

2020.03.20

analysis

K. N. Suzuki



➤ Good Dipole

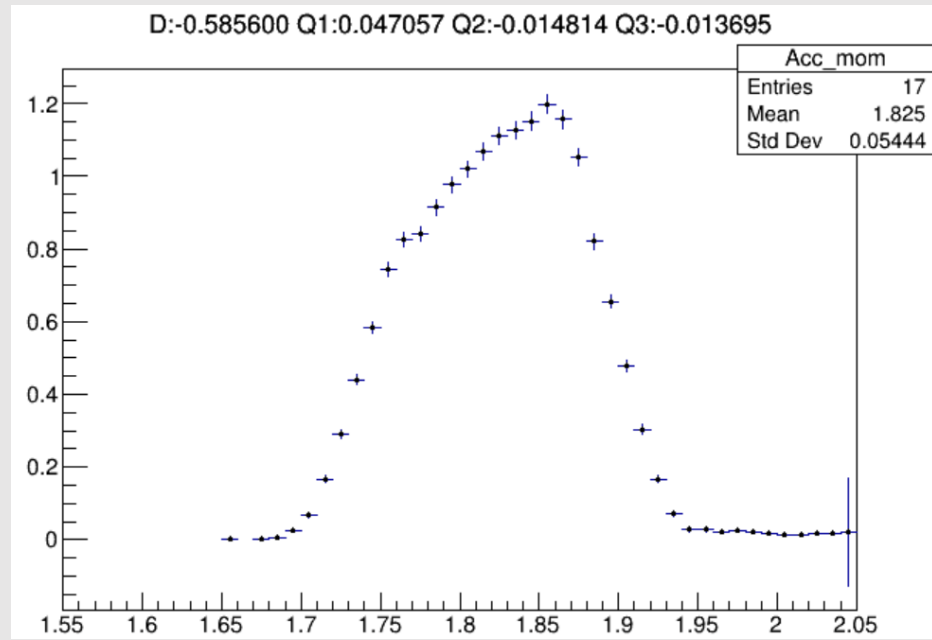
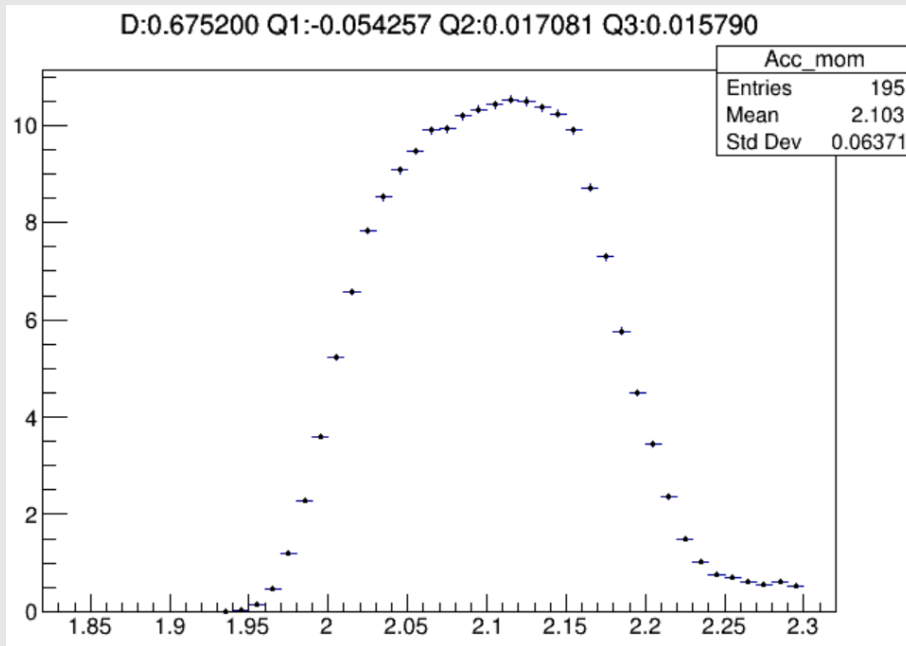
Good dipole ~Hkinematics

3 / 6

Including Physics

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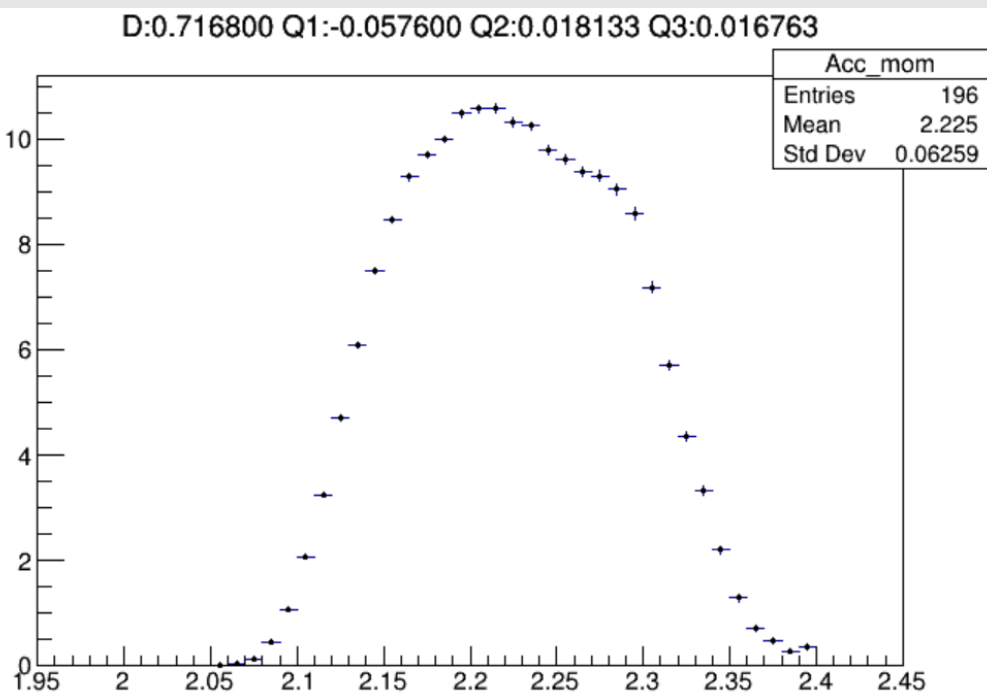
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Good dipole ~Tkinematics

Including Physics

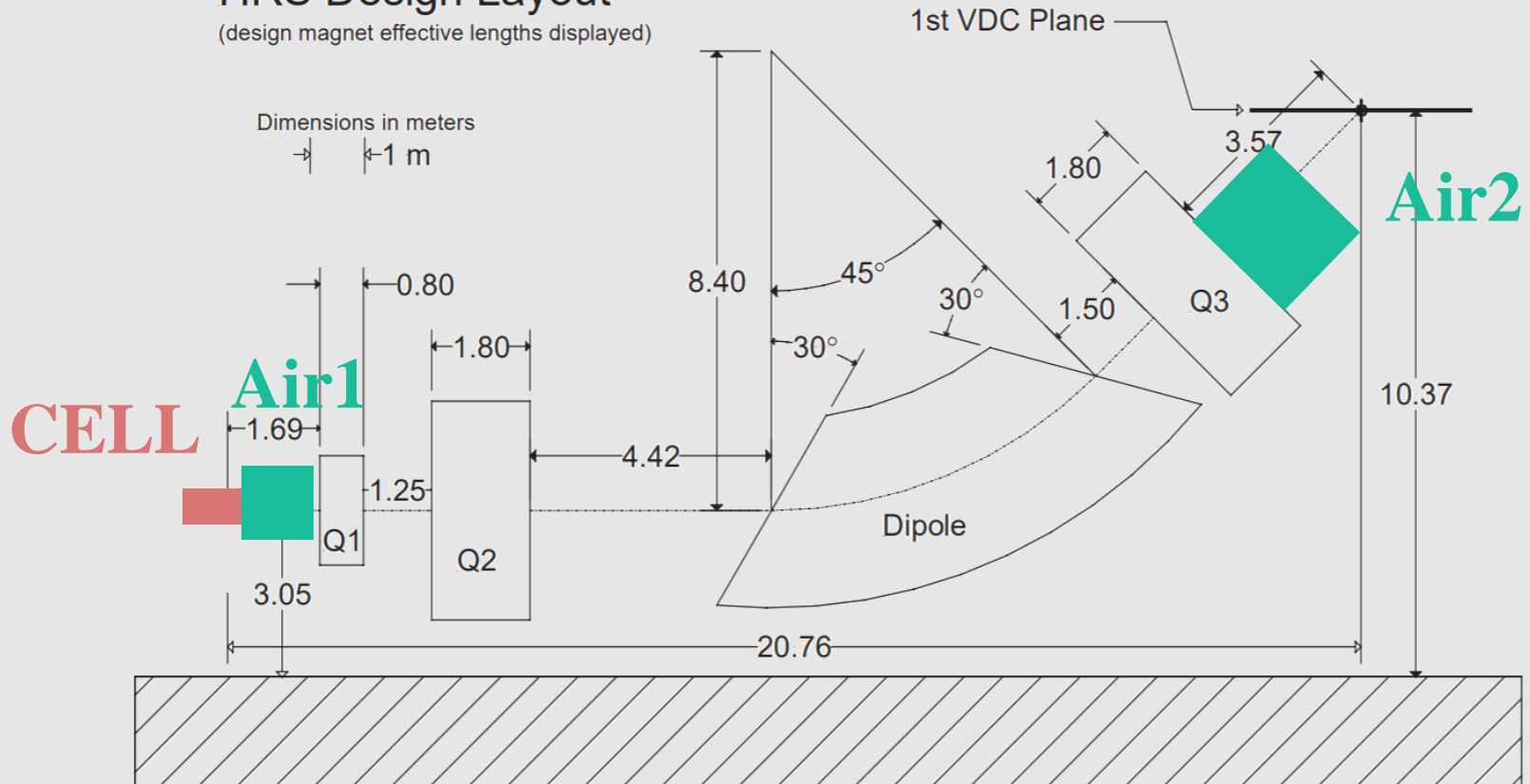
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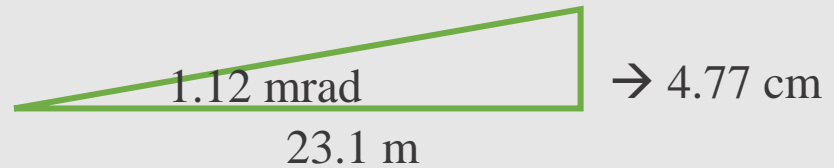
Three kinds of materials exist

HRS Design Layout

(design magnet effective lengths displayed)



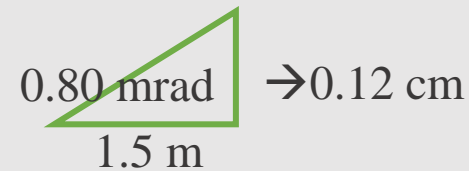
CELL: $\Delta\theta = 1.12$ mrad



Air1: $\Delta\theta = 0.54$ mrad



Air2: $\Delta\theta = 0.80$ mrad



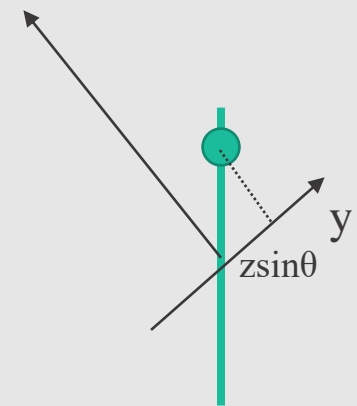
$$\begin{bmatrix} x_{fp} \\ \theta_{fp} \\ y_{fp} \\ \phi_{fp} \\ \delta_{fp} \end{bmatrix} = \begin{bmatrix} -2.48 & 0.0 & 0.0 & 0.0 & 12.4 \\ -0.15 & -0.40 & 0.0 & 0.0 & 2.04 \\ 0.0 & 0.0 & -0.40 & -1.30 & 0.0 \\ 0.0 & 0.0 & 0.54 & -0.78 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 1.0 \end{bmatrix} \times \begin{bmatrix} x_{tg} \\ \theta_{tg} \\ y_{tg} \\ \phi_{tg} \\ \delta \end{bmatrix}$$

$$x_{fp} = -2.48 x_{tg} + 12.4 \delta$$

$$\theta_{fp} = -0.15 x_{tg} - 0.40 \theta_{tg} + 2.04 \delta$$

$$y_{fp} = -0.40 y_{tg} - 1.30 \phi_{tg}$$

$$\phi_{fp} = 0.54 y_{tg} - 0.78 \phi_{tg}$$



$$y_{tg} = z \sin \theta$$

$$\begin{bmatrix} x_{fp} \\ \theta_{fp} \\ y_{fp} \\ \phi_{fp} \\ \delta_{fp} \end{bmatrix} = \begin{bmatrix} -2.48 & 0.0 & 0.0 & 0.0 & 12.4 \\ -0.15 & -0.40 & 0.0 & 0.0 & 2.04 \\ 0.0 & 0.0 & -0.40 & -1.30 & 0.0 \\ 0.0 & 0.0 & 0.54 & -0.78 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 1.0 \end{bmatrix} \times \begin{bmatrix} x_{tg} \\ \theta_{tg} \\ y_{tg} \\ \phi_{tg} \\ \delta \end{bmatrix}$$

$$dx_{fp} = -2.48 x_{tg} + 12.4 d\delta$$

$$d\theta_{fp} = -0.15 x_{tg} - 0.40 d\theta_{tg} + 2.04 d\delta$$

$$dy_{fp} = -0.40 y_{tg} - 1.30 d\phi_{tg}$$

$$d\phi_{fp} = 0.54 y_{tg} - 0.78 d\phi_{tg}$$

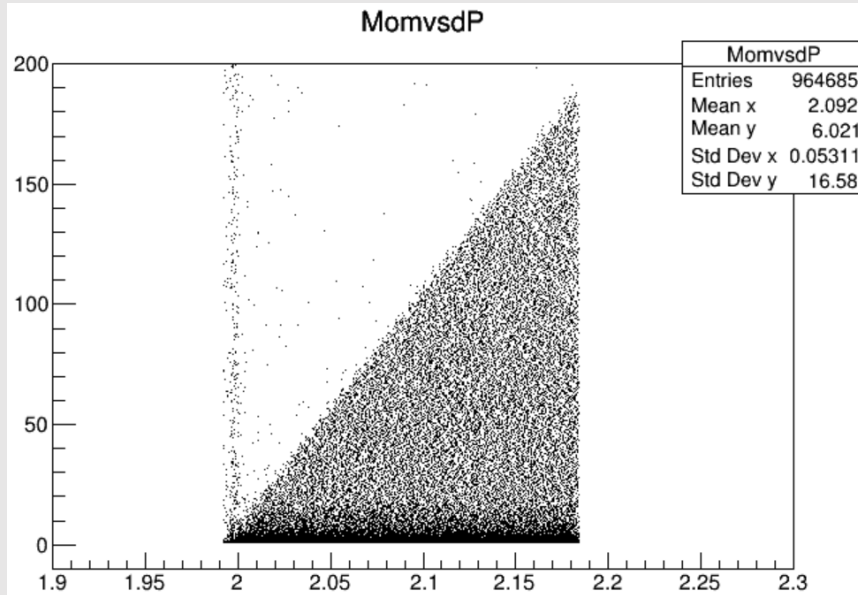
dx_{fp} imply E struggling

dy_{fp} and $d\phi_{fp}$ imply MSE

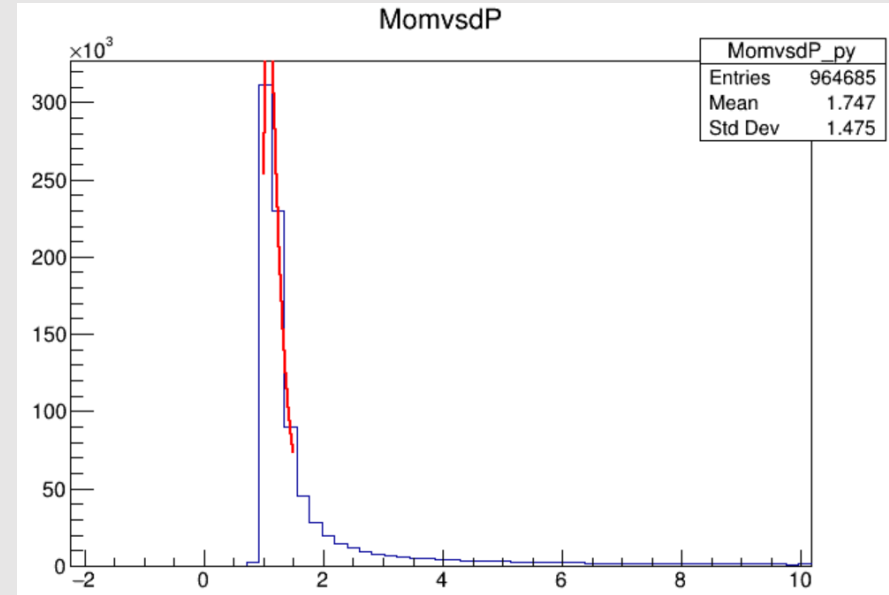
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Physics: h2kine_genfromfile_noAir_z0th0_Physics_forMSE.root

Mom Loss (MeV)



e Mom (GeV)



Mom Loss (MeV)

MPV = 1.1 MeV

$\sigma = 0.074$ MeV

$$dx_{fp} = 12.4 d\delta = 12.4 \times \left(\frac{1.1}{2100} \right) = \mathbf{0.64 \text{ cm} ?}$$

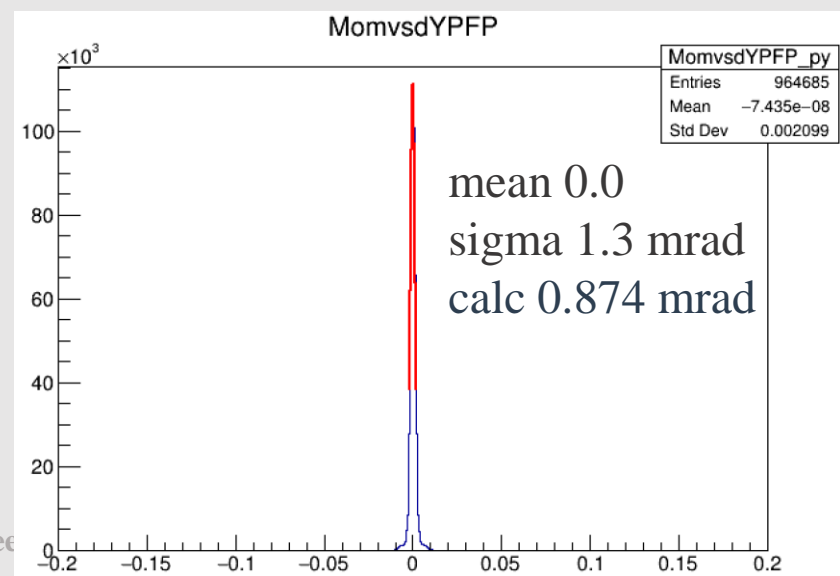
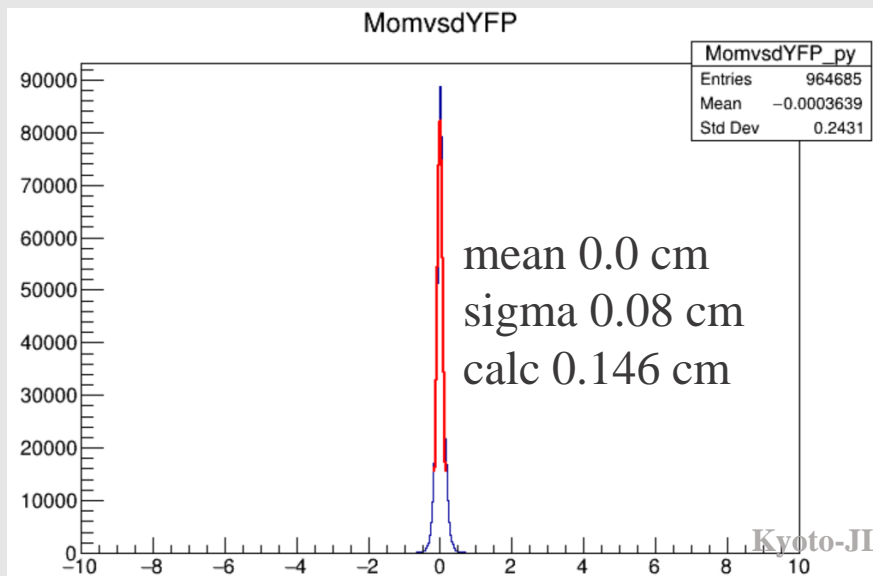
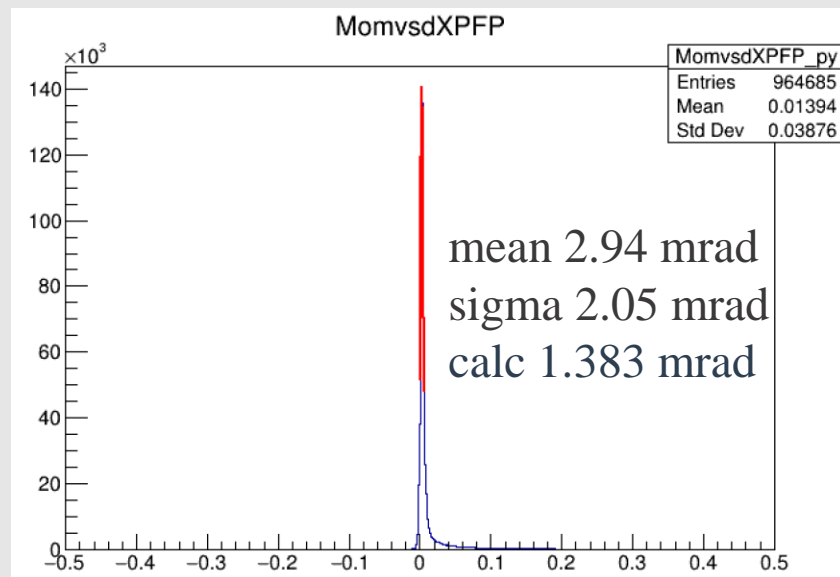
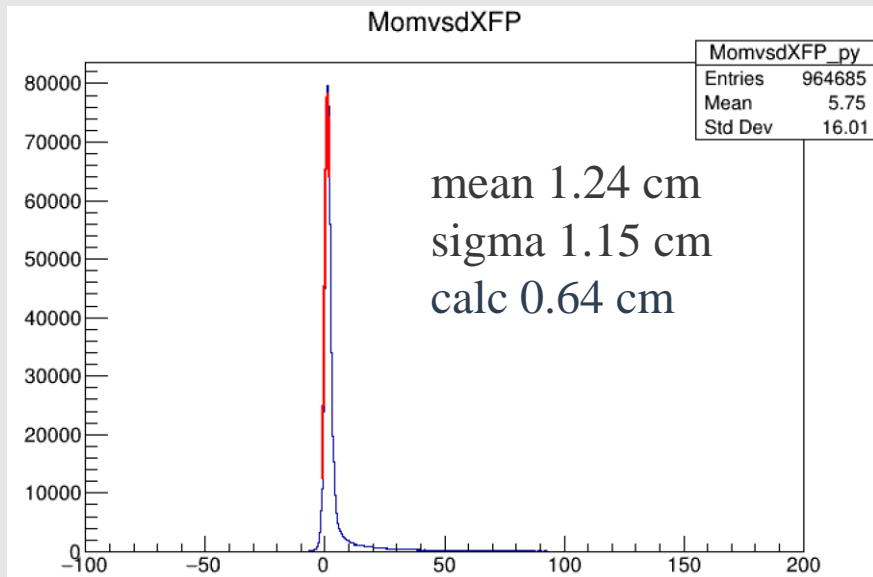
$$\begin{aligned} dy_{fp} &= -1.30 d\phi_{tg} = -1.30 \times 1.12 \text{ mrad} \\ &= 1.46 \text{ mm} = \mathbf{0.146 \text{ cm}} \end{aligned}$$

$$\begin{aligned} d\theta_{fp} &= 0.40 d\theta_{tg} + 2.04 d\delta \\ &= 0.40 \times 1.12 + 2.04 \times \left(\frac{1.1}{2400} \right) \times 1000 \\ &= 0.448 + 0.935 \text{ mrad} = \mathbf{1.383 \text{ mrad}} \end{aligned}$$

$$d\phi_{fp} = -0.78 d\phi_{tg} = -0.78 \times 1.12 \text{ mrad} = \mathbf{0.874 \text{ mrad}}$$

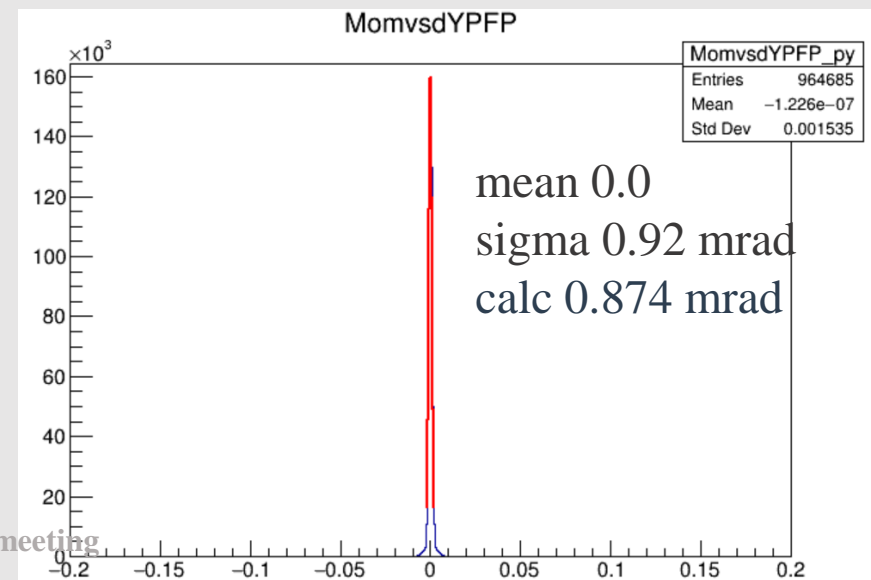
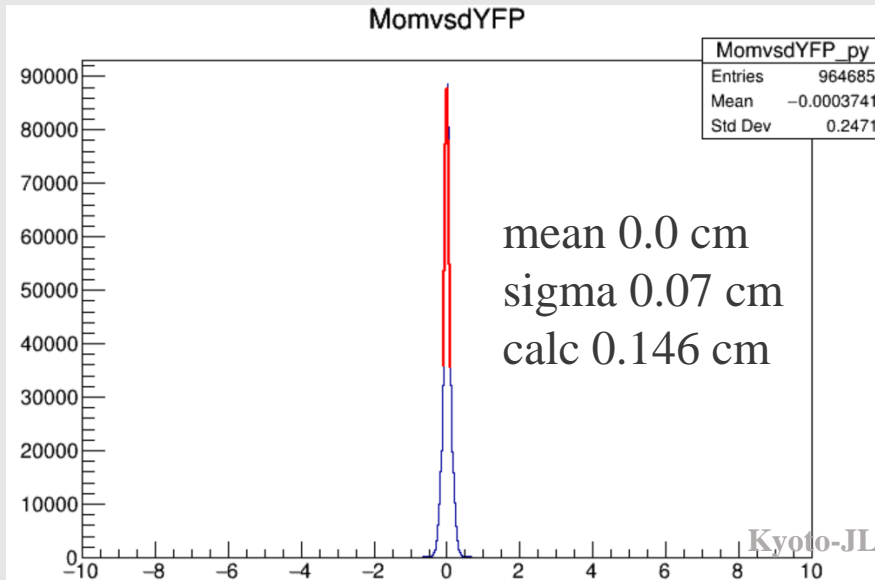
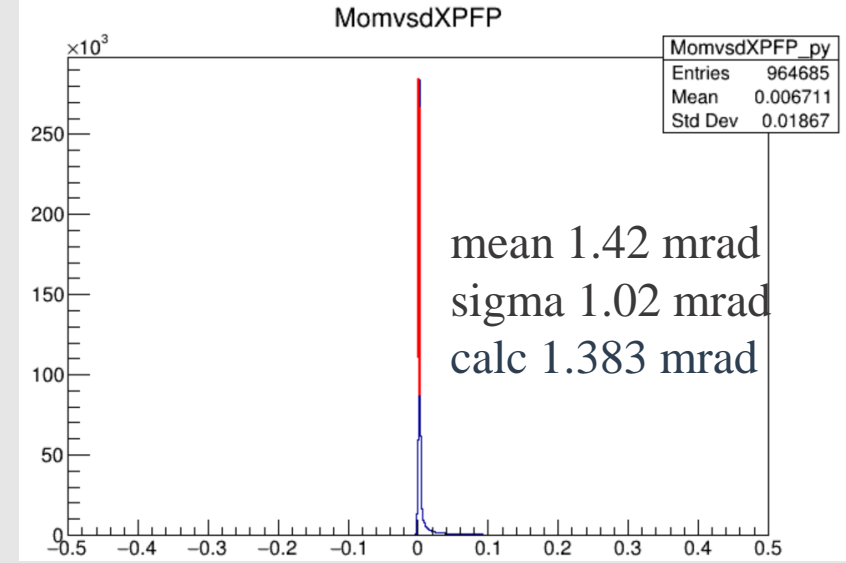
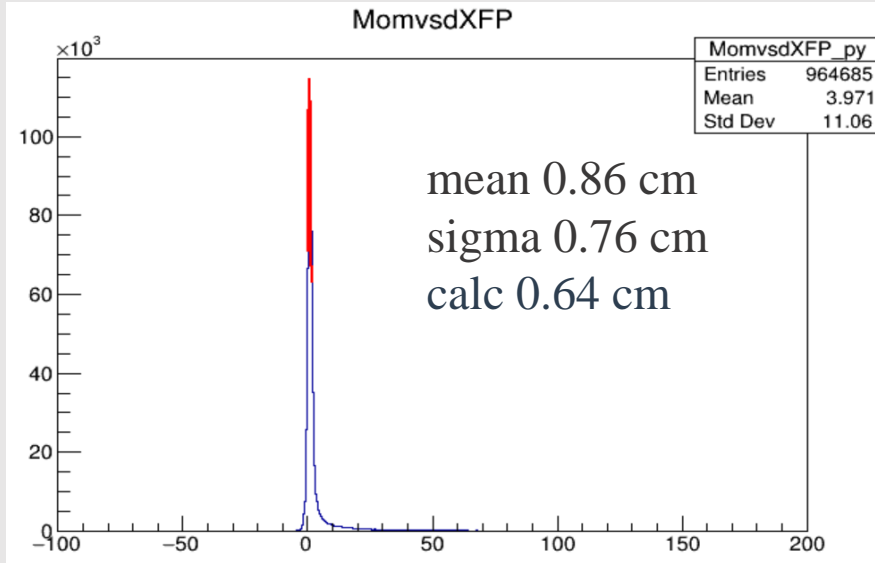
$$X_p = p_x/p_z$$

$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$



$$X_p = p_x/p_z$$

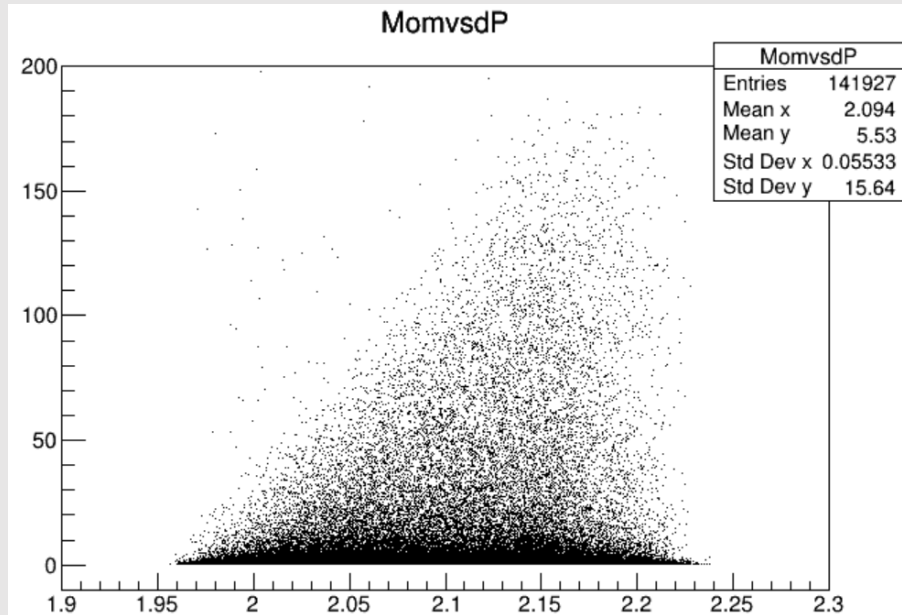
$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$



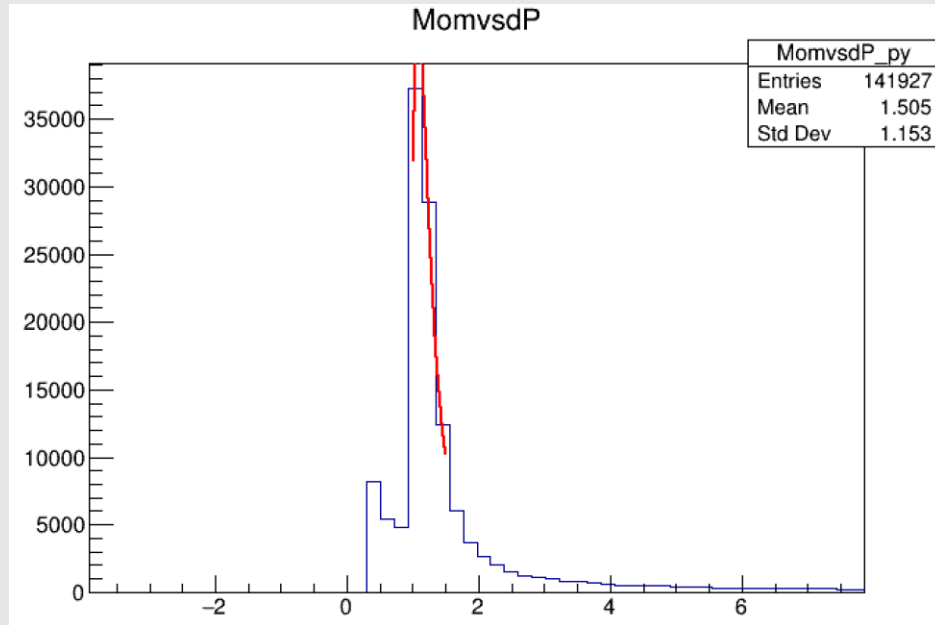
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Physics: h2kine_genfromfile_noAir_Physics_forMSE.root

Mom Loss (MeV)



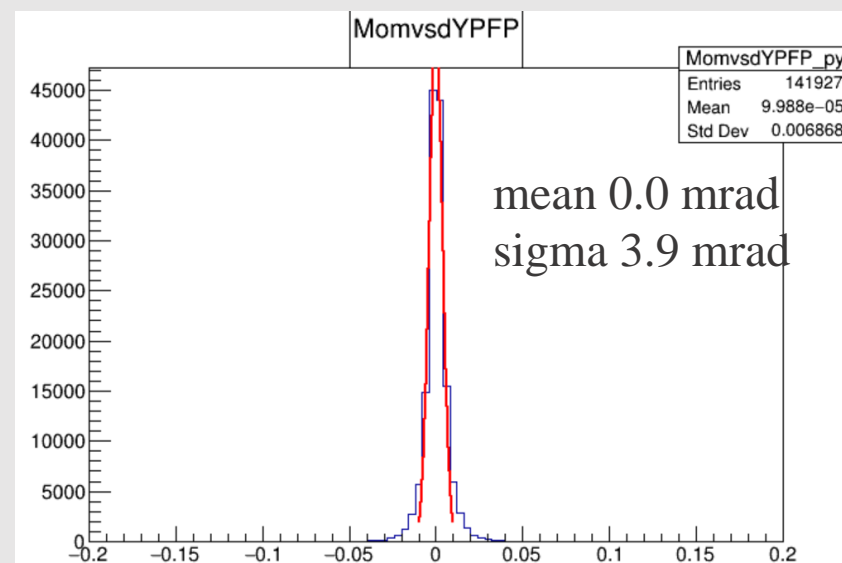
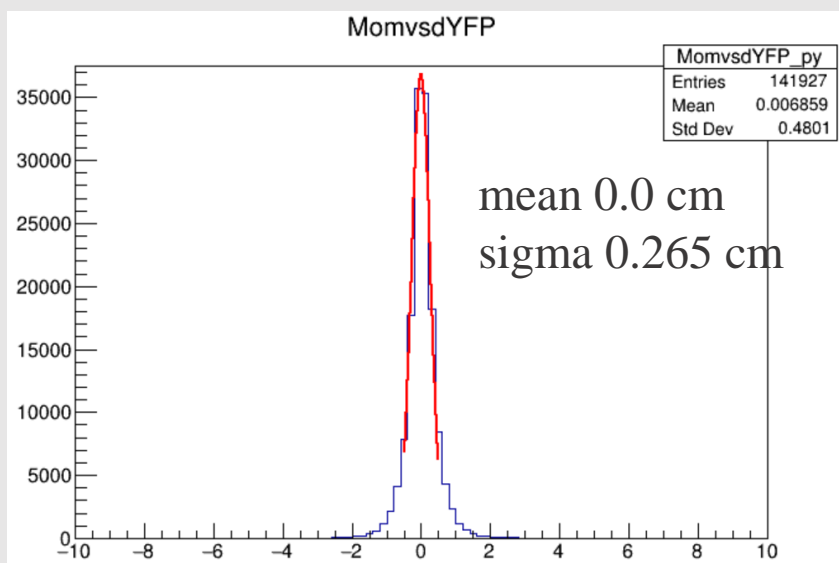
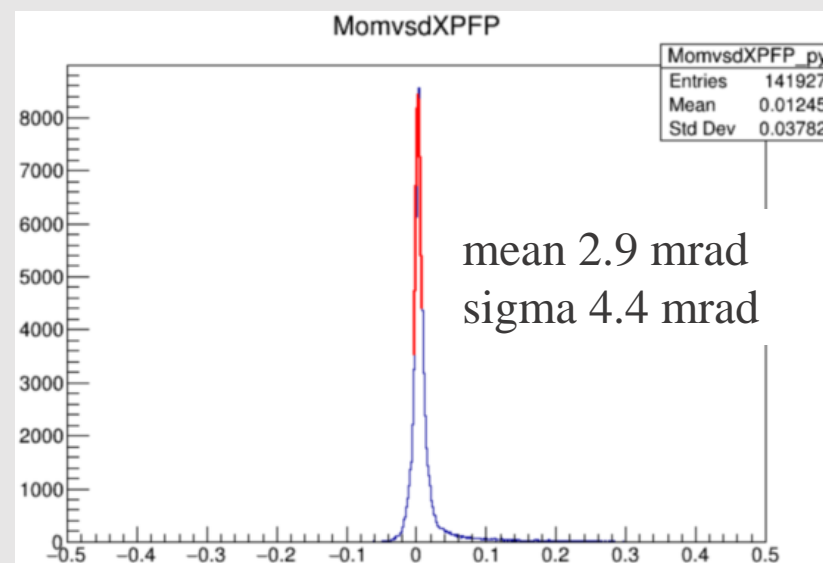
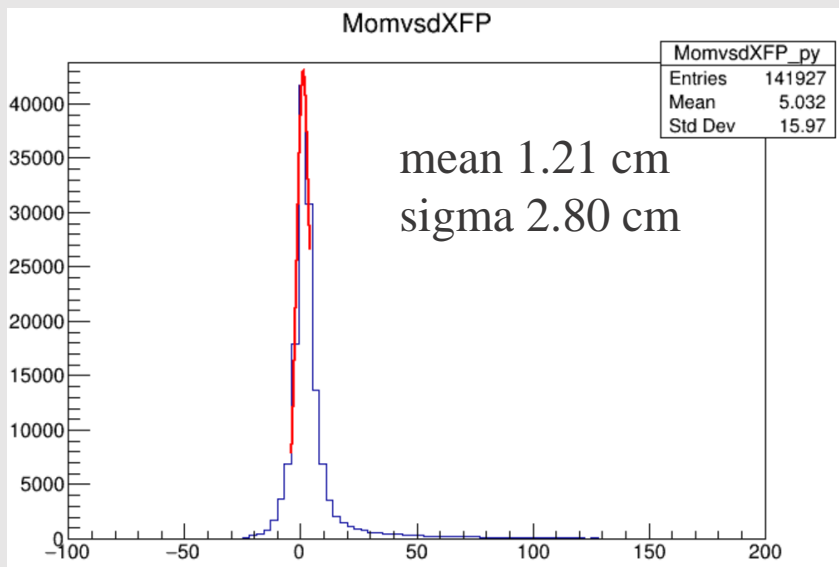
e Mom (GeV)

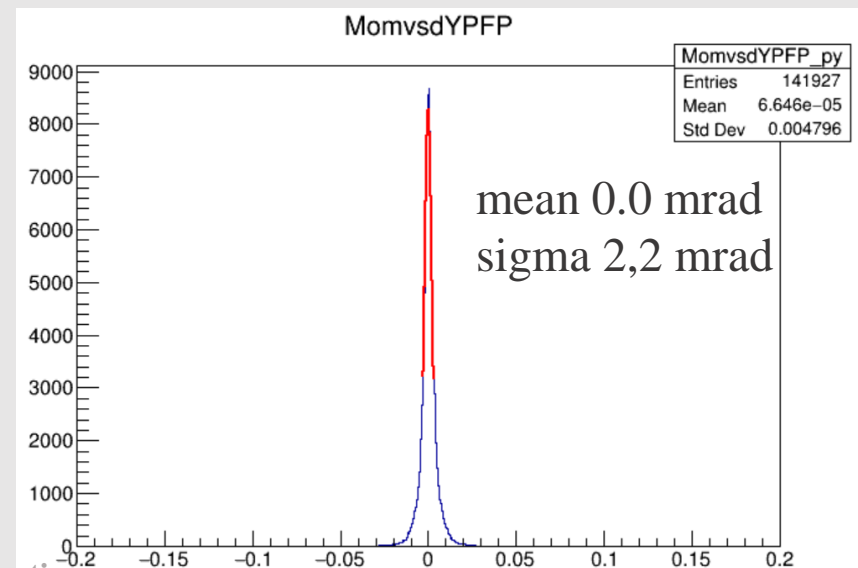
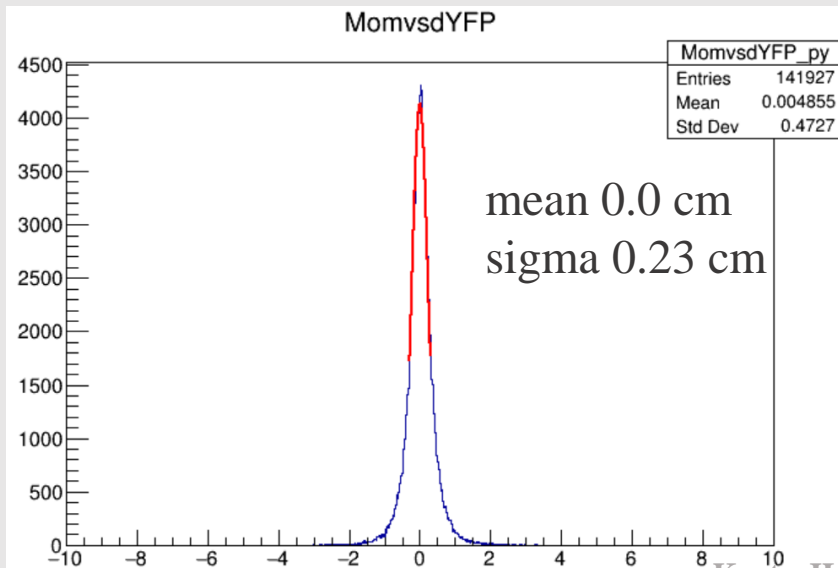
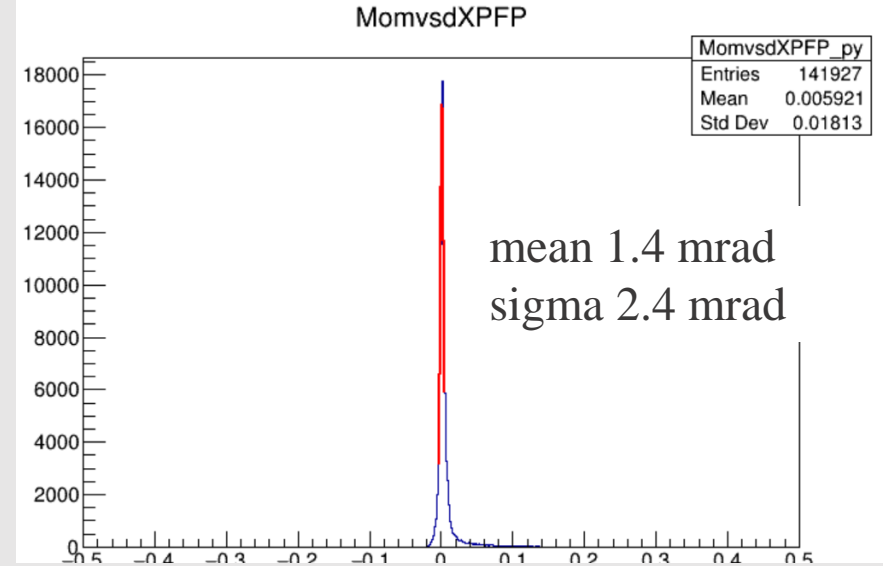
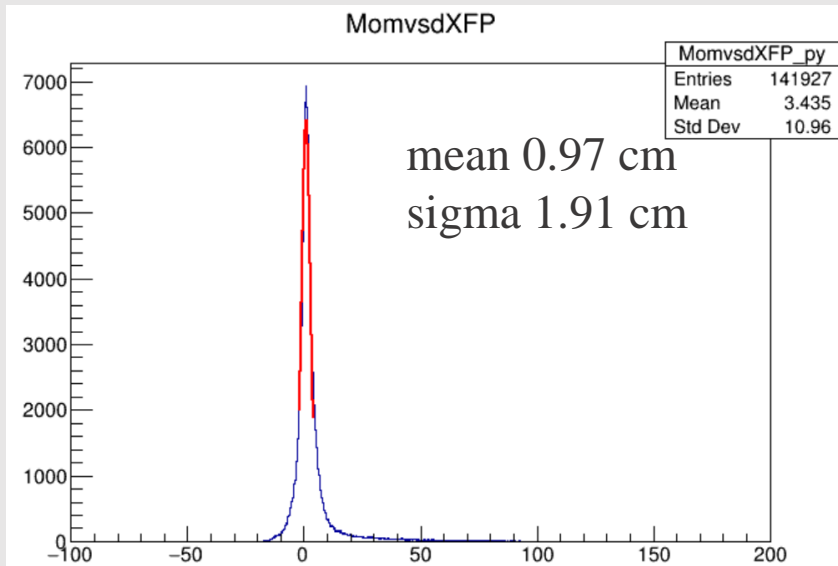


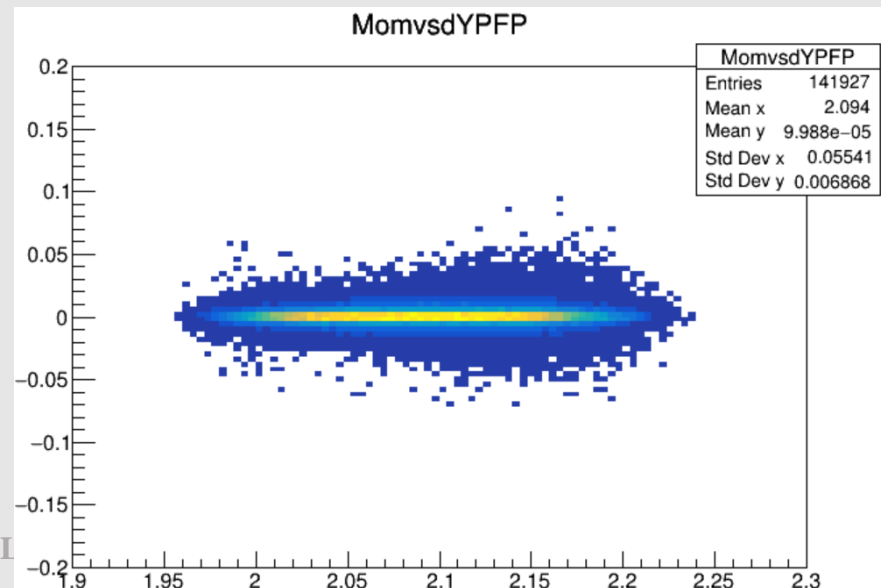
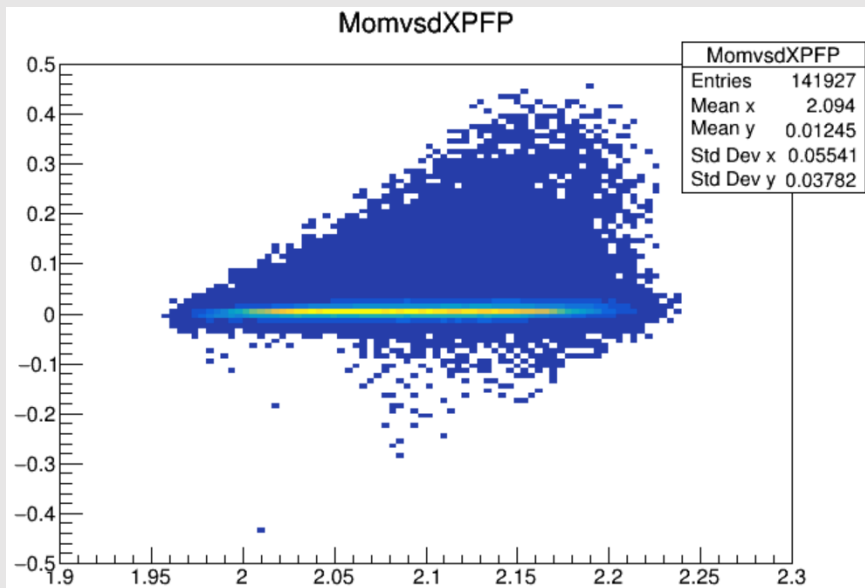
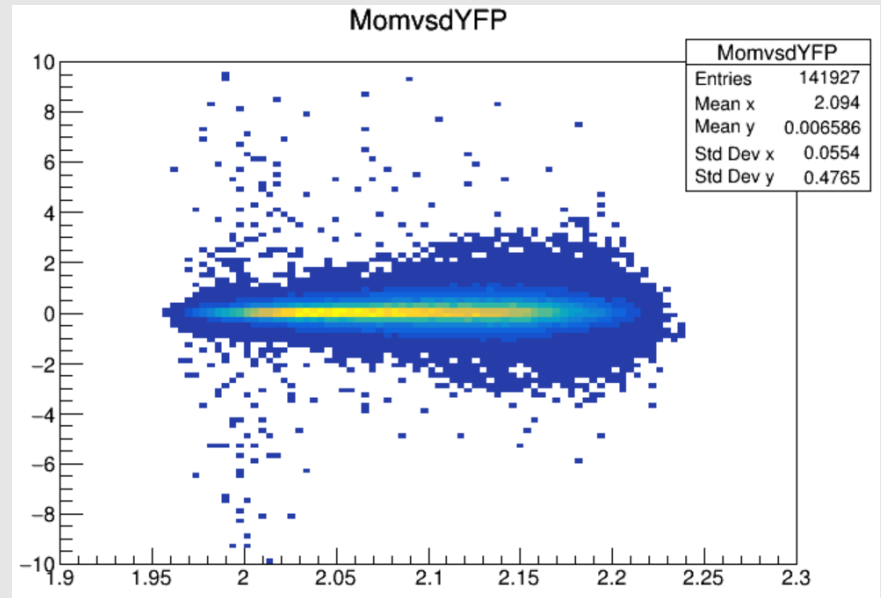
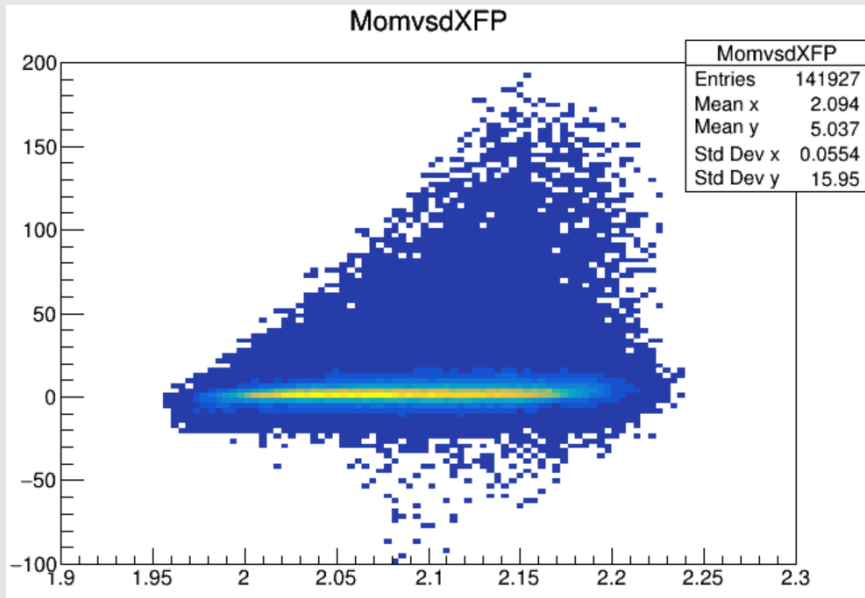
Mom Loss (MeV)

MPV = 1.1 MeV

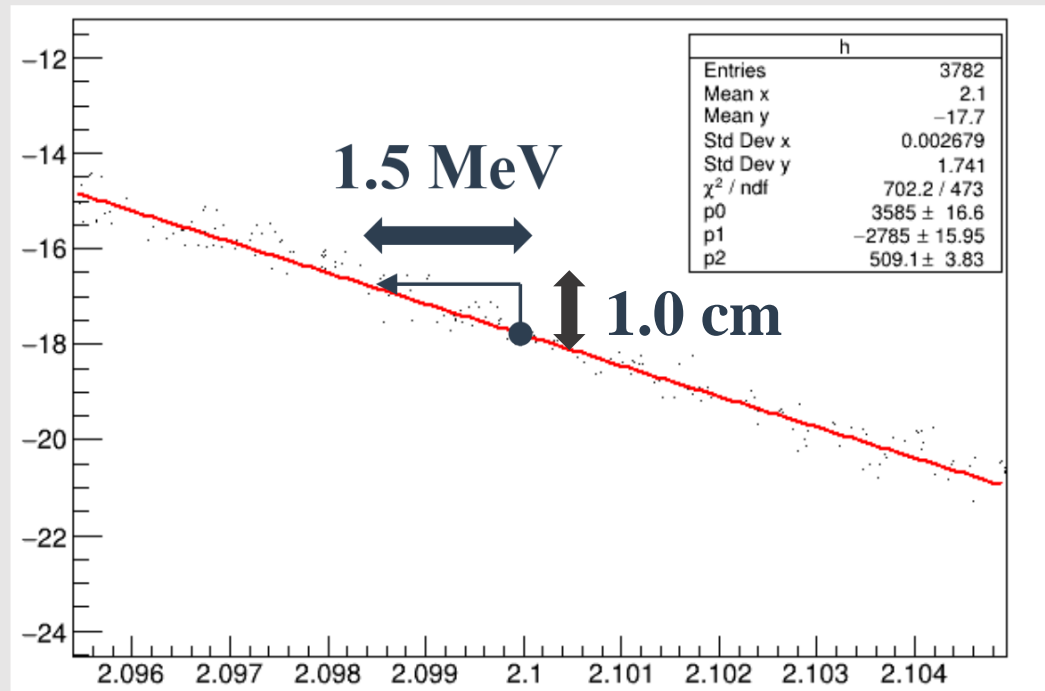
$\sigma = 0.084$ MeV







FP x (cm)

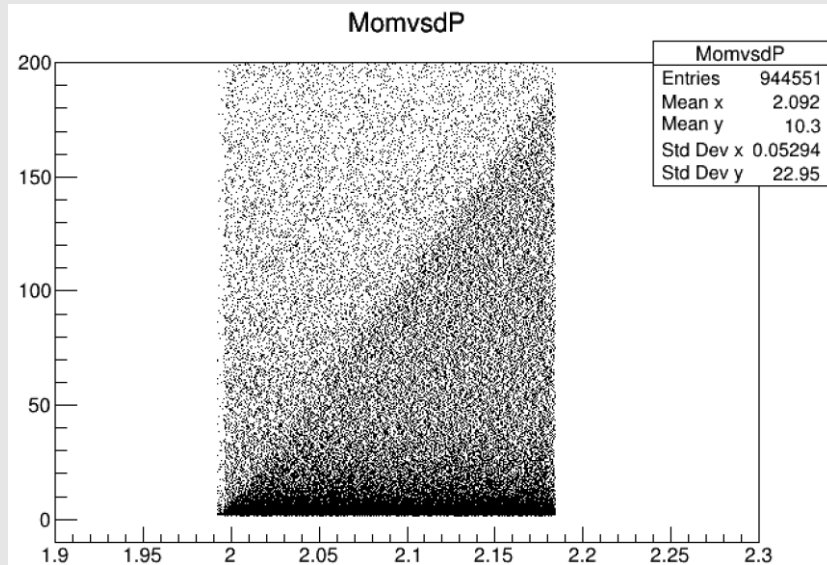


Momentum (GeV)

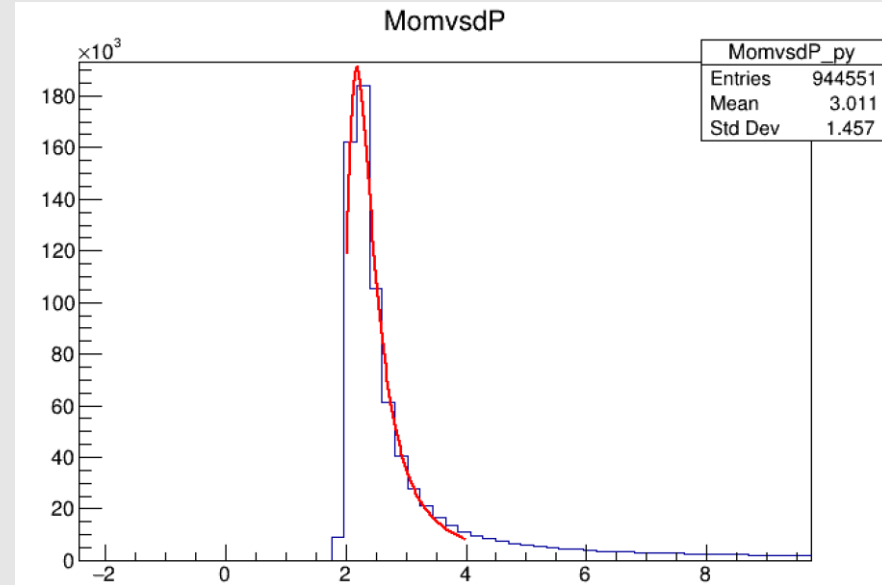
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Physics: h2kine_genfromfile_z0th0_Physics_forMSE.root

Momentum Loss

Mom Loss (MeV)



e Mom (GeV)



Mom Loss (MeV)

$$\text{MPV} = 2.2 \text{ MeV}$$
$$\sigma = 0.14 \text{ MeV}$$

$$dx_{fp} = 12.4 d\delta = 12.4 \times \left(\frac{2.2}{2100} \right) = \mathbf{1.29 \text{ cm}}$$

$$\begin{aligned} dy_{fp} &= -1.30 d\phi_{tg} = -1.30 \times 1.24 \text{ mrad} \\ &= 1.612 \text{ mm} = \mathbf{0.16 \text{ cm}} \end{aligned}$$

$$\begin{aligned} d\theta_{fp} &= 0.40 d\theta_{tg} + 2.04 d\delta \\ &= 0.40 \times 1.24 + 2.04 \times \left(\frac{2.2}{2400} \right) \times 1000 \\ &= 0.496 + 1.87 \text{ mrad} = \mathbf{2.37 \text{ mrad}} \end{aligned}$$

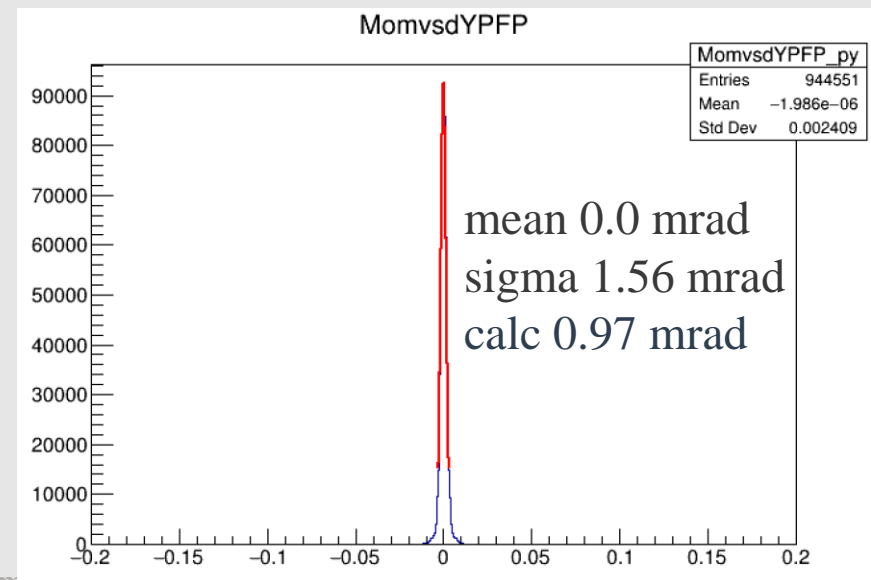
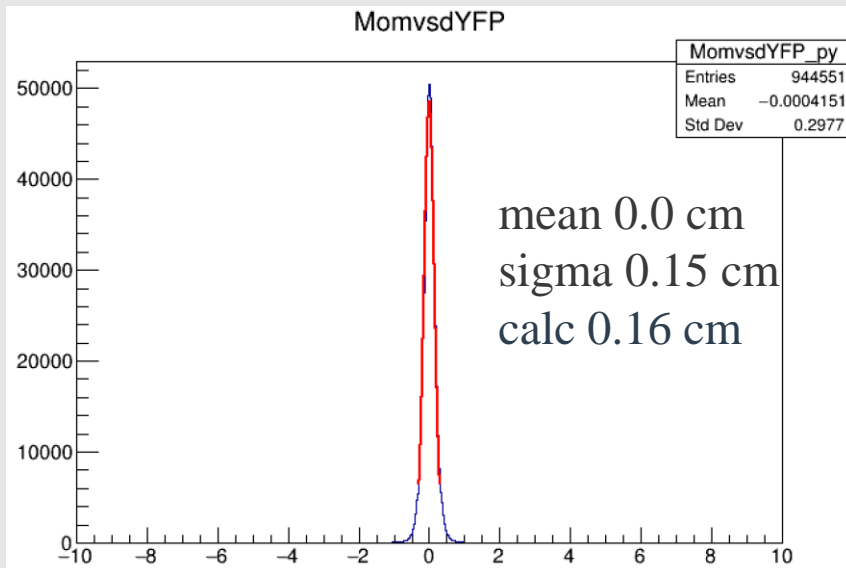
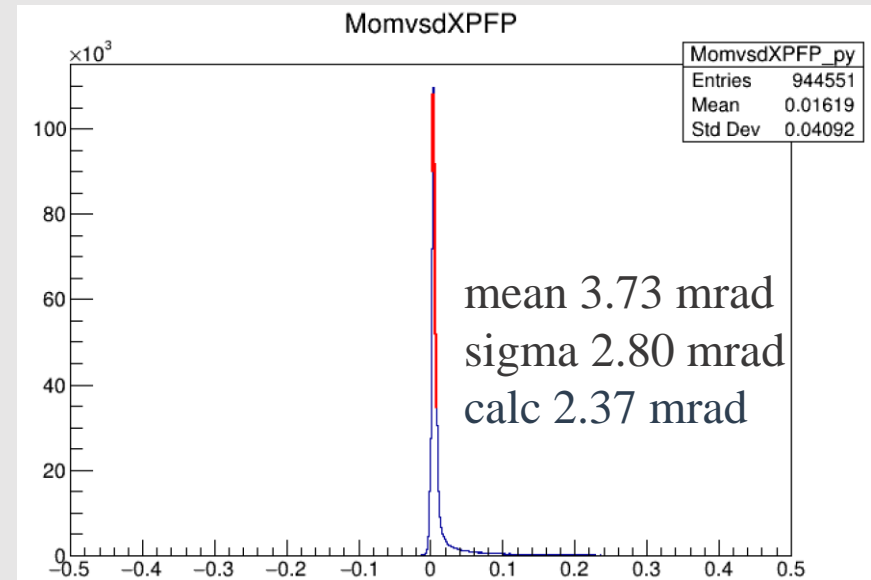
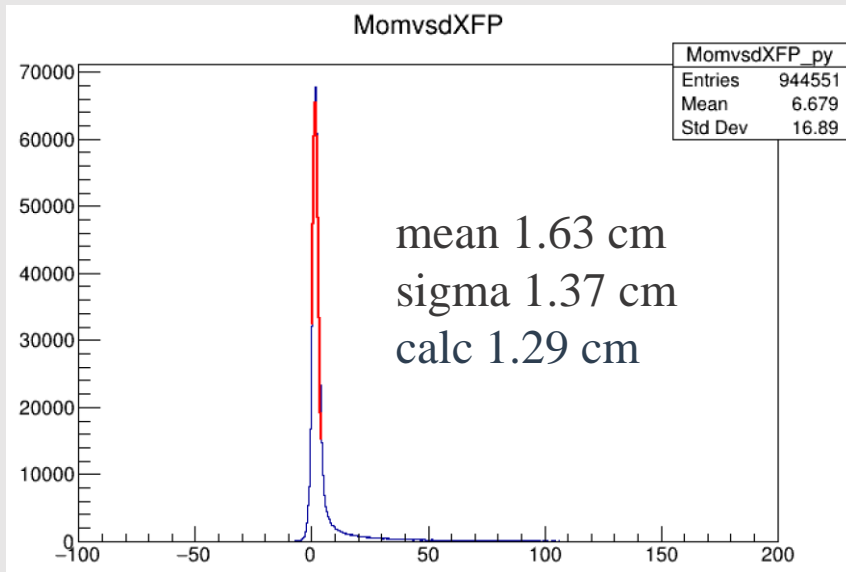
$$d\phi_{fp} = -0.78 d\phi_{tg} = -0.78 \times 1.24 \text{ mrad} = \mathbf{0.97 \text{ mrad}}$$

$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$

Geant4 (VDC1)

$$X_p = p_x/p_z$$

23 / 6

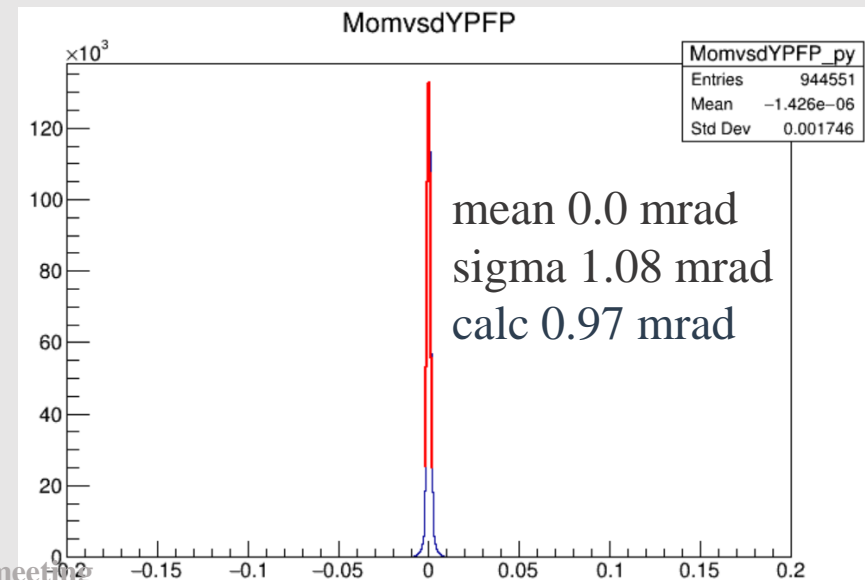
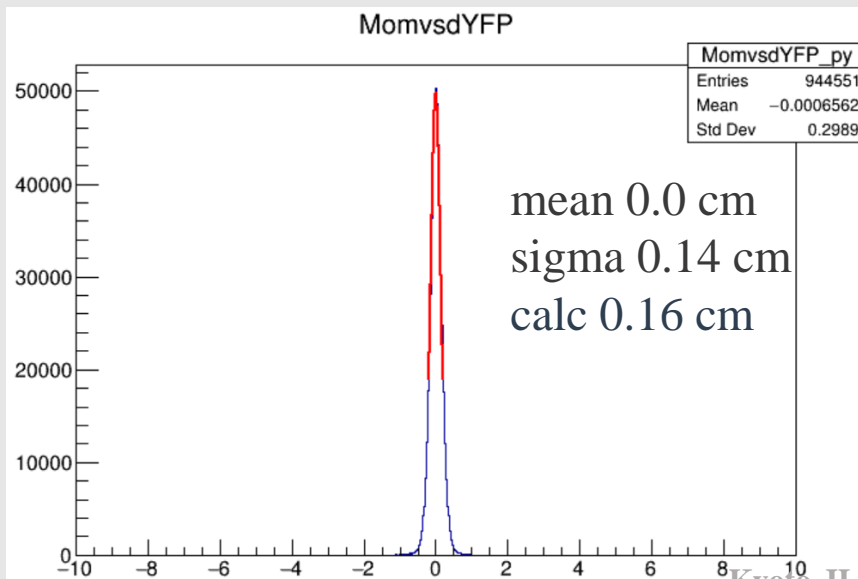
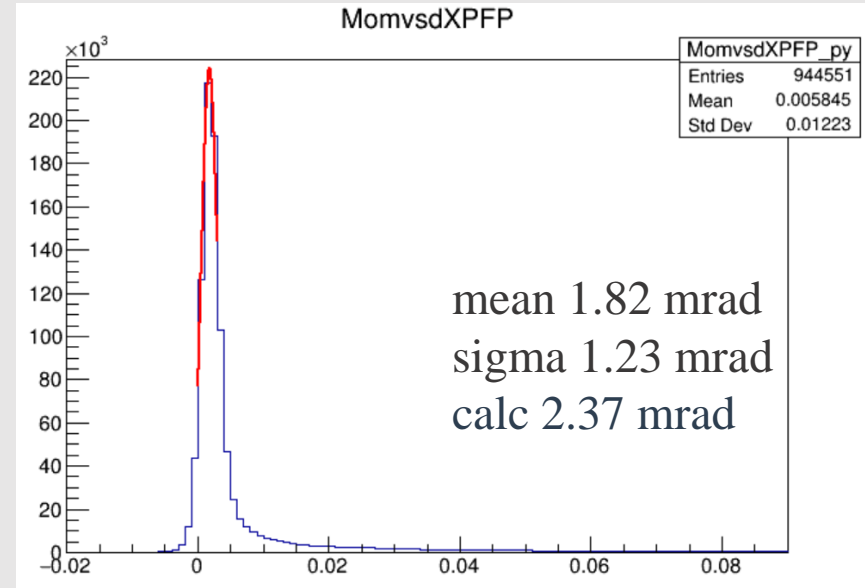
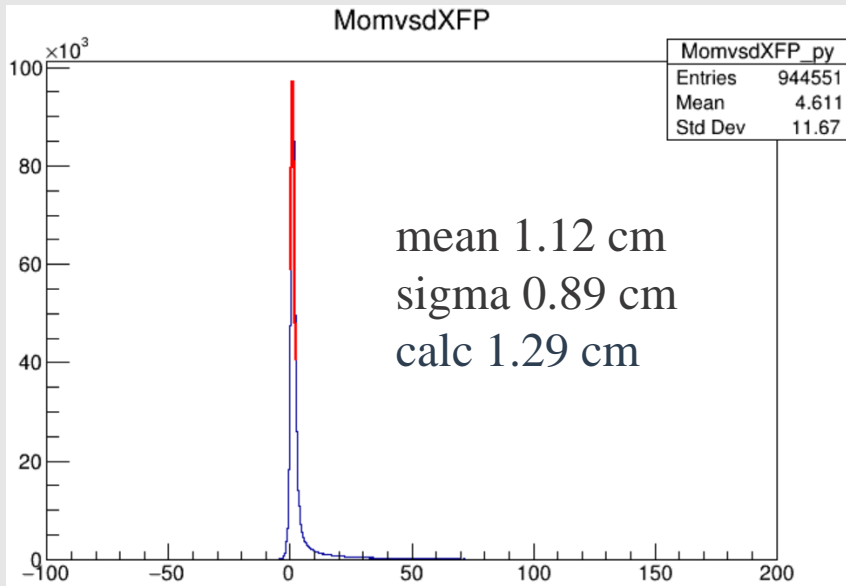


$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$

Geant4 (FP)

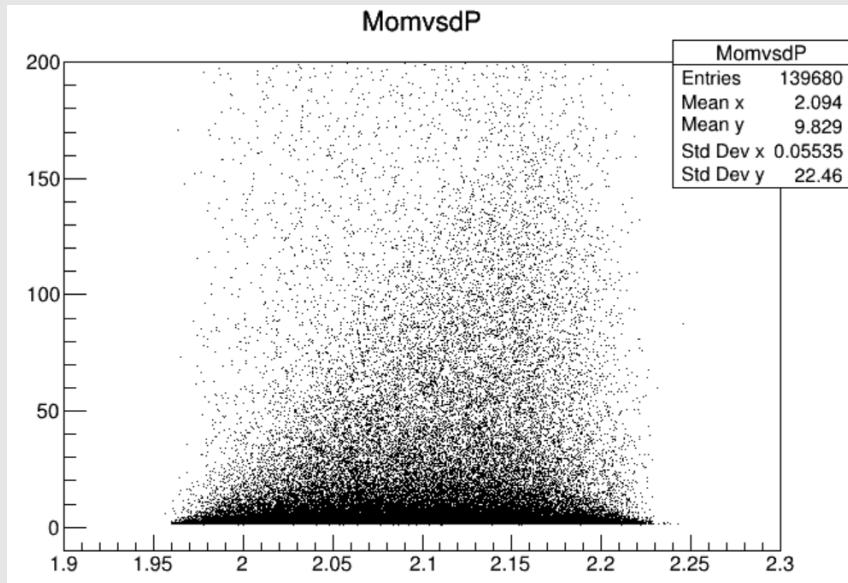
$$X_p = p_x/p_z$$

24 / 6

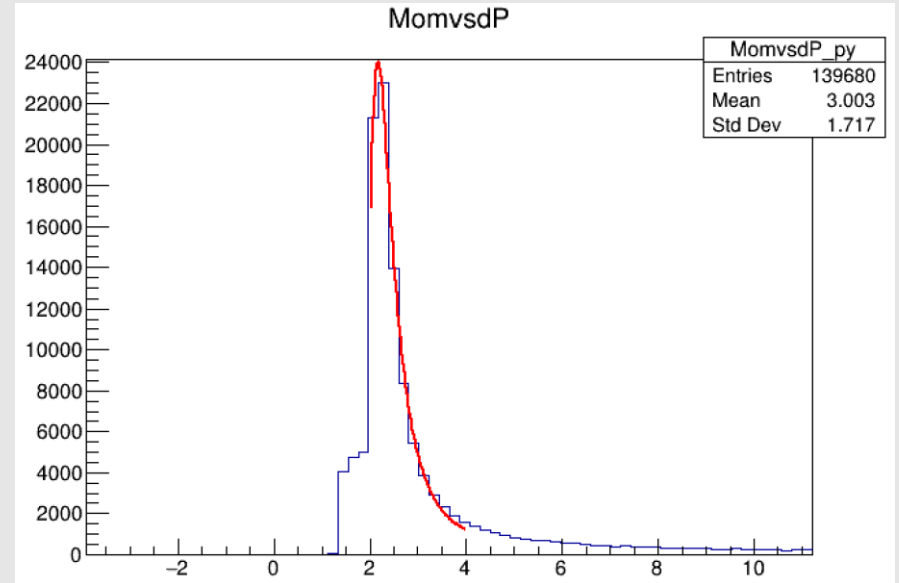


NoPhysics: h2kine_genfromfile_noAir_noPhysics_forMSE.root
Physics: h2kine_genfromfile_Physics_forMSE.root

Mom Loss (MeV)



e Mom (GeV)



Mom Loss (MeV)

MPV = 2.2 MeV

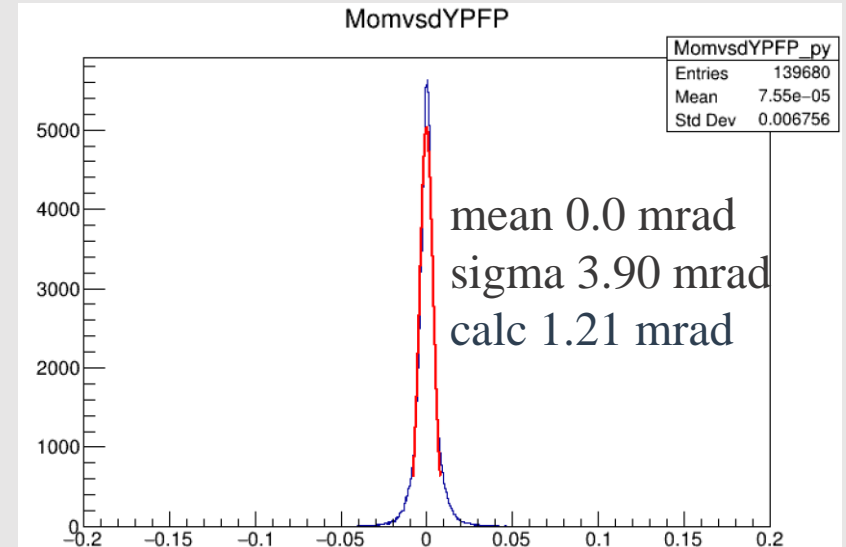
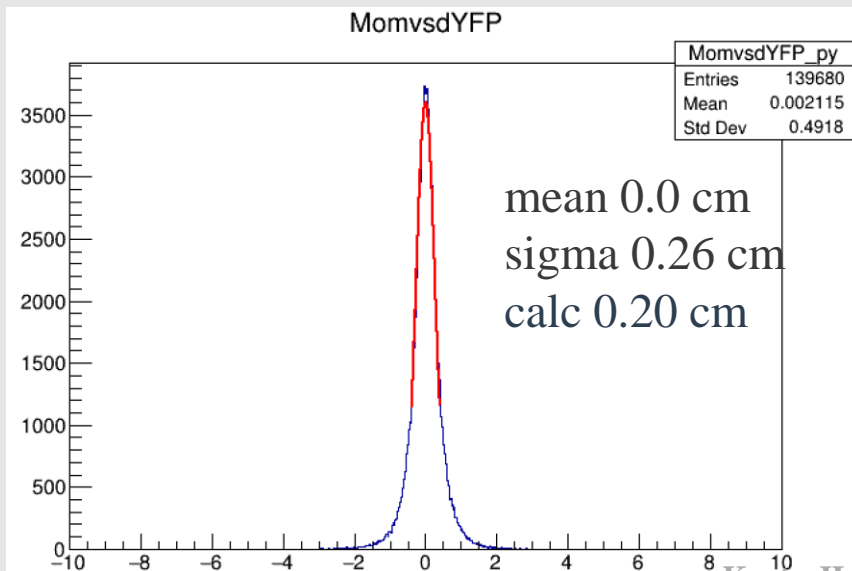
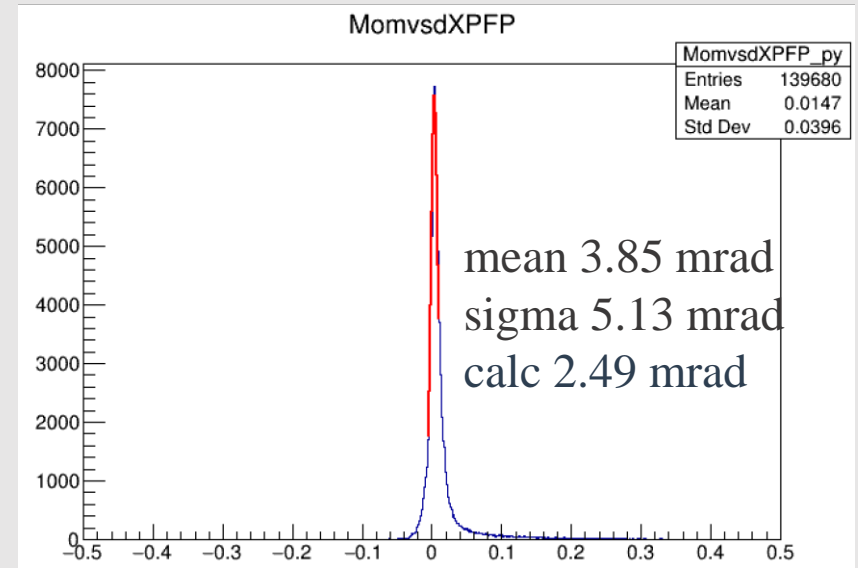
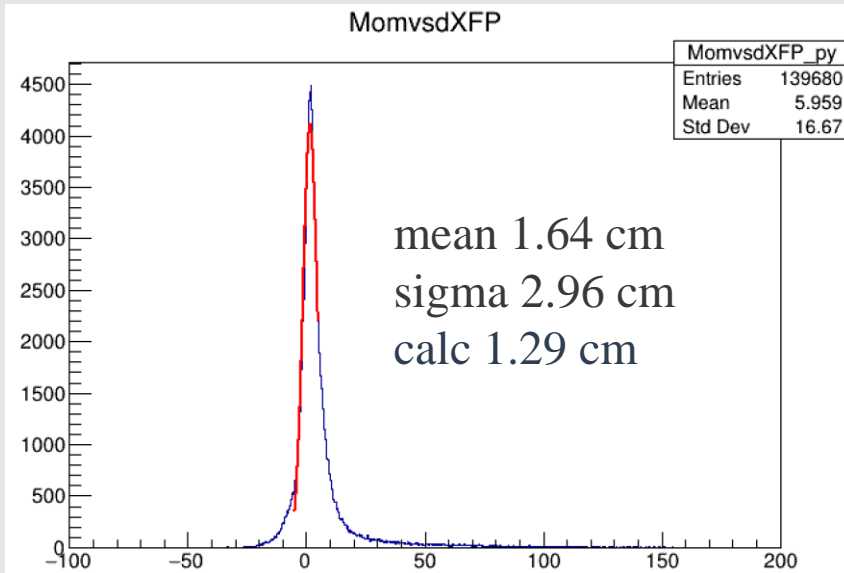
$\sigma = 0.15$ MeV

$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$

$$X_p = p_x/p_z$$

Geant4 (VDC1)

27 / 6

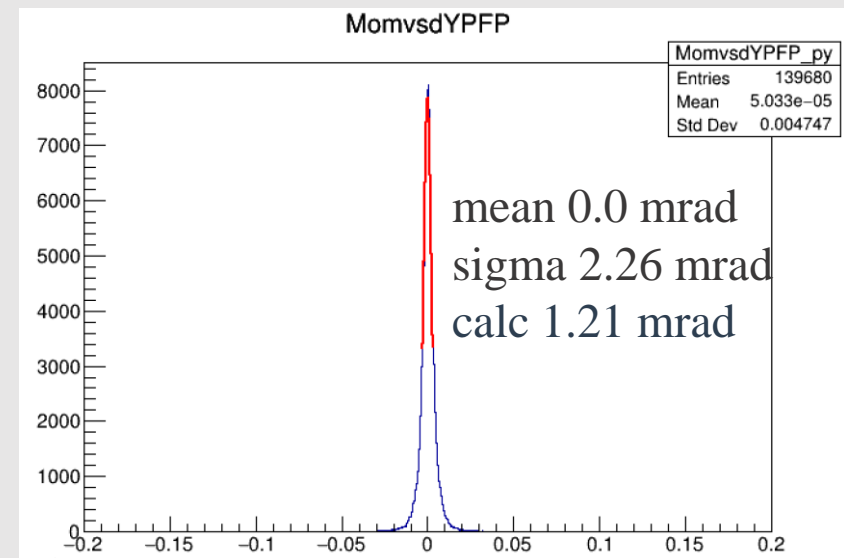
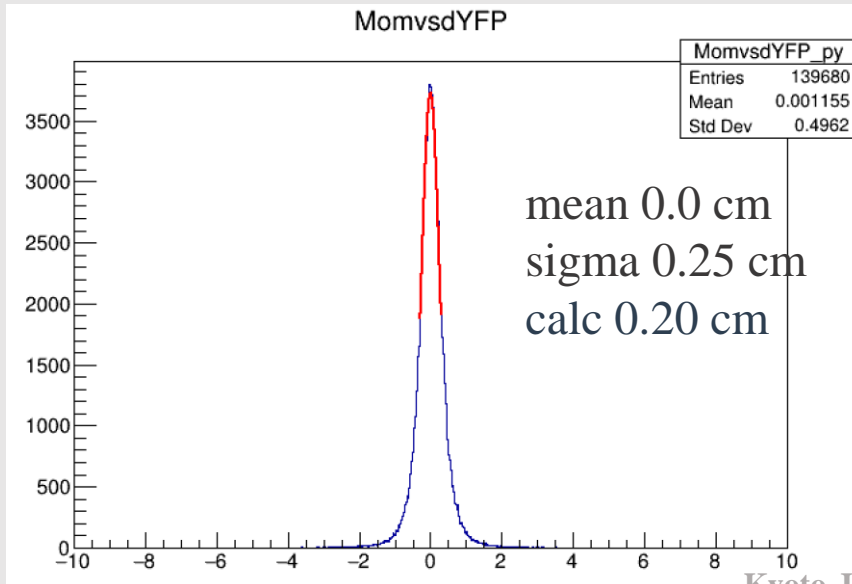
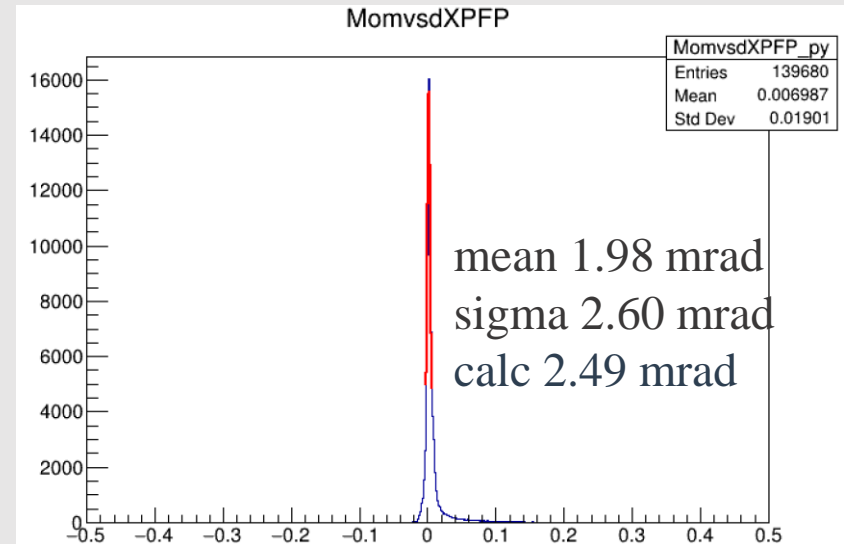
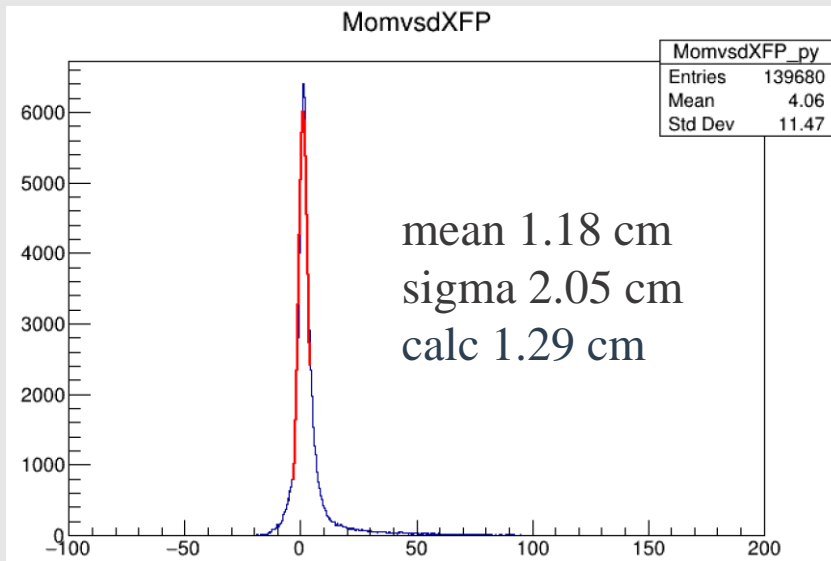


$$\theta = \arctan(X_p) \sim X_p \text{ rad}$$

Geant4 (FP)

$$X_p = p_x/p_z$$

28 / 6



CELL ONLY

	Mom loss	dX	dY	dXP	dYP
z θ Fixed	1.1 MeV	0.76	0.07	1.02	0.92
z θ Randam	1.1 MeV	1.91	0.23	2.4	2.2
Calc		0.64	0.15	1.38	0.87

CELL + AIR

	Mom loss	dX	dY	dXP	dYP
z θ Fixed	2.2 MeV	0.89	0.14	1.23	1.08
z θ Randam	2.2 MeV	2.05	0.20	2.60	2.26
Calc		1.29	0.16	2.37	0.97

Why dX is large when z and θ are random?



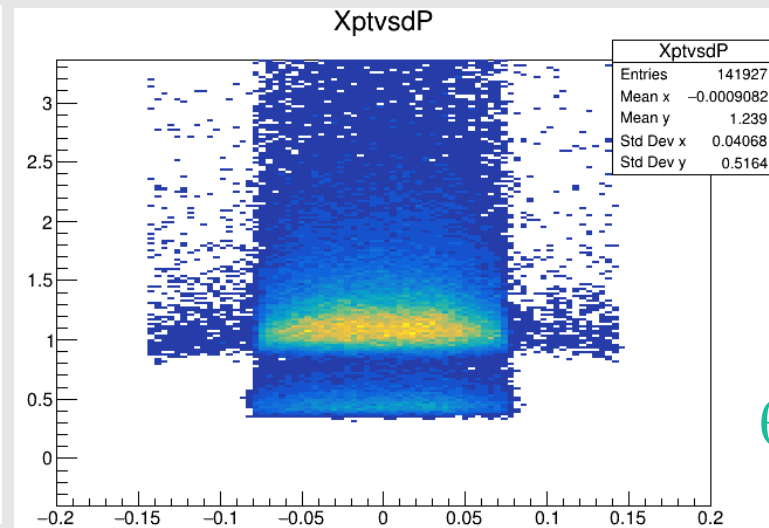
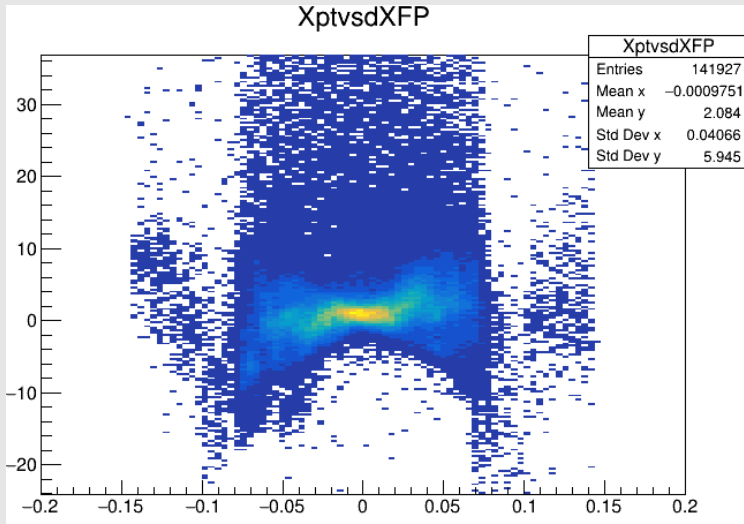
$dX = 12.4 \delta \rightarrow$ only δ is important

two possibilities

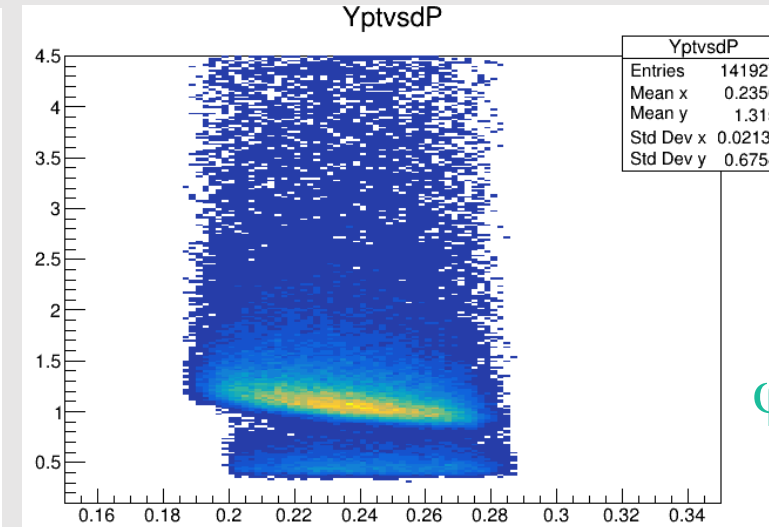
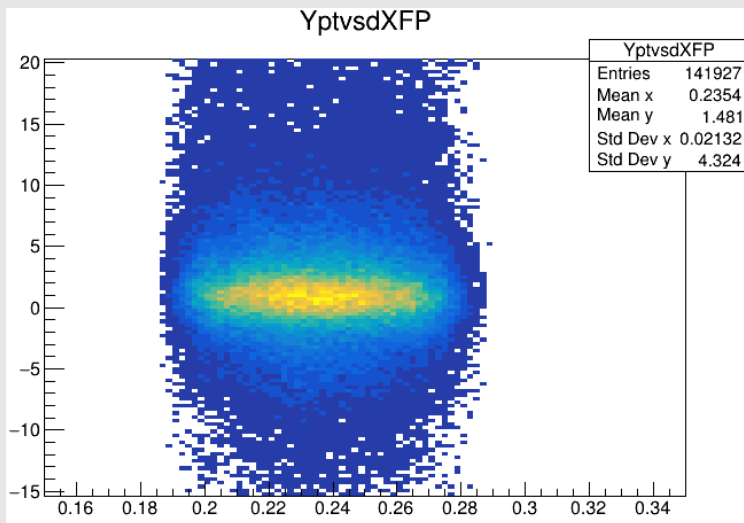


1. δ itself is depend on z or θ
2. Optics about δ is z or θ dependent
(2nd order matrix $z\delta$ or $\theta\delta$ is large)

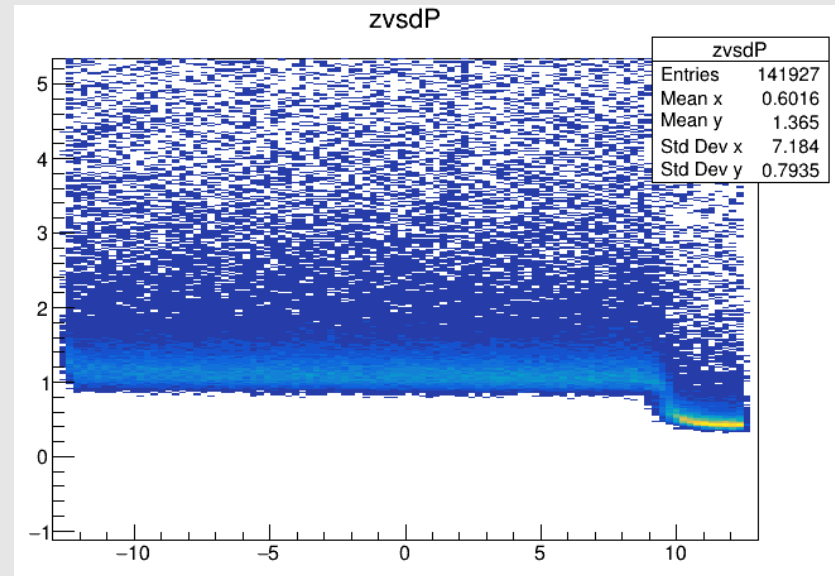
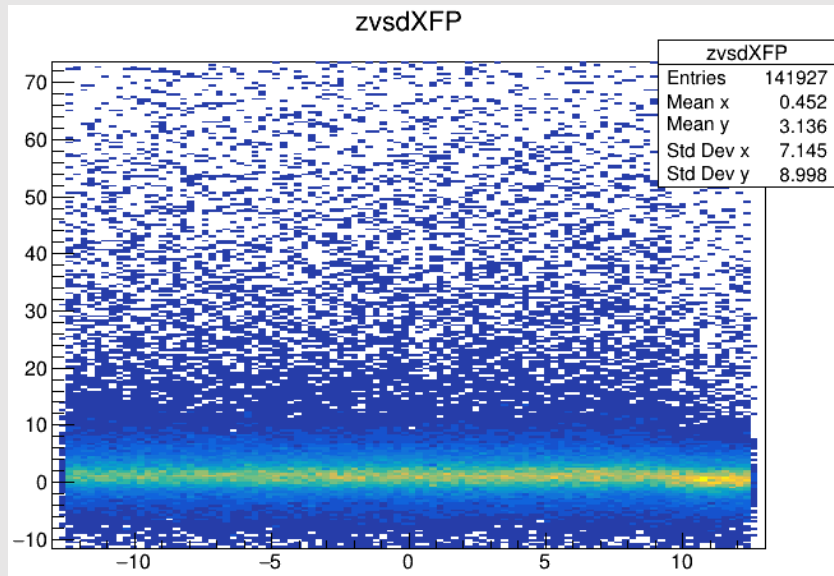
Answer is 2 \rightarrow See the next page.



$\theta\delta$ is large



$\phi\delta$ is small



$z\delta$ is small