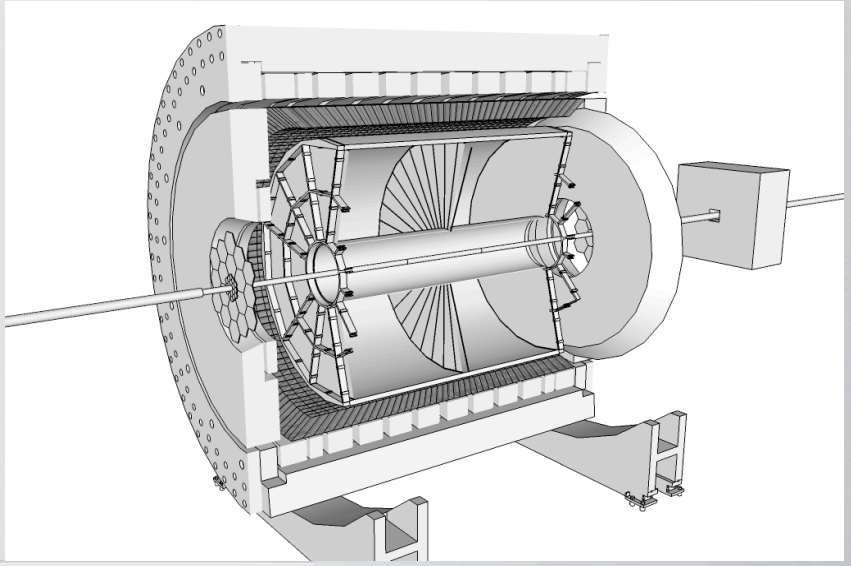
Report on pp collisions in Run 12 from STAR



Renee Fatemi

For the STAR Collaboration

June 14, 2012

2012 + 2013 STAR BUR

YEAR	ENERGY	TIME	SPECIES	GOAL
2012	$\sqrt{s}$ = 500 GeV	3 weeks	$\vec{p}\vec{p}$	FGT commissioning
		9 weeks		P^2L = 42 pb^{-1}
				P^4L = 12 pb^{-1}
		1 week		pp2pp @ high β^*
2013	$\sqrt{s}$ = 500 GeV	8 weeks	$\vec{p}\vec{p}$	P^2L = 50 pb^{-1}
	$\sqrt{s}$ = 200 GeV	10 weeks	$p^{\uparrow}p^{\uparrow}$	P^2L = 7.2 pb^{-1}
			$\vec{p}\vec{p}$	P^4L = 7.1 pb^{-1}

2012 PAC Recommendation

& Final Run Scenario

200 GeV ➔ 5 weeks polarized pp

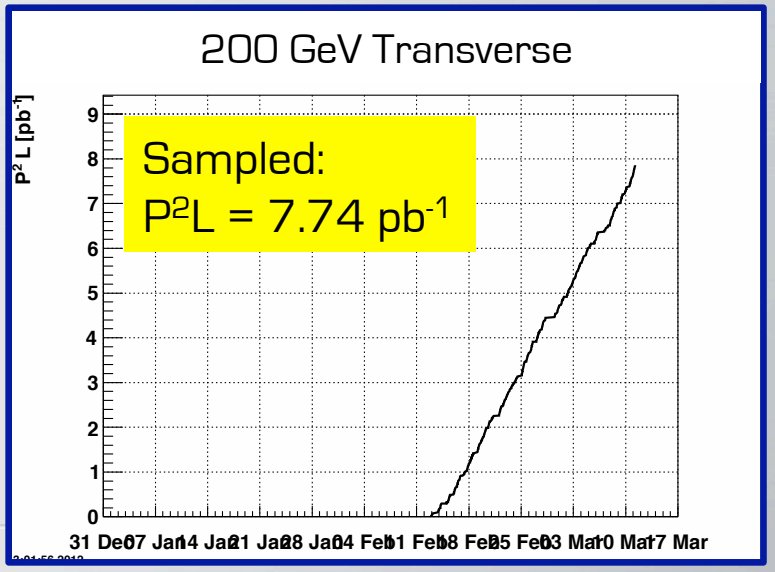
➔ 4 weeks transverse running

500 GeV ➔ 7 weeks polarized pp

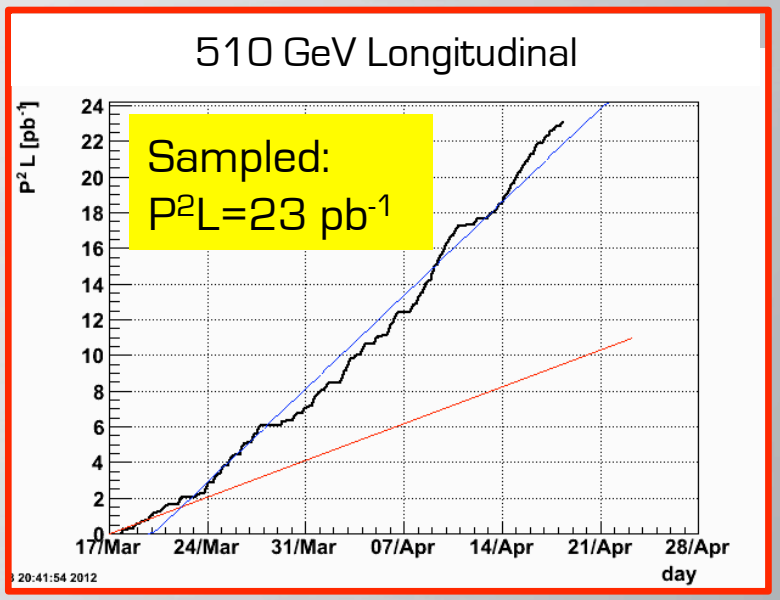
➔ 4.5 weeks longitudinal running @ 510 GeV

Run 12 pp Beam Energy Split

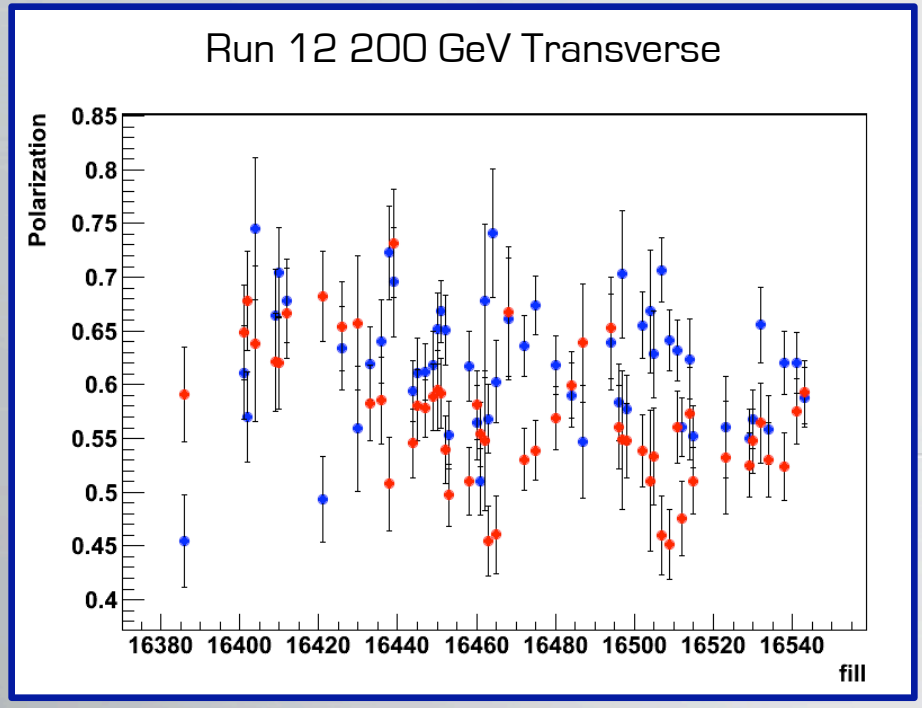
Although 12 total weeks of pp running was nearly = the requested run length, splitting the run into 200 and 500 GeV made STAR nervous about collecting sufficient statistics within a single beam energy for a significant 2012 result.



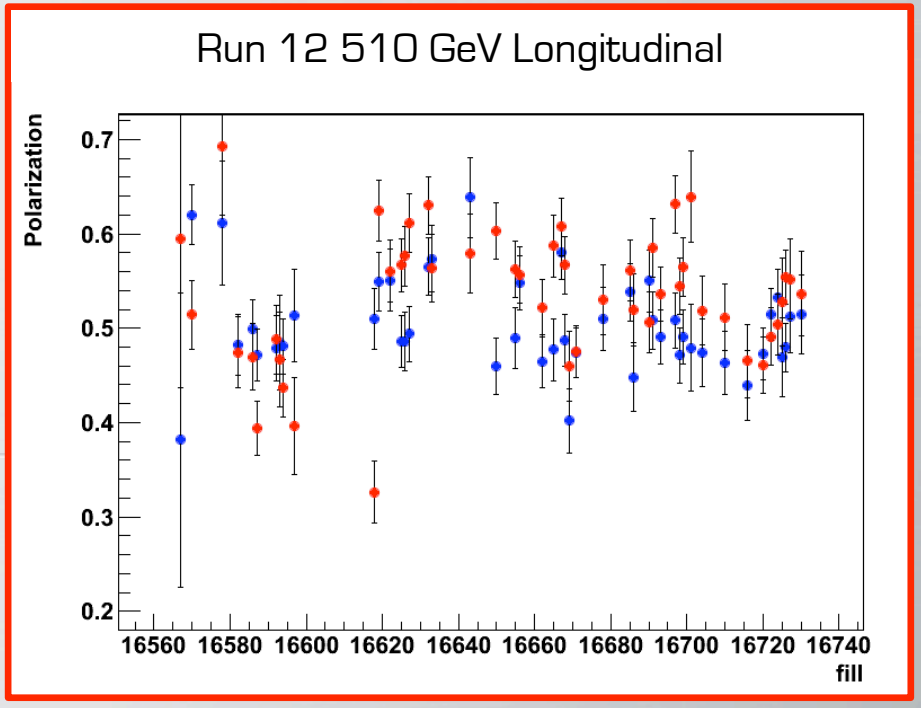
Consistently high beam polarization and luminosity allowed STAR to collect the requested FOM **in less than half the expected running time!** **THANK YOU!**



Beam Polarization



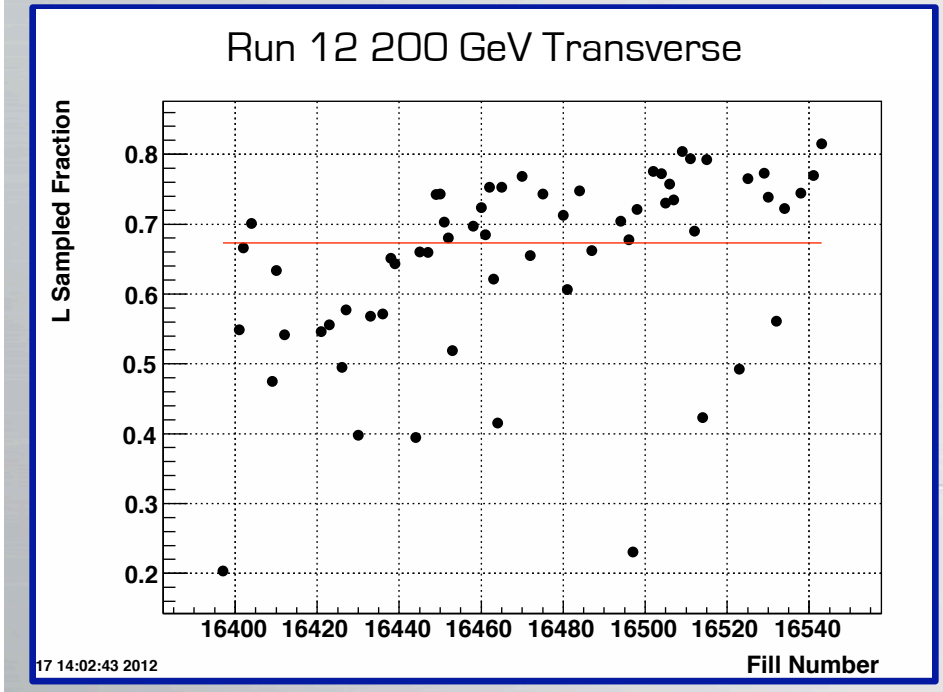
Blue = 61% Yellow = 56%

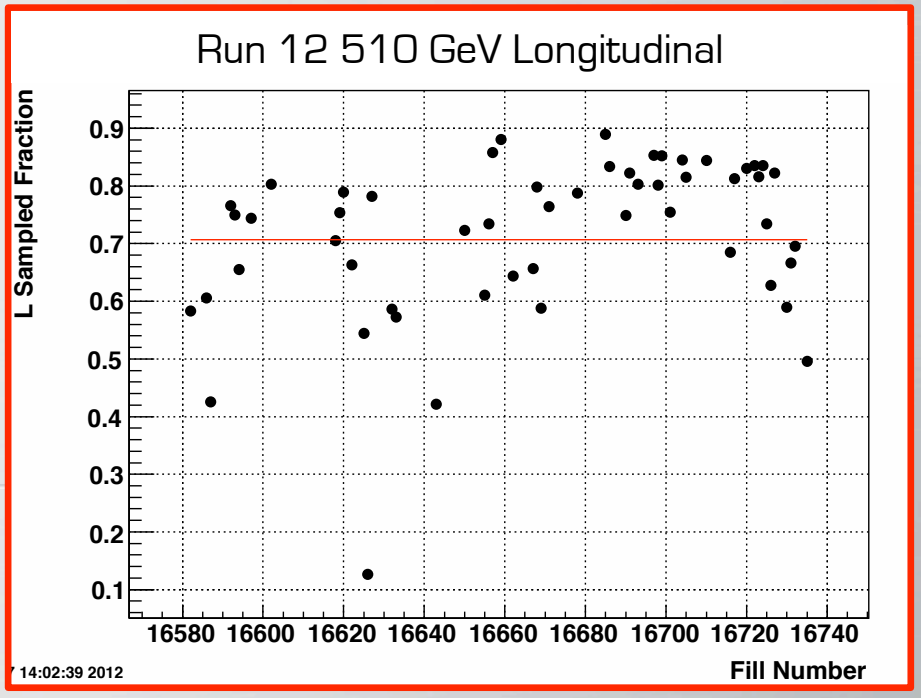


Blue = 50% Yellow = 53%

Fast online feedback and documentation → http://www.phy.bnl.gov/cnipol/rundb/
https://wiki.bnl.gov/rhicspin/Polarimetry/H-jet/Run12

STAR Sampling Fraction





STAR streamlined startup procedures and calibration runs to maximize sampled luminosity. Consistently reached **75-80%** later in the run.

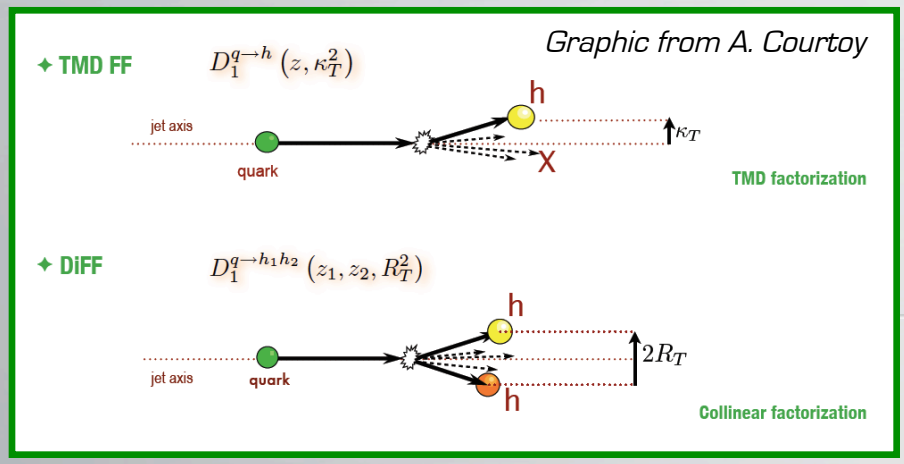
Motivations for Transverse Running @ 200 GeV in 2012

$\Delta_T q(x)$ $\Delta f_{1T}^{\perp}(x, k_T)$

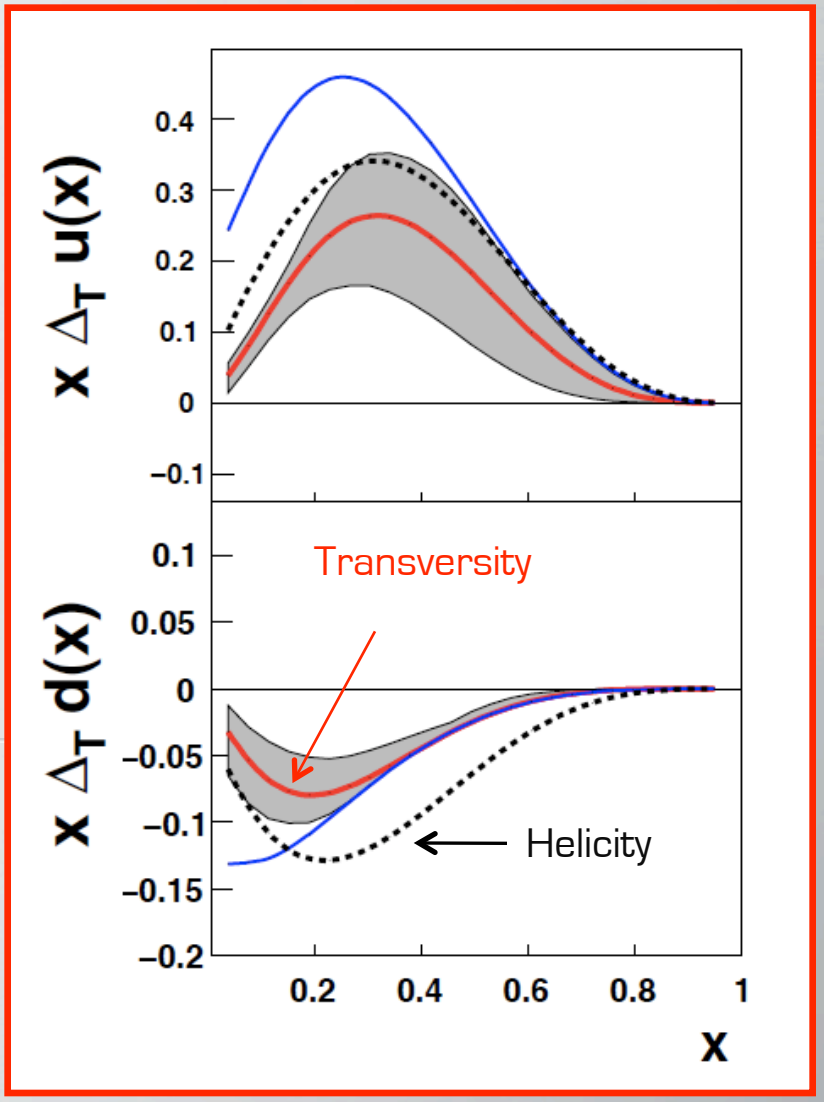
Quark Transversity Distributions

Transversity is one of the three PDFs necessary to fully define proton structure at leading twist in a collinear framework.

$\Delta_T q(x)$ is a chiral odd function and therefore not as constrained as the **Helicity** PDFs.

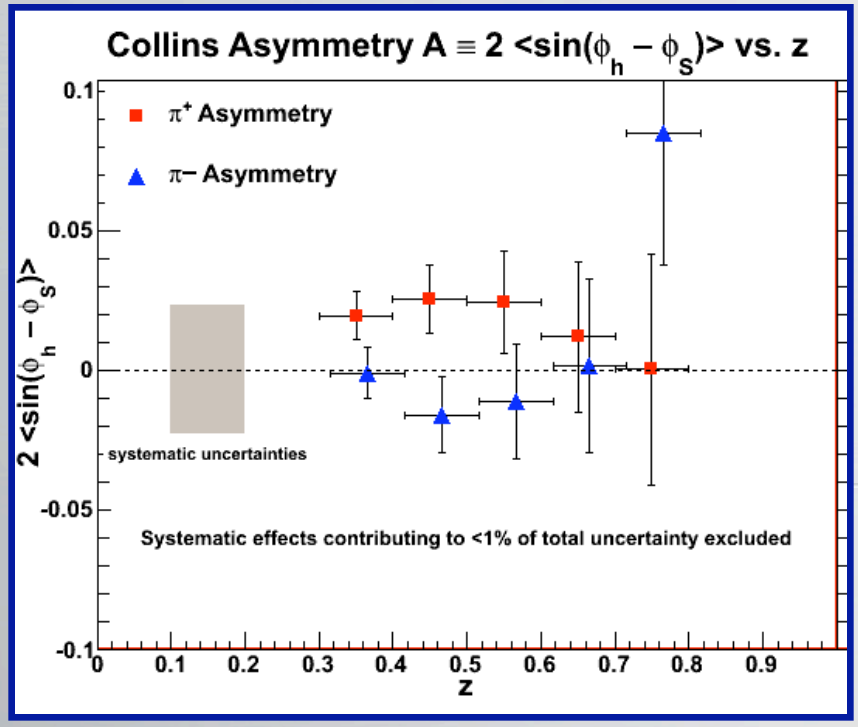


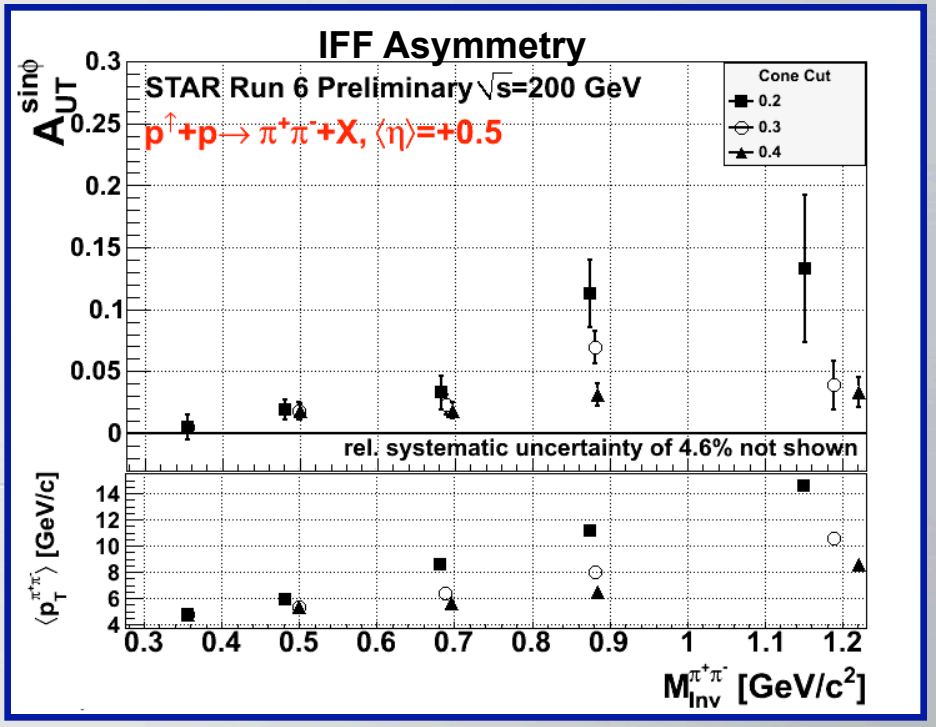
Access **$\Delta_T q(x)$** via observables sensitive to chiral odd FF : **Collins and Interference FF**.



Nucl.Phys.Proc.Suppl. 191 (2009) 98-107

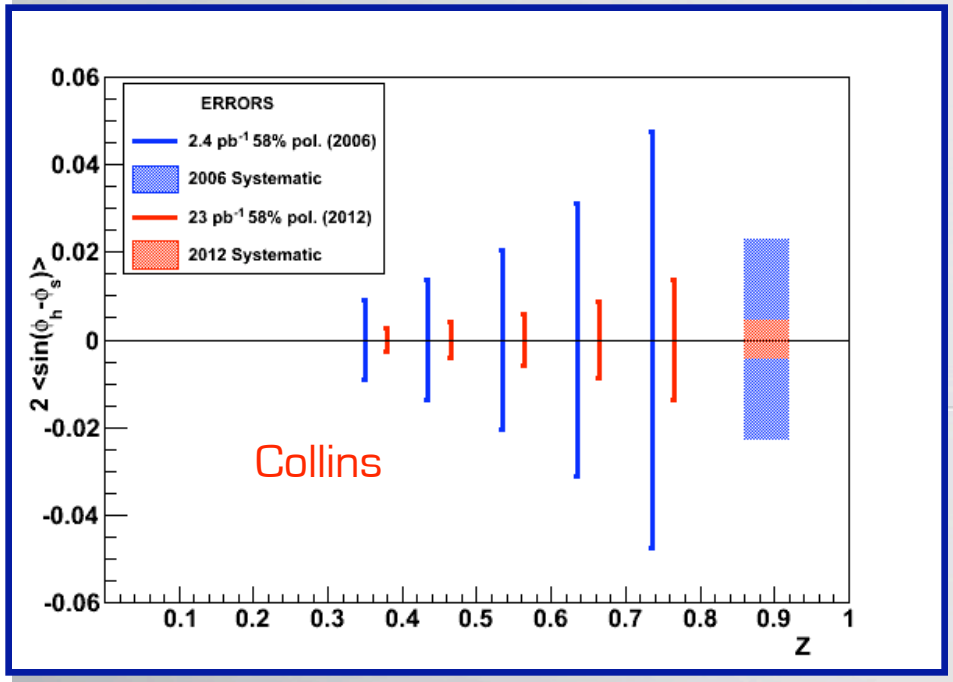
Mid-rapidity Surprise!

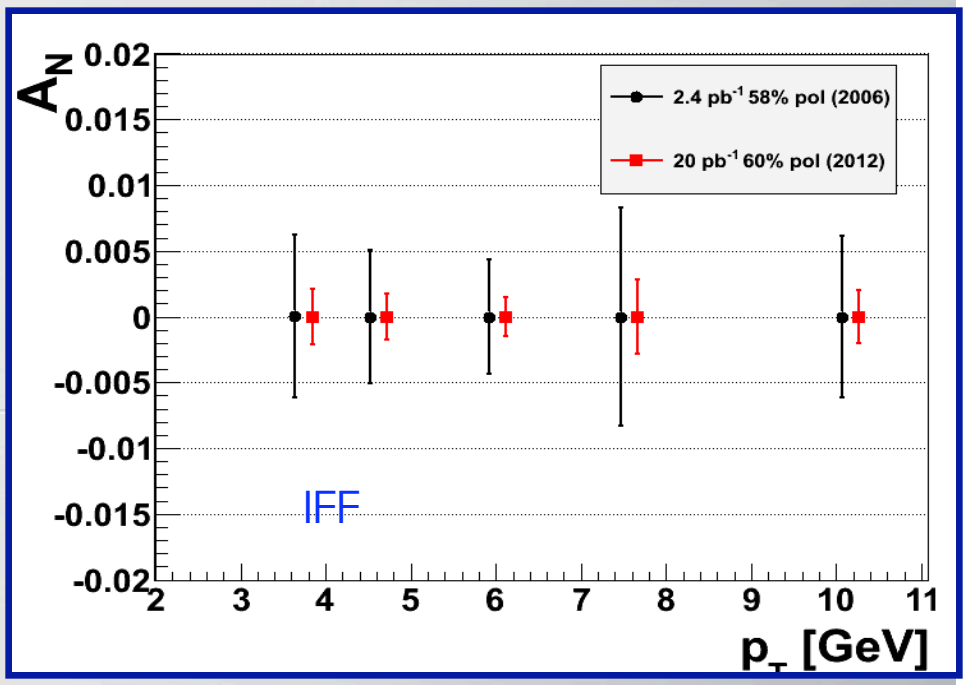




Exploratory Analysis from 200 GeV Transverse Running in 2006 show **first clear signal of transversity** in pp collisions at RHIC!

STAR 2012 mid-rapidity Collins + IFF Sensitivities





- Collected order of magnitude more data in 2012 with comparable polarization
- Analysis of IFF & Collins will allow comparisons of kT and collinear evolutions
- New understanding of Sudakov effects in Collins
- May be able to extend analyses to include neutral pions – although signals are likely smaller than charged pion signals.

Take hints from Run 11 500 GeV Transverse

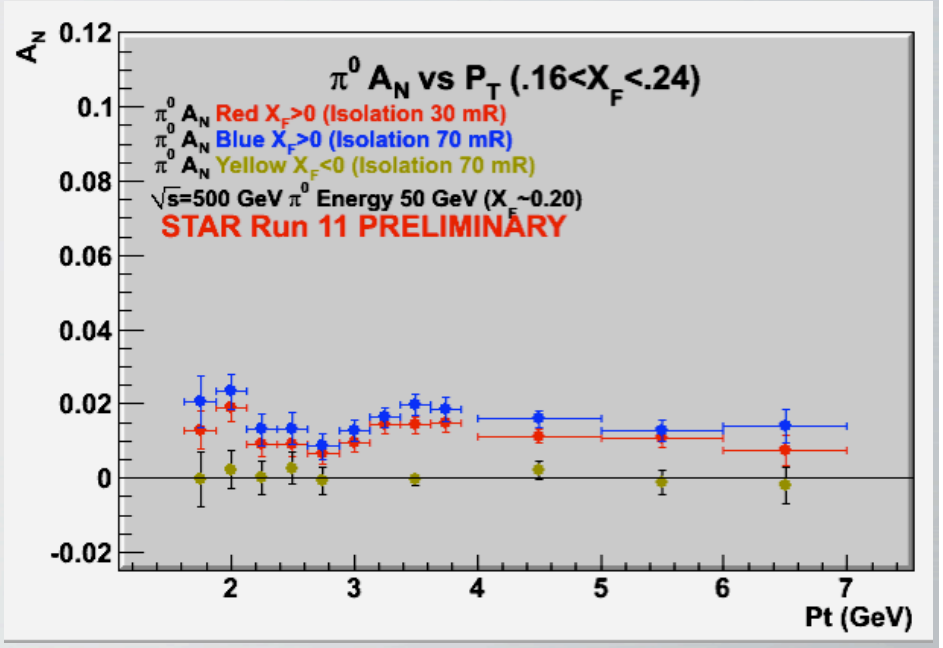
- π^0 A_N in FMS (2.5 < η < 4) for 500 GeV polarized pp collisions from Run 11.

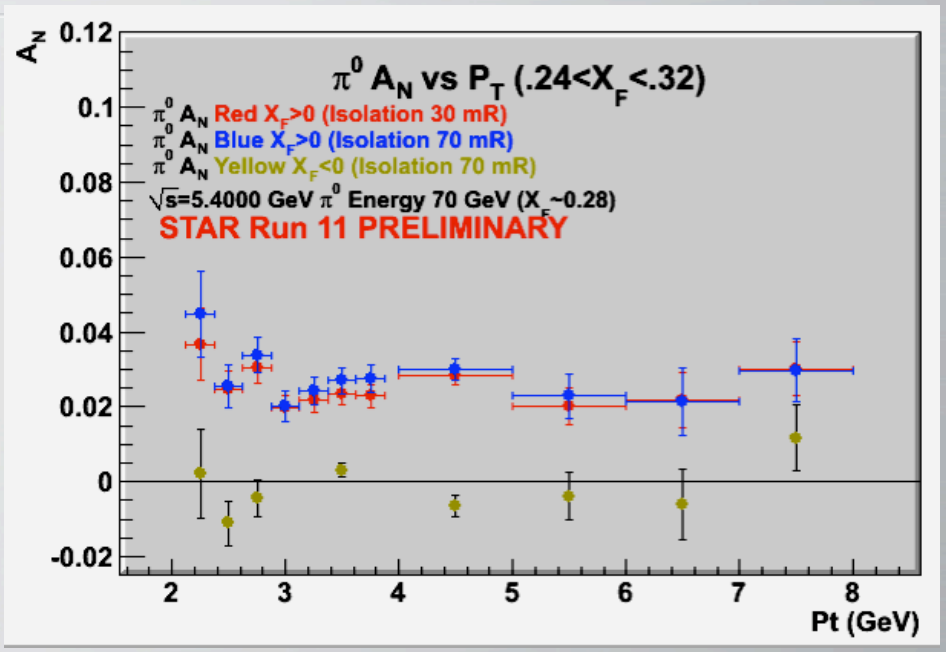
- Asymmetries extend to very high p_T – still no clear turnover

- For 0.16 < x_F < 0.32, events with additional photons in close proximity to the π^0 (>~5 GeV between 0.03 and 0.07 radians from the π^0) contribute little to the observed asymmetry

- Will use Run 12 data to look at isolation cone effect in 200 GeV pp collisions.

- Implications are that higher twist 3-parton correlations (Sivers) may not be driving this SSA.

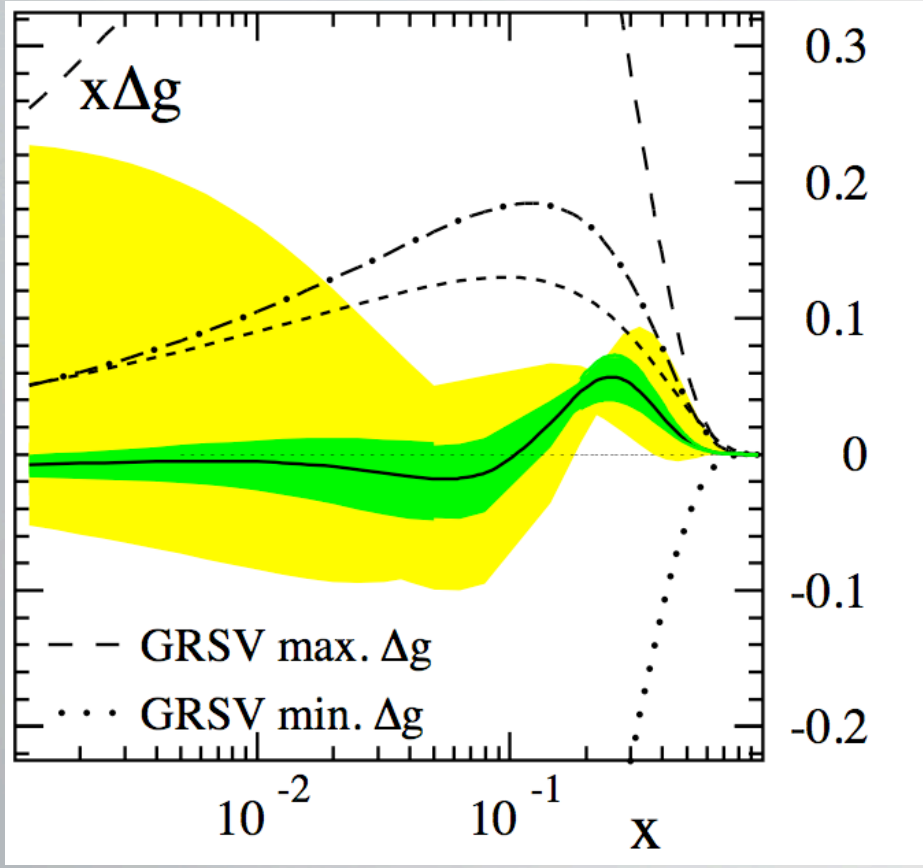




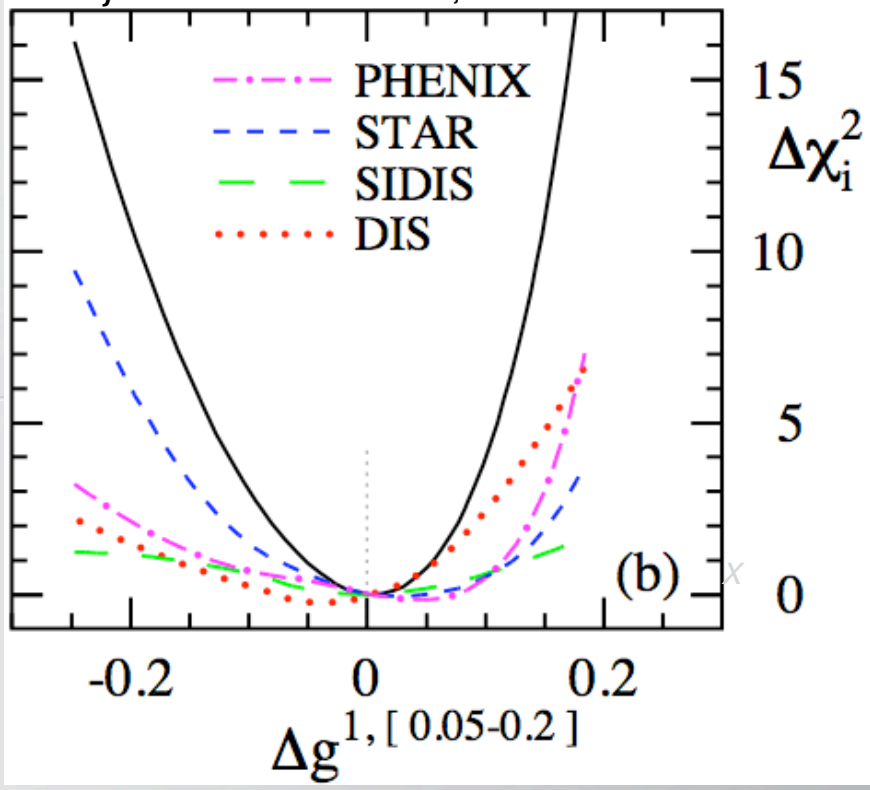
Motivations for Longitudinal Running @ 510 GeV in 2012

$\Delta g(x)$ $\Delta \bar{u}(x)$ $\Delta \bar{d}(x)$

ΔG Global Analysis of World Data Including 2005+2006 RHIC results

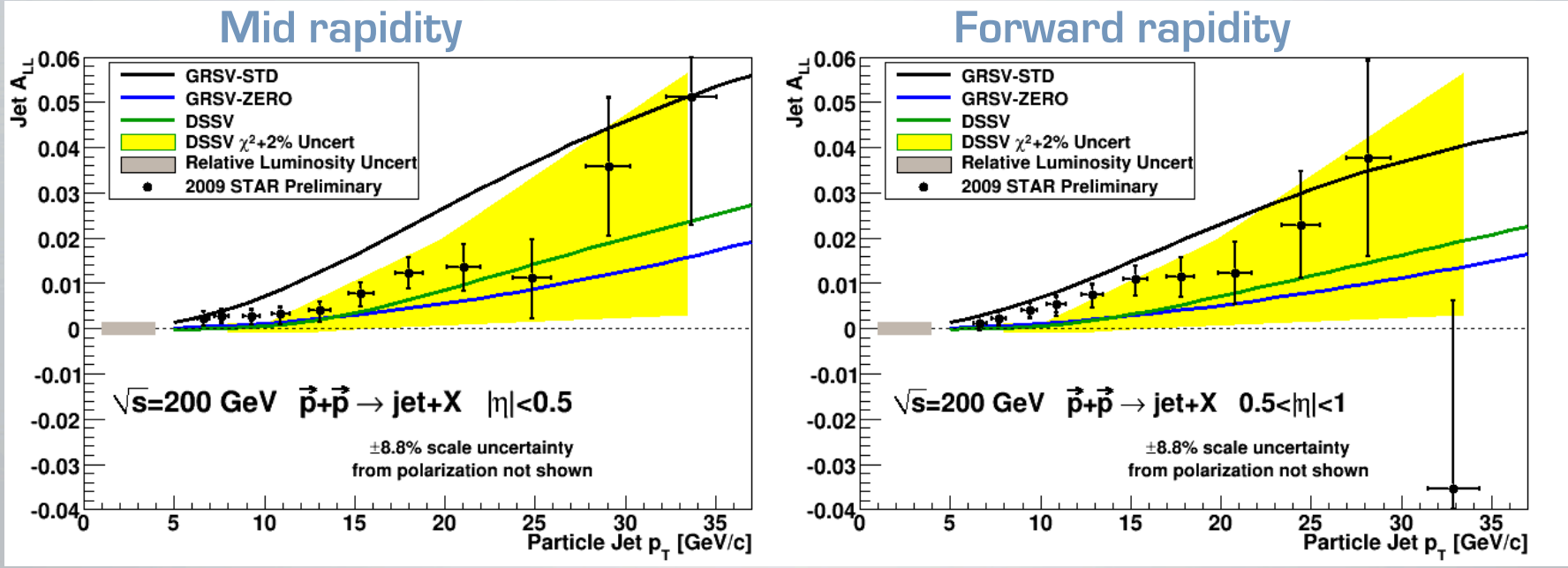


DeFlorian, Sassot, Stratmann and Vogelsang, Phys.Rev.Lett. 101:072001, 2008



$$\int_{0.05}^{0.2} dx \Delta g(x) = 0.005^{+0.129}_{-0.164}$$

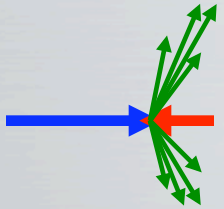
2009 STAR inclusive jet A_{LL} @ 200 GeV

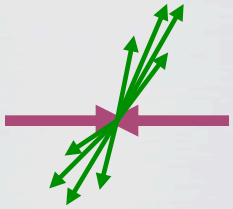


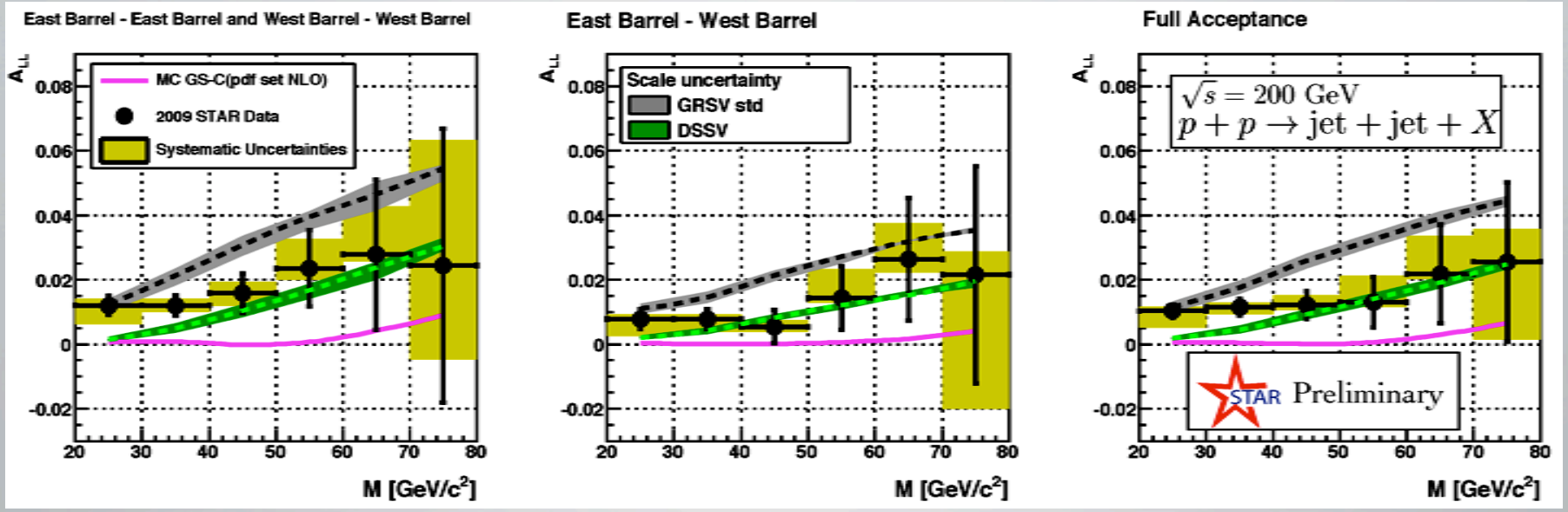
- 2009 took 25 pb^{-1} of data – more than 4x previous years combined
- Forward jets sample larger fraction of quark-gluon sub-process
- Forward jets have larger $|\cos(\theta^*)|$, which reduces partonic a_{LL}
- **A_{LL} falls between the predictions from DSSV and GRSV-STD**

FIRST STATISTICALLY SIGNIFICANT INDICATION OF NON-ZERO ΔG!

2009 *STAR* Dijet A_{LL} @ 200 GeV

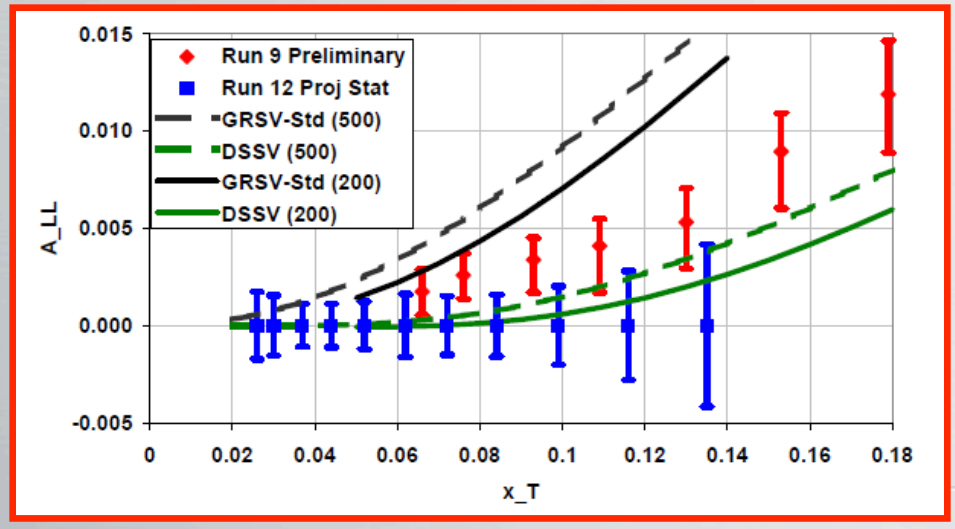






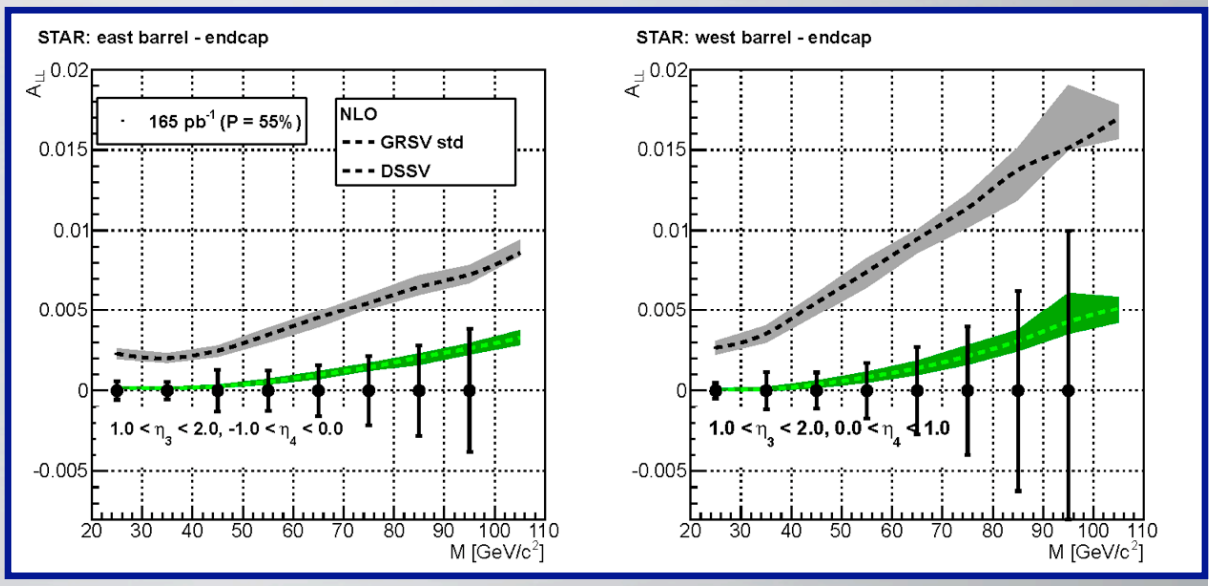
A_{LL} falls between the predictions from DSSV and GRSV-STD. Although it uses a very different correction scheme dijets show excellent agreement with inclusive results.

Inclusive and Dijet A_{LL} at 510 GeV

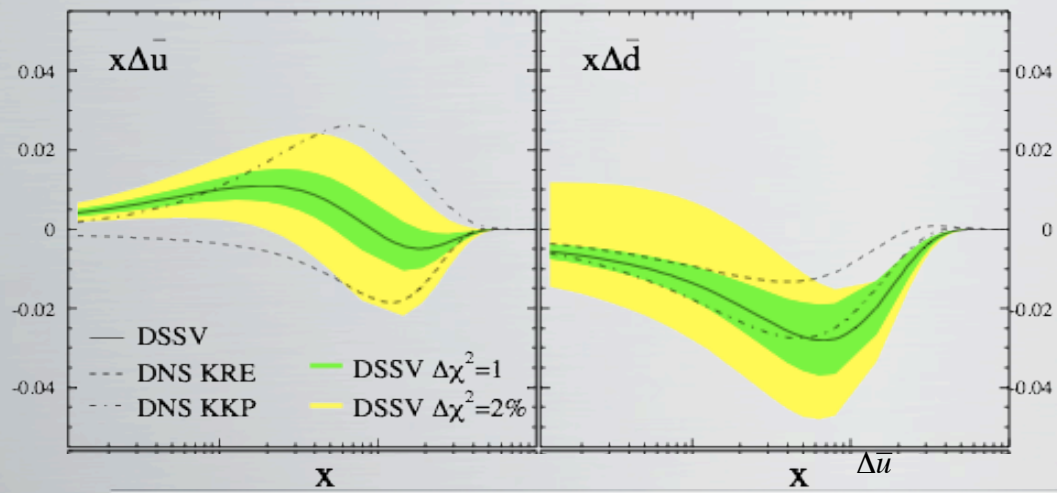


- Constrains ΔG at lower x
- Overlap with 200 GeV x regime allows independent verification of 200 GeV A_{LL}

- Dijet projections are for possible 500 GeV Run 13 contribution. Errors are 40% larger for Run 12 only.



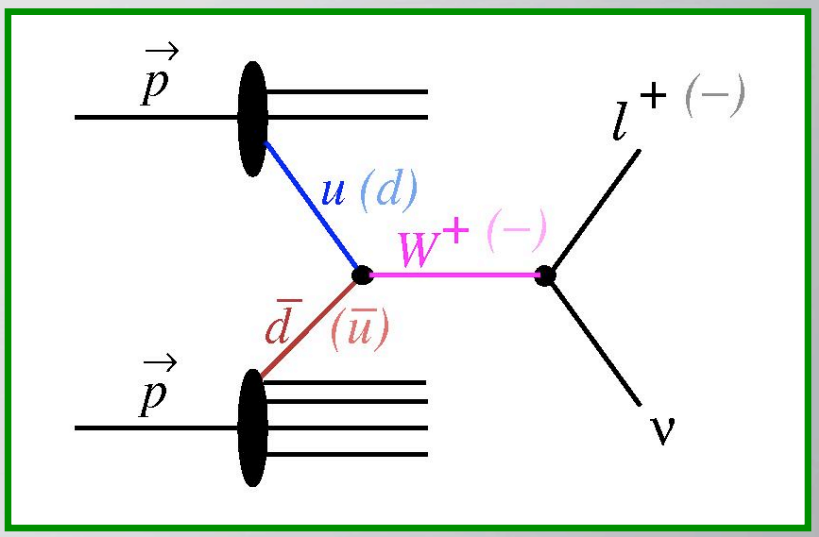
Light Anti-quark Sea Helicity PDFs: $\overline{\Delta u}, \overline{\Delta d}$



D. de Florian et al., Phys. Rev. Lett. 101 (2008) 072001

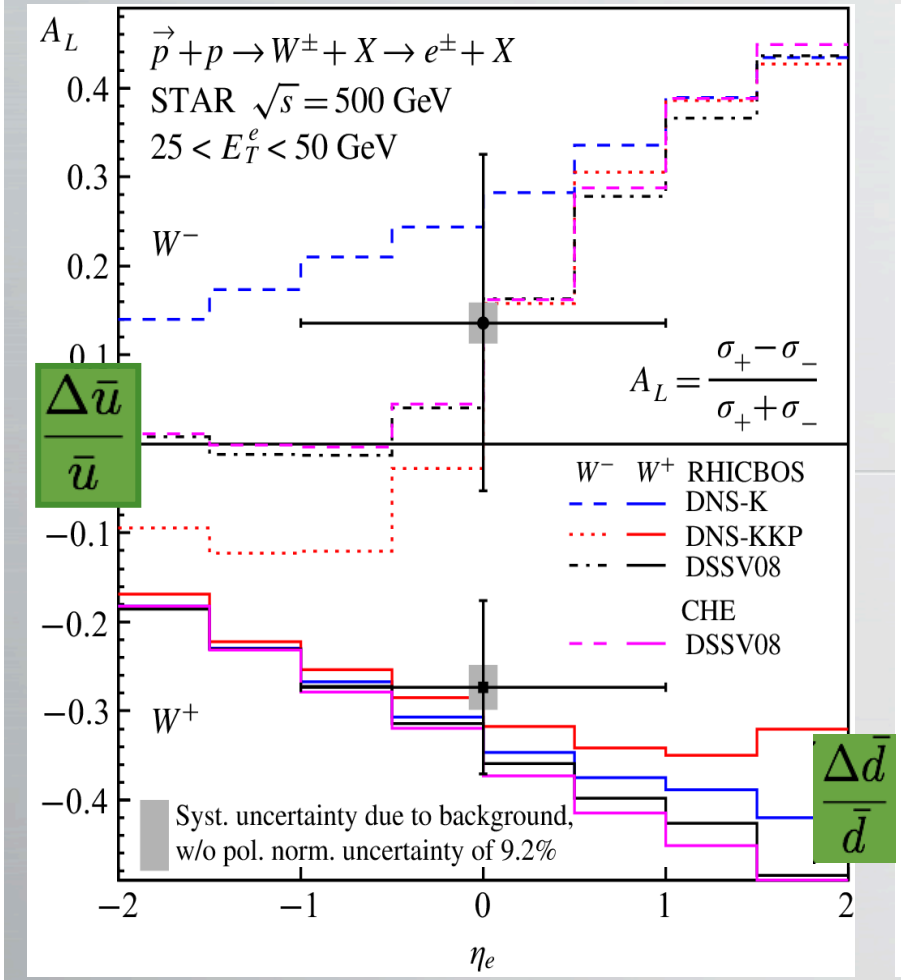
- Currently flavor separated quark distributions are determined only from SIDIS
- Extraction relies on independent determination of fragmentation functions.

- DSSV fits find the sea to not be SU(2) symmetric
- Additional measurements from W production in hadronic collisions will constrain PDFs for x > 0.05 and provide insight into mechanisms behind generation of light sea.

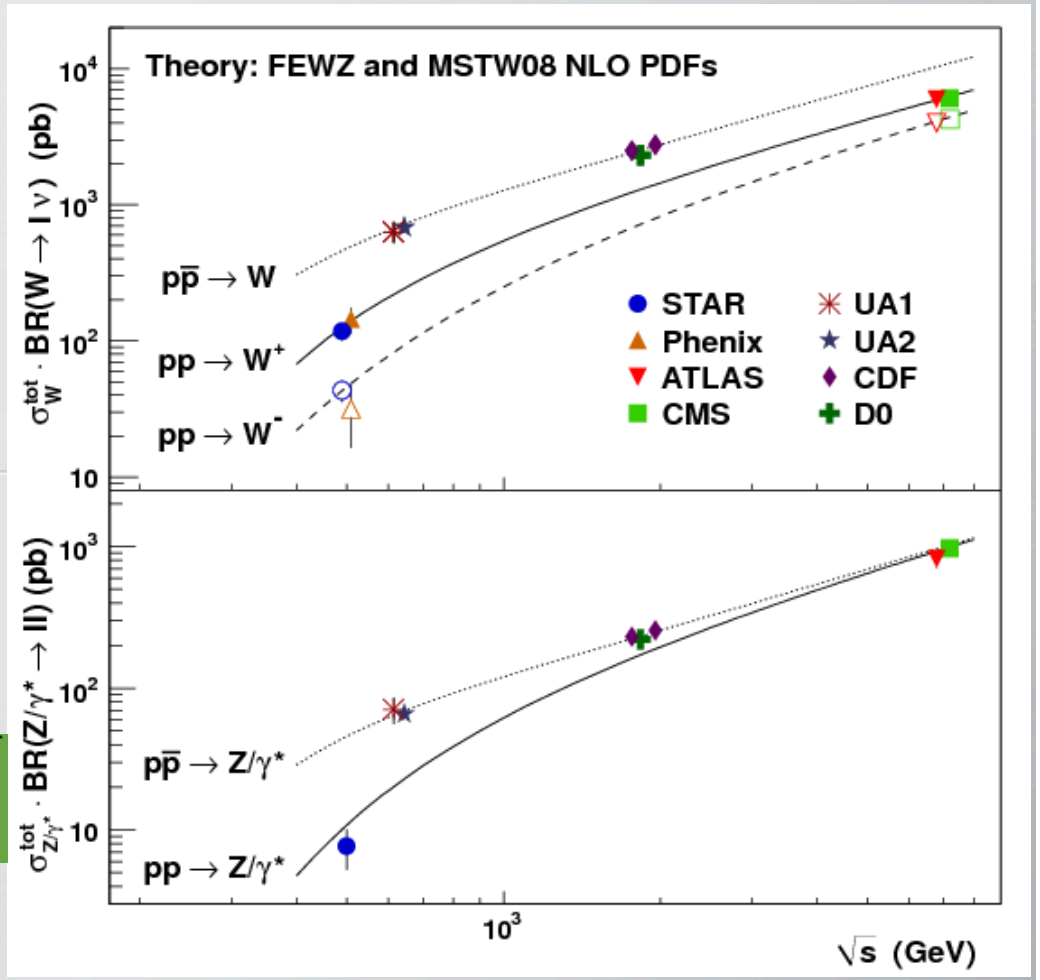


2009 Parity Violating $W^{+/-}$ A^e_L W/Z Cross-Section

PRL 106, 62002 (2011)



PRD 85, 92010 (2012)



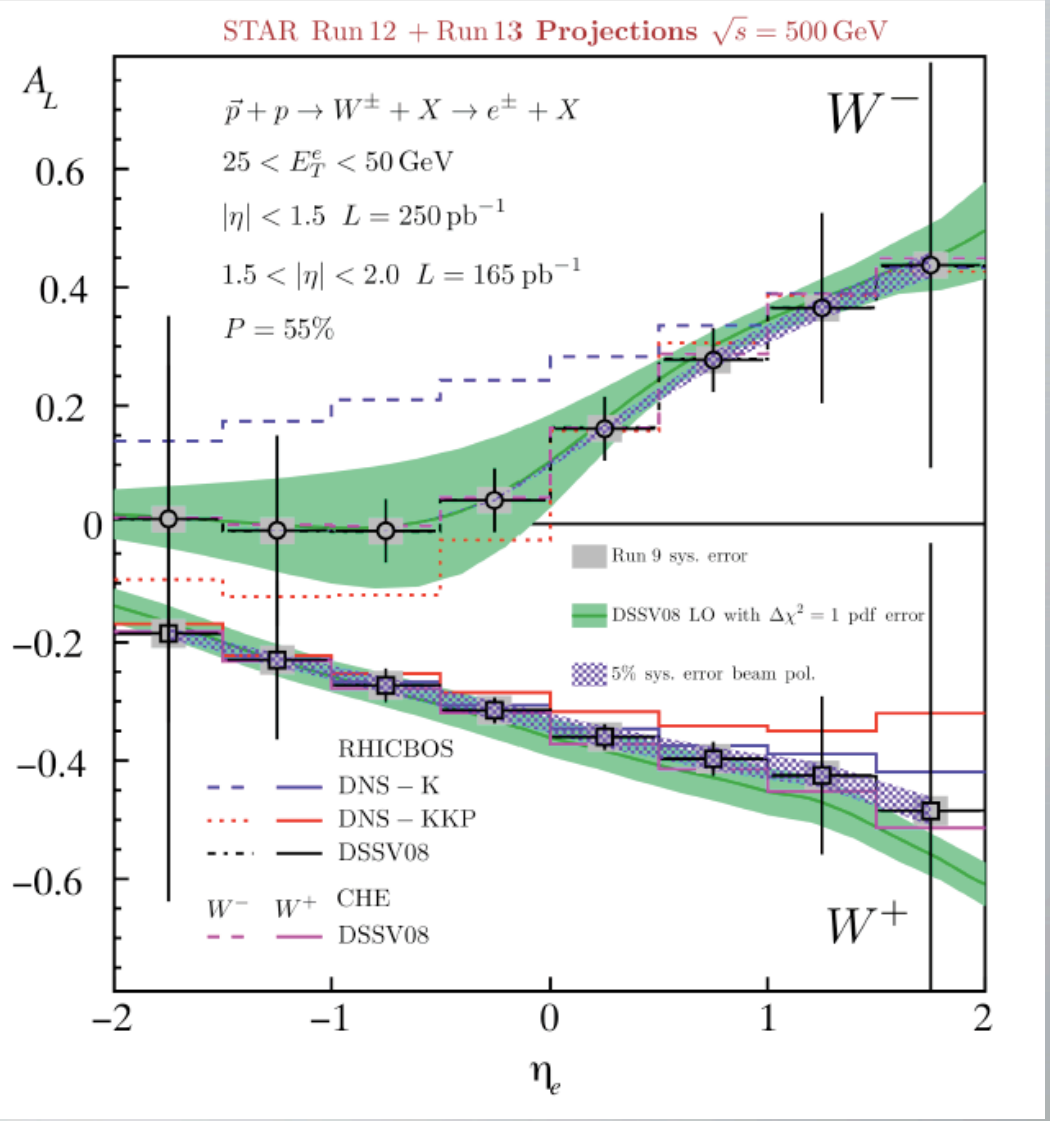
$$A_L(W^+) = -0.27 \pm 0.10(stat) \pm 0.02(syst)$$

$$A_L(W^-) = 0.14 \pm 0.19(stat) \pm 0.02(syst)$$

$$\sigma^{fid}_{W(Z)} \cdot \mathrm{BR}(W(Z) \to e\nu(ee)) = \frac{N^{obs}_{W(Z)} - N^{bkgd}_{W(Z)}}{L \cdot \varepsilon^{tot}_{W(Z)} \cdot A_{W(Z)}}$$

Run 12: First high Statistics Run for W

- Run 9 was proof of principle measurement for $|\eta| < 1$
- Run 12 delivered FOM = 25 pb^{-1}, sufficient to start investigations into η dependence of A_L ultimately needed for $\Delta q/\Delta qbar$ separation.
- Run 13 request for FOM = 50 pb^{-1} is critical step towards recording the necessary statistics for reducing error bars on global analysis of light sea anti-quark.
- Run 12+ Run 13 should allow for significant reduction of $\Delta qbar$ uncertainties for x > 0.05.



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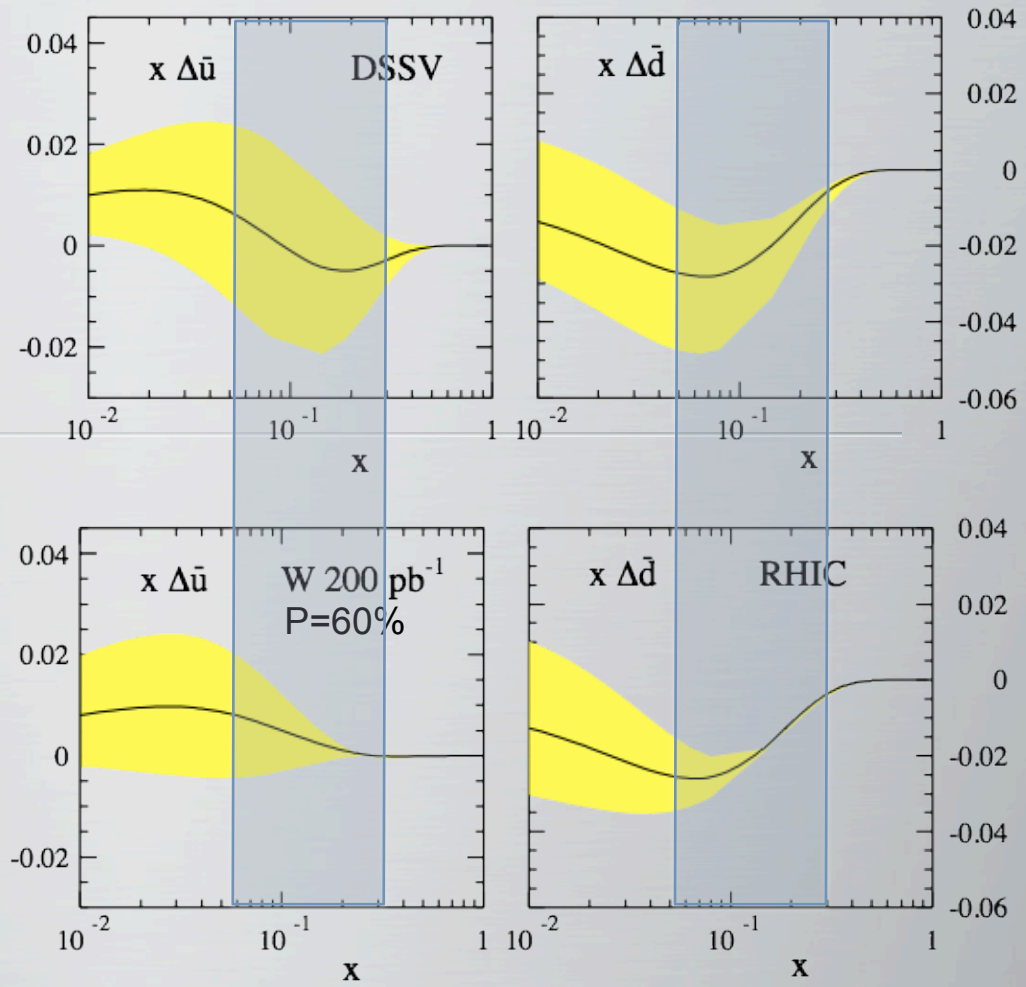
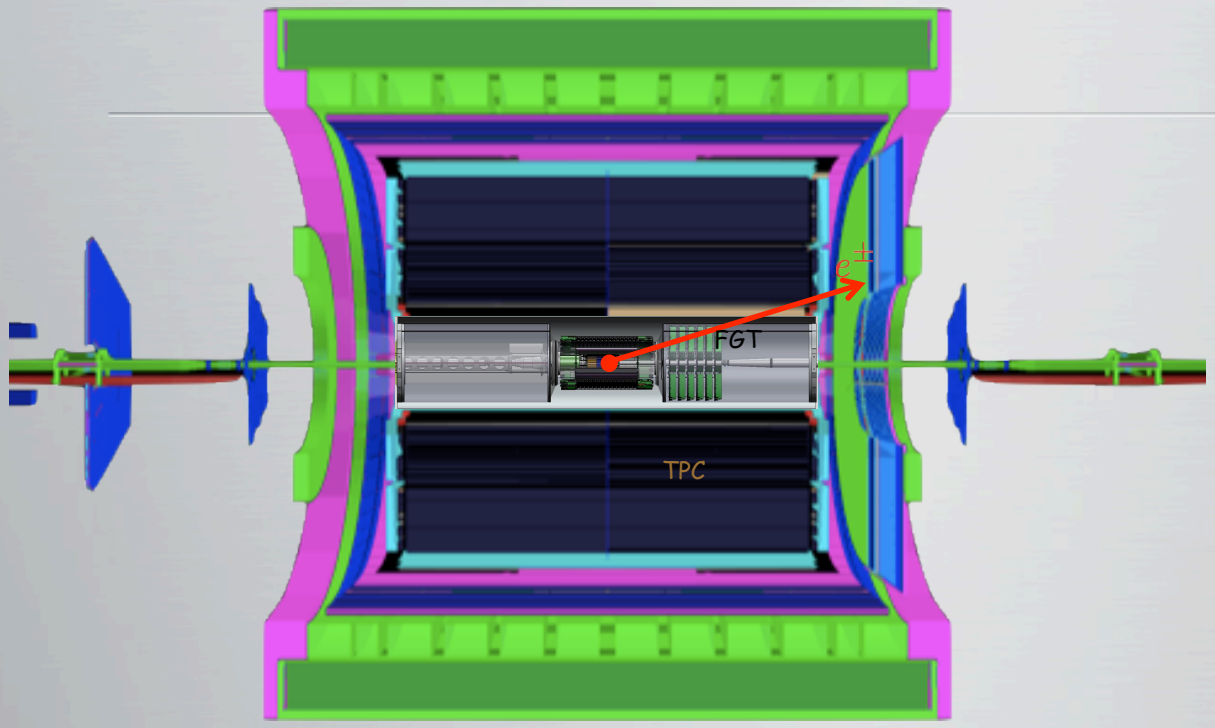
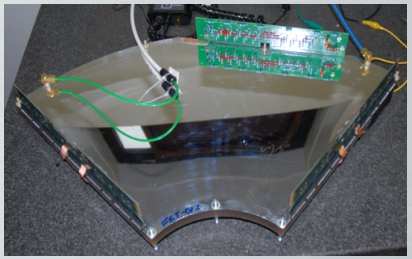
D. deFlorian and W. Vogelsang, PRD81, 094020 (2010)

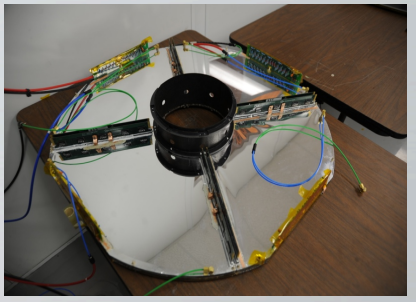


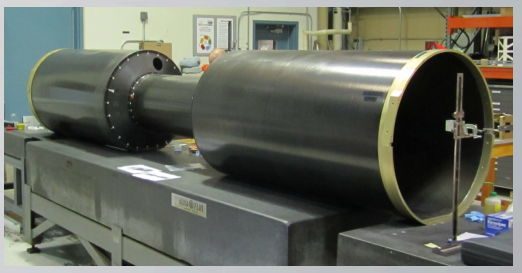
Forward Gem Tracker

- Extend parity violating A_L to $1 < \eta < 2$ via tracking capable of charge sign discrimination in front of EEMC
- Partial installation (14/24 quarters) in fall of 2011
- Disk 1 has 4 quadrants, all other disks have 2 quadrants
- Commissioning during 200 GeV running

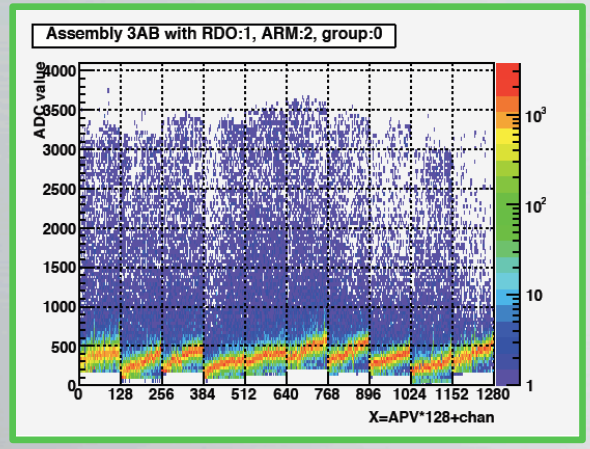




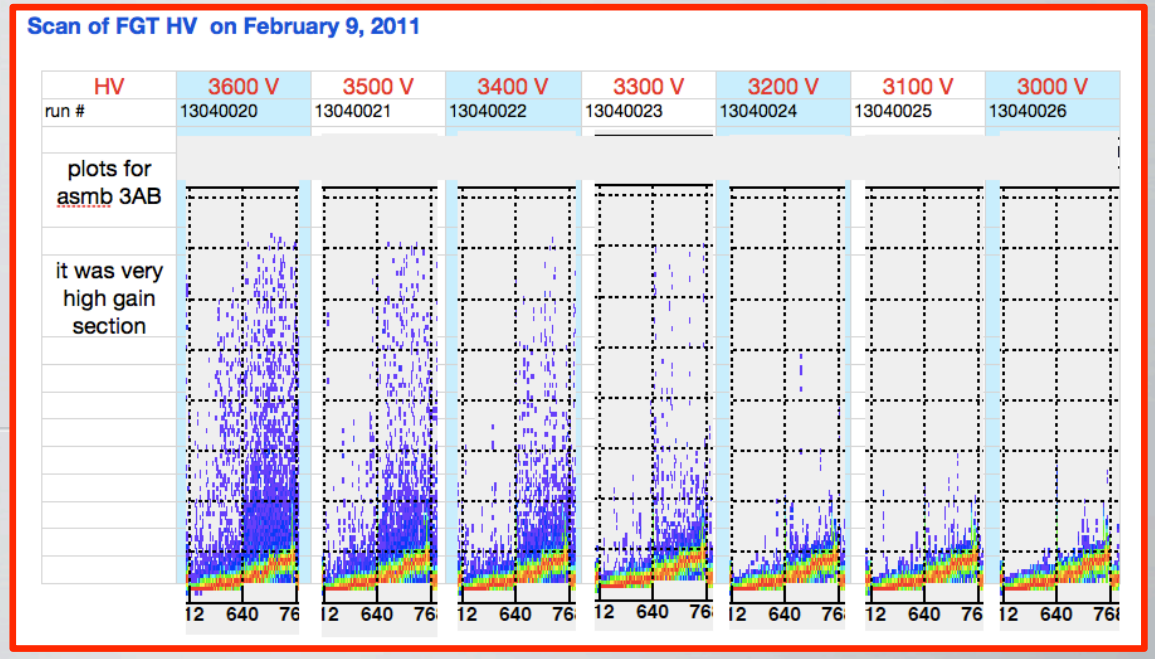




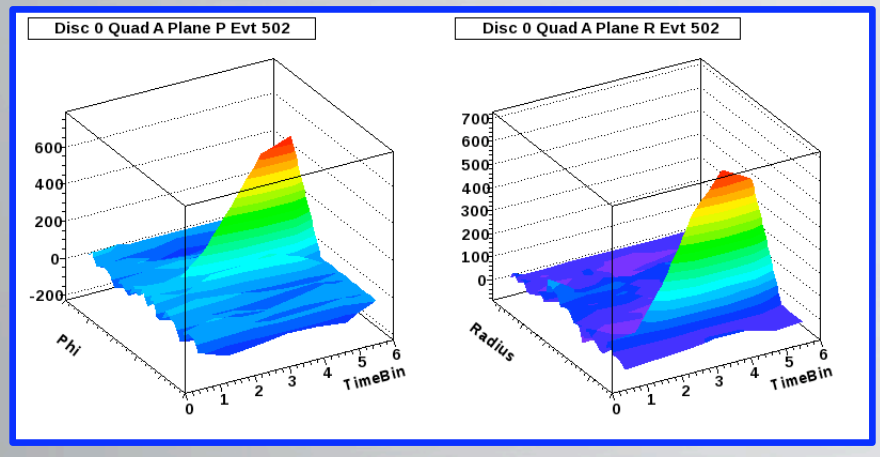
2012 Commissioning

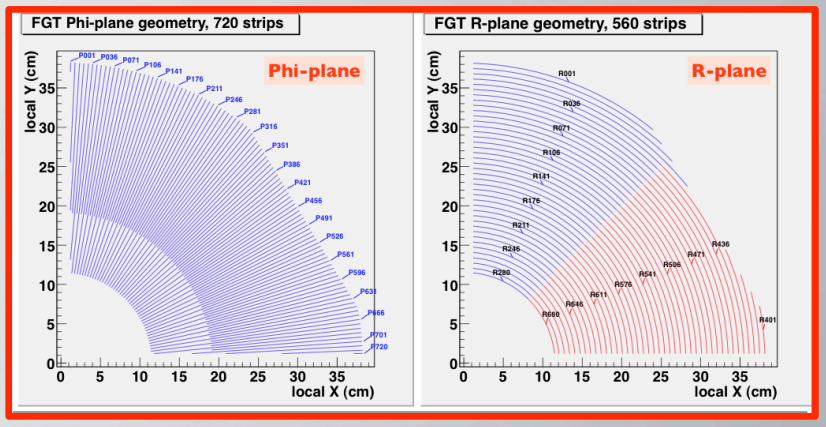


High Voltage Scan – Control GUIs and database implemented



- Adjust APV pedestals – monitoring of all channels via online plots
- Optimize signal timing

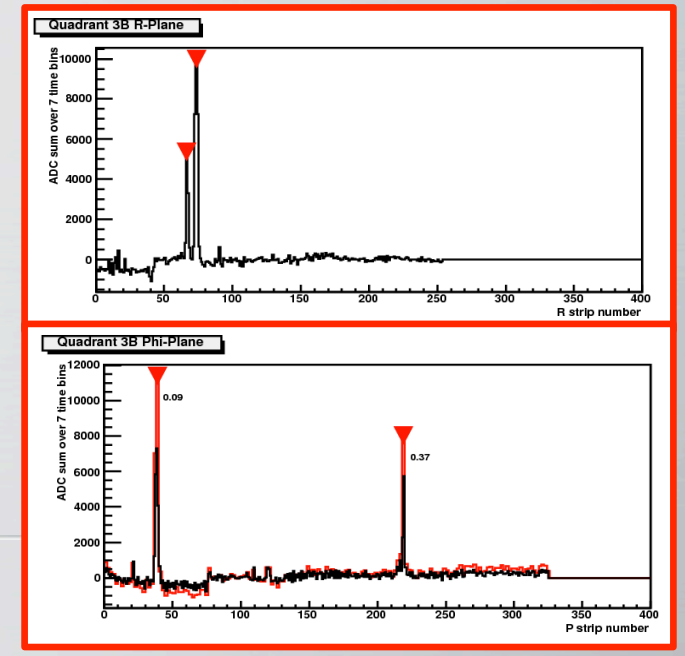




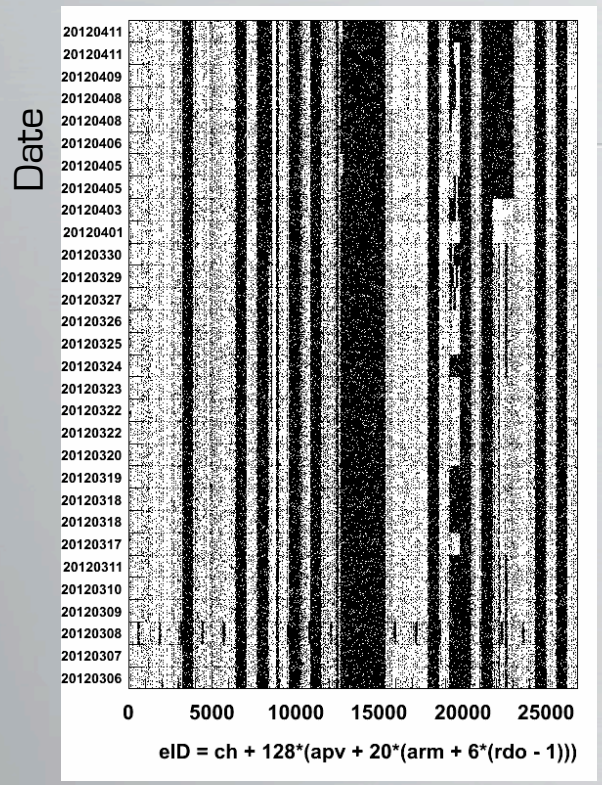
FGT Software Library

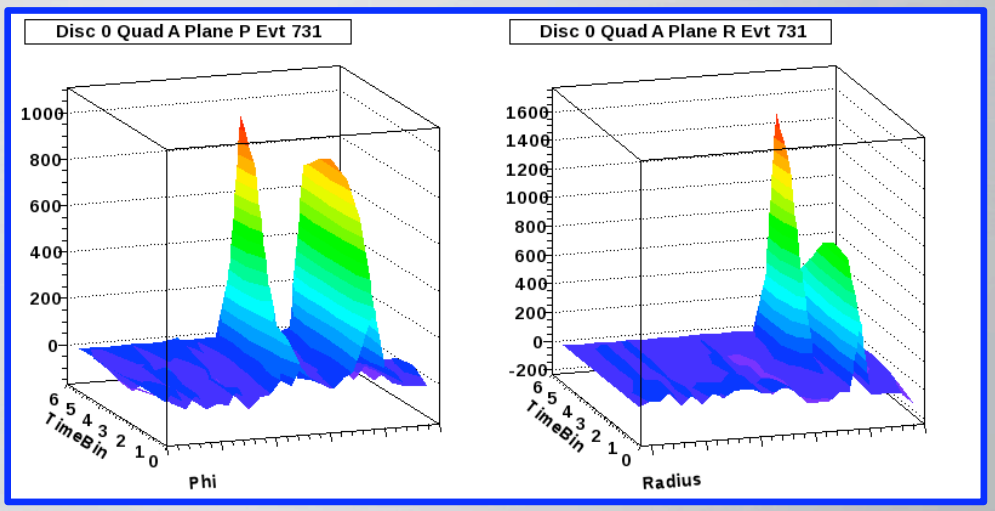
Functionality includes:

1. Ability to analyze signals from raw DAQ files & MuDst
2. Pedestals and status determined daily
3. Database framework for ped/status/gain and geometry mapping is operational
4. Several types of cluster finders available
5. Straight Line and helical trackers permit vertex reconstruction

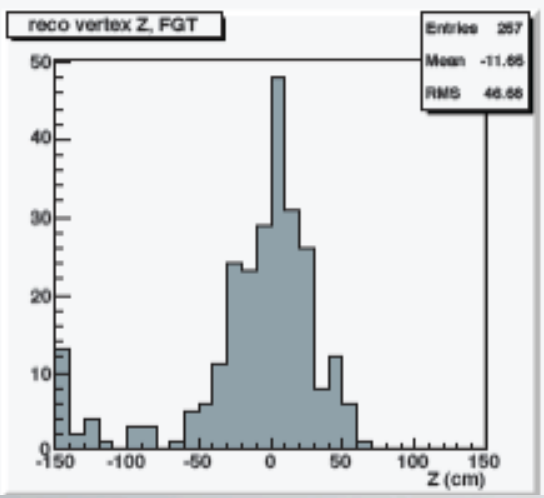


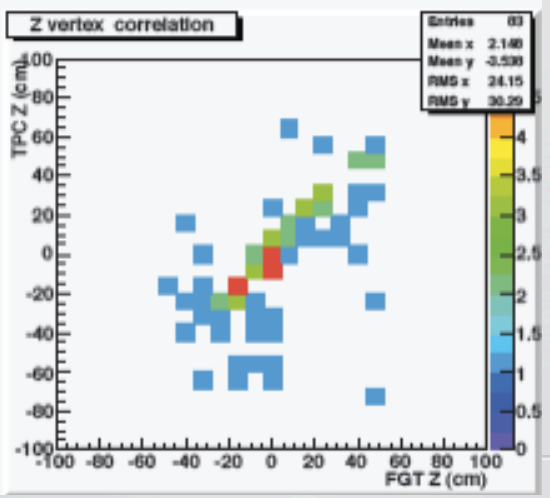
Detector Channel Status





First look at Efficiencies and FGT-TPC Vertex Correlation



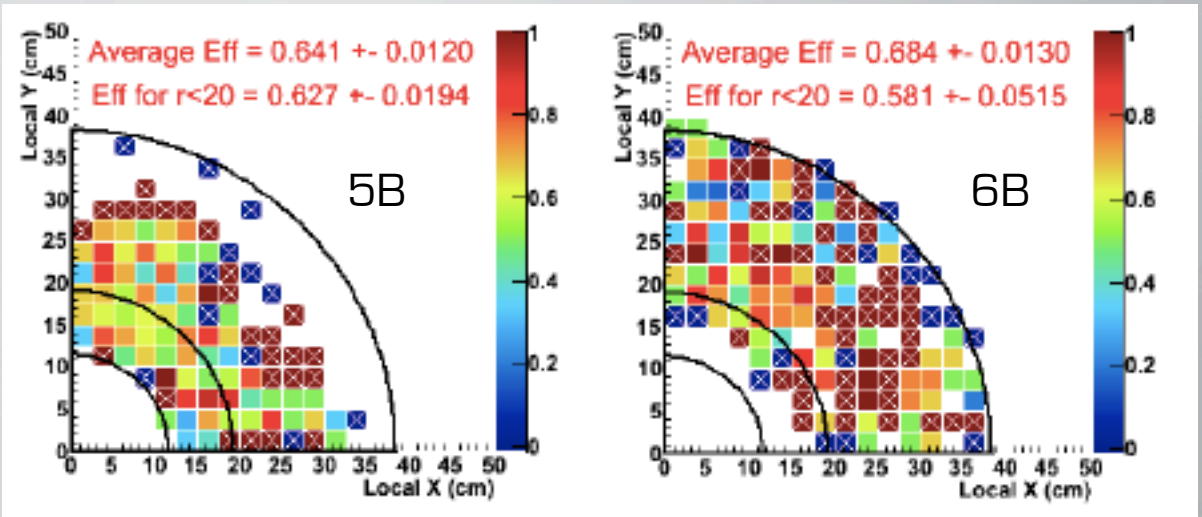


LEFT: Reconstructed Tracks from FGT clusters

RIGHT: Correlation between FGT and TPC vertex

Use tracks to determine quadrant efficiencies – results from different clusters finders agree.

NOTE: Dead areas and spacers not taken into account yet.



Summary

- 2012 was a very productive run for STAR

- 200 GeV Transverse data

  - First substantial data set to probe transversity @ mid-rapidity
  - Allow investigations of isolation cones for π^0 A_N in FMS
  - Continue work towards measuring direct photon A_N in FMS with goal of understanding the process dependence of Sivers functions
  - Installation of partial FGT & initial commissioning tasks complete

- 500 GeV Longitudinal data

  - Push measurements of $\Delta g(x)$ to lower x via inclusive jet and dijet probes.
  - First substantial run for parity violating W asymmetries - big step on way to constraining light flavor anti-quark distributions.
  - Analysis of FGT data taken during 500 GeV continues. Studies of signal shapes and cluster algorithms will allow us to set optimal running conditions for upcoming runs and understand detector efficiencies.