

## Accelerator Complex Status

### End week 7 (Monday 22 February 2021)

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#### Technical Infrastructure (J. Nielsen):

A reasonable week.

Statistics:

- Slightly more than 6000 alarms.
- 737 phone calls (525 incoming, 212 outgoing).
- 85 ODM created.

Events worth mentioning:

- Tue 16.02: A short circuit on the lights in building 378 caused a local powercut that took out also the IT starpoint. Investigations were rather complicated because this power supply was not monitored and it was not obvious at first to fault find. TIOC recommendation to add a second, secure powerline for the IT starpoint.
- Tue 16.02: The new SSO ([auth.cern.ch](https://auth.cern.ch)) was inaccessible for several hours on the morning of the 16th of Feb. This was due to insufficient memory, when one host ran out of memory and caused a knock-on effect.
- Tue. 16.02: Technical problem on fire detection in RR17 caused an evacuation of octant 1-2.
- Wed. 17.02: During planned switch on of the BEQ2 compensator, the EMD2/BE tripped and caused a local power cut. The switch on of BEQ2 was postponed due to an earth fault detected on the equipment.
- Fri 19.02: Many people reported not being able to access various buildings at CERN. After contacting access experts it was found that a update of 30.000 people was being done in the system. It was estimated to take at least another hour to process. It will be investigated how such a big update took place.
- Sat. 20.02: IT network down for Linac / PSB and the machine logbooks. The problem was traced back to a router in 513, P513-A-IP957-LBR7K-K10 (model: ICX 7750-48C (10GBASE-T). The 2 switches stack was down. The IT technician changed the fibers router side and link comes up.

Details: <https://wikis.cern.ch/display/TIOP/2021/02/22/TI+week+summary%2C+Week+7>

#### LINAC 4 (Giulia Bellodi):

It was a rather smooth operation week for Linac4, mainly providing commissioning beam to the PSB. Beam availability for the week was 96.5% , due to many short chopper trips (< 5 minutes downtime in average) and the IT database outage.

As a summary of the main events:

- On Tuesday, after observing that the source gas pressure had been steadily dropping for a few days, gas and RF were retuned to restabilize conditions.
- On Wednesday we had a very short Linac stop (5 minutes) to switch to a backup pump after EN/CV noticed that the temperature of the klystron pump was too high.
- On Saturday afternoon all controls (CCM, working sets etc) became suddenly unavailable due to an IT database connection issue. The LN4 OP VETO was activated to put the machine in safe mode before the operators managed to close the beam stoppers via the FESA navigator (1hr downtime total impact).

As for the list of open issues:

- There are still rather frequent (27 in a week) chopper trips, which are under close investigation by the SY/RF team. The exact cause has not been identified yet. A new FEC release to add extra

monitoring was meant to be installed before the weekend, but was eventually delayed as not working as expected.

- Concerning the interference of the LBS.BVT10 magnet stray field on the injected beam trajectories in the PSB during ion measurements, a meeting was held last week with all equipment groups. As mitigation measure it was decided to re-install as soon as possible shielding along the BI line vacuum chambers (steel sheets if they are confirmed to be available). Shielding of the magnet itself and software correction for the field perturbation are additional solutions to be studied. The integrated stray field was calculated to be in the order of 0.4 mTm.
- Finally, an issue was observed with the performance of the BPMs installed in the BI line. Depending on the settings adopted for the debuncher cavity, it was observed that the quality of the BPM raw signals could be severely affected. This is presently understood to be related to the longitudinal structure of the beam, and to the fact that, as confirmed by simulations, the beam can be quite debunched (overlapping bunches) for certain optics, and the harmonics used by the narrowband read-out electronics probably does not have sufficient signal intensity. The issue will be discussed this week with the SY/BI experts.

#### **PS Booster (Gian Piero Di Giovanni):**

It was a good week for the PSB beam commissioning without many interruptions. The most worrisome problem happened on Saturday when we lost control of both Linac4 and PSB for a bit more than 1 hour, apparently due to a database connection issue. During this time we protected the PSB with the "PSB Inhibit" button.

During the week, the focus was put on finalizing the first beams for the PS beam commissioning, LHCINDIV and a TOF-like beam at low intensity ( $\sim 100 \times 10^9$  ppr), and, at the same time, on increasing intensity on a TOF beam and having a first look at the preparation of the LHC25ns.

Since the beginning of the week, the debuncher has been operating in PPM mode to provide different energy spreads for the PSB beam production schemes. And we started observing issues related to this new setting. In particular, the debuncher setting for 450 keV RMS energy spread, needed for the LHC25ns beam production scheme, leads to bad raw signals for the BI BPMs, possibly due to a more debunched beam structure wrt the natural energy spread, i.e. 280 keV RMS. A series of tests were done in collaboration with BI software experts and it is clear that we need the hardware expert to check. He should be back this upcoming week.

During the beams preparation, we also realized the need to provide additional models for the PSB injection to accommodate for the working point exploration performed in the last days to optimize the injection performance and minimize the resonance crossing (and necessary compensation). The models are being prepared and the goal is to upload them this upcoming week.

The RF team managed to successfully close the servo-loops up to  $H=16$ . This is an important milestone, especially in view of increasing intensity. Until recently the servo-loops were closed up to  $H=8$ .

The **LHCINDIV** is currently matching the basic specifications in both longitudinal and transverse planes and in 4 rings. Work is still needed to clean-up and fine tune the settings, but the basic structure is in place.

**A TOF-like** beam has been the workhorse to probe the increase of intensity. By the end of the week, we could reach  $\sim 490 \times 10^9$  ppr in 4 rings. An instability occurs around a kinetic energy of 440 MeV for intensity above  $\sim 200 \times 10^9$  ppr which is consistent with past instability observations caused by the extraction kicker termination. To mitigate this problem, the TFB with the upgraded digital electronics

was employed. We could use the higher intensity to perform scans of the blade position in the recombination line and adjust them to minimize losses. In the week-end, the operation crew systematically reviewed the extraction and steering to the dump and established an initial configuration for the BLMs at this high intensity. It was also remarked that some of the longitudinal parameters (e.g. bunch structure) need to be reviewed at this intensity.

ABP/ABT/RF/OP teams has started the setting up of the **LHC25ns in R3**. This was the occasion to review the energy matching as a function of energy spread. The initial measurements showed a negative difference wrt the expected value for large energy spread (e.g. **LHC25**) and a positive difference for small energy spread (e.g. **LHCINDIV**). The difference could be reduced by adjusting the debuncher phase (15 degrees change). Another round of energy matching with the debuncher detuned is then needed to get the correct PIMS11-12 amplitude.

Also, 4th order resonances have been observed for the LHC25 beam for the very first time, which could require a reconfiguration of the multipoles in the PSB to allow connecting the available octopole magnets in all rings. Currently, due to the limited number of available converters the octopole magnets are connected to power converters only in R2 for testing. In R2 it is possible to compensate the resonances and get a much better transmission. However, we are almost at the limit of the power converters and we cannot refine the compensation during the ramp.

Studies have been also carried to:

- Finalize the resonance compensation on 160 MeV flat bottom cycle. All 3rd order resonances compensated in all rings.
- Refine measurements on half integer resonance. It seems that in all rings we can correct it up to 3-5% losses during the crossing.
- First studies of vertical beam profile with and without injection chicane compensation to see possible impact on beam tails - not yet conclusive.
- Establish more precise calibration curves of the main dipoles which showed better tune evolution in the middle of the cycle.
- Measure the dispersion in the extraction line to validate the model.

We still have the **outstanding issue with the POPS-B regulation**. The new RST voltage regulation, together with a new B-field saturation models has been deployed for the MPS, as well as a FFW algorithm for the quadrupole circuits. Unfortunately, they could not be tested on the real load, as the settings identified on the spare bank did not yield satisfactory results, yet. As usual, we are regularly following this topic between OP, EPC and ABP. In fact, the POPS-B regulation is now one of the main limiting factors in performance. For instance, it is rather complicated to establish an effective beta-beating correction for the first ms of the cycle with an oscillating regulation during the ramp.

#### [ISOLDE \(Alberto Rodriguez\):](#)

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#### [PS \(Oliver Hans\):](#)

- Topic of the week was the failure of PS injection septum SMH42. The septum tripped after pulsing at 25 kA. After on-site tests the decision was taken to remove the septum and transport to workshop for further diagnostic. The problem was found at the high current feedthrough. Repair has started and the magnet should be back mid-end of next week. After installation, a vacuum bake-out is needed and pumping the sector over next weekend.

- RF 10 MHz cavity repair has started as scheduled. Every day two cavity amplifiers will be exchanged with new improved ones.
  - For Wednesday power test of BT.BHZ10 is scheduled (last test was in Nov'20).
  - Over the next week several RP and OP patrols will be done to have all sectors ready and to have all necessary beam permits signed by Friday.
  - Still waiting for wire scanners to be tested.
  - Several dry-runs:
  - PFW stability, very good results
  - KFA reliability run, no missing pulses were observed
  - Injection bumpers, power converter good synchronised for LHC optics
- In conclusion: Goal is to have all ready for beam for 1st of March. Septum will be just in time, (we hope). Otherwise all tests, patrols, and beam permits ready for Friday 26th Feb.

#### AD (Laurette Ponce):

AD stochastic cooling kicker: after the bake-out a vacuum leak from a cooling water pipe inside the tank was found (similar to issue about 20 years ago). An attempt to fix by inserting resin into the cooling water pipe, as successfully done 20 years ago, will be made. Situation is very worrying.

#### ELENA (Laurette Ponce):

Continuation of setting up of a cycle with acceleration and

- Deceleration:
  - Improved setting of the working point allowed to bring some beam through the whole cycle back to 100 keV. The main issue is to measure the tunes reliably (worked reasonably well on Wednesday, but results difficult to interpret on Friday after orbit correction). Orbit correction (can probably be further improved as only 5 SVD vectors to limit corrector strengths and to avoid to run into limits of the maximum time derivative of the current) through the whole cycle. A significant fraction of the intensity is lost when the beam reaches 100 keV. Loss looks similar to what had been seen with antiprotons on 2018.
- Transfer line studies by SY/ABT team:
  - Fine tuning of fine delays of fast deflectors in transfer line started. Special cycle with harmonic number  $h=4$  capture of the beam debunched after injection giving four long low intensity bunches used.
- Hardware Interventions on Tuesday (magnetic pick-ups in line, profile monitors, ion switch power converter ...)
- One profile monitor in the line towards the ASACUSA experiment was found broken. If possible (enough monitors available) it will be exchanged, otherwise the lines can be operated without (beam reached the ASACUSA area without this monitor).
- Discussions on faster ramping of corrector power converters on-going (will very likely be implemented soon)
- Again investigations on magnetic pick-up calibration.

#### SPS (Stephane Cettour Cave):

Summary week 7:

- Main dipole transformers verifications and repair all week
  - All the transformers were inspected
  - All the reinforcements of insulation the bus bar High Voltage has been done
  - Not found other major issues
- BEQ1 and BEQ2 compensator are connected to the network after solved some issues
  - Will be tested in dynamic when dipoles become available the date to be confirmed with EPC

- MKDV after some issues during the week the TMR1 has been changed on Friday and the conditioning restarted
  - MKDV pulsed at 20 kV and the target is 34 kV
- MKDH after a water leak solved and strip line refurbished the conditioning restarted
  - MKDH pulsed at 8 kV and the target is 10 kV
- ABT started a conditioning slow along of the WE
- BHZ377 & BHZ378 put back in chain and the problem with the vacuum chamber which moved with the magnet pulse should be solved.
- SPS Fire safety systems global re-testing Tuesday -> done
  - Two issues found during the test, mechanical problem on two doors (action on week 8)
- Aux PS testing and general HWC continue in parallel as planned
- Continuation FII/FEI debugging -> awaiting the gateway in TT10
- Kicker MKE4 pulse check -> resolved a fault on a repeater of the pre-pulse in BA4, now the pre-pulse is in FC in BA4, awaiting the MPS pulse to see the kicker pulsing synchronously with the extraction pulse
- BLM test -> found an issues on BLM reset
  - BLM reset is to late to rearm the BIS loop with the TSU sequences -> under investigation
- Dry run Coast and transactional trim
  - FGC\_91, FGC\_94, FGC\_63 after some debugging working fine
  - RFFG working fine, it stay to implement the coast recover
- Checked safe probe beam flag with intensity simulated on BCT 4
- Consigned MBIV.1003.M and MAL.1001.M in TT10 to keep the SPS safe because normally the beam in PS should be imminent

Plans week 8:

- Main power supply:
  - Main quads hopefully available to pulse at nominal condition on Tuesday 2 March
  - Dipoles available by Monday morning for single test on SMD12 and the 13 other stations. hopefully ready to pulse on Wednesday
- MKE4 test, pulse synchronously with the extraction pulse when the main dipoles will be pulsed
- Hopefully MKDH, MKDV conditioned
- Aux PS testing and general HWC continue
- Polarity check BA2, BA3, BA4, BA6, BA7, TT20, TT40, TT60
- BLM reset problem under investigation
- Heat run on all Aux PS
- Heat run on Aux PS TI8, LHC side
- Dynamic test on BEQ1 to be confirmed

#### AWAKE (Edda Gschwendtner):

**WEEK SUMMARY:** No electron beam because of a water leak (fixed on Thursday-Friday). Work on lasers and downstream streak camera

- **[From last week: Water leak in the electron gun cooling circuit radiator fixed temporarily, so that the circuit can be used next week. An additional intervention will be needed in April to install a new part and complete the fix. ]**
- **Laser:** finished aligning the IR laser (in low-power mode) all the way to the OTR screen of the downstream streak camera
- **Downstream streak camera:** timing synchronization of (1) streak camera trigger (2) marker laser (3) IR laser, finally achieved on Tuesday. Wednesday we took some data with both lasers on the streak camera. In terms of DAQ, both JAPC and the Event Builder application worked well
- **RF system:** maintenance intervention on the water interlock system for the Electron Gun

- **Electron spectrometer:** control of spectrometer magnets handed to the AWAKE team. Spectrometer camera tested and working.
- **Next week:** measure the electron beam using the downstream streak camera and the spectrometer, to ensure these diagnostics are fully working.

#### LINAC 3 (Detlef Kuchler):

On Monday afternoon the oven was refilled with a new lead sample. We used again a crucible with beak filled with fresh lead. The oven ramping was done using the GHOST oven start-up module. In parallel the RF team solved a small issue on the tank3 amplifier (a cracked soldering was found and repaired in the driver amplifier anode filter box).

Tuesday morning the source was restarted. The performance of the source was the whole week not as good as before the oven refill (the reason is not known; could be related to the aging of the aluminum coating or due to variations in the crucible filling). The ion beam intensity varied over time and the source had to be tuned more often. The maximum ion current out of the RFQ was around 100 eμA.

On Wednesday stripper foils of three different thicknesses (100, 125 and 150 μg/cm<sup>2</sup>) produced by GSI were installed. Before the issue reported last week of the limited stripper arm stroke was fixed and tested (relocation of the end switches).

Thursday and Friday Giulia did measurements to characterize the newly installed stripper foils.

Friday afternoon Richard continued with the measurements of the ion beam in the LBS measurement line and the characterization of the debuncher.

#### LHC (Jörg Wenninger & Paolo Chiggiato):

Good progress on phase 2 in S78 with 97% of the tests done. Training of RQs ongoing, already 6 quenches on RQ6.L8 with 350 A to go.

QPS boards with 200 mV threshold installed in S34. Phase1 started on low current circuits.

**Short circuit confirmed in RQF.A67 circuit in S67 at Q8.L7 .** Warm-up started to room temperature for a repair (similar to S81).

Friday there was an accident/incident where a person who fell accidentally damaged a vacuum cable connection on an ion pump, putting a part of S34 (B5R3) under atmospheric pressure. Friday afternoon the ion pumps was changed together with a gauge. The system is now under vacuum and for safety reason, the turbo pump was valved off during the weekend. The pumpdown is going to continue from Today. Today also the vacuum team will propose how and when the sector is going to be re-baked.