

Accelerator Complex Status

End week 44 (Monday 8 November 2021)

Technical Infrastructure (Jesper Nielsen):

Statistics:

- About 7'000 alarms.
- 816 phone calls (590 incoming, 226 outgoing).
- 119 ODM created.

Events worth mentioning:

- Thu. 04.11, Local emergency stop in building 193 activated by error, cut the power supply [ERD59*49](#) which was quickly repowered by EN-EL.
- Sat. 06.11:
 - Lost patrol in BA2 due to access control card problem
 - Lost patrol in BA80 due to access control card problem
- Mon. 08.11, Lost patrol in BA2 due to access control card problem

Details: <https://wikis.cern.ch/display/TIOP/2021/11/08/TI+week+summary,+Week+44>

LINAC 4 (Alessandra Lombardi)

A generally quiet week for LINAC4 except for a problem on the CCDTL3-4 RF power source that stopped the beam for 5 and ½ h on Friday evening.

In short

- RF went down and couldn't be re-set remotely
- PIPO came and changed a faulty high power board on the modulator
- after the intervention above From the RF side we could not reach the full voltage for the klystron (-108 kV) and had to run with a slightly reduced voltage (-104 kV) which still gave about 10% power margin – enough for the LLRF regulations. We should just re-establish the nominal voltage of -108 kV which gives another 10% power margin.
- the cause of the limitation of the voltage has been identified. It requires a short planned intervention (15-20min) to be fixed. This intervention will be planned soon.

PS Booster (Alan Findlay):

Overall it was not a bad week for the PSB itself, with just a couple of PSB issues cutting the beams.

Wednesday mornings central timing issue brought down the PSB around 09H45, but a problem with a faulty card in POPSB meant that it was not operational again until 11H20, so we were only able to deliver beam once again from 11H30.

Friday morning around 09H00 a circuit breaker in one of the TFB racks tripped, which was quick to rearm, but the MTE beam especially was still very lossy during acceleration. Although all the indications were that the HW was all OK, we kept losing communication with one of the crates in the rack after a few minutes of normal operation. Whenever the crate was rebooted (which was quite regularly!) all high intensity beams were affected. The crate power supply was changed and solved the issue, so we returned to normal operation after just over 2 hours.

Otherwise, it was business as usual, with nothing else major to report.

ISOLDE (Alberto Rodriguez):

It has been a good and very busy week at ISOLDE. No significant downtime with only minor problems in the machine.

On the REX/HIE-ISOLDE side, we continued delivering 61Zn beam with an energy of 7.5 MeV/u to the ISS experimental station until Thursday morning. Afterwards (starting on Thursday afternoon and until Friday), we started injecting a mixture of noble gases (Ne, Ar, Kr and Xe) into the EBIS using our new gas supply system. By doing so, we were able to produce and deliver a cocktail of beams ($20\text{Ne}5+$, $36\text{Ar}9+$, $40\text{Ar}10+$, $80\text{K}20+$, $84\text{Kr}21+$, $128\text{Xe}32+$, $132\text{Xe}33+$, $136\text{Xe}34+$, $16\text{O}4+$ and $12\text{C}3+$) to the ISS for commissioning of their new ion chamber.

On the GPS side, we installed a new target on Thursday (right after the 61Zn beam delivery finished), heated it up over night and prepared a new set-up to the GLM line on Friday. Users in that experimental station have been taking several Dy isotopes during the weekend.

On the HRS side, we installed a new target on Monday, heated it up during the night and completed the set-up of the separator and low-energy transfer line on Wednesday and Thursday when we also completed the proton scan and yield optimization. Later that day the VITO users started taking 37K into their station. They have been taking beam since then and they are scheduled to stop this morning at 9:30.

PS (Heiko Damerau):

A busy week for the PS with several small issues preventing beam production for short durations. Nonetheless the average beam availability was of the order of 90%.

During the night from Monday to Tuesday the converter of a DC powered magnet in the FTA line (FTA.BVT9045) was not delivering current while its acquisition stayed frozen at a meaningful value. This complicated the troubleshooting and the AD-OP team identified the problem in the morning, resulting in about 7h without beam to the AD.

On Tuesday afternoon the magnets in the primary zone of the EAST area tripped multiple times due to erroneous interlock signals from two flow meters, which caused a stop of some 2h30 of all beams to the EAST hall. As hardware safety is assured, the flow meters have been temporarily removed as interlocks from the PLC.

An unexpected reboot of the timing system on Wednesday, most likely due to insufficient memory of the central timing front-end, caused 1h45 without beam. Repairs on one 10 MHz cavity and two 200 MHz cavity amplifiers were required as a consequence of the sudden timing interruption. The PS was ready for beam after 1h.

A test to remove the sign switching of the radial loop gain when stretching bunches at the unstable fixed point on Friday had unexpected side-effects on the LHC25ns cycle for HiRadMat and 0h50 were required for troubleshooting. On Friday afternoon, asymmetric bunch splittings, as well as increased losses during acceleration were intermittently observed on all beams. In the shadow of the Linac4 stop, these were traced down to the cavity controller of the 10 MHz cavity C10-96 which did not correctly resynchronize from time to time. The problem disappeared by itself while investigating locally, without further occurrences on Saturday. A short access to exchange a gap relay of cavity C10-81 could also be organized on Friday night, in the shadow of the Linac4 problem.

A module of the PS injection kicker tripped multiple times on Saturday. Since then, the AD beam is injected by using only 3 modules of KFA45. Many beam tests to understand the magnetic field

dependency on the preceding cycle have been performed throughout the week by checking well-defined sequences of cycles. However, the root cause has not yet been identified. A cycle decelerating beam down to 1 GeV has been tested for aperture scans. Studies will continue to understand a radial position excursion and to potentially decelerate to lower energies.

PS - East Area ():

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AD - ELENA (Pierre Freyermuth):

- Tuesday 2nd: no proton on the target, it took us some time to figure out a power supply didn't provide current despite good status and acquisition.
- Wednesday 3rd: RF MD on elena. Aegis ramped up their superconducting magnet, affecting the surrounding lines. The Alpha line has to be re-steered as the beam is lost on the vertical plane.
- Thursday 4th: Aegis magnet quenched during the night, we restored the steering for Alpha. Later Aegis put back their magnet on, and the settings of the Alpha line seems reproducible enough to restore quickly a centered beam.
- Friday the 5th: We had to steer Asacusa line as well due to Aegis magnet. All settings stored. The H- source hydrogen cartridge drained out, access needed to exchange it. 5 users request the beam from Elena. As we only have 4 bunches, a check policy was implemented in the beam request server. If one element (such as beam stopper during zone access) prevent the bunch to reach an experiment, the request is ignored.
- Saturday 6th: The new beam request server behavior is qualified as unviable by Alpha, so we rolled back. However, due to the design of the line with fast deflectors, it might happens an experiment get more than one bunch for a sigle trigger.
- Sunday 6th: AD quadrupole power supply tripped.

Other than that, the Pbar complex is stable and the beam intensity delivered as well.

SPS (Kevin Li):

Week 44 has been yet another chapter in this year's chronicles of HiRadMat. At the same time, it was the last HiRadMat experiment of the year. The experiment required highest possible intensities at 288 bunches. Given the state of the machine, in particular the dump kickers, it was clear that this was going to be challenging. Overall availability is a round 80% (higher for NA physics) at the time of writing.

Monday had been foreseen for dedicated scrubbing at the long flat bottom with the machine put into "scrubbing mode" (enlarged MKDV thresholds). Unfortunately, the day started with an access in the PSB for repairing the faulty R2 extraction kicker. The originally planned BA80 access in the shadow of this finally did not take place. Even after the access, the PSB could deliver beams only in degraded mode, not suitable for scrubbing. Therefore, the optics commissioning for the HiRadMat beams was done instead. NA continued running in parallel in degraded mode. Dedicated scrubbing did not start before 15:00 in the afternoon and continued all night. Early Tuesday morning the cycles were switched and scrubbing continued up to flat top on the nominal HiRadMat cycle. By Tuesday morning, the machine had been carefully, but thoroughly scrubbed and 288 batches could be taken to flat top at intensities of 1.2×10^{11} ppb. Beam quality as well as vacuum pressure levels were extremely good.

Extraction, however, would not be permitted by the machine for the entire day... At first, an unmaskable interlock from a removed BTV in TT66 inhibited any extractions. The interlock connection had been forgotten when removing the device; a patch was put in place (to be fixed during the YETS) such the extraction would become possible. When taking the beam back later in the morning, the MKDV started interlocking regularly on vacuum pressure. The signature seen on the pressure gauges were small pressure rises up to 4×10^{-6} mbar maximum, as established during the scrubbing. There were no visible spikes beyond the threshold level, hinting once again towards

spurious dumps, probably generated by very fast, beam induces spikes on the signals sent to the dump kickers. After, desperately, trying a multitude of machine and beam settings in an attempt to relax the situation for the kicker without success, a meeting with ABT and VSC experts was called, where it was negotiated to raise the MKDV thresholds to $1e-7$ mbar. This finally gave the required margin such that 288 bunches could be accelerated and extracted. The initial shots showed inconsistencies on the expected BTV signals, however, which is why the experiment decided to re-verify the optics once more on Wednesday morning before actually starting to take shots on targets.

Wednesday morning the optics was checked; it turned out that the BTV images were inaccurate, explaining the discrepancy with the expected images. After a close to 2 hours downtime due to a crash of the central timing system and a few further checks, finally, the experiment was launched and HiRadMat used the day to take 14 + 12 shots of 288 bunches on 7 of the 18 targets. This had brought the MPK close to the temperature interlock threshold which is why the cycle was switched back to NA physics production during Wednesday night. Thursday started with a series of BBA using LHCINDIVs at first and 36 bunches later. At a certain point all beams got blocked and were lost right after injection. It took some investigation to figure out that the RF conditioning had gotten desynchronized and was playing during BEAMIN instead of during BEAMOUT, effectively rendering the RF destructive to the beam. After fixing this, beams were taken back for BBA during the major part of the daytime only interrupted by another timing glitch. High intensity beams were taken back in the evening and another 20 + 4 shots at high intensity were taken until extraction was halted for the cool-down of the MKP. Friday was again spent for BBA with LHCINDIVs during most of the daytime. When getting ready for the last couple of high intensity extractions towards the evening, LINAC4 went into a 5.5 hour downtime due to an issue with one of the klystrons. It was decided to finish off the experiments on Saturday starting at 9 in the morning.

The HiRadMat cycle was ready for extraction of 288 bunches on Saturday morning and extractions were started immediately. At around noon, 8 of the 12 + 8 remaining shots were done, when the patrol was lost in BA2 as a result of the usual access system trips. When restarting at around 14:30, the HiRadMat beam no longer entered the machine. Injection steering and orbit looked okay. WR2RF Grafana showed red lights on the cavity control. The RF system was checked inside out but all settings and signals both in the SPS as well as in the PS looked correct. Steering did not fix the problem either. Moving RS thresholds also did not solve the problem. The LHCPILOT could be injected and passed though. When attempting a test with 72 bunches at reduced intensity, another access system trip occurred. This time the patrol was lost in BA80. The machine was back at around 20:00. When taking the 72 bunches back, the intensity was accidentally reset to the original high values in the PSB... and the beam passed without any issues! Some orbit correction and injection steering was done to provide a little more margin in 118, but the beam had already passed and further batches were injected to set up the beam for the final HiRadMat shots. Issues with the PS injection kicker delayed the restart to midnight, but then the experiment was able to take the final 20 shots and by Sunday morning at 4 could successfully complete their programme! What caused the bipolar state of the machine during the access system trips is not entirely clear.

While the HiRadMat programme was full of excitement, wonders and surprises, the NA remained comparatively quiet. Physics was partly impacted by the spurious vacuum interlocks, but apart from that, could be reasonably decoupled from any impact due to the HiRadMat cycle and beams. A change of sharing was done on Tuesday, taking 5 units from T6 and moving them onto T4. On Friday night there was an issue with the servospill, resulting in large 50 Hz and 100 Hz noise on the SE spill. This could be fixed on Saturday morning, though.

With the dense programme, no slot for the FW upgrade for the ions next week could be found. This will need to be done first thing on Monday morning.

Open issues:

- FW upgrade to be done for BC
- Access needed for RF active feedback system

- ECONOMY mode not working for mains
- FGC update still needed by Quentin
- TI2 tests for Gill
- Central timing card is running at it's memory limit and is unstable; further timing glitches are possible

SPS North Area ():

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AWAKE (Giovanni Zevi Della Porta):

Minor interventions. Water leak in electron gun area

- **BPM re-cabling, part 1:** split the output of electron BPM 412351, sending part of the signal to the electronics of proton BPM 412352. Now 412352 is disconnected (ready to be replaced by Cherenkov Diffraction Radiation BPM). We should still get the same e and p information, but all from BPM 412351
- **BPM re-cabling, part 2:** Swapped H and V cables for proton BPM 412319 for troubleshooting. Since H intermittently sends no data, we will check if the problem moves from H to V or stays on H.
- **Water leak in electron gun area:** demineralized water dripping from TCV4 mezzanine. CV intervened and fixed the leak, but electron gun, magnets, waveguides etc were wet, as well as the ground. Area was fully dry on Friday. All system experts contacted, equipment checked. No apparent damage, and we will attempt to restart systems starting Monday.

Plan for Week 45: Prepare for SPS protons expected on Saturday/Sunday. Attempt to restart all electron and laser systems after water leak. Laser Flippers/PLC intervention on Thursday.

LINAC 3 (Rolf Wegner):

It was a very good week for Linac3 in terms of reliability - no fault at all. However, the desired intensity of 30 uA out of the Linac could not be reached.

- The Linac accelerated the lead beam without interruption on Monday and Thursday with an intensity between 28 and 29 uA, measured at BCT 41.
- On Wednesday morning the scheduled, dedicated MDs were performed.
- On Thursday both ovens were refilled with (already used) lead.
- Beam was back on Friday early morning with an intensity of about 26 to 27 mA.
- In order to increase the intensity, the stripper foil was exchanged on Friday afternoon from a foil with a density of 100 ug/cm² to one with 129 ug/cm². Unfortunately, this did not significantly increase the intensity.

Over the weekend the source behaviour changed and Detlef could gain in beam intensity by re-optimising the source and LEBT. The intensity is now approaching 30 uA.

- Regular beam energy measurements were taken throughout the week.

LEIR (Nico Madysa):

Main activities:

- calibration measurements of non-linearity of injection transfer line BPMs
- adjustments of NOMINAL beam in preparation to hand beam over to SPS
- MDs on instabilities, Schottky measurements, and on timing in ITE.BHN40

CLEAR (Wilfrid Farabolini):

This week was fully dedicated to the preparation of the next week experiment with our CHUV collaborators, that will be resuming their CLEAR experiments in presence after more than one year

of interruption. The samples handling robot was used for the first time in real beam conditions, and a “blank run” of next week experiment was performed, with 16 films irradiated in the water tank and several position scanned with its YAG screen. We also continued training of our new students, familiarizing them with the CLEAR operations and trouble-shooting. A record of beam charge was obtained with 42 nC at 3 GHz laser frequency, that will fulfil the CHUV request for high dose in single pulse.

Data processing programs were also written to exploit the scanned films and the YAG camera images.

Full reports can be found as usual here: <https://indico.cern.ch/category/10682/>

LHC (Jörg Wenninger & LHC Coordination webpage):

S12	S23	S34	S45	S56	S67	S78	S81
Completed	Phase 2	Completed	Completed	Completed	Completed	Training	Completed
77 / 11950 A	0 / 0 A	71 / 11950 A	87 / 11950 A	76 / 11600 A	62 / 11600 A	10 / 10509 A	55 / 11600

Training of S78 restarted Mo 01.11, with a very swift recovery so far. Following the discovery that the ULO in 21L3 in a buckled RF finger, the decision was taken to warm up S23 to replace the PIM.