SUMMARY

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for
RHIC Spin Collaboration Meeting X
RIKEN BNL Research Center

Since its inception, the RHIC Spin Collaboration (RSC) has held semi-regular meetings each year to discuss the physics possibilities and the operational details of the program. Having collected our first data sample of polarized proton-proton collisions in Run02 of RHIC, we are now in the process of examining the performance of both the accelerator and the experiments. From this evaluation, we not only aim to formulate a consensus plan for polarized proton-proton during Run03 of RHIC but also to look more forward into the future to ensure the success of the spin program.

In the fourth meeting of this series (which took place at BNL on June 17, 2002), we focused on the latter. Specifically, we heard reports on the status of the following efforts:

- a polarized hydrogen jet target experiment in RHIC,
- a CNI polarimeter for the AGS, and
- a spin flipper for RHIC.

In addition, because of its central role to all spin analysis for Run-02, there was an update presentation on the status of the RHIC CNI polarimeter analysis.

The polarized jet target effort aims to measure the absolute beam polarization via elastic proton-proton scattering from a polarized proton target so that the more rapid measurements from RHIC CNI polarimeters can be absolutely calibrated at flattop energies. For this purpose, a jet target will be installed at the 12:00 interaction point. This target will be fed with polarized hydrogen by an atomic beam source (ABS) which is presently being designed. The particles from beam scattering will be detected in an array of silicon detectors. To open this meeting, Tom Wise discussed the current status of the design of the target and the interfacing of it to the RHIC ring. The most troublesome aspect of this effort had been the magnet design because the magnet needs to provide an uniform holding field in order to avoid depolarizing the target by resonances with the bunched beam, yet also must not significantly deflect the recoil protons since the scattering angle of these protons is determined from position measurements made outside of the field region. A nice design by Wuzheng Meng with two concentric Helmholtz coils sandwiching an iron core was presented and is considered to be nearly final. By powering the coils with oppositely directed current, the field in the region through which target atoms transverse is uniform, yet the momentum kick given to scattered particles is largely canceled because the $\int B \cdot dr$ is nearly zero. Sandro Bravar then presented a status report on the design of the experiment for detecting the recoil protons. The setup would consist of silicon strip detectors using the same readout electronics as the CNI polarimeters and, as mentioned, positioned outside of the target magnet. These detectors would measure the scattering angle and energy of the recoil proton to isolate the signal from background particles. The left-right asymmetry of the signal particles would then be measured to determine the beam polarization. And, finally, Yousef Makdisi presented a timeline for the project. The goal is to have this setup in place by October, 2003 so that the experiment can be commissioned during RHIC Run-04.

Prior to the presentation on the AGS polarimeter, Haixin Huang presented an update on the offline analysis of the AGS polarization data from Run-02. First, the AGS polarimeter had been upgraded with additional forward arms so that inclusive proton-proton scattering could be measured at 3 different energies. During the run, however, time constraints allowed for a measurement at only one energy (corresponding to $G\gamma$ of 7.5, the first "large" resonance above

the AGS injection energy of ~ 3 GeV). The polarization determined from this measurement was in agreement with the polarization measured by the 200 MeV polarimeter in the LINAC. The mystery of the low asymmetry measured at this energy in September 2000 remains. Second, following up on the presentation by Mei Bai in the April meeting, further studies have been done to try to understand the loss of polarization at the $24\text{-}\nu_y$ weak resonance. Looking at past runs, Haixin showed that, during the last time when the slow ramp rate was used (April, 1994), they also observed a polarization loss at this resonance. However, like now, they did not understand this loss. Presently, he speculated that this loss may be a result of the slow ramp rate and thus would resolve itself for Run-03. And, finally, he pointed out that the emittance growth (which tends to increase polarization loss at resonances) was definitely observed in the AGS during Run-02 even when the the AC dipole was not operating. If this effect is also a result of the slow ramp rate, we can expect it to be improved for Run-03. Certainly, it will be something which will be studied as part of the AGS commissioning effort for polarized proton running.

To provide faster feedback about polarization during tuning of the AGS, a CNI polarimeter will be installed in the AGS and made operational for Run-03. Jeff Woods presented the status of this effort. The design of this polarimeter is the same as the 90° components of the RHIC polarimeter, except that the detectors are positioned further from the beam since the beam bunches are longer in the AGS than in RHIC. To a large extent, this effort is piggy-backing on the development effort for the RHIC CNI polarimeters. However, one new concern for this effort is the pickup of electronic noise from the AGS. Effort is underway to understand this noise and to design a shield or grounding arrangement which eliminates it. In addition, the carbon target for it will be longer and wider but of the same thickness as the one used for RHIC and is being manufactured by Indiana. The expected installation time for the polarimeter is September, 2002.

To open the afternoon session, Dave Underwood presented some further analysis of the polarization trends seen during a fill using the online polarization results from the RHIC polarimeter. This work indicates that, at first glance, the blue beam was losing polarization during the course of the fill and maybe (though, definitely, not clearly) the yellow was also losing polarization.

Presently, in RHIC, the polarization orientation of each bunch is determined at the source. So, under unfavorable circumstances, differences between bunches could be correlated with polarization and thus, as in the case of the relative luminosity, give rise to false asymmetries. This problem can be minimized by flipping the spin of the bunches in RHIC. For this reason, a spin flipper was designed, built, and installed in RHIC for Run-02. During this run, this device was commissioned. Mei Bai presented the results on the analysis of this commissioning effort. In the blue ring, she was able to flip the spin twice without losing all of the polarization. The efficiency of the flipper was $\sim 67\%$. In yellow beam, however, the polarization was completely lost on the first flip. She suspects that this total loss (as well as perhaps the inefficiency seen in the blue) was due to the snakes not being tuned perfectly. More studies will be done on this device as part of the commissioning effort for Run-03.

Stephen Bueltmann presented a status report on the analysis of the data collected by pp2pp experiment during their dedicated fill. After introducing the (spin-) physics programme of the experiment, he outlined the principle of the measurement. Because of the small elastic

scattering angle, the scattered protons are in the vicinity of the beam and are subject to the beam transport magnets. It was emphasized was that the addition of Roman Pot detectors at 3 m downstream of the existing setup would eliminate the dependence on the scattering vertex perpendicular to the beam momentum by measuring the angle of the scattered protons in the detection area. The performance of the silicon detectors was discussed by showing a spectrum of the energy deposited by protons. A method of calculating the silicon detector efficiency was explained and the result as a function of strip number shown for two detectors. For 14 out of 16 detectors, the average efficiency is above 0.95, resulting in a position detection efficiency of above 0.99 when combining the detectors. The running conditions for the low intensity fill, resulting in 14 hours of data, were reviewed. A total of about 300k elastic events were recorded. The positions of the scattered protons were shown and the shift of the position due to the roll of a quadrupole magnet pointed out. The correlation between coordinates measured for the two scattered protons showed a very clear band of elastically scattered protons and very low background. Finally, accuracy estimates for the measurement of the analyzing power under different conditions, like beam polarization, detector position with respect to the beam, *etc.*, were given.

And, to close the meeting, Werner Vogelsang gave an introduction to QCD resummation. Very inelastic hadronic reactions are probes of nucleon structure since they may be described in terms of a partonic hard scattering in which a constituent of the nucleon participates. Such hard-scattering cross sections are amenable to QCD perturbation theory. Often, low orders in perturbation theory suffice to obtain a good description of the process. However, the situation is different if the partonic cross section is probed near an exclusive limit of phase space, where it develops large logarithmic terms associated with soft-gluon emission. An example is the Drell-Yan cross section at low measured transverse momentum of the Drell-Yan boson. It is possible in many cases to take into account ("resum") the large logarithmic corrections to all orders of perturbation theory. Recent progress presented by Vogelsang includes the development of a more general resummation formalism, and the application of resummation to single-inclusive cross sections and to spin asymmetries.

Vogelsang also presented new studies for transverse double-spin asymmetries for direct-photon and jet production at RHIC, showing that these processes will be very promising tools for a direct measurement of transversity at RHIC.

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