Straw beam test
data analysis

A. Berdnikov, Ya. Berdnikov, V. Kim, K. Kuznetsova, V. Solovev

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Parasitic beam test at SPS H8
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- 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).
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 analysis
  - 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, $\sigma$:
  \[ \chi^2 = \frac{1}{\sigma^2} \sum (x_o - az - b)^2 \]
- Minimizing Chi2 to get track parameters and checking for misalignments:
  
  **Individual residuals**
  
  No misalignment in y
  
  X-misalignment

  **Beam divergence:**
  
  X-misalignment or beam deflection $< 2^\circ$
Testbeam analysis

DWC alignment and resolution studies

- No need for y-alignment (but blind for relative “DWC vs straw” shift)
- Additional event cleaning using:
  - scintillator 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
  \[ \sigma_y \sim \text{RMSD} = 171 \text{ um} / \sqrt{3} \sim 100 \text{ um} \]

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

Assuming almost parallel tracks:

\[ \sigma_y \sim 111 \text{ um} \]

\[
\begin{align*}
\Delta Y_{int} &= \sqrt{\left( \frac{dy}{d(az)} \right)^2 (\Delta(az))^2 + \left( \frac{dy}{d(b)} \right)^2 (\Delta(b))^2 + 2\text{cov}(az,b)} \\
Y &= az + b, \; z=255 \\
\Delta a &= \sqrt{\sigma_a^2}; \; \Delta b = \sqrt{\sigma_b^2}; \\
\sigma_a^2 &= \frac{3 \sigma_{DWC}^2}{\sum z^2 - (\sum z)^2} \\
\sigma_b^2 &= \frac{\sigma_{DWC}^2 \sum z}{3 \sum z^2 - (\sum z)^2} \\
cov(a,b) &= \frac{\sigma_{DWC}^2 \sum z}{3 \sum z^2 - (\sum z)^2}
\end{align*}
\]

\[ z = z1, z2, z3 = 30, 133, 378 \]

Y interpolated error: always near 0.111 mm

Z uncertainty = 1mm
Testbeam analysis

Straw resolution studies

- Obtain V-shape as
  \[ t = (t_{\text{straw}} - t_{\text{scint}}) \text{ vs interpolated } y^{\text{int}} \]
  long straw: \[ t_{\text{straw}} = \frac{(t_{\text{strL}} + t_{\text{strR}})}{2} \]

- Get reconstruction \( y^{\text{reco}} \) as
  - inverse function of fitted \( t(y^{\text{int}}) \) (parabolic fit)
  - bin mapping (more general, work ongoing)

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

Short straw: \( \sigma(\text{straw}) \sim 160 \, \mu\text{m} \)

\[ \sigma^2 = \sigma^2(y^{\text{int}}) + \sigma^2(\text{straw}) \]
Testbeam analysis

Long straw with shifts:

- no offset
- 0.3 mm
- 0.5 mm
- 0.4 mm

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.
Testbeam analysis

Long straw results using parabolic fit

Long straw without offset: $\sigma_{\text{straw}} \sim 330 \, \mu m$

Fit stability for no or small offsets $\sim 20 \, \mu m$

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)

- 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

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