

From the ALD's Desk
RHIC News Bulletin Update
August 2017

At the time of this Bulletin we are in the midst of the evolving FY 2018 budget process. After the Office of Management and Budget unveiled the detailed President's budget request in May, Congress got to work and developed its own budget proposals in the various appropriations committees. The encouraging news at this time is that the House and Senate marks for RHIC operations funding in FY 2018 are at the same level as the appropriations in FY 2017, at \$174.6M. If these levels are enacted, RHIC will be able to execute its 2018 run as presently planned with 15 cryo-weeks.



André Lahaie

RHIC Run-17: The 21 cryo-week RHIC Run 17 ended on July 3. This was another ambitious run, with many challenging goals both on the collider side and the experimental side, but all rose to the challenge and we had another very successful run. On the collider side the challenges included providing transversely polarized p+p collisions at $\sqrt{s} = 510$ GeV with dynamic beta* luminosity leveling for the primary STAR physics goal, 54 GeV Au+Au collisions for the secondary STAR physics goal, as well as radially polarized 510 GeV pp collisions for the RHICf program which ran in conjunction with STAR. Other major collider efforts in Run 17 were the initial commissioning of portions of the LEReC system, as well as the running of the CeC Proof-of-Principle experiment.

STAR successfully installed and ran several new systems. Two important new systems designed, fabricated, installed, and operated for the Run 17 physics program were the Forward Meson Spectrometer (FMS) Post Shower Detector, and the FMS in-situ ultraviolet light curing system. The FMS Post Shower detector, built using the same scintillator slat/SiPMT readout as successfully used in the FMS Pre-Shower system built for Run 15, performed very well. It provides important electron hadron discrimination data, which enables the Run 17 Drell-Yan program. The FMS UV curing system also performed extremely well, allowing STAR to keep the triggering thresholds and gains of the FMS lead glass towers constant in the high radiation environment the FMS resided in.

Prototype systems installed for Run 17 included a quadrant of the Event Plane Detector (EPD), planned for installation and use for Run 18 as well as the BES-II runs, two prototype TPC FEEs using early versions of the new SAMPA chips that will be used for the iTPC upgrade in the BES-II running, and a prototype module of an Endcap Time of Flight System (eTOF) which will be very important for the fixed target program that will be run during BES-II. Some EM calorimeter modules, with a variety of light readout technologies and a prototype wave form digitizer readout, were tested during the run as part of an EIC and STAR forward upgrade R&D effort. Last but not least, a forward position-sensitive calorimeter system was installed and integrated into the STAR system to enable the RHICf group to take a physics data set at the end of Run 17.

STAR met or exceeded just about every one of its data goals for run 17. For the 510 GeV transversely polarized p+p program STAR accumulated 130% of the 280 pb⁻¹ W and Z⁰ trigger goal, 93% of the Drell-Yan data set goal, 115% of the min-bias goal, 93% of the FMS di-board sum goal (forward photons), and 95% of the Roman Pot goal. For the 54 GeV Au+Au run STAR accumulated 134% of its one billion min-bias event goal.

The large collected transverse polarized proton data set will provide a unique opportunity to answer several fundamental questions in QCD. Accessing transverse momentum dependent parton distribution functions (TMDs) simultaneously through single spin asymmetries in W production and forward Drell-Yan and direct photon production will allow STAR to probe the unique predictions that color interactions among quarks manifest themselves differently in p+p and e+p collisions, and that the change of TMDs with the resolution scale Q² is significantly different from that for the common parton distribution functions. Answering these questions will not only put a DOE milestone (HP13) to rest but also provide critical input to launch a program to map the proton's 3D internal structure at a future Electron-Ion Collider.

A measurement of π⁰-production at forward rapidity in the FMS in this year's Au+Au collisions at 54.4 GeV, in combination with the data for full energy Au+Au collisions taken in 2016, provides the unique opportunity to have a first look to the longitudinal structure of the initial stages of heavy ion collisions and their change with center-of-mass energy.

RHIC Publications: Recent highlights include the publication by STAR of an article on global Lambda hyperon polarization [*Nature* **548**, 62] and of first results utilizing the STAR Heavy Flavor Tracker providing evidence for charm quark thermalization and flow at RHIC (*Phys. Rev. Lett.* **118**, 212301). PHENIX submitted the first paper from the d+Au beam energy scan in 2016 run. The paper (arXiv:1707.06108) reports the elliptic flow measurements from multi-particle correlations in d+Au at 200, 62.4, 39, and 19.6 GeV, providing evidence for collectivity in d+Au at all energies.

STAR: At their May collaboration meeting the STAR Collaboration elected Helen Caines (Yale) and Zhangbu Xu (BNL) as their new co-spokespersons.

PHENIX: The PHENIX Collaboration organized the first "PHENIX School" June 15-19. The school introduced more than 30 new students and postdocs to RHIC physics and methods of PHENIX data analysis and related skills.

sPHENIX: It has been a busy three months for sPHENIX. The Collaboration continues its rapid growth, with Central China Normal University (CCNU), CEA Saclay, and Purdue University joining the effort at the end of June. The Collaboration continues to make great progress on tracking software and physics simulations and has developed a detailed five-year run plan that incorporates the latest C-AD projections of future RHIC capabilities. The sPHENIX project is also marching forward expeditiously. Good progress is being made toward a full-field test of the superconducting solenoid. A box-like magnetic flux return built from steel recycled from the venerable Multi-Particle Spectrometer (MPS) has been finished and the solenoid has been rigged into place inside it. Next steps include making all

the needed cryogenic and electric connections in preparation for the test, scheduled for this fall. A Director's review of a MAPS-based precision vertex detector for sPHENIX (MVTX) was conducted July 10-11. Its preliminary results are encouraging, and the final report from the review committee is expected very soon. The Director's Review of the baseline sPHENIX detector in preparation for a future CD-1 review took place August 2-4, 2017. The committee noted the impressive progress that has been made by the project team, but also identified several areas that need further work before a successful CD-1 review can be held, most likely in the spring of 2018.

RHIC Cold QCD Program: Responding to a request from BNL management, the STAR and sPHENIX collaborations have produced documents describing about the physics potential of modest forward upgrades, especially the cold QCD matter measurements they would enable. In parallel, the sPHENIX Collaboration is in the process of documenting the wealth of medium-energy physics addressable by the baseline sPHENIX detector.

RHIC Users Meeting: The 2017 RHIC/AGS Annual Users Meeting was held June 20–23 at BNL. The Users Meeting featured a special session dedicated to BNL's 70th anniversary, as well as keynote talks by Tim Hallman (DOE) and Edmundo Garcia-Solis (NSF) about news from the funding agencies. Berndt Mueller summarized the recent accomplishments and future goals of the RHIC science program. This year's RHIC/AGS Users Thesis awards went both to Prashanth Shanmuganathan (Thesis supervisor: Declan Keane, Kent State University) for his work on "*First Moment of Azimuthal Anisotropy in Au+Au Collisions from the Beam Energy Scan at the Relativistic Heavy Ion Collider*" and Zilong Chang (Thesis supervisor: Carl Gagliardi, Texas A&M University) for his analysis "*Inclusive Jet Longitudinal Double-Spin Asymmetry A_{LL} Measurements in 510 GeV Polarized p+p Collisions at STAR*".

RHIC/AGS PAC: The RHIC & AGS Program Advisory Committee [current members: H. Gao (Duke) J. Harris (Yale, chair), H. Huang (UCLA), V. Koch (LBNL), J.C. Peng (UIUC), S. Pratt (MSU), K. Rajagopal (MIT), A. Schäfer (Regensburg), and J. Velkovska (Vanderbilt)] met June 15-16, 2017 to consider the Beam Use Proposal for the RHIC runs in 2018 and 2019. Reports on the status of analyses of data from previous RHIC runs were presented by PHENIX and STAR. In addition, the sPHENIX and STAR Collaborations presented Letters of Intent for proposals of modest forward upgrades to their detectors for data taking after the completion of the Beam Energy Scan II.

The committee made the following recommendations for Run 18:

- As highest priority: $\sqrt{s_{NN}} = 200$ GeV $^{96}\text{Ru}+^{96}\text{Ru}$ and $^{96}\text{Zr}+^{96}\text{Zr}$, 1.2 billion minimum bias events in each system. This program has the potential to clarify a question of major significance in the field – can a signal of the chiral magnetic field be extracted from charge separation measurements in two isobaric systems.
- 3 weeks of $\sqrt{s_{NN}} = 27$ GeV Au+Au collisions accumulating 1 billion events to measure effects of global polarization of Lambdas and anti-Lambdas with high statistics, assuming RHIC operates with 15 weeks of cryogenic running in 2018.
- 2 days of $\sqrt{s_{NN}} = 3$ GeV Au+Au collisions in fixed-target mode to accumulate ~100 million events in order to investigate net proton fluctuations at an energy between its BES I run and the lower energy HADES runs.

NAS Panel on EIC: The National Academy Panel studying the scientific case for a U.S. based Electron-Ion Collider, co-chaired by Ani Aprahamian and Gordon Baym, held its second meeting on April 19-20 at the NAS Beckman Center in Irvine, CA. The panel heard presentations on the EIC science case and selected topics of relevance to the study:

- Physics of gluon saturation (J. P. Blaizot, Saclay)
- Heavy ion physics at CERN (P. Braun-Munzinger, GSI)
- Deep inelastic scattering (A. Cooper-Sarkar, Oxford)
- Theoretical perspectives on EIC science (X. Ji, Maryland/Shanghai)
- JLAB 5-year physics agenda (Z. Mezzani, Temple)
- Science potential of a U.S. based EIC (A. Deshpande, Stony Brook)

EIC Users Meeting: The first international EICUG meeting was held in Trieste, Italy (July 18-22, 2017). Organized by INFN Trieste and the University of Trieste, it was attended by 112 scientists, mostly from Europe and from the U.S. The first day was dedicated to an Accelerator Workshop organized by Fulvia Pilat and Ferdinand Willeke. The morning session contained a broad review of various European accelerator research initiatives and organizations. Speakers from CERN, LNF & IN2P3, and DESY spoke about the accelerator research initiatives at their institutes and in Europe, in general. Status and plan for LHeC were also presented. The afternoon session consisted of presentations of the eRHIC and JLEIC design status and also of the R&D efforts associated with beam dynamics, hadron and electron cooling, SRF technology and SC magnet technology for EIC IR magnets. The day ended with announcement of joint collaboration meeting of the US EIC Collaboration in October 2017 at BNL.

A special session was held on July 19 to present the EIC science case to the broader European community, and also to present the latest status of EIC in the context of the U.S. Long Range Plan and the on-going National Academy Study, to senior representatives of the institutions and organizations. Abhay Deshpande reviewed the EIC Science case, Bernd Surrow presented the status of the National Academy's study of the EIC. DOE's Tim Hallman reviewed the Status of EIC in the broader context of U.S. nuclear science and urged the European collaborators and institutions to get involved in the EIC. These presentations were followed by presentations by Angela Bracco (Chair, NuPECC), Barbara Erazmus (EU Hadron Physics), Patrice Verdier (IN2P3 plan for Nuclear & Particle Physics), Anne-Isabelle Etienne (IRF/CEA plan), and Eugenio Nappi (INFN) — on behalf of Fernando Ferroni — on INFN's vision of nuclear science and the Italian community's intentions to get involved in the US EIC project.

The afternoon comprised plenary presentations on various detailed aspects of science, machine design and detector technology needed to realize the EIC. The day ended with a discussion about the EIC UG organization and future planning. The following two days consisted of parallel sessions on technologies, proton and nuclear structure, harmonization, phenomenology and new observable. The EIC Users' Institutional Board (IB) met for the first time in person. The final day of the meeting saw summaries by parallel session conveners, followed by a report on the IB meeting by Christine Aidala (IB-Chair). In this she also announced the election of Bernd Surrow as the next EICUG Steering Committee following Abhay Deshpande. Charles Hyde was elected to the position of Deputy SC chair.