RICH Alignment

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Study RICH alignment with more statistics:

- Compute x_{ring}-x_{SPFit} and y_{ring}-y_{SPFit}

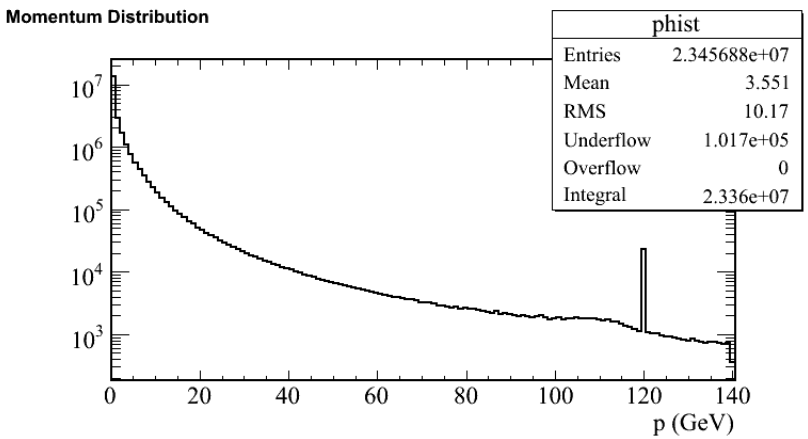
  (x_{ring}, y_{ring}) – RICH ring PMT digits

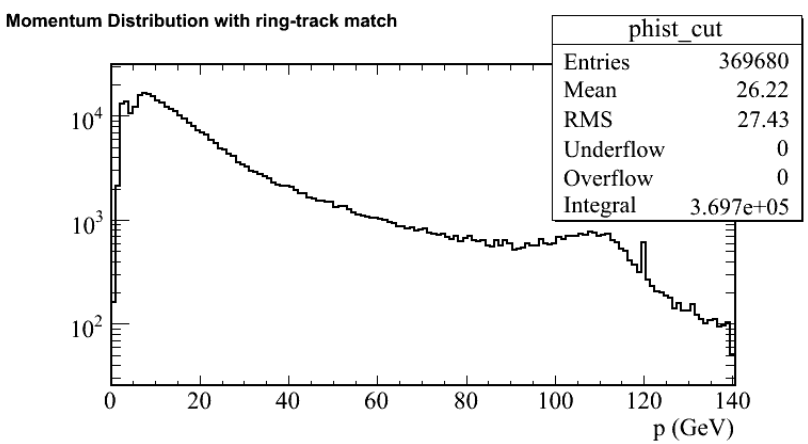
  (x_{SPFit}, y_{SPFit}) – reflected track position
- DST files used for analysis:

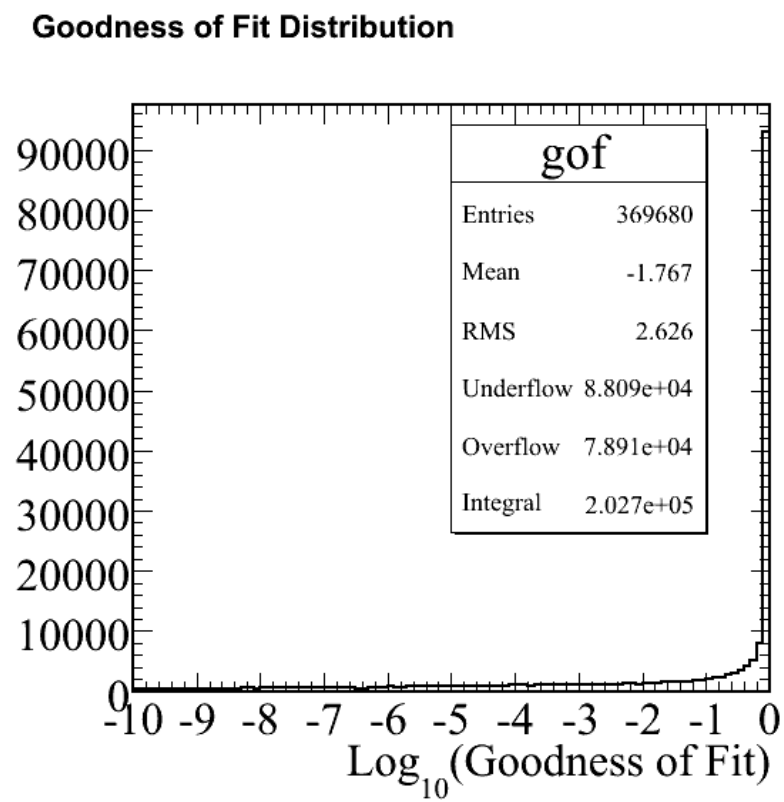
  438 NuMI target subruns
- General Cuts:

  1. Good beam: n_{beam}=1 & $|x_{beam}|$<0.5cm & $|y_{beam}|$<0.5cm
  2. Multiple good tracks: n_{trk}>1 & $|x_{trk}|$<10cm & $|y_{trk}|$<10cm
  3. p <= 140 GeV

Track Quality After Cuts



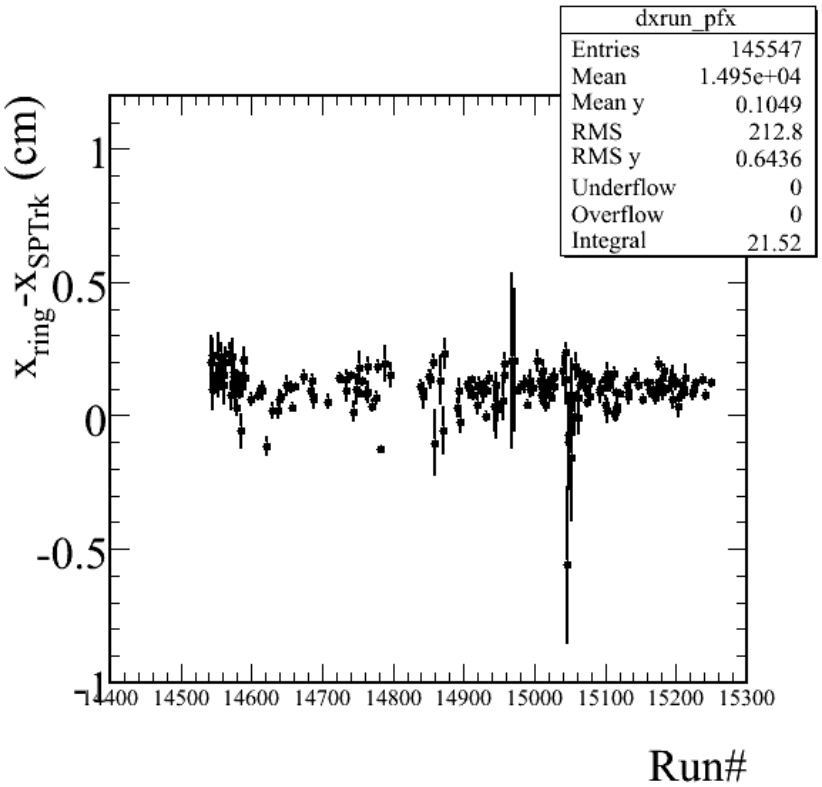




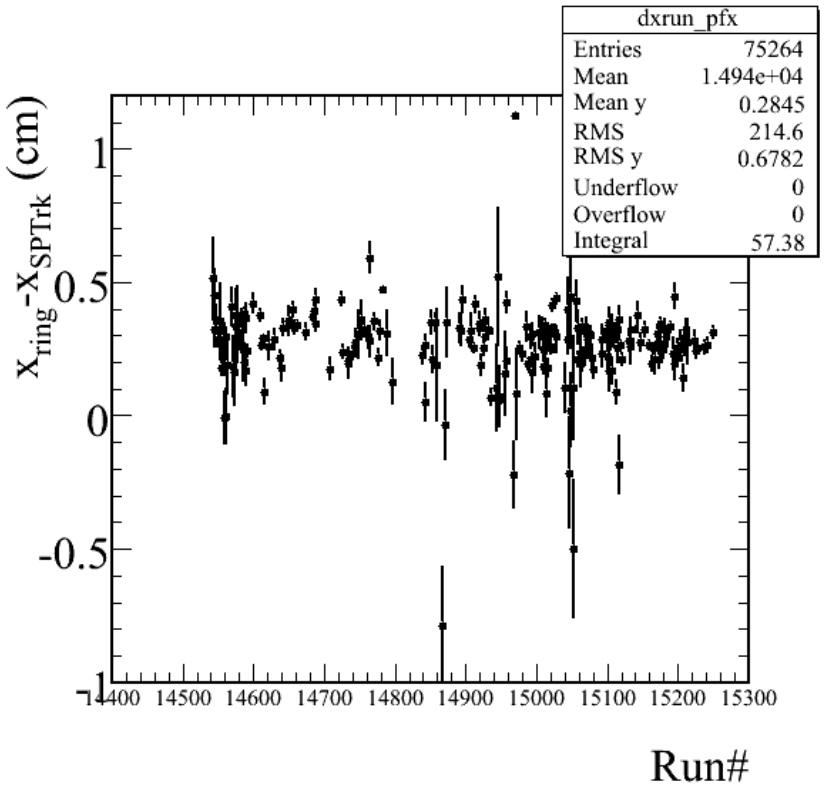
Extra cuts: "rich-track match" & gof>0.01 & charge

$x_{ring} - x_{SPtrk}$ vs. Run

Positive tracks

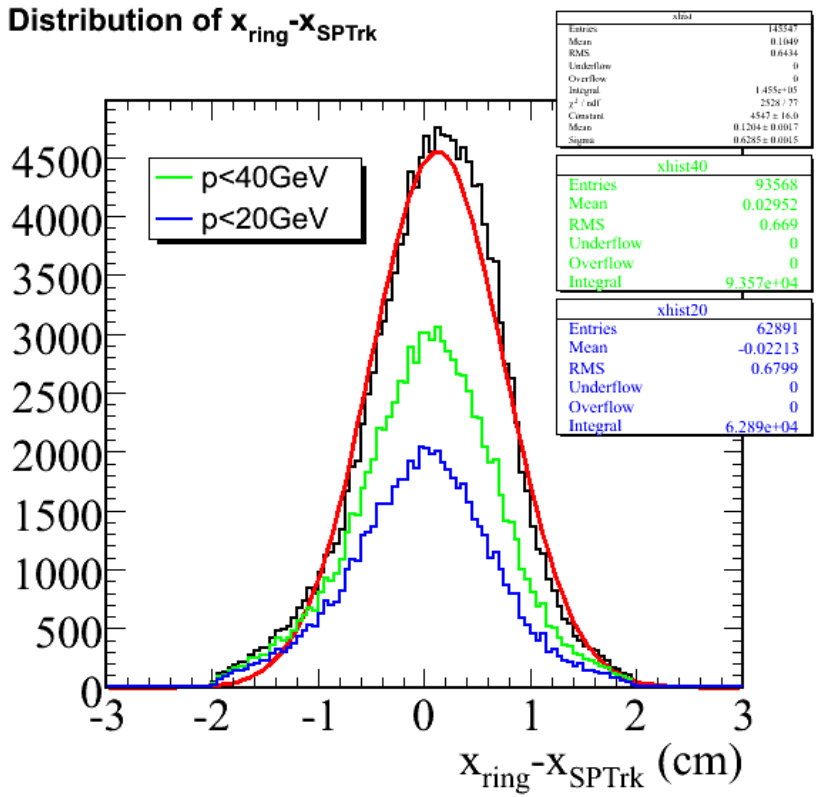


Negative tracks

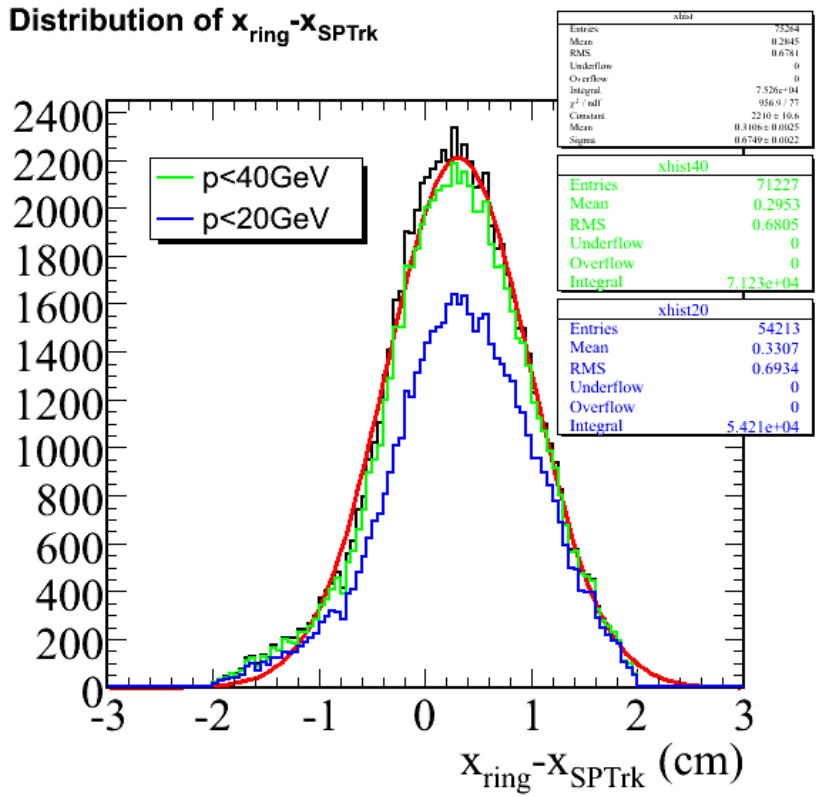


Distribution of $x_{ring}-x_{SPtrk}$ on PMT

Positive tracks



Negative tracks

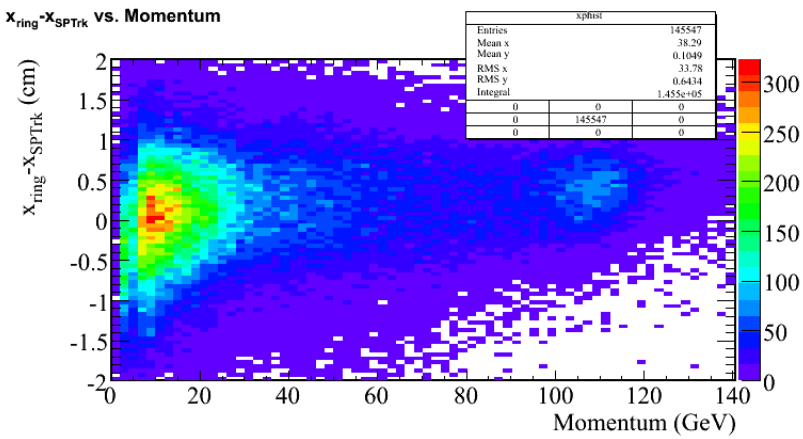


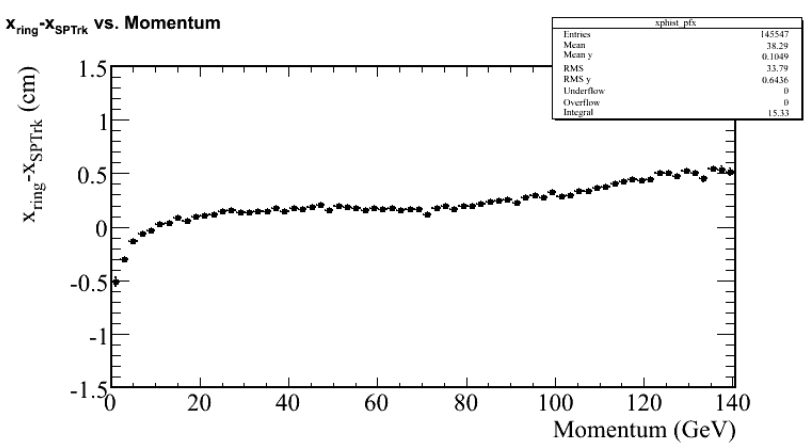
mean 0.1204 ± 0.0017cm
RMS 0.6285 ± 0.0015 cm

mean 0.3106 ± 0.0025 cm
RMS 0.6749 ± 0.0022 cm

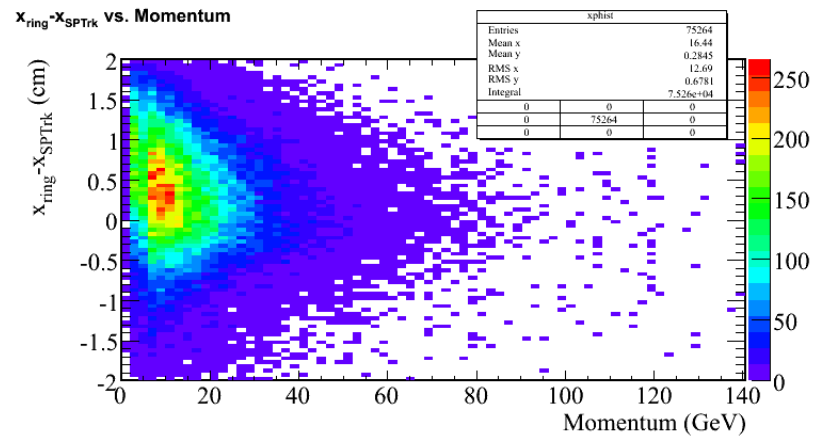
$x_{ring} - x_{SPtrk}$ vs. momentum

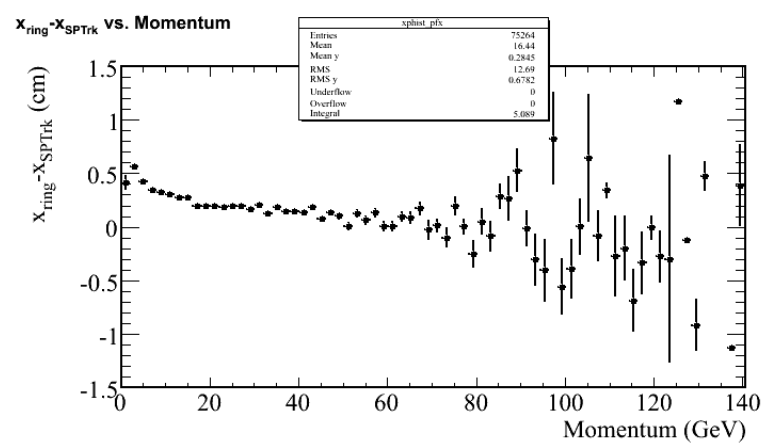
Positive tracks





Negative tracks

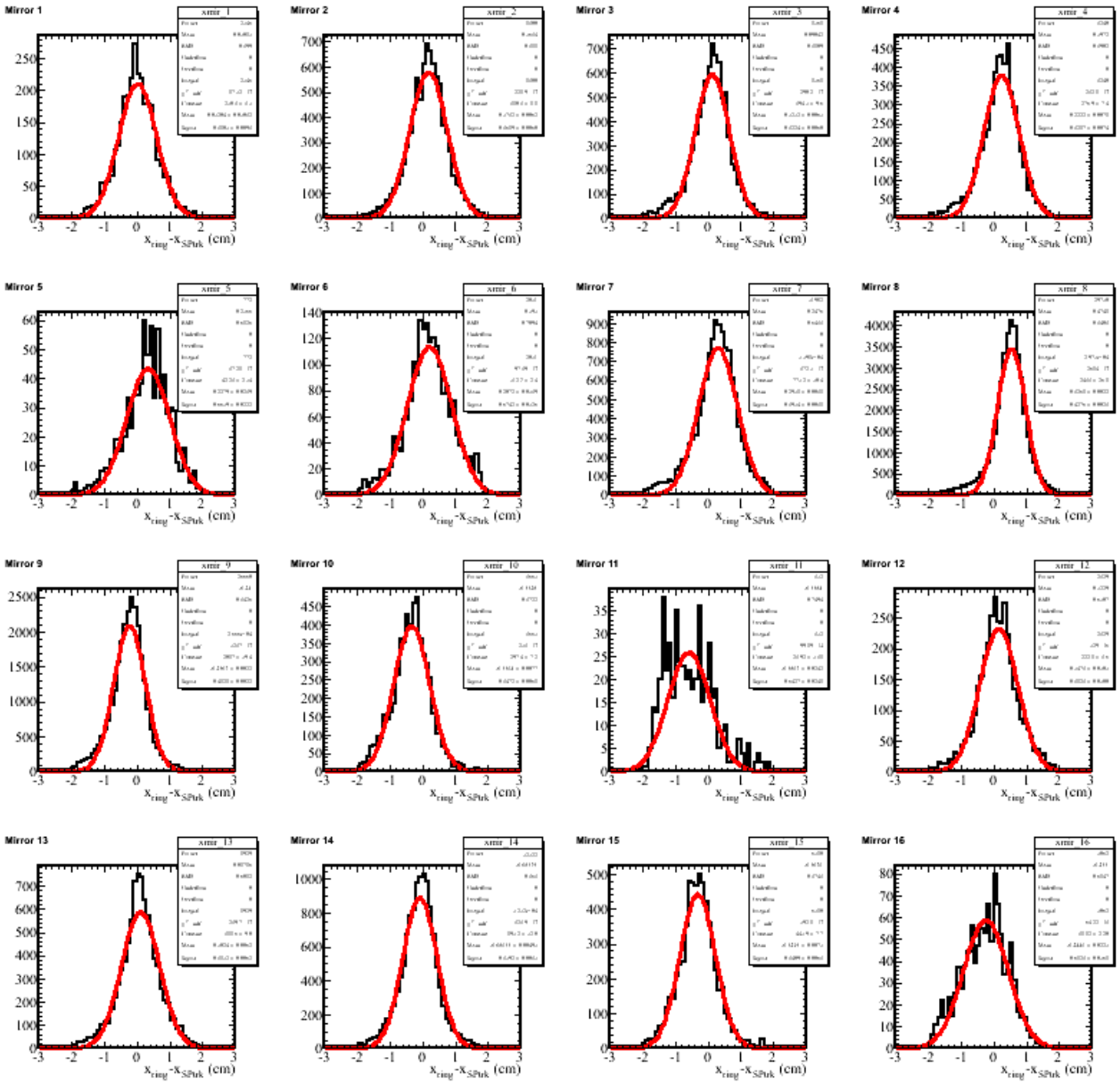




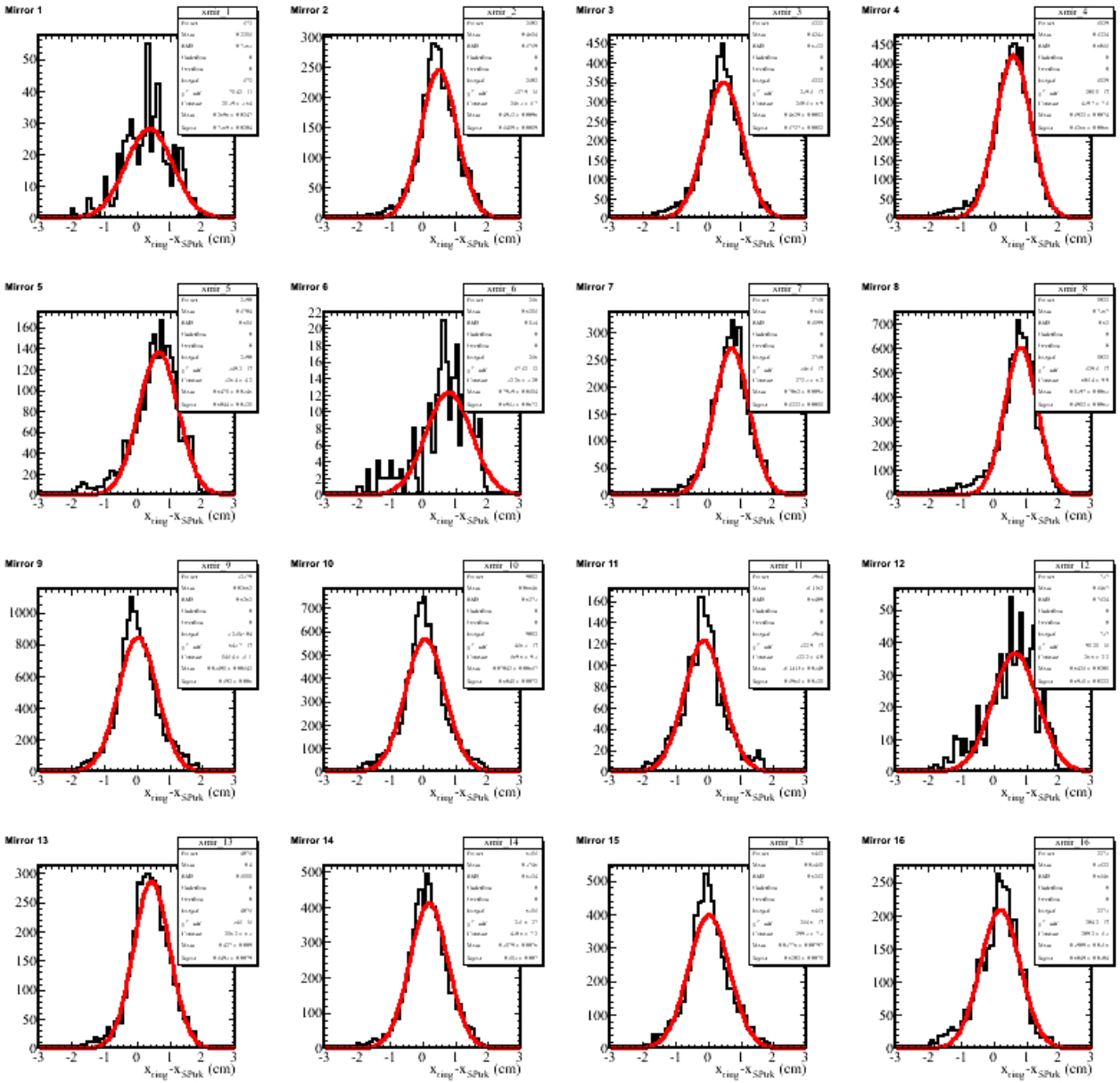
x_{ring}-x_{SPtrk} increases with p for +ve tracks

x_{ring}-x_{SPtrk} decreases with p for -ve tracks

Positive: $x_{ring} - x_{SPtrk}$ for each mirror

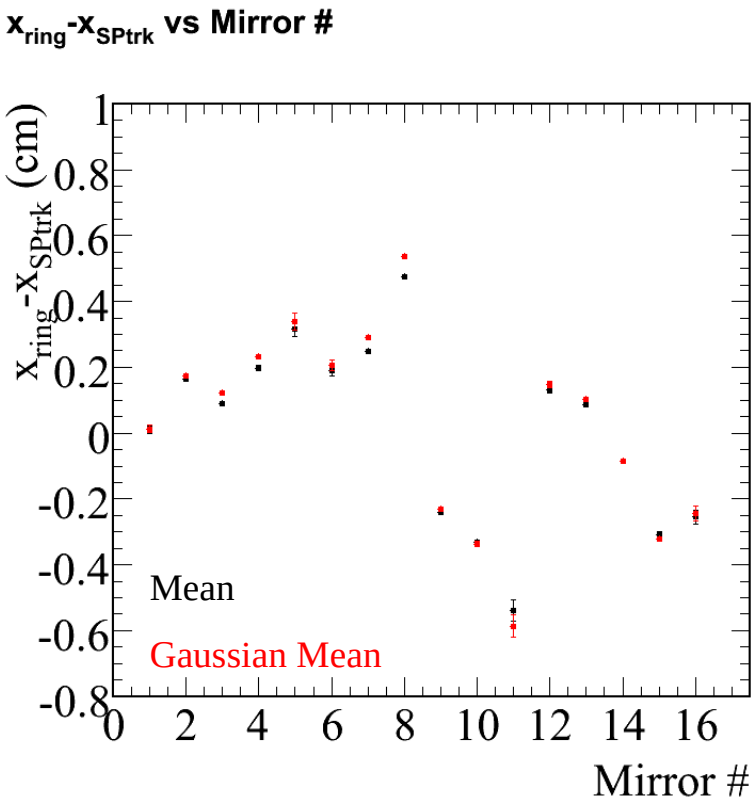


Negative: $x_{ring} - x_{SPtrk}$ for each mirror

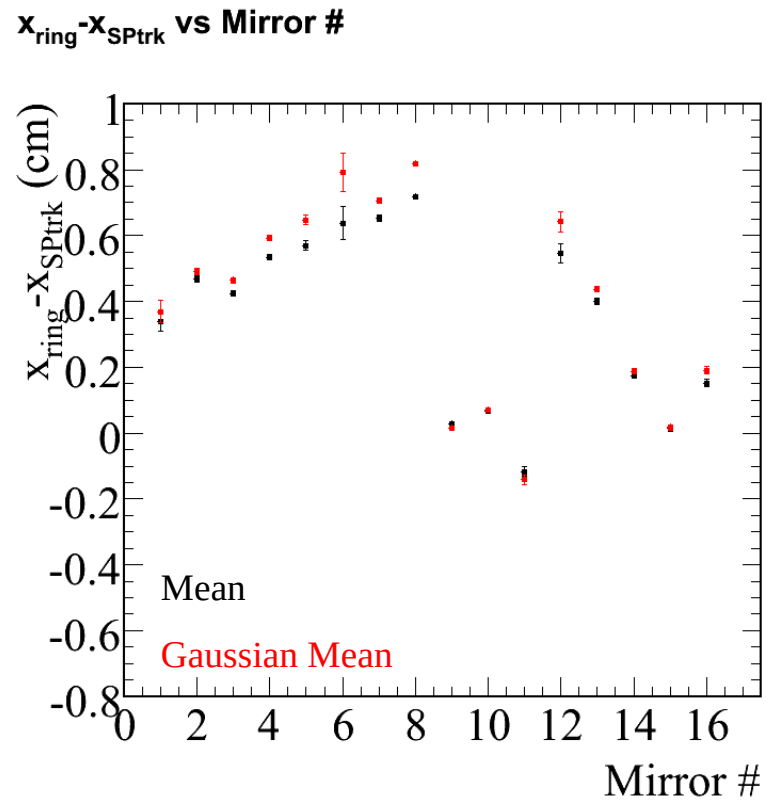


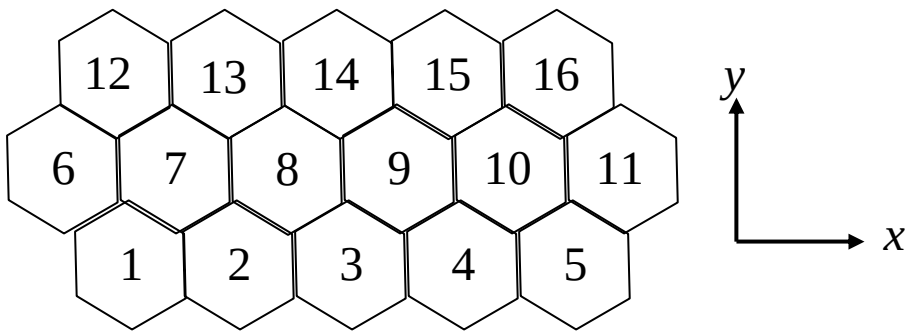
$x_{ring} - x_{SPtrk}$ vs Mirror

Positive tracks



Negative tracks



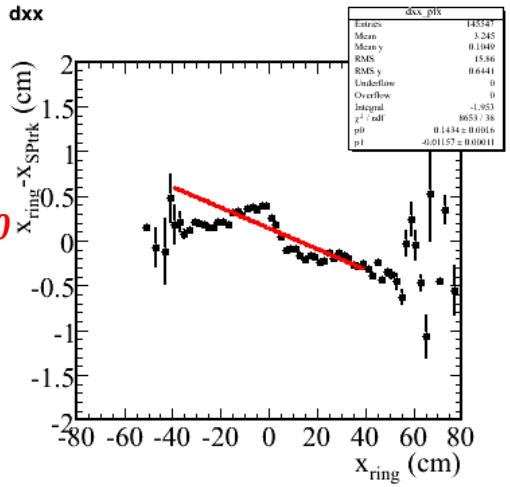


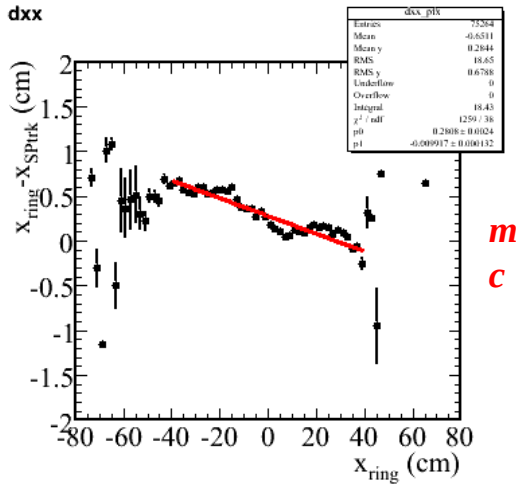
- ***Mirror-to-mirror variations of order 1.2cm***
- ***Similar trend for positive and negative tracks, apart from a constant offset of ~3mm between them***

$x_{ring} - x_{SPtrk}$ vs x_{ring} & y_{ring}

Positive tracks **Negative tracks**

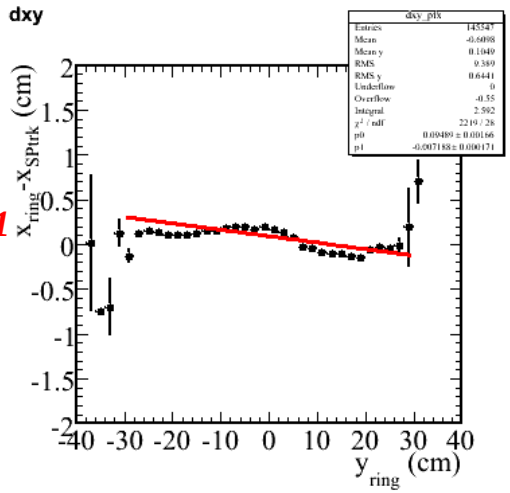
m = -0.011565 ± 0.000110
c = 0.143418 ± 0.001582

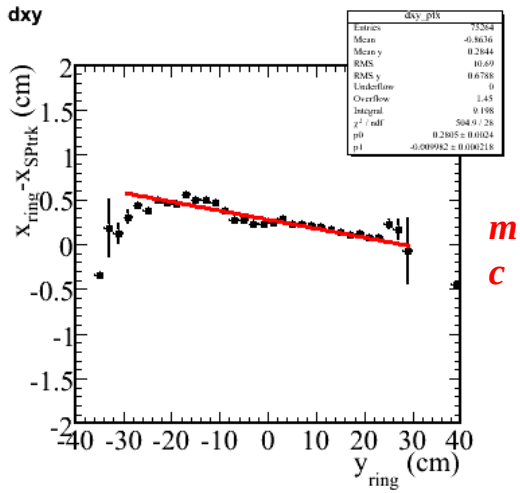




m = -0.009917 ± 0.000132
c = 0.280764 ± 0.002366

m = -0.007188 ± 0.000171
c = 0.094895 ± 0.001659





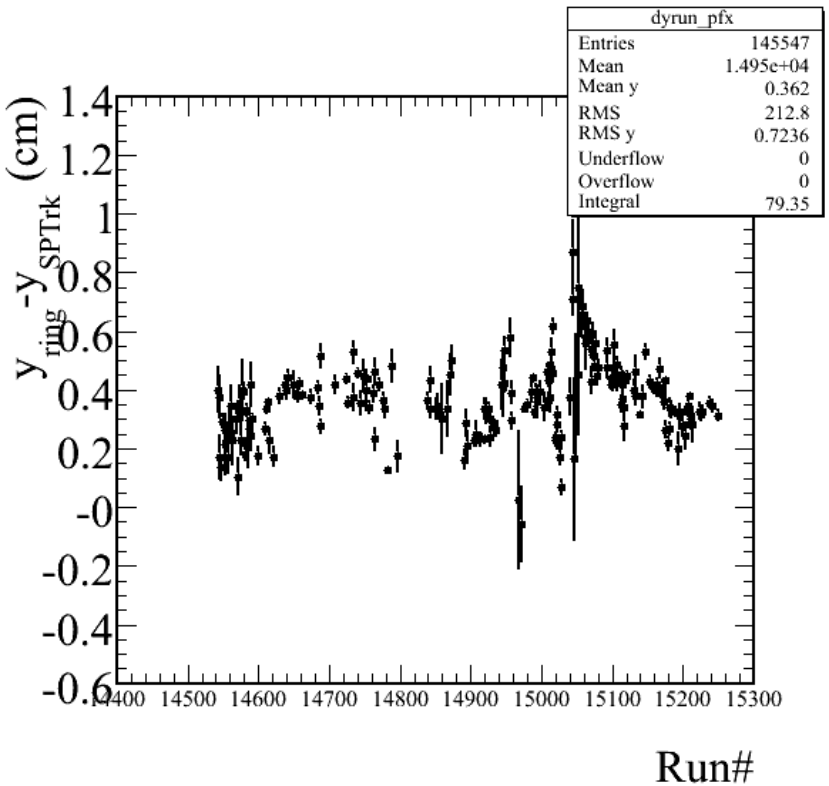
m = -0.009982 ± 0.000218
c = 0.280480 ± 0.002424

x_{ring}-x_{SPtrk} decreases with x_{ring} and y_{ring} for +ve and –ve tracks

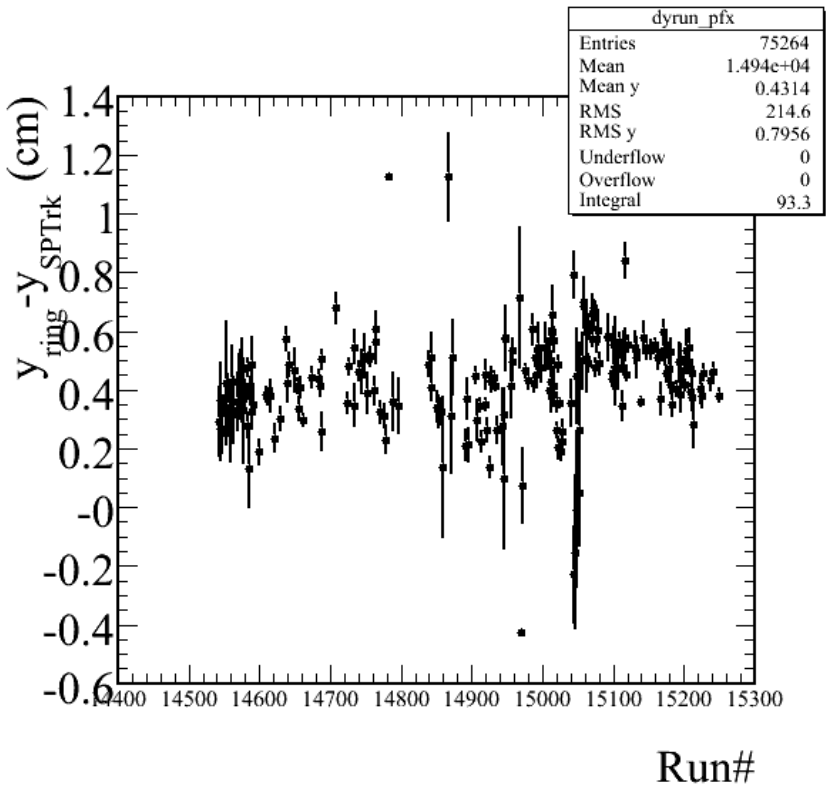
Constant offset between +ve and –ve tracks!!!

$y_{ring} - y_{SPtrk}$ vs. Run

Positive tracks

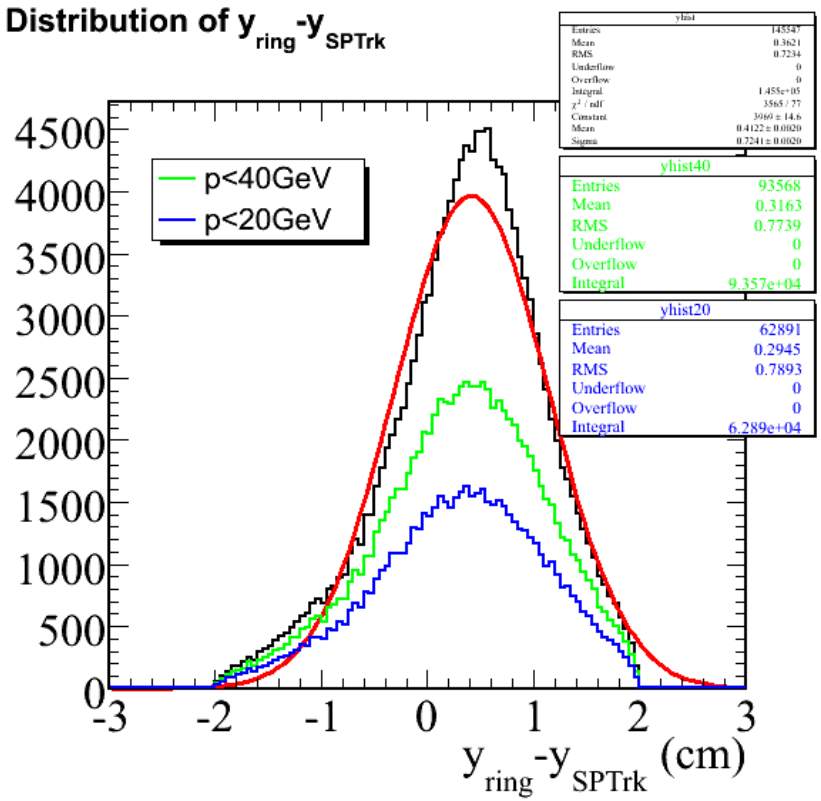


Negative tracks

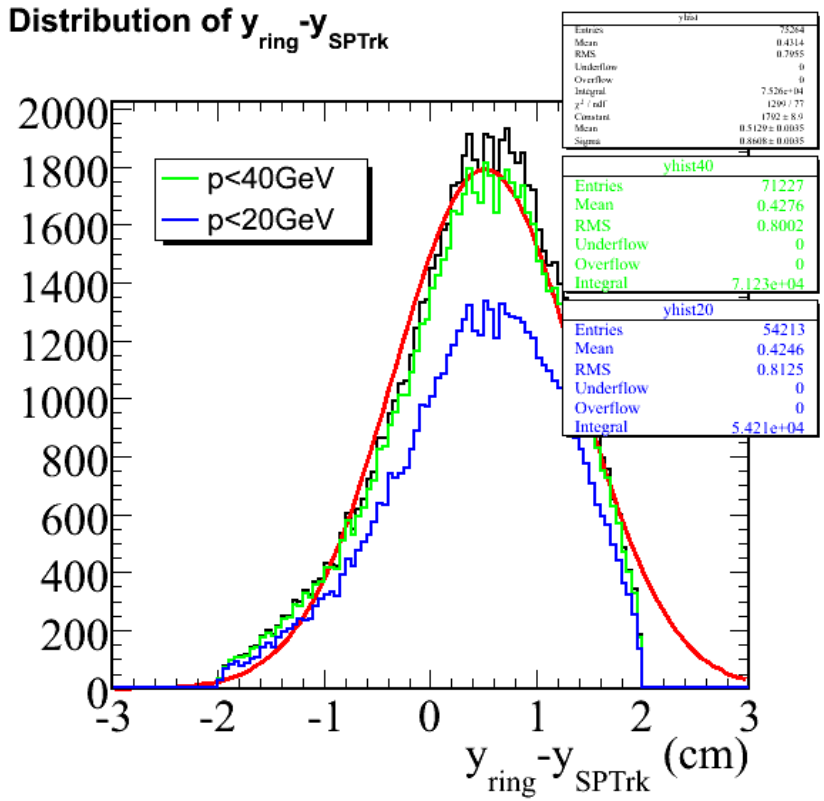


Distribution of $y_{ring}-y_{SPtrk}$ on PMT

Positive tracks



Negative tracks

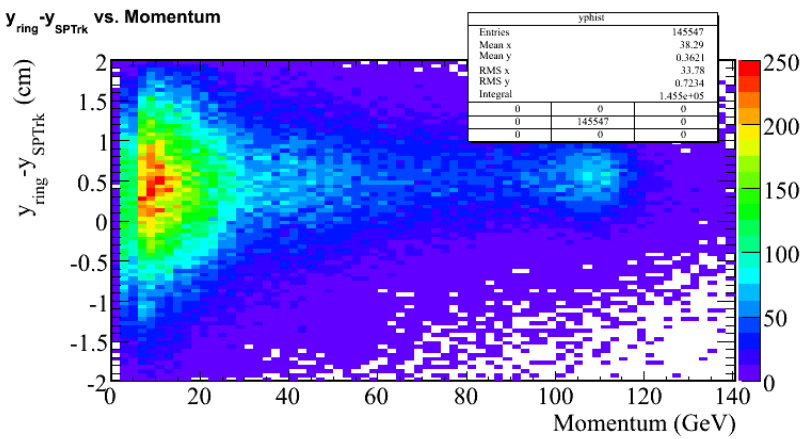


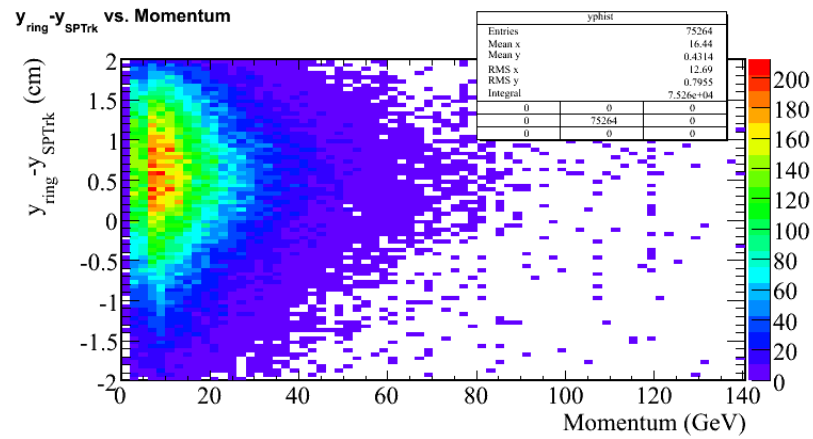
mean 0.4122 ± 0.0020cm
RMS 0.7241 ± 0.0020 cm

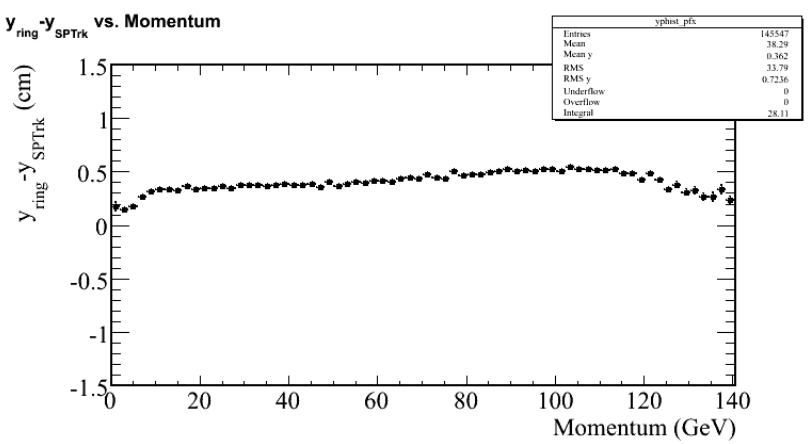
mean 0.5129 ± 0.0035 cm
RMS 0.8608 ± 0.0035 cm

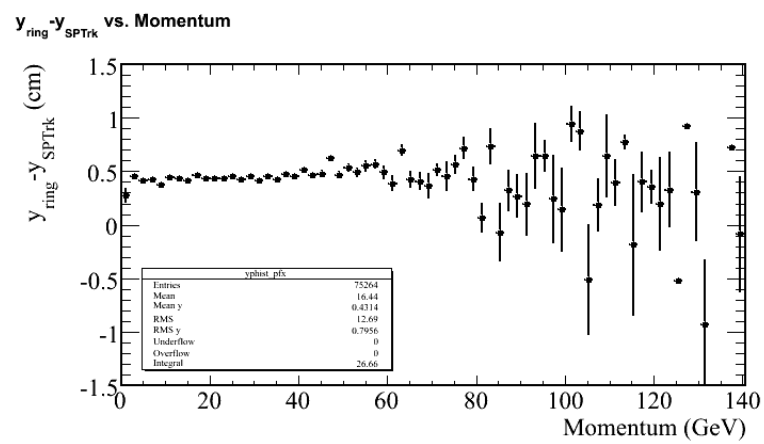
$y_{ring}-y_{SPtrk}$ vs. momentum

Positive tracks **Negative tracks**





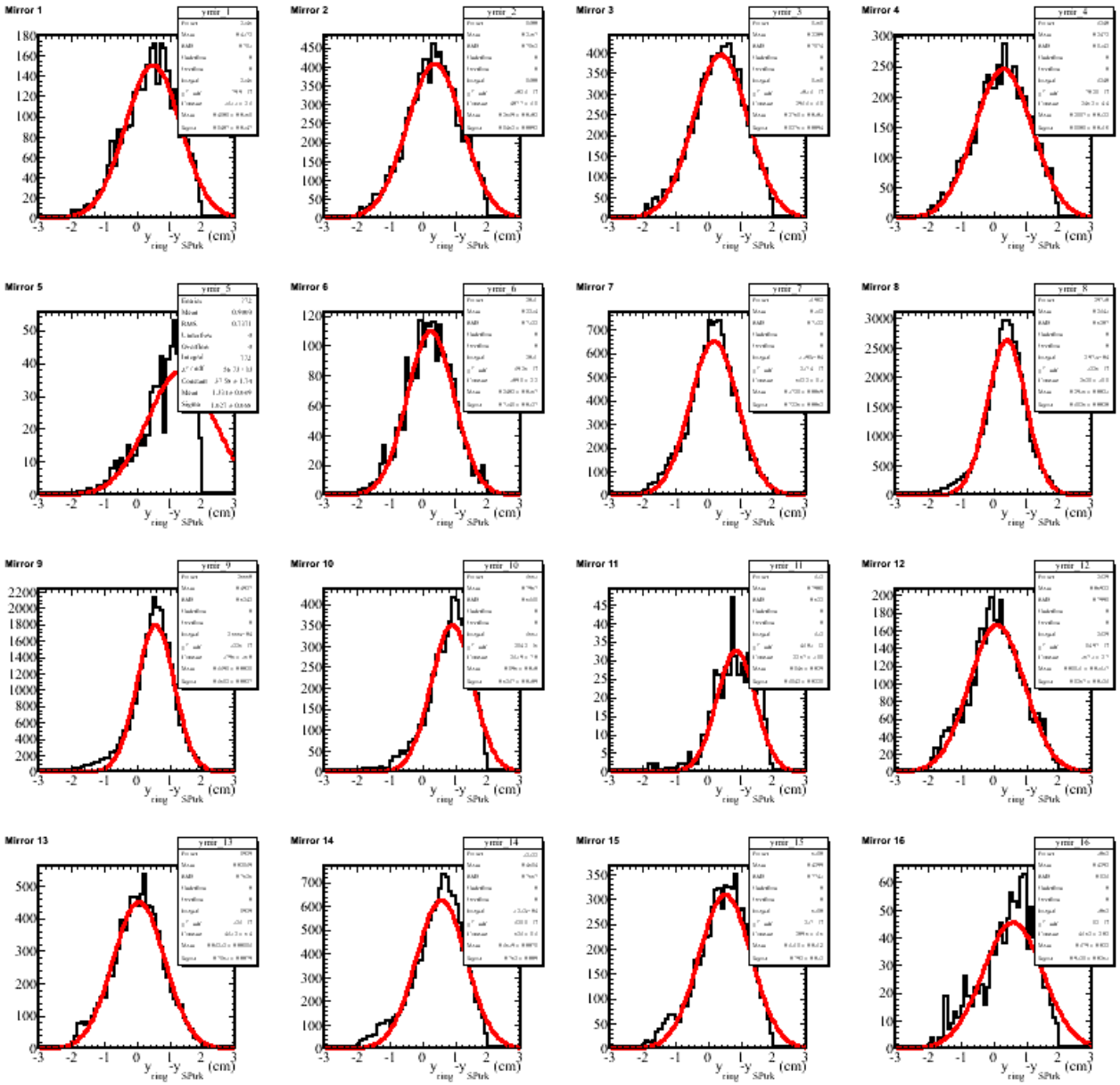




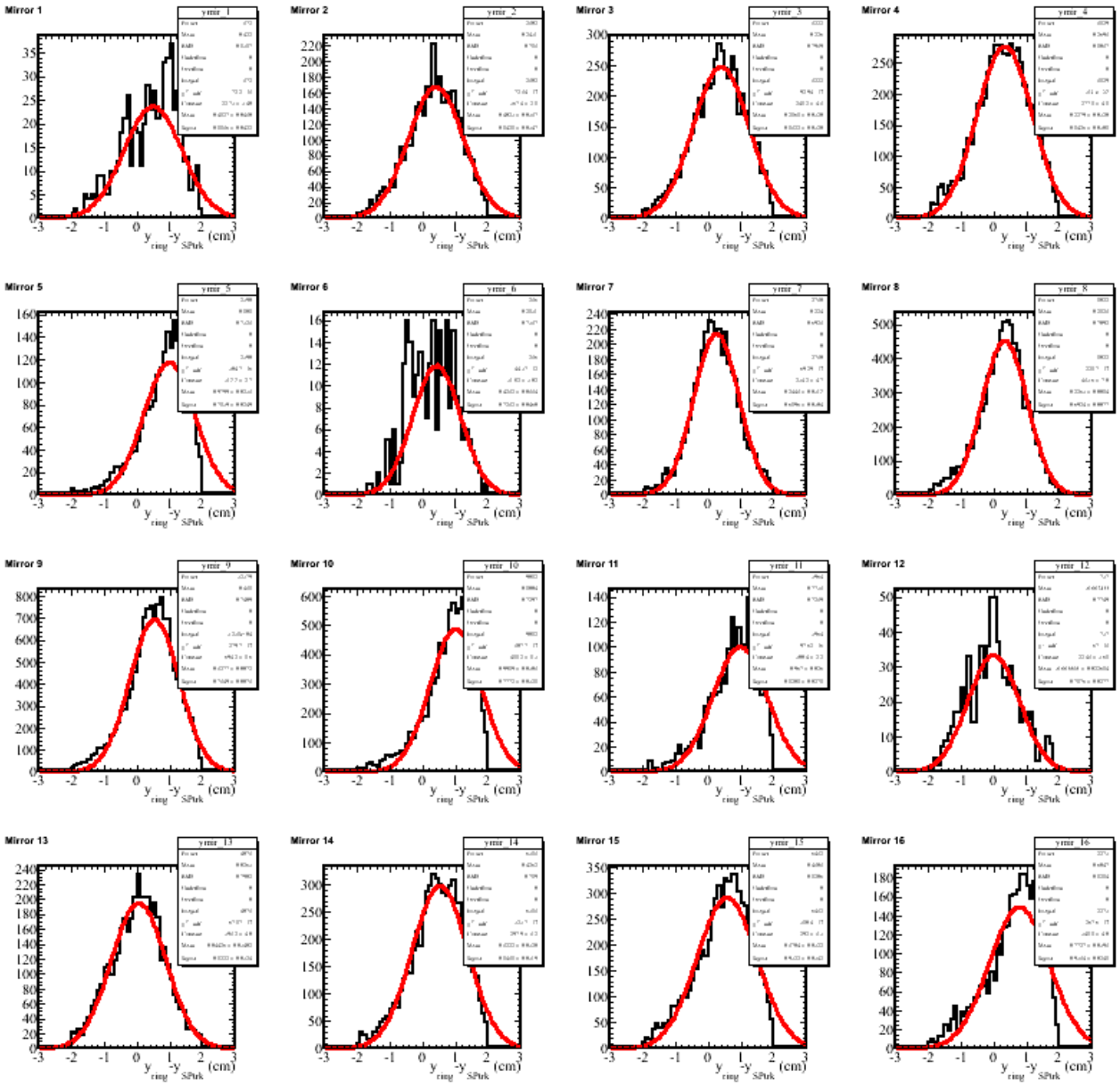
y_{ring}-y_{SPtrk} increases with p for +ve tracks (for p<110GeV)

y_{ring}-y_{SPtrk} does not seem to change with p for -ve tracks

Positive: $y_{ring} - y_{SPtrk}$ for each mirror

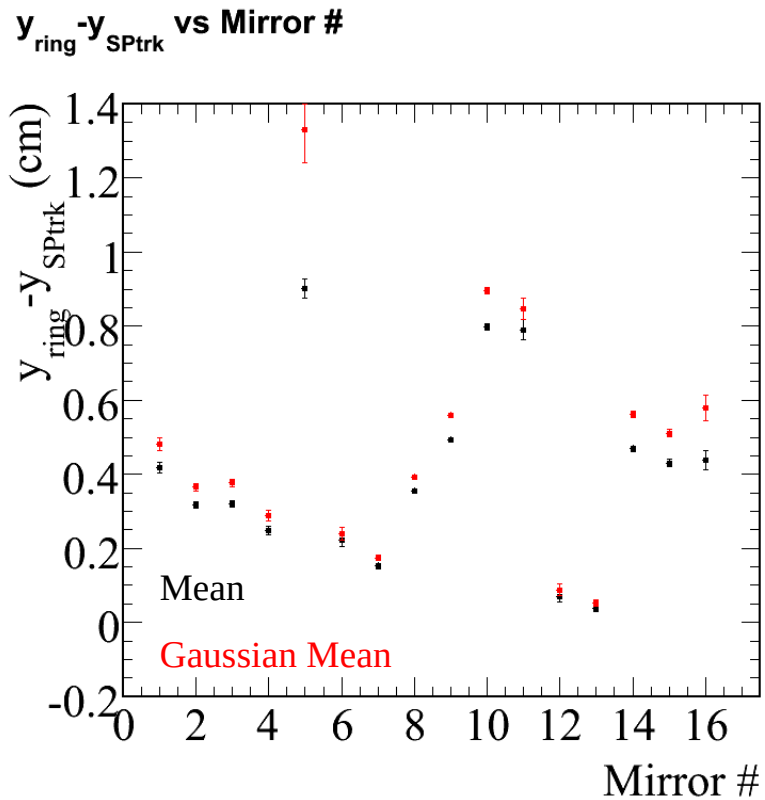


Negative: $y_{ring} - y_{SPtrk}$ for each mirror

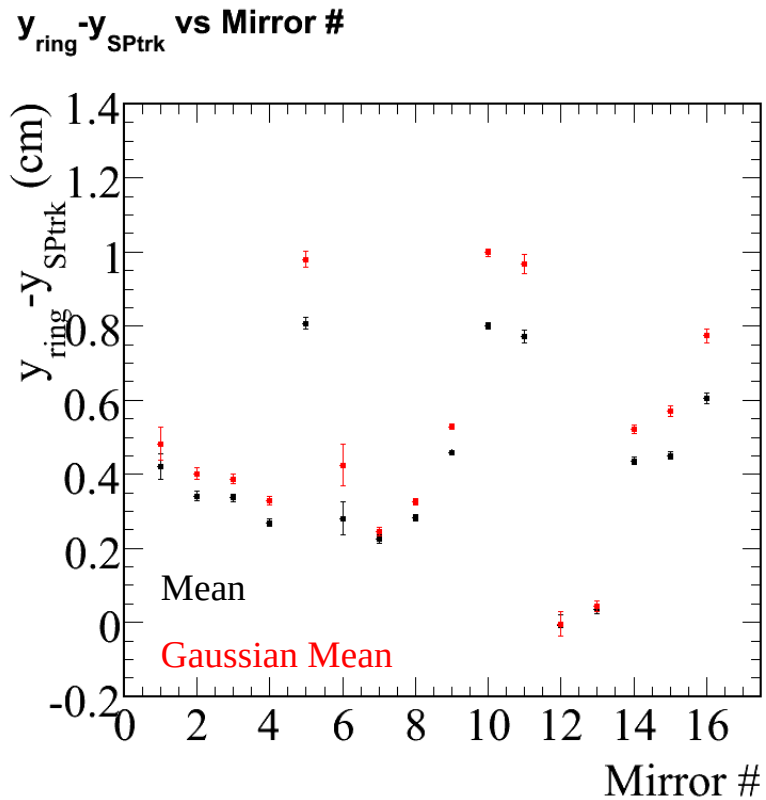


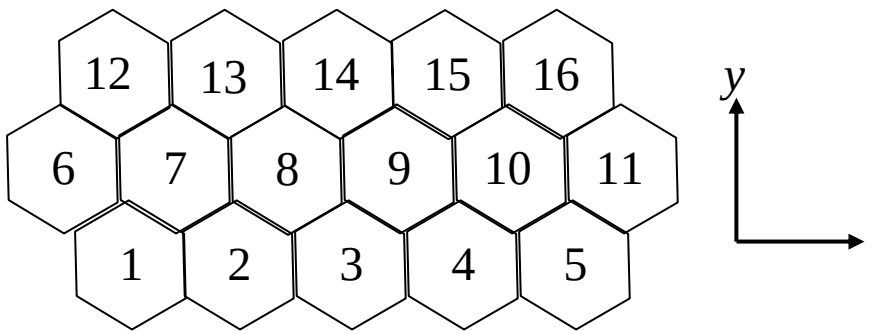
$y_{ring} - y_{SPtrk}$ vs Mirror

Positive tracks



Negative tracks



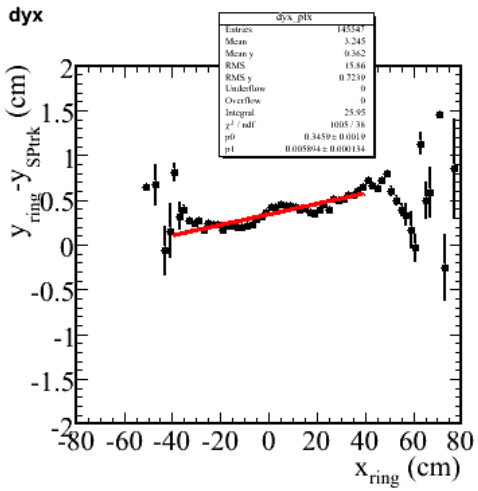


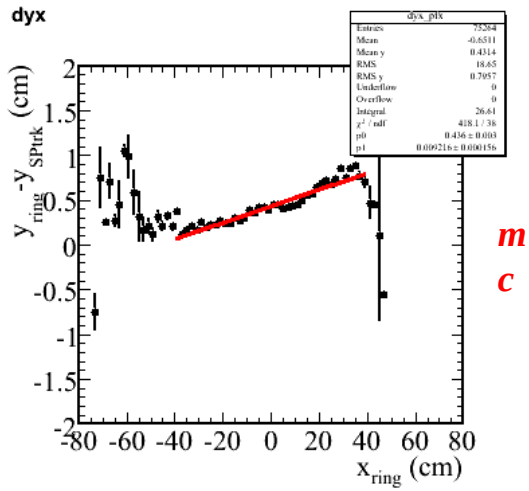
- *Overall spread is ~1cm*
- *Same trends for positive and negative tracks, with a constant offset of <1mm between them*

$y_{ring} - y_{SPtrk}$ vs x_{ring} & y_{ring}

Positive tracks **Negative tracks**

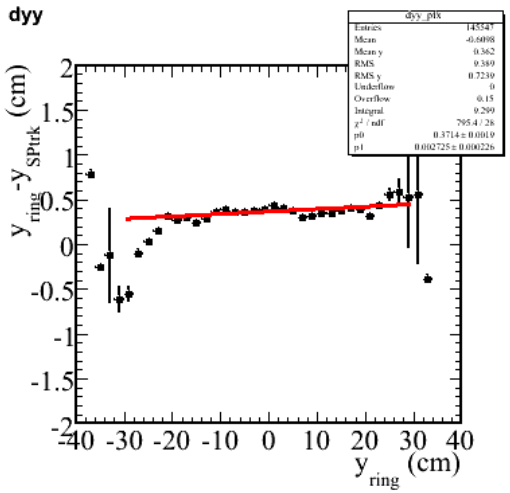
m = 0.005894 ± 0.000134
c = 0.345909 ± 0.001895

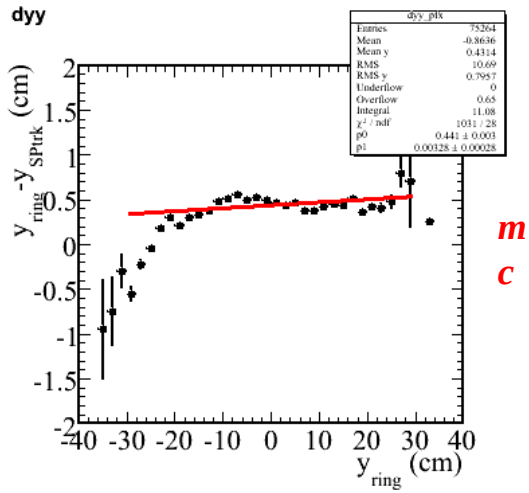




m = 0.009216 ± 0.000156
c = 0.436032 ± 0.002843

m = 0.002725 ± 0.000226
c = 0.371441 ± 0.001852





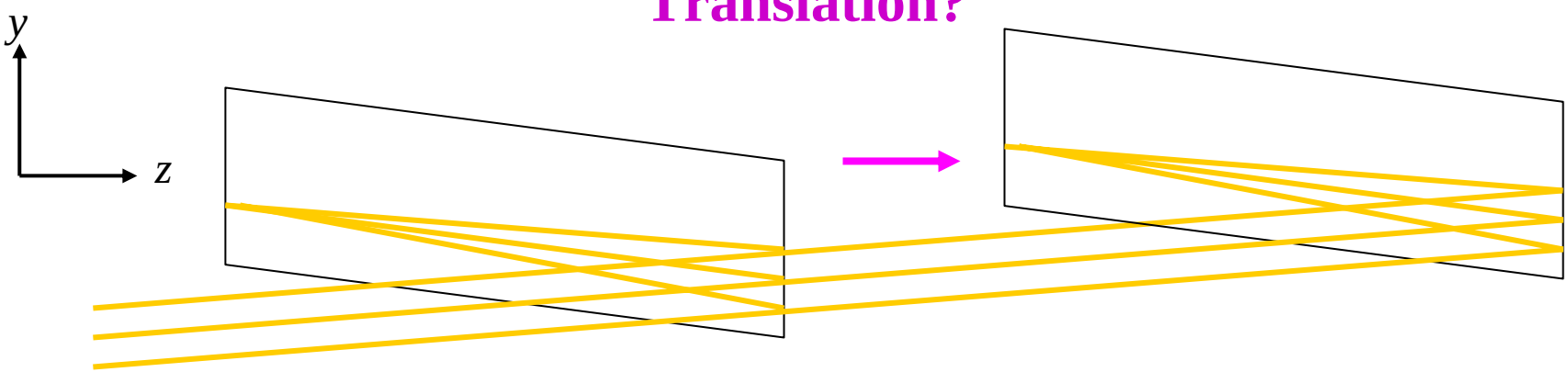
m = 0.003280 ± 0.00082
c = 0.440994 ± 0.002874

y_{ring}-y_{SPtrk} increases with x_{ring} for +ve and –ve tracks

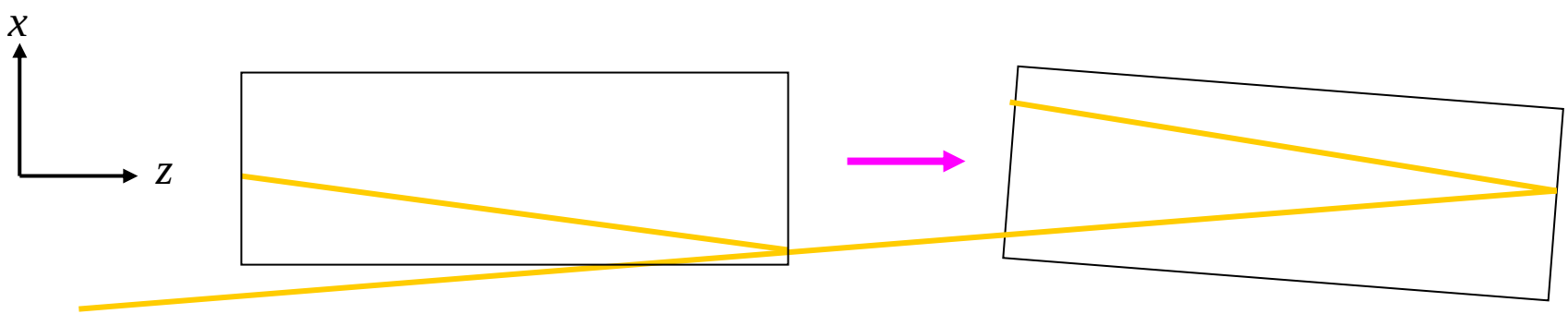
Alignment

Before **After**

Translation?



Rotation?



Conclusion

- x-offset
  - Strong momentum dependency for +ve and –ve tracks
  - Similar offsets for +ve and –ve tracks, except a constant offset of ~3mm between them
- y-offset
  - Small momentum dependency for +ve tracks
  - Same offset for +ve and -ve tracks (constant offset between them is <1mm)
- Difference between +ve and –ve tracks due to small mis-modelling of the magnetic field?
- Alignment
  - Constant offset: rotation
  - Slope: combination of rotations?