HEC TB meeting
09.12.99

Analysis of August 99 TB data

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- **Some methodical problems**
- **Electron data analysis**
- **Pion data analysis**

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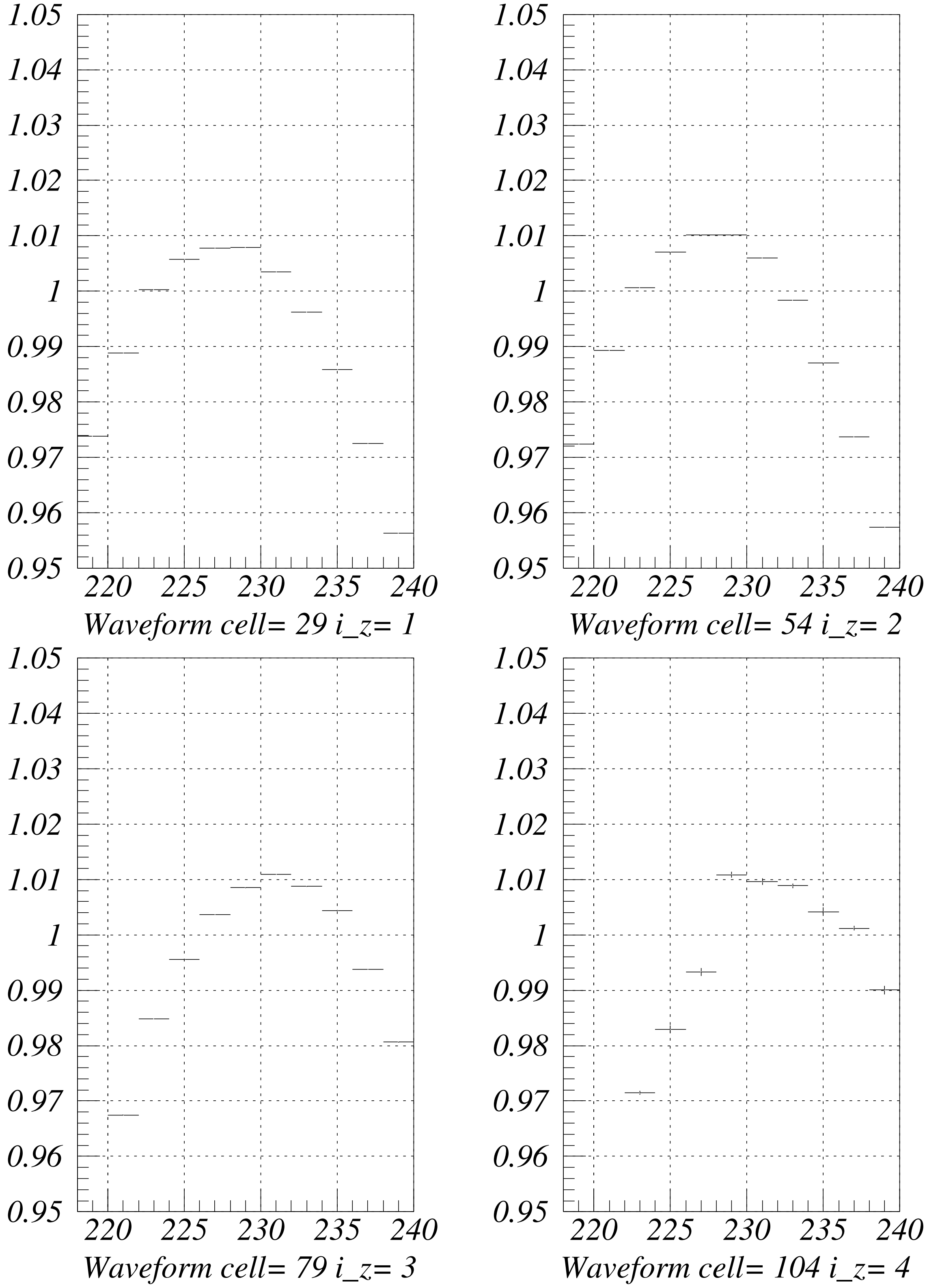
Some methodical problems

- **Quality of amplitude reconstruction by OF procedure**
  - **the normalized averaged time profile of a signal in a given cell is used for the check. Before averaging measured samples are divided by the value of the OF amplitude, reconstructed for the current event. If the reconstruction is done correctly, the profile maximum should be normalized exactly to 1.0;**
  - **the noticeable deviation of the reconstructed OF amplitude out of the true value can be due to either i) wrong signal shape, used for the calculation of OF weights, or ii) the time shift of a real signal relatively to its** *expected* **position by a significant value (>5-6 ns);**
  - **the following two observations can be done:**
    - **the A_{OF} is systematically** *underestimated* **by about 0.7% on average for all the cells of the 3rd and 4th layers and for about half of the cells of the first two layers. The possible reason may be not quite correct model used for the transition from the calibration signal shape to the particle signal shape;**
    - **for the other half of the cells of the first two layers the A_{OF} is** *overestimated* **in rather wide range - up to 6%. Such large deviations can be caused only by strong distortions of calibration signal shapes in the affected channels.**

180 GeV pions: normalized amplitude



Signals with amplitude greater than 30 ADC counts were used only

Layer 1			
65	*61**	*57*	*53*
-0.6	**-0.2**	**0.8**	**0.3**
*41**	*37*	*33**	*29*
2.0	**-1.0**	*6.0*	**-0.8**
17	*13**	*9*	*5*
—	*2.8*	**-0.7**	—

Layer 2			
90	*86*	*82*	*78*
0.1	**-0.6**	**-0.5**	**-0.4**
66	*62*	*58**	*54*
-0.5	**-1.0**	*2.1*	**-0.9**
*42**	*38**	*34**	*30*
6.0	*1.4*	*3.8*	**-0.8**

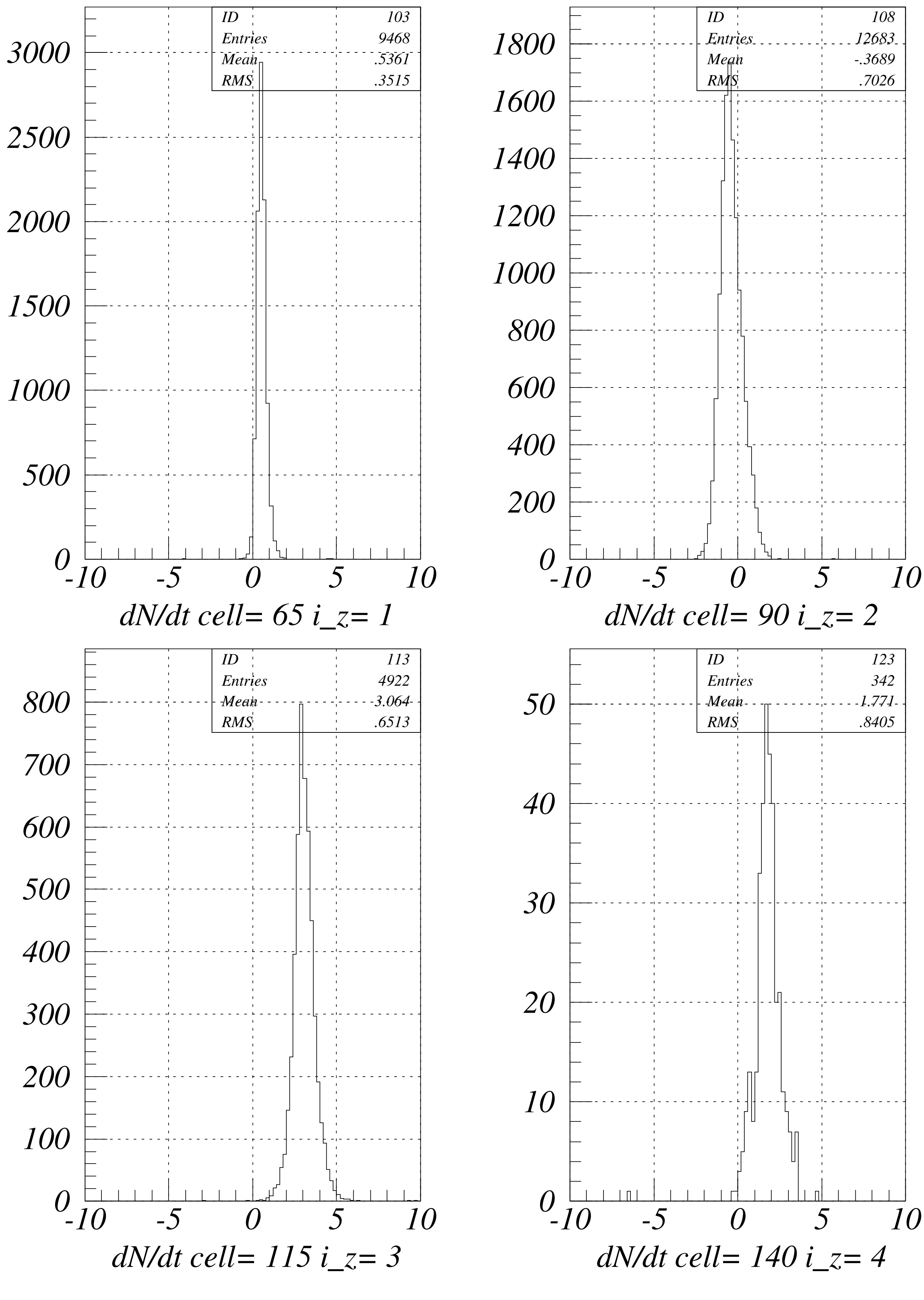
Layer 3			
115	*111*	*107*	*103*
-0.8	**-0.6**	**-0.5**	**-0.6**
91	*87**	*83**	*79*
—	*-1.4*	*-1.5*	**-1.1**
67	*63*	*59*	*55*
—	**-0.4**	**-0.5**	—

Layer 4			
140	*136*	*132*	*128*
-0.2	**-0.5**	**-0.4**	**-0.5**
116	*112*	*108*	*104*
-1.0	**-0.9**	**-0.6**	**-0.7**
*92**	*88*	*84*	*80*
-1.5	**-0.8**	**-0.6**	**-1.2**

Table 1. The deviation of an OF reconstructed amplitude (in %) out of the true value: A_{OF} - A_{true}. Asterisks mark cells with large deviations.

- **Time shifts of the particle signals**
  - **the time positions of signals for all the cells are found using calibration data and they are parametrized in the OF weights;**
  - **the cells with *unreliable* (see the previous table) OF weights are marked by asterisks. The found values of shifts for these cells are also unreliable as a consequence;**
  - **the following observations can be done:**
    * **the shifts are rather small to cause noticeable distortions of the reconstructed OF amplitudes;**
    * **the approximate mean shifts for layers 1-4 are (in ns):**
      0.6 -0.6 3.1 1.2
    * **these shifts can be easily corrected layer by layer and the residual shifts will be inside the ±1 ns interval;**
    * **there is no any necessity in cell by cell correction.**

Time shifts of *real particle* signals w.r.t. their *expected* positions



Layer 1			
65	*61**	*57*	*53*
0.5	*3.3*	**-0.1**	**0.2**
*41**	*37*	*33**	*29*
2.5	**1.2**	*2.8*	**0.8**
17	*13**	*9*	*5*
—	*3.3*	**0.7**	—

Layer 2			
90	*86*	*82*	*78*
-0.4	**-1.2**	**-1.2**	**-1.0**
66	*62*	*58**	*54*
0.3	**-0.3**	**0.4**	**-0.3**
*42**	*38**	*34**	*30*
2.8	**1.0**	**1.0**	**0.0**

Layer 3			
115	*111*	*107*	*103*
3.1	**2.4**	**2.7**	**2.9**
91	*87**	*83**	*79*
—	**2.8**	**3.2**	**3.2**
67	*63*	*59*	*55*
4.5	**3.5**	**3.7**	**3.6**

Layer 4			
140	*136*	*132*	*128*
1.8	**1.2**	**1.2**	**1.4**
116	*112*	*108*	*104*
1.5	**1.4**	**0.8**	**1.1**
*92**	*88*	*84*	*80*
1.8	**1.4**	**1.3**	**1.5**

Table 2. The deviation of a particle signal position (in ns) out of the expected (from calibration) position. Asterisks mark cells with non-reliable OF weights.

- **Variation of electronic noise**
  - **the size of a cluster used for the analysis is 5-6 cells for electrons and 45-58 cells for pions;**
  - **the first 5 measured samples are preceding the signal and they can be used for noise estimates;**
  - **the following procedure is used to estimate the noise in a selected cluster:**
    - **OF weights are applied to the first 5 samples for each cell;**
    - **the obtained values are summed through all the cells,which belong to the cluster for the current event;**
    - **the obtained distribution of the cluster noise for a *given run* is fitted by a Gaussian;**
    - **the fitted value σ is used as the noise estimate for this run;**
  - **the noise in the electron cluster (point C, stat.err.$\sim$0.02):**

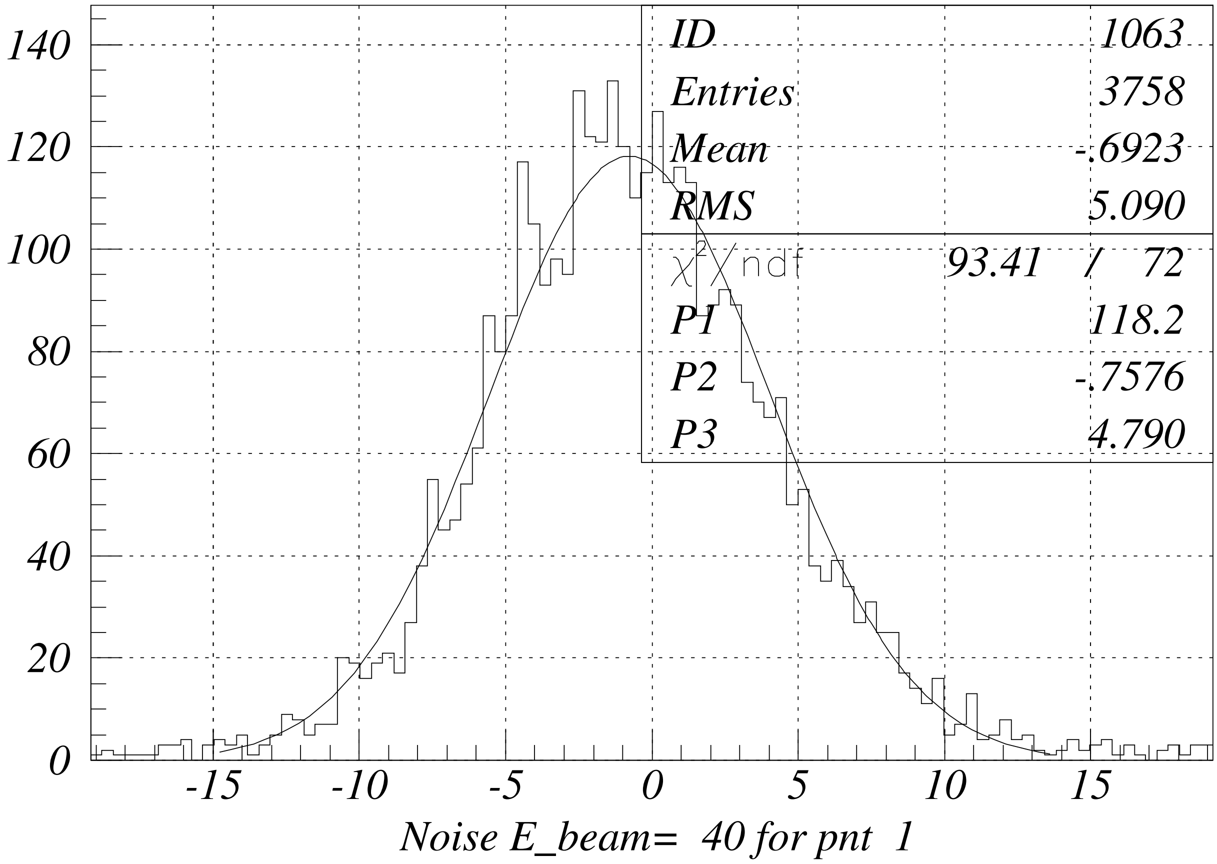
E(GeV)	10	20	40	60	80	100	119	148	193
run #	9015	9033	8728	8719	8702	8653	8679	8606	9171
σ(GeV)	0.82	0.74	0.79	0.88	0.96	0.86	1.18	0.95	0.79

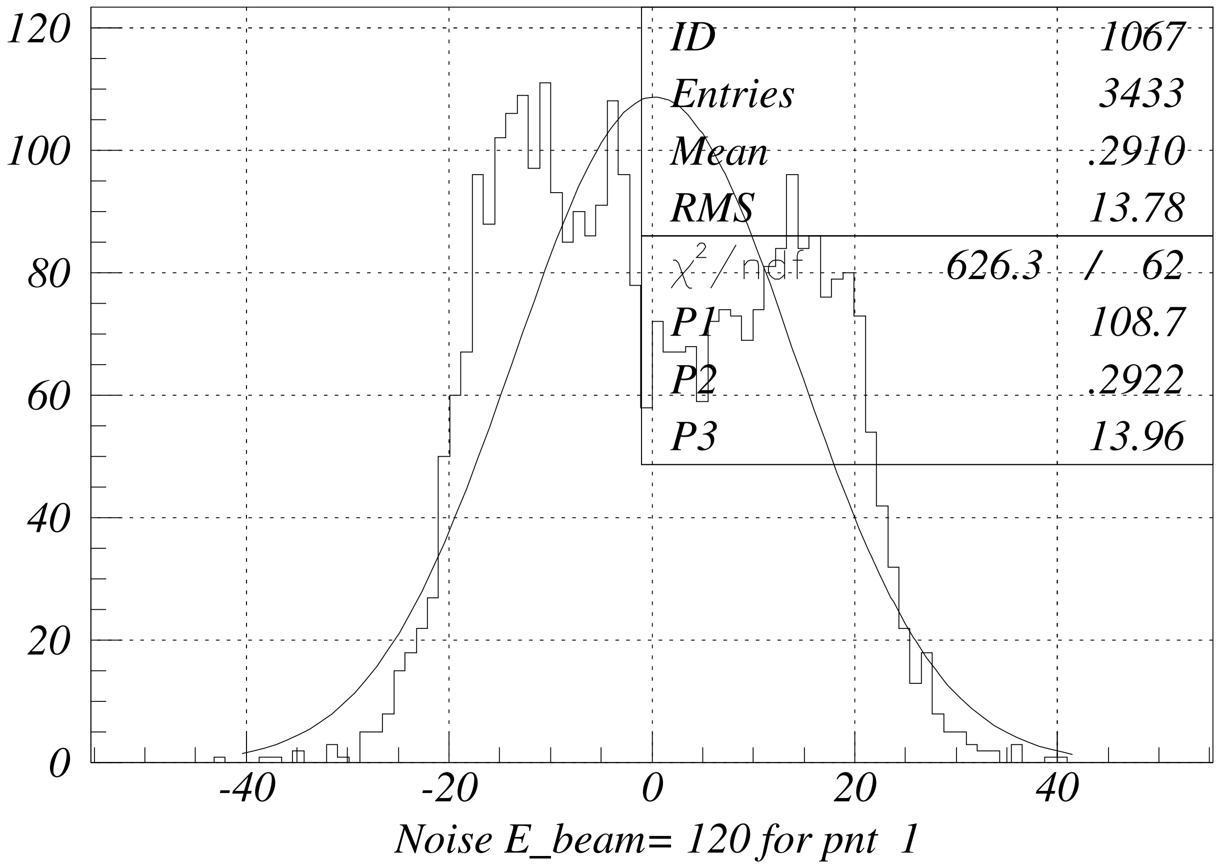
  - **the noise in the pion cluster (point A, stat.err.$\sim$0.1):**

E(GeV)	10	20	40	60	80	100	120	150	180	200
run #	9000	8986	8828	8818	8803	8781	8778	8754	8739	9189
σ(GeV)	5.5	6.2	4.8	4.9	5.2	6.9	14.0	10.1	10.0	7.4

  - ***cluster* noise is strongly varying in time: from 4.8 upto 14.0 GeV for the pion cluster;**
  - **at the same time the *cell* noise varies by about 10% only, i.e. the additional noise is highly coherent;**
  - **because of this noise variation, acceptable results for fits of the energy dependence of resolution (especially for pions) can be obtained only after noise subtraction at each the energy.**

Bad noise distributions

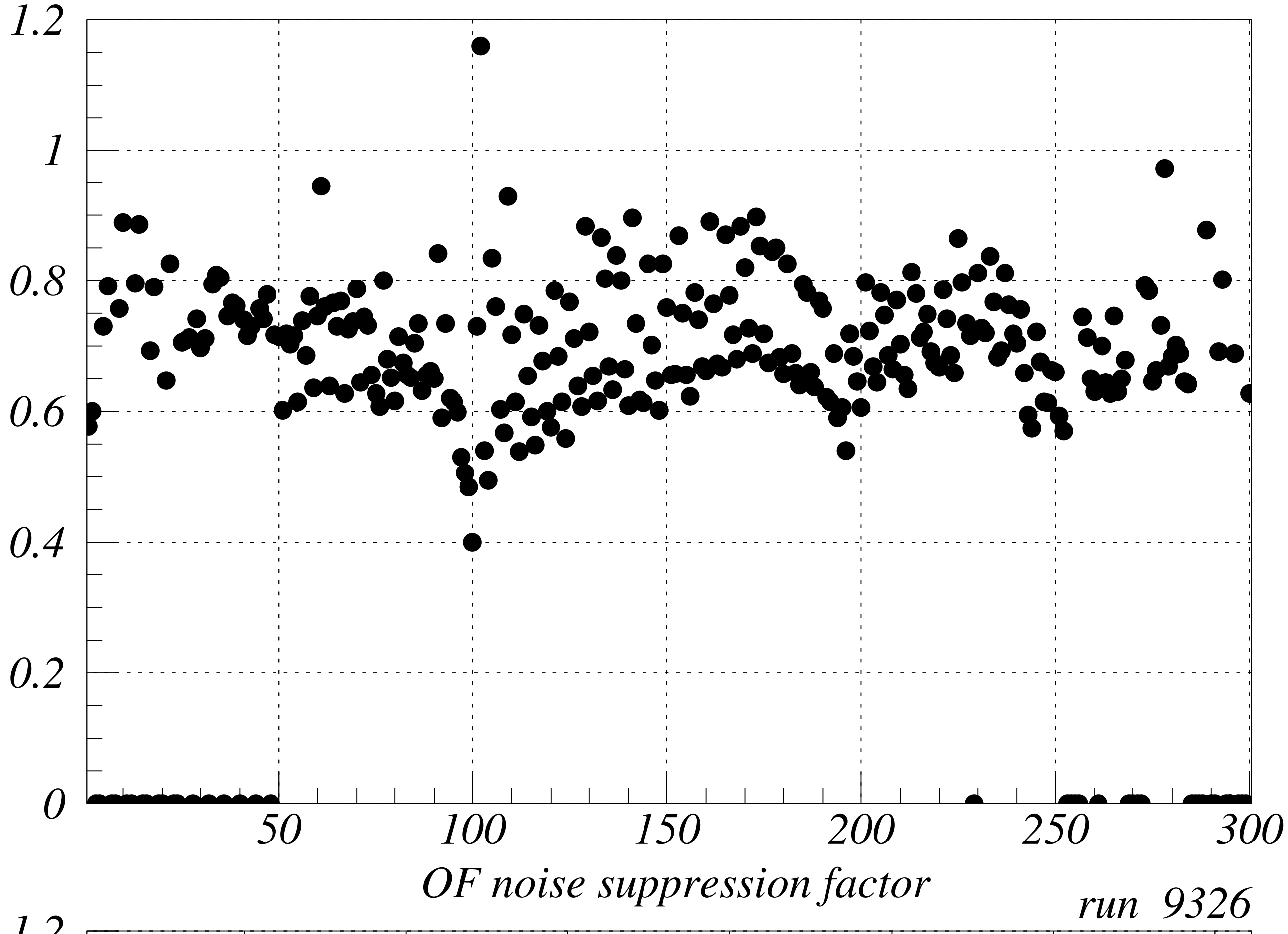




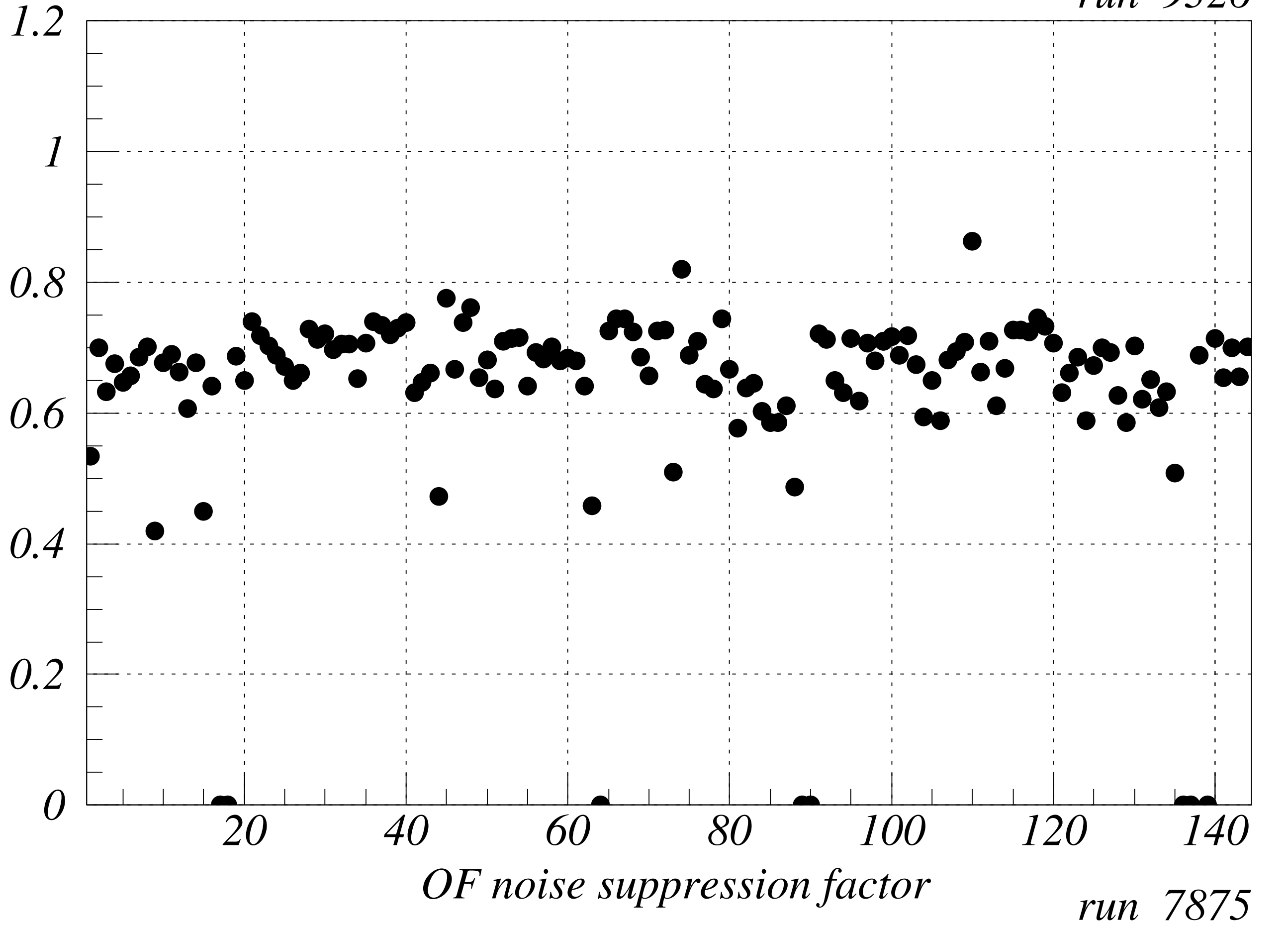
- **OF noise suppression factor**
  - **its variation is stronger than for the 1998 data and the mean value is smaller.**
- **HV correction factors**
  - **the following HV correction factors were applied:**

1.33	**2nd layer**	**module 1**
1.33	**4th layer**	**module 2**
2.00	**2nd layer**	**module 3**
1.33	**4th layer**	**module 3**

  - **these corrections thoroughly restore the resolution and the only consequence of the HV problems is corresponding rise of electronic noise;**
  - **additional corr. factor of 2.0 was applied to cell # 61.**



1.2
1
0.8
0.6
0.4
0.2
0
50
100
150
200
250
300
OF noise suppression factor
run 9326

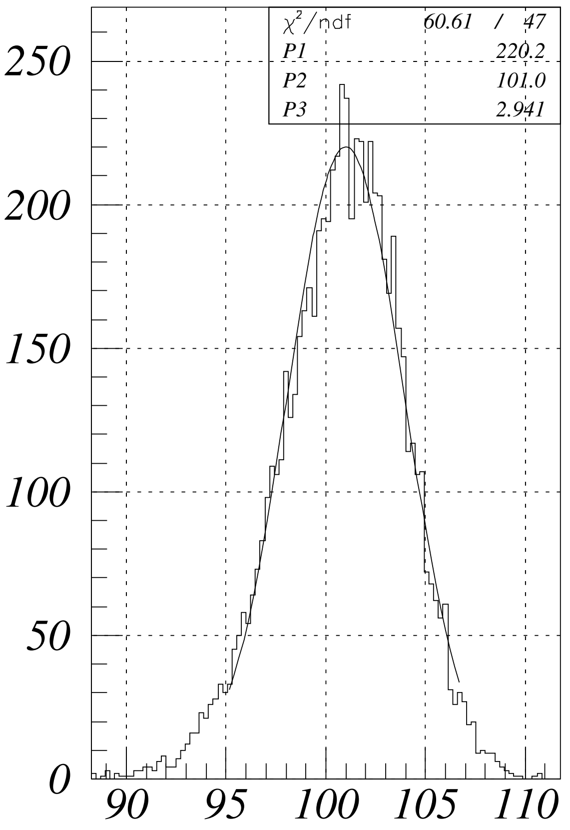


1.2
1
0.8
0.6
0.4
0.2
0
20
40
60
80
100
120
140
OF noise suppression factor
run 7875

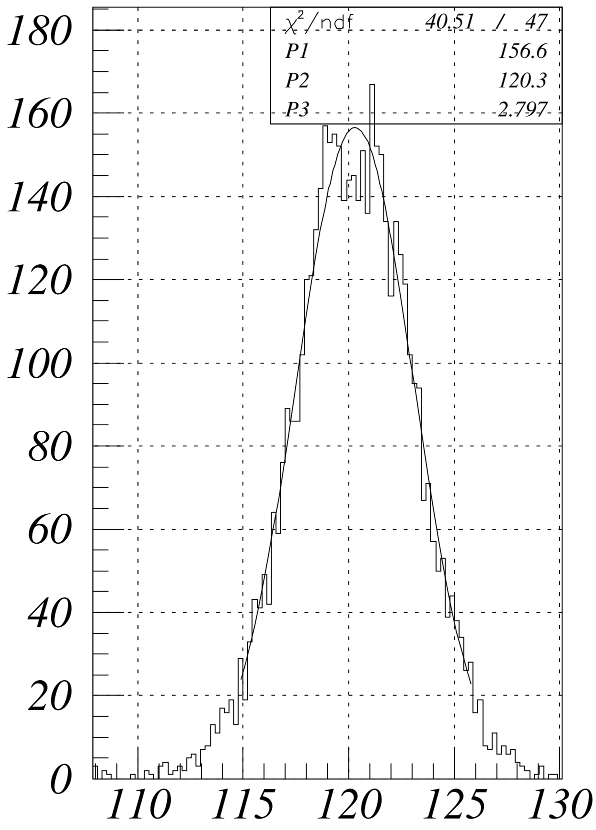
Electron data analysis

- **electrons at 15 points: A,B,C,D,E,F,G,H,K,L,O,M,N,P,Q;**
- **9 energies: 10,20,40,60,80,100,119,148,193;**
- **cluster selection: mean cell signal greater 100 nA at 80 GeV;**
- **cluster size (5-6 cells) varies from point to point but independent on the energy;**
- **at each the point one calibration factor α_{em}, averaged through all the energies, is used, no any adjustable parameters for the resolution improvement;**
- **energy dependence of resolution:**
  - **sampling term - about 22% (compatible with 1998)**
  - **constant term - for many points it differs from zero (0.25-0.7%) in contrast to 1998 results (calibration problems !)**
- **the resolution is somewhat worse for points A-D because of their contiguity with the tie-rods;**
- **the main consequence of the calibration problems is large spatial non-uniformity of response: $\sim 5\%$ in comparison with $\sim 1\%$ for the 1998 data;**
- **noticeable deviation from linearity is observed for the lowest energies 10 and 20 GeV;**
- **the mean absolute calibration α_{em} =0.00395 GeV/nA strongly differs from the corresponding 1998 value - 0.00321 GeV/nA.**

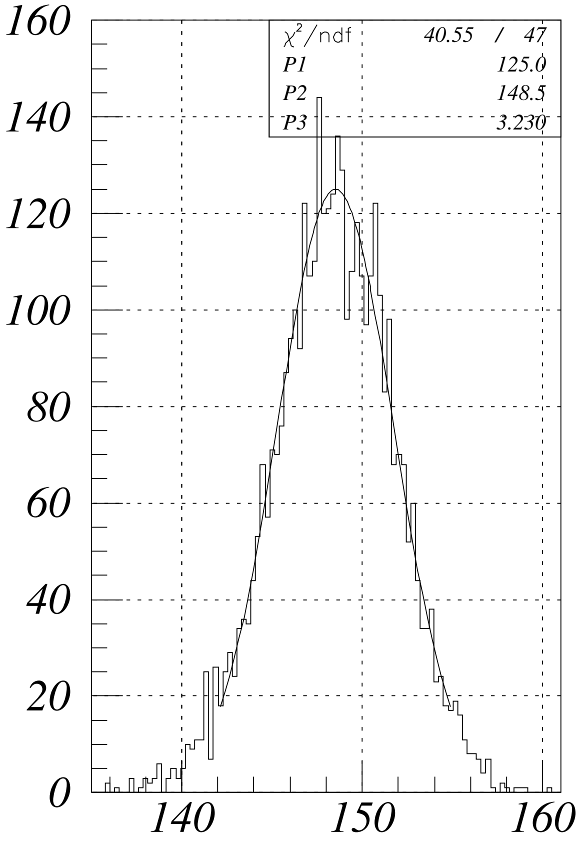
Electron energy distributions



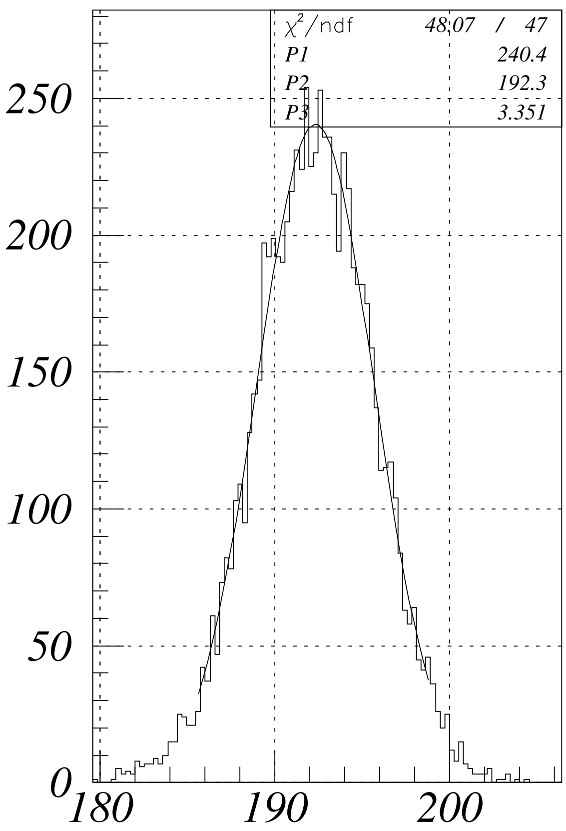
dN/dE E_beam= 100 for pnt 3



dN/dE E_beam= 119 for pnt 3



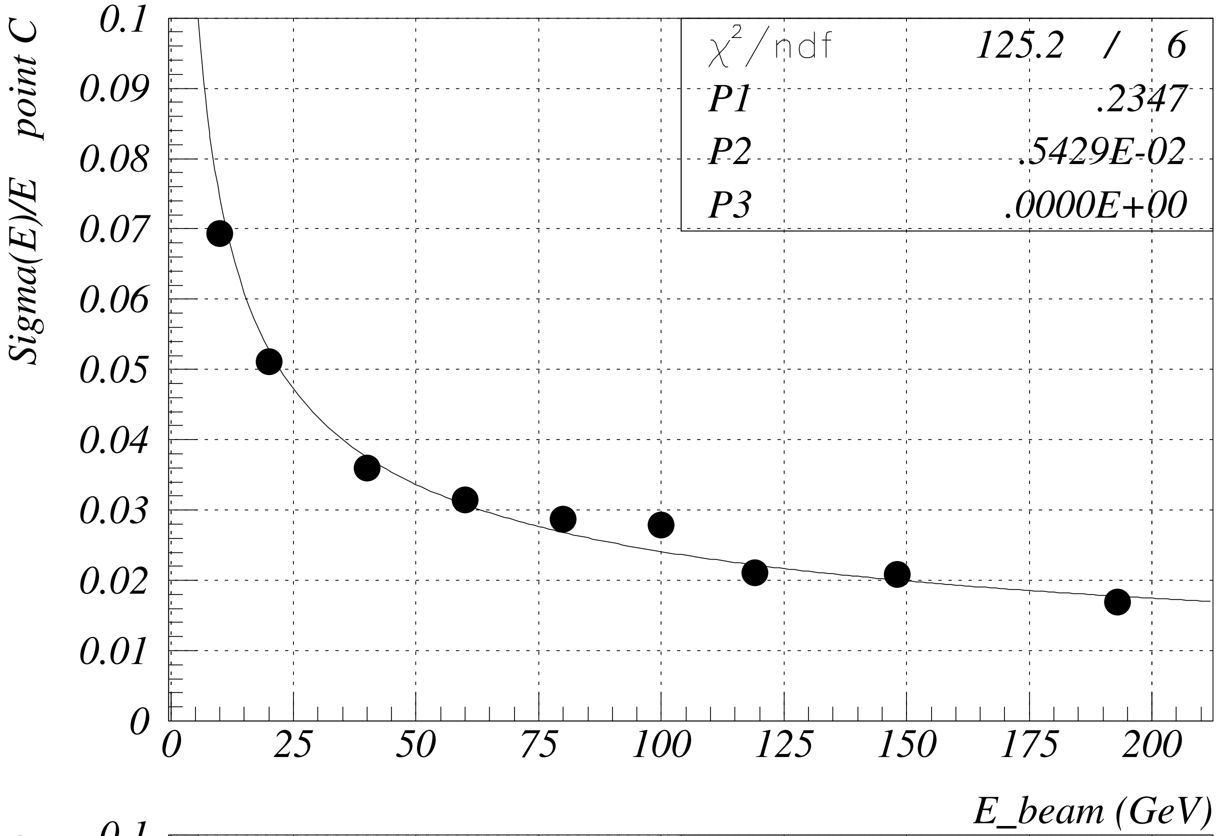
dN/dE E_beam= 148 for pnt 3

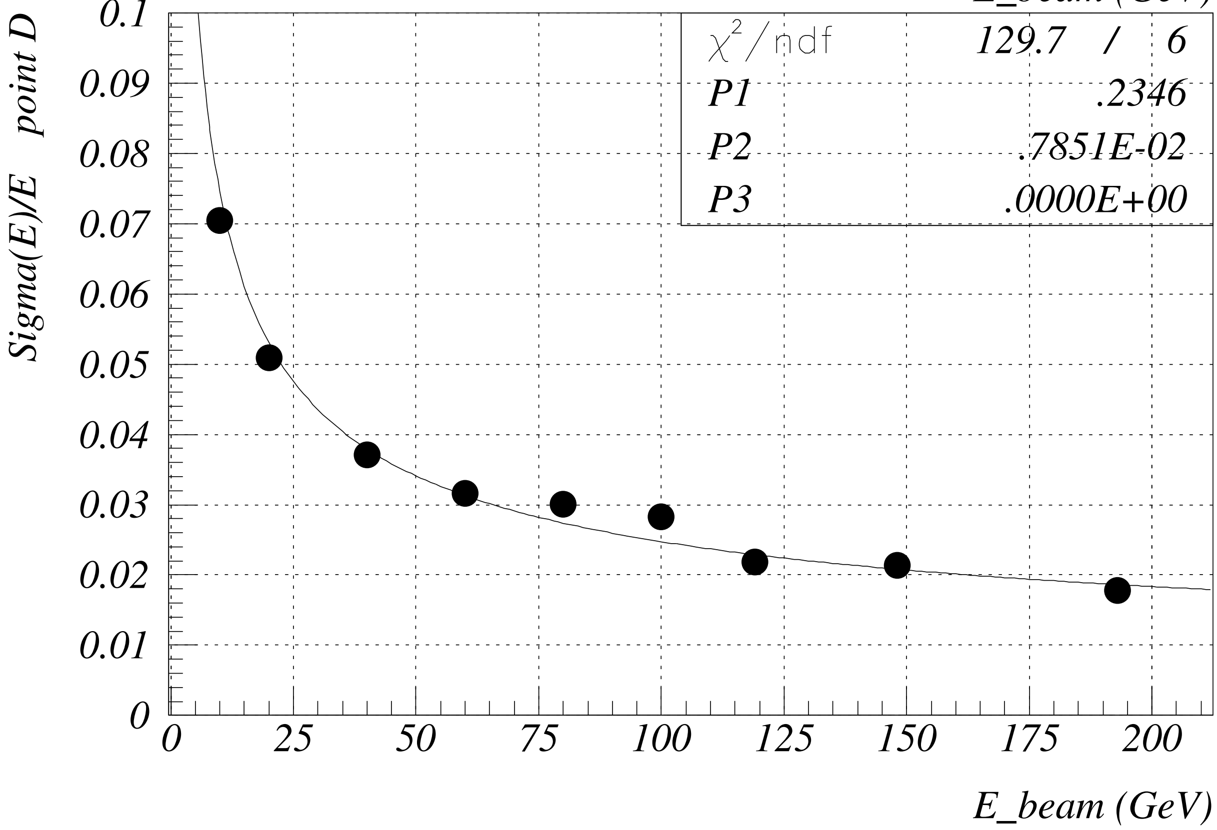


dN/dE E_beam= 193 for pnt 3

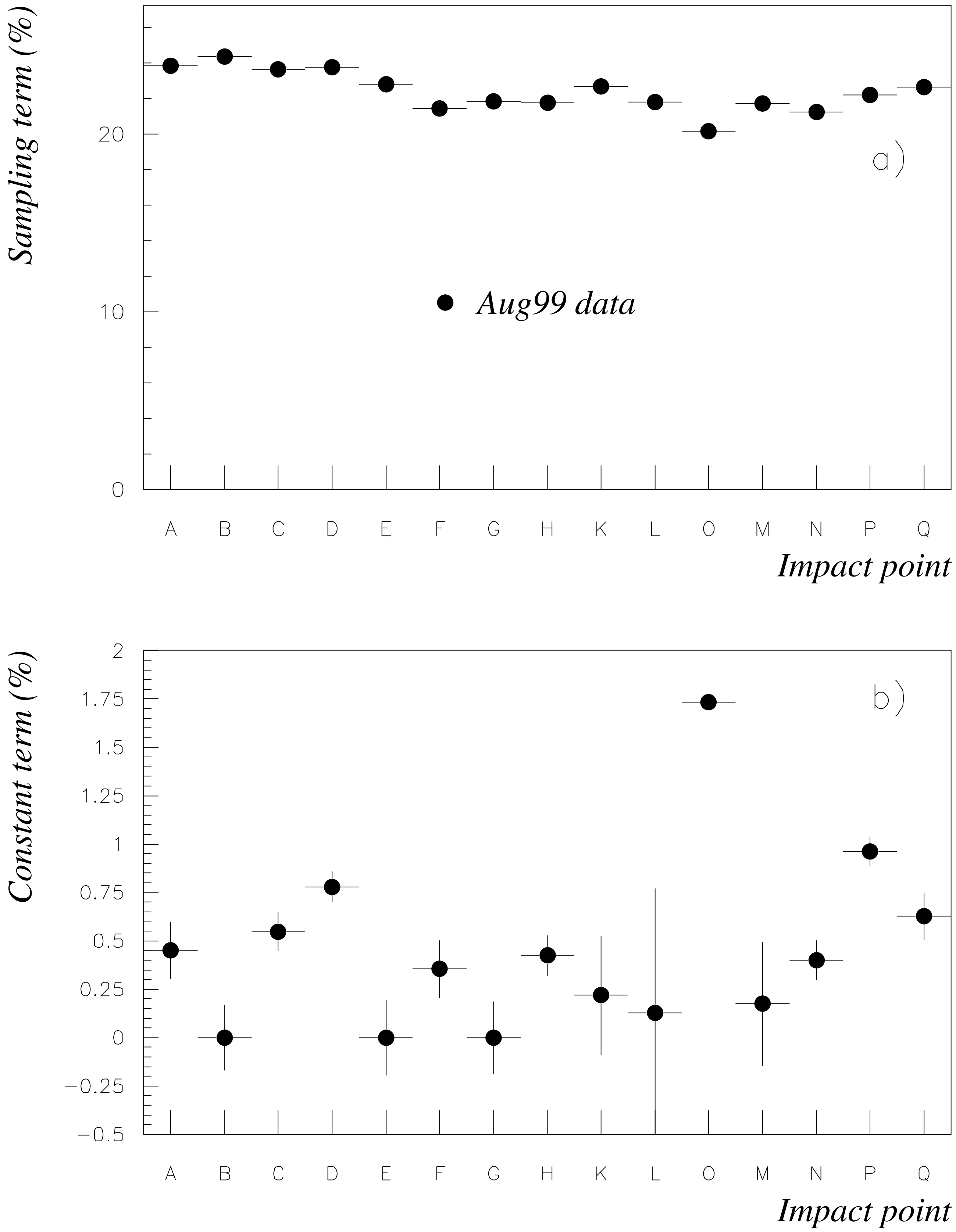
Energy resolution for electrons

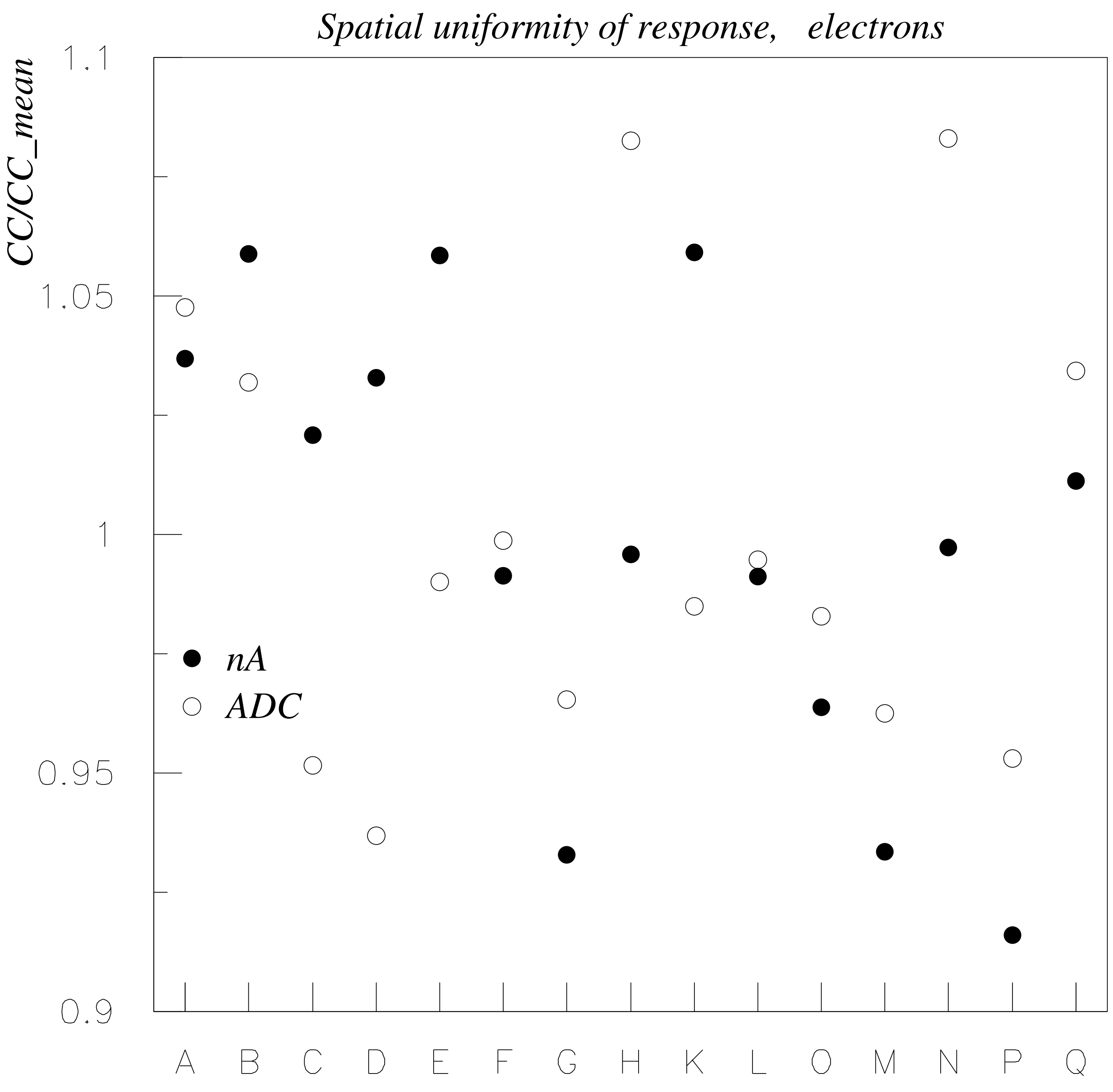
Noise subtracted

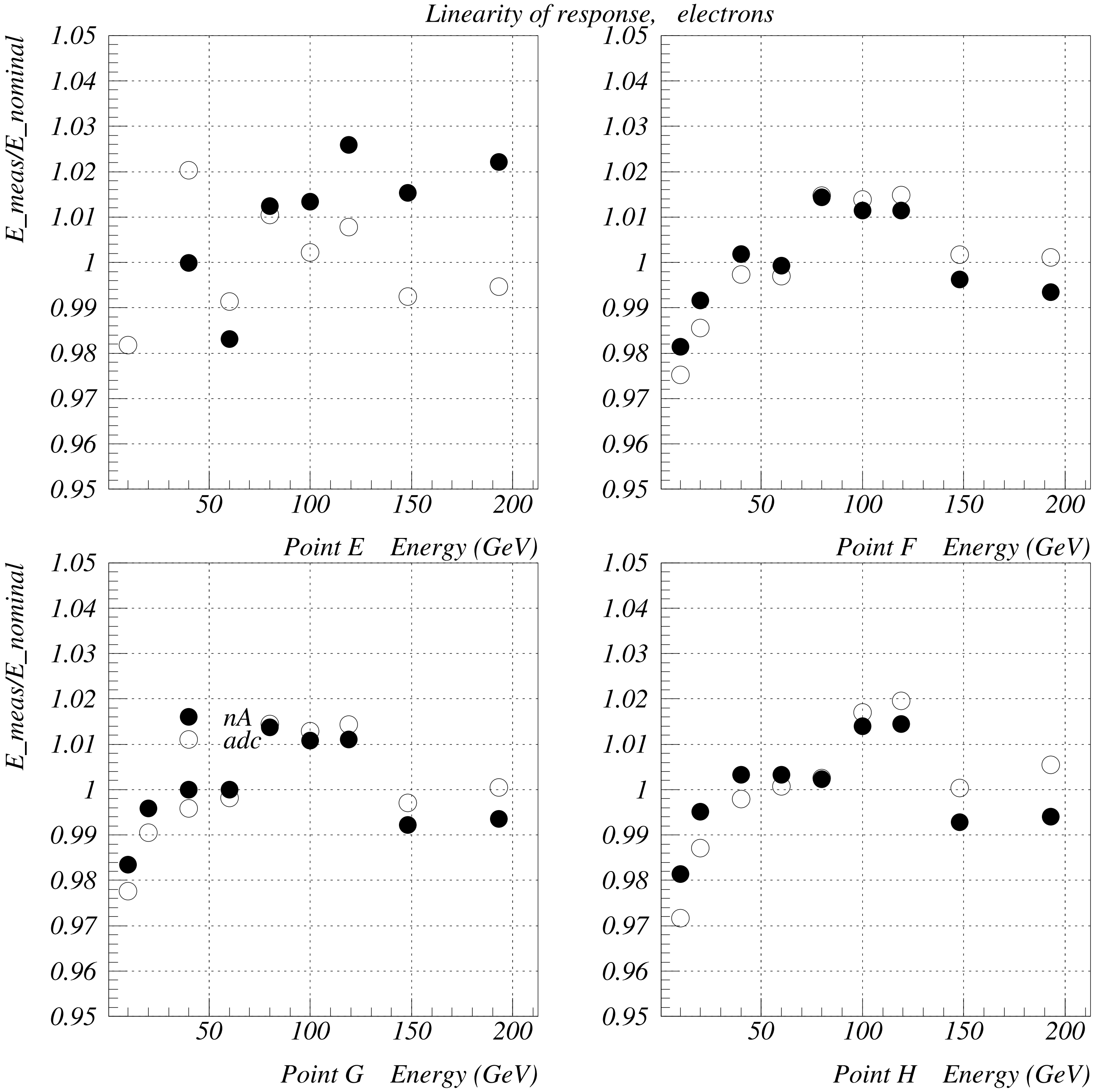




Energy resolution for electrons




Spatial uniformity of response, electrons
CC/CC_mean
1.1
1.05
1
0.95
0.9
nA
ADC
A
B
C
D
E
F
G
H
K
L
O
M
N
P
Q

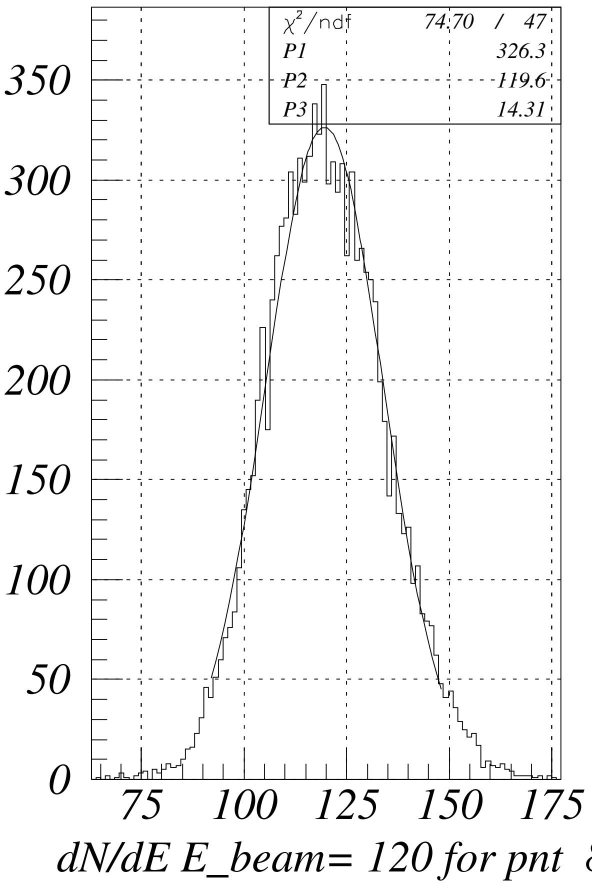


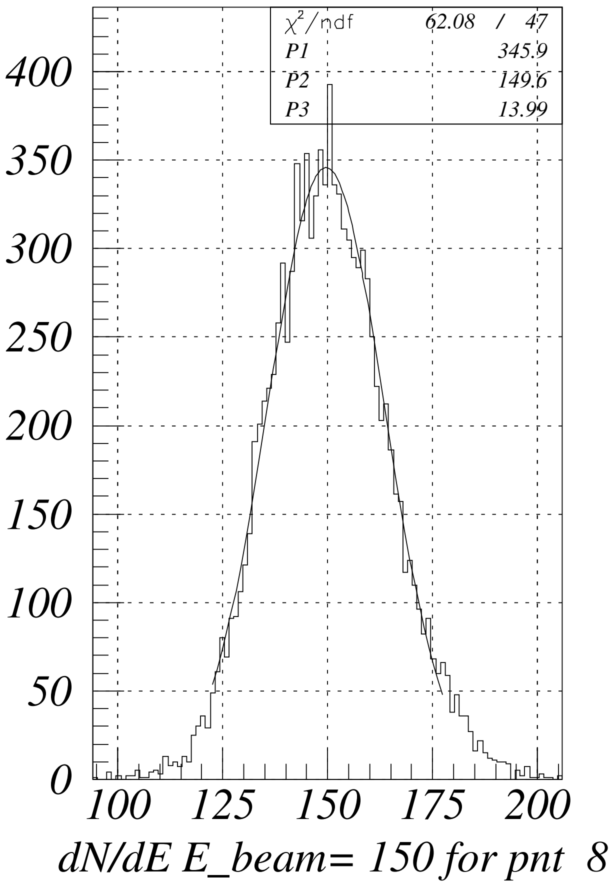
Linearity of response, electrons
E_meas/E_nominal
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
50
100
150
200
Point E
Point F
Point G
Point H
Energy (GeV)
nA
adc

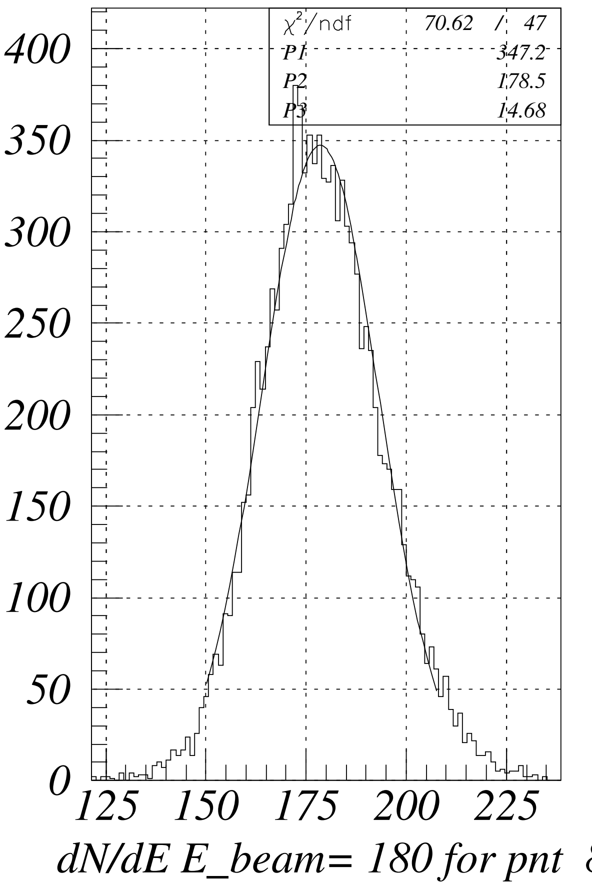
Pion data analysis

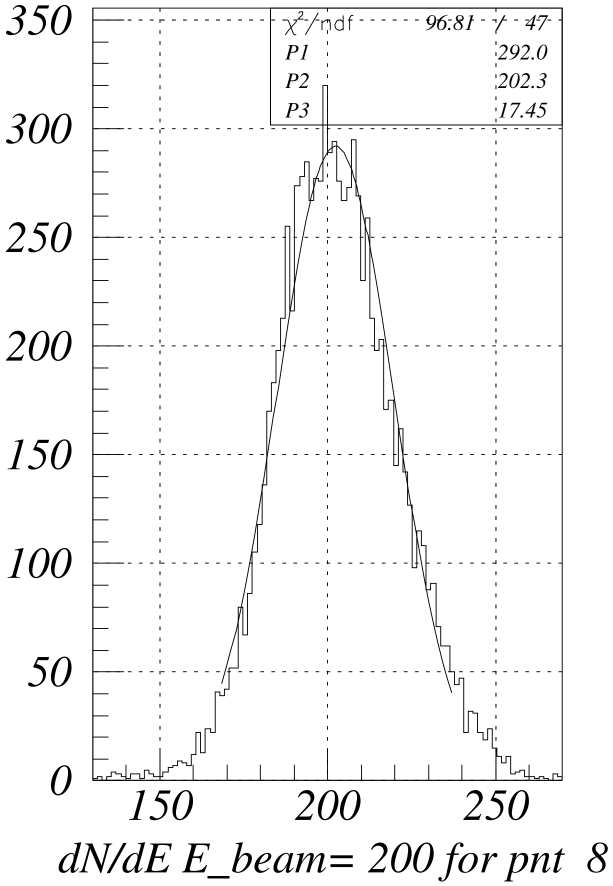
- pions at 13 points: A,B,C,D,E,F,G,H,K,L,O,M,N;
- 10 energies: 10,20,40,60,80,100,120,150,180,200;
- cluster selection: mean cell signal greater 15 nA at 180 GeV;
- cluster size (45-58 cells) varies from point to point but independent on the energy;
- at each the point one calibration factor α_{π}, averaged through the 3 highest energies, is used, no any adjustable parameters for the resolution improvement;
- energy dependence of resolution:
  - sampling term - about 75% (compatible with 1998)
  - constant term - about 5.5% (compatible with 1998)
- the const. term is larger by 0.5-1.0% for points A-D because of their contiguity with the tie-rods;
- the resolution at points E and K is strongly spoiled because of a dead ADC channel (# 91) in the 3rd layer;
- the spatial non-uniformity of response is $\sim \pm 5\%$;
- noticeable deviation from linearity is observed for the lowest energies;
- the mean absolute calibration α_{em} =0.00488 GeV/nA strongly differs from the corresponding 1998 value - 0.00410 GeV/nA.

Pion energy distributions

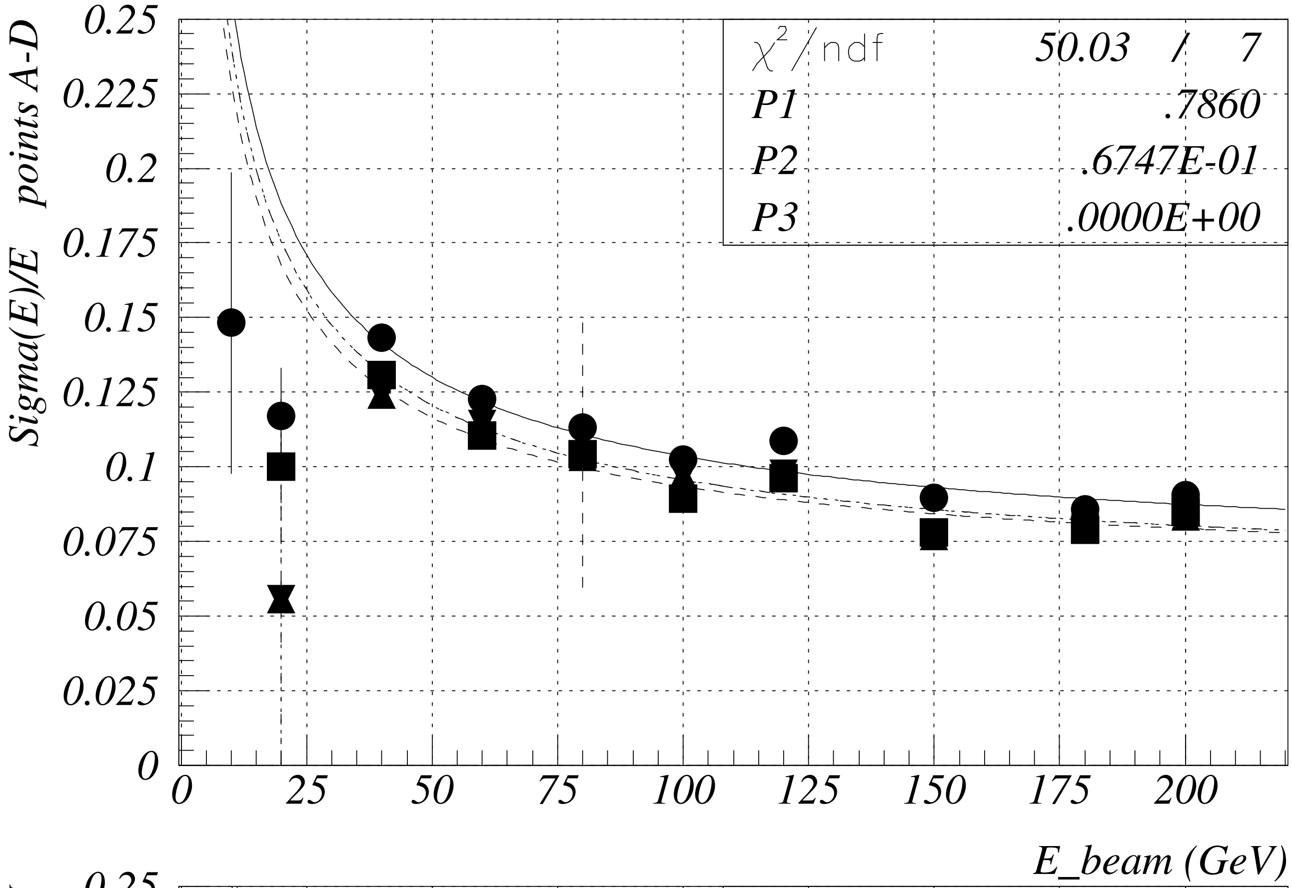


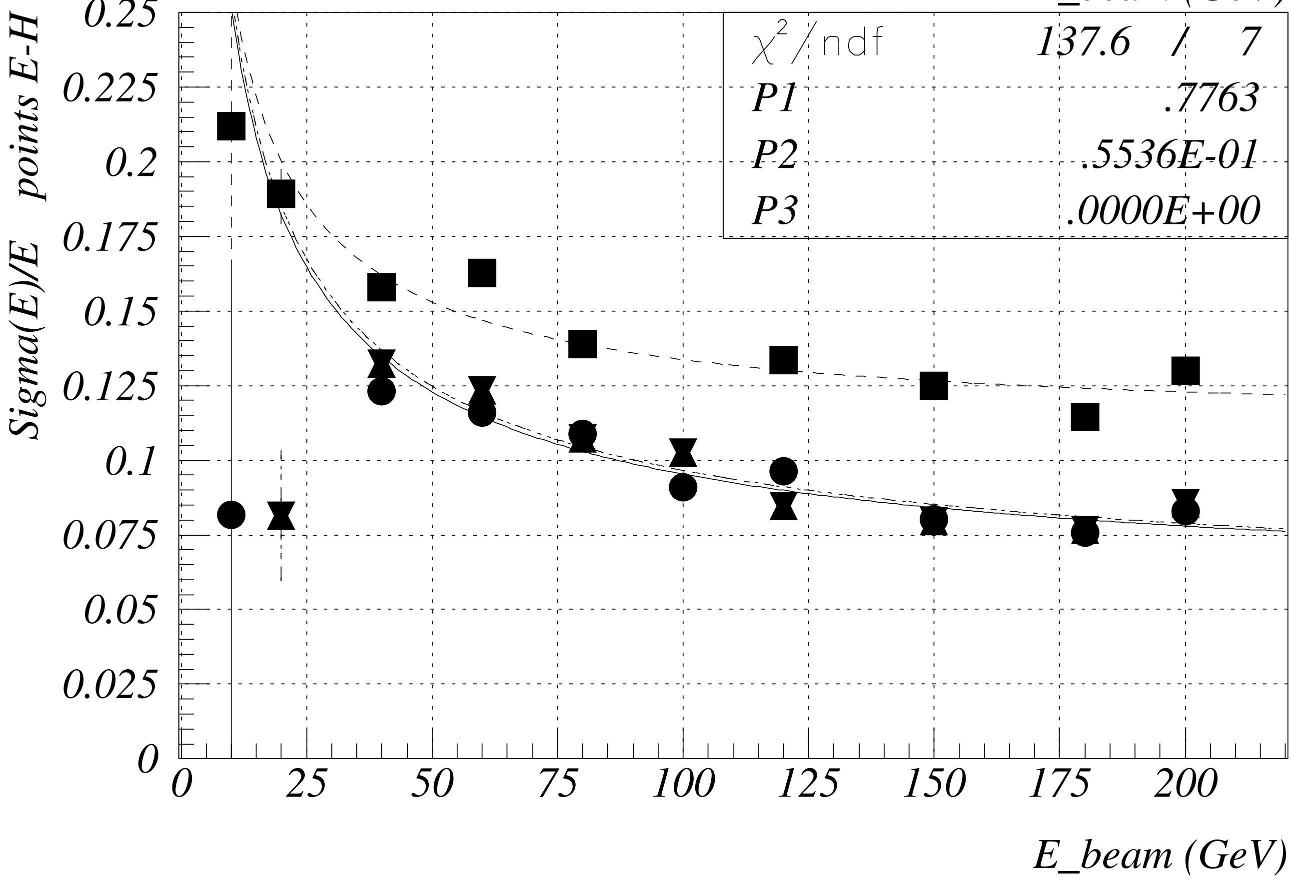




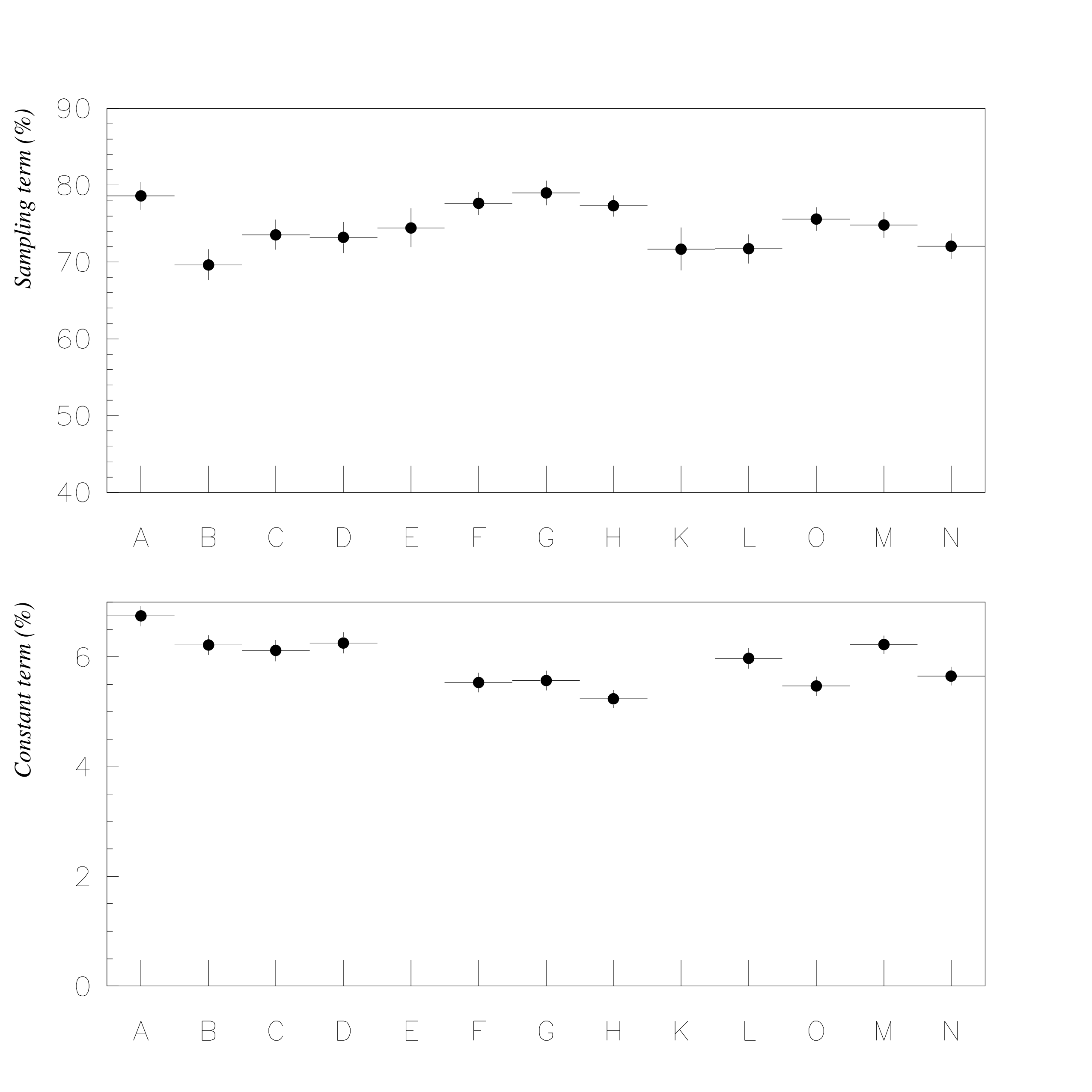


Energy resolution for pions

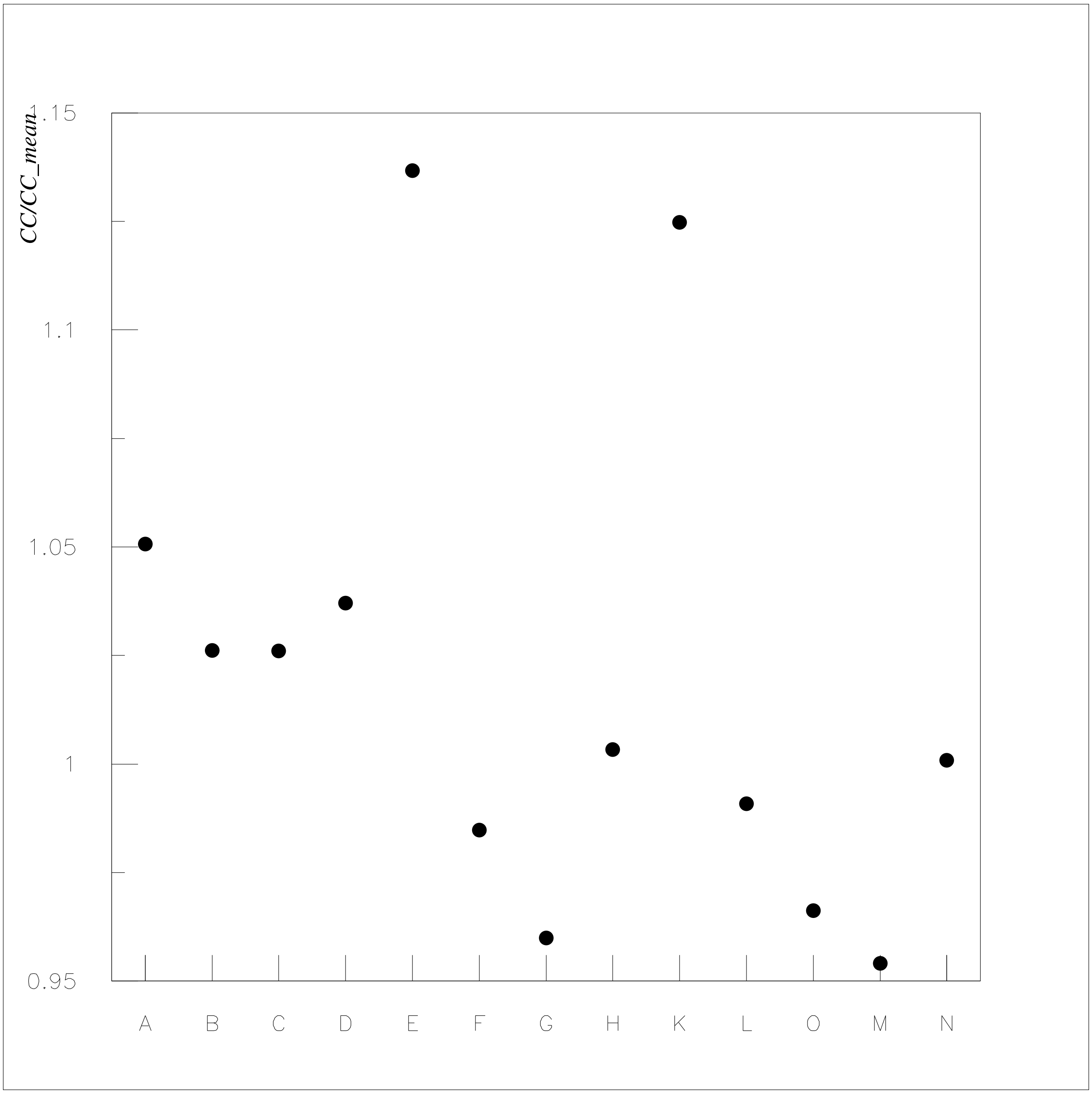


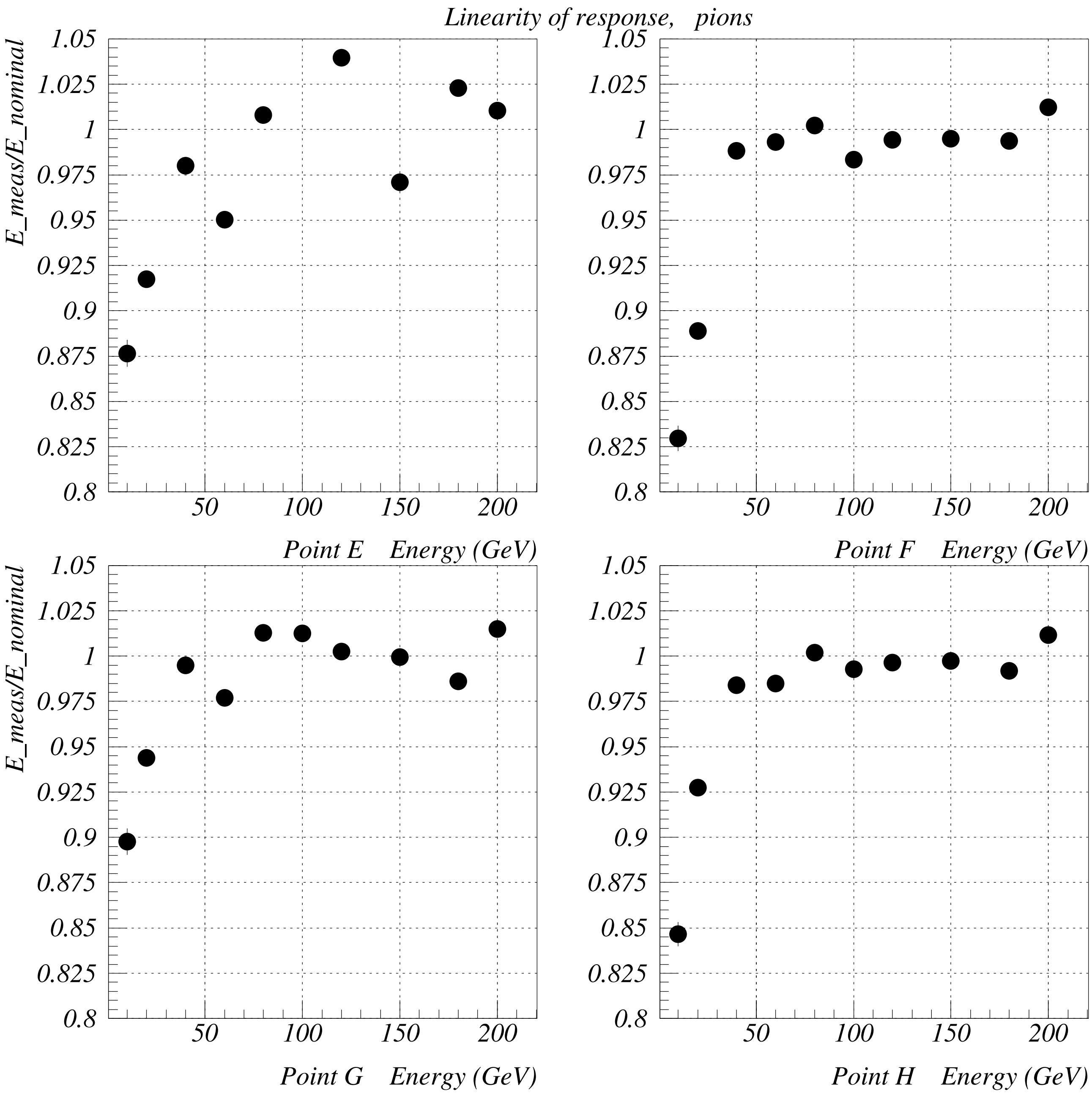


Energy resolution for pions



Spatial uniformity of response for pions




Linearity of response, pions
E_meas/E_nominal
1.05
1.025
1
0.975
0.95
0.925
0.9
0.875
0.85
0.825
0.8
50
100
150
200
Point E Energy (GeV)
Point F Energy (GeV)
Point G Energy (GeV)
Point H Energy (GeV)