Testbeam results

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EUDET Annual Meeting - JRA 1 Parallel Session
8/10/2007

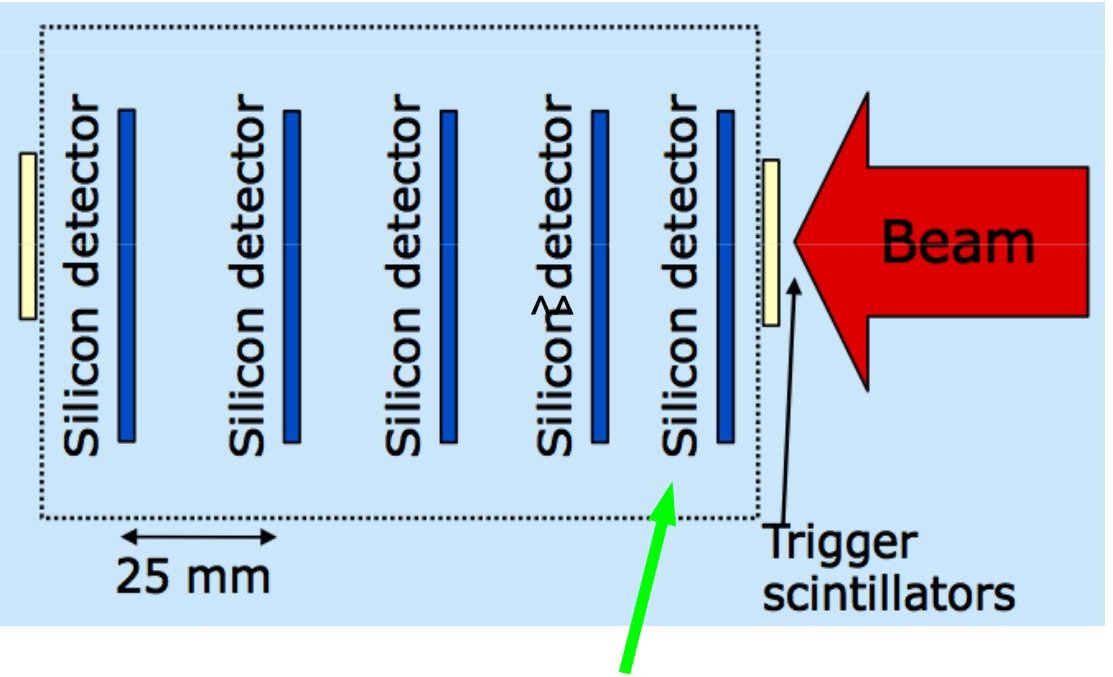
Results shown were produced by:
Antonio Bulgheroni, Aleksander Filip Zarnecki, Ph. R.

Will not talk about the analysis software
→ see talk by Antonio Bulgheroni in this session.

Testbeam at DESY (August)

Electron beam

first sensor:
thin (14 µm) epi layer



100.000 events 3 GeV RAW mode
100.000 events 6 GeV RAW mode

100.000 events 6 GeV mixed (RAW + Zero suppressed)

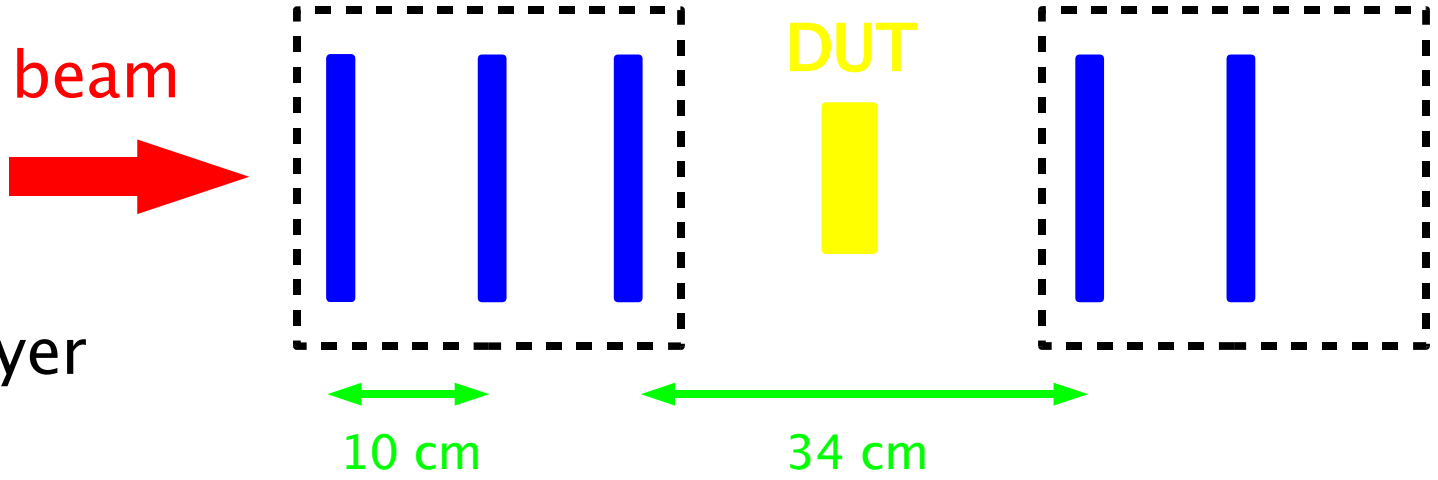
450.000 events 6 GeV Zero suppressed

Testbeam at CERN (September)

180 GeV π^+ beam

5 sensors

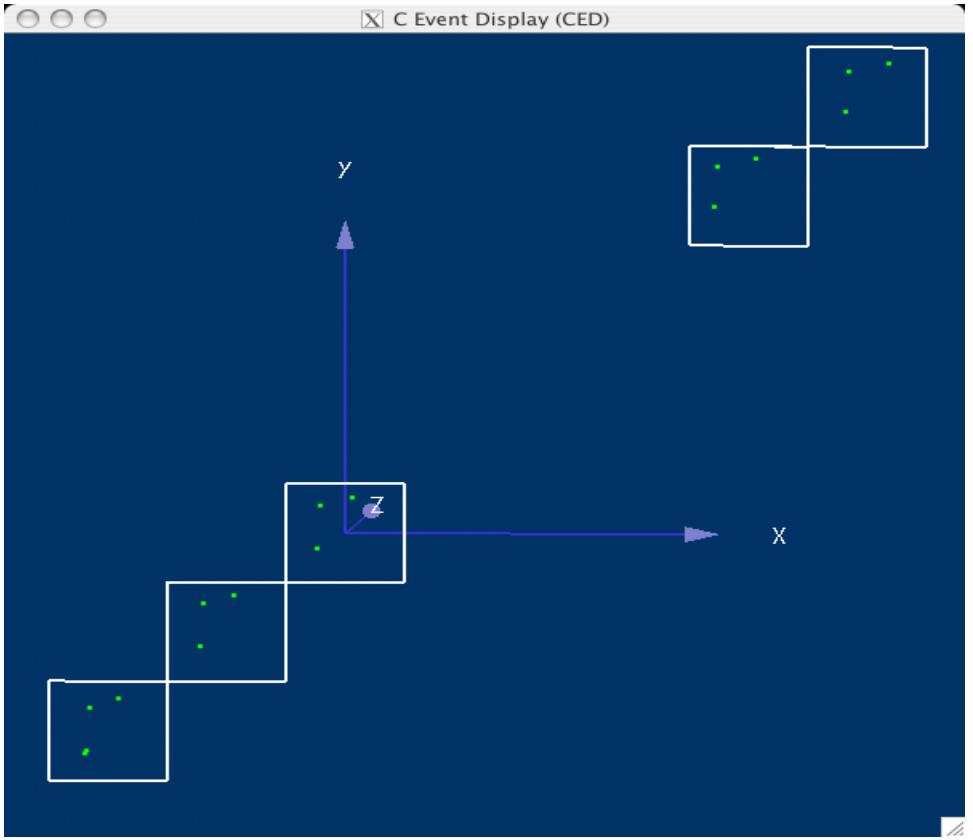
first three sensors:
thin (14 µm) epi layer



RAW mode:
80.000 events, “medium” multiplicity ≈ 5.5

100.000 events, “high” multiplicity ≈ 40, DEPFET as DUT
6.000 events, “low” multiplicity ≈ 3.5, DEPFET as DUT

Zero suppressed:
120.000 events with “high multiplicity” setting, DEPFET as DUT

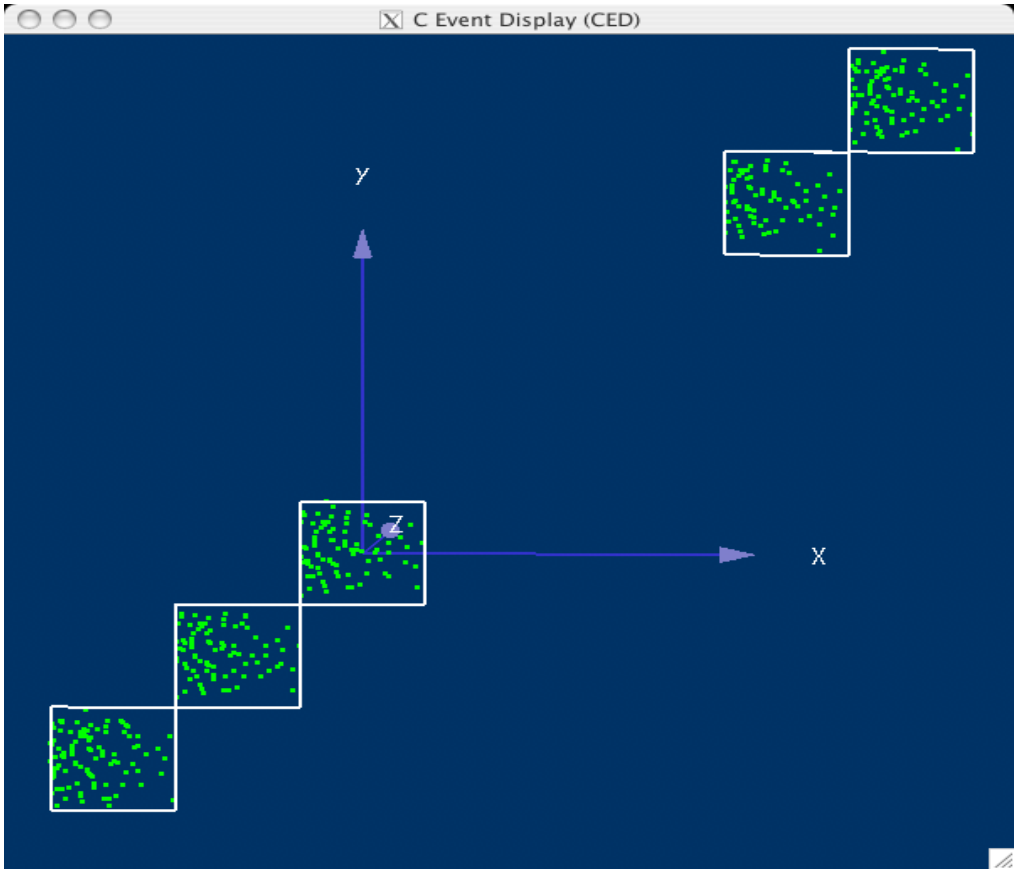


“Low” multiplicity data:

Very useful to understand tracking and alignment.

“High” multiplicity data

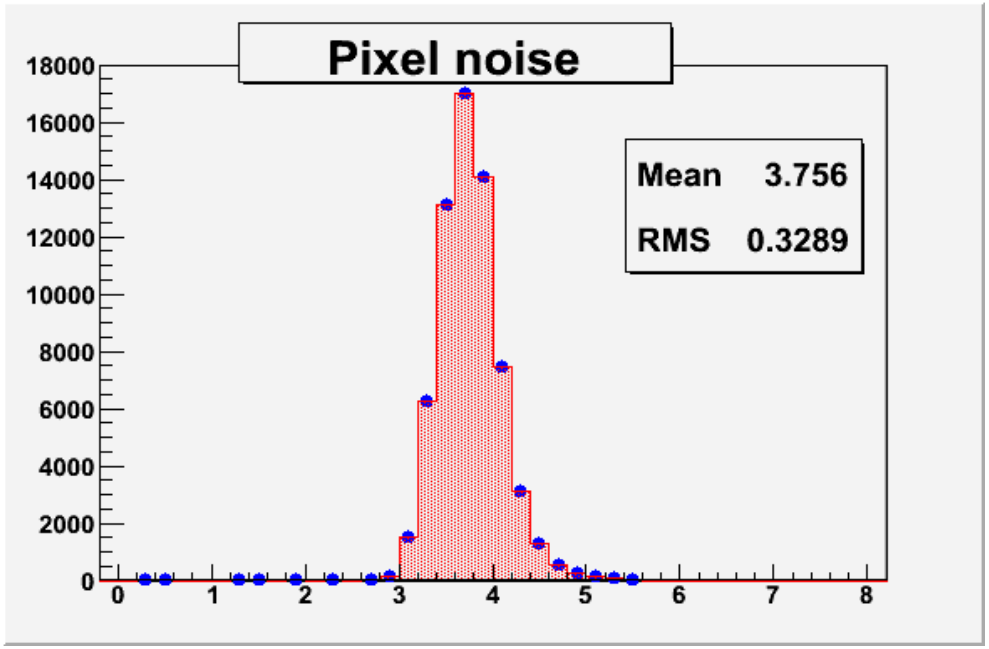
4.6 million hits!



Data processing

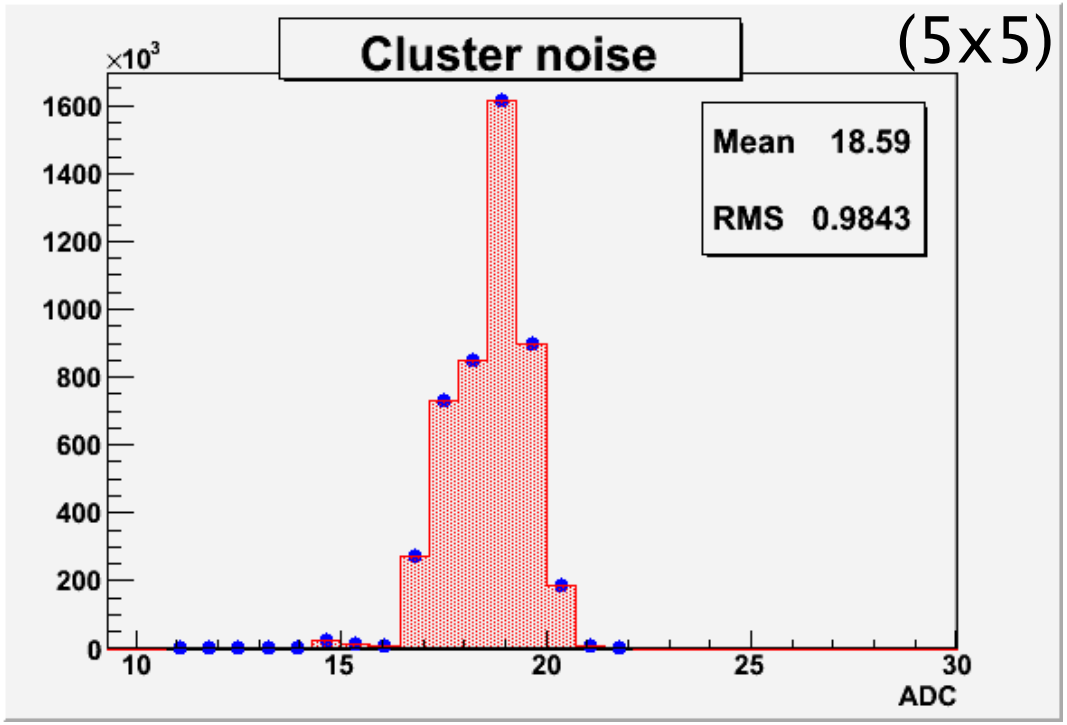
- Size of recorded data: 630 GB for August
  430 GB for September
- Stored on tape at DESY
- All time consuming processing steps (conversion to LCIO, cluster finding) were performed on the GRID.

Noise distributions



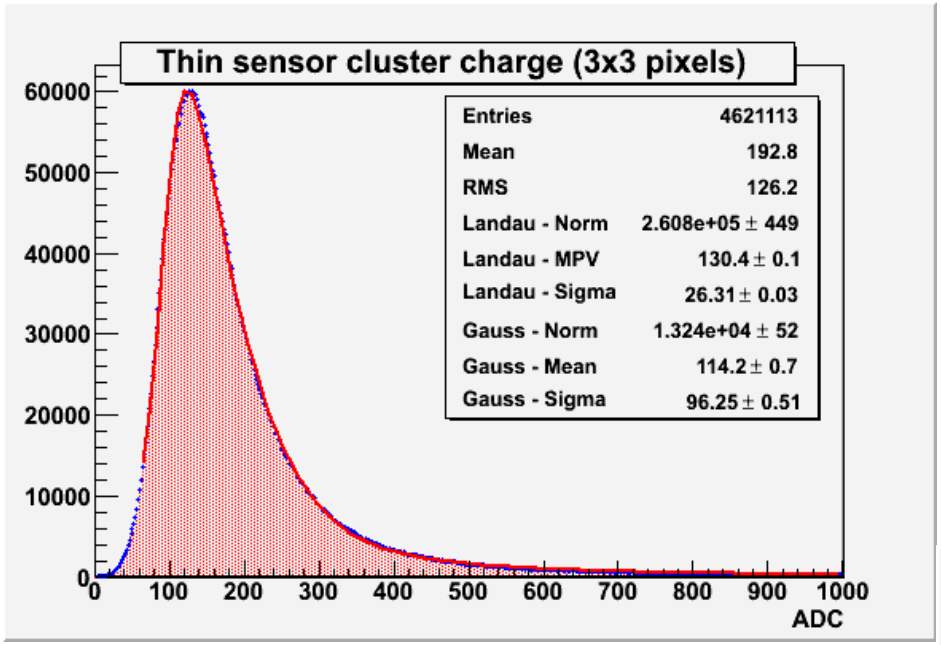
CERN “high” multiplicity” data
(very similar for DESY data)

14 µm epi layer



Plots provided by
A. Bulgheroni

Signal distributions

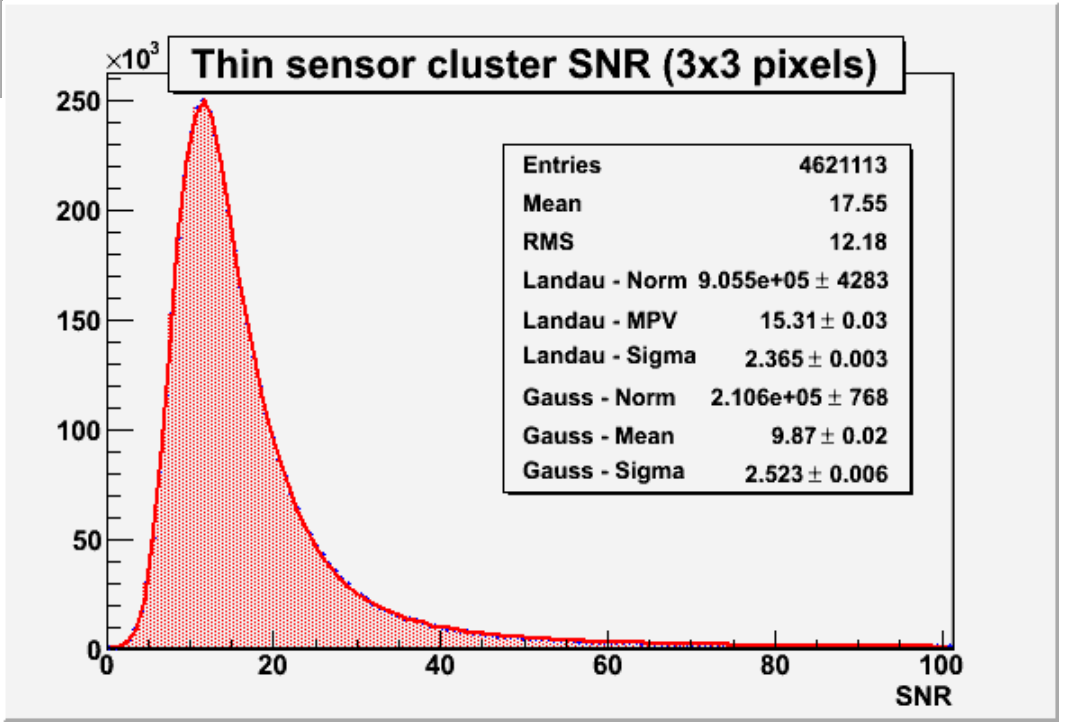


Blue points: data
Red line: fit

Sum of landau + gaussian gives nice agreement

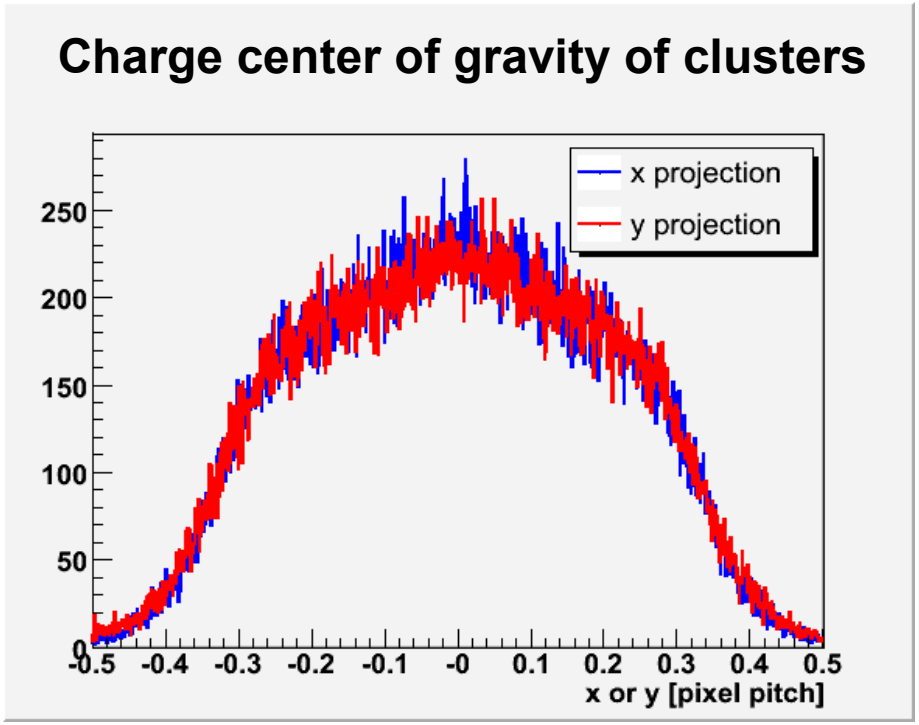
CERN “high multiplicity” data

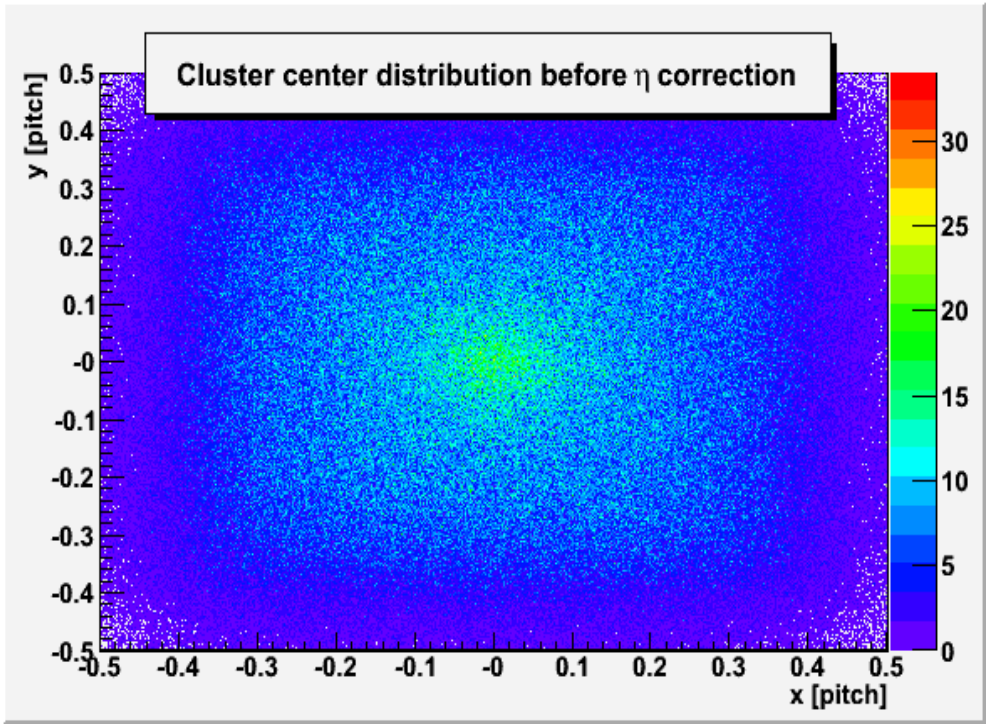
14 µm epi layer



Eta function correction

The cluster center spacial distribution should be flat within one pixel.



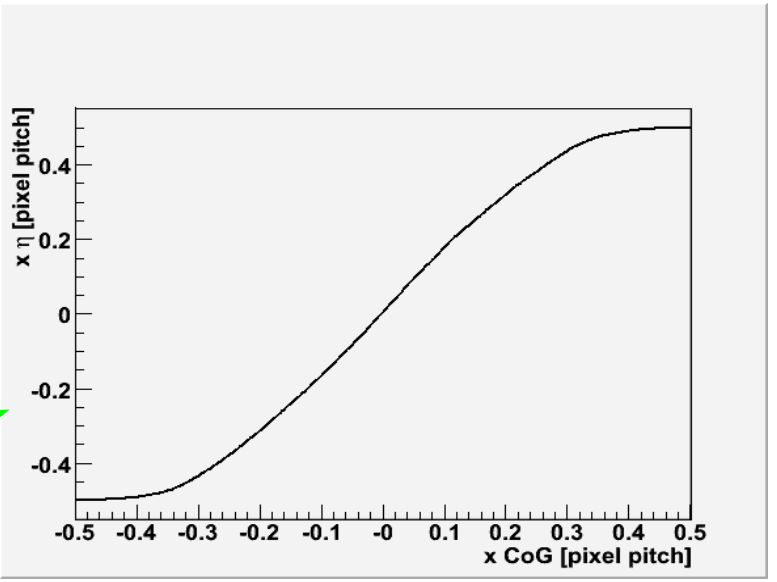


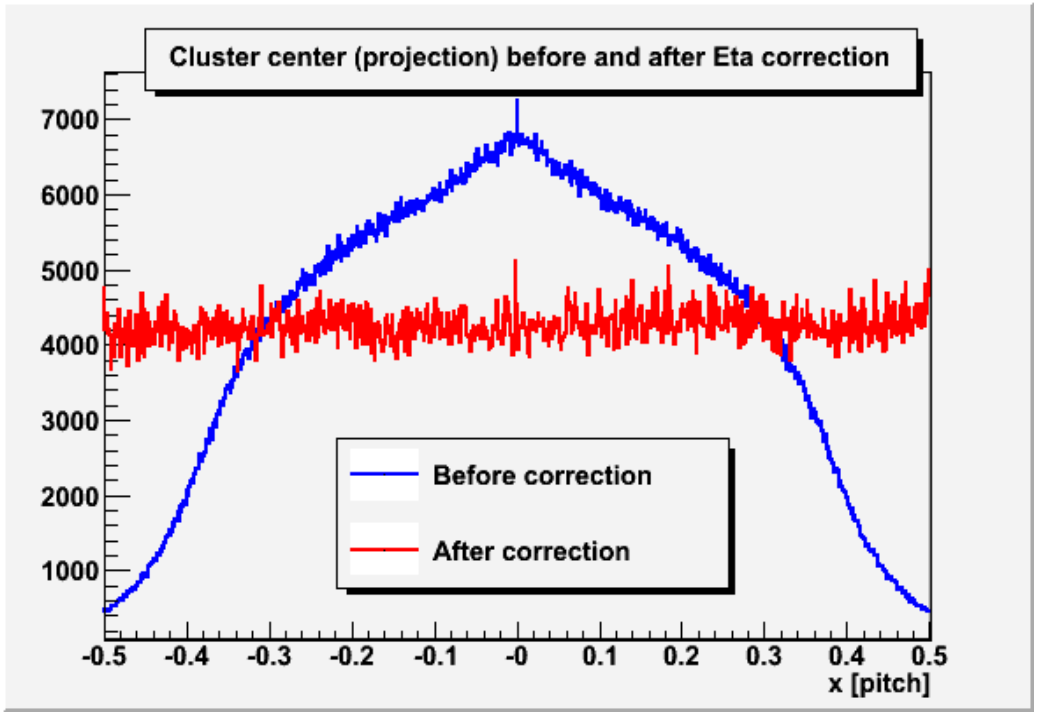
6 GeV DESY data

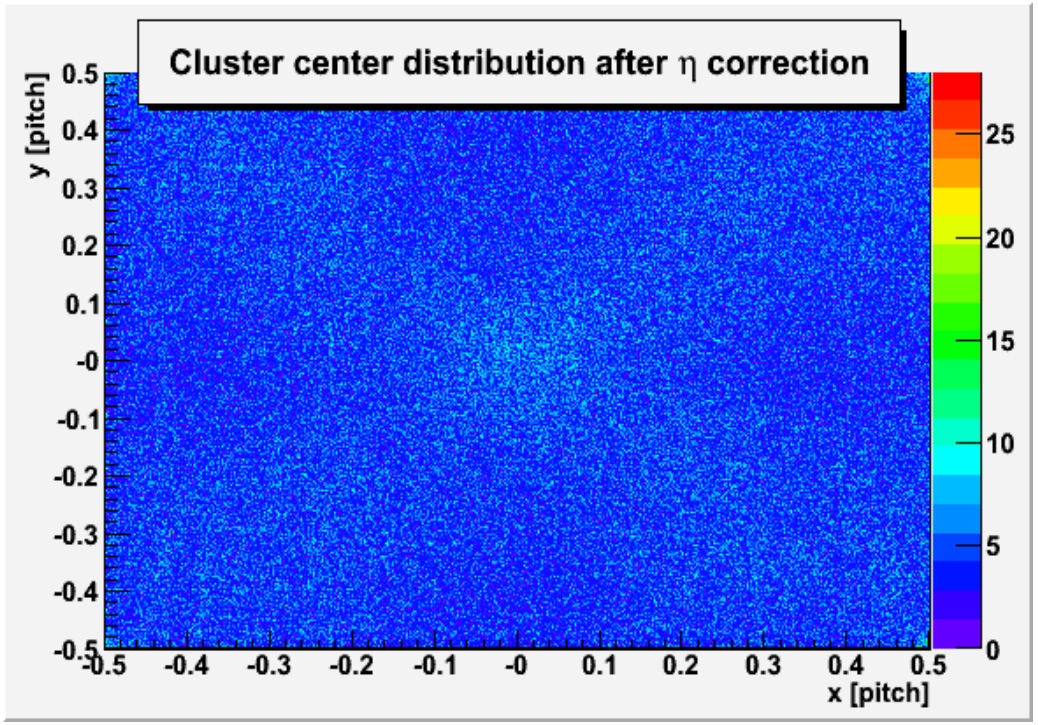
→ Use non-linear weighting function for cluster center calculation.

The eta-function was calculated on a subset of the data:

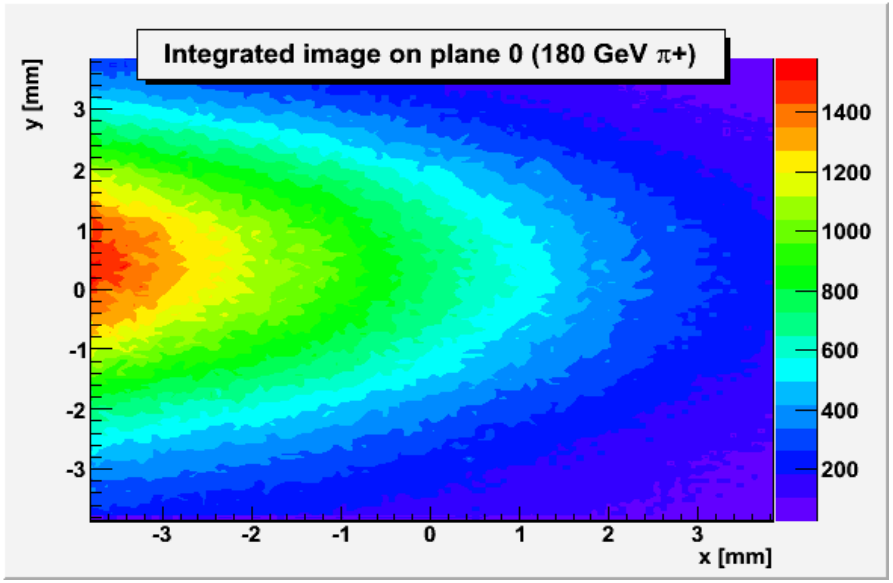
- Both coordinates were treated separately.
- For all clusters the CoG was calculated.
- This distribution is integrated.
- The integral is normalised by the highest value and shifted down by half. → eta function

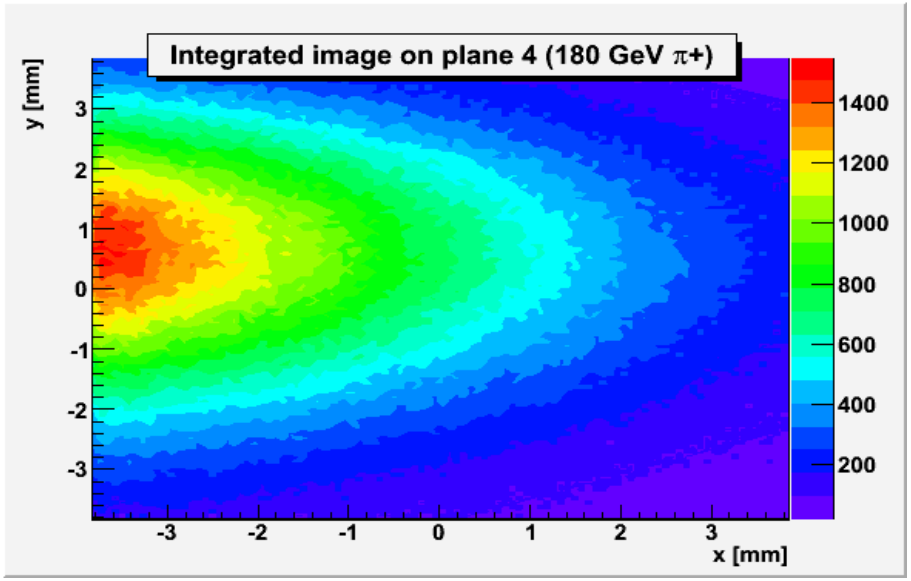






Hit maps



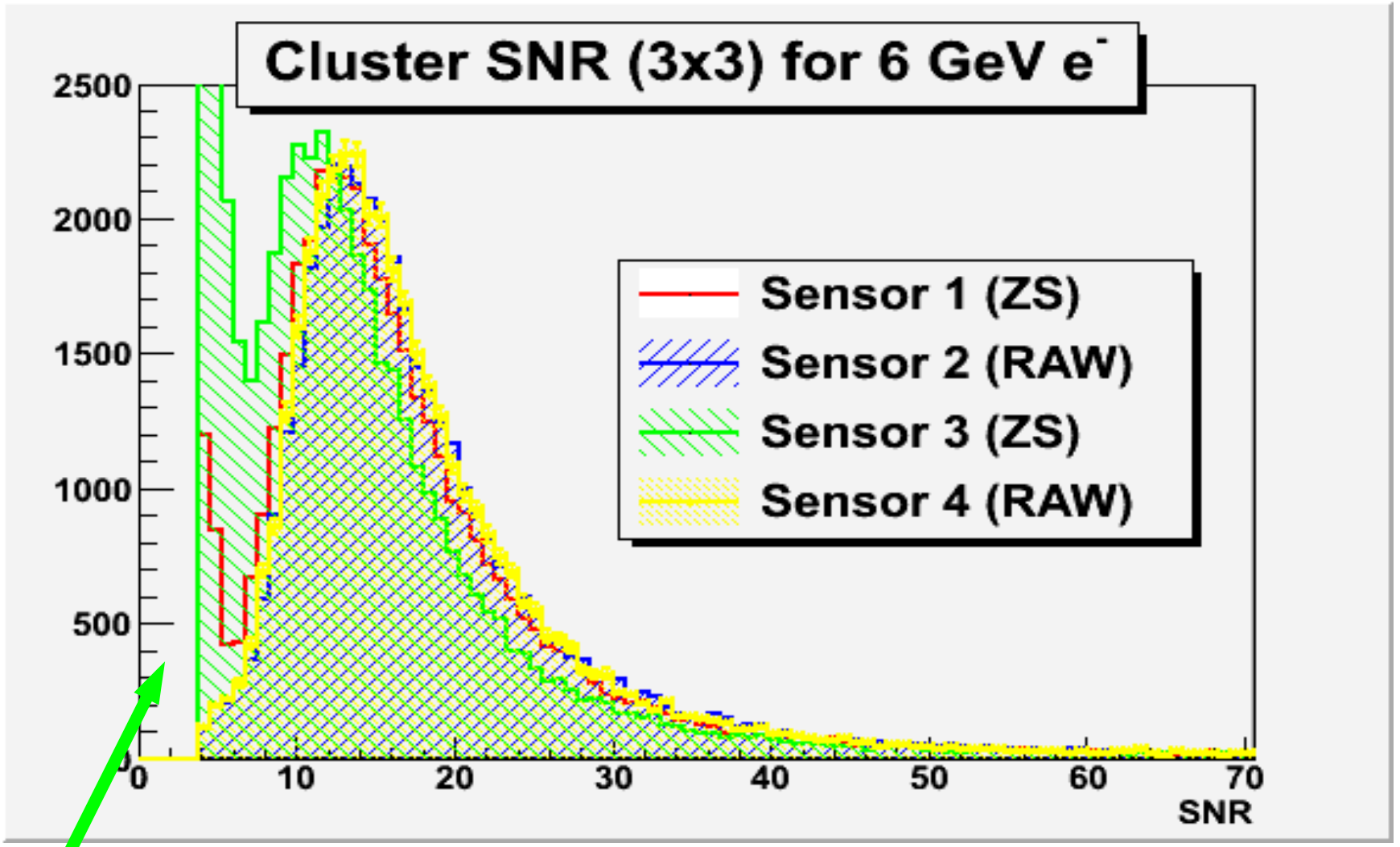


CERN “high multiplicity” data

Hits transformed to telescope frame of reference

Structure of beam visible

First look at zero suppression



"Noisy sensor"

All sensors: 20 µm epi layer

Line fitting

- The existing line fitting proccessor was extented to handle more than one track per event.

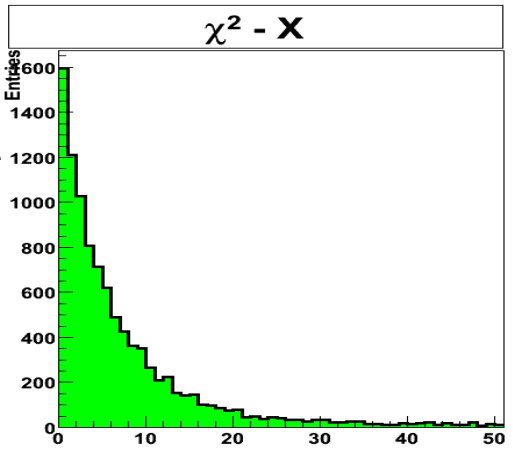
- **Simple alignment:**
Align three sensors in the first box by minimising the difference between the measured position and the prediction from the previous sensor (2 offsets and three angles). Then use tracks from first box to align the other two sensors.

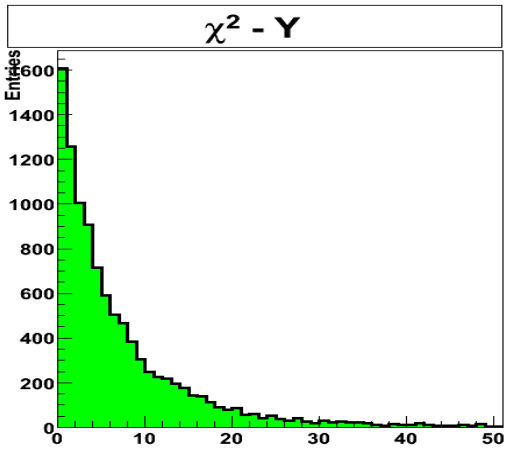
- The sensor in the middle opeates as DUT and the other sensors were used to fit tracks.

- CERN “low” multiplicity data

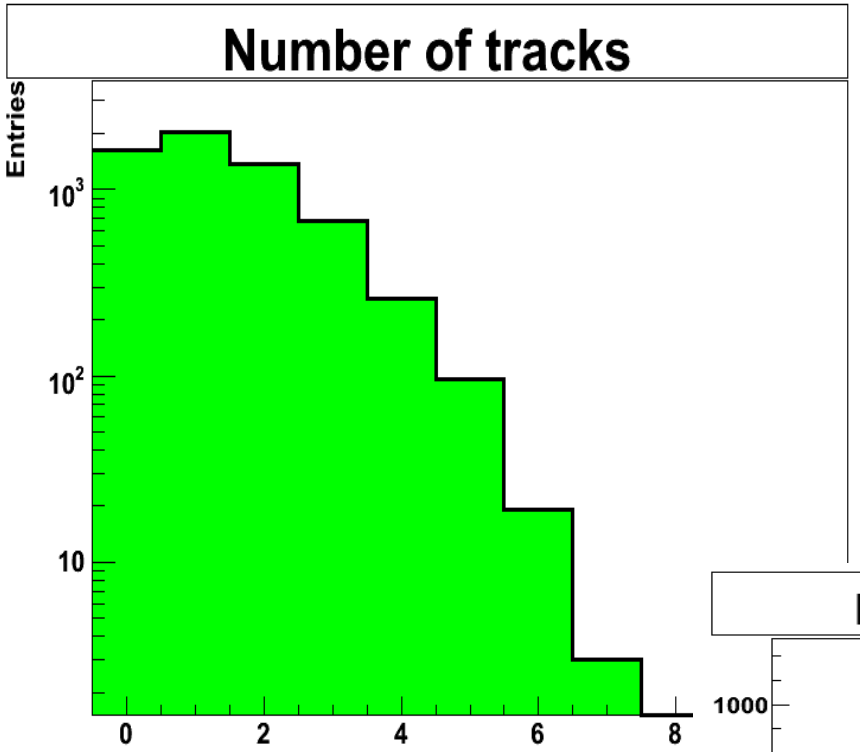
- Cut: $\chi^2 < 20$

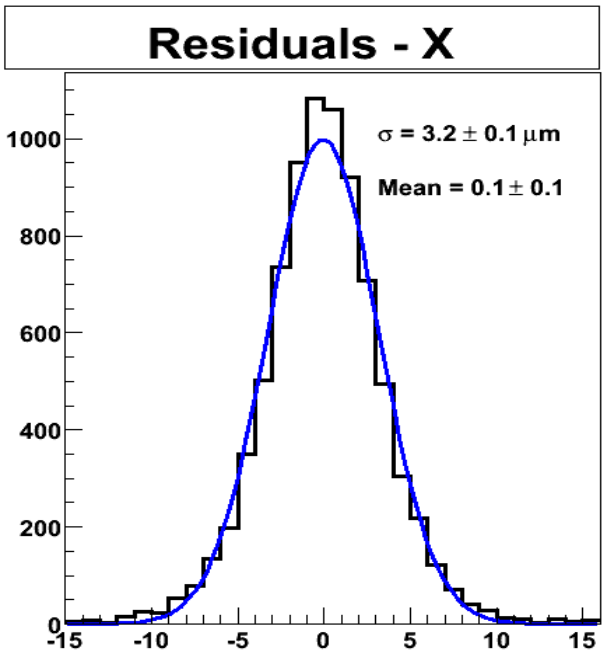
- Result very preliminary

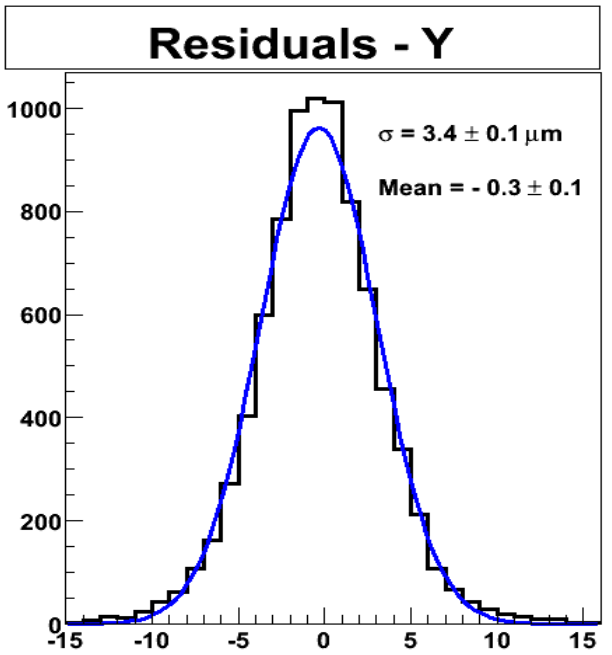




Results from line fitting







EUTelTestFitter

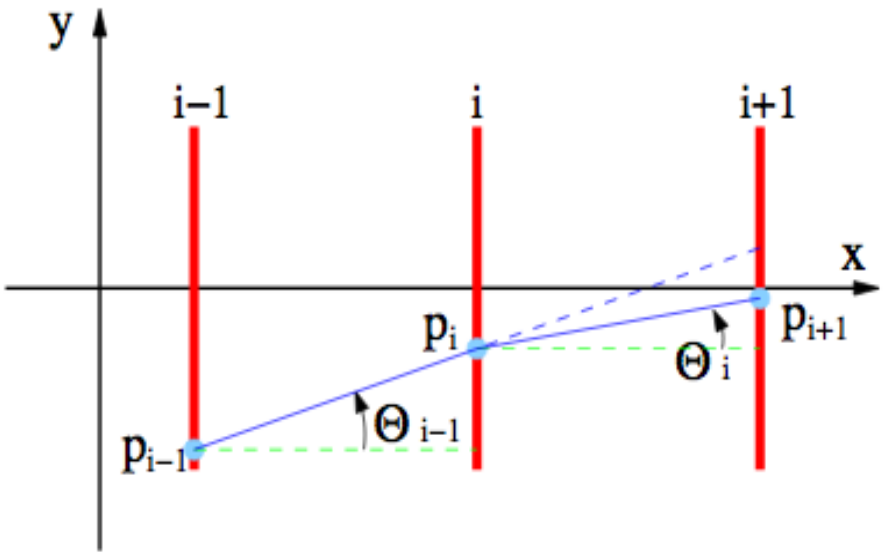
Results provided by A.F. Zarnecki

Analytical approach

We can determine track position in each plane (including DUT), i.e. N parameters $(p_i, i = 1 \ldots N)$, from $M < N$ measured positions in telescope planes.

We use constraints on multiple scattering!

Contribution of plane i to χ^2 of the fit



position measurement — multiple scattering

$$\Delta\chi_i^2 = \left(\frac{y_i - p_i}{\sigma_i}\right)^2 + \left(\frac{\Theta_i - \Theta_{i-1}}{\Delta\Theta_i}\right)^2$$

where: $\Theta_i = \dfrac{p_{i+1} - p_i}{x_{i+1} - x_i}$

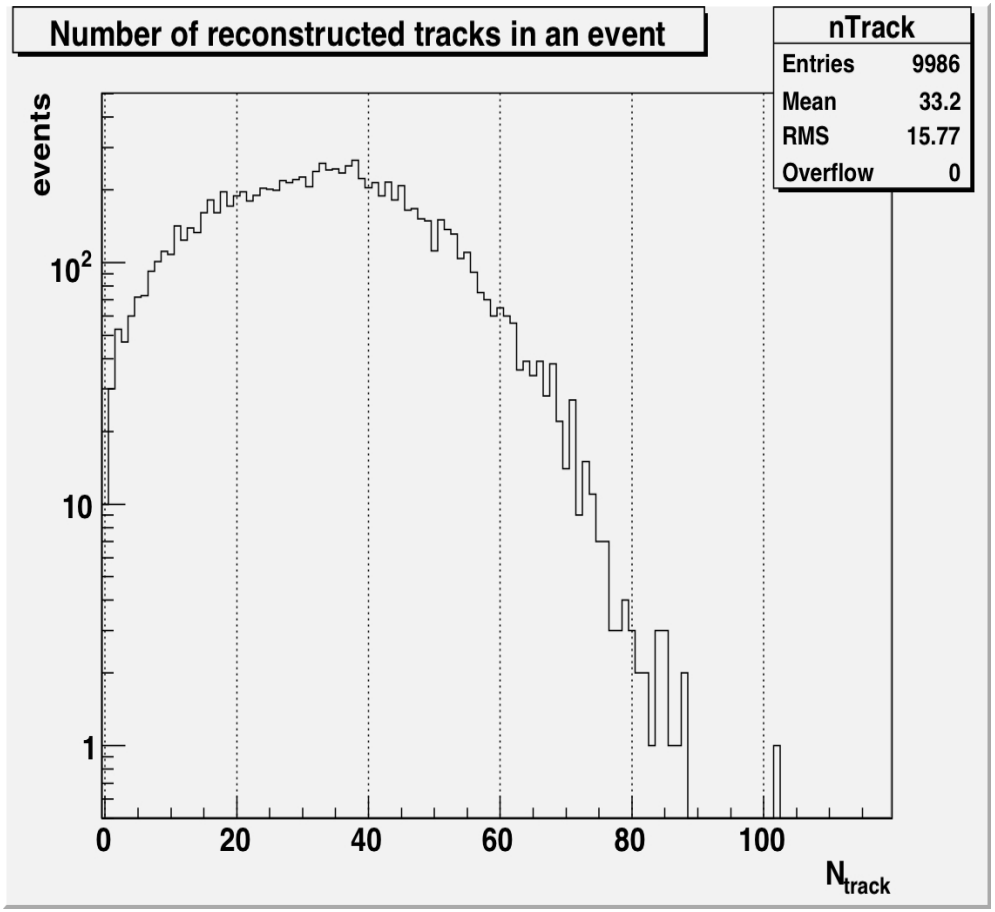
Both terms present for planes $i \neq 1, i_{DUT}, N$,
first term missing for DUT, second for first and last plane

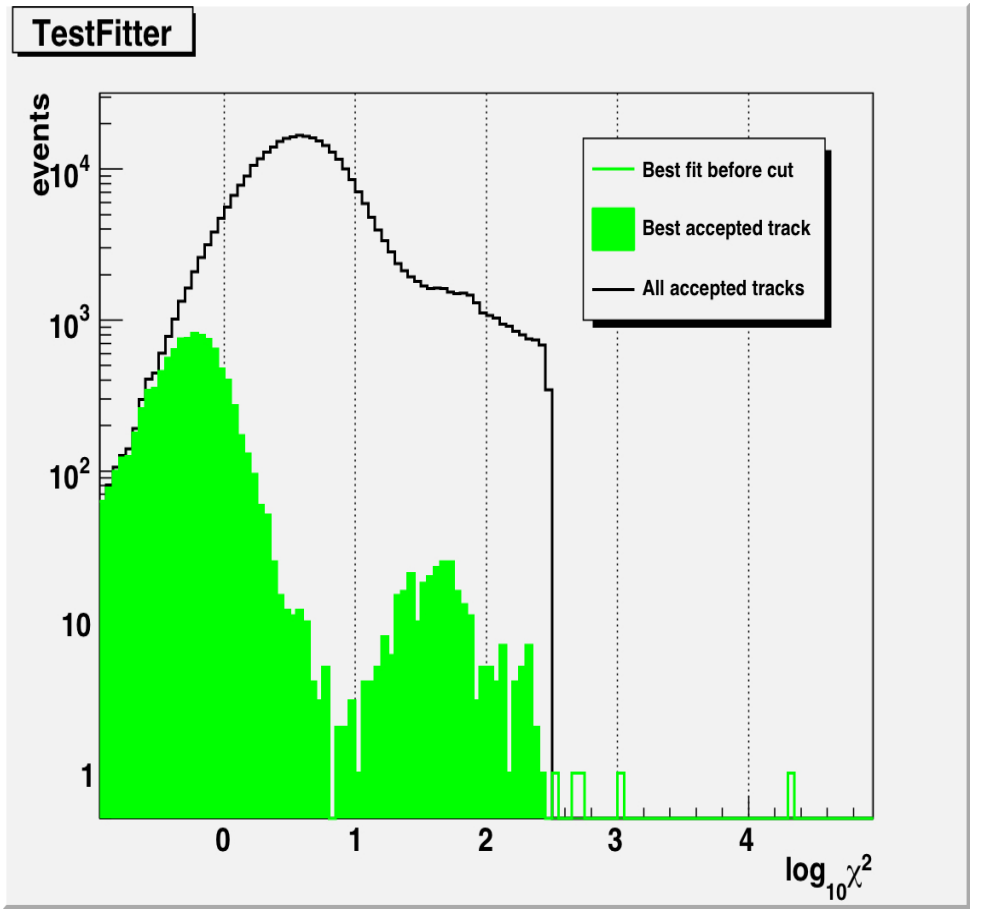
χ^2 minimum can be found by solving the matrix equation - fast!

Constraint from the beam direction can also be taken into account.

Results for “high” multiplicity data

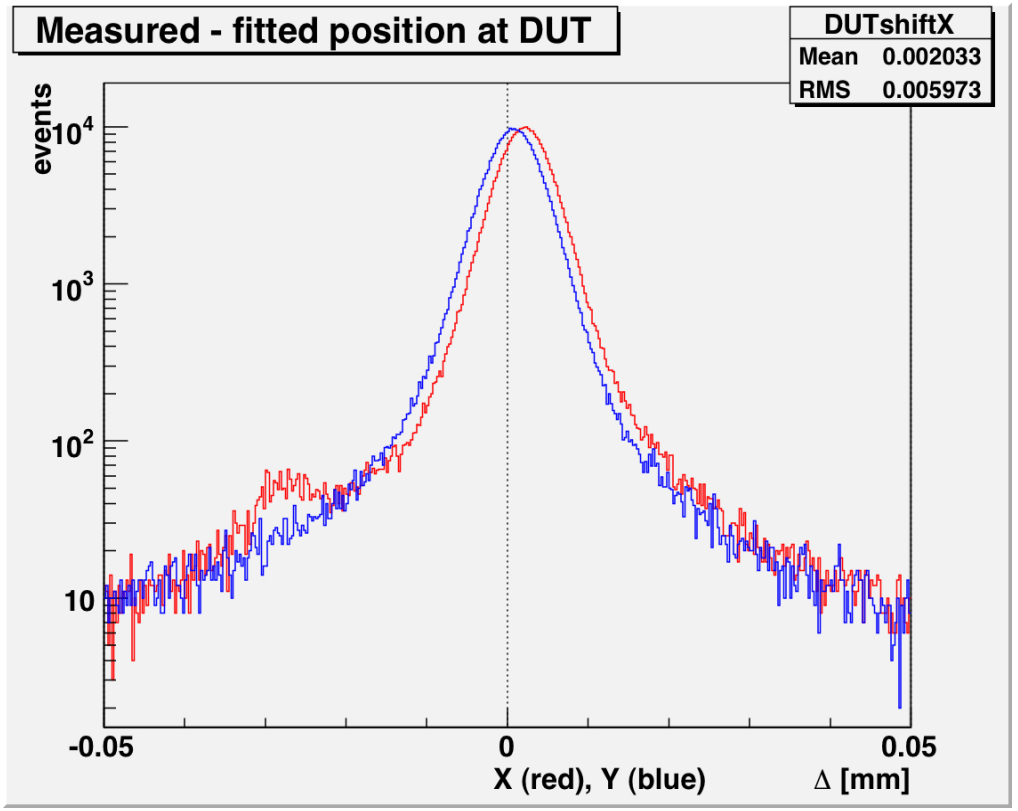
Fit to 4 planes.

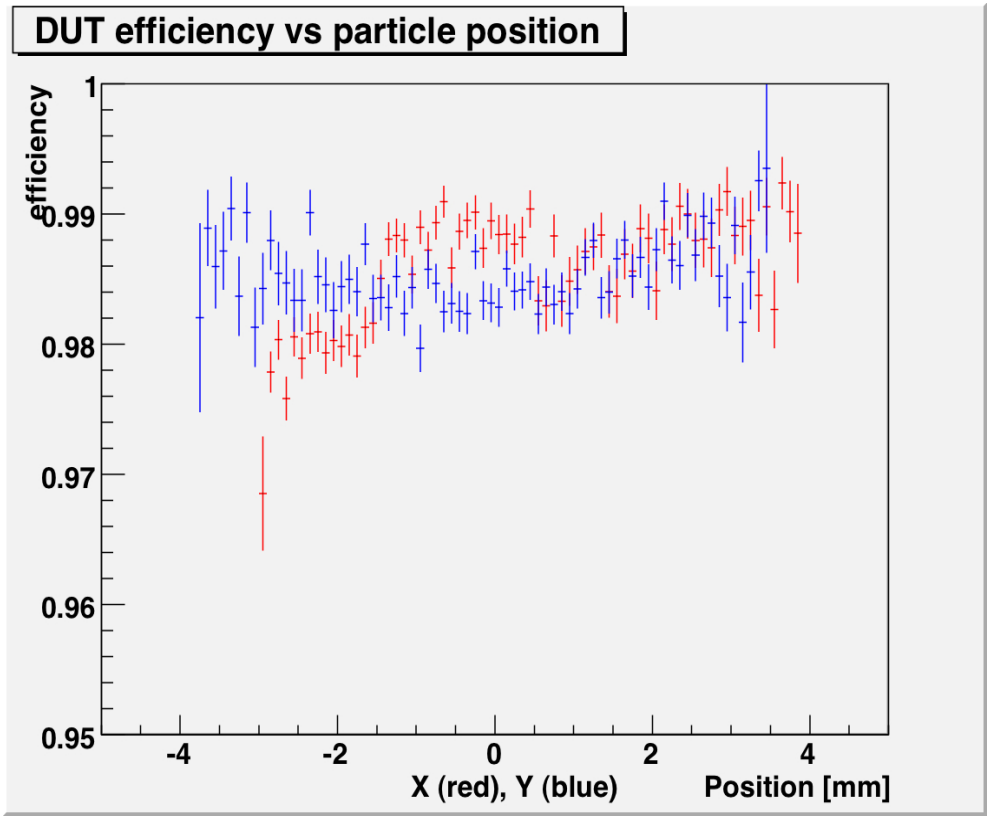




Alignment from EUTelFitHistograms

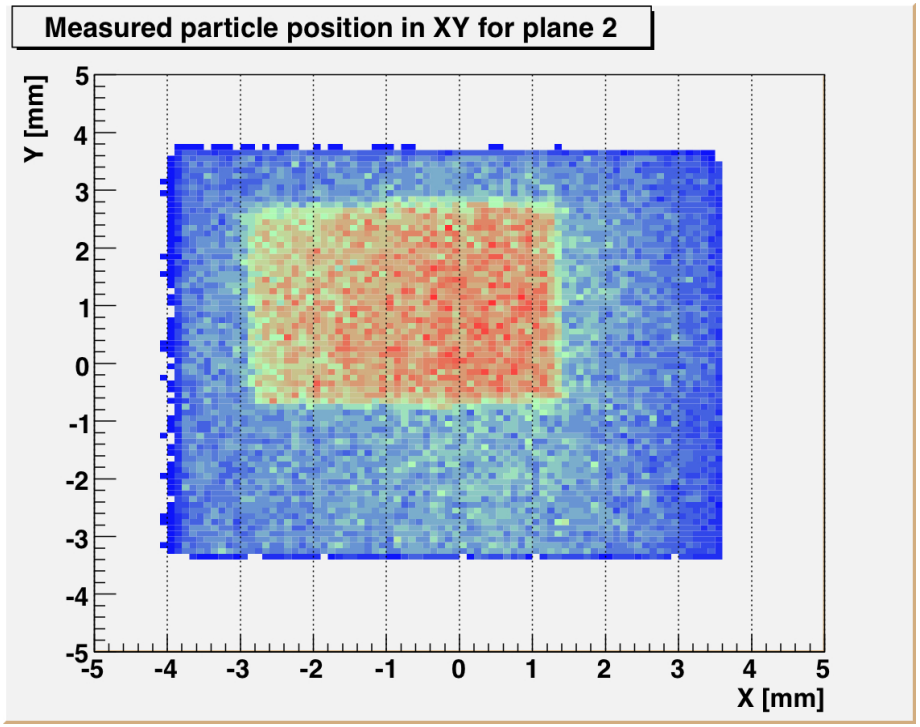
Resolution

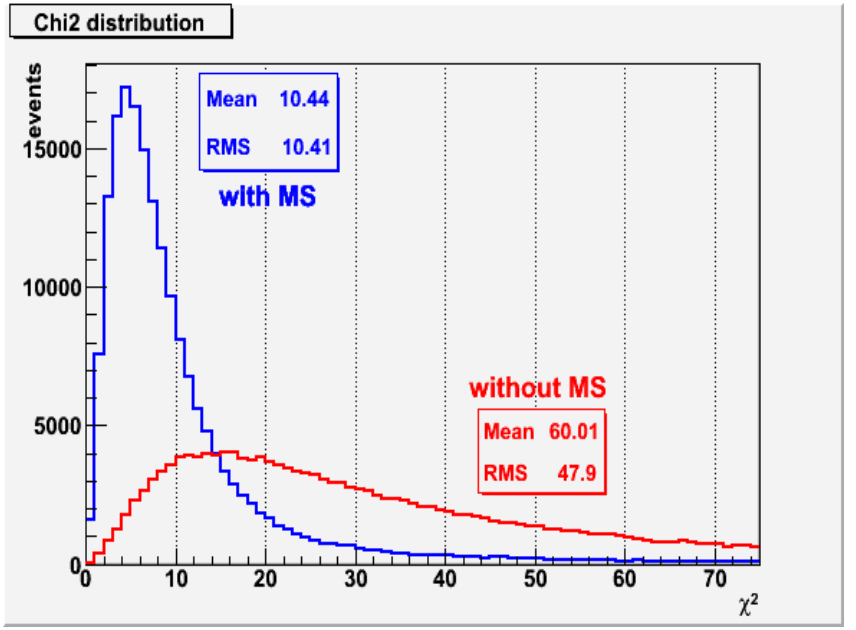




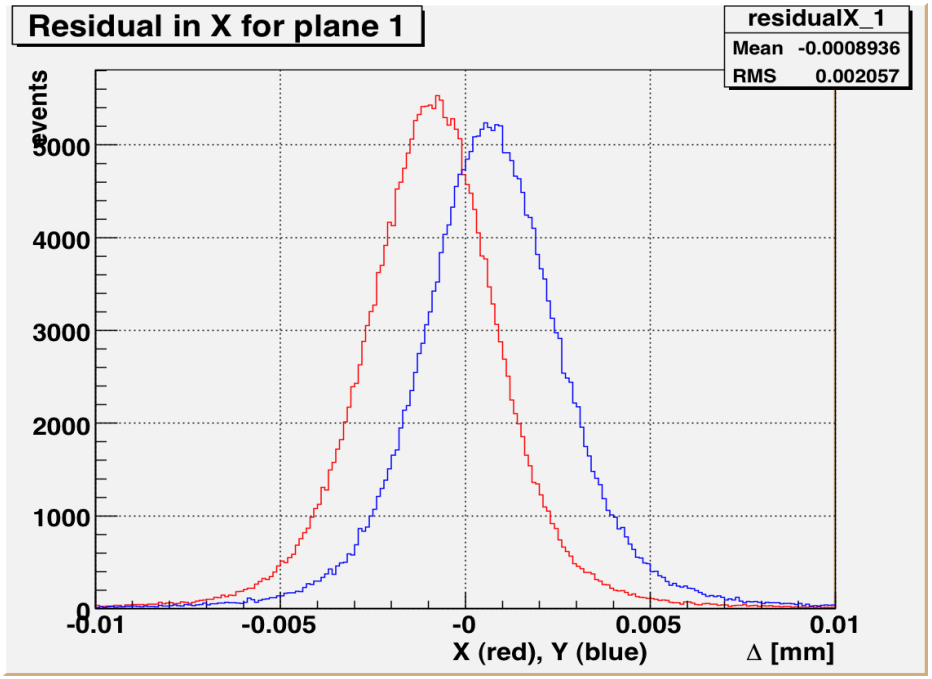
Observed width of **3.4 µm** is in good agreement with expectation assuming a single plane resolution of 3 µm and a fit precision of 1.74 µm.

3 GeV DESY data





Much lower multiplicity
→ trigger visible

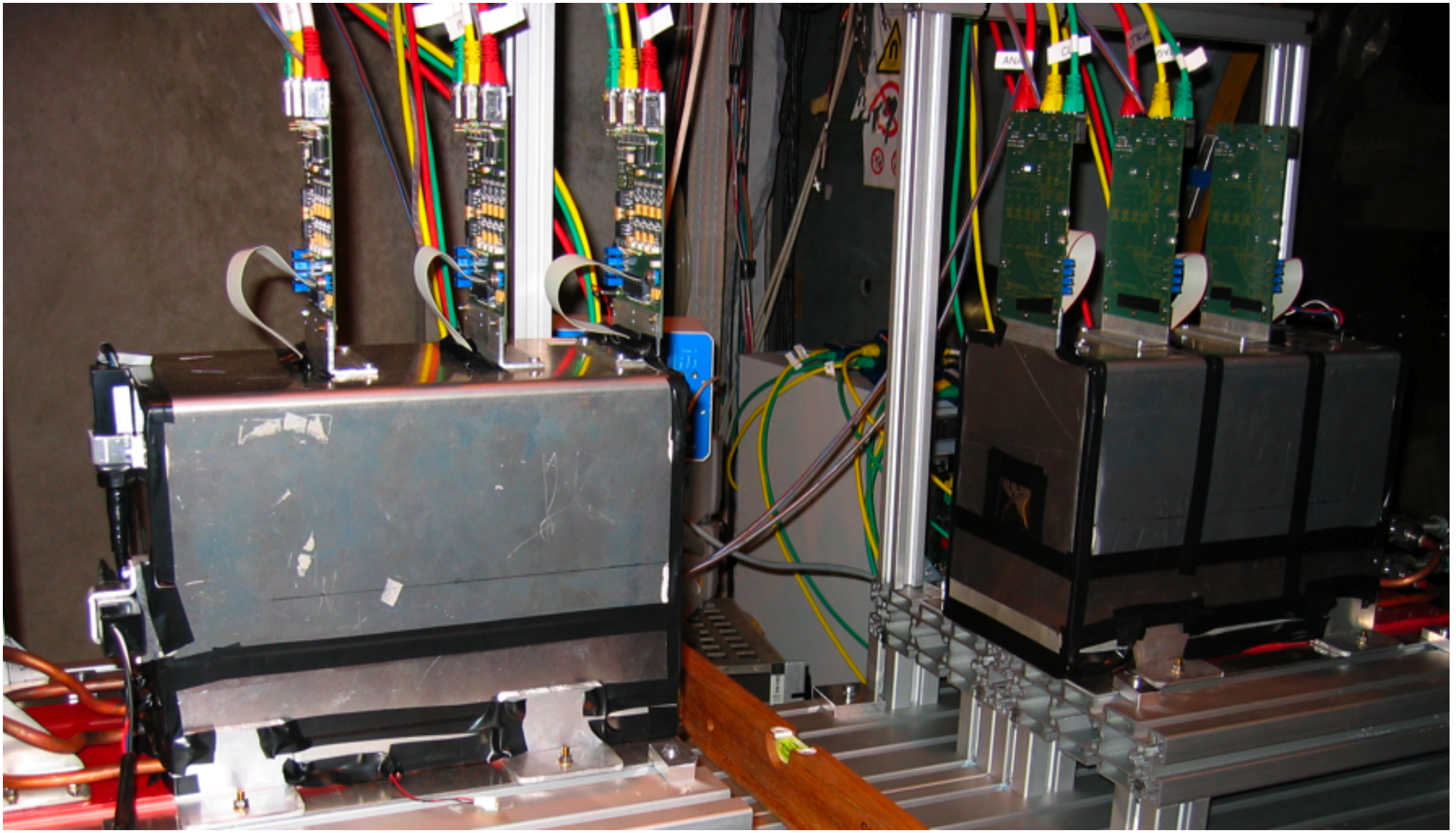


Summary

- Already lot of results from the testbeams at DESY (August) and CERN (September) are available.
- Eta-correction and hit reconstruction work well.
- Track fitting evolves fast.
- Next steps: Understand zero suppression
  Improve alignment
  Compare to simulation
- Expect many more exciting plots in the next months...

Backup slides

Telescope at CERN



Default cuts

- 3x3 cluster SNR > 4 for all sensors
- Seed SNR > 6 for the first plane, > 5 for the other planes
- Maximal number of seeds: 100

EUTelTestFitter

Recent development

With multiple hits in each plane many fit possibilities have to be checked.

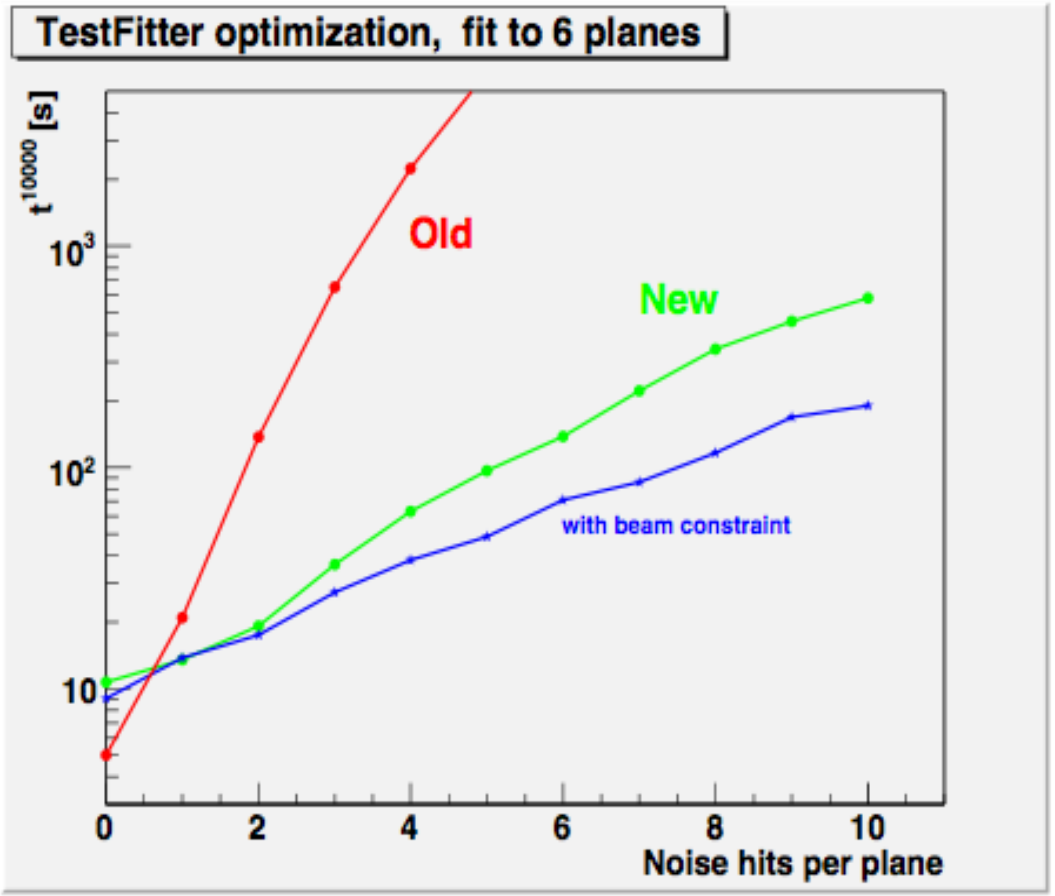
Old approach: fit all of them.

New method:

check all 3 hit combinations (2 hit when using beam constraint). If $\chi^2 > \chi^2_{max}$: skip all fits including these hits.

$\Rightarrow$ orders of magnitude improvement!

Hit multiplicity per plane is still limitted by MAXINT value (2^{31}).



$N \leq 34$ for 6 planes, $N \leq 72$ for 5 planes, $N \leq 214$ for 4 planes

Fit to 5 planes