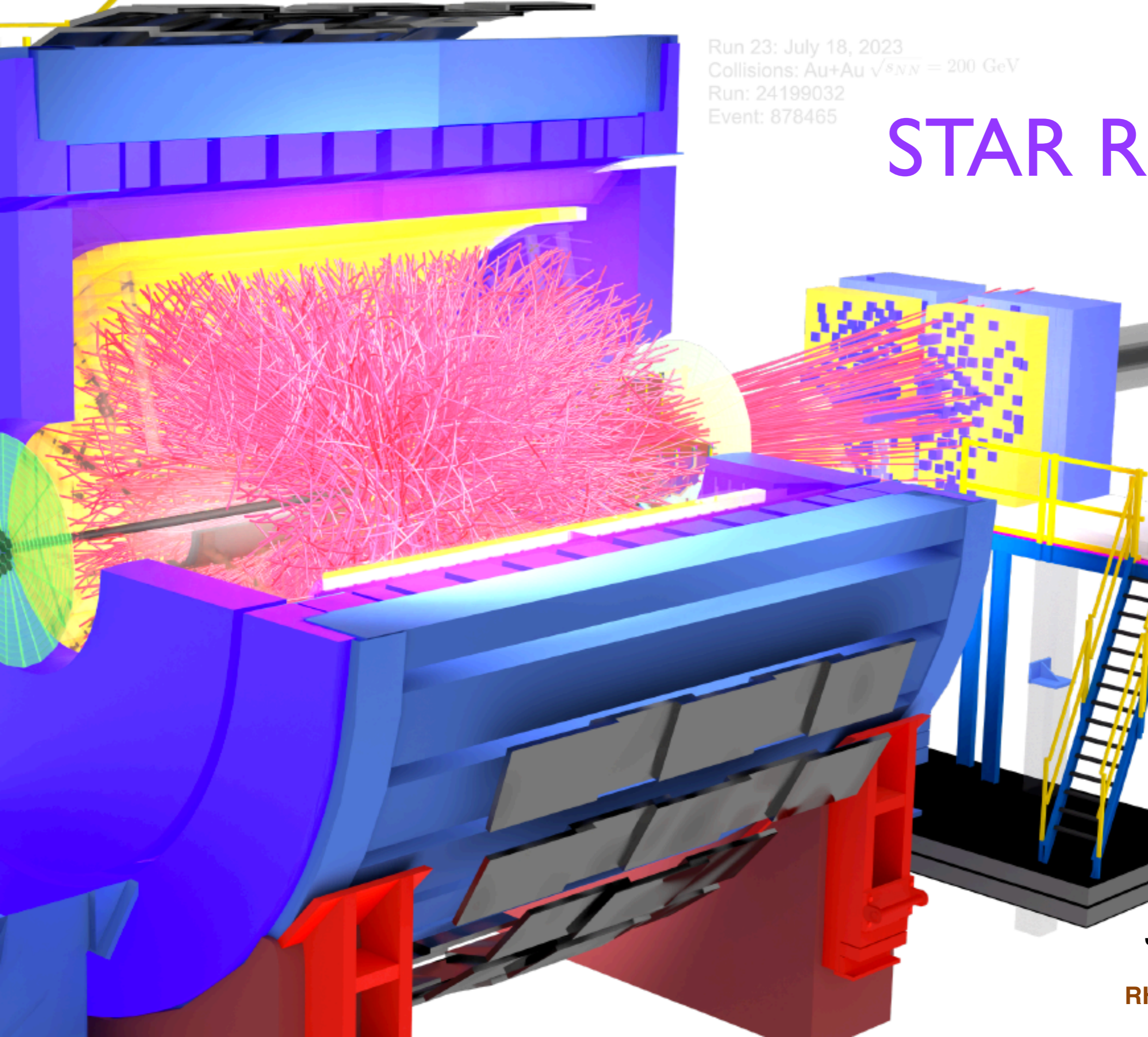


Run 23: July 18, 2023
Collisions: Au+Au $\sqrt{s_{NN}} = 200$ GeV
Run: 24199032
Event: 878465

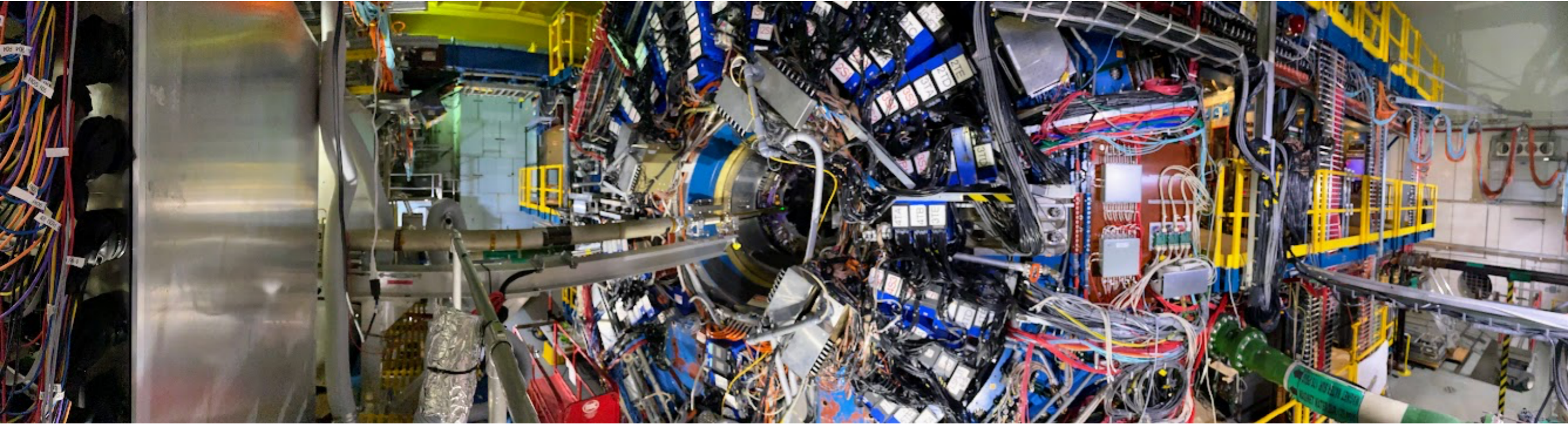
STAR Run23



J.H. Lee

RHIC Retreat

STAR Run23



- First full energy Au+Au physics run with **inner TPC** ('19) and **Forward** ('22) upgrades
 - Additional detectors - **Event Plane Detector**, **Endcap Time-Of-Flight** detector since the last Au+Au Run16
 - » Extended coverage and Improved particle identification capability
- TPC readout speed upgrade (x2 to 5kHz)
 - » Higher data collection rate

Beam Use Request for Run23

$\sqrt{s_{\text{NN}}}$ (GeV)	Species	Number Events/ Sampled Luminosity	Year
200	Au+Au	20B / 40 nb ⁻¹	2023+2025
200	<i>p+p</i>	235 pb ⁻¹	2024
200	<i>p+Au</i>	1.3 pb ⁻¹	2024

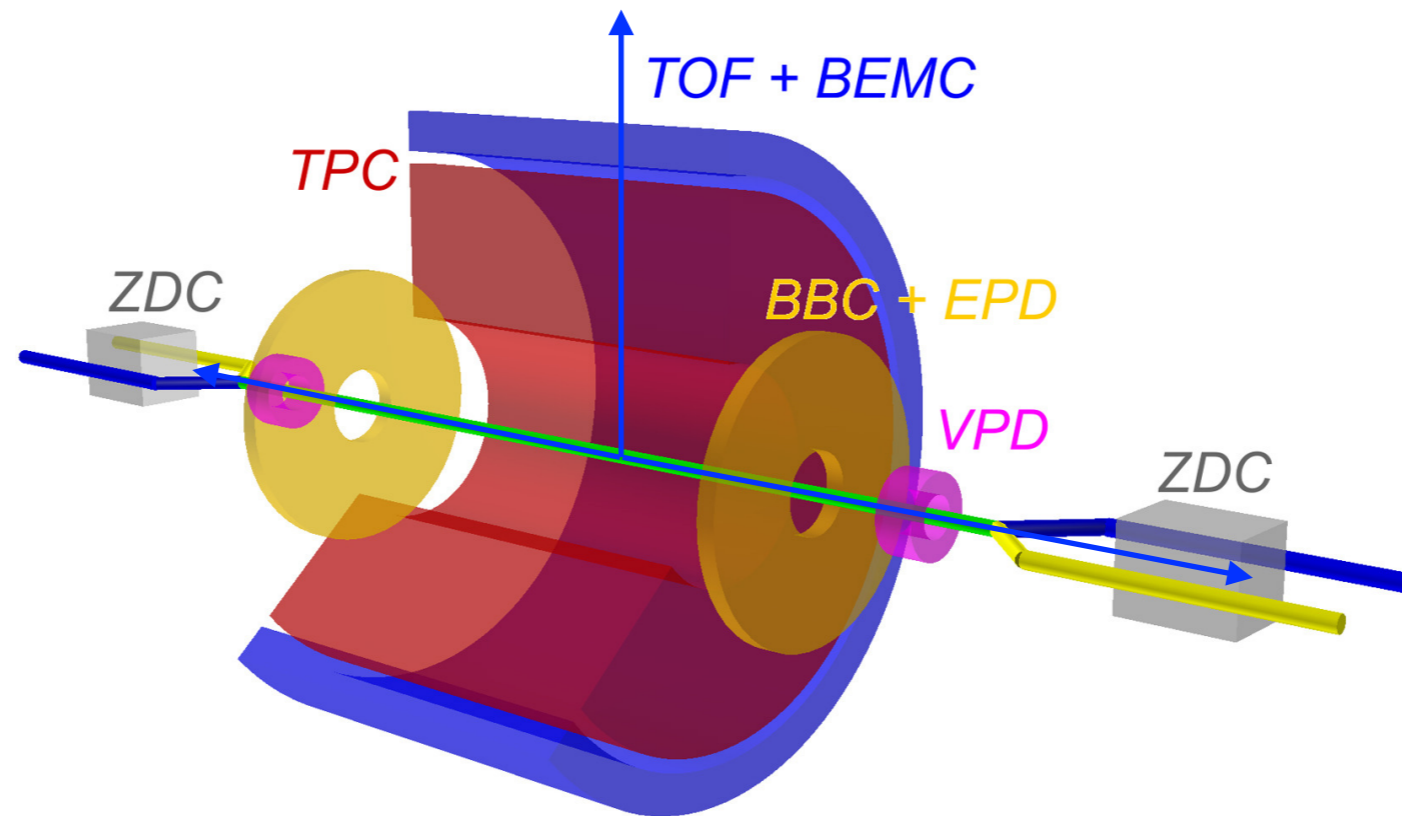
Assuming 24 physics weeks / year

- Au+Au at 200 GeV
- High luminosity for rare probe/high- p_{T} physics + controlled low luminosity for minimum bias physics
 - minimum bias : leveled ZDC rate at ~10 KHz (19 weeks)
 - high- p_{T} : ZDC ~ 100 KHz (29 weeks)
 - Mix two data taking modes depending on luminosity/beam condition to achieve the goal

Run23 - Schedule

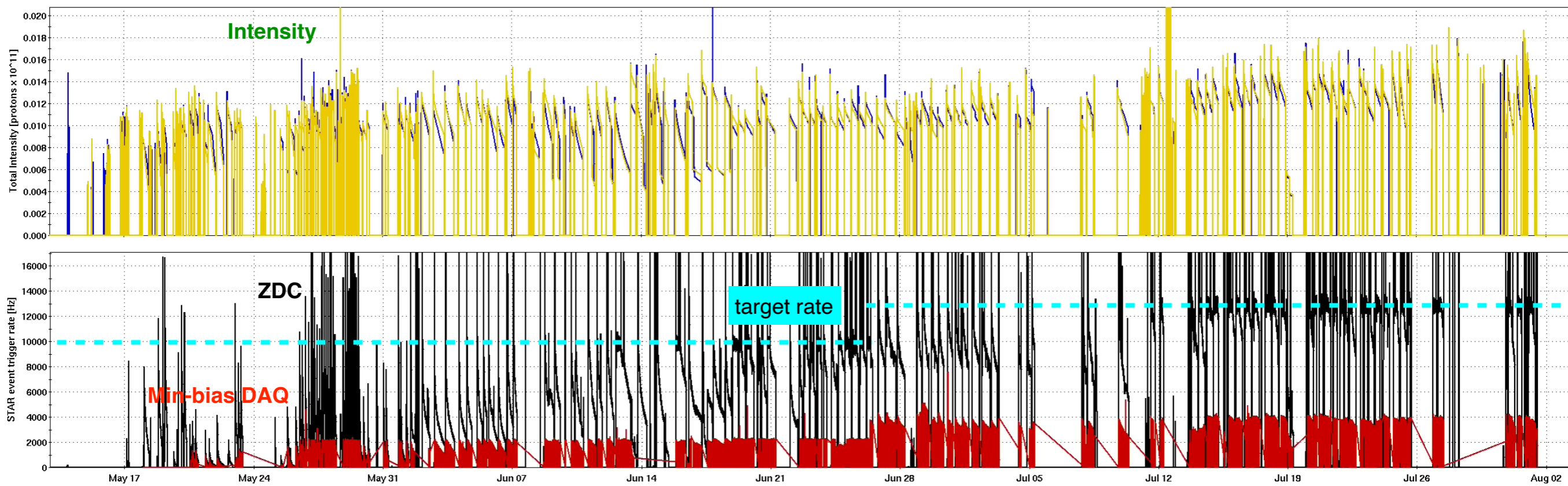
- 4/25/23 : Shift start, TPC flammable gas flow
- 4/27 Cosmic Data taking with STAR magnet at Forward Full Field
- **5/8 : RHIC Cooldown start, STAR magnet polarity flip**
- **5/18 : First collision**
- **5/19 : Start physics**
- **6/2 : (Longitudinal) Stochastic cooling**
- **6/6 : (Longitudinal+Horizontal) Stochastic cooling**
- 6/8 : STAR Shutdown due to HSSD LOTO
- 6/11-16: STAR Magnet down
- 6/26 : DAQ5k commissioning completed
- 7/20 : 5B Min-bias events accumulated
- 8/1 : Last physics run
- 8/4-7 Cosmic with Forward Full Field

“Minimum bias”



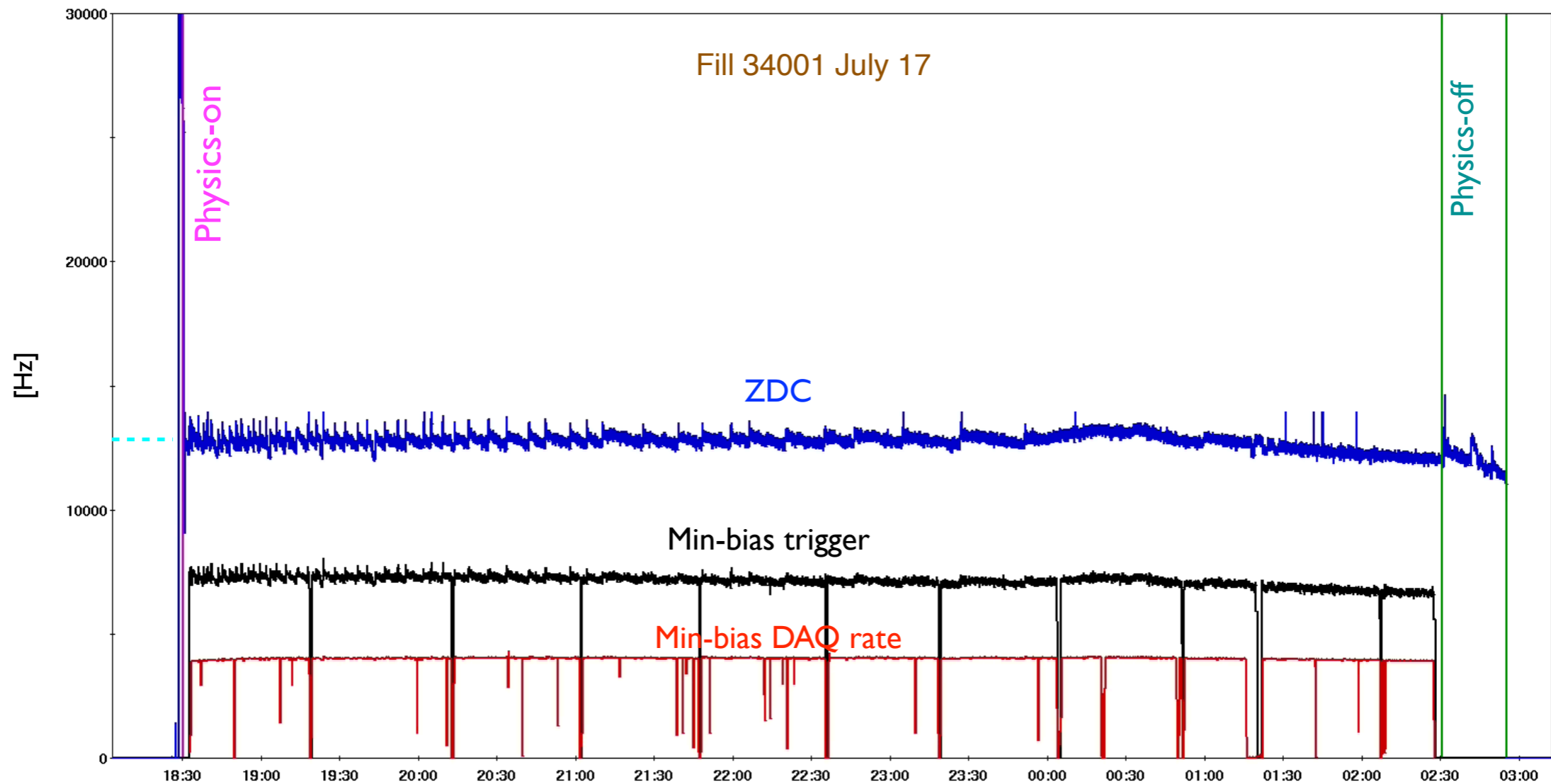
- Min-bias trigger: ZDC (B+Y) and $TOF > 0$
- samples (mostly) nuclear interaction
- Min-bias/ZDC $\sim 57\%$ (cross-section + acceptance)
- additional triggers included in Min-bias running : UPC

ZDC and Min-bias DAQ rates



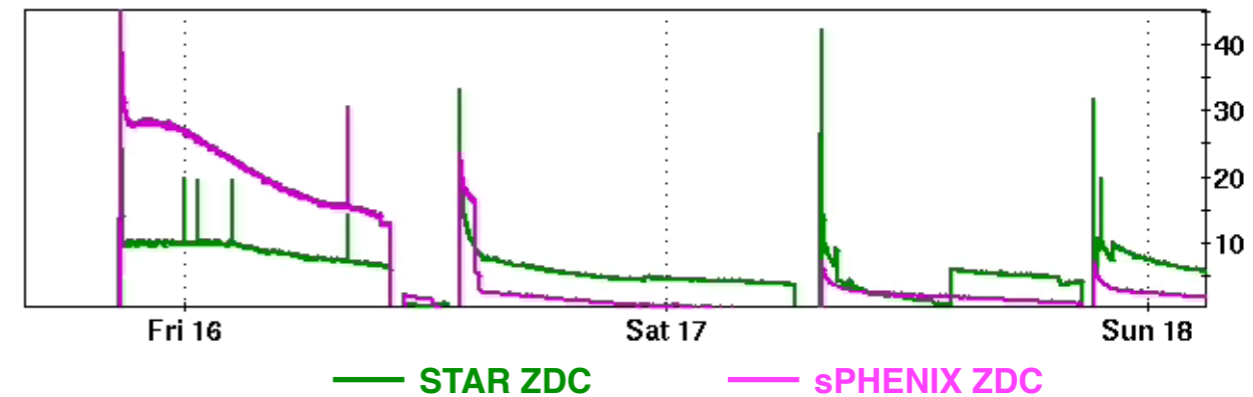
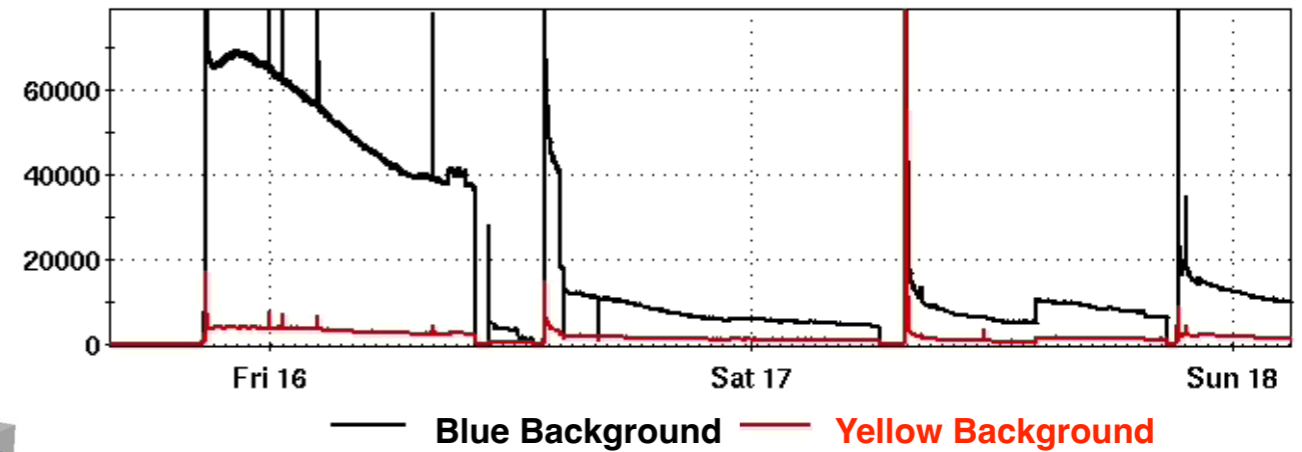
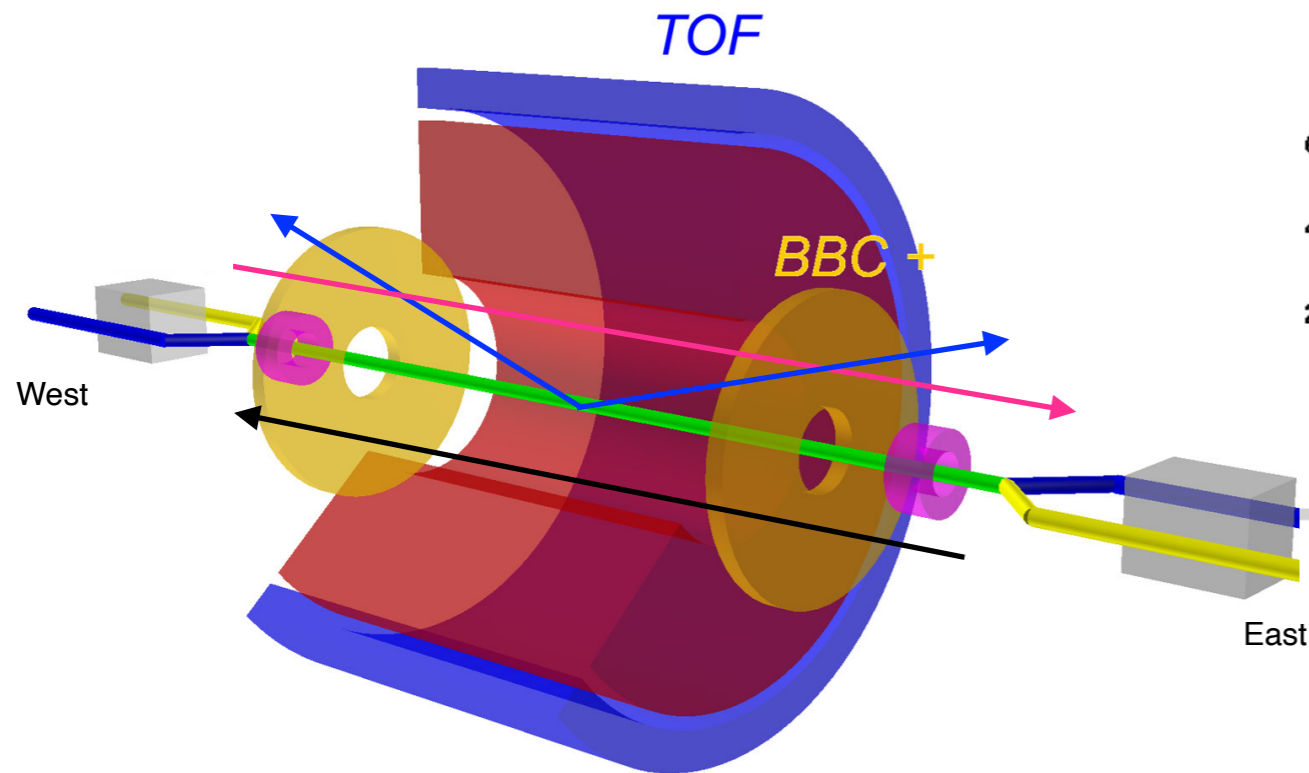
- Target luminosity: ZDC at 10kHz → 13kHz
- Min-bias DAQ rate: ~2.2k → ~4kHz with DAQ5k

Luminosity leveling



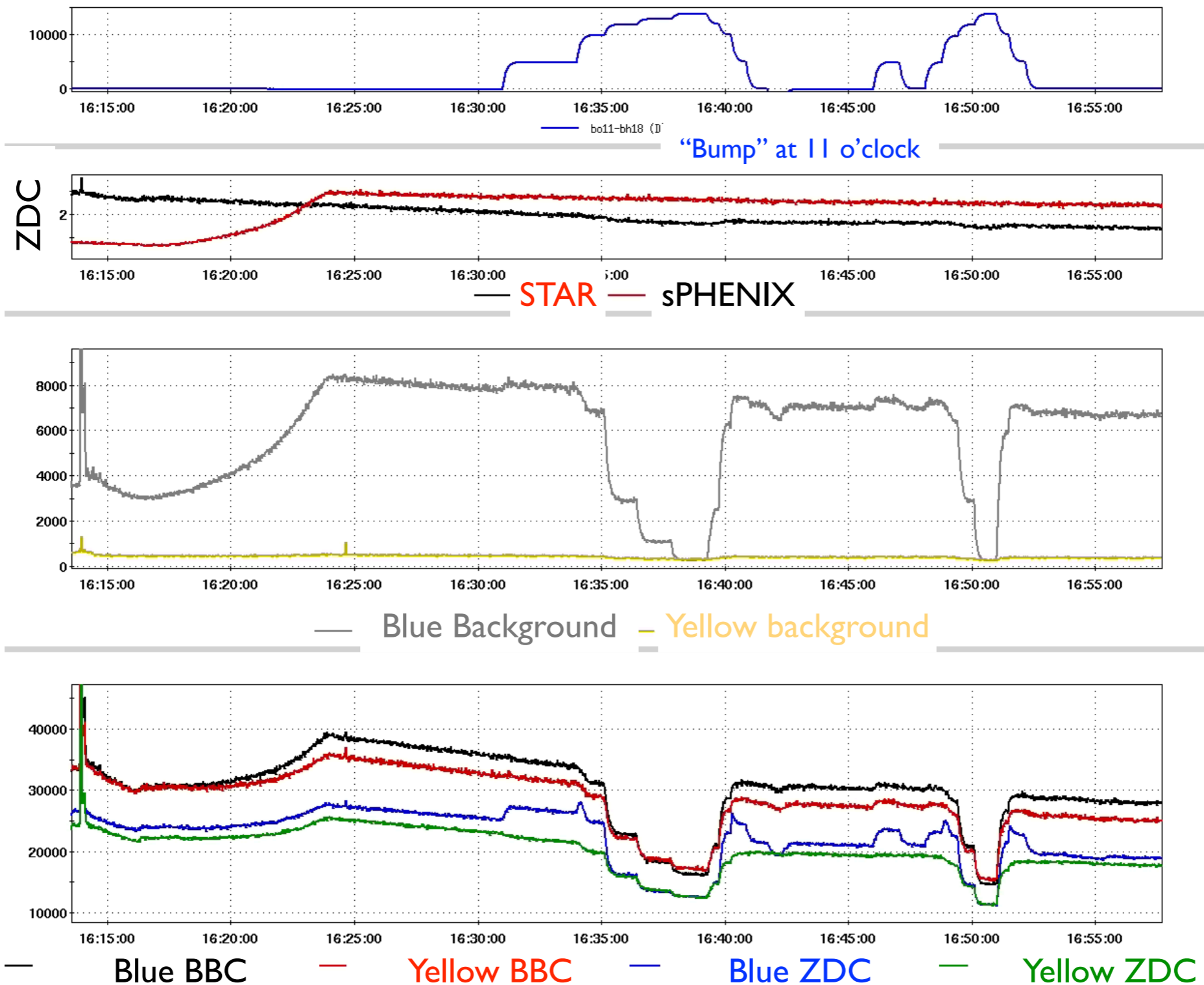
- Leveling to rate optimizing data quality and maximizing DAQ rate
- Luminosity Leveling worked well

Background



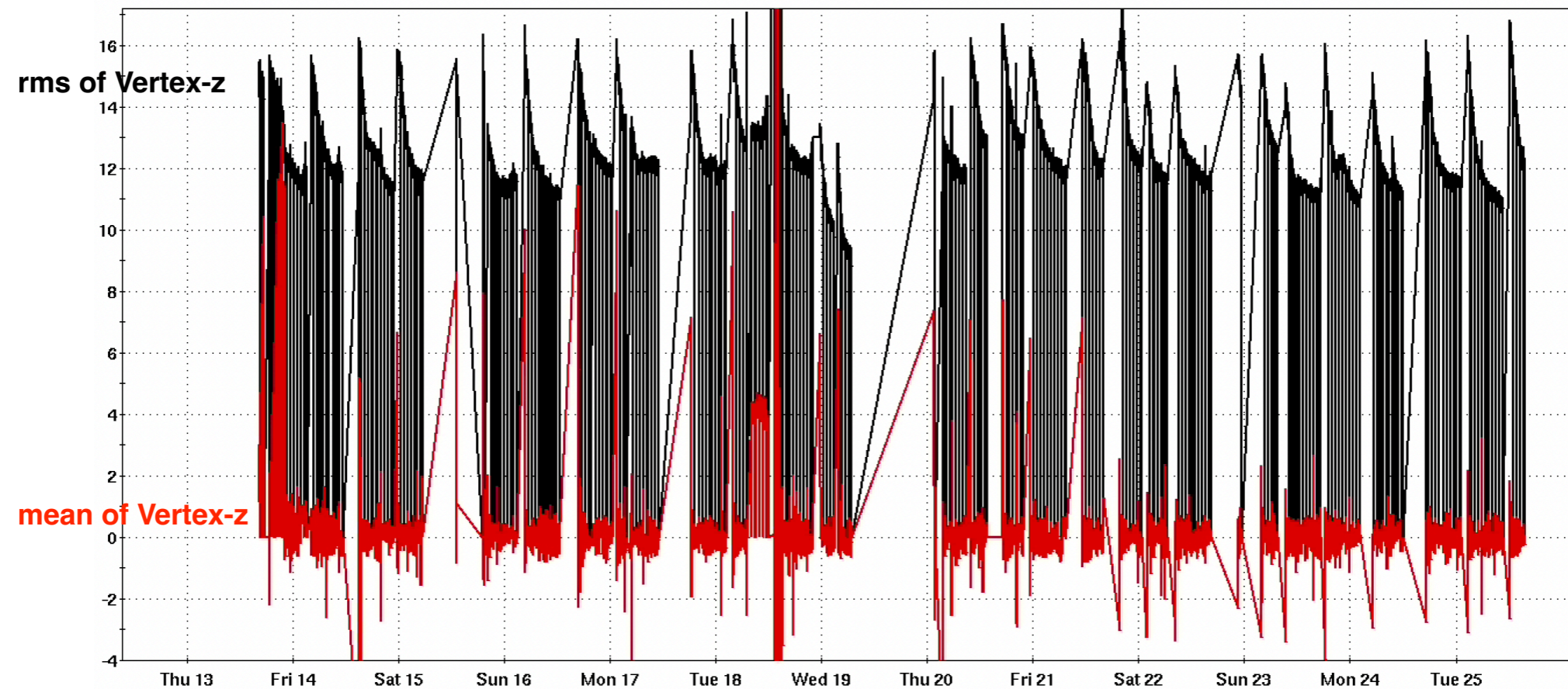
- Background identified with BBC (BBC and with 24 nsec difference)
- Asymmetric background: Blue \gg Yellow
- Blue Background strongly correlated with collision rates at sPHENIX
- Background from Au78 created by collisions?

Background from Au78



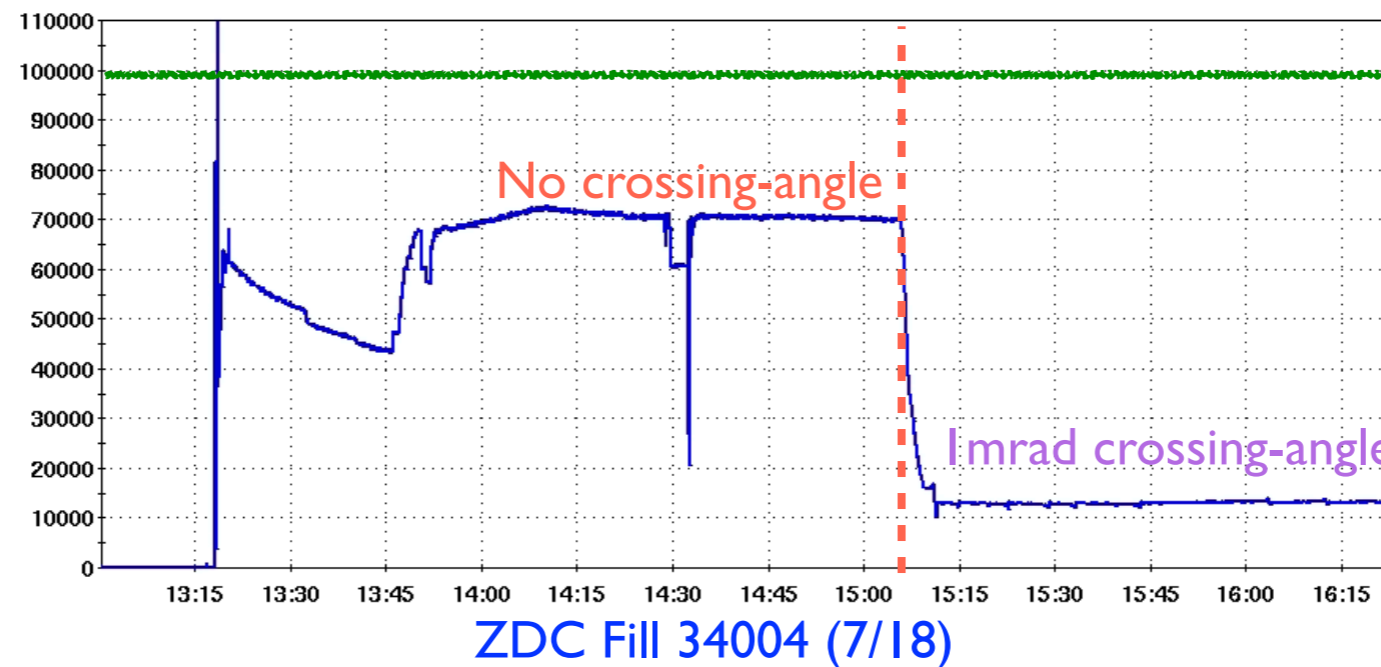
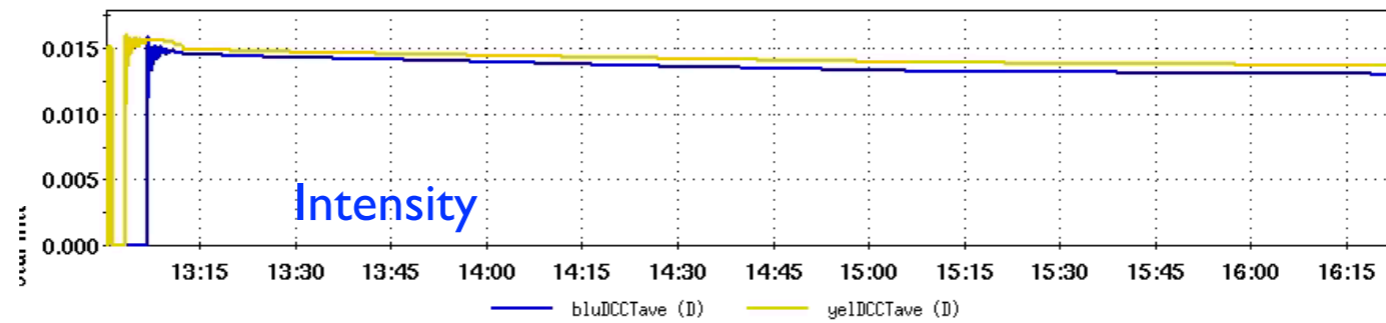
- Blue background understood with “Au78 test” (June 29)
- new lattice needed: data quality expected to be significantly improved

Collision Vertex position adjustment



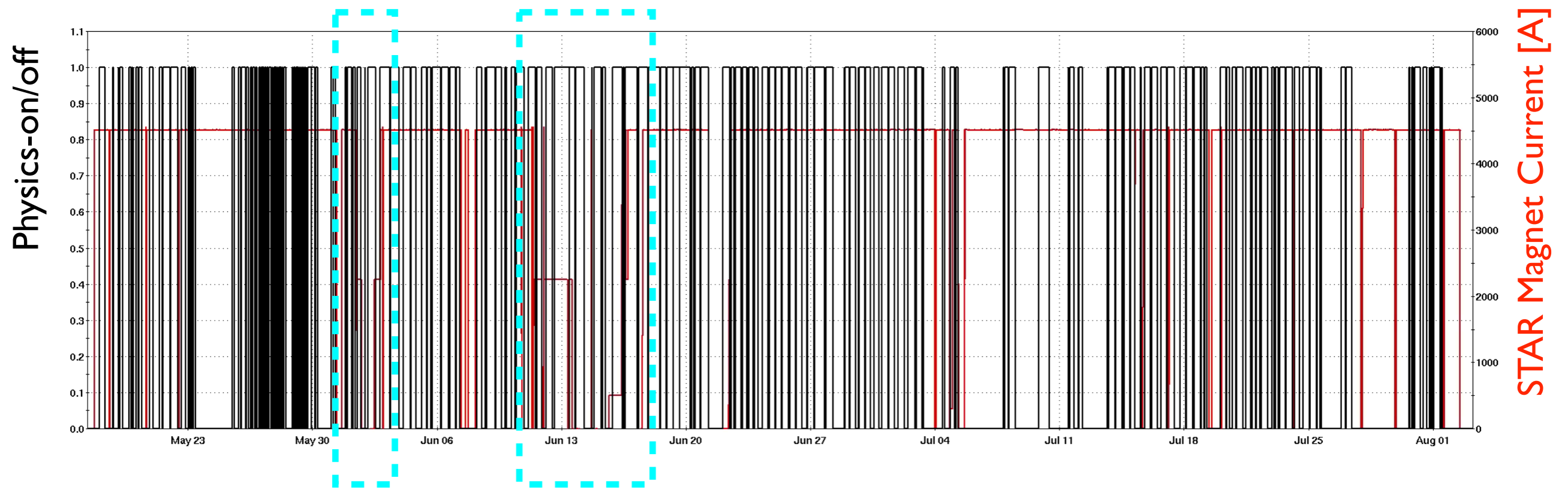
- Vertex-z center well adjusted, typically in ± 1 cm
- Crossing angle and stochastic cooling: tight Vertex-z distribution

Crossing angle vs luminosity



- High-luminosity test fill without crossing angle
 - ZDC ~ 70 kHz
- Total luminosity reduction from 1mrad crossing angle: ~x4.2 (V_z rms: 50cm - 18cm)
 - High reduction factor “consistent” O+O (run21) x3.5, Au+Au (run19) x3, p+p (run22) x4.5
- Likely to run without crossing angle for High- p_T program to achieve high lumi (ZDC ~100 kHz)

Magnet issue



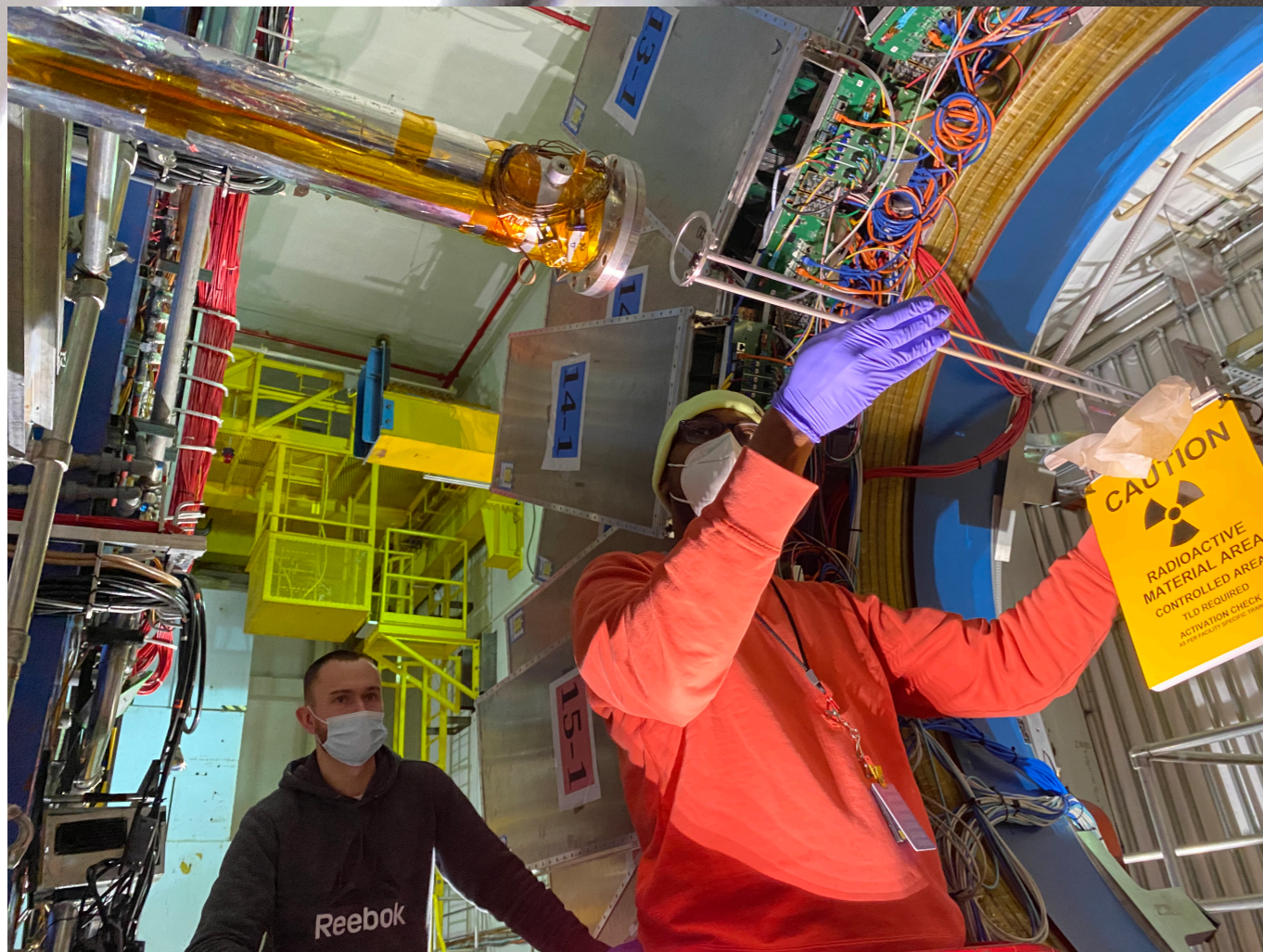
- Chiller oil leak, clogged/fouling in heat exchangers
- multiple days down or at less than half field

HSSD LOTO



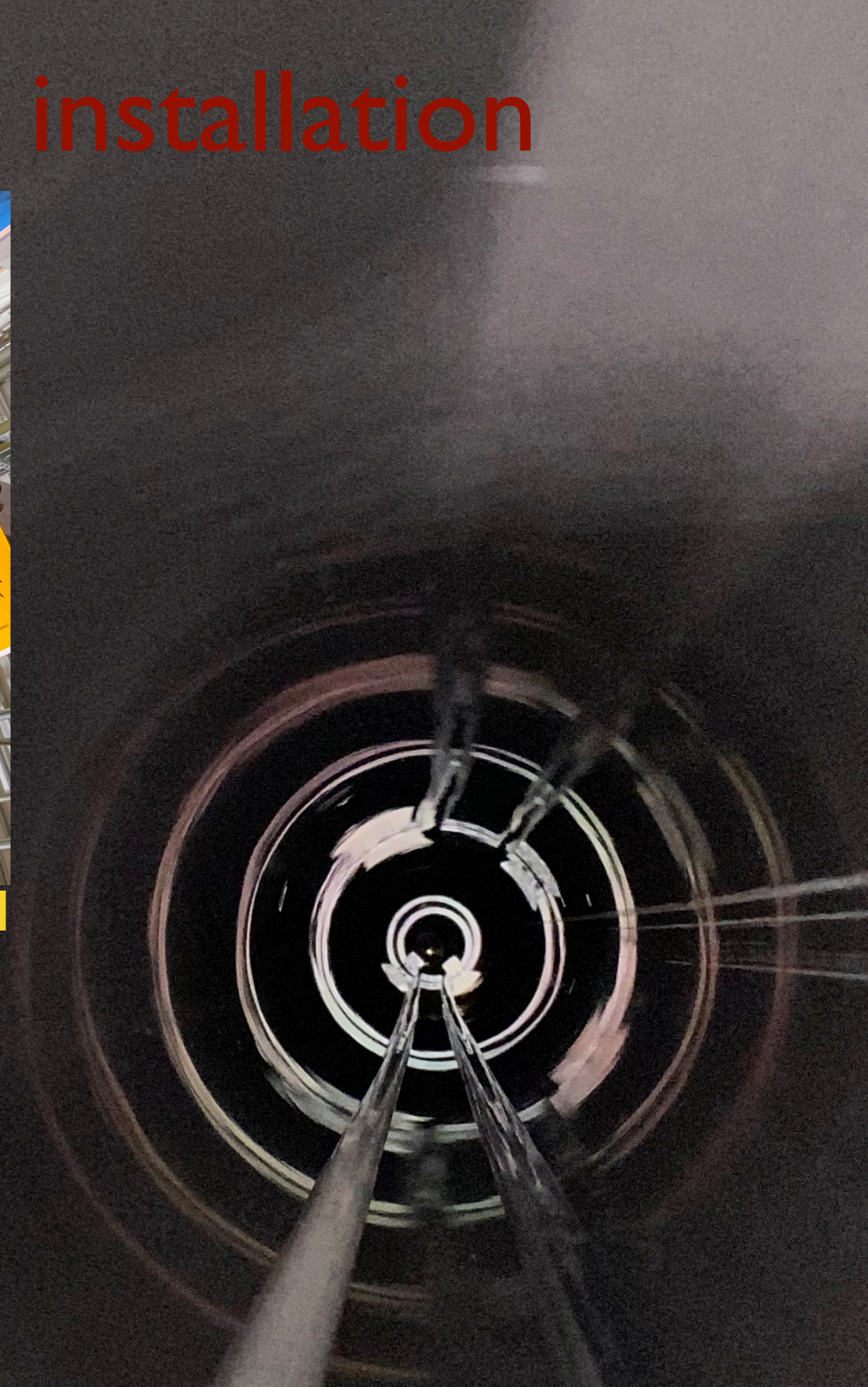
- STAR shutdown with High Sensitivity Smoke Detection System off due to smoke from Canadian wildfire: 6/7-6/8 ~ 24hrs
 - ASE requirement
 - All power on the platform off, LOTO
- recovery took multiple hours

Fixed target installation



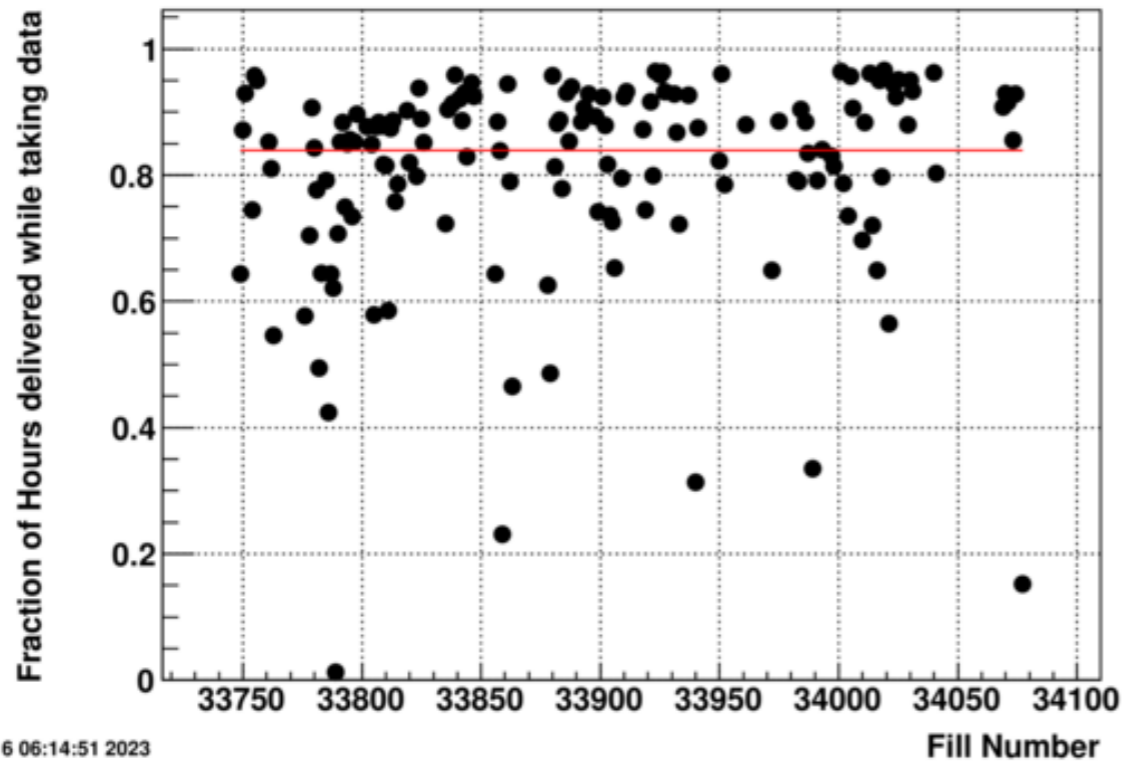
12/22/2022

- Three targets (1mm C (graphite), Ni, 1.5mm Al)
- East side at 1.8m to face Blue beam (Au target remains in West side at 2m)
- for Space Radiation program: to run likely in Run25



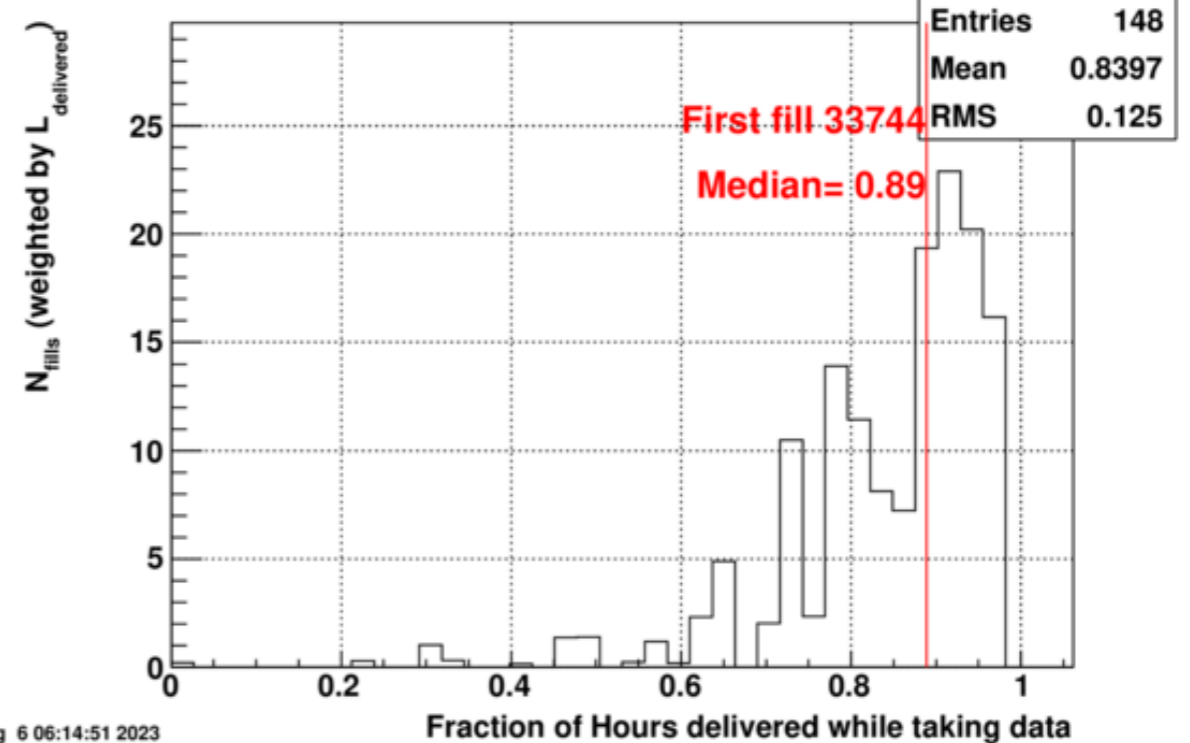
Data collection efficiency

Fraction of Hours delivered while taking data



Sun Aug 6 06:14:51 2023

Hdev_data_byfill

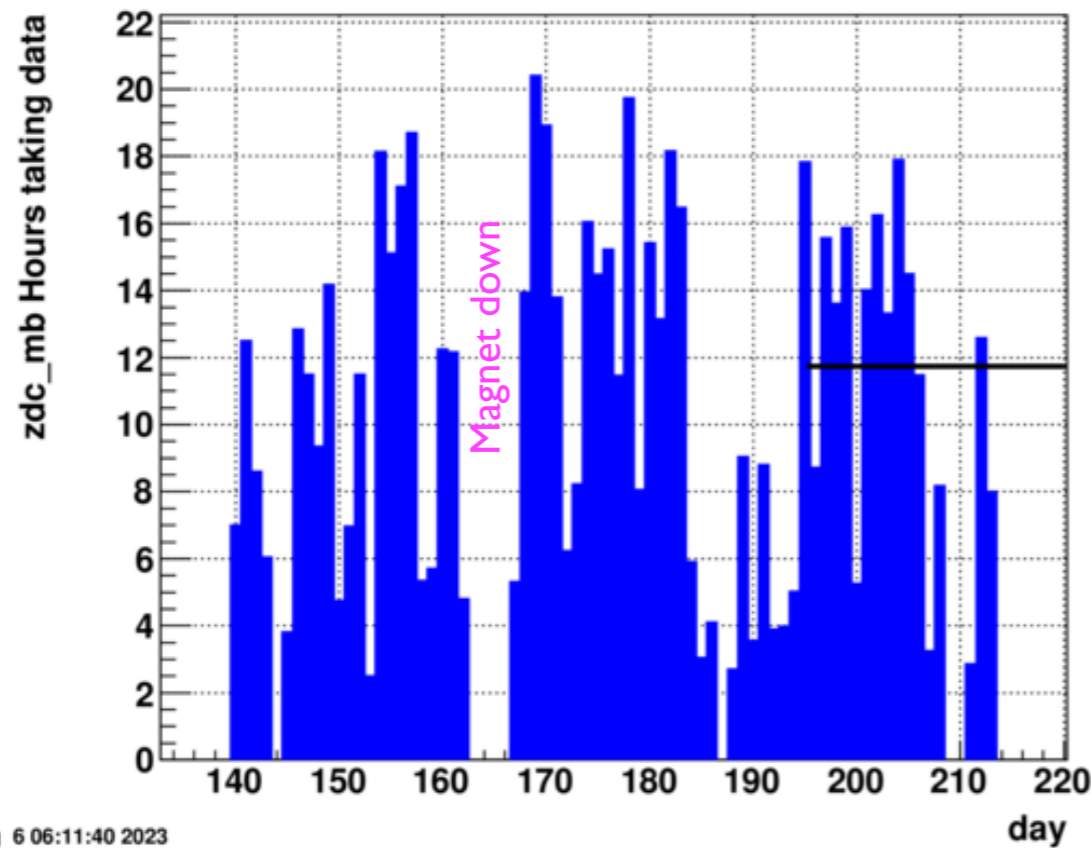


Sun Aug 6 06:14:51 2023

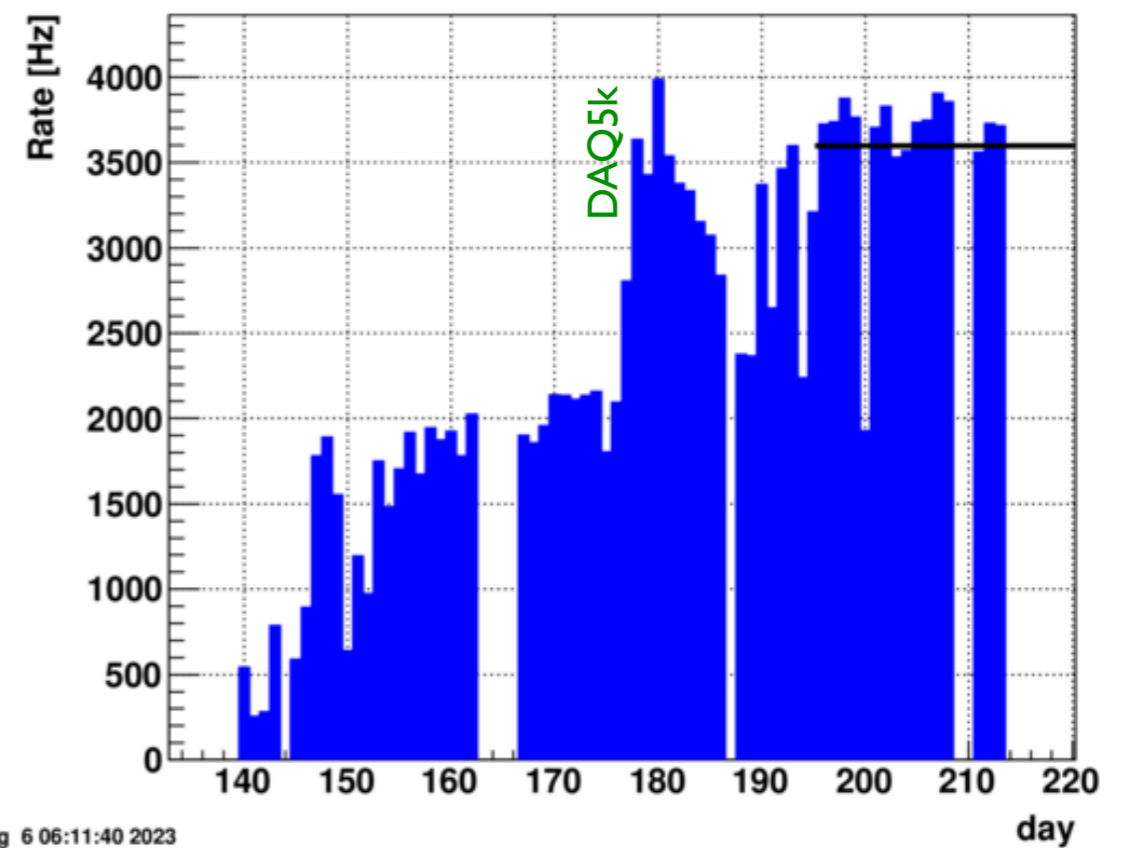
- STAR DAQ Uptime ~85%
- DAQ Downtime: interruptions for run control (~4%) detector ramping up/down (~1%), detector issues (~10%)

Min-bias hours and rate

hours_perday_zdc_mb.txt

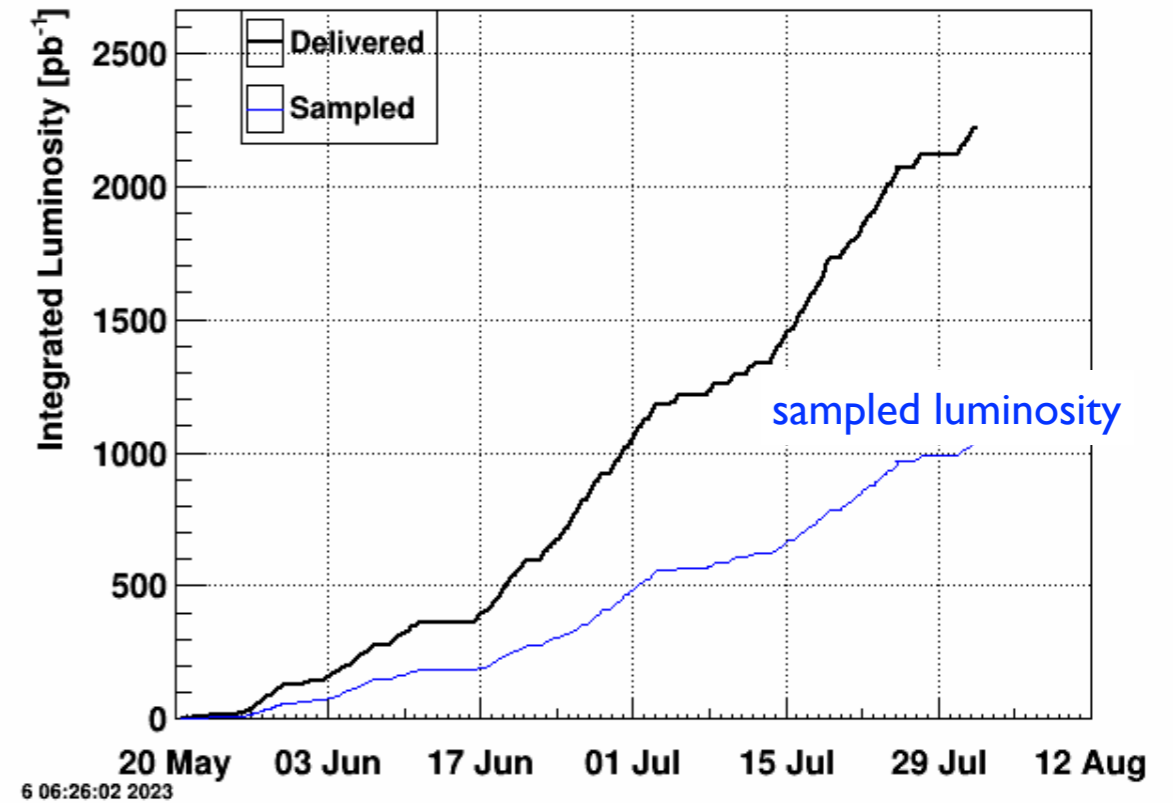
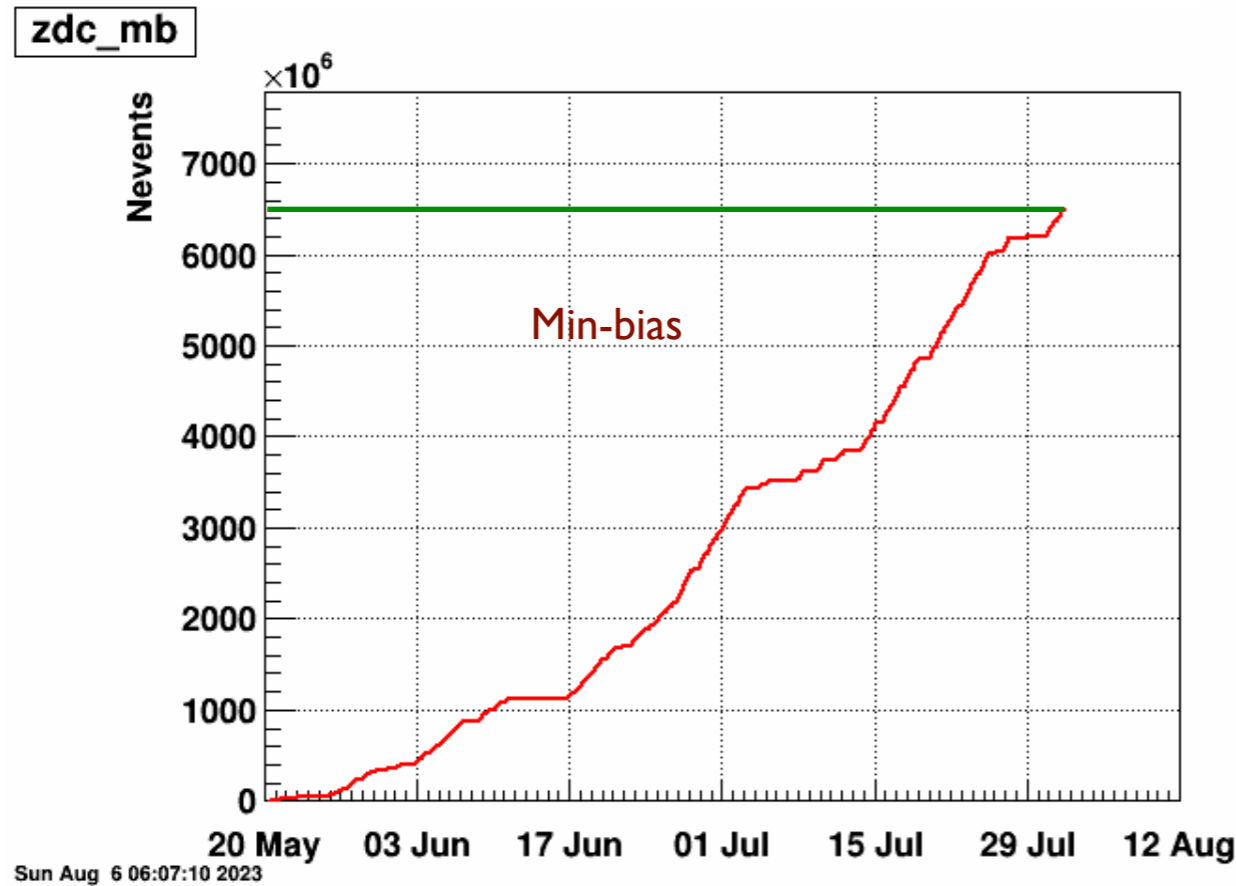


zdc_mb Average Rate [Hz]



- 10.8 hours/day
- Average Min-bias DAQ rate up by x2 with DAQ

Physics goals



Final score:

- 6.5B Min-bias collected
- No dedicated high- p_T program done in Run23 : $\int L \sim 1 \text{nb}^{-1}$

Summary

- Beam
 - Worked well: crossing-angle, luminosity leveling, vertex adjustment
 - To come: high luminosity, reduction of background
- STAR operation
 - No major issues with detectors
 - Successful DAQ5k upgrade
 - (heat related) Issues: Magnet chiller, AC
- Collected high-quality Min-bias data set: 6.5B
- Thanks to CAD for all the collisions and the support during the run

Extra

Beam Use Request Revised

$\sqrt{s_{\text{NN}}}$ (GeV)	Species	Number Events/ Sampled Luminosity	Year
200	$p+p$	142 pb ⁻¹ /12w	2024
200	$p+\text{Au}$	0.69 pb ⁻¹ /10.5w	2024
200	Au+Au	18B / 32.7 nb ⁻¹ /40w	2023+2025

DAQ5k (TPC running at 5kHz)

- Rewrite the DAQ online software for iTPC and TPX in the new framework Redo and evaluate the cluster finder in the common framework for iTPC and TPX. This was completed, and a comparison between new and old demonstrated that the differences are small and satisfactory
- Improve network connectivity by rearranging topology with network switches
- Add additional DAQ PCs and event builders to handle the increased data volume. This was accomplished by a combination of purchases and re-purposing of SDCC inventory
- The original gating grid driver that had a limit of 2.2 kHz was replaced for Run-22 and can now easily handle more than 5 kHz