

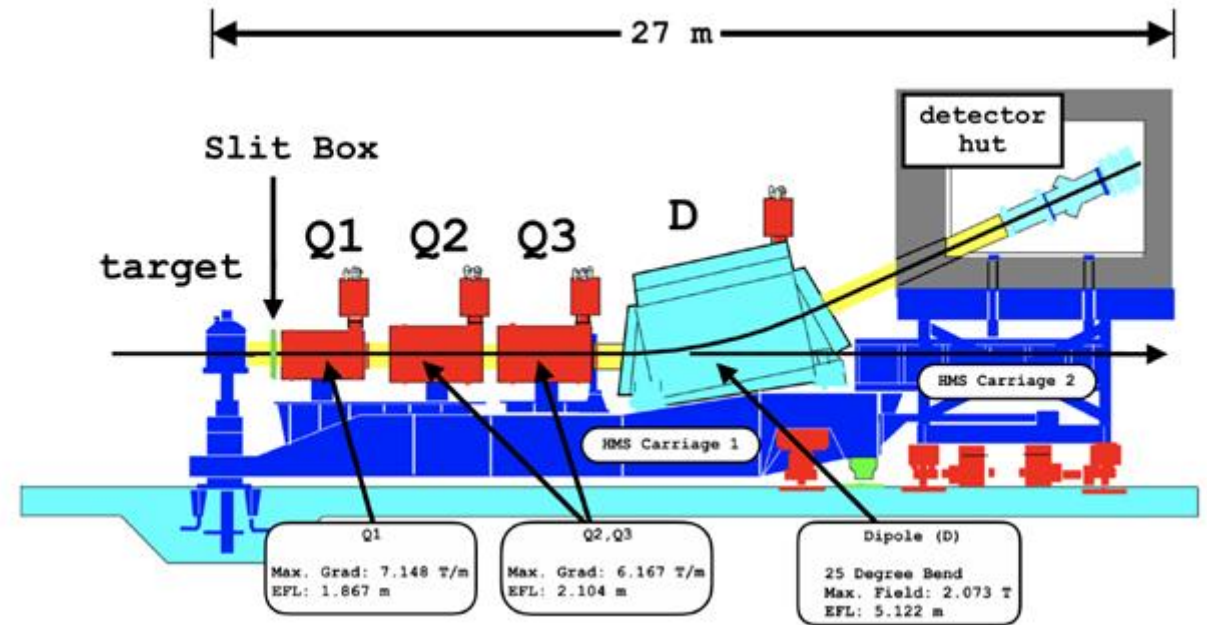
HMS Optics Calibrations: Carbon-Sieve

Jacob Murphy

PionLT Meeting 2022/09/28

High Momentum Spectrometer

- Electromagnet Dipole D and quadrupoles Q1, Q2, Q3 generate magnetic field
- Central Momentum p_0 for HMS set between 0.5 and 7.5 GeV/c
- Prior to recent Jlab 12 GeV upgrade, only went as high as 5.5 GeV/c

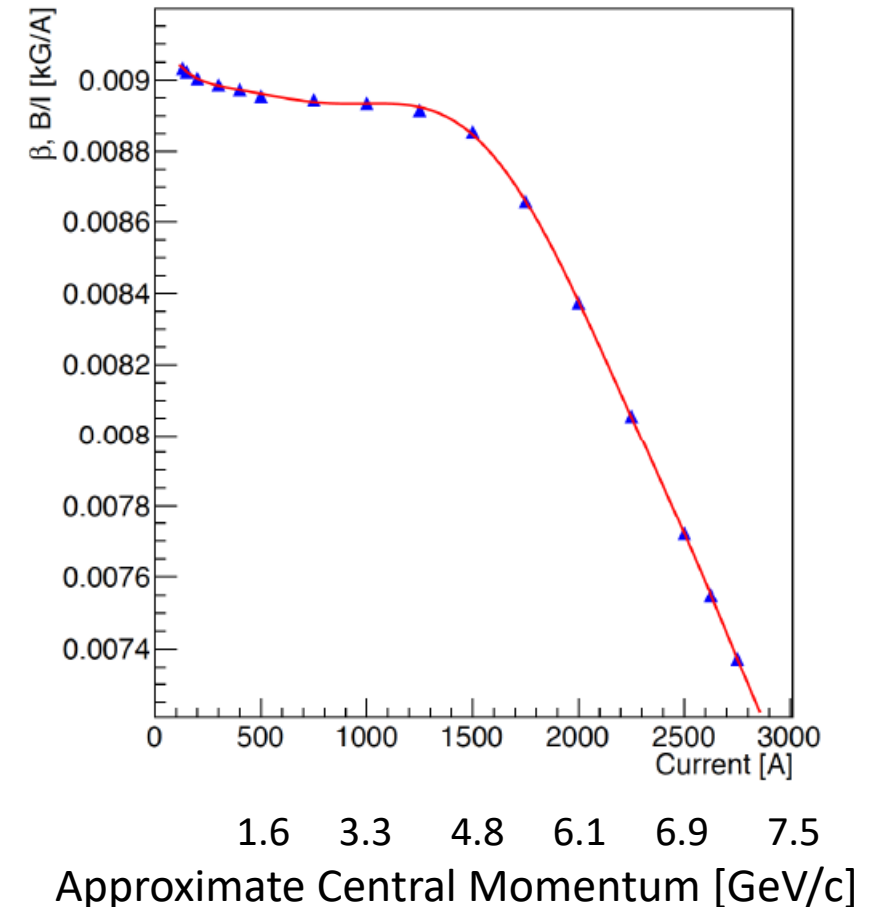
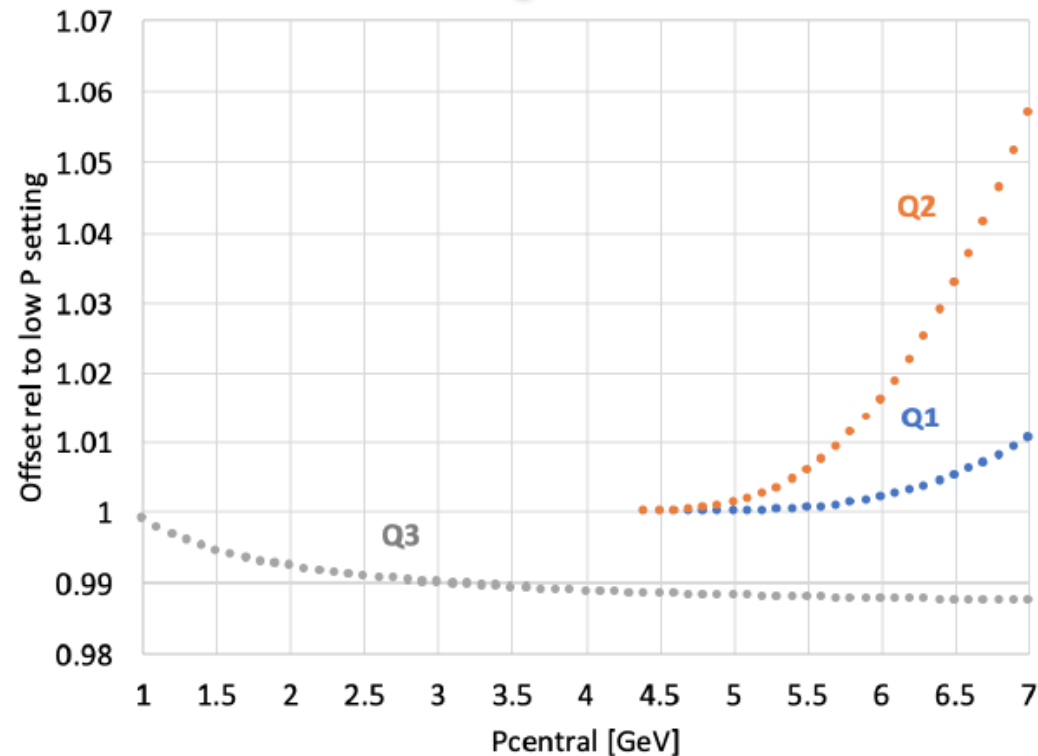


C. Yero, Cross Section Measurements of Deuteron Electro-Disintegration at Very High Recoil Momenta and Large 4-Momentum Transfers (Q²), Ph.D. thesis, Florida Intl. U. (2020), arXiv:2009.11343 [nucl-ex].

Saturation at High Momentum

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

- Left figure shows central (Dipole) field B/I as a function of set current
- When set to high central momentum settings, HMS dipole and quadrupole saturation effects occur
- Bottom figure shows quadrupole offsets



Optical Matrix for HMS

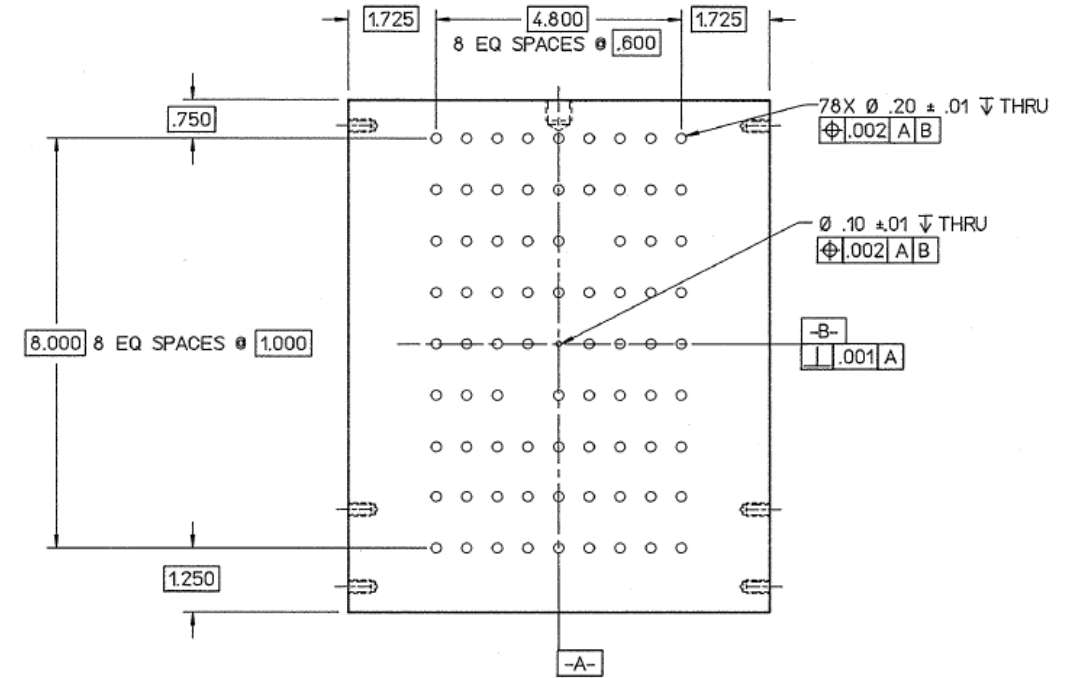
- Optical Matrix M relates focal plane (fp) variables to physics variables (vertex position, scattering angle, and momentum fraction δ)
- Matrix elements are coefficients C used up to 6th order to reconstruct physics variables

$$\begin{bmatrix} x'_{tar} \\ y_{tar} \\ y'_{tar} \\ \delta \end{bmatrix} = M \begin{bmatrix} x_{fp} \\ x'_{fp} \\ y_{fp} \\ y'_{fp} \end{bmatrix}$$

$$x'_{tar} = \sum_{i,j,k,m=0}^6 C_{ijkmn} (x_{fp})^i (x'_{fp})^j (y_{fp})^k (y'_{fp})^m$$

$$\delta = \frac{p_0 - P}{p_0} \times 100$$

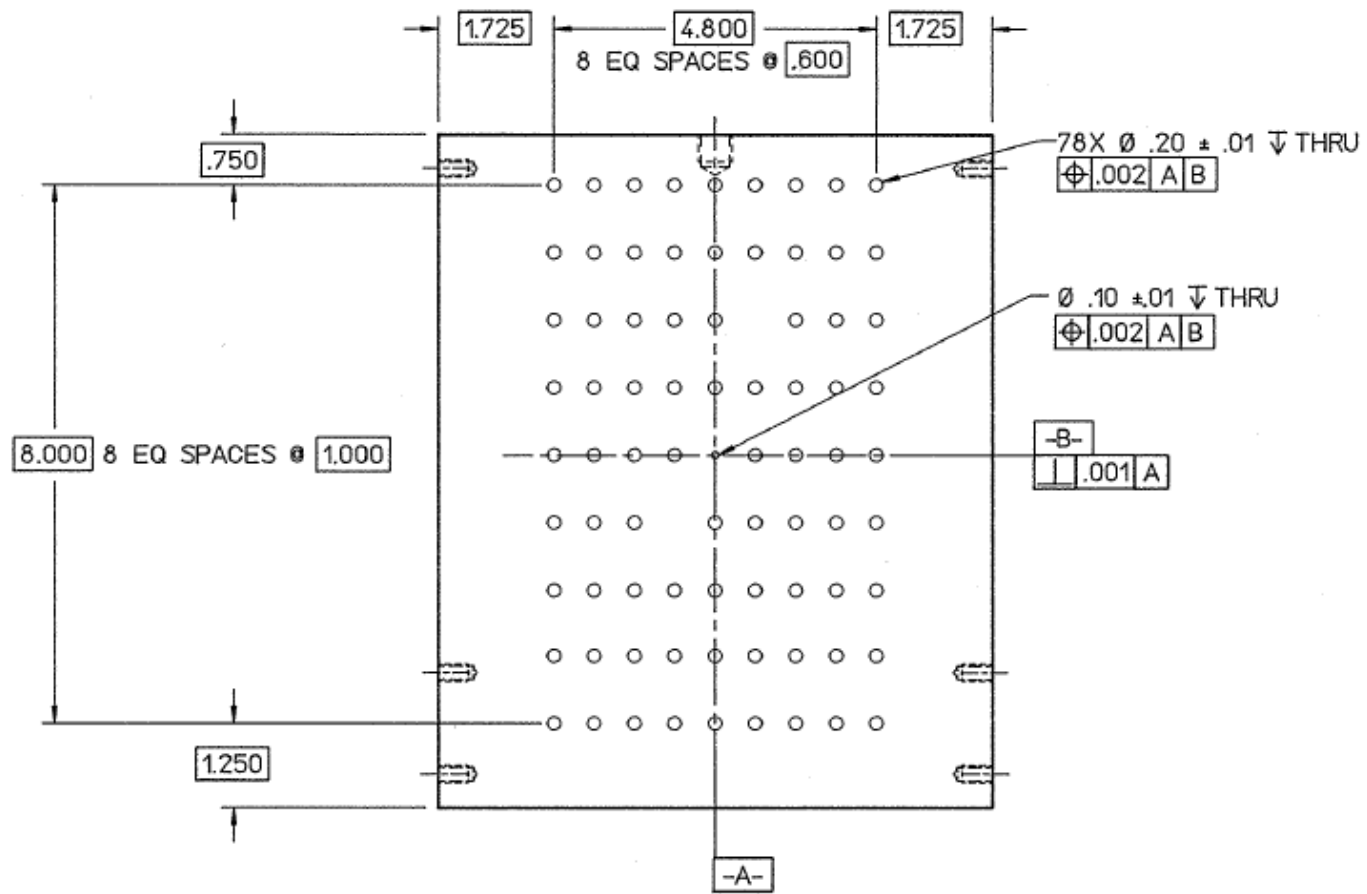
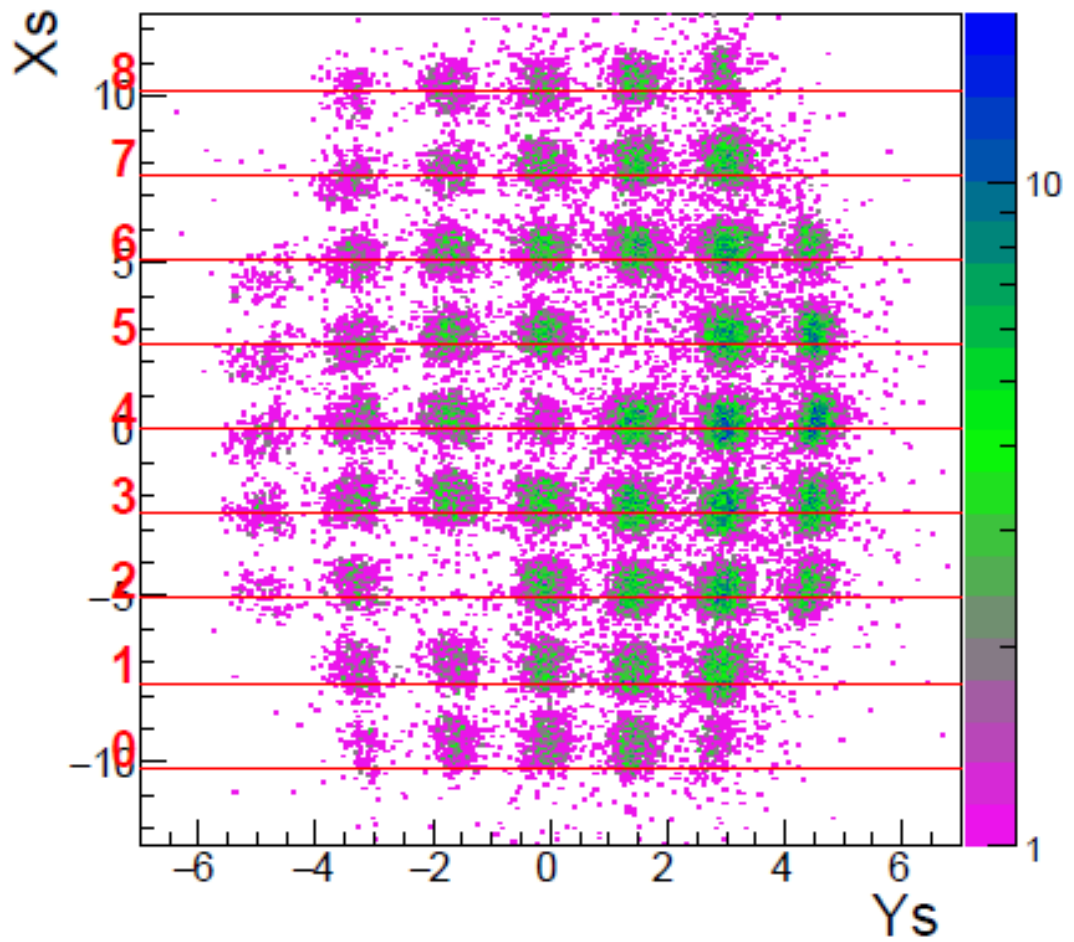
Carbon-Sieve Data



HMS Sieve Slit Schematic
Mark Jones

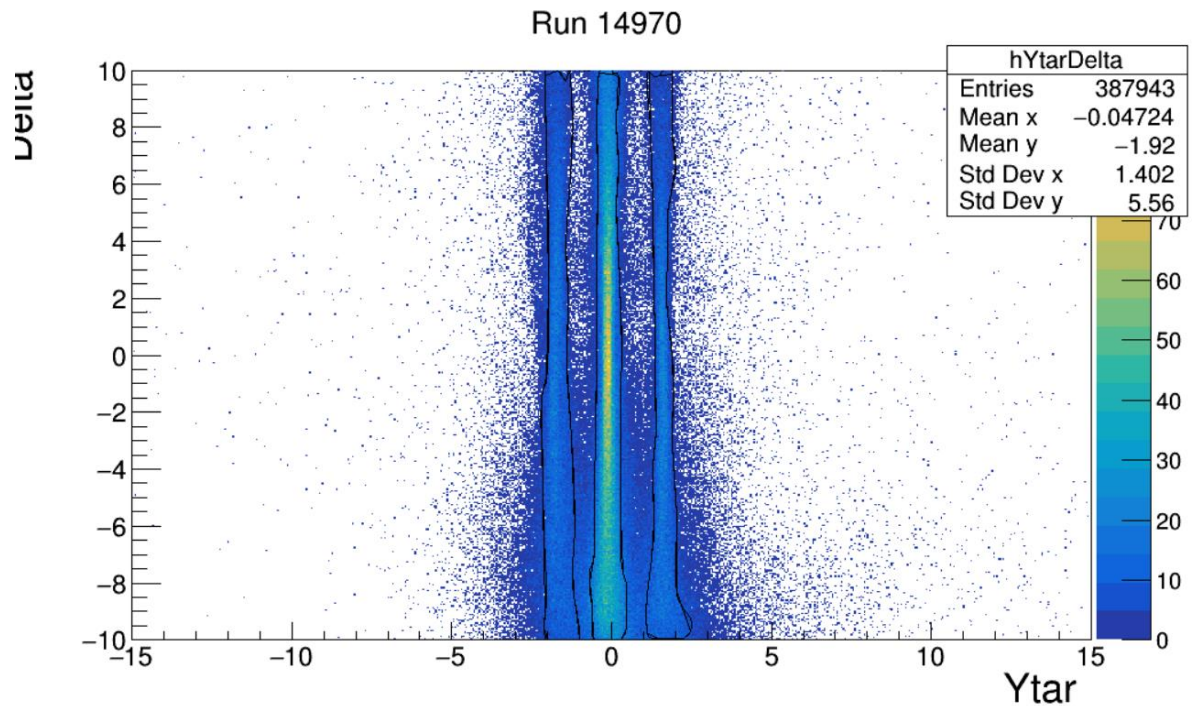
<https://hallcweb.jlab.org/DocDB/0011/001104/002/HMS-Sieve.pdf>

Angles (X_{pTar} and Y_{pTar}) and Target Position (Y_{Tar}) Optimizations

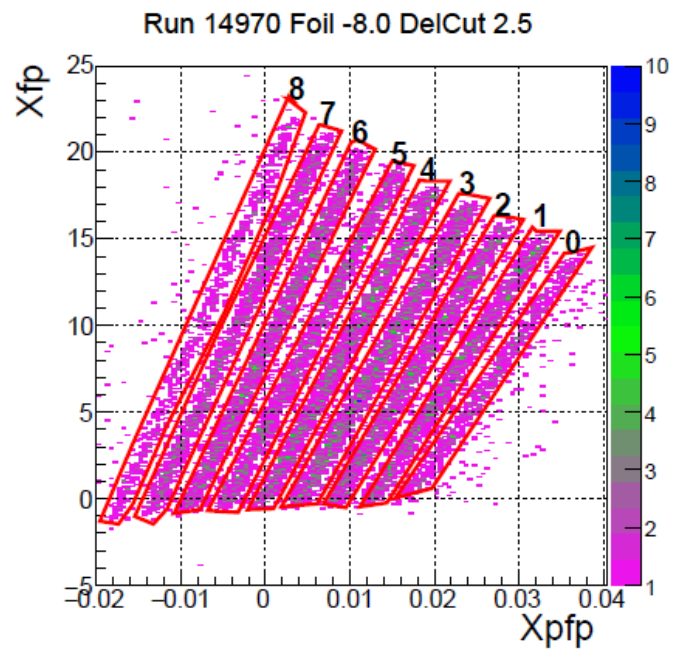


Carbon Foil Target Position (YTar) versus Momentum (Delta) Cuts

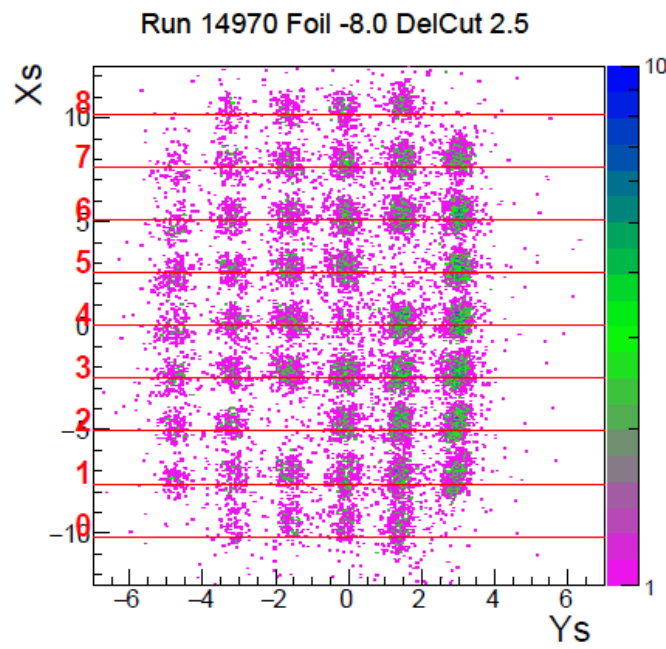
- YTar-Delta cuts along 3 carbon foils
- Examine Delta regions between 10 % and -10 %
- Left shows combined runs 14970-14973
 - These are the +/-8 Optics and 0.5% Carbon targets



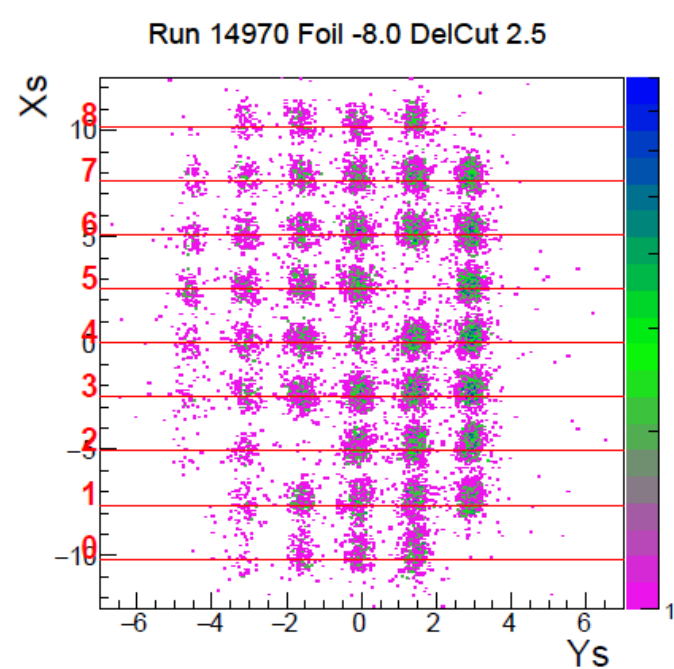
Focal Plane



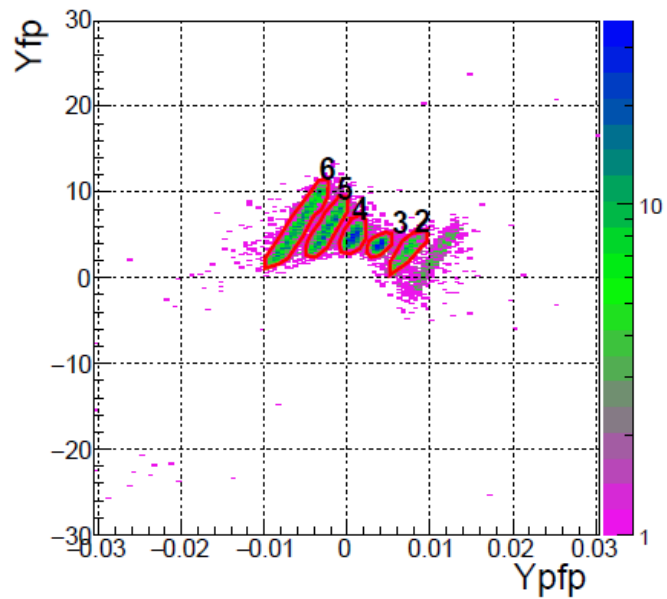
Sieve Plane Original



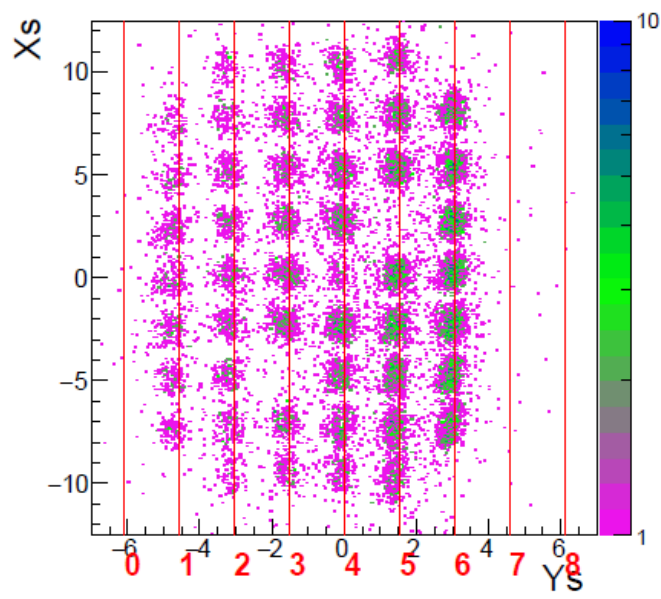
Sieve Plane Corrected



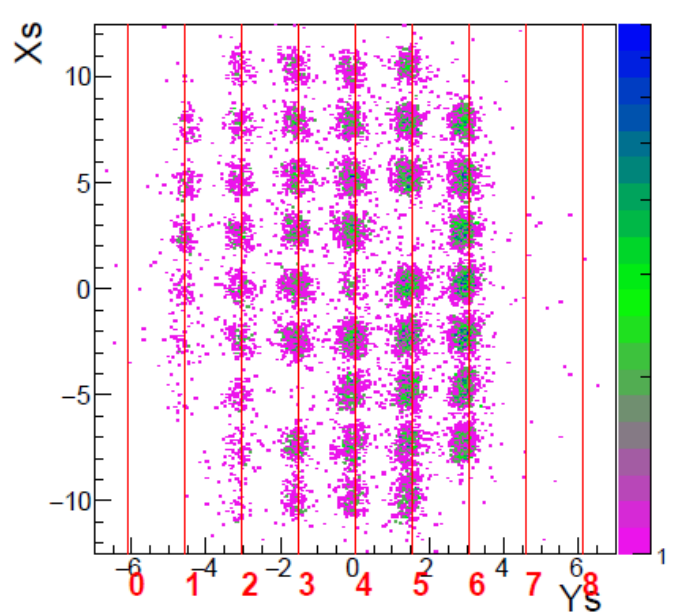
Run 14970 Foil -8.0 DelCut 2.5



Run 14970 Foil -8.0 DelCut 2.5



Run 14970 Foil -8.0 DelCut 2.5



Current Status on Optics Calibrations

- Found and corrected hard-coded issues in carbon-sieve scripts
- Made new batch submission script for optics calibrations
 - Includes argument for ID value in hcana_ID.param file
 - Allows for easier time switching between param files in replays
- All HMS carbon-optics replayed
- First pass at 6.8 GeV Complete
 - Ytar cuts too tight->missing sieve holes
- TO DO:
 - Plan to rewrite scripts to not require drawn Ytar cuts but rather different root files with different foils
 - Trying out 3D histograms for better FP cuts
 - Rinse-and-Repeat Carbon-Sieve Calibrations for 5.9 and 5.6 GeV
 - Delta Calibrations for all Beam Energies
 - SHMS Calibrations (need to meet with Holly to confirm process)