# MC with Updated Beamspot/Tilt

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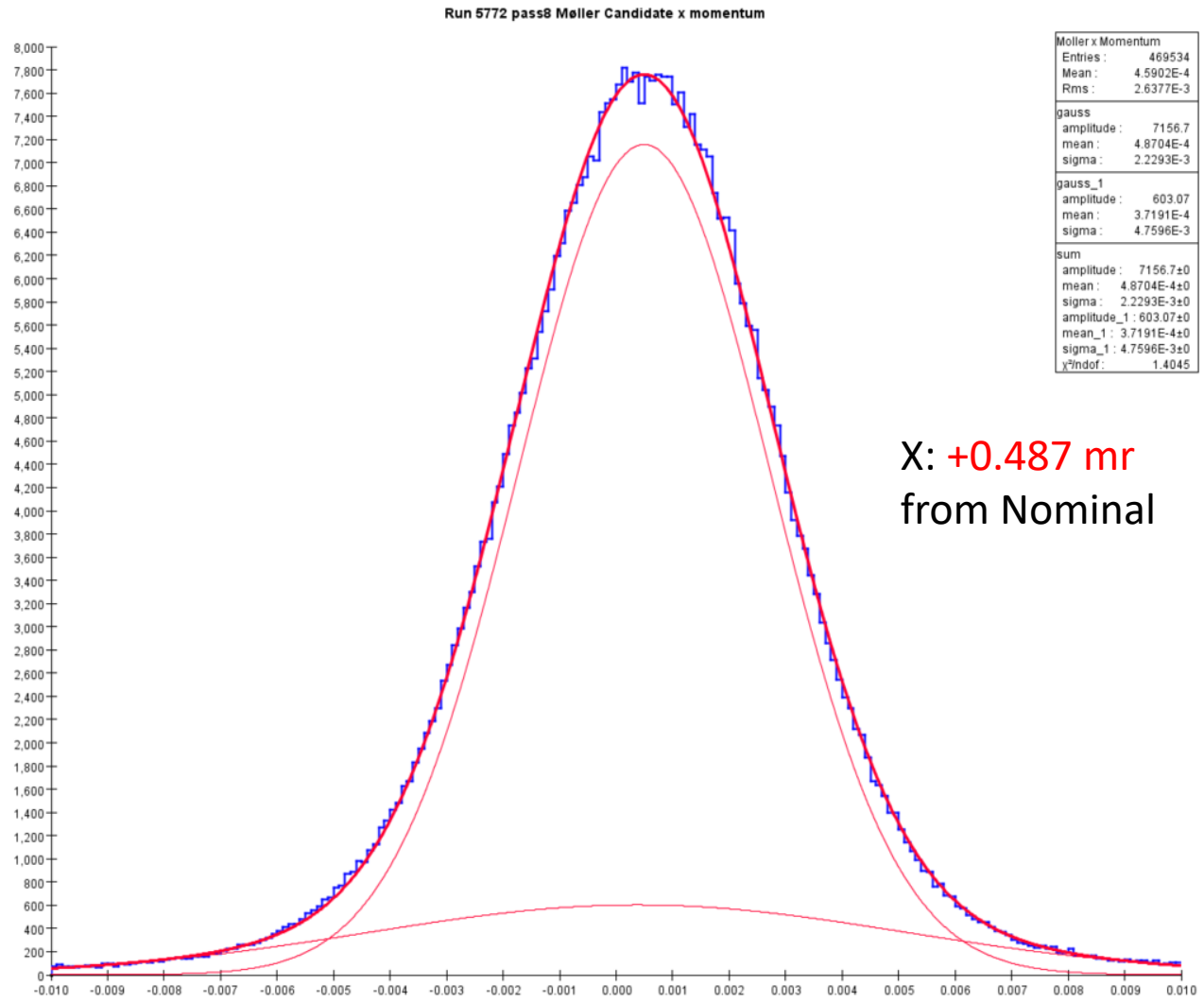
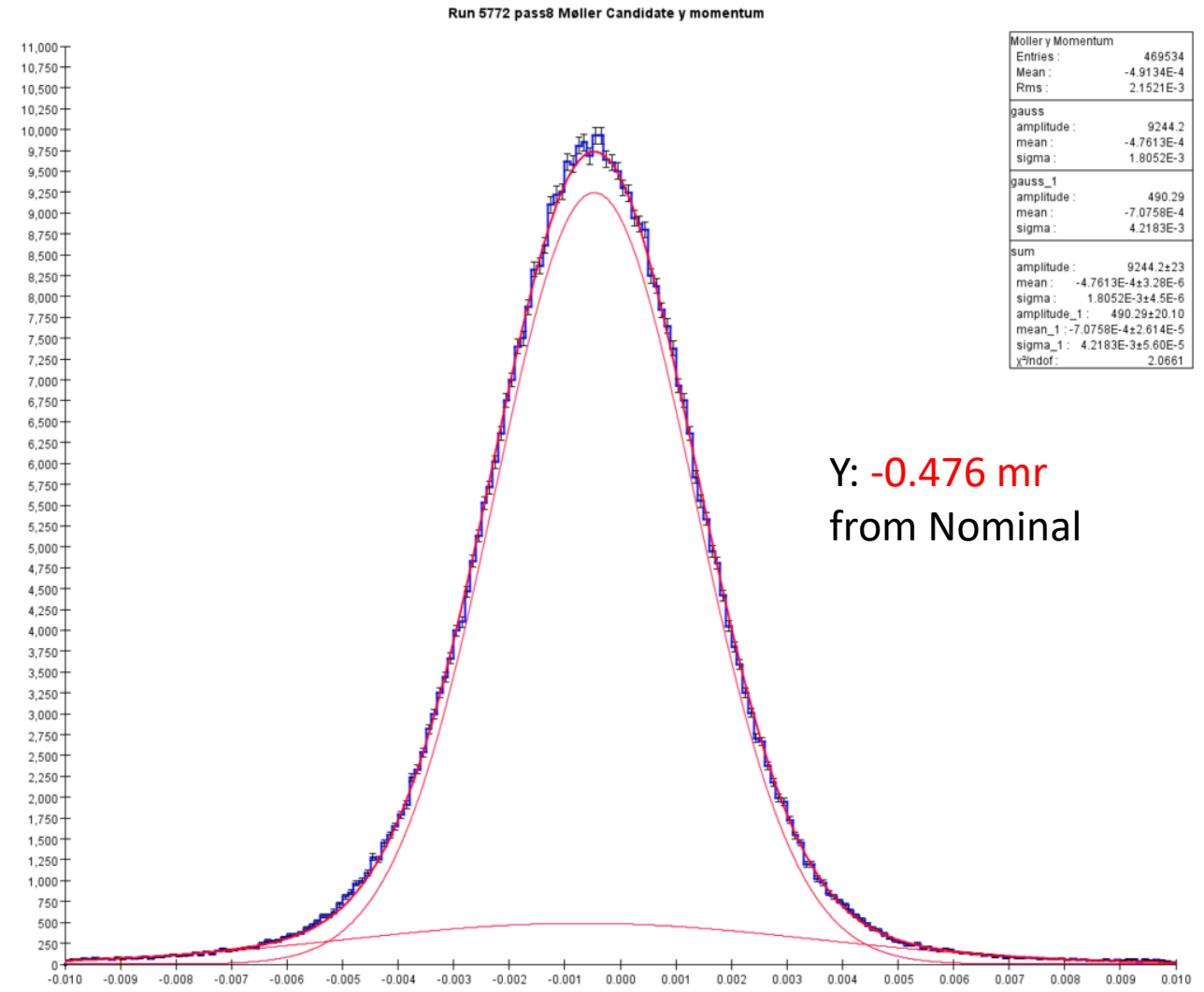
# Discovered Beam Tilt (Norman)



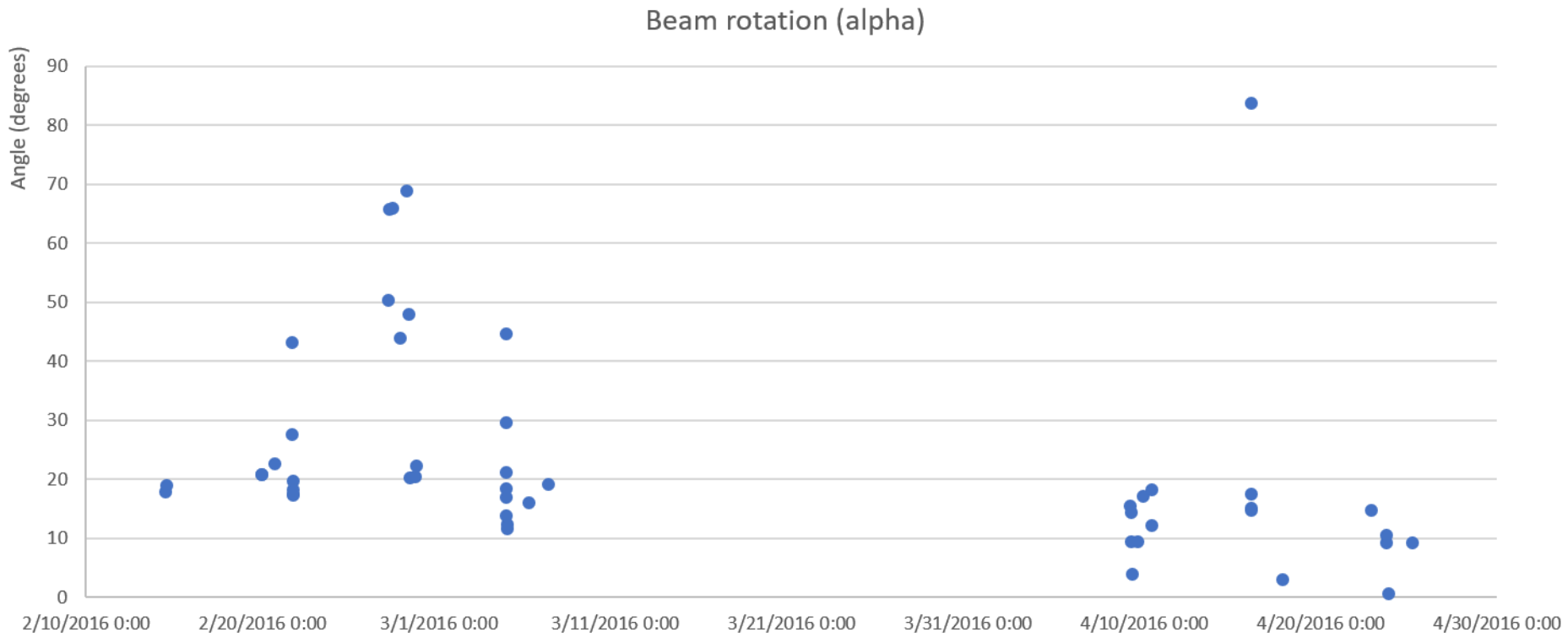

X: +0.487 mr
from Nominal



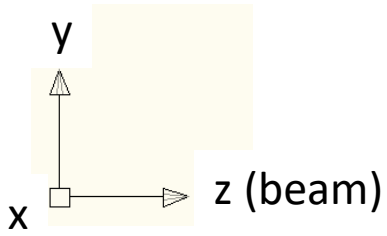

Y: -0.476 mr
from Nominal

# 15 degree rotation about beamline for MC

Based on 2016 harp scans



# New Nominal + Tilted MC Events




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

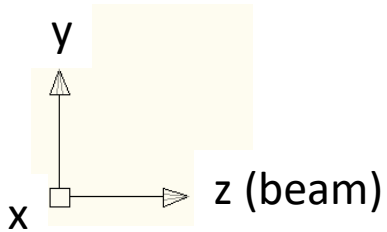
- x31_yneg0pt5_withZTilt/
  - Theta_x = 30.99 mrad,
  - Theta_y = -0.49 mrad
  - z rotation = 261.8 mrad (15 deg.)

Everything is also generated with a beamspot width to match reconstruction
- [x130um, y50um] new vs. [x300um, y30um] old

File locations:
/mss/hallb/hps/production/BeamTilt/
/work/hallb/hps/mc_production/BeamTilt/tuple/

Replaces ‘MG_alphaFix’

# Procedure (pre-SLIC)




## 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)

x = sigma_x * gsl_ran_gaussian(r,sigma_x);
y = sigma_y * gsl_ran_gaussian(r,sigma_y);

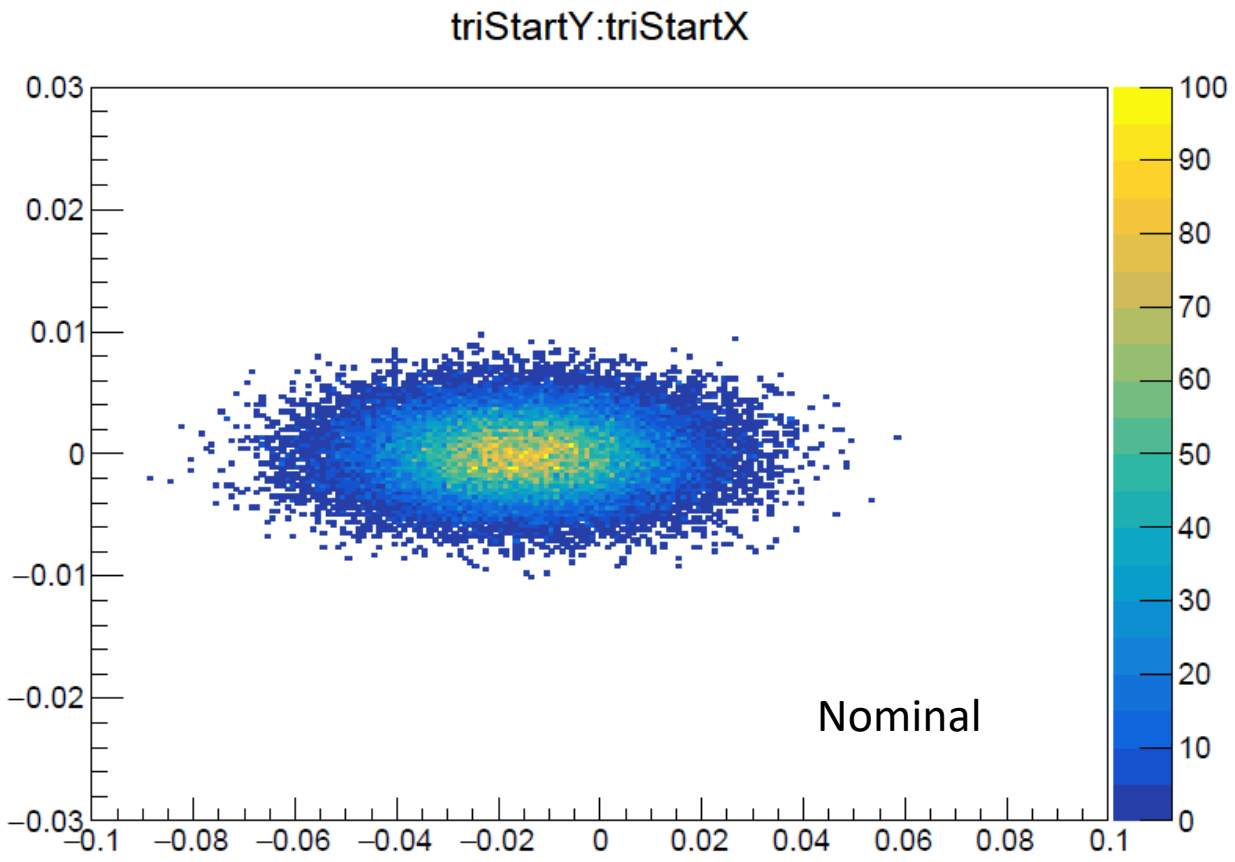
x' = x * cos(theta_z) - shift_y * sin(theta_z);
y' = y * cos(theta_z) + shift_x * sin(theta_z);

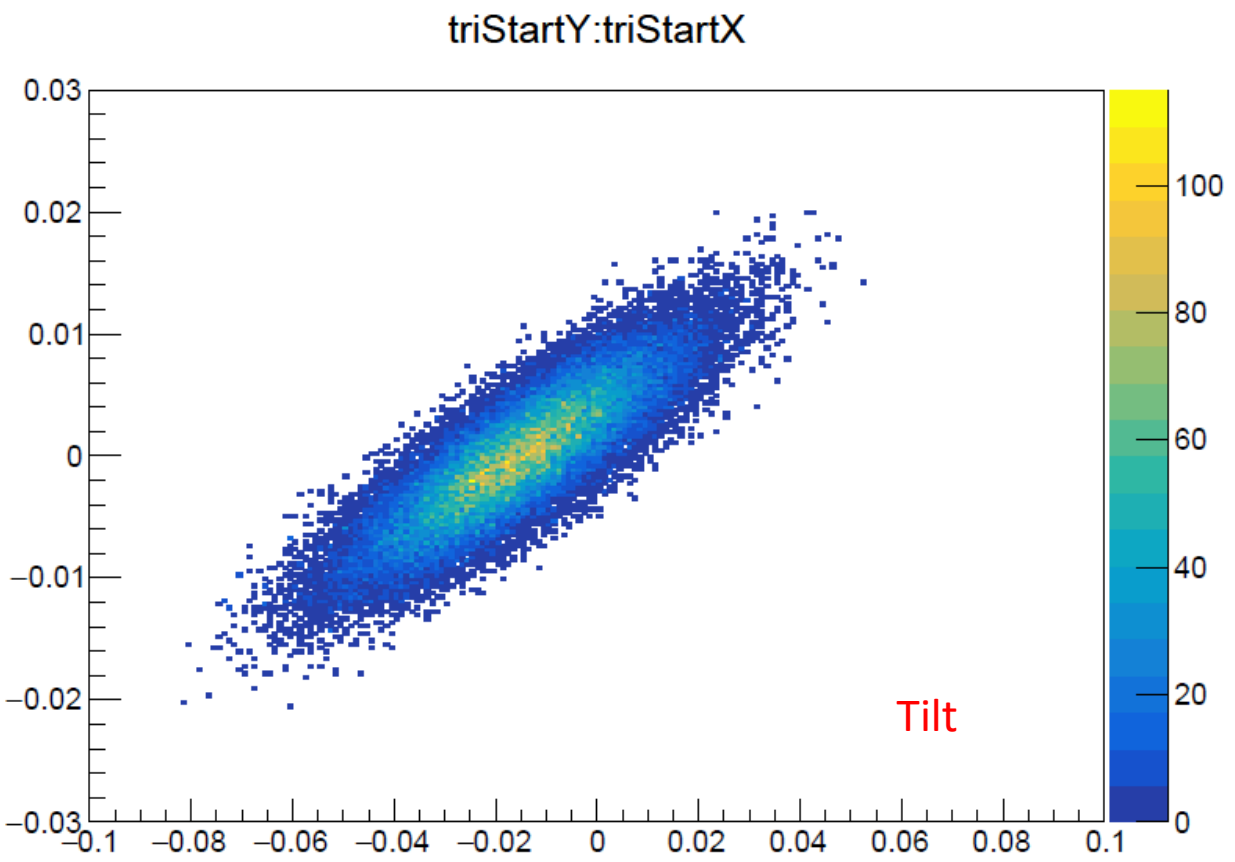
sigma_x,y = (130,50) microns

# Tilted MC Events

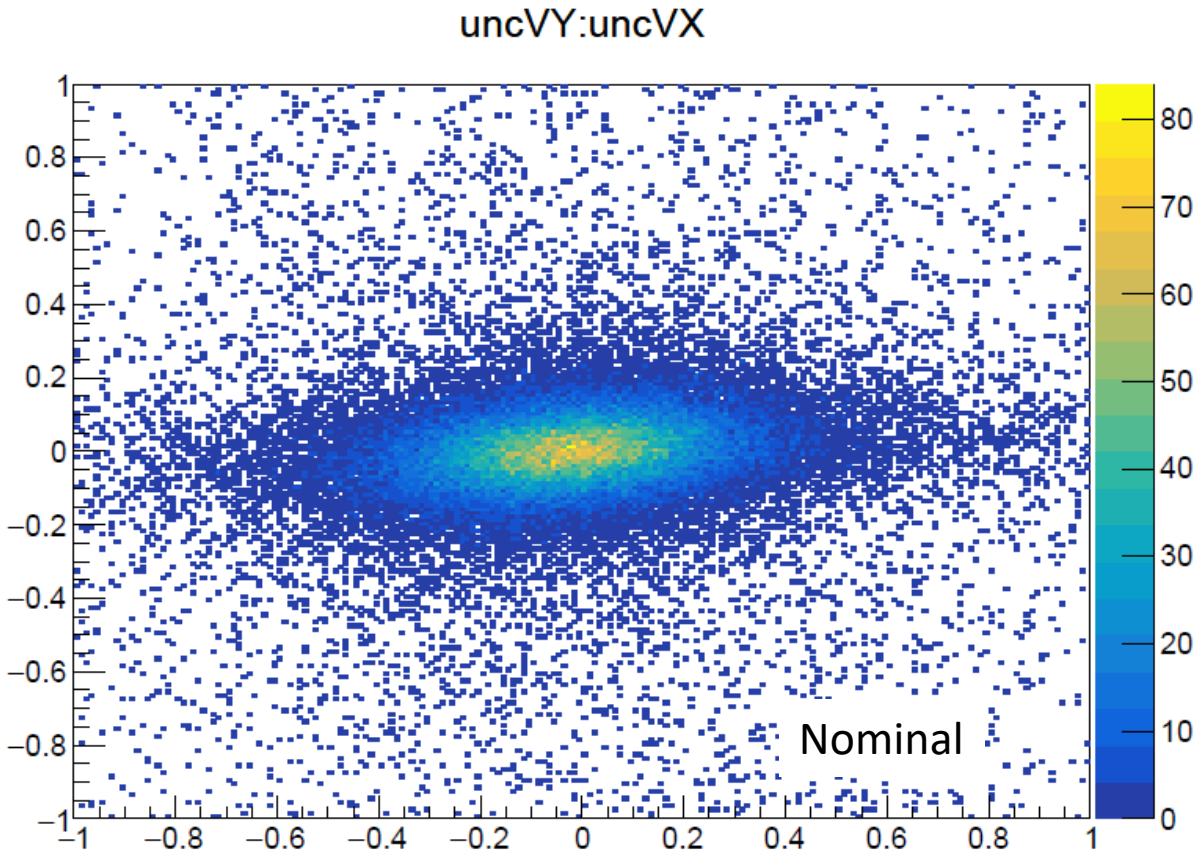
- Using the Nominal and Tilted events, the following quantities were compared:
  - Truth/recon beam profiles
  - Top/bottom asymmetry
  - Mass resolutions
    - singles0 Mollers
    - 50 MeV prompt A’ (near Moller mass)
  - 2016 Radiative fraction

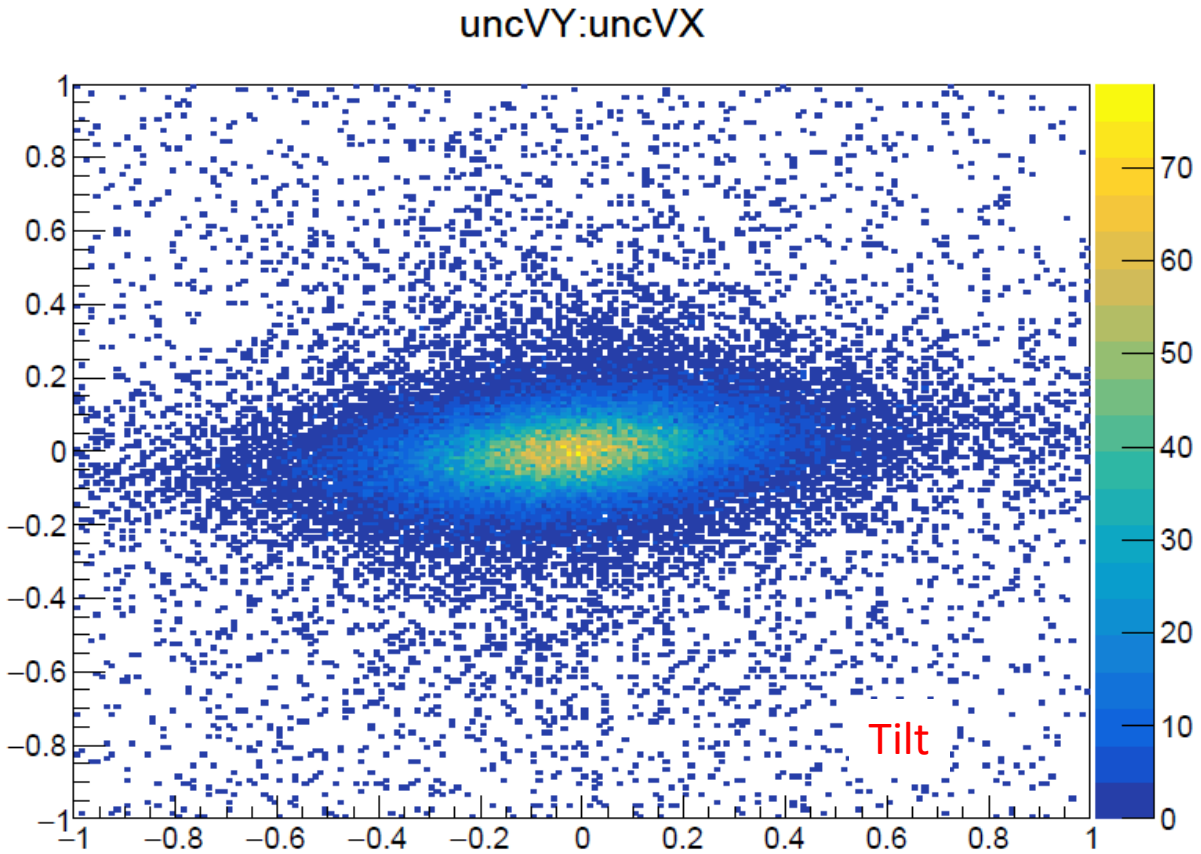
# Nominal vs. Tilted Truth Beamspot



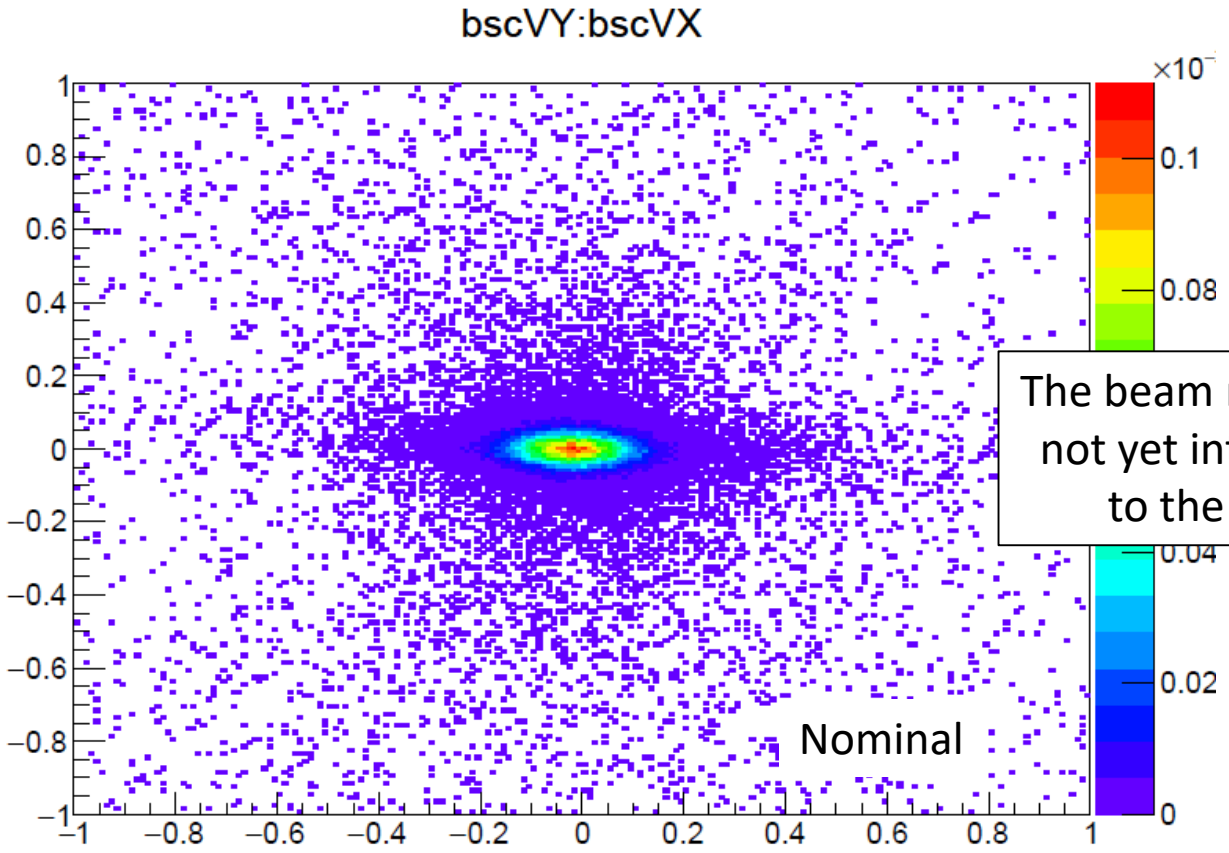



# Reconstructed Beamspot(?)

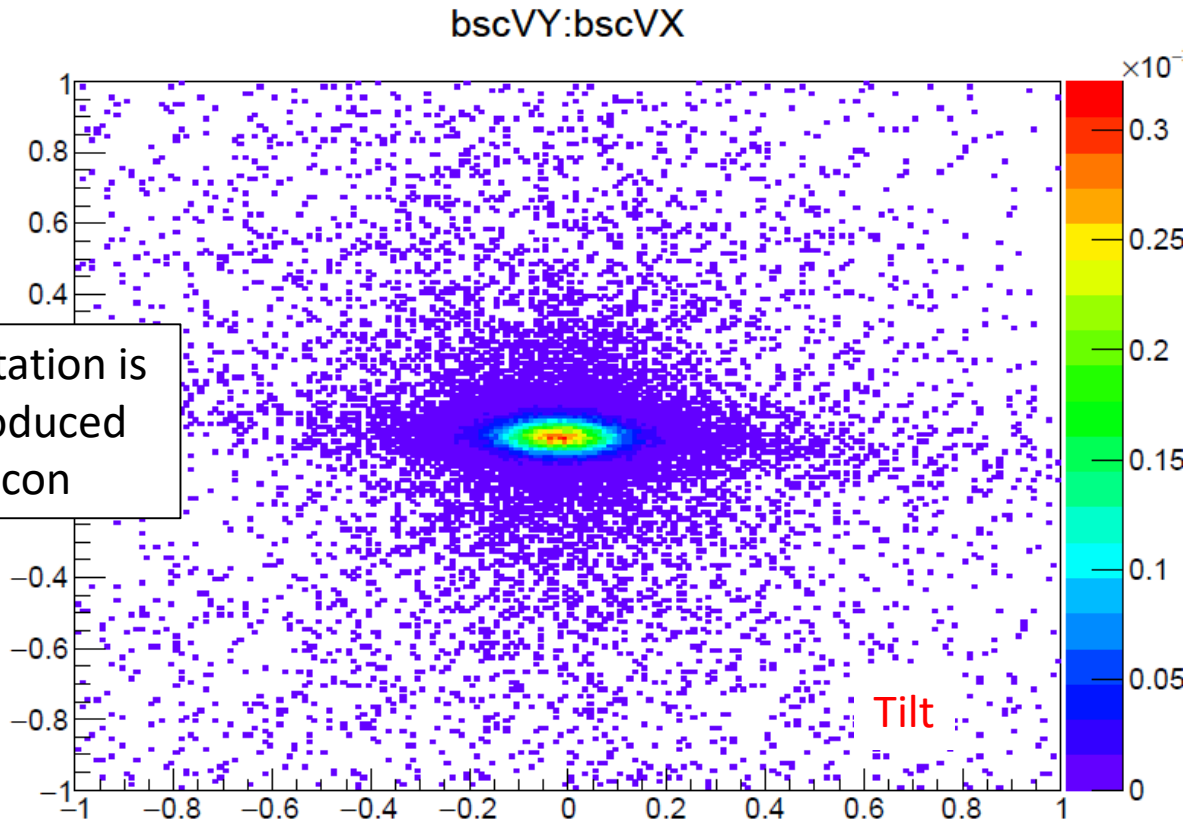


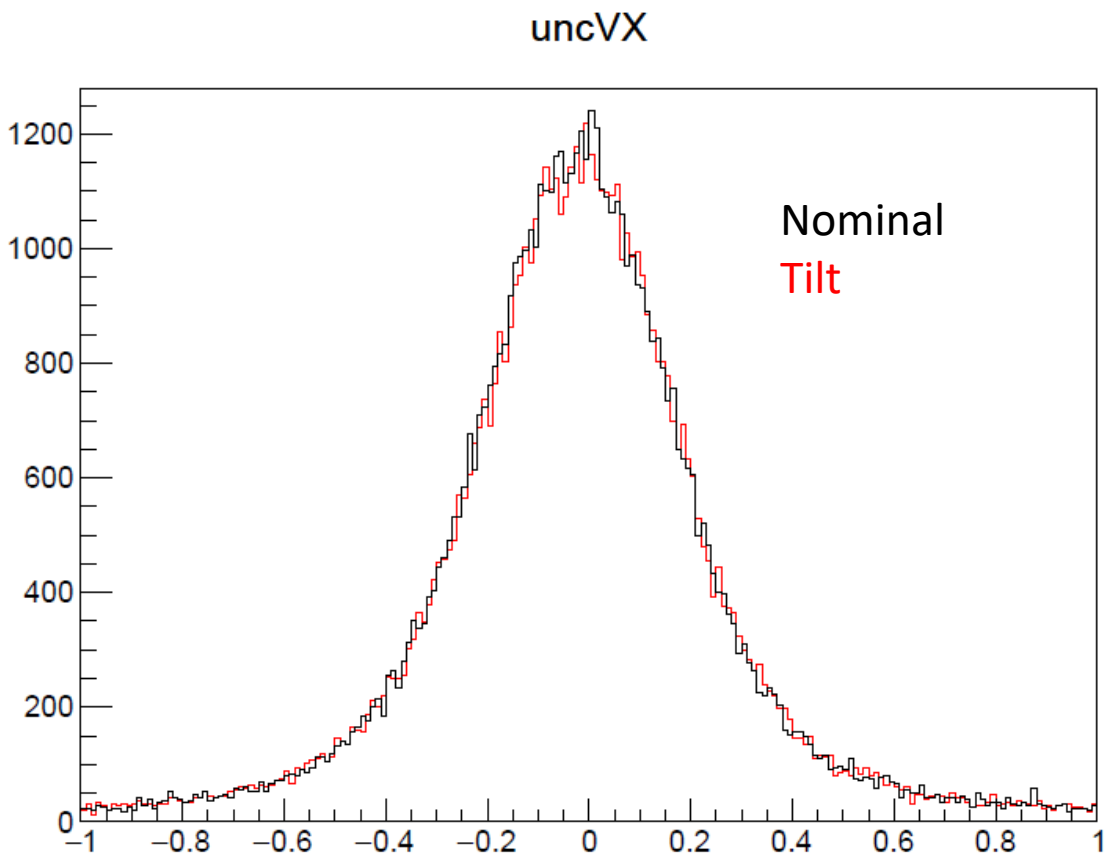
# Reconstructed Beamspot(?)

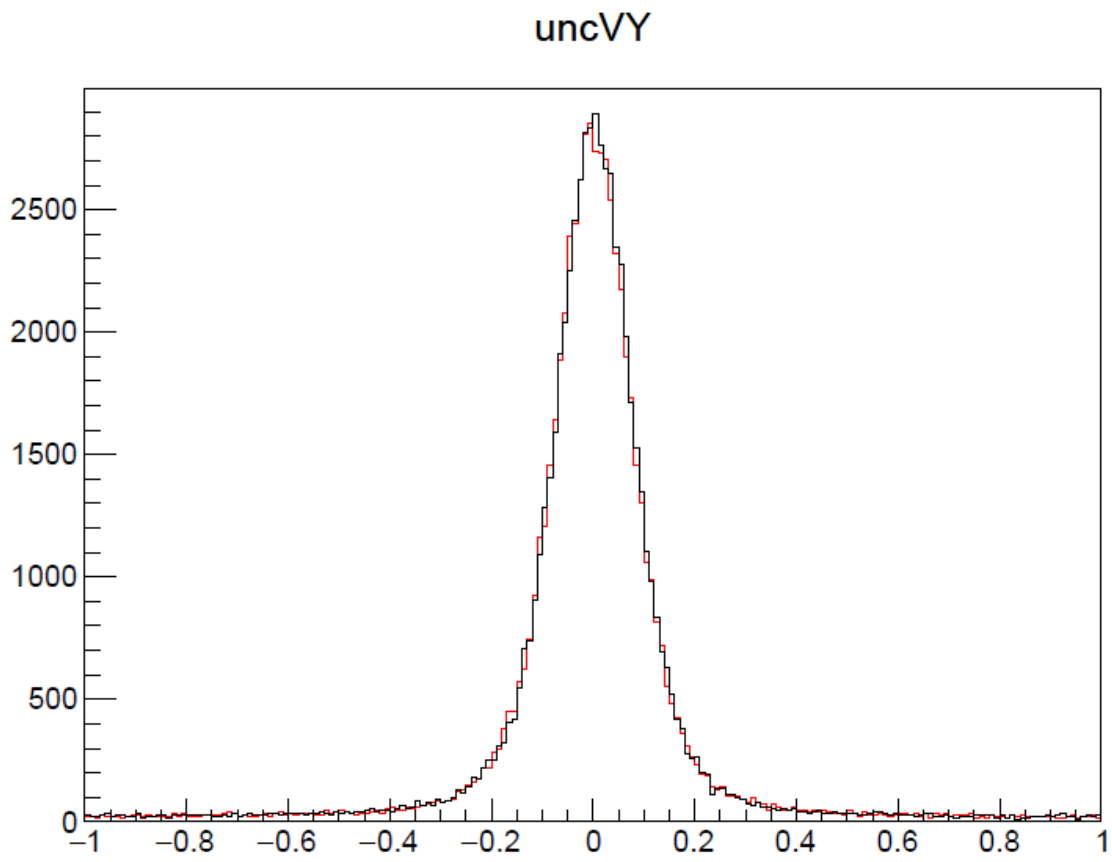



The beam rotation is not yet introduced to the recon

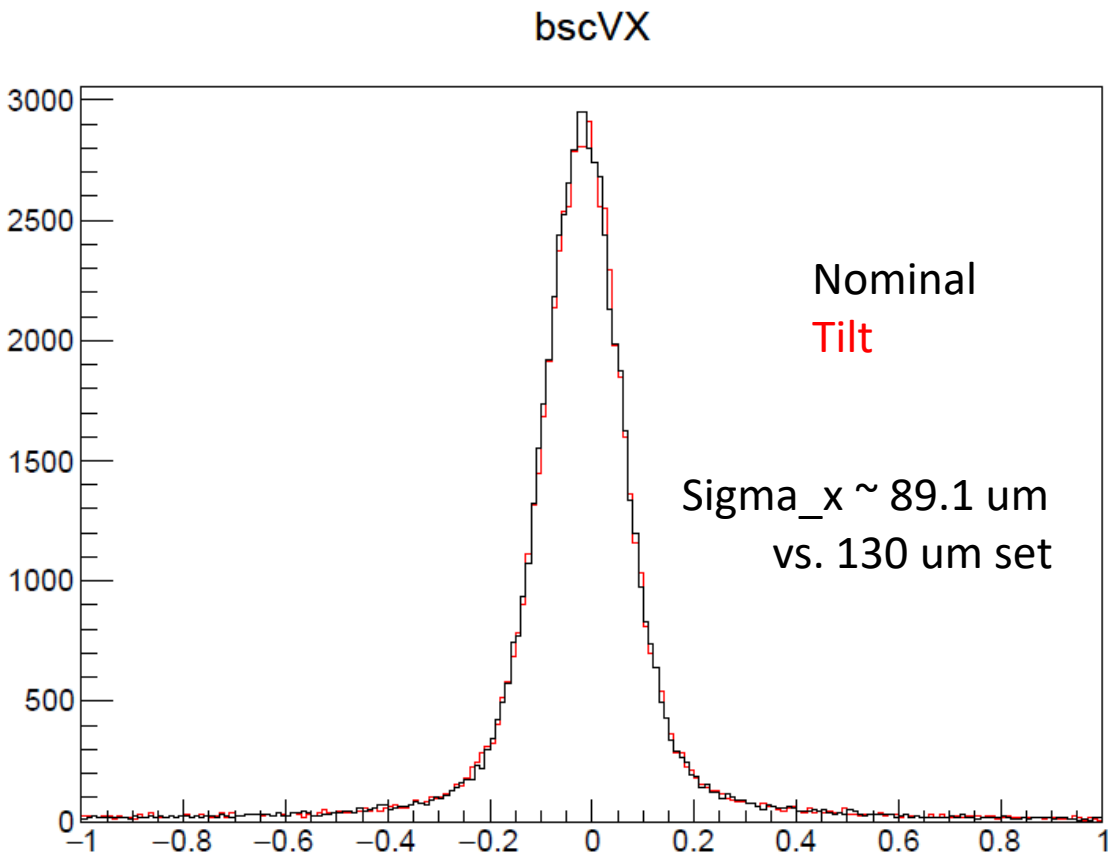


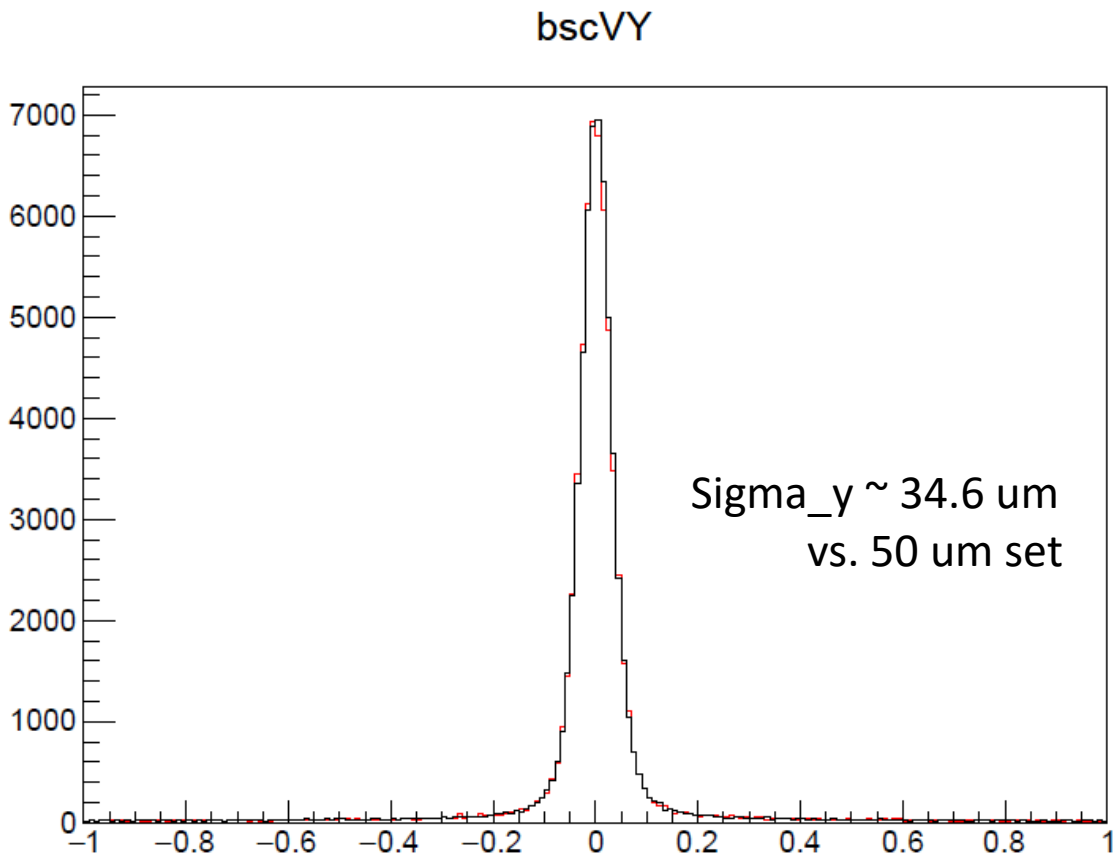
# Nominal vs. Tilted Vertex (unconstrained)



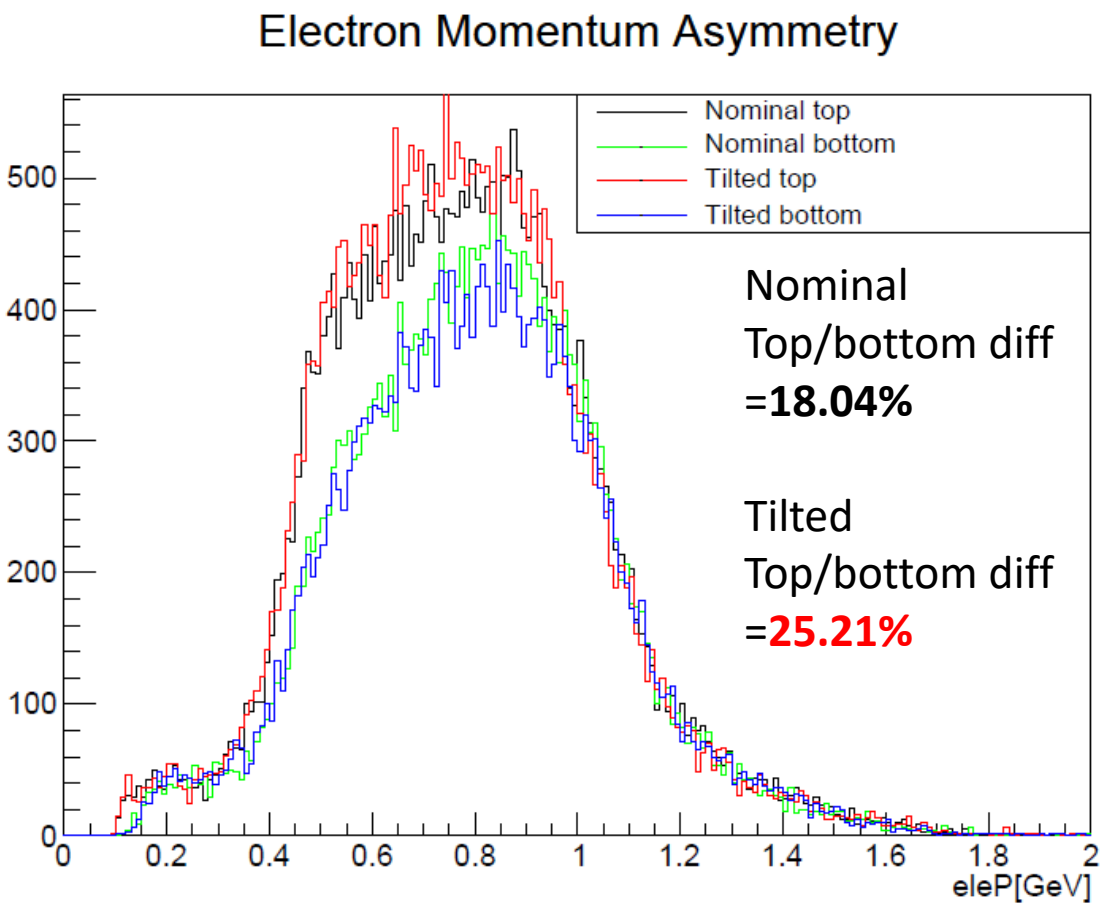



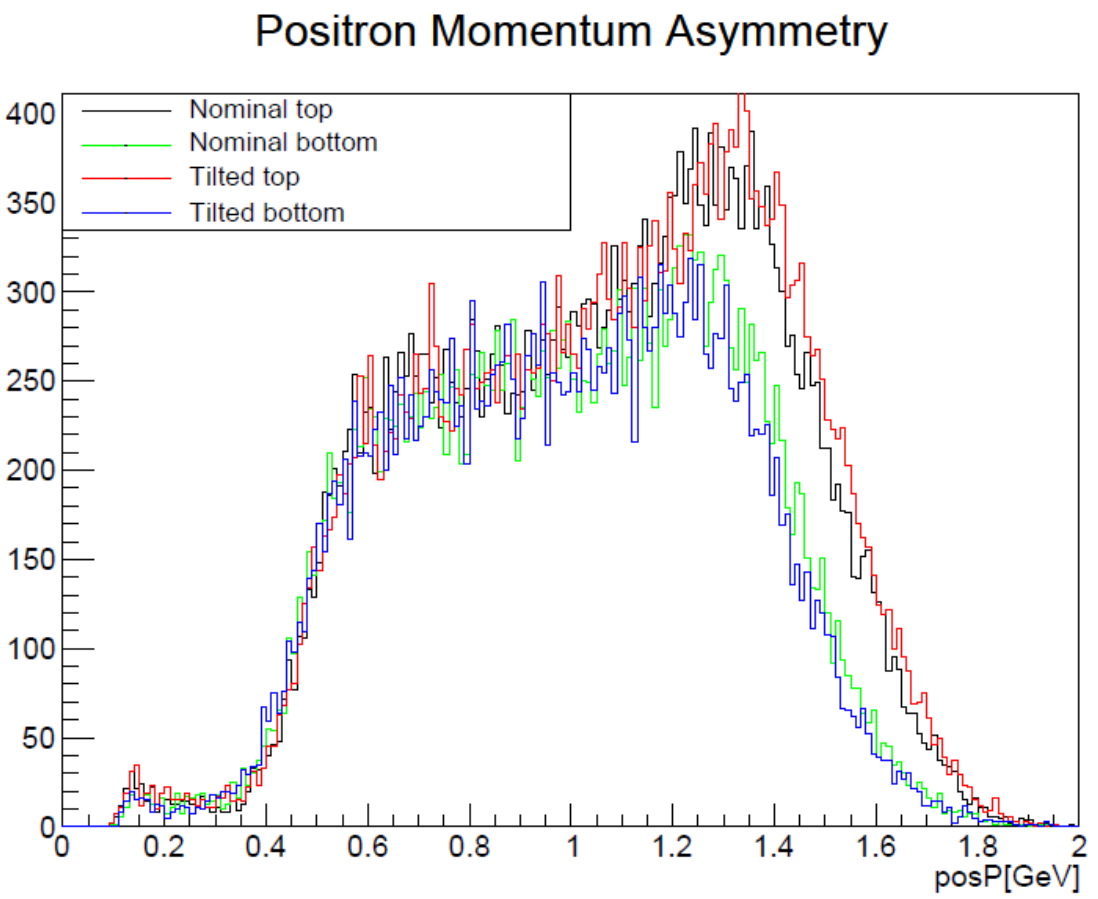
# Nominal vs. Tilted Vertex (beamspot constrained)



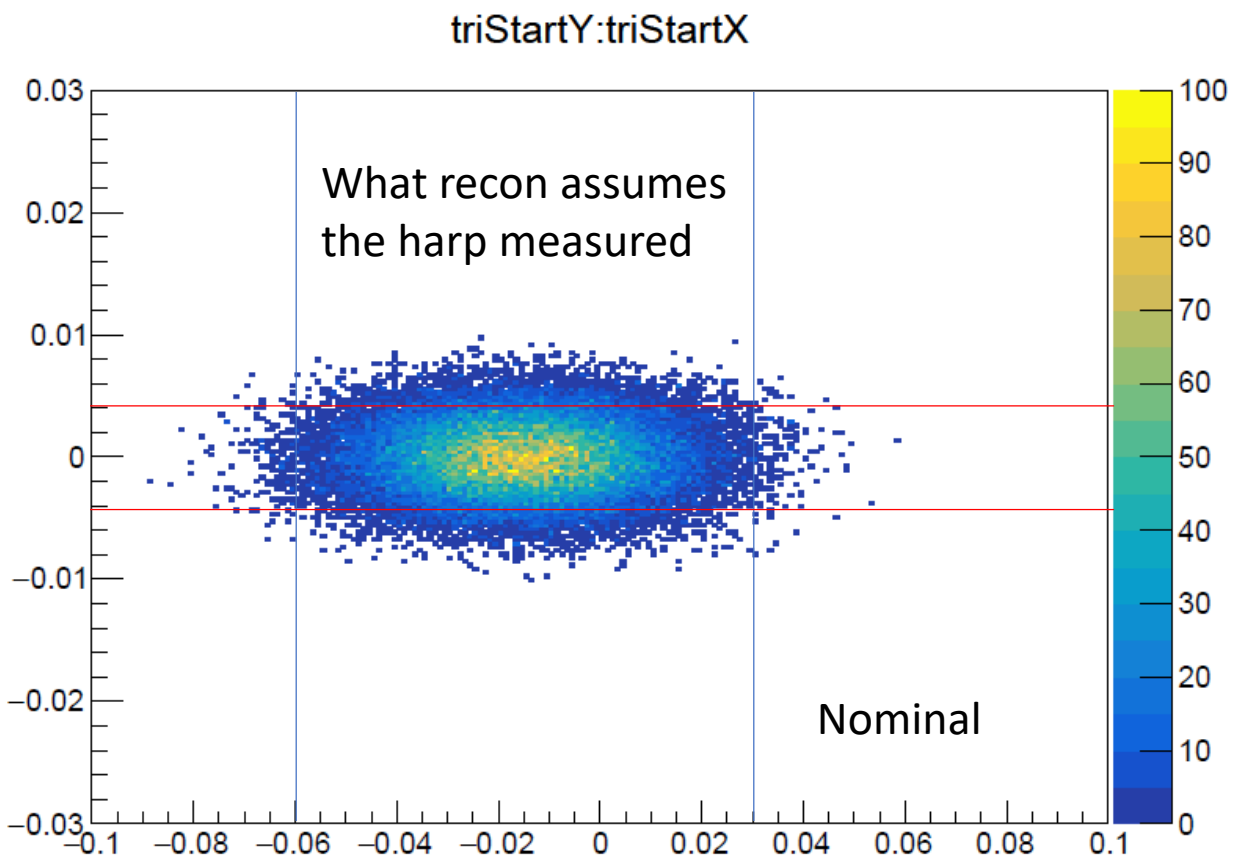



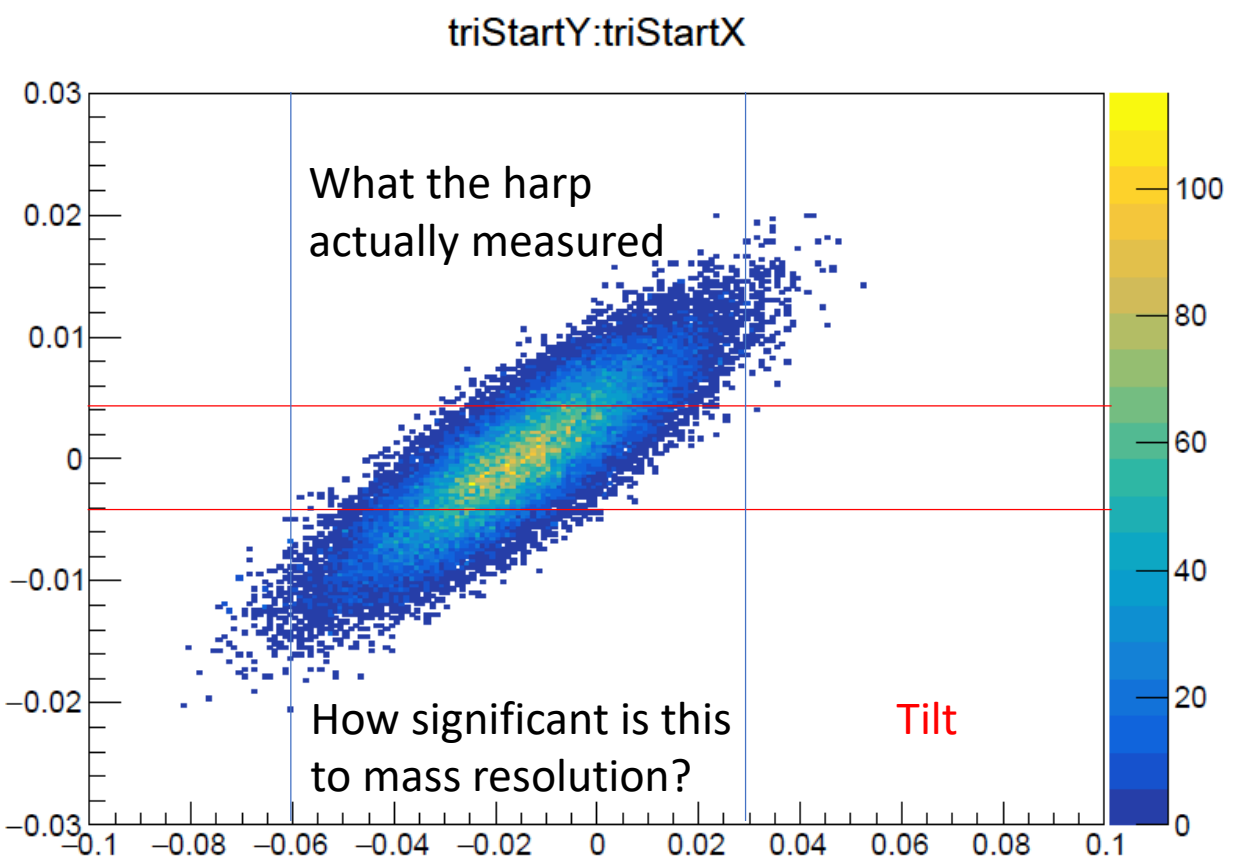
# Pairs1 Momentum Asymmetry



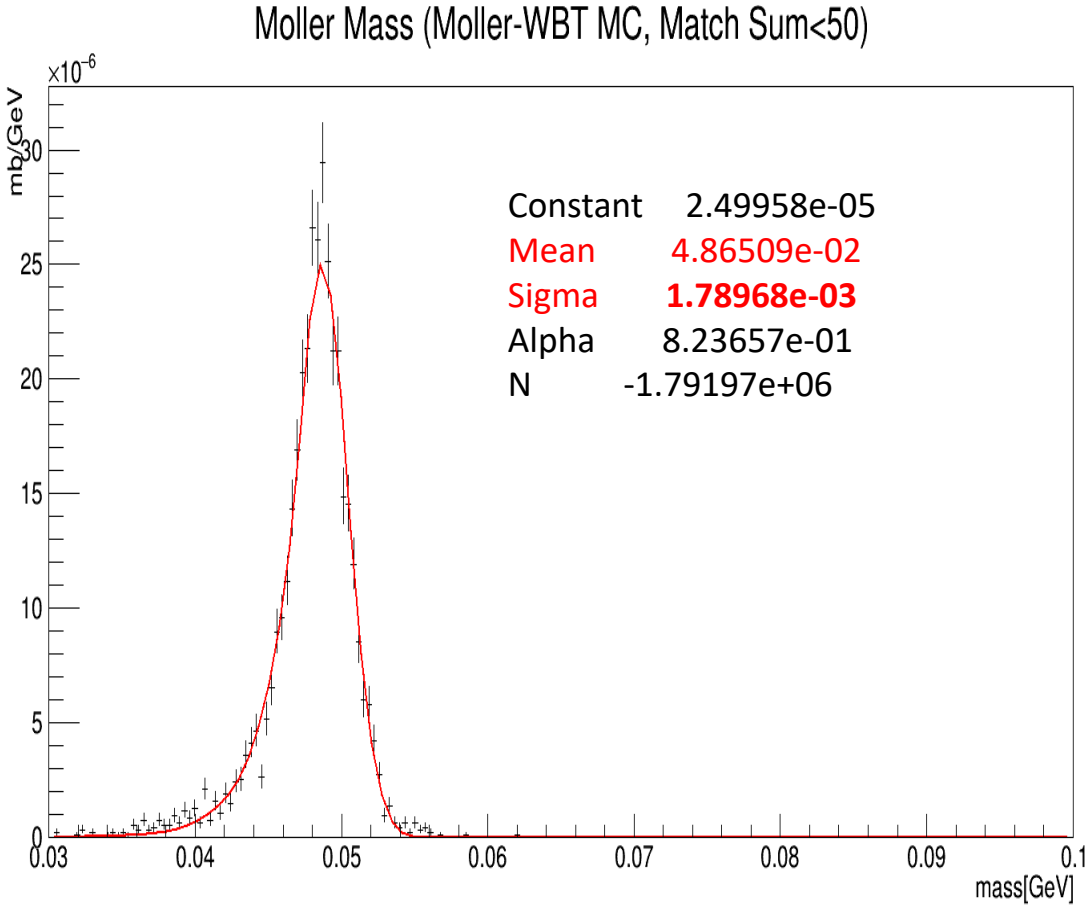



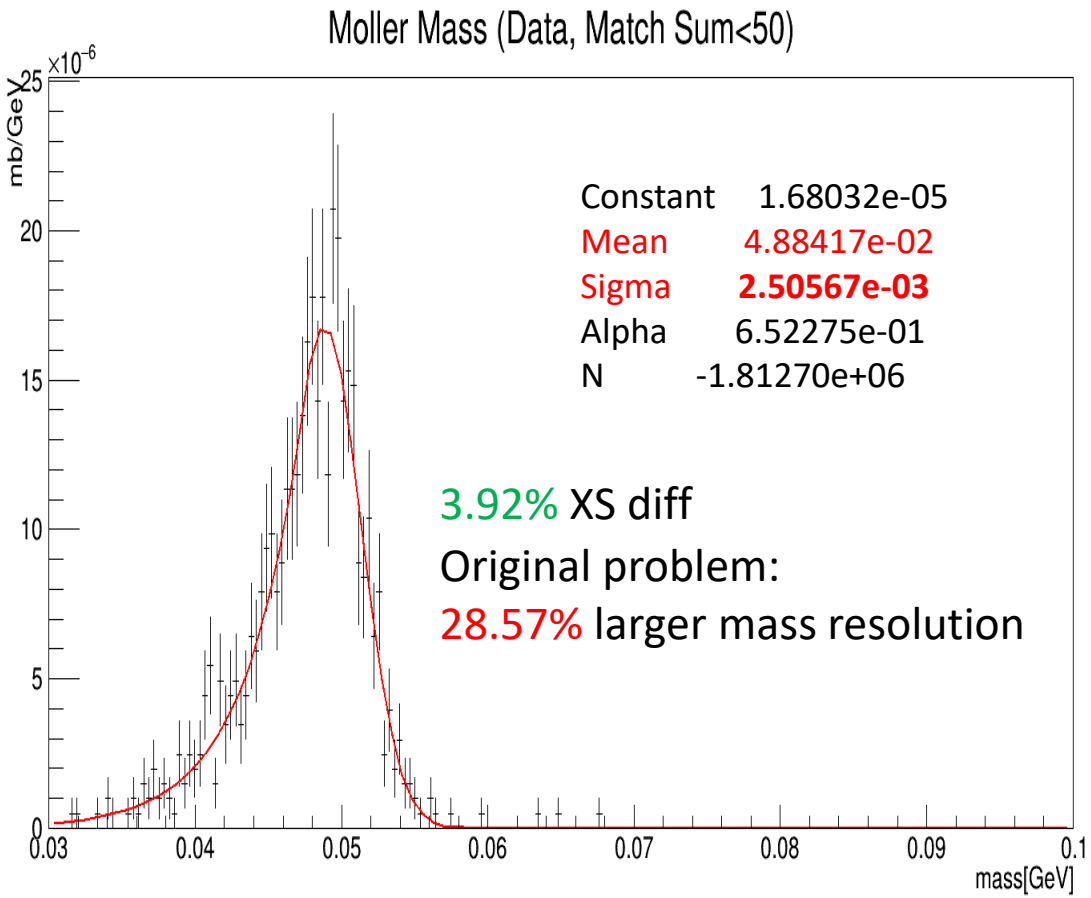
# How the beam skew may affect resolutions



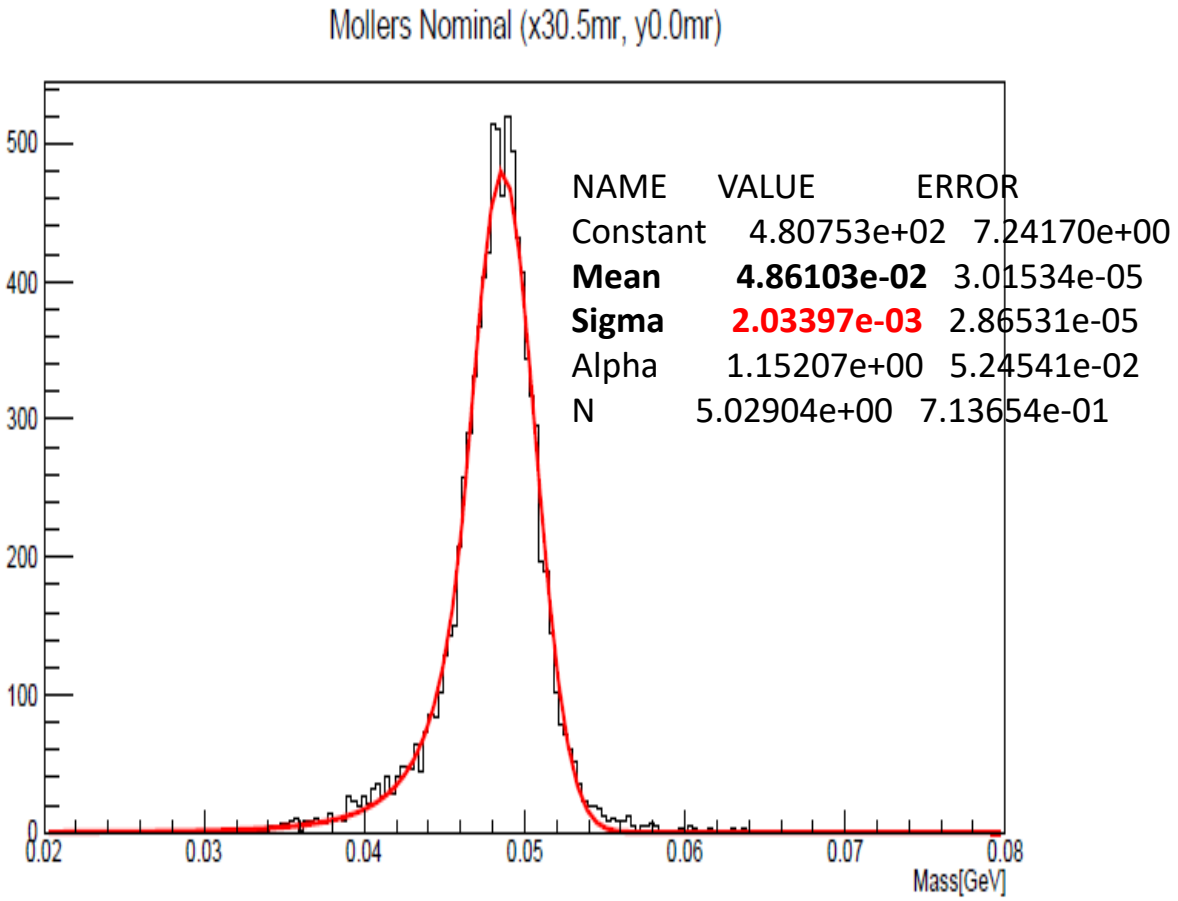



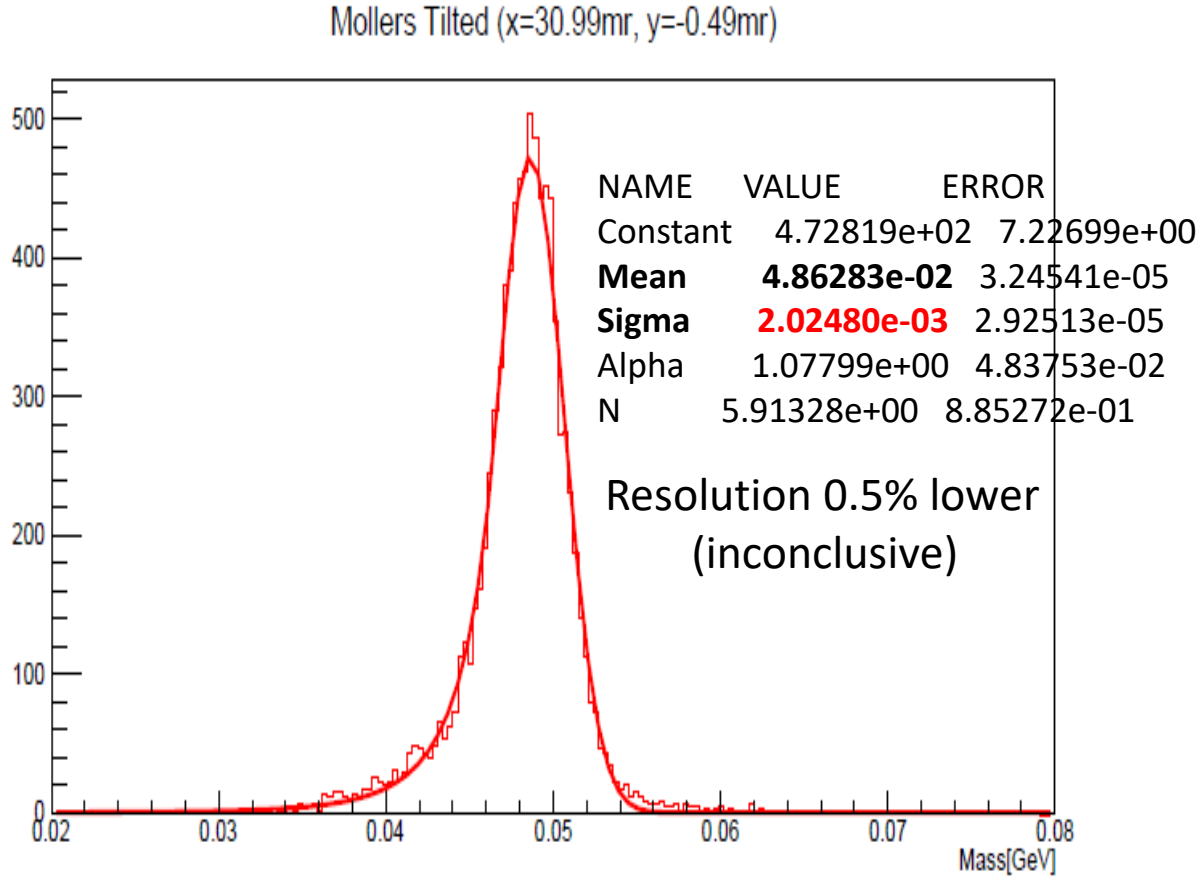
# MC vs. Data Moller mass discrepancy (old recon)



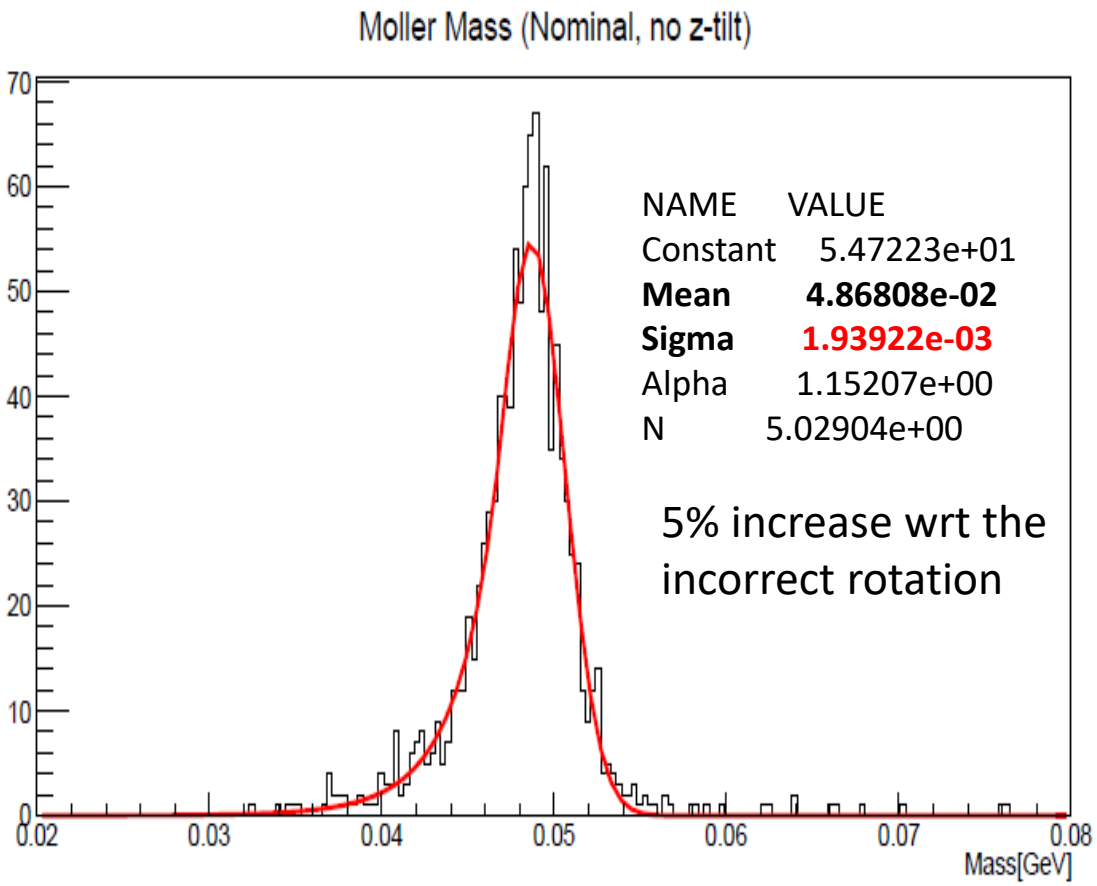



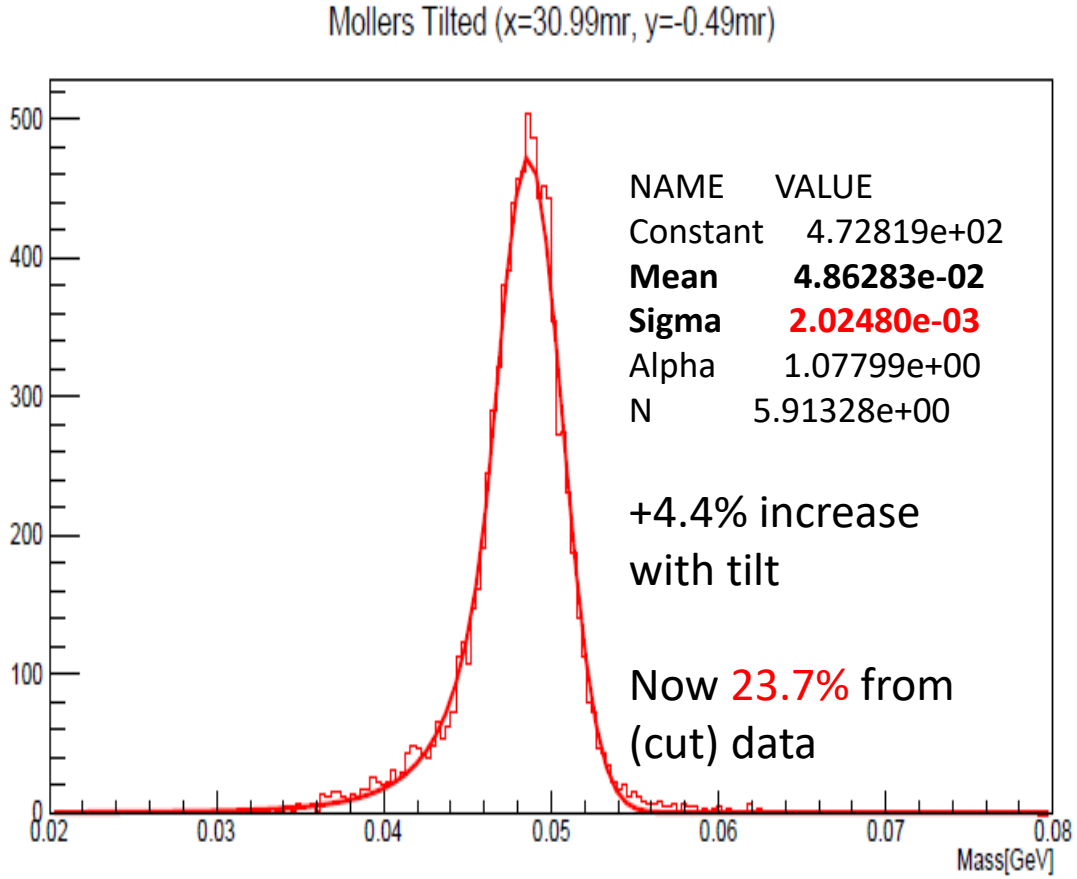
# New Nominal (incl. beam rotation) vs. y-Tilt, uncut



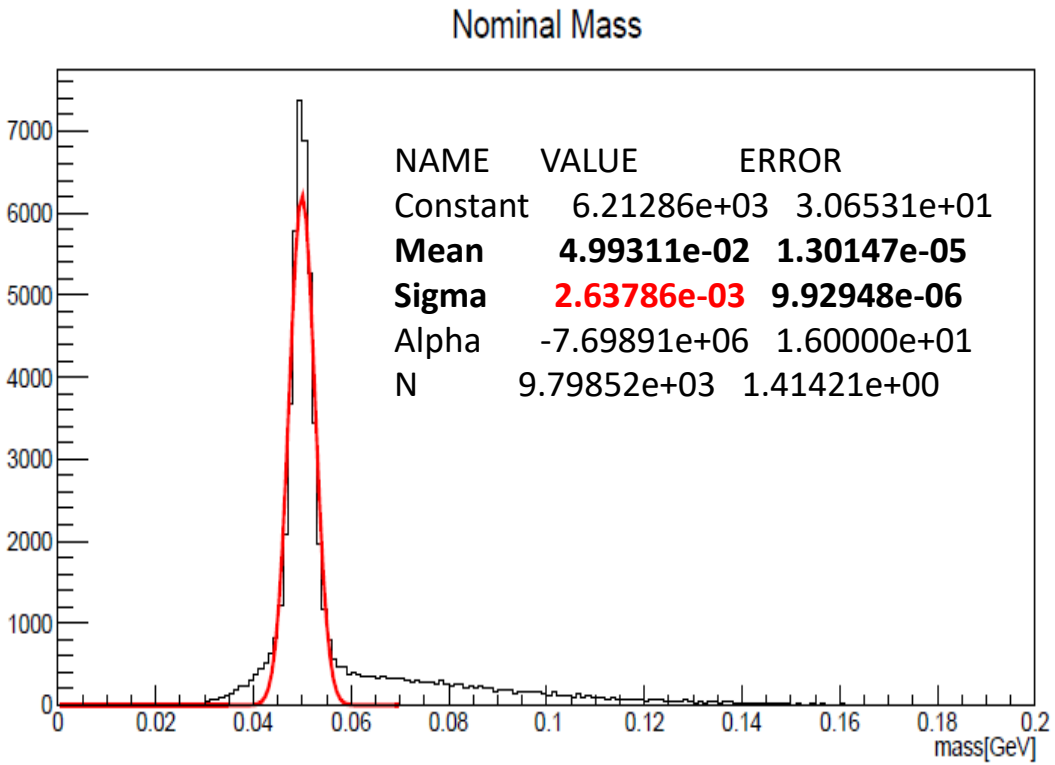



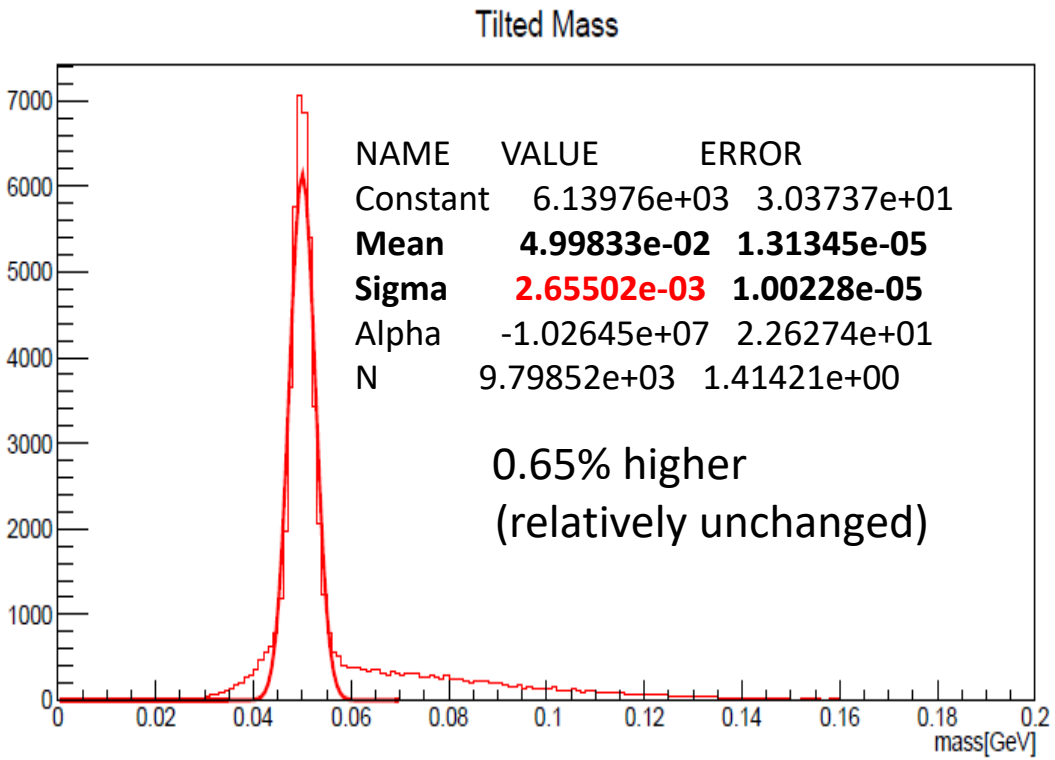
# New Nominal vs. y-Tilt, uncut before vs. after beam rotation



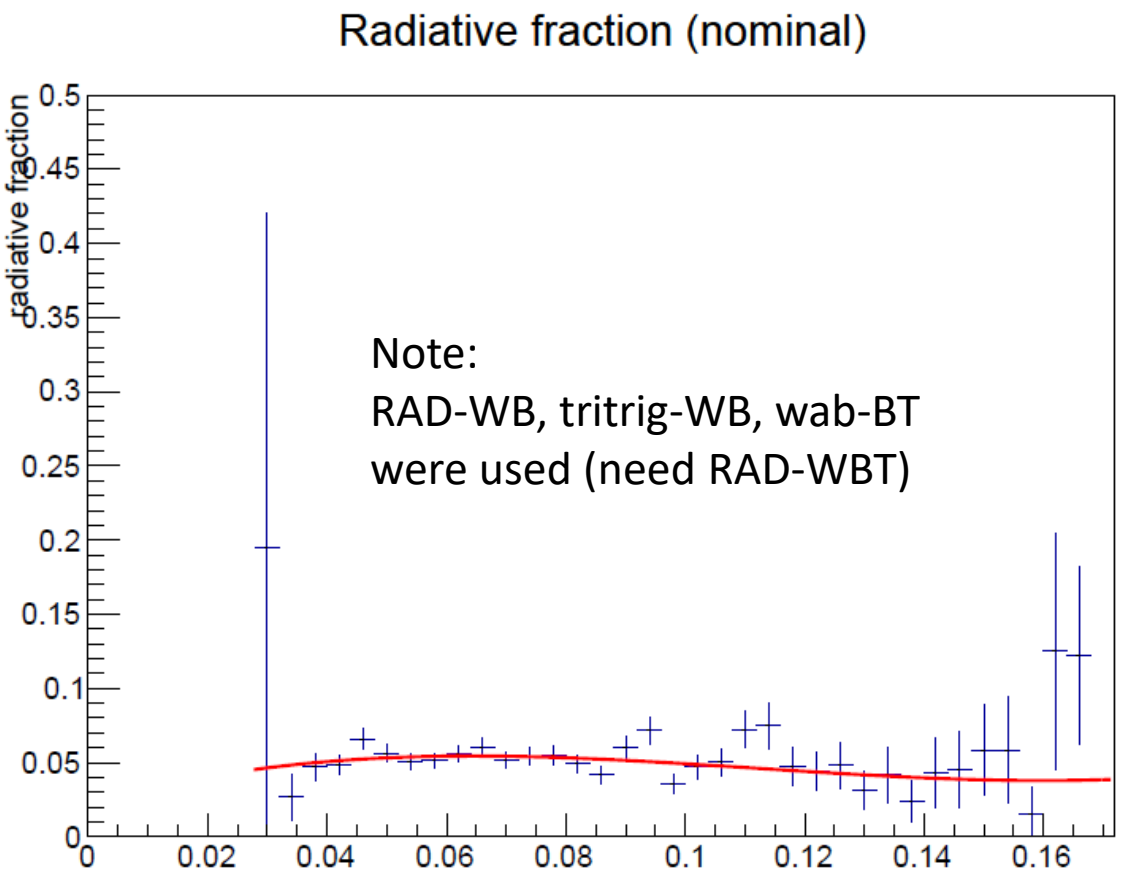



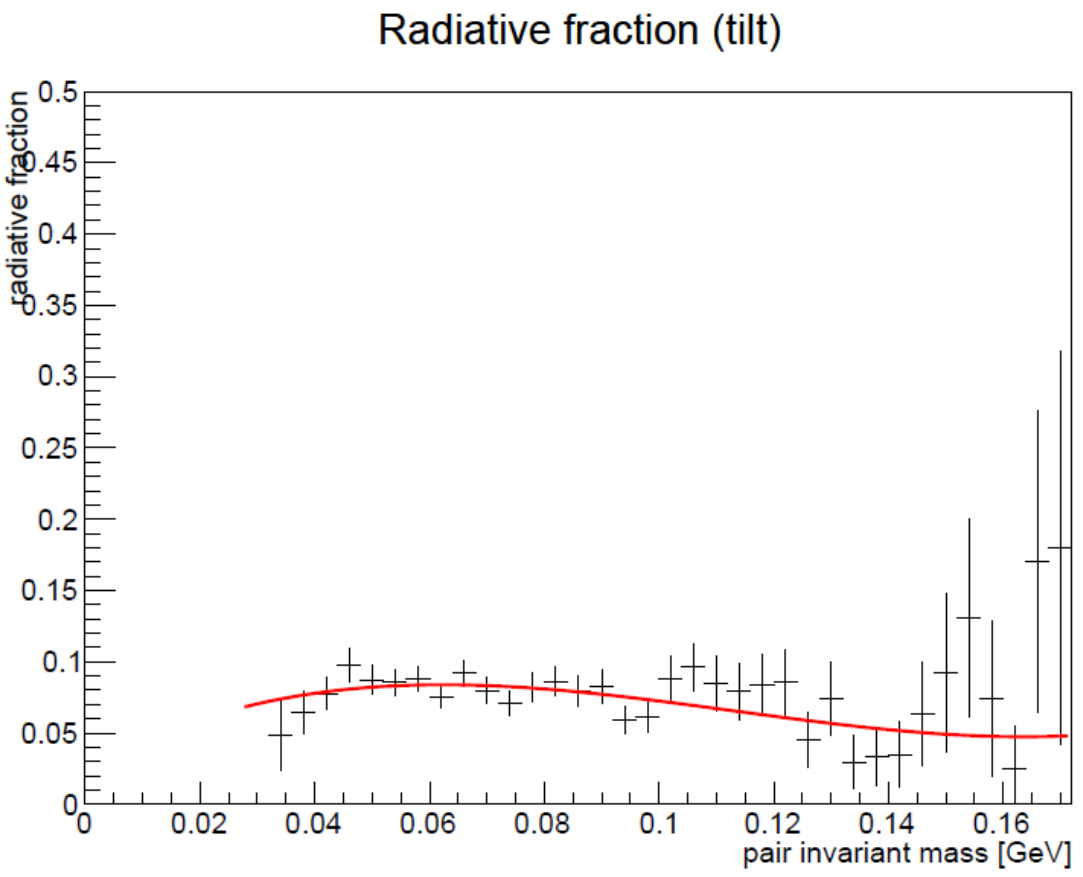
# 50 MeV prompt A’ mass resolution



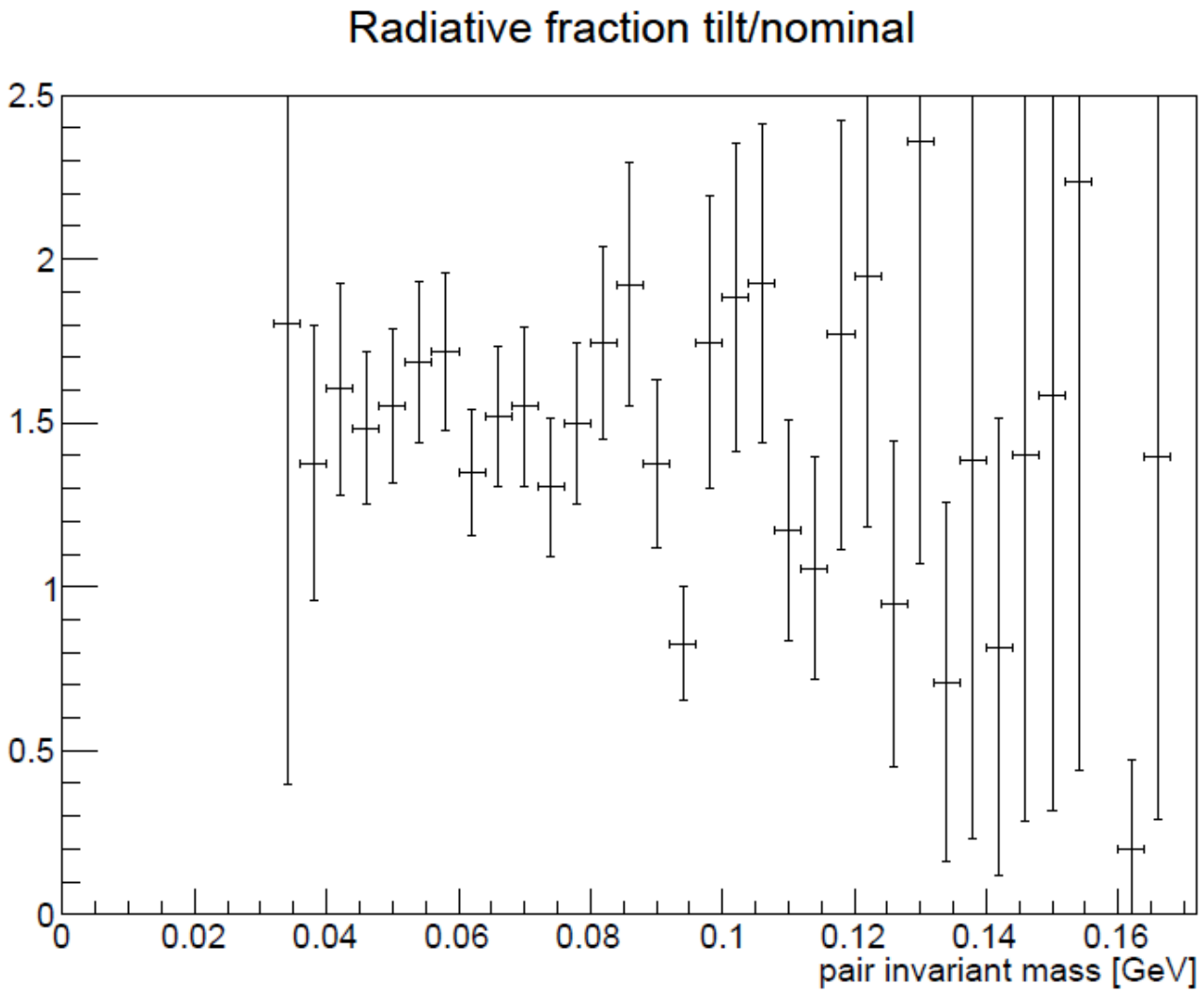



# 2016 Radiative Fraction



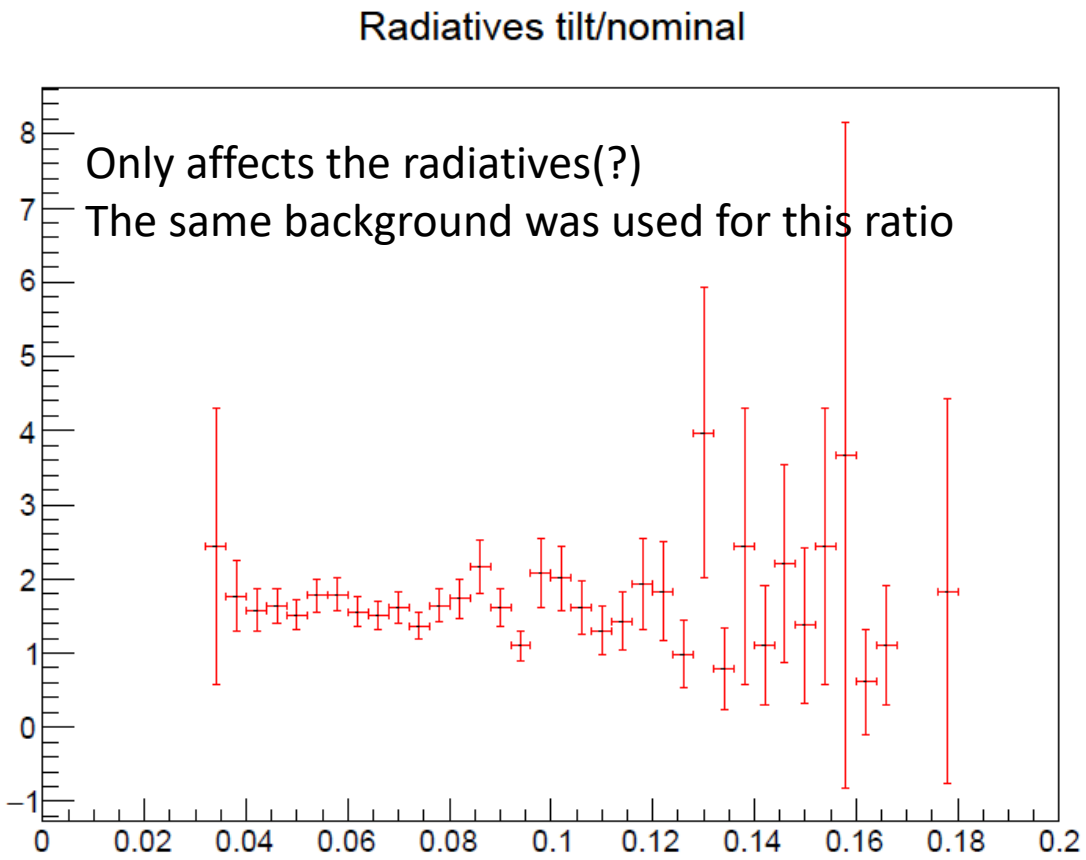
# Radiative fraction ratio

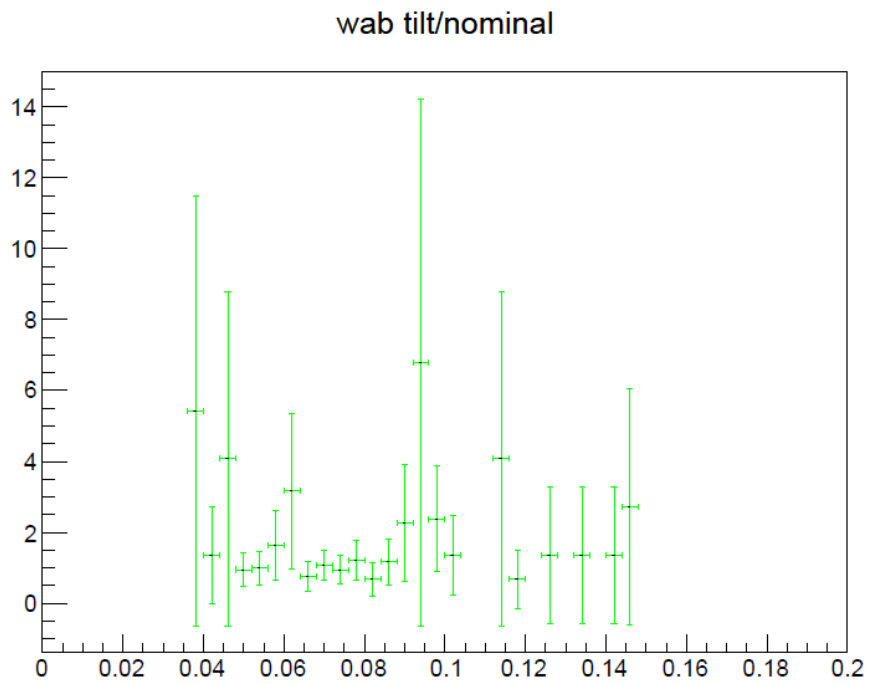


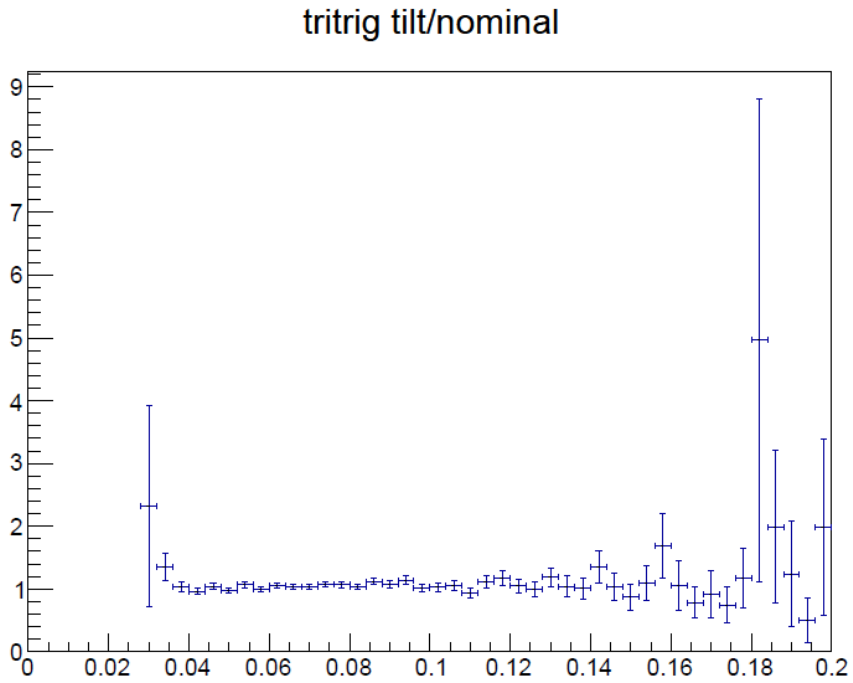

1.5x higher radiative fraction

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

# Individual Ratios



# 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);

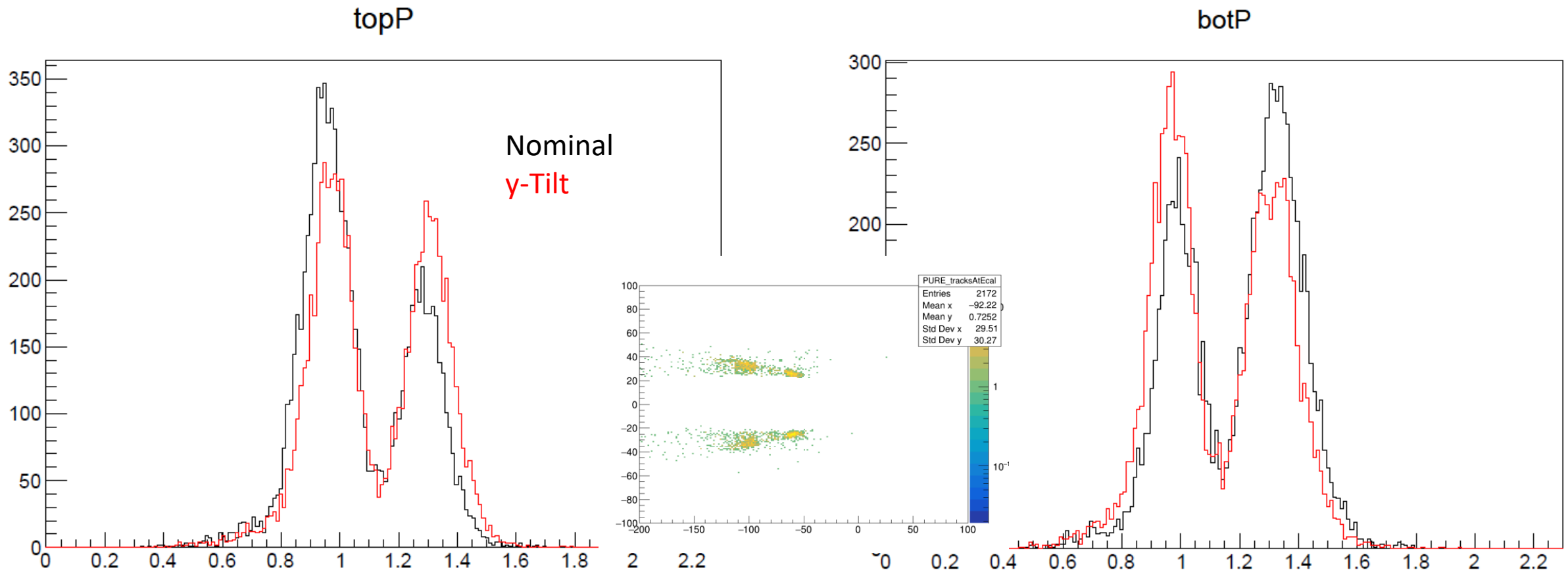
- // rotate about y-axis (rotation in x-z)
  px’ = px*cos(theta_x) + pz*sin(theta_x);
  pz’ = pz*cos(theta_x) - px*sin(theta_x);

// 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