

sPHENIX Summary and the Run 25 Plan

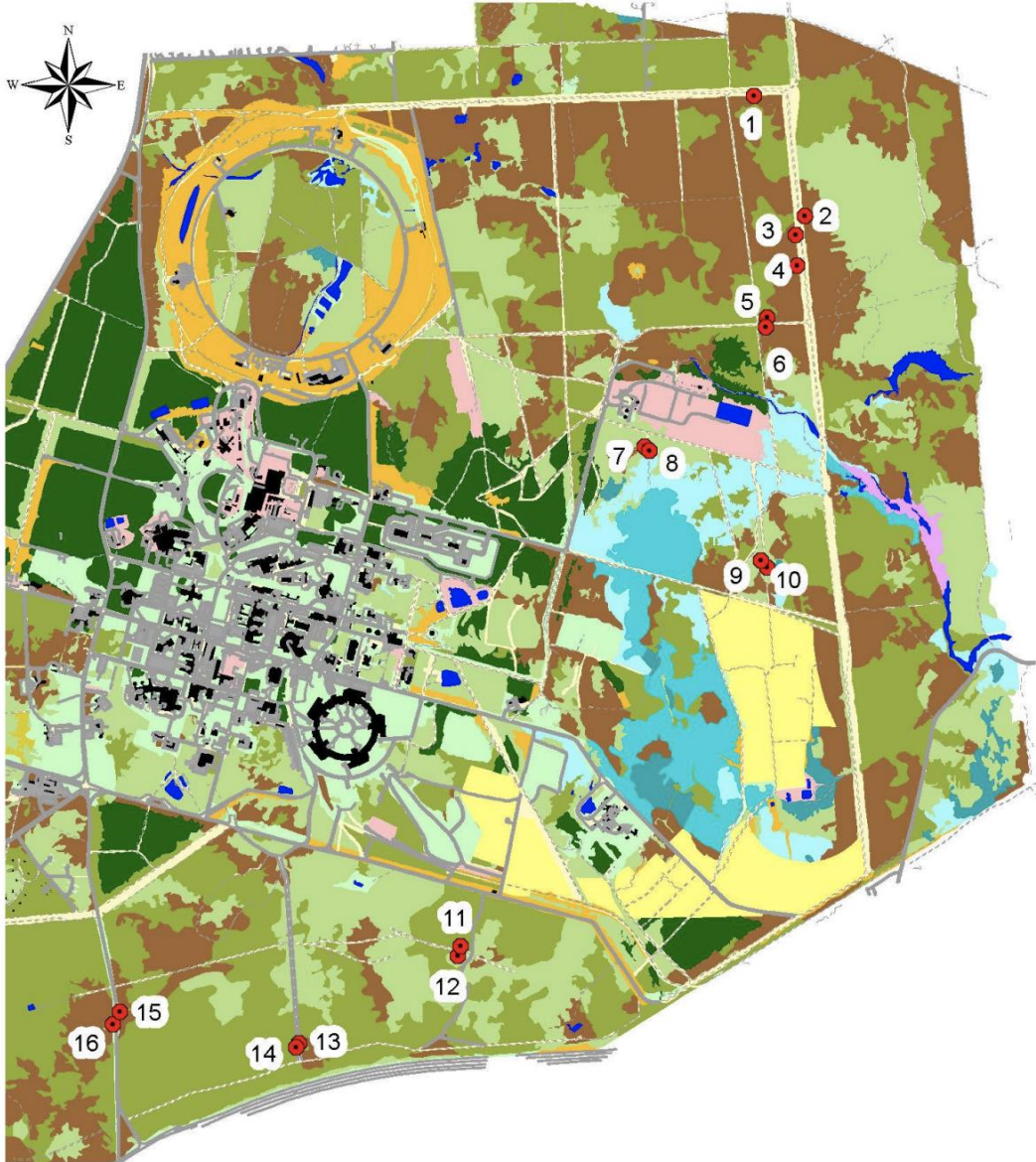
RHIC Retreat

November 15, 2024

Jamie Nagle
University of Colorado Boulder
Presented by
John Haggerty
Brookhaven National Laboratory

10:10 AM → 10:40 AM **sPHENIX Summary and Run 25 Plan**

Speaker: John Haggerty (Brookhaven National Laboratory)

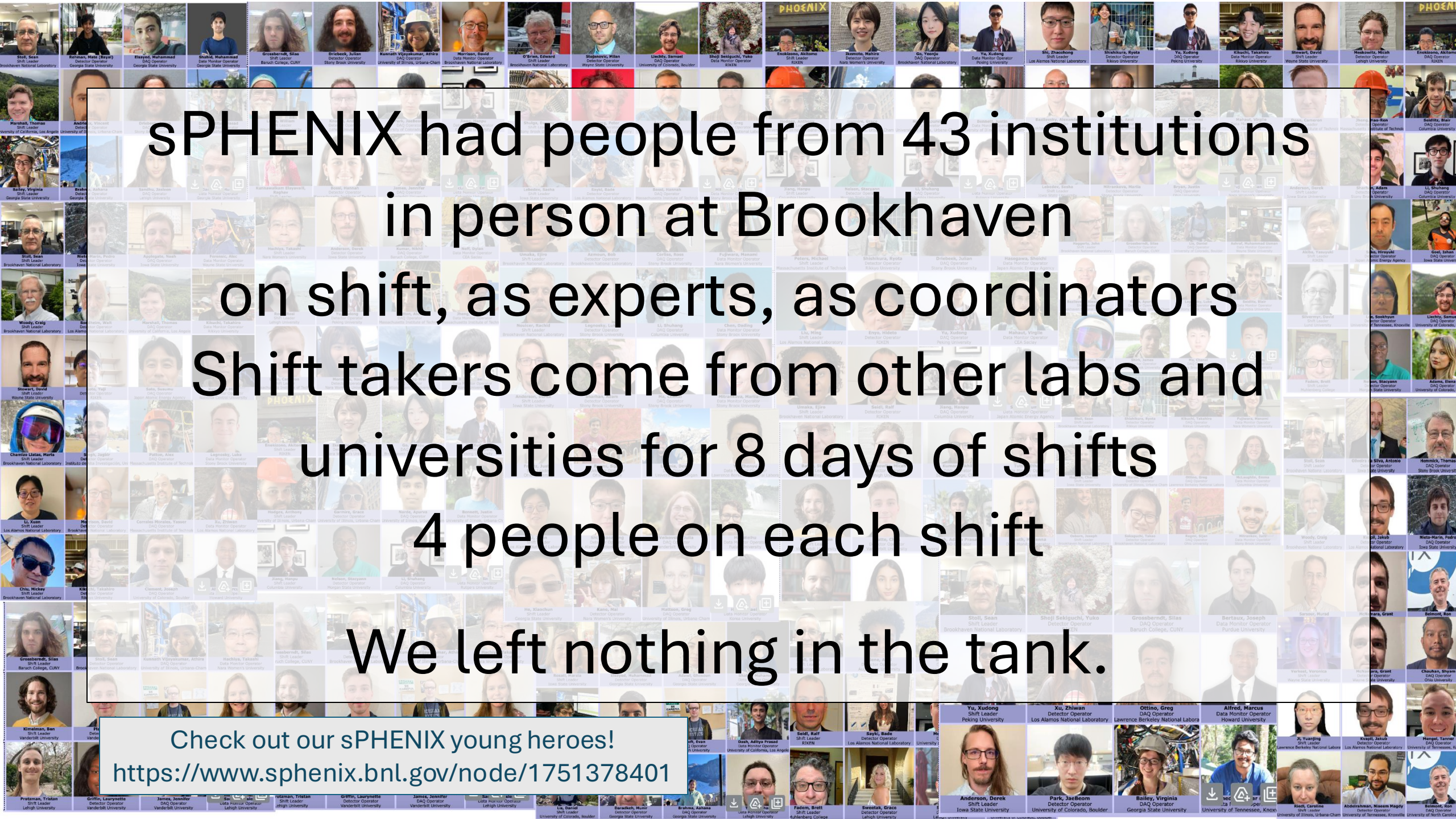


sPHENIX, and I personally, want to convey our deepest appreciation to C-AD and particularly to Kiel Hock!

Very positive items to build on...

- Meetings starting exactly on time
- Organized plan & coordination
- Always available to explain / discuss
- Careful, expert checks and tests





sPHENIX had people from 43 institutions
in person at Brookhaven
on shift, as experts, as coordinators
Shift takers come from other labs and
universities for 8 days of shifts
4 people on each shift
We left nothing in the tank.

Check out our sPHENIX young heroes!
<https://www.sphenix.bnl.gov/node/1751378401>

sPHENIX plan going into Run 2024:

BUP proton-proton goals

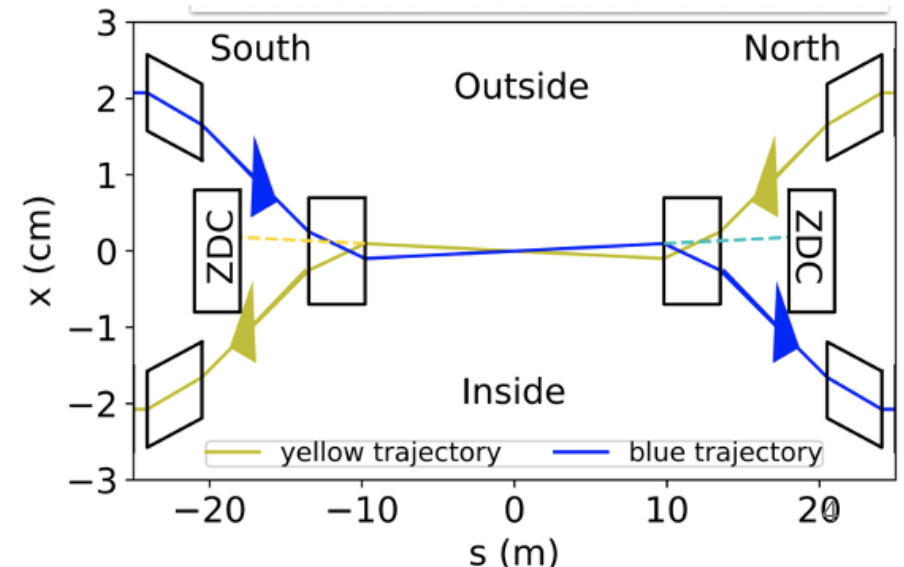
- 45.0 pb⁻¹ within $|z| < 10$ cm sampled with photon, jet, Upsilon triggers
- 4.5 pb⁻¹ within $|z| < 10$ cm recorded (10% streaming) for open heavy flavor physics

BUP gold-gold goals

- Commission sPHENIX for high occupancy collisions
- Understand beam backgrounds in MVTX and mitigate them

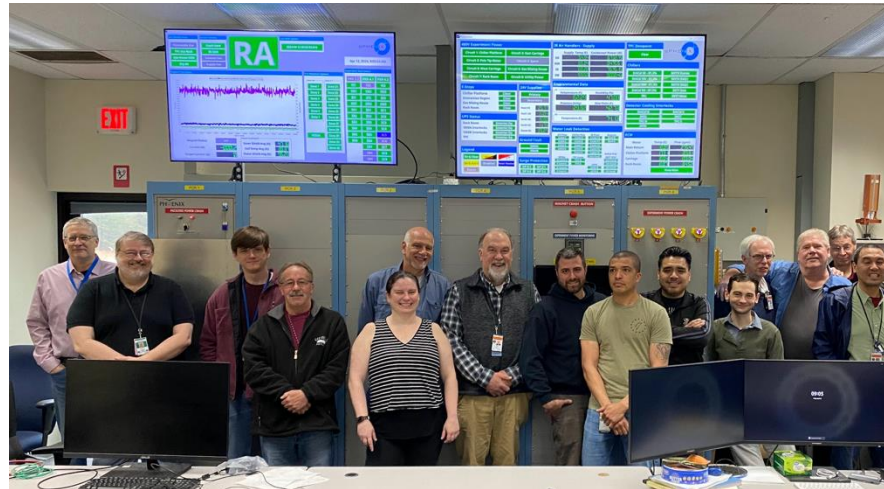
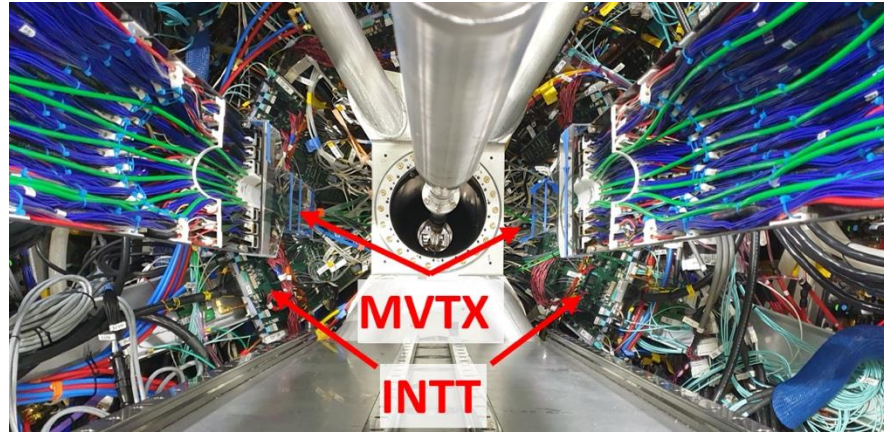
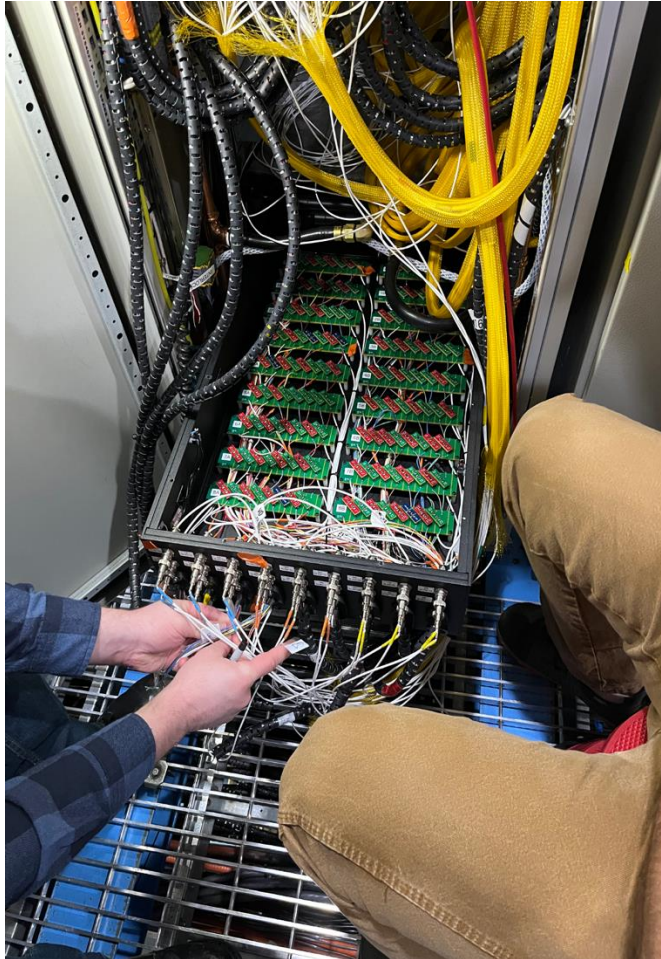
Available:

- 19 (FY24)+ 6 (carryover FY23) = 25 cryo-weeks
- Planned -2.0 mrad crossing angle to get needed luminosity and $\sigma_{z\text{-vertex}} \sim 10$ cm



sPHENIX Shutdown Complete

sPHENIX requested delayed cooldown to complete TPC High Voltage mitigation, reinstall silicon detectors and beam pipe, and check everything out with cosmic rays.



Huge multi-month effort by sPHENIX technical crew, detector experts, and many C-AD personnel.

John Haggerty

Jim Mills

Kin Yip

Jimmy Labounty

Tom Hemmick

Evgeny Shulga

Frank Toldo

Jeff Hoogsteden

Aaron Allen

Joel Vasquez

Dan Cacace

Mike Rau

Mike Lenz

Sean Stoll

(Not in the picture)

Sal Polizzo

Bill Lenz

Damon Miraglia

Kevin Mandracchia

Marianna Albanese

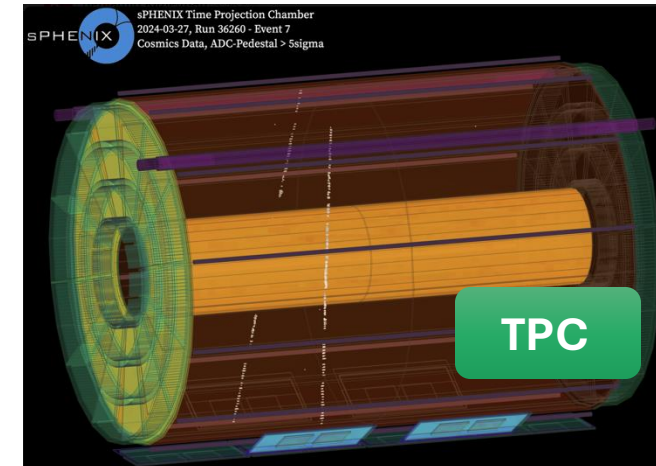
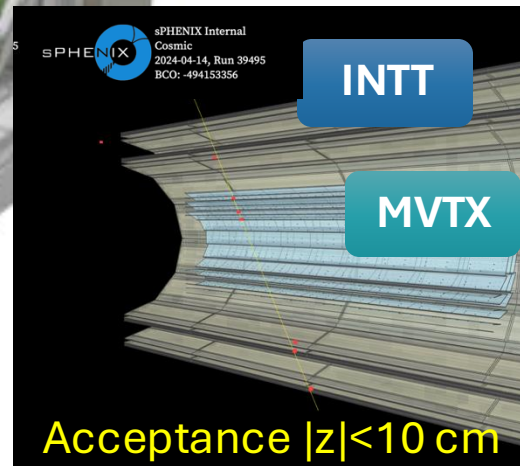
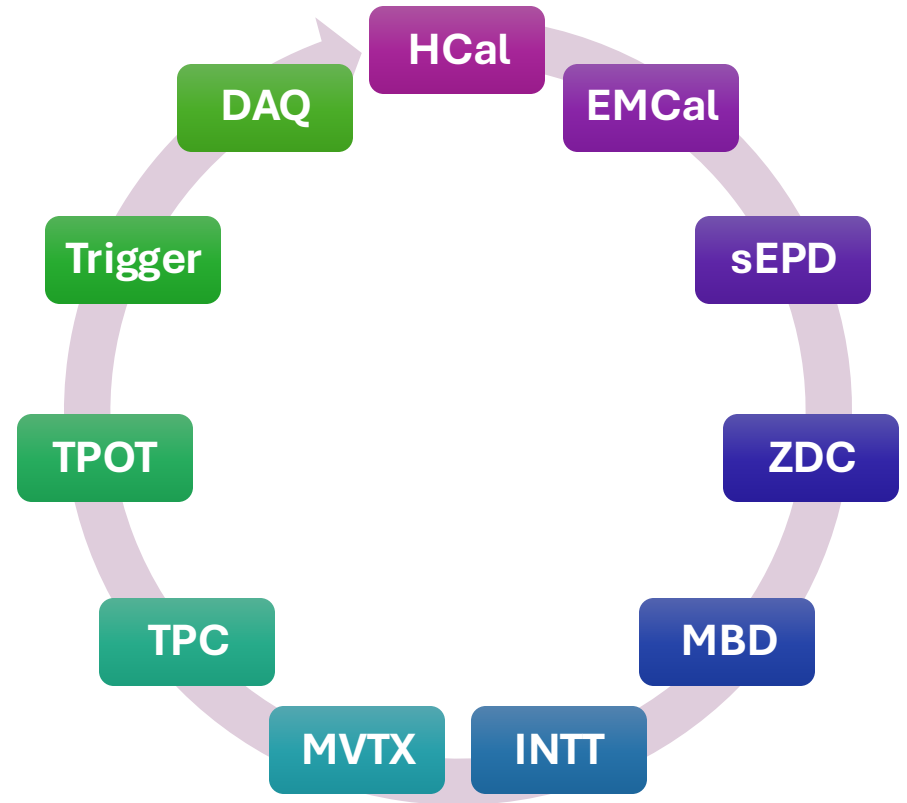
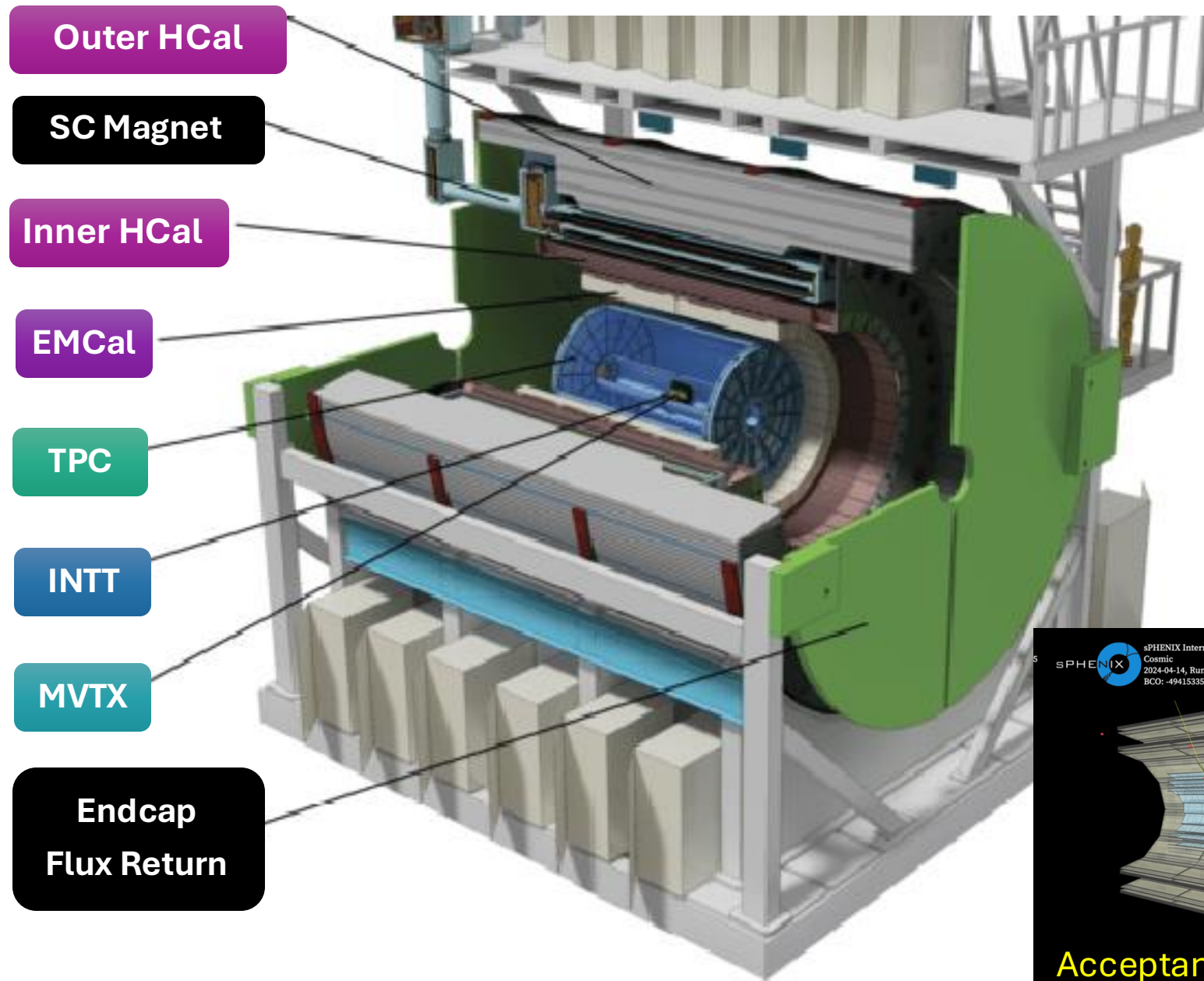
Rob Pisani

Bob Azmoun

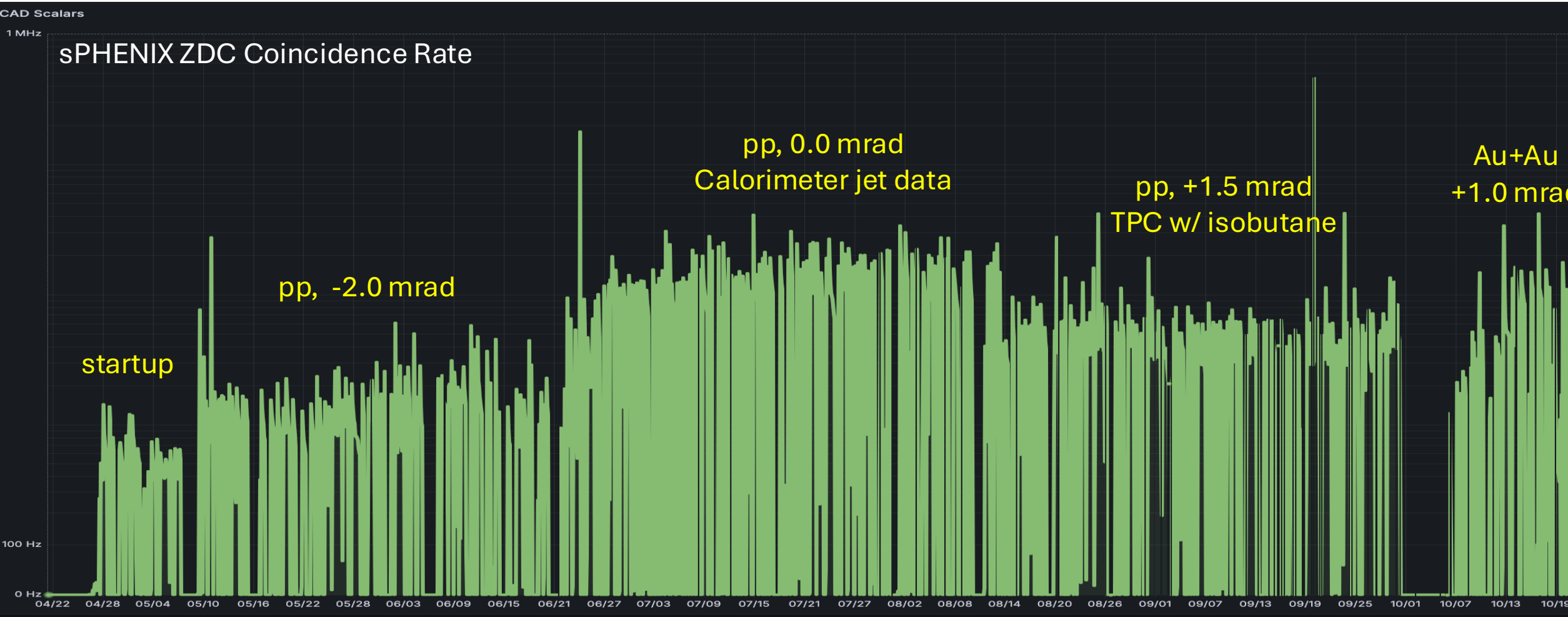
Many more...

Retiring/leaving group

sPHENIX Detector Guide



A long and challenging and fun sPHENIX Run 2024



April 28

May 10

June 21

August 14

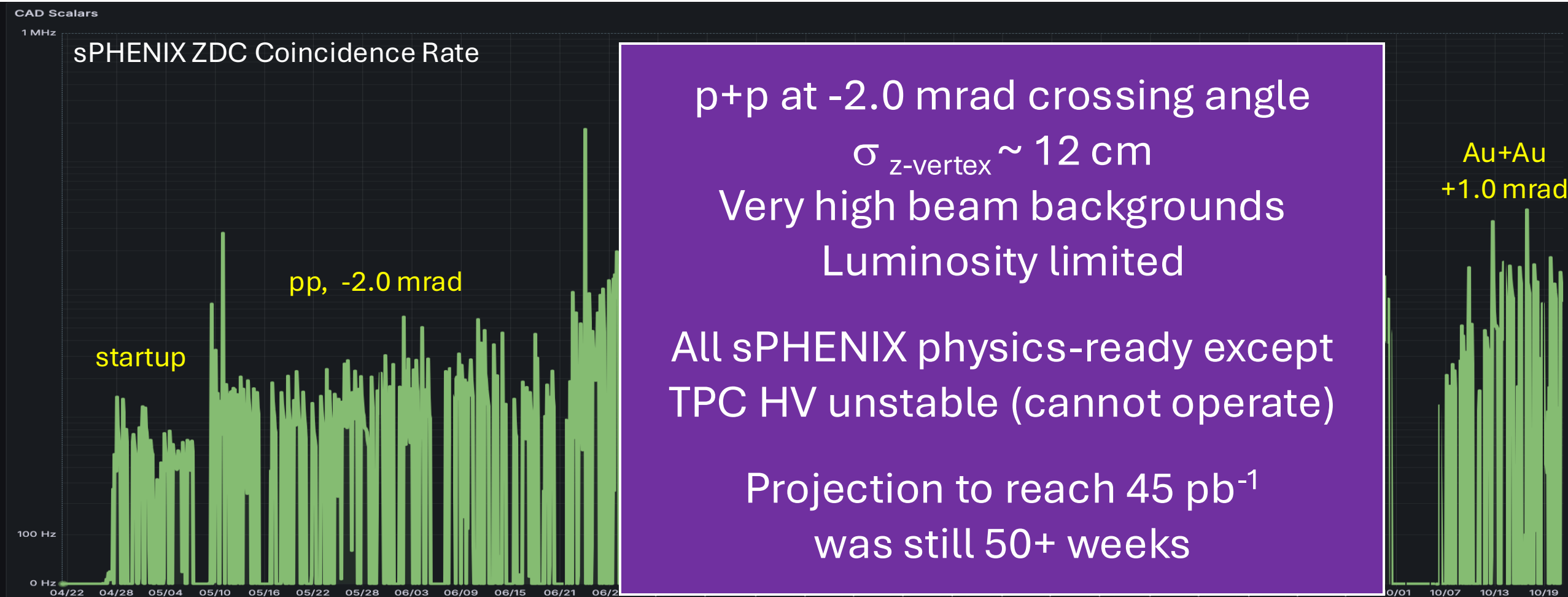
October 7

October 21

Run 24 in a nutshell

- Prolog Aug 1, 2023 – Feb 20, 2024
 - sPHENIX maintenance: TPC HV reconstruction, removal and re-insertion of MVTX and INTT
- Introduction Feb 20-May 10
 - Shifts begin, cooldown, magnet turned on, rare triggers commissioned, detectors see beam on Apr 19
- Chapter 1 May 10-Jun 21
 - p+p at -2 mrad crossing angle; high backgrounds, limited luminosity
- Chapter 2 Jun 24-Aug 14
 - p+p at 0 crossing angle; calorimeter jet data taking
 - Begin tests with isobutane Jul 27
- Chapter 3 Aug 14-Oct 7
 - p+p at 1.5 mr crossing angle; isobutane in TPC enables full physics program
- Chapter 4 Oct 7-Oct 21
 - Au+Au test with many beam conditions to study operation of MVTX (and the rest of sPHENIX)
- Epilog Oct 21-Feb 25(?)
 - Detector maintenance; new TPC HV power supplies

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11/15/24

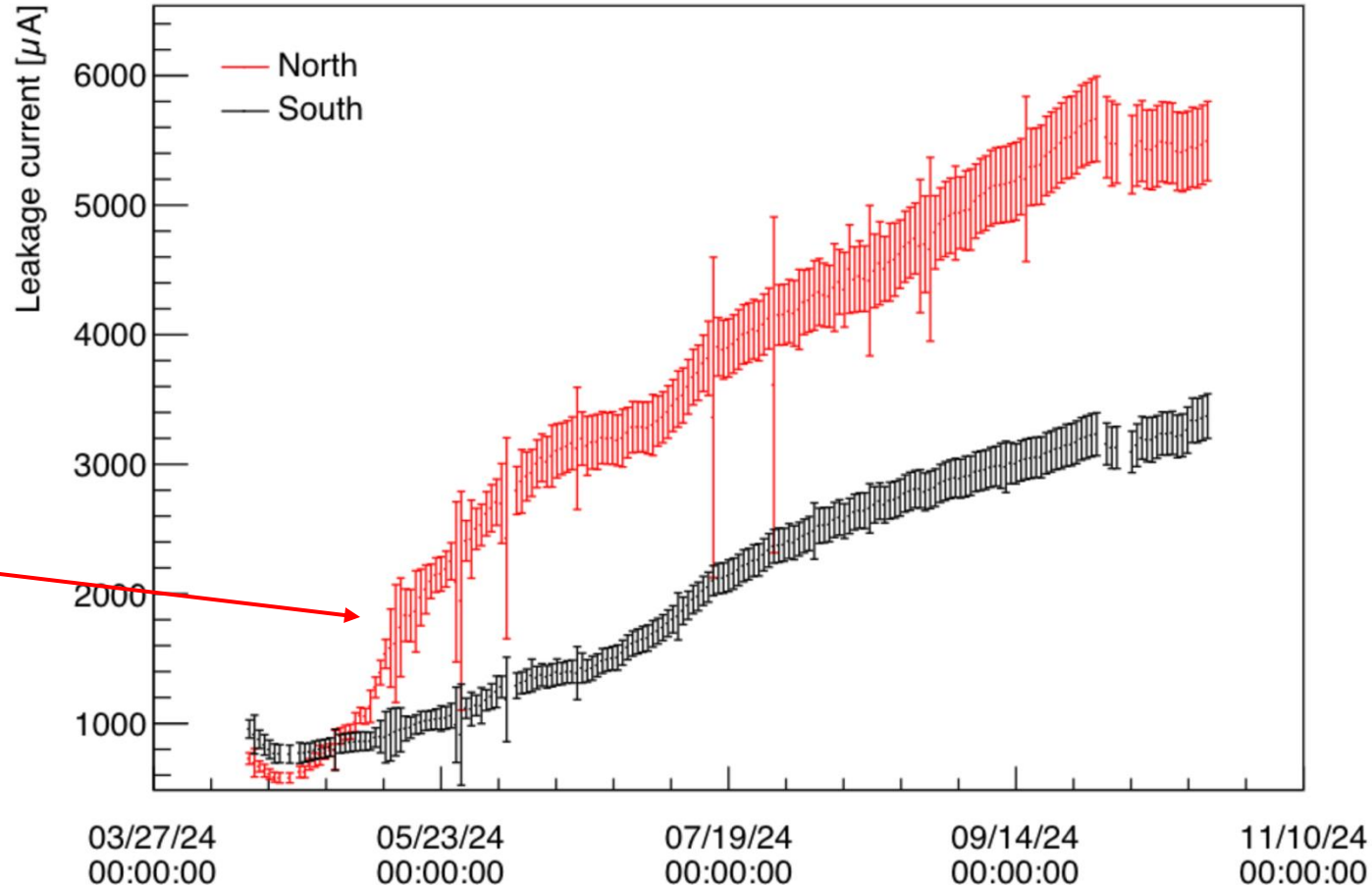
Chapter 1

sPHENIX Report at RHIC Retreat

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Backgrounds and SiPM Damage

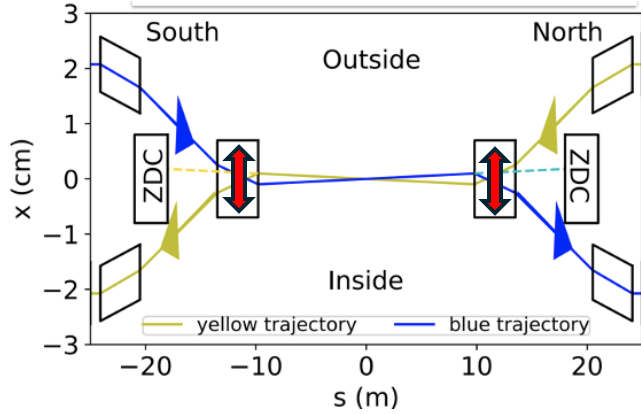
sPHENIX EMCAL IB5



Radiation damage on the EMCAL was correlated with the blue injections: with the negative crossing angle configuration

Note that this level of radiation damage is consistent with expectations
The surprise was the non-uniformity

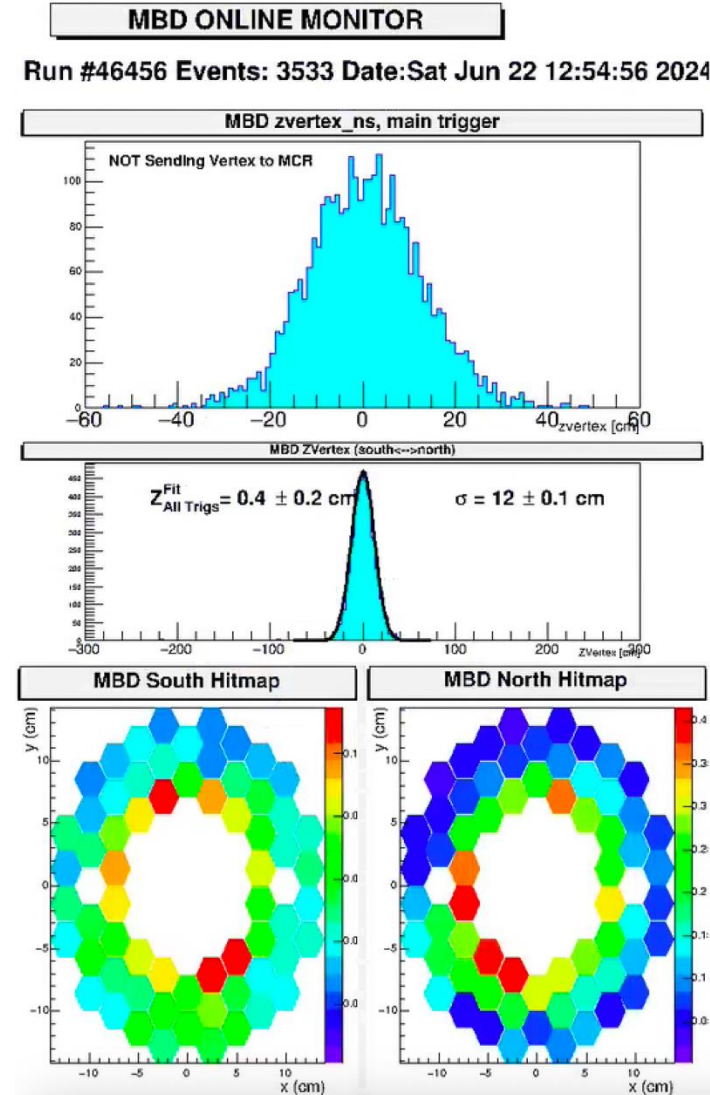
C-AD changed D0 magnet polarity



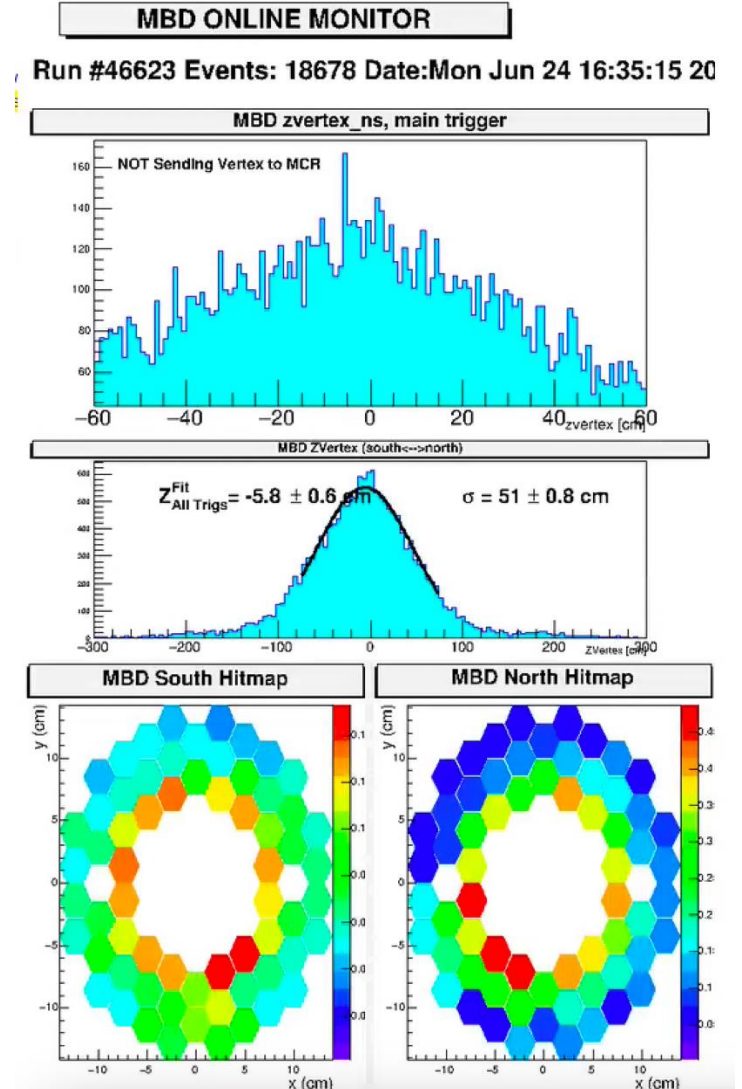
+2 mrad crossing,
instead of earlier
-2 mrad crossing.

June 24, 2024,
started running
sPHENIX at
0 mrad crossing.

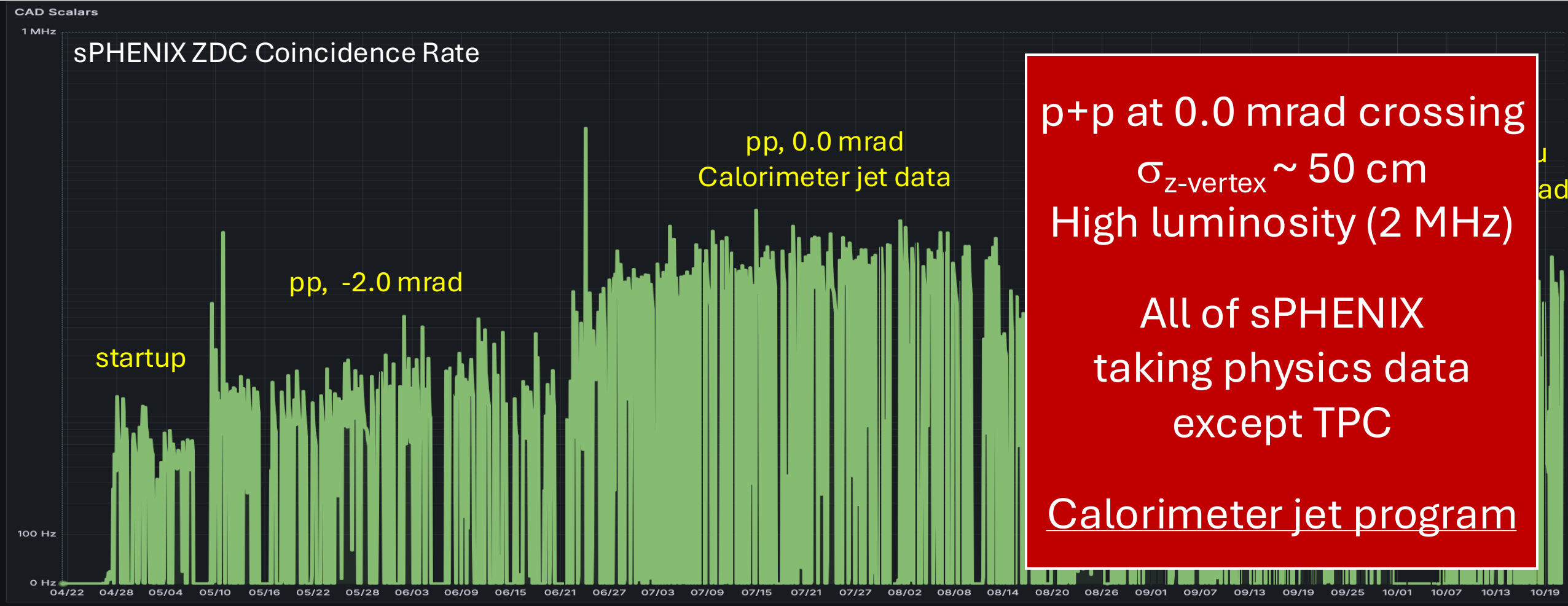
+ 2 mrad has the same
z-vertex width as -2 mrad
 $\sigma \sim 12 \text{ cm}$



+ 0 mrad has a wide
z-vertex distribution
 $\sigma \sim 50\text{-}60 \text{ cm}$



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Chapter 2

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TPC Status

Heavy lift by many people to safety approve isobutane in the TPC
 Special thanks to Ray Filler, David Mohamed, and Joe Levesque

(Kin) An “all negative” USI (Unresolved Safety Issue) — concerning our usage of isobutane in TPC — has been signed by C-AD this morning, after the AESRC (Accel. & Expt. Safety Review Com.) review on July 17, 2024. [This is good news.](#)

- A walkthrough has been scheduled on Tuesday, July 23, 2024, at 11 am.
- We also need isobutane delivery, finish testing and procedure revision etc.

Flowing isobutane in TPC of sPHENIX

- Agreement to implement the July 12 version of the USI.
- There will be an AESRC review tomorrow and after that, the USI would be ready for signatures.
- We are also updating procedures, alarm instructions and necessary training.
- Walkthrough will be scheduled in consultation with AESRC.
- Target date for operation: earlier next week.

C-AD and IP Unreviewed Safety Issue (USI) Evaluation Form
 (C-A-OPM 1.10.1.b)

Justification: The supplied airflow will dilute the isobutane to less than 10% of the LEL with a total safety factor over 30. In the event the supplied airflow is compromised, isobutane supply will be closed.

The C-AD and sPHENIX are in alignment with utilizing cutting-edge safety for cutting-edge science and minimizing gas loss is a priority. The above risk analysis concludes that the introduction of isobutane within the TPC is an activity of extremely low risk. The semi-quantitative hazard analysis shows the controls implemented and maintained through 10 CFR 851 safely mitigate the hazard to acceptable levels.

III. USI Evaluation Criteria:

1. Does the planned activity or discovered condition introduce a new or previously unreviewed accelerator-specific hazard that is not adequately addressed by the current SAD and approved ASE?

Yes No

Justification: (use attachment if necessary)

The planned activity does not introduce a new or previously unreviewed accelerator-specific hazard as isobutane is being used in the TPOT. The introduction of an additional isobutane supply is safely mitigated by extending the existing 10 CFR 851 controls.

2. Does the planned activity or discovered condition introduce a new or previously unreviewed non-accelerator specific hazard that is not adequately addressed by the current SAD and approved ASE and increases the risk level as per the SAD risk table which would require at least one new credited control?

Yes No

Justification: (use attachment if necessary)

The planned activity does not introduce a new or previously unreviewed non-accelerator specific hazard that increases the risk level as per the SAD risk table or require at least one new credited control. The introduction of isobutane is safely mitigated with controls implemented under 10 CFR 851. The Maximum Credible Incident (MCI) associated with this hazard includes a fire hazard that is covered through the fire hazard analyses as well as an initiator to a cryogenic release via pipe rupture that has been previously analyzed in the sPHENIX USI for cryogenics and gas use.

3. Does the planned activity or discovered condition require additional credited controls, modification to existing credited controls or processes and/or procedures that implement credited controls as described in the SAD and implemented in the ASE?

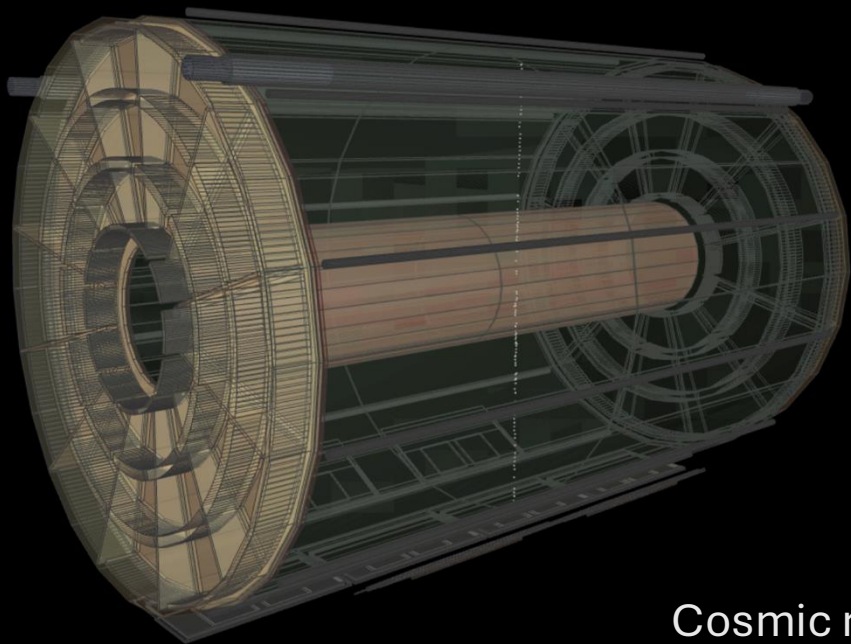
Yes No

Table 1: Scenarios Requiring Isobutane Valve Isolation

Location	Scenario	Engineered Control/Response	Administrative Control/Response
IR8 (sPHENIX Detector Hall)	Bore Dehumidifiers $\Sigma N > 100$ cfm and $\Sigma S > 100$ cfm		No Change
IR8 (sPHENIX Detector Hall)	Ceiling VESDA HSSD Smoke Detected		No Change
IR8 (sPHENIX Detector Hall)	Bore VESDA HSSD Smoke Detected	Turn off Isobutane Supply (KGT) and alarm sPHENIX Control Room	No Change
IR8 (sPHENIX Detector Hall)	Bore isobutane detected		Alarm MCR; Resume after handheld flammable gas survey
Gas Mixing House	GMH Vent Fan Fail		No Change
Gas Mixing House	Isobutane Shed Vent Fan Fail		No Change
Gas Mixing House	GMH Isobutane Detected		Alarm MCR; Resume after handheld flammable gas survey
Gas Mixing House	>6% Isobutane Mixture		No Change
Gas Mixing House	Emergency Stop Button		No Change

- We are implementing the above controls necessary for sPHENIX to flow isobutane from the Gas Mixing House to the IR.
 - The firmware and software implementation/changes are done by an outside company as well as a BNL software engineer.
- Fans in the isobutane shed and the Gas Mixing House are being restored.
- Ventilation in the IR bore (~ inside Magnet doors) needs to be maintained continuously.

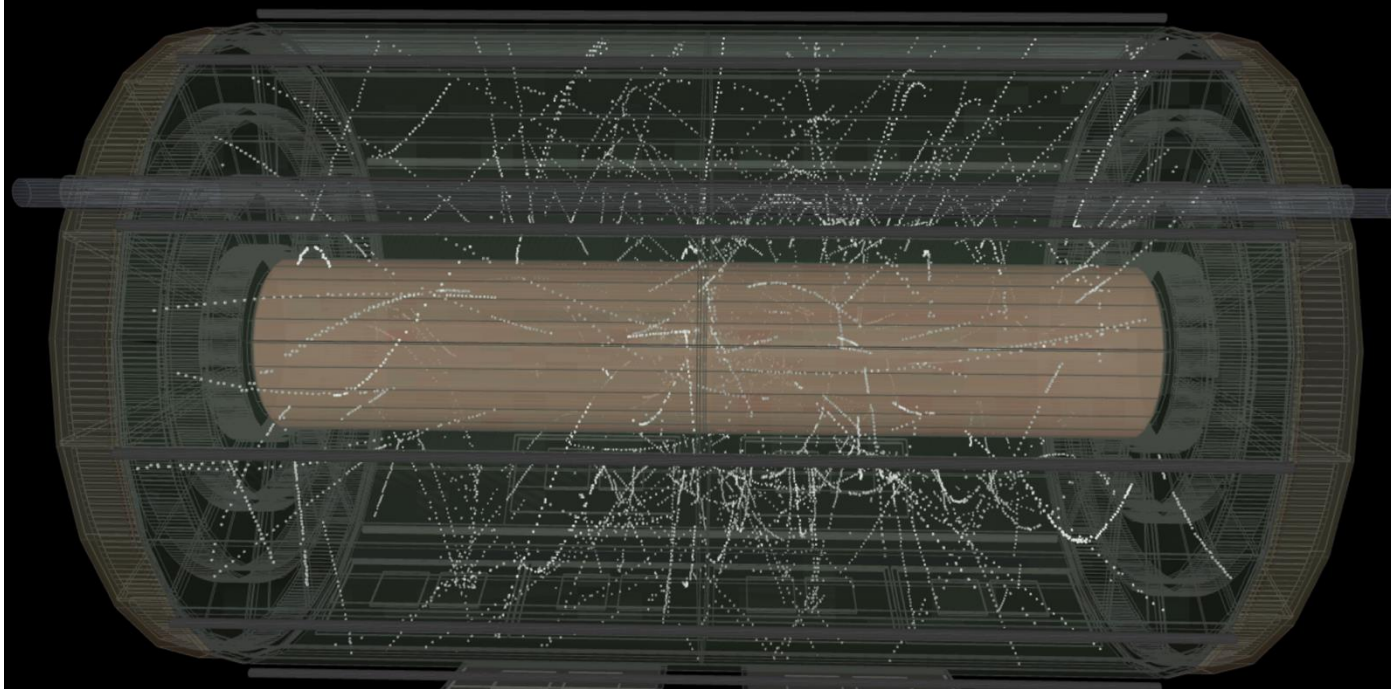
sPHENIX Internal
Cosmic
2024-07-29, Run 49547
Event #0



Cosmic ray

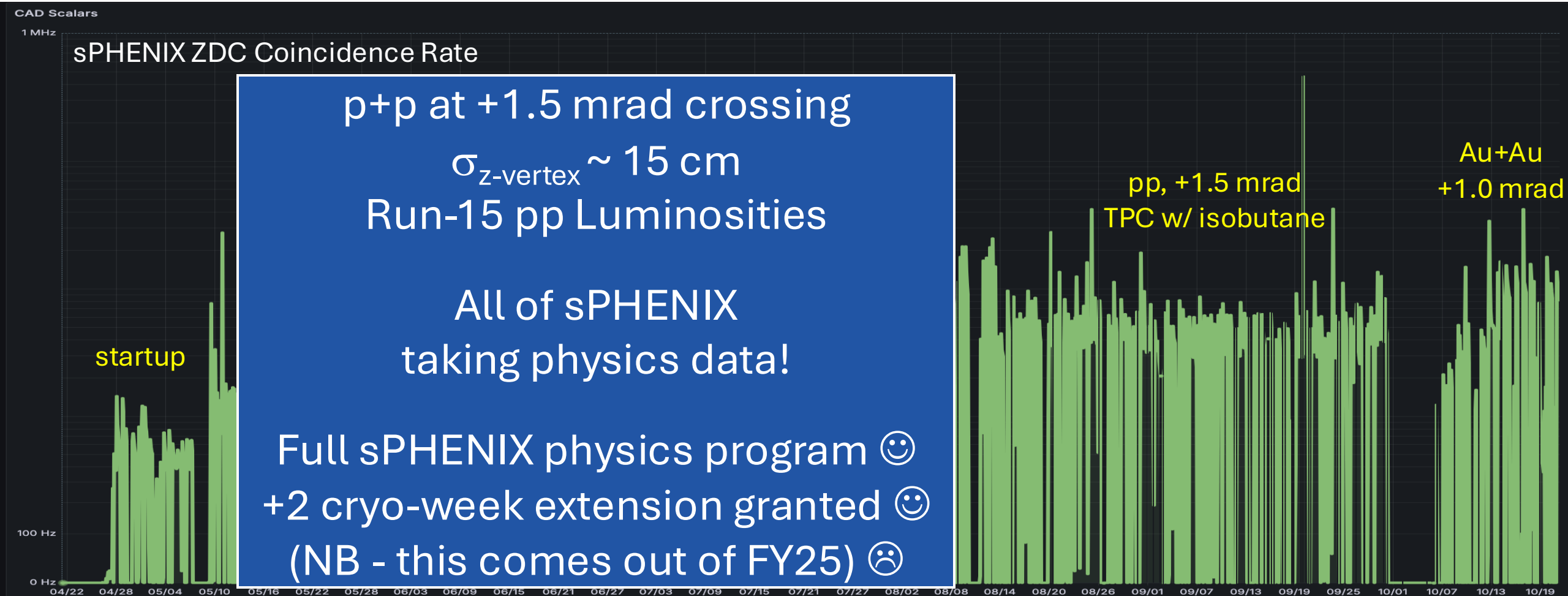
Got Isobutane? Yes!

sPHENIX Internal
200 GeV pp
2024-08-04, Run 50440, Event #0
TPC HV: (GEMs - 3.3 kV, CM - 42.3 kV), 0 mrad crossing angle.



Extended Readout – Multiple pp collisions

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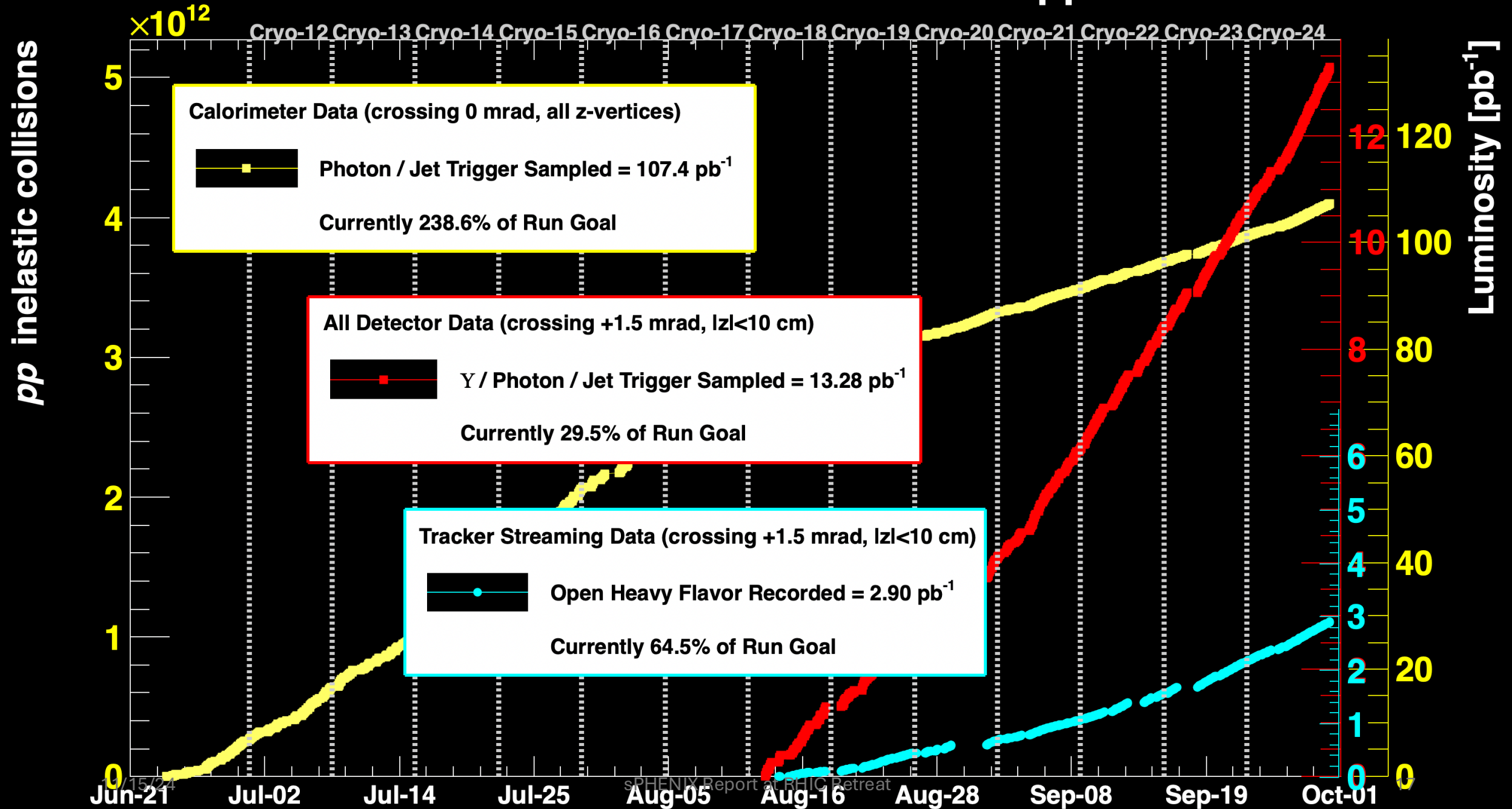
Chapter 3

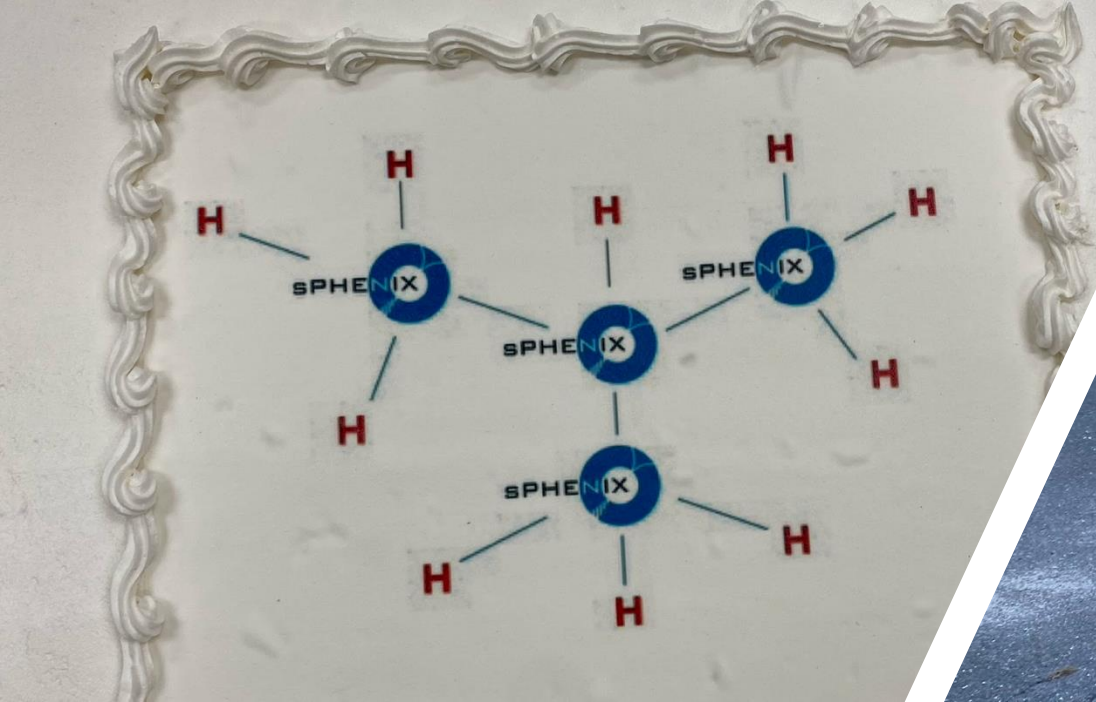
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sPHENIX exceeds goal of 10% streaming by x3, enabling very rapid open heavy flavor statistics

sPHENIX Run 2024 pp $\sqrt{s}=200$ GeV



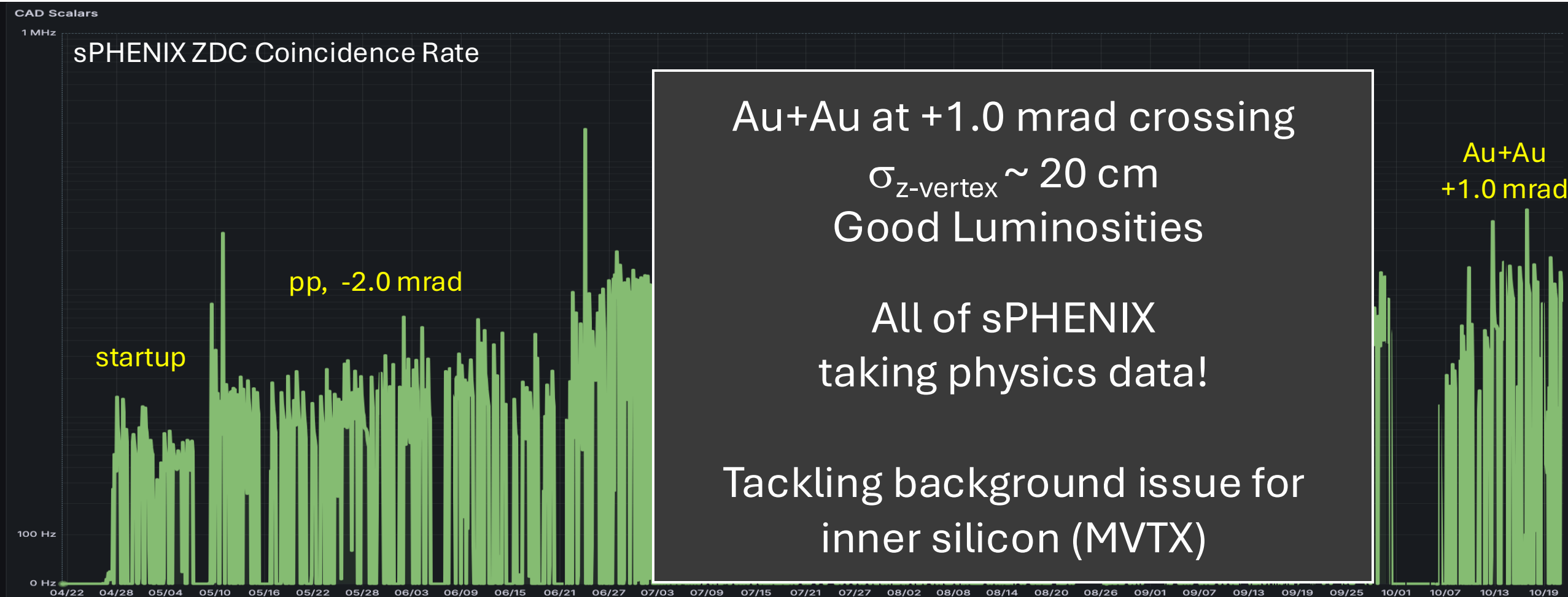


11/15/24



sPHENIX Report at RHIC Retreat

A long and challenging and fun sPHENIX Run 2024



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May 10

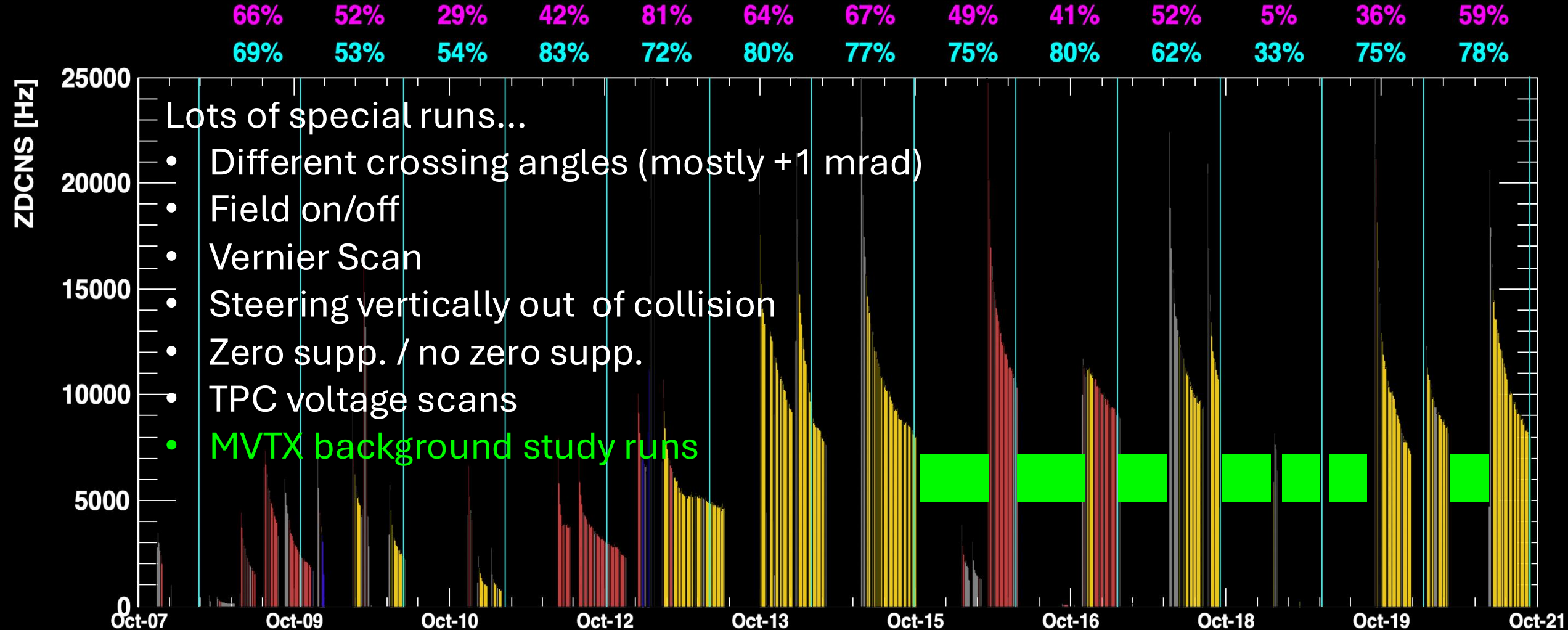
June 21

August 14

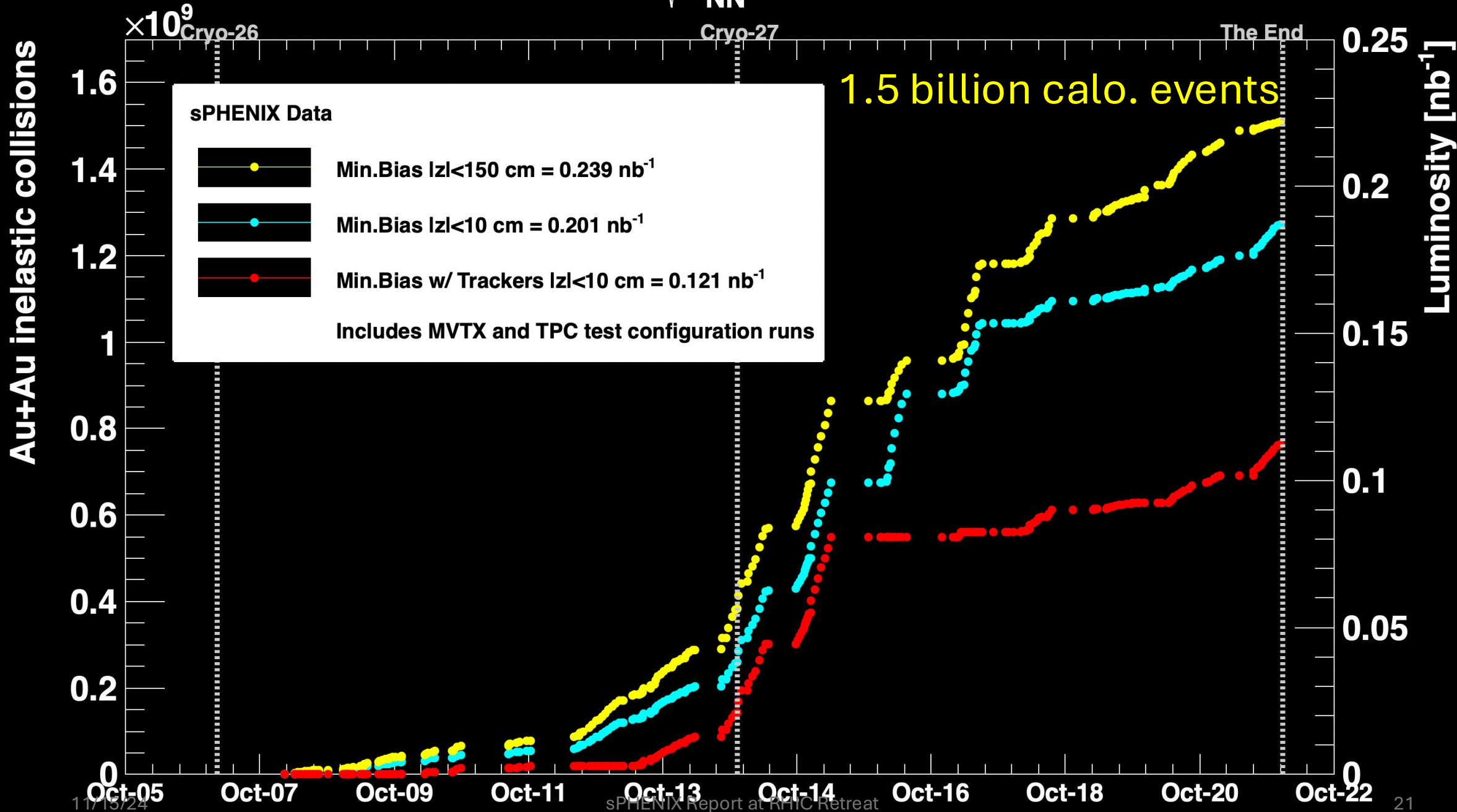
October 7

October 21

Au+Au 3 weeks in a nutshell



sPHENIX Run 2024 Au+Au $\sqrt{s_{NN}}=200$ GeV



TPC Summary

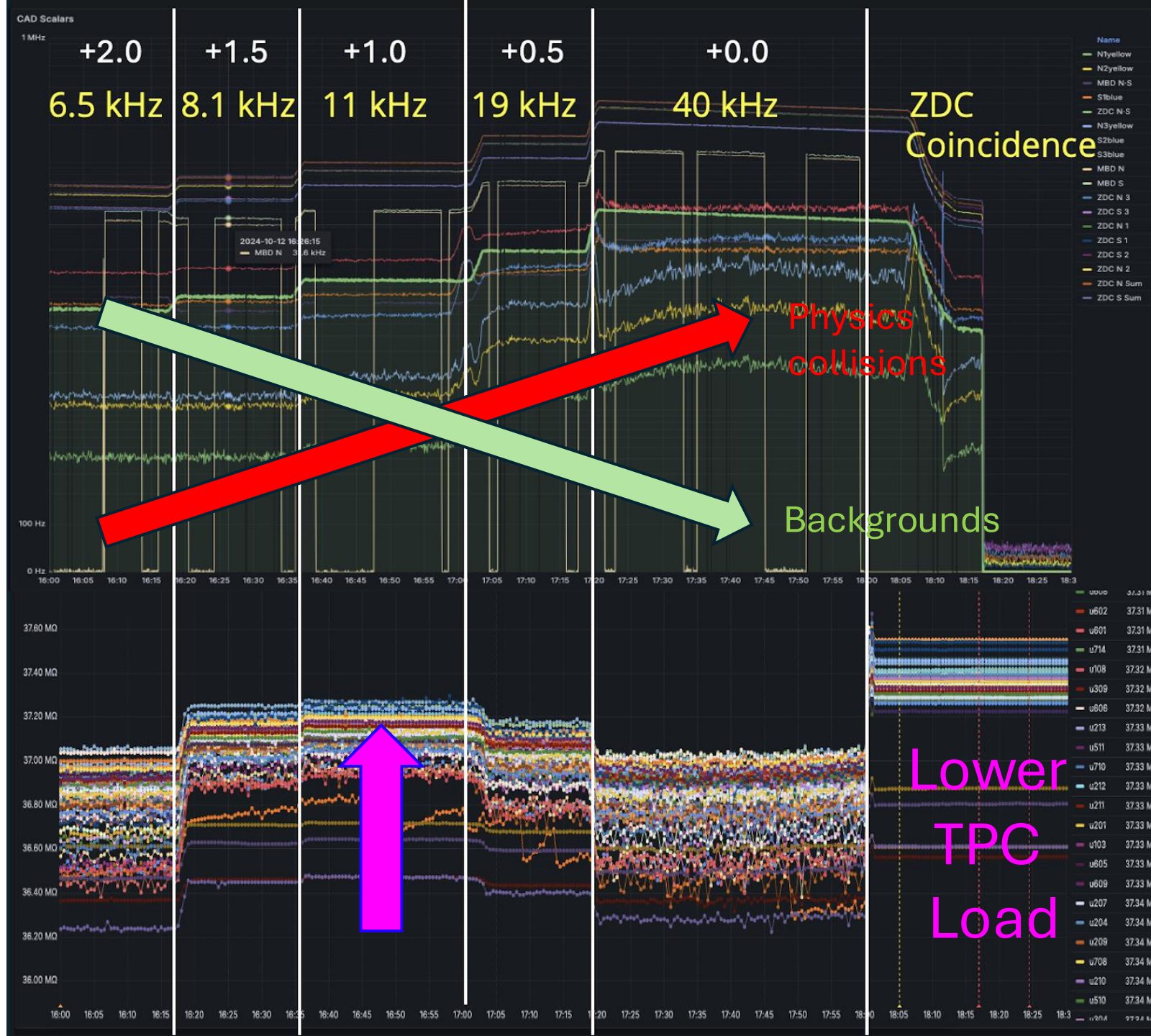
The TPC charge load appears to be dominated by beam background (not collisions)

Charge load is directly related to TPC distortions.

Implications for Run 2025, default is now +1.0 mrad to start.

Tested 2 sectors w/ new CAEN HV system.

Potential gas contamination issue in last 10 days. Under study.

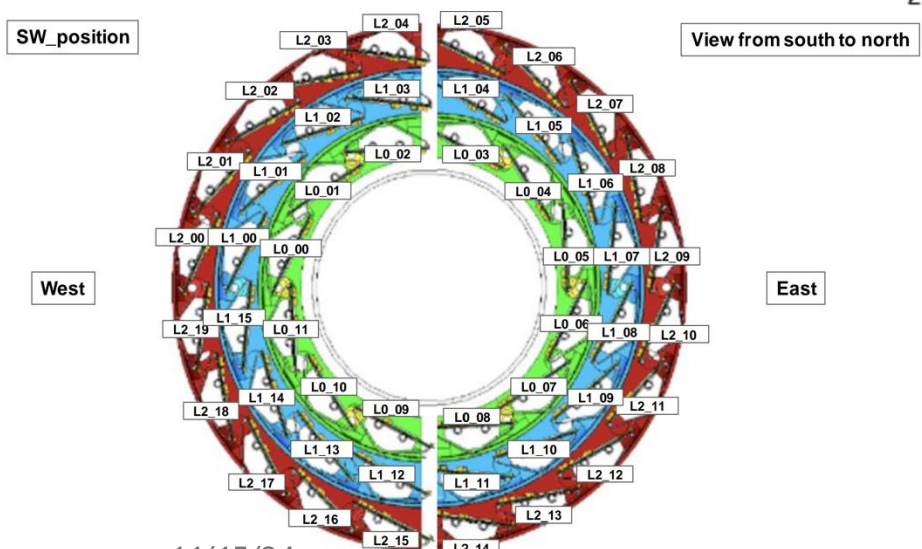
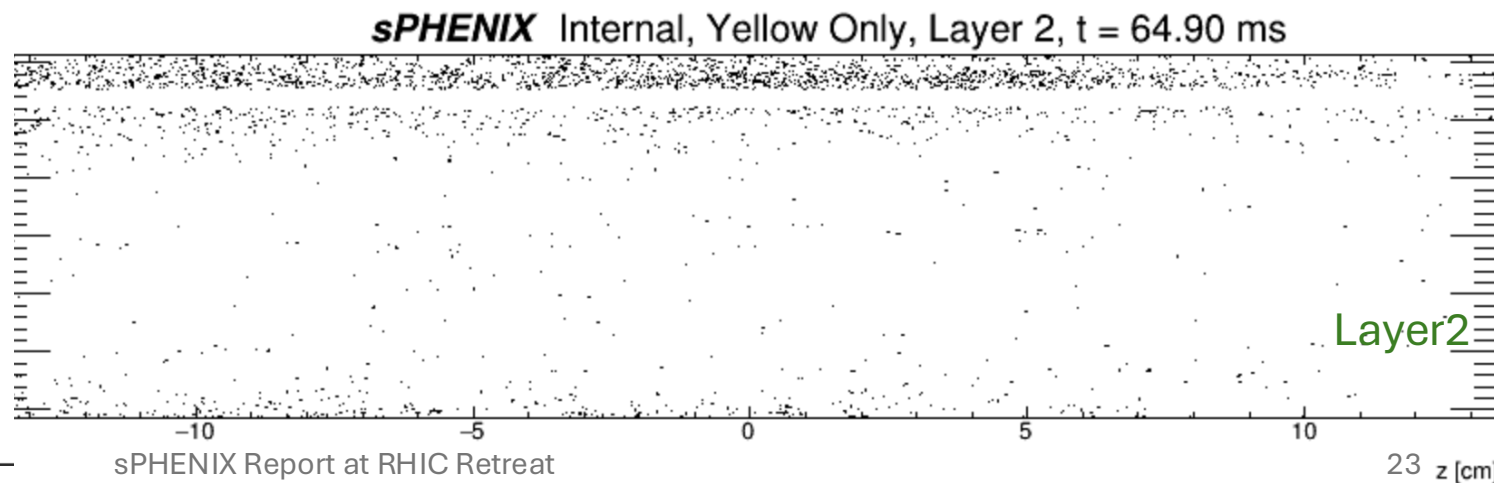
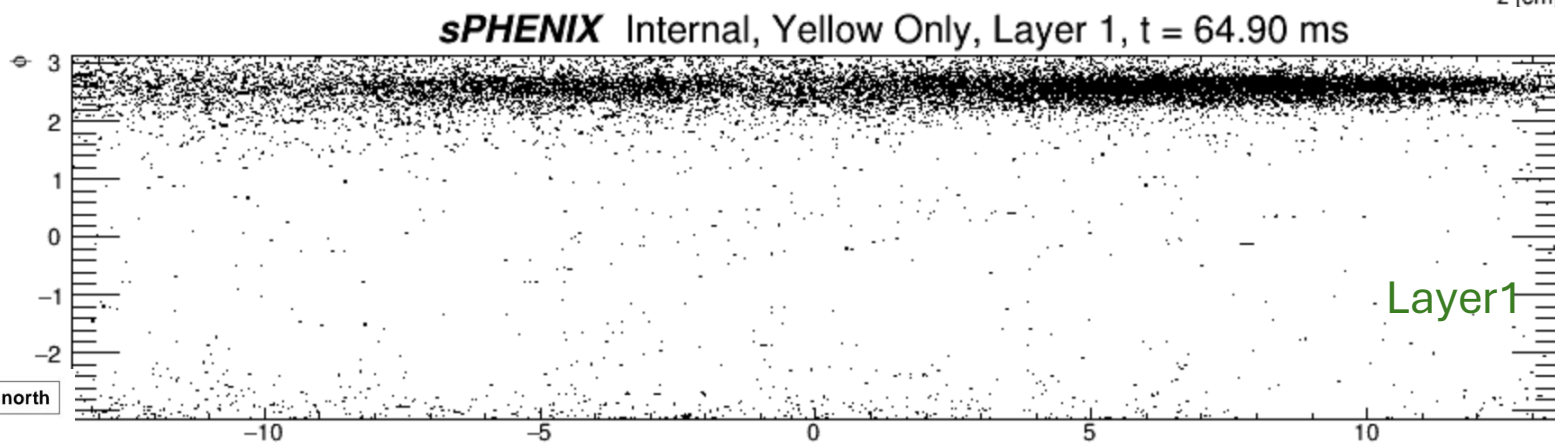
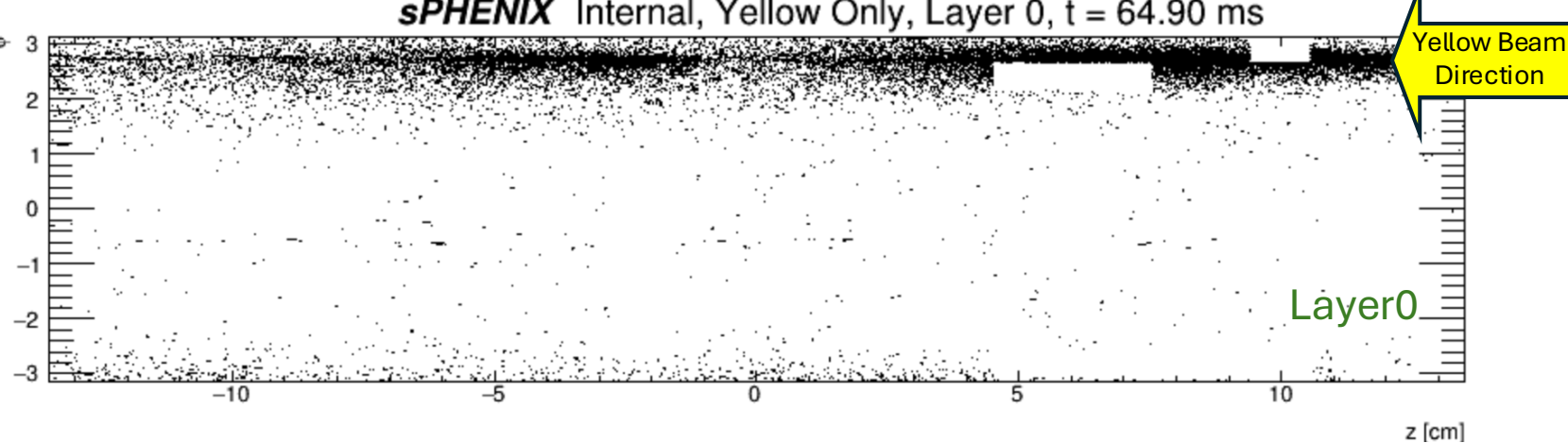


MVTX Backgrounds

No problems in proton-proton

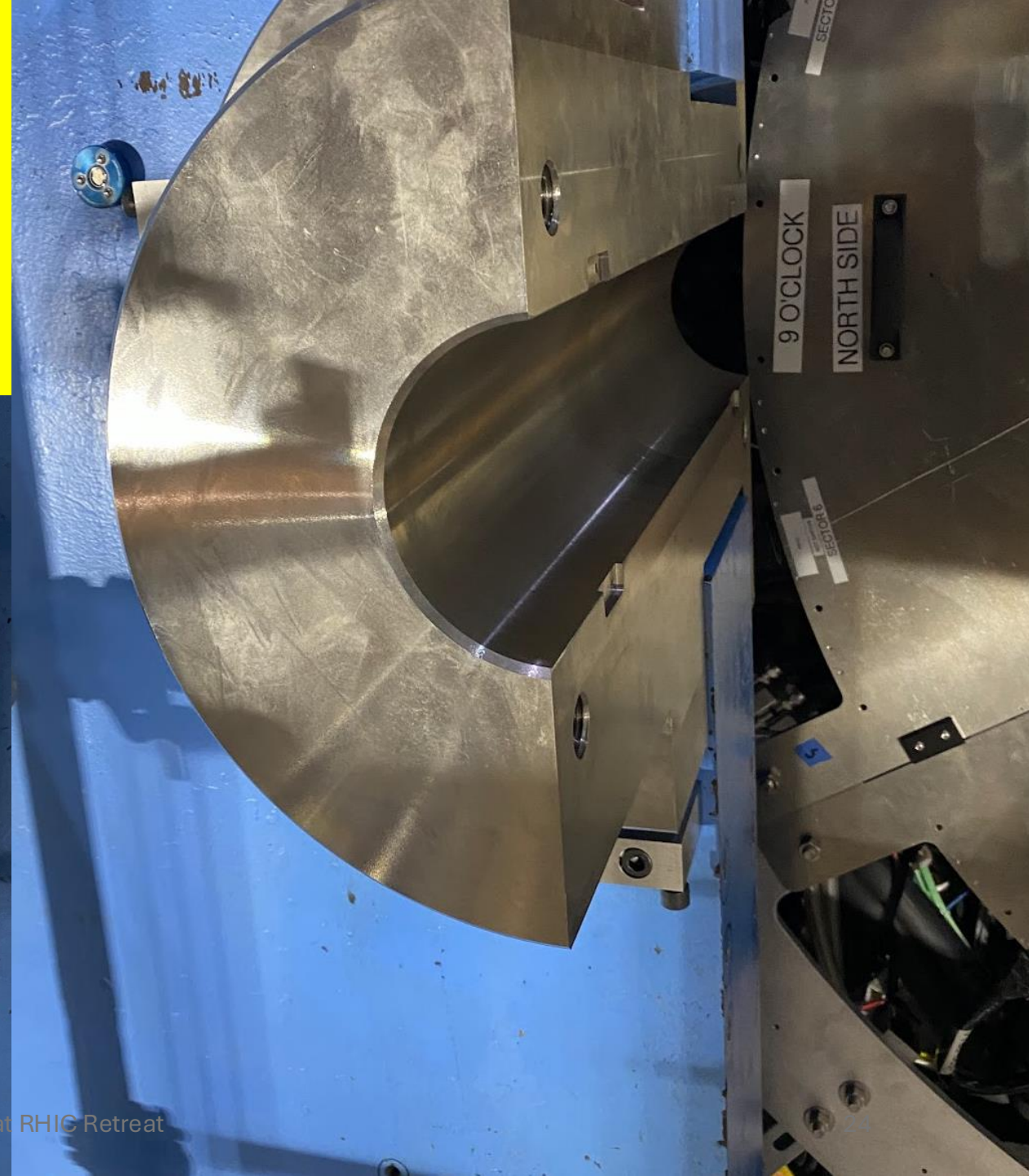
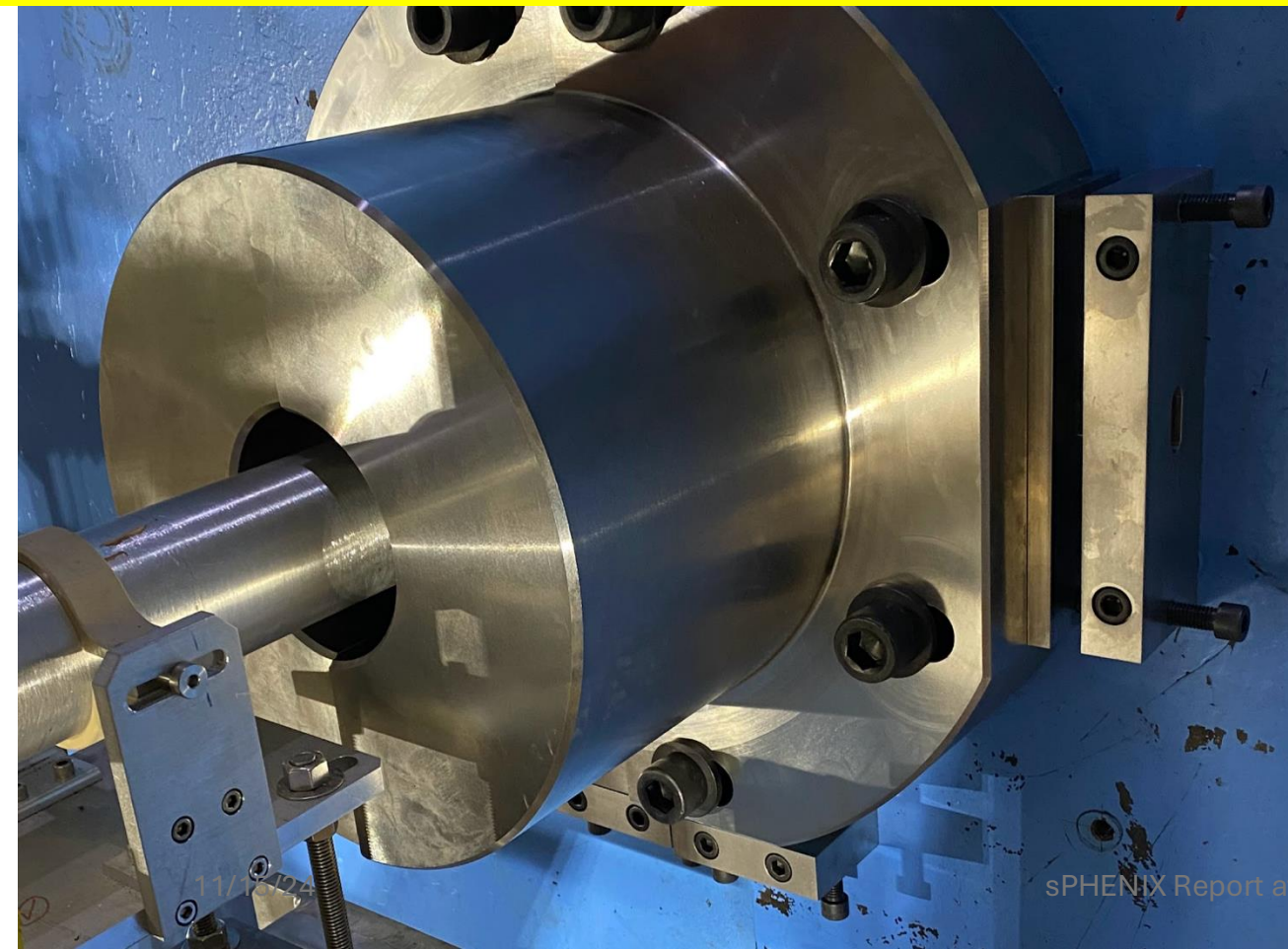
Major background in Au+Au,
even with just one bunch in
the yellow ring
(i.e., no collisions)

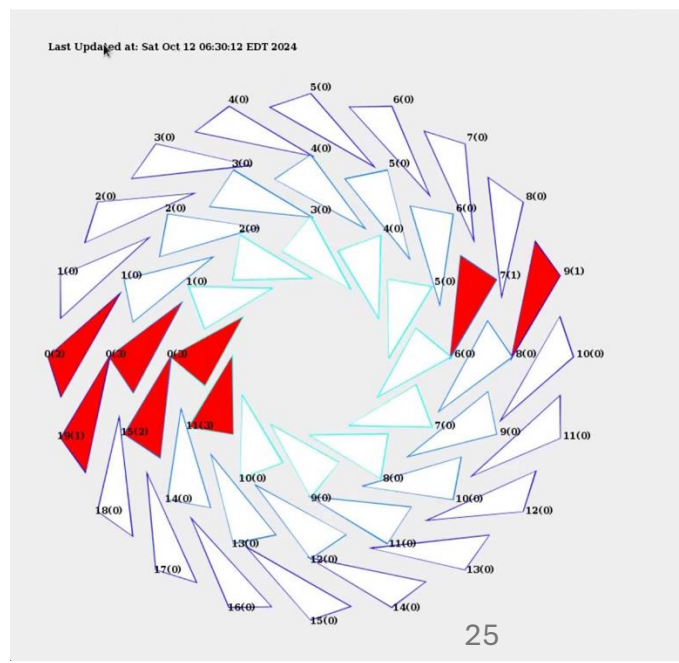
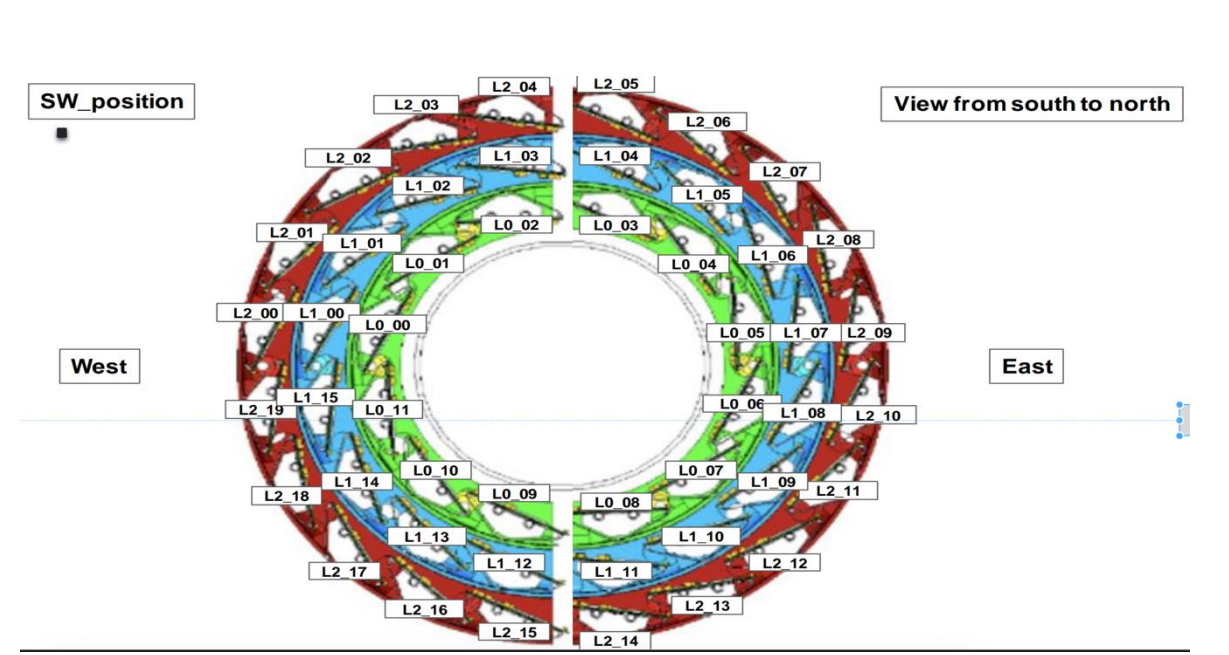
Beam backgrounds... induces
auto-recoveries in MVTX



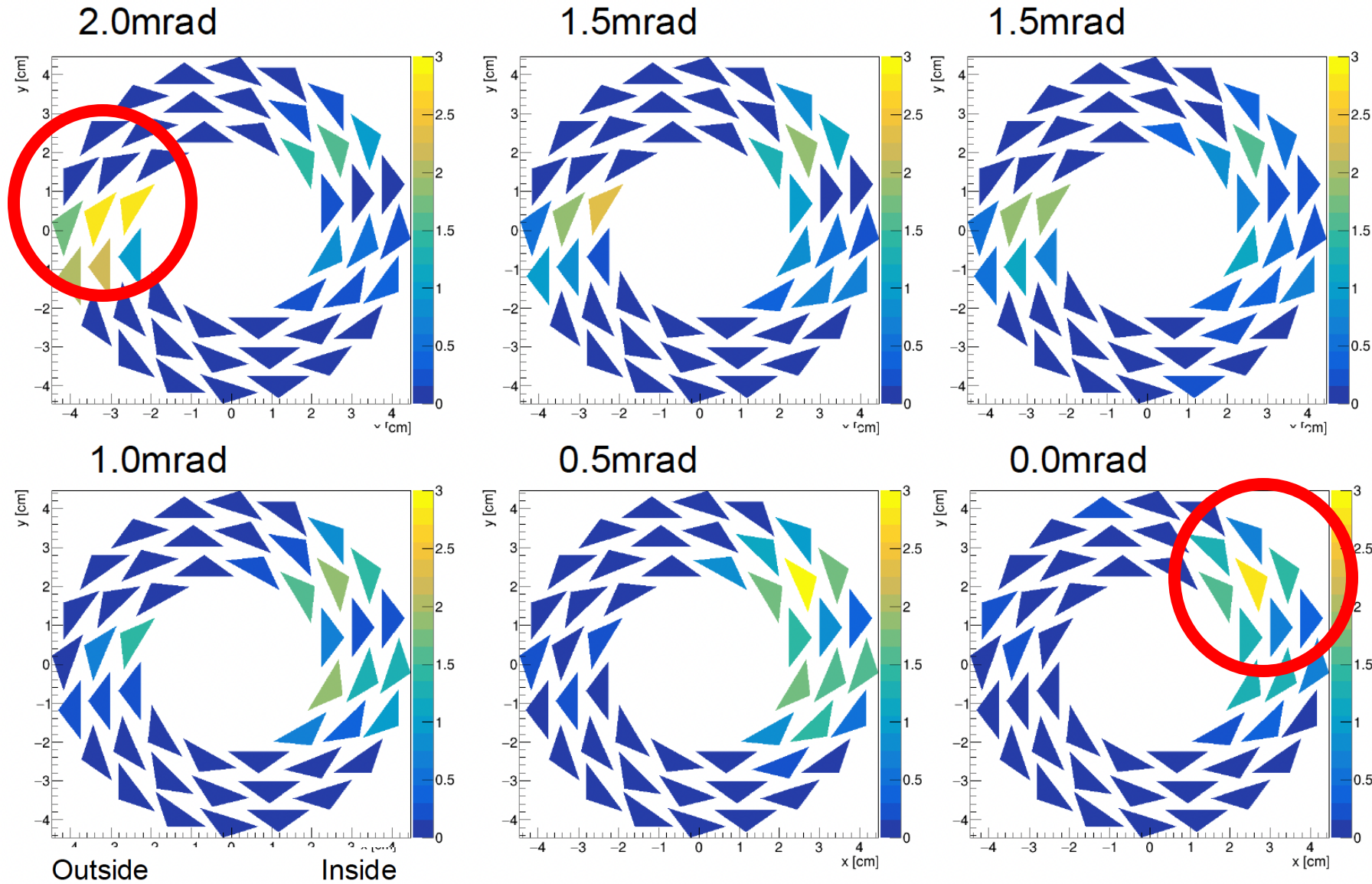
North absorber installed on
Thursday, October 10, 2024
Shielding for Yellow Beam backgrounds

No impact on MVTX auto-recoveries...
Maybe not so surprising...





X-ing angle summary, 1x1 bunches



Crossing angle change completely moves where the background hits.

C-AD has many test results to develop a mitigation.

sPHENIX MVTX intended to run in 100% streaming mode. That makes it susceptible to 100% of splash events → autorecovery (AR)

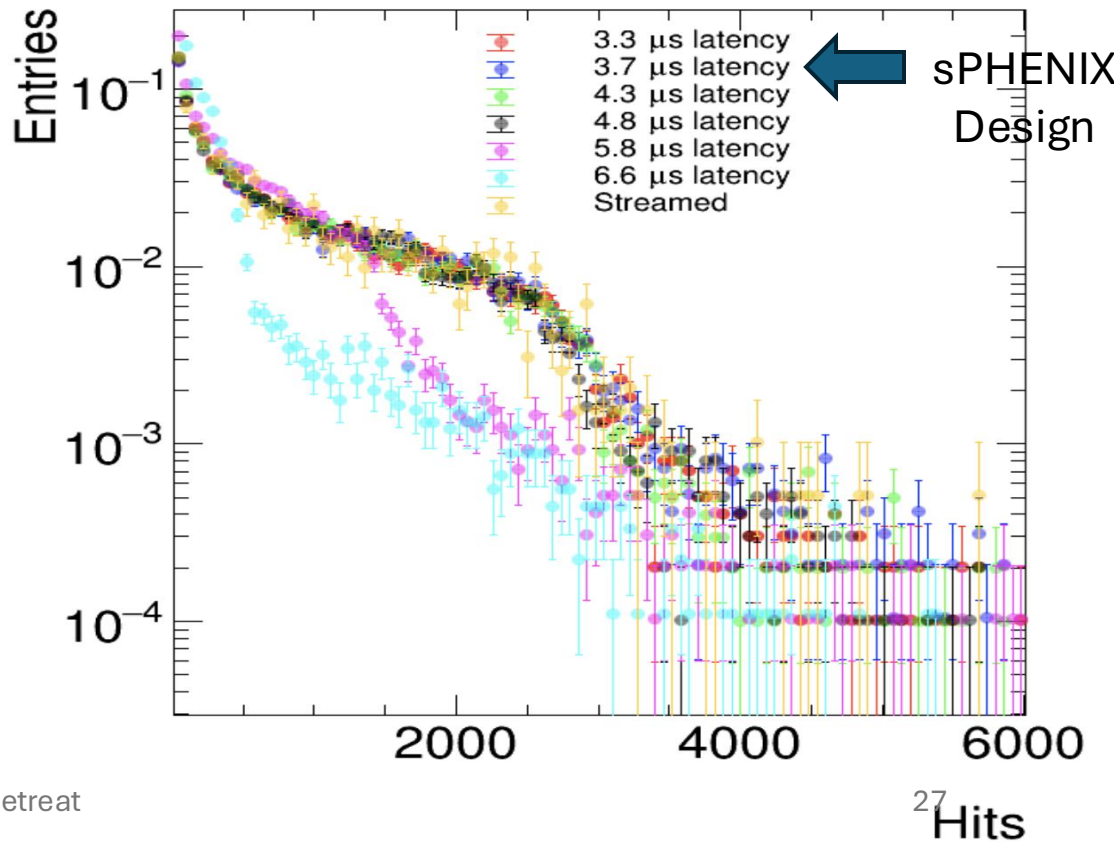
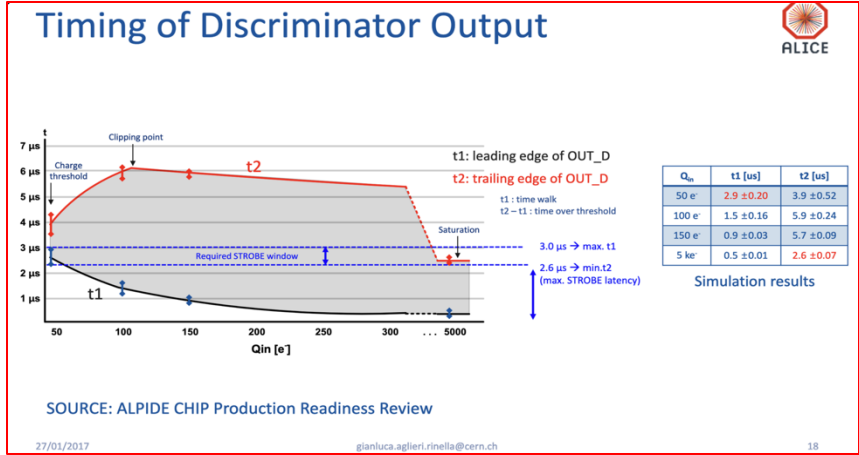
ALICE ALPIDE supports triggered mode with 2.5 microsecond latency. Reduces AR by x10-20.

sPHENIX default is 3.7 μs.

Latency scan yielded encouraging results, But full analysis needed to understand efficiency for low p_T kaons and protons

Confident that next year running in triggered mode and with C-AD improvements, MVTX will be fully functional.

* Note streaming mode for future p+Au running may be an issue.



Given many challenges,
excellent sPHENIX pp data set the result of
sPHENIX and C-AD smarts and true grit.

Run 2024 pp data set

- 230% BUP jets/photons
- 65% BUP open heavy flavor
- 30% BUP Upsilon/full program

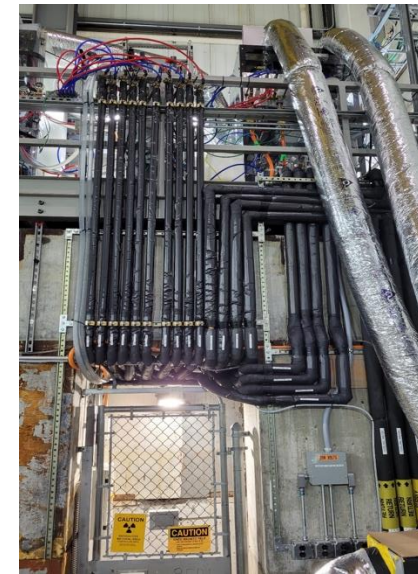
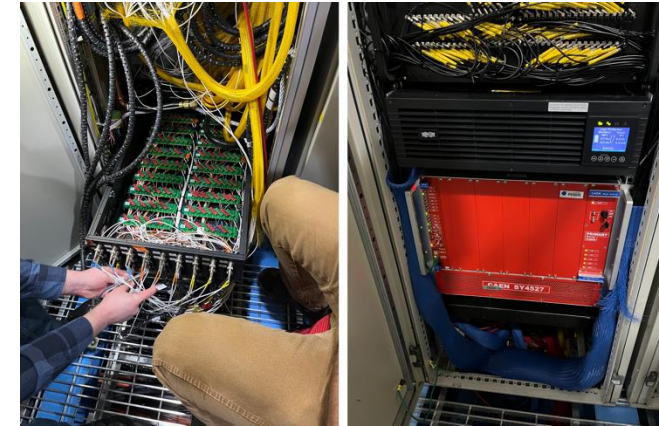
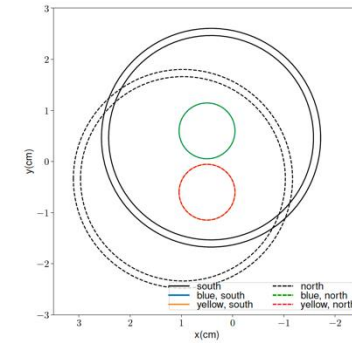
sPHENIX and C-AD have the data needed to
solve remaining issues for a very successful
Run 2025 Au+Au.



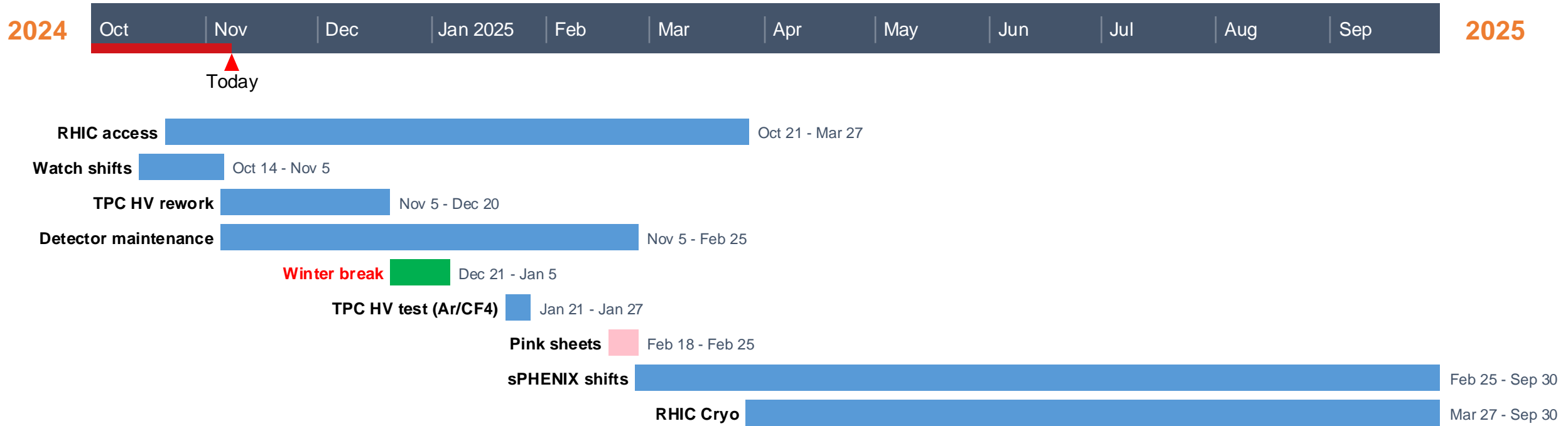
Plans for Running in 2025

Shutdown activities

- After detailed discussions, including C-AD, sPHENIX will not remove beampipe, MVTX, INTT in attempt to re-align.
- TPC CAEN High Voltage system hooked up (no more resistor swaps)
- Doubling number of DAQ Buffer Boxes for 2x data bandwidth
- Enclosing cooling system on platform (humidity issue in summer)
- sPHENIX will again need C-AD help!



sPHENIX FY2025 Shutdown

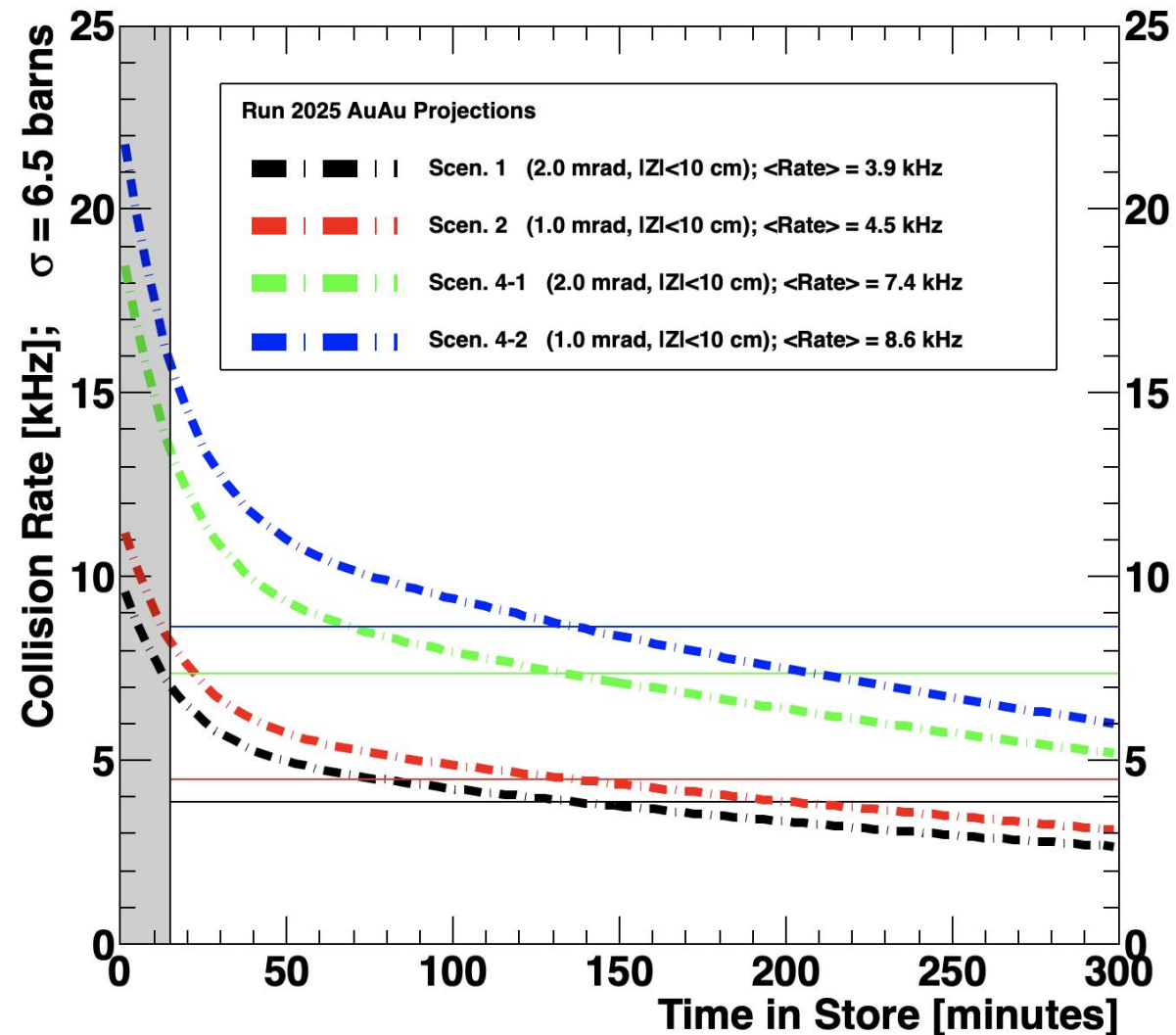
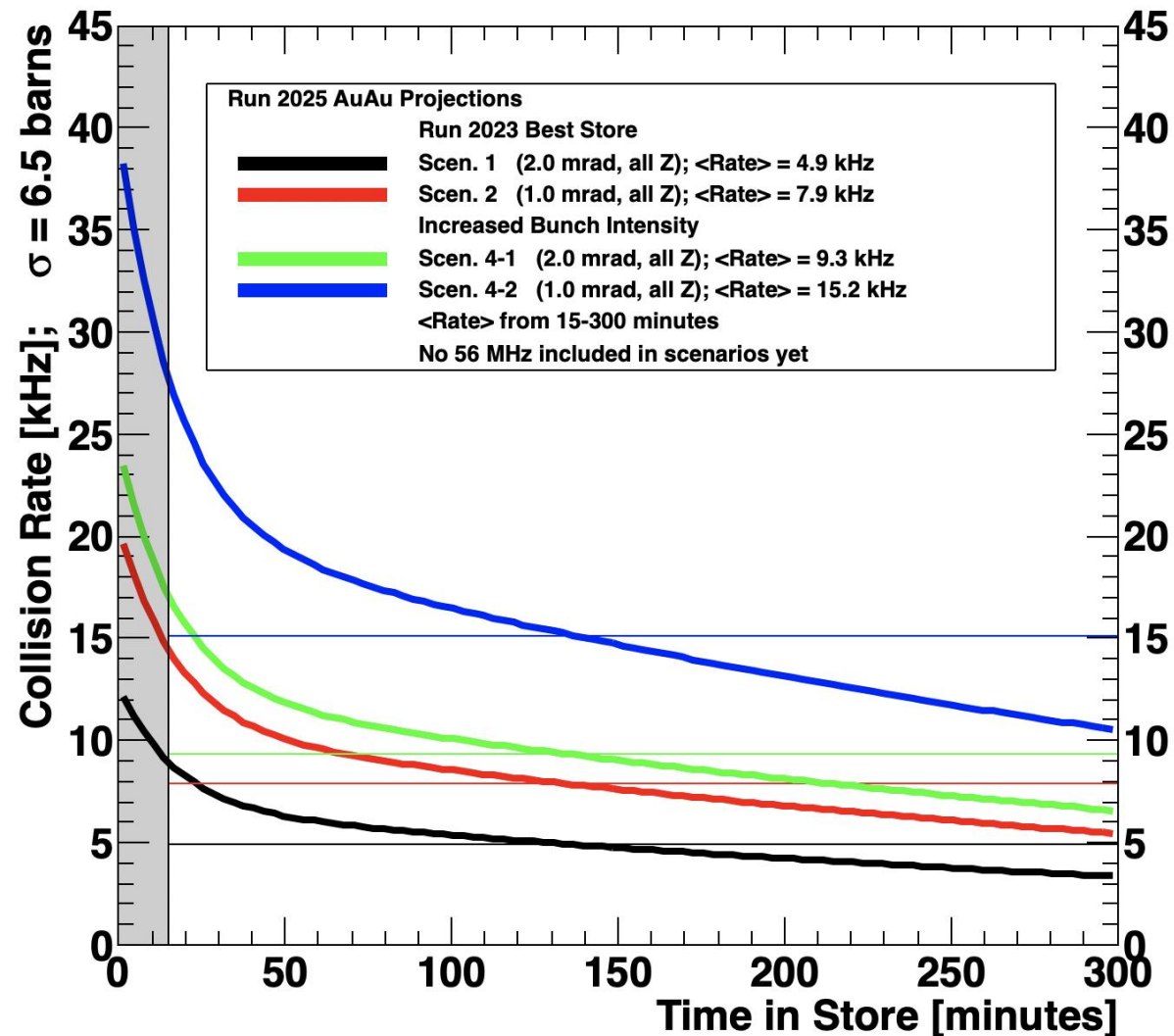


Rosi Reed is Run 2025 Run Coordinator



- Rosi is a professor at Lehigh University
- She was the manager of the sPHENIX Event Plane Detector
- She will be in residence at BNL Feb-Oct 2025

C-AD Au+Au projections for Run 2025



With sPHENIX DAQ buffer box upgrade, can record all collisions within $|z| < 10$ cm.

Plans for Running in 2025

- Exact run plan for 2025 not fully determined yet
 - Beam Use Proposal submitted
 - PAC met Nov 7-8 <https://indico.bnl.gov/event/25236/>
 - Closeout recommendation was “aim to collect a large 200 GeV AuAu data set”
- Need to remain flexible over the next few years
- MVTX background issue remains largest concern.
 - Solutions will be a combination of background mitigation and MVTX triggered mode.
 - Additional monitoring devices being considered.
 - Background Task Force w/ C-AD & sPHENIX working together is critical.