221st Meeting of the Machine Protection Panel

LHC topics

March 25th, 2022, via Zoom

Participants:

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The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico (221st meeting).

Minutes and actions from the 220th meeting (LHC topics)

The minutes of the 220th MPP meeting have been circulated and have been approved. Daniel recalled the actions.

BLM thresholds change for Run III (Belen Salvachua)

Belen introduced the presentation of the BLM thresholds changes for Run III.
A summary had been presented at the LHC Operations Workshop (Evian 2021).

Changes in Layout and InforEAM affecting LSA BLM settings

Belen informed that these changes do not affect the BLM thresholds and the functionality stays as in Run2, and thus no ECR has been prepared. The BLM hardware information is synchronized "on-demand" from the Layout Database to LSA. Due to some modification of the information between Layout and InforEAM, the database code for this synchronization was updated.

Correction of BLM LSA database bug on history triggers (LHC-BLM-ECR-0071)

This bug concerns the history data of BLM threshold attributes. It was found in December 2021 to be incomplete. The BLM threshold attributes contain all necessary parameters, configuration function and corrections in order to build the final set of threshold values. These parameters are stored and tracked in LSA and are used to generate the thresholds. The final tables contain

the threshold values for the 12 running sums and for 32 energy levels. These are the final values sent to the hardware (the master thresholds). Every time there is a change on the threshold parameters, history tables are built automatically. It was found the field "CONFIG_VALUE" was not tracked correctly. It contains a configuration value for different parameter names.

In the summer of 2021, the thresholds and attributes for all the families had to be recovered from history. With this action, the information on "CONFIG_VALUE" was not propagated and thresholds could not be re-calculated, however the final values were present as they were also stored in the history. The issue was not identified at the time as the master thresholds were present in history for existing BLM families. For the pilot run in 2021 the master thresholds, for existing families and thus using existing data, were validated, and compared with the logged values of Run II.

However, when creating a new family, or updating the parameters, the master thresholds need to be re-calculated.

A solution has been implemented to recover the missing data. All the history triggers were checked to identify possible other missing fields. Two more were identified and corrected. The history triggers were corrected by regenerating them. The "CONFIG_VALUE" was recovered for all BLM families. A copy of pre-LS2 data was used in addition to the LS2 snapshot in LSA. The correctness of the recovered data was verified. The calculation was re-triggered for all affected families and the master thresholds were compared with the expected values. This has been presented at the 89th BLM thresholds WG where additional issues were discovered. The discrepancies have been described in the ECR.

After recovering the "CONFIG_VALUE" some families showed different BLM thresholds than the ones used in the pre-LS2 tables. Two types of issues were found:

- The re-calculation procedure failed due to the absence of "CONFIG_VALUE" in pre-LS2 data: affected two families without BLMs and three families with BLMs. The latter were all connected to the BIS. For the five families the pre-LS2 thresholds were recovered, the thresholds exist but no modification is possible as the "CONFIG_VALUE" parameters are not and were never present in the database.
- The re-calculated procedure succeeded but difference with pre-LS2 data was found. Three types of error were found: (i) deprecated families from Run I not removed from the database (ignored and to be removed from the database), (ii) differences below 0.001% between pre- and post-LS2 thresholds (differences accepted), and (iii) large differences on RS06 that could be corrected to below 10% (see below).

The last issue concerns only two families: "THRI_DFB", containing one BLM in 5R6, and "THRI_LEIR" with no BLM. When recalculated, it was found that RS06 was equal to RS05 while in the pre-LS2 data they were indeed different. To fix this, corrections were applied to recover the correct values for RS06.

Belen concluded that with these modifications, all the families that were in operational use during Run II have been recovered.

LHC BLM Threshold Model for collimators in IR7 (LHC-BLM-ECR-0072)

These change concern the update of the thresholds model for the BLM associated with collimators in IR7. The main idea is to treat the collimation system in IR7 as a whole, instead

of considering individual collimators, taking into account the showers building up downstream of the collimators. The damage limit values have been updated for Run III: the maximum power loss is now kept constant over different beam energies and the equivalent number of protons is calculated. The new response factors are calculated for each family from measured loss maps from Run II as the expected BLM signal per proton lost in the collimation system. All the families have been checked with Run II data.

A FLUKA validation of the total power on the jaw and peak power on the coating has been performed assuming direct proton impacts on a stand-alone TCSPM for different impact angles and geometries. The RS09/10 presents the worst case. The results served as input for the thermo-mechanical simulations done for the 0 µm and 200 µm jaw tilts. Two types of failures were identified: the carburization of the coating (because of the maximum temperature) leading to a loss of electrical conductivity and the structural failure of the coating interface (due to the maximum temperature but also to the temperature difference) leading to the coating peel-off. None of the possible failures seem to be an issue, however, safety factors should be considered until more experimental data are available regarding the peel-off.

The new thresholds were validated with data from Run II. The thresholds for the new families were extracted and the ratio between measured BLM signals and the new thresholds was calculated. The results show that 11 fills would have been dumped using the new thresholds. These were actually dumped due to 16L2 losses in IR7. Excluding these 11 fills, most of the fills have losses below 30% of the limits. The losses during the ramp were also checked for one random fill of 2018 for which they remained below 40% of the limit.

Question Jan asked about the collimator overheating issue and asked if the temperature is monitored with PT100 sensors. Belen confirmed that a temperature measurement is in place. Daniel commented that these are installed in case of issues with the water cooling. The overheating of the coating cannot be protected against with the temperature sensors.

LHC BLM threshold changes on magnets (LHC-BLM-ECR-0073)

These thresholds were revised during LS1. Run II experience shows that most assumptions and parameters were accurate, and no major revision is foreseen for Run III. Only the "Q2B" scenario, involving losses in the triplets other than collision debris, might need some revision. Some ad-hoc corrections (mainly at flat-top) need to be revised due to the higher beam energy. Those will be monitored and adapted during the intensity ramp-up. The BLM thresholds strategy for UFOs has been reviewed, keeping the same approach but decreasing the thresholds for magnets affected by non-conformities. The 15R8 (ULO) and 16L2 thresholds have been reverted.

UFOs are expected to remain the dominant source of fast losses in the arcs and dispersion suppressors. Run II experience showed that the best machine performance (integrated luminosity) can be achieved if UFO-induced dumps are avoided while quenches are tolerated. The thresholds have been maintained at 3 times the quench level in 2016-2018.

It is proposed to keep the 2016-2018 arcs and DS BLM threshold strategy for Run III. Any quench poses a risk (0.2%) that a sector needs a warm-up. This risk is considered acceptable for UFOs as the number of UFO-induced quenches will remain small compared to the number of quenches during the training campaign.

Nevertheless, it is proposed to reduce the thresholds at a selection of magnets presenting non-conformities: 1 dipole and 1 quadrupole with a missing quench heater, 10 quadrupoles bypass diodes having under-dimensioned venting holes, 24 dipoles whose bypass diodes might be affected by reduced helium venting.

It is proposed to keep reduced threshold settings for all Q10 magnets of MQM type to limit the risk of symmetric quenches.

All the threshold changes for cold arc and dispersion suppressor magnets for Run III have been summarized in an ECR.

Thresholds in the injection regions

New transfer line collimators have been installed during LS2 and some collimator locations have changed in TI8. This can affect the cross-talk with machine BLMs. The BLM thresholds in the injection regions will be revised with measurements during Run III. Filters have been proactively reinstalled for BLMs on top of the QBBI interconnects (cells 8/9 left of IR2) which represented the main bottleneck in 2017-2018. Additional filters might be needed for B1 BLMs on Q7/Q8 right of IR8 due to the new transfer line collimator position changes.

The same thresholds as for Run II will be kept for the new TDI(S), but a revision might be required following measurements during Run III.

Status of threshold tools

The thresholds GUI has been updated with multiple improvements on the displays, thresholds curves, changes, etc. One important change concerns the change of master thresholds: only 1 signature with MCS-role is now needed to update them. A second person should be observer and both names must be mentioned in the JIRA issue. The GUI creates a JIRA issue automatically when a commit to the database is performed.

BLMTWG representatives and signatory list

The list of the new representatives has been agreed upon and is available in the slides.

Discussion

Daniel commented on the amount of work performed during LS2 and added that it is positive to see the changes on the models come to life.

Belen added that the response factors for the collimator BLMs will be checked with a loss map during start-up. Anton added that the TCLs and TCTs thresholds will be revised during the run in a similar way as what has been done for IR7.

Anton commented on the blindable BLMs in the injection region and whether this feature is needed. Belen commented that this will be commissioned and will possibly be made operational during the next YETS, unless it is required earlier. Christos added that issues are observed with the firmware and that more information will be available shortly. This will allow to decide if this can be included this year.

Christophe mentioned that an action from the MPP workshop was to check the coherence between the BLM threshold and the Beam Condition Monitor (BCM) thresholds of the experiments. Anton replied that this has not been discussed with the experiments and added that the experiments need very low thresholds for protection reasons.

Greg asked if the LSA bug was present during the whole of Run II or if it had been introduced at the beginning of LS2. Belen replied that it was present during Run II. Christos added that the "config value" parameter was added during LS1.

Greg asked who maintains the thresholds GUI. Belen replied that it is currently maintained by the BI software team. Belen added that the discussions on changing the GUI technology will take place with the Controls team but that is not foreseen to be implemented during Run III.

Daniel asked what the next steps are. Belen replied that the changes concerning the collimators are already in place and that magnet changes will take place next week. The correction of the bug is already implemented.

Daniel summarized that the MPP supports these changes and commented that they are coherent with prior changes.

AOBs

M. Deile mentioned the validation of the roman pots in IR5. The machine-mode tests will take place next week. All other interlock tests are complete.

The RP system is not yet complete and ready for data tacking. Damage happened to a detector. One detector package had to be removed and is now in test with beam. It will require access to go back in the pot. Also, the diamond timing detector was not delivered on time and is also missing. This does not concern the movement system and should therefore be transparent for the interlock functionalities. However, a very quick user permit revalidation would be performed after any re-installation that would happen.

Daniel asked if this would happen before the intensity ramp-up. Mario confirmed.

Daniel mentioned that it should be envisaged to condense the tests related to the roman pots system in a re-commissioning procedure. The above-mentioned point could then be included in the procedure. Mario replied that this is difficult to foresee with the current level of resources. Daniel answered that we will follow-up this topic after the commissioning.

Summary of actions

No action was identified.