

# 223<sup>rd</sup> Meeting of the Machine Protection Panel

## LHC topics

April 21<sup>st</sup>, 2022, via Zoom

### *Participants:*

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The slides of all presentations can be found on the [website of the Machine Protection Panel](#) and on [Indico \(223<sup>rd</sup> meeting\)](#).

## Minutes and actions from the 222<sup>nd</sup> meeting (LHC topics)

The minutes of the previous meeting have not been circulated yet. Daniel recalled the actions of the 222<sup>nd</sup> meeting:

1. Provide semi-flat functions to test 2023 Beta\* levelling mechanics in 2022 without interfering with levelling. In 2022, lumi server will move the collimators and limits according to these functions to gain experience and test the levelling mechanics in view of 2023 (M. Hostettler and D. Mirarchi)
  - Michi commented that the flat limits are not yet implemented, that a collimation cycle is being prepared, and once all nominal settings are there the special limits will be setup.
2. Check the aperture limits of the new BSRTM device are in accordance with Run3 parameters (D. Mirarchi and R. De Maria)
  - Daniel commented that a Joint Collimation Working – MPP meeting will be organized on Friday 29.04.2022 and cover that topic.

## Status of MP system commissioning before first beam

### Collimation

Daniele first presented the status of the checklist: all tests are completed. In addition, details were provided on the interlock of the replacement chamber for the crystal collimator goniometers. The new FESA class features threshold functions on the goniometer linear stage were updated and tested.

Daniele provided additional information on the status and collimation plan for the first beams and for beam threading. The collimators to be used for the threading are in the horizontal plane, except for the vertical TCT in IR5, to spare the TCT with wires.

Beam process and sequences for coarse collimator settings during the commissioning have been prepared and tested.

No outstanding issue was identified regarding the commissioning and testing of the collimation system in view of the first beams.

### Injection protection

Yann reported that most tests are completed and validated. Some remain to be completed today, in particular, the beam permit and MSI as it requires a closed BIS loop and no access.

The following tests will be completed after first beam:

- The Abort Gap Keeper will be setup and tested
- All tests requiring beam
- Global protection tests with beam.

Yann mentioned that the systematic check of the extraction permits for LSS4 and LSS6 would require more time. Raffaello commented that these have already been tested on the BIS side. Jan proposed to reference the BIS tests in the injection commissioning procedure. Jorg added that some of these tests also involve the HiRadMat logic. Daniel suggested to update this item in the procedure after the end of the HWC.

Action (Yann): Review Injection protection HWC procedure item 17.2 and make coherent with equivalent BIS test.

Yann reported that one test failed regarding the MCS. MCS settings can be modified directly on the FESA class from the LHC island (location based RBAC). The issue seems to be widespread to multiple systems. A ticket was opened by N. Magnin. Jorg commented that when changing a FESA class name, the change must also be made on the access map files, otherwise the names won't match and the MCS will not be enforced. However, no error message is provided if it is not the case. Daniel suggested that all other MP systems verify the situation for their relevant FESA classes.

Action (MPS responsables): Validate that MCS settings are correctly protected for machine protection setting

The list of tests to be performed after the first beam is agreed upon and no blocking point is identified.

## LBDS

Some tests remain to be completed after the first beam, notably the AGK, BTVD and BTVSE interlocking with intensity. A repeated issue with BLM data collection on post-mortem was identified. More details are available in Christos' presentation (see below).

An open question from the commissioning tests in October 2021 remains concerning the relaxed constraint approved by the MPP on a delay between opening the BIS loop and the arrival of the 'beam dumped' timing event. Grzegorz commented that this should be below 200  $\mu\text{s}$  but was measured to be between 300  $\mu\text{s}$  and 400  $\mu\text{s}$  and is an erratic behaviour related to the hardware implementation. It is under investigation. Daniel stated that it is important to understand the source of this behaviour, as it could potentially lead to missing data from after an emergency dump.

**Action:** Follow -up on the delay of the beam dumped event sent out over the timing system (Grzegorz K.).

An issue was identified with the SPS extraction. On 13 April, the beam was kicked out of the SPS on the edge of the SPS MKE kicker wave form. The beam was not correctly extracted and was sprayed over the injection region. The bunch intensity was low and no damage was caused. The issue was tracked down to a reloading of earlier settings in LSA, including an RF phasing setting that controls the bunch position relative to the extraction kicker. As a mitigation measure, the setting was added to the SPS SIS. A robust solution must be identified and implemented to avoid dangerous beam losses.

Michi commented that this setting could be a MCS (PPM MCS). However, to reload settings from a LSA tag operators would then have to get all the relevant roles. Daniel proposed to continue the discussion off-line and identify a long-term solution.

**Action:** Follow-up on the protection of settings for the SPS MKE phasing and discuss the potential impact of rolling back with LSA tags on other critical settings (MPP, OP).

No outstanding issue is blocking prior to the first beam, provided that some remaining tests are successfully completed today.

## BLMs

The installation of diode boxes in LSS3 was completed, to solve an issue due to reduced HV when significant losses are measured at many BLMs, like during loss maps. The HV cables for IR3 are 3km long, compared to other locations where they are shorter than 200m. The system was validated and tested with modulation of the detector's bias supply at LHC installation. It remains to be verified and validated during a loss map in the coming weeks.

**Action:** Report on the validation of the diode solution for the LSS3 BLMs issue (Christos Z.)

Additional signal filters were added for the detectors on top of the QBBI for cells 8-9 left of IR2. Filter boxes have been prepared for cells 7-8 right of IR8.

The installation was completed for two cryo BLM detectors per point. Additional external diamond detectors for cross check will be used. All detectors are in DC measurement mode with standard LHC electronics.

The firmware including the interlock inhibit (“blinding”) is deployed to all crates (version from 2015). Two new properties can be used to setup and monitor the functionality: one to set the timer value and one to read the timer countdown and indicate if the function is active.

One issue was identified with fixed displays warning messages that one of the crates is down (not systematic). The cause has not been found yet, however the data in NXCALS do not have gaps.

Christos provided details on the XPOC issue and PM buffers remaining frozen or not getting restarted and causing missing data. A “race condition” which could explain the issue could not be reproduced. Daniel commented that this needs to be investigated, while in the meantime it appears that linking the two beam permits in the BIS will solve the issue. Christos agreed, the risk being the lack of post-mortem data. Chiara commented that in case of missing BLM data in the XPOC an expert reset is not required.

**Action:** Identify and solve the BLM XPOC issue (Christos Z.)

Regarding the issue of missing packets in the 100Hz data, a new firmware will be deployed were only the check for the BLECS settings and critical parameters is kept. This will be included in the schedule. All other settings will be validated (as in the past) before every injection.

All the hardware checkout is complete, including the verification of all detectors (battery or source test) with respect to the database. The thresholds and flags have been updated and the energy level distribution to the crates has been tested. All CIBU bypasses for LS2 development have been removed. The SIS interlock for missing high-voltage test is still pending. Jorg suggested to perform that test in the coming weeks and confirmed that it has already been observed that the SIS interlock works but the systematic check is currently missing.

No blocking issue for the first beam has been identified.

[BIS / PIC / WIC / FMCM / SMP](#)

Raffaello reported on the commissioning tests for these systems.

WIC

All machine checkout tests were completed in 2021 and no other test was required.

PIC

All tests have been carried out successfully. The RSS bypass test, PP60A and SIS access condition tests were performed after LS2 and all of them passed. As no change was made by EPC during the 2021-2022 YETS, the tests were not repeated.

## FMCM

All SPS transfer line FMCM tests have been carried out successfully. The 2021 issue with the RD1 test has not been reproduced and the RD1 test was successful. All other LHC FMCM tests have been carried out successfully, except for the RMSI. For RMSI.R8B2, the FMCM did not produce PM data, although the test itself was valid. For RMSI.L2B1, the test was not successful as the FMCM did not trigger. That test passed after LS2 and nothing was changed. Jan commented that this will be sorted out in the coming weeks before the injection of trains. One option is to reduce the FMCM threshold for the test. MPE-MI will provide a test proposal. Action (MPE-MI): Propose updated procedure for the testing of the FMCM on the RMSI.

## SMP

All SMP-SPS tests were completed. All SMP-LHC tests were completed correctly or did not need to be repeated.

## BIS

All BIS input channel jumpers have been restored to their nominal configuration. The IST tests have been completed and all pre-operation checks passed.

There is a pending issue with the redundant power supplies for two CIBUs of the LHC injection BIS, which are currently not powered. This needs to be checked by EN-EL. This has only an impact on availability not protection.

All systems are green for the first beam.

## Vacuum

Daniel shared the information received from G. Pigny. The MPP checklist for the vacuum tests has been updated. The only missing checks concern the validation of the vacuum signals transmitted to RF and to the MKI. All the other tests are done and validated.

No blocking point was identified, RF and MKI teams confirmed that they will test their signals.

## SIS

Jorg confirmed that all tests that do not require beam have been successfully performed. No blocking point was identified.

## ADT

The system is in a good general state. Martin stated that it is important to test the existing SIS injection inhibit interlock which checks, if the ADT is setup for a lower intensity than what is used in the machine. If the ADT is setup for low intensity and high intensity is injected, it might damage the pick-up electronics, where we currently do not have spares at CERN, and delivery times are currently very variable.

Daniel and Jorg recommended to consider a hardware interlock given the associated risk. Christoph W. asked to confirm the length of the excitation window (511 bunches). It will be verified that this corresponds to the endorsed proposal (see [211<sup>th</sup> MPP](#)).

**Action:** Confirm the length of the ADT excitation window in terms of number of bunches (C. Hernalsteens, M. Soderen)

### AFP/ALFA

Both AFP and ALFA are fully commissioned, with the last test performed on 8 April. The MPP checklist is fully completed, and all tests are summarized in a report to be posted on EDMS.

From a machine protection point of view, both AFP and ALFA are fully ready to take part in the LHC operation.

For the 900 GeV run, the RP movement must be added to the sequence and the settings must be confirmed with collimation.

### TOTEM/CPPS

Everything is described in detail in the EDMS document. Details of the test in presentation from the [209<sup>th</sup> MPP](#). No anomalies were observed, and the system is ready for beam from an interlock point of view.

However, the system is not ready for data taking (missing detector packages in the RPs). After installation (in May 2022) all concerned pots will require a short interlock validation. A few hours of testing will be required.

For the 900 GeV run, the movement will be added to the sequence and the settings will be validated with collimation.

### Discussion

Daniel concluded for the MPP that the machine protection systems are ready to take the first beams in the LHC. Further commissioning test and the follow-ups mentioned above will be performed with low-intensity beams.

## Summary of actions

The actions from the meeting are:

- LBDS
  1. Follow -up on the delay of the beam dumped event sent out over the timing system (Gryegorz K.)
  2. Follow-up on the protection of settings for the SPS MKE phasing and discuss the potential impact of rolling back with LSA tags on other critical settings (MPP, OP)
- BLMs
  1. Report on the validation of the diode solution for the LSS3 BLMs issue (Christos Z.)
  2. Identify and solve the BLM XPOC issue (Christos Z.)
- ADT
  1. Confirm the length of the ADT excitation window in terms of number of bunches (C. Hernalsteens, M. Soderen)