Accelerator Complex Status

End week 14 (Monday 11 April 2022)

Technical Infrastructure ():
Statistics:
- About 4'500 alarms.
- 591 phone calls (410 incoming, 181 outgoing).
- 84 ODM created.

Events worth mentioning:
- Fri. 08.04, Several gaz alarms in building 153. Fire Brigade intervention, there was a real leak of CO2 in the building. Happened twice during the morning. Investigation of the cause ongoing by the Fire Brigade.

Details: https://wikis.cern.ch/display/TIOP/2022/04/11/TI+week+summary,+Week+14

LINAC 4 (Giulia Bellodi):
There was a good beam availability of 98.5% this week at Linac4.

The two main events were:
- on Wednesday night: a broken amplifier of the source 2 MHz RF tube, which needed intervention for replacement (~2h15' downtime)
- on Friday night: a triggered RFQ breakdown recovery (~15' downtime).

PS Booster (Simon Albright):
It was another good week for the PSB with about 95% availability. Other than a few stops of Ring 4 related to the ongoing RF problem and interruptions from the linac, there was only the usual scattering of minor resets and trips. Otherwise, it was a calm and productive week with a lot of progress on operational fronts and the typical wide variety of machine studies.

There were two LLRF interventions on the issue of voltage spikes. The first, on Tuesday morning, was unsuccessful and lead to some down time of Ring 4 (other rings unaffected). After some more work by the experts, another intervention on Thursday morning appears to have cured the voltage spikes issue on Ring 4. As all rings are currently operational and stable, we are now entering an extended testing phase of the new firmware on Ring 4.

The new 1.7 GeV cycle, which will be used for ISOLDE beam tests, is progressing well, with 300E10 ppr extracted with minimal losses. The AWAKE cycle has been prepared, currently at 30E10 ppb and 0.3 eVs longitudinal emittance. The new 5 bunch variant of the AD cycle has been delivered operationally for most of the week, with positive feedback from downstream machines. There was also an LHC25 variant prepared with 2 injections of 3 bunches, which can be used in case one ring is not operational for an extended period.

ISOLDE (Erwin Siesling):
A good week for ISOLDE from the physics point of view, but with a few technical issues:

HRS:
On HRS we have installed a new target on Friday and we will start tuning this week to have the beam ready for the users by Wednesday.

GPS:
At the GPS side we a running for the IDS IS685 experiment with RILIS lasers running for Cd ionization. The target was mounted on Tuesday. It has a special quartz line which is suppressing a large scala of contaminants.
A sever problem was found when adding the powerful RILIS blaze laser. After entering through the laser window in the GPS separator magnet it would scatter and stop the ionization process. It appeared that the laser window was slightly coated due to back scattering of the lasers from the sector valve to the front-end which had been closed during the previous run with the lasers still on. To avoid this in the future an interlock system is being installed.
The laser window has been replaced on Thursday and physics at GPS started with some delay on Thursday-evening.
Even though the yield is somewhat low (factor 4-5 lower than expected) the users obtained good results over the weekend for several Cd isotopes.
On Sunday the target and line heating went off due to one of the two penning gauges going off in the GPS front-end sector. The beam was recovered in a few hours.
This morning the target went off again for unknown reason but could be recovered fast.

REX/HIE ISOLDE:
C. Gagliardi is working on the conditioning the REX RF for lower repetition rate.
D. Valuch has finished the conditioning of the HIE RF at warm so far. The next step is the conditioning at cold. The cryo modules are at ~125K and soon LHe will be send (end of cooldown to be expected end of April as per schedule).
REX EBIS was cooled down by F. Wenander after the quench the week before. With a LHe boil-off rate much higher than normal there was a suspicion there could be a cold-leak inside the magnet which would be serious. The magnet was further cooled down and it appears things are holding. Today more tests will be carried out before it can be concluded that the EBIS is ok again.

PS (Matthew Fraser):
The PS had considerable downtime this week due to a major failure of the FGCs controlling the injection system in building 365 (septum, bumpers and low beta quads). Totalling about 18h, from Thursday lunchtime all beams were perturbed by the PI.SMH42 FGC tripping on a communication fault, along with the PI.QLB showing errors. In a first intervention the EPC piquet replaced an ethernet switch distributing the network to the FGCs in building 365. The replacement switch installed was of type Brocard. The machine was operational again and running until after 17h when beam loss at injection and radiation alarms started intermittently (every 30 mins) without any FGC reporting a faulty state. This was extremely confusing and hard for the OP team to debug, especially as the injection elements appeared to be pulsing.

The EPC piquet worked overnight with little success and the EPC expert started working at 6 am on Friday. The replacement Brocard switch was a “managed” type and generates DHCP communication packets that can disturb FGC communication with the network. Brocard switches are commonly used by ITS and available at CERN. This was the assumed the problem after the first intervention.

FGC compatible “unmanaged” CISCO switches that are FGC compatible are no longer produced and hard to find but EPC could source a replacement from their laboratory for installation at 16h on Friday. The replacement CISCO switch did not stop PI.BSW43/44 from tripping again. At this point the EPC team noticed spurious communication packets coming from one of the spare convertors in 365. After disconnecting the spare from the ethernet network the problem was resolved.

A follow-up of this incident will be organised this week by OP and EPC to understand what happened along with the impact of various FGC firmware updates that were made during Friday. One important part of the follow-up must look at the diagnostics available to the OP team to debug FGCs and, in particular, the availability of analogue OASIS signals on critical equipment. A long access during a beam stop will be needed to check the behaviour of the spare FGCs.

The FGC issue had minimal impact on the SPS scrubbing programme and the LHC BCMS beam was prepared ready for next week at the requested 1.8e11 ppb.

In other operational news… the PI.SMH42 flashed over on Friday evening as the machine was started up, closing the adjacent the vacuum valves and stopping operation. After checks from the ABT expert the septum was restarted without problem and the flashover is assumed to have been beam induced. On Sunday afternoon a faulty water flow meter sending short and intermittent errors to the WIC controller caused East Area physics (T9 only) to stop until the expert is available tomorrow morning.

The MTE spill was sent to the SPS and an optimiser exploiting BOBYQA was successfully used to correct the spill trajectory with the DFA magnets in TT2 that are now both equipped with staircase generators.

AD continued to take the 5 bunch variant without issues throughout the week and work continued on the FTA line over the weekend.

A first EAST cycle with a parasitic TOF bunch at 300e10 was also setup this week.

PS - East Area ():
No report received.

AD - ELENA (Laurette Ponce):
Highlights of last week in AD and ELENA:

- Beam commissioning progressing in both machines
- A lot of work on the setting-up/measurement of 2 GeV stochastic cooling
- Commissioning of the 5 bunches injection scheme in AD, decided with PS RF expert to keep this variant to test stability in time
- After couple of optimisation on horn kick strength, injection lines settings, we now inject about 2.7e7 pbars in AD. Very good transmission to 300 MeV, more work needed on the last ramp.
- After connection of the compressed air to the profile monitors in LNE51, it was possible to start commissioning of the line with Hminus, and first pbars.
- First measurement with AD IPM gave promising results with gaz injection

Issues:

- investigation on the e-losses observed when activating the HV switch between the 300MeV/c and 100 MeV/c plateau.
- Problem of BCCCA for intensity measurement: many investigation, including access in AD, to understand the problem with intensity higher than ~1.2e7. A workaround have been put in place allowing to get back intensity measurement on Friday.

SPS (Michael Schenk):
Main focus of beam commissioning week 5 was setting up slow extraction towards NA (SFTPRO) and continuing intensity ramp-up and quality optimisations of 25 ns multi-bunch beams up to flat top during scrubbing (LHC25NS).

SFTPRO:
Slow extraction successfully set up in COSE mode up to TT20 TED on Monday using MTE core (5E11 p). ZS alignment was performed doing manual girder scan and using automatic anode position optimisation. Once missing NA DSO tests were finished on Tuesday afternoon, “NORTH TRAN” beam permit was obtained and TT20 TED “deconsigné”, allowing successful steering to T2, T4, and T6 on Wednesday. From Thursday, 5-turn MTE beam (5E12 p) was steered to said targets with first protons on H2/H4 in the evening set up in collaboration with BE-EA. Target symmetries were optimised to > “90 a” on Friday using auto-pilot after resolving issue with BSM signals. BE-EA teams were taking beam Thursday and Friday evening, and during weekend. Diamond BLMs were commissioned and signals observed on the TT20 line detector, however, not on the detector located underneath ZS (investigations ongoing). Several mini-scans were performed as well. A clone of the SFTPRO1 cycle, *to be used only for physics with 5-turn MTE,* was made on user SFTPRO2 (MTE core) for further commissioning activities.

Cycle / spill optimisation activities:

- Bunch rotation by voltage jump set up, forcing RF voltage to 0 V instead of switching RF “OFF” after jump to unstable phase. Provides cleaner and more homogeneous beam structure. To be verified by NA62.
- Continued setting up controlled longitudinal blow-up: not possible to go beyond 1 ns bunch length without inducing too many losses and beam dumps. To be continued.
- Successfully used optimisers for: **1)** losses on splitters in TT20; **2)** 50 Hz / 100 Hz noise corrections in spill structure; **3)** transfer trajectory optimisations of 5-turn MTE from PS to SPS.
- Corrections on main dipole, QF, and QD currents using "Auto Trim". Investigations on QD ‘current spikes’ ongoing. Corrections potentially reduced spurious beam dumps triggered by BETS earlier in the week.

LHC25NS:
Like last week strategy was to push intensity further and reaching flat top focusing on beam quality. Scrubbing time per day limited by MKP, MKDH vacuum pressures, and MKP temperature. Typically 6 h of scrubbing followed by 18 h of MKP cool-down per day. Best beam performance: 4x72b @1.55E11 ppb at flat top with bunch length ~1.7 ns, batch spacing 250 ns, transverse emittances ~2 um, and overall transmission from PS extraction to SPS flat top ~92 %. Effort was put into optimising longitudinal settings to improve longitudinal beam stability during ramp and bunch length at flat top. On Tuesday, noticed that bumpers in LSS6 were ON, but those in LSS4 were OFF. To scrub for operational scenario, bumpers have all been switched ON since. On Wednesday, scrubbing was challenging given issues in PSB (R4) and PS (longitudinal coupled-bunch feedback). Situation much improved on Thursday. In attempt to reduce MKDH vacuum spikes, scraping was set up, but currently induces too many losses to be used in practice — to be followed up with experts. On Saturday, had MKP4 electric spark requiring 2 h conditioning.

Other activities:

- Longitudinal damper commissioning at flat bottom and beginning of ramp completed and damper used on scrubbing cycle.
- MKE delays: following Beam Controls update, managed to align timing such that MKE delays for LHC, HIRADMAT, and AWAKE users now identical. MKE4 & MKE6 waveforms revalidated. Nominal kicker delay settings copied to all LHC users.
- Thu morning, w/o beam stop: NA TT81 & TT83 interventions on magnets.
- Friday, 9-11 AM, several interventions, w/ beam stop: BLMs 518 & 519 to allow masking at time of dump, RP intervention for vetos, MKDV intervention in ECA5, QNL.011167 leak repair in TT81, solid state amplifier module exchange on 800 MHz system, software and

firmware releases on 200 MHz and 800 MHz systems, reboot control system machine SVC BEQ1.

Main issues:

- **800 MHz RF system faults** (power system & LLRF). Various changes made: **1)** Cavity 1: timing card replaced. **2)** Cavity 2: IOT trolley changed. **3)** Increased Vmin from 200 kV to 300 kV to avoid undesired step in IOT power response. IOT reconfigured, but issue reappeared. At present set voltage, higher Vmin not ideal since operating in counter-phasing regime. **4)** OTFB for cavity 2 currently OFF, observed RF power trip when attempting to switch back ON. To be followed up.
- **TT20 BI: 1)** FESA read-back indicated several SEM grids in beam position while they were not. Triggering move several times fixed problem. **2)** Various calibration factors to be reverted in LSA to fix intensity readings on Page 1. **3)** SEM grid gain adjustments important for signal quality, but not clear from profiles when signals saturated. Solution to be put in place to provide warning. **4)** BSMs: low signals observed on target positions. Read-back indicated elements to be in beam ref. position, but potentially not the case. Moving elements out and back into position resolved issue. Had great support from BI which was key.
- Masked TT20_VENTILATION_BEAM interlock when attempting to go past TT20 TED. Recurrent issue from last year, now resolved.

Carry-over items:

- **SFTPRO2:** TT20 optics tests and measurements, continue work on blow-up.
- **AWAKE:** voltage step set up and verification of stability.
- **SFTPRO1:** Vertical stability study and transverse damper (M2V) validation.
- **COAST:** transverse damper make rule blocking tune trims fixed, to be tested.
- **MKP delays:** automatic optimisation of trajectory. First tests done, more time needed.

Next week is devoted to NA secondary beam lines commissioning, scrubbing, and BCMS beams.

SPS North Area ():

Beam commissioning has started.

AWAKE (Giovanni Zevi Della Porta):

Last week's focus: Laser and electron alignment studies

- Elevator
    - The entire week and part of previous week was without BB4 elevator (out of order from March 30 to April 8)
    - Next time we have the same problem, it should hopefully require less time: 2 additional spares were ordered
    - Thanks to all those who kept AWAKE running despite the stairs (including the proton beam tests); to the crane team who agreed to help during Week 15 if necessary (in the end it will not be needed); and of course thanks to those who fixed the elevator!
- Laser:
    - Characterized jitter at different timescale on Main and Virtual lines, using 1 hour of 10Hz events
    - Measured effect of mirror motion for each mirror, on each screen on both lines
    - Lost pico-motor controlling one mirror: should be fixed next week
    - Wrote first-order version of automated alignment: will test once pico-motor is fixed.
- Electrons:

- Continued investigating YASP orthogonal steering. Factor of ~2 scaling at BTV position confirmed, not understood. In addition, angular motion pivot point is ~ 1 m away from correct point. Beam experts (SY-ABT-BTP) are investigating, but it looks like positions in YASP are correct.

Plan for week 15: Access and vacuum opening to install 2 new BPMs (HF and ChDR). Change of water hoses for laser cooling circuit. Several other activities were planned (shielding, CV, cleaning) but they were postponed due to uncertainty on the elevator repair date.

LINAC 3 ():

YETS.

LEIR ():

YETS.

CLEAR (R. Corsini, P. Korysko):

The first half of the week was dedicated to preliminary tests of the prototype Wall Current Monitor (WCM) from Bergoz. The second half of the week was dedicated to prepare the Manchester VHEE focusing water phantom experiment, scheduled for the week starting April 25th. An issue with the laser prevented from starting beam on Monday, some main amplifier parts had to be exchanged and repaired, which was done fastly and efficiently by the laser team. Thanks to their effort, beam ewas resumed on Tuesday, with improved stability. Data taken by Bergoz colleagues on Tuesday were very promising, and will be furhter analyzed. On Wednesday the C-Robot was re-installed, and the rest of the week was taken by quadrupole scans and beam studies. An instability in the RF pulses from MKS11 was identified and tracked down to arcs in the charge power supplies. An impedance adaptation resistor was changed, and this solved the issue.
Full operation reports can be found in the CLEAR Weekly Operation Meeting series, here: https://indico.cern.ch/category/10682/

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	53 / 11592 A	71 / 11950 A	87 / 11950 A	76 / 11600 A	62 / 11600 A	21 / 11600 A	55 / 11600

Start of RF conditioning for S45 cavities and start of cool down of S34 cavities on Monday. S34 cavity cooldown completed Tuesday evening. S45 RF conditioning completed, while conditioning of S34 cavities started om Friday.

Very slow progress in S23 with many de-training cycles. Sector 23 reached 11'600 A on Saturday on cycle # 52, but quenched at FT after a few milliseconds. The following cycle saw again a de-training.

The machine reliability was tested by bring all circuits (except S23) + LBDS + BIS to 6.8 TeV on Saturday and Sunday. The LBDS remained armed between 2 and 8 hours, dumped by circuits (twice) and spurious BLM triggers (twice, HW issue). The circuits remained at 6.8 TeV for over 13 hours on Sunday.