

137th Meeting of the Machine Protection Panel

Participants: E.B. Holzer, M. Kallikoski, D. Lazic, B. Lindstrom, Y. Nie, J. Uythoven, M. Valette, D. Wollmann, C. Xu, G. Vandoni, 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#136's minutes

- Actions from 136th MPP:
 - MKB erratic: Perform a reliability run with lower voltage during the EYETS and study the new failure case. Determine the criticality of lower dilution as well as the failure of ≥ 2 dilution kickers for the dump window and absorbers. (ABT)
 - Transmit the proposal for asynchronous beam dump delay increase to Etienne Carlier and Nicolas Magnin so they can comment. (S. Gabourin)
 - Come back before or early during the EYETS with a testing plan for the new CIBDS. (S. Gabourin)
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 Foreseen interlocks for the operation of crab cavities in SPS (MD and fixed target) (G. Vandoni)

- The prototype crab cavities (CC) are planned to be tested in the SPS during 2018 and possibly in run 3, as there is a chance that the production is late and parts may be postponed. Installation is foreseen in the 2017/2018 YETS.
- The plan for the SPS test is to use a broad range of energies and intensities, see table on the slides.
 - Jan commented these numbers should include not only energy and bunch charge but also the number of bunches or the total intensity in the SPS.
 - Daniel added that Rama Calaga called for a meeting on the specific SPS crab cavity test program in late spring 2017.
- Due to aperture limitations in the SPS, CC operation is compatible with slow extraction to the North Area but not for fast LHC extraction, as opposed to COLDEX. The cryomodule has a bypass chamber and the vacuum is sectorized by valves. All the active components like He compressor and RF amplifiers are located in surface areas.
- The RF controls are under the responsibility of Luca Arnaudon. The RF control system receives data from the access system, position and movement of the cryomodule, status of the cryogenic system, vacuum and radio protection. This is relevant as the same data will be available for possible interlocks. The

interlock signal is handled by a logic using a truth table. The truth table has three categories: safety, equipment and machine protection.

- For safety: the risks come from RF radiation, Cryo Helium spill and mechanical damage. The RF-power is enabled if there is no access, the table is in a defined position and the table override key is in. There is the standing request of the equipment responsible to maintain the possibility of commissioning the table without going through the RF PLC. The table can only be moved when there is no access, if the Helium tank is empty and if the vacuum valves are closed. RF power can be on when the table is out, with a general interdiction of access, unlike in the LHC where access can be sectorised. There is a risk of damaging the valves due to dark current from the cavities which has to be quantified in SM18.
 - Jan commented that there is also a risk for dark current to damage the beam pipe with the valves open. This risk also needs to be quantified.
- Beam related interlocks: Verena proposed a maskable interlock preventing beam to be in the SPS if the table is IN. This interlock is maskable in order to allow for beam acknowledgement by the operator during MDs. There is no automatic removal of masks via the SMP in the SPS, therefore there is a certain risk for human error when operating with higher intensity beams, where masks could be forgotten in place.
 - Jan stated this all comes down to an assessment of the failure modes and their criticality. If failure modes are identified not to be critical then one can rely on procedures instead of hardware interlocks.
 - This should be part of the discussions during the above mentioned second SPS crab cavity test day in spring 2017.
- The beam would be dumped if losses, beam loading or beam positions are over threshold.
 - BLMs or BPMs would interlock via existing BI concentrators for this equipment. Beam loading would also interlock via an RF signal to the BIS which would collect several RF interlocks.
 - Markus commented that in the presented scheme the signals and interlock functions are mixed between systems, which makes it difficult to diagnose in case of a problem. It would be clearer (and probably) safer to have a different input from each of the systems in this truth table (e.g. BLMs define the operational envelope for losses and dump the beam via a dedicated CIBU connection, rather than folding together beam losses with beam positions and RF table positions before entering the CIBU....).
 - Jan added one would want to dump on the dedicated BLMs independently of CC operation, to protect the cavities.
 - The failure modes have to be identified and loss levels determined.
 - Daniel stated that studies on this have been started by Björn Lindström and Matthieu Valette in MPE and should be well advanced by the Workshop on the CC test program in spring to serve as input.

- Special BPMs have been designed, similar to the ones for the Roman Pots, they would be located just outside the cryomodule next to the valves.
 - Jan asked if one could interlock on these BPMs.
 - It is not foreseen since the cabling is unknown.
 - Daniel commented that if one is to detect a failure in the CCs it would need a BPM that is sitting at a position with close to 90 degrees' phase advance wrt the cavities.
 - Matthieu added, that one could still require a local BPM to protect the crab cavities.
 - Daniel answered the beam offset in the cavity could probably be detected faster via beam loading.
- The dedicated BLMs around the CCs would be Ionization Chambers just like the regular LHC BLMs
 - Daniel asked if some diamond BLMs are foreseen to record turn by turn losses.
 - Barbara added if one wants a sub nanosecond BLM, to measure losses from the head or tail, a Cherenkov detector could do. There is no equipment ready in storage but it could be built for the tests.
- An extra cabling campaign is already planned to connect all the equipment.
- The MD scenario will depend a lot on the experience from moving the table and cooling the cold mass. It was specified to be less than 10 minutes to benefit from Wednesday MD time in the SPS. Tests with full beam are now only planned at low energy.
 - Daniel added that it would be important to have a wire scanner around the CCs to create UFO-like losses, it is a test Machine Protection would like to perform.

Action: Organise a circulating checklist with points to be followed up between the CC team and MPP – iterate during a coffee discussion early January.

- Jan commented one should really check the cabling needs. For further discussion, the failure modes are needed for interlocking and planning the tests.
- Markus asked if there are enough available channels in the BIS because six extra channels is quite a lot.

AOB - Review of last PP intensity cruise checklist (J. Uythoven)

- There is an [Excel file](#) on the Indico page which contains the presented information.
- The checklist relates to the 20/09-30/10 period. A review of different categories was made:
 - Issues with dump kickers, diluter erratic and BLM system fault.
 - Daniel commented the BLM system fault is fully understood and does not originate from physical losses. This topic should come back in a future MPP.
 - Zinur identified two dumps due to QPS trip, which were solved.
 - Failures of FMCM ISA due to a delayed conversion of FGC buffers.

- Goniometer didn't stop during the movement of crystal collimator during MD. It was thought to be a logic problem but was in fact an accumulation of commands at the low level of the control system. This topic will be followed up before allowing any higher intensities. Discussions with EN-STI are ongoing.
- 24-bit upgrade of the FBCT has been validated, a final decision for integration and revalidation after the EYETS is pending.
- 4 UFOs dumps happened in the concerned period, 3 dumped because of the experiment's BCM. The coherence of thresholds in ring BLMs and experimental BCMs should be addressed in the BLMTWG.
 - Matti commented the BLMTWG has no idea what the LHCb threshold is and the ALICE ones have to be re-addressed.
 - Daniel answered the BCM data should be in PM.
 - Markus added that they are there, already except for the LHCb ones, the format is different from one experiment to another though.
- RF didn't fill in the checklist.
- BI noted a problem with a BLM in the dump channel.
 - Jan commented one needs it in case things go very wrong, the EYETS is a good time to do an intervention, unless it is too radioactive.
- Collimation, the LHC was operated at the edge of the 3-month validity for loss maps, everything went ok.
- OP, ok.
- Injection kicker erratic, the magnet was eventually replaced, vacuum activity at soft start has to be monitored.
- Heating: a detailed analysis was done by Benoit, the temperature goes up by a few degrees in different elements. Everything is tolerable for the moment.
- Daniel thanked Jan for the summary, and pointed out, that a comparable check list is pending for the ion run.

AOB - all

- Next week there will be a short MPP it will be the last of 2016.