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PSB operation procedure for injection into less than 4 rings

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Introduction

- Update from MPP 11/10/2019 (https://indico.cern.ch/event/852948/)
- Linac4/PSB BIS action cannot remove beam for individual rings
  - Full beam pulse is always cut with Chopper/Pre-chopper
- Failure and risk analysis (https://edms.cern.ch/document/1715266) has identified some ring-specific equipment failures that could lead to longer beam down-time (>half a day)
  - Modified BIS layout implemented allowing to mask such PSB injection equipment:
    - Painting kickers (BIr.KSW; r=1…4)
    - Chicane bumpers (BIr.BSW; r=1…4)
    - Injection foil system
    - In general, failures requiring pump-down of the injection region 1L1

PSB Injection BIS Layout – PSB-1…-4 BICs

Ch.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OUT
Interlock Users	SIS	BI WD	PSB Injection WD	H^0/H^- Current Monitor	Distributor	BLMs in BI line & in PSB Injection	BI.SMV	*Not used*	BI1.KSW	BI1.BSW	Injection Foil Status #1	SF Vacuum Valves#1	*Not used*	*Not used*	*Not used*	PSB_1 OK Slavve BIC Beam_Permit
	1	1	1	1	1	1	1	x	1	1	1	1	x	x	x	1

Figure 12 : Truth table of the 'PSB-1' Slave BIC

Ch.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OUT
Interlock Users	SIS	H^0/H^- Dumps OK	Head & Tail Dump OK	WIC BI line	WIC PSB Mains	WIC PSB Aux#1	WIC PSB Aux#2	WIC PSB Aux#3	BI2.KSW	BI2.BSW	Injection Foil Status #2	SF Vacuum Valves#2	*Not used*	*Not used*	*Not used*	PSB_2 OK Slavve BIC Beam_Permit
	1	1	1	1	1	1	1	1	1	1	1	1	x	x	x	1

Figure 13 : Truth table of the 'PSB-2' Slave BIC.

Ch.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OUT
Interlock Users	SIS	PSB RF Global	BLMs in PSB extraction & transfer lines	POPS-B Status	BE.SMH15L1	BI + BR + BT Vacuum Valves	WIC BE + BT lines	*Not used*	BI3.KSW	BI3.BSW	Injection Foil Status #3	SF Vacuum Valves#3	BE.BSW Status	*Not used*	*Not used*	PSB_3 OK Slavve BIC Beam_Permit
	1	1	1	1	1	1	1	x	1	1	1	1	1	x	x	1

Figure 14 : Truth table of the 'PSB-3' Slave BIC.

Ch.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	OUT
Interlock Users	SIS	BLM IC Ring 1 & 2	BLM IC Ring 3 & 4	BLM FIC Ring 1 & 2	BLM FIC Ring 3 & 4	*Not used*	*Not used*	*Not used*	BI4.KSW	BI4.BSW	Injection Foil Status #4	SF Vacuum Valves#4	*Not used*	*Not used*	*Not used*	PSB_4 OK Slavve BIC Beam_Permit
	1	1	1	1	1	X	X	X	1	1	1	1	x	x	x	1

Figure 15 : Truth table of the 'PSB-4' Slave BIC.

Procedure (https://edms.cern.ch/document/2380281)

Pre-requisite to operate with less than 4 rings: written go-ahead from rMPP (mailto:inj-mp-restricted@cern.ch)

1) Insert the L4T beam stopper
2) Set the number of injected turns to zero for the affected ring(s)
   - Four new External Conditions (I_B.RINGr with r=1…4; push-buttons in CCC) → will set the timing BIrX.NT0-EC with r=1…4 → beam length of the affected ring forced to zero
   - Ensures that even if new cycles are mapped (independent of number of turn setting), beam into the affected ring will be removed by Chopper/Pre-chopper
3) Mask failing equipment is now allowed
   - Masked channels will be shown as warning in LASER as well as in PSB elogbook at each start of shift (under implementation)
   - TE-MPE will implement RBAC protection for all maskable user_input channels for these four PSB BICs (PSB supervisor egroup)

The beam stoppers can be removed at this point.

Additional Protection for Vacuum Valves

For certain failure scenarios it will be necessary to close the vacuum valves around sector 1L1 and mask their BIC user_input in addition:

- When vacuum pump-down is needed after an intervention (limited gain in operational uptime)
- In case of a leak in the 1L1 vacuum sector waiting for repair (expected to be a rare event)

Additional protection:

- 2 additional BLMs have been installed just downstream of BIr.VVS20 (r=1…4), one covering the upper rings and another one the lower rings. The threshold of these BLMs must be set correctly during beam commissioning, and the number of allowed bad shots fixed to 1 (the valves would theoretically sustain several direct beam impacts up to ~40). The BLM user_input is not maskable.
- In addition, SIS will monitor the status of the vacuum valves that enclose the vacuum sector around 1L1. In case the status of a valve in ring r differs from 'OPEN', SIS sets the timing BIr.NT0-SIS, meaning that the pulse length for this ring is forced to zero (redundancy for BIrX.NT0-EC in case somebody would by mistake disable the CCC EC button).

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PROCEDURE

PSB: injection into less than four rings

ABSTRACT:

Pre-LS2 it was possible to operate the PSB with less than four rings in case of failure of ring-specific equipment installed in the Booster injection region. During LS2, the Beam Interlock System (BIS) was deployed for the PSB. Along with its chosen design for the PSB injection certain limitations were introduced, and this procedure describes how to operate the PSB with less than four rings post LS2 in case of certain failure scenarios of injection equipment.

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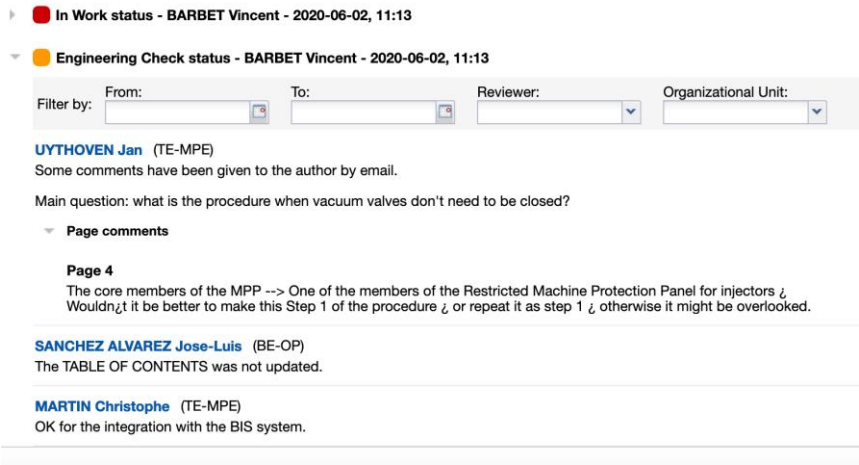

All comments have been addressed in revised version.

Can it be approved?