183rd Meeting of the Machine Protection Panel

The meeting took place on **October 18th 2019** in 774/1-079.
Participants: Andy BUTTERWORTH (BE-RF), Marek GASIOR (BE-BI), Rhodri JONES (BE-BI), Thibaut LEFEVRE (BE-BI), Tom LEVENS (BE-BI), Belen SALVACHUA FERRANDO (BE-BI), Raffaello SECONDO (TE-MPE), Jan UYTHOVEN (TE-MPE), Jorg WENNINGER (BE-OP), Christoph WIESNER (TE-MPE), Daniel WOLLMANN (TE-MPE), Markus ZERLAUTH (TE-MPE)

The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico.

1.1 Minutes from the 181th MPP meetings

- No comments on the minutes of the last MPP meeting on LHC topics (181st MPP) have been received. Three of the four pending actions from the meeting have already been closed. The remaining open action will be added to the MPP homepage.

1.2 BCCM status, thresholds and PM (Marek Gasior)

- Marek presented the **status of the new development for a Beam Current Change Monitor (BCCM)** for the LHC. A new system based on button pickups and the DOROS electronic was designed from scratch.
- The system shows a **very promising performance**, in particular the specified one-turn sensitivity of 3e11 lost protons was achieved with ample margin.
- The system was already successfully tested with beam, but the interlock functionality remains to be validated.
- To complete the FPGA code and the FESA software, the functional specifications should be finalized.
- Marek explained the analog (Slides: 3-8) and digital (Slides: 9-13) **signal processing chains**. After low-pass filtering and amplification of the BPM sum signal, the system calculates the sample difference on a turn-by-turn basis using a 40 MHz sampling rate, thus, achieving a high precision for the relative change of the signal.
    - For better reproducibility, the signal processing is synchronised to the beam upon injection.
    - The required 40 MHz signal is derived from the 400 MHz RF signal. A missing RF-signal input would therefore be the sole dependency to trigger a beam dump.
- After subtracting the DC offset without beam, the absolute loss values are calculated from the differential signal by using a single **calibration coefficient**. This calibration coefficient has to be derived from the measurement of the Fast Beam Current Transformer (FBCT).
    - Answering a question from Markus, Marek explained that a single factor would be sufficient for cross-calibration with the FBCT because the signal behaves sufficiently linearly with the bunch intensity.

    - Jan asked how often the calibration coefficient would have to be adapted. Marek replied that, in principle, it should be fixed at the beginning of the run, but automatic checks are foreseen to monitor it during the run. Rhodri added that one can maintain the same calibration coefficient until a certain discrepancy with respect to the FBCT is exceeded, and then decide to recalibrate. Jorg reminded that an accuracy of ~10% in absolute losses would be sufficient for the given purpose.
    - Thibaut asked why the DC BCT is not used for the calibration. Marek replied that this indeed an option, but that all three devices should give coherent values. However, the BCCM depends on bunched beam and uncaptured beam will not be measured by the BCCM.
    - Daniel asked if the calibration requires the full beam since we will operate with reduced intensity during commissioning. Marek replied that one could initially calibrate with a reduced number of bunches. Jorg commented that the scrubbing run could be used for calibration.
    - Marek remarked that the intensity measurement is sensitive to the bunch length, resulting in up to 5% deviation due to different bunch lengths. Therefore, the worst case (highest losses within error bars) is assumed.
- The **system sensitivity** can be significantly improved by up to ~300% if multiples of 20 ms are used as integration windows to average out mains interference. Therefore, it was recommended to change the two longest integration windows from 256 turns to 225 turns, and from 1024 turns to 1125 turns.
    - Daniel asked if this behaviour is consistently observed across different data sets. Marek replied that it was checked for the different beam modes during an entire fill, and that he expects it to be a general feature.
- The system specifications are simplified by reducing the required **beam energy ranges** from previously four to two (below or above 0.5 TeV). The energy information is received from the LHC timing system and directly decoded in the FPGA of the system. Once the energy threshold of 0.5 TeV is crossed, the system locks on the high-energy thresholds and stops monitoring the beam energy until it is reinitialised after the ramp-down. In case of missing energy information, the high-energy loss limits are used.
- The **logged BCCM data** will include ~70 variables per system, plus the standard logging data of the DOROS front-ends.
- Data buffers with different integration windows will be sent to the **post-mortem (PM)** system after each dump, using a similar approach as for the present BLM system.
    - Jan suggested to automatically check in the Post Mortem after every dump that the systems triggered as expected. Markus replied that the test could be included in the BIS IPOC module.
    - It was discussed how many data points should be sent to PM. Jorg proposed to use the same buffer length of 16000 data points for each integration window to simplify the data structure. Thibaut and Belen emphasised that the data would also be relevant for an on-demand PM.
- Markus asked how the loss thresholds can be changed. Tom replied that the values are embedded directly in the code. Markus suggested to store them instead as

machine-critical settings so that they can be adapted during the run, which would increase the flexibility and usefulness of the system.

- Replying to a question from Rhodri, Marek clarified that the expected noise level is 10 times smaller than the specified loss level of 3e11 charges so that no false dumps are expected.
- Markus asked if measurement artefacts are expected during the injection process. Marek replied that this is not expected. However, Jorg pointed out that beam losses after an injection are not visible for the length of the integration window because they are hidden by the increased intensity from the injection.
- Daniel summarized the required follow-ups.
    - Action (Daniel, Markus/TE-MPE, Marek/BE-BI): Update and finalise functional specifications and commissioning procedure for the BCCM, including adaptability of loss threshold settings.
    - Action (Markus/TE-MPE, MPP): Specify required data (window size and number of points per integration window) to be sent from the BCCM to Post Mortem, and evaluate feasibility to implement automatic check of BCCM trigger in BIS IPOC.

1.3 AOB: Settings of the SMP min/max beta* values (Raffaello Secondo)

- Raffaello reported on an action from the 181st MPP (27.09.2019) concerning the clarification of settings of the **minimum and maximum beta* values** in the Safe Machine Parameters (SMP) system.
- The SMP receives the information of the beta* as set by the operators, and checks if these values are coherent within the **upper limit (presently 655 m)**, **lower limit (presently 1 cm)**, and **maximum window size (presently 30 m) before allowing to set the Stable Beams Flag**.
- The resolution of the beta* value in the SMP is 1 cm.
- Jorg reminded that it had initially occurred several times that, as the acceptance window was not adapted accordingly, the Stable Beam mode could not be declared for the Van der Meer Scans. For this reason, the limits were opened up significantly since 2010.
- Jan concluded that **the current limits should not be changed for now**, but that the **SMP Functional Specifications (EDMS #1096447) should be updated** with the actual values. One could discuss at a later point about the best approach for SMP V2.
- Action (Raffaello/TE-MPE): Update the Functional Specifications of the SMP with the currently used beta* limits.

1.4 AOB: MD-type SIS mask

- Jorg reported on an open action from the MPP workshop about introducing an **MD-type mask to allow automatic un-masking in the SIS**.
- In general, the SIS tests may be configured to be maskable or un-maskable. In practice, the un-maskable tests have been replaced by a mask category that requires a special SIS RBAC role. The latter is currently limited to three experts.

- From the four possible mask categories, two categories (Default and LEVEL1) have been used so far.
- For Run 3, the **LEVEL2 category will be used for MD-specific SIS interlocks**. For consistency, the current LEVEL1 category will be reassigned to LEVEL3.
- Each SIS test can be associated to pre-defined TAGs. The standard operations (as MASK, UNMASK, UNLATCH) can then be applied to a TAG.
- By combining a mask category for MD specific tests (e.g. Long Range Beam Beam Compensating Wires, crystals) and an 'MD' TAG for tests that are frequently masked during MDs (e.g. related to ORBIT), one can setup a **sequencer task that will automatically un-mask all those tests (category MD and TAG 'MD')** at the start of each fill.
- Jan reminded that one has to ensure that the SIS test is associated to the correct category.
- It was concluded that the **proposal should be implemented for Run 3**.

1.5 Open Actions

The actions from the meeting are:

- Action (Daniel, Markus/TE-MPE, Marek/BE-BI): Update and finalise functional specifications and commissioning procedure for the BCCM, including adaptability of loss threshold settings.
- Action (Markus/TE-MPE, MPP): Specify required data (window size and number of points per integration window) to be sent from the BCCM to Post Mortem, and evaluate feasibility to implement automatic check of BCCM trigger in BIS IPOC.
- Action (Raffaello/TE-MPE): Update the Functional Specifications of the SMP with the currently used beta* limits.