Quad test beam update: mean residuals

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Lepcol meeting

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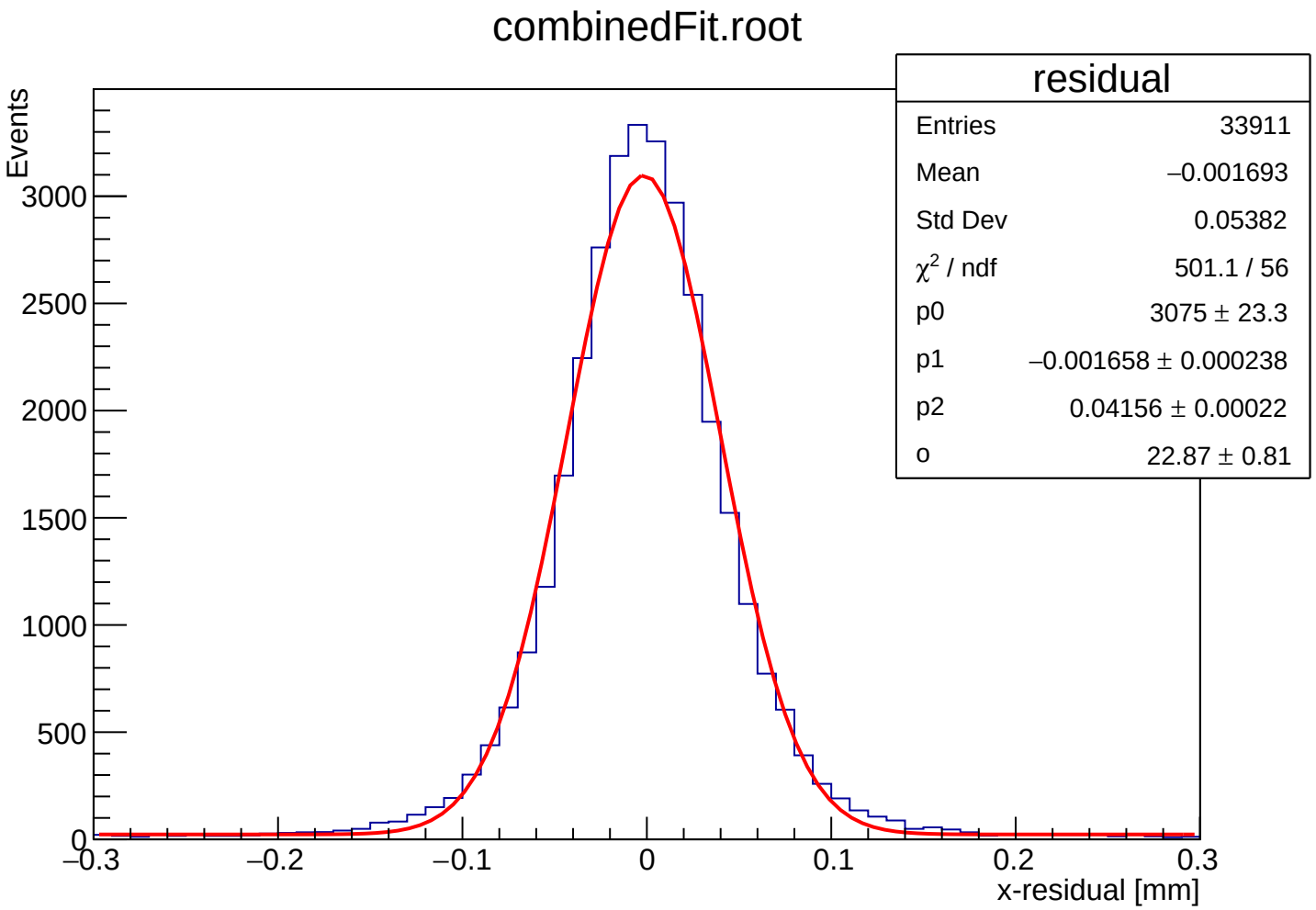
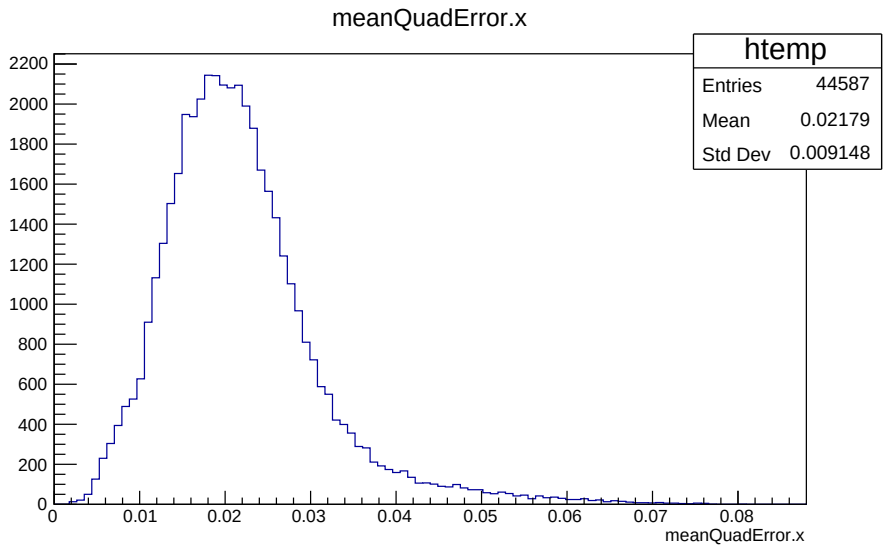
Mean distance from quad to to telescope track

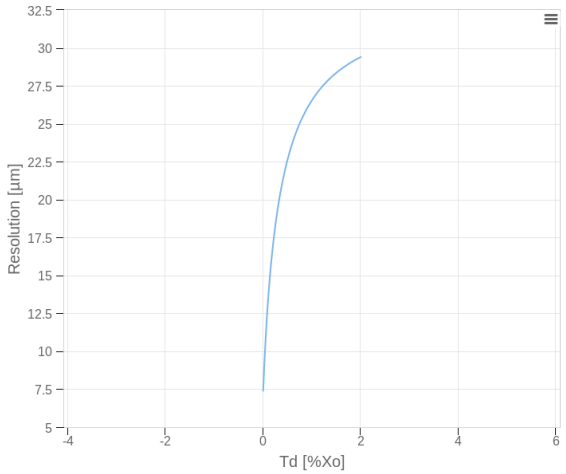


fitted with Gaussian + offset

Error of mean quad position and telescope fit



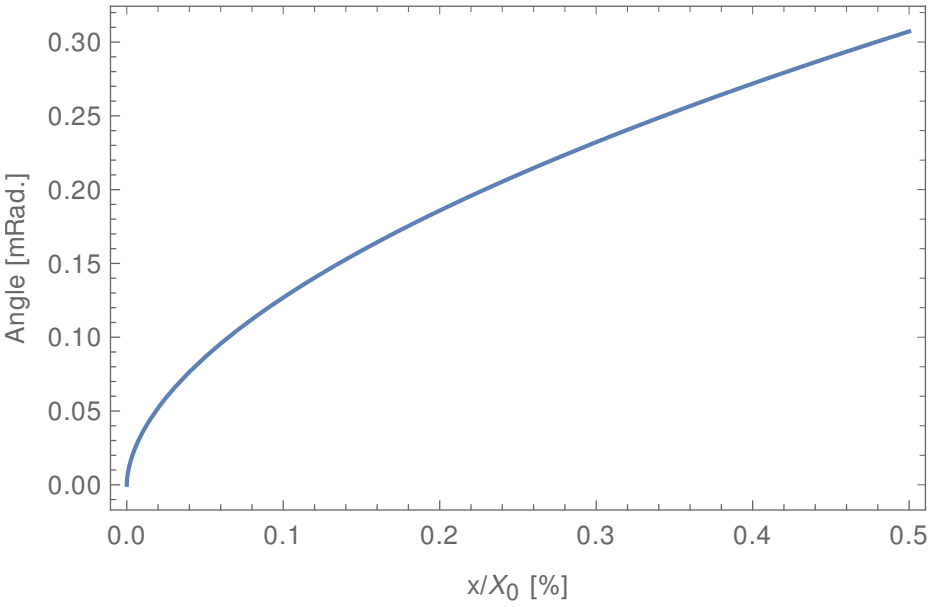
Error on telescope track prediction



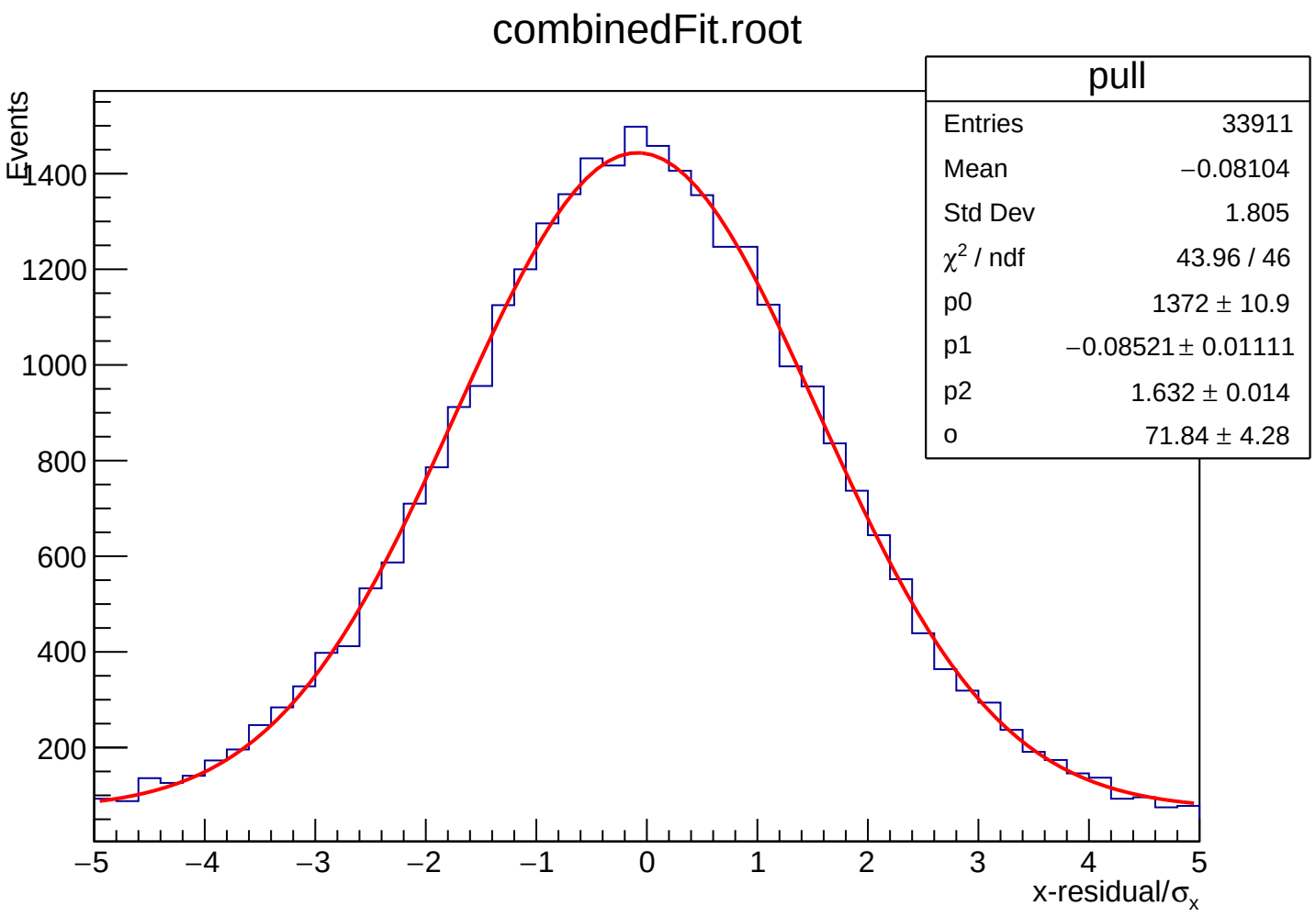
	X0	d	Thickness
Argon	117 m	∼10 cm	0.09 %X0
Kapton	286 mm	2×50 µm	0.035 %X0
Air	304 m	360 mm	0.12 %X0
Telescope per plane (included in graph)			0.075 %X0
Copper	14.35 mm	50 µm	0.35 %X0

Track fit in analysis does not take multiple scattering into account, so the telescope error in the analysis is too small

Scattering of 2.5 Gev electrons



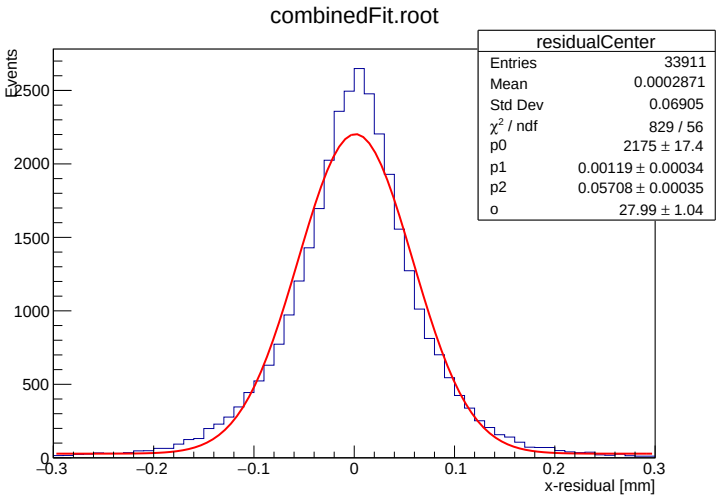
Pull of distance from quad to telescope track

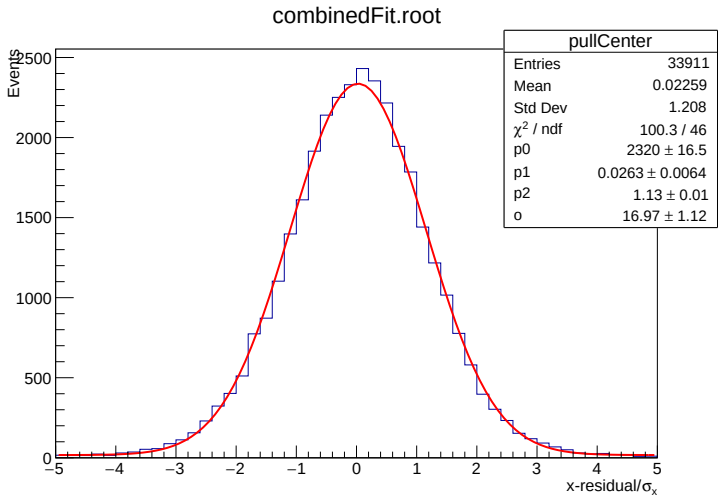


$\sigma_{\text{fit}} = 42\,\mu\text{m}$ and pull is 1.6, so $33\,\mu\text{m}$ unaccounted for

Difference of two partial fits

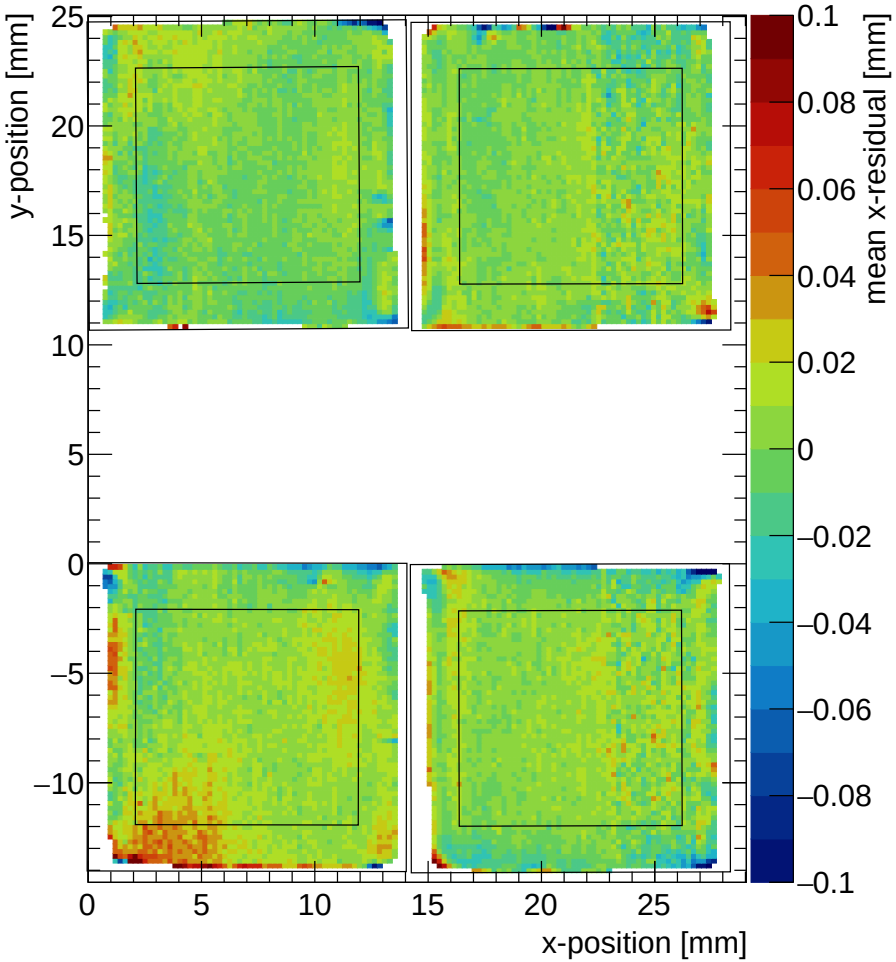
Fit first three telescope plane together with the first two chips and the last two telescope planes together with the last two chips and calculate their difference in the center of the quad

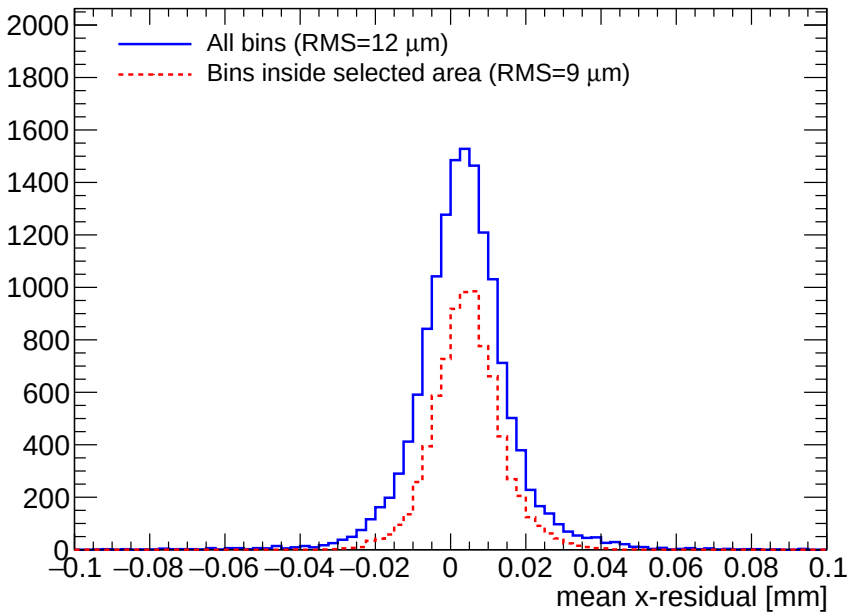




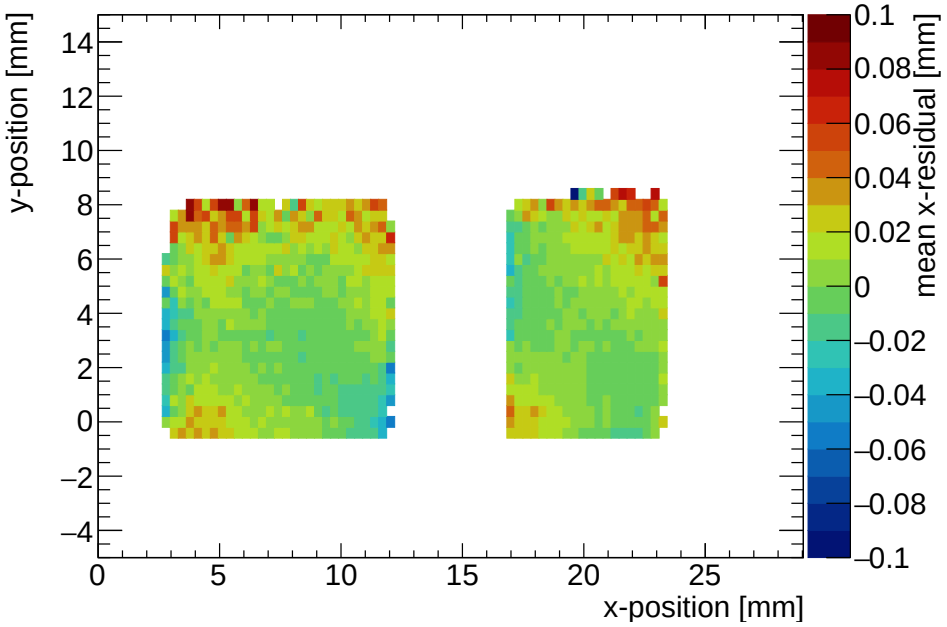
$\sigma_{\text{fit}} = 57\,\mu\text{m}$ and pull is 1.13, so $26.5\,\mu\text{m}$ unaccounted for
Improved by $\sqrt{33^2 - 26.5^2} = 20\,\mu\text{m}$: is this multiple scattering?

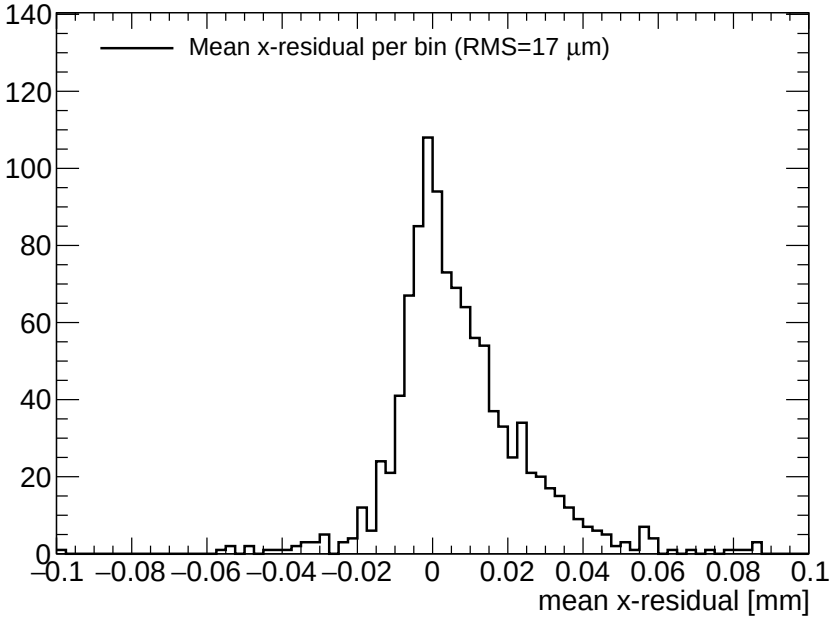
Deformations in the pixel plane





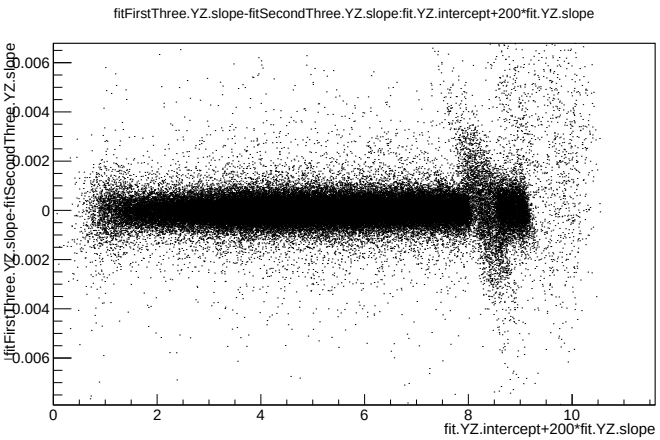
x-deformations in the drift direction

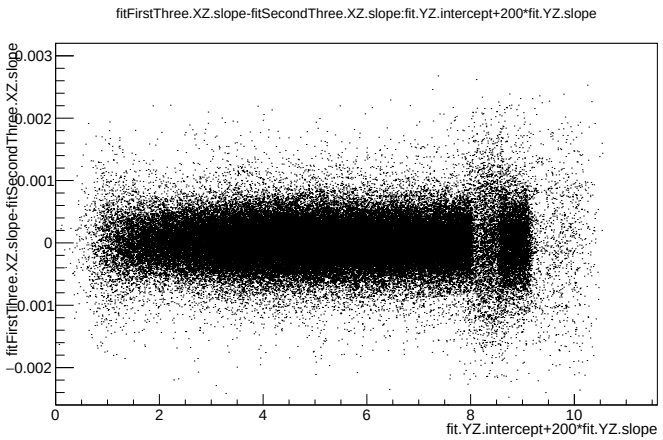




After correction for bins with more than 500 entries

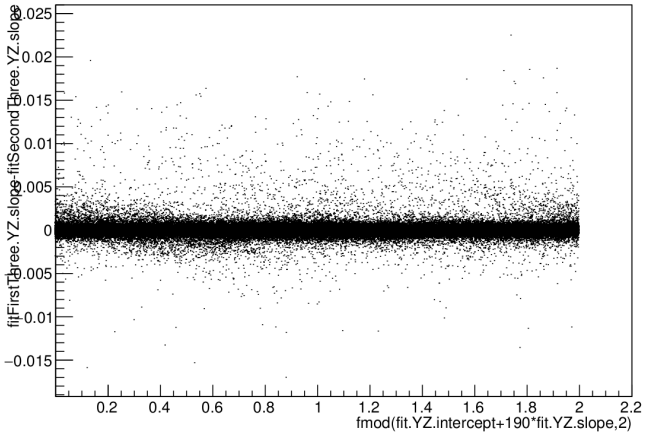
Multiple scattering

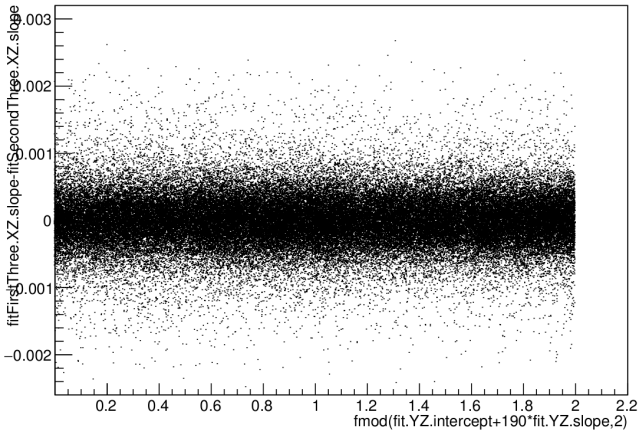




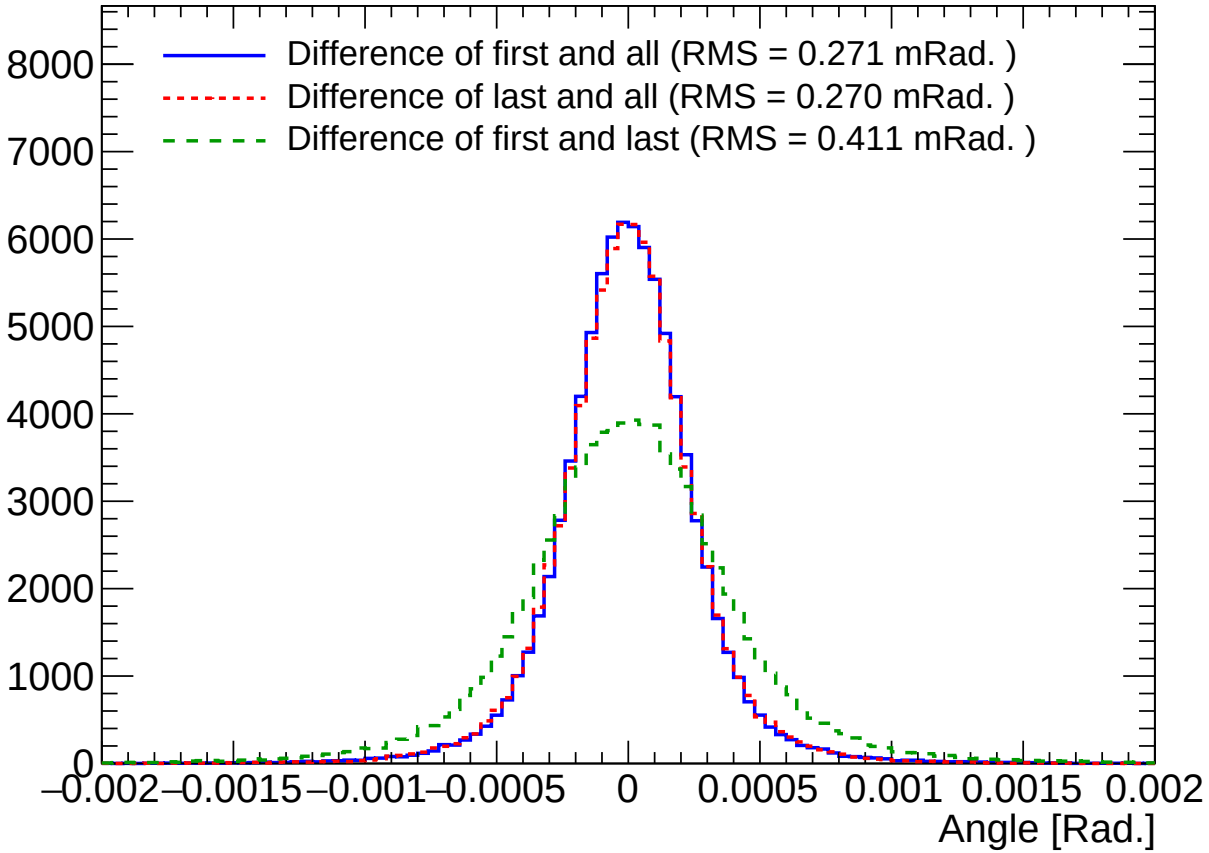
No indication for scattering on e.g. field wires

And after doing the modulus2:





Scattering



$\sigma_{\text{first-all}} \approx \sigma_{\text{last-all}} = 0.270$ mRad

$\sigma_{\text{first-last}} = 0.418$ mRad

$\sqrt{2}\sigma_{\text{first-all}} = 0.382$ mRad

Calculation of scattering

Calculate measurement error using:

- $\sigma_{\text{first}} = \sigma_{\text{last}}$
- Scattering in DUT: θ_{DUT}
- θ_{DUT} only affects total angle by $\theta_{\text{DUT}}/2$
- Neglect σ_{all}

$$\theta_{\text{first}} - \theta_{\text{all}} \rightarrow \qquad \sigma^2_{\text{first-all}} = \sigma^2_{\text{first}} + \sigma^2_{\text{all}} + \sigma^2_{\text{DUT}}/4$$

$$\theta_{\text{first}} - \theta_{\text{last}} \rightarrow \qquad \sigma^2_{\text{first-last}} = 2\sigma^2_{\text{first}} + \sigma^2_{\text{DUT}}$$

Solve for $\sigma_{\text{first-all}} = 0.270$ mRad and $\sigma_{\text{first-last}} = 0.418$ mRad $\rightarrow$
$\sigma_{\text{first}} = \sigma_{\text{last}} = 0.242$ mRad and $\sigma_{\text{DUT}} = 0.241$ mRad
Or in terms of thickness $0.32\%X_0$

Quad resolution

The demonstrated resolution is 42 µm

- 26 µm from quad and statistical telescope error?
- 32 µm from other contributions:
  - 9 µm from deformations in pixel plane
  - 17 µm from deformations in drift direction
  - 26 µm from Telescope / other unknown contributions?

x residual by ToT