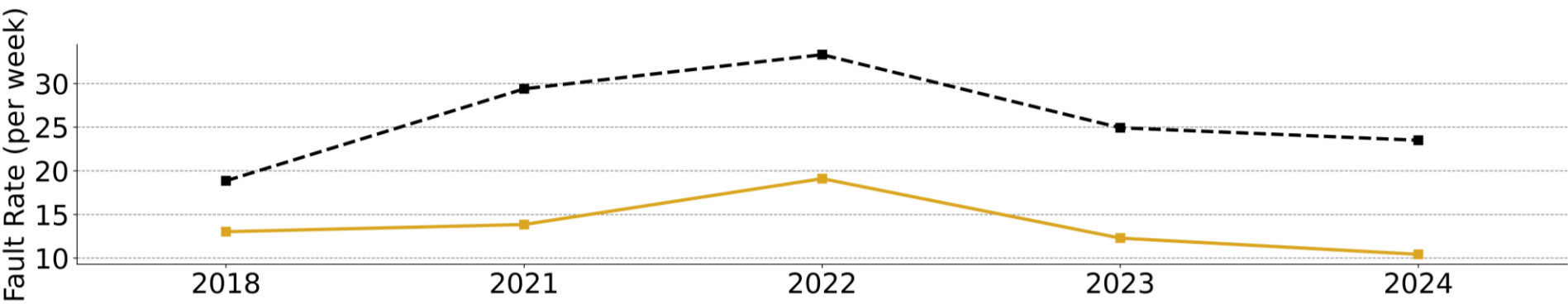
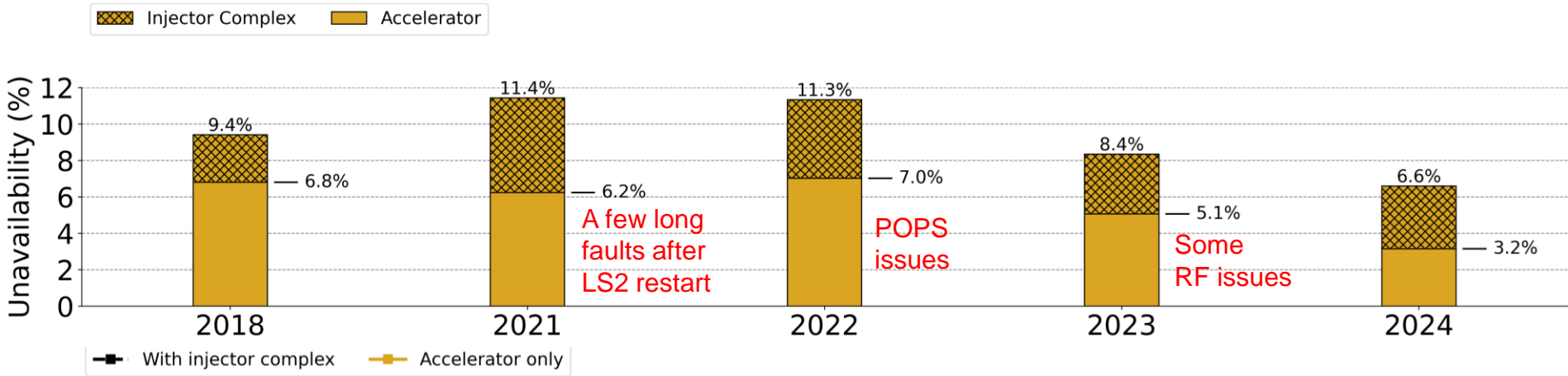


PS Availability Statistics 2024

PS Physics Periods

- ('08-03-2018 09:00:00', '18-06-2018 09:00:00'),
- ('20-06-2018 09:00:00', '17-09-2018 09:00:00'),
- ('19-09-2018 09:00:00', '10-12-2018 06:00:00'),
- ('23-04-2021 00:00:00', '15-09-2021 14:00:00'),
- ('16-09-2021 11:00:00', '15-11-2021 06:00:00'),
- ('07-03-2022 09:00:00', '11-03-2022 08:30:00'),
- ('11-03-2022 12:00:00', '17-05-2022 04:00:00'),
- ('17-05-2022 17:00:00', '13-09-2022 08:00:00'),
- ('14-09-2022 12:00:00', '28-11-2022 06:00:00'),
- ('17-03-2023 09:00:00', '10-05-2023 08:00:00'),
- ('10-05-2023 12:00:00', '20-06-2023 08:00:00'),
- ('21-06-2023 20:00:00', '13-11-2023 06:00:00'),
- ('01-03-2024 07:00:00', '17-04-2024 08:00:00'),
- ('17-04-2024 17:30:00', '12-06-2024 07:30:00'),
- ('14-06-2024 23:00:00', '02-12-2024 06:00:00')

2024 in Context

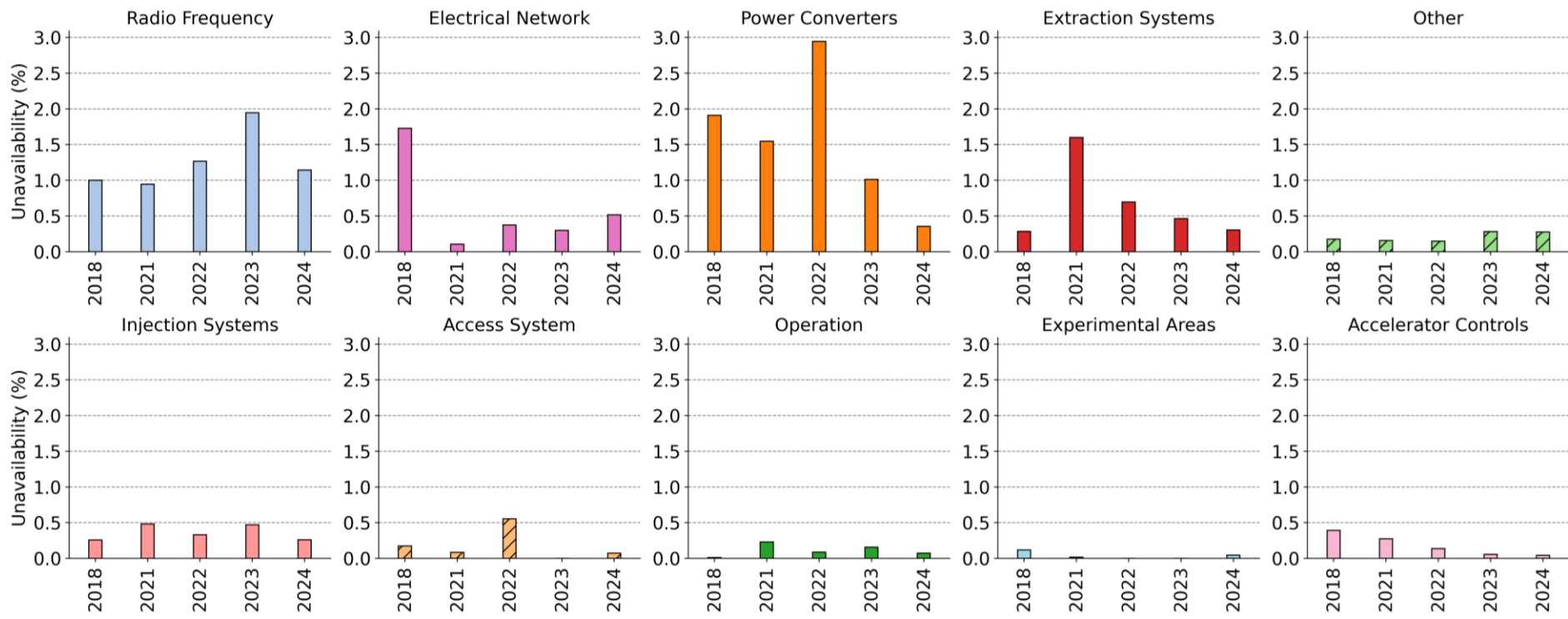


Very positive trend of increasing availability of the PS itself and its injectors since LS2.



System Downtime

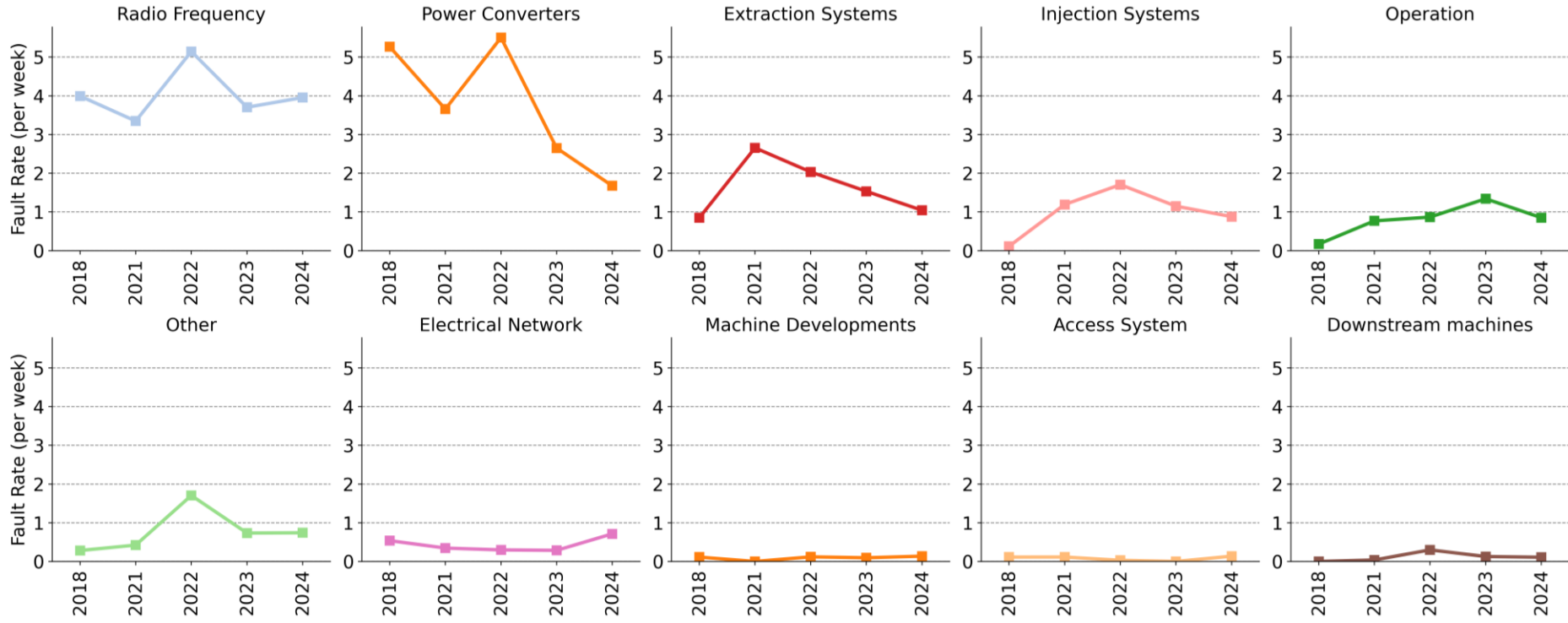
Improved availability thanks to continuous work and improvements from equipment experts and OP, combined with understanding and resolution of certain faults (e.g. POPS, RF, ABT).
Slight degradation in Electrical Network due to a few longer incidents.



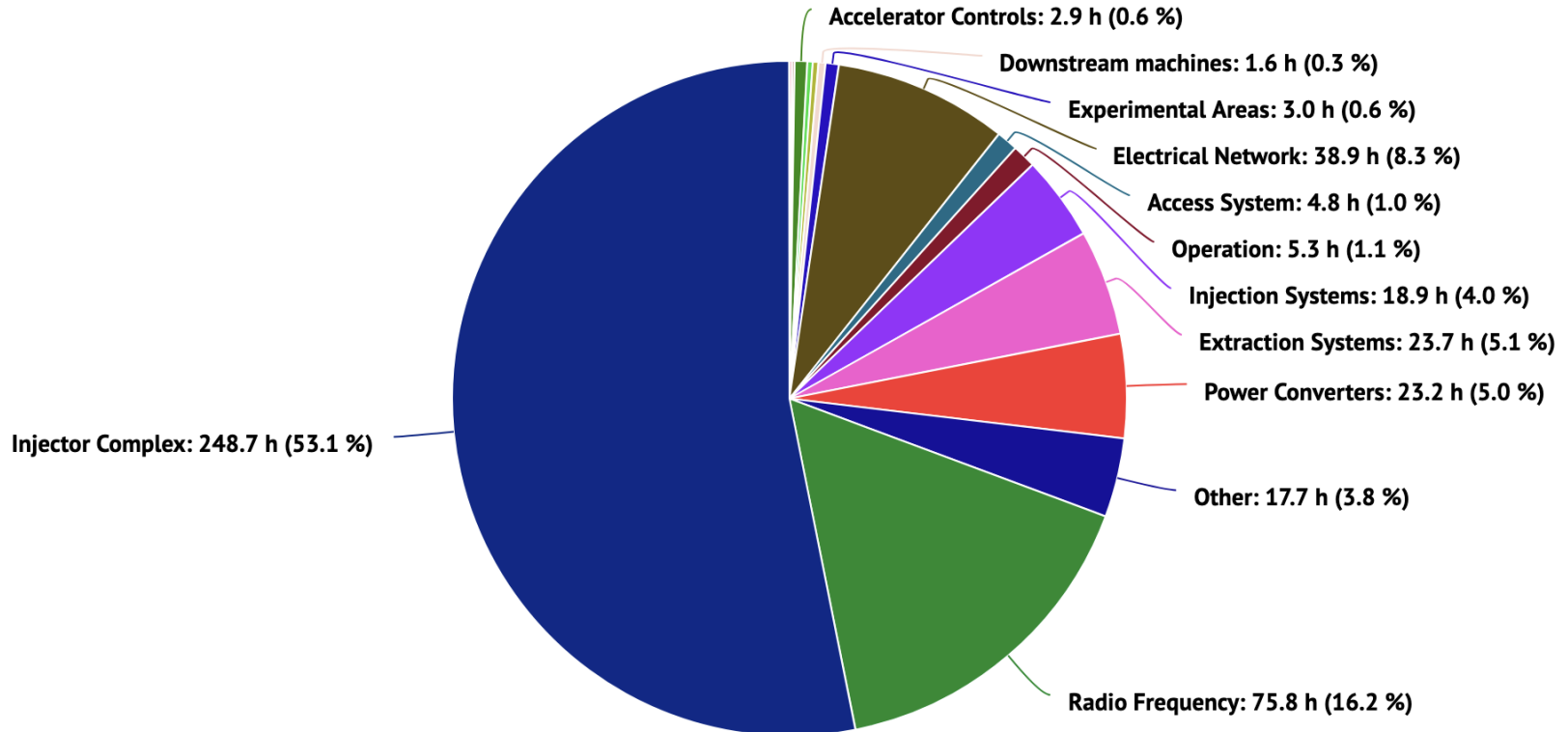
System Failure Rate

Analysis for RF and Extraction/Injection systems see next slides.

Power converters: accumulation of water-cooling faults for certain circuits will be followed up by EPC and CV during the YETS24/25.



Root Cause Fault Time by System



Radio Frequency

Manual reclassification of all 2024 RF faults by RF team ✓

Does 2024 match your expectations?

✓ Yes for standard operation

✓ Downtime reduced wrt. 2023 outlier and back to established 'standard', certainly due to the important maintenance activities during the previous YETS

✓ Cavity auto-resets and auto-restarts implemented

○ No for LIU MDs

○ The SPS MD users report back that faults from the PS (RF) had important impact on their program; not reflected in AFT → might need some dedicated evaluation (e.g. SPS MD as full-blown user in AFT?)

Trends?

• Frequent short duration faults since start of Run2 not well understood.

➤ Lack of tools to understand and address these; **tools and diagnostics are being developed** to better understand root cause of the events (e.g. looking for correlations → to be continued in 2025)

• **Long lasting hardware issues to be addressed with LS3 upgrade/CONS**

➤ Downtime from signal quality on the LLRF, which will be replaced by digital system during LS3

➤ Downtime from gap relays which are now obsolete (alternatives being investigated), and from amplifiers

Accelerator Fault Statistics 2024, RAWG, 05.12.2024

Radio Frequency

Are any mitigations foreseen?

- No immediate mitigation during YETS except for the already planned maintenance activities
- Nonetheless, the **analysis of faults** already allowed to unveil some systematic patterns that will be investigated in 2025.

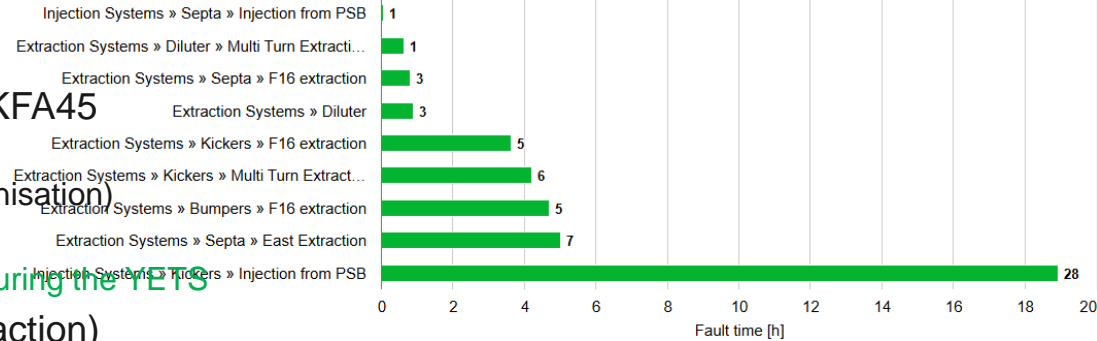
How do you expect this to evolve in 2025?

- Expected to be comparable or worse than 2024, with hopefully some improved understanding on the root cause of some systematic short faults.
- Important **uncertainties due to items undergoing upgrades and prototyping that may have impact on downtime.**
- Important uncertainties for 2026 as there will be no time for maintenance during YETS25/26.

Injection/Extraction Systems

System Downtimes: Root Cause (Extraction Systems, Injection Systems) ⓘ

● Fault time by system



Fault analysis:

- Injection system downtime dominated by KFA45
 - Some hardware failures
 - One loss of settings (voltages and synchronisation) caused recurrent trips early in the year
 - Plan of moving hardware settings to LSA during the YETS
- Extraction system kicker KFA71 (F16 extraction)
 - Recurrent module trips requiring reset not always counted in AFT; manual moved to automatic reset (UCAP)
 - Planned generator 4/5/6 refurbishment and new trigger amplifier on each module during YETS24/25
- Extraction system BFA9 (for MTE)
 - Some contact issues during the run; contact checks planned for the YETS24/25
- Extraction system DFA (for MTE)
 - Some sporadic issues now addressed; planned hardware exchanges (thyatron tbc, contact issues...)

Summary and Outlook:

- Number and total duration of injection/extraction system faults continues decreasing
- Improved hardware monitoring and move some settings to LSA during YETS24/25
- New reset actor for KFA71-9 → impact on availability to be seen although not all trips recorded

Expect further availability improvement in 2025



Unavailability by Duration

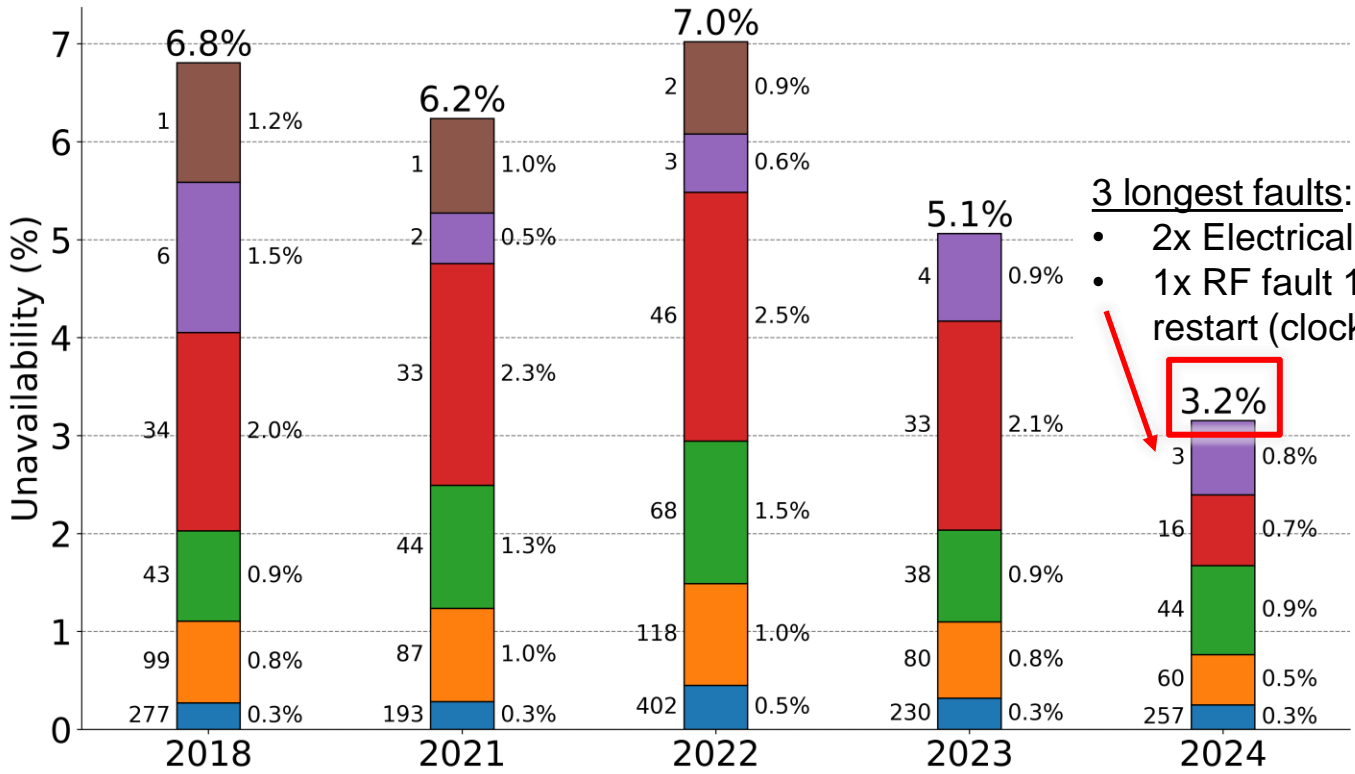
No long faults >1 day in 2023 and 2024.

Noticeable reduction in 2024 of faults lasting between 2-10 hours.

25-11-2024 17:26:42

(w/o injector complex)

PS



3 longest faults:

- 2x Electrical Network
- 1x RF fault 1 week after restart (clock issue)

3.2%

Summary & Conclusion

- **Excellent PS availability in 2024**, following trend of downtime decrease in Run3
 - Not a single fault lasting >1 day
 - Will be hard to top this result in 2025
- **Continuous effort of equipment groups** in terms of hardware, controls and monitoring improvements as well as regular maintenance
- Introducing **automatic resets of RF cavities and kicker modules** – collaboration between OP and equipment experts
 - Should not forget the cut-off of 2 mins for declaring faults, so can still gain 'AFT-transparent' availability
- Working on **automated AFT faulty system assignment** using BigSister based on UCAP equipment failure analysis
- For better data consistency would be important to **extend fault propagation between PS complex and the SPS** during the YETS