Meeting of the restricted Machine Protection Panel

MD 4 / 5 review

September 20th, 2024.

Participants:

R. Bruce (BE-ABP), X. Buffat (BE-ABP), A. Butterworth (SY-RF), D. Butti (SY-BI), Y. Dutheil (SY-ABT), L. Giacomel (BE-ABP), C. Hernalsteens (TE-MPE), G. Iadarola (BE-ABP), E. Maclean (BE-ABP), L. Mether (BE-ABP), D. Mirarchi (BE-OP), N. Mounet (BE-ABP), K. Paraschou (BE-ABP), J. Pucek (SY-BI), M. Solfaroli Camillocci (BE-OP), G. Sterbini (BE-ABP), J. Uythoven (TE-MPE), F. Van Der Veken (BE-ABP), A. Vella (BE-OP), J. Wenninger (BE-OP), C. Wiesner (TE-MPE), C. Zannini (BE-ABP).

The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico.

rMPP comments on MD

Christoph explained that, prior to the meeting, rMPP core members had reviewed the MD procedures and selected the MDs that should be presented and discussed in more detail. The initial comments and questions can be found on Indico.

MD12663: Wire compensation during the beta*-leveling

Christoph commented that this MD was already discussed in the rMPP for MD3, however it could not take place during the MD3 block due to unavailability.

The rMPP asked to clarify the changes in the MD procedure regarding the beam intensity. Guido commented that the new procedure requests two trains per beam but this time, one at 1.6e11 ppb and one at 1.8e11 ppb to probe the 2025 intensities.

Christoph reminded that the bunch intensity when arriving at β^*=30 cm will be higher than during a normal physics fill. The collimation hierarchy should therefore be closely monitored. Guido confirmed that this will be the case and that the criteria on how to monitor the collimation hierarchy during the MD will be added to the MD procedure. Jan stressed that if a hierarchy breakage is observed, one has to revert back to a safe situation or dump the beams.

The validation fill will take place before the actual MD fill. Gianni commented that this is included in the planning. Christoph added that an invitation for a dedicated rMPP on the validation of this MD will be sent out in due time.

MD12843: Heat load measurements

Lotta confirmed that the measurements will be performed with beam parameters close to the Run II parameters (1.2e11 ppb) with trains of 2x48b and bunch length below 1.2 ns.

It was decided that the SIS bunch length interlock (which is currently set to 1.15 ns) can be reduced to 1.05 ns for the MD. The procedure has to explicitly mention this step as well as the roll back of the settings after the MD.

MD13144: Coronagraph resolution study

The procedure refers to the "new large optics in Point 4" (HL optics for IR4). Jan P. commented that this idea was to use the optics from another MD which would take place before (HL optics MD). However, an MD will take place in parallel on the other beam, e which makes it difficult to accommodate the change of optics.

After discussion and to keep things simple, it was decided to keep the nominal optics for the MD.

MD13523: Measurements for improvement of intensity dependent correction

Matteo confirmed that the filling scheme will be adjusted so that the exact number of bunches fits within the LMC approved bunch limitation (385b at 2.4e11 ppb and 684b at 1.8e11 ppb). Christoph commented that a pure 8b4e scheme generates different sidebands of the beam spectrum than the operational 25 ns beam, which can affect the heating. Matteo remarked that he does not expect a significant effect since less than 700b of 8b4e beam are used at injection. Gianni added that the availability of 8b4e beams for MD5 is not granted and has to be assessed with the injectors, taking into account the requests from the other MDs.

If the 8b4e beam is available in the injectors and can be used for this MD, it is recommended to carefully watch the beam induced heating during the MD.

MD13543: Statistical properties of Schottky spectra

Nicolas clarified that one train of 12b would be used per beam.

MD13546: Decay and Ramp RDT measurements

Ewen clarified that most of the MD will take place at injection energy and a ramp will be performed at the end, if time allows. The only optics change will be the pausing of the FIDEL correction at injection. The FIDEL corrections will be resumed and the tunes and chromaticities will be corrected before the ramp. Therefore, the requirements of less than 20% beta beat for using the AC dipole above 4 TeV with 3 pilot bunches will be met. Christoph reminded that another requirement is that the BLMs at the TCTs are not masked. Ewen confirmed that this will be applied.

MD13548: Doughnut beams for detuning

It was clarified that the core part of the MD will take place at injection energy, if time allows measurements will be taken at flat top towards the end of the MD.
The planned collisions between a pilot bunch and a nominal bunch will be performed at injection energy. Jorg recommended to first establish collisions with two nominal bunches, as otherwise the signal will be very low. Ewen confirmed that the MD procedure will be updated with the clarifications above.

MD13703: ML assistant crystal channelling optimization and MD10343: Energy ramp to 6.8 TeV in steps

Daniele and Jorg confirmed that as soon as the crystal will be put in beam position, the SIS interlock for the replacement chamber must be masked. Jan asked that the masking before and the unmasking after the MD is added to the procedure.

MD9551: E-cloud heat load with high intensity at injection (25 ns) (L. Mether)

The main goal of the MD is to improve the estimates of cell-by-cell heat loads for the HL-LHC era.

Using trains of 2x48 bunches (96 bpi), the following fills will be requested:

- Bunch intensity of 2.3e11 ppb and 12b + 10 times 2x48b (972b)
- Bunch intensity of 1.9e11 ppb and 12b + 12 times 2x48b (1164b)
- Bunch intensity of 1.5e11 ppb and 12b + 16 times 2x48b (1548b)
- Bunch intensity of 1.1e11 ppb and 12b + 22 times 2x48b (2124b)

Heat loads measurements will then be performed over 30 minutes per fill (TDIS retracted).

The number of bunches is driven by the need for a sufficiently high heat load to minimize the impact of intrinsic fluctuations in the measurements.

The current intensity limit as set by the LMC is 385b with 2.4e11 ppb and 684 bunches with 1.8e11 ppb for a bunch length of 1.0 ns. For this MD, a bunch length of 1.2 ns will be used. Therefore, the requested filling schemes stay below the allowed bunch/intensity curve for degraded rf fingers contact. Jan asked if these intensities are considered safe for beam-induced heating and underlined that this assessment has to come from the experts in ABP. Carlo confirmed that the requested intensities are acceptable for a bunch length of 1.2 ns.

Christoph asked how the minimum bunch length will be guaranteed during the MD. Lotta replied that the bunches during operational fills are injected with a bunch length of 1.2 ns and that the bunch length will naturally increase after injection and exceed the 1.2 ns limit.
Jorg commented that the SIS bunch length interlock is not active at injection energy.
It was agreed to take the following steps during the MD:

- Monitor manually the bunch length and dump the beam if the value falls below 1.2 ns
- Set the bunch length limit in the SPS BQM to above 1.2 ns to avoid injection of too short bunches.

Lotta confirmed that this will be added to the MD procedure.

MD13547: Measurement/correction of weak/strong Long-Range Beam-beam (continued)

MD12263 in MD2 performed first measurement of LRBB driven resonances in Beam 2. The main goal of this MD is to measurement the resonance strength caused by LRBB on Beam 1. Corrections will also be tested.

The low intensity beam will have 3 pilots (1 without collision, 1 with full long-range in IP1/5 and one with partial LR in IP1/5). The other beam will have 144 bunches. The strong beam has intensities above the setup beam flag so that all collimator interlocks will remain active.

Jan commented that the MCSSX trim is 5x larger than nominal operation and asked what would happen in case of issue. Ewen replied that the ramp rate is slow (below 25 A/min) and an intermediate beta-beating measurement could be performed. It was agreed to perform this measurement. Ewen will update the procedure accordingly.

MD13945: Long-range beam-beam RDT compensation (EoF MD)

The goal of this MD is to test the implementation of the MCSSX corrections at end-of-fill in view of a possible operational use in 2025. The test will be done at the end of a proton-proton physics fill with a full machine. The correction computed for an intensity of 1.6e11 ppb will be scaled down to the surviving bunch intensity at end-of-fill. The working point would be kept constant by adjusting the tune with the MQT. The predicted beta-beat due to feed-down from the MCSSX trim is expected to be below 6% for the full correction.

Jan commented that the beta-beat will be measured at half-correction and for the full correction during the dedicated MD and suggested that this information should be used to determine if the end-of-fill test with a full machine can be executed. Ewen replied that the dedicated MD is scheduled for MD5 and that it would be preferrable to perform the end-of-fill before.

An additional test is to apply the inverse correction to purposefully increase the strength of the 3Qy resonance. The lifetime would be degraded. Jan added that this should be tested before the dedicated MD.

It was agreed that the end-of-fill test can be performed after validating the beta beating and the tune effect. This could be either performed during MD13547 or during a dedicated measurement (e.g. during another MD).
In addition, it was agreed that the MCSSX current should be changed slowly and in steps while beam losses and the collimation hierarchy are closely monitored. In case the hierarchy is evidently broken, the settings have to be reverted, or the beams should be dumped.
Ewen confirmed that the MD procedure will be updated accordingly.

MD13583: Improved tune-shift measurements

Lorenzo clarified the requested bunch intensities at injection and at flat-top:

- Injection: 0.5e11, 0.75e11, 1.0e11, 1.25e11, 1.5e11
- Flat-top: 0.5e11 and 1.6e11 (operational intensity).

The details on the collimation retraction and jaw movements were provided. For the single collimator measurements, the secondary collimators will be used (as they can be retracted more than the primaries). The TCSPM.B4L7.B1 or TCSG.D4L7.B1 will be cycled. Nicolas commented that the collimators in IR3 will be at their nominal positions. The details of the plan were agreed with the collimation team. Frederik confirmed that this is indeed fine because only one collimator is opened at a time.

Conclusions

The MDs were approved understanding that the clarifications and modifications above will be included in the procedures. The rMPP core team should be notified when the modifications to the procedures have been made.