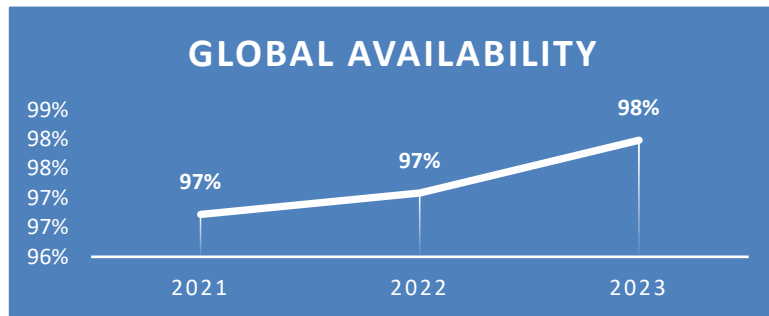


LINAC4

Availability Statistics 2023

Lukas Felsberger
Piotr Skowronski

2023 in Context

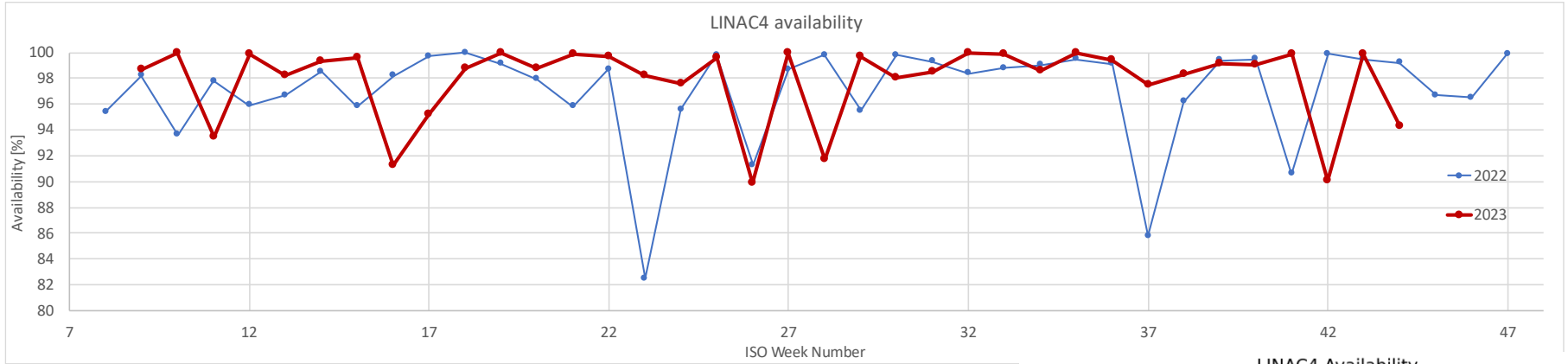


Try to put the year in context of other years. Is it matching your expectations?

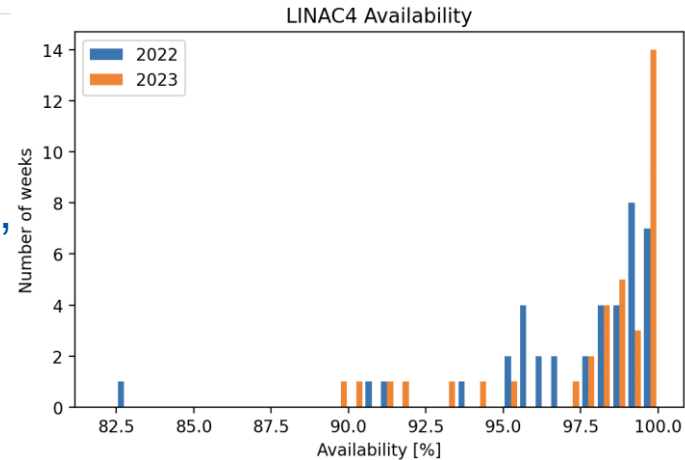
➤ Yes.

- We continue solving issues which repeatedly cause downtime.
- Machine is still relatively new: we don't see many aging effects.
- There was smaller number of major faults, i.e., longer than 2h.
- Increasing experience also plays a role

Weekly Availability by Destination



- Continued solving issues that repeatedly cause downtime.
 - In 2023 14 weeks with availability above 99.5%, 5 weeks with 100%
- 7 major faults



Major faults

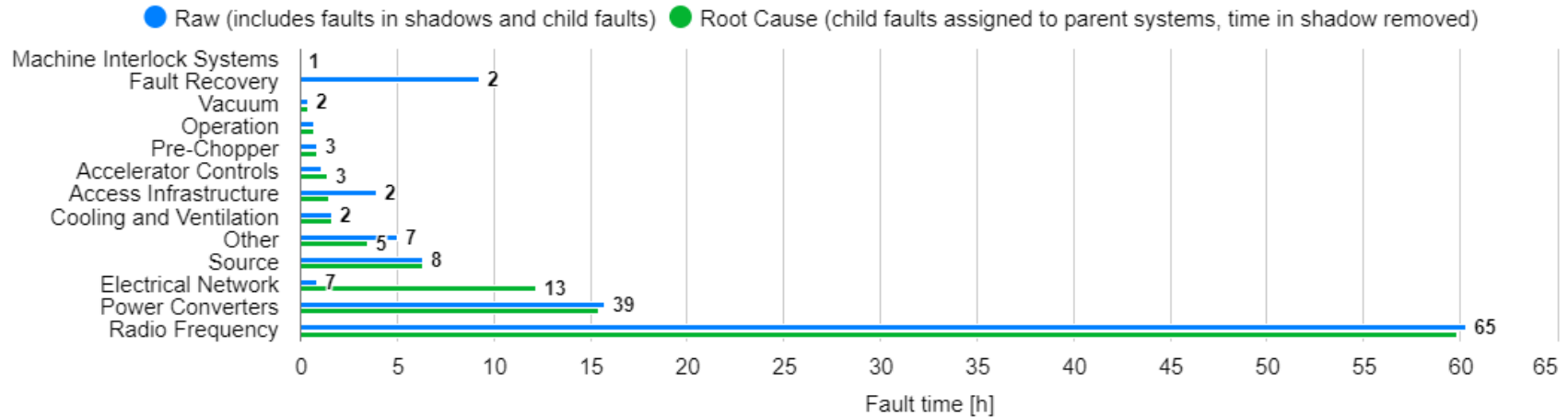
- 2x burned connector on focus circuit
 - Other connectors were verified during ITS
 - Consolidation during YETS
- Hydrogen valve in the source
- Aftermath of LEIR circuit breaker fault
- Card measuring filament current (interlock)
- Water pressure sensor (interlock)
- Card measuring focus current (interlock)
+ difficulties in the system restart
- Sensor checking socket connection (interlock)

date	element	downtime
Mar 15	PIMS1112	9 hours
Apr 15	PIMS0102	8 hours
Apr 28	source	5 hours
Jun 27	multiple	7 hours
Jun 1	CCDTL1	4.5 hours
Jun 12	CCDTL1	13.5 hours
Oct 17	CCDTL7	10.5 hours
Nov	pre-chopper	4.5 hours

4 out of 7 are related to faulty sensors interlocking the machine

System Downtime

Faults by Root Cause



- In linacs RF is the main, and by far the most challenging system: it must be the main downtime contributor
- Modulators are power supplies that deliver above 100 kV voltage for klystrons. De facto, they are integral part of RF powering system:
 - They interlock with fast abort if RF lines stops.
 - They suffer from any RF sparking (breakdown) or malfunctioning

Therefore, it is not a surprise that they are the 2nd contributor to the downtime

Implemented improvements

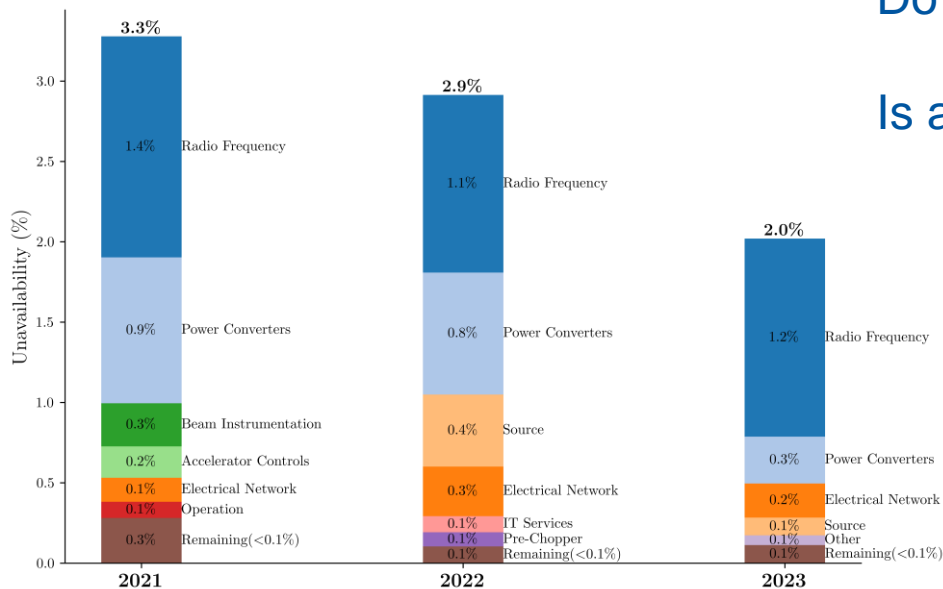
- Contained sparking in modulator-klystron interface
 - Minimized modulator voltages
 - Modified layout implemented on the most affected system brought the expected result, we could come back to the nominal voltage
- Exchanged DTL1 klystron
- Understood and fixed the long-standing klystron control issue
- Chopper:
 - Upgrade of amplifier and control electronics
 - Updated PLC firmware implementing protection and interlock logic
 - Chopper dump alignment line and better steering in MEBT:
- Cavity break down protection implemented on all single cavity lines
 - Dual cavity lines will be equipped during this year
- Modified timing layout reduced BCT watchdog interlocks

Chopper upgrades

- TTL logic ICs matching: to have internal synchronization between the boards and similar time responses between the modules.
- Implementation of the "fail-safe Logic" for the modules (in cooperation with the modification on the PLC): Now, if something goes wrong, the module switches OFF. Before, it was kept ON and potentially pulsing.
- EMI upgrade. For each module, a few boards and the cabling between them have been modified to reduce crosstalk and unwanted, random activation spikes.
- Better filtering of the Mosfet boards.
- Relay circuit modification, to avoid random activation of the IGBT boards for capacitance discharge.

Unavailability by System

LINAC4 Unavailability by System



Do these trends match your impression?

Yes

Do you want to point out a positive trend?

Yes

Is any trend worrying you?

No

Summary & Conclusion Slides

- Improvements brought the desired effect in reduced downtime
- Hopefully, we can keep the trend of increasing availability, however, it depends on number and severity of major faults.

„Information“ 1/2

These slides are a template to summarize the availability of your machine in 2023. Please correct and complement the slides considering following questions:

- What are the main events & reasons impacting availability?
 - Does the data show them and is it matching your expectations?
 - Is any crucial aspect not visible in the data that we should have a closer look at?
- What is the outlook for next year?
 - Are you expecting some interventions over the YETS that might improve availability next year?
 - Could certain circumstances lead to an availability degradation?

„Information“ 2/2

- There will be additional questions on each slide.
- All charts can be regenerated from [AFT – Dashboard \(cern.ch\)](#)
- For further inspiration what to put in the slides, please have a look at <https://indico.cern.ch/event/1104980/>

Considered Times

- Availability counting starts once beam has to be delivered for downstream machine
 - → 03-03-2023 09:00:00 - 13-11-2023 06:00:00
- Excluded time periods
 - MD
 - 10-05-2023 08:00 – 18:00
 - 30-10-2023 07:30 – 31-10-2023 18:00
- (Should these times be wrong, please correct the times above or add additional excluded time periods and let us know – we can update your template)