242nd Meeting of the Machine Protection Panel

LHC topics

December 15th, 2023, via Zoom

Participants:

Cedric Hernalsteens (TE-MPE), Yann Dutheil (SY-ABT), Dragslav Lazic (EP-UCM), Ivan Romera (TE-MPE), Mathieu Saccani (SY-BI), Belen Salvachua (SY-BI), Brad Schofield (BE-ICS), Raffaello Secondo (TE-MPE), Jan Uythoven (TE-MPE), Pieter Van Trappen (SY-ABT), Nicolas Voumard (SY-ABT), Christoph Wiesner (TE-MPE), Daniel Wollmann (TE-MPE), Christos Zamantzas (SY-BI).

The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico (242nd meeting).

Minutes and actions from the 240th and 241st meetings

The minutes of the previous MPP meeting have been distributed. Daniel recalled the actions from the 240th meetings; there was no action defined for the 241st meeting.

BIS v2 and change of the actuator interface (I. Romera)

Ivan summarized the changes introduced by the BISv2 to the interface between the BIS and the actuators. The architecture in place with BISv1 is visible on Fig. 1 for the LBDS, SBDS, LHC Injection and SPS extraction. This solution is redundant, fast, adequate for long distance transmission and reliable. In addition, multiple actuators can be inserted in the beam permit loop. The drawbacks include the fact that the frequency decoding to derive Beam Permit status and diagnostics is under the responsibility of the actuator.

A different solution in place for the injectors (Linac4, PSB, and SPS injection) and shown in Fig. 2 , using a master and slave BIC. The Master BIC sends the local permit to the CIBR. This restricts the number of possible actuators. However, it simplifies the interface, and no BIS loop decoding is required on the actuator side. The diagnostics is still under the responsibility of the actuator.

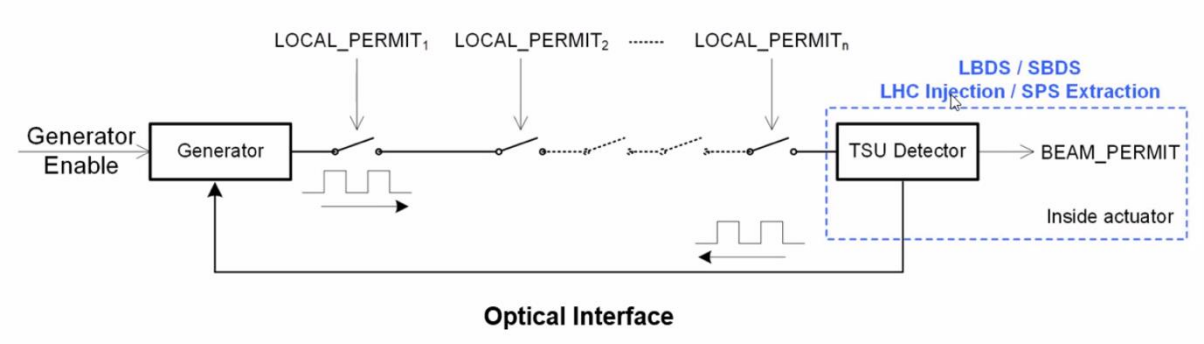

Figure 1 BISv1 interface for the LBDS, SBDS, LHC Injection and SPS extraction.

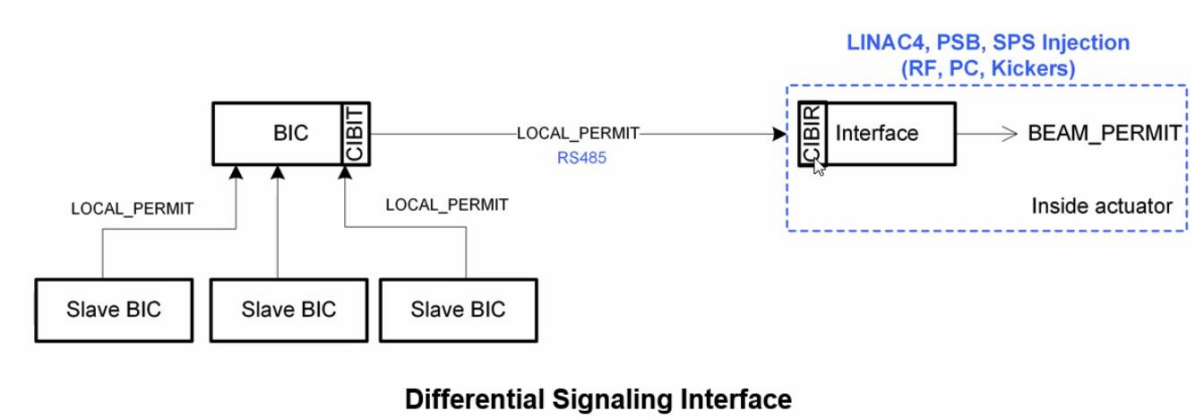

Figure 2 BISv1 interface for the Linac4, PSB, and SPS injection.

The BIS team proposes to standardize the interface between the BIS and actuators for BISv2 with the introduction of a common hardware interface to the actuators (as is done for the user inputs with the CIBU). The solution also provides easy maintenance of the optical infrastructure (no need to disconnect the fibers to test). A schematic is shown in Fig. 3. The CIBAB

- Is responsible for decoding the beam permit frequencies.
- Provides the beam permit via differential pairs using the fail-safe RS485 transceivers.
- Includes a set of redundant boards (1 board for loop A and B).

The CIBAB is a VME64xb board with a front panel including two 1-pin LEMO connectors, 1 SFP transceiver and 2 4-pin LEMO connectors to transmit the beam permit to the actuator and to receive the permit feedback from the actuator. The back panel also includes a connector to send the beam permit to the actuator and to receive the feedback from the actuator. A FESA class will allow the monitoring and control.

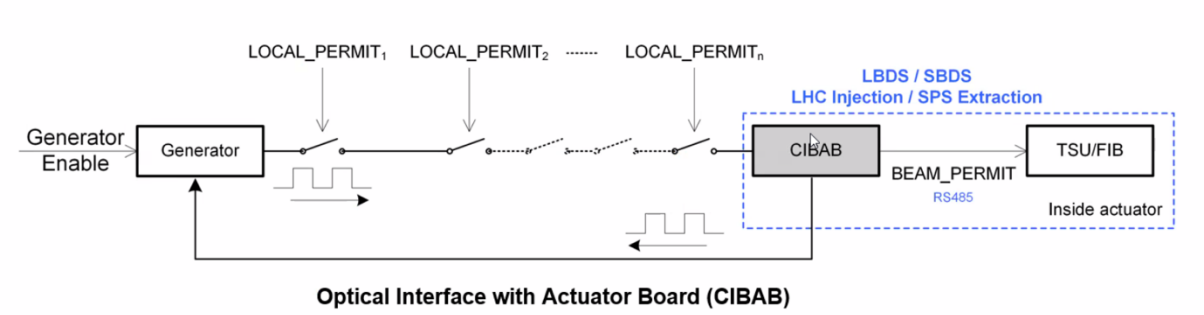

Figure 3 BISv2 interaface with the introduction of the CIBAB.

Three options are therefore available regarding the architecture of the interface between the CIBAB and the TSU-FIB.

Option 1

The CIBAB would be deployed in the TSU/FIB crate and provide the beam permit via the VME rear interface. This is the best option in term of reliability. However, this option would require a new design for the TSU/FIB.

Nicolas V. commented that this option is not available for the FIB interface as it would require a new design of FIB which is not foreseen.

Option 2

The CIBAB would be deployed in a new crate next to the TSU/FIB crate. The beam permit would be provided via the front panel LEMO connector. This solution is a good compromise in terms of reliability, but the possibility of swapping the A and B triggers cannot be excluded.

Option 3

The CIBAB would not be used at all. The TSU/FIB would receive the beam permit frequencies via the CIBSFP mezzanine board.

Nicolas commented that this can be done if without change in the TSU. The TSU/FIB would received the beam permit frequencies via the CIBSFP mezzanine board. This was already tested in the LHC SFP testbed. It would not require any hardware modification and only require a modification of the safety critical code.

Jan commented that options 1 and 2 are coherent with BISv2. Option 3 is equivalent to continuing with the old system, which is seen as sub-optimal by both HW groups. Daniel added that the old system has been very reliably working.

Ivan then listed the next steps following the endorsement by the MPP.

Daniel commented that option 1 is the full implementation of the changes and benefits brought by BISv2. Option 2 would be sub-optimal.

Implications of the BISv2 design for the LBDS (N. Voumard, P. Van Trappen)

Nicolas first summarized the impacts of the BISv2 changes for SY/ABT. The TSU is used to centralize the beam dump requests from BIS, BETS, LBDS Slow Control (SCSS), BLM and Early Dump (SBDS). BIS is the major client. It synchronizes beam dumps with the beam abort gap using beam revolution frequency (BRF) and delay.

The FIB (fast inhibit board) prevents the firing of the LHC MKI2 or MKI8 and connected to the injection BIS.

The TSU uses CIBO cards, whose interface is compatible with CIBSFP. The BIS signal passes through the TSU with feedback to the output. This is deemed reliable for SY/ABT but does not provide enough diagnostics on fibers.

The impacts of the proposed changes for the TSU are:

- Change of the BIS frequency decoding in TSU by CIBAB
- The BIS state only cannot indicate on which BIS loop with TSU is connected to in case of option 2.

Two scenarios are considered depending if the TSU renovation is approved or not:

- In case of renovation of the TSU: the CIBIR circuit or interface can be integrated in the TSU
- No renovation of the TSU: it would not be possible to use the CIBIR.

Jan asked about the renovation of the TSU and asked if the beam dump request could be received by the back plane. Nicolas replied that this was not foreseen. Jan commented that when proceeding with the renovation, this will be the cleanest and most reliable option.

Daniel asked if the absence of renovation of the TSU would exclude Option 2. Nicolas replied that this scenario is in between Options 1 and 2.

Daniel asked about the Impacts for the FIB. The FIB cards are already compatible with CIBIR interfaces. The check of the permit fault signal in CIBIR mode is already implemented. The advantage of the CIBIR-like interface is to use the fail-safe RS-485 transceivers, and to obtain the status of the transmission line. CIBIR circuit can be directly added to the TSU.

Nicolas reminded the general timeline. In particular, a prototype of the new TSU system must be started quickly and be ready by end of 2024.

Discussion

Daniel asked about the situation for the FIB and which options (among the three options presented by Ivan) are available. Nicolas replied that for the FIB Option 2 is mandatory as it will not be renovated. In addition, a LEMO connector is already available on the FIB.

For the TSU, options 1 and 2 are available but need to be studied in more details. Daniel asked by when we will now if the TSU renovation is approved. Pieter replied that it will be known in a few weeks.

Daniel commented that in the absence of renovation option 3 would probably be the safest and best option. Jan commented that BISv2 introduces a change of frequencies which imply that the situation would anyhow be different compared to the present situation.

In case of renovation of the TSU, option 2 will work in any case and option 1 must be studied. Pieter added that a reliability study must be performed for options 1 and 2. Daniel mentioned that any change of the TSU (depending on the chosen option) requires a reliability study. Pieter commented that in that case help with expertise from TE-MPE would be appreciated.

Daniel concluded that the MPP waits for decision on the TSU renovation before endorsing a solution. In case the renovation is approved, options 1 and 2 are preferable and the BISv2 will in any case need to support both options.

Action: Report to the MPP regarding the decision on the TSU renovation and the outcome of the reliability analysis or the new interface between BIS and TSU (N. Voumard, P. Van Trappen).

AOB: installation of additional BLMs and replacement of 6 SEMs by LICs in the collimation region (B. Salvachua, C. Zamantzas)

Belen summarized the motivation for this proposal. During the 2023 proton run, losses in IR7 during injection were dumping the beam with 236b injection trains (for Beam 1 only). These were fast losses on RS1.

It was estimated that 6.8e8 protons lost on the TCP would saturate RS1 for the TCP BLMs. This was confirmed experimentally with a pilot beam direct impact on TCP in June 2023.

The proposed solution is to displace the ionization chamber in order to capture fewer showers. We would need at least a factor 2 reduction for the primaries to avoid unnecessary dumps. After that, other BLMs will be limiting. FLUKA estimates are necessary to estimate the new optimal position. These simulations are on-going.

The proposal is therefore to install during the 23-24 EYETS additional IC BLMs next to the present ones and move the interlock functionality to these ones after confirming with beam the new response factors.

Other options were discussed but are not considered at the moment:

- Blindable in IR7: cannot be deployed in IP7 with the current way of its implementation (blinding out all maskable BLM channels of one crate).
- LICs: offer about a factor 14 reduced sensitivity as compard to the standard IC BLMs. Stability and linearity for the monitors will need to be assessed and their performance validated for future use.

The final locations will be confirmed following the results from the FLUKA simulations and following in-situ inspection and integration.

The interlocking during injection on the LICs is a possibility for post-LS3 operation. The stability of the LICs needs to be assessed. To gather these data, some SEM detectors in IR7 would need to be replaced by LICs.

The proposal is to replace 6 SEM detectors by LIC for Beam 1 (Beam 2 already has LICs). The LICs are 14 times less sensitive than the IC BLMs, while the SEMs are ~7e4 times less sensitive.

Discussion

Christos commented that SEMs and LICs should not be mixed on the same card. So, the options are the 7 SEM near the TCP and/or the 3 SEM near the TCLA and MBW.

Yann asked if the interlocking can be moved to the newly installed IC BLMs as soon as the reduction factor is confirmed and before the first injections of trains. Belen replied that this is a simple operation in the database. Jan added that the change of the interlock from the current to the new monitors should be brought back to the MPP after the first experience with beam.

Action: Report on the first experience with beam regarding the reduced sensitivity of the newly installed BLMs and propose the interlocking strategy for the 2024 run (B. Salvachua).

Daniel concluded that the MPP endorses the proposals to install the new IC detectors and to replace the 7 + 3 SEM detectors by LICs.

Summary of actions

The pending actions from the meetings are:

1. Implications of the BISv2 design for the LBDS
   - Report to the MPP regarding the decision on the TSU renovation and the outcome of the reliability analysis or the new interface between BIS and TSU (N. Voumard, P. Van Trappen).
2. AOB: installation of additional BLMs and replacement of 6 SEMs by LICs in the collimation region
   - Report on the first experience with beam regarding the reduced sensitivity of the newly installed BLMs and propose the interlocking strategy for the 2024 run (B. Salvachua).