78th Meeting of the Machine Protection Panel

Participants: C. Bracco, V. Chetvertkova, B. Dehning, S. Gabourin, K. Fuchsberger, A. Di Mauro, A. Lechner, A. Masi, G. Papotti, L. Ponce, J. Uythoven, S. Wenig, J. Wenninger, D. Wollmann, M. Zerlauth.

1 Presentations

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

1.1 Optics in TI2/8 and virtual beta*. (J. Wenninger).

- Jorg explained how β* is currently calculated with SIS for the LHC ring.
  - ✓ For each Interaction Region, two Power Converters (PC) are selected (one from Ring 1, one from Ring 2) in such a way that the ratio of two currents is a monotonous function of β*.
    - Reference data are stored as a table of current ratios of the converter currents vs. β*.
    - Such a table applies only for one squeeze type. The current tables do not work for ATS pre-squeeze, and they work even less so for the real ATS squeeze. In the ATS squeeze the β* at an IP is determined also through converters elsewhere in the ring, therefore it would be necessary to include at least 2 PCs more.
  - ✓ SIS subscribed to the PCs, calculates the equivalent β*, sends the β* values (one per IP) to the SMP system which feeds it into the LHC MTG.
    - This is not a real measurement of β* at the IP. The assumptions are based on a fixed type of squeeze.

- ✓ β* values are received by collimator FECs through the timing card and are used in combination with a β* gap limit for interlocking (TCTs only).
    - Kajetan asks: Why couldn't the β* values be published directly from LSA?
        - Jorg answers that the initial idea was to monitor the true current in the power supply to exclude as much as possible any issues with transmission of settings.
        - Using the PC currents directly is the best way of independently checking the values.

- Limitations and post-LS1 changes.
    - ✓ The tables PC-ratio- β* are hardcoded inside the SIS code.
        - Only experts can change the tables.
        - Problem: Does not work for ATS optics – neither for pre-squeeze nor for squeeze.
    - ✓ After LS1 the idea is to move the tables to become LSA settings (MCS) – one set for each hypercycle.
        - Here it would be possible to store and handle different settings for ATS pre-squeeze.
    - ✓ To be able to cover the pure ATS squeeze, a second table must be added for IR1 and IR5.
        - Needed PCs in IR4+IR6 for IR5 squeeze and PCs in IR2 and IR8 for IR1 squeeze;
        - Adapt the IR2 and IR8 pairs not to be perturbed by ATS squeeze.
- Transfer lines (TL).
    - ✓ Since the injection collimators have similar FEC software connected to the LHC timing (β* limits are possible to be implemented, but they are currently not used.). The idea is to extend the ring concept to them.

- ✓ There is no β* distributed yet in the TL's, but one could define an artificial 'virtual' β * for a TL optics and re-use the SIS-SMP-MTG chain.
  - Proposal would be to use the LSA optics ID (unique) as β*.
  - This would at the same time provide a logging of the TL optics in Timber.
  - To make this possible two additional timing events – telegram pairs in the LHC - are required.

- TL optics and virtual β* concept.
  - ✓ For each TL optics, store ALL quad currents as critical settings in LSA. This requires to associate a unique virtual β*, which must be stored in the BP that contains the TCDI settings. In same BP store also the virtual β* limits for TCDI. Alternatively one could only pick two quad currents like in ring – to be evaluated.
  - ✓ SIS reads the reference settings and compares them to the published extraction currents (for every cycle).
    - If in tolerance publish virtual β* value associated to optics.
    - If not in tolerance, then publish 0 leading to the generation of an interlock by the collimators.
  - ✓ On TCDI side read β* from MTG and check if within limits.
    - Markus asks if the additional β* values could be included in the SMP and how difficult it is to include the other parameters.
      - Jorg answers that there is a possibility to skip the SMP chain and directly send from the SIS to the timing system.
      - Stephane says that including the additional parameters depends on the memory, otherwise there are no constraints.

Action: Stéphane Gabourin to check for the possibility to include the two additional β* values in the timing telegram.

- Jorg comments that in case of levelling with β* the current (tight) tolerances on the β* values will have to be relaxed.
  - Stéphane says that the limits are hardcoded within the VHDL code of the SMP and are not changeable without recompilation.
  - Markus adds that this change should be done at the same time as the re-definitions of the functions for the setup beam flag.
  - Jorg mentions that special attention needs to be paid during SMP updates.
- Stephane asks about the time scale.
  - Jorg says it should be done after LS1, with first tests to happen around the autumn of 2014.
- Jan comments that one could also directly dump the beam from the SIS in case a non-matching current is found, rather than relying on the COLL interlock.
  - Jorg answers that he still prefers to keep it as described, as the SIS does currently not interlock, but only provides β* for distribution via the SMP.
  - Daniel mentions that there is an advantage of interlocking at the collimators: optics is interlocked and the position of collimators is checked (not done by SIS).

- Remarks.
  - ✓ TCDI settings, virtual β* limits and TL optics (quad) references are stored together in a single BP.
    - If the wrong BP is used, the SIS interlock will fail (unless the optics happens to match, but then it is OK).
  - ✓ We re-use the existing concepts. New items:
    - Reference settings for TL quads + virtual β*;

- β* limits for TCDIs;
- SIS code for the logic;
- Timing event/telegram pair (hopefully there is room for another 2 telegrams).

- Use cases.
  - ✓ Case 1: SPS operates with a single cycle configured for fast extraction.
    - Every cycle SIS checks the currents and publishes β*.
    - Note that β* is published after the cycle. In case of cycle change, the first time a cycle is executed the β* comes from an older cycle.
      - Jan comments that this is acceptable because we always start with a pilot only.
    - Not easy to get around that unless everything is done closer to hardware.
    - If the cycle has a TL optics that matches, β* will have the assigned value. If the TL optics does not match, β* is 0.
  - ✓ Case 2: SPS operates with more than one cycle configured for fast extraction, and one cycle has 'wrong' settings (e.g. a HiRadMat cycle). The PCs will publish the table, however
    - After a good LHC cycle, β* published correctly.
    - After the 'bad' cycle, β* published is 0.
    - Here β* oscillates between 0 and the correct value. Extraction does not work.
    - The publication of '0' could be suppressed by a check of the SPS USER destination, i.e. it would only be published on cycles for the LHC.

Questions and comments:

- Jorg comments that it is unlikely to have different optic settings with the same collimators positions (gaps).
  - Markus emphasizes that the mechanism intends to protect against serious failures.

- Jorg adds that if the optics is changed the TL setting have to be changed as well and all systems have to be adapted.

- Alessandro comments that this requires a change of the bit mask (i.e. recoding of the MTG); one week is needed to change the settings at each point. This also requires a change in the coding of the data telegram.
- Jorg points out that the data telegrams have only 16 bits. This allows only one β* per telegram, as otherwise the granularity gets too small. A new telegram for the transfer line (virtual) β* will, therefore, be required. ➔ to be checked with Jean Claude.
- Markus comments that the details shall be worked out in the next months and summarized in a detailed engineering specification before implementation.
- Kajetan proposes to interlock the power converter currents via the PC Interlock system (which is already aware of optics changes and BPs) and use the published the LSA values, which would work for all the optics. This saves some tables and settings. Assuming that all the relevant PCs for the TLs are correctly interlocked in the PC interlock system this.
    - Jorg agrees that this should be possible provided it is extended to the relevant quadrupole magnets in the TLs.
    - Markus encourages discussing this further outside the meeting.
- **Action:** Work out implementation of virtual β* for TCDIs and summarize in a detailed engineering specification and an ECR. (S. Gabourin, A. Masi, J. Wenninger)

1.2 The AccTesting Framework – MPS recommissioning. (K. Fuchsberger)

- Kajetan reminds that MPS commissioning during Run 1 was based on EDMS documents for individual MPS systems (LHC-OP-MPS-000*)
    - ✓ The documents covered system overview, dependencies on the other systems, commissioning steps from IST, machine checkout, commissioning with beam for individual MPS subsystems.
    - ✓ The commissioning phases (individual commissioning, end-of-fill tests etc.) were done according to the procedures described in

EDMS documents and the progress was logged on the Share-Point site. This process involved ~400 steps (including 'manual' signature of the tests).

- ✓ Disadvantage of this approach: system dependencies and boundary conditions were only on paper; several people were in charge of keeping track of the step and enforcing the tests
  - No guarantee all the necessary steps are completed;
  - The results are distributed via EDMS, Logbook, SharePoint, etc.
  - No coherency for execution and analysis of repetitive tests.

- The web-page "Alvaro's pages" for hardware commissioning has by now been made obsolete.
- The new framework is proposed for its use during the commissioning phase of the MPS systems. It has the following advantages:
  - ✓ The test phases have to be completed in a certain order;
  - ✓ The test phases are divided into several tests which could be executed in arbitrary order within the phase. When certain tests are chosen in the tool, they are not immediately executed, but scheduled for the execution on the server. It is possible to check which test will be executed next. The execution starts when all the conditions are fulfilled.
    - Markus comments that it's possible to run some of the tests in parallel.
  - ✓ Each test has several steps: Execution, (possible) Automatic Analysis, and Manual Signing.
    - Jan asks if it is possible to add comments, when signing the tests.
      - Kajetan answers that it is possible to add comments. Alternatively links can be added e.g. to the Logbook, where plots and other comments on the test could be placed.

        - Jorg comments that if links to the eLogbook are possible, it is not necessary to duplicate the functionality to store attachments.
        - Markus mentions that for MPS beam commissioning the Logbook is most convenient to be used.
    - ✓ Statistics could be obtained (e.g. how many tests were executed/day...).
- Kajetan points out some requirements that need to be fulfilled before MPS commissioning can be implemented into AccTesting:
    - ✓ With the help from the equipment teams a responsible person should put the data into the database.
    - ✓ The Test Plans should be edited.
        - Current approach involves direct editing of the database to change the test plan.
        - New approach: when choosing a system, all the possible tests and the order of the execution should be listed. The user should be able to create a campaign with the chosen tests to be executed, the option of activating and deactivating the tests should be added, test relations/properties should be chosen.
            - Jan asks if it would be possible to choose the order of the tests to be executed.
                - Kajetan answers that this will be possible. Moreover, if the order of the tests is arbitrary it would be possible to choose this option too.
            - Jan asks: What's the reason for activation and deactivation of certain tests?
                - Kajetan answers that in some cases it might be necessary to perform just a subset of the tests, e.g. in the case of a partial re-commissioning after a TS.

- Bernd asks: What kind of subset of the tests is active per campaign in case of commissioning of different systems?
  - Kajetan answers that this is a design issue still to be discussed.
  - Markus comments that in case of hardware commissioning the list of the tests is static, however some of the tests can be activated/deactivated if not applicable for a given campaign.
- Jan proposes to add the history feature: the ability to see the results of a similar test that was done in a previous campaign.
  - Kajetan says that all the data are stored - one just needs to provide the interface to extract it in a convenient way.
  - Markus proposes to add a panel with an option to choose the tests of the same type in the database.
  - Kajetan says that this feature will be added.

✓ The option Barriers (when the commissioning of a system reaches a Barrier Point, it has to wait until all other systems with the same barrier reach it also) should be introduced.

- This option provides linking between the systems.
  - Stephane asks if there are relations between the phases only or the tests within a phase are also checked for dependencies when deciding which test to execute.
    - Kajetan answers that at the moment only phases are considered for dependencies. The implementation of dependencies for single tests would make the test program unnecessarily complex. All the tests within a

phase must be completed before starting the next phase. Currently one way to implement dependencies for a single test is to create a phase with only one test.

- ✓ The option System Relations is to be completed.
  - At the moment there are 17000 systems, 48000 Relations and 200 MB of Data (in memory) already modeled, this needs to be extended to cover e.g. also the BLM system,…
- ✓ Automated Analysis is to be provided.
  - Subproject: access of the system to the Post Mortem DB, Logging DB etc.

- Requirements to the other teams:
  - ✓ Review of the Test Procedures
  - ✓ Help defining the 'Test Plan' within AccTesting
  - ✓ Give Feedback
  - ✓ (Think about automation …)
  - ✓ Use it!
- **Action**: MPE
  - ✓ Test Plan Editing: end of 2013 (TE-MPE-MS)
  - ✓ Finalization of the Test Procedures: spring 2014
  - ✓ Creation of the Test Plan: summer 2014
    - Assign the responsible person.

Discussion

- Markus comments that it is very beneficial to model the commissioning sequence in such a tool as it will be re-usable for future campaigns (without having to re-think it every time).
- Jan comments that the LBDS should already be tested by spring 2014, when the reliability run is scheduled. Jan will check what kinds of tests are needed before the reliability run.
- Barbara concludes that the 1st step is to revise the EDMS documents.

- Markus adds that the EDMS documents contain the details of the test.

- Alessandro asks if the test steps would be recommended or mandatory.
  - Markus answers that they would be mandatory.
- Markus comments that tracking and documentation would be moved to the new framework. The working on the procedures would need to start before the end of the year to allow for the necessary time to model the sequence in the database.
- Jan reminds that the current EDMS documents define the repetition frequency of tests. These are however outdated and it is necessary to redefine the category of the documents to serve as a template for the new procedures.
  - **Action:** MPP to create a template for the commissioning procedures.
- Kajetan adds that it would be useful to add the type of the campaign (big commissioning or technical stop etc.).
  - Siegfried asks about the automatic validation of the beam permit, that the users (e.g. experiments) provide to the beam interlock system. Markus comments that automation of execution and analysis only makes sense when many repetitive test need to be done. The others will be a second objective to come after LS1.