Spin Physics at RHIC
An Early History and Early Data

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Outline

- A brief history
- The RHIC Spin Collaboration
- Approval and preparations
- The Polarimeters and Polarized Jet Target
- Early Spin Physics

The Culprits and Proposal

At the Spin symposium 2002

- Bunce, Roser, Tannenbaum, and Makdisi started the process early 1990
- The Polarized Collider Workshop held at Penn State University, November 15–17, 1990
- A first PAC presentation in 1991
- The proposal approved 1993 and published 1996
- 1995 Agreement for RBRC & help funding the RHIC Snakes, Spin rotators, PHENIX Muon arm.

Ozaki, Yokosawa, Nagamiya, Samios, Lee, Ishihara

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The RHIC Spin Collaboration 1991

1. Present members of the RHIC Spin Collaboration:

Argonne	M. Beddo, D. Hill, D. Grosnick, D. Lopiano, H. Spinka, D. Underwood, A. Yokosawa.
BNL	G. Bunce, A. Carroll, E. Courant, R. Fernow, Y.Y. Lee, D. Lowenstein, Y. Makdisi, L. Ratner, T. Roser, A. Sambamurti, M. Tannenbaum
Dubna	A.V. Efremov
Indiana	S.Y. Lee
Helsinki	N. Törnquist
ITEP	Y. Arestov, B.V. Chuiko, A.M. Davidenko, A.A. Derevschikov, O.A. Grachov, A.K. Likhoded, A.P. Meschanin, S.B. Nurushev, V.L. Rykov, A.G. Ufintzev, A.N. Vasiliev
KEK	S. Hiramatsu, Y. Mori, H. Sato
Kyoto	H. Enyo, K. Imai, A. Masaike
Marseille	J. Soffer
MIT	R. Jaffe
Padova	M. Pusterla
Penn State	J. Collins, S. Heppelmann, G. Ladinsky, E. Minor, R. Robinett
Unaffiliated	D. Sivers
Trieste	A. Penzo, P. Schiavon
Genova	M. Conte
UCLA	G. Igo

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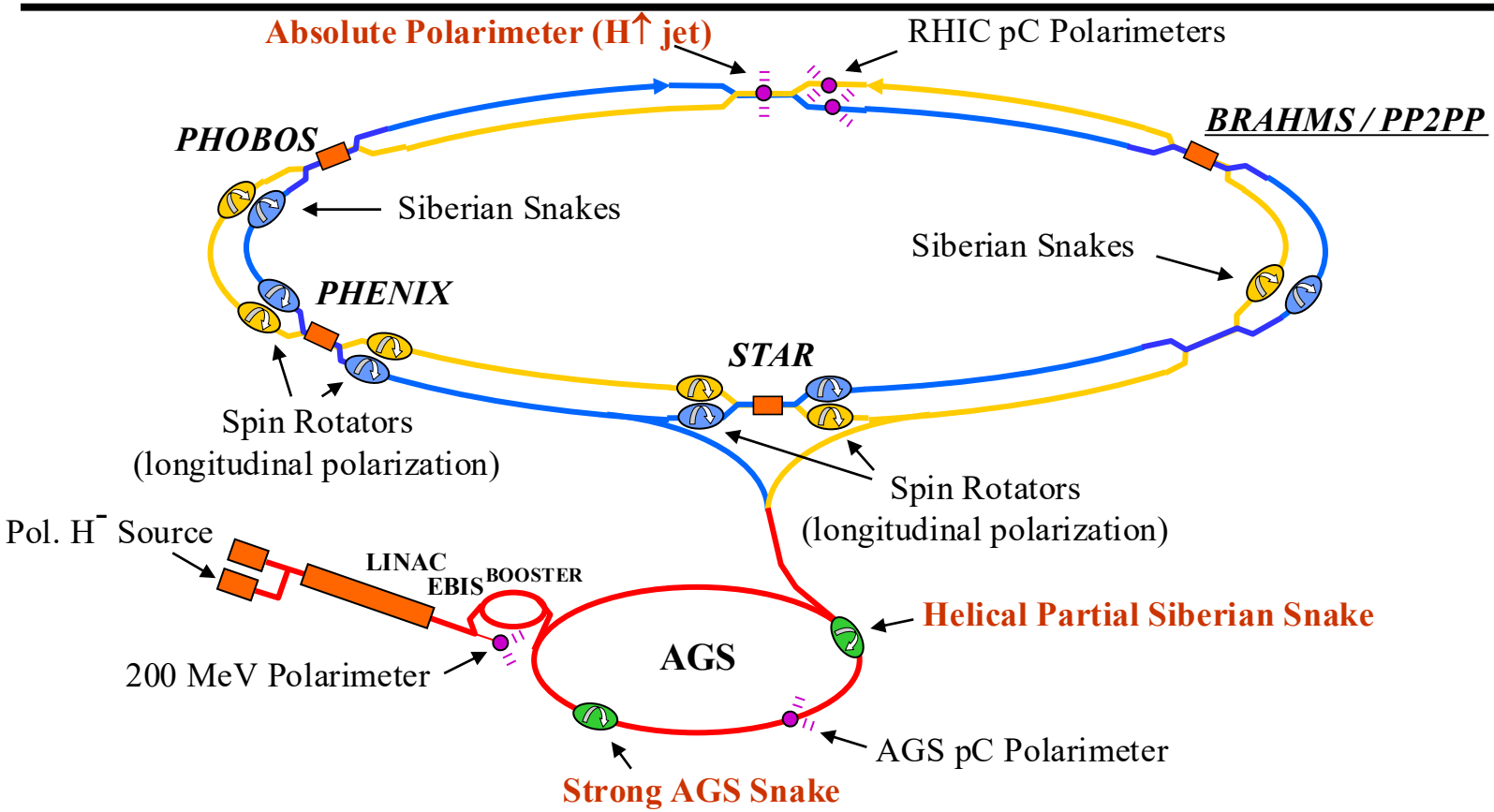
The RHIC Polarized Collider



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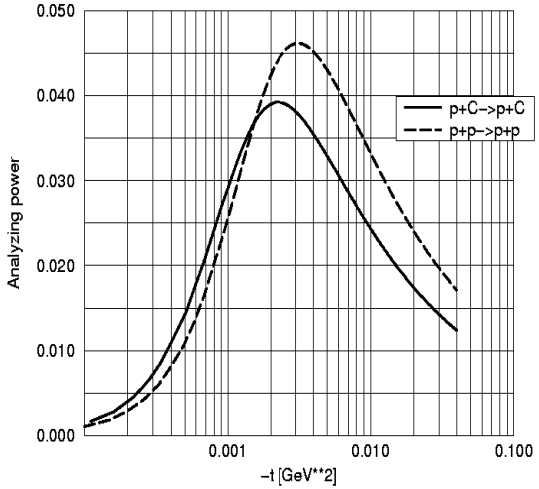
RHIC Spin Physics and Polarimetry Requirements

- The Program is quite versatile:
  - Various CMS energies 48-500 GeV
  - Spin rotators: the freedom to chose a preferred spin alignment
  - Measure the contribution to the proton spin: quarks, gluons and antiquarks. For gluons "direct photon production".

- The polarimeters operate at a wide energy range 24-250 GeV
  - The physics program required precision polarimetry < 5%
  - Absolute polarimeter calibration (Polarized H-Jet target)
  - Allowed beam polarization profile(s)
  - Polarization lifetime or decay during a store

Polarimeters



For RHIC initially p-C inclusive pion production. High analyzing power.

Theoretical help N. Buttimore, E. Leader, B. Kopeliovich, J. Soffer, L. Trueman
Suggested CNI Polarimetry in both the AGS and RHIC. Lower analyzing power high stats

Tested the concept with p-Carbon at IUCF
Early AGS installation used Yale equipment.
H. Huang, A. Bravar, H. Spinka, I. Alekseev
D. Underwood, D. Svirida, K. Yip, O. Eyser
W. Schmidke, A. Deshpande

Installed in the AGS first and then RHIC

Polarized Proton Jet Target

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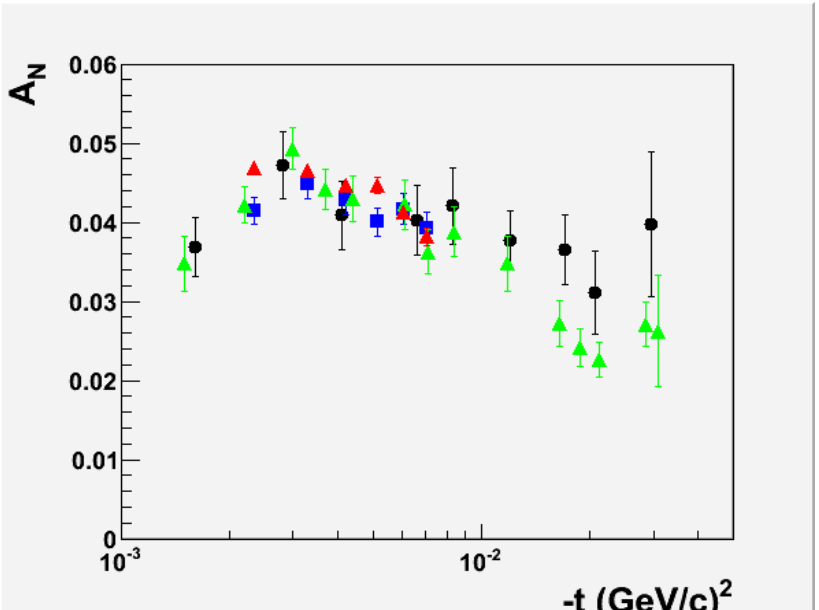
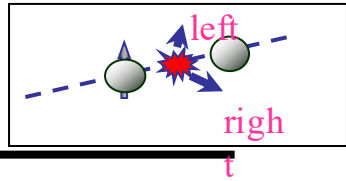
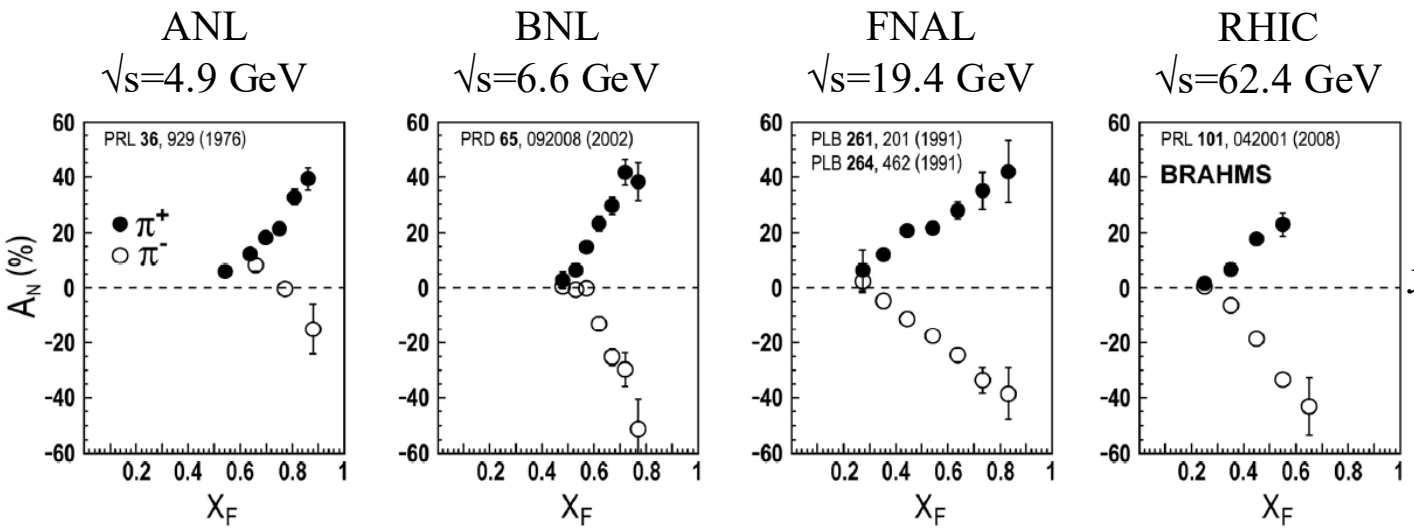
- Construction BNL & U Wisconsin
  Zelenski, Wise, Nass, Haeberli, Makdisi
- Installed 2006
- H. Okada, N. Saito, A. Bravar, O. Eyser
  Statistical and systematics <5%
  Improved to 2% by A. Poblaguev



p⇧+p → h± SSA and CNI

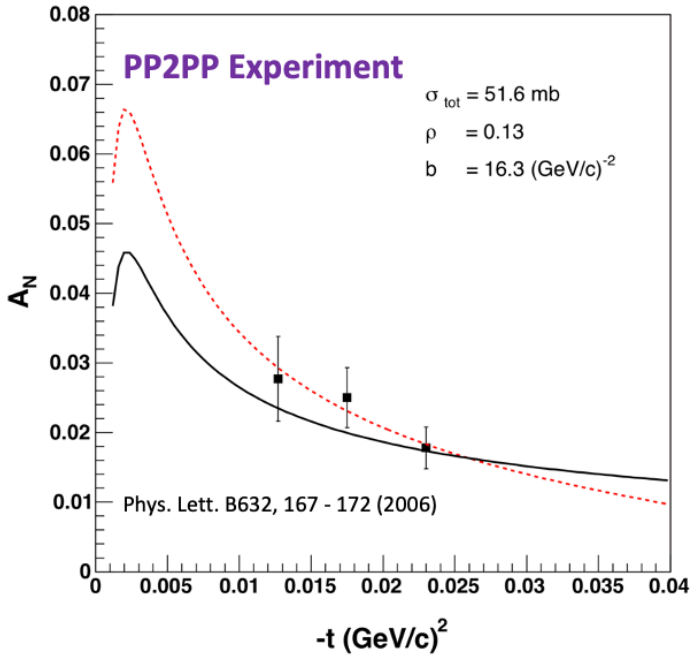




$$x_F = \frac{p_L}{\sqrt{s}/2}$$

Large asymmetries seen over large range in √s, including RHIC energies BRAHMS

Early PP2PP data in the CNI region



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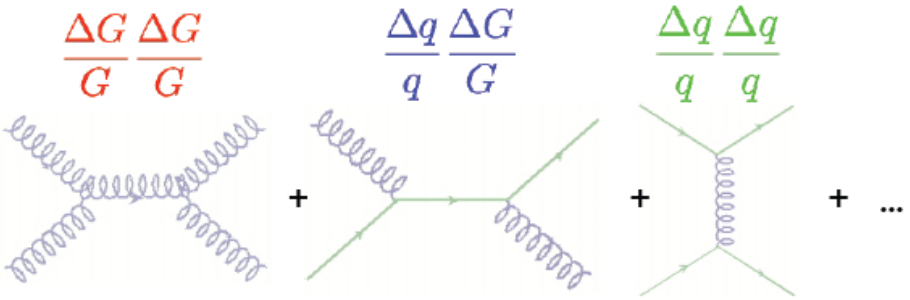
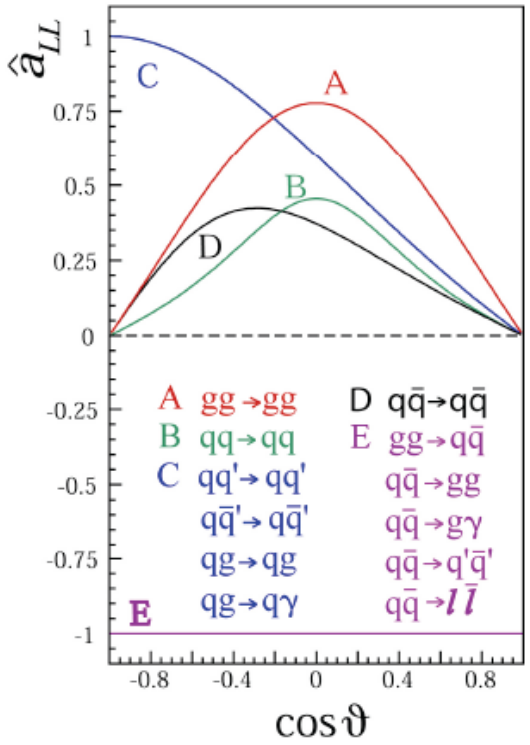
Accessing the gluon polarization ΔG

Polarized Gluon Distribution Measurements :

- ✓ Use a variety of probes with variety of kinematics
  - Access to different gluon momentum fraction x
  - Different systematics
- ✓ Use different beam energies
  - Access to different gluon momentum fraction x
  - Double longitudinal spin asymmetry A_{LL} is sensitive to ΔG





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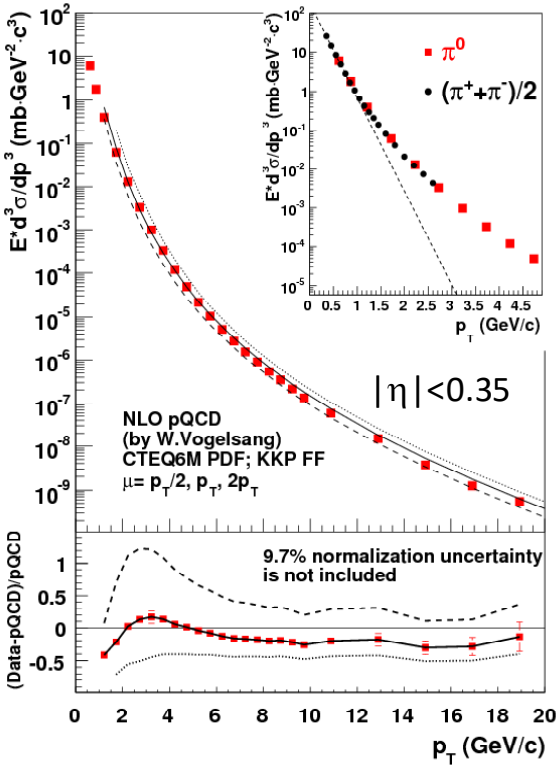
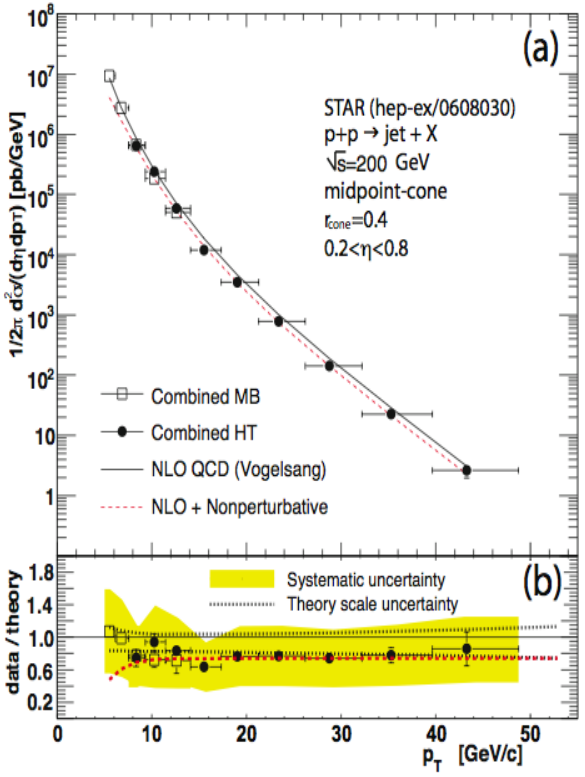
Cross Section and PQCD √s=200 GeV

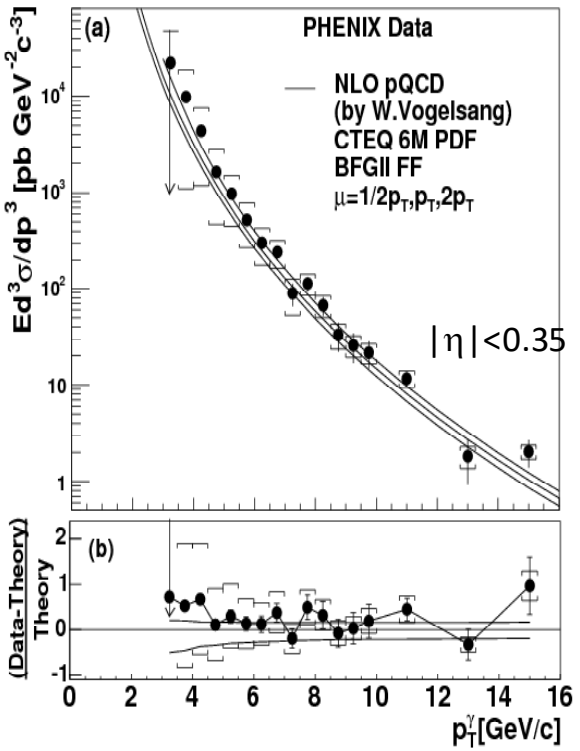
PHENIX pp→ π^0 X
PRD76, 051106

STAR: pp→jet X
PRL 97, 252001

PHENIX pp→γ X
PRL 98, 012002







Good agreement between NLO pQCD calculations and data ⇒ pQCD can be used to extract spin dependent pdf's from RHIC data.

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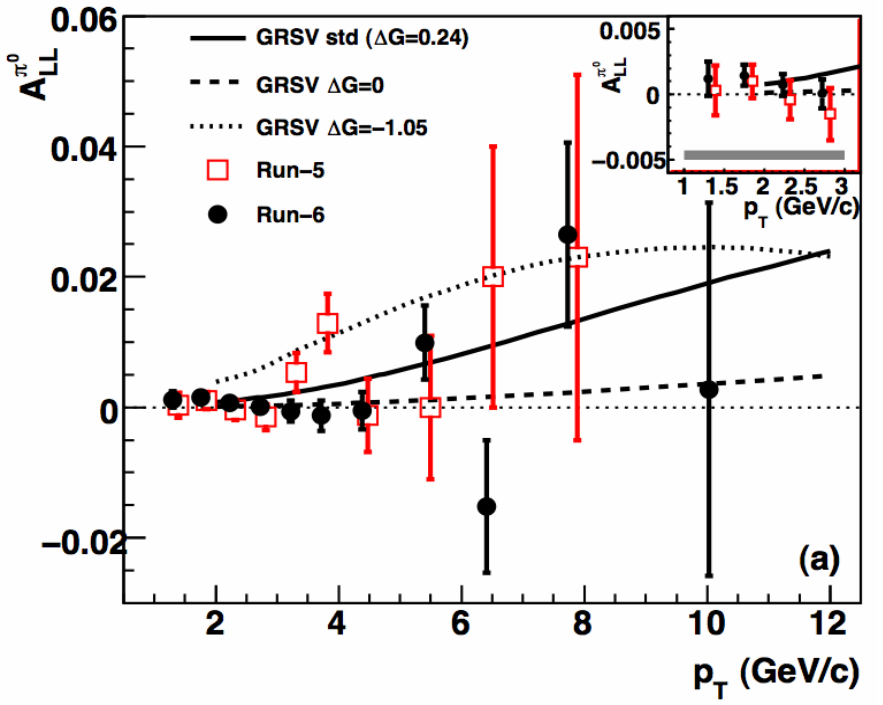
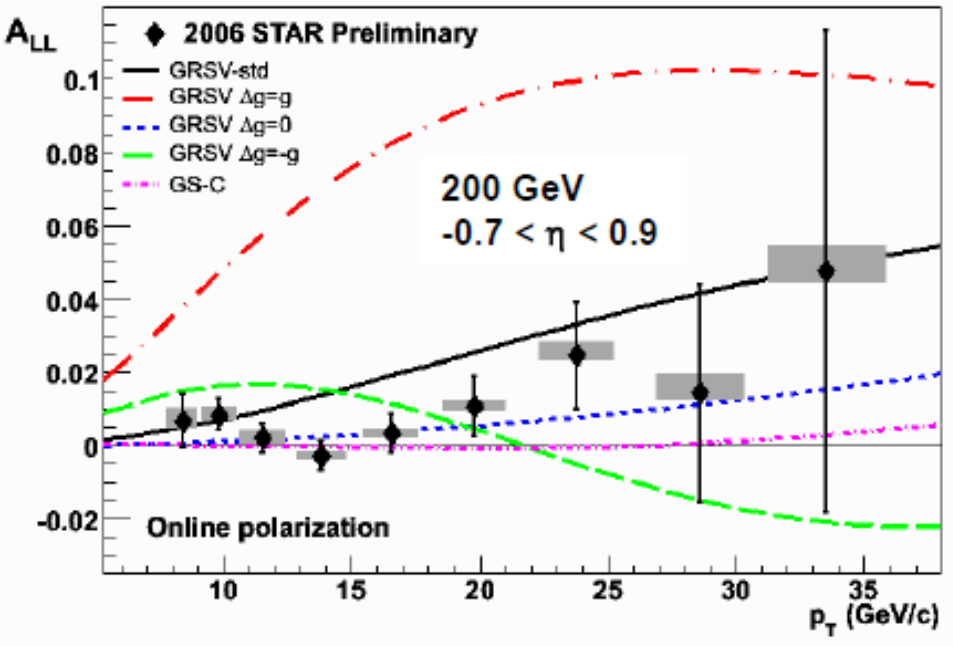
A_{LL}: π^0 : PHENIX & Jets from STAR

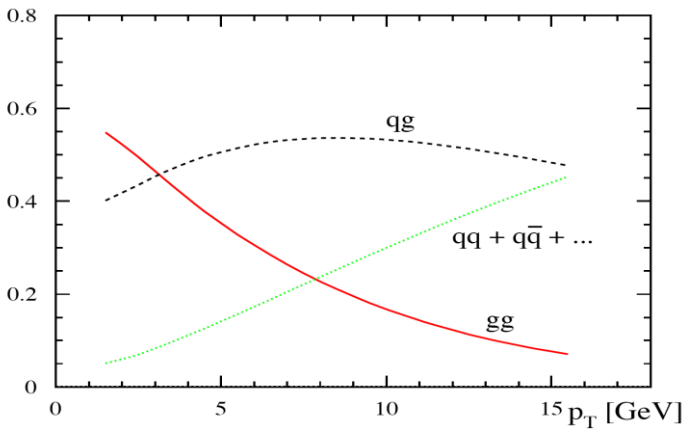
PHENIX Run5+6: PRL103, 012003



STAR Preliminary Run6 (√s=200 GeV)



Good discriminative power between calculations with different assumption for ΔG



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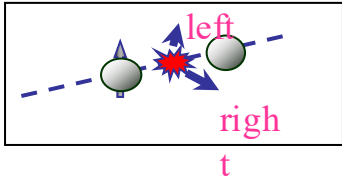
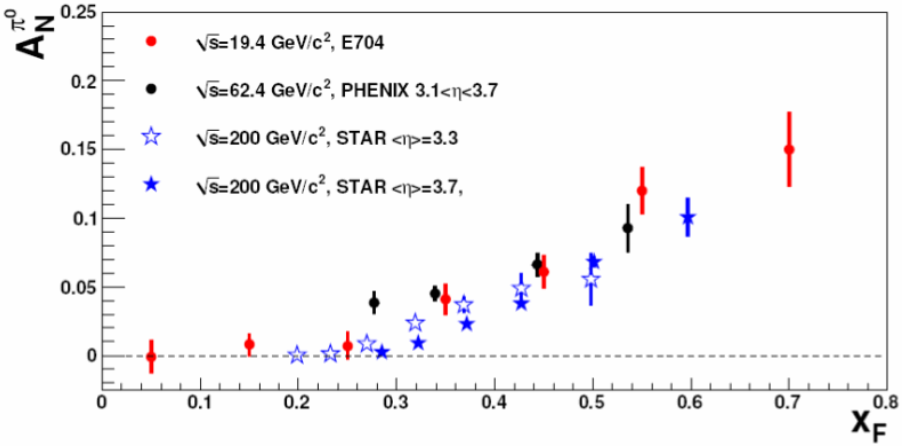
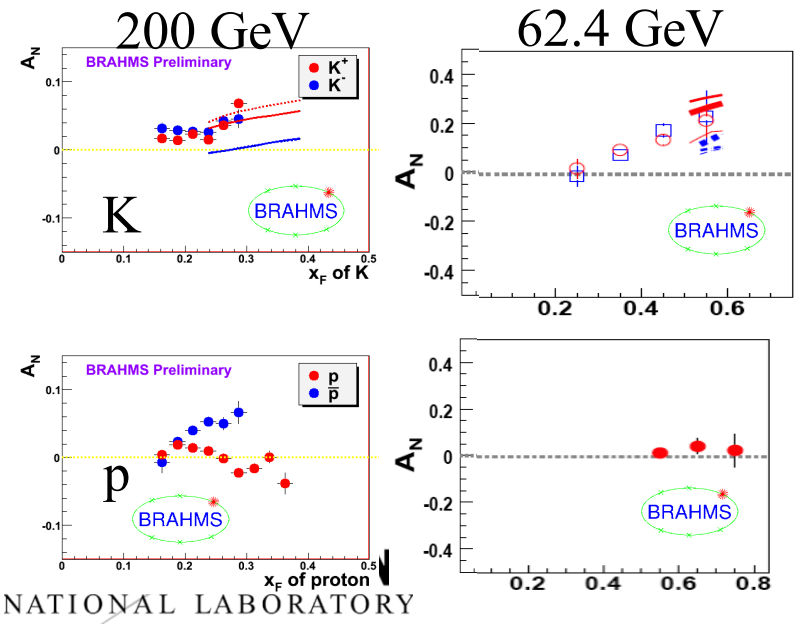
Asymmetry in Forward Production

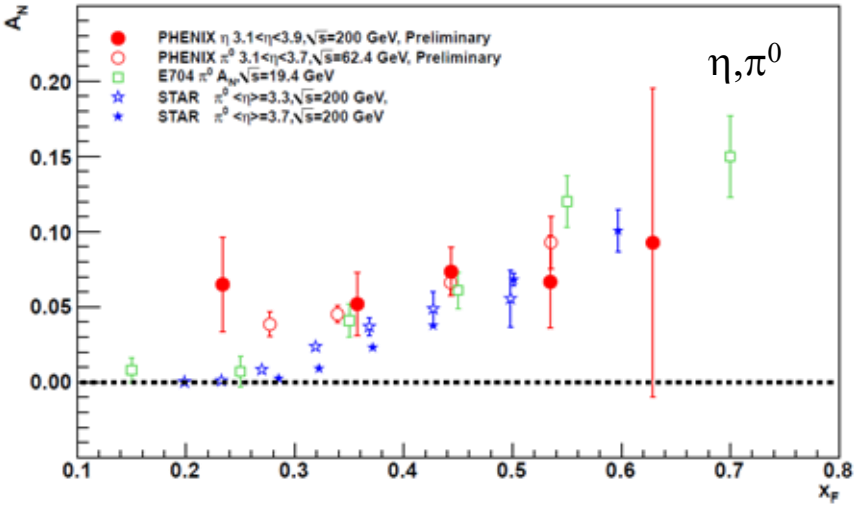


At RHIC, we have measured forward SSA for many hadrons

- π^0, $\pi^{\pm}$, K, p, η







Summary

- It has been quite a trip
  - A significant effort on behalf of several entities: The RSC The RBRC, The AGS, The Magnet Division and RHIC
  - Provided a unique and first Polarized Proton collider
  - Longitudinal polarization to probe the gloun contribution to the proton spin through several venues
  - The antiquark polarization measurement
  - Large transverse polarization observed similar to lower energy results