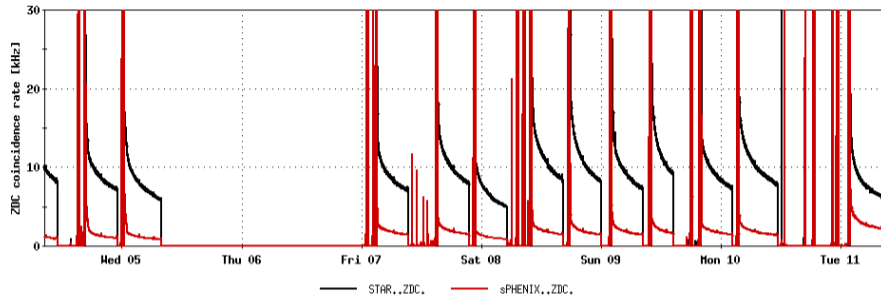


# RHIC Status

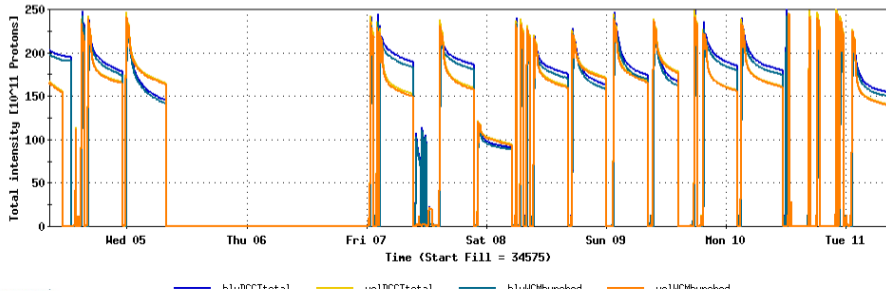
Kiel Hock

June 18, 2024

# Last Week at RHIC

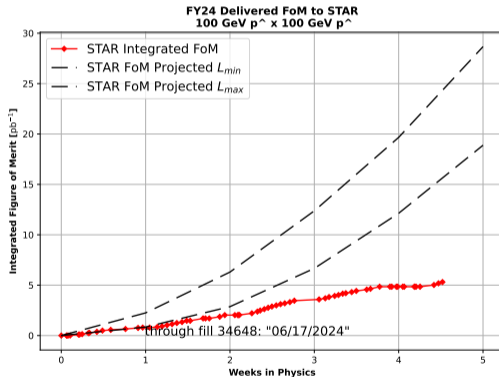
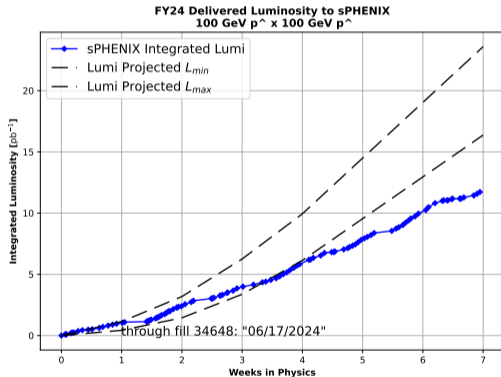


RHIC Beam Intensity



# RHIC status and Lumi Projections

111x111 physics running since 4/30. Preliminary luminosity accounting



# RHIC Status

- physics running with up to  $2.0 \times 10^{11}$ /bunch at store
- RHIC has been ODH1 for the last week, requiring additional work planning and PPE for entrance
- Maintenance Thursday, 6/20
- cold snake has increase heat load
  - ▶ unpolarized protons used Wednesday-Saturday.
  - ▶ limited polarization optimizations to maintain helium reserves

## Friday

- QLI from y12-dh0-ps voltage dip caused QLI, rezeroed 12a-qd2 quench bucket
- y6-q89-ps replacement
- y10-qd-psw, AC-DC converted for main contactor replaced

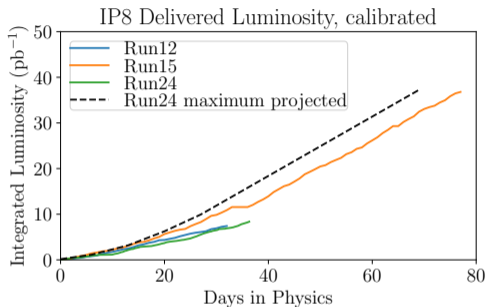
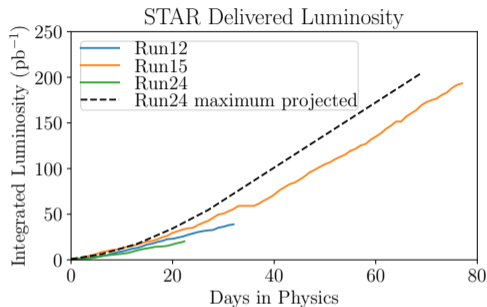
## Saturday high beam losses on b6-lm3.2

- H-jet bump collapse timing change resulted in collisions at IP12 from orbit overshoot when going to goal

## Sunday

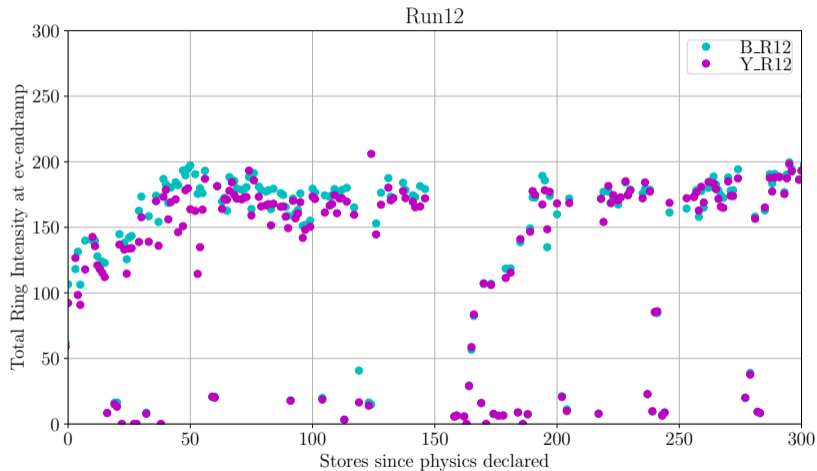
- correctors in alcove 5c tripped due to a bad relay on blue interlock system

# Comparison with previous runs

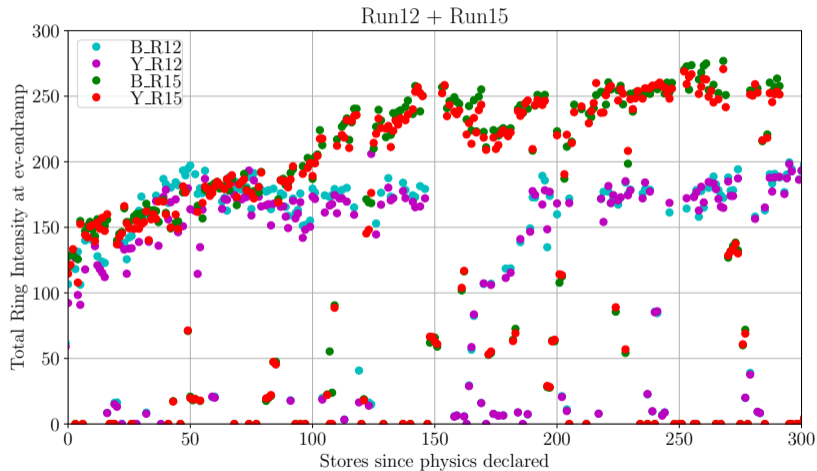


Run15 and Run12 scaled based off of emittances and calculated crossing angle  
A factor of 2 improvement would put STAR at the projected Luminosity/day  
sPHENIX needs  $\sim 60\%$  increase

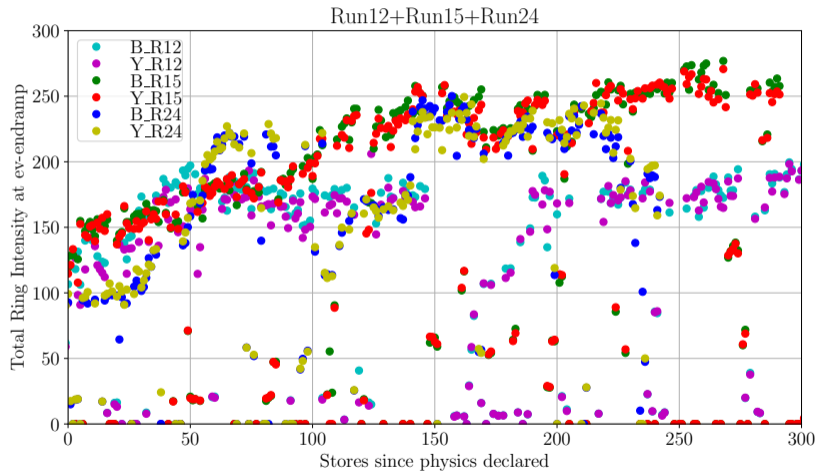
# Comparison with previous runs, Intensity



# Comparison with previous runs, Intensity

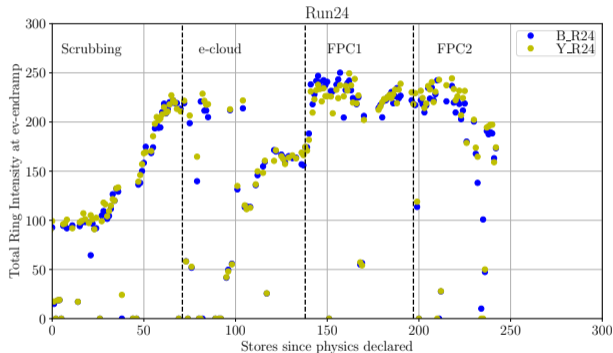


# Comparison with previous runs, Intensity



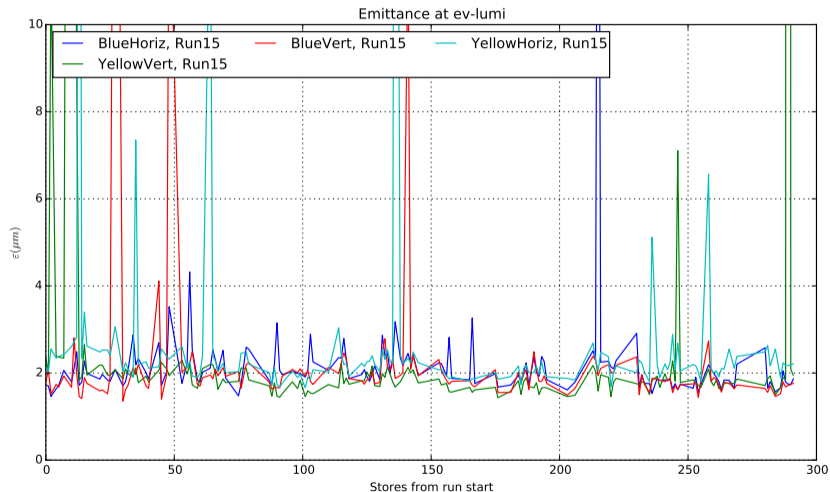


# Intensity comparison

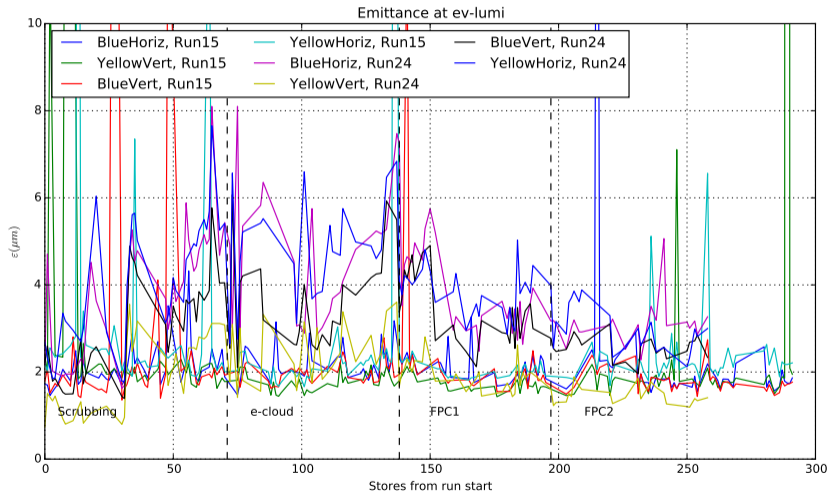


- Current intensities are near Run15 levels, exceeding Run12 levels
- Periods of low intensity to address different issues such as vacuum scrubbing, electron cloud formation
- Current taper in intensity from blm at end of rotator ramp

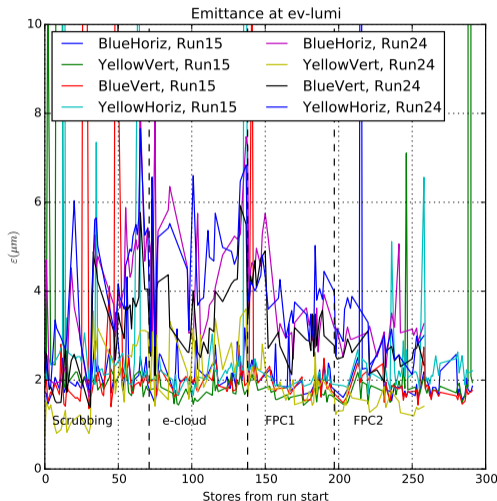
# Comparison with previous runs, Emittance



# Comparison with previous runs, Emittance



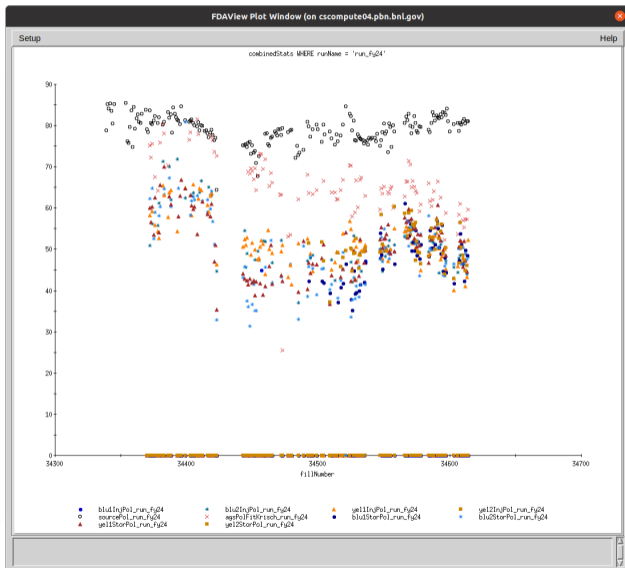
# Emittance comparison



A large intensity-dependent emittance growth was observed which has now been resolved

- initially degraded vacuum due to newly installed components was suspected
  - ▶ vacuum scrubbing reduced vacuum response from beam to nominal levels
- second, electron cloud formation as a result of non-coated pipes for newly installed components
  - ▶ reduced number of bunches alleviated emittance growth, minimal other signatures of electron cloud formation
- Beam driving higher order modes in the 56 MHz leading to transverse emittance growth
  - ▶ FPC1+2 full inserted to provide maximum damping

# Polarization Performance



- Polarized source stability suffered early on due to contamination in the He cell
- Large emittance-dependant drop in RHIC polarization transmission prior to resolution of 56 MHz
- Current downward trend correlated with reduced polarization in the AGS
- Following adjustments to the new blue snake, yellow:blue polarization now within 3%, previously 10%.

# Performance for sPHENIX only, no polarization

Beam-beam parameter for 1 IP with a crossing angle of 2 mrad is approximately half of the head-on case.

- Operating sPHENIX at a crossing angle only and assuming we are currently operating near the beam-beam limit,  $4e11$  protons/bunch could be collided
- These intensities are not possible to deliver
- $3e11$  protons/bunch would be a 2.3x increase to delivered luminosity
- For reliable running, RHIC needs to be well-tuned to avoid any losses

Pros of polarization

- Optimized polarization performance translates to better emittances and better luminosity

Cons of polarization

- More equipment that can fail
- frequent issues with OPPIS (earlier in the run) and ongoing issues with the cold snake require frequent switching between injector setups
- rotator ramp doubles store-to-store time

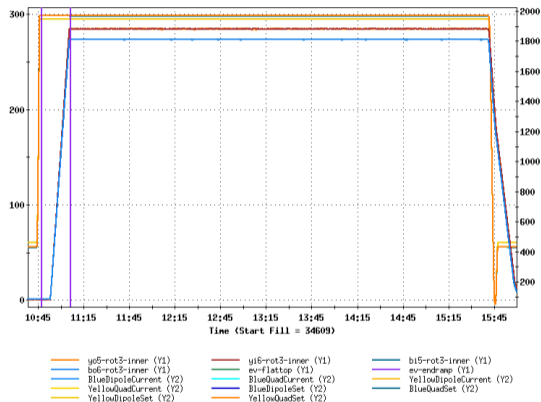
# Performance for STAR only

STAR is already operating with head-on collisions

- Assuming current operation near the beam-beam limit, RHIC may be able to achieve  $3e11$ , a 2.3x increase to delivered luminosity
- RHIC would need to be well-tuned to avoid any losses

# Impact of the rotator ramp

Process	Duration (minutes)
Filling RHIC	16.0
Energy Ramp	3.2
Rebucketing	1.0
Polarization Meas.	2.0
Rotator Ramp	13.1
Storage Ramp	0.5
Ramp to injection	6.3
Rotator Ramp down	19.0
<b>Total w/ Rotators</b>	<b>54.3</b>
<b>Total w/o Rotators</b>	<b>29.0</b>

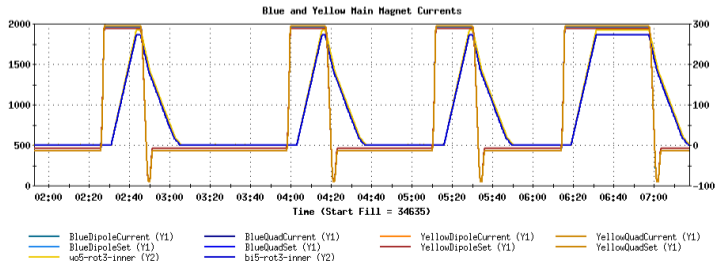
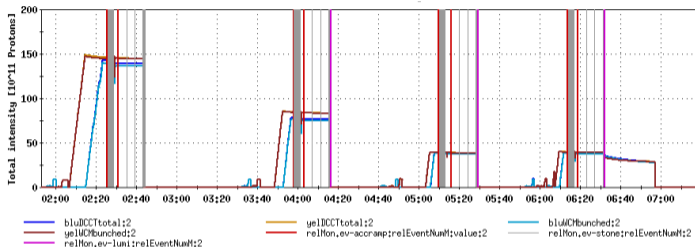


Rotators result in a 90% increase in store to store time

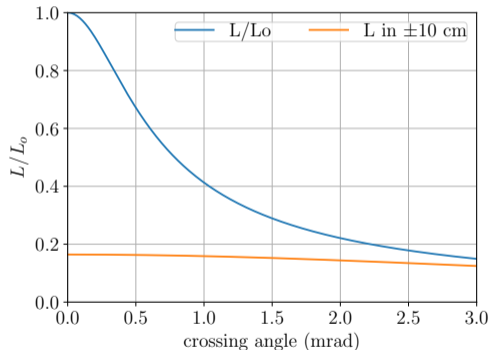


# Impact of the rotator ramp, II

## Impact on troubleshooting and diagnostics doubles with rotator ramps



# sPHENIX without xing angle – what can we give STAR without impacting sPHENIX



- sPHENIX crossing angle implemented for beam-beam suppression and to maximize collisions within  $\pm 10$  cm.
- 4.5x increase in luminosity if going to head-on and looking at the full luminosity distribution
- IR8 D0 polarity will need to be switched back to nominal for head-on collisions (4 hours on maintenance day)

## sPHENIX without xing angle – what can we give STAR without impacting sPHENIX, II

1. Current configuration but reversed with sPHENIX head-on and STAR with large crossing angle
2. sPHENIX in collisions at start of store, STAR at collisions for part of store

Machine development today to study effects from collisions at IP6 and IP8