Method 1 – Elog post 191

$$\theta_i = \tan^{-1}\left(\sqrt{\left(\theta_{beam}^2 + \phi_{beam}^2\right)}\right)$$
$$\phi_i = \tan^{-1}\left(\frac{\tan\left(\theta_{beam}\right)}{\tan\left(\phi_{beam}\right)}\right)$$

Incident beam theta/phi with coordinate transformation to HCS (?) from bpm

$$\theta_o = \theta_{rec}$$
$$\phi_o = \phi_{rec}$$

scattered beam theta/phi from optics reconstruction in HCS

$$\vec{A} = \left[\sin\left(\theta_i\right)\cos\left(\phi_i\right), \sin\left(\theta_i\right)\sin\left(\phi_i\right), \cos\left(\theta_i\right)\right]$$
$$\vec{B} = \left[\sin\left(\theta_o\right)\cos\left(\phi_o\right), \sin\left(\theta_o\right)\sin\left(\phi_o\right), \cos\left(\theta_o\right)\right]$$

$$\theta_{scat} = \cos^{-1}\left(\vec{A}\cdot\vec{B}\right)$$

Method 2 – Chao's optics technote

$$\theta_i = \cos^{-1}\left(\frac{1}{\sqrt{\left(\tan^2(\theta_{beam}) + \tan^2(\phi_{beam}) + 1\right)}}\right)$$

$$\phi_i = \tan^{-1}\left(\frac{\tan(\theta_{beam})}{\tan(\phi_{beam})}\right)$$

Incident beam theta/phi with coordinate transformation to TCS (?) from bpm

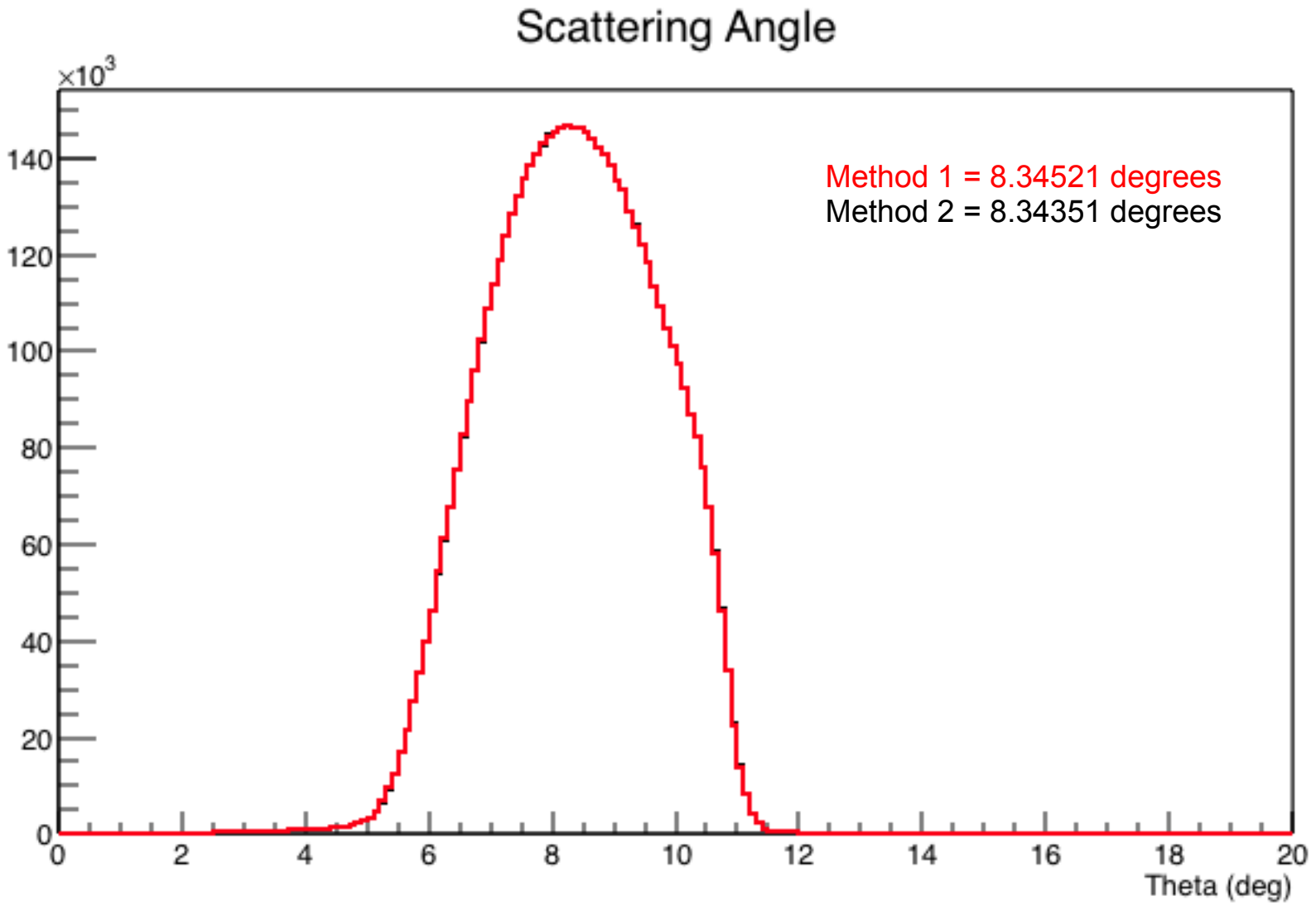
$$\theta_o = \theta_{tg}$$
$$\phi_o = \phi_{tg}$$

scattered beam theta/phi from optics reconstruction in TCS

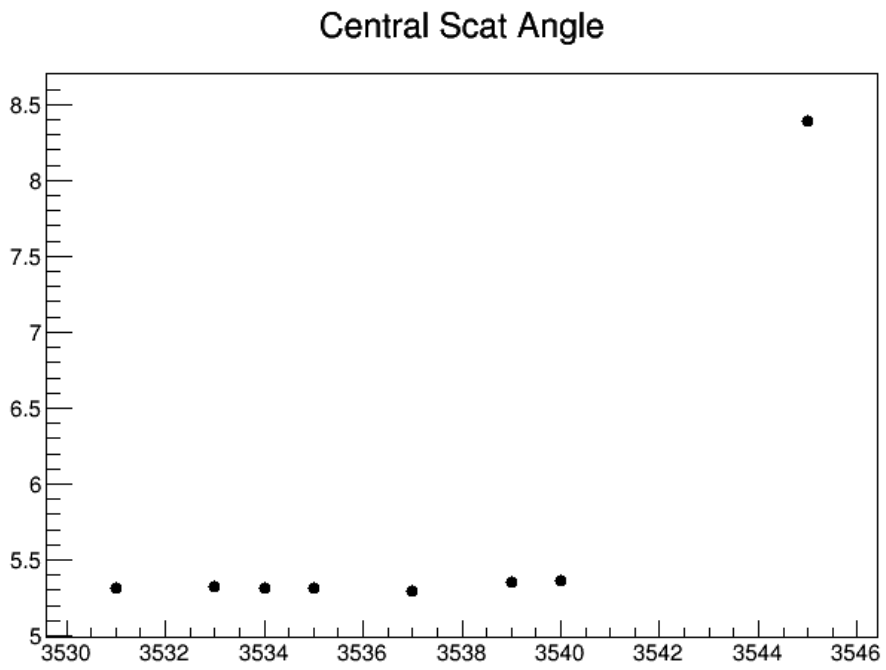
$$\vec{A} = [\sin(\theta_i)\cos(\phi_i), \sin(\theta_i)\sin(\phi_i), \cos(\theta_i)]$$

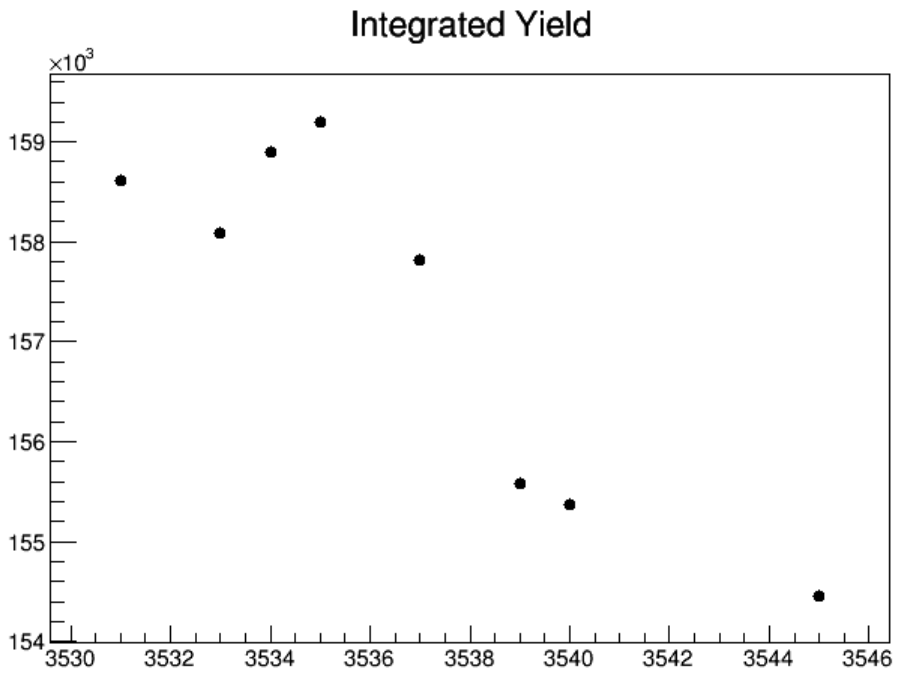
$$\vec{B} = [\phi_o \cos(\theta_{central}) + \sin(\theta_{central}), -\theta_o, \cos(\theta_{central}) - \phi_o \sin(\theta_{central})]$$

$$\theta_{scat} = \cos^{-1}\left(\frac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|}\right)$$



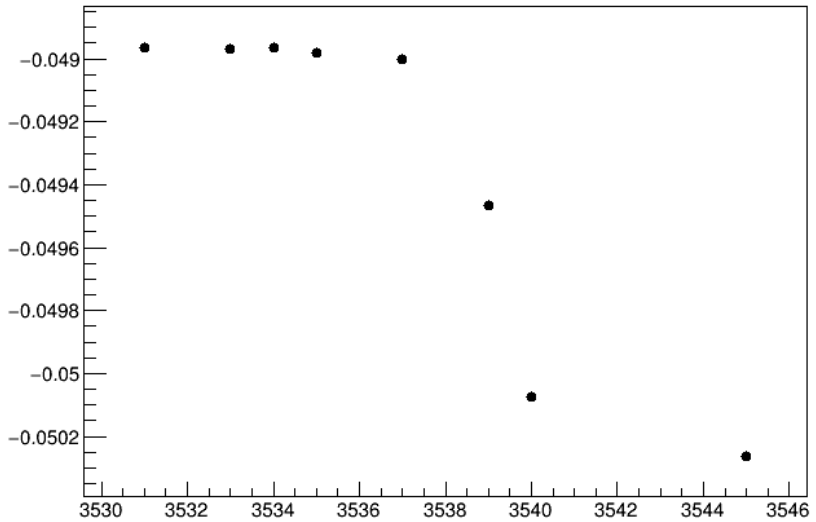
Example calculated from run 3545



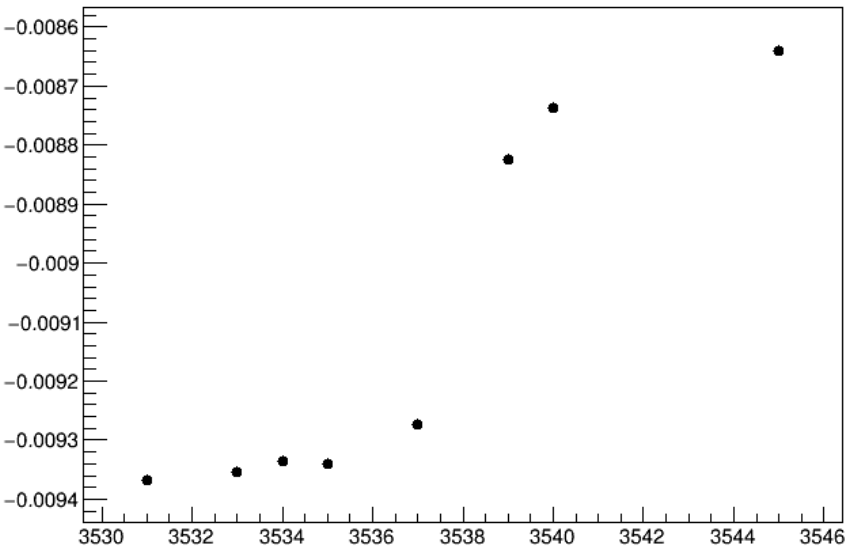


- 2.254GeV 2.5T transverse, p0=1.55GeV.
- All runs >50nA
- >3 degree jump in scattering angle not seen in integrated yield.
- 4 terms go into scattering angle (theta/phi from bpm, theta/phi from optics).

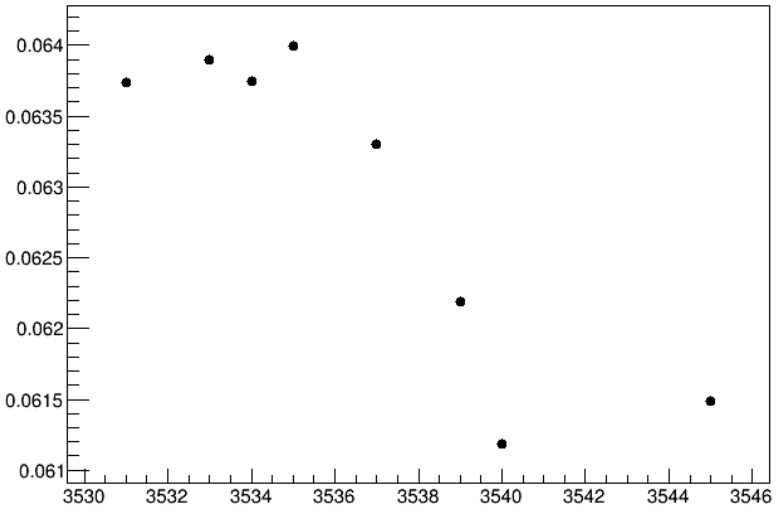
Theta (optics)



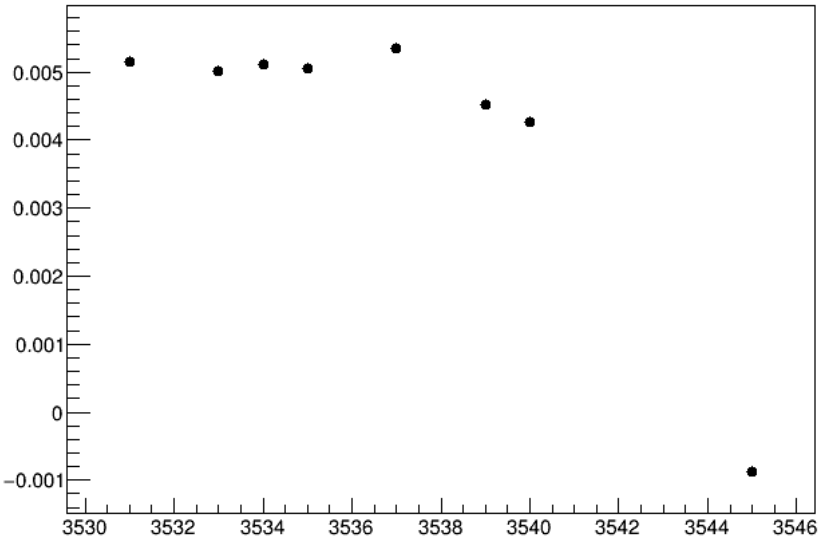
Phi (optics)



Theta (bpm)



Phi (bpm)



Summary

- Angle is not consistent with what we would expect from looking at the integrated yield.
- This study was repeated with extremely tight acceptance cuts (unfortunately I don't have the plots to show).
- Same scattering angle/integrated yield result with tight acceptance cut.
- Haven't looked at theta/phi behavior with tight acceptance cut yet.
- Looks like an issue with phi bpm reconstruction, even when current >50nA.

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