Measurement of W Asymmetry in Transveresely Polarized pp Collisions at STAR

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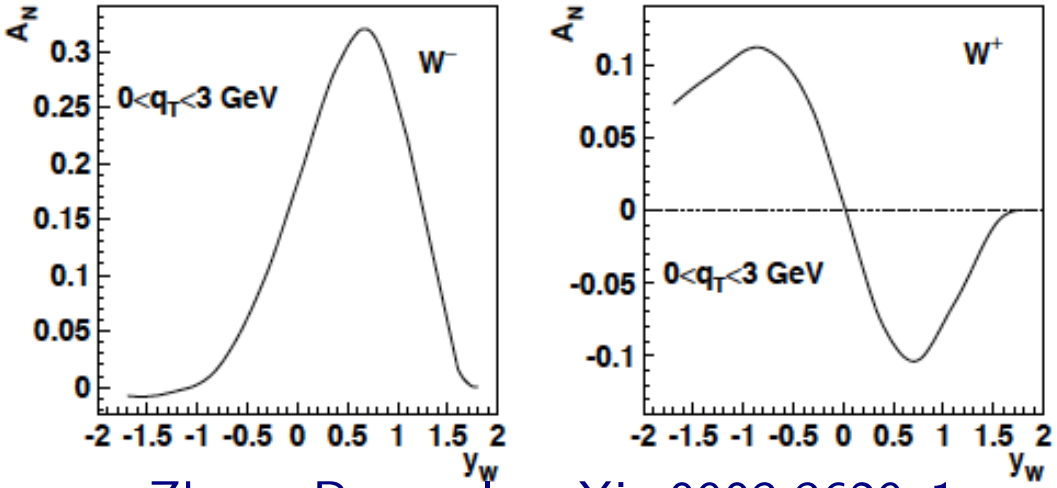
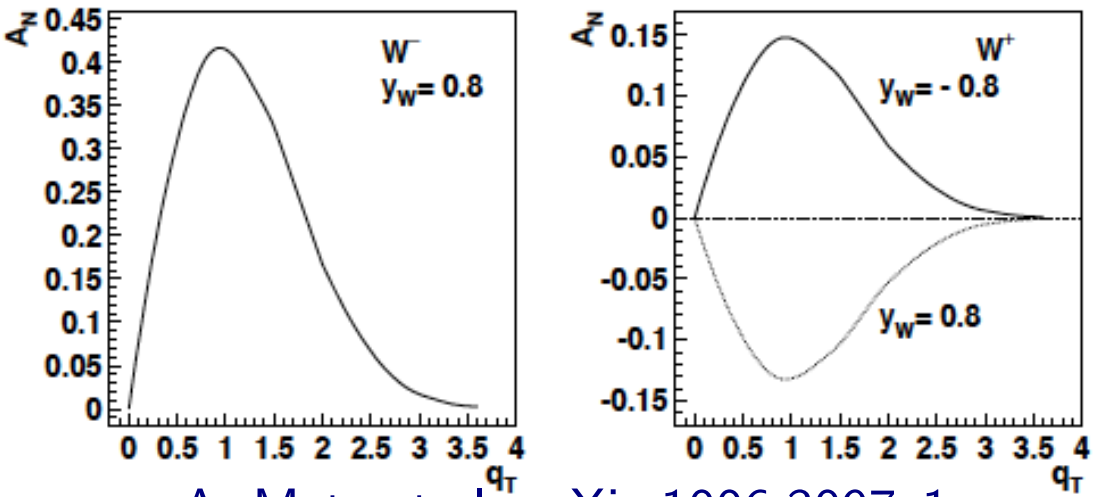
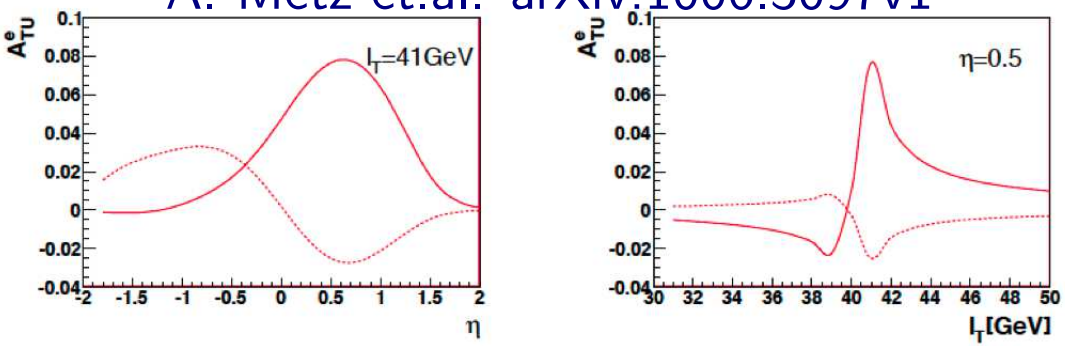
Motivation



Zhong-Bo et.al. arXiv:0903.3629v1



A. Metz et.al. arXiv:1006.3097v1



- As with DY process the W production can be used to measure the sign change of the Sivers function
- Collins' prediction of the sign change can be verified

$$\text{Sivers(SIDIS)} = -\text{Sivers(DY)} = -\text{Sivers}(W^{\pm})$$

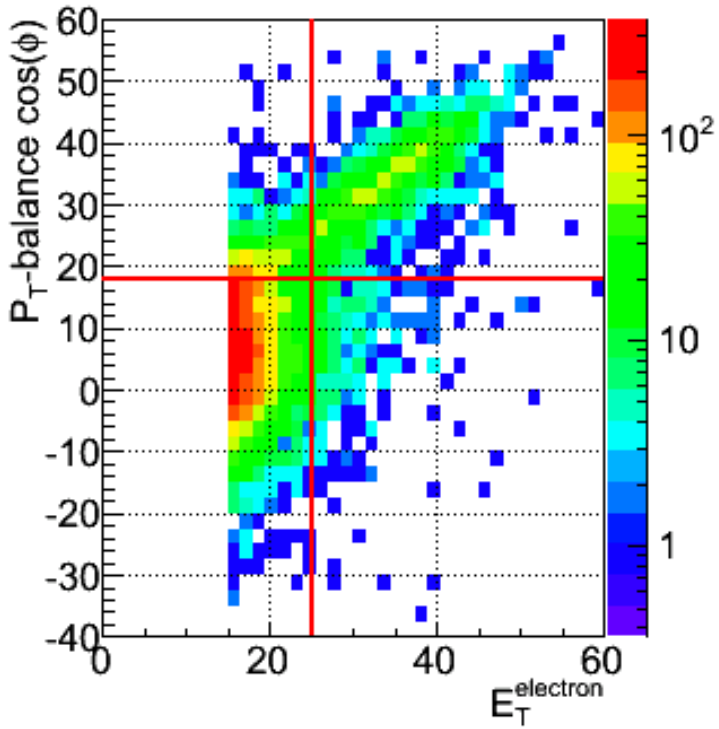
- The W asymmetries expected to be larger than the lepton ones
- While the lepton direction is measured directly the W asymmetries require the knowledge of W momentum
- This study is the first attempt to reconstruct the W kinematics at STAR

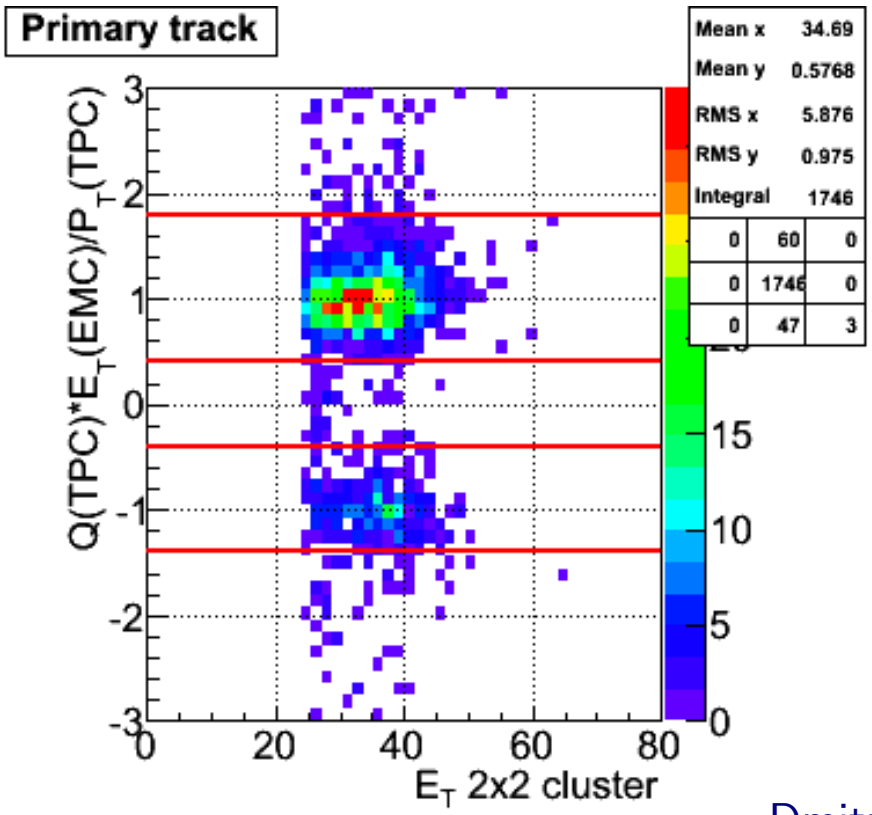
Data and MC Samples

- ~ 900 data runs from Run 11
  - $L \approx 25$ pb^{-1}
  - Initial sample size 6.2M events (high threshold barrel or endcap trigger)
- Signal
  - $W \to e\nu_e$
- Backgournds
  - $W \to \tau\nu_\tau \to e\nu_e\nu_\tau$
  - $Z \to ee$
  - Data-driven QCD
- Events reconstructed with SL12c libraries. MC is not embedded
- Official request for embedded Run 11 MC submitted

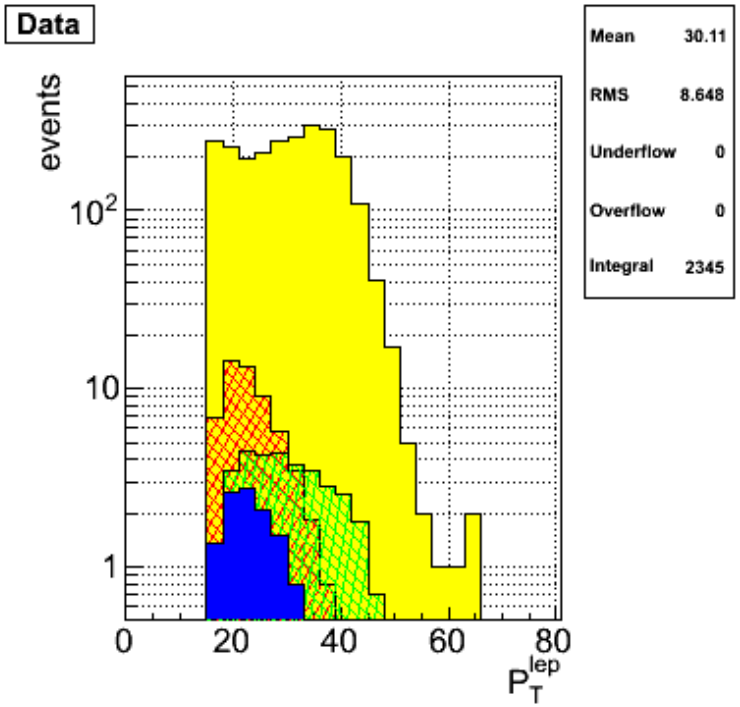
Data Selection

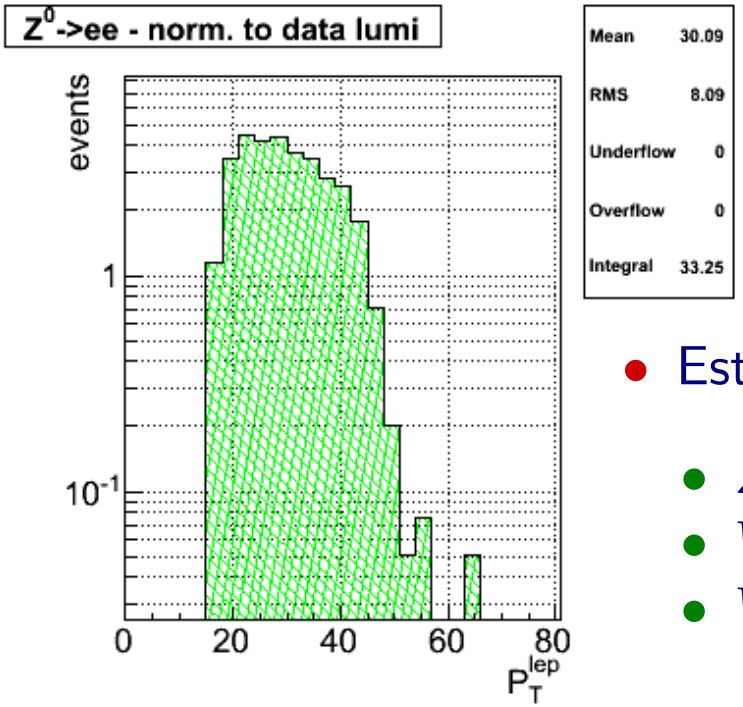
- Signal enreached event sample:
  - At least one good vertex within $|z| < 100$ cm
  - Require a good track matched to EM cluster (< 7 cm) with at least 15 hits ($> 50\%$ of possible hits)
  - Track $|\eta| < 1$, Isolation cut > 0.88
  - Deposited energy in the barrel $E_T > 15$ GeV ($E_T > 25$ GeV for "final" sample)
  - Charge separation cuts
- Data-driven QCD sample obtained by reversing the $\vec{\not{E}}_T$ (aka P_T balance) cut



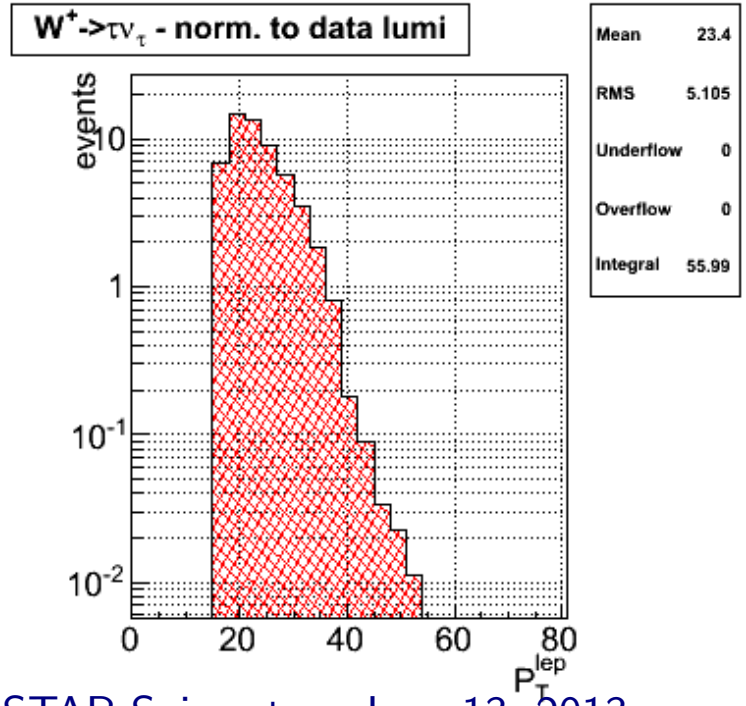


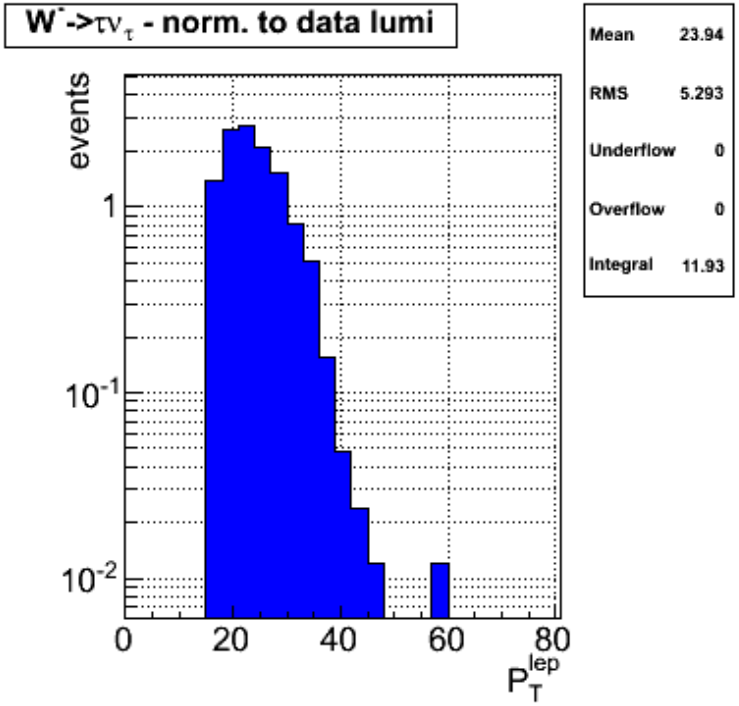
Background Estimation



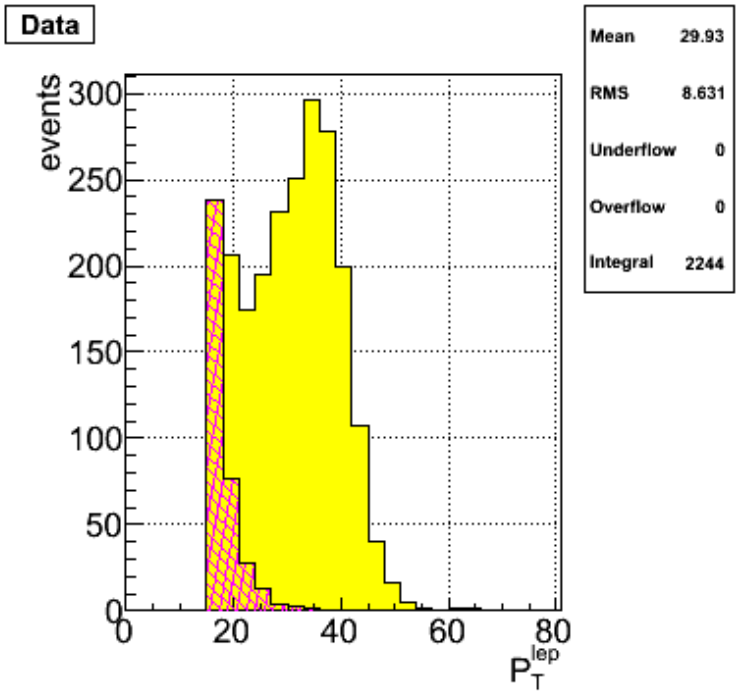


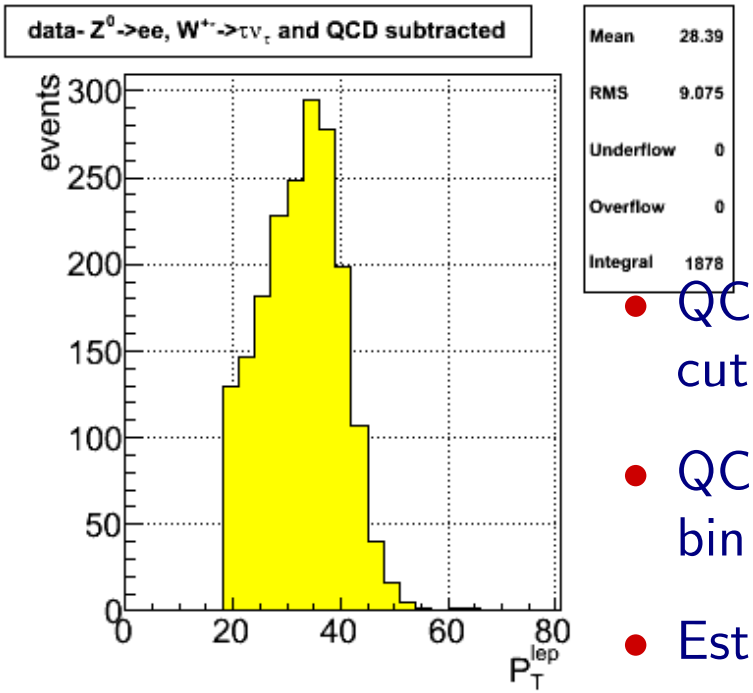
- Estimated background fractions:
  - $Z \to ee$: $\approx 1.4\%$
  - $W^+ \to \tau^+\nu_\tau$: $\approx 1.1\%$
  - $W^- \to \tau^-\nu_\tau$: $\approx 0.3\%$

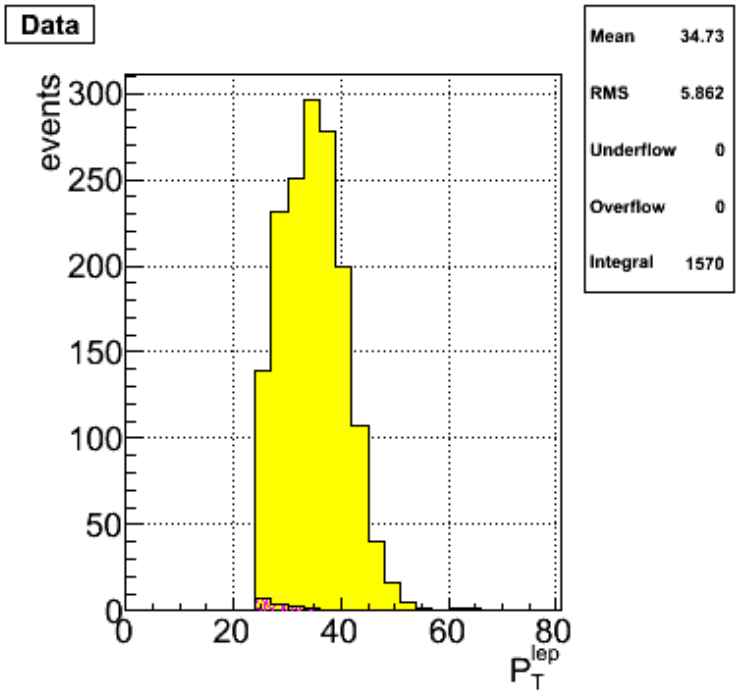


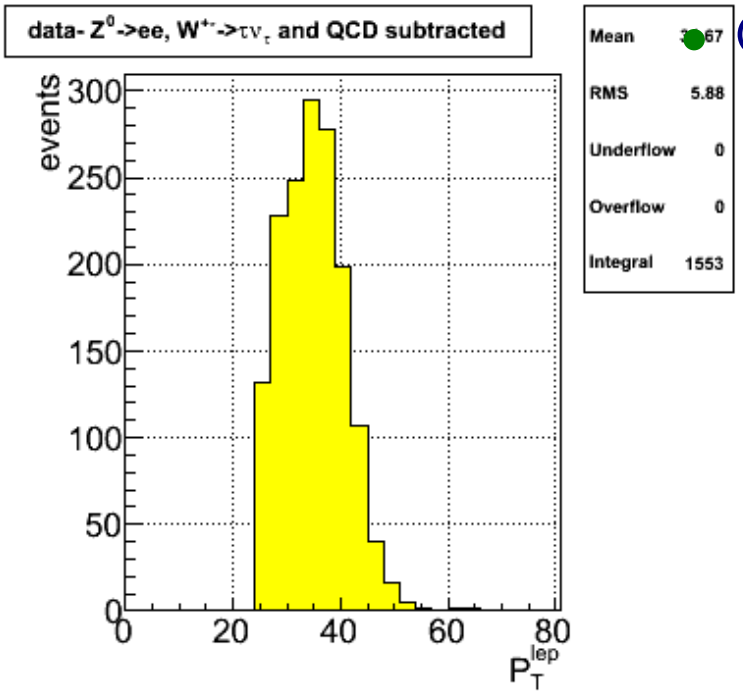


QCD Background Estimation







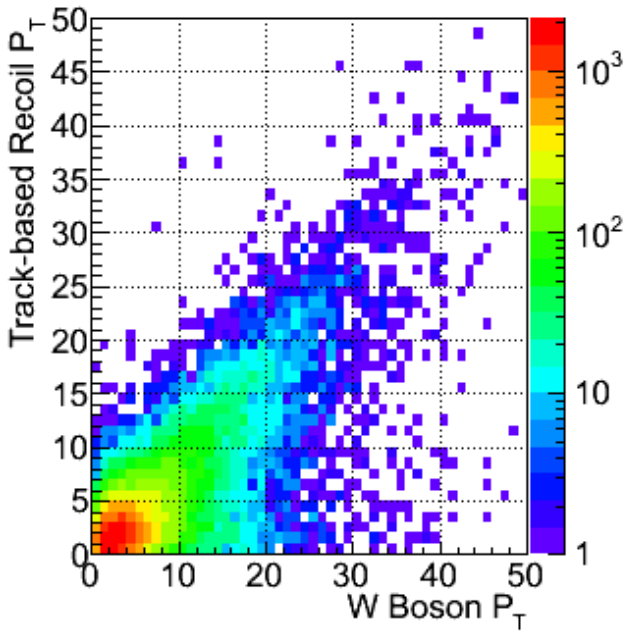


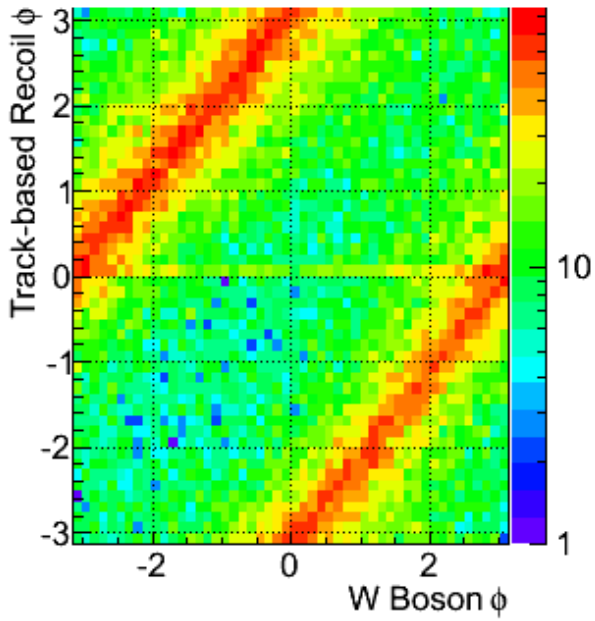
- QCD shape is with reversed $\vec{\not{E}}_T$ cut
- QCD is normalized to the first bin
- Estimated background fraction:

QCD: $1.4 \pm 0.1\%$

W Kinematics

- In transverse plane: $\vec{P}_T^W = \vec{P}_T^e + \vec{P}_T^\nu = \vec{P}_T^{\text{recoil}}$





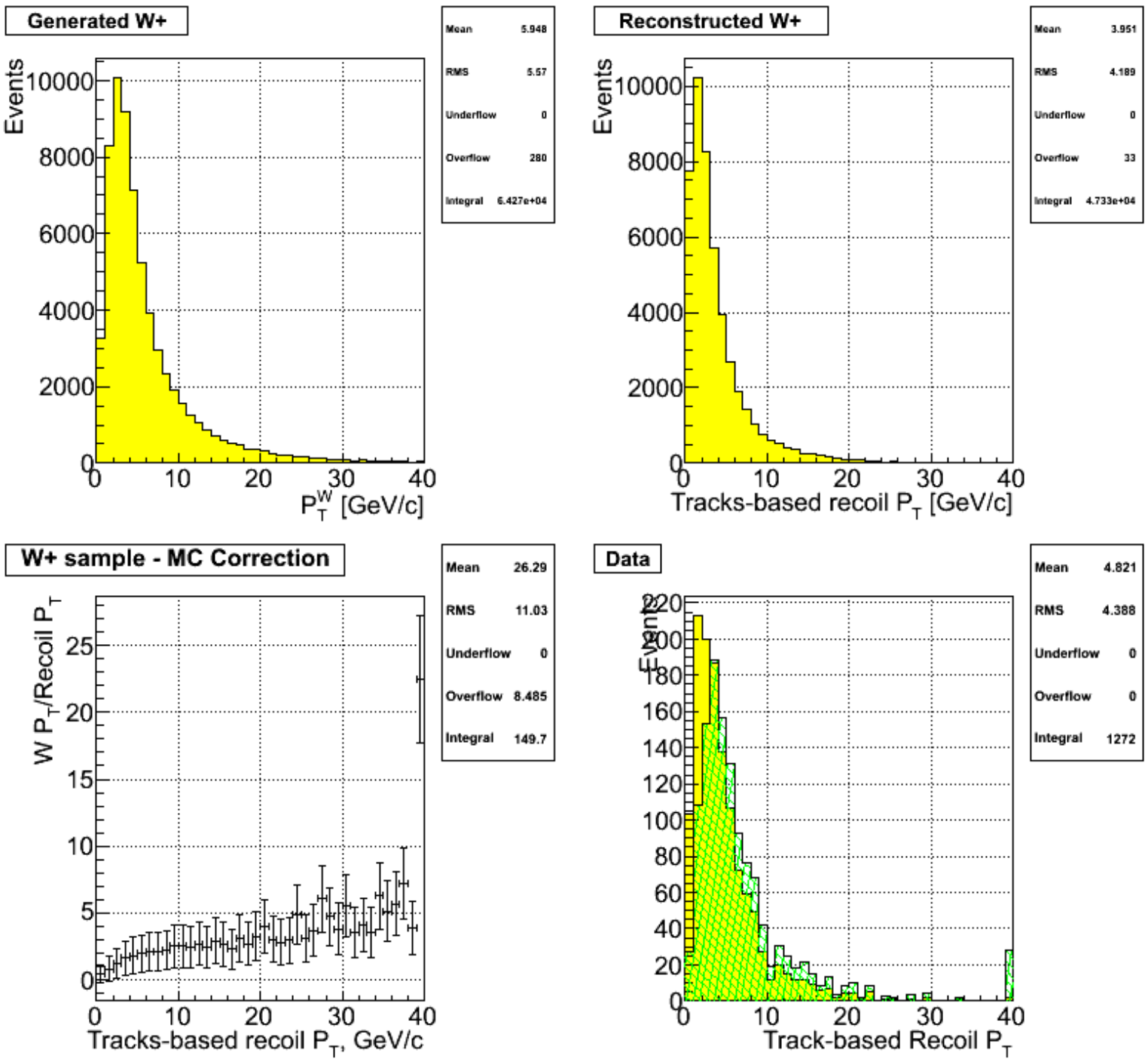
- Recoil reconstructed in data has to be corrected

$$P_T^W = k \times P_T^{\text{recoil}}, \text{where } k = \left(P_T^W / P_T^{\text{recoil}}\right)_{MC}$$

- Definition of recoil can play significant role in final systematics of this method

$$\vec{P}_T^{\text{recoil}} = \sum_{i=\text{jets, tracks+clusters}} \vec{P}_T^i$$

MC-based Recoil P_T Re-weighting



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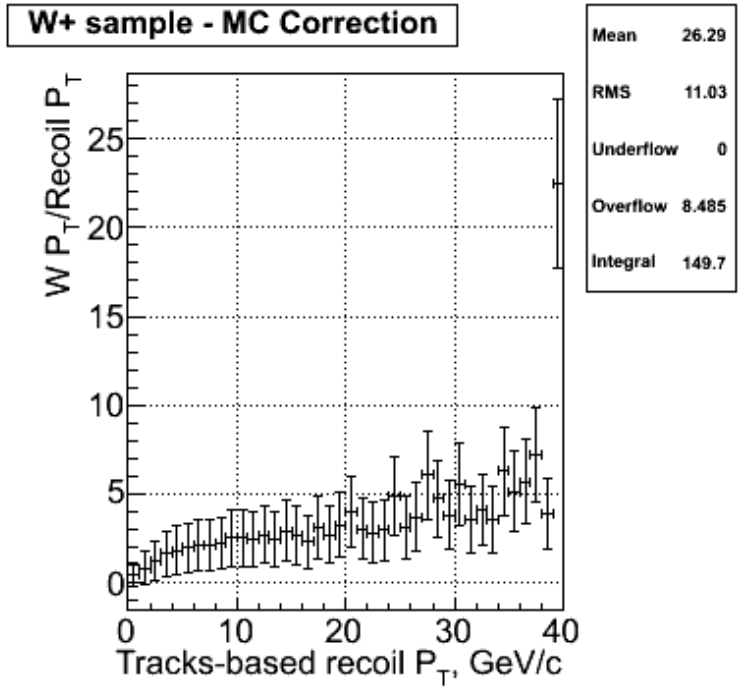
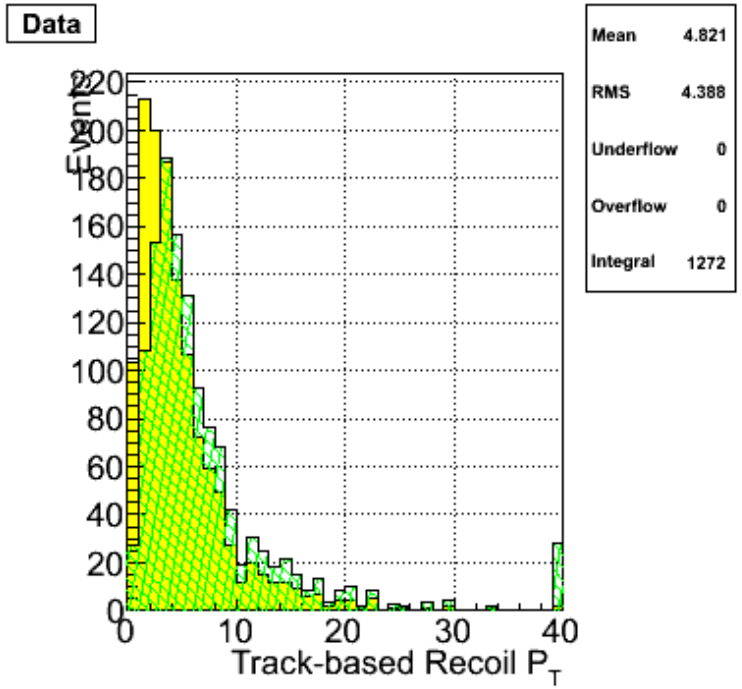
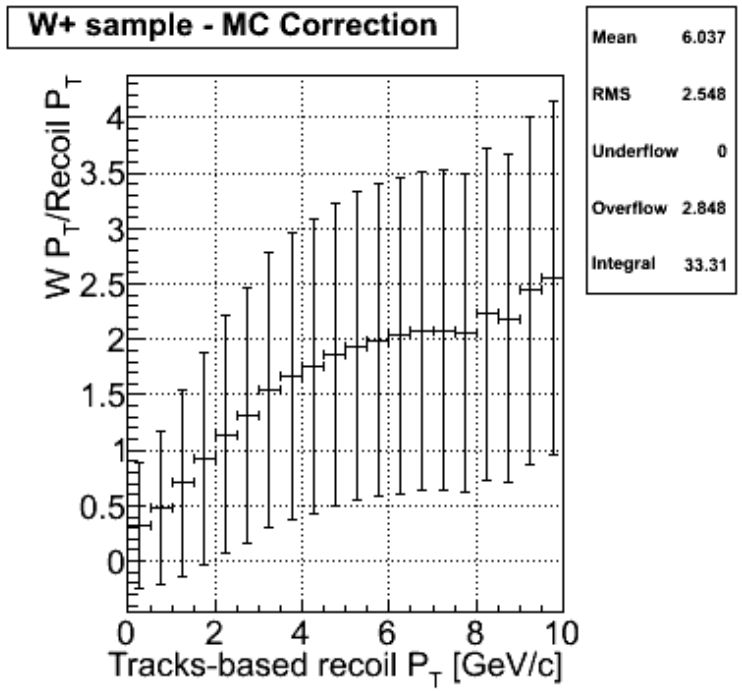
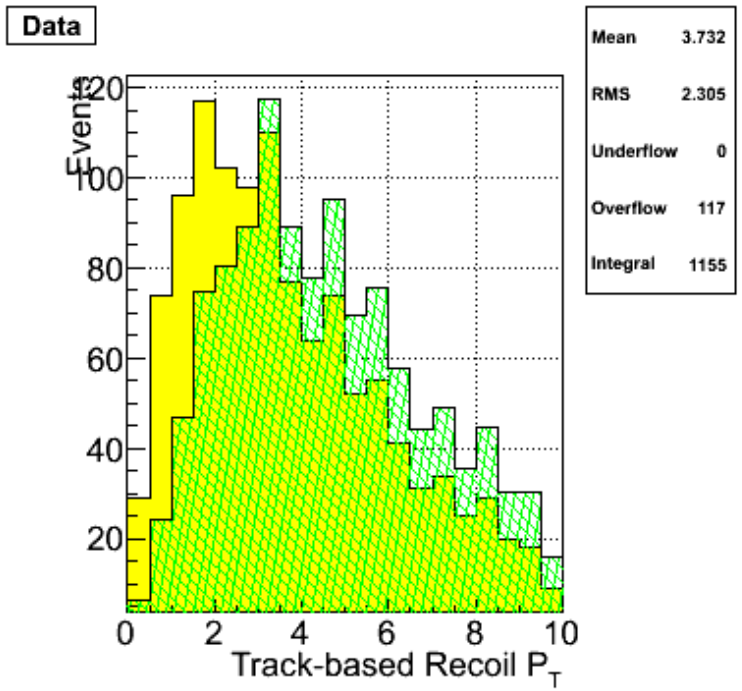
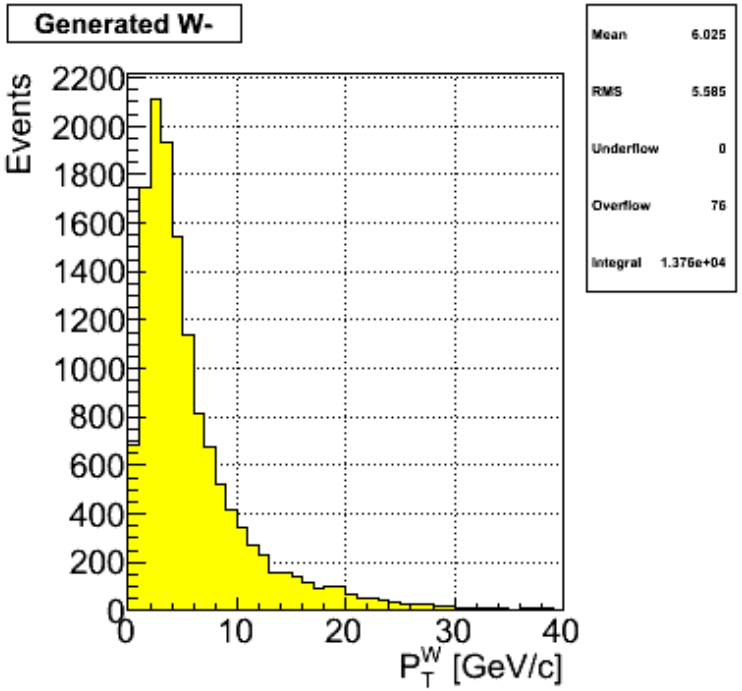


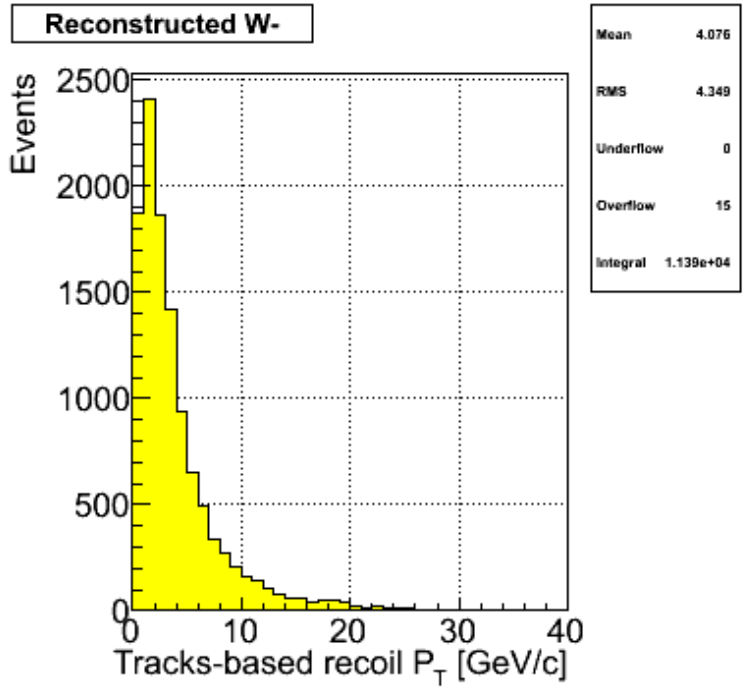


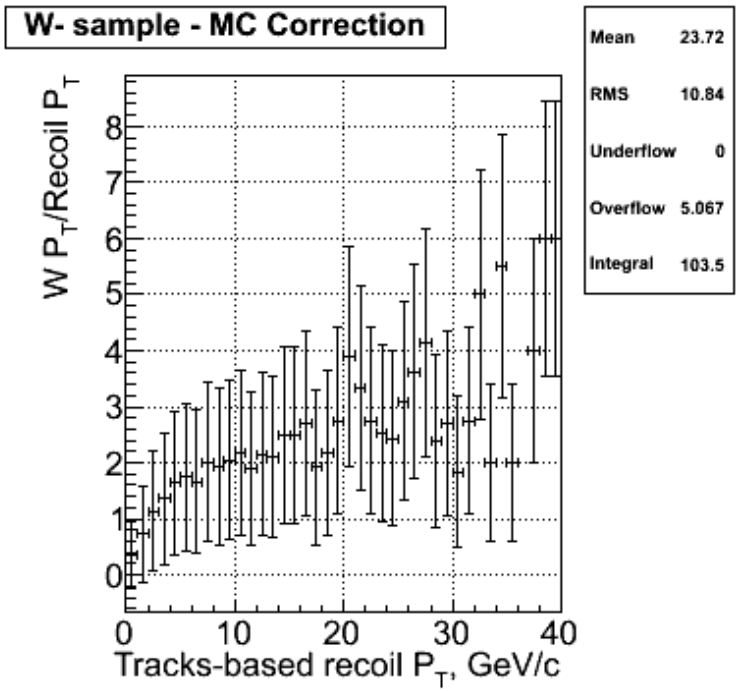


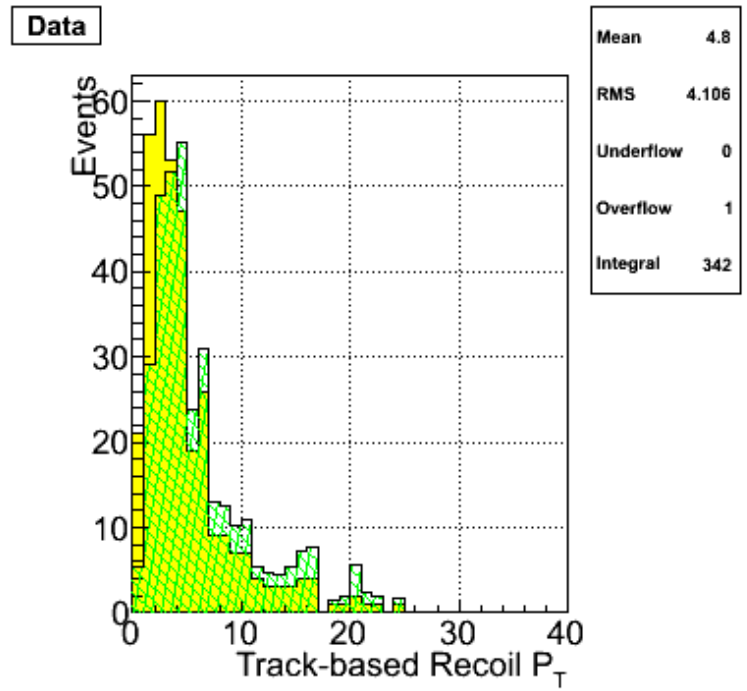


MC-based Recoil P_T Re-weighting









W Lepton Asymmetry

- The number of events with particle $p_T \in \Delta p_{T,i}$ and going in solid angle $\Delta\Omega_i$ is:

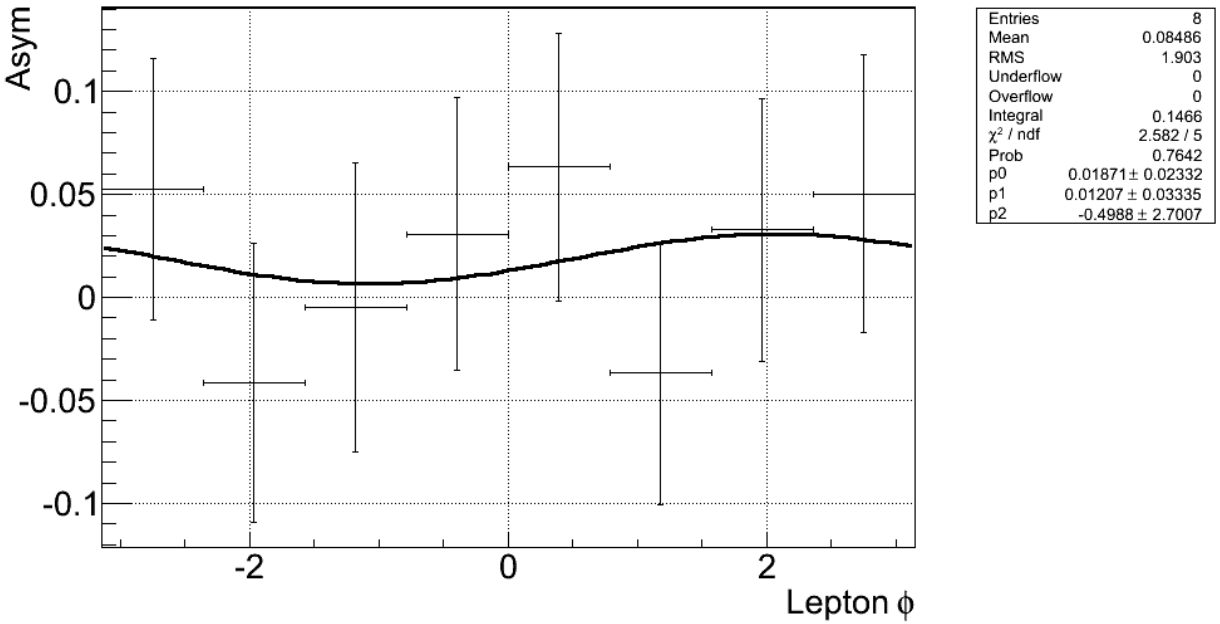
$$N_{\uparrow/\downarrow,i} = \mathcal{L}_{\uparrow/\downarrow}\sigma_{0,i}\varepsilon_i\Delta\Omega_i\Delta p_{T,i}\left(1 \pm A_{N,i}(\Omega, p_T)P\right)$$

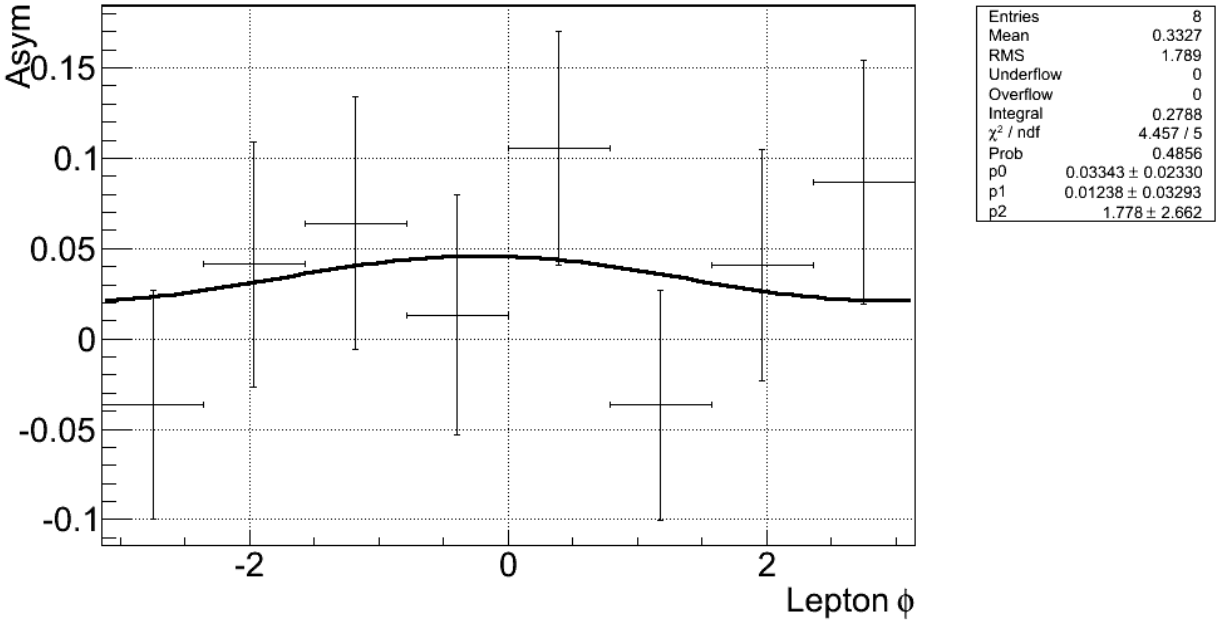
  where cross section $\sigma_{0,i}$, efficiency ε_i, and asymmetry $A_{N,i}$ are averaged over the bin $\{\Delta\Omega_i, \Delta p_{T,i}\}$

- The longitudinal component is ignored
- Asymmetry

$$A_{N,i} = \frac{1}{P}\frac{N_\uparrow(\phi_i) - R \times N_\downarrow(\phi_i)}{N_\uparrow(\phi_i) + R \times N_\downarrow(\phi_i)}$$

W Lepton Asymmetry





Summary

- Estimated background contributions in the signal sample
- Need to check the background asymmetries
- MC samples with embedding. . .
- Next time
  - Lepton asymmetries binned in P_T and η
  - W asymmetry in P_T