

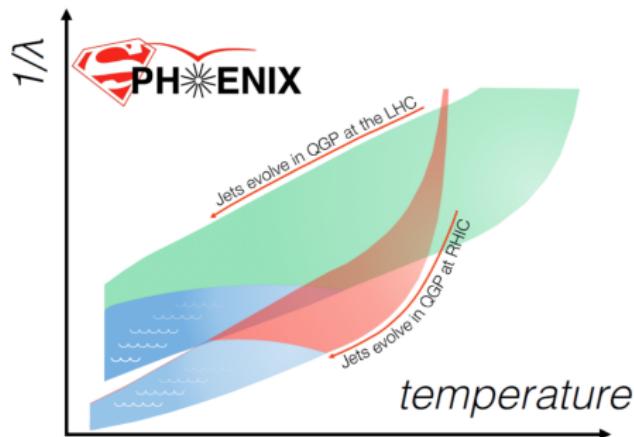
Recent Results on Reconstructed Jets from PHENIX at RHIC

Nathan Grau

for the PHENIX Collaboration
Augustana University

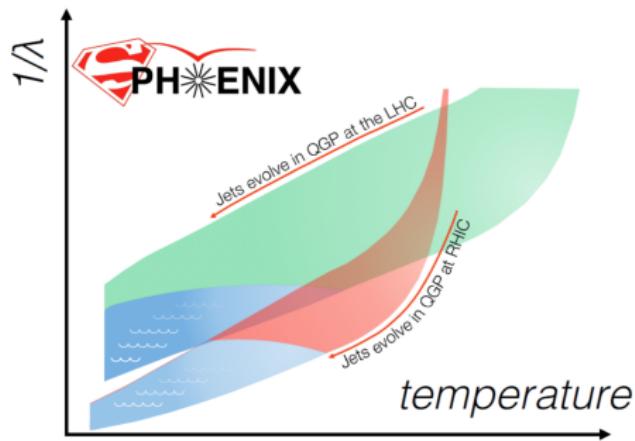
August 6, 2016

The Physics of Jets

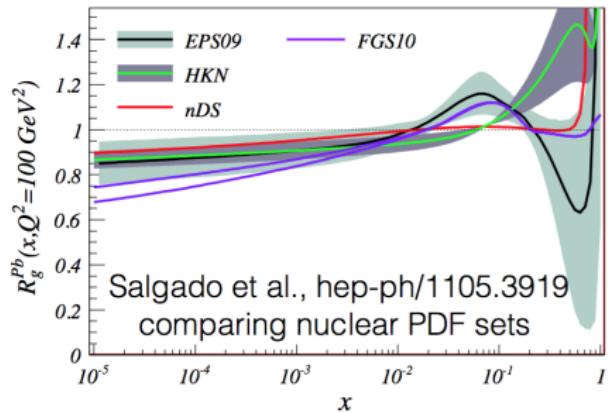


- ▶ Jets in A+A probe the QGP

The Physics of Jets

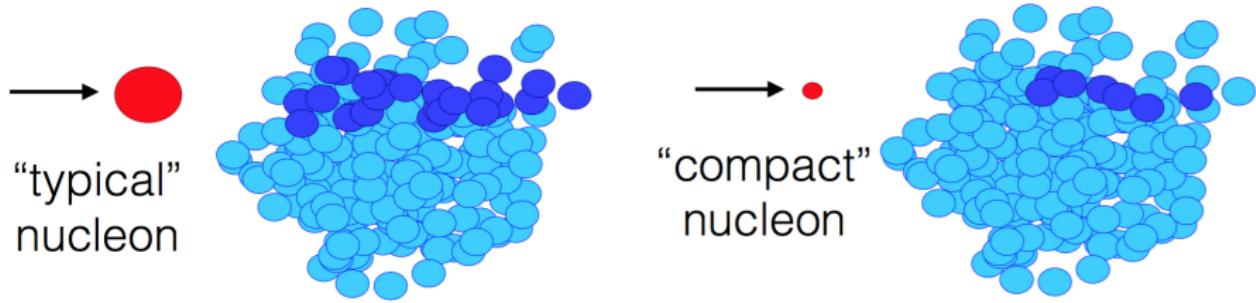


- ▶ Jets in A+A probe the QGP



- ▶ p+A jets expected to be sensitive to nPDFs

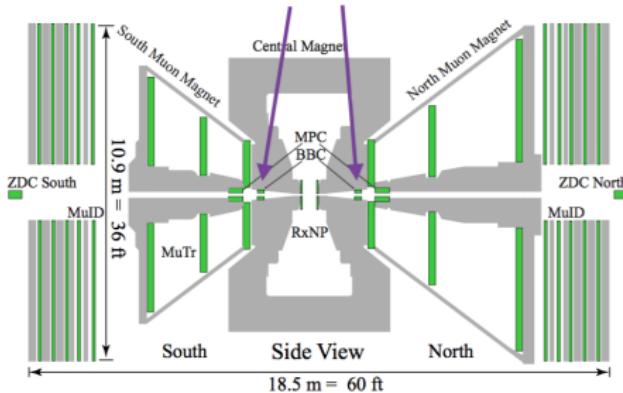
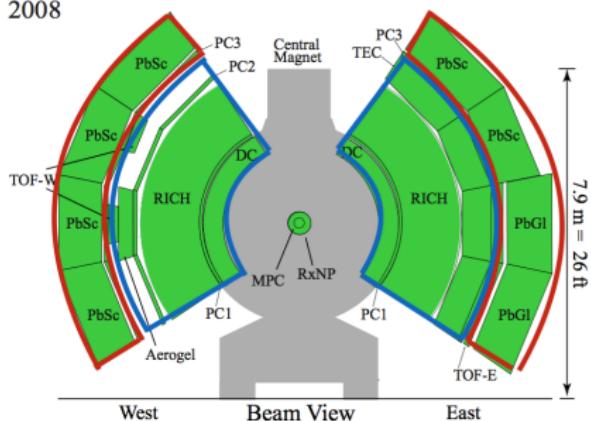
The Physics of Jets



- ▶ But, maybe the nucleus probes the structure of the nucleon in p+A?

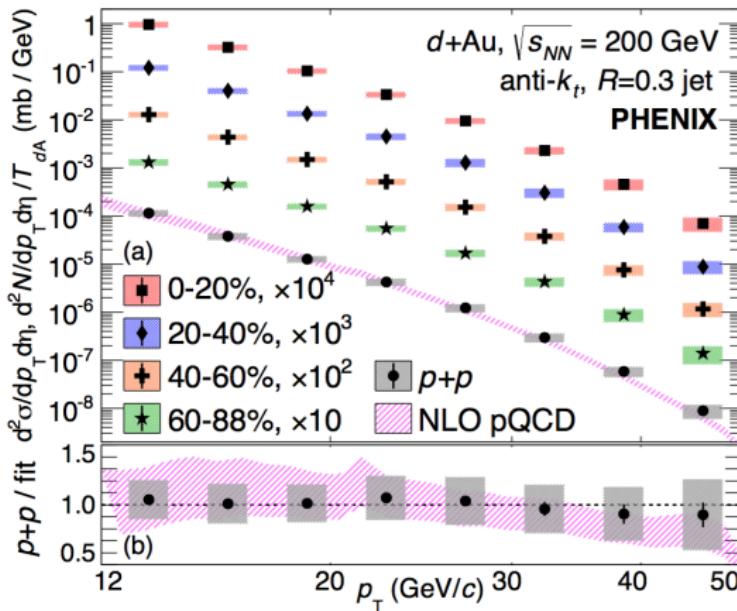
PHENIX Jet Detection

2008



- ▶ Tracking chambers for hadrons, **EM calorimetry** for photons.
- ▶ Jet results are for Anti- k_T algorithm using combinations of EM energy and track p_T .
- ▶ Results unfolded to true jet p_T scale using SVD using PYTHIA to construct the response matrix.

Jets in $p + p$ and $d+\text{Au}$

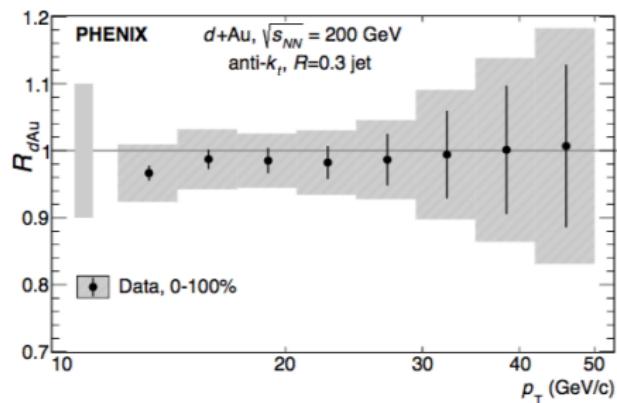


- ▶ $p + p$ consistent with NLOJET++ w/ NNPDF2.3 and hadronization corrections from Pythia.
- ▶ $d+\text{Au}$ measured in several different centralities.

Phys. Rev. Lett. **116** (2016) 122301

Jets in $p + p$ and $d+\text{Au}$

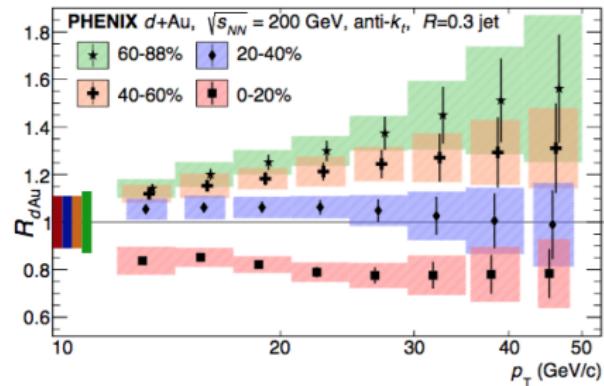
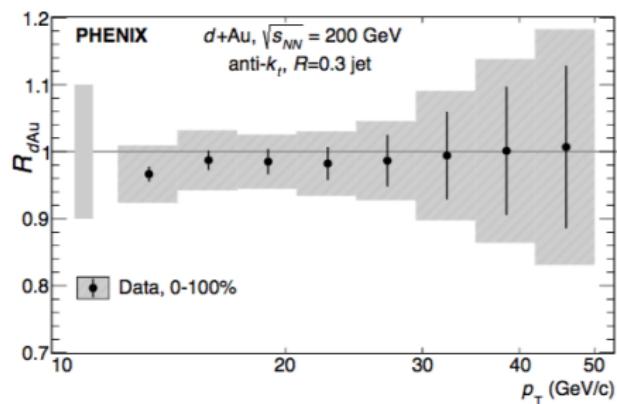
$$R_{dA} = \frac{\text{Yield}_{d+\text{Au}}}{\langle N_{coll} \rangle \text{Yield}_{p+p}}$$



- ▶ Min bias $d+\text{Au}$ jets N_{coll} scales
 - not terribly surprising.

Jets in $p + p$ and $d+\text{Au}$

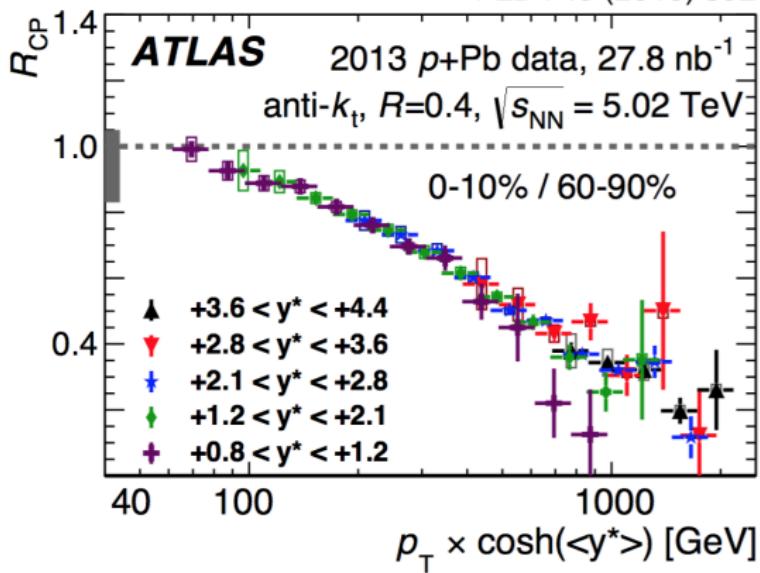
$$R_{dA} = \frac{\text{Yield}_{d+\text{Au}}}{\langle N_{coll} \rangle \text{Yield}_{p+p}}$$



- ▶ Min bias $d+\text{Au}$ jets N_{coll} scales – not terribly surprising.
- ▶ But centrality dependence is quite surprising.

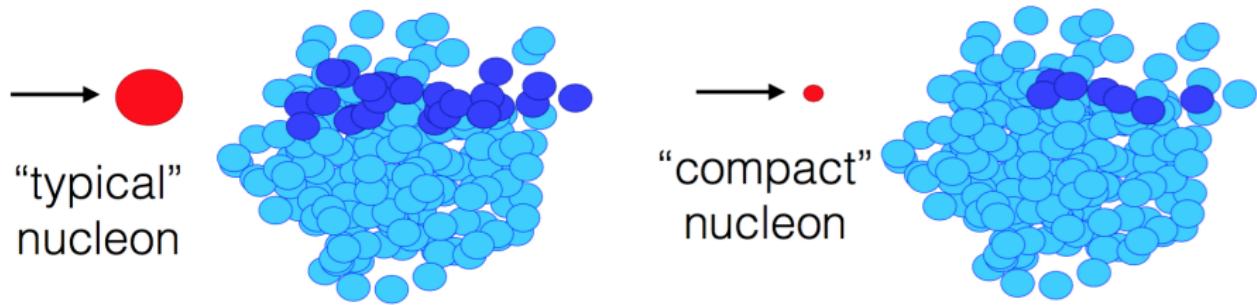
Probing the Nucleon

PLB 748 (2015) 392



- ▶ Similar results from ATLAS
- ▶ R_{CP} scales with proton x

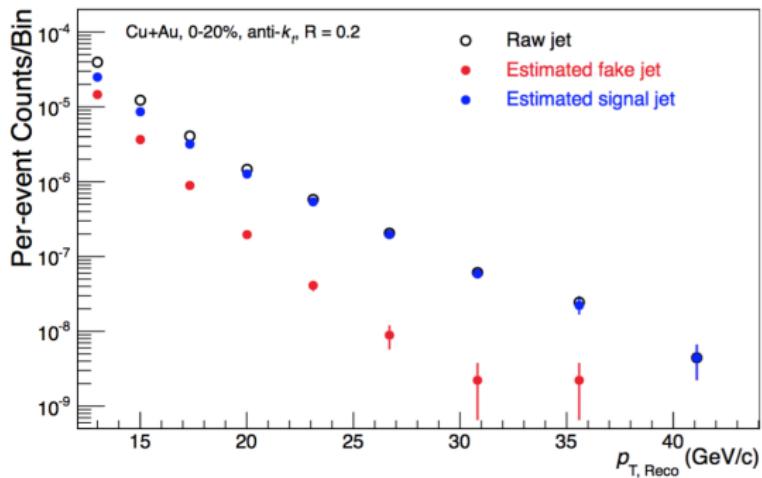
Probing the Nucleon



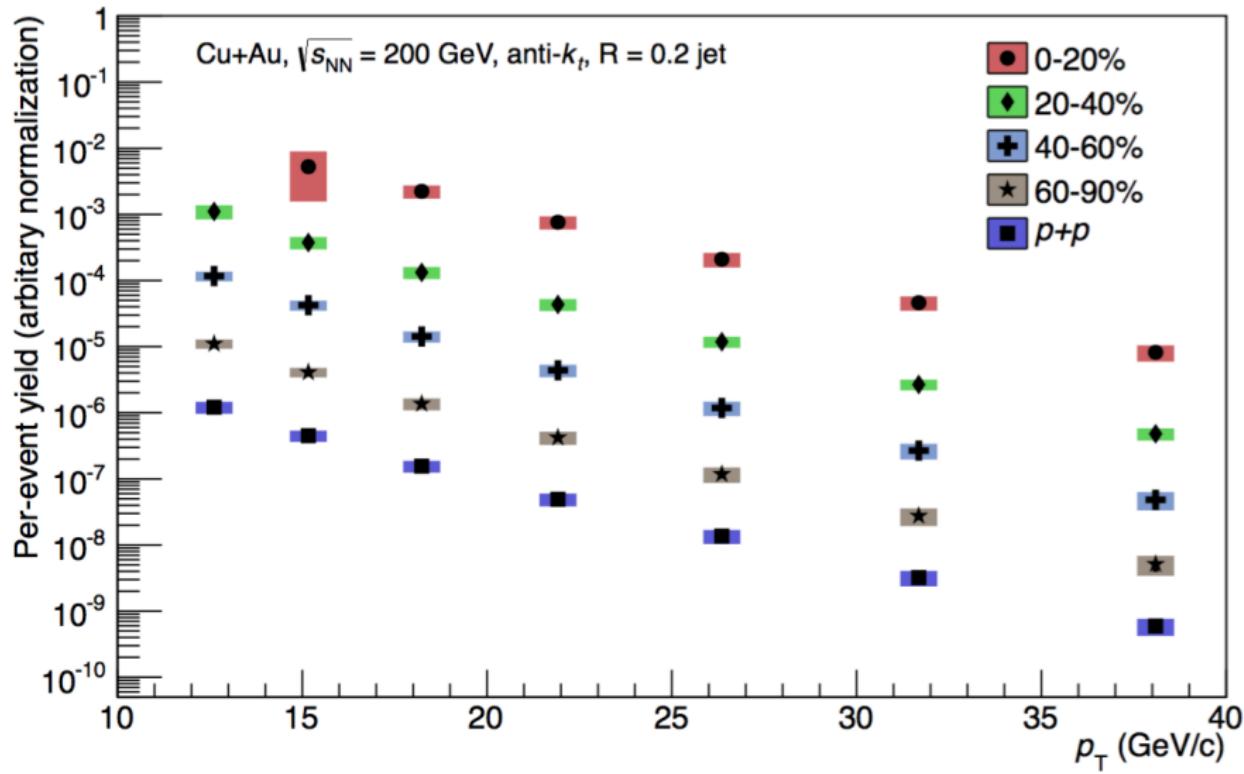
- ▶ A proton with a high- x parton will be “smaller” than average and strike fewer protons.
- ▶ Smaller N_{coll} than average causing R_{dA} to be greater than 1.
- ▶ Several theoretical efforts in this area: Perepelitsa, Cole and Strickman (PRC 93 (2016) 011902), Bzdak et al. hep-ph/1408.3156, Armesto et al. PLB 747 (2015) 441

Jets in Cu+Au

- ▶ Anti- k_T R=0.2 to reduce affect of underlying event.
- ▶ Data-driven underlying event determination
 - ▶ Reconstruct jets from randomly shuffled tracks and clusters.
 - ▶ Fake rate $\sim 30\%$ at 15 GeV and drops to 5% by 25 GeV.

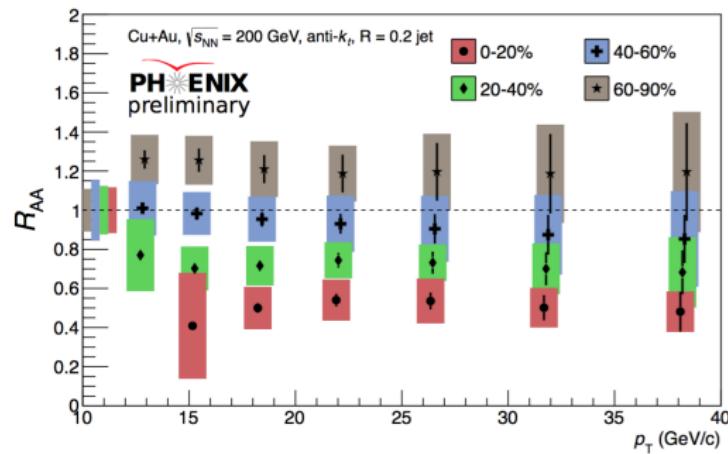


Jets in Cu+Au



Jets in Cu+Au

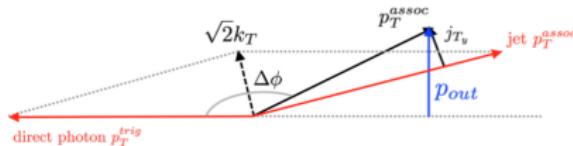
- ▶ $R_{AA} \sim 0.5$ in central
- ▶ Hint of $R_{AA} > 1$ in peripheral.



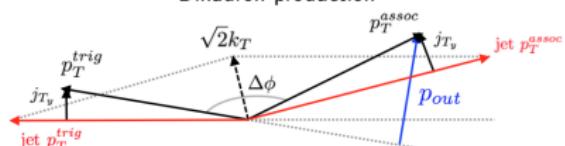
$$R_{AA} = \frac{\text{Yield}_{\text{Cu+Au}}}{\langle N_{coll} \rangle \text{Yield}_{p+p}}$$

Probing the Nucleon Transverse Structure

Direct photon-hadron production

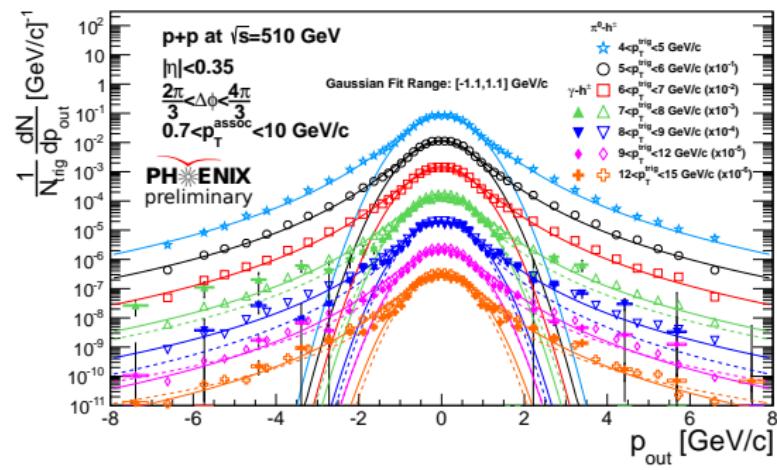


Dihadron production

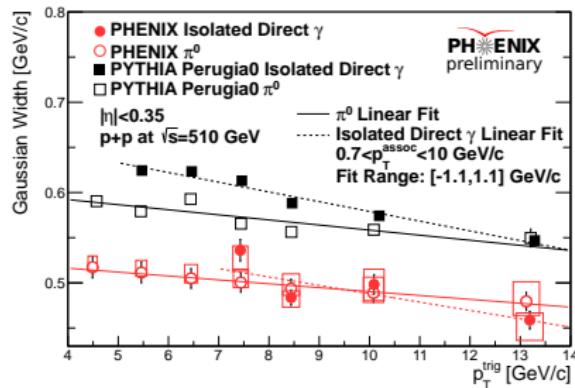


$$p_{out} = p_T^{assoc} \sin \Delta\phi$$

- ▶ p_{out} core Gaussian from intrinsic k_T .
- ▶ Power-law tail due to hard gluon radiation.

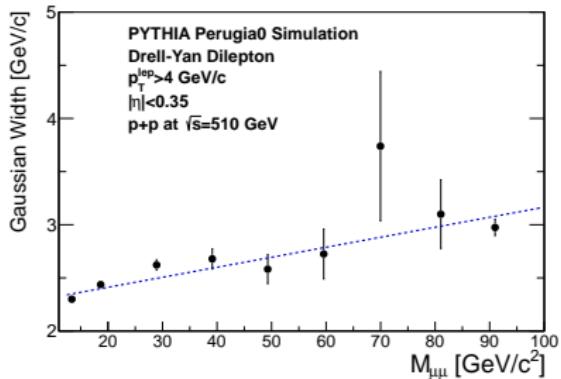
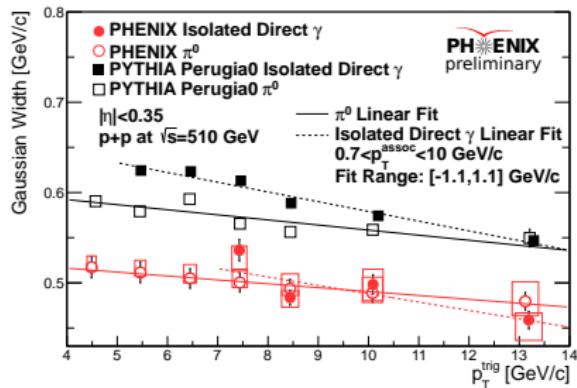


Probing the Nucleon Transverse Structure



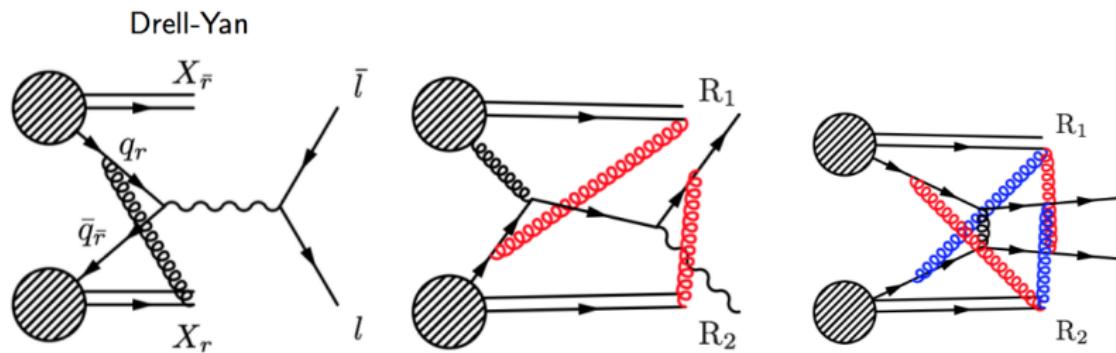
- ▶ PYTHIA magnitude doesn't match the magnitude of the data but matches the magnitude of the slope.

Probing the Nucleon Transverse Structure



- ▶ PYTHIA magnitude doesn't match the magnitude of the data but matches the magnitude of the slope.
- ▶ PYTHIA produces opposite sign slopes for p_{out} Gaussian widths in Drell-Yan events compared to γ -jet and di-jet events.

Probing the Nucleon Transverse Structure



- ▶ Interactions with remnants can be handled in transverse momentum-dependent (TMD) PDFs for the Drell Yan case.
- ▶ Rogers and Mulder Phys. Rev. **D81**, 094006 (2010) predict breakdown of factorization (i.e. separation of PDF, hard cross section and fragmentation) in a TMD framework for di-hadron events in hadronic collisions.

Summary and Conclusions

- ▶ PHENIX has measured Anti- k_T jets in $p + p$, $d + \text{Au}$ and $\text{Cu} + \text{Au}$ collisions.
- ▶ $\text{Cu} + \text{Au}$ suppression of jets in most central events.
- ▶ $d + \text{Au}$ R_{dA} for different centrality may be interpreted as evidence of the nucleus probing the nucleon.
- ▶ Direct γ -hadron and di-hadron correlations in $p + p$ are also sensitive to the transverse structure of the nucleon in very fundamental ways.