Setting the Scene of 2022 Operation (and Availability)

A. Apollonio

Joint Accelerator Performance Workshop – 07.12.2022

Acknowledgements: A. Asko, L. Felsberger, Machine Coordinators, AFT support

Fault Recording in 2022

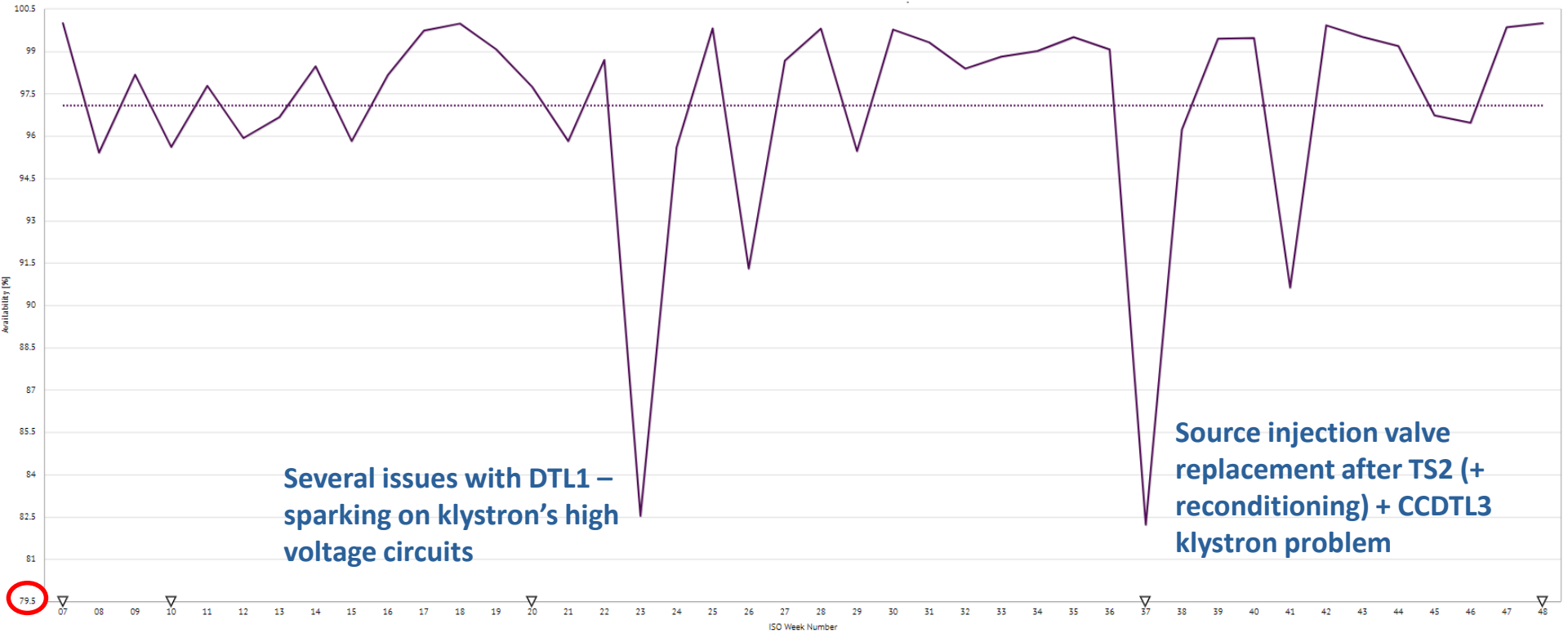
- Fault tracking and statistics are managed through the **Accelerator Fault Tracker** (AFT)
- Entry points for fault recording are:
  - The OP e-logbook, linking to the AFT interface
  - The Big Sister, recording faults through the AFT API

- **NEW in 2022: automatic fault recording** extended to all injector complex (following SPS Big Sister model, with machine-specific logic)
- **NEW in 2022: automatic fault propagation** to downstream machine implemented in AFT
  - Significant reduction of the workload on operators to record faults while increasing granularity (not yet perfect, but on the good track!)

- **Fault review**:
  - Meeting each Monday morning with machine coordinators of the injectors to review faults and expert comments, in preparation for the FOM
  - LHC treated with coordinators mostly on an ad-hoc basis

Linac4 in 2022

Average availability = 97%

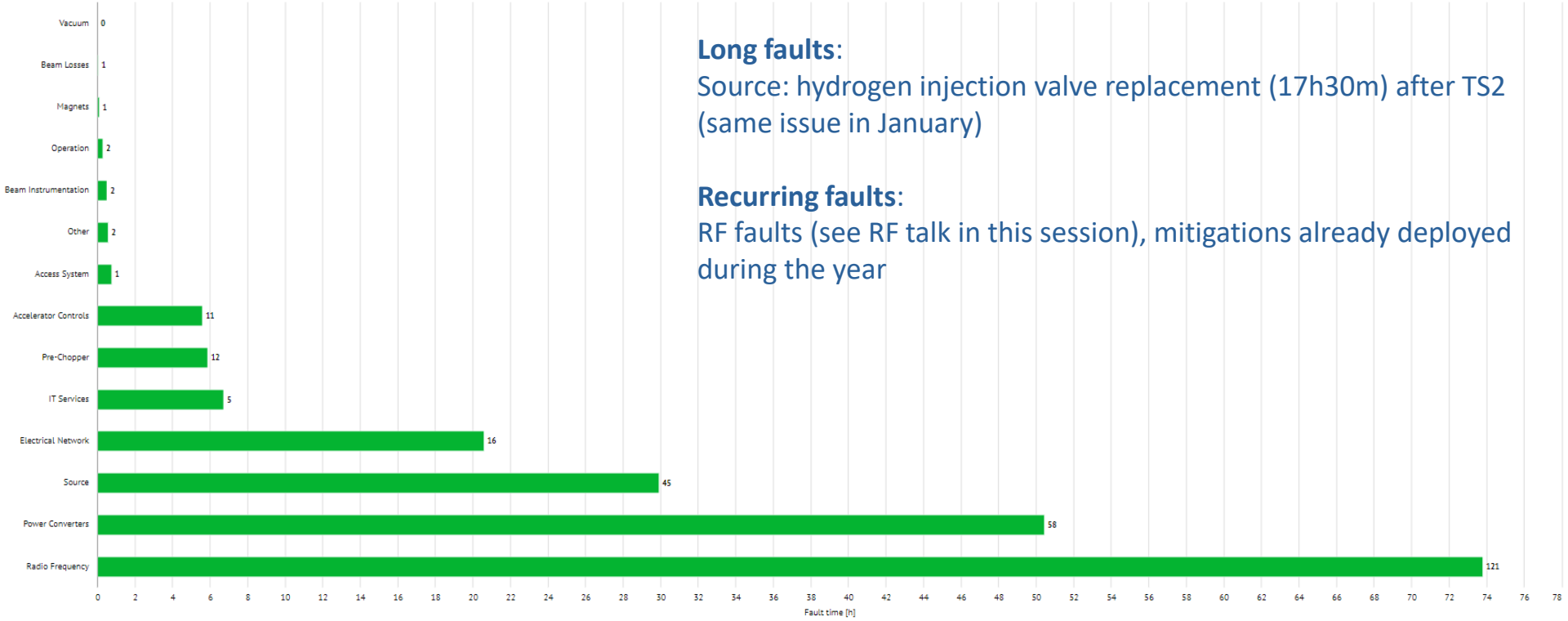


Several issues with DTL1 – sparking on klystron's high voltage circuits

Source injection valve replacement after TS2 (+ reconditioning) + CCDTL3 klystron problem

Time Interval: 21st February – 28th November

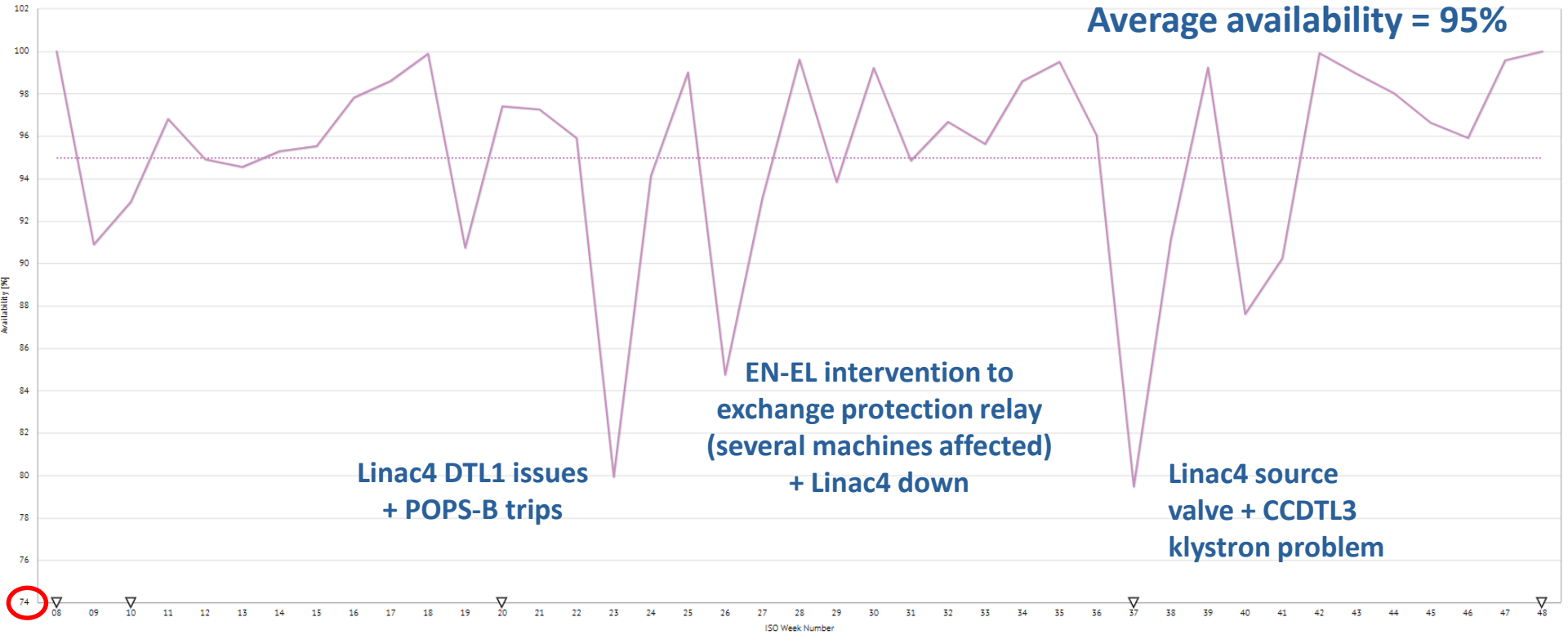
Linac4 Downtime in 2022



Long faults:
Source: hydrogen injection valve replacement (17h30m) after TS2 (same issue in January)

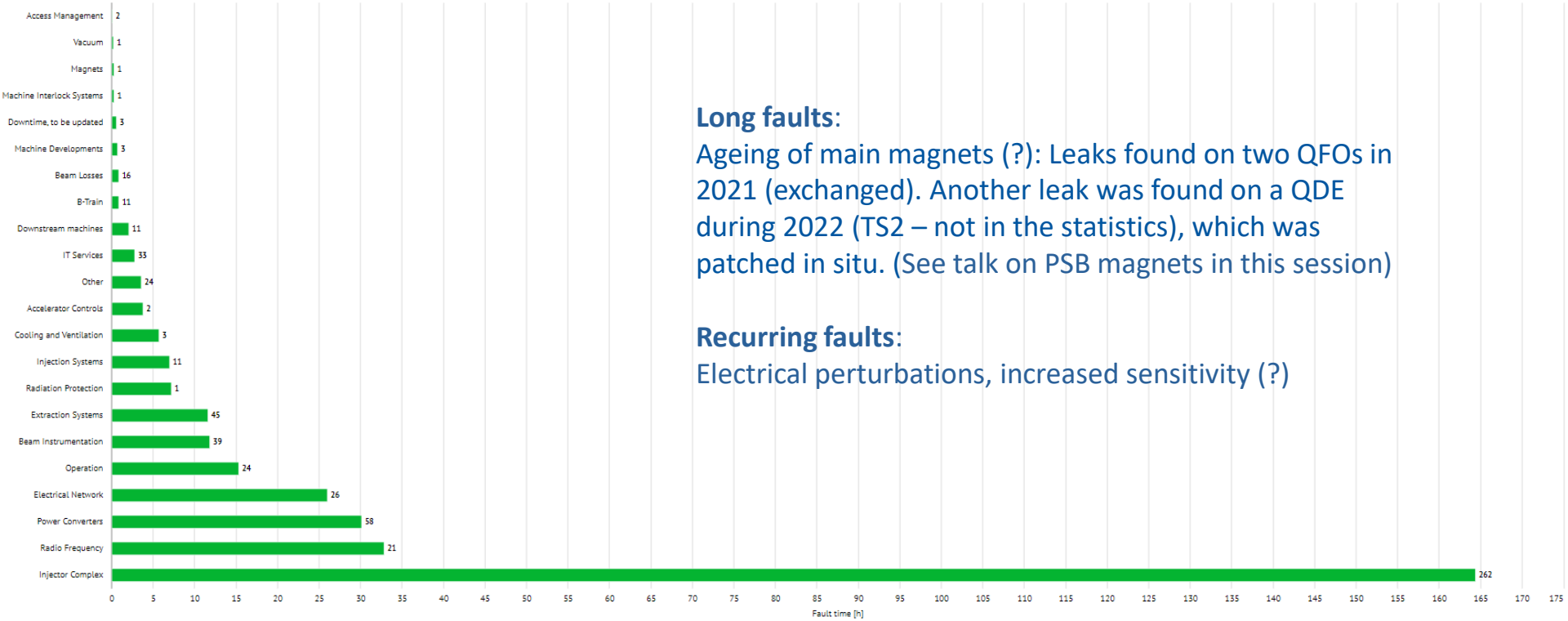
Recurring faults:
RF faults (see RF talk in this session), mitigations already deployed during the year

PSB in 2022



Time Interval: 28th February – 28th November

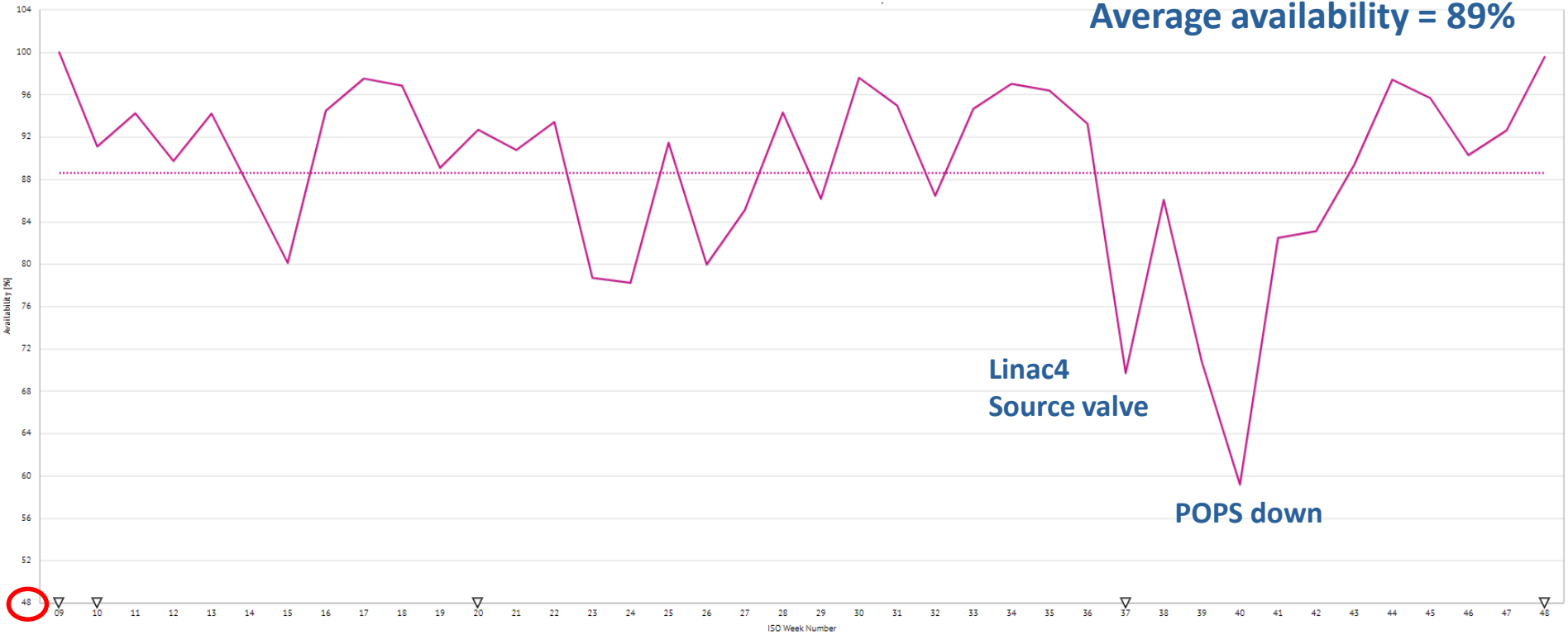
PSB Downtime in 2022



Long faults:
Ageing of main magnets (?): Leaks found on two QFOs in 2021 (exchanged). Another leak was found on a QDE during 2022 (TS2 – not in the statistics), which was patched in situ. (See talk on PSB magnets in this session)

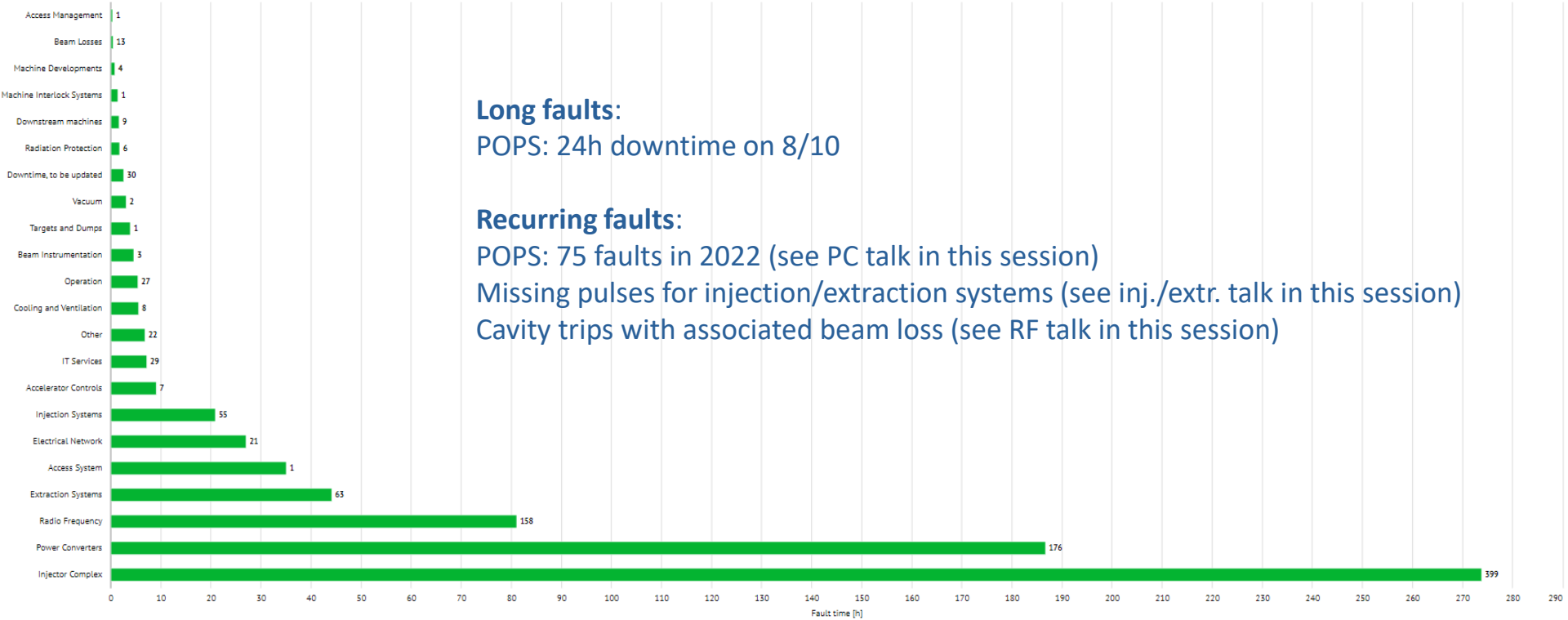
Recurring faults:
Electrical perturbations, increased sensitivity (?)

PS in 2022



Time Interval: 7th March – 28th November

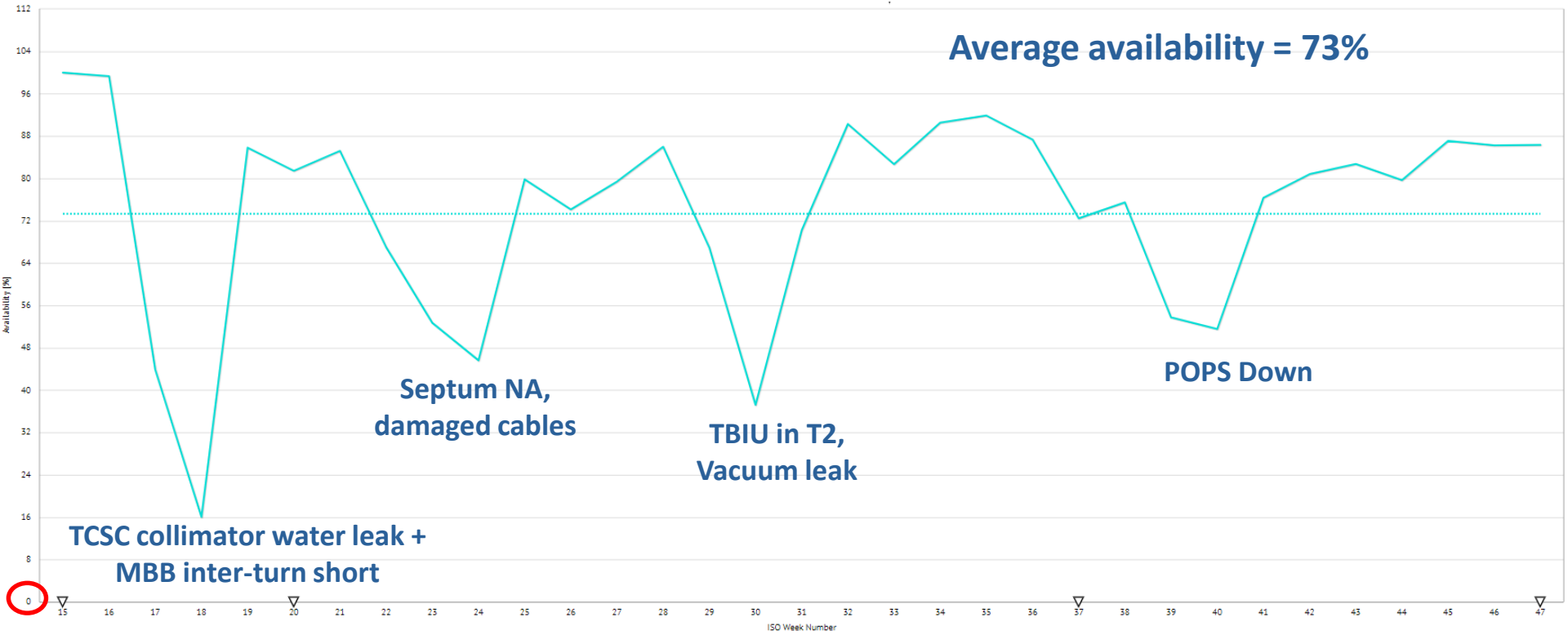
PS Downtime in 2022



Long faults:
POPS: 24h downtime on 8/10

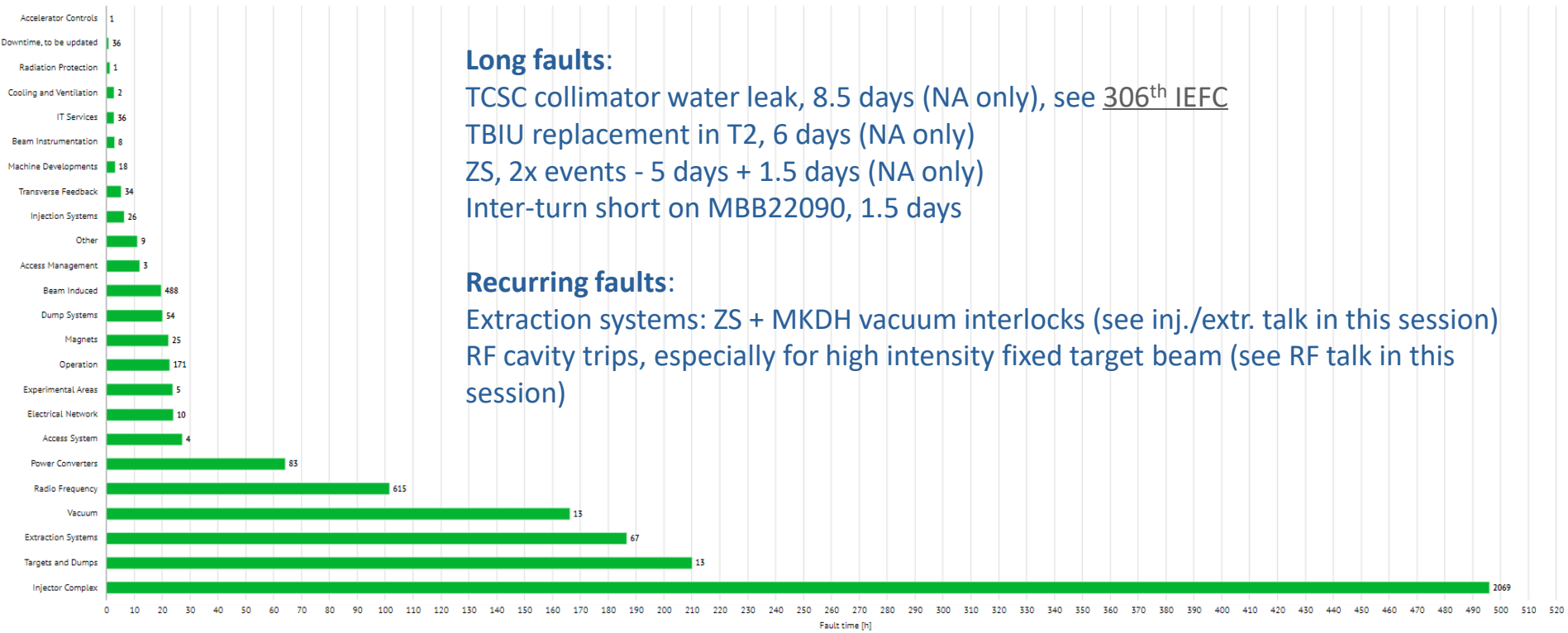
Recurring faults:
POPS: 75 faults in 2022 (see PC talk in this session)
Missing pulses for injection/extraction systems (see inj./extr. talk in this session)
Cavity trips with associated beam loss (see RF talk in this session)

SPS in 2022 (NA destination)



Time Interval: 18th April – 28th November

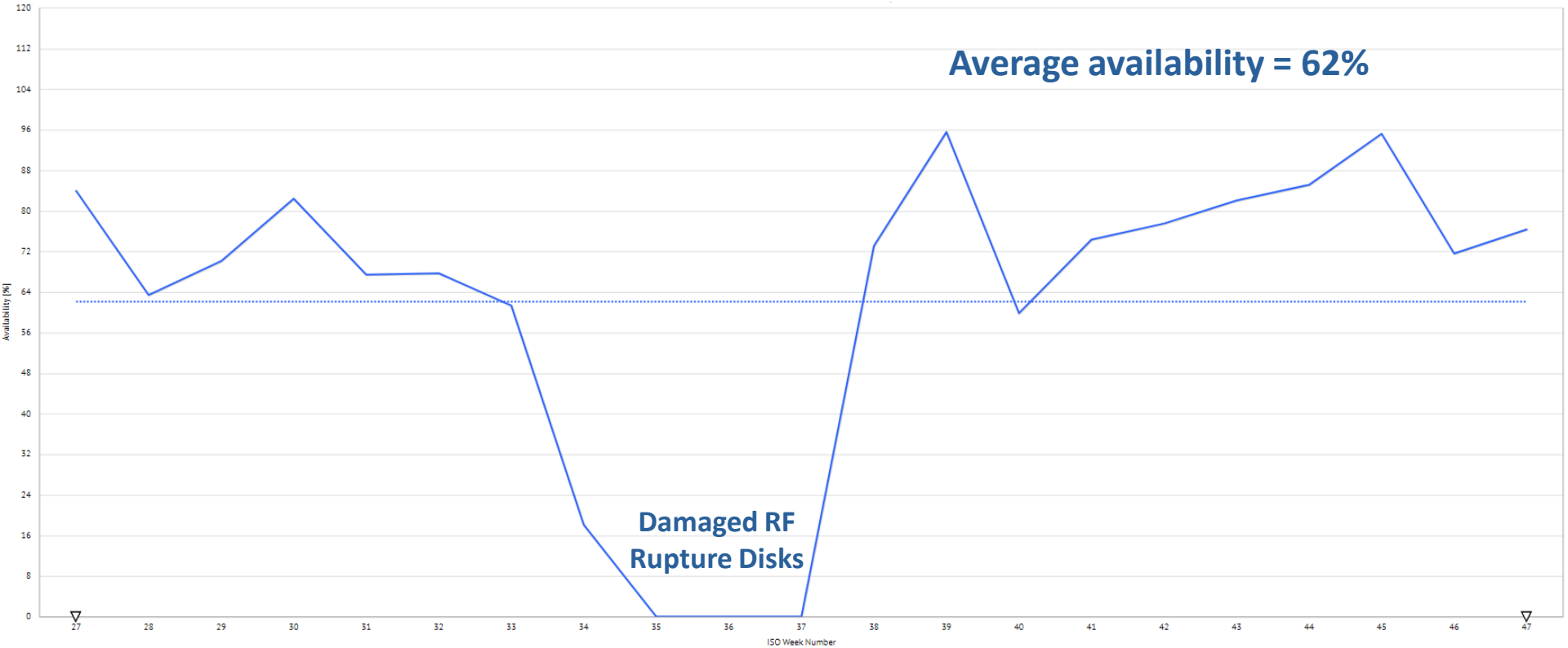
SPS Downtime in 2022



Long faults:
TCSC collimator water leak, 8.5 days (NA only), see 306th IEFC
TBIU replacement in T2, 6 days (NA only)
ZS, 2x events - 5 days + 1.5 days (NA only)
Inter-turn short on MBB22090, 1.5 days

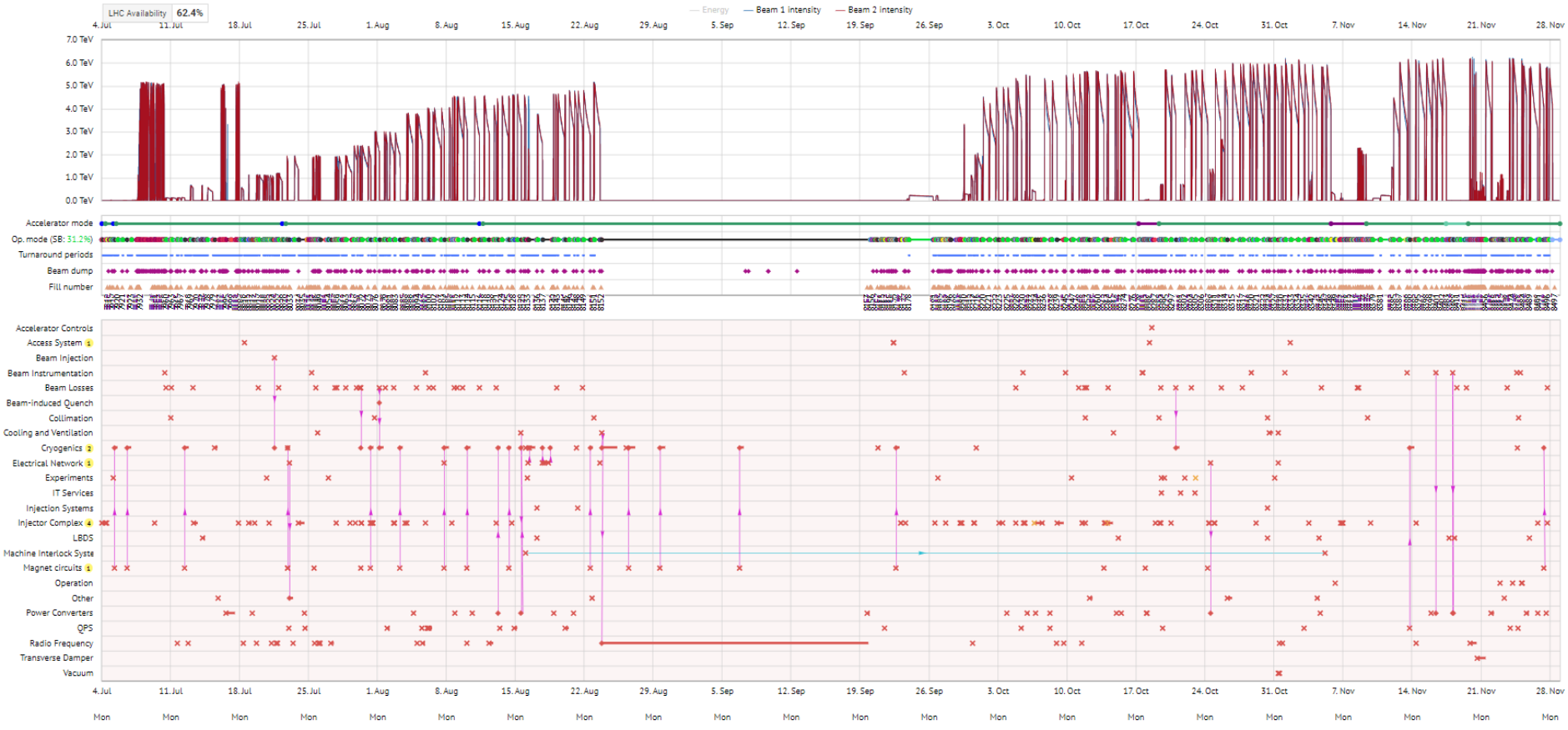
Recurring faults:
Extraction systems: ZS + MKDH vacuum interlocks (see inj./extr. talk in this session)
RF cavity trips, especially for high intensity fixed target beam (see RF talk in this session)

LHC in 2022

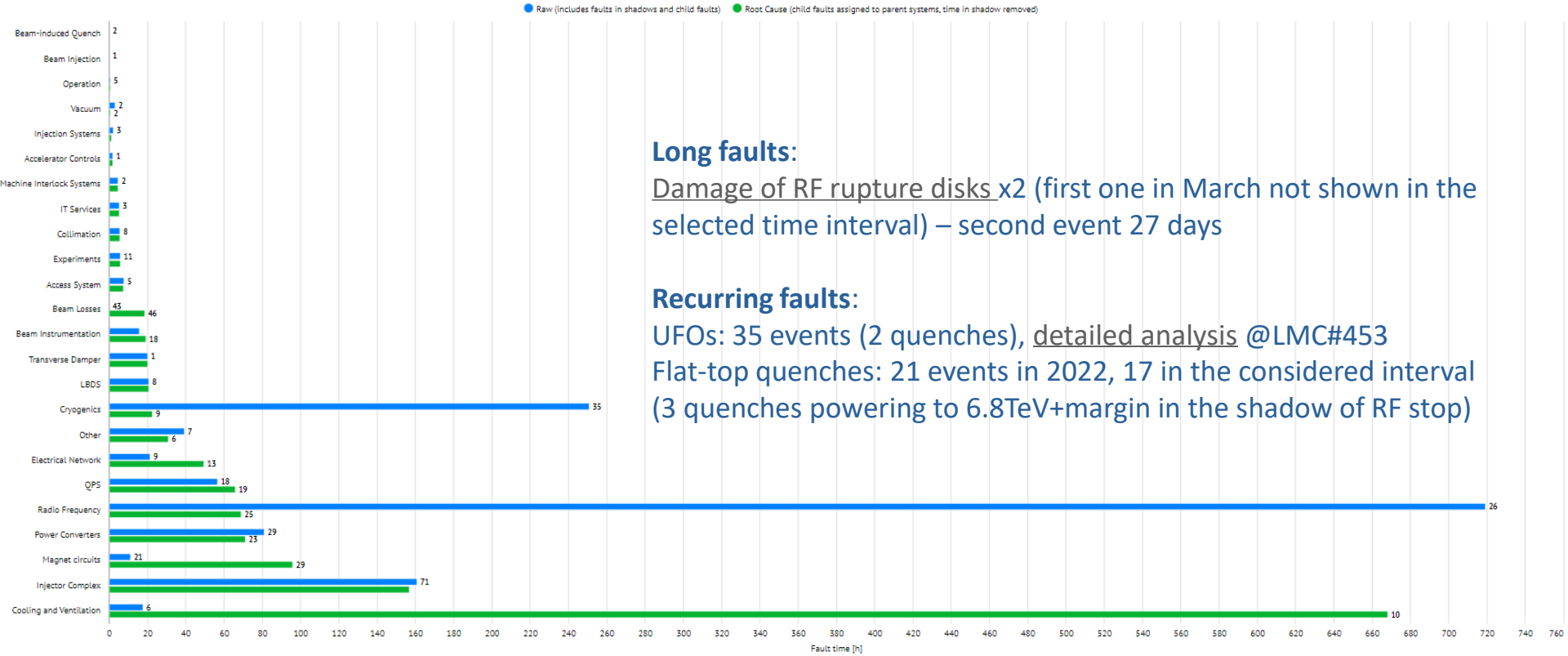


Time Interval: 4th July – 28th November

LHC in 2022 - Cardiogram



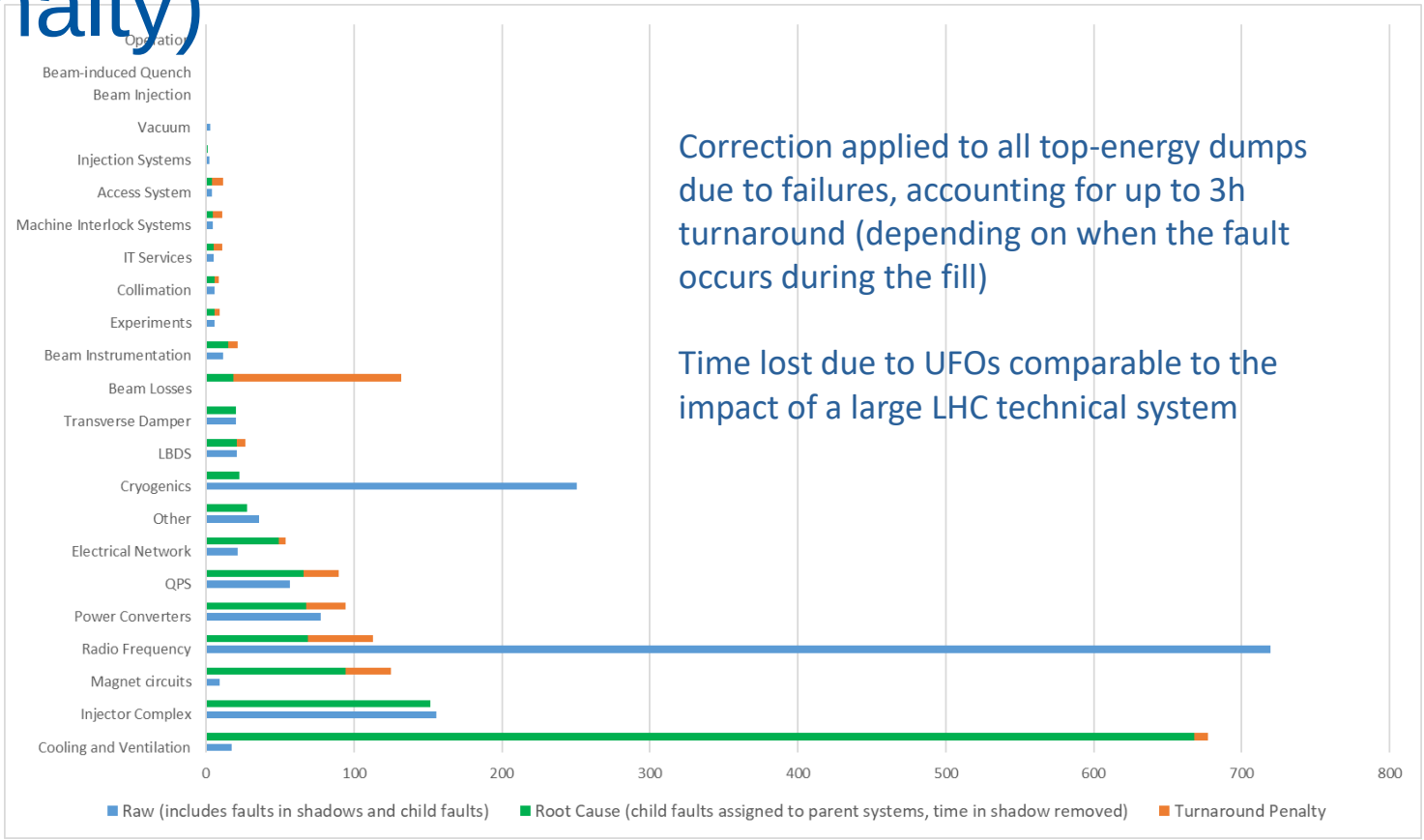
LHC Downtime in 2022



Long faults:
Damage of RF rupture disks x2 (first one in March not shown in the selected time interval) – second event 27 days

Recurring faults:
UFOs: 35 events (2 quenches), detailed analysis @LMC#453
Flat-top quenches: 21 events in 2022, 17 in the considered interval (3 quenches powering to 6.8TeV+margin in the shadow of RF stop)

LHC Downtime in 2022 (Turnaround Penalty)

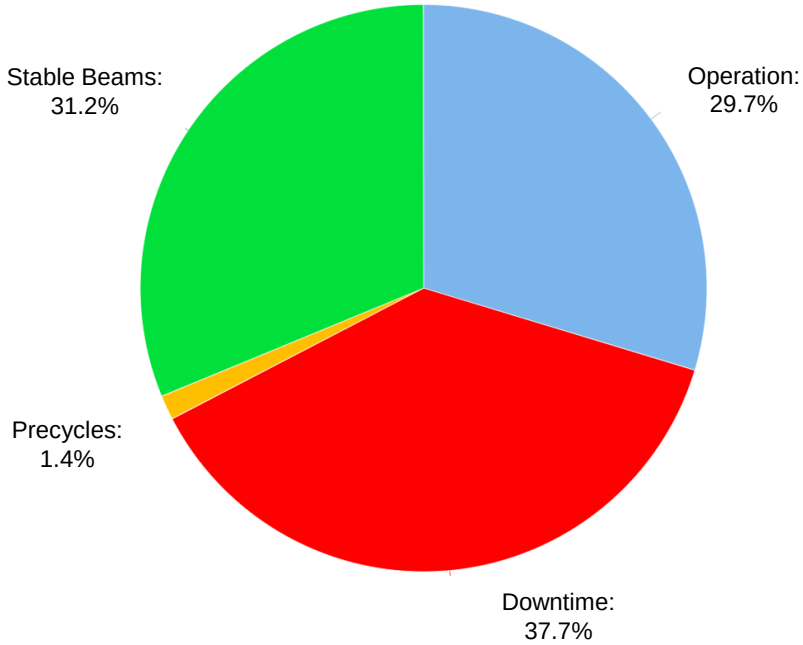


Correction applied to all top-energy dumps due to failures, accounting for up to 3h turnaround (depending on when the fault occurs during the fill)

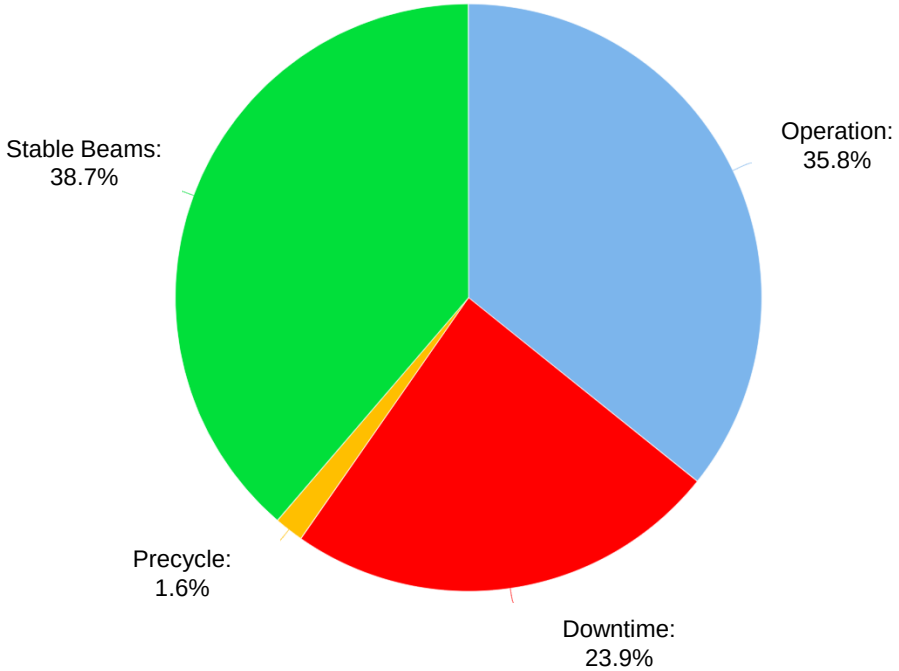
Time lost due to UFOs comparable to the impact of a large LHC technical system

Courtesy L. Felsberger

LHC Stable Beams in 2022



Excluding TSs, MDs



Excluding TSs, MDs, RF stop

Plans for 2023 Fault Tracking / RASWG

- **Towards fully automatic fault recording** in the injectors:
  - Discussions ongoing in OP on how to synchronize individual instances of Big Sister in order to avoid fault duplication while considering propagation to downstream machines → also improve destination-dependent statistics
  - AFT API extension foreseen to receive data from Big Sister in a “new format”

- **Continue with weekly fault reviews** with machine coordinators, involving also LHC

- Involvement of **experimental areas coordinators** to be improved

- Increase **engagement of equipment groups** and system experts in the review process
  - Interest for equipment group performance tracking and maintenance

Conclusions

- **Average availabilities**:
  - Linac4: 97%, close to Linac2 performance!
  - PSB: 95%, the main source of faults was Linac4
  - PS: 89%, POPS problems affected operation significantly from September
  - SPS: 73%, mainly driven by long faults affecting the NA
  - LHC: 62%, strongly affected by RF burst disks rupture (3 weeks downtime)

- Working **towards fully automated fault tracking**:
  - Extension of Big Sister to all injectors
  - Automatic fault propagation of faults to downstream machines
  - Integration and synchronization of different Big Sister instances foreseen for 2023

- **Engagement** of machine coordinators and system experts fundamental to ensure **high data quality**

Thank you for your attention