

189th and 190th Meeting of the Machine Protection Panel

Joint session of LHC and injectors topics

May 8th, 2020 via Zoom

Participants:

Alain Antoine (TE-MPE), Andrea Apollonio (TE-MPE), Wolfgang Bartmann (TE-ABT), Andy Butterworth (BE-RF), Stephane Cettour (BE-OP), Fabio Follin (BE-OP), Miguel Hermo Serans (BE-CO), Cedric Hernalsteens (TE-MPE), Verena Kain (BE-OP), Ioan Kozsar (BE-CO), Bettina Mikulec (BE-OP), Filip Moortgat (EP-CMG), Brian Petersen (EP-ADT), Dragoslav Llazic (EP-UCM), Bjorn Lindstrom (TE-MPE), David Nisbet (TE/EPC), Ivan Romera (TE-MPE), Raffaello Secondo (TE-MPE), Piotr Skowronski (BE-OP), Matteo Solfaroli (TE-MPE), Richard Scrivens (BE-ABP), Jan Uythoven (TE-MPE), Jorg Wenninger (BE-OP), Christoph Wiesner (TE-MPE), Wojtek Sliwinski (BE-CO), Daniel Wolmann (TE-MPE), Markus Zerlauth (TE-MPE).

The slides of all presentations can be found on the [website of the Machine Protection Panel](#) and on [Indico \(189th meeting\)](#) and [Indico \(190th meeting\)](#).

Minutes from the 186th MPP meeting (injectors)

- No comments on the minutes of the last MPP meeting on injectors topics (186th MPP) have been received.
- **Follow-up** on the installation of a new connection “MKP enabled” from the MKP to the TT2-TT10 slave BIC (I. Romera, 186th MPP meeting):
 1. The request to EN/EL for the pulling of cables for the signal “MKP enabled” connection to the TT2/TT10 slave BIC has been done.
 2. The update of the specifications for the SPS injection BIS (new input) has been done.
- An update of the open actions has been added to the MPP homepage.

Critical settings management for Linac4 and PSB (Bettina Mikulec)

Bettina presented a proposal for the critical settings management for LINAC4 and the booster which can be split in two categories:

1. Settings of power converters (PC) connected to BIS (HW or SW);
2. MCS (machine-critical settings) in LSA using RBAC authentications.

Proposal for PCs connected to the BIC for LINAC4

Details of the interlocking of the power converters can be found in EDMS-1016233. This description concerns the Low-energy quadrupoles and the Main bending magnets and are connected to the BIS:

- Settings implemented with the FGC Interlock (FI) application are presently +/- 10 A for the quadrupoles and +/- 1 A for the dipoles. These settings need to be refined by ABP
- The proposed RBAC role to attach to these settings is MCS-LN4EXP (CPS shift leaders, L4 supervisors)
- **Question** David asked when this will be in place. Bettina replied that it should be ready, when the beam is back. Jan pointed out that it is indeed a good idea to put this in place for the first day of operation.
- **Question** Christoph asked if the bellow incident was due to the settings of the low energy quadrupoles. David replied that it was mainly due to the settings of the steerers and Bettina commented that this incident happened in a very special MD configuration.
- **Comment** Bettina commented that for the settings of the MEBT an optics online model would be very helpful for OP. Richard replied that this is foreseen in the long term. As of now, the proposed settings should not be modified by the operation.
- **Action** Study how to implement an online optics model and related configuration management depending on the optics (R. Scrivens, B. Mikulec).

Proposal for PCs connected to the BIC for the booster

The proposal is described in EDMS-1016233 and includes the Main bending magnets in the PSB extraction transfer line. Settings for power converters linked to the BIS shall be implemented with the FI application, except for BTY.BHZ301 which still has an old PowM1553 converter control. The proposed RBAC role attached to these parameters is “MCS-PSBEXP” (CPS shift leaders, PSB supervisors)

- **Question** David asked when this will be in place. Bettina replied that it will also be in place when the beam is back.

Proposal concerning the MCS for LINAC4

The RBAC role attached to the solenoid settings would be “MCS-LEBT”, which is currently held by L4 supervisors and R. Scrivens. The watchdog settings and the BLM thresholds need to be modified during measurements (*e.g.* SEM grid) by the operators. Therefore, the proposed role would be “MCS-LN4OP”, which is held by L4 supervisors, CPS operators and G.P. Di Giovanni. A procedure how to implement changes to the watchdog and BLM thresholds for measurements with beam intercepting devices is currently under preparation.

- **Question:** Upon a question from Jan, Bettina explained that the interlock threshold of three bad shots for the different watchdog corresponds to three consecutive bad shots.
- **Question** It was asked if the solenoid LEBT settings (CCV) should also become MCS. David commented that the settings should not but that the measured currents should be considered.
- **Comment** Verena commented that the MCS framework allows any setting to become MCS.

Bettina asked if the solenoid set points should also be protected as MCS (slide 6), as they also have an impact on the RFQ protection (in addition to the protection by the SIS on the power converter measured currents):

- **Follow-up** received from Bettina and David: adding the MCS limitation to the set-point would have repercussions on the power converter configurations, and on the maintenance/intervention of the equipment when not in beam operation. Following some discussion (with Richard, Alessandra, Raul and Piotr) we agreed that the protection implemented in the context of the RFQ surveillance (which uses the SIS to monitor the solenoid measured current) is an adequate protection.
- It is therefore decided that the solenoid set points will not be MCS settings.

Proposal concerning the MCS for the Booster

The proposal for the use of MCS in the booster is similar to Linac4 and shown on slide 6. The proposal includes:

- BI line watchdog, the booster injection watchdog acts as backup for the H0/H- monitor to protect against foil breakage. The watchdog and BLM thresholds are cycle dependent (ppm). However, the H0/H- monitor thresholds are not cycle dependent and, therefore, a foil breakage with low-intensity beam might not be detected. For the H0/H- monitor the RBAC role MCS-PSB-Injection, held by C. Bracco, G.P. Di Giovanni, B. Mikulec and F. Roncarolo) is proposed. For the BI line watchdog and the BLM thresholds RBAC role MCS-PSBOP, held by PSB supervisors, CPS operators and P. Skowronski is proposed. For the booster injection watchdog, Bettina, proposes the MCS-PSBEXP RBAC role, which is held by CPS shift leaders and PSB supervisors.
- Bettina mentioned that in the beam commissioning checklist for the PS booster, an item requiring the tightening of the watchdog and BLM thresholds at the end of the beam commissioning needs to be added.
- Bettina informed, that two procedures are currently in preparation: one describing the “sequencer tasks to reduce the Linac4 intensity” and another one on “routine beam measurements in Linac4”. The documents are in EDMS and will be distributed for check after the meeting.
- **Comment** David commented that, to allow sufficient support during the commissioning it might be important to add people from the EPC group to the proposed MCS roles for the settings of the solenoid, quadrupole and main bending magnets. Bettina replied that herself, Jorg and Verena have editor rights for the MCs roles and can add people to these roles ad-hoc in case of need.

SPS extraction interlock: doubling the SMP connection (Raffaello Secondo)

Raffaello gave a description of the architecture of the safe machine parameters for the SPS. As inputs it receives the machine energy and beam intensity from several redundant sources. It uses a dedicated FPGA board for the execution of the calculation logic. The calculated flags are either directly transmitted or broadcast with the GMT (*e.g.* SPS setup beam flag). The parameters broadcast by the GMT are received for the LHC with a dedicated board (CISV, while for the SPS no dedicated HW, but standard timing cards (CTRP or CTRV) are used and configured using a LTIM class to decode the flags.

The setup beam flag is critical because it is received by the SPS extraction BIS. An additional flag will be distributed after LS2 for the SPS: the “TED flag” (see EDMS: SPS-OTH-ES-0001). The setup beam and TED flag are sent via the GMT (payload of a timing event). Some complications arise:

- The two flags are encoded in the timing event, with redundancy of bits and checksum. However, the GMT presently filters the redundant bits and only the least significant bit is available;
- The extraction CTRB (BA4 and BA6) must decode the setup beam flag only. The TED crates must decode the TED beam flag only;
- The BIS requires two redundant inputs for the setup beam flag. However, the LTIM provides only the logical AND of the two. Therefore, a Lemo ‘T’ connector splits the signal after the decoding. The full redundancy throughout the entire chain is thus lost.

Proposed solutions by Raffaello:

- The filter needs to be removed for two reasons: to allow the correct decoding of the TED flag and to restore the correct redundancy for the SBF sent to the BIS. Furthermore, the Lemo ‘T’ connector for the SBF needs to be removed to restore the redundancy required. Finally, generate fully redundant signals, created by redundant HW, the existing 2 CTRP cards will be replaced by 2x CTRV cards. After this change, signals A and B of the flags will be fully redundant and can be checked for consistency.
- In the long-term, specific receiver cards (possibly again based on the CISV) with SMP specific firmware should be developed comparable to the existing CISV cards for the BIS in the LHC. This will be envisaged for SMPv2 foreseen for LS3.

The proposal made by Raffaello was accepted by the MPP.

Reports on Major Machine Protection Event (Christoph Wiesner)

Joint session of LHC and injectors topics

Christoph recalled that the proposal for the reporting of major machine protection events is a follow-up from the Evian 2019 workshop, where it was requested to document such events with “quality insurance and rigor”.

The proposed procedure is as follows:

1. The MPP requests a “report on major machine protection event” and in turn reports to the LMC (LHC topics) or to the IEFEC (injectors topics)
2. This report is requested in case one or more of the following criteria are met:
 - Damage to machine element
 - Considerable downtime (>24h)
 - Unexpected beam loss pattern
 - A machine protection relevant system did not fulfil its function or showed an unexpected behavior or non-conformity
3. The reports will be stored on EDMS and will follow the proposed template, which includes the:
 - Event description;
 - Description of the recovery and revalidation procedure;
 - Lessons learnt;
 - Mitigation measures and required actions.
4. The reports shall be issued from Run 3 onwards

Christoph showed an overview of ~10 Run 2 events, which would have qualified for a major event report. Major event reports have been produced for two example cases: The MKBV flashover in the LHC and the beam sent un-intentionally towards the PSB during the LINAC4 LBE run. These reports have been uploaded in EDMS and have been verified by the responsible equipment groups.

Bettina mentioned that the proposed Major Event Reports would also be useful for the injectors. The MPP accepted the proposed major event report template and the procedure. The proposal will now be presented to the LMC and the IEFC for the LHC and injectors respectively.

Summary of actions

The actions from the meeting are:

- Study how to implement an online optics model and related configuration management depending on the optics (R. Scrivens, B. Mikulec).