

Measurements of longitudinal double-spin asymmetries of inclusive jet and dijet production at STAR

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For the STAR collaboration

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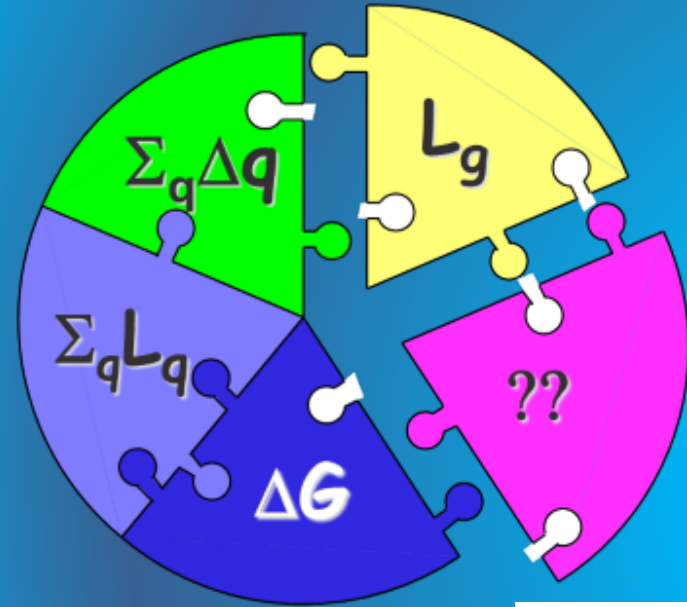
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Proton Spin Puzzle



Measure the individual contributions of quarks, antiquarks and gluons, to the spin of the proton.

The proton spin sum rule (Jaffe-Manohar 1990):

$$\langle S_p \rangle = \frac{1}{2} = \frac{1}{2} \Delta\Sigma + \Delta G + L_q + L_g$$

- Polarized DIS results $\Delta\Sigma \approx 0.3$
- Flavor separation from **STAR**, *Phys. Rev. D* 99 (2019) 051102

Gluon polarization

Quark and gluon orbital angular momentum contribution

poorly constrained 2/12

Gluon helicity distribution

$$\langle S_p \rangle = \frac{1}{2} = \frac{1}{2} \Delta \Sigma + \Delta G + L_q + L_g$$

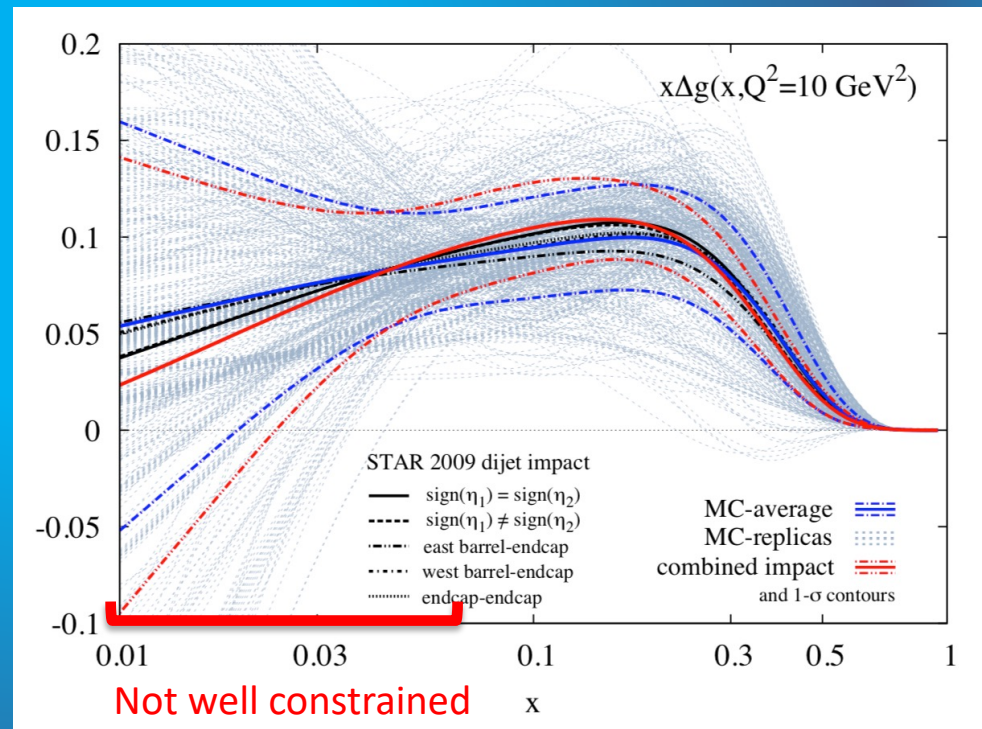
- Gluon polarization can be measured using A_{LL} of jets in proton-proton collisions.
- Dominating processes at RHIC are gg and qg scatterings.
- STAR 2009 dijet A_{LL} results at 200 GeV, were included in the latest DSSV analysis.



$$A_{LL} = \frac{\sigma^{++} - \sigma^{+-}}{\sigma^{++} + \sigma^{+-}} \propto \frac{\Delta f_a \Delta f_b}{f_a f_b} \hat{a}_{LL}$$

$$\Delta G = \int dx \Delta g(x)$$

DSSV, Phys. Rev. D 11 (2019) 114027

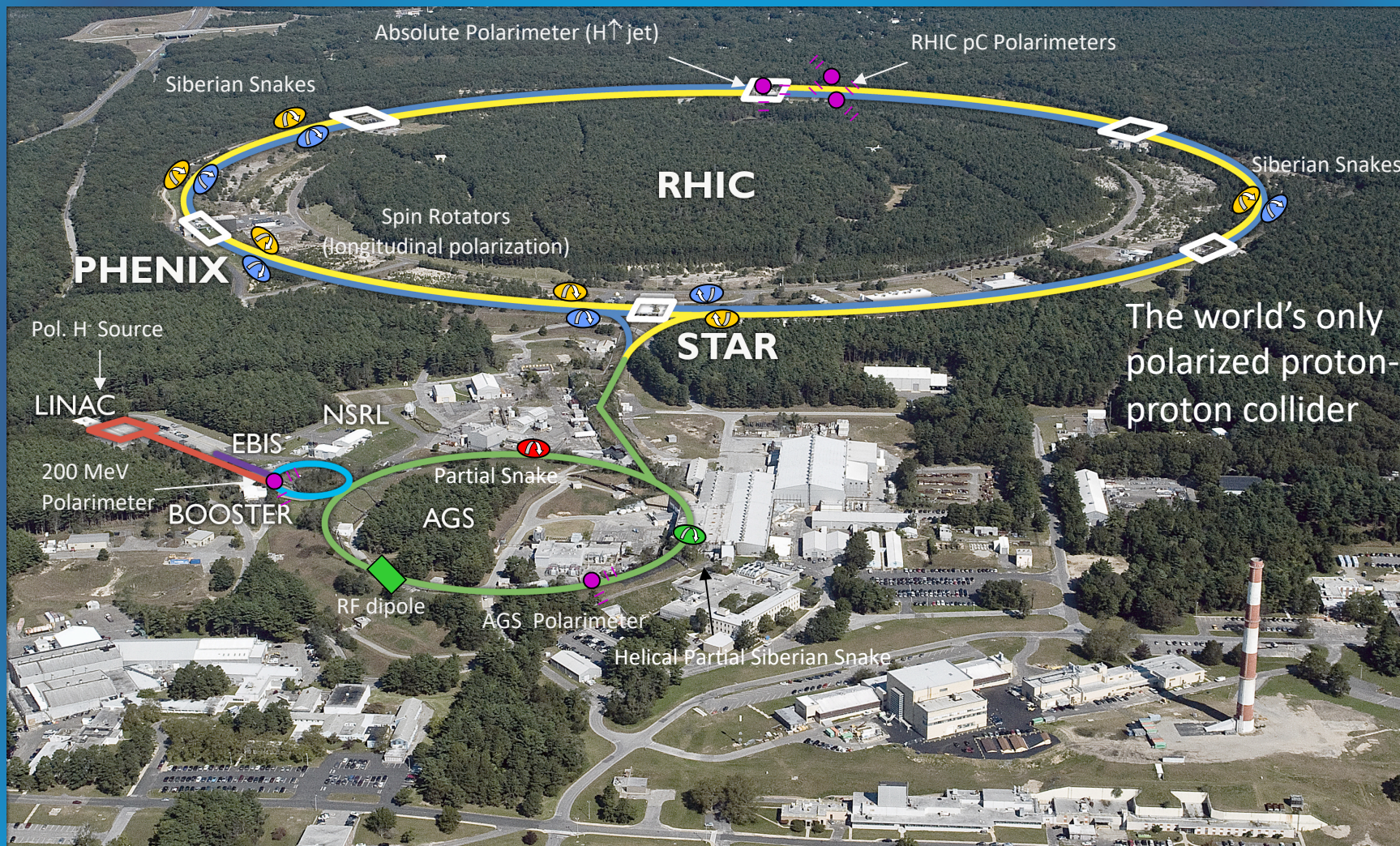


Including 2009 STAR dijet measurements:

Before reweighting: $\int_{0.1}^1 \Delta g(x) dx = 0.133 \pm 0.035$

After reweighting: $\int_{0.1}^1 \Delta g(x) dx = 0.126 \pm 0.023$

Relativistic Heavy Ion Collider



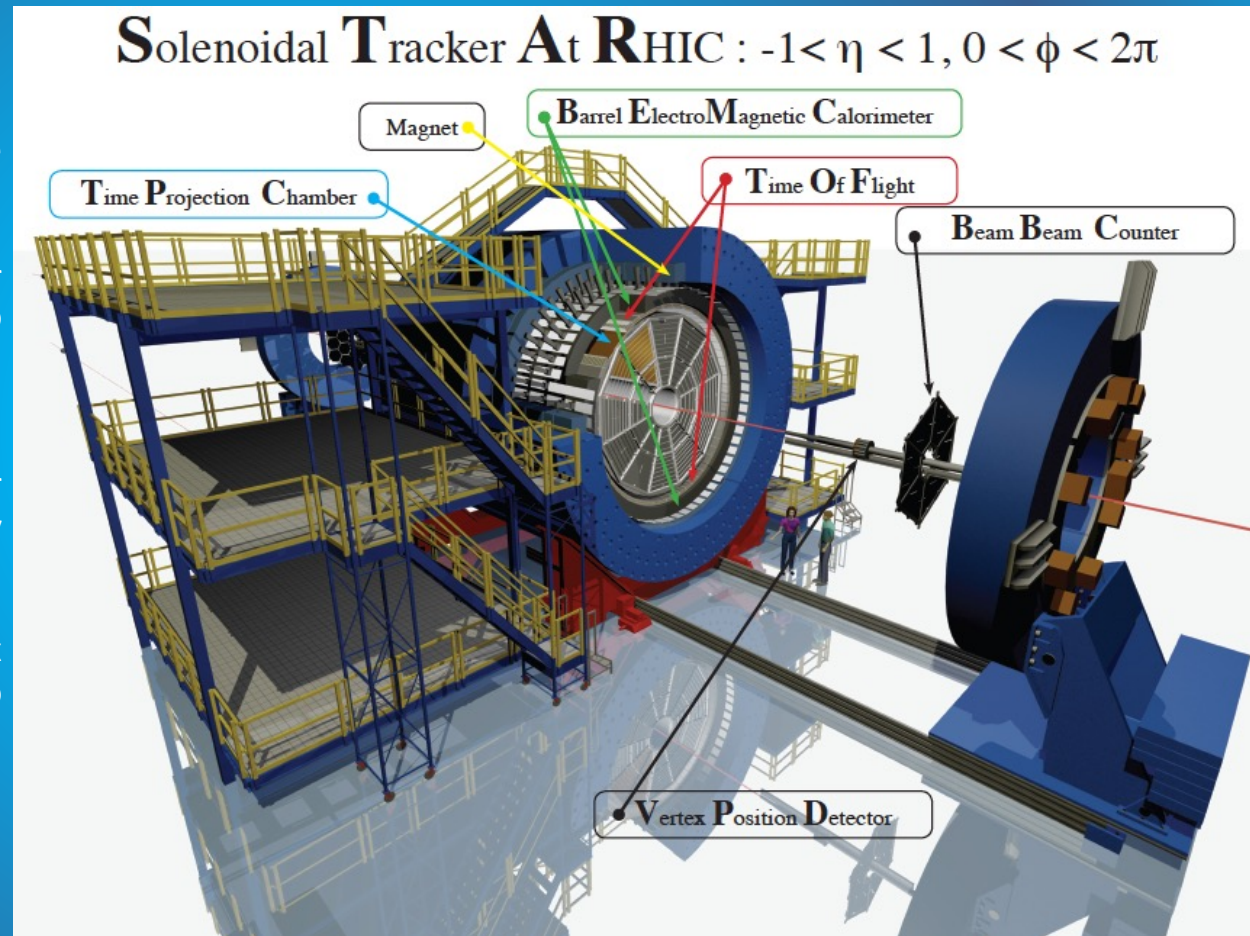
STAR detector

The main tracking device is a Time Projection Chamber (TPC) at $|\eta| < 1$.

The Barrel Electromagnetic Calorimeter (BEMC) covering $|\eta| < 1$, is used to trigger high momentum jets via EM energy deposit.

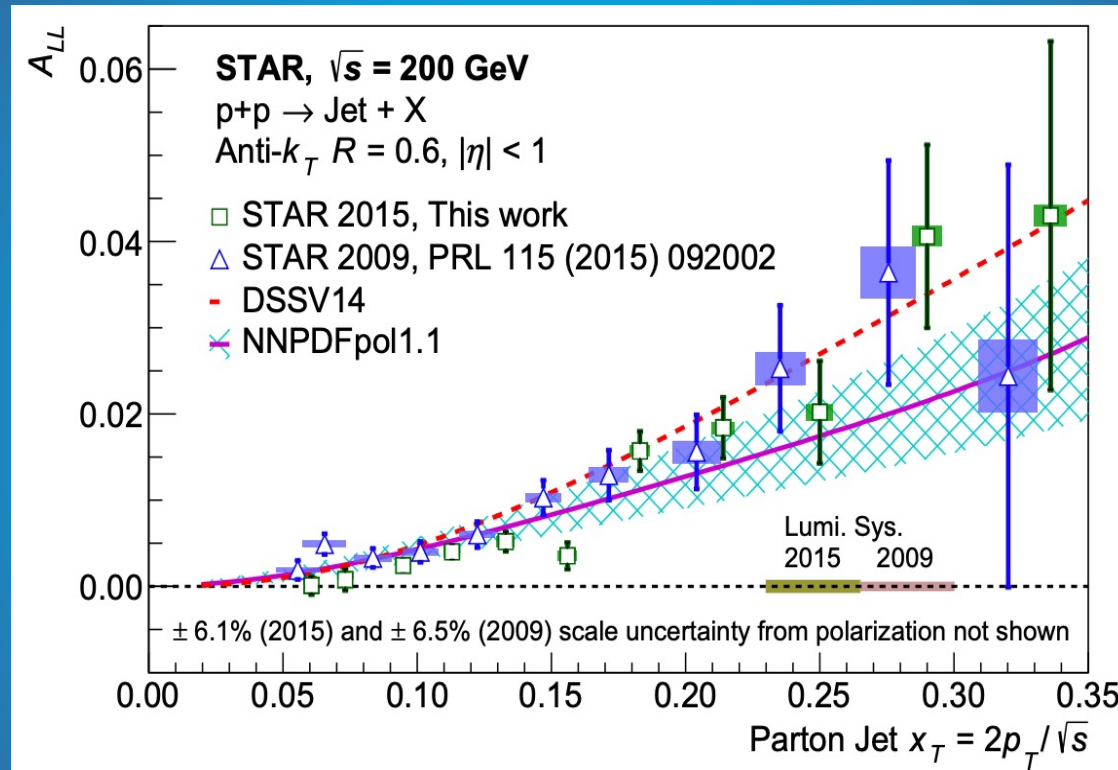
An Endcap Electromagnetic Calorimeter (EEMC) complements the BEMC by extending the coverage to $1.1 < \eta < 2$

Luminosity is measured with the Vertex Position Detector (VPD) and the Zero Degree Calorimeter (ZDC).



Inclusive jets at 200 GeV and $|\eta| < 1$

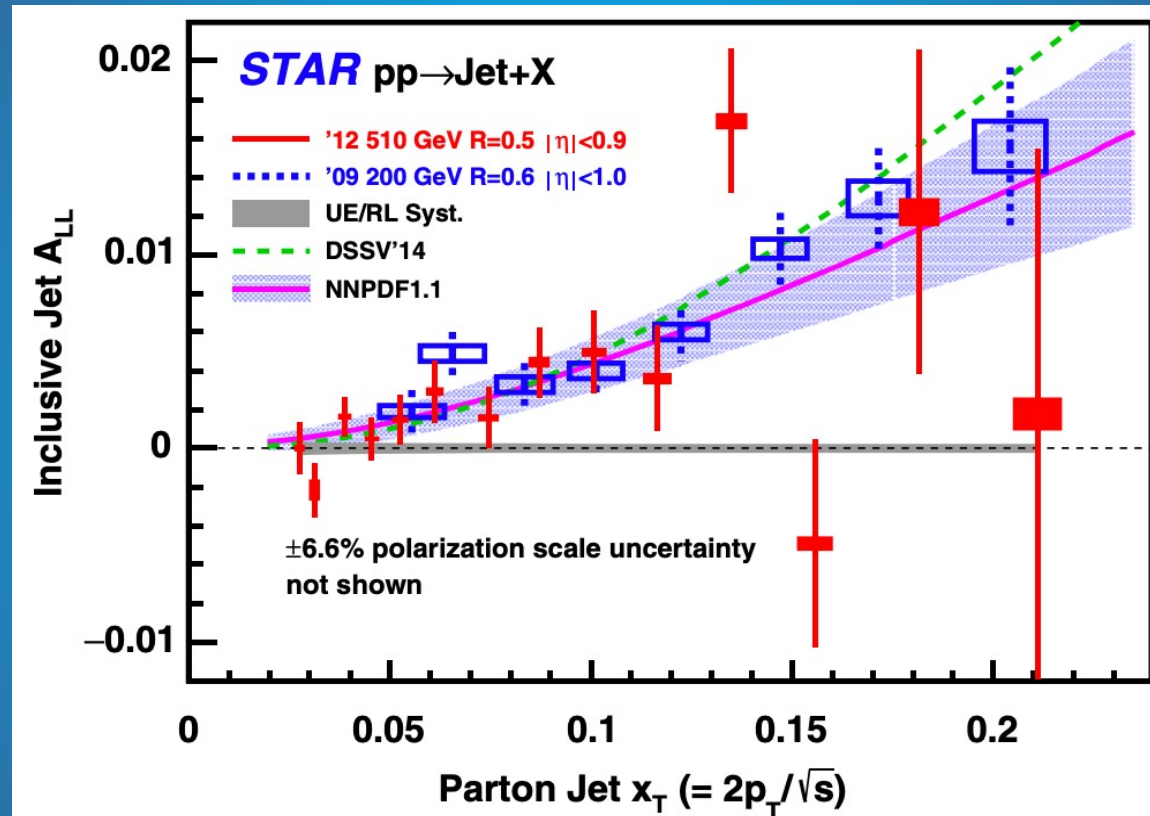
STAR, PRD 103 (2021) L091103



- Inclusive jet A_{LL} results from 2015 data, consistent with previous STAR results and global fits.
- Twice larger figure of merit with improved systematics.
- This result will reduce uncertainty of gluon polarization for $x > 0.05$.

Inclusive jets at 510 GeV and $|\eta| < 0.9$

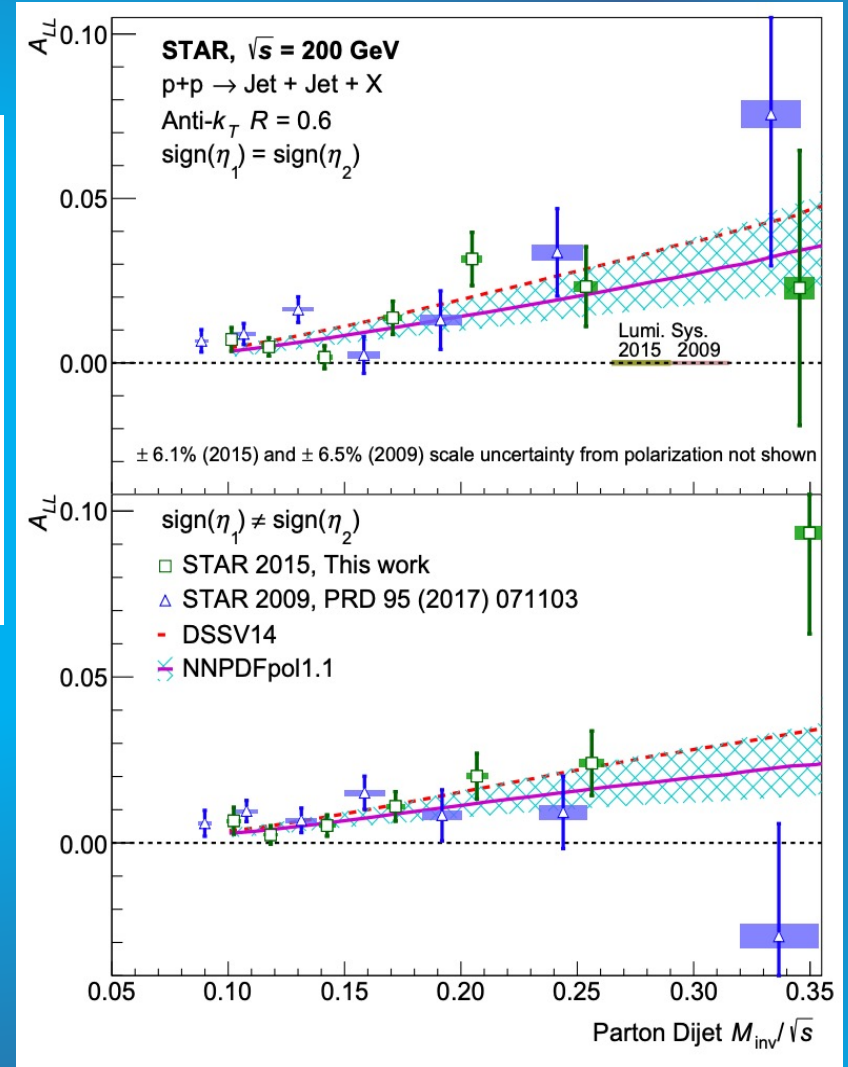
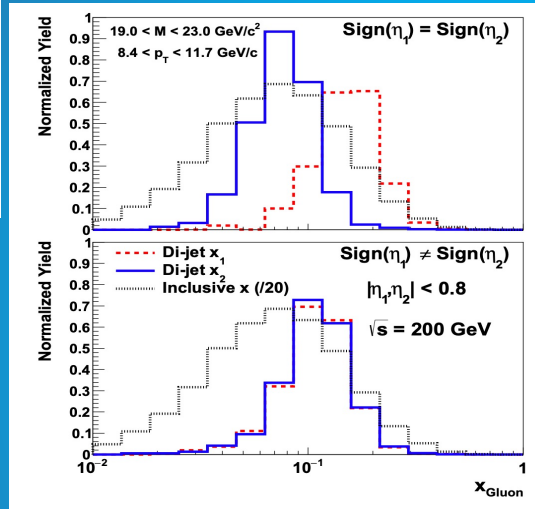
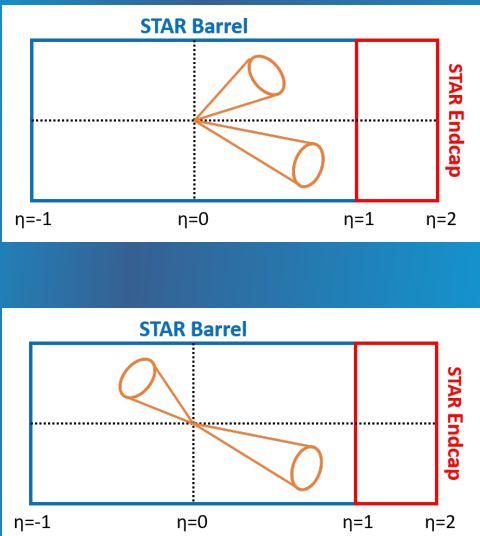
STAR, PRD 100 (2019) 052005



- Inclusive jet A_{LL} results from 2012 data, consistent with previous STAR results and global fits.
- Higher center of mass energy pushes sensitivity to $x > 0.015$.
- Run 2013 A_{LL} measurement, publication in preparation.

Dijets at 200 GeV and $|\eta| < 1$

STAR, PRD 103 (2021) L091103

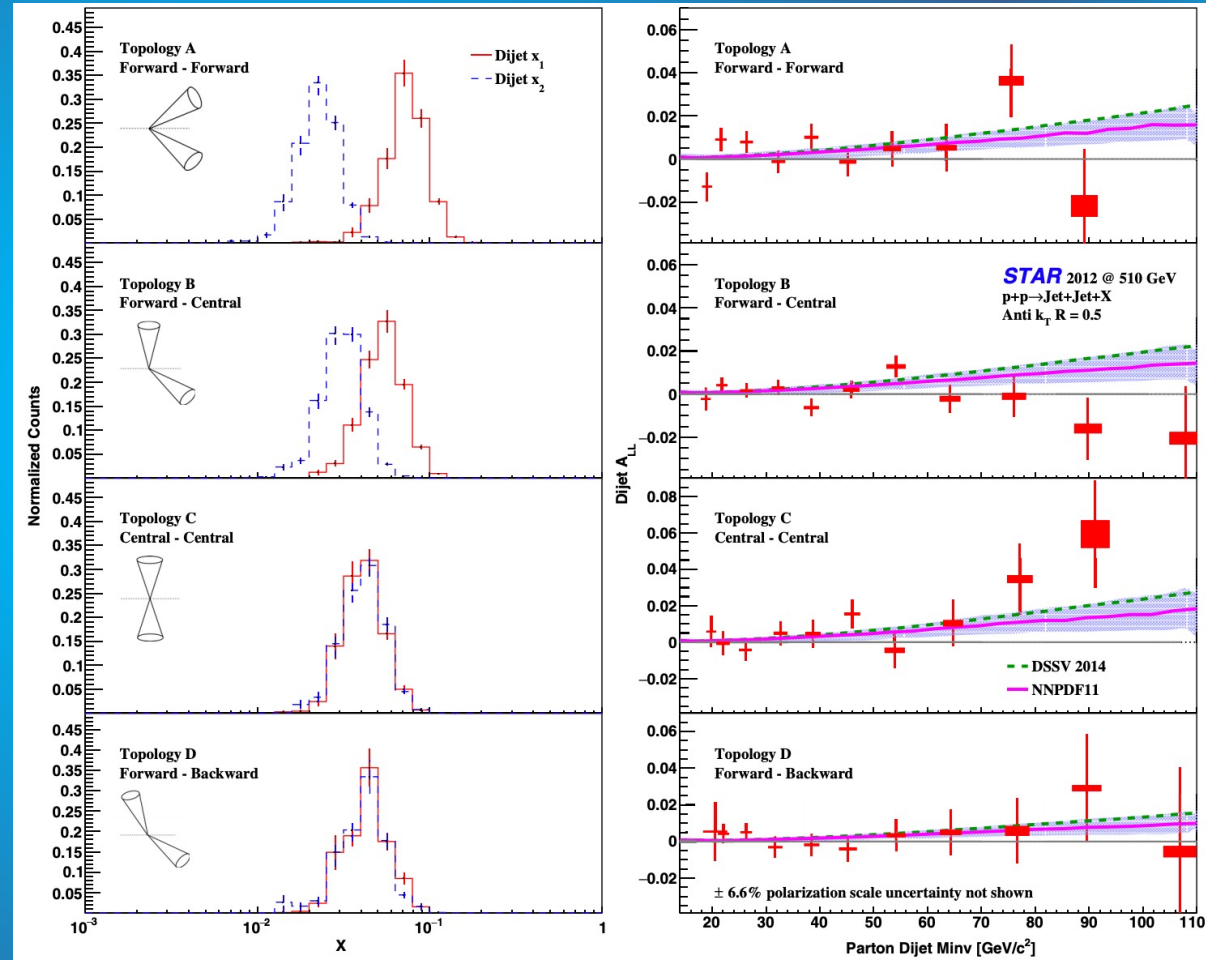


- Dijet A_{LL} results from 2015 data, consistent with previous STAR results and global fits.
- Dijet production constrains the gluon polarization in narrower x regions than inclusive jets.

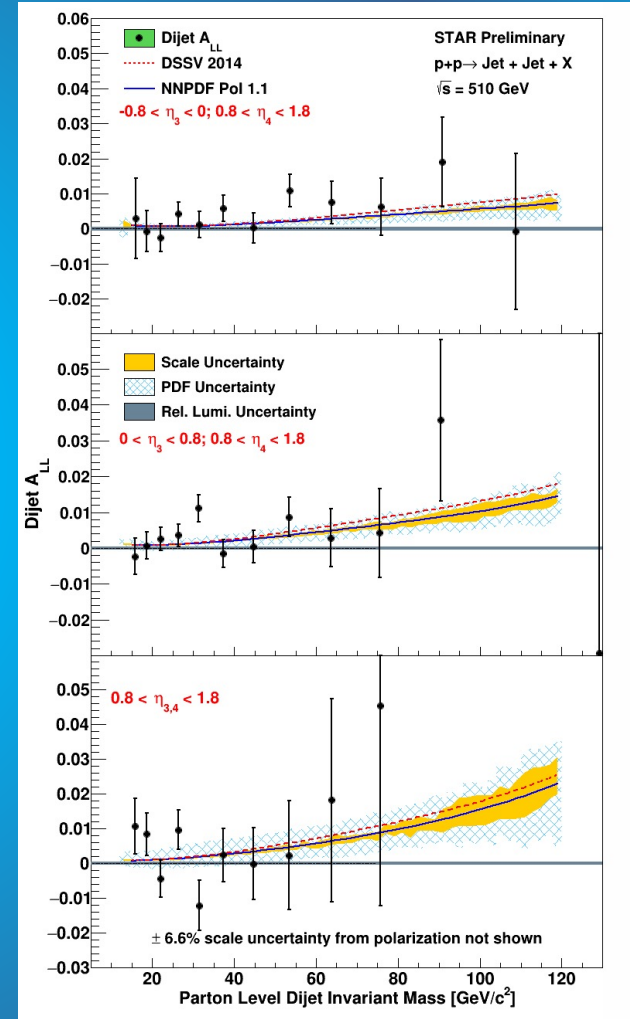
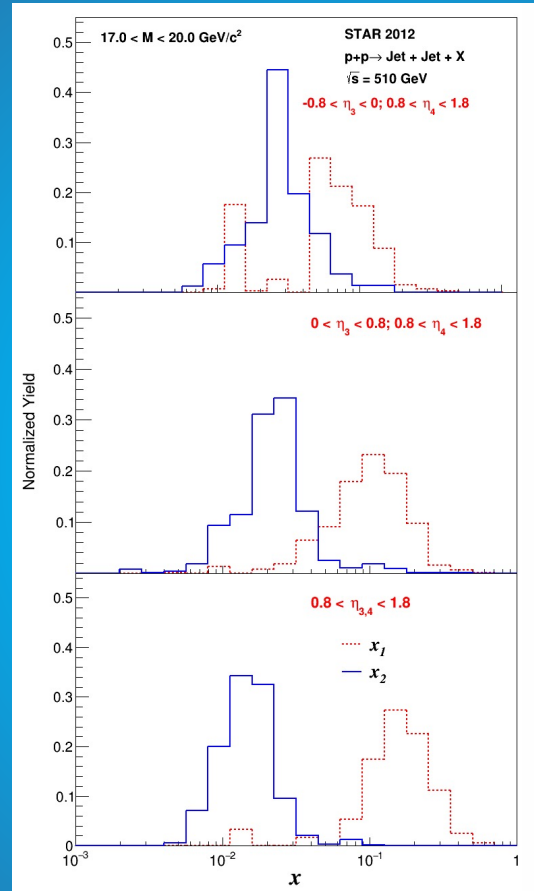
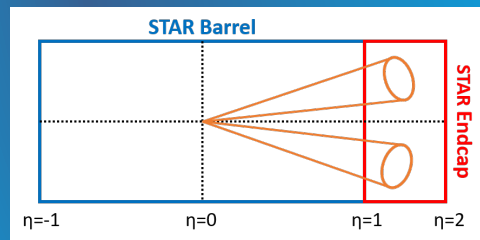
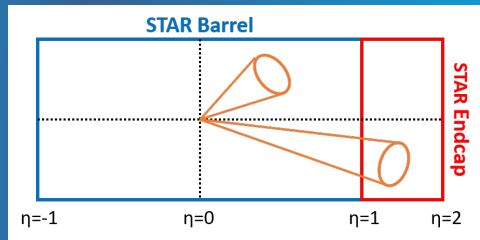
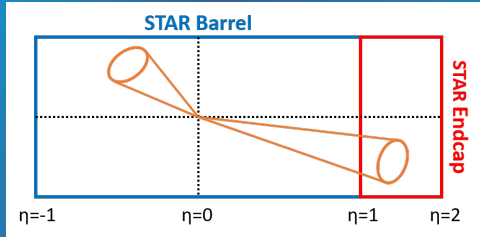
Dijets at 510 GeV and $|\eta| < 0.9$

STAR, PRD 100 (2019) 052005

- Different dijet configurations are sensitive to different kinematic regions.
- Four different η topology bins
- Better constraints on the functional form of $\Delta g(x, Q^2)$.
- Run 2013 A_{LL} measurement with same topologies, publication in preparation.



Dijets at 510 GeV and $-0.8 < |\eta| < 1.8$



- Preliminary results using 2012 data and consistent with 2009 results [STAR Phys. Rev. D 98, 032001 \(2018\)](#).
- More statistics for 2013 data (~2.5x).

Summary

\sqrt{s}	Run	Central Jets ($ \eta < 1$)	Central Dijets ($ \eta < 1$)	Inter. Dijets ($0.8 < \eta < 1.8$)
200	2009	Published $x > 0.05$	Published $x > 0.05$	Published $x > 0.01$
200	2015	Published $x > 0.05$	Published $x > 0.05$	
510	2012	Published $x > 0.015$	Published $x > 0.015$	Preliminary $x > 0.004$
510	2013	In preparation for publication $x > 0.015$	In preparation for publication $x > 0.015$	In Progress $x > 0.004$

- New sets of measurements available, to be included in global fits.
- **Collection of longitudinally polarized data concluded in 2015.**
- STAR measurements enable unique QCD physics before the Electron-Ion Collider (EIC) that will access even lower x -values.