

RHIC Performance in Run-25

40 minutes including Q&A test

don't expect to need all this time: 14 slides (or maybe 12 slides) with 5 transition slides

(succeeds A. Seryi)

Michiko Minty
Accelerator Operations and Research Division head, C-AD

C-AD MAC-22
17 – 19 December 2025



@BrookhavenLab

Outline

RHIC Performance in Run-25

Timeline and Performance

Accelerator availability

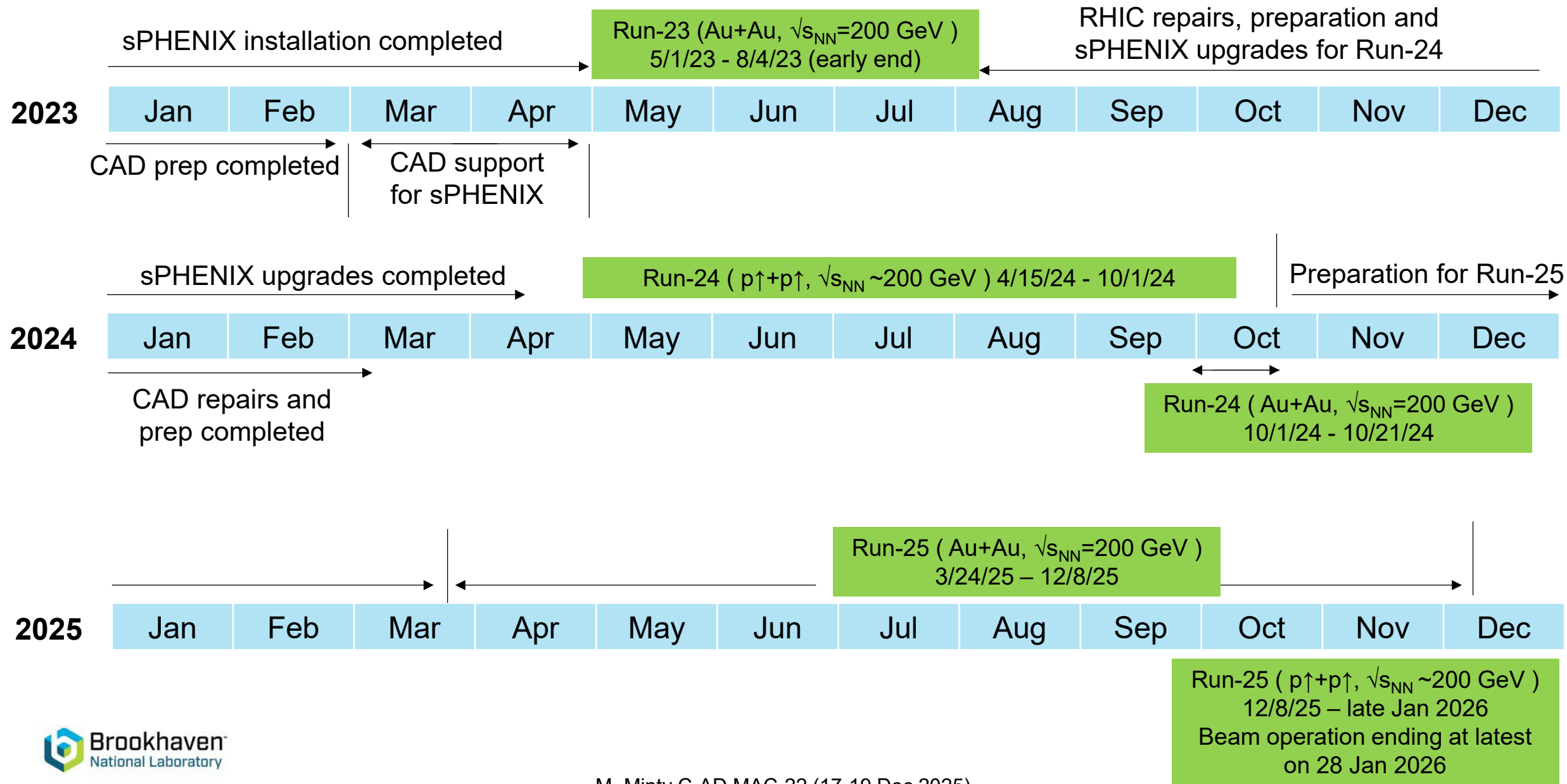
Accelerator Physics Experiments (APEX)

Summary

RHIC Run-25

Timeline and Performance

Recent RHIC schedule



RHIC Run-25 timeline and achievements

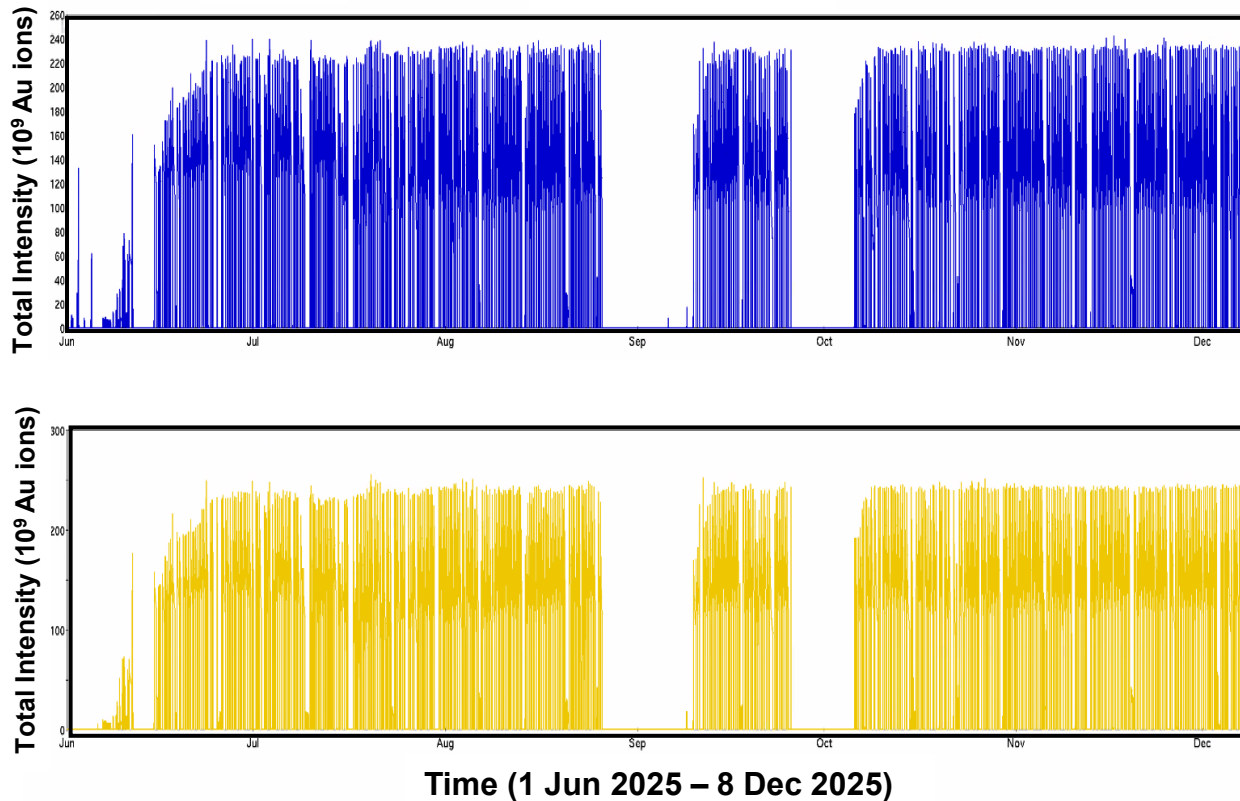
Run coordinator: T. Shrey

- 4K cooldown start, start
- Beam injection
- **Au+Au, $\sqrt{s_{NN}}=200$ GeV**
- APEX and maintenance

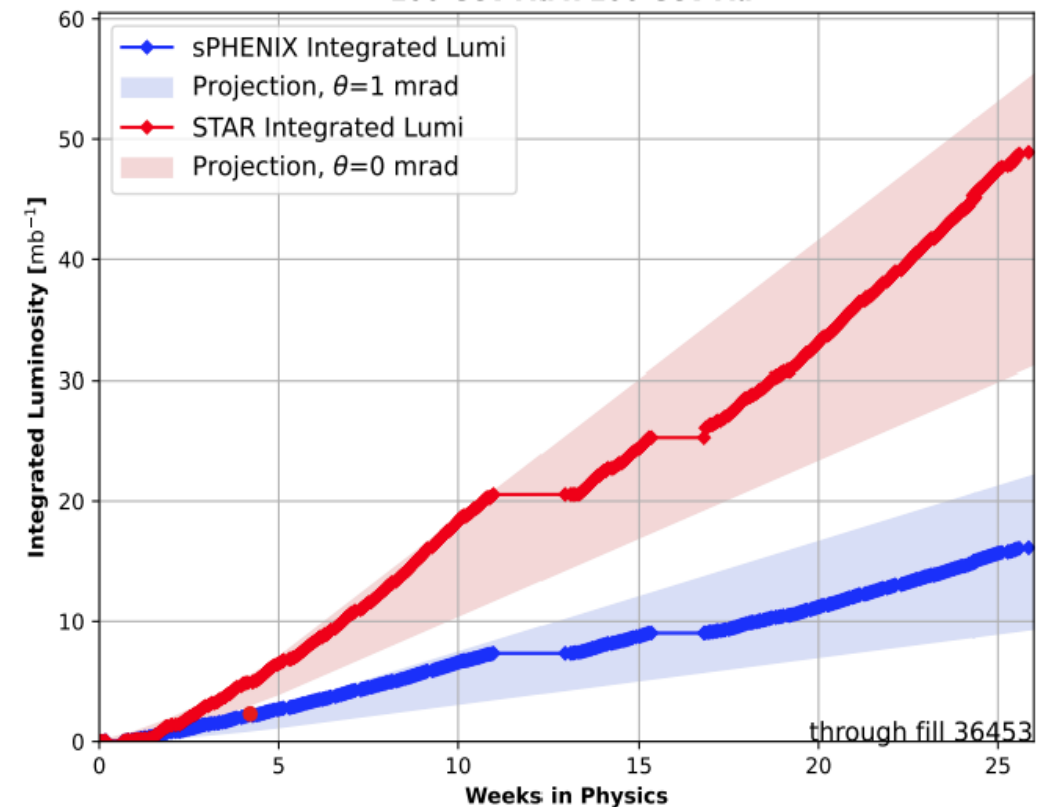
24 Mar 2025, then 28 May 2025
29 May 2025 (Blue), 3 June 2025 (Yellow)
8 June 2025 – 8 Dec 2025
alternating weeks starting 25 June 2025

confirm
dates

Beam intensities



FY25 Delivered Luminosity to sPHENIX and STAR
100 GeV Au x 100 GeV Au



Beam User Requests (presented to NPP PAC, 7-8 Nov 2024) and status

sPHENIX

J.Haggerty “sPHENIX Summary and Run 25 Plan”

Improve optics

sPHENIX Physics Target in Run-25: 7 nb ⁻¹ (50B events)		
Collision Species	Cryoweeks	Projected luminosity, z < 10 cm
Au+Au 200 GeV	20	2.4 – 4.2 nb ⁻¹ recorded
Au+Au 200 GeV	28	3.6 – 6.4 nb ⁻¹ recorded
If Au+Au luminosity target is met, ordered priority list for additional running:		
Collision Species	Physics weeks	Projected luminosity, z < 10 cm
1. p+p 200 GeV	8	13 pb ⁻¹ sampled + 3.9 pb ⁻¹ streaming
2. p+Au 200 GeV	5	80 nb ⁻¹ sampled + 24 nb ⁻¹ streaming
3. O+O 200 GeV	2	13 nb ⁻¹ sampled + 3.9 nb ⁻¹ streaming



in progress

not funded

STAR

J.H. Lee “STAR Summary and Run 25 Plan”

$\sqrt{s_{NN}}$ (GeV)	Species	Number Events/ Sampled Luminosity	Year
200	Au+Au	8B+5B / 1.2 nb ⁻¹ +20.8 nb ⁻¹	2023+2024+2025 (20 cryo-weeks)
200	Au+Au	8B+9B / 1.2 nb ⁻¹ +28.6 nb ⁻¹	2023+2024+2025 (28 cryo-weeks)



Performance Summary, (Au+Au, $\sqrt{s_{NN}}$ ~200 GeV), 8 June 2025 – 8 Dec 2025

- Priority (NPP PAC) for sPHENIX, provided collisions also for STAR.
- sPHENIX background issue (identified in Run-24) not present (had removed a legacy “mask during preceding shutdown
- Achieved highest-priority goals

Next physics priority, (p↑+p↑, $\sqrt{s_{NN}}$ ~200 GeV), 8 Dec 2025 – late Jan 2026

- Expect to achieve additional requested physics goals (p+p for sPHENIX)
- My run additional experiments (FXT and CeC) if p↑+p↑ goal is achieved (contingent on DOE approval)

RHIC Run-25 Availability

Question:
Present next 3 slides (one per major intervention) or summarize and place these in backup?

2 Month delay to start the run

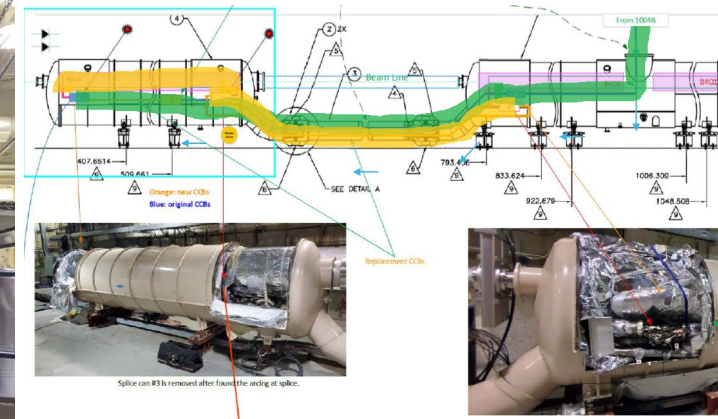
Blue ring main dipole would not pass the high-potential test once the ring was cold. Limited number of places where the fault could be narrowed down, required a full cryogenic warm up.

After exhaustive work from large parts of the department the short was identified after opening multiple areas in sector 4. It was found to be a sharp point on a repaired splice from the DX failure in Run23. Cryostat opening to the start of the cooldown took over 1 month.

Simultaneous with this were power supply failures for both extraction bumps in the AGS. Pulsed power group and power supply technicians effectively built all new supplies and wrapped up one day before RHIC was ready for beam.

Beam Operations began 5/31/25

confirm
dates

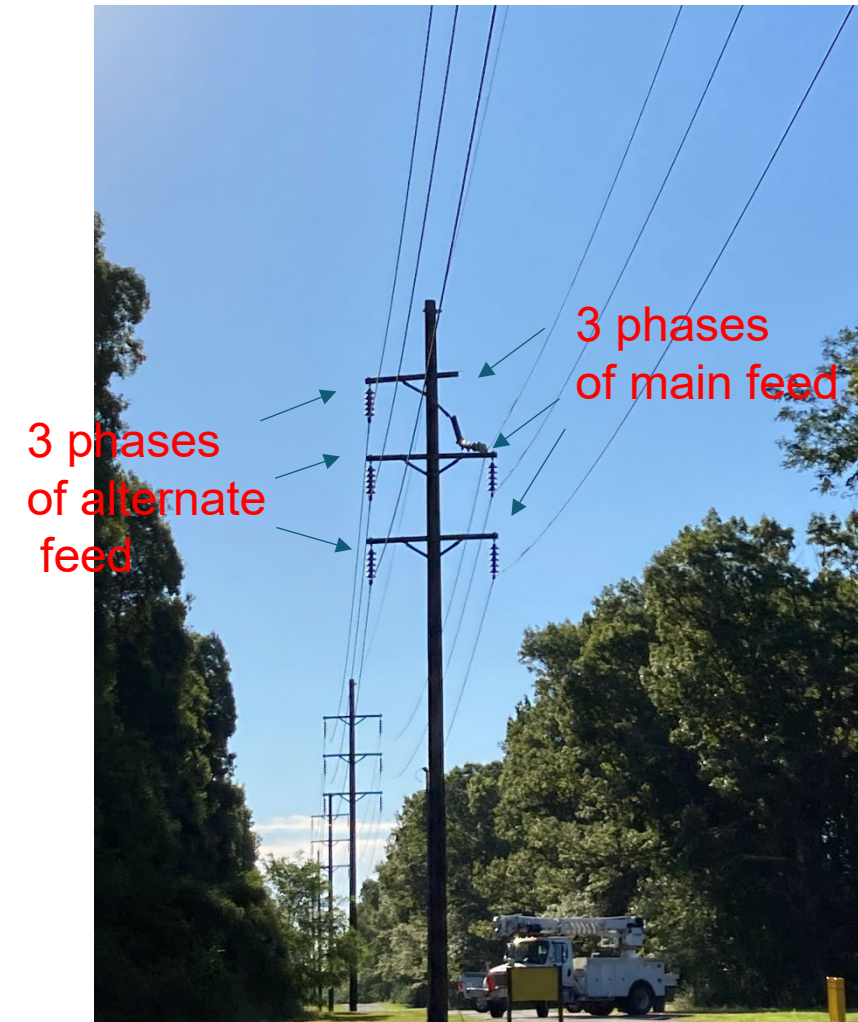


Power line failure

A failed arm on one of the 69 kV power poles that feed the north campus was identified. The single pole carried both the main feed and the alternate feed; PSEG would not carry out the repair without both lines shut off.

A power interruption of more than a few hours would result in massive helium inventory loss from the cryogenic plant if the rings remained cold. Cryogenic experts worked around the clock to warm up in a controlled way that utilized all of our storage capacity.

The repair was ultimately completed very quickly (90 minutes) and minimal helium inventory was lost. Cooldown commenced immediately and beam operation was restored; total time lost was 14 days

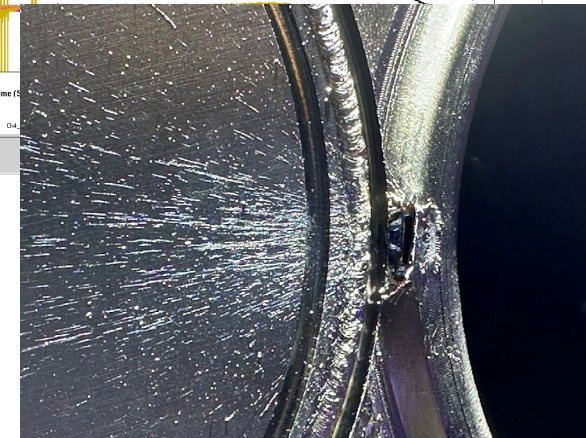


Abort kicker failure

Two modules of the abort kicker fired early in a still-unexplained failure mode of the system (module 1 thyatron appears to have been conducting continuously for 12 seconds). The almost-perfect overlay in delays pushed 2/3 of the bunch train into the small section of flange between the circulating beampipe and the dump window.

Vacuum group and riggers disassembled the dump pipes and a weld repair was made spectacularly fast. Vacuum bakeout and pump down took approximately 1 week, with a total downtime of 11 days.

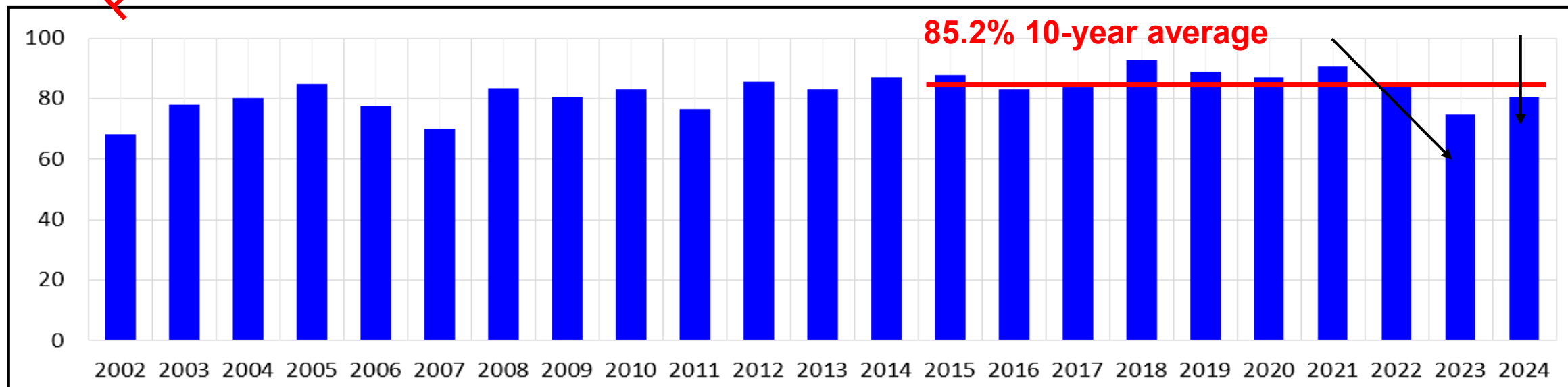
In response to the failure MCR will be monitoring injection and store performance of the abort kicker modules going forward for every fill. There is an indication that the failure was preceded by strange timing shifts in the module in question for several stores before the incident.



RHIC Availability

Au+Au 100 GeV 74.4% FY23
 p↑+p↑, Au+Au 100 GeV 80.4% FY24

RHIC Availability [%]



Availability = beam time / scheduled beam time

Availability goals: 82.5% (< FY20), 85% (FY21-FY22), 82.5% (FY23), 80.0% (FY24-FY25)

RHIC Run FY25: **80.98% (12/9/25)**

Average over last 10 years: **XX (update)**

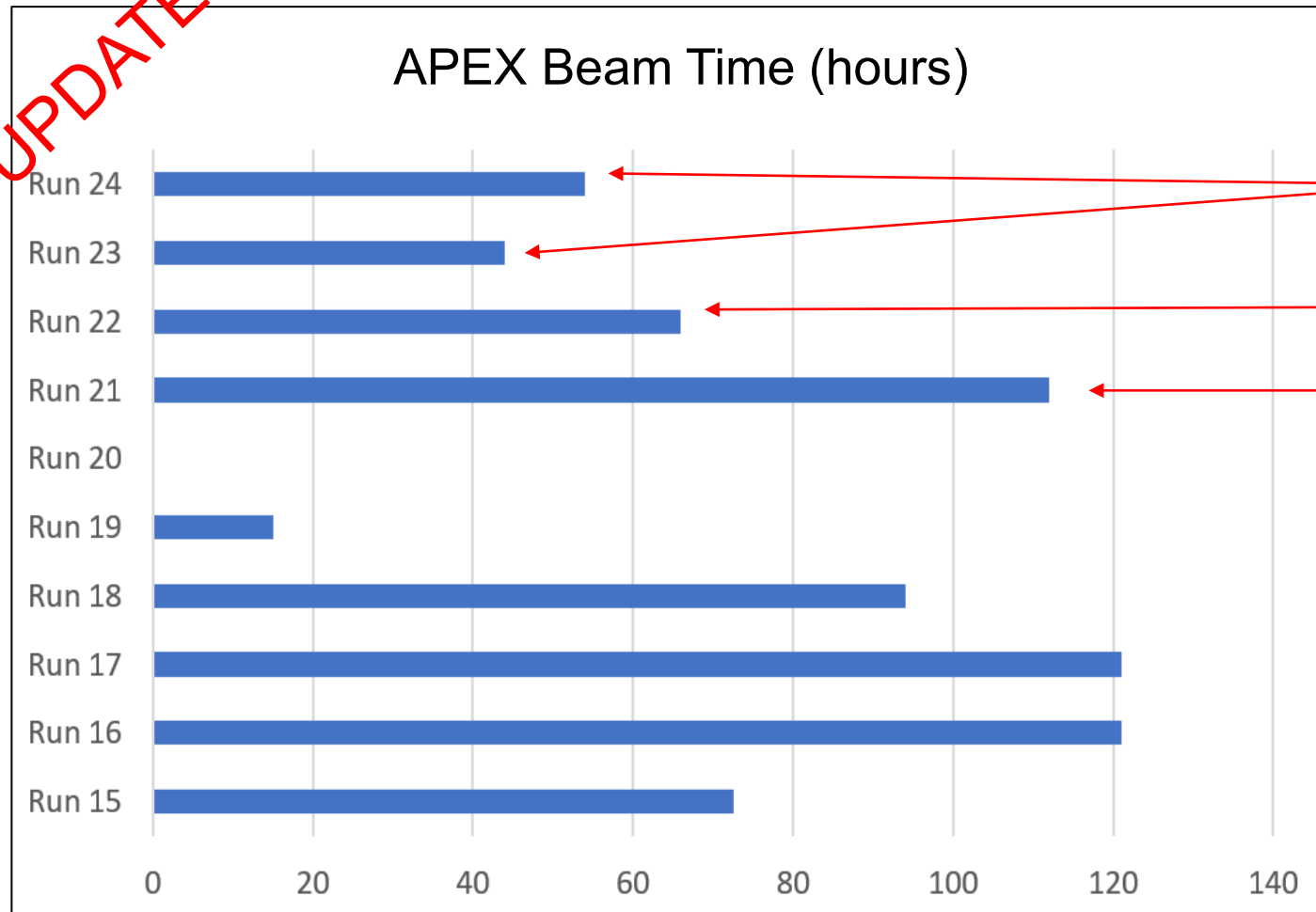
RHIC Run-25: operated over extended period including through summer
 Accelerator availability goal met in FY25/FY26 (so far).

Accelerator Physics Experiments (APEX)

Accelerator Physics Experiments (APEX) - Overview

APEX coordinators:
H. Huang (C-AD)
and Y. Luo (EIC)

UPDATE



experiments to inform EIC design

experiments to inform EIC design and
beam cooling studies

focus: beam cooling studies

(minimal APEX during BES-II and
pandemic)

APEX workshop held March 2024 <https://indico.bnl.gov/event/22322/>. Featured:

- comprehensive list of EIC-related APEX requests for 2024/2025 (next slide)
- detailed plans for experiments

Current proposals in the order of Grades

Improve optics

Index	Proposal title	Spokesperson	Time asked (h)	Time used (h)	Grade	Species	Energy	Status
24-03	Accelerating flat gold ion beams from 31GeV to 100GeV	Y. Luo	48	29	0A	Au	31, 100GeV	Done
25-01	Maximize beam-beam parameter with flat beam collision in RHIC	Y. Luo	12	25	0A	Au	100GeV	
25-04	RF transient beam loading studies	F. Severino	4	4	0A	Au	injection	Done
23-02	IP8 optics tuning with crossing angle and short vertex	X. Gu	12	3.5	1A	Au	100GeV	Done
25-09	Measure Longitudinal Impedance in RHIC	M. Blaskiewicz	6	4	1A	Au	injection	Done
25-12	Octupole Limit in RHIC	M. Blaskiewicz	6	6	1A	Au	injection	Done
25-08	Using Sextupole to Reduce Vertical Emit. Growth in Flat Beam Collision	D. Xu	12	20	1A	Au	store	Done
25-10	Benchmark IBS Rate with Coupling for Flat Beam	Y. Luo	12	5.5	1A	Au	store	
23-10	Transition Jump with Reduced Number of Jump Quadrupoles	H. Lovelace	16	20	1B	Au	ramp	Done
25-02	Coherent electron Cooling Experiment	V. Litvinenko	168	13	1B	Au	19.57 GeV	
Total			296	130				

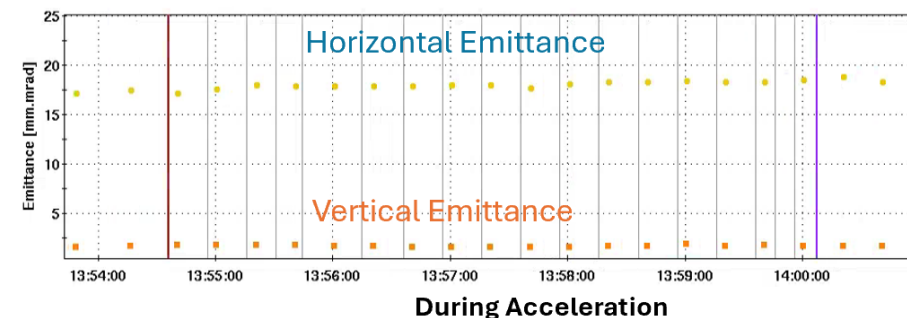
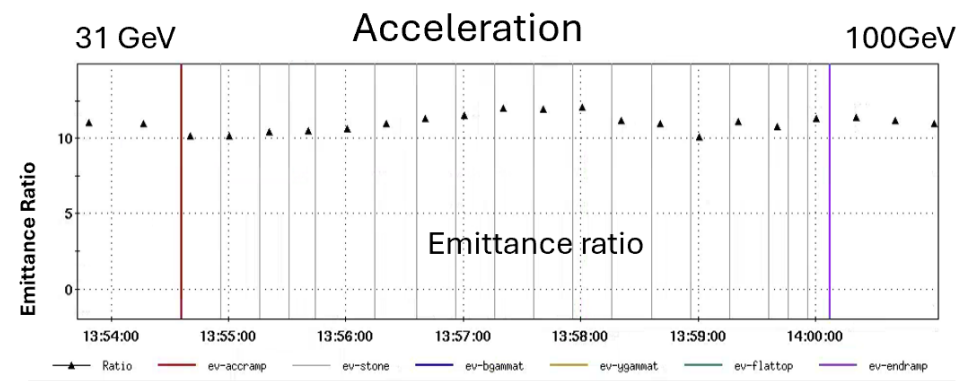
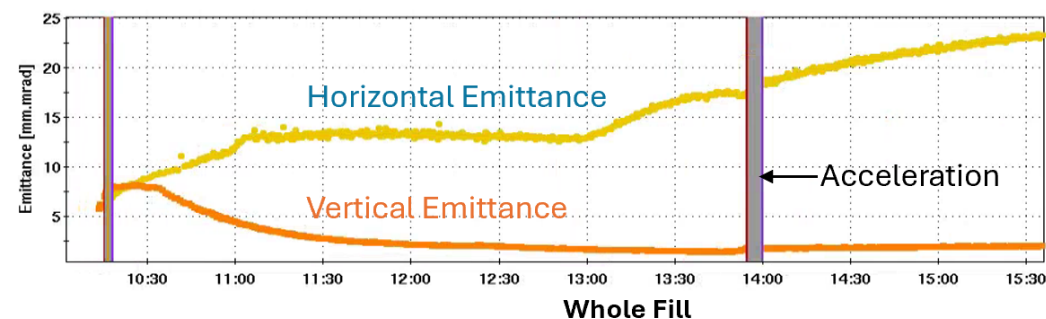
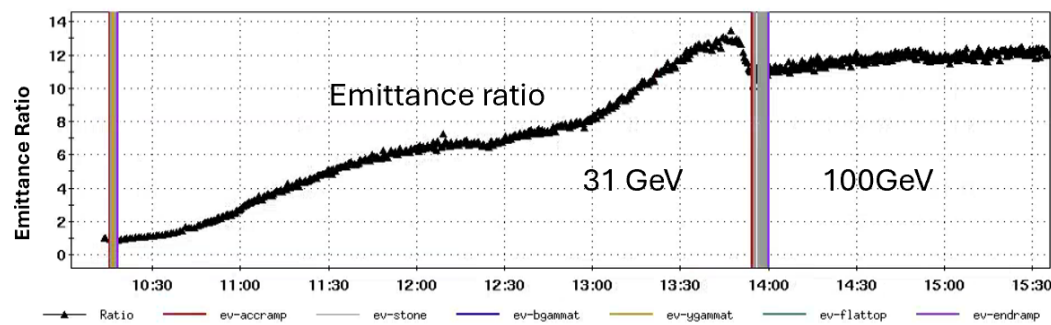
The APEXs carried out this year are primarily for EIC design. They can be categorized into four groups:

1. Flat beam related APEXs 69.5 hours.
2. Machine limitation for EIC (Transition jump with less quads and octupole limit) 26 hours.
3. RHIC parameter check for EIC (Impedance of RHIC and beam loading) 8 hours.
4. CeC test 13 hours so far
5. AI lumi optimization 3.5 hours.

Flat Beam Acceleration Experiment in RHIC

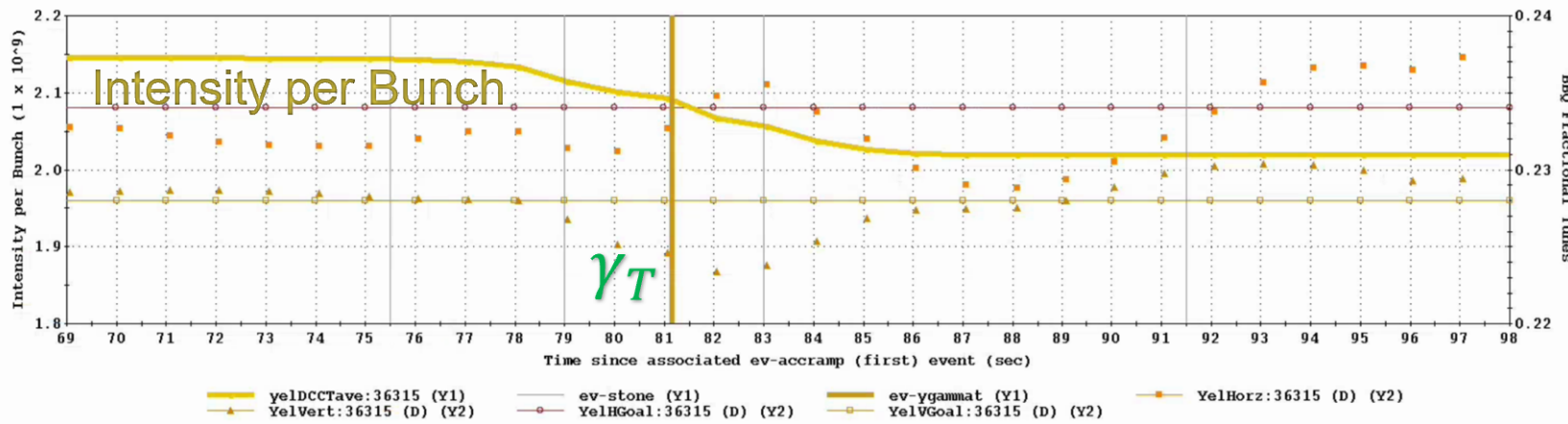
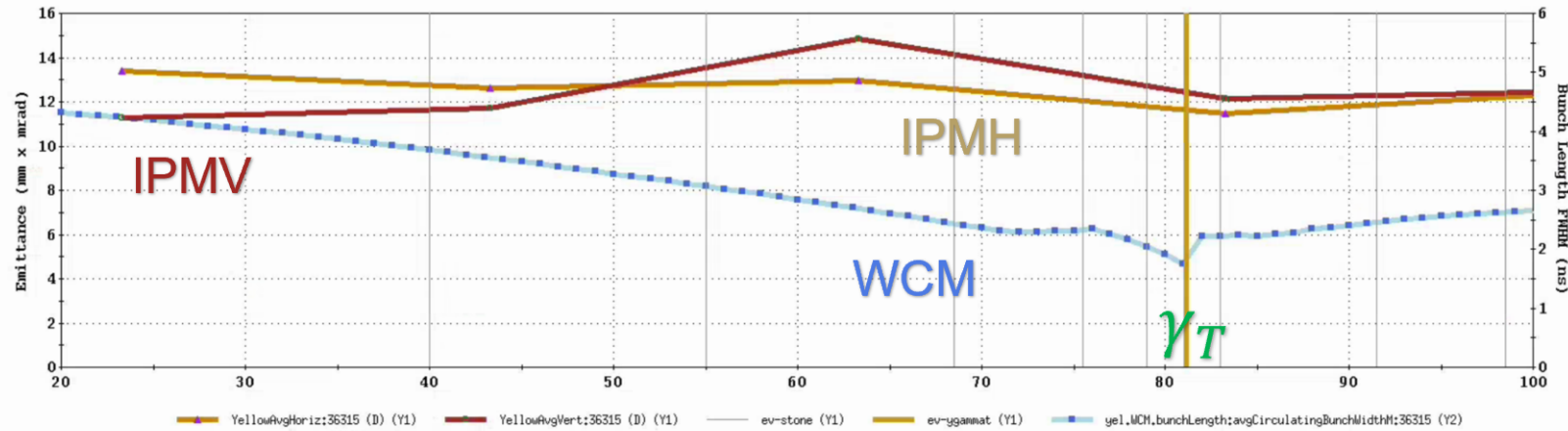
Improve
optics

- For EIC/HSR, a large emittance ratio proton beam will be generated at injection energy (~ 24 GeV) and be accelerated to store energies for high luminosity collision.
- In this experiment, gold ion beam with a maximum transverse beam emittance ratio 13:1 was generated at 31 GeV/nucleon with stochastic cooling. Transverse emittance ratio 11:1 was well maintained during acceleration from 31 GeV/nucleon to 100 GeV/nucleon.



Reduced Number of Jump Quadrupoles (RJQ)

Improve optics



- The RJQ APEX demonstrated the effects of crossing transition with fewer transition jump quadrupoles (Total 48)
 - 44 jump quadrupoles (G24Q20)
 - 40 jump quadrupoles (G24Q16)
- 111 bunches, $\sim 2 \times 10^9$ at transition
 - No significant beam loss ($\sim 6\%$)
 - No emittance blowup

Summary

Summary

RHIC performance in RHIC Run-25: Au+Au at $\sqrt{s_{NN}} \sim 200$ GeV

- Total of **XX** cryo-weeks: **XX** weeks + 2 weeks expended during RHIC Run-25
- Emergent issue from Run-24 with sPHENIX backgrounds (MVTX auto-recovery events) resolved by removal of upstream hardware.
- Three large interventions during run (main dipole short in Blue Ring, 69 kV power line breakage, abort kicker failure)
- Accelerator Physics Experiments (APEX) to inform design and/or operation of the EIC were successfully executed.
- Achieved (NPP PAC definition) Au+Au run goals for sPHENIX and STAR.
- Accelerator availability: operation during summer months (environmental controls) very successful - achieved 80% target (**XX%**) with 10-year average of **XX%**.

Underway (since 8 Dec 2025): $p\uparrow+p\uparrow$ at $\sqrt{s_{NN}} \sim 200$ GeV for sPHENIX

Other experiments (FXT for STAR and Coherent Electron Cooling) TBD, contingent on reaching $p\uparrow+p\uparrow$ luminosity goal and DOE approval.

The era of RHIC beam operations will conclude at latest on 28 Jan 2026.

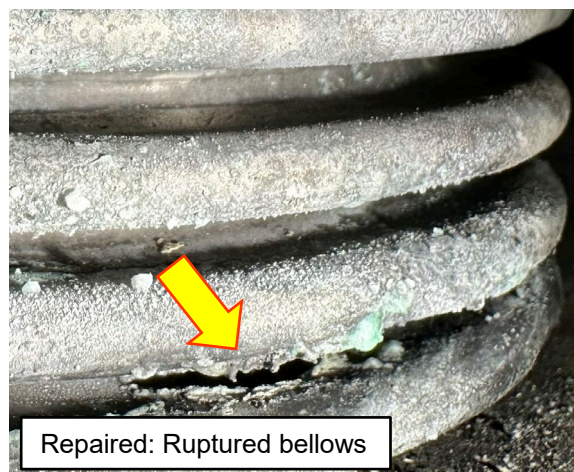
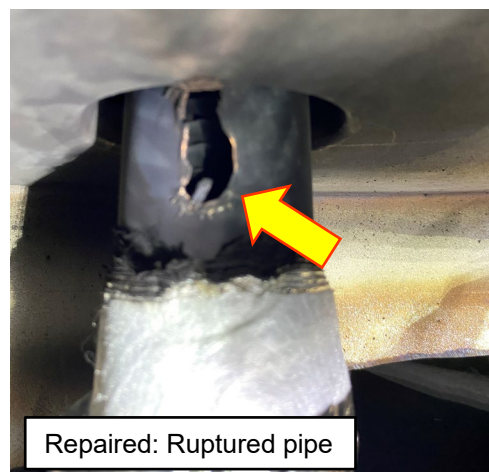
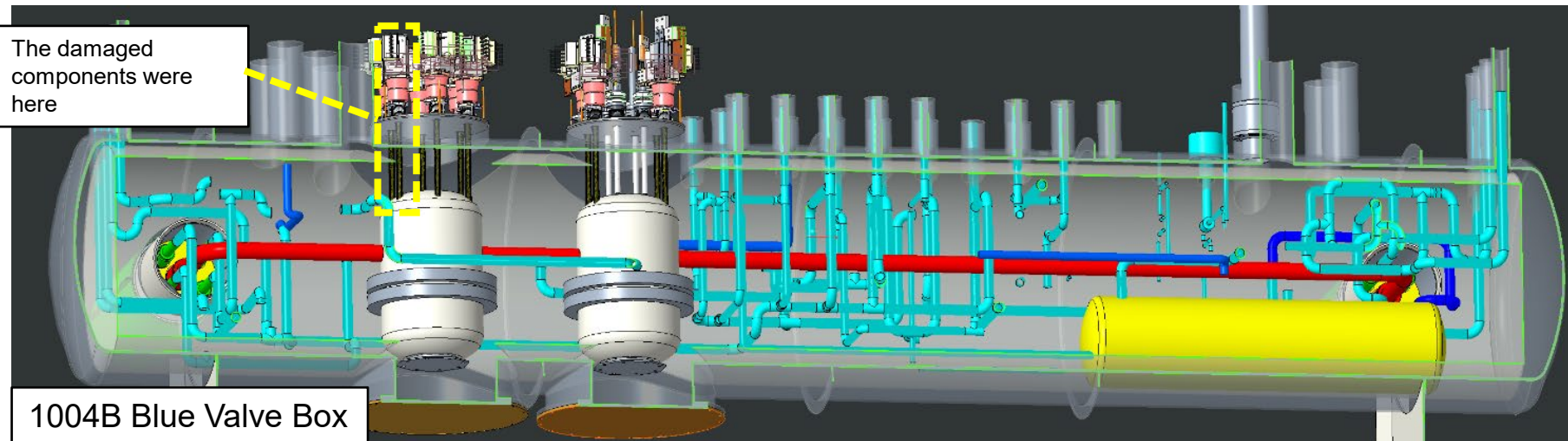
Supplementary Slides

RHIC Run-24 repair work

R. Feder, C. Mi,
J. Escallier et al

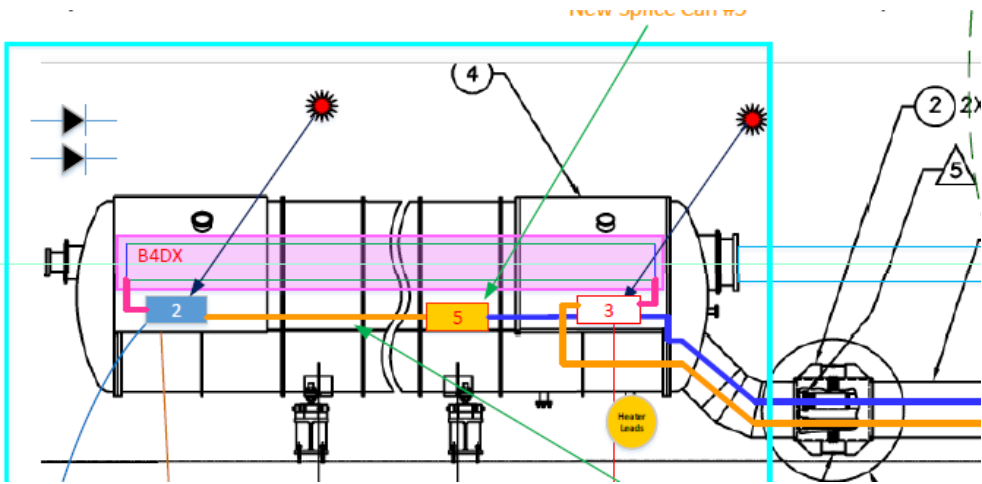
Failure of a magnet power supply 150A current lead in 1004B blue valve box (Aug 2023)

External review of causal analysis and engineering solutions (Nov 2023) <https://indico.bnl.gov/event/20923/>

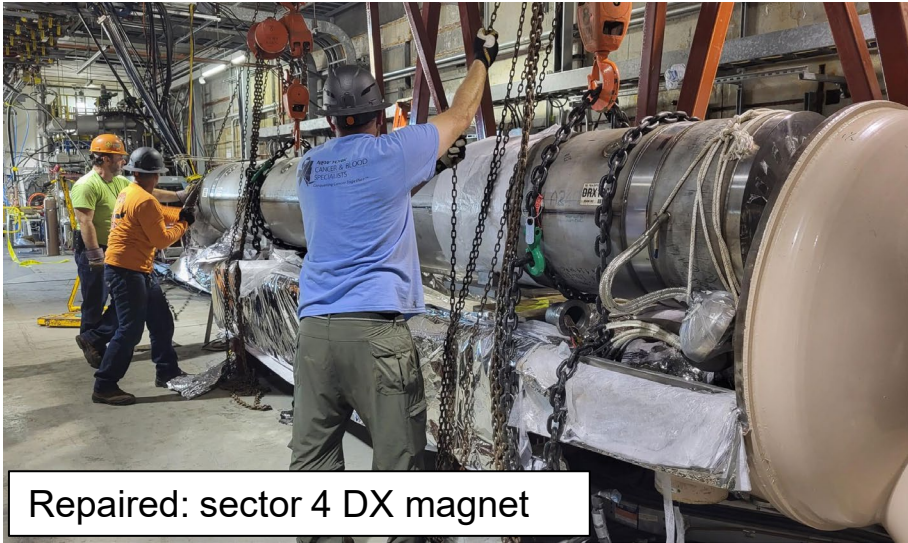


Downstream damage found at 4:00 cable splice joints and in the DX magnet, and later at the B3Q8 diode
8-month recovery effort involving more than 40 people across many disciplines and departments.

C. Mi, R. Feder,
et al



Repaired: SC splice joint at can #2



Repaired: sector 4 DX magnet



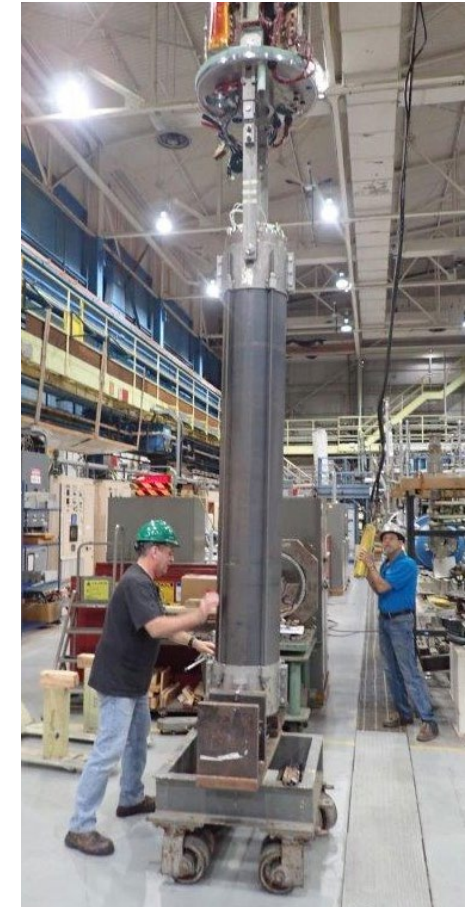
Repaired: SC splice joint at can #3

All repairs completed, RHIC ASE and USI (additional ODH controls) updated, all systems operating as expected.

RHIC Blue Snake Magnet

C. Atanasio, M. Hartsough,
M. Milidantri et al

- Two Snake magnets damaged during Run-22 (13 Dec 2021, 12 Dec 2021).
- With strong support of SC Magnet Division, repair completed Jul 2023.
- Installed for RHIC Run-24.



Installed prior to Run-24, magnet fully functional and working as expected.