HMS and SHMS Optics for Extended target

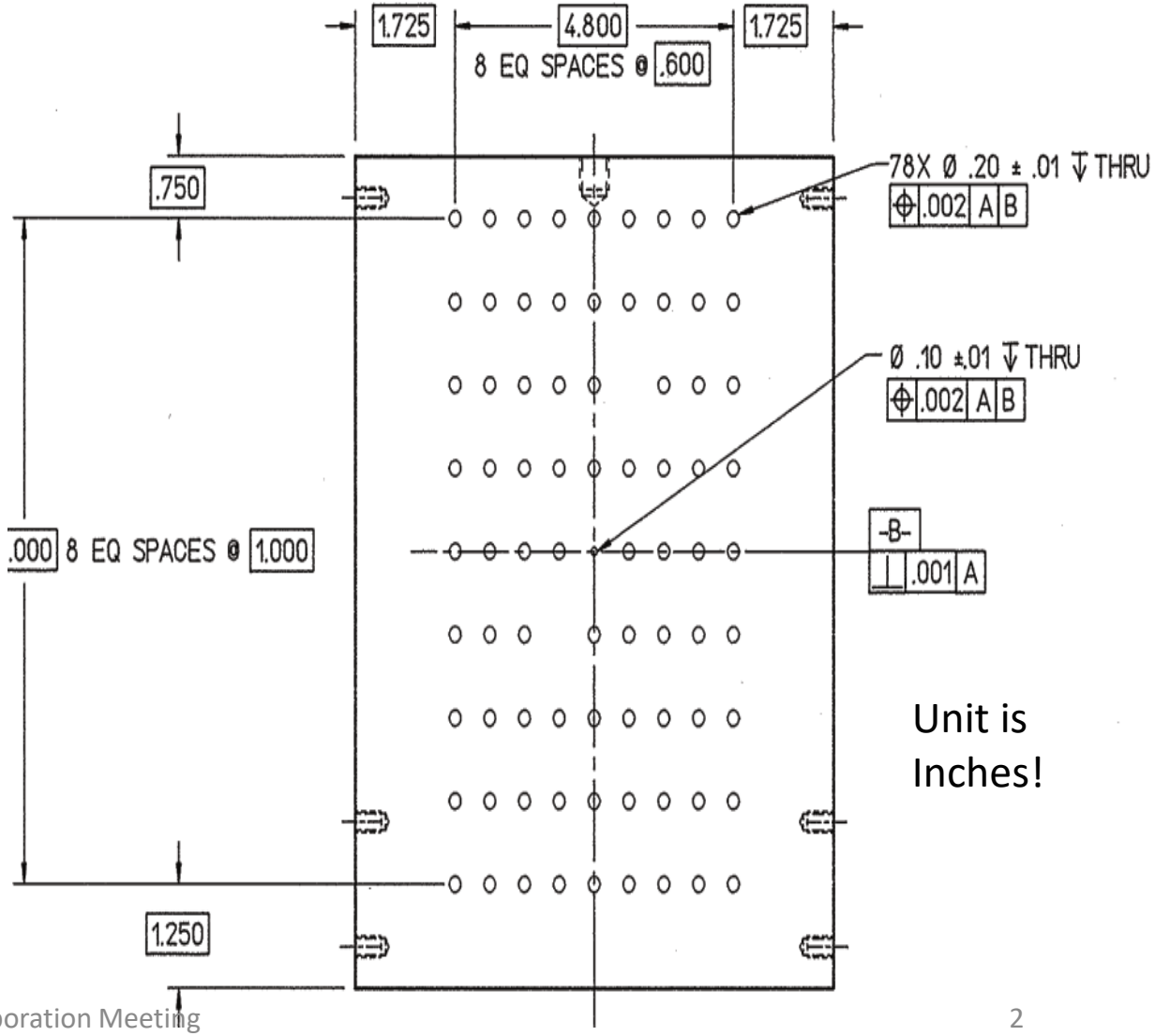
HMS optics, Mark Jones

SHMS Optics, Holly Szumila-Vance

Optimize HMS polarized target

- HMS Data taken with foils at 20,13.34,0,-20,-32.4
- HMS 13.5 degrees with runs 3593-95 and 3599.
- HMS 16.4 degrees with run 3606.
- HMS 20.0 degrees with runs 3610,3612-15.
- HMS 30.0 degrees with runs 3110-3122,3134-3137,3139-3141
- HMS 22 deg run 1342-1343 -10,0,10 foils

- Select ytar vs delta cut for each foil.
- Set cuts on ypfp vs yfp and xpfp vs xfp for different delta regions.
- Determine HMS mispointing at each angle assume center foil at ztar = 1.17mm.
- Fit all angles at once.
- At sieve 1cm is about 6mr.



Unit is Inches!

Optics Reconstruction matrix

- Reconstruction matrix for Ytar, dx/dz, dy/dz
- Fitted with polynomials that depend on focal plane quantities and polynomials that depend on focal plane and x_{tar}.

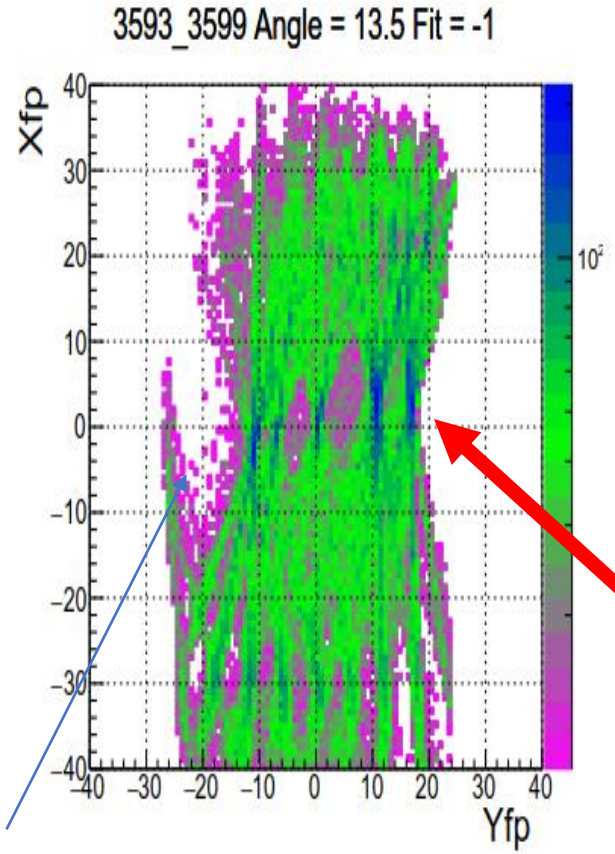
$$\frac{dx_{tar}}{dz_{tar}} = \sum_{ijlk} a_{ijlk} * x_{fp}^{i} * xp_{fp}^{j} * y_{fp}^{k} * yp_{fp}^{l} + \sum_{ijlkm} b_{ijlkm} * x_{fp}^{i} * xp_{fp}^{j} * y_{fp}^{k} * yp_{fp}^{l} * x_{tar}^{m}$$

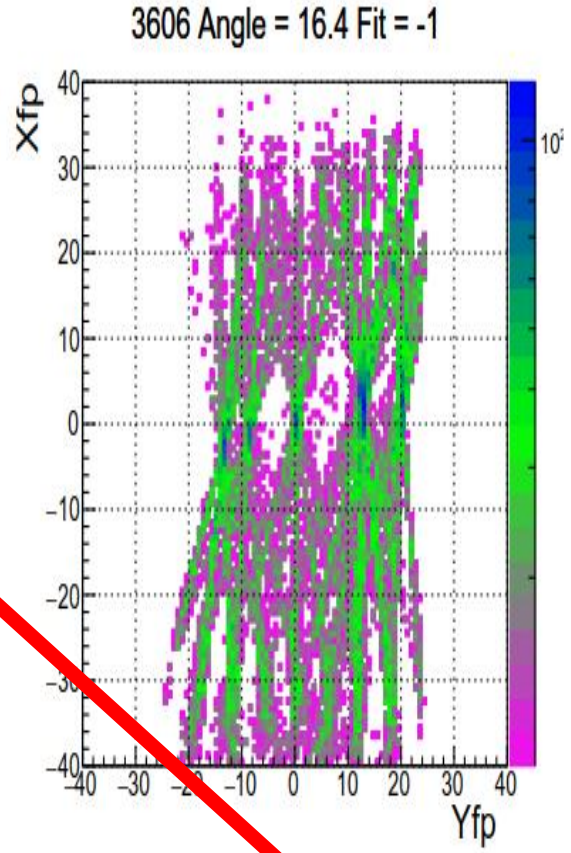
- X_{tar} , the vertical position at the target is a calculated quantity.
  - Need to know xptar, yptar, ytar (to calculate ztar) to determine xtar.
  - For ztar = 20cm and xptar = 80mr then xtar = 15mm
  - Use an iterative procedure to
    - First calculate xptar,ytar, yptar without xtar correction and determine xtar
    - Recalculate xptar,ytar,yptar with xtar.
  - Updated HCANA so that reconstruction is iterated over xtar for 5 times or if improvement < 2mr.
    - Previously HCANA did just one iteration which was fine for relatively short targets.
- Fitting procedure was fixing the x_{tar} dependent reconstruction terms.
  - Changed fitting procedure to fit the x_{tar} terms (up to 2nd order in focal plane combined with 3rd order in x_{tar})
- Fit 5th order polynomial for x_{tar} independent terms

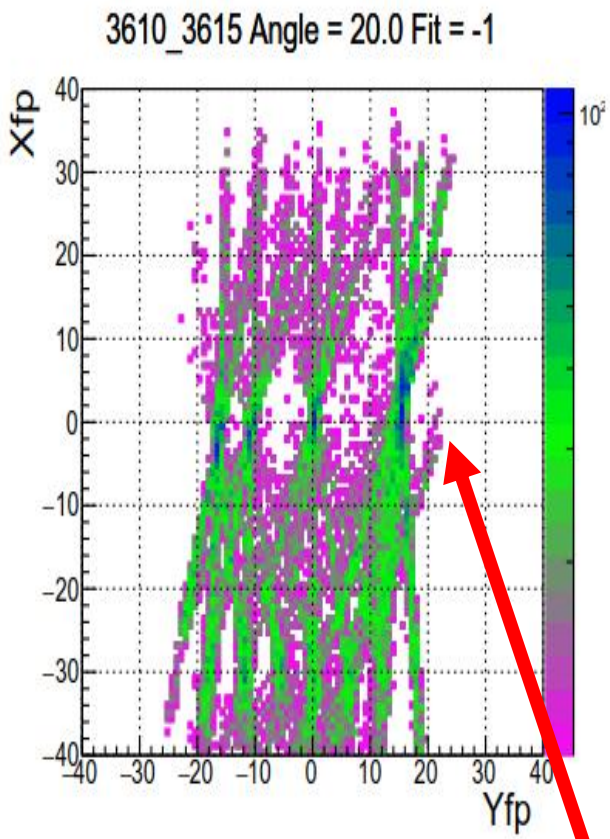
$$x_{tar} = -\frac{dx_{tar}}{dz_{tar}} * z_{tar} * \cos(\theta)$$

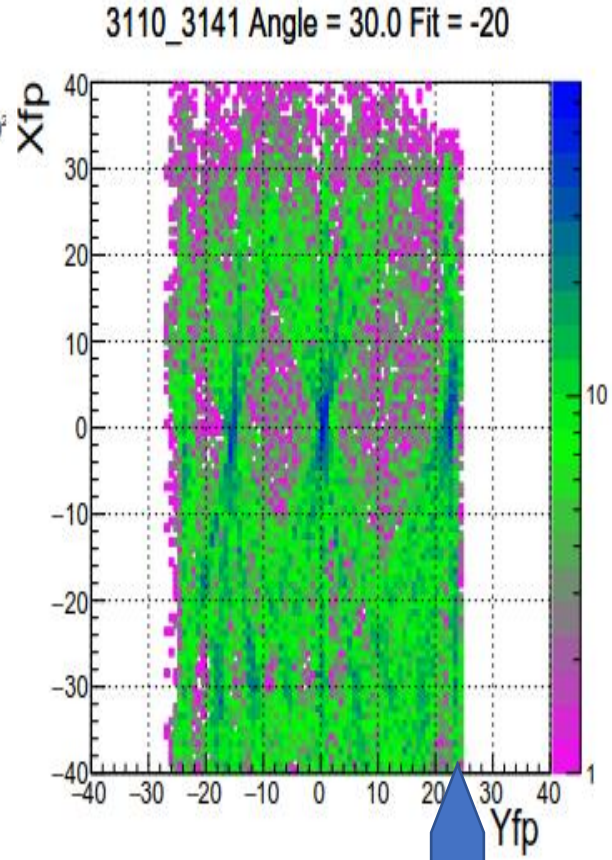
$$\frac{dx_{tar}}{dz_{tar}} = \frac{1\text{mrad}}{1\text{mm}} * x_{tar}$$

Focal plane distributions





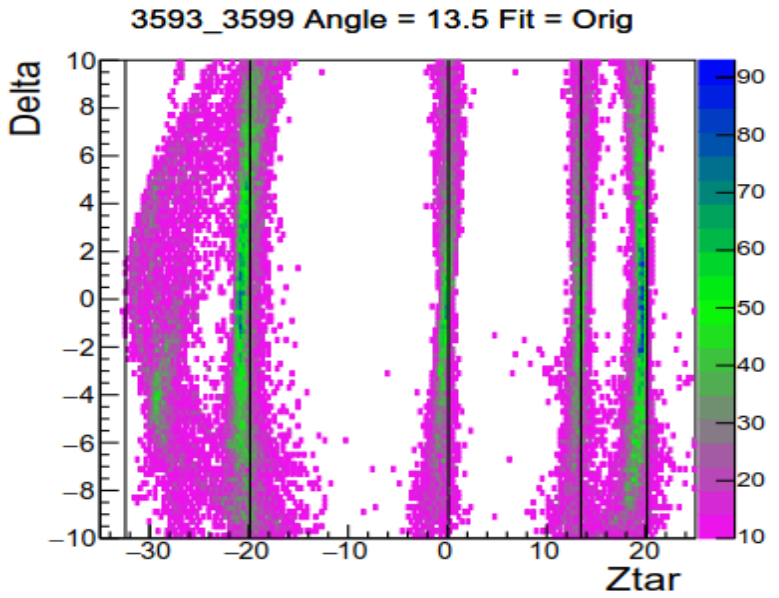


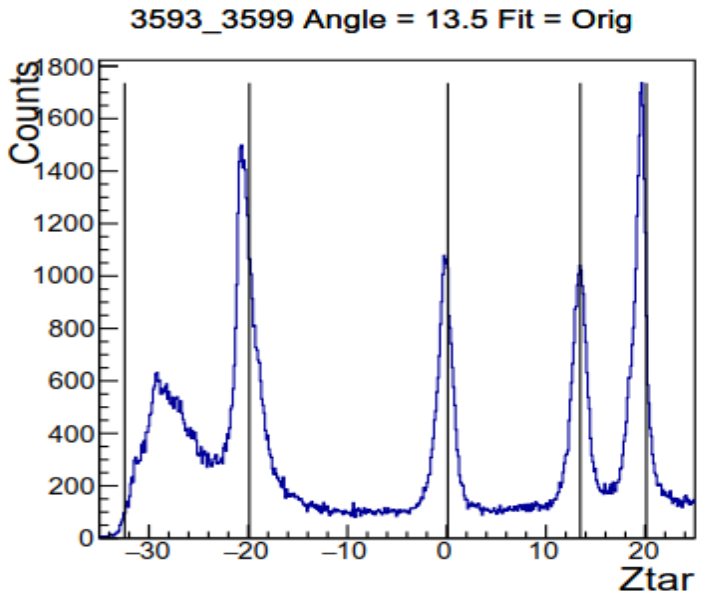


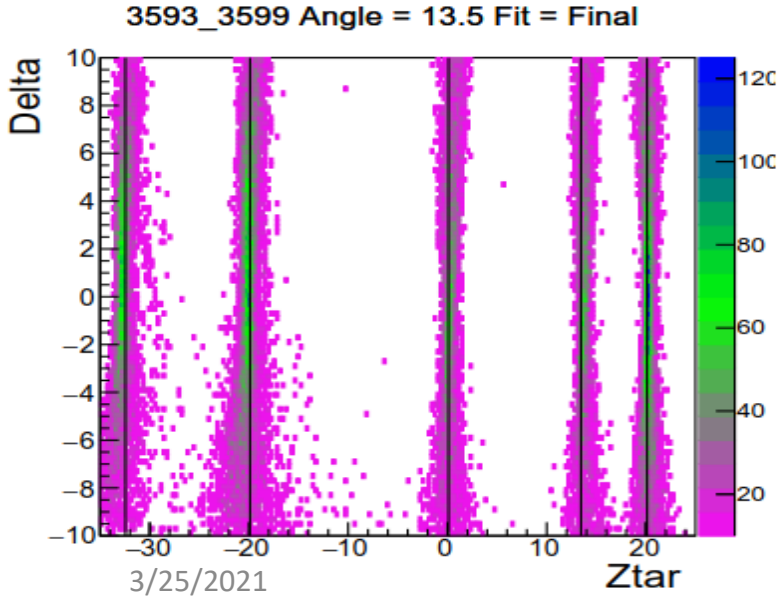
Downstream Beam entrance

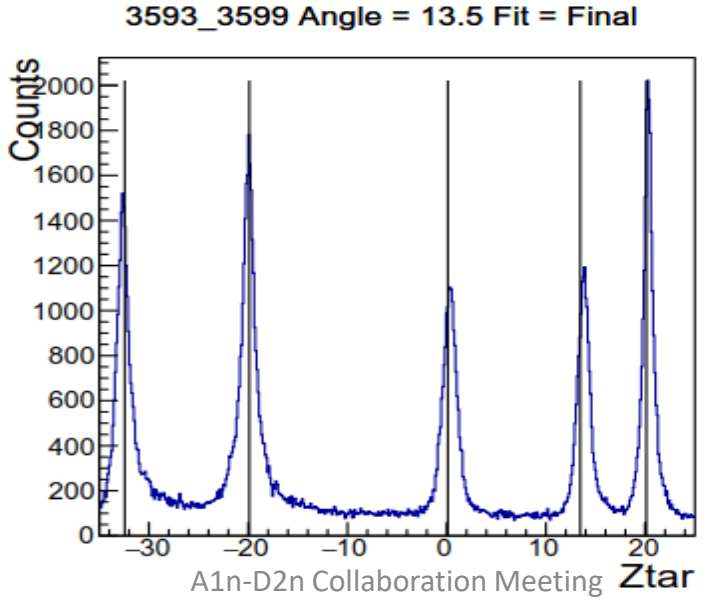
- Gradually the upstream beam window moves off the focal plane with increasing HMS angle
- At HMS =20 degree, see a little of the upstream beam window but focus is off focal plane.
- The HMS DC Yfp width is about +/-26cm. At 30^{o} , the windows are at end of Yfp.

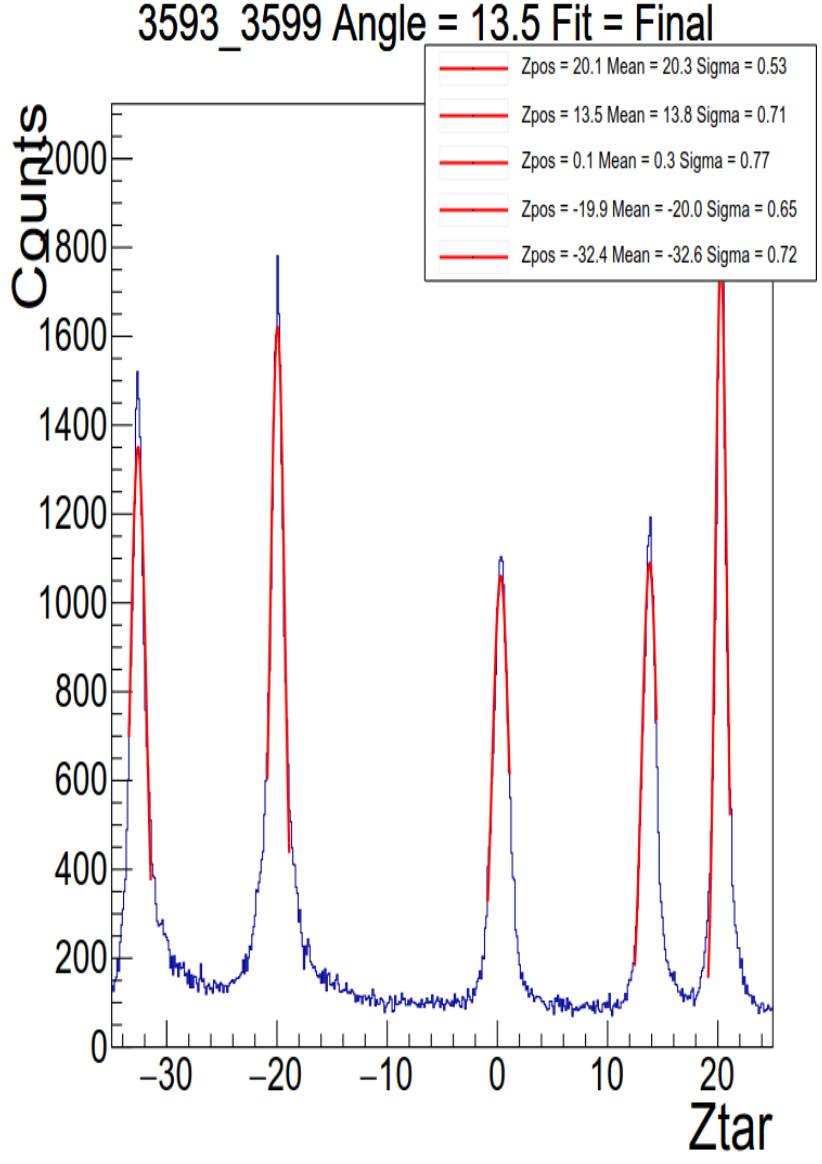
HMS 13.5 degrees. Ztar Comparison before (Orig) to after (Final)



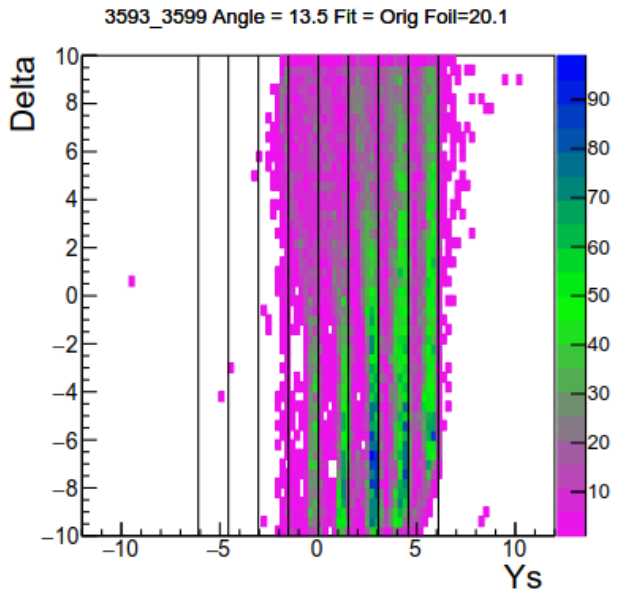


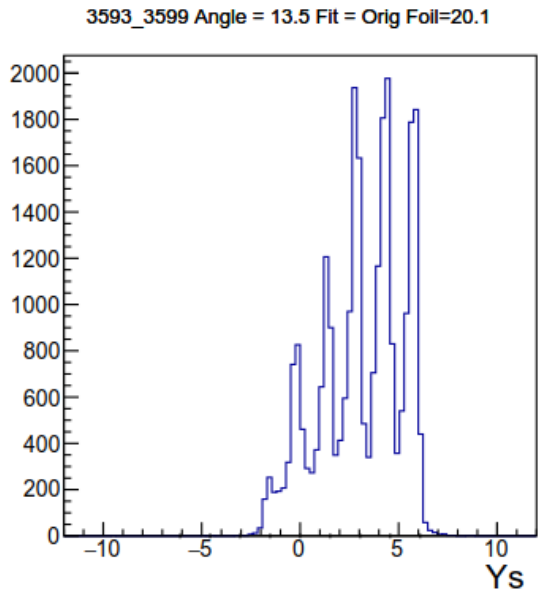


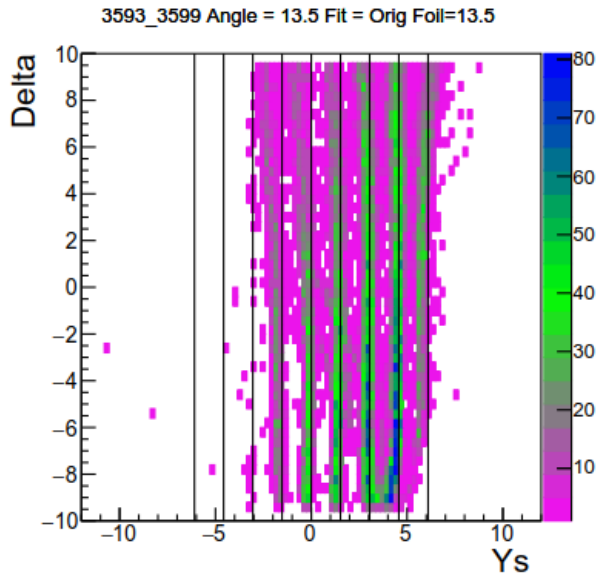


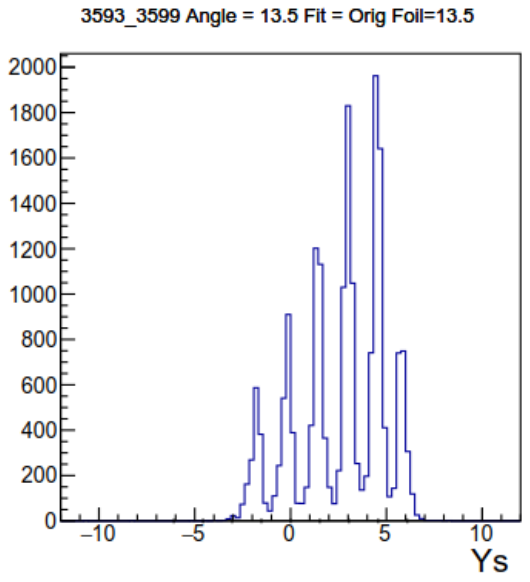


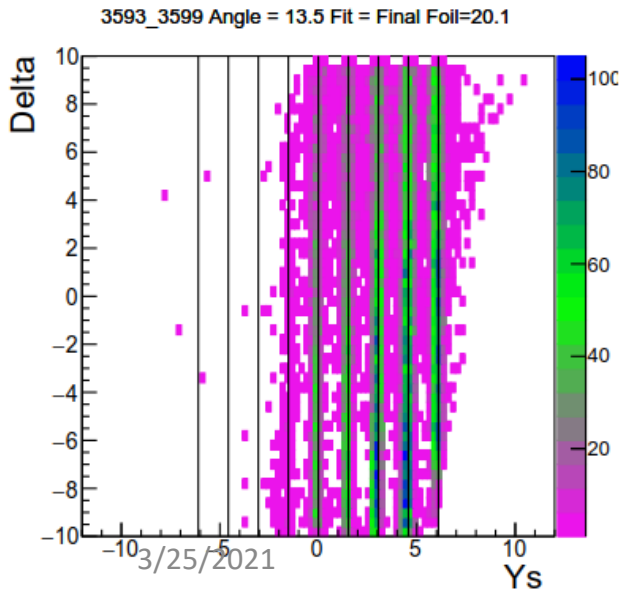
HMS 13.5 degrees Ysieve Comparison before (Orig) to after (Final)

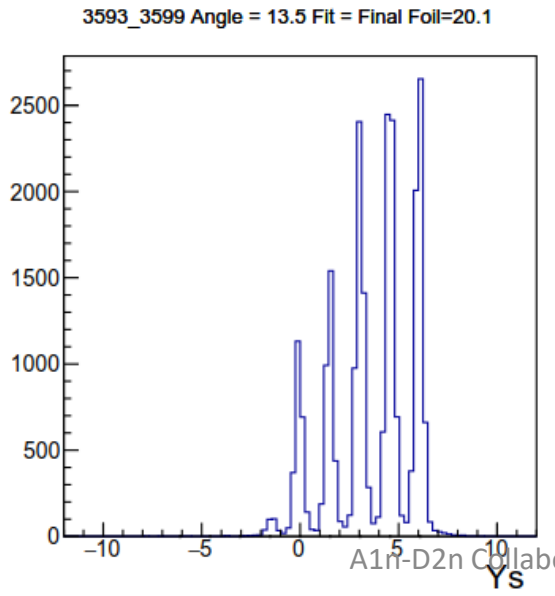


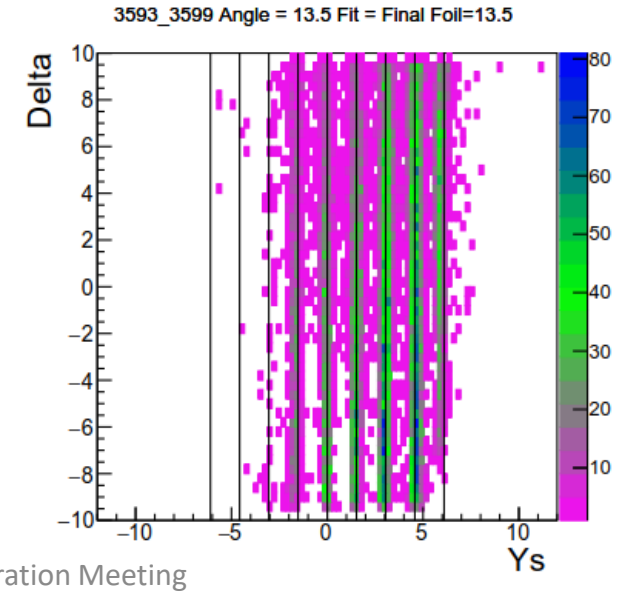


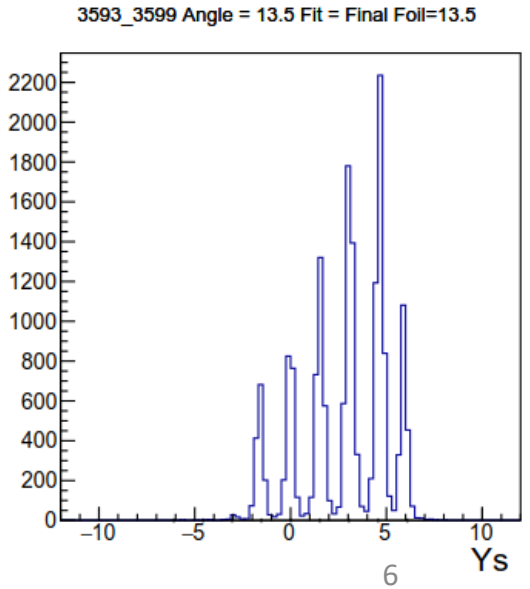




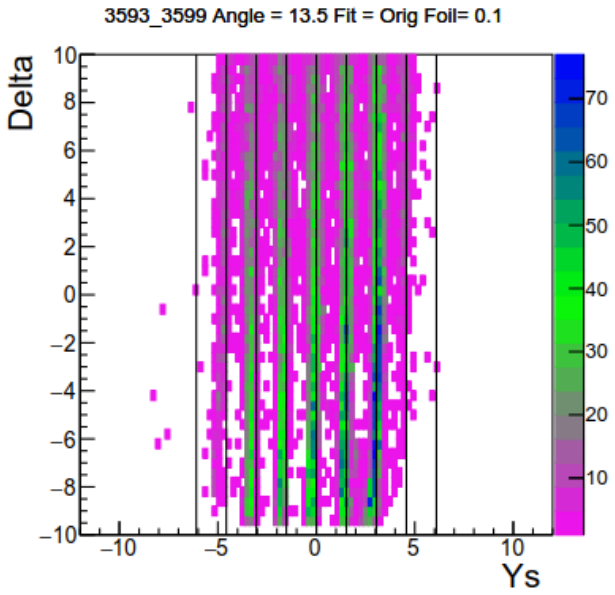


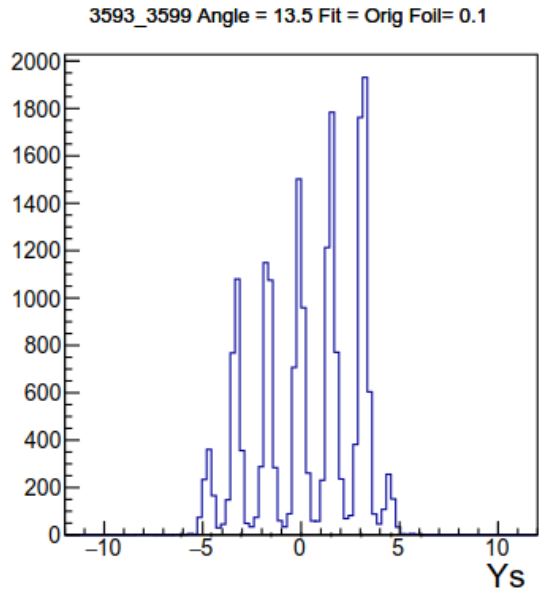


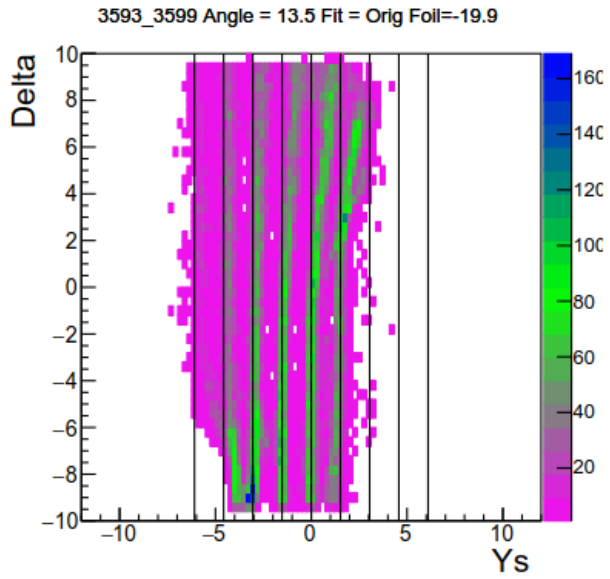


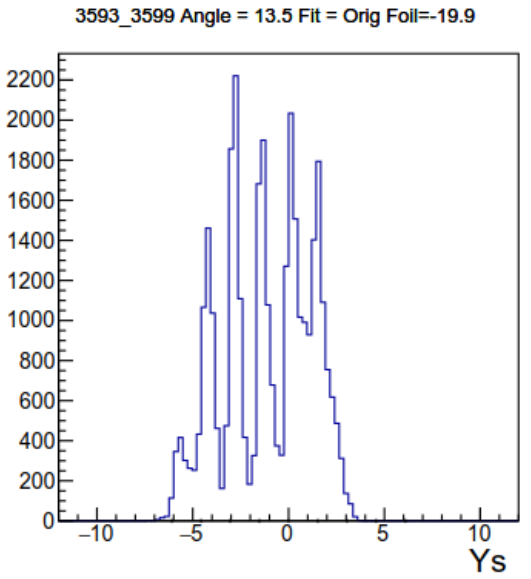


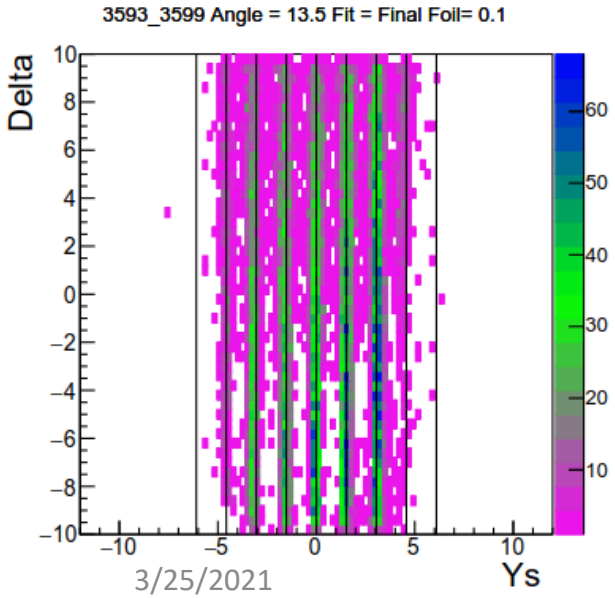
HMS 13.5 degrees Ysieve Comparison before (Orig) to after (Final)

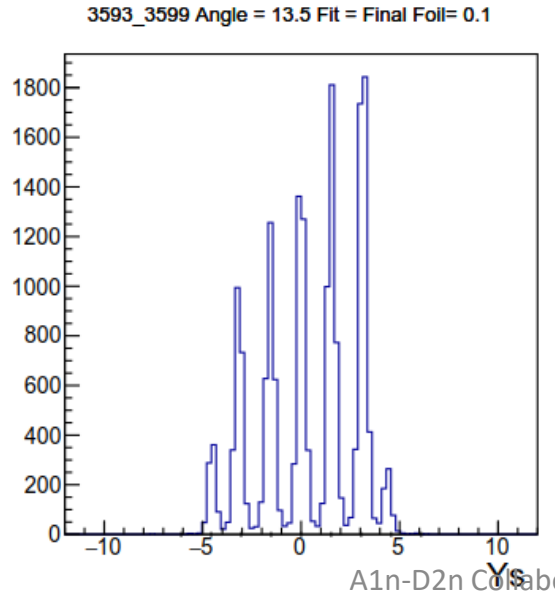


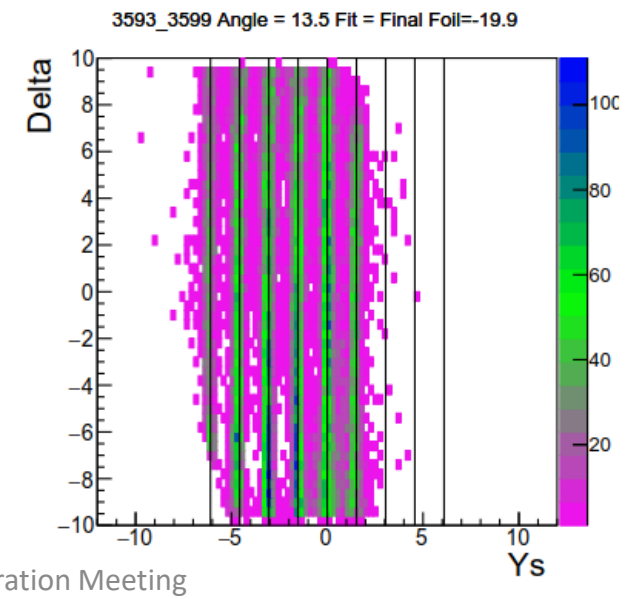


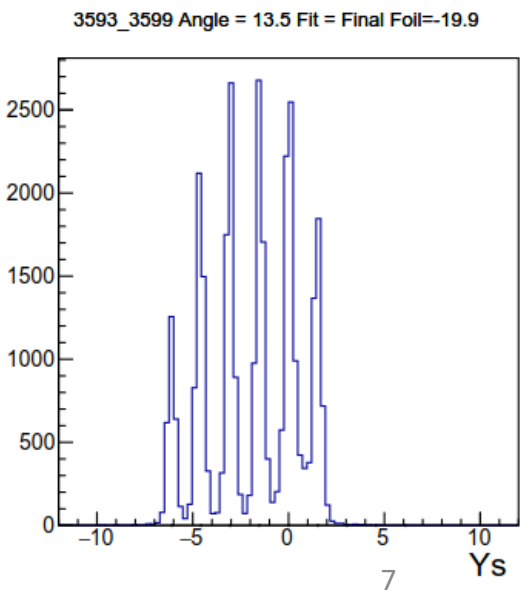




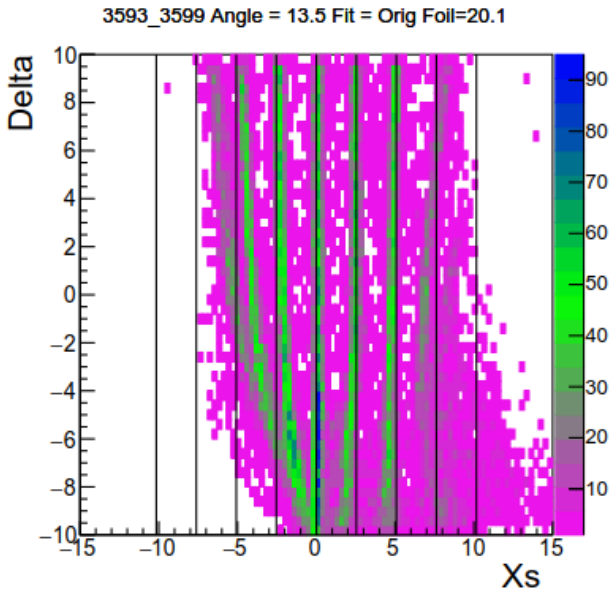


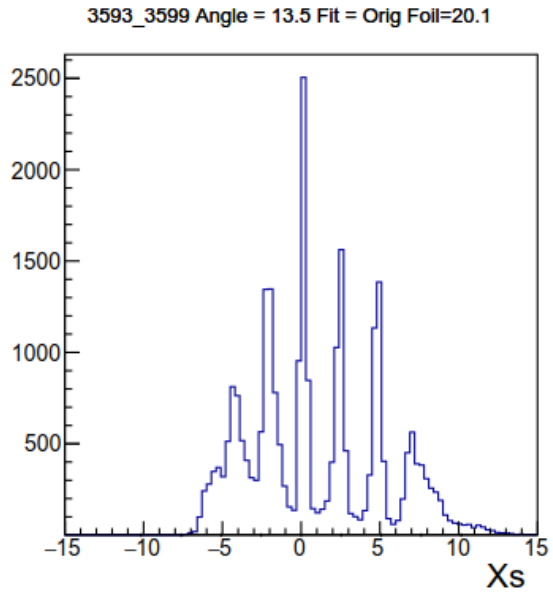


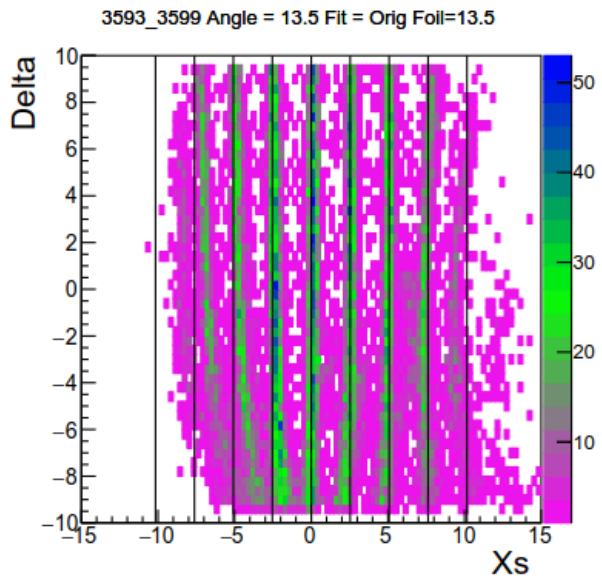


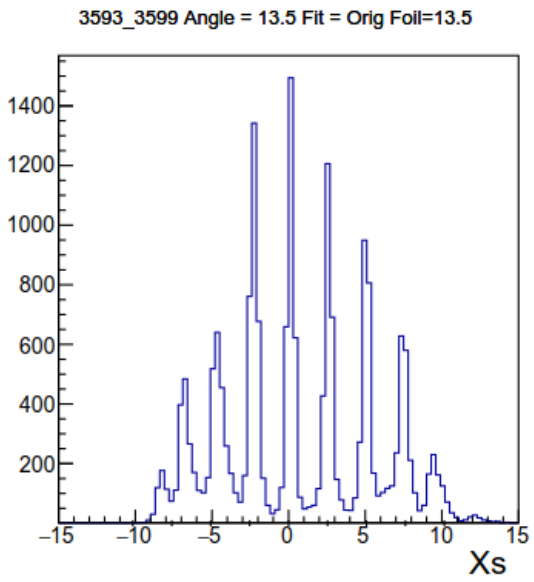


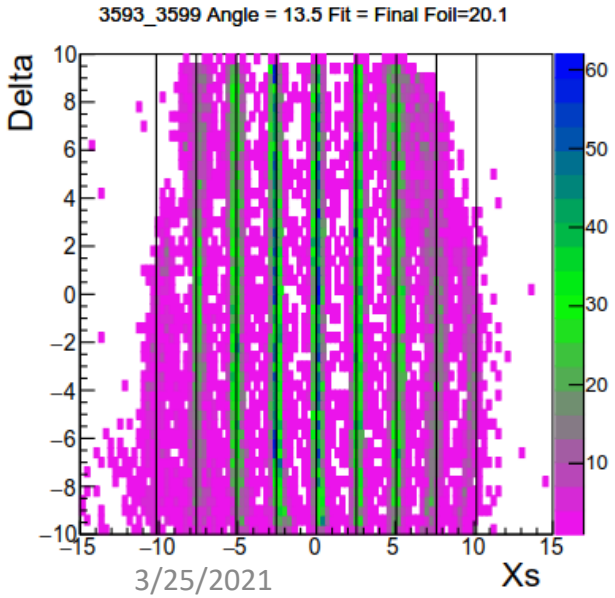
HMS 13.5 degrees Xsieve Comparison before (Orig) to after (Final)

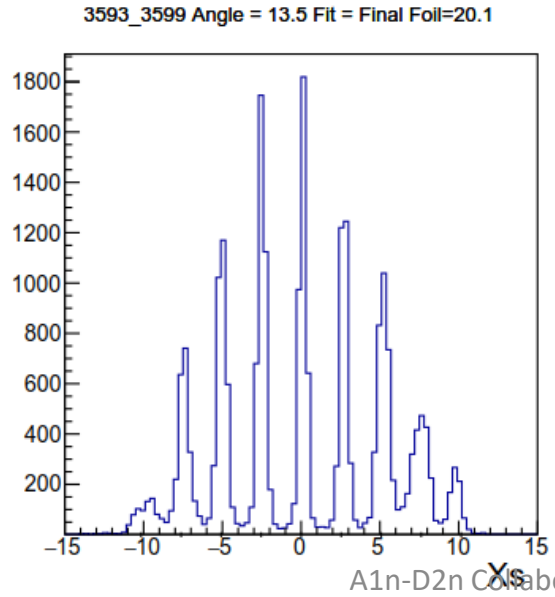


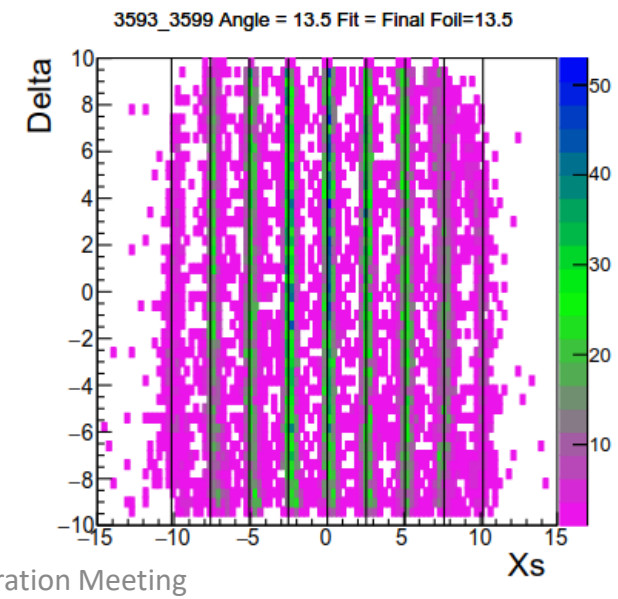


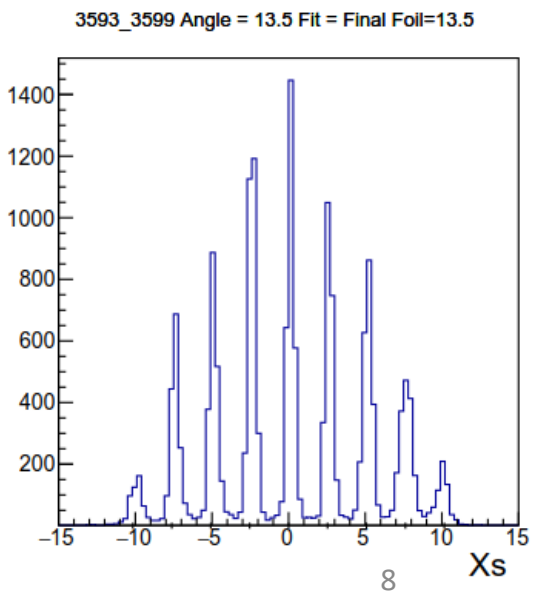




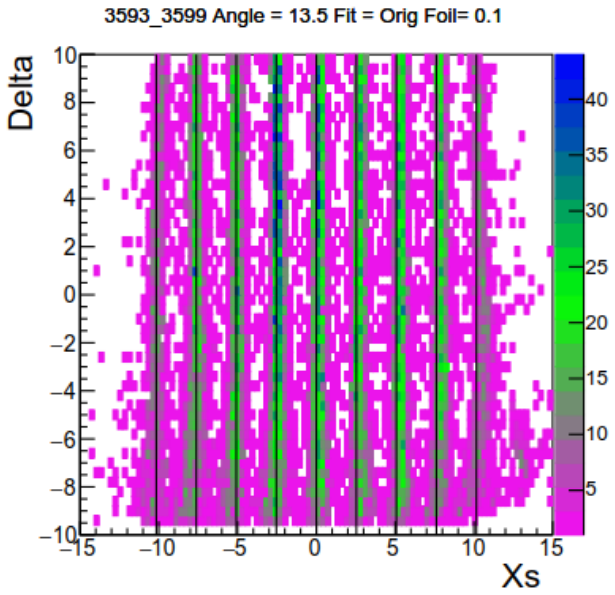


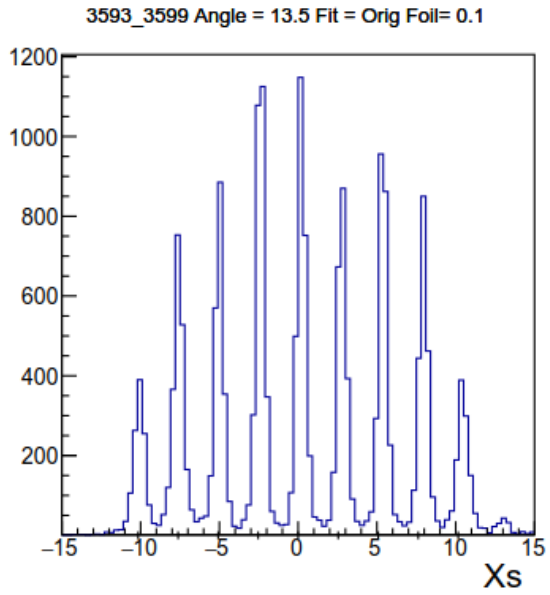


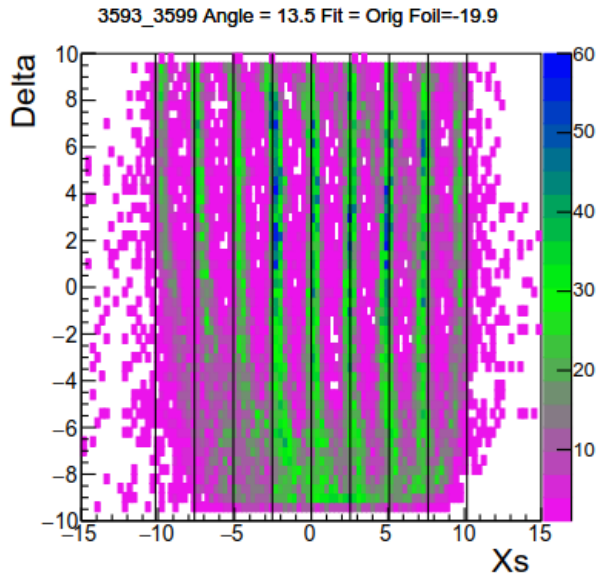


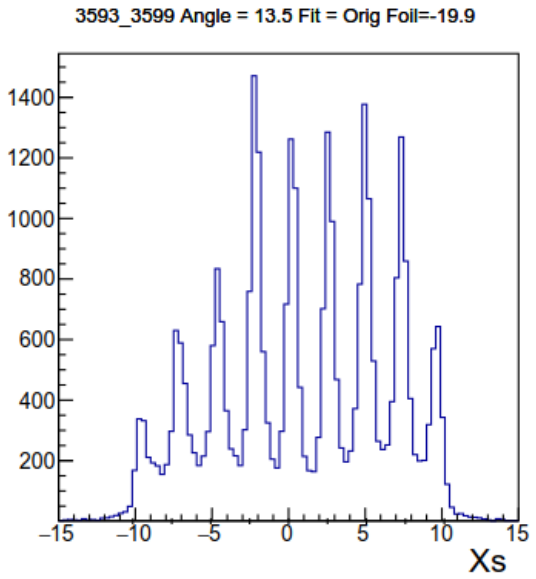


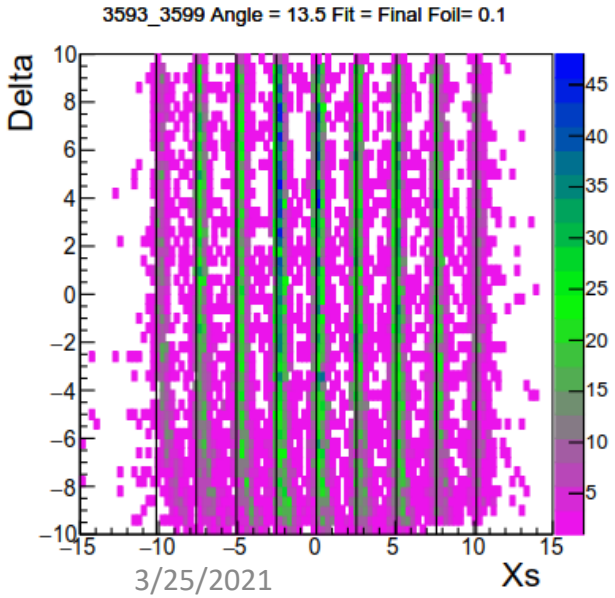
HMS 13.5 degrees Xsieve Comparison before (Orig) to after (Final)

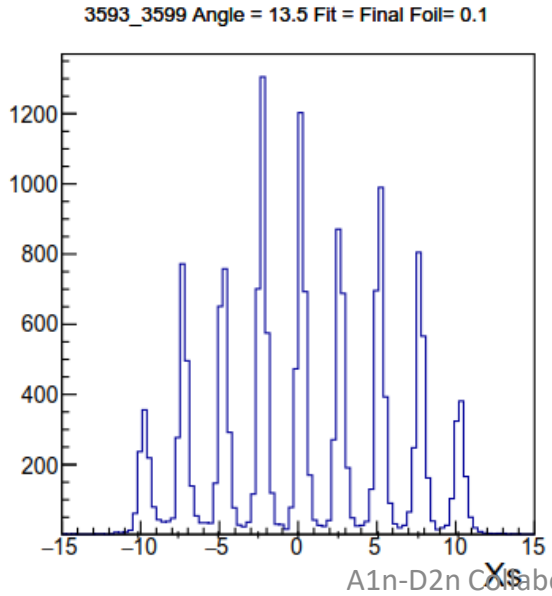


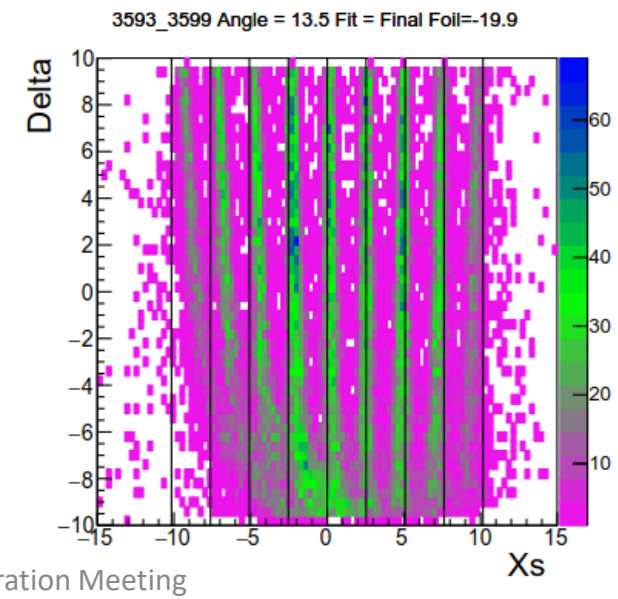


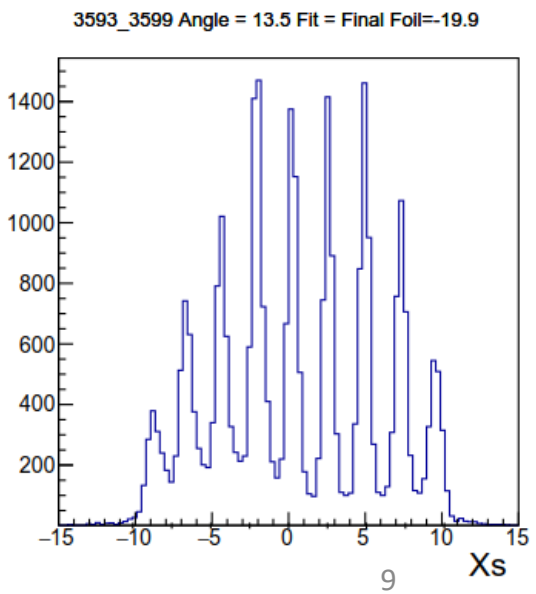












Overview of HMS Optimization

- Zip file of plots is on DocDB

Pdf file name	
Comp_hms_xsieve_delta_fits_nrun	Plots xsieve versus delta and 1-d xsieve plots for Original and Final recon matrix
Comp_hms_ysieve_delta_fit_peak_nrun	Plots fits for the 1-D ysieve for Final recon matrix
Comp_hms_yseive_delta_fits_nrun	Plots ysieve versus delta and 1-d xsieve plots for Original and Final recon matrix
Comp_hms_ztar_delta_fits_nrun	Plots ztar versus delta and 1-d ztar plots for Original and Final recon matrix Fit 1-D ztar for Final recon matrix
Optics_nrun_nfit_xpdiff	Plot of Xp recon – Xp true versus Ys for each delta bin for different Xs
Optics_nrun_nfit_xpdiff_xs	Plot of Xp recon – Xp true versus Xs for different delta
Optics_nrun_nfit_ypdiff_ys	Plot of Yp recon – Yp true versus Ys for different delta
Optics_nrun_nfit_ydiff_delta	Plot of Y recon – Y true versus delta for different Z foil
Optics_nrun_nfit_ydiff_xs	Plot of Y recon – Y true versus Ys for each Z foil for different delta bins

SHMS Optimization

Slides provided by Holly Szumila-Vance

Summary about the optimization in on DocDB

11 deg: runs 10776-10780
14.5 deg: run 10786
18 deg: runs 10790, 10793-10795
30 deg: runs 10301-10333

Procedure:
-global optimization for extended target in SHMS for -13-25% in delta

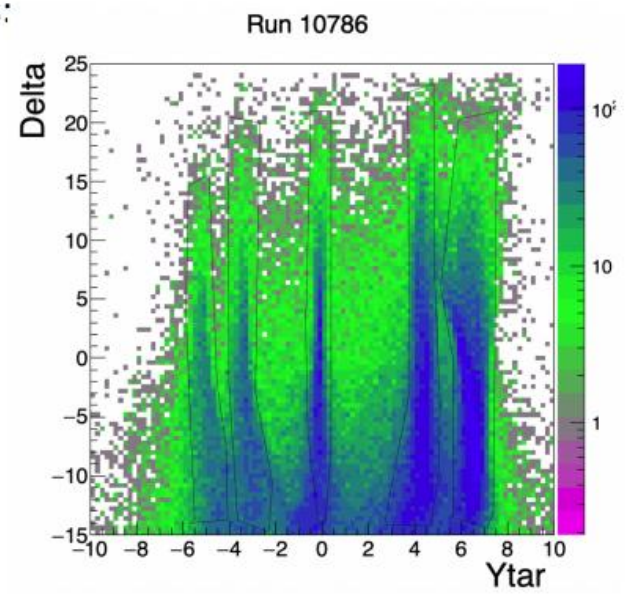
Final optics matrix: hsv_fit_global.dat

In process of re-running analysis with re-calculation of react.z after obtaining yTar

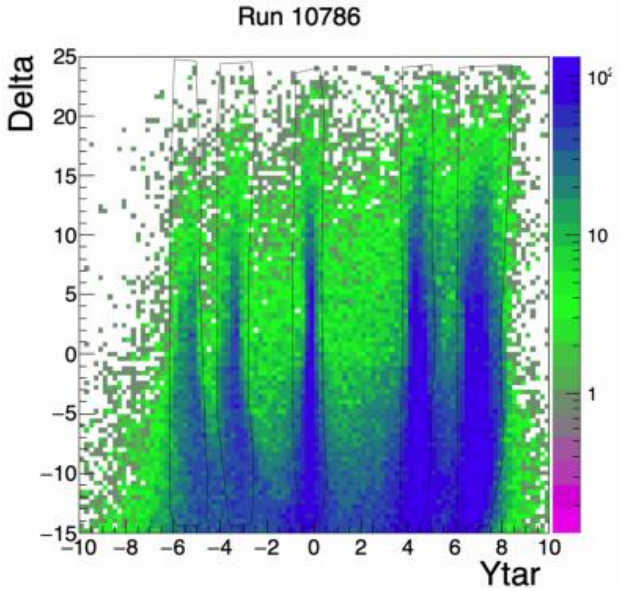
SHMS Ytar Optimization

14.5-deg runs:

Pre-opt:

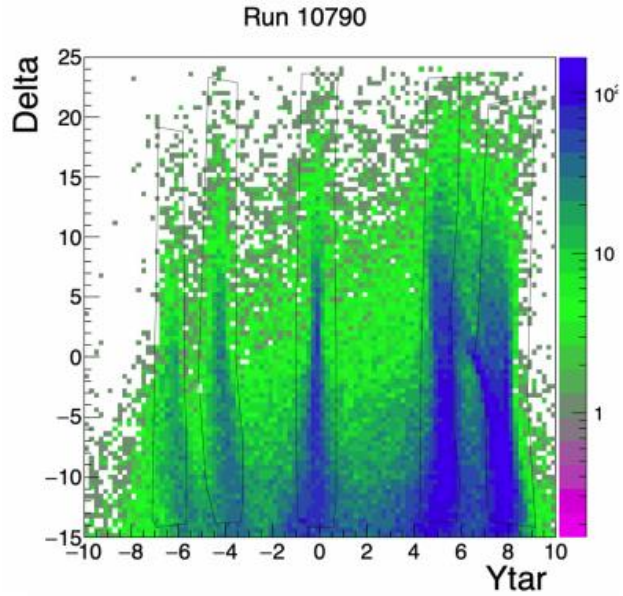


Optimized:

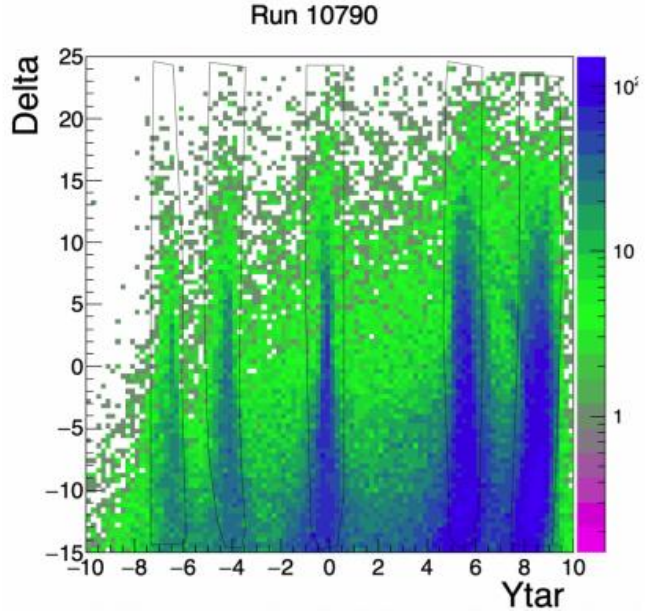


18-deg runs:

Pre-opt:

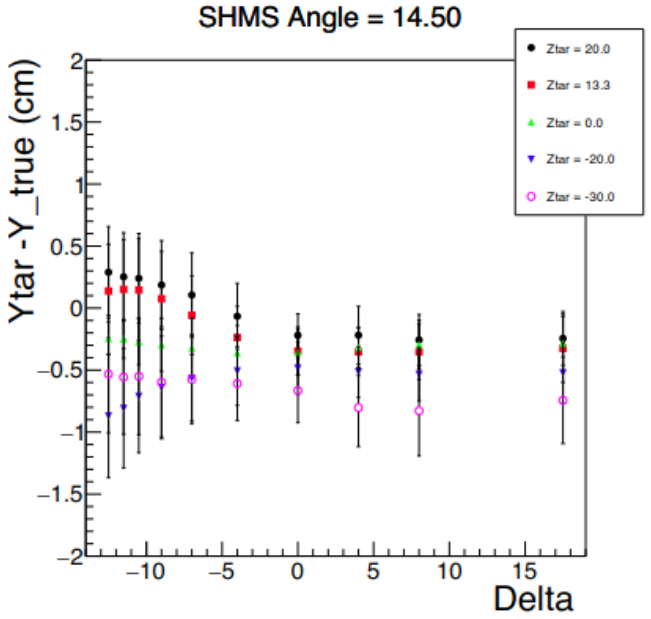


Optimized:

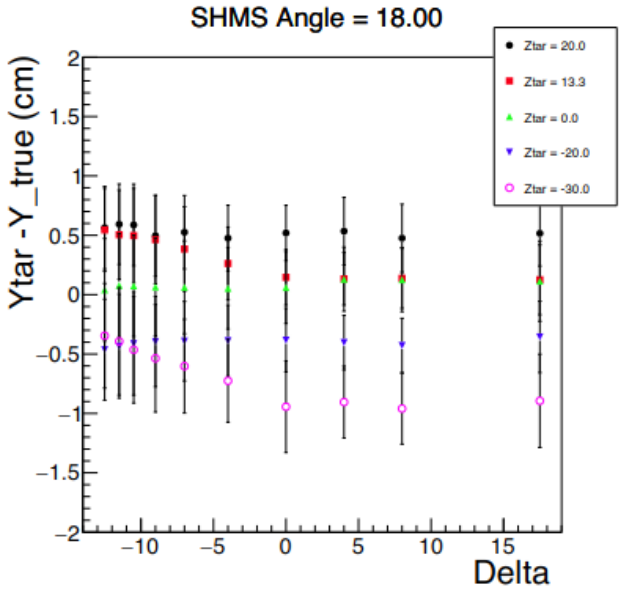


SHMS Ytar Optimization

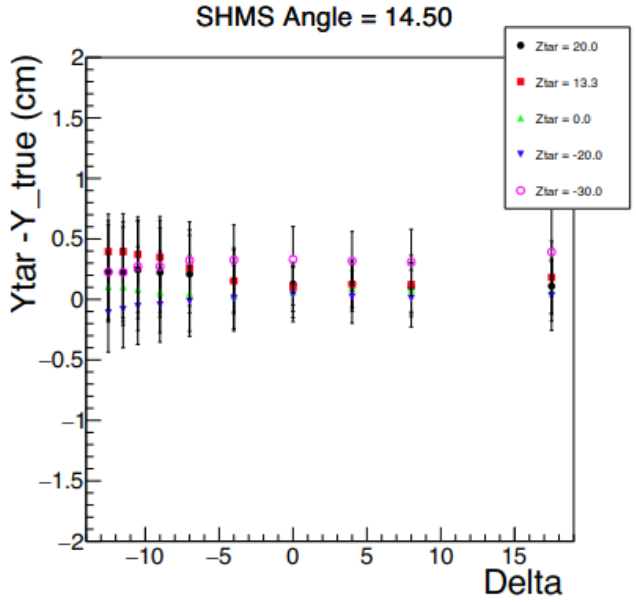
Pre-opt:



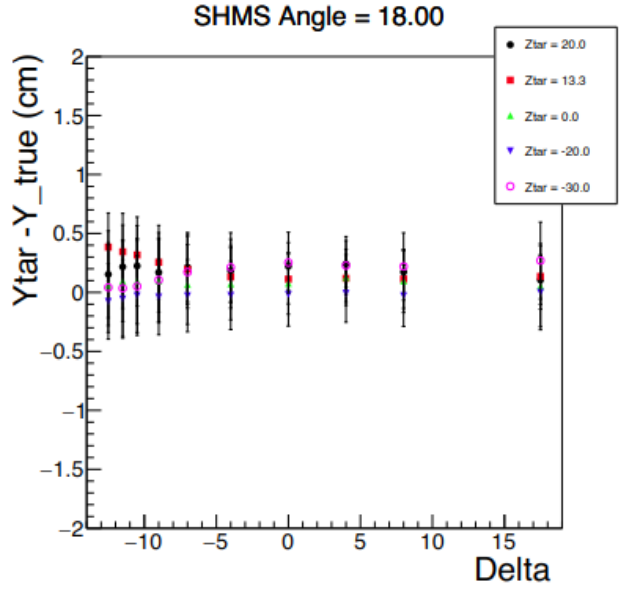
Pre-opt:



Optimized:



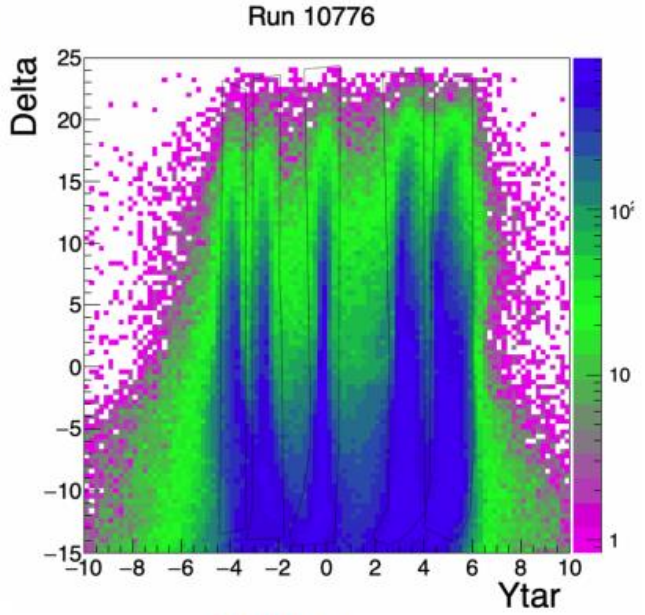
Optimized:



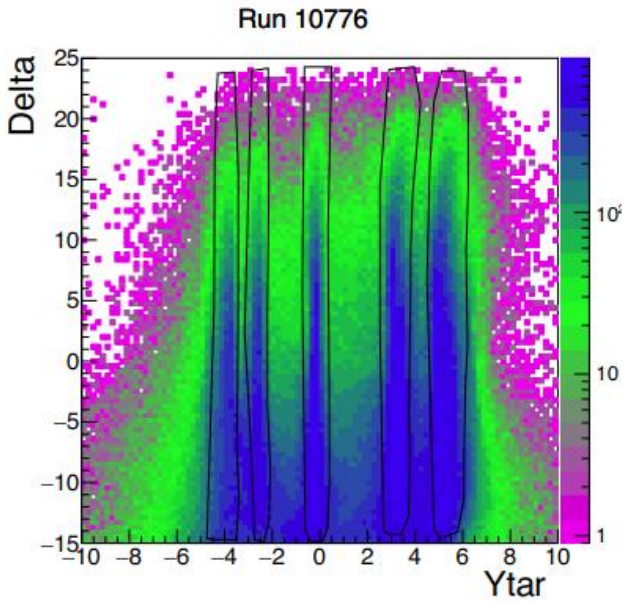
SHMS Ytar Optimization

11-deg runs:

Pre-opt:

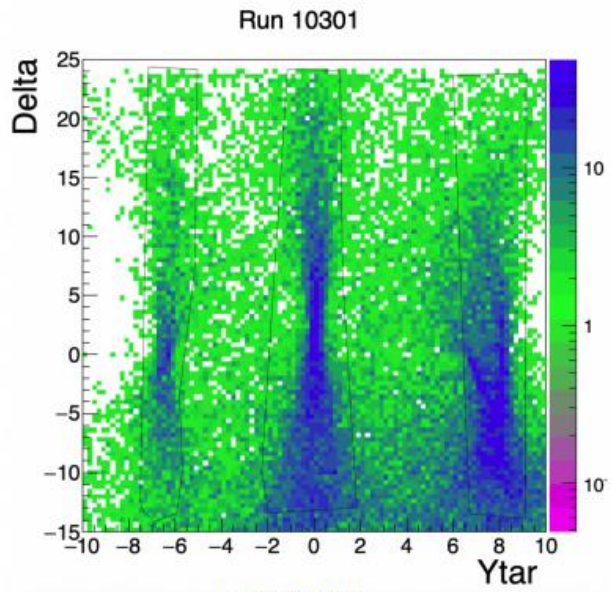


Optimized:

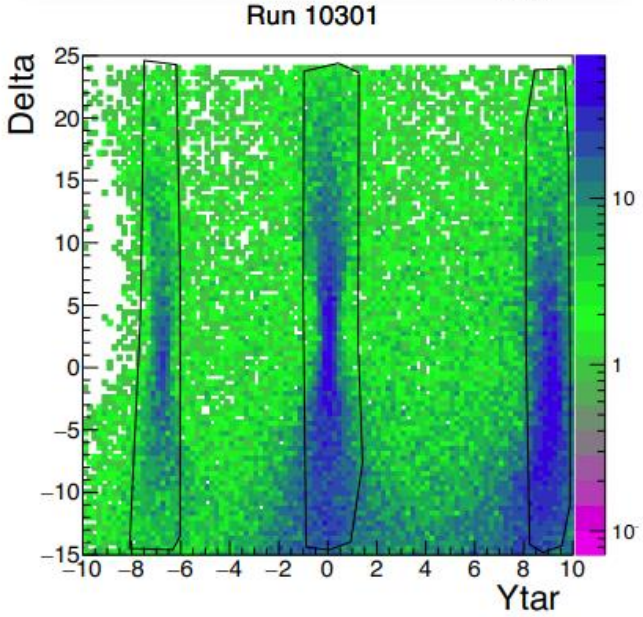


30-deg runs:

Pre-opt:

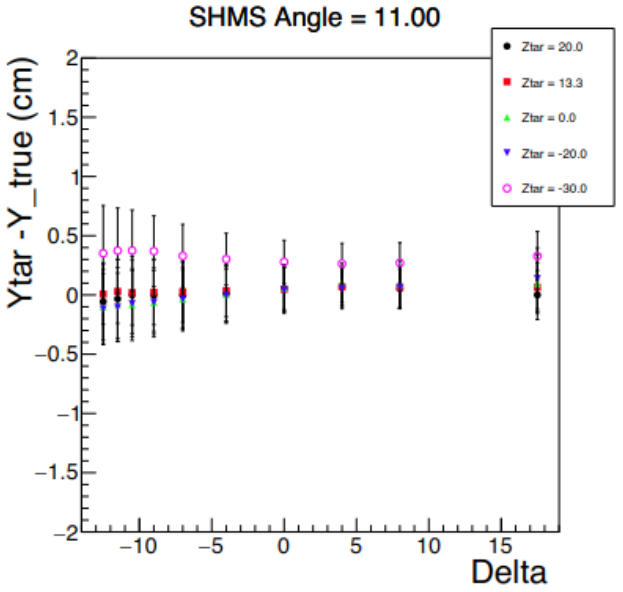


Optimized:

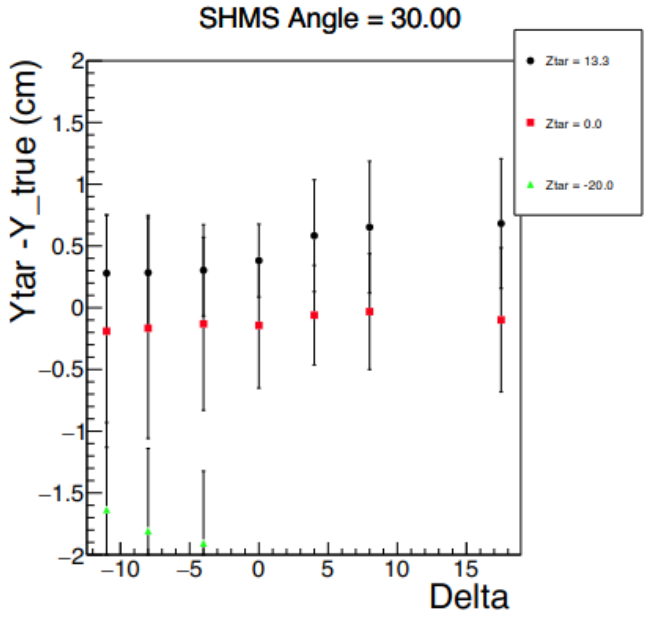


SHMS Ytar Optimization

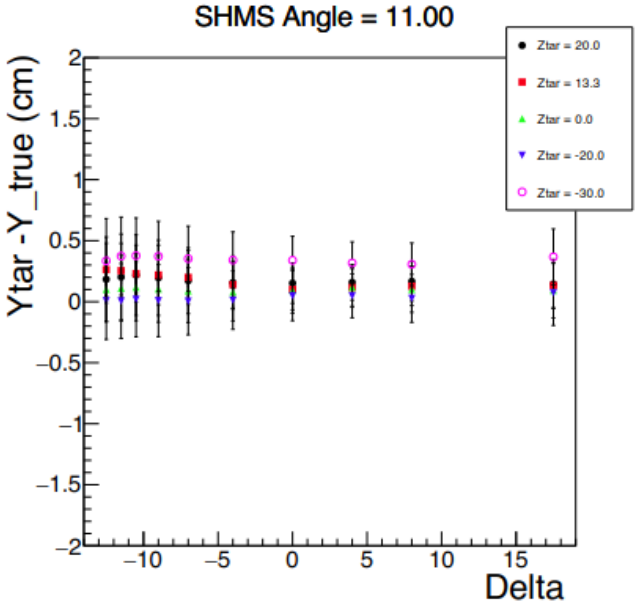
Pre-opt:



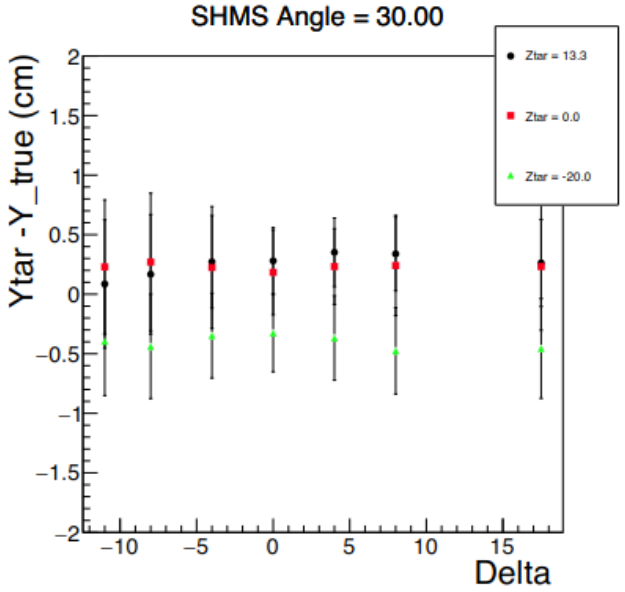
Pre-opt:



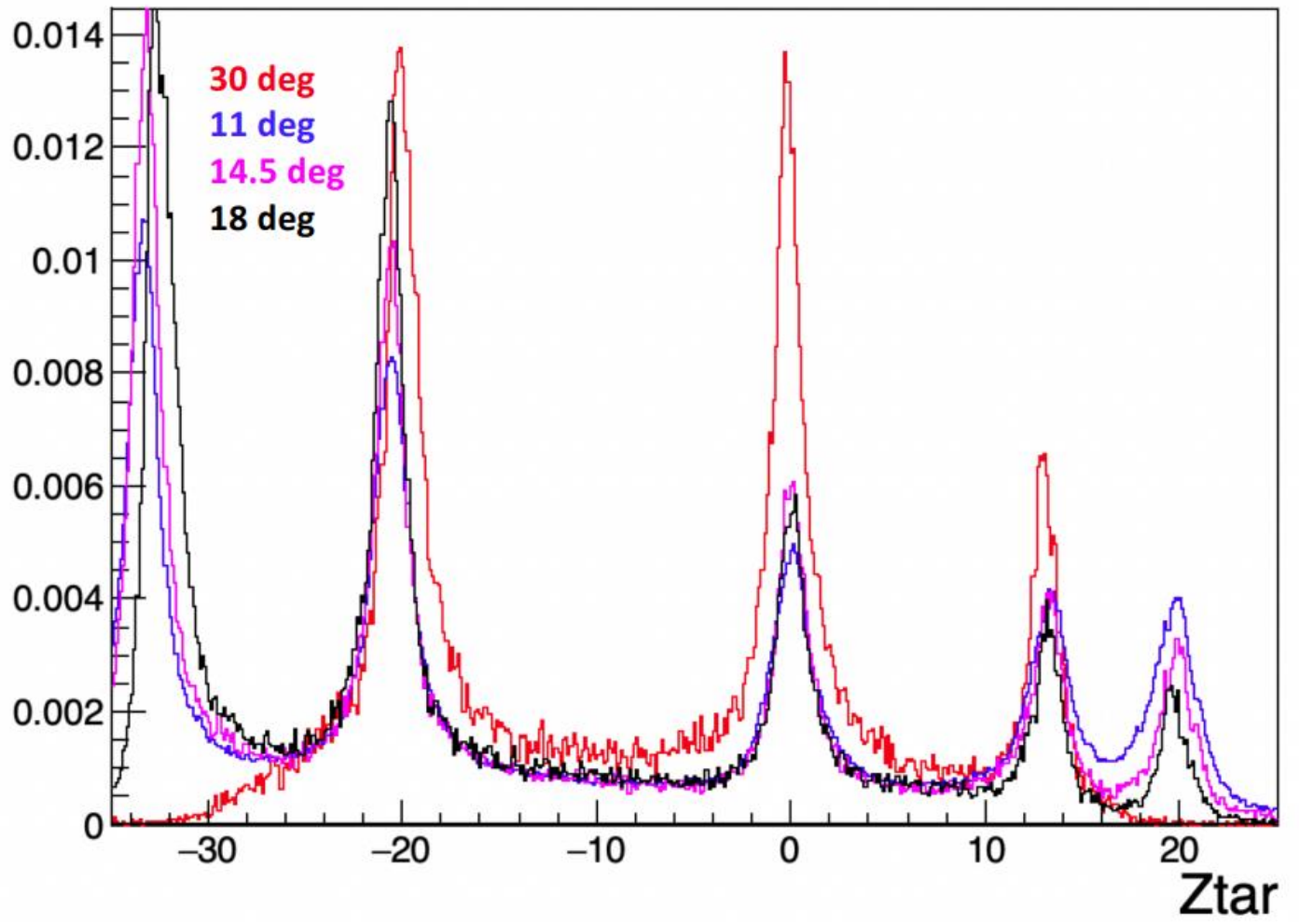
Optimized:



Optimized:



SHMS Ytar Optimization



Played with various properties of the fitting, but could not obtain a happy solution at zTar=-20 with the 30 deg run always being slightly off…

Hopeful that recalculation of react.z using yTar after xTar correction will help this converge!

Conclusion

- Completed HMS and SHMS optimization. New matrix elements.
- Contribution of xtar to reconstruction is important
  - Modified HCANA to have more iteration for applying the xtar contribution.
  - In replay script
    - need to add call THcReactionPoint after THcExtTarCor to get final Ztar.
    - Call to THcReactionPoint before THcExtTarCor is needed to get starting Ztar and X,Y beam positions
  - In mc-single-arm:
    - Fixed mistake in HMS which was using the fast raster vertical position as the xtar for the reconstruction when it should use the thrown xtar (that includes the fast raster).
    - SHMS was done correctly.
    - Ideally would do the xtar correction in an iterative approach like in HCANA
  - HMS is more sensitive to the xtar correction than the SHMS.
- Friendly reminder that need to used different raster conversion factor in gbeam.param by factor of 2 when going from 5-pass (used two raster coil) to 1-pass (used one raster coils).