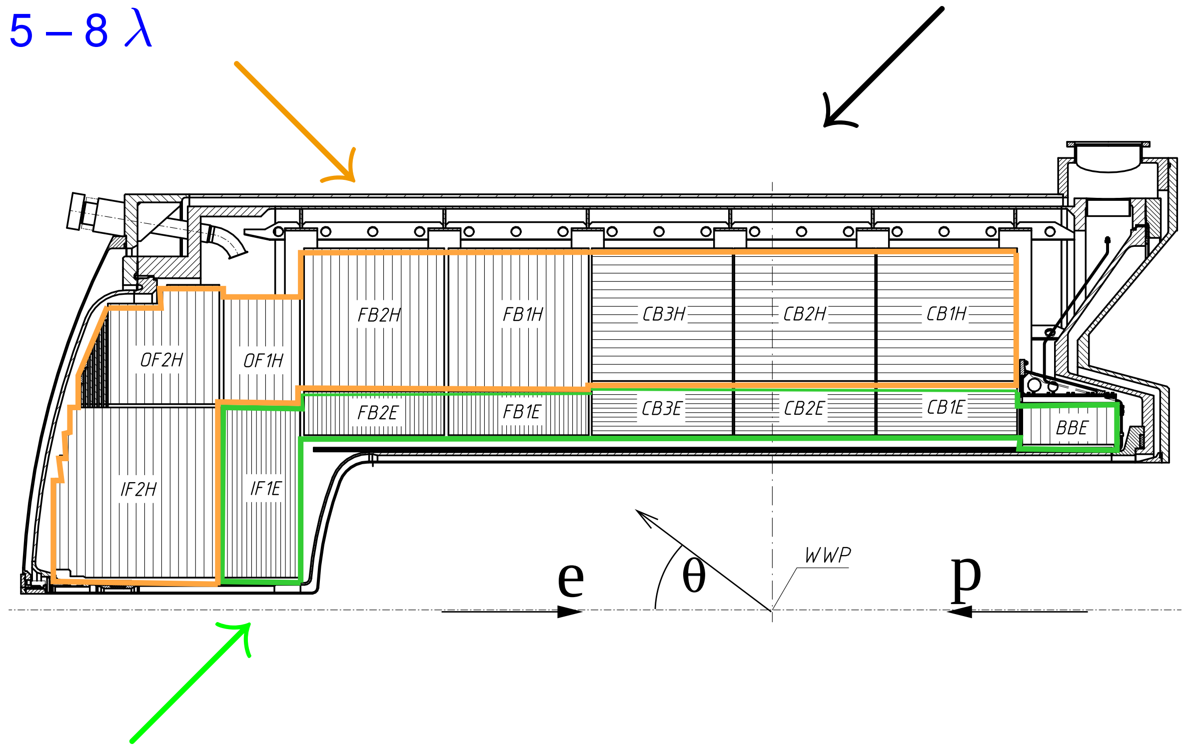
⇐

⇓

LAr calorimeter
non-compensating

The H1 Liquid Argon Calorimeter

- absorber in hadronic modules: stainless steel, in total $5 - 8\ \lambda$
- 8 self supporting wheels, 8 octants per wheel



- absorber in electromagnetic modules: lead, 20 - 30 X_0
- active material: liquid argon
- high granularity: 45.000 cells
- compensation: software weighting

Calorimeter Calibration

electron calibration

electron energy E_e:

double angle method

- $E_e(\Theta_e, \Theta_h) =$

$$\frac{2 \cdot E_{e-beam} \cdot \sin \Theta_h}{\sin \Theta_e + \sin \Theta_h - \sin(\Theta_e + \Theta_h)}$$

E_{e-beam}:

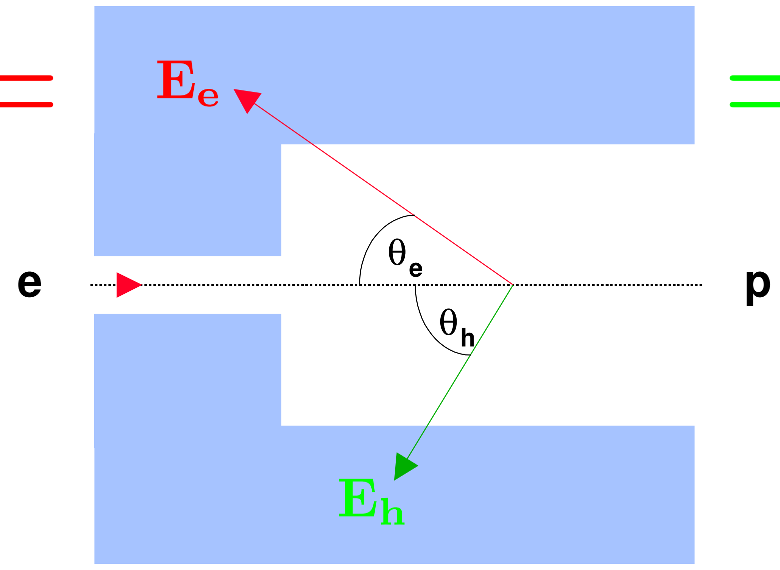
well known electron beam energy,

Θ_e, Θ_h: scattering angles:

independent of calorimeter calibration

(in first order)

$\Leftarrow$



$\Rightarrow$

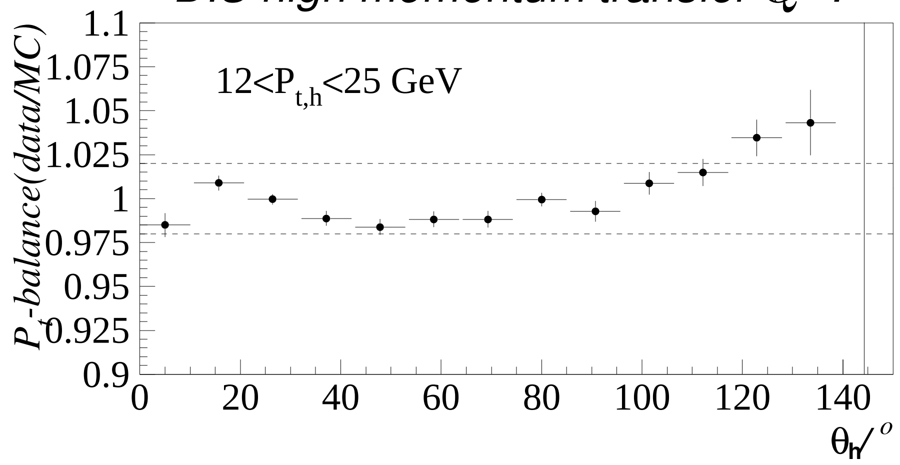
hadronic calibration

hadronic energy E_h:

p_t balance: p_t^h / p_t^e

- electron and hadronic jet back to back in ϕ
- $\vec{p}_t^{\,h} + \vec{p}_t^{\,e} = 0$

DIS high momentum transfer Q^2*:*

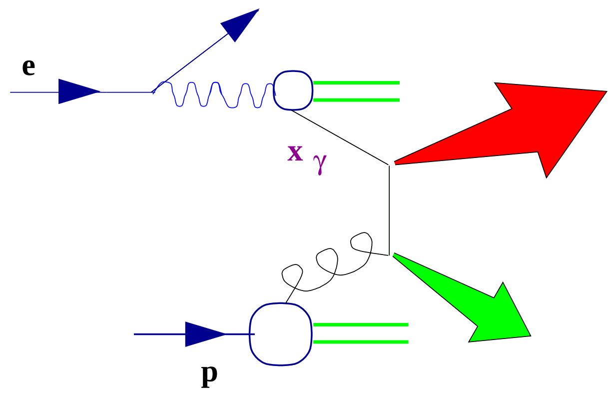


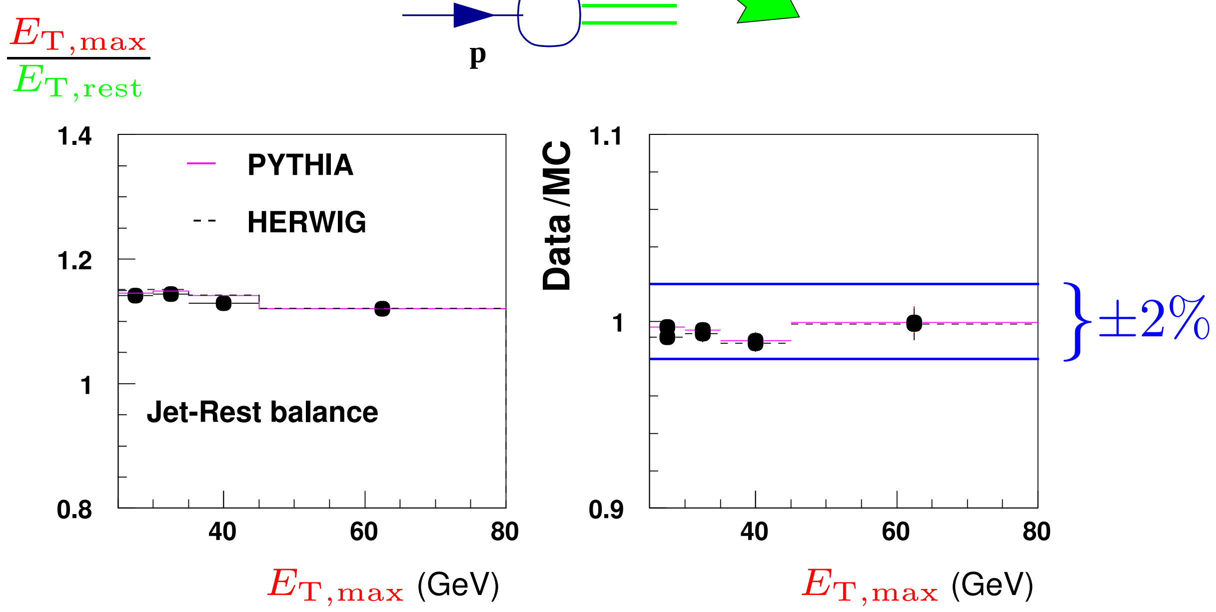
$\} \pm 2\%$

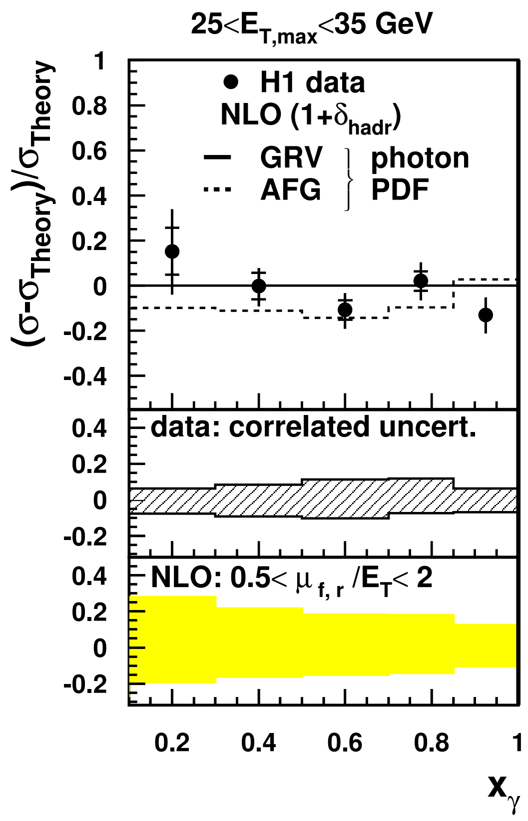
hadronic energy scale uncertainty: 2% (data/MC)

Dijet Cross Section in Photoproduction

an example for an application of the calibration using γp events







x_γ: longitudinal momentum fraction of the photon taken by the interacting parton

2% uncertainty in LAr energy scale

$\Rightarrow$ experimental errors are smaller than theoretical ones

Measurement of Hadronic Energy

electromagnetic component:

e. g. π^0, η, γ

- pair production, bremsstrahlung, ionisation

$\Downarrow$

high energy density

hadronic component:

e. g. $\pi^{\pm}, p, n, \ldots$

- nuclear reactions: energy losses due to short range fragments, broken up nuclear bonds

$\Downarrow$

low energy density

- fluctuating electromagnetic component: energy dependent

$\Leftarrow$

- e. g. relative fraction of π^0 production in nuclear interactions increases with energy

- response: $\frac{e}{\pi} = 1.35$ (@10 GeV) energy dependent

Towards a New Weighting Scheme

new weighting procedure: using tabulated correction factors ω on cell level

reconstructed energy in cell i $\longleftarrow$ $\boxed{E^i_{\rm rec} = \omega\,(\,E^i_0/Vol^i,\,E_{\rm group}\,)\cdot E^i_0}$ $\longleftarrow$ energy in cell i (signal)

energy density: "distinguish" between em and hadronic deposition

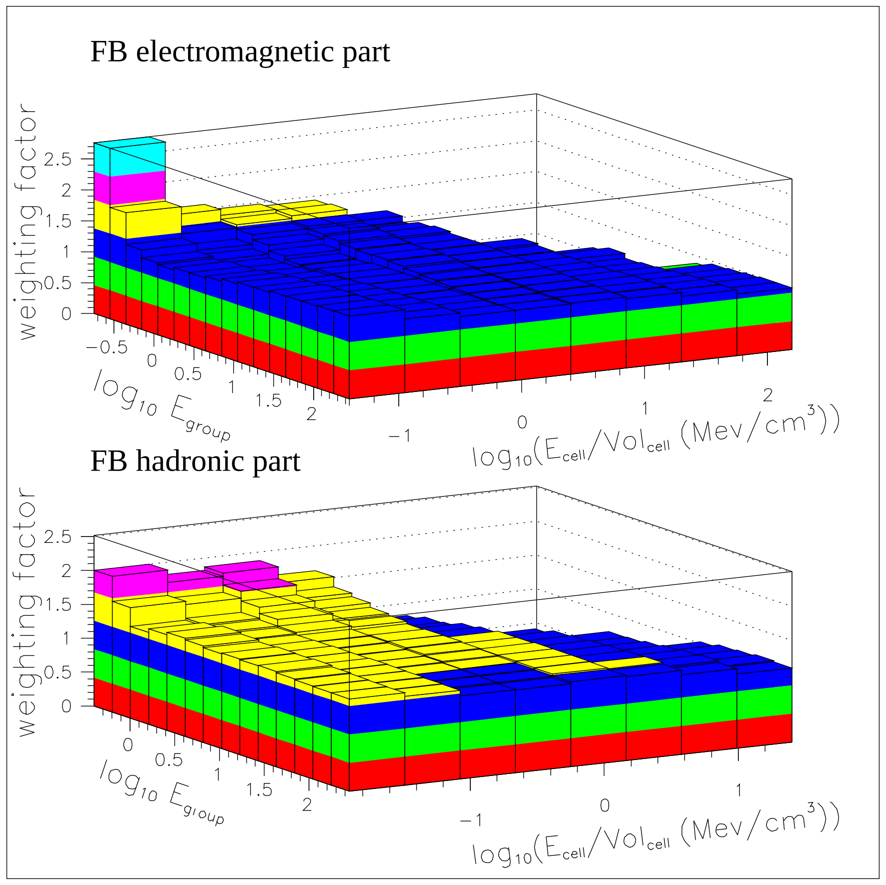
energy of group of clusters: energy dependence of $\frac{e}{\pi}$ and fluctuations

- reconstruct hadronic shower differentially
- derive weighting factor tables wheelwise (EMC, HAC) using single π detailed simulation
- energy range: down to noise level energies
- additive noise correction
- calibrate with real DIS data: adjust wheelwise $p_{\rm t}^{\rm had}/p_{\rm t}^{\rm e} \rightarrow 1$

$\Rightarrow$ increasing weighting factors ω for:

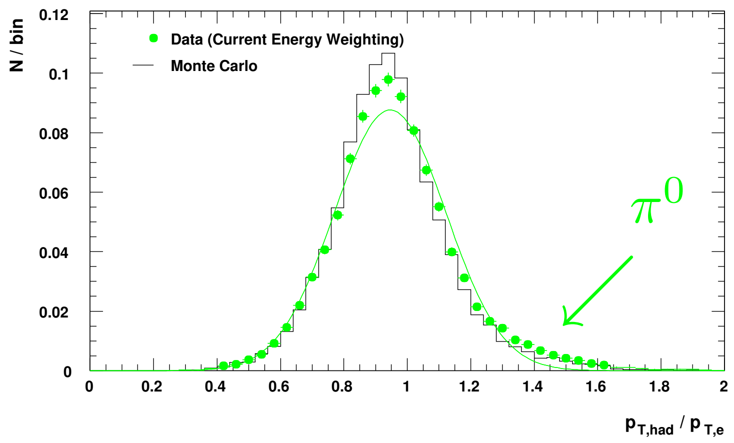
– $\downarrow E_{\rm group}$ ($\downarrow \pi^0$ fraction)

– $\downarrow$ energy density (hadron–like clusters)

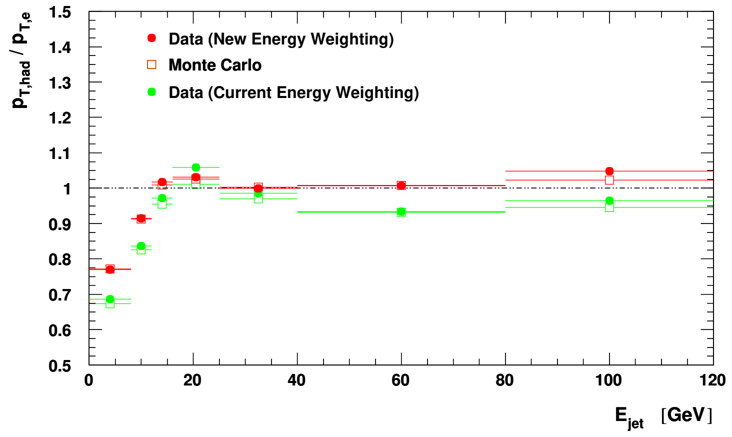


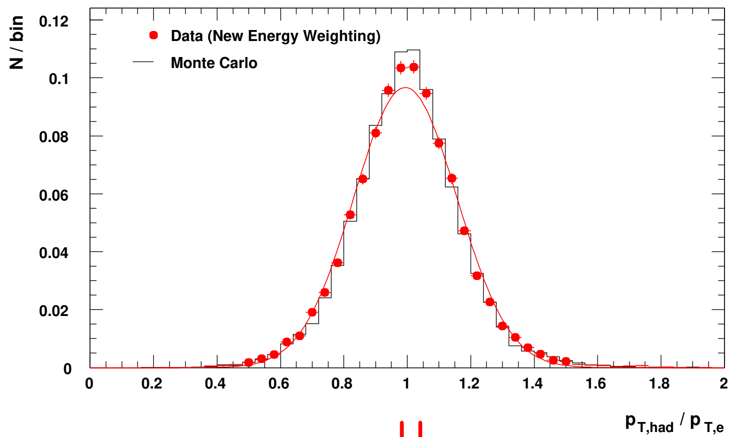
Results from DIS High Momentum Transfer Q^2 Data Sample

jet energy dependence

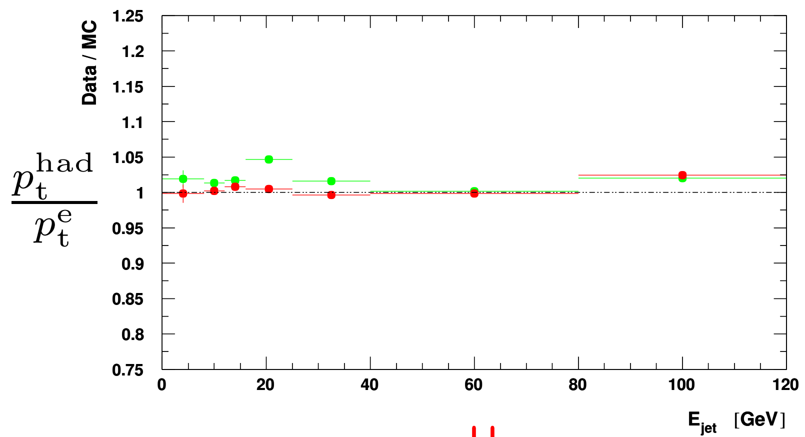


$\frac{width}{mean} \approx 0.19$





$\frac{width}{mean} \approx 0.16$



$\Downarrow$

- less entries in tails
- more gaussian-like shape
- improved resolution

$\Downarrow$

- improved response at small jet energies
- data/MC very good agreement

Conclusions

- using ep physics for jet calibration of LAr Calorimeter

  $\Rightarrow$ systematic uncertainties $\mathcal{O}(2\%)$ for high jet transverse energies (photoproduction, DIS high Q^2)

- alternative weighting scheme:
  reconstruction of hadronic shower differentially !

  – first applications (DIS high Q^2)

  $\Rightarrow$ improvement in the response at low energy

  $\Rightarrow$ more gaussian-like shape and improvement in the resolution of p_{t} balance between hadronic system and electron