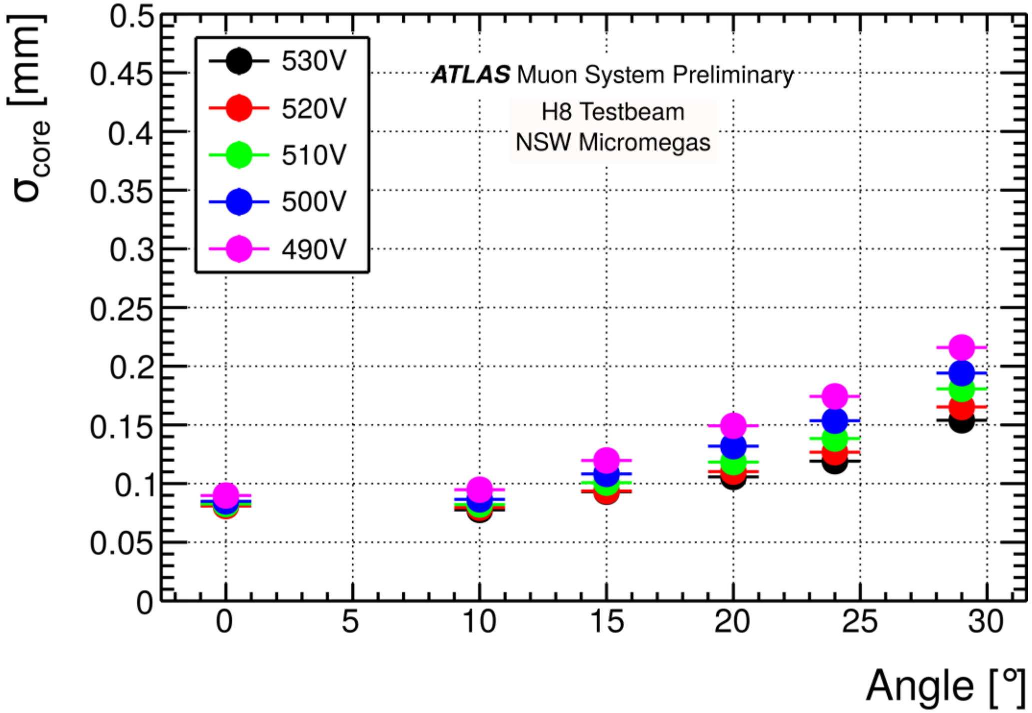
NSW Micromegas Resolution Studies

LMU

LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

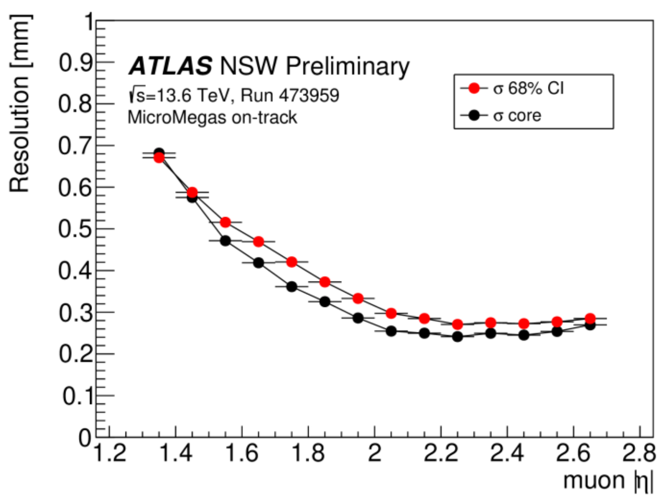
What do we want?

NSW MM Testbeam 2024 results



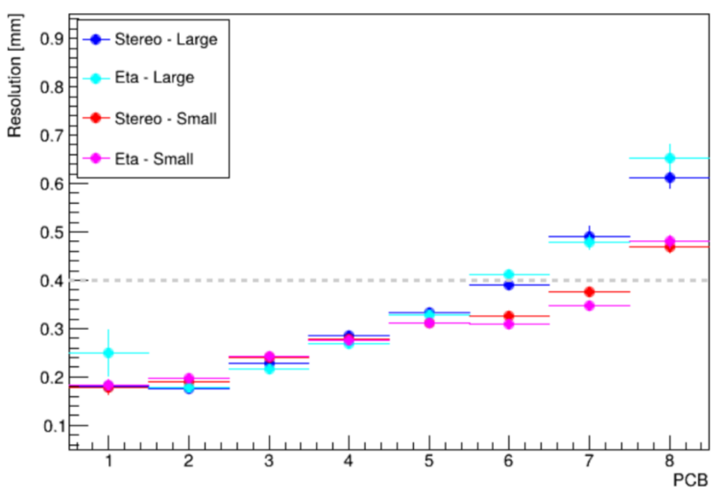
What are the current results?

Centroid Resolution
with Toroid On



ATL-COM-MUON-2024-011

Clustertime Corrected
Resolution +
Alignment Corrections
+ Toroid Off



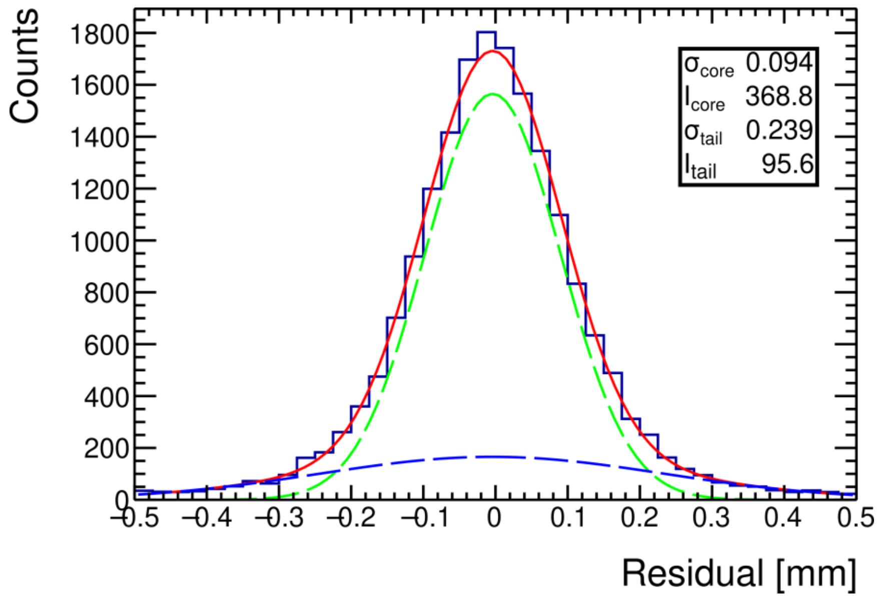
Romano Orlandini,
https://indico.cern.ch/event/1452292/contributions/6203512/attachments/2956854/5199583/QT_presentation_29_10_24.pdf

180 – 500 µm for Eta - Small

Intermezzo – Residual, Resolution (core, weighted), 68% CL

$\text{Residual} = \text{Pos}_{\text{Detector}} - \text{Pos}_{\text{Track}}$

$\text{Pos}_{\text{Detector}}$ = Reconstructed Position in the detector
$\text{Pos}_{\text{Track}}$ = Inter-/Extrapolated position in detector plane, given by reference system



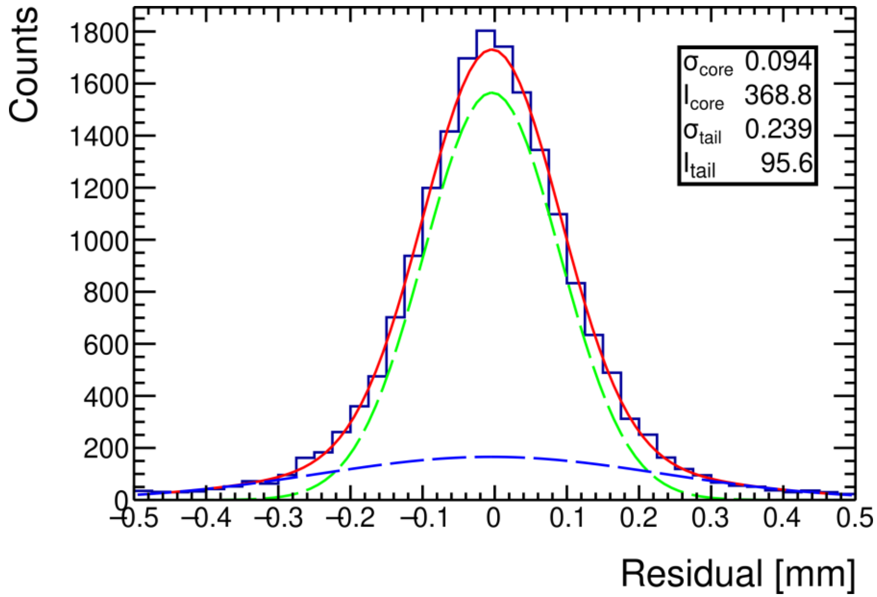
σ_{Core} = Width of the narrow gaussian (green) of a double-gaussian fit (red)
σ_{Weighted} = Integral weighted convolution of narrow (green) and broad (blue) Gauss:

$$\sigma_{\text{Weighted}} = (I_{\text{Core}} * \sigma_{\text{Core}} + I_{\text{Tail}} * \sigma_{\text{Tail}})/(I_{\text{Core}} + I_{\text{Tail}})$$

Intermezzo – Residual, Resolution (core, weighted), 68% CL

68% Confidence Limit:

Alessandra Betti Definition



- Fit with double Gaussian in range [Mean – 3* RMS, Mean + 3* RMS]
- Integral of double Gaussian in that range is total value N_{Total}
- Starting from the center of the Gaussian, increase the width by 1 µm, i.e. $N_{Current}$ = Integral [Mean – n * 1 µm, Mean + n * 1 µm]
- If $N_{Current}$ >= 0.683 * N_{Total} → σ_{68CL} = n * 1 µm

What do I have to play around?

Currently I am using 2023 Toroid OFF data to compare to Testbeam results. Sparse documentation what the parameters (branches) in the ROOT trees are:

```
*............................................................................
*Br  706 :trig_L1_roiNumber : vector<int>
*Entries :     5000 : Total  Size=     109647 bytes  File Size  =
*Baskets :        4 : Basket Size=      40448 bytes  Compression=
*............................................................................
*Br  707 :trig_L1_sectorAddress : vector<int>
*Entries :     5000 : Total  Size=     109687 bytes  File Size  =
*Baskets :        4 : Basket Size=      40448 bytes  Compression=
*............................................................................
*Br  708 :trig_L1_source : vector<short>
*Entries :     5000 : Total  Size=      90381 bytes  File Size  =
*Baskets :        4 : Basket Size=      34816 bytes  Compression=
*............................................................................
*Br  709 :trig_L1_thrNumber : vector<int>
*Entries :     5000 : Total  Size=     109647 bytes  File Size  =
*Baskets :        4 : Basket Size=      40448 bytes  Compression=
*............................................................................
*Br  710 :trig_L1_thrValue : vector<float>
*Entries :     5000 : Total  Size=     109637 bytes  File Size  =
*Baskets :        4 : Basket Size=      40448 bytes  Compression=
*............................................................................
*Br  711 :trig_L1_vetoed : vector<bool>
*Entries :     5000 : Total  Size=      80763 bytes  File Size  =
*Baskets :        4 : Basket Size=      32256 bytes  Compression=
*............................................................................
```

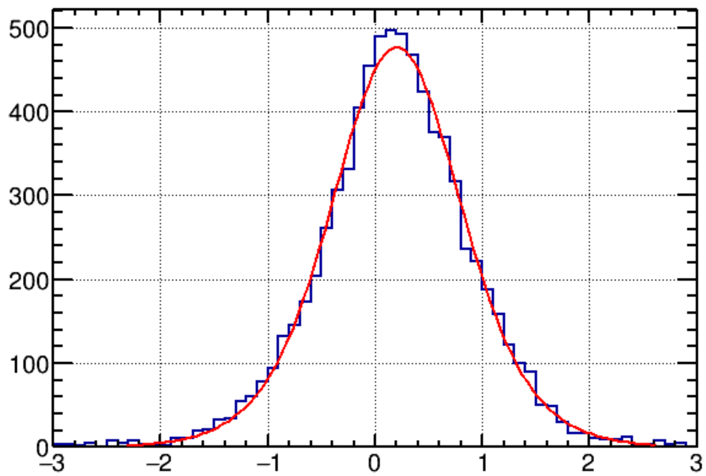
711 branches, including to many things that I do not know off:

- → Check the Muon Common Plotter to extract the information I care about (https://gitlab.cern.ch/atlas-muon-software/nswperformancestudies/nswcommonplotter/-/blob/master/src/plotter.cpp?ref_type=heads)
- → Reduction to 27 Branches with 71 Million Events
- → Focusing on Combined Muons with $p_T > 5$ GeV

Starting point of the analysis

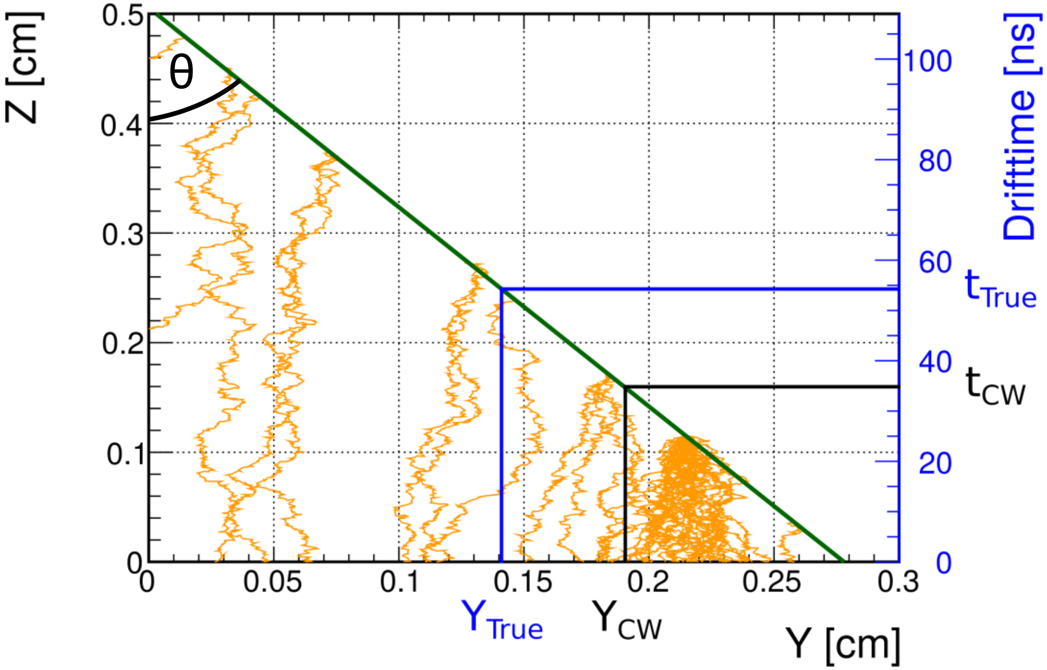
Residual Distributions (10m events at the moment):

- No time Correction applied
- (possible) Misalignment of the detectors (Shifts, Rotations)
- (possible) Zebra Shifts (shift of the RO-Electronics by a multiple of the pitch)
- The big unknown?



A12 Layer 1 PCB 8:
σ_{Core} = 0.527 mm
σ_{68CL} = 0.646 mm

Application of the Clustertime Correction



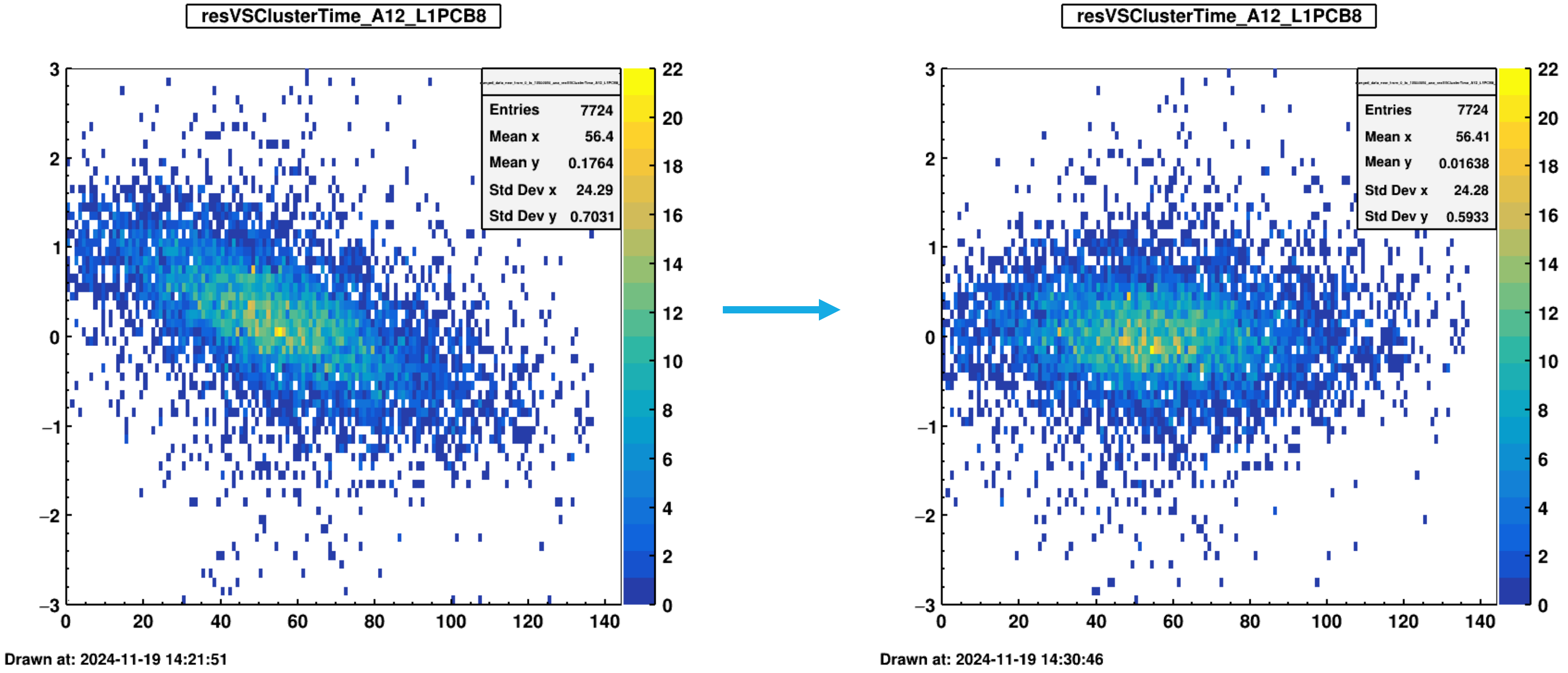
Charge weighted position $Y_{CW} = \frac{\sum_i q_i \times y_i}{\sum_i q_i}$

Charge weighted Clustertime $t_{CW} = \frac{\sum_i q_i \times t_i}{\sum_i q_i}$

First approach is PCB wise correction of the angular dependent correlation, however we know VMM-based correction (Stefanie) or even strip-wise correction should perform better

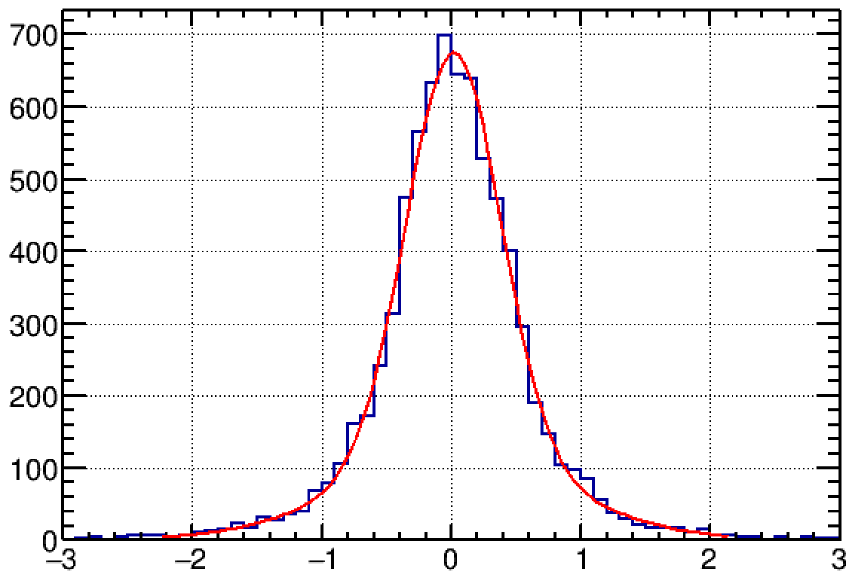
→ Later

Time Corrected Residuals



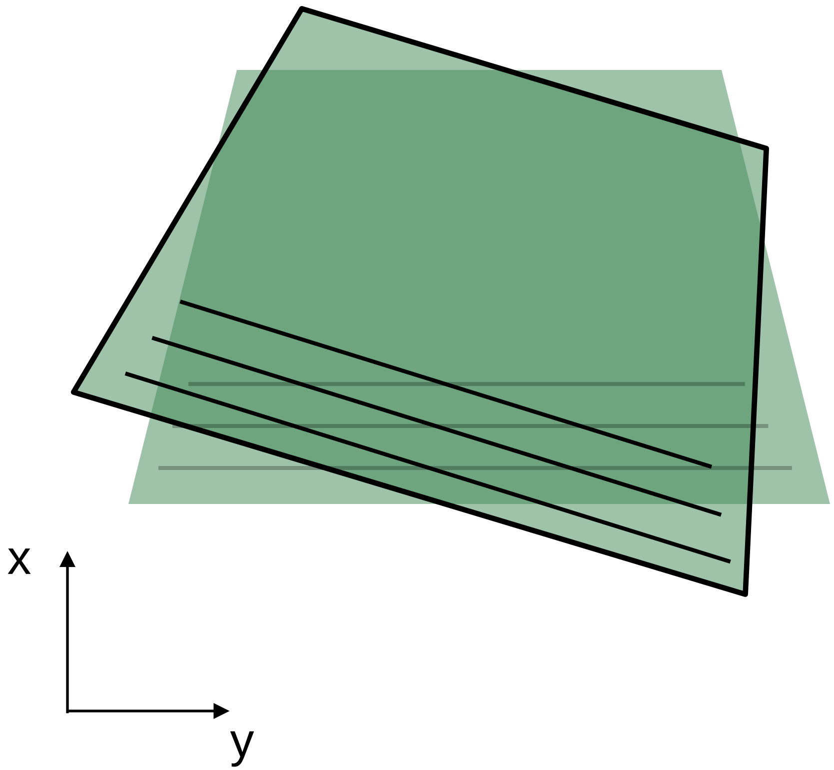
Intermediate Residual Distribution

Improvement w.r.t. no correction



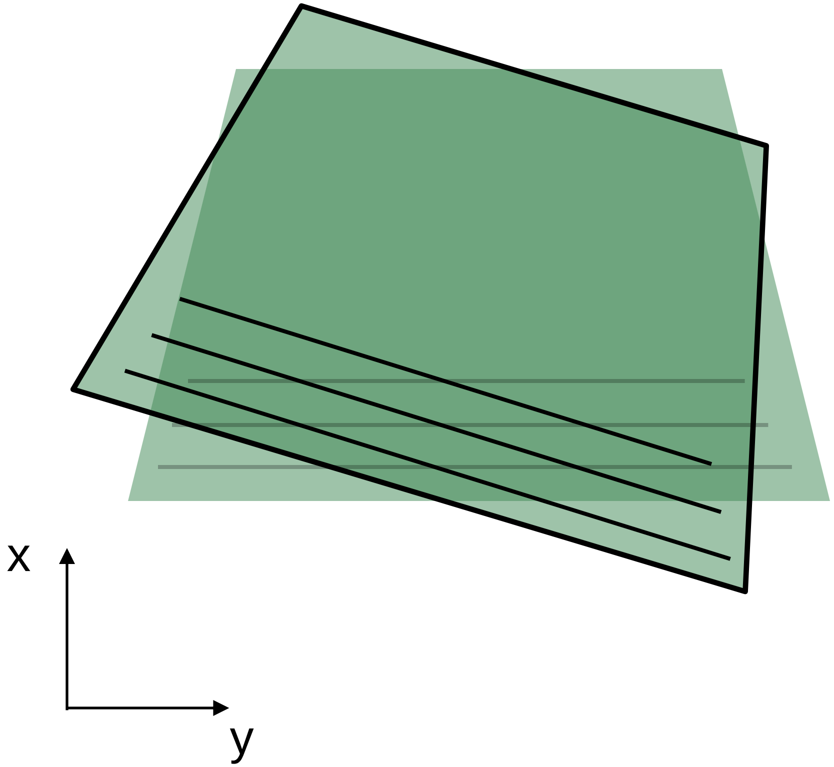
A12 Layer 1 PCB 8:
σ_{Core} = 0.366 mm (-161 µm)
σ_{68CL} = 0.470 mm (-176 µm)

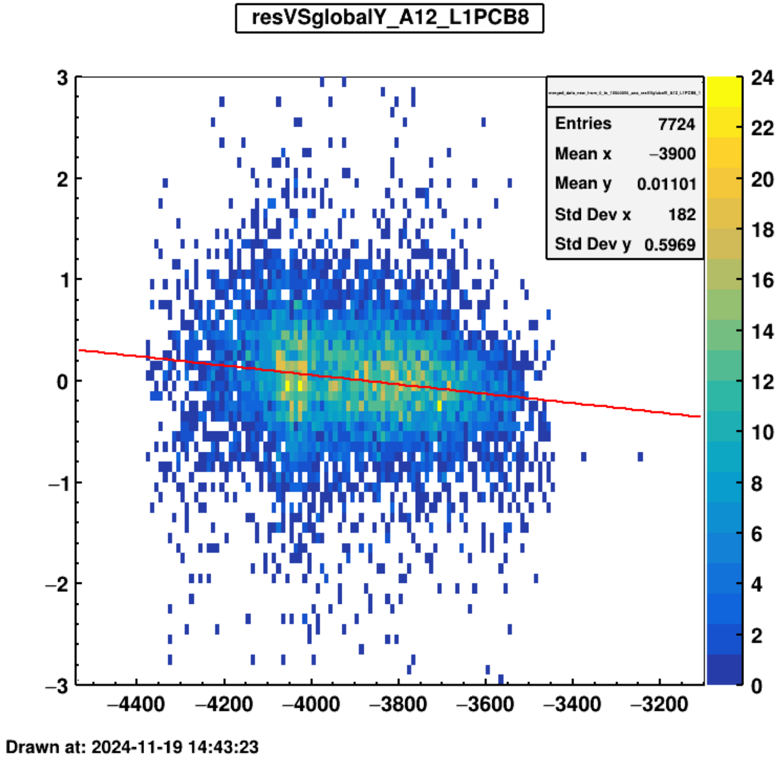
In-plane rotation



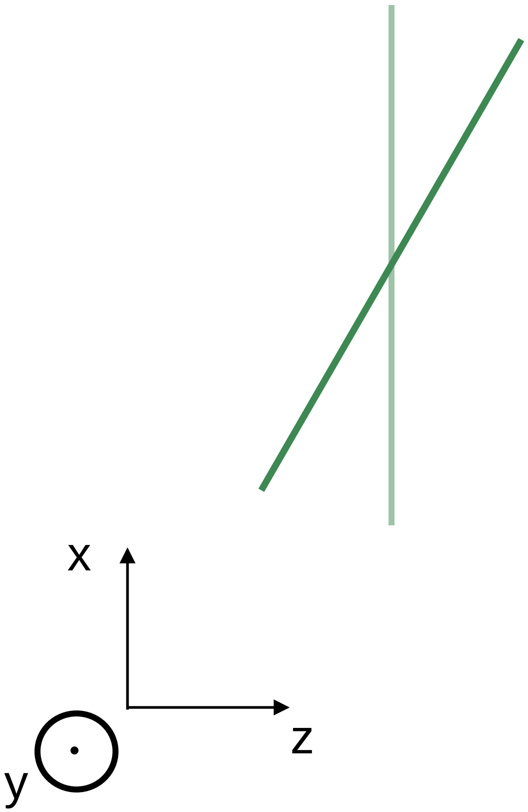
Residual in x depends on y position!

In-plane rotation



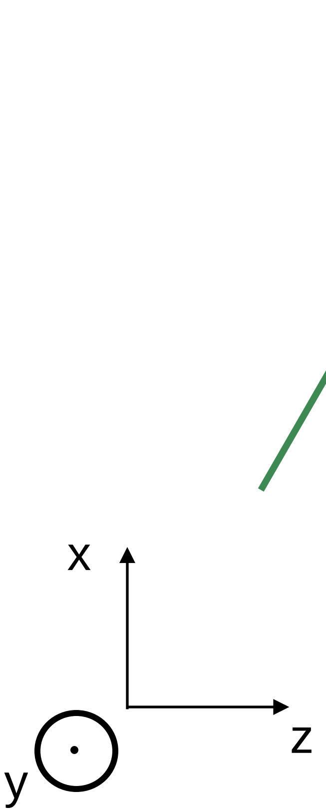


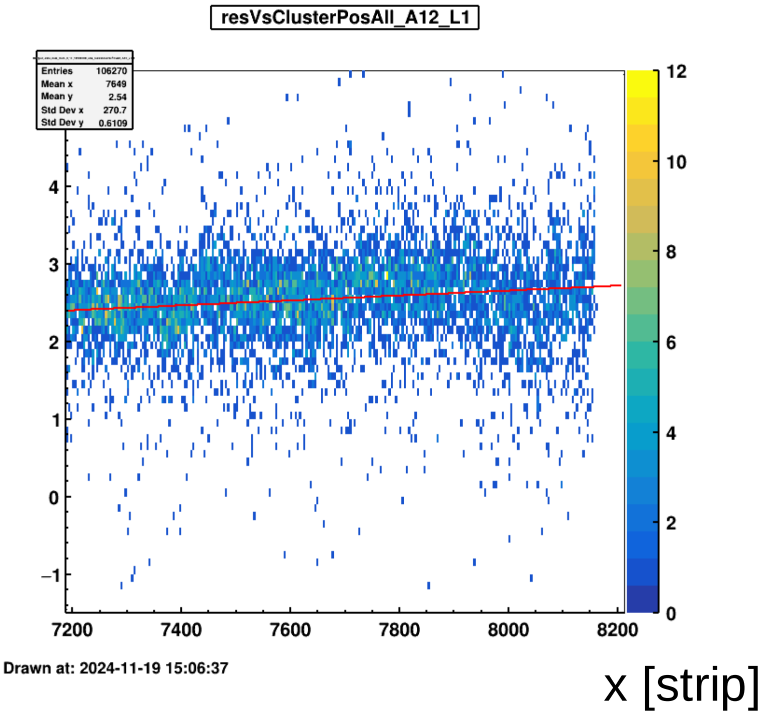
Rotation around Y-Axis



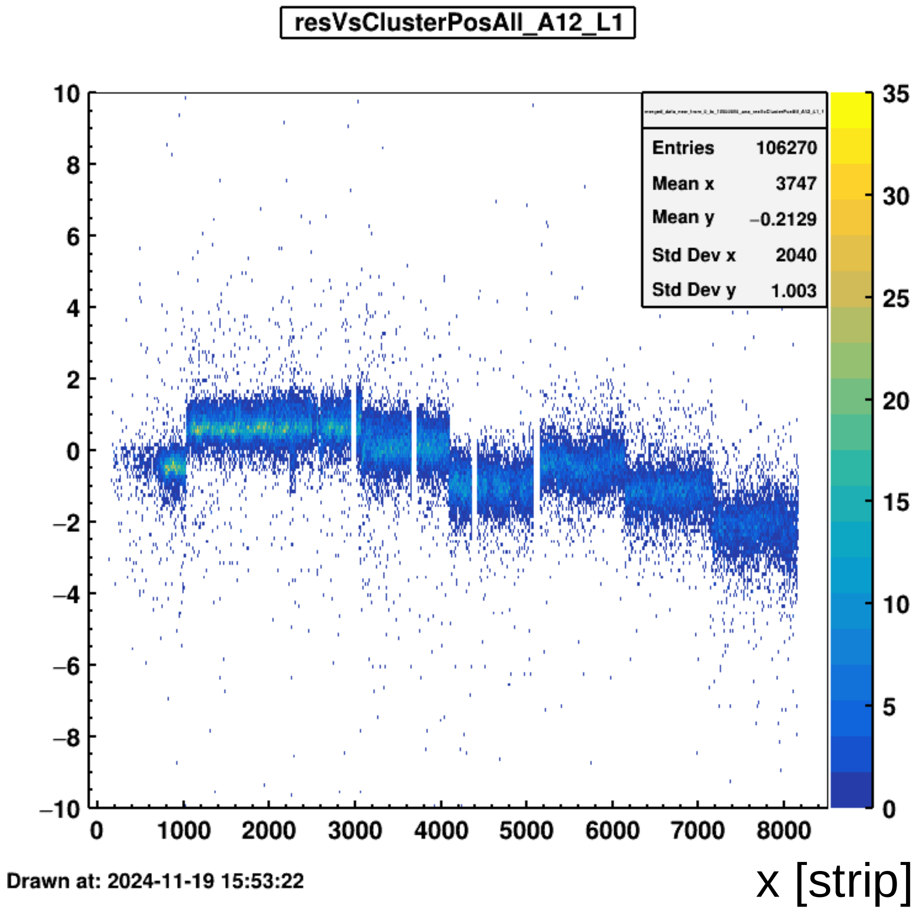
Residual in x depends on the x position!

Rotation around Y-Axis



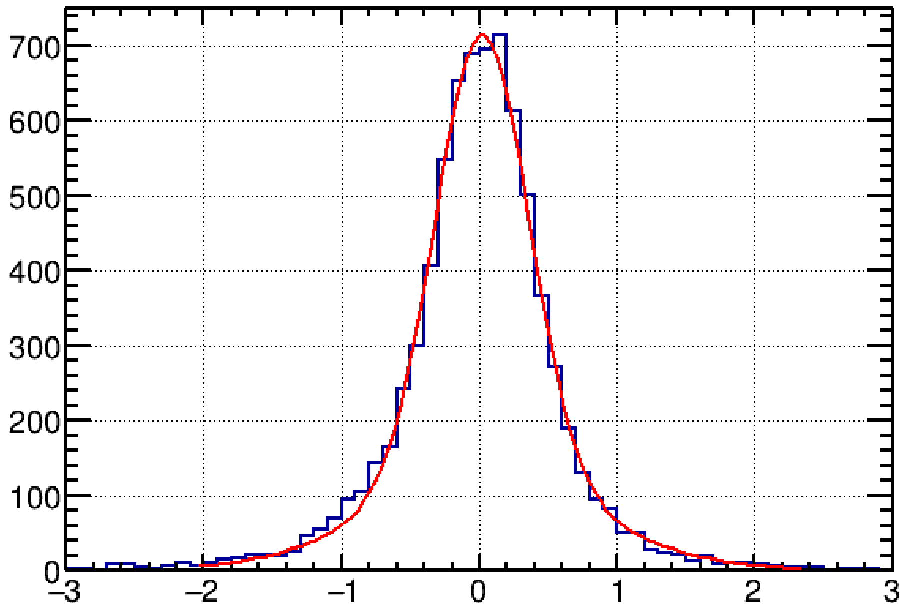


Zebra Shifts



(preliminary) Final Resolution

Improvement w.r.t. Time Corrected Centroid



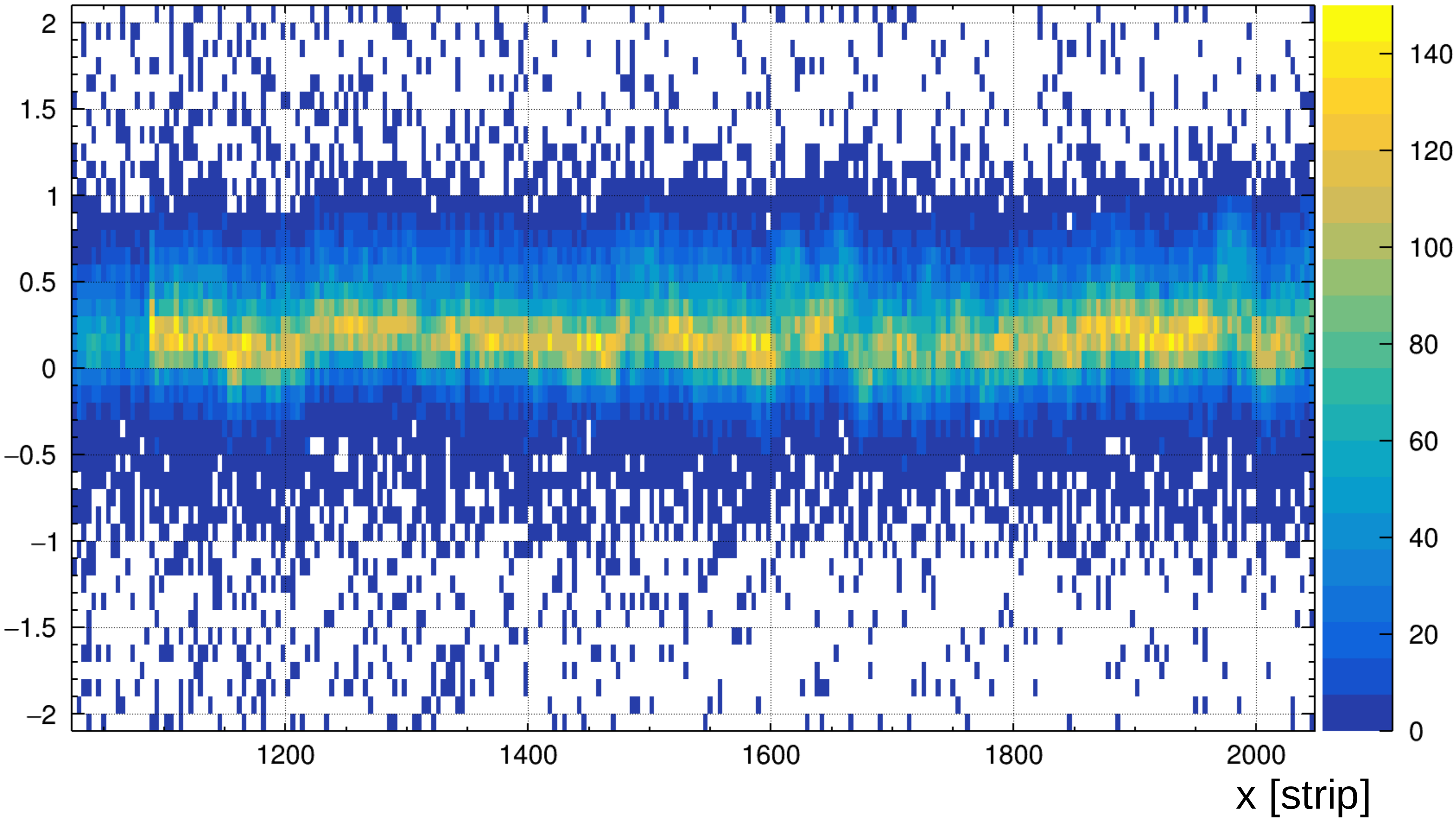
A12 Layer 1 PCB 8:
σ_{Core} = 0.330 mm (-36 µm)
σ_{68CL} = 0.443 mm (-27 µm)

→ Identical to Romanos results

What now?

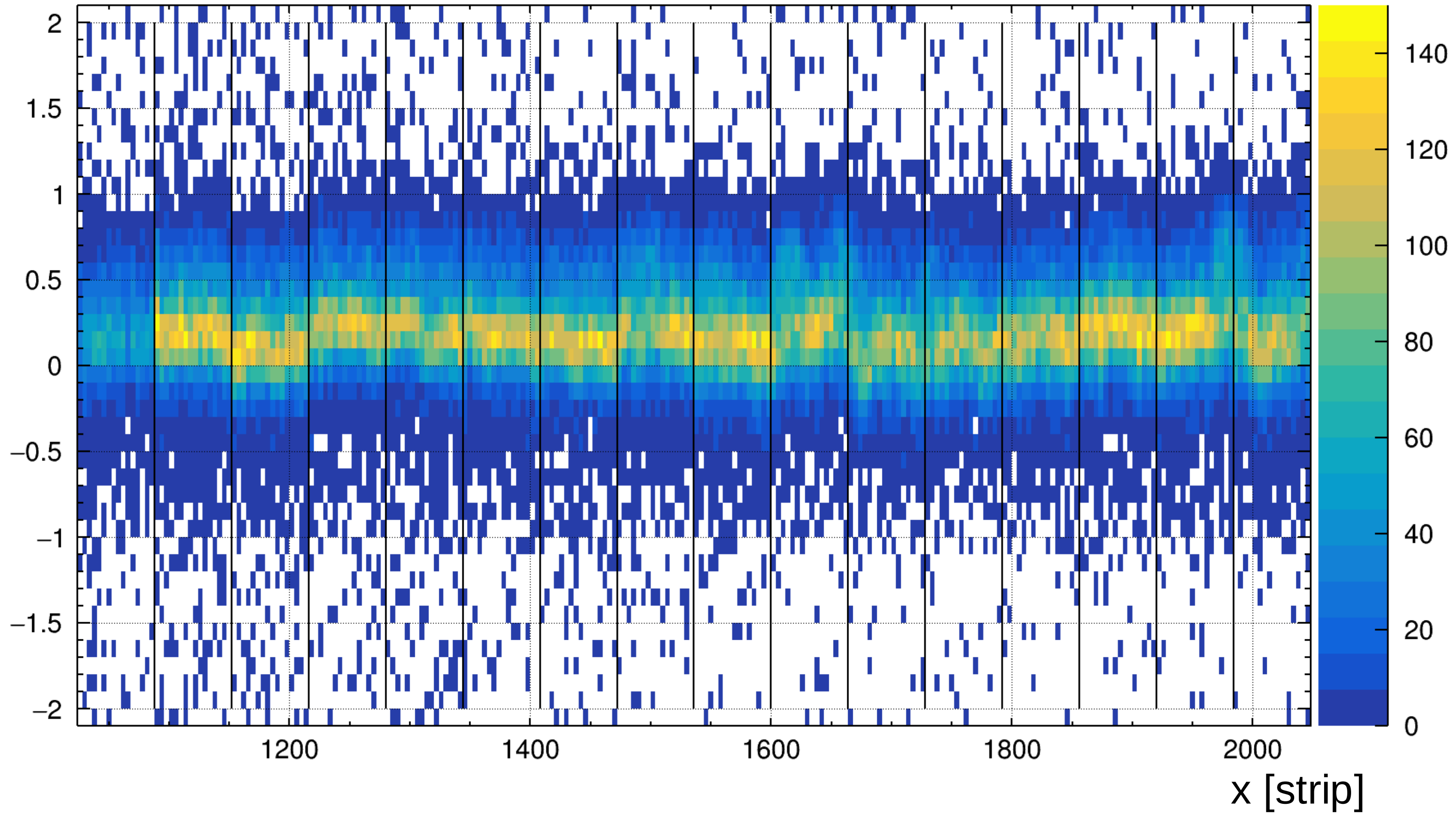
Check Timing Calibration
Check Clustering/Clusterparameters (#Strips, Charge, Hole, noisy strips, saturated strips, timing, ...)
Drink a Coffee
Check for other unknown effects (e.g. ResVsPhi and ResVsEta, which should be covered by ResVsY and ResVsX, but ...)
Go to this years Toroid Off Run for higher amplification voltages
Maybe another Coffee
Determine the angle dependent p1-correction parameter for the Clustertime Correction of the Centroid Position
...

PCB 2 ResVsPos



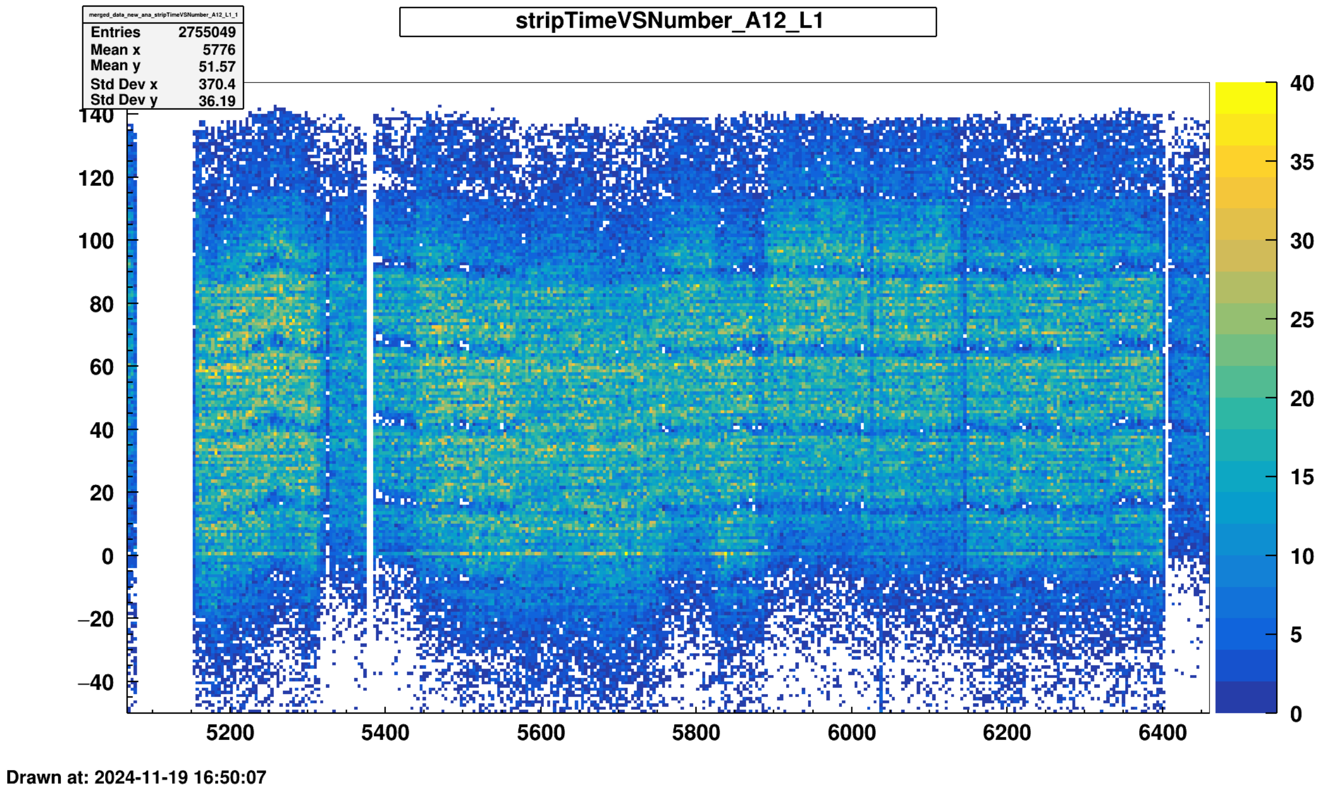
Drawn at: 2024-11-19 16:21:23

PCB 2 ResVsPos



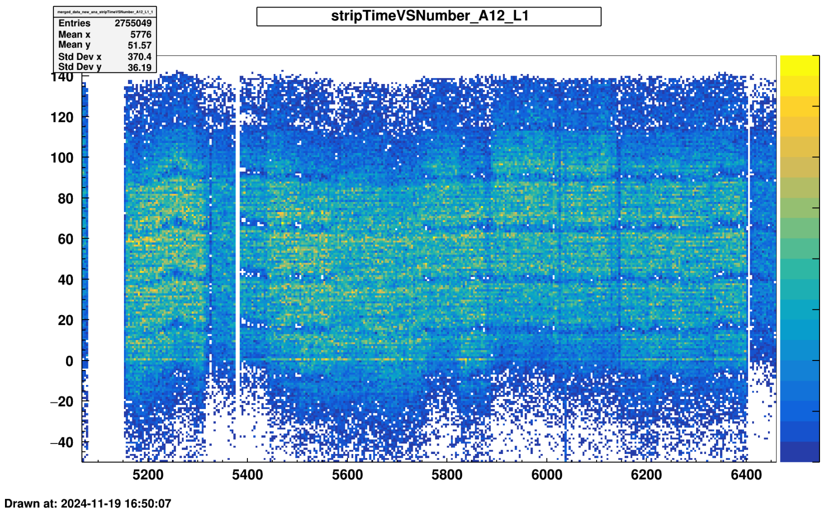
Drawn at: 2024-11-19 16:21:23

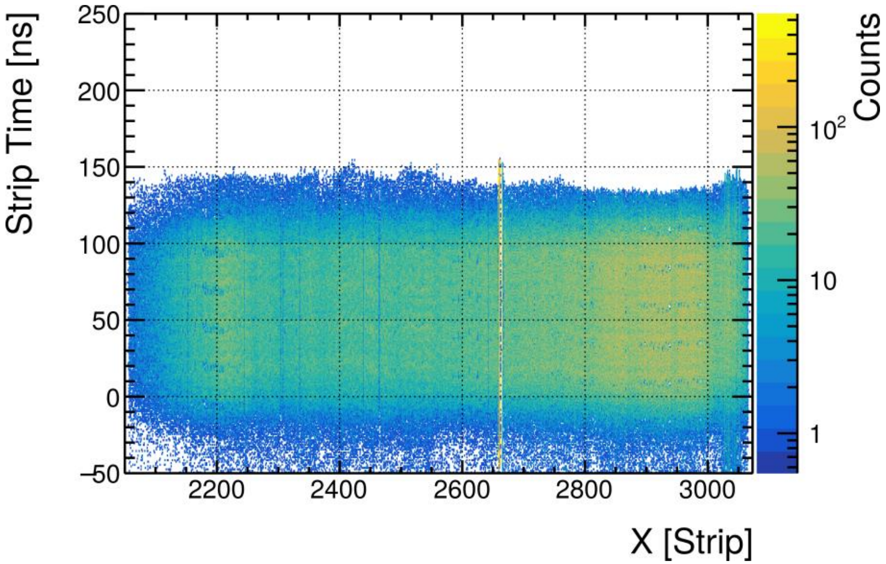
PCB 5 Striptime Distribution VS Strips



PCB 5 Striptime Distribution VS Strips

PCB 3 Testbeam Time VS Strips

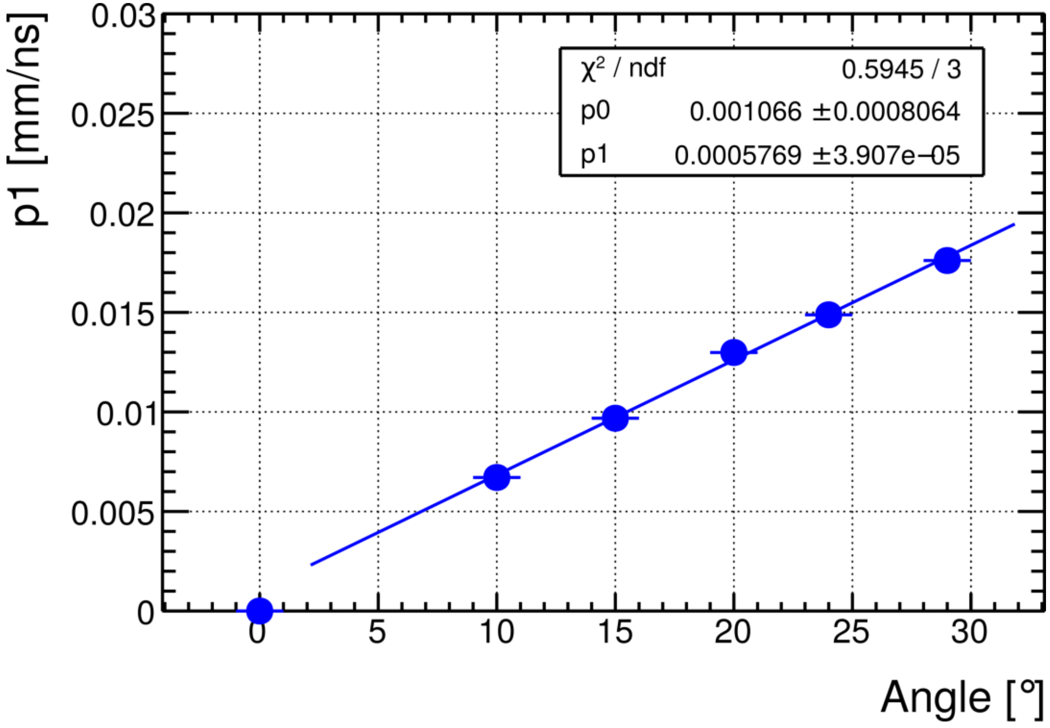




Work to do

Backup

Correlation parameter (Testbeam)



Correlation parameter p_1 scales linearly with angle → Extrapolatable!