

# 216<sup>th</sup> Meeting of the Machine Protection Panel

## LHC topics

October 29<sup>th</sup>, 2021 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 \(216<sup>th</sup> meeting\)](#).

## Minutes from the last meetings (LHC topics)

Daniel reviewed the minutes of the [214<sup>th</sup> MPP meeting](#). Jan confirmed that the list of NXCALS variable names was communicated to Belen.

## Status MP system commissioning before ramp of a pilot to 3.5 TeV

### Collimation (Stefano Redaelli)

Daniel summarized in place of Stefano that from the collimation point of view everything is fine for a pilot bunch up to 3.5 TeV. The collimators will not be ramped and will be kept at the injection settings.

### LBDS (Yann Dutheil)

Initially additional validation tests were considered: the BETS test up to 3.5 TeV (trim of each input to the BETS to validate the trigger of the synchronous dump) and vacuum interlock tests in the dump line (validate with VSC experts the interlock on pressure and pump status by changing them and observing the triggering of synchronous dump).

The BETS test was done at injection but not at 3.5 TeV. The vacuum tests were skipped during the injection tests due to the relatively low voltages used at injection energy.

For the BETS, the likeliness of failure is extremely low as this was tested at injection and the system is identical for all energies. Also, there is a redundant check on magnet current by the SIS. The potential consequence is extremely limited due to the low energy carried by a single pilot, even at 3.5 TeV. If the LBDS fails due to the BETS the bunch will be absorbed by the collimation system.

For the VSC interlock, there is a very low likeliness of failure. Since the LBDS has already been pulsed for weeks at up to 7.25 TeV without vacuum issues. Even if there is a flashover there is no risk of beam damage in the machine. No specific mitigating measures is proposed as the test will not be done prior to the ramp.

Matteo asked if the VSC test was performed before. It is not clear if the digital vacuum interlock to the LBDS was tested systematically, coming out of LS2.

Jorg commented that Nicolas has been ramping and testing at 7+ TeV. If this has been done at lot of time without checking with vacuum, then why wasn't that test done before.

Daniel concluded that we do not require the BETS or VSC tests for ramping a pilot bunch to 3.5 TeV. The risk that the pilot cannot be dumped is limited and the experiments will be switched off. The probability to have a magnet flashover in case of very bad vacuum is low.

#### BLM system (Belen Salvachua)

The machine protection aspects for the system have been validated for the pilot run at injection. Some issues were encountered and mitigated or solved.

Some beam tests were not performed before the pilot run:

1. Interlock request functionality of the BLETC for  $RS > 1.3$  s,
2. Test the interface of direct VLMS with beam dumping system,
3. Test the injection interlock inhibit functionality.

These must be performed before Run III.

Some issues were encountered during the pilot run:

1. Noisy channels in 11R1 (not passing HV modulation tests, fixed on Friday 22/10 during general access),
2. SR5.R crate sending SIS interlocks on HV (crate seems faulty, not limiting operation, but will need to be investigated and repaired after the pilot run),
3. Bypass of the 'Beam Info' signal at IP1 & IP8 BLM racks. Caused a beam dump request from all crates and both maskable and unmaskable outputs while beam circulated. A check will be added to the procedure to check all devices are removed before operation (action of the 214<sup>th</sup> MPP).

The status in view of ramping a pilot bunch to 3.5 TeV is as follow:

- To mitigate the issue of post-mortem data recording not re-started at random locations after events causing missing data at later data requests, a sequencer tasks was added (whenever the LBDS is re-armed, all the BLM buffers are restarted) and an SIS task, monitoring the state of those buffers, to block new beam injection if not recording.

- The triplet areas and arc from cell 11 have not been tested. This will be done during the YETS. Even though highly unlikely, a channel inversion in these areas cannot be excluded.
- The BLM thresholds of the new monitors added during LS2 are not ready and will be set during the YETS. This concerns mostly the TCLD in 11R2 and 11L2, the TCSPM in IP7 and the related monitors have been added to similar threshold families and connected to the interlock matrix. The crystal collimators in IP7 are also similarly set but are not connected to the BIS.

Jorg commented on the issue about the BLM buffer reset: the SIS is now latching injection until it is reset. Stephen added that this is a good thing to have in place and that it should be left in place for the next run. Daniel commented that this is only a software test, which is of a limited protection. Stephen replied that this is only an issue for PM data, not a protection issue, it should be fixed before Run III, and that in the long term the SIS could catch unintended change in the behavior of the system.

For the masked in the SIS of the HV check due to the SR5.R intermittent errors: Christos commented that under the circumstances it will be sufficient to manually check the voltage level before the beam ramp.

For a pilot bunch up to 3.5 TeV in case the BLM do not react the beam energy is well below the damage limit.

Belen also provided an update regarding BLM system latency, including the BIS and LBDS time stamps (see slides). The BLM latency from beam injection (rise time of MKI) to BLM removal of USER\_PERMIT in the BIC should be below 3 LHC turns. All results are within tolerance.

Daniel concluded that there is no limitation from the BLM system to ramp a pilot to 3.5 TeV.

#### BIS / PIC / WIC / FMCM / SMP (Jan Uythoven, Alain Antoine, Raffaello Secondo)

Jan provided a quick status of the BIS, PIC and WIC:

- BIS is independent of energy, and everything is fine,
- PIC: magnets have been ramped in training and all is fine,
- WIC does not depend on energy and the system all clear.

Alain provided a status of the FMCM. The hardware commissioning is complete. The RMSI.R8 has been tested successfully, however the PM data acquisition is still not available.

During the beam commissioning of the FMCM the testing of some of the circuits was not successful as it was not possible to trigger a beam dump by switching of the power converter since the ramp down was too smooth. In 2017 all tests passed successfully. A potential solution for the RD1 circuits is to slightly reduce the threshold. For the RD34 circuits large margin tests could be done to allow future tests to be performed at 450 GeV. This will be followed-up during the YETS.

Jorg added that the FMCM always triggered for nominal currents.

There is no showstopper to take a pilot bunch to 3.5 TeV.

Raffaello provided a status of the SMP. The system is running smoothly. Yesterday an issue with the SPS slow BCT generating the probe beam flag from the SPS was observed. This has been fixed by BI. The probe beam flag needs to be fully tested with beam.

SIS (Jorg Wenninger)

Jorg commented that as the test is done with safe beam, by default everything in the SIS is masked. Lots of parasitic tests performed and all passed for injection, including the IQC.

RF (Andy Butterworth)

Andy commented that the RF system is operational for a ramp to 3.5 TeV, with no longitudinal blow-up (not available).

## Summary

Daniel summarized that no additional tests (especially for the LBDS) are needed for a pilot run at 3.5 TeV.

There is no objection from machine protection point of view.