Reliability and Availability Working Group

Minutes for the RAWG meeting on 5th December 2024

Present: P. Alexaki, A. Asko, S. Bertolasi, E. Blanco Vinuela, M. Blaskiewicz, N. Charitonidis, D. Cotte, G. P. Di Giovanni, H. Dostmann, L. Felsberger, B. Fernandez Adiego, J. Ferreira Somoza, X. Fink, J. Heron, M. Hostettler, A. Huschauer, P. Jurcso, D. Lafarge, K. Li, B. Mikulec, D. Nisbet, E. Nowak, L. Ponce, B. Rae, S. Ramberger, P. Skowronski, M. Solfaroli Camillocci, R. Tegas, J. Uythoven, E. Veyrunes, F. Waldhauser, J. Wenninger, D. Westermann, C. Wiesner, D. Wollmann

Special RAWG - Accelerator Availability in 2024

The slides are available on indico.

Agenda

1 Overview of Accelerator Availability in 2024 - J. Heron 1

B. Mikulec opened the meeting. The minutes of the previous RAWG meeting on 24/10/2024 were approved with no comments.

1 Overview of Accelerator Availability in 2024 - J. Heron

J. Heron presented an overview of the accelerator availability in 2024 with inputs from OP colleagues, machine coordinators and system experts. In total, more than 12,500 faults were recorded and reviewed in 2024. He thanked everyone involved in this collaborative effort. Moreover, **J. Heron** thanked OP to have completed the templates sent out to them. The detailed results can be found on the indico page of this RAWG meeting, whereas this presentation provides a summary of all inputs. **J. Heron** pointed out that the accelerator operational schedules are used as basis for the availability evaluation.

LINAC4. For LINAC4, the availability is slightly lower than in 2023, mainly due to downtime caused by RF and power converters. **J. Uythoven** pointed out that the downtime caused by power converters is generally on a nice slope down while 2023 was exceptionally good. **G. P. Di Giovanni** noted that the downtime in the power converters increases between 2023 and 2024 because of the fault sharing between RF and power converters, which is done as it is often not possible to decide on the root fault cause. **D. Nisbet** commented that many faults in the klystron modulators lead up to a klystron change. He emphasized that this is a sign of aging LEP klystrons and this downtime is hence due to the decision of not changing the klystrons. **B. Mikulec** commented that this is a strategic point to follow up at JAPW 2024. **S. Ramberger** added that faults are shared due to the shared responsibility for HV and since the klystron exchange changes the HV tank the fault sharing is correct. Finding the root-cause is not yet possible and aging cannot be directly concluded. Without the CCDTL klystron exchange the unavailability would be similar to last year. **G. P. Di Giovanni** noted that there was another klystron exchange during the TS which does not show up in AFT statistics. **J. Uythoven** highlighted the excellent performance of LINAC4 in 2024.

PSB. PSB saw record-high availability since the beginning of AFT fault logging. Experienced downtime was mainly due to power converters. While the fault rate for EPC has decreased, the unavailability increased due to longer repair times caused by aging BTY electronics. In response to a question from **J. Uythoven** about the fault rate plots, **J. Heron** confirmed that they show the rate per week. **S. Bertolasi** commented that it was a cubicle and not a transformer which exploded in the EA. **D. Nisbet** pointed out that EPC is performing well and

the entire increase in unavailability resulted from two interventions. For one of these interventions, downtime was extended because the piquet team had reached the end of their working hours due to interventions in the SPS, necessitating a wait until the next day for the intervention.

G. P. Di Giovanni added that the low unavailability was also thanks to the fact that the PSB has 4 rings and OP managed to maintain all the requested beams with 3 rings, e.g., during a kicker fault that lasted 5 days. In addition, record low losses in extraction were also achieved.

PS. The PS also achieved record-high availability in 2024, mainly due to continuous work from equipment groups and OP. **B. Mikulec** noted that the RF unavailability was decresead not only due to automatic cavity restarts, but also significant follow-ups from the RF team. **J. Uythoven** asked whether there is maintenance planned for RF. **B. Mikulec** responded that this is scheduled for YETS 25/26. **S. Ramberger** commented that the YETS 24/25 IST situation is very tight and due to the short YETS 25/26 the ISTs have to be significantly reduced, which might lead to an increased fault rate in 2026. He added that they are currently working on a solution for gap relays and the evolution of the fault rate depends on how good the solution works out. Evaluation of potential solutions already caused some downtime and could also lead to downtime in the future, e.g. by testing of a prototype amplifier, which is planned for June.

K. Li asked if auto restart and reset is the same. **A. Huschauer** replied that it is not the same, but both are now in place for the PS. **K. Li** recommended checking why it is not implemented for the SPS. **S. Ramberger** responded that he cannot comment on SPS. The SPS uses the same PLC control, but the situation might be different. **D. Cotte** added that in the PS the automatic reset is active since the beginning of the year and the automatic restart since end of September. However, interlocks are triggered in the SPS if one cavity is missing, which is not the case for the PS, so it might not be useful for SPS. **K. Li** responded that currently a manual cavity restart is required, which could be automated. **E. Veyrunes** raised the concern that SPS cavity restart with Thales is more dangerous, and one thus has to be careful. **B. Mikulec** commented that PS OP conducted studies together with RF and error messages can be evaluated to decide if an automatic restart is possible and safe. **K. Li** noted that RF should have more knowledge on this than OP and hence RF should monitor these restarts and embed their knowledge in the systems. **B. Mikulec** agreed that one should work towards a common solution which can be also beneficial for RF. **S. Ramberger** will forward the request to the SPS but, noted that possible differences between the machines should be considered.

A. Huschauer pointed out that short faults below two minutes are not logged and are thus not seen in the statistics. **B. Mikulec** confirmed and emphasized that the number of short faults is significantly underestimated, which also sometimes lead to radiation alarms.

SPS. The availability of the SPS is similar to last year, with slightly decreased downtime coming from the injector complex, while the SPS downtime increased. Main contributors for downtime are RF and EPC. **J. Ferreira Somoza** commented that two magnets had problems with leaks this year. The leak in the vacuum chambers could not be located after tests done on the first chamber. Studies are continuing to understand the issue. **D. Nisbet** pointed out that in the SPS transformers many false trips have been observed. Better monitoring is expected to improve this situation next year. Moreover, new control systems were installed on the main power converters, which required a lot of work to get them running smoothly, which has improved over the year.

K. Li commented that in fact two inter-turn shorts happened, while one occurred during commissioning and is therefore not showing up in AFT. **K. Li** added that the machine startup at the beginning of runs seems to be particularly stressful for the transformers. This issue is closely followed up, but faults arising during beam commissioning are not shown in AFT. **K. Li** brought up that loss of patrol happens often during technical stops caused by ignorance, as clear instructions exist but are not followed. This should also show up in the fault statistic. **L. Felsberger** responded that placeholder faults can be added at the beginning of physics time to account for delays happened during technical stops. **M. Hostettler** voiced concern if AFT is the right place to track this. **B. Mikulec** emphasized that equipment experts should be reminded before TSs in FOM and coordination meetings to follow the correct procedures.

Ion injectors. LINAC3 and LEIR also achieved the highest availability since 2018. **J. Heron** noted, that the graphs should not be overinterpreted in terms of trends, as they are just based on few weeks of operation each year, as fault tracking only starts when beam is delivered to LHC. The largest source of downtime this year for LINAC3 is an unplanned oven refill. The RF teething problems of 2023 have been resolved leading to fewer RF faults. A risk of lack of spare parts has been raised and a solution should be ready for the 14 GHz source generator. The availability performance of LEIR for 2025 is expected to be similar in 2024. **B. Mikulec** highlighted that these are excellent performances for LINAC3 and LEIR.

LHC. The LHC achieved the best availability year of Run3. **J. Uythoven** commented that this is partially due to not pushing bunch intensity this year. **M. Hostettler** responded that the lower availability compared to Run2 is R2E-related due to the higher luminosity.

It was highlighted that the fault rate for the LHC in Run3 was not higher than in Run2. **M. Solfaroli Camillocci** commented that this means the average fault duration is longer. **D. Wollmann** responded that this is partially just caused by the improved systematic tracking of faults. **J. Uythoven** added that in Run3 more radiation areas were affected by faults, which require clearance from RP to solve, causing a longer intervention time. **M. Solfaroli Camillocci** mentioned that there have also been changes in fault recording procedures by the experts, e.g. from closing the fault once the system fault is repaired to closing the fault once beam is restored. **L. Felsberger** responded that they looked at this last year, and the fault duration extension to precycle was partially already done in Run2.

M. Hostettler commented that TS data should be removed from the availability overview, as this will always be at 100% availability. **L. Felsberger** responded that this is planned, but was originally not excluded as there was also an effort to track unavailability during the TS, which was eventually not done.

M. Hostettler raised the issue of how scheduled accesses are to be logged, as this is currently not done in a consistent way. Some are logged in the "other" category and others in "access management". **L. Felsberger** responded that they should be logged in "other" whenever the reason for the access is unclear. **J. Uythoven** added that it would be interesting to have a statistic on how often scheduled access is given. **L. Felsberger** responded that VIP visits are excluded when on the schedule. **J. Uythoven** responded that there should be a category for it to log the data and have statistics on how much physics data the visits cost.

J. Uythoven highlighted that the proton time seems to be more than double than that of last year, which **M. Solfaroli Camillocci** commented to be due to the absence of a very long fault in 2024. **D. Wollmann** pointed out that it is important to make clear that the 2023 statistic is corrected by the new schedule after the long fault. This means the run in 2023 was much shorter. **M. Hostettler** commented that the increased fraction of times spent in stable beams for 2024 in comparison to 2023 means there was increased efficiency in OP. **L. Felsberger** added that the tracking begins from first stable beams and not from 1200 bunches. Since 2023 saw a longer fraction of time in intensity ramp up in comparison to 2024, the fraction of the operation time was much higher in 2023, causing less time in stable beams.

The proton run faults in 2024 were mainly caused by Cryogenics and QPS issues with the QPS showing an upward trend over recent years. **J. Uythoven** commented that this scales with luminosity due to increased radiation. **D. Wollmann** responded that it is likely no singular cause, but also caused by equipment aging effects such as power supply issues, interventions taking longer due to training, overall a mix of many causes.

J. Uythoven commented on the ion run statistics that this year was a huge success compared to last year even if not shown very well in the OP hours statistic. If the penalty for last year was added the downtime would be much larger. **L. Felsberger** added that the availability was around 5-6% better this year, but the penalty was not included in the QPS statistic. **D. Wollmann** argued that even with the penalty, 2024 will not look much better than 2023 due to multiple long stops of the machine caused by failures of the QPS. **L. Felsberger** added that this year there were no cryogenics faults whereas last year there were some long ones. **J. Uythoven** asked for a statistic on the fault rate with penalty in the presentation. **M. Hostettler** commented that the penalty will have a lower effect for the ion than proton run because "optimal" stable beams duration is shorter. **J. Uythoven** pointed out that the turnaround time is longer though. He further added that the unavailability from beam losses are not shown, which were significant last year. **B. Mikulec** proposed using the stacked downtime statistic plot showing the change of faults over the years for more systems.

AD/ELENA. For AD/ELENA the same two major faults as last year occurred (magnetic horn and HE levels in BCCA). It was highlighted that there were many issues not covered by AFT and thus not showing in the statistics. **L. Ponce** noted that AD & ELENA faults are still dominated by the power converters. There were also more solenoid trips this year due to aging of the systems and limited spares. Some systems will be replaced in LS3, which should solve certain issues. There was a similar amount of trips on the main quadrupoles compared to last years, however due to EPC efforts there was a shorter recovery time.

ISOLDE. For ISOLDE GPS and HRS there is a slow upward trend in unavailability, and most of the downtime is still in the target category due to R&D carried out by users. There is no mitigation foreseen until at least LS3. There were no comments on the slides during the presentation.

EA/NA. The statistics have not been ready yet but will appear in JAPW.

Discussion after the presentation:

L. Felsberger thanked everyone for the feedback from the surveys on AFT and that it will be decided what can be implemented next. **M. Hostettler** commented that in the YETS the automatic fault recording can be improved, as they now have a publication from AFT back to automatic recording agents. **B. Mikulec** commented that this goes in line with what was discussed with **E. Veyrunes** and **K. Li** . **B. Mikulec** proposed that **E. Veyrunes** should set up a meeting to discuss this further with **M. Hostettler** and others, as only the last steps are still missing to connect all the machines.

B. Mikulec closed the meeting, highlighting that there were many interesting discussions in this meeting that could be used as input to JAPW 2024.