Jet Energy Corrections with the ZEUS Barrel PREshower Detector

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ZEUS Barrel Preshower Detector (BPRE)

Jet Corrections

Selection of jet "Test Beam"

Derivation of jet correction parameters

Results for cone jets

Optimized detector objects

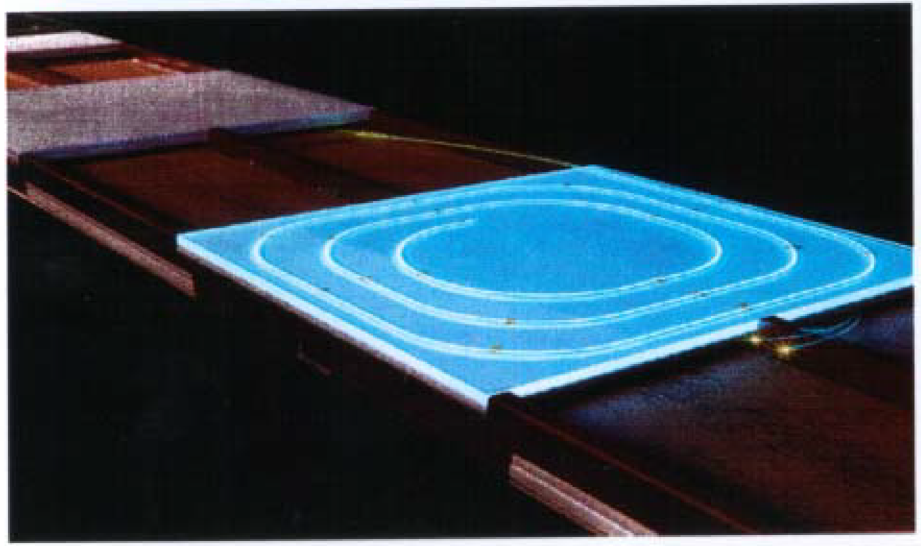
Track substitution

EM cluster corrections

Results -> optimization of jet energy resolution

Summary

ZEUS Barrel Preshower Detector (BPRE)



Installation -> January to June 1998

Commissioning -> Fall 1998

Full Operation -> January 1999 to Present
80 pb-1 data so far

Dead Material Map of Barrel Region

use DIS scattered e+/e- to verify Monte Carlo simulation code

Calorimeter Energy Corrections

DIS Scattered e+/e-

energy-independent BPRE corrections improve resolution by 4%

Jets

results - energy correction and resolution improvement

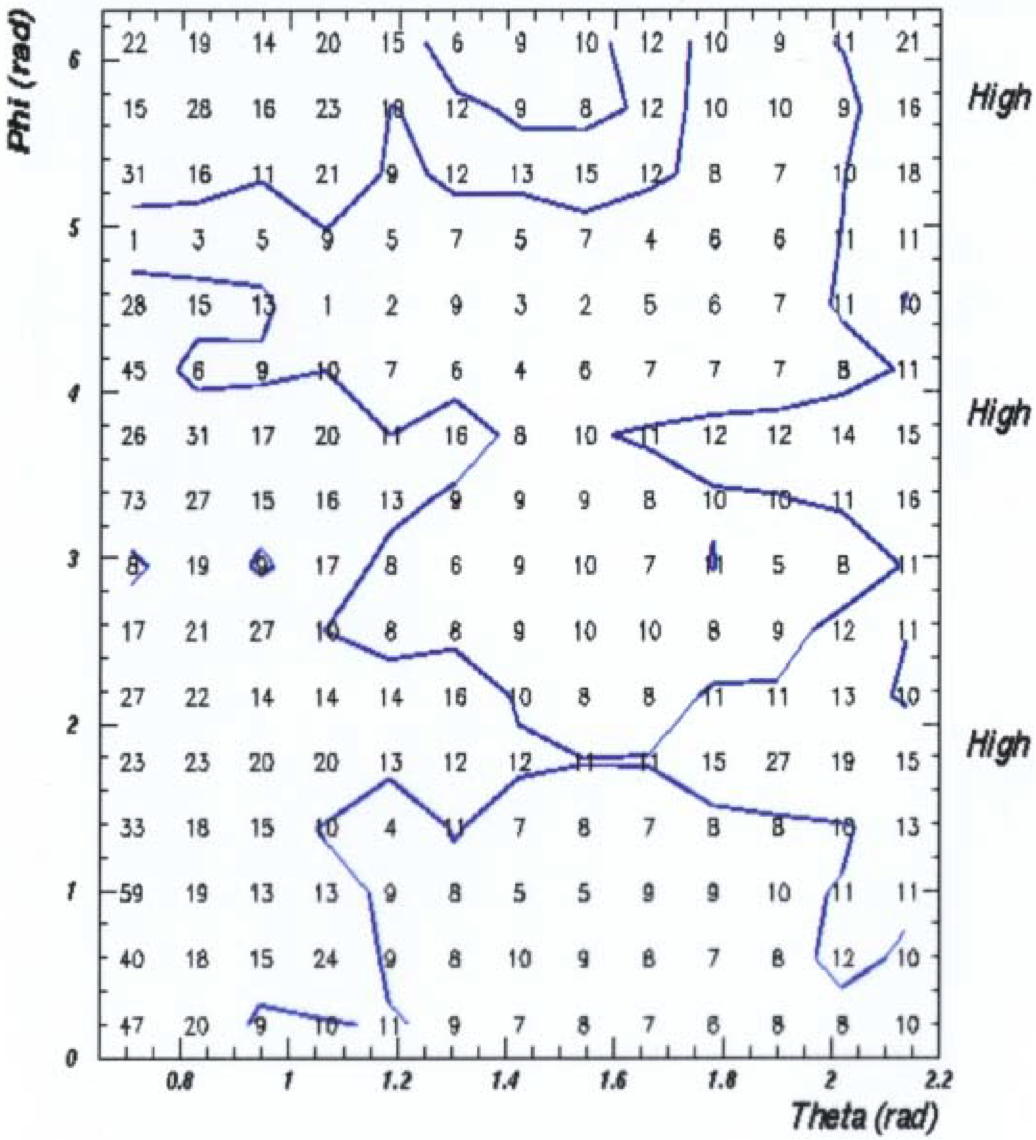
Optimized detector objects

towards ultimate use of tracks and preshower-corrected CAL clusters

Prompt Photons

BPRE mips analysis independent of calorimeter

Dead material map of ZEUS barrel region



Using 1999 e+ only (20 pb-1)

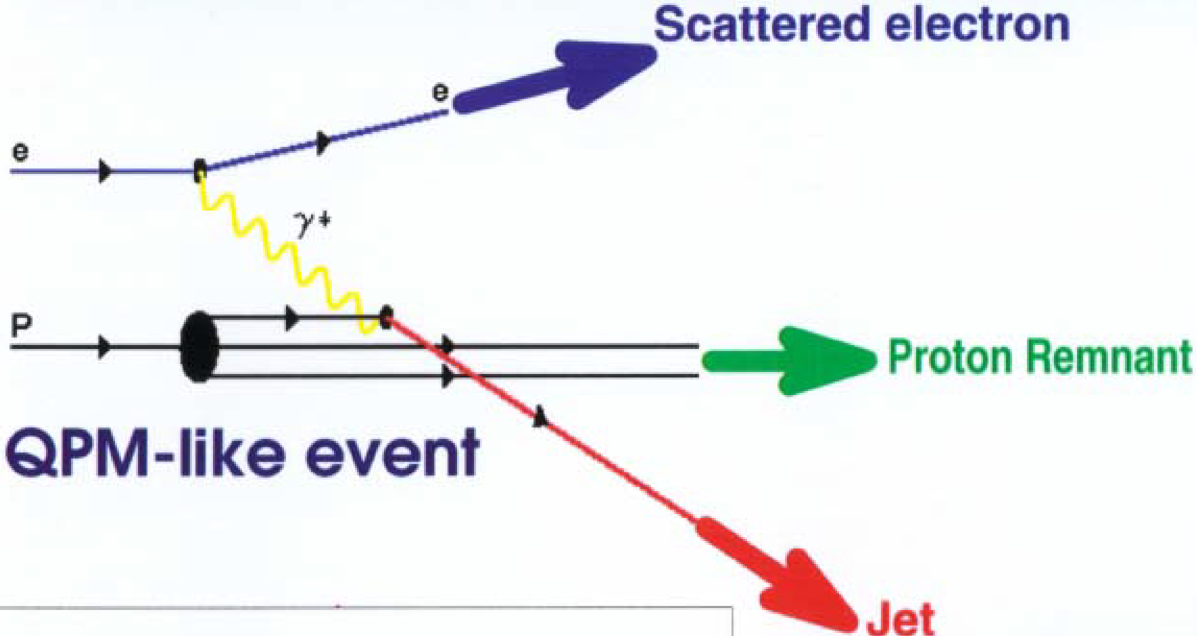
Values are average BPRE signal in Mips for scattered e+

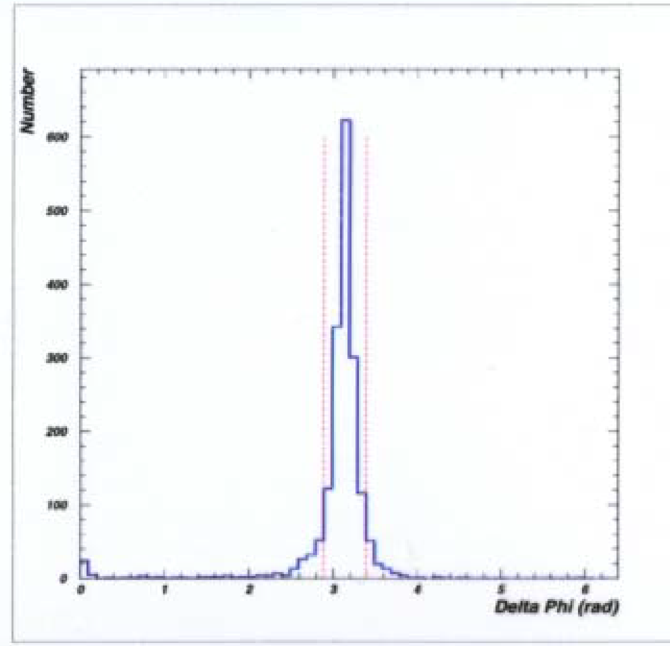
Contour is drawn at 11 Mips

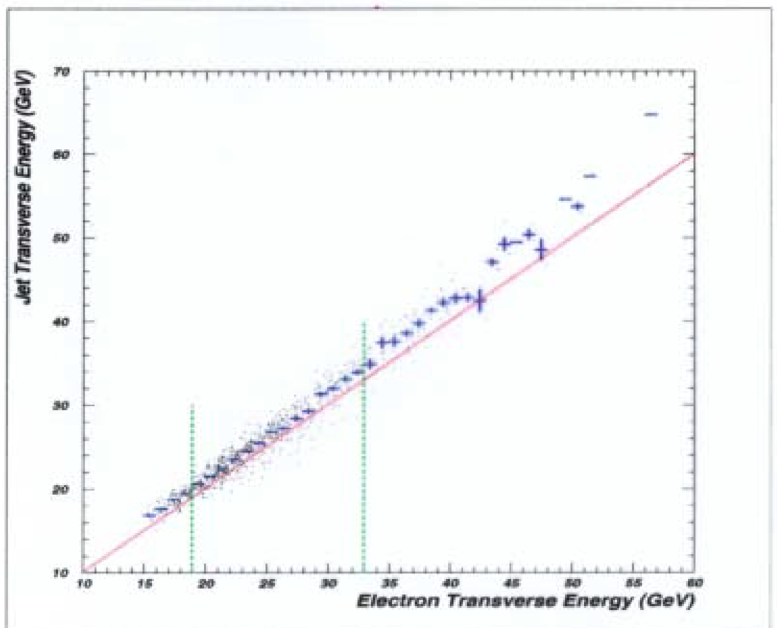
3 regions of increased dead material
- around 2, 4, and 6 rad

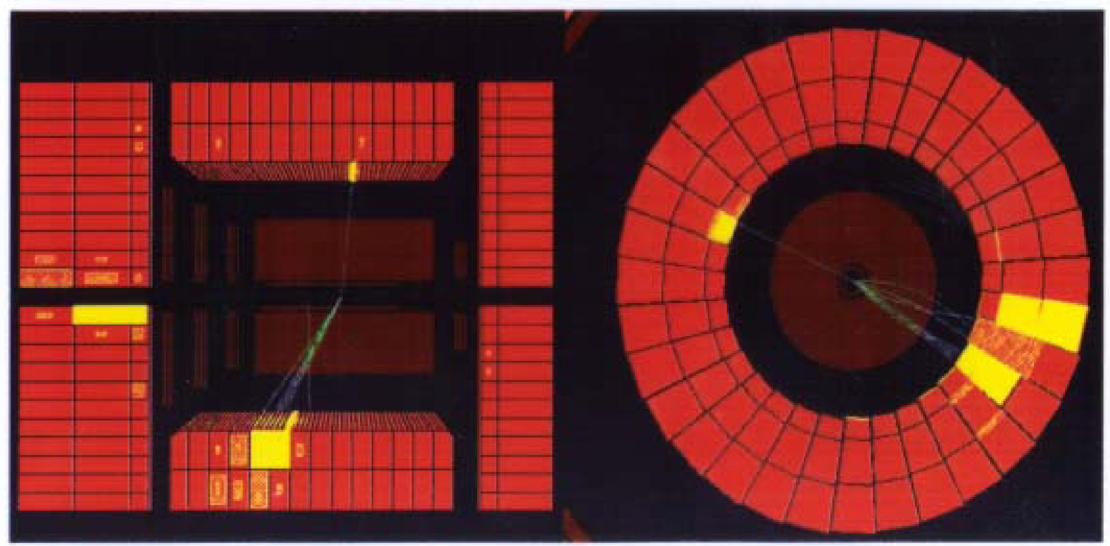
Correlates with measured versus true positron energy in CAL

Jet Corrections -> Selection of jet "test beam"

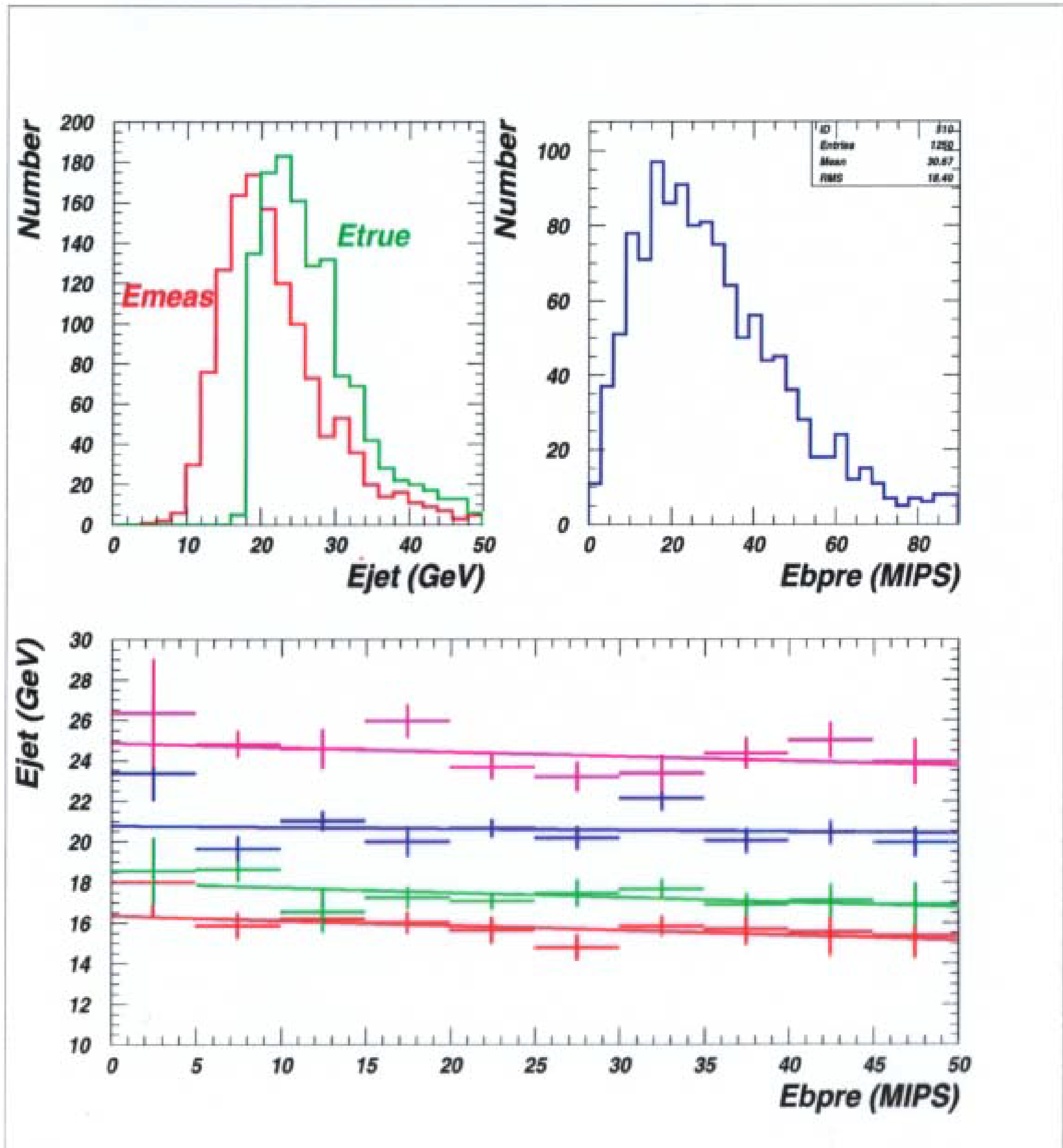








Jet/Preshower Correlation



Jet Algorithm - Cone of 1.25 with E_T cut of 5 GeV

Top left - measured jet energy (red) compared to "true" jet energy (green) calculated from the polar angle of the scattered electron and the polar angle of the jet (DA method)

Top right - preshower detector mips for selected jets

Bottom - plots of measured jet energy versus preshower mips for the following true jet energy ranges :

19 to 21 GeV
21 to 23 GeV
23 to 28 GeV
28 to 33 GeV

Fitted to straight line

Typical slope ~ -30 MeV/Mip

Derivation of BPRE Jet Correction Parameters

1. **Plot E(CAL) in GeV versus E(BPRE) in Mips in bins of E(true)**
   - fit to a straight line : $E(CAL) = A0 + A1 * E(BPRE)$

2. **Assumptions for correction parameters, A0 and A1 contain constant and energy-dependent parts :**

$$A0 = a0 + b0 * E(true)$$
$$A1 = a1 + b1 * E(true)$$

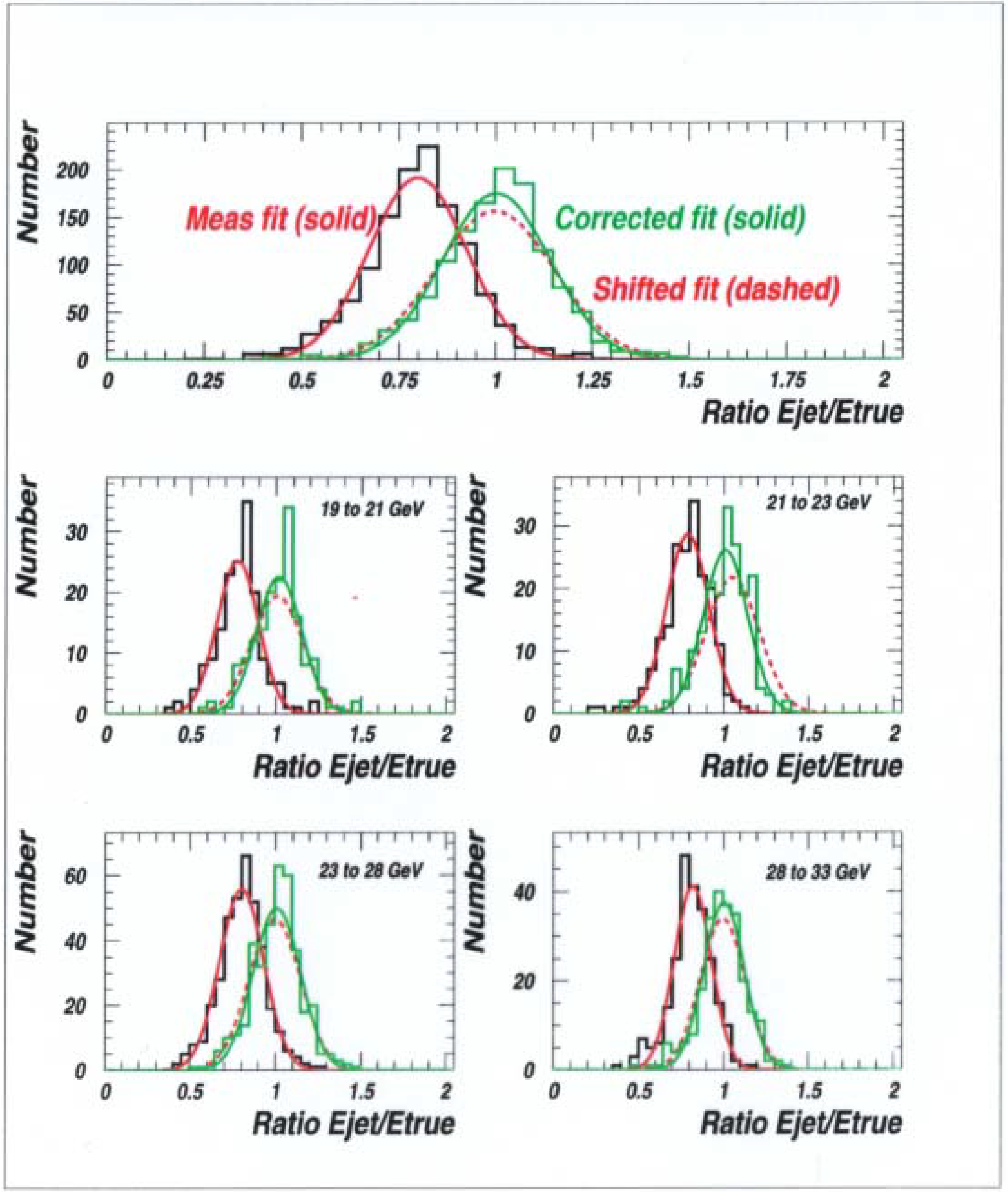
3. **Solve all pairs of equations for parameters :**
   - a0 (GeV) --> constant energy parameter - dE/dx
   - a1 (GeV/Mip) --> shower-dependent parameter - dead material
   - b0 --> constant shift - E-scale?
   - b1 (Mip-1) --> shower-dependent shift term

4. **Histogram and fit (gaussian) to obtain <a0>, <a1>, <b0>, <b1>**

5. **Use to obtain corrected energy :**

$$E(corr) = \frac{E(CAL) - \langle a0 \rangle - \langle a1 \rangle * E(BPRE)}{\langle b0 \rangle + \langle b1 \rangle * E(BPRE)}$$

Results -> Preshower corrections to cone jets

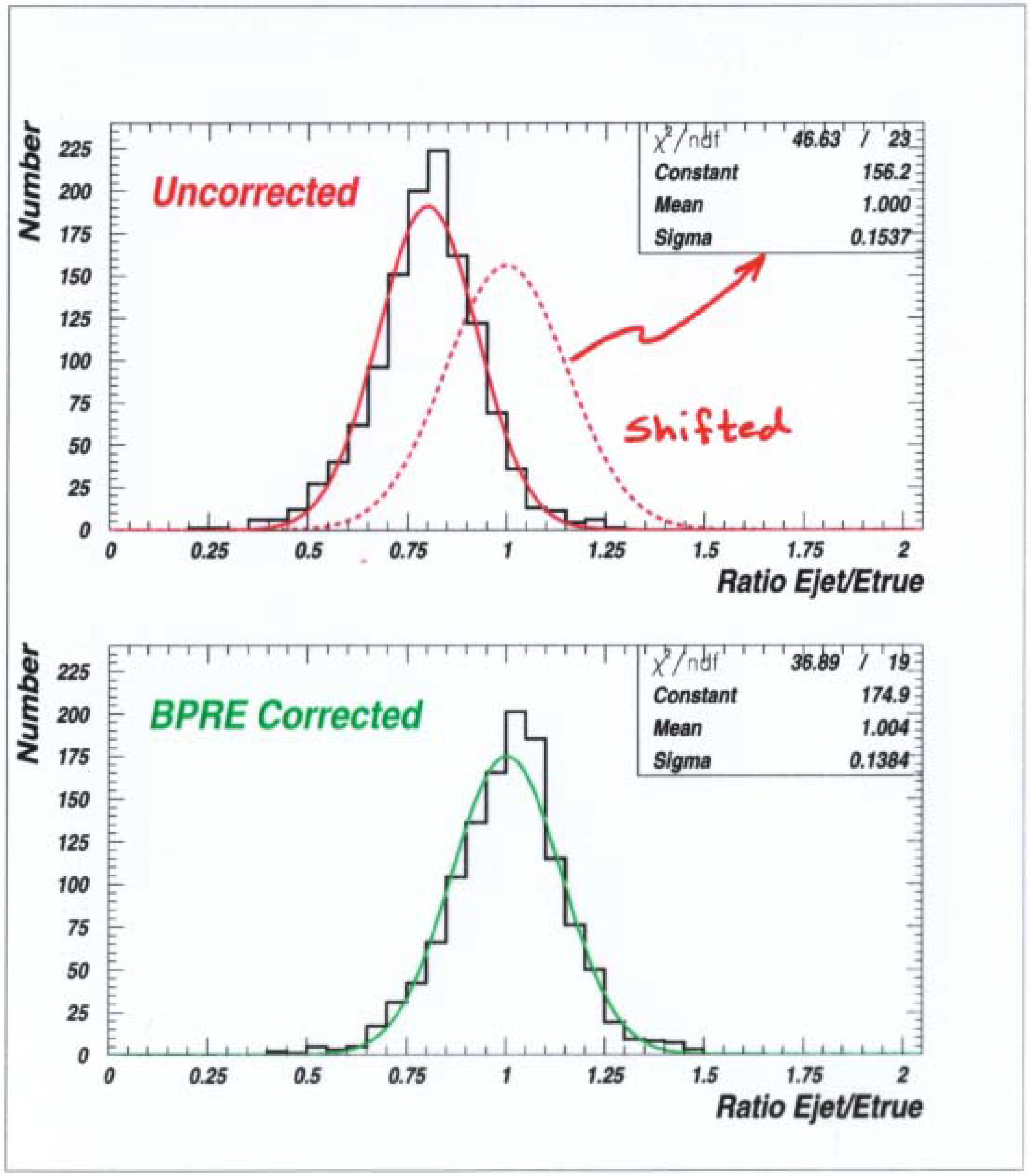


Comparison of fits to measured ratio Ejet/Etrue and BPRE-corrected fits for all jets (top plot) and in individual bins

Shifted fit (red dashed line) is the measured fit shifted to a ratio of 1 using the mean of the measured fit.

Bin	sig/mean measured	sig/mean corrected	change
all	0.157	0.138	12%
19-21	0.154	0.131	15%
21-23	0.159	0.131	18%
23-28	0.161	0.138	14%
28-33	0.132	0.119	10%

Summary - Cone jet correction results



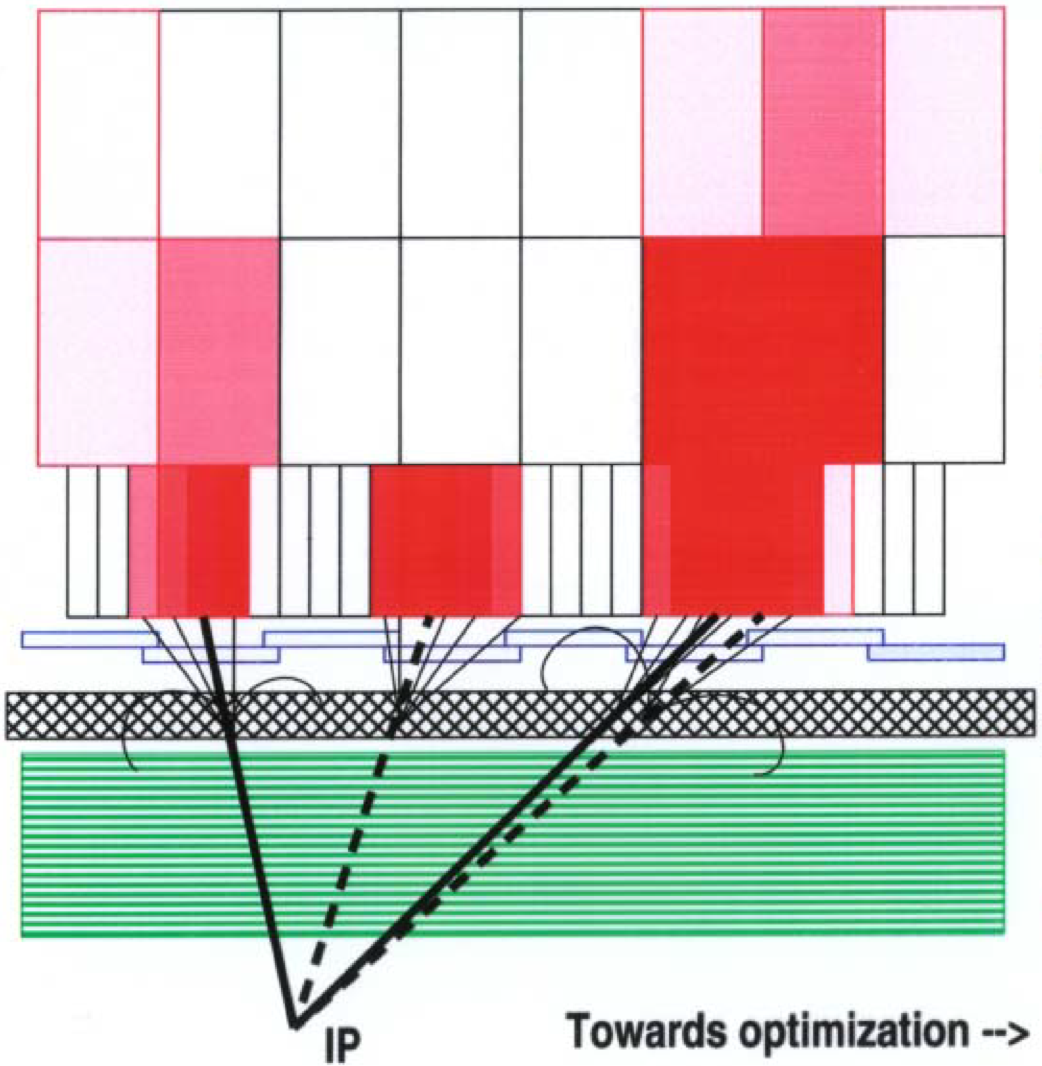
An improvement in mesured energy resolution of about 12% on average is seen in jets corrected for energy loss in dead material with the BPRE

The correction is energy and model independent

The slope parameter (a1) obtained for jets is consistent with that obtained for scattered electrons ; the offset (b0) is about 2 times larger than that for scattered electrons - consistent with the average mip signal for each

The total correction results from a constant energy addition (dE/dx?), a 12% shift, and a dead material correction

Optimized Detector Objects



Jets : collection of <u>low E</u> hadrons and photons

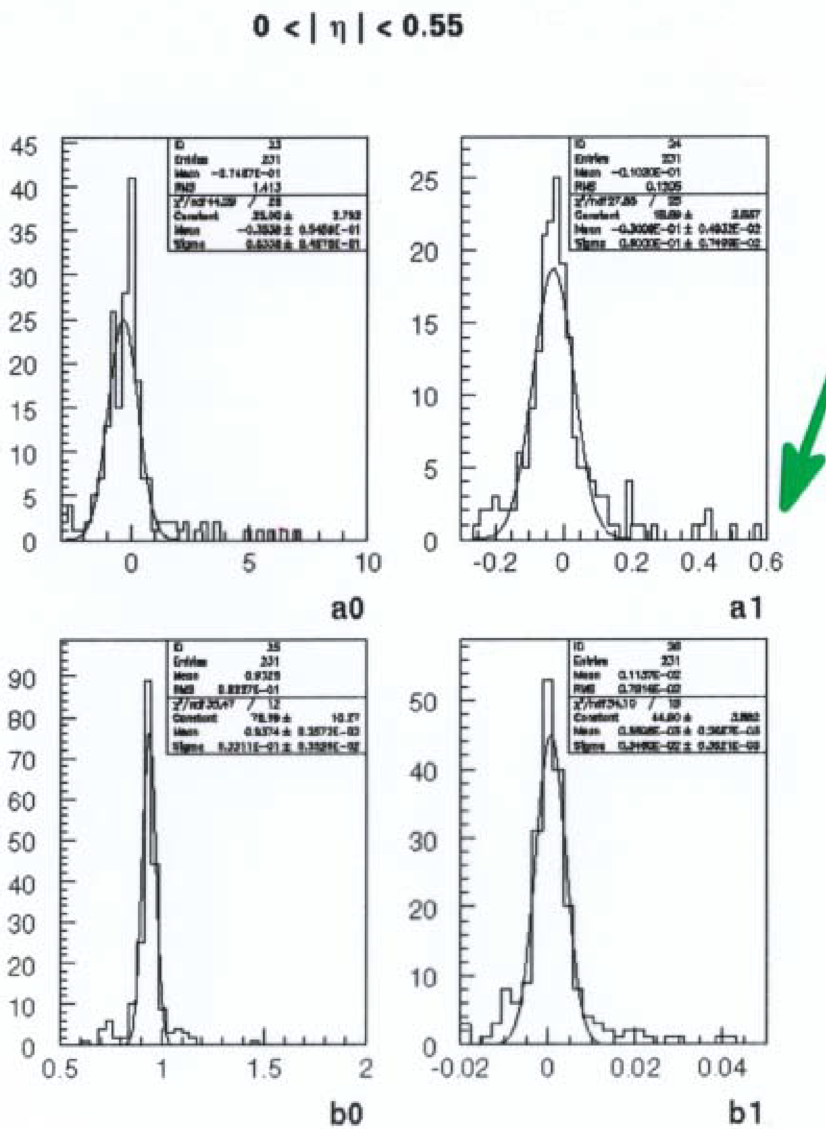
Energy loss in coil --> Preshower Detector

Track Substitution requirements :

1. 1:1 unique match
2. Ptrack > Ecluster

Towards optimization --> Tracks for hadronic clusters (π+-)
Preshower-corrected EM clusters (photons)

Correction parameters for EM objects (from DIS e+/e- and J/Psi)



BCAL central region : |eta| < 0.55

<a0> = -0.35 +/- 0.05 GeV
<a1> = -0.030 +/- 0.004 GeV/Mip
<b0> = 0.937 +/- 0.002
<b1> = 0.0005 +/- 0.0003 Mip-1

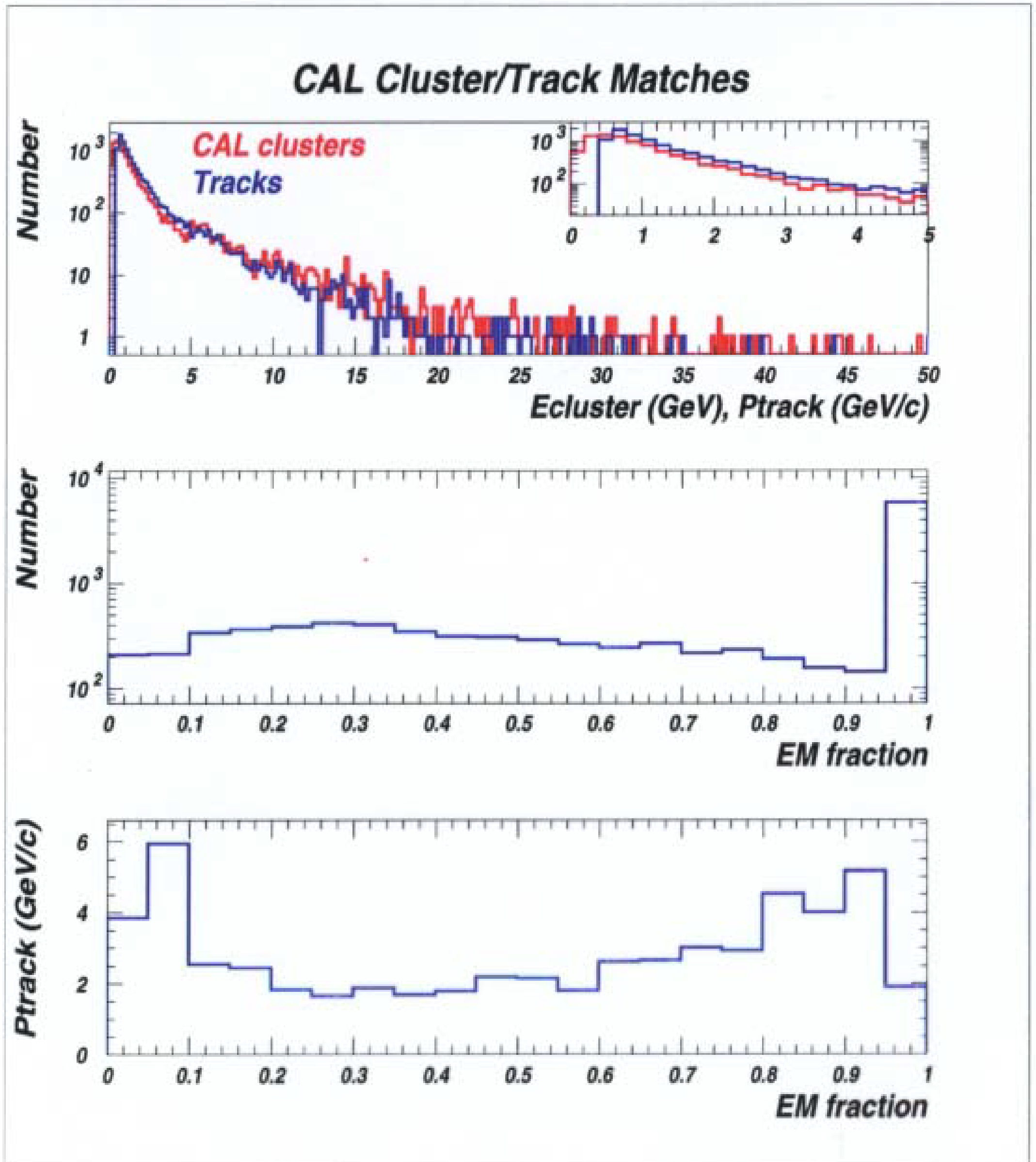
BCAL outer rings : 0.55 < |eta| < 0.65

<a0> = -0.49 +/- 0.08 GeV
<a1> = -0.041 +/- 0.009 GeV/Mip
<b0> = 0.928 +/- 0.004
<b1> = 0.0007 +/- 0.0004 Mip-1

BCAL ends : 0.65 < |eta| < 1.1

<a0> = 0.5 +/- 0.3 GeV
<a1> = -0.08 +/- 0.02 GeV/Mip
<b0> = 0.85 +/- 0.01
<b1> = 0.005 +/- 0.001 Mip-1

Track substitution for CAL clusters



Cluster/Track Match Characteristics

Energy, momentum comparison - typically P>E

Matches dominated by clusters with EM fraction > 95%

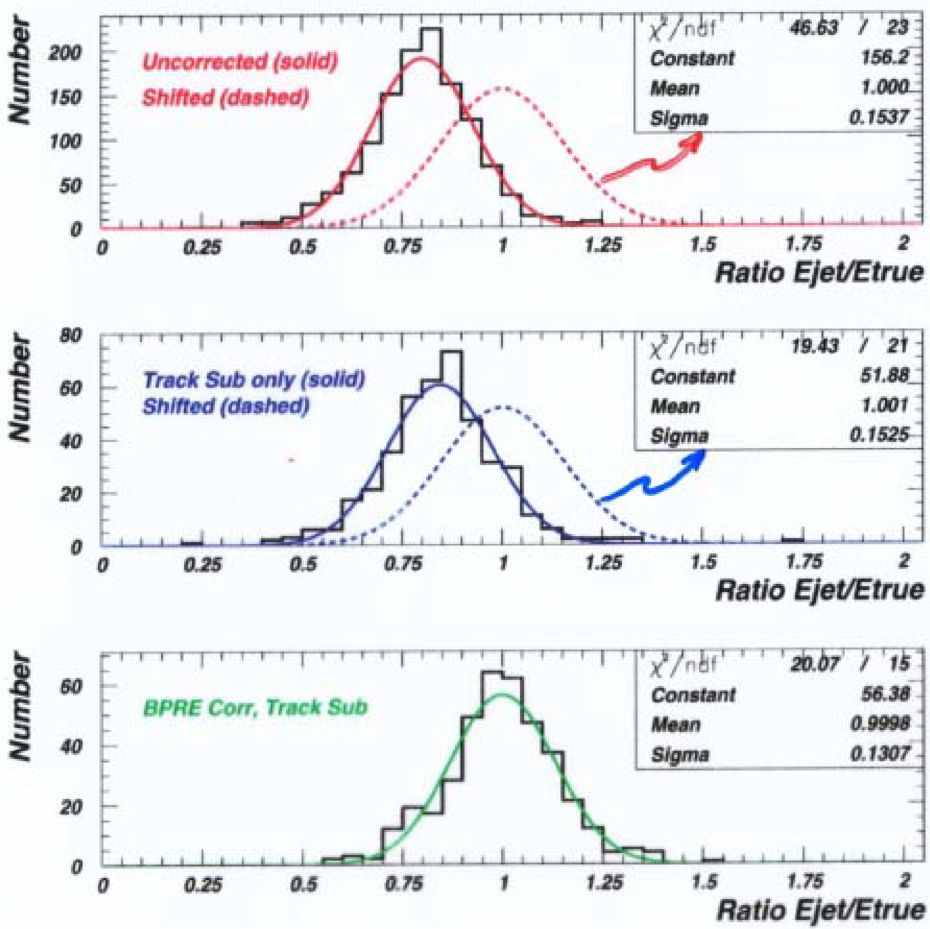
But, hadronic cluster/track matches typically have more momentum than EM clusters

for tracks : sigma/P_T ~ .005 P_T

for clusters : sigma/E ~ .35/$\sqrt{E}$

Tracks <------ 17 GeV ------> Cal

Summary - results using optimized inputs



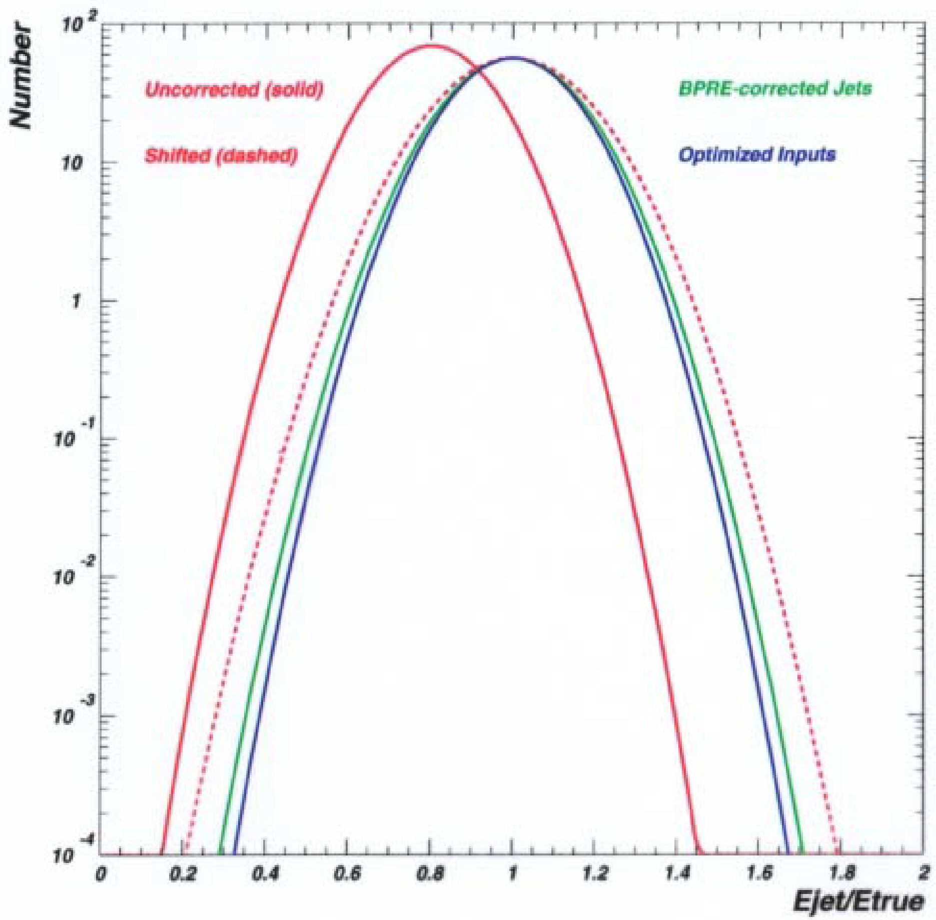
First results combining track substitution and EM cluster preshower correction :

NO JET ALGORITHM DEPENDENCE

Track sub only partially corrects for energy loss and with marginal resolution improvement

Combining track substitution and preshower correction results in ~17% improvement in the jet resolution of fully-corrected jets - a 5% improvement over jets corrected using only the preshower correction method

Summary



The recently-installed ZEUS Barrel PREshower Detector can be used to correct jets for energy loss in dead material

Correction parameters for jets and scattered electrons exhibit the energy-independence and dead material dependence typical of preshower corrections

Jet energy resolution can be improved by ~12% on average using the preshower correction method

A first look at optimizing the ZEUS detector energy resolution by combining tracks and corrected CAL clusters has resulted in an improvement of ~17% in the jet energy resolution --> further work is ongoing