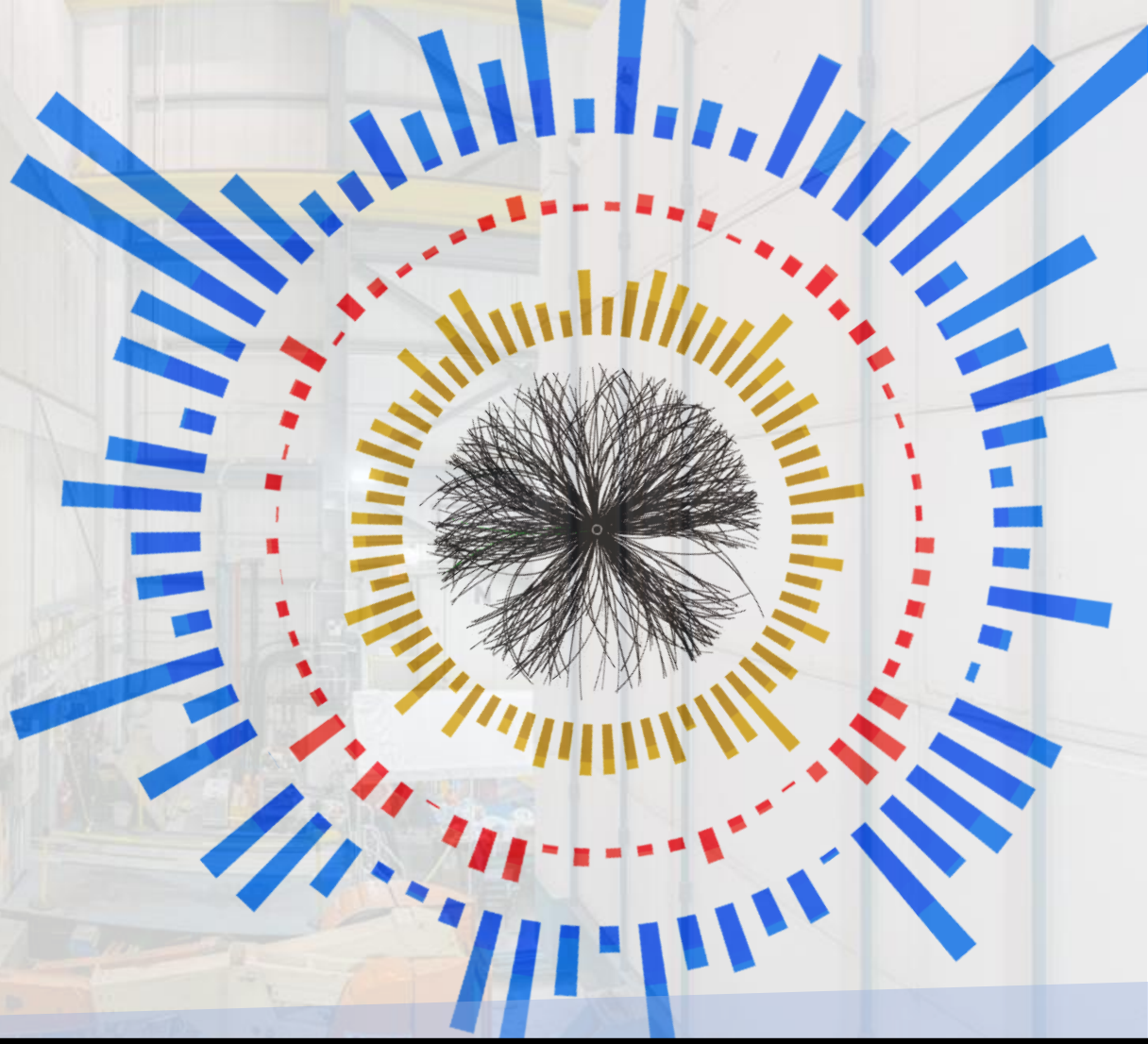
sPHENIX
Status and Aspirations
BNL NPP 2025 PAC Meeting

Jin Huang (BNL)
Megan Connors (GSU)

June 17, 2025



sPHENIX

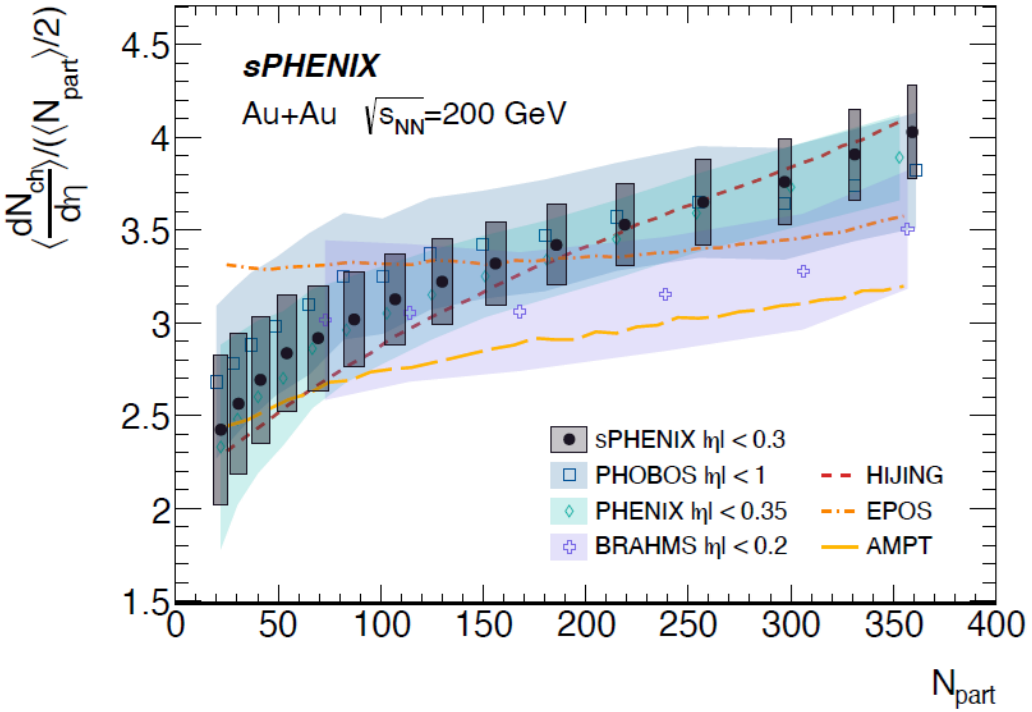
Data recorded: 2025-06-10 05:50:10 EST
Run / Event: 66641 / 146
Collisions: Au + Au @ $\sqrt{s_{NN}}$ = 200 GeV

First paper submission from sPHENIX Run24

Run24 Oct 21 — PAC-24 Nov 7-8 — First papers submission Apr 3 — QM-25 Apr 6-12 — PAC-25, Jun 17

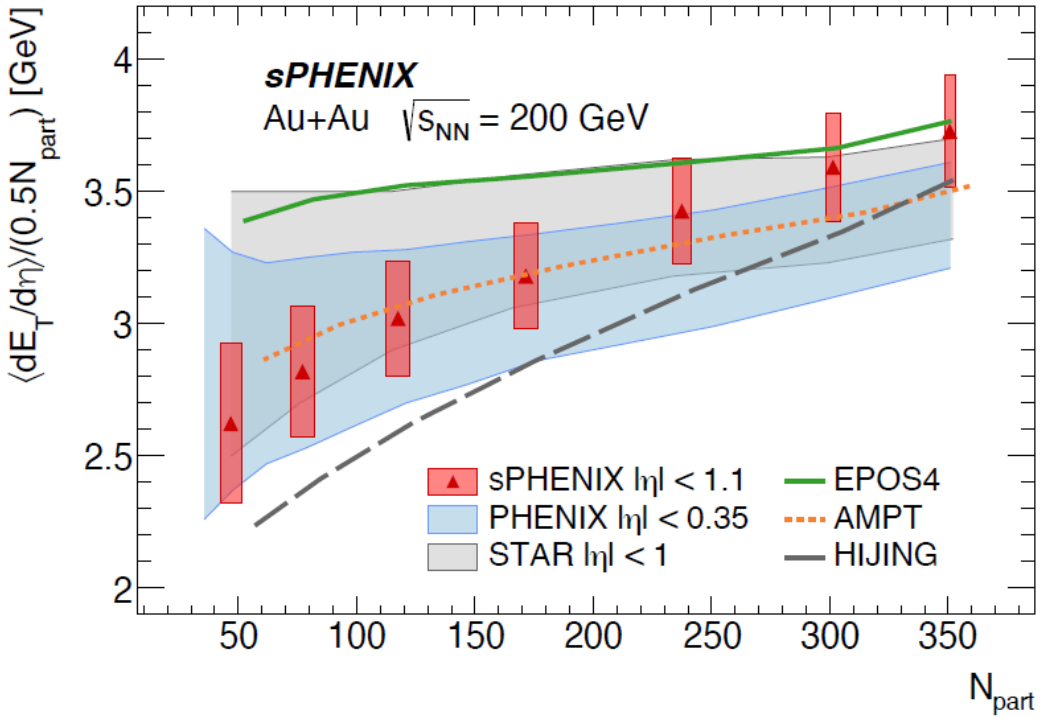
Charged Hadron Multiplicity

arXiv:2504.02240, under review for JHEP



Transverse Energy Density

arXiv:2504.02242, under review for PRC



Within 6 months of Run 24 completion, submitted standard candle Au+Au measurements

→ Consistent with past publications; physics readiness from online to offline

Preliminary results from sPHENIX Run 24 p+p

PAC-24 Nov 7-8

PAC-25, Jun 17

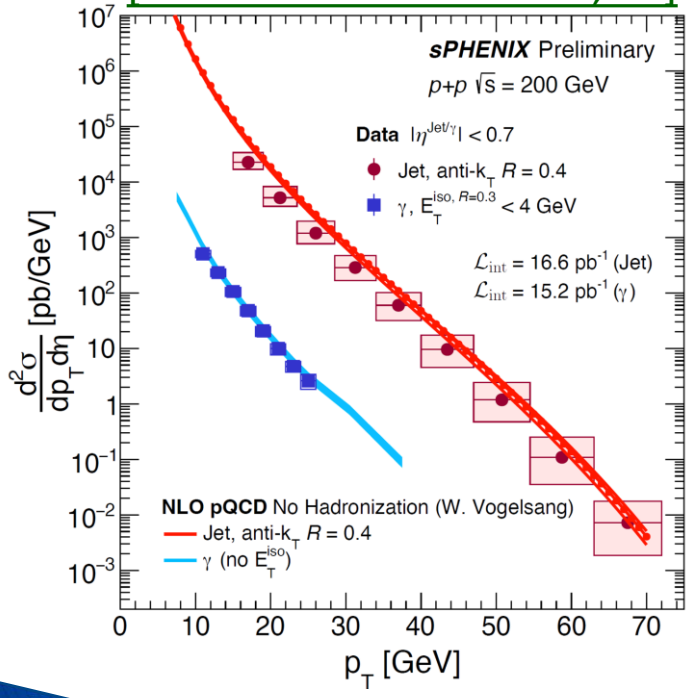
Run24 Oct 21

DIS-25 Mar 24-28

QM-25 Apr 6-12

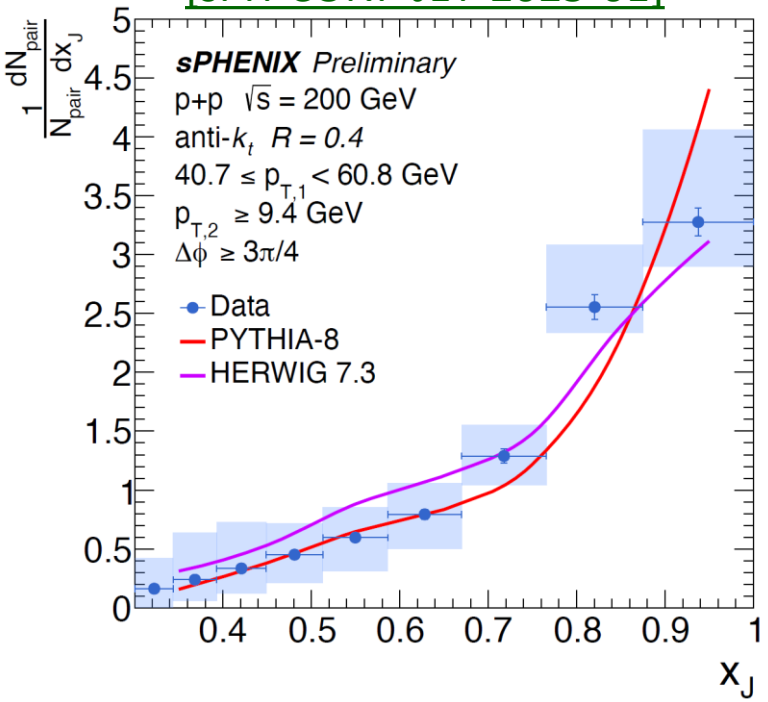
Jet and photon spectra

[sPH-CONF-JET-2025-02, 03]



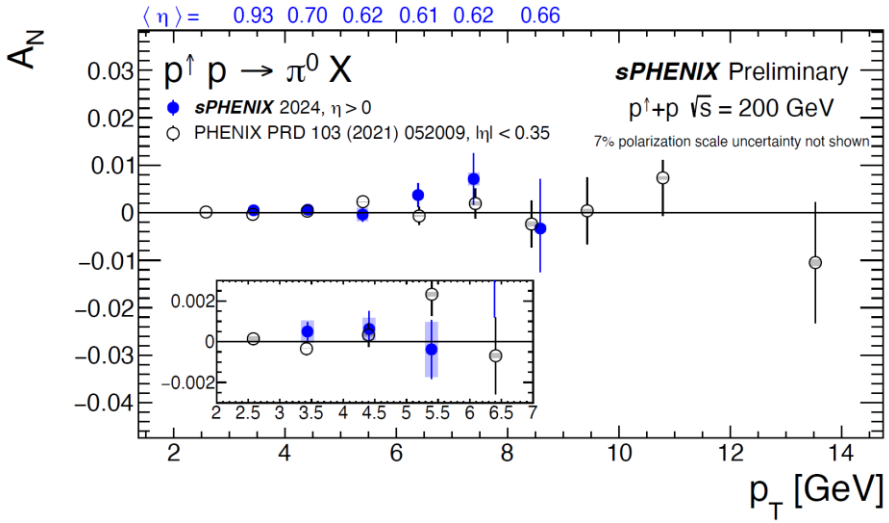
Dijet balance

[sPH-CONF-JET-2025-01]



π^0 Trans. Spin Asymmetry

[sPH-CONF-COLDQCD-2025-01]

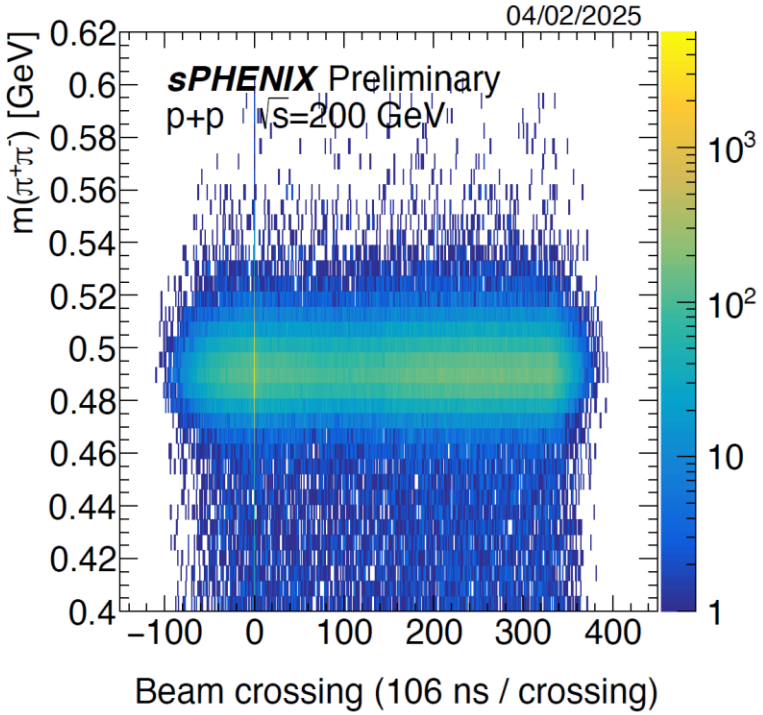


With a fraction of the data, demonstrated unpresented jet kinematic reach; first spin results

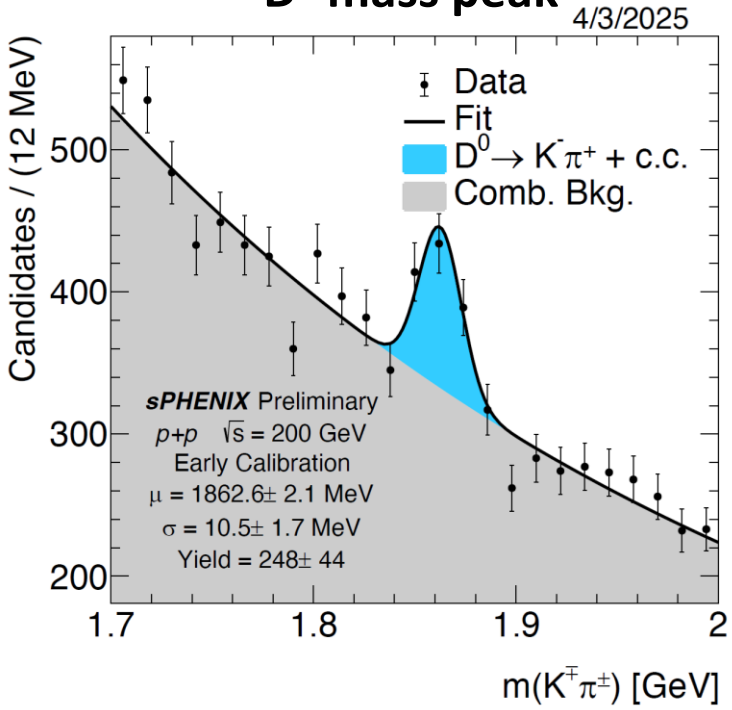
See more results: https://www.sphenix.bnl.gov/PublicResults

Streaming-enabled capability from sPHENIX Run24 p+p

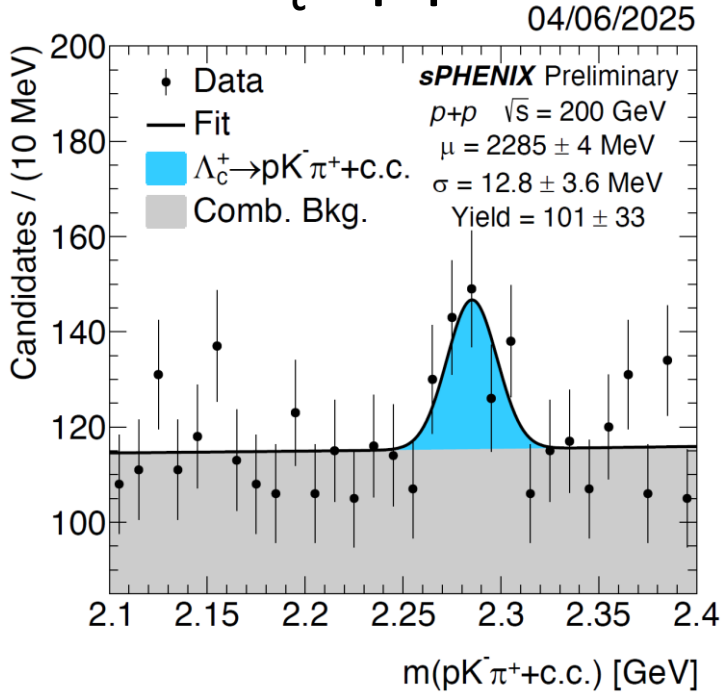
Steady $K^0_s \rightarrow \pi^+ \pi^-$ peaks in streaming



D^0 mass peak



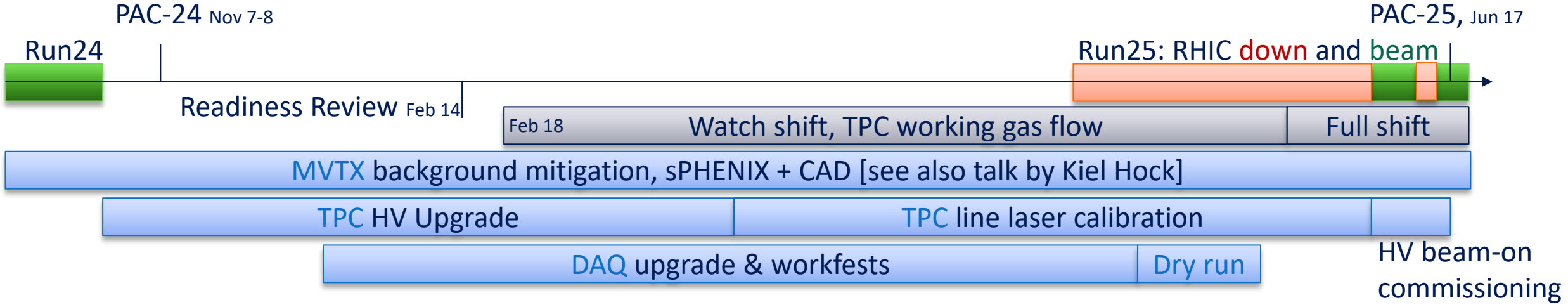
First Λ_c in p+p at RHIC



Very successful streaming program for non-triggerable HF signals → HF resonances observed in ~1 hour of data

See more results: https://www.sphenix.bnl.gov/PublicResults

Since PAC-24: work at sPHENIX to max physics capability

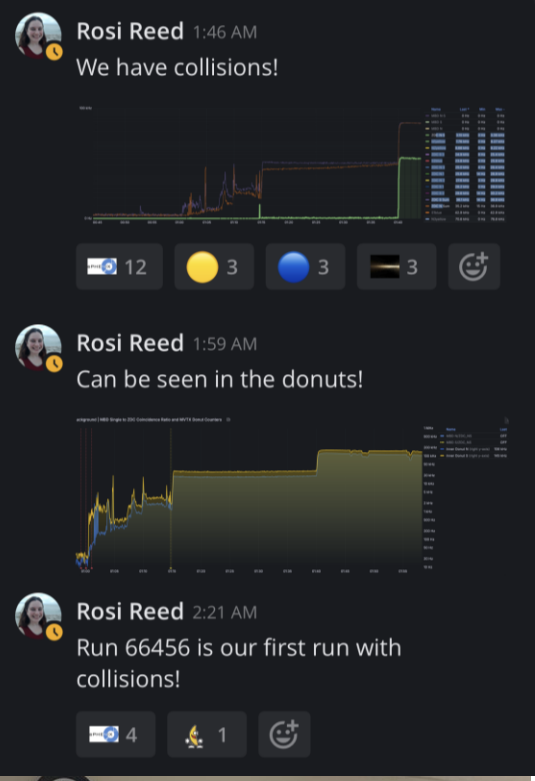


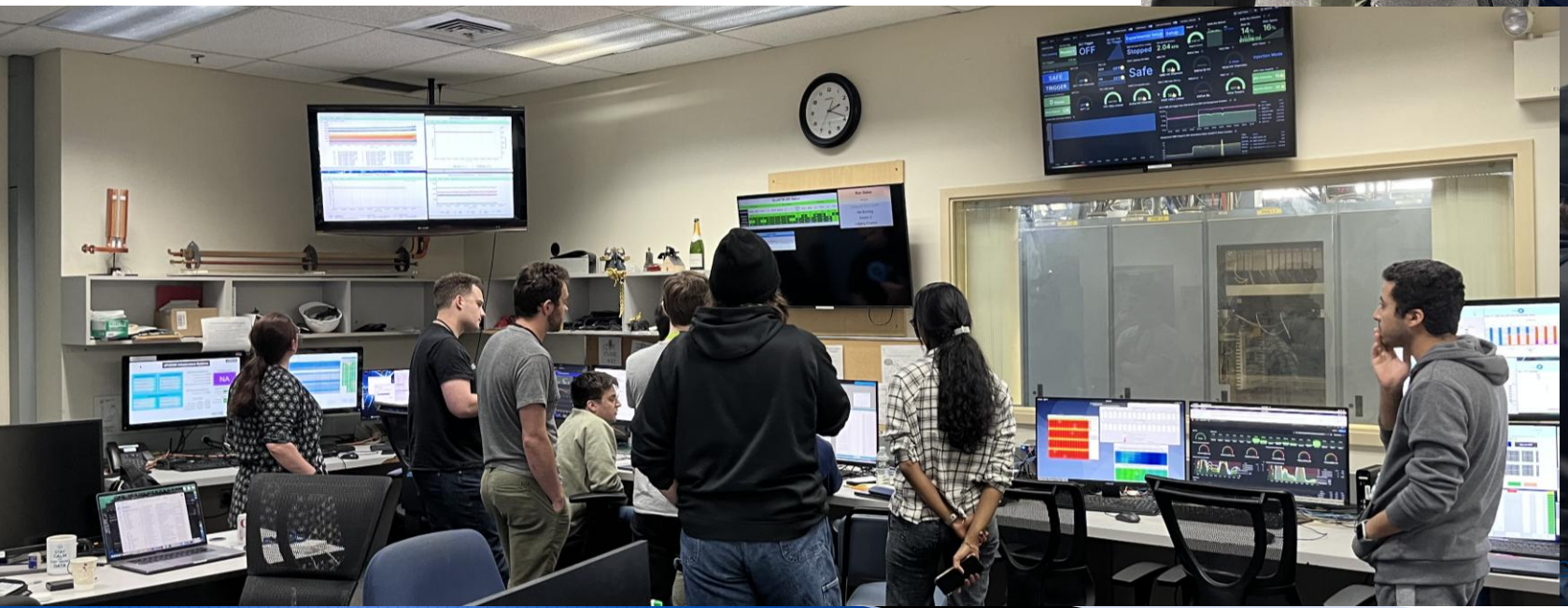
Challenges → mitigations:

- Beam background on MVTX → CAD+sPHENIX beam background taskforce
- TPC HV stability → upgrade to cascade power supply
- High lumi Au+Au data expected → completed the scheduled DAQ buffer disk upgrade, doubling data logging throughput
- Down time due to RHIC magnet short → "summer task" of TPC line laser calibration

First Run 25 collisions!

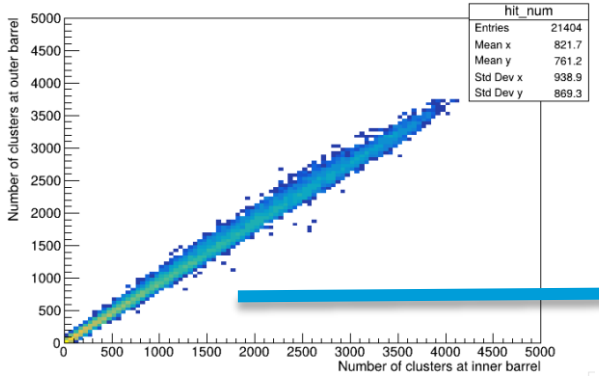
- June 9 1:40 am we saw the first collisions of Run 25!
- Special thanks to our Run coordinators, shift crews, and experts who were ready



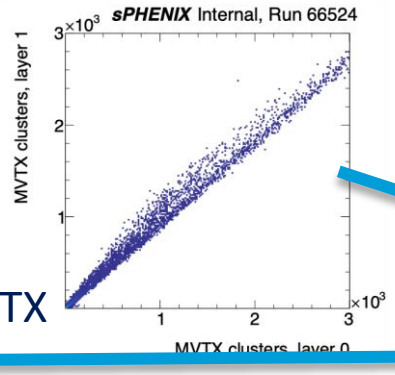


Data checks immediately following collisions!

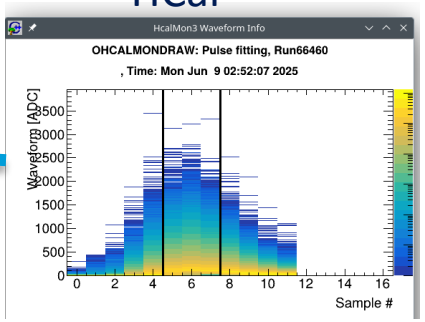
INTT

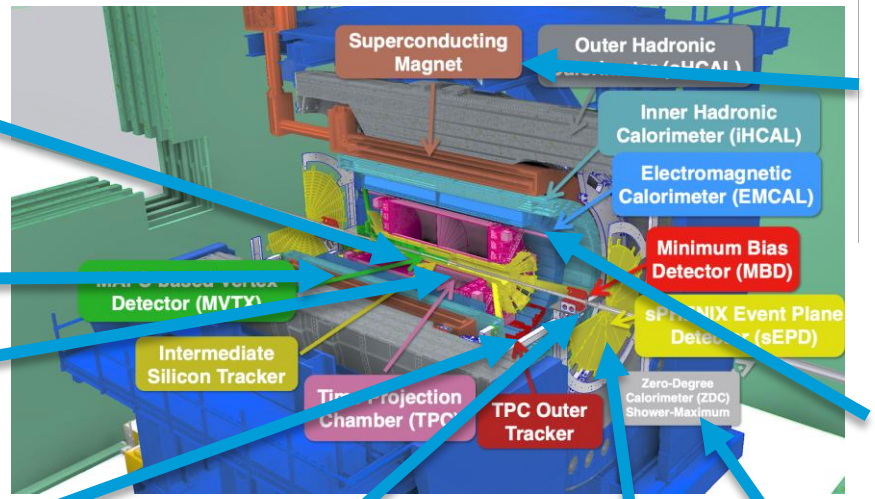


MVTX

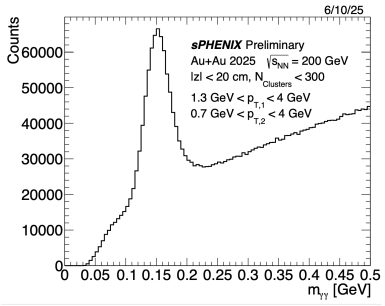


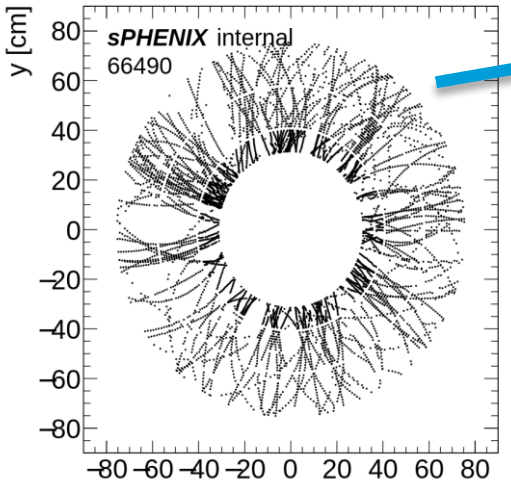
HCal



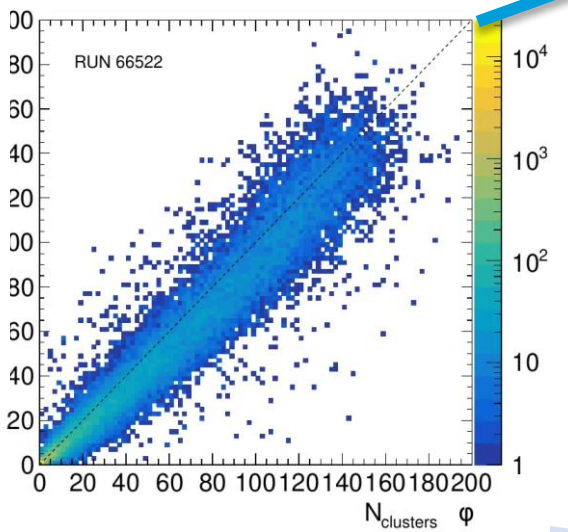


EMCal



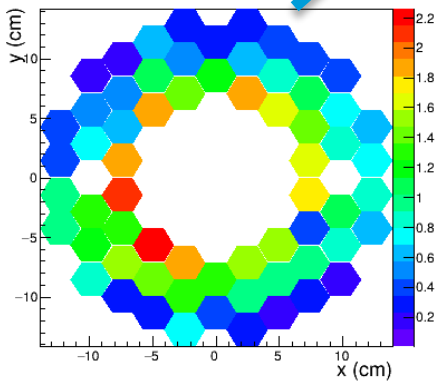


TPOT

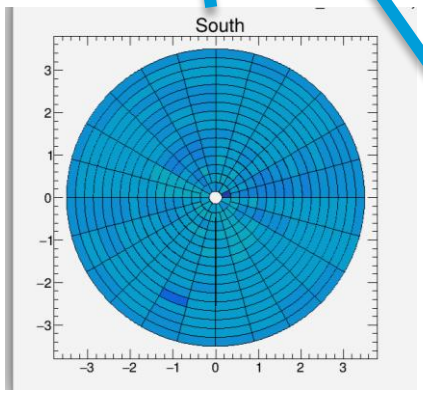


TPC

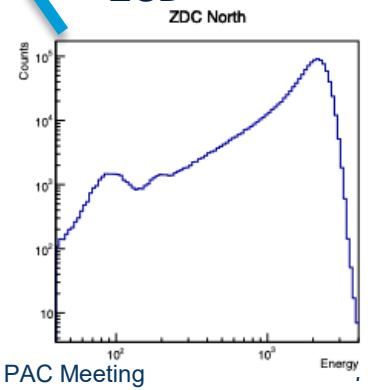
MBD



sEPD

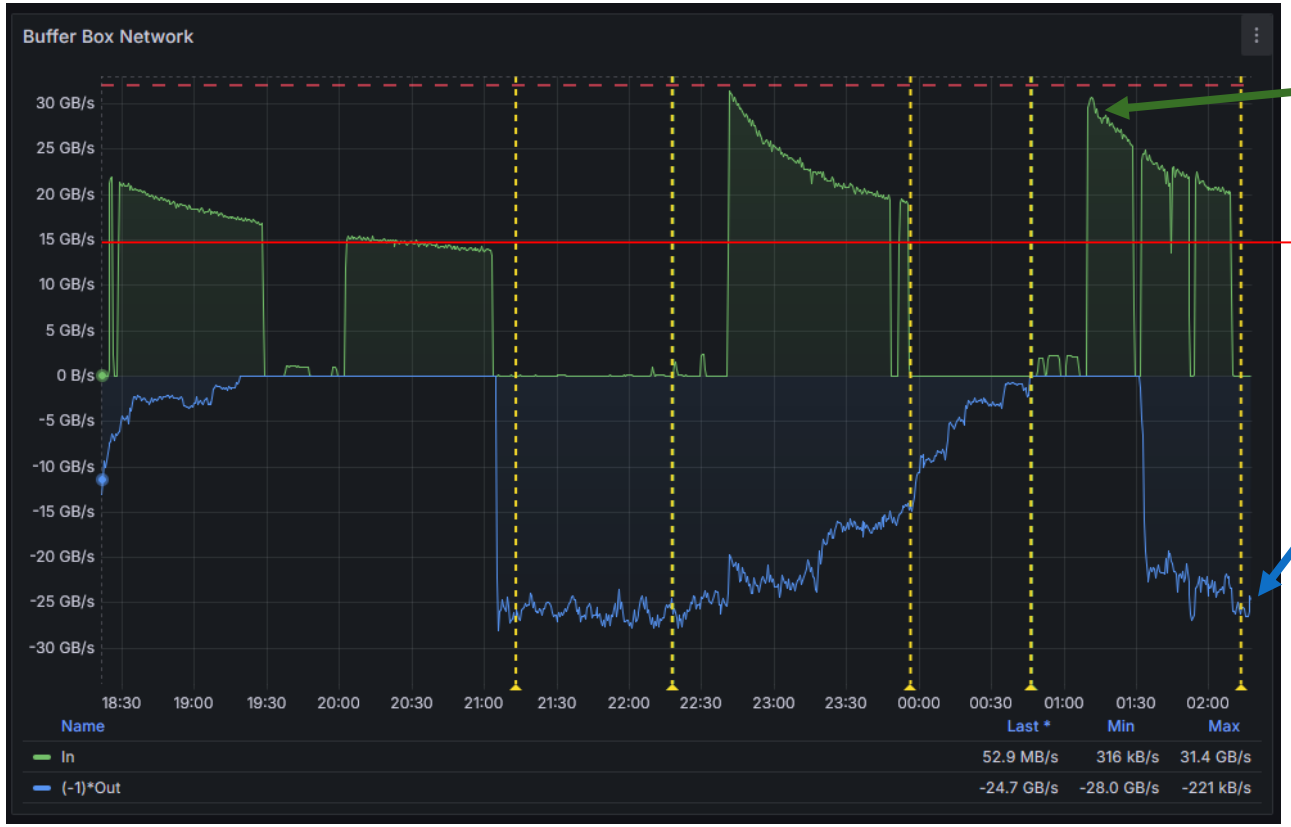


ZCD



DAQ system upgrade

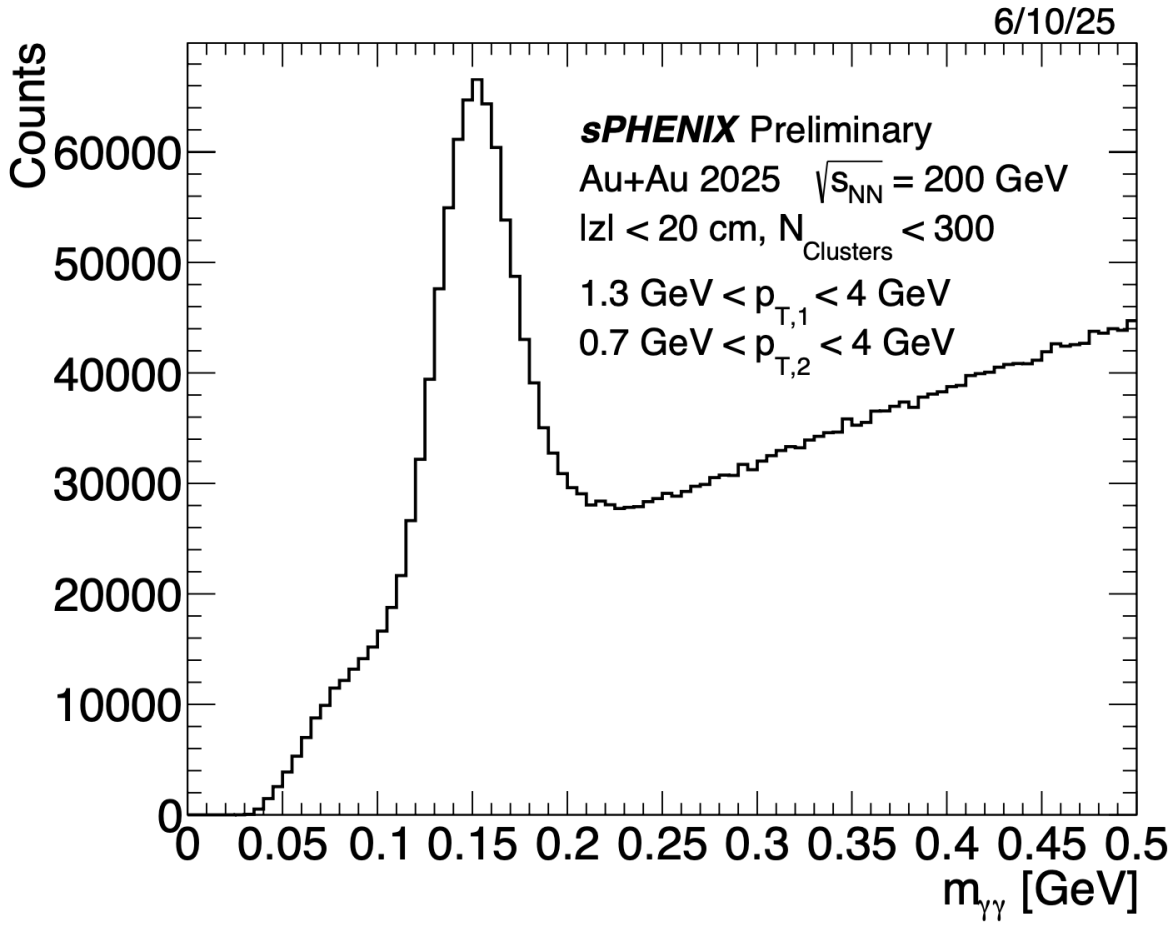
Data logging and migration rate: June 15, 2025 physics data taking



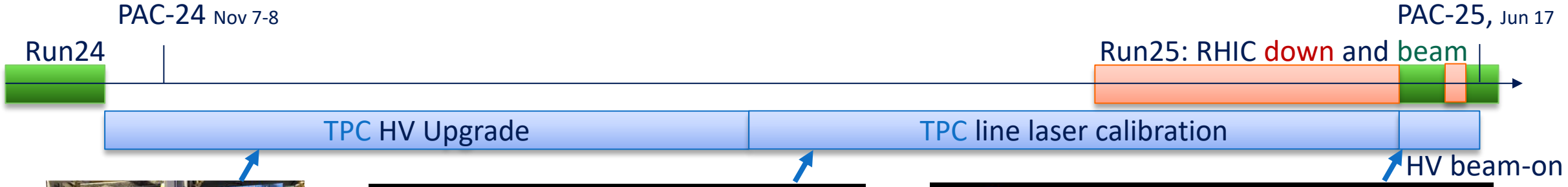
- Doubled sPHENIX data buffer for high lumi Au+Au (as planned)
- Green line: sPHENIX data logging rate in physics run
  - About twice the throughput of Run24 (bottleneck of p+p streaming)!
- Blue lines: sPHENIX buffer → SDCC data migration
  - In Run 24, it had to be paused during data taking
- Prompt processing at SDCC with 132k CPU-cores, among largest condor instances in the world

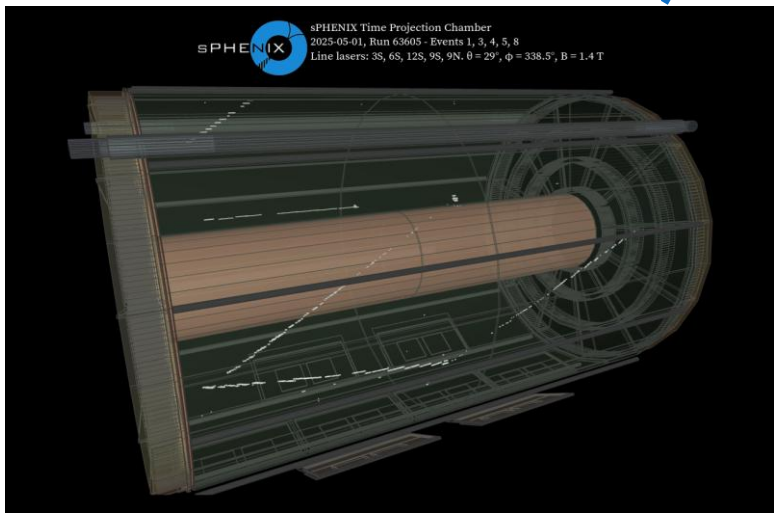
Calorimeter update and validation with beam

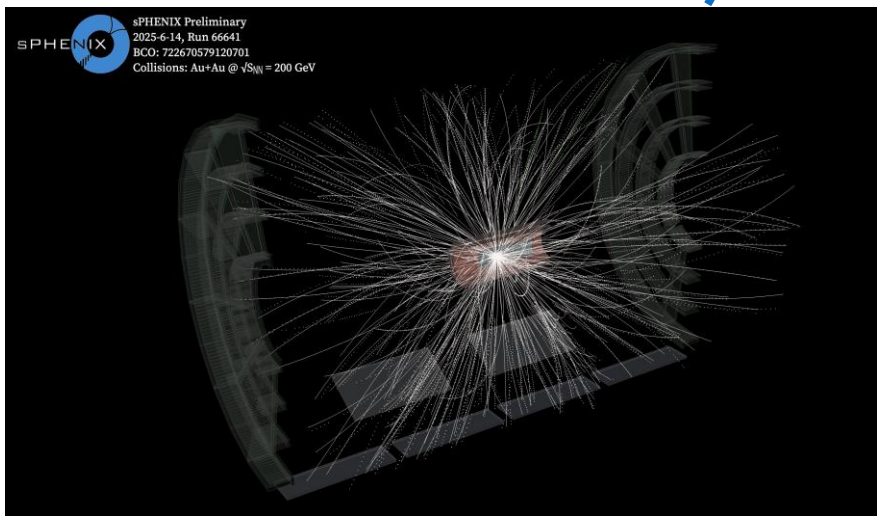
- EMCal gains have been adjusted to provide improved performance out to approximately 50GeV
  - Accounting for kinematic reach accessible with $7nb^{-1}$ of luminosity in Au+Au
- Energy scale validated with $\pi^0 \rightarrow \gamma+\gamma$ reconstruction



TPC upgrades and first line laser calibration







HV System Upgrade

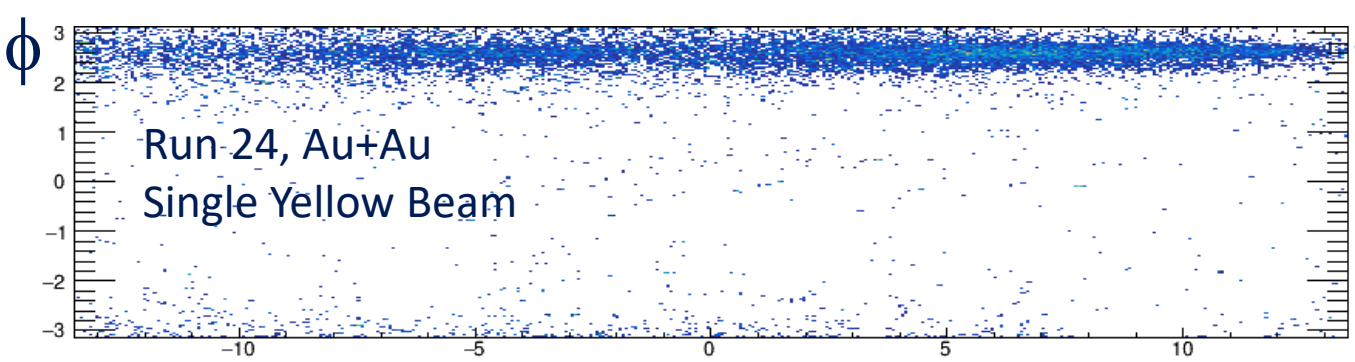
- Upgraded to Cascade power supply to address HV stability issues encountered in Run 24
- Successful operation in physics data

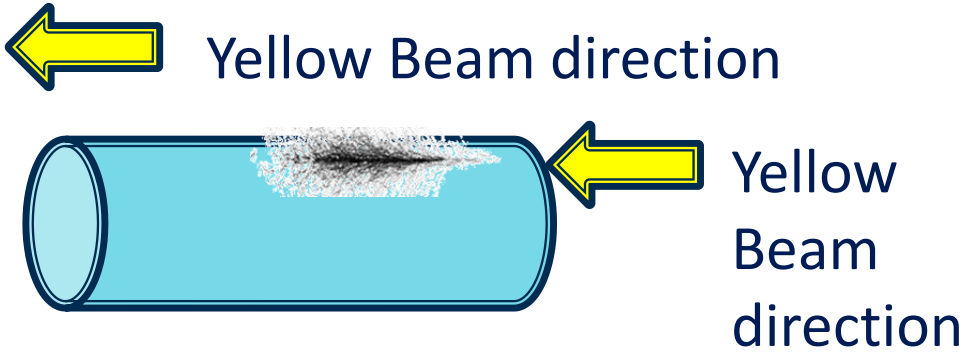
Line Laser Commissioning

- Line laser is a highly complex system, used for static distortion correction
- Fully operational
- Data taking on-going when beam is off and magnet is on

MVTX: Ion Beam Background Issues

[see also talk by Kiel Hock]



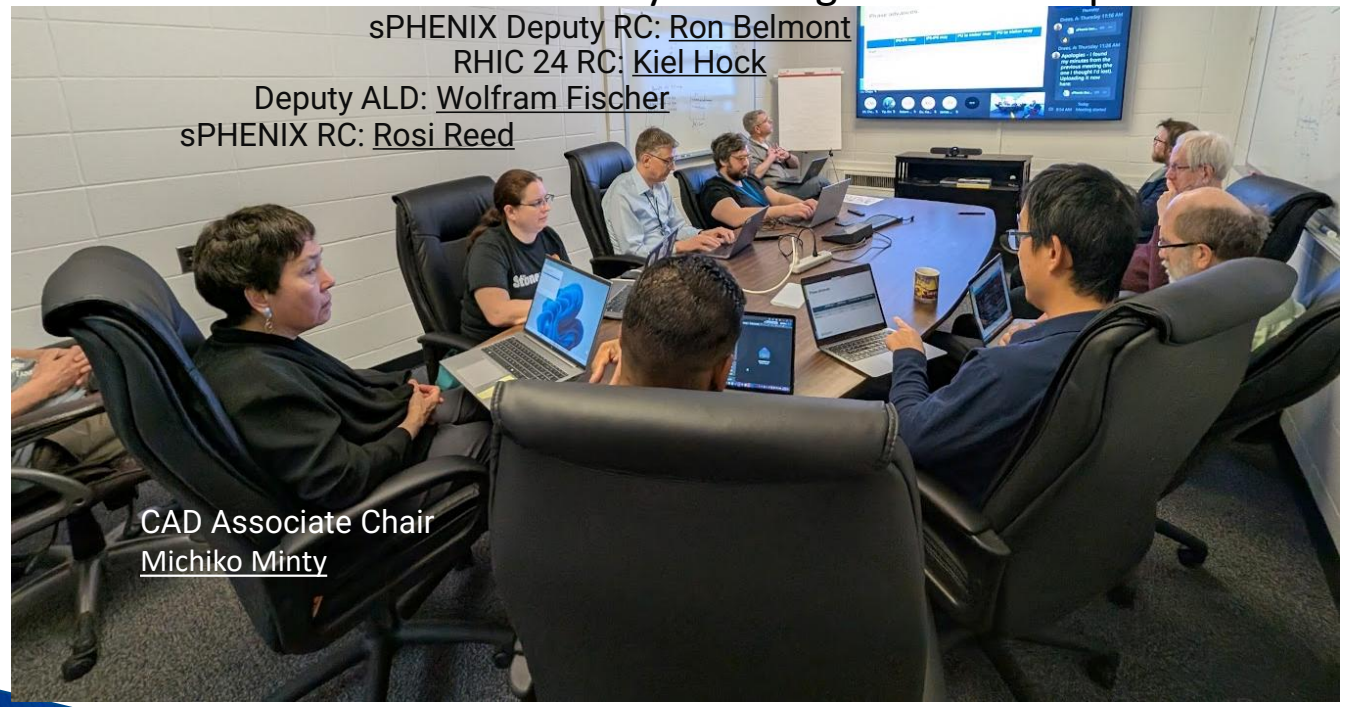


- Background event with large amount hit in MVTX sensor, upset readout logic, require ~20s recovery
- Hundreds of tests during Run 24 Au+Au running with the help of CAD
  - No ideal configuration removes the background
- Move from streaming to triggered mode
  - Triggered mode is much less suspectable to upset events (1/15 reduction)
  - Verification we can run in this mode (next slides)
- Regular joint sPHENIX-CAD background meetings after Run 24 conclusion

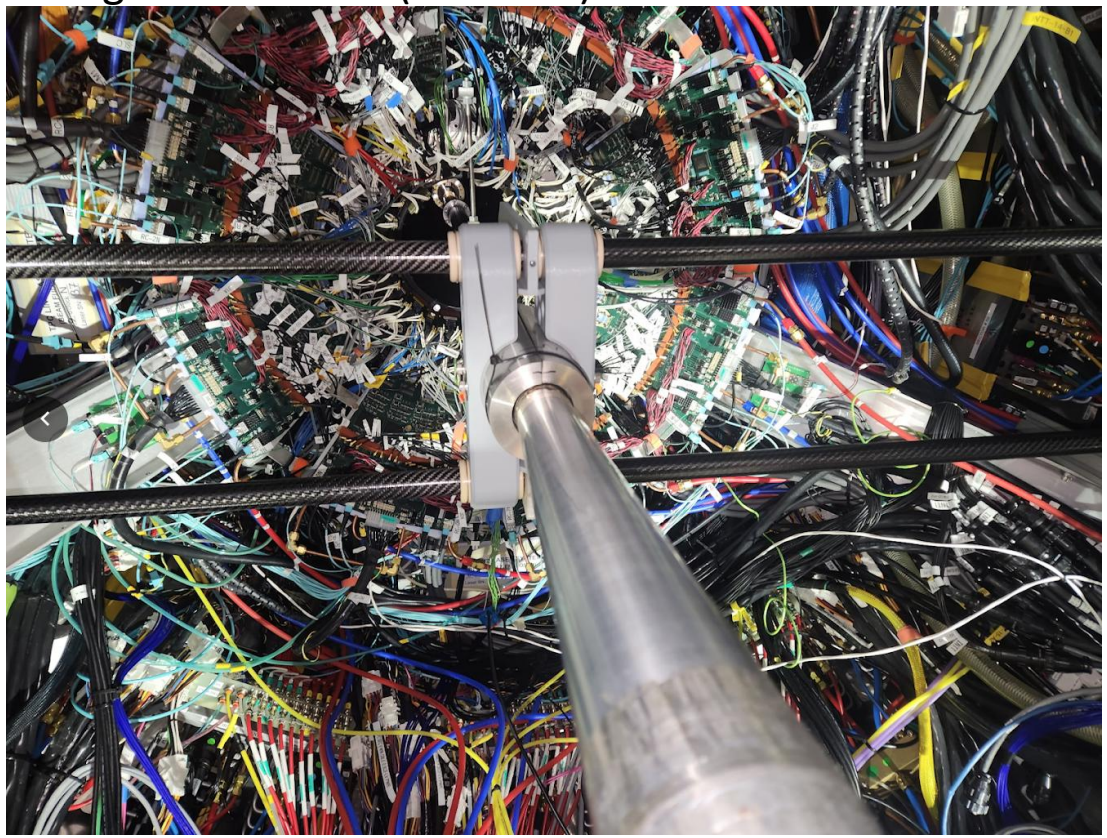
MVTX background mitigation

- Working closely with CAD developing multiple mitigation options and start of Run 25 plan [see also talk by Kiel Hock]

Bi-weekly meeting with CAD in past months



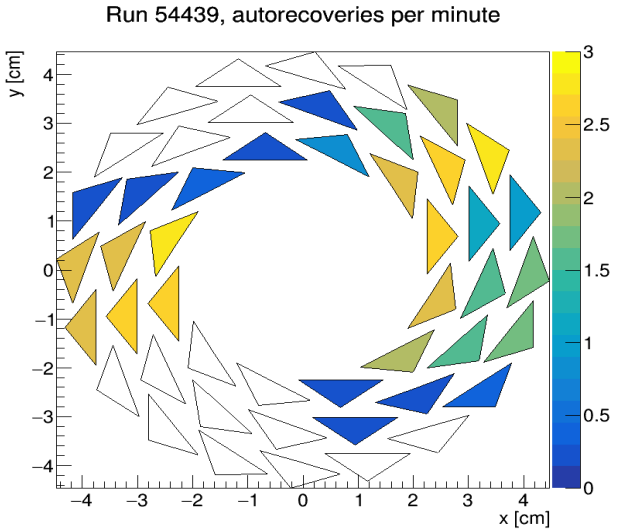
Background scatter (movable) and donut counters



Observed significant background improvement for Run25!

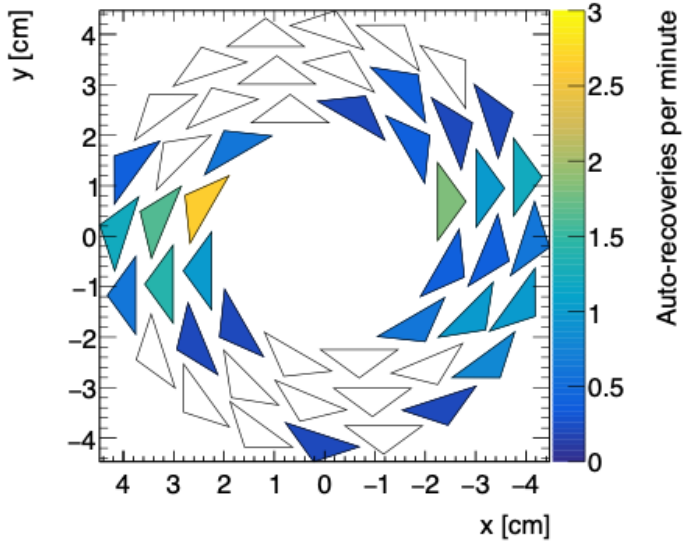
[see also talk by Kiel Hock]

Run 24



Outside Inside

Run 25



Notes:

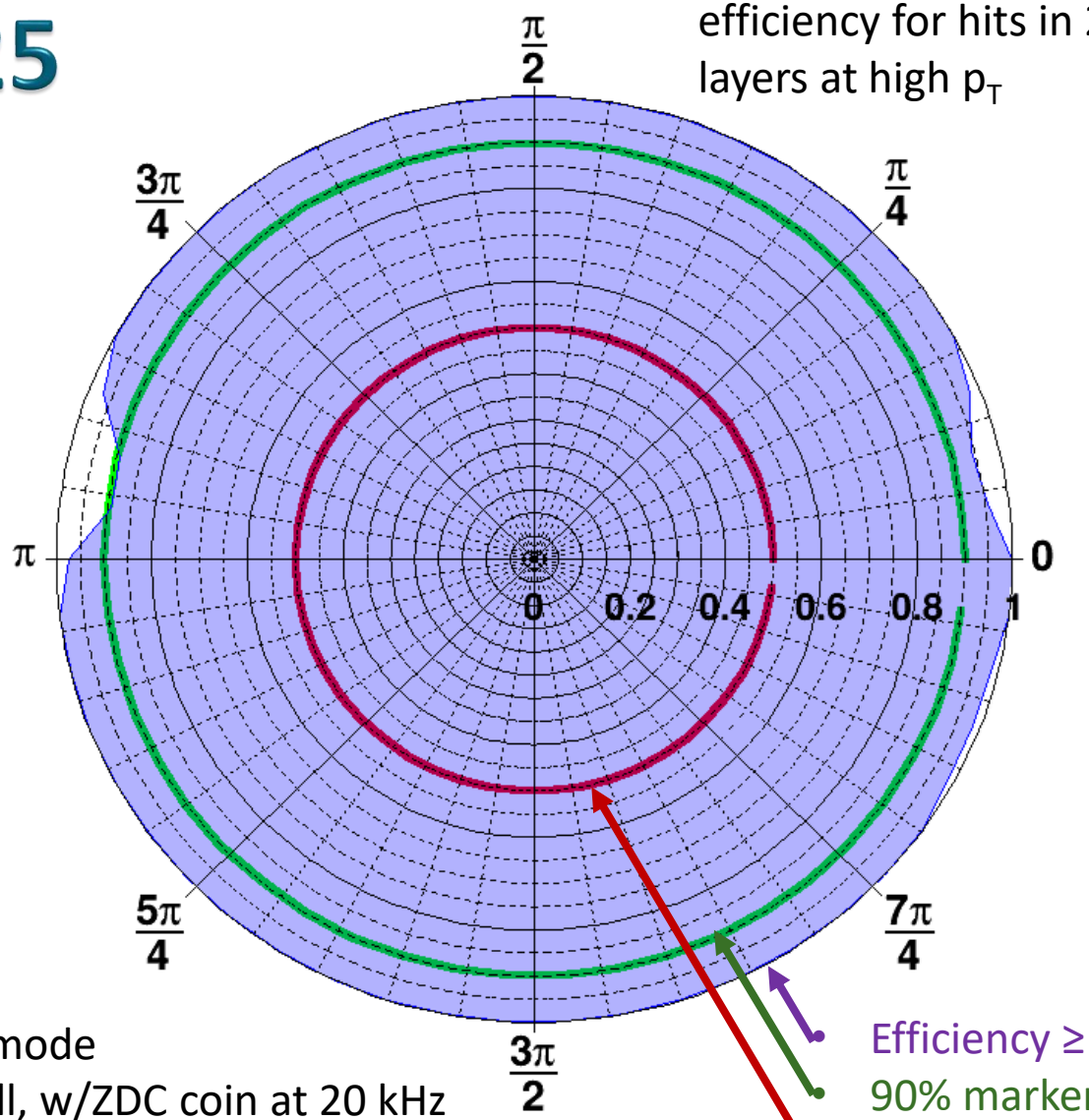
- The diagnostic streaming mode used in this study to enhance Auto-recovery upset rate for clear measurement of background.
  - Production run aim to use trigger mode (~1/15 reduction)
- Both test performed at 56x56 bunch collisions

Thanks to many regular meetings between sPHENIX and C-AD to work on addressing the MVTX beam background issue!

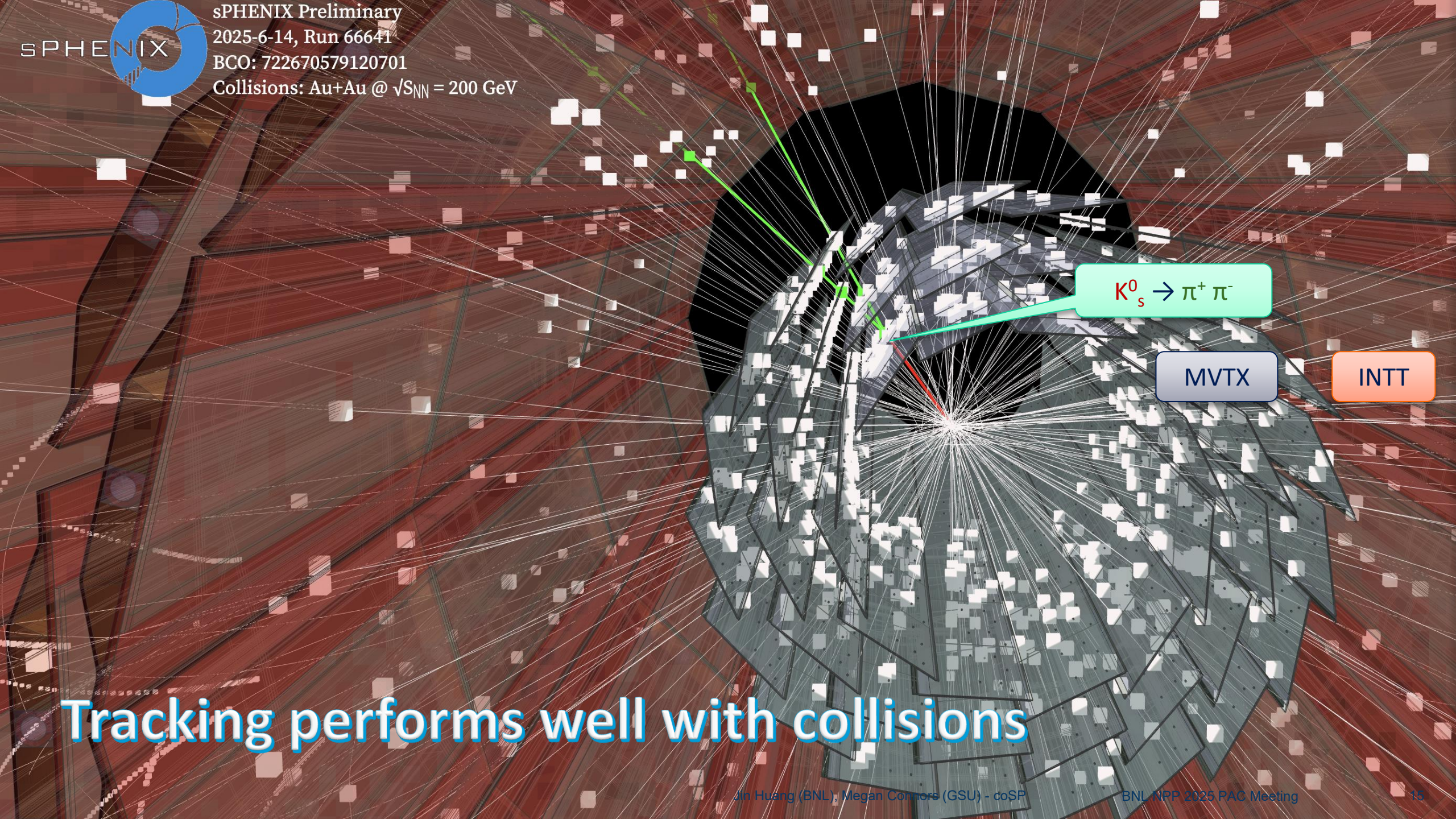
MVTX operation for Run 25

- MVTX demonstrated capability to operate in Au+Au at physics quality beam and rate
- We are cautiously optimistic to run MVTX at full RHIC luminosity and trigger rate
- Further improvement under discussion, but need to balance with physics uptime

Approximate track efficiency for hits in 2 layers at high p_T

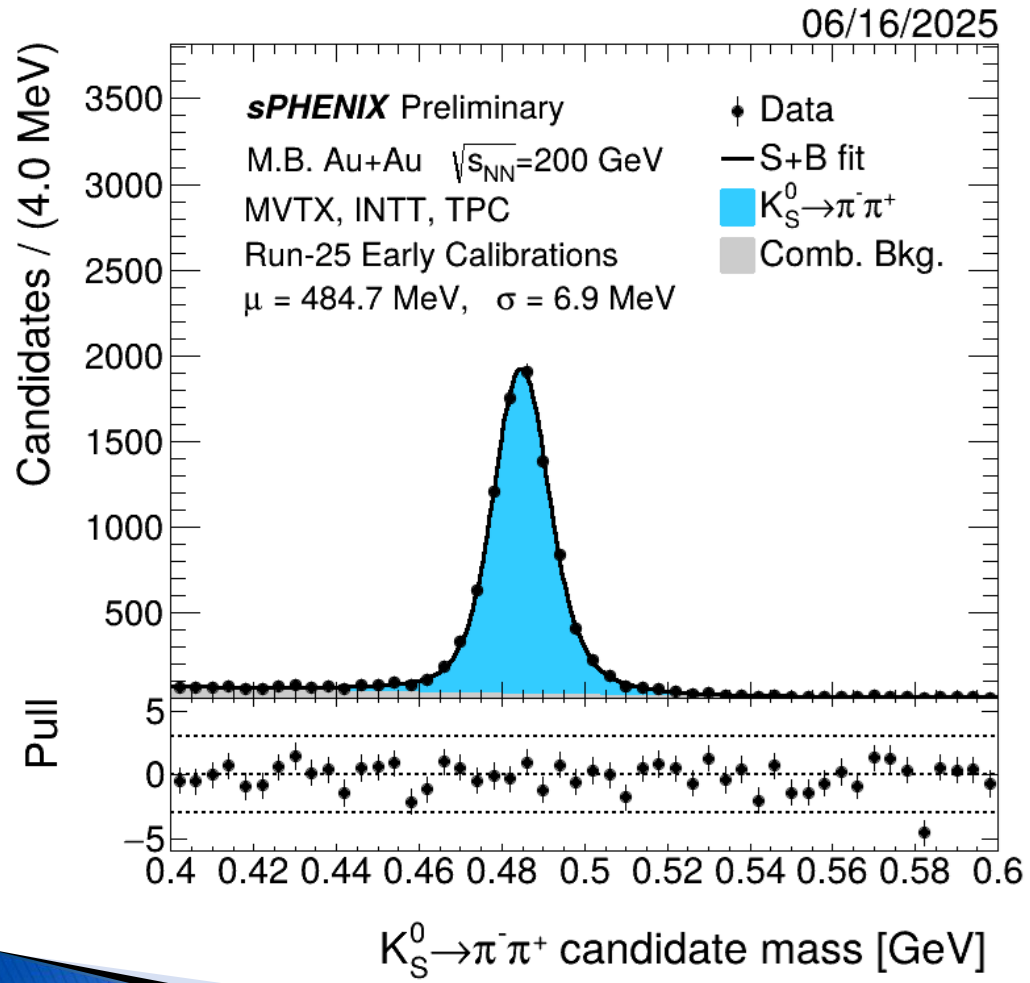


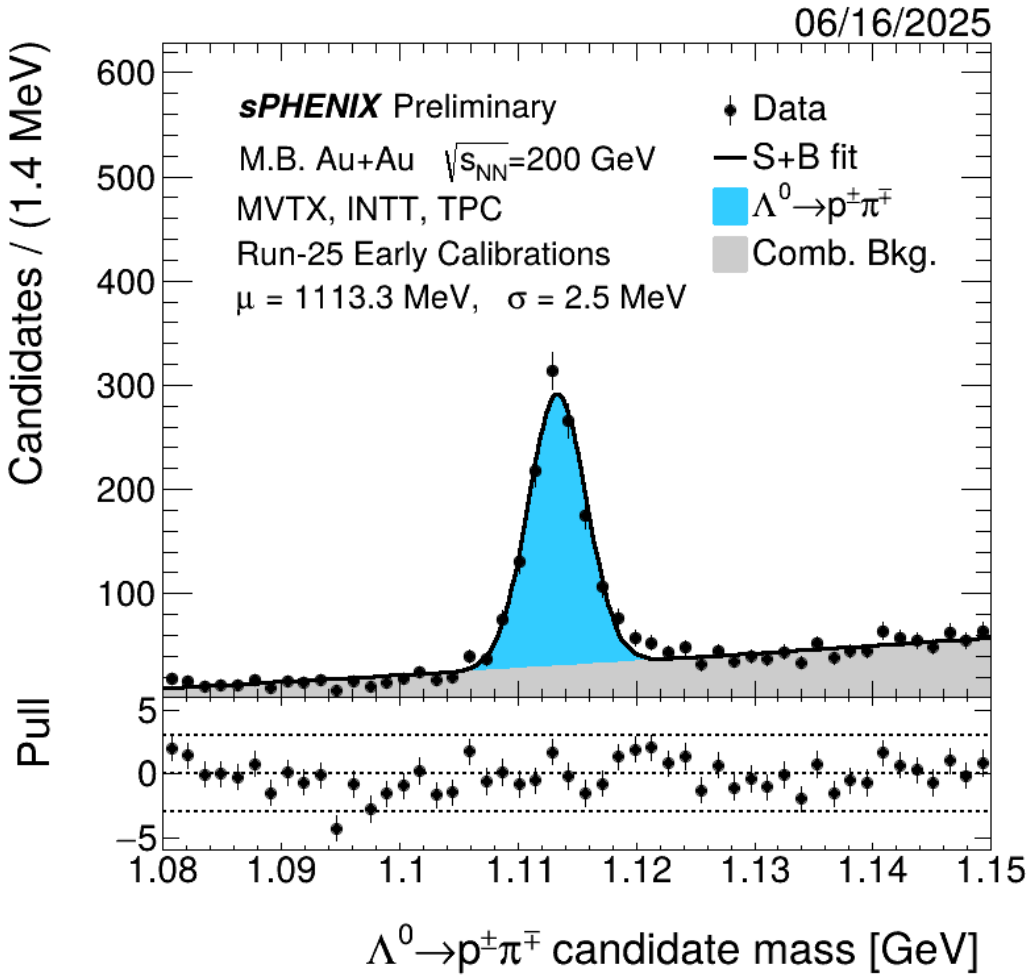
- Triggered mode
- 111x111 fill, w/ZDC coin at 20 kHz
- Triggered at 12 kHz



Tracking performs well with collisions

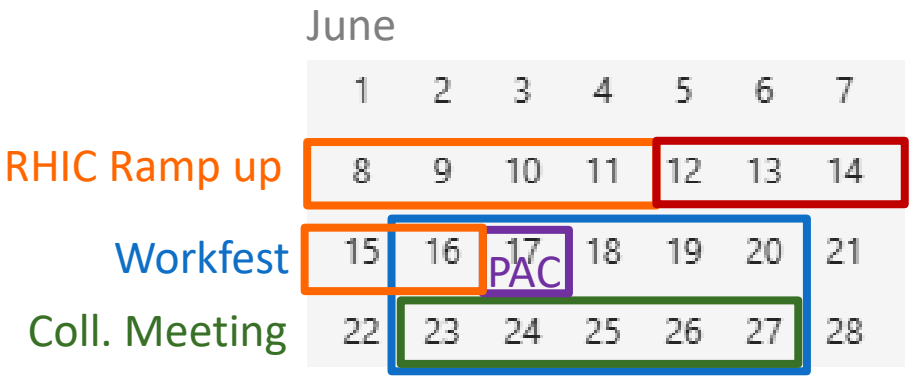
First Run 25 Au+Au resonance reconstruction





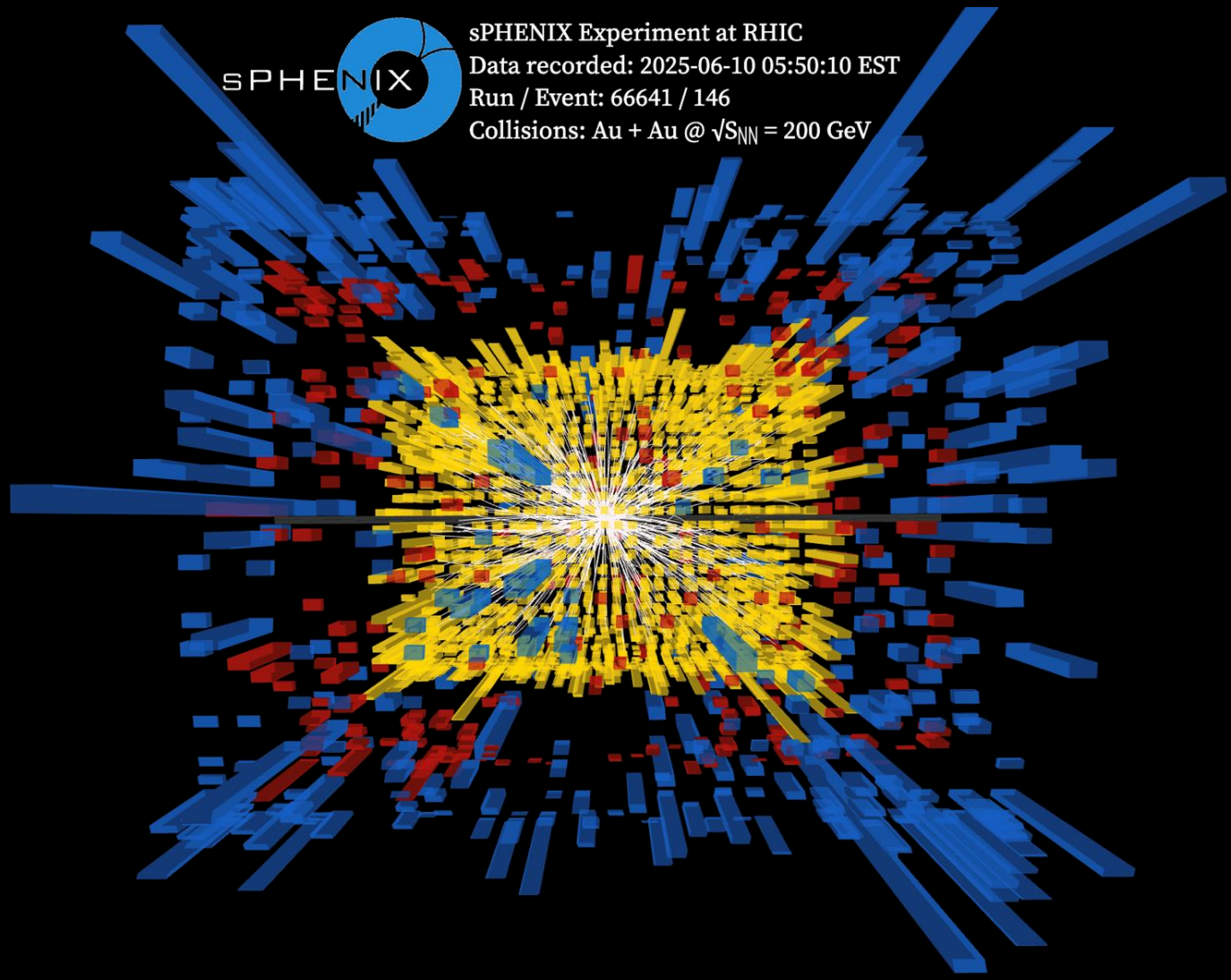
Check, and double check, from online to offline

- sPHENIX is committed to ensuring data is physics quality from the start of run
- Thanks to the computing resource upgrade right before this run
- Two-week-long deep data check workfest starting this week



Status summary: sPHENIX is taking physics data!

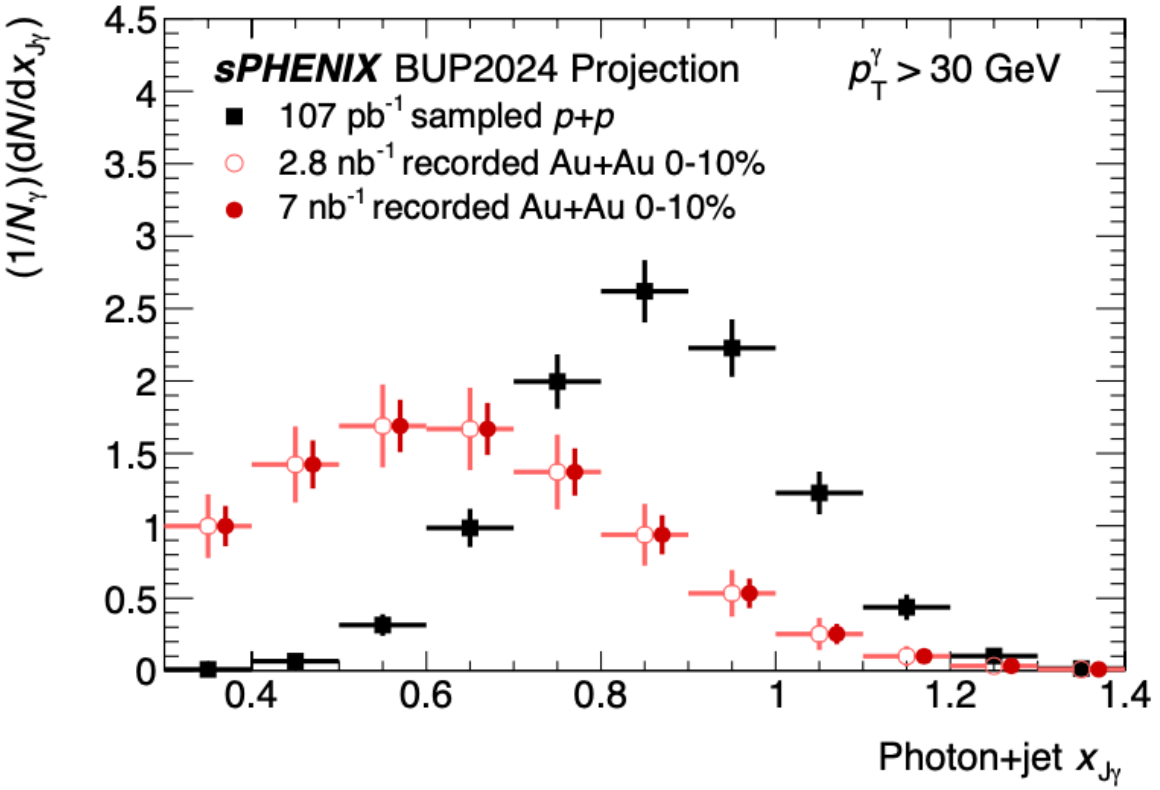
- sPHENIX completed shutdown tasks and started taking physics data with all detectors
  - TPC HV and DAQ upgrade successful
  - Demonstrated physics data taking
- Many thanks to C-AD for their hard work and continued collaboration to improve beam background issue on MVTX!



» Aspirations

Highest Priority: 7 nb^{-1} of Au+Au

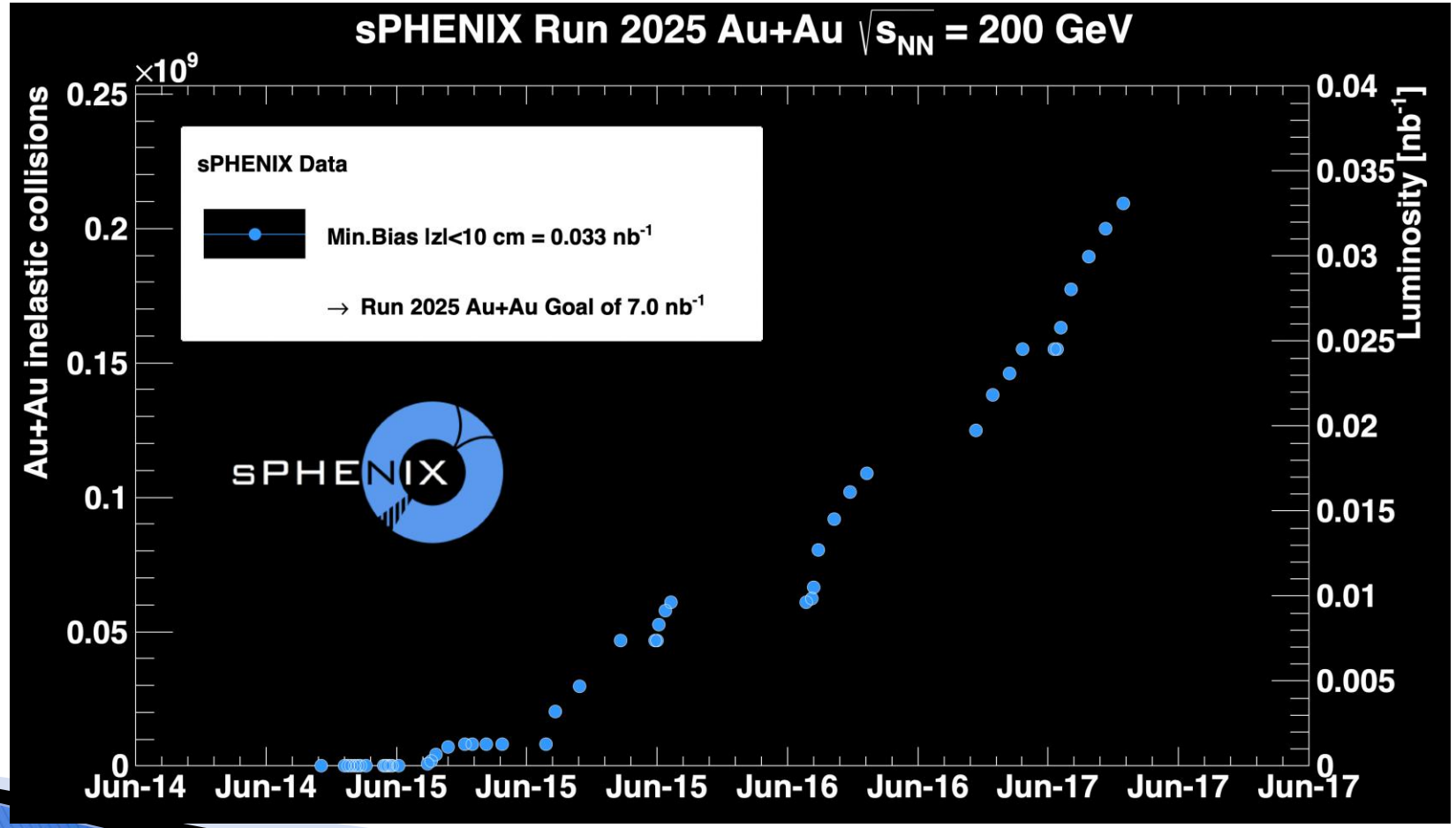
- sPHENIX physics program initially planned for 25 nb^{-1} (sampled) [BUP20]
- The sPHENIX 2024 Beam Use Proposal describes the need for minimally 7 nb^{-1} of Au+Au data
  - To achieve the goals outlined in the 2023 LRP for RHIC to complete its scientific mission
- "The PAC recommends a Au+Au run in which sPHENIX collects at least 7 nb^{-1} of data as the highest priority for Run 25."



7 nb^{-1} of Au+Au remains our top priority!

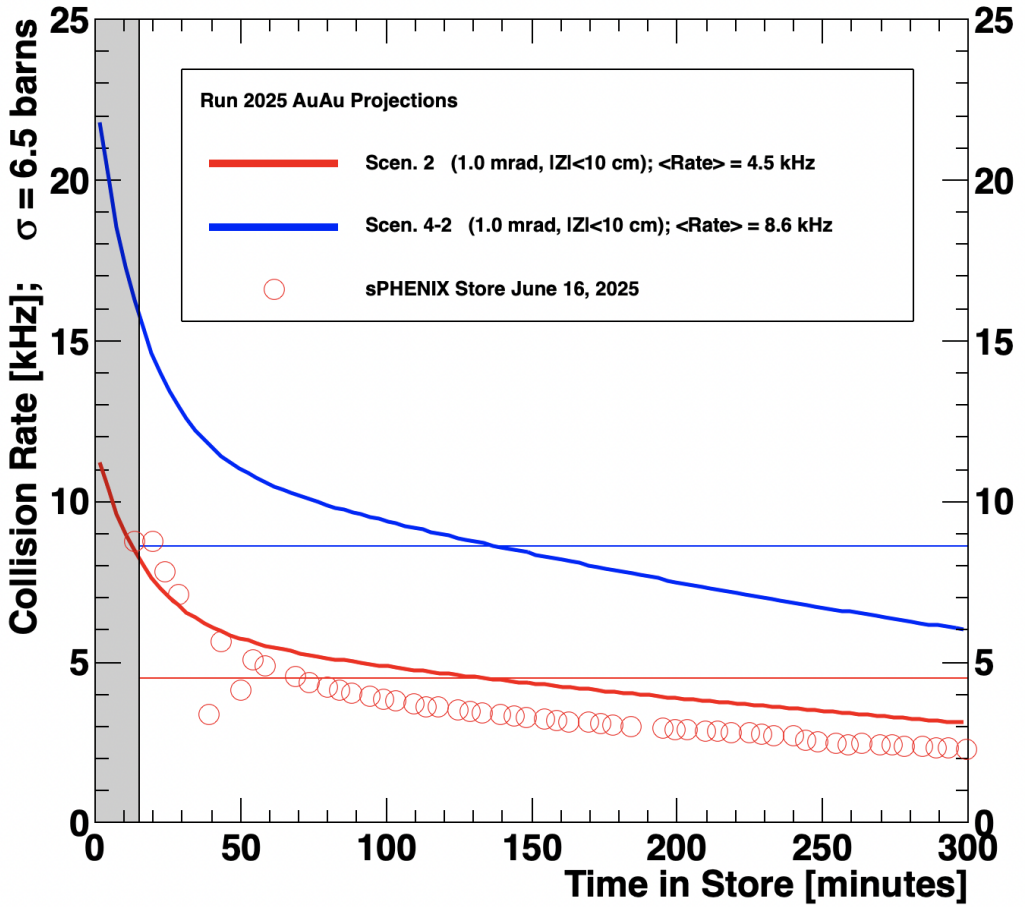
Tracking progress toward 7 nb^{-1} of Au+Au

- Data collected with all subsystems through 8 am June 17



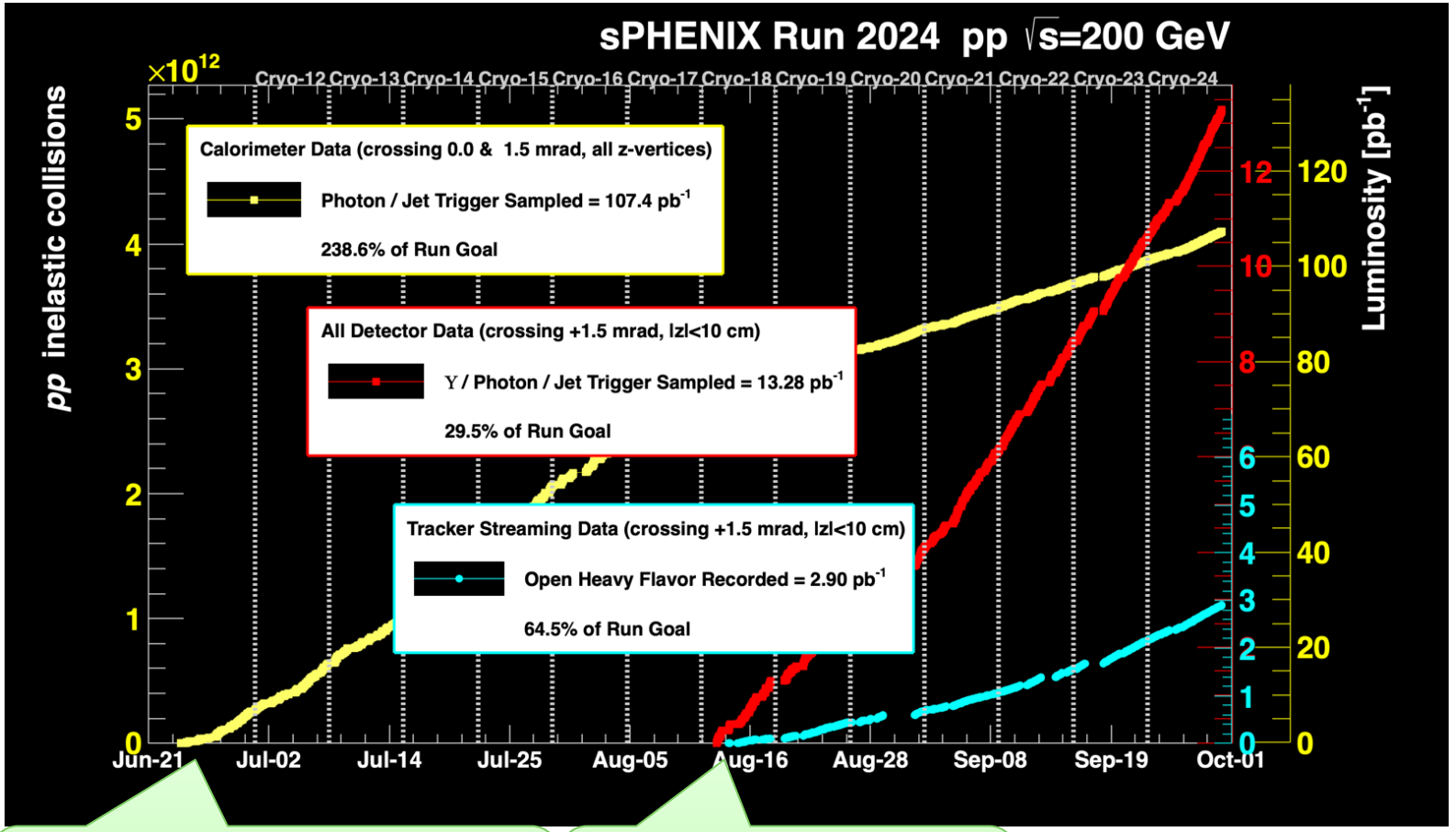
Projected run time for 7 nb^{-1} of Au+Au

- Calculations are based on BUP 2024, including:
  - 1mrad running & |z| < 10 cm
  - Apply standard assumptions for luminosity development over time and conservative RHIC uptime for running through the summer months
- sPHENIX would require 28 (48) physics weeks if running at the C-AD "max" ("min") projections
  - First collisions June 9th → December 2025 (at the "max" projections) to May 2026 ("min") to accumulate 7 nb^{-1}
  - Changing the above assumptions can affect these dates, but not the essential conclusion of potentially running into CY2026



Recall: 2024 p+p successes and limitations in p+p data

- All sPHENIX systems collected data efficiently after commissioning
  - Reflected again in fast Run25 tracking commissioning
- Thanks for the two-week extension of p+p run time!
- Nonetheless, with limited physics run time: p+p data with all-subsystems achieved 29.5% of the Run Goal
  - Upsilon
  - Jet Substructure
  - b-tagged jets



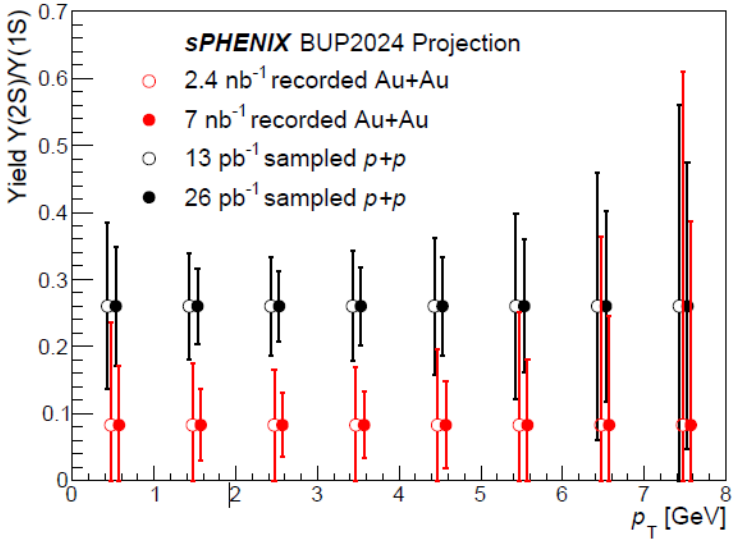
Completion of calorimeter commissioning

Completion of tracker commissioning

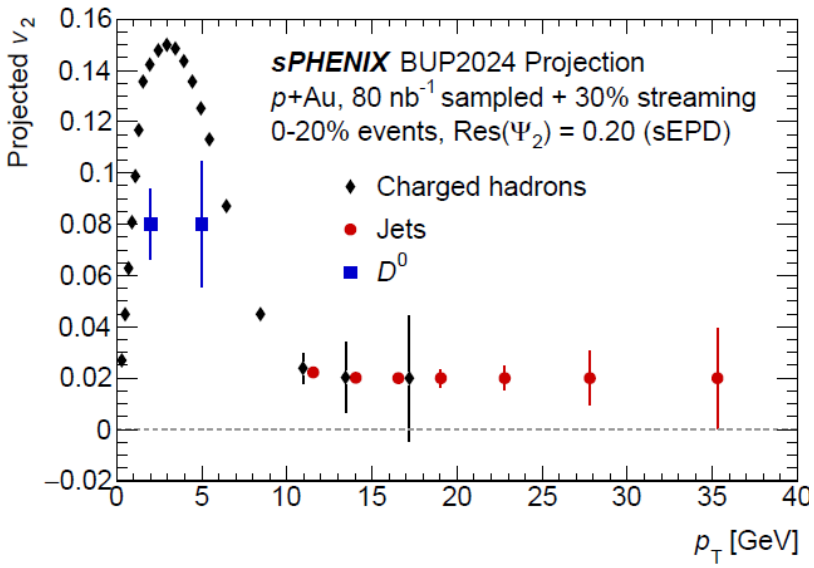
We thank the PAC for support for p+p, p+A, and O+O

[sPHENIX BUP 24]

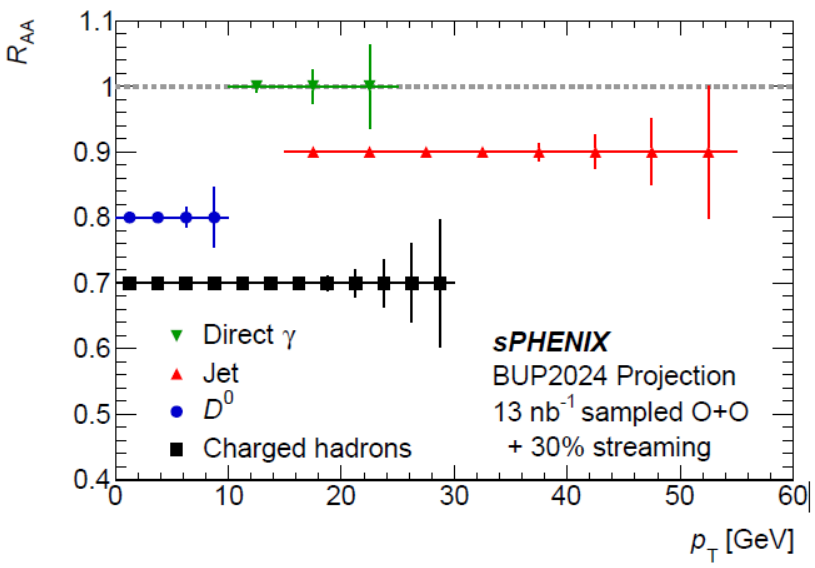
8 weeks of p+p



5 weeks of p+Au



2 weeks of O+O



- PAC24 Report : “The PAC sees all three of these proposed runs as fully aligned with RHIC’s core scientific mission, and in fact as key elements of completing that mission”
- “Each of these three proposed runs is necessary to address central open RHIC Science questions in a decisive way. ”

Summary

- sPHENIX completed shutdown tasks and started taking physics data with all detectors
  - Many thanks to C-AD for their hard work and continued collaboration to improve beam background issue on MVTX!
  - TPC HV and DAQ upgrade successful
  - Demonstrated physics data taking
- sPHENIX is ready for physics, but success critically dependent on beam availability
- Collecting 7 nb^{-1} Au+Au luminosity remain the top priority for sPHENIX
  - Beam time need projection is Dec 2025 to May 2026 (assuming high/low of CAD proj.)
  - Accelerator Safety Envelop (ASE) extension/renewal is necessary to allow running in 2026
- p+p & small system running are key elements in completing the sPHENIX scientific program

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

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