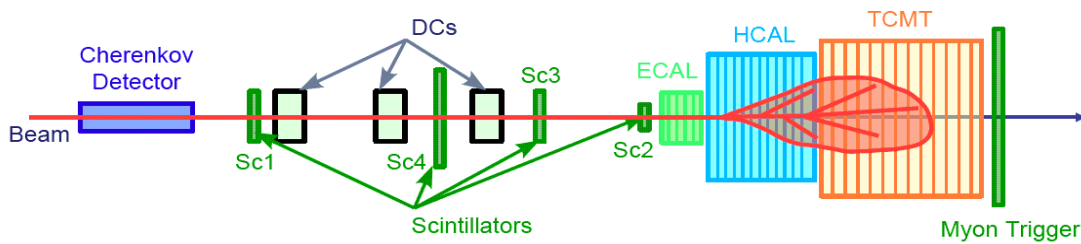


Report on alignment of the Hadron calorimeter with the drift chambers

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1. Detector setup

1. Introduction

The FLC group is working on a new generation of detectors for the ILC. This report describes the process and development of a code to aligning the Hadron Calorimeter with the Drift Chambers. In a few steps it is now possible to find out if the alignment constants of the Drift Chambers are good and if the Hadron Calorimeter or some of its layers are misaligned.

The code was developed by using data from a muon test run at CERN in 2007.
Run no. 331589.

Important boundary condition:

The Drift Chambers are fixed in position and the Hadron Calorimeter is not.
The cell size of the Hadron Calorimeter is fixed in this run to 30x30mm.

For the analysis one needs the hits from the Drift Chambers and the hits in the Hadron Calorimeter.

The first step is to check the internal alignment of the Drift Chambers without the Hadron Calorimeter.

This is used to find out if one Chamber is misalignment in x or y.

The second step is to check the correlation of the hits in the HCAL and the extrapolated tracks from the DCs.

Up to now only the first 30 layers of the HCAL are taken into account due to the fact that in the region that was used for the alignment only 30X30mm cells are used.

2. The process of alignment

Checking the DCs

General function of a delay wire chamber.

Each chamber is build with one row of wires and gas in between them. At the end of the chamber the wires are connected to a delay wire. The delay wire is on both ends connected to a TDC unit.

An incident particle ionizes the gas in the chamber. The free charge drifts to the wires what leads to a current on the wires. The current is now traveling to the delay wire and moves to both sides.

The TDC records the time of an arriving current.

With a TDC to mm conversion factor the difference of the two TDCs is used to calculate the position of the passing particle in the chamber.

Since it is possible to have multiple signals due to noise or multiple signals on the wires it is possible to have miscalculated positions of hits (ghost hits).

From the fact that the size of the chambers is fixed the sum of the TDCs of a good signal must be constant. By using this fact the ghost hits can be removed.

This can be done by applying a cut on the sum of the TDCs.

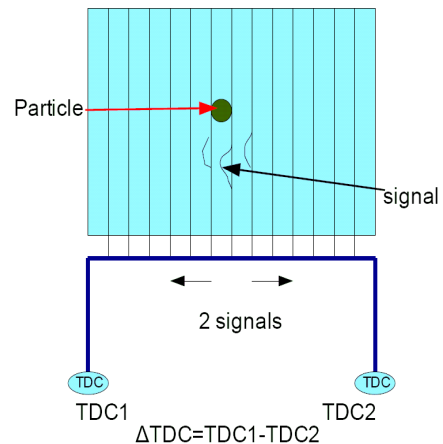
For each chamber the cut can be different depending on the way the chamber is build.

In this analysis all chambers had the same setup and the sum of tdc1 and tdc2 was around 1250.

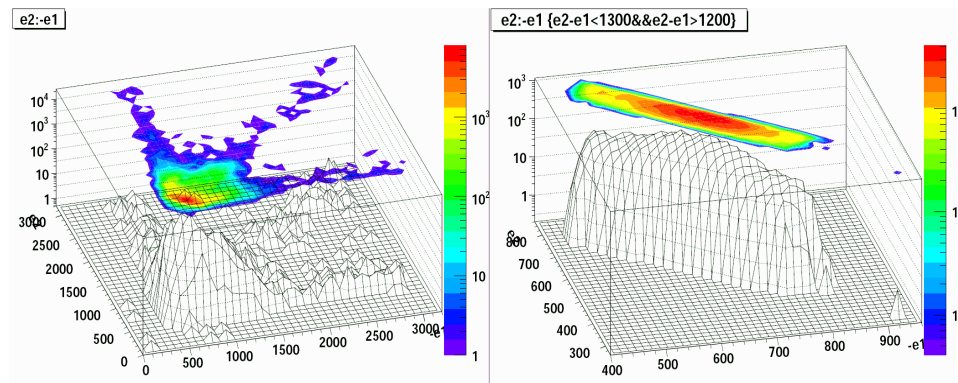
With a cut of $1200 < \text{tdc1} + \text{tdc2} < 1300$ the ghost hits were removed.

From the now clean hit positions the tracks of the particles were calculated.

1 Driftchamber



2. Setup of a Drift Chamber



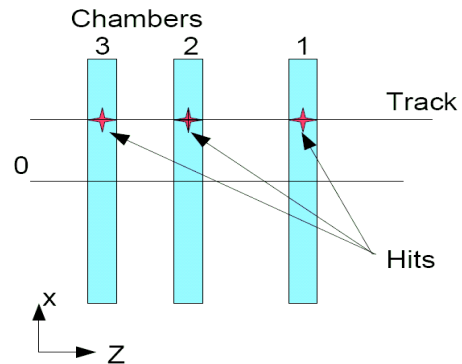
3. Plotted: Both graphs the possible combinations of signals from both sides of the delay wire.

Left: without a cut right: with the cut of $1200 < \text{tdc1} + \text{tdc2} < 1300$

To check if the relative positions of the chambers are consistent the correlation between the track extrapolation in each chamber and the hit was checked. The correlation of the hit in each chamber and the extrapolated track was fitted with a linear function.

$$\text{hit}(\text{track}) = \text{track} * a + b.$$

In case of a perfect alignment: $a=1$ and $b=0$.



4. 3 DCs with hits and track

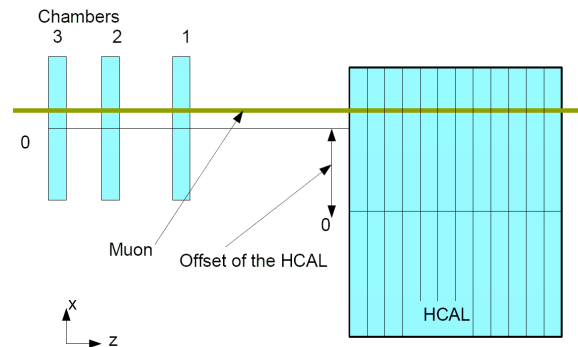
Comparing the Hits in the HCAL and the extrapolated tracks from the Drift Chambers

By just looking at the drift chambers the system is under determined.

There are still 2 possible misalignments of the drift chambers and a possible offset in x or y of the HCAL or an angel of the HCAL to the beam line.

Misalignment 1:

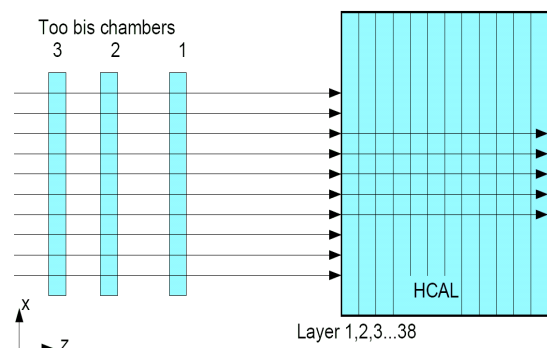
To find out if the HCAL has an offset in x or y one can compare the extrapolated tracks from the DC with the hits in the HCAL. If the difference of the tracks and hits is constant over the layers and independent of the hit position there must be an offset proportional to the difference of the two values.



5. Misalignment 1. HCAL offset in x or y

Misalignment 2:

From comparing only the Chambers without a reference scale it is possible that the positions in the chambers are all too small or too big. Since the cell size in the HCAL is fixed it is reasonable to compare the distribution of the tracks vs the hits.



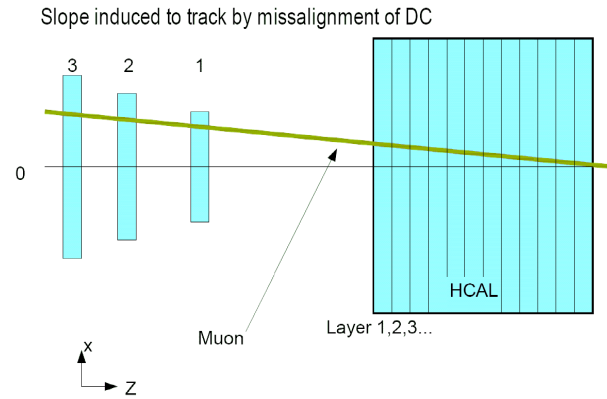
6. Misalignment 2. Small calculated size of the DCs

If the profile of the extrapolated tracks in the HCAL is different from the fixed size of the DCs the TDC to mm conversion factor is wrong.

Misalignment 3:

Another misalignment can be distinguished by looking at the increasing or decreasing difference of hit in the HCAL and the track extrapolation.

If over the layers the difference varies and at some line parallel to the beam line is mirror symmetric the scaling factor for all chambers is different and therefore the positions are wrong calculated in at least 2 chambers.



7. Misalignment 3. Angle between track and beam line

The DC had a resolution of $\sim 1\text{mm}$ but for the HCAL the resolution is fixed to 30 mm by the cell size. The positions of all hits in one cell is set to the position of the center of the cell.

The comparing of the hits in the HCAL and the extrapolated tracks led to discrete values for the hits and almost continuous values for the tracks.

This profile was fitted by a step function.

The step function

The step function consists of 5 fitting parameters.

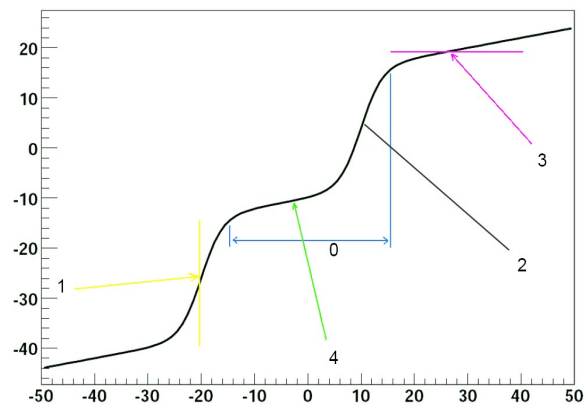
P0 - step width

P1 - x-offset of the first step

P2 - slope of the step

P3 - y-position of the highest leg

P4 - linear slope of the plateaus



8. The step function: In the profile on the x axis track on the y axis hit

The fitting process

For each layer and x and y separately a fit was done.

The fitting process consisted of 5 steps:

1. A TProfile was created with all the extrapolated tracks in one layer on the x axes vs. all the hits on the y axis.
2. This TProfile was cleaned by applying a cut of demanding that the error on each value had to be positive but below two mm.
3. After the profile was cleaned an algorithm was used to find all the step in the profile. A single step was applied to the profile with a fitting range that was varied over all bins. By applying a cut that the probability had to be above 0.1 good steps were found. When the fitting range comes to an actual step this step could have been found for various fitting ranges. To prevent double counting it was demanded to have a spacing of at least 20 mm between two steps.
4. The position of the highest leg was initialized to the highest value in any bin.
5. From the found no. of steps it was chosen to fit a function with various no. of steps. For the fitting 5 parameters were needed. The first step (P1) was found with step 3. With step 4 the position of the highest leg was found and set (P3). The other parameters were set in the expected range.

The fitting was done by using root in combination with the step functions.

Only P0 and P1 were used for further calculations.

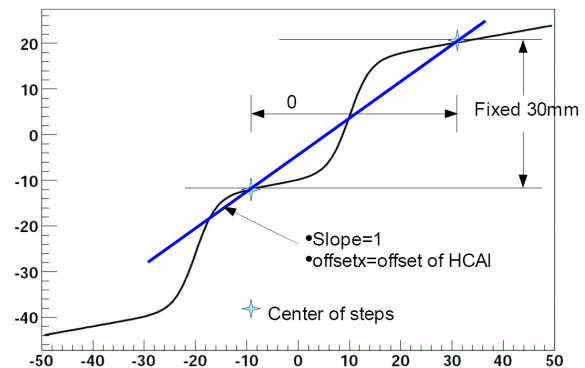
The parameters P2 P3 and P4 are only of technical use for the fitting process.

For this analysis P0 and P1 in combination with the fixed cell size of 30mm were used to calculate a linear function.

The middle of each plateau is the position of the center of a cell. These are the only points on the step function where the actual position of a hit can be found.

By fitting a linear function through these points it was possible to check the correlation of the hits and the extrapolated tracks.

Analog to the DC a slope of one and an offset of zero was expected.



9. Finding the linear function from the step function

If the offset for all layers was different from zero misalignment 1 would be true.

If for all layers the slope was equally different from one misalignment 2 would be the case.

If there is a linear development of the slope over the layers misalignment 3 would be

true.

Of course combinations would be possible.

3. Results

Run 331589

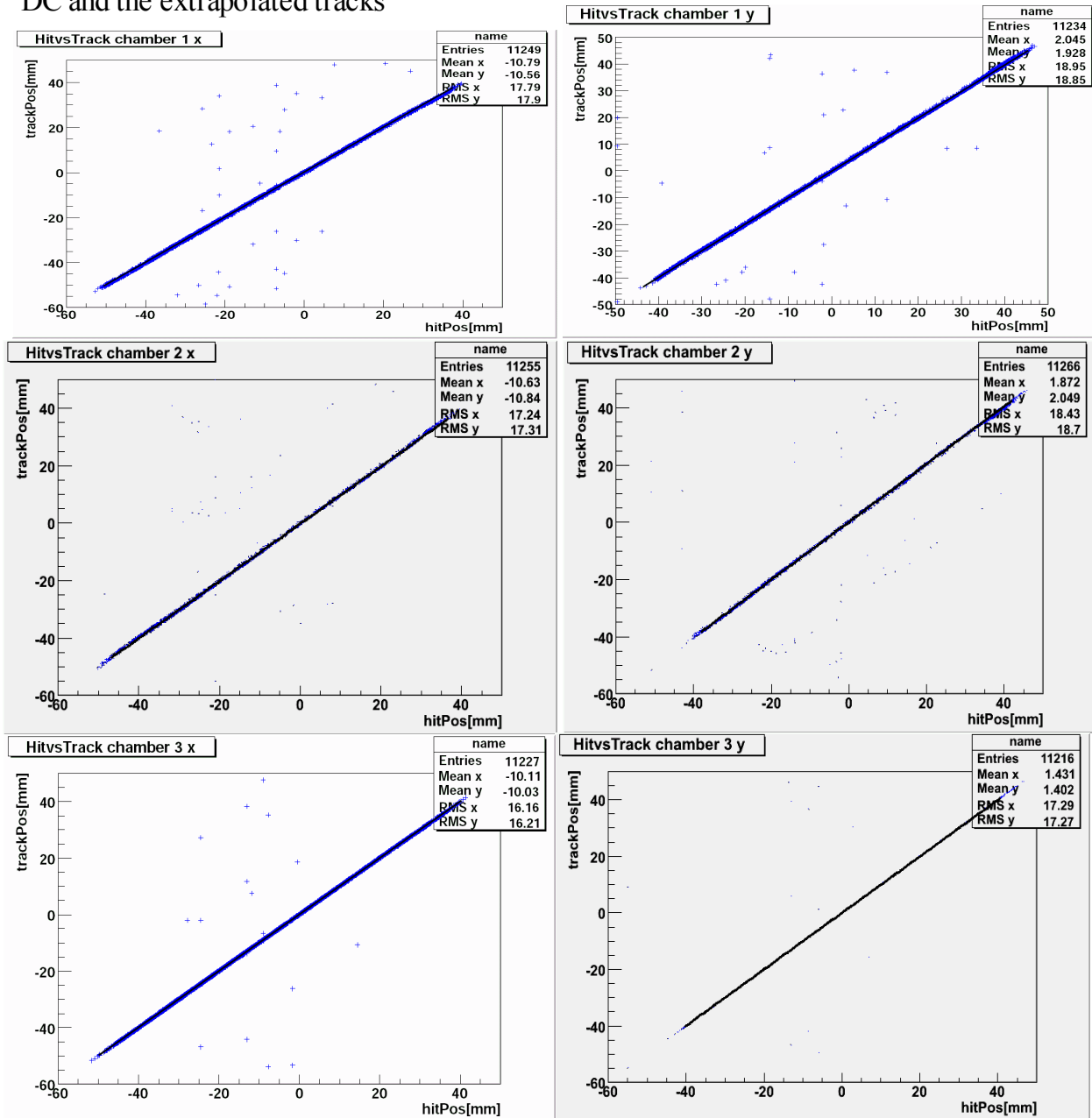
Drift Chambers

From the table it is obvious that the chambers by them self seem to have good alignment.

For X		
DC Nr.	b[mm]	a
1	0.26±0.01	1.00±0.00
2	-0.23±0.01	1.00±0.00
3	0.09±0.01	1.00±0.00
For y		
	b[mm]	a
1	-0.12±0.01	0.99±0.00
2	0.18±0.01	1.001±0.00
3	0.03±0.01	1.00±0.00

10.a Results for the linear fitting in the DCs. With
a=slope b=offset.

10-12a/b. Correlation of the hits in each DC and the extrapolated tracks



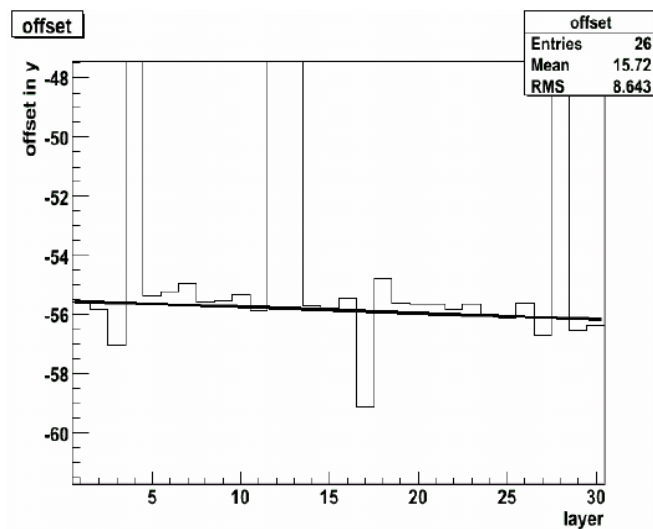
The correlation between the Drift Chambers and the Hadron Calorimeter

Note: For all layers in x and y the plots of the extrapolated track vs. the hits is in the attachment.

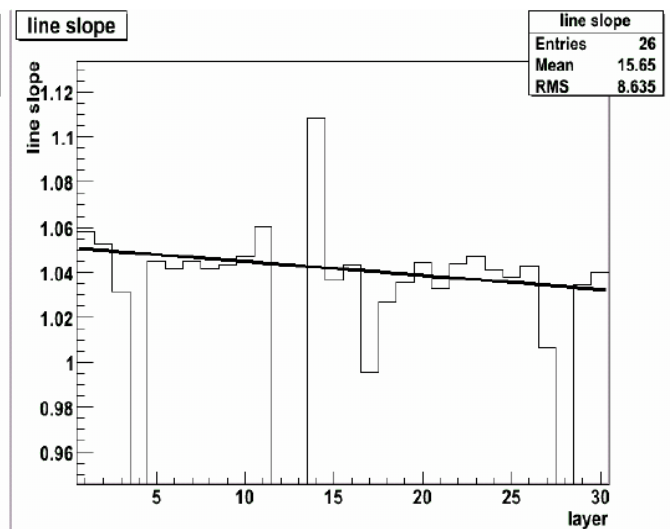
In y

The HCAL is moved by $-55,54 \pm 3,04$. The change of the offset over the layers is $-0,02 \pm 0,20$.

The correlation between the hits and tracks is $1,05 \pm 0,42$ with a development over the layers of $0,00 \pm 0,02$.



13.a Offset of the HCAL in y for each layer

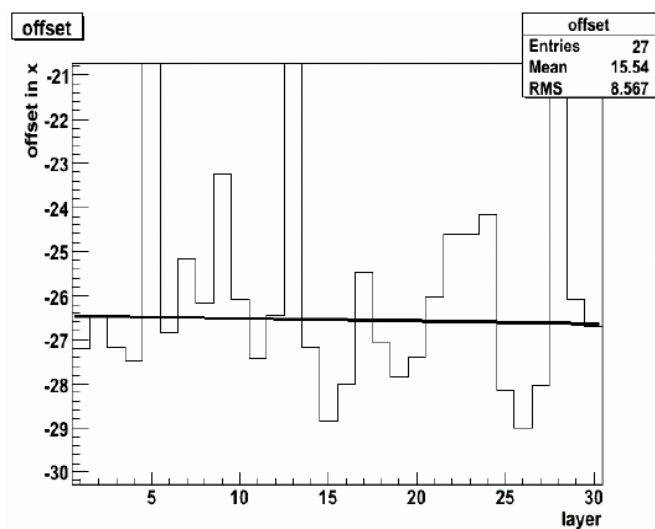


13.b development of the linear slope over the layers in y

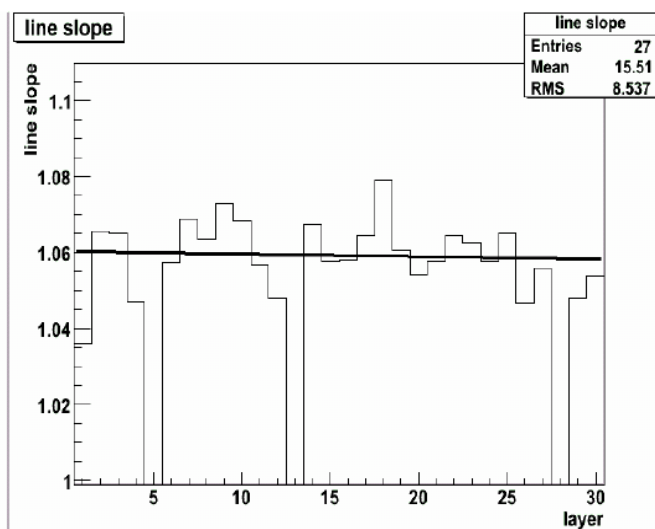
In x

The HCAL is moved by $-26,46 \pm 2,05$. The change of the offset over the layers is $0,00 \pm 0,16$.

The correlation between the hits and the tracks is $1,06 \pm 0,51$ with a development over the layers of $0,00 \pm 0,02$.



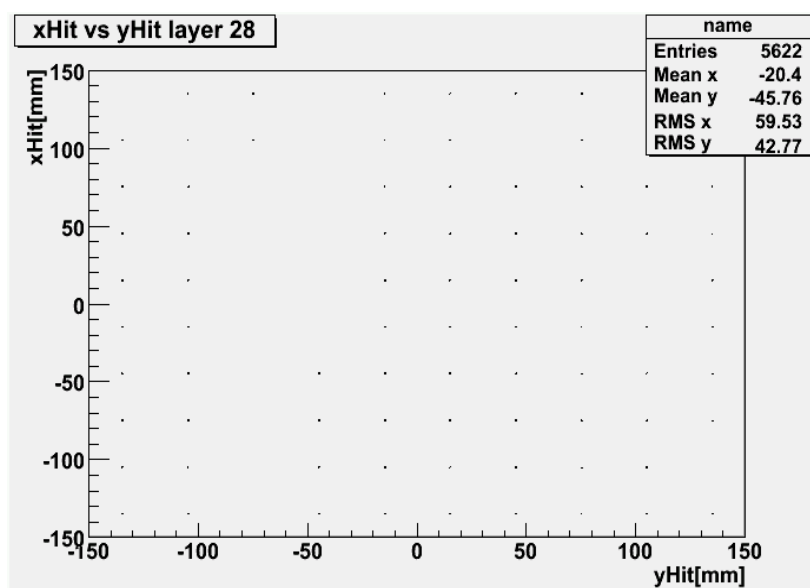
14.a Offset of the HCAL in x for each layer



14.b development of the linear slope over the layers in x

In run 331589 the alignment of the Chambers is good. The only misalignment I found is an total offset of the HCAL in x and y.

Another important outcome of this study is the possibility of broken cells in layer 28 of the HCAL.



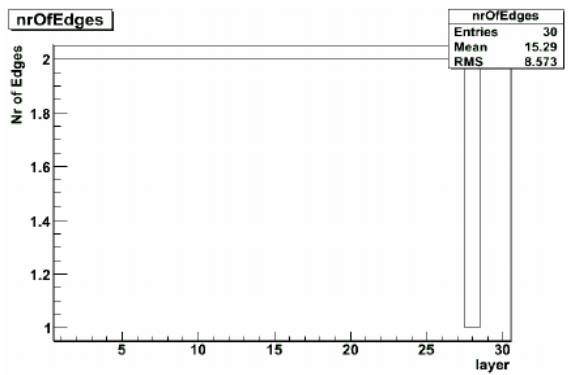
15.a For layer 28 each point indicates hits in cells in the middle some blank spot potential dead cells

Since my time was limited I was not able to check the code on other runs but in the code is written to be easily applied to other runs.

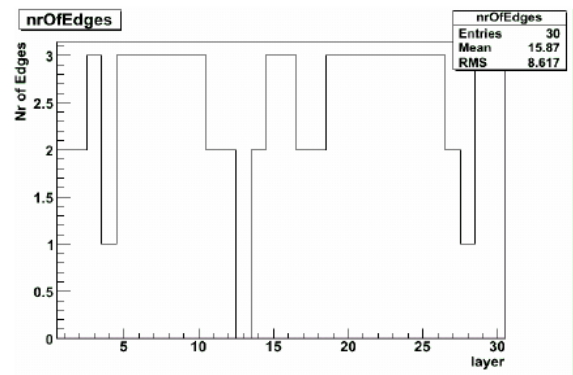
For references there are two files with all the fitted parameters for all layers in x and y.

4. Difficulties with the step function fitting process

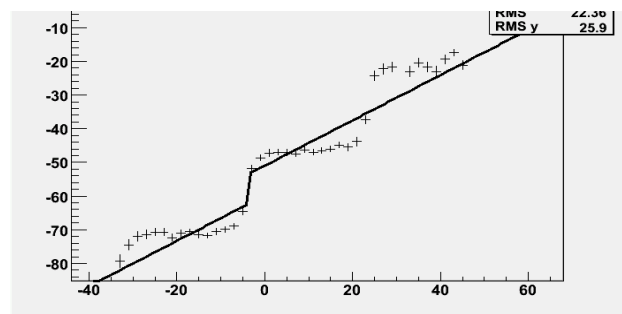
To give you an impression on how reliable the fitting process works these plots show the amount of found edges vs. the layers for x and y.



No of found edges left for x right for y

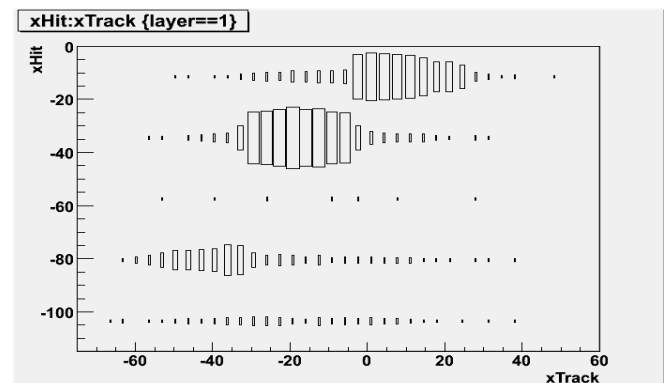


For most cases the process went quiet well. Never the less in some plots root was not able to find steps where by eye one can see there are steps. This problem is still not fully solved.



16.a Example plot for a falls matched(y layer 13) step. X axis is the track on the y axis the hit

What I already fixed is the fact that the level of the steps is not flat but has a slope. This slope arises from the fact that the extrapolated tracks are not 100% accurate but smeared. As you can see in the plot the steps are not sharp but some tracks are falls calculated in wrong cells increasingly by approaching the step. This was fixed by applying to the step function a over all linear slope(P4).



16. for layer 1 of the HCAL xTrack vs xHit with the size of the box proportional to the amount of hits

To further improve the step finding problem it could be helpful to change the binning what could lead to a more accurate profile of the steps.

I also tried to introduce a 6 parameter. The step heights. But in the given time I was not able to get root to work with 6 parameters.

Another possible improvement could be achieved by changing the conditions a step has to full fill to be recognized as a good step.

Appendix

Fitting parameters for x

```
/* parameters:
  p[0] - step width
  p[1] - x-offset of first step
  p[2] - slope of step
  p[3] - y-position of highest leg
  p[4] - linear slope
  p[5] - step hight
*/
```

Layer nr. 1

```
FCN=52.1362 FROM MIGRAD      STATUS=CONVERGED      203 CALLS      204 TOTAL
                        EDM=4.60245e-10      STRATEGY= 1      ERROR MATRIX UNCERTAINTY      3.0
```

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.89606e+01	1.97064e-01	2.20486e-05	1.90807e-04
2	p1	-3.23671e+01	1.68653e-01	-2.41697e-05	7.46726e-05
3	p2	2.03169e+00	3.07841e-01	-9.00827e-06	6.69897e-05
4	p3	-2.14870e+01	9.44651e-01	1.14799e-04	1.79197e-04
5	p4	1.32622e-01	2.10502e-02	-2.96472e-06	6.64280e-03
6	p5	3.00000e+01	fixed		

Probability 0.00115207

Nr of Edges found 2

Layer nr. 2

```
FCN=71.3583 FROM MIGRAD      STATUS=CONVERGED      206 CALLS      207 TOTAL
                        EDM=1.12608e-09      STRATEGY= 1      ERROR MATRIX UNCERTAINTY      1.6
```

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81479e+01	1.45295e-01	8.63078e-05	4.14129e-04
2	p1	-3.18520e+01	1.09884e-01	-1.44642e-05	6.15908e-04

3	p2	1.53654e+00	1.45119e-01	-9.69636e-05	-3.66995e-04
4	p3	-2.05792e+01	7.83339e-01	5.90765e-04	-7.74149e-05
5	p4	1.21976e-01	1.77685e-02	-1.12854e-05	-2.00531e-03
6	p5	3.00000e+01	fixed		

Probability 2.41352e-06

Nr of Edges found 2

Layer nr. 3

FCN=75.3342 FROM MIGRAD STATUS=CONVERGED 207 CALLS 208 TOTAL
EDM=4.46313e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.8

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81709e+01	1.22346e-01	6.62965e-06	-9.76387e-05
2	p1	-3.08822e+01	8.24242e-02	-1.80703e-05	-5.58567e-04
3	p2	2.14202e+00	4.71378e-01	9.85010e-05	-2.65573e-05
4	p3	-2.19403e+01	8.70420e-01	-8.02652e-06	-1.30495e-05
5	p4	1.63051e-01	2.03265e-02	4.05045e-07	-5.74752e-04
6	p5	3.00000e+01	fixed		

Probability 6.03071e-07

Nr of Edges found 2

Layer nr. 4

FCN=67.3063 FROM MIGRAD STATUS=CONVERGED 176 CALLS 177 TOTAL
EDM=1.26636e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.9

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.86525e+01	1.60426e-01	-1.08560e-07	1.11397e-04
2	p1	-3.16304e+01	1.21573e-01	-1.24130e-06	6.35463e-05
3	p2	1.35490e+00	1.32463e-01	-2.13505e-05	1.16564e-04
4	p3	-2.16130e+01	8.33905e-01	1.23146e-04	1.05501e-04
5	p4	1.39733e-01	1.91230e-02	-3.04776e-06	3.90066e-03
6	p5	3.00000e+01	fixed		

Probability 9.59035e-06

Nr of Edges found 2

Layer nr. 5

FCN=85.8084 FROM MIGRAD STATUS=CONVERGED 229 CALLS 230 TOTAL
EDM=1.65988e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.2

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.79397e+01	1.53269e-01	-1.42860e-05	6.19878e-05
2	p1	-3.32865e+01	1.25311e-01	9.50329e-06	9.02469e-05
3	p2	1.51421e+00	1.37485e-01	8.24364e-06	-4.16859e-05
4	p3	-1.99895e+01	6.56779e-01	1.07895e-06	-3.77378e-05
5	p4	1.10415e-01	1.55315e-02	8.76232e-08	-1.45008e-03
6	p5	3.00000e+01	fixed		

Probability 1.36563e-08

Nr of Edges found 2

Layer nr. 6

FCN=46.657 FROM MIGRAD STATUS=CONVERGED 174 CALLS 175 TOTAL
EDM=7.444e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.9

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83697e+01	1.47930e-01	-1.75320e-05	-1.55180e-05
2	p1	-3.19353e+01	1.18703e-01	6.56480e-06	7.42254e-06
3	p2	1.35065e+00	1.15988e-01	1.53098e-06	6.28505e-05
4	p3	-1.99523e+01	8.11784e-01	-2.29828e-05	-1.48515e-04
5	p4	1.01882e-01	1.87098e-02	5.82807e-07	-6.62354e-03
6	p5	3.00000e+01	fixed		

Probability 0.00538013

Nr of Edges found 2

Layer nr. 7

FCN=50.0149 FROM MIGRAD STATUS=CONVERGED 214 CALLS 215 TOTAL
EDM=9.81675e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.8

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.80627e+01	1.41831e-01	-1.66502e-05	2.07724e-04
2	p1	-3.30710e+01	1.02689e-01	-1.94802e-05	5.15238e-04
3	p2	1.40951e+00	1.57439e-01	3.06559e-05	4.92598e-05
4	p3	-1.98443e+01	7.26633e-01	-4.80576e-04	1.70152e-04
5	p4	1.02751e-01	1.65946e-02	1.09500e-05	5.04643e-03
6	p5	3.00000e+01	fixed		

Probability 0.00140981

Nr of Edges found 2

Layer nr. 8

FCN=61.778 FROM MIGRAD STATUS=CONVERGED 179 CALLS 180 TOTAL
EDM=8.69768e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.6

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.82046e+01	1.37270e-01	-8.02244e-07	1.15701e-06
2	p1	-3.21955e+01	1.05385e-01	-7.95656e-06	4.32344e-06
3	p2	1.32703e+00	1.19966e-01	9.06408e-07	4.79270e-05
4	p3	-1.95055e+01	7.14261e-01	-1.60394e-05	-2.52287e-05
5	p4	9.71404e-02	1.64675e-02	1.96225e-07	-1.15153e-03
6	p5	3.00000e+01	fixed		

Probability 5.92135e-05

Nr of Edges found 2

Layer nr. 9

FCN=64.1647 FROM MIGRAD STATUS=CONVERGED 252 CALLS 253 TOTAL
EDM=6.15878e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.3

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.79606e+01	1.40493e-01	8.27974e-06	-1.97448e-05
2	p1	-3.45224e+01	1.10446e-01	-8.63732e-06	-4.19190e-05
3	p2	1.57962e+00	1.59135e-01	5.79493e-06	-2.46533e-05
4	p3	-1.89529e+01	6.33148e-01	-2.26502e-05	-4.65841e-07
5	p4	8.75924e-02	1.47761e-02	4.83200e-07	1.67516e-04
6	p5	3.00000e+01	fixed		

Probability 1.61263e-05

Nr of Edges found 2

Layer nr. 10

FCN=30.6996 FROM MIGRAD STATUS=CONVERGED 172 CALLS 173 TOTAL
EDM=8.0148e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.6

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.80848e+01	1.33930e-01	-3.62811e-06	-4.98354e-05
2	p1	-3.20641e+01	1.04064e-01	6.40038e-06	-7.02995e-05
3	p2	1.37646e+00	1.02282e-01	1.34885e-06	3.61516e-06
4	p3	-1.83760e+01	6.13495e-01	-1.77443e-05	3.58596e-05
5	p4	7.21565e-02	1.45283e-02	3.58904e-07	1.37931e-03
6	p5	3.00000e+01	fixed		

Probability 0.162635

Nr of Edges found 2

Layer nr. 11

FCN=47.7 FROM MIGRAD STATUS=CONVERGED 225 CALLS 226 TOTAL
EDM=9.16095e-10 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83850e+01	1.38947e-01	3.25834e-04	1.85997e-04
2	p1	-3.12966e+01	1.05119e-01	2.34859e-04	-1.82119e-05
3	p2	1.51146e+00	1.82814e-01	5.25525e-04	1.51173e-04
4	p3	-2.12994e+01	8.39867e-01	3.63967e-04	-1.12966e-04
5	p4	1.36229e-01	1.94782e-02	8.40513e-06	-6.33584e-03
6	p5	3.00000e+01	fixed		

Probability 0.0040505

Nr of Edges found 2

Layer nr. 12

FCN=55.4901 FROM MIGRAD STATUS=CONVERGED 212 CALLS 213 TOTAL
EDM=7.78863e-14 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 0.7

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.86218e+01	1.58031e-01	3.60814e-06	-1.02631e-06
2	p1	-3.25803e+01	1.14709e-01	2.16562e-07	-2.54561e-06
3	p2	1.34649e+00	1.27488e-01	-2.04430e-06	1.29806e-06
4	p3	-2.20757e+01	7.98735e-01	-7.20974e-07	-5.76783e-07
5	p4	1.51255e-01	1.78969e-02	5.37589e-08	-5.67160e-05
6	p5	3.00000e+01	fixed		

Probability 0.000424269

Nr of Edges found 2

Layer nr. 13

FCN=152.476 FROM MIGRAD STATUS=CONVERGED 229 CALLS 230 TOTAL
EDM=3.04047e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.3

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.85114e+01	2.17440e-01	9.35811e-07	5.67216e-05
2	p1	-3.22543e+01	1.67465e-01	2.94324e-06	-7.30021e-05
3	p2	1.71856e+00	3.00748e-01	5.96105e-05	-1.56093e-04
4	p3	-2.74627e+01	1.18415e+00	-4.83737e-05	1.95033e-05

5	p4	2.76154e-01	2.65912e-02	4.16057e-07	1.61279e-03
6	p5	3.00000e+01	fixed		

Probability 5.42101e-20
Nr of Edges found 2

Layer nr. 14

FCN=34.6566 FROM MIGRAD STATUS=CONVERGED 219 CALLS 220 TOTAL
EDM=2.36568e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.5
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81026e+01	2.01544e-01	1.16835e-05	-4.23389e-05
2	p1	-3.12038e+01	1.69712e-01	-1.13266e-05	-2.07309e-05
3	p2	1.40443e+00	2.03456e-01	1.05133e-05	-1.00570e-05
4	p3	-1.99257e+01	1.08138e+00	-4.28330e-05	1.95883e-05
5	p4	1.05583e-01	2.57666e-02	7.74631e-07	1.09057e-03
6	p5	3.00000e+01	fixed		

Probability 0.0736575
Nr of Edges found 2

Layer nr. 15

FCN=54.5746 FROM MIGRAD STATUS=CONVERGED 253 CALLS 254 TOTAL
EDM=7.6547e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.9
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83610e+01	1.44150e-01	3.06218e-05	9.70606e-05
2	p1	-2.98746e+01	1.10328e-01	8.05310e-06	8.95176e-05
3	p2	1.43173e+00	1.27058e-01	4.40540e-07	3.03217e-05
4	p3	-2.12323e+01	8.05319e-01	-1.06921e-04	-2.71396e-07
5	p4	1.36117e-01	1.84112e-02	4.41668e-06	-8.41181e-04
6	p5	3.00000e+01	fixed		

Probability 0.000357111
Nr of Edges found 2

Layer nr. 16

FCN=31.5407 FROM MIGRAD STATUS=CONVERGED 192 CALLS 193 TOTAL
EDM=9.94113e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.4
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83588e+01	1.53199e-01	1.76229e-05	-7.89432e-05
2	p1	-3.08968e+01	1.15966e-01	-2.03811e-05	-1.58501e-04
3	p2	1.37425e+00	1.39545e-01	-1.32334e-05	6.78422e-05
4	p3	-2.11176e+01	8.82018e-01	4.48840e-05	1.40000e-04
5	p4	1.27348e-01	2.04795e-02	-1.20936e-06	5.72095e-03
6	p5	3.00000e+01	fixed		

Probability 0.171736
Nr of Edges found 2

Layer nr. 17

FCN=67.8066 FROM MIGRAD STATUS=CONVERGED 241 CALLS 242 TOTAL
EDM=8.15139e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.0
per cent

EXT	PARAMETER			STEP	FIRST
-----	-----------	--	--	------	-------

NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81848e+01	1.39958e-01	5.43729e-06	5.09631e-04
2	p1	-3.29523e+01	1.05266e-01	-2.91077e-05	7.35321e-04
3	p2	1.60087e+00	2.08998e-01	1.05687e-04	4.69198e-05
4	p3	-2.18533e+01	7.69757e-01	-1.29568e-04	-1.72170e-04
5	p4	1.49340e-01	1.78548e-02	2.41137e-06	-6.17264e-03
6	p5	3.00000e+01	fixed		

Probability 8.10421e-06

Nr of Edges found 2

Layer nr. 18

FCN=38.4937 FROM MIGRAD STATUS=CONVERGED 192 CALLS 193 TOTAL
EDM=3.33729e-13 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.77958e+01	1.97455e-01	4.28729e-07	8.09486e-06
2	p1	-3.09052e+01	1.62579e-01	-2.31669e-06	8.87206e-06
3	p2	1.14335e+00	1.16247e-01	6.40409e-06	2.67816e-06
4	p3	-1.97396e+01	9.52345e-01	-7.95219e-05	1.98780e-06
5	p4	1.03552e-01	2.28598e-02	1.65257e-06	7.31220e-05
6	p5	3.00000e+01	fixed		

Probability 0.0413735

Nr of Edges found 2

Layer nr. 19

FCN=60.8776 FROM MIGRAD STATUS=CONVERGED 191 CALLS 192 TOTAL
EDM=3.75177e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.1

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.82854e+01	1.54720e-01	1.49267e-05	-1.22214e-05
2	p1	-3.05642e+01	1.13046e-01	2.22025e-06	2.17229e-07
3	p2	1.17898e+00	9.36764e-02	-3.11640e-06	1.22462e-04
4	p3	-2.04188e+01	8.26858e-01	-3.66050e-05	5.78074e-05
5	p4	1.21850e-01	1.91337e-02	7.92320e-07	2.32403e-03
6	p5	3.00000e+01	fixed		

Probability 7.90582e-05

Nr of Edges found 2

Layer nr. 20

FCN=48.5504 FROM MIGRAD STATUS=CONVERGED 172 CALLS 173 TOTAL
EDM=1.36484e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 3.0

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.84588e+01	1.54970e-01	2.72496e-06	3.35703e-05
2	p1	-3.14557e+01	1.23414e-01	-2.93524e-06	3.72923e-05
3	p2	1.17752e+00	9.70988e-02	-2.70638e-06	2.18163e-05
4	p3	-1.93380e+01	7.92071e-01	2.82352e-05	2.84964e-05
5	p4	8.84904e-02	1.82239e-02	-6.78265e-07	9.22231e-04
6	p5	3.00000e+01	fixed		

Probability 0.00320244

Nr of Edges found 2

Layer nr. 21
 FCN=61.2724 FROM MIGRAD STATUS=CONVERGED 179 CALLS 180 TOTAL
 EDM=1.70479e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 5.7

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83644e+01	1.62118e-01	1.27624e-05	1.25235e-05
2	p1	-3.25693e+01	1.27858e-01	-1.36626e-05	-1.24317e-04
3	p2	1.18977e+00	1.14527e-01	-1.11726e-05	-1.31690e-04
4	p3	-2.04127e+01	9.25140e-01	2.30174e-04	-5.88731e-05
5	p4	1.15881e-01	2.14875e-02	-5.14419e-06	-2.06618e-03
6	p5	3.00000e+01	fixed		

Probability 6.96672e-05
 Nr of Edges found 2

Layer nr. 22
 FCN=57.7756 FROM MIGRAD STATUS=CONVERGED 201 CALLS 202 TOTAL
 EDM=2.30169e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.6

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81861e+01	1.50324e-01	3.26024e-06	4.68038e-05
2	p1	-3.36199e+01	1.15437e-01	-6.03639e-06	3.37390e-05
3	p2	1.26506e+00	1.11833e-01	1.95345e-05	-1.38656e-04
4	p3	-1.96374e+01	6.54683e-01	1.40200e-05	2.12233e-04
5	p4	1.00386e-01	1.50622e-02	-1.07798e-07	8.48859e-03
6	p5	3.00000e+01	fixed		

Probability 0.000130729
 Nr of Edges found 2

Layer nr. 23
 FCN=56.6754 FROM MIGRAD STATUS=CONVERGED 224 CALLS 225 TOTAL
 EDM=8.66035e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.82316e+01	1.62666e-01	1.30770e-05	2.53329e-05
2	p1	-3.37805e+01	1.23984e-01	-2.80506e-06	9.13161e-06
3	p2	1.07368e+00	9.67947e-02	1.04294e-05	3.23417e-05
4	p3	-1.96077e+01	8.28669e-01	-6.02522e-05	4.62888e-05
5	p4	9.66684e-02	1.93490e-02	1.52713e-06	1.82993e-03
6	p5	3.00000e+01	fixed		

Probability 0.000295396
 Nr of Edges found 2

Layer nr. 24
 FCN=52.084 FROM MIGRAD STATUS=CONVERGED 205 CALLS 206 TOTAL
 EDM=2.30459e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.83656e+01	1.33302e-01	1.75634e-05	3.64230e-06
2	p1	-3.42354e+01	1.01692e-01	-1.99737e-05	2.50397e-04
3	p2	1.58290e+00	1.36149e-01	5.06494e-05	-1.06260e-04
4	p3	-2.01969e+01	6.45119e-01	1.35742e-04	-9.73943e-06
5	p4	1.13311e-01	1.49007e-02	-3.22340e-06	3.09921e-04

6 p5 3.00000e+01 fixed

Probability 0.000762907

Nr of Edges found 2

Layer nr. 25

FCN=39.8138 FROM MIGRAD STATUS=CONVERGED 184 CALLS 185 TOTAL
EDM=1.6587e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.8

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.81710e+01	1.59797e-01	-6.27188e-05	1.43794e-04
2	p1	-3.05019e+01	1.15555e-01	5.82124e-05	2.59786e-04
3	p2	1.07542e+00	8.55617e-02	-2.19450e-05	-5.06115e-05
4	p3	-1.89821e+01	8.47564e-01	3.72288e-04	-9.18672e-05
5	p4	7.96379e-02	1.98029e-02	-8.95535e-06	-3.09058e-03
6	p5	3.00000e+01	fixed		

Probability 0.0304745

Nr of Edges found 2

Layer nr. 26

FCN=56.142 FROM MIGRAD STATUS=CONVERGED 244 CALLS 245 TOTAL
EDM=5.77802e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.9

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.86599e+01	1.62970e-01	2.13764e-05	4.03770e-05
2	p1	-2.97868e+01	1.19012e-01	-1.78914e-05	6.45380e-05
3	p2	1.19311e+00	1.07454e-01	1.80460e-05	-5.14210e-05
4	p3	-2.13018e+01	7.97887e-01	-2.21062e-04	-7.57777e-05
5	p4	1.42373e-01	1.88050e-02	4.87087e-06	-2.49696e-03
6	p5	3.00000e+01	fixed		

Probability 0.000347862

Nr of Edges found 2

Layer nr. 27

FCN=36.1615 FROM MIGRAD STATUS=CONVERGED 250 CALLS 251 TOTAL
EDM=6.18147e-11 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.84126e+01	1.66813e-01	3.57024e-04	7.40696e-07
2	p1	-3.04798e+01	1.23011e-01	2.47618e-04	-2.39295e-05
3	p2	1.20441e+00	1.16974e-01	2.87950e-04	1.09893e-04
4	p3	-2.01009e+01	9.17686e-01	3.11862e-04	2.64709e-05
5	p4	1.14453e-01	2.16803e-02	7.38708e-06	6.76901e-04
6	p5	3.00000e+01	fixed		

Probability 0.0691843

Nr of Edges found 2

Layer nr. 28

FCN=11.3106 FROM MIGRAD STATUS=CONVERGED 445 CALLS 446 TOTAL
EDM=4.2456e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.2

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	4.94961e+01	2.00008e+01	-5.82463e-04	2.84970e-07

2	p1	-3.14067e+01	1.78792e-01	-5.71885e-06	8.62022e-07
3	p2	9.49811e-01	1.42127e-01	4.52261e-06	-1.78924e-05
4	p3	-4.61868e+01	5.63188e-01	-1.22387e-05	1.89078e-05
5	p4	6.49071e-02	4.12617e-02	1.30162e-06	4.05296e-04
6	p5	3.00000e+01	fixed		

Probability 0.33384
Nr of Edges found 1

Layer nr. 29

FCN=53.8939 FROM MIGRAD STATUS=CONVERGED 190 CALLS 191 TOTAL
EDM=1.13122e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 3.0

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.86235e+01	1.93731e-01	-1.32350e-05	-1.06619e-04
2	p1	-3.26971e+01	1.49416e-01	-8.67915e-06	-1.79565e-04
3	p2	8.65337e-01	7.87817e-02	1.34232e-05	-8.42915e-05
4	p3	-1.87486e+01	1.01324e+00	-1.17468e-04	-1.84326e-05
5	p4	7.88579e-02	2.36844e-02	2.95758e-06	-6.12836e-04
6	p5	3.00000e+01	fixed		

Probability 0.000685841
Nr of Edges found 2

Layer nr. 30

FCN=45.2632 FROM MIGRAD STATUS=CONVERGED 223 CALLS 224 TOTAL
EDM=4.79749e-10 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.84638e+01	1.65171e-01	3.64590e-04	-1.54852e-04
2	p1	-3.20789e+01	1.29700e-01	2.69507e-04	-1.54918e-05
3	p2	1.02687e+00	8.44525e-02	2.24063e-04	-1.98921e-04
4	p3	-1.96859e+01	8.42801e-01	3.06410e-04	1.08850e-04
5	p4	9.80277e-02	1.95697e-02	7.10849e-06	4.94269e-03
6	p5	3.00000e+01	fixed		

Probability 0.00542149
Nr of Edges found 2

////////////////////////////////////

Fitting parameters for y

```
/* parameters:
  p[0] - step width
  p[1] - x-offset of first step
  p[2] - slope of step
  p[3] - y-position of highest leg
  p[4] - linear slope
  p[5] - step hight
*/
```

Layer nr. 1

```
FCN=50.5966 FROM MIGRAD      STATUS=CONVERGED      410 CALLS      411 TOTAL
                        EDM=2.52538e-10      STRATEGY= 1      ERROR MATRIX ACCURATE
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
 1  p0      2.83566e+01      1.88550e-01      5.53183e-04      1.00847e-04
 2  p1      -4.69231e+00      8.35090e-02      2.47182e-04      9.83296e-05
 3  p2      1.99733e+00      3.54459e-01      9.48515e-04      4.97488e-05
 4  p3      -2.27912e+01      8.85021e-01      4.25540e-04      -1.08650e-04
 5  p4      1.70692e-01      2.00170e-02      9.62843e-06      -4.90653e-03
 6  p5      3.00000e+01      fixed
```

Prob 0.00118816
Nr of Edges found 2

Layer nr. 2

```
FCN=40.6785 FROM MIGRAD      STATUS=CONVERGED      218 CALLS      219 TOTAL
                        EDM=2.76279e-12      STRATEGY= 1      ERROR MATRIX UNCERTAINTY      2.4
per cent
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
 1  p0      2.85100e+01      1.76609e-01      1.15458e-05      1.75784e-06
 2  p1      -4.38570e+00      9.41762e-02      2.42690e-06      2.03074e-05
 3  p2      1.90921e+00      2.14527e-01      -2.50479e-06      1.48266e-05
 4  p3      -2.19125e+01      8.20625e-01      3.11619e-05      -3.96975e-06
 5  p4      1.51238e-01      1.86236e-02      -6.88998e-07      -3.20323e-04
 6  p5      3.00000e+01      fixed
```

Prob 0.0248081
Nr of Edges found 2

Layer nr. 3

```
FCN=88.1434 FROM MIGRAD      STATUS=CONVERGED      246 CALLS      247 TOTAL
                        EDM=1.74636e-09      STRATEGY= 1      ERROR MATRIX UNCERTAINTY      3.1
per cent
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
 1  p0      2.90883e+01      1.25801e-01      2.79230e-05      2.17400e-04
 2  p1      -3.31832e+01      1.39515e-01      -4.42636e-05      -2.36382e-04
 3  p2      1.76773e+00      2.57360e-01      2.53342e-05      -2.02684e-04
 4  p3      -2.84370e+01      1.70211e+00      2.71946e-04      2.98128e-04
 5  p4      1.67229e-01      2.30661e-02      -4.12555e-06      2.26321e-02
 6  p5      3.00000e+01      fixed
```

Prob 2.8988e-06
Nr of Edges found 3

Layer nr. 4

FCN=10.8647 FROM MIGRAD STATUS=CONVERGED 982 CALLS 983 TOTAL
EDM=7.13481e-10 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	1.69177e+02	7.32290e+02	2.56513e-02	-1.48066e-06
2	p1	-4.25328e+00	1.11014e-01	1.76962e-04	-1.53414e-04
3	p2	1.53370e+00	2.37918e-01	2.93964e-04	2.18475e-05
4	p3	-4.62140e+01	7.29741e-01	2.64209e-04	-8.80036e-05
5	p4	1.61403e-02	7.75787e-02	2.55322e-06	-1.45609e-02
6	p5	3.00000e+01	fixed		

Prob 0.36816

Nr of Edges found 1

Layer nr. 5

FCN=69.842 FROM MIGRAD STATUS=CONVERGED 244 CALLS 245 TOTAL
EDM=2.62455e-09 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.3

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.87133e+01	9.50232e-02	3.17956e-05	-6.28191e-04
2	p1	-3.33177e+01	1.09621e-01	-3.01460e-05	-5.91748e-04
3	p2	1.81442e+00	2.05669e-01	-1.63178e-05	2.65860e-04
4	p3	-2.39555e+01	1.14990e+00	-1.03003e-04	-1.30024e-04
5	p4	1.22226e-01	1.58162e-02	9.70793e-07	-6.12915e-03
6	p5	3.00000e+01	fixed		

Prob 0.00174626

Nr of Edges found 3

Layer nr. 6

FCN=76.7628 FROM MIGRAD STATUS=CONVERGED 274 CALLS 275 TOTAL
EDM=3.62854e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.8

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.88101e+01	1.05962e-01	8.30022e-07	1.00263e-06
2	p1	-3.33874e+01	1.35638e-01	-5.07153e-06	-1.61978e-05
3	p2	1.54694e+00	1.76911e-01	3.72249e-06	6.29431e-05
4	p3	-2.34388e+01	1.21947e+00	5.29131e-05	2.52074e-05
5	p4	1.17288e-01	1.70281e-02	-7.20550e-07	1.79564e-03
6	p5	3.00000e+01	fixed		

Prob 5.85684e-05
Nr of Edges found 3

Layer nr. 7

FCN=44.5633 FROM MIGRAD STATUS=CONVERGED 318 CALLS 319 TOTAL
EDM=3.16667e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 3.0
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.87180e+01	9.05832e-02	8.10173e-06	6.23832e-05
2	p1	-3.35750e+01	1.16657e-01	-1.17537e-05	-2.17127e-05
3	p2	1.67107e+00	1.68509e-01	-1.44724e-05	-3.44020e-05
4	p3	-2.55096e+01	1.20127e+00	2.65966e-04	8.72318e-05
5	p4	1.46020e-01	1.67429e-02	-3.67986e-06	6.54439e-03
6	p5	3.00000e+01	fixed		

Prob 0.129023
Nr of Edges found 3

Layer nr. 8

FCN=54.2678 FROM MIGRAD STATUS=CONVERGED 375 CALLS 376 TOTAL
EDM=1.57169e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.2
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.88112e+01	7.51579e-02	6.49873e-06	-1.51393e-05
2	p1	-3.31313e+01	1.04856e-01	1.99194e-05	-2.28681e-04
3	p2	2.30934e+00	3.38597e-01	-1.12942e-05	-1.00590e-06
4	p3	-2.61348e+01	1.11961e+00	-7.96086e-05	1.67214e-04
5	p4	1.53656e-01	1.53278e-02	1.59607e-06	1.14789e-02
6	p5	3.00000e+01	fixed		

Prob 0.0259033
Nr of Edges found 3

Layer nr. 9

FCN=65.4556 FROM MIGRAD STATUS=CONVERGED 220 CALLS 221 TOTAL
EDM=1.14908e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 0.9
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.87484e+01	1.13233e-01	-4.03426e-06	-2.99080e-05
2	p1	-3.32759e+01	1.48438e-01	1.20776e-05	-2.55694e-05
3	p2	1.22126e+00	1.16798e-01	6.37279e-06	2.40324e-06

4	p3	-2.36543e+01	1.31132e+00	5.77649e-05	3.30283e-06
5	p4	1.17052e-01	1.80292e-02	-7.32156e-07	1.92369e-04
6	p5	3.00000e+01	fixed		

Prob 0.00369359
Nr of Edges found 3

Layer nr. 10

FCN=94.6239 FROM MIGRAD		STATUS=CONVERGED		243 CALLS	244 TOTAL
EDM=5.49186e-11		STRATEGY= 1		ERROR MATRIX ACCURATE	
EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.86511e+01	9.14523e-02	2.40255e-04	3.94599e-06
2	p1	-3.32681e+01	1.08450e-01	2.74940e-04	1.11160e-05
3	p2	1.75688e+00	2.04590e-01	8.53038e-04	4.90070e-05
4	p3	-2.38514e+01	1.02895e+00	3.80477e-04	5.11278e-05
5	p4	1.21230e-01	1.41757e-02	5.24157e-06	3.53092e-03
6	p5	3.00000e+01	fixed		

Prob 2.54589e-06
Nr of Edges found 3

Layer nr. 11

FCN=46.5605 FROM MIGRAD		STATUS=CONVERGED		349 CALLS	350 TOTAL
EDM=4.52244e-11		STRATEGY= 1		ERROR MATRIX ACCURATE	
EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.82910e+01	1.65271e-01	4.88725e-04	-1.43404e-05
2	p1	-4.40907e+00	9.24805e-02	2.46154e-04	-6.01080e-05
3	p2	1.81042e+00	2.01034e-01	5.81716e-04	-1.81539e-06
4	p3	-2.19650e+01	8.74161e-01	4.14691e-04	6.03495e-05
5	p4	1.51345e-01	1.98750e-02	9.47649e-06	2.32824e-03
6	p5	3.00000e+01	fixed		

Prob 0.00167395
Nr of Edges found 2

Layer nr. 12

FCN=103.447 FROM MIGRAD		STATUS=CONVERGED		265 CALLS	266 TOTAL	
EDM=1.7825e-10		STRATEGY= 1		ERROR MATRIX UNCERTAINTY		2.5
per cent						
EXT	PARAMETER			STEP	FIRST	
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE	
1	p0	2.84537e+01	1.11197e-01	3.62029e-05	-6.08805e-05	
2	p1	-3.34879e+01	1.43864e-01	-4.69322e-05	1.35712e-04	

3	p2	1.25024e+00	1.15066e-01	2.55287e-06	-4.78650e-05
4	p3	-2.22778e+01	1.30174e+00	-3.99474e-05	9.14716e-06
5	p4	9.88020e-02	1.81890e-02	4.72088e-07	7.11173e-04
6	p5	3.00000e+01	fixed		

Prob 5.21646e-09
Nr of Edges found 3

Layer nr. 13

The nr of steps is more than 3 or 0 but there are only functions for 1 to 3 steps defined. There were 0 found. The Nr will be set to 1

FCN=751.363 FROM MIGRAD STATUS=CONVERGED 827 CALLS 828 TOTAL
EDM=7.61541e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7
per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.07739e+01	1.10548e+00	-9.06778e-05	-1.75488e-05
2	p1	-2.15083e+01	6.28544e-01	-1.79437e-05	1.46192e-05
3	p2	-5.67790e-01	1.03756e-01	-1.05362e-06	4.67766e-05
4	p3	-6.59741e+01	6.31510e-01	1.77910e-05	-2.89177e-05
5	p4	9.33701e-01	1.05038e-02	8.03465e-07	-2.31969e-03
6	p5	3.00000e+01	fixed		

Prob 0
Nr of Edges found 0

Layer nr. 14
Set for y

FCN=58.5552 FROM MIGRAD STATUS=CONVERGED 258 CALLS 259 TOTAL
EDM=3.20313e-09 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.70659e+01	2.59510e-01	7.05335e-04	2.39591e-04
2	p1	-4.17962e+00	1.57218e-01	4.43920e-04	3.90300e-04
3	p2	1.05582e+00	2.05527e-01	5.24308e-04	-2.44443e-04
4	p3	-1.86003e+01	1.57202e+00	5.52926e-04	-3.43290e-04
5	p4	8.00242e-02	3.88411e-02	1.35858e-05	-1.43832e-02
6	p5	3.00000e+01	fixed		

Prob 0.000164867
Nr of Edges found 2

Layer nr. 15

FCN=67.4374 FROM MIGRAD STATUS=CONVERGED 213 CALLS 214 TOTAL
EDM=4.77012e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.8

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.89533e+01	1.07263e-01	-2.14231e-05	9.66133e-05
2	p1	-3.33708e+01	1.36719e-01	1.11143e-05	2.06764e-04
3	p2	1.51923e+00	1.68958e-01	-2.34318e-05	1.48338e-04
4	p3	-2.32857e+01	1.28346e+00	-2.49914e-04	-2.76433e-04
5	p4	1.09194e-01	1.74570e-02	3.31609e-06	-1.95926e-02
6	p5	3.00000e+01	fixed		

Prob 0.00314245

Nr of Edges found 3

Layer nr. 16

FCN=43.4103 FROM MIGRAD STATUS=CONVERGED 199 CALLS 200 TOTAL
EDM=5.99632e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 4.7

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.87597e+01	1.07267e-01	-1.20058e-05	4.20078e-05
2	p1	-3.32599e+01	1.43413e-01	2.12667e-05	2.61122e-05
3	p2	1.56968e+00	1.69300e-01	3.41656e-05	6.78852e-05
4	p3	-2.34018e+01	1.16377e+00	-3.31698e-04	6.78480e-05
5	p4	1.14915e-01	1.62846e-02	4.74529e-06	4.07883e-03
6	p5	3.00000e+01	fixed		

Prob 0.251723

Nr of Edges found 3

Layer nr. 17

FCN=73.2941 FROM MIGRAD STATUS=CONVERGED 236 CALLS 237 TOTAL
EDM=1.12499e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.5

per cent

EXT PARAMETER				STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	3.01360e+01	2.43349e-01	4.82340e-05	4.56172e-05
2	p1	-3.42621e+01	2.02358e-01	-6.44041e-05	-4.01573e-05
3	p2	1.23589e+00	1.61372e-01	3.41978e-05	-4.00600e-05
4	p3	-5.92476e+01	1.30407e+00	-1.34719e-04	3.40527e-05
5	p4	2.43727e-01	2.77846e-02	2.43870e-06	2.12373e-03
6	p5	3.00000e+01	fixed		

Prob 1.23336e-06

Nr of Edges found 2

Layer nr. 18

FCN=40.7732 FROM MIGRAD STATUS=CONVERGED 268 CALLS 269 TOTAL
EDM=1.4589e-11 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER	VALUE	ERROR	STEP	FIRST
NO.	NAME			SIZE	DERIVATIVE
1	p0	2.92165e+01	2.21452e-01	4.11433e-04	-1.39387e-05
2	p1	-5.08004e+00	1.87544e-01	3.06403e-04	2.16428e-05
3	p2	1.39642e+00	2.00948e-01	4.57335e-04	-1.48246e-05
4	p3	-2.09051e+01	9.18252e-01	3.69095e-04	-2.05084e-05
5	p4	1.35007e-01	2.17451e-02	8.63105e-06	-8.35426e-04
6	p5	3.00000e+01	fixed		

Prob 0.0242495
Nr of Edges found 2

Layer nr. 19

FCN=78.8011 FROM MIGRAD STATUS=CONVERGED 262 CALLS 263 TOTAL
EDM=7.88265e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7

per cent

EXT	PARAMETER	VALUE	ERROR	STEP	FIRST
NO.	NAME			SIZE	DERIVATIVE
1	p0	2.89792e+01	1.09097e-01	2.24629e-05	1.68830e-04
2	p1	-3.35469e+01	1.50723e-01	-8.12760e-05	6.05209e-05
3	p2	1.10806e+00	1.07752e-01	-1.08223e-05	-3.70607e-06
4	p3	-2.25337e+01	1.39190e+00	3.22353e-04	-4.37112e-06
5	p4	9.94994e-02	1.90926e-02	-5.34775e-06	2.71852e-04
6	p5	3.00000e+01	fixed		

Prob 0.000166817
Nr of Edges found 3

Layer nr. 20

FCN=79.9844 FROM MIGRAD STATUS=CONVERGED 265 CALLS 266 TOTAL
EDM=1.78684e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.9

per cent

EXT	PARAMETER	VALUE	ERROR	STEP	FIRST
NO.	NAME			SIZE	DERIVATIVE
1	p0	2.87290e+01	9.73416e-02	2.26667e-05	-8.55895e-05
2	p1	-3.31028e+01	1.29209e-01	-7.41853e-06	-2.59404e-05
3	p2	1.63003e+00	2.02067e-01	2.32652e-05	1.68161e-05
4	p3	-2.57407e+01	1.25952e+00	-1.24740e-04	2.34133e-05
5	p4	1.46319e-01	1.72929e-02	1.82283e-06	1.81375e-03
6	p5	3.00000e+01	fixed		

Prob 0.000120269
Nr of Edges found 3

Layer nr. 21

```
FCN=96.268 FROM MIGRAD      STATUS=CONVERGED      265 CALLS      266 TOTAL
                        EDM=6.48213e-10      STRATEGY= 1      ERROR MATRIX ACCURATE
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
1  p0      2.90388e+01      1.24833e-01      2.90865e-04      -1.62413e-04
2  p1      -3.34634e+01      1.69103e-01      3.68001e-04      -2.30768e-04
3  p2      1.24709e+00      1.28931e-01      4.89579e-04      -2.31525e-04
4  p3      -2.46503e+01      1.52563e+00      5.05235e-04      1.91345e-04
5  p4      1.29871e-01      2.09228e-02      6.92317e-06      1.48504e-02
6  p5      3.00000e+01      fixed
```

Prob 1.53637e-06

Nr of Edges found 3

Layer nr. 22

yMax=-15.5172

```
FCN=48.2599 FROM MIGRAD      STATUS=CONVERGED      277 CALLS      278 TOTAL
                        EDM=1.22445e-10      STRATEGY= 1      ERROR MATRIX ACCURATE
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
1  p0      2.87424e+01      1.11282e-01      1.82760e-04      2.97760e-05
2  p1      -3.30959e+01      1.56161e-01      2.44159e-04      2.19335e-05
3  p2      1.30607e+00      1.29504e-01      3.61717e-04      -1.41408e-04
4  p3      -2.33709e+01      1.25787e+00      2.99906e-04      -4.53100e-05
5  p4      1.11451e-01      1.73187e-02      4.12224e-06      -2.61643e-03
6  p5      3.00000e+01      fixed
```

Prob 0.123018

Nr of Edges found 3

Layer nr. 23

```
FCN=70.9523 FROM MIGRAD      STATUS=CONVERGED      202 CALLS      203 TOTAL
                        EDM=4.55582e-12      STRATEGY= 1      ERROR MATRIX UNCERTAINTY      1.5
```

per cent

```
EXT  PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
      NAME      VALUE      ERROR      SIZE      DERIVATIVE
1  p0      2.86609e+01      9.72035e-02      -3.54405e-06      -3.02553e-05
2  p1      -3.30814e+01      1.37643e-01      -1.23730e-06      -2.04768e-05
3  p2      1.35700e+00      1.25178e-01      1.05465e-05      -1.61720e-05
4  p3      -2.38531e+01      1.27908e+00      -2.31477e-05      3.66803e-05
5  p4      1.19752e-01      1.78241e-02      2.90556e-07      2.59010e-03
6  p5      3.00000e+01      fixed
```

Prob 0.00132275

Nr of Edges found 3

Layer nr. 24

FCN=62.2029 FROM MIGRAD STATUS=CONVERGED 193 CALLS 194 TOTAL
EDM=3.89835e-11 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.9

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.88162e+01	1.06891e-01	1.77749e-05	-5.47696e-05
2	p1	-3.29064e+01	1.34980e-01	-1.27116e-05	-3.40465e-05
3	p2	1.25277e+00	1.08307e-01	-3.92840e-06	5.00369e-05
4	p3	-2.19813e+01	1.21251e+00	1.12505e-04	-1.94597e-05
5	p4	9.36740e-02	1.67277e-02	-1.40205e-06	-2.19960e-03
6	p5	3.00000e+01	fixed		

Prob 0.0105106

Nr of Edges found 3

xnull<-20 -60.233

Layer nr. 25

yMax=-15.303

FCN=62.4135 FROM MIGRAD STATUS=CONVERGED 190 CALLS 191 TOTAL
EDM=9.59002e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 3.5

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.89062e+01	1.23120e-01	2.25618e-05	2.49314e-04
2	p1	-3.26577e+01	1.55603e-01	6.24576e-06	4.38361e-08
3	p2	1.06456e+00	9.71388e-02	-6.31359e-06	-3.40987e-04
4	p3	-2.06723e+01	1.28566e+00	-1.21164e-04	5.36028e-04
5	p4	7.77676e-02	1.80024e-02	2.30818e-06	3.93095e-02
6	p5	3.00000e+01	fixed		

Prob 0.0131938

Nr of Edges found 3

Layer nr. 26

FCN=55.987 FROM MIGRAD STATUS=CONVERGED 233 CALLS 234 TOTAL
EDM=6.17952e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 1.7

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.87706e+01	9.87990e-02	-2.52194e-06	1.46494e-05
2	p1	-3.31297e+01	1.40290e-01	1.19905e-06	2.82899e-05
3	p2	1.25453e+00	1.18696e-01	1.88502e-06	-1.72585e-05
4	p3	-2.16878e+01	1.27569e+00	1.73855e-05	1.61545e-05
5	p4	9.10521e-02	1.75788e-02	-2.86539e-07	1.12946e-03
6	p5	3.00000e+01	fixed		

Prob 0.0233925

Nr of Edges found 3

Layer nr. 27

FCN=59.1198 FROM MIGRAD STATUS=CONVERGED 190 CALLS 191 TOTAL
EDM=6.57466e-12 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.5

per cent

EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.97993e+01	2.27033e-01	-1.39206e-05	1.96003e-05
2	p1	-3.34465e+01	2.08425e-01	8.23237e-06	1.62344e-05
3	p2	1.25826e+00	1.31858e-01	2.13007e-05	-1.66892e-05
4	p3	-5.11069e+01	8.82961e-01	-5.71086e-05	-3.07311e-05
5	p4	1.28045e-01	1.96358e-02	1.53018e-06	-1.42756e-03
6	p5	3.00000e+01	fixed		

Prob 0.000138085

Nr of Edges found 2

Layer nr. 28

FCN=9.04085 FROM MIGRAD STATUS=CONVERGED 966 CALLS 967 TOTAL
EDM=1.25161e-10 STRATEGY= 1 ERR MATRIX NOT POS-DEF

EXT	PARAMETER		APPROXIMATE	STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.13704e+02	1.09737e+03	1.27118e-01	-1.89981e-07
2	p1	2.44884e+01	1.49907e-01	2.21678e-04	1.15095e-05
3	p2	1.28245e+00	2.50450e-01	3.58054e-04	1.12715e-05
4	p3	-1.62967e+01	4.08085e-01	3.87784e-04	-3.77656e-05
5	p4	5.14156e-03	2.84919e-02	3.16342e-06	-7.63823e-03
6	p5	3.00000e+01	fixed		

Prob 0.433512

Nr of Edges found 1

Layer nr. 29

FCN=75.6173 FROM MIGRAD STATUS=CONVERGED 218 CALLS 219 TOTAL
EDM=3.42638e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY

NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.90091e+01	1.39946e-01	-5.65965e-05	1.15544e-04
2	p1	-3.28575e+01	1.77032e-01	4.15351e-05	1.77542e-04
3	p2	1.02922e+00	1.01277e-01	2.83940e-05	-3.16166e-04
4	p3	-2.37832e+01	1.66014e+00	-5.95796e-04	-1.46733e-04
5	p4	1.13896e-01	2.25841e-02	8.04161e-06	-1.00164e-02
6	p5	3.00000e+01	fixed		

Prob 0.000394797

Nr of Edges found 3

Layer nr. 30

FCN=79.2993 FROM MIGRAD STATUS=CONVERGED 202 CALLS 203 TOTAL
EDM=1.17205e-10 STRATEGY= 1 ERROR MATRIX UNCERTAINTY 2.4

per cent

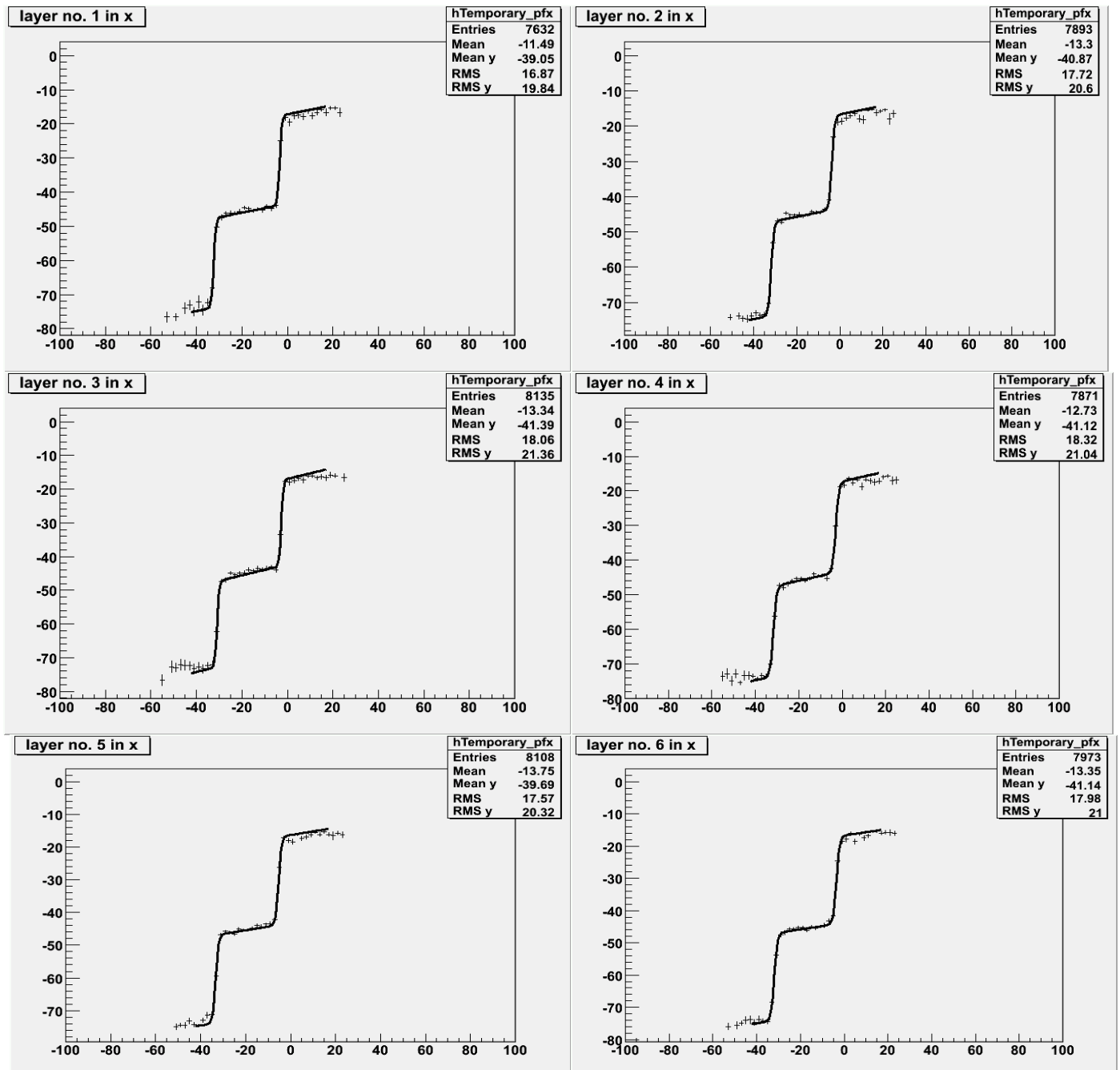
EXT	PARAMETER			STEP	FIRST
NO.	NAME	VALUE	ERROR	SIZE	DERIVATIVE
1	p0	2.88491e+01	1.16701e-01	-8.91056e-06	1.82525e-04
2	p1	-3.24455e+01	1.53546e-01	1.05284e-05	1.27659e-04
3	p2	1.00784e+00	7.83847e-02	1.65827e-06	1.31862e-04
4	p3	-2.13420e+01	1.30547e+00	-1.30129e-05	-2.25782e-05
5	p4	8.65915e-02	1.79989e-02	2.95741e-07	-1.16869e-03

6 p5 3.00000e+01 fixed

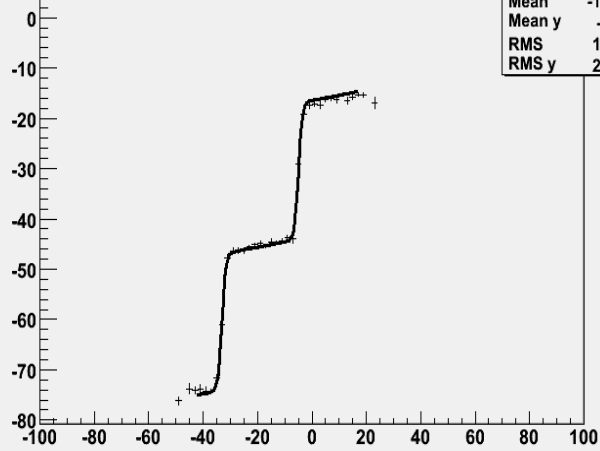
Prob 0.000145416
Nr of Edges found 3

Plots for x

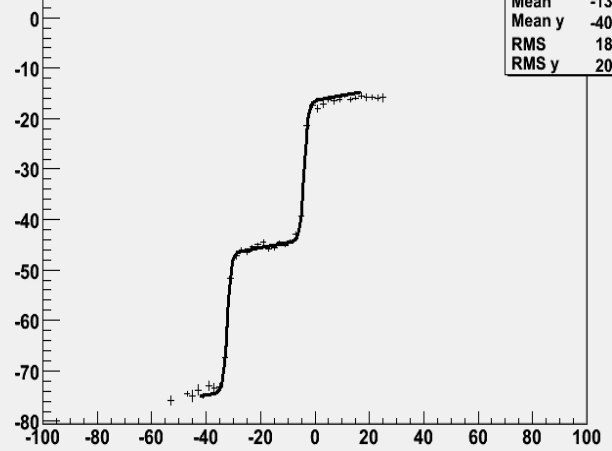
The x axis is always extrapolated tracks from the DCs
The y axis is always hits in the HCAL



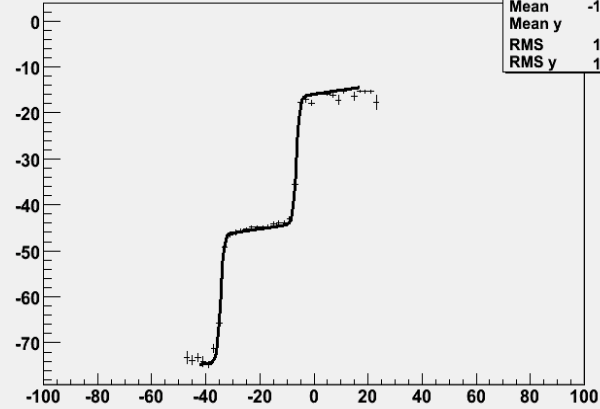
layer no. 7 in x



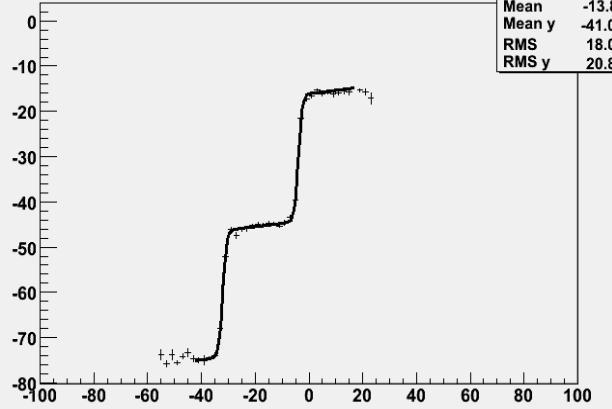
layer no. 8 in x



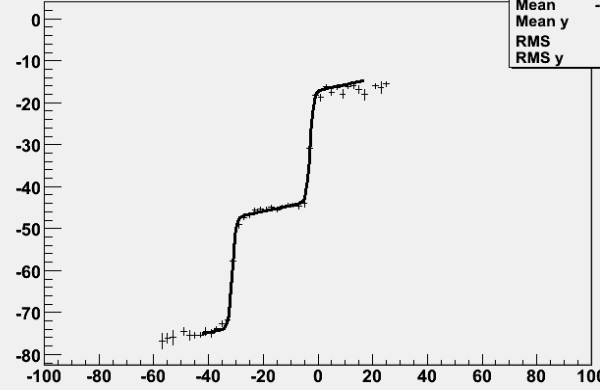
layer no. 9 in x



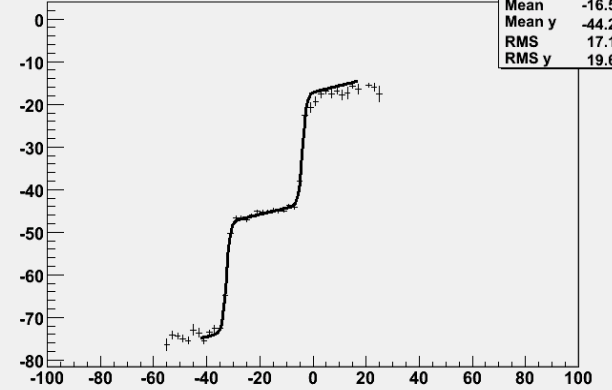
layer no. 10 in x



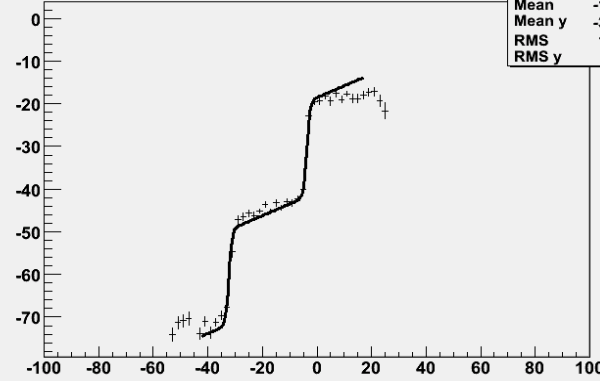
layer no. 11 in x



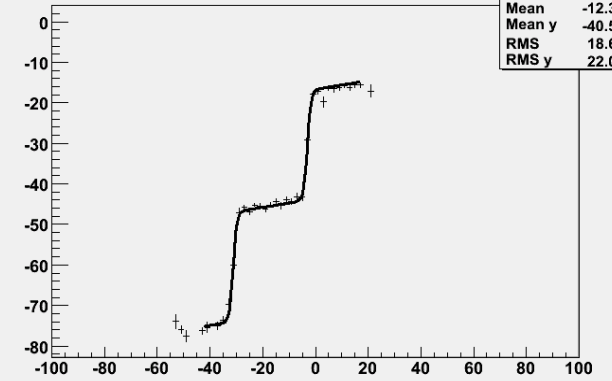
layer no. 12 in x

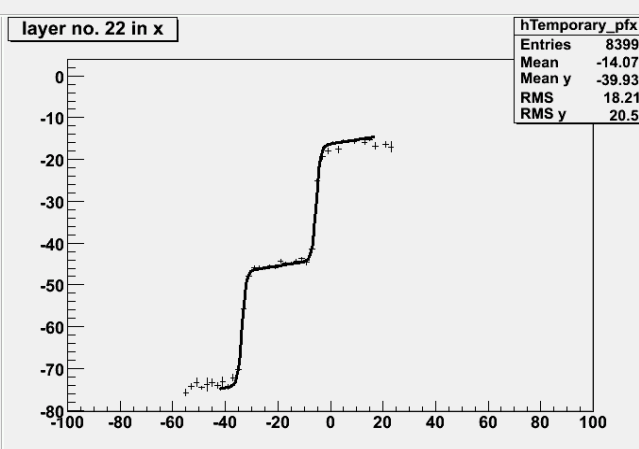
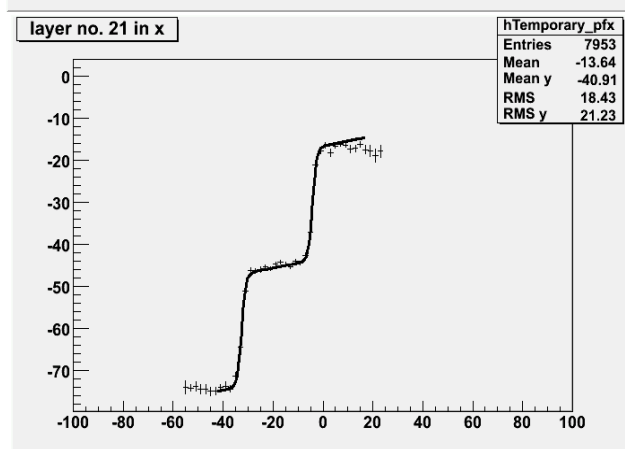
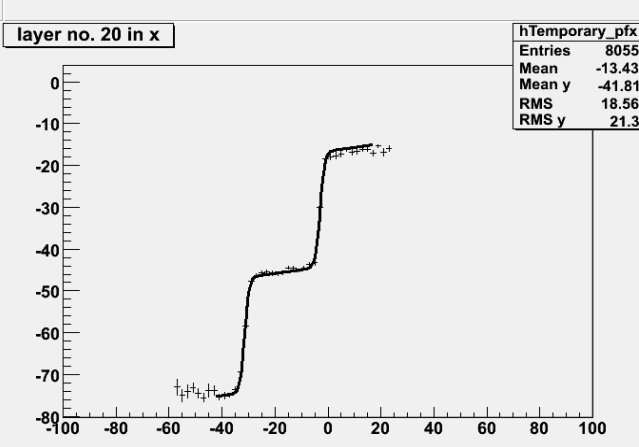
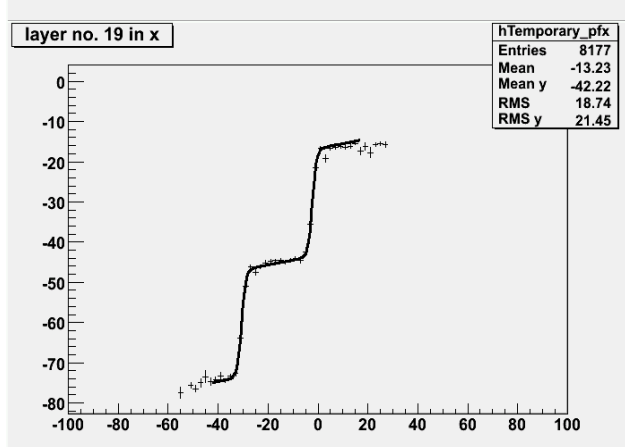
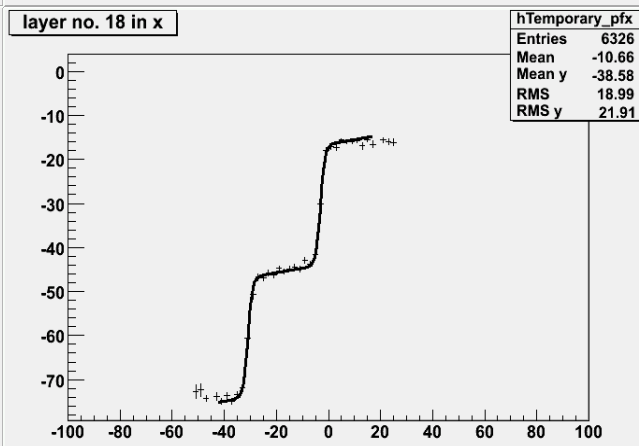
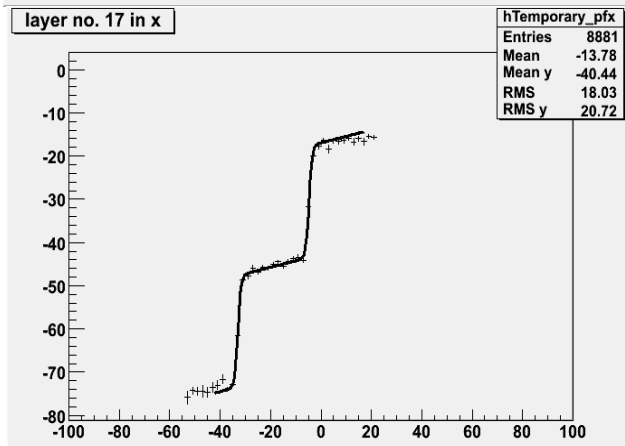
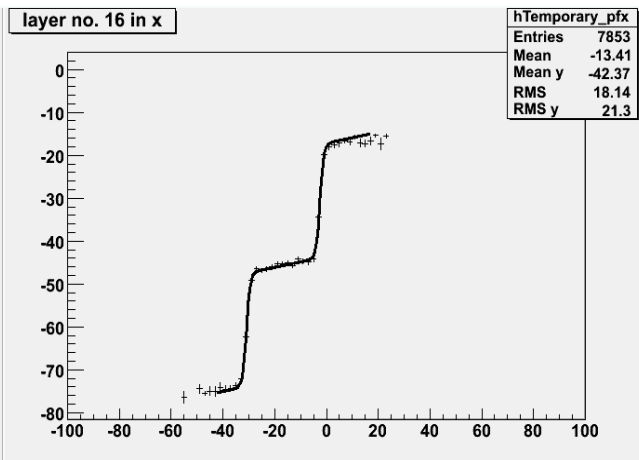
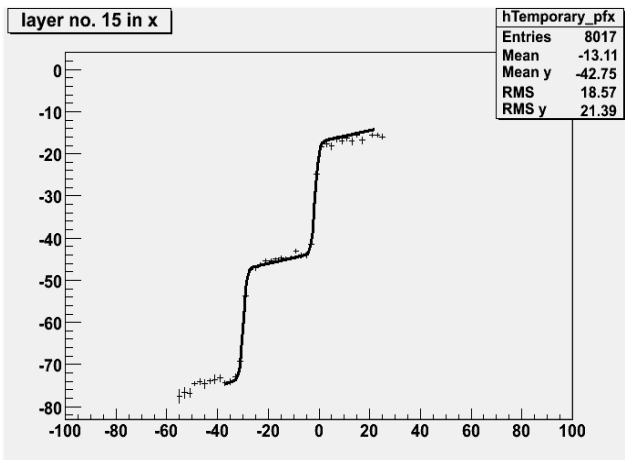


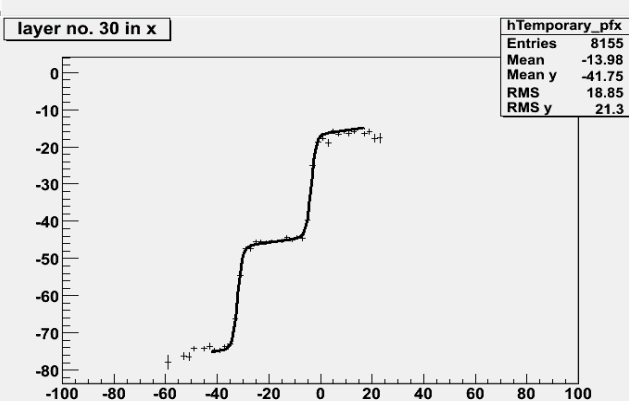
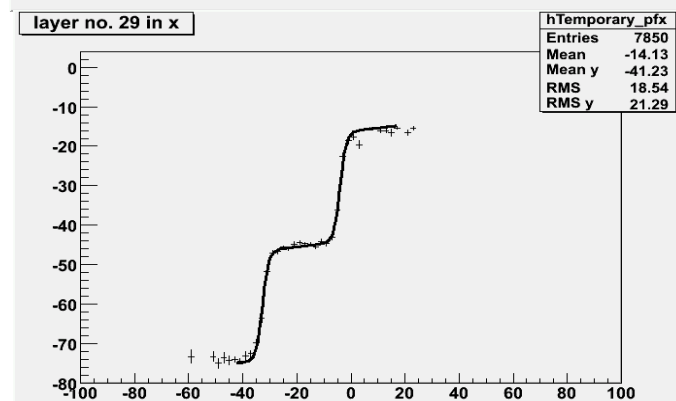
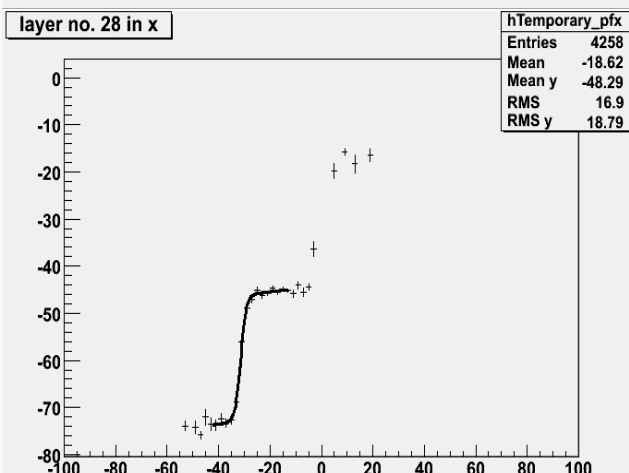
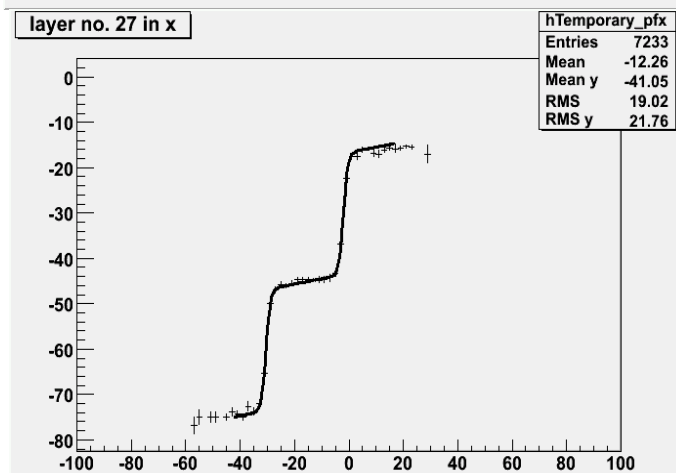
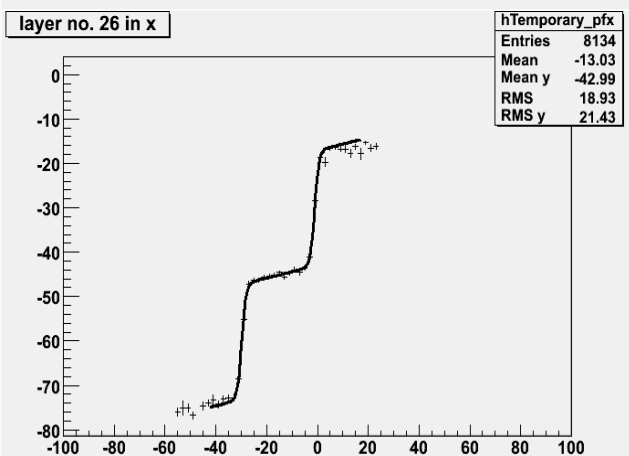
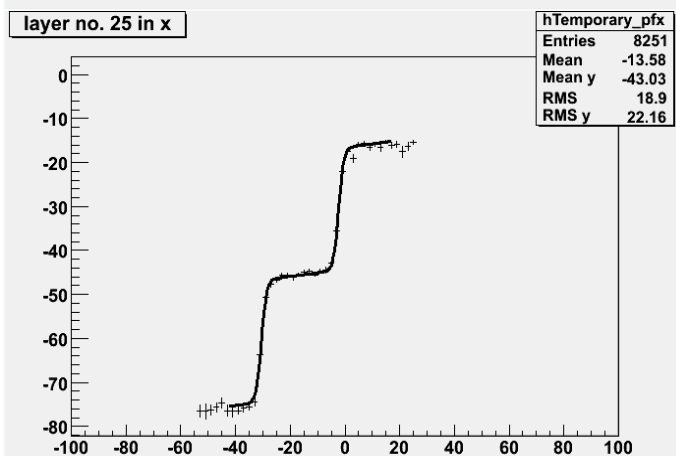
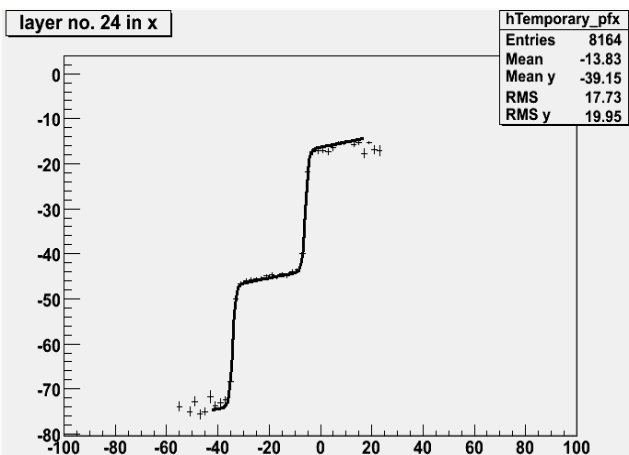
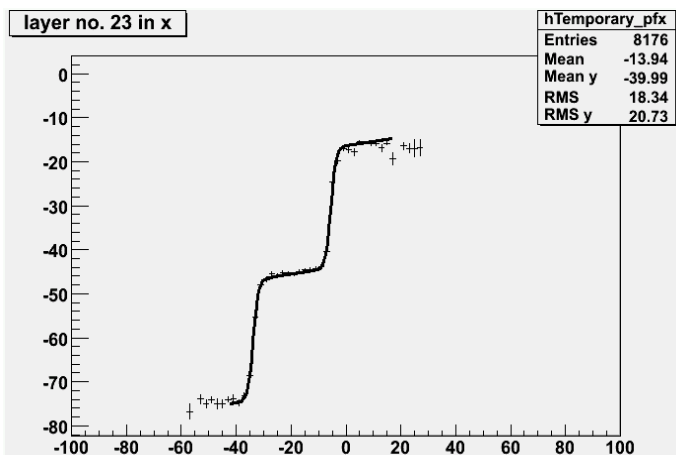
layer no. 13 in x



layer no. 14 in x



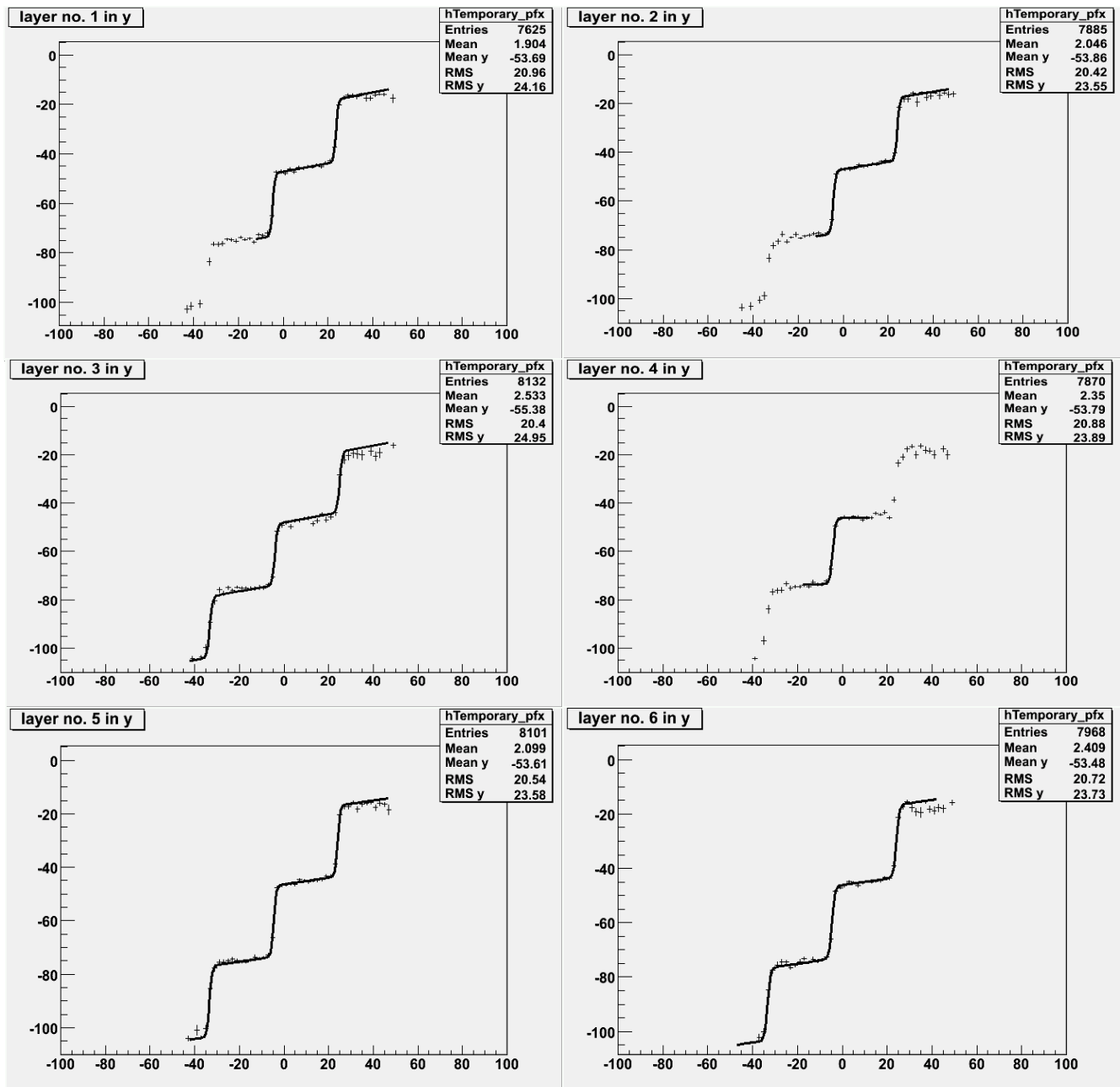




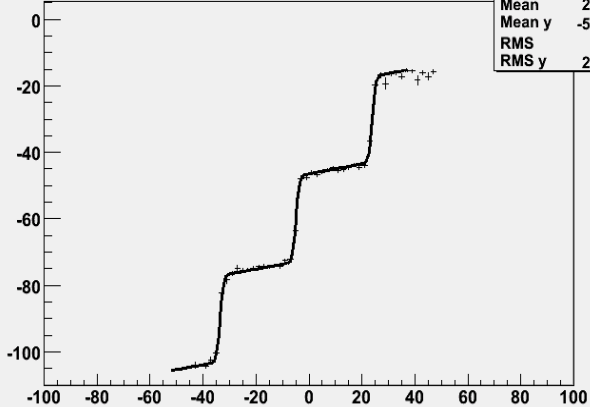
Plots for y

The x axis is always extrapolated tracks from the DCs

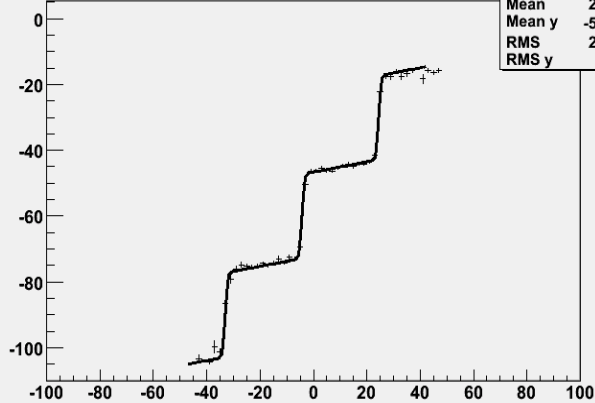
The y axis is always hits in the HCAL



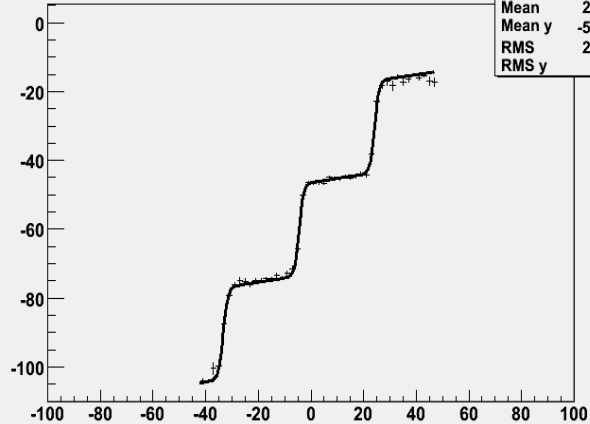
layer no. 7 in y



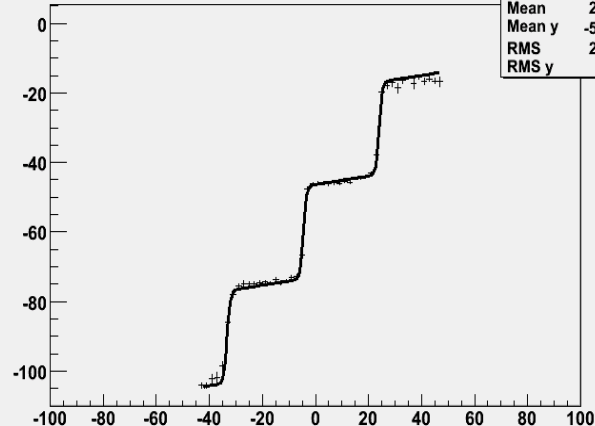
layer no. 8 in y



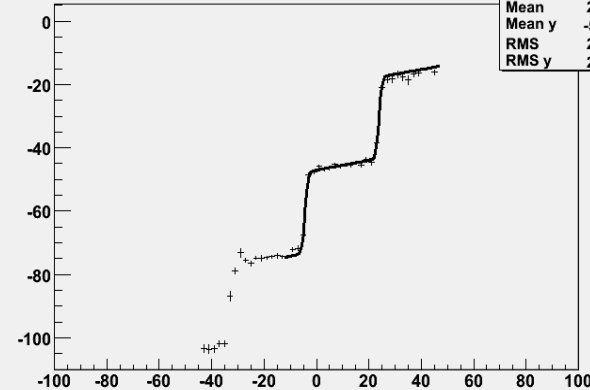
layer no. 9 in y



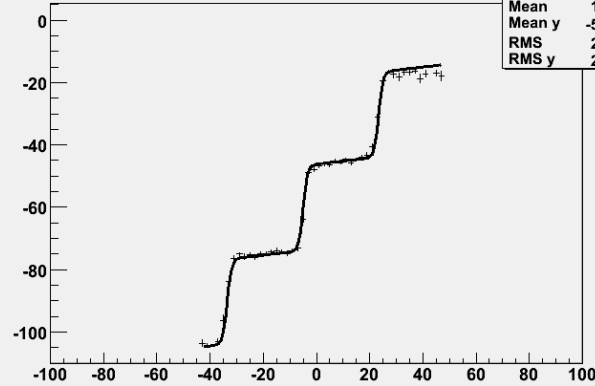
layer no. 10 in y



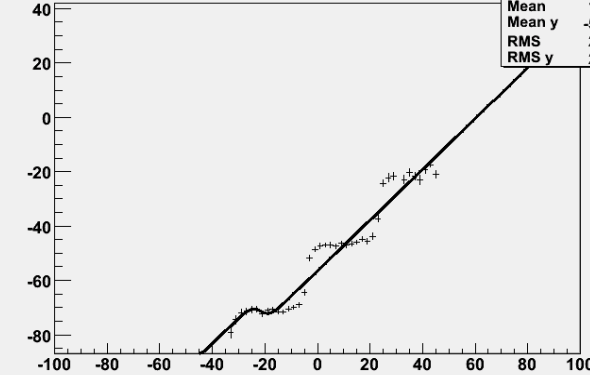
layer no. 11 in y



layer no. 12 in y



layer no. 13 in y



layer no. 14 in y

