# Run25 performance and challenges

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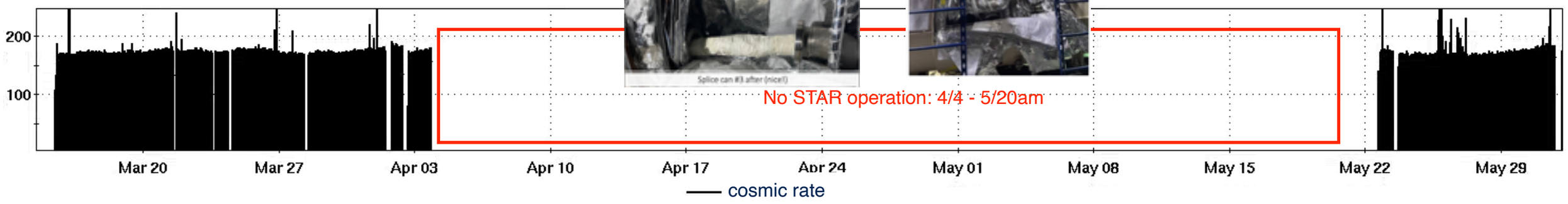
**BNL NPP 2025 PAC Meeting**
**October 16 2025**

# STAR Run25 Request

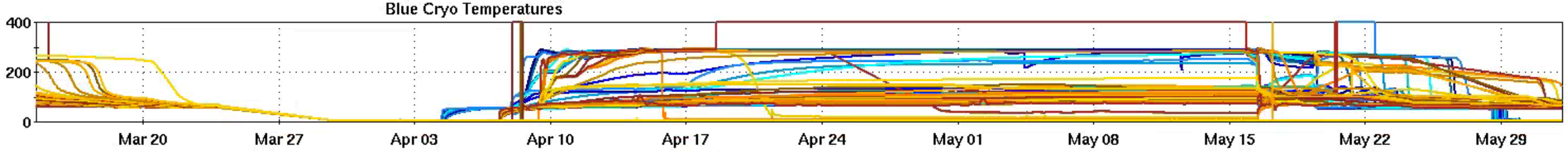
| $\sqrt{s_{\mathrm{NN}}}$ (GeV) | Species | Number Events/ Sampled Luminosity | Year |
|---|---|---|---|
| 200 | Au+Au | 8B+**5B** / 1.2 $\mathrm{nb}^{-1}$+**20.8** $\mathbf{nb}^{-1}$ | 2023+2024+**2025 (20 cryo-weeks)** |
| 200 | Au+Au | 8B+**9B** / 1.2 $\mathrm{nb}^{-1}$+**28.6** $\mathbf{nb}^{-1}$ | 2023+2024+**2025 (28 cryo-weeks)** |

- Completing Au+Au at 200 GeV
  - Original Goals: Min-bias 20 B / Sampled luminosity 40 $nb^{-1}$
- Au+Au running mode: high luminosity for rare probe/high-$p_T$ physics + controlled low luminosity for minimum-bias physics
  - Mix two data taking modes depending on luminosity/beam condition to achieve the goals
  - High luminosity: 0 crossing angle
  - Minimum-bias: 1 mrad crossing angle+leveled ZDC rate
- Requesting an extension of Run25 beyond 28 weeks allowing
  - 5 weeks of pAu, targeting 0.22 $pb^{-1}$

# Before the physics - Preparation and downtime

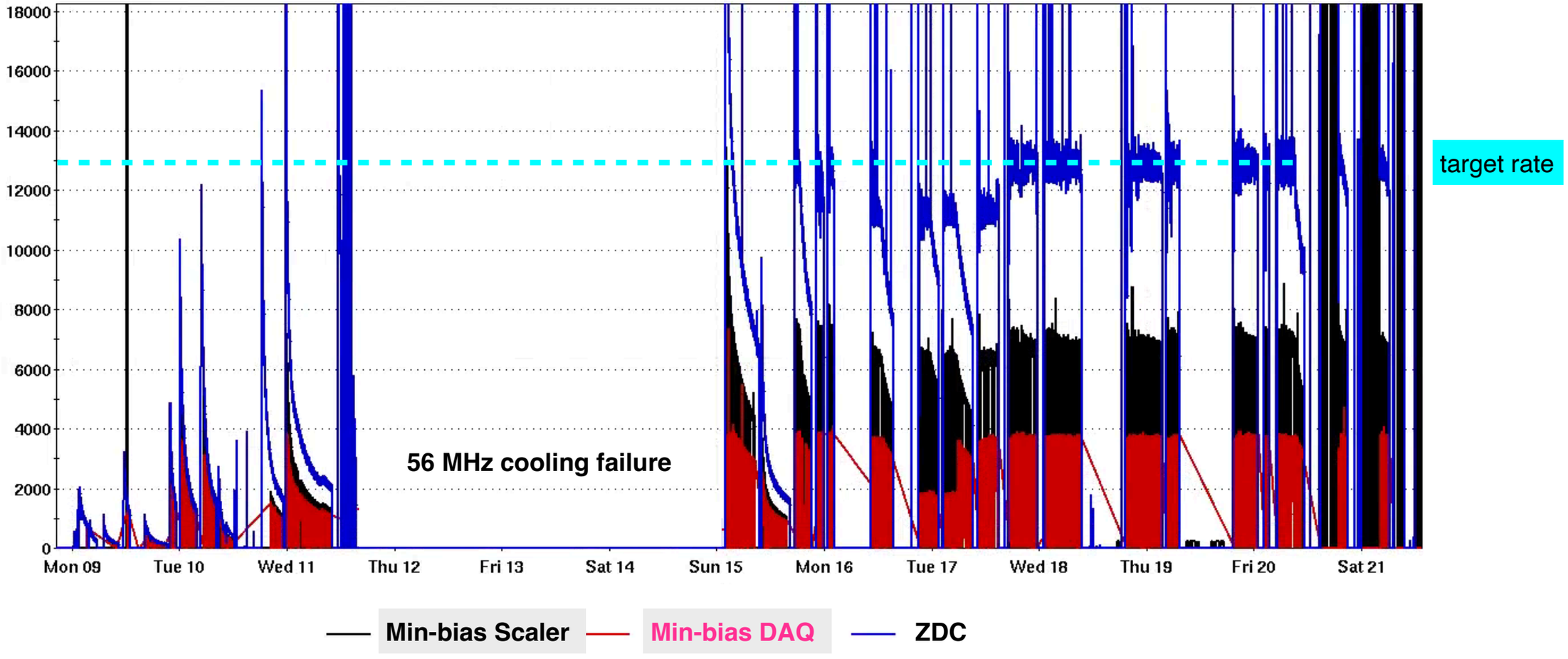

cosmic rate




Cryo Temperature

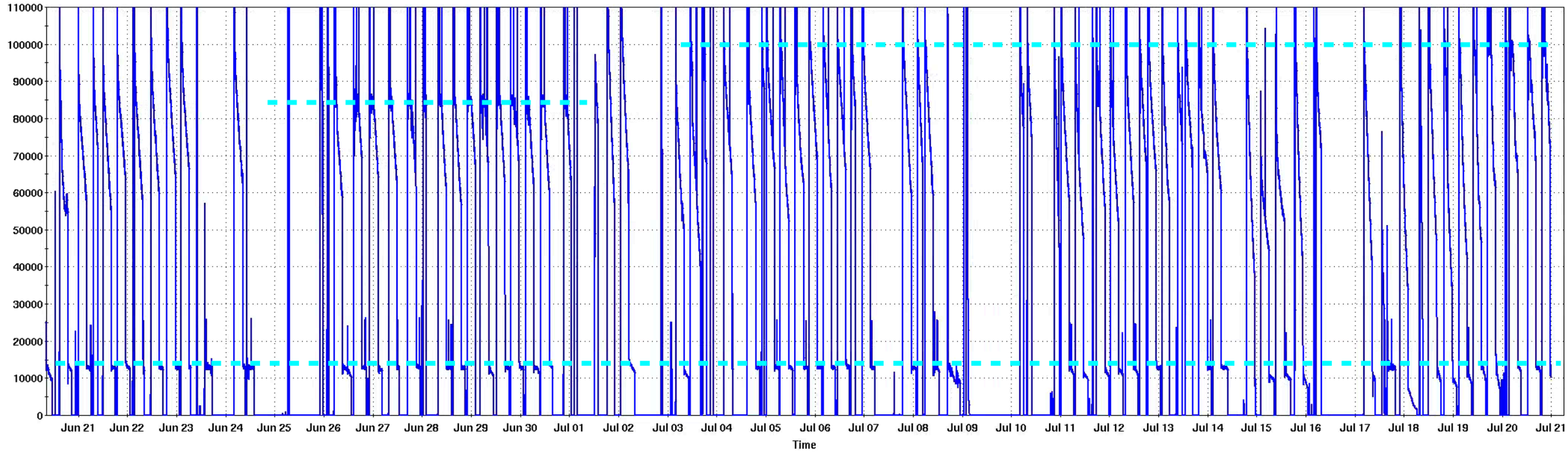
- Long downtime during the machine repair: decided to shutdown STAR operation
- Cosmic data taking at B (reverse)- and A (forward) -polarities at Full field
- 260M, 14M Cosmic events
- **Resumed operation smoothly after the shutdown**

# Started physics with Min-bias



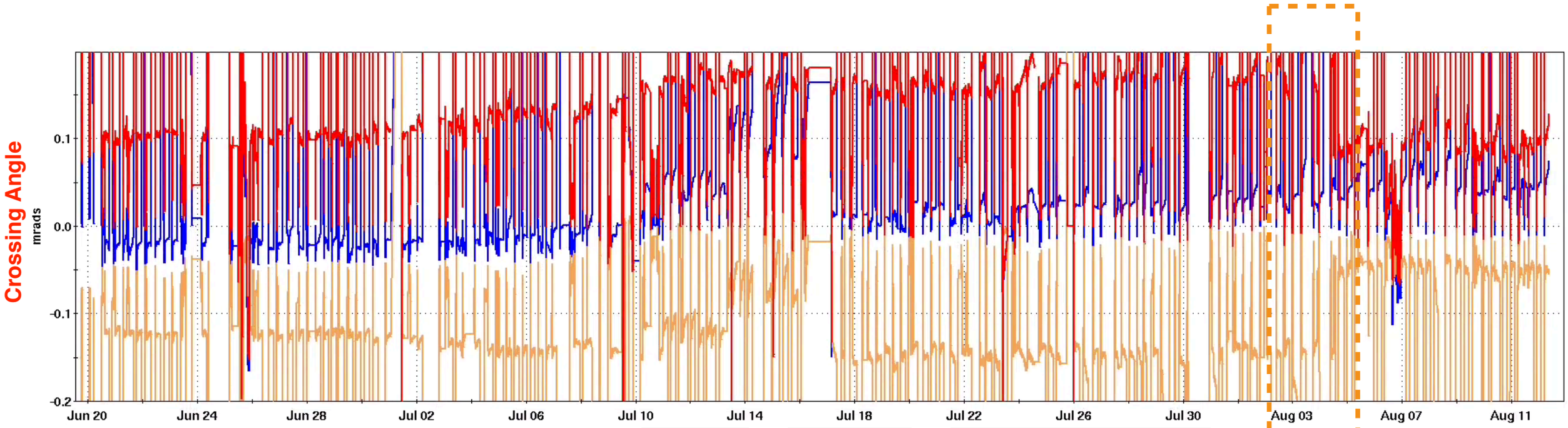

- Crossing angle 1mrad and luminosity leveled ZDC at 13kHz for min-bias
  - to minimize event pile-up while maximizing DAQ rate
  - "ZDC": ZDC with killer bit
- Min-bias: zdc & tof >0
- Min-bias DAQ: ~3800 Hz

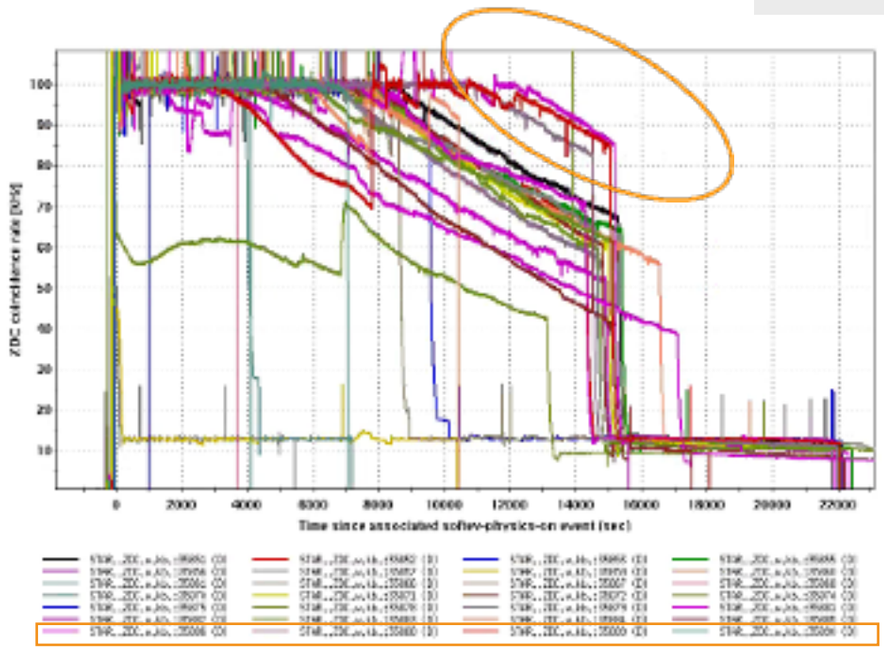
# High-, low-luminosity running




- Since 6/20 (10 days after Physics)
- **To maximize physics and data collection efficiency:**
  - No crossing angle; luminosity leveling with ZDC: no leveling ➔ 85kHz ➔100kHz
  - First 4 hrs of the store then switch to min-bias mode for the last 2 hrs (nominal 6-hr store)
    - switching mode (crossing angle, leveling): ~4 min. ; continuous taking data
- Machine:
  - Full 3d stochastic cooling
    - longitudinal 6/12, +vertical only: 6/18, full 3d: 7/13-23 Yellow, Blue
  - Automated precise luminosity leveling
  - Continuous gap cleaning at 1Hz : no significant background in TPC

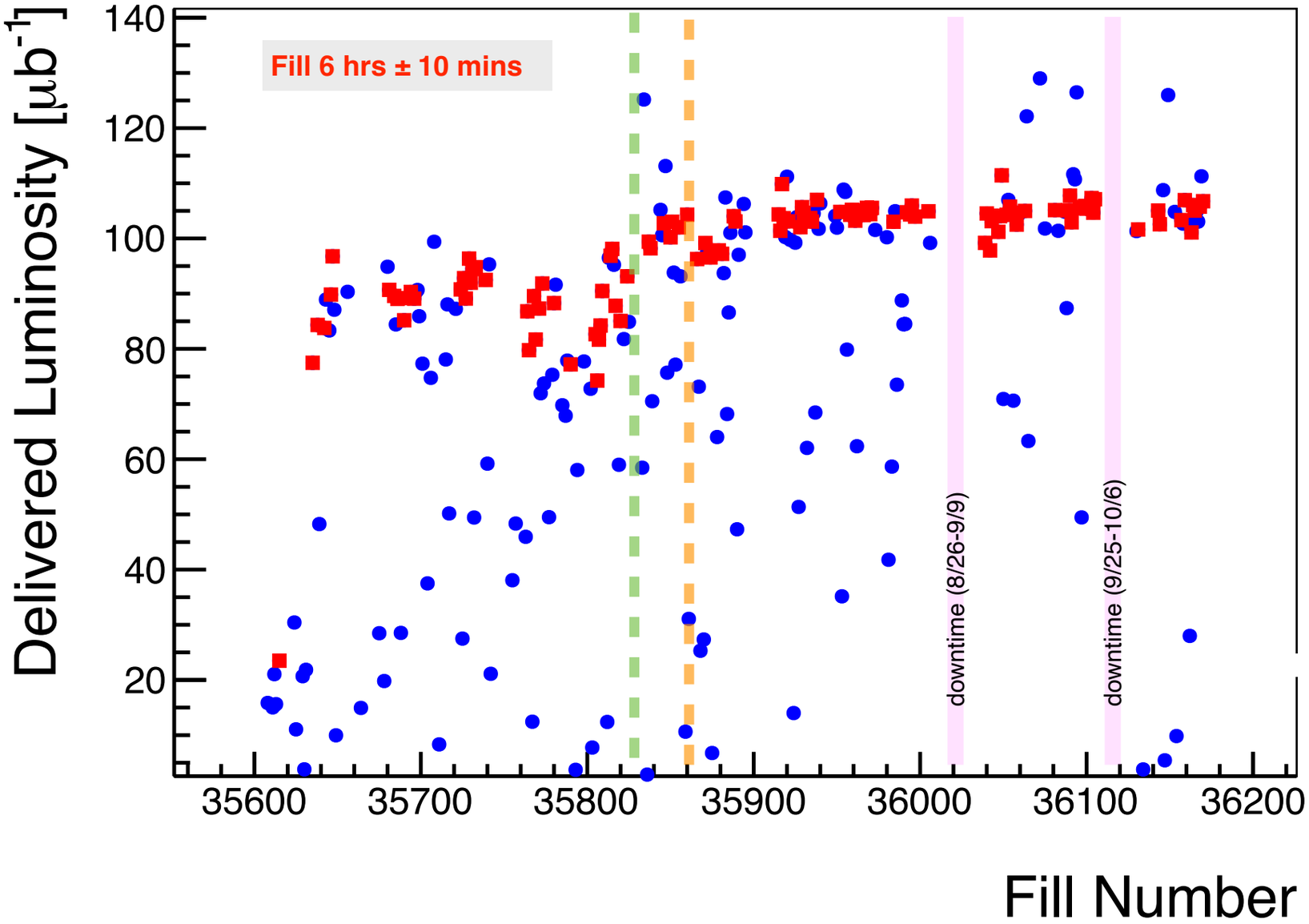
# Luminosity vs Crossing angle



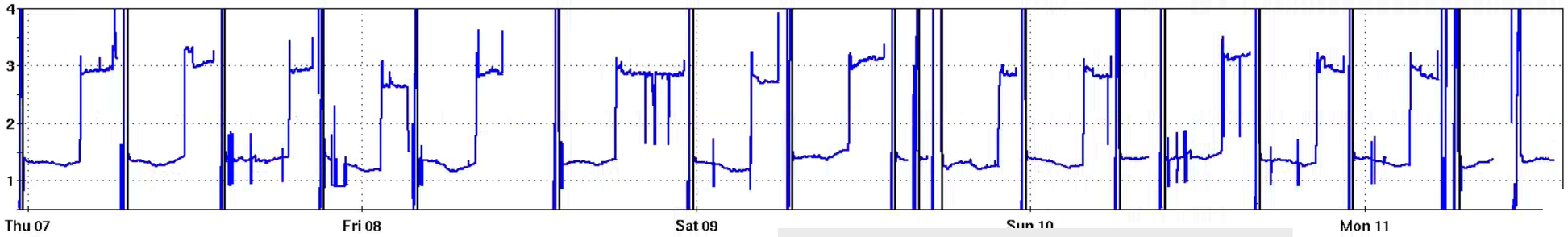

- "Hidden" crossing angle for high-luminosity (head-on) removed on 8/3
  - 0.1mrad from Yellow
  - Improved luminosity ~ sustain 100 kHz leveling for 3 hrs

# Luminosity

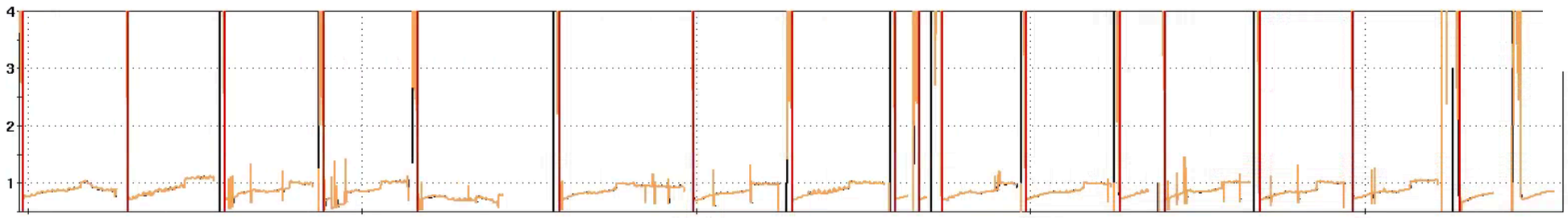



- Adding Yellow Horizontal Stochastic cooling plane
- removing Hidden crossing angle
- +Continuous optimization - highest luminosity in AuAu at 200 GeV

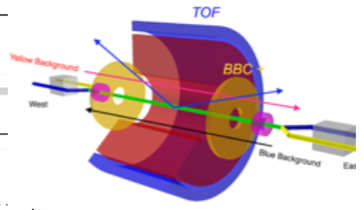
# Background

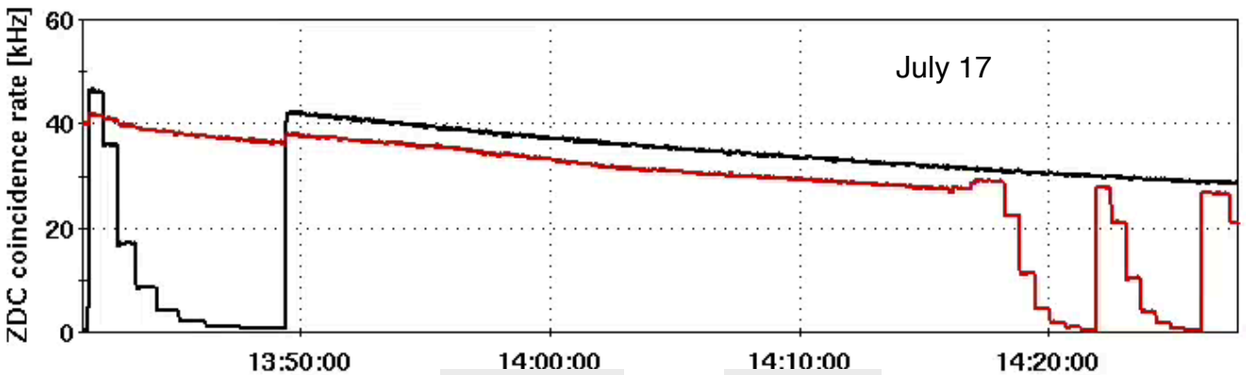



Blue background / BBC

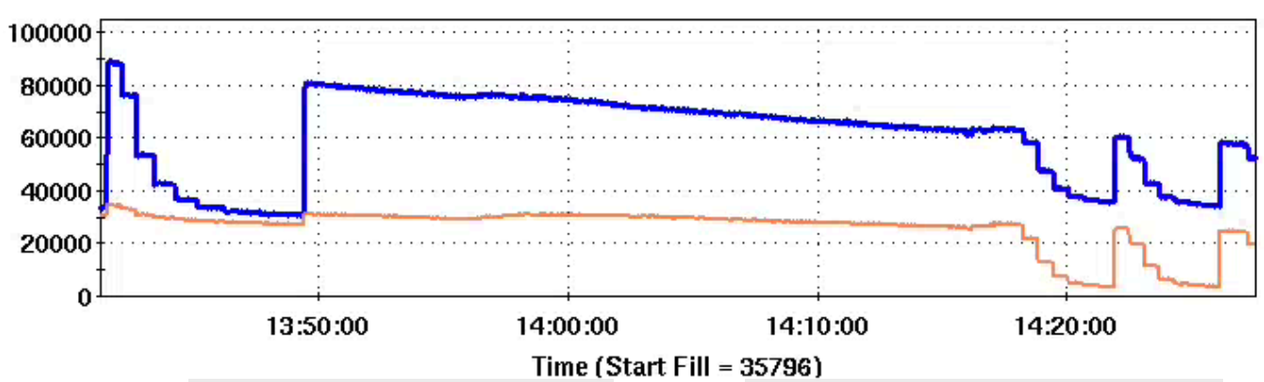



Yellow background / BBC



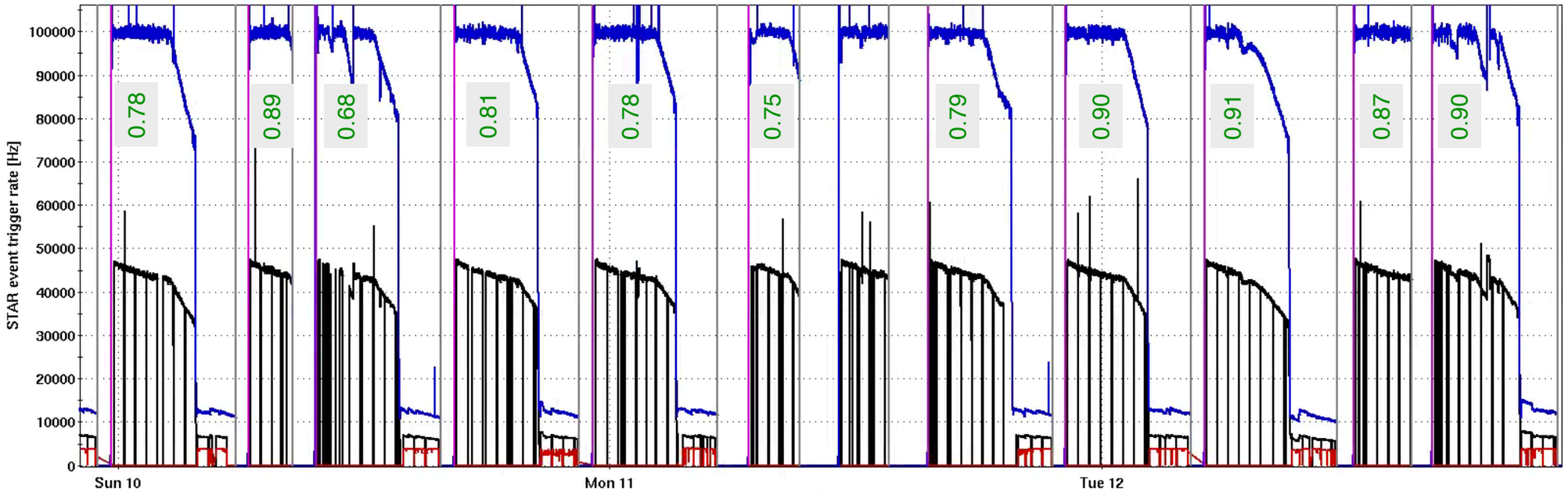

sPHENIX STAR

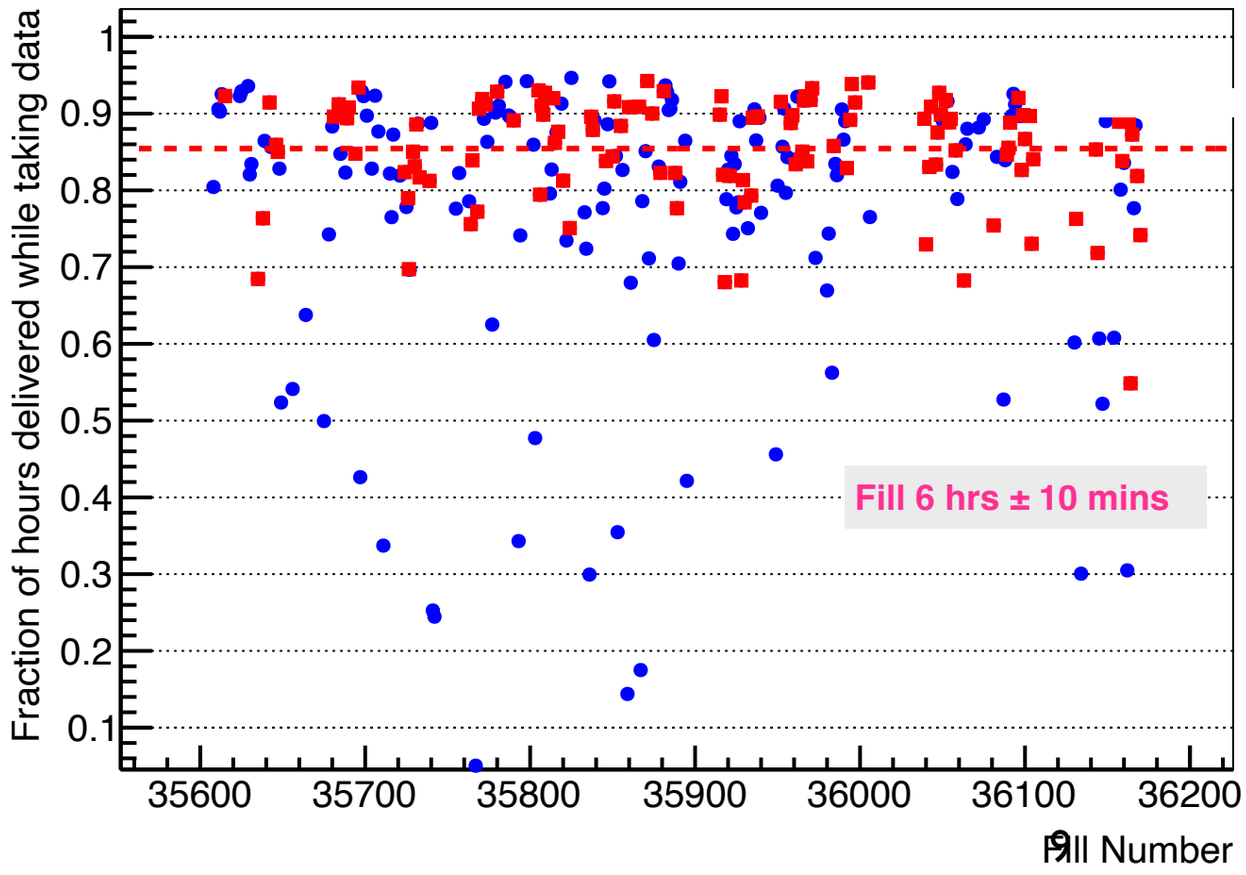



Blue background / BBC Yellow background / BBC

- No significant background except IP8 collision induced background in Blue
  - As in Run23,24:"Au78"
  - Contribute up to ~2/3 of Blue background
- No remedy to reduce the background implemented

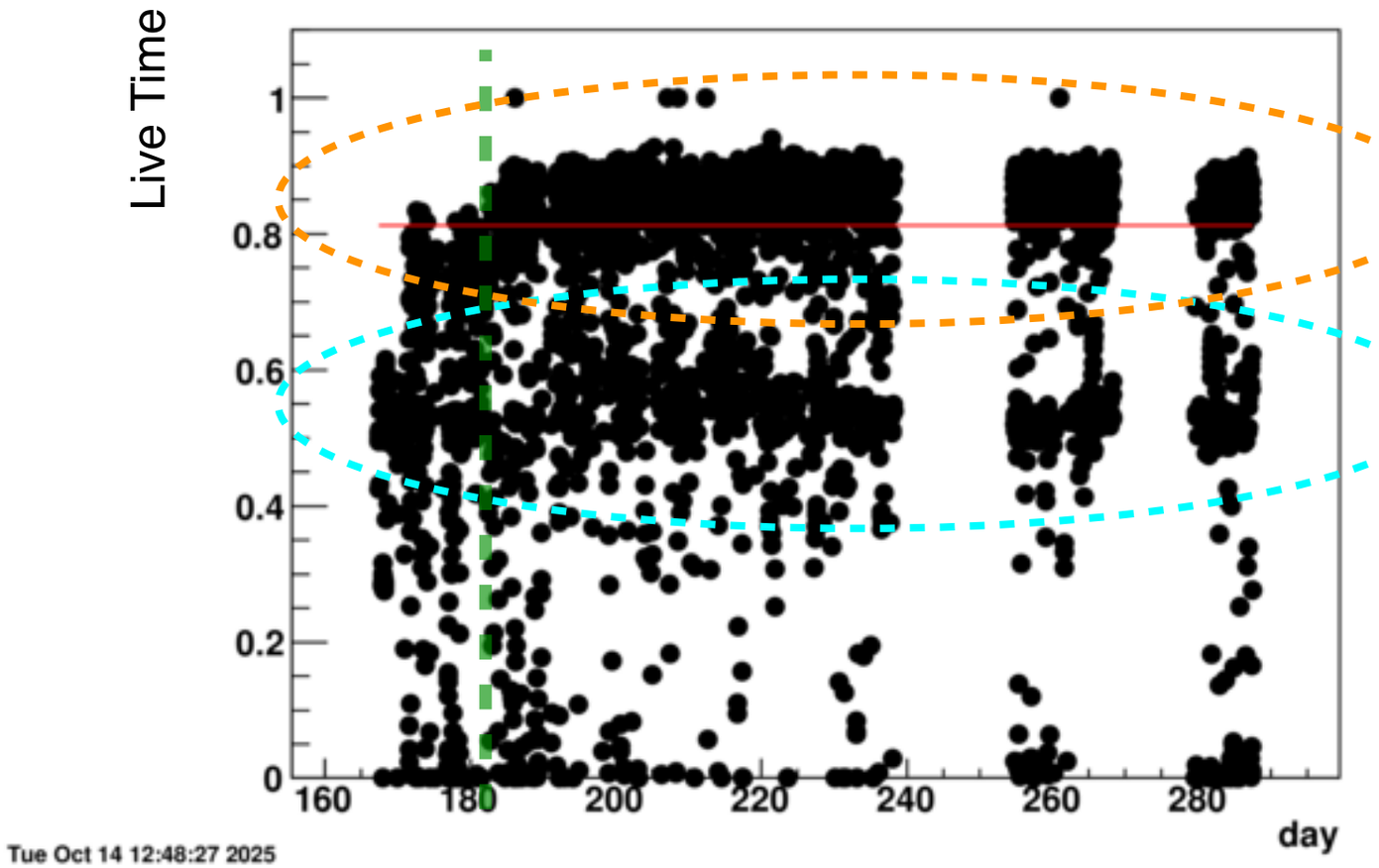
# Running Efficiency

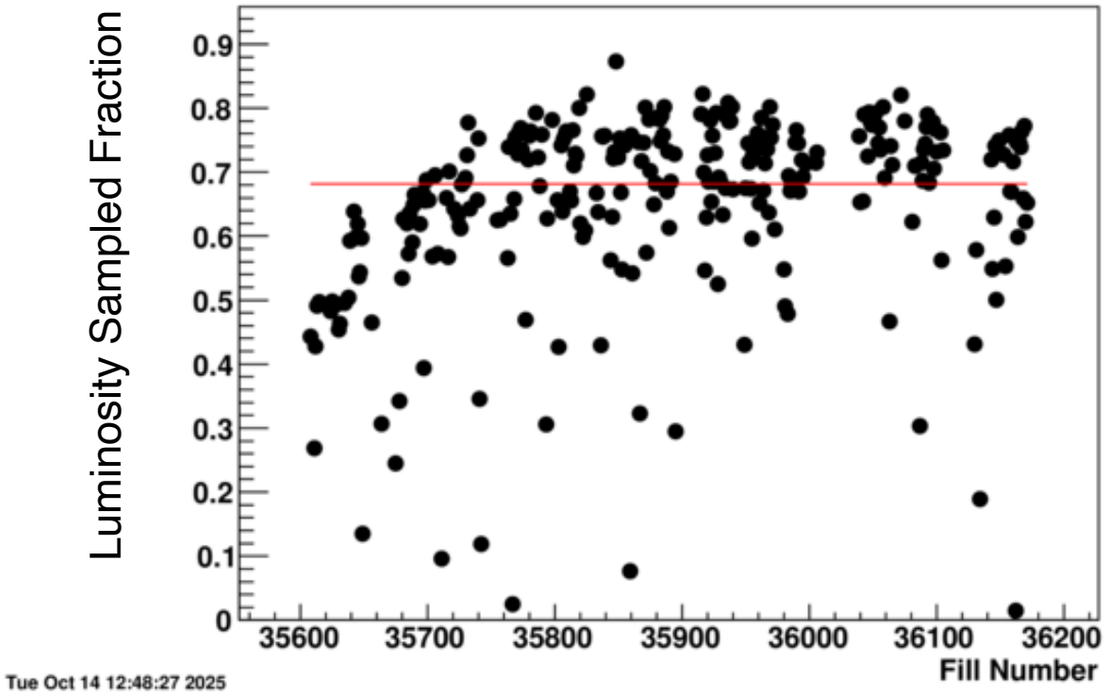



- Running efficiency (data taking time fraction)
  - ~85% (6 hr fills)
    ~83% (overall)
  - Run24 pp: ~80%

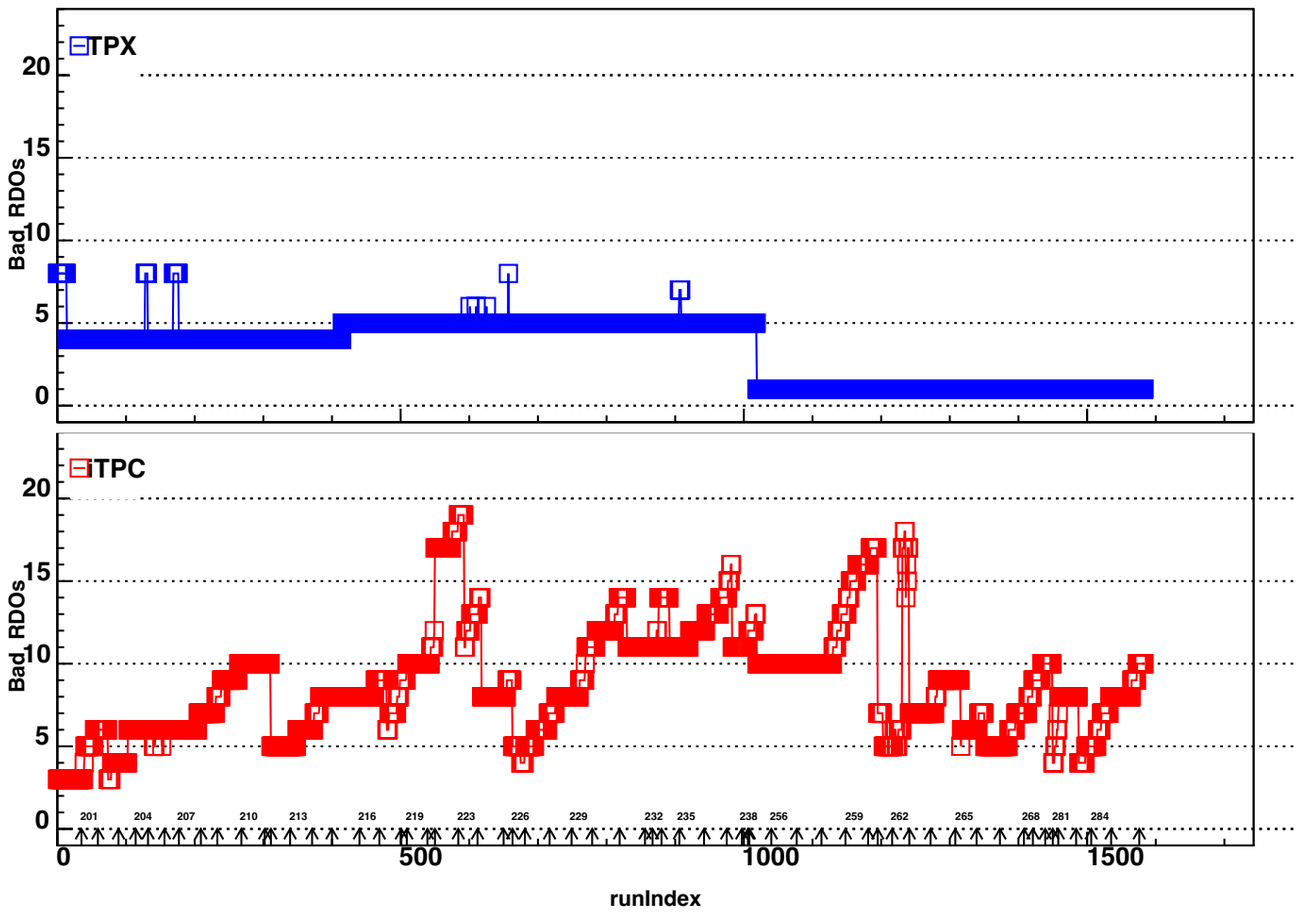
# Live time



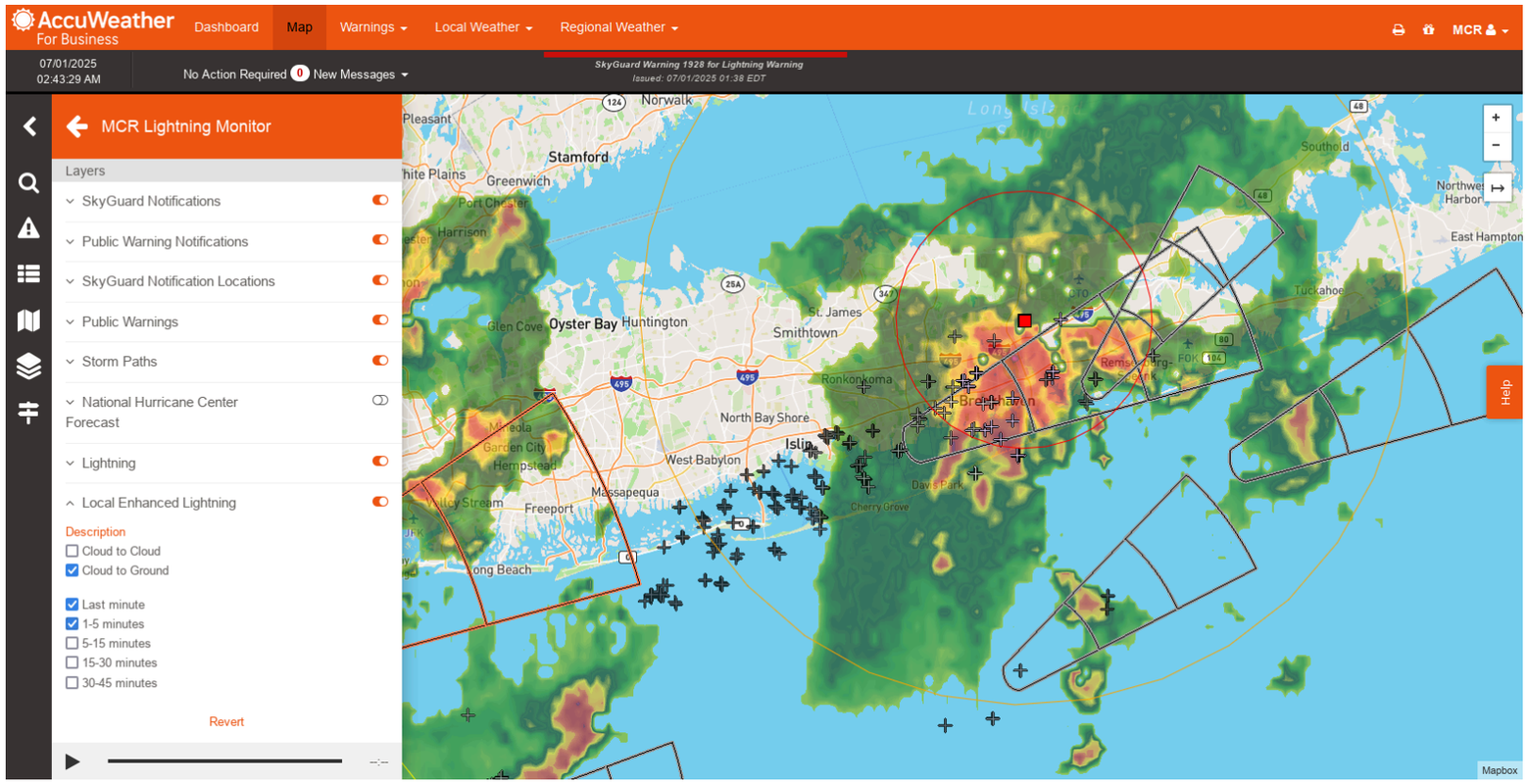

- Hi-luminosity/High-$p_T$ : DAQ ~900 Hz ~90% live
- Min-bias : DAQ ~4k Hz ~55% live
- Re-optimizing trigger distribution to keep dead time low and maximize physic rates
  - High-tower, Min-bias, dimuon, UPC.. triggers

# TPC in high luminosity



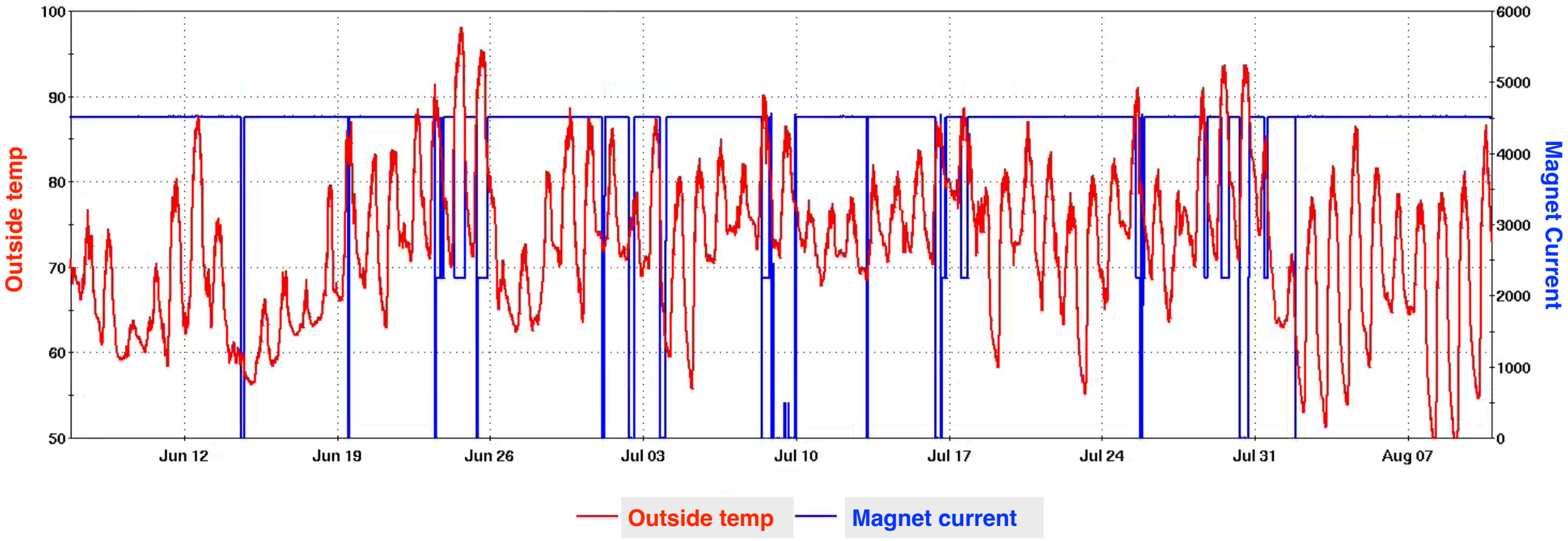

- The radiation environment in Run25 is harsh particular for high-luminosity running
- Typically 3-5 auto recoveries per run
- 1-2 iTPC RDO masked out per day
- 4 TPX RDO out due to power issues (recovered during the downtime)
- Up to 10-15% of TPC is dead at times
- Varying coverage with run may be a challenge for some physics analysis

# Operation challenges



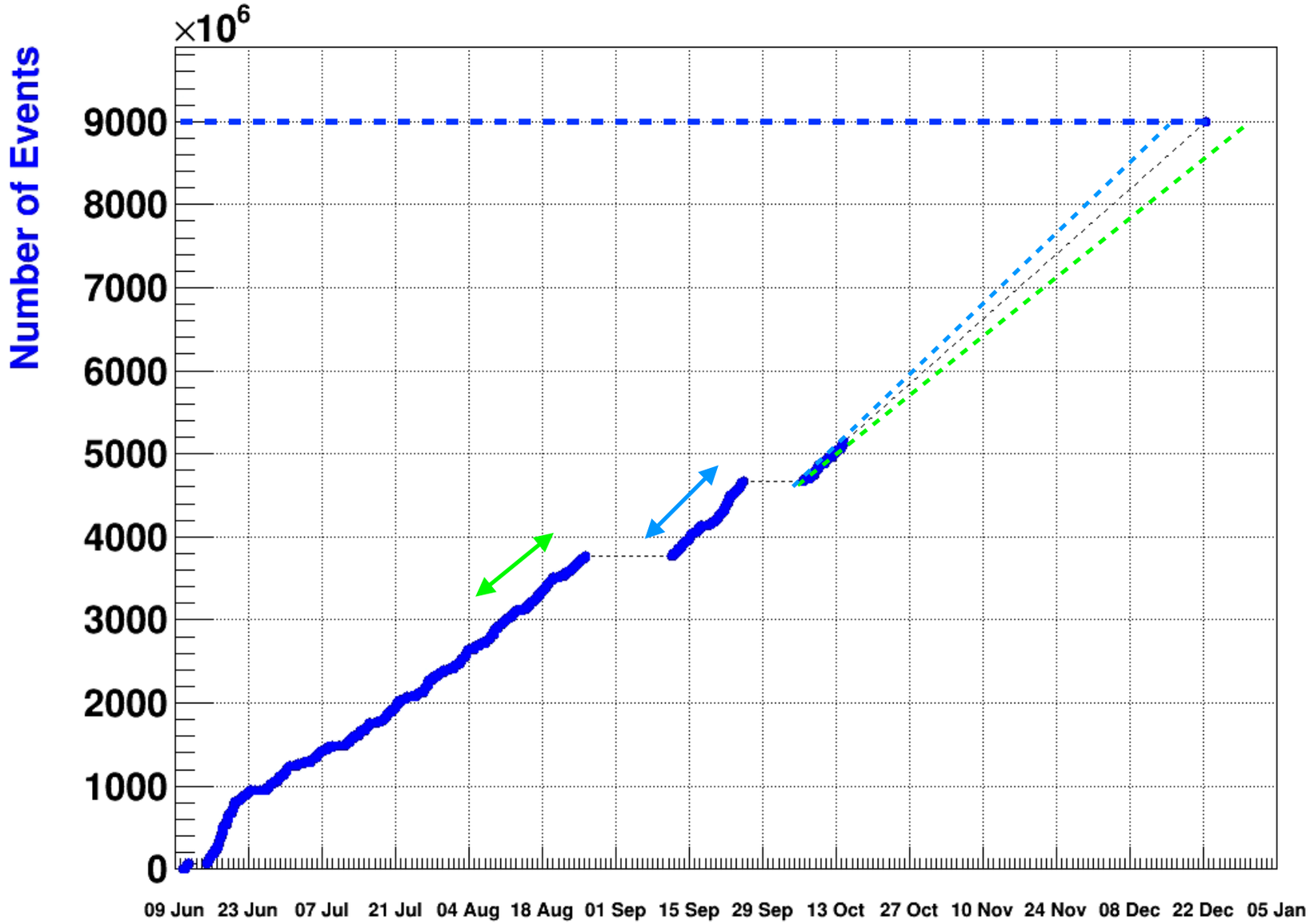

- Difficulty staffing shifts with a dynamic schedule
- Experts availabilities (for STAR and Machine)
- Major impact with temperature issues (originally 7 weeks of "summer break" was planned): Magnet cooling, AC…
- Weather-related stand-downs, power dips

# Magnet at Half Field



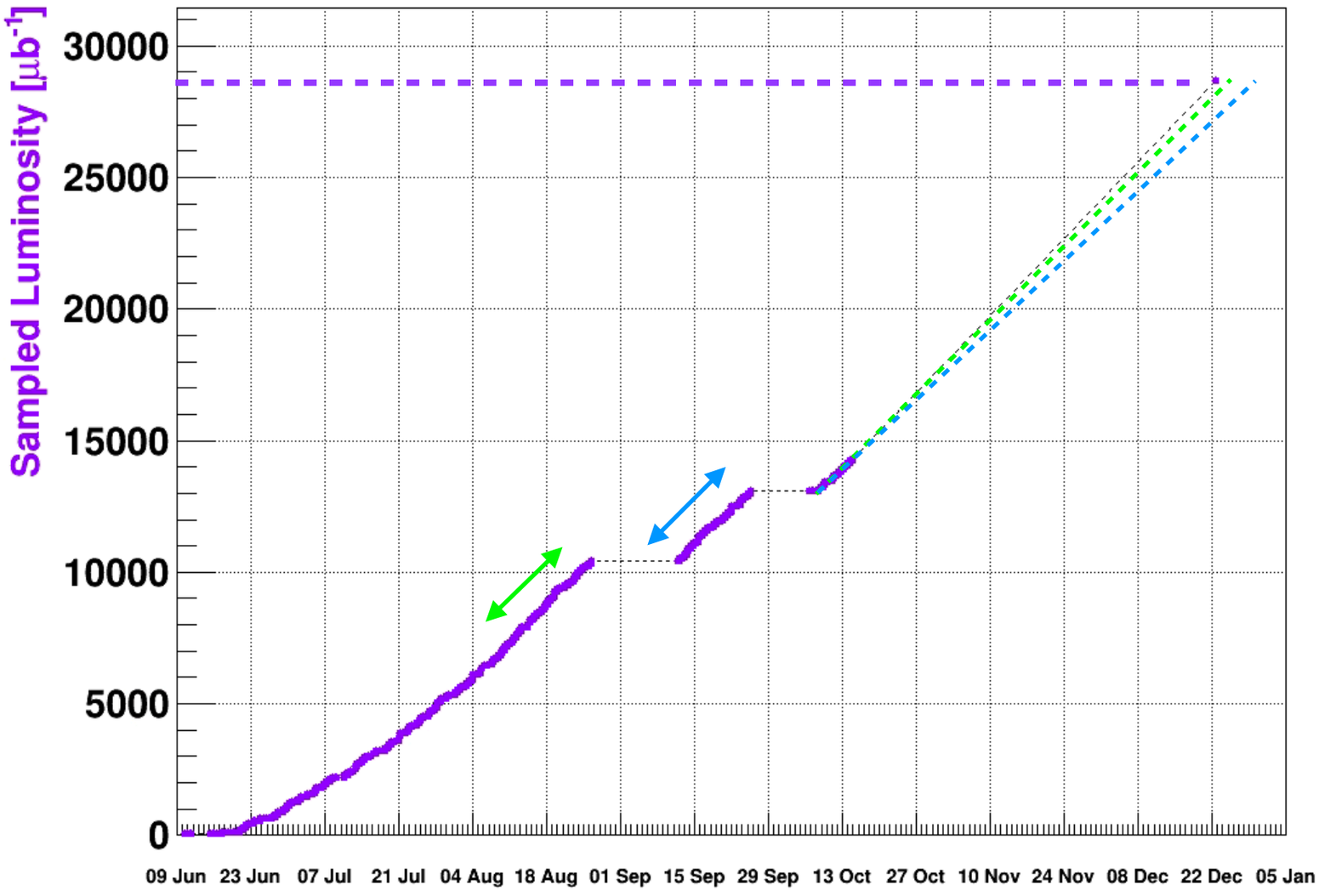

- Outside temperature too high during the day for the magnet cooling capacity - running at half field
- Opportunistic configuration to increase low-$p_T$ acceptance for UPC and min-bias
- Field change can be done during a store
- 22 hrs accumulated running (55 M min-bias events)

# Run25 Goal: Min-bias




- Run25 Goal: 9B
- 5.1 B as of 10/14 - 57% of goal
- projected to reach goal by Dec 31(Dec 15)

# Run25 Goal: High-$p_T$/High Luminosity




- Run25 Goal: Sampled Luminosity 28.6 $nb^{-1}$
- 14.2 $nb^{-1}$ as of 10/14 - 50% of goal
- Projected to reach goal by Dec 25 (Dec 31)

# Summary

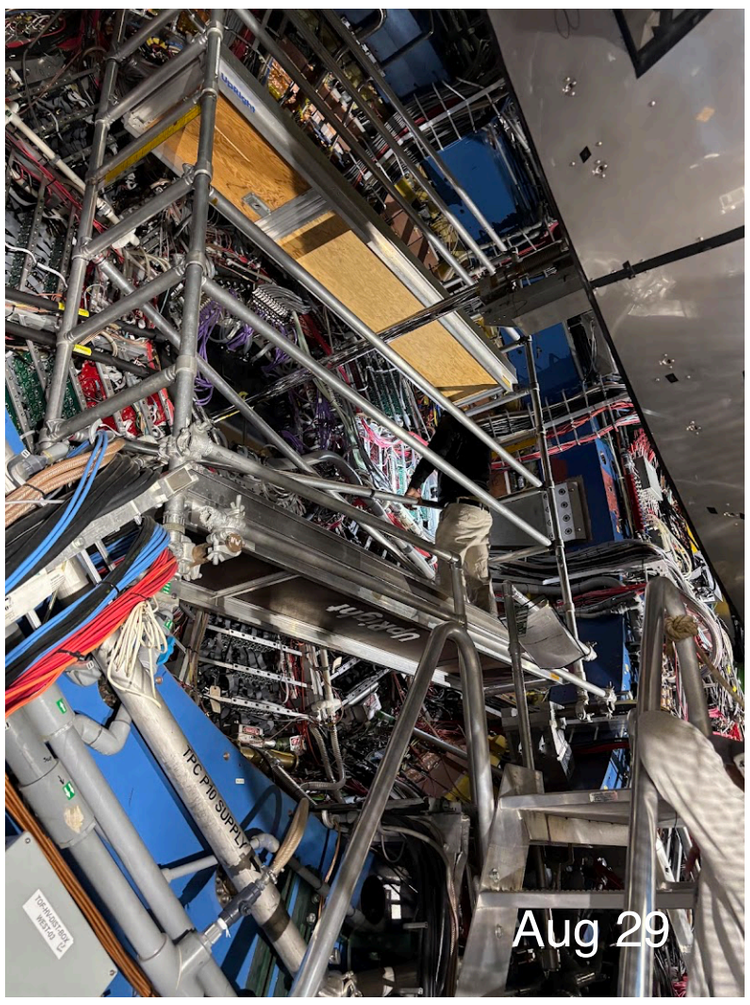
- **Run25**, good progress despite challenges - dynamic schedule, weather, multiple running configurations…
  - No major issues with subsystems
  - On track to reach physics goals
- Looking forward to successful finale of the RHIC program at STAR

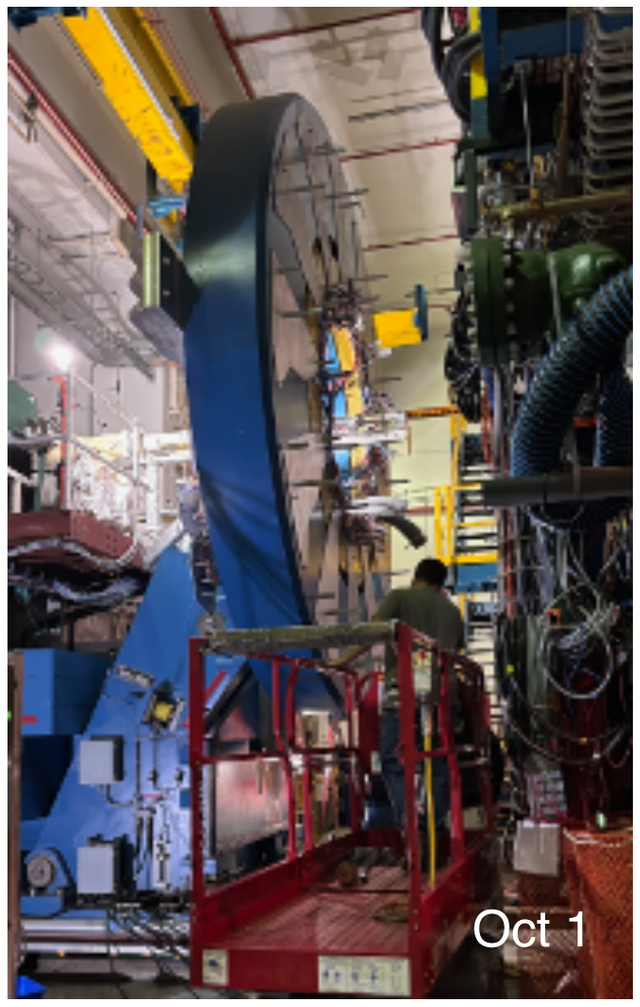
# Extra

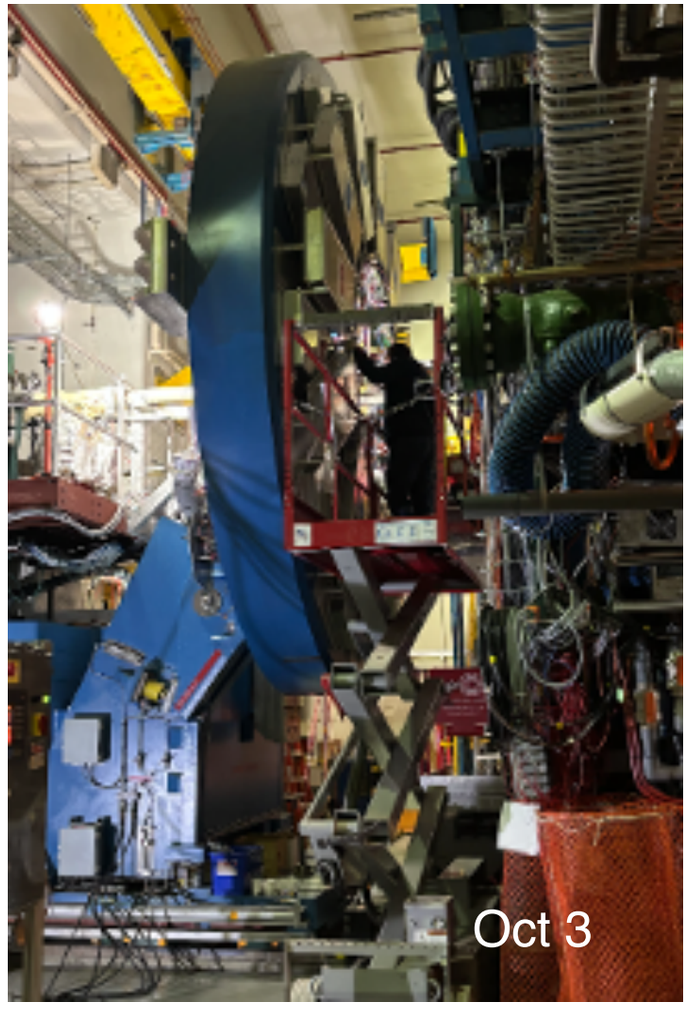
# Run25 - timeline

- 3/11/25 : Shift (2 person) start, flammable gas flow
- 3/16-: Cosmic Data taking with magnet on
- **3/24 : RHIC 4k Cooldown start**
- 3/26 : Blue main high-pot failure (short in ground)
- 3/31 : RHIC repair start
- 4/1 : originally planned Physics start date
- 4/3 : Shutdown STAR operation (for 47 days)
- 5/15: Cooldown resume
- 5/20: Shift resume, flow gas
- 6/9: Collisions for setup
- **6/10: physics (Fill 35586)**
- 8/26-9/9: downtime - 69kV power line failure
- 9/25-10/6: downtime - Vacuum rise from Yellow abort kicker prefire
- **End of Run: Dec 22?**

# Maintenance and repair during two downtimes

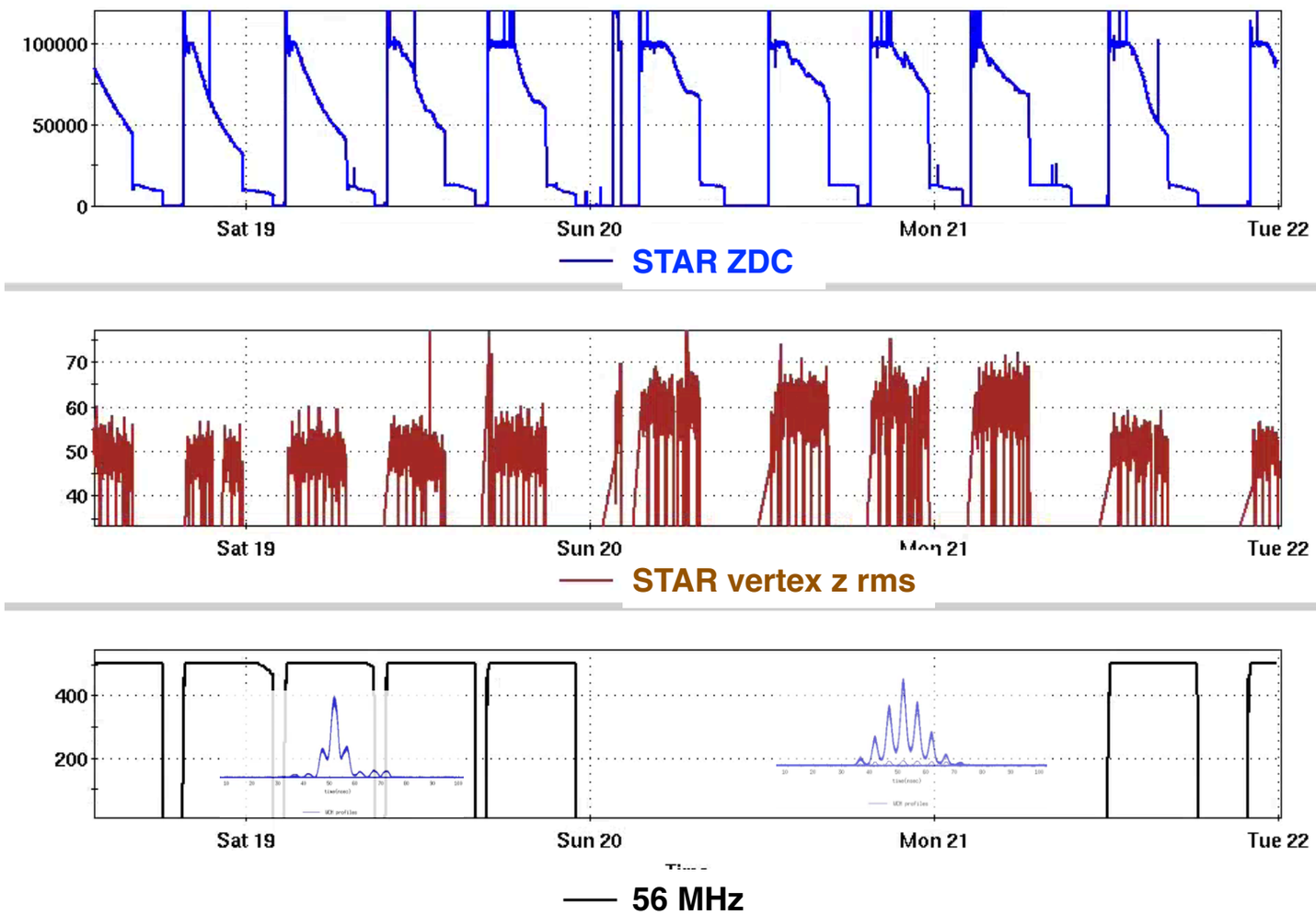



- Repaired and Reinstalled ETOF (ready for fixed target)
- TPC RDOs recovered
- Cosmic data with half field at A-, B-polarities for TPC calibration

# 56 MHz




- 56 MHz Cavity first used for physics to improve vertex distribution 7/15-22
  - mainly for sPHENIX requires narrow acceptance (z ±10cm)
- Visible improvement in the distribution: ~15% gain for sPHENIX
- beam lifetime worsen, and ~5-10% luminosity decrease for STAR
- ~~To be restored (if possible)~~