Accelerator Complex Status

End week 13 (Monday 4 April 2022)

Technical Infrastructure (Jesper Nielsen):

Statistics:

- About 6'000 alarms.
- 573 phone calls (503 incoming, 170 outgoing).
- 113 ODM created.

Events worth mentioning:

- Tue. 29.03, Electrical perturbation, caused the trip of all injectors except SPS that didn't have beam at that time. -13.8 % voltage drop for 75 ms. RTE confirmed a short circuit on a 400 KV line between Chaffard and Mions. No cause found on RTE side yet.
- Wed. 30.03:
    - Electrical perturbation, caused the trip of the PS, RF cavities. -12.3 % voltage drop for 70 ms. RTE confirmed a short circuit on a 400 KV line between Creys and St Vulbas 2, caused by bad weather.
    - TIM server upgrade, with some problems restarting the C2MON servers due to a missing control tag in one of the databases. It took some time to understand and fix the issue and that's why the intervention took a bit longer than expected.

Details: https://wikis.cern.ch/display/TIOP/2022/04/04/TI+week+summary,+Week+13

LINAC 4 (Piotr Skowronski)

Linac4 had following stops:

- On Tuesday early morning glitch in electric network tripped one power converter (10 minutes downtime)
- On Thursday at 4h30 CCDTL1 klystron over current damaged IGBT card in its modulator (3h45 downtime)
- On Friday there was a scheduled intervention to shorten pulses of all the modulators in order to reduce risk of their damage (1h30 downtime)
- On Saturday at 13h05 chopper sparked (9 minutes downtime).

PS Booster (Gian Piero Di Giovanni):

The PSB had a good week with an availability of about 95%.
The stop on Friday in the shadow of the Linac4 intervention went according to planning: The KSW and BCTDC FECs were rebooted to deploy new software for additional features and for fixing an intermittent issue with the arrival of the B-Train, respectively. EPC experts took the opportunity to apply modifications on the Active Front End input filters of the QUAD converters which should nowcompletely eliminate the possibility of having the QUAD converters tripping for the same reason as previously. EPC experts will monitor the QUADs behavior closely to be sure that these modifications have no undesired effect on the performance of the unit. A similar stop will be needed in the future to dig further in the root cause and the EPC team is working on a plan of actions.

Otherwise, the main stops in the PSB were due to Linac4 and a few POPS-B trips. Concerning the latter, one trip was due to the electrical glitch on Tuesday morning, a few happened before the intervention and were due to the recurrent issue, which should be now fixed, and a couple happened after the intervention on Friday. The latter were caused by a broken relay and uncorrelated with the intervention done in the morning.

The RF team is still battling the issues with the LLRF voltage spikes/drops, causing beam losses. The experts resurrected the control of R0 and managed to reproduce the issues while adding diagnostic. They narrowed down the search to some memories that hold the cavity compensation tables. They could observe that the addresses that are being sent have bits that flip, even while the data is being read, when these bit should be fixed. Of the 4 memories that are used, the first which looks after the h1-4 are always correct, hence why we do not have issues with any of the first 4 harmonics. However, they could see bits flip, hence corrupted data, for the other 3 memories. Reading the memories back from the operational rings, the data in the memories for hamonics 5 and above, are often corrupted. These should be loaded at power up and remain fixed until the next power cycle. The investigation will continue based on the progress done last week.

Ending with some good news:

- Physics has started and we had a good availability for ISOLDE. The data taking has been intermittently interrupted by issues with the watchdog in the BTY TL. They could be always reset within a few minutes, and in the week-end the issue was understood as being caused by an incorrect measurement in the BT.BCT10. The BI experts will follow this up.
- An optimized steering in the extraction line (using the GEOFF framework) was propagated to LHC, AD, MTE, EAST_T9, EAST_North, GPS. This setting reduces the losses measured at the BLM location by more than a factor 10 all along the TL. The plan is to continue propagating it to the other operational users.
- POPS-B is back to the 2021 performance. Numerous measurements taken by ABP colleagues confirmed it and a few smoothing were added to get rid of nonphysical oscillations. The beta-beating correction is being finalized. The measurement of the LHC brightness is the next step.
- The AD with 5 bunches have been reviewed in the week-end, in preparation of tests in the PS this week.

ISOLDE (Eleftherios Fadakis):

Nice week with no major issue that we could not solve in under 15 minutes.
Only our tesla meters on HRS kept us busy for one day until the equipment owner could solve the issue.

GPS

Users performing 149Tb collection in GLM and 155Tb in GHM
Friday 1st of April a new target (734) was put in place.
By afternoon users were taking beam (129Xe, 133Xe) on GLM, GHM.

HRS

Users (VITO) taking stable beam to optimize position on their detectors.
On Tuesday the 29th after the proton scan, users took protons and have been running on 49K.

We had an issue with both of the HRS separator magnets. First the MAG 90 would get stuck at a certain current, then the MAG 60. It turns out it was the tesla meters. The equipment owner exchanged both and the situation improved.

REX-HIE side

Restarting Low Energy RF amplifiers.

PS (Alexander Lasheen):

The week 13 in the PS was marked by the start of physics for the TOF and EAST users, delivery to the AD target and multibunch beam for SPS scrubbing.

The beam was consistently delivered to the **TOF** users throughout the week, using the parameters obtained after the major optimization in Week 12.

- The main work during Week 13 was to investigate on the interlocks triggered by the SIS from the measured profiles on the SEM grids before the TOF target, to ensure that the beam stays well within the limits specified by the STI group. The effort consisted in verifying the beam profile analysis, the implementation and means to identify faster that the interlock was triggered (WIP).
- Further work is needed to further improve the beam in the ring, in particular to reduce losses at transition.

The beam was also delivered to all **EAST** destinations with a beam intensity ranging from 20e10-60e10 ppp. The beam was optimized throughout the week.

- A possible influence of the PFW field settlement on the early spill was outlined and will be further studied
- First evaluation of the supercycle composition on the beam trajectories at extraction
- Improved steering on the IRRAD BPMs
- Despite the numerous activities, space was found in the supercycle to accommodate more spills to EAST lines when possible (e.g. LDMX setup on EAST T9).

Beam was delivered to the **AD** target and beam intensity was rapidly increased close to nominal value during the week.

- The optimization of the trajectories in the FTA line was continued during the weekend.
- A test of the new 5 bunch beam is planned next Tuesday 05/04 morning together with AD.

The multibunch **LHC**-type beam was provided for SPS scrubbing with varying beam intensity (1.4-1.8e11 ppb, 72b). In the PS, the work was targeted towards improvements of beam quality at high beam intensity.

- An important stream was to try mitigating the observed instability at low energy in the horizontal plane (no coupling, low RF voltage, with transverse feedback). The important outcome for this week was to observe that the instability only concerns the 4^{th} bunch from the PSB (Ring1), even in absence of other bunches. Specificities linked to injection from PSB Ring1 will be checked.
- The second aspect was to finalize and enable all cavity impedance reduction feedbacks (one turn delay and multi-harmonic feedbacks). The longitudinal beam quality provided for the SPS scrubbing is now on par with the quality expected for the LHC.
- The setting up of the BCMS beam has started. All RF manipulations until extraction could be performed and the beam now requires a review to check transverse and longitudinal beam quality.

The **SFTPRO** beam for the SPS was prepared in view of setting up during Week 14

- The beam will be ready for the SPS request on Monday with the following specifications
    - (i) MTE core beam (50E10 p) and (ii) full MTE beam (500E10 p)
- The beam has been played in the PS this week up to a beam intensity of 1800E10 p.

Other **notable items** in the PS were

- The machine availability is, as of today, of 93.8% in the PS. The main downtime was due to the Linac4 DTL1 issue and a long restart after the beam stop on Friday due to difficulties to restart POPS.

- The beam stop was used on Friday in the PS for two accesses in the ring. The water flow for one of the 10MHz cavities was adjusted and the pick-up 63V, which was having an offset in measurements, was found to have an important roll angle which could justify the offset.
- The B train calibration window and coil calibration factors were tested. A problem was found regarding the calibration window by the MSC group (peak detection on the calibration marker) and will be fixed on the operational B train during a future beam stop. Regarding the coil calibration factors, further work is done to find the optimal setting to ensure the energy matching with the PSB together with a good centering of the beam at injection. This will also influence the transfer to the SPS where energy matching should be re-iterated.
- An upgrade of the FESA class of the high frequency cavity controllers was done during the beam stop. The update introduced issues which will be investigated during Week 14. Nonetheless, for the present beam intensity provided to the SPS, solutions were found in terms of settings and usage of spare cavities to continue providing beam with minimal impact.

PS - East Area ():

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AD - ELENA (Laurette Ponce):

A very good week for AD and ELENA, good progress with beam commissioning.

- The power converter of QMAIN2 circuits has been repaired on Monday in parallel of injection setting-up in AD.
- The heat run at nominal current of the circuit allowed to have circulating beam at injection energy and the first test of bunch rotation and stochastic cooling.
- After some hick-ups to control the RF cavity and a rough setting-up of stochastic cooling and e-cooling, beam was successfully decelerated in AD on Wednesday.
- the new Hminus cycle for 2022 with improved orbit and working point settings and new LLRF controls logic has been migrated to a pbars cycle and on Thursday, beam was successfully injected on ELENA, decelerated and extracted to both LNE50 and LNE00 on Thursday.
- On Friday, during the PS stop, access in the AD to fix connection issue on the stochastic cooling and tests of the pause at 3.5 Gev for half an hour.
- all along the week and especially during night and week-end, work on the DI optimization and FTA optics to try improving the injected pbars intensity
- some instability in the beam position observed on Thursday with the Hminus source

Couple of issues:

- BCCCA intensity reading is not reliable depending on beam parameters at injection, making the optimization of injection tricky. Experts are working on it to understand the source of the "blinding" of the instrument.
- If we use the BCT7049 (extraction from AD), we are missing 30-50 % of injected intensity
- HV switch of the e-cooler not yet switch on due to vacuum spike. E-beam are on during the last ramp. More study needed to optimize the working condition.
- 2 GeV notch filter of the stochastic cooling seems to be broken, repair plan on Monday
- problem with the trigger on the profile monitors in LNI.

SPS (Giulia Papotti):

The main aim of the week was the setting up of the fast extractions (to LHC, HRM and AWK), in parallel to scrubbing.

Extractions to the TT40 and TT60 TEDs were setup and fine adjusted, and the first (few) protons were delivered to AWK and HRM after the “deconsignation” of the TT40 and TT60 TEDs.
The kicker waveform measurements were performed for the MKE4 and MKE6.
The HRM bump was setup.
The rephasing to LHC and AWAKE frequencies was successfully performed, and the SPS Beam Quality Monitor was setup for all 3 extractions.
The beams could also be requested via the LHC mastership.
A way to align bucket 1 for all extractions with respect to the extraction pulse was found, and can be implemented after a modification in the beam control.
Following the change in the beam synchronisation with the extraction pulse, a fine adjustment of the MKEs is still needed.
All the other extraction settings have been propagated to all users.
The AWK bunch rotation and the synchronisation stability remain to be checked at the next occasion.

The TPSC4 (dummy septum to protect the MSE) alignment was done.
The injection kicker (MKP) delay optimisation was close to completion on Friday and will need some more time in the upcoming week.

Scrubbing was focused on lower intensity than the previous week, but improved beam quality.
4x72 bunches were accelerated (with 1.45e11ppb at injection, and 1.35e11ppb at the flat top, with emittances of 1.5/1.5um in H/V and 1.65ns bunch length).
A major clean up of the scrubbing cycle took place (orbit, tune, chromaticity, radial correction ...).
The cause for the major orbit correction required at the start of ramp was not understood.

The amount of daily scrubbing was limited by the MKP temperature (early in the week) and vacuum (later in the week), and MKDH1 vacuum (mostly earlier in the week, with slightly higher intensity per bunch).
Scrubbing can only take place for only about 25% of the time per day.
A shorter supercycle on Monday night (LHC25NS+MD1) is assumed to be the cause for high vacuum spikes on the MKP7-A.
Tuesday daytime was spent re-qualifying the MKP to exclude a 4h intervention to reconfigure it.
The worrying breakdowns could not be reproduced, possibly thanks to the extended conditioning that took place in the second part of Monday night.
OP-SPS needed the support of the kicker piquet many times over the first half of the week, so that, since the weekend and until the end fo scrubbing, the shift crews are supposed to contact the experts for the most critical equipment (MKP, MKDH/V - instructions by SY-ABT).

The TIDVG “cooling” interlock threshold was temporarily lowered from 500 m3/h to 400 m3/h on Tuesday to avoid unnecessarily trigger the interlock (which was slowing operation on Monday evening).

The commissioning of the longitudinal damper progressed well, accompanied by simulations that improved the understanding.
It is used at the flat bottom on the scrubbing cycle, and measurements at the beginning of the ramp were started on a different user.

Issues with the 800 MHz system were coming and going all week (mainly C2, but also C1 at times).
Multiple investigations are taking place: the causes for the frequent trips, settings generation and make rule corrections, expert LLRF parameter calibration, puzzling observations with the scrubbing beam.

The phase of the 800MHz with respect to the 200 MHz was re-measured, and a shift of approx 15 degrees at 800MHz was found but not understood.
The 800MHz was used on the scrubbing beam from the start of the ramp, or along the flat bottom when paired with the longitudinal damper, to avoid degraded transmission along the flat bottom.
C2 is off for the scrubbing cycle over the weekend.

The coast cycle for the crabs was tested with beam, which could be accelerated and held at 270 GeV. Some issues with trims of tune and orbit bumps will need follow up with experts.

The North Area DSO tests were attempted on Tuesday, but could not be completed due to missing EIS. They are scheduled to be repeated on Tuesday 15:00, after which the TT20 TED will need to be "deconsigné".

Additionally:

- polar loops re-enabled on 200MHz c3 and c6.
- phasing of the 800MHz at high energy was studied on the AWAKE cycle, measurement campaign not finished.
- Friday's accelerator complex stop used for access to install a BLM in BA4 (SP.BLML.41804.ILS.TPSC4), to take a water sample from the dump circuit in ECX5, to install a PFN monitor, to inspect the crab cavities, to change a card in the SBDS).
- LSA trim history problem most likely fixed.

The focus of the upcoming week is the setting up of the slow extraction.

SPS North Area ():

AWAKE ():

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LINAC 3 ():

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LEIR ():

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CLEAR (P. Korysko):

CLEAR operation is under way since beginning of March, and it's high time to resume the weekly report. Reports from the last weeks can be found in the CLEAR Weekly Operation Meeting series, from March 7th on, here: https://indico.cern.ch/category/10682/

Last week was dedicated to Beam Loss Monitor studies in collaboration with SY/BI colleagues, using two optical fibres. Some beam time was also dedicated to train students for operation.
First tests for a scatterer for VHEE beams were done with C. Robertson (Oxford). Some preparation was done as well to test the new quadrupole for the VHEE focusing experiment
with Manchester University, scheduled for the week starting April 25th.

LHC (Jörg Wenninger & LHC Coordination webpage):

S12	S23	S34	S45	S56	S67	S78	S81
Completed	Training	Completed	Completed	Completed	Completed	Completed	Completed
77 / 11950 A	42 / 11540 A	71 / 11950 A	87 / 11950 A	76 / 11600 A	62 / 11600 A	21 / 11600 A	55 / 11600

RF cavities in S34 at room temperature on Tuesday, intervention in rupture disks and preparation for cool down Wed-Thu. Friday cooldown of S45 RF cavities.

Training of S23 is still proceeding slowly, a bit less than 10 A per quench cycle on average. But S23 has now exceeded by 2 A the maximum current reached in 2021.

After intervention on MKI8 and on MKI controls, both MKIs could be pulsed remotely. The BIS and LBDS were armed at injection without problems with 28 ring BIS channels disabled. LBDS and BIS could be ramped to 6.8 TeV, but in 1 ramp out of 4, internal LBDS triggers were observed due to energy tracking. Despite HW interventions in the tunnel the issue could not be solved yet.

Checkout proceeded with OMC tools and HW (AC-dipole, MKQ ad MKA), PM, IQC, injection and LBDS despite those issues.

The problem of the LASS cabled loop in point 7 could not be reproduced.