Final Countdown to RHIC Spin Program

Hideto En'yo, Igor Alekseev*1, Terry Awes*2, Mei Bai*3, Bernd Bassalleck*4, Stefan Bathe*5, Alexander Bazilevsky, Melynda L. Brooks*6, Damian Bucher*5, Henner Buesching*5, Gerry Bunce, Vince Cianciolo*2, Abhay Deshpande*7, Jack Doskow*8, Scott Eilerts*4, Douglas E. Fields*4, Yuji Goto, Hideki Hamagaki, Naoki Hayashi, Haixin Huang*3, Vernon Hughes*7, Takashi Ichihara, Ken'ichi Imai, Mikhail Ippolitov*9, Masayasu Ishihara, Vadim Kanavets*1, David M. Lee*6, Edouard Kistenev*3, Leonid Kotchenda*10, Kazuyoshi Kurita, Kris Kwiatkowski*8, Benji Lewis*4, Zihong Li, Bill Lozowski*8, Yousef Makdisi*3, Yajun Mao, Hans-Otto Meyer*8, Vanessa Mexner*5, Jiro Murata, Masanobu Nakamura*3, Stephen Pate*11, Thomas Peitzman*5, Ullrich von Poblotzki*5, Kyle Pope*12, Barbara Przewoski*8, Ken Read*8,*2, Tom Rinkel*8, Thomas Roser*3, Adam Rusek*3, Nahito Saito, Tai Sakuma*13, Hiroki Sato, Shinya Sawada, Toshi-Aki Shibata, Brauner Smith*4, Walter Sondheim*6, Soren Sorenson*12, Makoto Sugioka, Dmitry Svirida*1, Mike Syphers*3, Atsushi Taketani, Etsuji Taniguchi, Timothy L. Thomas*4, Wei Tian*2,*14, Junji Tojo, Hisayuki Torii, David Underwood*15, Christos Velissaris*11, Yasushi Watanabe, Sebastian White*3, David Wolfe*4, Kazuhiro Yamamoto*16, Satoshi Yokkaichi, and Lihua Zhu

[*pp* interaction, Struture function, Spin, Asymmetry, Polarized beam]

The relativistic heavy-ion collider (RHIC) will undergo its first collision in the year 2000. The RIKEN collaboration of this international project has resulted in strong enhancements to the collider, one of which is the upgrade of the collider for the acceleration of polarized protons and another is the upgrade of the PHENIX detector for the study of spin physics. The RHIC has become the machine with which to explore "The creation of quark gluon plasma" which has been a dream of physicists for over 20 years, as well as to solve "The spin puzzle of the nucleon" which relates to the fundamentals of quantum chromodynamics (QCD).

The superspectrometer, PHENIX, which we are working on, will play an important role in exploring such physics at RHIC. The collaboration includes 41 institutes and about 400 physicists and engineers. The spectrometer consists of two arms for electron and photon detection and another two for muon detection (see the figure below). The second muon arm was added to increase the spin physics capability of PHENIX. These probes (leptons and photons) are essential for the investigation of the state of nuclear matter in heavy-ion collisions, and also for the detection of possible spin carriers (gluons and antiquarks) to reconstruct the missing spin in a nucleon from individual constituents of a nucleon. The polarized proton collider will enable us, for the first time, to directly measure those spin carriers which remain unidentified in former experiments using polarized lepton scattering.

In 1999 we passed a very important milestone with the onset of RHIC operation with the successful storage of beam particles in the rings. The development of the RHIC polarimeter is one of our major contributions this year to the spin acceleration project at RHIC. Our recent work has established a novel technique using proton-carbon nuclear interference for the beam polarization measurements[1)]. The RHIC polarimeter design is now in progress based on this method.

The successful completion of the muon identifier construction, which was carried out in Japan and the USA[2,3)], is now followed by efforts to make the detector operational in the collision hall[4)]. Since May 1999 we have been contributing to the muon tracking-chamber construction[5)], another of the key detectors in the muon arms to be installed in the summer of 2000. The quality assurance of the produced chambers is the one of our major responsibilities.

For the detections of electromagnetic probes it is essential to understand the calorimeter response for high-energy particles. A test experiment was carried out at CERN in 1998[6)] and the analysis is essentially finalized[7)]. The outcome is very promising for the direct γ and the $W \rightarrow e + \nu$ measurements which are the key channels of the spin program. The measured energy resolution of the calorimeter was $d\sigma/E = 1.9\% + 8.2\%/\sqrt{E}$ with a linearity better than 2% up to the energy of 80GeV.

The new project of constructing a computing complex containing 300 Linux-based PCs at Wako was begun in 1999[8)], and is the key project in the analyses

*1 Institute of Theoretical and Experimental Physics, Russia
*2 Oak Ridge National Laboratory, US
*3 Brookhaven National Laboratory, US
*4 Department of Physics and Astronomy, University of New Mexico, US
*5 University of Muenster, Germany
*6 Los Alamos National Laboratory, US
*7 Department of Physics, Yale University, US
*8 Indiana University Cyclotron Facility, US
*9 Kurchatov Institute, Russia
*10 Interphysica, Russia
*11 New Mexico State University, US
*12 University of Tennessee, US
*13 Tokyo Institute of Technology, Japan
*14 CIAE, China
*15 Argonne National Laboratory, US
*16 Department of Physics, Kyoto University, Japan

of the data. The goal of the project is to reach 10k SPECint95 by the end of 2001. Even in the preliminary stages of development in 1999, the simulation works have progressed significantly owing to this new computing project. A possible new probe, the coincidence signal of electron and muon, to detect gluon polarization was recently studied with the simulation, and proved to be sensitive to the gluon-gluon scattering which produces a heavy quark pair with an excellent signal-to-background ratio[9]. Progress is has also been made in the muon identification and muon tracking software[10] through the full simulation of the detector response in the muon arms.

The final countdown to the first collision has begun. Although a lot of work remains to be accomplished by then, we enjoy marching towards the promised land of spin physics.

Reference

1) J. Tojo et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
2) K. Kurita et al.: RIKEN Accel. Prog. Rep. 32 (1999) 48.
3) A. Taketani et al.: RIKEN Accel. Prog. Rep. 32 (1999) 50.
4) A. Taketani et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
5) J. Murata et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
6) Y. Goto et al.: RIKEN Accel. Prog. Rep. 32 (1999) 47.
7) H. Torii et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
8) T. Ichihara et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
9) H. D. Sato et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.
10) Y. Mao et al.: RIKEN Accel. Prog. Rep. 33 (2000) ??.

Fig. 1. The PHENIX detector. Two magnets with a flowerpot shape on the left- and right-hand sides are the muon magnets (the left one is fabricated in Kobe, Japan). Adjacent to these, one can see the panels of the muon identifiers. The central magnet and the frames of the central arms are seen at the center, pending the installation of the detectors for electrons and photons. [Photograph by R. Stoutenburgh (BNL)]