
Disabling Rules

E.B. Holzer for the threshold WG

Summary

- Background information
 - Aim for changing the existing disabling rules
 - Rules already approved
 - New rules proposed
 - Summary of new rules
-
- Appendix:
 - Rules for inner triplets

Background Information

- If a BLM channel is not working properly:
 - the internal sanity checks of the BLM system fail and the LHC cannot operate. This is also the case for monitors which are not connected to BIS including the dump line monitors, as all channel connections and monitor types declared in the LSA database are verified by the sanity checks.
 - E.g. if a channel has declared the “cable connected” flag = FALSE in the DB, but actually a monitor is connected on the channel → the BLM connectivity check will fail and LHC operation is not possible
- ***In case of hardware failure, it is always the default action to repair the fault.***
- But in rare cases where this is not possible to repair within a reasonable timescale, individual channels can be disabled according to MPP approved set of rules.
 - At certain locations, access to the monitor and/or to part of the analogue cabling is not always possible e.g. for safety reasons or because it would require a long cooldown
 - The rules make use of the fact that many BLM channels have shown sufficient redundancy
- “disabling” of a monitor (in this context) means to:
 - **Physically disconnect** the input from the analogue readout electronics
 - Action performed by BLM hardware piquet
 - Measurement and protection functionality disabled!
 - Set the “cable connected” **flag in the LSA database** to false
 - currently performed by two BLM threshold experts
- A flag in the LSA DB gives the applicable disabling rule for each monitor and the application of the rule is encoded in the DB (not active at the moment!).

Aim

- In 2013 and in February **2015** new Run2 disabling rules for LHC BLM were decided by MPP. Three groups of monitors have been defined:
 - “**not to be disabled**” – no procedure defined in case a failure cannot be repaired
 - A **case-by-case** monitor requires two BLM experts + rMPP representative (2018: + concerned equipment representative) + BLM hardware piquet → time consuming decision and procedure
 - Application of “**pre-set**” rule requires only BLM experts. The rMPP is to be informed immediately of the disabling, but an approval by rMPP is not required.
 - 2 BLM threshold experts + BLM hardware piquet
- 2018 proposal:
 - Remove category of “not to be disabled” enforced by LSA DB
 - Create additional “pre-set” rules for monitors not previously covered and remain with as few as possible case-by-case locations
 - Open up existing rules if they are too tight
- Longer term goal:
 - “**pre-set**” rules: Change LSA DB implementation and remove the two BLM threshold experts from the procedure (no piquet service) as safety will be ensured by LSA DB → In case repair is not possible, rMPP responsible can authorise the BLM hardware piquet to disable a monitor.
 - Not ready for 2018 start-up!

Rules decided 2013 and Feb 2015

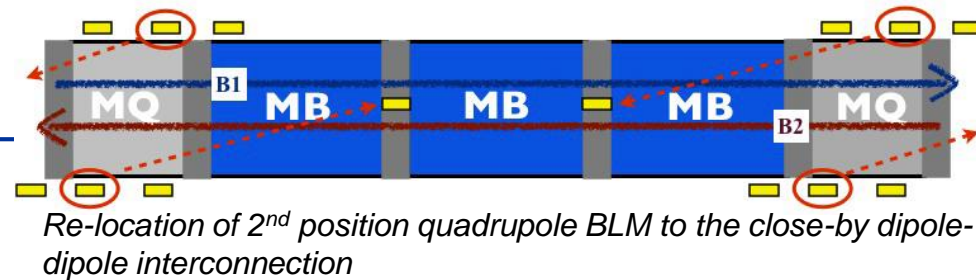
- Pre-set-Rules decided Feb 2015
 - Inner triplet ✓
 - Arc ✓
 - LSS quadrupoles ✓
 - Ion (partly)
- Not allowed to disable:
 - LS3, LS7, all DS, all collimators and movable absorbers
- All others: case-by-case

New Rules

New Rules

- No monitor in a _CRIT family shall be disabled.
 - when monitors are moved to _CRIT family, the disabling flag has to be changed at the same time
- Locations of CRIT monitors in October 2017: Q10, ULO location (15R8), 16L2 (until success of partial warm-up YETS 2017/2018 is confirmed with beam)
- Monitors not connected to BIS can be disabled with the exception of monitors labelled critical for injection or extraction quality verification
- No more monitors where DB does not allow disabling
- For all case-by-case monitors the equipment specialist has to agree to a monitor disabling (on top of rMPP and BLM experts):
 - Magnets and circuits, injection, extraction, collimation, ions, experiments, BI, RF
- Implementation:
 - Only one set of rules can be implemented in LSA DB, active for ions and protons → need to implement the stricter rule

Extend Arc rule to DS



- **ARC:** Four ICs are installed around each quadrupole magnet, two for each beam. At each dipole-dipole interconnect, one IC is installed on top of the interconnect. It reads losses from both beams equally.
- **DS:** BLM system considers Q7 as part of the DS: including Q7 up to Q11
 - 2-3 BLMs per beam per quad
 - 1 dipole-dipole BLM in half-cells 8 till 11 and 1 dipole-missing dipole monitor in half cell 11
- **Rules for ARC and DS:**
 - A minimum of 1 monitor per beam per quadrupole magnet has to stay operational (P1, P2 or P3). If a quadrupole IC in P1 or P3 was disabled in the half cell n, the corresponding (P1 or P3 respectively) in both the half cells n-2, n+2 shall remain operational.
 - One dipole-dipole (or dipole-missing dipole) BLM per half-cell can be disabled if all neighboring quads have at least 2 BLMs per beam (no matter in which position).
- **Justification for extending this rule from the ARC to the DS:**
 - Dispersive losses from collimation leakage from IR7 are always spread over half-cells 9 and 11, which are horizontally focussing and have a dispersion maximum. The n+/- 2 rule ensures that at least one of these loss locations is covered. **The same should be checked for IP3 dispersive losses at the start of the ramp.**
 - For the experiments, the machine setup and validation will assure that standard luminosity losses will not quench magnets. This is ensured by an appropriate setup of the collimation system. The same is true for ion operation.
 - Damage protection is assured with this rules. Quench protection is not necessarily assured (but this is already the case with the opened thresholds to reduce the number of UFO dumps).

Individually powered cold quadrupoles Q4-Q6

- *LSS-Q Applicable monitors:*
- BLMs at cold LSS quadrupoles excluding the triplets and up to and including Q6 in all LSS. This rule also includes the cold quadrupoles Q6 in the collimation regions IR3 and IR7. Excluded are, however, the warm quadrupoles in IR3 and IR7.
- *Rule:*
 - At least 2 monitors per beam shall remain operational on each cold LSS quadrupole.
- NEW is that this rule also includes the cold Q6 in IR3 and IR7

Extra monitor in the DS

Installed **horizontally** in the DS (or the arc) at different times either:

1. For dispersive losses (start-up) only (DIS)
2. For ions losses (start-up or LS1) only (ION)
 1. Now part of special ion family
 2. Not part of special ion threshold family
3. For both reasons

These monitors are installed along the dipole magnets or the empty cryostat on the inside (DIS) or on the inside or outside (ION) of the LHC ring.

- **Rule:**

- One monitor per half-cell can be disabled during proton or ion run.

Collimators, movable or intercepting devices, masks

- IP7 and IP3
 - High redundancy of monitors and access problematic (radiation)
 - But it is too difficult to pre-define disabling rules for these collimators (regions). Any disabling would require a **case-by-case** decision.
- Monitors on collimators and other movable or intercepting devices outside of IP3 and IP7 **shall not be disabled**:
 - TCL, TCT, wire scanner, BGV, roman pots
 - Not foreseen that the DB enforces that these monitors cannot be disabled! – But give them a separate flag to highlight the criticality.
 - Disabling would be ok if movement (gas injection) is safely blocked by other means.
- Monitors at masks
 - outside of beam pipe but named TCXXX
 - **shall not be disabled OR case-by-case?**

Summary

- Remove LSA DB category where DB prevents disabling
 - Use case-by-case (or “pre-set”) rule instead
 - But include the equipment expert in all decisions
- Longer term plan is to disable “pre-set rule” monitors by BLM hardware pique on request of the rMPP representative
 - 2 persons involved which are guaranteed available 24/7
 - Equipment specialist and BLM threshold experts to be informed immediately, but no agreement from them is required
- Arc rule extended to DS
- IR3 and IR7 MQ6 included in “pre-set” rule
- New “pre-set” rule for additional DS horizontal monitors
- List of critical monitors for injection and extraction
 - Case-by-case
 - All measurement monitors not on these two lists can be disabled

Appendix

Inner Triplet Rules (approved 2015)

- **LSS-Triplet.** On the inner triplet magnets, the BLMs are divided into two groups for the purpose of the disabling rules:
- In group 1 (yellow in the picture) are 4 position 3 monitors (out of a total of 6 position 3 monitors) per IP side. They are less relevant for protection against beam losses, as they integrate a high signal from collision debris. All 3 position 3 monitors of the outgoing beam are in this group, together with the innermost (towards the IP) position 3 monitor of the ingoing beam (see Figure 1).
 - 2 out of these 4 monitors per IP side can be disabled in group 1.
- In group 2 are all other monitors: 3 or 4 monitors per magnet, which integrate less collision debris signal, and hence are relevant for protection. This group holds 14 monitors per IP side.
 - 1 out of the 3 or 4 monitors per magnet can be disabled in group 2; but only a maximum of 2 monitors per IP side.

