Test Beam analysis 2017: results on alignment and tracking

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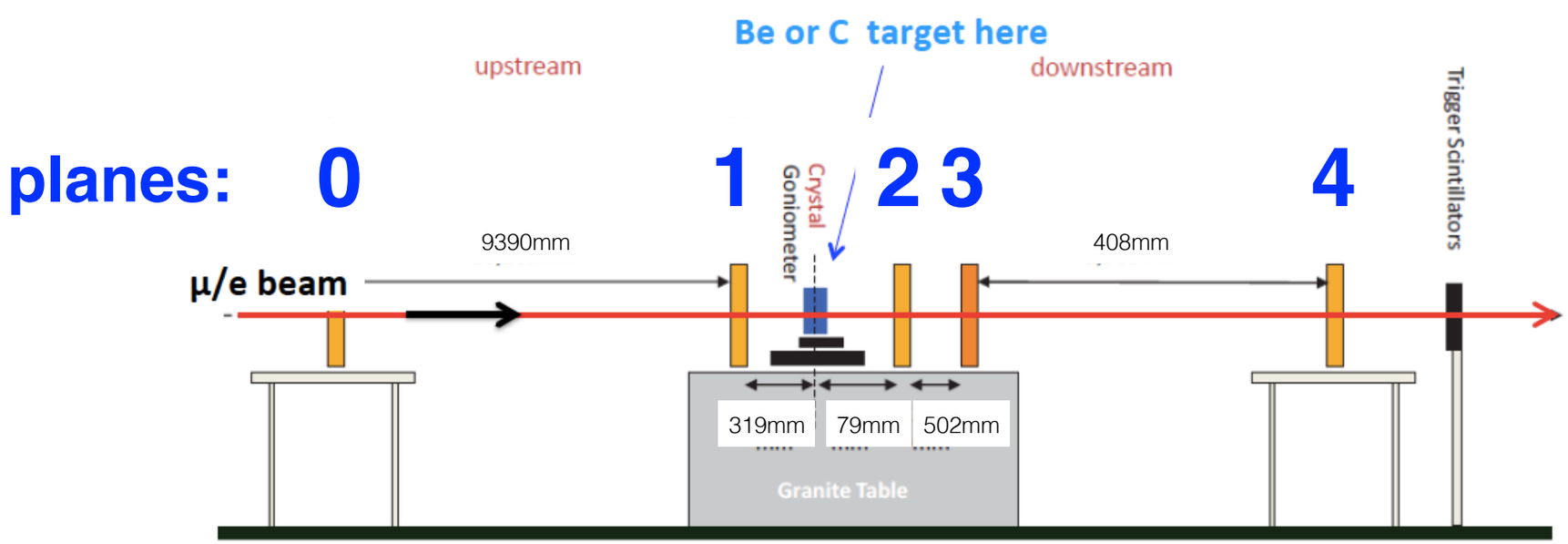
A bit of history…

- First preliminary data we received as “aligned” had some problems of alignment, probably due to change of silicon plane distances respect of UA9 apparatus (in order to improve our acceptance);
- *Clara, Giovanni, Umberto and I* have made independent codes to correct these preliminary data with success;
- finally we decided to ask all **unaligned data** (with all statistics) to prevent any possible problems due to multiple analysis on the same sets;
- next slides will show you main results of our work on these **unaligned runs** and then tracking of electron runs;
- then *Graziano* shows some results about comparison data / MC, obtained in collaboration with *Fedor Ignatov*.

Summary of alignment procedure

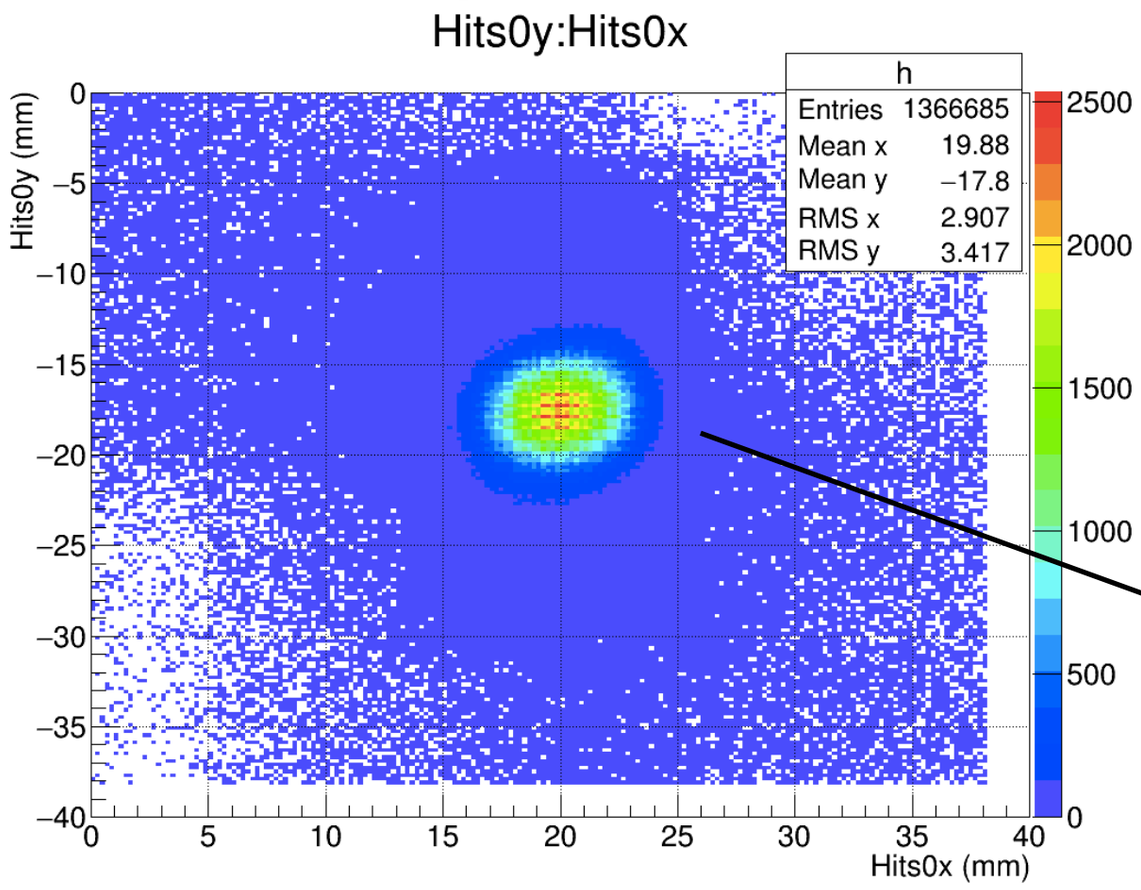
- To align electron runs, we analyzed the pion ones: with our high energy pions (180 GeV), we are confident they tell us what alignment problems test beam have got.
- We've made an **iterative alignment**, first it corrects silicon planes translations and then the relative rotations between them and so on.
- To do so, as you will see, planes 0 and 1 acts as a reference planes.



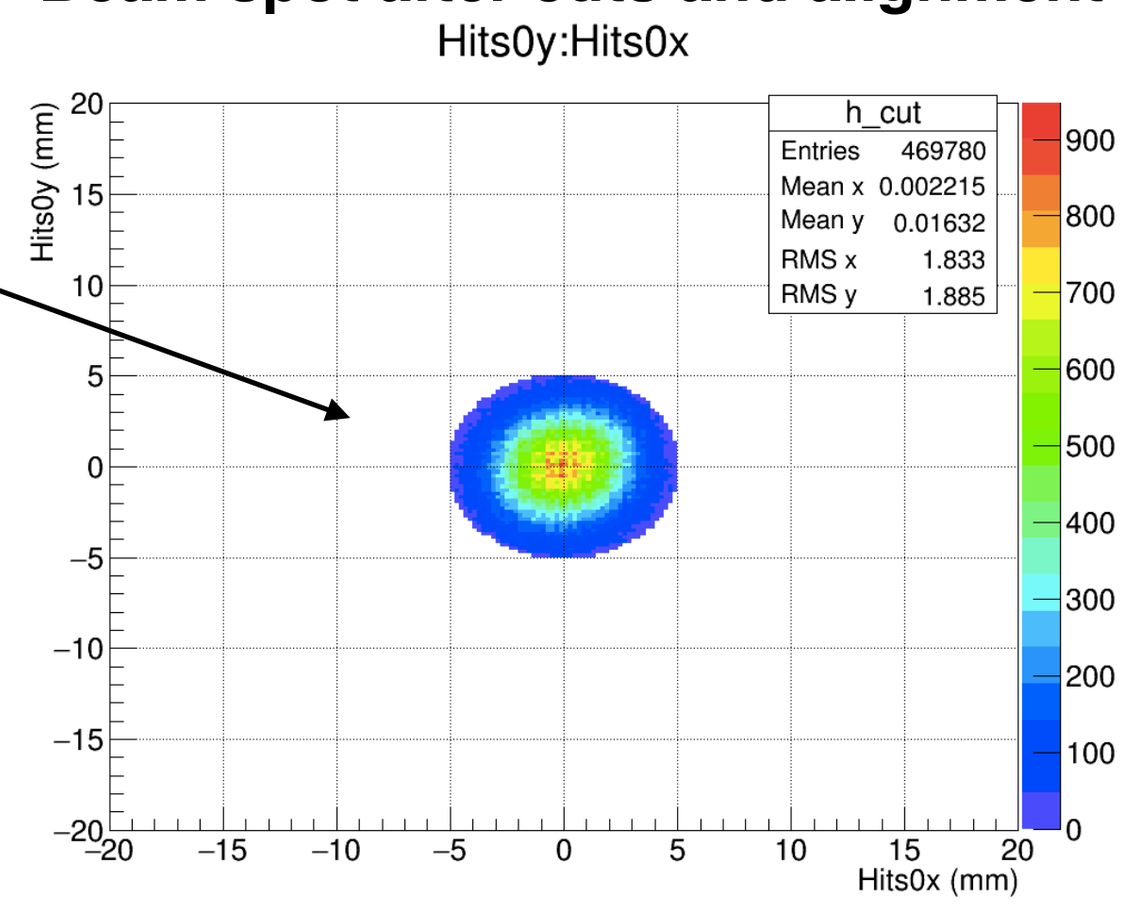
Work on pion runs: reference frame

- **First**, we select single multiplicity and a circle around beam spot: so transform hits 0 and 1 in the global frame and control hits 1 for rotations. Hits 0 and 1 are reference frame to align planes 2, 3 and 4 (they will be “downstream planes”).

Beam spot before cuts



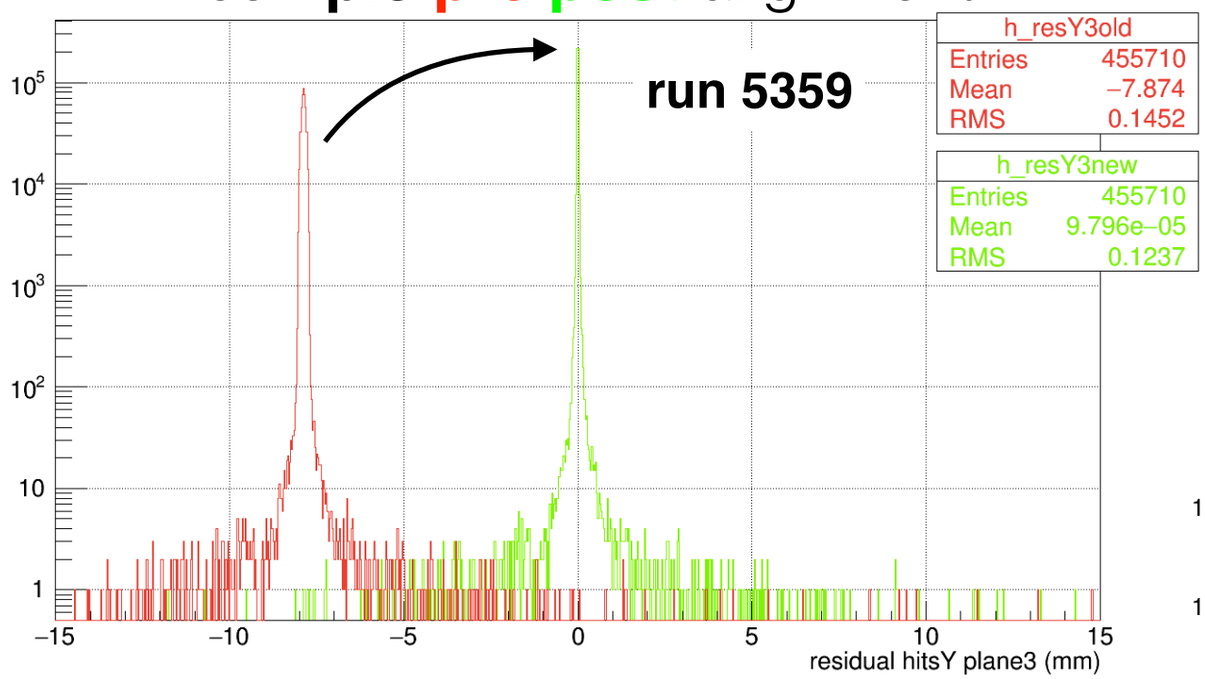
Beam spot after cuts and alignment



Work on pion runs: translations of planes 2, 3, 4

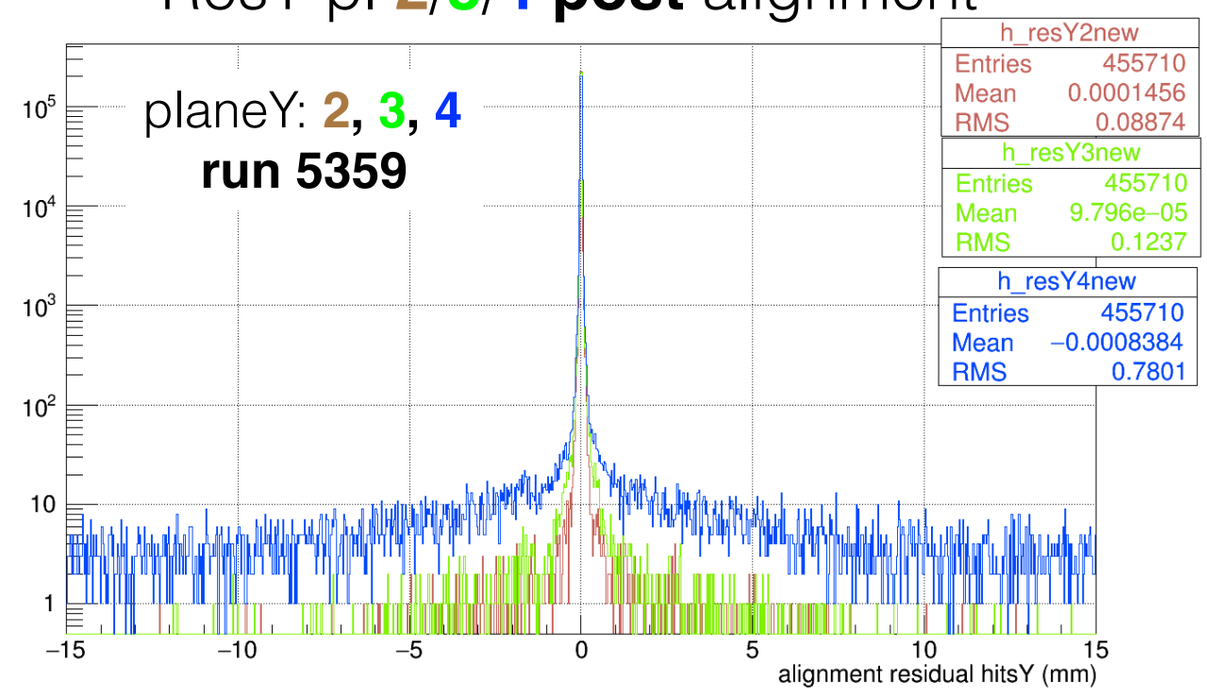
- **Second**, we check residuals of straight lines (for 0 and 1) on the planes 2, 3 and 4 and correct them for residual means (residuals: hits - line extrapolation on planes).

ResY **pl3 pre/post** alignment



mean pre-alignment: ~ -7.9 mm

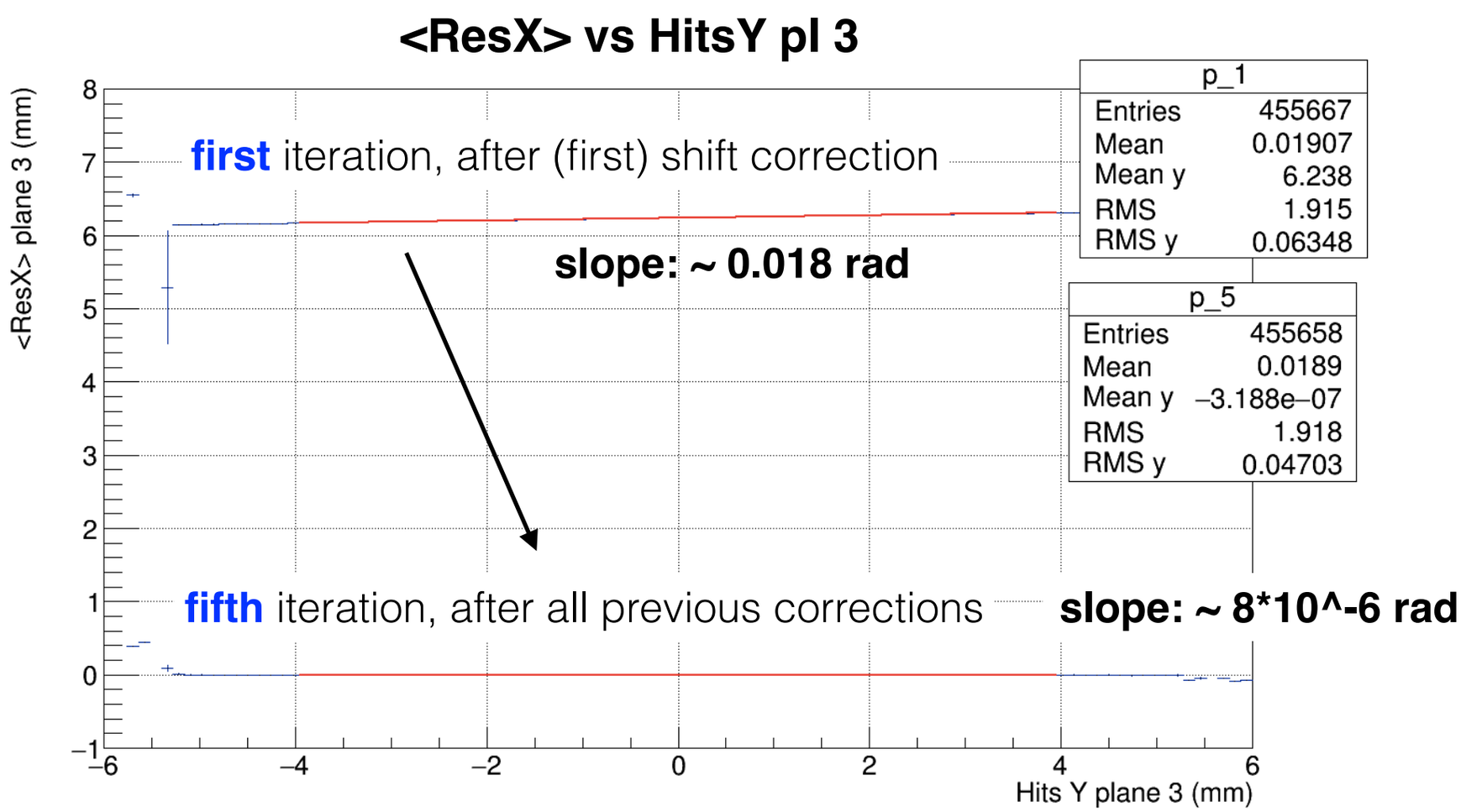
ResY pl **2/3/4 post** alignment



mean gaus cores < 0.1 micron
sigma gaus cores: **~ 9, 11, 13** micron

Work on pion runs: rotations of planes 2, 3, 4

- **Third**, check possible rotations of planes transverse to beam line, using correlations between residuals X (or Y) vs hits Y (or X). Then, we check corresponding alignment of hits plane 1, using a fit for 0, 2, 3 and 4.

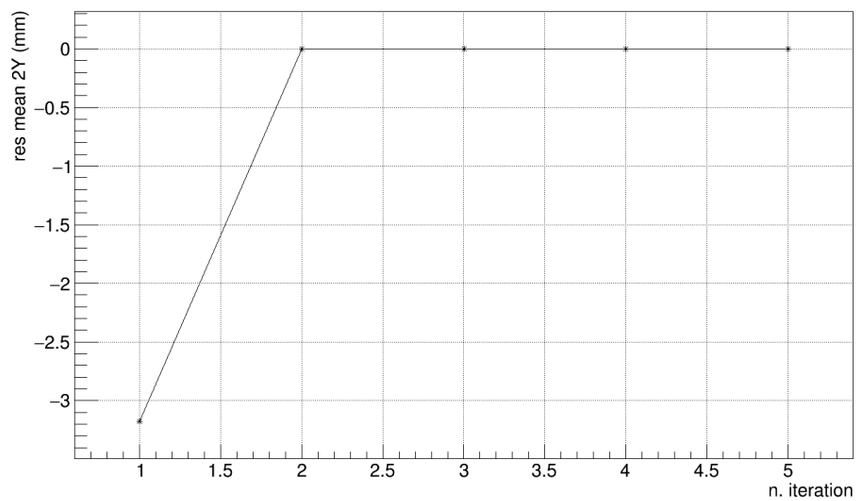


- Applied independent rotations for X and Y, for each planes: an open question.

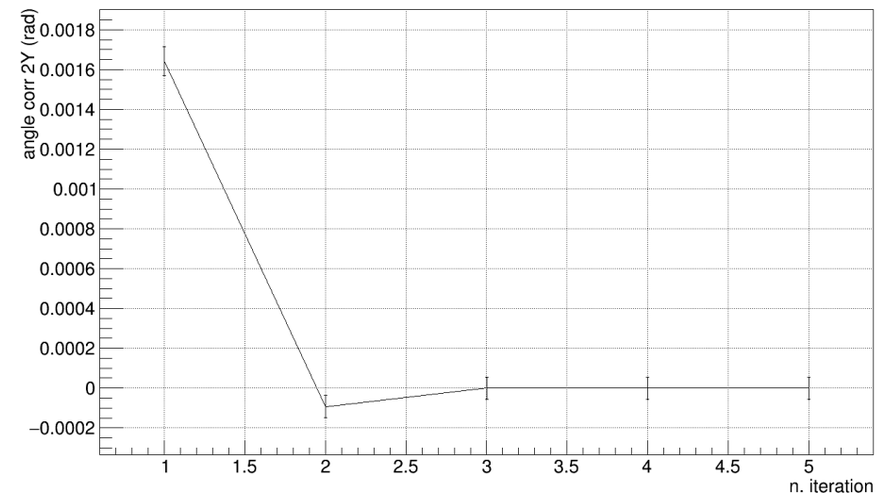
Work on pion runs: final correction constants

- We extract correction constants for all pion runs and check trends with iterations and time. These constants will align relative electron runs.

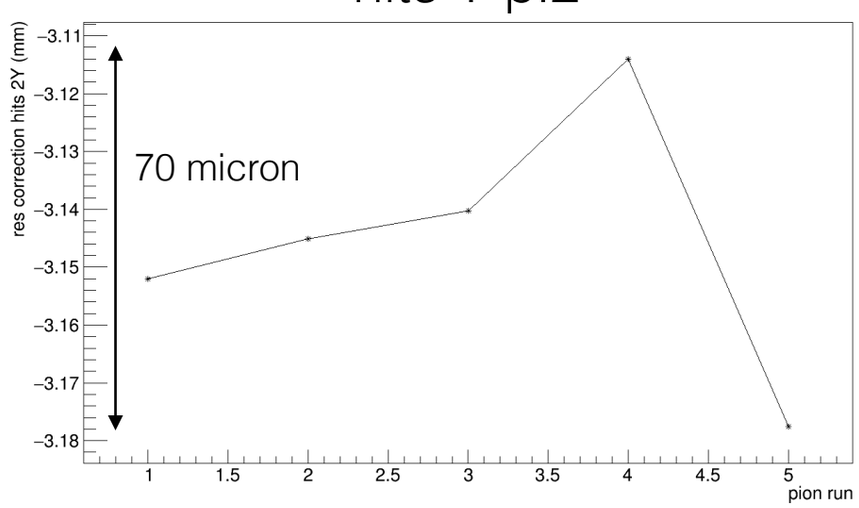
residual mean vs iterations
pion run 5359 hits Y pl2



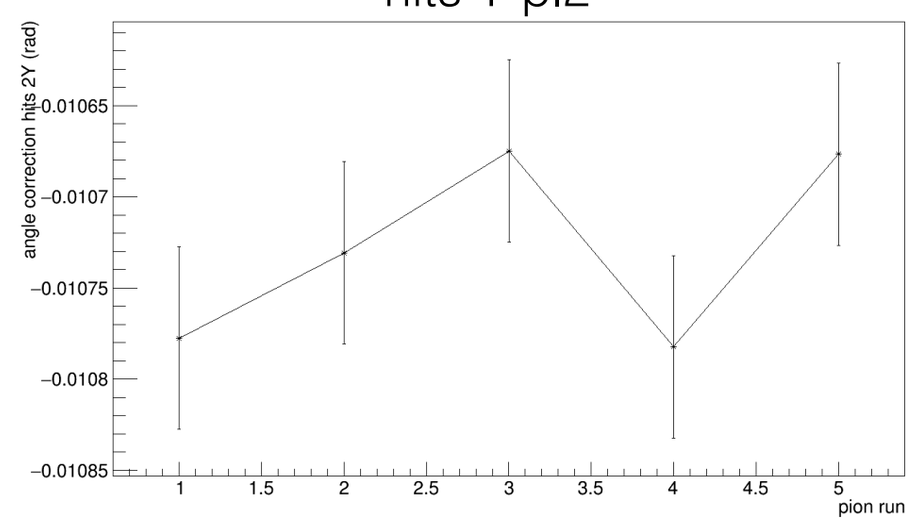
angle correction vs iterations
pion run 5359 hits Y pl2



residual mean vs pion run
hits Y pl2



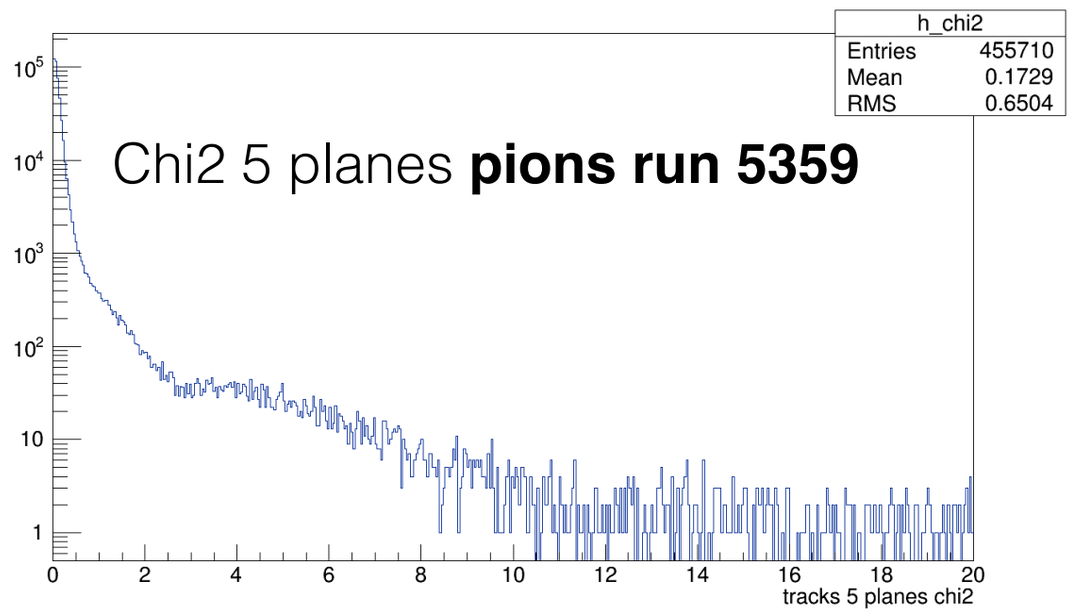
angle correction vs pion run
hits Y pl2



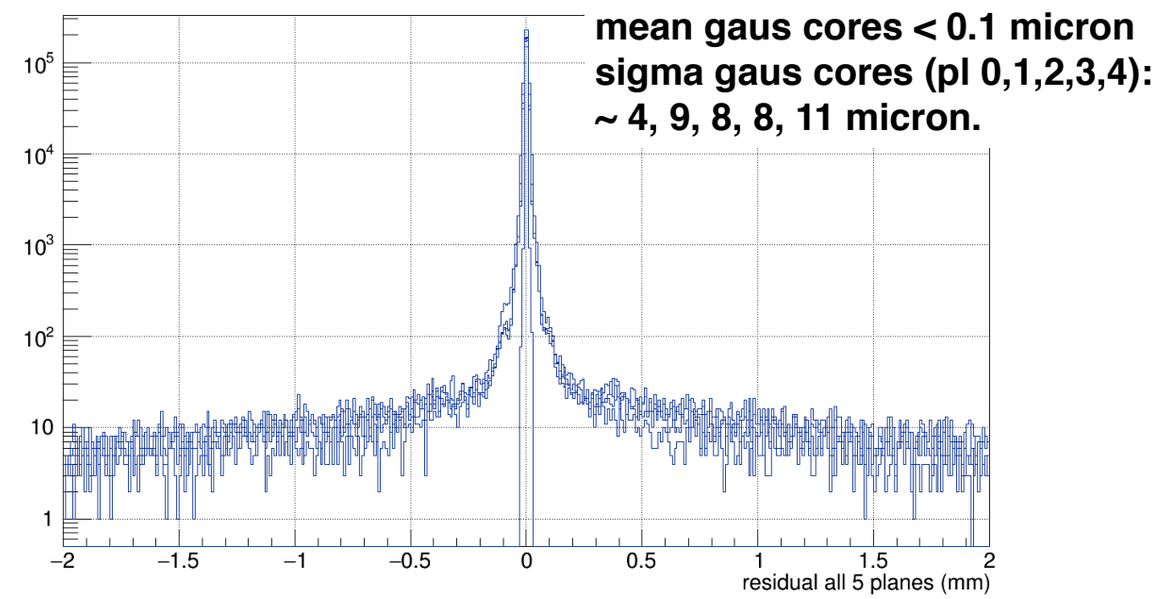
pion run (1=5303, 2=5310, 3=5316, 4=5356, 5=5359)

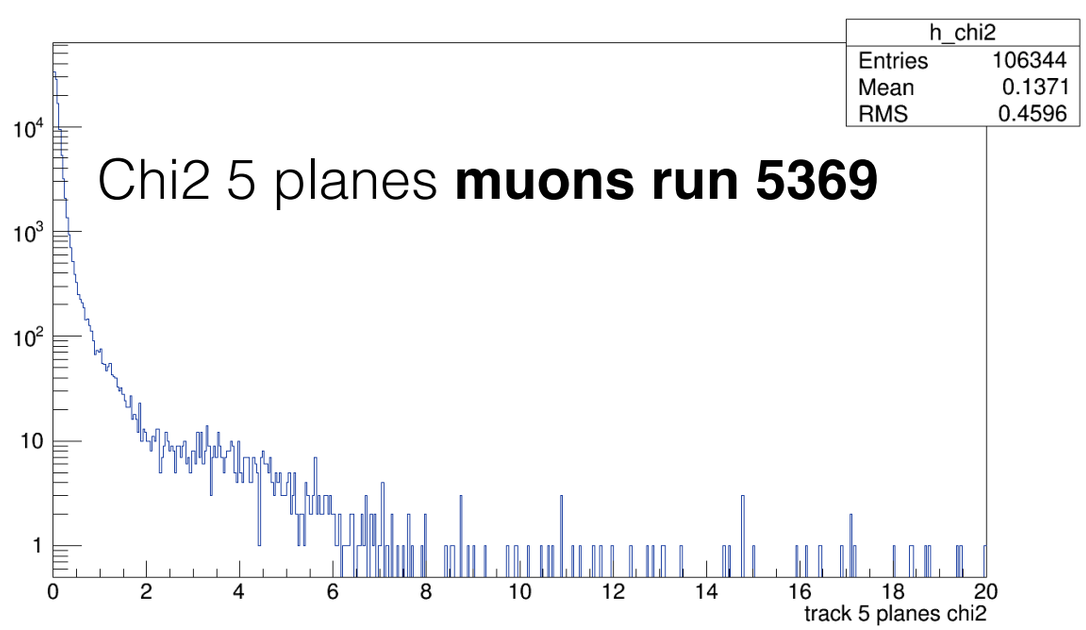
Work on pion runs: alignment quality

- Using a fit for all planes, after alignment, we evaluate potential problems on planes. We're working also on **muon** runs (without target) to compare **pions / muons** and exclude possible background due to pions activity: needs more work on it.

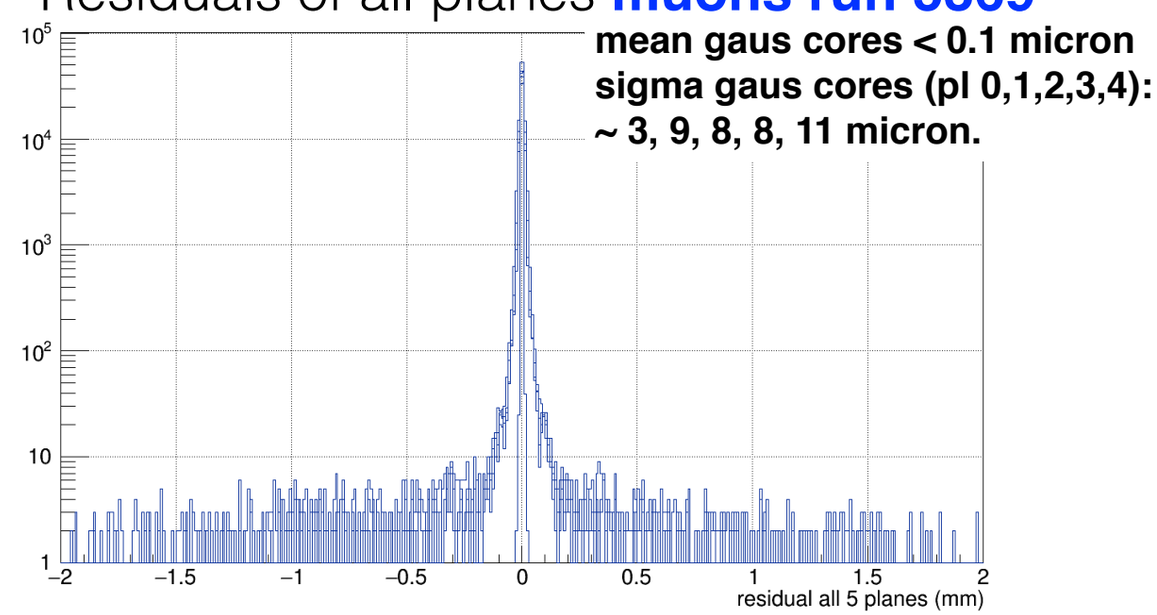


Residuals of all planes **pions run 5359**





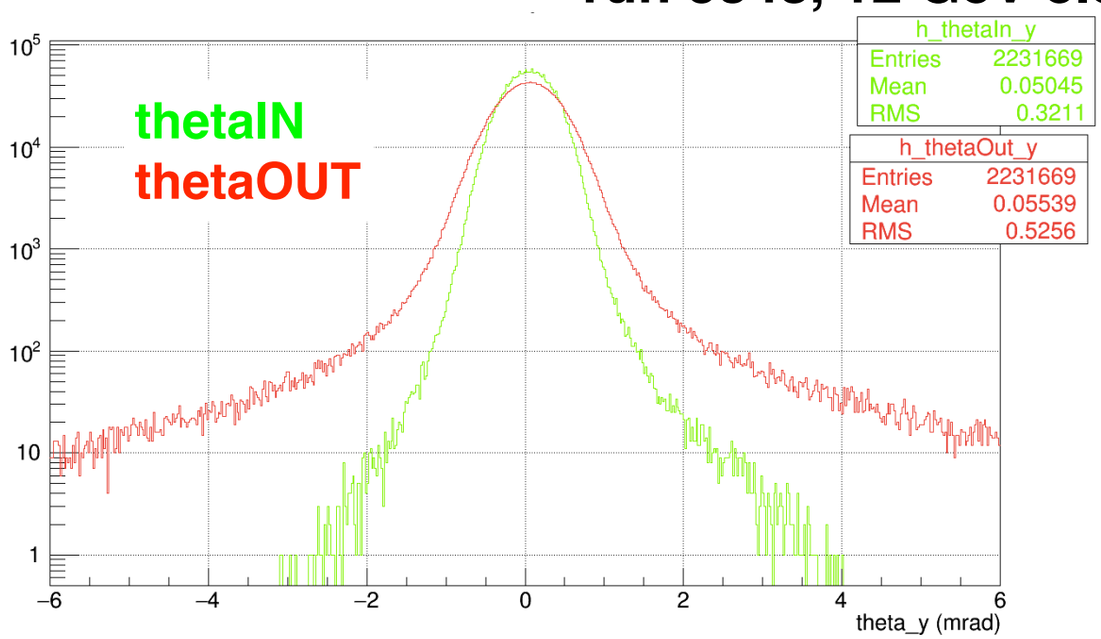
Residuals of all planes **muons run 5369**

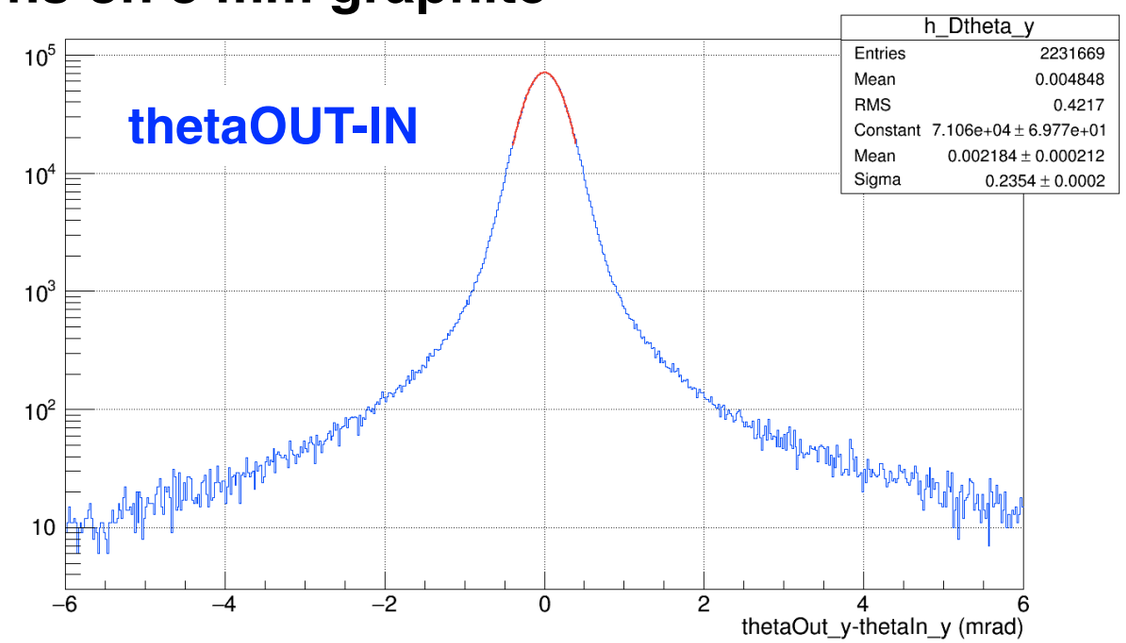


Tracking of electron runs with target

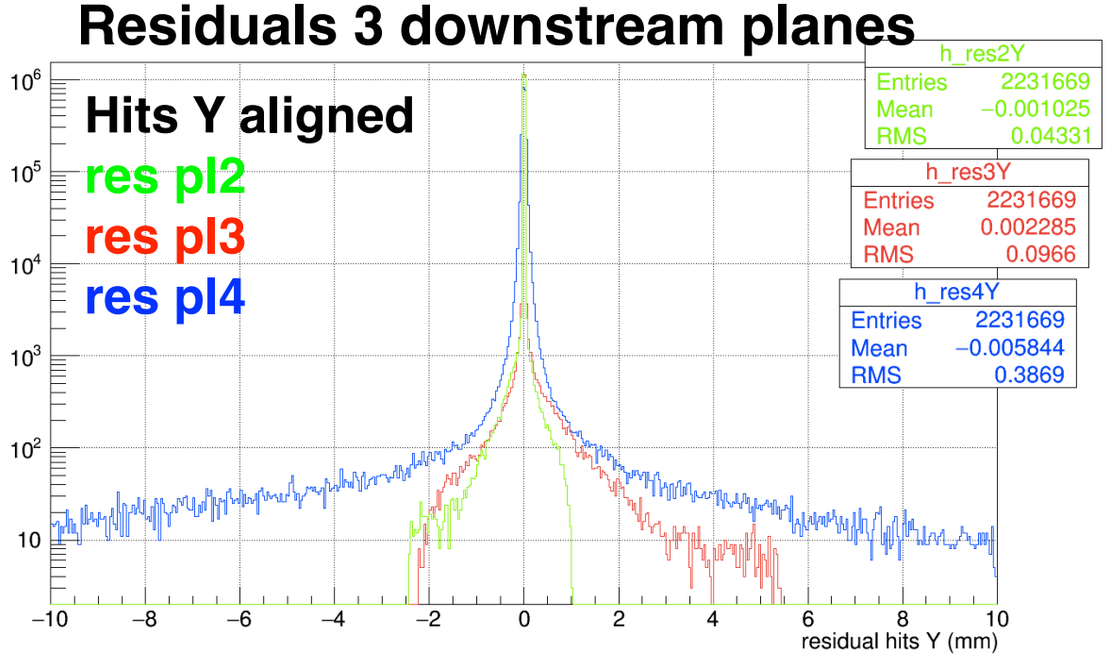
- Each electron runs was aligned with closest pion run and then single tracks (single molteplicity per plane) is reconstructed.

run 5348, 12 GeV electrons on 8 mm graphite





Residuals 3 downstream planes

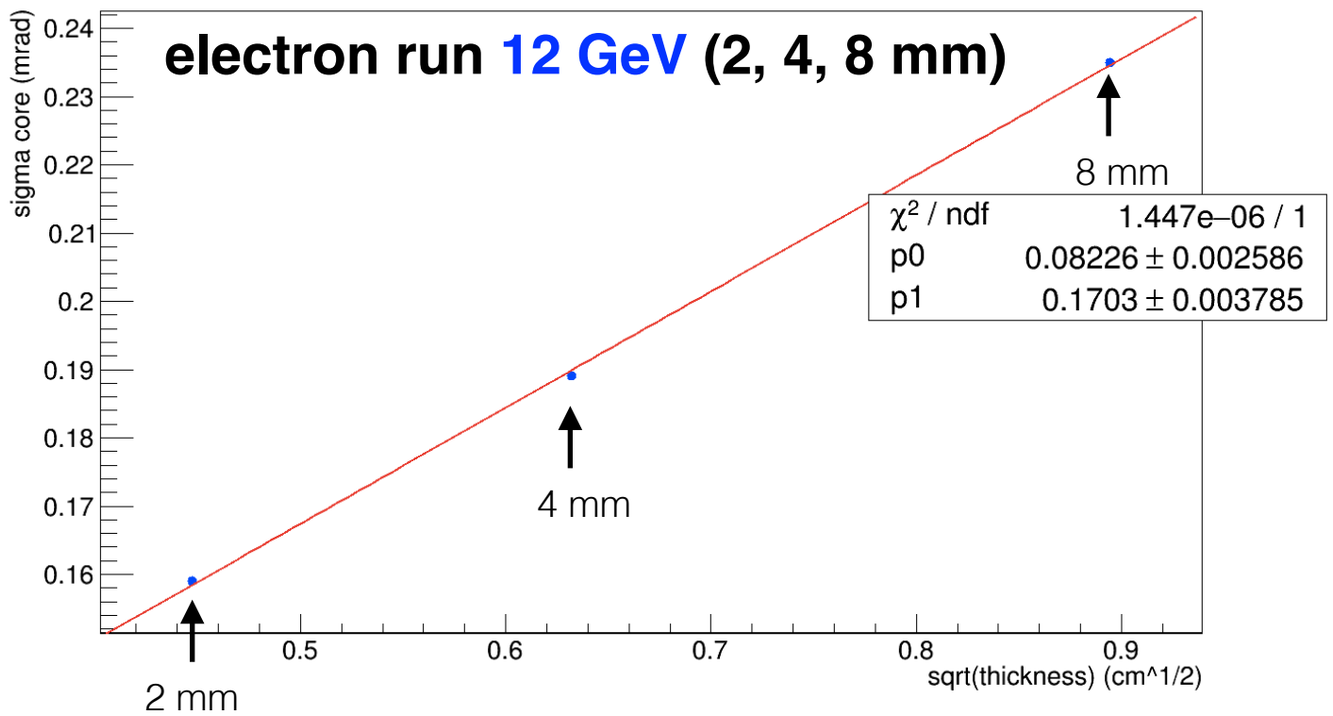


Residual fit downstream planes

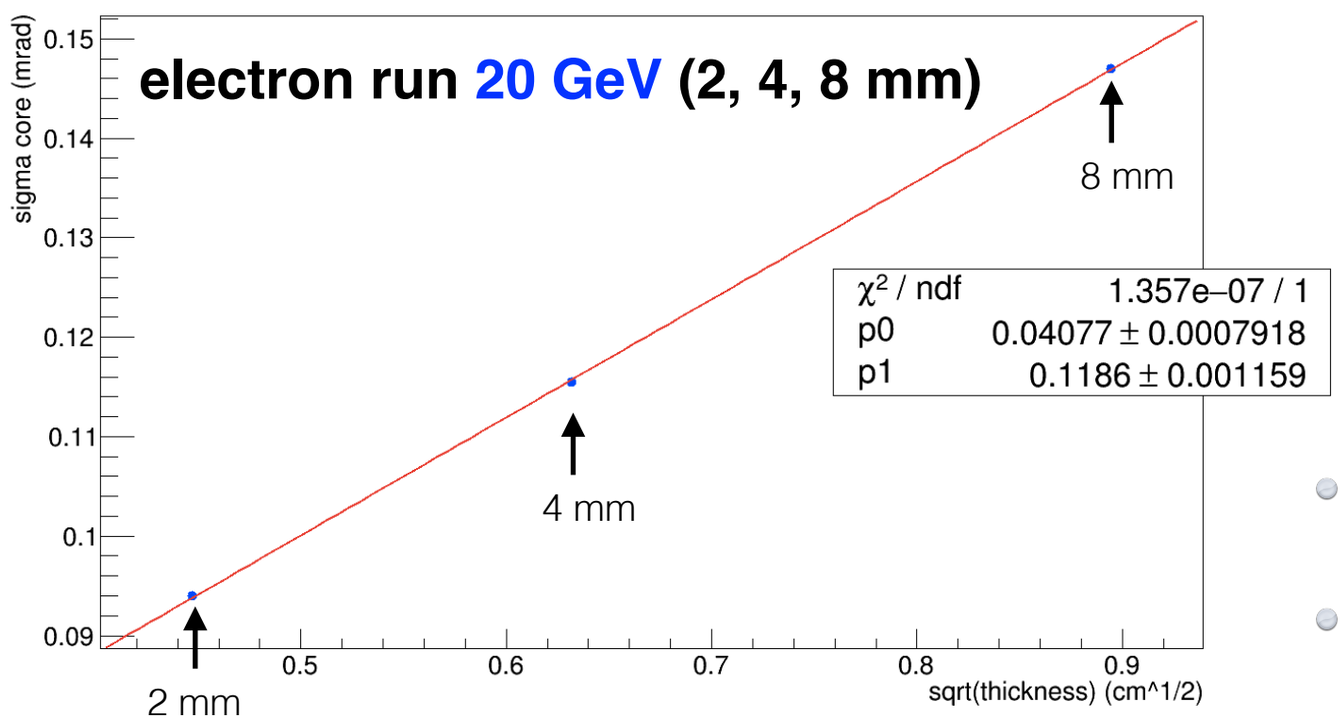
mean gaus cores < 1 micron

sigma gaus cores: ~ **3.7**, **4.4**, **32.3** micron

Sigma core thetaOUT - IN vs sqrt(thickness) graphite



run 5333,34: 12 GeV 2 mm
run 5341: 12 GeV 4 mm
run 5348: 12 GeV 8 mm



run 5311,12,13,14,15: 20 GeV 2 mm
run 5344: 20 GeV 4 mm
run 5352: 20 GeV 8 mm

- Dependence almost linear, as we expected from Highland-Moliere formula.
- Note energy scaling.

Backup slides

Correction constants for pion run 5359

Alignment planes 0 / 1:

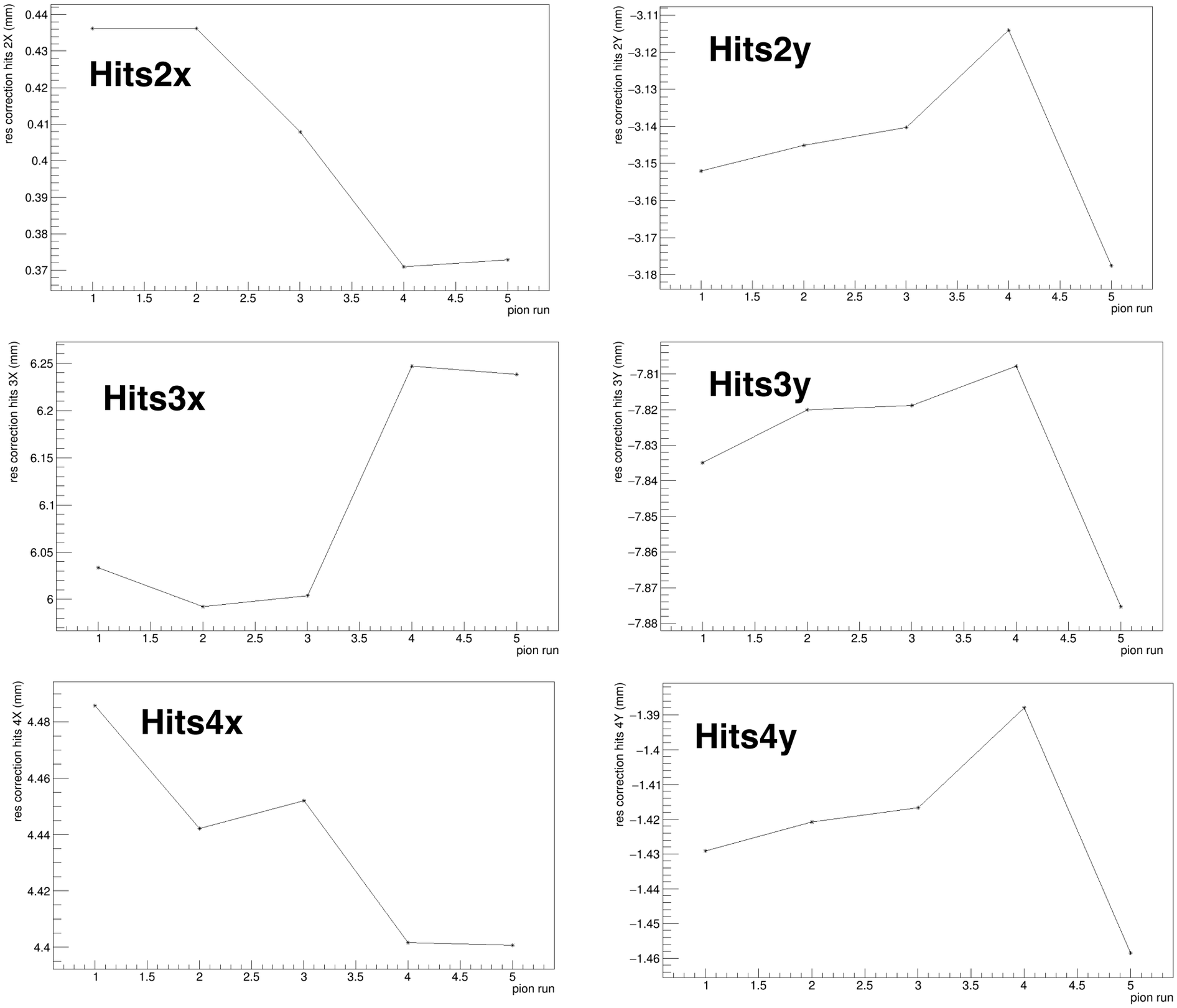
offset0x: 19.6954 mm
offset0y: -17.8893 mm
offset1x: 19.1668 mm
offset1y: -19.481 mm

Alignment 2 / 3 / 4:

Residuals:
sum_res X (mm): 0.372898 6.23836 4.40069 (+offset0x)
sum_res Y (mm): -3.17753 -7.87527 -1.45845 (+offset0y)

Angles:
sum_angle X (rad): 0.00437897 0.0229213 0.0105303
sum_angle Y (rad): 0.00154973 -0.0171097 0.00672341

Residual corrections (mm) vs pion run



Angle corrections (rad) vs pion run