

RHIC Run16 Availability/Reliability

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RHIC Retreat
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U.S. DEPARTMENT OF
ENERGY

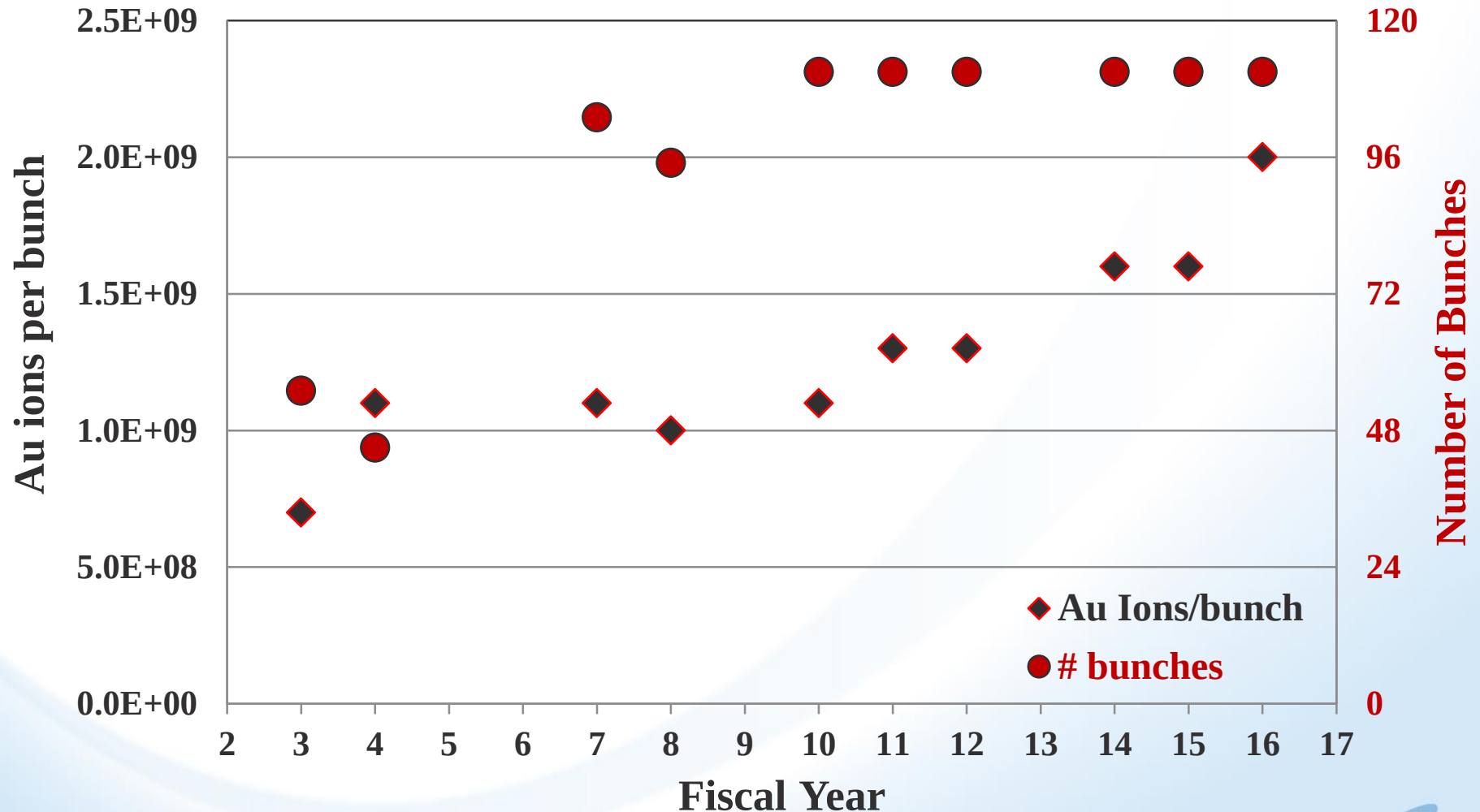
Office of
Science

This Presentation

- Charts, Charts, and more boring charts.
- Availability
 - Run16 Availability
 - RHIC Availability history from Run-2
- “Major” System Reliability

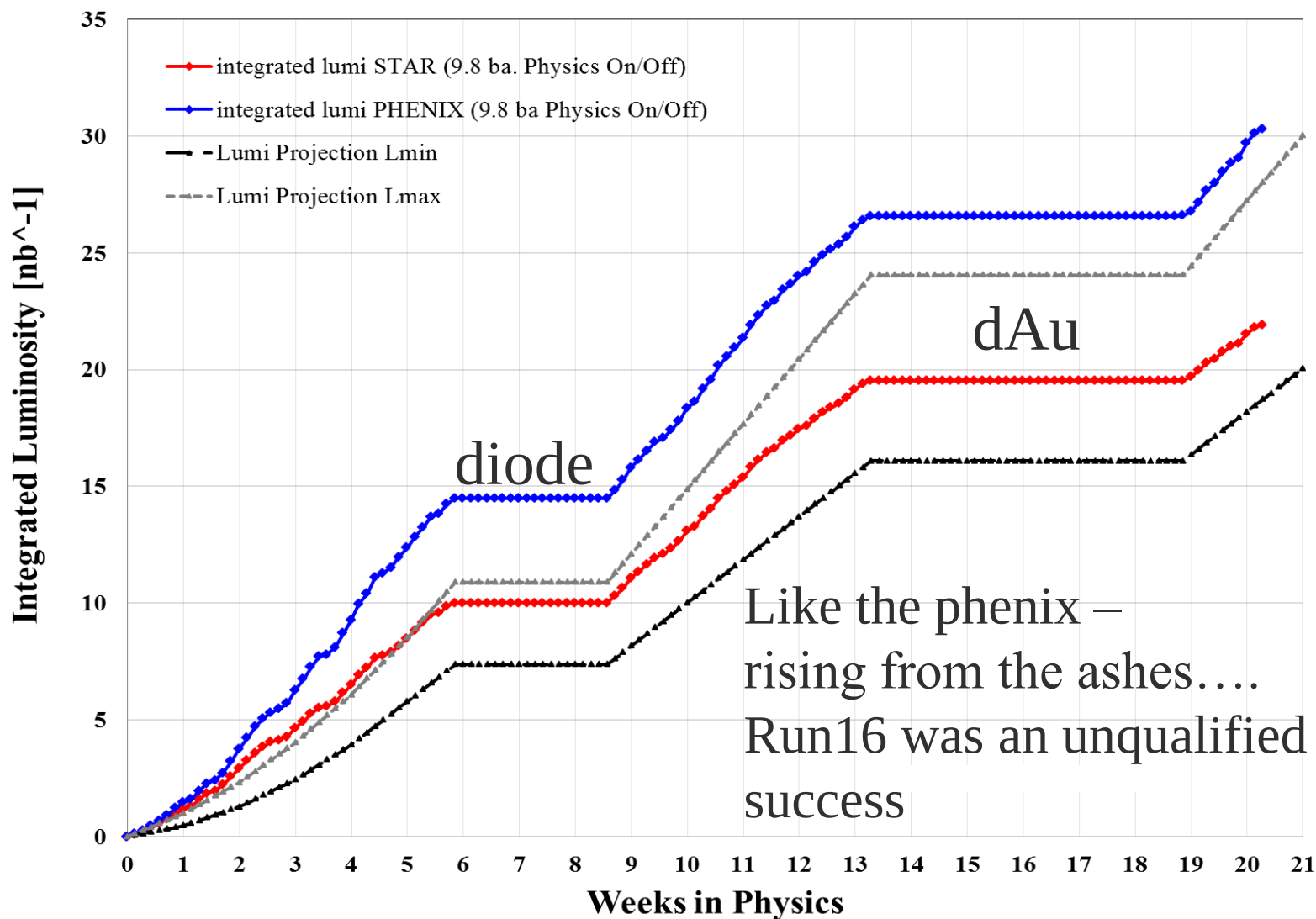
The Bottom Line

Increased circulating beam current... Au Ion per bunch evolution



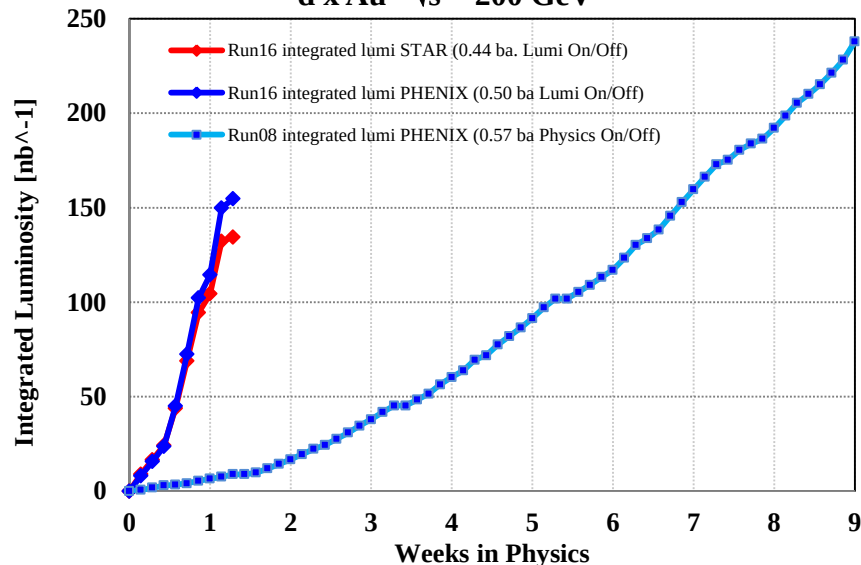
Run16 Delivered Luminosity

Au x Au $\sqrt{s} = 200$ GeV

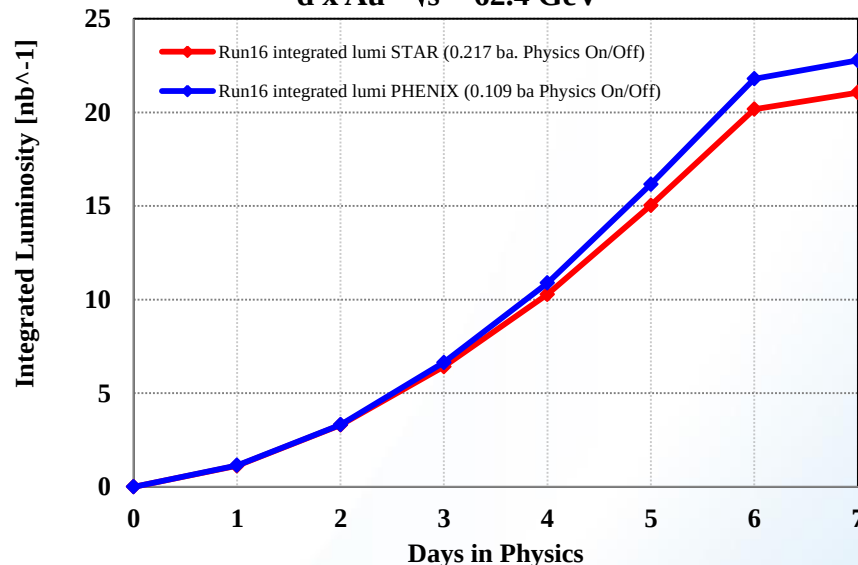


Run16 deuteron Gold Operations

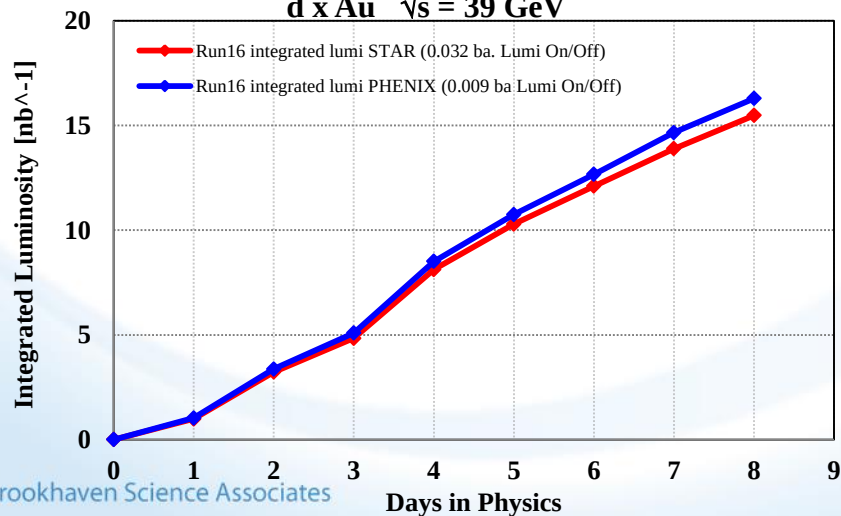
Run16 vs Run08 Delivered Luminosity
d x Au $\sqrt{s} = 200$ GeV



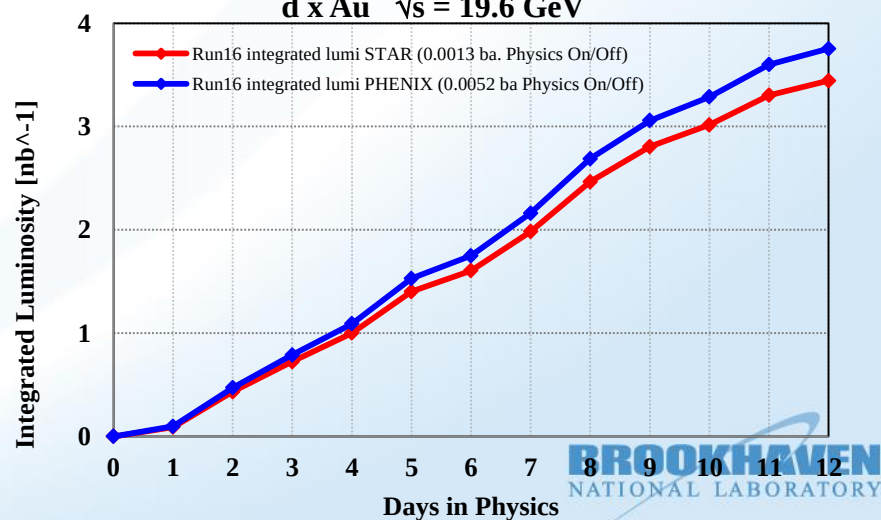
Run16 Delivered Luminosity
d x Au $\sqrt{s} = 62.4$ GeV



Run16 Delivered Luminosity
d x Au $\sqrt{s} = 39$ GeV

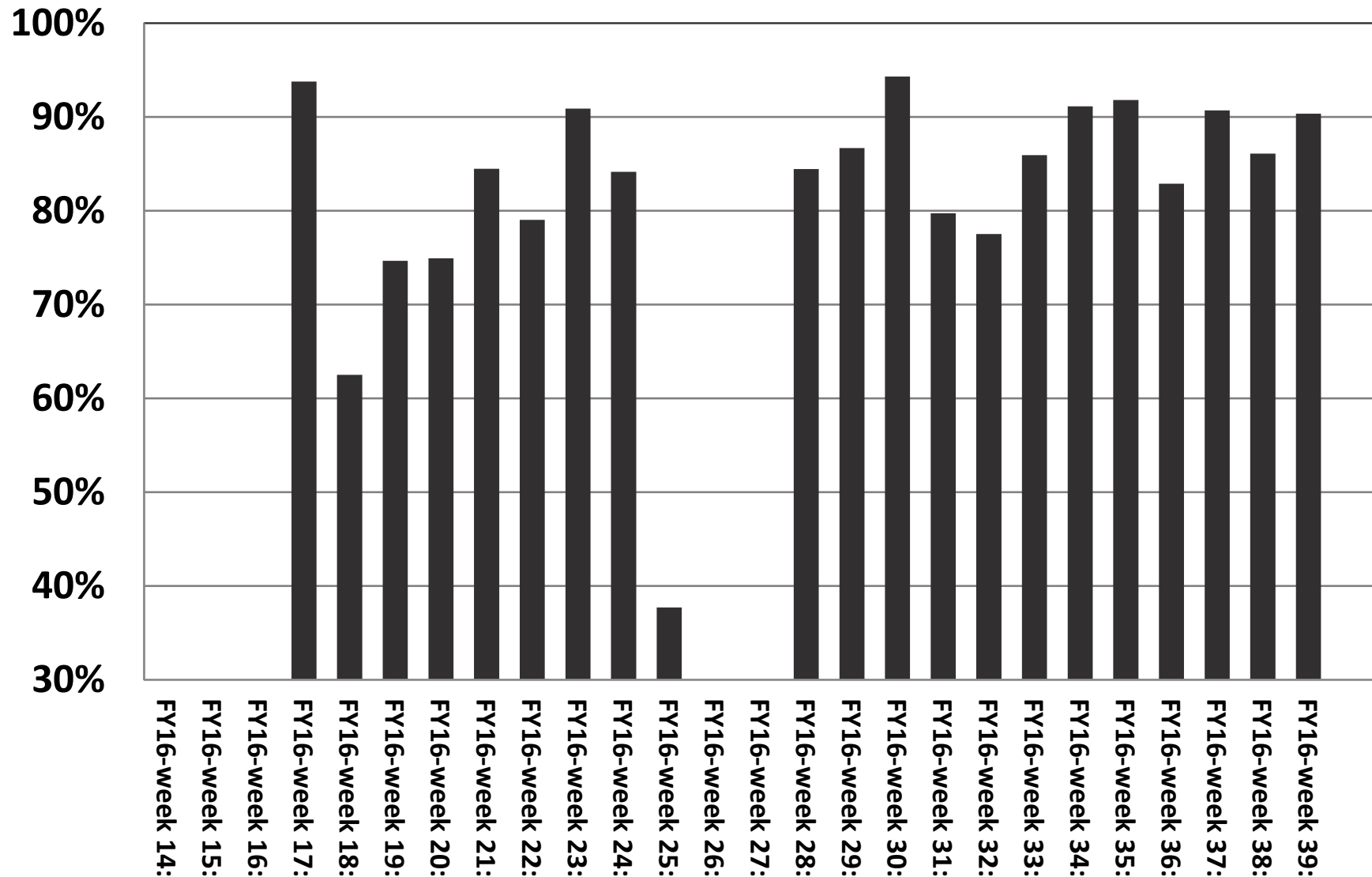


Run16 Delivered Luminosity
d x Au $\sqrt{s} = 19.6$ GeV



Availability

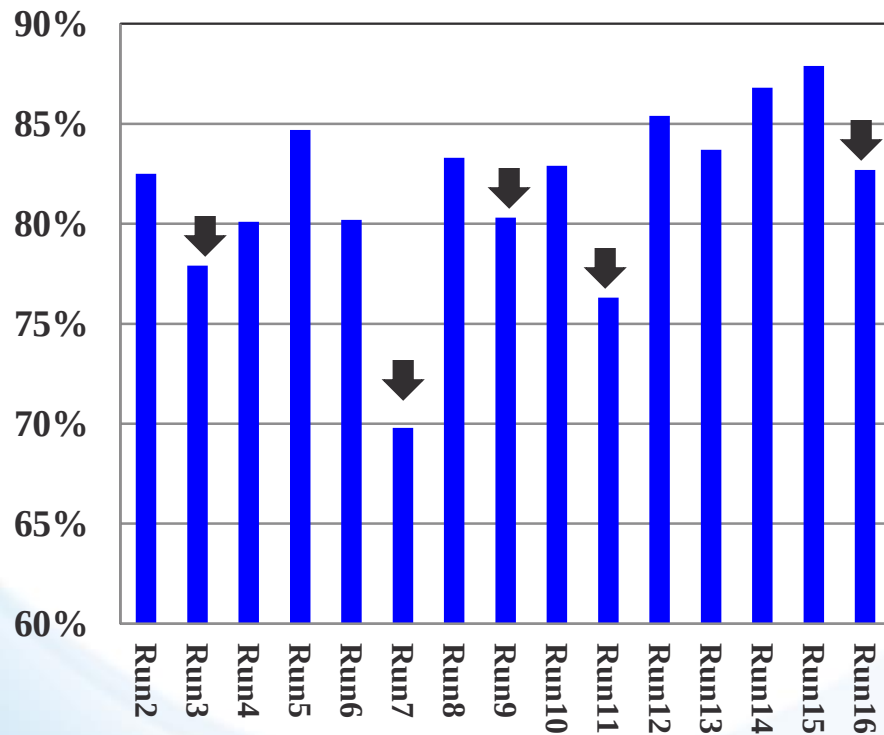
Run16 availability 83%



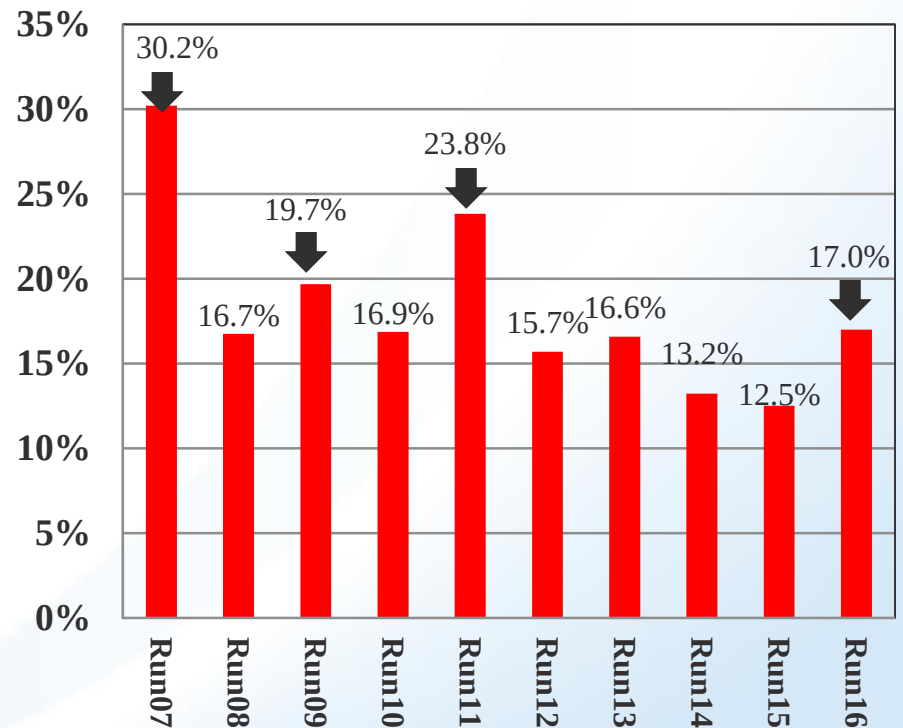
RHIC Availability History

Given Run16 Misfortunes – no surprise it ranks fifth worst run by “Availability”

RHIC Availability by Run [%]

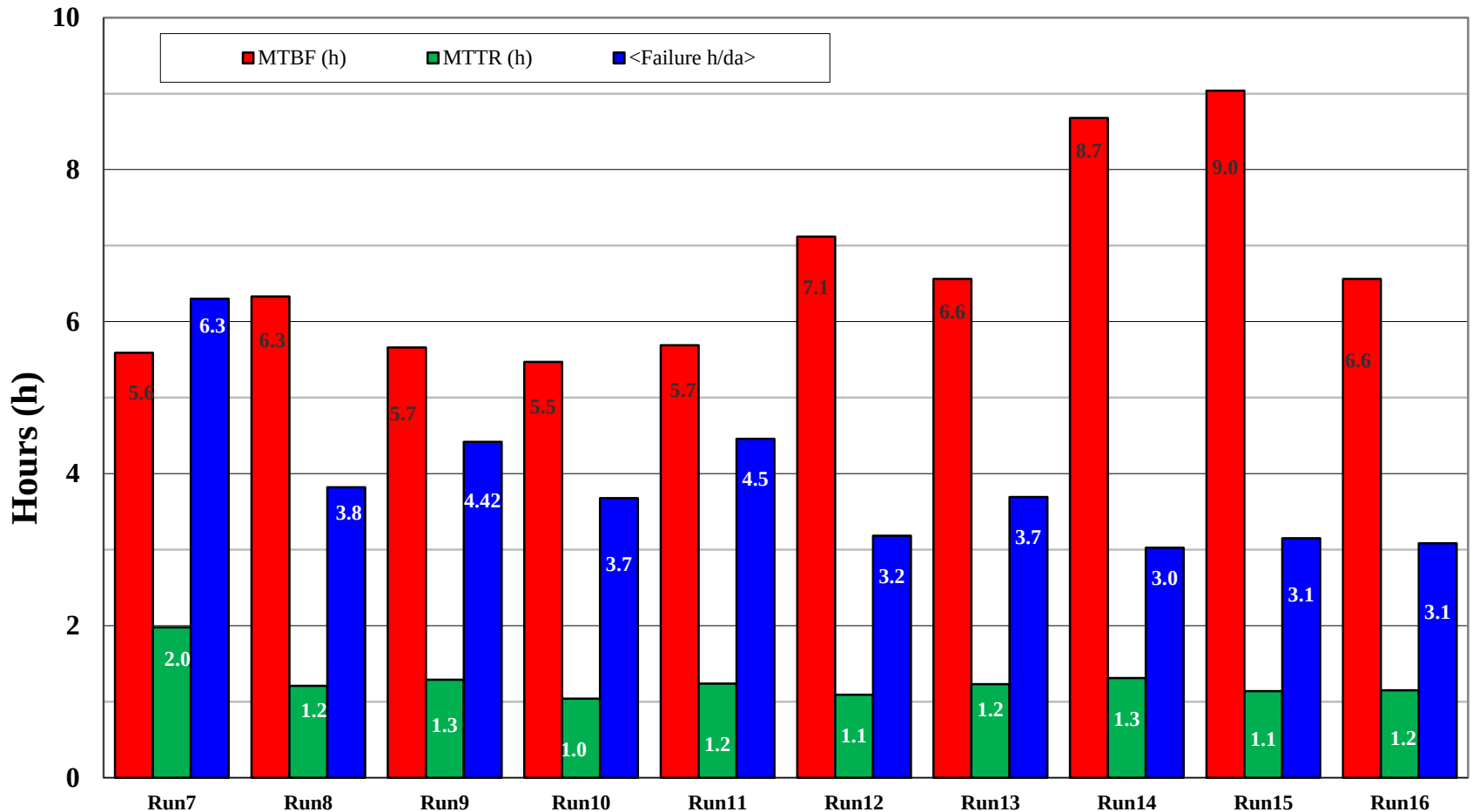


Failure as % Scheduled Ops



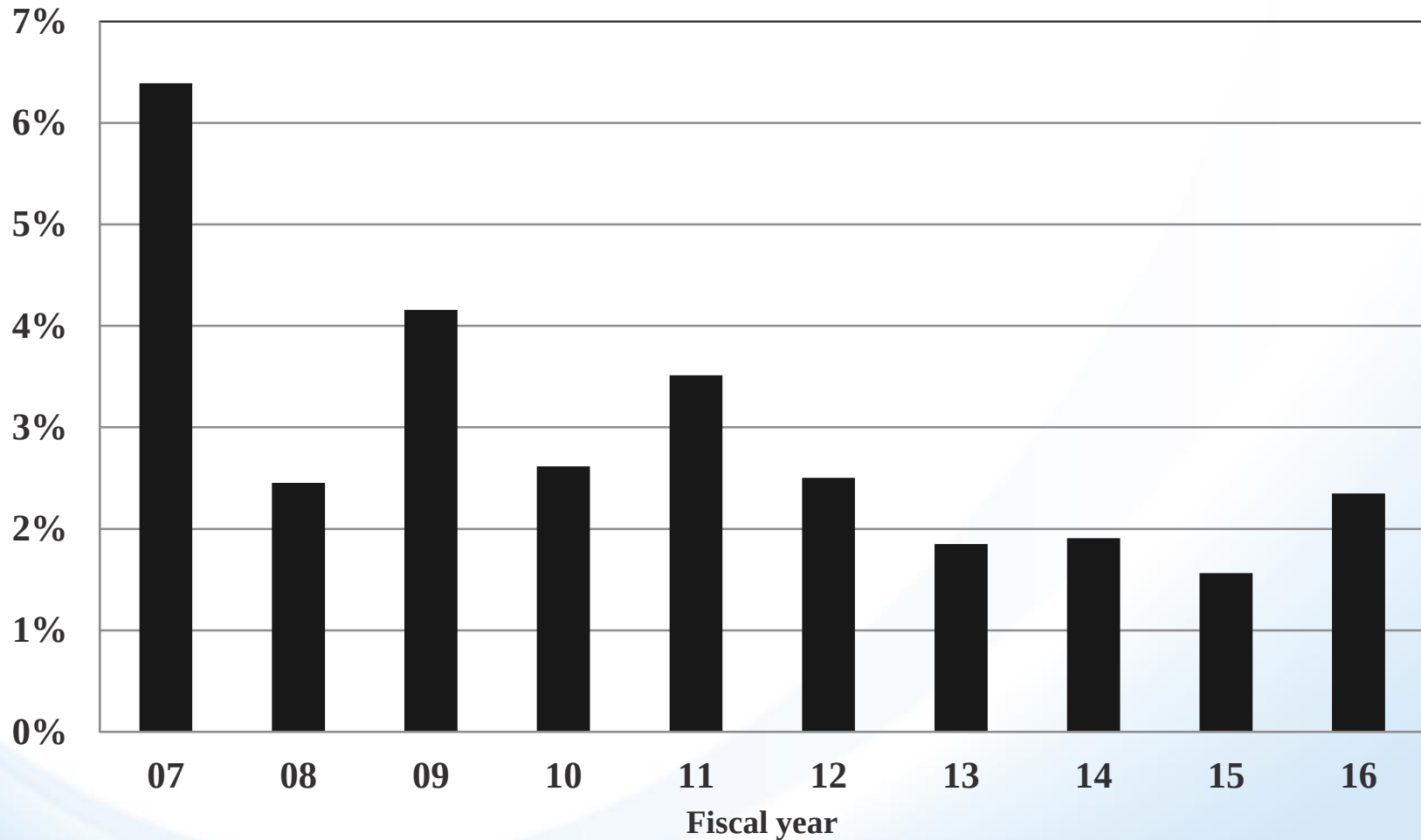
RHIC + Injectors

MTBF, MTTR, <Failure hours/da>



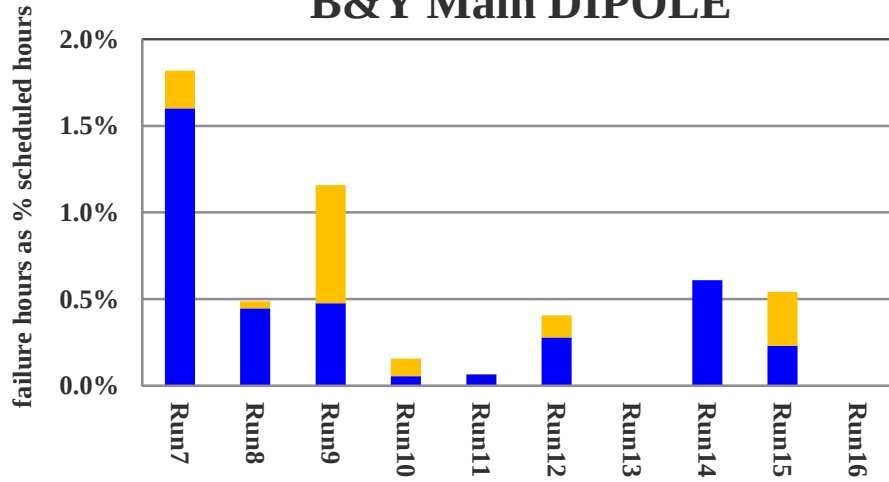
Systems Reliability

RHIC Power Supplies – failure as % Scheduled Ops

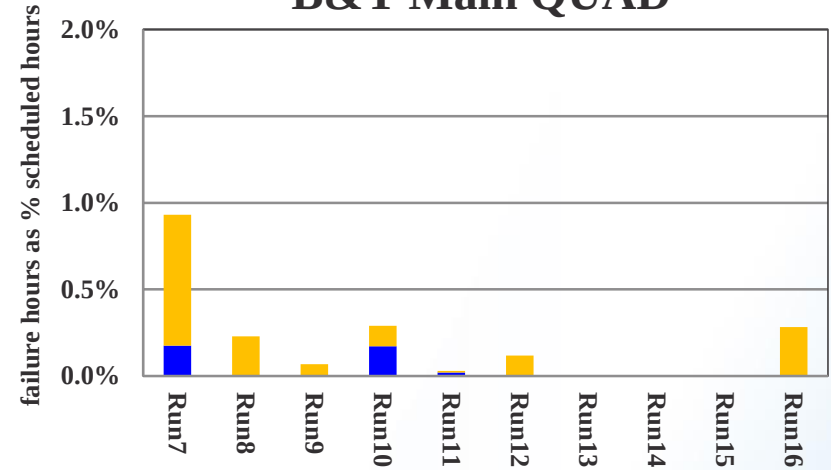


RHIC Power Supplies – failure as % Scheduled Ops

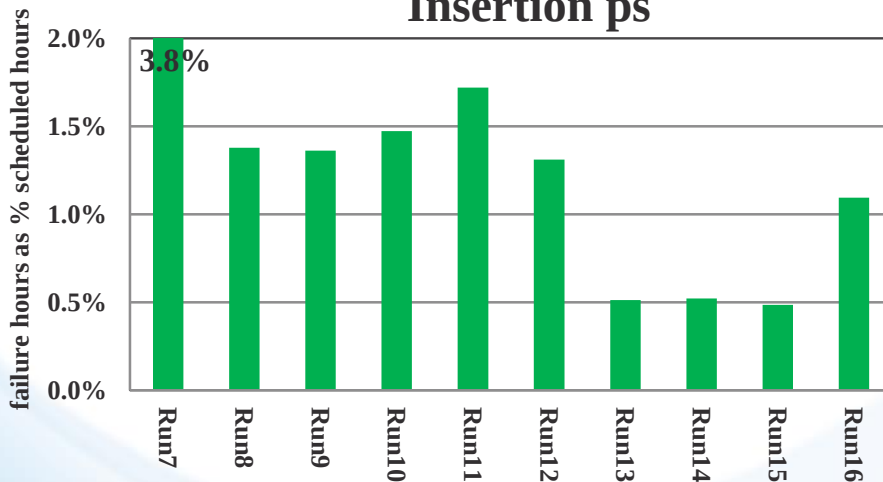
B&Y Main DIPOLE



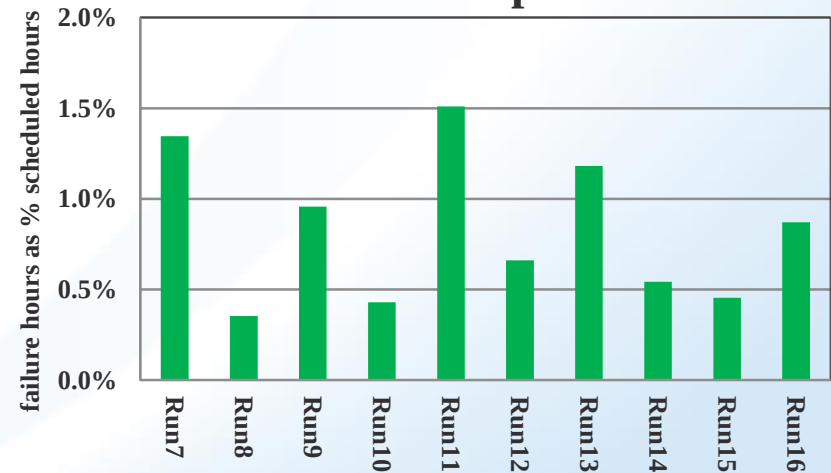
B&Y Main QUAD



Insertion ps



Corrector ps

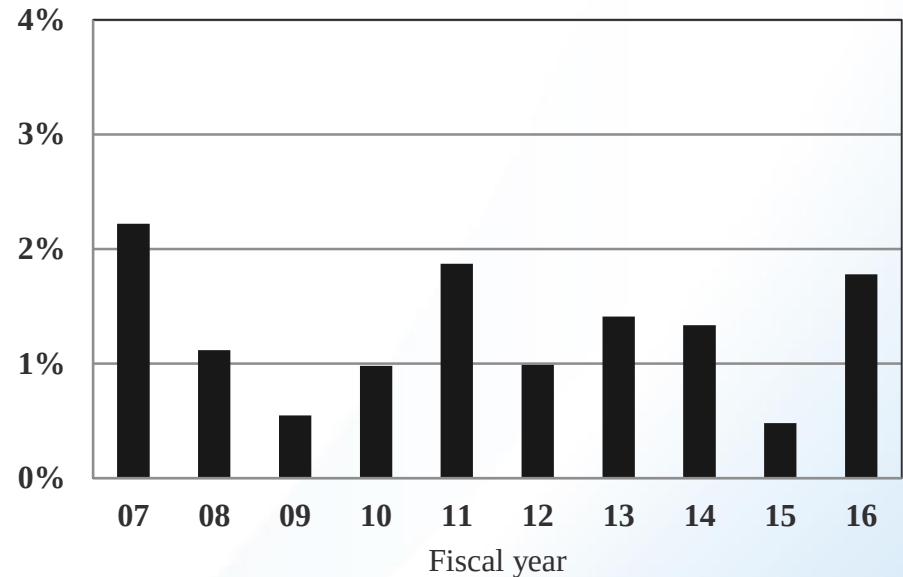


Intensity Challenge – RHIC Rf

Run16

- Plagued by trips of storage cavities – beam loading. Cavity performance did not keep pace with per bunch intensity increase.
- Group focus was on SRF (56 MHz & CeCPoP 704MHz), LINACRf, LLRf.
- Lost focus – forgot to condition cavities after 19 day diode replacement outage.

RHIC Rf System Failures
% of Scheduled Ops

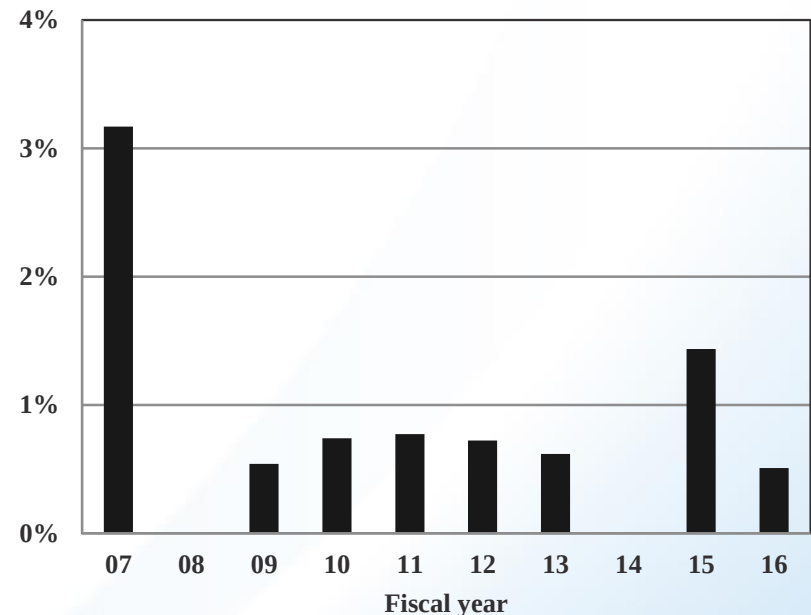


	197MHz trips	197 MHz downtime (h)	28 MHz trips	28 MHz downtime (h)
Run14	113	19.5	30	8.3
Run16	107	28.6	36	19.6

Intensity Challenge — Cryogenics

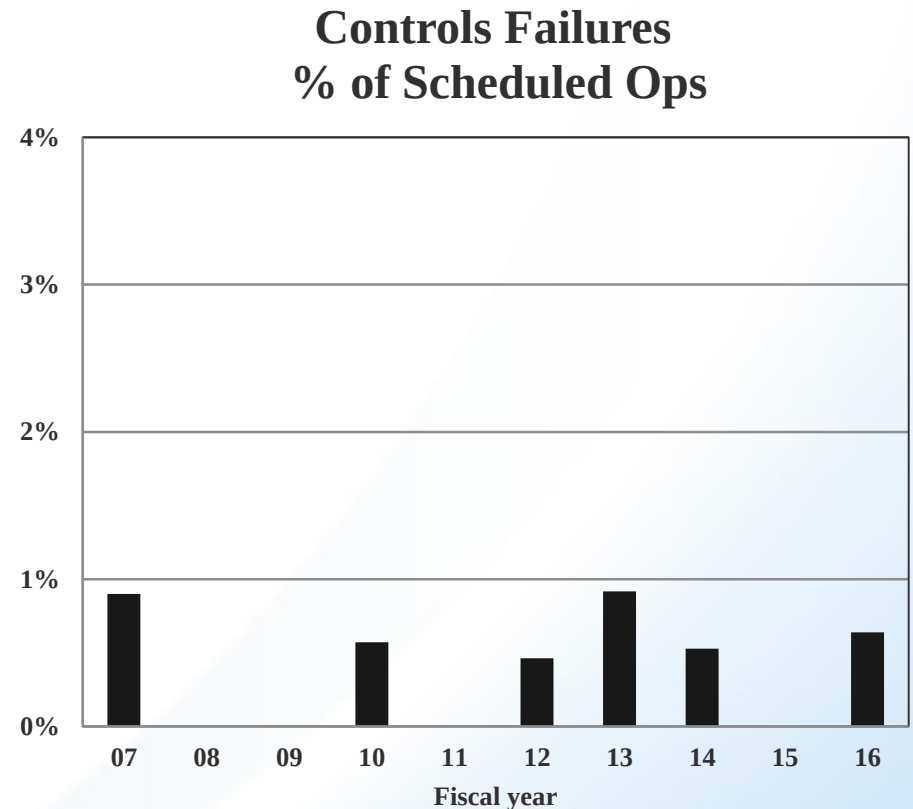
- To date -- 66% of controls racks moved out of the tunnel per Roberto.
- Rack 11Q21 was “affected” during Run16
 - ~18 Cryo eLog entries
- Rack migration stalled with added workload (ERL, 56MHz, CeC, sPHENIX)

RHIC Cryogenic Failures
% of Scheduled Ops



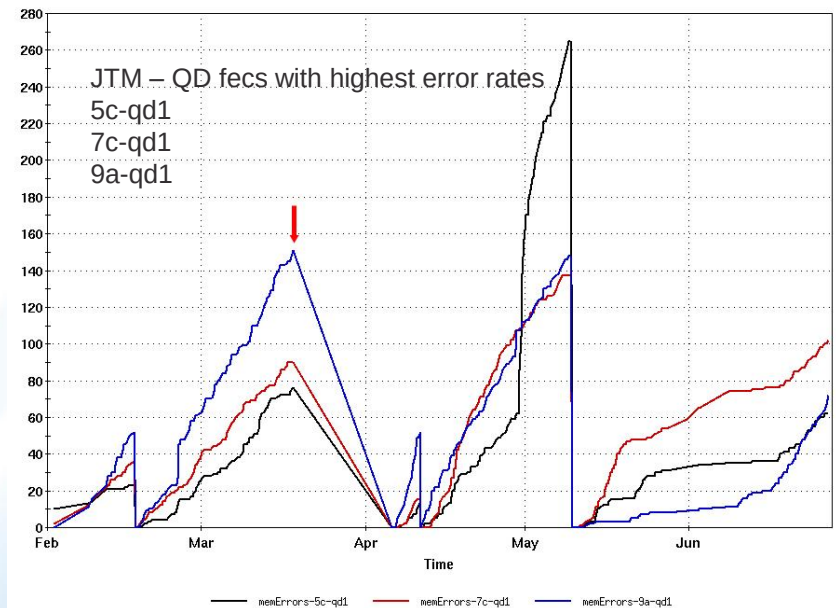
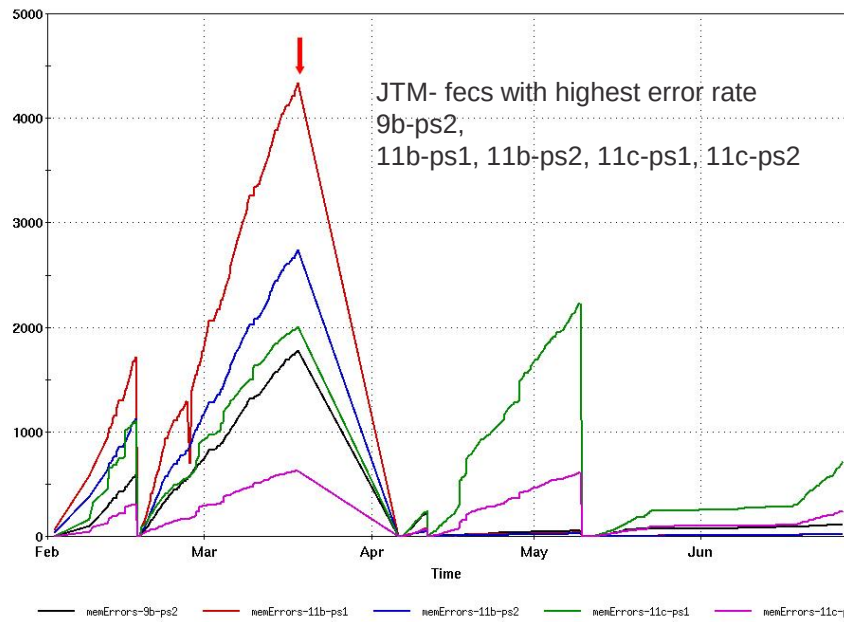
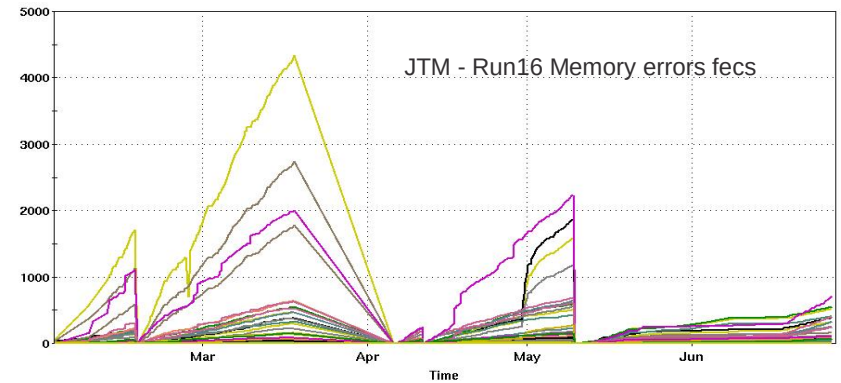
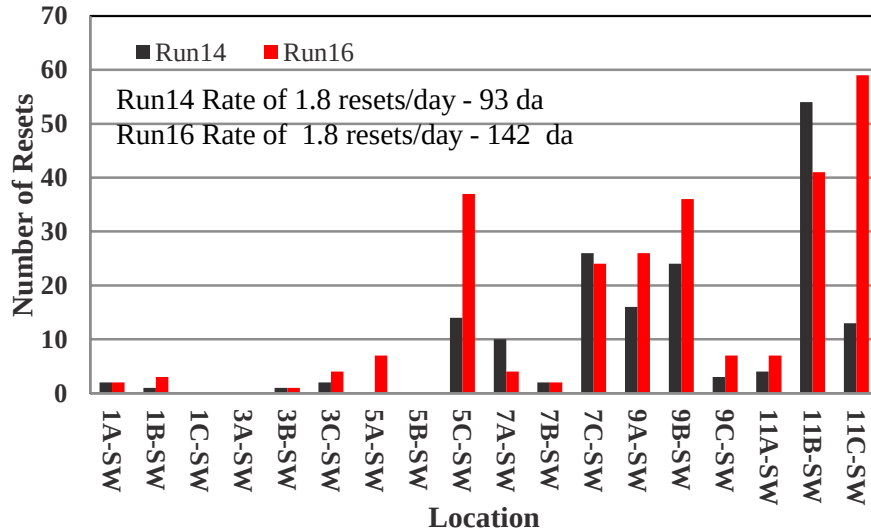
Intensity Challenge – Controls

- In spite of recent front end resets/upsets Controls has historically contributed **LITTLE** in the way of downtime.
- Others, e.g. KAB, JTM, will speak to Run16 Controls challenges



Controls –fec Memory errors “the canary in the coal mine”

Run14 v Run 16 Network Switch Resets by Location -JTM



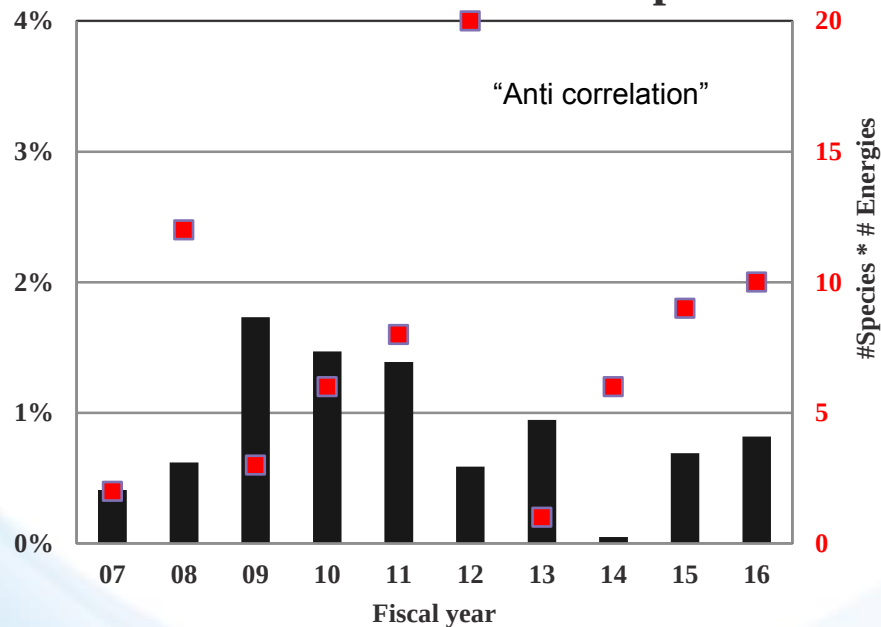
RHIC Runs (Wolfram) in tabular form (“complexity”)

Run(FY)	B species	Y species	E _b [GeV/n]	E _y [GeV/n]		Run (FY)	B species	Y species	E _b [GeV/n]	E _y [GeV/n]
16-1	Au	Au	100	100		9-1A	p ⁺	p ⁺	249.9	249.9
16-2A	d	Au	101.3	99.4		9-1B	p ⁺	p ⁺	100.2	100.2
16-2B	d	Au	31.3	31.1		9-1C	p ⁺	p ⁺	100.2	100.2
16-2C	d	Au	9.8	9.8		8-1	d	Au	100.7	100
16-2D	d	Au	19.6	19.4		8-2	p ⁺	p ⁺	100.2	100.2
15-1	p ⁺	p ⁺	100.2	100.2		8-3A	Au	Au	4.6	4.6
15-2	Au	p ⁺	103.36	97.37		8-3B	Au	Au	2.5	2.5
15-3	p ⁺	Al	103.36	98.64		7-A	Au	Au	100	100
14-1A	Au	Au	7.3	7.3		7-B	Au	Au	4.6	4.6
14-1B	Au	Au	100	100		6-1A	p ⁺	p ⁺	100.2	100.2
14-2	³ He	Au	103.9	100		6-1B	p ⁺	p ⁺	11.25	11.25
13	p ⁺	p ⁺	254.9	254.9		6-1C	p ⁺	p ⁺	31.2	31.2
12-1A	p ⁺	p ⁺	100.2	100.2		6-1D	p ⁺	p ⁺	250	250
12-1B	p ⁺	p ⁺	254.9	254.9		5-1A	⁶³ Cu	⁶³ Cu	100	100
12-2	²³⁸ U	²³⁸ U	96.4	96.4		5-1B	⁶³ Cu	⁶³ Cu	31.2	31.2
12-3	⁶³ Cu	Au	99.9	100		5-1C	⁶³ Cu	⁶³ Cu	11.2	11.2
12-4	Au	Au	2.5	2.5		5-2A	p ⁺	p ⁺	100.2	100.2
11-1	p ⁺	p ⁺	249.9	249.9		5-2B	p ⁺	p ⁺	204.9	204.9
11-2A	Au	Au	9.8	9.8		4-1A	Au	Au	100	100
11-2B	Au	Au	100	100		4-1B	Au	Au	31.2	31.2
11-2C	Au	Au	13.5	13.5		4-2	p ⁺	p ⁺	100.2	100.2
10-1A	Au	Au	100	100		3-1	d	Au	100.7	100
10-1B	Au	Au	31.2	31.2		3-2	p ⁺	p ⁺	100.2	100.2
10-1C	Au	Au	19.5	19.5		2-1A	Au	Au	100	100
10-1D	Au	Au	3.85	3.85		2-1B	Au	Au	9.8	9.8
10-1E	Au	Au	5.75	5.75		2-2	p ⁺	p ⁺	100.2	100.2
10-1F	Au	Au	2.5	2.5		1-1A	Au	Au	27.9	27.9
						1-1B	Au	Au	65.2	65.2
						1-2	p ⁺	p ⁺	24.3	25.1

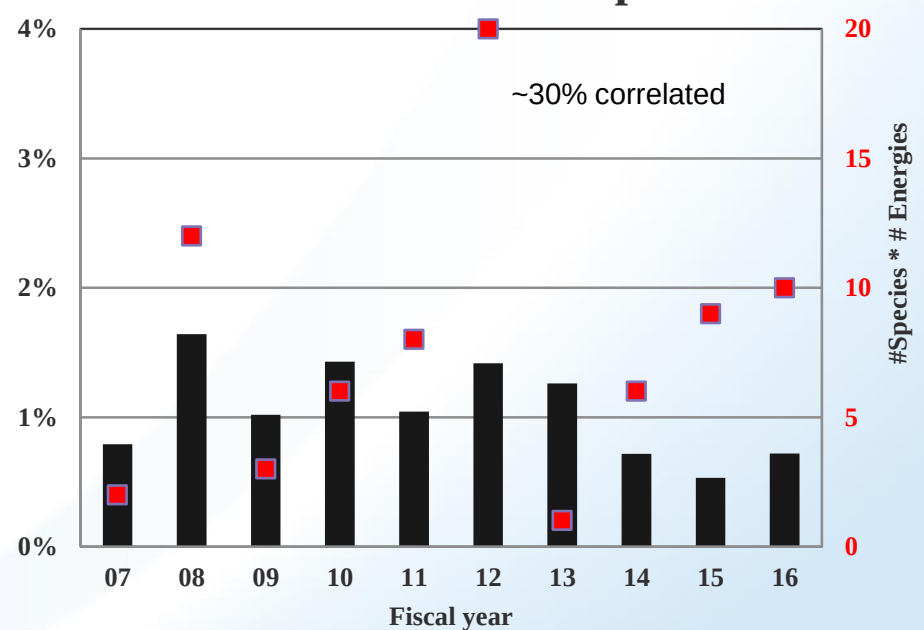
BLM Interlocks & Human Error Correlated with “Run Complexity”?

Run Complexity = (# species * # COM energies)

Rad Monitor Interlocks
% of Scheduled Ops



Human Error
% of Scheduled Ops

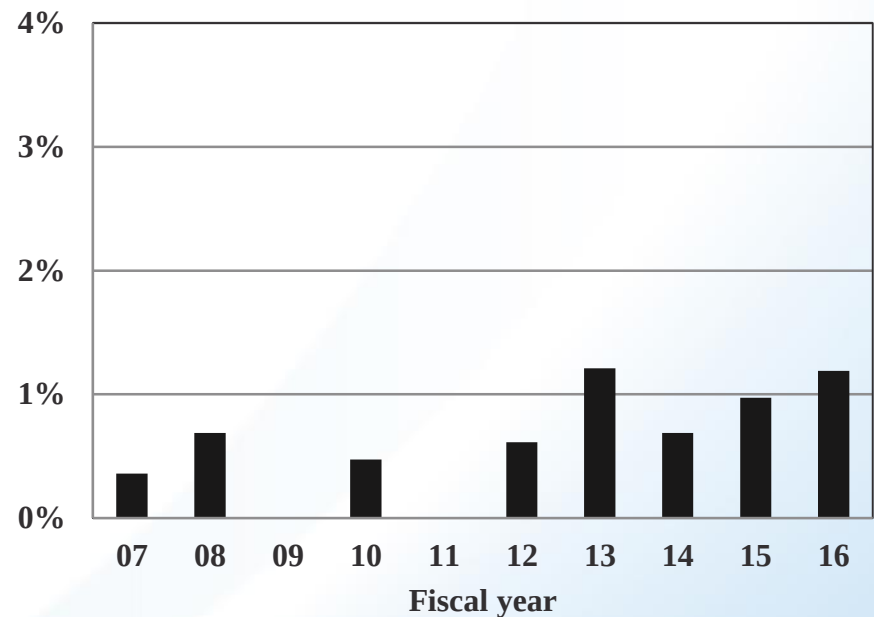


Experiments

CeC contributes to Run16 totals

- Failure as a % of Scheduled Ops
 - STAR 0.4%
 - PHENIX 0.5%
 - CeCPoP 0.3%

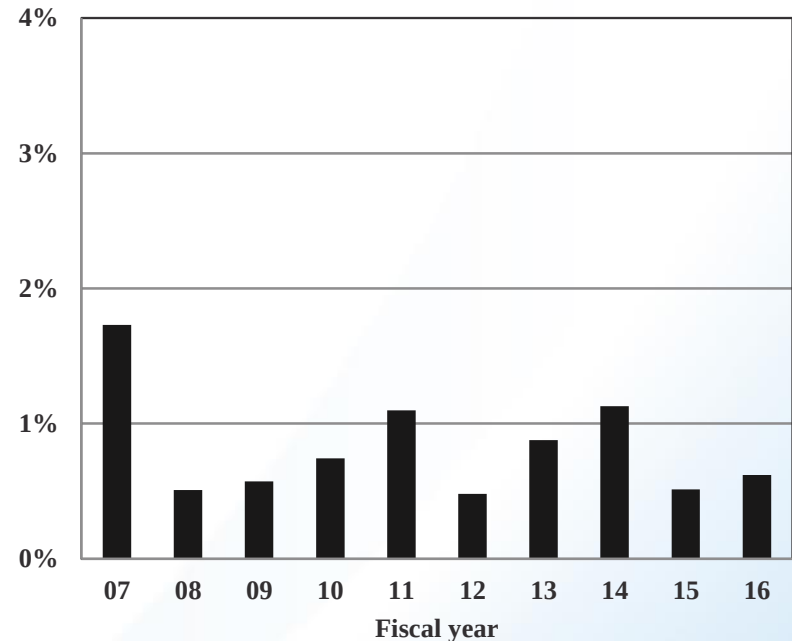
RHIC Experiments
% of Scheduled Ops



Pulsed Power

- Pulsed power equipment does not directly contribute very much to downtime.
- Pulsed power indirect contribution (machine protection work arounds) were significant in Runs 15 (PHENIX) & 16 (Diode)

RHIC Pulsed Power Failures
% of Scheduled Ops



			Summary of Abort Kicker Pre-Fire <15/yr>					KAD		
Ring	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	Totals
Blue	2	11	12	9	2	8	6	1	9	60
Yellow	2	2	8	15	8	14	12	7	4	72

Potential Future Availability Impacts

- Ever Higher per bunch Intensities
 - Machine Protection
 - Experiment protection
 - Rf system and beam loading
- Trying to do too many things...
 - e.g. Rf & Cryogenic groups focused on SRF for new electron machines.
- Electrical Infrastructure – lurking in the background
 - AGS electrical feeders are decades old – Run11
 - AGS first began operation in 1960