



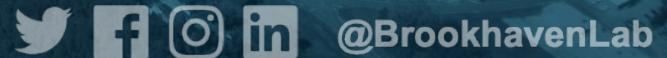
Opening Remarks

Haiyan Gao

ALD, Nuclear and Particle Physics

RHIC & AGS Users' Meeting

June 13, 2024



BNL anti-harassment policy and Our Values and Expected Conduct

At Brookhaven National Laboratory (BNL) or BNL-sponsored events,

“Discriminatory behavior or harassment of conference participants or presenters will not be tolerated.”

Please refer to logistics on the webpage for the Annual Users' Meeting for BNL anti-harassment policy

<https://www.bnl.gov/rhicagsaum/logistics.php#webcast>

And **Our Values and Expected Conduct**

<https://www.bnl.gov/about/values-conduct.php>

Thank to the strong engagement of RHIC/AGS users,
NPP DEI Council, and JoAnne's leadership

Our Values and Expected Conduct

At Brookhaven Lab, our vision is to enable discovery science and transformative technology that power and secure the nation's future. Our mission is to deliver expertise and capabilities to drive scientific breakthroughs and innovation for today and tomorrow.

Achieving this vision and mission requires simultaneous excellence in science, laboratory operations, and service to the community. We are committed to making positive impacts for the region, the nation, and the world.

We are committed to treating all in an ethical manner—with [respect](#) through common courtesy, civility, and effective communication.

We expect to be treated that way in return.

We strive to maintain a [diverse, equitable, inclusive, and accessible](#) work environment in which all in the Lab community—including staff, guests, facility users, visitors, students, educators, and contractors—are valued and empowered to work to their fullest potential.

We do not tolerate any form of [harassment](#), [discrimination](#), or [retaliation](#) against or by members of the Lab community while working at the Lab site or off, and when representing Brookhaven at meetings, workshops, and other events.

In all we do, we are guided by our values: leadership, integrity, responsibility, innovation, safety, security, and environmental stewardship, respect, and teamwork.

As a Lab community, we work in an environmentally responsible, safe manner and adhere to our Environmental, Safety, Security, and Health Policy.

Through these commitments, we lead and support diverse research teams in support of the DOE's mission to ensure the nation's security and prosperity.

To report conduct or behavior inconsistent with these commitments, please communicate through EthicsPoint, which is hosted by an independent third party.

Safety is a core value and safety first

“...the entirety of our workforce must readily understand that schedule pressure is never a justification for deviations from safe work practices.”
from **Juston Fontaine, Deputy Director for Operations, Office of Science, DOE**

Principles of the Safe Conduct of Research:

- Everyone is personally responsible for ensuring safe operations.
- Leaders value the safety legacy they create in their discipline.
- Staff raise safety concerns because trust permeates the organization.
- Cutting-edge science requires cutting-edge safety.
- A questioning attitude is cultivated.
- Learning never stops.
- Hazards are identified and evaluated for every task, every time.
- A healthy respect is maintained for what can go wrong.

Users' support of and commitment to safety first is important to help us achieve simultaneous excellence in operations and scientific mission!

Selected Highlights

2023 NSAC Long Range Plan

Nuclear Science Advisory Committee (NSAC) approved the 2023 LRP on Oct 4, 2023, public Roll-Out on Oct 6, 2023

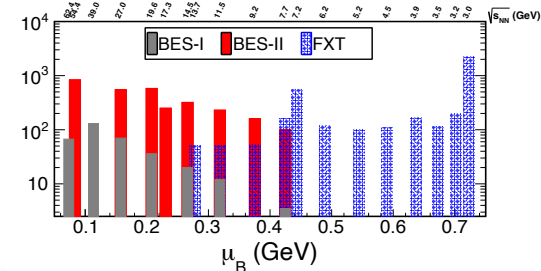
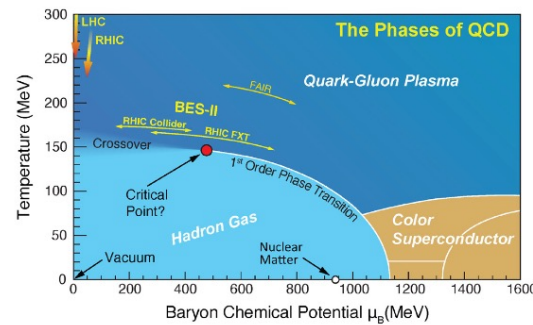


<https://nuclearsciencefuture.org/wp-content/uploads/2024/02/23-G06476-2024-LRP-17x11-pcg-1.24.24.pdf>

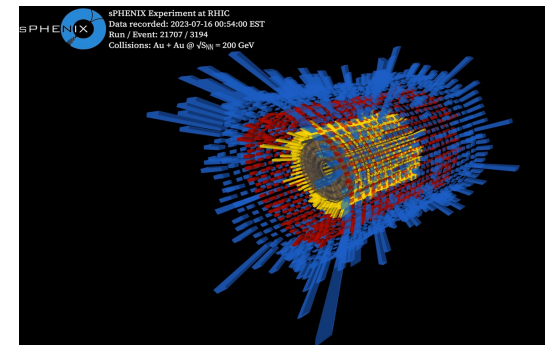
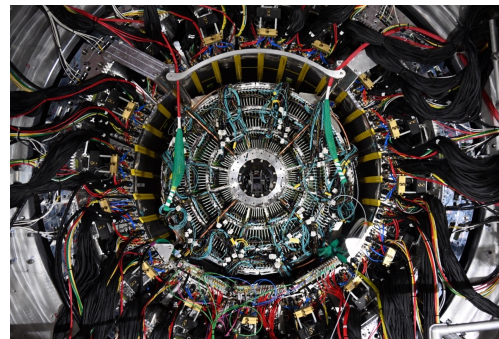
Major Accomplishments since 2015 Long Range Plan

2015 LRP: “There are two central goals of measurements planned at RHIC, as it completes its scientific mission, and at the LHC: (1) Probe the inner workings of QGP by resolving its properties at shorter and shorter length scales. The complementarity of the two facilities is essential to this goal, as is a state-of-the-art jet detector at RHIC, called sPHENIX. (2) Map the phase diagram of QCD with experiments planned at RHIC.” **(part of recommendation 1 to capitalize on investments made)**

- STAR completed Beam Energy Scan (BES) data collection that benefited from Low Energy RHIC electron Cooling (LEReC)
- Completed sPHENIX construction and installation, sPHENIX commissioning with RHIC beams started in Run 2023

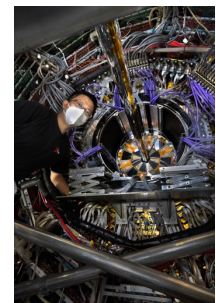
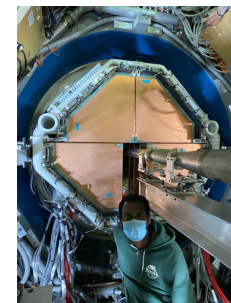
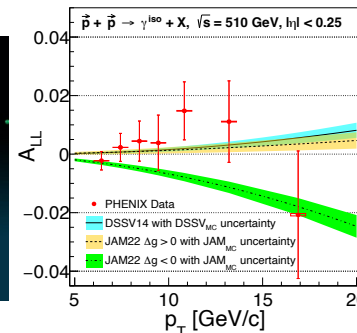
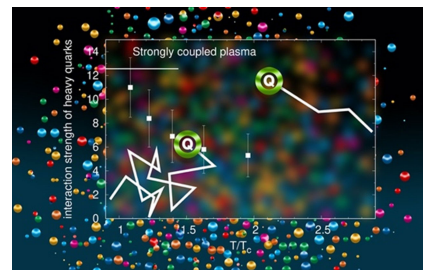
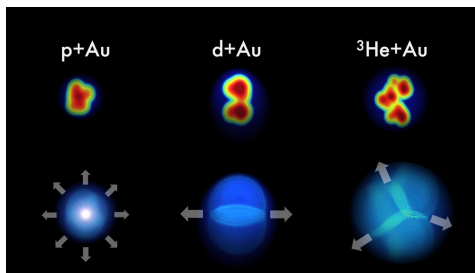
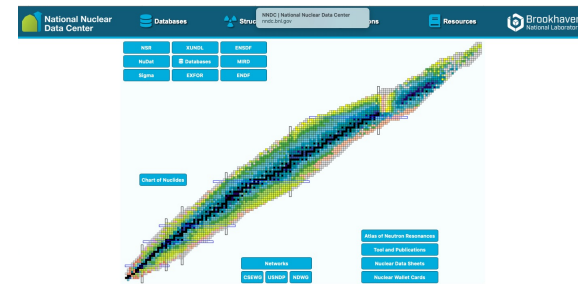
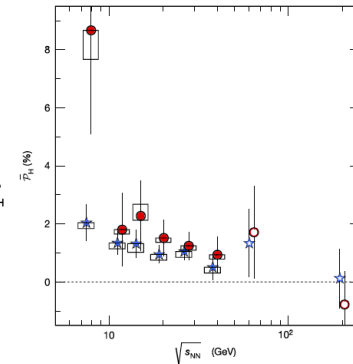
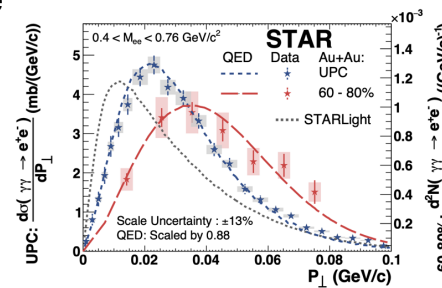


LEReC: First-ever electron cooling with bunched beams
 Demonstrator for electron cooling at EIC



NP at BNL since 2015 Long Range Plan

- Discovery of Breit-Wheeler process (matter created from pure energy), vacuum birefringence, quantum interference enabled nuclear tomography to extract strong-interaction nuclear radii
- Observation of global Λ hyperon polarization in nuclear collisions: evidence for the most vortical fluid.
- Evidence for small drops of perfect fluid from RHIC
- Achieved the most precise measurement of any heavy ion collisions experiments in search of chiral magnetic effect with isobar collisions
- Established gluons' helicity contribution to the proton spin, and they align in the same direction as that of the proton spin
- BNL Nuclear Theory program is highly visible and impactful, guiding RHIC physics and beyond and the future EIC experimental program
- National Nuclear Data Center <https://www.nndc.bnl.gov>
- STAR completed forward upgrades and fSTAR used successfully in Run 2022 & Run 2023



2023 Long Range Plan

All four recommendations have impact on the nuclear physics program at the lab

2023 LRP

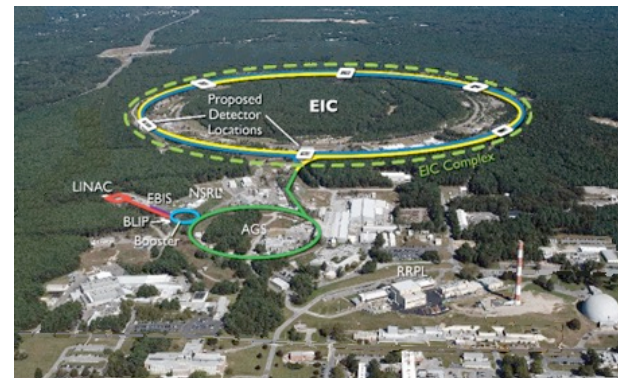
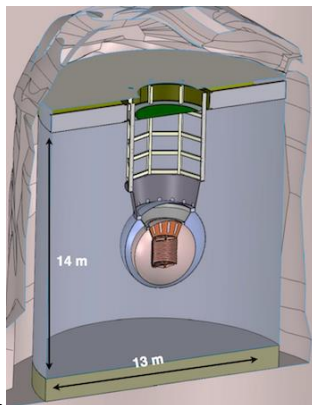
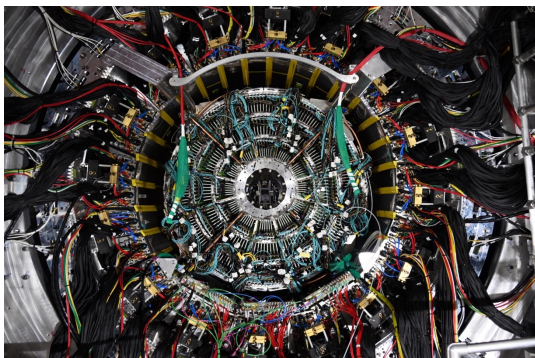
Recommendation 1: Strong support for completing RHIC science mission

Recommendation 2: BNL is engaging in nEXO international collaboration

Recommendation 3: BNL leads the construction of the Electron-Ion Collider

Recommendation 4: BNL are leaders/actively engaging in Nuclear Data, Computing, QIST, AI/ML, multi-disciplinary and topical collaborative centers; nuclear theory efforts, applications program (e.g., isotope, space radiation), and workforce development efforts highly visible

*“Next, we reaffirm the exceptionally high priority of the following two investments in new capabilities for nuclear physics. The **Electron–Ion Collider (EIC)**, to be built in the United States, will elucidate the origin of visible matter in the universe and significantly advance accelerator technology as the first new particle collider to be constructed since the LHC. **Neutrinoless double beta decay experiments** have the potential to dramatically change our understanding of the physical laws governing the universe.”*



The Electron-Ion Collider

2023 LRP Recommendation:
We recommend the expeditious completion of the EIC as the highest priority for facility construction.

Polarized electrons colliding with polarized protons, polarized light ions, and heavy ions will allow us to study sea-quarks and gluons to understand:

- mass and spin of the proton.
- spatial and momentum distribution of low-x partons
- possible gluon saturation
- modifications of parton distribution functions when a nucleon is embedded in a nucleus
- hadron formation

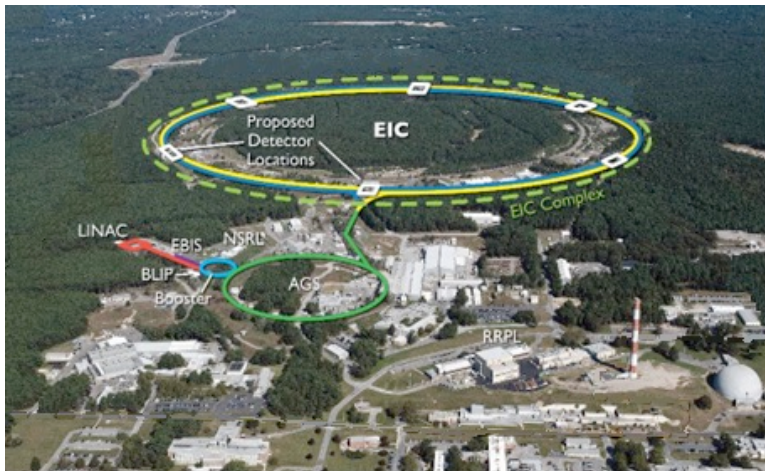
The EIC is a partnership between BNL and Jefferson Lab.

CD-1 June 2021, CD-3A March 2024

Project is aiming for CD2/3 in 2025

ePIC detector design is advanced. Significant international support and participation (160+ institutions, 24 countries)

EIC Resource Review Board (RRB) formed and RRB met in April 2023 at Stony Brook, December 2023 at CUA in DC, May 2024 in Rome

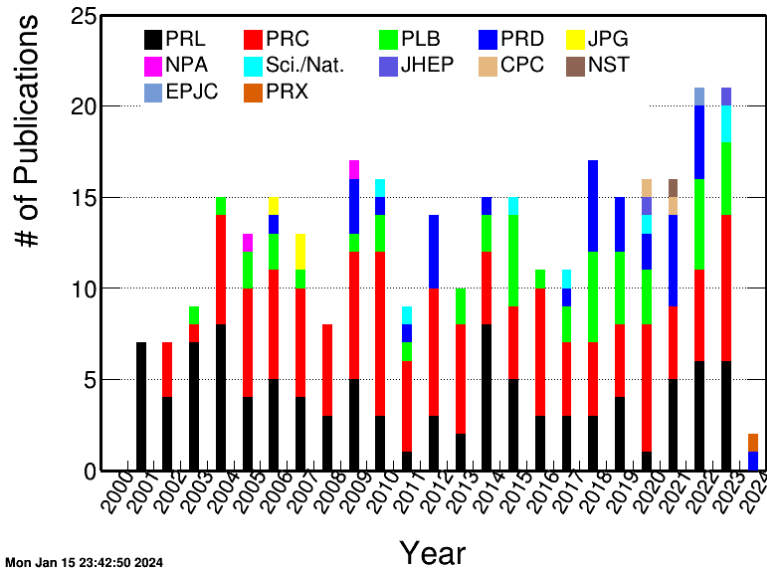


Major discovery potential!

EIC Resource Review Board Meeting, May 6-7, 2024, Rome, Italy



STAR publications



Mon Jan 15 23:42:50 2024

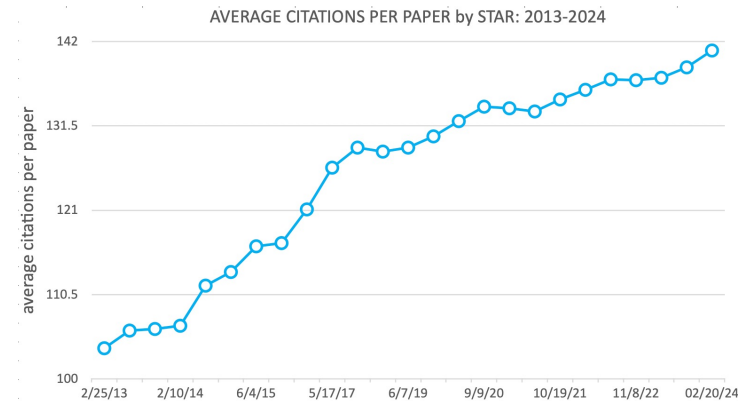
- **2023:** 21 published 6 PRL, 8 PRC, 4 PLB, 2 Sci/Nat, 1 JHEP
- **2024:** 2 published + accepted 1 PRD, 1 PRX

Journal review: 18; Collaboration review: 2; Active GPCs: 29

99% of STAR papers uploaded to HEPData, remaining 3 papers are newer and on track to be uploaded soon

Continued strong publication and presentation record across all Physics Working Groups

Observation of the electromagnetic field effect via charge-dependent directed flow in heavy-ion collisions at RHIC, the first PRX paper in heavy ion physics.



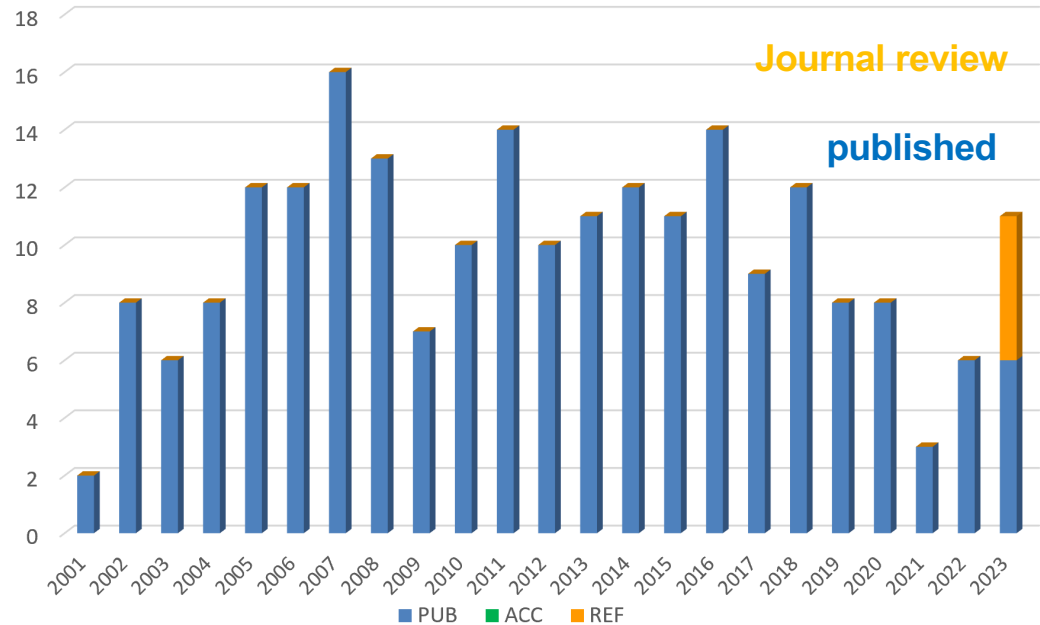
Continued steady growth in citations
Total citations > 43800

PHENIX publications

- **218 physics papers published/accepted**
 - Phys. Rev. Lett. 76
 - Phys. Rev. C 90
 - Phys. Rev. D 46
 - Nature Physics 1
 - Phys. Letter B 4
 - Nucl. Phys. A 1
- **Total citation: ~33000**
- Topcite 1000+ 2
 - 500-1000 8
 - 250-500 21
 - 100-250 63
 - 50-100 46

PHENIX White Paper: 3475 cites
Jet quenching discovery: 1181 cites
Nature P paper: 258 citations
140 physics papers in topcite 50+
(162 if proceedings and detector papers are included)

Published PHENIX papers in each year

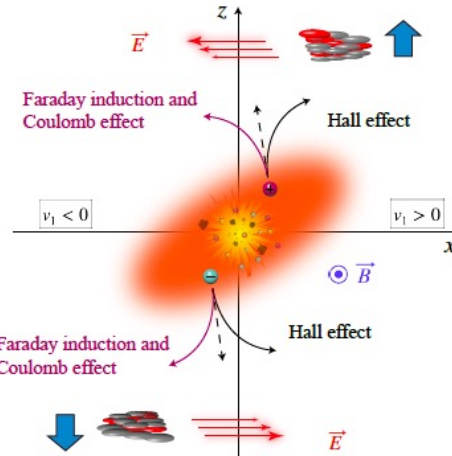
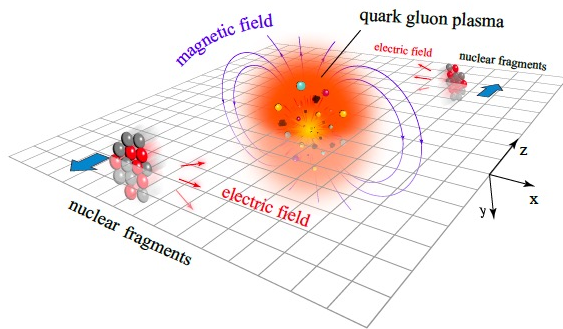


6 papers published in 2023, 5 papers under journal review

Colossal Magnetic Field Detected in Nuclear Matter

STAR, arXiv: 2304.03430, PRX 14, 011028 (2024)

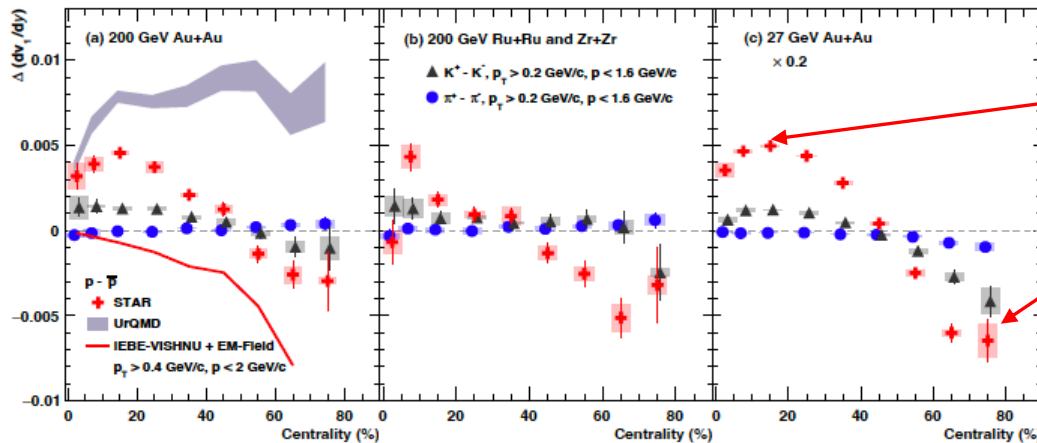
a magnetic field 10^{18} times stronger than Earth's,
1000 times of those on neutron stars



Transported-quark effect:
positive charge-dependent v_1 slope

Faraday + Coulomb:
negative charge-dependent v_1 slope

Attracted worldwide media and public interests



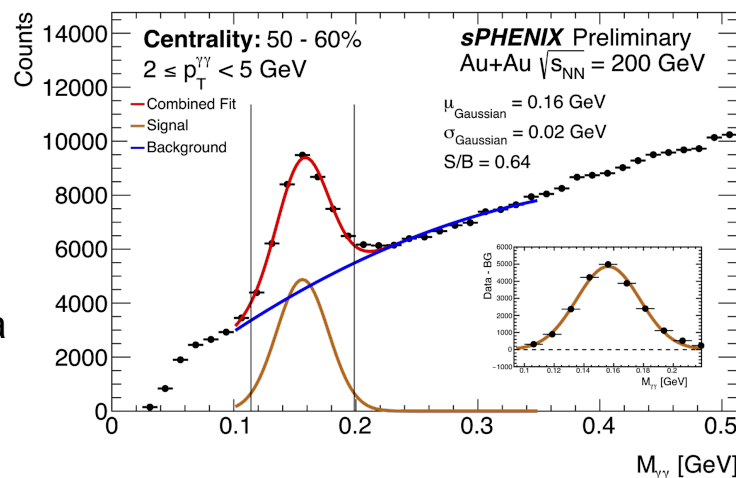
Results in central collisions can be explained by transported quark effect.

Results in peripheral collisions reveal the contributions from the Faraday induction and Coulomb effect for the first time in heavy-ion collisions.

sPHENIX commissioning in Run 23 & first “standard candle” measurements

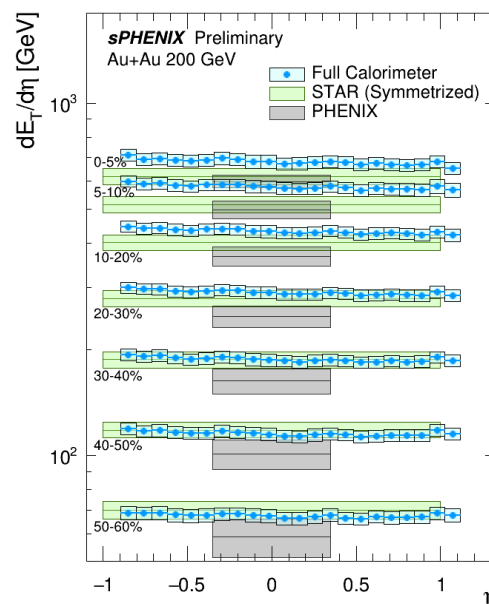
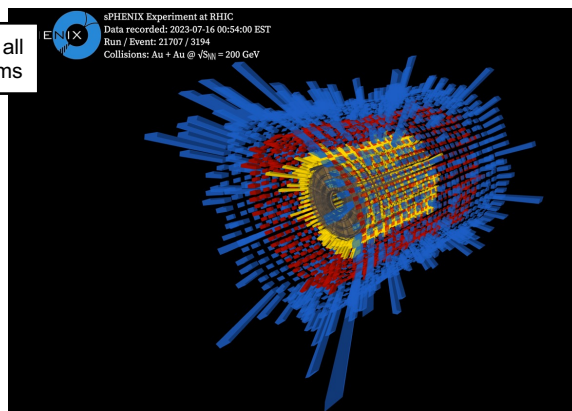
[sPH-CONF-BULK-2024-01](#)

- Commissioning with beam started on May 18, 2023
- Ten sub-detectors* and DAQ to commission
- SC magnet operated very stably
- All sPHENIX subsystems, including the MVTX, took RHIC data and stored data in HPSS
- Excellent support from C-AD in providing wide variety of RHIC beam conditions
- Prior to August 1, 2023, focus had been on operation of TPC at full HV and on MVTX response to apparent beam halo



- Two photon invariant mass — clear π^0
- Used in π^0 v_2 measurement

Central Au+Au event in all three calorimeter systems



[sPH-CONF-BULK-2024-02](#)

- First transverse energy measurement at RHIC with a hadronic calorimeter
- Centrality measure still being finalized

Scientific Data and Computing Center Meeting RHIC needs

Smooth operation of computing for RHIC

Supporting RHIC Run 2024 and preparing for 2025

- In FY24, SDCC provides a total of 880 kHS23 of computing power for sPHENIX through ~68k computing cores
- Default scenario is to increase the CPU capacity, for a total of ~2100 kHS23 in early FY25
- STAR and sPHENIX disk storage at BNL O(100) PB (additional 23 PB will be installed in February 2025)
- Tape deployment : Projected cumulative 209 PB in FY24; Projected cumulative **0.54 ExaByte** in FY25 → will require capital purchase of another pair of IBM TS4500 tape silos

Support for RHIC data & knowledge preservation; STAR online computing and offline infrastructure

Support for sPHENIX and STAR databases (DAQ, File Catalogs, Calibration, etc); Data Carousel services (efficient use of tape & disk for data on-demand)

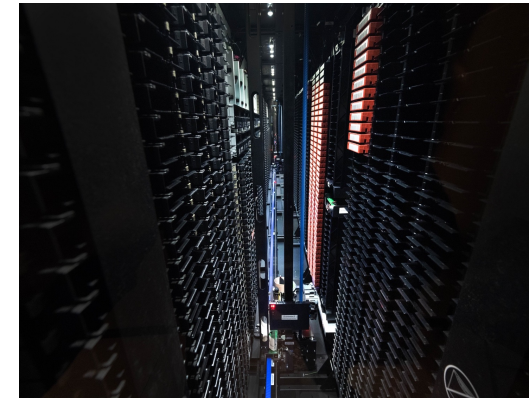
Support for EIC simulations studies

Engagement in BNL's AI/ML strategy & planning and AI/ML R&D for EIC detector(s)

Coordinated effort with JLAB on EIC computing

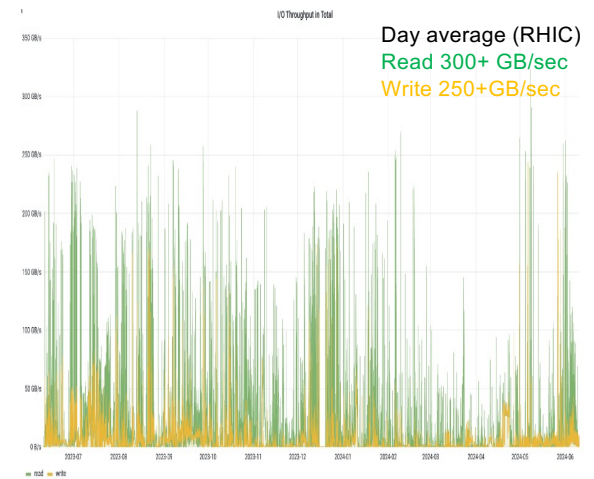
- Coordinated effort with ePIC collaboration SW&C on Computing Model and Distributed Computing
- ePIC /EIC computing review at the end of September 2024

Lab's data center power/cooling upgrade (IGPP) plan received approval and FY24/FY25 challenges are addressed – no obstacles to installing the sPHENIX CPUs and disks for RHIC Run-25



sPHENIX Tape Library
Projected 209 PB in FY'24 and more than 0.5EB in FY25

Disk **Read/Write** Throughput Jul 23 – Jun 24



sPHENIX : The most data-intensive research in Nuclear and Particle Physics, and frontier in data science

RHIC Run 2024 and plan for 2025

RHIC PAC 2023 Recommendations

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.*

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.*

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

Upcoming PAC meeting, August 3, 2024 (zoom session)

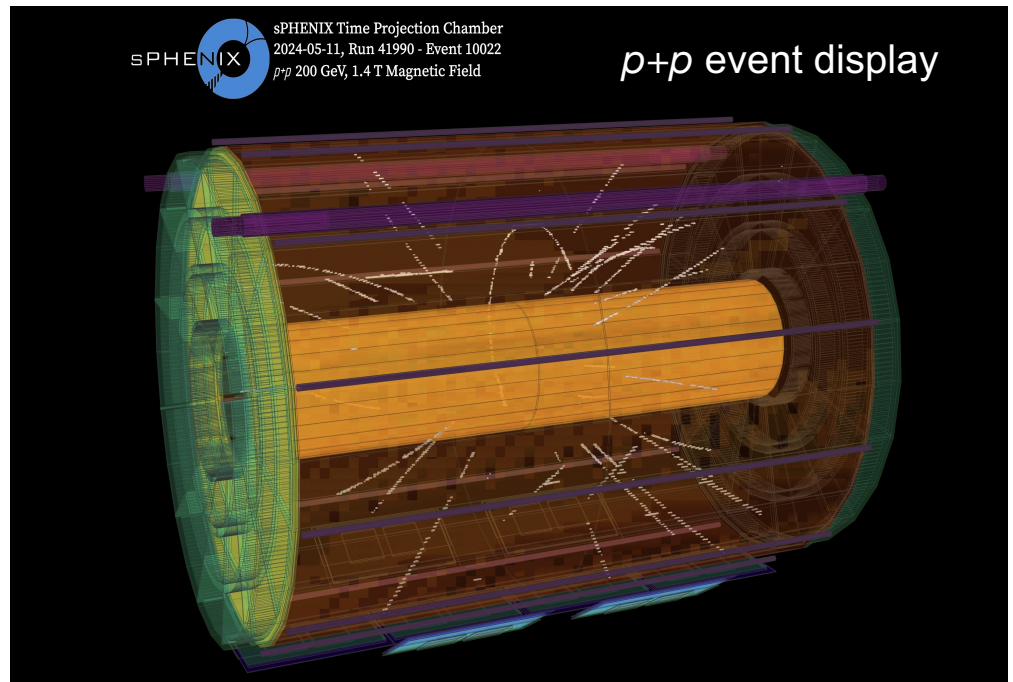
Full PAC meeting in October 2024

Where we are?

- RHIC Run-2024: started April 15, 2024, and will run 25 cryo-weeks including 6 FY23 carryforward weeks into the first week of October 2024
- Run-2025: President's budget request was released in March 2024 – first step towards the final budget – stay tuned!

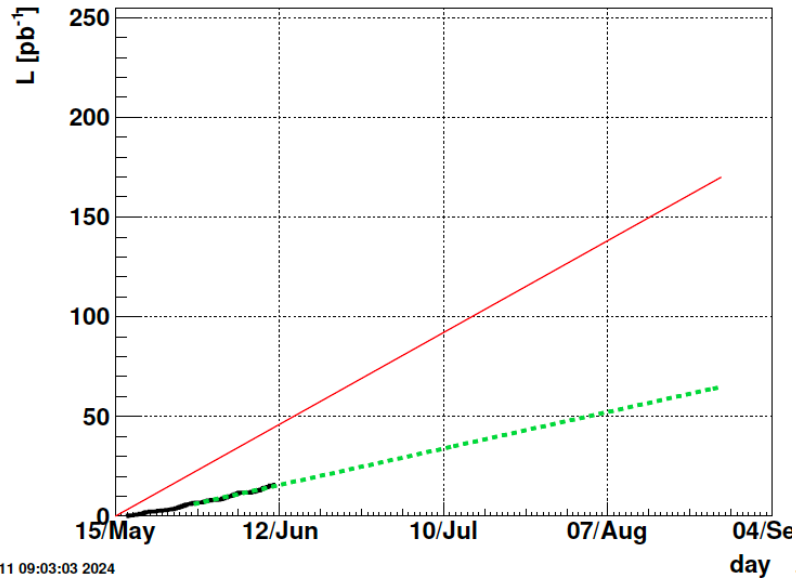
sPHENIX in Run 24

- Photon and jet physics program with calorimeters in full swing
- Rare triggers operational
- DAQ rate > 15 kHz
- Continued progress on TPC and full suite of tracking detectors



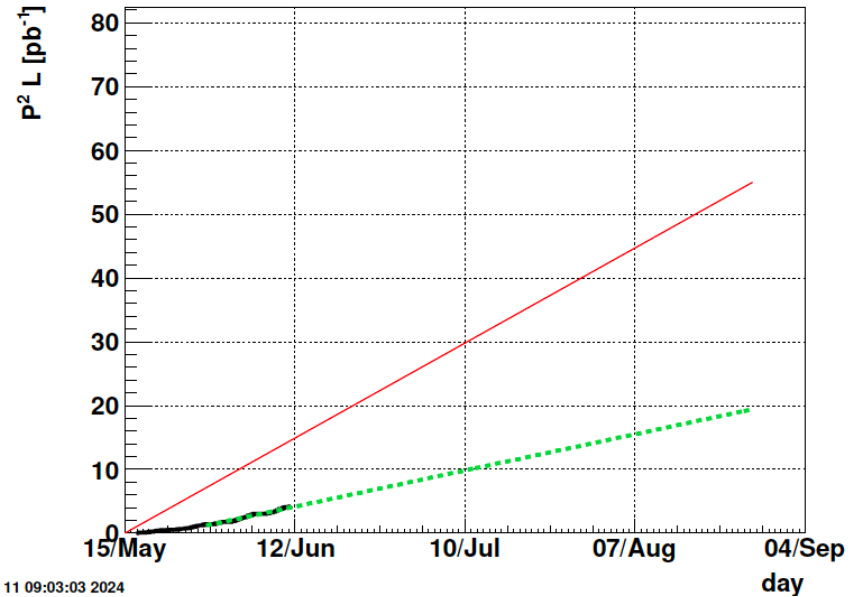
Run 24: a very challenging run

JP2



Tue Jun 11 09:03:03 2024

JP2



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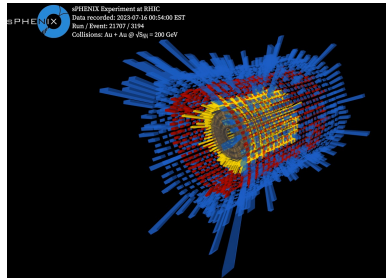
- Run24 goals: sample **luminosity 170 pb⁻¹** and **figure of merit $P^2L = 0.57^2 \times 170 \text{ pb}^{-1} = 55 \text{ pb}^{-1}$** for cold QCD physics
- **STAR takes data smoothly when beams are available**
- **Collected 1.5 B minimum-bias and 1.5 B high multiplicity triggered events with low luminosity for the first 2 weeks**
- As of June 11, STAR sampled **luminosity 15.8 pb⁻¹** and **figure of merit 4.2 pb⁻¹** for cold QCD physics; **challenging to meet our goals** (Red lines: goals; Green: performance of last two weeks)

Completing the RHIC Mission

2023 NSAC LRP recommendation 1: “..... **completing the RHIC science program, pushing the frontiers of human knowledge.**”.....

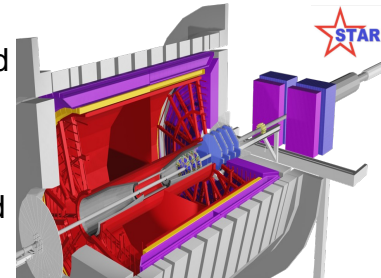
sPHENIX

- Energetic probes to study quark-gluon plasma (QGP) with different length scales & unprecedented precision
- Address how the structureless "perfect" fluid emerges from interactions of quarks and gluons at high temperature?
- sPHENIX outer hadron calorimeter will be part of the EIC project detector, ePIC



STAR with forward upgraded detectors

- Initial state of nucleon and nuclei from high to low x and the inner workings of QGP
- Tomography of gluons and sea quarks inside the nucleon
- Nuclear medium effect on quarks and gluons, their correlations, and interactions, and non-linear effects



RHIC 2024 data taking ongoing & scheduled for 2025, sPHENIX and STAR fully utilize enhanced (44 times Au+Au design) luminosity

Transition to EIC

- Physics EIC group leader, Thomas Ullrich started September 18, 2023
- EIC computing plan with JLab, ePIC and EIC project
- EIC/NPP working together on staff transition, and plan at person level developed
- Plan: dynamic and dependent on funding levels
- Staffing plan includes detector and RHIC tunnel removal and repurposing, operations of injector complex and applications program (Isotope, NSRL)

Maintaining Injector Complex in a Ready State

Funding from FY 2026 onwards keeps

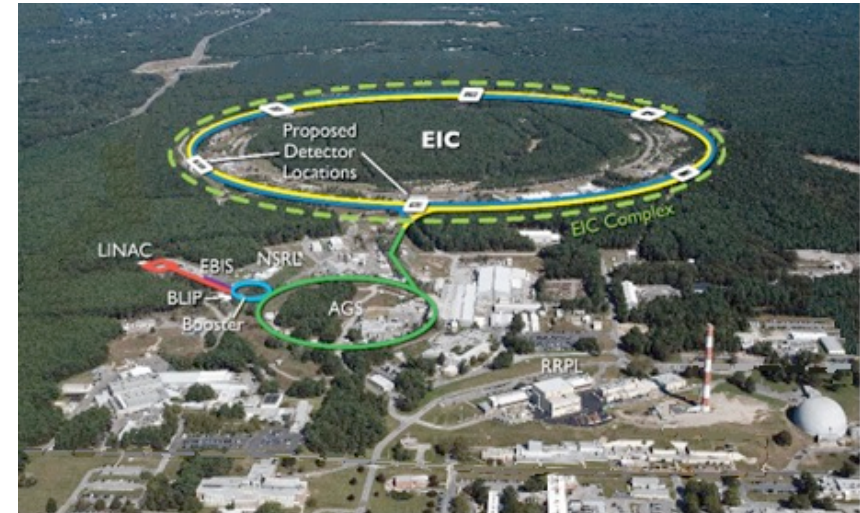
injector complex in ready state

- also allows for continuation of synergistic application programs
- enables facility upgrades for EIC

- **Isotope production – DOE IP**

DOE mission essential function

- uses 200 MeV H⁻ Linac + BLIP
- incremental cost charged to Isotope Program



- **Space radiation testing – NASA (biology) + DoD/others (electronics)**

- uses LION/EBIS/Booster + NASA Space Radiation Laboratory (NSRL)
- NSRL pays 40% of LION/EBIS ops cost, and 20% of Booster ops cost
- proposed HEET facility would also contribute to LION/EBIS/Booster and additionally, AGS ops cost – **DoD RFI response submitted on 31 Jan 2024**

NPP User Experience

Improvements:

- Increase shuttle service – 2 Vehicles now at peak times
 - More trips to LIRR; more shuttles available for pick ups
 - Bus to shopping centers on Wednesday and Saturday
 - Shuttle route to RHIC ring created
- Updated bicycle programs with more bicycles available
- New laundry room(s) in Cavendish and Compton dorm
- Uber and Uber Eats can come onsite if driver has US citizenship
- Replaced mattresses in housing units
- Converted downstairs Cavendish to all-inclusive floor
- Cavendish kitchen floor redone and downstairs rooms renovated
- Provided funds to sPHENIX and STAR to improve user experiences on shifts/on-site

Continued work on:

- Internet at on-site apartments – conversion to 5G internet
 - 9 installs left for this week
 - Verizon will need to configure system so end of June is start date.
- Appearance of on-site housing needs updating
- NPP creating welcoming baskets for new Users to BNL for their first day on-site
- Improve access to food especially after hours
 - Micro Mart in 510 and cafeteria needed
 - Vending machines need to be filled timely – New vendor being sought now
- Discolored water in housing units needs improvement
 - Provide water cooler for drinking water
- Improve off hour site transportation especially for shift worker
- ADA accessible bus awaiting DOE approval
- New lobby furniture for the lobbies of Curie, the guest house, and Compton

Diversity, Equity, Inclusion and Accessibility

- BNL ranked #7 on the top 20 list of government employers by the STEM Workforce Diversity Magazine in 2023; #7 on the Top 20 Government Employers, Equal Opportunity Magazine's 2024 Readers' Choice; #16 2024 Women Engineer Top 20 Government Employer's list
- DEI focus theme on Psychological Safety launched in Spring 2024
- Search ongoing at the lab for an ombudsperson
- Science Accelerating Girls' Engagement (SAGE) starting this summer
- NPP DEI council has been active with many initiatives, ALD Advisory Council (AAC) is active focusing on improving employees' experiences, benefiting users
- 10 proposals encouraged to submit responding to DOE FAIR (4) and RENEW (6) programs in collaborations with MSIs/ERIs
- Workforce development and pipeline: outreach, BNL open house events, SULI, SCGSR, Nuclear Chemistry Summer School, African School of Physics, SAGE, and more

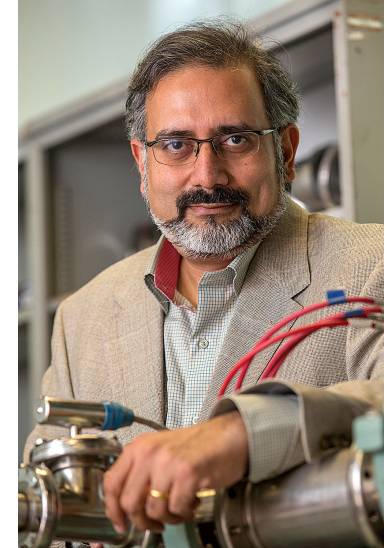
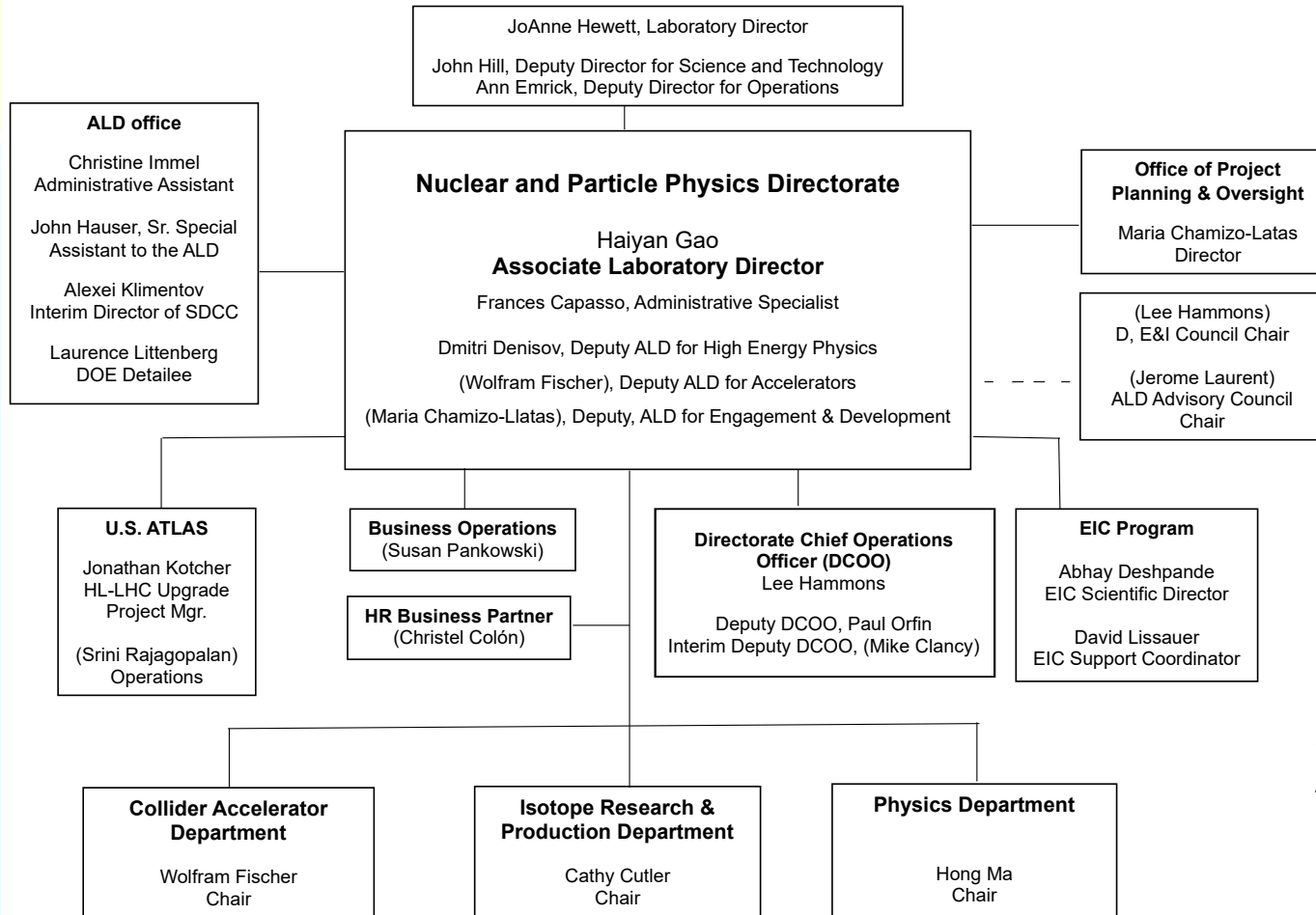


Mini-semester Jan 2024



SBU WISE event, November 2023

BNL Nuclear and Particle Physics



Haiyan will return to Duke at the end of June 2024
Abhay becomes interim ALD, NPP starting July 1, 2024

Isotope Research & Production
New department since October 1, 2023

Thank you for your time and attention!



Thank Yasuyuki Akiba, Dave Morrison, Paul Orfin, Lijuan Ruan, STAR, PHENIX, sPHENIX collaborations, many others, and the DOE and NSF