144th Meeting of the Machine Protection Panel

Participants: A. Apollonio, M. G. Berges, R. Bruce, A. Di Mauro, C. Hessler, D. Lazic, A. Lechner, T. Medvedeva, A. Mereghetti, Y. Nie, A. Rossi, J. Uythoven, M. Valette, J. Wenninger, D. Wollmann, C. Xu, M. Zerlauth.

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#143's minutes

- Actions from 143rd MPP:
  - BE-BI and TE-ABT: propose commissioning test to verify BLM inhibit functionality in case of too high transverse losses at injection.
    - Covered in this MPP.
  - 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 during last MPP and endorsed in the LMC); 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.
    - Presented in the LMC.
  - BE-OP, Collimation, MPP: Define interlock logic for DOROS BPMs at collimators (what to do if no data or data inconsistent, etc). Summary to be presented together with the re-commissioning presentation of Collimation.
  - Collimation, BE-OP, MPP: Define requirements for DOROS BPM post mortem data and provide them to BE-BI (see above).
  - BE-BI: 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.
- The discussion on the variable Abort Gap Keeper (AGK) will take place in the next MPP. In the meantime, Jan commented that a detailed procedure should be published on how to change the variable AGK and that it should be done not more often than once or twice a year.
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 BLM System: Summary of changes and re-commissioning after EYETS (C. Zamantzas)

- The BLM machine checkout tests include 3 software checks and 8 hardware tests.

- The list of all five tests with beam is detailed in the excel document associated with the presentation. Some tests would require pilots and others trains of 288 bunches which is similar to what is used for scrubbing.
- The criteria for successful tests include:
    - Verifying the injection inhibit functionality, allowing not to interlock with losses above thresholds on the respective crates.
    - The redundancy of protection with non-inhibited (standard) crates, which must interlock if losses are above the threshold even when inhibited crates do not interlock.
    - The setting of an appropriate inhibit time, which can be re-adjusted later.
- An ECR document summarizes the changes in the tunnel installations and the name changes during EYETS 2017, e.g.:
    - Replacement of water flow valves in two thermalized BLM racks (SR6 and SR7) to avoid spurious interlocks
    - In 2016, a couple of HV issues have been observed damaging several BLM cards. The high voltage power supplies have been identified as the source of these issues. An analysis of the design revealed that the supplier of the power supplies used some obsolete and weak components. They were redesigned, tested and the components were replaced in all power supplies installed in the tunnel.
    - A check was added to verify the firmware versions of the crates. This revealed that 7 out of 27 crates were running on old firmware versions. These crates were updated.
    - RBAC roles were verified and redistributed.
- Outstanding issues:
    - In some cases, the sanity checks cannot complete correctly, as their result is not correctly registers in the BLECs. The reason for this behaviour is currently unknown.
    - The PM data buffer is sometimes not working properly due to problems with the SRAM memory (probably aging), the spikes seen come from the markers for channels, the affected cards have been exchanged.
    - The sync between crates was checked and there is a 40-80 µs jitter from one crate to another. In some events there is a 1 ms difference, this comes from the timing events in B1 and B2 coming 1 ms apart.
        - Markus commented that this difference in timing events may happen from time to time (in case the event arrives towards the end of the 1ms telegram length), therefore the system should be able to deal with this situation.
- Summary: the hardware and machine checkout tests are ongoing; the tests with beam have to be planned. There are no MP critical issues to report; some work is still needed to make the system fully operational. Some accesses are needed but will wait until the ELQA tests are done.

1.3 Changes to the BLM thresholds during EYETS (C. Xu)

Action (C. Xu): prepare an overview list of all threshold changes for 2017.

- Sector 12 will be reverted to previous thresholds optimized to avoid UFO dumps. It was lowered to avoid quenches in the sector 12 containing the magnet with a suspected inter-turn short.
- For all other sectors, the 2016 strategy was to put the thresholds 3 times above the quench level to avoid unnecessary dumps. Three dumps were caused by the lower thresholds in sector 12. This strategy paid off and saved seven dumps in 2016, two quenches were allowed which could have been avoided with more conservative thresholds.
- A discussion was started with the experiments to adjust their BCM thresholds, where possible, in order to gain availability and avoid unnecessary dumps. There is little margin with ATLAS and CMS, LHCb is looking into it but it would require a modification of the firmware. Regarding ALICE and the large UFO event, a proposed lower threshold on long running sums for the three BLMs next to the experiment should give adequate protection and cut the dose on the detector, which intrinsically could not be provided by the BCM. Looking at the 2017 data, there was no event with similar losses so this should not affect availability.
- Regarding the IPQ BLMs in position 3 (see slides), it is proposed to use a larger threshold which would allow to unify the monitoring factors. Anton pointed out, that this change would make the thresholds more physical.
- There is a new AFP roman pot and two new corresponding BLMs. Since the setup is symmetric right and left of ATLAS, it is proposed to use the same thresholds in the new BLMs as the ones of the other side of the IP.
- For the BLMs next to the collimators in IR7:
    - The BLM next to the low impedance collimator was renamed to reflect name of the installed element. In addition this BLM will be connect to the BIS. The threshold will be set to the electronic limit.
    - Two new BLMs were installed next to the two new crystal collimators in B2. These BLMs are not connected to the BIS and are installed for monitoring purposes.
- Conclusions: The new thresholds should not lead to additional dumps (based on the 2016 experience). Four ECR documents are under preparation.
    - Anton asked if it was necessary to monitor the position of the low impedance collimator prototype to interlock.
        - Alessio answered that the low impedance collimator used the same interlocking strategy as all other collimators. Thus, the beams would be dumped if the jaw or gap positions would move outside the defined interlock limits.
        - Roderik mentioned a request from the impedance team to limit the ‘out’ position of the jaws to 15 mm position instead of the usual parking position, as this would reduce the risk to have RF fingers sticking out.

- Daniel stated there are no objections to the changes and that MPP recommends their implementation after endorsement of the LMC.

1.4 AOB: Update of BLMTWG participation list (A. Lechner)

- Anton explained that the BLMTWG member list was based on the quench studies working group from before LS1 and that some members never attended the BLMTWG.
- There are three lists: info, members and UFO info.
- **Proposed changes**: teams involved in signing the ECRs and other documents should be in the members list, and their deputies should be on the info list. A list is proposed in the slides. MPP is now cut in two, MPP and rMPP, at least one of the four people involved is requested to sign a threshold change document. For the experiments, there is only one person each but they are only required to sign when it involves the said experiment.
    - Markus commented the list should now include Reyes (to replace John J. for Ion runs).

1.5 AOB: Beam Beam wire compensator: final implementation of wire temperature interlock (A. Rossi)

- Reminder on the LRBB: the copper wire is inside the collimator jaw, the only part of the wire not being actively cooled is the part from the jaw though the vacuum to the outside of the collimator tank.
- Tests were performed in the lab and the tunnel to derive the dependency of the resistance on the wire temperature. Measurement confirmed the simulations and a temperature of 60 ^{o}C was reached at 350 A, with an active cooling of the collimator jaw. Note that the cooling in the lab was not as efficient as it is in the tunnel. Tests were also done without cooling; the stiffeners reach 200 ^{o}C after 5 hours at 200 A; at 300 A it reaches 500 ^{o}C. Since the kick from the LRBB is relatively small, the protection is only meant to avoid the overheating of the wire and the collimator, which would lead to deformation and could finally damage the collimator.
- If the voltage over the wire reaches 3 V, the WIC will cause trip of the power converter, but not dump the beam. If the jaw temperature reaches 100 ^{o}C, a software interlock will switch off the power converter. In addition, the collimator control system will dump the beam, when the jaw temperature reaches 50 ^{o}C. The logic of the interlock box is presented in the slides. The issue is that the box is only measuring unipolar currents, whereas a bipolar power converter was installed to power the wire. The converter polarity was fixed in the FGC firmware, additionally there should be a SIS interlock implemented to limit current to -10 and 10 A outside of MD periods. It is proposed to add a further SIS interlock to prevent currents outside [-10,300] A throughout the year.
    - Jan commented on the limiting factors in this situation which are the in-jaw BPMs, which might be damaged first due to overheating. Therefore, the jaw temperature should stay below 250 ^{o}C, which is

the bake-out temperature. Therefore, the limit should be set to 200 °C.

- The MD procedure will include a polarity check and a sanity and interlock check of the box before the start of any wire powering. All relevant parameters will be displayed in the CCC during the MD. In the mid/long term, a bipolar interlock box will be required to ensure a hardware interlock on both power converter polarities. A PLC was suggested but discarded as it is too time intensive to be developed for this test setup.
    - Markus commented that if long term operation of the LRBB is requested a more reliable HW interlock solution would be required.
- Hardware tests were performed, everything worked with the collimator cooled. The interlocking tests were successful. A detailed presentation will be given in the CollWG on the 8th of May. The control system is to be completed and commissioned.

AOB - all

- Markus brought up the turn by turn interlock of the SPS BIS of BA6. It should be removed as it was a prototype installation, which was never made operational and had to be continuously masked by the operators in the past years.

Action (BIS Team): This BIS input will be disconnected and the CIBU and BI hardware removed.