

208th Meeting of the Machine Protection Panel

Injectors topics

May 7th, 2021 via Zoom

Participants:

Andy Butterworth (SY-RF), Enrico Bravin (SY-BI), Andrea Calia (BE-OP), Yann Dutheil (SY-ABT), Luigi Salvatore Esposito (SY-STY), Cédric Hernalsteens (TE-MPE), Wolfgang Hofle (SY-RF), Verena Kain (BE-OP), Grzegorz Kruk (BE-CSS), Thibaut Lefevre (SY-BI), Tom Levens (SY-BI), Kevin Li (BE-OP), Bettina Mikulec (BE-OP), Diogo Miguel Louro Alves (SY-BI), David Nisbet (SY-EPC), Jan Uythoven (TE-MPE), Belen Salvachua (SY-BI), Brad Schofield (BE-ICS), Raffaello Secondo (TE-MPE), Christoph Wiesner (TE-MPE), Daniel Wollmann (TE-MPE).

The slides of all presentations can be found on the [website of the Machine Protection Panel](#) and on [Indico \(208th meeting\)](#).

Minutes from the last meeting (Injectors topics)

Daniel recalled that the minutes of the last MPP meeting on injectors topics (203rd MPP) have been circulated and summarized the two open action points.

Major event report on PSB extraction (Bettina Mikulec)

Bettina introduced the PSB extraction BIC. The main purpose is to survey the main bending magnets that go to the different destinations (provided through timing events). The WIC is also connected to the BIC. For the BYI (PSB to ISOLDE) transfer line the WIC input is bypassed as the WIC is not yet installed. The BIC also has an input for the PS dump status. The role of this master BIC is to prevent the pulsing of the PSB extraction kicker in case of absence of the beam permit for that destination.

It was discovered that the PSB extraction BIC was not acting as supposed as a bypass was still in place on the kicker side. The bypass was implemented to perform the kicker ISTs during LS2. The bypass was not removed afterwards, once all BIC user input conditions were available. The kicker expert was waiting for notification from BE-OP to perform a final test during which the bypass would have been removed. The test was missing on the OP checklist. On the SY-ABT side, there is no special tracking in place for the installed bypasses. The beam operation was started with the bypass still in place.

The problem was discovered and solved on April 14th, 2021. It caused no equipment damage.

The following tests were performed to validate the PSB extraction BIC and the connection to the extraction kicker:

- The connection of *BEr.KFA14L1* to the BIC *cbix.361.psb.ext* was validated by C. Martin (TE-MPE) on June 5th, 2020. Following this successful test, SY-ABT activated the bypass of the FIB to allow SY-ABT to execute ISTs and dry runs before all BIC user inputs were TRUE.
- On October 16th, 2020, a dry run took place between BE-OP and SY-ABT to validate the extraction kickers. A few follow-up actions were noted, but there was no mention about the bypass. Unfortunately, in the dry run test list, the test to validate the BIC action was missing. This test has been added.
- In November 2020, the individual user inputs of the PSB extraction BIC were tested following the OP checklist for the BIS. The test to validate the BIC was missing and has now been added.

Bettina indicated that no damage was caused by this event. Two other machine protection mechanisms were in place and functional. First, a SIS task is monitoring the interlock properties of the bending magnets and the status of the PS dump. This was added during LS2. The SIS check allows to avoid unnecessary machine activation in case of absence of the BIC beam permit by setting the number of injected turns to zero. This prevents the full beam to be lost in the machine. Second, the BLMs in the extraction beamline would have cut the beam via the choppers (pre-chopper and chopper) BIC after a certain number of bad pulses.

After the removal of the bypass of the extraction kickers, the beam production for the PS was temporarily interrupted. During a check of the WIC system, TE-MPE-MI discovered on April 14th, 2021, that even with a FALSE user permit on the WIC BTP channel connected to the extraction BIC, PS beam were produced. The WIC expert informed the BIS expert about the issue. The BIS experts investigated and rapidly found that the extraction BIC was not being considered for the PS beam production. They then reported the major event to BE-OP-PSB. After a quick check, it was found that a bypass was still in place at the extraction kicker level. On behalf of the ABT expert, the BIS expert removed the bypass. As consequence, the beam production for the PS was interrupted. The reason was a fault in the user permit 12 to the PSB extraction BIC coming from the WIC, which allowed to discover the bypass on the ejection kicker in the first place. This fault was produced due to one locked-out BTP line corrector (BTP.DVT10) whose power converter status was bypassed as provided to the BIS. This WIC interlock was not discovered at the time the power converter was locked-out as beam was not being produced for the PS. To re-establish the operation, the interlock cable of this power converter was disconnected from the WIC system, so the power converter cannot resume operation until the interlock cable is reconnected. After the intervention, the beam operation to the PS could be re-established, resulting in a total downtime of 1h23 for the PS.

Bettina mentioned that it is not always straight-forward for the operation team to decode a master BIC like the PSB extraction BIC with the current BIS-GUIs, as the Operator has to know the interlock matrix, which in this case is dependent on the destination.

Question Jan asked if this is an action. Bettina replied that an application from Jorg has that feature. For the future it would be good to have something like this in place in the MPE GUI. Jan suggested to organize an informal meeting between OP and the MPE software team. Daniel added that clear specifications will be needed for the SW team, as outcome of the meeting.

Action: Organize a meeting between OP and the MPE SW team to define the specifications for an improved BIS GUI (Bettina).

The following mitigation measures and actions are put in place:

1. The test of the individual BIC actions needs to be added to the PSB hardware commissioning checklist. This has been already done.
2. Schedule by default the functional test of the beam permit signal at equipment actuator level during the cold checkout phase. The final test should be performed jointly by BE-OP, TE-MPE and the equipment expert.
3. A tracking mechanism for bypassing beam permit signals at equipment actuator and user levels should be implemented. It will remain necessary to test the PSB extraction kickers before all BIC user inputs will be TRUE, but the bypassed equipment has to be documented properly. For that reason, the creation of a centralized bypass record should be envisaged.

Discussion David commented that it is not clear who should be informed and stressed that any bypass happening after the validation tests is a serious deliberate act and should be recorded. Daniel added that here it concerns a bypass on an equipment that was actuated by the BIC, so this is a worse case than what usually happen, where bypass happen on the input side of the BIC. Jan mentioned that he will investigate possible ways for such a tracking and that we can then decide who will look after it.

Action: Investigate the possibilities for tracking of bypassed equipment and propose solution to the MPP (Jan).

4. Tag at kicker level a bypassed system (physically at the equipment) as “not ready for operation”.
5. Study the possibility to implement a dynamic beam permit signal bypass mechanism within BIS2.

Discussion David commented that receiving feedback, and not just the status of a possible bypass, would be useful. Jan added that this is the role of the post-mortem.

The major event report has been edited. It was circulated on [EDMS-2593724](#) after the meeting. It will then be reported to the IEFC for approval. Bettina also added that the WIC to BIS mapping is being reviewed and an ECR is in preparation.

Commissioning procedure for SPS injection tests with new MDSH functionality (Francesco Velotti)

Francesco introduced the new failure mode discovered during the design of new controls for the new SBDS. Basically, beam could be injected in the SPS even after the dump MKD kickers have been discharged. The beam would then circulate and be accelerated without the possibility to dump it. This can happen if the MKDs fire during the 70 μ s window between the pre-pulse and the start of the MKP pulse.

Thanks to the new injection interlock put in place, the MDSH can be used to solve this issue. The MDSH will check again for the beam permit 1 ms after injection. If the beam permit is false, then the MDSH will pulse so that the beam is lost at injection.

The following commissioning procedure will be followed:

- Use a cycle with 2 injections
- Set an early dump a few μ s just before the second injection (1200 ms after the first one)
- Check that the MKP pulses (to see that the second injection is OK)
- Evaluate the MDSH current, it should pulse after about 1200 ms following the first injection

There has been a successful test of the HW (without beam) to test the new functionality. The procedure worked as expected, and it could be shown that this solves the recently discovered failure mode of the SBDS at injection.

A test with beam must still be performed, also to assess where the beam losses occur and if they match with simulations.

Discussion David commented that there are many settings in the MDSH to make this work. Actions will be taken to make validity checks on these settings.

The details of the procedure will be added to the checklist.

Update on SPS crystal interlocking (Francesco Velotti)

Francesco described the request to remove the hardware interlock that was put in place for the TECS in LSS2 (crystal devices, used before LS2 as MD device) which has a maskable BIC entry checking that the device was at its 'out' position for normal operation.

It was foreseen to "reverse" the interlock (TECS should be in beam for operation). But, as it would only check if it is not at the out switch, the device could be outside of the beam, close but not at the out switch, and the interlock would not remove the beam permit. Also, this hardware interlock does not allow to check the position and angle of the crystals. This is done via SIS.

As there is no risk to damage the ZS, it is proposed to completely remove the HW interlock and to rely only on SIS for the moment.

For the future, it should be investigated if it possible to add a HW interlock on position and angle with sufficient accuracy for smooth and safe operation.

Discussion Jan commented that this is feasible as long as there is no risk damage anything, in particular the ZS. Daniel added that the interlock which is present now does not add any safety.

It was decided that the channel can be removed from the BIC maskable inputs. This action was followed-up by Ivan. After the meeting it was realized that the TQCD.201271 is also interlocked by the same CIBU. It was then decided to keep the CIBU, following modifications so that only the TQCD.201271 and not the TECS.21602 is interlocked. The intervention has been completed and the system validated.

Summary of actions

The actions from the meeting are:

- Major event report on PSB extraction
 1. Organize a meeting between OP and the MPE SW team to define the specifications for an improved GUI (Bettina)
 2. Draft a procedure for the tracking of the bypassed equipment (Jan)