FDC Alignment with Millepede

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GlueX Collaboration Meeting

What Millepede does

Alignment is an optimization problem. The objective function to be minimized is:

$$\chi^2(\mathbf{p}, \mathbf{q}) = \sum \left(\frac{\text{residual}(\mathbf{p}, \mathbf{q})}{\text{error}} \right)^2$$

alignment parameters **track parameters**

What we need to minimize this function:

$$\frac{\partial \text{residual}(\mathbf{p}, \mathbf{q})}{\partial(\mathbf{p}, \mathbf{q})}$$

How the residual change when we shift parameters.

Millepede

Returns optimized $\mathbf{p}$**.**

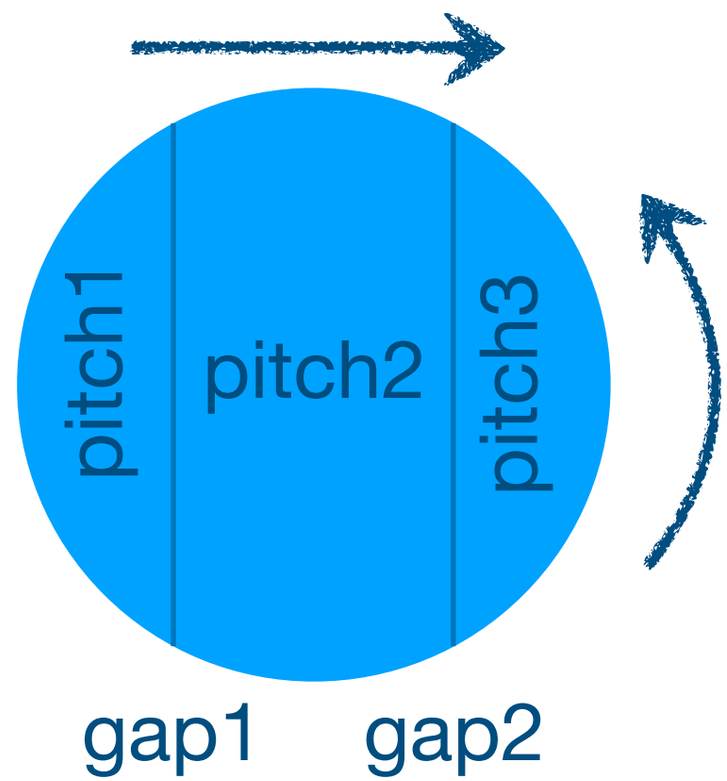
FDC alignment parameters

wire plane
- offset
- rotation

cathode plane
- offset
- rotation
- pitch
- gap

z-position of planes

Cathode plane

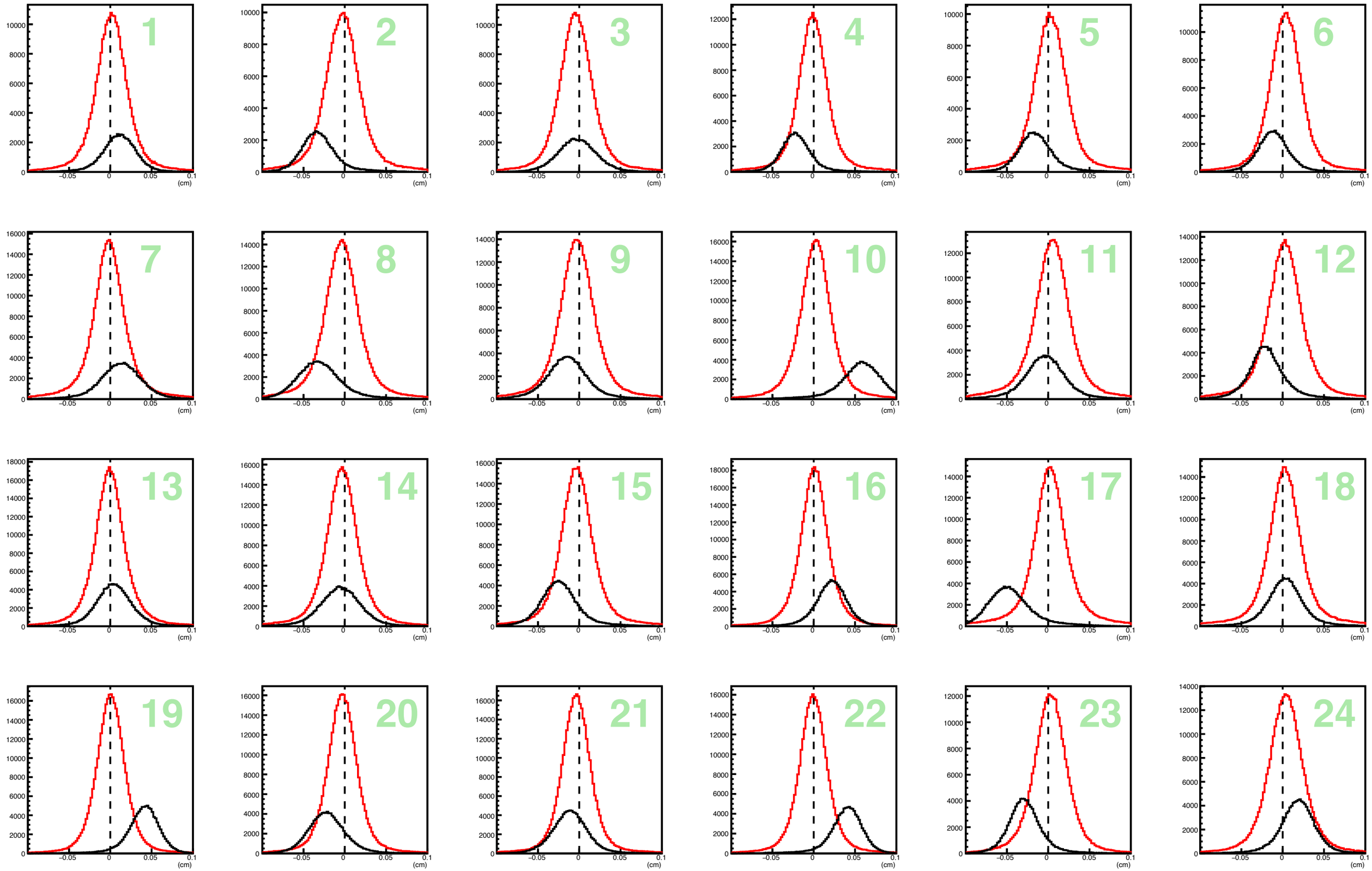


I am focusing on Run040847 [2018 spring] straight track run for FDC alignment.

Cathode Residual

histogram range: -0.1 — 0.1 cm

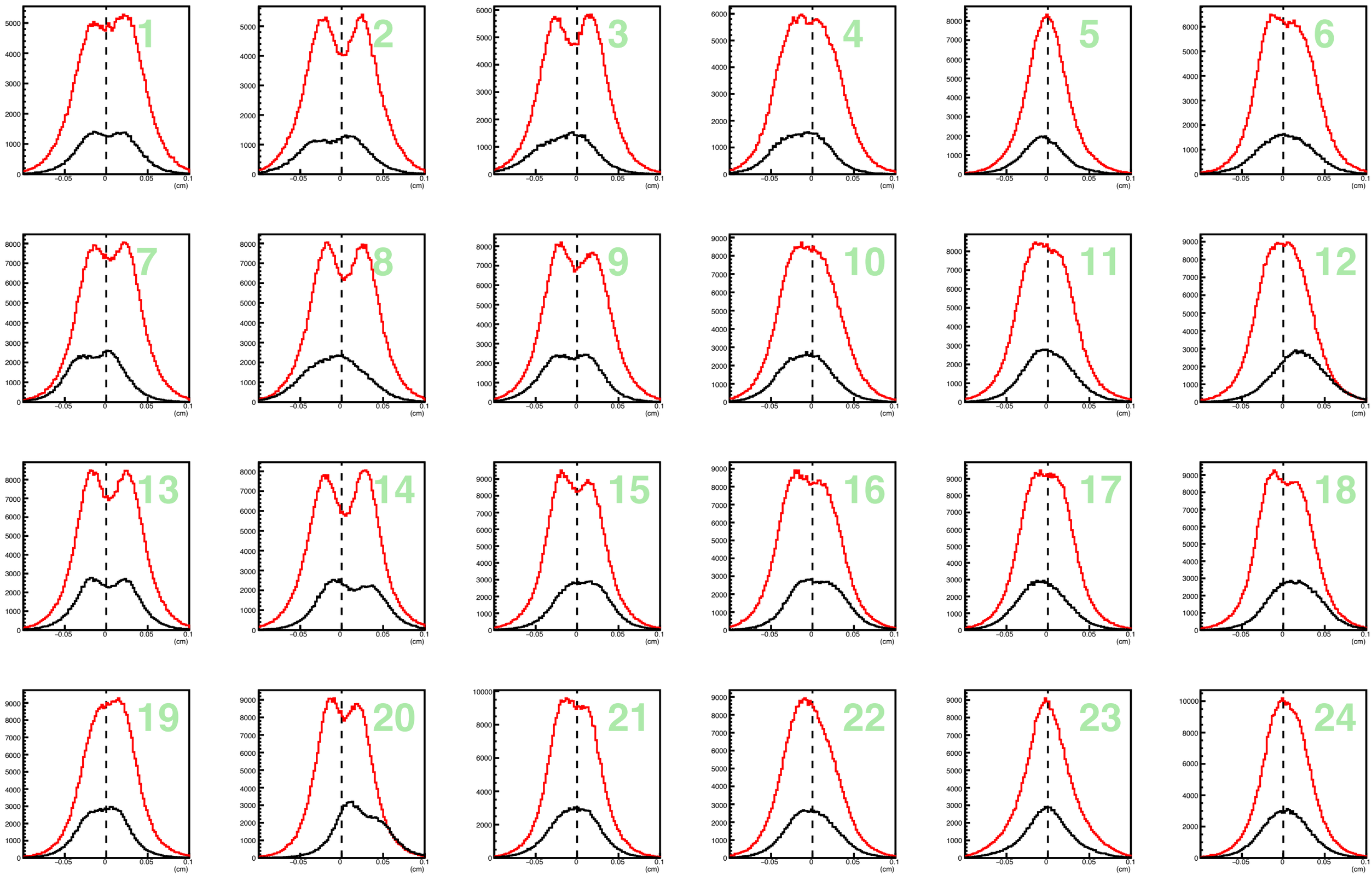
before Millepede alignment
after Millepede alignment



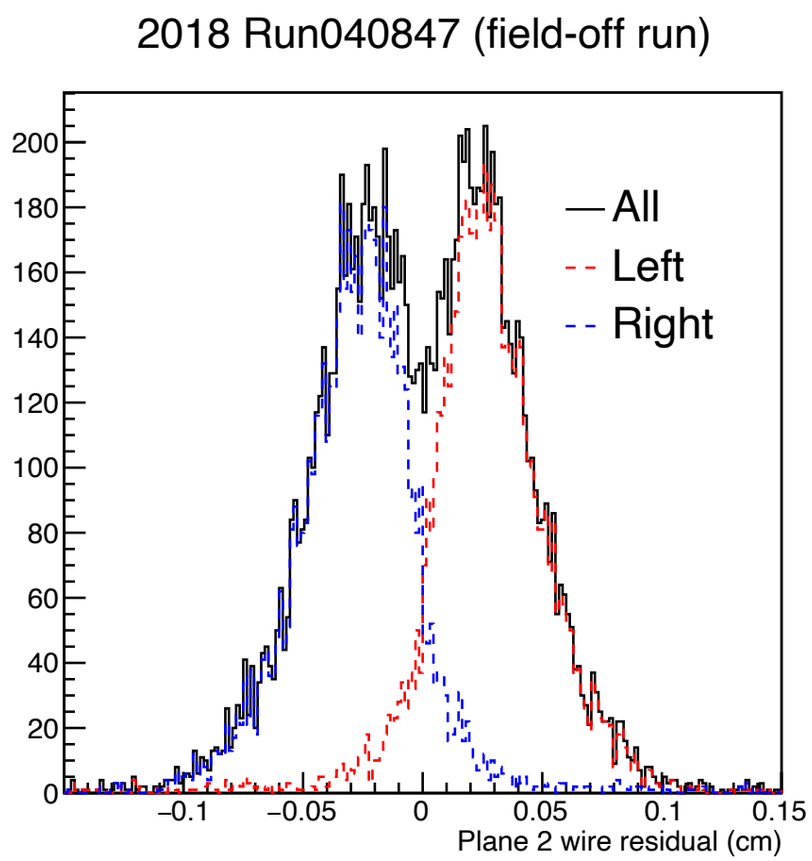
Wire Residual

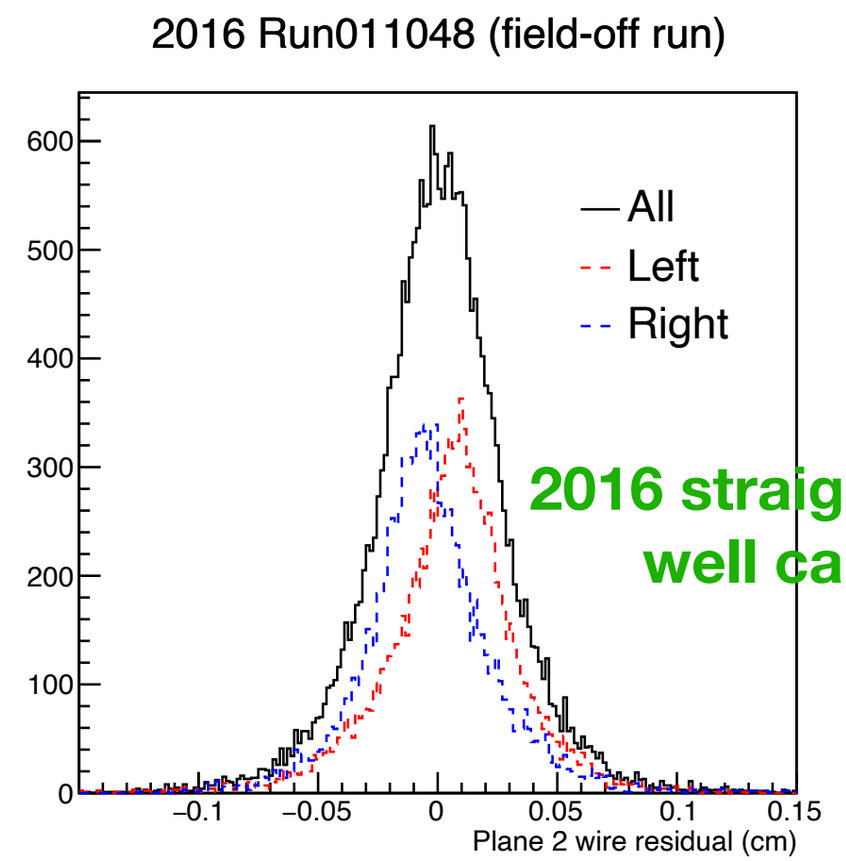
histogram range: -0.1 — 0.1 cm

before Millepede alignment
after Millepede alignment



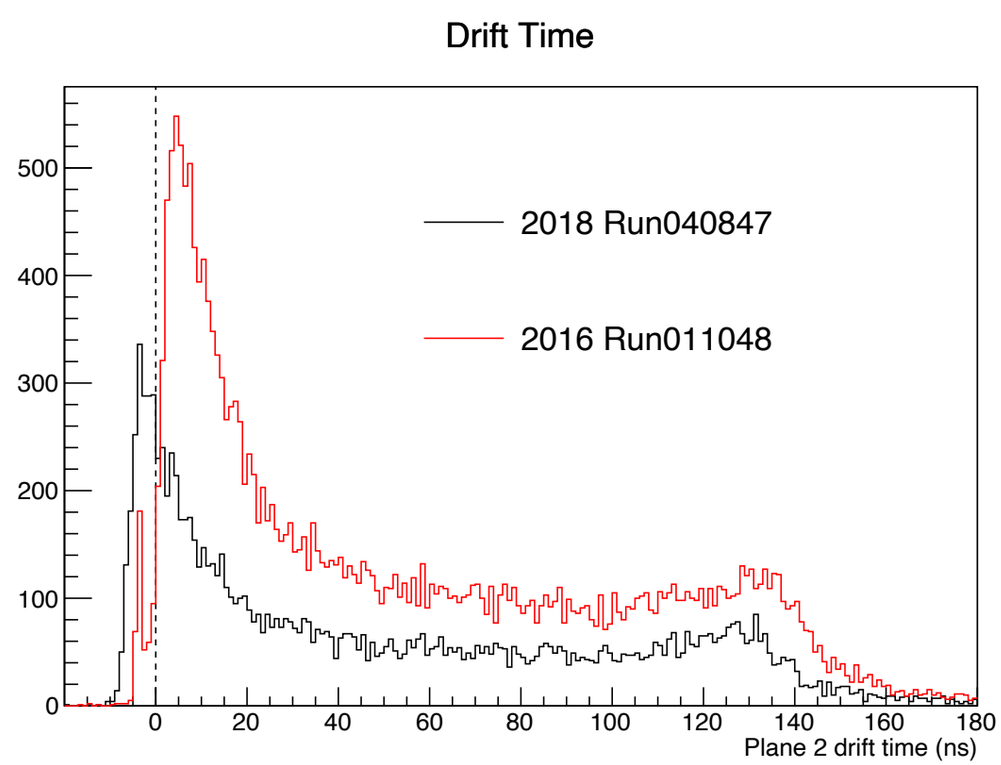
Wire Residual (Plane 2)





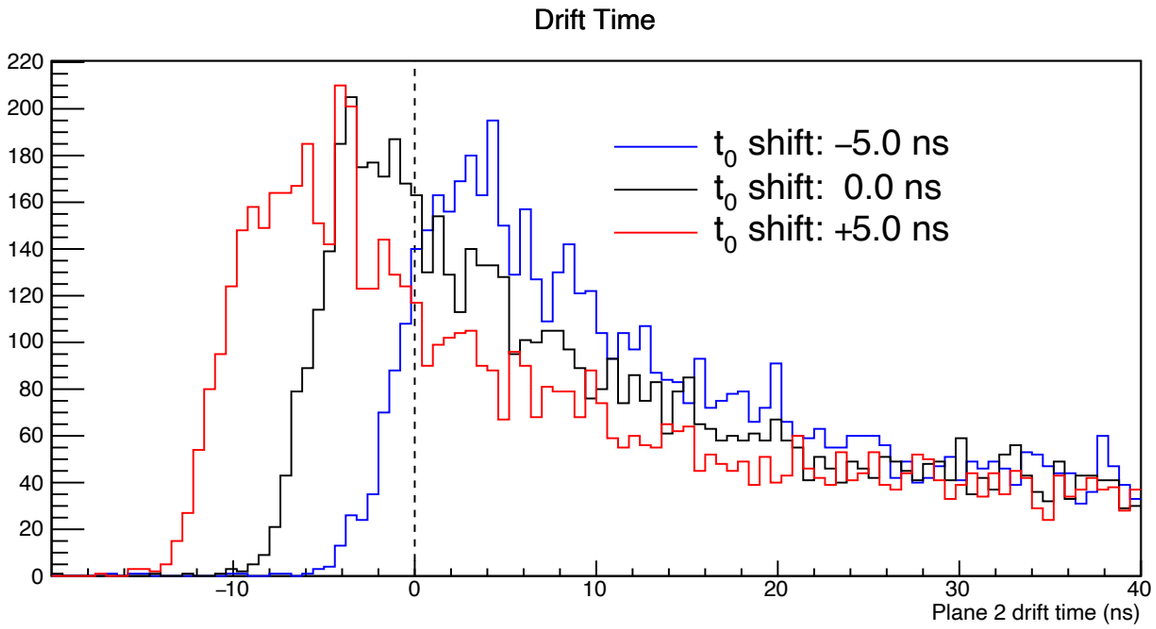
2016 straight track run well calibrated

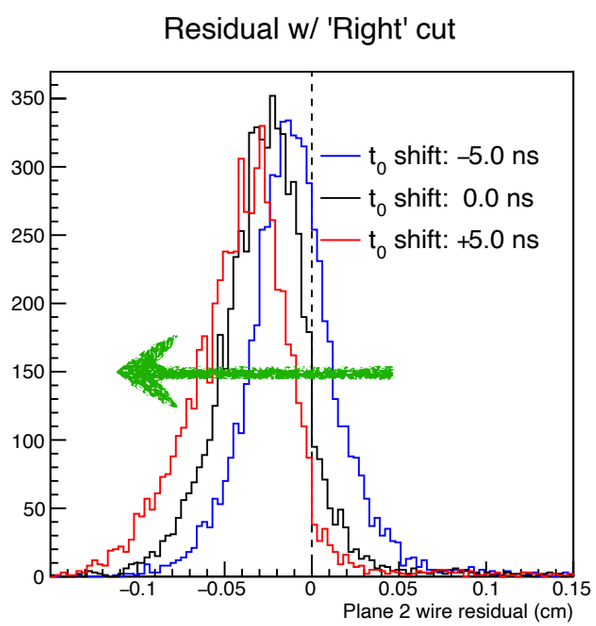
Left-side hit and right-side hit show different residuals.

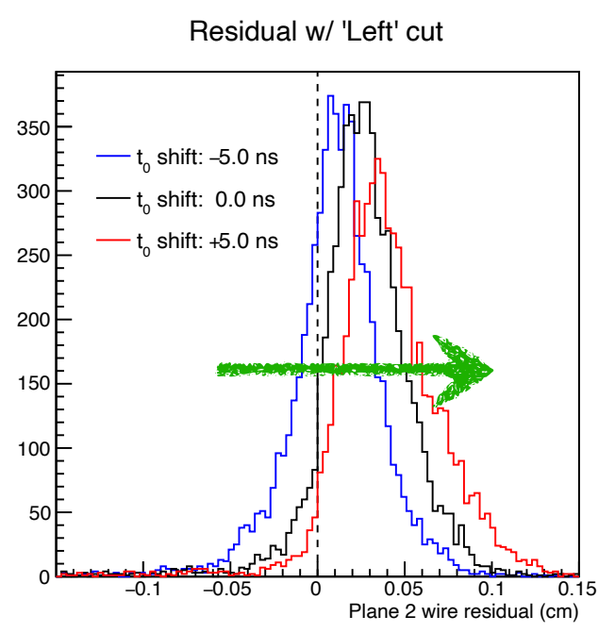


t_0 (wire position) shifts [Plane 2]

t_0 shift

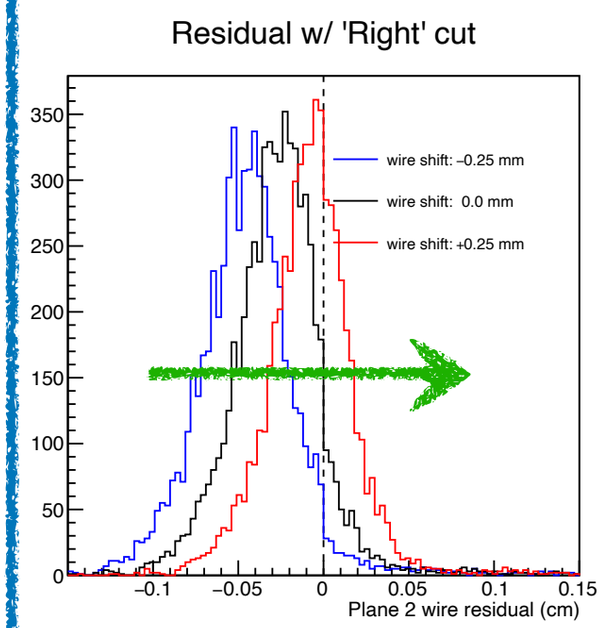


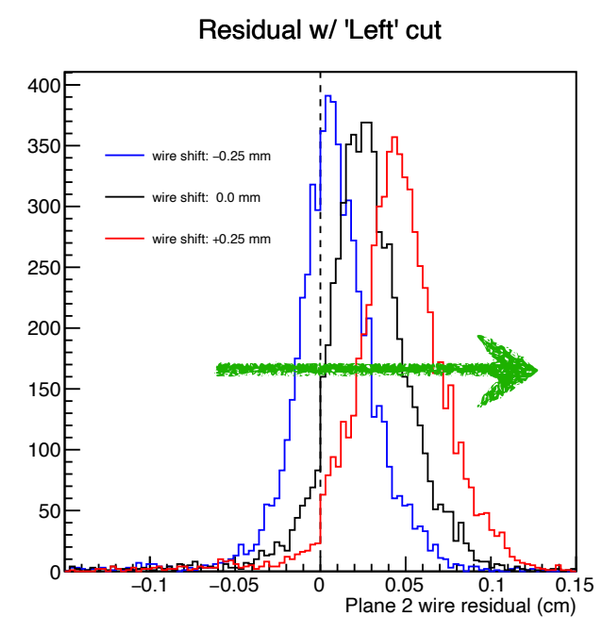




wire position shift

wire shift: -0.25 mm
wire shift: 0.0 mm (default)
wire shift: +0.25 mm



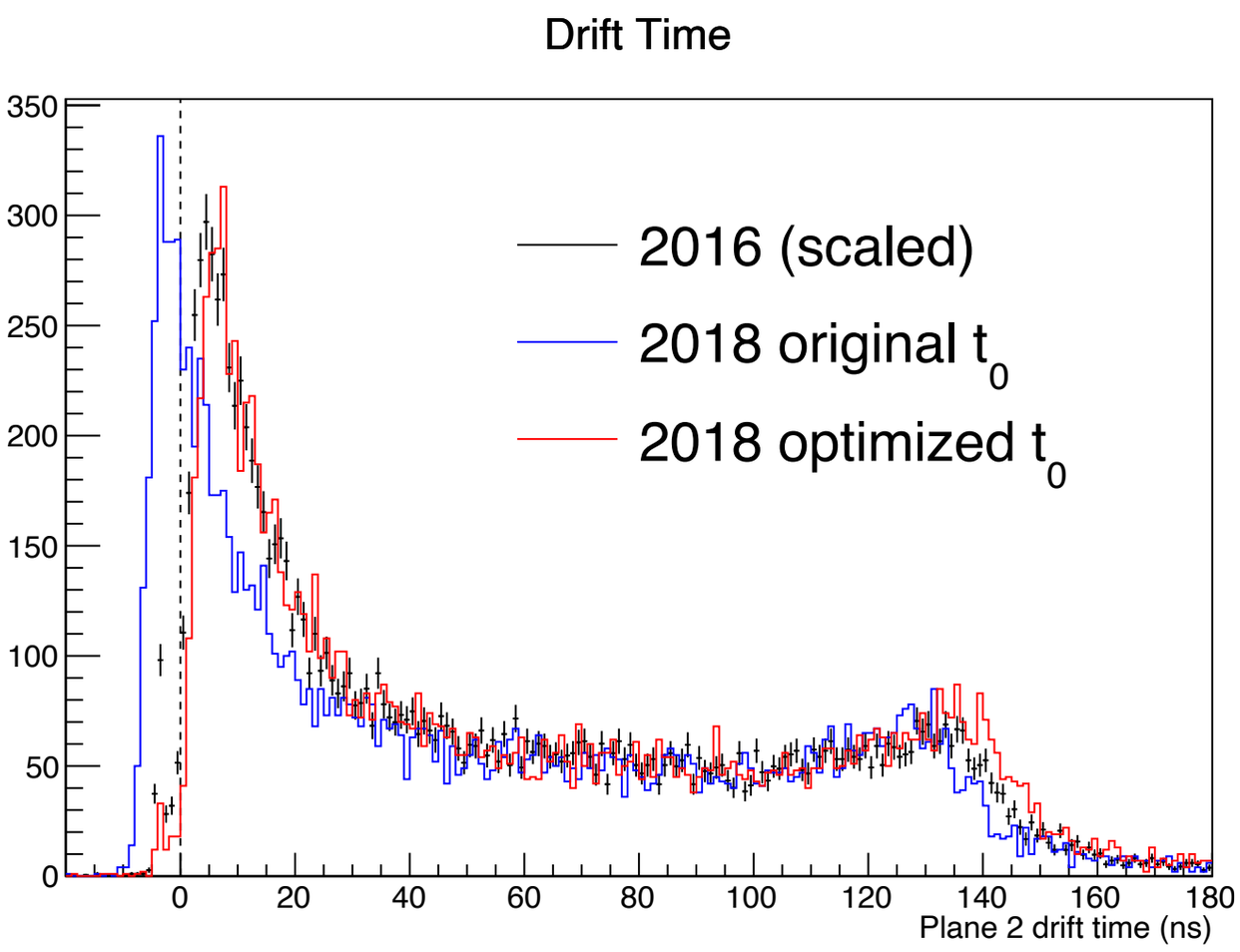


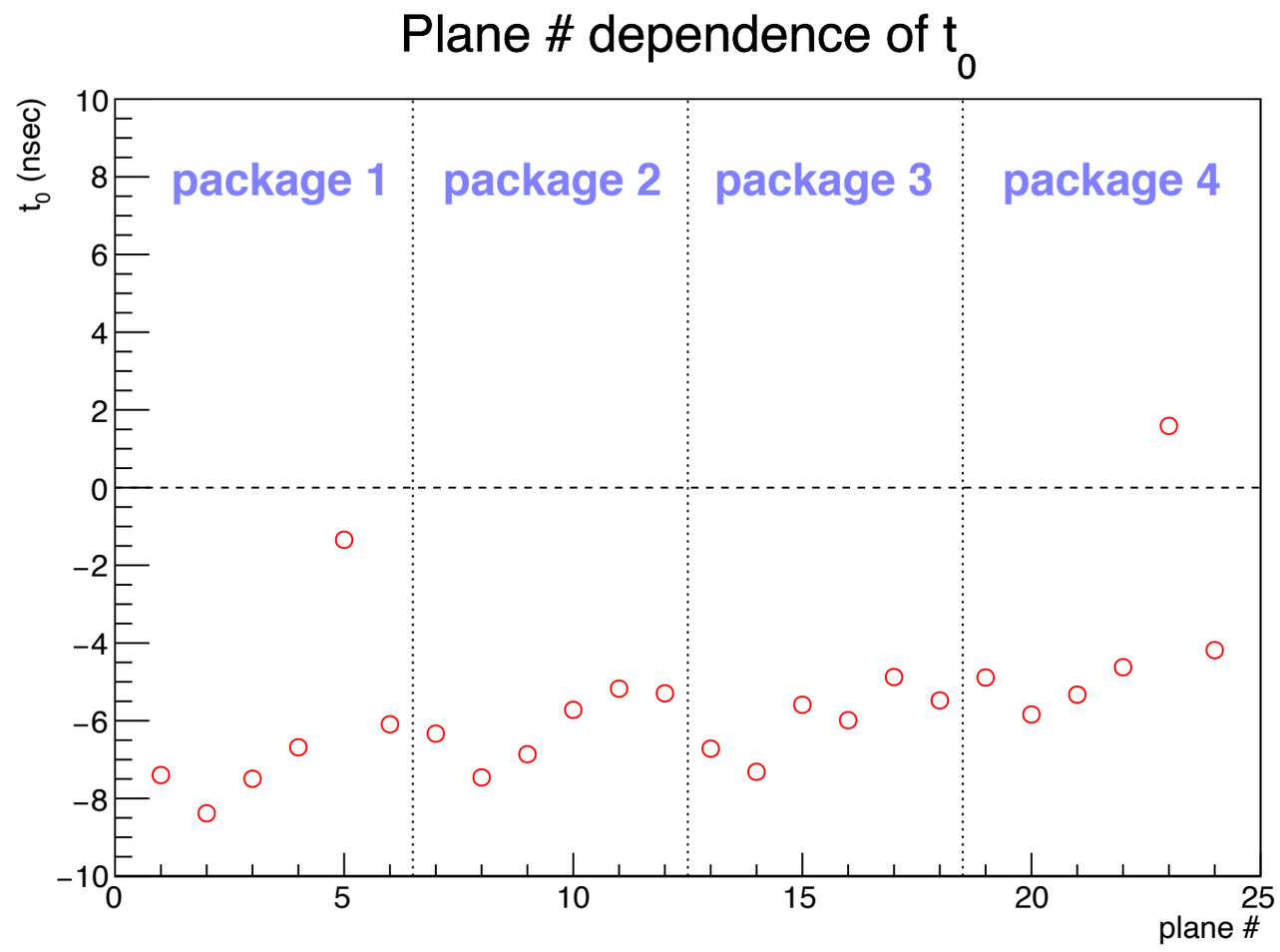
Similar effects, but different.

t_0 parameter is sensitive to the two-peak residual.

t_0 optimization using Millepede

Using Millepede, t_0 parameters are re-optimized plane by plane.

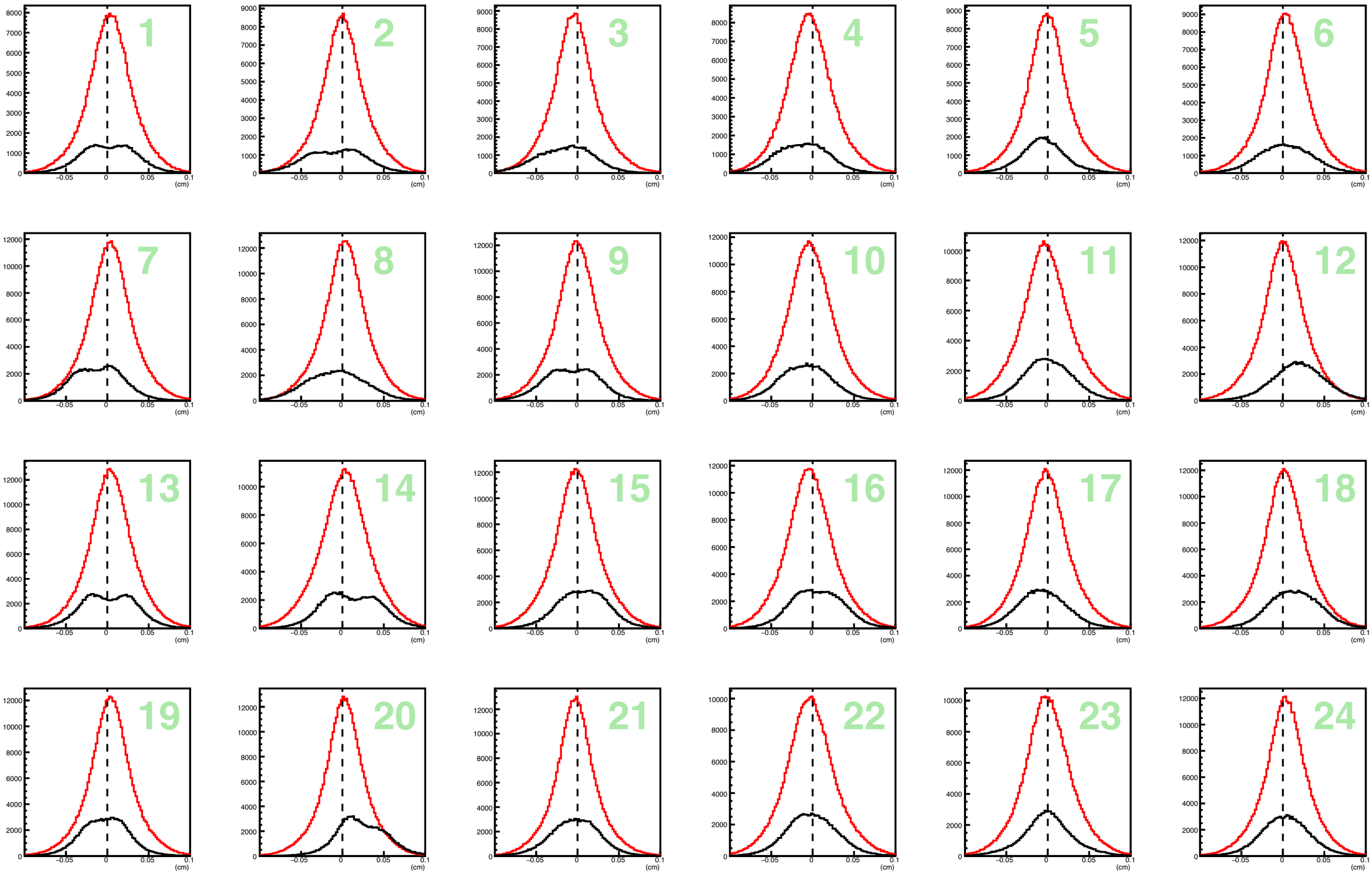




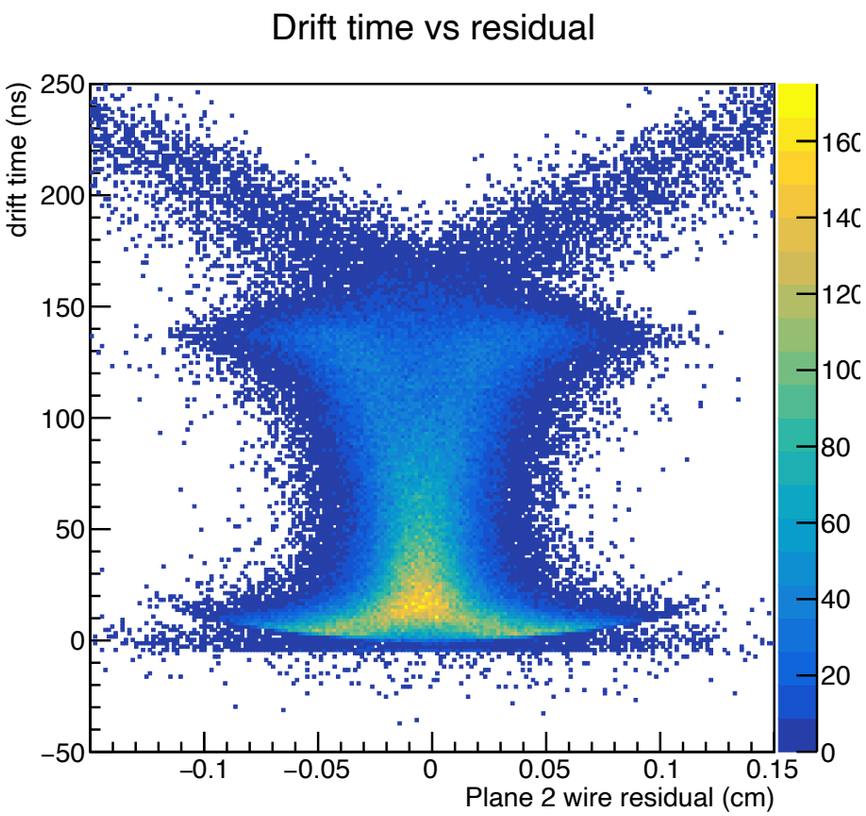
Wire Residual after t_0 optimization

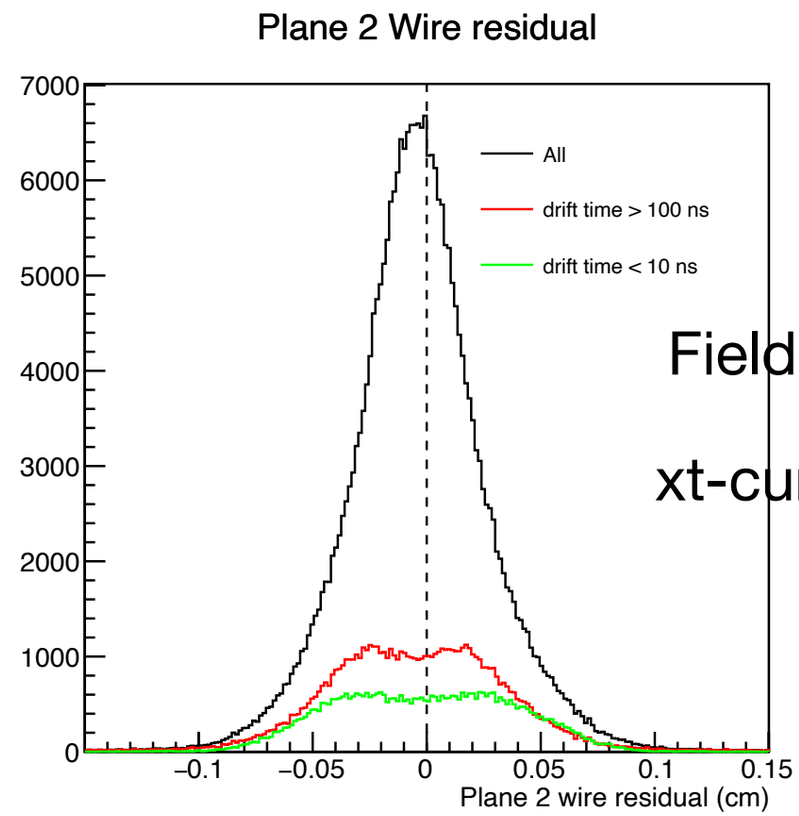
histogram range: -0.1 — 0.1 cm

before Millepede alignment
after Millepede alignment



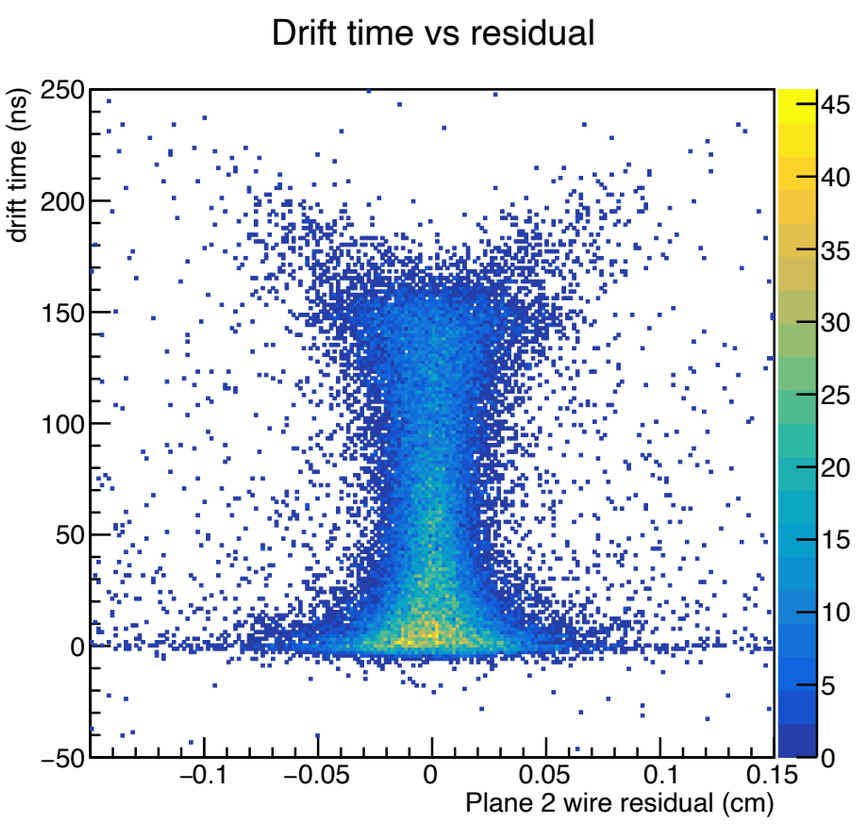
Drift time vs Residual

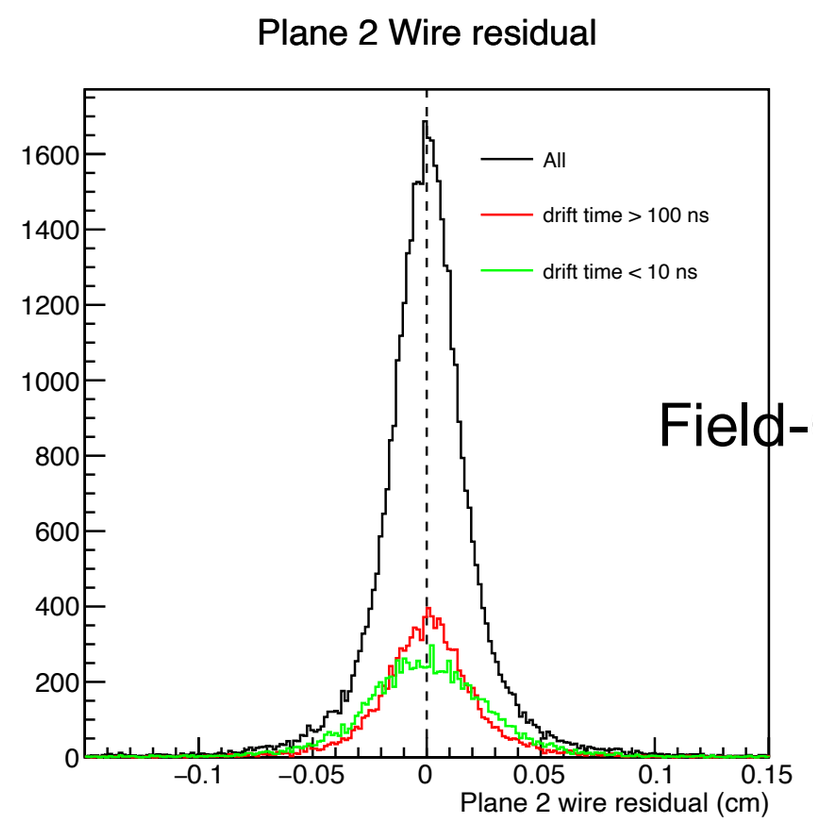




Field-OFF (Run040847) data

xt-curve is not fully optimized?





All

drift time > 100 ns

drift time < 10 ns

Field-ON (Run041510) data

Summary

- Millepede works w/ straight track data.
- Residuals w/ Left-Right cut give us rich information.
- Timing calibration should be optimized especially for the straight track data.
- The next step: CDC alignment