Measurement of W Asymmetry in Transveresely Polarized pp Collisions at STAR

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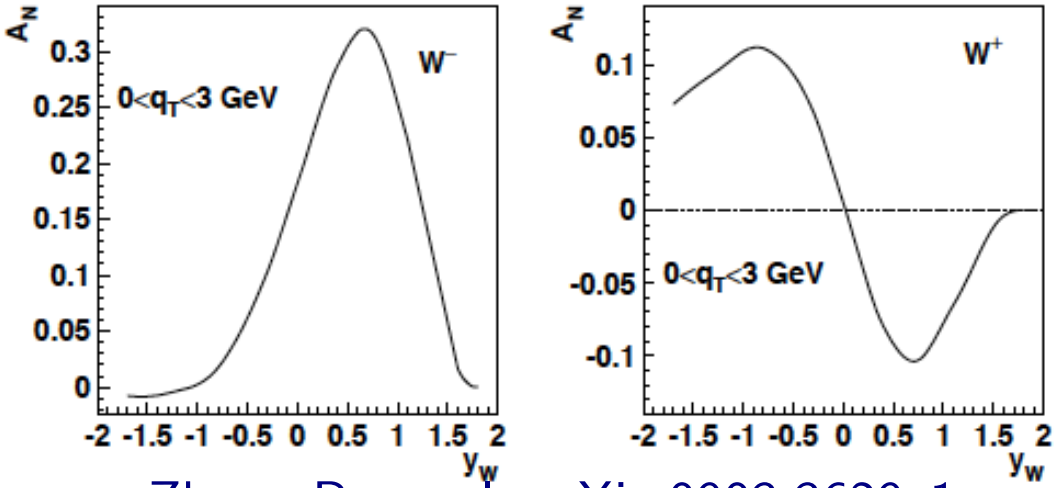
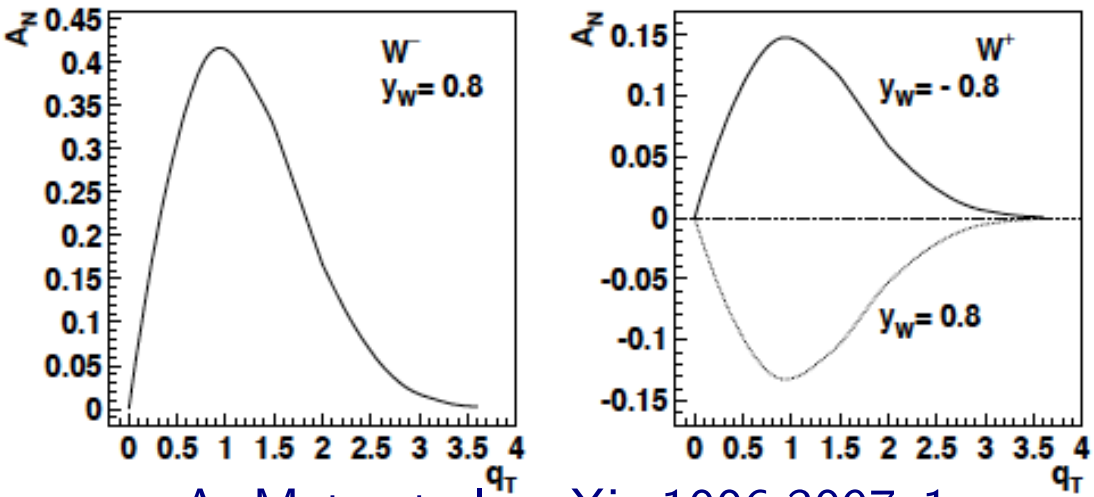
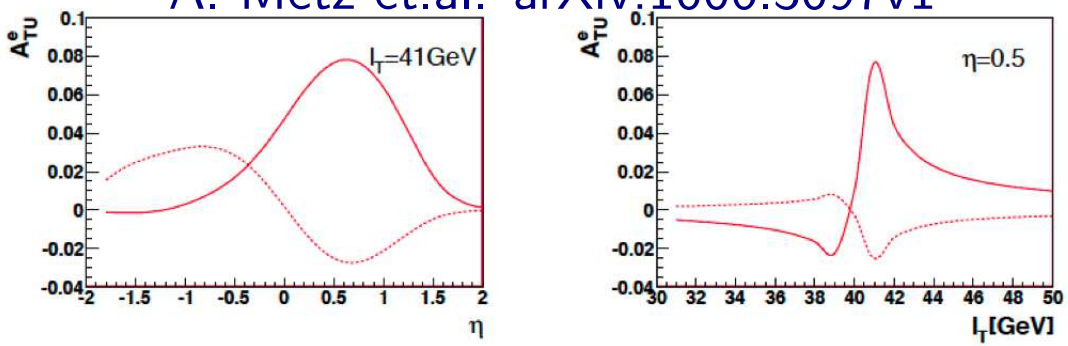
Motivation



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

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

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

Data and MC Samples

- **Data:** ~ 900 runs from Run 11
  - $L \approx 25$ pb^{-1}
  - Initial sample size 6.2M events (high threshold barrel or endcap trigger)
- **MC samples:**
  - $W \to e\nu_e$: Perugia Tune, **zero bias embedded,** $\sim 100k$ events
  - $W \to \tau\nu_\tau \to e\nu_e\nu_\tau$
  - $Z \to ee$
  - Data-driven QCD

Monte-Carlo Tuning

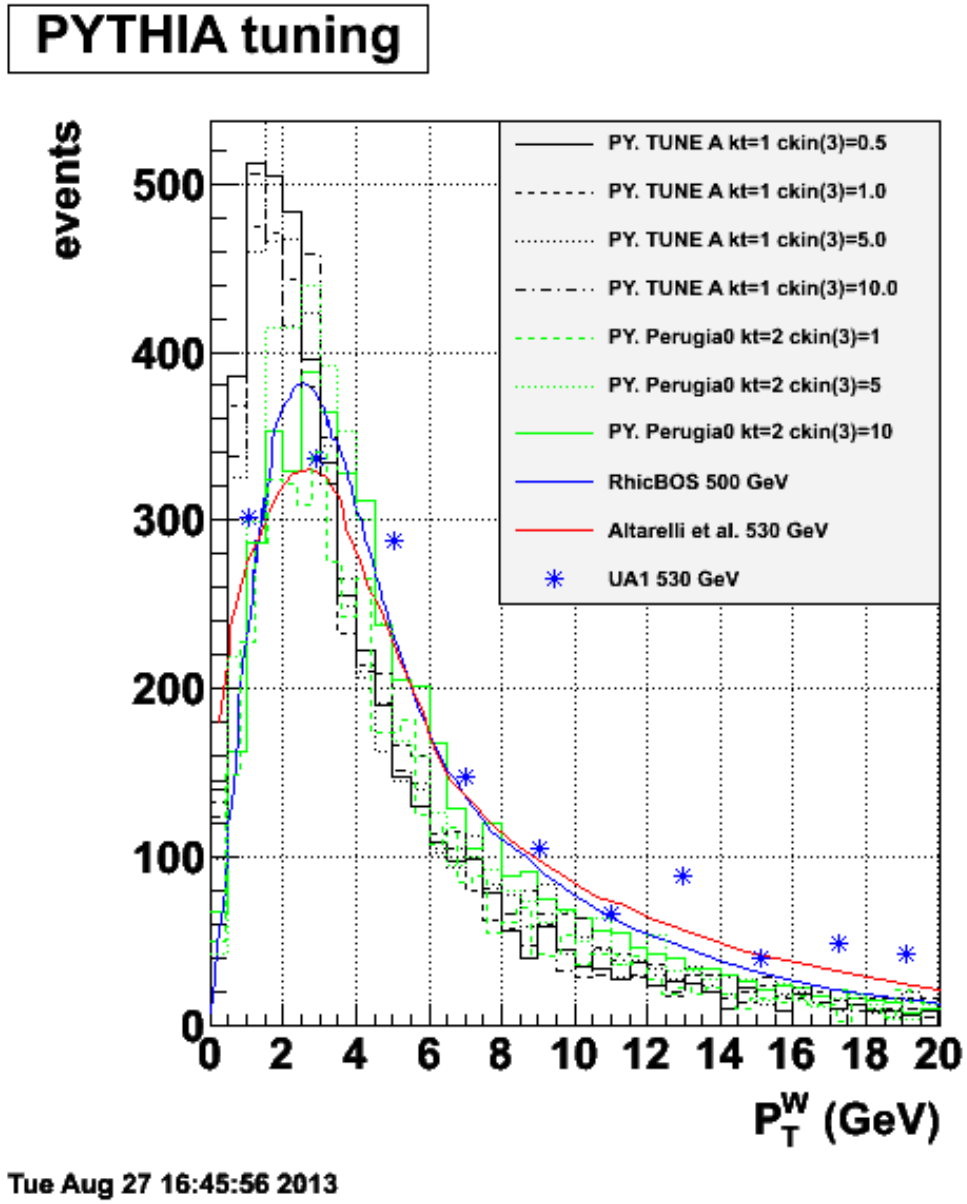
- In transverse plane:

$$\vec{P}_T^W = \vec{P}_T^e + \vec{P}_T^\nu \approx -\vec{P}_T^{\text{recoil}}$$

$$\vec{P}_T^\nu \approx \vec{\not{E}}_T = -\sum_{i \in \text{tracks, clusters}} \vec{P}_{i,T}$$

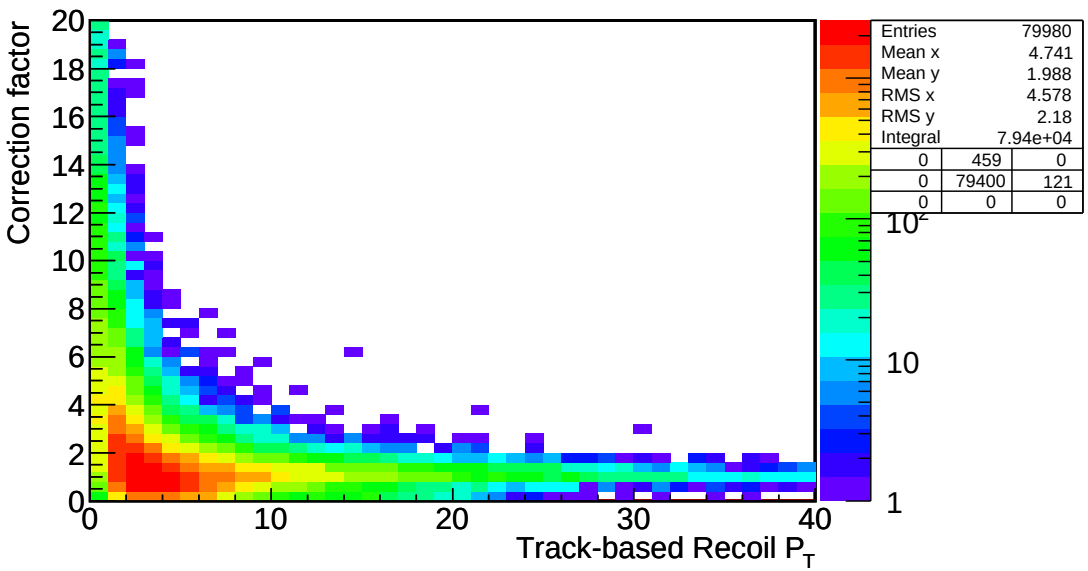
$$\vec{P}_T^{\text{recoil}} = \left(\sum_{i \in \text{tracks, clusters}} \vec{P}_{i,T} - \vec{P}_T^e \right)$$

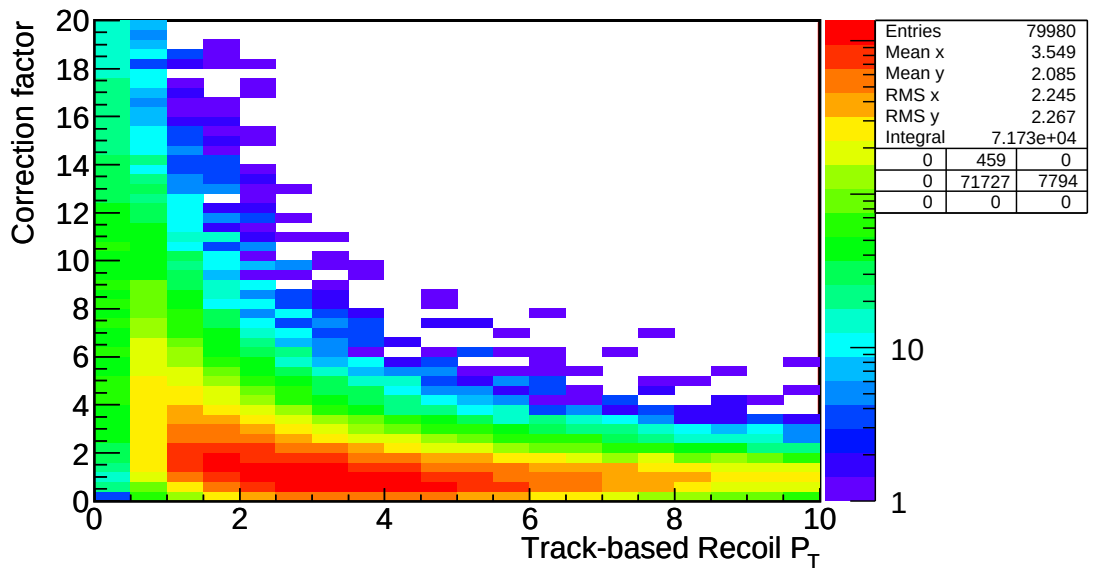
- Recoil reconstructed in data has to be corrected



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

MC Based Recoil Correction k

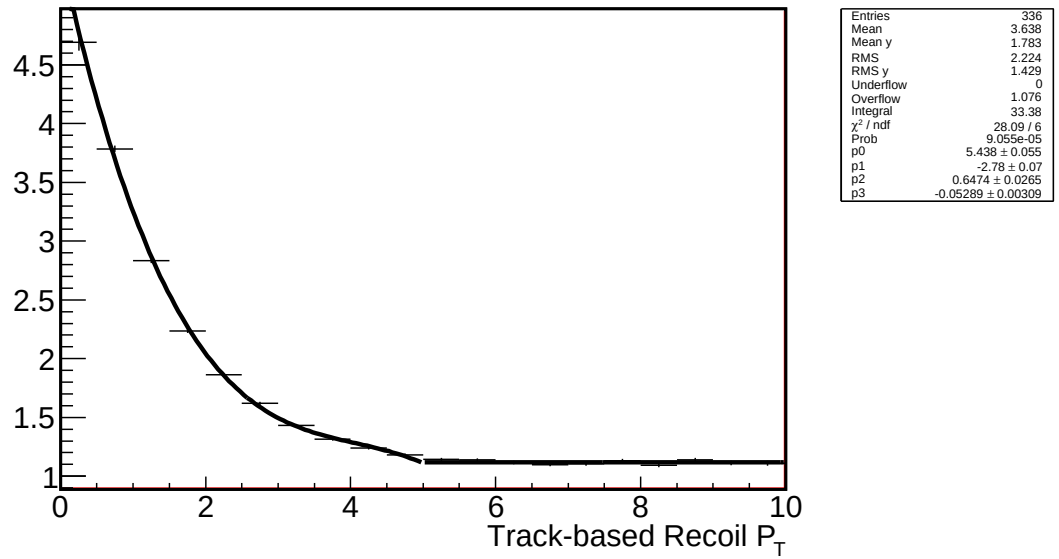




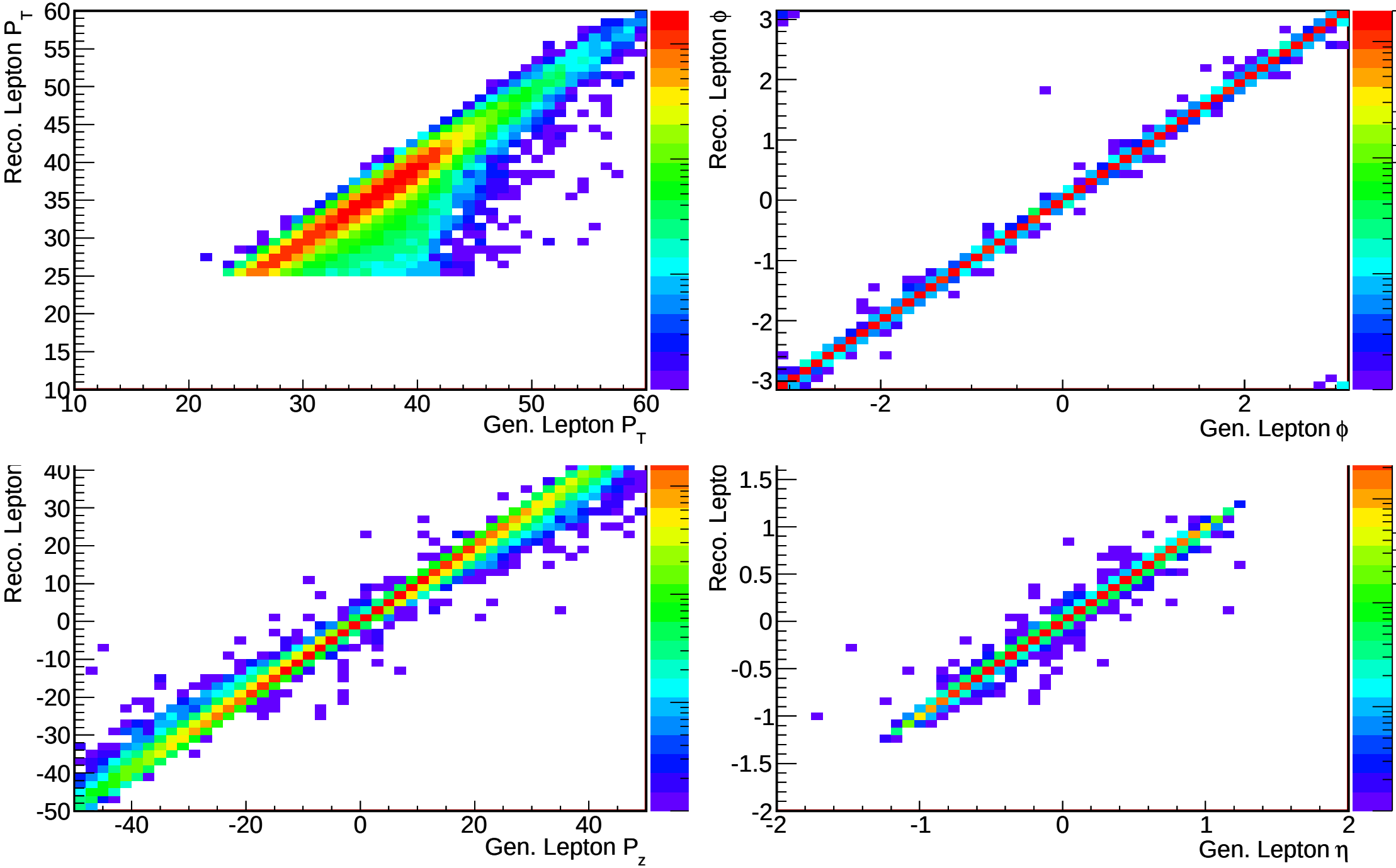
- Recoil correction is event-based

$$P_T^W = k \times P_T^{\text{recoil}},$$

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



Reconstructed vs. Generated: $e^{\pm}$



Neutrino ν Reconstruction

- In transverse plane:

$$\vec{P}^{\nu}_{T} \approx \vec{\not{E}}_{T} = -\sum_{i \in \substack{\text{tracks,}\\ \text{clusters}}} \vec{P}_{i,T}$$

- Longitudinal z-component can be reconstructed from invariant mass. Currently assume constant M_W, W produced on shell

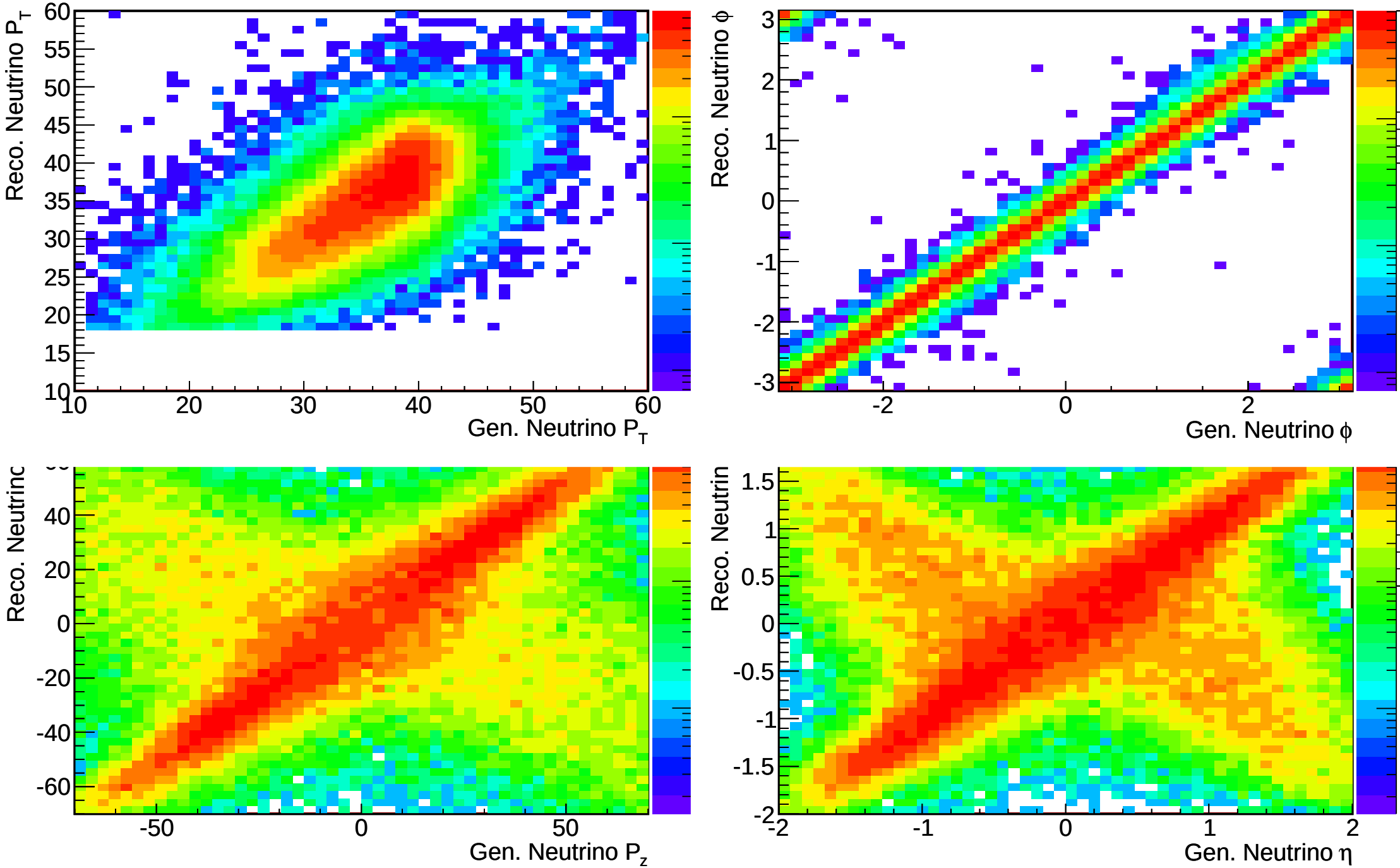
$$M_W^2 = (E_l + E_\nu)^2 - (\vec{p}_l + \vec{p}_\nu)^2$$

- Quadratic equation for $p_{\nu,z}$:

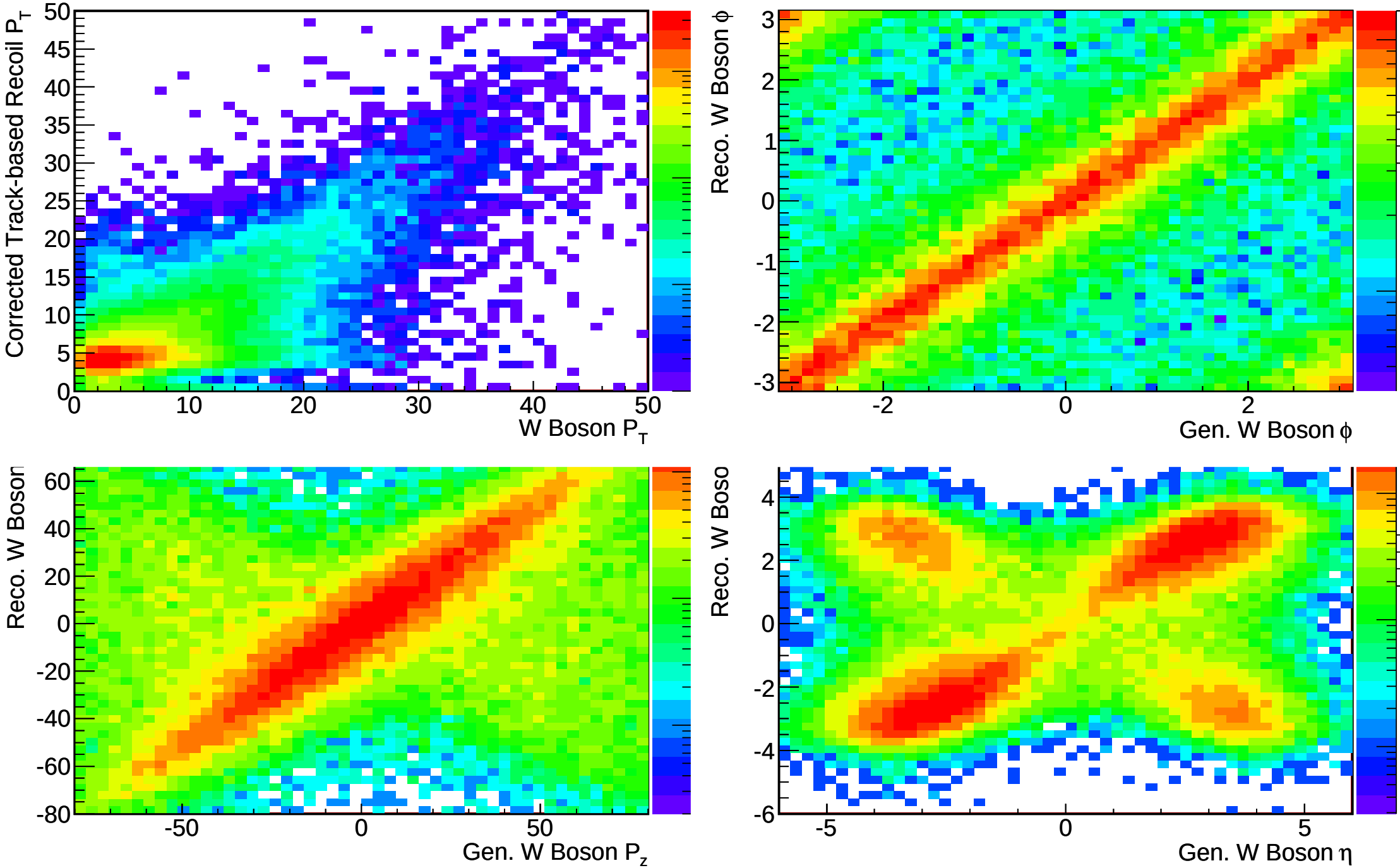
$$|\vec{p}_{l,T}|^2 p_{\nu,z}^2 - 2A p_{l,z} p_{\nu,z} + |\vec{p}_{\nu,T}|^2 |\vec{p}_l|^2 - A^2 = 0$$
$$A = M_W^2/2 + \vec{p}_{l,T} \cdot \vec{p}_{\nu,T}$$

- Currently select the smallest absolute solution

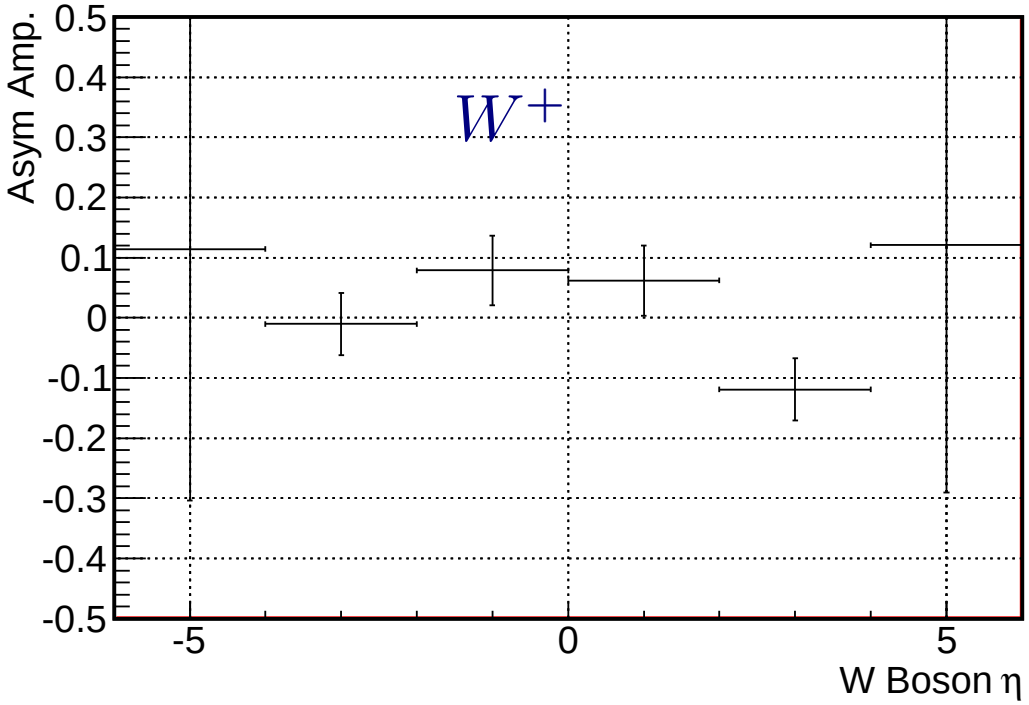
Reconstructed vs. Generated: ν

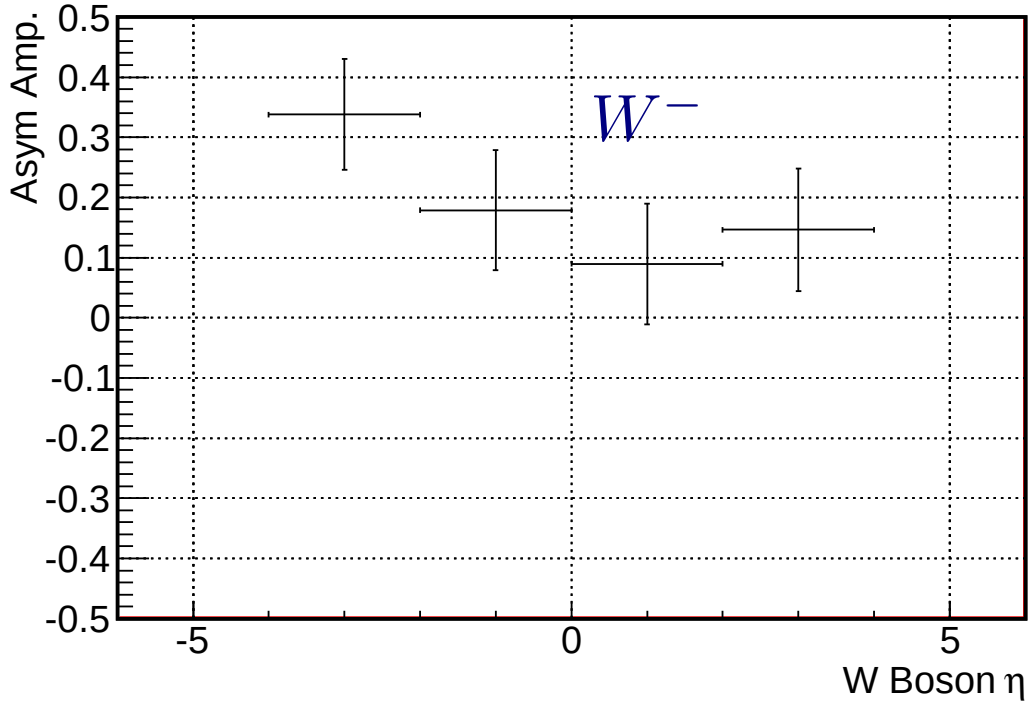


Reconstructed vs. Generated: $W^{\pm}$

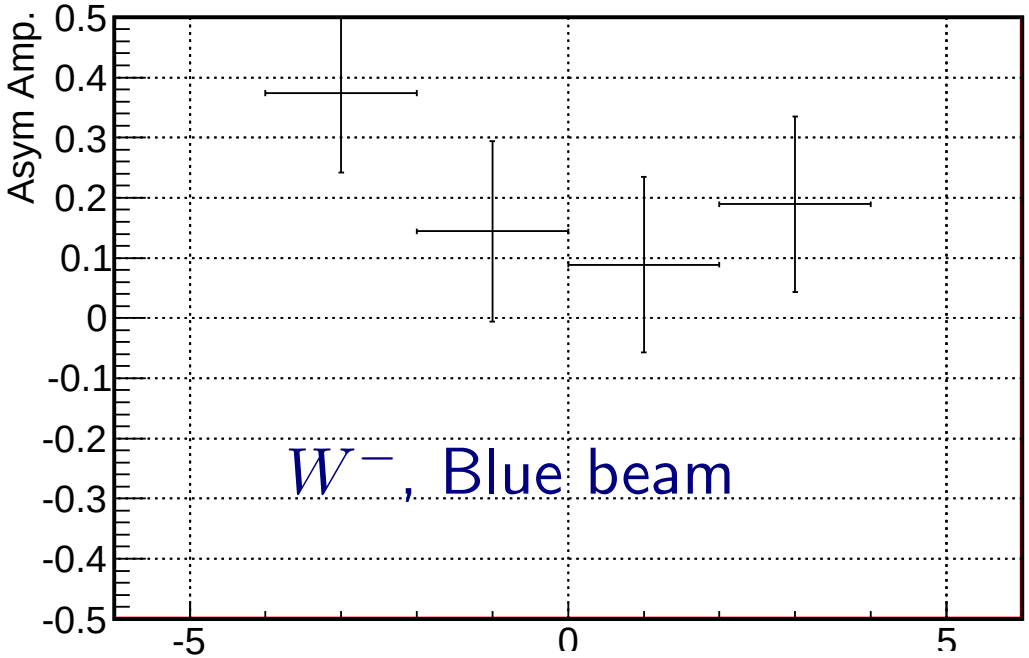


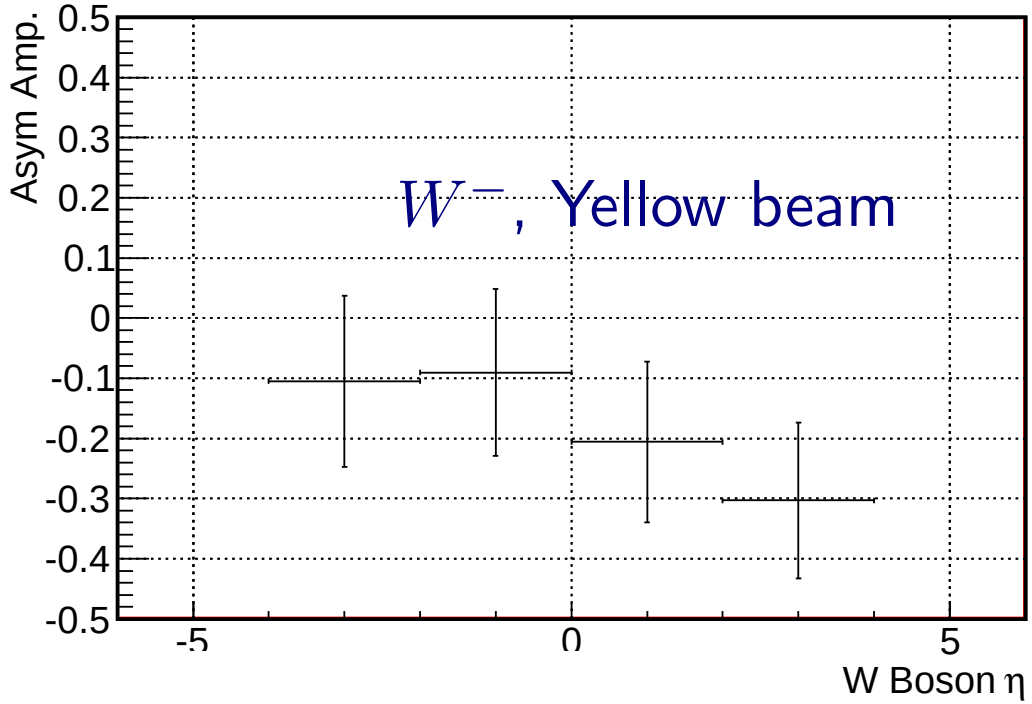
W Asymmetry vs. η

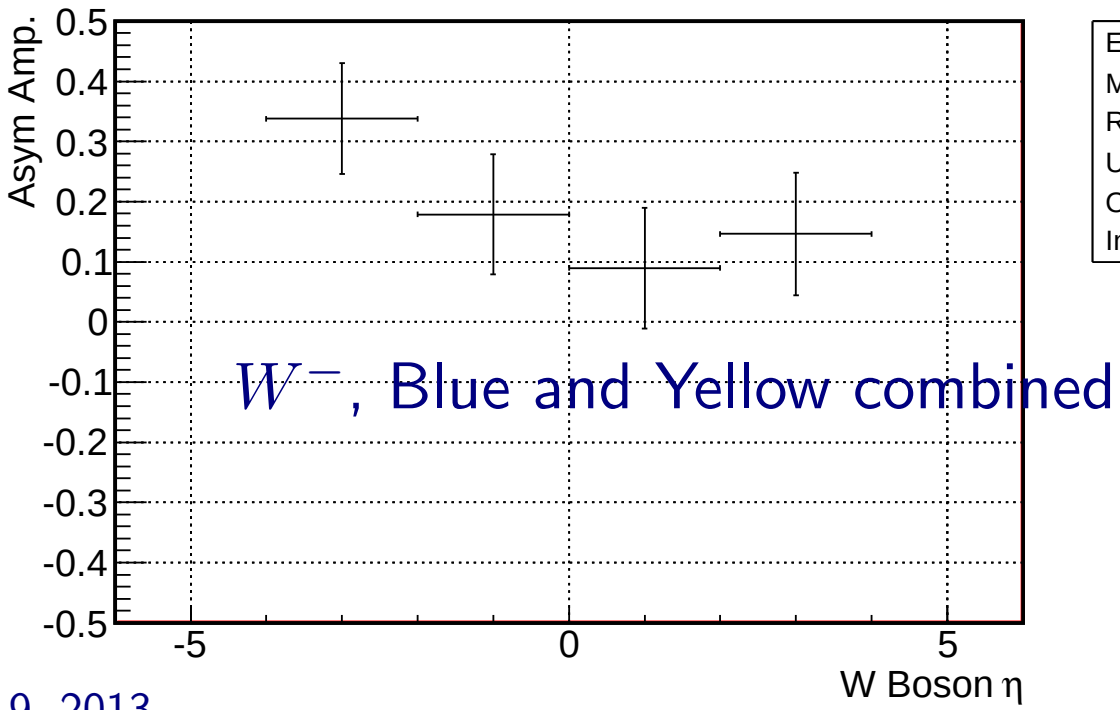




How we Combine Blue and Yellow Beams: W^- vs. η

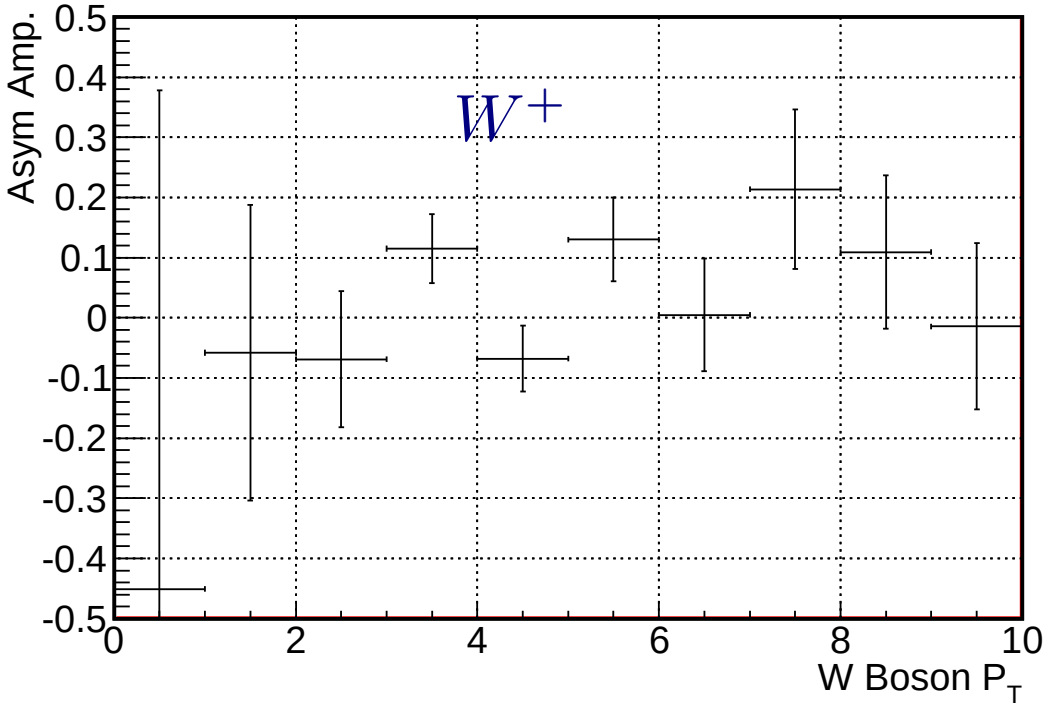


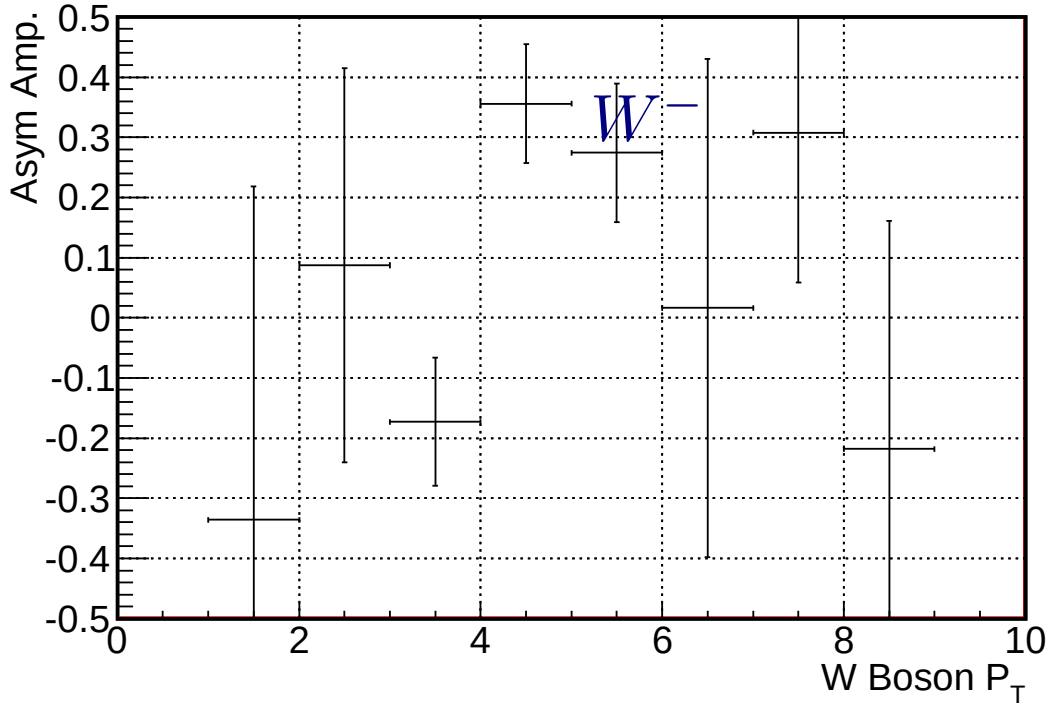




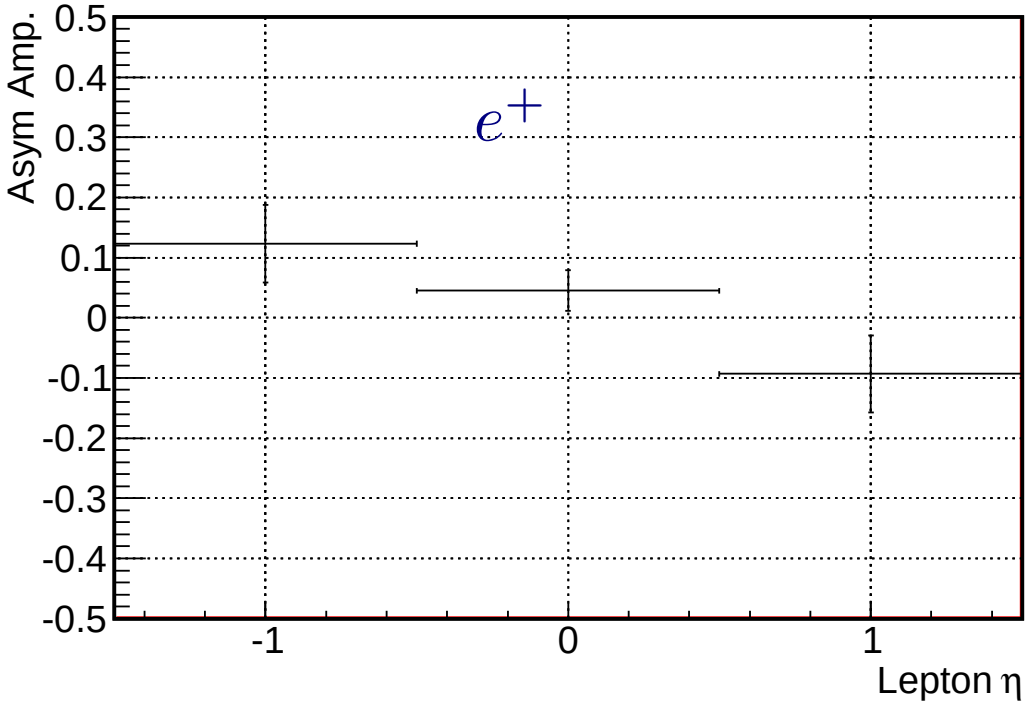
Entries	6
Mean	-0.3619
RMS	4.14
Underflow	0
Overflow	0
Integral	0.7525

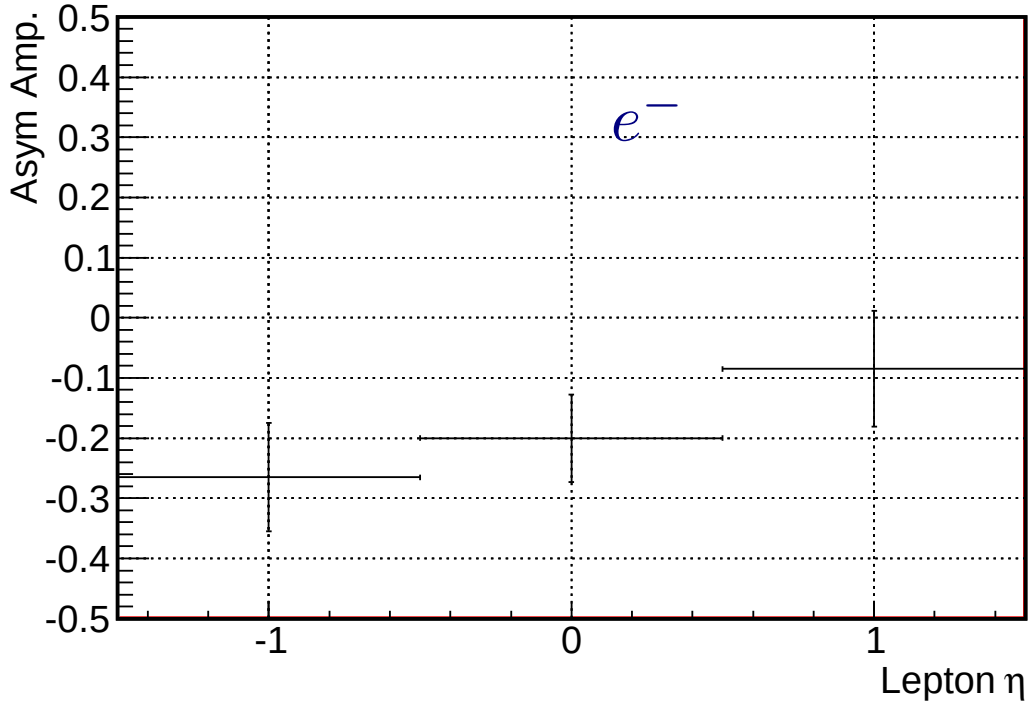
W Asymmetry vs. p_T



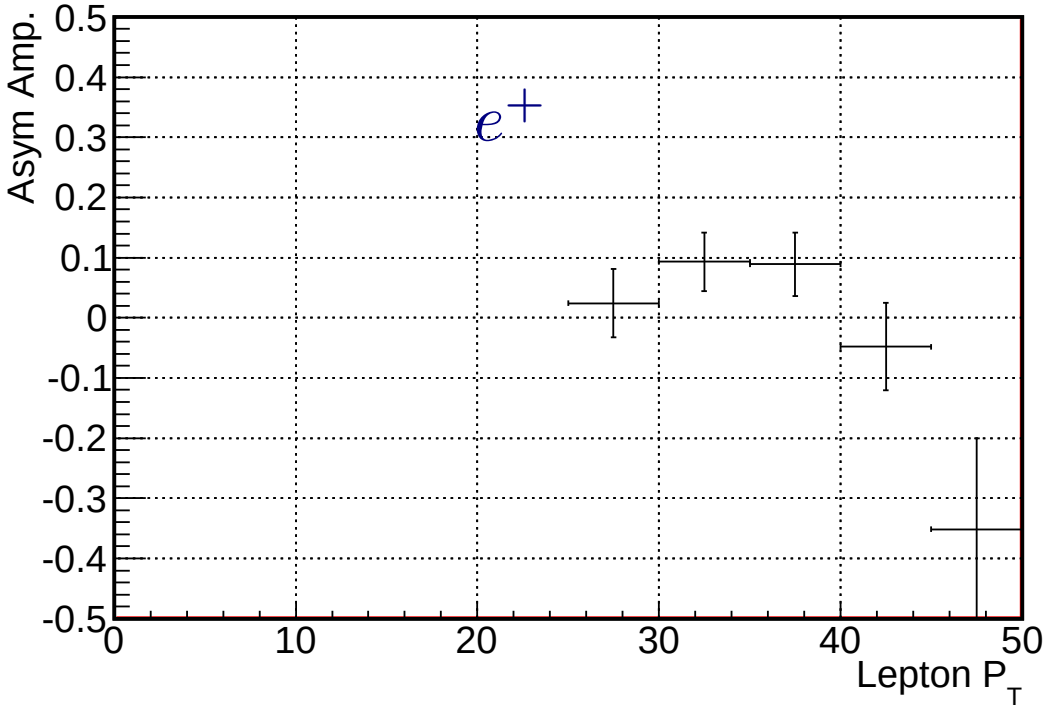


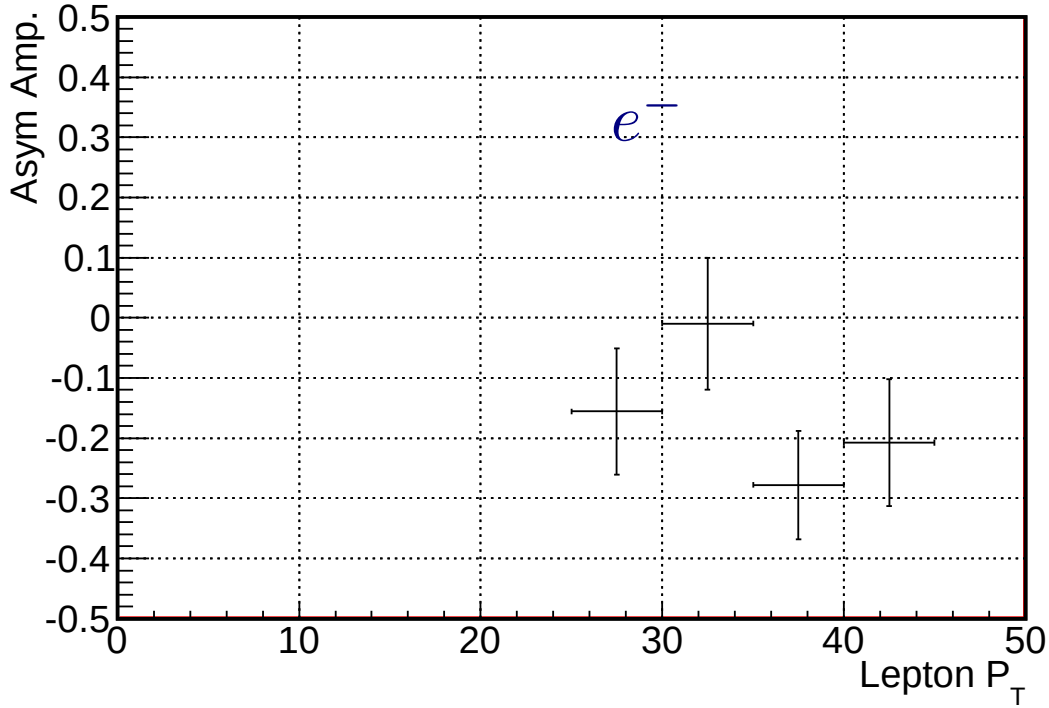
Lepton Asymmetry vs. η





Lepton Asymmetry vs. p_T





Summary and Outlook

- First look at W asymmetries as a function of W's η and P_T
- Missreconstructed neutrino's z component may additionally dilute the asymmetry
- Do cross checks with longitudinal pp sample