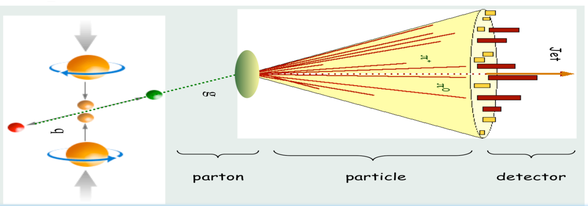
Probing Δg(x) through Di-Jet production in polarized p+p collisions

College of Science and Technology
TEMPLE UNIVERSITY®

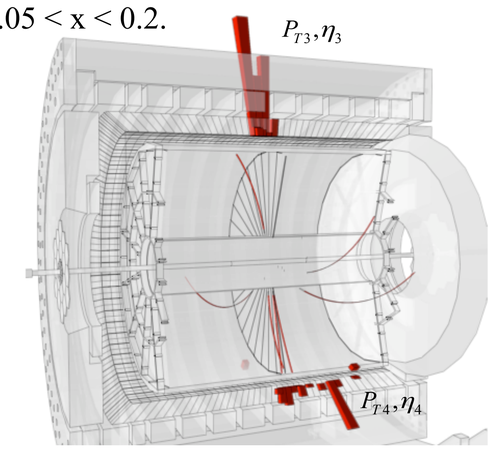
Daniel L. Olvitt Jr.
for the STAR collaboration
Temple University, College of Science and Technology, Philadelphia, PA

Motivation for Di-Jets

- What contributes to the total spin of the proton is one of the unresolved problems in Quantum Chromodynamics (QCD).
- RHIC is able to directly probe gluons; providing better constraints on the gluon's intrinsic spin contribution towards the proton spin.
- In contrast to inclusive jets, di-jets allow access to the initial-state partonic kinematics.



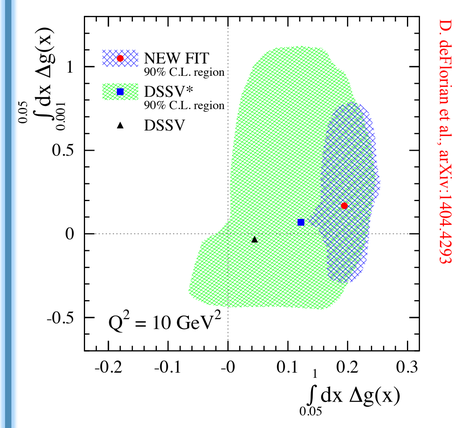
- Run 9 di-jet asymmetry at √s=200 GeV showed statistically significant non-zero result for the gluon polarization for $0.05 < x < 0.2$.



T. Sakuma (Ph.D. MIT, 2010)

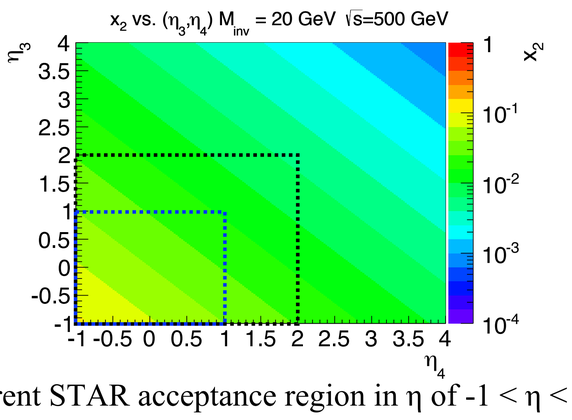
Forward Di-Jet production

- Low x region can be accessed by di-jet production in forward η at high √s collisions.

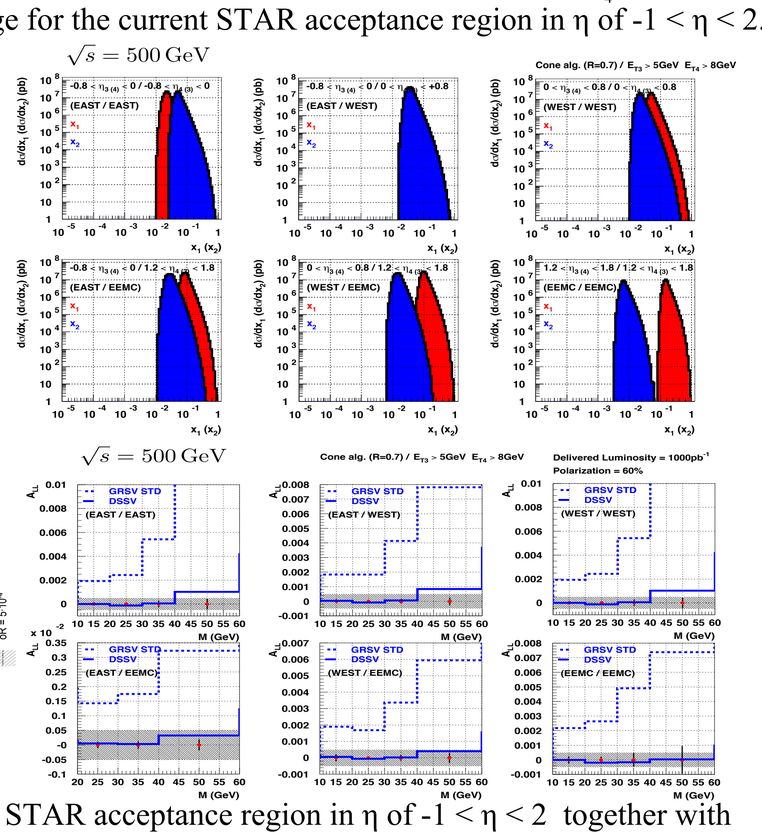


D. deFlorian et al., arXiv:1404.4293

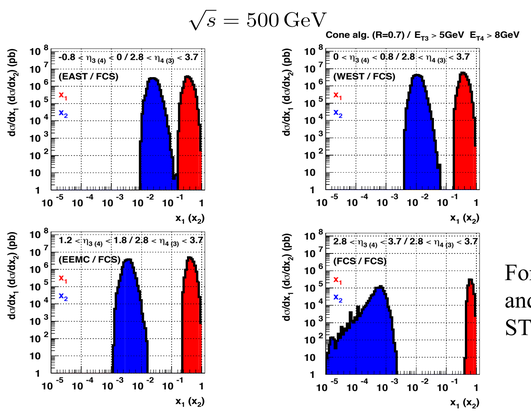
- Low-x coverage (x_2) shown as a color shade for di-jet (2-2) final states showing η_3 vs. η_4 for the invariant mass value of M=20GeV. Blue line is for published (inclusive jet) RHIC results, black line is RHIC's current measurement region.



- x_1 / x_2 range for the current STAR acceptance region in η of $-1 < \eta < 2$.

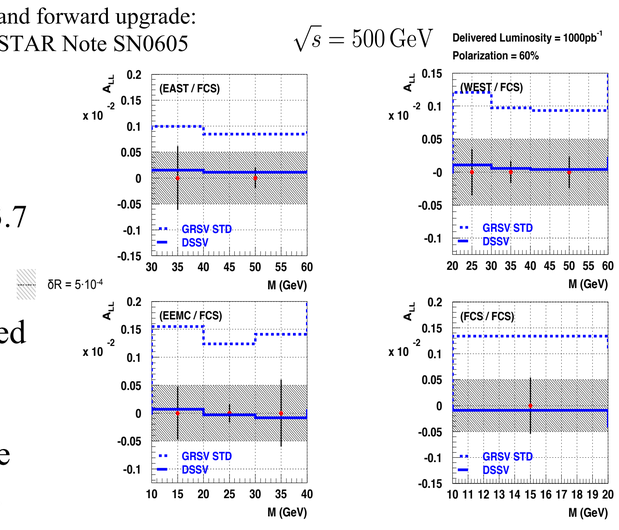


- A_{LL} (NLO) for the current STAR acceptance region in η of $-1 < \eta < 2$ together with projected statistical and systematic uncertainties.
- The statistical and also the systematic uncertainties are much smaller compared to the separation between DSSV and GRSV-STD.
- The forward upgrade would require a new Forward Calorimeter System (FCS) providing nominal acceptance of $2.5<\eta<4$.



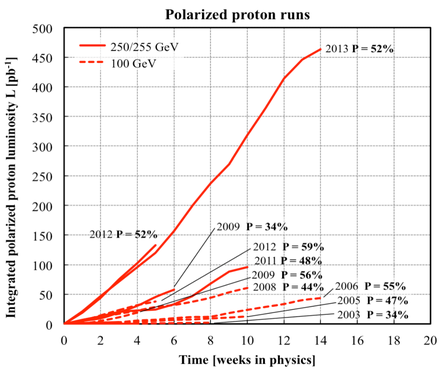
- x_1 / x_2 range for the forward STAR acceptance region in different η combinations (Fiducial volume η ranges):
  - East Barrel ($-0.8<\eta<0$) - FCS ($2.8<\eta<3.7$)
  - West Barrel ($0<\eta<0.8$) - FCS($2.8<\eta<3.7$)
  - Endcap ($1.2<\eta<1.8$) - FCS($2.8<\eta<3.7$)
  - FCS ($2.8<\eta<3.7$) - FCS($2.8<\eta<3.7$)

For more info on the FCS and forward upgrade: STAR Note SN0605

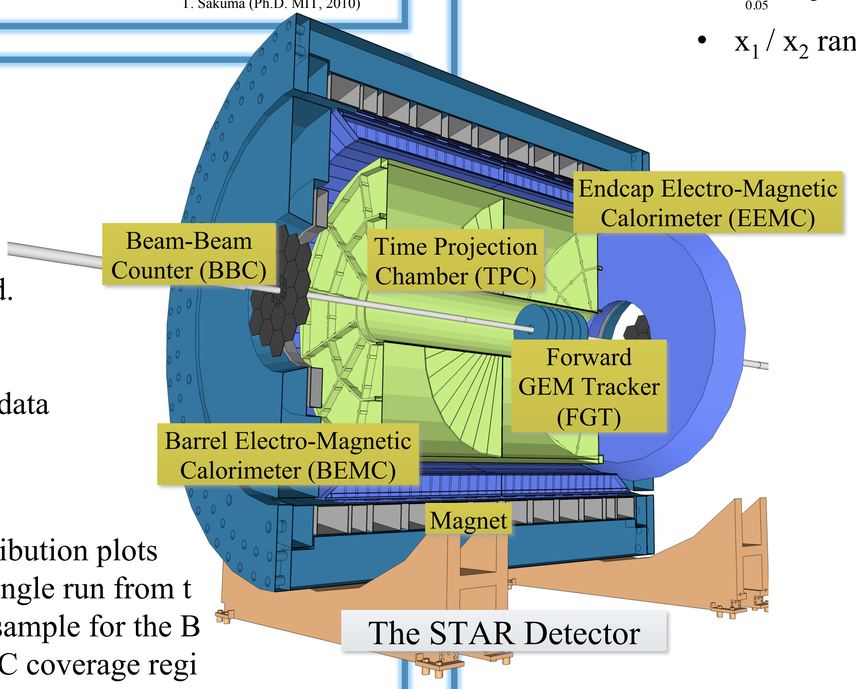


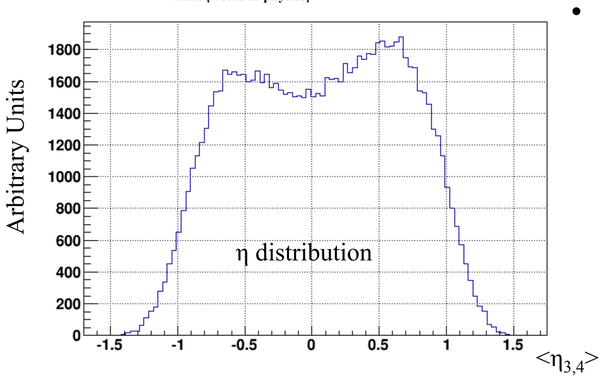
- A_{LL} (NLO) for the forward STAR acceptance region in η of $2.8 < \eta < 3.7$ together with projected statistical and systematic uncertainties.
- The systematic uncertainty assumed to be driven by the relative luminosity uncertainty of $\delta R = 5 \cdot 10\text{-}4$ is dominating over the size of the statistical uncertainties.

Analysis Status Run 13

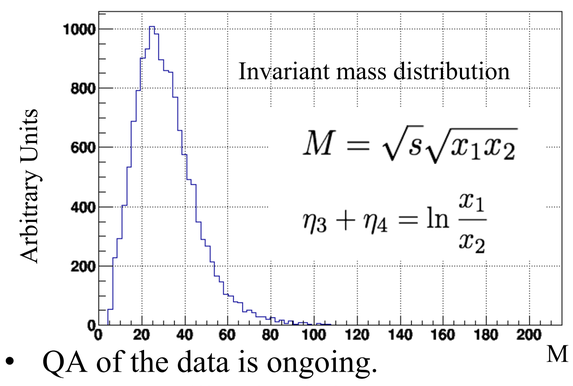


- Over the years the luminosity has increased.
- For 2013:
  ~450 pb^{-1} delivered
- Approximately half the data for run 13 has been produced.





- The dijet distribution plots represents a single run from t he 2013 data sample for the B EMC & EEMC coverage regi on.

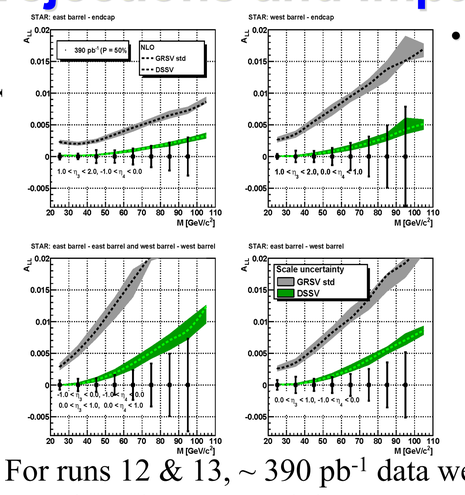


Analysis Flowchart

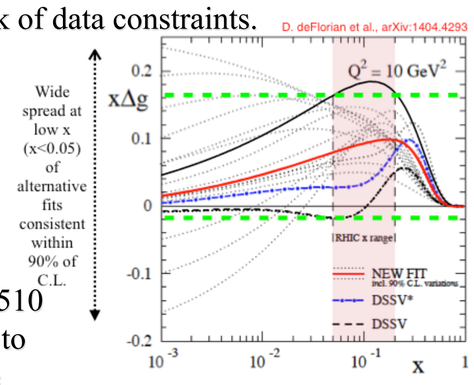
Collect Data
↓
Calibrate the Detector (TPC, Calorimeter)
↓
Reconstruction
↓
QA the Data (Obtain run list)
↓
Analysis Background/ Acceptance correction/ Unfolding/Determination of A_{LL}
↓
Final result including systematic error studies

- QA of the data is ongoing.
- Detector calibration is in progress.
- Eta distribution is asymmetric due to a larger forward coverage from the EndCap. Most of the statistics are between $-1<\eta< 1$, but the EndCap ($1.2<\eta<2$) should have enough statistics for a complete analysis.
- Invariant mass distribution is as expected, with a peak below 40 GeV.

Projections and Impact



- Latest perturbative QCD (DSSV 2014) fit, which includes the RHIC 2009 data extracts a non-zero gluon polarization contribution to the total proton spin. For the $x<0.05$ region, the uncertainties remain large due to lack of data constraints.



- For runs 12 & 13, ~ 390 pb^{-1} data were collected √s =510 GeV in order to extend the RHIC measurement range to lower values of Bjorken-x; this will help constrain the gluon's contribution to the proton spin for $x < 0.05$.

Summary

- Run 9 Di-jet results will allow one to constrain the shape of Δg, run 13 will extend these results to smaller x-values.
- With increased statistics from runs 12 & 13 at √s = 510 GeV, will help determine the value of Δg at lower Bjorken-x.
- Forward di-jet production in combination with measurements of the current STAR acceptance region would allow one to probe spin phenomena of gluons well below the currently accessible region of $0.05 < x < 0.2$. Such results are 'badly needed' as argued in the recently released new global analysis by the DSSV group.