d_2^n Simulation Update

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Outline

- Introduction
- Analysis and Simulation Goals
- Simulation Progress
- Summary and Future Work

Introduction

- Single arm Monte Carlo simulation is used to determine the spectrometer acceptance and resolution.

- MC event generation is based on spectrometer phase space (ztarget, x′, y′, delta), includes multiple scattering at target and in the spectrometer.

- To get realistic yields, MC simulation output is weighted with cross-section model.

- Simulation with physics weighting is compared with charge normalized yield from the data.

$$\text{yield} = \frac{\text{no of events}}{\text{charge (coulomb)}} \quad \Rightarrow \quad \text{yield} = \frac{\text{rate}}{\text{current (Amp)}}$$

$$\text{where,} \quad \text{rate} = \frac{d^2\sigma}{dE'\,d\Omega} * \Delta E' * \Delta\Omega * \rho_{He3} * \left(\frac{I_{beam}}{e}\right) * \left(\frac{\text{length}_{target}}{n_{trials}}\right)$$

Analysis Goal

- Extract unpolarized cross section (σ_0) and electron asymmetries ($A_\parallel$, $A_\perp$) to determine spin structure functions g_1 and g_2.

$$g_1 = \frac{MQ^2}{4\alpha^2}\frac{2y}{(1-y)(2-y)}\sigma_0\left[A_\parallel + \tan\left(\frac{\theta}{2}\right)A_\perp\right]$$

$$g_2 = \frac{MQ^2}{4\alpha^2}\frac{2y}{(1-y)(2-y)}\sigma_0\left[-A_\parallel + \frac{1+(1-y)\cos(\theta)}{(1-y)\sin(\theta)}A_\perp\right]$$

- Access g_1 and g_2 from the polarized cross section difference.

$$\frac{d^2\sigma}{dE'\,d\Omega}(\downarrow\Uparrow - \uparrow\Uparrow) = \frac{4\alpha^2 E'}{MQ^2\nu E}\left[(E+E'\cos\theta)g_1(x,Q^2) - \frac{Q^2}{\nu}g_2(x,Q^2)\right] = \Delta\sigma_\parallel$$

$$\frac{d^2\sigma}{dE'\,d\Omega}(\downarrow\Rightarrow - \uparrow\Rightarrow) = \frac{4\alpha^2\sin\theta\,E'^2}{MQ^2\nu^2 E}\left[\nu g_1(x,Q^2) + 2E g_2(x,Q^2)\right] = \Delta\sigma_\perp$$

Simulation Goal

- Extract cross section by the following methods:

1. Acceptance correction method

$$\frac{d\sigma}{d\Omega dE'} = \frac{Y(E',\theta)}{\left[(\Delta E\,\Delta\Omega).A(E',\theta).L\right]}$$

Where,

$Y(E',\theta)$: efficiency corrected electron yield

L : Integrated Luminosity

$A(E',\theta)$: Acceptance for bin ← Determined from simulation!

$A(E',\theta)$ is the probability that a particle will make it through the spectrometer.

2. Monte Carlo ratio method

$$\frac{d\sigma}{d\Omega dE'} = \sigma^{mod} \cdot \frac{Y(E',\theta)}{Y_{MC}(E',\theta)}$$

- Use cross section model (σ^{mod})
- Assume, $A_{MC} = A$

Simulation Progress

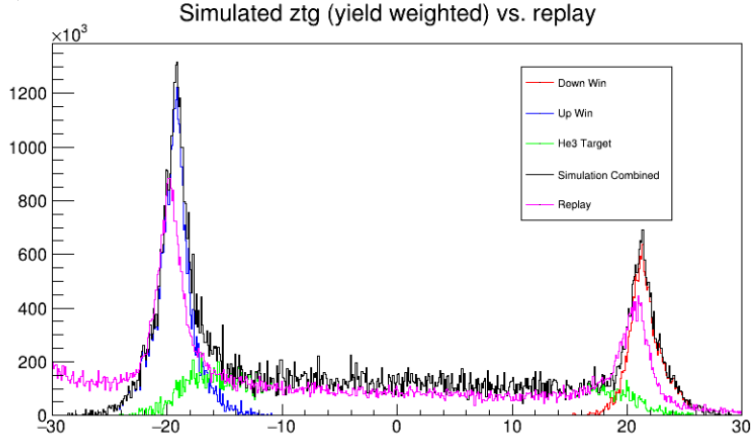
Cuts applied:

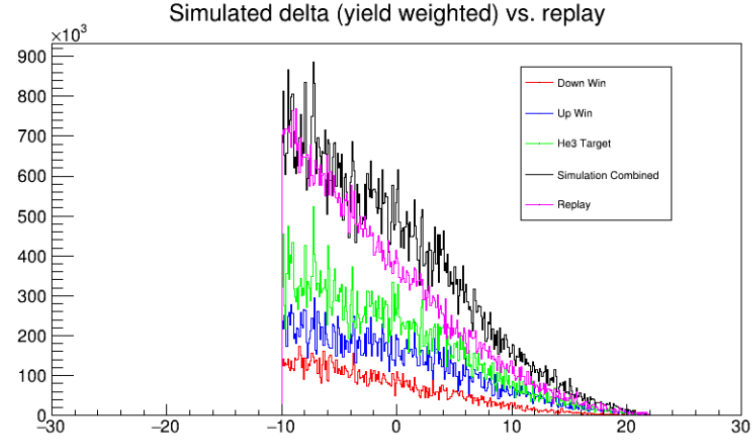
1. -10 < P.gtr.dp && P.gtr.dp < 22
2. fabs(P.gtr.ph) < 0.05
3. fabs(P.gtr.th) < 0.06
4. fabs(P.react.z) < 30
5. 0.8 < P.cal.etottracknorm < 2
6. P.ngcer.npeSum > 1
7. ibcm1 > 1

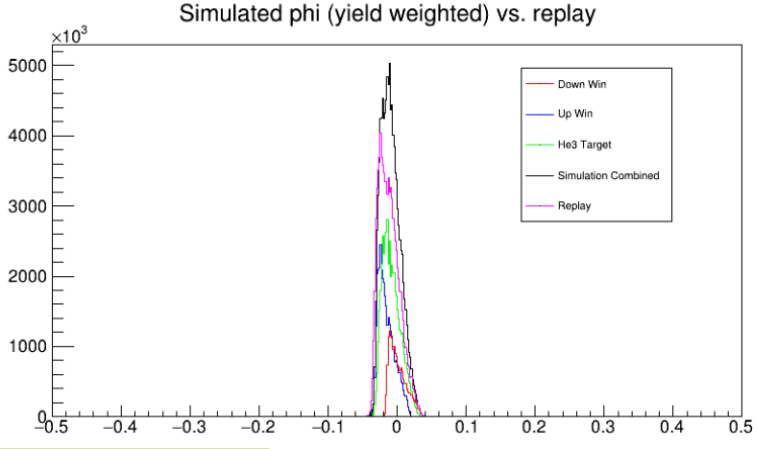
Comparison of ^{3}He Target Simulation and Data

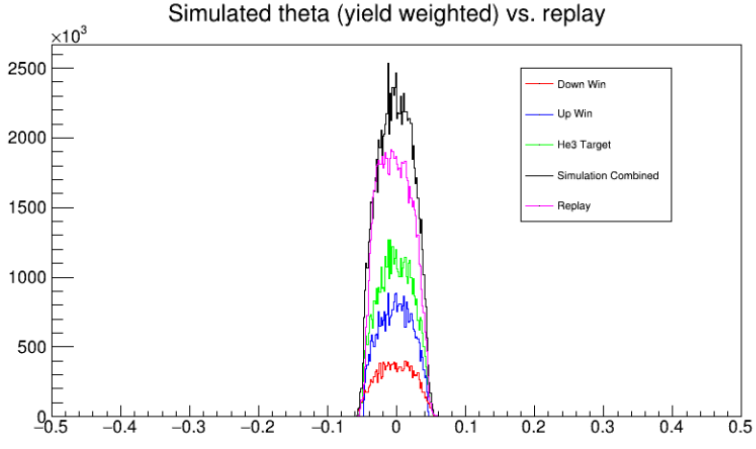
SHMS-X : 11 deg, -7.5 GeV/c

- SHMS Run 11395
- Transverse 90 deg
- Trig 1 (¾), ps_factor=5
- Target cell : Tommy
- BCM1: 2839.5 mC









Simulation Progress

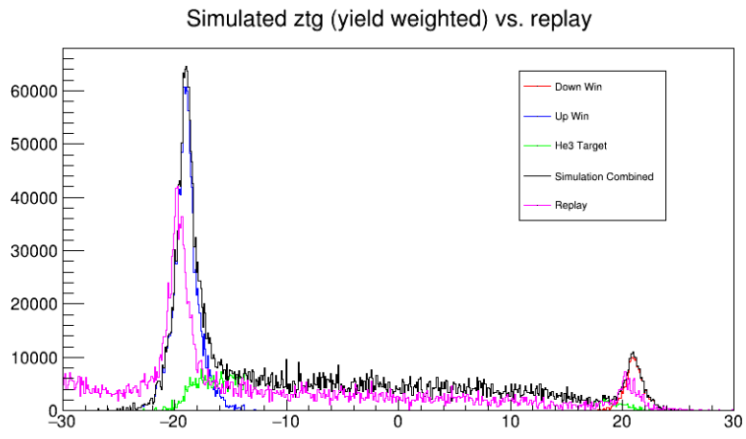
Cuts applied:

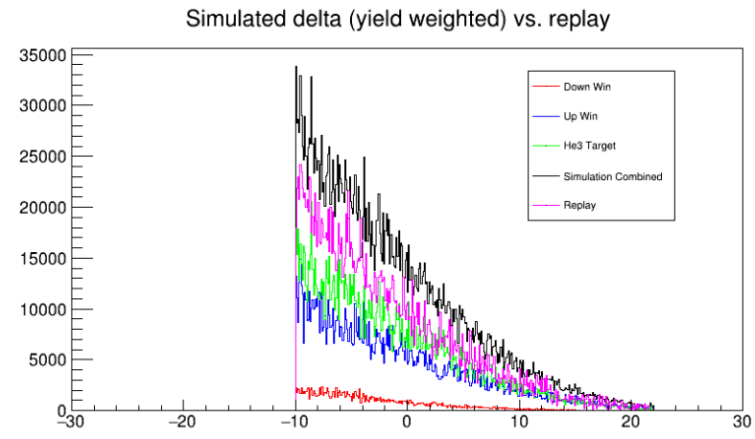
1. -10 < P.gtr.dp && P.gtr.dp < 22
2. fabs(P.gtr.ph) < 0.05
3. fabs(P.gtr.th) < 0.06
4. fabs(P.react.z) < 30
5. 0.8 < P.cal.etottracknorm < 2
6. P.ngcer.npeSum > 1
7. ibcm1 > 1

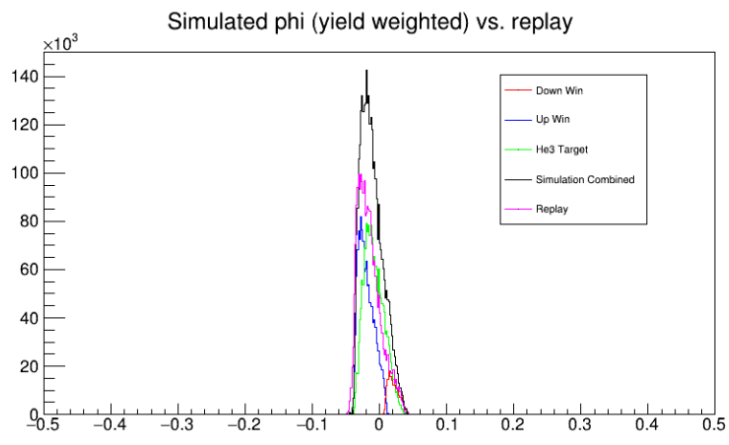
Comparison of ^{3}He Target Simulation and Data

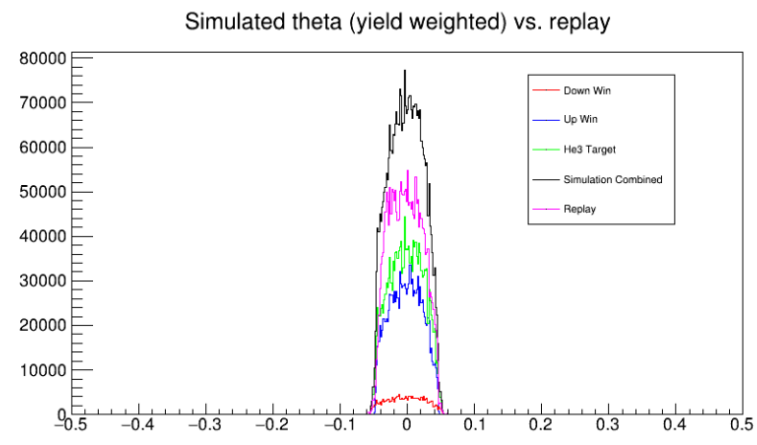
SHMS-Z : 18 deg, -5.6 GeV/c

- SHMS Run 11369
- Transverse 90 deg
- Trig 1 (¾), ps_factor=1
- Target cell : Tommy
- BCM1 charge: 4345.946 uC









Simulation Progress

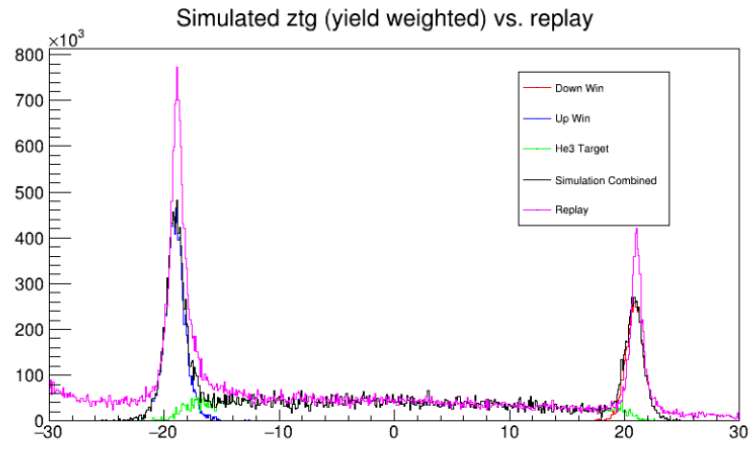
Cuts applied:

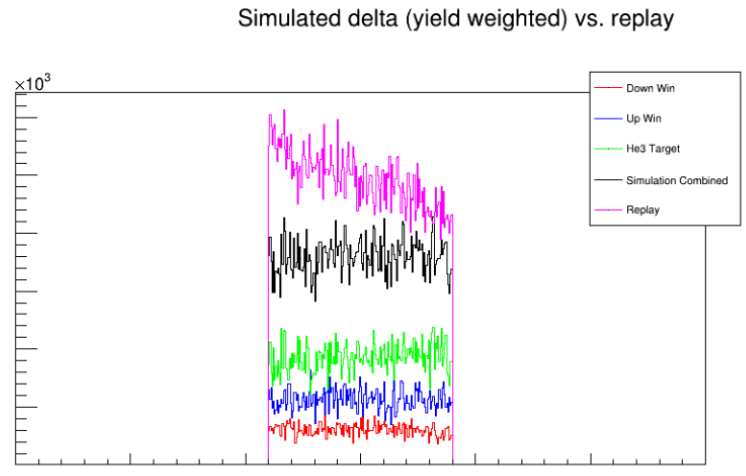
1. -8< H.gtr.dp && H.gtr.dp < 8
2. fabs(H.gtr.ph) < 0.05
3. fabs(H.gtr.th) < .06
4. fabs(H.react.z) < 30
5. 0.8 < H.cal.etottracknorm < 2
6. H.cer.npeSum > 1
7. ibcm1 > 1

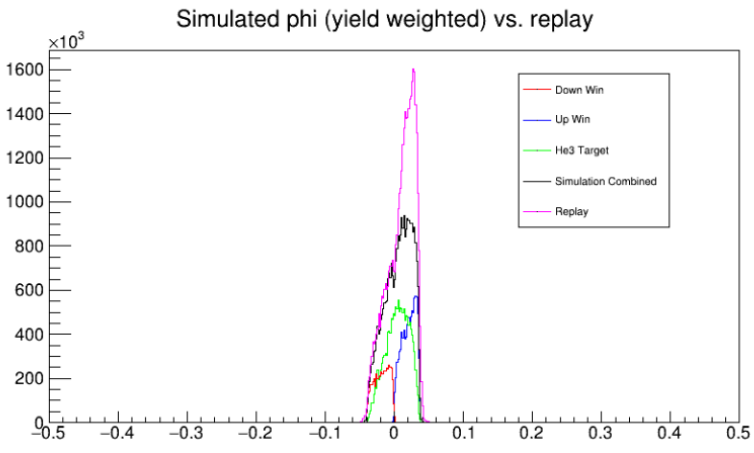
Comparison of ^{3}He Target Simulation and Data

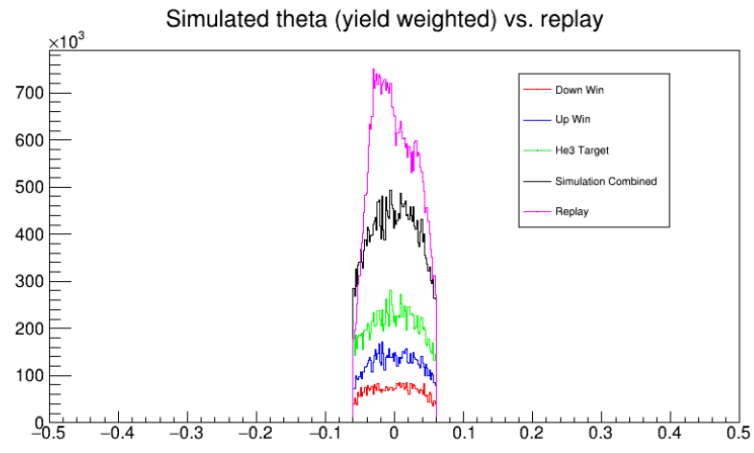
HMS-A : 13.5 deg, -4.2 GeV/c

- HMS Run 4195
- Transverse 90 deg
- Trig 1 (¾) , ps_factor=3
- Target cell : Tommy
- BCM1 charge: 3155.704 uC









Simulation Progress

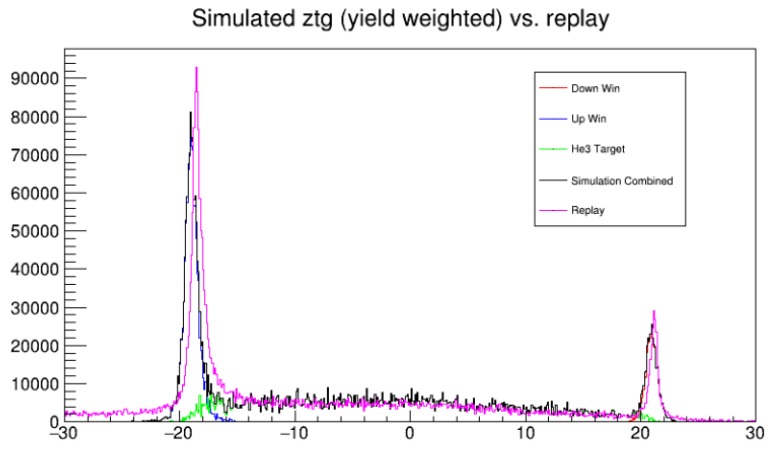
Cuts applied:

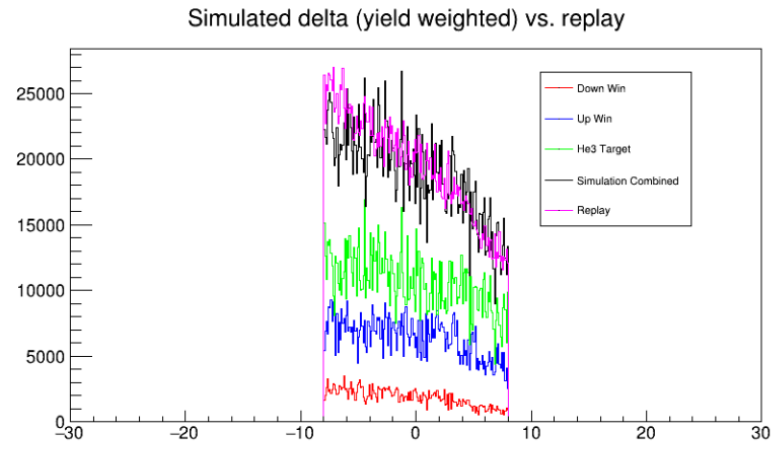
1. -8< H.gtr.dp && H.gtr.dp < 8
2. fabs(H.gtr.ph) < 0.05
3. fabs(H.gtr.th) < .06
4. fabs(H.react.z) < 30
5. 0.8 < H.cal.etottracknorm < 2
6. H.cer.npeSum > 1
7. ibcm1 > 1

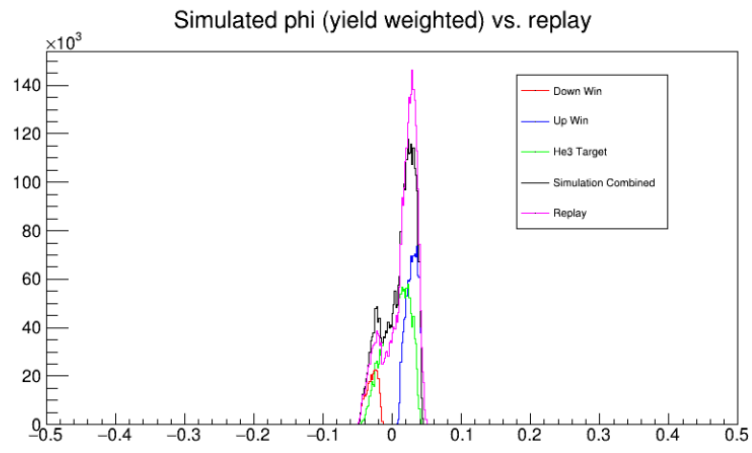
Comparison of ^{3}He Target Simulation and Data

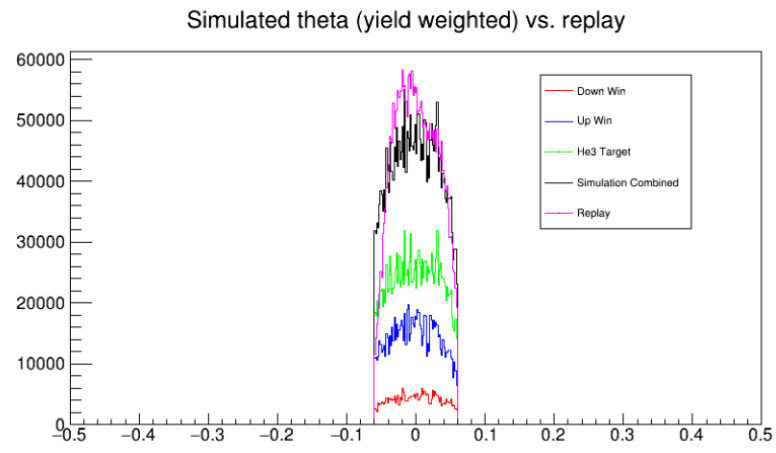
HMS-C : 20 deg, -4.0 GeV/c

- HMS Run 4233
- Transverse 270 deg
- Trig 1 (¾), ps_factor=1
- Target cell : Tommy
- BCM1 charge: 13094.074 uC









Summary and Future Work

- For SHMS, the window simulation is higher than the yield from replay and for HMS, the replay is higher than the simulation.
- To better understand the difference in MC simulation and data yield, currently looking at the focal plane distribution.
- Next step is to determine the acceptance cuts.
- Proceed with cross section extraction.

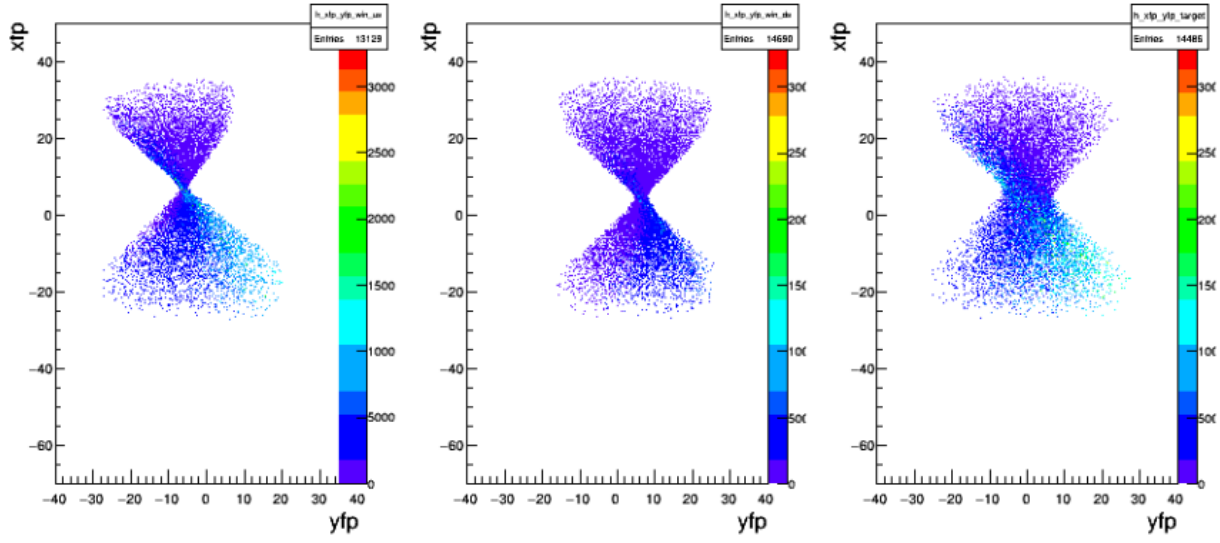
Backup Slides

Comparison of MC Simulation and Data in Focal Plane

xfp vs yfp

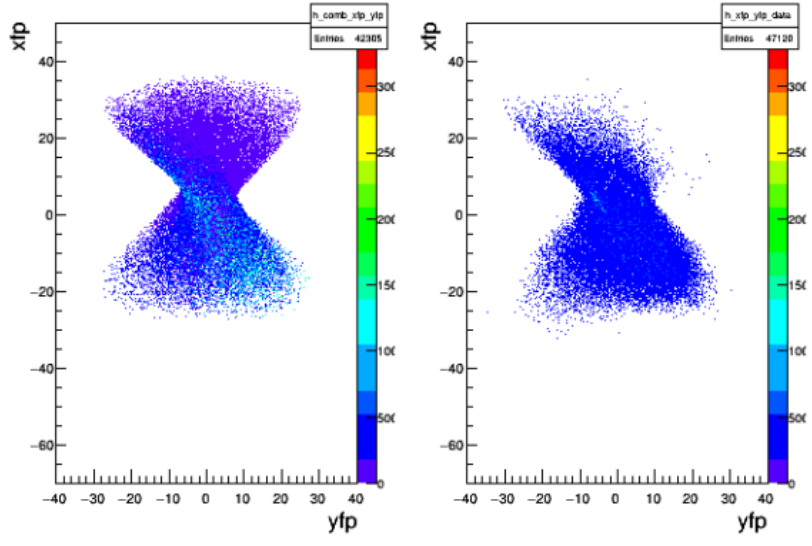
SHMS run 11395

- SHMS-X : 11 deg, -7.5 GeV/c
- Transverse 90 deg
- Trig 1 (¾), ps_factor=5
- Target cell : Tommy
- BCM1: 1907.165 mC



Cuts applied:

1. -10 < P.gtr.dp && P.gtr.dp < 22
2. fabs(P.gtr.ph) < 0.05
3. fabs(P.gtr.th) < 0.06
4. fabs(P.react.z) < 30
5. 0.8 < P.cal.etottracknorm < 2
6. P.ngcer.npeSum > 1
7. Ibcm1 > 1

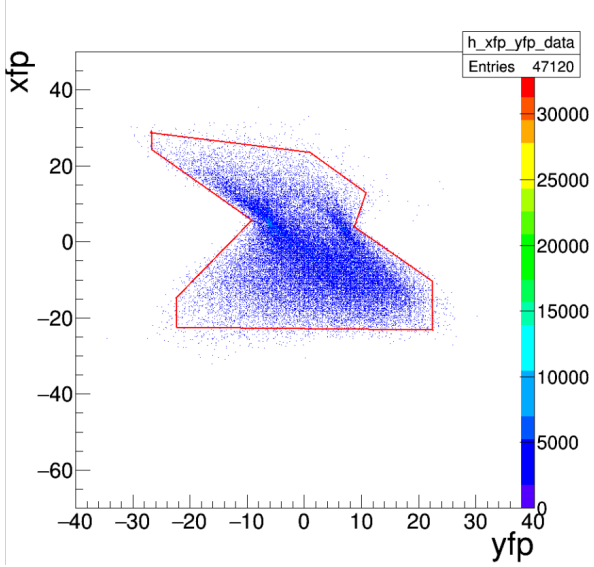


Comparison of MC Simulation and Data in Focal Plane

xfp vs yfp

SHMS run 11395

- SHMS-X : 11 deg, -7.5 GeV/c
- Transverse 90 deg
- Trig 1 (¾), ps_factor=5
- Target cell : Tommy
- BCM1: 1907.165 mC



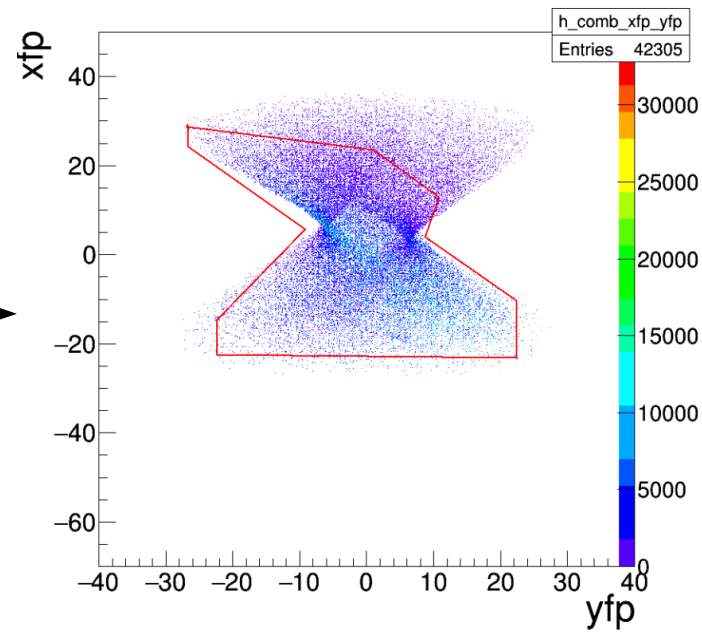
Data (300,000 replay)

Cuts applied:

1. -10 < P.gtr.dp && P.gtr.dp < 22
2. fabs(P.gtr.ph) < 0.05
3. fabs(P.gtr.th) < 0.06
4. fabs(P.react.z) < 30
5. 0.8 < P.cal.etottracknorm < 2
6. P.ngcer.npeSum > 1
7. Ibcm1 > 1

MC simulation (100,000 events)

Superimposed the cut from the data.



Comparison of MC Simulation and Data in Focal Plane

Ratio of MC and data in focal plane

xfp vs yfp

SHMS run 11395

- SHMS-X : 11 deg, -7.5 GeV/c
- Transverse 90 deg
- Trig 1 (¾), ps_factor=5
- Target cell : Tommy
- BCM1: 1907.165 mC

Cuts applied:

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6. P.ngcer.npeSum > 1
7. Ibcm1 > 1