ATLAS-HEC Performance to electrons and pions

August 99 Beam Test Results

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Abstract

Outline

- Noise Studies
  - Noise distribution using digital filtering
  - Underestimating the noise ?
  - Noise fluctations with time/energy
- Electron Beams Result
  - Energy response
  - Electromagnetic constant and offset
  - Reconstructed energy plots
  - Resolution curve
- Pion Beams Results
  - Energy response
  - Reconstructed energy plots
  - Resolution
- Conclusions

Outline

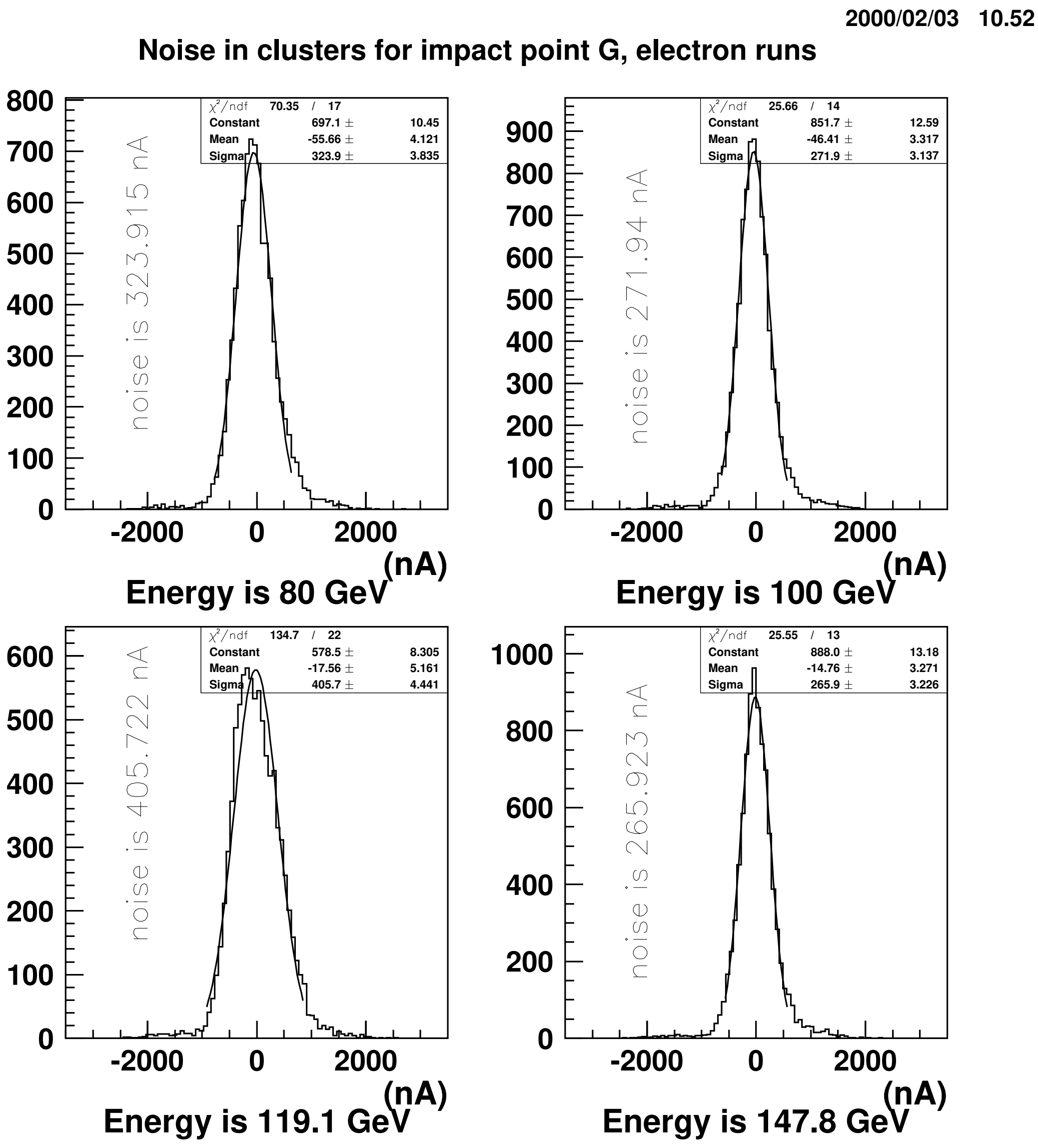
Procedured used for this Analysis

- Digital Filtering used
- Analysis is done in nA
- Latest calibration files used (12/10/99)
- HV correction factors used :
  - 4.0/3.0 for module 1, layer 2
  - 4.0/3.0 for module 2, layer 4
  - 4.0/2.0 for module 3, layer 2
  - 4.0/3.0 for module 3, layer 4
- Correction factor of 2 applied to cell #61
  - This applies only for run number greater than 8605

Noise Studies

Noise in 9 cells clusters for e^+ beam runs :

- Noise studied using digital filtering on first 5 time slices
- Physics events chosen

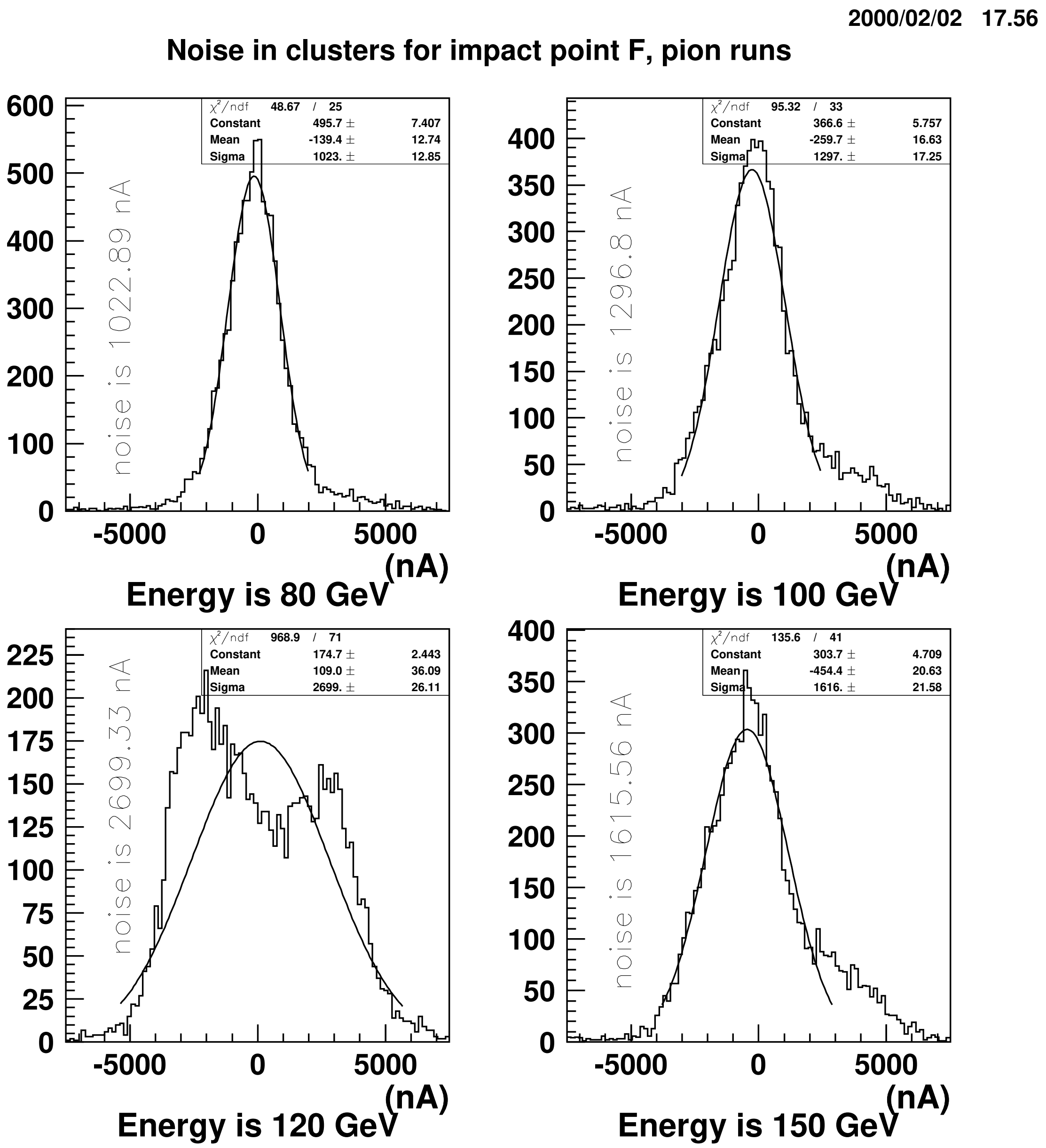


Fit done on interval $\pm 2\sigma$

Noise Studies

Noise in 53 cells clusters for π^+ beam runs :

- Same method as for e^+ beam runs used
- Non-gaussian distributions are observed

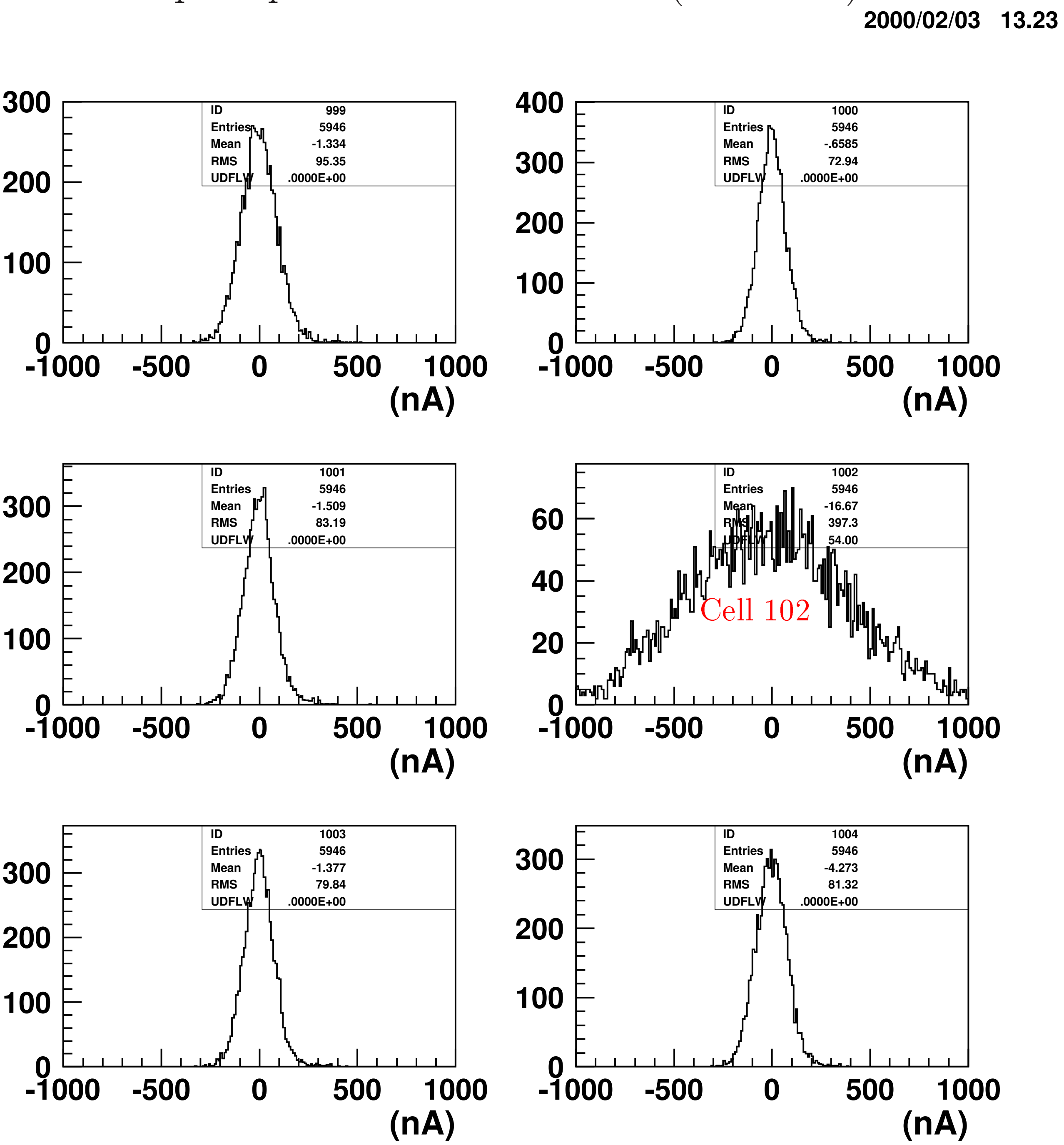


Fit done on interval $\pm 2\sigma$

Noise Studies

Non-gaussian distribution is coming from a few bad cells :

Noise at impact point G for π^+ beam (run 8675)

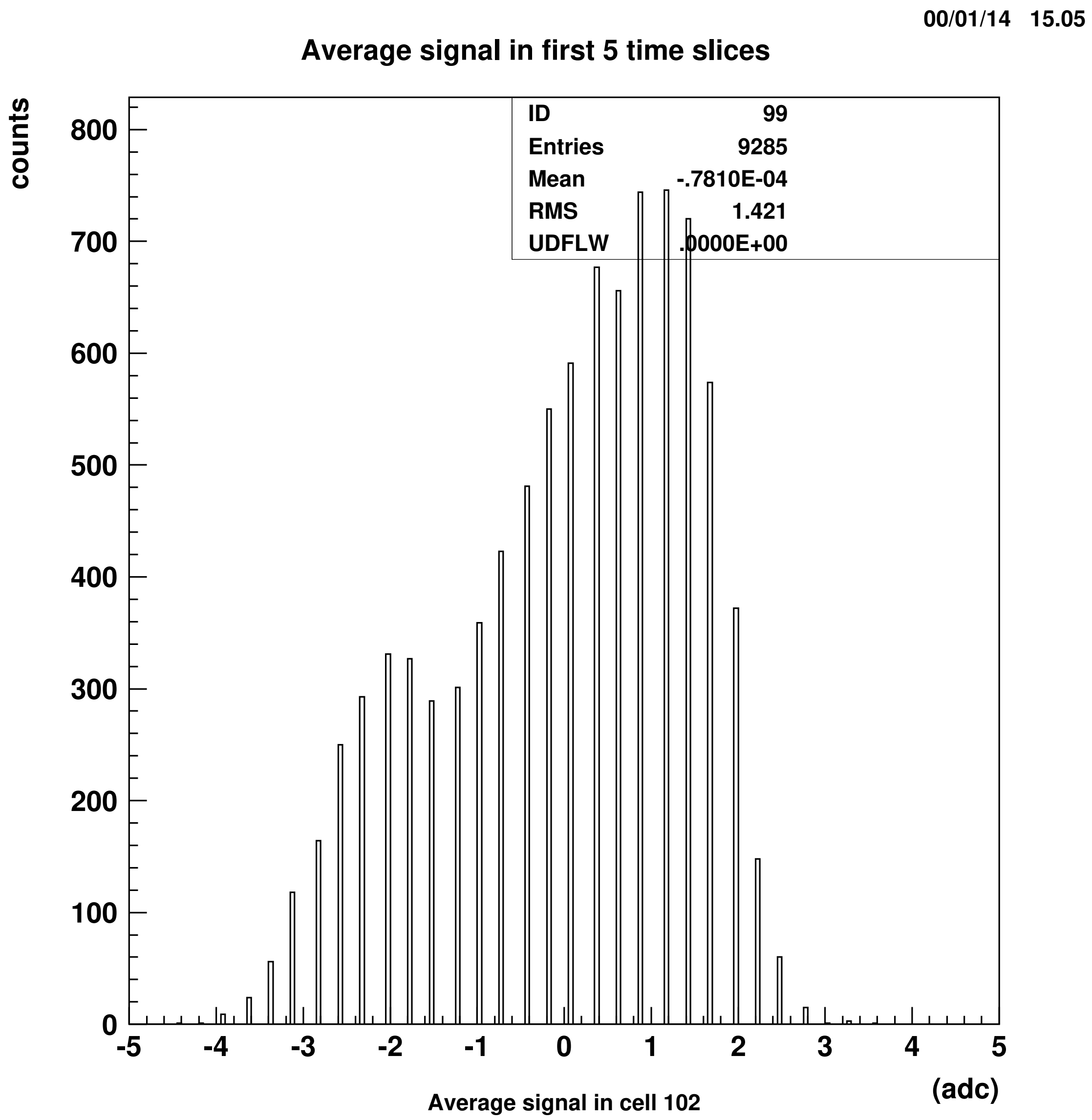


Noise Studies

Possible source of bad noise distributions :

- Bad timing, background signal from previous events ?
- Bad digital filtering of some cells ?

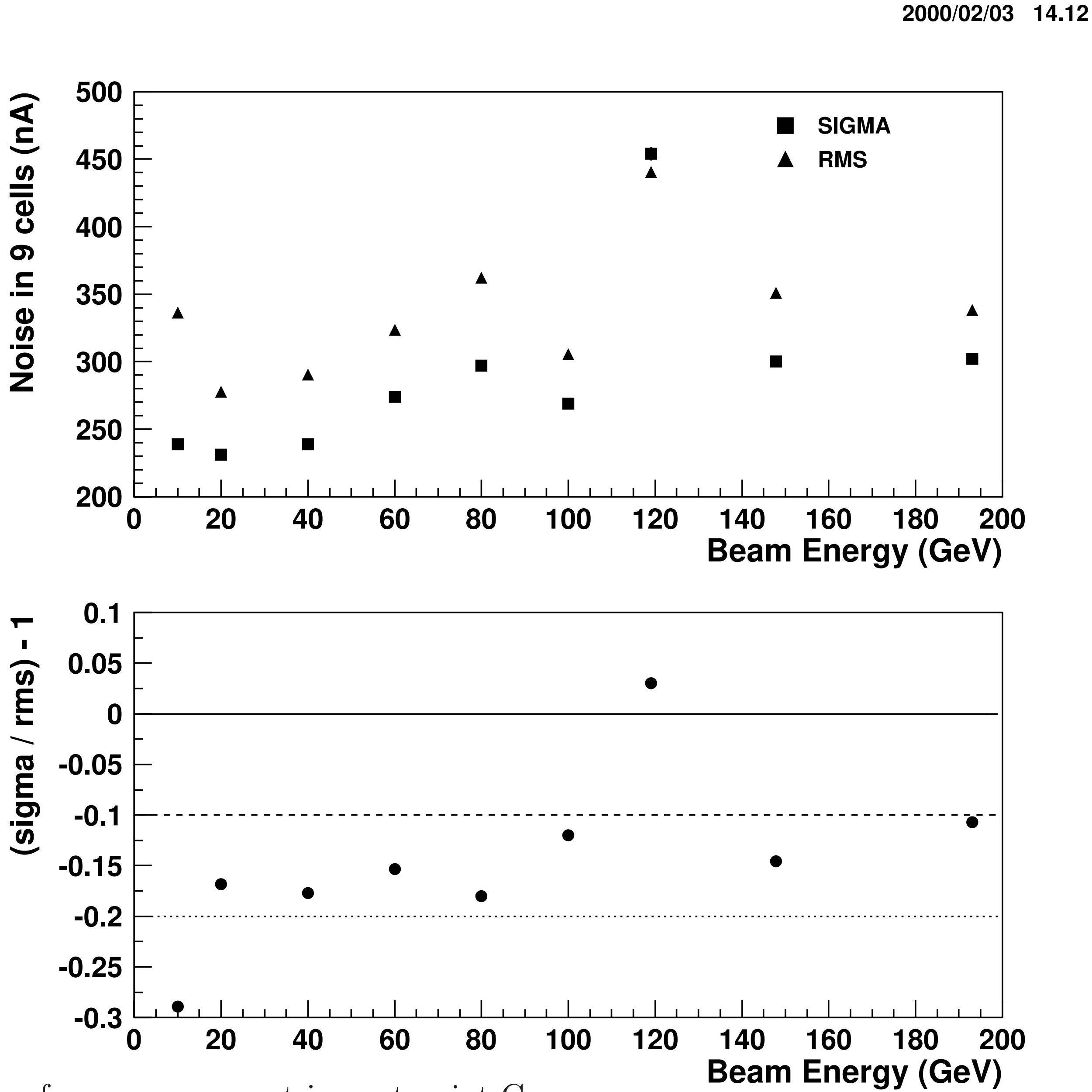
Problem is not digital filtering as shown from cell 102 :



Noise Studies

Bad noise distribution leads to underestimation of noise :

Noise taken from sigma of fit is less than rms



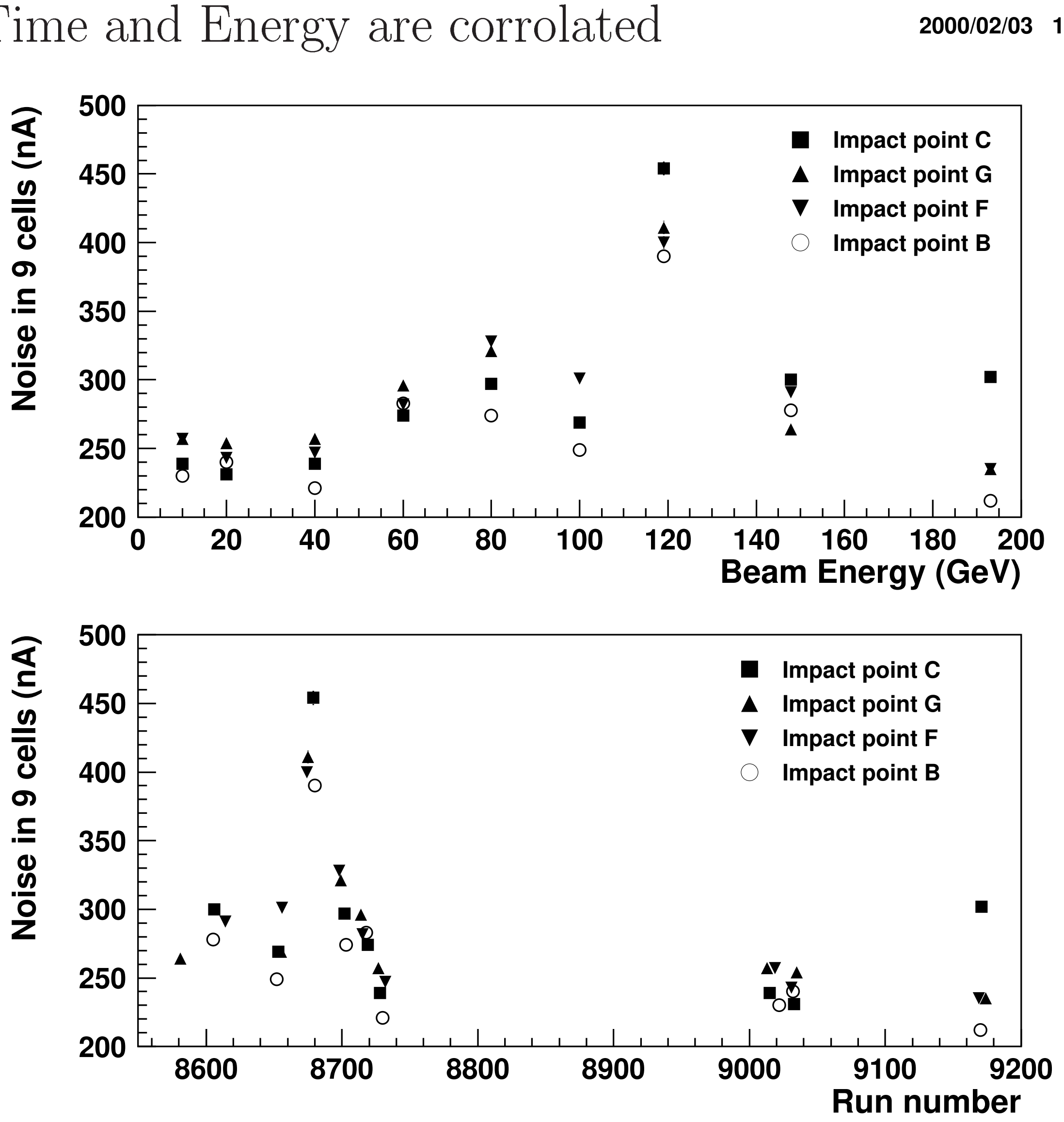
Runs for energy scan at impact point C

Noise calculated in 9 cells clusters

Noise Studies

Noise Fluctuations with Time/Energy :

- Noise is not constant with Time/Energy
- Time and Energy are corrolated



Nothing in logbook to explain peak at 119.1 GeV (19/08/99)

Noise Studies

Results of Fitted Electronic noise in beams :

Noise in nA for e^+ runs (9 cells clusters)

Impact point	10 GeV	20 GeV	40 GeV	60 GeV	80 GeV	100 GeV	119.1 GeV	147.8 GeV	193.1 GeV	Avg (nA)	Avg (GeV)
B	230 3	240 3	221 3	283 3	274 4	249 3	390 4	278 3	212 2	264 6	1.03 0.02
C	343 5	328 3	341 4	375 5	420 5	381 5	624 7	432 5	499 6	415 10	1.62 0.04
F	257 4	243 3	247 3	282 3	328 4	301 4	400 5	291 4	235 3	287 6	1.12 0.02
G	257 4	254 3	257 3	296 3	321 4	269 3	411 5	264 3	235 3	284 6	1.11 0.02

Note that for impact point C, 12 cells cluster is used

Noise in nA for π^+ runs (53-54 cells clusters)

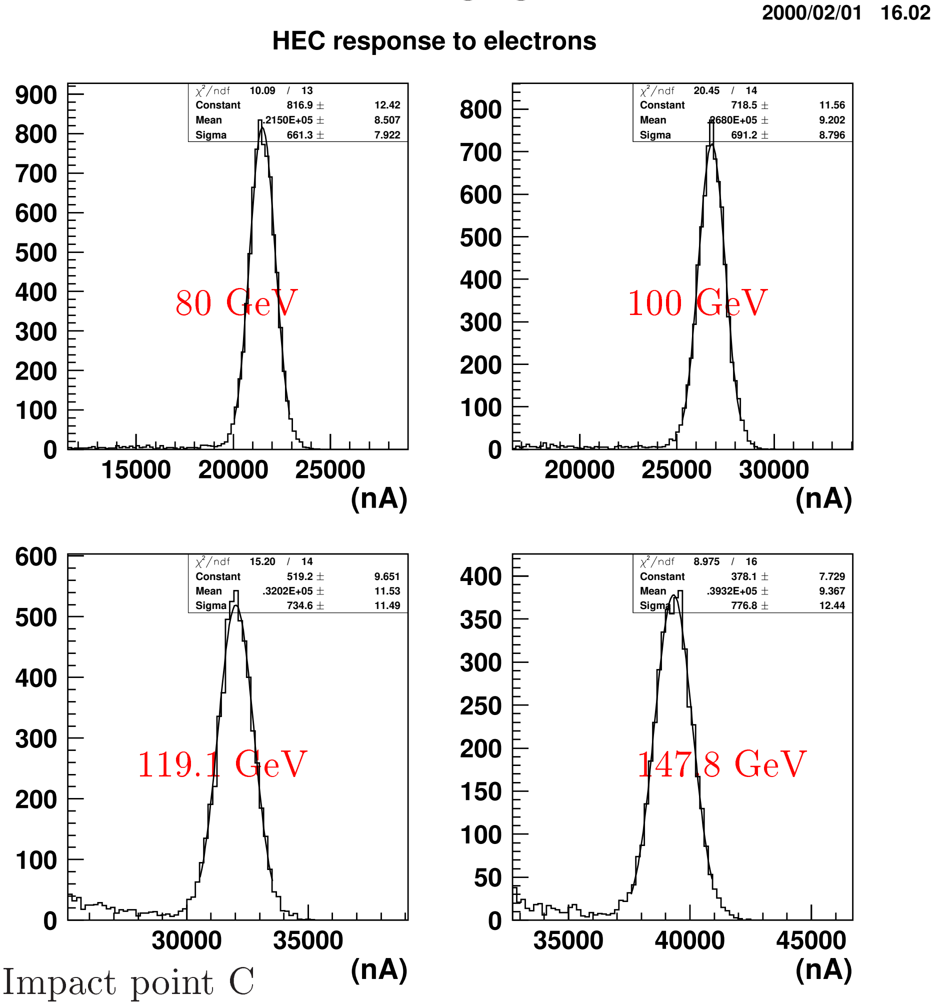
Impact point	10 GeV	20 GeV	40 GeV	60 GeV	80 GeV	100 GeV	120 GeV	150 GeV	180 GeV	200 GeV	Avg (nA)	Avg (GeV)
B	1716 25	1164 15	997 12	995 12	1035 13	1252 16	2766 26	1634 21	1486 18	1256 16	1430 50	5.6 0.2
C	1771 26	1262 16	985 11	1075 12	1126 14	1196 14	2597 20	1644 21	1652 21	1245 16	1455 50	5.7 0.2
F	1062 15	1339 18	948 12	969 12	1022 13	1297 17	2700 26	1616 22	1807 22	1343 17	1410 50	5.5 0.2
G	1118 17	1123 14	1006 12	1507 20	1147 14	1189 15	1523 26	1681 22	1555 18	1336 16	1319 20	5.14 0.08

All errors shown are only statistical

Electron beams Results

HEC Response to e^+ :

- Energy Scans done for four impact points: B, C, F, G
- 9 cells clusters chosen such that full containment of shower is achieved to obtain a non-biased EM scale
- Gaussian response with negligible π contamination

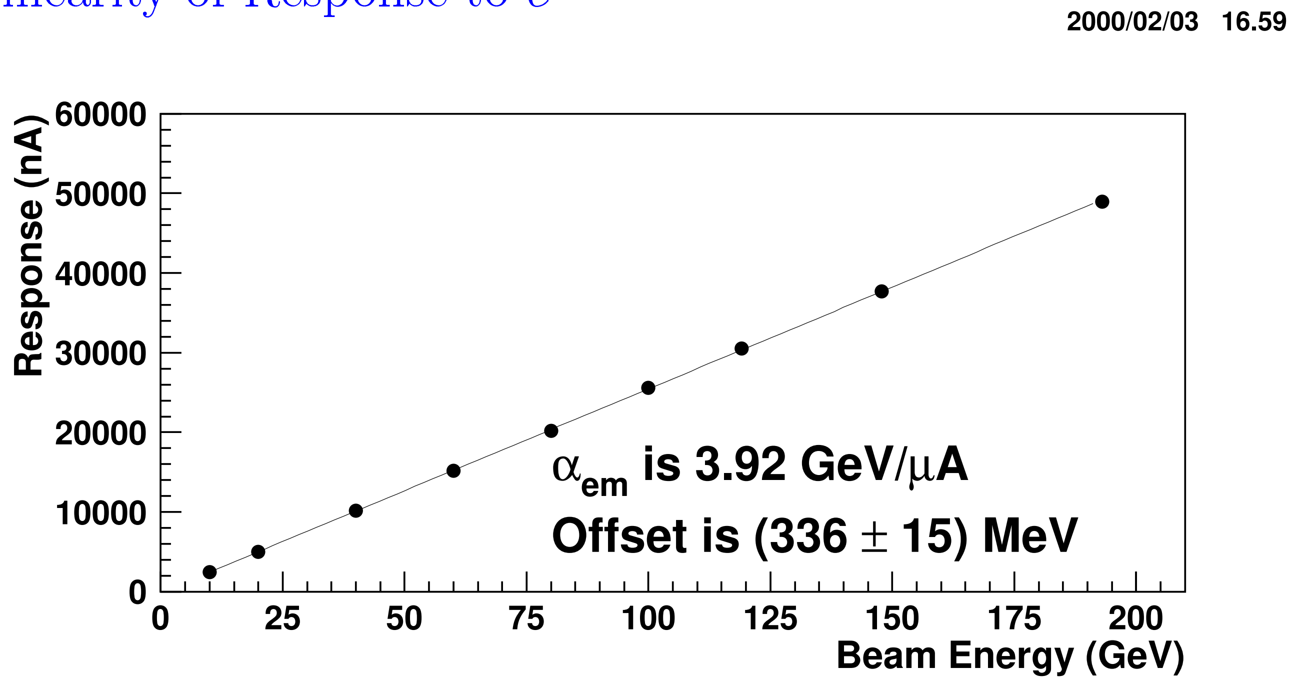


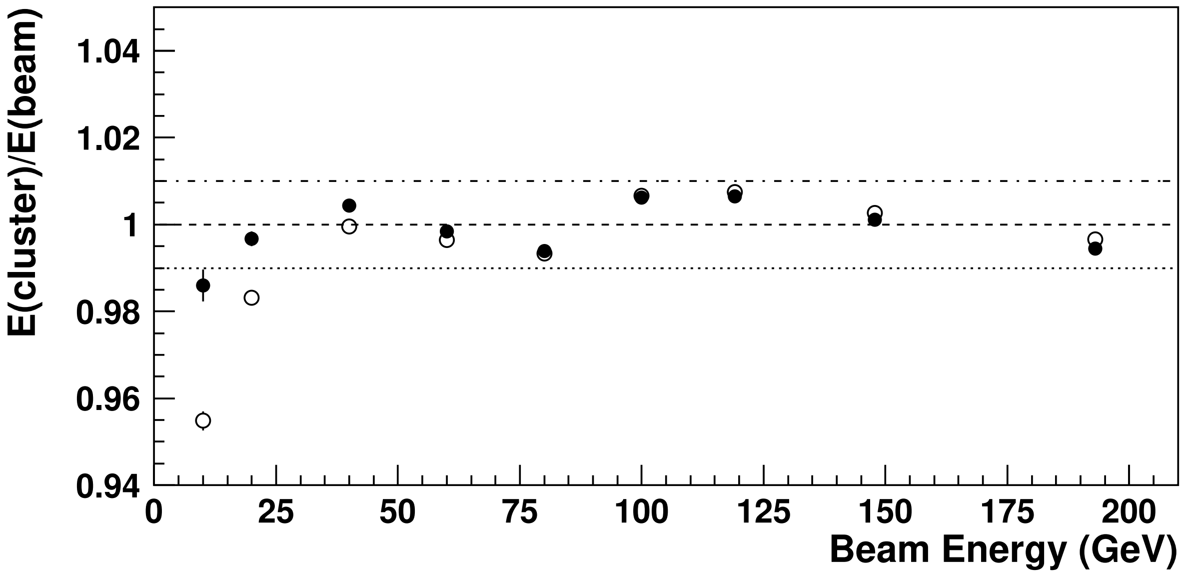
Response at Impact point C

Fits were done on interval $\pm 2\sigma$

Electron beams Results

Linearity of Response to e^+



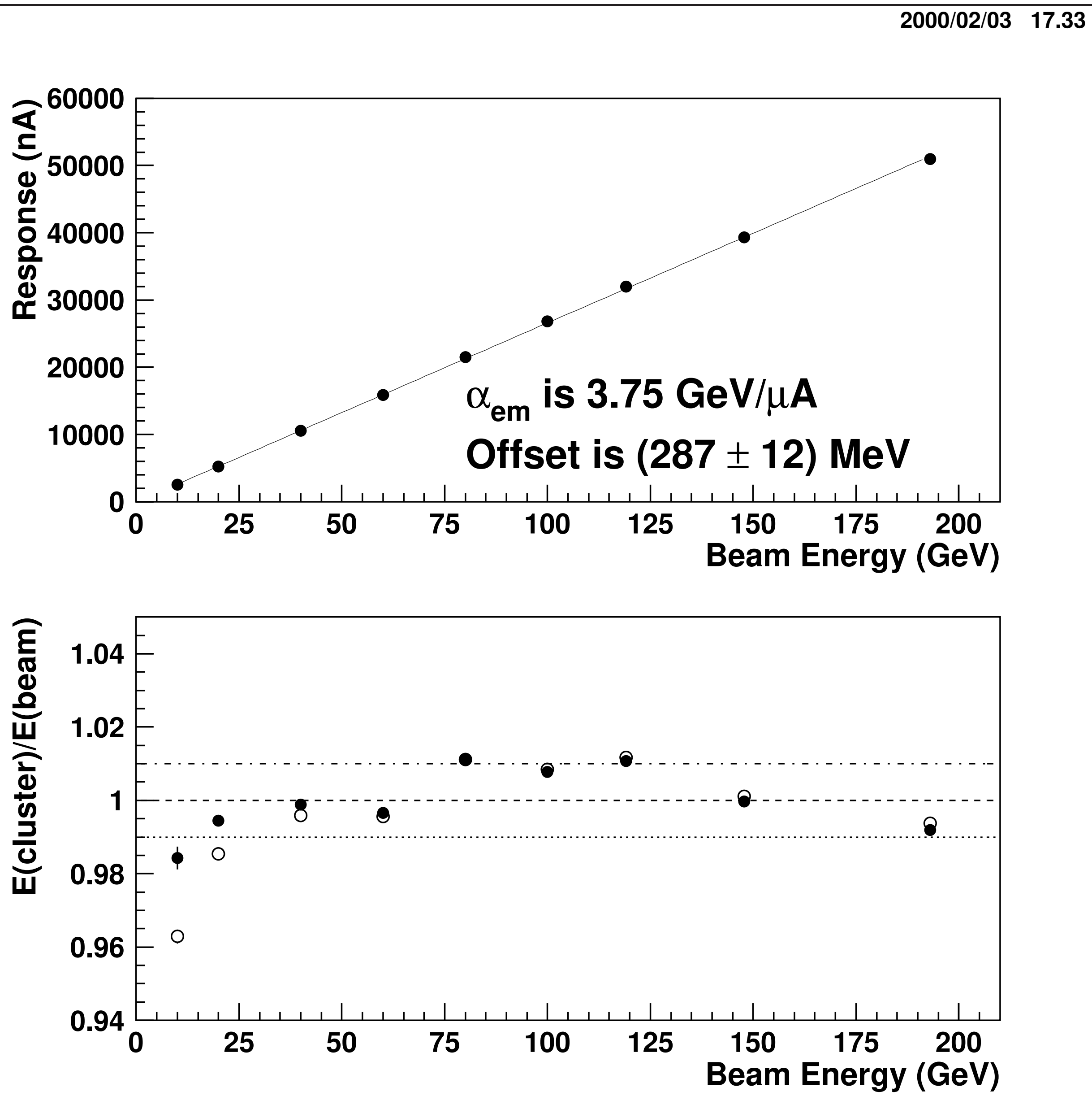


Response for impact point C

Note that only statistical errors are included

Most of reconstructed energy lies within 1% of beam energy

Electron beams Results



Response for impact point G

Again, most of reconstructed energy lies within 1% of beam energy

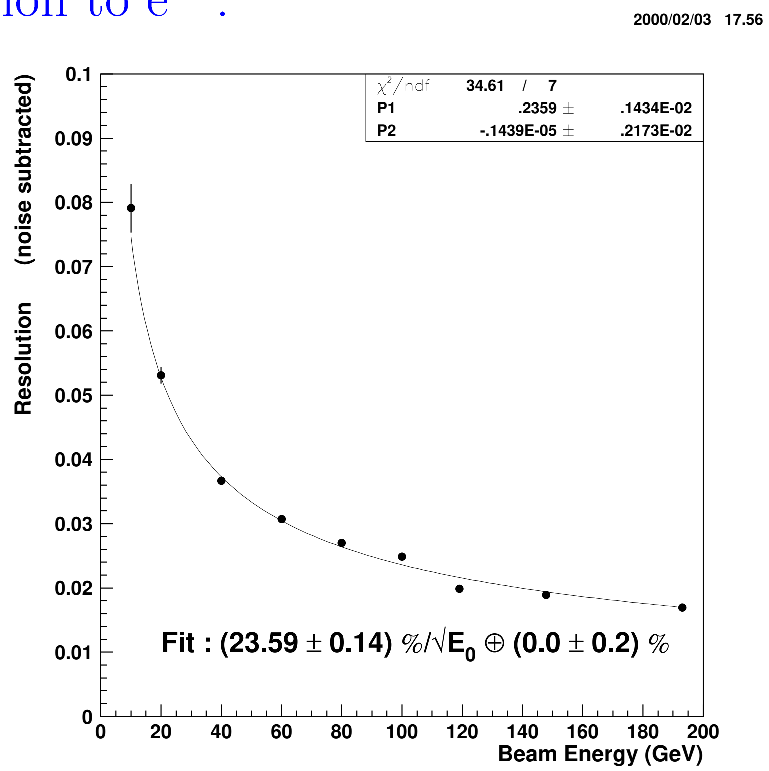
Average α_{EM} over 4 impact point :

$$\overline{\alpha_{EM}} = (3.90 \pm 0.04)\mathrm{GeV}/\mu\mathrm{A}$$

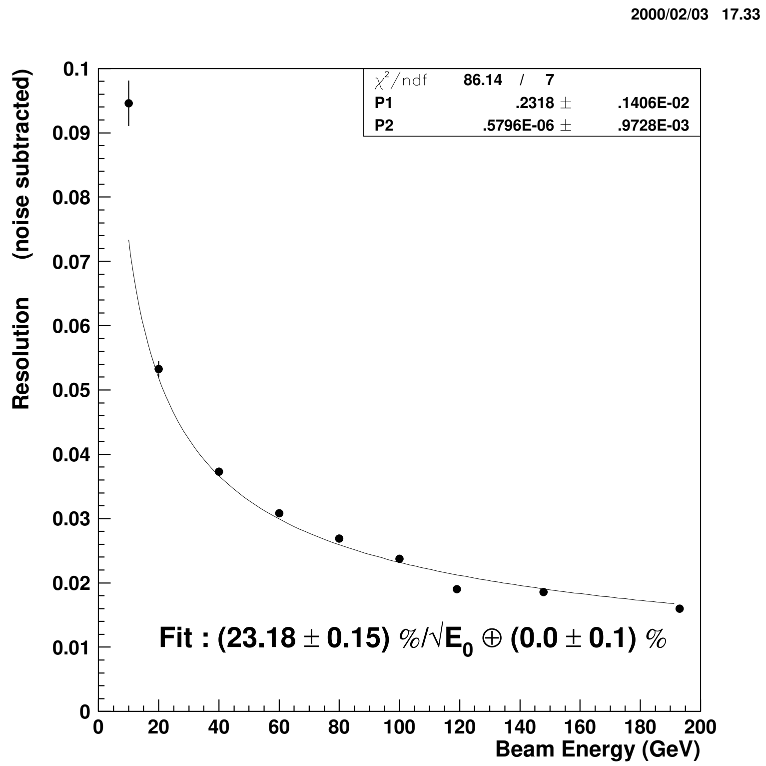
Electron beams Results

HEC Resolution to e^+ :

Impact point F :



Impact point G :



Electron beams Results

Summary of Results for e^+ beams

Impact point	Sampling term ($\%\sqrt{\text{GeV}}$)	Constant term (%)	α_{EM} (GeV/μA)	Offset (MeV)	Cluster size (# cells)
B[1]	24.7 0.5	1.04 0.17	4.10 neg. error	1070 13	9
C	24.9 0.15	0.00 0.17	3.92 neg. error	336 15	12
F	23.59 0.15	0.0 0.2	3.84 neg. error	287 12	9
G	23.18 0.15	0.0 0.1	3.75 neg. error	261 12	9
Avg	24.1 0.2	0.26 0.13	3.90 0.04	500 100	

1. Study done for E < 147.8 GeV only

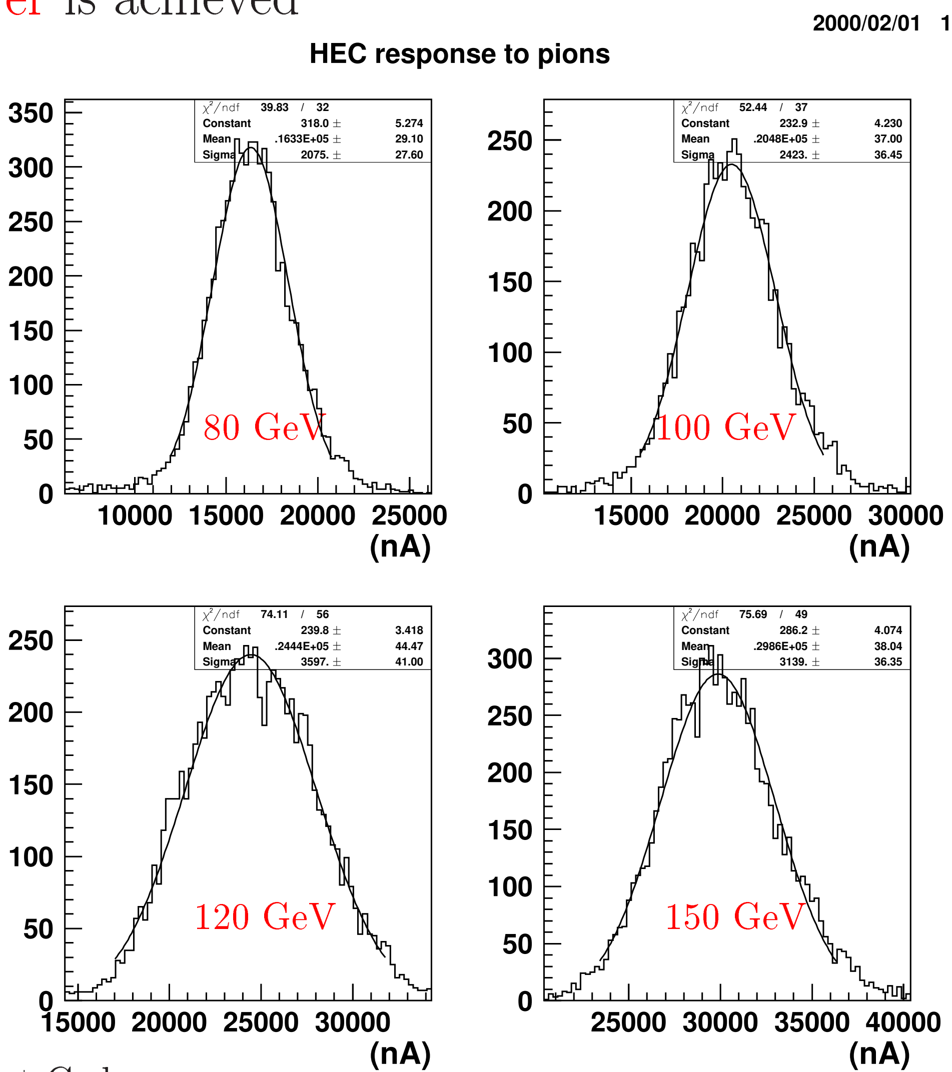
From this one sees that :

- $\overline{\alpha_{EM}}$ consistant with value obtained by A. Minaenko in December (3.95 GeV/μA).
- Sampling term slightly worse than previously : 24% compared to 22% (contiguity with tie-rods ?)
- Constant term is consistant with zero for most impact points (12/10/99 calibrations better than 11/18/99)
- The use of an offset improves linearity of response

Pion beams Results

HEC Response to π^+

- Energy Scans done for four impact points: B, C, F, G
- 53-54 cells clusters chosen such that full containment of shower is achieved



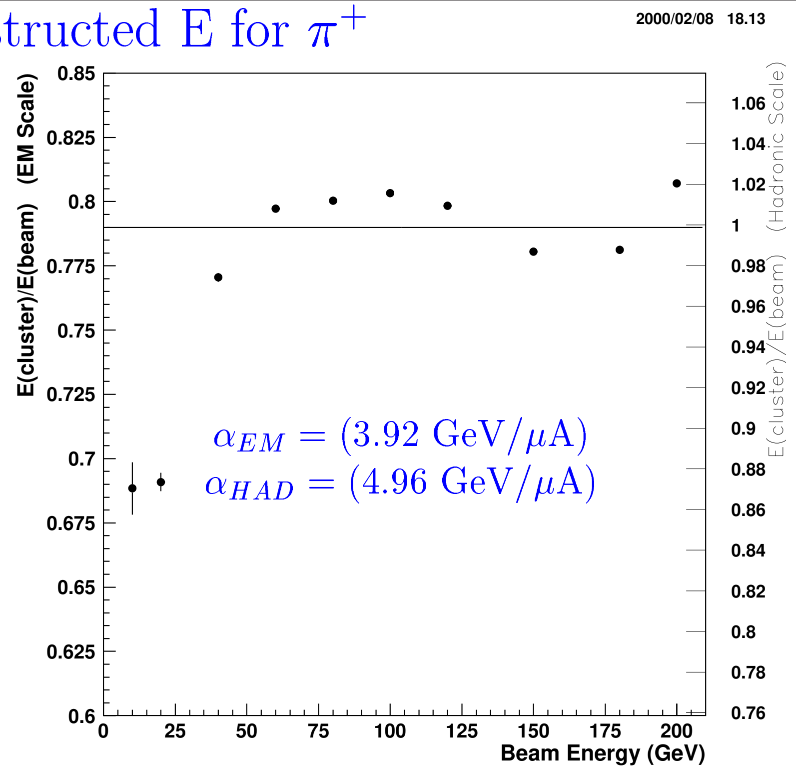
Impact point C chosen

Fits were done on interval $\pm 2\sigma$

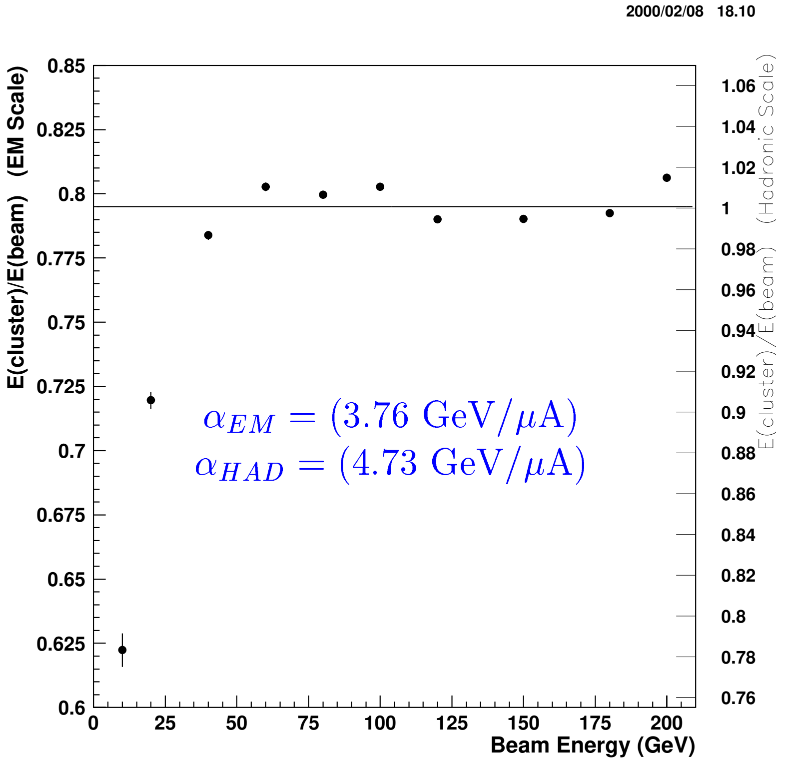
Pion beams Results

HEC Reconstructed E for π^+

Impact point C:



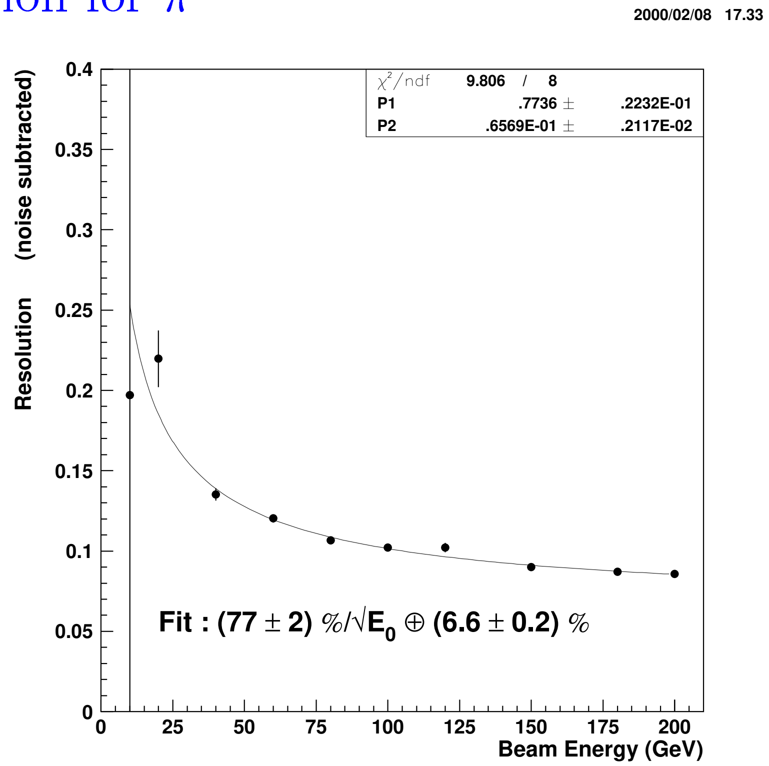
Impact point G :



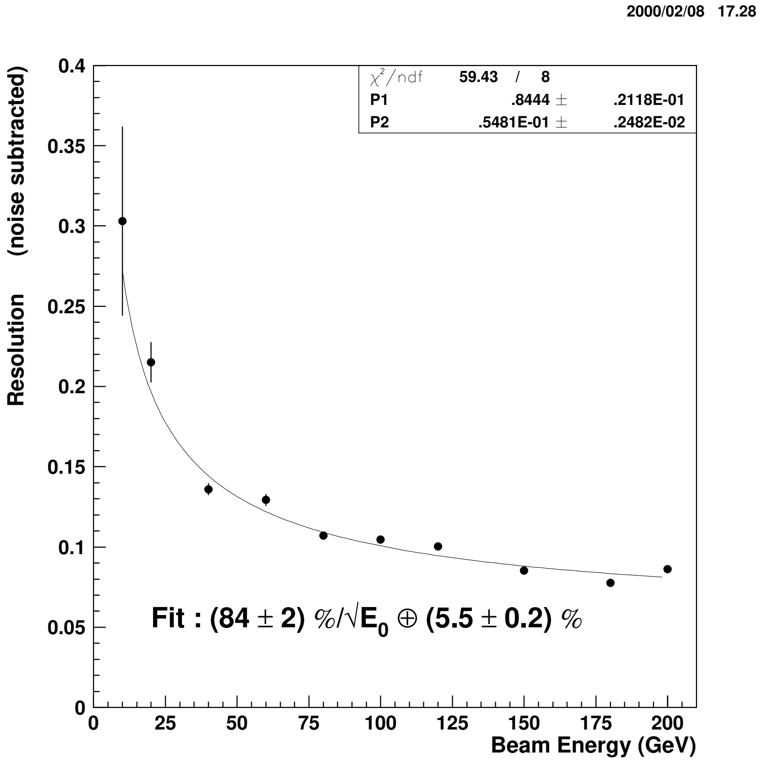
Pion beams Results

HEC Resolution for π^+

Impact point C :



Impact point G :



Pion beams Results

Summary of Results for π^+ beams

Impact point	Sampling term ($\%\sqrt{\text{GeV}}$)	Constant term (%)	α_{HAD} (GeV/μA)	Cluster size (# cells)
B	80 2	6.5 0.2	5.08 neg. error	53
C	77 2	6.6 0.2	4.96 neg. error	54
F	86 2	5.7 0.2	4.81 neg. error	53
G	84 2	5.5 0.2	4.73 neg. error	54
Avg	82 1	6.08 0.14	4.90 0.04	

From this one sees that :

- $\overline{\alpha_{HAD}}$ consistant with value obtained by A. Minaenko (4.88 GeV/μA).
- Sampling term somewhat worse than previously : 82% compared to 75%
- Constant term is about 6% (consistant with 1998 value)
- Worse resolution possibly due to the underestimation of noise (maybe optimization of clusters possible)

Conclusions

- Study conducted over 4 impact points : B, C, F, and G
- Electromagnetic constant :

$$\overline{\alpha_{EM}} = (3.90 \pm 0.04)\mathrm{GeV}/\mu\mathrm{A}$$

- Electron energy resolution :

$$\frac{\sigma'}{E'} = \frac{(24 \pm 1)\%}{\sqrt{E_0(\mathrm{GeV})}} \oplus (0.26 \pm 0.13)\%$$

- Hadronic constant :

$$\overline{\alpha_{HAD}} = (4.90 \pm 0.04)\mathrm{GeV}/\mu\mathrm{A}$$

- Pion energy resolution :

$$\frac{\sigma'}{E'} = \frac{(82 \pm 1)\%}{\sqrt{E_0(\mathrm{GeV})}} \oplus (6.08 \pm 0.14)\%$$

- Most results consistant with those from A. Minaenko, but still need to :
  - Improve the evaluation of electronic noise in clusters
  - Perhaps Optimize pion clusters