

182nd Meeting of the Machine Protection Panel

The meeting took place on **October 11th 2019** in 774/1-079.

Participants: Andrea APOLLONIO (TE-MPE), Andy BUTTERWORTH (BE-RF), Miguel HERMO SERANS (BE-CO), Verena KAIN (BE-OP), Grzegorz KRUK (BE-CO), Alessandra LOMBARDI (BE-ABP), Christophe MARTIN (TE-MPE), Bettina MIKULEC (BE-OP), Filip MOORTGAT (EP-CMG), David NISBET (TE-EPC), Laurette PONCE (BE-OP), Federico RONCAROLO (BE-BI), Frank TECKER (BE-OP), Jan UYTHOVEN (TE-MPE), Christoph WIESNER (TE-MPE), Daniel WOLLMANN (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](#).

1.1 Minutes from the 179th and 180th MPP meetings

- Comments for the 179th MPP have been received from Bettina Mikulec and for the 180th MPP from Gianluigi Arduini. The minutes on Indico and on the [MPP website](#) will be updated accordingly.

1.2 Updates of the MPP membership

- Christoph Wiesner presented the proposed update for the MPP membership that has already been discussed in the last MPP on LHC topics (181st MPP, see [slides](#)). In particular, new members have been added from the Injectors, for Timing/Controls, for Vacuum, and from EN-SMM.
- Bettina asked if a representative for vacuum questions in the injectors should be added. It was decided this is not necessary for the moment, but that instead additional experts should be invited to dedicated meetings when required for the topic.
- No further comments or additional proposal for new members were discussed.
Action (all): All groups and teams should verify their proposed MPP representative and inform Christoph and/or Jan if they have comments or suggestions.

1.3 External Conditions Renovation Status (Miguel Hermo Serans)

- Miguel presented the **renovations status of the External Conditions (EC)** for PSB and PS. The renovation is necessary because a) certain hardware components reach their end of life, b) the new power converter controllers (FGC) do not provide a hardware interface to the EC system, and c) certain interlock conditions will be moved from EC to the new Beam Interlock System (BIS).
- In the new system, the ECs will be obtained either directly via CMW subscription or by connection to a PLC hardware I/O module. They are published by the clients at ~1 Hz.
- The systems that will directly use the **CMW interface to the EC** are listed on Slides 7-10. They include beam stoppers, targets, kickers, and power converters.

- The systems that will be **connected via PLCs** are listed on Slides 12-14. They include vacuum, the CCC buttons, and several other ECs.
- An ECR about the “PSB External Conditions for Post-LS2” has been released on [EDMS](#) and is under discussion.
- Frank added that for the PS the functionality remains unchanged. The details are included in the Functional Specification of the “LIC External Conditions” ([EDMS](#)), presently in Draft 0.4.
- Markus asked if issues can be caused in case signals via CMW arrive with additional delays wrt direct hardware signals. Greg replied that the timestamps of the updates are always checked and the signal is discarded if it’s older than one basic period. In this case, one would just miss one basic period.
- Answering a question from Frank, Bettina explained that the PSB ring and injection vacuum will now be interlocked via the BIS, while the extraction vacuum remains in EC.
- Jan asked about the EC being an input to the LINAC4/PSB BIS, according to the Engineering Specifications in [EDMS](#). It was briefly discussed that this needs to be updated and the External Conditions will not anymore feed into the BIS.
Action (Christophe Martin/TE-MPE): Update the LINAC4/PSB specification of the BIS, replacing the input from the External Conditions (section 4.6 to be removed and complete document to be updated accordingly).
- Jan commented that he was surprised about the idea to connect the **Warm Magnet Interlock Controllers (WIC)** to the EC. He explained that it’s technically challenging and that it’s already late to implement hardware changes.
 - Bettina remarked that the initial motivation was to use the WIC information about the transfer line magnets (PSB to PS and to ISOLDE) to optimize the proton delivery by switching to spare cycles. Jan emphasized that a WIC failure will trigger the BIS and stop the beam for the respective destination.
 - Verena suggested that the BIS information can be used as input for the SIS, taking into account many other signals than just the WIC, and send this information to the EC.
 - Greg mentioned that another option to be investigated is to read the BIS status directly within the EC/Timing System.
 - **Action (Miguel Hermo Serans/BE-CO, Jose-Luis Sanchez Alvarez/BE-OP): Update the ECR on “PSB External Conditions for Post-LS2”, removing the WIC connection to the EC.**
 - **Action (Grzegorz Kruk/BE-CO): investigate and if possible implement the link between BIS and External Conditions. Otherwise, implement link via SIS.**

1.4 PSB: injection into less than 4 rings (Bettina Mikulec)

- Bettina presented the topic of **injecting beam into less than four booster rings**.
- The BIS doesn’t act on specific PSB rings. This implies that a false beam permit will block injection into all four rings. To increase the overall operational efficiency, the possibility to allow injection into less than four rings was analysed in 2017 ([EDMS](#)).

- A few **ring-specific systems** were identified that could lead to long downtimes (>6 hours), in particular a damaged stripping-foil holder or a vacuum or water leak in the injection section. Thus, for these failure cases a considerable gain of availability could be achieved by facilitating operation with less than four rings.
- To allow injection into less than four rings, several **ring-specific maskable channels were added to the four PSB BICs**, including the painting kickers, injection chicane bumpers, injection foil status, and injection vacuum valves.
- The **masking of these channels** should follow a clearly defined procedure and it should be a **management decision** whether to mask the channel.
- Bettina proposed that the **core members for the MPP injector topics** should be responsible to take this decision when required. They would, thus, play a similar role as the rMPP members for the LHC.
 - David asked how fast the decision would have to be taken. Bettina replied that a quick response is required, even outside working hours, in order to gain from the operation with less than four rings.
 - Verena commented that the question of how to decide on masking of interlock channels is also relevant for the SPS, e.g. for the slow extraction, where, after masking, the protection relies on procedure.
 - **Action (Jan/MPP): Make a proposal for the decision-taking process of masking critical interlock channels.**
- After discussing several options and based on a proposal by Verena, **the following technical implementation was suggested to allow injection into less than 4 rings:**
 - Obtain **agreement of decision body** if BIS input channels can be masked.
 - Use of a **sequencer task** that
 - forces the **maximum allowed pulse length** for the given ring to zero for all cycles,
 - possibly **masks the required SIS channels** (see discussion below),
 - **masks the faulty BIS client input for the given ring.**
 - The launching of the sequencer task has to be protected via RBAC.
 - The sequencer task has to be tested during commissioning to ensure its proper functioning.
- Bettina remarked that during early commissioning it is required to inject a low-intensity beam into one ring without the stripping foil inserted. Verena replied that parts of the sequence can be skipped by the RBAC role holder.
- Verena asked about the **potential damage** if injecting beam into a non-operational ring. Bettina answered that, in case of injection into a ring with a broken stripping foil, the beam will be sent to the H⁻ dump, which can withstand at least one full LINAC4 pulse. She reminded that additional protection is ensured by the downstream BLMs and the injection watchdogs, which have latching interlocks. Jan added that the vacuum valves can also withstand the impact of one full pulse.
- Laurette mentioned that also some SIS masks might need to be applied if injecting into less than four rings. This should be included in the sequencer task.
- **Action (Bettina/BE-OP): Write procedure for injection into less than four PSB rings.**
- The question of **automatic reminders for masked BIS channels** was discussed.
 - Bettina explained that an automatic reminder of all the masked BIS channels in LASER and in the logbook would be very useful for safe and efficient operation.

- Markus confirmed that this is technically feasible, but that one has to be careful not to pollute the logbook with automatic messages. He stressed that, if done properly and in a way that is also applicable for other machines, this requires significant work. So, one should evaluate what is the most efficient way to pass the relevant information.
- Jan summarized that there is clear interest in sending the automatic reminders, that it is technically feasible, but that the implications have to be evaluated in more detail. He suggested to continue the discussion in one of the next meetings.

1.5 AOBs

Open action: **absolute watchdog thresholds for LINAC4**

- Alessandra reported on an open action from the 179th MPP about evaluating the “feasibility of implementing absolute watchdog thresholds in hardware (i.e. lost number of particles/charges)” for the high-loss thresholds. She summarized the outcome of a discussion between Bettina, Christoph, Jan and herself.
- **Findings:**
 - The **LINAC4 watchdogs** calculate the beam transmission between different locations in the Linac and the transfer lines, based on the measurements from the Beam Current Transformers. Two options have been considered for the high-loss threshold: calculate the transmission either in *a) lost number of charges* (integrated beam current, i.e. pulse-length dependent) or in *b) lost beam current* (measured in mA, i.e. independent of the beam pulse length). Presently, the high-loss watchdogs are using the latter.
 - The **watchdog** input channels to the BIS are **not maskable**.
 - During certain **commissioning phases**, in particular during cavity re-phasing, high relative loss levels up to the full beam are expected, while the integrated losses are kept low by using shorter pulse lengths. For the commissioning procedure, this implies:
 - **Option a (using limits on lost charges):** probably no manual change of interlock limits required.
 - **Option b (using limits on lost beam current):** the watchdog interlock would trigger and inhibit the next pulses until being reset. To allow commissioning, the interlock loss limits for these cases would have to be increased up to the full beam current.
 - However, during **normal operation**, the lost beam current is the more important parameter to monitor and to interlock on.
- **Conclusion:** Taking into account that
 - 1) the **loss limits measured in beam current are better suited for standard operation** and the operators rely on these values,
 - 2) the **limits on integrated losses (in charges) improve the protection only for rare cases** during commissioning,
 - 3) the **main identified risk** is to accidentally keep the changed loss limits when going back from commissioning to operation with long beam pulses,

it is considered acceptable to continue using loss limits measured in beam current, and protect the machine during commissioning by procedure and the appropriate use of RBAC roles.

- The action can be closed and transformed into a follow-up.
Action (Alessandra/BE-ABP): Define procedure under which circumstances and how to change the high-loss LINAC4 watchdog limits, including roll back to standard operation.

1.6 Open Actions

The actions from the meeting are:

- Action (all): All groups and teams should verify their proposed MPP representative and inform Christoph and/or Jan if they have comments or suggestions.
- Action (Christophe Martin/TE-MPE): Update the LINAC4/PSB specification of the BIS, replacing the input from the External Conditions (section 4.6 to be removed and complete document to be updated accordingly).
- Action (Miguel Hermo Serans/BE-CO, Jose-Luis Sanchez Alvarez/BE-OP): Update the ECR on “PSB External Conditions for Post-LS2”, removing the WIC connection to the EC.
- Action (Grzegorz Kruk/BE-CO): investigate and if possible implement the link between BIS and External Conditions. Otherwise, implement link via SIS.
- Action (Jan/MPP): Make proposal for the decision-taking process of masking critical interlock channels.
- Action (Bettina/BE-OP): Write procedure for injection into less than four PSB rings.
- Action (Alessandra/BE-ABP): Define procedure under which circumstances and how to change the high-loss LINAC4 watchdog limits, including roll back to standard operation.