MC with Updated Beamspot/Tilt

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Discovered Beam Tilt (Norman)



15 degree rotation about beamline for MC

Based on 2016 harp scans



Beam rotation (alpha)

New Nominal + Tilted MC Events



- nominal_withoutZTilt/
 - Theta_x = 30.5 mrad,
 - Theta_y = 0.0 mrad

Everything is also generated with a beamspot width to match reconstruction

• [x130um, y50um] new vs. [x300um, y30um] old

- x31_yneg0pt5_withZTilt/
 - Theta_x = 30.99 mrad,
 - Theta_y = -0.49 mrad
 - z rotation = 261.8 mrad (15 deg.)

File locations:

Replaces 'MG_alphaFix'

/mss/hallb/hps/production/BeamTilt/ /work/hallb/hps/mc_production/BeamTilt/tuple/

Procedure (pre-SLIC)

y x z (beam)

1) Passively rotate the event momenta in x-y (normal to beamline)

- // rotate about x-axis (rotation in y-z) py' = py*cos(theta_y) - pz*sin(theta_y); pz' = py*sin(theta_y) + pz*cos(theta_y);
- // rotate about y-axis (rotation in x-z) px' = px*cos(theta_x) + pz*sin(theta_x); pz' = pz*cos(theta_x) - px*sin(theta_x);

- // rotate beamspot
 vy' = vy*cos(theta_y) + vz*sin(theta_y);
 vz' = vy*sin(theta_y) vz*cos(theta_y);
- vx' = vx*cos(theta_x) + vz*sin(theta_x); vz' = vz*cos(theta_x) - vx*sin(theta_x);

2) Sample from a Gaussian and rotate about beamline (z-axis)

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x = sigma_x * gsl_ran_gaussian(r,sigma_x);
y = sigma_y * gsl_ran_gaussian(r,sigma_y);
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x' = x * cos(theta_z) - shift_y * sin(theta_z); y' = y * cos(theta_z) + shift_x * sin(theta_z);

sigma_x,y = (130,50) microns

Tilted MC Events

- Using the Nominal and Tilted events, the following quantities were compared:
 - Truth/recon beam profiles
 - Top/bottom asymmetry
 - Mass resolutions
 - singles0 Mollers
 - 50 MeV prompt A' (near Moller mass)
 - 2016 Radiative fraction

Nominal vs. Tilted Truth Beamspot



Reconstructed Beamspot(?)

uncVY:uncVX

uncVY:uncVX



Reconstructed Beamspot(?)



Nominal vs. Tilted Vertex (unconstrained)



Nominal vs. Tilted Vertex (beamspot constrained)



bscVY



Pairs1 Momentum Asymmetry

Electron Momentum Asymmetry



Positron Momentum Asymmetry



How the beam skew may affect resolutions



MC vs. Data Moller mass discrepancy (old recon)



New Nominal (incl. beam rotation) vs. y-Tilt, uncut

Mollers Nominal (x30.5mr, y0.0mr)

Mollers Tilted (x=30.99mr, y=-0.49mr)



New Nominal vs. y-Tilt, uncut before vs. after beam rotation



50 MeV prompt A' mass resolution

Nominal Mass Tilted Mass 7000 7000 NAME VALUE ERROR NAME VALUE ERROR 6000 6.21286e+03 3.06531e+01 Constant 6.13976e+03 3.03737e+01 Constant 6000 Mean 4.99311e-02 1.30147e-05 Mean 4.99833e-02 1.31345e-05 5000 2.63786e-03 9.92948e-06 2.65502e-03 1.00228e-05 5000 Sigma Sigma Alpha -7.69891e+06 1.60000e+01 Alpha -1.02645e+07 2.26274e+01 4000 4000 9.79852e+03 1.41421e+00 9.79852e+03 1.41421e+00 Ν Ν 3000 3000 0.65% higher (relatively unchanged) 2000 2000 1000 1000 0.04 0.06 0.08 0.18 0.04 0.06 0.02 0.1 0.12 0.14 0.16 0.2 0.08 0.12 0.16 0.18 0.02 0.1 0.14 0.2 mass[GeV] mass[GeV]

2016 Radiative Fraction



Radiative fraction ratio

Radiative fraction tilt/nominal



1.5x higher radiative fraction

Need to check with corrected z-tilt using RAD with BH background included

14 Individual Ratios 12 10 Radiatives tilt/nominal 8 Only affects the radiatives(?) 7<u></u> The same background was used for this ratio 6 0.02 0.08 0.04 0.06 0.1 0.12 Ω tritrig tilt/nominal 8 7 6 5 4 3 2 1 3 2 0 0.18 0.2 0 0.02 0.06 0.08 0.1 0.12 0.14 0.16 0.04

0

0.02

0.08

0.1

0.12

0.14

wab tilt/nominal

0.16

0.14

0.18

02

0.2

0.18

0.16

Summary

- Applying a tilt + beamspot rotation appears to
 - Affect top/bottom momentum asymmetry (need corrected MC to quantify)
 - Increase mass resolution for Mollers, but leaves A' unchanged(?)
- There are still some corrections to be made, and tests are being re-generated
 - Radiative fraction is inconclusive at this point, without the same background in numerator
- It may not affect much, but this should still be the right thing to do for pass2 and beyond
 - The beam angle per run should also be added to the database for data recon
- The recon beamspot needs to be rotated as well

Extra

Rotations before SLIC

These are wrong.

- // rotate momentum about z-axis (rotation in x-y) px' = px*cos(theta_z) - py*sin(theta_z); py' = px*sin(theta_z) + py*cos(theta_z);
- // rotate about x-axis (rotation in y-z) py' = py*cos(theta_y) - pz*sin(theta_y); pz' = py*sin(theta_y) + pz*cos(theta_y);
- // rotate about y-axis (rotation in x-z) px' = px*cos(theta_x) + pz*sin(theta_x); pz' = pz*cos(theta_x) - px*sin(theta_x);

// rotate vertex
 vx' = vx*cos(theta_z) - vy*sin(theta_z);
 vy' = vx*sin(theta_z) + vy*cos(theta_z);

vy' = vy*cos(theta_y) + vz*sin(theta_y); vz' = vy*sin(theta_y) - vz*cos(theta_y);

vx' = vx*cos(theta_x) + vz*sin(theta_x); vz' = vz*cos(theta_x) - vx*sin(theta_x);

Top and Bottom Momentum (Single0 Mollers, y-tilt)



Background XS Nominal vs. y-Tilt

Pair cross-sections (old)



Pair cross-sections

