Meeting Summary

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March 26, 2002

The second part of the sixth RHIC Spin Collaboration (RSC) meeting was held on November 15, 2001 at Brookhaven National Laboratory. Previous meetings have elaborated on the new generation of proton spin-structure studies (*e.g.* gluon polarization and flavor separation of q and $\bar{q}$ polarizations via real $W^{\pm}$ production) enabled by studying polarized proton collisions at energies and momentum transfers where perturbative QCD models are expected to be applicable. The focus of this meeting was on many of the experimental issues that must be resolved to achieve these physics goals. This summary is written with the benefit of hindsight following the completion of the first-ever run of a polarized proton collider. This first run can be considered as a successfully completed milestone of the RHIC Spin Collaboration. Other milestones remain important.

Long term machine items were identified in Waldo Mackay's talk, the most important being the completion of the spin rotator magnets that will be installed in 2002 to allow the flexible orientation of the proton beam polarization at the PHENIX and STAR experiments. At the meeting Waldo discussed a stronger partial snake magnet for the AGS as a means of producing highly polarized proton beams to inject into RHIC. Developments subsequent to this meeting suggest that a superconducting helical dipole magnet may be feasible for the AGS, and is likely to be needed to achieve the 70% beam polarization in RHIC. Longer term items were also presented, including potential increases in luminosity by the addition of electron cooling to RHIC and the possibility of increasing the collision energy by ~20% by replacement of the DX magnets. These items could be considered for a second generation of RHIC spin experiments.

The other topics covered at the meeting were related to polarimetry and to the absolute calibration of the proton beam polarization in RHIC. These topics were divided into short- and long-term solutions to polarimetry issues. George Igo led a discussion about the addition of a Coulomb-Nuclear Interference (CNI) polarimeter to the AGS prior to FY2003 RHIC operations. The experience from the first RHIC spin run reinforces the need for reducing the time needed to complete polarization measurements in the AGS, and illustrated the importance of polarization measurements at different energies in the RHIC injectors. Progress continues to be made on the completion of a CNI polarimeter for the AGS prior to the FY2003 run.

Doug Fields discussed the possibility of improving the calibration of the RHIC CNI polarimeter at the RHIC injection energy by studying the elastic scattering of polarized proton beams extracted from the AGS from an existing polarized proton target. The effective analyzing power of the RHIC CNI polarimeter at high energies can be determined by measuring the beam polarization at the RHIC injection energy before and after an acceleration/deceleration cycle. In the short term, once deceleration ramps are commissioned, and polarization loss through up- and down-ramps is minimized, knowledge of the absolute proton beam polarization at flat top in RHIC will be limited by the uncertainties in the analyzing power for $\vec{p}p$ elastic scattering. Until the completion of a polarized gas jet target to study $\vec{p}p$ elastic scattering from beams accelerated and stored in RHIC, polarization measurements at RHIC injection energies before and after an acceleration/decelertion cycle remain

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the sole means of measuring the beam polarization magnitude. There is a window of opportunity to employ a polarized target made by the group at the University of Virginia for such measurements.

It is generally agreed that the long-term solution to an absolute measurement of the proton beam polarization after acceleration in RHIC requires the measurement of the analyzing power for $\vec{p}\vec{p}$ elastic scattering from a polarized gas jet target. These measurements will calibrate the effective analyzing power of the CNI polarimeters. Tom Wise gave a detailed status report about adapting a polarized atomic beam source and Breit-Rabi polarimeter design, presently in use in the HERMES experiment at DESY, for use at RHIC. Substantial design work on the polarized target has been completed, but detailed engineering is still required. To enable the completion of this target for commissioning in the FY2004 run, it is critical that the design phase of the polarized gas jet gets completed soon, so that construction work can begin. The calibration measurement itself was described in talks by Ed Stephenson and Alessandro Bravar. The experience of the UA6 collaboration in cleanly detecting pp elastic scattering events at small $|t|$ by observing only the low-energy recoil proton suggests that recoil detectors alone, without forward proton tagging detectors, should be sufficient for the polarization calibration measurement. One significant complication is the effect of the target magnetic field on the low energy recoil protons. A moderate magnetic field is required to eliminate depolarization associated with the fields produced by the circulating beams. More complete simulations of the recoil proton detection, accounting for the target magnetic field and a realistic density profile of the gas jet are needed to assess whether the systematic errors can be controlled at the needed level.

These are exciting times for the RHIC spin collaboration. Substantial work remains to be done to obtain precise measurements of the proton beam polarization.

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RHIC SPIN Collaboration Meeting VI-2

RBRC Workshop

November 15, 2001

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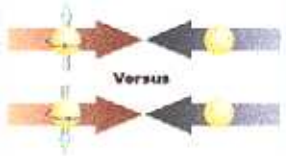
RHIC Spin Collaboration Meeting –VI-1

- Progress in Machine, Experiments, and Theory
- Machine
  - OPPIS 80% Polarization Achieved
  - 200 MeV Polarimeter
  - AGS 66% "Spin Transmittance" with Westinghouse; AtR 96%
    → Total "Spin Transmittance" from OPPIS to RHIC = 63.4%
  - Snakes, Spin Flipper
  - RHIC Polarimeter (currently 60 bunch mode assumed; 120 bunch "doable" but NOT trivial)
- Experiments
  - New Detectors for pp run
    - STAR : BB, FPD
    - PHENIX : NTC, (Local Polarimeter), Trigger Boards
    - Pp2pp : Inelastic Detectors, Roman Pots
- Theory
  - Better understanding of uncertainties in "year-1" signal - HADRONS

Goals of the 1st Spin Physics Run

- Establish Stable Asymmetry Measurements
  - Beam Polarization > 50%
  - Luminosity ~5E30cm^{-2}s^{-1} → 1.7E30cm^{-2}s^{-1}
- 1 week of transverse polarization (~0.75 pb^{-1})
  - A_N ~ Higher Twist Effects



- 4 weeks of longitudinal polarization (~3 pb^{-1})
  - A_{LL} for pion ~ Δg Measurements
  - A_{LL} for J/ψ in muon Arm

- Change over from "T" to "L" subject to achievements

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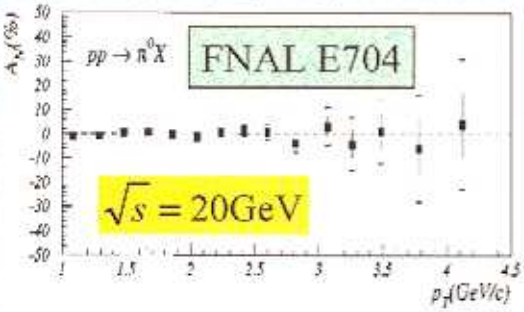
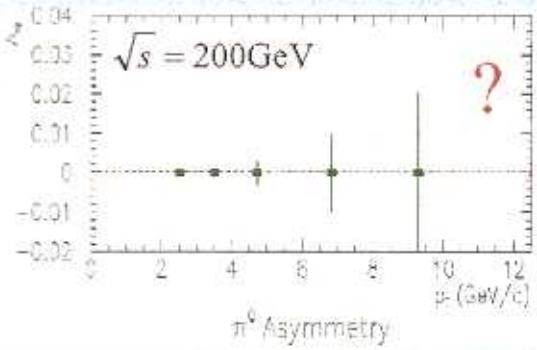
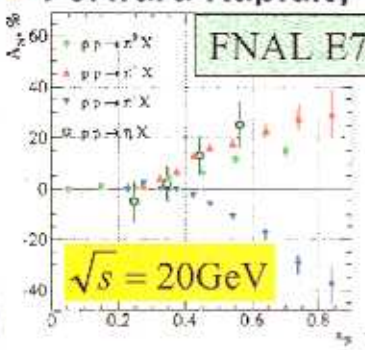
Single Transverse Spin Asymmetry

- Central Rapidity





- Forward Rapidity



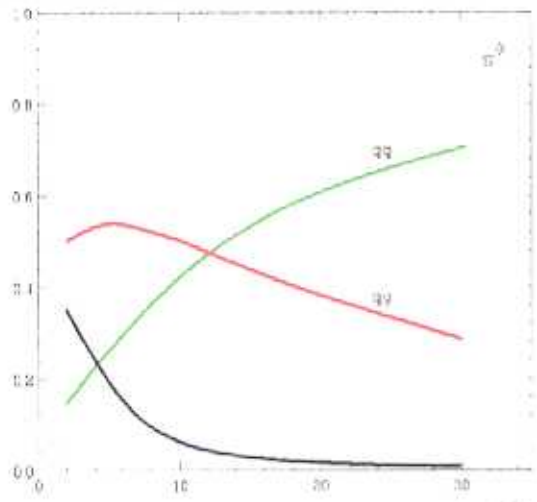
STAR Forward Pion Detector

Local Polarimeter @ 12 o'clock

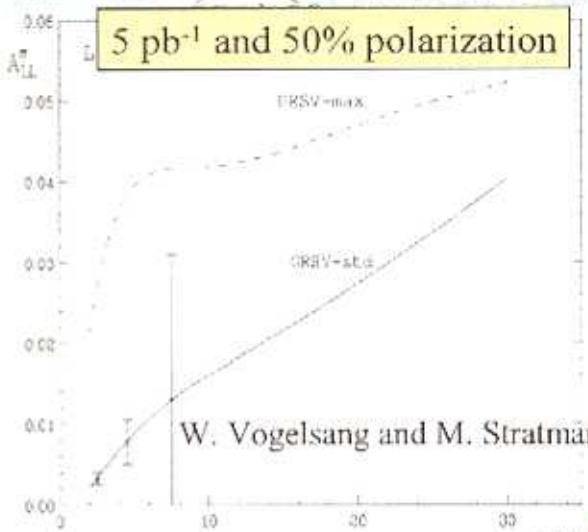
Double Longitudinal Spin Asym

- Hi Statistics Pion Data! Sensitive to $\Delta g(x)$!

$gg \to gg$ $\propto \frac{\Delta G}{G}\frac{\Delta G}{G}$ $\quad gq \to gq$ $\propto \frac{\Delta q}{q}\frac{\Delta G}{G}$ $\quad \propto \frac{\Delta q}{q}\frac{\Delta q}{q}$



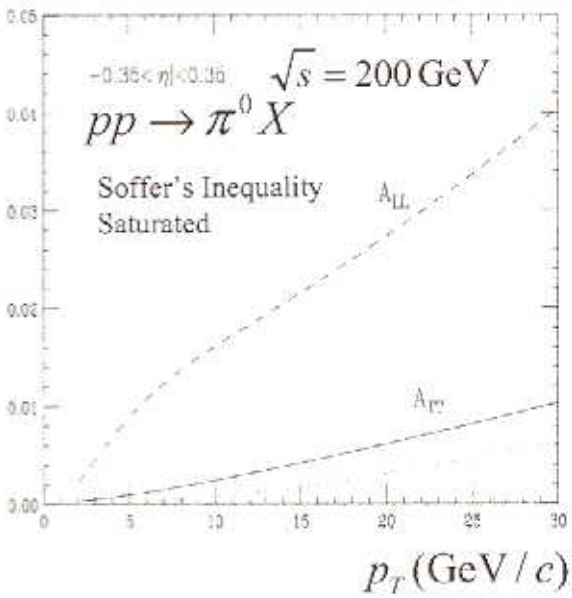
5 pb^{-1} and 50% polarization

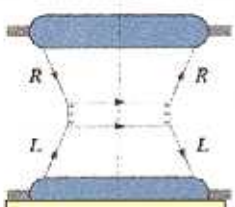


QCD Selection Rule

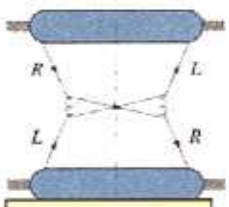
R.L. Jaffe and N. Saito PLB382(96)165; W.Vogelsang (01)

- $A_{TT} << A_{LL}$ due to
  - No gluon "transversity"
  - Even for qq; Chiral Odd Requires exchange process (color suppression)





Chiral Even



Chiral Odd

RHIC Spin Plan (PHENIX and STAR)

Year	CM Energy	Weeks	Int. Lum.	Remarks
FY2001	200 GeV	5	7 pb^{-1}	Gluon pol. with pions
FY2002	200 GeV	8	160 pb^{-1}	Gluon pol. with direct γ, jets/ TT
	500 GeV	2	90 pb^{-1}	PV W production, u-quark pol.
FY2003	200 GeV	8	160 pb^{-1}	Gluon pol. with γ + jet/ TT
	500 GeV	2	120 pb^{-1}	First ubar,dbar pol. meas..
FY2004	500 GeV	8	480 pb^{-1}	Gluon pol. with γ+jet, γjet+jet, heavy flavor, ubar, dbar pol.
	200 GeV	2	48 pb^{-1}	Gluon pol. with γ, γ+jet, heavy flavor/TT
FY2005	500 GeV	5	300 pb^{-1}	More statistics
	200 GeV	5	120 pb^{-1}	
FY2006	200 GeV	10	210 pb^{-1}	

Still on track if we change FY → CY or JFY

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Absolute Beam Polarization

- Ultimate Calibration from Polarized Gas Jet Target → Afternoon Session
  - Plan / Budget / Man Power
- Intermediate Solution → Morning Session
  - Hal & Doug's Summary: ΔP_B=20-25% basing on
    - E925 (9%(stat) + 12%(syst)) → 15%
    - E950 (10%(stat)+5%(syst)) → 11%
    - Acceleration + Deceleration (1.4%)
- Discussion → Late Afternoon

Beat Them!

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Future of RHIC SPIN

- RHIC II
  - Upgrades in Detectors
  - L (x25) and E (x1.3) Upgrades
- EIC
- Polarized TEVATRON? LHC?
- Workshop in Spring/Summer to discuss physics cases

RHIC Detector and CDF II

- RHIC Detectors barely covers hadron collider detector capabilities:
  - e-detection: EW, heavy flavor, beyond
  - γ-detection: QCD, EW, beyond
  - μ-detection: EW, heavy flavor,beyond
  - Jet detection: QCD, beyond
  - b/c-tagging: QCD, beyond, CKM
  - Missing E_T: EW, beyond
- Spin measurements often requires Particle Correlation
  - γ+jet , J/ψ+γ, W+γ, 2-pion or 3-pion
- Large Acceptance with Lepton-ID and Missing-ET Capabilities desirable

	PHENIX	PHENIX-u	STAR	STAR-u	CDFII
electron detection	yes	yes	yes	yes	yes
photon detection	yes	yes	yes	yes	yes
muon detection	yes	yes	no	no	yes
jet detection	no	yes?	yes	yes	yes
b-tagging	no	yes?	no	yes?	yes
c-tagging	no	yes?	no	yes?	?
missing ET detection	no	no	no	no	yes