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Goal :

Find the resolution of DT chambers on autotriggered cosmic ray tracks.

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 T_0 , yelds ~450μm resolution/layer .
But in each event all points (drift time of differents layers) have the same time displacement in the range of 25 ns.

In the present work in each event all drift times defining a track have been displaced of the same quantity δt_0 , traslated in positon with a constant drift velocity and the track refit. The X^2 of the fit was then minimised as a function of the value of δt_0.
The method has been checked with Test Beam data (scintillator trigger & fix angle)

and applied to

-Legnaro cosmic rays data (autotrigger H & fix angle)
-Commissioning data MB3 –Sect 9 (autotrigger [H(phi1)+anytheta & fix angle])
-Commissioning data MB3 –Sect 9 (autotrigger [H(phi1.or.phi2)+anytheta & all angle])
-Commissioning data MB1 –Sect10 (autotrigger [H(phi1.or.phi2)+anytheta & all angle])

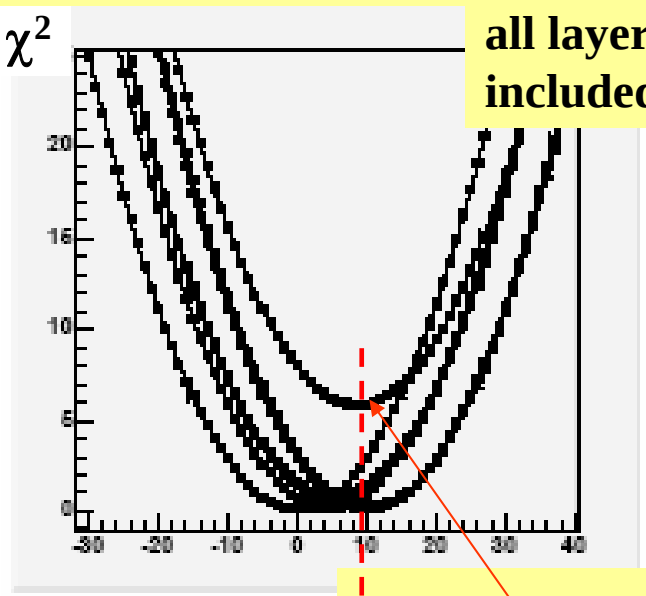
(*)thanks for discussion to F.Cavallo & F.Gasparini ..

Check of the method with Test Beam data (run 2551 TB2004 - scintillator trigger- fix angle track).

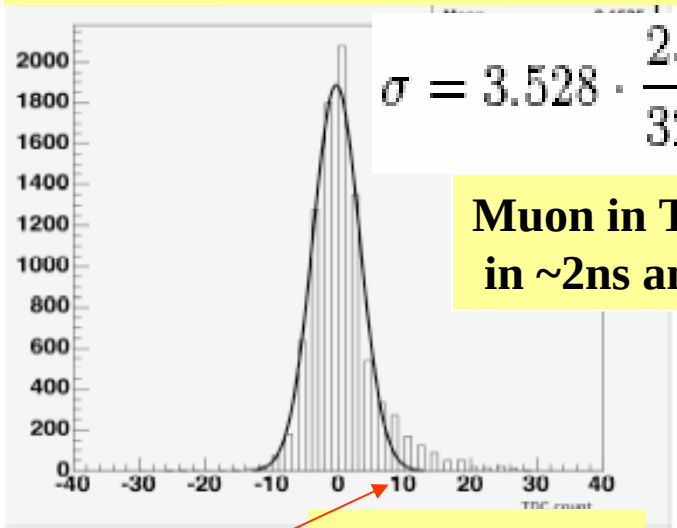
Selection: tracks reconstructed with >5 layers

- 1 Relative efficiency /event

Examples of the X^2 fit vs δt_0 of 10 tracks



δt_0 distribution that minimize the X^2 fit Test Beam



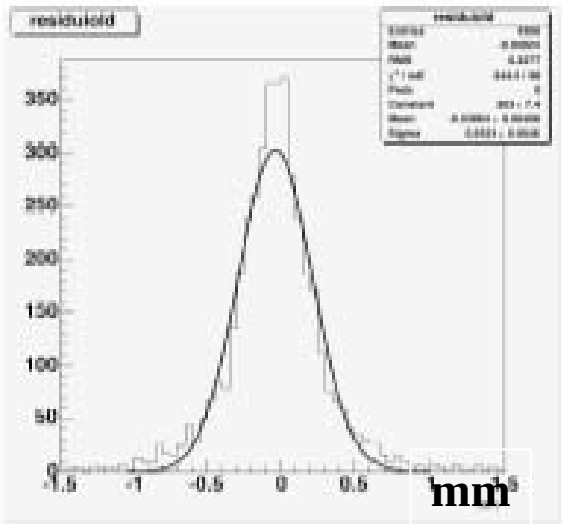
$$\sigma = 3.528 \cdot \frac{25}{32} ns = 2.756 ns$$

Muon in TB were packed in ~2ns and bunched

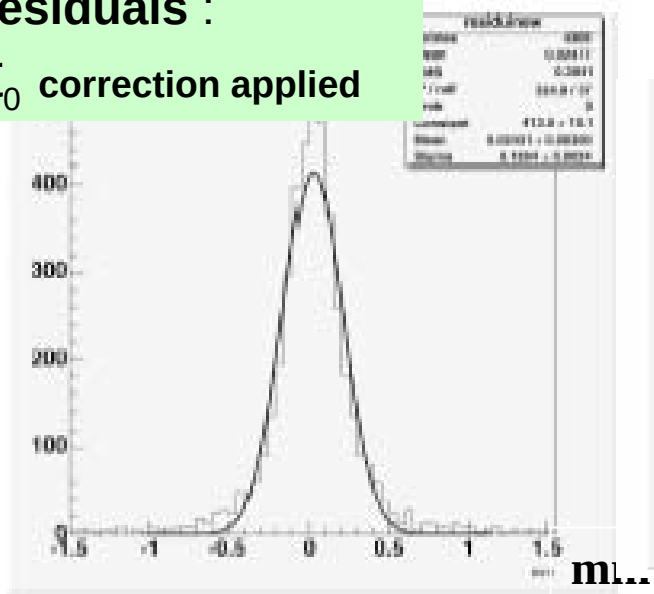
δt_0 of min X^2 fit for one track

Residuals in each layer : TB data

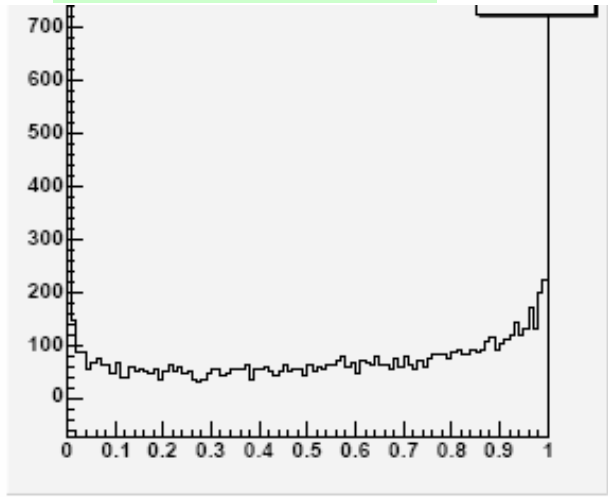
Residuals: no δt_0 correction



Residuals : δt_0 correction applied



X^2 probability



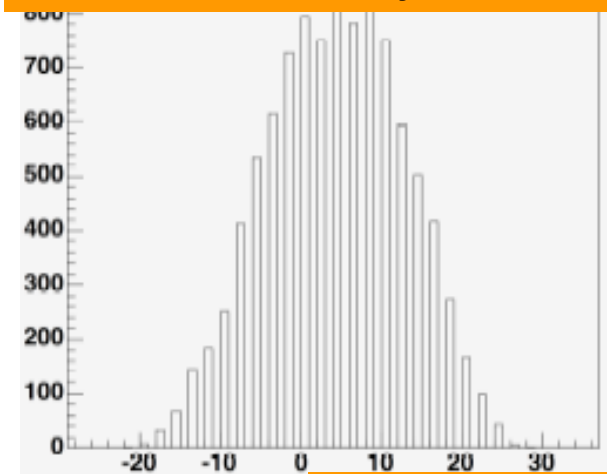
layer	mean [μm]	sigma [μm]
1	-16±2	194±2
2	3±2	201±2
3	-1±2	190±2
4	17±2	192±2
5	30±3	219±3
6	-1±2	188±2
7	14±3	212±3
8	-41±3	234±4

layer	mean [μm]	sigma [μm]
1	-17±2	181±2
2	7±2	179±2
3	-9±2	174±2
4	19±2	178±2
5	17±2	173±2
6	2±2	177±2
7	9±2	173±2
8	-24±3	188±2

$$\sigma_{media_{new}} = (178 \pm 1)\mu m$$

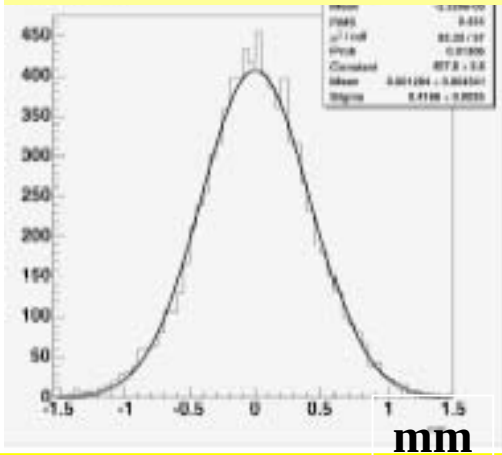
Application of the method to LNL cosmic ray autotriggered data with fix angle. **ie HH+anyTheta trigger but K (BTI)=constant=~10+-2 degrees comparison with TBeam data**

δt_0 distribution that minimize the X^2 of the fit of "both PHI tracks" with >5 layers



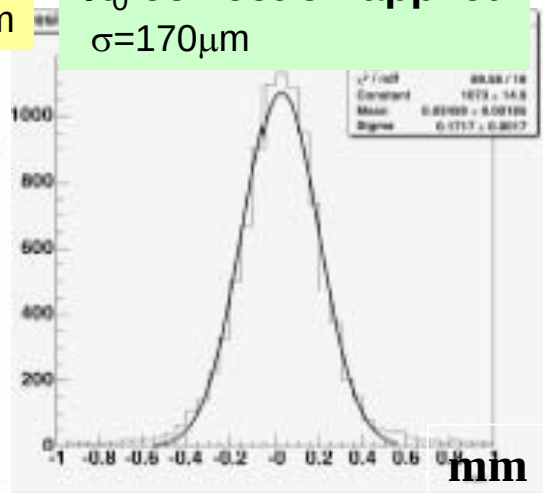
δt_0 TDC units

Residuals:
no δt_0 correction σ=440μm



mm

Residuals : **event** δt_0 **correction applied** σ=170μm



mm

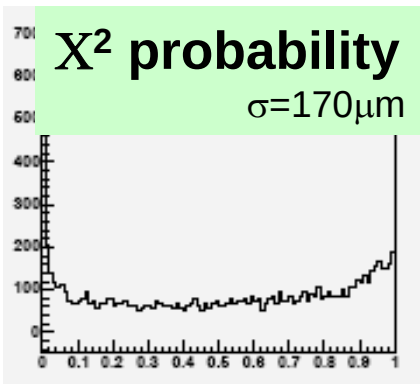
layer	mean [μm]	sigma [μm]
1	4±5	397±4
2	-14±5	451±5
3	-14±5	431±4
4	21±5	424±4
5	5±5	395±4
6	-4±9	491±8
7	9±5	444±5
8	-33±5	459±4

$\sigma_{media_{old}} = (437 \pm 5)\mu m$

layer	mean [μm]	sigma [μm]
1	-6±2	161±2
2	-6±2	154±2
3	8±2	156±2
4	-2±2	166±2
5	25±2	172±2
6	21±2	166±2
7	-3±2	151±1
8	-31±2	158±2

$\sigma_{media_{new}} = (161 \pm 1)\mu m$

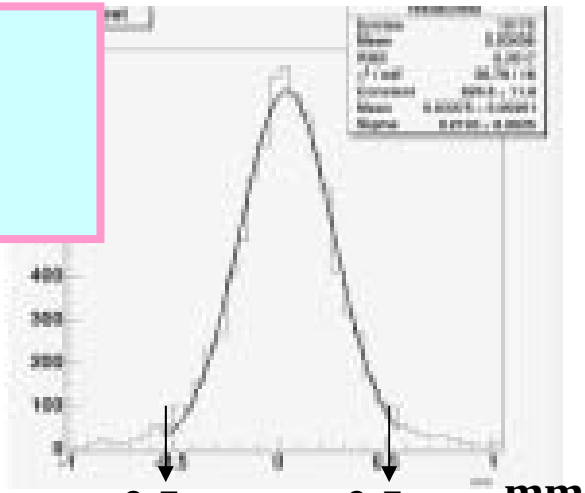
X^2 probability
σ=170μm



Application of the method to LNL cosmic ray autotriggered data.

Check of the residual distribution layer by layer: all layers included in the fit but one

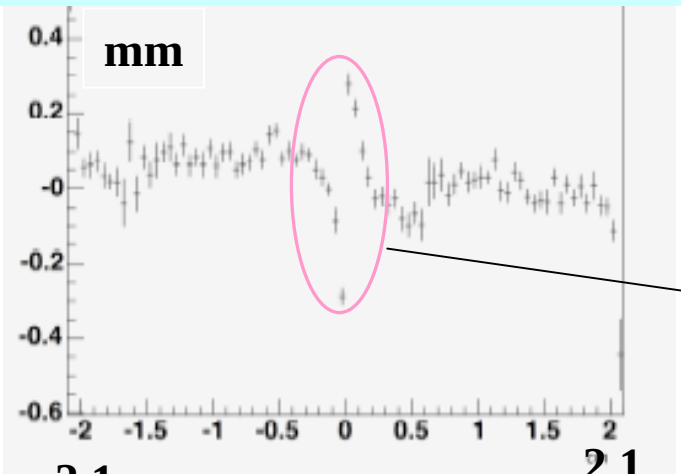
Residuals distribution of the layer not included in in the fit with the **event δt_0 correction applied**



layer	mean [μm]	sigma [μm]
1	-11±3	213±3
2	-9±2	198±2
3	11±2	199±2
4	-2±2	201±2
5	34±3	219±3
6	26±3	209±3
7	-6±2	205±2
8	-47±3	219±3

Residuals of the layer not included in in the fit as a function of position in the cell

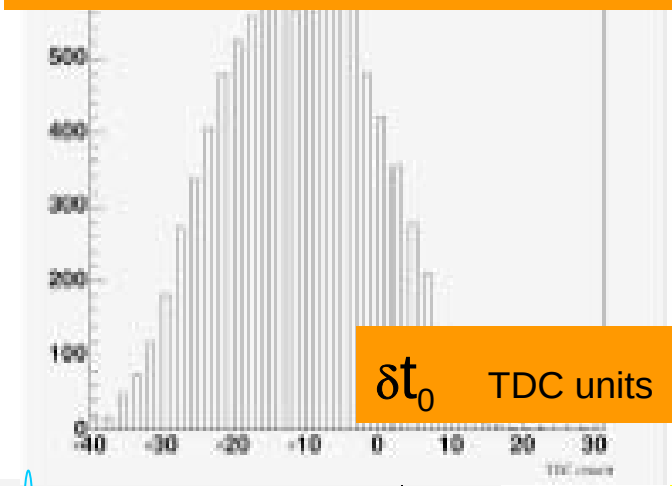
$$\sigma_{media_{test}} = (208 \pm 1)\mu m$$



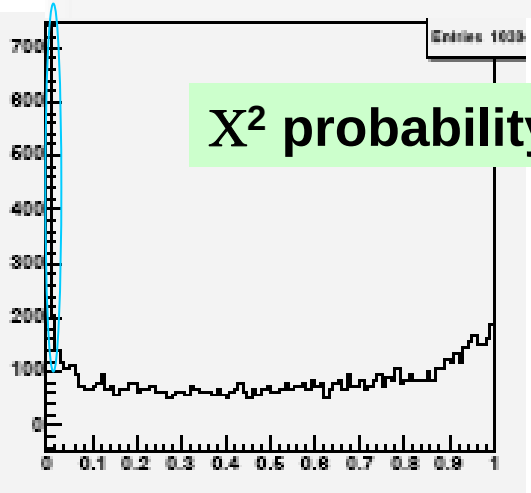
Wrong left right hit associated (used the old association) ;can probably be corrected... Next work

Application of the method to Commissioning cosmic ray autotriggered data. MB1W2S10-run3192 All tracks>5 Layers **NB all angles, H + anyTheta.**

δt_0 distribution that minimise the X^2 of the fit of "both PHI tracks" with >5 layers

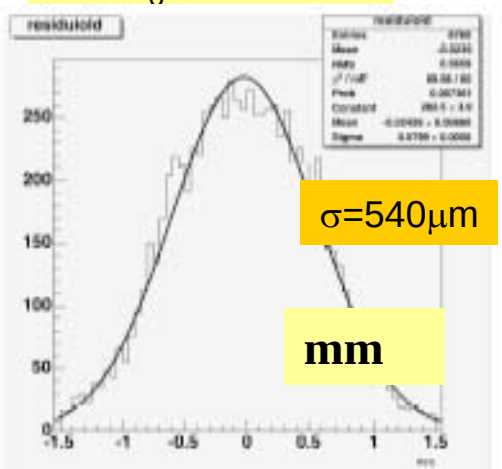


δt_0 TDC units

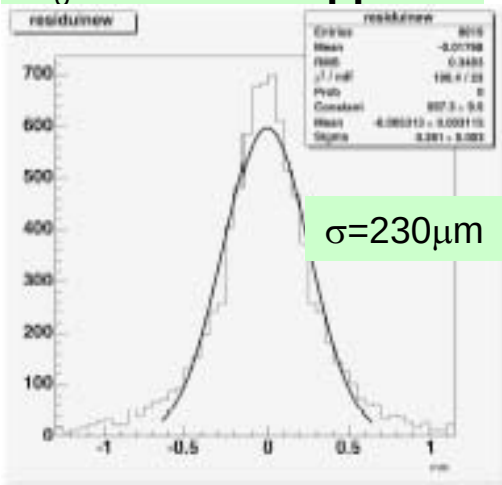


X^2 probability

Residuals:
no δt_0 correction



Residuals : **event** δt_0 **correction applied**



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

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

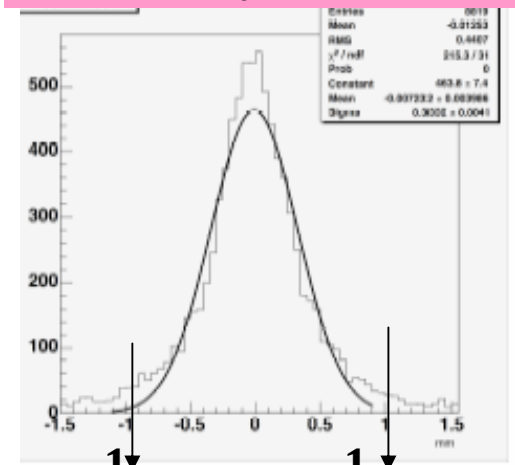
layer	mean [μm]	sigma [μm]
1	-2±3	221±3
2	-16±3	220±3
3	7±3	227±3
4	9±3	239±3
5	-9±3	247±3
6	25±3	235±3
7	-18±3	222±3
8	3±3	244±3

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

Application of the method to Commissioning cosmic ray autotriggered data. MB1$_{W2S10}$-run3192 All tracks>5 Layers **NB all angles, H + anyTheta.**

Check of the residual distribution layer by layer:
all layers included on the track fit but the one under test

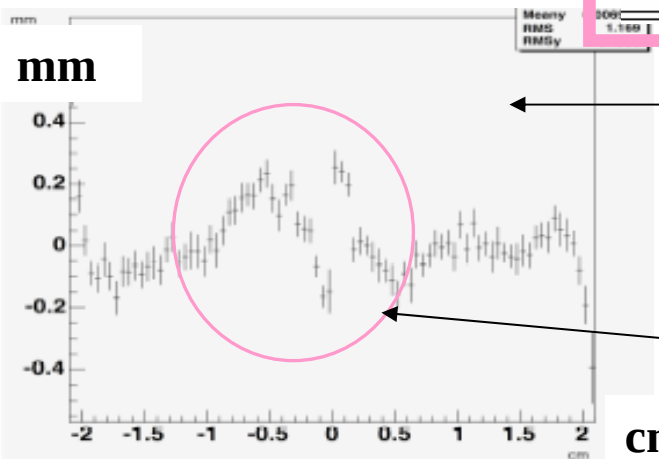
Residuals of the layer not included in in the fit with the **event** δt_0 **correction applied**



layer	mean [μm]	sigma [μm]
1	2±5	303±6
2	-20±4	278±5
3	7±4	284±5
4	10±4	300±5
5	-7±4	307±4
6	36±4	308±4
7	-24±4	282±5
8	8±4	353±4

$$\sigma_{media_{test}} = (302 \pm 3)\mu m$$

But not real fit is performed: the previous left right hit association is used in the track parameter computation ..must be update...



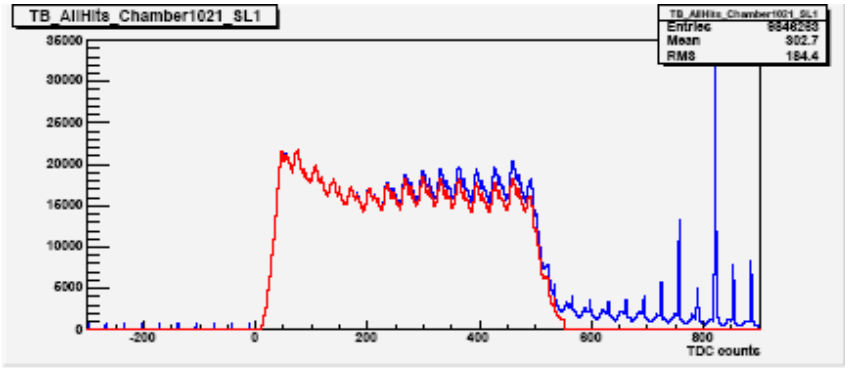
Residuals of the layer not included in in the fit as a function of position in the cell

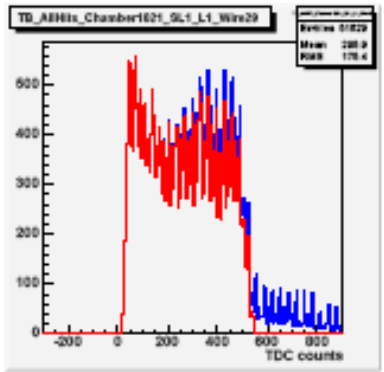
Wrong left right hit associated .. Drift velocity with angle..? (used the old association) ;can be corrected... Next work

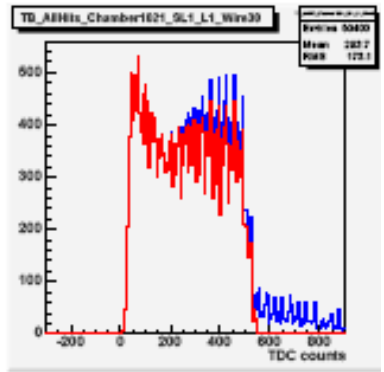
SLAYERS

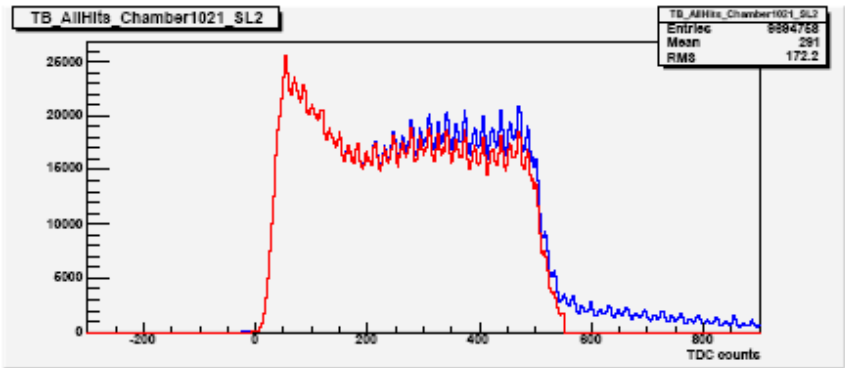
TIME BOXES MB1
Run 3192

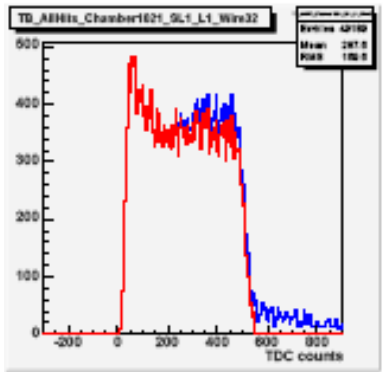
Some wires

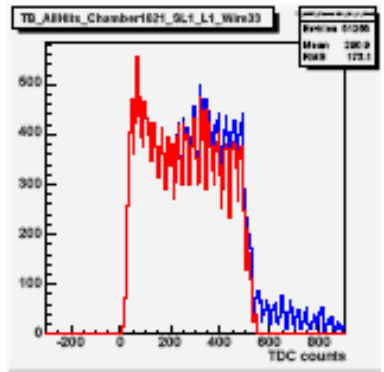


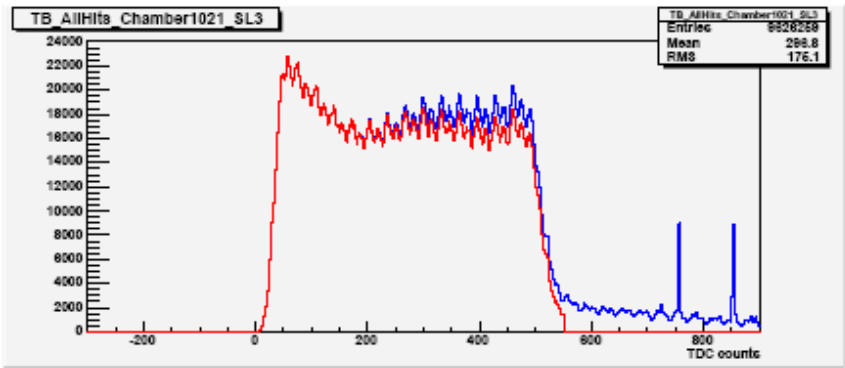


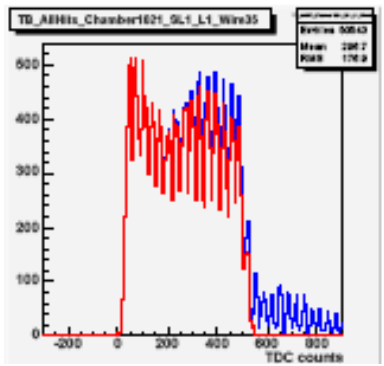


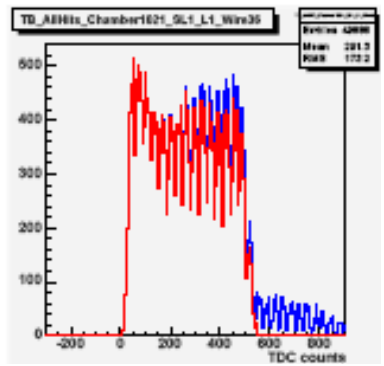








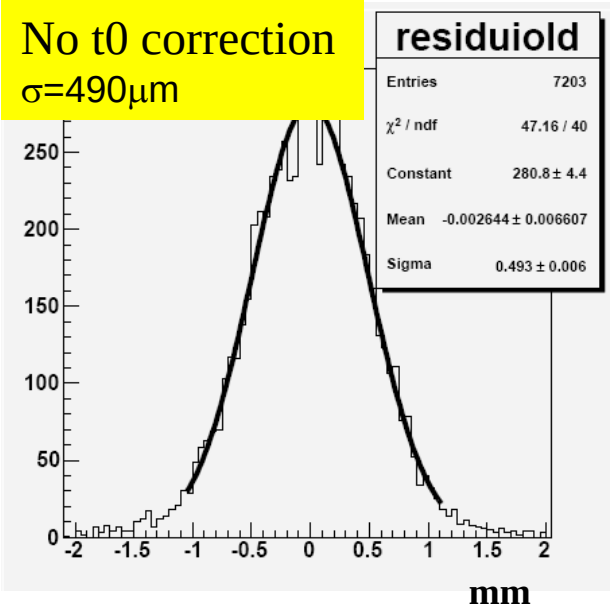


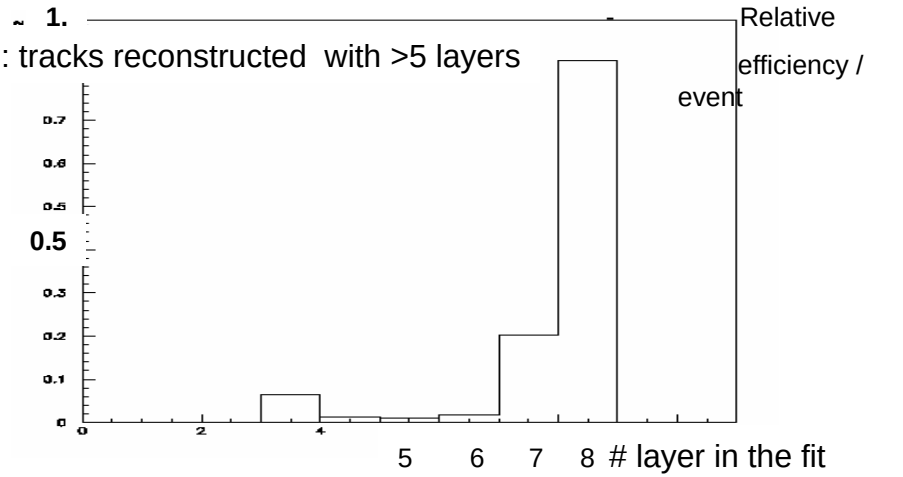


Application of the method to commissioning data. Run 3633

MB3-c34, settore 9 Autotrigger H+anyTheta

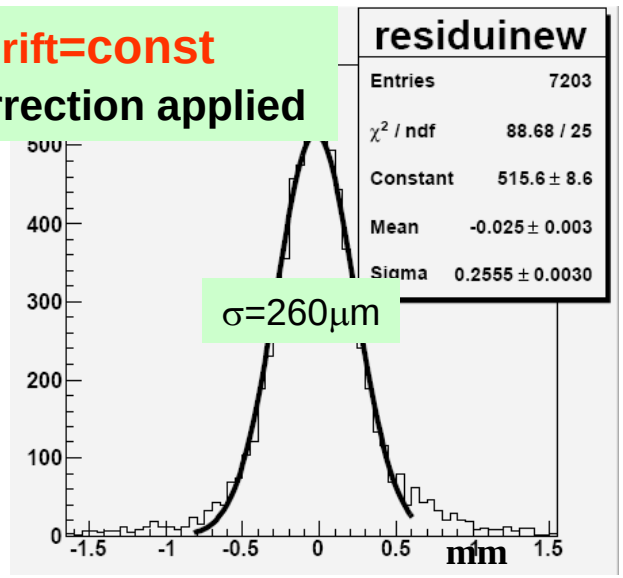
No t0 correction
σ=490μm

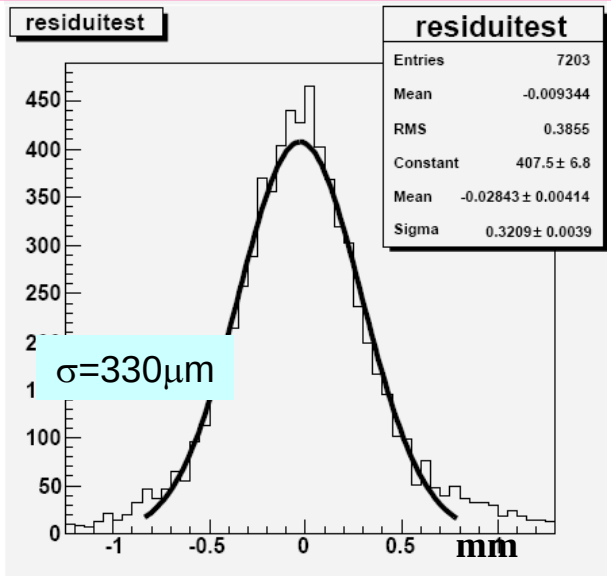




Residuals: all layers included in the fit but one

Residuals : **Vdrift=const**
& Event δt_0 correction applied





Application of the method to commissioning data. Run 3633

MB3-c34, settore 9 Autotrigger H+anyTheta

In the MB3 worst resolution wrt the previous chamber (MB1) in sect 10. This MB3 chamber is in sector 9, not horizontal.

Drift velocity depends on angle (CR-2004/042, CMS NOTE-2003/017)

Use a drift velocity in the Time to Position relation parametrised as a function of the cosmic ray angle (from CMS NOTE-2003/017) Vdrif= Vdrif(angle).

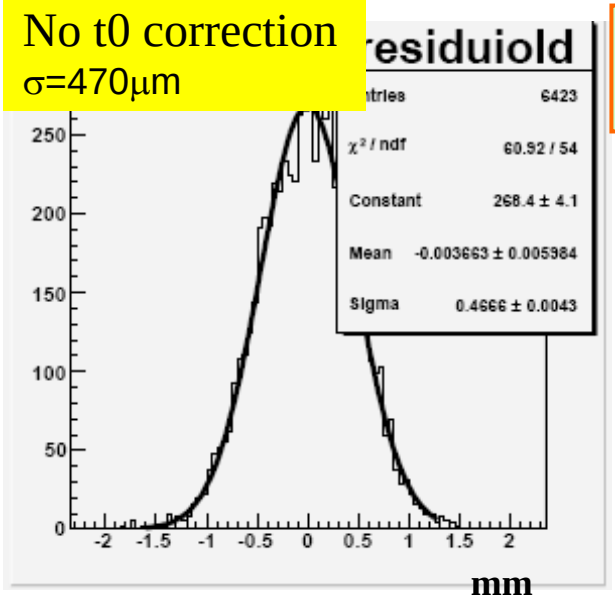
Add selection: angle<30 degrees

Results : residuals go from σ=~260μm to σ=~225μm .

Mechanichal layers/wires position are not taken into account but resolution is anyway below 250μm .

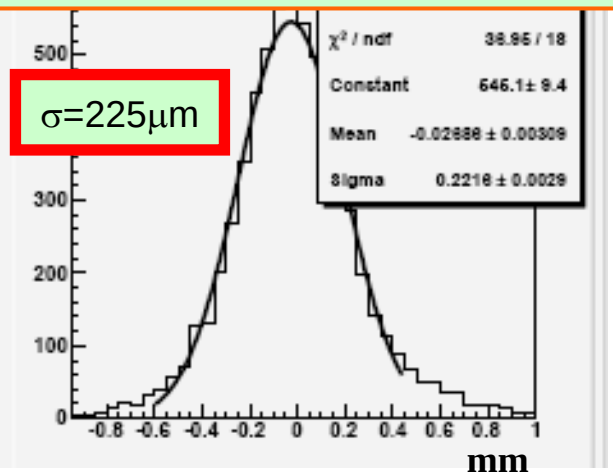
No t0 correction

σ=470μm

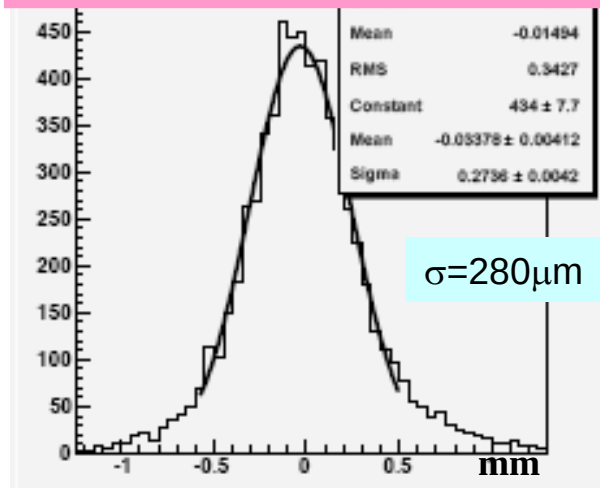


Residuals : **Vdrif(angle)** & **event δt_0 correction aplied**

σ=225μm



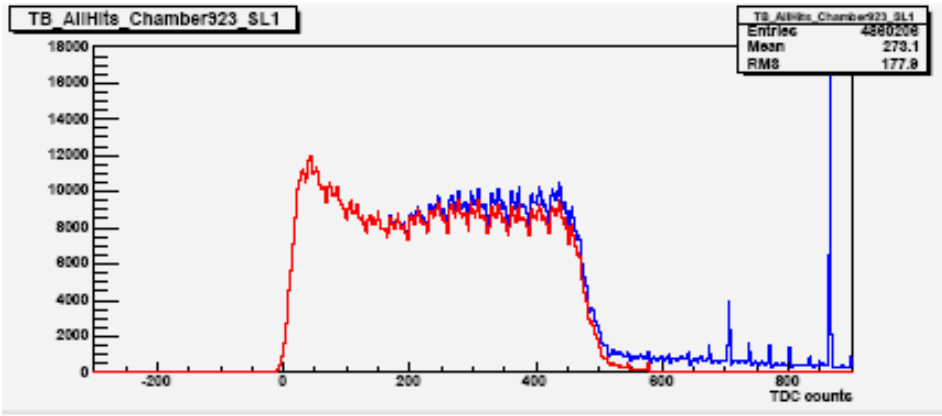
Residuals: all layers in the fit but one

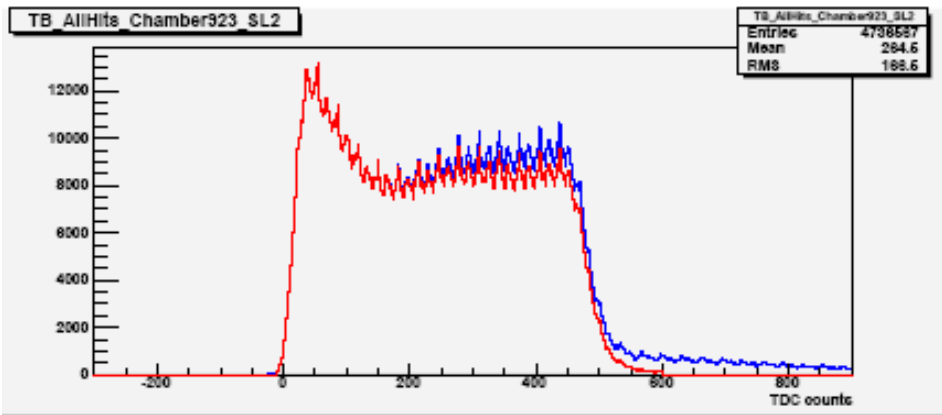


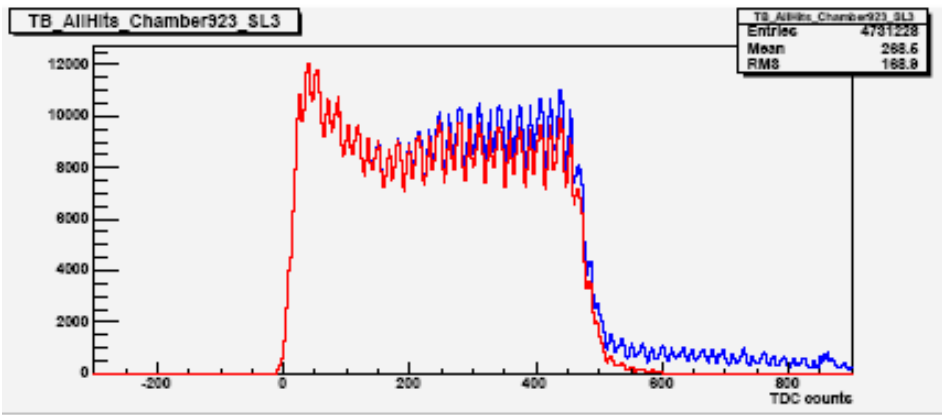
SLAYERS

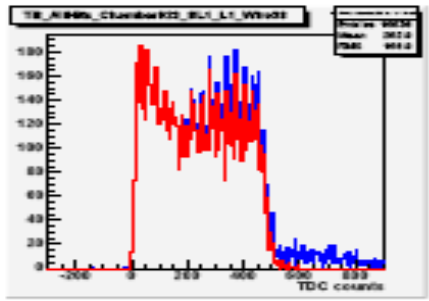
Time boxes
MB3 run 3633

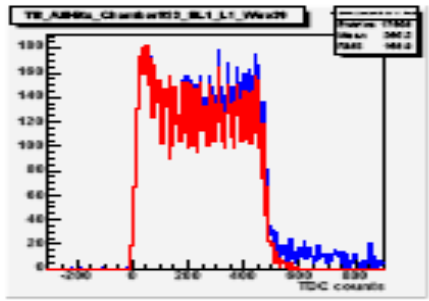
Some wires

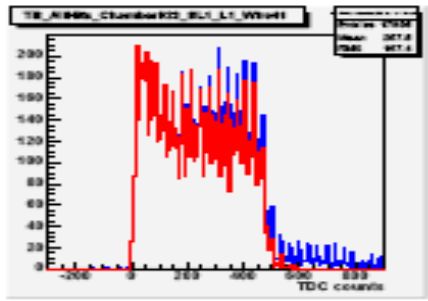


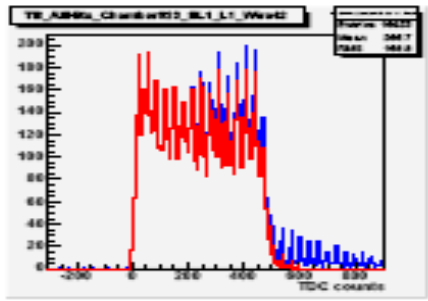


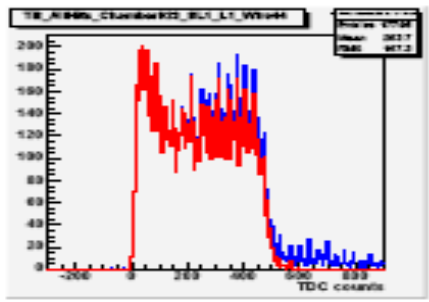


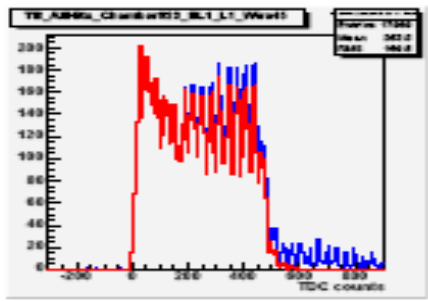


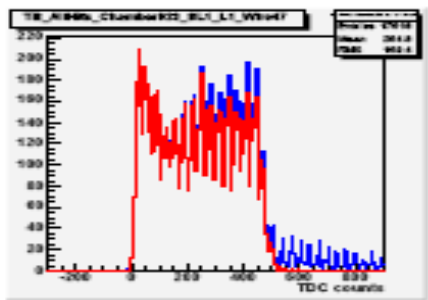


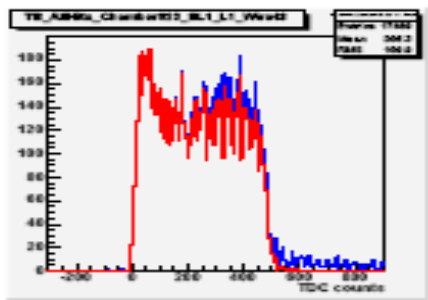












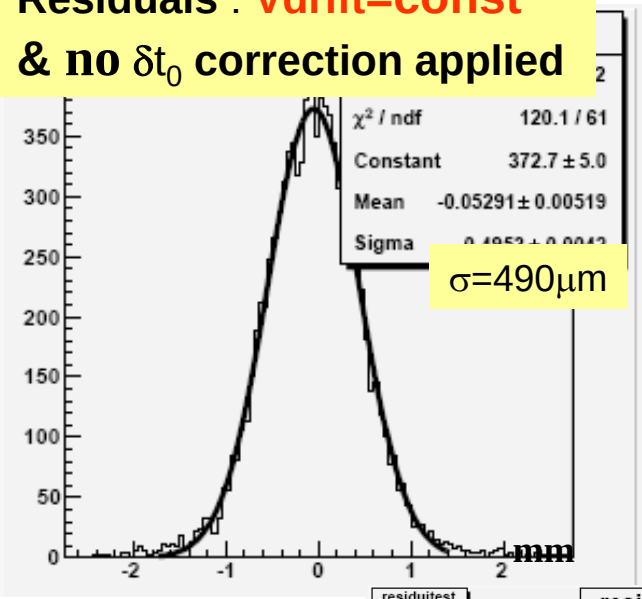
Application of the method to commissioning data. Run 3638_MB3

Indeed angle and trigger type are important ...same MB3 chamber but

Autotrigger Phi1+anyTheta and **K (BTI)=constant=~0+-2 degrees** (Vertical only)

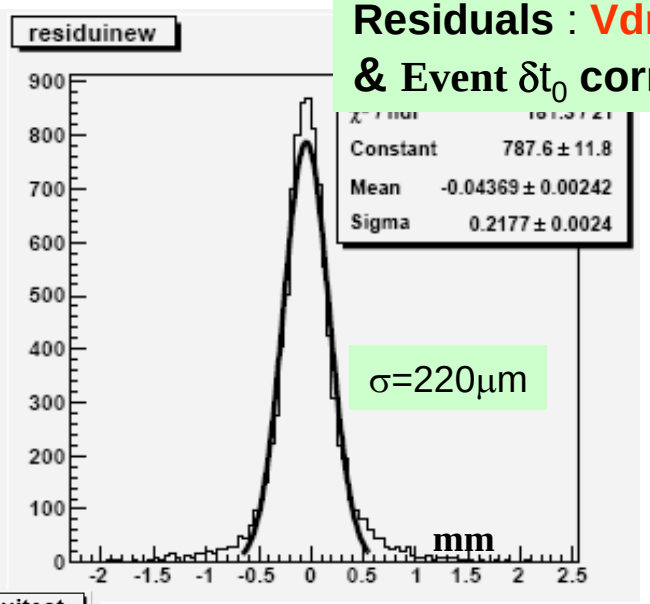
Residuals on layer 1 Phi2 (layer not in the trigger)

Residuals : **Vdrift=const**
& no δt_0 correction applied

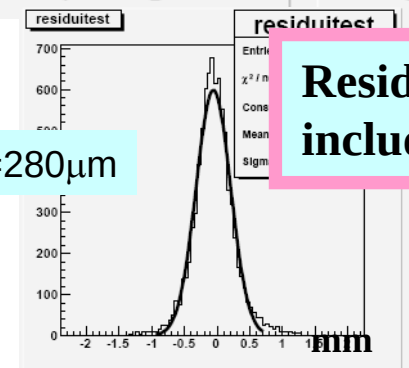


σ=490μm

Residuals : **Vdrift=const**
& Event δt_0 correction applied



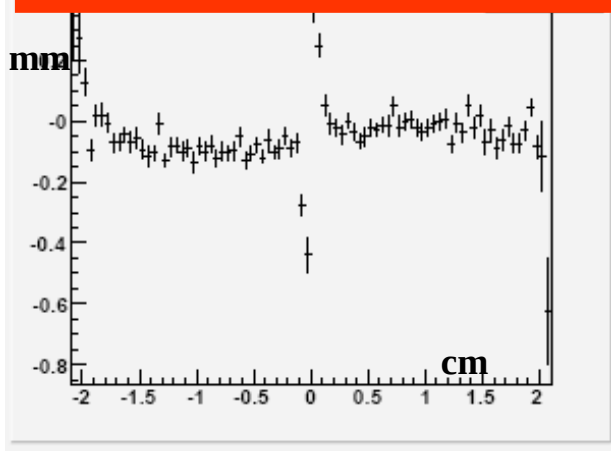
σ=220μm



σ=280μm

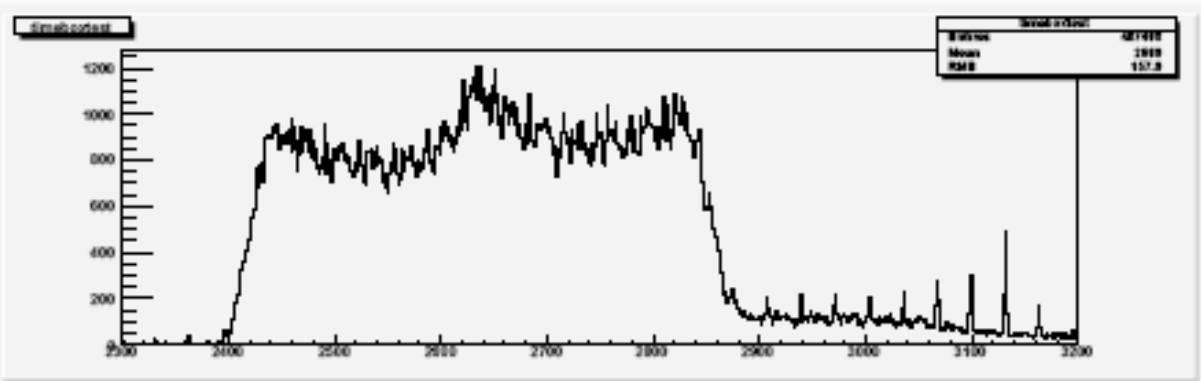
Residuals: all layers included in the fit but one

Residuals (mm) as function of cell position (cm)

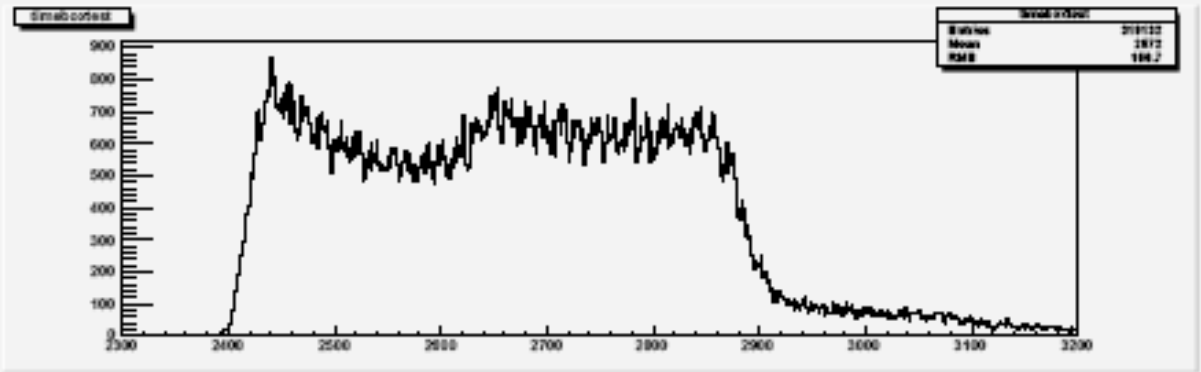


Time boxes (all hits)
MB3 run 3638 same chamber of run MB3

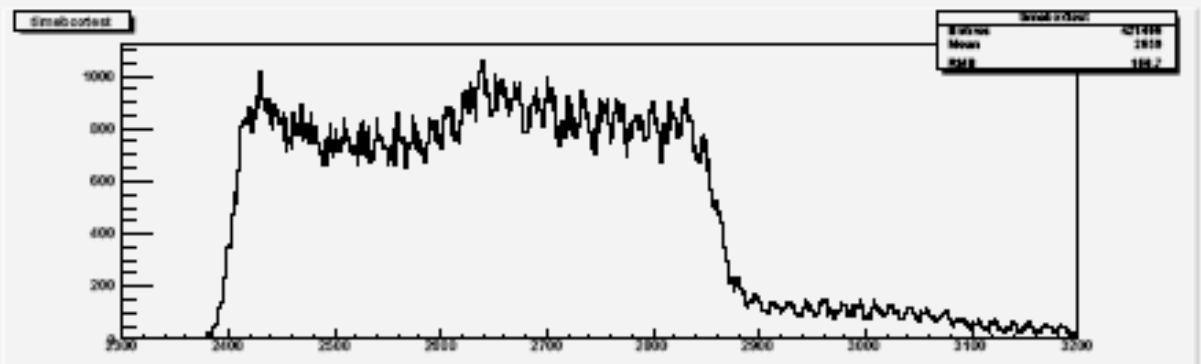
SL phi1



SL Theta



SL phi2



SUMMARY

Run	trigger	No corr. micron	Correct Vd const micron	Correct Vd(angle) micron	Correct Single layer not in fit micron
TBeam	scintillator 0 deg	204	178		240
Cosmic Autotrigg. LNL	H +any T 10 deg	440	170		208
MB1 3192 Commiss.	H +any T All angles	540	230		302
MB3 3633 Commiss.	H +any T All angles	490	260	220	330 Vd const 290 Vd(angle)
MB3 3638 Commiss.	H 1 + any T 0 deg	490 In PHI 2	220 In PHI 2		280

Conclusions

The t_0 computation event by event method can be applied successfully and recover the unknown gitter of the muon cosmic ray tracks with respect to the TDC trigger (L1A) .

The method has been checked with Test Beam data and in two chambers of Commissioning (1 MB3 and 1 MB1) reaching a 200-250 micron per cell.

•No alignment correction related to the mechanical construction (e.g. wire positions etc) was included .
•No cuts were applied to the data so and correlation with the not flat time ditribution (25 ns) has been found.
•The intrinsic chamber resolution depends on the trigger type, on the angle distribution of the tracks and on selection cuts. (to remove deltas rays cutting the peak at <0.001 in the probability plot - see for example slide 6- removes almost all deltas rays)

Next:

•Check in all the commissioning data the efficiency and the resolution of the chambers.
•The method can be easily mplemented in the standard analysis code as a fast option of track parameter computation (it recovers automatically the time propagation along the wire and the difference of time of flight) in the cosmic challenge test at least and it can be used always in the MB4 station since no theta SL for teh position along the wire for Phi track .