

RHIC Run25, Status & Aspirations

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Run24 Au at RHIC, 3 week run

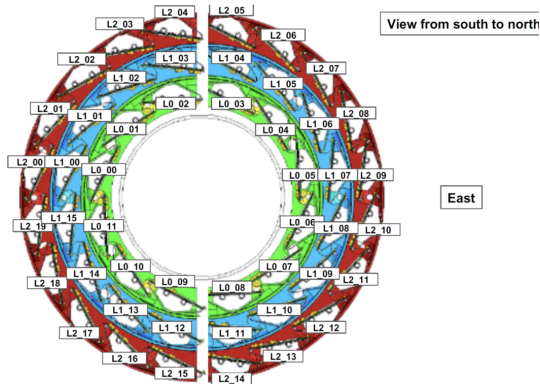
Goals of 3-week Au run

- Increase intensity to 1.8×10^9 /bunch, fully commission the 56 MHz RF system.
- Ensure sPHENIX systems are ready for Run25.
- Provide enough physics for STAR to reach 1-2 B events on their minbias trigger.

Notes

- Injection into blue delayed 4.5 days due to g9-blw-ps failure.
- Injection into yellow delayed 5 days due to yellow abort kicker issue.
- 3 days from first injection to physics.
- Max store intensity reached 1.3×10^9 /bunch
- 2 sessions of successful 56 MHz commissioning. Operated at full voltage with 1.3×10^9 /bunch.
- Backgrounds on sPHENIX MVTX prompted daily studies from 10/11 to 10/21 (discovered on 10/09, absorber install on 10/10 with no observed effect). All other systems, ready to go.
- STAR recorded over 1.5 B minbias events.

The MVTX detector



- 48 staves in three layers, centered at 0 m, and extends ± 13.5 cm.
- Simulations by sPHENIX show a single Au ion (or shower from striking the beampipe) with a longitudinal trajectory, striking the MVTX would result single/multiple MVTX staves going into auto-recovery
- Simulations during diagnostics indicated the source of backgrounds was from particles with a large momentum error.
- Auto recovery process is 20s

Beampipe radius	2.14 cm
MVTX Layer 0	2.4 cm
Layer 1	3.1 cm
Layer 2	3.9 cm

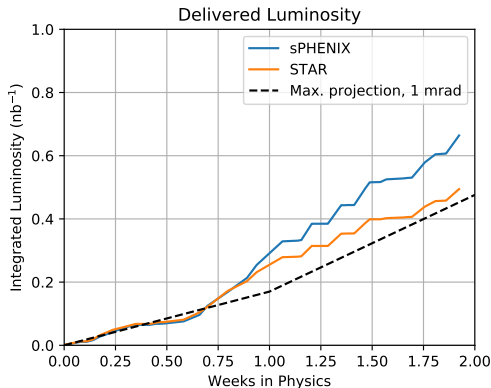
sPHENIX MVTX Backgrounds studies

Studies performed and their implications

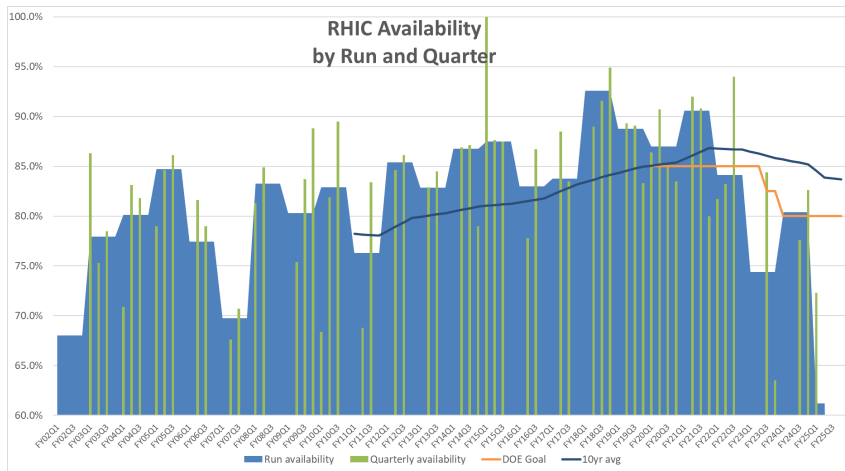
Study	Summary
Yellow only studies	High backgrounds even with single bunch → prompted single yellow bunch studies
Blue only studies	Significantly lower backgrounds than with yellow, 56 bunches in blue better than single yellow bunch → primarily sourced by yellow
Unrebucketed beam	Improved auto-recoveries → affected by bucket area
Local steering (position and angle)	Significant reduction in auto-recovery rate → losses can be moved locally and redistributed
Unsqueeze of IP8	No significant change → losses not the result of local scraping in triplet or local dispersion
Squeeze of IP10	weak change in auto-recoveries with a bump at IP10 → particles can be lost at upstream squeezed IR
Adjustment of global octupoles	Little to no effect → not from high betatron amplitude particle
Prefire protection bump	Significant reduction when combined with local steering and 12 bunches (did not scale to 56 bunches) → off-momentum particle
Bump scan in dispersive region	reduction in auto-recoveries → phase of prefire protection bump may not be optimal

RHIC Performance

- Despite the short run, luminosity stayed ahead of maximum projection.
- Plateaus in delivered luminosity correspond to MVTX background studies.
- $L_{\text{delivered},\text{sPHENIX}} = 0.66 \text{ nb}^{-1}$.
- $L_{\text{delivered},\text{STAR}} = 0.49 \text{ nb}^{-1}$.



RHIC Availability



A target availability of 80% for Run25 has been set.

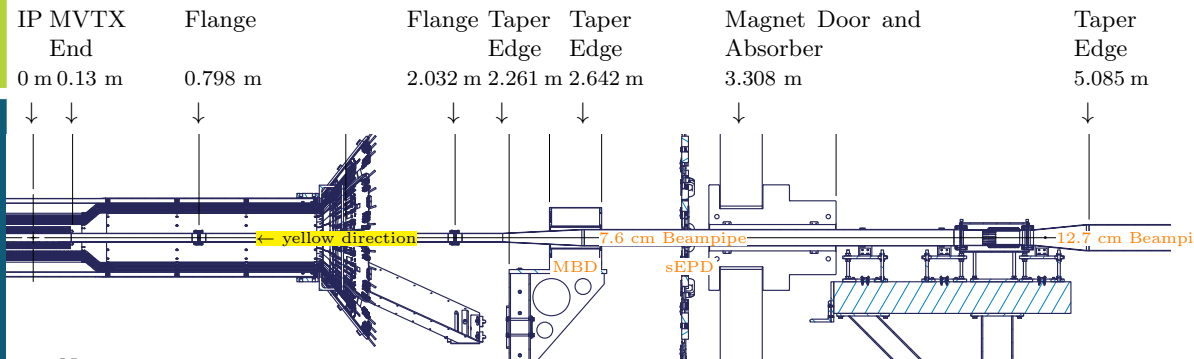
Run24 Au at RHIC, 3 week run

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sPHENIX Geometry



Notes

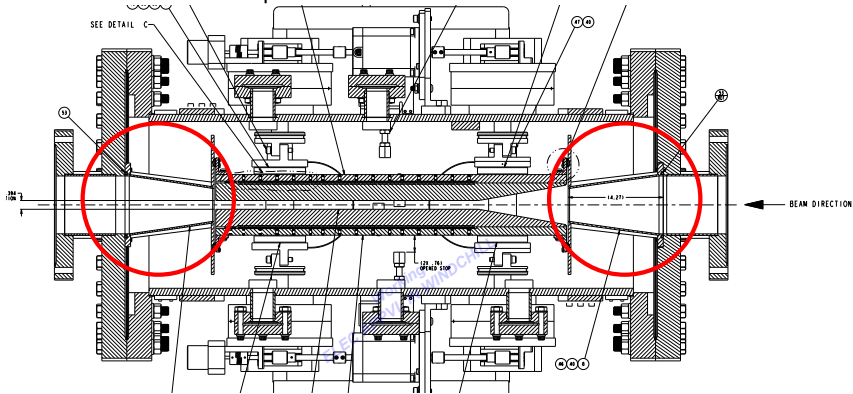
- Opening of absorber is 12.7 cm
- The MBD and sEPD sit on the 7.6 cm beampipe (MBD on 7.62→5.4 cm taper)
- Material is beryllium to first flange, aluminum until transition from 7.62 cm to 12.7 cm.

Task Force Findings and Actions

- Backgrounds result of a two part mechanism:
 - ▶ high amplitude particles strikes limiting aperture
 - ▶ secondary beam generated and strikes MVTX.
- Diagnostics added at each of the beampipe tapers (12.7→7.6 cm and 7.6→5.4 cm)
- The sector 8 yellow mask was determined as a potential source, ~50 m upstream of IP8.
 - ▶ Tracking showed particles over a large energy range could strike the MVTX from this origin.
- The blue mask was moved into the yellow ring at IP4 to provide additional collimation.
- Gamma quads in sector 4 had added supplies to produce a dispersion bump at the new mask to remove high momentum particles.
- "Collar" absorbers designed to be installed between last taper and MVTX to provide additional shielding.

Yellow Mask

The mask (shown in closed position) tapers down from nominal beampipe radius down to an aperture of $r=2.44$ cm. Jaws are open at 2.5-2.8 cm from center.



- Narrow aperture gave only $\sim 8 \sigma$ clearance.
- This item was removed.

Task Force Proposals

Topic	Order	Time(h)	Invasiveness	Notes
Baseline	1	2	dedicated	Ready after ramp+store development
Donut Counters	1	0	Passive	Ready in parallel with baseline
Gap cleaning	2	1	passive	Ready following baseline and Artus setup
Stochastic Cooling	2	8	passive	Ready following baseline+~1 week setup for SC
RF Voltage	3	0.5	passive	Ready following baseline
W-fct optimization	3	24+	dedicated	Lattice optimization and DA simulations ongoing. Intended to be ready
Single octupole	3	4	dedicated	Ready following baseline
NLC correction	3	8	dedicated	Script ready to generate corrections following baseline
Last sextant sextupoles	3	4-8	dedicated	Simulations ongoing. Updates?
Collar absorbers	4	4	access	Ready after baseline when needed
DispIP4 w/ mask	5	24+	dedicated	Development ongoing.

Notes:

- W-fct and Disp@IP4 are both commissioning a new ramp, that is initially optimizing with a low bunch count and then progressively increasing the number of bunches.

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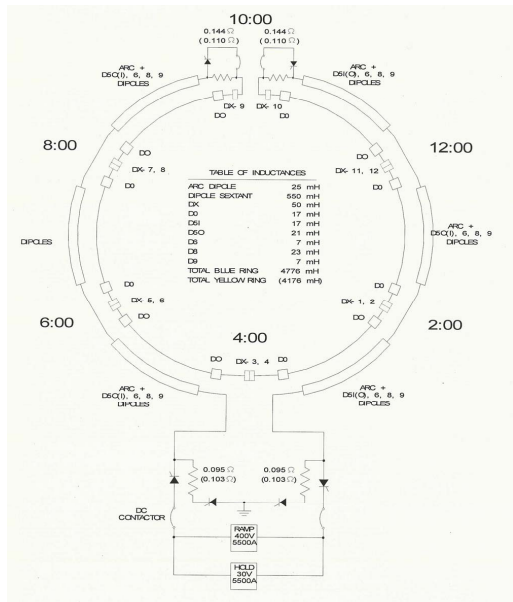
Current State & Outlook

Startup Issues

- After initial cooldown to 4k, the hi-pot at ~ 650 V revealed low resistance.
- Determination was the short to ground was located in the region of the failed DX from Run23.
- A warmup of blue and yellow arcs in that section was required.
- Opening of the sector 4 DX splice can revealed a wire protruding from its insulation and making contact with the wall. The wire was re-wrapped.
 - ▶ The wire was re-wrapped.
 - ▶ Cryostat was closed.
 - ▶ Cooldown to 4k recommenced
- First beam injection delayed from March 30th to May 31st.
- 56 MHz warm He circulator circuit malfunctioned after water flow interruption.
 - ▶ Cavity was warmed up to clear ice (3 days).
 - ▶ Occurred the day physics began.

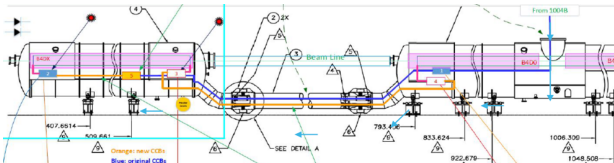
Details on short repair

- Short found on the blue main dipole return bus in sector 4.
- While cold, the short was determined to be between the D4 and valve box.
- A warmup was required to diagnose further and repair.
- Once warm, several cryostats had to be opened to access the splice cans and to more precisely locate the location of the short.
- Eventually narrowed to the DX.



Details on short repair

- Diagram showing crystats and splice can locations.
- Wrapped splice after the repair (lower left).
- cryostat ready to be welded (lower middle).
- Other end of DX with cryo return lines, ready to be welded (right).



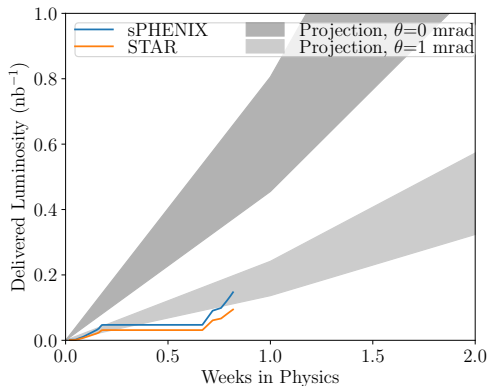
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Physics Status



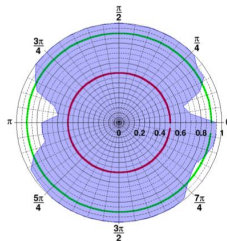
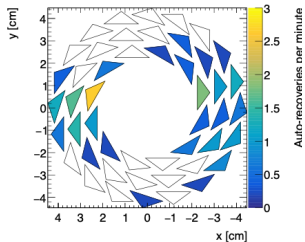
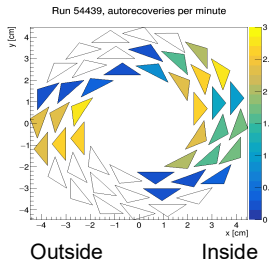
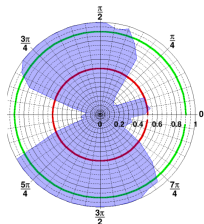
- STAR and sPHENIX operating with a 1 mrad full crossing angle.
- Less than one week since physics started.
- Pronounced 3 days of downtime due to 56 MHz clog.

MVTX Backgrounds, streaming mode

Comparison of 56x56:

Run 24

Run 25

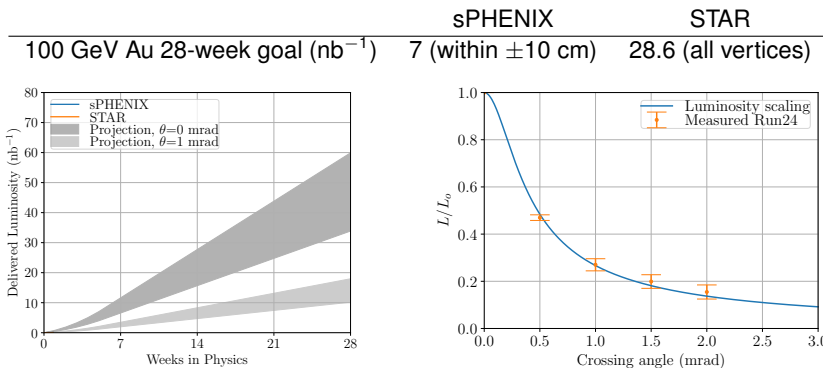


Comparison with 12 yellow bunches

Configuration	$\langle \text{ARR} \rangle$	improvement
12 yellow bunches, 2024 baseline	1.2	-
12 yellow bunches+pfp+orbit, 2024	0.067	17.9
12 yellow bunches, 2025 baseline	0.089	13.5

*large number of staves in full saturation

Luminosity Projections and BUR goals



- $L_{\text{delivered}}=55.7 \text{ nb}^{-1}$ over all vertices if $\theta = 0$ mrad. Assumption of 50% time at store.
- With $\theta = 1$ mrad, a luminosity reduction of $L/L_0=30\text{-}40\%$ is expected (highly dependent on the time of store, beam geometries at that time, and initial beam-sizes).
- At the maximum projected luminosity, $\theta = 1$ mrad, and $L/L_0 = 30\%$: $L_{\text{delivered}}=15.6 \text{ nb}^{-1}$.
- Within ± 10 cm for sPHENIX, approximately 50 – 60% of the collisions occur in this vertex, this corresponds to $L_{\text{delivered}}=9.36 \text{ nb}^{-1}$.

Summary

- Run24 Au was short but did exceed maximum projections.
- The MVTX task force:
 - ▶ Identified the primary source of the backgrounds and had it removed.
 - ▶ The removal of the mask provided background reduction on par with the PFP bunch and local orbit steering.
 - ▶ Proposed several possibilities to further mitigate the background, with varying degrees of time cost.
- Several issues delayed the startup and early availability of RHIC, with a total delay of approximately 2 months.
- In 28 weeks, collisions with a 1 mrad full crossing angle at the maximum projected luminosity, a total of 15.6 nb^{-1} will be delivered over all vertices and 9.4 nb^{-1} within $\pm 10 \text{ cm}$.
- The maximum peak luminosity currently achieved is approximately 50% of the projection, and 33% of the maximum achieved during Run16.
- Due to the extended failures for the DX short and the 56 MHz, RHIC will run through July and August.



Thank you

Thank you and questions.