Recommendations of the Nuclear and Particle Physics Program Advisory Committee

Brookhaven National Laboratory

September 11 - 12, 2023

1. Executive Summary

The Program Advisory Committee (PAC) convened on September 10 - 11, 2023, to evaluate the sPHENIX and STAR Beam Use Requests for Runs 24 – 25. In addition to the Beam Use Requests, the PAC heard presentations by STAR on the status of the ongoing analyses in its heavy-ion and cold QCD research programs, by PHENIX on the status of its data analysis and data preservation, and by sPHENIX on its progress in commissioning and integration, and its plan for first science.

The PAC wishes to thank the collaborations for their presentations and cooperation in responding to the PAC's questions. Input from the C-AD and BNL NP-HEP managements was appreciated and very helpful in the PAC's considerations. We highly commend the sPHENIX Collaboration for their successful completion of installation and a start of commissioning. sPHENIX appears to be in a state to complete commissioning and commence data-taking in early 2024. STAR is congratulated for successful data taking during the commissioning run of sPHENIX. The unfortunate valve box failure in the Blue Ring of RHIC on August 1 curtailed RHIC operations in 2023, cutting short the sPHENIX commissioning run. Fortunately, the remaining six weeks of commissioning will be added to the FY2024 run schedule. However, RHIC operation into the summer months of 2024 may pose a challenge for C-AD.

The PAC recognizes and commends the sPHENIX collaboration and project team for their extraordinary effort and accomplishments in the commissioning thus far of the sPHENIX detector systems. The sPHENIX detector subsystems have been integrated into the DAQ and correlations of signals in subsystems confirmed physical measurements from collisions at RHIC. We look forward to a completion of commissioning followed by successful data acquisition to produce the valuable physics that is anticipated from sPHENIX.

The PAC was impressed by the number of high-quality publications, the overall scientific productivity and the continuing large numbers of PhDs awarded from the RHIC collaborations. The PAC was very pleased by the wealth of excellent presentations from STAR, PHENIX and sPHENIX at the recent Quark Matter Conference. Furthermore, the diversity of speakers in every way from RHIC was quite impressive.

The PAC commends the STAR collaboration for the successful commissioning and operation of the full Forward Detector Upgrade. The PAC is impressed with the fact that the new detectors are fully commissioned, operated exceptionally well during Runs 22 and 23, and poised for data-taking to include new forward, cold QCD and heavy-ion physics in the 2024-25 RHIC campaigns. We congratulate STAR for the completion of several cold-QCD analyses, and we are pleased to see that the results have been well-represented at the DIS and SPIN conferences. Some highlights

include the extraction of transversity using the interference fragmentation function in two-pion production data and also the improvement of the gluon helicity extraction from the double longitudinal-spin measurements.

STAR continues to expand its heavy-ion portfolio with new and different analyses. Some highlights include a novel approach to extract the strong-interaction nuclear radii, the light nuclei yield ratio over several collision energies, the pattern of local spin alignment of vector mesons, the hyper-order cumulant ratios and the observation of sequential upsilon suppression. In addition, the PAC is pleased to hear the progress in analyzing the net-proton fluctuation data, which play a crucial role in locating a possible critical point in the QCD phase diagram. The PAC recommends that BNL assist STAR to find the necessary resources (computer and IT-personnel) to achieve timely completion of their analysis efforts crucial to the accomplishment and success of the RHIC BES-II physics program.

PHENIX is commended for achieving the goals set by the collaboration last year. The PAC commends PHENIX for making significant progress in their data and analysis preservation effort. We contend that the preservation of RHIC data in general is BNL's overall responsibility and recommend that BNL management take the lead in this effort.
Guidance from the BNL-ALD for Runs 24 and 25 was presented to the collaborations for the Beam Use Requests and consisted of the following:

"For Run 2025, the first number is the proposed RHIC run duration for scenario 1 and the second number corresponds to optimal duration (scenario 2) presented to the DOE-ONP in BNL's FY25 Lab Managers' Budget Briefing:

2024: 20/24/28 + six weeks of Au+Au

2025: 24 (28)

Note the eventual running cryo-weeks for each run will depend on the final budget guidance for that year."

The numbers above are the possible scenarios for numbers of cryo-weeks for each run. The PAC considers at least 28 weeks (+6 in 2024) of cryo operation each for Runs 24 and 25 as a minimal run scenario that can provide sPHENIX the opportunity to achieve insights into the microscopic structure of the quark-gluon plasma created at RHIC and completion of the RHIC science mission.

The PAC recommends that the top priority for Run 24 is to complete the commissioning of sPHENIX and to collect the high statistics pp dataset necessary as a reference for all the sPHENIX hard probes Au+Au measurements in Run 25, and simultaneously allow STAR to make landmark polarized proton measurements using its new forward instrumentation. We recommend p+Au running in Run 24 if, and only if, the top priority above has been completed and a p+Au run of at least 5 weeks can be accomplished.

The top priority for Run 25 is to collect the high statistics Au+Au data set for sPHENIX that is essential for completion of the RHIC science mission.

The PAC urges BNL and sPHENIX to procure the computing resources necessary to make Runs 24 and 25 successful. The sPHENIX computing paradigm requires much of the data processing to be performed in real time. Without more resources, beyond what is already approved, sPHENIX will only be able to collect and process approximately 60% of the Run-25 data. Thus, actions to increase the computational throughput for sPHENIX must begin immediately, if such resources are to be in place for Au+Au data taking.

The PAC recognizes the importance of a successful completion of the sPHENIX program and strongly urges BNL to make all necessary efforts to provide the integrated luminosity necessary for sPHENIX to accomplish its scientific goals, which are the central remaining elements of the RHIC scientific mission.

2. The Beam Use Requests

2.1 Discussion of RHIC Runs 24 and 25

We are excited as the final episode of the RHIC scientific program begins and look forward with great anticipation to what we will learn from the data to be taken by sPHENIX and STAR in the coming two years.

In this context, it is worthwhile to restate or paraphrase some important framing from last year's PAC report, in particular about the sPHENIX program. It is unusual to build an entirely new detector for the concluding three years of a 25-year program, but the scientific case for doing so that was made in the 2015 Long Range Plan is sufficiently compelling. Last year and the year before the PAC looked forward with great anticipation to the insights into the microscopic structure of quark-gluon plasma that the sPHENIX detector has been designed to deliver. Having seen the impressive successes of BNL, C-AD, and sPHENIX in the commissioning work done during Run 23, our anticipation is even more palpable.

The top overall priority in planning for the coming two years is to complete the commissioning of the sPHENIX detector and to achieve its scientific program, which has been identified since 2015 as central to the RHIC science mission. The investment that the DOE, BNL and the collaboration have made in sPHENIX means that these two years should be seen and managed as the first (and at the same time final) years of a major, brand-new, high-impact, experimental effort.

sPHENIX is the first detector at RHIC designed from the ground up to measure jets, Upsilons and other hard probes at the high luminosities needed in order to make definitive measurements. Doing so with kinematics that overlaps that in analogous measurements made at the LHC presents the additional opportunity of using sPHENIX and LHC measurements in concert to discern how the microscopic structure of quark-gluon plasma changes with temperature, and with the length (or momentum) scale at which it is probed. *Realizing this opportunity and in so doing completing the*

RHIC science mission requires sufficient RHIC luminosity; ***the motivation for sPHENIX has, from the beginning, rested upon the design of the detector and to be able to collect data with the anticipated luminosity of RHIC.***

In this context, the significant reduction in the C-AD luminosity projections for Runs 24 and 25 relative to the projections we saw last year and in the preceding years presents a challenge, and risks, to the successful completion of the RHIC science mission. *We urge the C-AD, BNL and the DOE to focus energy, creativity, personnel and resources on optimizing integrated RHIC luminosity for Runs 24 and 25, with the hope that the outcome exceeds this year's projection.*

2.2 Discussion and Recommendations for RHIC Run 24

Run 24 top priority: ***The top priority for Run 24 is completing the commissioning of sPHENIX and collecting the high statistics pp dataset that is the necessary reference for all the sPHENIX hard probes Au+Au measurements to come in Run 25 and that will at the same time allow STAR to make landmark polarized proton measurements using its new forward instrumentation*****.**

Commissioning sPHENIX requires at least three weeks of Au+Au running sometime during Run 24. Run 24 could begin with Au+Au running and then switch to polarized pp, or it could begin with polarized pp with the three weeks of Au+Au coming later. We expect that the decision of when to do the Au+Au running will be made later this Fall after both sPHENIX and C-AD have more information from the preparatory work that each has currently underway.

The goal for the pp running is for sPHENIX to collect 45/pb (calo triggered) integrated luminosity. Even with this reference data set, the uncertainties in the flagship hard probes measurements that sPHENIX will be able to make using the pp data in Run 24 and Au+Au from Run 25 will be limited by the statistical errors in the pp measurements. *A pp dataset that is smaller than 45/pb will begin to compromise the ability of sPHENIX to make definitive measurements.* The plots that we saw demonstrate that two of the flagship sPHENIX measurements (measuring and distinguishing the suppression of the three Upsilon states; and photon-jet measurements in a kinematic regime overlapping that accessible at the LHC) would simply not be possible with 23/pb integrated pp luminosity (which corresponds to a 20 cryo-week pp run with the current luminosity projections) in Run 24 and a 24 cryo-week Au+Au run with current luminosity projections in Run 25. *We urge C-AD, BNL and DOE to pursue every possible opportunity to provide the RHIC luminosity and cryo-weeks necessary for sPHENIX to collect 45/pb of pp data in Run 24.*

This high-statistics polarized pp data set will also allow STAR to make precision measurements of the signals related to transversity and TMDs already observed, and to improve them and enlarge their reach thanks to the forward upgrade. These data will remain unique, will allow for a more complete comparison with SIDIS results, and will enable the quantitative investigation of important open questions in QCD such as universality, evolution and factorisation.

Run 24 second priority: ***We recommend p+Au running in Run 24 if, and only if, the top priority above has been completed and a p+Au run of 5 weeks can be accomplished.***

We have heard a compelling case from both STAR and sPHENIX for the scientific impact that measurements in p+Au collisions would yield. For STAR, with its new forward instrumentation in place, this is as high a priority as polarized pp.

RHIC is the only collider in the world, today and for the foreseeable future, capable of colliding polarized protons with heavy nuclei. With its new forward instrumentation STAR is prepared to make polarization measurements that will be unique, now and for the future. Furthermore, these measurements, and indeed the broad suite of unpolarized p+Au measurements that both STAR and sPHENIX have described, are important for the future e+A program at the EIC. Testing the universality and factorization of QCD requires measurements made in ep, e+A, pp and p+A collisions. For example, dihadron correlation measurements made at RHIC in pA collisions, together with the universality that is intrinsic to models of saturation in QCD, will yield tight predictions for e+A measurements at the future EIC that could then either rule out or support the discovery of saturation.

A p+Au dataset will also provide new input into collectivity in small systems, a topic of much interest in heavy ion physics today.

Although a longer run would be preferable for many of these goals, even a 5-week run would allow for valuable measurements that could stand forever. *We recommend p+Au running in Run 24 if, and only if, the top priorities above (three weeks of Au+Au commissioning/running; pp running so as to yield 45/pb sPHENIX data set) have been accomplished and a p+Au run of 5 weeks can be accomplished.*

Given how important the pp dataset (the top priority above) is to the completion of the RHIC science mission, and given the compelling science case for a p+Au run of at least five weeks, *we urge BNL and DOE to do everything possible to enable a Run 24 with 28+6 cryo-weeks, where the 6 is carried forward from Run 23.*

2.3 Discussion and Recommendations for RHIC Run 25

Run 25: ***The top priority in Run 25 is collecting the marquee, high statistics, Au+Au data set that is the raison d'etre for sPHENIX, essential for completion of the RHIC science mission, and that will also allow STAR to complete its scientific program.***

Completing the commissioning of sPHENIX in Run 24 and collecting the pp reference dataset are necessary precursors to the execution, and scientific success, of the Run 25 top priority.

We note that the p+Au run identified as the second priority for Run 24 is not a necessary precursor to Run 25. ***Looking at the compelling scientific case for this run, and in particular its importance to the science of the future EIC, if the p+Au run is not done in Run 24 there will be a compelling***

case for running RHIC beyond the completion of the Run 25 Au+Au data-taking in order to include at least five weeks of p+Au running, even if doing so extends Run 25 beyond June 2025.

2.4 Other Opportunities

Should the opportunity arise for running RHIC beyond 2025, sPHENIX proposes to double the Au+Au dataset and increase by more than a factor of 10 the pp dataset enabled by upgrade of the data acquisition system to full streaming mode. Ensuring collection of significant statistics of sPHENIX Au+Au and p+p data, to enhance the overall scientific impact in completing the 2015 LRP objectives, is clearly the first priority of the PAC for RHIC data taking until 2025 and beyond if necessary.

With further data-taking beyond 2025, sPHENIX also proposes measurements in small-ion species such as O+O and Ar+Ar. These data sets would have no trigger biases or selections that would preclude any analysis within the acceptance and performance parameters of sPHENIX. They would represent the largest datasets at these energies, which could be preserved for future exploration when RHIC is no longer in operation. If indeed an opportunity for extending RHIC operations arises, the PAC will entertain these proposals in the future.

STAR proposes two possible shorter runs for consideration at lower priority than achieving the Run 24-25 goals for Au+Au, pp and p+Au data-taking, if the primary goals of Run 24 were to be completed in less than 28 cryo-weeks. The first is to investigate the shapes and radial profiles of atomic nuclei utilizing various new beam combinations. This is motivated by recent analyses of Ru+Ru and Zr+Zr data from RHIC and constraints on the neutron skin depth of 208Pb extracted recently from measurements of Pb+Pb collisions at LHC energies. The second is to utilize three different beams in the $12 < A < 56$ mass range on fixed targets at low energy for space radiation protection measurements. Both require about two weeks of RHIC operation including beam development time. The PAC thanks the collaborations for their proposals to take advantage of additional physics opportunities at RHIC, however it is unlikely that sufficient beamtime can be allocated without infringing on the core sPHENIX physics program. Thus, any of these additional runs are especially unlikely.

In summary, the PAC supports as the highest priority for Runs 24 (pp) and 25 (Au+Au), collection of the sPHENIX datasets that make its flagship RHIC program possible. The PAC also supports achieving the compelling scientific goals that a p+Au run would bring, taking full advantage of the new forward upgrade in STAR. STAR has requested 11 weeks of p+Au running. If and only if the sPHENIX pp and Au+Au goals are satisfied, the PAC supports a 5 week p+Au run that would enable impactful measurements with the new STAR forward instrumentation and with sPHENIX, although with only 5 weeks of p+Au data-taking some of STAR's proposed p+Au goals for Run 24 would be compromised.

3. RHIC Collaboration Reports

3.1 STAR

The PAC is impressed by the STAR collaboration's output in terms of high-quality publications, PhDs awarded, strong representation and new analyses at the Quark Matter 2023 Conference and overall very high scientific productivity. The collaboration published 20 papers in 2023, 2 of them notably in Science/Nature, and several Journal reviews. The PAC commends STAR for the remarkable quality of the analyses and data they presented.

3.1.1 STAR Run 2023 Report and Cold QCD Update

Run 2023 was the first full energy Au+Au run after the installation of the iTPC and the forward upgrade. We commend the STAR collaboration for the successful completion of these upgrades. The PAC is impressed with the fact that the new detectors are fully commissioned and operated exceptionally well during Runs 22 and 23. In addition, the TPC readout upgrade, DAQ5k, which speeds up the readout to 5kHz was successfully completed in Run 23. The PAC is pleased that this crucial upgrade is ready for the collection of high-luminosity data in the remaining RHIC runs.

STAR faced a number of challenges during Run 23. In addition to the limitations from running concurrently with the commissioning of sPHENIX, the STAR magnet was off for several days due to magnet chiller issues, and there was a LockOut/TagOut with the high-sensitivity smoke detector system off due to smoke from wildfires. Although the planned high-luminosity program could not be completed, we commend STAR for collecting a significant fraction of their minimum bias data goal despite several setbacks and the early conclusion of Run 23.

We congratulate STAR for the completion of several cold-QCD analyses, and we are pleased to see that the results have been well represented at the DIS and SPIN conferences. Some highlights include the impact of the measurements of double longitudinal-spin asymmetries on the extraction of the gluon helicity, the new results on double longitudinal spin asymmetries for tagged jets, the measurement of the Z0 transverse spin asymmetry to test the non-universality of the Sivers function, and the access to the transversity function using the interference fragmentation function.

The PAC is also pleased to see the submission for publication of the analysis of the Sivers asymmetry via the di-jet production and the Z-boson production from STAR. We look forward to the publication of the W-boson Sivers asymmetries for the 2017 data. Analysis of the additional Run 22 data sensitive to the Siver asymmetries (W/Z/Drell-Yan/Dijet) with the forward upgrade is eagerly anticipated. Results from these analyses, combined by the anticipated polarized pp data in Run 24 at 200 GeV, should provide a definitive test of the predicted sign-change of the Sivers functions.

We encourage continuing efforts to establish the connection and complementarity between the p+A physics (polarized and unpolarized) at RHIC and e+A physics at EIC. This is especially

important in the context of probing and establishing universality of non-linear phenomena in QCD. Analyses of the Run 15 polarized p+A data could further strengthen the physics case for additional p+Au running during Runs 24/25. Some examples include the study of nuclear effects for the Collins and Sivers functions from the Run 15 p+A data.

3.1.2 STAR - Heavy Ion Update including BES-II

The PAC is particularly impressed by the variety of analyses and by the quality of the data presented by the STAR collaboration. Some highlights include a novel approach to extract the strong-interaction nuclear radii, the light nuclei yield ratio over several collision energies, the pattern of local spin alignment of vector mesons, the hyper-order cumulant ratios and the observation of sequential upsilon suppression.

The PAC is happy to hear about the progress in analyzing the net-proton fluctuation data, which play a crucial role in locating a possible critical point on the QCD phase diagram. The PAC is excited to hear that the analysis of the 3.2 (FXT), 7.7, 14.6, 19.6 and 27 GeV data is near completion and eagerly awaits publication of these results.

The PAC is concerned that the unavailability of embedding is slowing down the analysis of 9.2, 11.5, 17.3 GeV and FXT data on net-proton fluctuations as well as other analyses.

- The PAC recommends that BNL assist STAR in finding the necessary resources (computer and IT-personnel) to achieve timely completion of their analysis efforts crucial to the success of BES-II.

3.2 PHENIX - Status of Data Analysis and Data Preservation

The PAC was impressed by the continuing high scientific output of the PHENIX collaboration. The first measurement of heavy-flavor elliptic flow at forward rapidity, the heavy flavor A_N, the measurement of $\psi(2s)$ and J/ψ in a variety of systems, and the analyses involving direct photons and neutral pions were particularly impressive. Many of these measurements exploit the unique capabilities of the PHENIX detector at RHIC.

The PHENIX collaboration continues to maintain a high level of publication output with 9 papers published, several papers submitted and in journal review, and essentially returning to a pre-pandemic high level of publication output. The papers are of high visibility, with two PRC Editor's suggestions and one BNL/RIKEN news release.

PHENIX is commended for their progress in data and analysis preservation. The collaboration is close to achieving the goal of making available the data for all 218 published PHENIX papers on HEPData, and the collaboration has established a requirement that the data for all new papers be made available on HEPData.

The PAC appreciates and commends the PHENIX collaboration's DAP efforts on REANA. The PAC recognizes the importance and challenges of this project, and agrees with PHENIX that these efforts require additional dedicated resources. The PAC encourages PHENIX to seek ways to streamline the process so as to increase the number of analyses that can be preserved.

4. sPHENIX

The PAC commends the sPHENIX project team and collaboration for their achievement in the commissioning of the state-of-the-art sPHENIX detector system. The PAC, and indeed the entire community as demonstrated at the Quark Matter 2023 Conference, are very impressed and sincerely grateful for the efforts of everyone in sPHENIX and from BNL towards this success.

4.1 sPHENIX commissioning and integration, computing readiness, and plan for first science

Major subsystems including the superconducting magnet, Inner and Outer HCal, EMCal, TPOT (TPC Outer Tracker), ZDC, MBD (Minimum Bias Detector), INTT (Intermediate Silicon Strip Tracker) completed major commissioning tasks and reached stable operations. The sEPD, SMD and DAQ continue to be worked on during the shutdown for completion or further improvements. The TPC and MVTX have operated with RHIC Au+Au collisions. Unfortunately, the unexpected shutdown of RHIC operation terminated the commissioning effort of these detectors. Remaining major commissioning tasks for the TPC and MVTX include the mitigation of the TPC HV operational instability, possibly due to beam-related space-charge accumulation and/or mechanical stress induced GEM-based sector deformation; and mitigation of the MVTX readout lock-up and reduction of beam halo related background along the beam pipe.

The sPHENIX detector subsystems were integrated into the DAQ and correlations of signals in subsystems confirmed physical measurements from nuclear collisions at RHIC. Full integration and tuning of the zero suppression will be performed during Run 24.

The PAC commends the smooth transition from a detector construction project to a collaboration-led commissioning, operation and scientific enterprise. The collaboration has an outstanding plan, balancing continued commissioning efforts with the concerted physics analyses for the first science from sPHENIX data collected in Runs 23 and 24. The PAC endorses the topics planned for sPHENIX first science, which addresses interesting physics for bulk properties of the QCD matter created at RHIC and matches the sPHENIX detector capabilities well.

- The PAC recommends that sPHENIX develop and enact a schedule, designating the effort and technical resources to address the remaining technical challenges for the start of Run 2024, which is expected in early January 2024. The PAC re-affirms that successful commissioning, operation and data-taking in sPHENIX is the highest priority for RHIC and recommends that BNL provide the necessary engineering support for sPHENIX to complete commissioning tasks and start the scientific data-taking in the early part of Run 24.

- The PAC urges sPHENIX and BNL to procure the computing resources necessary to make Runs 24 and 25 successful. Without more resources, beyond what is already approved, sPHENIX will only be able to collect and process approximately 60% of the Run-25 data. The sPHENIX computing paradigm requires much of the data processing to be performed in real time. Thus, actions to increase the computational throughput for sPHENIX must begin immediately, if such resources are to be in place for Au+Au data taking.

5. Off-Line and On-Line Computing for Runs 24 and 25

The PAC commends BNL, STAR and sPHENIX for increasing the access to computational resources. Not only must resources be found for the unprecedented upcoming volume of sPHENIX data, but STAR's DAQ upgrade has doubled its data rate, not to mention the increase associated with the additional forward coverage in recent years. Despite these increases in computing, it was reported that resources for the upcoming runs appear insufficient. This is especially true for Run 25, where the currently procured resources account for only 60% of the expected data volume. Given that the sPHENIX computing paradigm involves much of the data processing to be performed as the data is collected, the PAC urges BNL, STAR and sPHENIX to address this shortfall with greatest urgency.

6. Better Facilitating Collaboration with the Theory Community

The breadth, scope, and discovery potential – as well as the complexity – of the RHIC data sets: from the recent Beam Energy Scan and the STAR fixed target program, from the enhanced forward instrumentation in the STAR detector, and soon from sPHENIX with its unprecedented capabilities, all demand a commensurate effort from theoretical modeling if the scientific potential of these investments is to be realized. Theoretical simulations of the droplet of hot matter produced in heavy-ion collisions and the hadrons that result involve sophisticated three-dimensional modeling, with complicated thermalization physics, over a wide range of baryon densities. Theoretical modeling of jets, including their wakes, and heavy quarks and quarkonia requires adding the dynamics of the interaction between these hard probes and the aforementioned hot matter. In order to optimize progress on the theory front, given the expanded experimental coverage and statistics, the application and integration of such models in a way that addresses the key scientific issues will require tight coordination between STAR, sPHENIX and the theory community.

- The PAC recommends that BNL pursue a strategy to better facilitate the progress of RHIC physics through strategic involvement of the theoretical community, whether it be through workshops, visitor programs, or sabbatical support.

7. PAC Recommendations

STAR Analysis:

- The PAC recommends that BNL assist STAR in finding the necessary resources (computer and IT-personnel) to achieve timely completion of their analysis efforts crucial to the success of BES-II·

sPHENIX:

- The PAC recommends that sPHENIX develop and enact a schedule, designating the effort and technical resources to address the remaining technical challenges for the start of Run 2024, which is expected in early January 2024. The PAC re-affirms that successful commissioning, operation and data-taking in sPHENIX is the highest priority for RHIC and recommends that BNL provide the necessary engineering support for sPHENIX to complete commissioning tasks and start the scientific data-taking in the early part of Run 2024.

- The PAC urges sPHENIX and BNL to procure the computing resources necessary to make Runs 24 and 25 successful. Actions to increase the computational throughput for sPHENIX must begin immediately, if such resources are to be in place for the Au+Au data taking.

BNL Lab Management:

- The PAC strongly urges BNL management to provide all necessary resources to ensure that the RHIC physics program is completed as envisioned in the 2015 LRP. We have expanded upon this recommendation above.

- We urge the C-AD, BNL and the DOE to focus energy, creativity, personnel and resources on optimizing integrated RHIC luminosity for Runs 24 and 25, with the hope that the outcome exceeds this year's projection. We urge C-AD, BNL and DOE to pursue every possible opportunity to provide the RHIC luminosity and cryo-weeks necessary for sPHENIX to collect 45/pb of pp data in Run 24.

- The PAC urges BNL and sPHENIX to procure the computing resources necessary to make Runs 24 and 25 successful. Without more resources, beyond what is already approved, sPHENIX will only be able to collect and process approximately 60% of the Run-25 data. The sPHENIX computing paradigm requires much of the data processing to be performed in real time. Thus, actions to increase the computational throughput for sPHENIX must begin immediately if such resources are to be in place for Au+Au data taking.

- The PAC recommends BNL assist STAR to find the necessary resources (computer and IT-personnel) to achieve timely completion of their analysis efforts crucial to the success of BES-II.

- The PAC emphasizes the importance of data preservation, and contends that the preservation of RHIC data in general is BNL's overall responsibility. The PAC recommends that BNL management ensure that the efforts from PHENIX, STAR and sPHENIX are both coordinated and supported.
- The PAC recommends that BNL pursue a strategy to better facilitate the progress of RHIC physics through strategic involvement of the theoretical community, whether it be through workshops, visitor programs, or sabbatical support.

2023 BNL Nuclear and Particle Physics Program Advisory Committee

Roberta Arnaldi, INFN, arnaldi@to.infn.it

Leticia Cunqueiro Mendez, Rome Sapienza U, leticia.cunqueiro.mendez@cern.ch

John Harris, Yale, (Chair), john.harris@yale.edu

Huan Huang, UCLA, huang@physics.ucla.edu

Anna Martin, Trieste Univ. and INFN, anna.martin@ts.infn.it

Jen-Chieh Peng, UIUC, jcpeng@illinois.edu

Scott Pratt, MSU, prattsc@msu.edu

Krishna Rajagopal, MIT, krishna@mit.edu

Claudia Ratti, University of Houston, cratti@central.uh.edu

Anna Stasto, Penn State, ams52@psu.edu

Mikhail Stephanov, UIC, misha@uic.edu

Julia Velkovska, Vanderbilt, julia.velkovska@vanderbilt.edu