Simulation update

Last time:

Event Generator

Pf Uncertainty study

Last Time

Event Generator

- Old generator $d\theta_{tg} d\phi_{tg}$ uniform distribution
- New generator

solid angle uniform distribution

$d\Omega = d\cos\theta \ d\phi$

weighted $d\sigma = \frac{d\sigma}{d\Omega} d\Omega$

Event Generator

❑ Assume 3 kinds of phase space distribution

- (θ_{tg}, ϕ_{tg}) uniform distribution
- $(tan\theta_{tg}, tan\phi_{tg})$ uniform distribution
- $(\cos\theta, \phi)$ uniform distribution

⇨ Phase space density difference

- $\mathrm{d}\Omega = d\cos\theta \; d\phi$

Event Generator

$$d\Omega = d\cos\theta \ d\phi$$

Assume 2D uniform distribution
Then density difference

$$= \left| \frac{\partial(cos\theta, \emptyset)}{\partial(tan\theta_{tg}, tan\phi_{tg})} \right| d(tan\theta_{tg}) d(\ tan\phi_{tg})$$

$$= \frac{1}{(1 + tan^2\theta_{tg} + tan^2\emptyset_{tg})^{3/2}} d(tan\theta_{tg}) d(\ tan\phi_{tg})$$

Density difference function f1= $\frac{1}{(1+tan^2\theta_{tg}+tan^2\emptyset_{tg})^{3/2}}$

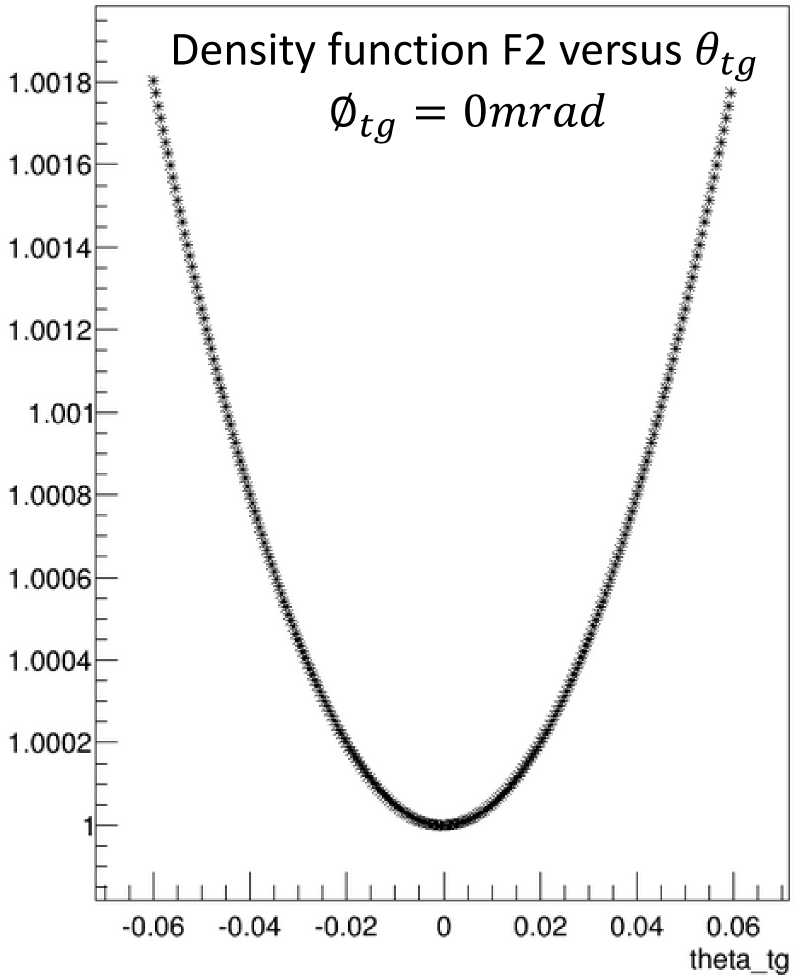
$$= \frac{1}{(1 + tan^2\theta_{tg} + tan^2\emptyset_{tg})^{3/2}} \frac{1}{cos^2\theta_{tg}} \frac{1}{cos^2\emptyset} d(\theta_{tg}) d(\ \phi_{tg})$$

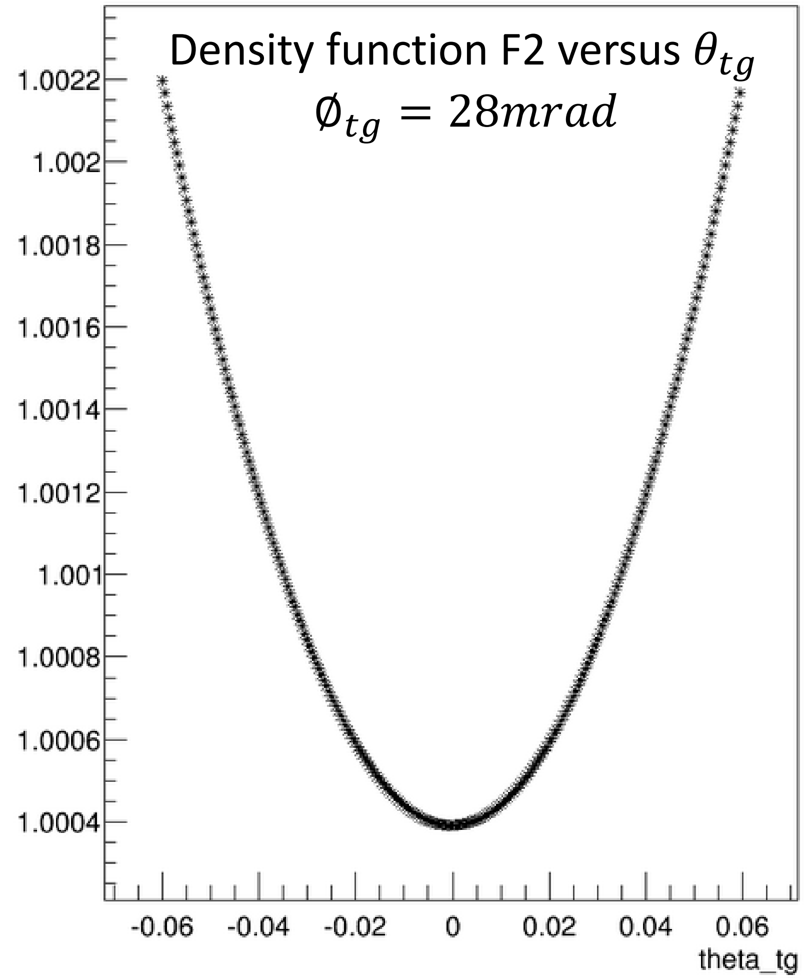
Density difference function f2= $\frac{1}{(1+tan^2\theta_{tg}+tan^2\emptyset_{tg})^{3/2}} \frac{1}{cos^2\theta_{tg}} \frac{1}{cos^2\emptyset_{tg}}$

$$\approx \left(1 + 0.5 * (\theta_{tg} * \theta_{tg} + \emptyset_{tg} * \emptyset_{tg})\right) < 1.002$$

Consider HRS Angular Acceptance: Vertical $\theta_{tg} : \pm 50mrad$ Horizontal $\emptyset_{tg} : \pm 28mrad$

Density function





Difference is very tiny

Last Time

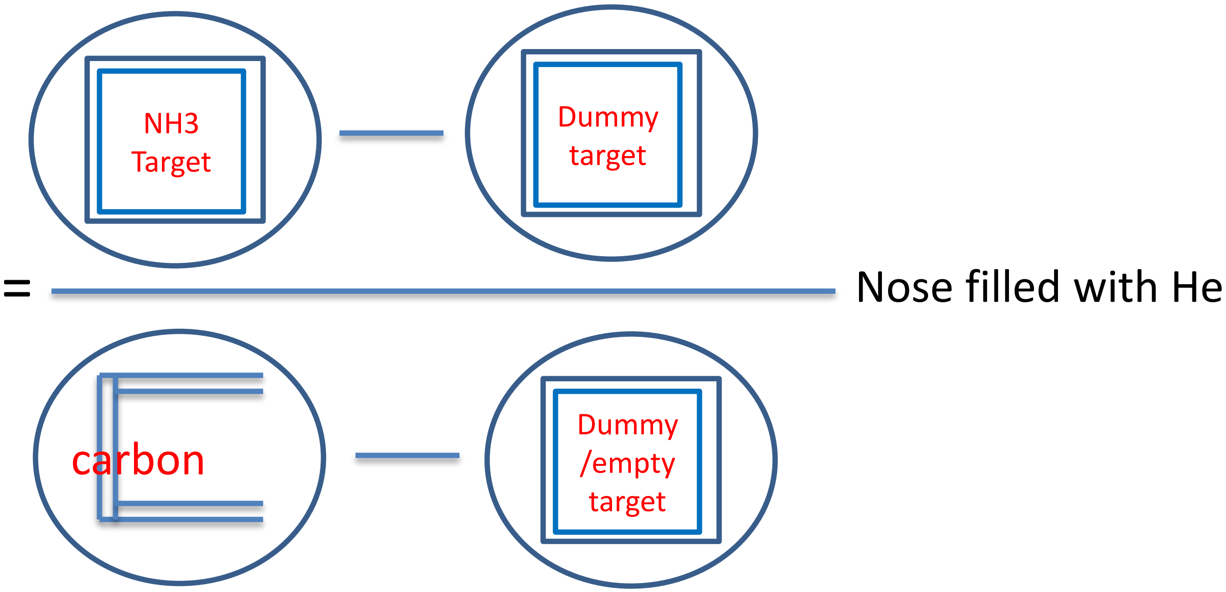
Pf Uncertainty Study

- For example 2.2GeV, 2.5T

Runs	Yields	Beam x	Beam y	Beam th	Beam ph
3446	814930	4.57	3.38	0.0635	0.0042
3447	508891	4.53	3.41	0.0636	0.0042
3448	426499	4.62	3.30	0.0635	0.0042
3449	428489	5.89	1.69	0.0619	0.0056

Last Time   Pf Uncertainty Study

$$\frac{Y_{\exp\_target} - Y_{\exp\_dummy}}{Y_{\exp\_carbon} - Y_{\exp\_LHe}} =$$



$$= \frac{\left[\frac{d_{NH3}}{M_{NH3}} T_{cell} * pf * (\sigma_N + 3 * \sigma_H) + \frac{d_{He}}{M_{He}} T_{cell} * (1 - pf) * \sigma_{He}\right] - \frac{d_{He}}{M_{He}} T_{cell} * \sigma_{He} + \frac{d_{He}}{M_{He}} (T_{total} - T_{cell}) * (\sigma_{He1} - \sigma_{He2})}{\frac{d_C}{M_C} T_C * \sigma_C + \frac{d_{He}}{M_{He}} (T_{total} - T_{endcap}) * \sigma_{He3} - \frac{d_{He}}{M_{He}} (T_{total} - T_C) * \sigma_{He2} + \frac{d_{He}}{M_{He}} T_{endcap} * \sigma_{Al}}$$

$\sigma_{He1}, \sigma_{He2}, \sigma_{He3}$ are He XS for NH3 target run, dummy run, carbon run.
Can be Simplified : due to NH3 , carbon and dummy run almost same beam information

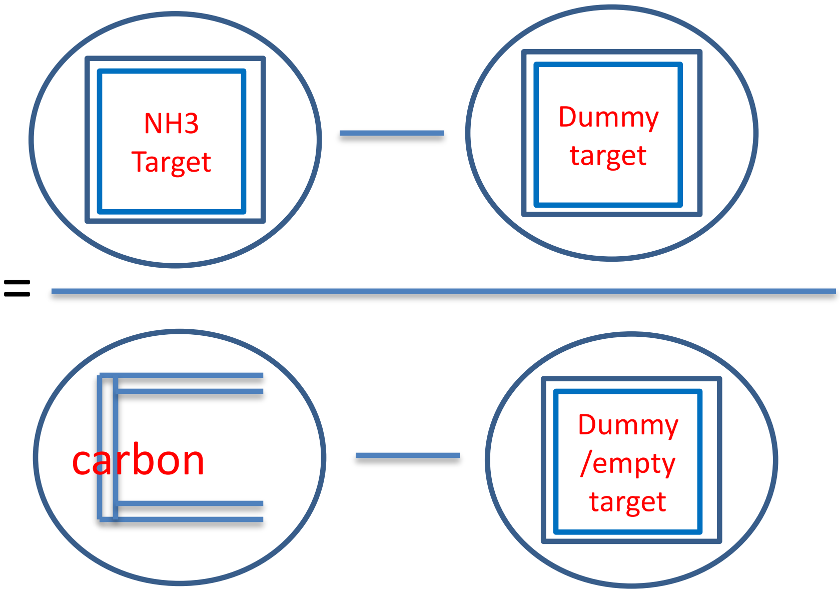
Pf= 0.67

a) $\delta_{Pf}/_{Pf} = 31.9\%$, assume $\sigma_{He1}, \sigma_{He2}, \sigma_{He3}$, σ_N, σ_H ,σ_C independently

b) $\delta_{Pf}/_{Pf} = 37.8\%$, assume $(\sigma_{He1}, \sigma_N, \sigma_H), \sigma_{He2}, (\sigma_C , \sigma_{He3})$ independently

Pf Uncertainty Study

$$\frac{Y_{\exp\_target} - Y_{\exp\_dummy}}{Y_{\exp\_carbon} - Y_{\exp\_LHe}} =$$



Nose filled with He

$$= \frac{\left[\frac{d_{NH3}}{M_{NH3}} T_{cell} * pf * (\sigma_N + 3 * \sigma_H) + \frac{d_{He}}{M_{He}} T_{cell} * (1 - pf) * \sigma_{He}\right] - \frac{d_{He}}{M_{He}} T_{cell} * \sigma_{He} + \frac{d_{He}}{M_{He}} (T_{total} - T_{cell}) * (\sigma_{He1} - \sigma_{He2})}{\frac{d_C}{M_C} T_C * \sigma_C + \frac{d_{He}}{M_{He}} (T_{total} - T_{endcap}) * \sigma_{He3} - \frac{d_{He}}{M_{He}} (T_{total} - T_C) * \sigma_{He2} + \frac{d_{He}}{M_{He}} T_{endcap} * \sigma_{Al}}$$

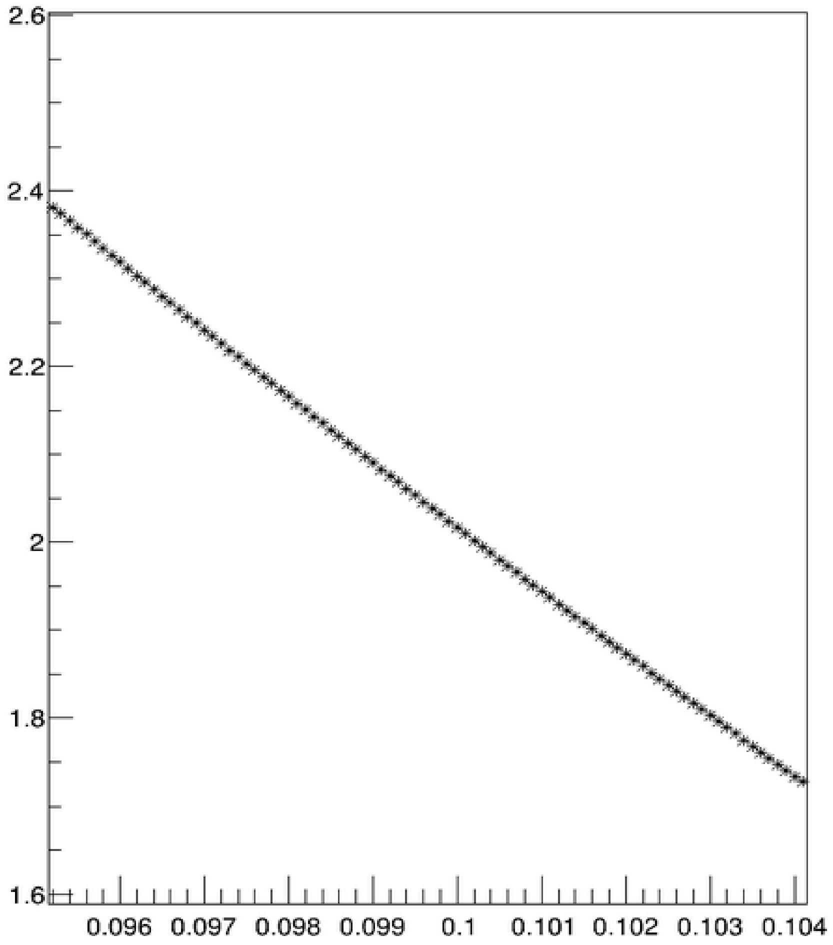
Pf= 0.67

a) ${}^{\delta_{Pf}}/_{Pf} = 7.19\%$, 1mrad uncertainty

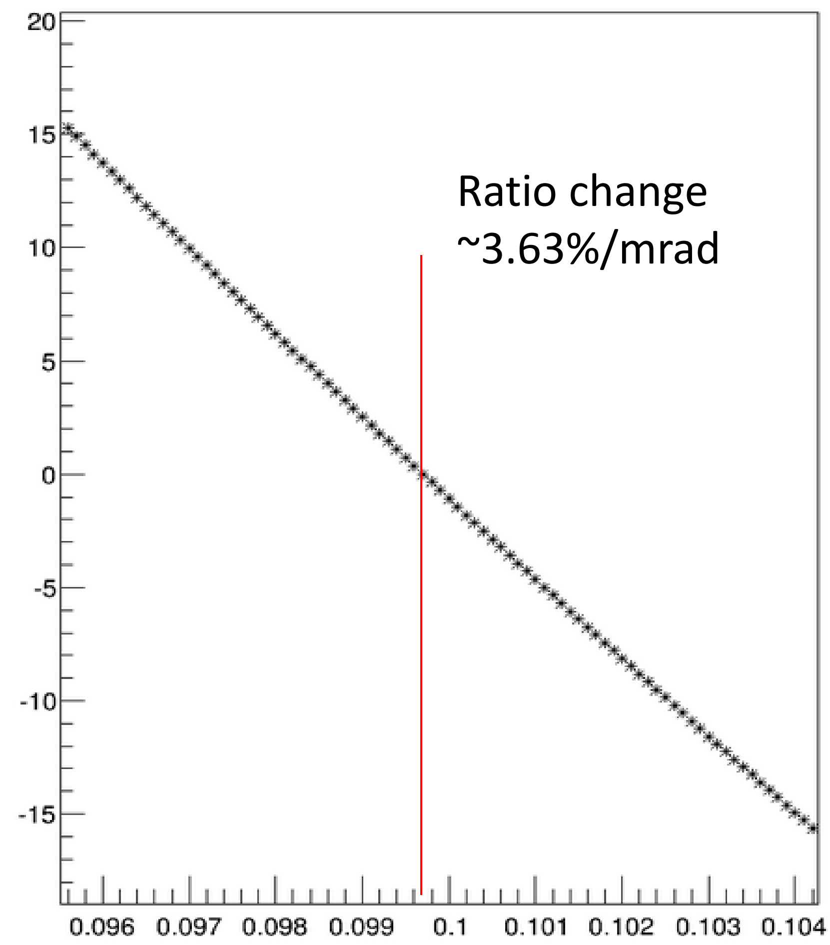
- assume run 3446,3447,3448, relative beam shift is small, bpm absolute uncertainty 1mrad
- So $\delta\left(\frac{\sigma_{He}}{\sigma_{He1}}\right) = 0, \delta(\sigma_{He2}/\sigma_{He1}) = 0, \delta(\sigma_{He3}/\sigma_{He1}) = 0,$
- $\delta\left(\frac{\sigma_N}{\sigma_{He1}}\right) = 4.74\%, \delta\left(\frac{\sigma_H}{\sigma_{He1}}\right) = -0.95\%, \delta\left(\frac{\sigma_C}{\sigma_{He1}}\right) = 3.63\%$

Elastic XS σ_c/σ_{He} ratio -----calculate directly

σ_c/σ_{He} vs. scattering angle

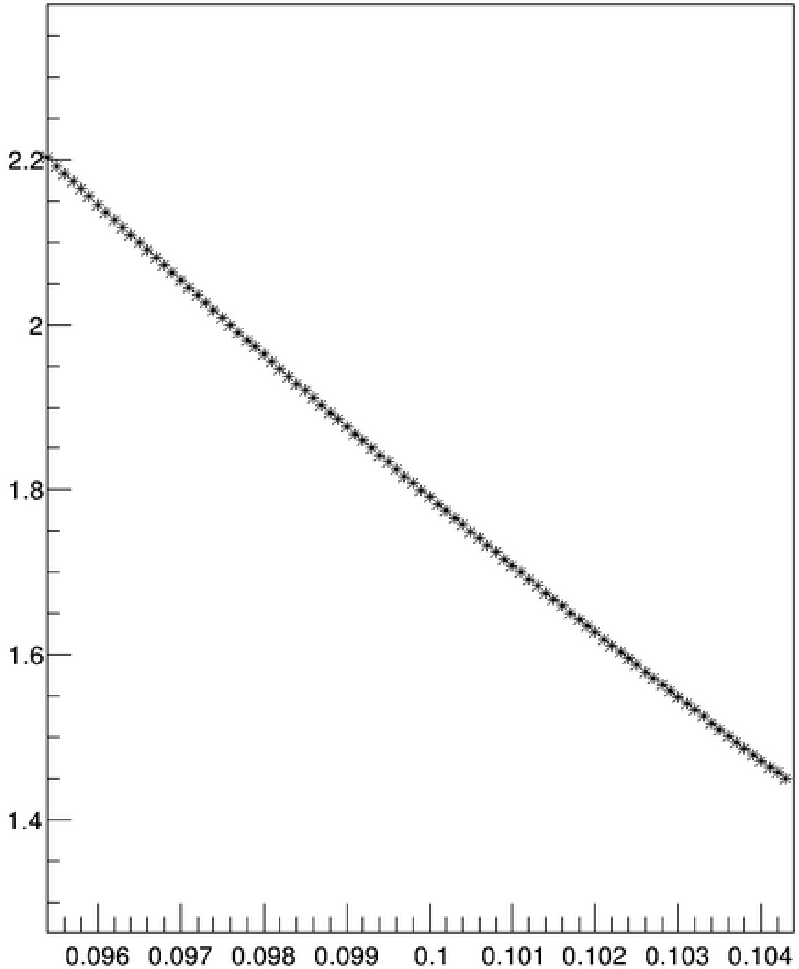


$\delta(\sigma_c/\sigma_{He})$ vs. scattering angle

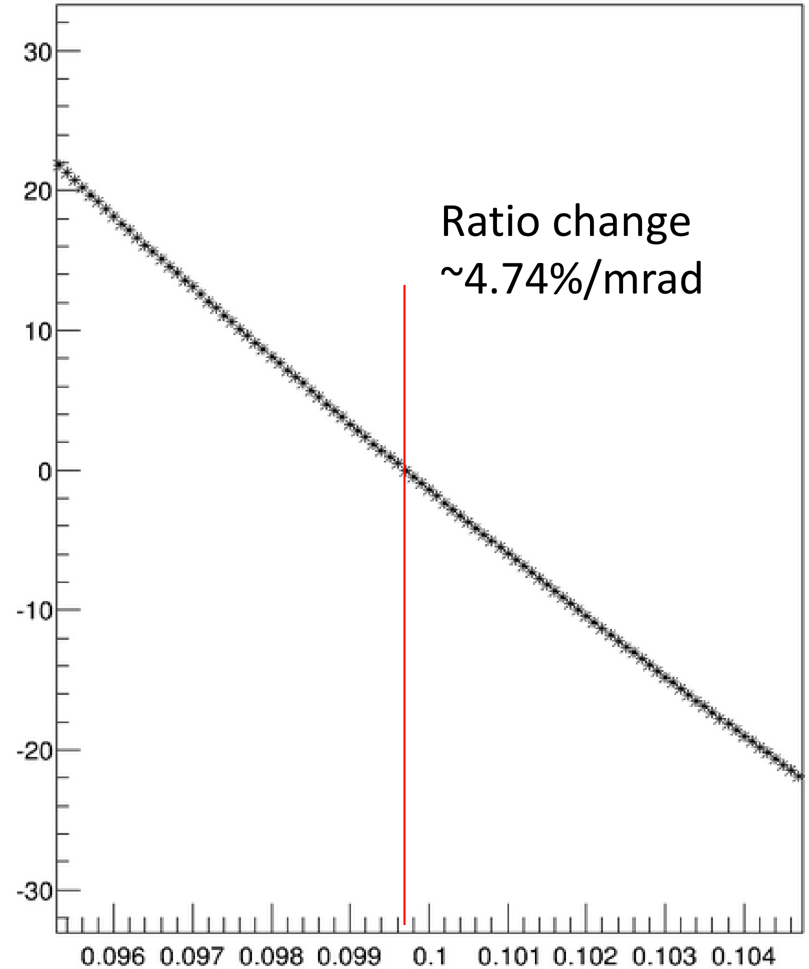


Elastic XS σ_N/σ_{He} ratio -----calculate directly

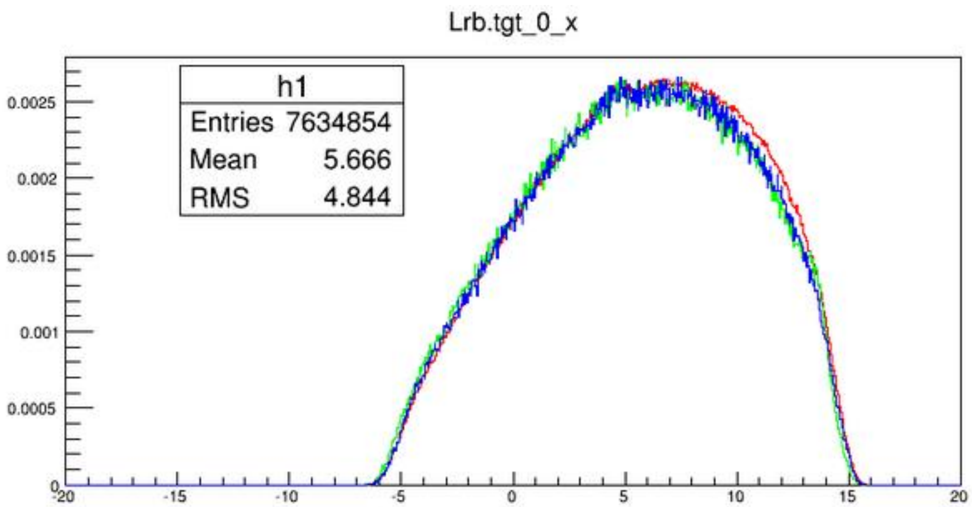
σ_N/σ_{He} vs. scattering angle

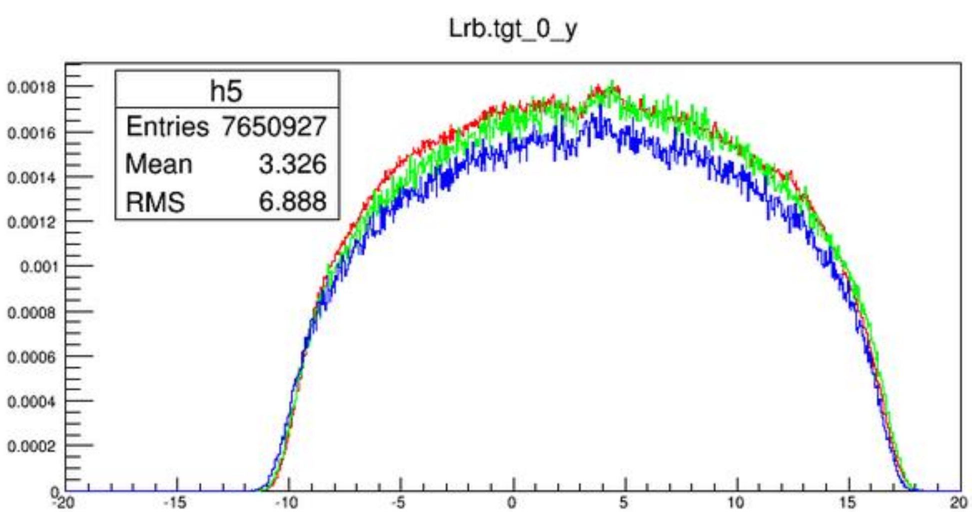


$\delta(\sigma_N/\sigma_{He})$ vs. scattering angle



Beam information





- Cell radius: 13.61mm
- Plus cell wall: 0.89mm
- Total radius: 14.50mm

- ○ Run 3446: Red
- ○ Run 3447: Green
- ○ Run 3448: Blue

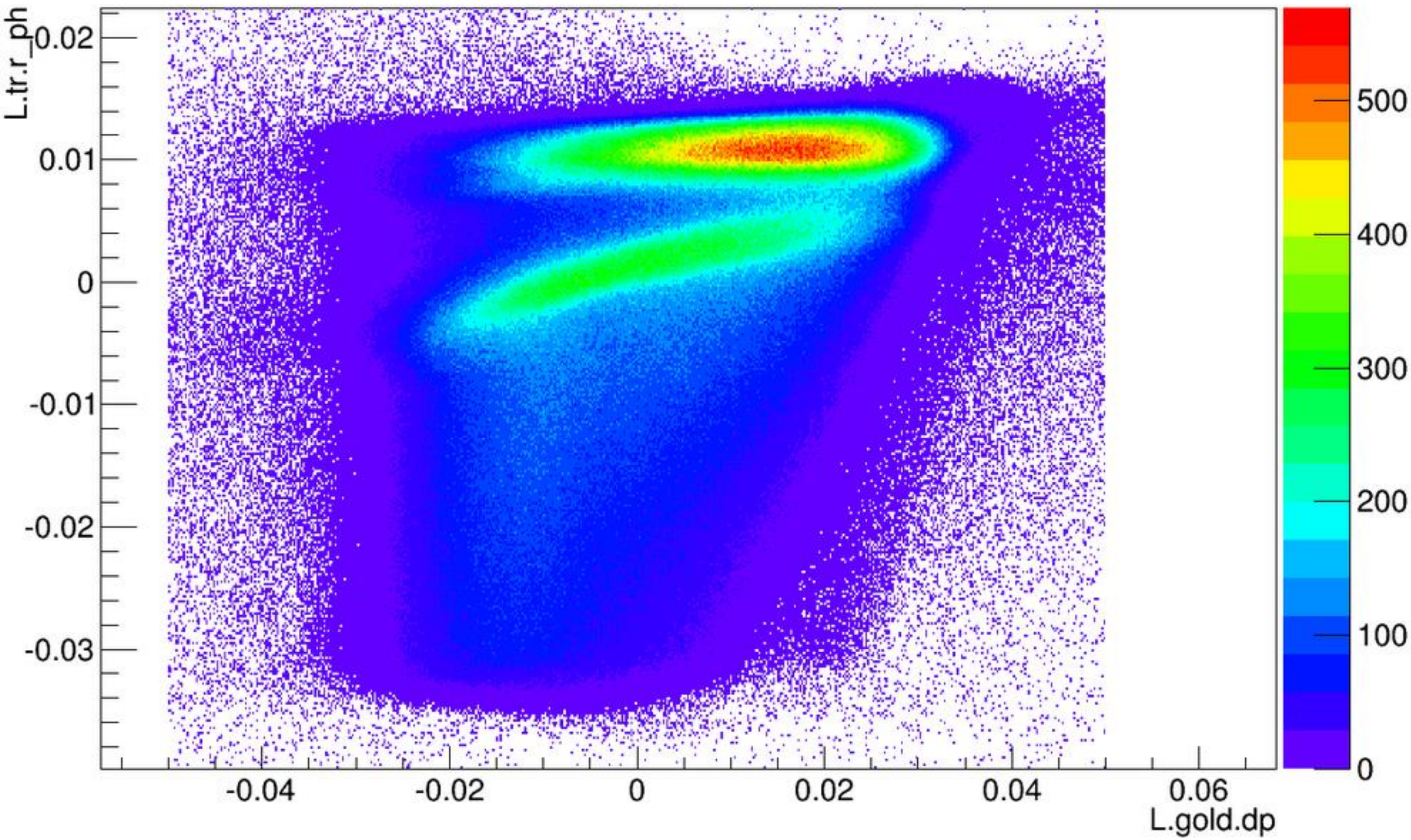
- ✓ Target offset?
- ✓ Beam spot large?

$$y \approx R + \frac{L}{2} * \tan(tiltangle)$$

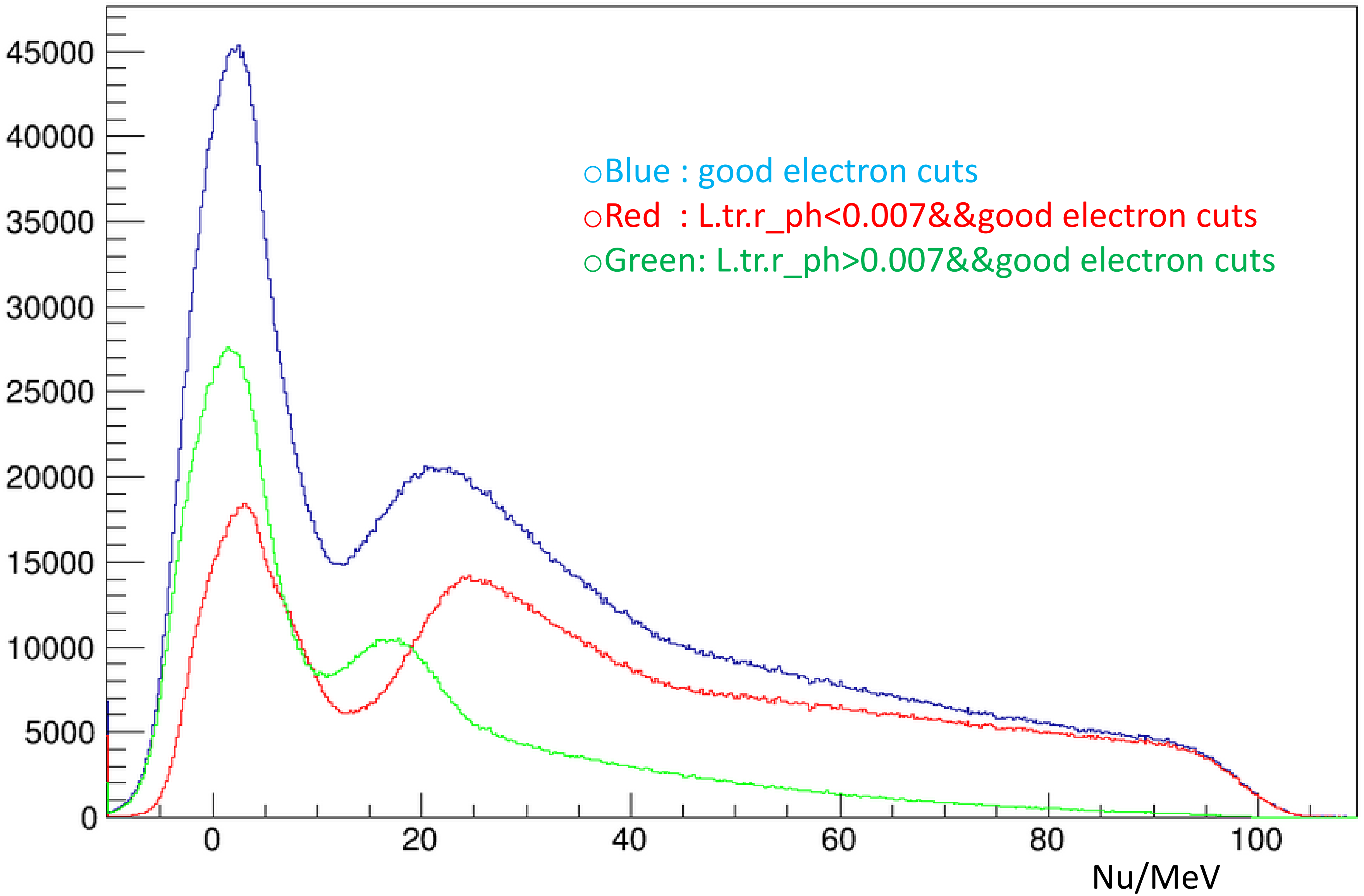
$$\approx 13.61 + 0.9 = 14.51mm$$

For cell itself, not add wall

Run 3446



L.tr.r_ph
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.02
0
0.02
0.04
0.06
L.gold.dp
500
400
300
200
100
0



○Blue : good electron cuts
○Red : L.tr.r_ph<0.007&&good electron cuts
○Green: L.tr.r_ph>0.007&&good electron cuts
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
Nu/MeV

Todo

- Check target offset?
- Check energy loss model, packing fraction simulation…