## Physics with STAR at RHIC

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The primary goal of the STAR spin physics program is to measure the gluon contribution to the spin of the proton as a function of the longitudinal momentum, *x*, of the gluon and to determine the total integral contribution $\Delta G$ to ±0.5. This will be done by measuring the longitudinal double-spin analyzing power, $A_{LL}$, in polarized *pp* collisions for the production of high-$p_T$ direct photons in coincidence with jets, a signal that is characteristic of quark-gluon Compton scattering. In addition, STAR will measure the polarization of the *u* and *d* quarks in the proton at large *x* and of the antiquarks in the proton at small to moderate *x* via simultaneous, complementary measurements of $A_L$ in *W*-boson production and $A_{LL}$ in Drell-Yan scattering. This information is crucial if we eventually hope to understand the fundamental properties of baryons from basic QCD.

The STAR spin physics program began this past year, as RHIC collided polarized protons at 100 GeV/c for the first time. This represented the first ever collisions of polarized beams in a hadron collider. The run lasted a total of 5 weeks during December-January. Unfortunately, the polarization of the two beams was only ~15%, due to the failure of the Siemens motor-generator for the AGS during the 2001 RHIC heavy ion run, which was well below the 40-50% that had been anticipated. Without the Siemens, the AGS needed to ramp the beam energy more slowly than planned, making the depolarizing resonances that occur during ramp much stronger. This low polarization prevented us from taking useful data with longitudinally polarized beams because the sensitivity to double-spin asymmetries scales like $P^4I$, where *P* is the polarization of the beams and *I* is the intensity.

STAR had a very productive spin run, nonetheless, investigating transverse analyzing powers. At present, data are being analyzed to determine the transverse analyzing power of high energy forward $\pi^0$ production at large Feynman-*x* ($0.2<x_F<0.6$) and moderate $p_T$ ($1<p_T<4$ GeV/c). This reaction is predicted to have a significant analyzing power (0.01-0.05) in some models and, thus, may prove useful for local polarimetry at the STAR interaction region. A separate data set is being analyzed to determine the transverse analyzing power of inclusive forward charged particle production. This reaction will provide one of our important luminosity monitors during the gluon polarization measurements. Therefore, it is crucial that we understand its transverse analyzing power, since that could represent a systematic error if it is sizable. However, a sizable transverse analyzing power would also make this a very useful reaction for local polarimetry. Finally, a third data set is being studied to investigate the analyzing power of leading charged particles produced at mid-rapidity in *pp* collisions. Perturbative QCD predicts that this analyzing power should vanish in the limit of large $p_T$. Thus, observation of a significant analyzing power for this reaction at a moderate $p_T$ could be a signature for the limitations of perturbative QCD.

In addition to the spin physics run, we have continued our work on the STAR Endcap

Electromagnetic Calorimeter (EEMC). The EEMC was described in last year's progress report, and the key role that it will play in the STAR gluon polarization measurements was discussed. The EEMC will be read out by 720 traditional photo-multiplier tubes (PMT) and 576 16-pixel multi-anode phototubes (MAPMT), all of which will be mounted on the back of the STAR west pole tip. We are responsible for the design and construction of the steel boxes that will house these PMTs and shield them from the 200-1000 Gauss fringe fields that exist in that region. During the past year, we finalized the design of the PMT and MAPMT magnetic shielding boxes, as well as their placement on the back of the pole tip. We also built a prototype PMT box. It was mounted on the STAR pole tip during November, so that its performance could be studied while the STAR magnet was energized for the *pp* run. Twelve PMTs were monitored with LED pulsers to check for gain shifts, and the temperature was monitored with a thermistor. The prototype PMT box was found to satisfy all of our requirements. Since then, a few minor changes have been made to strengthen the mechanical design at the request of our IUCF and BNL collaborators, and we have begun mass production of the 60 boxes, plus 6 spares, that will ultimately be needed. Construction of a prototype MAPMT box was delayed a few months as IUCF finalized the design of the electronics that it must house in addition to the MAPMTs. This has now been completed, and a prototype MAPMT box is under construction. The current plan is to install 1/3 of the EEMC during the current RHIC shutdown for use during the next RHIC run. The mechanical and optical components that will be needed are on track for this, as are the PMT electronics. These will suffice for us to study the performance of the sampling calorimeter and the trigger system. The electronics for the MAPMTs may be late, but at worst, they should be available for installation during scheduled access periods throughout the run.

Our group has become fully integrated into the STAR collaboration over the past year and, thus, is also playing an active role in the ultra-relativistic heavy ion collision program. During the fall of 2001, RHIC collided Au nuclei at its full design energy of 100 GeV/nucleon for the first time. STAR collected over 4 million events with a hadronic minimum bias trigger, 3.5 million events with a central collision trigger, and a very large number of events with an ultra-peripheral collision trigger over the course of the 14 week long RHIC physics run for Au+Au collisions at 200 GeV/nucleon-nucleon pair. We made a substantial contribution to staffing the "skilled" shift positions during the heavy ion running, especially given the small size of our group. This included one week of shift leader coverage, five weeks of detector operator coverage, and one week of run-time system coverage. Group members are now serving on a number of heavy ion "god-parent committees." These are charged to provide advice to the principal authors, while overseeing the final stages of the physics analysis and the writing of a specific STAR paper. One of us (CAG) has just been named chair of the STAR committee on Publication and Talks Policy. Finally, our role in the heavy ion program is likely to grow during the upcoming year. RHIC is expected to investigate *d*+Au collisions for the first time during the next run. This is an area where we bring some expertise to STAR from our previous work on Fermilab

E866. Members of the STAR high-$p_T$ physics working group have already consulted us on a number of issues during the early planning stage.