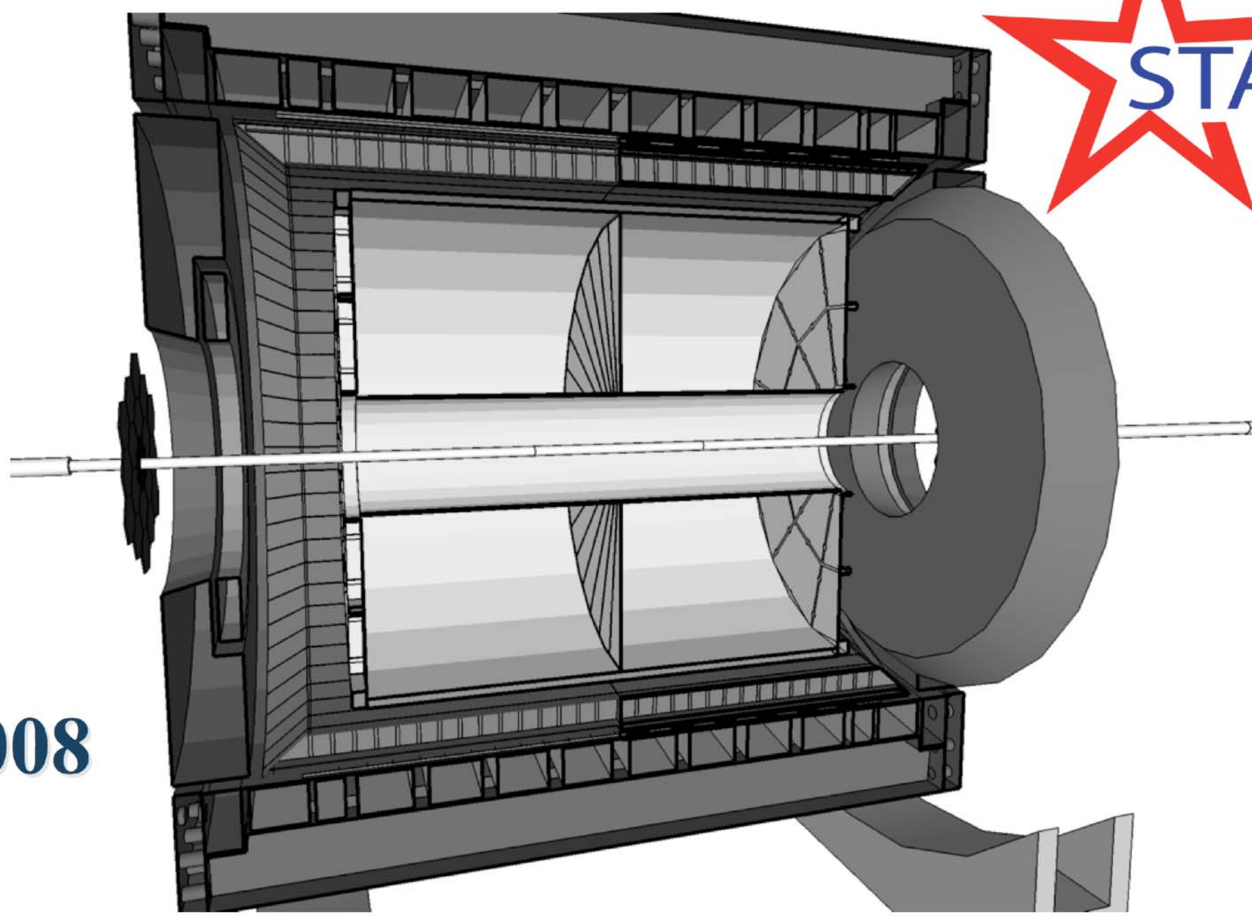
# Status of Dijet Cross Section and Double Longitudinal Spin Asymmetry Measurement in 200 GeV Proton+Proton Collisions at RHIC



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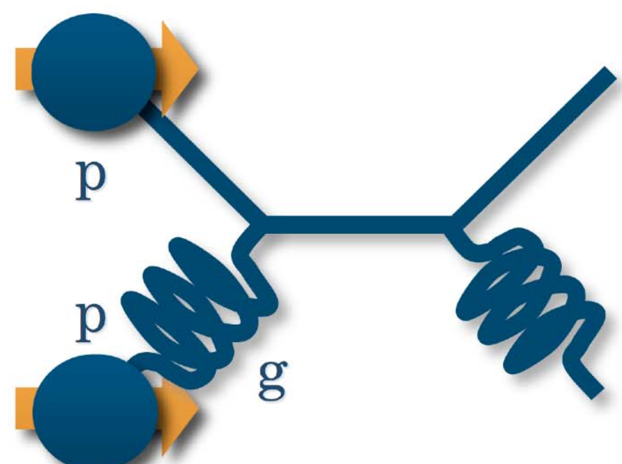
# Contents

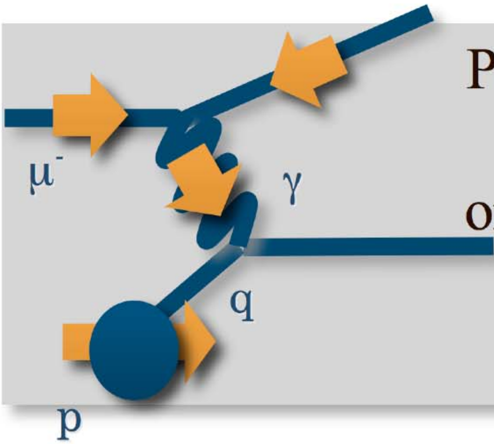
1. ΔG measurement at STAR

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

2. The status and projections of the dijet analysis



# ΔG measurement at STAR



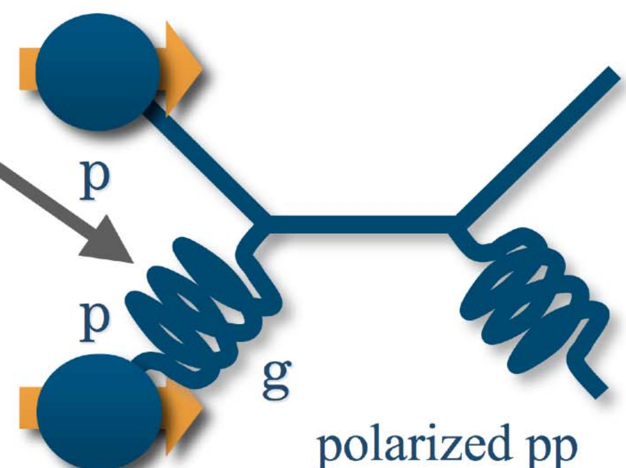

Polarized DIS found that quarks carry only a small fraction of the proton spin

$\Delta\Sigma \approx 0.3$

ΔG is only loosely constrained from polarized DIS data.

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

proton spin — quarks — gluons — orbital motions

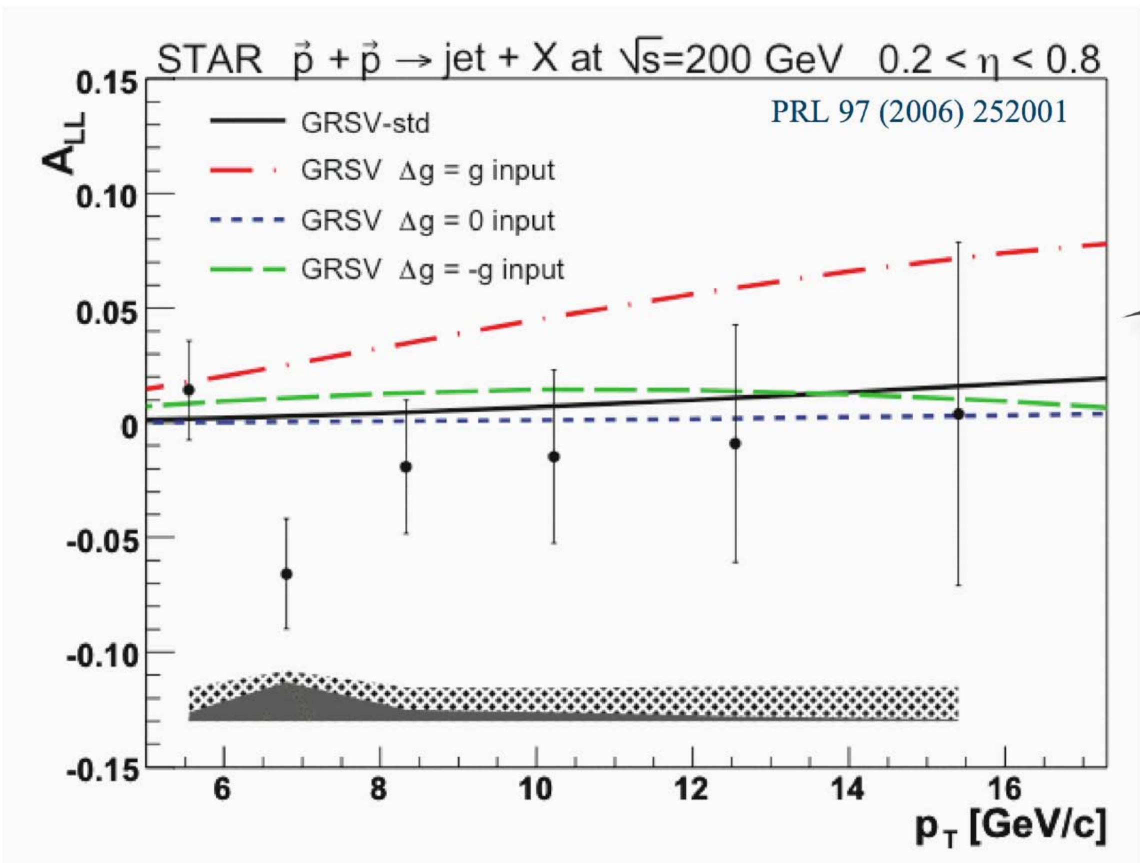


# In polarized pp collisions, $A_{LL}$ is the most important quantity to measure to determine ΔG.

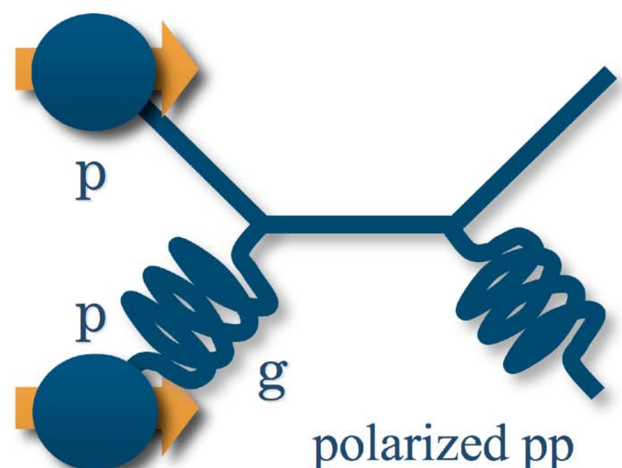
**$A_{LL}$** - the double longitudinal spin asymmetry

$$A_{\rm LL} = \frac{\sigma_{++} - \sigma_{+-}}{\sigma_{++} + \sigma_{+-}}$$

- sensitive to ΔG




As an example of $A_{LL}$, this is one of the early results from STAR.

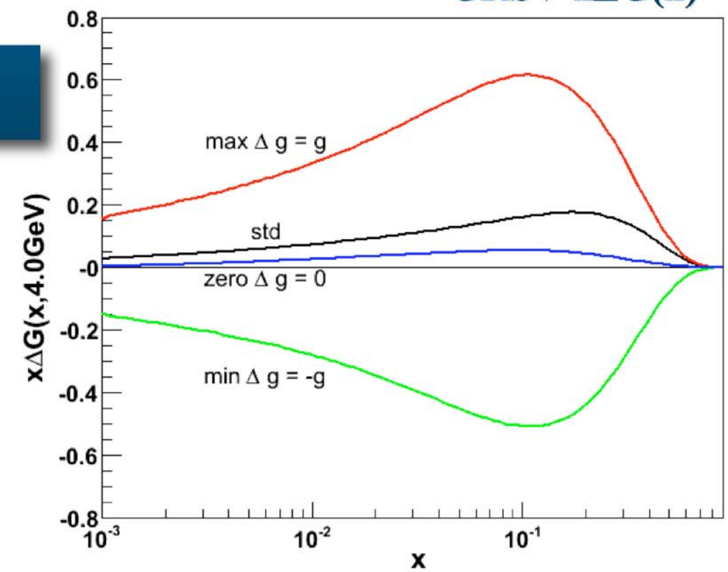


# $A_{LL}$ is sensitive to $\Delta G$

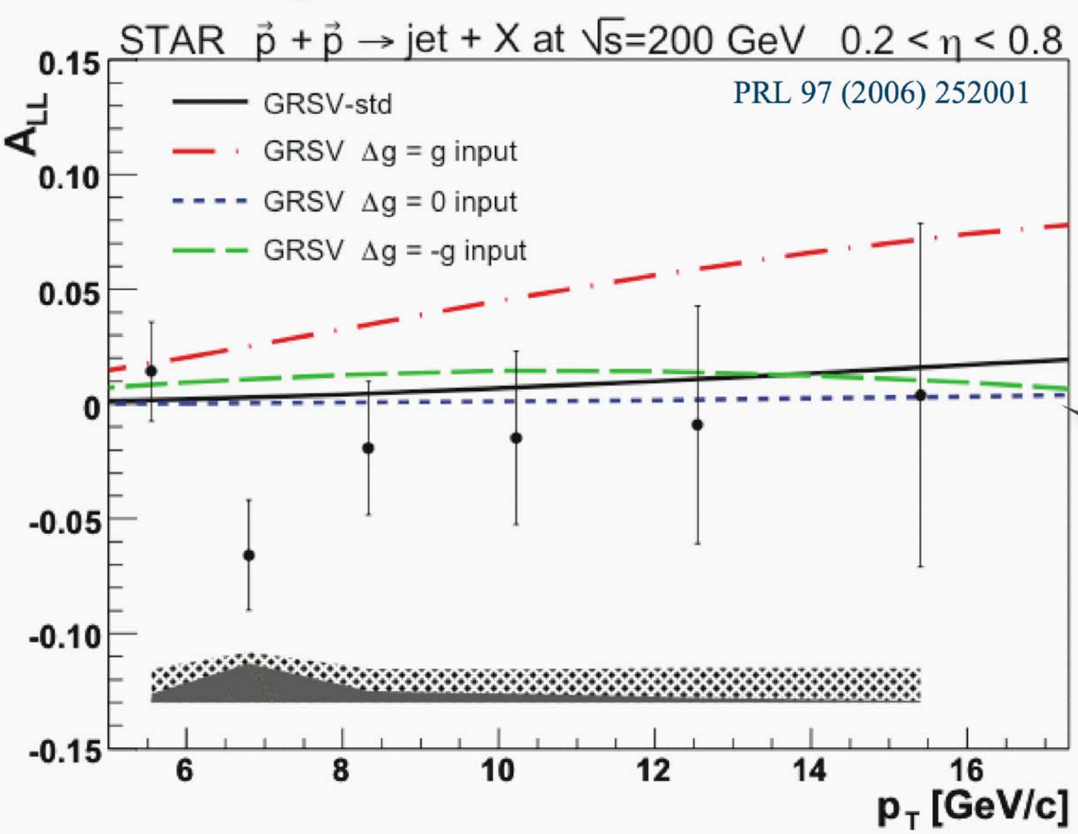
Perturbative QCD

$$A_{\rm LL} = \frac{\sum_{i,j}\int {\rm d}x_1 \int {\rm d}x_2 \Delta f_i(x_1,Q^2)\Delta f_j(x_2,Q^2)\hat{\sigma}(\cos\theta^*)\hat{a}_{\rm LL}(\cos\theta^*)}{\sum_{i,j}\int {\rm d}x_1 \int {\rm d}x_2 f_i(x_1,Q^2) f_j(x_2,Q^2)\hat{\sigma}(\cos\theta^*)}$$

$$\Delta g(x) = \Delta f_i(x)|_{i=g}$$




Polarized Gluon Distribution Functions




$A_{LL}$ is sensitive to polarized gluon distribution

# The cross section measurement is to confirm pQCD framework

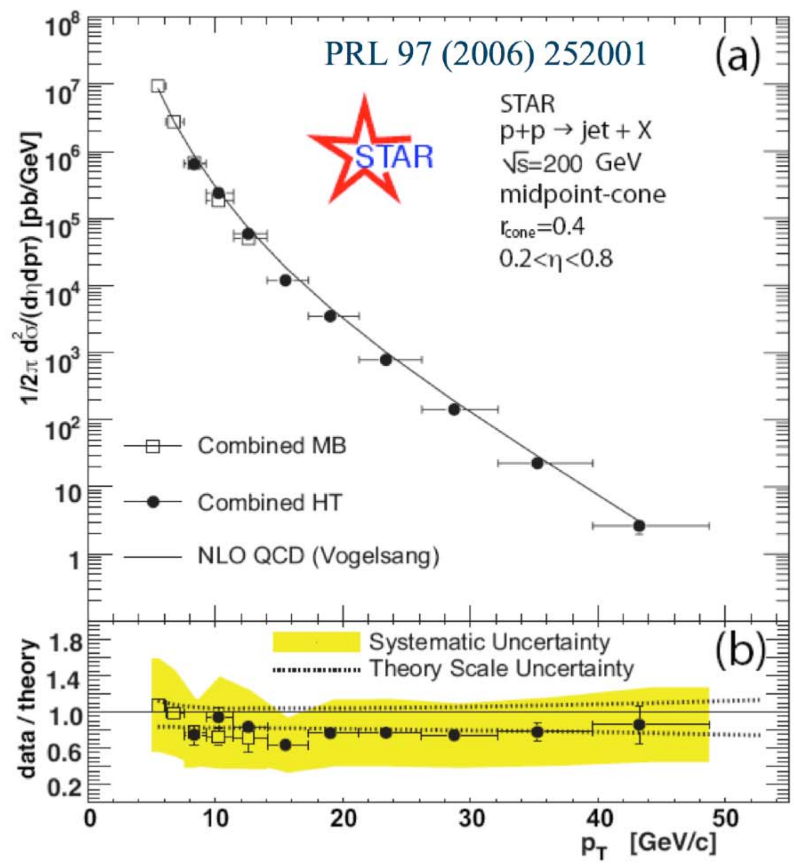
**Perturbative QCD**

$$A_{\mathrm{LL}} = \frac{\sum_{i,j}\int \mathrm{d}x_1 \int \mathrm{d}x_2 \Delta f_i(x_1,Q^2)\Delta f_j(x_2,Q^2)\hat{\sigma}(\cos\theta^*)\hat{a}_{\mathrm{LL}}(\cos\theta^*)}{\sum_{i,j}\int \mathrm{d}x_1 \int \mathrm{d}x_2 f_i(x_1,Q^2) f_j(x_2,Q^2)\hat{\sigma}(\cos\theta^*)}$$

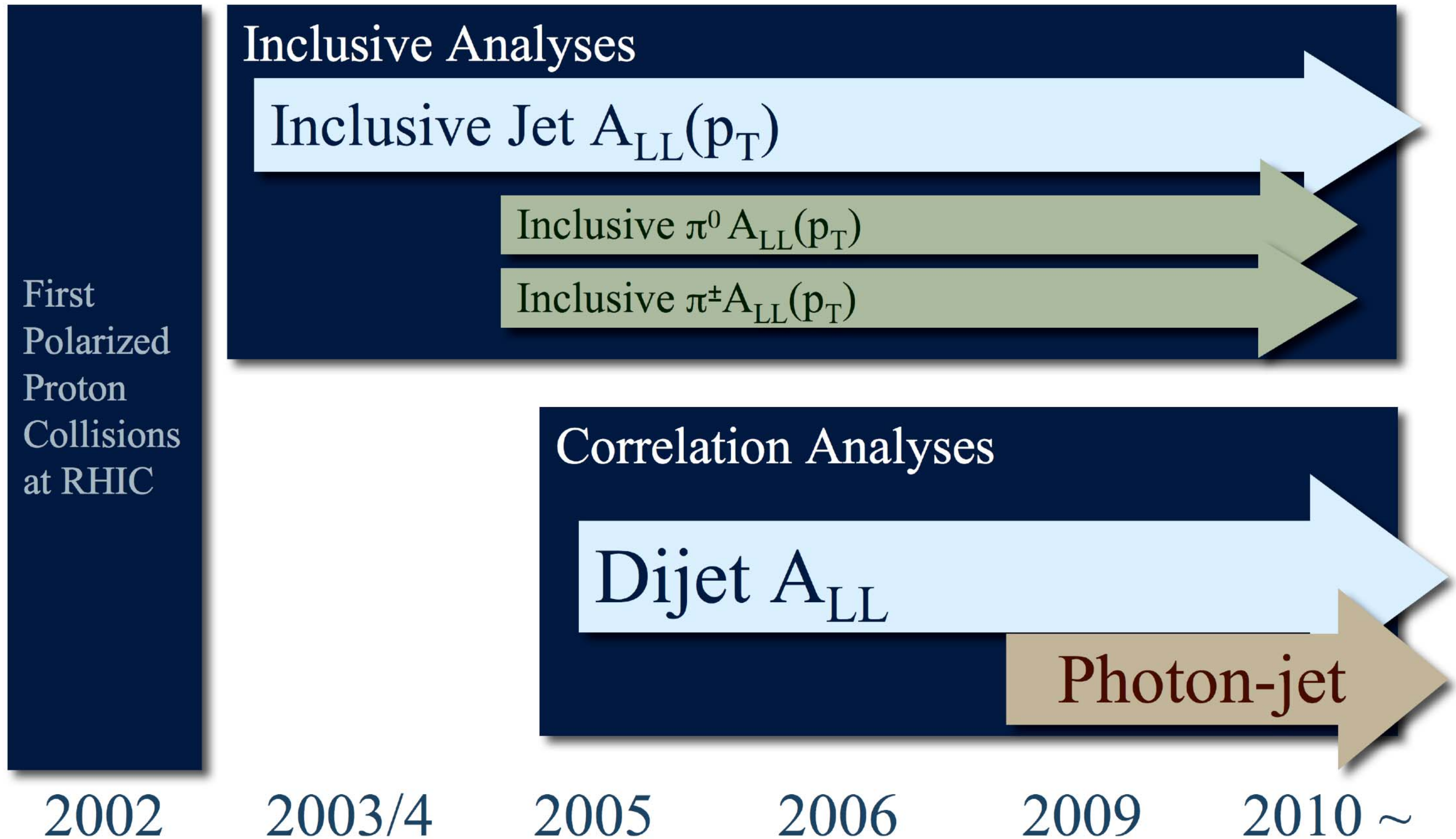
$$\Delta g(x) = \Delta f_i(x)|_{i=g}$$

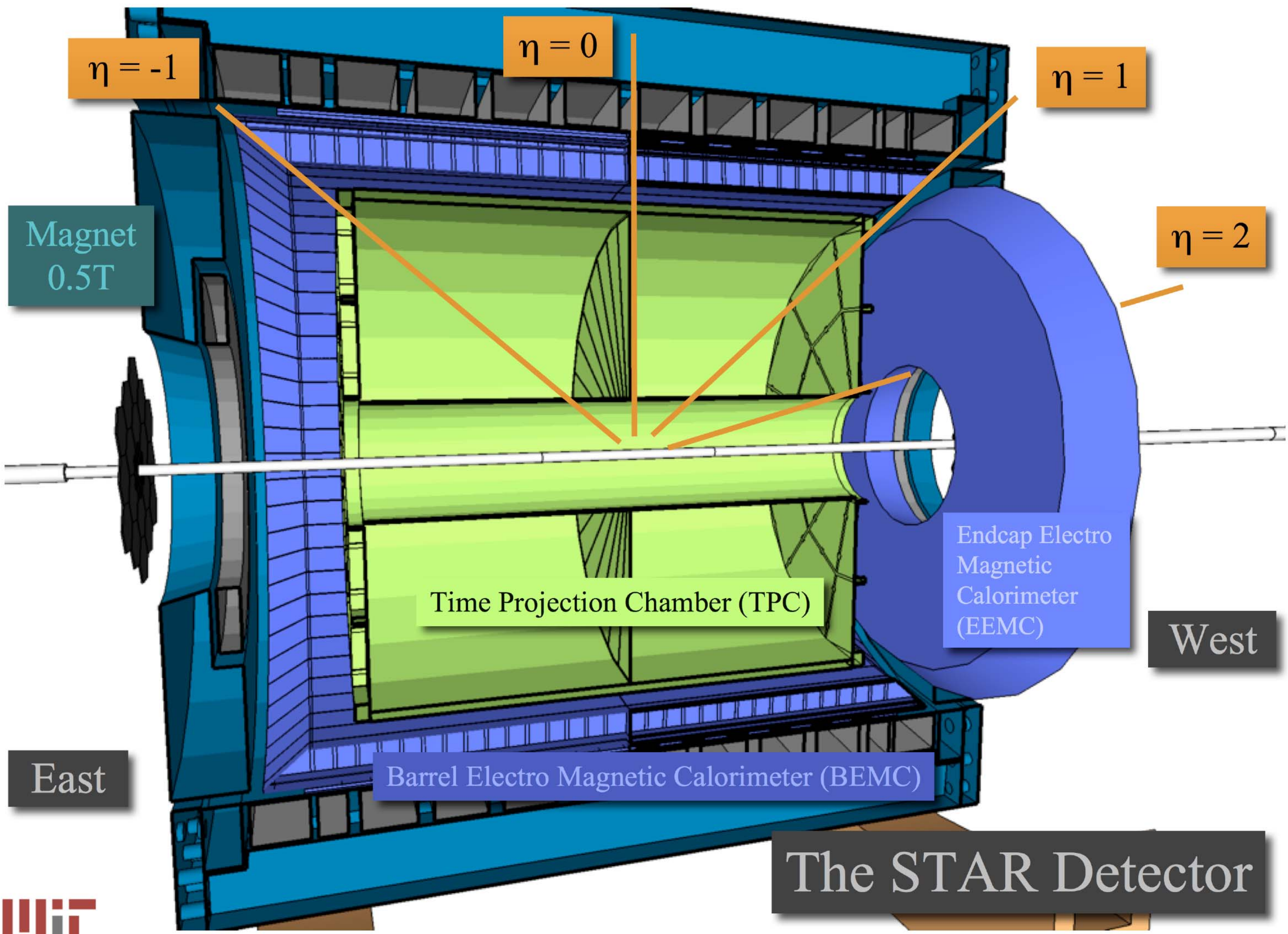
verify the framework

$$\sigma = \sum_{i,j}\int \mathrm{d}x_1 \int \mathrm{d}x_2 f_i(x_1,Q^2) f_j(x_2,Q^2)\hat{\sigma}(\cos\theta^*)$$



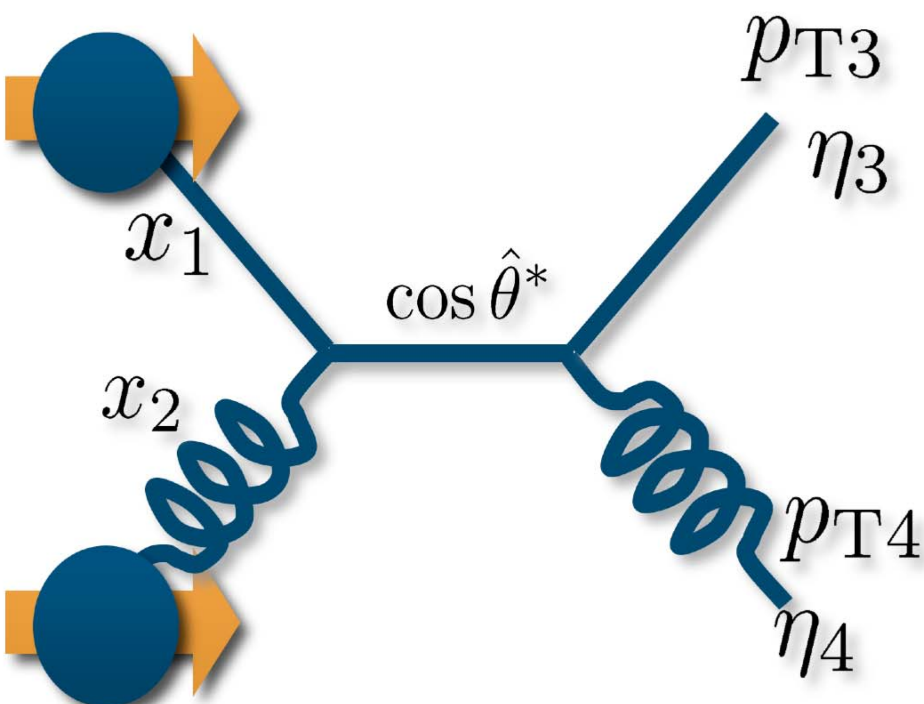
# STAR measures $A_{LL}$ for various final states.





η = -1
η = 0
η = 1
η = 2
Magnet 0.5T
Time Projection Chamber (TPC)
Endcap Electro Magnetic Calorimeter (EEMC)
Barrel Electro Magnetic Calorimeter (BEMC)
West
East
The STAR Detector

# Motivation for Dijet $A_{LL}$ is to constrain $\Delta G$ with initial event kinematics




$$x_1 = \frac{1}{\sqrt{s}}(p_{T3}e^{\eta_3} + p_{T4}e^{\eta_4})$$

$$x_2 = \frac{1}{\sqrt{s}}(p_{T3}e^{-\eta_3} + p_{T4}e^{-\eta_4})$$

$$M = \sqrt{x_1 x_2 s}$$

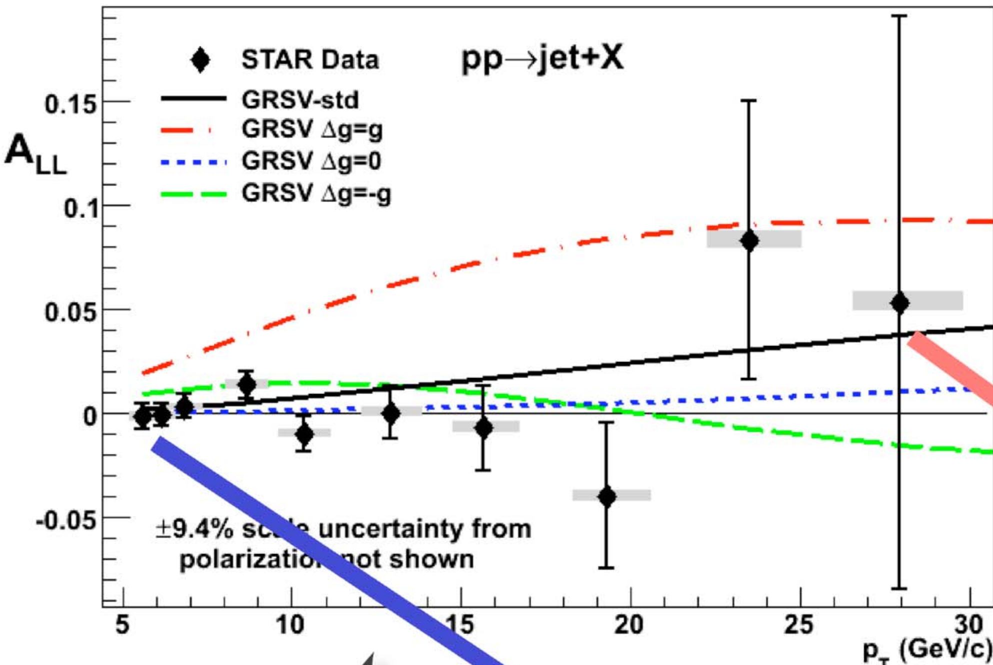
$$\eta_3 + \eta_4 = \log\frac{x_1}{x_2}$$

$$\tanh\frac{\eta_3 - \eta_4}{2} = \cos\theta^*$$

The initial state variables can be written in terms of the final state variables

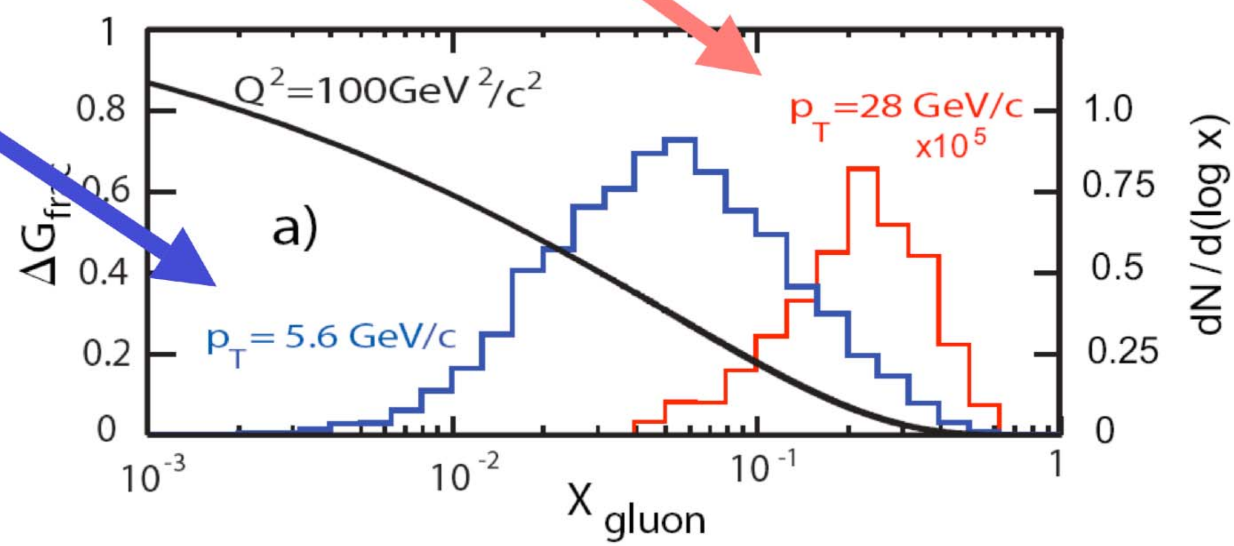
# Compared to the inclusive jet $A_{LL}$

STAR PRL **100**, 232003 (2008)



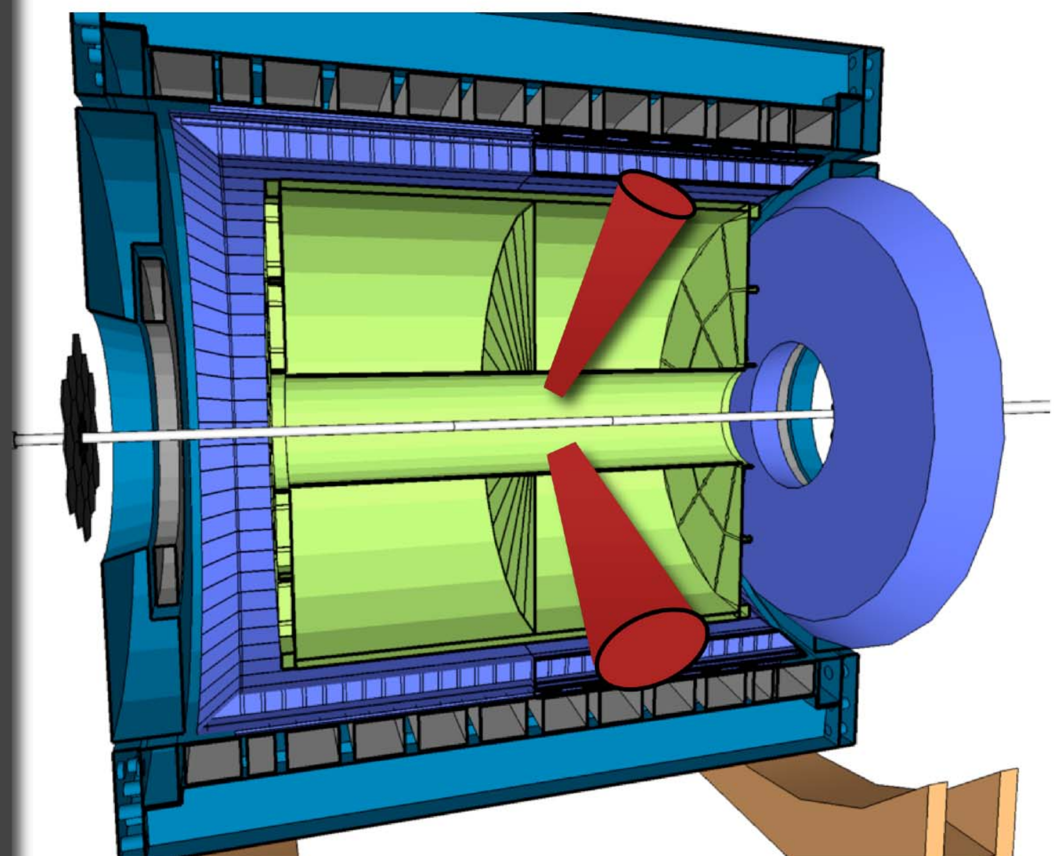

Each bin is integral over a range of x

$A_{LL}$ as a function of $p_T$



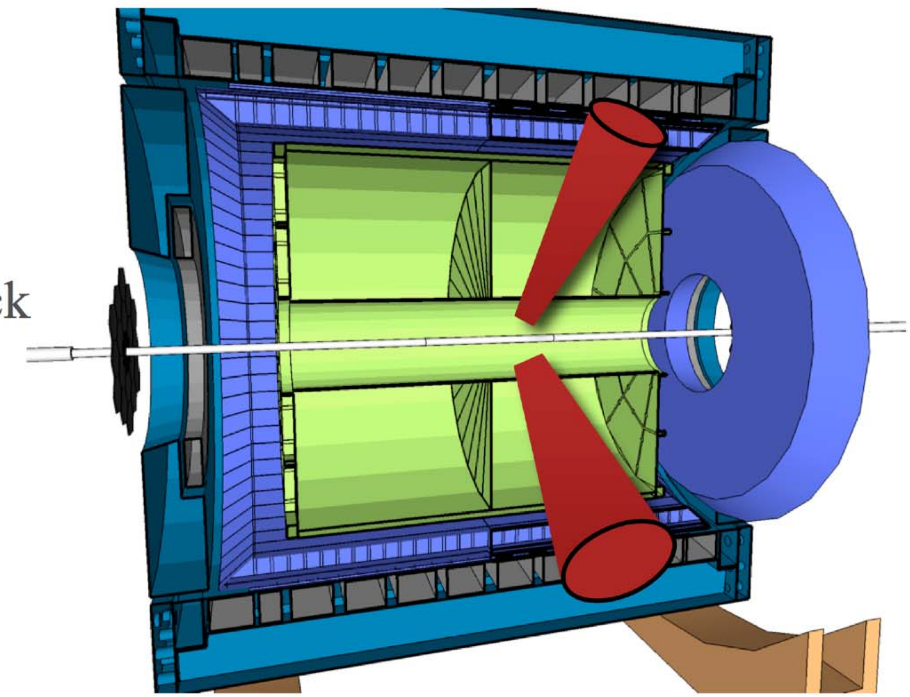
# Evolution of STAR Dijet program

- 2005
  - First cross section measurement
  - west barrel - west barrel dijets
- 2006
  - First $A_{LL}$ measurement
  - barrel - barrel dijets, barrel - endcap dijets
- 2009
  - May provide better constraint on $\Delta G$ than inclusive jets
  - Wide acceptance including endcap - endcap dijets



# Dijet Definition

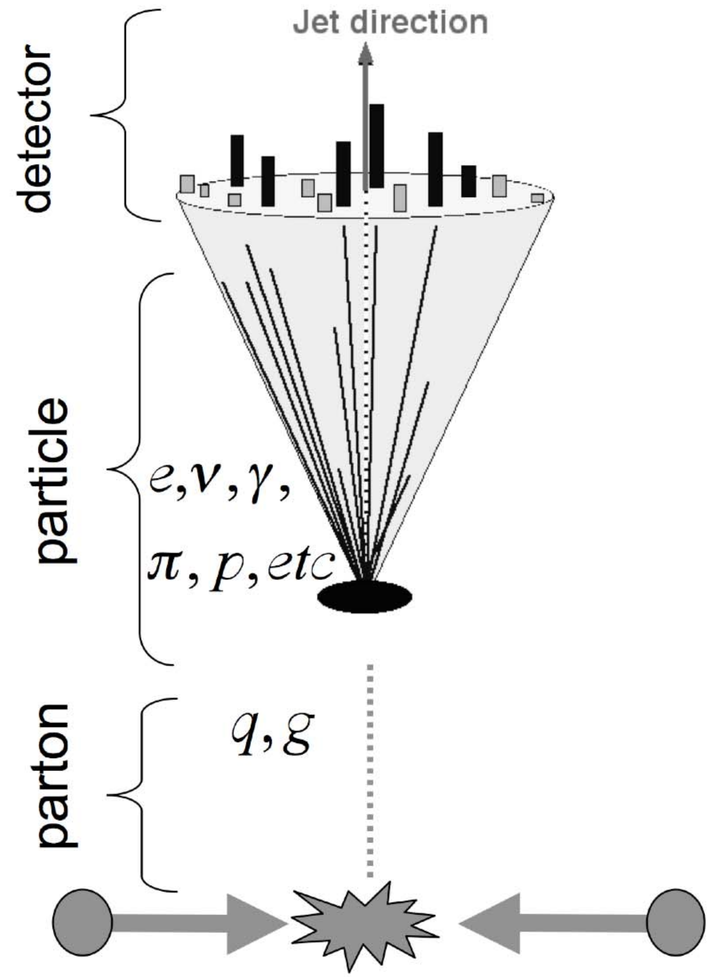
- Jet Definition
  - Collection of charged tracks and tower energy deposits in a circle in $\eta$ x $\phi$ plane
    - Charged Tracks
      - TPC
      - Pion mass assumption
    - Tower Energy Deposits
      - BEMC
      - Photon mass assumption
      - MIP energy subtraction for track
  - Midpoint Cone Algorithm
    hep-ex/0608030
    - Cone Radius: 0.4(2005), 0.7(2006)
- Dijet Definition
  - Two leading pT jets



# Cross Section Measurement

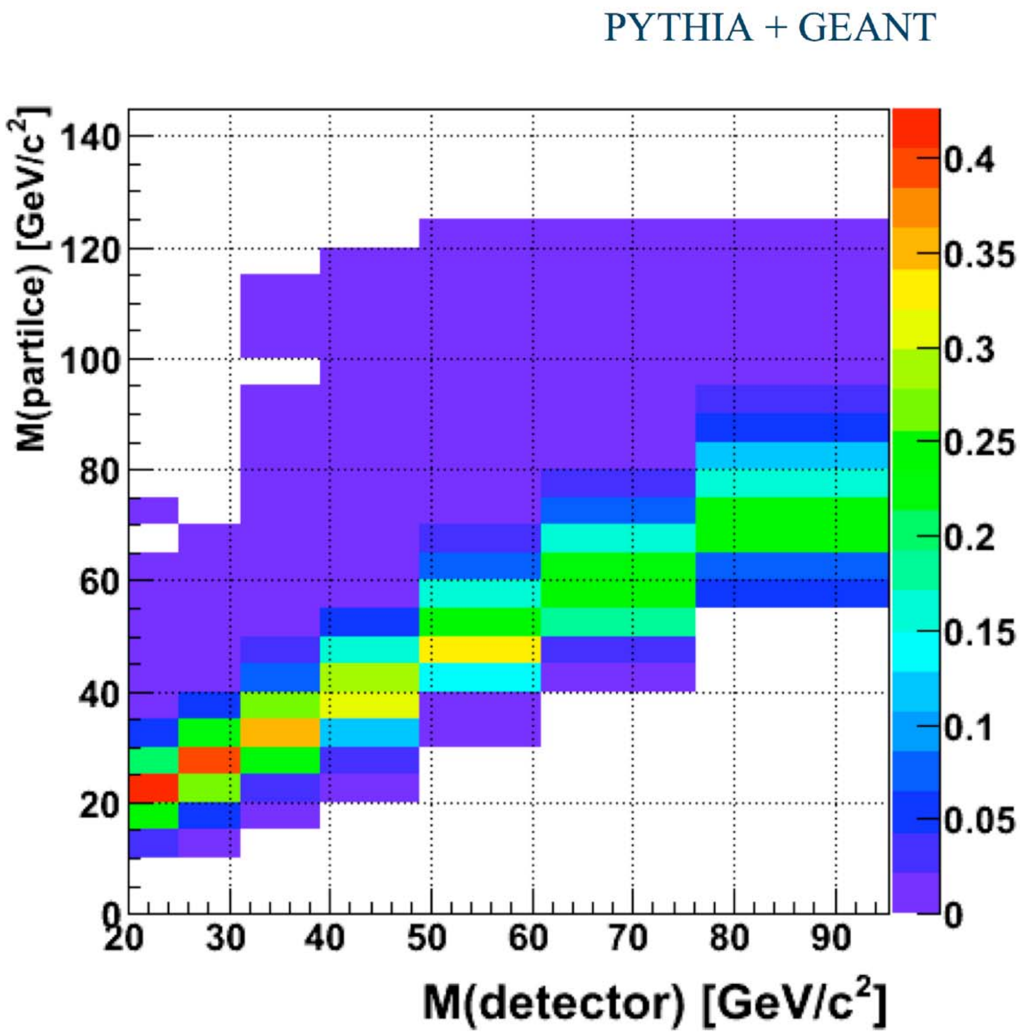
$$\frac{d\sigma}{dM\,d\eta_3\,d\eta_4} = \frac{N_{\rm dijet}}{dM\,d\eta_3\,d\eta_4} \cdot \frac{1}{\int \mathcal{L}dt} \cdot \frac{1}{c}$$

- Data Collection
  - RHIC 2005 Run
  - 200 GeV, $2.2\text{pb}^{-1}$
- Phase Space
  - $\min(p_T) > 7$ GeV, $\max(p_T) > 10$ GeV
  - $-0.05 < \eta < 0.95$, $|\Delta\eta| < 0.5$
  - $|\Delta\varphi| > 2.0$
- Data - NLO comparison
  - The comparison is made at particle level.
    - Detector jets are corrected to particle jets with Pythia
    - The corrections for hadronization and underlying events on NLO calculation are evaluated with Pythia

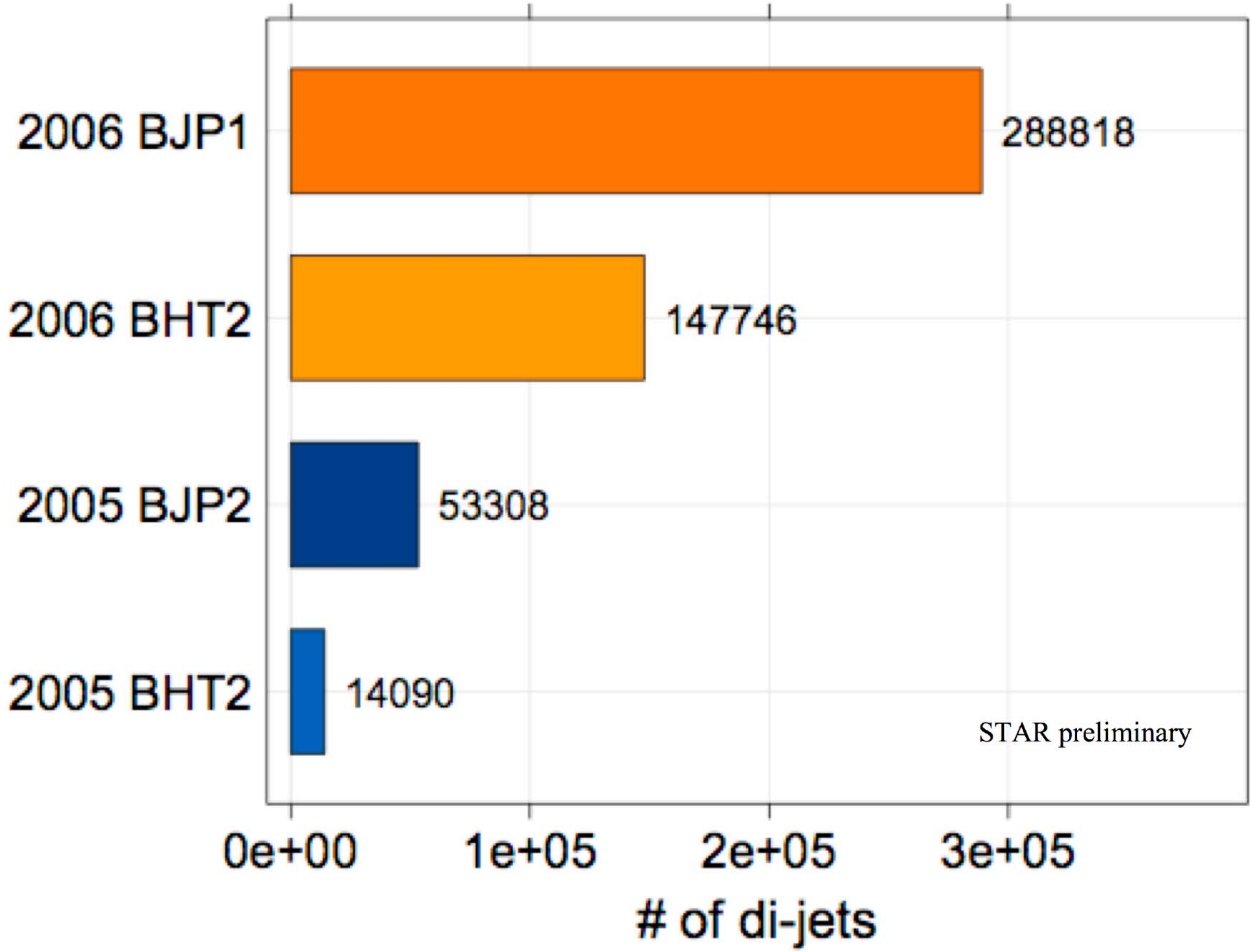


# Unfolding dijet cross section with Pythia MC sample

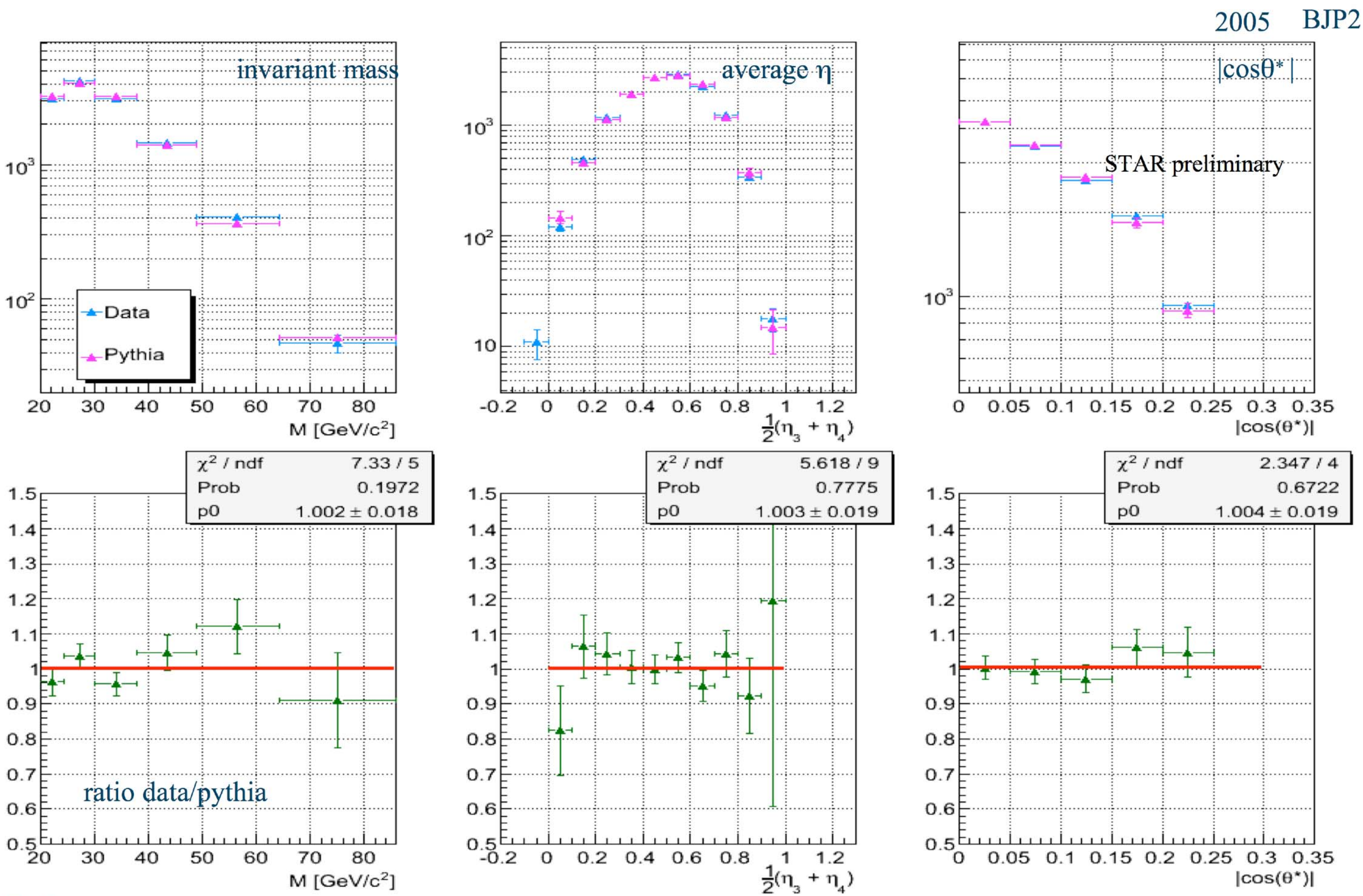
- The particle level distribution is different from the detector level distribution due to the detector response.



# Dijet Yield

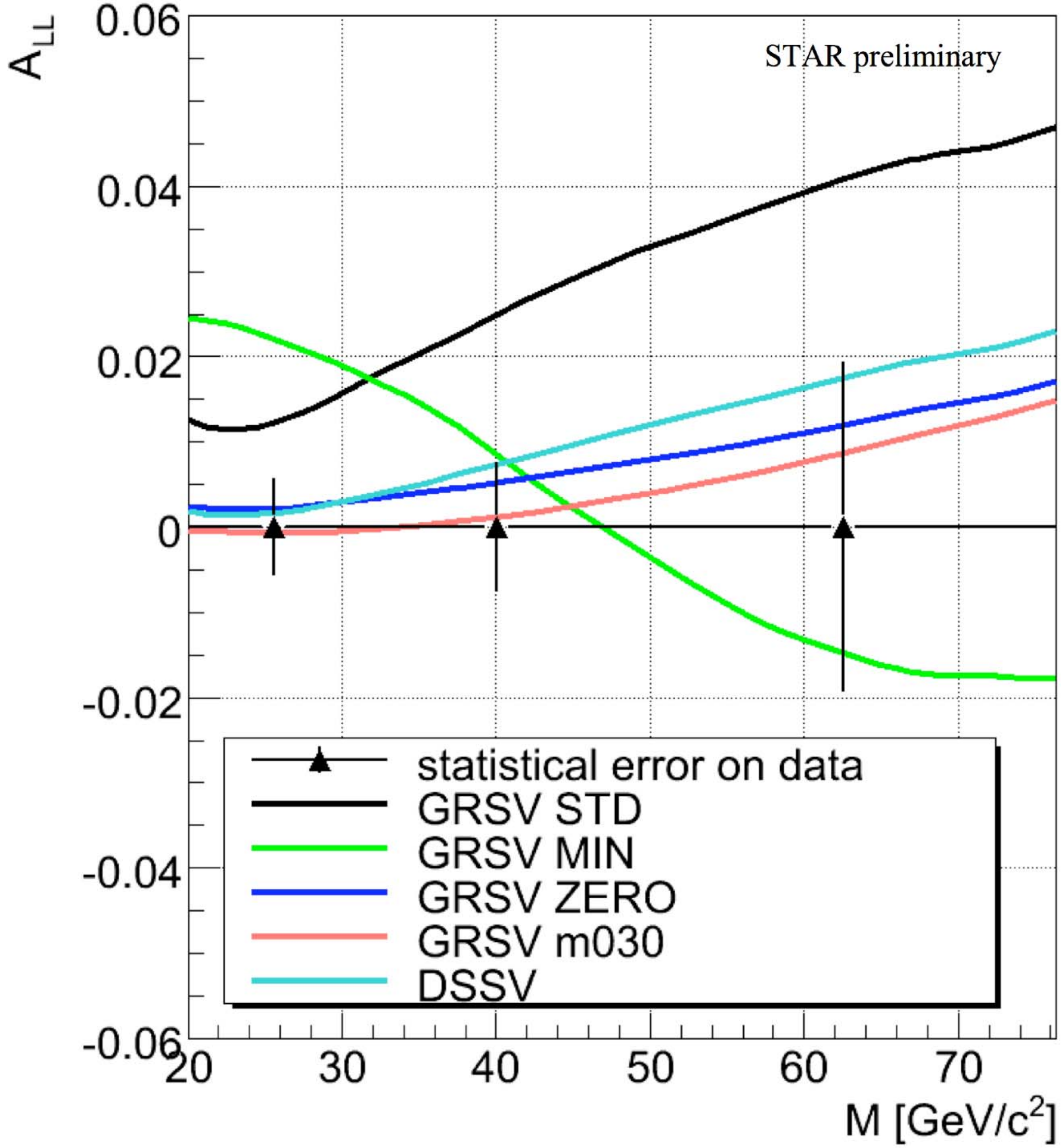

2006 BJP1
288818
2006 BHT2
147746
2005 BJP2
53308
2005 BHT2
14090
STAR preliminary
0e+00
1e+05
2e+05
3e+05
# of di-jets

# Dijet distributions are well described by MC



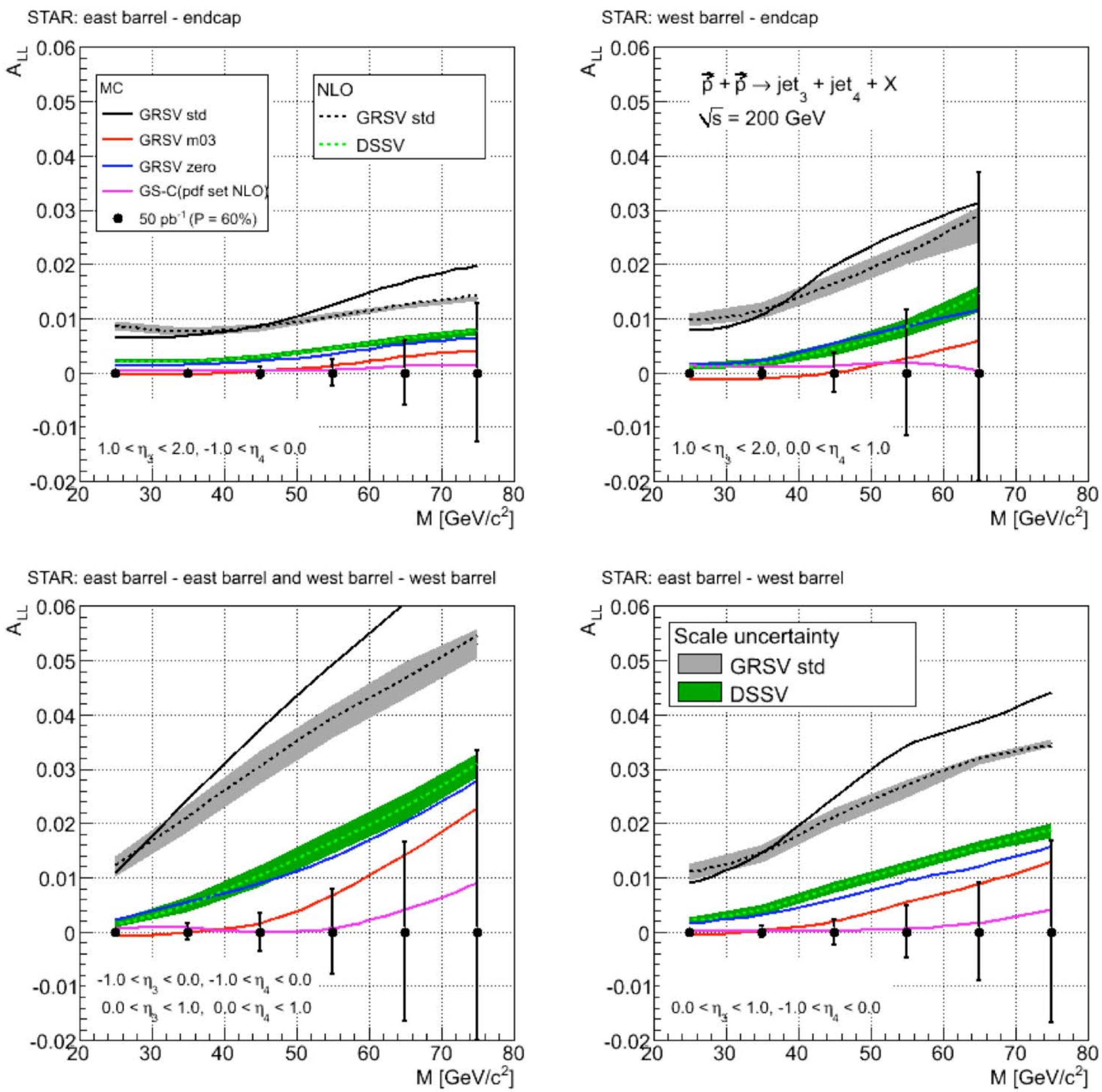

$\sqrt{s} = 200$ GeV  $\min(p_T) \geq 7.0$ GeV/c, $\max(p_T) \geq 10.0$ GeV/c  $-0.05 \leq \eta \leq 0.95$  $|\Delta\eta| < 0.5$  $|\Delta\varphi| > 2$

# Size of statistical errors on dijet $A_{LL}$ (2006)




$\sqrt{s} = 200$ GeV, $-0.7 \leq \eta \leq 0.9$, $p_T \geq 5.0$ GeV/c, $M \geq 20$ GeV/c$^2$ BJP1

# The 2009 dijet $A_{LL}$ is expected to provide significant constraint on ΔG.



# Summary

- The dijet $A_{LL}$ allows us to constrain $\Delta G$ with initial parton kinematics.
- The dijet cross section measurement in pp collisions at 200 GeV are in progress.
  - Data - NLO comparison will be made at the particle level jets.
  - The effect of the underlying events and hadronization is being evaluated.
- The first dijet $A_{LL}$ will come from 2006 data
- With 2009 data, the dijet $A_{LL}$ is expected to put further constraint on $\Delta G$ with the event kinematics.