Constraining the Polarized Gluon Distribution Through Dijet Measurements at $\sqrt{s}$=510 GeV at STAR

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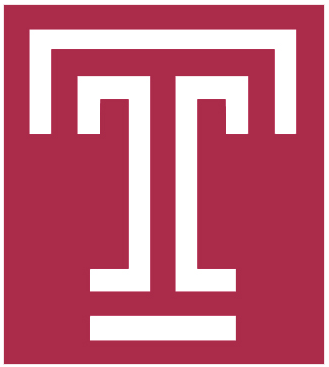
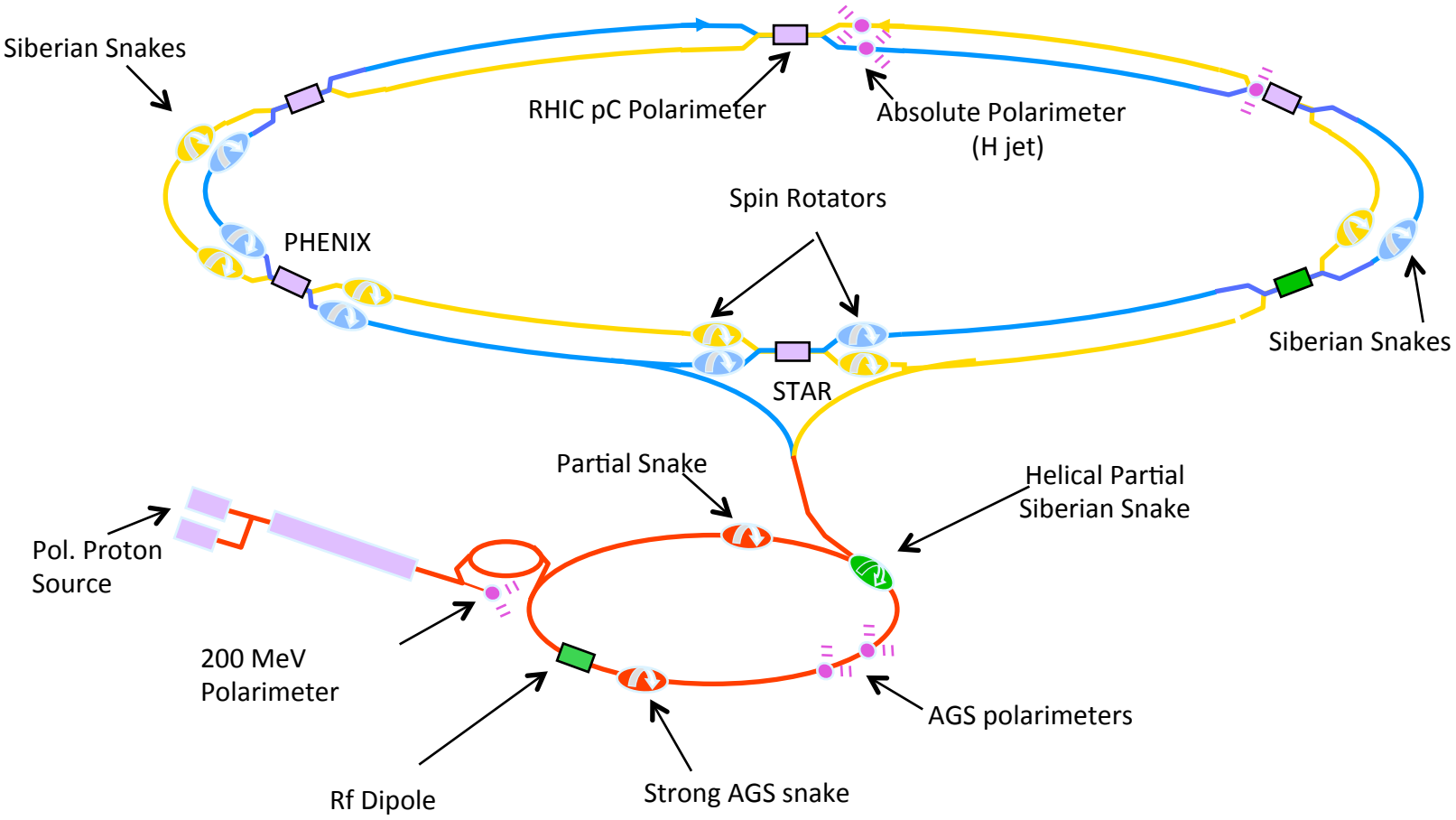
for the STAR Collaboration

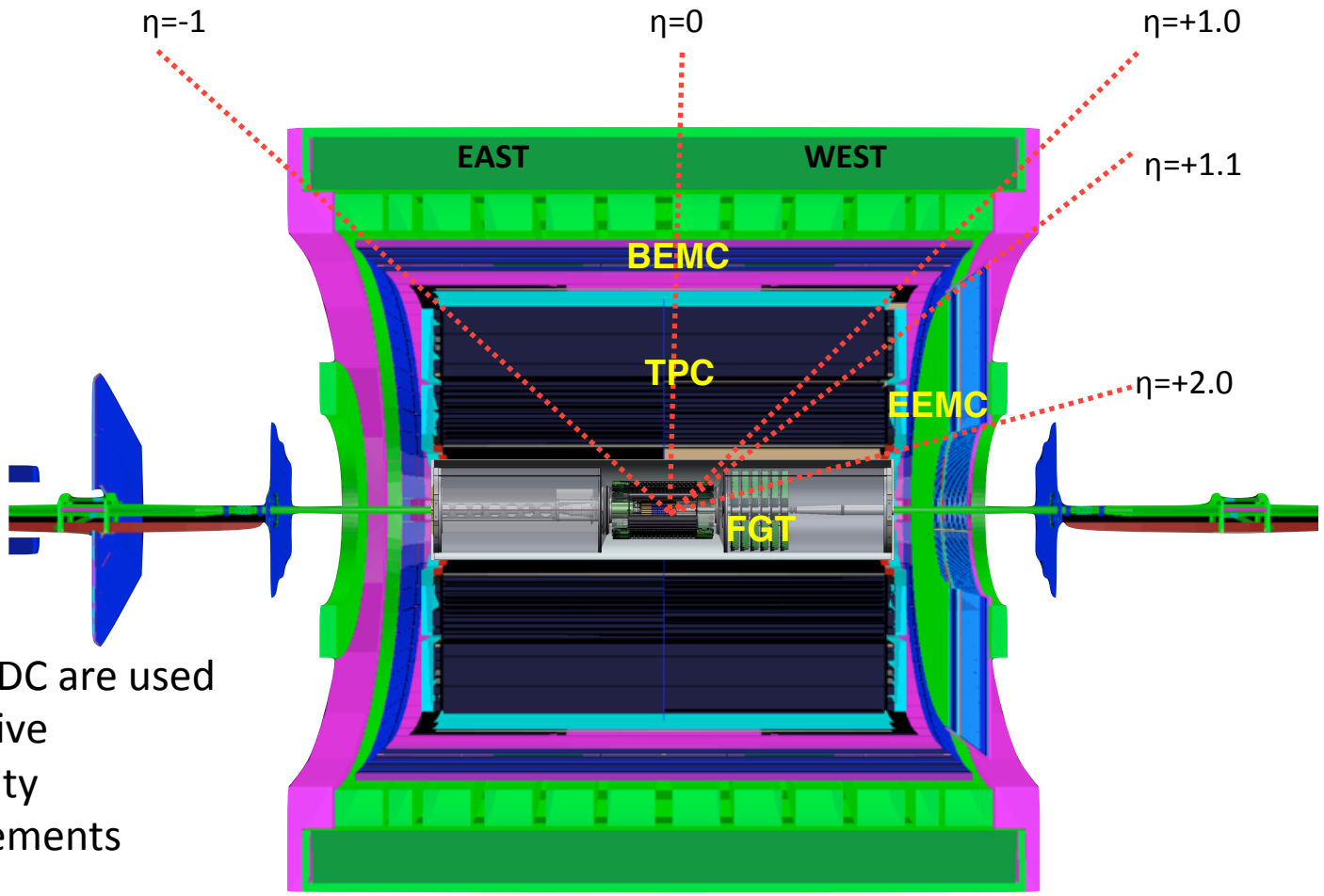


RHIC

World's first and only polarized proton collider



STAR Experiment – 2013 Setup



VPD & ZDC are used for relative luminosity measurements

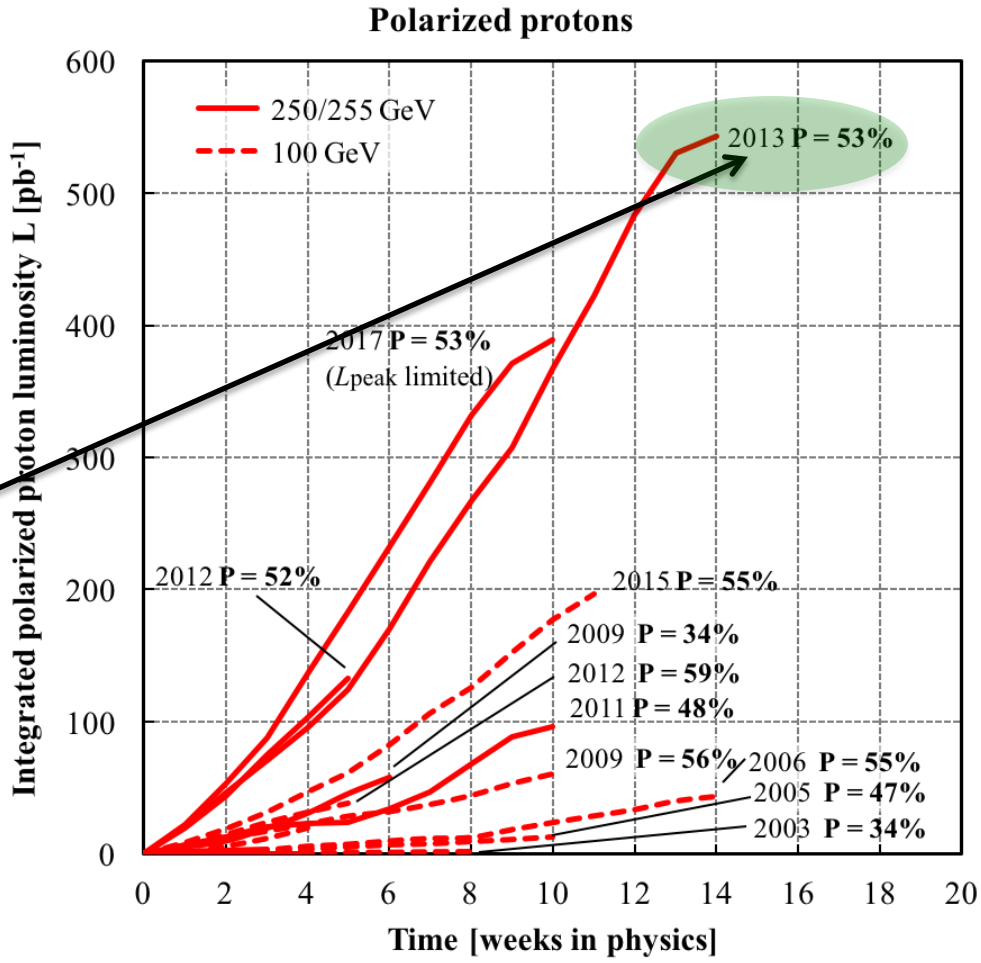
EMC Coverage
BEMC: |η| ≤ 1
EEMC: 1.1 <η< 2

Tracking Coverage
TPC: |η| ≤ 1.3
FGT: 1 <η< 2

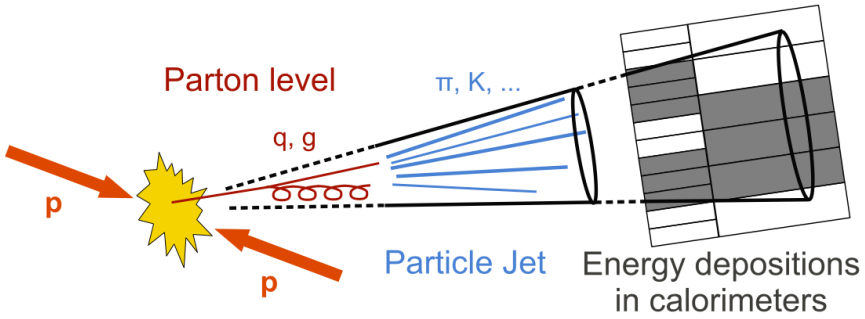
$$\eta = -ln\left(\tan\frac{\theta}{2}\right)$$

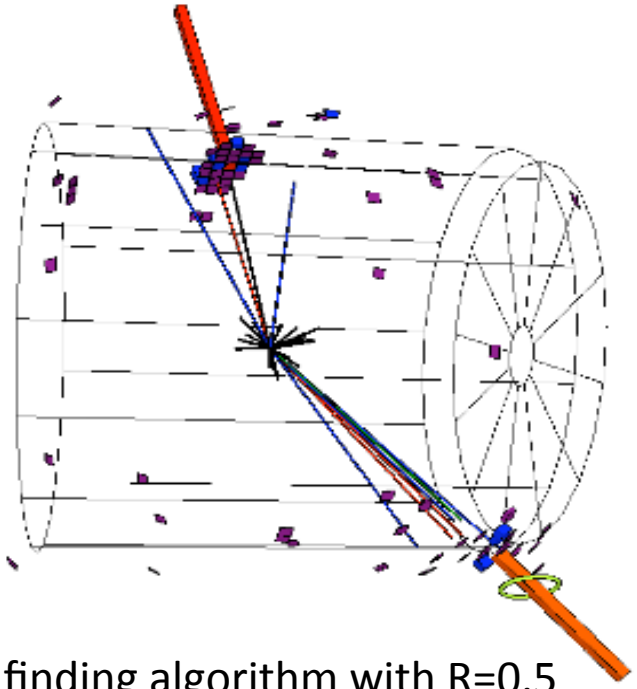
Data Collection at STAR

- Polarized p+p collisions
- In 2009, 2012, & 2013, longitudinally polarized collisions at √s=500/510 GeV
- 2013 collected ~3 times the data compared to 2012



Jet Definition





Parton: Jets contain gluons and quarks
Particle: Jets contain hadrons (pions, kaons, etc.)
Detector: Reconstructed from measured charged-particle momenta and neutral-particle energies

- Jets were reconstructed using the anti-k_t jet finding algorithm with R=0.5
- Dijets allow access to the initial partonic kinematics

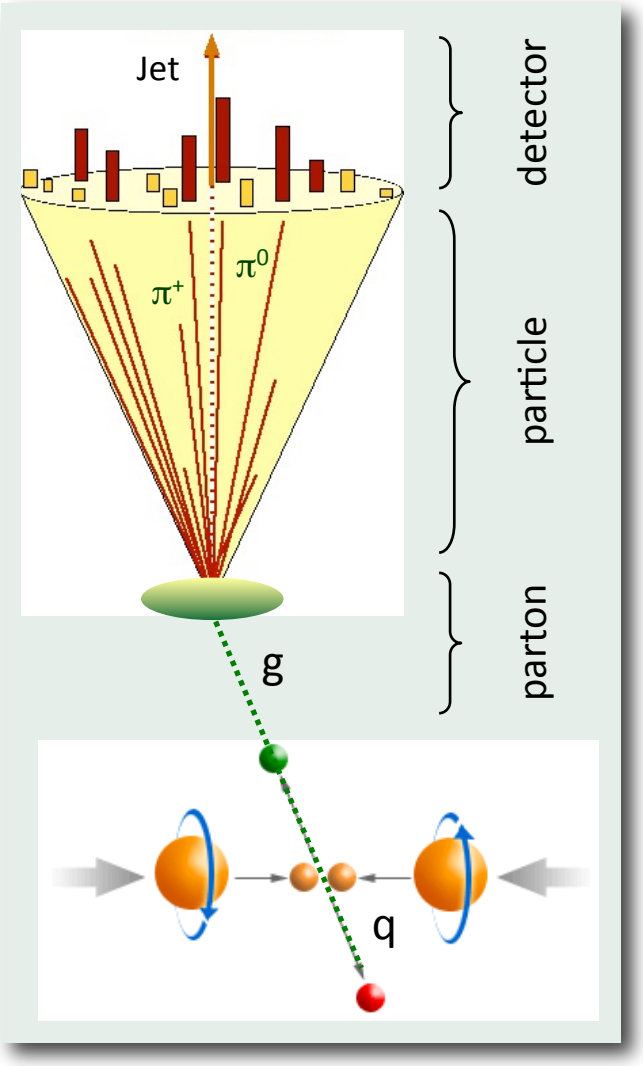
$$x_1 = \frac{2}{\sqrt{s}}\left(p_{T3}e^{\eta_3} + p_{T4}e^{\eta_4}\right)$$

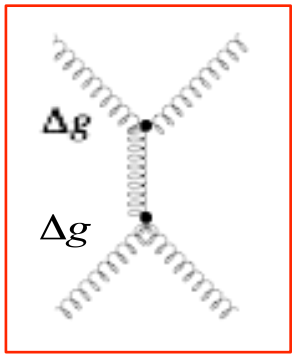
$$x_2 = \frac{2}{\sqrt{s}}\left(p_{T3}e^{-\eta_3} + p_{T4}e^{-\eta_4}\right)$$

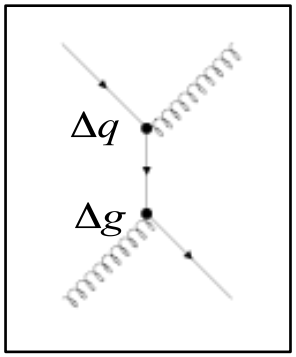
$$\eta = -ln\left(\tan\frac{\theta}{2}\right)$$

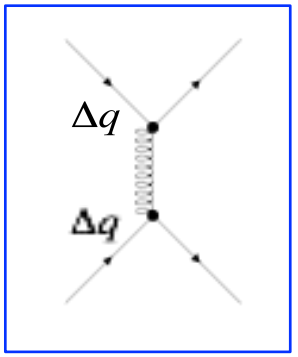
1,2: Incoming Partons
3,4: Outgoing Partons

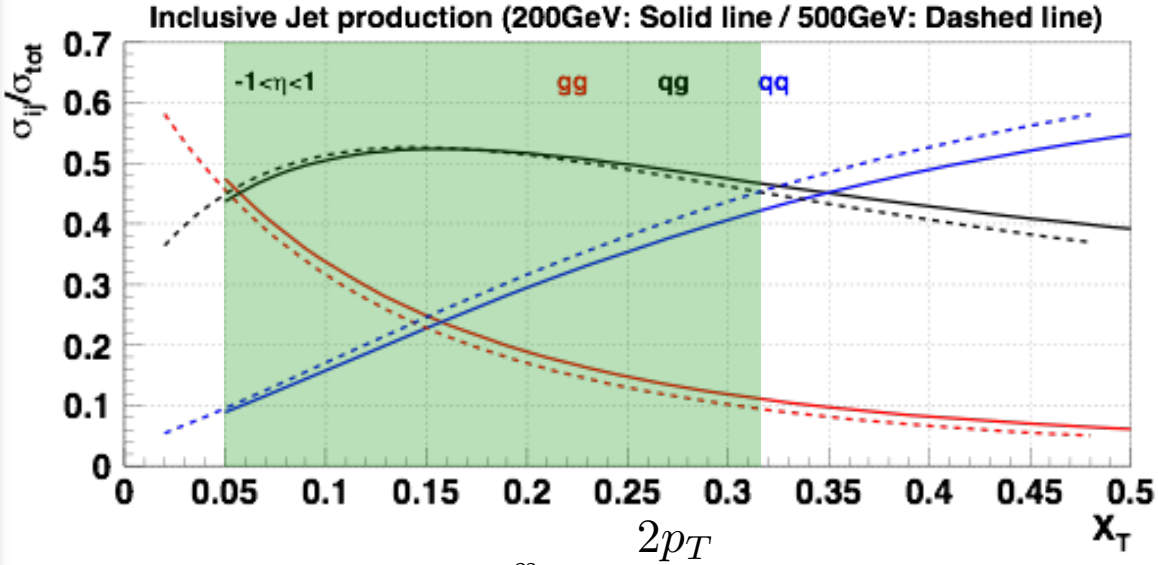
Access to Gluons at STAR





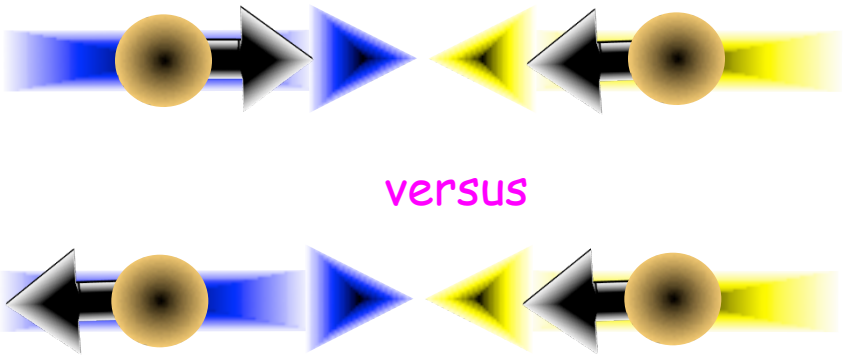


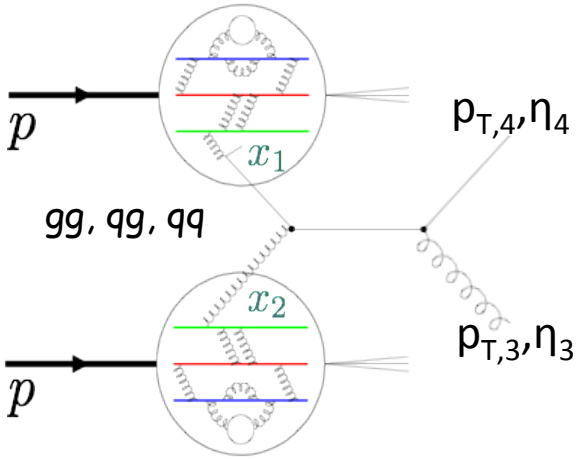




$$x_T = \frac{2p_T}{\sqrt{s}}$$

Access to ΔG





Dijet production

$$A_{LL} = \frac{\sigma^{++} - \sigma^{+-}}{\sigma^{++} + \sigma^{+-}} = \frac{1}{P_1 P_2} \frac{N^{++} - RN^{+-}}{N^{++} + RN^{+-}} \propto \frac{\Delta f_a \Delta f_b}{f_a f_b} a_{LL}$$

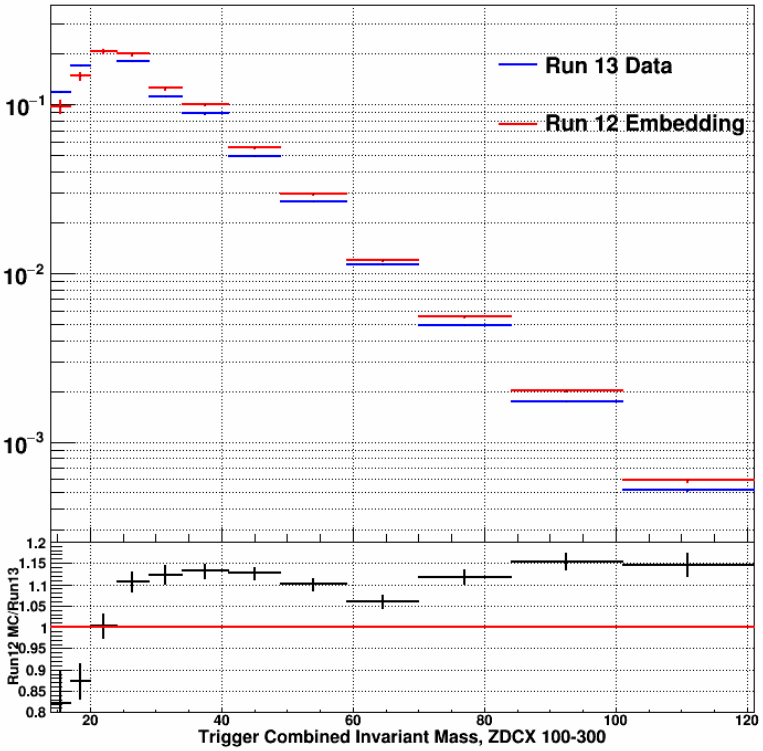
$$N = \sigma L, R = \frac{L^{++}}{L^{+-}}$$

For Jets Only

Experiment

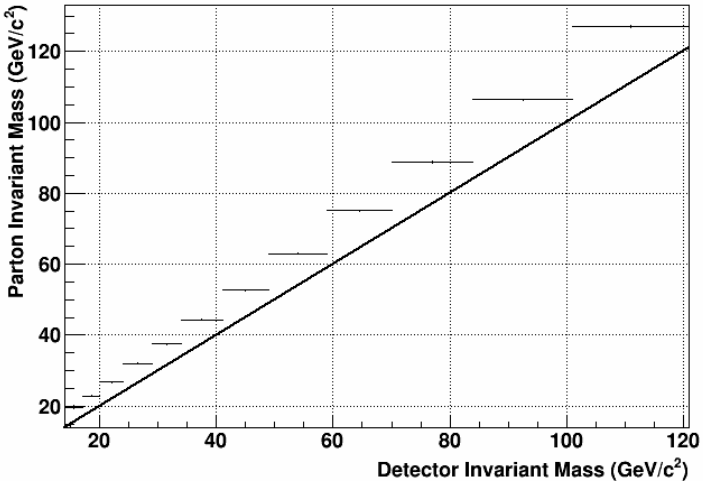
Theory

Systematic Errors

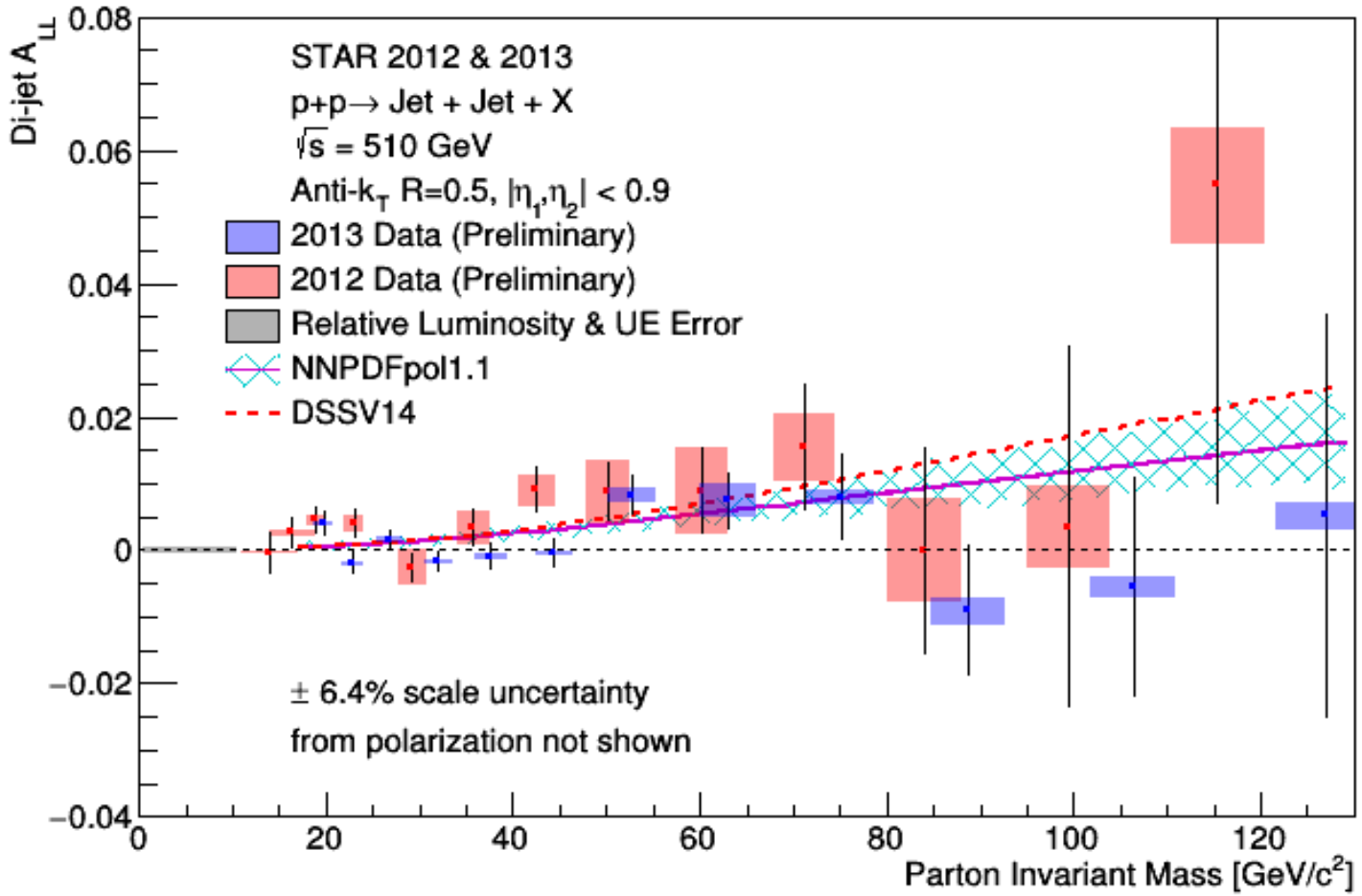


- Since 2012 embedding is used, only showing ~40% of the data

- Embedded simulation for 2012 was used to calculate 2013 preliminary systematic errors and mass shift
  - Reasonable agreement between the 2 samples
- Adopting NNPDFpol1.1 allowed for a reduction in the trigger and reconstruction bias systematic uncertainties compared to 2012 preliminary results

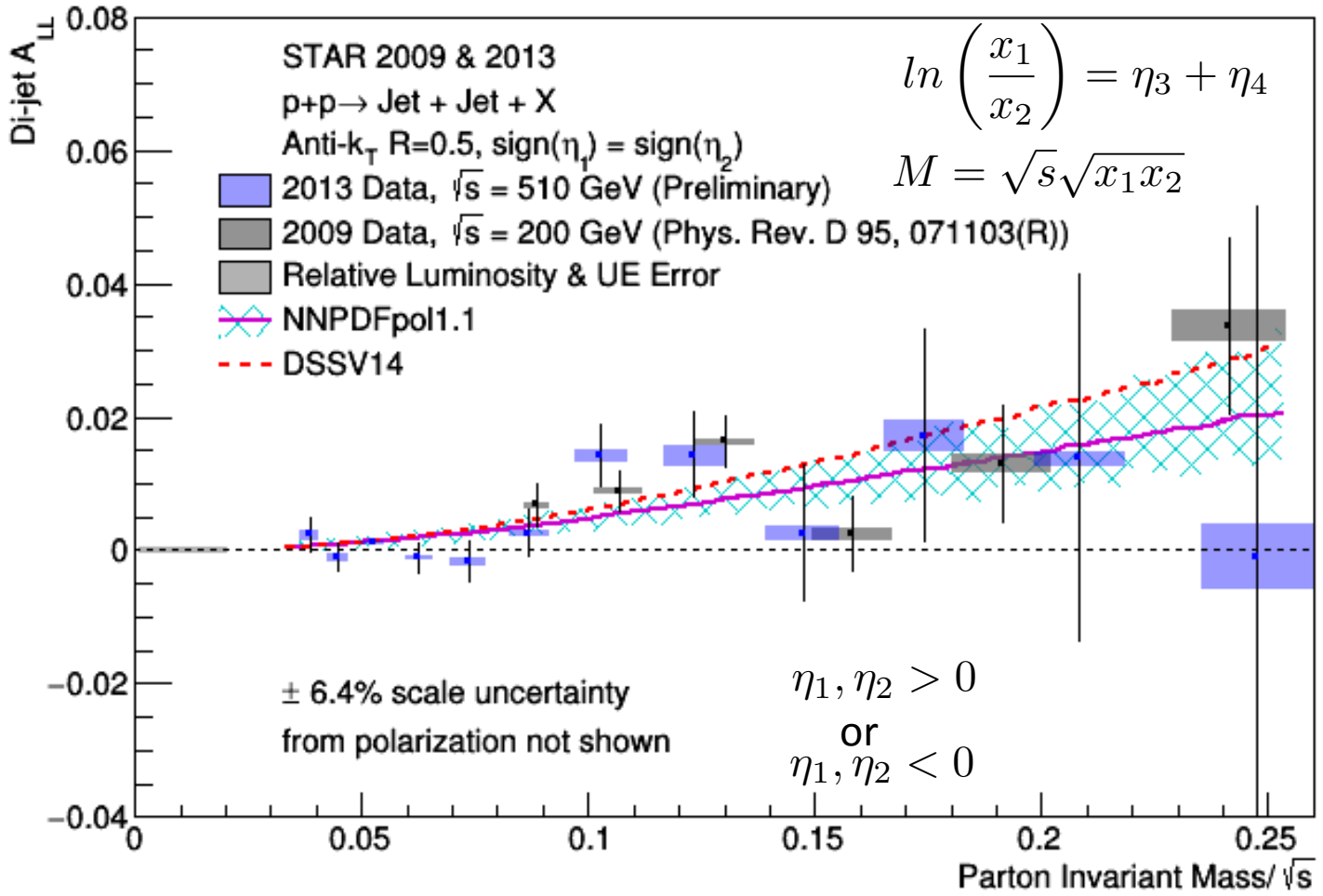


2013 Preliminary



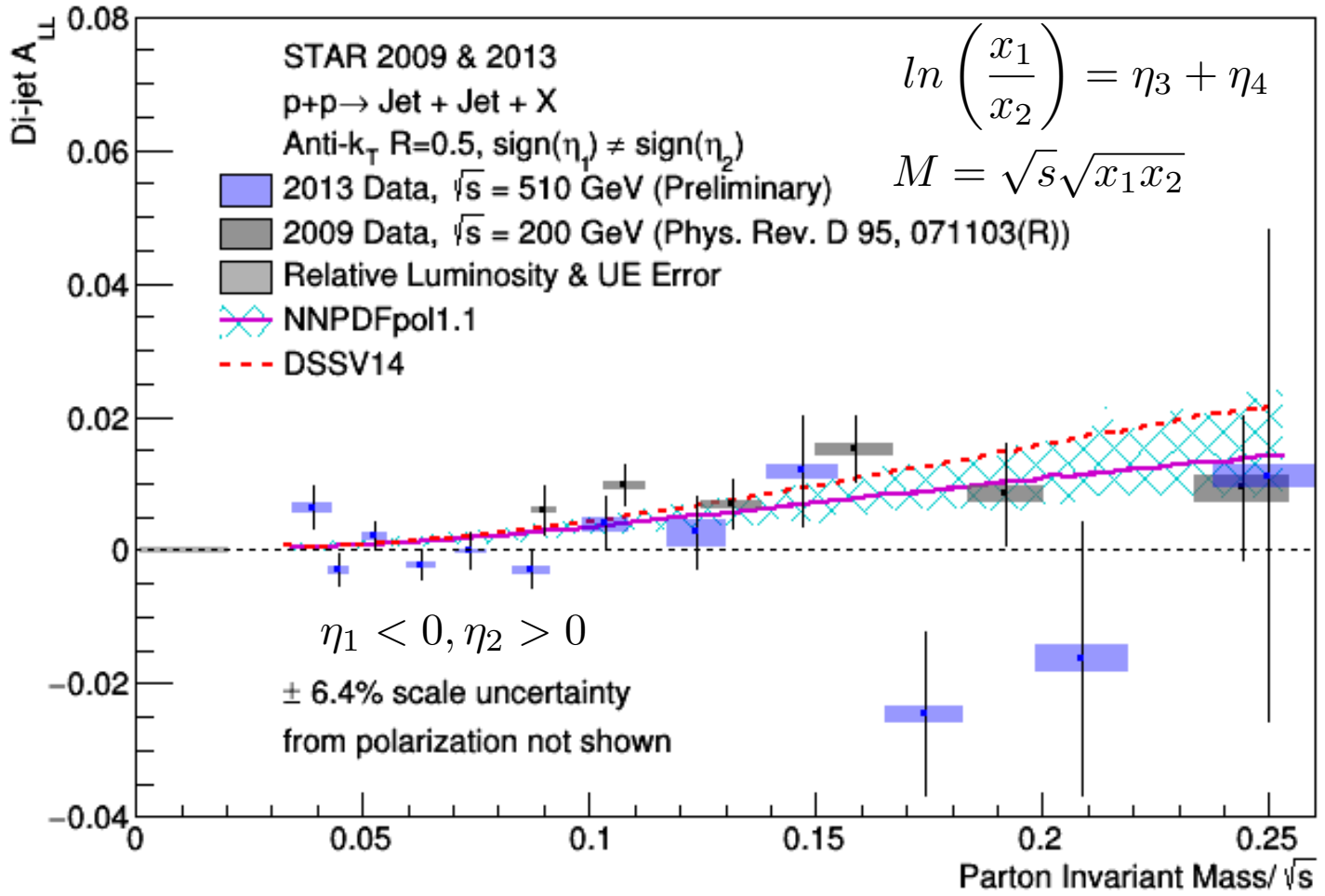
- 2012 and 2013 dijet asymmetries are in agreement
- Reduced statistical and systematic uncertainties for 2013 compared to 2012

2013 Preliminary



- 2009 (200 GeV) and 2013 (510 GeV) dijet asymmetries are in agreement in the overlap region
- The igher center of mass energy of 510 GeV in 2013, allows STAR to probe lower x

2013 Preliminary



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RHIC Impact on Global Analyses

- Inclusion of the 2009 RHIC data greatly reduced the uncertainty on ΔG for the DSSV group for $x \geq 0.05$

- DSSV − New Fit Δg(x)

$$\Delta G = \int_{0.05}^{1} \Delta g(x, Q^2 = 10 GeV^2) = 0.20^{+0.06}_{-0.07}(90\% C.L.)$$

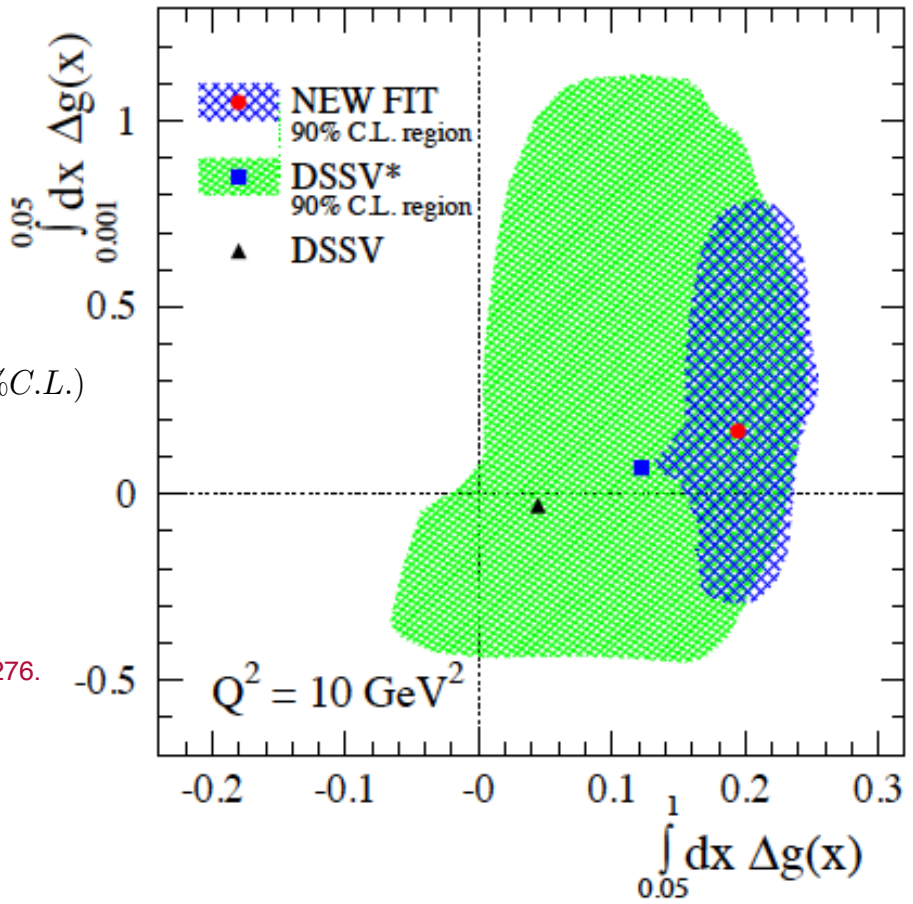
- An independent analysis by NNPDF shows similar results

$0.23^{+0.07}_{-0.07}$ for $0.05 < x < 0.5$

E. R. Nocera et al., Nucl. Phys. B887 (2014) 276.

- Large 2013 data sample will provide better constraints at lower Bjorken x

D. deFlorian et al., Phys. Rev. Lett. 113 (2014) 012001.



DSSV: Original global analysis (first RHIC results, 2005 & 2006)
DSSV*: New COMPASS inclusive and semi-inclusive results
DSSV − NEW FIT: Now includes RHIC 2009 data, strong impact of Δg(x)

Summary

- STAR has continued to take advantage of the highly polarized proton beams at RHIC allowing the development of a strong jet/dijet program

- Dijet measurements allow us to measure the gluon polarization function
  - 2009 STAR Inclusive jet results at 200 GeV made a strong impact in reducing uncertainty in RHIC kinematic range ($0.05 \leq x \leq 0.2$)
  - Dijet measurements will allow one to constrain the shape of Δg
  - 2013 results will reduce the uncertainty at lower Bjorken x values

- Success of the STAR ΔG program, with high precision measurements complements an EIC facility which will extend these measurements to even lower values of Bjorken x