130th Meeting of the Machine Protection Panel

Participants: B. Dehning, M. Deile, R. Denz, E.B. Holzer, M. Kalliokoski, D. Lazic, A. Lechner, Y. Nie, E. Papotti, M. Valette, A. Verweij, G. Willening, D. Wollmann, M. Zerlauth.

The slides of all presentations can be found on the website of the Machine Protection Panel:
http://lhc-mpwg.web.cern.ch/lhc-mpwg/

1.1 Approval of MPP#128 and MPP#129's minutes

- Actions from 128th MPP:
  - Collimation, Stefano: prepare a list with loss maps required after the XRP intervention. From that the machine coordinators can derive a list of required fills.
- Actions from 129th MPP:
  - E. Metral: Make a proposal for the test at injection and at flat top, mentioning how many bunches will be excited and with which amplitude.
  - D. Valuch, R. Tomas: Make a proposal for the maximum excitation windows length and amplitude.
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 Symmetric quench protection of IPQs part 2 (MQMs) and consequences for BLM thresholds (G. Willering)

- Reporting for the MP3, a draft version of the recommendation was uploaded to EDMS. This recommendation is proposing changes to QPS thresholds and the BLM thresholds of the concerned magnets.
- Most of the magnet protection strategy is based on detecting asymmetric quenches by performing a differential comparison between both apertures/coil-parts to eliminate the inductive component of the measured voltage.
- Symmetric quenches are supposed to happen on both coils in the same aperture and cold-mass, detection could be delayed for these cases, especially for the individually powered quadrupoles (IPQs). A fully symmetric quench is not detectable with the current quench protection system in the IPQs with only one magnet in the cold mass.
- For the IPQ, in case of a single cold mass, two poles are compared with two other poles.
  - Markus asked for more details on which pole is compared to which.
  - R. Denz answered it that this depends on the magnet type. Inside the magnets the connexion is really complex, we have to look things up

for each of the 78 IPQ magnets, and the primary goal in any case is to cancel inductive voltage.

- There are overall 4 different families of IPQ magnets for protection against symmetric quenches:
  - For the magnets with two cold masses, things are easy, we can compare a pole from each cold mass, and since they are physically far away symmetry in quenches is not expected.
    - Anton added there is no different family of BLMs for these magnets.
  - For the case of the MQY and the MQM at 4.5K and powered with 4kA, good level protection can be reached.
  - The 4th and last case, the MQM at 1.9K and powered with 5kA, is the trickiest one.
- Studying expected hotspot temperature allows deriving the delay margin in milliseconds between the start of the quench and damage.
- To avoid damaging the magnet, a limit of 400K for the hot-spot is assumed.
- The lowest margin is found for the type 4 magnets (MQM, 1.9K, 5kA).
- This then allows deriving a voltage threshold setting for asymmetric quench protection.
  - Arjan commented these thresholds have to be divided by two in case of a symmetric quench.
- If the threshold is set to 14mV, it can allow a 1.2V voltage for a 400K hotspot, thus protecting to a 97% symmetry level.
- For case 4, one can only protect up to 67% symmetry level, which is considered to be insufficient, a tighter BLM threshold is therefore needed.
- The reason for this limit is the level of the QPS noise, reaching around 40mV for RQ4.L5. RQ10 is critical for noise mainly during electrical perturbations and fast power aborts in the neighbouring main circuits, therefore the discrimination time has been increased from 10ms to 20ms for RQ9 and RQ10.
- The recommendations from MP3:
  - No changes for case 1 magnets, no need for tighter BLM settings.
  - For case 2 no reason to increase threshold, can be left as it is if no trips are observed.
  - Case3 is not the most critical.
  - For case 4 magnets like Q7 and Q8, reduce threshold to 50mV, no need for tighter BLM threshold.
  - For other case 4 magnets: for RQ10 magnets, it is not possible to lower the threshold because of the noise. The BLM thresholds have to be tighter (reduced below quench limit) to avoid beam induced symmetric quenches as far as possible.
    - R. Denz commented that before LS1, the threshold was 100mV, but it was optimised and we now have a separated protection for the busbar and the magnet.
- The recommendation is in draft and will be released in EDMS next week.
  - Daniel commented it is not completely clear which pole is connected to what, as it is a small number of magnets, we might reduce the

number of critical magnets if we find out which pole is compared to which pole.
    - Anton answered that if the beam is in the centre of the magnet in a straight section, the heat deposition in case of losses is the same in every direction, the biggest worry here is an UFO in the LSS.
    - Gerard added that it takes about 20s for the quench to propagate to a neighbouring magnet during a fast power abort, the current by then already decreased down to 2.5kA and the sensitivity to symmetric quench is increased.

1.3 AOB - Increase of BLM thresholds to reduce the number of UFO dumps in matching sections (A. Lechner)

- BLM thresholds at the IPQs started to become a bottlenecks for UFO dumps in early 2016. We need higher thresholds for availability and take into account the low sensitivity to symmetric quenches in RQ10.
- There were 18 BLM dumps and 3 quenches last year, mostly in the arcs. In 2016, 5 dumps for 2 quenches, mostly in LSS.
    - Daniel asked if this is due to the change of threshold.
    - Anton answered the rate of UFOs is actually lower this year.
    - Daniel added we benefited from some cleaning.
- Dumps were caused by different families in the LSS, some could have been avoided.
- An example was given with one dump of fill #5018 which reached 226% of threshold on TCDS without quenching the magnet. The thresholds are really conservative now as the MF was changed to 0.1 as a temporary measure against symmetric quenches (while it was increased to 0.33 at the end of 2015).
- IPQs have three BLMs, the position 3 monitors are set to the electronic limit.
- The proposal from the BLMTWG: increase monitor factor to 0.333 for the position 1 and position 2 monitors (we would leave the BLMs with higher monitor factor for other reasons unchanged) and set the position 3 ones to 1.
    - Anton commented he doesn't see a reason to put non-physical thresholds. It was agreed to scale the position 2 thresholds to position 3 monitors (change to be applied in a second phase).
    - Daniel asked how urgent this is, because the intensity will not increase soon.
    - Anton answered one can't exclude a dump because of an UFO.
    - E.B. Holzer said two weeks should be fine.
- MP3 confirmed that there is no need for a special family for the Q4L/R5, the thresholds can remain as they are.
- The MBX (D1 magnet) is still a point to be discussed because the threshold was not increased last year. Do we still want to keep it low there?
    - Gerard commented that it was needed to protect against symmetric quenches
    - Arjan answered there is quite a bit of margin.

- About the Q10 magnet: Arjan and Daniel summarized the low temperature, high currents and noise level on the quench detection cabling make it a critical situation.
- To protect against UFOs in these locations, one could apply the same BLM threshold strategy as for the ULO.
- The BLMTG recommends going back to the 2015 settings, without the 2016 UFO correction-increase, to a monitor factor of 0.15
    - Arjan commented that a MF of 0.33 is supposed to represent the quench level of the magnet.
    - Anton answered that for the MB we reach the threshold every time there is a quench, but there is more margin on the MQ.
- A special family can be created for the Q10 MQM with a 0.15 monitor factor.
- In conclusion, with the new family we would have avoided one unnecessary UFO dump already.
- Increasing monitor factor for IPQ will emphasize other threshold bottlenecks (TCT, TCL, XRP) which will be discussed later:
    - MPP asked for TOTEM to make a comment.
    - Mario answered he has no basis yet to make a statement.
    - Daniel clarified the current thresholds are set for the protection of the RP devices but not for downstream magnets.
    - Mario added TOTEM doesn't have the manpower to study this.
    - Daniel concluded one of the MP or FLUKA teams could study it.
    - Anton added that the FLUKA model is already there, AFLA already requested an increase of the thresholds for the running sums of their BLMs.
- In a few weeks, a talk on UFOs is foreseen in the LMC. A discussion on other threshold bottlenecks could take place then.
    - Anton said the UFO rates are going down and we hardly have any large events, therefore we still should have a bit of margin.
    - Arjan commented that protection comes first and availability comes second.
    - Daniel concluded that without objections, we go for this proposal. A final decision for P3 monitors will be taken later.

AOB - all

- No AOB, next meeting on the 22nd of July.