Update on QA procedure and use of CgemLineFit in it

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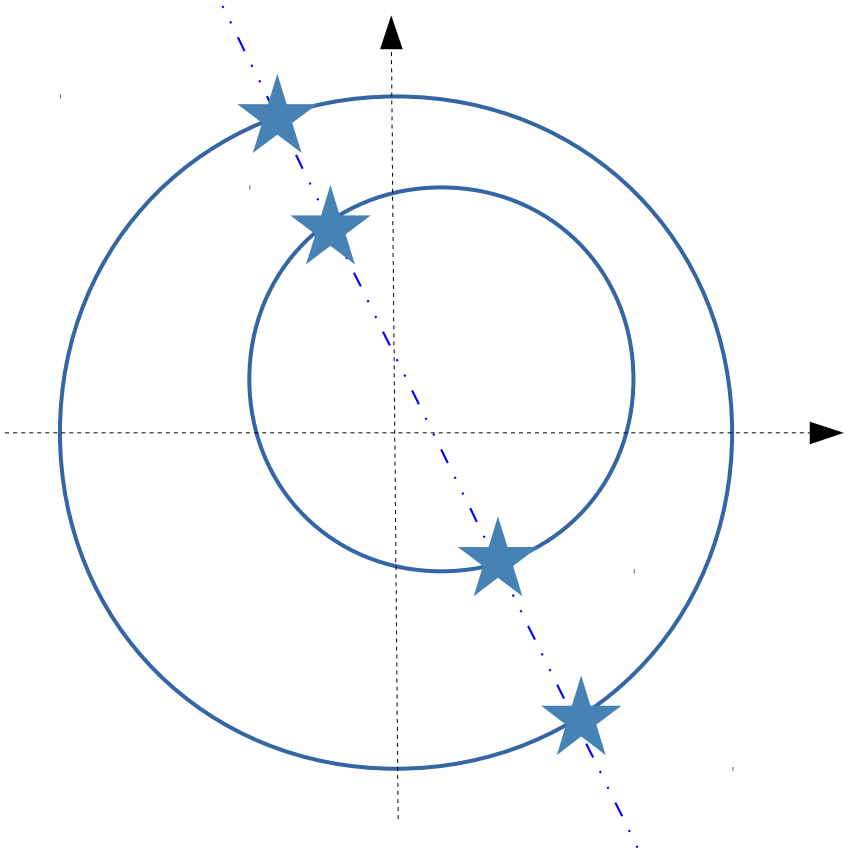
2020-10-29

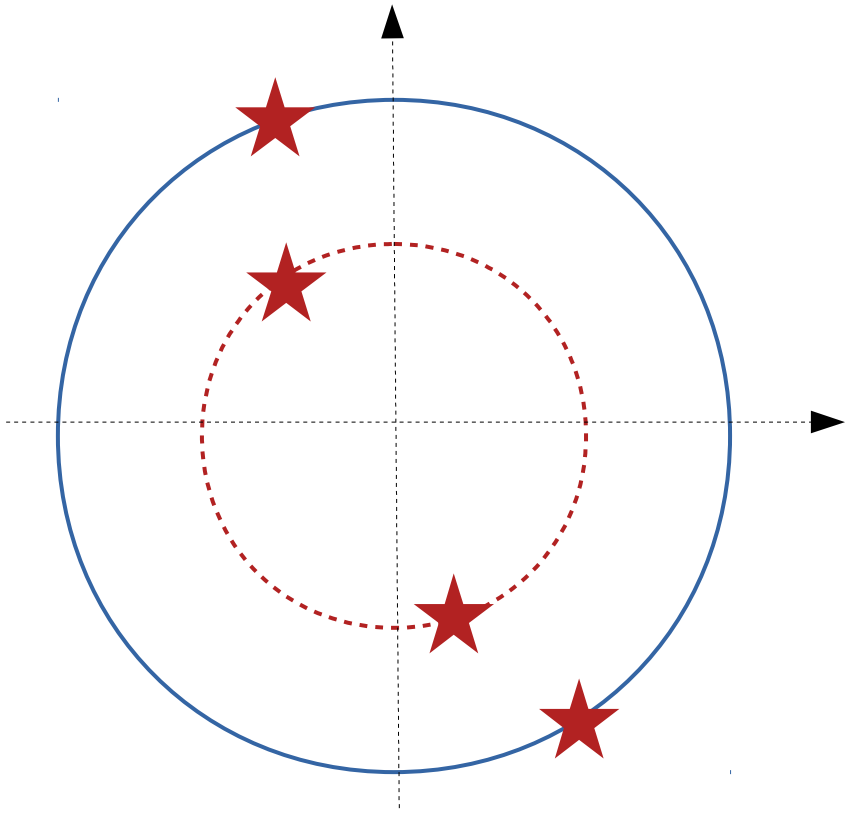
Fixed CgemCosmicRayQA

- usage of alignment functions
- computation of intersections of the fit track to the planes
- computaion of residual distros



REALITY

- The dotted line is the real cosmic ray
- The blue stars are the positions where the cosmic ray is detected on the layers as positioned in the real setup

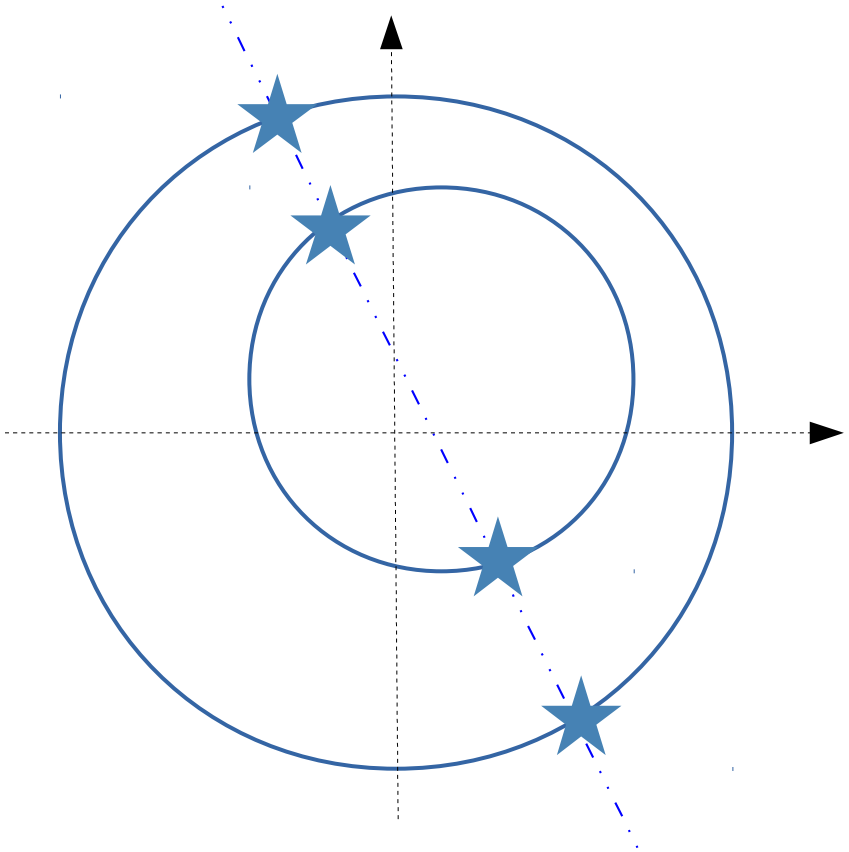


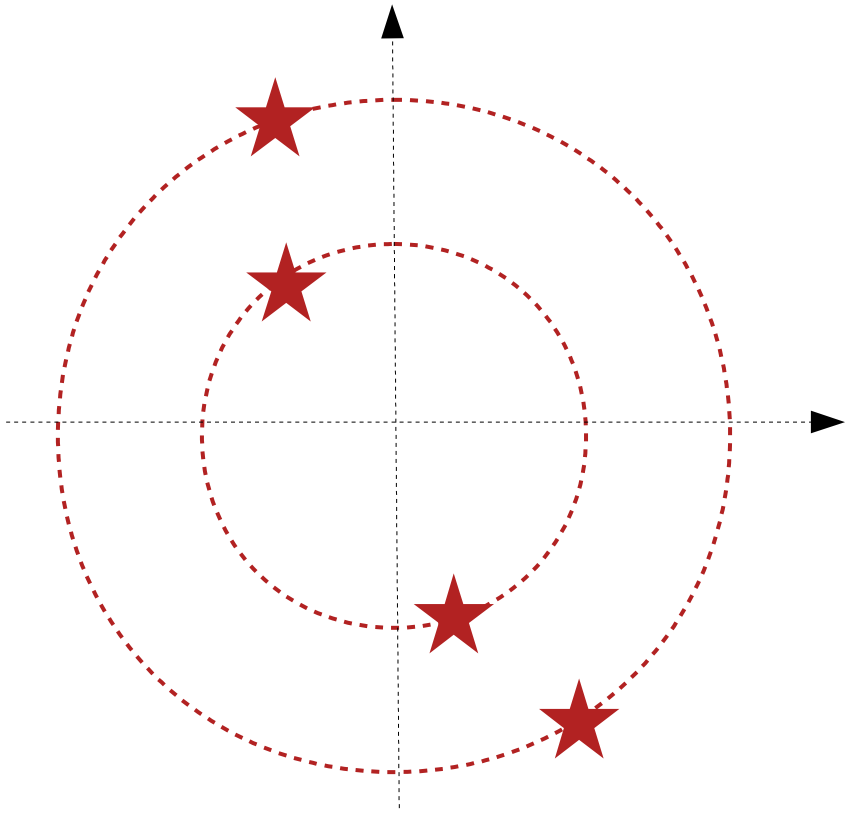
EXPERIMENTAL POINTS

before alignment

- The red stars are the measurements on the layers, they are not aligned since the position of the layers is not corrected

- These are the points without alignment



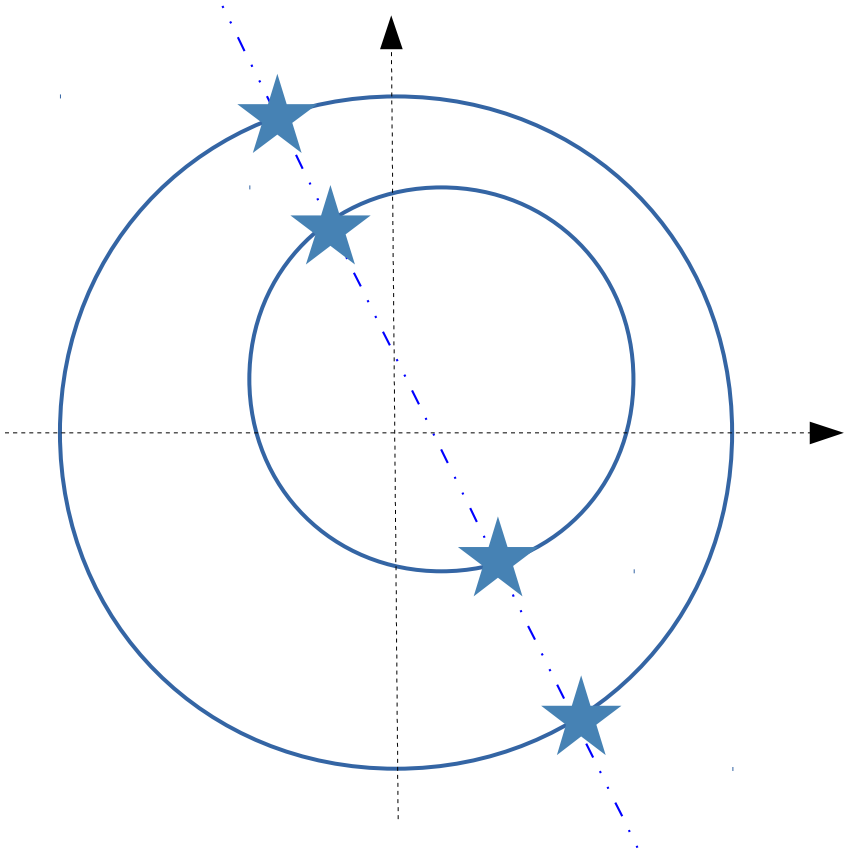


GLOBAL (aligned) reference frame

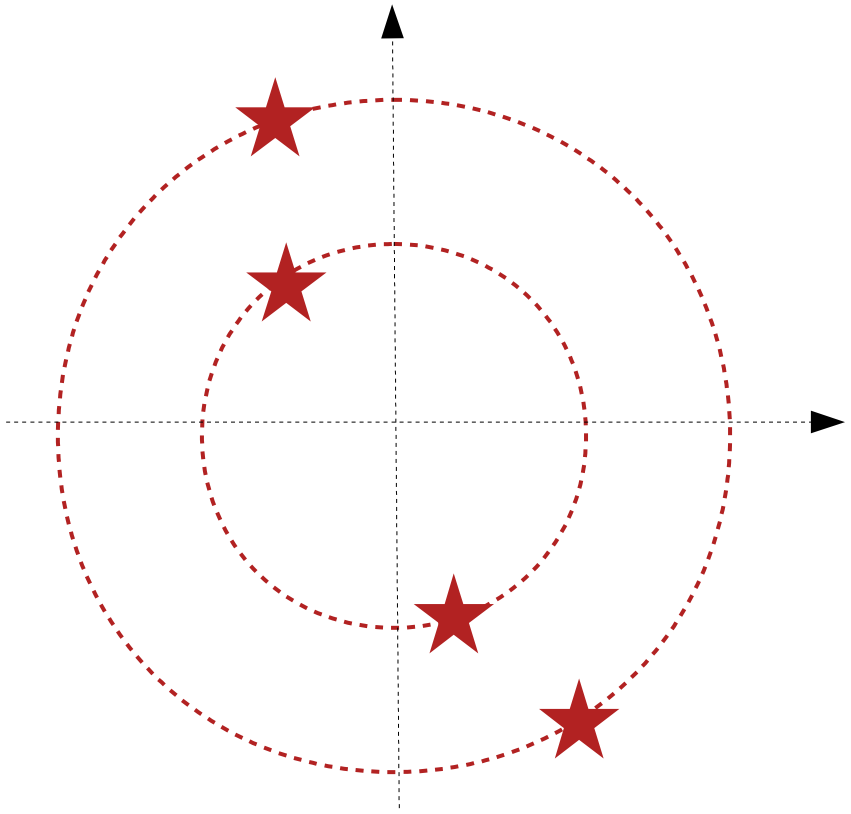
- Track from fit
- Intersections of the fitted track on the layers, coordinates x,y,z
- Point Of Closest Approach (POCA) of the fitted track to (0,0,0)

LOCAL (not-aligned) reference frame

- Experimental hits
- Reco clusters 1D
- Reco clusters 2D
- Intersections of the fitted track on the layers, coordinates f, v



GLOBAL (aligned) reference frame

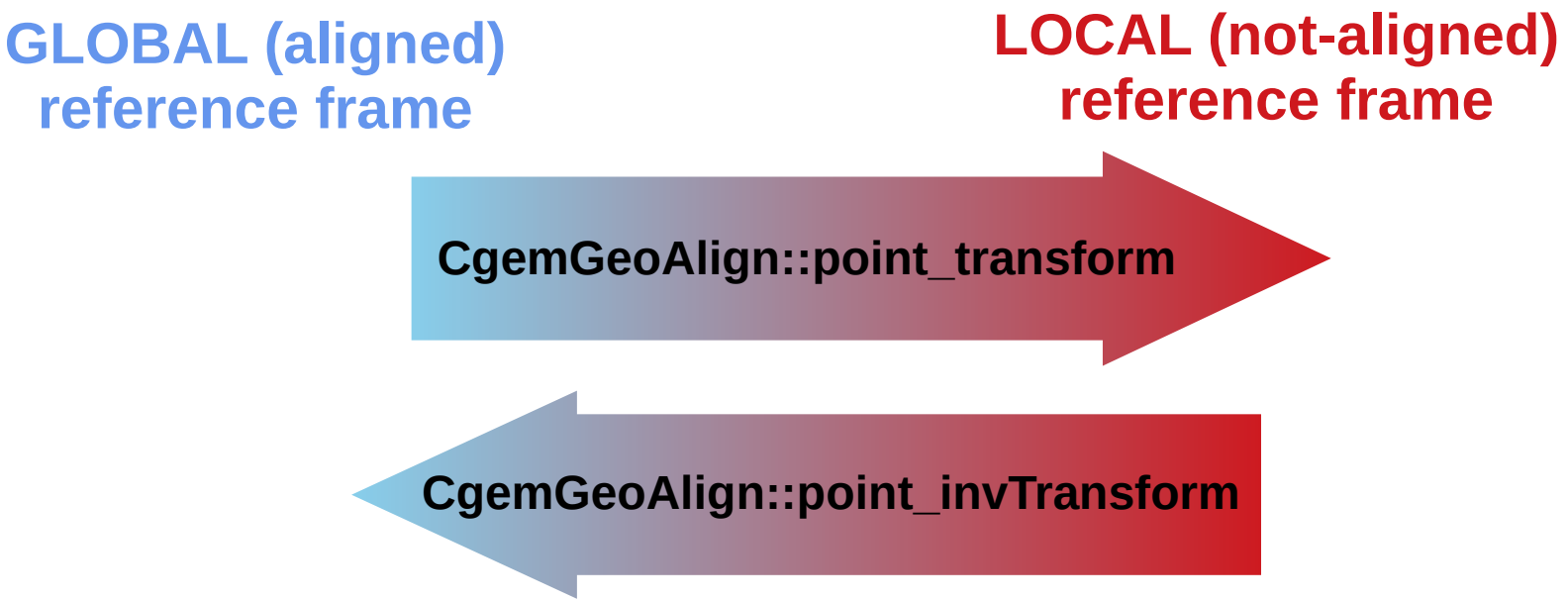


LOCAL (not-aligned) reference frame

CgemGeoAlign::point_transform

CgemGeoAlign::point_invTransform

Thanx to Aiqiang



MY PREVIOUS VERSION WAS <u>WRONG</u>

- I was computing the residuals all in the GLOBAL frame
- porting there the experimental positions with point_invTransform
- BUT I was finding the intersections of the fitted line to **non aligned** layers (LOCAL) with my **own** code → WRONG

NEW VERSION IS <u>FIXED</u>

- I compute the residuals in the LOCAL frame
- I compute the intersections in the GLOBAL aligned frame with the **dedicated** function

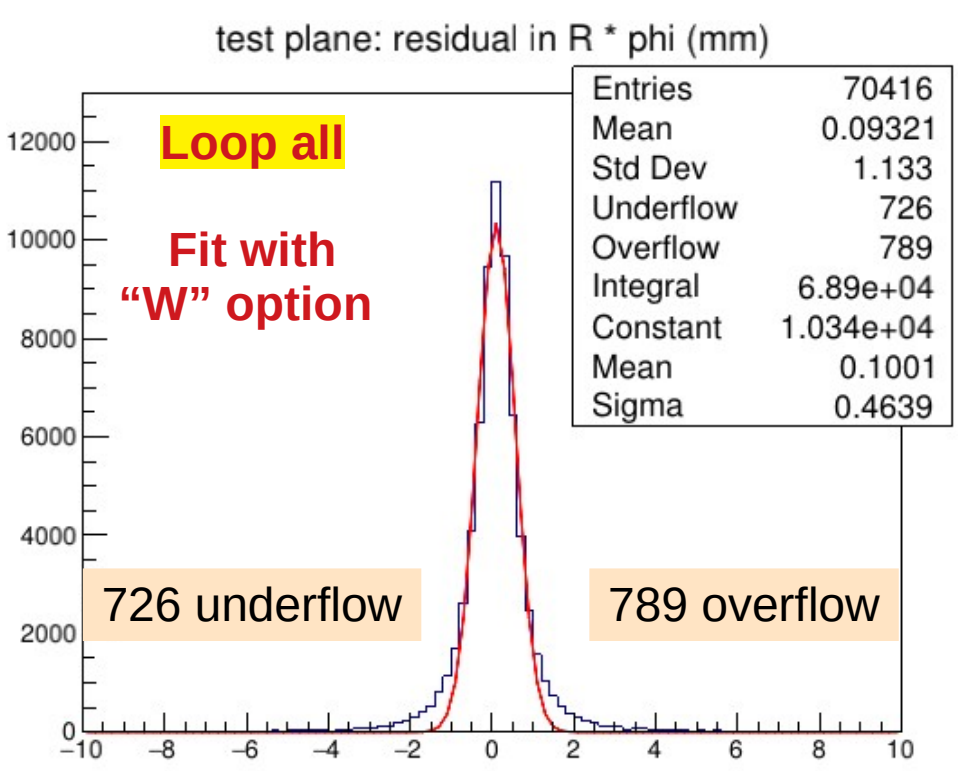
```
bool gotit;

if(align_flag==true) gotit = midplane->getPointAligned(layerid, linefit, posup, posdown, phivup, phivdown);
else gotit = midplane->getPointIdealGeom(layerid, linefit, posup, posdown, phivup, phivdown);
```

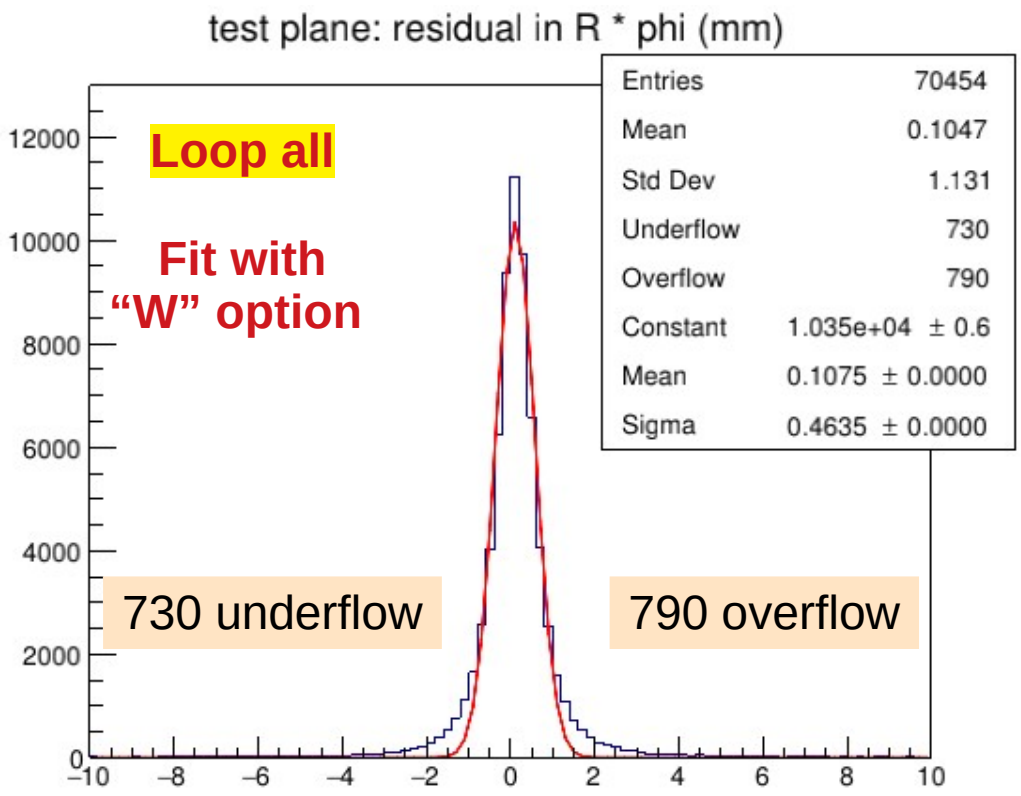
- Use ϕ and v from the LOCAL frame

residual r*phi - L1 bottom

PREVIOUS VERSION (WRONG)



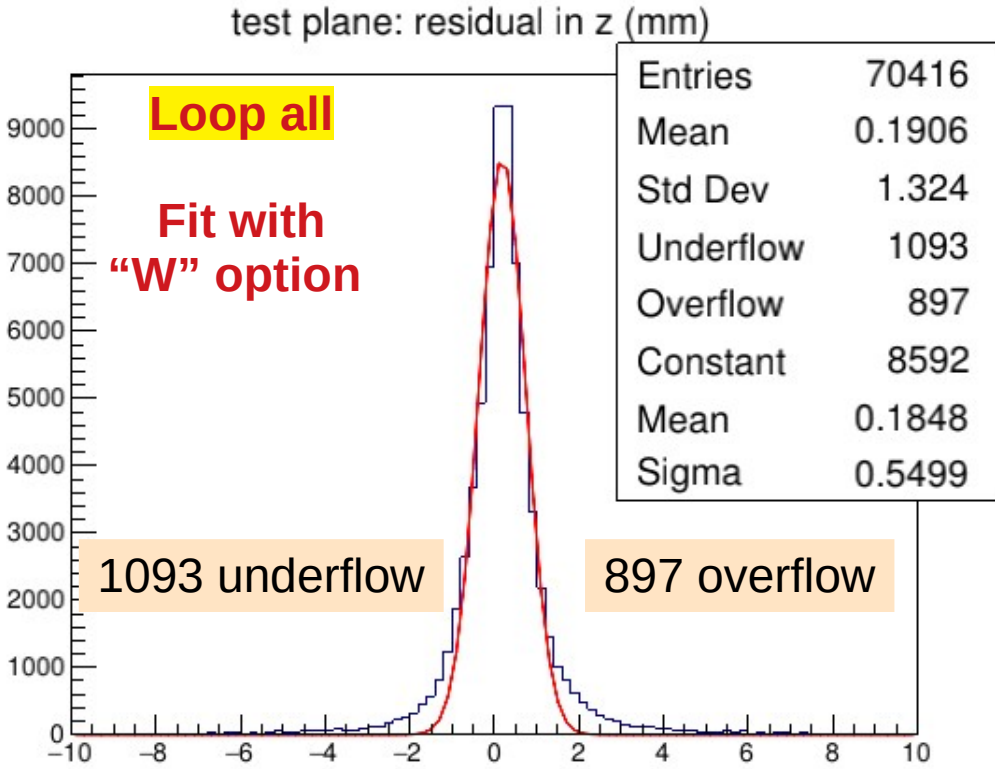
NEW VERSION (FIXED)



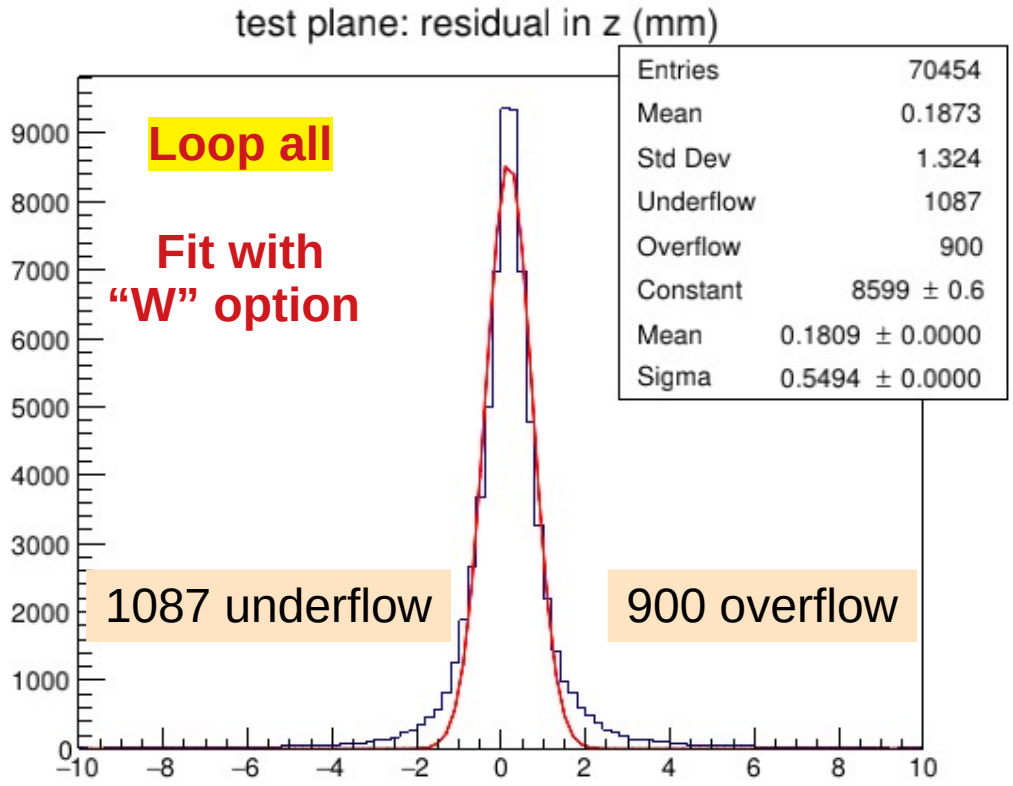
There is no actual difference in the results

residual z - L1 bottom

PREVIOUS VERSION (WRONG)



NEW VERSION (FIXED)



There is no actual difference in the results

Test 1 - use Loop All

- Use it on every test plane
- Tested alignment of residual distros
- Tested chi2 cut
- Tested cut on cluster charge

Loop All on all planes

- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

- **LoopAll** algorithm
- **Test all the layers**, one by one
- L1 TOP and L2 BOTTOM have problems

L1 BOTTOM

n FITTED track	120502
n VALID track (after cuts)	75089
efficiency	0.8520955133
background component	0.0238117434

L1 TOP

n FITTED track	0
n VALID track (after cuts)	0
efficiency	-nan
background component	-nan

L2 BOTTOM

n FITTED track	6402
n VALID track (after cuts)	3581
efficiency	0.8553476682
background component	0.01396258028

L2 TOP

n FITTED track	126655
n VALID track (after cuts)	81455
efficiency	0.8554907618
background component	0.01419188509

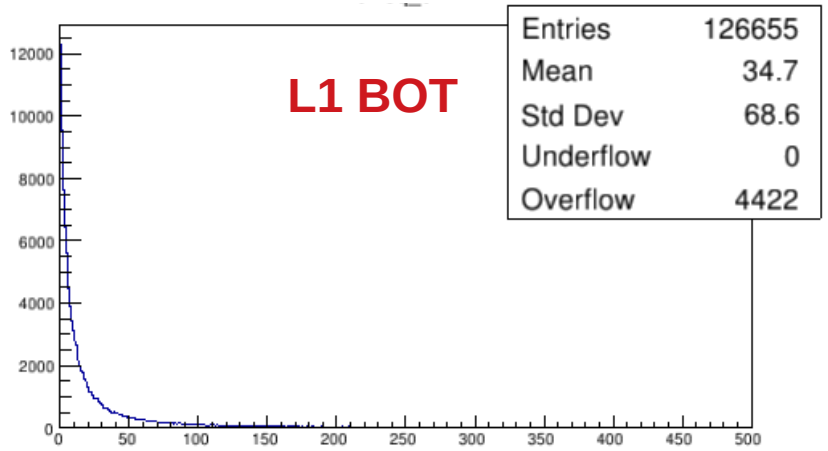
Loop All on all planes

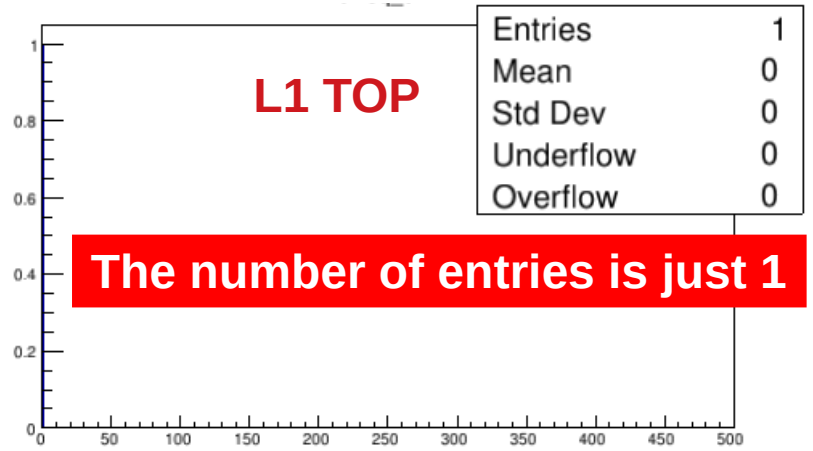
- Alignment **on**, parameters are:

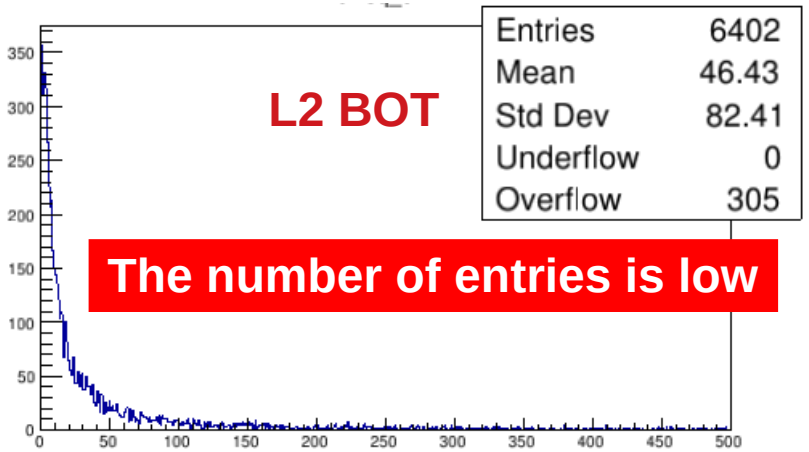
Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

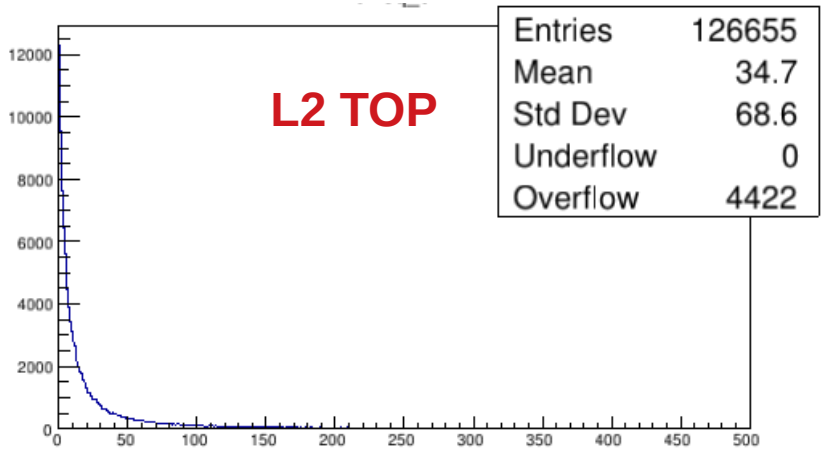
- **LoopAll** algorithm
- **Test all the layers**, one by one
- L1 TOP and L2 BOTTOM have problems: **the LoopAll fit does not work fine here!**

χ^2 DISTRIBUTIONS









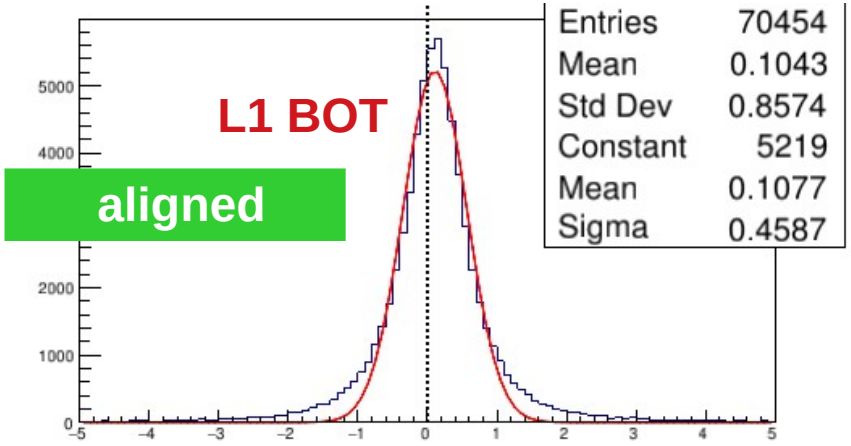
The residual distributions

- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

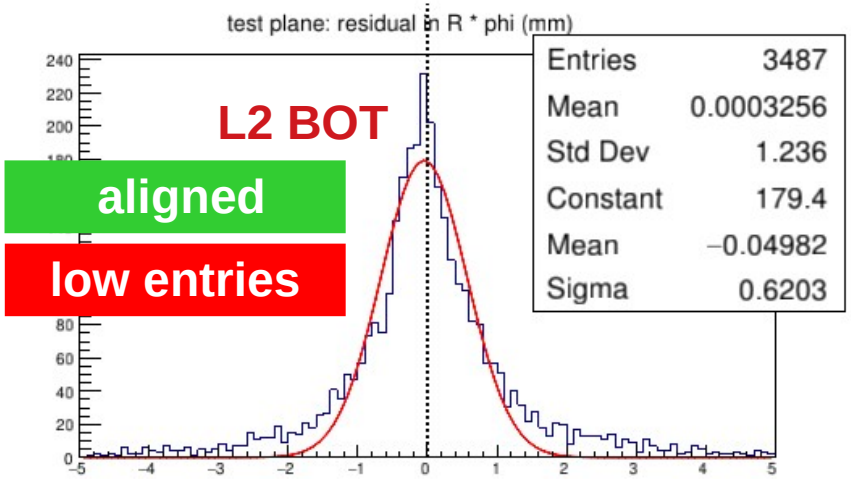
- **LoopAll** algorithm
- **Test all the layers**, one by one
- **Chi2 cut** = 20

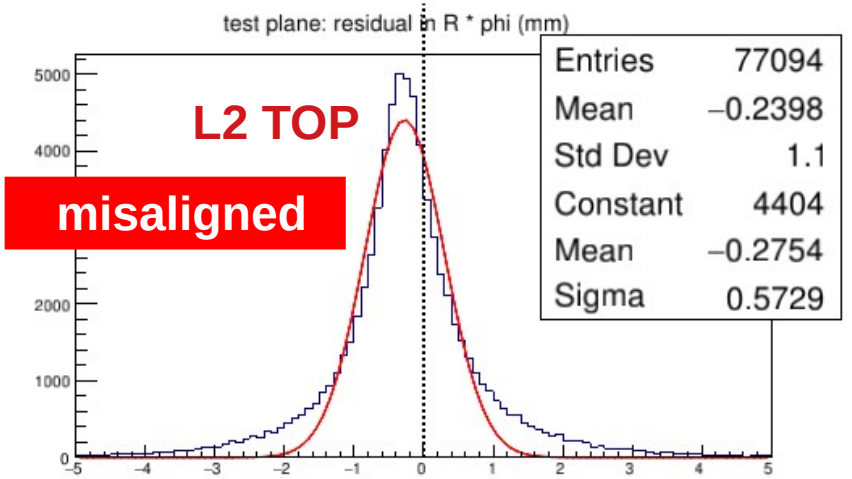
R * ϕ RESIDUAL DISTRO



L1 TOP

NO ENTRIES





chi2 CUT scan

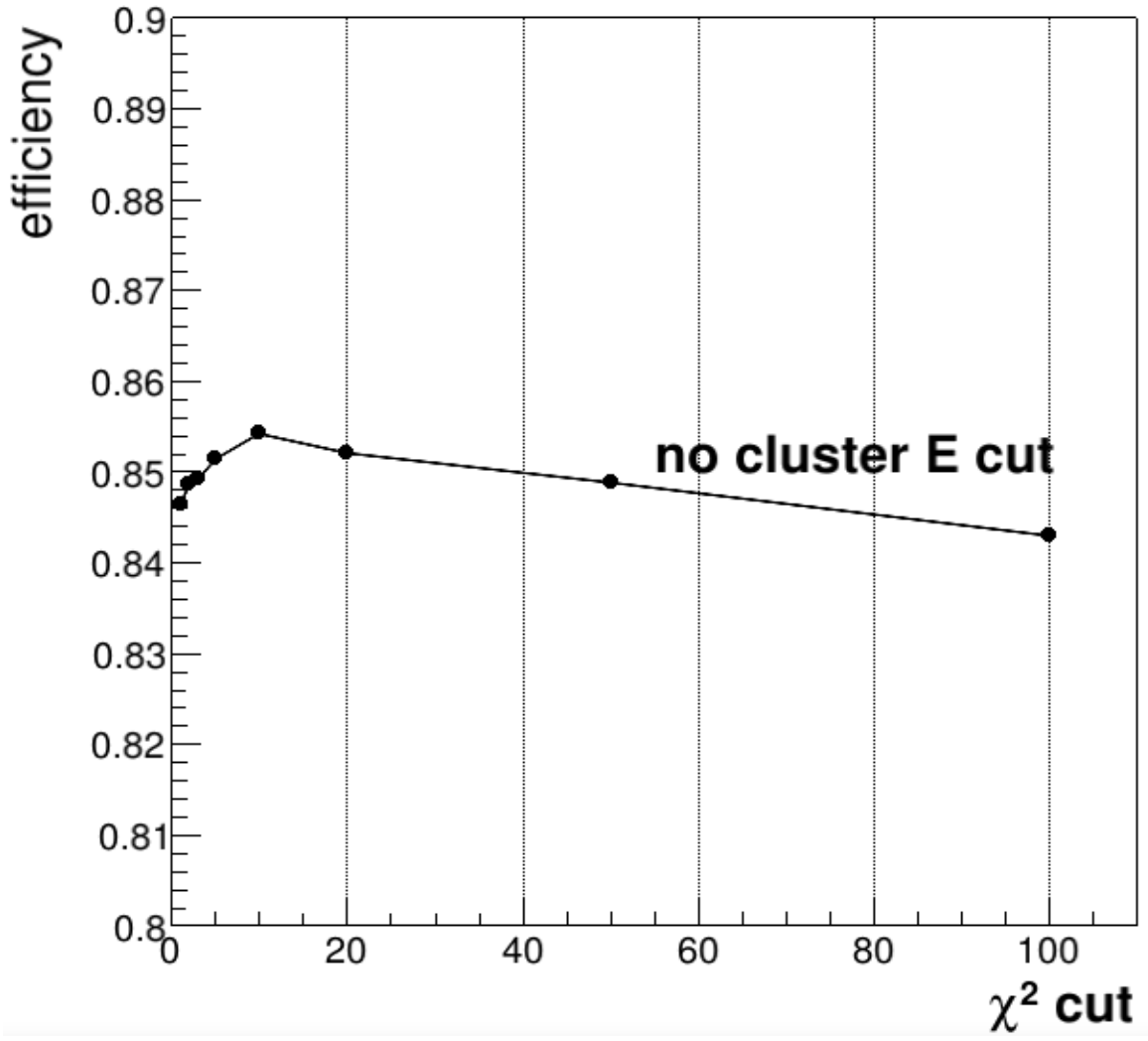
- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

- **LoopAll** algorithm
- **Run a chi2 scan for L1 BOT**

Chi2 scanned in the values [1,2,3,5,10,20,50,100]

There is not a real and relevant difference

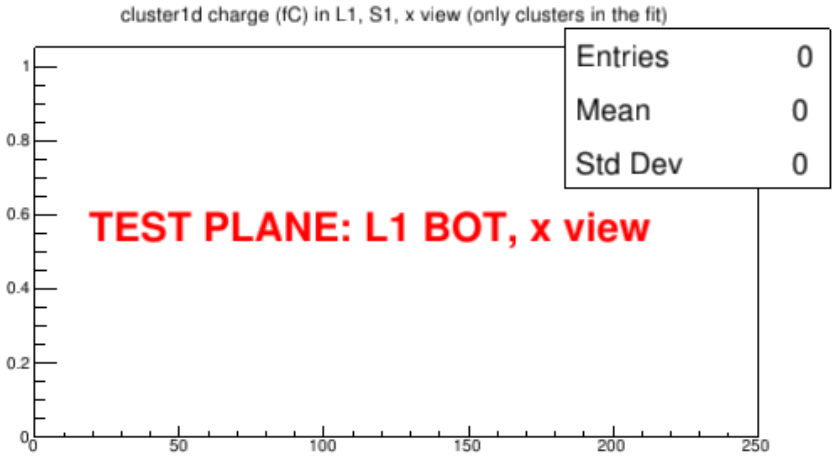


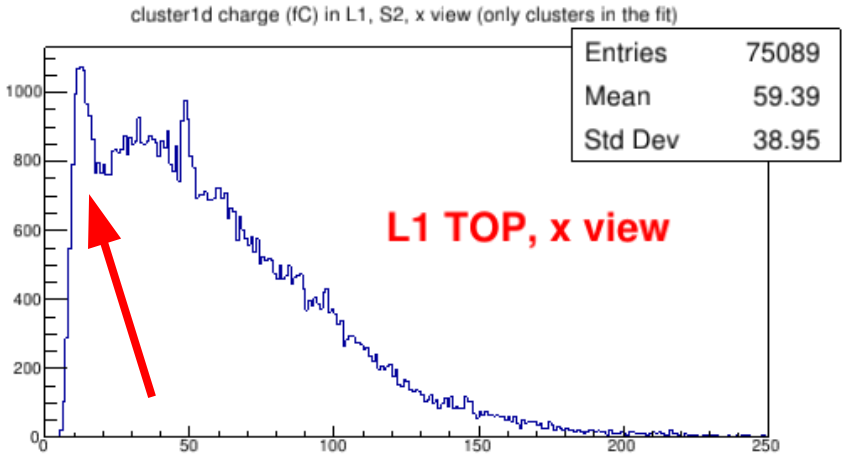
cluster energy

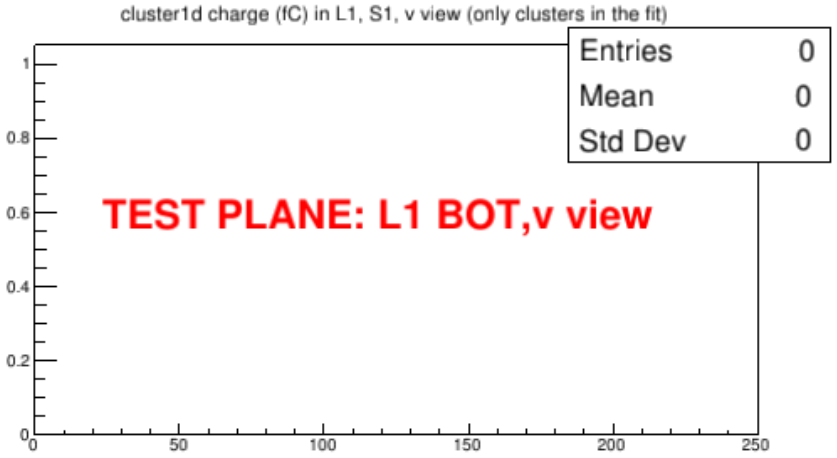
- Alignment **on**, parameters are:

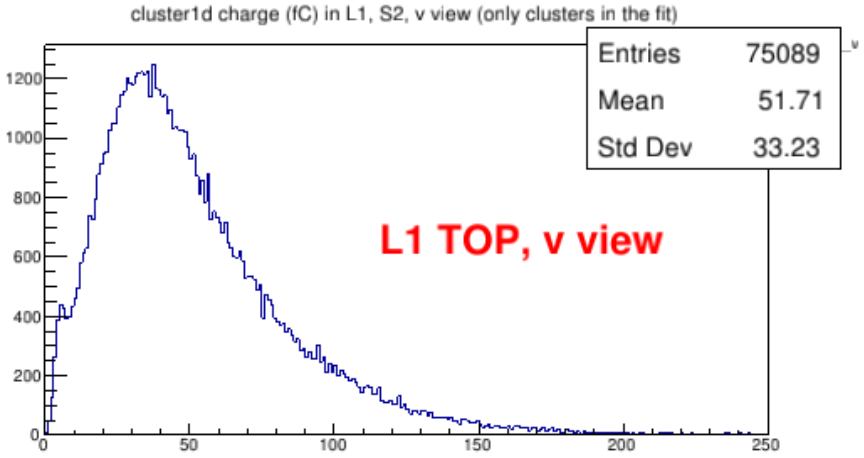
Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

- **LoopAll** algorithm
- **See the energy distribution of the clusters used for fitting**









cluster energy

- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
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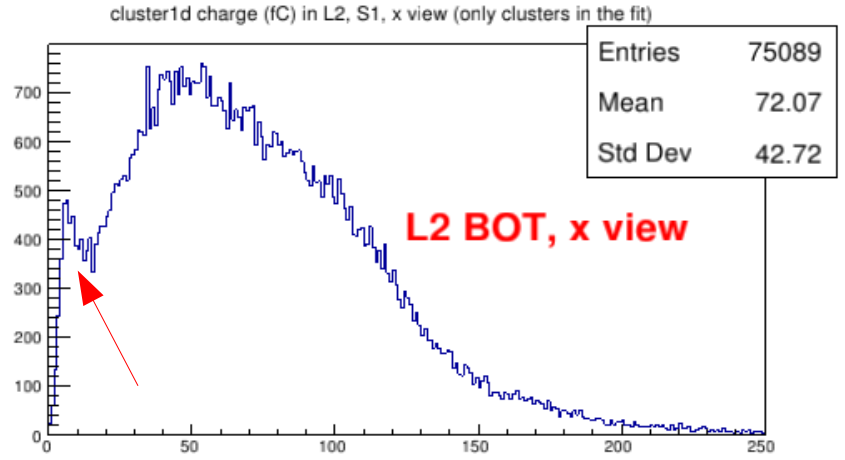
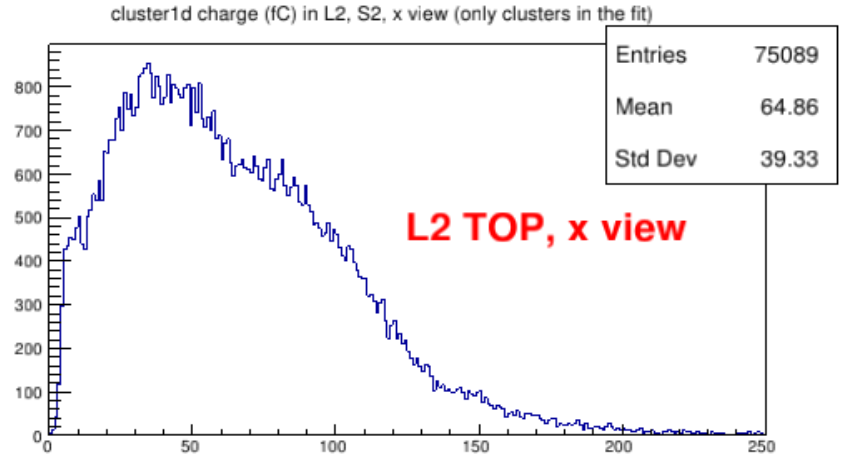
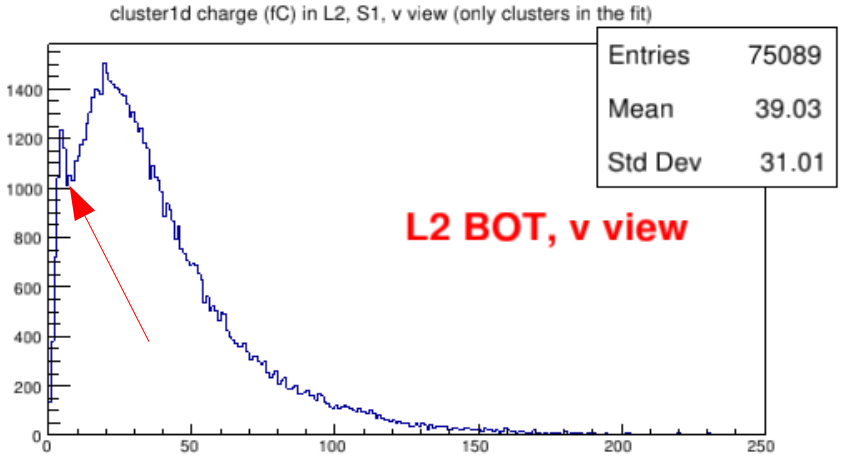
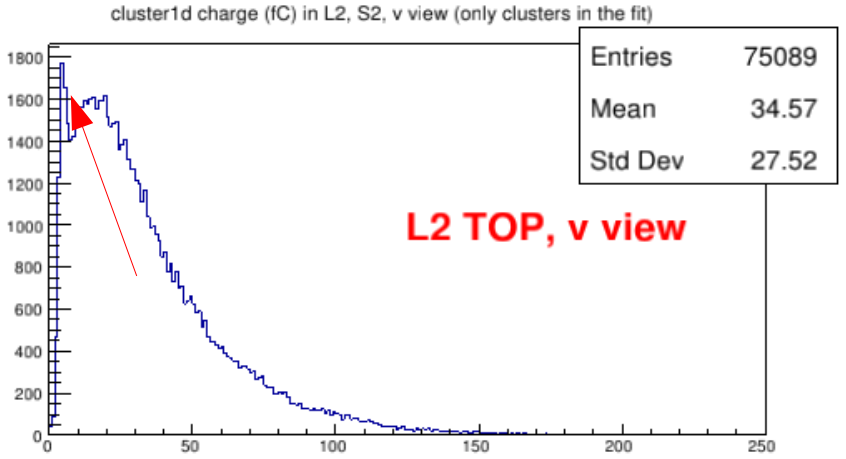
- **LoopAll** algorithm
- **See the energy distribution of the clusters used for fitting**







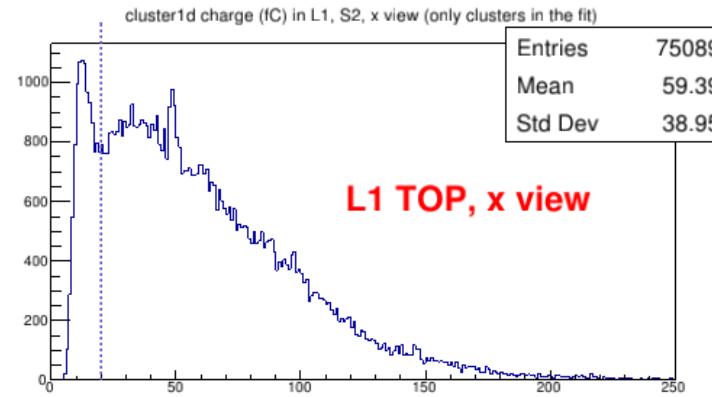


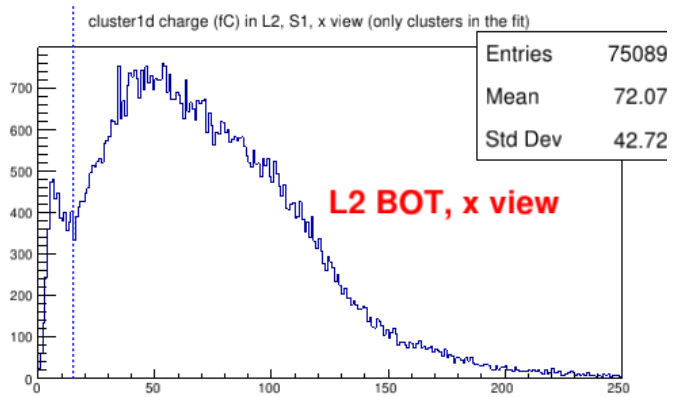
cluster energy

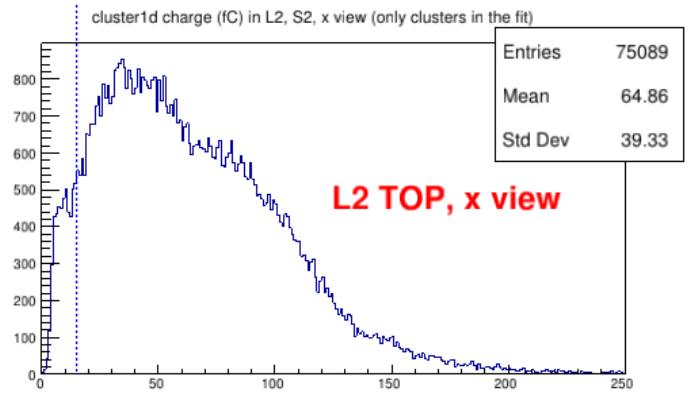
- Cuts used in my old standalone were:

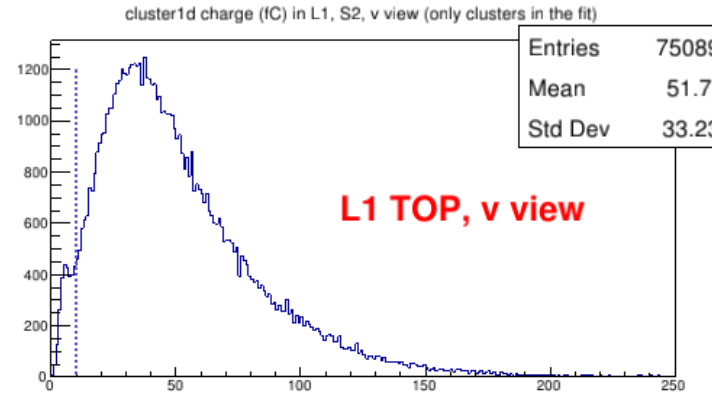
: L1, x view, $Q_{CLUSTER}$ > 20 fC; L2, x view, $Q_{CLUSTER}$ > 15 fC | L1, v view, $Q_{CLUSTER}$ > 10 fC; L2, v view, $Q_{CLUSTER}$ > 10 fC

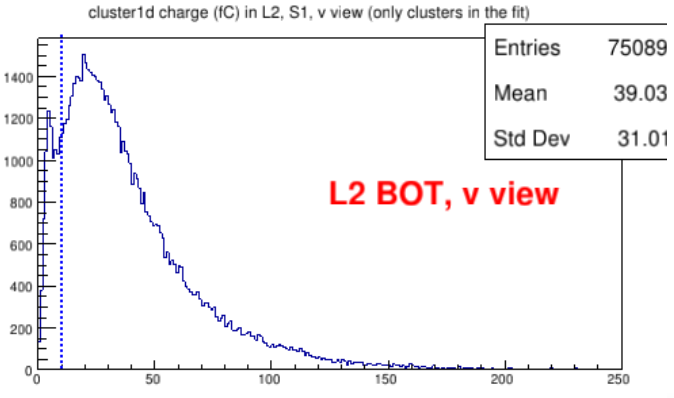
L1 TOP **L2 BOT** **L2 TOP**

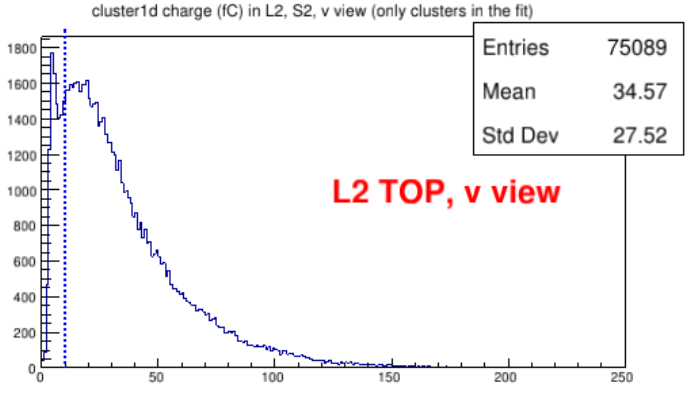










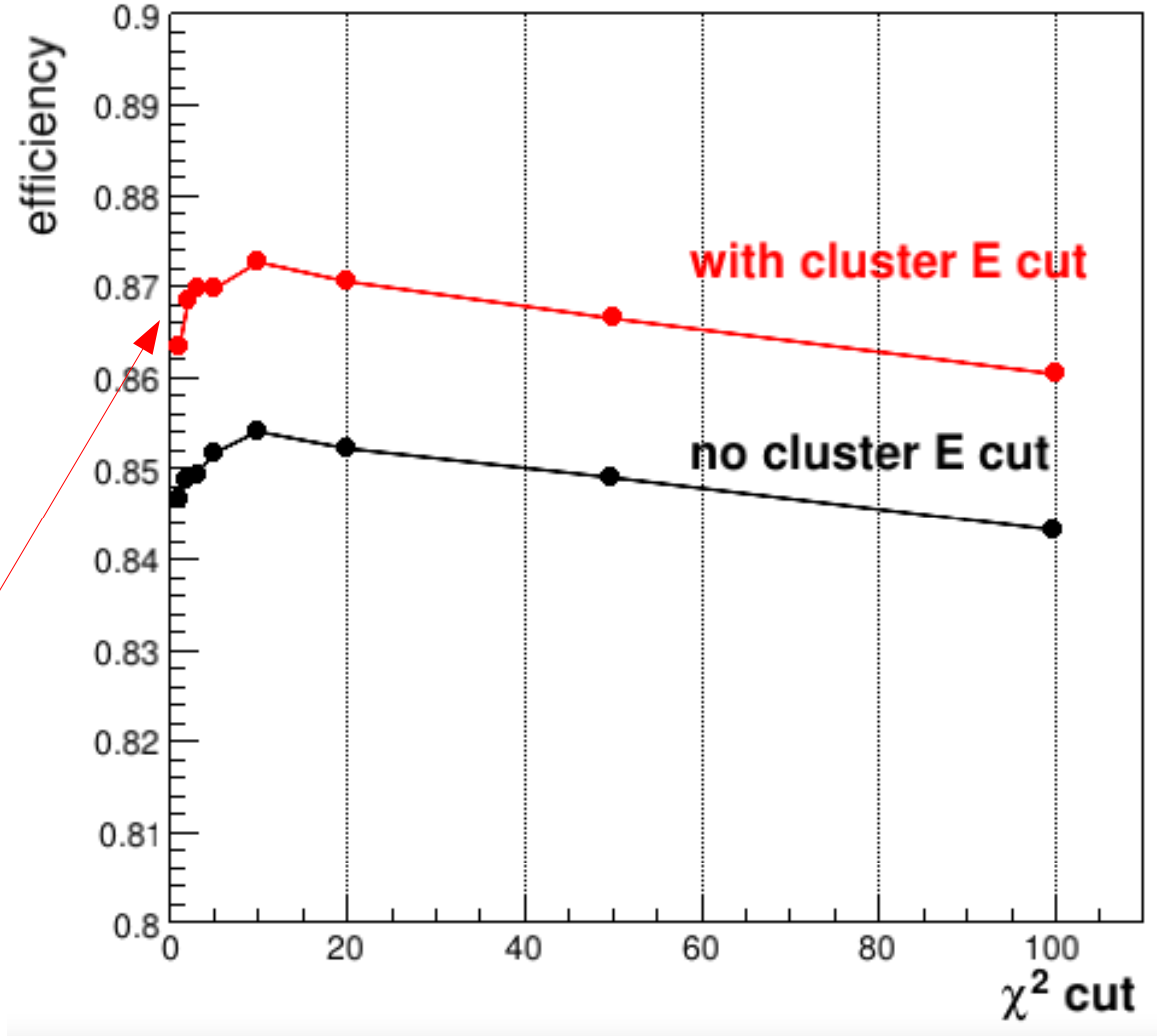


chi2 CUT scan

- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

- **LoopAll** algorithm
- **Run a chi2 scan for L1 BOT**



Chi2 scanned in the values [1,2,3,5,10,20,50,100]

There is not a real and relevant difference

Also by cutting away the events where one of the tracker cluster does not pass the energy cut there is no change by chi2 cut

Test 2 - use Loop All + Max Q

- Use it on every test plane
- Tested alignment of residual distros

Test 2 – Loop All + Max Charge

- Alignment **on**, parameters are:

Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

- **LoopAll + MaxCharge** algorithm
- **Test all the layers**, one by one
- **LoopAll+MaxChage has a fitting procedure which is fine for all the planes**

L1 BOTTOM

n FITTED track	153160
n VALID track (after cuts)	86453
efficiency	0.8354018947
background component	0.02558615664

L1 TOP

n FITTED track	151818
n VALID track (after cuts)	86609
efficiency	0.8479026429
background component	0.02145273586

L2 BOTTOM

n FITTED track	150586
n VALID track (after cuts)	86040
efficiency	0.8389702464
background component	0.01813110181

L2 TOP

n FITTED track	153433
n VALID track (after cuts)	88779
efficiency	0.8349834983
background component	0.01954290992

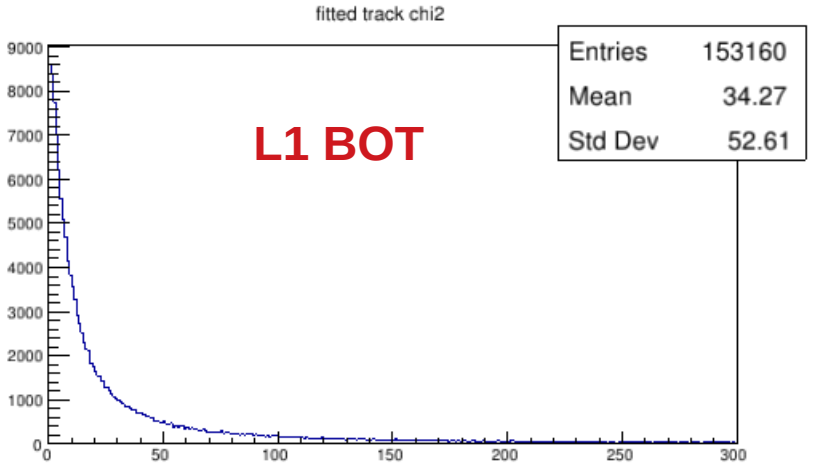
Loop All on all planes

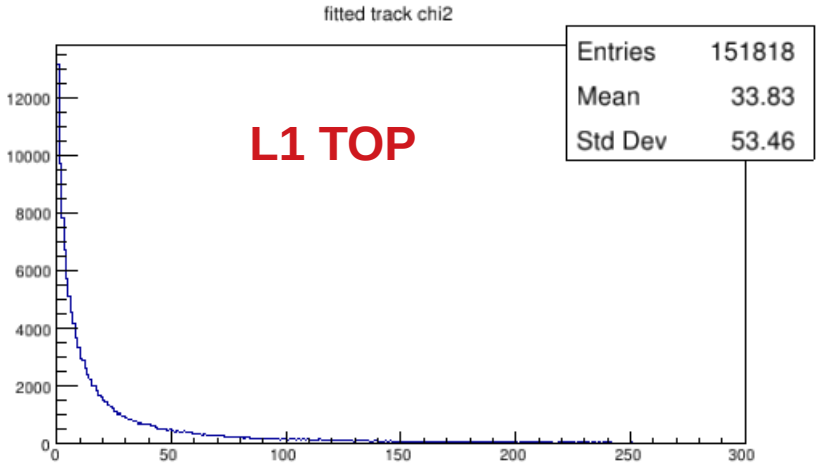
- Alignment **on**, parameters are:

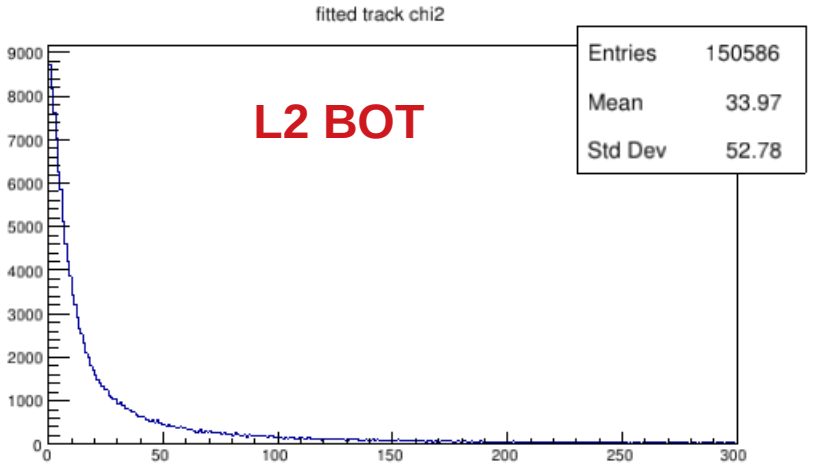
Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

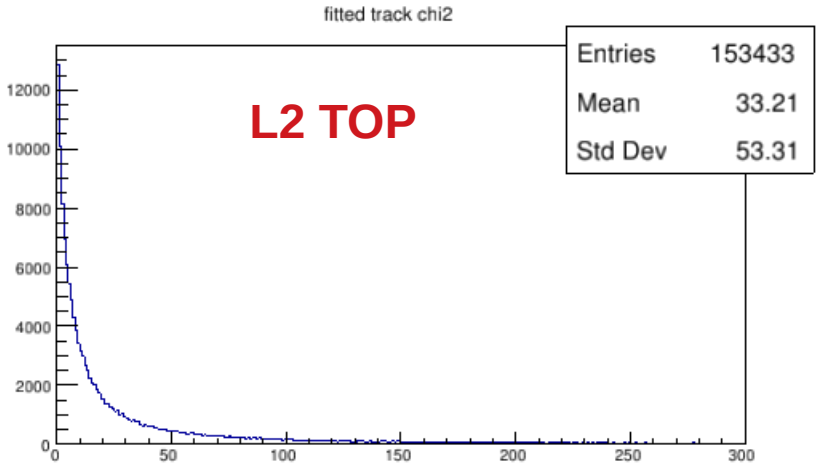
- **LoopAll + MaxCharge** algorithm
- **Test all the layers**, one by one

χ2 DISTRIBUTIONS









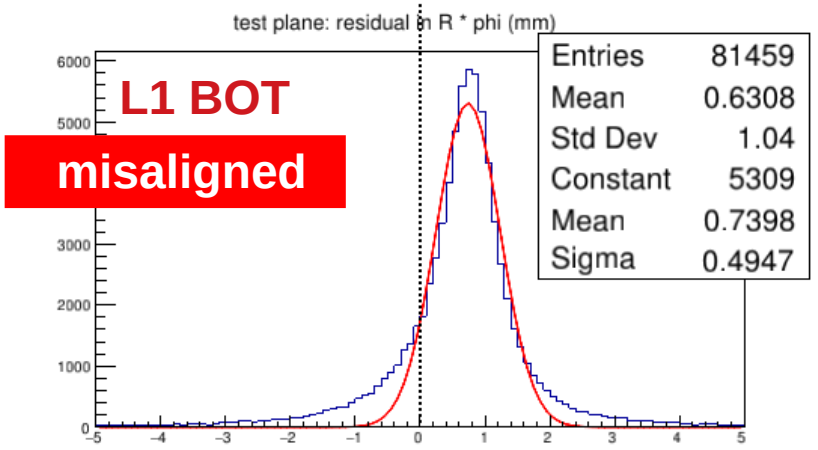
Test 2 – Loop All + Max Charge

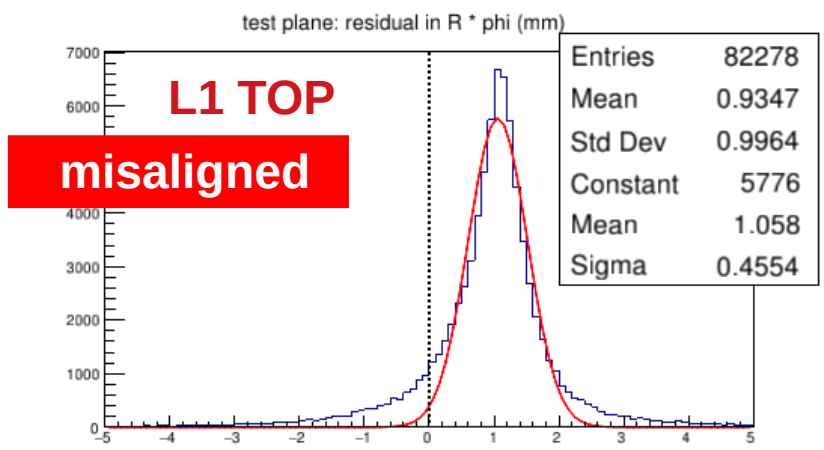
- Alignment **on**, parameters are:

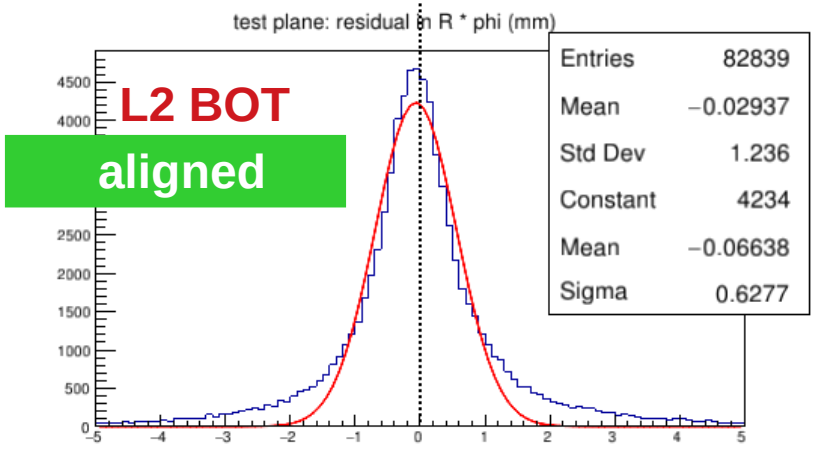
Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

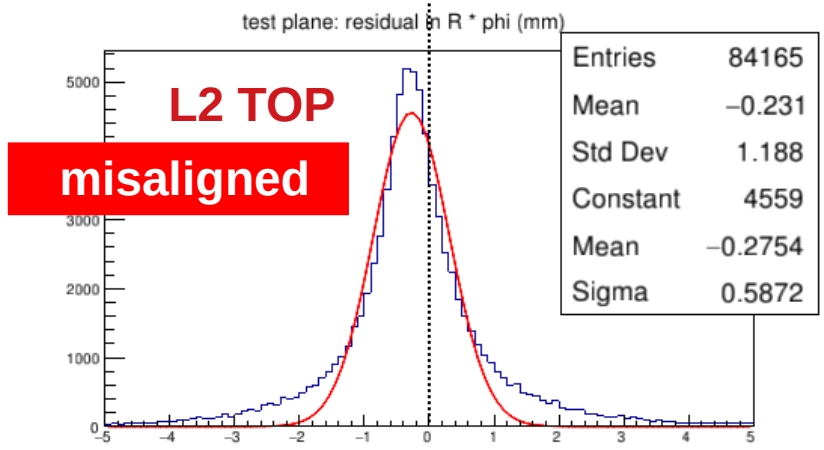
- **LoopAll + MaxCharge** algorithm
- **Test all the layers**, one by one
- **LoopAll+MaxChage: what about the misalignment?**

R * ϕ RESIDUAL DISTRO









Test 3 – use the 4 layers all at once

Number of fitted tracks

- Alignment **on**, parameters are:

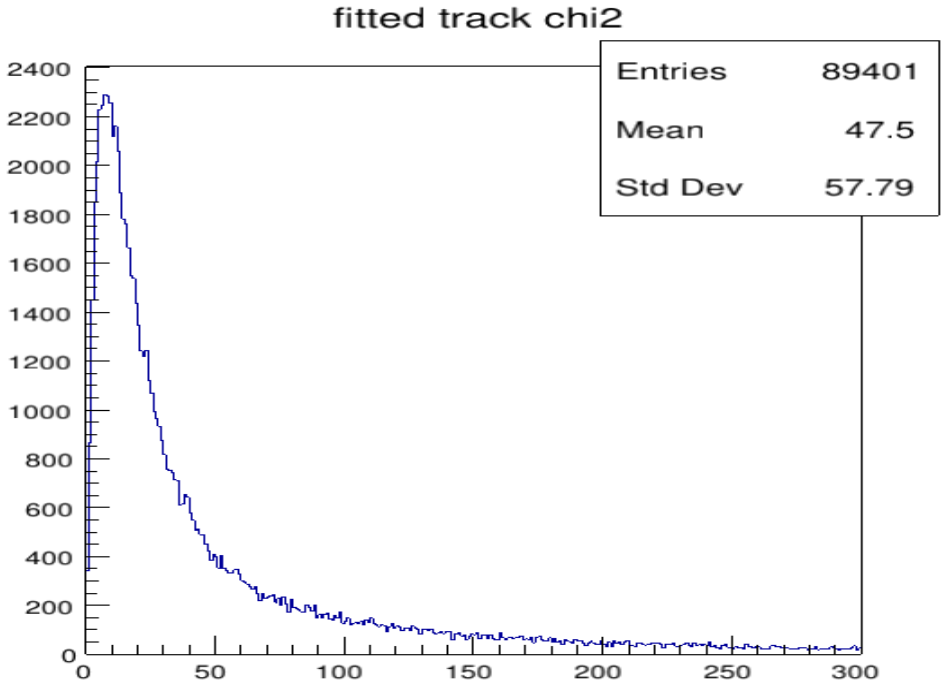
Elements	DeltaX(mm)	DeltaY(mm)	DeltaZ(mm)	RX(rad)	RY(rad)	RZ(rad)
layer1	0.0889837	0.0000000	1.8009692	0.0000000	0.0000000	-0.0092171
layer2	0.0000000	-0.0000000	-0.0000000	0.0000000	0.0000000	0.0000000
layer3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

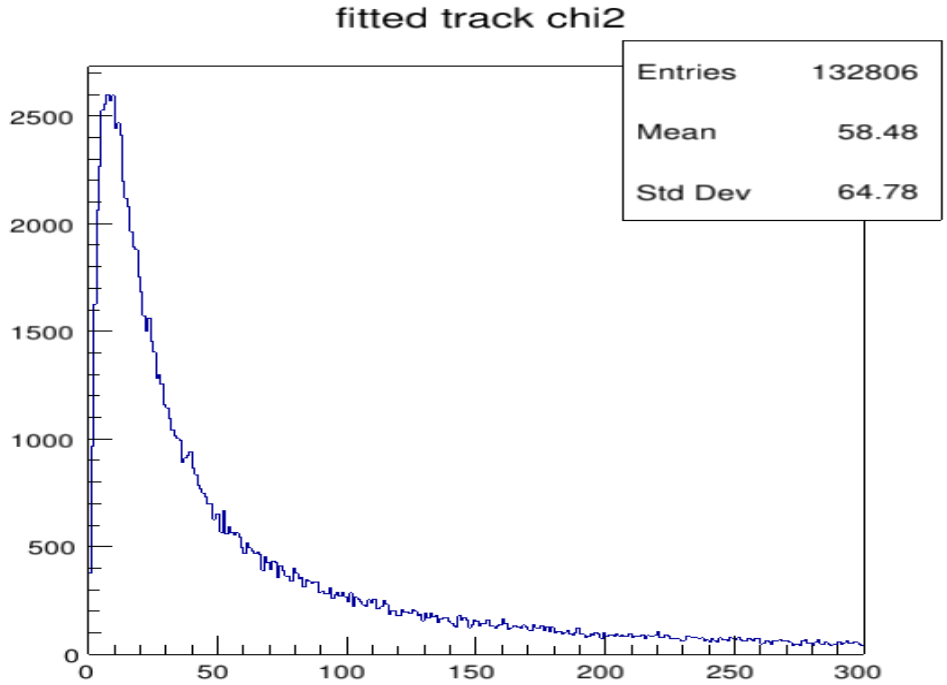
LoopAll

n FITTED track	89401
n not passing E cut	15052
n VALID track (after cuts)	20737

LoopAll + MaxQ

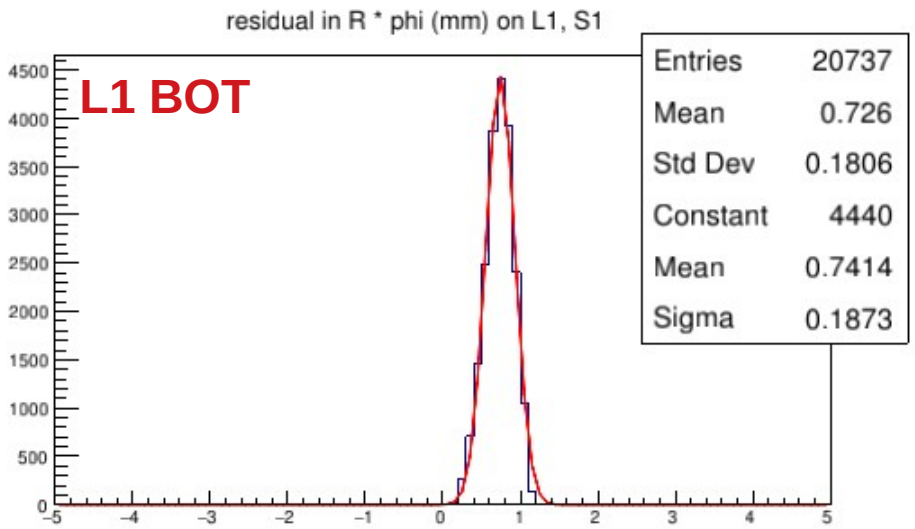
n FITTED track	132806
n not passing E cut	17535
n VALID track (after cuts)	23822

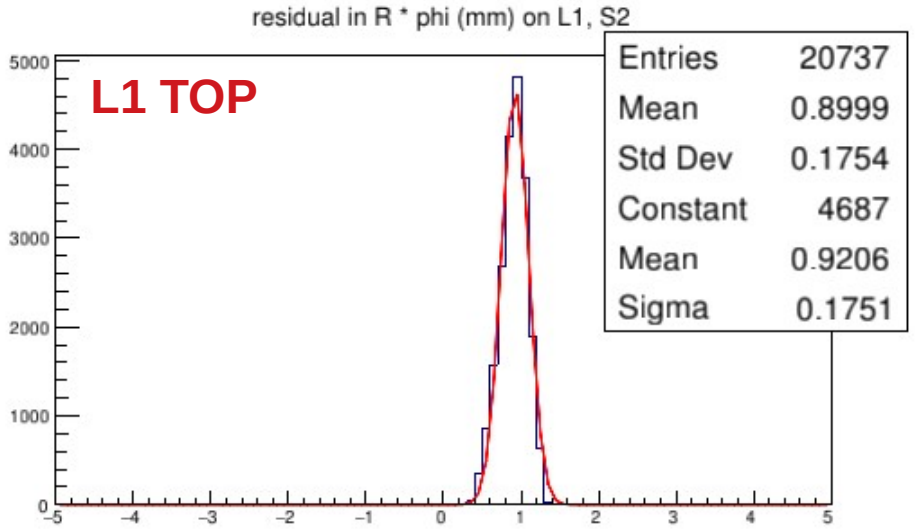


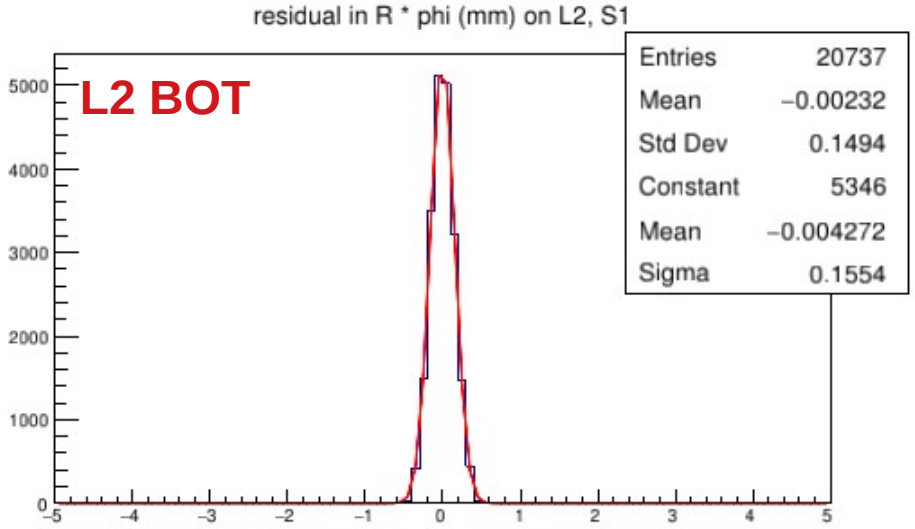


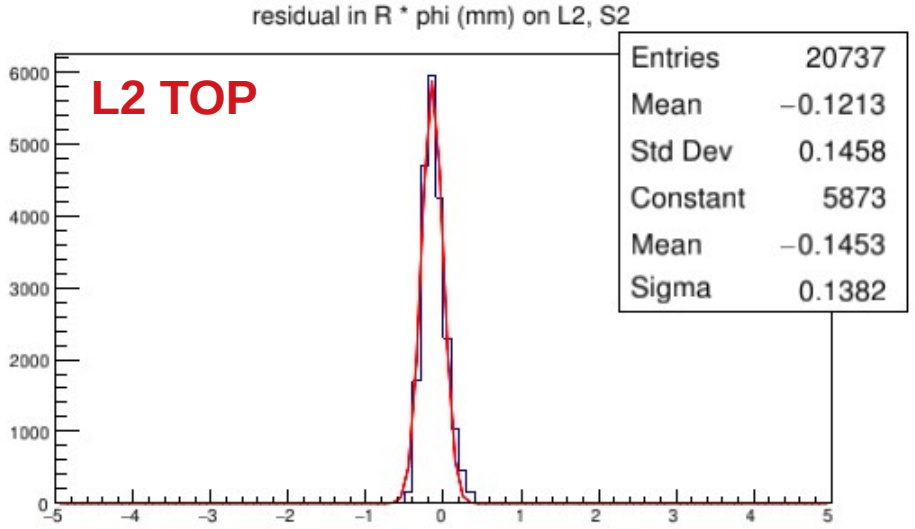
R * phi - LoopAll

- Alignment **on**
- Chi2 cut = 20
- Energy cut on clusters





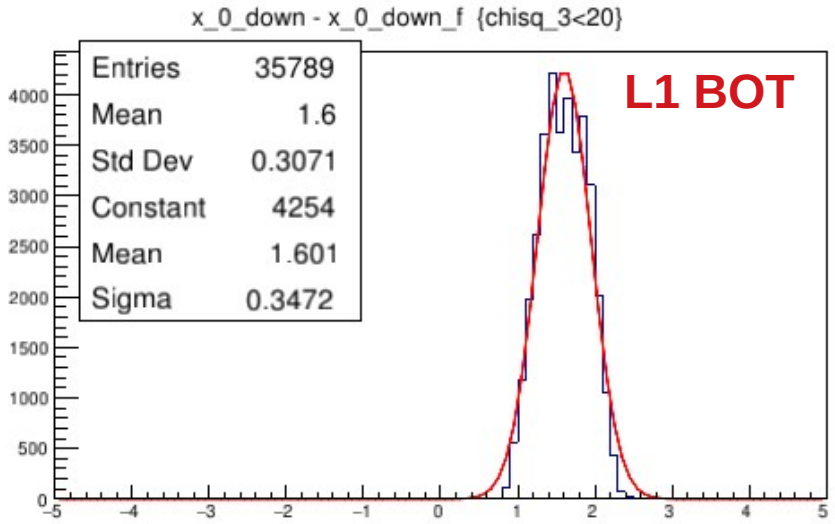


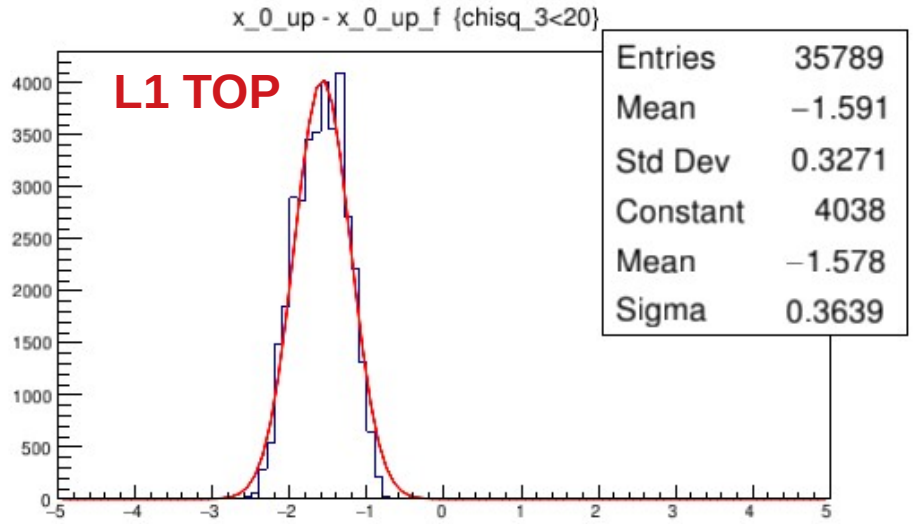


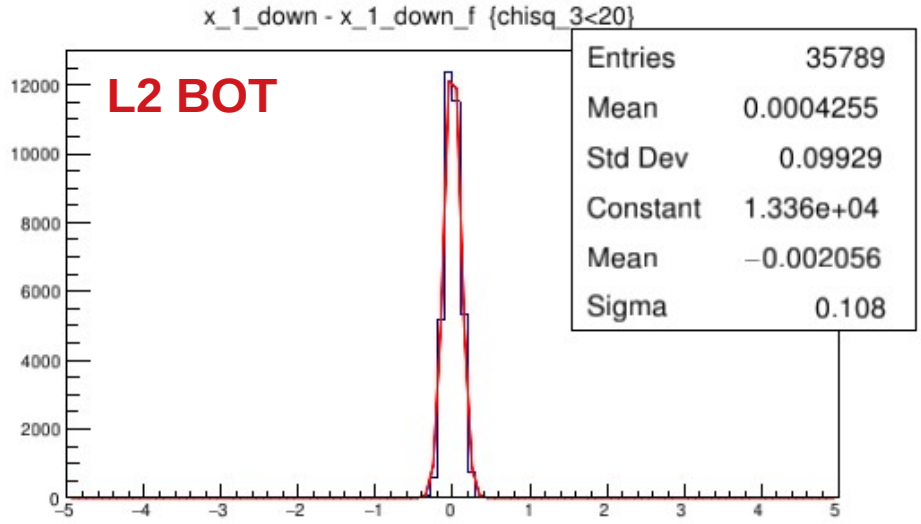
phi – LoopAll ~ HongPeng (?)

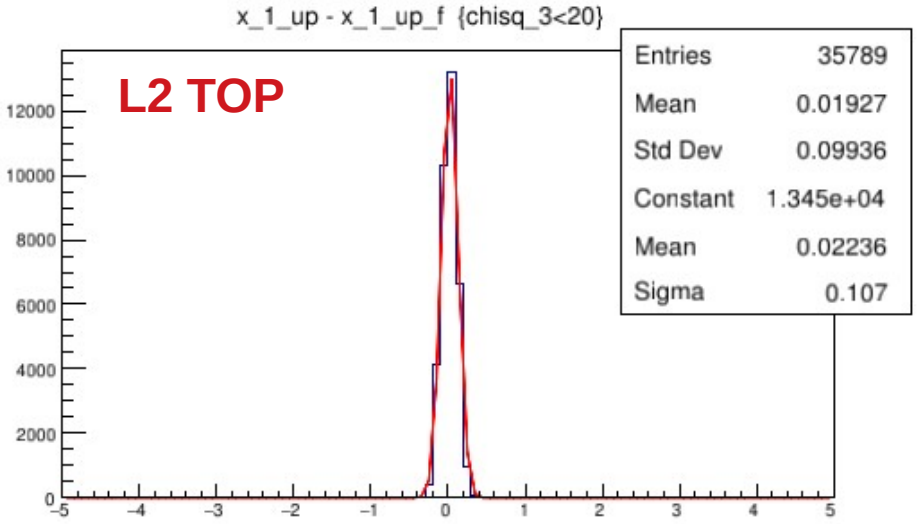
- Alignment **on**
- Chi2 cut = 20
- Energy cut on clusters

x_0_down - x_0_down_f



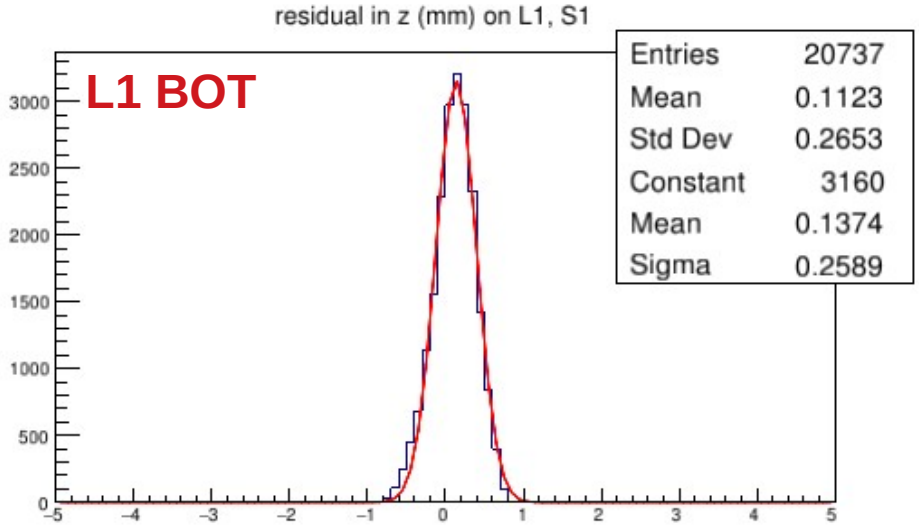


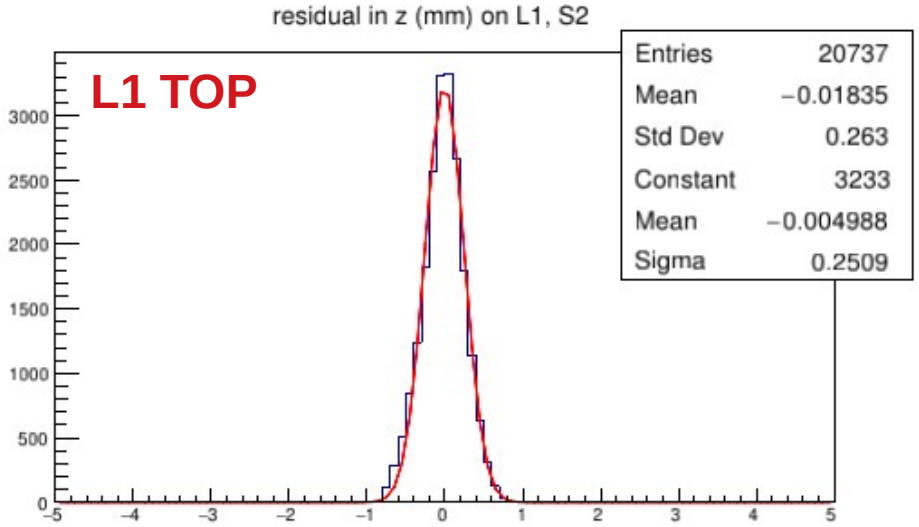


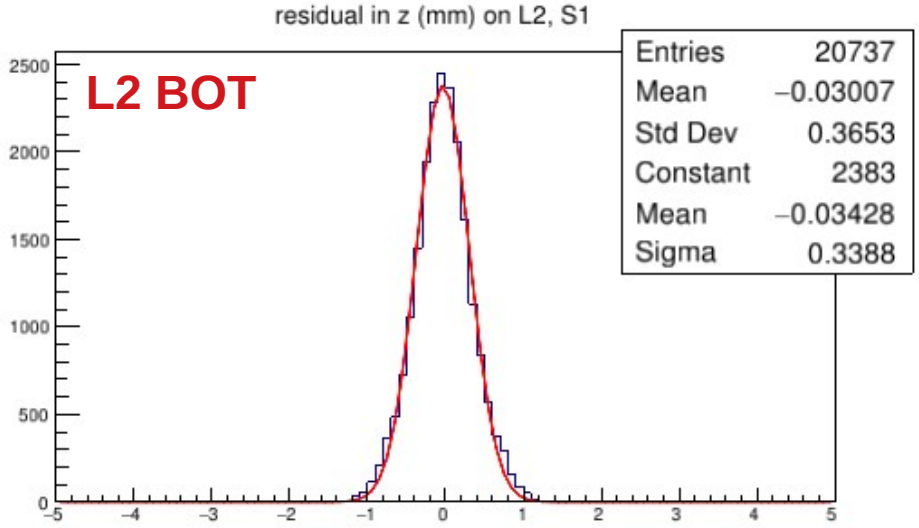


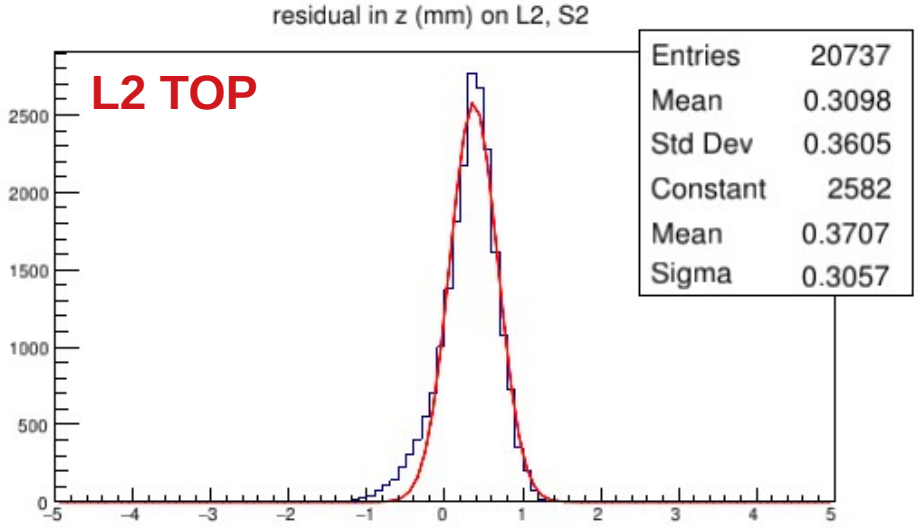
z - LoopAll

- Alignment **on**
- Chi2 cut = 20
- Energy cut on clusters



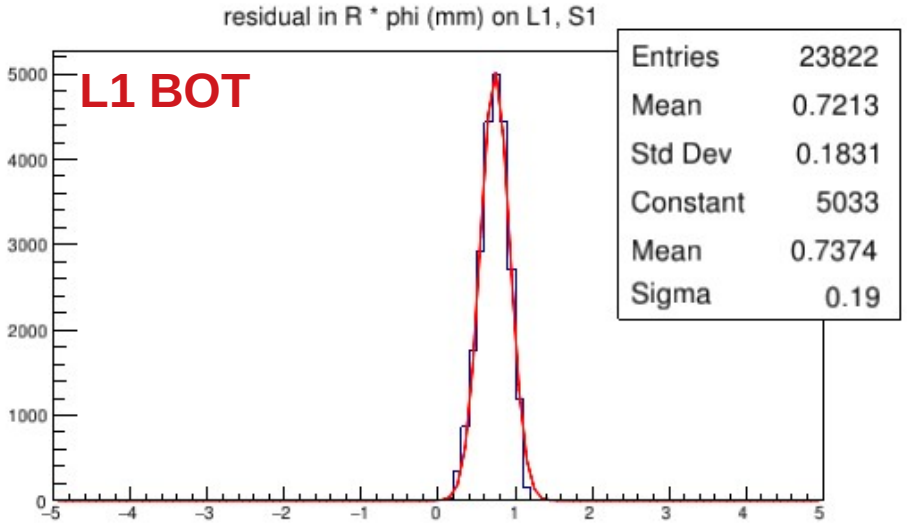


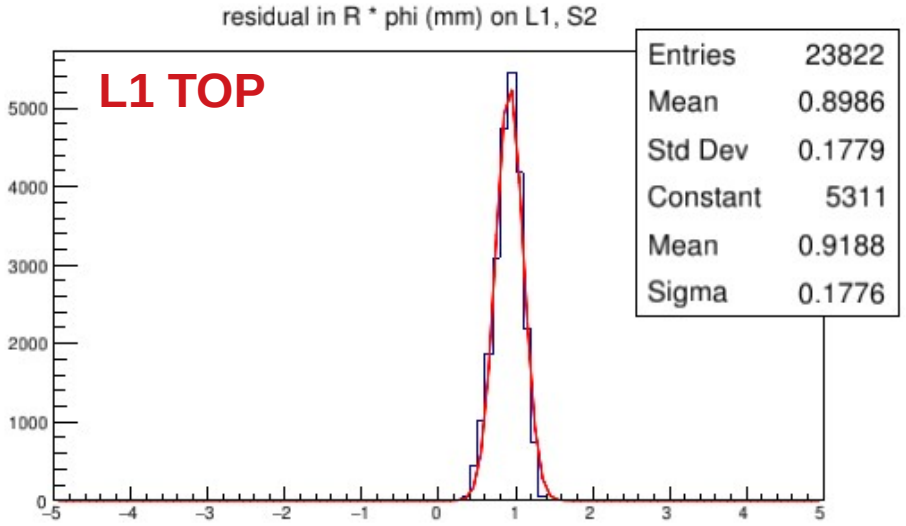


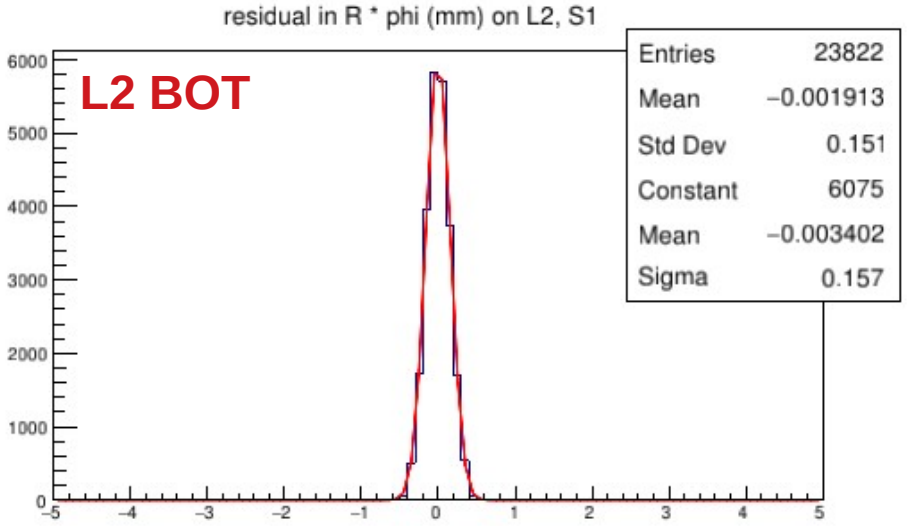


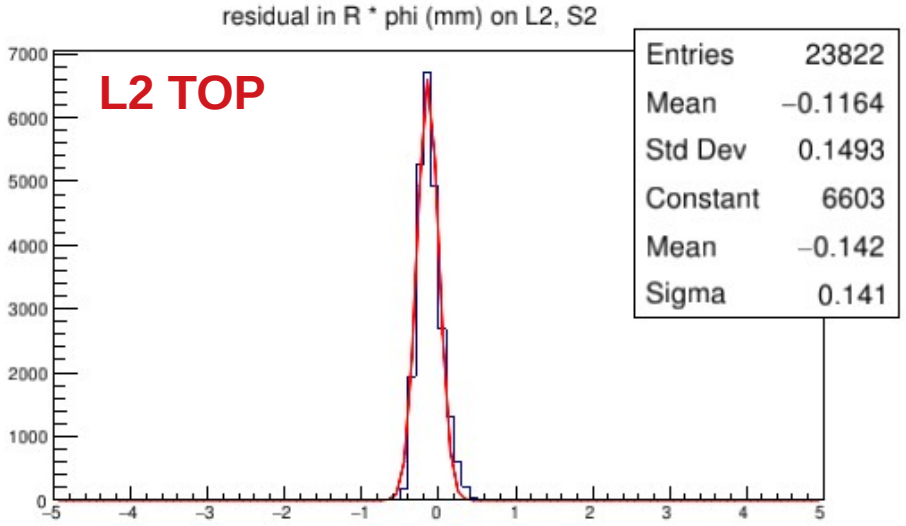
R * phi - LoopAll+MaxQ

- Alignment **on**
- Chi2 cut = 20
- Energy cut on clusters



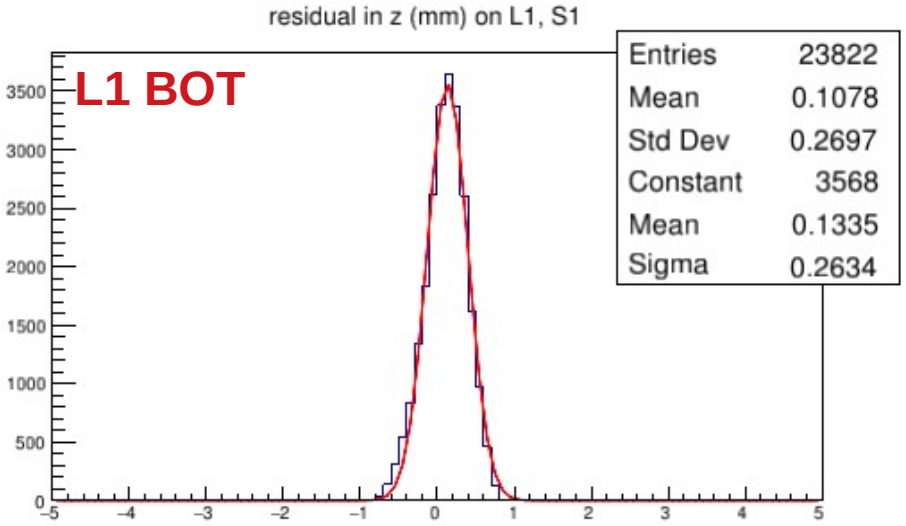


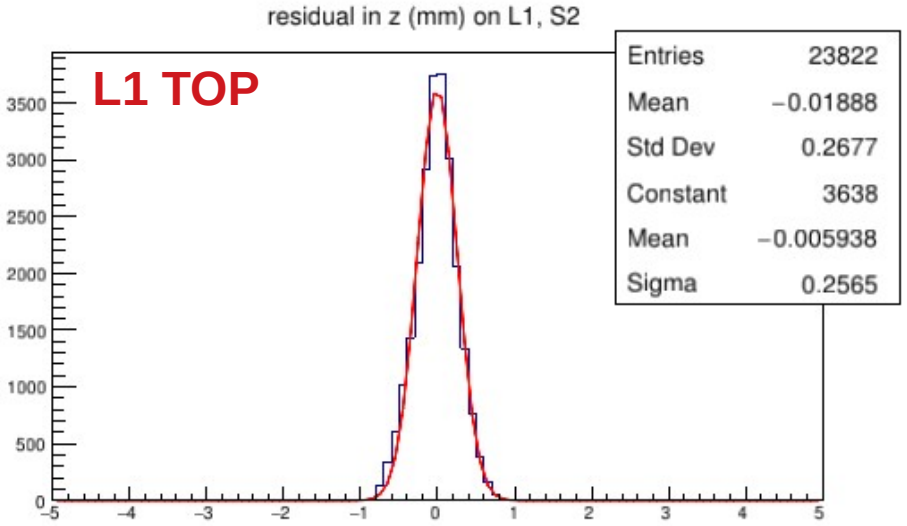


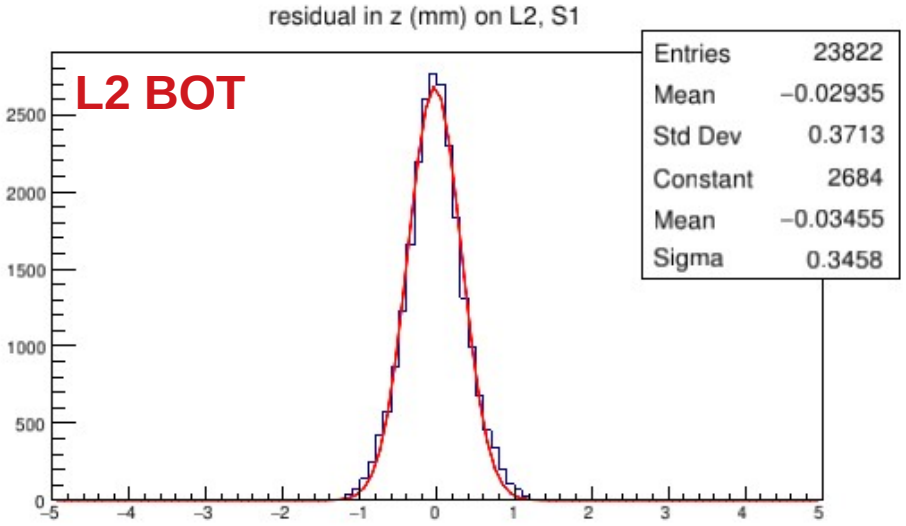


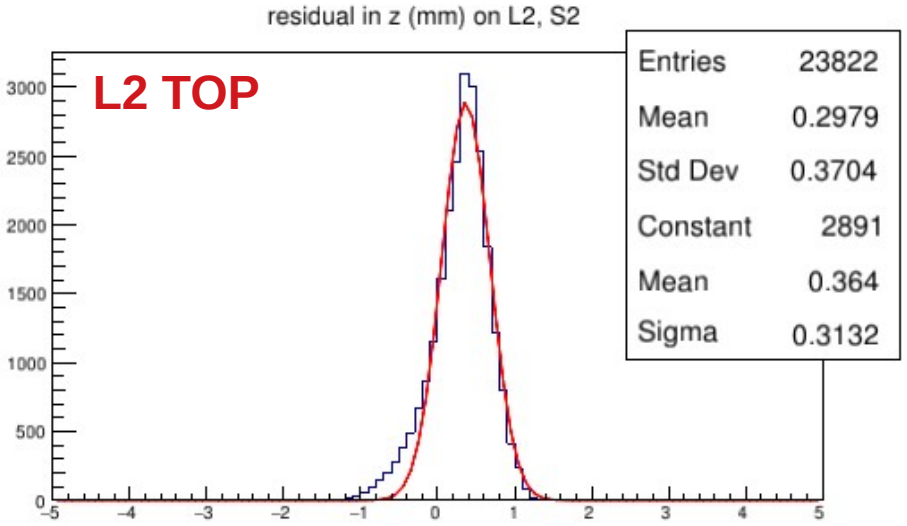
z - LoopAll+MaxQ

- Alignment **on**
- Chi2 cut = 20
- Energy cut on clusters









Conclusions

- uploaded the CgemLineFit-00-00-15 rev. with the fix in CgemCosmicRayQA
- Problem in LoopAll algorithm
- Alignment not taken into consideration properly?
- Can someone independently check the residuals so that we are sure everything is fine please?