Straw beam test data analysis

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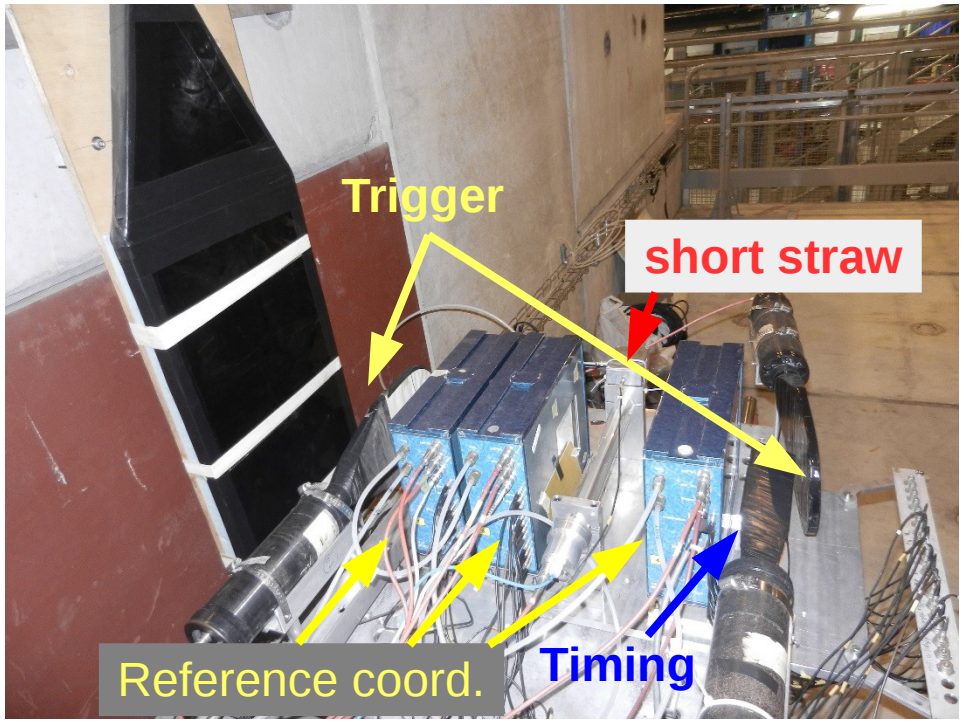
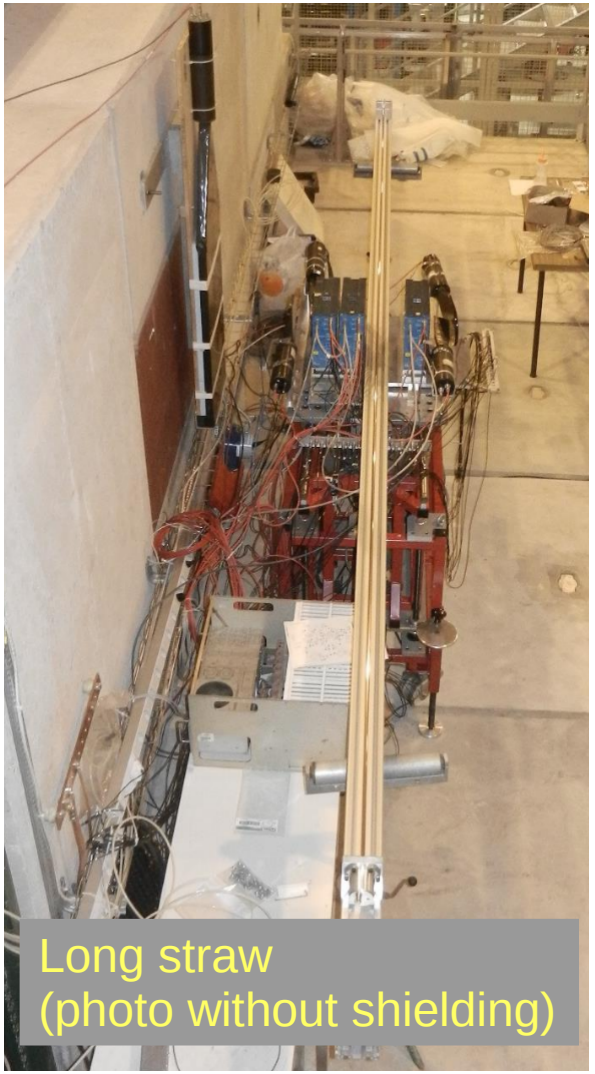
8th SHiP Collaboration Meeting, 13 – 15th June 2016

Testbeam-2015



Parasitic beam test at SPS H8
October – November 2015

- short (40 cm) straw
- long (5 m) straw
- long straw + controlled shift (0.1, 0.2,...0.5) mm



Readout Yu. Guz, Feb16

The signal from trigger, DWC and straw was shaped with CAEN V812 constant fraction discriminators and sent to a 32-ch TDC (CAEN V1290A).

The DWC anode signal amplitudes were measured by a 8-ch ADC (LeCroy 1182).

Long straw - double side read-out

Testbeam analysis

POLYTECH
Peter the Great
St.Petersburg Polytechnic
University

PNPI / SPbPU team joined the testbeam analysis
at the beginning of 2016

PNPI: V. Kim, K. Kuznetsova
SpbPU: Ya. Berdnikov, A. Berdnikov, V. Solovev

- The ongoing analysis : bachelor thesis of V. Solovev
- Further contribution:
  - Possibly participation in testbeam datataking + prompt analysis
  - Further testbeam data analisis
  - Simulation studies of the tracker design within FairSHiP

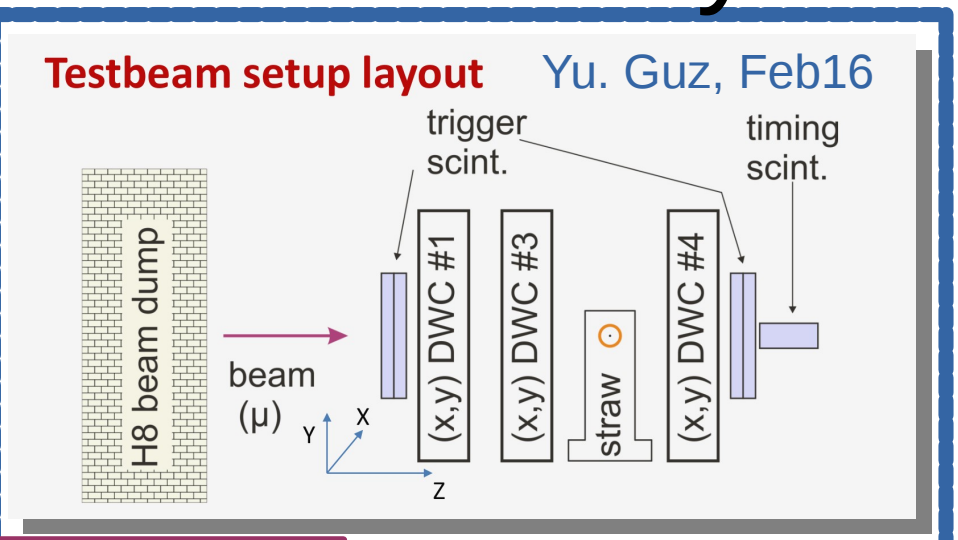
Testbeam analysis

DWC alignment and resolution studies

- 3 (X-Y) DWC stations
- Assuming equal resolution of all chambers, σ:

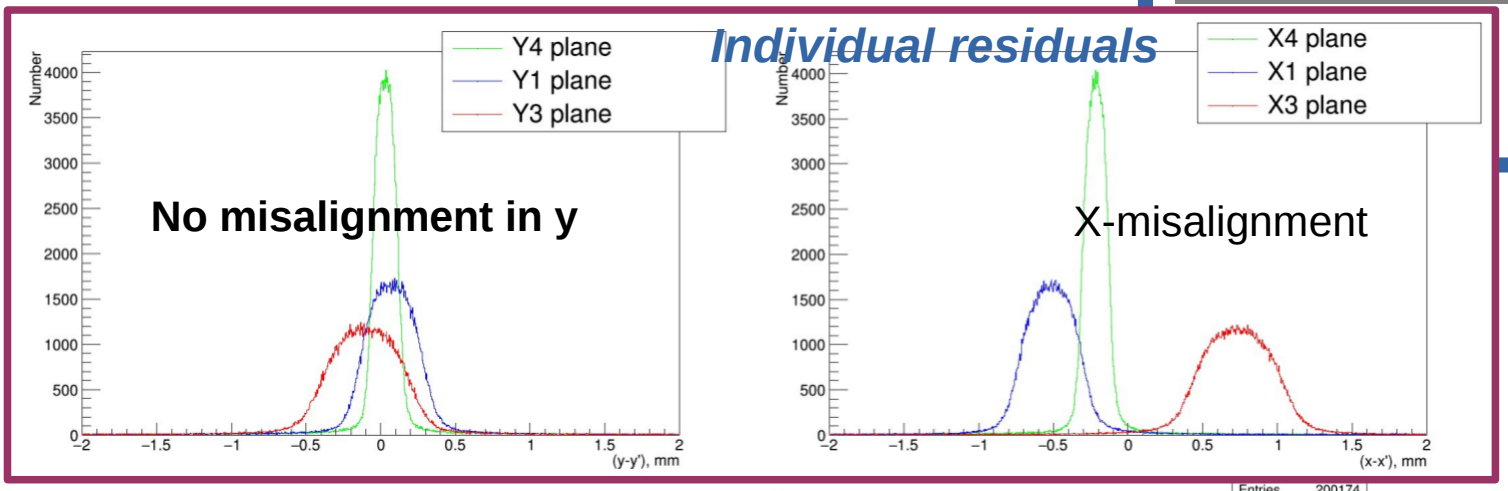
$$\chi^2 = \frac{1}{\sigma^2}\sum(x_o - az - b)^2$$

- Minimizing Chi2 to get track parameters and checking for misaligments:

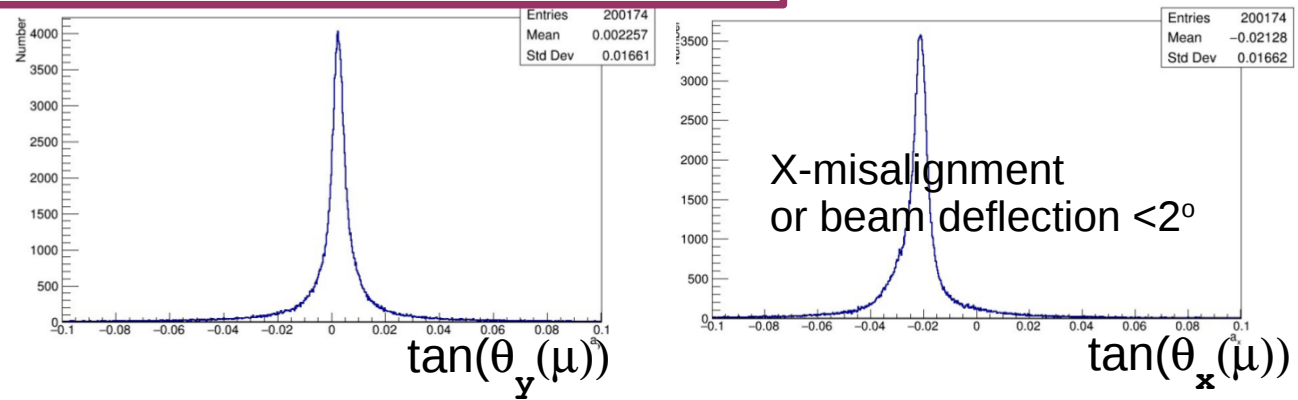


DWC: ~ 12x12 cm
Scint.: ~ 2x5 cm

Individual residuals



Beam divergence:

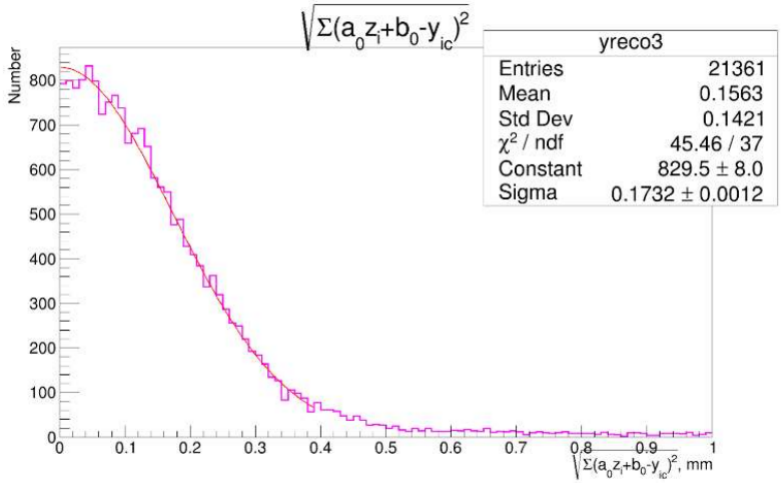


Testbeam analysis

DWC alignment and resolution studies

- No need for y-alignment (but blind for relative “DWC vs straw” shift)
- Additional event cleaning using:
  - scinillator acceptance (DWC edge effects)
  - DWC anode timing (cathode total vs anode time - noise cleaning)
- y-resolution at the straw plane:

- as a root mean square deviation from the track using DWC hits



Assuming almost parallel tracks:

σ_y~RMSD = 171 um / $\sqrt{3}$ ~ 100 um

- as an error on interpolated y-coordinates at the straw plane

Y=az+b, z=255

$$\Delta Y_{int} = \sqrt{\left(\frac{dy}{d(az)}\right)^2 (\Delta(az))^2 + \left(\frac{dy}{d(b)}\right)^2 (\Delta(b))^2 + 2cov\,(az, b)}$$

z=255

$$\left\{ \begin{aligned} \sigma_a^2 &= \frac{3\,\sigma_{DWC}^2}{3\sum z^2 - (\sum z)^2} \\ \sigma_b^2 &= \frac{\sigma_{DWC}^2 \sum z^2}{3\sum z^2 - (\sum z)^2} \\ cov\,(a,b) &= -\frac{\sigma_{DWC}^2 \sum z}{3\sum z^2 - (\sum z)^2} \end{aligned} \right\}$$

$$\Delta a = \sqrt{\sigma_a^2};\ \Delta b = \sqrt{\sigma_b^2};$$

z=z1,z2,z3=30,133,378

Y interpolated error: always near 0.111 mm

Z uncertainty = 1mm

σ_y~111 um

Testbeam analysis

Straw resolution studies

- Obtain V-shape as

  $t = (t_{straw} - t_{scint})$ vs interpolated y^{int}

  long straw: $t_{straw} = (t_{strL} + t_{strR})/2$

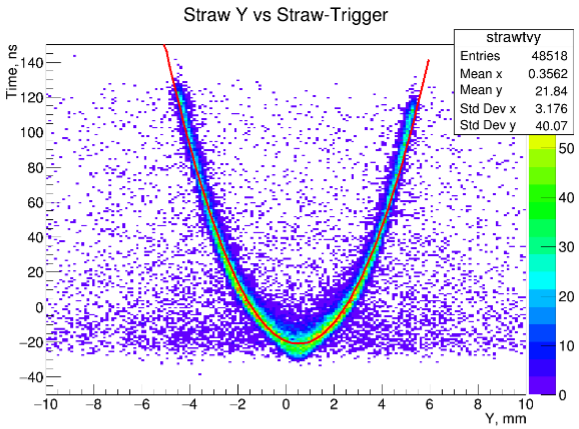
- Get reconstruction y^{reco} as
  - inverse function of fitted $t(y^{int})$ (parabolic fit)

    or
  - bin mapping (more general, work ongoing)

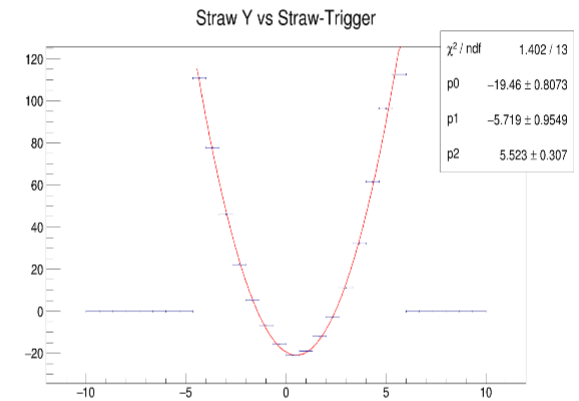
- Obtain resolution from y^{reco} - y^{int} and $\sigma(y^{int})$

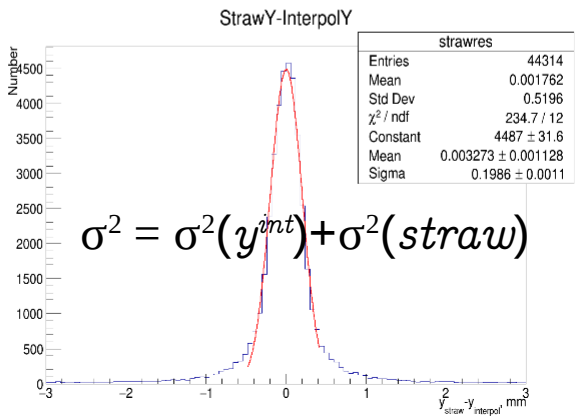
Short straw: σ(straw) ~ 160 μm

104923



SHORT



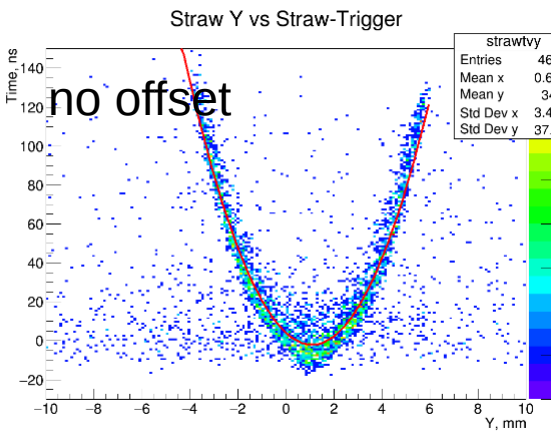


$$\sigma^2 = \sigma^2(y^{int}) + \sigma^2(straw)$$

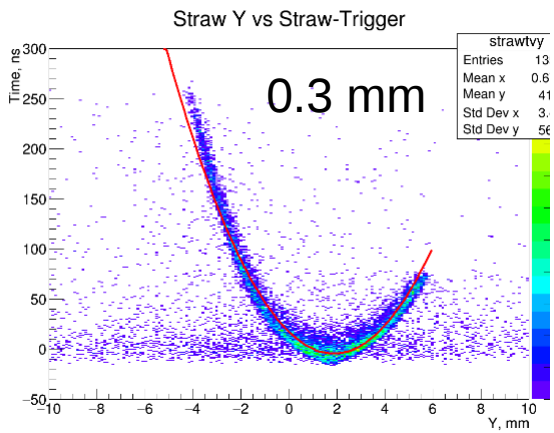
Testbeam analysis

Long straw with shifts:

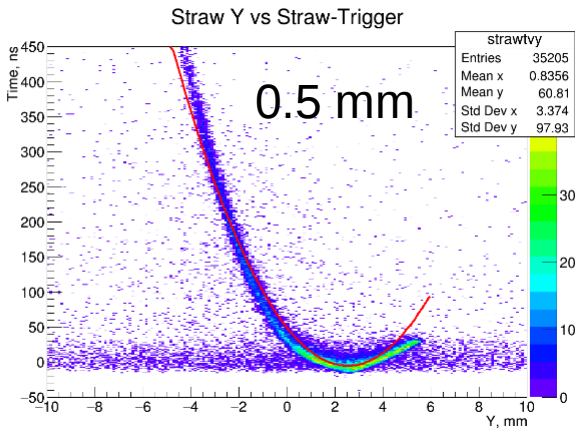
133543



150157 (0.3)



191320 (0.5)

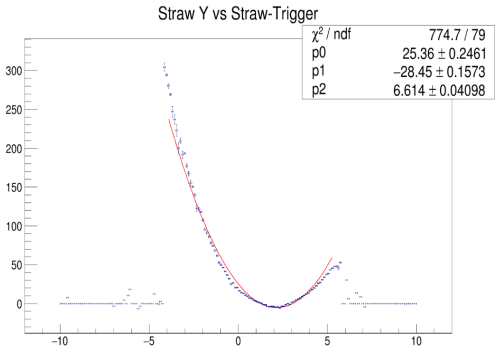


Without the straw offset the non-zero position of the minimum is due to relative misalignment

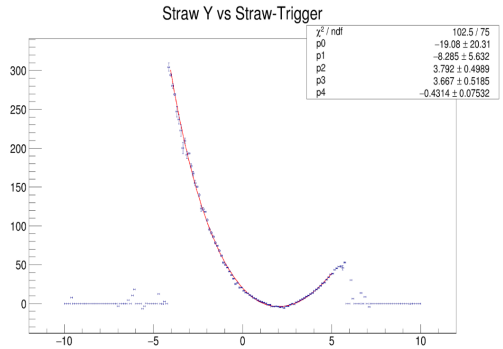
The fitting procedure for large straw offsets is more complicated, mapping may be more preferable

0.4 mm

Pol2 fitting



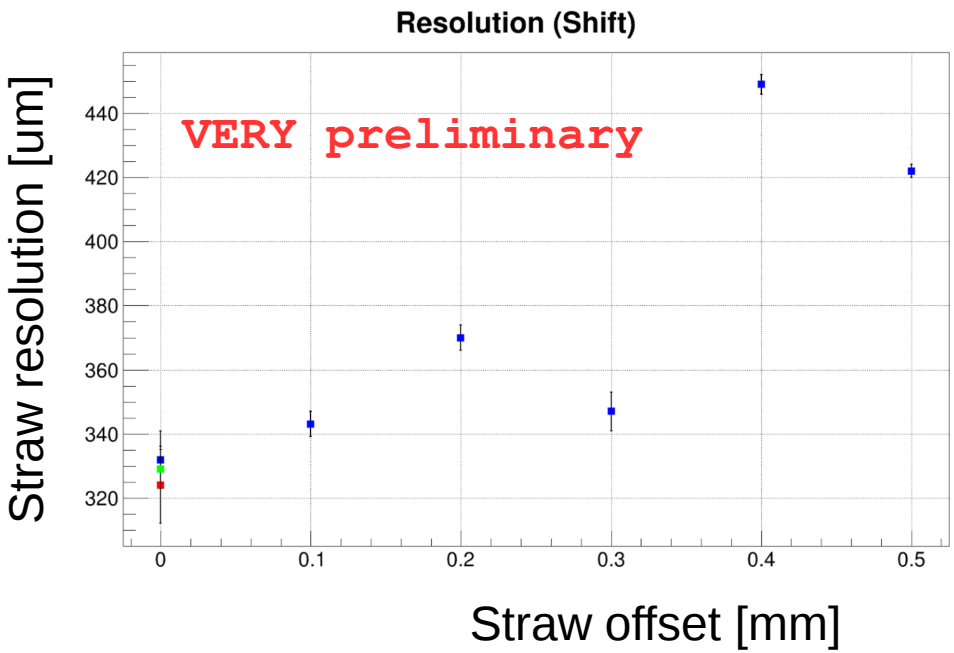
Pol2 + expo fitting

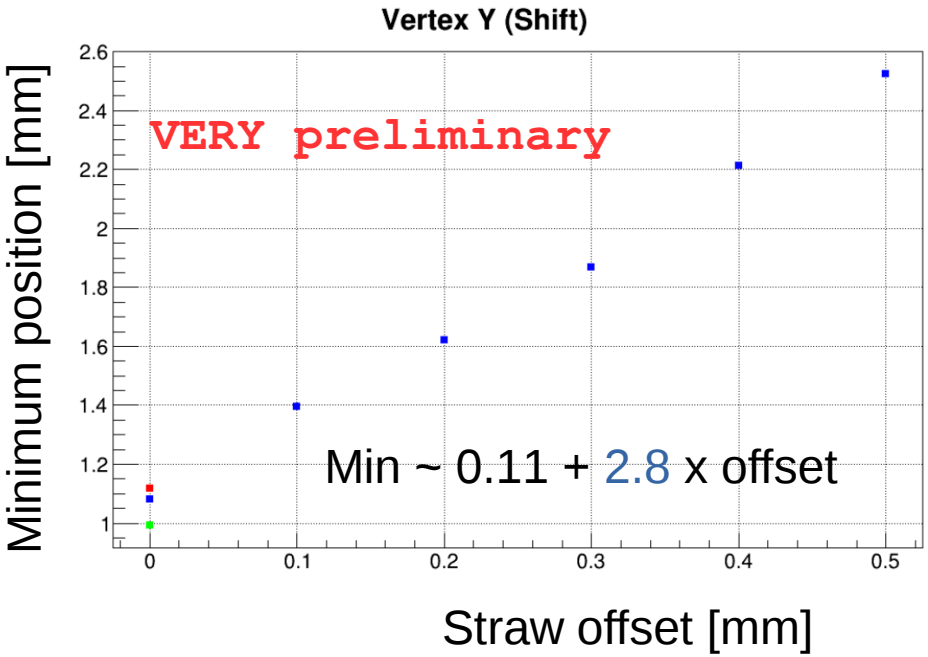


Testbeam analysis

Long straw results

using parabolic fit





Long straw without offset: σ(straw) ~ 330 μm

Fit stability for no or small offsets ~20 μm

The procedure has to be improved for large offsets

Summary

- The resolution of the testbeam tracking system (3 DWCs) is found to be ~110 um

- The straw resolution
  ~ 160 um (40 cm straw)
  ~ 320 um (5 m straw)

Yuri Guz:
the signal amplitude for the long straw is ~3 times lower than in the short straw (L / R + ~30% signal attenuation)

- Further work on the reconstruction procedure for shifted straws is ongoing:
  Improvement of y-reconstruction
  - better fit function
  - mapping

- More contribution from PNPI / SPbPU team is planned:
  - Finalizing the testbeam-15 data analysis
  - Prompt feedback + further analysis with testbeam-16 data
  - ...simulations studies