Beam commissioning of the HRS+septa optics and SciFi

APEX Collaboration meeting
July 24 2018

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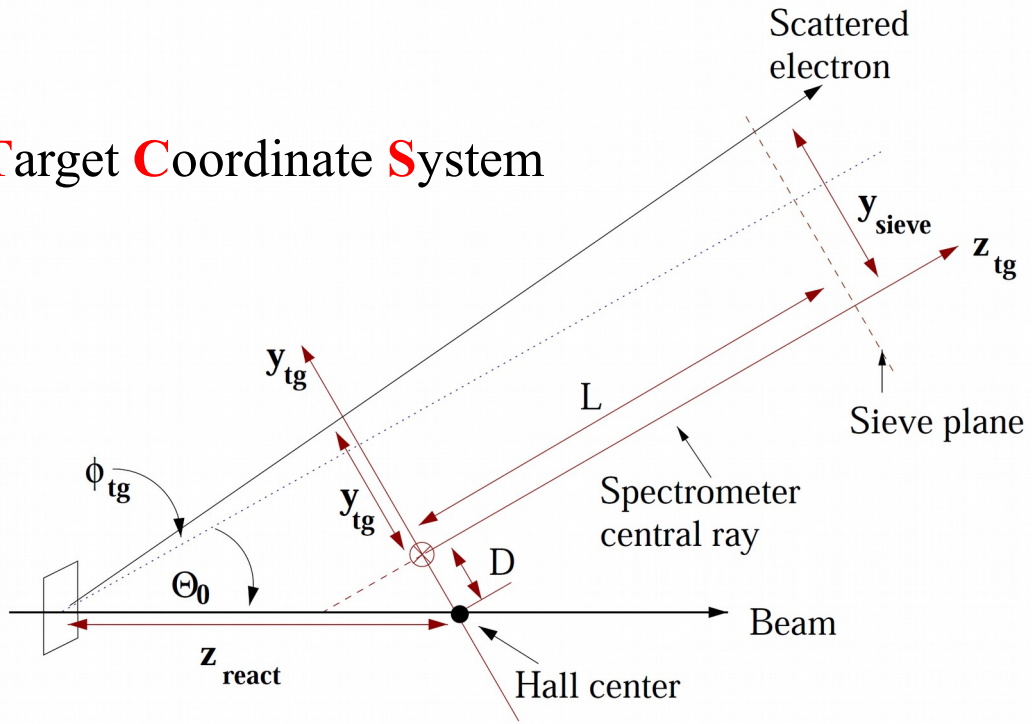
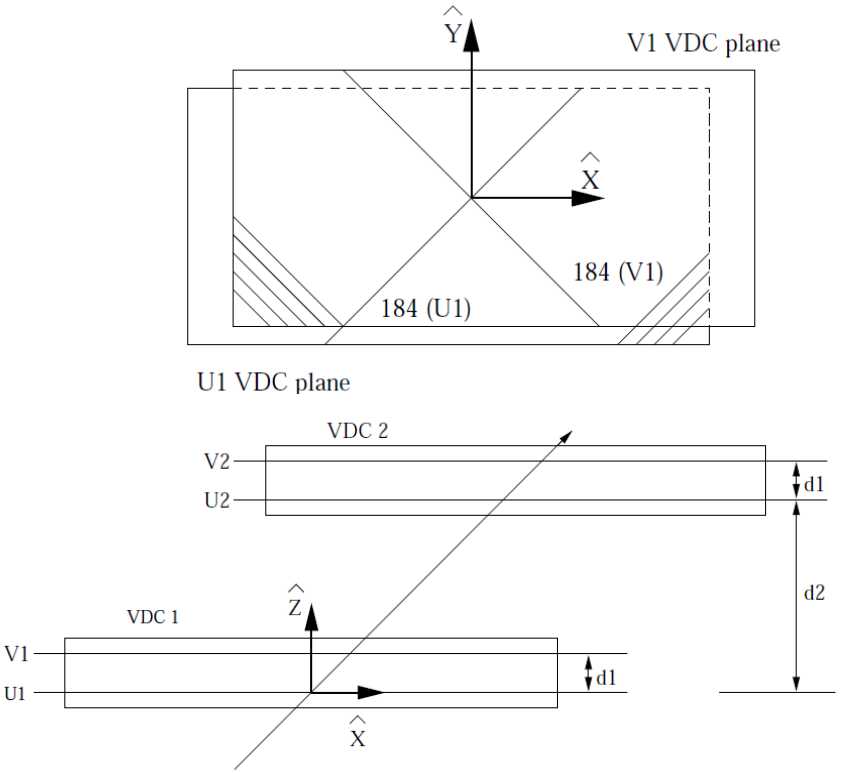
Coordinate Systems

Target Coordinate System



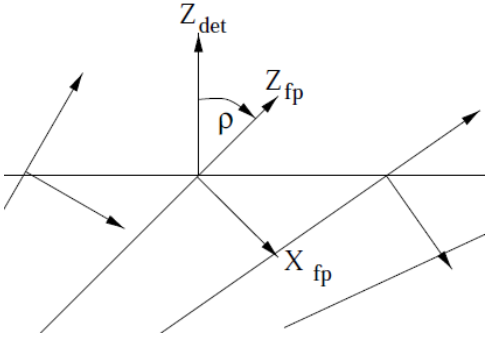
Detector Coordinate System



Matrix operations are used to reconstruct track parameters in TCS using FCS coordinates

$$\begin{bmatrix} x \\ \theta \\ y \\ \phi \end{bmatrix}_{fp} \Rightarrow \begin{bmatrix} \delta \\ \theta \\ y \\ \phi \end{bmatrix}_{tg}$$

Focal **C**oordinate **S**ystem is rotated DCS by angle ρ(ΔP/P) (angle between local central ray and z angle)



HRS Optics

$$y_{tg} = \sum_{j,k,l} Y_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp},$$

$$\theta_{tg} = \sum_{j,k,l} T_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp},$$

$$\phi_{tg} = \sum_{j,k,l} P_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp},$$

$$\delta = \sum_{j,k,l} D_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp},$$

$$\Delta(y) = \sum_s [\frac{\sum_{j,k,l} Y_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp} - y^0_{tg}}{\sigma^s_y}]^2$$

$$\Delta(\theta) = \sum_s [\frac{\sum_{j,k,l} T_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp} - \theta^0_{tg}}{\sigma^s_\theta}]^2$$

$$\Delta(\phi) = \sum_s [\frac{\sum_{j,k,l} T_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp} - \theta^0_{tg}}{\sigma^s_\theta}]^2$$

$$\Delta(\delta) = \sum_s [\frac{\sum_{j,k,l} D_{jkl}\theta^j_{fp}y^k_{fp}\phi^l_{fp} - \delta^0}{\sigma^s_p}]^2$$

$Y_{jkl}, T_{jkl}, P_{jkl}$ and D_{jkl} are polynomials in x_{fp}

$$Y_{jkl} = \sum_{i=1}^{m} C_i^{Y_{jkl}} x^i_{fp}$$

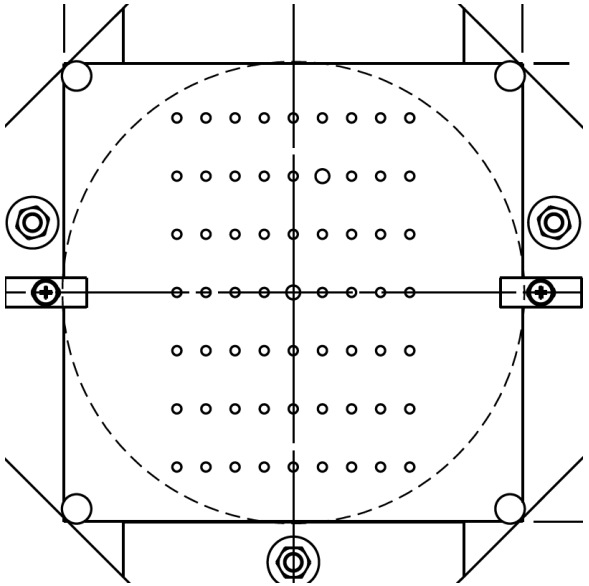
$$y_{tg} = \sum_{j,k,l} \sum_{i=1}^{m} C_i^{Y_{jkl}} x^i_{fp}\theta^j_{fp}y^k_{fp}\phi^l_{fp}$$

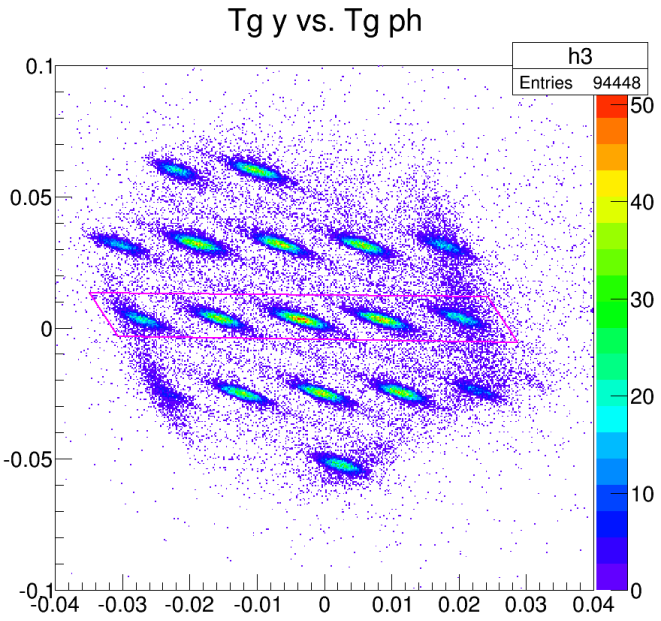
Minimization of $\Delta(y)$, $\Delta(\theta)$, $\Delta(\phi)$ and $\Delta(\delta)$ will help to find the Y_{jkl}, T_{jkl}, P_{jkl}, D_{jkl} elements

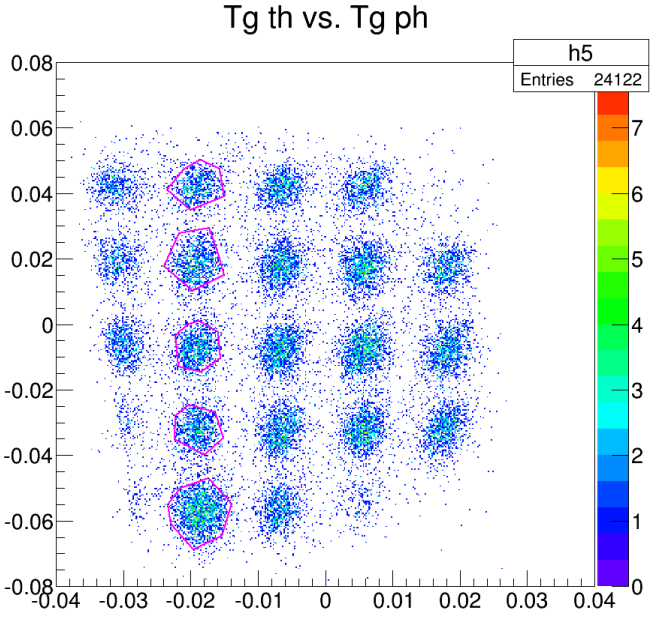
Nilanga Liyanage, Optics Calibration of the Hall A HRS using the new optimizer, JLAB-TN-02-012

HRS Optics

Sieve Slit

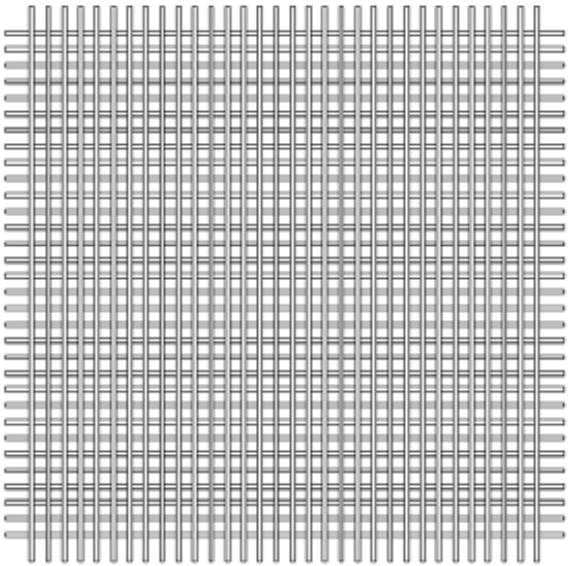






With graphical cuts we select events with known target parameters which later are used for the minimization.

SciFi



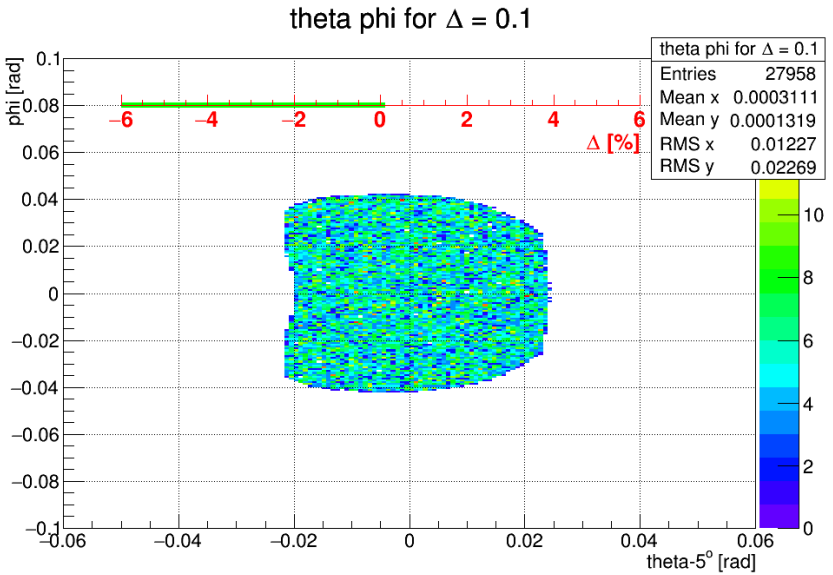
64 scintillation fibers:
32(V) and 32(H) directions
Size: 8.8(H) × 10.3 (V) cm^2
Fiber Ø – 1 mm

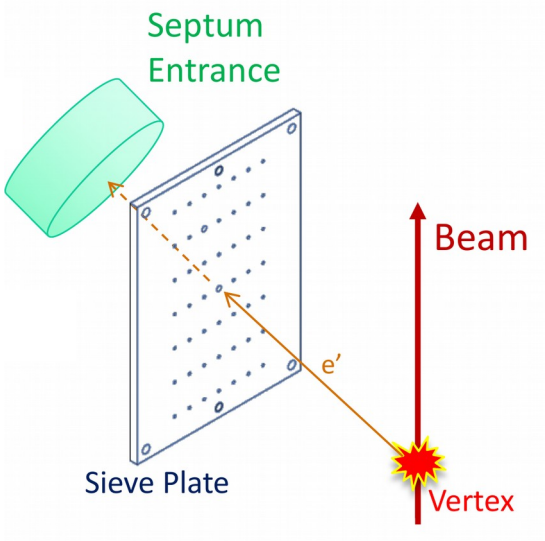
Hall A has an optics calibration code which is written for the Sieve Slit data.

For the SciFi based optics calibration instead of θ[row, column], ϕ[row, column] arrays, we need to use individual coordinates for each track.

APEX optics commissioning plan

APEX acceptance for the central target:
(~45 mrad in-plane and 80 mrad out-plane)





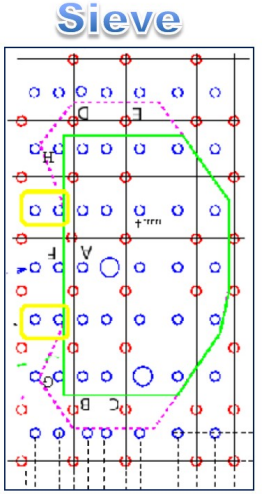
RHRS on negative polarity for the tuning of the optics:

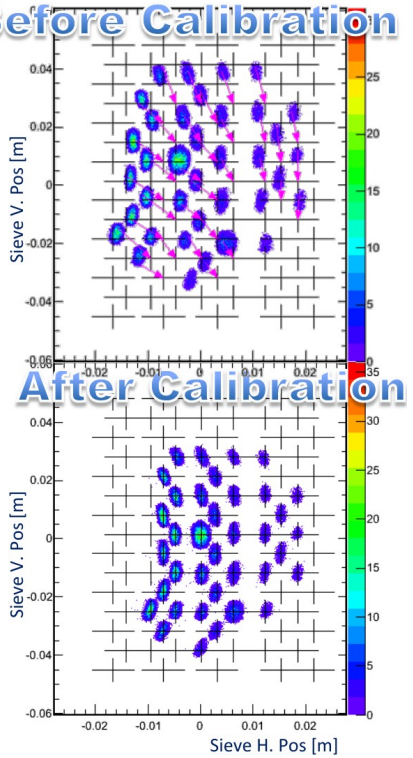
1. Septum current/magnetic field optimization will be performed using Sieve Slit data with single foil targets (center, downstream, upstream foils).

2. Then will be added more targets and performed preliminary optics calibration.

Meantime the LHRS will be on positive polarity for SciFi tests.

Jin Huang, 2010





APEX optics commissioning plan

3. As soon as the required tests are done and data is taken on RHRS we'll invert the LHRS and RHRS polarities and prepare for the optics calibration data taking:

- RHRS on positive polarity for the optics calibration data taking with the SciFi.
- LHRS on negative polarity for optics calibration data taking with the Sieve Slit.

Preparation works

Software preparation plans

- Septa and HRS mis-tuning studies (by Dec-1 2018).
  - Q1 mis-tuning studies using previous experiment data (GmP) and Monte-Carlo simulations;
  - Monte-Carlo studies of the mis-tuned septa;
  - Preparation of an analysis script for quickly identification of mis-tuned subsystems during the commissioning runs.

- Update of the optics calibration package that was used for the 2010 Test Run analysis and perform optics calibration calibration of 2010 data. (by Dec 2018)

- Preparation of a package for the optics calibration with SciFi. (in Jan 2019)