Study of True XY and Φ Distributions for UPC [Polarized and Un-polarized]

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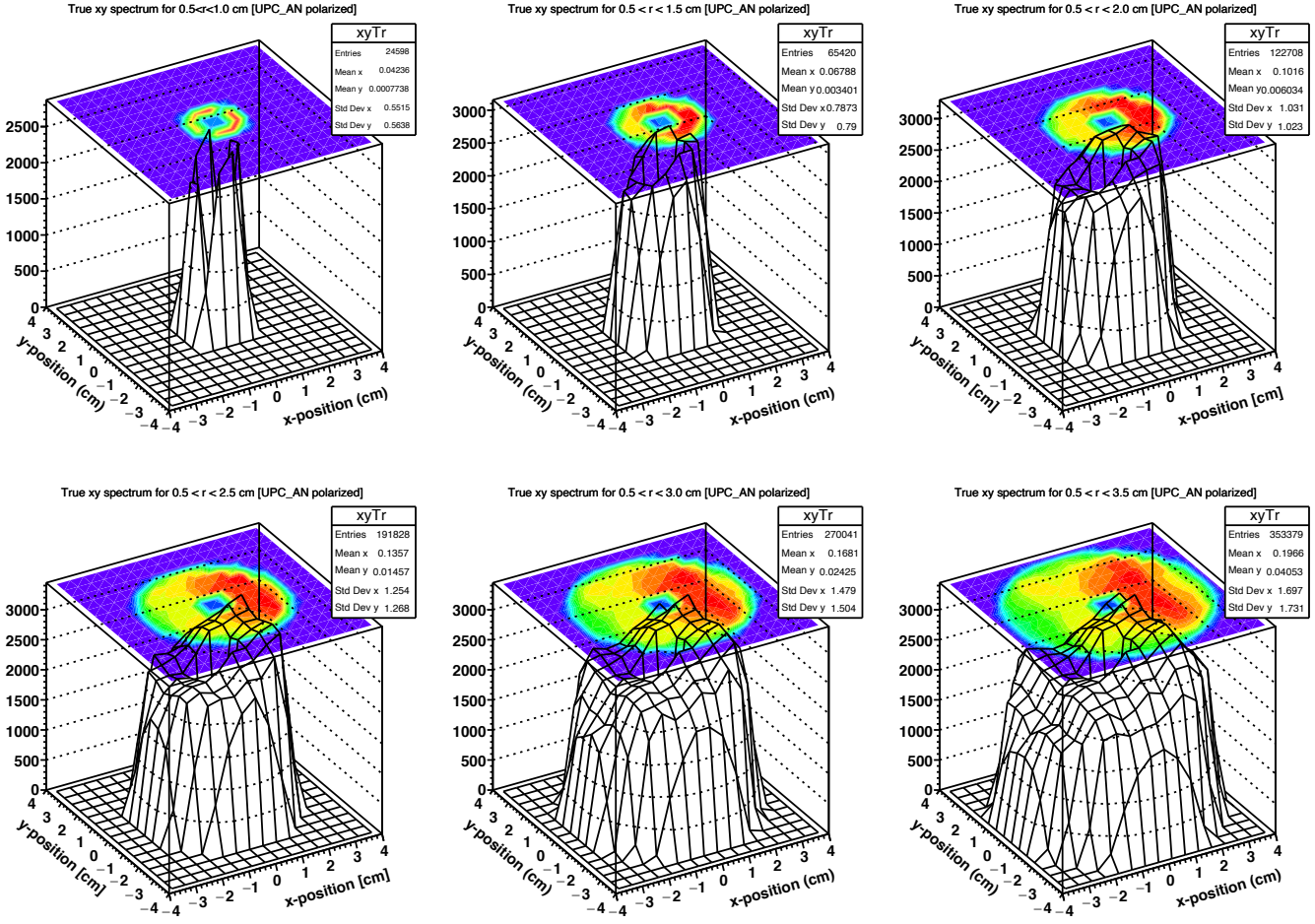
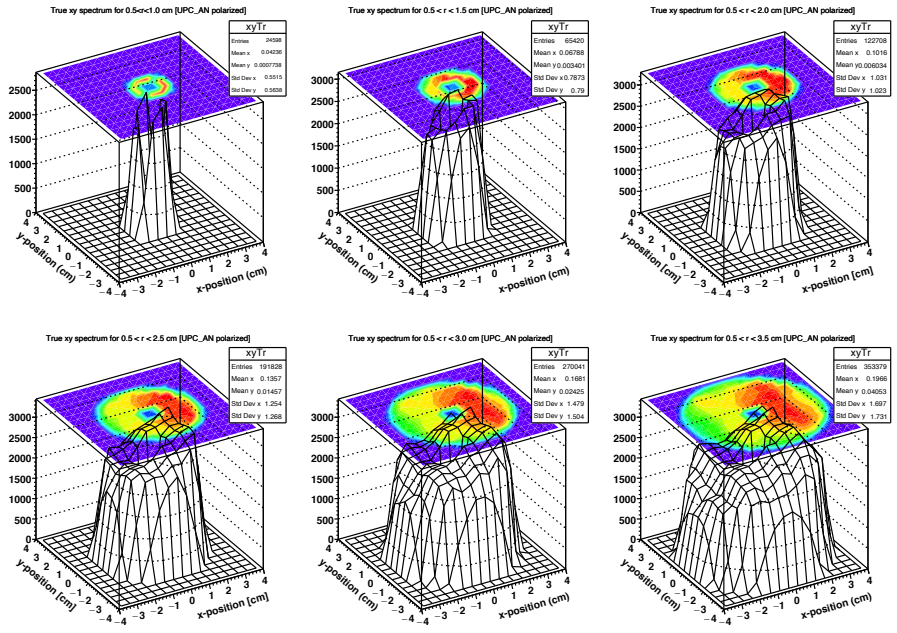
True XY Distributions for Polarized UPC_AN+0.2



Position distribution is spherical as expected for small r < 2.0 cm. But the more r tends towards 4 cm, the true xy distribution starts to respond to the square shape of our ZDC acceptance.

True XY Distributions for Polarized UPC_AN+0.2

According to my calculation so far, position distribution being spherical for small r < 2.0 cm is meaningful for unsmeared 100 GeV neutrons peaking around 0.1 GeV/c according to:
Pt (true) = r*En(true) / IP, where IP = 1856 cm for pAu, run15 data.
Therefore, r = Pt (true) * IP/En(true) = 0.1 (GeV/c) * 1856 (cm) / 100 GeV = 1.856 cm < 2.0 cm.

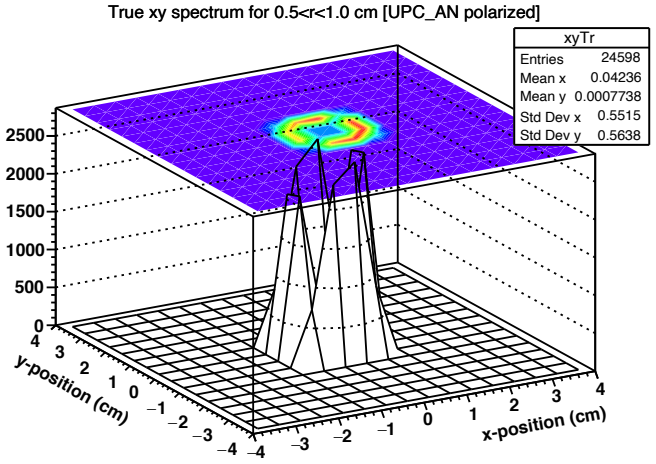


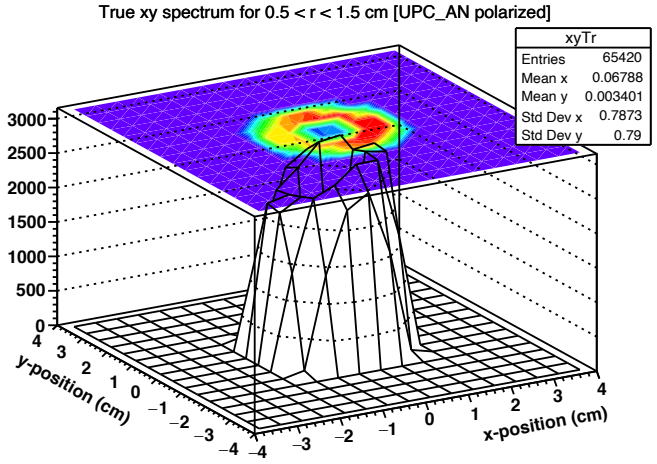
- But as we get passed r = 2 cm going towards r < 4 cm, which is the cut applied to data and, therefore, should be applied to the reconstructed and true spectra, the true xy position spectrum starts to take the square shape of our ZDC acceptance.
- So I am asking myself many questions like: I know the true beam is spherical but if it is projected on a 4 cm by 4 cm square x and y plane, would the true beam still remain completely spherical even close to 4cm or start to take the square shape like H_2O does depending on container?

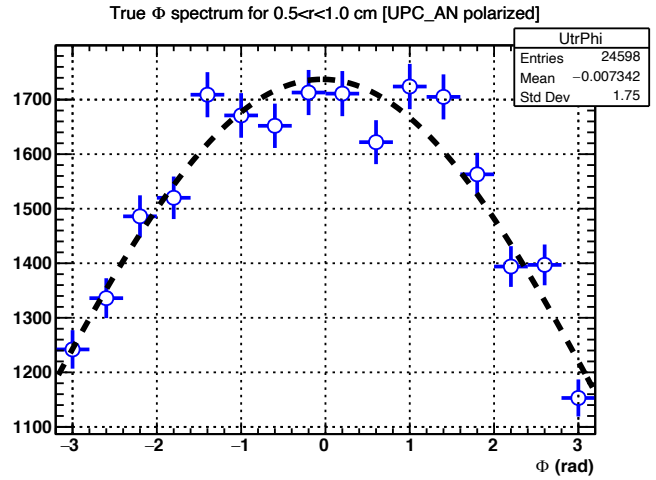
What effect can this square shape in our true position at r < 4 cm have on our final results and so on?
I have searched previous studies to see if I can come across true xy plot with r < 4 cm but none so far.

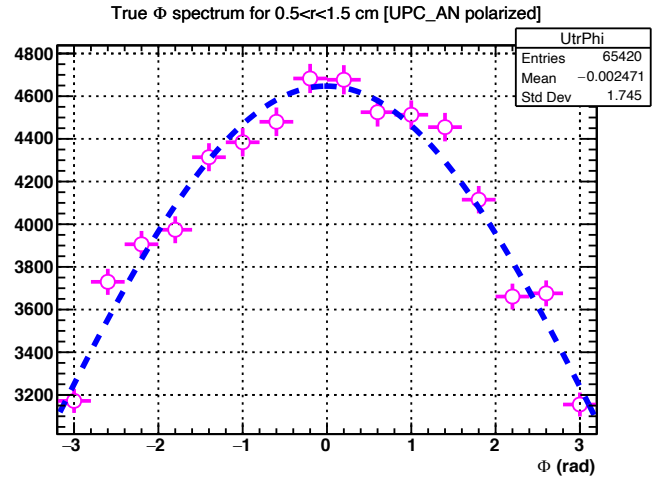
True XY and Φ Spectra for Various Radial Regions

Radial Regions: Between 0.5 cm and 1.0 cm (left panels), 0.5 cm and 1.5 cm (right panels)



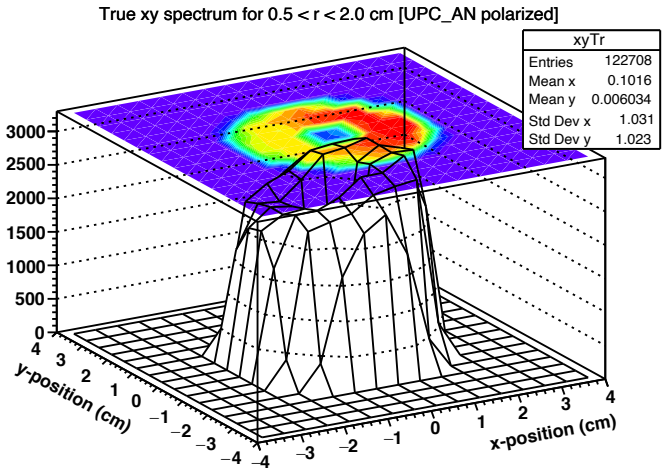


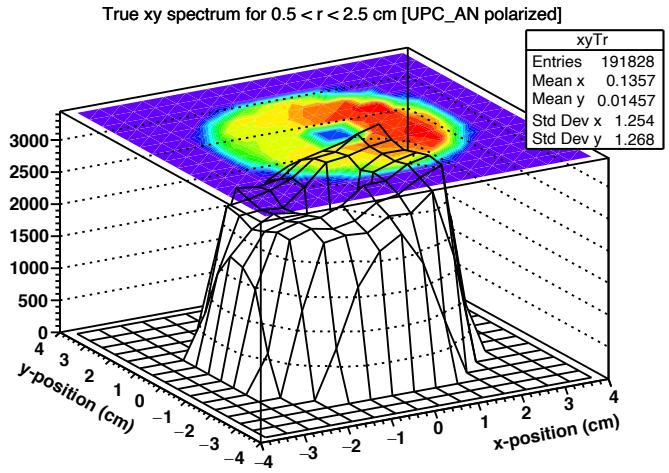


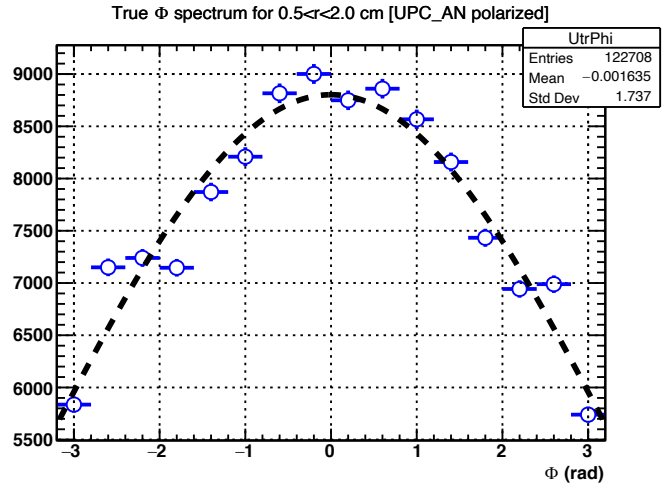


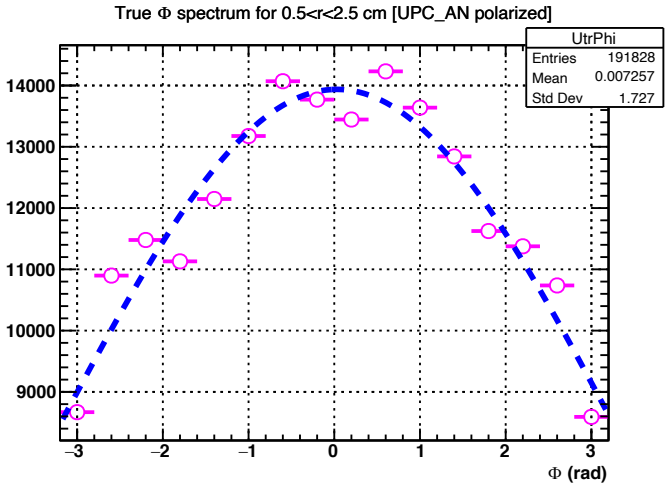
True XY and Φ Spectra for Various Radial Regions

Radial Region: Between 0.5 cm and 2.0 cm (left panels), 0.5 cm and 2.5 cm (right panels)



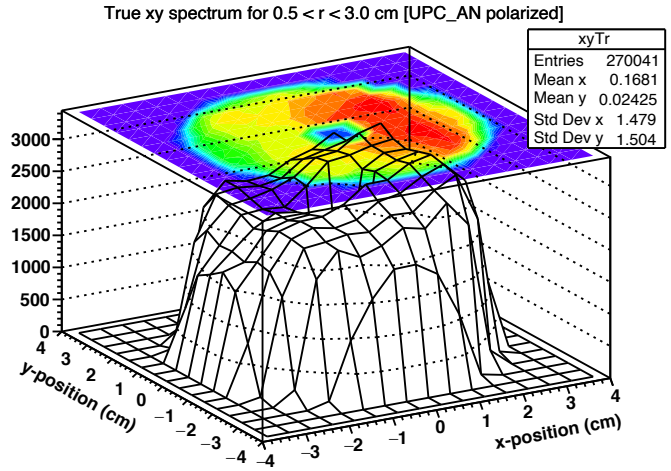


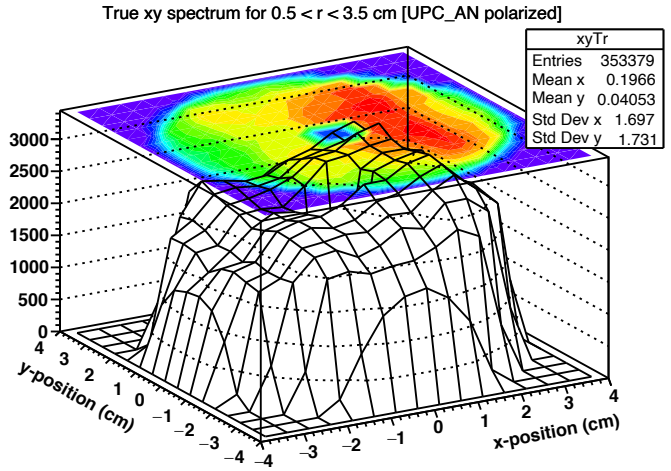


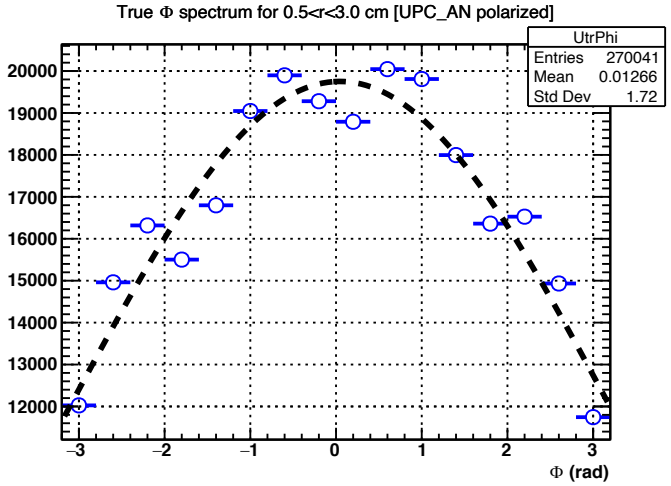


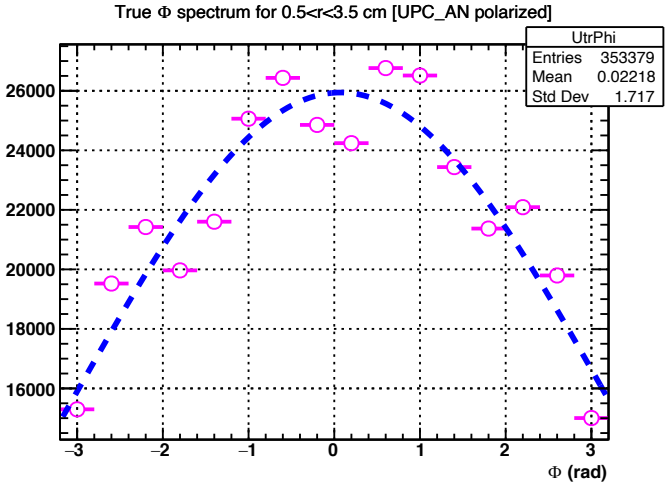
True XY and Φ Spectra for Various Radial Regions

Radial Region: Between 0.5 cm and 3.0 cm (left panels), 0.5 cm and 4.0 cm (right panels)

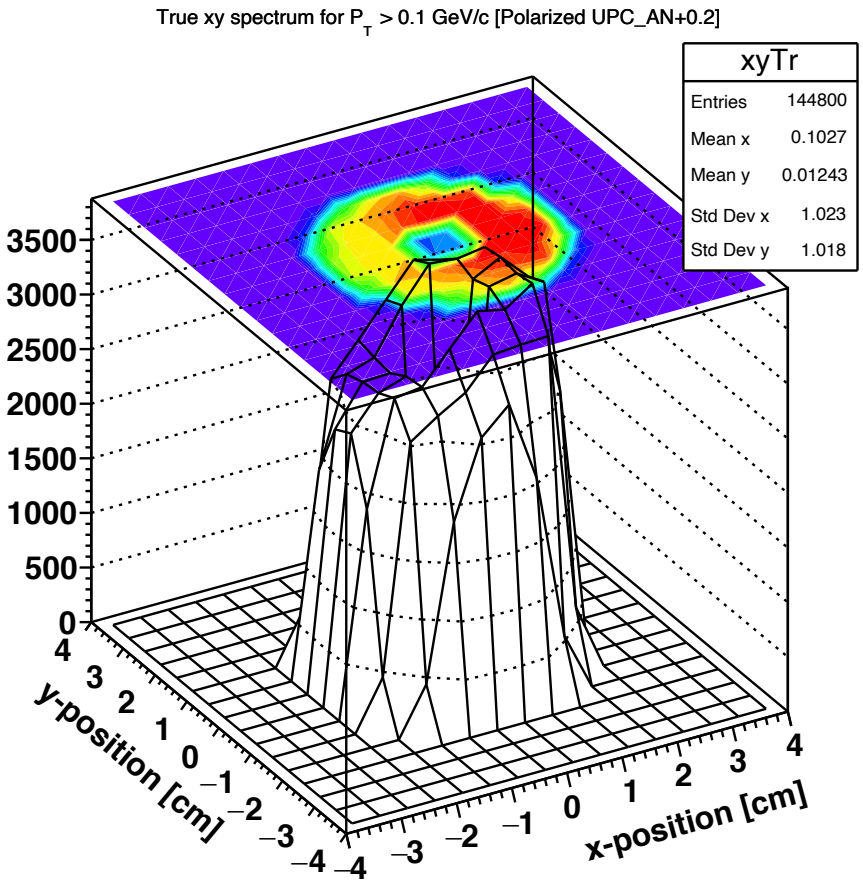


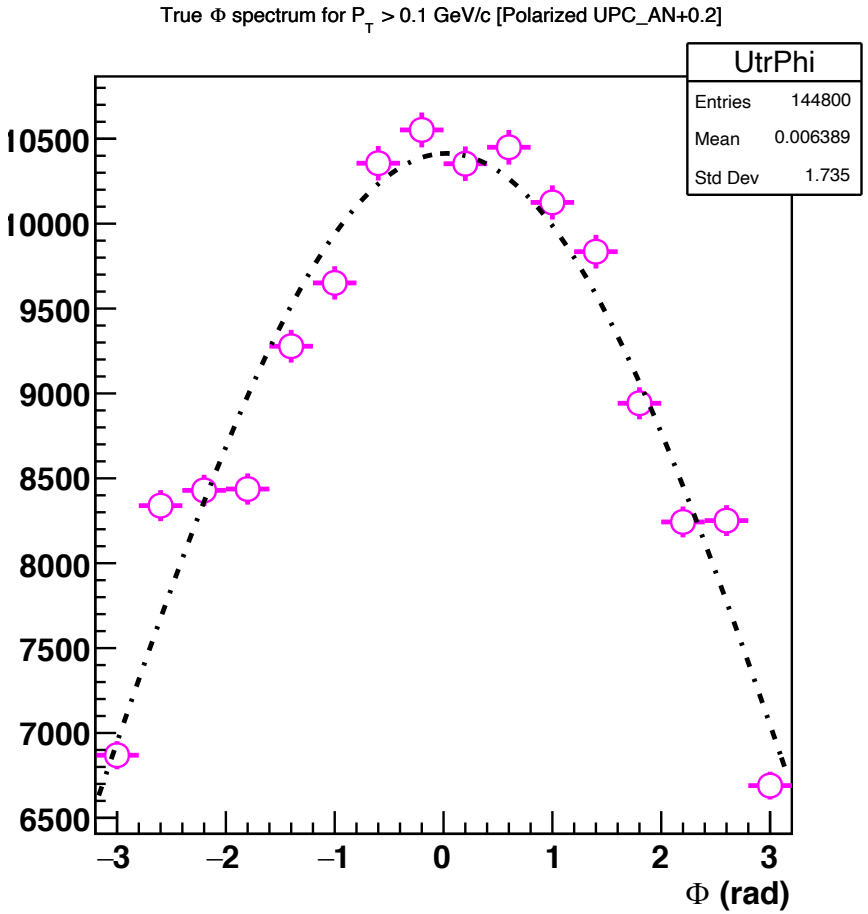






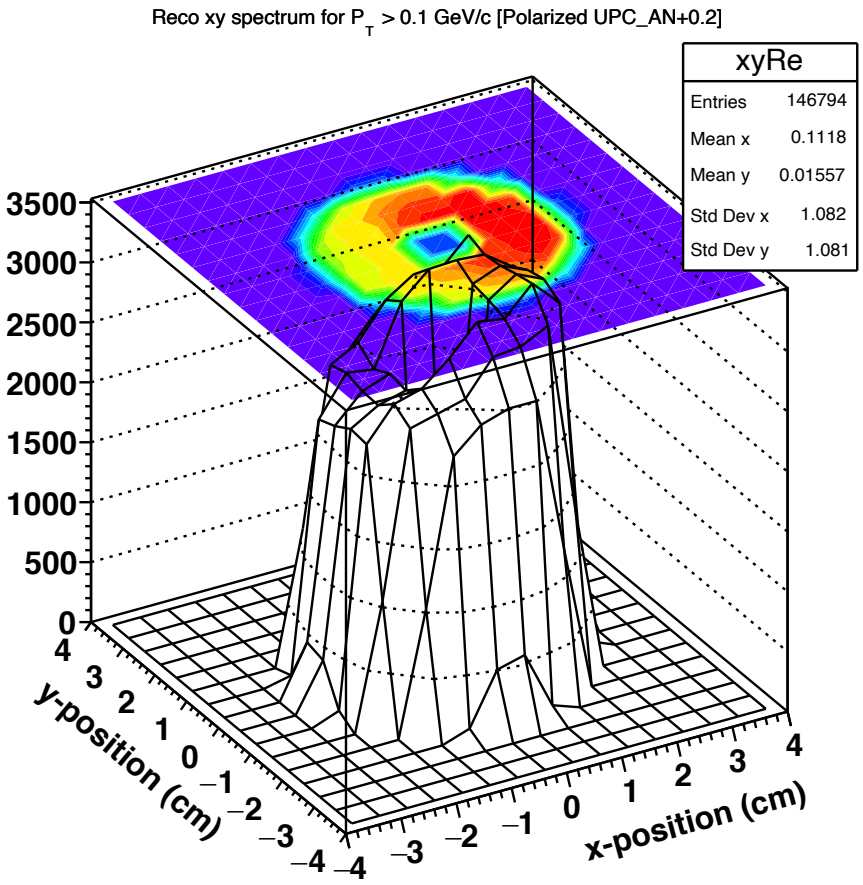
True XY and Phi Spectra for Polarized UPC_AN+0.2

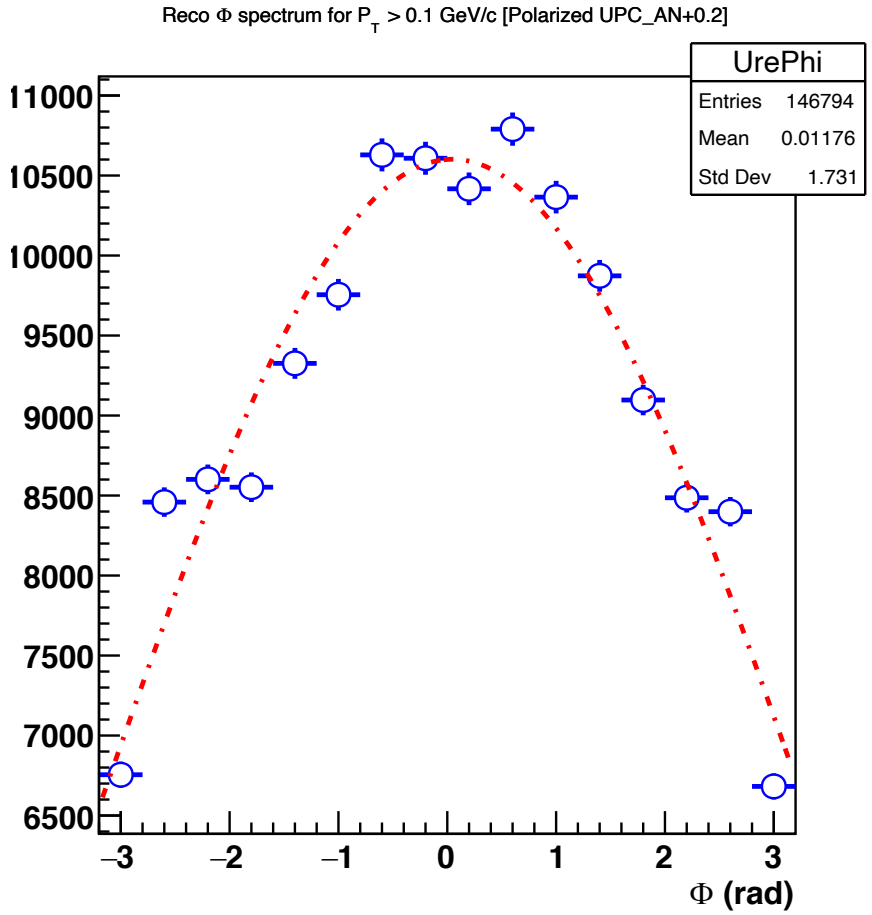




True neutron xy position distribution (Left) and corresponding azimuthal (Φ) distribution (right)

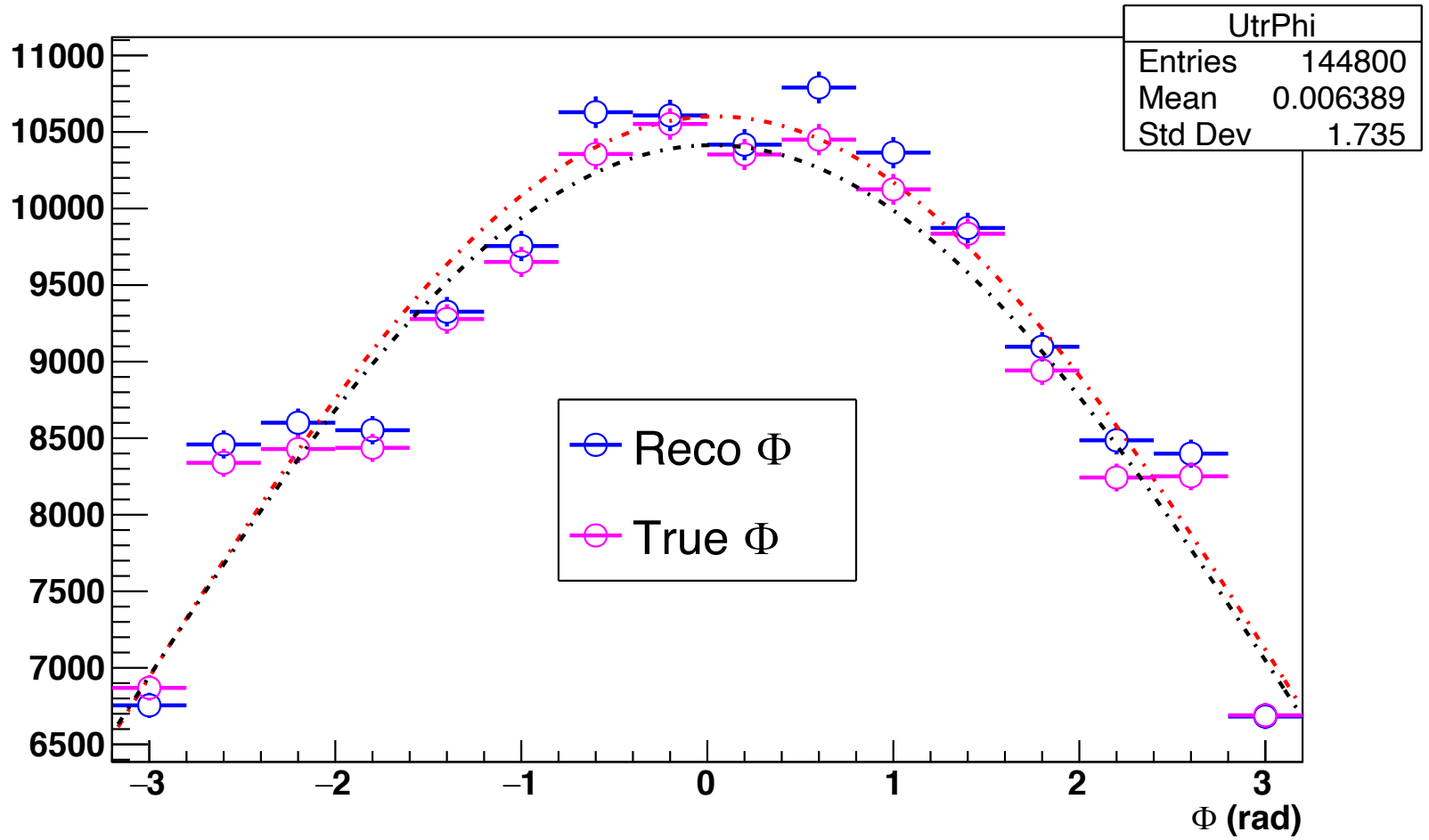
Reco XY and Phi Spectra for Polarized UPC_AN+0.2





Reco neutron xy position distribution (Left) and corresponding azimuthal (Φ) distribution (right)

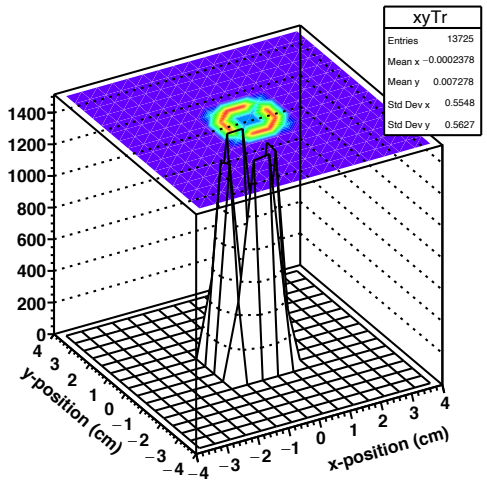
Comparison of True and Reco Phi Spectra for Polarized UPC_AN+0.2



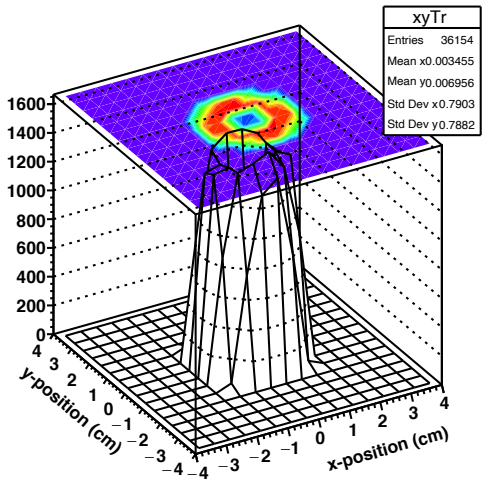
True azimuthal (Φ) distribution (Magenta) and reconstructed azimuthal distribution(blue)

True XY and Φ for Un-polarized UPC

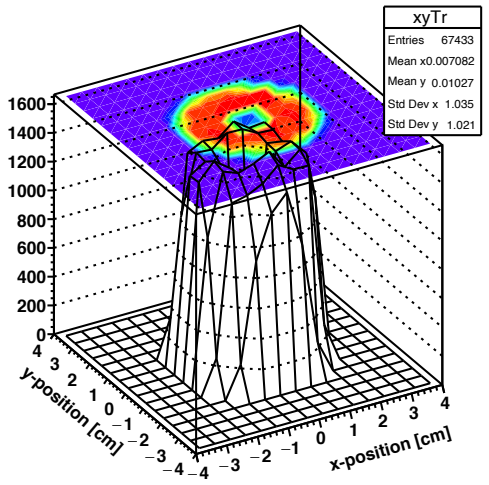
True xy spectrum for 0.5<r<1.0 cm [UPC un-polarized]



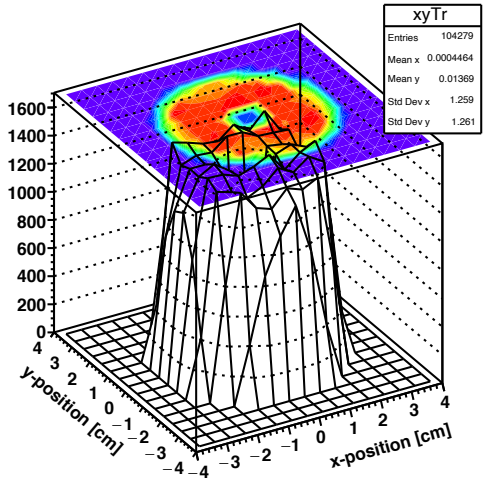
True xy spectrum for 0.5 < r < 1.5 cm [UPC un-polarized]



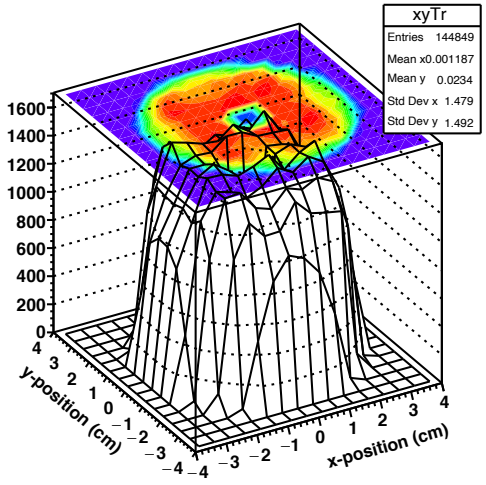
True xy spectrum for 0.5 < r < 2.0 cm [UPC un-polarized]



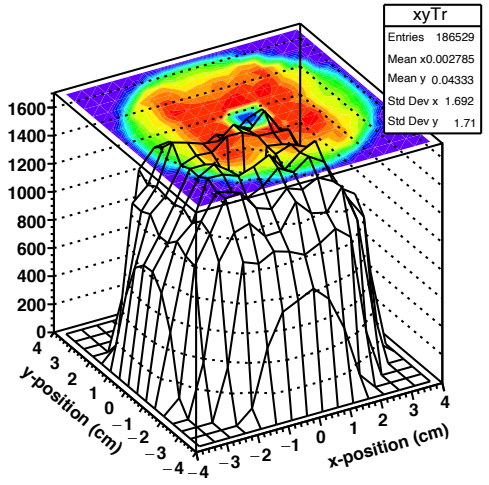
True xy spectrum for 0.5 < r < 2.5 cm [UPC un- polarized]



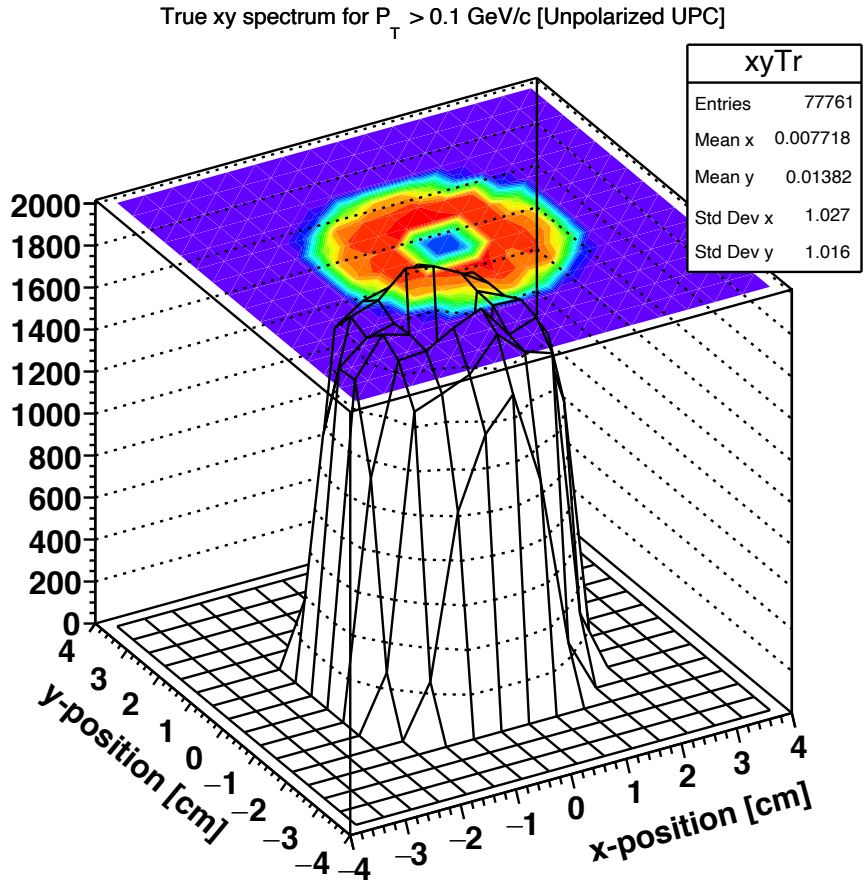
True xy spectrum for 0.5 < r < 3.0 cm [UPC un- polarized]

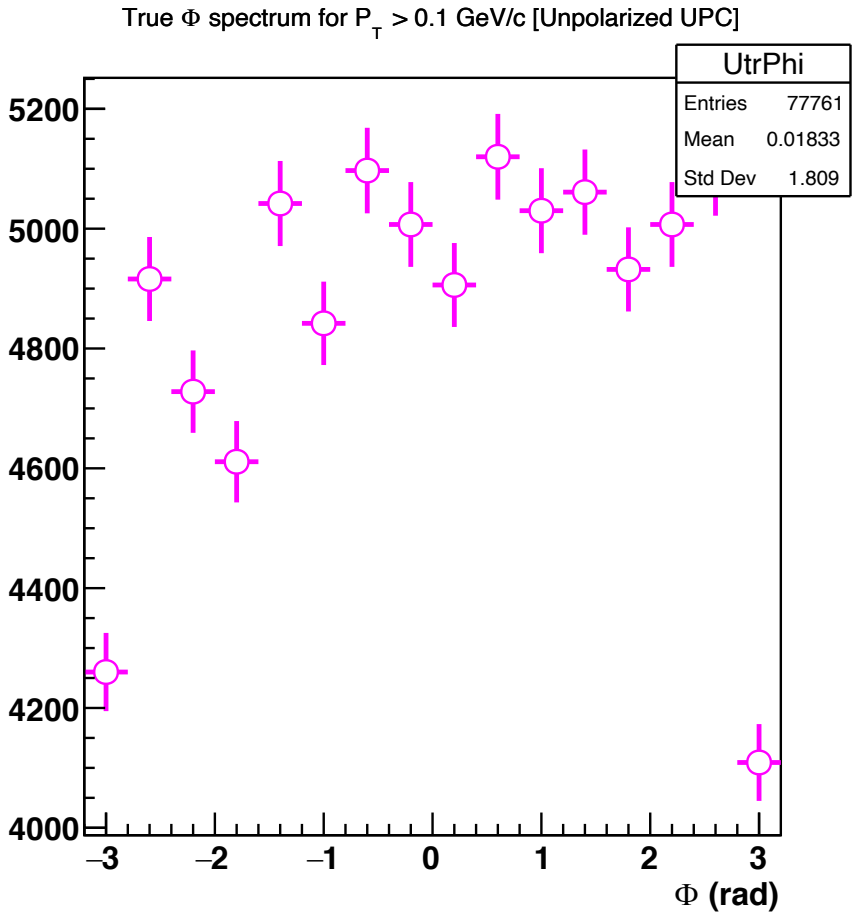


True xy spectrum for 0.5 < r < 3.5 cm [UPC un- polarized]



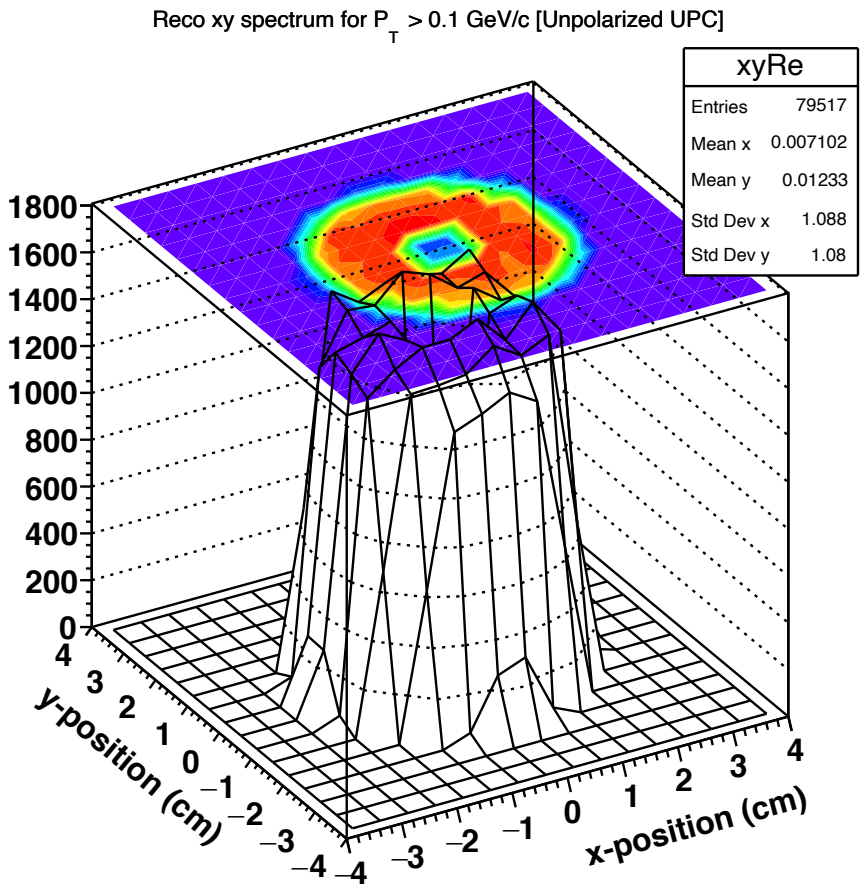
True XY and Phi Spectra for Unpolarized UPC

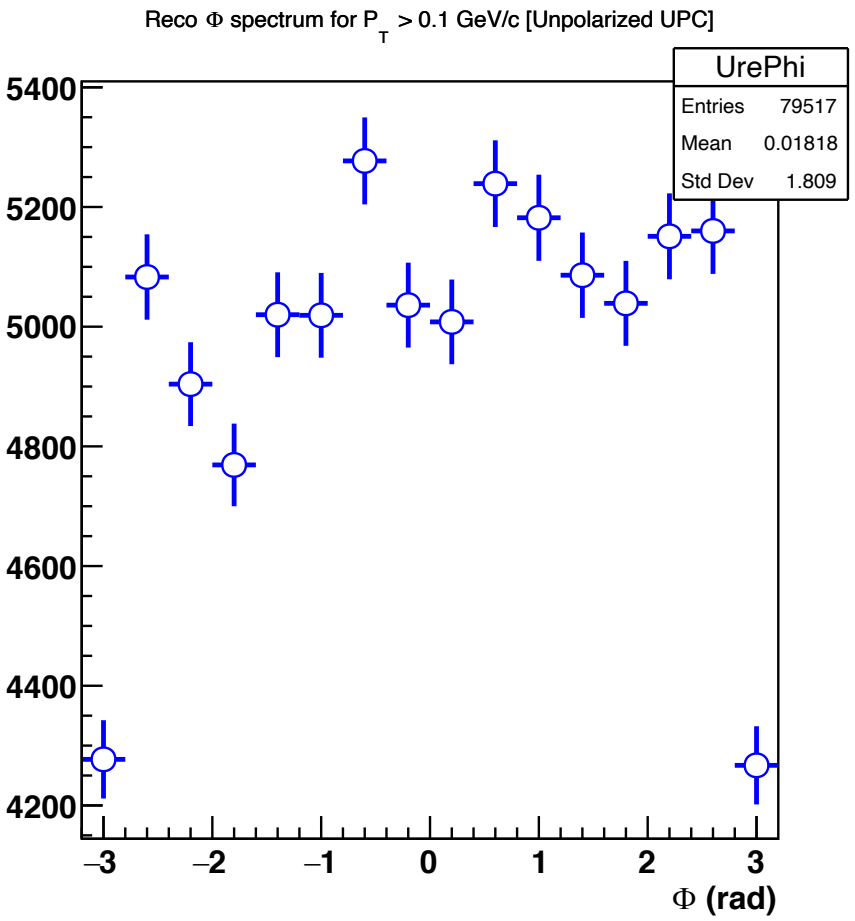




True neutron xy position distribution (Left) and corresponding azimuthal (Φ) distribution (right)

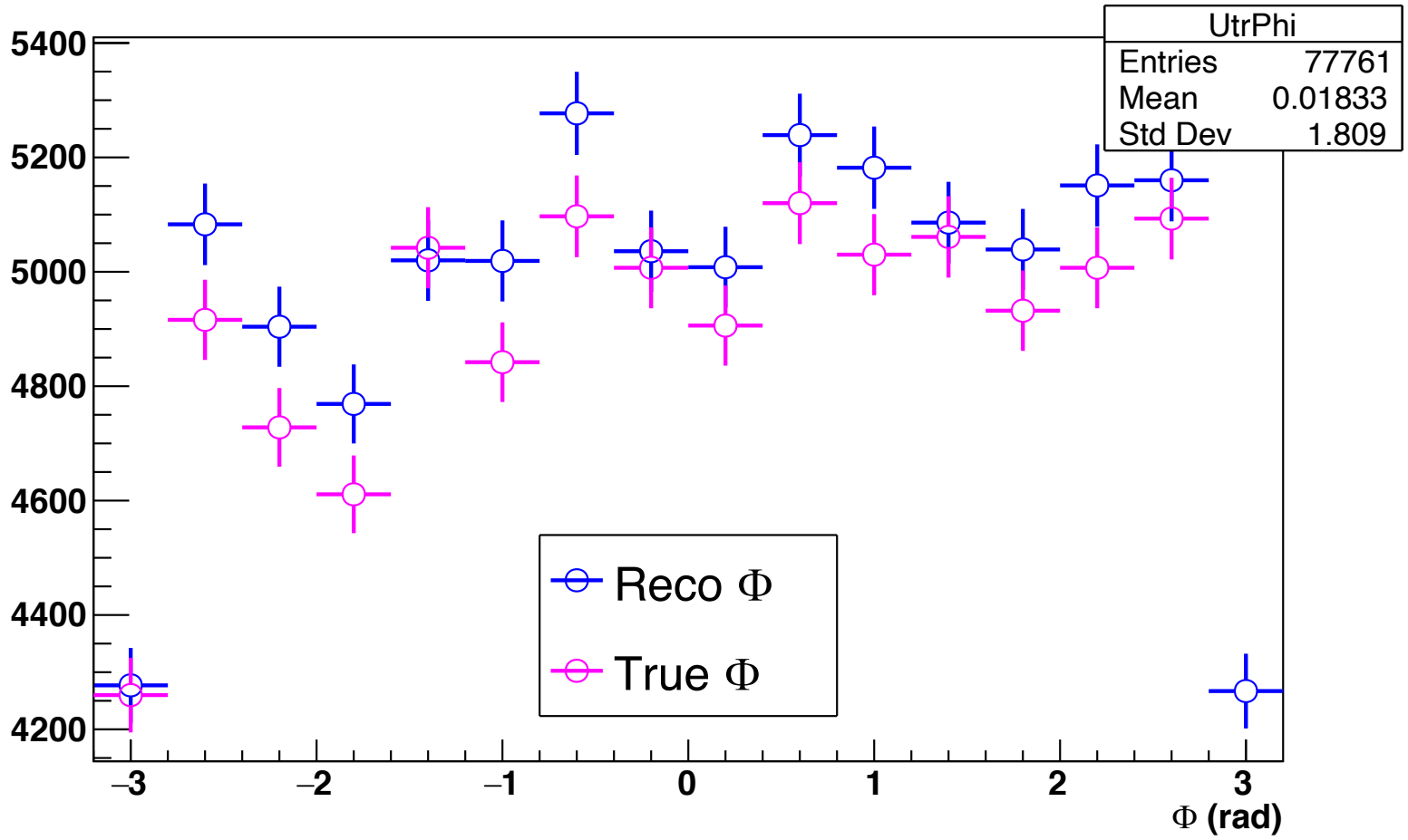
Reco XY and Phi Spectra for Unpolarized UPC





Reco neutron xy position distribution (Left) and corresponding azimuthal (Φ) distribution (right)

Comparison of True and Reco Phi Spectra for Unpolarized UPC



True azimuthal (Φ) distribution (Magenta) and reconstructed azimuthal distribution(blue)

BACKUP

True and Reco XY and Phi

For the true:

- Maximum energy, E(true) = 100 GeV
- Transverse momentum peak, Pt(peak) = 0.1 GeV

From above information, true r cut is:

Pt(peak) = [r * E(true)] / IP, where IP = 1856 cm [pAu run15 data]

Therefore, r cut to the true is:

r (true) = [Pt (peak) * IP] / E(true) = (0.1 * 1856) / 100 = 1.856 cm < 2.0 cm

So applying r (true) < 4.0 cm I applied in the first report while I was in BNL introduced some smearing.

True xy and phi distributions for neutrons are extracted from Lorentz math using the true variables x[ipart], y[ipart], z[ipart], px[ipart], py[ipart], pz[ipart], pdg, pid = 2112, mass (M) and energy (E)

- Mass (M)
  Extracted using method: TDatabasePDG::Instance()->GetParticle(pdg)->Mass(), where
  pdg = TDatabasePDG::Instance()->ConvertGeant3ToPdg(pid[ipart])
- Energy (E)
  Extracted using:
  E(true) = TMath::Sqrt(px[ipart]*px[ipart] + py[ipart]*py[ipart] + pz[ipart]*pz[ipart] + mass*mass)
- Using TLorentzVector, true variables x, y, z, px, py, pz, E, m are set using the method:
  SetPxPyPzE(px[ipart], py[ipart], -pz[ipart], E) and SetXYZM(x[ipart], y[ipart], z[ipart]., M)

True and Reco XY and Phi

From SetXYZM(x[ipart], y[ipart], 0., M) = L1, the true radial distance is:
r(true) = TMath::Sqrt(L1.X()*L1.X() + L1.Y()* L1.Y()) from which
rtrue (min) < 0.5 cm due to SMD position resolution
rtrue (max) < 2.0 cm as shown on top of previous slide.

And from SetPxPyPzE(px[ipart], py[ipart], -pz[ipart], E) = L2;
True azimuthal distribution is, Phi = L2.Phi()
with azimuthal area divided into 16 azimuthal bins.

For the reconstructed xy distribution, reconstructed variables are used:
xx_ev and yy_ev from which reconstructed radial distance is:
r(reco) = Sqrt(xx_ev * xx_ev + yy_ev * yy_ev) with;
rmin (reco) > 0.5 cm due to 1 cm position resolution of SMD
rmax (reco) > 2. 0 cm for neutrons with Pt > 0.10 GeV/c smeared neutrons.

The corresponding reconstructed phi distribution is calculated as:
Phi(reco) = TMath::ATan2(yy_ev, xx_ev)
With xx_ev and yy_ev being reconstructed x and y position of neutrons respectively.