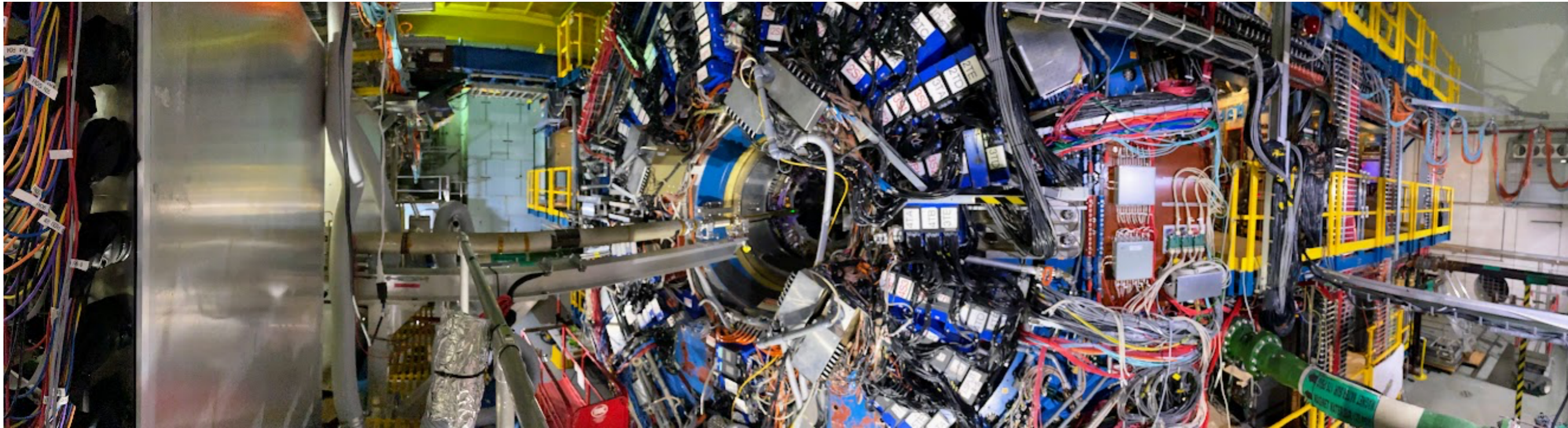




J.H. Lee (BNL)

BNL NPP PAC Meeting
Sept 2023

STAR Run23



- First full energy Au+Au physics run with **innerTPC** ('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

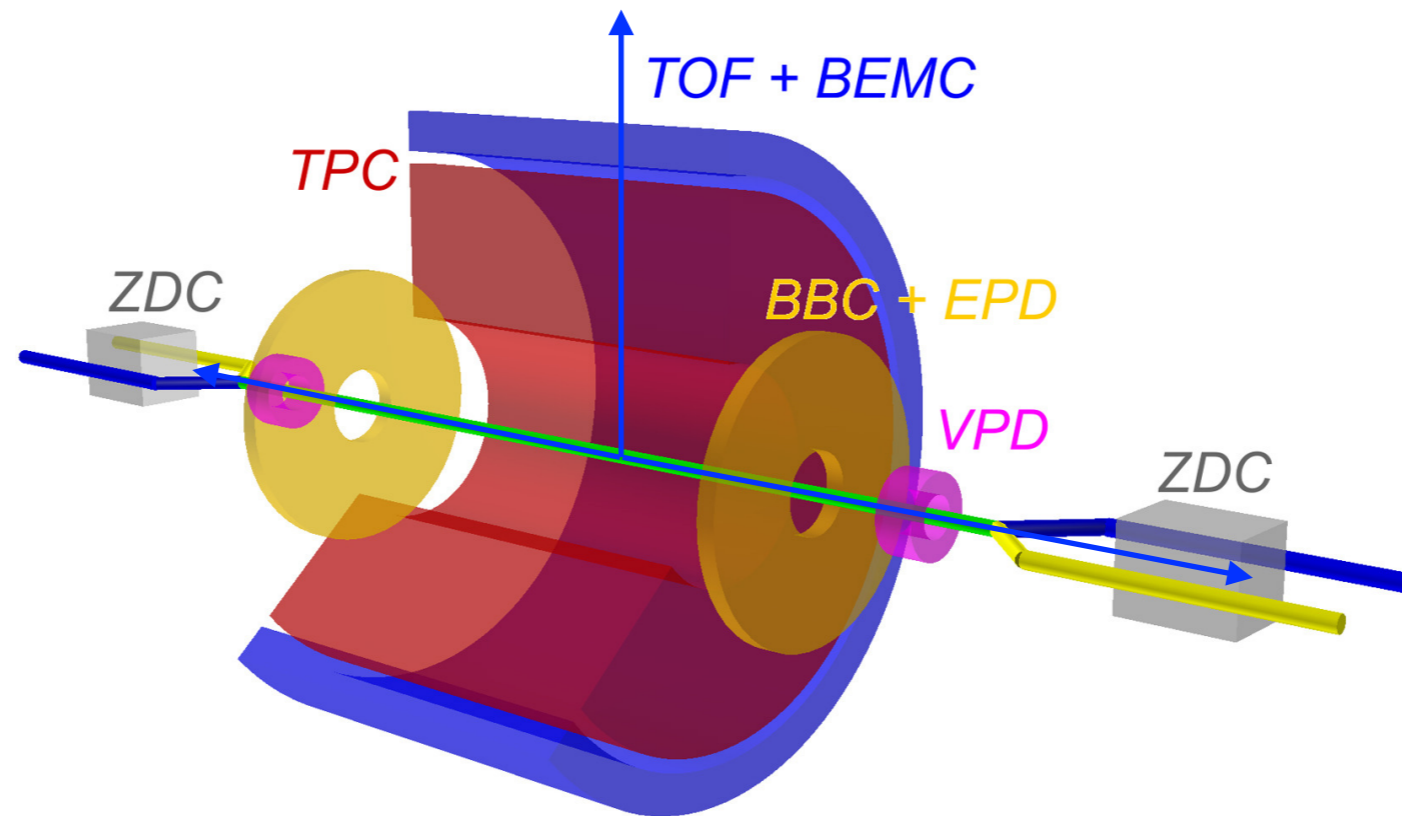
Assuming 24 physics weeks / year

- 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 - Timeline

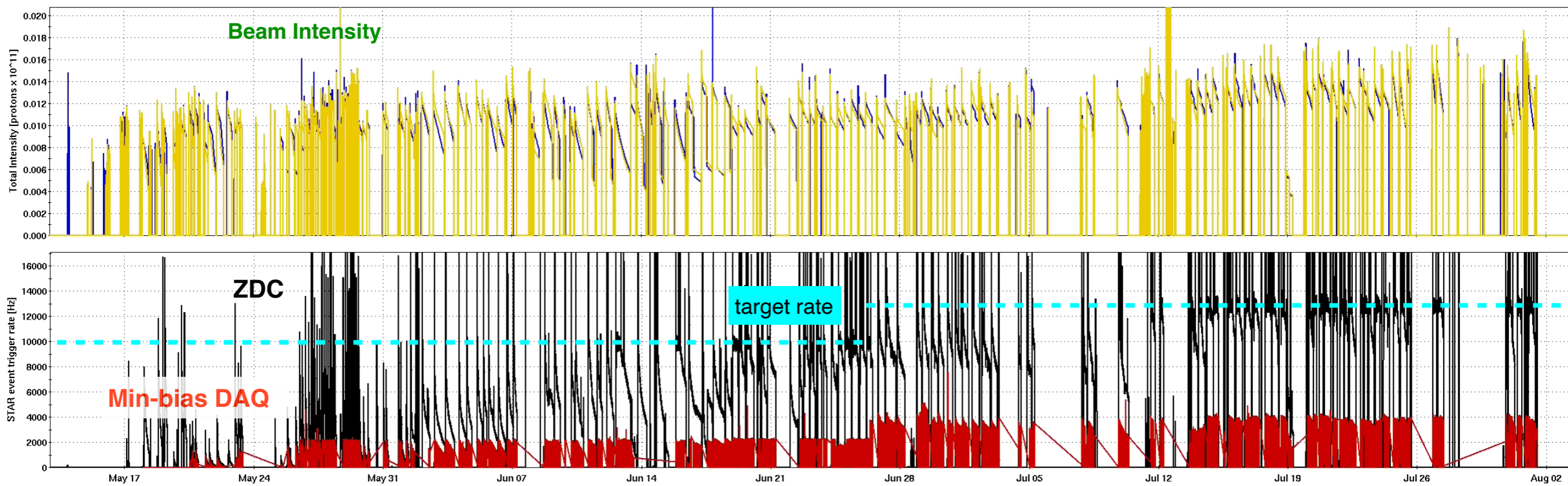
- 4/25/23 : Shift start, TPC flammable gas flow
- 4/27- : Cosmic data taking
- **5/8 : RHIC Cooldown start**
- **5/18 : First collision**
- **5/19 : Start physics**
- 6/2 : (Longitudinal) Stochastic cooling
- 6/6 : (Longitudinal+Horizontal) Stochastic cooling
- 6/8 : STAR Shutdown due to HSSD LOTO
- 6/11-16: STAR Magnet down
- 6/26 : DAQ5k commissioning completed
- 7/20 : 5B Min-bias events accumulated
- 8/1 : Last physics run, Blue Ring Valve box Failure
- **8/4 : End of Run (74 Days for Physics)**
- 8/4-7 : Cosmic data taking with Forward Full Field

“Minimum bias”



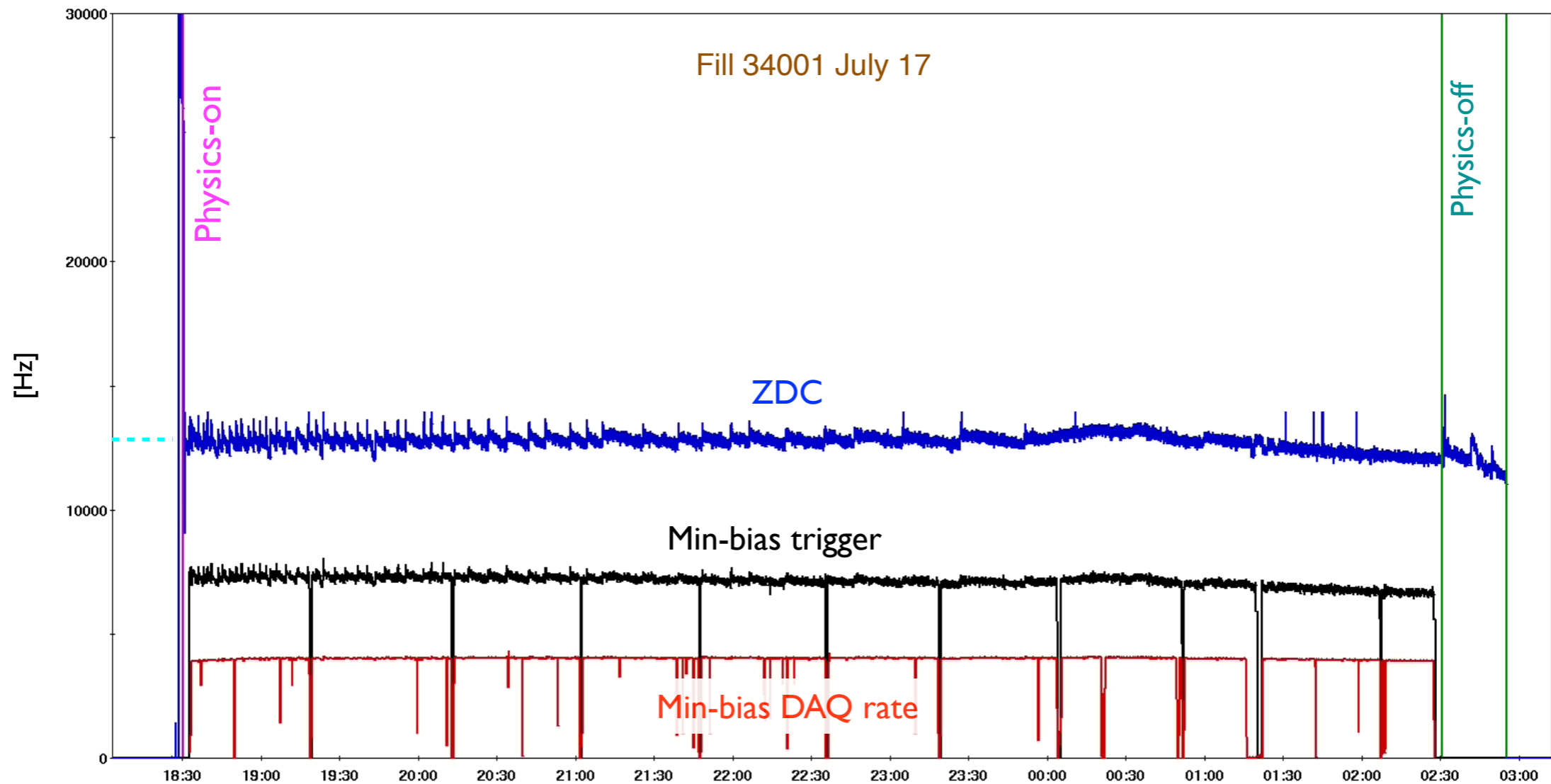
- Min-bias trigger: ZDC (B+Y) and TOF > 0
- samples (mostly) nuclear interaction
- Min-bias/ZDC ~ 57% (cross-section + acceptance)
- additional triggers included in Min-bias running : UPC

ZDC and Min-bias DAQ rates



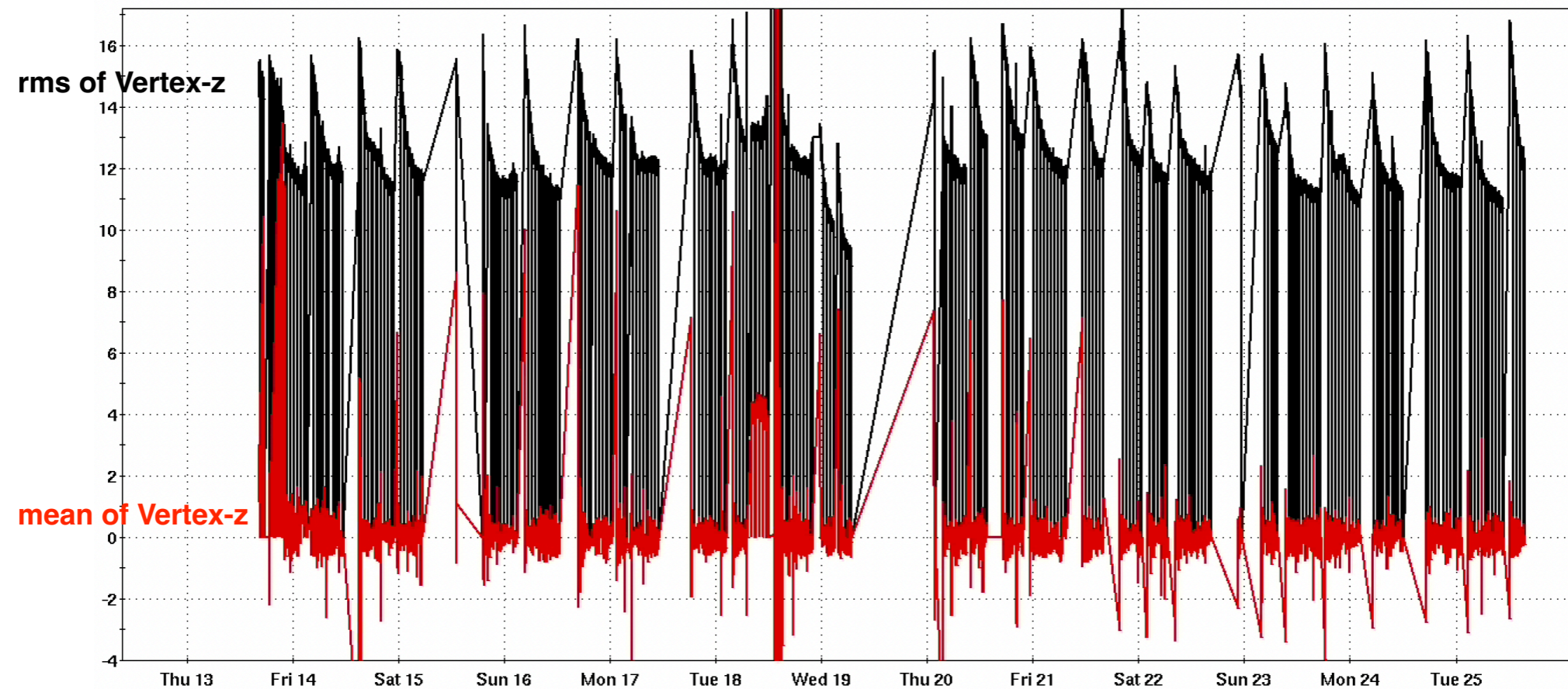
- Target luminosity: ZDC at 10kHz \rightarrow 13kHz
- Min-bias DAQ rate: \sim 2.2k \rightarrow \sim 4kHz with DAQ5k

Luminosity leveling



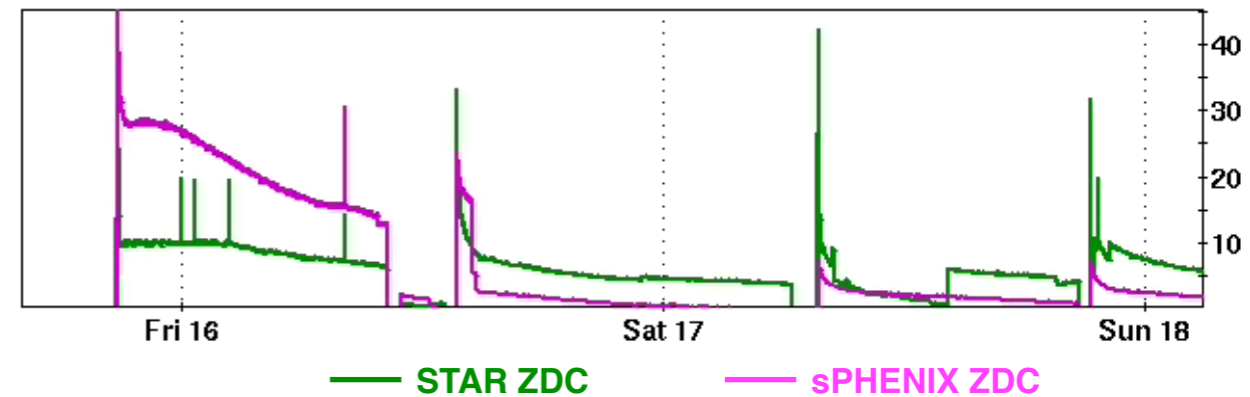
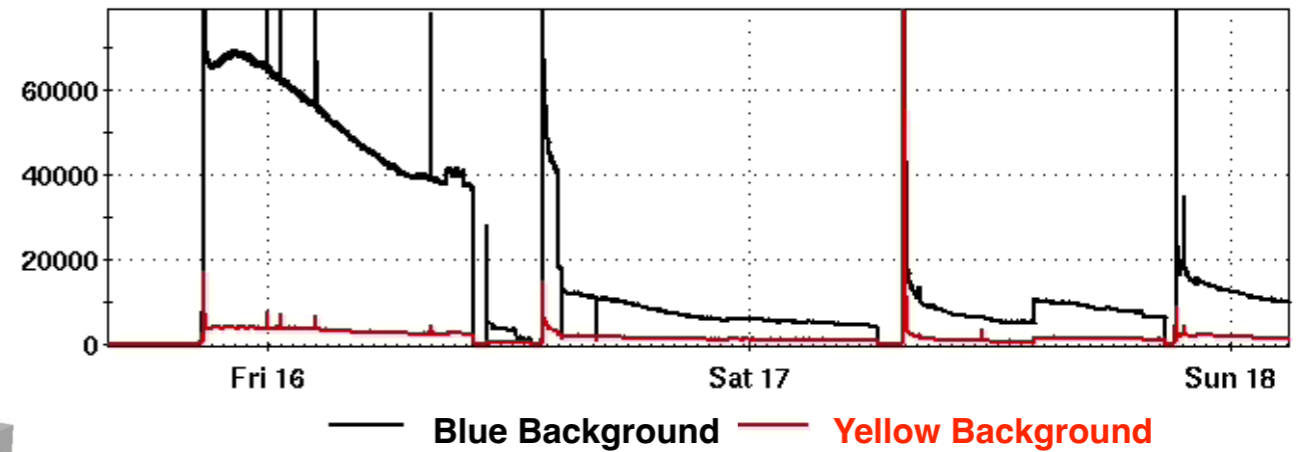
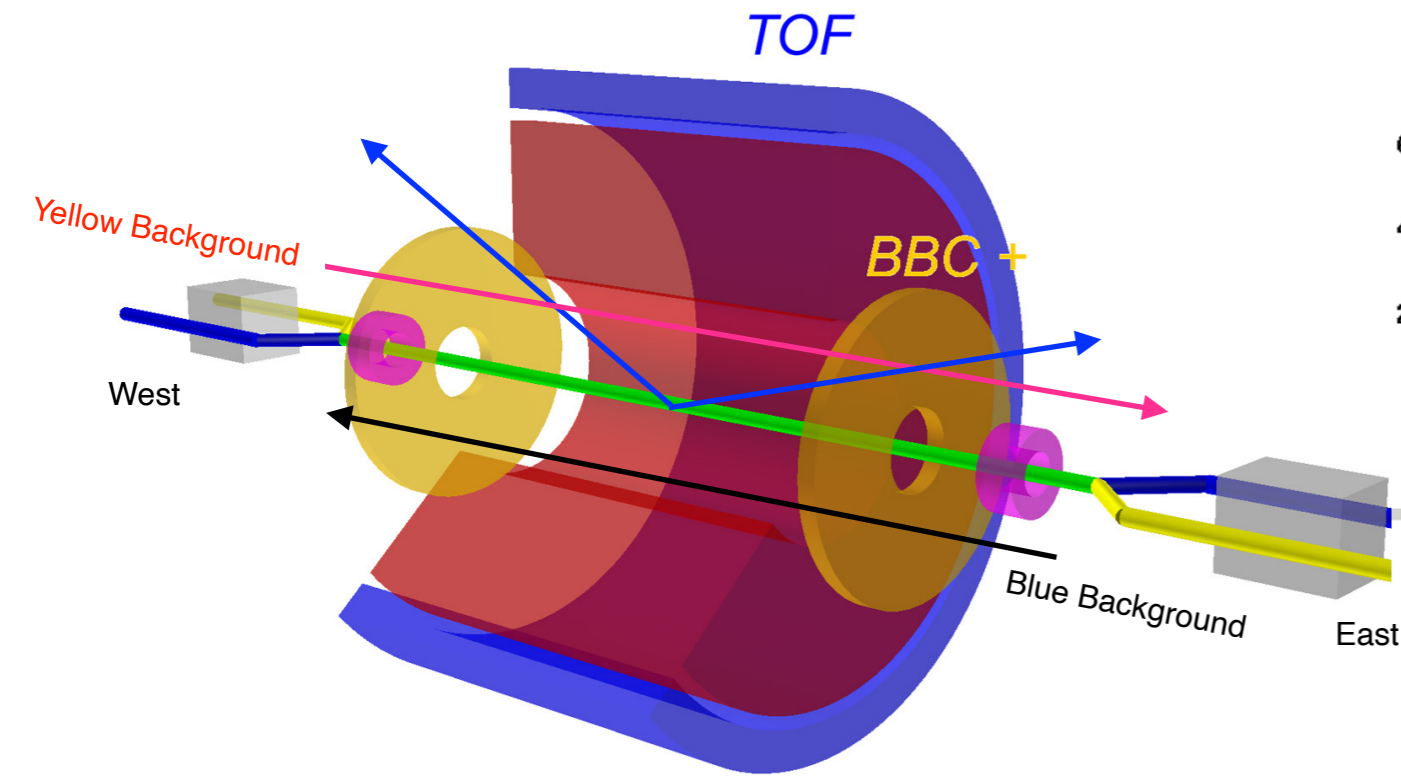
- Leveling to rate optimizing data quality and maximizing DAQ rate
- Luminosity Leveling worked well

Collision Vertex position adjustment



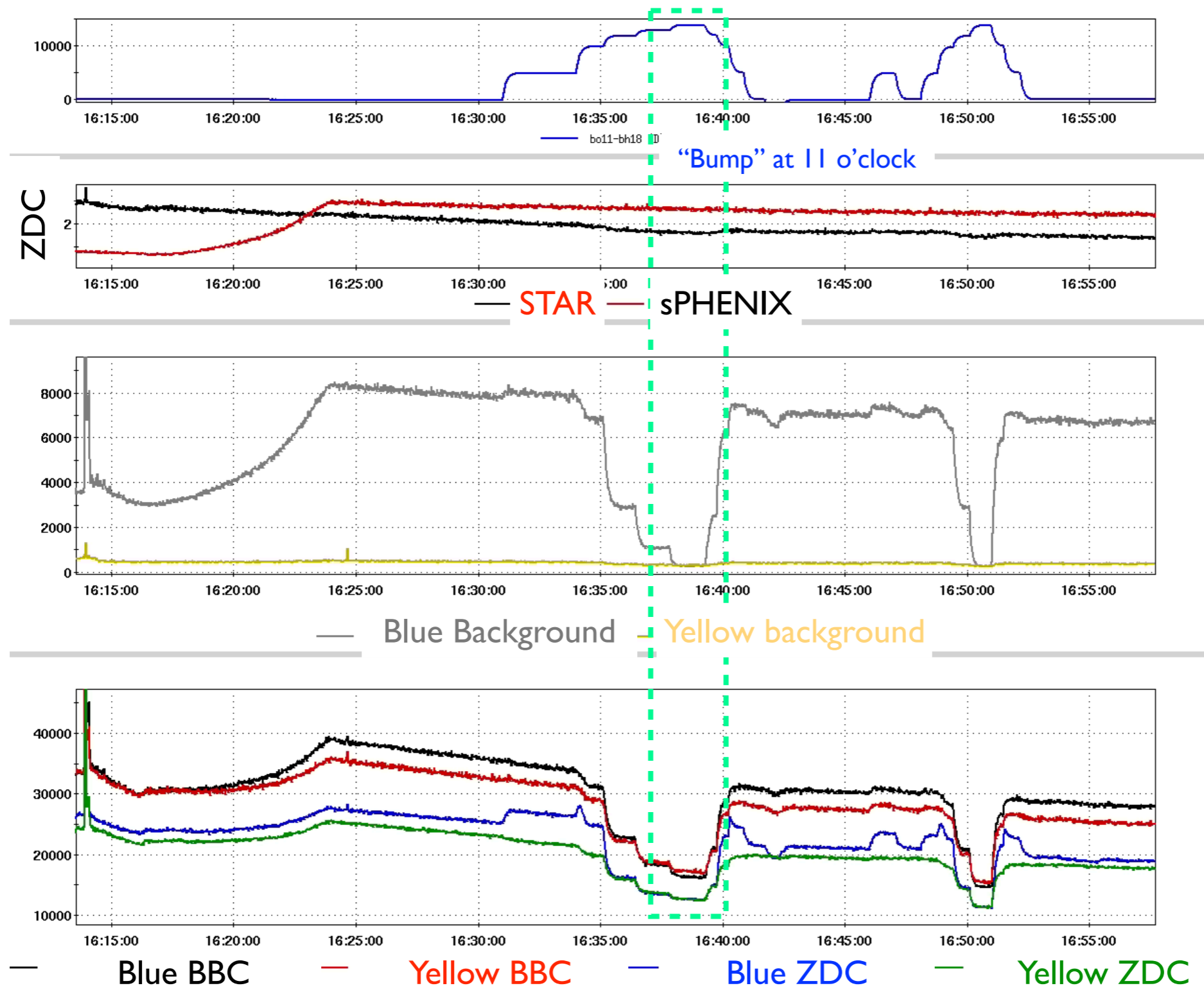
- Vertex-z center well adjusted, typically in ± 1 cm
- Crossing angle and stochastic cooling: tight Vertex-z distribution

Background



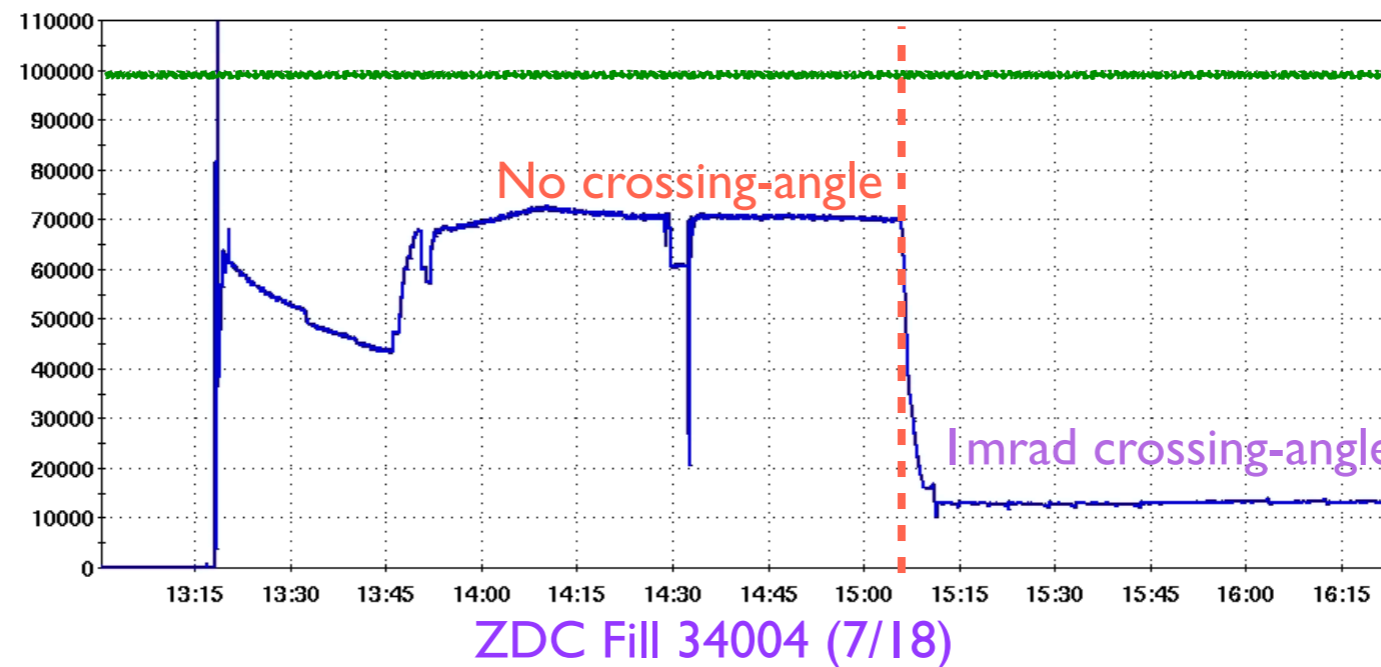
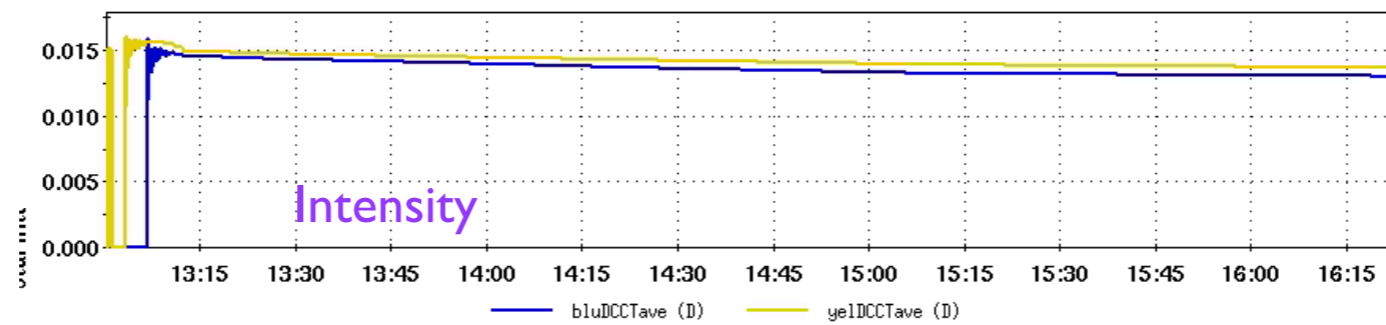
- Background identified with BBC (BBC and with 24 nsec difference)
- Asymmetric background: Blue \gg Yellow
- Blue Background strongly correlated with collision rates at sPHENIX
- Background from Au78 created by collisions?

Background from Au78



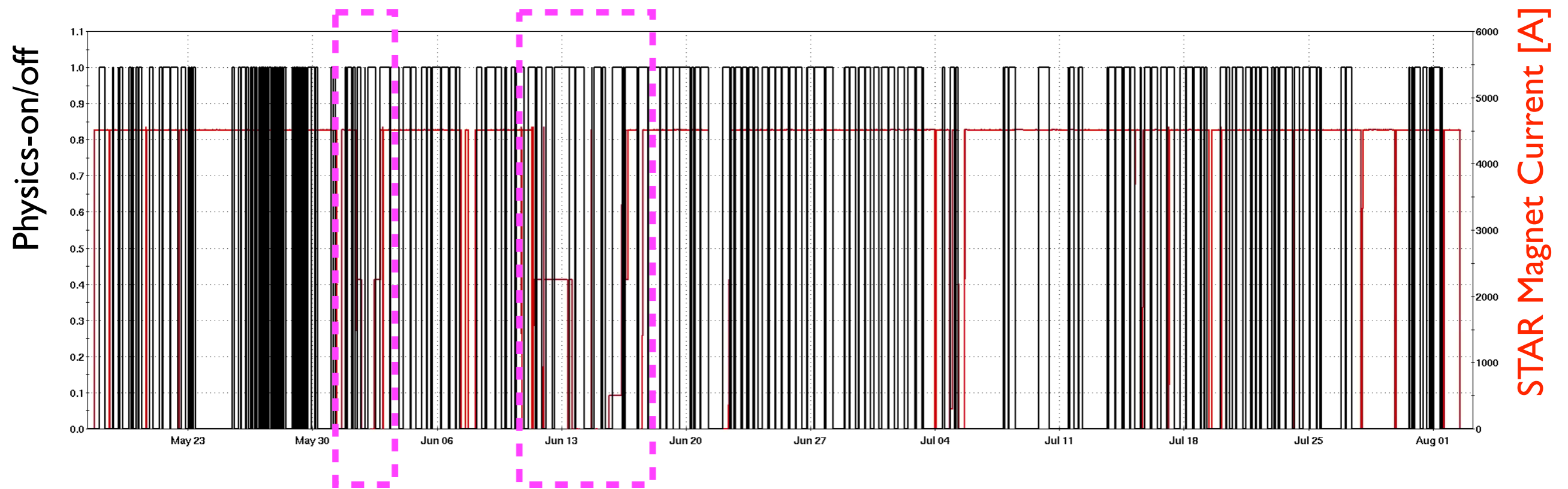
- Blue background understood with “Au78 test” (June 29)
- Removing “Au78” with Bump in orbit removed Blue background
- new lattice needed to implement (not done in Run23)

Crossing angle vs luminosity



- High-luminosity test fill without crossing angle
 - ZDC ~ 70 kHz
- Total luminosity reduction from 1mrad crossing angle: ~x4.2 (Vertex-z rms: 50cm → 18cm)
 - High reduction factor “consistent” with 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 luminosity (ZDC ~100 kHz)

STAR Magnet issue



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

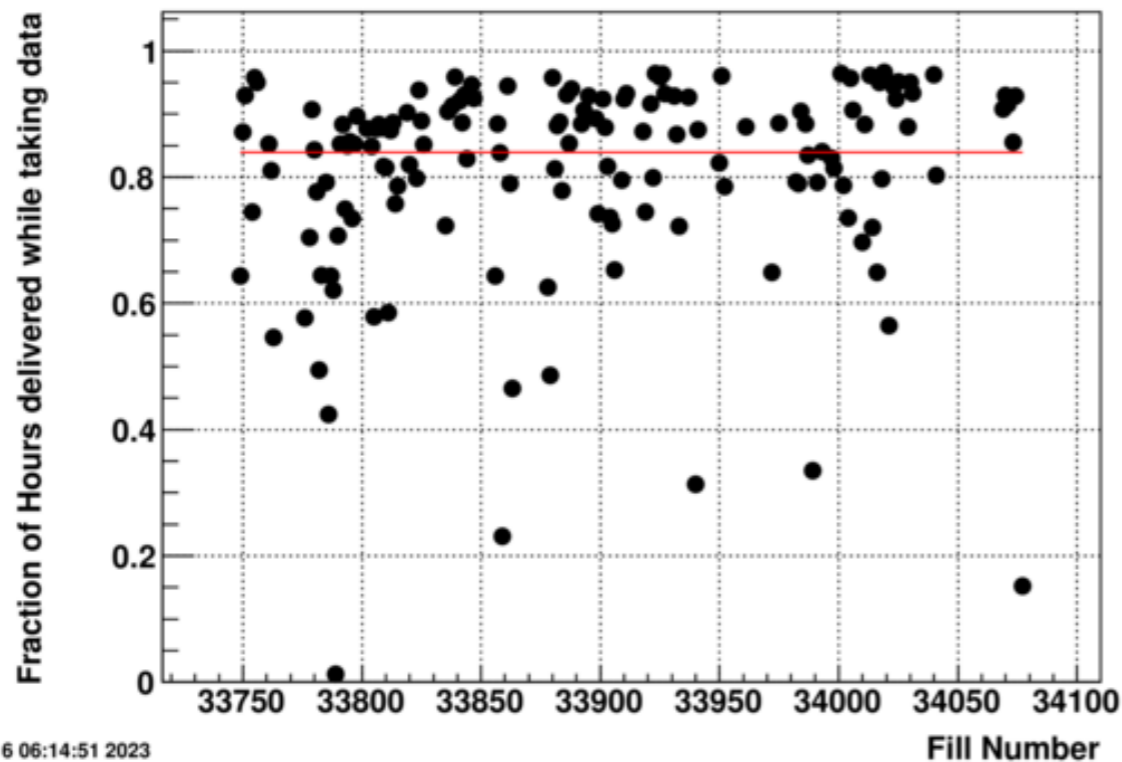
STAR down with HSSD LOTO



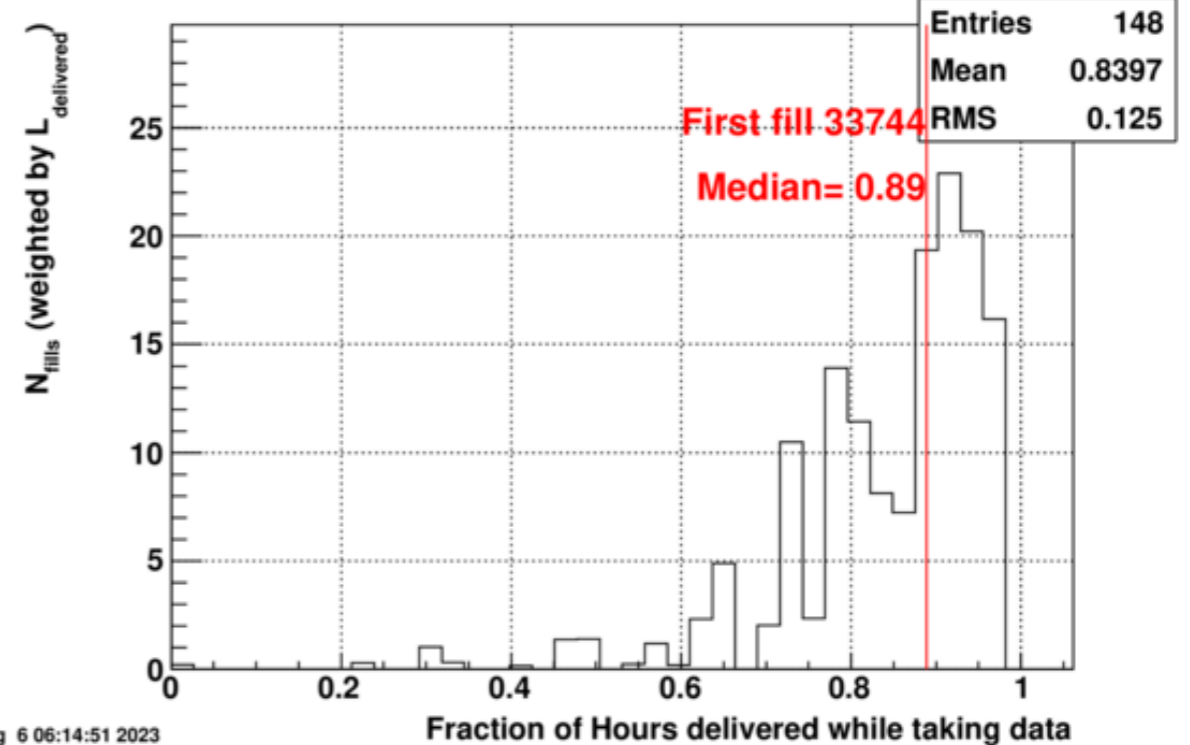
- STAR shutdown with High Sensitivity Smoke Detection System off due to smoke from Canadian wildfire: 6/7-6/8 ~ 24hrs
- ASE requirement
- All power on the platform off, LockOut/TagOut
- Recovery took multiple hours

Data collection efficiency

Fraction of Hours delivered while taking data



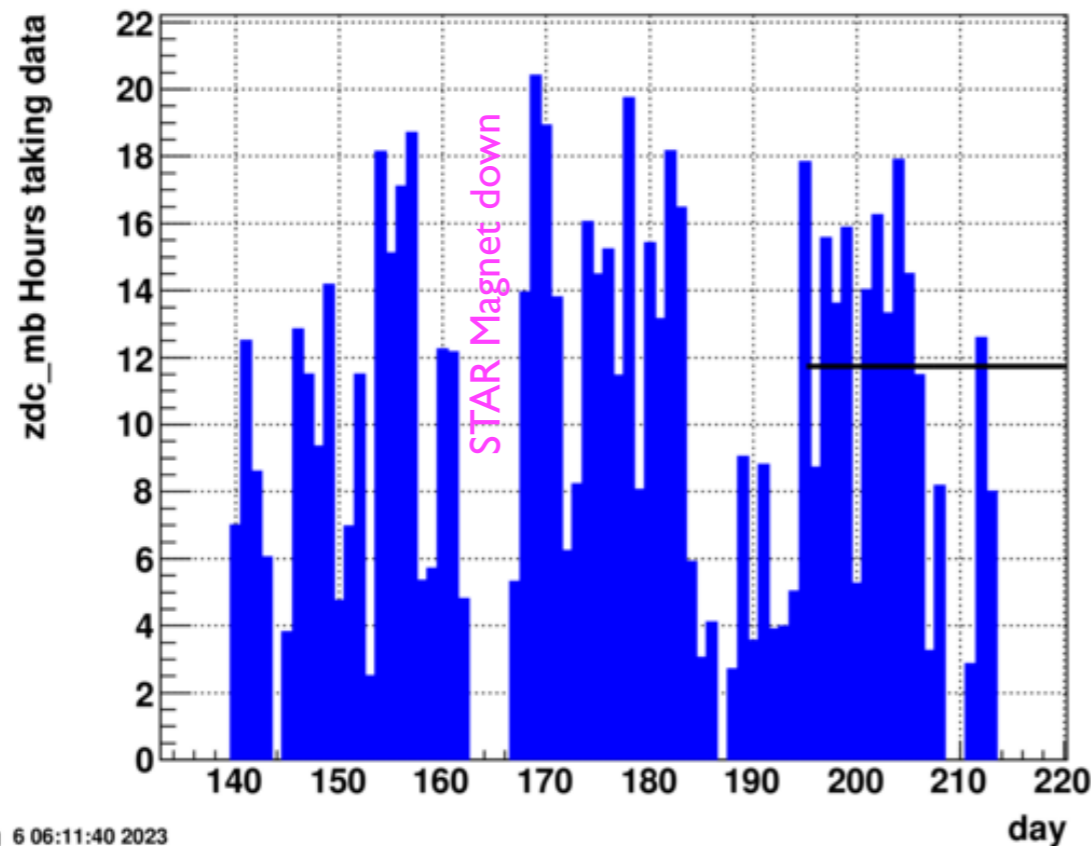
Hdev_data_byfill



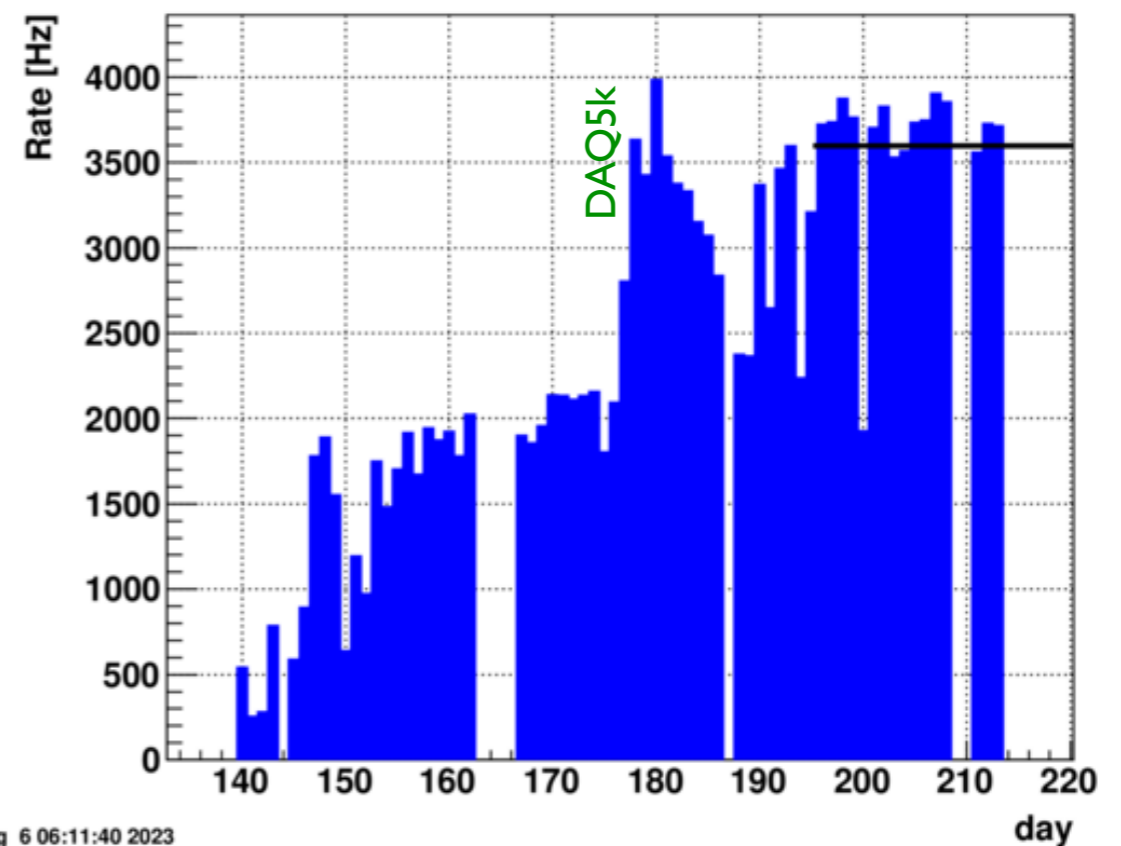
- STAR DAQ Uptime ~85%
- DAQ Downtime: interruptions for run control (~4%)
detector ramping up/down (~1%), detector/operation
issues (~10%)

Min-bias data taking hours and rate

hours_perday_zdc_mb.txt

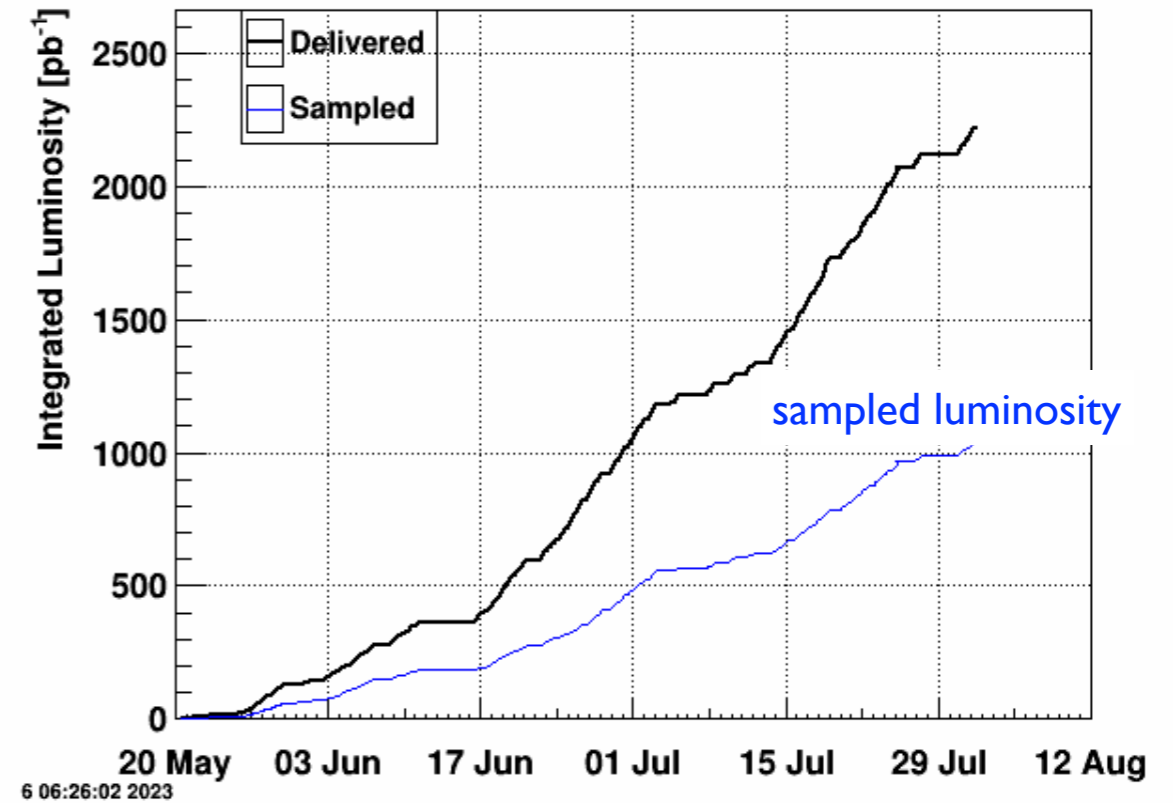
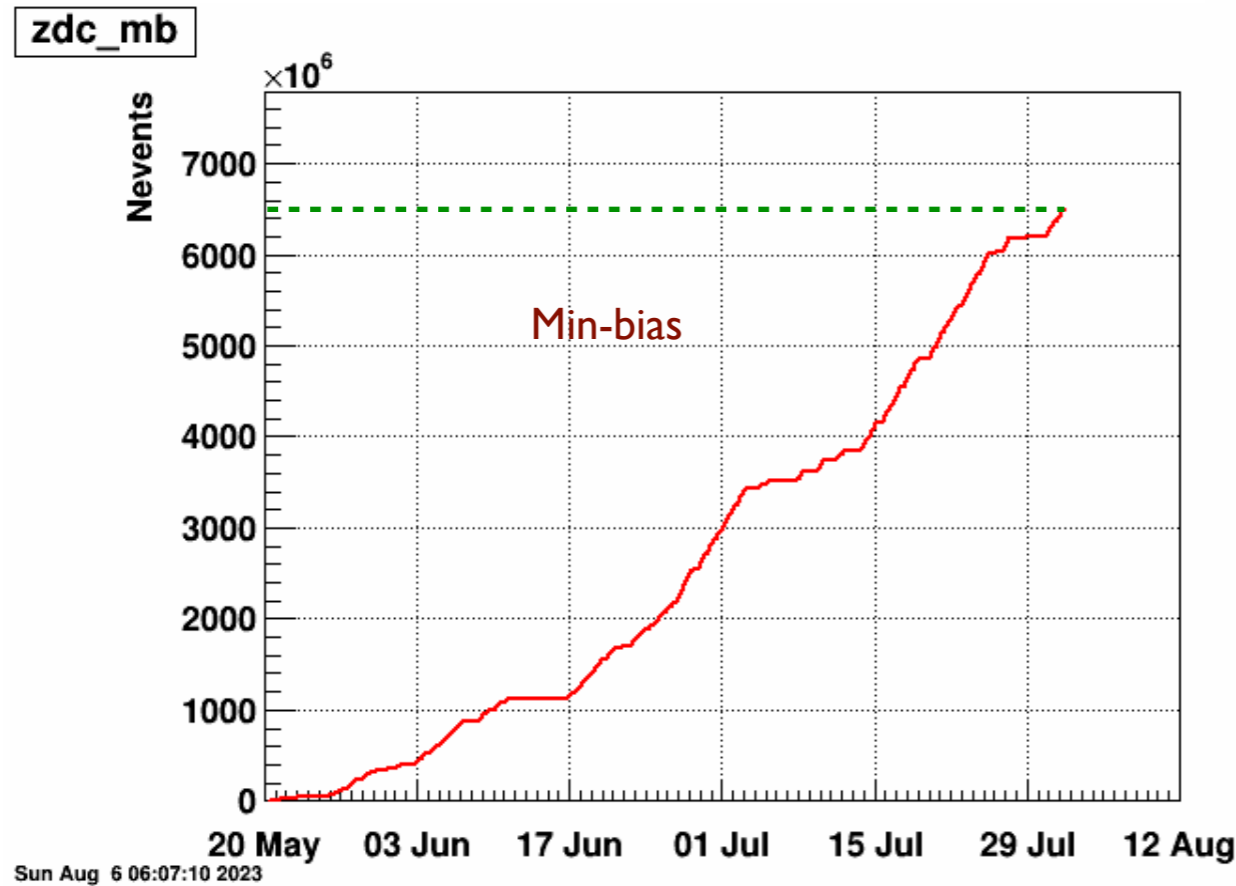


zdc_mb Average Rate [Hz]



- Data taking hours: 10.8 hours/day
- Average Min-bias DAQ rate up by x2 with DAQ5k upgrade

Physics goals



Final score:

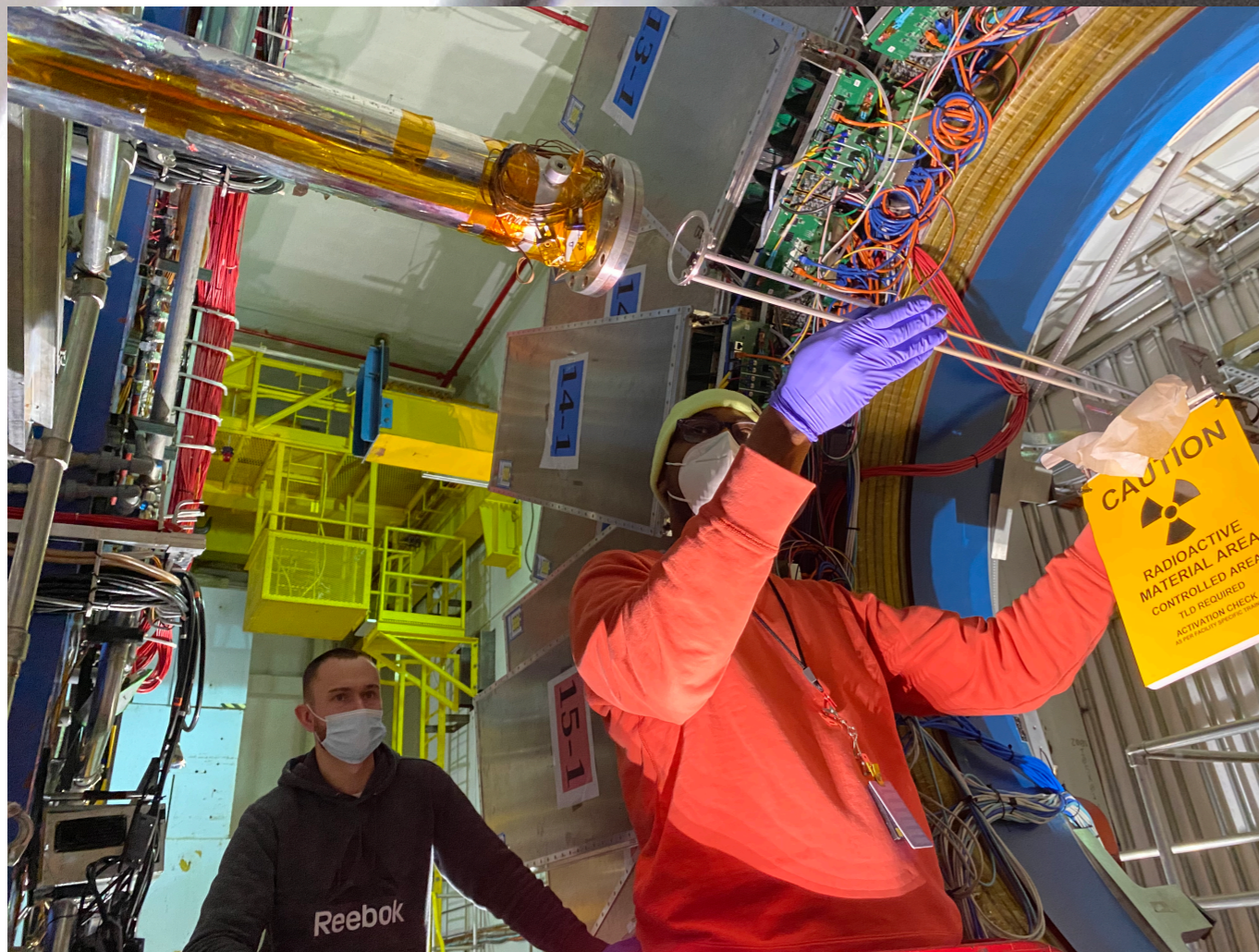
- 6.5B Min-bias collected (Initial Goal: 10B for Run23)
- No dedicated high- p_T program done in Run23 : $\int L \sim 1 \text{nb}^{-1}$

Run23: Summary

- **Beam**
 - Worked well: crossing-angle, luminosity leveling, vertex adjustment
 - To come: high luminosity, reduction of background
- **STAR** operation
 - Overall successful operation
 - No major issues with detectors
 - Successful DAQ5k upgrade as planned
 - (heat related) Issues: Magnet chiller, AC
- Collected high-quality Min-bias data set: 6.5B Events

Extra

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

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