Transverse Single Spin Asymmetry (A_N) for Electromagnetic-Jet in FMS

Dataset run 17 p↑ + p collision at $\sqrt{s}$=510 GeV

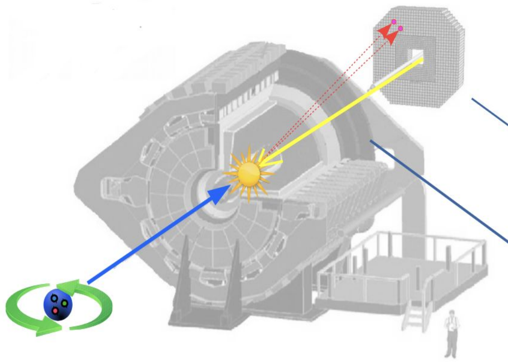
September 6, 2023

Bishnu Karki
UC, Riverside

Follow up for the status presented here
My Blog

EM-jet A_N ($p\uparrow + p \rightarrow$ EM-jet + X)

- Characterize A_N as a function of EM-jet-$p_{T,}$ energy, and photon multiplicities
- Explore the potential sources of large A_N



Data Features:

- Data-stream: FMS-stream
- Dataset: Run 17 ($\sqrt{s}$ = 510 GeV pp trans)
- Transversely polarized protons (<P>= 59%)
- Triggers: Small BS, Large BS, ~~FMS-JP trigger~~
- Vertex z priority : TPC, VPD, BBC
- Calibration from Minghui
- FMS hot channel masking before reconstruction
- Exclude highly bit-shifted FMS channels
- Production tag : P18ic
- STAR Library version: SL20a

EM-jet: Jet reconstructed out of photons only

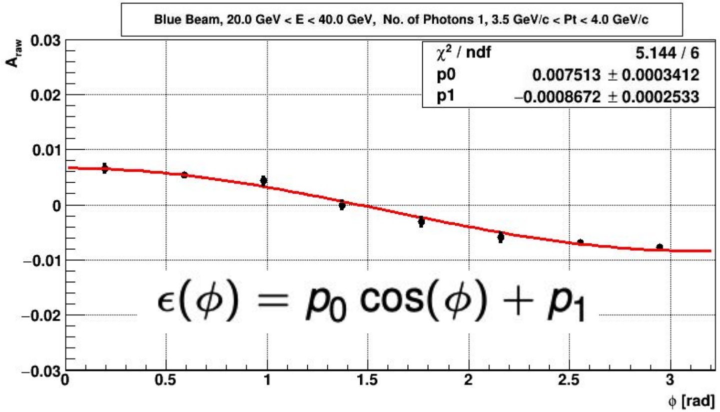
Jet Reconstruction

- Anti-k_T jet clustering algorithm with R= 0.7
- $E\gamma > 1.0$ GeV
- $-80 < z < 80$ cm
- Jet $p_T > 2.0$ GeV/c
- $2.8 < \eta < 3.8$

EM-Jet A_N Extraction

A_N as a function of EM-jet p_T, energy, and photon multiplicity (FMS data)

- Energy bins: [0-20] , [20 -40], [40 -60], [60 -80] , and [80 -100] GeV
- 16 equal $\boldsymbol{\phi}$ bins in the range - **π** to **π**
- 5 photon multiplicity bins
- Separately for $x_F>0$ and $x_F<0$

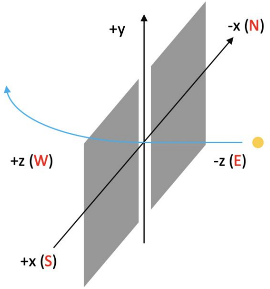


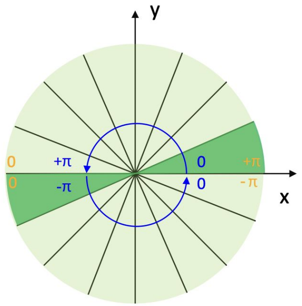
- Cross-ratio formula to calculate A_N

$$\epsilon = A_N \times P \times \cos(\phi)$$

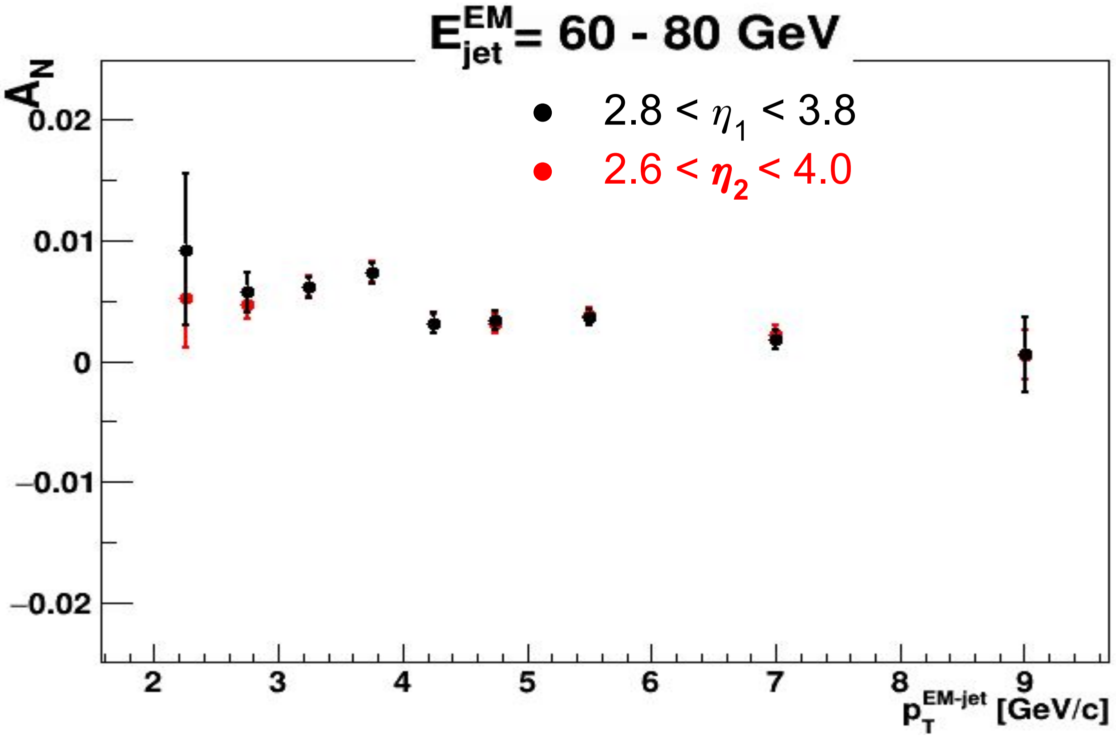
$$\epsilon \approx \frac{\sqrt{N_{\phi}^{\uparrow} N_{\phi+\pi}^{\downarrow}} - \sqrt{N_{\phi+\pi}^{\uparrow} N_{\phi}^{\downarrow}}}{\sqrt{N_{\phi}^{\uparrow} N_{\phi+\pi}^{\downarrow}} + \sqrt{N_{\phi+\pi}^{\uparrow} N_{\phi}^{\downarrow}}}$$

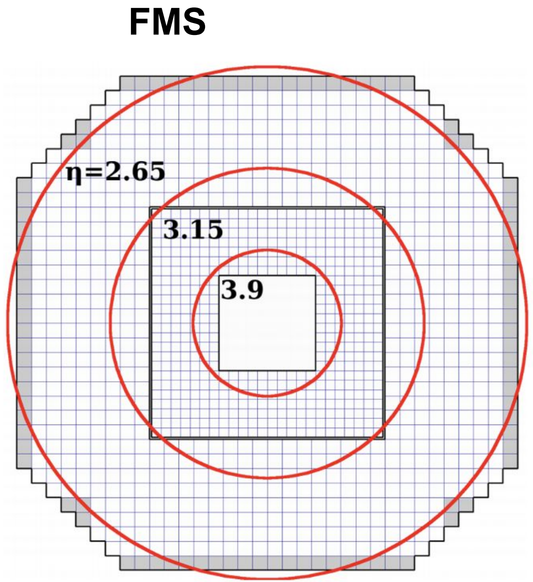
- Cancels systematics, such as luminosity and detector effects





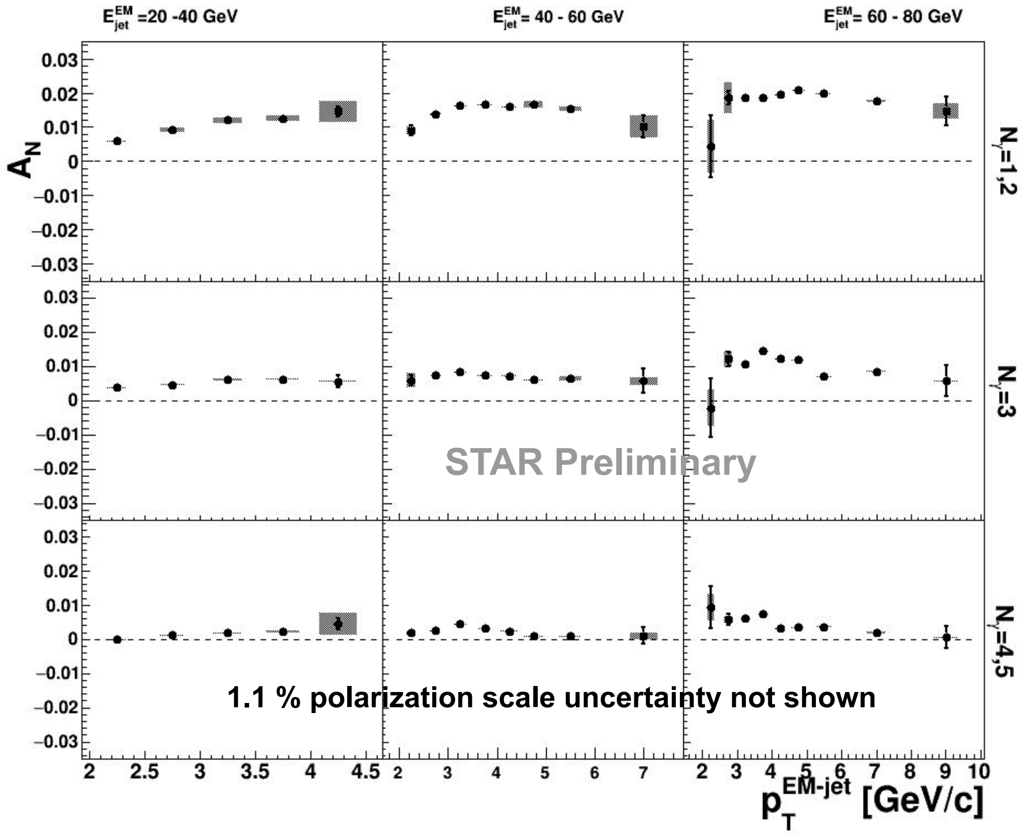
Systematic on A_N





$$\text{Systematic Error} = \left| \frac{(A_N^{\eta_1} - A_N^{\eta_2})}{A_N^{\eta_1}} \right|$$

EM-Jet A_N p↑+ p @√s=510 GeV

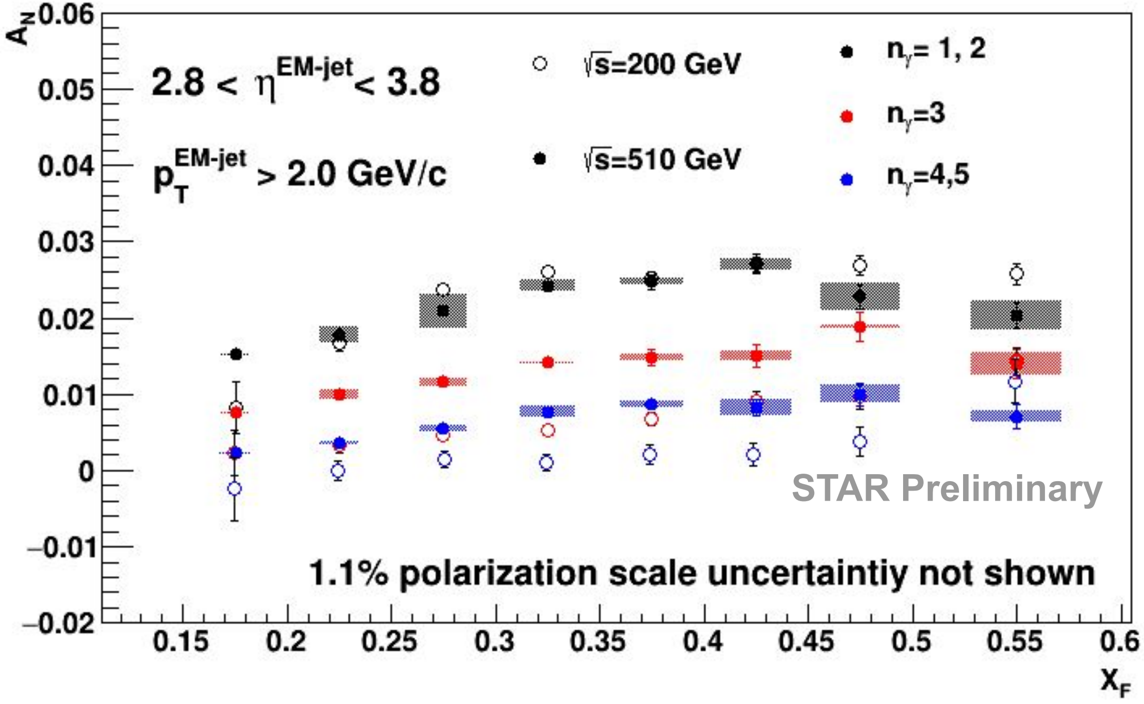


- **Energy or p_T Corrections and Uncertainties (~4%):**
  - Calibration uncertainty (3%)
  - Energy or p_T correction (1.5%)
  - Uncertainty due to radiation damage (2%)

- Systematic on A_N are consistent with M. Mondal's result and L. Kabir's result

- A_N decreases with higher photon multiplicities in EM-jet, consistent with previous results

EM-Jet A_N p↑ + p @√s=510 GeV



- Dependence in √s at higher multiplicities
- Results by J. Adams et al. Phys. Rev. D 103, 092009 (2021) have shown for case Nγ >2 with large statistical error

Electromagnetic-Jet A_N Correction and Uncertainty

- Underlying event correction, correction in p_T from detector-particle level done

- **Polarization Error (~1.1%)**

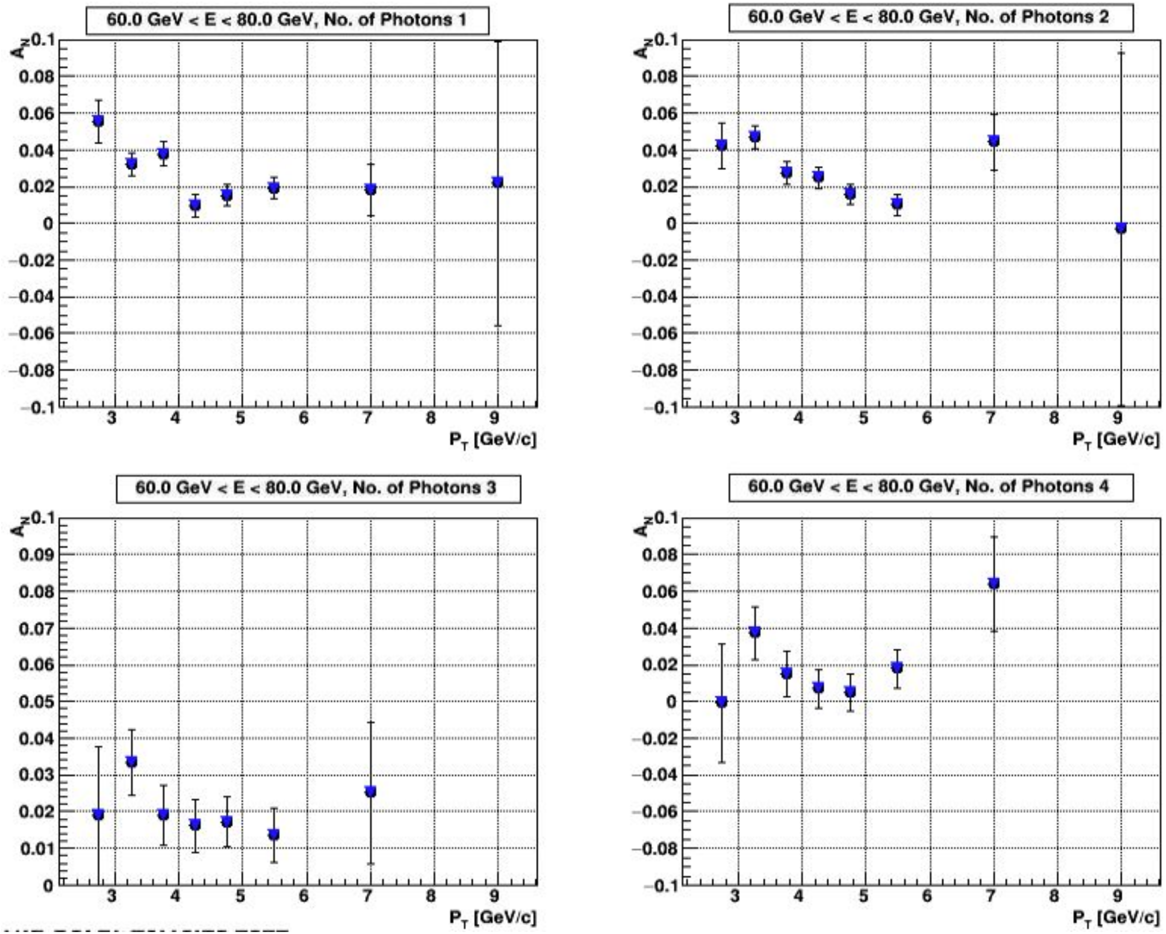
  [1] W.B. Schmidke , RHIC Polarization for Run 9-17
  [2] Z. Chang, Example calculation of fill-to-fill polarization uncertainties

- **Energy or p_T Corrections and Uncertainties (~4%):**
  - Calibration uncertainty ()
  - Energy or p_T correction ()
  - Uncertainty due to radiation damage ()

- Systematic on A_N (estimated A_N variation with η cut)
  - 1 - 8 % depending on energy, photon multiplicities, and p_t

Backup

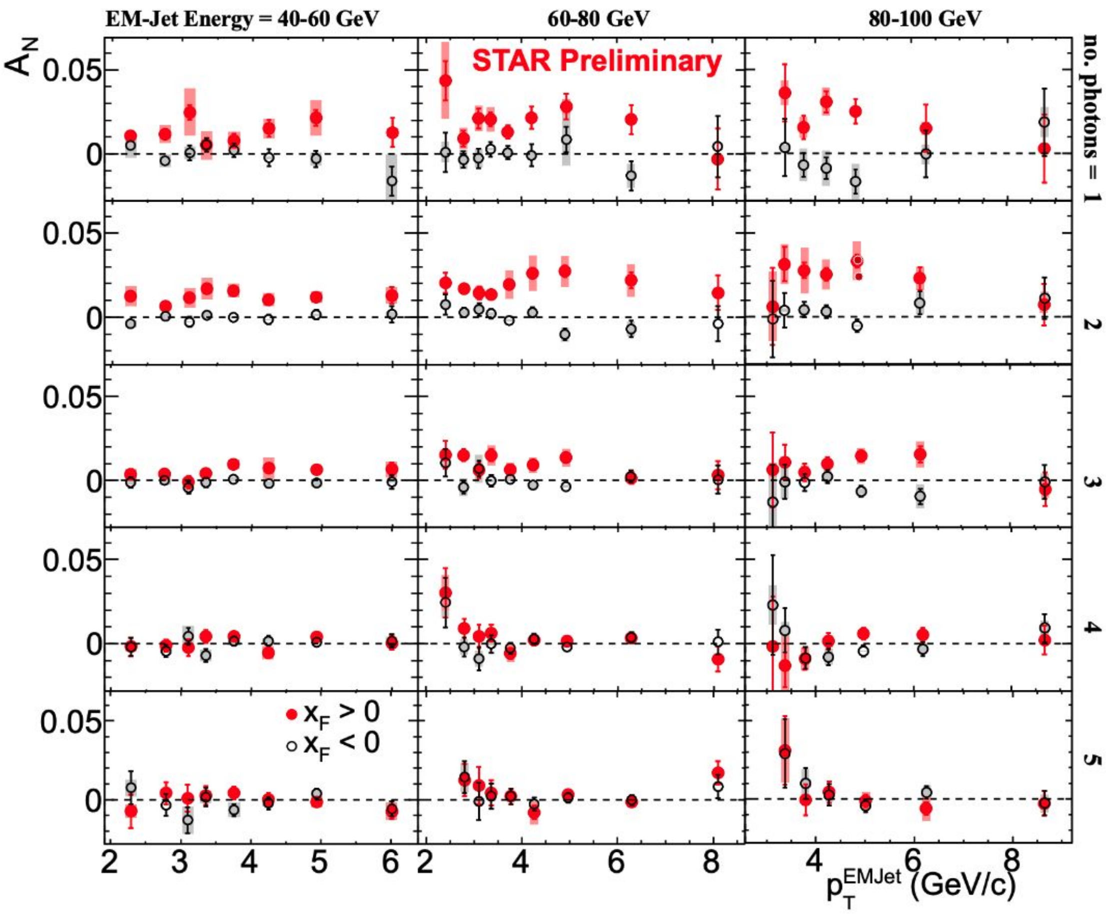
Reproducing L. Kabir's result



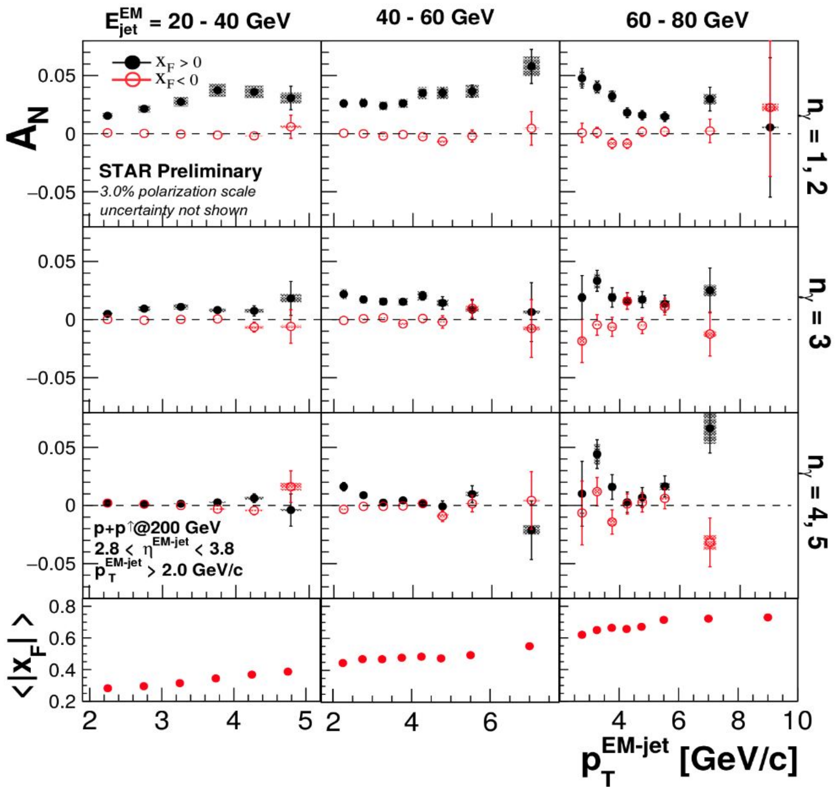
Used my code to reproduce L.Kabir's result (run 15)

Black open circle => From my analysis
Blue triangles => From Latif's analysis

Run 11, √s=500 GeV Mriganka Mouli Mondal result

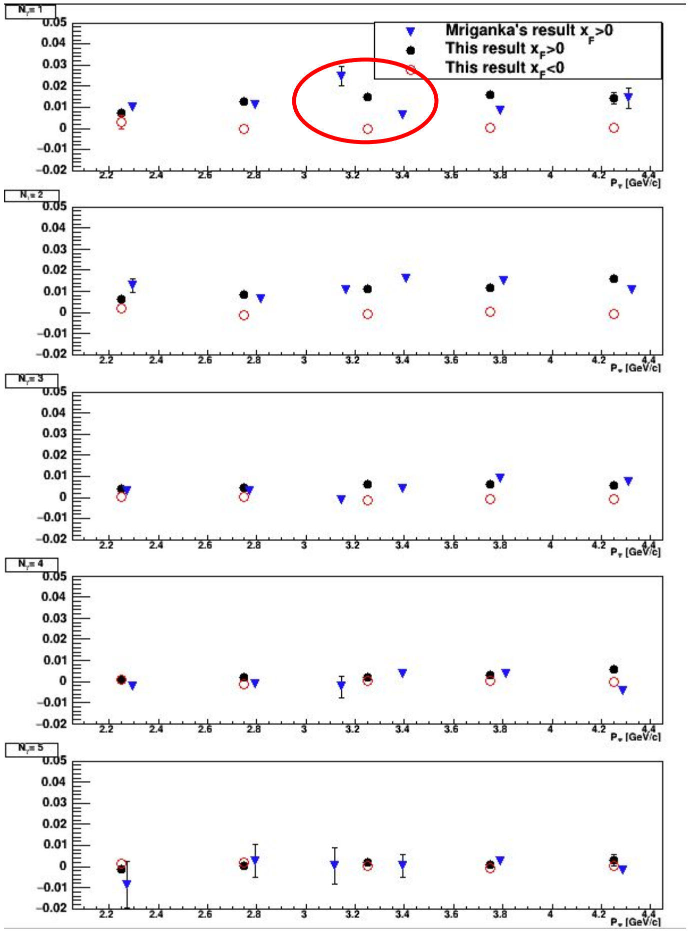


Run 15 √s=200 GeV (L. Kabir's result)

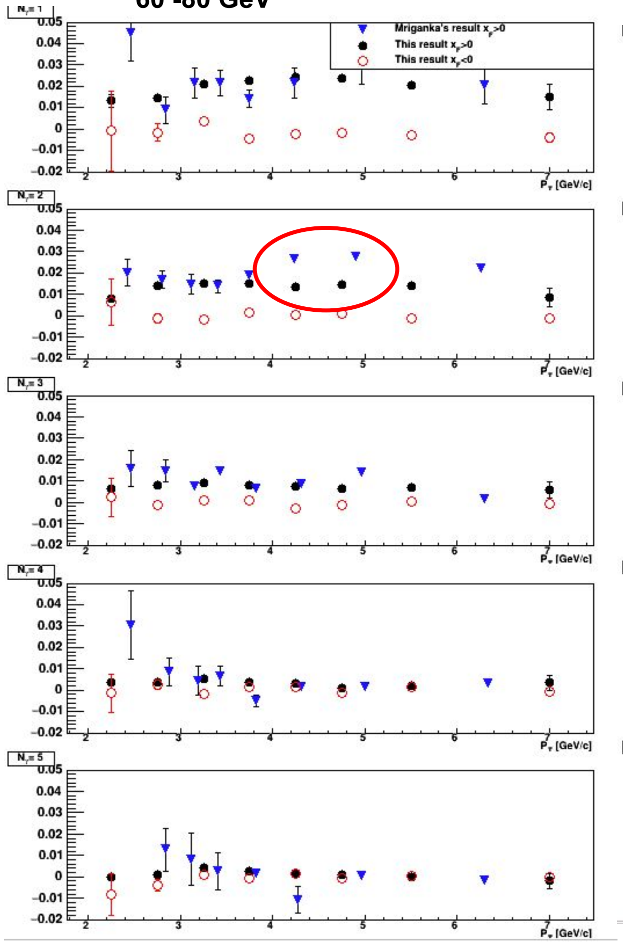


Comparison with existing results (Run 11, $\sqrt{s}$=500 GeV Mriganka Mouli Mondal)

40 -60 GeV



60 -80 GeV



80 -100 GeV