

Scientific Accomplishments

2006 – 2008:

- a. RHIC beam polarization measured to 5% (from run 5).
- b. FMS built, commissioned, ran 2008, describe.
- c. Precision transverse spin measurements – 2006 run.
- d. Precision $A_{LL}(\pi^0)$, (jet) – 2006 run, gluon polarization constrained.

Prior Years:

1. Organized, provided information, coordinated development of RHIC spin program through meetings with experimenters, machine physicists, theorists. Includes review in Ann. Rev. Nucl. Part. Physics “Prospects of RHIC Spin”, accelerator design report for spin program published in NIM, Research Plan for Spin Physics at RHIC, submitted to DOE in 2005.
2. Developed RHIC polarimetry (pC and pp jet). Includes waveform digitizer readout (supported development by Satish Dhawan at Yale, ITEP development of FPGA coding) from 2001, built AGS pC polarimeter in 2002/3.
3. Proposed and introduced beam-beam counters (BBC) to STAR as minimum bias trigger; discovery of analyzing power and use as local polarimeter for longitudinal polarization.
4. Proposed and introduced Forward Pion Detector (FPD) to STAR; discovered large forward π^0 transverse spin asymmetry, leading to modern era of transverse spin physics (with also results of Hermes and Belle); gluon saturation physics with FPD.
5. Proposed and introduced very forward neutron local polarimeter at PHENIX after group discovered neutron asymmetry in IP12 (with RBRC and others), provides measurement of vertical and radial polarization in collision, degree of longitudinal polarization.
6. Cross sections demonstrating applicability of pQCD for production of π^0 at mid-rapidity (PHENIX), forward (STAR), and production of direct photons at mid-rapidity (PHENIX).
7. Led A_{LL} measurements for π^0 PHENIX.
8. Participated in A_{LL} measurements for jets, STAR.
9. Accepted proposals for muon trigger upgrade (PHENIX, NSF) and Forward Meson Spectrometer (STAR, DOE).

(Numbers and/or letters after milestone refer to accomplishments listed above)

2008 DOE Milestone on gluon polarization: a,d,1,2,3,5,6,7,8,9

This milestone is addressed by development of the RHIC program plan (1); invention and application of new polarimetry for high energy protons (2); a first level collision trigger

and local polarimeter to set up and monitor longitudinal polarization for STAR (3); discovery of analyzing power for very forward neutrons, new local polarimeter to set up and monitor longitudinal polarization for PHENIX (5); cross section measurements that demonstrate applicability of the theory used to extract the gluon polarization from measurements (6); initial published measurements sensitive to the gluon polarization from PHENIX (7); initial measurements being prepared for publication, sensitive to the gluon polarization from STAR (8); extended coverage for photon, π^0 and jet to measure gluon polarization at lower momentum fraction for STAR (9).

2013 DOE Milestone on q, qbar polarization: 1,2,3,5,9

This milestone is addressed by the program, polarimeter, and local polarimeter developments described for the gluon polarization milestone (1,2,3,5). The muon trigger upgrade for PHENIX is required to use full luminosity for W boson production for the q/qbar polarization measurements (9).

Developing World Focus on Transverse Spin: b,c,1,2,3,4,5,6

Although this is not a DOE Milestone, measurements at RHIC have shown large asymmetries for transverse spin. This and other new measurements of large asymmetries have led to a new world focus on transverse spin. The RHIC program development and polarimeters are required (1,2,3,5), and the theoretical understanding of the interactions via quark and gluon subprocesses (6). The FPD was used to measure the large forward asymmetries for π^0 at STAR (4). Also, the BRAHMS experiment has measured large asymmetries for π^+ and π^- with opposite sign. These measurements were supported by our group's purchase of special scaler modules built by UC Berkeley for their use in these measurements.

2012 DOE Milestone to determine gluon densities at low x in cold nuclei: b,3,4,6

This milestone is addressed by (1) installation of forward calorimetry in STAR. Specifically, the Forward Pion Detector (2003), the FPD++ (2006) and plans for a Forward Meson Spectrometer (FMS); (2) results for forward π^0 cross sections in p+p collisions and their comparison to NLO pQCD calculations suggesting the predominance of valence quarks scattering from gluons as the mechanism for forward p0 production; (3) results for forward π^0 production in d+Au collisions suggesting the scaled cross section is strongly suppressed; and (4) results from exploratory studies of azimuthal correlations for pairs of hadrons separated by large rapidity intervals. In p+p collisions, the data support the partonic scattering picture. In d+Au collisions, there is evidence of suppression of the correlation peak, but the data are not conclusive evidence of gluon saturation. More comprehensive measurements will be pursued when the FMS is in place at STAR, providing nearly hermetic calorimetric coverage for $-1 < \eta < 4$. The broad coverage will enable measurement of the x dependence of the gluon density in the gold nucleus via a study of $\pi^0 - \pi^0$ and $\gamma - \pi^0$ rapidity correlations from d+Au collisions.