143rd Meeting of the Machine Protection Panel

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The slides of all presentations can be found on the website of the Machine Protection Panel:
http://lhc-mpwg.web.cern.ch/lhc-mpwg/

1.1 Approval of MPP#142's minutes

- Actions from 142nd MPP:
  - MPP: Produce a summary checklist of MPS tests to be performed during the beam commissioning period.
  - Matthieu**:** Request a pointer from Stephanie for future meetings, or get a dedicated one.
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 ABT MPS recommissioning after EYETS 16/17 (W. Bartmann)

- Up-to-date documents "MPS Aspects of the Injection Protection System Commissioning" and "MPS Aspects of the Beam Dump System Commissioning" can be found in EDMS. Detailed step-by-step procedures (mainly meant for internal use in ABT) are locate on dfs: \Departments\TE\Groups\ABT\Sections\BTP\LHC-Restart-2017\Procedures, and will be moved to EDMS after start-up.
- SPS extraction will follow usual steps, which can be tested with upstream TED before LHC beam commissioning.
- As for the transfer line, vertical smoothing of quadrupoles in TI2 was performed (196th IEFC meeting), and the TI2 vertical dipoles were also corrected at the top of the line where larger vertical excursions were measured. Aperture measurement with dipole kicks of 30 degree phase shift along the lines will be performed, and checking the optics with kick response will also be considered.
- For LHC injection, changes from 2015 on injection protection setup and validation will be kept. Additional tests will be performed including:
  - Kick response from line into ring to verify BPM capture is working.
  - MKI module synchronisation and verification of flattop start for B1 after TS exchange.
  - To verify if injection protection needs to be separately setup and validated for VdM scan optics, as this is the 2016 optics and not ATS 2017.

- There is no change to interlocking strategy. All BETS modifications as introduced after LS1 are kept. Modifications related to variable AGK will be reported by Nicolas Magnin in a future MPP meeting (update after the meeting: on 21.04.2017).
- BLM inhibit with 288 b trains will be tested.
    - Christos proposed a coffee meeting to discuss the necessity and definition of such tests.
    - Daniel remarked that if the test would be needed, it would be better to do it this year.

Action: BLM inhibit in case of too high transverse losses with injection: propose commissioning test to verify functionality (BE-BI and TE-ABT). To be presented in MPP either on 07.04. or 21.04.

- 4 nominal bunches will be injected at a time for VdM scans. Keeping TCLIB settings in mm results in 7.2 σ (P2) and 8.3 σ (P8), which is considered to be safe. Checks to be done for VdM scans are following:
    - Check the orbit difference with nominal bunches.
    - Perform alignment check with parallel jaws.
    - Perform injection loss maps with/without injection protection.
- For LHC extraction, modifications were performed during EYETS on dilution kickers to avoid MKB coupling, i.e., the retrigger box was insulated from the generators, and nano crystalline cores were added on the retrigger line to suppress common mode. After these modifications, no coupling up to 7.1 TeV has been observed. The results bring confidence for 6.5 TeV operation, however, margins for 7 TeV operation are unknown. Retriggering of MKBs is under serious consideration and study for a possible implementation in LS2.
- A 2 weeks reliability run of the LBDS at 7 TeV is ongoing. Reliability run of 1 week at 6.5 TeV will be performed. Rate of erratic and coupling is monitored. Baseline is to keep MKB at 100% voltage for 6.5 TeV. MKBH voltage reduction is kept as fall back option. LIBD with EN/STI input for operating at 80% MKB voltage is being prepared, which will be reported afterwards to the MPP.
- In addition to standard procedure, other LHC extraction tests will be performed as follows:
    - MKD waveform check: verify rising edge and rise time to check if component is ageing and to provide input for AGK modifications.
    - MKB waveform check: dump ~5 pilots distributed over the machine.
    - AG cleaning: check if SIS triggered cleaning works.

1.3 SIS: Summary of changes (L. Ponce)

- The ATS telescopic optics breaks the logic of β* reconstruction in SIS as the telescope is no longer 'local' to the IP.
- To include the TELE part of ATS, the logic based on the ratio of 2 local IR PCs has to be expanded to include the IR(s) that generate the telescope.
    - For IR1, both IR2 and IR8 are involved in the telescope, but as they have their own squeeze on top, they cannot be used easily.

- It has not been planned to use the TELE squeeze at start-up (as not needed for 40 cm), so there is no urgency to test the new feature. But we may use the TELE squeeze immediately, so untested logic must be made operational rapidly. Test can be done as soon as the PCs are available (even in simulation).
    - Laurette and Jörg remarked that tests could start next week.
- For TDE vacuum interlock, in 2016, ring permit was given as long as the values of gauge VGMA.6894700.B and VGMA.6294700.R were in the range of 1.1-1.35 bar. This was proven to be reliable last year.
- During the EYETS 16/17, VSC installed a 2nd piezo gauge with direct reading on the dump volume, the name of the old gauge was changed.
- As recommended from MPP, beam dump should be triggered if gauge value is < 1 bar (1min temporization for bad readings + communication loss)
    - Laurette wanted to make sure whether the 2 gauges should be combined or only the new one should be used.
    - Daniel answered that only the new gauge should be used.
    - Markus / Jörg commented that the new channel might be consolidated in the future (as an outcome of the ongoing studies and simulations) for appropriate reliability to become an active HW interlock channel (beam inhibit or dump).
- For injection inhibit, it should be triggered if either of the two pressure readings is < 1.025 bar OR if pressure readings diverge by ≥ 0.1 bar.
    - Markus proposed that pressure readings diverge by ≥ 0.1 bar might not be adopted.

Action (BE-OP): For TDE nitrogen pressure interlock, change gauge used for dumping in case of too low pressure (< 1 bar) to the newly installed one close to dump volume (as proposed by last MPP); introduce new injection inhibit if either of the two pressure gauges measures a pressure below 1.025 bar. In both cases implement waiting time of 1 min to avoid triggering on communication issues or wrong pressure readings.

- SIS surveillance of the redundancy of LBDS FEC power supply is a pending request since last year, which is deployed as injection inhibit. The FESA class for the MKISS is still missing.
- Together with sequencer check during ramp down to anticipate intervention, these will be tested during machine check-out.
- The introduction of the variable AGK has an impact on the SIS interlock that blocks injection when the requested bucket is too high (to avoid sending beam onto the TDI if AGK works).
    - In the past the last authorized injection bucket was hard coded in LBDS.
    - The logic must now include a parameter that defines the maximum length of a train from the SPS: *No*. bunches + *N* x SPS MKP gap.
    - Implementation work has not yet started as several details have still to be clarified with the LBDS team.

- SIS should also read back the length of the AGK, the length of the MKI pulse (setting) and perform a consistency check with the train length quoted above.
- Validation of variable AGK with pilot beam needs 2 shifts. Details of implementation are under discussion.
    - David asked when pattern check should be performed.
    - Jörg confirmed that it would be after the last injection into the SPS.
    - David pointed out, that with the new FBCT in BA5 it might be possible to send the filling pattern in time to the SIS to allow the evaluation before SPS tries to inject into the LHC.
- Other issues include:
    - Change of BSRT alignment system (corresponding BSRT_ALIGN_MIRROR SIS injection inhibit to be updated with the new devices).
    - BPM collimator interlocks to be made active when new settings are defined (may also add the BPM status).

Action: Define interlock logic for DOROS BPMs at collimators (what to do if no data or data inconsistent, etc) (BE-OP, Collimation, MPP). To be presented together with the re-commissioning presentation of Collimation.

Action: Define requirements for DOROS BPM post mortem data and provide them to BE-BI (Collimation, BE-OP, MPP).

1.4 BCCM: status and commissioning plans (D. Belohrad)

- Before EYETS, during 2016 LHC run, BCCM system was installed and measured throughout the year with only minor modifications in the firmware. The last important algorithm modification was the removal of the FIR filter at the beginning of Dec. 2016. As a result:
    - the system's response is faster as the FIR latency (108 bunch slots) is not present;
    - algorithm reacts faster on changes during ramp;
    - and FIR-less design surprisingly leads to lower system noise when comparing different amplitudes.
- The used FIR filter is generated by Altera. Algorithm is not known as it uses lots of optimisation techniques. Analysis is in progress to understand above effect.
- During EYETS, there was no change concerning the BCCM hardware. However, significant changes were performed in the analogue front end, including:
    - Installation of the last BCTW to the development beam 1.
    - Installation of the new head amplifiers to all 4 devices.
    - Verification and replacement of all the cables, as it turned out that some of them were not properly done. All cables have been measured using VNA.
    - Complete removal of the old analogue measurements.

  - Installation of a serial console to get more BCCM debugging data.
- Tests already performed are as follows:
  - All systems were again tested for broken ADC bits.
  - CIBU links were visually verified by invoking the BCCM test mode.
  - Whether the BCCMs noise floor is comparable between BCCMs was verified.
  - 5MHz sine wave was injected into BCTW calibration and the results on BCCMs were observed to see whether the calibration propagates through the measurement chain.
  - Injection-dump tests were performed by injecting the LHC pattern into the head amplifiers.
  - Dump tests were performed: injection of 5MHz sine wave for 10 seconds and verification whether BCCMs dumped.
- BCCM dump tests will be again turned on to debug FESA logging.
- At Pre-commissioning phase, the input signal amplitudes for the BCCMs have to be again setup, since the analogue chain was completely modified and the system gains were modified/adapted during EYETS. Therefore, the following scenario is proposed:
  - turn off the thresholds for the start-up.
  - when first pilot and nominal is injected, measure the system gain and enter machine to remove the attenuators:
    - pilot already gives a decent estimation of required gain;
    - fine tuning with ultimate intensity in beams.
  - activate/set again the thresholds using newly measured gains.
- Commissioning plan includes:
  - bunch amplitudes checks:
    - single nominal does not saturate ADC;
    - 5+ nominals do not saturate ADC.
  - setting the thresholds, then long-term check of dumping:
    - each non-scraping dump event must be followed by generation of the dump from given BCCM (automatic script).
  - Scraping exercise proposed by David:
    - 5 nominals at injection, 5 different loss rates until the beam is gone;
    - 3 nominals at flat-top, 5 different loss rates until the beam is gone;
    - David was wondering if it would be possible to make a total loss in 10 seconds' intervals, say, 10-60 seconds? (10 seconds creates roughly 7 measurement points)
    - Daniel said it would be possible as long as the total number of protons is less than ~3×10^{11} (setup beam intensity that would allow masking of some BLMs). However, to gain confidence, one should refer at first to loss rates which will be obtained during beam commissioning (collimation loss maps, asynchronous beam dumps, etc).
    - Markus and Daniel commented that the scraping should first be performed at injection energy, and then the signal might be

scaled. To achieve maximum experience from that the interlock levels of the BCCM should be reduced and the post mortem data analysed carefully.

Action: Make post mortem data operational for BCCM and reduce BCCM trigger levels for all running sums during the beam commissioning to fully exploit the experience from loss maps etc. (BE-BI).

  - injection of single bunches of various intensities:
    - Is it possible to have 5 different intensities to check the linearity of the system?
    - Jörg commented that this could be easily achieved with scraping and/or the ADT (for bunch intensities below 1.2×10^{11} = nominal bunch intensity).
  - changing the bunch lengths:
    - injection of a single nominal, changing its length.
    - Markus commented that changing the bunch length will normally be very slow (taking up to a few minutes) and should therefore not impact the system.
  - Position dependency is not needed as it was already verified.
- Open issues:
  - None of the EYETS works directly affected the BCCMs, but the analogue signal path was completely changed. Replacement of the cables could solve the issue of 0.1% jumps, which BI has measured during most of the 2016 run.
  - The signal amplitude jumps (correlated behaviour of old analogue acquisition, new digital acquisition and BCCM), are most likely issues of the analogue signal chain. It is difficult to solve the problem, since the jumps appear only under special conditions (B1, during physics run with high beam intensity). During EYETS stability tests nothing was revealed. Further tests must be fit in with the commissioning plan.
  - FESA is still not stable (hangs after few days of operation). Works are in progress there.

AOB – None