209th Meeting of the Machine Protection Panel

LHC topics

May 21st, 2021 via Zoom

Participants:
Gabriella Azzopardi (BE-ABP), Roderik Bruce (BE-ABP), Markus Brugger (BE-EA), Andrea Calia (BE-OP), Mario Deile (EP-CMT), Mario Di Castro (BE-CEM), Yann Dutheil (SY-ABT), Cedric Hernalsteens (TE-MPE), Michi Hostettler (BE-OP), Grzegorz Kruk (BE-CSS), Dragoslav Lazic (EP-UCM), Bjorn Lindstrom (BE-ABP), Ivan Lopez (EP-ADO), Daniele Mirarchi (BE-OP), Filip Moortgat (EP-CMG), David Nisbet (SY-EPC), Brian Petersen (EP-ADT), Jan Uythoven (TE-MPE), Stefano Redaelli (BE-ABP), Delphine Rivoiron (BE-OP), Andre Rummler (EP-ADO), Belen Salvachua (SY-BI), Brad Schofield (BE-ICS), Matteo Solfaroli (BE-OP), Joerg Stelzer (EP-UAT), Georges Trad (BE-OP), Maciej Trzebinski (EP-UAT), Frederik Van der Veken (BE-ABP), Jorg Wenninger (BE-OP), Christoph Wiesner (TE-MPE), Daniel Wollmann (TE-MPE).

The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico (209th meeting).

Minutes from the 206th and 207th MPP meetings (LHC topics)

Daniel recalled that the minutes of the two last MPP meetings on LHC topics have been circulated (207th MPP and 206th MPP).

The 206th meeting concerned the LBDS re-commissioning, with two actions: the release of the AGK commissioning document and adding the blindable BLMs in the procedure.

The 207th meeting was about the SIS commissioning; the actions can be found here.

Follow-up of MPS re-commissioning via checklist tool (Cédric Hernalsteens)

Cedric presented the commissioning checklists using the new checklist tool (migration from the previously used Sharepoint lists). The machine protection checklists are derived from the re-commissioning procedures by hardware experts, BE-OP and the MPP team. The checklists are available on the checklist website, under the machine protection tree. Cedric gave a demonstration of the new tool, showing the first MPP checklists that were already prepared.

Jan commented that we must give the correct access rights to the relevant people so that the lists can be updated and checked.

Action: Give administrator access to MPP representatives and user access to the people who will fill in the results, verify with each system representative (Cédric)

Re-commissioning of the collimation system (Daniele Mirarchi)

Daniele presented the MPS aspects of the collimation system commissioning. The procedure is EDMS-889345. The procedure focuses on the position, gap and temperature interlocking of all movable collimator jaws in the LHC vacuum system (*i.e.*, TCP TCPPM, TCPC, TCSG, TCSP, TCSPM, TCTPH, TCTPV, TCTW, TCLA, TCL, TCLIA, TCLIB, TCLD) and on the temperature interlocking of fixed absorbers outside of the LHC vacuum system (*i.e.*, TCAPA, TCAPB, TCAPC, TCAPD, TCAPM). The transfer lines collimators, the injection protection, the dump protection, and the roman pots are covered elsewhere.

The following changes took place during LS2:

- 4 IR7 TCPs (H&V) have been replaced by a new low-impedance design
- 8 new low-impedance secondary collimators (TCSPM) have been installed in IR7 (6 in empty slots, 2 replacing existing TCSG)
- 2 dispersion suppressor collimators (TCLD) have been installed in IR2
- 2 passive absorbers (TCAPM) have been installed in IR7
- 2 TCTW have been moved to a different slot:
    - All TCTW are installed as TCT collimators, and none uses TCL slots
- It is planned to replace 2 crystal (V) primary collimators (TCPC) during the YETS

All the new collimators feature the in-jaw BPM design, with a third BPM mounted on the vacuum tank of collimators in IR7.

The links to other equipment have not changed. The BIS connections use channel 8 for the interlock on positions (each IR except IR4), channel 9 for the interlock on temperature (each IR except IR4) and channel 10 in IR7 dedicated to the crystal collimators (moveable pipe and linear position). The SMP inputs are the beam energy and beta star, received by the timing card (CTRB) in each collimator front-end at 10Hz (a beam dump request is issued if more than 3 data points are missing or incorrectly received). The metrology calibration and collimator orientation is stored in the collimator configuration database. The interlock on the wire current is handled by SY/BI. The BPM are not used to generate hardware interlocks but are used to generate SIS interlocks (they are not part of the machine protection checks). Alarms are sent in case of warnings or errors, no need for safety-critical fast post-mortem data, as there are no rapidly changing parameters.

The operational settings are managed in a standard way within LSA. The FESA class and the low-level PXI exclusively use interlock thresholds in absolute coordinates. The settings generation tools have been upgraded during LS2 to integrate more functionalities in the LSA framework. The machine protection aspects are not affected.

The sequencer is responsible for the collimator settings orchestration. Recent developments of the operation approach include tools to orchestrate the luminosity leveling. The new tools take as input the present interlocking strategy. No addition change is required for the collimation system.

No change has been introduced regarding the handling of critical parameters. The list of peoples and roles has been updated. Human inputs are required for the interlock and warning thresholds for the jaw temperatures (protected by RBAC), for the interlock and warning thresholds for the jaw positions and gap values (handled through MCS) and for the interlock thresholds for the collimator gaps as a function of beam energy and beta star (handled through MCS).

Automatic or semi-automatic procedures are used to calibrate the LVDTs, with a validated software under the responsibility of BE/CEM which are performed as a part of the collimation hardware commissioning.

The beam-based collimator alignment is performed during the beam commissioning with a safe beam. The settings, warnings and interlock functions are MCS and RBAC protected. The energy and beta star limits are generated independently and are stored in the low-level.

No change has been introduced for the individual collimator tests and the verification of the collimators orientations has already been performed.

The systems tests to be performed during the machine checkout have not changed. Most of these tests are automatic and can be performed in parallel with other activities. These tests will be performed on a representative subset of collimators (one per BIC) after shorter shutdowns.

No change has been introduced for the tests with beam. The qualification of cleaning efficiency is mandatory before injecting high intensity in the machine. It includes the checks of sensors readings and controls, the update of the collimator settings and the validation of the cleaning efficiency at setup beam intensity using operational sequences (betatron loss map, off-momentum loss maps, asynchronous beam dump). The detailed list of required loss maps is worked out every year for the specific cycle and duration of the technical stop.

Daniele concluded on the following points:

- Several hardware changes were made during LS2 and a complete validation procedure will be applied to every single collimator
- The upgrade of the setting generation tool to integrate more functionality in LSA has no impact on the machine protection functionalities
- Recent developments of the operation approach include tools to orchestrate the luminosity levelling.
- No change of MPS aspects.

Discussion

Jan U. asked if the EDMS document is still completely valid. Daniele replied that it has een cleaned up (layout updated, historical sections removed) and ready for comments and final validation.

Action: Circulate a list of people for check and approve the EDMS procedure (Daniel W.).

Daniel W. asked if the new logic for the temperature interlocking is included. Mario replied that it has been included. The scripts to check the connections did not change.

Daniel W. asked about the energy and beta star limits: were they independent on the cycle in the past? Is it treated the same way as before? Stefano replied that the concept is still correct despite prior concerns. It might deserve a dedicated discussion. Jorg commented that this issue is still present. Protections have been added by can potentially be bypassed. Matteo commented that this is intrinsic to the operation. Jan suggested that we follow up with a dedicated presentation at a future MPP meeting.

Actions: Propose a redundant interlock mechanism on the energy and beta* limits via SIS (Collimation team, OP and other teams).

Re-commissioning of TOTEM/CTPPS (Mario Deile)

Mario presented the changes made during LS2:

- A beamline levelling took place in IR5 between the Q10 on the left and right sides. The vertical realignment included the roman pots. This is described in EDMS-2243875.
- The roman pot spectrometers XRPH.C6 unit was relocated to XRPH.A6 (on both sides of IP5). The old horizontal A6 pots were not equipped with rf shields and were not suitable for PPS operation. The horizontal C6 pots were equipped with rf shield but where in a bad location for the optics. The old A6 pots were removed and the C6 pots were relocated to the A6 location. The vertical units were not touched. This is described in EDMS-2045055.

The movement and interlocks of 24 single pots remains to be commissioned.

Mario then summarized the architecture of the movement system. The interlock logic did not change since 2015. Following the removal of the C6 units, the home switches have been bridged. The LVDT signals the logic in the FPGA card has been changed to consider the missing signal. The firmware of the interlock box did not change.

The modified architecture that was proposed in 2018 had to be abandoned due to missing drivers, despite long discussion with National Instruments. The decision has been taken to keep the old architecture.

The FESA frontend computers will soon be replaced (Kontron replaced with Siemens), leaving the software unchanged.

Metrology measurements have been performed for the A6 units (EDMS-2345567). All the scales were calibrated with laser measurements to provide new calibration curves for the motoer encoders, axis resolvers and LVDTs.

The following Interlock tests must be performed:

- Electrical tests of CIBUs with TE-MPE-MI (easier to do when able to change the position limits)
- Basic interlock functionalities for each pot
    - Injection permit removal (move each pot away from home switch)
    - User permit removal (make pot position illegal by changing limits
- Comprehensive test in a dry run with change beam modes and flags to cover full input combinatorics. Not needed before this year's pilot beam but before the 2022 run.

There will not be roman pots movements during the beam tests. The detectors will be installed after the pilot run.

Mario then shared some comments and inputs for a future collimation working group meeting regarding the two options for the luminosity levelling.

Discussion

Stefano asked about the interlocks. Does the functionality where the RP go back to parking position if the warning limits are reached been kept? Mario replied that it has been kept and tested but not for all the RPs.

Daniel asked how the testing is documented and if it should be added to the checklist. The complete matrix should not be added to the checklist, only the outcome of each series of tests.

Action: Add TOTEM/CTPPS interlock tests to the checklist (Cedric, Mario).

Action: Plan interlocks tests (basic interlock functionalities for each pot and comprehensive test in a dry run with changing beam modes and flags). Basic interlocking tests should be done before the pilot beams (Mario, OP).

Re-commissioning of ARP (Ivan Lopez)

Ivan started by presenting the current status of the detector: the ALFA detector FAR station is fully operational, but the motherboard is pending replacement, the AFP NEAR roman pots on both sides are equipped with detectors while the detectors of the FAR stations are planned to be installed end of August or beginning of September.

Ivan mentioned that ALFA would like to have the pots partially inserted (to test detector timings) during the 2021 pilot run.

Regarding the issue of self-retraction where the AFP C-NEAR pot would not reach the home position when self-retracting, a cable holder has been installed to relieve stress from the weight of the cables. So far it has only been installed in C-NEAR. New cable holders have been produced. The preliminary self-retraction tests in the tunnel after the cable holder installation show that the pot reaches the hardware limit closer than without the cable holder. Final tests will take place when the FAR stations are fully population.

The ARP BIS validation process will be performed, as documented in EDMS-1515678:

1. Injection permit tests (check the removal of the injection permit by a pot leaving its home position)
2. Response to the LVDT-to-limits comparison
3. Test of “user permit 1” and automatic pot extraction as a function of all input flags
4. LVDT bypass box
5. Hardware and software buttons

Ivan summarized the pot heating issue and the expected response during Run3. The roman pot temperature increases with the ATLAS instantaneous luminosity. Based on extrapolations, the expected temperature in the AFP FAR stations is 50 degrees. Studies started (interrupted by COVID) but were not conclusive (not accounting for the actual). A setup to measure the

temperature with beam directly has been prepared. No overheating is expected in 2022 but it will be monitored closely. In case of the need, the pots could be slightly retracted for data taking, to limit the increase in temperature.

Discussion

Jan U. asked about the connection to the CIBUs: did the user-side electronics change? Ivan replied that it has not changed. Daniel added that it goes through the ATLAS BIS connections.

Jan U. then asked about the pot temperature increase: what happens if the pots get to hot (deformation, electronics issue, etc.)? The pot bottom is the issue, and this could be an issue for the vacuum quality (outgazing).

The pilot beam insertion request needs to be validated with the Collimation Working Group.

Action: Add ARP interlock checks to the checklist based on previous EDMS documents (Ivan, Cedric).

Summary of actions

The actions from the meeting are:

- Follow-up of MPS re-commissioning via checklist tool
    1. Give administrator access to MPP representatives and user access to the people who will fill in the results, verify with each system representative (Cédric)
- Re-commissioning of the collimation system
    1. Circulate a list of people for check and approve the EDMS procedure (Daniel W.)
    2. Propose a redundant interlock mechanism on the energy and beta* limits via SIS (Collimation team, OP and other teams)
- Re-commissioning of TOTEM/CTPPS:
    1. Add TOTEM/CTPPS interlock tests to the checklist (Cedric, Mario)
    2. Plan interlocks tests (basic interlock functionalities for each pot and comprehensive test in a dry run with changing beam modes and flags). Basic interlocking tests should be done before the pilot beams (Mario, OP)
- Re-commissioning of ARP
    1. Add ARP interlock checks to the checklist based on previous EDMS documents (Ivan, Cedric)