

160th Meeting of the Machine Protection Panel

The meeting took place on March the 16th in 774/1-079.

Participants: A. Apollonio, G. Azzopardi, J. Baechler, R. Bruce, M. Deile, E.B. Holzer, S. Jakobsen, T. Medvedeva, A. Mereghetti, Y. Nie, S. Redaelli, A. Rossi, B. Salvalucha, C. Schwick, M. Trzebinski, J. Uythoven, M. Valette, S. Wenig, J. Wenninger, D. Wollmann, 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#159's minutes

- No actions from the 159th MPP.
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 MPS re-commissioning after YETS 2017/18: Collimation (B. Salvachua Ferrando)

- Belen presented a summary of the hardware and software changes made to the collimation system during the YETS and the plans for re-commissioning.
- The hardware changes only affected IP1 where the vertical TCT were replaced by wire collimators and a new vertical TCL equipped with a wire was added. The horizontal wire collimators from IP5 were untouched. The TCL in IP1 had to be added because the existing ones were horizontal, it will only be used for MDs. The B2 horizontal crystal collimator's goniometer was replaced. Crystal collimation MDs with intensities above the SBF limits will be requested this year, mainly with ions, which was already presented in MPP#157.
- The software changes include a new bit transmitted when interlocking which allows diagnostic if the STOP limit is reached by the LVDT. Stefano commented that this feature was added due to collimators being unable to move in 2017 which was identified by OP.
- The hardware commissioning is currently already ongoing with a dedicated follow-up meeting every Friday. The 5th axis functionality was verified for TCT, TCSPM and wire collimators contrary to previous years.
- On the software side, new devices were imported in LSA and additional data will be logged in the future (LVDT, temperature, BPM measurement ...). A new automatic alignment software based on spike recognition with a machine learning algorithm will be tested this year, with the normal software available as backup. The software was tested the day before the meeting during a dry run.
- For machine checkout, the updated procedure for MPS system was updated to the latest layout of 2018 (including the TCLW), interlocks are correctly generated and propagated to the CIBU. The interlock tests for all the collimator

families will take place next week, only one collimator per PXI/front end will be tested, as usual.

- Daniel asked whether or not the new wire collimator had its own PXI, which Stefano confirmed.
- Jorg commented the collimation system needs to go from the test super-cycle to the operational one to check the correct functioning of beam processes and hardware groups.
- Markus asked about the collimators temperature sensors' tests. They were run by STI and the results were documented. Stefano added the list of disabled sensors is available (about 20 sensors out of 700 have been disabled), there are also new sensors on the crystal collimators whose data is logged and can be interlocked on if necessary.

1.3 Beam-beam wire collimators (TCTW): new interlocking electronics and proposed commissioning tests for existing and newly installed TCTW (A. Rossi)

- Adriana gave a reminder on the layout of the wire collimators in IP1 which is similar to the ones in IP5 and presented the new interlocking as well as the plans for commissioning.
- The new TCLW are only installed on B2 (which will be the weak beam) on which long range beam-beam will be compensated during MDs. The collimator was installed between Q4 and Q5 in a non-ideal location for compensation as all the already existing TCLs were in the non-crossing plane.
- There is one wire in each jaw of the collimators but only the one between beams will be used during MDs, they are both interlock-able but only the interlocking of the wire, which will be used was tested.
 - Daniel asked about the earth fault detected on the wire following the installation. The fault was due to the cutting of the insulation to install the voltage tap, it was solved by re-installation and applying vacuum varnish.
- The commercial interlock box used last year in point 5 was replaced by the same one used in point 1 which is now functioning as well in bipolar mode, as the power converter. The threshold was set to 2.7 V which corresponds to powering the cooled wire with 375 A, or reaching a temperature of 200 °C when powering the wire with 300 A without cooling. The powering permit will be removed via the Warm Magnet Interlock Controller (WIC) once this voltage is reached. The interlock was also tested for stability by powering the wire with 350 A for 30 minutes with cooling and it did not trigger. The powering permit is also removed if the jaw temperature reaches 50 °C.
- The temperature of the uncooled part of the wire was measured on the spare collimator in the lab and confirmed by comparing the temperature of external parts using a thermal camera.
- A redundant SIS interlock was implemented with a threshold of 355 A for MDs and +/- 10 A during normal operation to avoid unforeseen powering of the wire. The interlock is non-maskable, except with a new SIS-expert role

introduced by Jorg (to avoid having to release a new SIS version to change this mask).

Proposal: The BBWC team proposes that the wire interlocking is tested only once per year and not before each MD block.

- Jan answered it is the BBWC team's responsibility to ensure the safety of the wire. Stefano commented that temperatures of up to 600 °C can be reached with the wires without cooling, which is higher than the bake-out temperature and which might compromise vacuum, the jaw flatness of the collimator and the BPM functionality. Markus concluded that one can certainly assume that the interlock hardware provided by BI exceeds the reliability of the previous commercial solution, a formal answer to the proposal will be given once the schematics for the interlock cards have been reviewed by MPE experts.

Action (A. Rossi): send schematics of interlock to MPE to verify the interlock card and if re-testing is required.

1.4 CT-PPS - TOTEM - changes during YETS 2017/18 and re-commissioning plans (M. Deile)

- Mario presented the activities carried out by TOTEM/CT-PPS during the YETS and their plans for recommissioning.
- The detector packages were replaced in the horizontal pots and new ultra-fast silicon detectors were added to pot A, they will be used for timing during the intensity ramp up and the high- β runs.
- The movement interlocking was consolidated in 2017 following a spurious dump. The system now includes a spike filter (three consecutive readings at 100 Hz must be above threshold to cause a dump) and a simple post mortem. As no further anomalies happened the event is still not fully understood. The interlocking was upgraded in the YETS, with the replacement of all the LVDT amplifiers, the post-mortem system was extended to record any crossing of the warning threshold (100 μ m before the dump threshold). The reboot mechanism was also improved so the PXI will automatically reboot with the rest of the system and does not need to be manually activated.
- The extraction of the pots can also be triggered via the DCS panel and by a secondary vacuum interlock if the pressure inside the pots reaches 10 mbar. Both were tested and prevent re-insertion. The interlock hardware was not touched but all inputs were, the logic remains that a dump should be triggered when the pots are in a forbidden position or outside home position in the wrong beam mode.
- For revalidation CT-PPS proposes that the same program as 2017 is used without the verification of the beam mode dependant behaviour as it is time consuming. As of the 16th of March, it was verified that all pots can remove

beam permit and retract in case of a violation of the limits, which are correctly transmitted. The test of the override key is yet to be done as a second person is needed in point 5 for it.

- The operational plan is to align all 18 pots for low- β , all horizontal pots will be used in all fills except the pot C which is empty and the pot A which is used for calibration only. The vertical pots will be used for calibration as well. The pots should be calibrated for crossing angles of 120, 121 and 160 μrad (current proposal is to use min., max. values and one fine step).
- Regarding limits the same limits as in 2017 could be used, this topic will be reviewed in an upcoming CollWG, the limit was defined by the following rule:

$$d_{XRP} = (n_{TCT} + 3) \cdot \sigma + 0.3 \text{ mm}, \text{ or a minimum of } 1.5 \text{ mm}$$

- Roderick commented that the TCTs would be set at 7.5σ only at the smallest β^* setting, otherwise they will stay at the same position and so should the roman pots. Mario answered that this scenario is not ideal because they would lose acceptance during the β^* -levelling whereas crossing-angle levelling would not affect them.

1.5 AFP & ALFA - changes during YETS 2017/18 and re-commissioning plans (S. Jakobsen)

- Sune presented the activities carried out by AFP/ALFA during the YETS and their plans for recommissioning. The two sets of roman pots have fully separated interlock systems which are concentrated in the ATLAS beam permit and injection permit, they tested the permit transfer to ATLAS and the transmission to the BIS should be tested together with ATLAS.
- ALFA fixed the memory leak in FESA and implemented an automatic recovery of the PXI like TOTEM did. AFP performed some de-cabling and re-cabling, there is still some ringing observed in AFP only. The PXI recovery presents the vulnerability of unknown limits at restart, this was made safe by preventing movement until CCC signals are received. This problem is absent from the TOTEM implementation as the PXI for pot movement and interlocking are independent.
- The recommissioning tests performed last year include: injection and user permit generation, LVDT to limit comparison, automatic extraction, LVDT-bypass key and hardware and software buttons in the ACR.
- This year the injection permits were tested, as well as the LVDT to limit comparison and the buttons. The reaction to flags is yet to be done but similarly to TOTEM, AFP and ALFA would prefer to skip it. Moreover, the LVDT bypass test could be simplified from four tests to only one to validate the main functionality.
 - Markus commented that it is sufficient to fully test the beam mode dependance only after major interventions and long shutdowns, as they will be exercised during the beam-commissioning period.
 - Daniel commented the override key test should be done.

- Jorg announced that the injection handshakes for the two main beam modes would take place on the 13th of April.

Proposal: The AFP/ALFA/TOTEM teams would propose to implement for the future an automatic beam-based alignment software similar to the one used by collimators, in order to save time during commissioning and be less vulnerable to human errors. The application would be implemented purely in high level software and involve no modification of the FESA and PXI.

- Belen commented the request for this is quite recent so the implementation could start only from the following week.
- Stefano raised the concern that the roman pots system might not take several 1 Hz commands as the collimation system.

AOB - BLM threshold changes during for re-start after YETS 2017/18 (T. Medvedeva)

- Tatiana presented a summary of the BLM threshold changes for 2018.
- New Tungsten based collimators were installed in IP1 (with wires), it will only be used for MDs so the applied thresholds will be the same as for other tungsten-based collimators but with more flexibility from the monitor factor. The TCL in IP5 for which the copper jaw was replaced by tungsten will have the same thresholds and monitor factor as the others, finer tuning will be done with collisions data.
- The monitor factors for TCPs, TCSGs, TCLAs were increased to 0.8 to allow for extended data collection of 16L2 losses, they will be reverted to 0.4. When loss maps are done, and flat top correction adjusted, monitor factors might be increased if the CollWG gives its green light.
- The flat top corrections were reverted for Q4/Q5/Q6 in IR6 and IR7 at energy level 11. They were implemented for the special 2.51 TeV run. Q6 and Q5 thresholds in the injection regions (left of 2 and right of 8) were merged with their standards families as thresholds for these families have exceeded the special injection corrections.
- New thresholds will be implemented for MB magnets in the dispersion suppressors (DS) (202 BLMs in 5 families), these thresholds were not updated since Run1. The new thresholds are more physical and scaled with an empirical model, they protect from damage to the magnet but not quenches as for the rest of the ring. The IR7 DS magnets are exempt from this update as further checks are needed.

AOB - all

- There will be an MPP next week on SIS and BLM recommissioning.