Angular and Position resolution

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Overview

- Analysis strategy:
  - Event selection
  - Angular resolution
  - Position resolution
    - S-curve correction

- Focus on systematic errors:
  - Tracking
  - Selection effect
  - Fits

- Conclusion

Run and event selection

- The same 2006 CERN runs used for the energy resolution paper were used for this study

| Run	Energy (GeV)
300670	6
300672	10
300235	15
300236	20
300207	30
300202	40
300208	45

- Reconstruction version is the latest available: reco_v0406

- Electrons were selected in each run using the paper selection:
  - 0.6 MIP threshold
  - $0.5\ E_{peak} < E < 1.5\ E_{peak}$
  - Cherenkov
  - Single cluster: T_{max}

Tracking

- Official tracking is available for these runs
- Required both direction to be well reconstructed
  - Chi - Probability > 0.1
- If more than one track is reconstructed, the best one (highest probability) is chosen
- Both directions are required or the event is discarded

Resolutions

The position resolution is evaluated from the distribution of

$$COG(X)_{ECAL} - X_{Track\ at\ front\ face}$$

The same is done for the angles along the planes X-Z and Y-Z

$$Angle_{ECAL} - Angle_{Track}$$
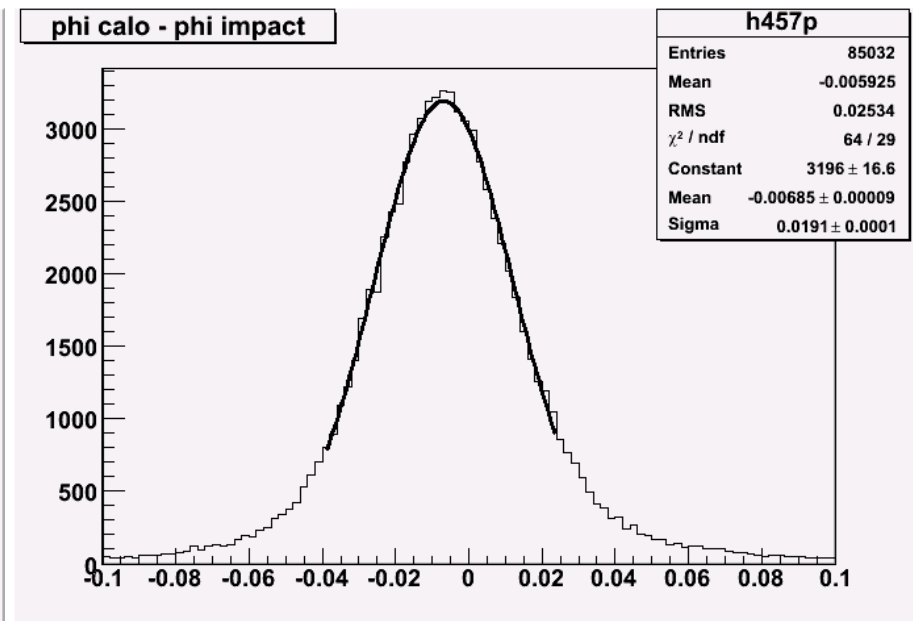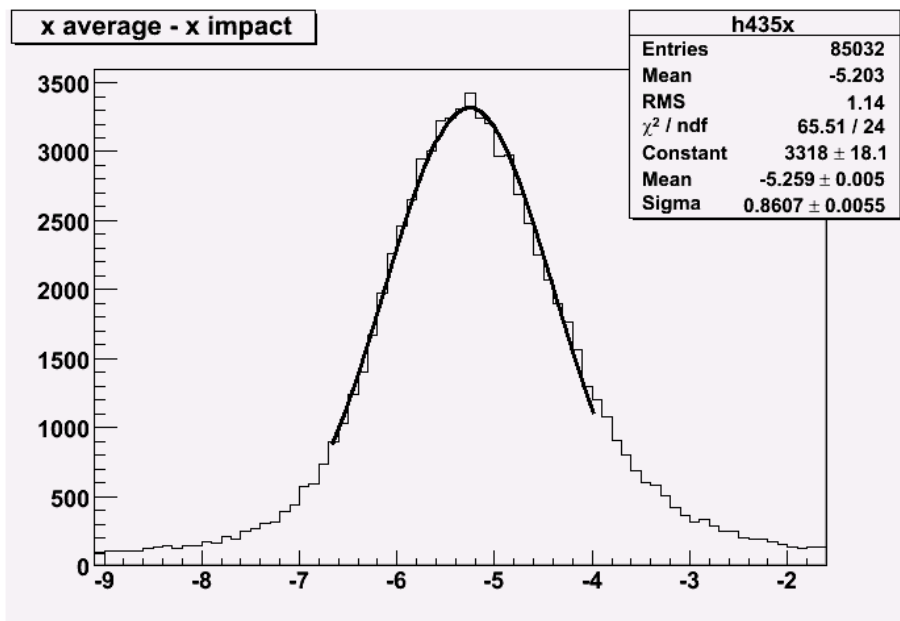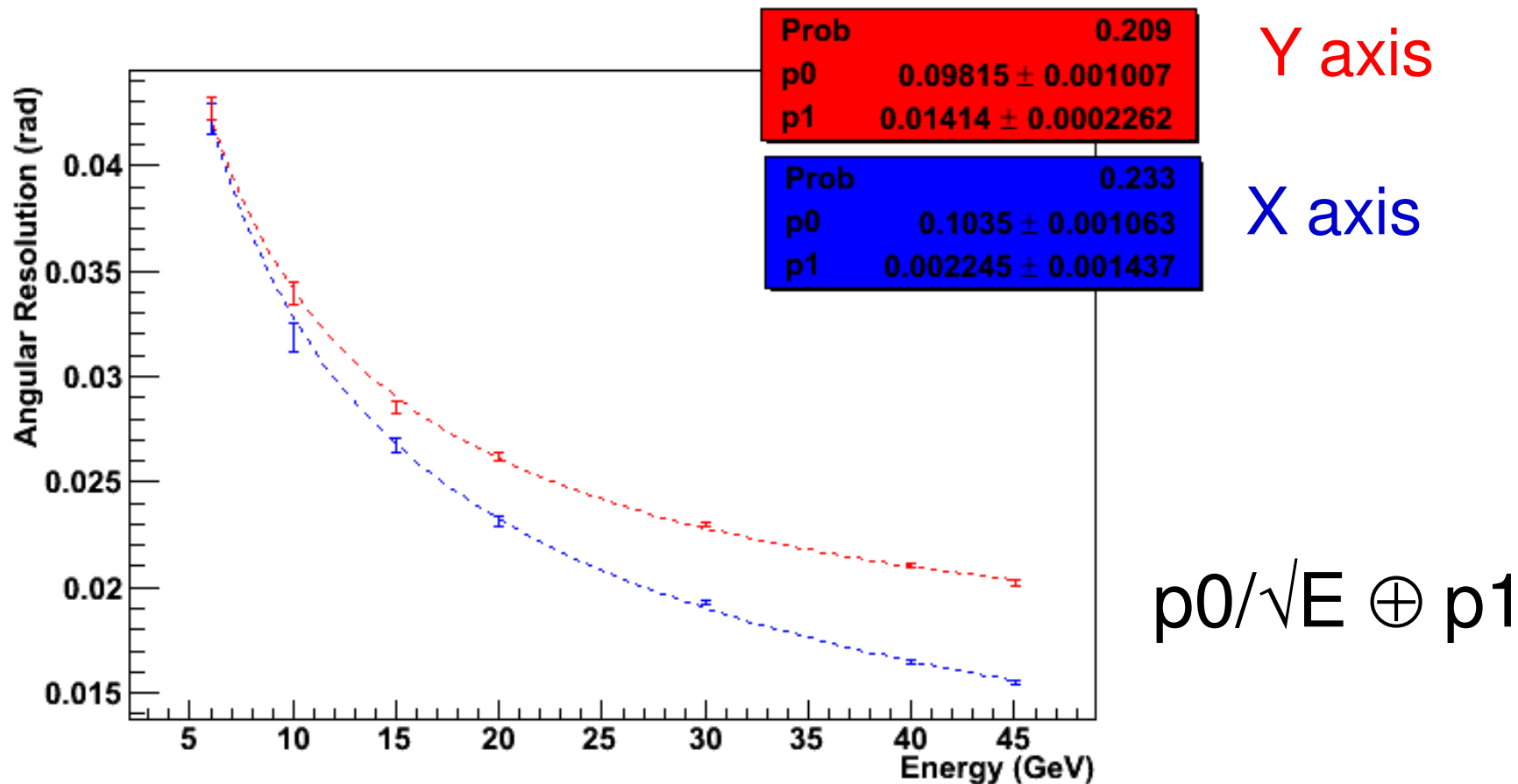

A first fit is performed without imposing a range, then the fit is iterated in the range (−1.5σ,+1.5σ) until the difference between the fitted mean and the previous one is smaller than the error on the mean.
The sigma of the latest fit is the resolution.

Angular resolution

Prob	0.209
p0	0.09815 ± 0.001007
p1	0.01414 ± 0.0002262

Y axis

Prob	0.233
p0	0.1035 ± 0.001063
p1	0.002245 ± 0.001437

X axis

$p0/\sqrt{E} \oplus p1$

- The difference between axis is explained by the different width of the ECAL in 2006:
  – 2 wafers along Y, 3 along X
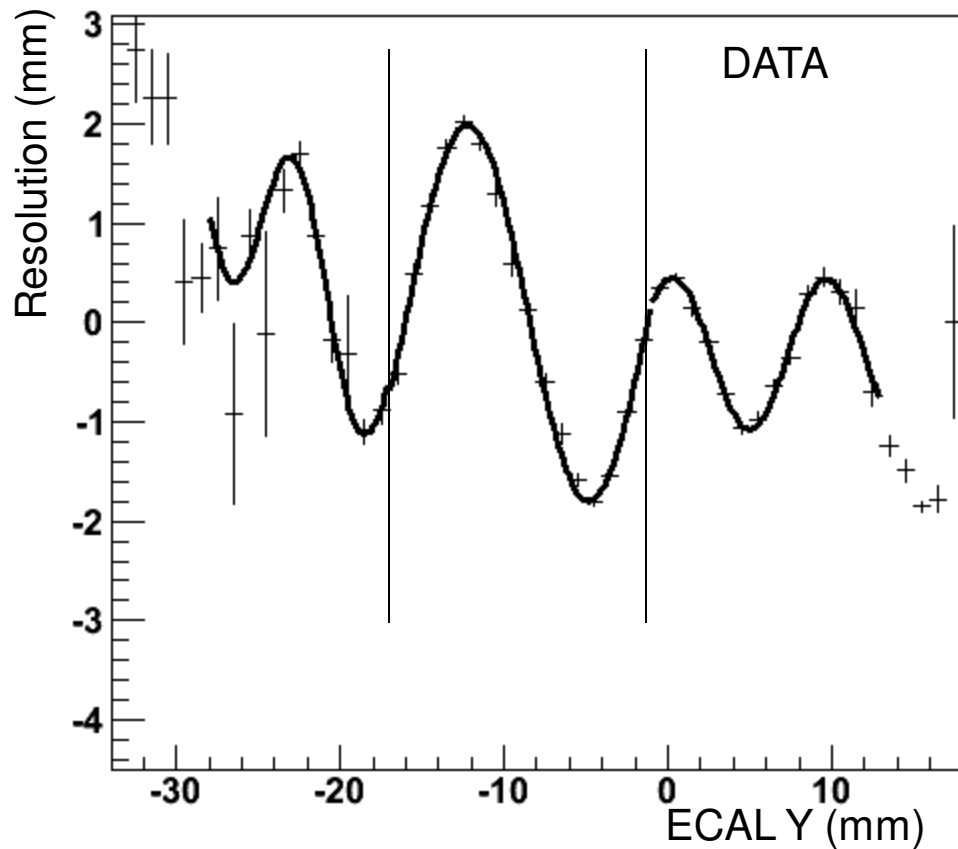
- Cell structure of ECAL causes an increase of the ECAL resolution

- The resolution ($X_{ECAL} - X_{Track}$) is zero if the particle hits the centre of a cell but is different from zero (thus increasing the sigma of the distribution) if the hit happens anywhere else

- Plotted as a function of the ECAL position, the resolution has a sinusoidal behavior

- The presence of gaps between wafers and their staggering has to be taken into account
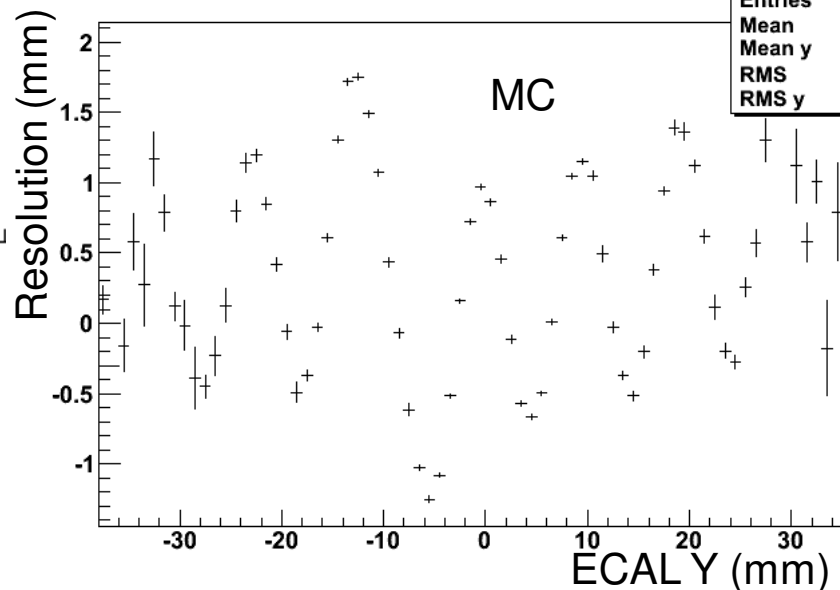
S-curve (Y)

Good agreement with MC

Effect of correction

No corrections

χ² / ndf	96.85 / 4
p0	11.03 ± 0.2333
p1	9.381e-010 ± 0.0002662
p2	0.8666 ± 0.008966

χ² / ndf	14.2 / 4
p0	11.65 ± 0.2703
p1	-2.897e-012 ± 0.0007368
p2	1.25 ± 0.01065

X axis

Y axis

Corrections applied

χ² / ndf	59.55 / 4
p0	10.2 ± 0.2905
p1	5.616e-014 ± 0.0002435
p2	0.7672 ± 0.009837

χ² / ndf	94.04 / 4
p0	9.157 ± 0.239
p1	1.064e-015 ± 4.742e-008
p2	0.882 ± 0.008775
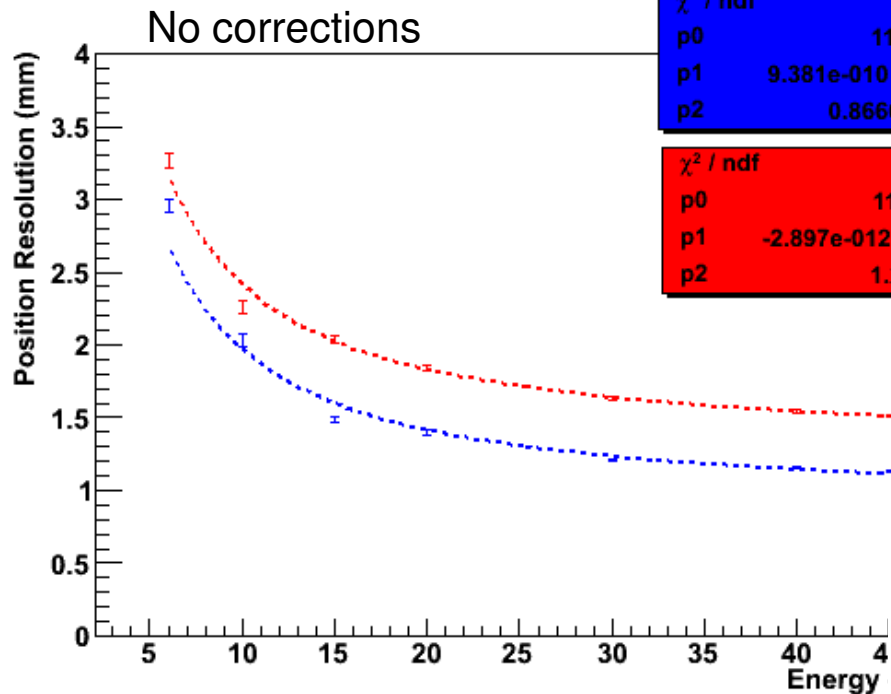
Large improvement especially along Y

(at 45 GeV from 1.6 mm to 1.2 mm)

Y axis

X axis

$$p0/E \oplus p1/\sqrt{E} \oplus p2$$

Prob		9.335e-05
p0		14.19 ± 0.2351
p1		2.256e-07 ± 1.577
p2		1.067 ± 0.005606

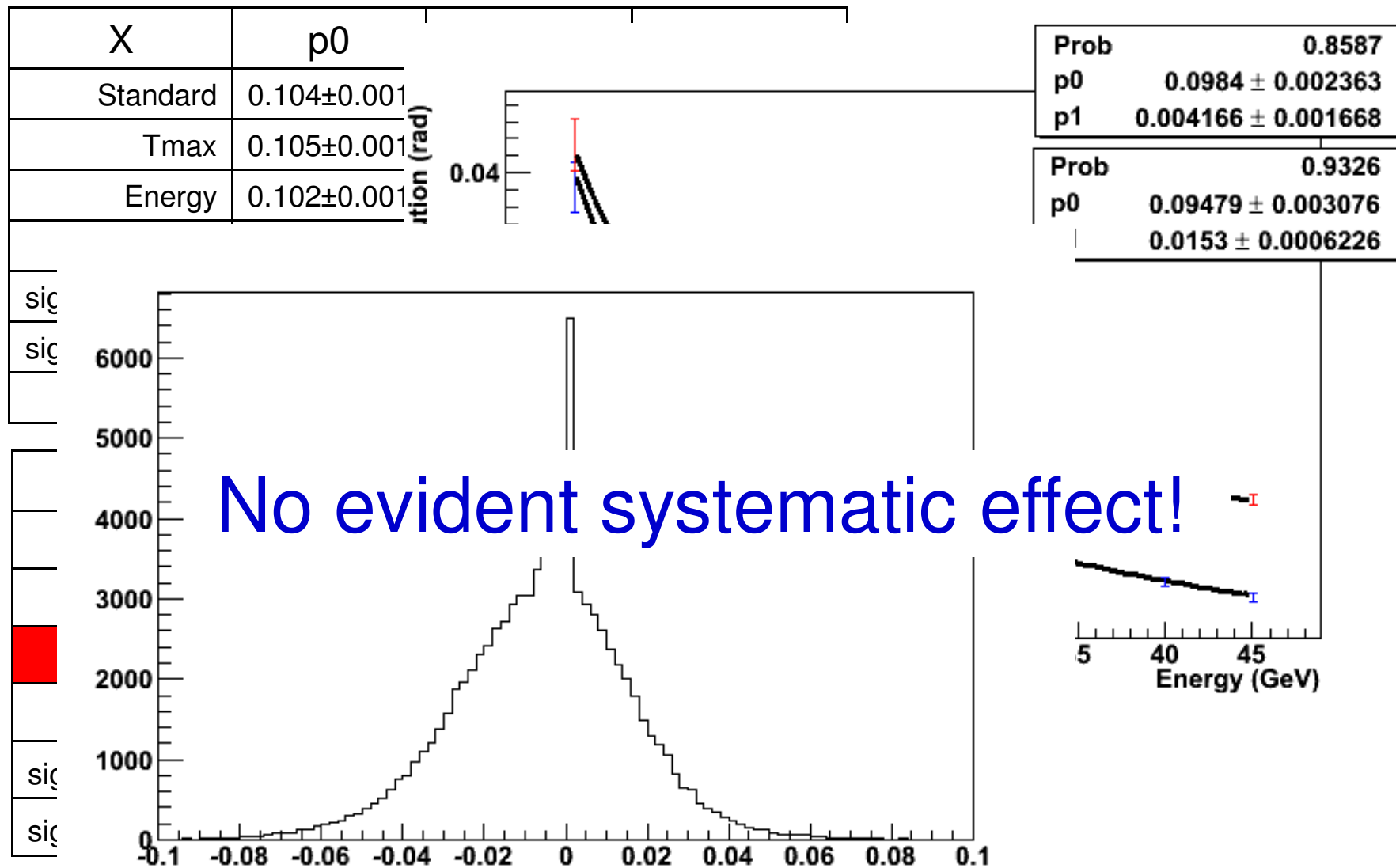|		
Prob		1.711e-05
p0		14.63 ± 0.8077
p1		1.769 ± 0.7
p2		0.9191 ± 0.02811
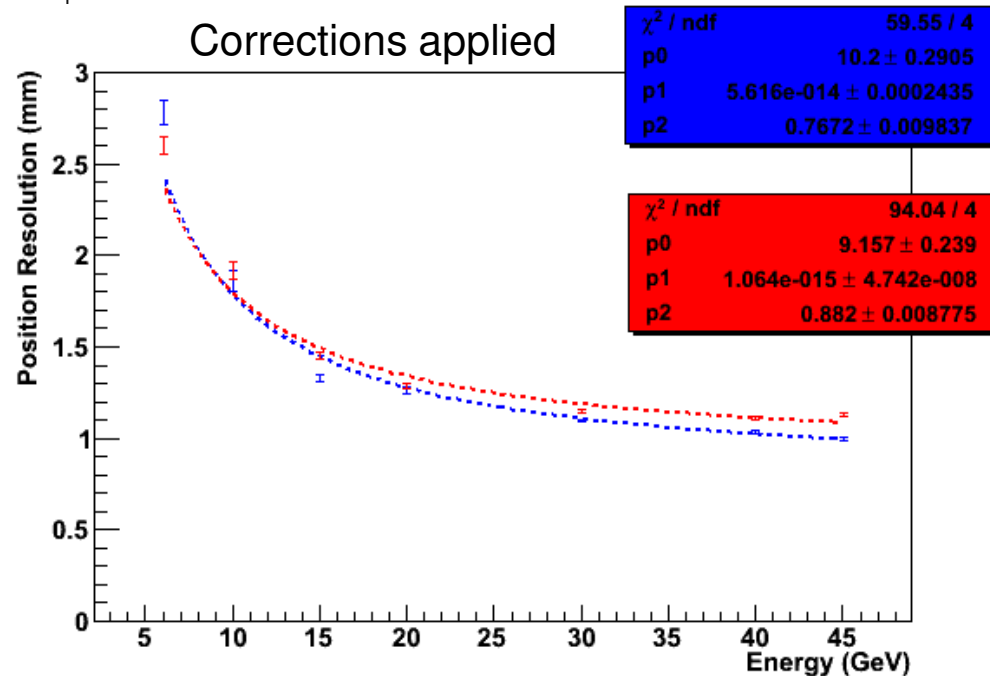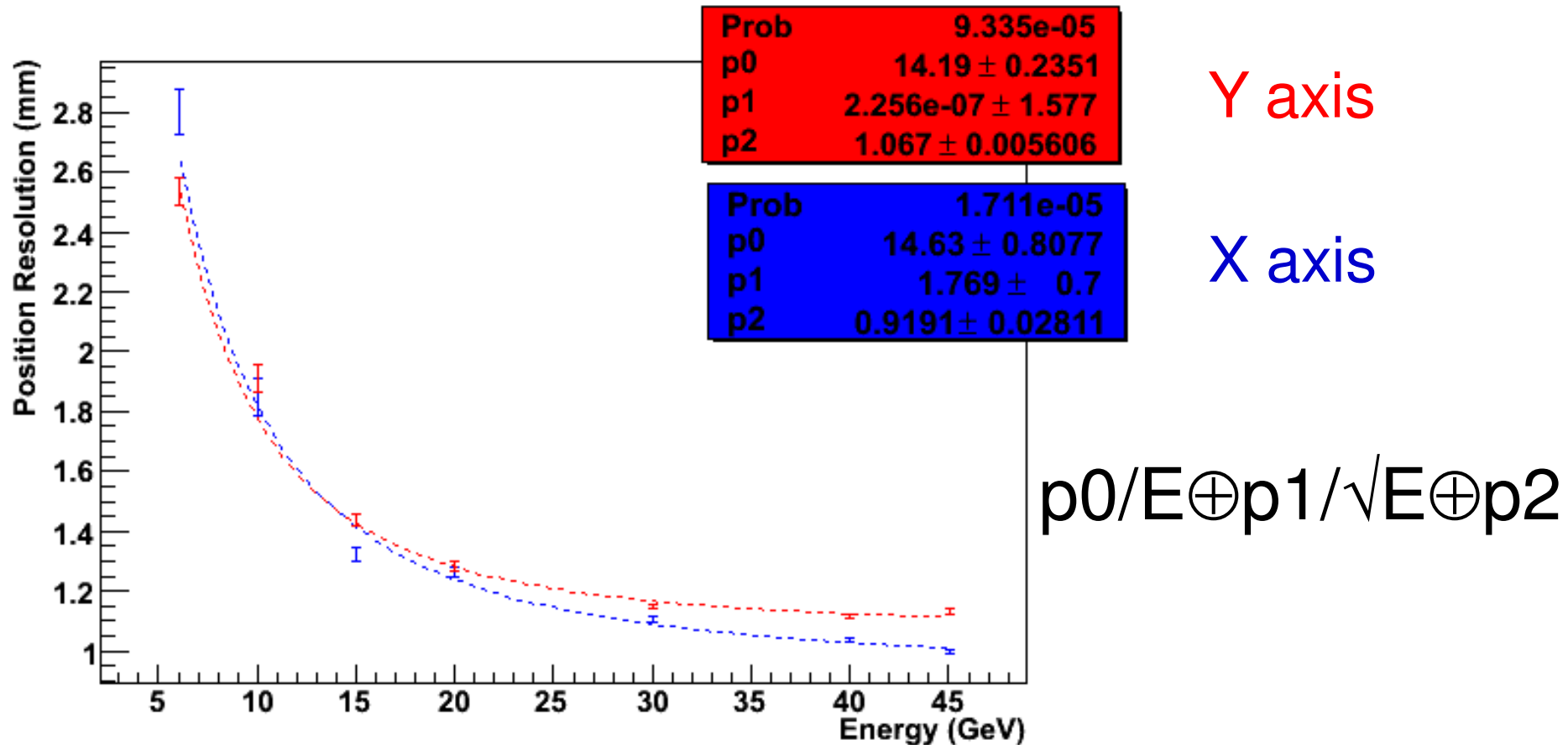
Fit has poor quality and term scaling as $1/\sqrt{E}$ is compatible with 0
Likely due to a high contribution from tracking

Systematic errors

- Search for large deviations (>2σ) from standard results varying:
  - Cut on Tmax
  - Energy cut   With or without cut
  - Cherenkov
  - Hit threshold
    - 0.4, 0.5, 0.6, 0.7 and 0.8
  - Fitting range
    - Removing 6 or 45 GeV runs
  - Fitting procedure for resolution
    - Fitting range from 1σ to 2σ

Angular resolution

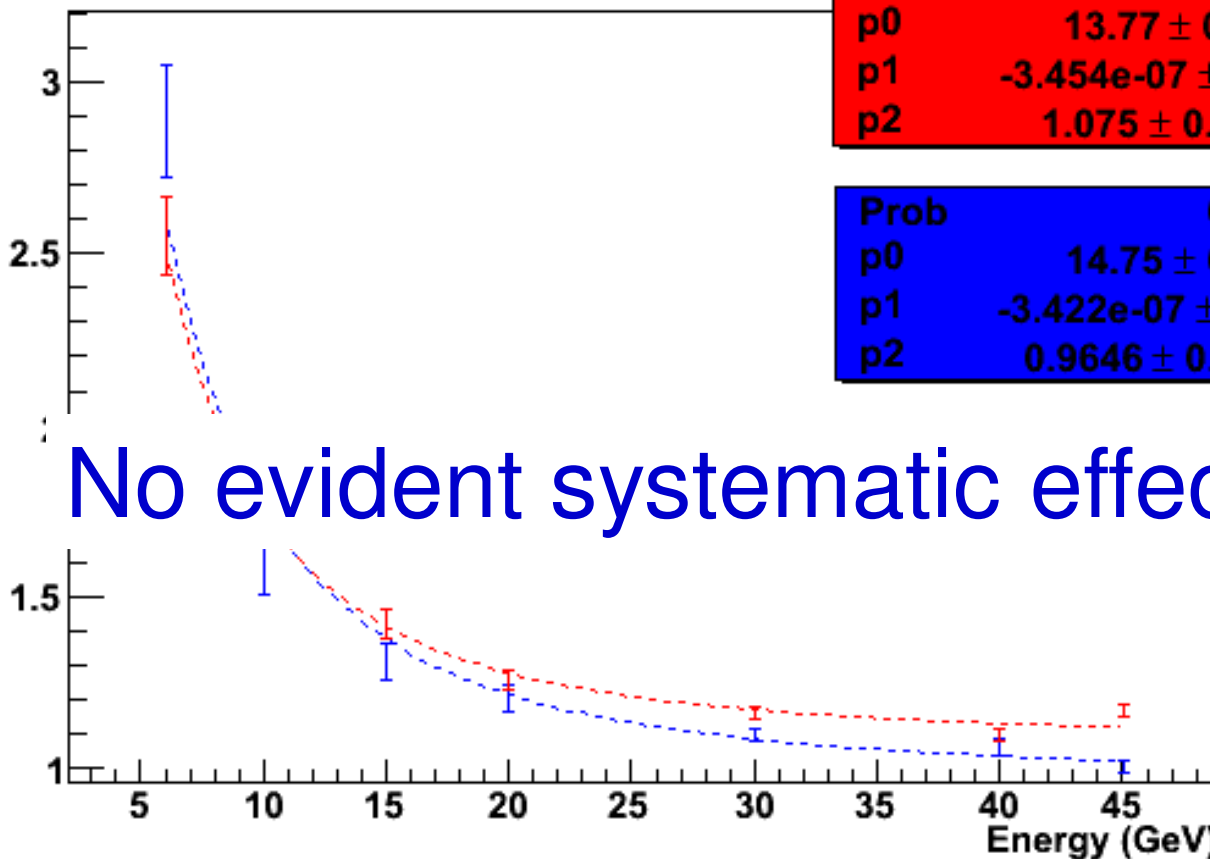| X	p0
Standard	0.104±0.001
Tmax	0.105±0.001
Energy	0.102±0.001

Prob	0.8587
p0	0.0984 ± 0.002363
p1	0.004166 ± 0.001668

Prob	0.9326
p0	0.09479 ± 0.003076
	0.0153 ± 0.0006226

No evident systematic effect!

X	p0	p1	p2	Probability

tion failed

Che

n

no

sigma f

sigma f

should

ndard?

No evident systematic effect!

Prob	0.01733
p0	13.77 ± 0.5304
p1	-3.454e-07 ± 1.351
p2	1.075 ± 0.01313

Prob	0.1329
p0	14.75 ± 0.6887
p1	-3.422e-07 ± 1.802
p2	0.9646 ± 0.01545

Che

n

no

sigma fit = 2.0	14.6±0.4	0.7±0.9	1.04±0.01	2.3E-06
sigma fit = 1.0	13.8±0.6	0±1.3	1.08±0.01	1.7E-02

Conclusion

- Position and angular resolution have been measured:
  - no problems with angular resolution
  - S-curve correction applied for position resolution
- Several systematic effect have been studied:
  - no evidence ($<2\sigma$ deviation) of systematic errors larger than the statistical error for angular resolution
  - Position resolution depends on correction procedure to S-curve, main effect on $1/\sqrt{E}$ term
- MC files now available
  - need to run tracking on them to complete the study
- Aim to write a note in parallel with MC study
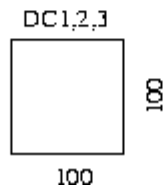
# Backup slides
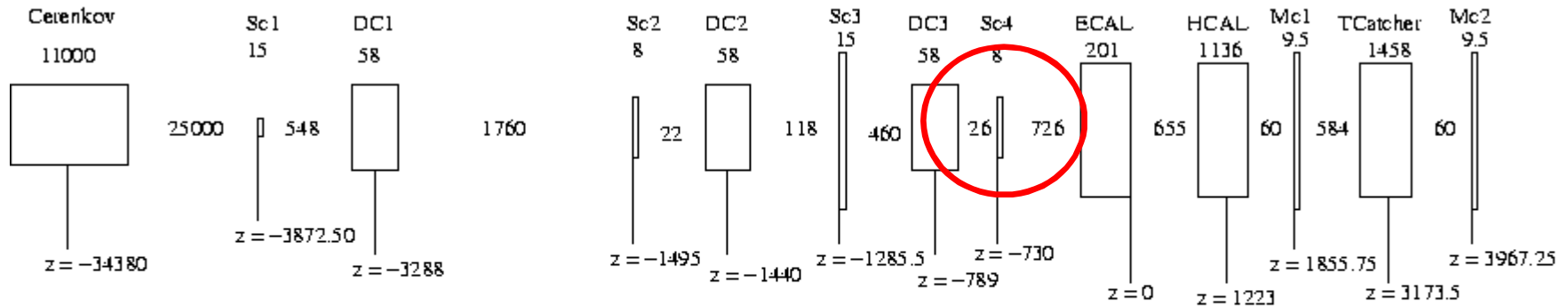
Calorimeter for ILC

H6 Area at CERN

In principle this is the best period to study position resolution as the DC3-Ecal distance was the smallest among all test beam periods

No survey for tracking alignment
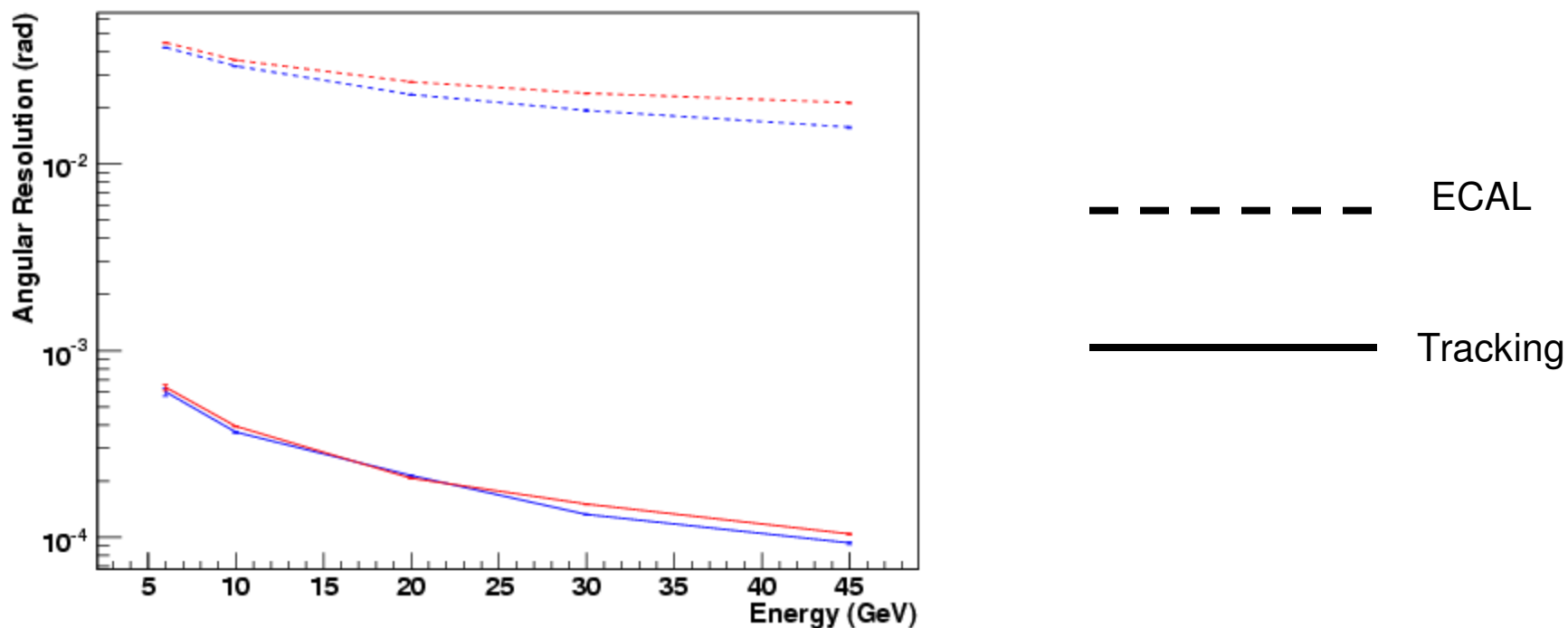No Calibration for the drift chambers (2007 values should be usable)

- Only top 3×2 wafers installed
- Staggering on X
  - 2.5 mm between the two layers in a slab
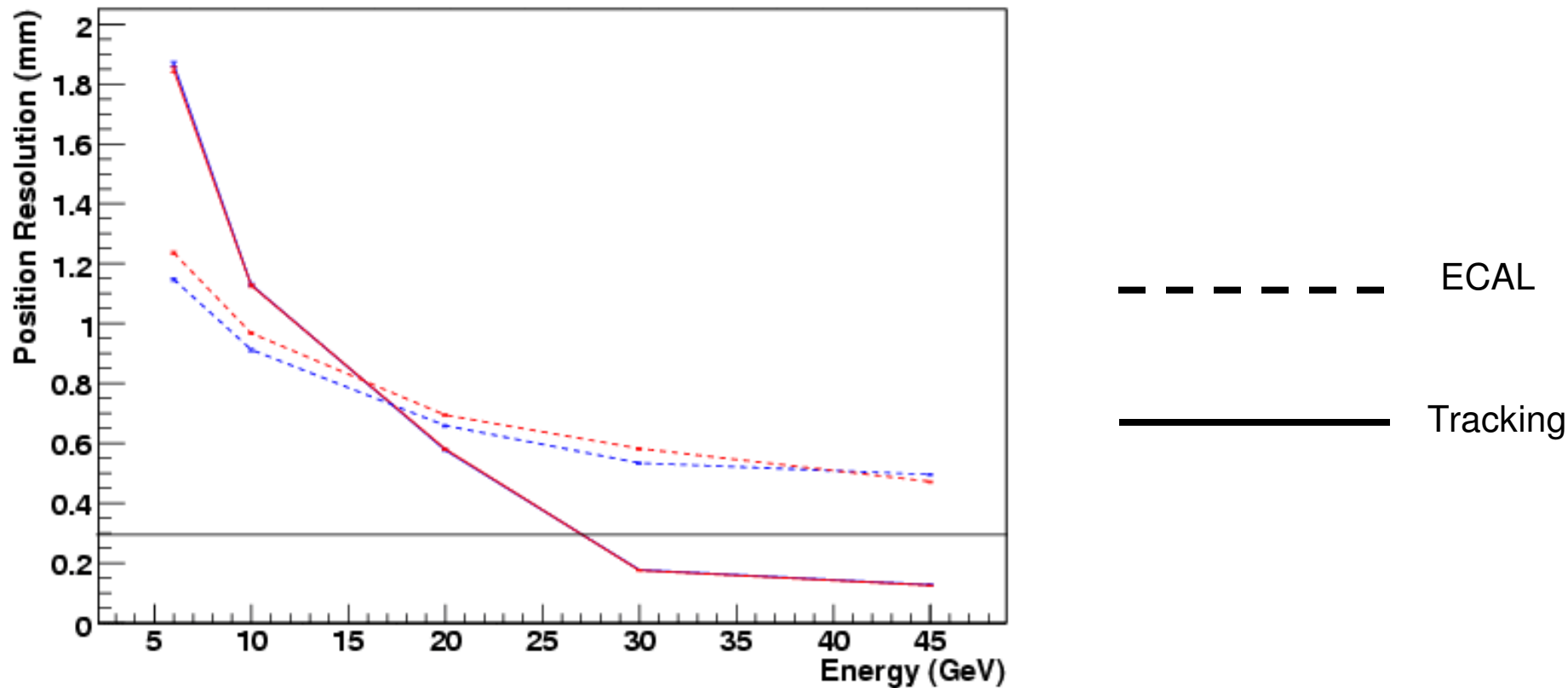 - 1.3 mm between slabs in each sector
- No staggering on Y
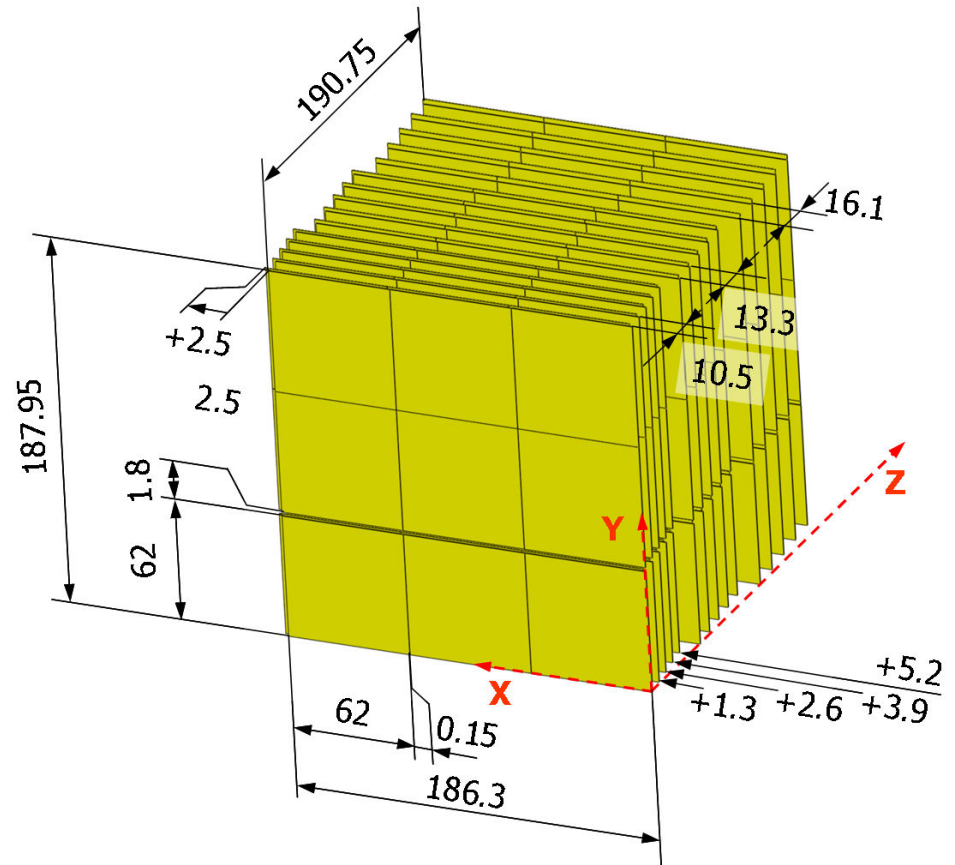
In MC, TRUE entry point and entry angle are compared to reconstructed value from ECAL and Tracking

- - - - - ECAL

—————— Tracking

Tracking should not affect the angular resolution

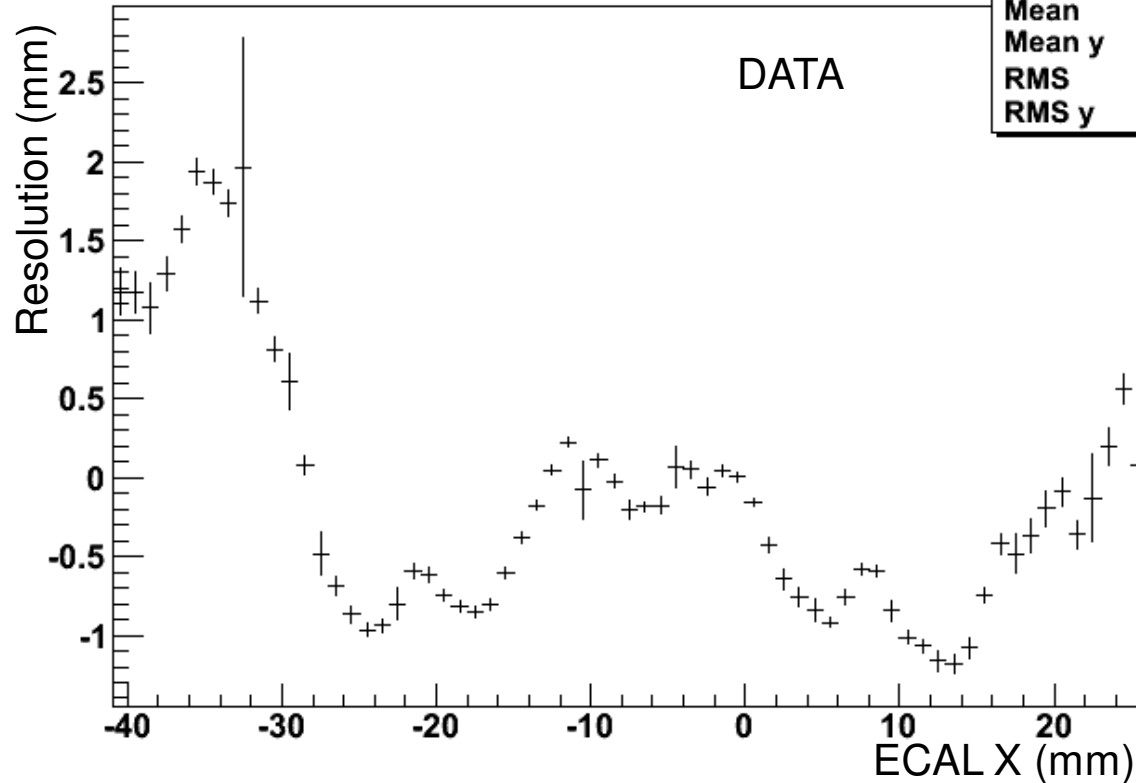From MC is possible to evaluate the different contributions to the position resolutions

The continuous line is the contribution from intrinsic resolution of tracking chambers
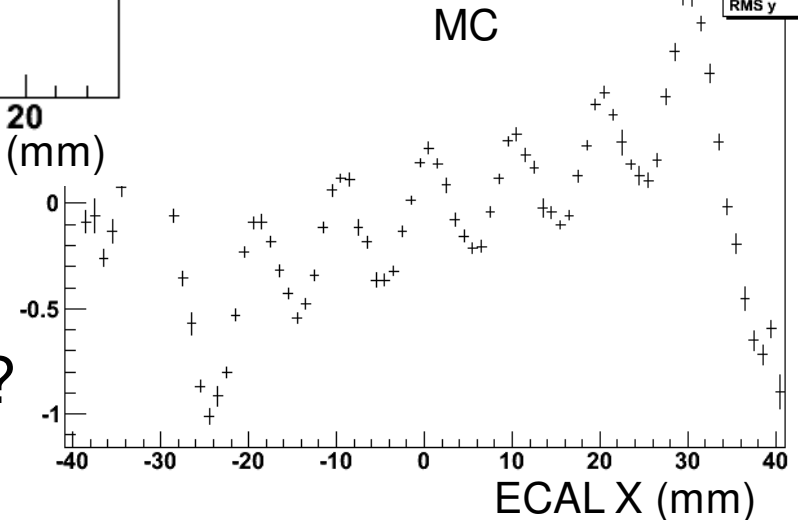
S-curve (X)

x average - x impact vs x average

h435_corx	
Entries	78461
Mean	-3.79
Mean y	-0.3705
RMS	13.45
RMS y	2.678

DATA

Difficult to correct for cell structure

h435_corx	
Entries	93295
Mean	0.06538
Mean y	-0.03392
RMS	15.9
RMS y	1.156

MC

Does the MC include all staggering?