Accelerator Reliability

2025 Ops Staytreat

Daniel Moser, Accelerator Operability

Jefferson Lab

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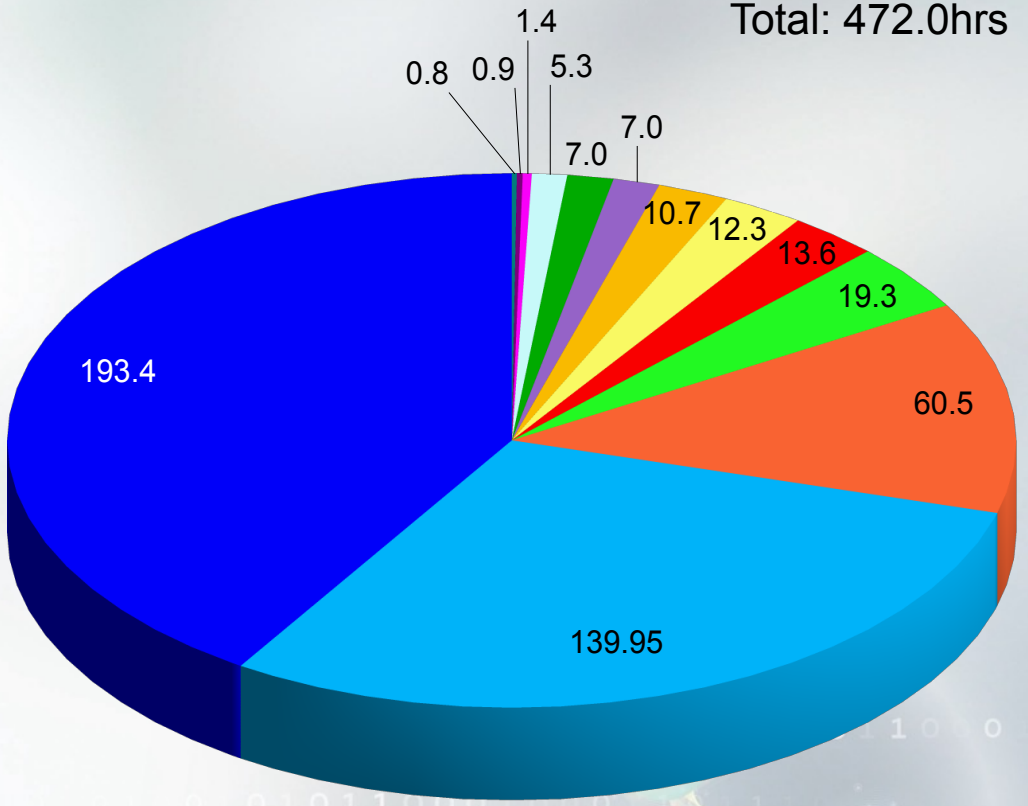
Outline

- Reliability
  - CEBAF 2025 Reliability
  - Reliability vs Maintenance, Emergent Tunnel Openings, Significant Events
  - Reliability Compared to Prior Runs
- Downtime
  - 2025 Downtime Hours
  - Downtime Hours Irrespective of Program Impact vs Downtime Hours that Fully Blocked Program
  - Downtime Hours Compared to Prior Runs
- Correlations
  - RF Trips vs Maintenance, RF Recovery, and Emergent Tunnel Openings
  - Injector Orbit Drifts
  - Running in the Summer
- Upcoming Improvements to Downtime Manager (DTM)

2025 Physics Run (3/19 - 9/3)

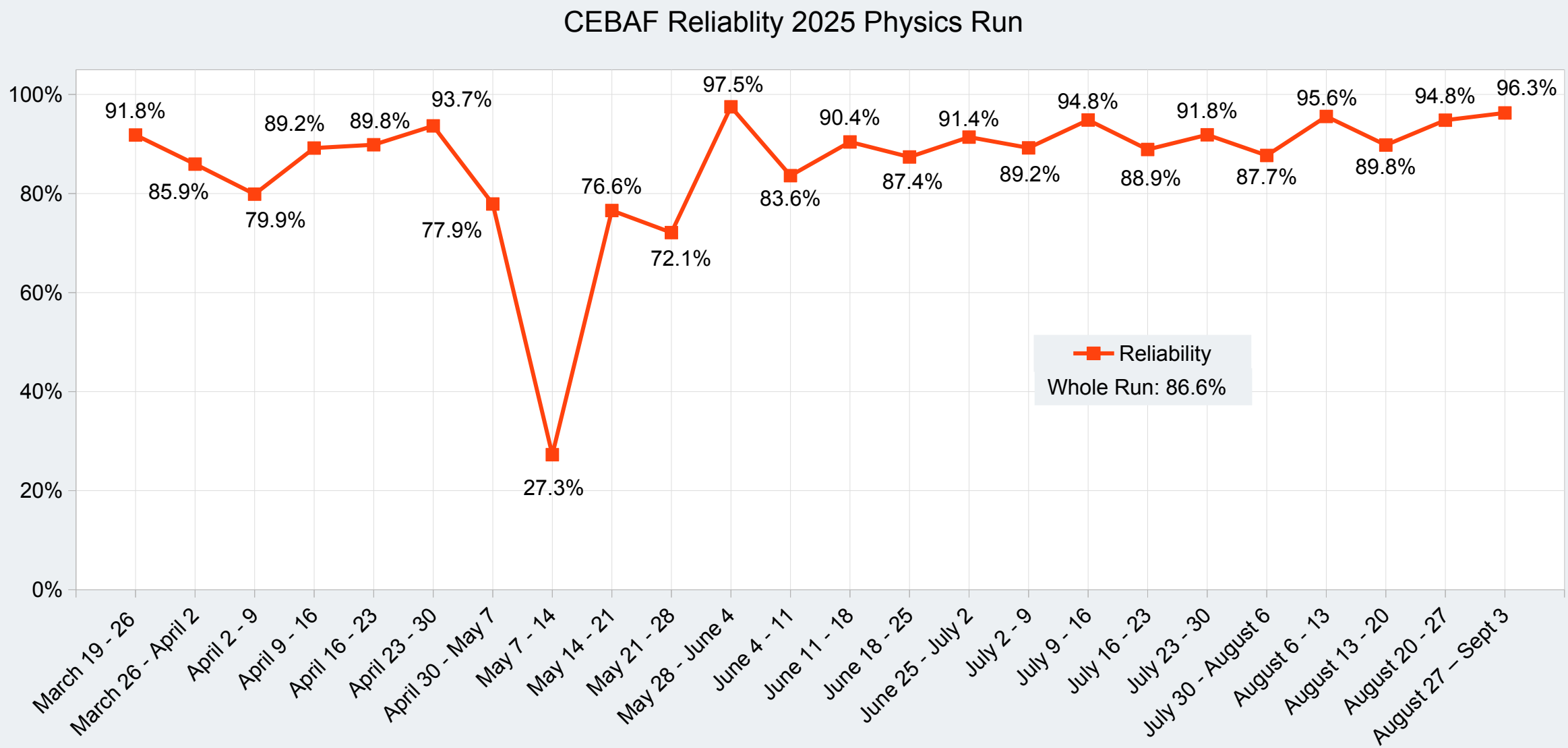
Downtimes that Fully Blocked Program

Total: 472.0hrs

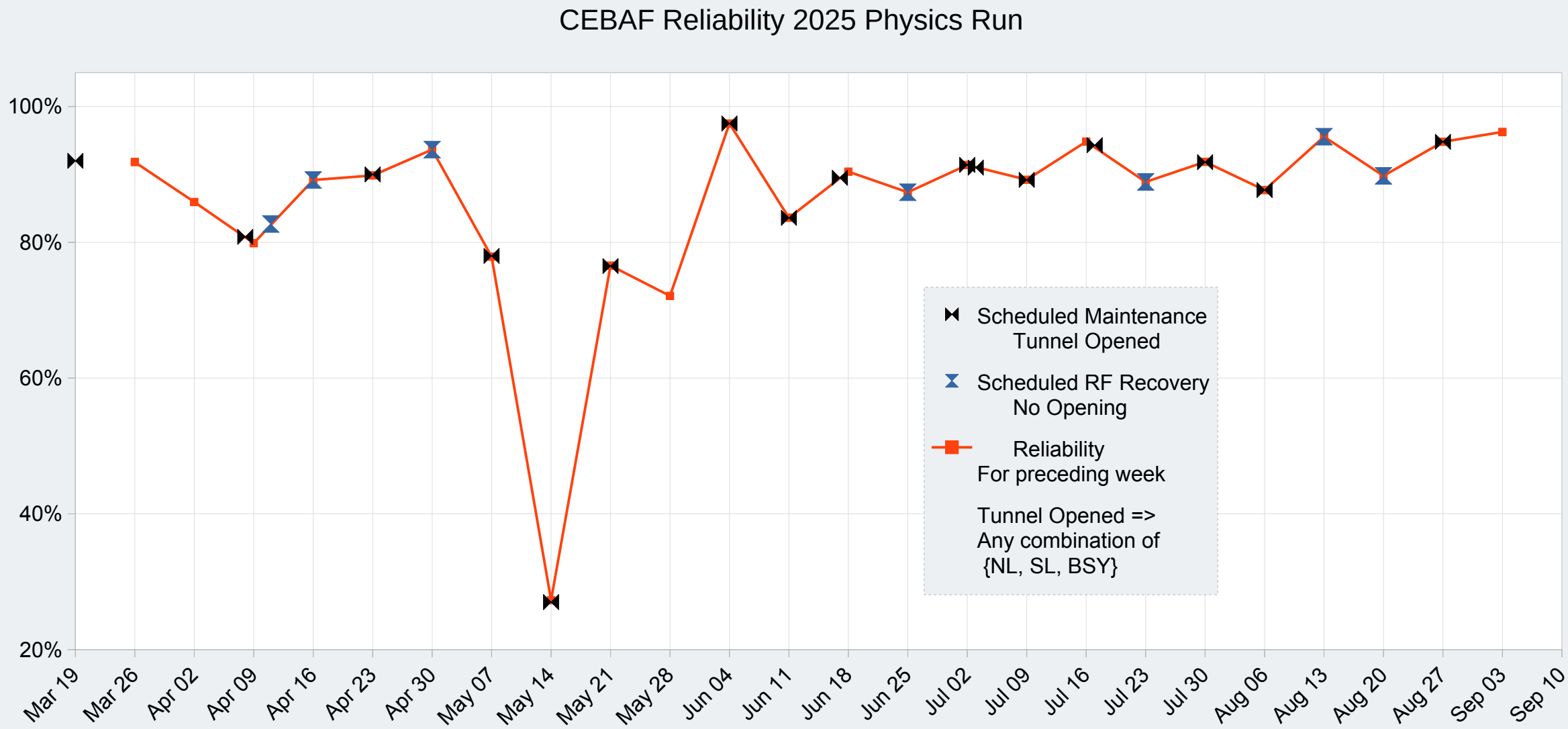


Program Hours: 3728.1hrs

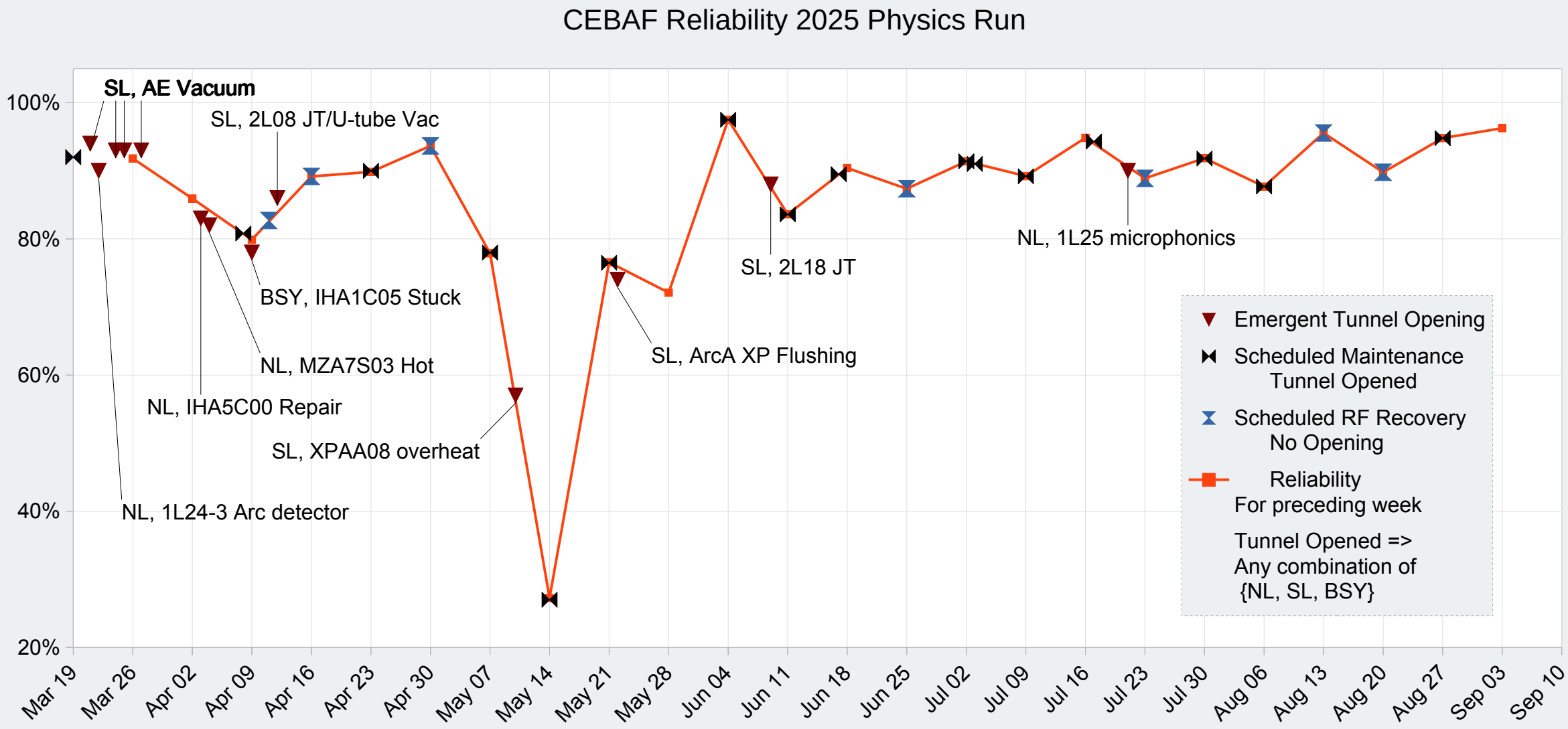
CEBAF Reliability



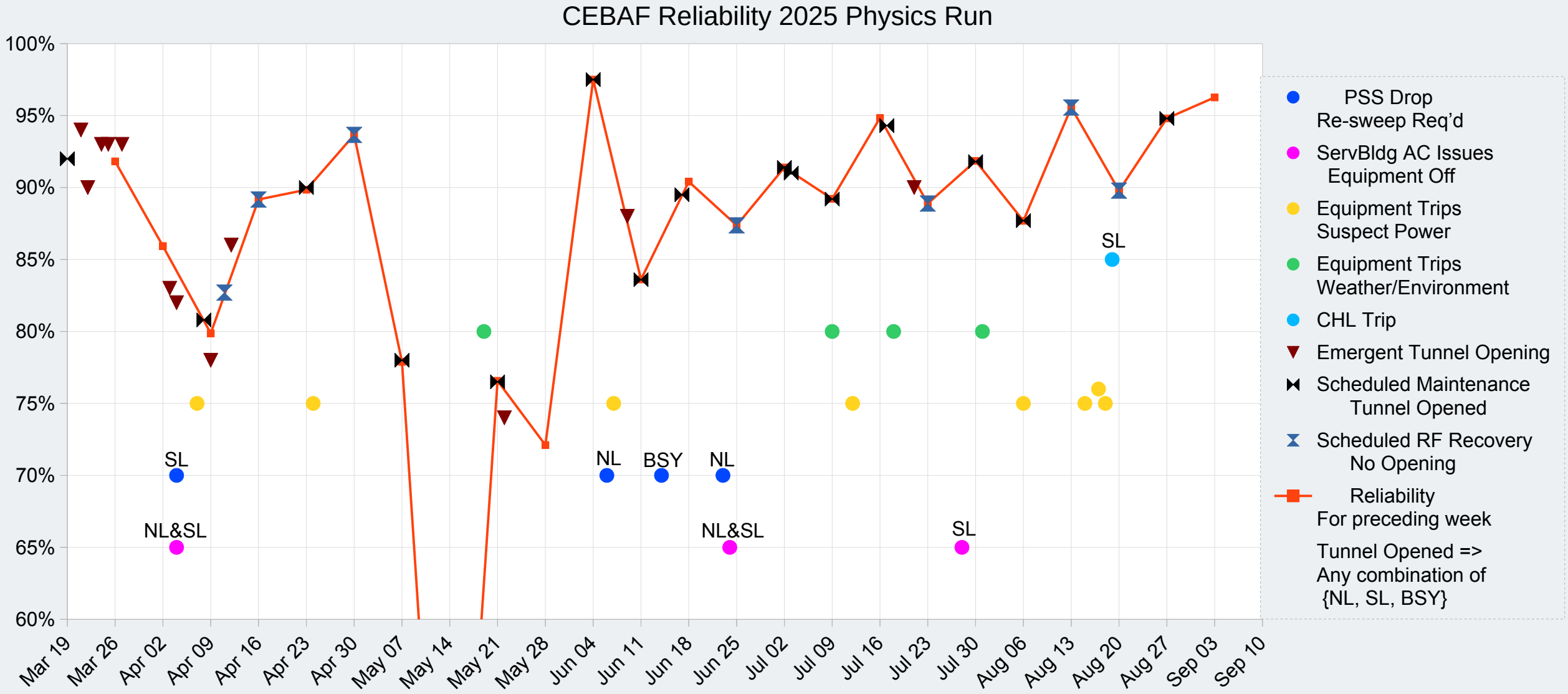
Reliability vs Maintenance



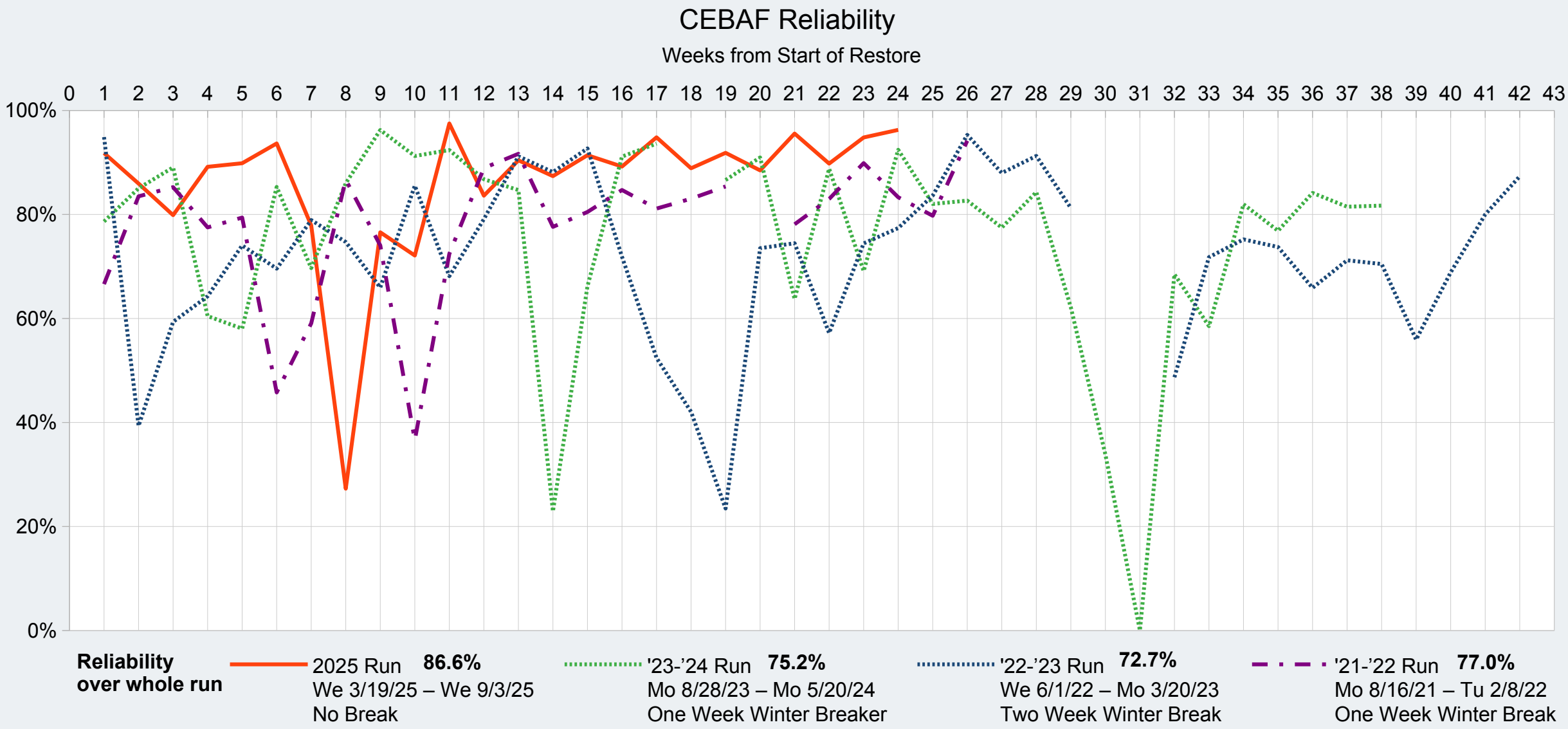
Reliability vs Emergent Openings



Reliability vs Significant Events



Reliability Past Four Runs



Downtime Hours by Category

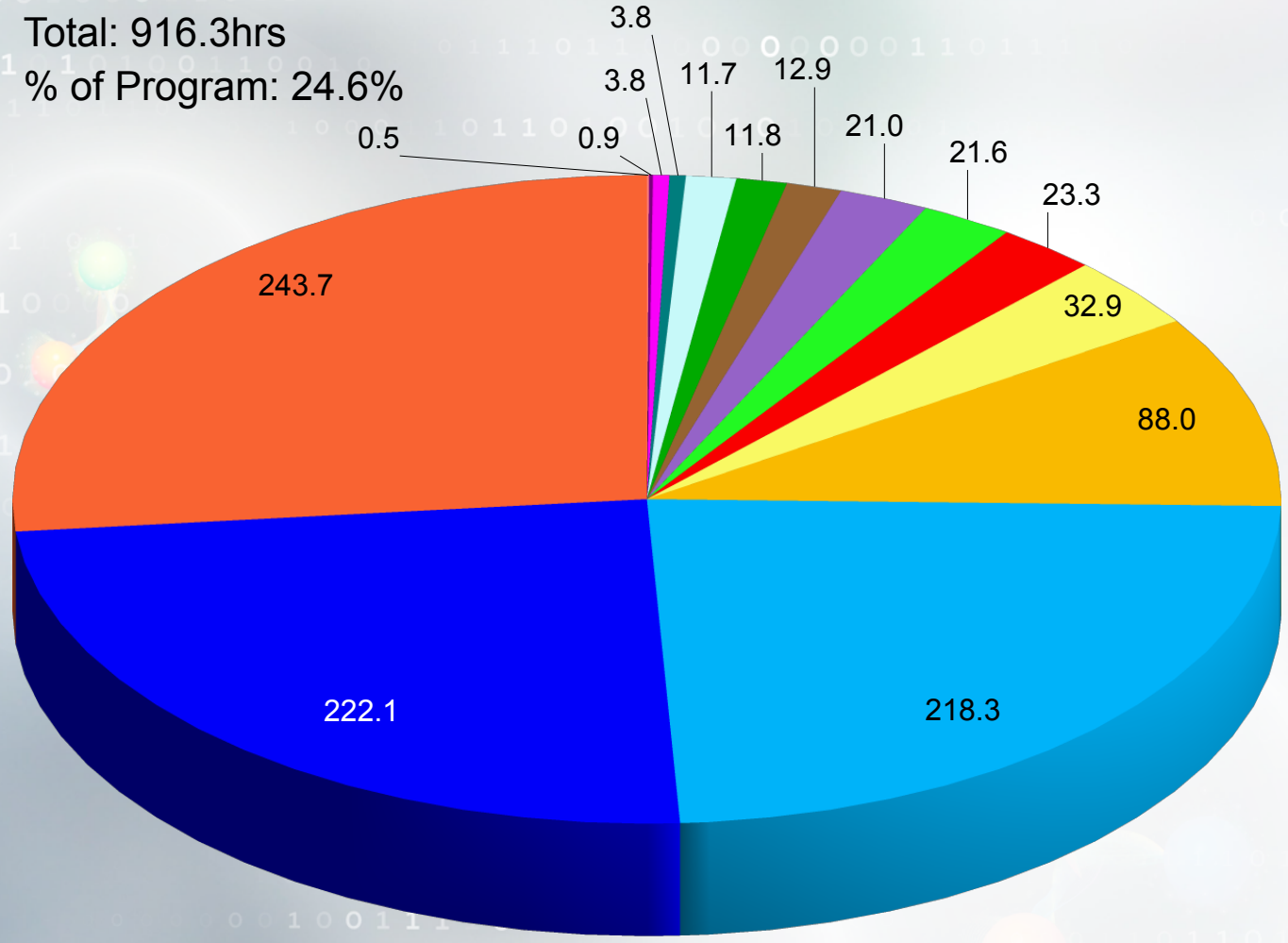
2025 Physics Run (3/19 - 9/3)

Program Hours: 3728.1hrs

Downtimes Irrespective of Program Impact

Total: 916.3hrs

% of Program: 24.6%



DTM Category	Downtime Hours	Incident Count
Magnets	243.7	132
RF	222.1	211
Beam Transport	218.3	185
Facilities	88.0	7
Other	32.9	18
Safety Systems	23.3	15
Control System	21.6	17
Vacuum	21.0	16
Beam Dumps	12.9	3
Diagnostics	11.8	7
Cryo	11.7	11
Info Systems	3.8	7
Operations	3.8	4
Radiation Controls	0.9	1
Gun/Laser	0.5	1

Downtime Hours by Category

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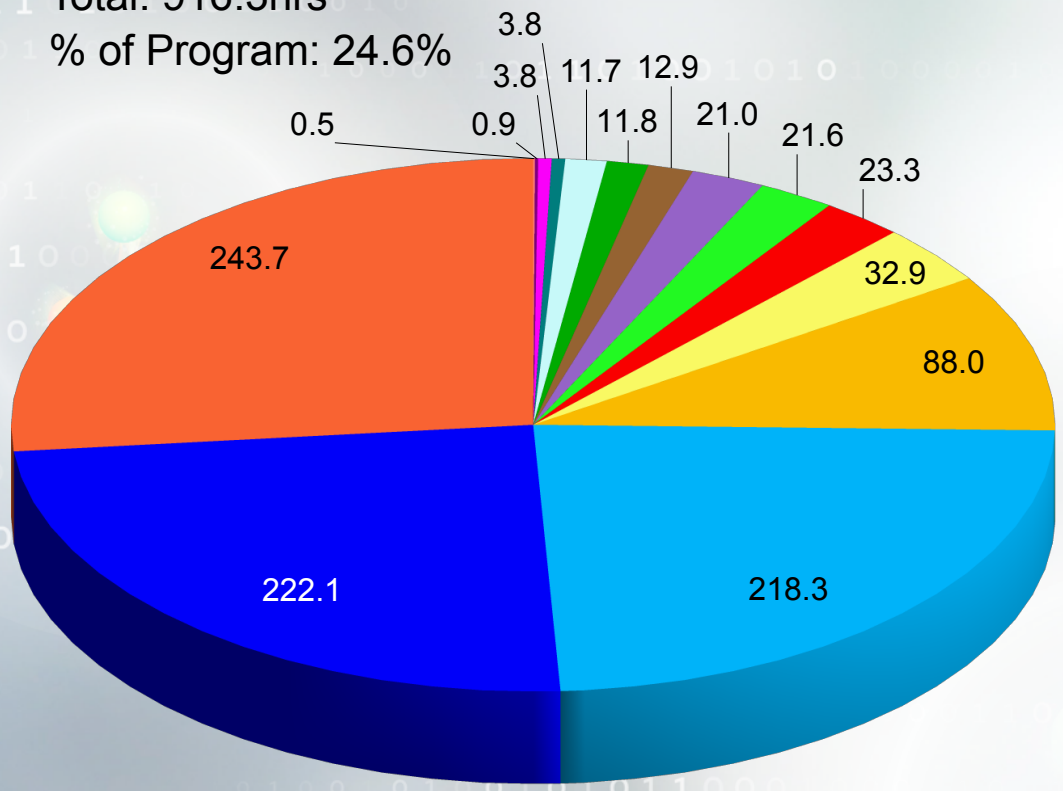
2025 Physics Run (3/19 - 9/3)

Downtimes Irrespective of Program Impact

Total: 916.3hrs

% of Program: 24.6%



Program Hours: 3728.1hrs

DTM Category
Magnets
RF
Beam Transport
Facilities
Other
Safety Systems
Control System
Vacuum
Beam Dumps
Diagnostics
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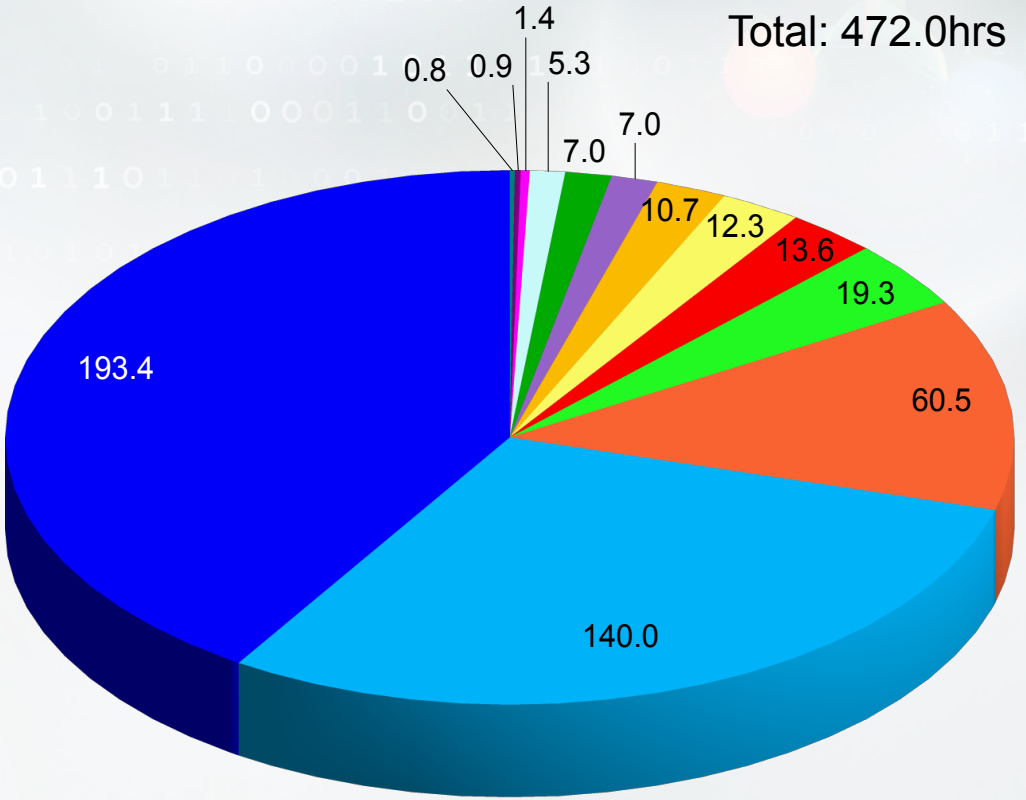
Radiation Controls
Gun/Laser

2025 Physics Run (3/19 - 9/3)

Downtimes that Fully Blocked Program

Total: 472.0hrs



Actual Hours program fully blocked: 500.1hrs

500.1hrs = 416.2hrs (Suspend) + 83.9hrs (Restore)

% of Program = 13.4%

=> Reliability = 86.6%

Downtime Hours Irrespective of Program Impact

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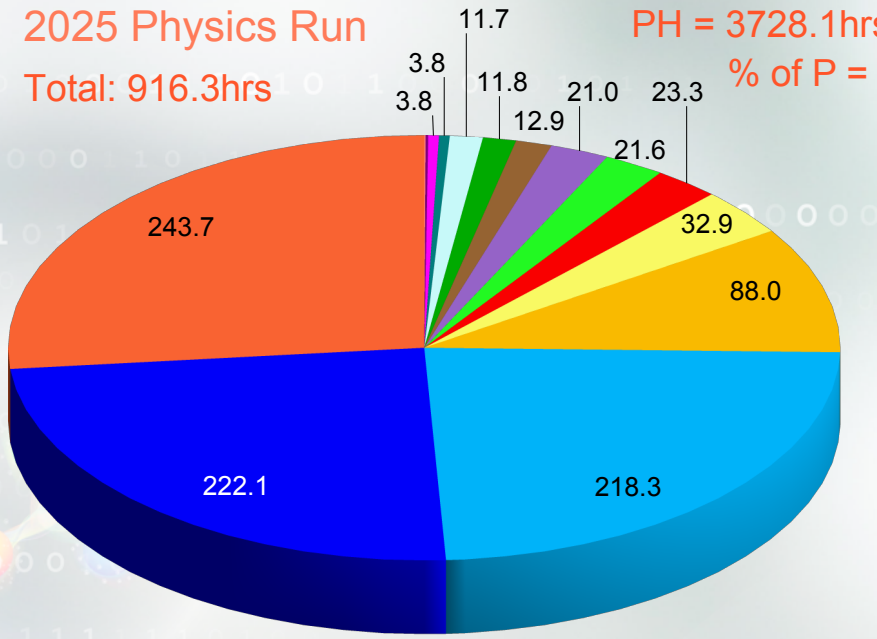
2025 Physics Run

Total: 916.3hrs

PH = 3728.1hrs

% of P = 24.6%

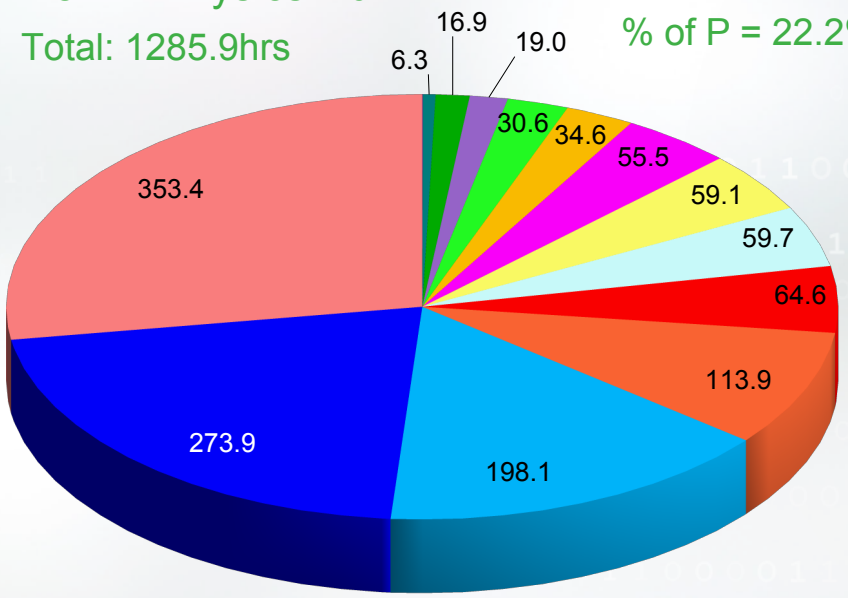


'23-'24 Physics Run

Total: 1285.9hrs

PH = 5793.7hrs

% of P = 22.2%

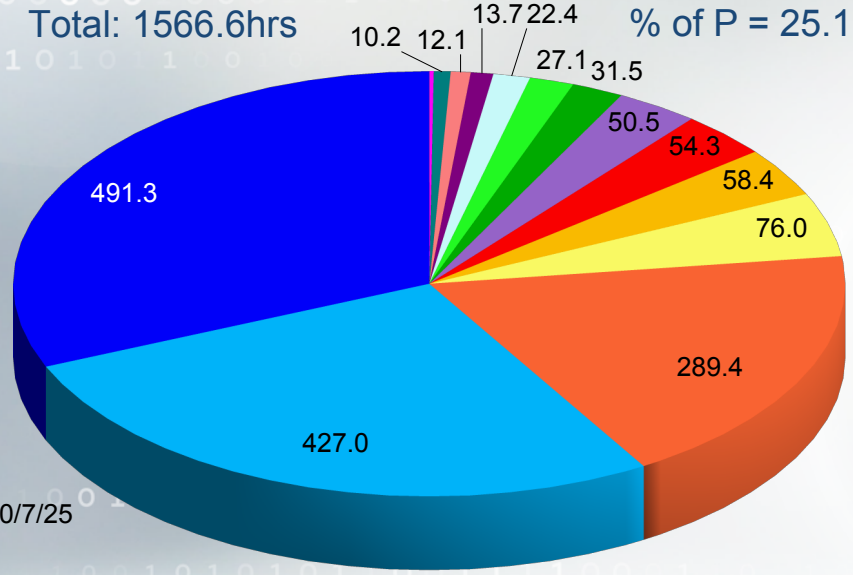


'22-'23 Physics Run

Total: 1566.6hrs

PH = 6245.7hrs

% of P = 25.1%

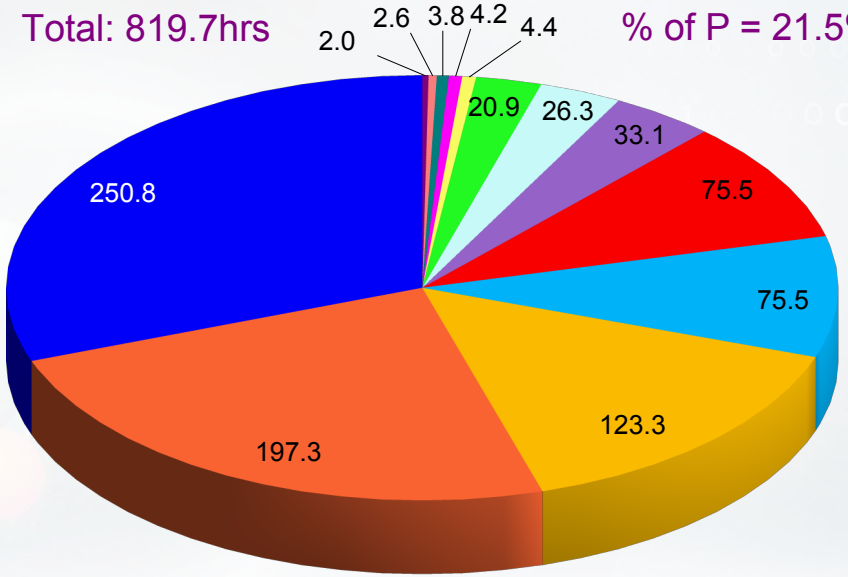


'21-'22 Physics Run

Total: 819.7hrs

PH = 3816.6hrs

% of P = 21.5%



DTM Category
Magnets
RF
Beam Transport
Facilities
Other
Safety Systems
Control System
Vacuum
Beam Dumps
Diagnostics
Cryo
Info Systems
Operations
Radiation Controls
Gun/Laser

PH = Program Hours

% of P = Percent of Program

Downtime Hours Irrespective of Program Impact

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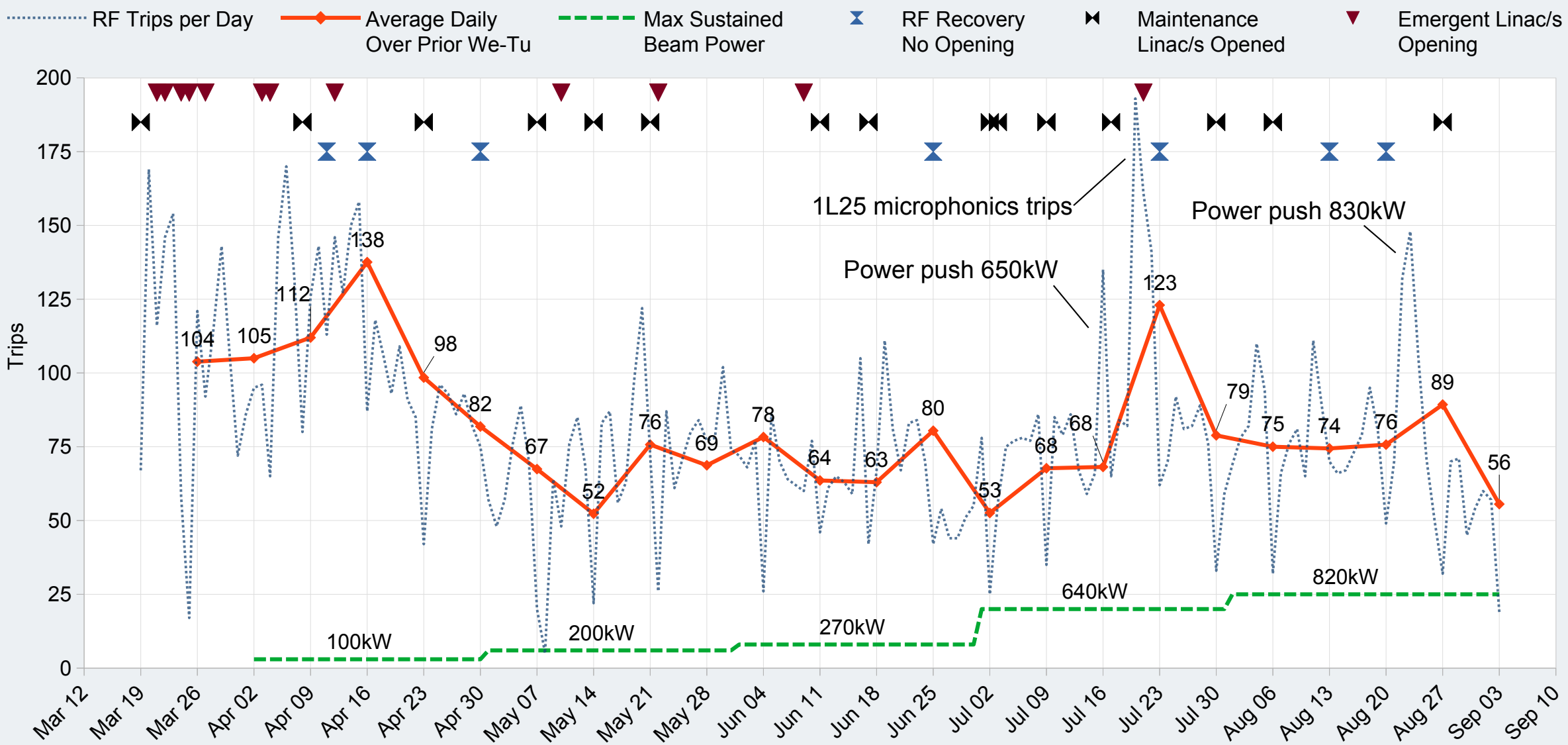
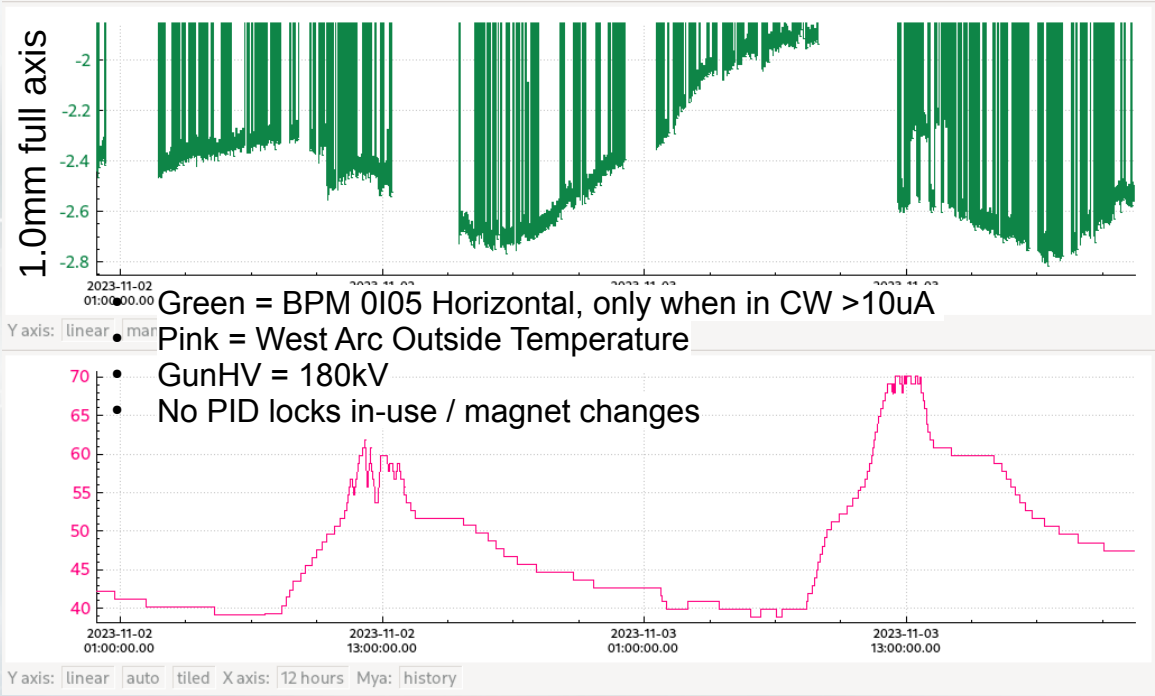
* Max sustained

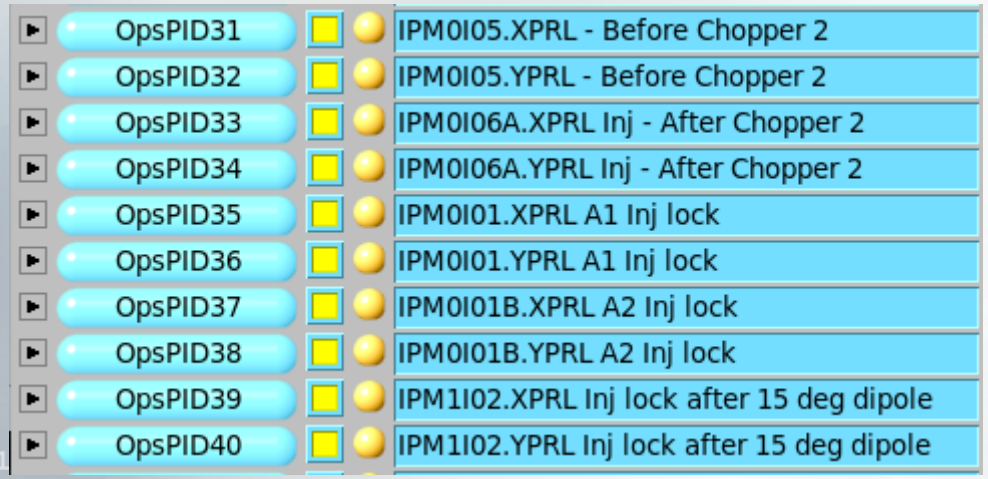
Run	2025		2023 – 2024		2022 – 2023		2021 – 2022	
Configuration	1060 MeV / linac		1047 MeV / linac		1047 MeV / linac		980 MeV / linac	
Beam Power*	820 kW		760 kW		910 kW		680 kW	
Program Hours	3728.1 hrs		5793.7 hrs		6245.7 hrs		3816.6 hrs	
Downtime Hours % of Program	916.3 hrs 24.6%		1285.9 hrs 22.2%		1566.6 hrs 25.1%		819.7 hrs 21.5%	
DTM Category	Downtime Hours Normalized to 2025 Program Hours, Percent of That Year's Total, Year-to-Year Trend							
Beam Dumps	12.9 ↑	1.4%	0.0 ↓	0.0%	0.1 ↑	0.0%	0.0	0.0%
Beam Transport	218.3 ↑	23.8%	127.5 ↓	15.4%	254.9 ↑	27.3%	73.7	9.2%
Control System	21.6 ↑	2.4%	19.7 ↑	2.4%	16.2 ↓	1.7%	20.4	2.5%
Cryo	11.7 ↓	1.3%	38.4 ↑	4.6%	13.4 ↓	1.4%	25.7	3.2%
Diagnostics	11.8 ↑	1.3%	10.9 ↓	1.3%	18.8 ↑	2.0%	0.0	0.0%
Facilities	88.0 ↑	9.6%	22.3 ↓	2.7%	34.9 ↓	3.7%	120.4	15.0%
Gun/Laser	0.5 ↓	0.1%	227.4 ↑	27.5%	7.2 ↑	0.8%	2.5	0.3%
Info Systems	3.8 ↓	0.4%	4.1 ↓	0.5%	6.1 ↑	0.7%	3.7	0.5%
Magnets	243.7 ↑	26.6%	73.3 ↓	8.9%	172.7 ↓	18.5%	192.7	24.1%
Operations	3.8 ↓	0.4%	35.7 ↑	4.3%	1.5 ↓	0.2%	4.1	0.5%
Other	32.9 ↓	3.6%	38.0 ↓	4.6%	45.3 ↑	4.8%	4.3	0.5%
Radiation Controls	0.9 ↑	0.1%	0.2 ↓	0.0%	8.2 ↑	0.9%	2.0	0.2%
RF	222.1 ↑	24.2%	176.2 ↓	21.3%	293.3 ↑	31.4%	245.0	30.6%
Safety Systems	23.3 ↓	2.5%	41.6 ↑	5.0%	32.4 ↓	3.5%	73.7	9.2%
Vacuum	21.0 ↑	2.3%	12.2 ↓	1.5%	30.1 ↓	3.2%	32.3	4.0%

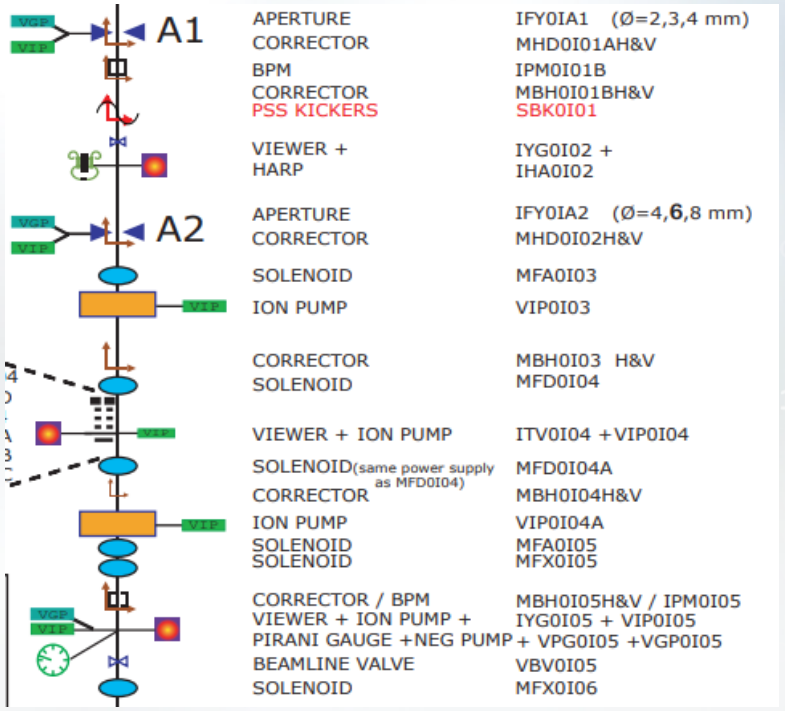
RF Trips vs RF Recovery, Maintenance, Emergent Openings



Injector Orbit Drift







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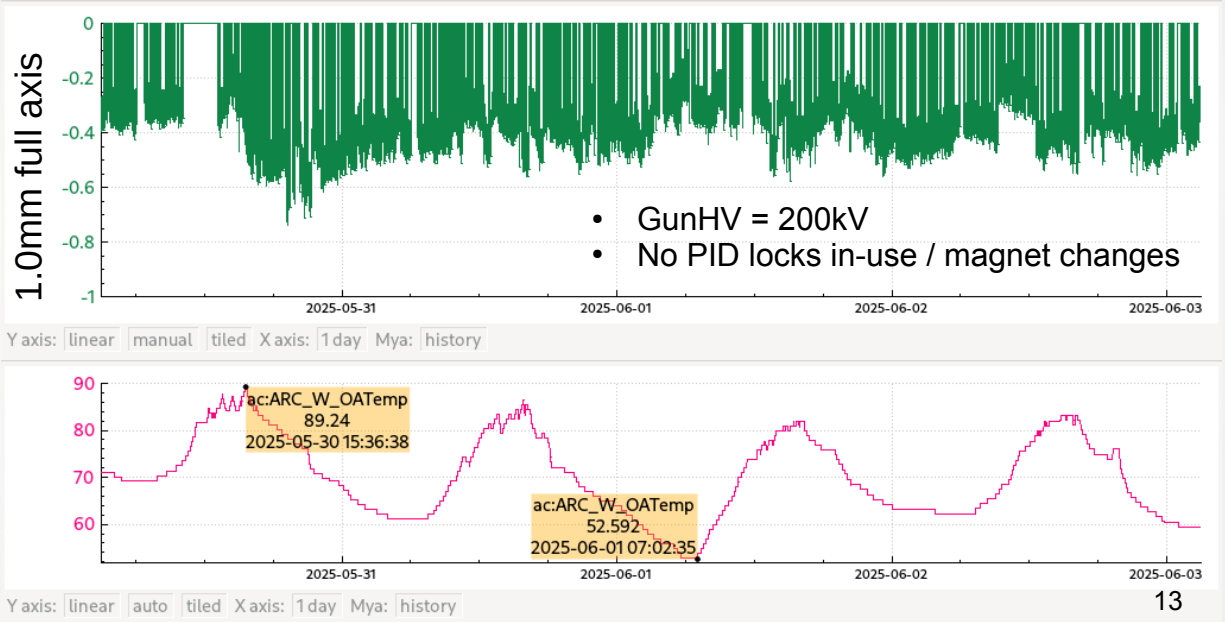
Injector Helium Vent Motorized Damper Installation

Tasklist:	ATLis
Task ID:	112082
ePAS Task #:	ATLIS-112082
Status:	DONE
Time Estimate:	1 Days
Required PSS:	NA
Priority:	Next Shutdown
Scheduled:	2024-11-25
Created:	2024-05-17
Updated:	2025-01-10



Running in the Summer

Service Building (SB) temperature stability impacts RF, DC Power, and diagnostic systems.

- Equipment less stable (e.g. need to compensate for phase drift at dawn and sunset)
- Shorter equipment lifetime
- Increased downtime:

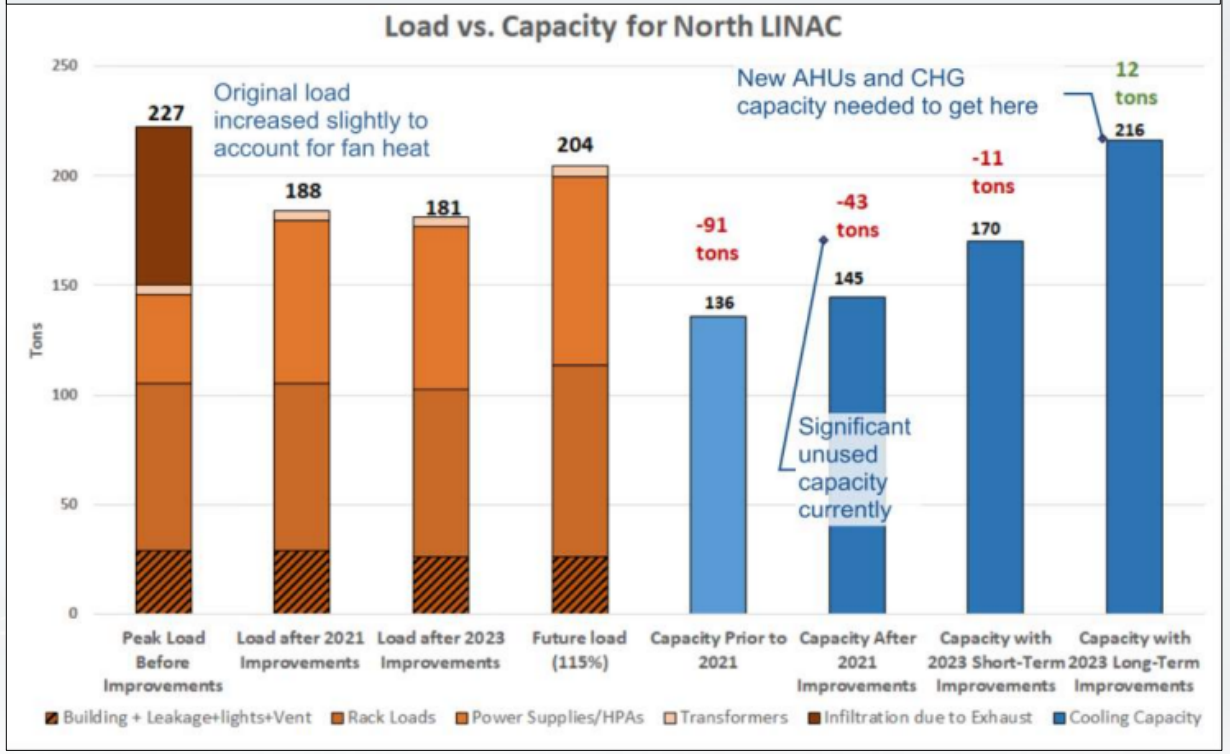
Running Weeks Between May 1st and Sept 30th		Downtime Attributed to Service Building Cooling
2025 (3/19 - 9/3)	18	14.1hrs
2023-2024 (8/28 - 5/20)	7	6.3hrs
2022-2023 (6/1 - 3/20)	17	14.9hrs
2021-2022 (8/16 - 2/8)	6	13.3hrs

* Not counting Restore time after incidents

* Service Building Cooling is covered by DTM Systems under Facilities category Air Conditioning (General Space Cooling) and Accelerator Chilled Water Loop

Portable HVAC unit on North Linac SB.

From 3/10/23 Linac Cooling Study Follow-up Report, Mason & Hanger



Upcoming Improvements to Downtime Manager (DTM)

In Progress:

- New DTM Event Types: Accelerator becomes
  - Accelerator (Program Partially Blocked)
    - Selection of which Halls affected
    - Only used in Physics (i.e. beam to Halls) mode
    - Doesn't count towards Unscheduled Failures
  - Accelerator becomes Accelerator (Program Blocked)
    - Continues to count towards Unscheduled Failures, part of Reliability calculation
- Beam Transport downtimes automatically count as Tuning, Setup, and Restore
  - Currently automatically count as Unscheduled Failures
  - At some point, do have to count Beam Transport as Unscheduled Failure, but not initially; we have allocated time for Tuning each week, each configuration change, each start-up

Under Consideration:

- Standardizing how downtime is calculated between Internal and Physics Modes
- Removing Level I incident acknowledgment and sending a weekly report of all Level I's
  - All looks good, no further action. Correction needed, reply.
- Counting Event Restore time (i.e. after incident closed) as Tuning, Setup, and Restore

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QUESTIONS?

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Backup Slides

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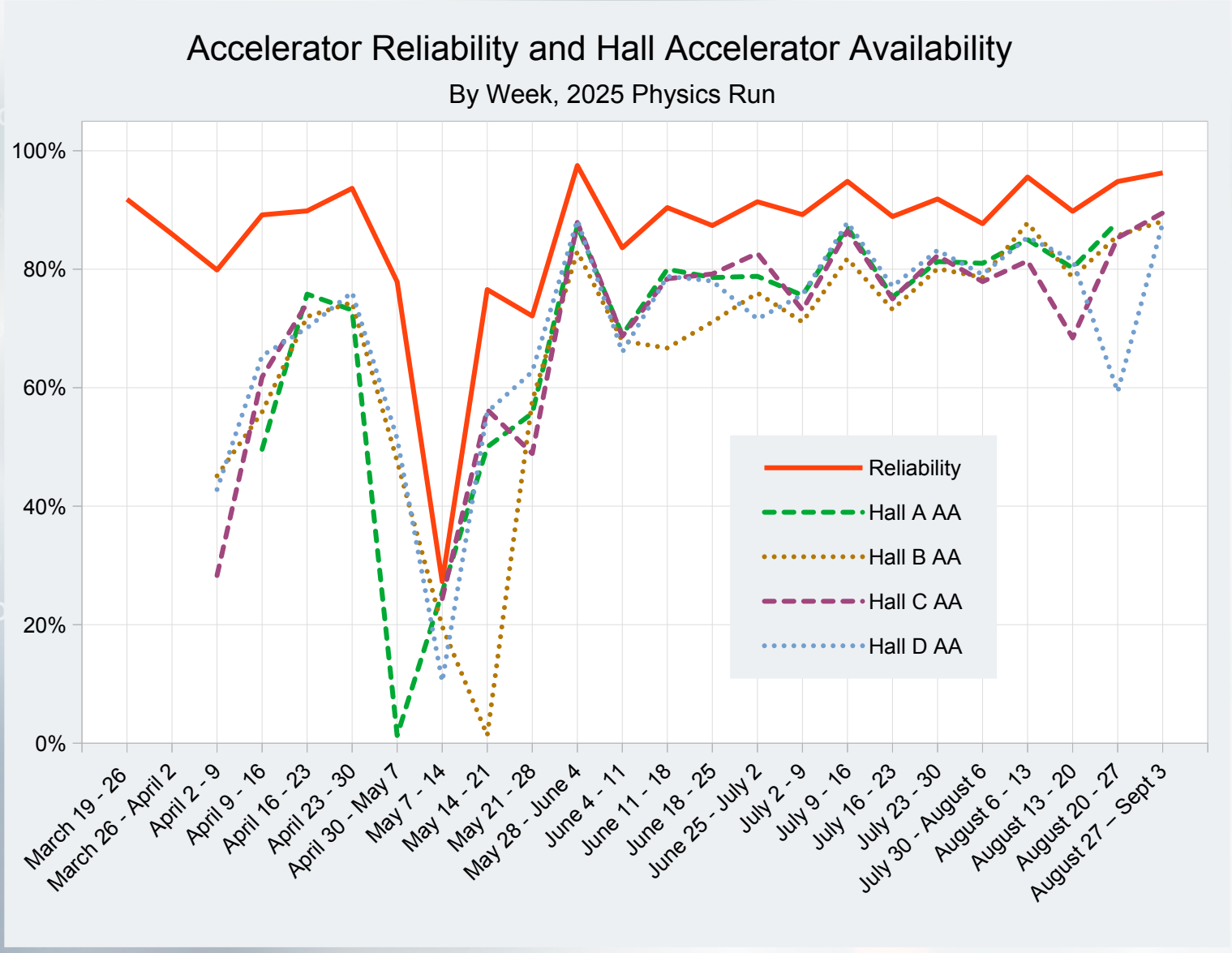
Accelerator and Hall Availability

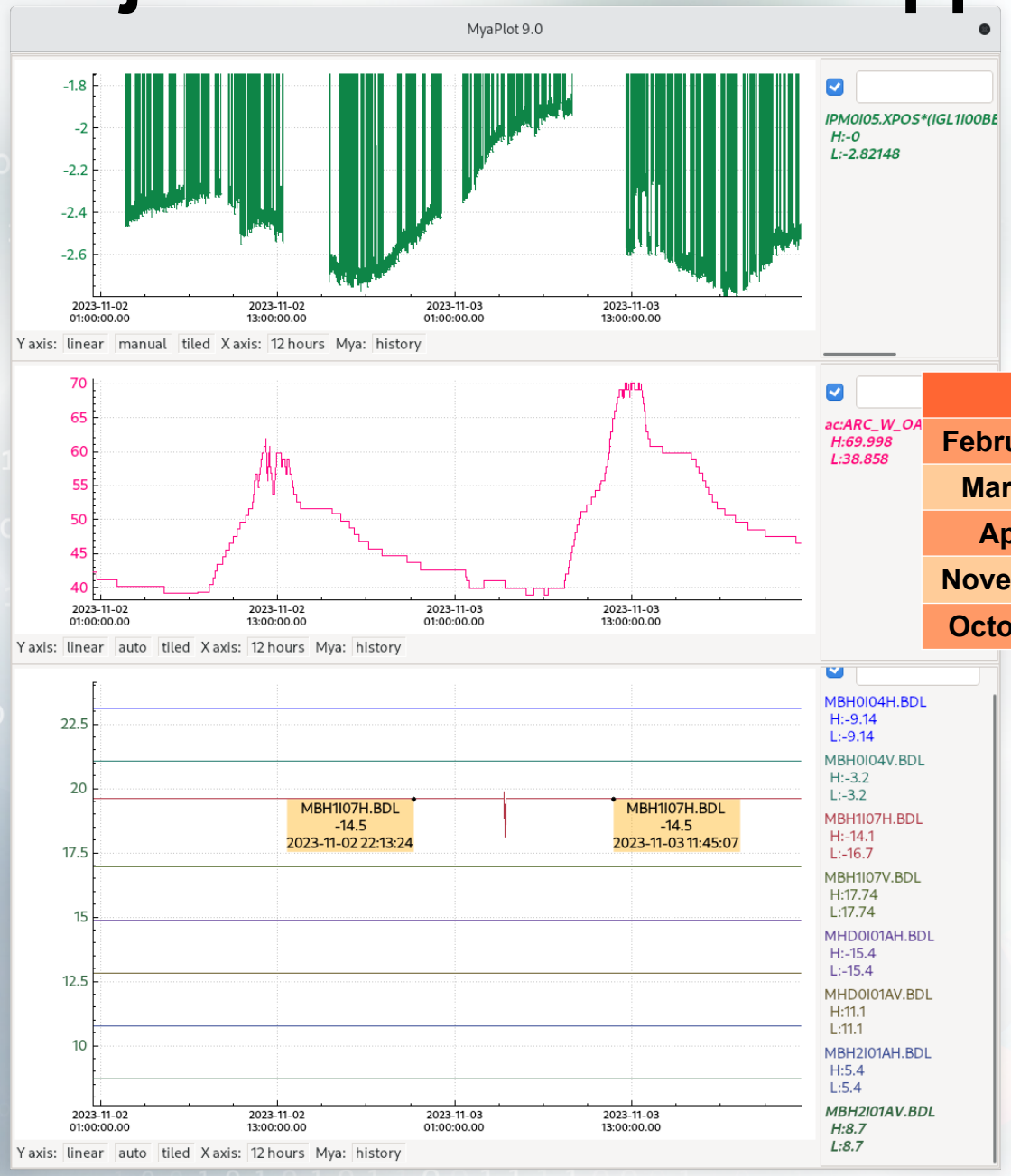


Accelerator Reliability		
Worst Week	Best Week	March 19th – September 3rd
27.3% May 7th – May 14th	97.5% May 28th – Jun 4th	86.6%

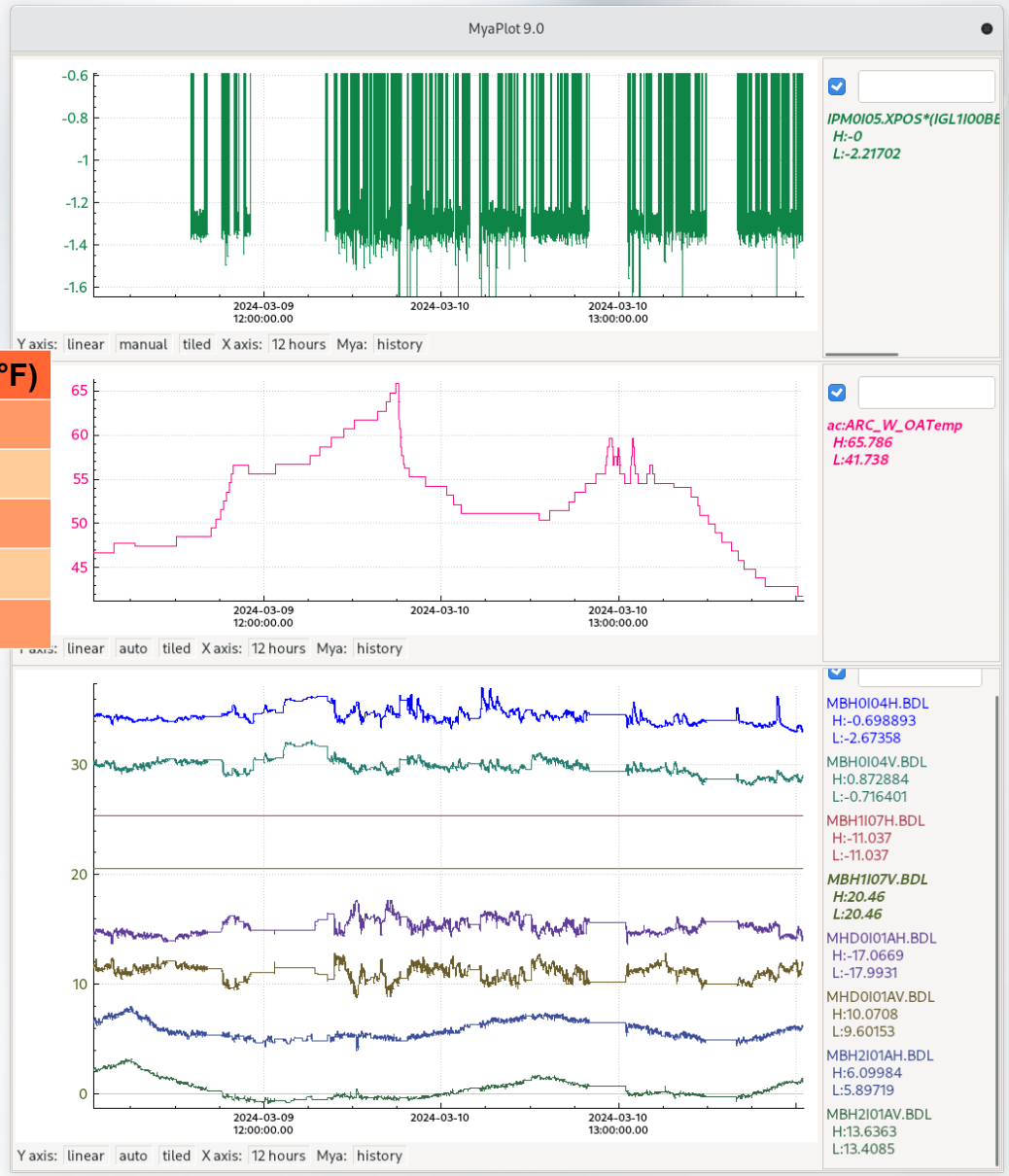
Hall Availabilities			
April 2nd – September 3rd	Accelerator Availability (AA)	Experiment Availability	Simultaneous Availability
Hall A	71.2%	90.7%	57.5%
Hall B	67.3%	90.6%	53.6%
Hall C*	70.8%	95.6%	58.7%
Hall D	70.8%	95.2%	61.1%

* Hall C went to Off during electrical panel work
April 23rd – May 7th

Injector Orbit Drift – Suppressed with Locks

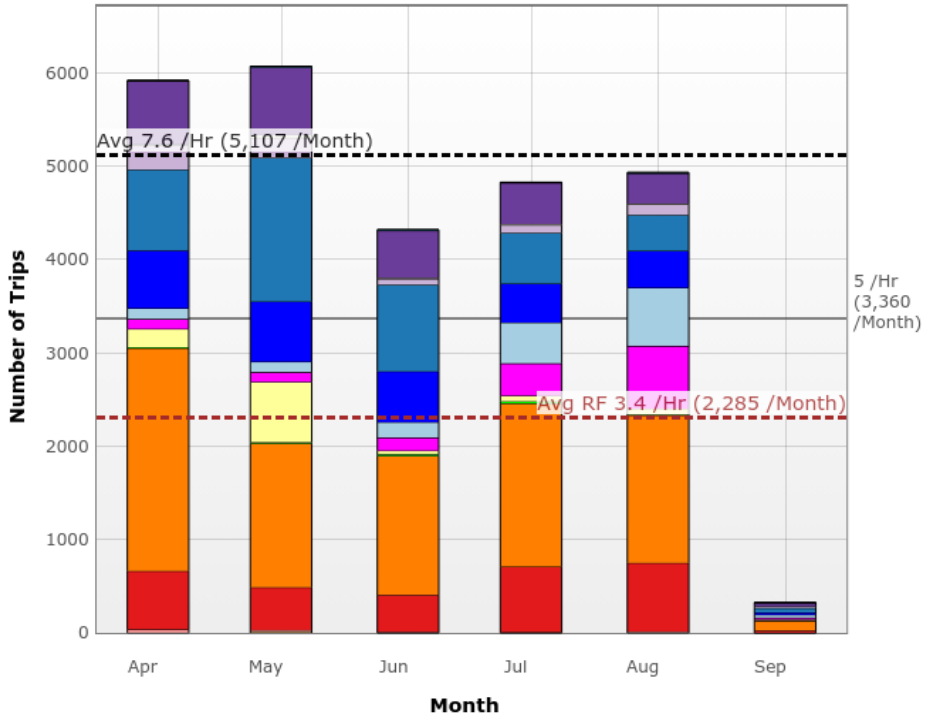


Date	Range (°F)
February 25, 2024	42°F
March 10, 2024	39°F
April 5, 2024	38°F
November 2, 2023	37°F
October 18, 2023	36°F



FSD Trip Summary

April 1 - October 1, 2025



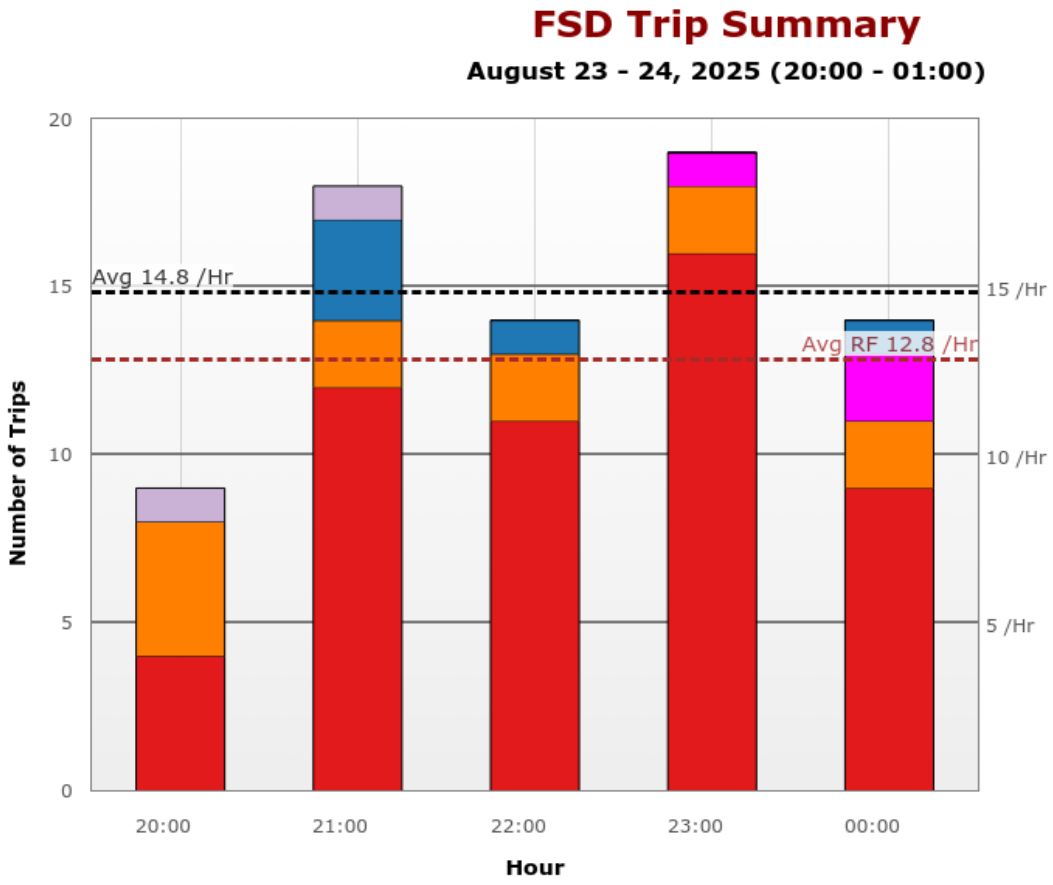
	Trips	Lost Hrs	Mins /Trip
Control System	5	0.1	1.2
Diagnostics	32	0.7	1.4
Dump (Insert.)	2,710	12.0	0.3
Hall	73	0.7	0.6
MPS (BCM/BLA)	752	4.2	0.3
MPS (BLM)	4,309	20.1	0.3
MPS (IC)	2,645	13.8	0.3
MPS (Multi/Other)	1,475	7.4	0.3
Magnets	1	0.0	1.3
Multiple/Other	1,393	8.1	0.3
Unknown/Missing	1,020	6.0	0.4
Vacuum	71	0.9	0.7
RF (C25/50)	8,849	58.8	0.4
RF (C75/100)	2,939	39.9	0.8
RF (Multi/Other)	87	2.6	1.8
RF (Separator)	20	0.3	1.0
Total:	**26,381**	**175.6**	**0.4**

- Max Trip Duration: 5 Minutes
- Rate from Program (3477.48 hrs)
- SAM Trips excluded

C75/C100 cavities do not have the mechanism which causes C25 faults yet these 31% of modules caused 25% of RF faults.

RF faults 45% of total.

MPS faults, aka current loss and radiation sensors, 35% of total.



	Trips	Lost Hrs	Mins /Trip
MPS (BCM/BLA)	2	0.0	0.2
MPS (BLM)	5	0.0	0.2
Multiple/Other	3	0.0	1.0
RF (C25/50)	12	0.1	0.3
RF (C75/100)	52	0.5	0.6
Total:	**74**	**0.7**	**0.5**

- Rate from Program (5.0 hrs)
- SAM Trips excluded

During 260 minutes at 830 kW, C75/C100 cavities accounted for 70% of the trips. They limit total beam power.
See TN-25-063 for details.