

LHC All Operation Availability Statistics 2024

Information I

These slides are a template to summarize availability of your machine in 2024. Please correct and complement the slides considering the following questions:

- What are the main events & challenges impacting availability this year?
 - Is this shown in the data, and does it match your expectations?
 - Is any crucial aspect not visible in the data that should be pointed out?
- What is the outlook for next year?
 - Are you expecting interventions over YETS that might improve availability?
 - It's possible (though not sure) that bunch intensity will be increased in 2025. That could have an impact on availability. More...that choice may oblige a change of beam type (25 ns vs hybrid filling scheme), which may as well bring surprises for availability
 - Could certain circumstances lead to an availability degradation?

Information II

- There will be additional questions on each slide. Feel free to spread out comments over multiple slides as required
- **We only need reviews of 2024.** Previous years are already well covered (e.g. see the Special RAWG on Accelerator Availability 2023, linked)
<https://indico.cern.ch/event/1340975/>
- All LHC faults this year can be found at:
https://aft.cern.ch/search?timePeriod=%257B%2522timePeriodType%2522%253A%2522fixed%2522%252C%2522startTime%2522%253A%252201012024000000%2522%252C%2522endTime%2522%253A%252201012025000000%2522%252D&accelerator=LHC&hadStates=BLOCKING_OP&excludedFaultStates=NON_BLOCKING_OP%252CUNDERSTOOD%252CSUSPENDED

Availability Schedule

Availability is counted over time periods as follows:

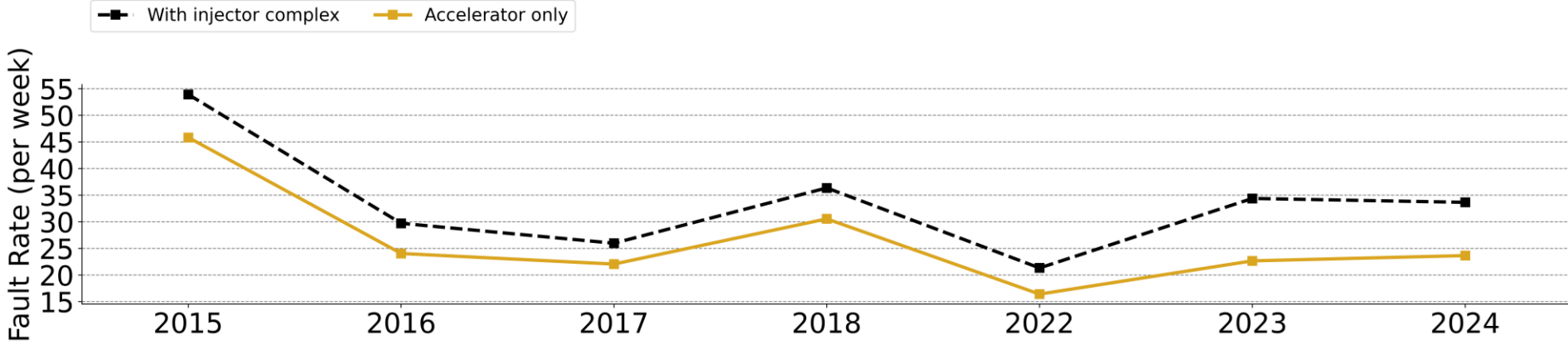
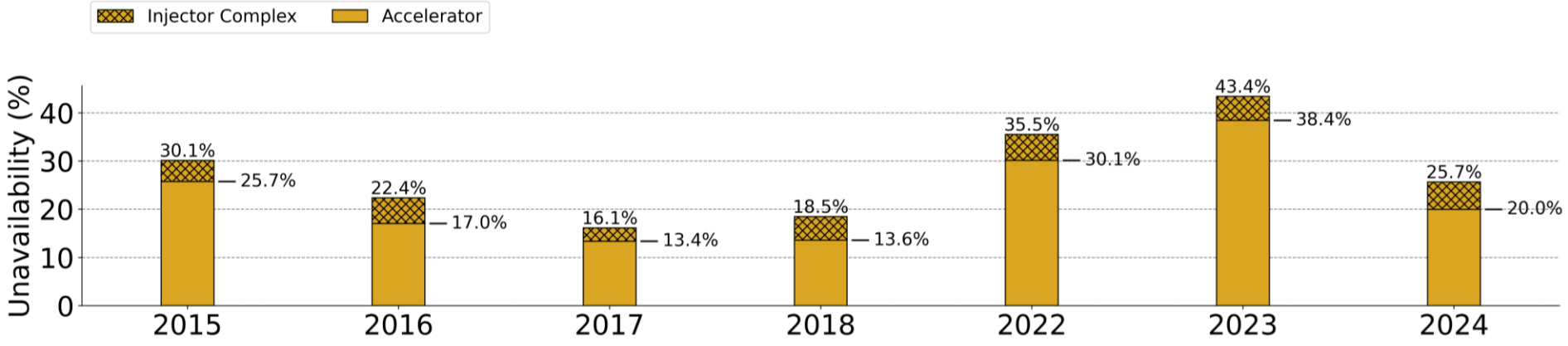
- L4, PSB, PS, SPS: starts once beam is required by a downstream machine
- L3, LEIR starts once beam is delivered to LHC
- LHC starts with beam commissioning
- ISOLDE, AD/ELENA, EAST, NORTH starts with respective physics period

LHC All Operations time periods are on the next page. [Should these times be wrong, please correct them and let us know](#)

LHC All Operations Periods

- ('05-04-2015 00:00:00', '14-12-2015 00:00:00'),
- ('29-03-2016 00:00:00', '05-12-2016 06:00:00'),
- ('01-05-2017 00:00:00', '04-12-2017 06:00:00'),
- ('30-03-2018 00:00:00', '03-12-2018 06:00:00'),
- ('26-04-2022 00:00:00', '28-11-2022 09:30:00'),
- ('28-03-2023 00:00:00', '30-10-2023 06:00:00'),
- ('08-03-2024 12:00:00', '25-11-2024 06:00:00') -> Not sure about the start date. If we consider beam commissioning in this (I would not, but it depends on how it is done historically) that would have to be 11.03, alternatively 05.04 (first SB) or 14th April (1200b -> start of physics production). END date is correct

2024 in Context



Does 2024 match your expectations? **I'd say yes**

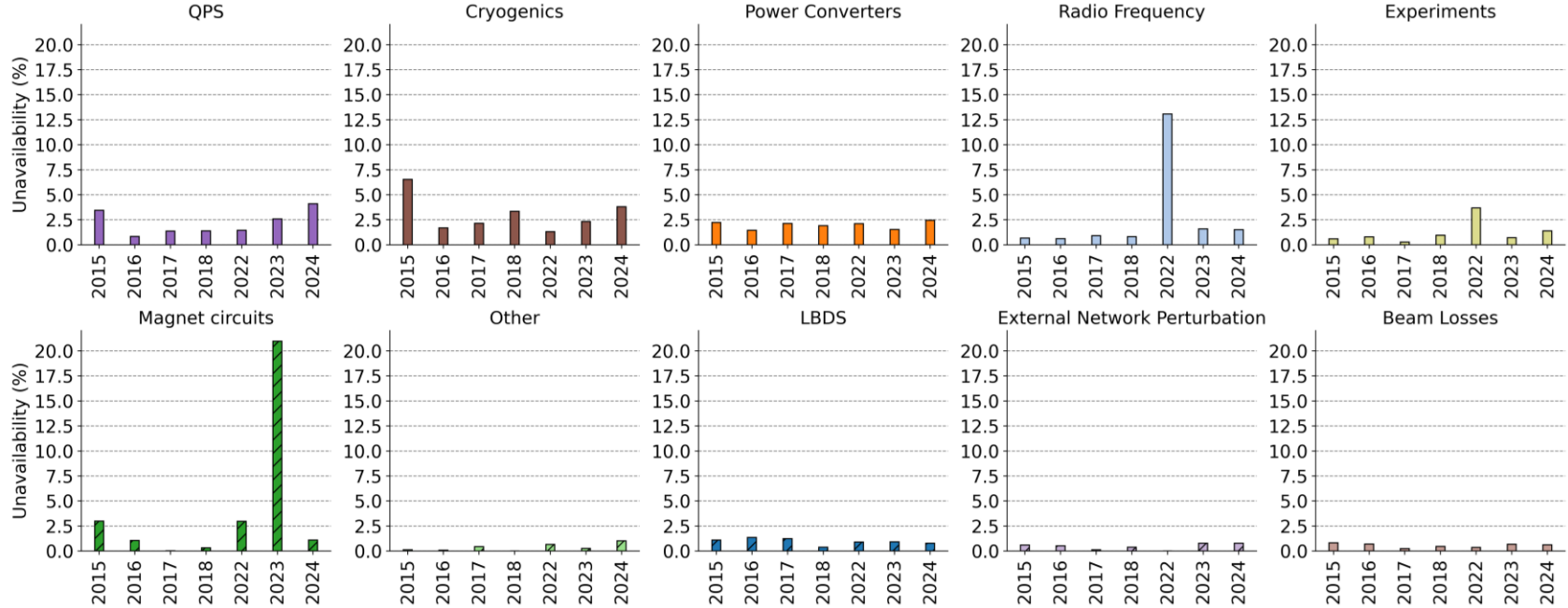
What could be responsible for the observed trends? **Best availability of Run3 (obvious),**

System Downtime

Please elaborate on the main events and down time.

Can any trends be easily explained?

ONLY “visible” trend is increase in the QPS downtime, also clearly visible in both p and IONS separately. To be checked in details...

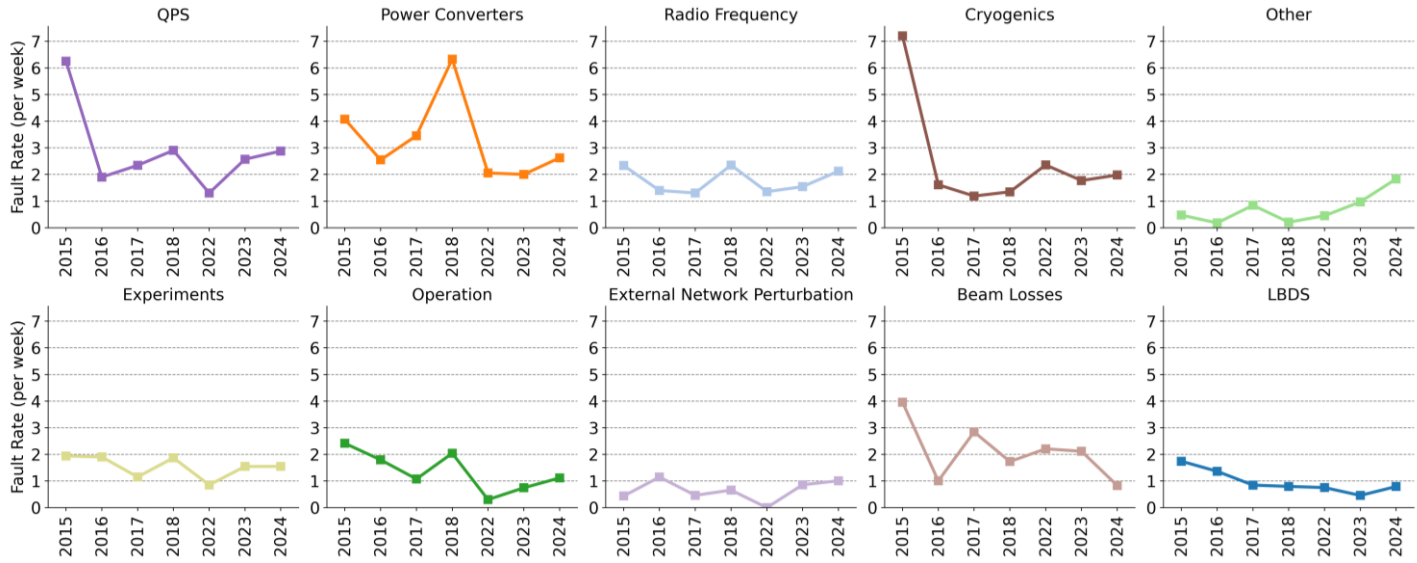


System Failure Rate

Are any mitigations foreseen?

How do you expect this to evolve in 2025?

Clear decrease of beam losses (thresholds adaptation + cleaner (BCMS beams vs hybrid)). Also small increase in OP, likely due to increase in sophistication of operation (combined levelling, more complicated MD?, to be checked, but may be fluctuation as it is very small)



Unavailability by Duration

Do these trends match your expectations?
 Any positive trends worth remarking?
 Are any trends worrying?

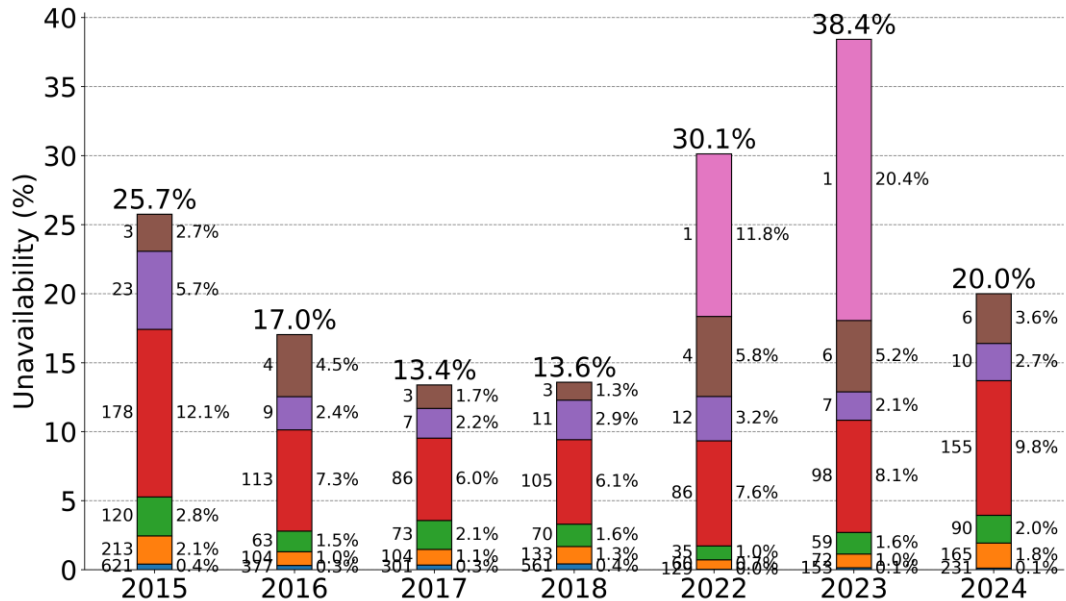
In line with expectations! Worth mentioning that the 2 cryo events of IP8 (21 April and 10 October (which BTW are not mentioned below), accounting for a total downtime of ~60h) are likely SUE on the electronic installed in UL84 Mitigation is planned for the upcoming YETS!

1. [Cryogenics, 23 Sep:](#)
Cold compressor could not restart after SVC trip, 2d 4h
2. [Cryogenics, 21 Apr:](#)
Loss of 1.8K pumping unit in LHC-8, 1d 17h
3. [Cryogenics, 27 Aug:](#)
QURCA-8 stop due to faulty pressure transmitter, 1d 13h
4. [QPS, 23 Nov:](#) FPA and following QPS induced quench of ~20 dipoles in S81, 1d 12h
5. [Magnet Circuits, 10 May:](#)
Quench in sector 23 needed cryo recovery, 1d 4h
6. [Other>Heat Load, 24 Apr:](#)
High heat load in S78 reached max capacity of cryo system at P8, 1d 3h

(w/o injector complex)

LHC All Operation

26-11-2024 10:56:17



Summary & Conclusion

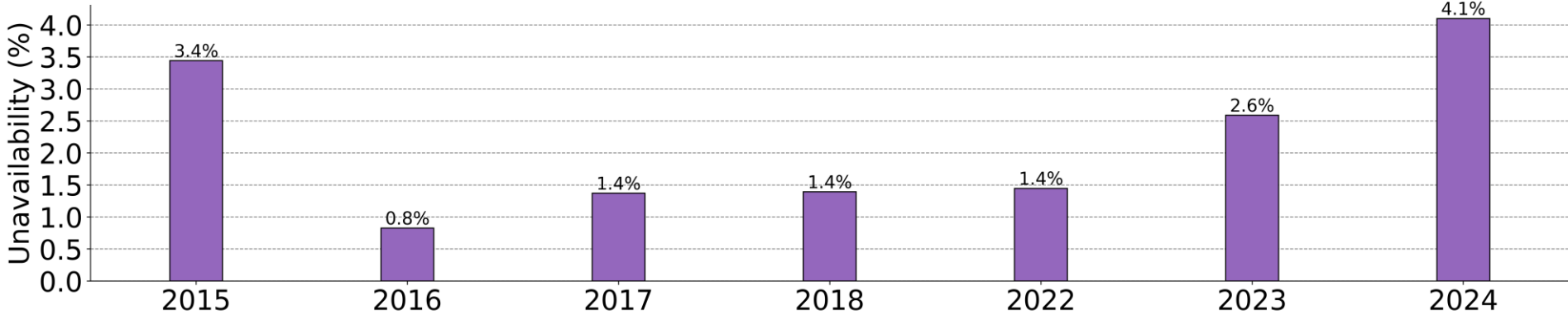
- Main message and conclusion for 2024?
- **GREAT year, all working better than previous years, no large faults**
- Would you like us to provide AFT statistics for a specific problem in more detail?
- **Worth checking the constant increase over Run3 of downtime from QPS**
- What is the outlook for next year? Are there any availability problems expected unless they are addressed over the YETS?
- **See S2 plus comment on mitigation for P8 cryo electronics in S9**
- Desiderata for fault tracking and AFT tool?

Appendix – top 5 systems for unavailability

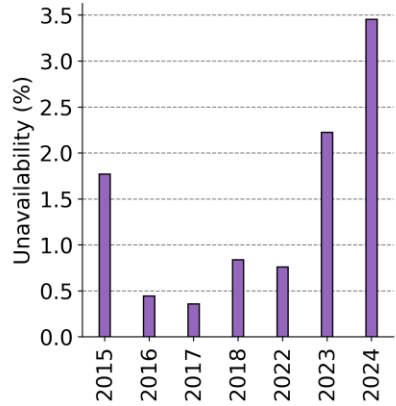
For additional information / interest.

We will follow up on specific equipment down time with the relevant experts separately, but feel free to comment if you see something.

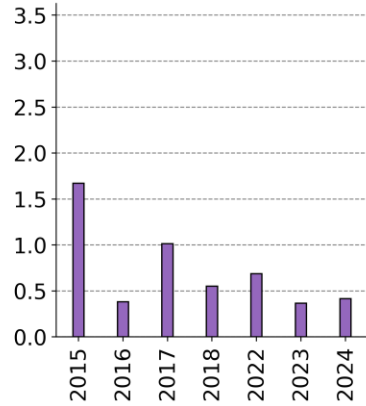
LHC All Operation - QPS



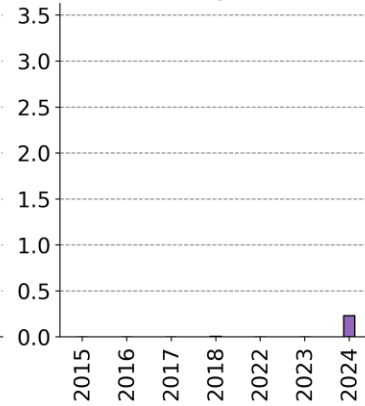
Controller



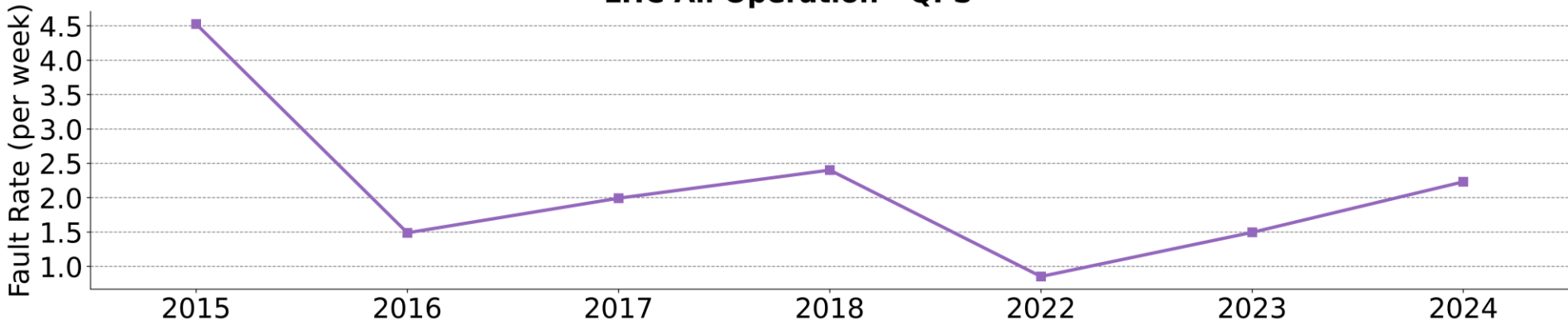
Hardware



Uncategorised



LHC All Operation - QPS



2015

2016

2017

2018

2022

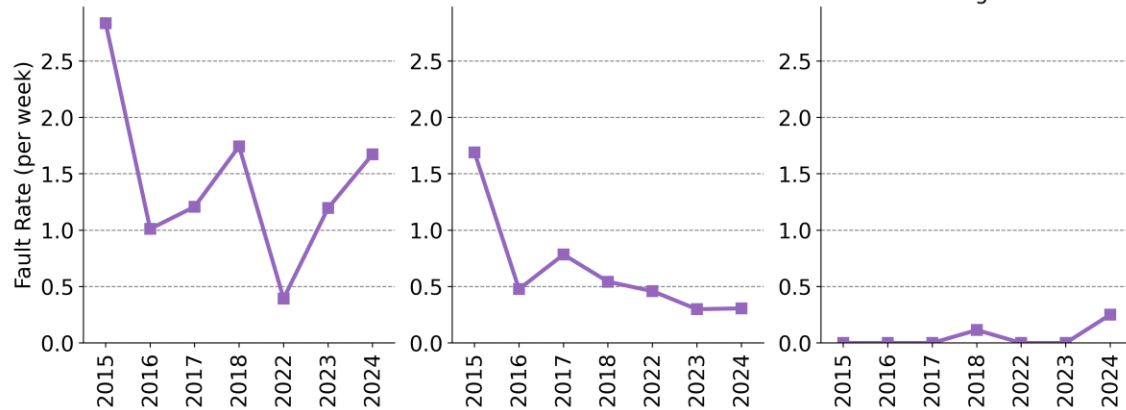
2023

2024

Controller

Hardware

Uncategorised



2015

2016

2017

2018

2022

2023

2024

2015

2016

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2022

2023

2024

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2016

2017

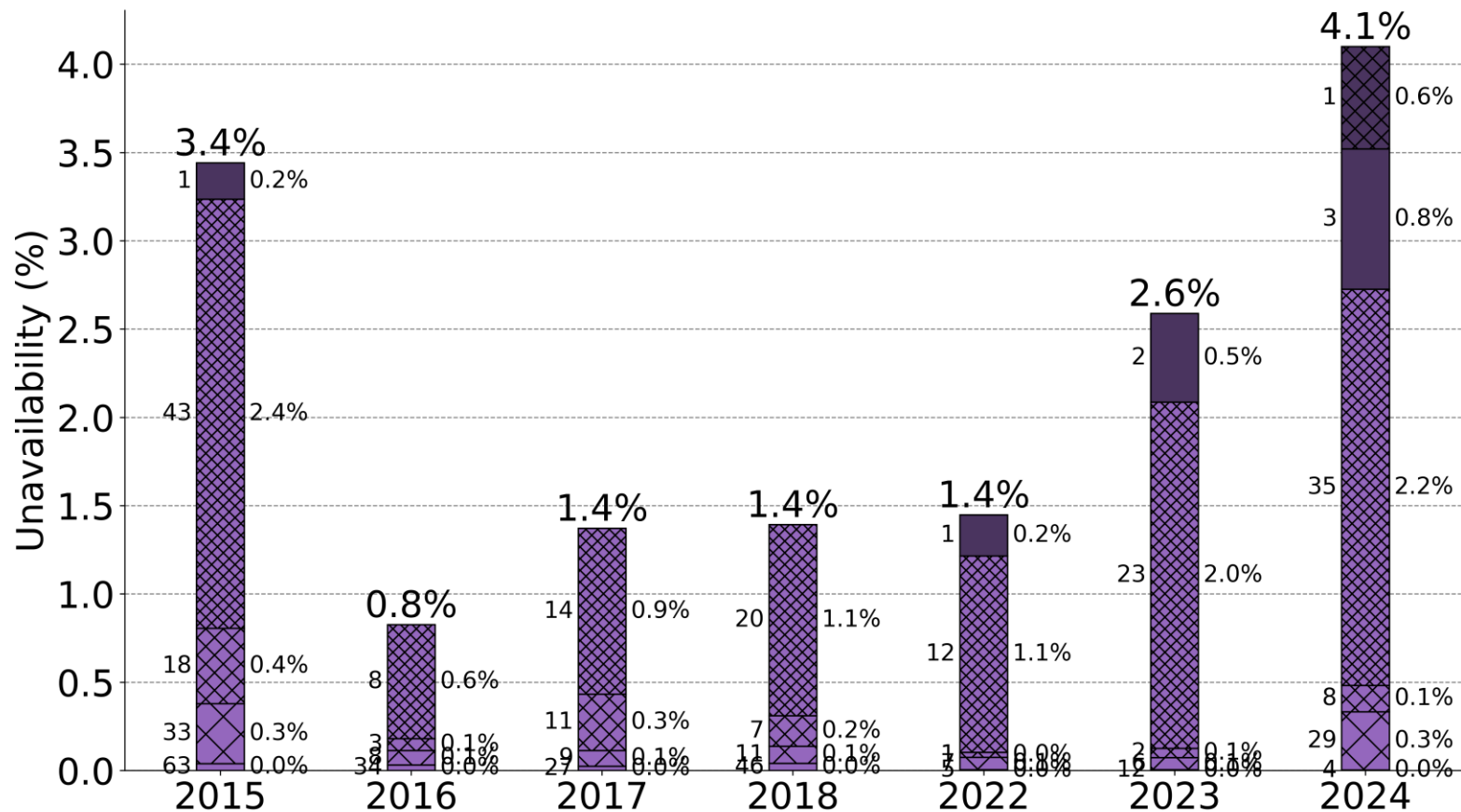
2018

2022

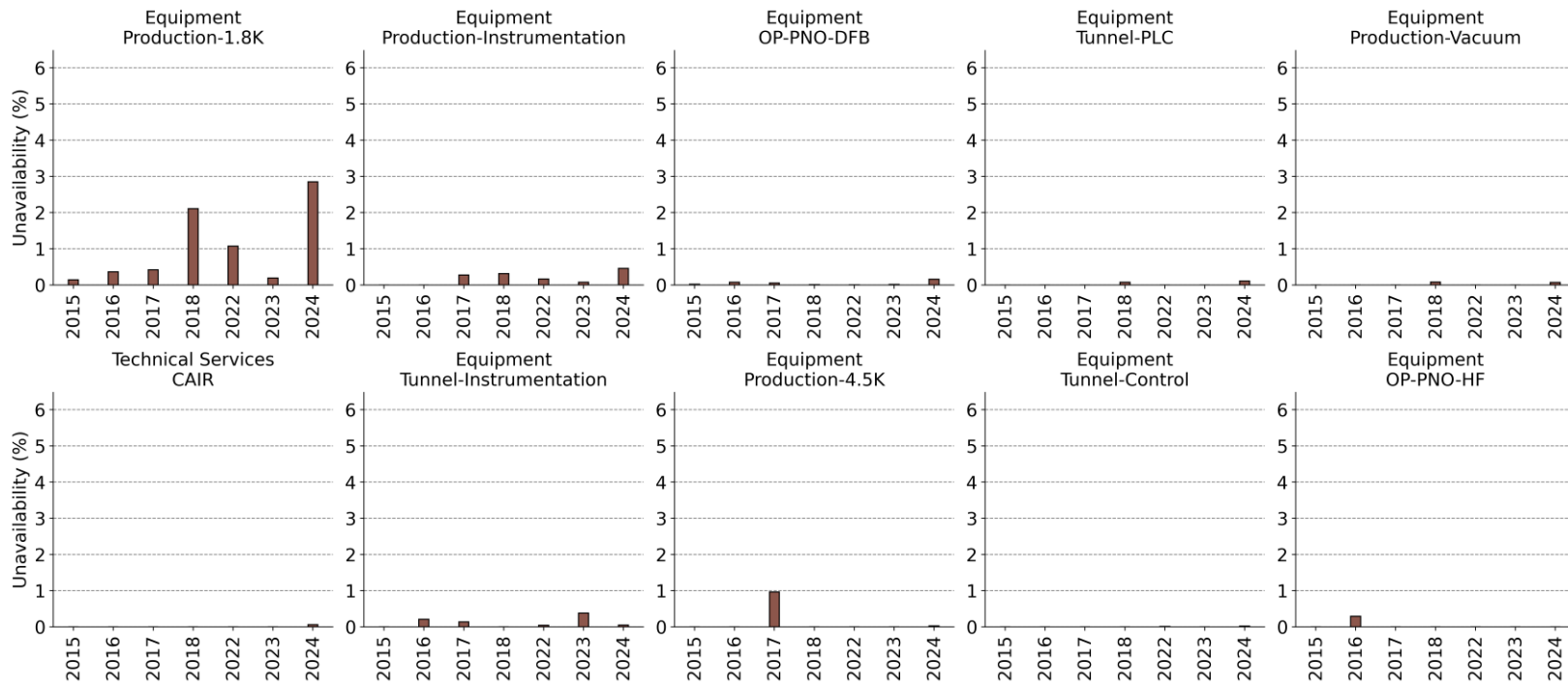
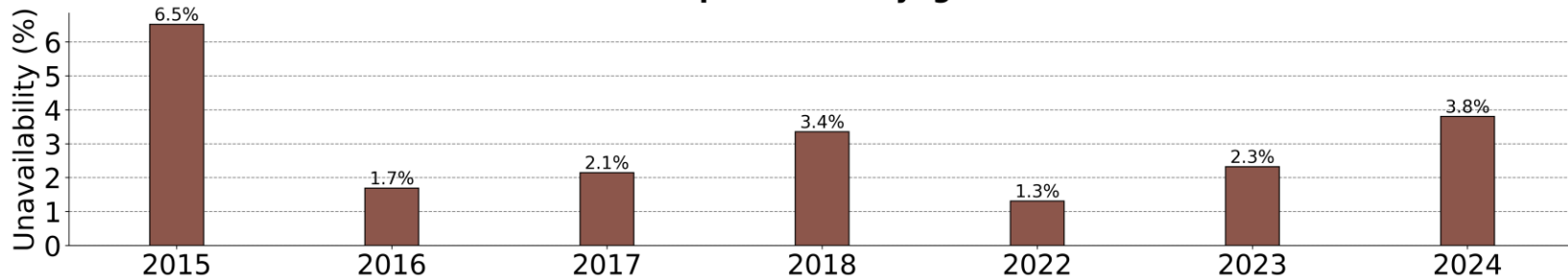
2023

2024

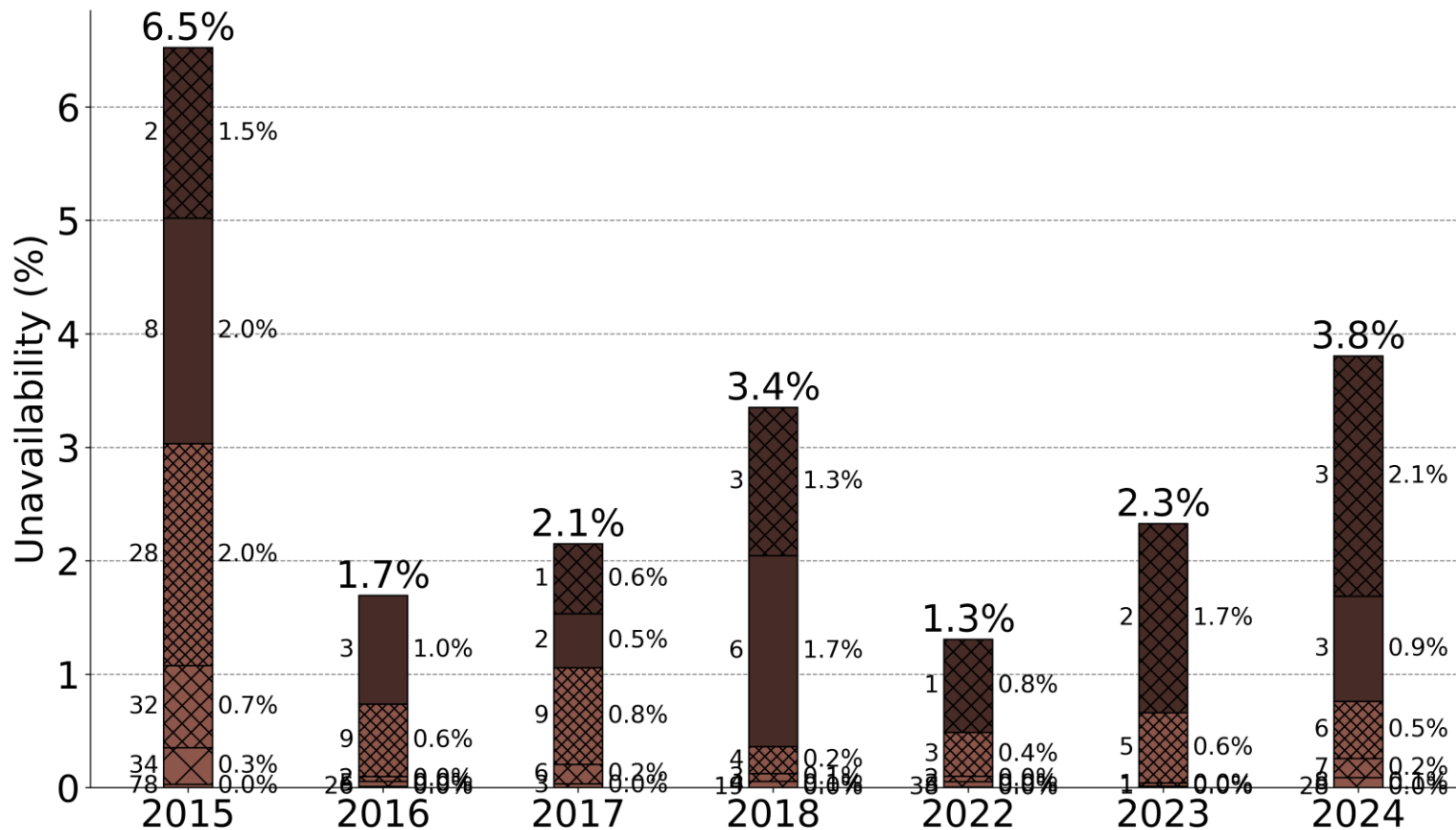
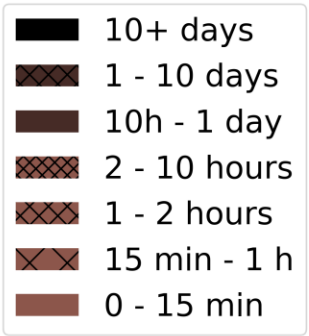
LHC All Operation - QPS



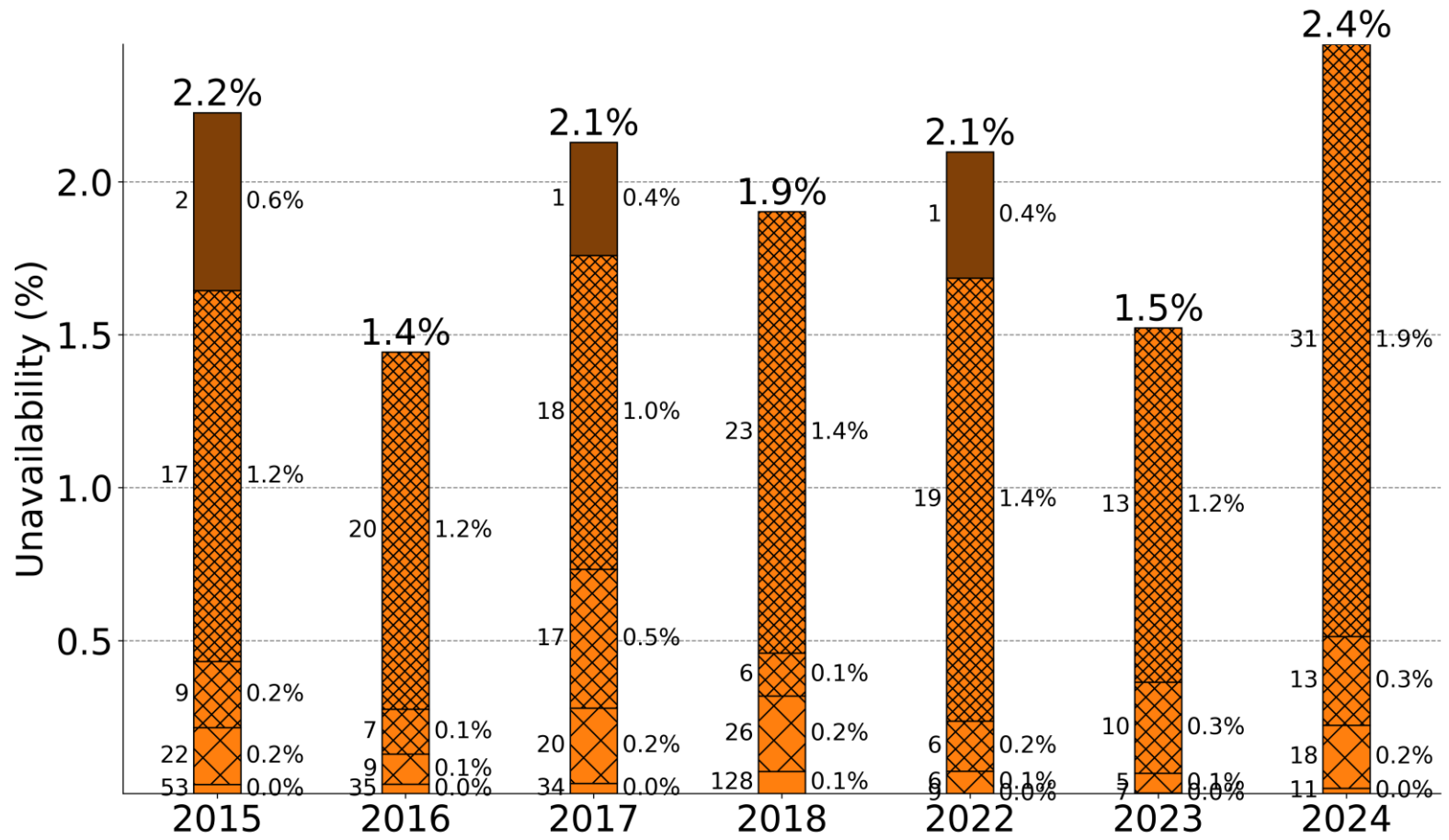
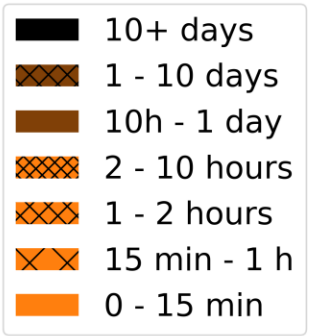
LHC All Operation - Cryogenics



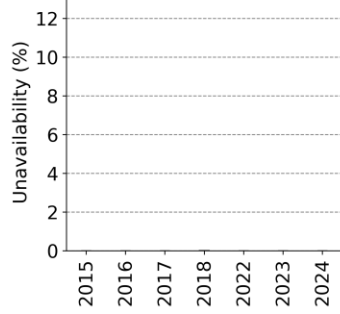
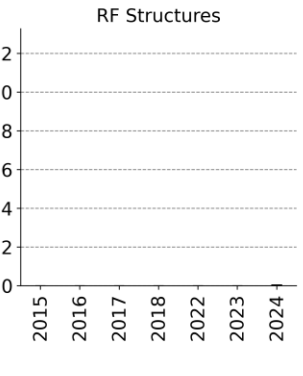
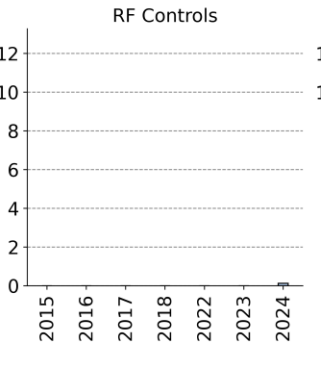
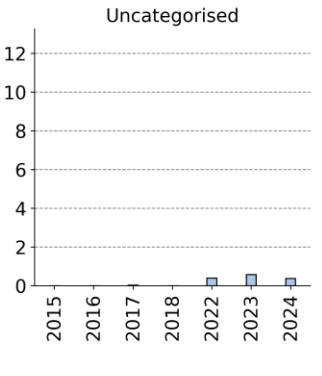
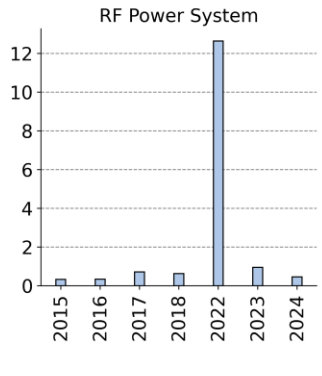
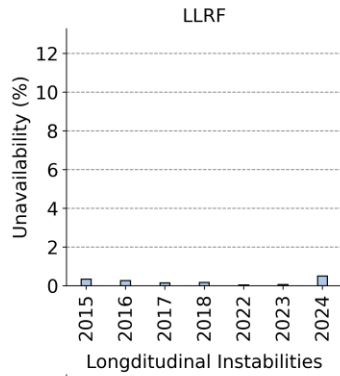
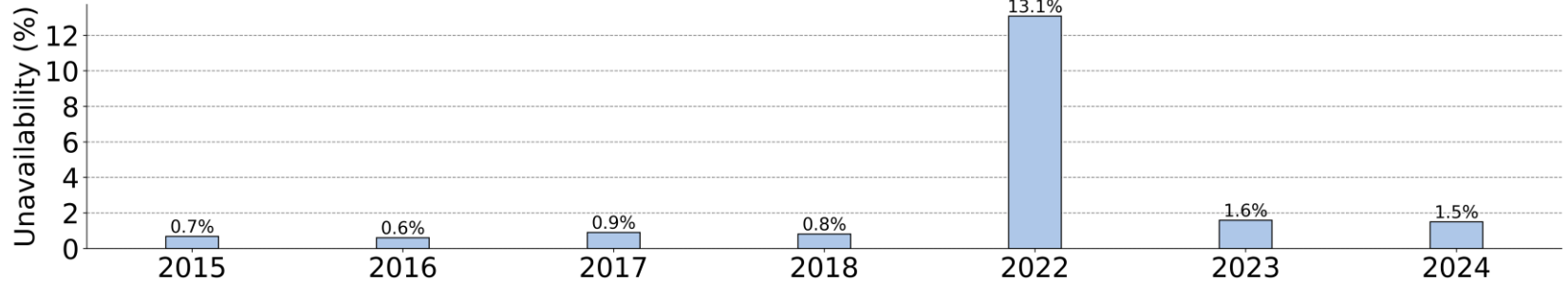
LHC All Operation - Cryogenics



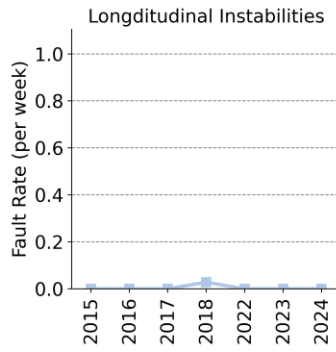
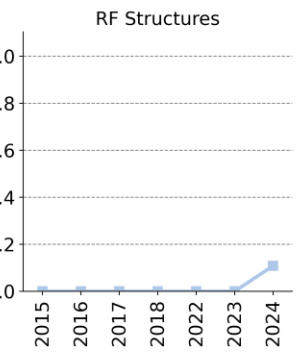
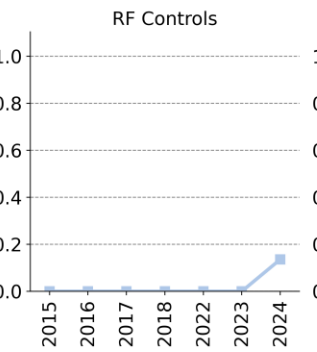
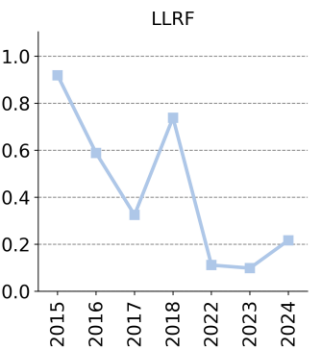
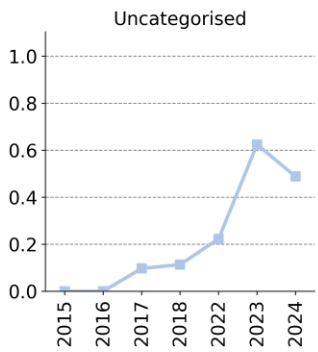
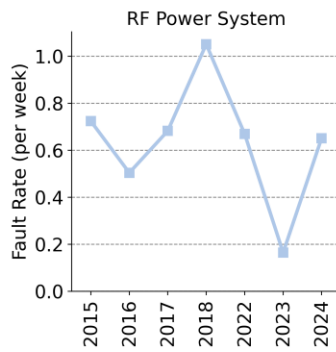
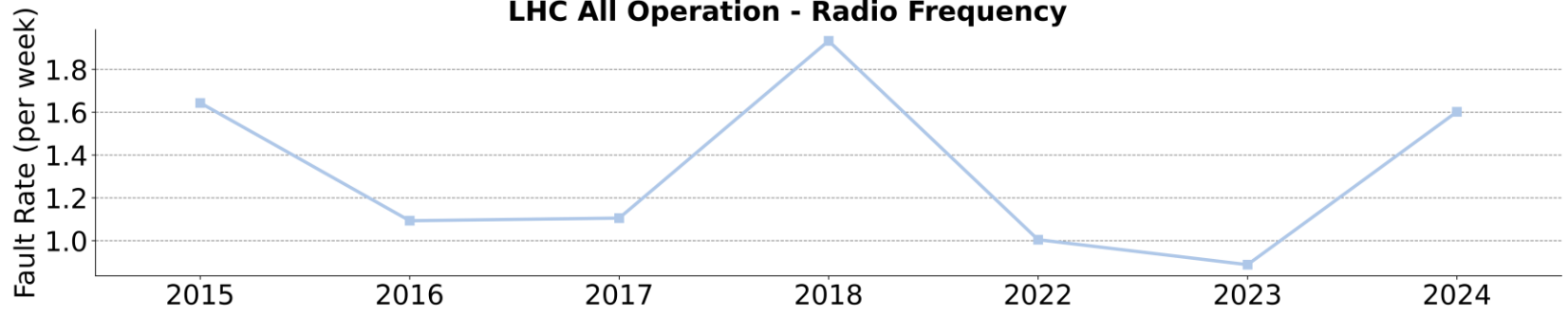
LHC All Operation - Power Converters



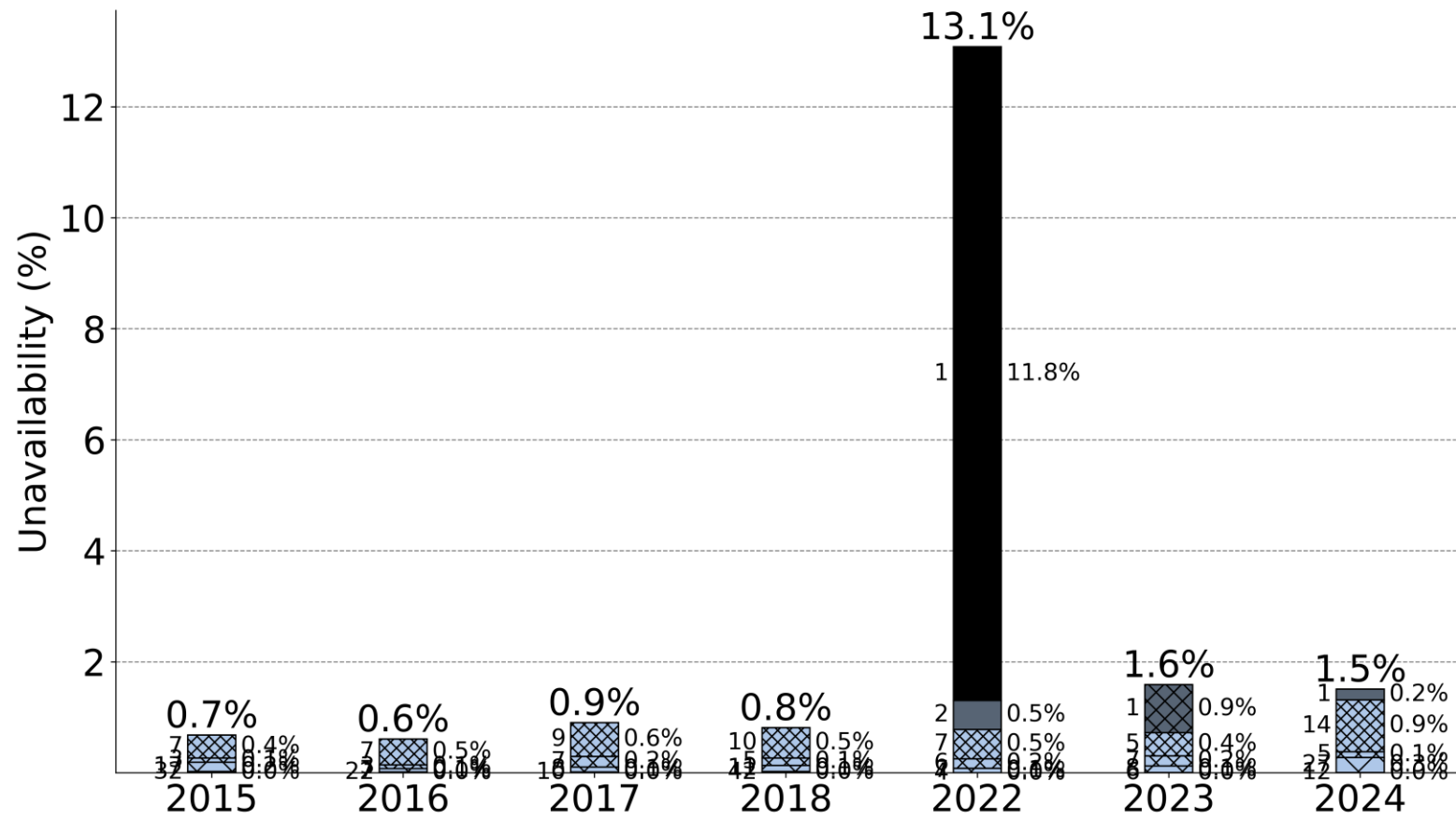
LHC All Operation - Radio Frequency



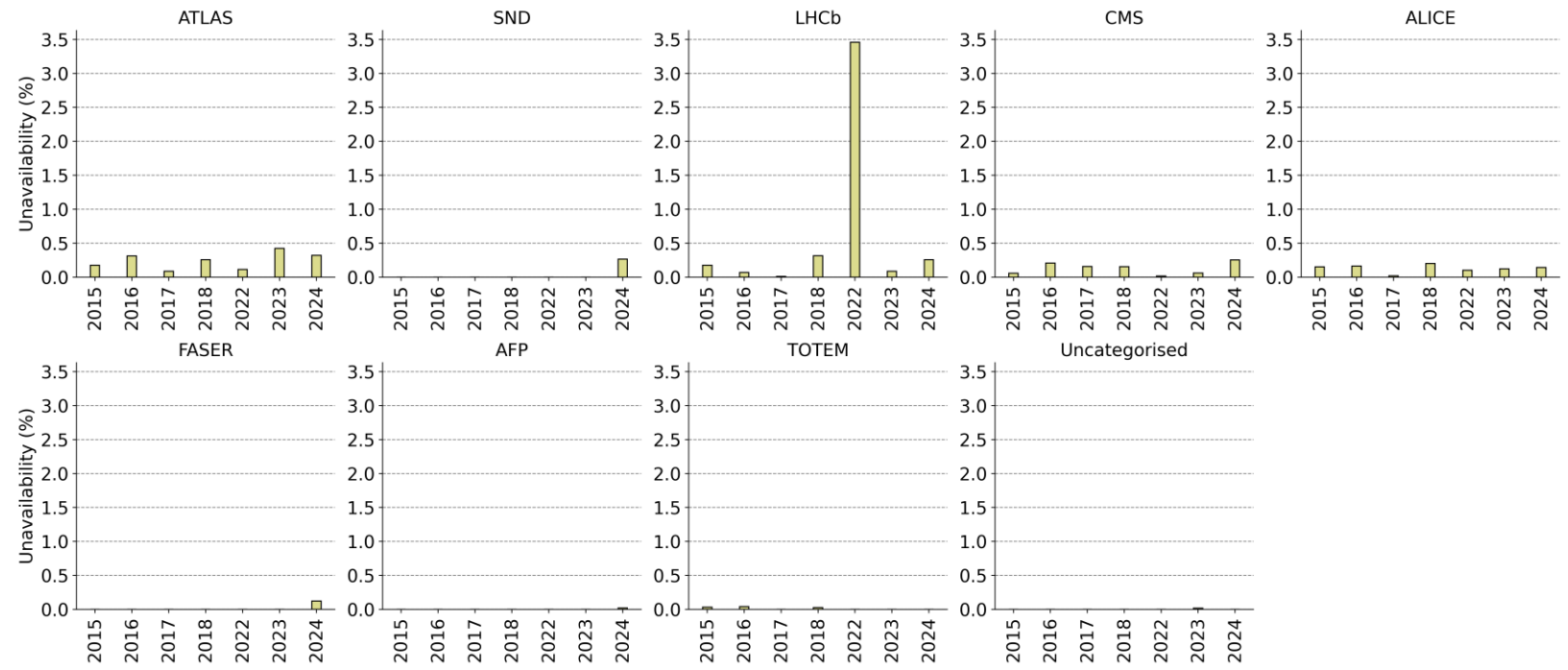
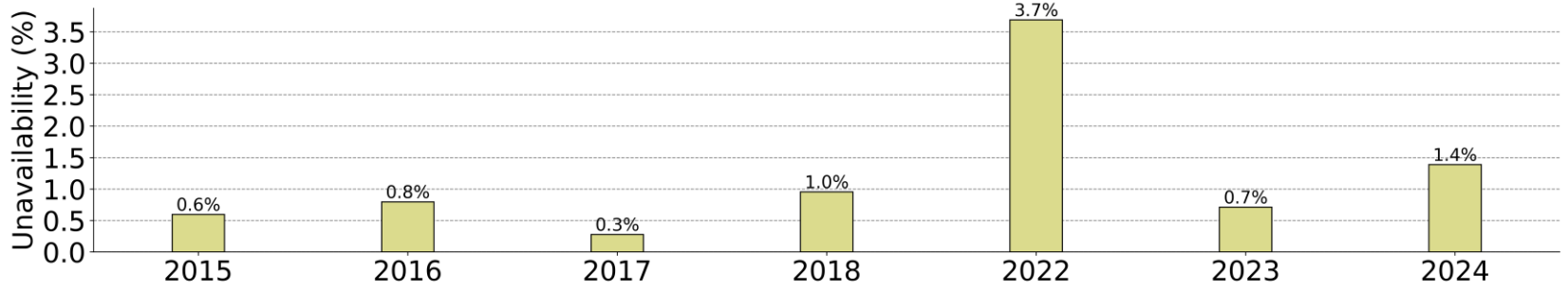
LHC All Operation - Radio Frequency



LHC All Operation - Radio Frequency



LHC All Operation - Experiments



LHC All Operation - Experiments

