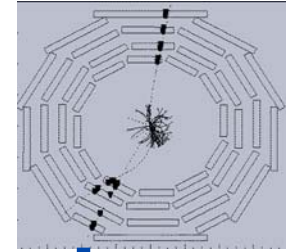**A. Meneguzzo** **Padova University & INFN**
**with contributions from F.Cavallo, M-C Fouz,, P.Ronchese and U.Gasparini**

Report on the analysis of SX5 cosmic ray data on Muon Barrel autotriggered chambers

-Flash: SX5 Sector test MB3+MB1 (run 4002) (UG &AM &P.R)

-Preliminary Resolution of MB chambers Wheel 2 (A.M)
what has been learned

-Preliminary efficiency of MB chambers Wheel 2 (F.C)
what has been learned

- Strategy and Status of the work on cosmic ray track reconstruction.
what has been learned (A.M. , M-C.F ,F.C)

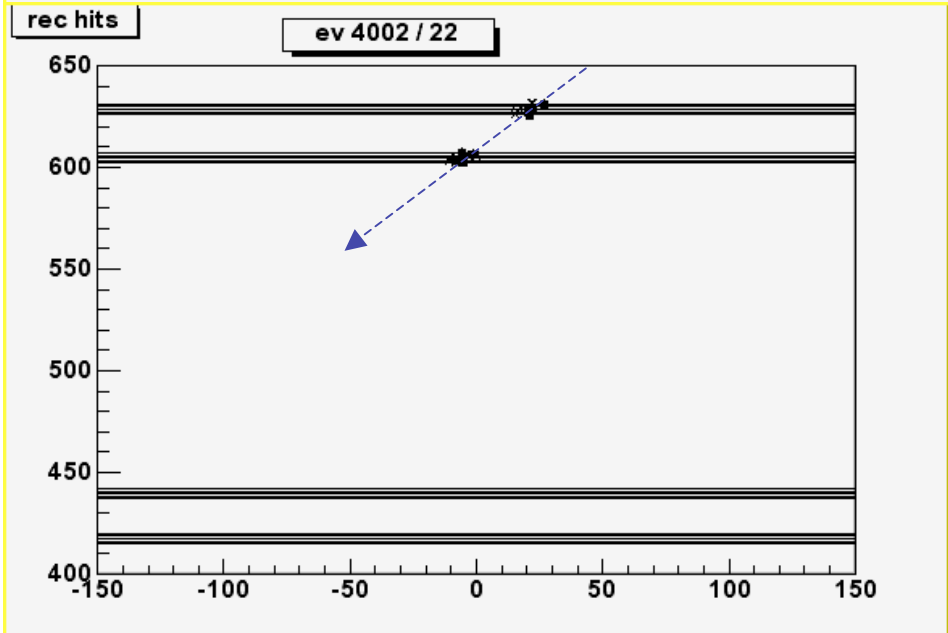**-Planned work and calls for contributions.**
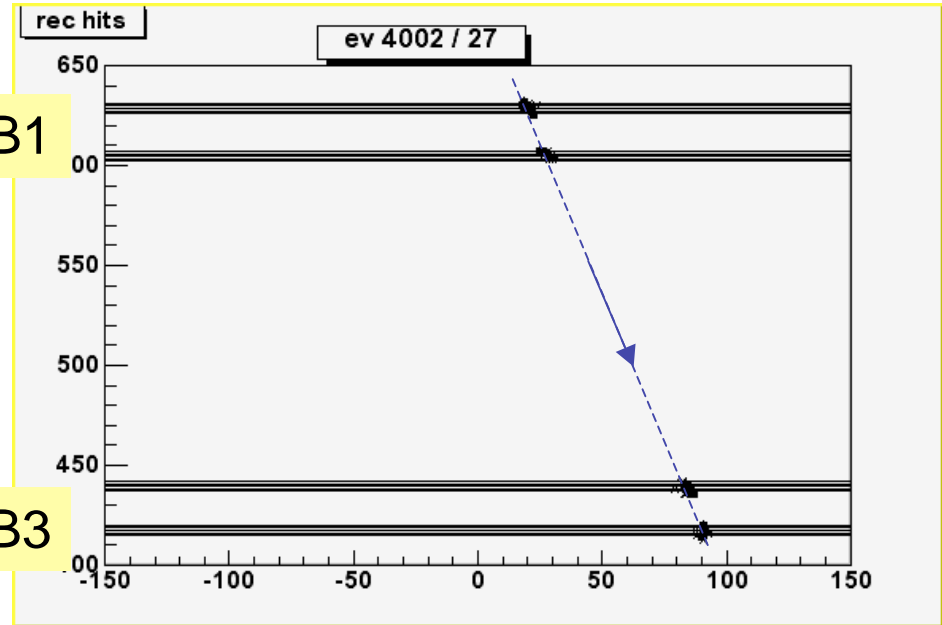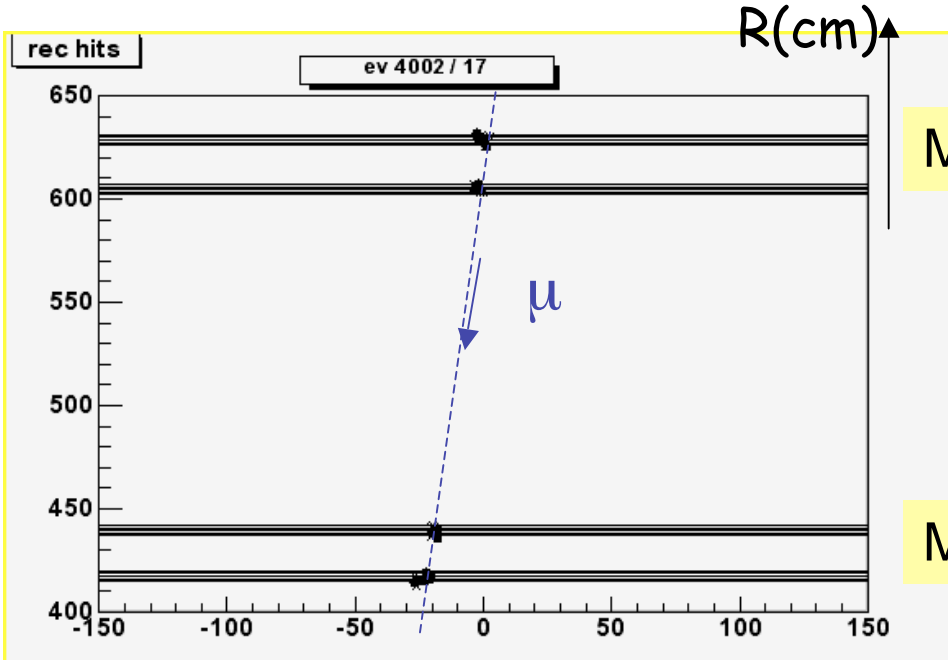
Events collected with
MB1 autotrigger

MB1 (3 Robs, r-φ view only) and
MB3 (4 Robs) equipped for DAQ

1 event in more detail...

week Dic 2005

2

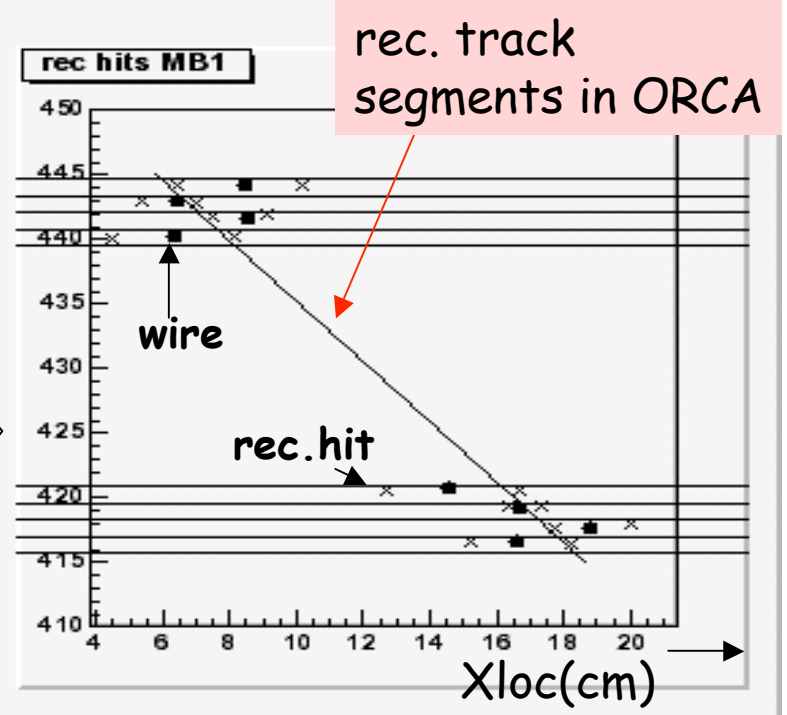Sector 4 Wheel +1

MB3

MB1

rec hits

ev 4002 / 20

μ

R (cm)

x(cm)

rec hits MB3

rec hits MB1

rec. track segments in ORCA

wire

rec.hit

Xloc(cm)
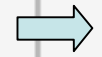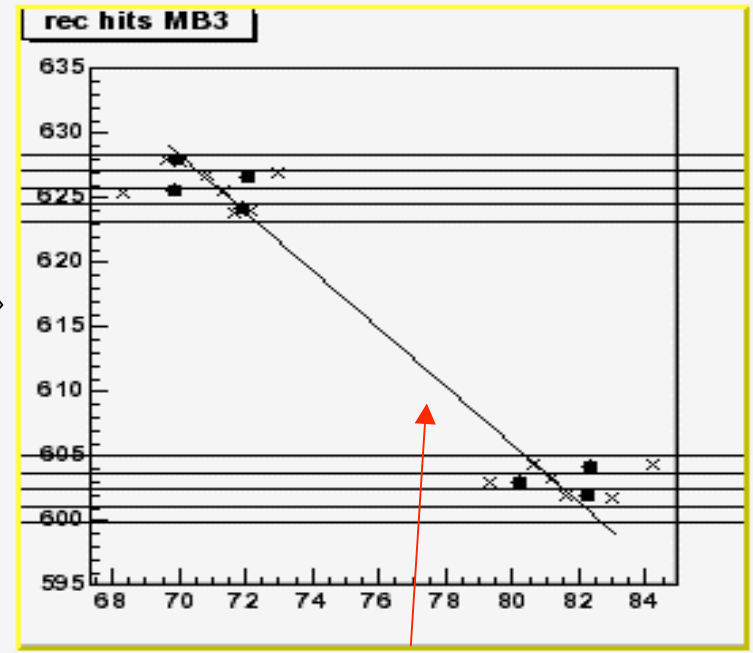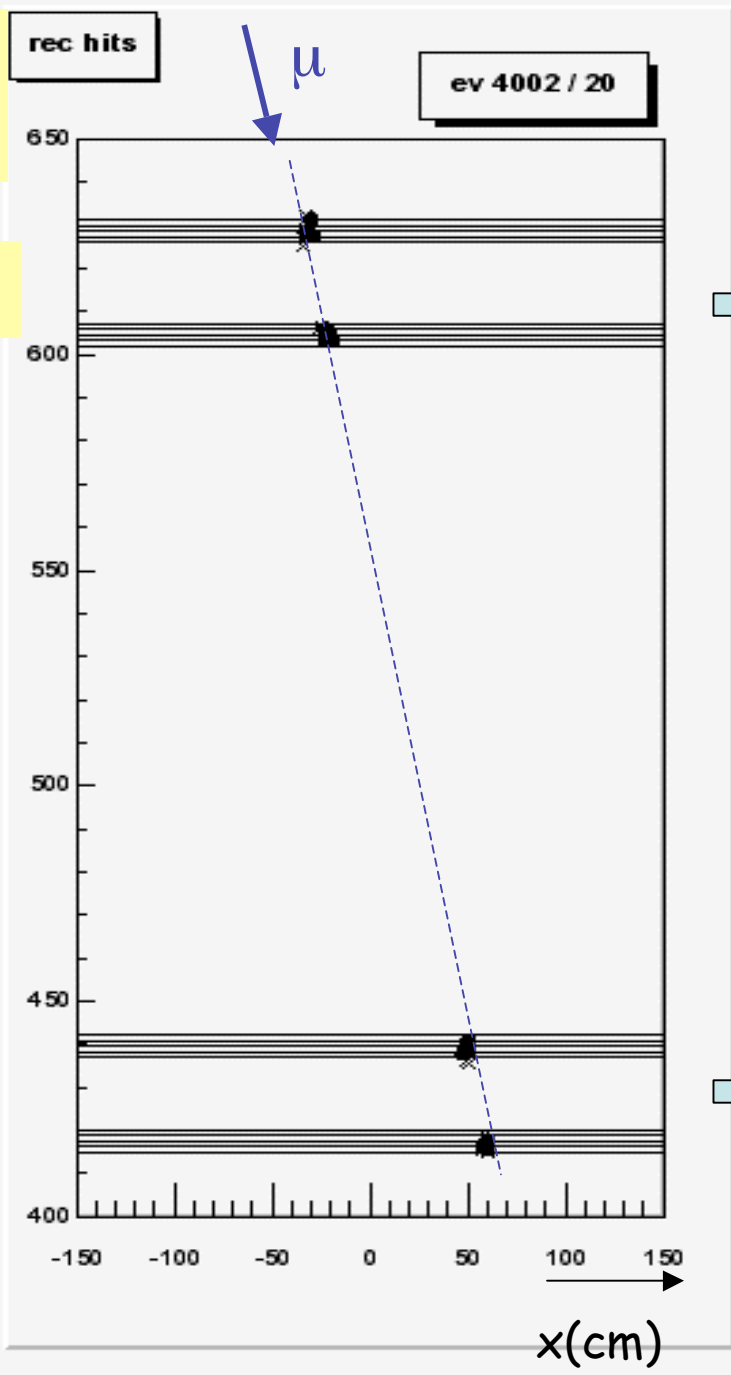
Rechits in track fit
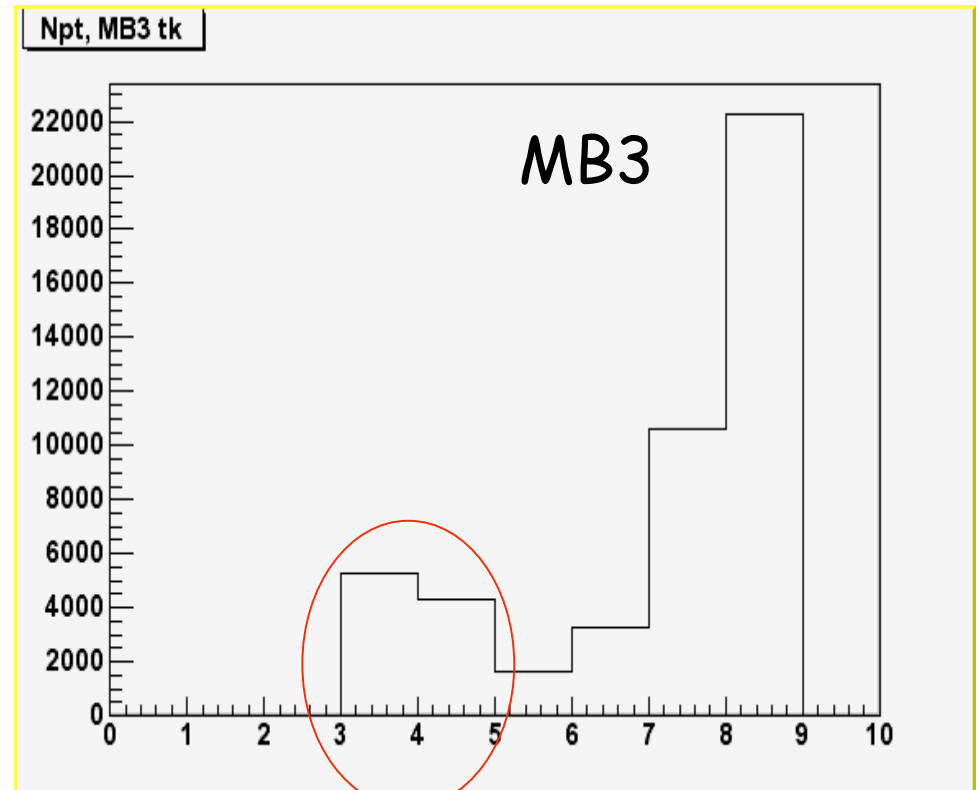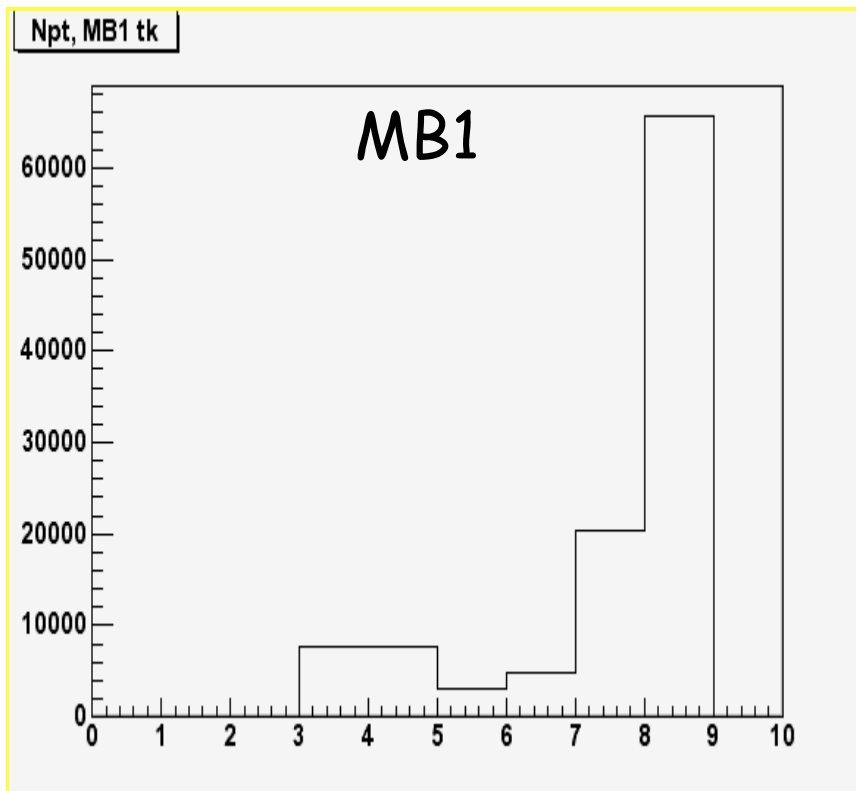
Events in 1 SL
(memo:
 MB3 is the non triggering chamber)
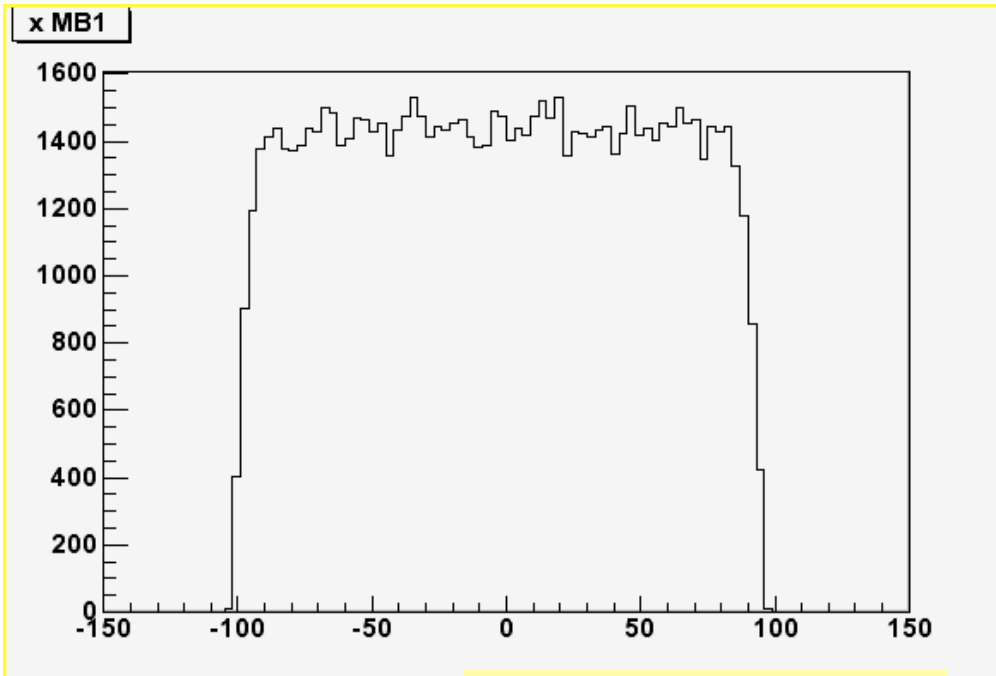
X track in MB1 (cm)
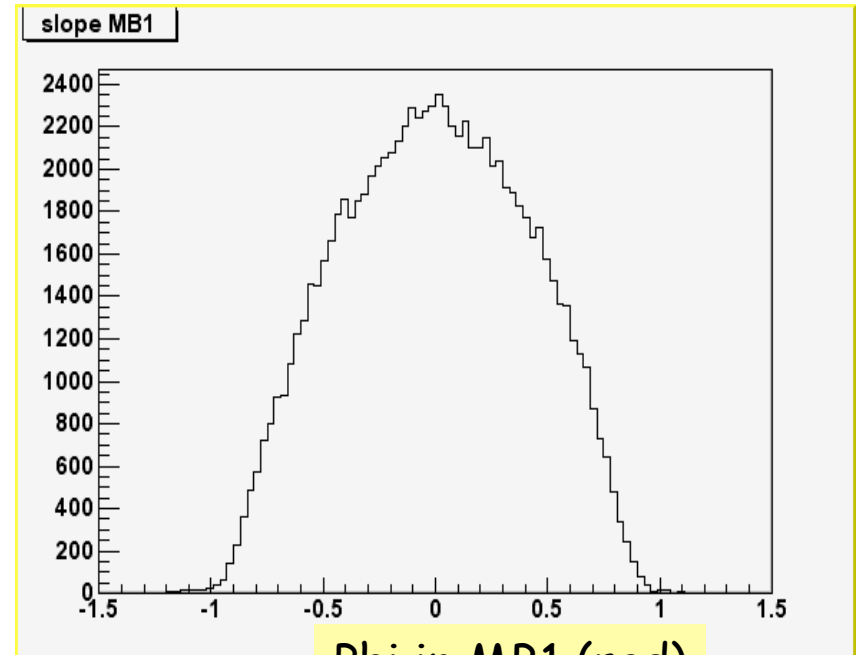
Phi in MB1 (rad)
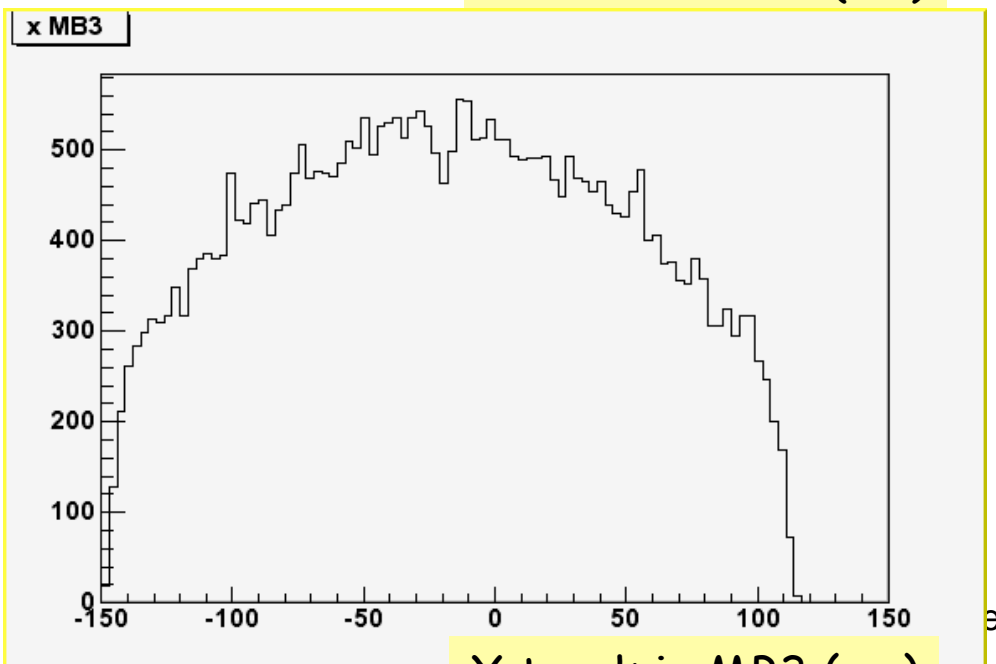
X track in MB3 (cm)
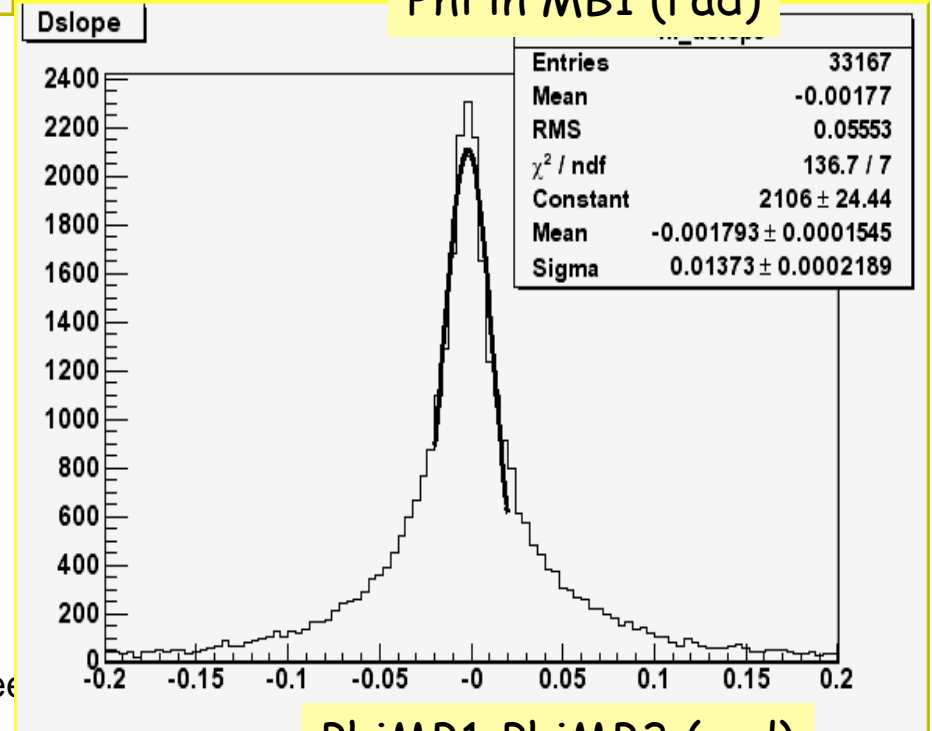
PhiMB1-PhiMB3 (rad)

Tracks reconstruction on cosmic data analysis

Goals : Reconstruct tracks with the best possible accuracy

That is necessarly required for

- final commissioning checks (as 25 ns effect studies)

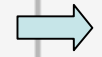- Effect of including to the ideal position the (production sites) wire and (ISR) corner blocks measurements (with Noemi & Zoltan).

- Measurement of chamber internal alignment with tracks (with Matorras et al.)

- cosmic challenge and magnet test chamber behavior in magnet field and CMS alignment parameter accuracy checks.

Track Reconstruction :

Work planned and done & tools refined:

- Standard Orca track reconstruction code working on data chambers (fix geometry,T0i,ref.system of reconstructed tracks)
    For geometry see http://cms.pd.infn.it/commissioning/maps/
    For T0i next slides & cmsfarm009.lnl.infn.it:/data/SX5/flat/W2/t0N/

- Implemented new 3 parameter tracks refit (angle, position and T0event computation) included in the standard ORCA track reconstruction code–MuBarSegment.

  - flat commissioning files selection and management in cmsfarm009.pd.infn.it see

    http://www.pd.infn.it/~ameneg/SX5/T0ev/T0ev_analysis_run.lis

  - production of root tree files in cmsfarm009 for ~all W2 chambers ->all data tree available in cmsfarm009 at lnl /data/anna/root/W2/MB*/t0evtree*.root

  - analysis >>>>>very very preliminary>>>

TOi should be stables >> can be >> FINAL FIGURES

Toi should contains the measure of the different cables lenght for the different Robs inside the MiniCrate.

Their measure is performed analysing TP signals.

That is done ~on line at SX5 commissioning .
TDC data has to be shifted of the measured value for

equalizing the T0 for all channels inside a Mini Crate .
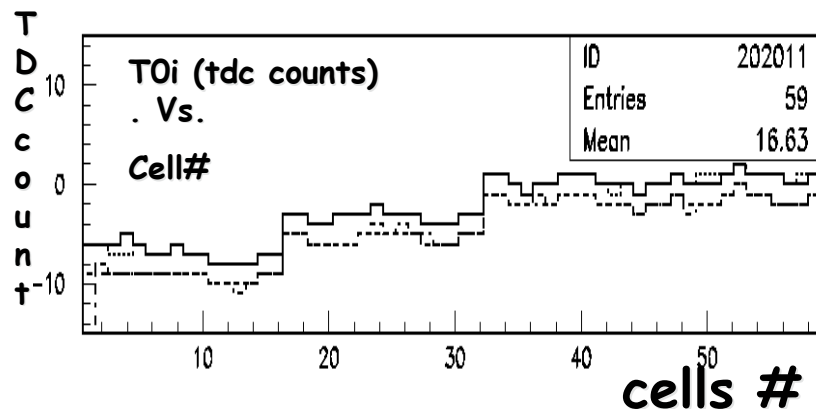
Example :

To for cells of layer 1 SL 1 MB2

2TP lines for odd and even layers shifted : not cables but TP lines : must be corrected

2TP lines for odd and even layers corrected

Wheel 2 Chambers MB2.
Mean TP value for each ROB normalized to ROB0

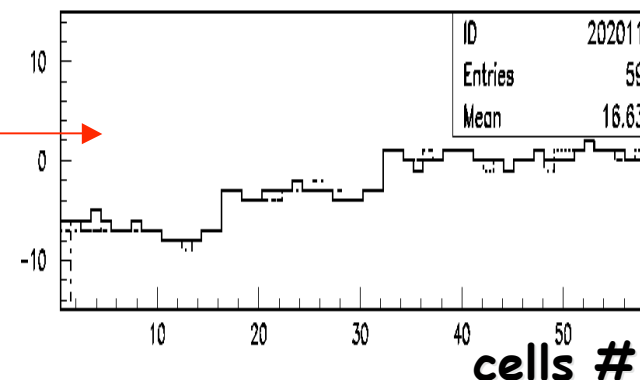| Sector	#Ch	Run	ROB0	ROB1	ROB2	ROB4	ROB5	ROB6
2/2/2	46	3567	0	3.22	5.88	6.21	15.37	8.59
2/3/2	47	3546	0	2.38	5.46	5.11	14.64	9.81
2/4/2	48	3470	0	3.47	5.85	6.13	15.49	8.88
2/5/2	19	3502	0	3.35	4.78	4.92	14.96	8.79
		3504	0	3.32	4.69	4.76	15.04	8.46
2/6/2	49	3426	0	2.30	5.02	5.14	13.92	9.52
2/8/2	22	3395	0	3.51	5.86	5.73	14.96	8.62
2/9/2	23	3343	0	1.96	4.50	4.24	13.12	9.98
			(1)	(2.96)	(5.50)	(5.24)	(14.12)	(10.98)
2/10/2	24	3074	0	2.40	4.96	4.95	13.16	9.70
2/11/2	17	3000						
2/12/2	26	3315	0	3.37	5.27	5.34	14.77	8.38
Expected values			0	2.84	5.68	5.68	2.84+δ	0+δ
Average of all sectors	Mean		0	3.00	5.39	5.41	14.66	9.05
	RMS		0	0.50	0.41	0.48	0.72	0.83

Mary_Cruz

Only R3502 used
for average

Not used for average

δ= Extra (FE)
cable length

δ= 11.82 δ=9.05

~1ns diff with
respect to
MB1 & MB3 values

Toi Channel by channel equalization

M-C reanalyzed independently the data very accuratly (flat files)

(see commissioning presentation of nov17-05)

TP study Results   :

T0i are ~ as expected from cables lenght inside MiniCrate.

- monitor on line computation is almost fine

– at SX5 checks implemented for TP cables swaps ->**done**

- equalisations of the 2 TP lines needed for T0i ->**done**

(partially done offline: should be implemented at SX5 within the standard procedure)

- at SX5 reload configuration before TP runs**->done**

- better accuracy on T0i automatic saving file (monitor)

T0_event correction

On autotriggered cosmic ray data the time of the cosmic ray track can vary
with an almost flat distribution of 25 ns with respect to the L1A
trigger signal, so the normal fit procedure, which uses a constant T0 (the input
parameter tTrig in ORCA code) , yelds ~500μm resolution for each hit
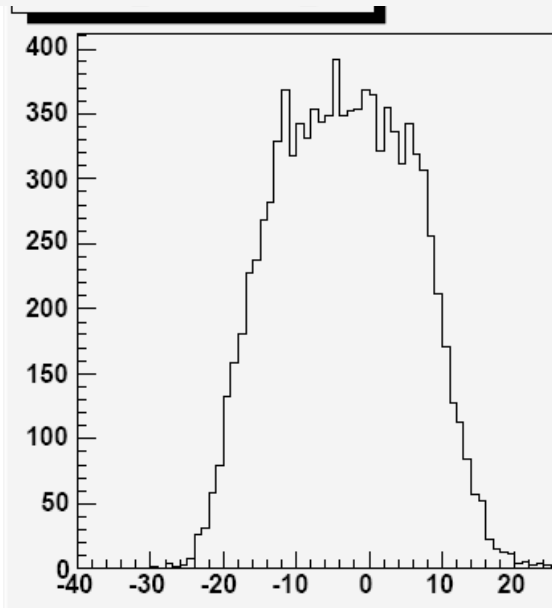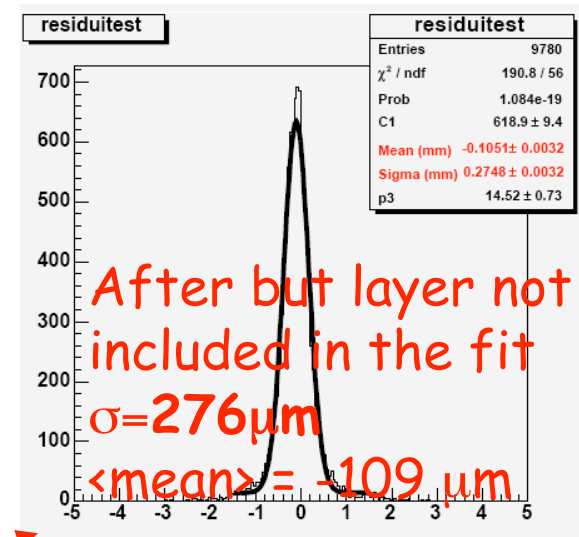included in the fit .
But in each event all points of a track (drift time of differents layers) have the
same time displacement in the range of 25 ns. That T0ev can be computing
with a minimization (see

T0ev time

→ Muon drift time

TDC measured drift time

t_4 t_4

t_3 t_3

t_2 t_2

t_1
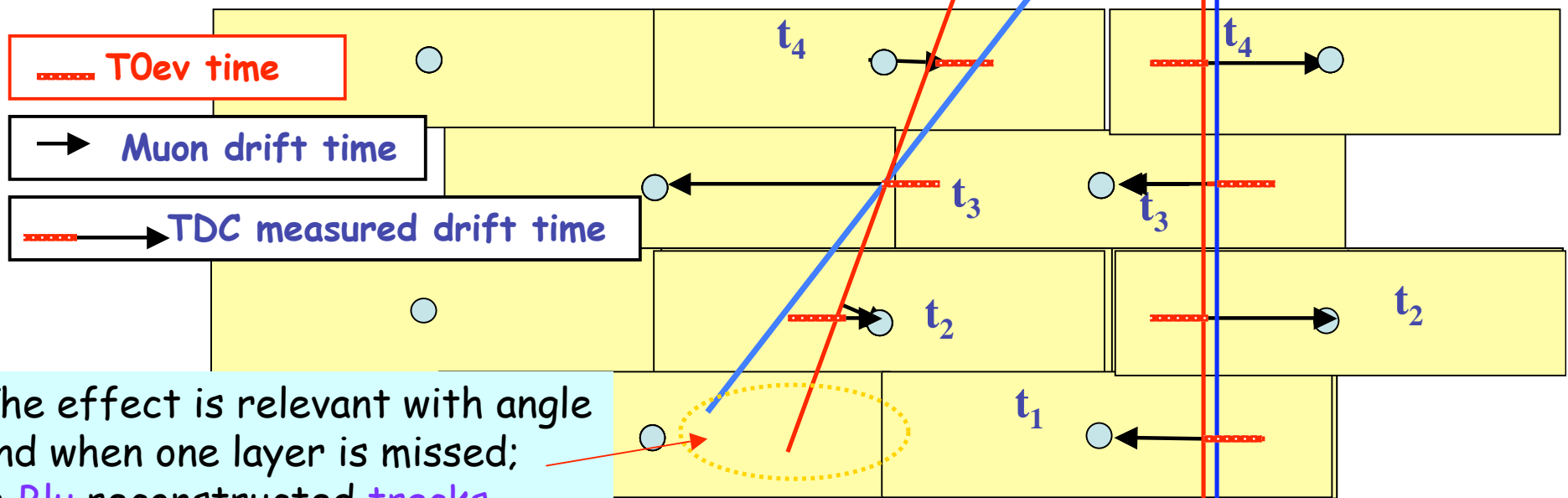
The effect is relevant with angle
and when one layer is missed;
in Blu reconstructed tracks
without t0event correction.;red :
real track and reconstructed
with T0ev correction included.

DT-CMS

For tracks in the same semicell only
residuals are different ; Blu and red
track (position and angle) are the same.

To_event correction checks: Residuals of l4-SL1 with respect to all "BothPhi" tracks reconstructed on 10K events

residuiold

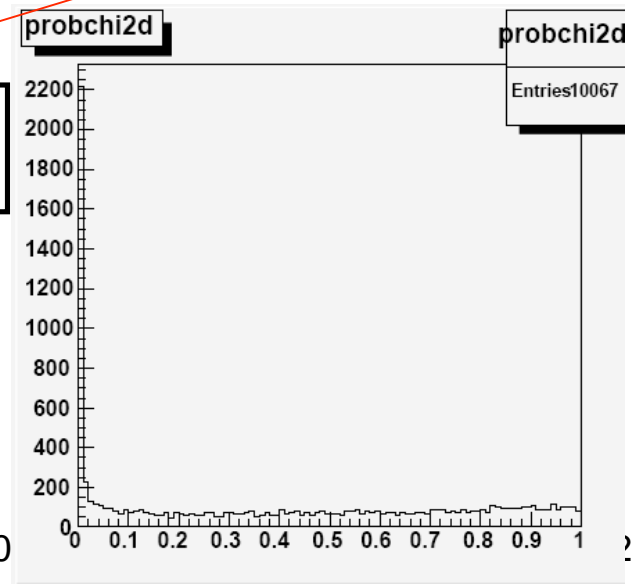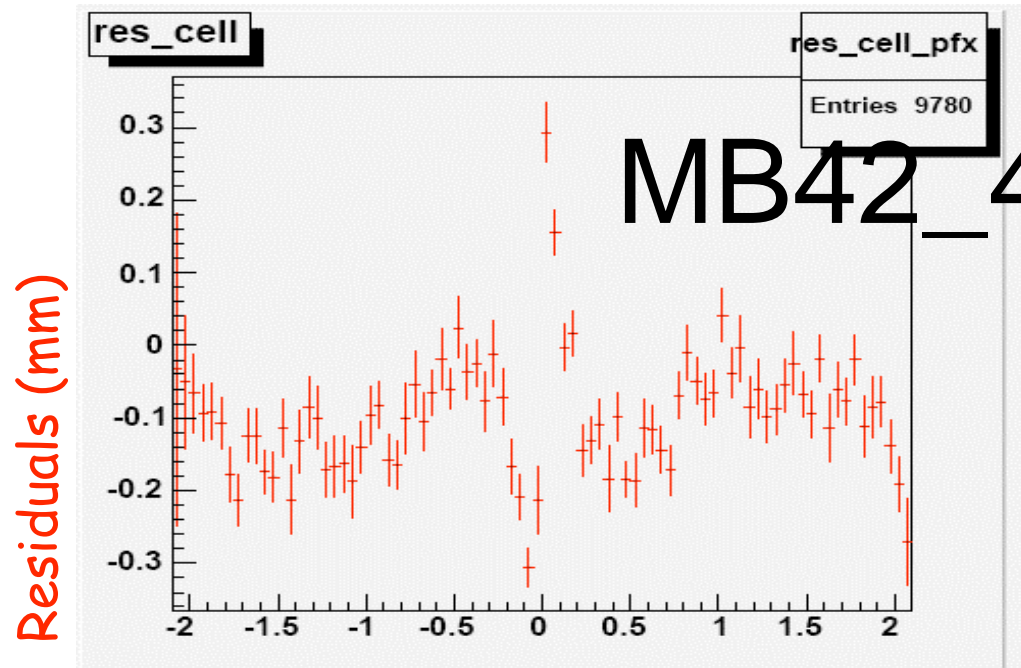| residuiold	
Entries	9780
χ² / ndf	113.2 / 56
Prob	9.51e-06
C1	378.9 ± 4.7
Mean (mm)	-0.07115 ± 0.00526
Sigma (mm)	0.5102 ± 0.0059
p3	-1.459 ± 1.274

Before t0ev correction σ=510μm   <mean> =-71 μm

residuinew

residuinew	
Entries	9780
χ² / ndf	138.3 / 36
Prob	1.178e-16
C1	817.9 ± 12.3
Mean (mm)	-0.07932 ± 0.00242
Sigma (mm)	0.2061 ± 0.0024
p3	23.63 ± 1.23

After

σ=**206μm**

<mean>= -79 μm

residuitest

residuitest	
Entries	9780
χ² / ndf	190.8 / 56
Prob	1.084e-19
C1	618.9 ± 9.4
Mean (mm)	-0.1051 ± 0.0032
Sigma (mm)	0.2748 ± 0.0032
p3	14.52 ± 0.73

After but layer not included in the fit
σ=**276μm**
<mean>= -109 μm

residuals

MB4 2_4_3

probchi2d

Entries 10067

Toev correction (TDC counts)

Chi2 probability

AM- DT-CMS week Dic 200

MB42_4_3:To_event

Residuals (mm)

Residuals: position in the cell(cm)
layer
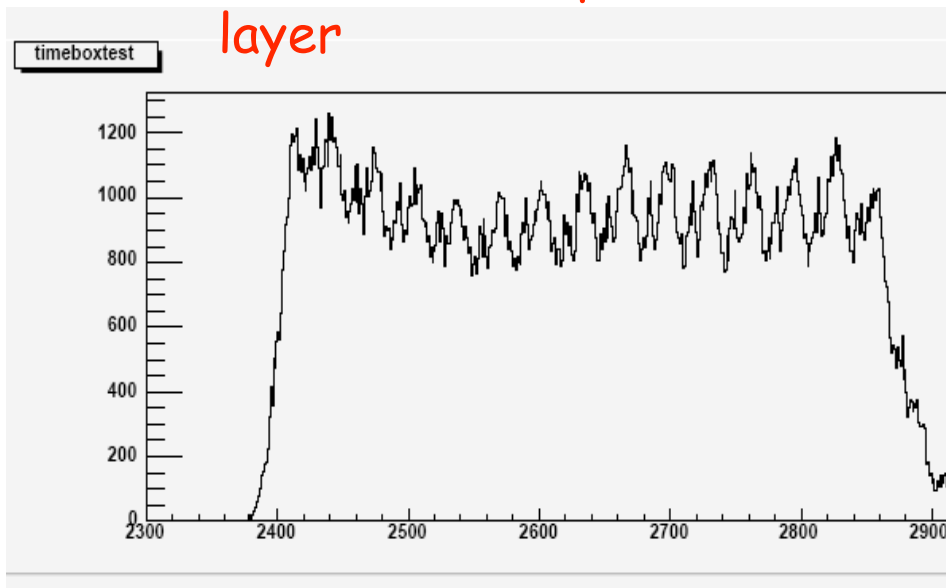
Time box of the data used :

 25ns effect quite large but seems not to affect resolution strongly not statistically indentified ...Studies more specific are planned (i.e. look at resolution as a function of the original (TDC row) time of the rechits related to the fitted track). And look at hits not associated to the track.

Very Very Preliminary Results of tracks reconstructed in ORCA withT0ev event correction. ~All data taken with 'not perfect' configuration on the Mini Crate

First analysis of all chambers data with the 'same' trigger and code reconstruction and first MB4 chambers with Orca

Results summary :www.pd.infn.pd/~ameneg/SX5/all_res.txt

*some plots in www.pd.infn.pd/~ameneg/SX5/Results/*pdf*

reconstruction quality and efficiency as function of sector

"automatic" tracks 'BothPhi' data analysis for almost all commisioned chambers of W2

- *All must be checked again : possible errors like association of*
    - *type of trigger ....*
    - *run number assignment....*
    - *T0i files ...   -*

*all will be update as soon as possible

Track reconstruction (ORCA standard code +T0ev improvement): 100K events

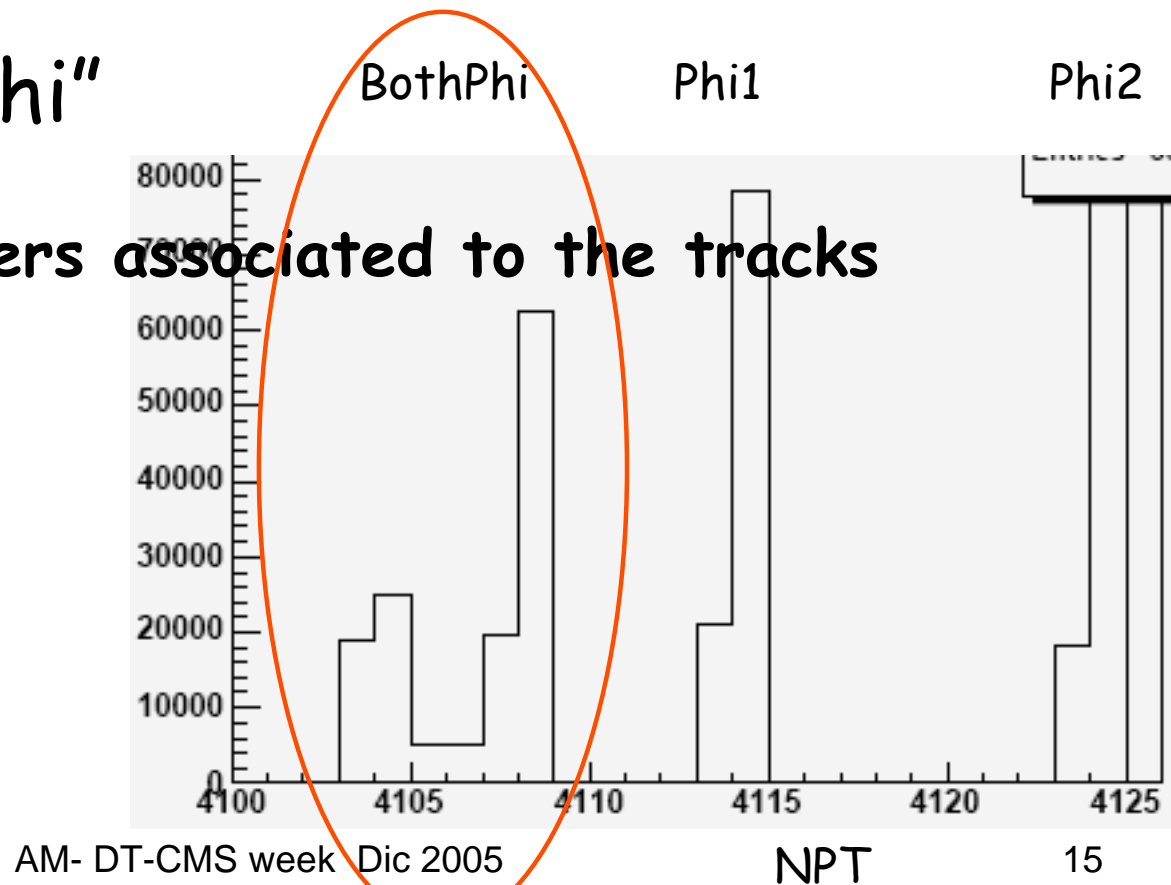-all Rhits with ~300 micron error

-tracks in each SL

-tracks in "BothPhi"

'npt'=**numbers of layers associated to the tracks**

NPT=   sector*1000

          +Station*100

          +10*type

           +npt

Type=0   : BothPhi

Type=10   : Phi1

Type=20   : Phi2


AM- DT-CMS week Dic 2005

NPT

15

BothPhi tracks : Residuals layer by layer

for > 4pt tracks residuals distribution for each layer in the chambers is fitted with a gaussian+p0 fit: for l2 SL 1 of ~all W2 chambers, the computed <mean> & sigmas & entries are reported in next slides summary tables. Even if preliminary all layers results are available in txt files and the plots as well
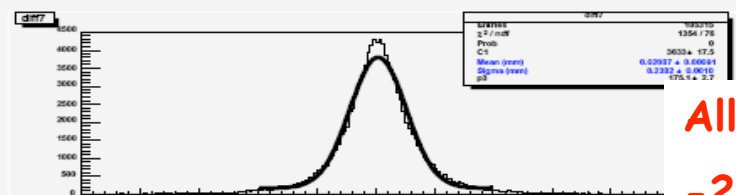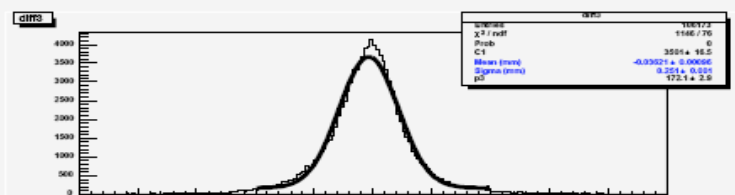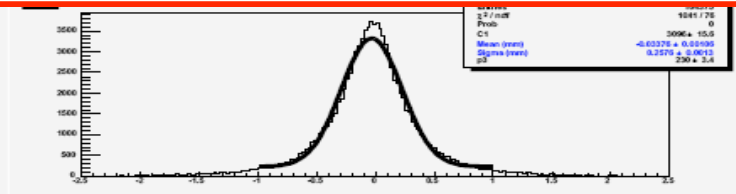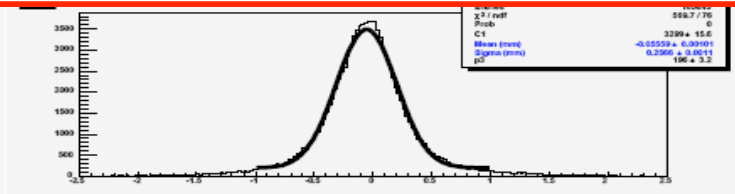
All plots ranges:

-2.5 mm : 2.5 mm
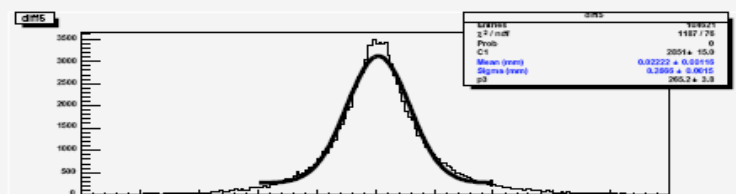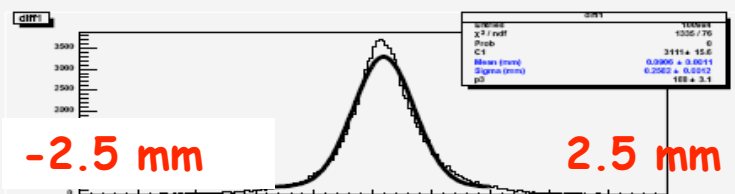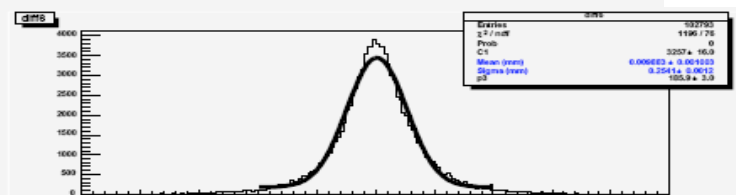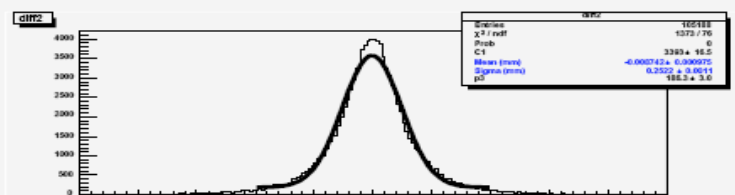
-2.5 mm   **2.5 mm**

Comments and warning on Resolution results :

   The found residuals distributions have usually the
aspect of the plots reported in the previous slide.
   That should be since the residuals with respect
to the reconstructed tracks reported here are the residuals of the
Rhits points included in the fit
                    nevertheless
-efficiency studies (see next slides F.C.) show that only
something below some 2- 4% of Rhits are not included
in the fit and the total mean cell efficiency is normally above ~ 97% .
-the effect of removing layer by layer in the fit is shown in slide 12
and is one of the planned work to do systematically.
The resolution ~200:250μm is near the intrinsic
   chamber resolution and allow

- alignment parameters can be computed by Matorras et al.
– the wire and ISR position measurement applied and their
effect will be measuredwork be performed on the tree
data offline).

Residuals W2

2_1_5	-7	219	97
2_2_5	20	227	96
2_3_5	34	223	97
2_4_5	182	232	76

2_1_3	-28	218	97
2_2_3	-16	219	95
2_3_3	3	230	96
2_4_3	30	213	? 78
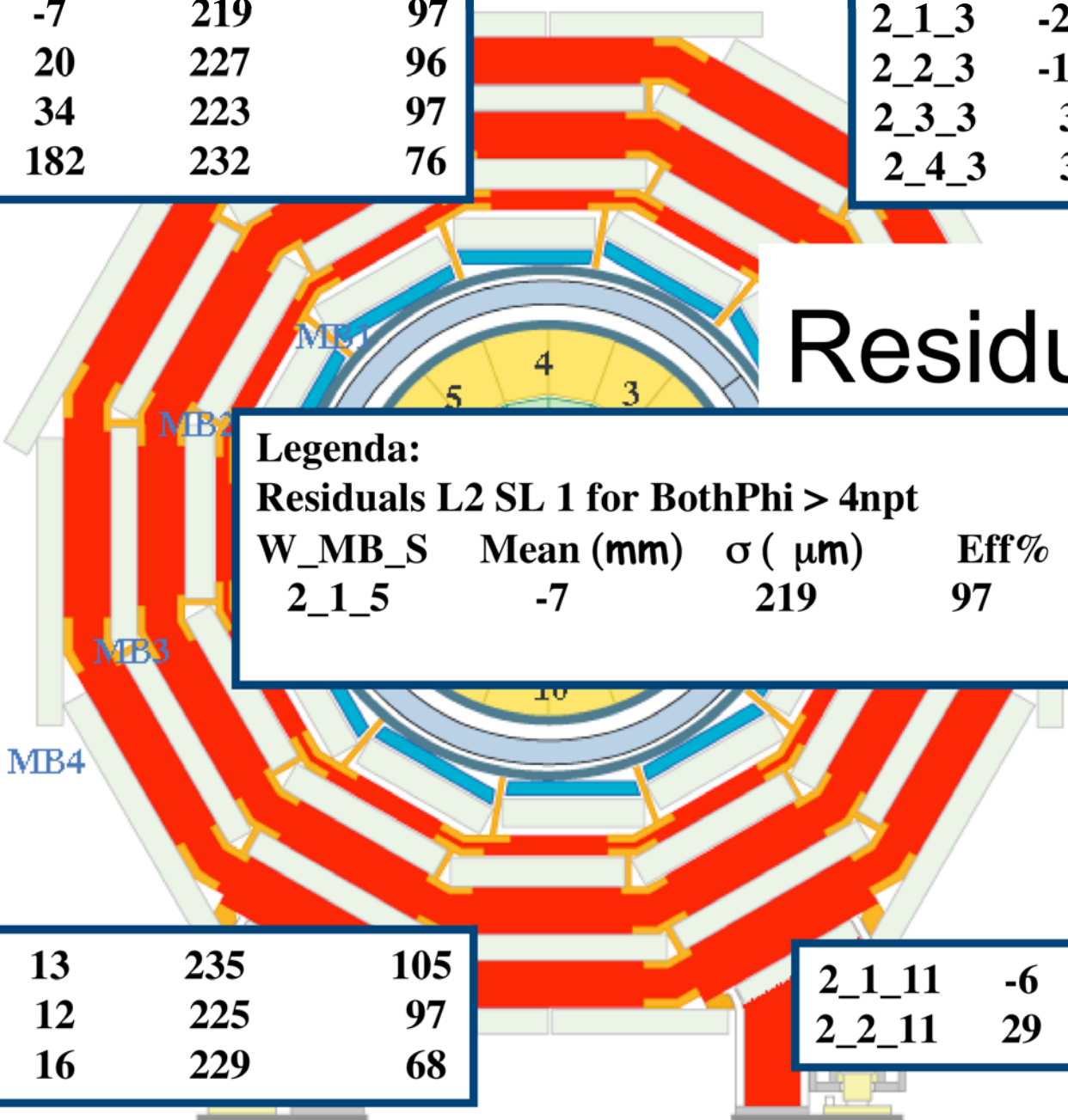
Legenda:
Residuals L2 SL 1 for BothPhi > 4npt

W_MB_S	Mean (mm)	σ (μm)	Eff%
2_1_5	-7	219	97

2_1_9	13	235	105
2_2_9	12	225	97
2_3_9	16	229	68

2_1_11	-6	227	96
2_2_11	29	233	97

MB1
MB2
MB3
MB4

4
5
3

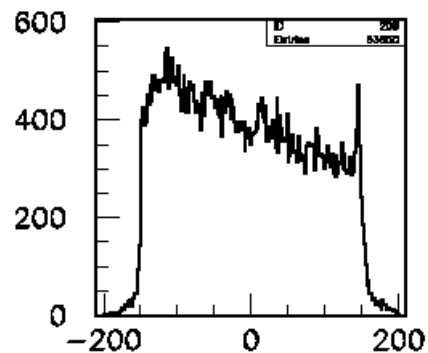**2_3_9   16   229   68**

All Reconstructed tracks "BothPhii"

Distribution of all Reconstructed tracks "BothPhii"   as function of position
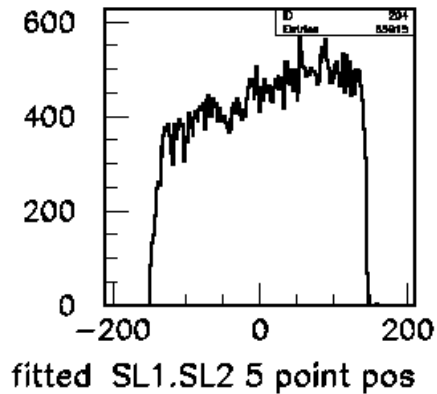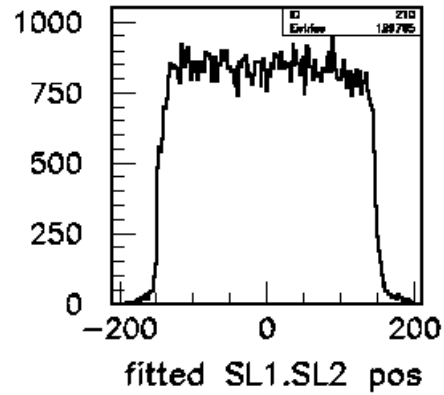
npt > 4 Reconstructed tracks "BothPhii"

npt < 5 Reconstructed tracks "BothPhii"

2_1_4	12	218	? 86
2_2_4	5	219	96
2_3_4	7	224	97
2_4_4	-7	236	79

Residuals L2 SL 1 BothPhi tracks> 4npt
Legenda

W_MB_S	Mean (mm)	σ (μm)	Eff%
2_1_5	-7	219	97

2_1_6	13	234	98
2_2_6	-14	235	97
2_3_6	-24	220	82

2_1_2	15	260	96

	2_1_12	-39	240	106
?	2_2_12	423	515	58
	2_3_12	15	224	92
y	2_4_12	-34	393	75

MB3

2_1_8	-8	252	105
2_2_8	29	246	79
2_3_8	23	244	83
2_4_8	12	221	76

2_1_10	18	233	98
2_2_10	-3	229	94
2_3_10	-46	230	97
2_4_10	11	219	77
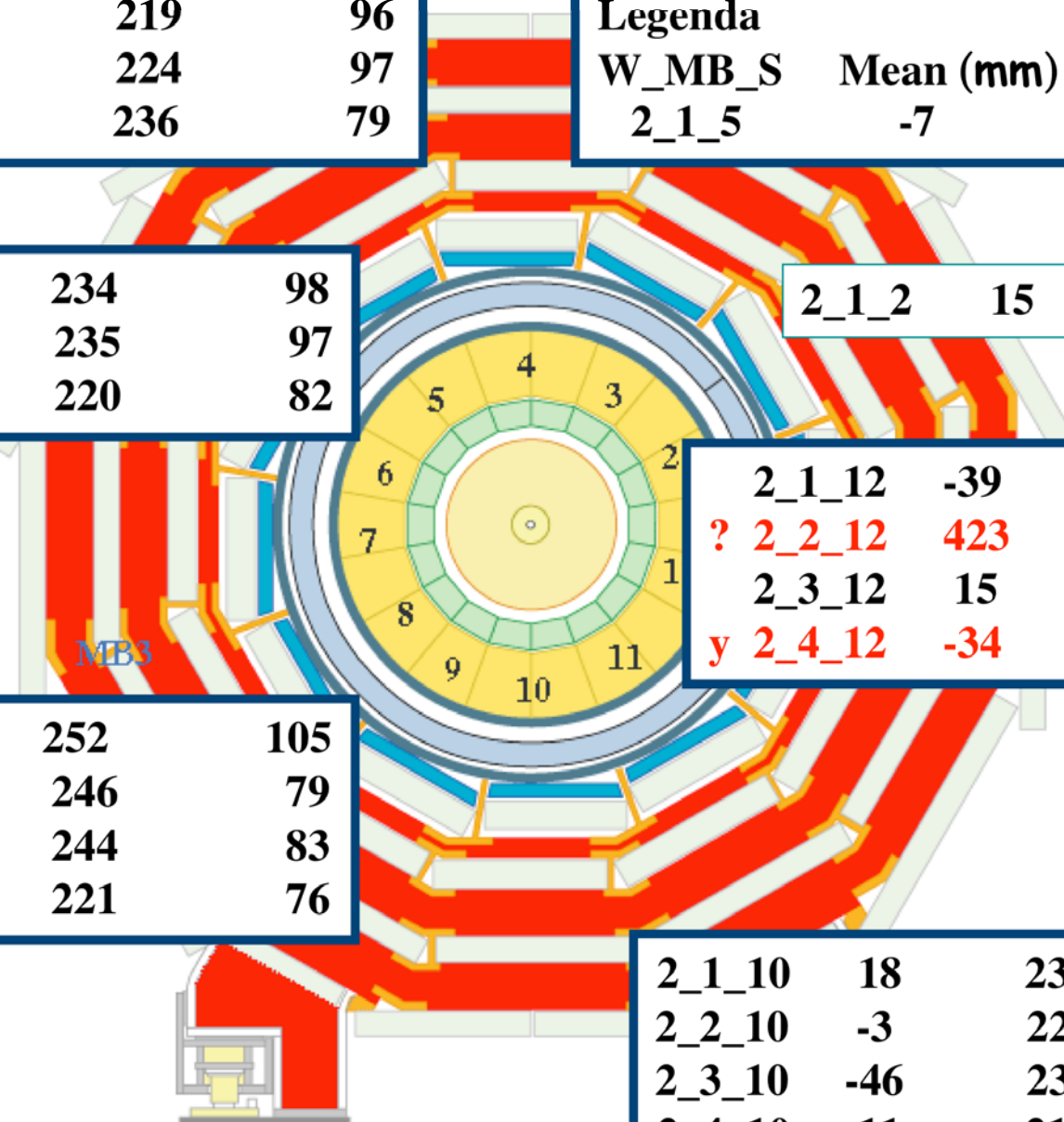
Track analysis performed : residuals as function of angle and cell in the layer

Residuals l2 (mm) — slope (rad) — Entries 62361

Residuals l2 (mm) — Wire # l2

npt<5 — slopelt5pt — Entries 17708 — slope (rad)

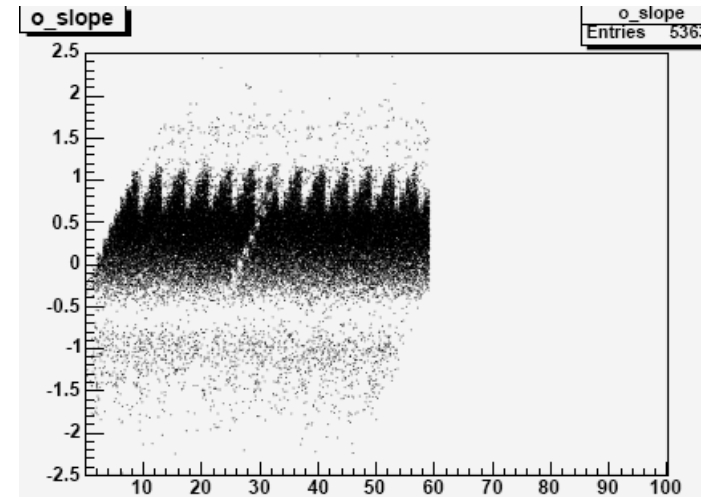npt>4 — slopegt4pt — Entries 86525 — <slope> — slope (rad)

21
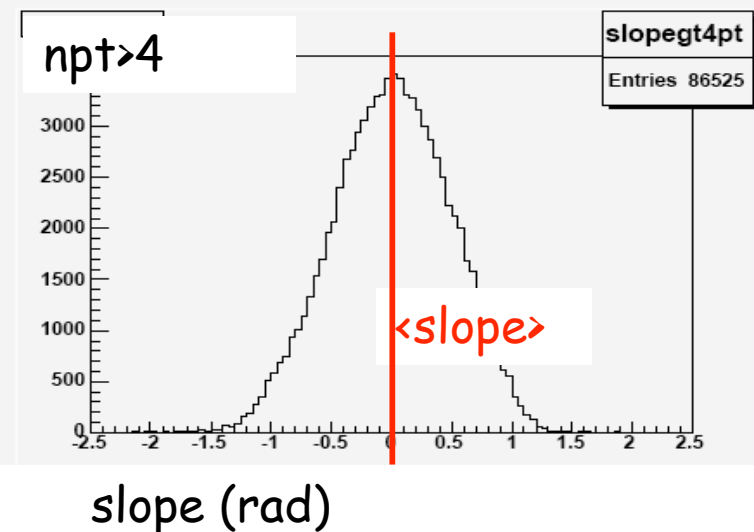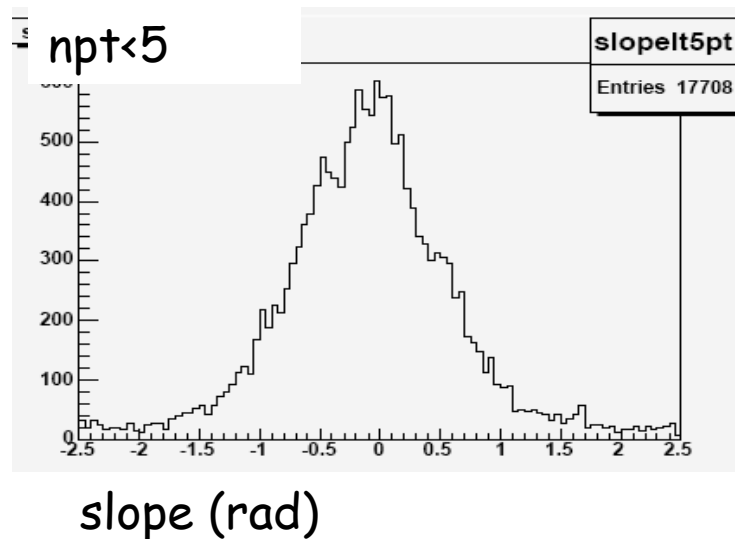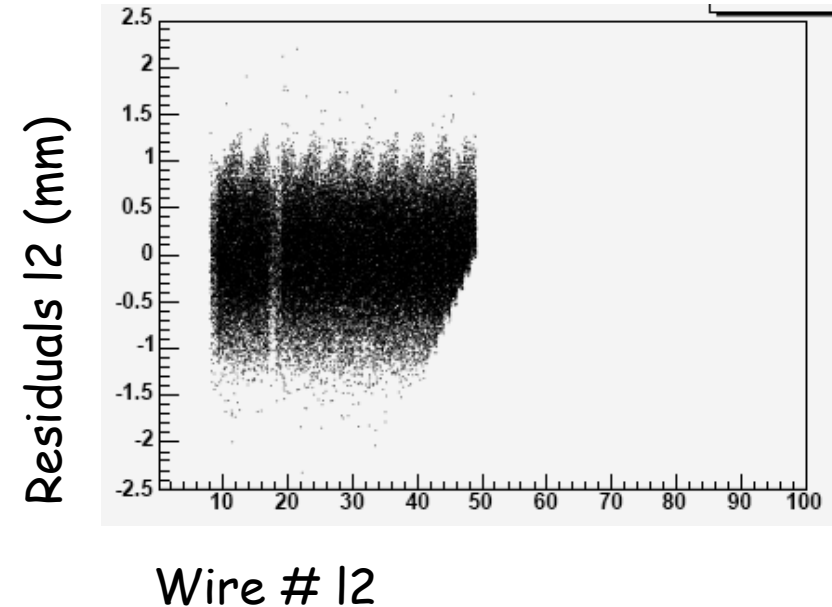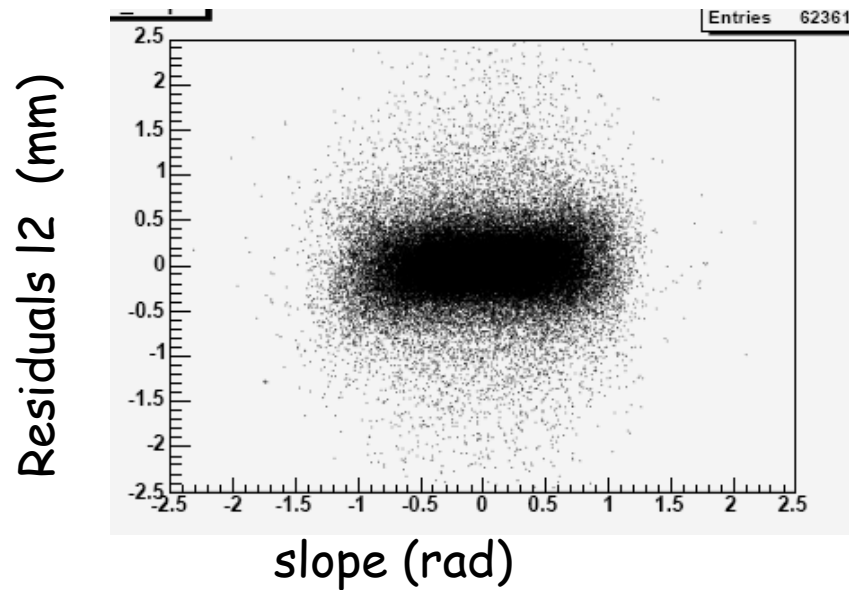
Track analysis performed : residuals as function of angle and cell in the layer MB2 2_2_8

Residuals l2 (mm)

slope (rad)

r_slope
Entries 53635

Residuals l2 (mm)

o_slope
Entries 536

Wire # l2

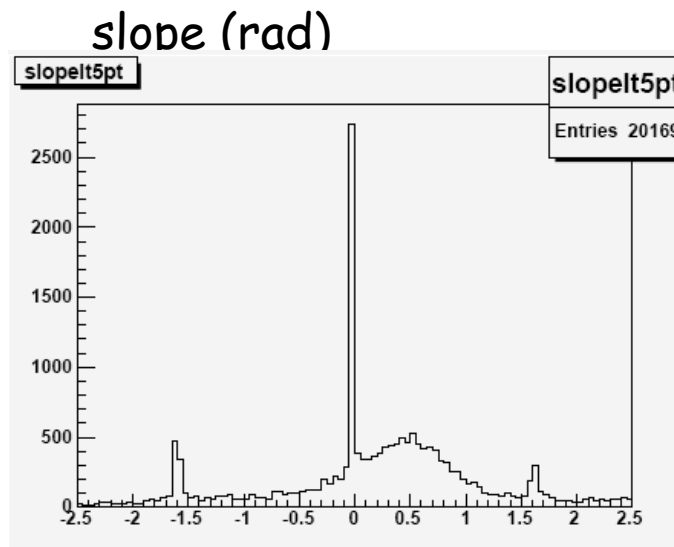npt<5

slopelt5pt
Entries 20169

slope (rad)

npt>4

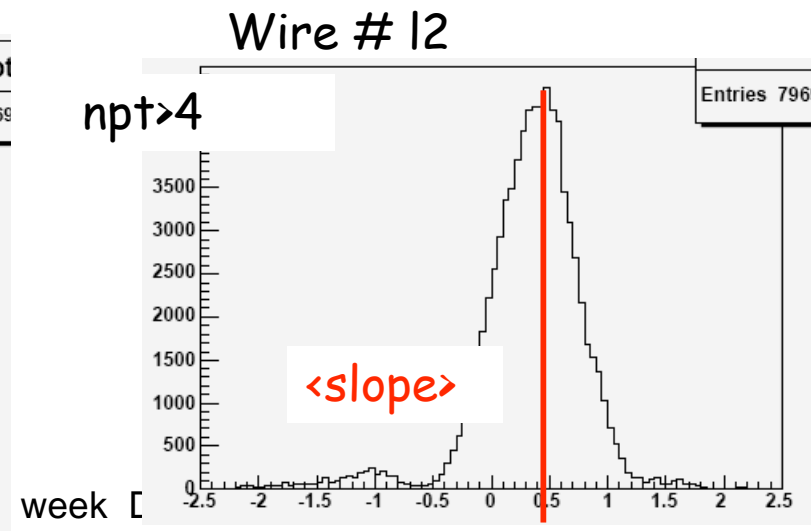<slope>

Entries 796
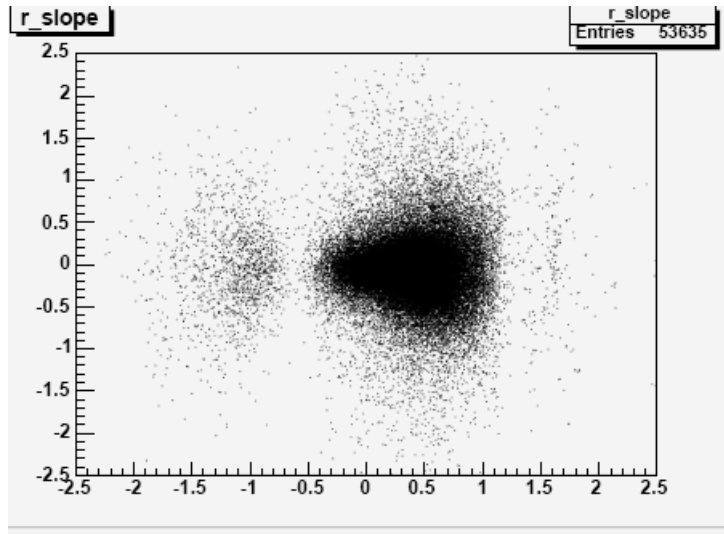
slope (rad)

2_1_5: <slope> : >5pt -0.2210
2_2_5: <slope> : >5pt -0.2504
2_3_5: <slope> : >5pt -0.2288
2_4_5: <slope> : >5pt -0.2139

2_1_3: <slope> : >5pt   0.1939
2_2_3: <slope> : >5pt   0.1398
2_3_3: <slope> : >5pt   0.2279
2_4_3: <slope> : >5pt   0.1102

slope

2_1_2: <slope> : >5pt   0.3822
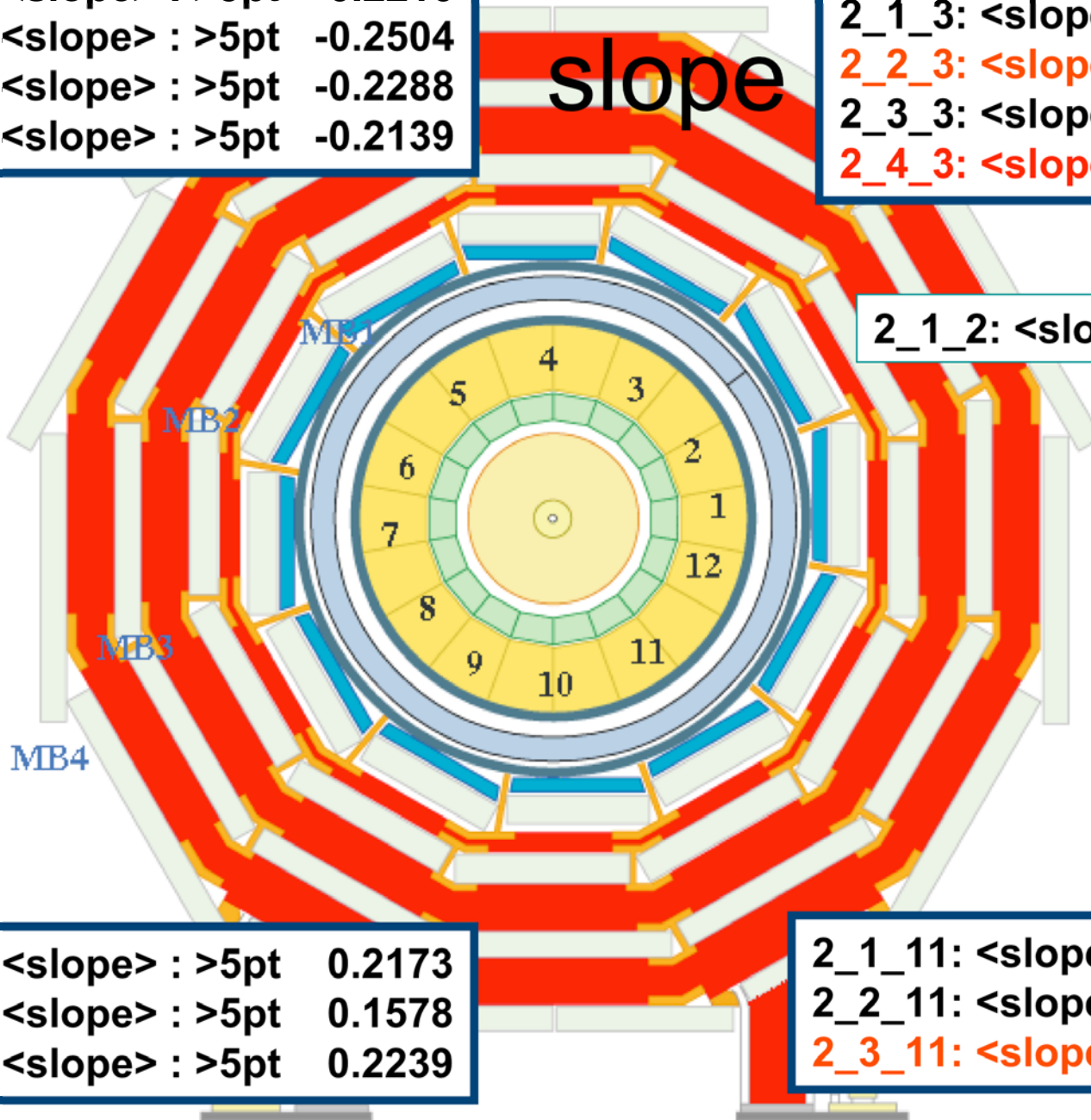
2_1_9: <slope> : >5pt   0.2173
2_2_9: <slope> : >5pt   0.1578
2_3_9: <slope> : >5pt   0.2239

2_1_11: <slope> : >5pt -0.2366
2_2_11: <slope> : >5pt -0.2276
2_3_11: <slope> : >5pt -0.7634

slope

2_1_4: <slope> : >5pt   -0.0029
2_2_4: <slope> : >5pt   -0.0571
2_3_4: <slope> : >5pt   0.0024
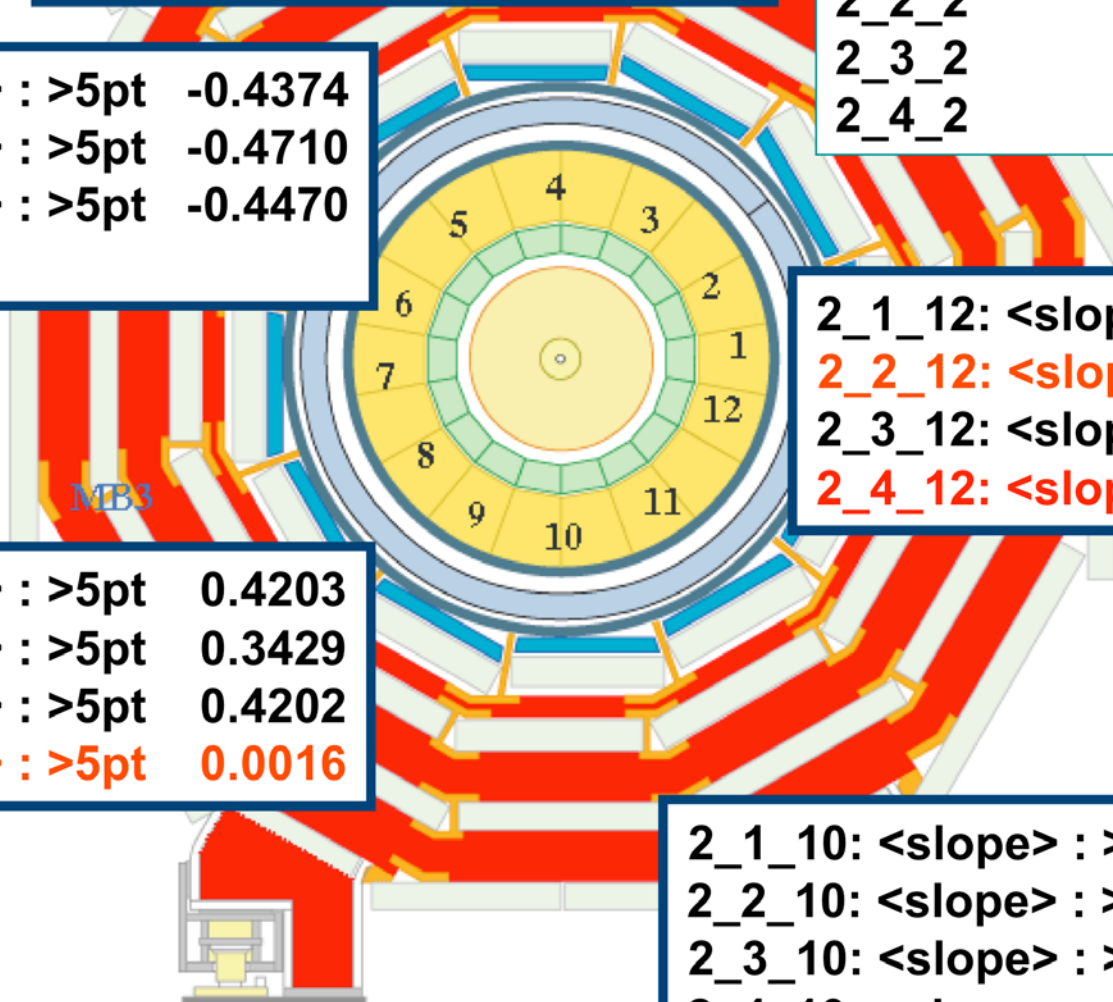2_4_4: <slope> : >5pt   0.0002

2_1_2: <slope> : >5pt   0.3822
2_2_2
2_3_2
2_4_2

2_1_6: <slope> : >5pt   -0.4374
2_2_6: <slope> : >5pt   -0.4710
2_3_6: <slope> : >5pt   -0.4470
2_4_6:

2_1_12: <slope> : >5pt   -0.4295
2_2_12: <slope> : >5pt   0.5558
2_3_12: <slope> : >5pt   -0.3694
2_4_12: <slope> : >5pt   -0.5332

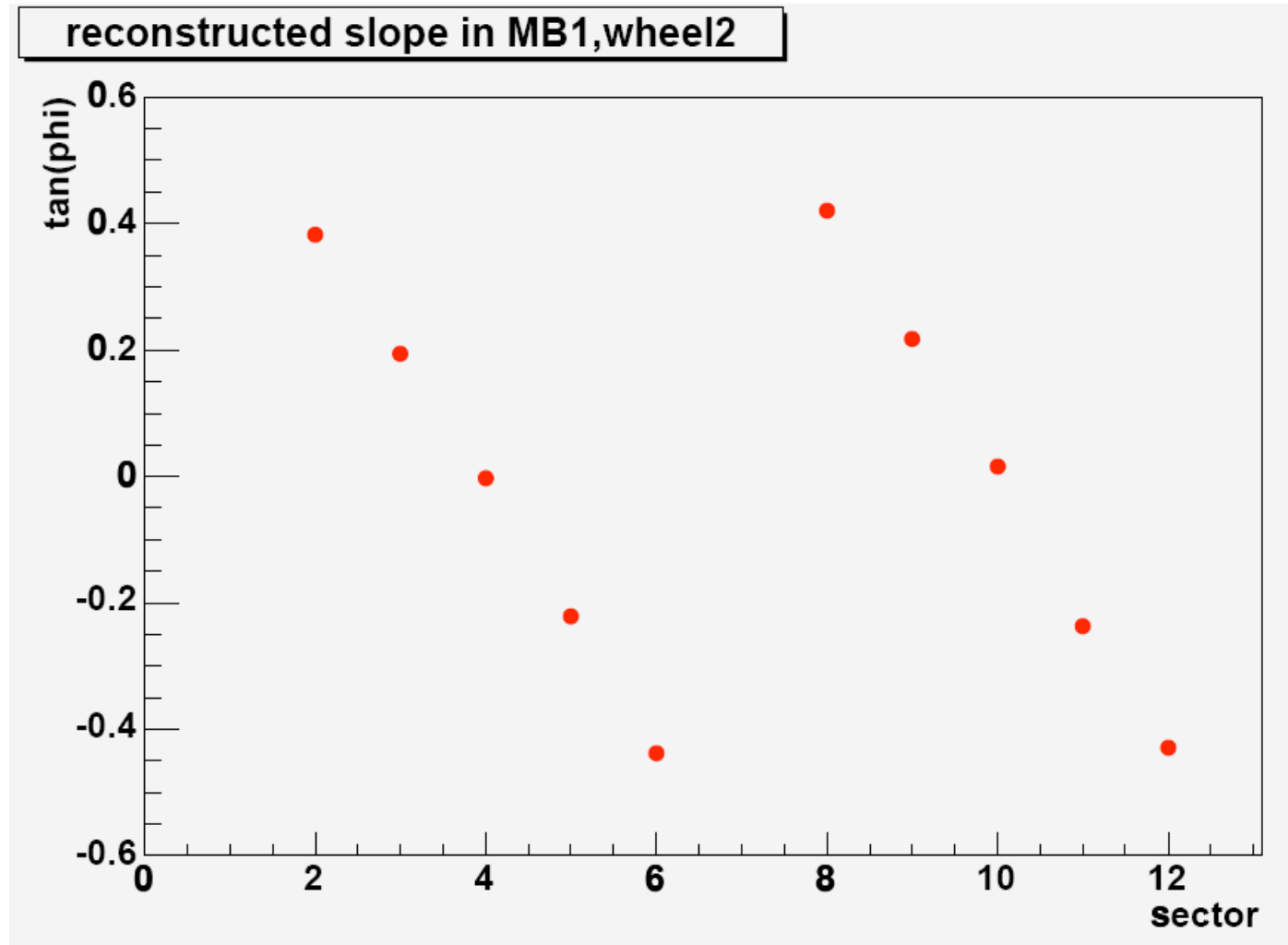2_1_8: <slope> : >5pt   0.4203
2_2_8: <slope> : >5pt   0.3429
2_3_8: <slope> : >5pt   0.4202
2_4_8: <slope> : >5pt   0.0016

2_1_10: <slope> : >5pt   0.0158
2_2_10: <slope> : >5pt   -0.0076
2_3_10: <slope> : >5pt   0.0141
2_4_10: <slope> : >5pt   -0.0687

Slope plots vs sector preliminary for MB1

Conclusions on tracks reconstruction

-Too much preliminary analysis peformed

    but

- Resolution is fine except few chambers and that must be checked accuratly

- Planned next

-Runs specific Phi1 or Phi2 or Theta triggered data for

- Check resolution of the others SLs on unbiased data samples

- measure resolution as function of angle of the tracks

-measure resolution as function of position on the cell

-yeld resolution as sector and chambers summary

For all MB1:   Efficiency

of each cell within 2.1 cms on reconstructed tracks with at leat 5 points in "BothPhi" tracks (3 points for Theta SL) is around 99%
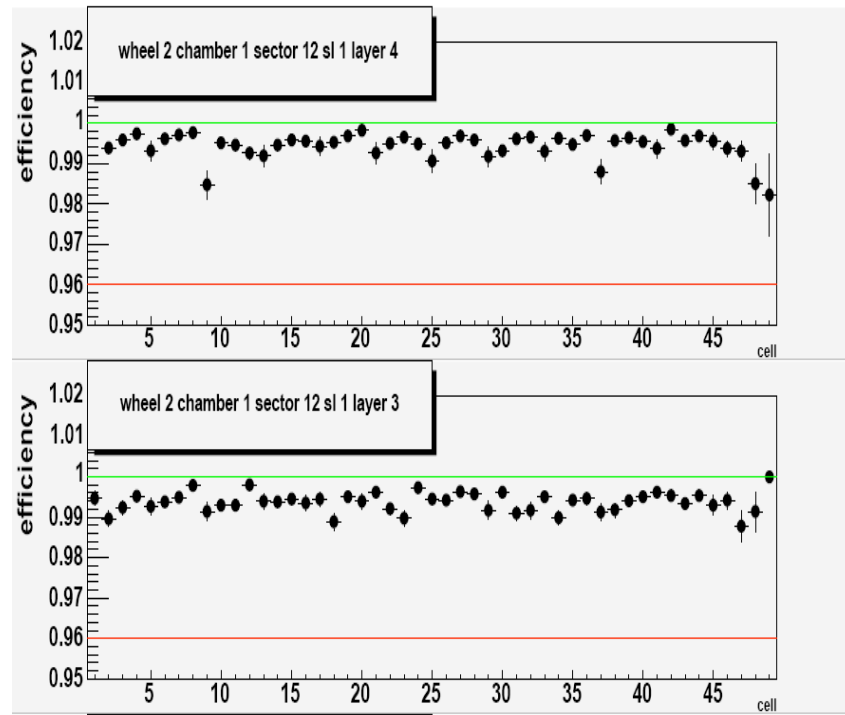
Efficiency good for MB1 that is efficiency seems to follow the trigger requirement "i.e. Configuration" and the geometrical acceptance.

MB1 Efficiency of each layer in SL1 as a function of sector with respect to reconstructed tracks with at leat 5 points in "BothPhi" tracks
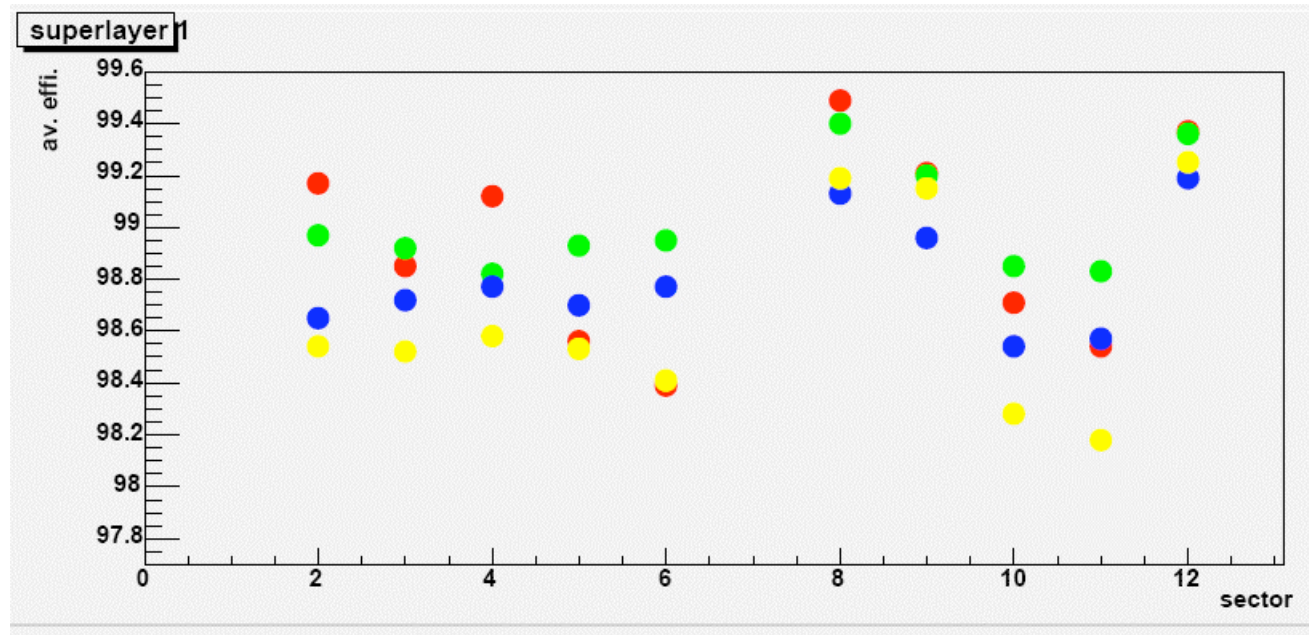
Sector

F.Cavallo .

Few MB4 chambers studied and added in http://agenda.cern.ch/fullAgenda.php?ida=a057521. The holes in the layers occupancy plots strongly present on MB4 data triggerd with HHHL with 'not good configuration', correspond to selections of the trigger quality since no real inefficiency is found and efficiency with the default configuration does not present these holes in the occupancy; Simulator results could reproduce the trigger performance.

> Efficiency >> work going on in:

- All chambers with HanyTheta (HHorHL for MB4) in wheel 2.

- On specified Phi1 Phi2 or Theta triggered data for the measure of the efficiency of the others SLs on unbiased data samples. (If the SL is on the trigger its efficiency always fine and the occupancy depend on the trigger requirement.)

- efficiency as function of angle of the tracks.

- efficiency as function of position on the cell.

- efficiency as function of sector and chambers summary.

Overall Summary

- That is a first very very preliminary analysis but
- Intrinsic chamber resolutions is measurable with cosmic data
- For quite a few sectors resolution found seems to be fine between 200:250 micron without any Chi2 cuts (for removing deltas queu) and it has been proved that resolution can be improved correcting for the angular dependence of drift velocity.
- Efficiency is above 98% for triggering SL following the trigger requirement.
- Real Efficiency must be studied on no triggering SL.
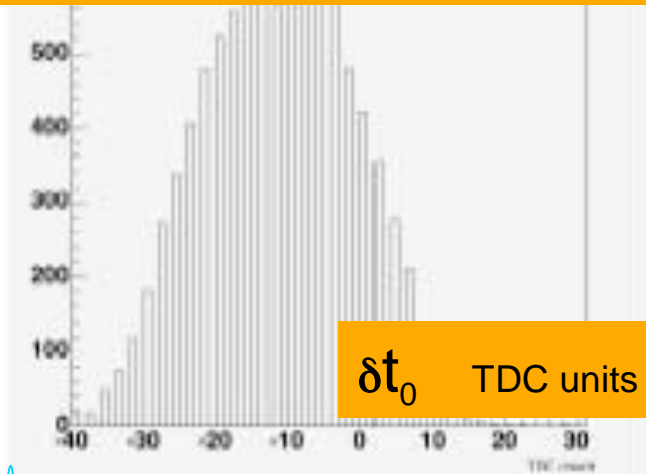- Trigger bias must be studied.

next

- Start immediatly Wheel=1

  (trigger configuration ~ok)
- T0i, flats files assignement etc etc
- Try to have simulation hits distribution

  for comparing angular acceptance.
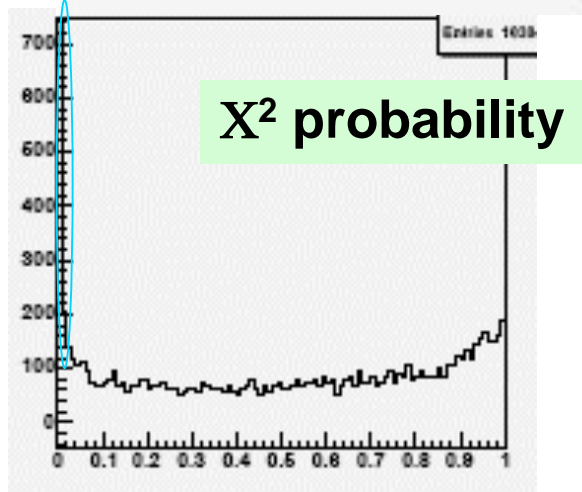- Try to have simulator on cosmic data phi only trigger

- END

Application of the method to Commissioning cosmic ray autotriggered data. MB1w2s10-run3192 All tracks>5 Layers **NB all angles (+-45 degrees), trigger H + anyTheta.**

δt_0 distribution that minimise the X^2 of the fit of "both PHI tracks" with >5 layers
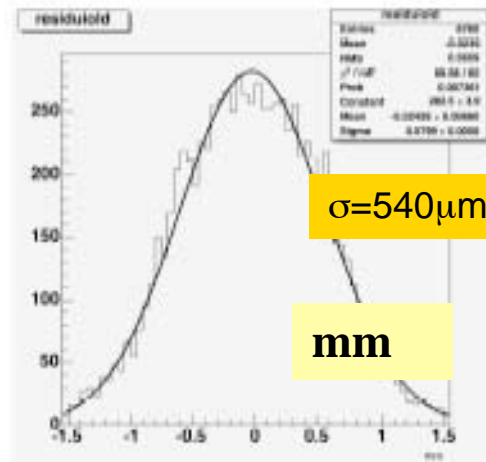
Residuals: no δt_0 correction

Residuals : event δt_0 **correction applied**

σ=540µm

mm

σ=230µm

δt_0 TDC units

X^2 **probability**

layer	mean [μm]	sigma [μm]
1	-8±15	518±7
2	-12±7	546±6
3	-14±7	552±5
4	14±7	537±6
5	-14±6	547±5
6	28±7	559±6
7	-22±7	556±5
8	15±6	526±5
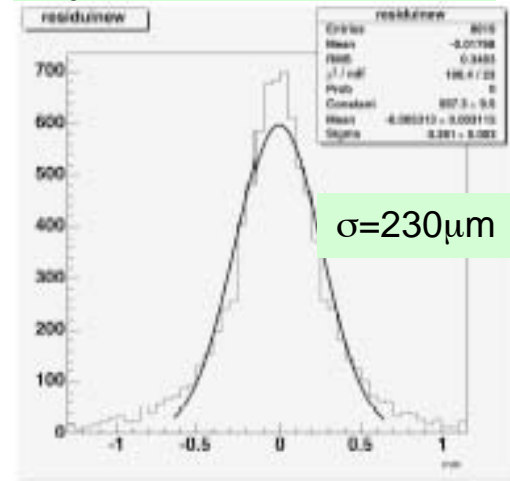
layer	mean [μm]	sigma [μm]
1	-2±3	221±3
2	-16±3	220±3
3	7±3	227±3
4	9±3	239±3
5	-9±3	247±3
6	25±3	235±3
7	-18±3	222±3
8	3±3	244±3

$\sigma_{media_{old}} = (543 \pm 2)\mu m$

$\sigma_{media_{new}} = (232 \pm 2)\mu m$

Application of the method to commissioning data. Run 3633
MB3–c34, settore 9   Autotrigger H+anyTheta W_MB_SecT=2_3_9

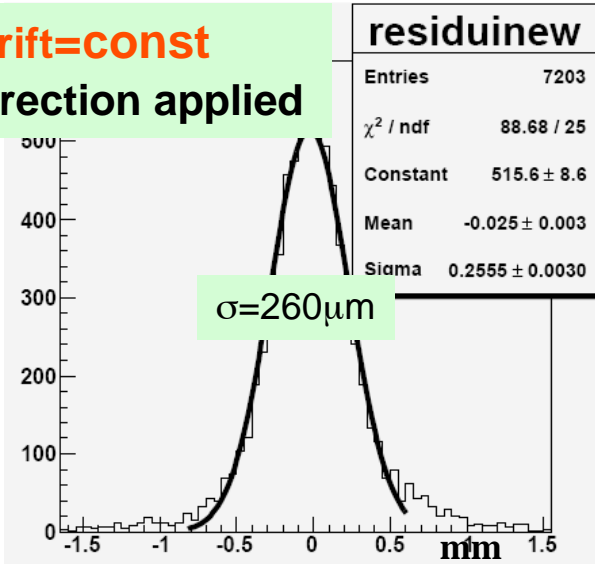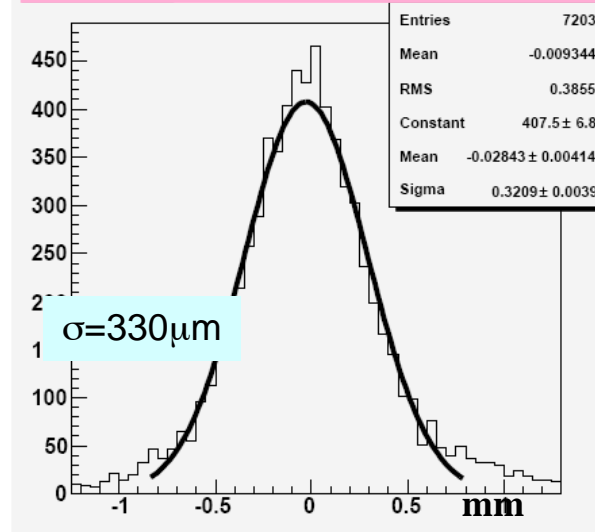**No t0 correction**
σ=490μm

residuiold

Entries	7203
χ² / ndf	47.16 / 40
Constant	280.8 ± 4.4
Mean	-0.002644 ± 0.006607
Sigma	0.493 ± 0.006

mm

Relative efficiency / event

Selection: tracks reconstructed with >4 layers

5   6   7   8 # layer in the fit

Residuals: all layers included in the fit but one under test
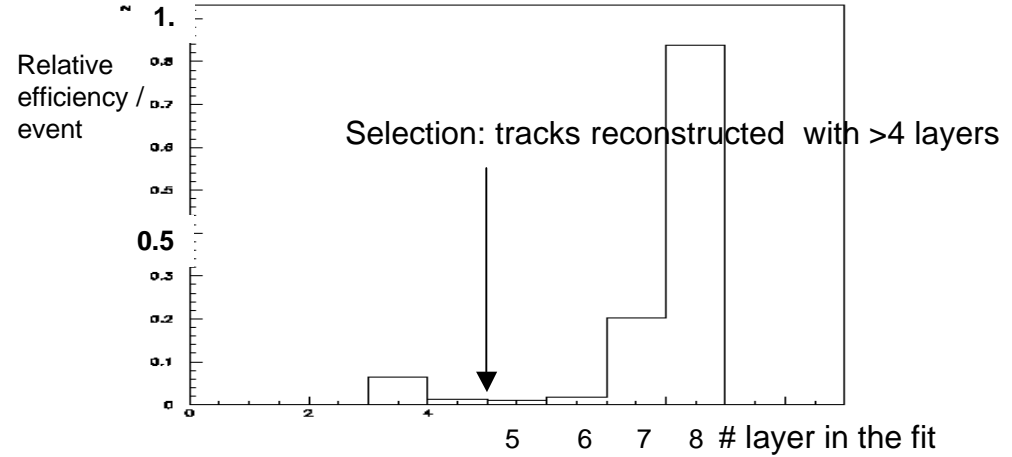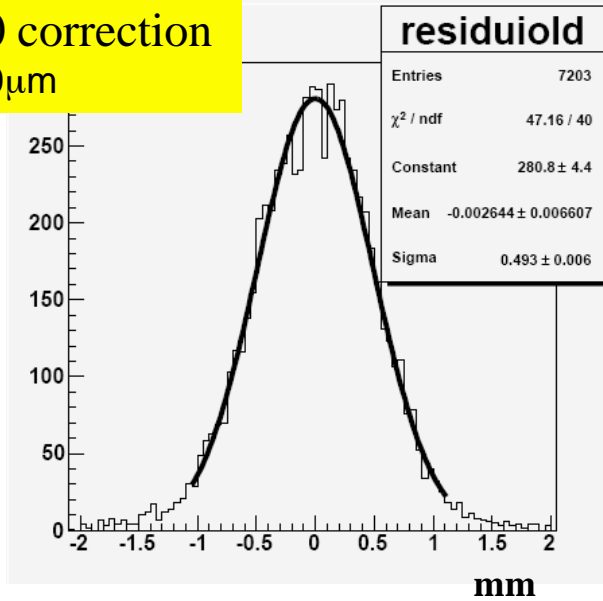
Residuals : Vdrift=const
& Event δt₀ correction applied

residuinew

Entries	7203
χ² / ndf	88.68 / 25
Constant	515.6 ± 8.6
Mean	-0.025 ± 0.003
Sigma	0.2555 ± 0.0030

σ=260μm

mm

Entries	7203
Mean	-0.009344
RMS	0.3855
Constant	407.5 ± 6.8
Mean	-0.02843 ± 0.00414
Sigma	0.3209 ± 0.0039

σ=330μm

mm

S week

Towards software integration:

IGUANA screenshot of DT-DQM application: occupancy plots from chamber commissioning data @ SX5

DTdigi in CMSSW