157th Meeting of the Machine Protection Panel

Participants: A. Antoine, A. Apollonio, C. Bracco, C. Hessler, E.B. Holzer, D. Lazic, A. Lechner, D. Mirarchi, A. Mereghetti, Y. Nie, B. Petersen, J. Uythoven, M. Valette, J. Wenninger, D. Wollmann, C. Zamantzas, 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#154-155-156's minutes

- From MPP#155: Collimation is requested to define the use cases for DOROS BPMs in IR7, which will provide BI with the input required to decide on the hardware implementation, especially on the necessary level of redundancy.

- From MPP#156: MPP should define operational scenarios and intensity ranges for the BPMS in IR6.

1.2 BLM disabling rules - final implementation (E. B. Holzer)

- Barbara presented a proposal for new disabling rules for BLMs in 2018.
- There are about 4000 BLM channels in the LHC, not all of which can dump. Until now, all of them needed to be operational because the internal sanity check would prevent re-injection of beam if one is broken. In case of hardware failures, the default action is to repair the faulty channel but since some locations are not accessible or because access would take too long it can be necessary to disconnect a monitor. The disabling rules take into account the redundancy, which exists between most channels. Disabling means physically disconnecting the channel, an action which is performed by the piquet team, whereby the measurement and protection functions are fully disabled. The flag in LSA is also changed (in order to exclude it from the sanity check) which is performed by the BLM experts.
- In 2013 the MPP defined disabling rules: not to be disabled, pre-set and case by case. Case by case meant the decision had to be taken by BLM experts and rMPP representatives, which is time consuming. Pre-set rules allowed to only inform rMPP without waiting for approval.
- The 2018 proposal includes: removal of the 'not to be disabled' category imposed by the LSA database which allows more flexibility, additional pre-set rules, and an adjustment of existing rules if too tight. In the longer term (not ready for 2018), the application will be changed to remove the experts from the process as safety will be ensured by the rules implemented in LSA, in case no repair is possible only an rMPP member is needed to authorise disabling a monitor.
    - Christos commented that it is difficult to change the application due to the way it is currently implemented. Jan proposed to test the rules first

and then remove the BLM experts from the RBAC roles once tested. Markus and Daniel agreed but recommended that the MPP (or equipment expert) approval should not be performed via RBAC signatures, but that the agreement to the disabling can be documented in the logbook or by email. Christos added that there is currently a pop-up telling what the rule is and asking for agreement in the application - it can be bypassed however.

- The previous pre-set rules included the Inner triplet, the arcs and the LSS quadrupoles. IR3, IR7 and the dispersion suppressors (DS) were in the 'not to disable' category.
- The new rules include:
    - No disabling of monitors from the CRIT family: Q10, ULO, 16L2.
    - Monitors not connected to BIS can be disabled except those labelled critical for injection and dumping.
    - For all 'case-by-case', the equipment specialist has to agree on top of the MPP and BLM expert
    - There is now only one set of pre-set rules in the database for both protons and ions, so the stricter criterion is taken.
    - Arc rules have been extended to the DS, from Q7 to Q11, the rule requires 1 monitor per beam and per quad. If a monitor is disabled at a position, the same one in cell N+2 and N-2 must be active. For dipole-dipole interconnects, one BLM can be disabled per half-cell if neighbouring quads have at least 2 active BLMs per beam.
- The cell N±2 rule allows extending the arc rule to the DS, as the dispersive losses are leaking to cells 9 and 11 which are horizontally focussing, this rule should be checked for losses from IR3 at the beginning of the ramp. For Q8 and Q7, only Q10 and respectively Q9 would be required. In summary, these rules allow preventing damage but not quenches, which is already the case due to relaxed thresholds for UFOs.
- For IPQs, the only change is to include the cold Q6 in the IR3 and IR7 magnets' rule which requires at least two monitors per beam in the cold LSS quads.
    - Anton commented that the philosophy here is different as one should also protect against quenches which would not be possible if the BLMs in position 2 and 3 are disabled.

Action (E.B. Holzer): include this restriction into the disabling rules.

- Regarding the extra monitors in the DS for ions, a special ion family rule was created and allows one monitor to be disabled.
    - Anton commented some of these monitors are for diagnostics and luminosity measurements with respect to quench. The luminosity will increase in 2018 but measures have been taken not to quench in IP2 for ions.
- For BLMs next to collimators and masks, access is difficult due to radiation and rules are therefore hard to come up with, which is why all monitors are included in the 'case by case' rule. All monitors for collimators outside IR3 and

IR7 should not be disabled (wire scanners, BGV, RP, TCT, TCL, masks, windows …) except if movement is disabled.
    - Daniel pointed out that after LS2 the monitors around the 11 T magnets and the respective collimator need to be included in the 'case-by-case' group.
- In summary, only two people should be involved in disabling BLMs in the future: the equipment specialist and the BLM expert should be informed. Barbara asked if an approval from the LMC was necessary. The topic will be covered in the MPP report covering the re-commissioning of the MPS, the intensity ramp-up and will be treated like changes of thresholds.

1.3 PIC/WIC/FMCM YETS activities & Re-commissioning plans (A. Antoine)

- Alain reported the activities from MPE-MI during the YETS and the commissioning plans for the various subsystems.
- For PIC, there was a problem in August with a crashed CPU due to the failure of a redundant power supply. The maintenance of WinCC supervision was done as well as the PLC firmware upgrades. In the future, commissioning and AccTesting will be performed from week 10. VersionDog has been implemented for the PIC and allows checking the versions and firmware of all CPUs, two errors are left as of today and BE-ICS is checking on it. WinCC includes new patches for the QPS_OK flickering and history buffers were fixed. Recommissioning in 2018 will be standard and no test with beam are necessary.
- For the WIC, changes were performed in IR1 due to the long range wires compensators. A full recommissioning is necessary, during week 8 for IP1 and week 10 for IP5. All transfer lines were gathered in the same GUI, the recommissioning was done. The BIS tests are to be done for the transfer line where a new version of the SW was deployed. Communications were lost with some PLCs in TI2 last year, with a couple of events in a few days which may be connected to some outside factor. Some measurement were done and the comparison with last year is ongoing, the architecture is similar to some systems from TE-ABT, which had problems with Profibus as well. It triggered an internal audit by Siemens.
    - Markus suggested to install extra diagnostics to monitor this but this would require stopping the SPS and the LHC.
- There were no changes in the FMCM this year. The new Saturn power converters were installed and have proven to be a success as they lead to no dumps. One parallel activity is ongoing: production of FMCM spares. The first one is almost ready. It will be exchanged with an operational one after tests in the lab to check before proceeding with the next 24 spares. If the spare is not ready and tested in time it won't be installed this year. All High Voltage boxes were inspected, as there were problems with voltage dividers last year.
- The recommissioning is detailed in the EDMS document. The procedure is classical.
    - Jan suggested that the testing of the FMCM spares could also be done in HiRadMat, where currently fully compatible DESY units are running.

1.4 Crystal collimation: operational plans in view of higher intensity MDs (D. Mirarchi)

- Daniele presented the plans for crystal collimation MDs with higher intensities. The Crystal collimators were only inserted in MDs until now with a replacement chamber for normal operation. All went well so the collimation team would like to go a step further and check continuous operations with Pb beams. Promising results were achieved with Xe beams with a factor ten better cleaning in the DS.
- The system consists of 4 devices, one per beam and plane. The goal would be to perform EOF tests after ions physics fills, and ideally some tests during the intensity ramp up. For interlocking, a separated channel will be maintained from the other collimators and a dump will be triggered if the chambers are accidentally moved with beam. Furthermore, the crystal position will be interlocked.
- Request: Implementation for 2018, ideally with tests during checkout and intensity ramp up. The details will be specified in the MD procedure and its machine protection impact will be reviewed in line with the other MDs.
    - Jan asked if it was also planned to use the crystals during high intensity proton operation. Daniele confirmed that this was not the case.
    - Daniel reminded that the use of the crystal chamber is only permitted with low intensity beam, due to impedance limits, and requested to ask the impedance team for a statement on the use with ion physics beam.
        - Daniele answered the impedance is mostly coming from the discontinuity, the crystal itself has no measurable impedance.

Action (Collimation): Request from the impedance team an official statement on the use of the crystal chamber with ion physics beam.

- Markus commented that in order to have EoF MDs one would need to survive a full fill with the replacement chamber out and the crystals in parking, a procedure would have to be defined and tested prior to an MD.

1.5 Crystal collimation: change of interlock logic and proposed implementation in low level electronics (M. Butcher)

- Mark presented the changes in the interlocking logic for the crystal collimators.
- The devices consist of 4 piezoelectric goniometers, two linear stages, one with the replacement chamber and one with the crystal. The system can only move in and out and rotation movements allow very small angular alignments. The in-switch of the replacement chamber is only turned on when alignment with the beam pipe is within 100 um. An animation is available on the slides to illustrate the movement.
- The beam permit is only true if both IN flags are true and both out flags are false. This interlock is masked for MDs. After the YETS a second condition will be added: an AND requiring both crystals to be in within specifications. In SIS

a (maskable) redundant interlock allows beam only if both replacement chambers are in.
    - Jan asked what would happen if the crystal were in too far. One would get a spike of losses. Jan also asked what would happen if one were to inject on the crystals. They should survive 288 bunches at injection as no damage was observed from HiRadMat tests. Daniel added the normal collimation system will be in place and protect the rest of the machine aperture.
    - Daniel suggested an intensity limit to be implemented in the SIS interlock because this system is not yet qualified for high intensity beam. Markus stated the limit can be as high as one hundred bunches just to be sure that it is not inserted in full intensity fills.
- Hardware-wise, all switches are redundant. The PXI is read by the LVDT in real time, similarly to LHC collimators at 100 Hz. A flag is sent to an Interlock logic FPGA if the position is outside tolerances. The interlock is latched and can be reset with a FESA command. There is one dedicated channel (number 10) per beam on CIB.TZ76.U7.B1/2. A flag for the replacement chamber in pipe switches will be published in the PiezoGonioMeter class for the SIS.
    - Daniel asked if movement is blocked when the position limit is reached as for other collimators. Mark confirmed that.
- Mark finally presented an outlook on the next generation of crystal collimators for run 3. The rotational position of crystals will be read with redundant readings from 3 interferometer heads with 2 FPGAs for independent reading. One will be used for closed loop control and the other for position monitoring.
    - Daniel suggested an additional SIS interlock to limit intensity when the replacement chamber is out and the crystal is in parking for the beginning of EoF MDs.
    - The controls will be ready by the end of March and changes will be documented in a CCR.

AOB - Summary of intensity cruise checklist for 2017 proton operation (MPP)

- Two systems are missing: RF and Coll. Daniele confirmed that collimation had verified the correct functioning of the system during the rare problems in 2017 and that the check list will be filled after the Chamonix workshop.

AOB - MPS re-commissioning planning overview (M. Zerlauth, D. Wollmann)

- Markus presented a schedule update: The machine checkout is scheduled to start now on 28/03, the experiments vacuum valves will be opened on 30/03 and final LBDS tests over the Easter weekend.
- There are a lot of powering tests to be done. It would be good to finish the commissioning procedures and get them approved. Some names of responsible have to be updated. A 5-10 minutes presentation will be requested from each system.
- A new procedure for changing the AGK parameters has to be agreed upon after the last MD where it proved easy to do.
- A link is available for the commissioning plan.

AOB - all

- Daniel announced that in the coming weeks he will contact to the different MPS equipment experts to schedule presentations for the re-commissioning.