

From the ALD's Desk RHIC News Bulletin Update

March 2019

As we are in the early stages of RHIC Run 19, we can look back at a very rewarding year 2018. The 28 cryo-week RHIC Run 18 was one for the record books, with an amazingly successful isobar comparison run that included several “firsts” for any collider. sPHENIX passed the CD-1/3a review in May and is now well on the way to realization. We are moving ahead with the proposed STAR forward upgrades. The low-energy RHIC electron cooling upgrade has begun commissioning, and the STAR acceptance upgrade with new inner TPC sectors, event plane detectors, and end-cap time-of-flight detectors is completed and functioning well.

The STAR team's efforts were recognized with the 2018 *Secretary of Energy Achievement Award*. Energy Secretary Rick Perry paid a visit to BNL in November 2018 and left deeply impressed with the science of RHIC and the applications enabled by the facility. Physics data taking in the first year of the high-statistics RHIC beam energy scan started in late February, supported by optimal RHIC operations funding appropriated in the first budget passed by Congress before the start of the fiscal year for decades. These are good reasons to rejoice and to look forward with anticipation to another year of world leading, spectacular science.



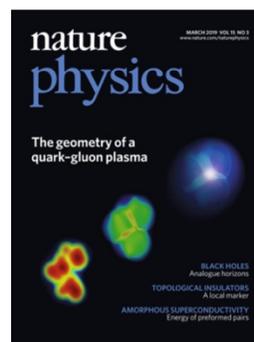
A handwritten signature in cursive script, likely of Rick Perry.

RHIC: After preparations that were unusually intense even for RHIC, including major accelerator and detector upgrades that had to be completed, physics data taking during RHIC Run 19 started at 4:00 a.m. on February 26, two weeks earlier than anticipated. Following the 2018 PAC recommendations, the plans for Run 19 are as follows:

- Commissioning of LReC for Au+Au collisions with $\sqrt{s_{NN}} = 7.7$ GeV and 9.1 GeV.
- Collider runs of Au+Au at $\sqrt{s_{NN}} = 19.6$ and 14.5 GeV.
- Fixed-target Au+Au collisions with $\sqrt{s_{NN}} = 3.9, 4.5, 7.7$ GeV.

Less than two weeks into the run, data taking is proceeding extremely well, with 70 million “good” events (events within 70 cm from the center of the detector) already on tape, well on the way to the desired total of 400 million good events.

PHENIX: PHENIX has a new paper published in the journal *Nature Physics* that presents compelling evidence that collisions of small nuclei with gold nuclei create small droplets of quark-gluon plasma. The paper, which was featured on the cover of the March 2019 edition of the journal includes a comprehensive analysis of the elliptic flow and the triangular flow in p+Au, d+Au, and $^3\text{He}+\text{Au}$ collisions. When these collisions create tiny hot spots of quark-gluon plasma, the pattern of collective motion of produced particles, i.e. flow, should retain some “memory” of each projectile's initial geometrical shape. PHENIX data show very strong correlations between initial geometrical shape and



the final flow patterns. The unique combination of three distinct geometries and two flow patterns provides unprecedented model discrimination. Hydrodynamical models that include the formation of a short-lived QGP droplet, provide a good description of the measurement.

This work is the culmination of a series of experiments designed to engineer the shape of the quark-gluon plasma. RHIC is the only accelerator in the world capable of making tightly controlled experiments involving colliding nuclei made of one, two, and three nucleons with the same large nucleus, gold, at the same energy.

Small Systems Workshop: There has been a long-standing debate about the question whether the data on anisotropic particle emission in small systems are unambiguous evidence of collective flow from a collectively expanding QGP medium, or whether they can also be explained by models describing the data as effects caused by the initial-state parton structure of the colliding nuclei. Motivated by the recently published results from PHENIX and new theoretical calculations of emission anisotropies generated by initial-state effects in p-Au, d-Au and ^3He -Au collisions, a *Workshop on Collectivity in Small Systems in High-Energy Collisions* will be held at Rice University in Houston, TX, on March 14-16, 2019, which will explore the conundrum in depth.

STAR: Preparations for the Beam Energy Scan II went smoothly, with all iTPC and eTOF sectors installed and tested prior to physics running being declared for 2019 in mid-February. The upgrade proposal enabling a post-BES-II forward physics program had a successful cost, schedule, and risk review on November 19, 2018. The review confirmed that the upgrade can be completed in time for a 500 GeV p+p RHIC run in late 2021 and STAR is now working to construct these forward upgrades on schedule. The scientific focus of the forward physics program will be to explore the dynamics of polarized partons at both high parton momentum fraction x (the valence quark region) and very low x , where gluons and the quark sea abound.

In 2018 STAR published a record number of papers: 3 PRL, 5 PLB, 4 PRC, 5 PRD and 3 NIM. These included a manuscript describing di-electron measurements from the BES-I which reported normalized low-mass excesses with no significant collision energy dependence, and an analysis of proton-Omega correlations suggesting a bound system with a binding energy of approximately 27 MeV. The first ever measurement of the transverse spin transfer to Lambda hyperons at collider energies demonstrated that it is consistent with zero, while a much-improved result on the longitudinal spin transfer to these hyperons revealed a tendency to be below expectations based on the extreme assumption that the quark polarized fragmentation functions are flavor-independent. Five others papers have been submitted for publication including a new measurement of the single-spin asymmetry for W bosons in polarized 510 GeV p-p collisions. These data clearly establish a difference between the u-bar and d-bar quark helicity distributions for $0.05 < x < 0.25$ which has the opposite sign compared with the unpolarized asymmetry.

The STAR collaboration mourns the losses of past STAR collaborators Father McShane of Creighton University and Prof. Andre Mischke of Utrecht University. I join the members of STAR in extending my thoughts and best wishes to their families and many friends.

sPHENIX: Clearing a major milestone, the sPHENIX project was granted CD-1/3A approval by DOE in August 2018. Preparing for this review was a big effort that involved the work of many people throughout the sPHENIX project and across the Laboratory. With CD-3A approval a number of long lead-time procurements for the detector are getting underway, including purchases of silicon photomultipliers, scintillating fiber and tiles, and tungsten powder. In late 2018, the sPHENIX Collaboration requested status as “CERN Recognized Experiment.” The request was well received, and the status was granted in early March 2019. The new status will help to access CERN resources for the production of detector components, such as GEM foils and silicon staves.

At the same time, the first sectors of the steel flux return for the superconducting solenoid have begun to arrive at a rate of nearly one sector a week. Each of the 32 sectors is 6.4 m long and weighs 14 tons. They are being stored on the floor of Bldg. 912, with the final sector scheduled to arrive in September 2019. Later, the sectors will be rigged into place to form a cylinder around the solenoid, and the slots in the sectors will be populated with scintillating tiles, transforming them into a midrapidity hadronic calorimeter.

Work on the MVTX, a precision micro-vertexing detector that will enhance the sPHENIX tracking system, is proceeding rapidly. The MVTX is closely based on the silicon MAPS sensors and supporting carbon fiber staves developed for the inner tracking system upgrade of the ALICE experiment. The MVTX, working in concert with the sPHENIX silicon strip tracker INTT and the compact TPC, enables a rich heavy flavor program for sPHENIX, from open heavy flavor at lower momenta to b-tagged jets at higher momenta.

RHIC/AGS Users Meeting: The annual RHIC/AGS Users Meeting will be held June 4-7, 2019 at BNL. It will be followed by the Program Advisory Committee Meeting on June 10-11.

EIC News: The eagerly awaited report of the National Academies assessment was released on July 24, 2018, immediately before the EIC Users Group Meeting that took place July 30 – August 31, 2017 at the Catholic University in Washington, DC. The EIC Users community is now looking forward to the 2019 edition of its Users Meeting at the École Nationale Supérieure de Chimie in Paris, France, on July 22-26.

A draft version of the pre-conceptual design report describing BNL’s ring-ring reference design for eRHIC was favorably reviewed by a committee of experts assembled by the Directorate in April 2018. The eRHIC pre-CDR is now going through a rigorous internal cost estimate and risk analysis process.

The joint SBU/BNL Center for Frontiers of Nuclear Science (CFNS) completed its first year of operations with an inaugural science symposium and a meeting of its International Advisory Committee in November 2018. The comments from the IAC members were extremely positive and applauded the rapid and successful start-up of the operations of the Center. The CFNS is now making its first round of appointments of postdocs and longer-term visitors, which will further enliven its already very active science program.