Optics at High Momentum

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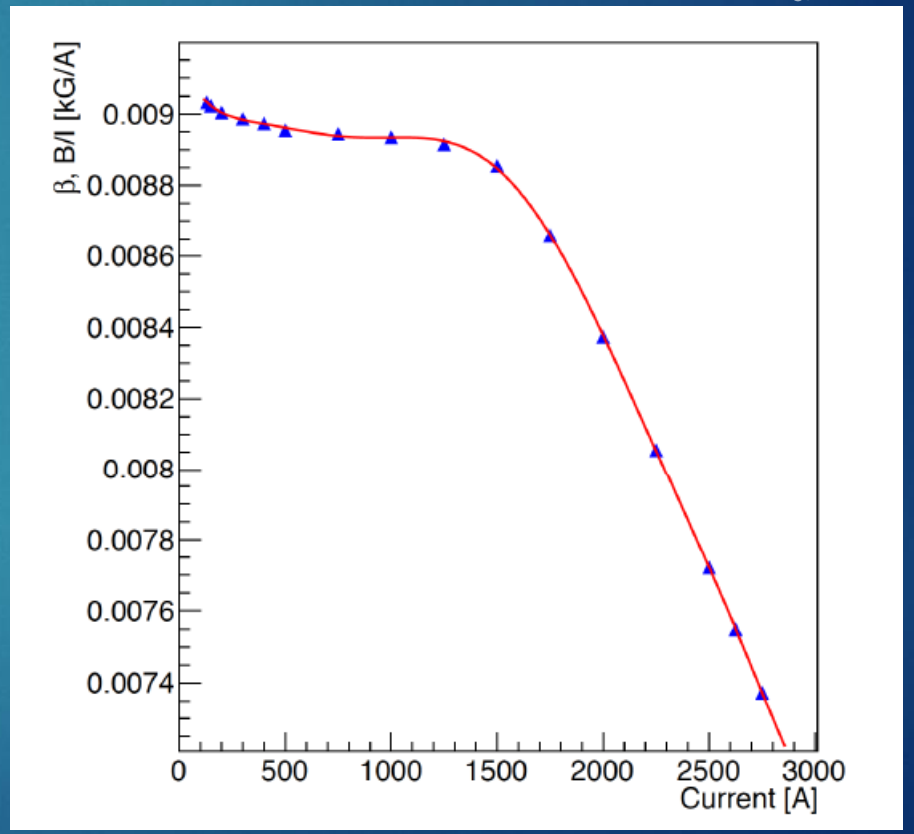
OHIO UNIVERSITY (NSF AWARD #1913170)

WORK DONE IN COLLABORATION WITH HOLLY SZUMILA-VANCE AND MARK JONES

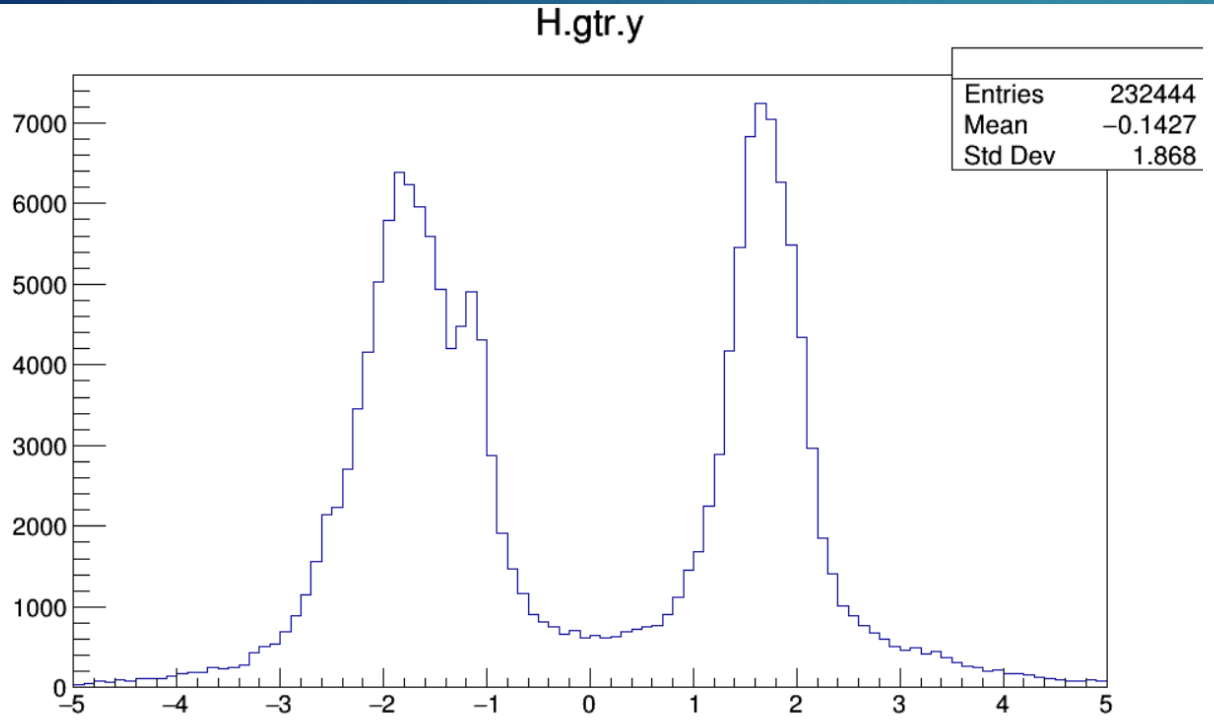
HMS Saturation at High Momentum

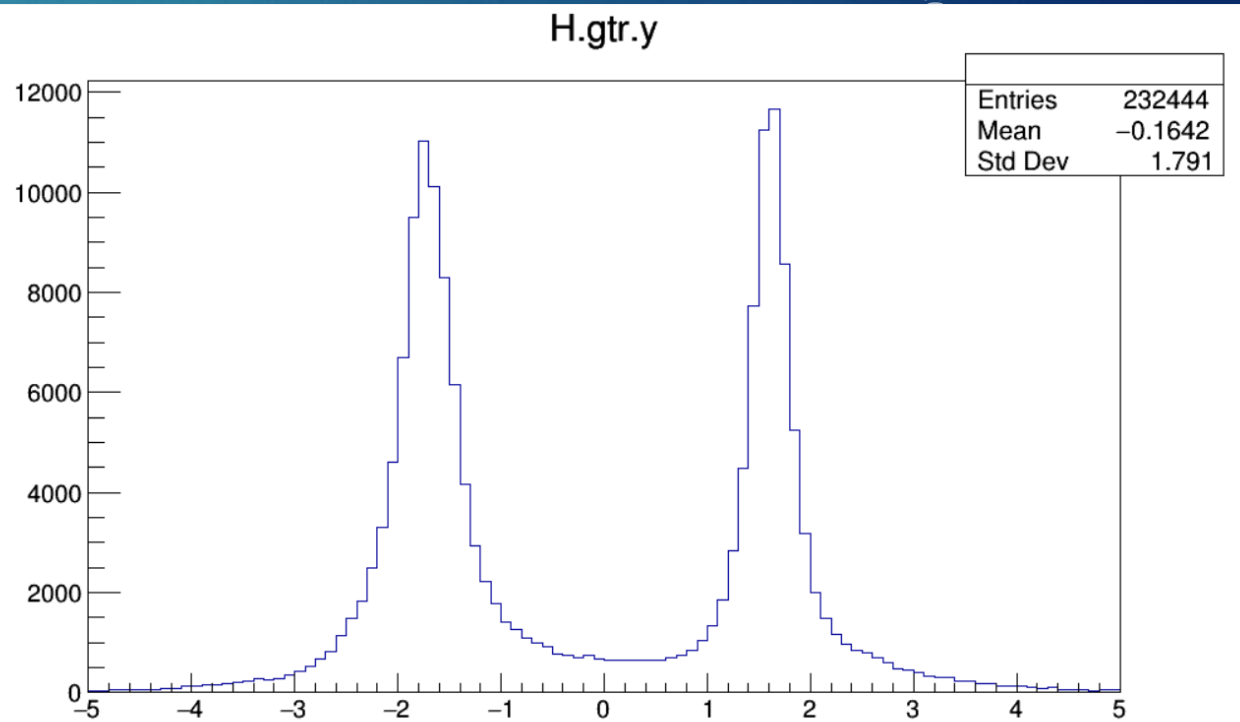
Commissioning the HMS optics in the 2017-18 run period
Holly Szumila-Vance
12/04/2018

- Figure shows central field B/I as a function of set current
- When set to high central momentum settings, HMS dipole and quadrupole saturation effects occur
- This study was done using Pion-LT Data at 6.8, 5.9, & 5.6 GeV/c Central Momentum
- Previous study at 6.6 GeV/c using Kaon-LT data can be found here:
- https://hallcweb.jlab.org/doc-private/ShowDocument?docid=1140



Optics Target (+/-8 cm) at 6.8 GeV/c - Ytar





- Default Optical Matrix vs Matrix Calibrated for High-Momentum

6.8 GeV/c Carbon-Sieve Corrections

USING POLTAR OPTICAL MATRIX

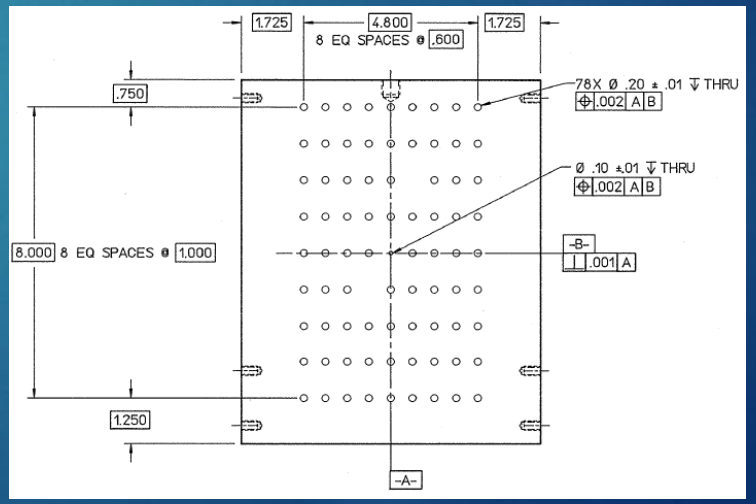
HTTPS://GITHUB.COM/JEFFERSONLAB/HALLC_REPLAY/BLOB/MASTER/DATFILES/HMS_POLTAR_FIT.DAT

Pion-LT HMS Optics Data

Carbon-Sieve Runs at 6.8, 5.9, and 5.6 GeV/c

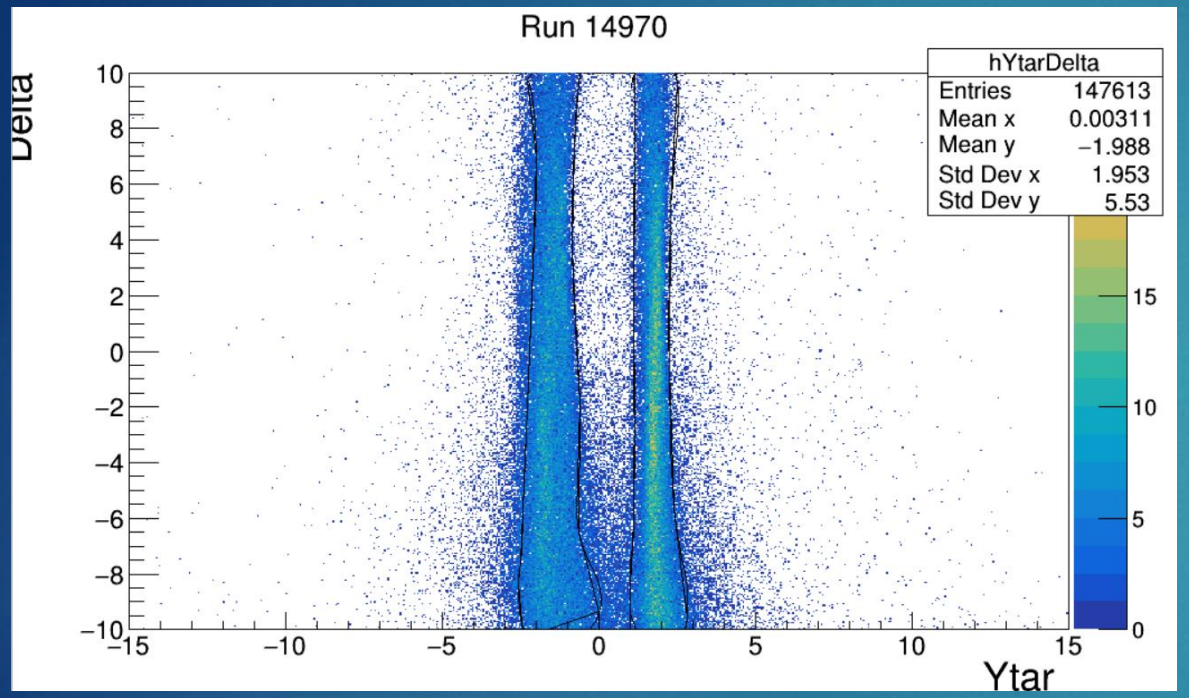
Run	Momentum	Angle	Foils
14970	6.792	12.495	2
14971	6.792	12.495	2
14972	6.792	12.495	2
14973	6.792	12.495	1
16023	5.587	13	1
16024	5.587	13	2
16025	5.587	13	1
16029	5.587	13	2
16031	5.587	13	1
16032	5.587	13	1
16033	5.587	13	1
16034	5.587	13	2
16035	5.587	13	2
16186	5.878	12.5	1
16187	5.878	15.5	2

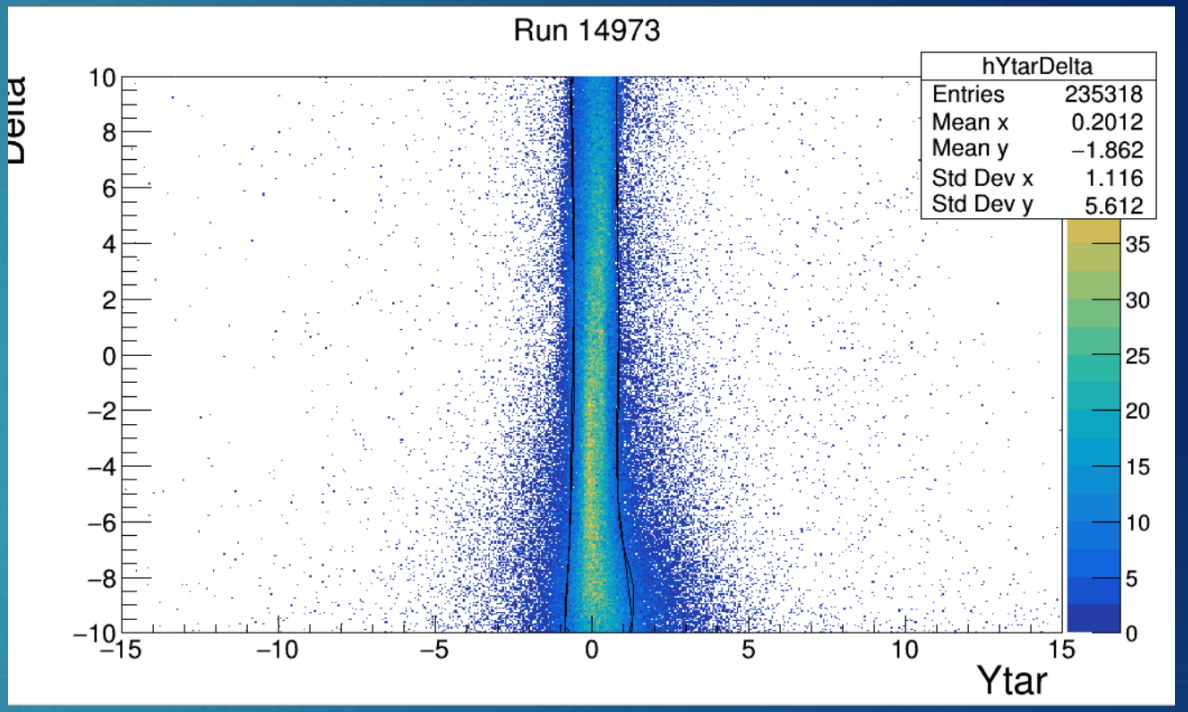
- 2 Foil is +/- 8 cm carbon optic target
- 1 Foil is 0.5% carbon target (at 0 cm)
- All runs have sieve-slit in place



HMS Sieve Slit Schematic
Mark Jones
https://hallcweb.jlab.org/DocDB/0011/001104/002/HMS-Sieve.pdf

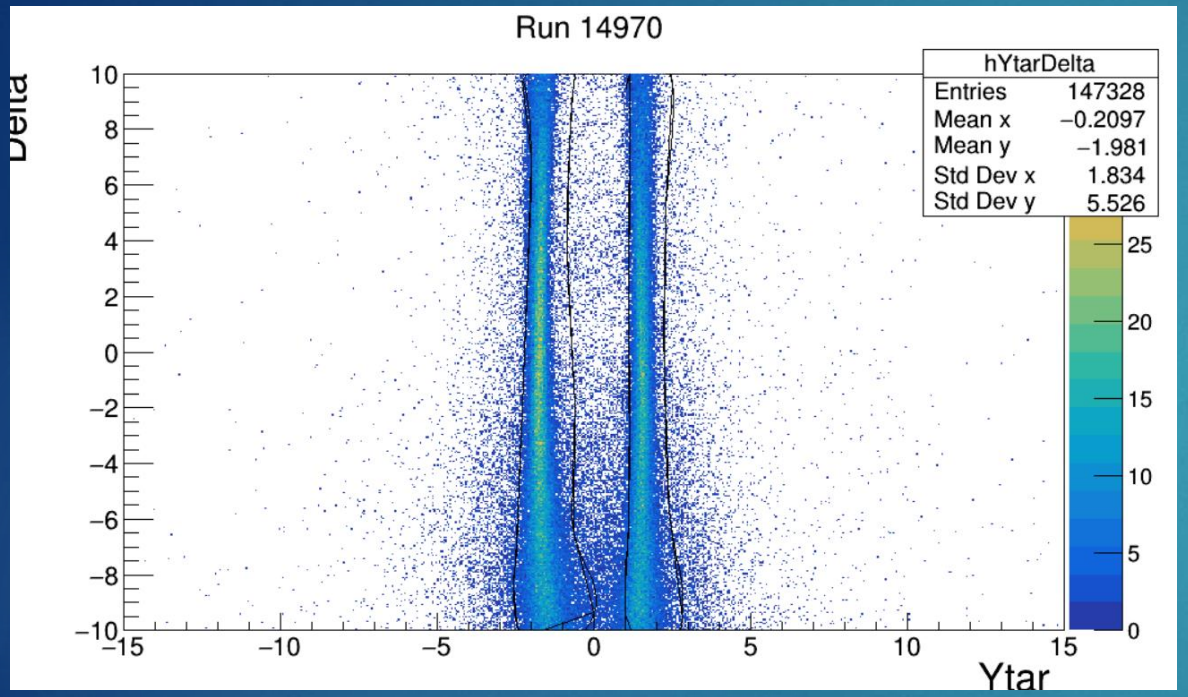
Ytar vs Delta Initial Cuts

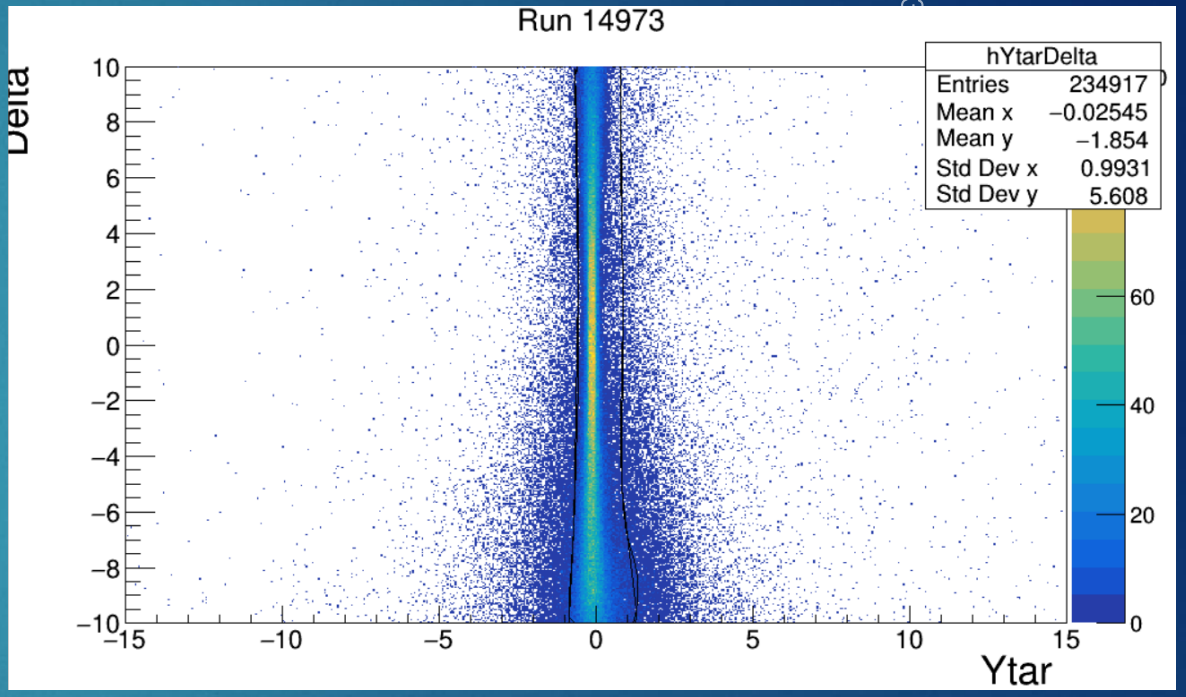




- Using 2D carbon targets, cuts placed along foils defines event scattering position in z

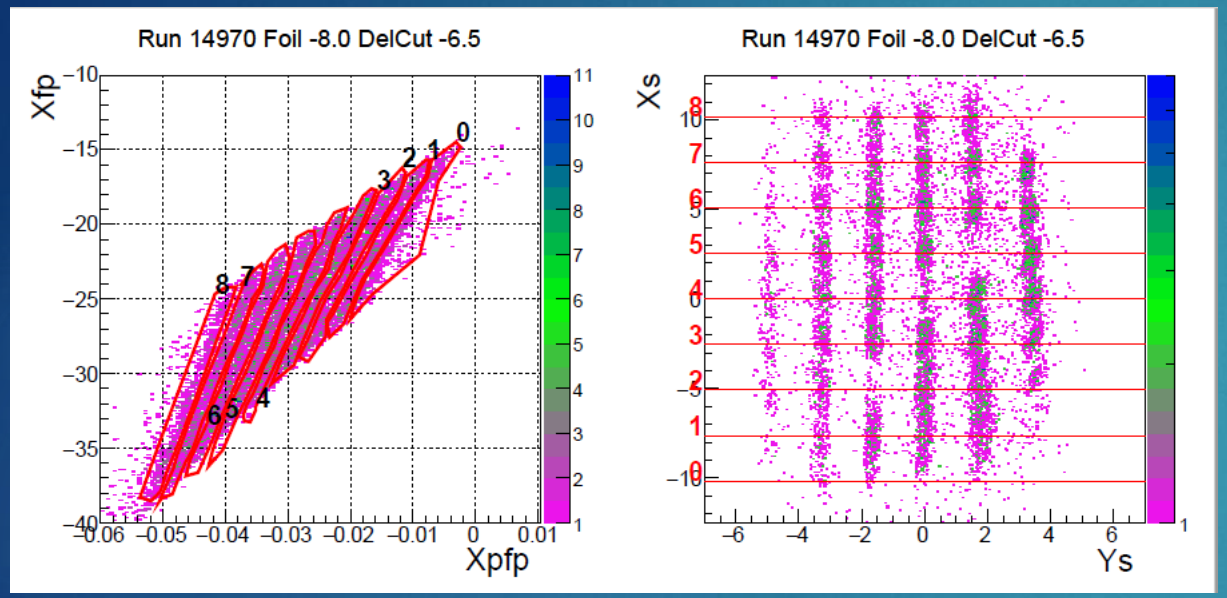
Ytar vs Delta Cuts with New Matrix

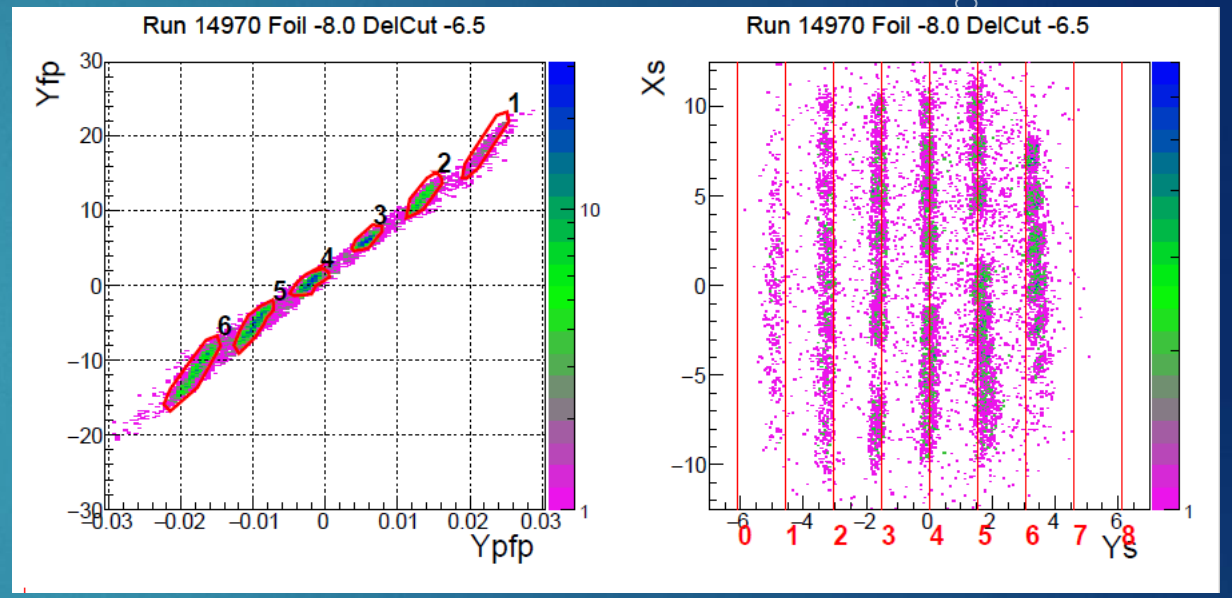




- For comparison, same initial cuts are shown after matrix optimization
- Note that more events fall within cuts now

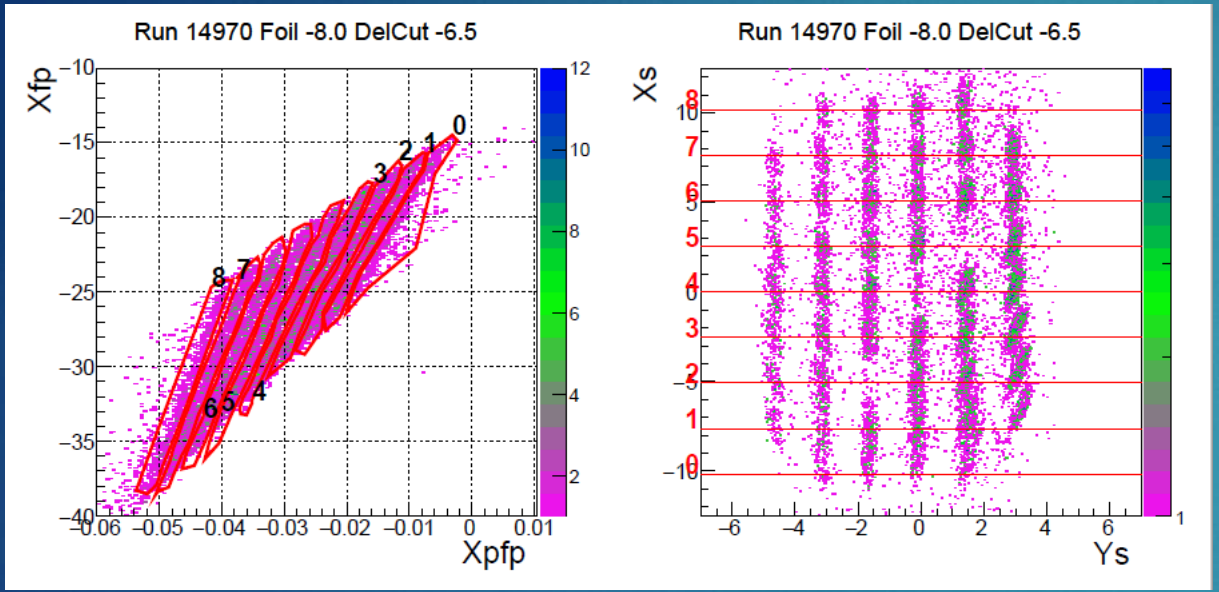
Sieve Hole Cuts in Focal Plane

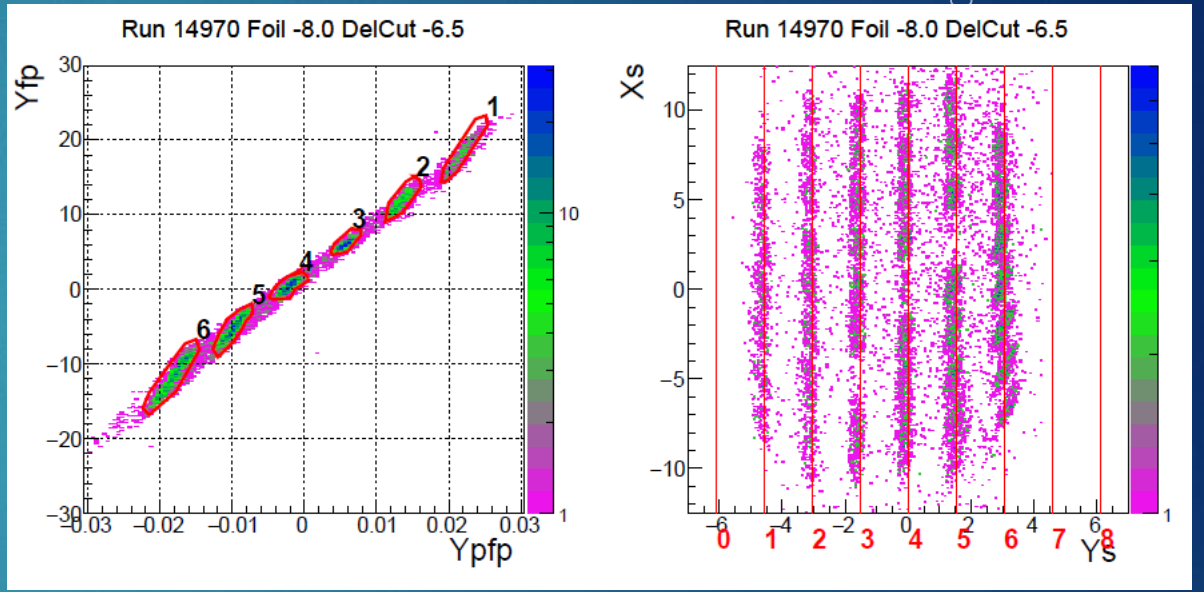




- Upstream (-8) foil and -8% < delta < -5%
- 9 sieve hole rows and columns
  - Not all y sieve are hit due to collimator shape and target placements
- Focal Plane cuts define event scattering angles for matrix optimization

Sieve Hole Cuts with New Matrix



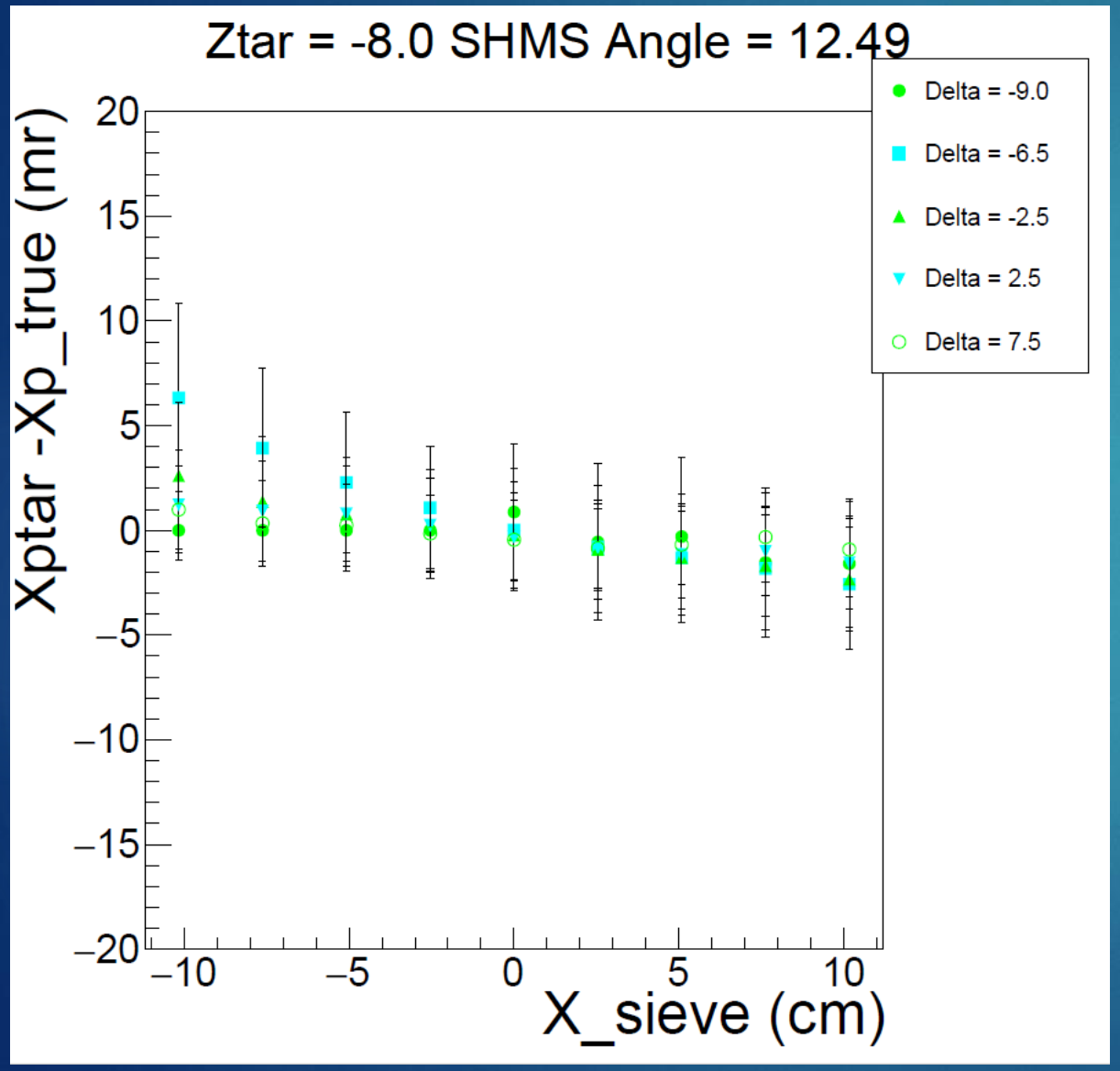


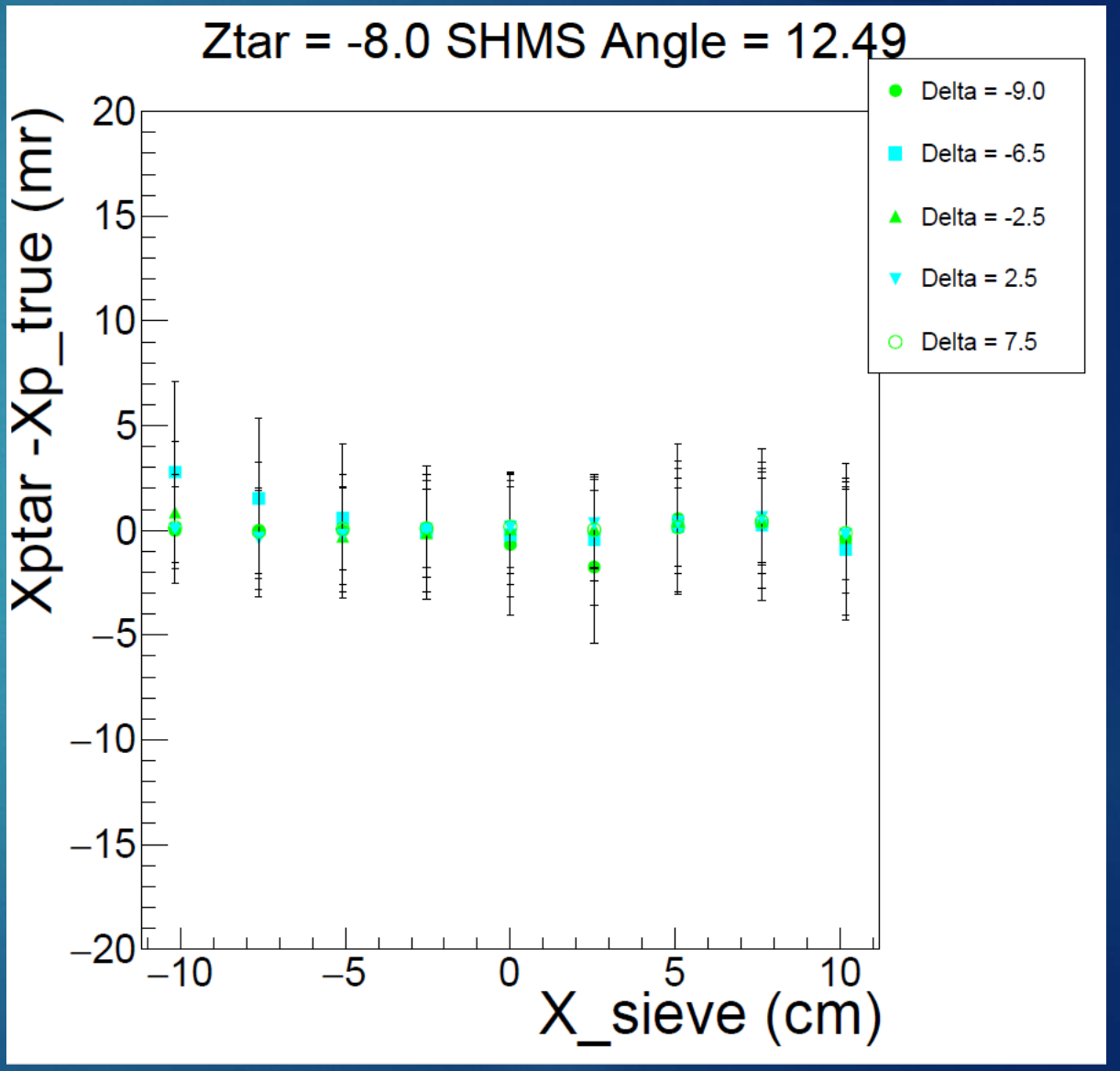
- For comparison – with new ytar positions, more events pass through first set of cuts, hence additional holes seen
- Some improvement in sieve hole resolution
  - Harder to resolve up-stream foil and negative delta

New Optical Matrix Results

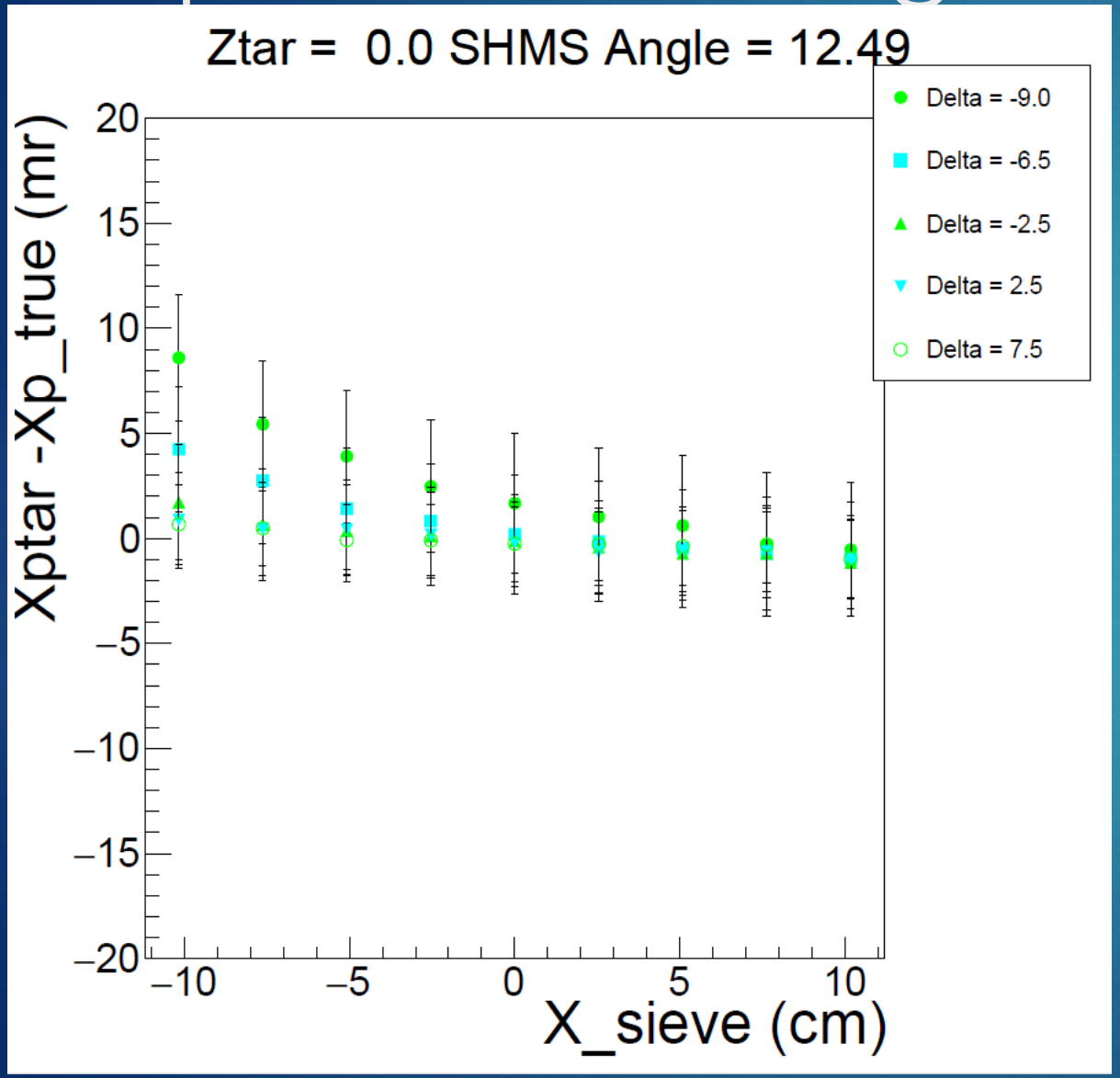
USING POLTAR MATRIX AND 6.8 GEV/C CARBON-SIEVE DATA

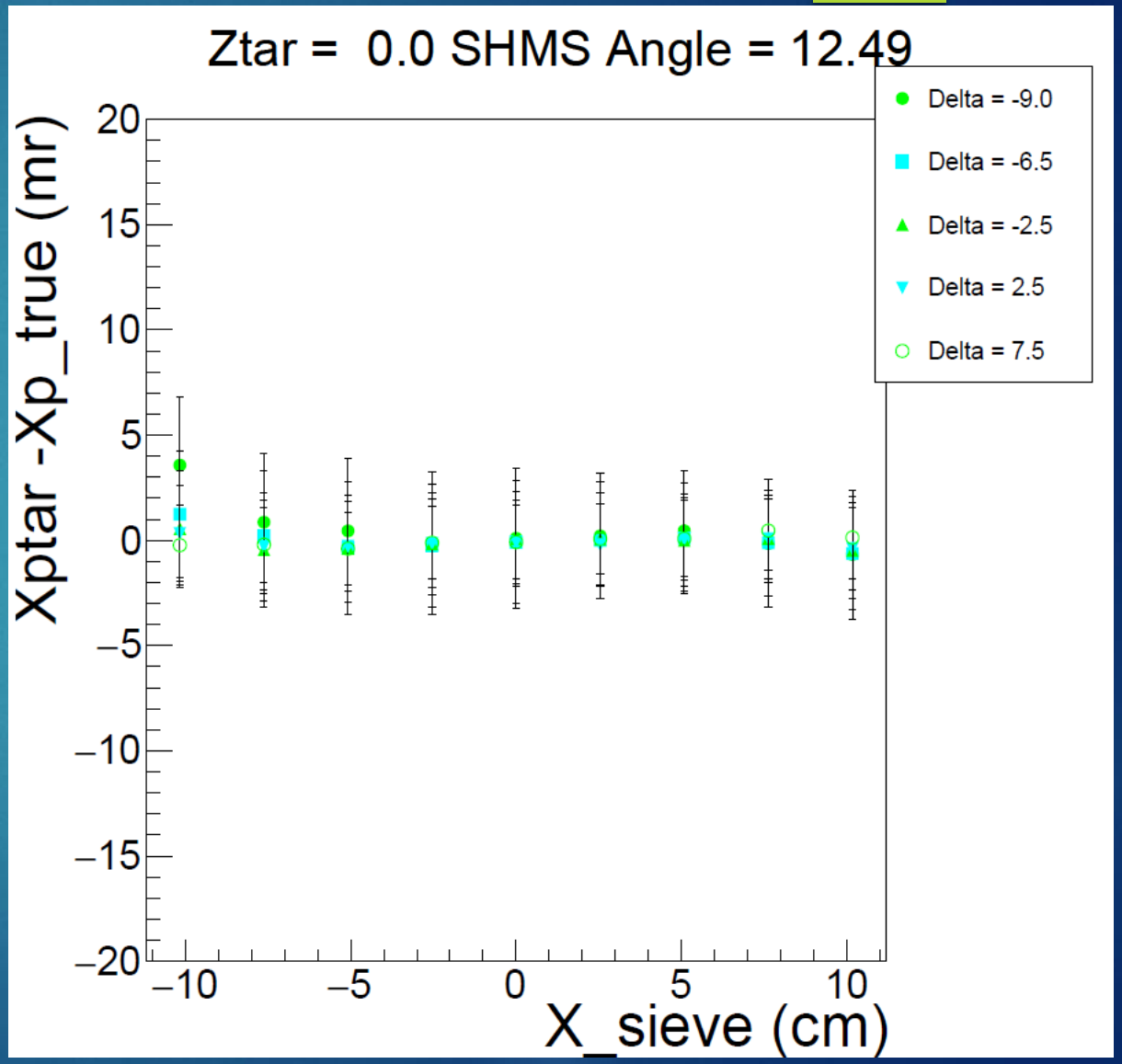
XpTar Offset Original vs Corrected



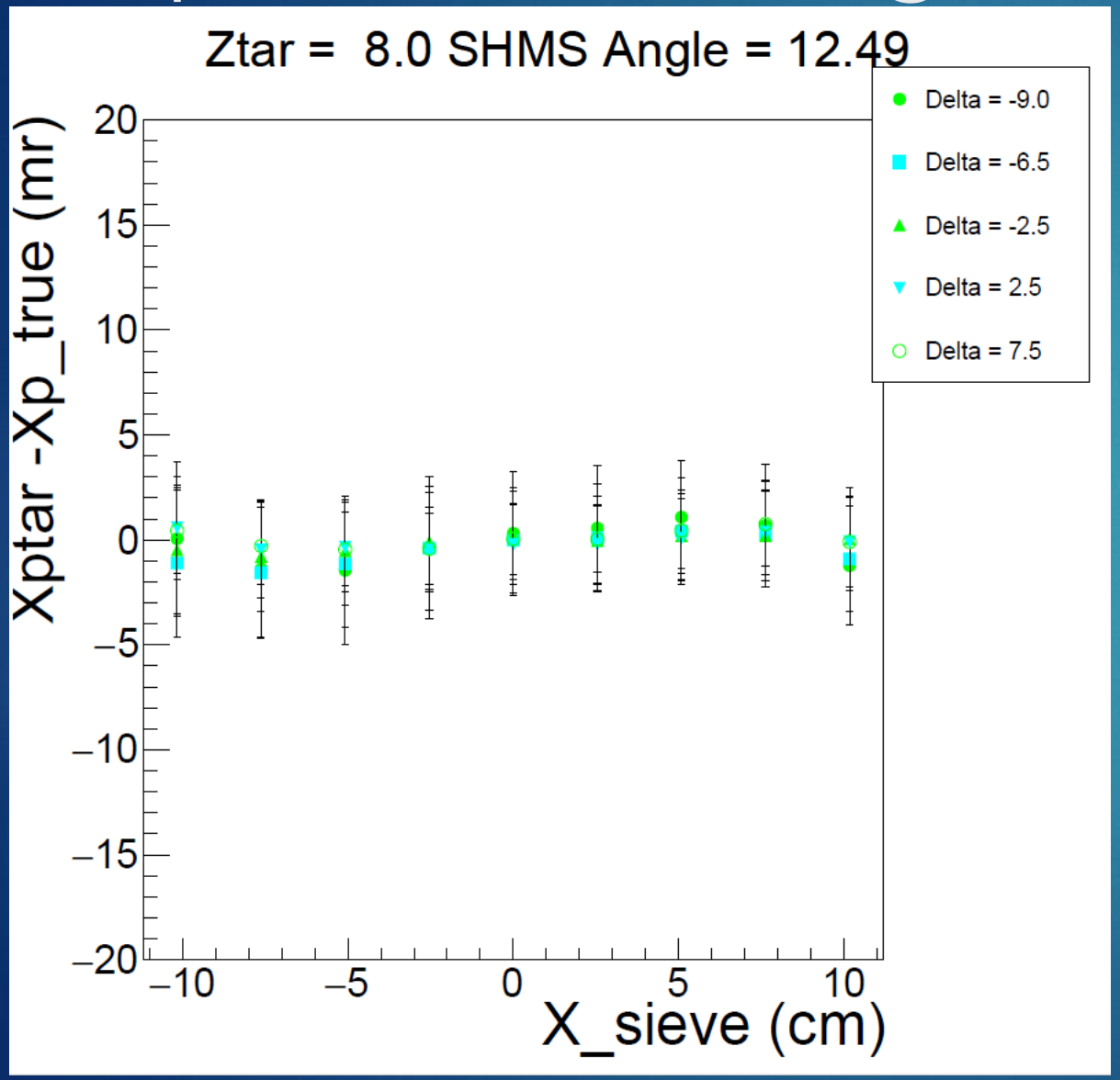


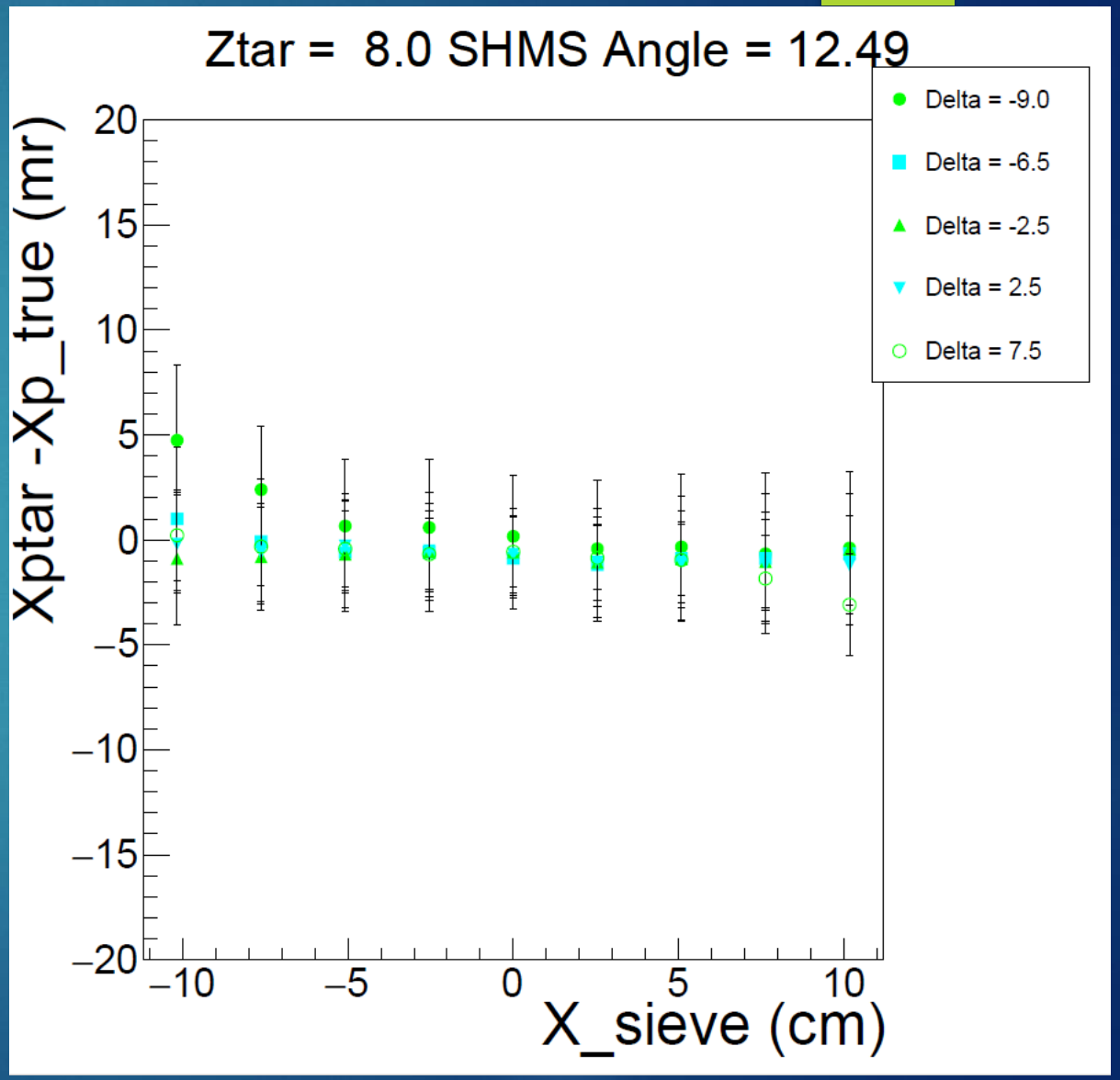
XpTar Offset Original vs Corrected



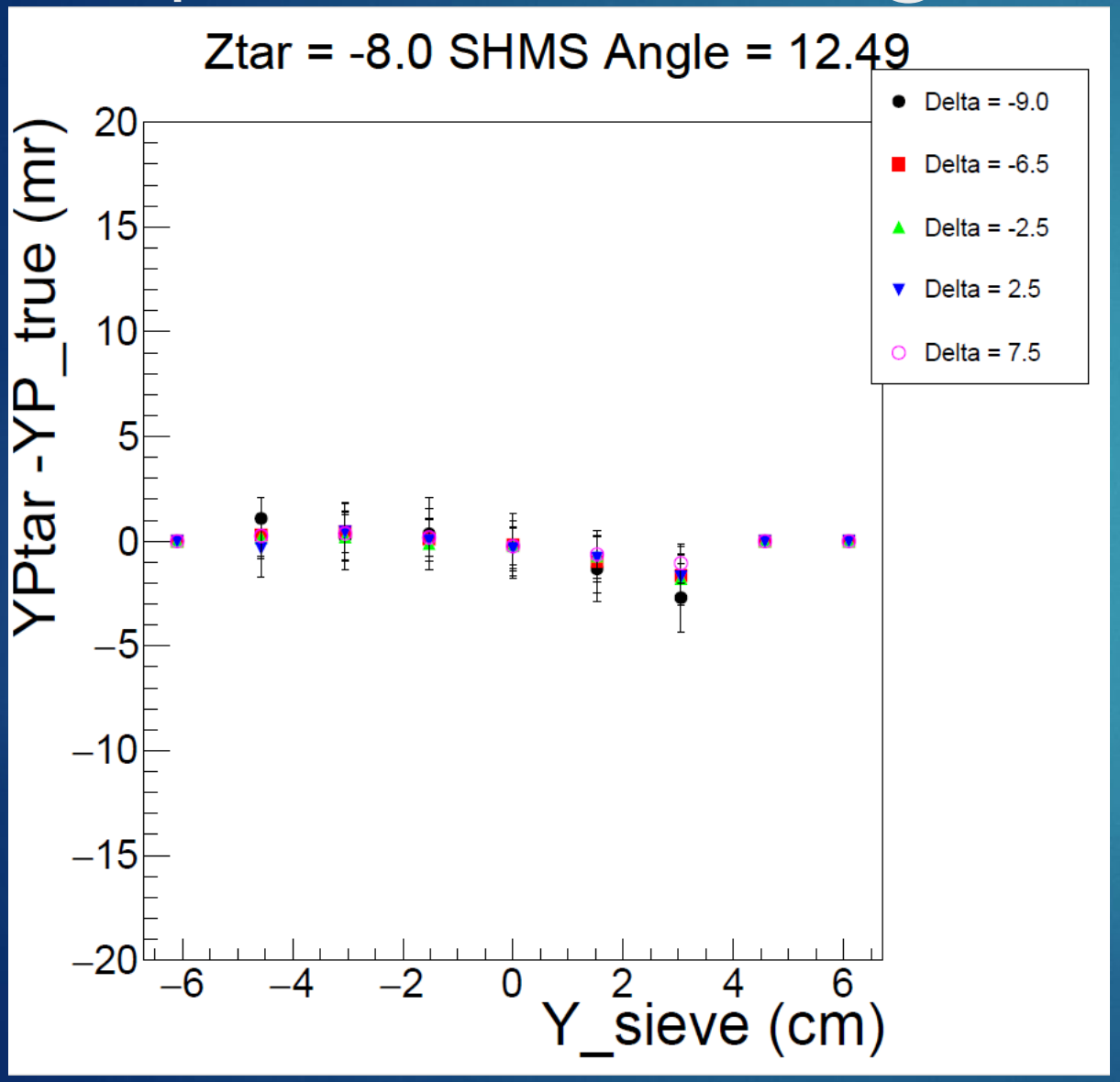


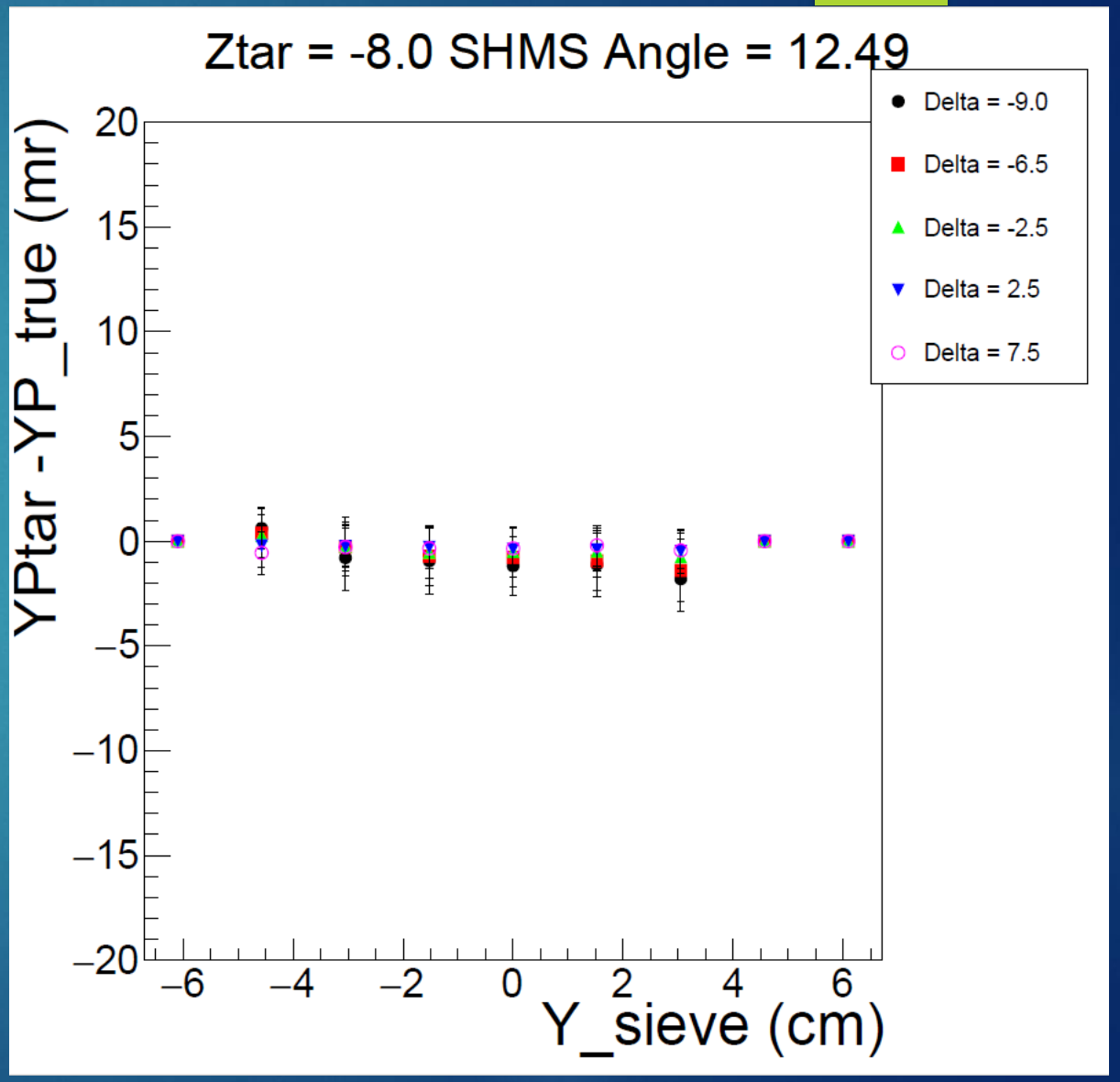
XpTar Offset Original vs Corrected



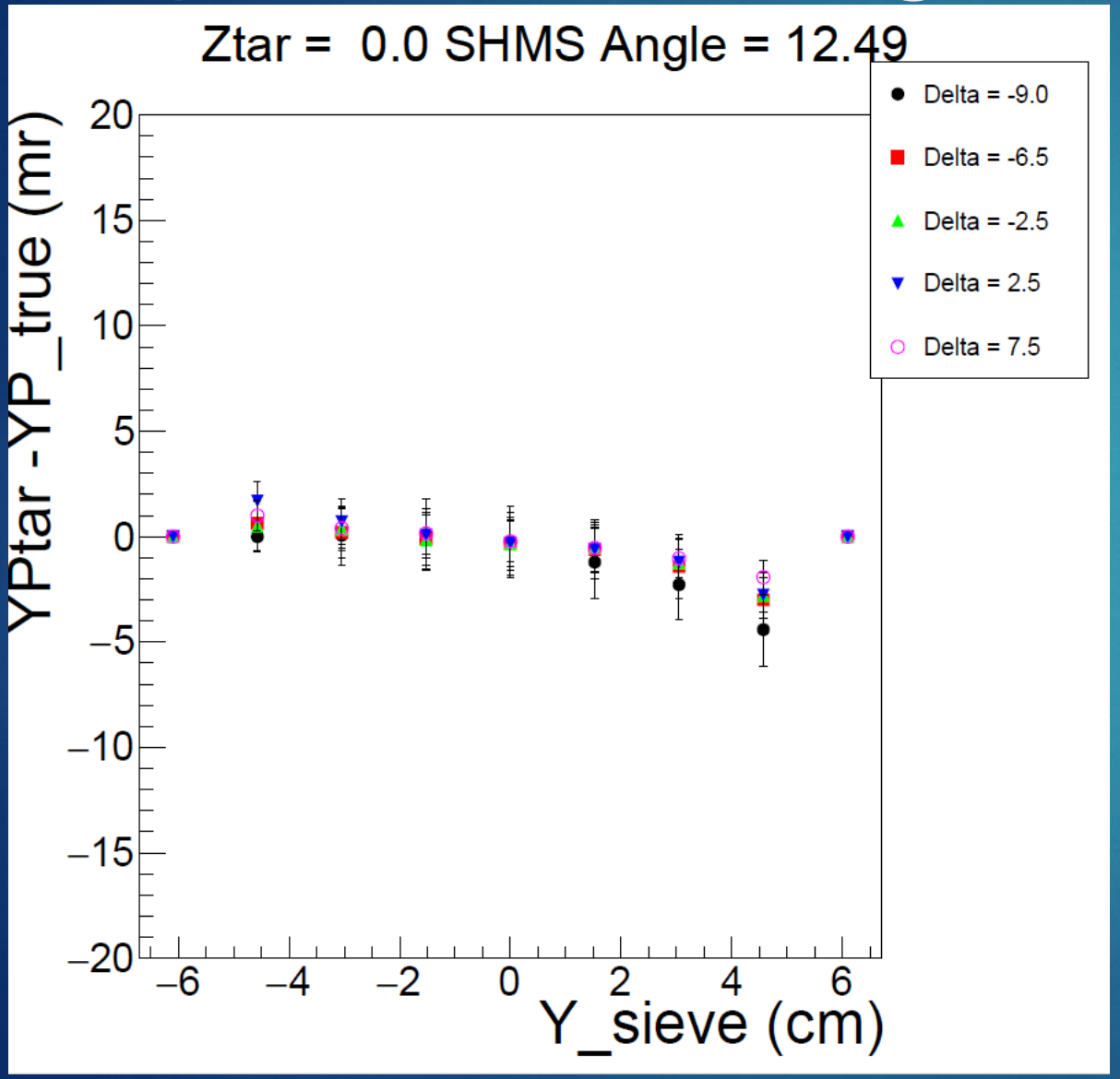


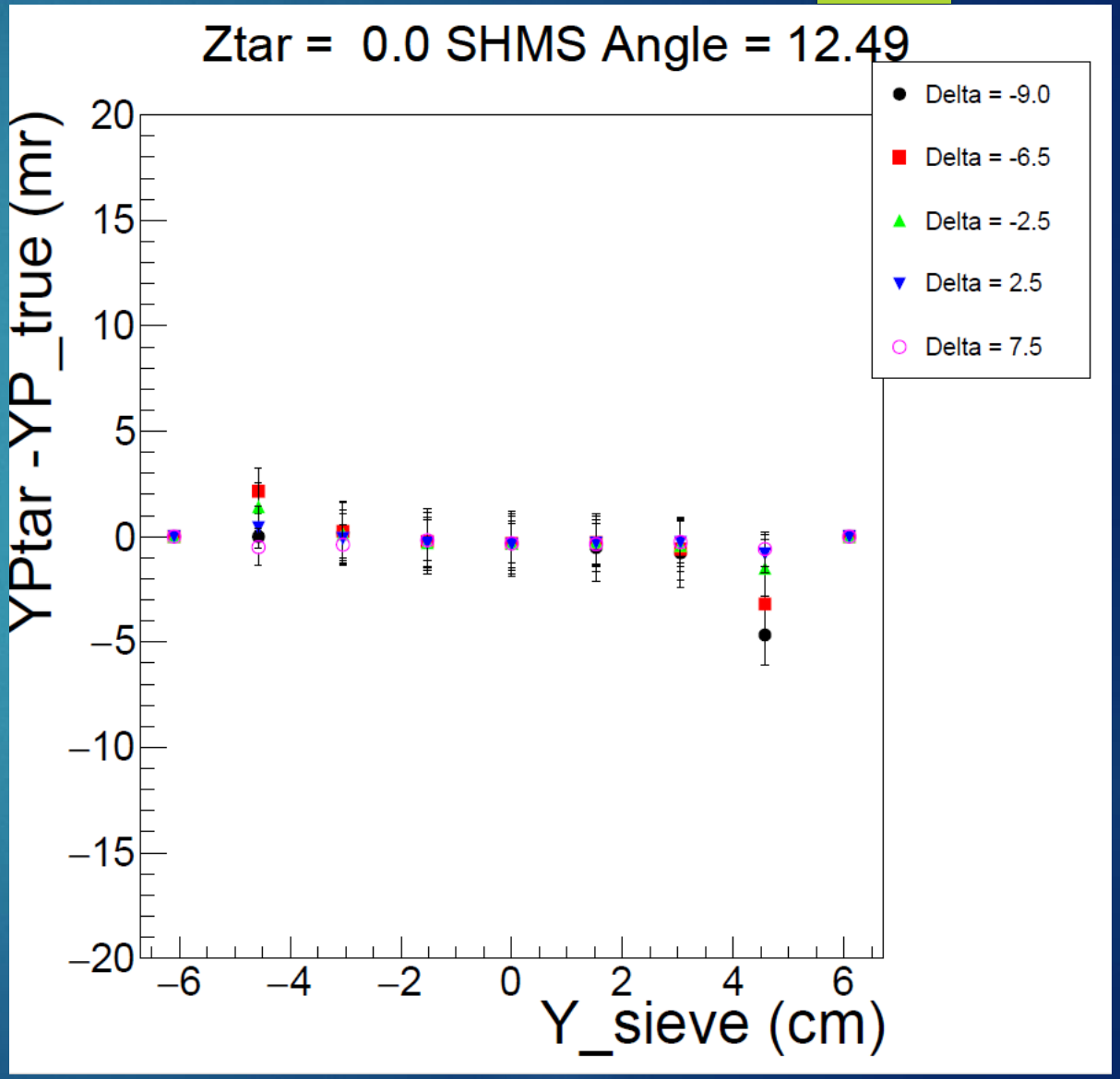
YpTar Offset Original vs Corrected



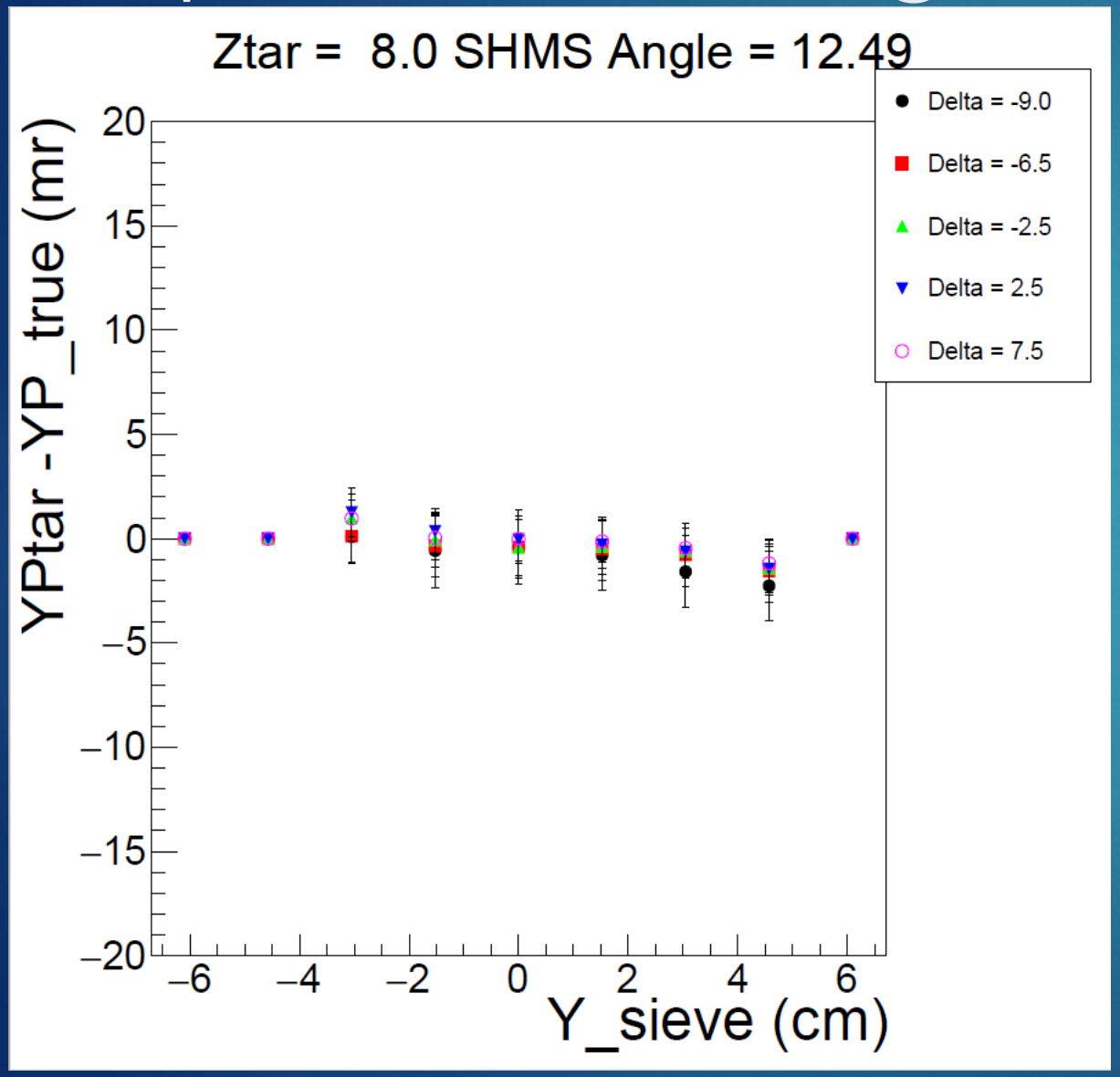


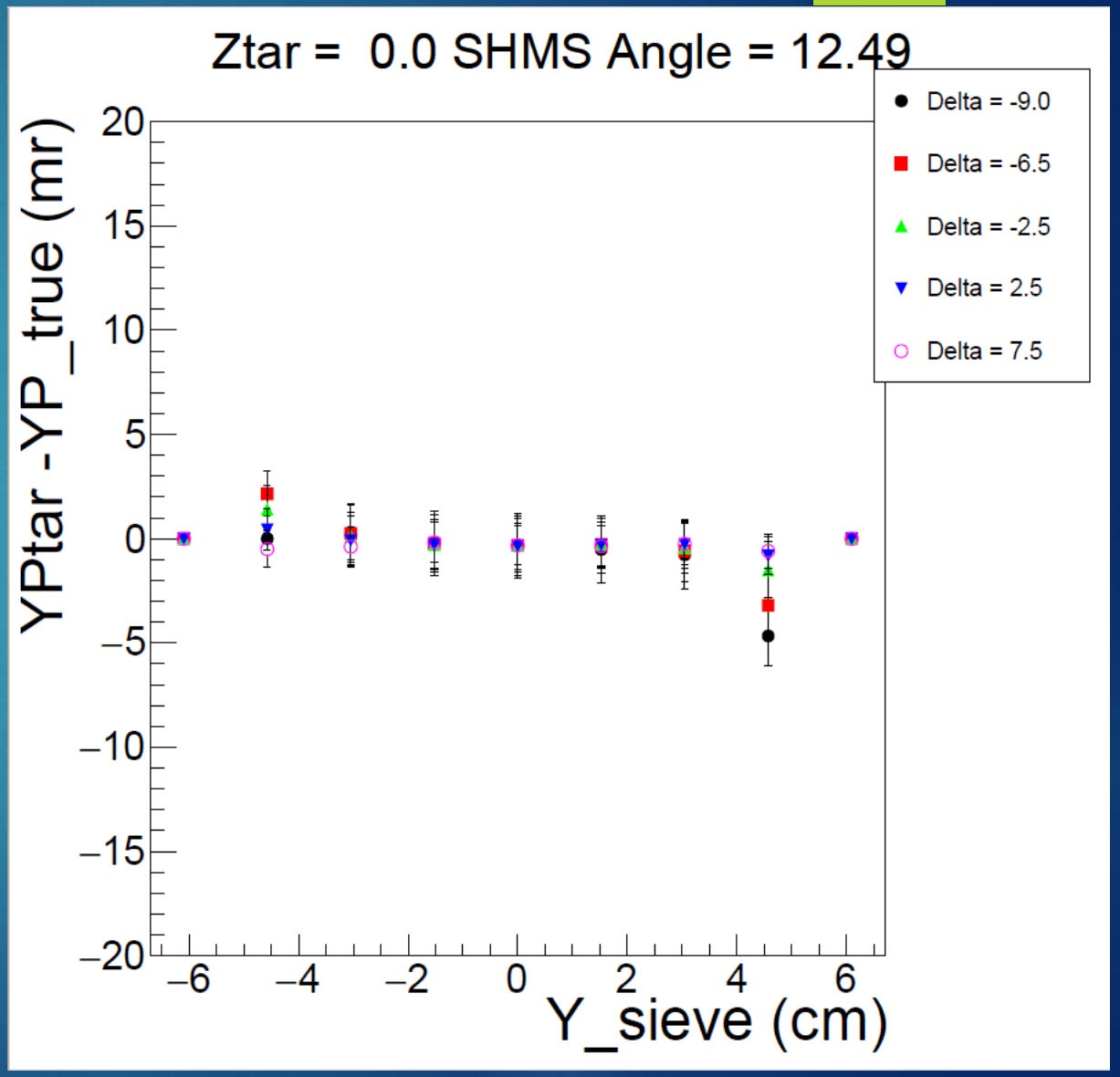
YpTar Offset Original vs Corrected



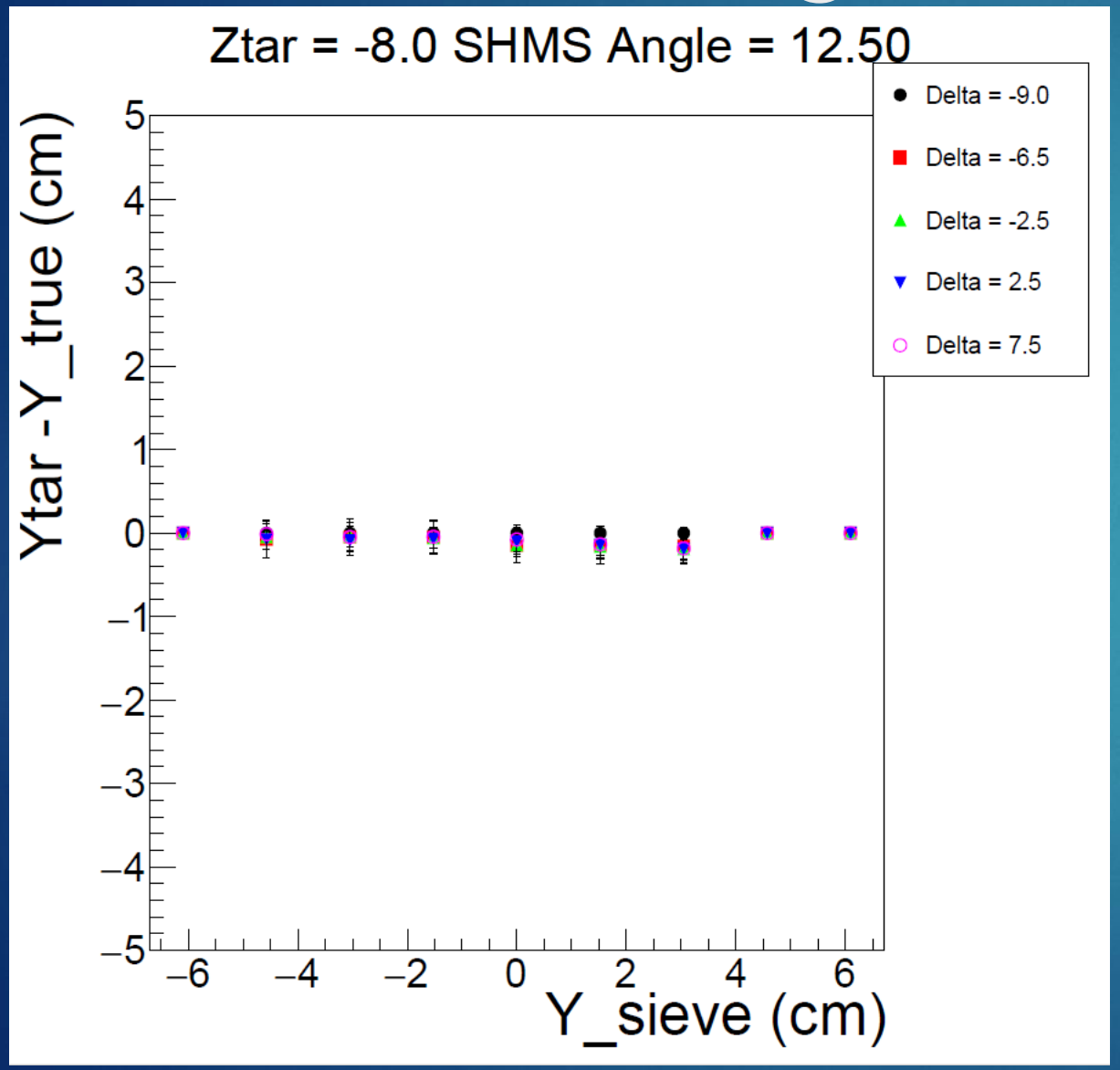


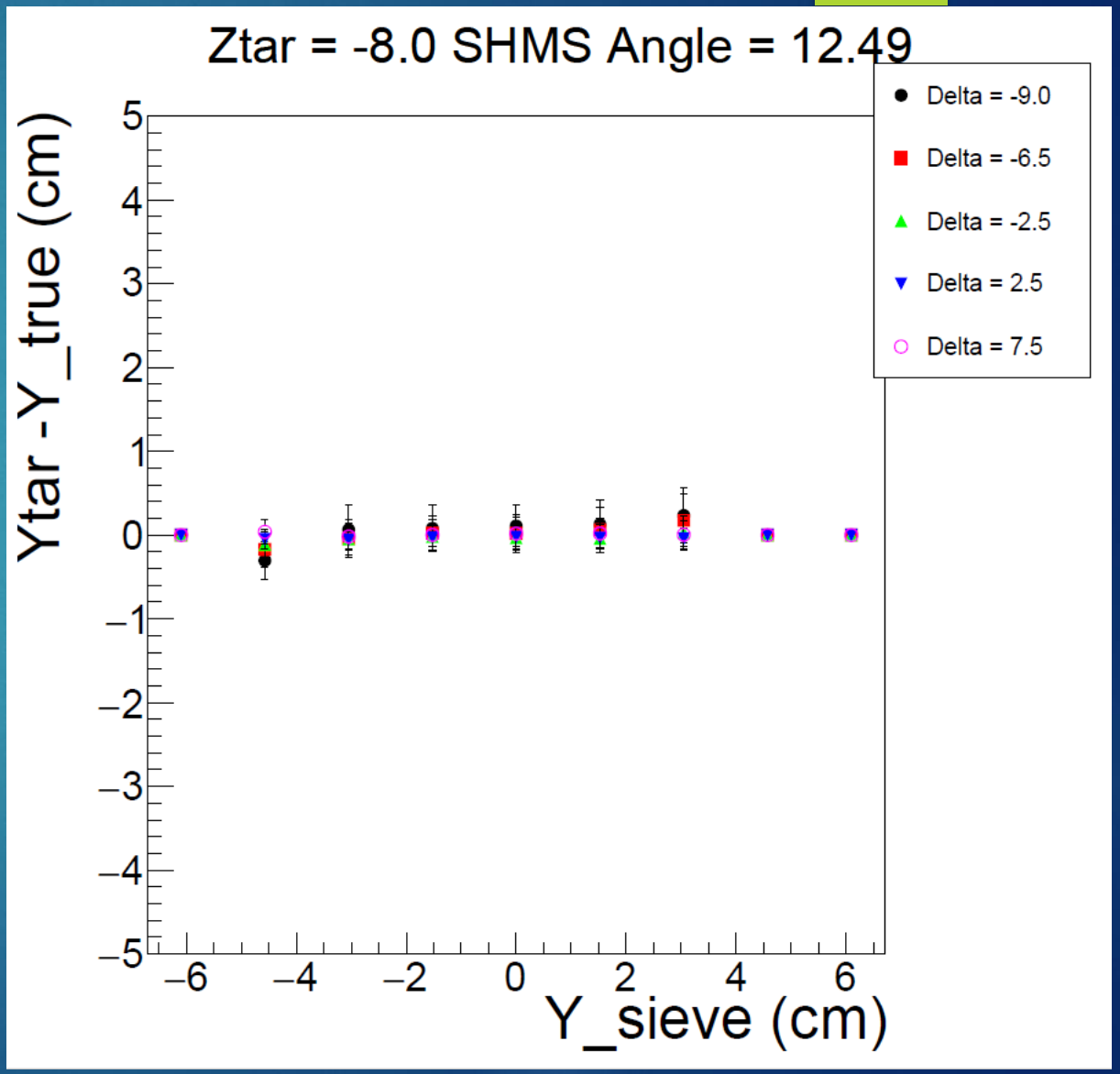
YpTar Offset Original vs Corrected



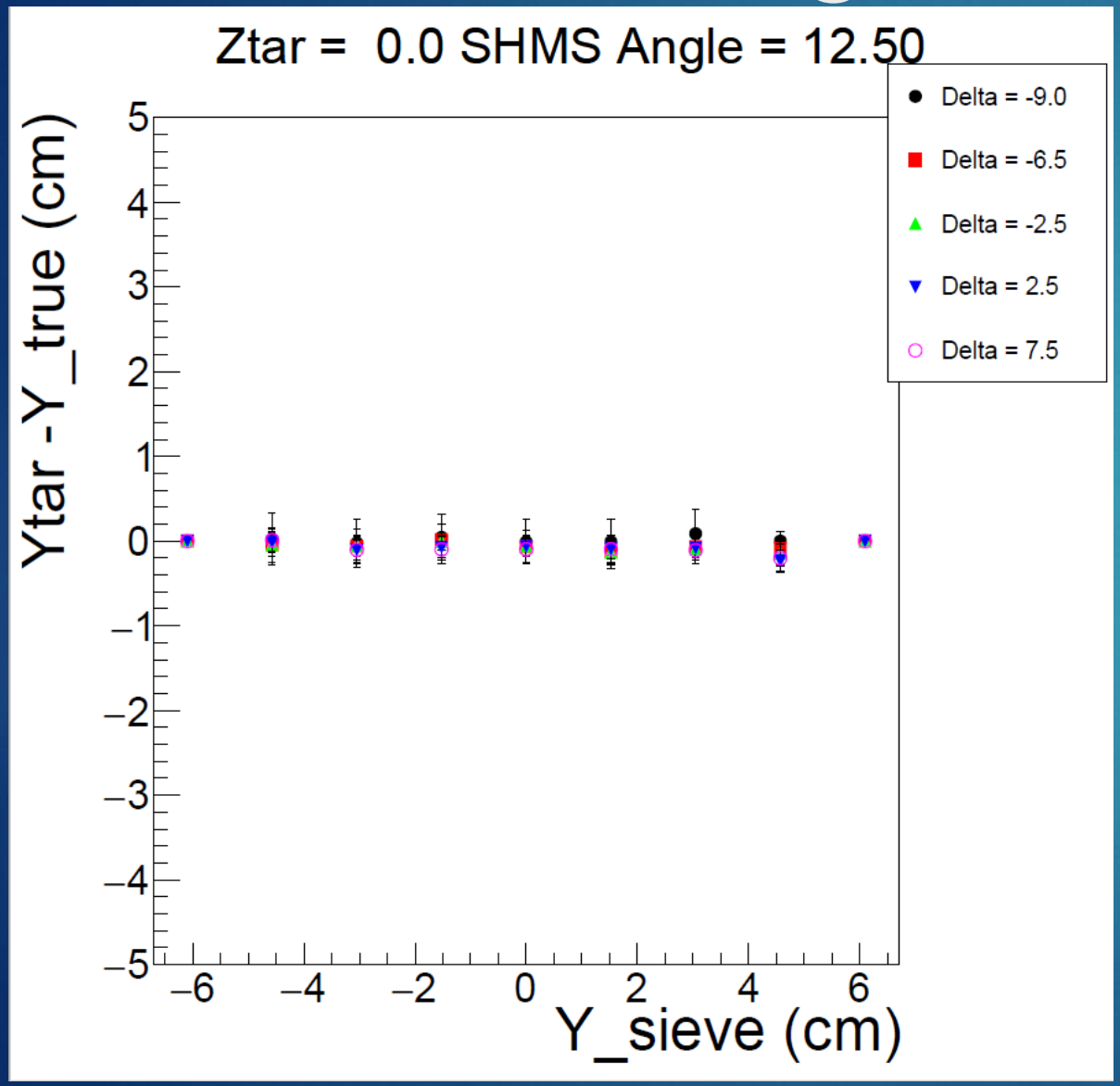


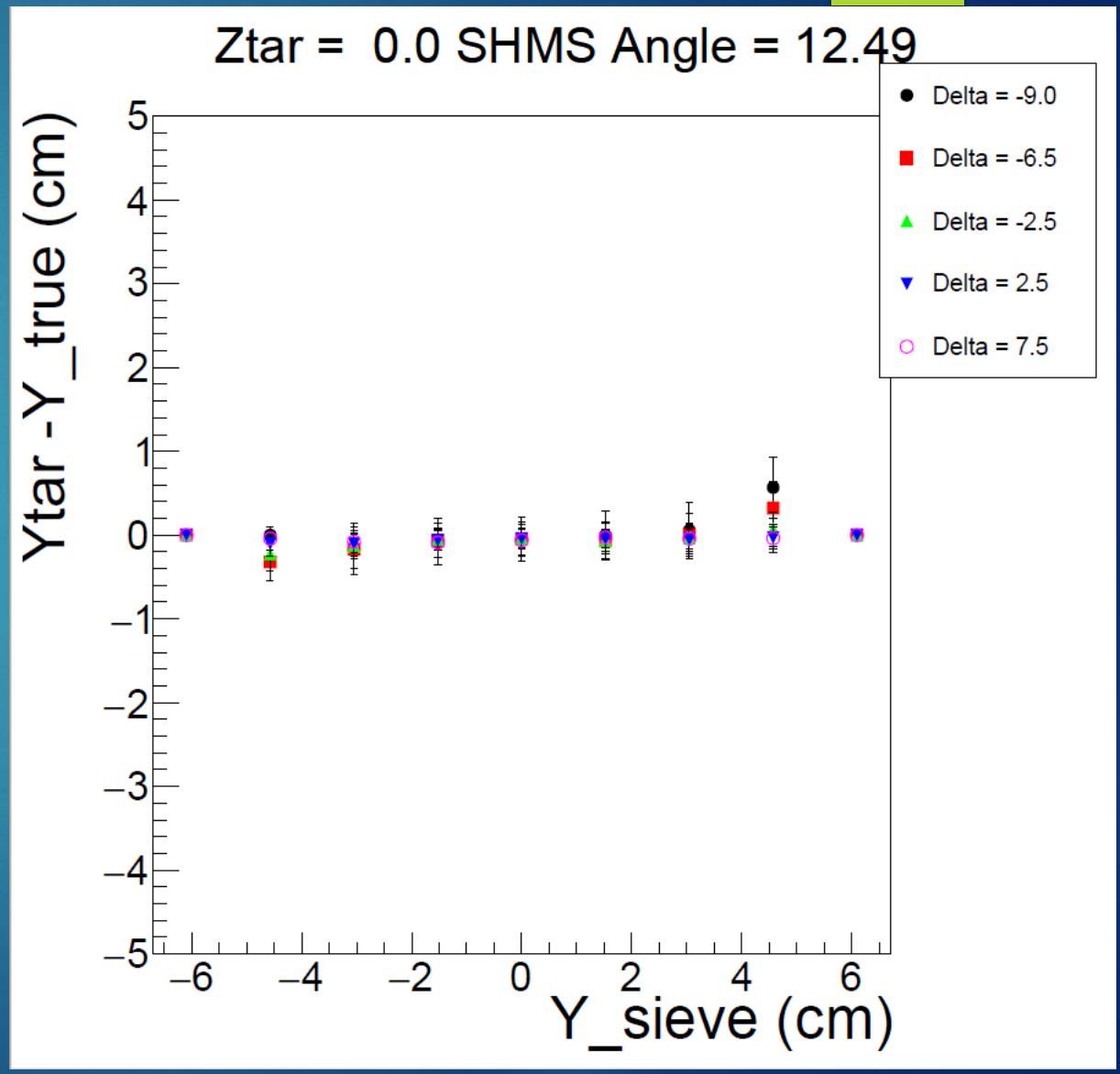
Ytar Offset Original vs Corrected



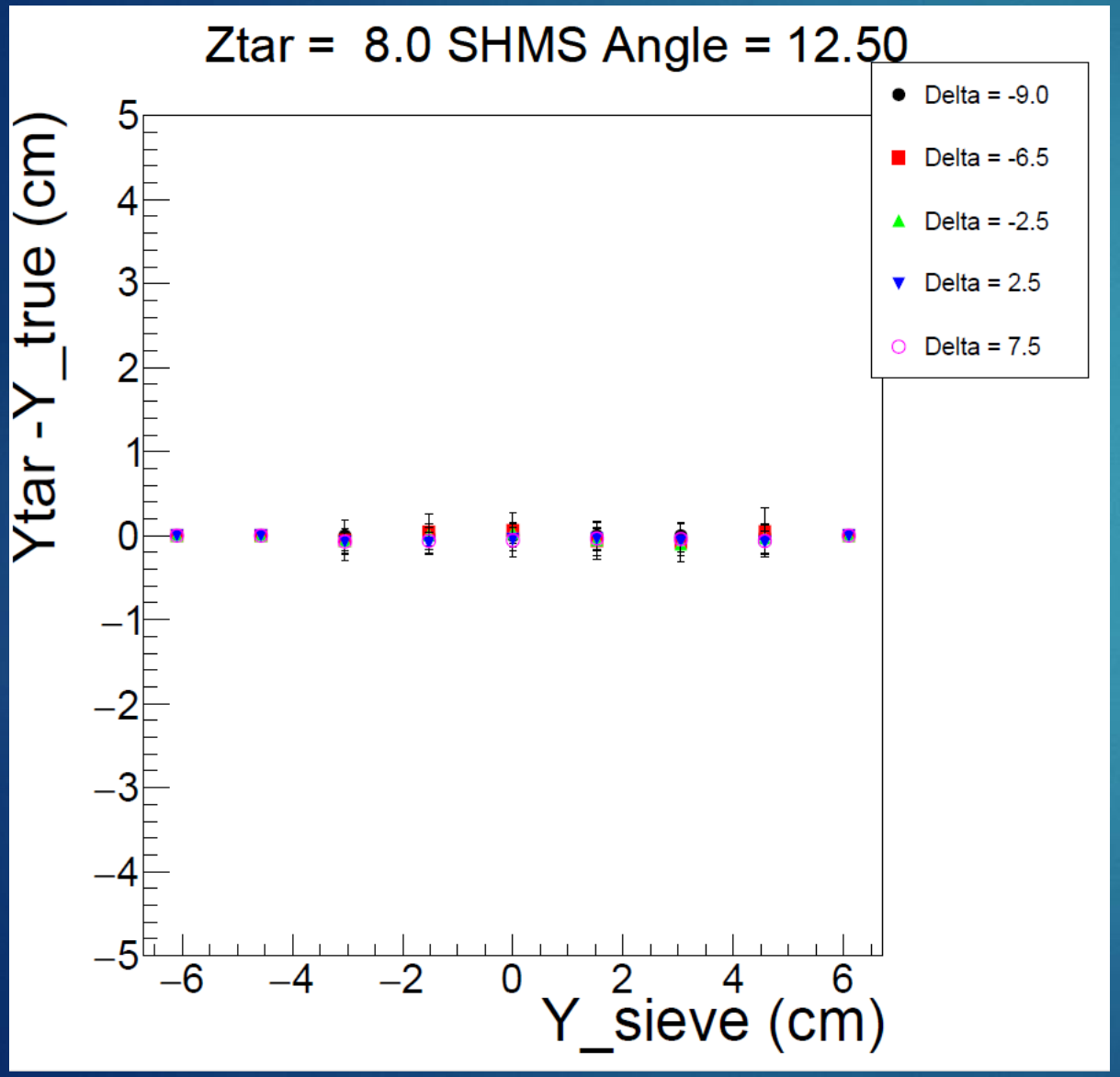


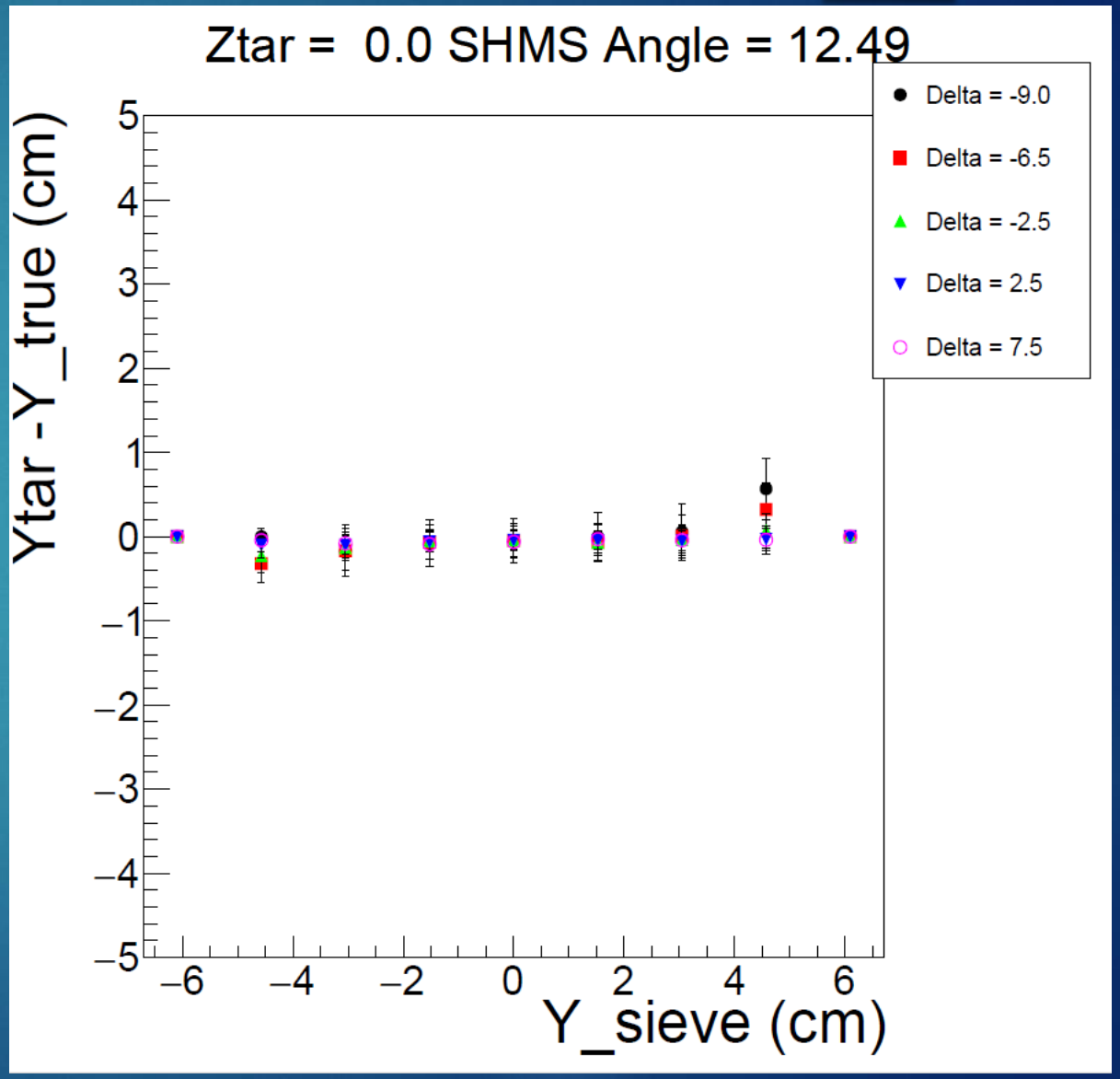
Ytar Offset Original vs Corrected





Ytar Offset Original vs Corrected

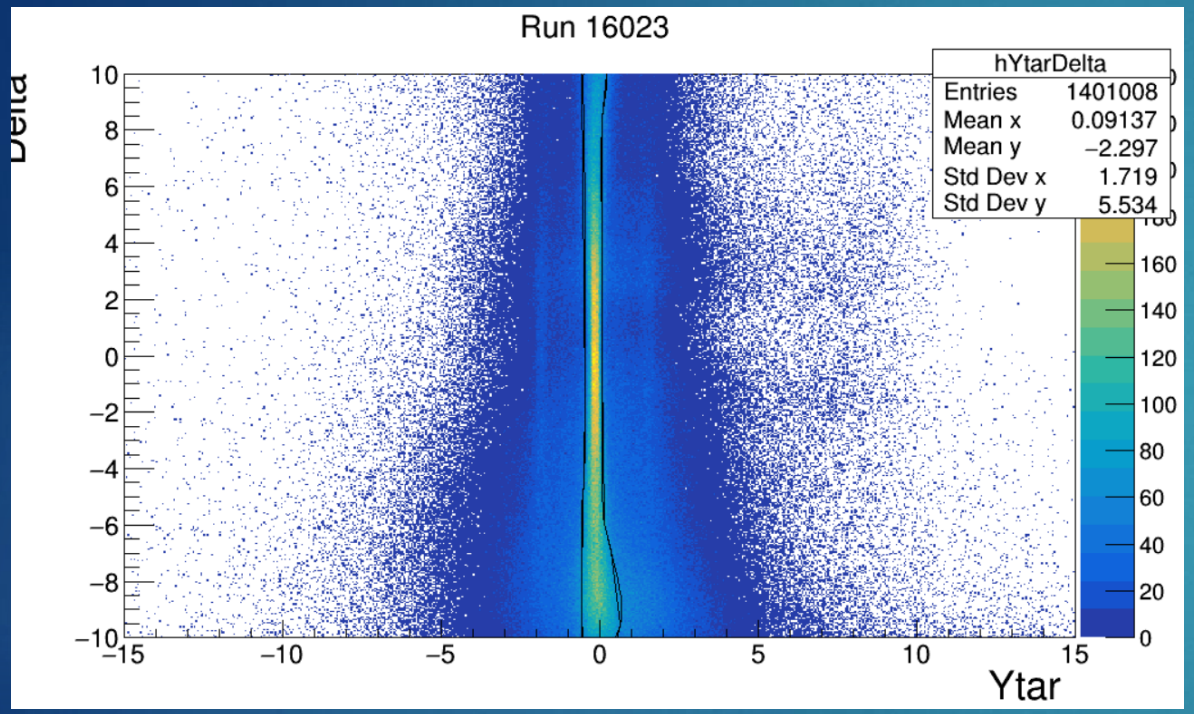


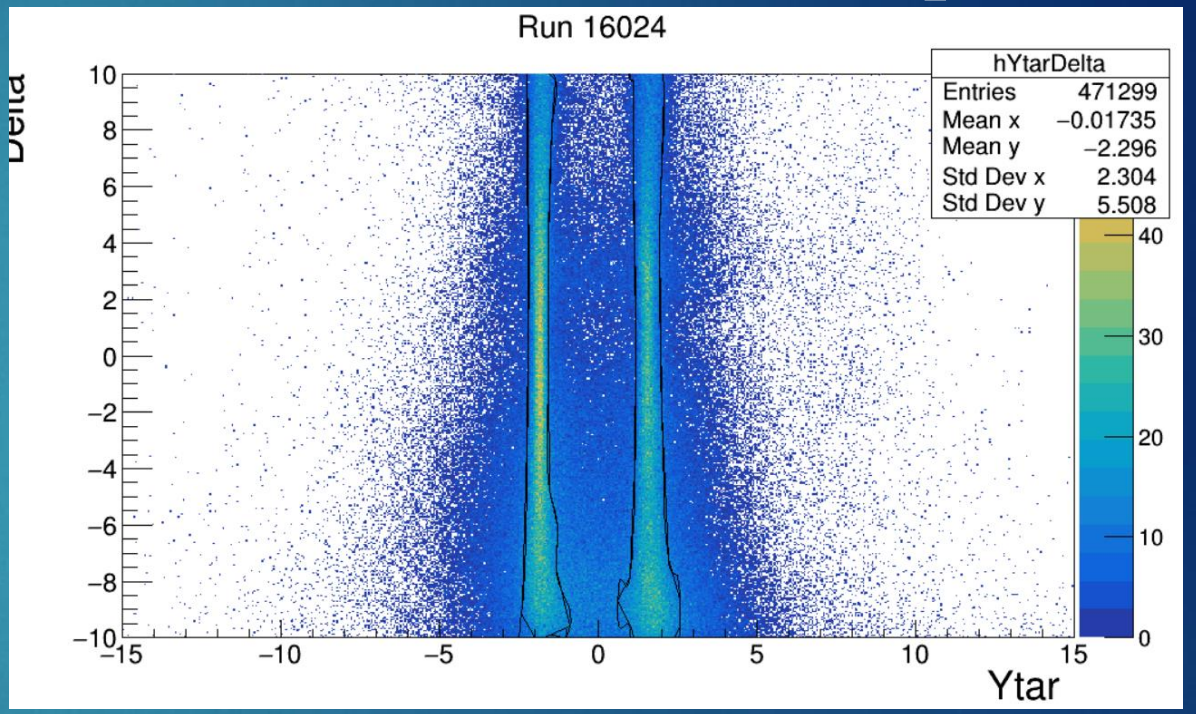


5.6 GeV/c Carbon-Sieve Corrections

IN-PROGRESS

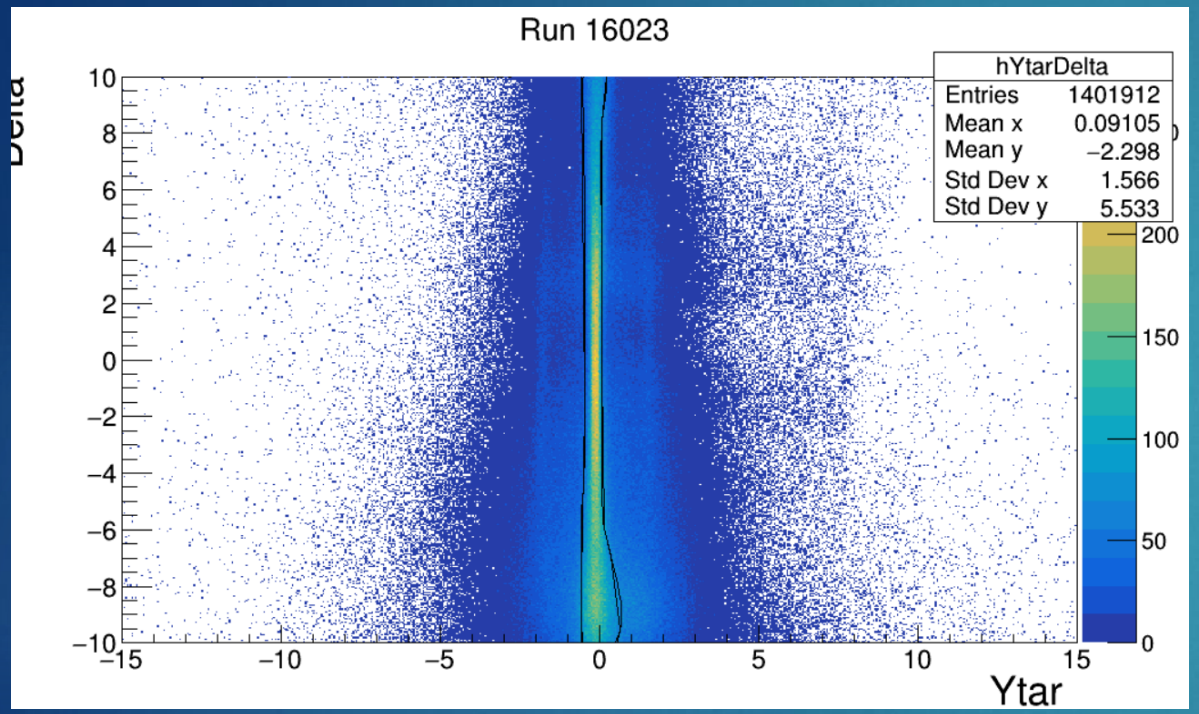
Ytar vs Delta Initial Cuts

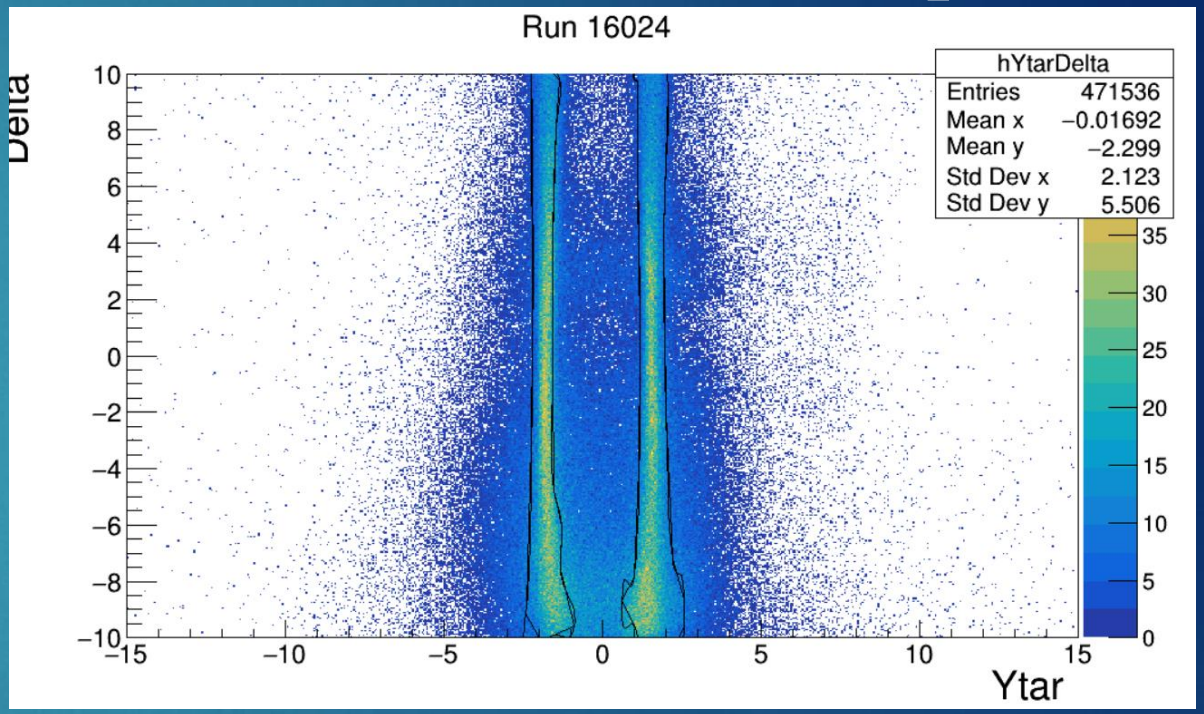




- Initial cuts are placed tightly along foils
  - Unexpected benefit of having 2 optical targets – easier cuts!

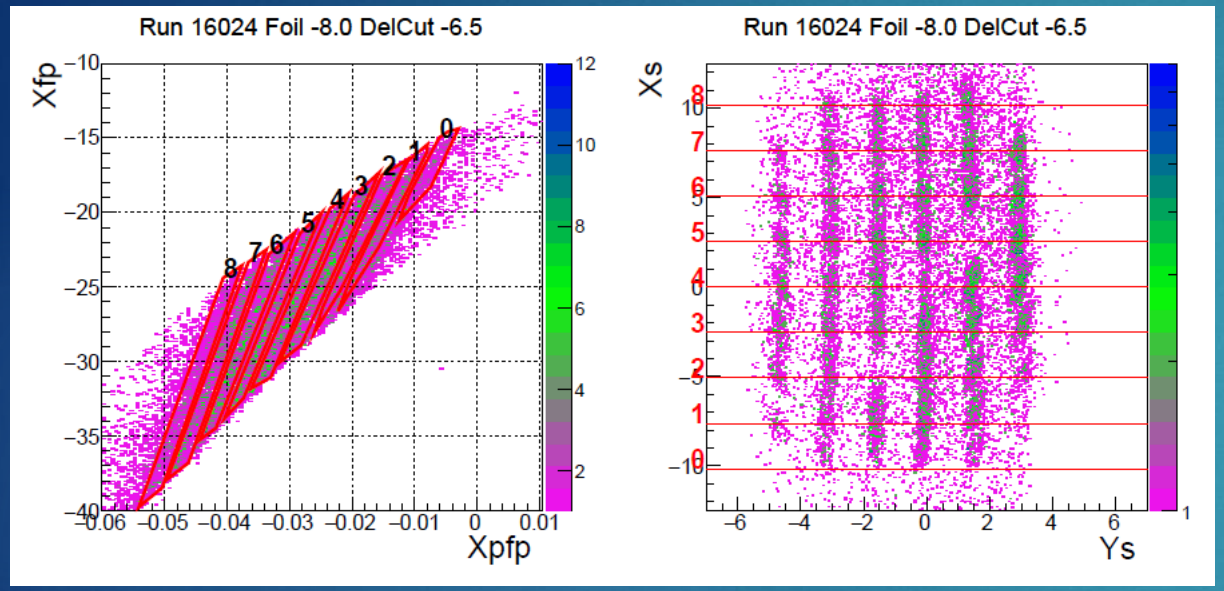
Ytar vs Delta Cuts with New Matrix

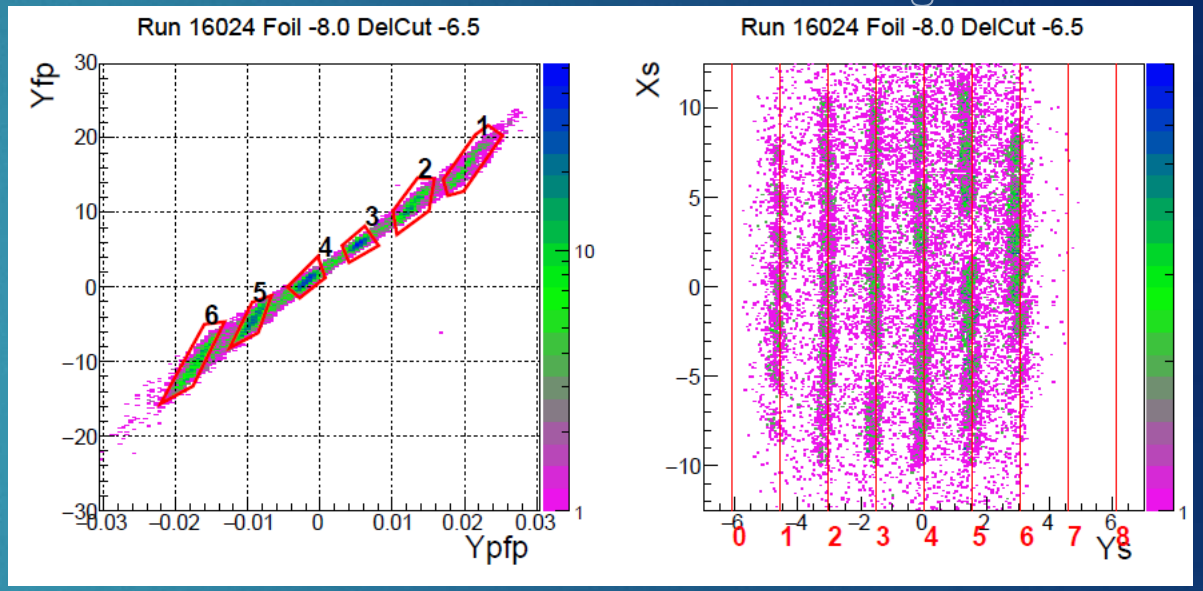




- Initial cuts shown again here
  - Ytar has little change, though +/-8 cm foils appear to curve slightly at negative delta

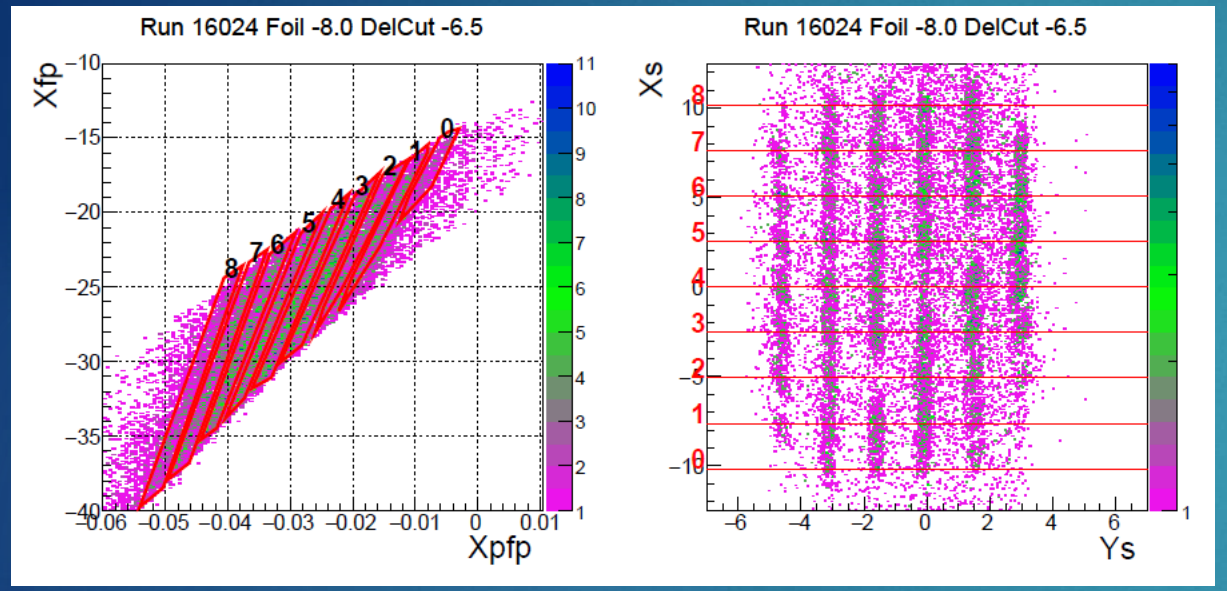
Sieve Hole Cuts in Focal Plane

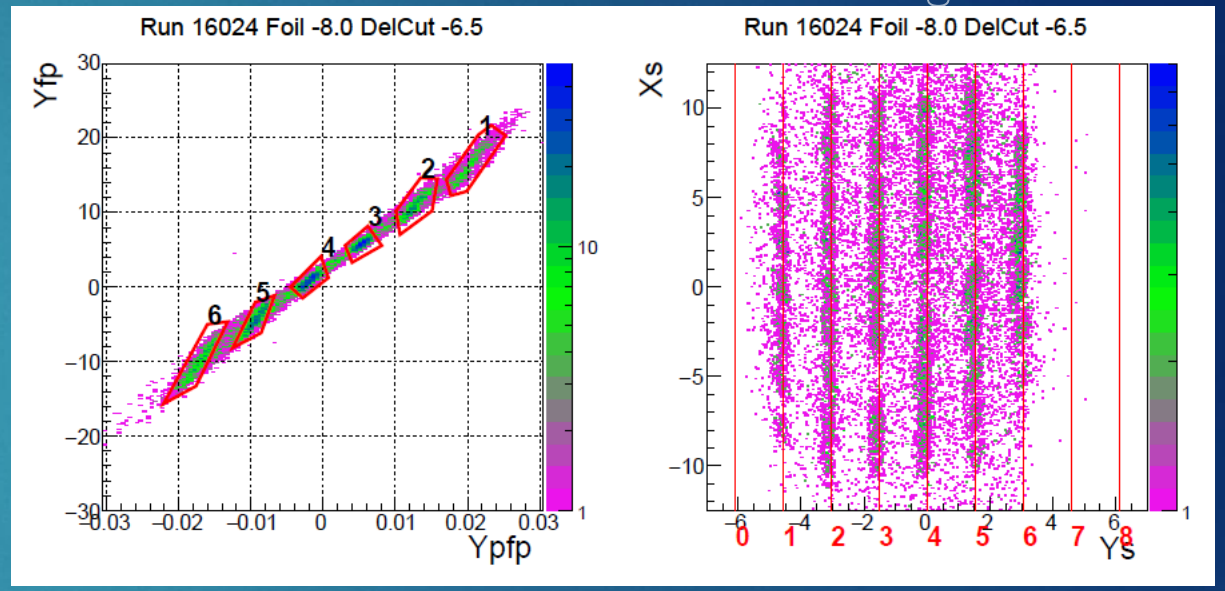




- Focal Plane cuts shown here are again for upstream (-8) foil and -8%<delta<-5%
  - delta<-8% not included in this optimization

Sieve Hole Cuts with New Matrix





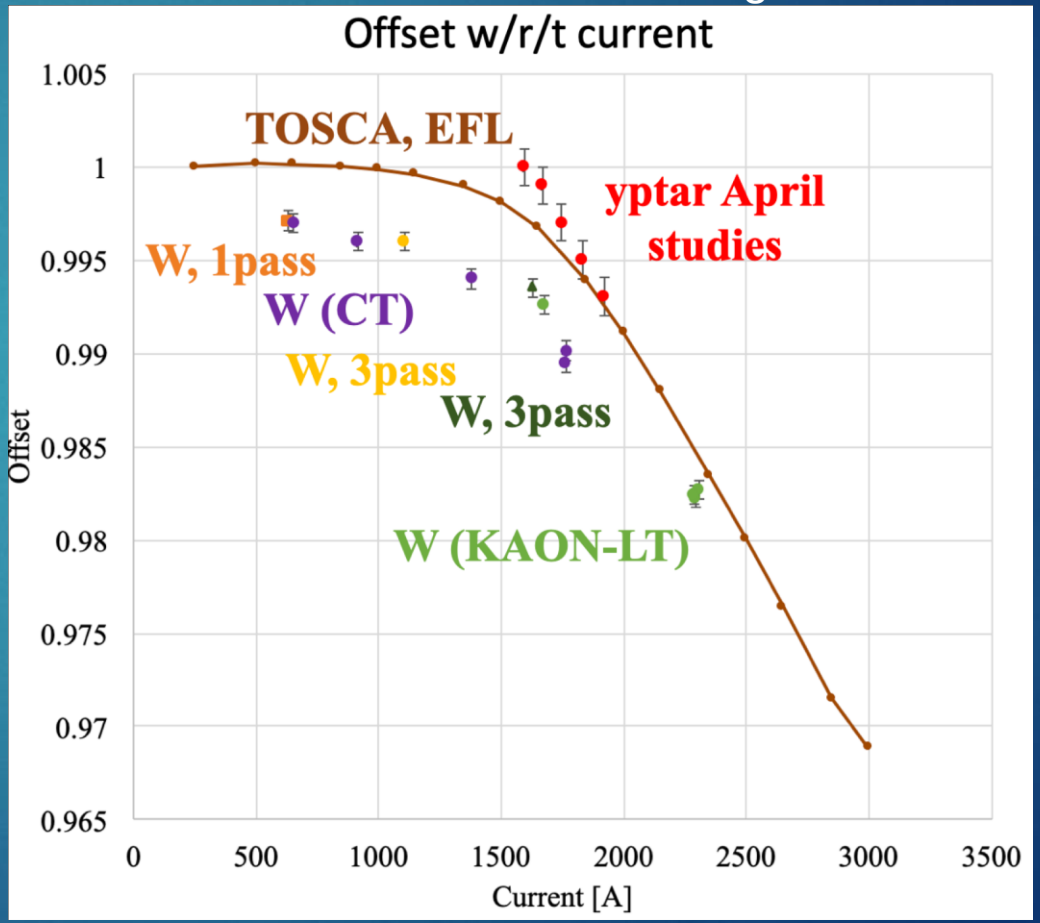
- No drastic changes seen with this optimization
  - Possible that poltar matrix is passible at 5.6 GeV/c
  - X sieve resolution seems to need improvement, however

Next Steps for HMS Optics

HMS High-Momentum Data

- 6.8 GeV/c (Pion-LT)
  - Delta-Optimization in-progress
- 6.6 GeV/c (Kaon-LT)
  - Optimization completed in 2021
- 5.9 GeV/c (Pion-LT)
  - In-progress
- 5.6 GeV/c (Pion-LT)
  - In-progress

*Presented by Holly Szumila-Vance
Hall C Winter Collaboration Meeting 01/28/2019



1.6 3.3 4.8 6.1 6.9 7.5
Approximate Central Momentum [GeV/c]

To-Do

- Complete 5.9 GeV/c Carbon-Sieve Calibrations
- Vary Starting Optical Matrix
  - Poltar Matrix (Mark, 2022) shown here, uses 40 cm extended target
  - 6.6 GeV/c Matrix (Jacob, 2021) used for 6.8 GeV/c online
  - 2018 Calibration Matrix (Holly, 2018) used for rest of Pion-LT online running
- Adjust Delta Cuts
  - Remove events outside -8<delta<8
- Complete Delta Corrections
  - Using Hydrogen Elastics
- Pion-LT SHMS Optics at 8 GeV/c

SHMS Optics from CaFe

- New SHMS optimization at 8.5 GeV/c using CaFe data completed by Holly
  - Minor changes
  - Plan to work in 8.0 GeV/c Pion-LT data with these changes in the future
- Delta corrections on-going for SHMS as well
- These corrections should prove useful not only for Pion-LT and CaFe, but ongoing and future experiments as well
  - XEM is operating with SHMS > 9 GeV/c!