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Tracking system: Status and Analysis

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Outline

- Introduction to tracking software:
  - Digitization
  - Efficiency & drift velocity
  - Track reconstruction

- Analysis
  - Wire ordering
  - Single chamber resolution
  - Resolution at front face of ECAL
  - “Drift velocity” at CERN

Digitization

- Marlin processor called DriftChamberDigitization
- Gaussian smearing of the MC hits.
- Processor parameters:
  - 4(3) DC hit input collections,
  - TDC output collection (with same format as data),
  - Single chamber resolution,
  - Energy cut on hits in DC,
  - Drift Velocity,
  - Prototype name (TBDesy0506,…).

Efficiency

- Marlin processor called DriftChamberEfficiency
  - Calculate chamber efficiency and drift velocity for DESY TB
  - single wire efficiency, propagation time and off-set for CERN TB
    - off-set is the sum of misalignment and wire readout off-set.
- Processor parameters:
  - TDC input collection,
  - Channel shift (for DESY data only),
  - Prototype name (TBDesy0506,…).

Track reconstruction

- Marlin processor called DriftChambertoTrack
- Reconstruct the track using linear fit.
- Processor parameters:
  - TDC input collection,
  - Prototype name (TBDesy0506,…),
  - Drift velocity (or propagation time for CERN),
  - Off-set (x and y, implemented only for CERN),

Extra information

- Database interaction is missing, everything must be hard coded or passed as input parameter.
- Still old coordinate system:
  - implementation of the new coordinate system in progress
  - reconstruction is not implemented for rotated ECAL runs
  - problems with shift of ECAL for edges studies
    - user will have to know the shift and correct the reconstructed position.
- Off-set is implemented for CERN but is not for DESY
- Information on each processor is available in the .hh file. Documentation will be available soon

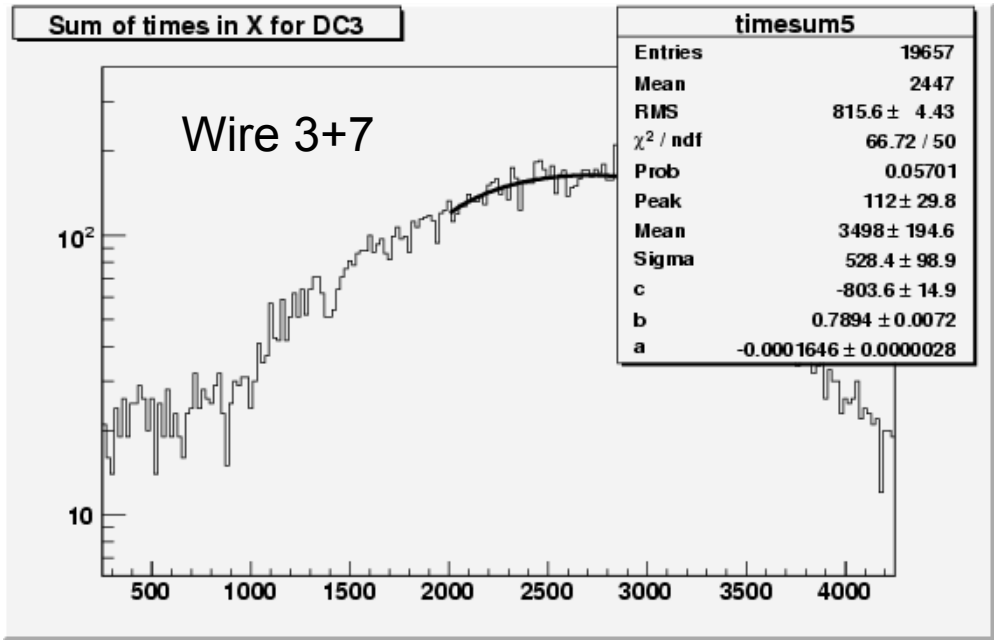
Wire ordering at DESY

- The information from the survey is not compatible with data. So it was assumed completely wrong and everything was deducted from data

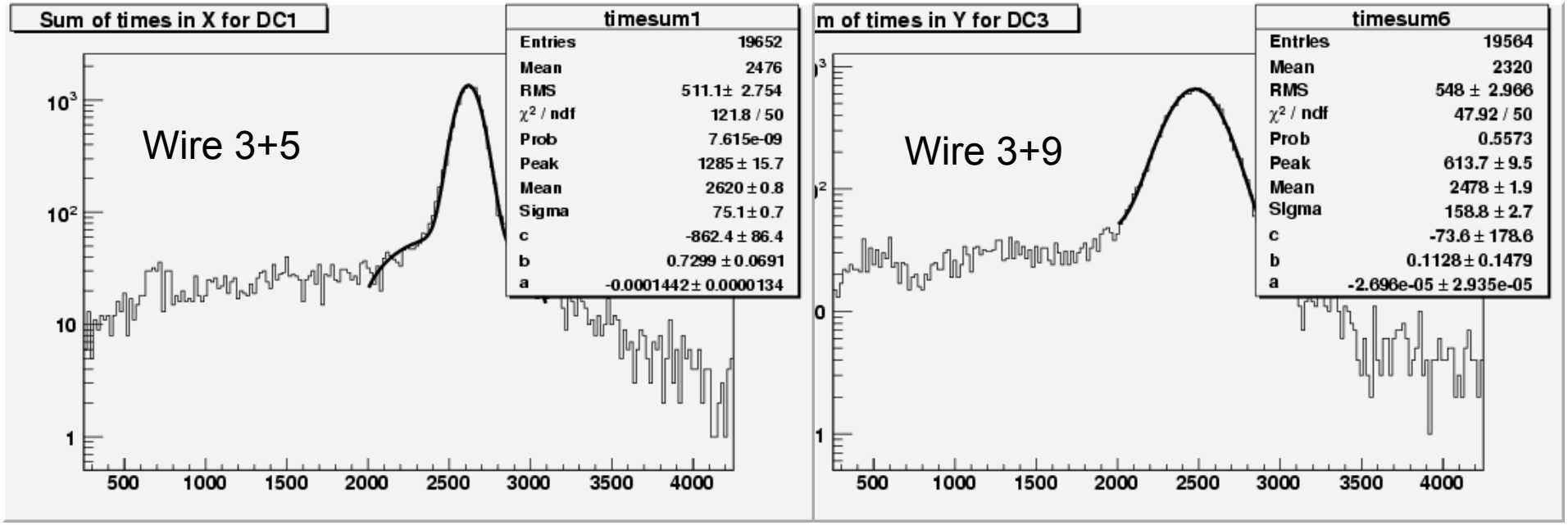
TdcCh	ChName	Position	Direction	Parity
3	X2	3	X	-1
4	Y2	3	Y	1
5	X1	2	X	1
6	Y1	2	Y	-1
7	X3	1	X	1
8	Y3	1	Y	-1
9	X4	0	X	-1
10	Y4	0	Y	1

In Parity: -1 is right/down

Plotting sum of wire 3 and 7
expected peak is missing



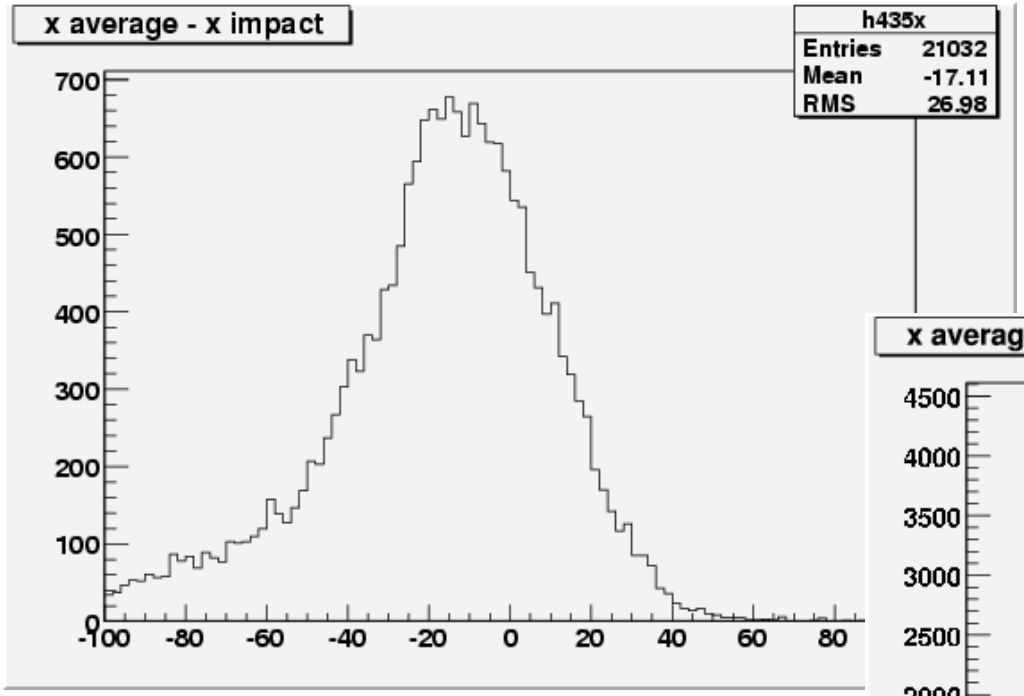
Relative position



- Plotted the sum of all combination, when a peak is evident wires must be on opposite position.
- To have the absolute position an external reference is needed.

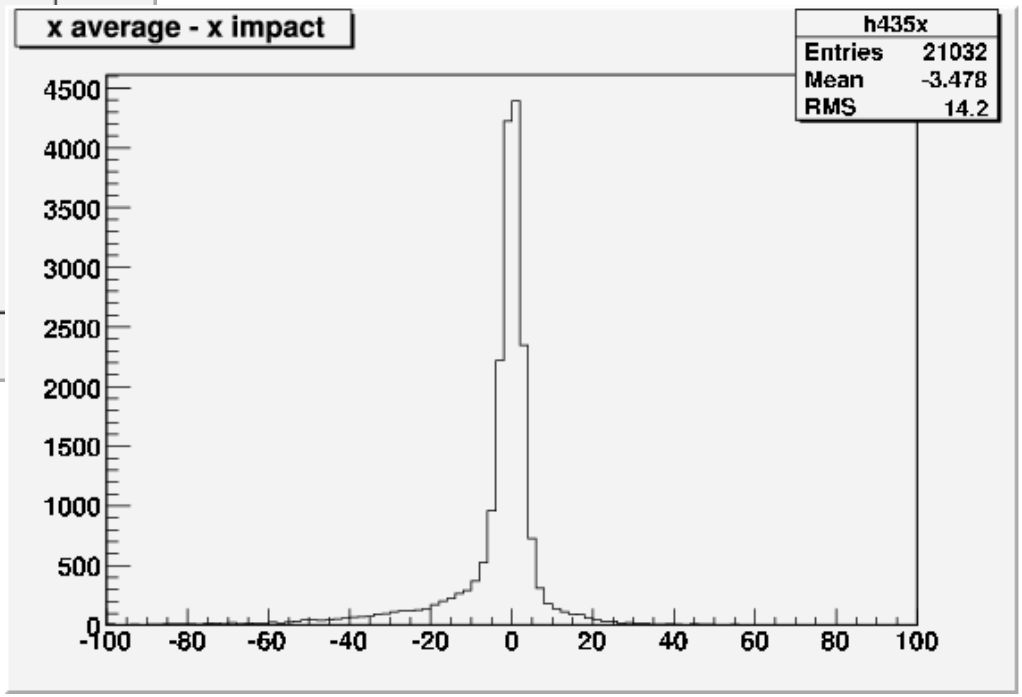
Absolute position

- Comparison of the reconstructed position at ECAL surface with cluster.



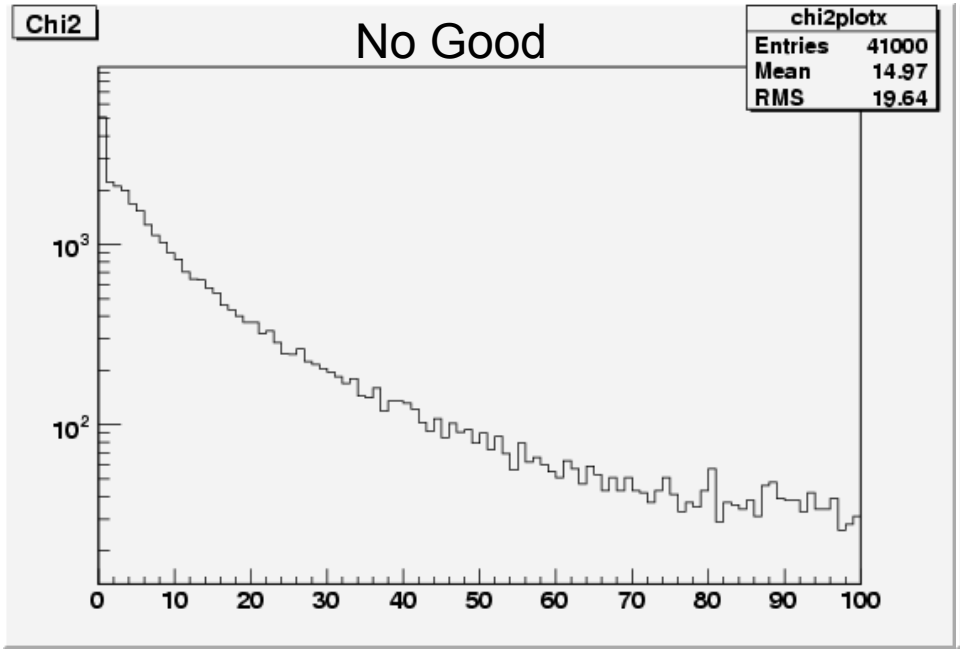
Wire 3 on the right

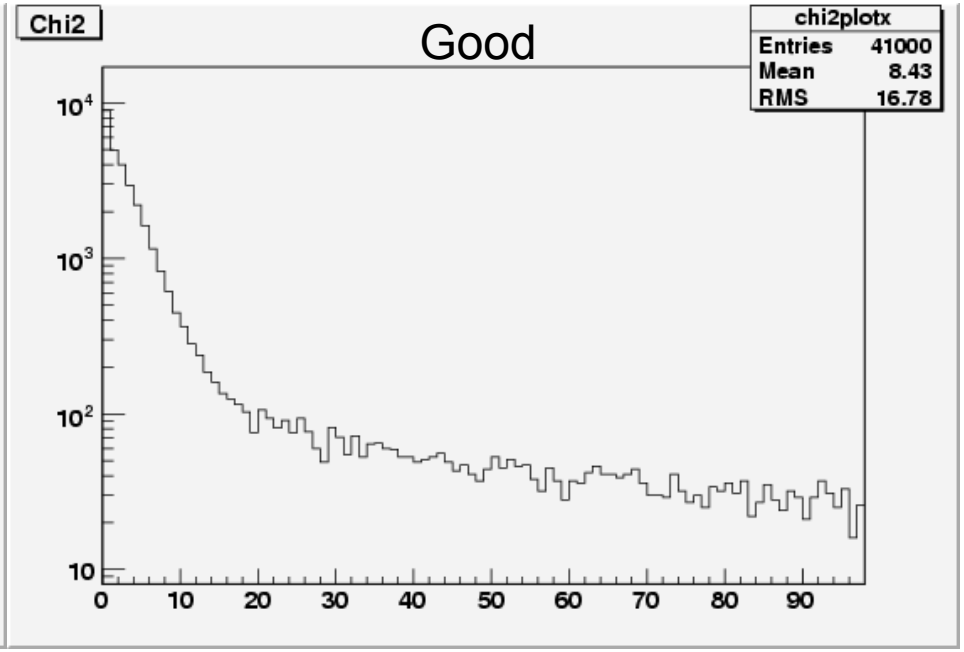
Wire 3 on the left



DC ordering

- DC can be swapped, so different combination of DC ordering (changing the z of the hits) were tried.
- Comparison of the fit of the track.





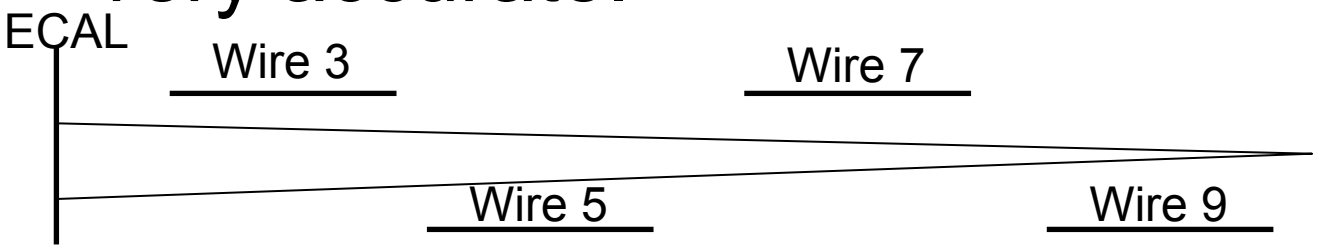
Wire table

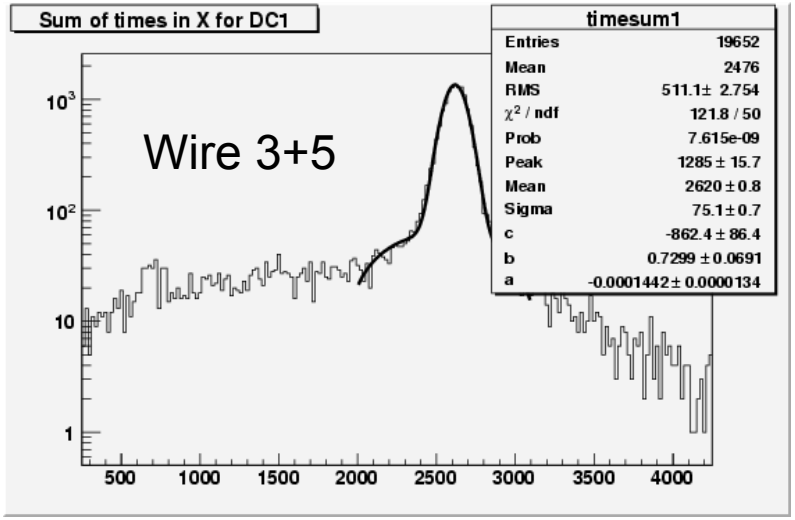
- The result of the analysis is summarized in the table and is identical to the one obtained by G. Mavromanolakis with a different study.

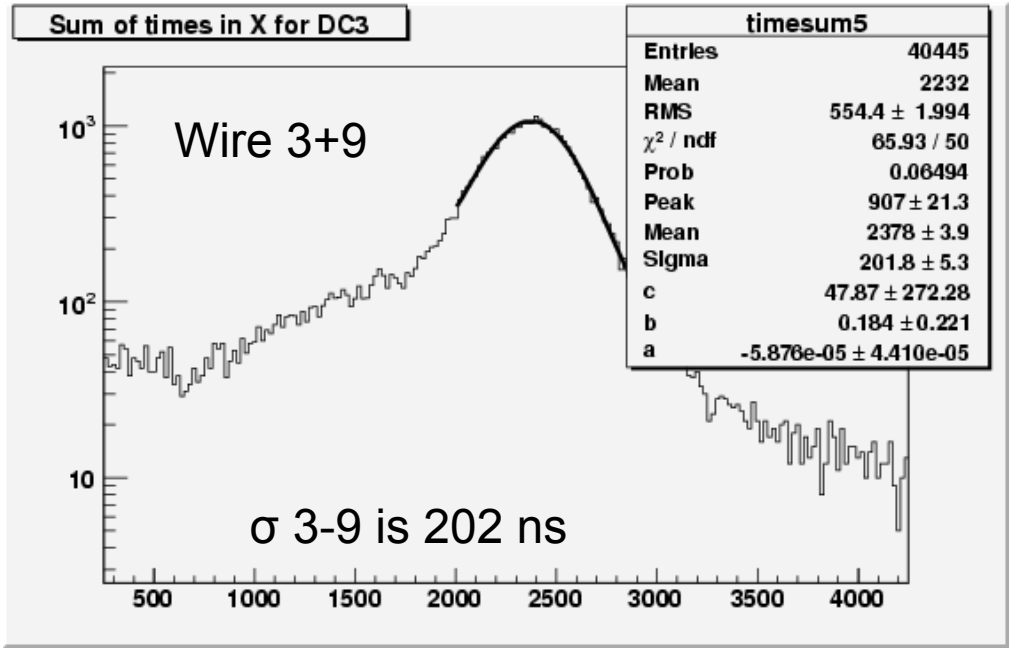
TdcCh	ChName	Position	Direction	Parity
3	X2	3	X	-1
4	Y2	3	Y	1
5	X1	2	X	1
6	Y1	2	Y	-1
7	X3	1	X	-1
8	Y3	1	Y	1
9	X4	0	X	1
10	Y4	0	Y	-1

Single chamber resolution

- The way the resolution was calculated is not very accurate.







The only explanation is that the width is mainly due to non orthogonal tracks!

Calculate σ

- One possible way to obtain sigma, assuming all chambers having the same resolution, is from the fit
  - The χ distribution has a mode $= \sqrt{n_d - 1}$
  - First the processor minimizes

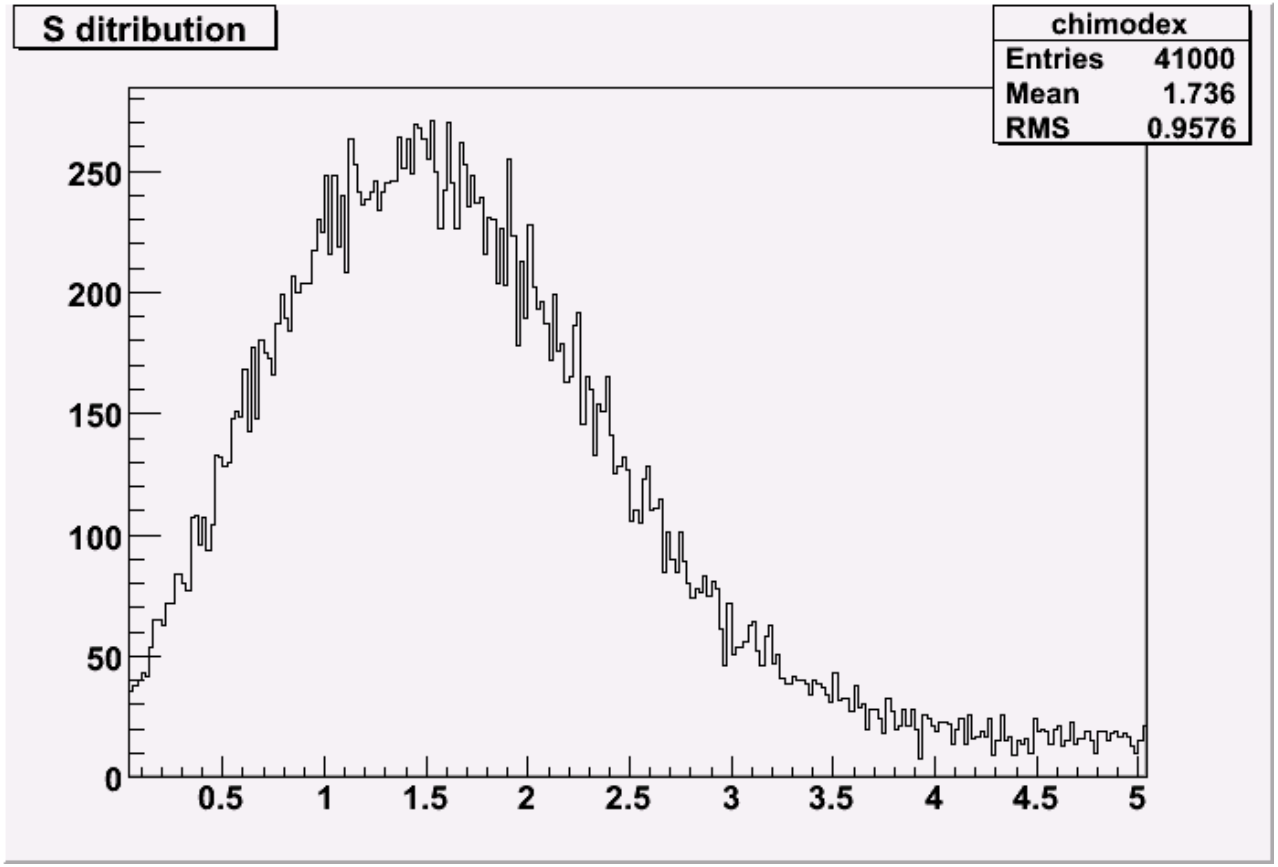
$$S = \sqrt{\sum_{i=1}^{n} (y_i - f(x_i;\theta))^2}$$

  - Then it is possible to estimate sigma using

$$\hat{\sigma} = \sqrt{\frac{\text{mode}[S]}{\sqrt{n_d - 1}}}$$

  - Where mode[S] is the mode of the distribution from the data

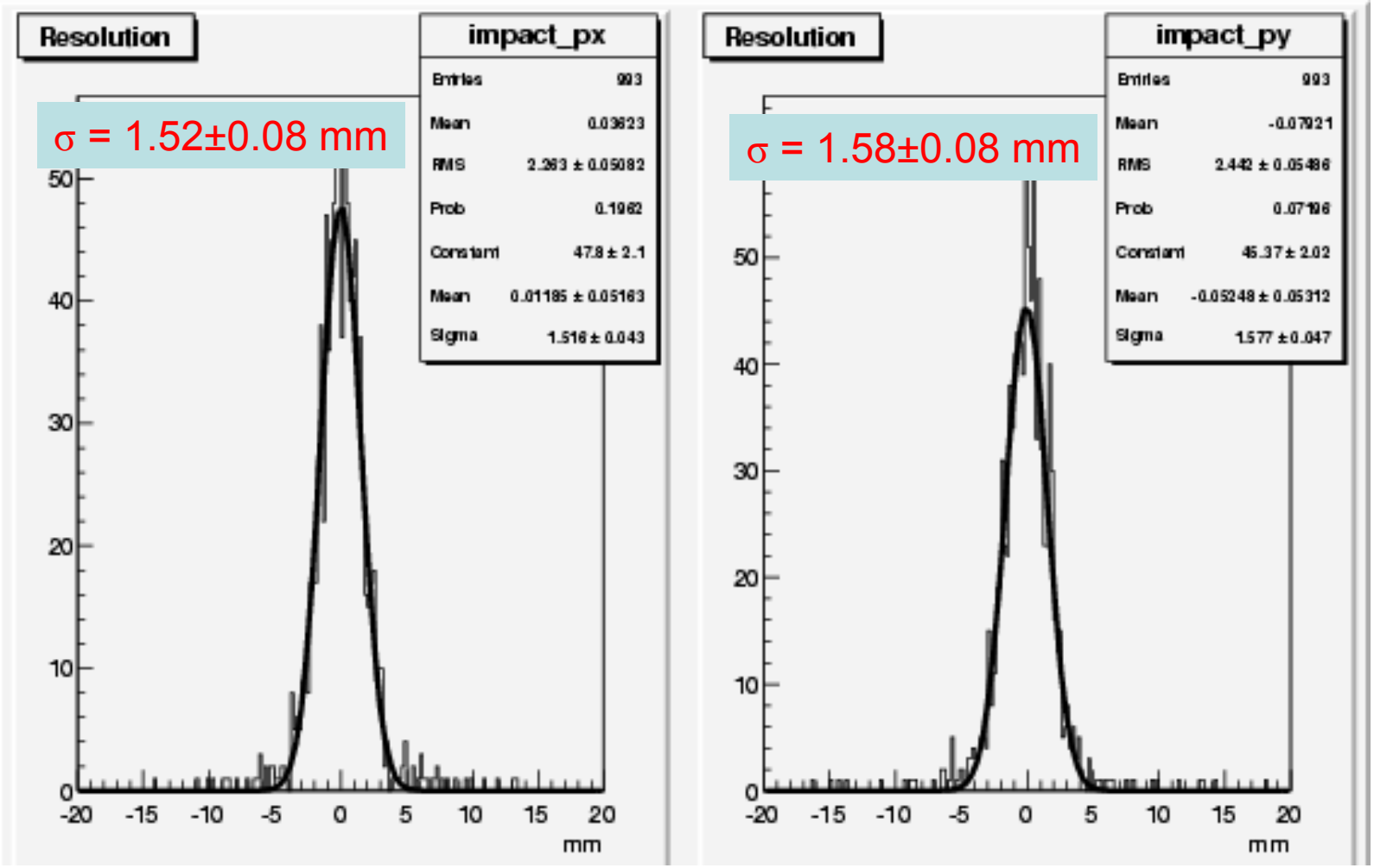
Resolution



$$\hat{\sigma} = \sqrt{\frac{1.5}{1}} = 1.22mm$$

Not as small as expected, may be due to bad approximation of linear fit.

Resolution at Ecal FF



With the old method σ = 1.66

Assuming perfect resolution and including only multiple scattering effects the best resolution is: σ = 0.66

CERN drift chambers

- Chambers are different from DESY
  - 2 TDCs are need
  - LCIO collection is different, …
  - everything had to be redone from scratch
- To measure a position, a wire is read at two ends
  - the difference of the two measures times the propagation velocity gives the impact point on the chamber.
- For the current tb results, the propagation velocity must be evaluated directly from data
  - There is a procedure to have better values (see MWDC documentation circulated by Erika) that should be performed before next tb

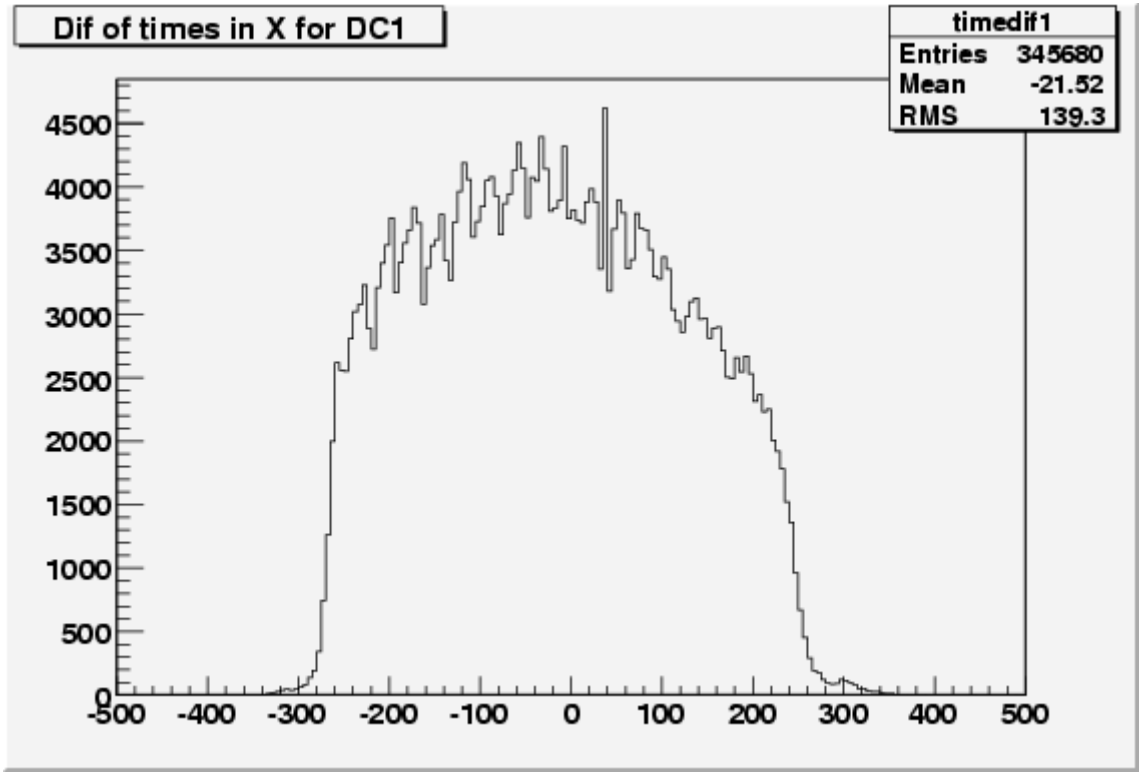
Propagation time

- Using muon runs the whole chamber is hit Since the active region is known, it is possible to calculate the velocity:

$$v_p = \frac{100mm}{t_{\max} - t_{\min}}$$

t_{max} and t_{min} are calculated from the plot as the first and last bin with at least 10% of the events of the maximum bin.

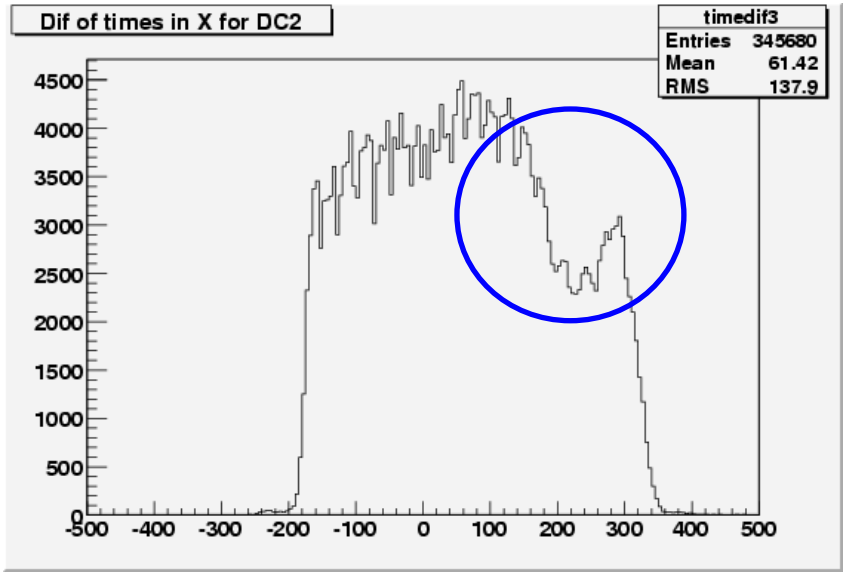
See summary table for results

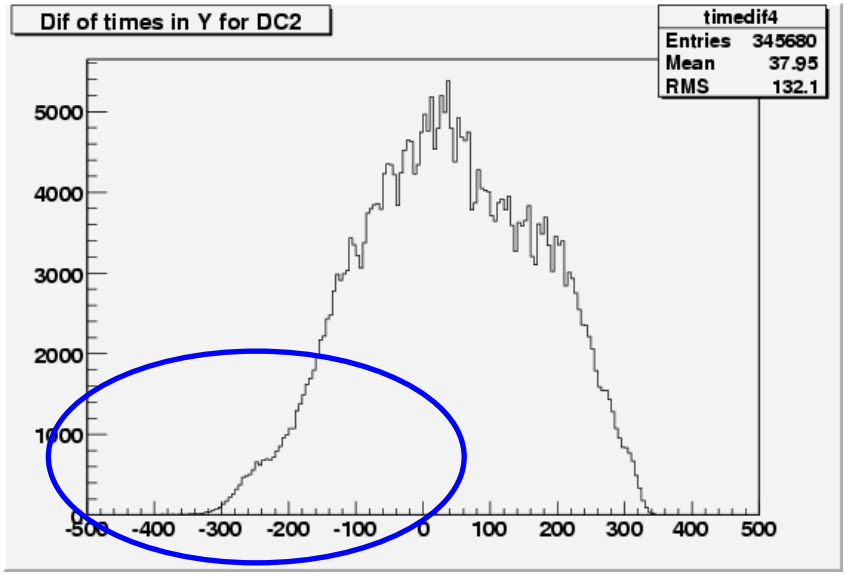


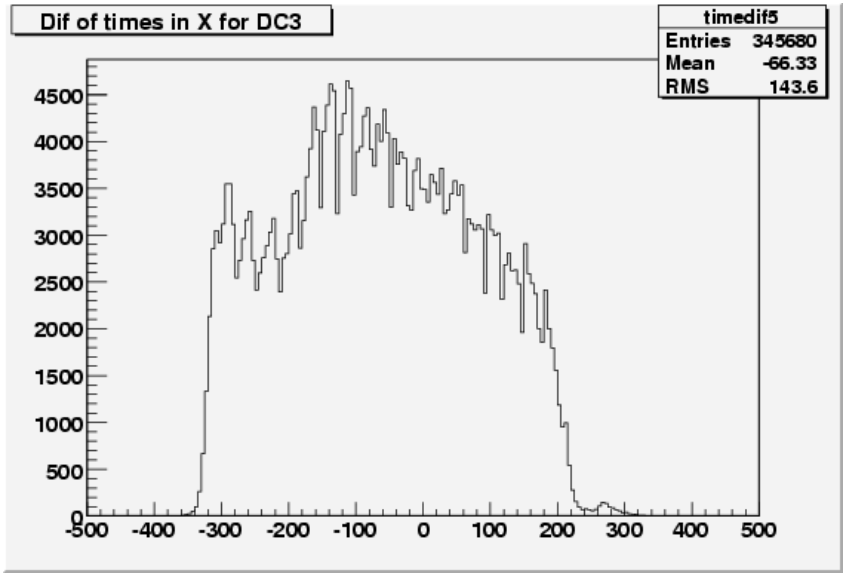
Offset

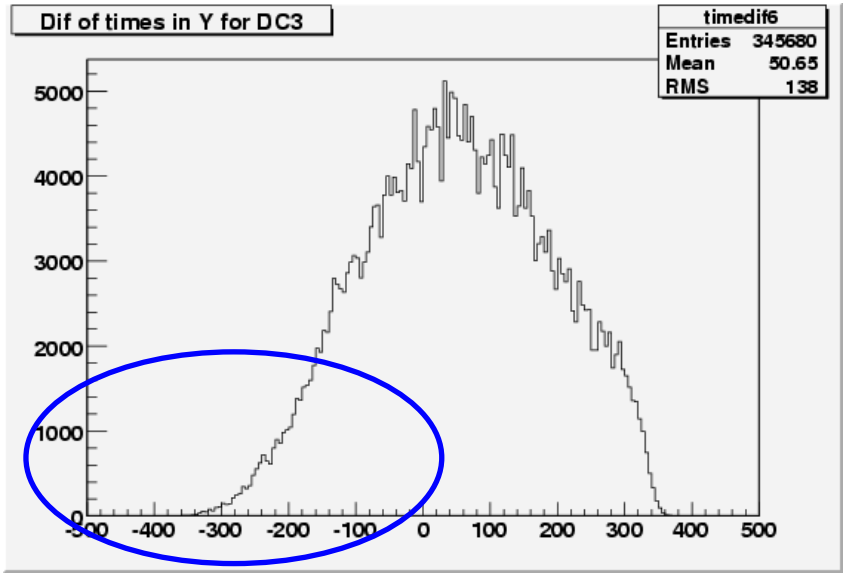
- From the same plot is possible to measure the alignment of the chamber from the shift of the mean from zero. This effect must be added to the offset of the readout.
- The only way to know the latter is to perform the mentioned calibration on each wire. Can we assume it to be zero?

Possible problems







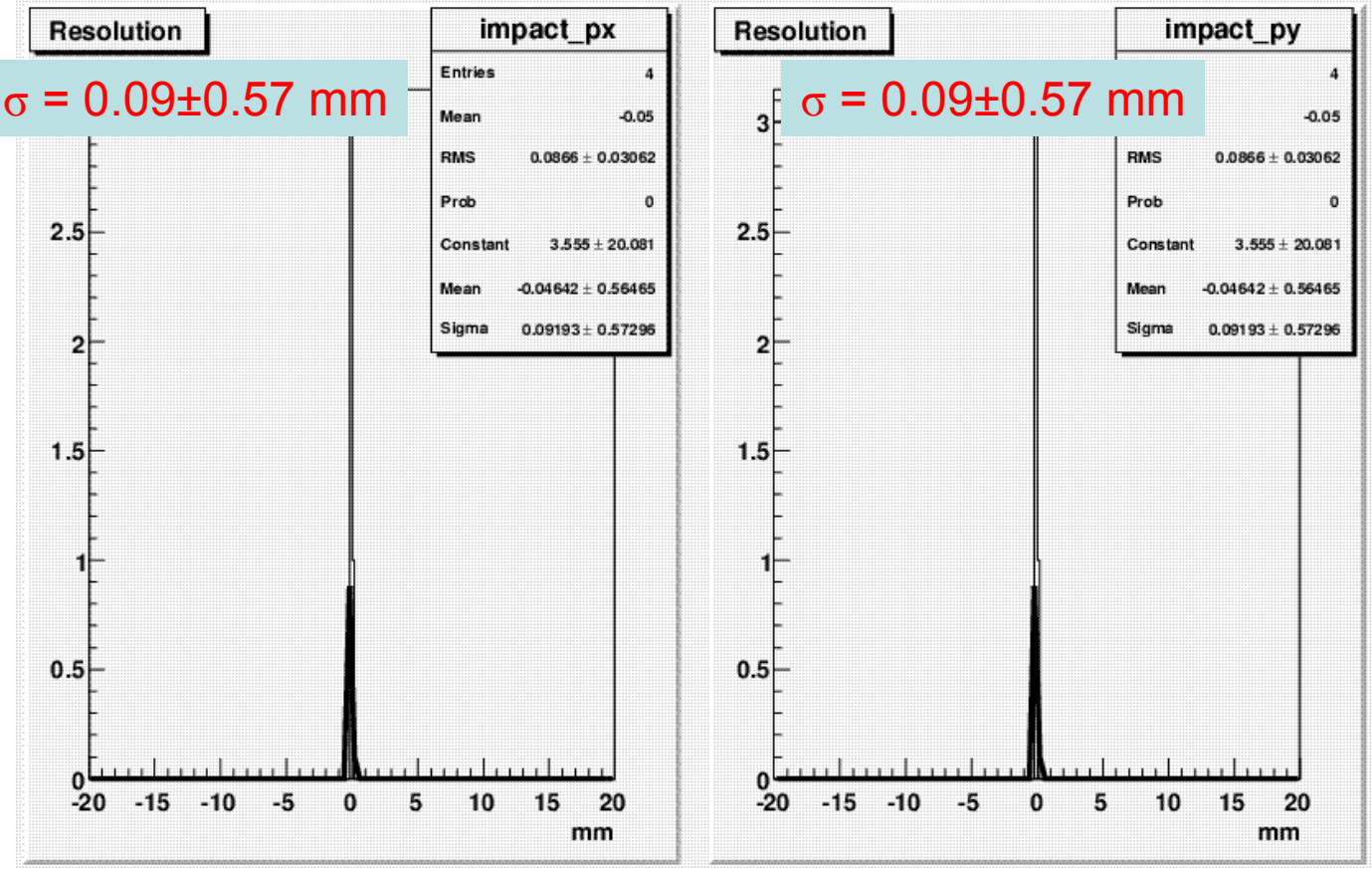


Summary of CERN DC

Wire	Direction	Efficiency	Prop. Vel	Offset
1	Y1	0,90	0,19	7,1
2	X1	0,94	0,18	-5,9
3	Y2	0,71	0,19	10,9
4	X2	0,87	0,18	6,6
5	Y3	0,88	0,18	-20,4
6	X3	0,92	0,17	5,6

Resolution at CERN

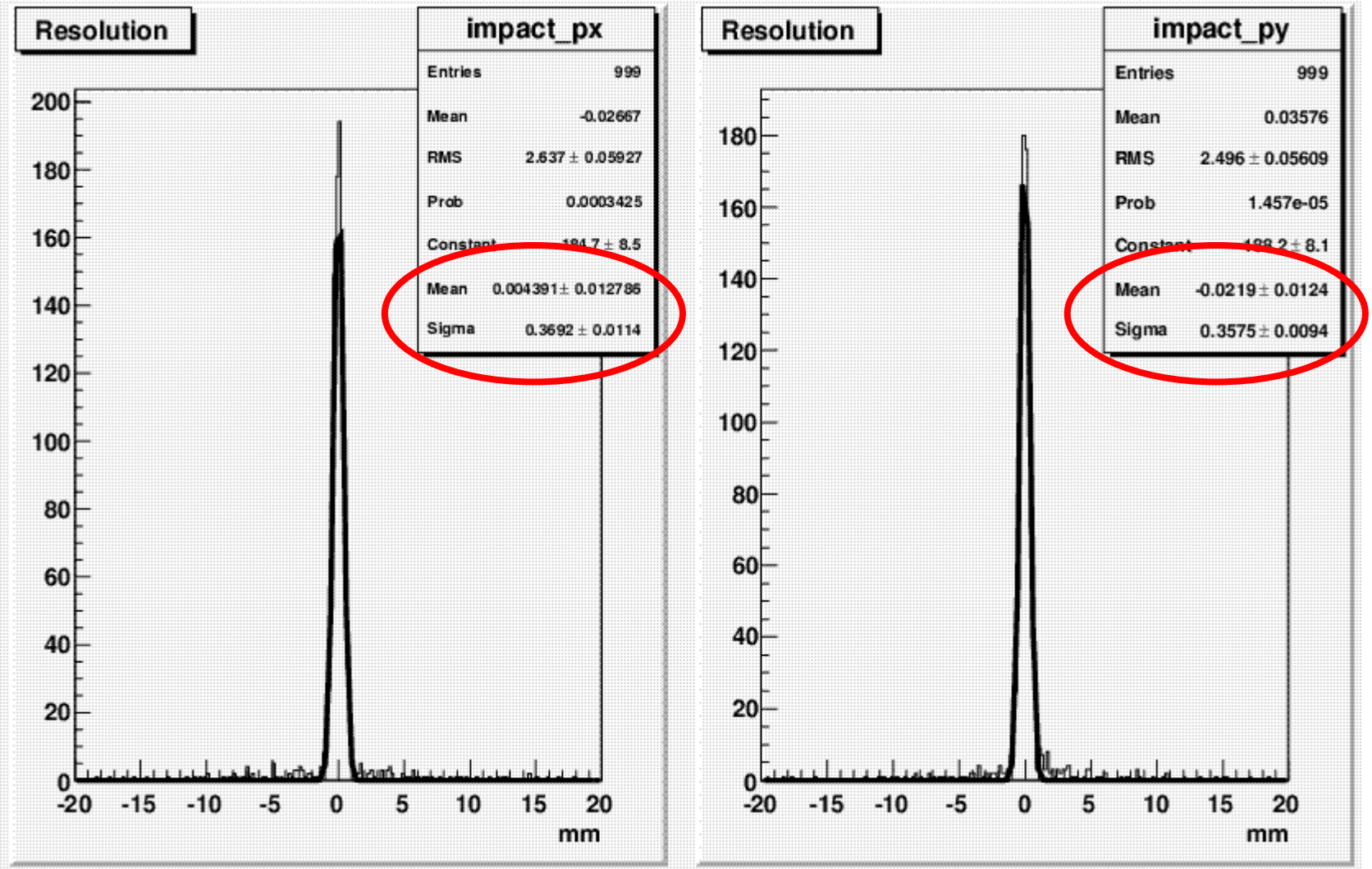
- Considering MS only



Too small: single chamber resolution should be ~200um.
Smaller impact than for DESY (40 Gev instead of 4 GeV)
Open to suggestion on how to calculate the resolution (fit?)

Resolution at CERN

- Using 200um chamber resolution



Conclusion

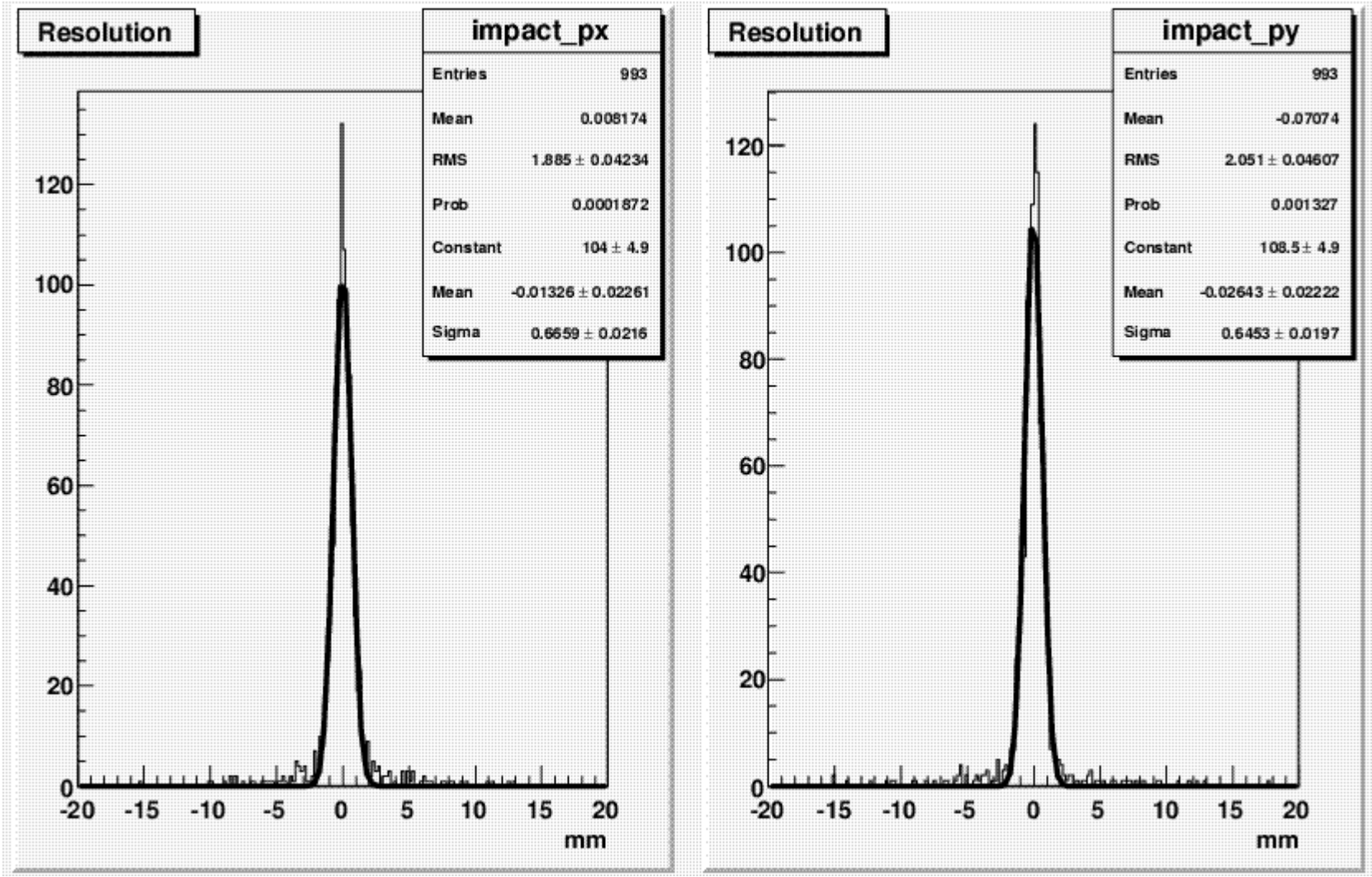
- Tracking software is now available for reconstruction
  - DESY well tested (thanks to all who helped)
  - CERN still needs some debugging
- Wire ordering checked
- Resolution at DESY re-evaluated
- Efficiency for CERN is good, propagation velocity and offset have been estimated
- Resolution should be much better than for DESY

To do

- Database interaction
  - Use db instead of hard coding info in processors
- Single wire resolution at CERN
- Improve fit procedure to include MS
- New coordinate system
  - Almost done, needs reconstructed files using new coord. system to do final tests
- DESY DCs have lower efficiency:
  - Possibility to use 3 hits instead of 4
    - What kind of output? (2 collections, one after cut set by user,…)
- Beam spread study
  - Simulate beam spread to test chamber resolution in real conditions

Backup

MS only @ DESY


Resolution
impact_px
Entries 993
Mean 0.008174
RMS 1.885 ± 0.04234
Prob 0.0001872
Constant 104 ± 4.9
Mean -0.01326 ± 0.02261
Sigma 0.6659 ± 0.0216
120
100
80
60
40
20
0
-20 -15 -10 -5 0 5 10 15 20
mm
Resolution
impact_py
Entries 993
Mean -0.07074
RMS 2.051 ± 0.04607
Prob 0.001327
Constant 108.5 ± 4.9
Mean -0.02643 ± 0.02222
Sigma 0.6453 ± 0.0197
120
100
80
60
40
20
0
-20 -15 -10 -5 0 5 10 15 20
mm