PSB

G.P. Di Giovanni on behalf of the PSB team

Outline

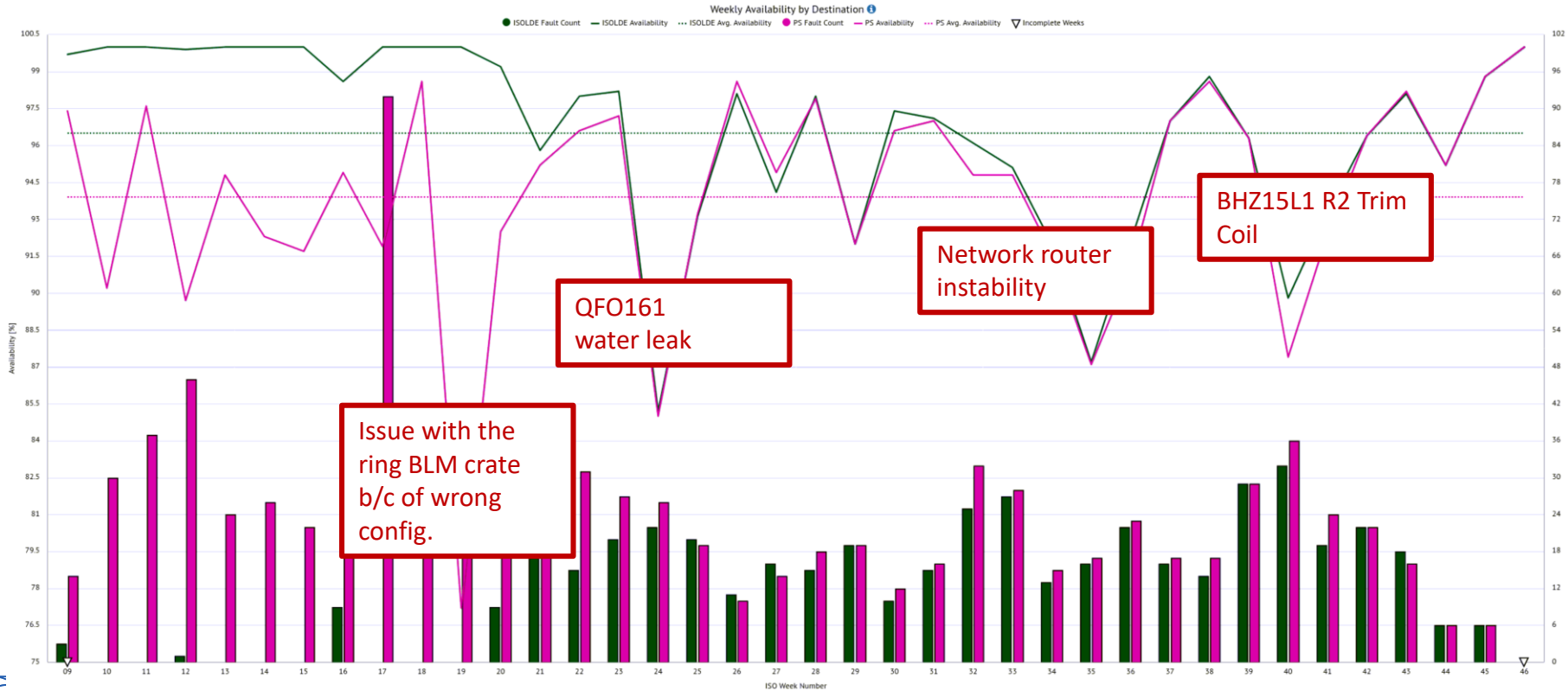
- 1 slide on weekly availability over the full operational period in 2021 (including availability by destination)
- 1 slide on downtime distribution by system over the full operational period in 2021
- 1 slide elaborating on observed top fault contributors and recurring faults
- 1 slide on plans for automatic fault recording - extension of Big Sister (+implemented logic)
- 1 slide on additional wishes for AFT + ideas to improve the fault recording / review process for 2022

In addition, I would kindly ask to report on any feedback you had on the subject during the Montreux workshop.

In particular I would like to involve more the experimental areas in our review process, as the related statistics are difficult to synchronize with the machines.

Anti will then provide an overview of the AFT developments already foreseen for next year.

PSB (01.03.2021 – 15.11.2021)



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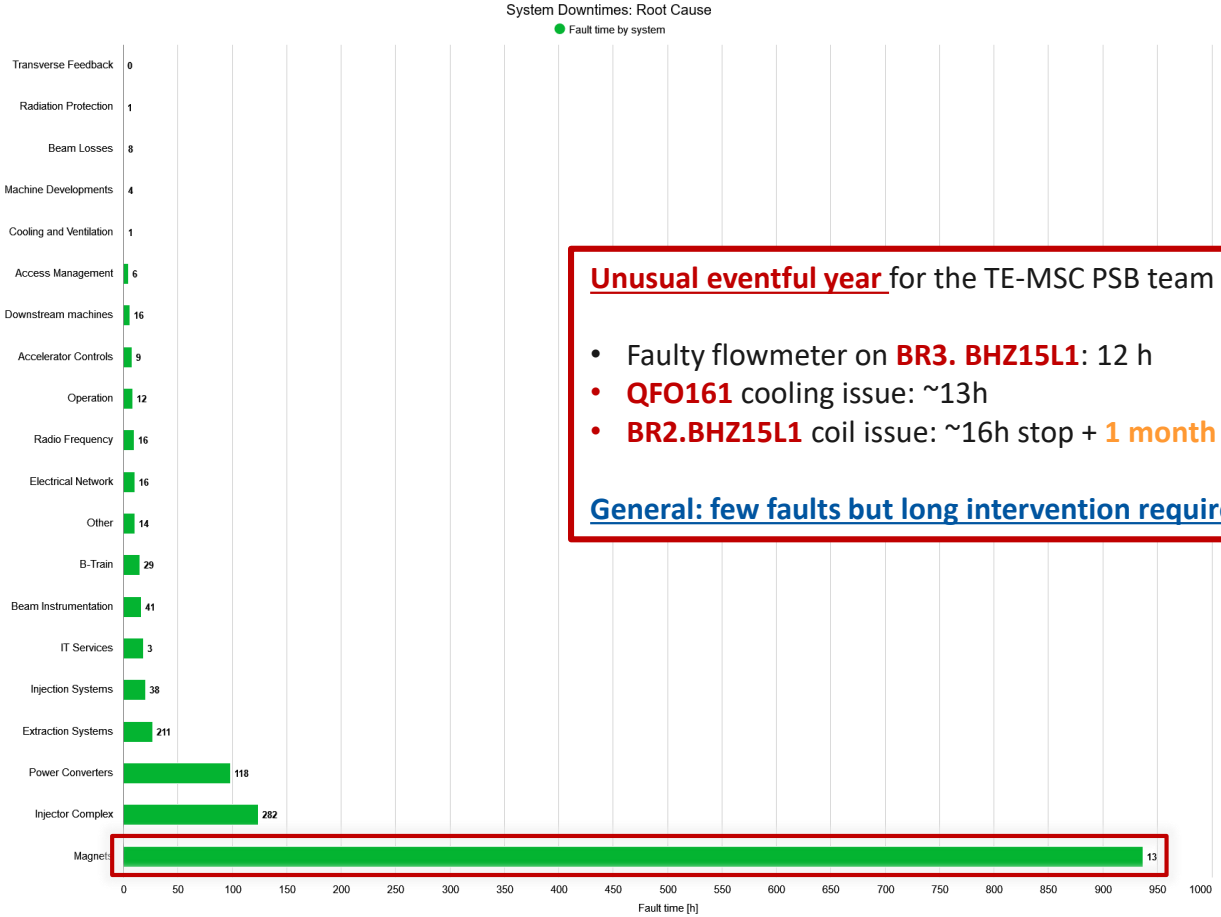


Unusual eventful year for the TE-MSC PSB team

- Faulty flowmeter on **BR3. BHZ15L1**: 12 h
- **QFO161** cooling issue: ~13h
- **BR2.BHZ15L1** coil issue: ~16h stop + **1 month in non-blocking**

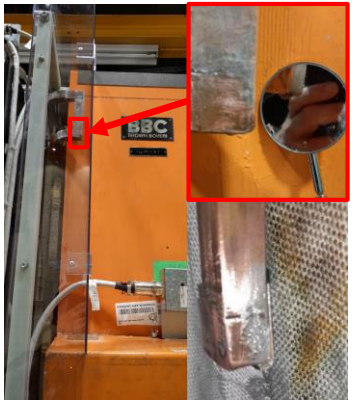
General: few faults but long intervention required every time (access needed)

Magnets

- **BHZ15L1 Special trim 2&3 failure:**
  - Additional coil (LIU) to BHZ15L1 & BHZ16L2 to reduce the saturation of the gaps 1:4 wrt 2:3
    - Turned to be beneficial for orbit corrections and extraction optimization as well.
  - **Partial failure in October 2021:**
    - **Half of the coil shunt** → **PSB team recovered the steering for all beams.**
      - Following studies indicate that **it is possible to still extract beam with a total failure of the coils.**
    - In a follow-up access, **R2 square vacuum chamber sleeve had moved upstream by several cm.**
      - **Could not conclude** if it was the cause of the issue. **Moved back in position**.
      - **Priority is magnet replacement during YETS for deep investigation**.

Vacuum chamber square sleeve to shim coils

- **QFO water leaks:**
  - End of June 2021, a leak was reported on the **QFO161**:
    - **First out of ~3500 brazing to fail in > 40 years of service.**
    - **To be replaced in YETS**. AS a note, previous magnet removals in PSB were correlated to vacuum issues.
  - **Second leak found on QFO91 during the HV tests** (YETS):
    - The magnet needs to be **exchanged**.
    - **Systematic issue? Consolidation program?** → Investigation ongoing.



Leak on QFO161

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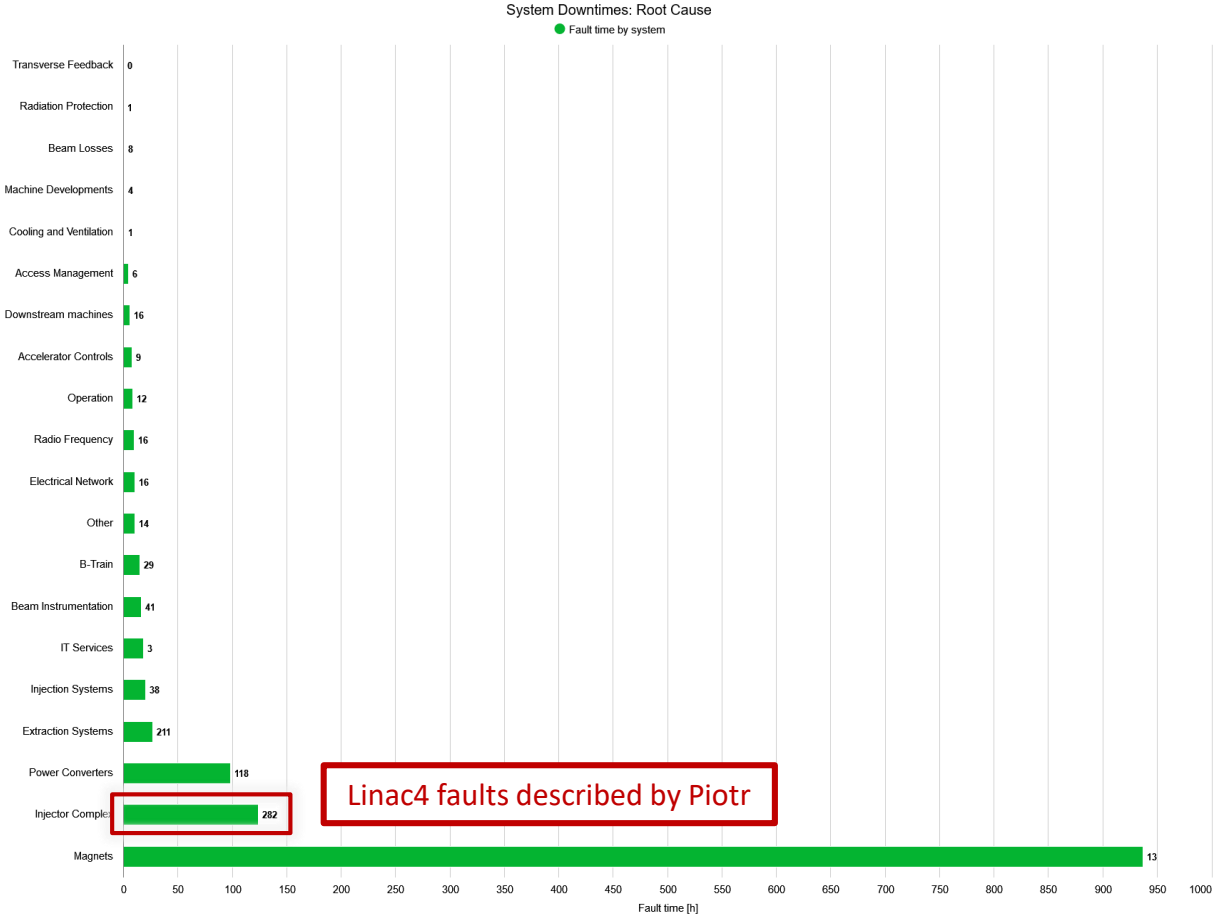
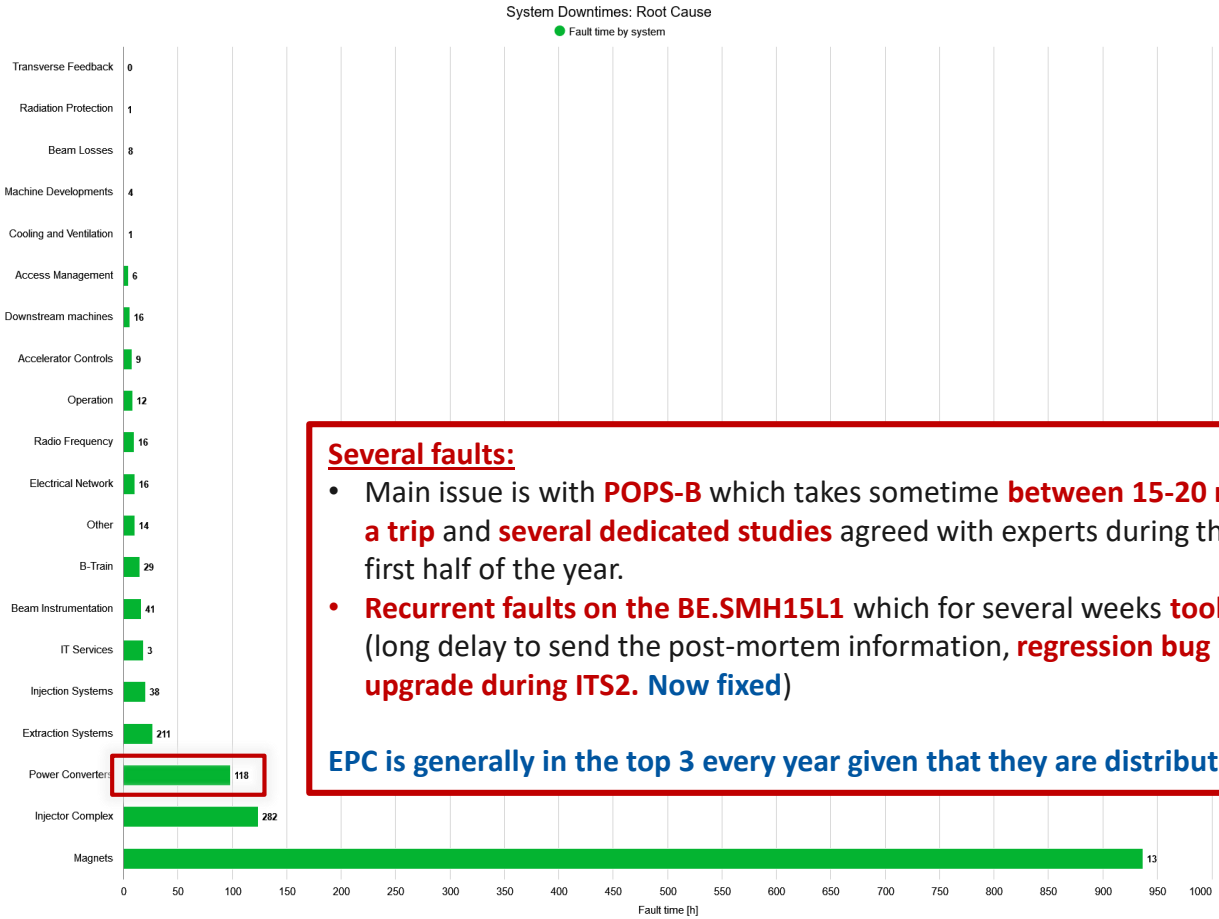


Linac4 faults described by Piotr

PSB (01.03.2021 – 15.11.2021)



Several faults:

- Main issue is with **POPS-B** which takes sometime **between 15-20 minutes to recover from a trip** and **several dedicated studies** agreed with experts during the run especially in the first half of the year.
- **Recurrent faults on the BE.SMH15L1** which for several weeks **took ~10 minutes** to restart (long delay to send the post-mortem information, **regression bug in one of the FGC62 upgrade during ITS2. Now fixed**)

EPC is generally in the top 3 every year given that they are distributed all over the machine

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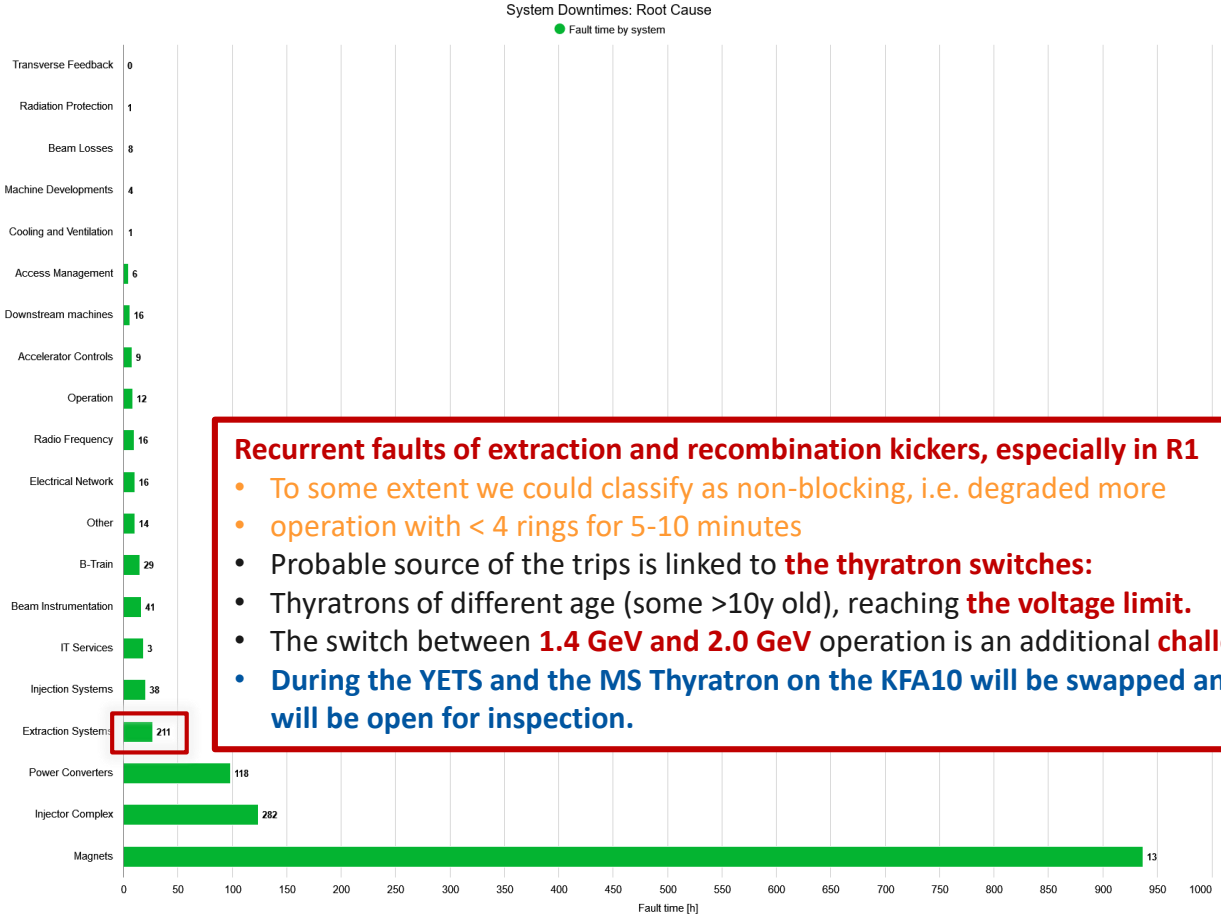

Recurrent faults of extraction and recombination kickers, especially in R1

- To some extent we could classify as non-blocking, i.e. degraded more
- operation with < 4 rings for 5-10 minutes
- Probable source of the trips is linked to **the thyratron switches:**
- Thyratrons of different age (some >10y old), reaching **the voltage limit.**
- The switch between **1.4 GeV and 2.0 GeV** operation is an additional **challenge**.
- **During the YETS and the MS Thyratron on the KFA10 will be swapped and KFA14L1 MS switch will be open for inspection.**

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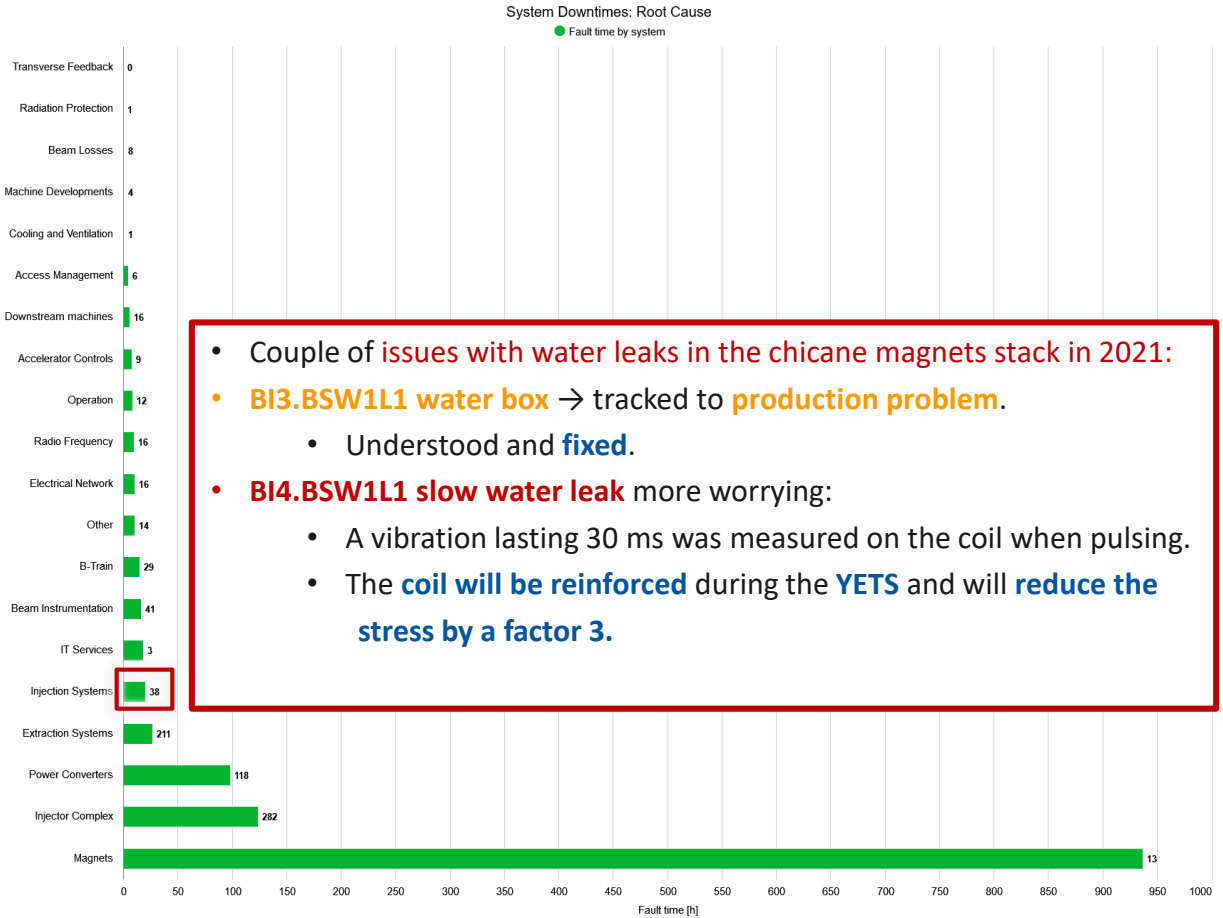
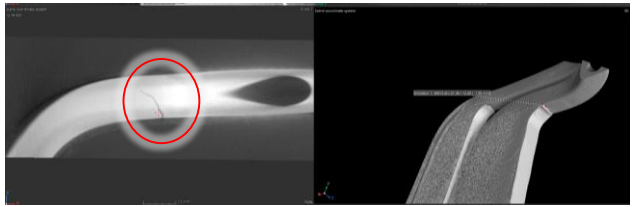


- Couple of issues with water leaks in the chicane magnets stack in 2021:
- **BI3.BSW1L1 water box** → tracked to **production problem**.
  - Understood and **fixed**.
- **BI4.BSW1L1 slow water leak** more worrying:
  - A vibration lasting 30 ms was measured on the coil when pulsing.
  - The **coil will be reinforced** during the **YETS** and will **reduce the stress by a factor 3.**

Water leak on BI4.BSW1L1



Radiography of the BI.BSW leaking coil

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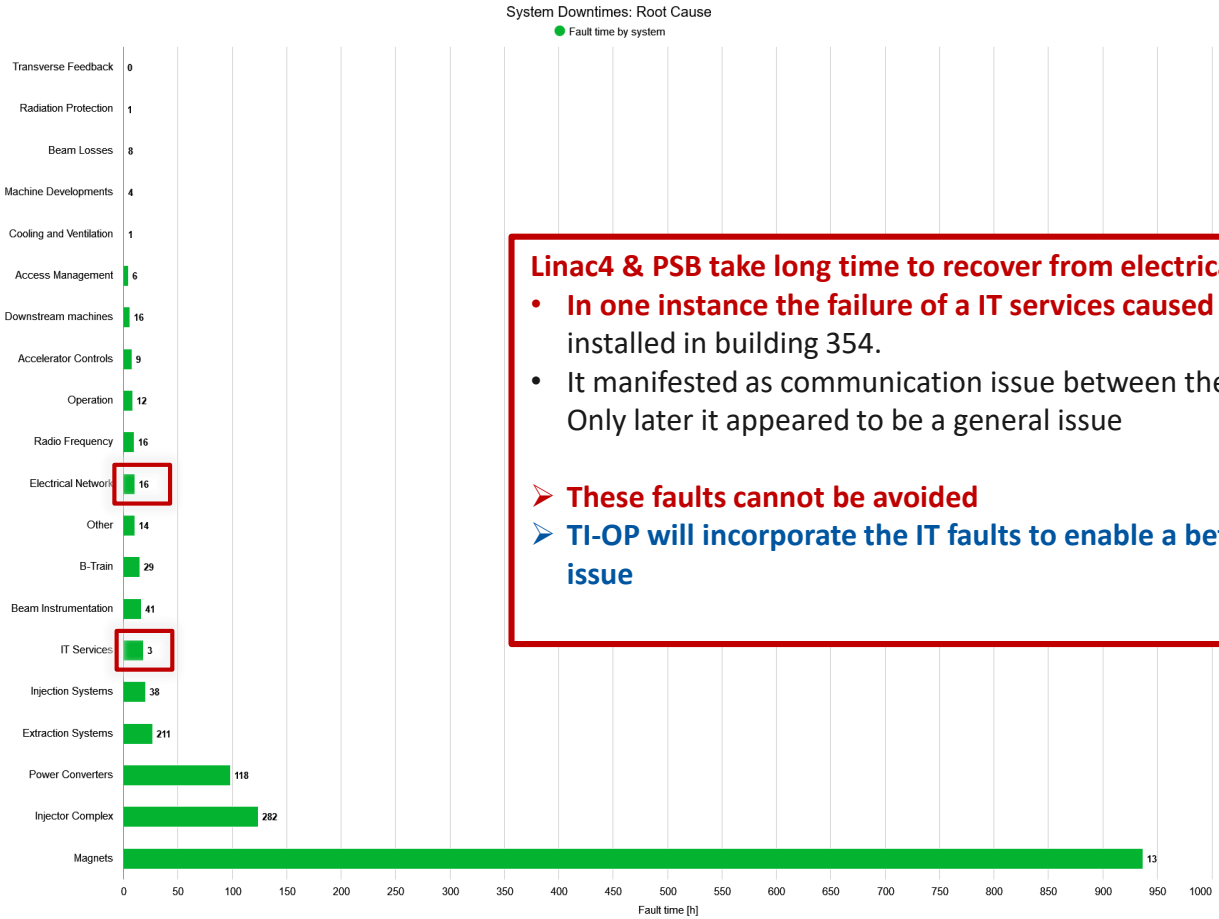

Linac4 & PSB take long time to recover from electrical glitch

- **In one instance the failure of a IT services caused** on the back-up technical router installed in building 354.
- It manifested as communication issue between the distributor and its front-end. Only later it appeared to be a general issue

➢ **These faults cannot be avoided**

➢ **TI-OP will incorporate the IT faults to enable a better and closer tracking of the issue**

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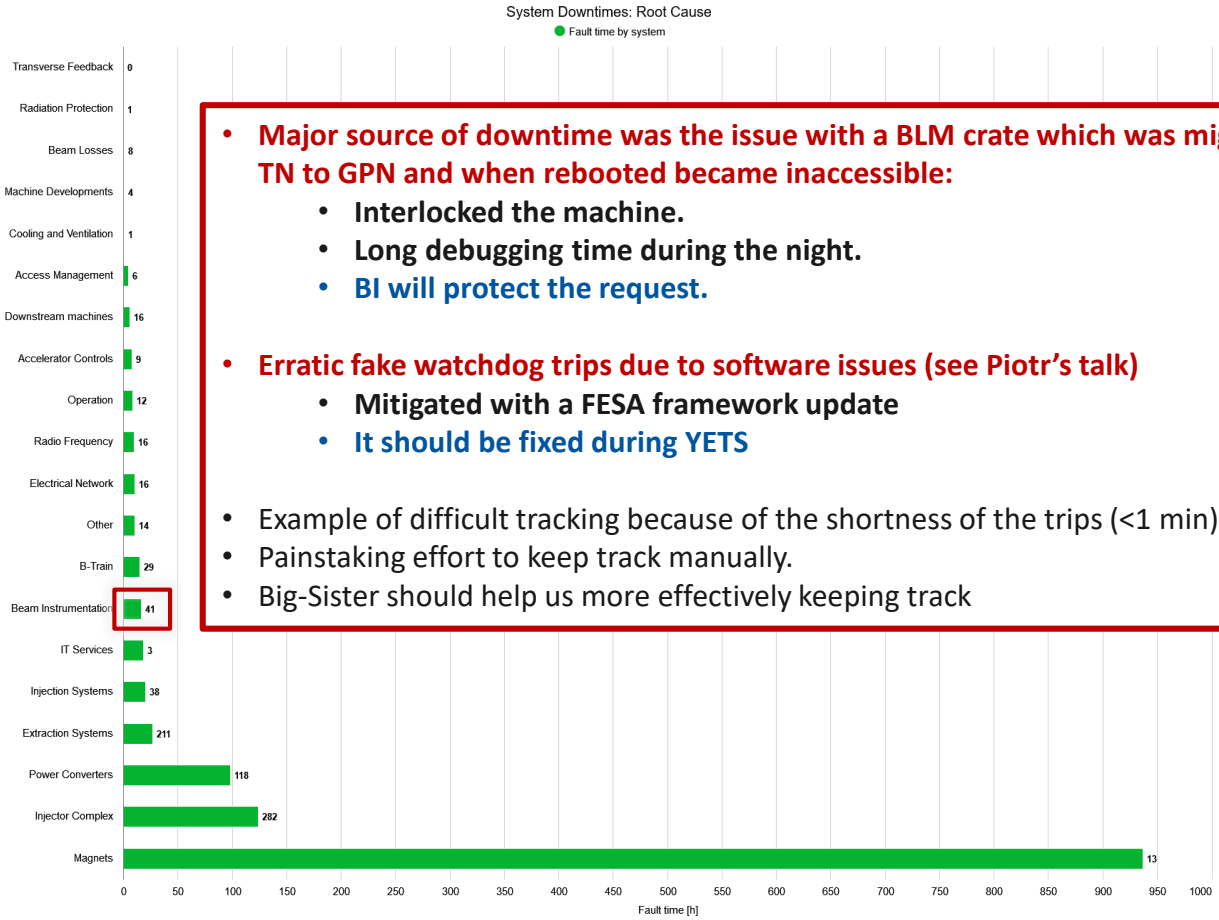

- **Major source of downtime was the issue with a BLM crate which was migrated from the TN to GPN and when rebooted became inaccessible:**
  - **Interlocked the machine.**
  - **Long debugging time during the night.**
  - **BI will protect the request.**

- **Erratic fake watchdog trips due to software issues (see Piotr's talk)**
  - **Mitigated with a FESA framework update**
  - **It should be fixed during YETS**

- Example of difficult tracking because of the shortness of the trips (<1 min) in most cases
- Painstaking effort to keep track manually.
- Big-Sister should help us more effectively keeping track

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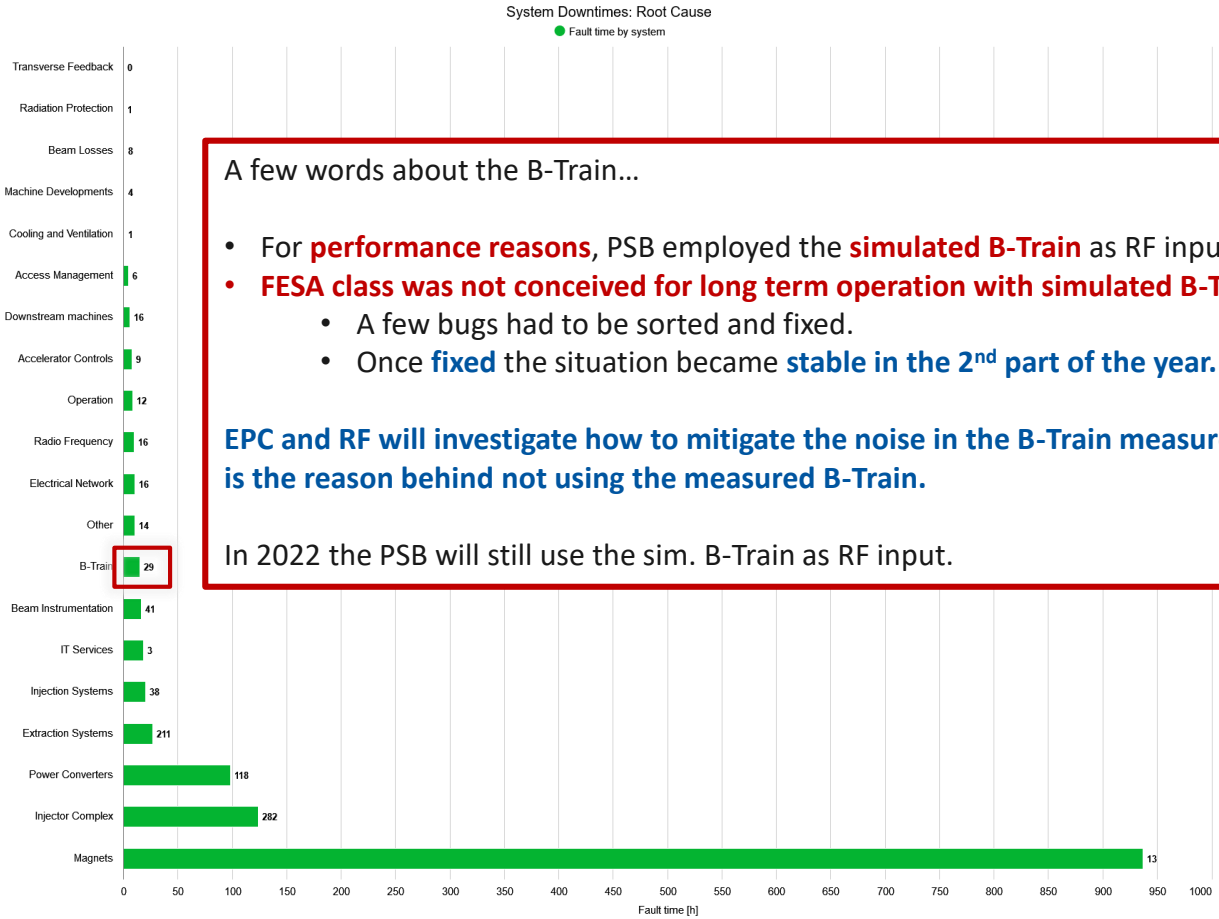

A few words about the B-Train…

- For **performance reasons**, PSB employed the **simulated B-Train** as RF input in 2021.
- **FESA class was not conceived for long term operation with simulated B-Train.**
  - A few bugs had to be sorted and fixed.
  - Once **fixed** the situation became **stable in the 2nd part of the year.**

EPC and RF will investigate how to mitigate the noise in the B-Train measurements which is the reason behind not using the measured B-Train.

In 2022 the PSB will still use the sim. B-Train as RF input.

Big Sister in 2022

- Plan is to implement Big Sister in the PSB as well
- Example of simple logic:
  - Looking at the BCT in the BT line at the PSB extraction.
  - If **Intensity in BT.BCT10 < threshold** (which is **higher than noise**) for **1 minute**, insert the fault

- Idea is to **start simple and build up complexity**:
  - In this configuration we already know that we will **miss faults associated to a single ring failures**, e.g. extraction or recombination kickers, etc, etc
  - Difficult as **some of the beams produced by the PSB do not use all rings**
    - Will need to look at **by-ring destination for instance**
  - Could include in the future interlock system/external conditions/SIS.

AFT Desiderata

- **Automatic fault entry in downstream machine/facilities** when a fault occur in one accelerator:
  - We said it already many times, but it worth repeating.
  - For instance now the PSB operator has to enter the fault twice for any L4 fault
  - **Cloning an entry to other AFT** in case?

- Automatic filling of the destination with only the blocking period when the fault is suspended, updated to non-blocking, etc, etc.

- Ideally in the future, a fantastic project would the **complete automatization of the fault entry.**

- **Feedback from the IEF WS:**
  - Use more effectively AFT to **help driving the CONSolidation project**
  - For instance **no global report done at the IEF WS**

Last Words

- The year 2021 has been an **excellent year for the PSB**
  - Exceeded the target availability of 90%
  - For the “best” years pre-LS2 (when we started AFT), the availability was ~95% (Linac4 > 99%)

- **Major time-consuming faults could not be anticipated** (BLM crate, magnet, IT network issues)

- **Several recurrent faults have been addressed or are being addressed by the specialists:**
  - New FESA class for injection watchdog
  - Replacement of components in extraction/recombination kickers
  - FGC class updates
  - ….

- **Some issues will always remain**, e.g. lead time to restart POPS-B in case of trips.

- A few good surprises:
  - No major downtime from RF.
    - Well designed and modular system, with excellent support.