

## Accelerator Complex Status

### End week 5 (Monday 8 February 2021)

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#### Technical Infrastructure (C. Pruneaux):

- Quite an eventful week.
- Statistics:
  - About 5200 alarms
  - 838 phone calls (585 incoming, 253 outgoing)
  - 105 ODM created
- Events worth mentioning:
  - Tue 02.02: Local power cut in the ME25 sub station (which tripped Booster). Same event than last week. Problem already fixed (faulty relay) and followed up in the previous event.
  - Fri. 05.02: Short circuit SMD12 (SPS) caused by a fault on EMD123/BE (power converter supply), re-powered by SY-EPC specialist.
  - Sun. 07.02: Water infiltration in UX85 (LHCb) which stopped demineralised water cooling for magnet. LHCb specialist stopped manually electrical power on racks and ask for fire brigade help to clean up the water. ED plants still off until repair of the leak during working hours.
- Details: <https://wikis.cern.ch/display/TIOP/2021/02/08/TI+week+summary,+Week+5>

#### LINAC 4 (Federico Roncarolo):

It was a rather smooth operation week for L4 with 97.5% availability, mainly providing commissioning beam to the PSB.

#### Summary of main events:

- the local power cut occurred on last Sunday (Jan 31st) basically did not affect L4
- the machine was restarted on Monday morning in the shadow of the PSB restart, during which EPC deployed new FGC 62 and 63 classes (foreseen updates)
- Wednesday several chopper trips occurred
  - This was traced down to an internal watchdog consisting in the CTU (Chopper Timing Unit) VME card SW checking that the proper chopping pattern is each time properly loaded in the HW.
    - The verification started to fail (only during day time) when a second timing card in the same VME crate, managed by the same FESA was activated. This second card (setup by RF for the BI is actually not needed for the moment. It was disabled and the chopper trips due to this problem stopped on Thu. RF is nevertheless investigating the reason for the issue.
- on Wednesday there was also a trip of the CCDTL due to a vacuum interlock. This required a local reset.
- on Thursday evening the PIMS 8 circulator current started to drift (causing some de-phasing). This was promptly fixed on Friday by changing a power supply driver --> the phase is stable since then
- concerning the PIMs klystrons temperature instability, observed for the first time on Jan 21st and presented at the last FOM by Piotr:
  - the temperature was kept under control during the week

- discussions and dedicated meetings with CV are ongoing: the cooling systems (designed as of specs), is prone to instability when switching between two different cooling modes ('wet' and 'dry', designed for 'hotter' and 'cooler' ambient temperatures).
- Mitigations and tests are under discussion to ensure there will be no problems during summer. (I'm sure more details will be presented in the next weeks).
- the real impact of this instability (observed beam phase changes are clearly correlated to temperature changes), also compared to other known instabilities/jitters is under discussion/study

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

Another week of beam commissioning has gone by, with good progress on several fronts and identification of several issues to tackle with high priority.

#### **TFB commissioning:**

- Verification of the automatic delay compensation at 320 MeV done for all rings.
- General review of the setting and tune scans ongoing to validate the mapping in the firmware.

#### **RF commissioning:**

- Increasing intensity. **The highest intensity extracted in a single ring (R3) has been ~90E10 protons.**
- Started the commissioning of the phase noise longitudinal blow-up for beam stabilization.
- Improved and refined several settings. For instance we had a considerable improvement in the Mean Radial Position (MRP) for the first 10 ms of the cycle, which is critical for the ongoing injection studies.
- First look at the splitting at the end of the cycle, one of the main ingredients to produce MTE beams.

#### **POPS-B:**

- SY-EPC continued the investigation on the **QDE regulation**. The attempts done the week before did not yield remarkable changes.
- To give a context the BE-ABP team **observed ripples in the tune measurements directly related to the ripples in the QDE circuits**, of the order of +/- 0.02 in tune units. Using the measured currents as an input, our team of experts **managed to reproduce the measured tune**, which is a testament of a deep understanding of the machine, and at the same of how sensitive the new PSB has become.
- SY-EPC **continued the investigations:**
  - They switched to the **QDE spare circuits**, but there was **no improvements in the response**.
  - **Dedicated time** (as POPS-B regularly trips during the tests) was allocated **for measurements**. The newly calculated regulation **did not yield the expected improvements**.
- Unfortunately SY-EPC was stretched thin in resources during the week, as the same team was commissioning POPS. After talking to F. Boattini on Friday, he ensured that they will now focus more intensively on POPS-B and I remain confident.
- In parallel, the SY-EPC control team worked on the **development of the feed-forward algorithm, even though it is not clear if this will work sufficiently well**. The last information that we received is that they should be ready to test it with POPS-B during this upcoming week.

#### **Optics measurements:**

- **Measurement and correction of the beta-beating** during the first 5-10 ms with the new k-modulation application.
- Study of the **resonance compensation**. In detail, the half-integer compensation found now is somehow not compatible with the values used in 2018. BE-ABP is investigating.

- Dedicated time to review PSB injection and at the same time profit to collect more data for the H0/H- calibration (more later).
- **In depth studies to understand the KSW-BSW interplay** during the injection and understand any imperfection.

#### Extraction line:

- After commissioning the extraction at 2.0 GeV to the dump, the a few **discrepancies between the model and the measurements** were observed (via kick-response)
- The discrepancies are both due to **imperfect modeling**, being reviewed, and an imperfect correction of the **non-linear response for several BPMs in the recombination lines**. We are in discussion with the SY-BI experts to review their corrections, but it is more of a medium term project.

#### Beam instrumentation:

- Issue with the PSB **BPM in ring 1 giving different results for reasonable change of gains** (btw not observed in other rings before) **seems solved**. SY-BI reported no intervention, so we will monitor to see if the issue re-appears.
- SY-BI invested significant time to review and adjust the BCT settings in the PSB rings.
- **H0/H- calibration:**
  - Thursday (04/02) was fully dedicated to the review of the injection process and actually most of the time was used to collect data for the H0/H- monitor calibration.
  - With a Linac4 current of **25 mA the signal on the plates were saturated and it was necessary to switch to low current mode** (as for the Linac4 phasing). Since this was not tested in the **BI line, a few settings had to be reviewed and adjusted on the fly**. SY-BI collected data which is being analyzed offline.
  - Emittance measurements were possible in the extraction line with 3 SEM grids.
  - **LIU-WS:**
    - This is still an **expert operation and the debugging is ongoing**
  - **pre-LS2 WS:**
    - The response in **R1 and R3 is not yet reliable**.
    - The profiles in **R2 are inverted**, but the experts ensured about the sigma calculation.
    - **R4 working**. By comparing wire scanner and SEM grid measurements for ring 4 yielded comparable emittances; **emittances are clearly reduced when reducing the injection kicker plateau from 150 to 3 us** (for a 3-turn injection). This result shows that **foil scattering can indeed be used to blow up the beams**, which is an important milestone together with the observation that low emittances for the BCMS beam are in reach.
    - The SY-BI experts will access the machine on Tuesday 9th February for a long stop planned to combine several Linac4 and PSB interventions.

The weekend was invested by the operation crew:

- Review the timing setting for the PSB rings and extractions process.
- Continue with the checklist for beam instrumentation, mostly BLMs.
- Systematic review of the WS performance

In terms of availability **two were the main sources of disruption:**

- **Two** electrical glitches on Sunday (31/01) and Tuesday (02/02) of the **ME25 electrical relay**. The PSB took a few hours on both occasion to come back
- **Recurrent chopper faults** on Thursday and Friday, which were finally fixed by the Linac4 RF team. More in the Linac4 report.

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

Even though we were limited in what we could do last week since we will only get the water back in the facility today, we already started a few of the recommissioning tasks. Here you have the highlights:

- Machine supervision rota (with no stand-by service yet) started last Tuesday
- Electrostatic power supplies were unlocked last Wednesday
- With the exception of two sectors in the HRS separator, all others in the low-energy beamlines were pumped down last Friday
- The first batch of hardware tests were conducted to check the beam instrumentation of the low-energy beam lines. A few issues were found and our colleagues in BI are working on them

In addition:

- New beam scanners were installed after the GPS separator
- Installation work of the new HRS front-end continues (alignment)

#### PS (Oliver Hans):

- HWC for PSR completed, except: SY-EPC has asked one week more for commissioning of power converter:
  - Injection septum, SMH42
  - ejection bump, BSW12, 14, 20, 22 and QKE16
- Today starts the Cold Checkout. All equipment should be able to be used as with beam.
- Dry Runs to be done, e.g. PSB stray field compensation
- Dry Run with SY-BI important to check Wire Scanner and BLMs.
- TT2 wrong polarity corrected and verified, all ok now. HWC completed.
- TT2 in Access for work on BHZ377/378:
  - TE-VSC insulated the vacuum chamber from magnet yoke
  - Insulated the vacuum chamber between flanges
  - Installed vacuum supports
  - Today on-site check with TE-VSC, SY-EPC and OP.
- n-TOF primary HWC completed. Magnet polarity checked and new SEMGrid installed.

#### AD (Laurette Ponce):

An intervention by the fire brigade to pump infiltration water from the injection line region (unusual location). After investigation of the origin of the water by Bertrand Lefort, we have requested the cleaning of the evacuation of the "vide sanitaire" which is around AD hall wall and was found full of water.

#### ELENA (Laurette Ponce):

Main objectives and results of the week were:

1. to switch ON fully the electron cooler magnetic system.  
After the Tune meter was put back in operation, we could progress on keeping ON the electron cooler magnetic system for all production H- beams. The impact of the magnetic system on the circulating ion beam at 100 keV is non-negligible and the working point had to be corrected. Impact on the closed orbit is not yet fully compensated, we need to define knobs acting in the H and V plane. New studies will follow in the coming week(s). The magnetic system will be kept ON so that e-beam studies can be performed in parallel of studies with Hminus beam.
2. Continue the transfer line commissioning with first optics measurement in the shorter (LNE06) of the two ASACUSA lines. SY/ABT continue the scans to characterize the SEM monitor. Data analysis/results will be presented on Monday.

Additionally:

- We checked the acceleration/deceleration cycle with e-cooler magnetic system ON

- we are continuing to give access once per week in ELENA zone to complete AEGIS line installation and preparation for the LNE51 line
- Problems encountered last week with several FESA classes (e.g. BPM, Tune meter, RF Cavity) have been fixed or a work around has been found
- SY/RF continues to drive the effort to obtain a reliable and accurate intensity measurement of the extracted beams.

### SPS (Stéphane Cettour Cave):

#### **Summary of week 5:**

- Main dipoles pulsed without faults all week until Friday evening.
- Friday evening, we had two consecutive trips.
- First diagnostic:
  - first tripped caused by a doors switch of PCs at full energy 450 GeV.
  - Second tripped caused by a switch off EMD123 which powering the station SMD12 following a detection of a short circuit -> Investigation on Monday.
- Continuation commissioning main quad
  - QD test completed
  - QS and QF single test in progress
- TI2 access to resolve issues on vacuum valve -> Completed and tested
- Aux PS continue as planned
  - BB3 completed sextupoles and octupoles handed to OP
- Continuation FII/FEI debugging
  - Awaiting from EPC to install a new gateway in TT10
- MKDH HV cable insulation
  - 1.5 days access required. Planned 9, 10 February
- MKDV conditioning -> some sparking at ~33KV in the tank causing vacuum spikes
  - Under investigation
- Tested TSU arming and closed the Ring BIS loop and the Injection BIS
- Kicker MKE6 pulse tested with the prepulse synchronisation
- Adjustment of fire doors completed at all sites except BA1
  - Planned for next Thursday
- AWAKE closed Tuesday to Friday for TT41 AUX PS commissioning
  - Commissioning of RBI81607 this power converter supplies two chains of magnets dipolar
    - Awake: Earth fault on the magnets -> resolved problem on a cooling hose
    - TI8 : Earth fault on the magnets -> resolved ionic pump cable which was in contact with the busbar of the dipole MBI.86007

#### **Planning for week 6:**

- Investigation on the main dipole problem and repair
- Polarity and current check on sextupoles and octupoles circuits
- MKDH HV cable insulation
  - Planned 9, 10 February SPS Ring in access
- Pulling cable for BLM, and VSC in BA2
- Aux PS continue as planned
- Main Quad should pulse with FGC at the end of week
- Continuation FII/FEI debugging
- Kicker MKE4 pulse check. Link with the awake commissioning
- SBDS control and software commissioning continues

### AWAKE (Giovanni Zevi Della Porta):

**WEEK SUMMARY:** mostly no access due to SPS magnet tests. Some work on electron beam (remotely) and streak camera optical line.

**Update from last week on the AWAKE Water Temperature Issue:** After investigating, CV found that this was caused by two issues: an out-of-order bypass around the SPS cooling tower and a malfunctioning valve in the surface building of BB4. The first issue is now fixed, allowing our Klystron to run. The second issue will be fixed, providing further protection from cold water, as soon as a new valve arrived. CV is also looking into the possibility of remote regulation for the secondary circuit to the Klystron, but this would only be needed if both issues above arise simultaneously.

**TAG41 interventions:** Monday was the only day of guaranteed access, so RP, networking and UPS teams took advantage of this for small interventions.

**AWAKE Electron Beam:** on Tuesday we setup the electron beam and we were able to propagate the beam to the first BTV after the vapor source. On Wednesday we used the beam to test the new digital camera we connected at the end of the streak line.

**AWAKE streak camera:** connected a standard digital camera to the end of the streak line, with eventually the purpose of taking simultaneous (x, y) and (x, t) images. We tested this camera briefly on Wednesday with the electron beam, but since it is not intensified it cannot see the OTR light from electrons.

**AWAKE BLMs:** we tried to turn on the BLMs around the plasma cell, which are used to center the beam on the iris of the plasma cell. These were working well in 2020. Unfortunately, the HV power supply is now giving an error, which we are investigating.

**SPS Magnet tests status:** the magnet tests found an issue which might require further intervention next week

**Next week:** Access week (work on laser and streak line). No access on Tuesday due to Access System yearly maintenance.

#### LINAC 3 (Rolf Wegner):

- Beam from the source has a very good long-term stability with the new oven crucible and the aluminium coated chamber with
- Charge distribution measurement showed 150 uA of PB 29+, small amounts of carbon and nitrogen but no aluminium.
- Tank2 and 3 amplifier stopped working on Tuesday evening due to a fault of the power converter. EPC could repair it Wednesday afternoon. The system is running reliably since then.
- Hardware and beam commissioning continued.

#### LHC (Jörg Wenninger):

First week of phase 1 powering in S78 with excellent progress on all circuits (> 80% tests completed). Completed powering Phase1 in S45.

Local warm up to 20K of sector 56 to investigate and fix the 8mm misalignment of connection cryostat LHC.LEJL.5L6. X-rays confirm that the interconnect has a step change in vertical, but all components seem to be in good shape, including PIMS. Preparation to dismantle the dump line above the connection cryostat to allow for the installation of the tomograph to monitor the realignment which should be done at 20K.

This week the powering test in S78 will continue.