

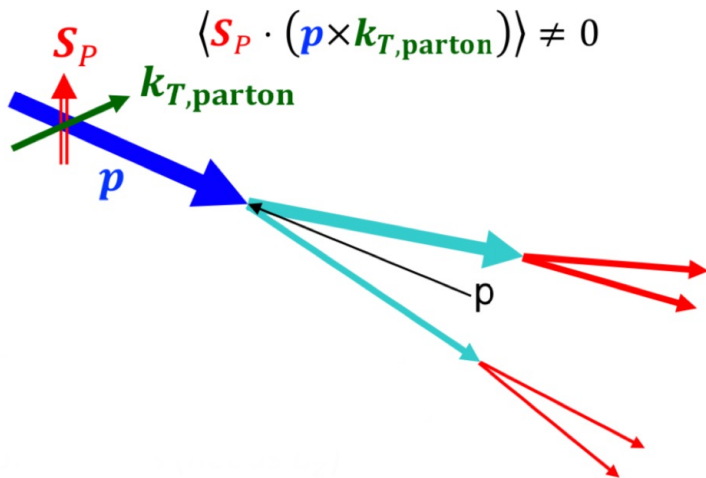
First look at gluon Sivers function with dijets

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Motivation

- **Gluon Sivers function:** correlation between gluon's transverse momentum with the proton spin



... k_T distribution of the partons could have an azimuthal asymmetry, when the hadron was transversely polarized.

How to access GSF?

- **Photon-gluon fusion**

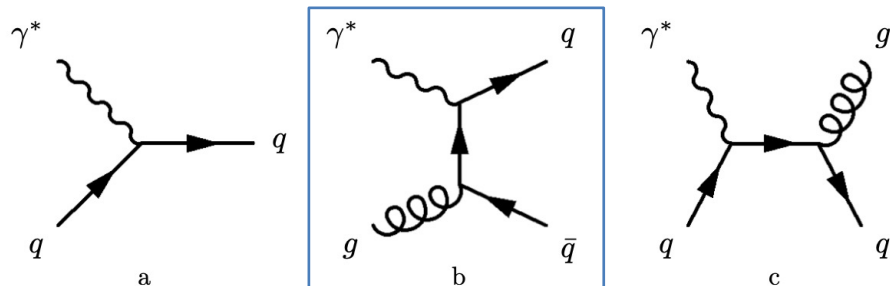


Figure 1: Feynman diagrams for hard subprocesses: a) $\mathcal{O}(\alpha_s^0)$ DIS, b) $\mathcal{O}(\alpha_s^1)$ Photon-Gluon Fusion, and c) $\mathcal{O}(\alpha_s^1)$ QCD Compton scattering.

HERMES, JHEP 08 (2010) 130

- **Final states:** **dijets**, di-hadrons, D mesons, etc

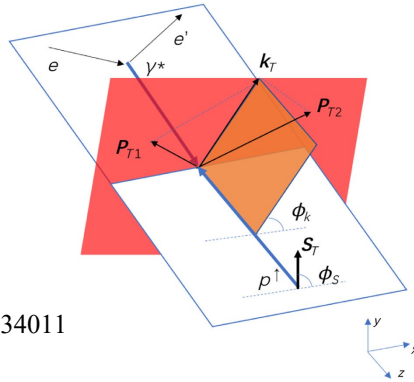
L. Zheng, et. al., PRD 98 (2018) 034011

Simulation details

- PYTHIA8 could not simulate photon-gluon fusion
- PYTHIA6.428
 - pythia-eic within eic-shell
 - <https://gitlab.com/eic/mceg/PYTHIA-RAD-CORR>
 - Tuned to HERA data
- Collision: ep, 18x275, $Q^2 > 1 \text{ GeV}^2$
- Processes: $\gamma^* + g \rightarrow q + \bar{q}$, $\gamma^* + q \rightarrow g + q$ ($\sigma = 6.2\text{e-5 mb}$)
 - Based on [RUN CARD](#)
 - Statistics: 9k events, $\sim 1.5\text{e-4 fb}^{-1}$
 - Ambiguity with virtual photon interacting with the gluon radiated by a quark. Plan to turn off ISR

Observable

- Azimuthal correlation between gluon k_T and proton spin in γ^*+p center-of-mass frame



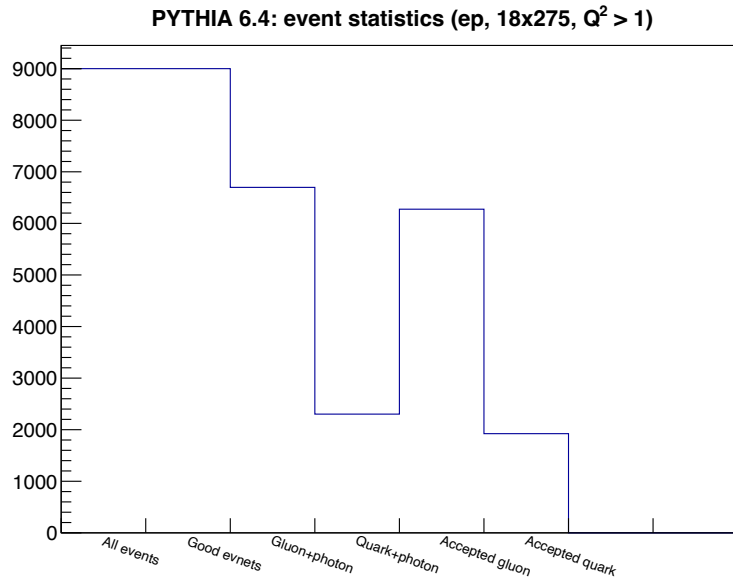
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$$A_{UT} \sin(\varphi_k - \varphi_S)$$

$$\varphi_k - \varphi_S = \varphi_{kS}$$

- Use di-jet $\vec{k}_T = \vec{p}_{T,jet1} + \vec{p}_{T,jet2}$ to approximate gluon k_T

Event statistics



- Event selection
 - $Q^2 > 1$
 - $0.01 < y < 0.95$

Fraction of quark vs. gluon

L. Zheng, et. al., PRD 98 (2018) 034011

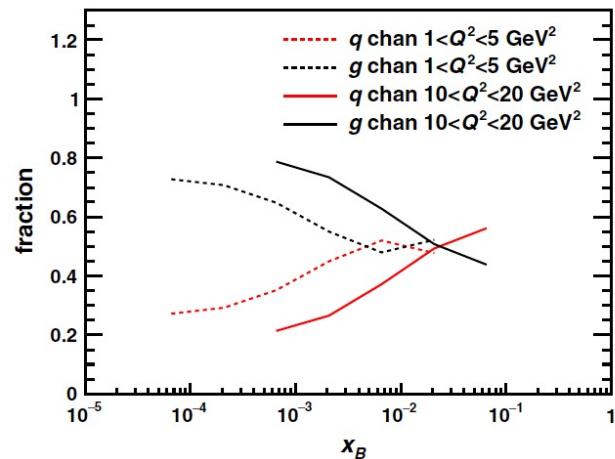
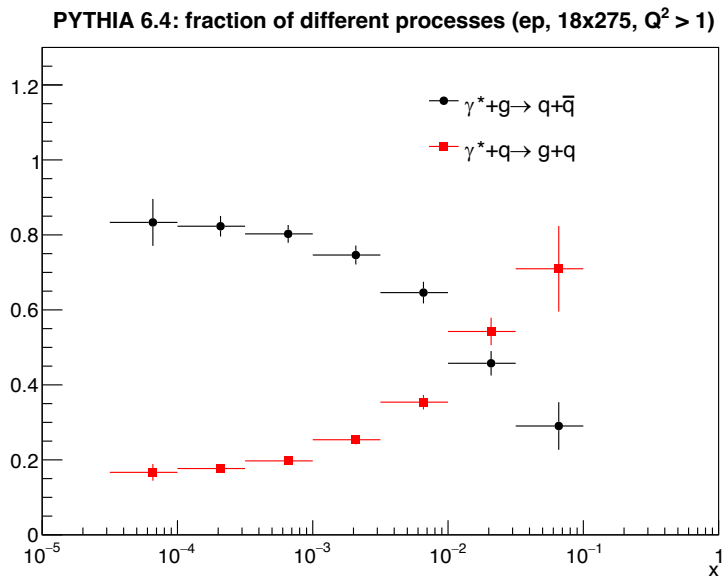
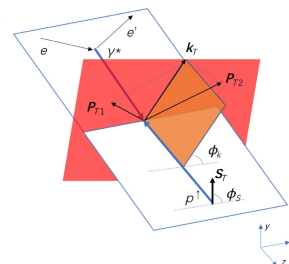
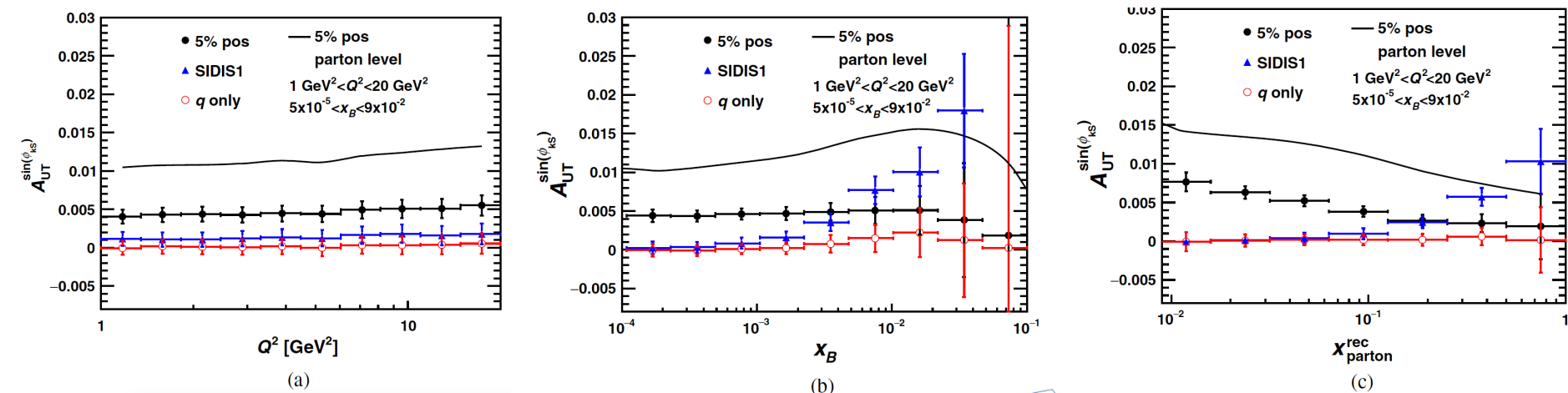


FIG. 12. Underlying subprocess fraction initiated by quarks (red curves) or gluons (black curves) for dijet production. The solid and dotted curves represent the Q^2 bins of $10 < Q^2 < 20$ GeV² and $1 < Q^2 < 5$ GeV², respectively.

Previous work: gluon Sivers

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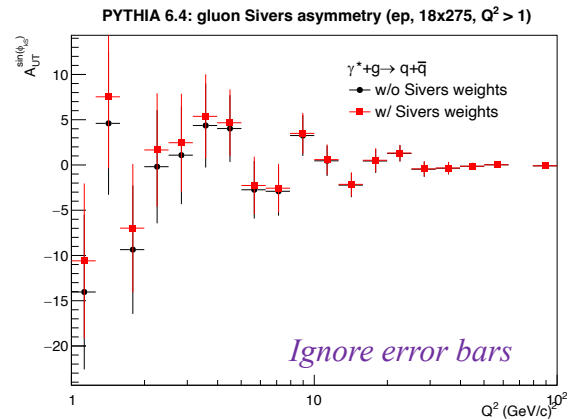
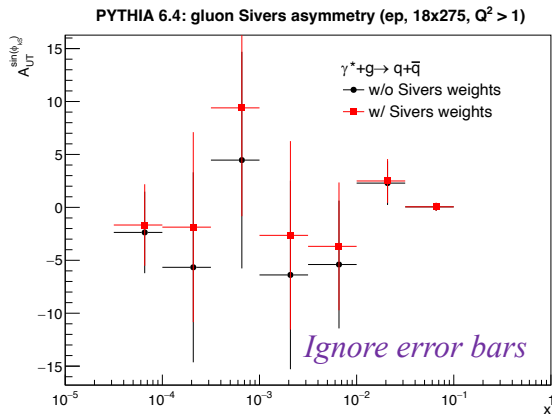
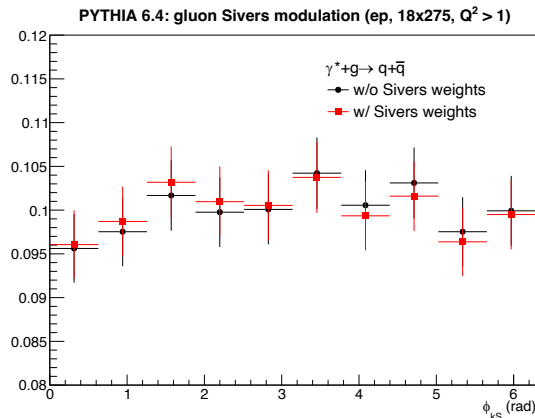


$$A_{UT} \sin(\varphi_k - \varphi_S)$$

$$\varphi_k - \varphi_S = \varphi_{kS}$$

FIG. 13. SSA modulation dependent on Q^2 (a), x_B (b) and x_B^{rec} (c) for the dijet channel with the following kinematic cuts: trigger jet $p_T^{\text{jet1}} > 4.5$ GeV and associated jet $p_T^{\text{jet2}} > 4$ GeV, $0.01 < y < 0.95$ and $1 \text{ GeV}^2 < Q^2 < 20 \text{ GeV}^2$ at the electron-proton beam energy $20 \text{ GeV} \times 250 \text{ GeV}$ with an integrated luminosity $\mathcal{L}_{\text{int}} = 10 \text{ fb}^{-1}$.

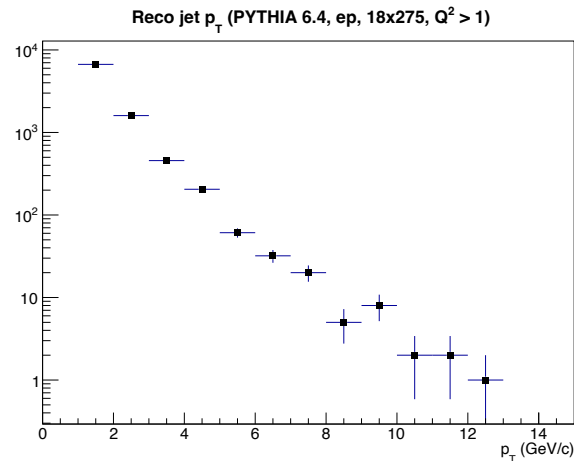
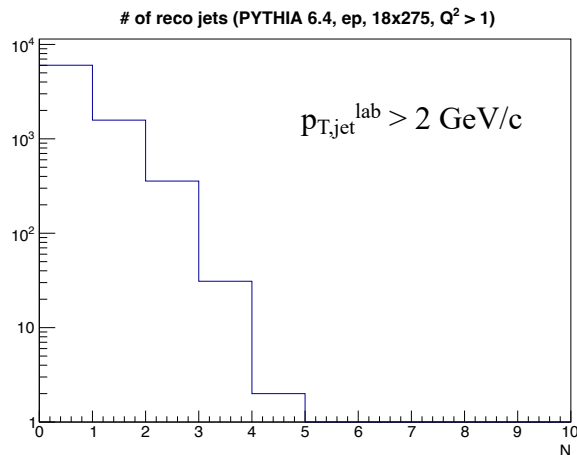
Sivers effect for gluons



- Add 1.5% Sivers effect for gluons, and 0% for quarks

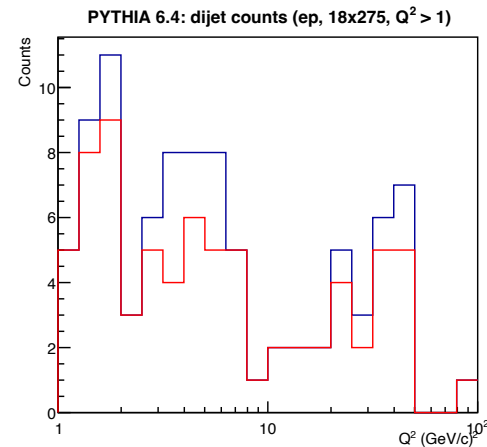
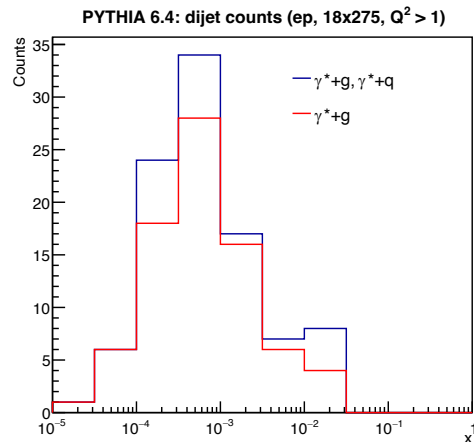
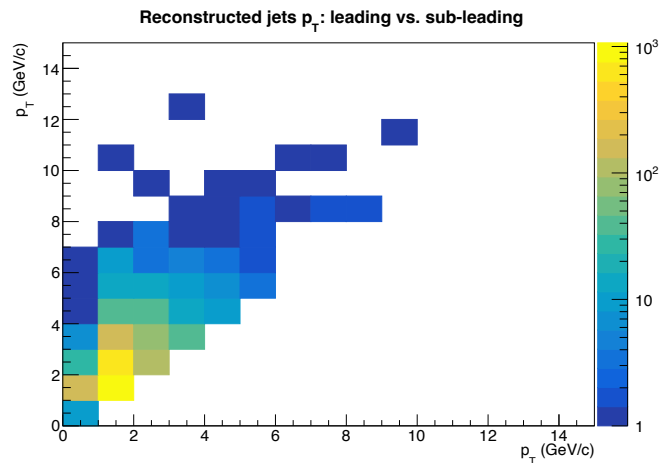
Jet reconstruction

- Official “ReconstructedChargedJets” branch
 - Anti- k_T , $R = 1.0$
 - Charged track only
 - $|\eta_{\text{jet}}^{\text{lab}}| < 2.5$



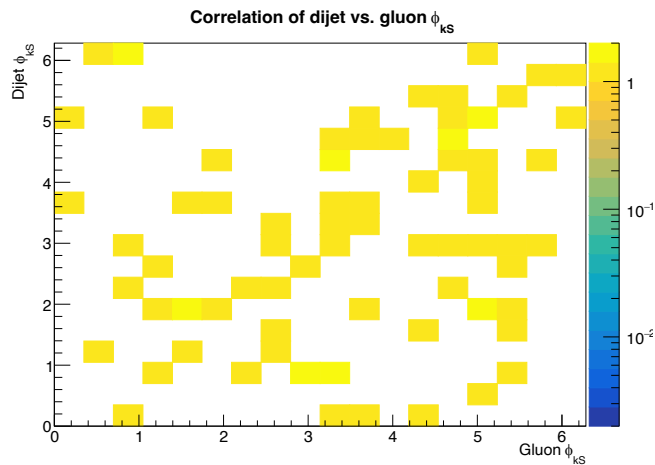
Dijet selection

- Boost to γ^*+p center-of-mass frame
- $p_{T,\text{jet}}^{\text{lead}} > 3.5 \text{ GeV}/c$, $p_{T,\text{jet}}^{\text{sub}} > 3 \text{ GeV}/c$

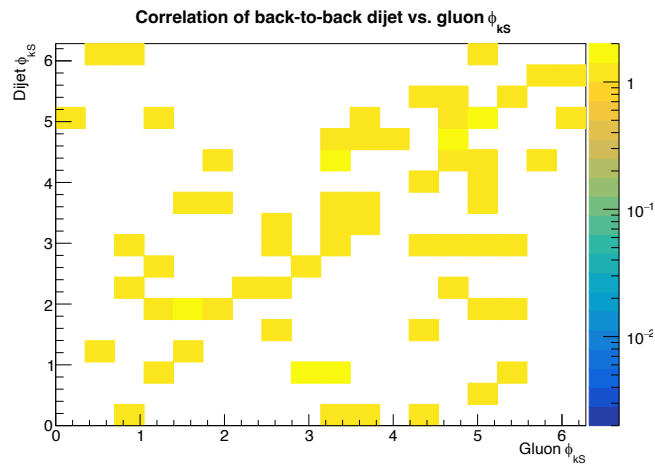


Sivers angle: gluon vs. dijet

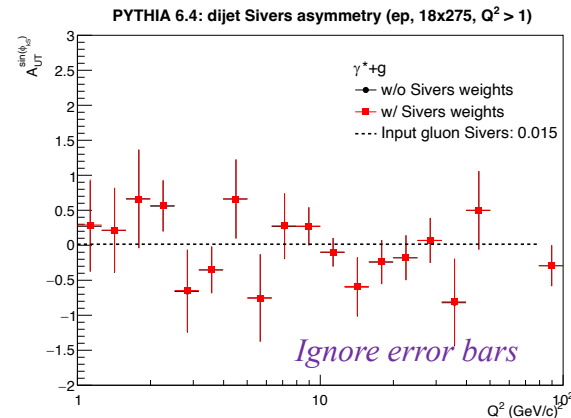
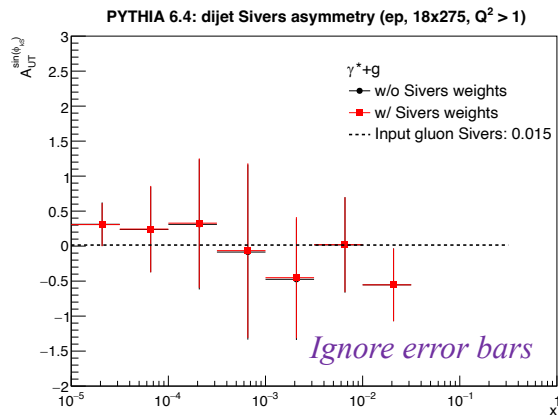
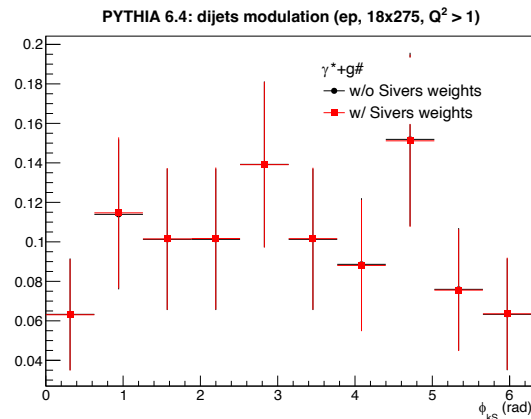
All dijet pairs



Back-to-back dijet pairs

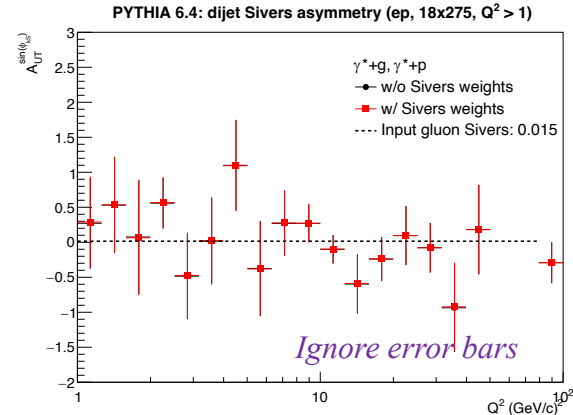
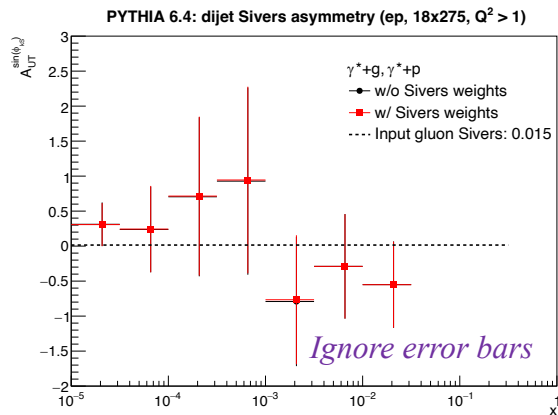
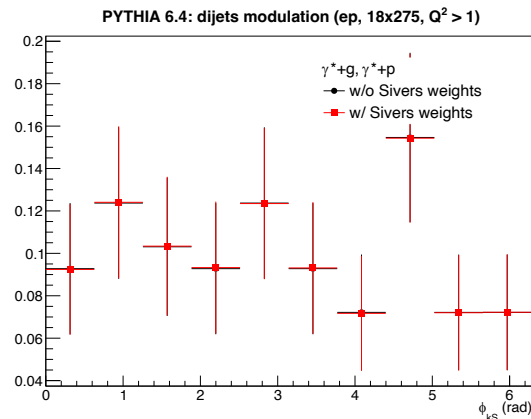


Sivers effect for dijets



- Select only events with $\gamma^* + g \rightarrow q + \bar{q}$

Sivers effect for dijets



- Select all events

What's next

- Turn off ISR
- Production of large sample ($\sim 450k$)