

## From the ALD's Desk RHIC News Bulletin Update

January 2018

As I am writing this Bulletin, the scientific and technical staff in the Collider-Accelerator Department is in the final stages of preparing for this year's run of RHIC, presently planned with 15 cryo-weeks. We still don't have a final budget for the year 2018, but are optimistic that we will be able to execute the run as currently planned (see below). As has become the rule, RHIC plans to operate in a new mode – change of species day-by-day – but the most important goal, as always, is to operate the machine and the detectors safely. Please, do your part in keeping this year's run accident free!



A handwritten signature in cursive script, appearing to read "André Michalek".

**RHIC Run-18:** The 15 cryo-week RHIC Run 18 will have three components: The highest priority of the run will be the comparison of the two isobar systems ( $^{96}\text{Zr}$  and  $^{96}\text{Ru}$ , with 40 and 44 protons, respectively), collecting 1.2 million minimum bias events for each system. The goal of this part of the run is to tease out the effect of electromagnetic fields generated by the colliding ions, in particular that of the magnetic field, on the dynamics of the quark-gluon plasma created in the collision. The data promise to present a decisive test on the presence of dynamical phenomena caused by the chiral anomaly of QCD in matter where the approximate chiral symmetry of up and down quarks is restored. The different charge of the two systems is predicted to result in an approximately 15 percent difference in the observables associated with this “chiral magnetic effect”, if they are entirely due to this new effect. The data will have an uncertainty of only 6 percent of the predicted difference.

This will be the first time that RHIC scientists aim at a comparative measurement with this kind of precision. An unambiguous observation would not only, for the first time, prove the existence of anomalous electric currents in QCD matter, but also provide direct evidence for the restoration of the chiral symmetry of light quarks in the quark-gluon plasma. Not only the scientific stakes are high: The run will use enriched  $^{96}\text{Ru}$  that has been produced specifically for this experiment at great expense. The new stable isotope production facility at ORNL represents the only global source for this material. ORNL staff have literally worked day and night and weekends in making this heroic effort a success and deserve special thanks. The enriched material is scheduled to arrive at BNL later this month.

For these reasons, the RHIC operators and scientists are planning to take unprecedented steps: RHIC will switch between the two systems on a daily basis, and the data will be analyzed in a blinded manner. No collider has ever been operated in such a mode. In order to ensure that the isobar comparison run is conducted optimally and safely, a task force was asked to evaluate the possible risks last year. C-AD now feels confident to implement this challenging new mode of machine operation without risk to the success of the run.

The second component of the run will be a short (3 week) Au+Au run at 27 GeV. The primary goal of this part of the run will be to collect high statistics data for a measurement of the global Lambda hyperon polarization, to confirm the recently published results and to attempt a measurement of the difference between the polarization of hyperons and anti-hyperons. While the average polarization of hyperons and anti-hyperons is attributed to the local vorticity of the plasma at the moment of hadronization, the difference could be caused by the presence of a late-time magnetic field, which acts oppositely on particles and antiparticles because of the different sign of their magnetic moments. This actually ties back to the isobar comparison run, because a clear manifestation of the chiral magnetic effect requires the presence of long-lived magnetic fields in the quark-gluon plasma.

Finally, the third important objective of Run 18 is the coherent electron cooling Proof-of-Principle experiment that was commissioned in Run 17. A new optical system that will allow the team to monitor the infrared light from the free-electron laser has been installed. The Proof-of-Principle demonstration needs to be completed during this year's run because the FEL wiggler is incompatible with the ion beam profile at the low energies required in the Beam Energy Scan II.

RHIC Publications: The STAR *Nature* article reporting a first observation of global Lambda polarization captured the public's imagination culminating in *Discover* magazine naming it one of the top 100 discoveries of 2017. Other recent publication highlights from STAR include an article on coherent diffractive photo-production, indicating that the nucleus is beginning to act like a black disk, a new approach to measuring jet quenching, and a detailed report on the bulk properties of the medium as a function of collision energy, as well as the first di-jet momentum asymmetry measurements in Au+Au and p+p collisions at RHIC, which was published as the editors' suggestion in *Physical Review Letters*. This analysis showed that the momentum balance in Au+Au is restored to that observed in p+p for a jet resolution parameter of  $R = 0.4$  when soft particles are included.

The PHENIX collaboration published a paper on the nuclear dependence of the single spin asymmetry of forward neutrons in p+A collisions in *Physical Review Letters*. This surprising result from Run 15 was featured in BNL and RIKEN news releases, which were picked up by *Newsweek*, *Science Daily*, *Gizmodo* and *Physics World*. PHENIX also published a paper from the Run 16 d+Au beam energy scan and has another paper on d+Au accepted in *Physical Review Letters*. The data presented in these articles suggest that even these small collision systems may produce tiny droplets of short-lived quark gluon plasma. A news story on these results will soon appear in DOE SC highlights. A PHENIX paper on  $B \rightarrow J/\Psi$  in Au+Au collisions at RHIC reports the first B-production measurement down to  $p_T \approx 0$ .

PHENIX: A PHENIX collaboration meeting, held on December 1–3, 2017, focused on data analysis, including about 20 talks on analysis by students and postdocs.

STAR: The STAR collaboration mourns the passing, at the age of 80, of Prof. Hongfang Chen (USTC) who was a long-time leader of the STAR Time-of-Flight (TOF) project and played a crucial role in opening up nuclear experiments, like STAR, to Chinese institutes. Prof. Chen inspired many Chinese students to pursue a career in physics. She will be deeply missed.

STAR scientists successfully used the CORI supercomputer at NERSC to reconstruct data — the first time this has been done by a nuclear physics experiment. This achievement will drastically reduce the time it takes to make data available for analysis. The collaboration is now preparing for the 2018 isobar run. The BES-II upgrades are proceeding well. The EPD is on schedule for full installation prior to Run 18. The iTPC upgrade had a successful DOE review in September and the first sector has been installed. Commissioning of the eTOF provided by CBM continues according to plan. A second CBM-STAR joint collaboration meeting took place in September in Wuhan.

Awards: Wolfram Fischer was honored with the 2017 BNL Science & Technology Award. Elke Aschenauer received a Humboldt Research award. UC Riverside graduate student David Kapukchyan won the best oral presentation prize at the BNL Early Career Researcher Symposium. Yu-Gang Ma was elected to the Chinese Academy of Sciences. Rachid Nouicer, Ernst Sichtermann, and Peter Steinberg were named APS Fellows.

sPHENIX: A main focus of the sPHENIX project is preparation for the DOE Office of Project Assessment CD-1 review scheduled for May 8-10, 2018. There has been excellent progress on a wide range of key R&D fronts, including the TPC, the EMCal, the calorimeters, the silicon tracking and vertex detectors, and the electronics. The latest generation of detector refinements is being prepared for beam tests at FNAL starting in February. A full size prototype of the outer hadronic calorimeter sector was delivered to BNL at the end of August. The sPHENIX superconducting solenoid is preparing for an important test of the former BaBar magnet at its full operating current of 4600 A at 4 K.

An sPHENIX collaboration meeting was held in Santa Fe, NM, December 8-10, 2017, with three invigorating days of discussions of sPHENIX science and technology. After a positive institutional board vote, the several prominent Chinese institutions were admitted to the collaboration: Fudan University, Institute of Modern Physics (IMP), Peking University, Shanghai Institute of Applied Physics (SINAP); Sun Yat Sen (Zhongshan) University, Tsinghua University, and the University of Science and Technology of China (USTC). These additions increase the number of collaborating institutions to 70 and substantially add to the scientific and technological strength of the sPHENIX effort.

RHIC Users Meeting: The 2018 RHIC/AGS Annual Users Meeting will be held June 12-15 at BNL.

RHIC/AGS PAC: The 2018 RHIC & AGS Program Advisory Committee [current members: M. Gazdzicki (CERN), J. Harris (Yale, chair), H. Huang (UCLA), V. Koch (LBNL), J.C. Peng (UIUC), S. Pratt (MSU), K. Rajagopal (MIT), A. Schäfer (Regensburg), M. Stephanov (UIC), and J. Velkovska (Vanderbilt)] will meet June 6-8, 2018 to consider the Beam Use Proposal for the Beam Energy Scan II RHIC runs in 2019 and 2020.

EIC News: A EIC Accelerator Collaboration Meeting was held on October 10-12, 2017 at BNL. The meeting was attended by approximately 100 scientists. DOE-NP has issued a Funding Opportunities Announcement for R&D on Next Generation Nuclear Physics Accelerator Facilities; proposals are due by January 19, 2018. The semi-annual review of the EIC Generic Detector R&D Program will be held at BNL on January 18-19, 2018.

The joint Stony Brook – BNL Center for Frontiers in Nuclear Science (CFNS) was launched on September 1, 2017. The new center, directed by Abhay Deshpande, will have an initial focus on the science of an electron-ion collider. The center organizes a weekly seminar alternating between SBU and BNL and plans to hold a number of EIC related workshops in 2018.