Major Event Report on PSB Extraction

B. Mikulec, E. Carlier, C. Martin

Thanks to additional input from
SY-ABT, TE-MPE and BE-OP

Introduction PSB Extraction BIC

Ch.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OUT	
Interlock Users	SIS	Destination PSB Dump	Destination ISOGPS	Destination ISOHRS	Destination PS	AQN BT.BHZ10 BDUMP/ISOLDE	AQN BT.BHZ10 PS	BTM.BHZ10 PSB Dump & ISO GPS & ISO HRS	AQN BTY.BVT101 ISOLDE	AQN BTY.BHZ301 GPS	AQN BTY.BHZ301 HRS	WIC BTM	WIC BTP	WIC BTY	PS Dump	PSB Extraction Master Beam_Permit	
Matrix Equation	1	1	0	0	0	1	0	1	0	x	x	1	x	x	x	1	Beam to Dump
	1	0	1	0	0	1	0	1	1	1	0	1	x	1	x	1	Beam to GPS
	1	0	0	1	0	1	0	1	1	0	1	1	x	1	x	1	Beam to HRS
	1	0	0	0	1	0	1	x	x	x	x	x	1	x	1	1	Beam to PS

- 4 timing inputs provide beam destination
- User inputs: main bending magnets, WIC, PS dump
- Actuator: PSB Extraction kicker (not pulsing in case of FALSE beam permit)

Event Description

On 14/04/2021 it was discovered that the ==PSB Extraction BIC was not acting as conceived== (disabling the PSB extraction kicker in case of a FALSE Beam Permit), as ==a bypass was still in place on the kicker side== (implemented to allow kicker ISTs during LS2), which was never removed 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. Unfortunately, this test ==was missing in the OP Checklist==, which underwent a complete rehaul during LS2 due to the multitude of new systems, including the full BIS deployment for the PSB. On the SY-ABT side there is no special tracking in place for installed bypasses.

==Beam operation was started with the bypass still in place==. The problem was finally discovered and solved on 14/04/2021. This event caused no equipment or other damage.

Additional Information

Tests 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 05/06/2020. Following this successful test, SY-ABT activated the bypass of the FIB (electronic card receiving the signals of the BIC) to allow SY-ABT to execute ISTs and Dry Runs before all BIC user inputs were TRUE.

- On 16/10/2020 a Dry Run took place between BE-OP and SY-ABT to validate the extraction kickers (https://logbook.cern.ch/elogbook-server/GET/showEventInLogbook/2125556). 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 (https://op-webtools.web.cern.ch/checklist/ - /machine/7/node/10915/test). It has been added since.

- 23/10 – 27/11/2020: Test of the individual user inputs of the PSB Extraction BIC following the OP Checklist for the BIS (https://op-webtools.web.cern.ch/checklist/ - /machine/7/node/12278/test). Again, the test to validate the BIC action was missing in the Checklist and has been added since.

Damage

No damage was caused by this event.

It should be noted that it was decided during LS2 to put in place in parallel to the Extraction BIC an SIS task that checks the interlock properties of the bending magnets as well as the status of the PS Dump (inputs of the Extraction BIC). Therefore, apart from the WIC **a redundant interlock was in place** and fully operational. This was done to avoid unnecessary machine activation in case of a FALSE Extraction BIC Beam Permit (not pulsing the extraction kicker results in the full beam being lost in the PSB rings), which sets the number of injected turns to zero.

In case this SIS task would not have been present, the BLMs in the extraction line would have cut the beam via the Choppers BIC, after a certain number of allowed bad pulses.

Downtime

During a health check of the WIC system (the WIC currently provides user inputs 11 WIC BTM and 12 WIC BTP of the PSB Extraction BIC), TE-MPE-MI discovered on 14/04/2021 that even with a FALSE user permit on the WIC BTP channel connected to the Extraction BIC, PS beams were produced. The WIC expert informed the BIS experts about the problem.

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 (TE-MPE with SY-ABT), it was found that a bypass was still in place at the extraction kicker level. At 15:14 on behalf of the ABT expert, the BIS expert removed the bypass. As consequence, the beam production for the PS was interrupted (no other beam clients present yet).

The reason was the fault in the user permit 12 to the PSB Extraction BIC, 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 (the BTP.DVT10 magnet has a short circuit, which cannot be repaired at the moment due to its inaccessible location). To re-establish the operation, it was necessary to bypass the status of this power converter as provided to the BIS, task done by the WIC team. 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 1h23m of total downtime for the PS.

It should be mentioned here that it is not always straight-forward for the operations team to decode a master BIC like the PSB Extraction BIC, as the matrix must be known, which in this case is dependent on the destination.

Proposed Mitigation Measures/Actions

1)

BE-OP: **Add the test of the individual BIC actions to the PSB Hardware Commissioning Checklist** → DONE (https://op-webtools.web.cern.ch/checklist/#/machine/7/node/12278/test).

Schedule by default the functional test of the beam permit signal at equipment actuator level during the Cold Checkout phase, once all client interfaces have been validated. The final test should be performed jointly by BE-OP, TE-MPE and the equipment expert and the result tracked (see 2)).

Proposed Mitigation Measures/Actions

2)

As it will remain necessary to test the PSB extraction kickers before all BIC user inputs will be TRUE (during IST and/or Hardware Commissioning periods), implement a tracking mechanism for beam permit signal bypassing at equipment actuator level and also at the user level. **For that reason, the creation of a centralized bypass record should be envisaged**.

- In general, it would be desirable that through this centralized bypass record an overview of all bypassed actuators as well as bypassed BIC user inputs during IST, HW and BC phases as well as standard operation.

Proposed Mitigation Issues/Actions

3)

SY-ABT proposes to **visually tag at kicker level a bypassed system** (physically at the equipment) as "not ready for operation" once bypassed (no remote monitoring of the bypass exists).

4)

TE-MPE: Study the possibility to implement a dynamic beam permit signal bypass mechanism within the BIS2.

Summary

➢ **Major Event Report** has been edited and should now be circulated on EDMS before approval by the IEFC

➢ **Mitigation measures** have been proposed
  ➢ Partly already implemented; the remainder to be followed up

➢ As a side-remark, the **WIC to BIS mapping** is being reviewed → ECR in preparation by BE-OP

Report on a Major Machine Protection Event

PSB OPERATION WITH BYPASSED PSB EXTRACTION BIC ACTION

Date of the Event: 20/01/2021 - 14/04/2021

Machine: PSB

Abstract

During the PSB Individual System Tests (ISTs) and the hardware commissioning (HWC) a bypass was installed in the PSB extraction kicker to allow testing of the kickers while the PSB Extraction BIC Beam Permit was still FALSE, as a FALSE Beam Permit of this BIC disables the kick of the PSB extraction kickers. This bypass was still in place during operation with beam.

Prepared by:	To be checked by:	To be approved by:
B. Mikulec BE-OP E. Carlier SY-ABT C. Martin TE-MPE	A. Akroh, A. Antoine, C. Chanavat, F. Chapuis, L. Felsberger, G.P. Di Giovanni, N. Magnin, C. Martin, A. Miranda Fontan, R. Mompo, A. Newborough, J. Uythoven, C. Wiesner, D. Wollmann	Daniel Wollmann (for the MPP) B. Goddard (for the IEFC) M. Meddahi (for the IEFC)