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Measurement of the Longitudinal Double-Spin Asymmetry for Inclusive Jet and Di-Jet Production in Polarized Proton Collisions at $\sqrt{s}$ = 200 GeV

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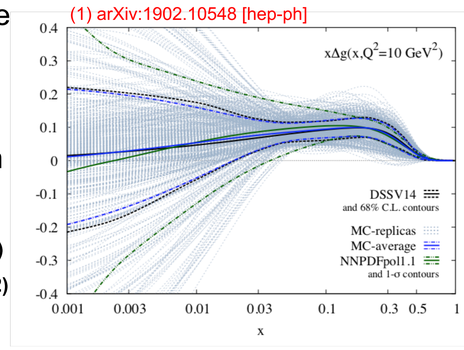
Motivation

- The contribution of gluon polarization (ΔG) to the spin of the proton is still an open question in QCD.
- The latest global analyses, which include all STAR Run 2009 (200 GeV) results, extract a positive gluon polarization contribution to the proton spin.

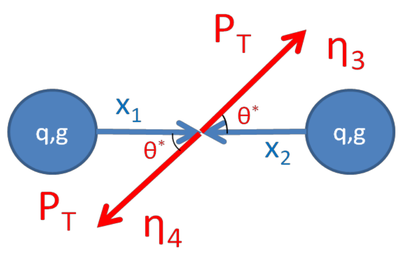
$$\Delta G = \int dx \Delta g(x)$$

DSSV[1] : 0.126 ± 0.023 (0.1 < x < 1)
NNPDF[2] : 0.17 ± 0.06 (0.05 < x < 0.2)

(1) arXiv:1902.10548 [hep-ph]



- Di-jets allow access to the initial partonic kinematics so they probe a narrower x region.



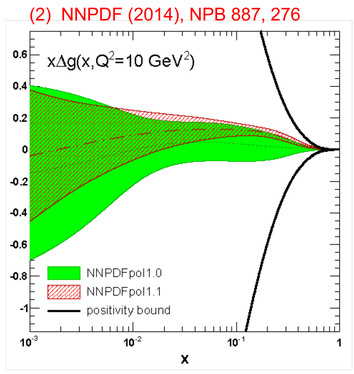
$$x_1 = \frac{2}{\sqrt{s}}\left(p_{T3}e^{\eta_3} + p_{T4}e^{\eta_4}\right)$$

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

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

1,2: Incoming
3,4: Outgoing

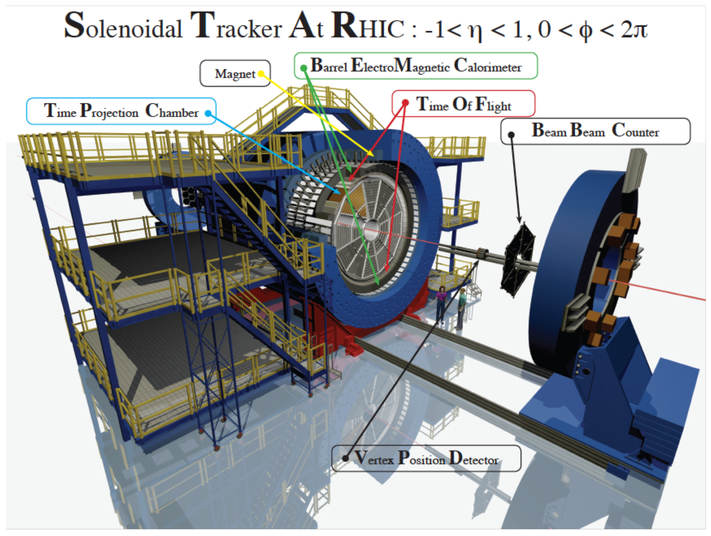
(2) NNPDF (2014), NPB 887, 276



- STAR Run 2015 (200 GeV) inclusive jet and di-jet A_{LL} results will further constrain ΔG contribution to the spin of the proton.

The STAR Experiment

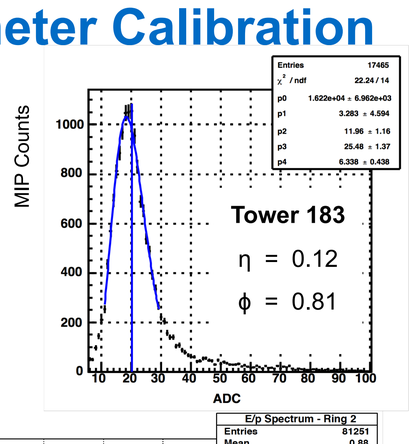
- The Solenoidal Tracker at RHIC (STAR) is one of the main experiments at the Relativistic Heavy Ion Collider (RHIC).
- The main tracking device is the Time Projection Chamber (TPC) which covers a range of $|\eta| < 1.3$
- The Electromagnetic Calorimeters $(-1 < \eta < 2)$ provide the triggering for high p_T particles.

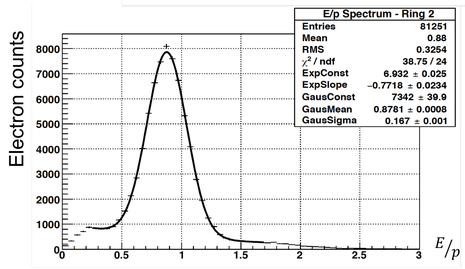


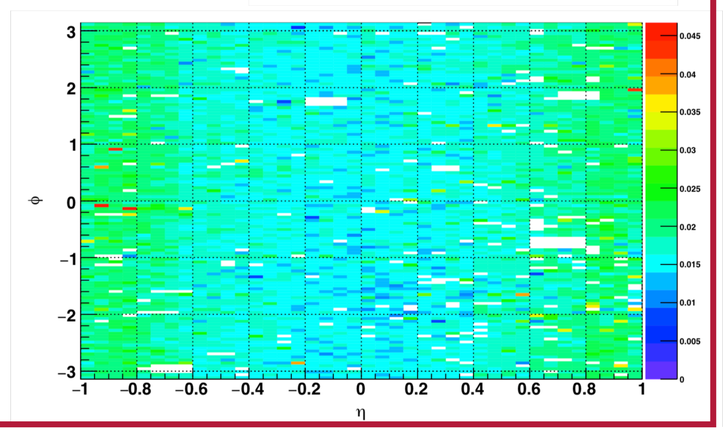
- The relative luminosity is determined using the Vertex Position Detector (VPD) and the Zero Degree Calorimeter (ZDC).

Barrel Electro-Magnetic Calorimeter Calibration Overview

- The BEMC is composed of 4800 towers made from layers of lead and plastic scintillator which measure the energy deposited by particles.
- Minimum Ionizing Particles (MIPs) are used to find tower-by-tower relative gain constants for the calibration (See plot for Tower 183).
- Electrons are used to find the absolute gain constants. The electron's momentum is determined by the TPC and compared to the energy measured by the calorimeter. At high energies the electrons can be considered massless and the ratio E/p should be equal to 1.
- The calibration using electrons is performed for each of the STAR BEMC's 40 η-rings.
- Initial results for the absolute gain constants are displayed in the figure to the right.

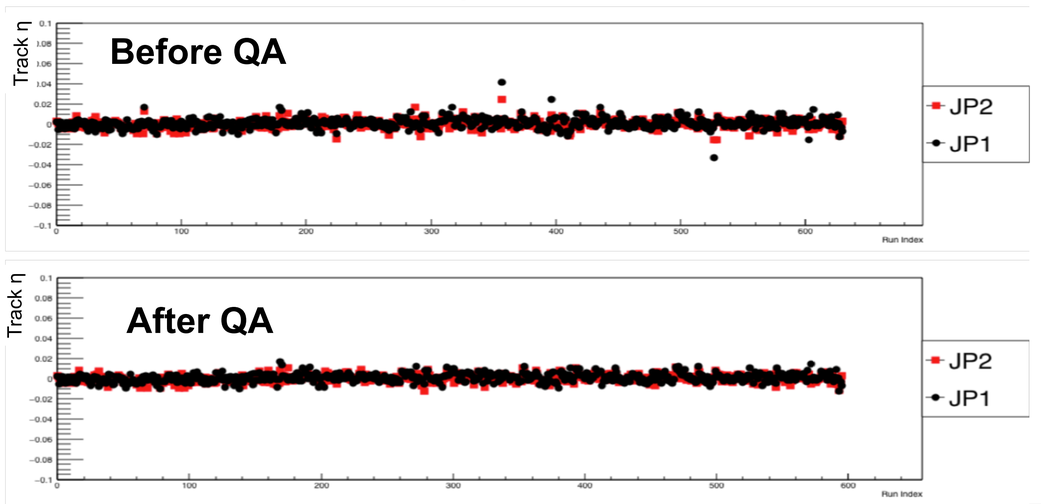




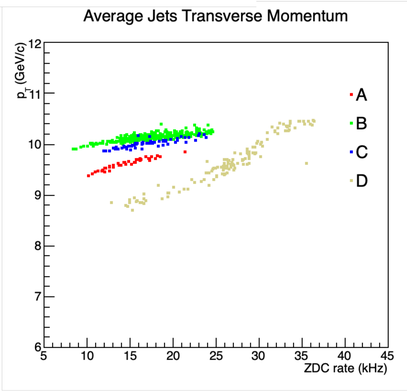


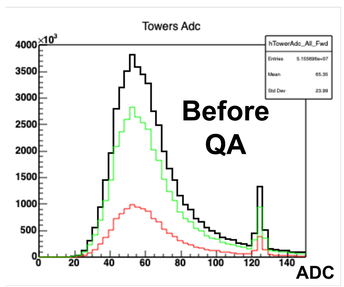
Run 2015 QA

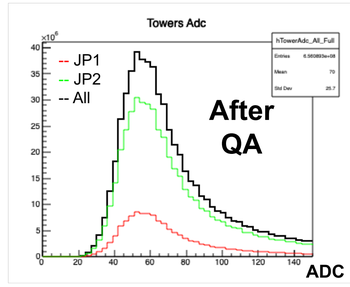
- The run 2015 data sample underwent quality assurance (QA) at the event level. Track and tower quantities were averaged over runs and outliers were removed.



- The run 2015 data sample also underwent QA at the jet level. The sample was divided into different periods (see plot to the right), then average values for each run were determined and outliers were removed
- As part of the BEMC calibration, the towers also underwent QA, which removed hot towers. The effect can be seen in the plots below.

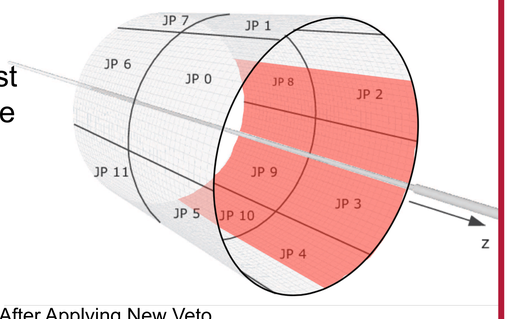




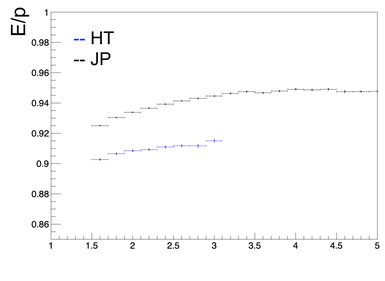


BEMC Calibration Updates

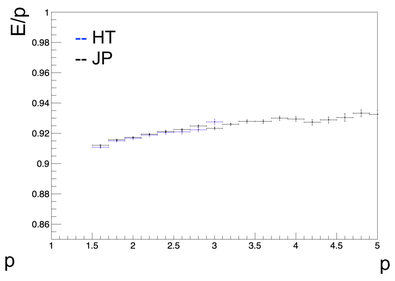
- The calibration is performed using two types of triggers, Jet Patch (JP) and High Tower (HT).
- The E/p average values for the individual triggers have shown a discrepancy of 2-3% in previous calibrations. In Run 2015 a new trigger bias vetoing scheme was introduced.
- The new veto removes tracks that don't pass at least 60˚ away in ϕ from at least one tower or patch above a HT or JP threshold, respectively.
- HT and JP E/p values show significantly improved agreement after introducing the new veto



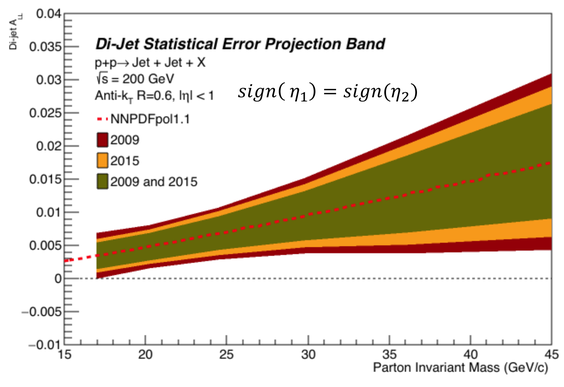
Before Applying New Veto

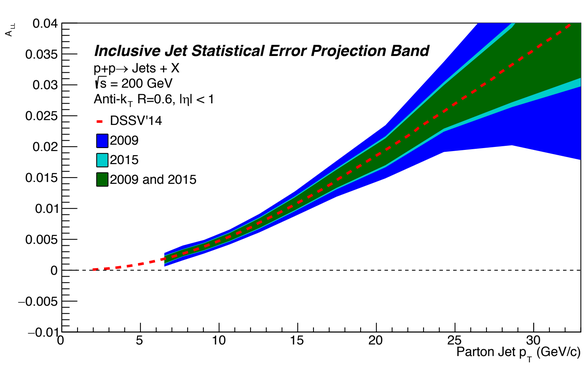


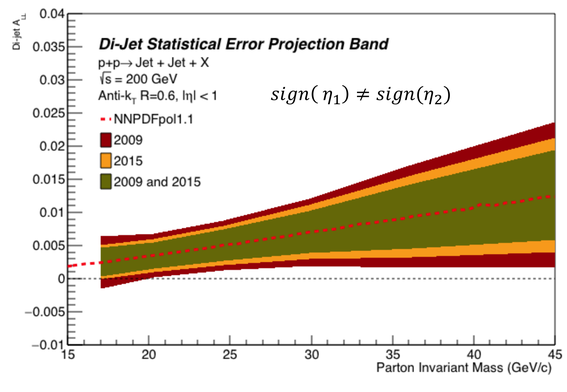
After Applying New Veto



Summary and Projections







- The inclusion of the Run 2015 results with the results of Run 2009 will significantly reduce the statistical error bands for inclusive jet and di-jet measurements of A_{LL}
- These high precision measurements motivate the natural step forward to the STAR forward upgrade program and an Electron Ion Collider to reach lower *x*.