67th Meeting of the Machine Protection Panel

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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 Observations and conclusions after TDI issue in IP8; Scrubbing Run: TDI, MKI and MKE interlocks – (C. Bracco)

- Two problems with the TDI in IR8 (right/lower jaw) were observed in August.
- TDI-reminder: The motors are fixed with support bars 900mm from the jaw ends. The distance between the support bars is 2200mm. The support bars allow movement due to an expansion of the jaw. The installation of LVDTs on each side of the support bar (i.e. 2 LVDTs per support bar; e.g. RU1 and RU2) allows the detection of deformations.
- Only one LVDT per support bar is interlocked (e.g. RU).
    - Markus asks what the current parking positions of the TDI jaws are. Chiara answers that they are at 55mm.
    - Roderik asks, at which time in the operational cycle the jaw heating was seen mostly: injection, top energy? Chiara responds that it is observed in both. Less heating happens at top energy then during injection, but as the time in collision is much longer, the heating can be significant.
    - Antonello asks why only the TDI in IP8 is discussed here. Alice is suffering from heating and background, which maybe partly due to the TDI in IP2.
- On 07.08. the RU motor stopped, when going into parking position. The downstream motor (RD) didn't stop, which led to an angle in the jaw.

Therefore, one corner of the jaw touched the beam halo, which caused beam losses and finally dumped the beam.

- Later a 150μm offset in the LVDT (RD) reading with respect to the respective resolver was discovered (see slides of Mario Di Castro). A deformation of the jaw or the movement mechanism was suspected, but no mechanical problem was found. Most likely the problem was caused by a spurious glitch on the RU hardware end-switch, which stopped the motor movement.
- As follow-up the control module of the switch was exchanged. Since then, the problem did not appear again. In addition a new task in the LHC sequencer was introduced, which checks the TDI position before starting the ramp.
- After the exchange of the electronics, the motor counter was reinitialized from the LVDT (parking position as reference). As the 150μm LVDT offset hadn't been discovered at this time, this introduced an additional uncertainty of 150μm in the LVDT position with respect to the beam. Therefore the RU LVDT was too close to the inner dump threshold and caused an interlock.
- The LVDT was then re-initialized with a previous LVDT reading during injection as reference, which removed the offset.
- TDI setup checks were performed, to measure the jaw-angle and the retraction between TCP and TDI (expected 6.8 sigma). No deformation (angle) and wrong retraction was found. TDI in IP8 is ok.
- During TS3 the low-level control software will be updated to automatically check the angle of the TDI jaws (check requested position, perform additional checks with resolver readings to avoid dangerous jaw states). These changes will not cause a beam dump, but stop the motor movement and send a warning to the operator.
- Discussion on TDI angular problem:
    - Markus asks if the observed 150μm deformation is real. Alessandro answers that there is probably a deformation in the mechanics, which is now taken into account in the calibration of the LVDT. Thus, for operation this shouldn't cause any problems.

Only problem, if the jaw will be tilted to its full angle this could be dangerous.

- Alessandro adds that as the change in the low level control only effects the motor control (MDS) and not the check of the position interlocks (PRS) the machine protection test are still valid and do not need to be repeated.

- **Scrubbing run with 25ns (04.-08.10.):**
- The scrubbing run will mainly take place at injection. Trains of 144-288 bunches will be injected. There will be long periods without injection of beam but at injection energy.
- TDI has to be retracted to parking position if staying >15mins without injections to limit heating and deformation.
- Is there a risk of an erratic of the MKI, with retracted (or while retracting) the TDI?
  - MKI-interlocks: No trigger pulse -> the PFN gets discharged through the dump switch ~2.5ms after the injection pre-pulse.
  - TDI interlocks: injection inhibit if TDI jaws open to parking (BIS)-> no beam permit -> inhibit the pre-pulse triggers and not possible to charge the MKI PFN-> no erratics
- Risk of extraction from SPS with TDI retracted?
  - MKE (SPS) interlocks: MKE interlocks: “NO-TRIGGER PULSE” only in point 4. No dump switch in point 6 but no beam permit if TDI open (injection permit removes the extraction permit). Only possible to extract if TED in.
- Further protection: Dedicated sequence to put MKI into STANBY before moving the TDI out (Injection permit removed when MKI in STANDBY).
- **Action**: For LS1 it is planned to add the TDI jaw position into the MKI BETS, to avoid charging of the MKI, if the TDI is not at the supposed position.

Discussion:

- There is a small time window, when the MKI can be charged (and not pulse) until it is dis-charged (~2.5ms).

- Alessandro points out that within 2.5ms the TDI can move max. 10μm.
- The question is raised how one would retract the TDI. Chiara responds that in the ideal case one would first put the MKI to STANDBY and then move the TDI out.
- Verena explains, that the MKI-STANDBY and move out TDI commands are already combined in a sub-sequence. Therefore they cannot easily be executed independently.
- Richard asks why the SIS can't check this? Jorg responds that the SIS is too slow (2s, compared to the discharge time of ~2.5ms).
- Verena points out that it seems to be almost impossible to have an erratic, when the MKI is still charged but the TDI is moving out.
- Rudiger asks, how the HW interlocks are done (redundancy etc.). Ruediger recommends combining the two tasks (MKI Standby, move out TDI) in one sequence, which reduces the risk to execute them independently. Then there are two protection nets. If the sequencer fails, there are still the HW interlocks.
- Chiara mentions that there were also discussions to pulse the MKI during the scrubbing runs to produce UFOs.
- It is decided that no changes in the interlocks, pulse lengths etc. should be allowed for these tests.
- **Action (V. Kain, C. Bracco et al.):** Before the scrubbing run a sequence step needs to be created. Markus proposes to make a special sequence for the scrubbing run, which reduces the likelihood of moving the TDI out without putting the MKI into STANDBY.
- **Action (MPP):** Rudiger proposes to start a brainstorming if and how injection protection can be improved for LS2. Jorg reminds that there is no passive protection (with collimators, masks etc) in the horizontal plane.

1.2 Proposal for a MPP workshop early 2013 (D. Wollmann)

- Daniel W. introduced the idea of a MPP Workshop in early 2013, with the objective to discuss the mid- and longer-term improvements of the MP systems.

- A first draft of the different topics to be covered was presented and can be found here.

Discussion:

- Jan proposes via email to add the following topics to the program:
  - BLM LICs: are they working and will they allow reliable injection and protection?
  - Interlocked BPMs in point 6: post mortem data and/or other improvements
  - XPOC: operational experience. Rights to reset. Changes?

1.3 Follow-up of recent MPP anomalies (CMS solenoid trip, LHCb trip, RQX.R5 – (M. Zerlauth)

- The CMS solenoid tripped (fast discharge), which did not cause a beam dump. After 3 mins the beams were dumped due to a SIS interlock of the BLM HV in IR7. B1 and B2 orbit changed by up to 400μm within the 3mins, but only B2 saw high losses along the whole machine.
- Thus, the solenoid has a slow but non-negligible effect on the beam and causes very slow and distributed losses.
- Agreement with CMS: Provision will be taken to provide an interlock in case of a Fast Discharge (new design of MSS already ongoing) for LS1.
- Another possibility would be to use low OFB after LS1 during physics.
  - Jorg comments that we currently do not use the OFB, as currently the major measured orbit changes are due to temperature drifts in the BPM racks. If this is mitigated in the future a slow OFB could be used (with low gain).
- LHCb trip: The trip caused a beam dump with a delay of 25ms. 80-90% of this delay are caused by filtering and output relays in the Magnet Safety System (MSS) of the experiments. There is a new development on-going for post LS1 operation. It was proposed to use optic-couplers instead of the safety relays and to remove the 10ms input filter. This should bring down the MSS transit time to 5ms.
  - Rudiger suggests to propose the system used in LHC (safety PLC + FPGA). Maybe it can be used also here.

  - **Action:** Markus will check this with Sylvain.
- RQX.R5: tripped and caused orbit changes. The beams were dumped due to losses. PC interlock was only sent with a delay of 2.6s.
- Reason identified: There is a watch dog implemented, which should keep the PC on for 2s, if the FCGs are down, to reboot them. As this watch dog has never been used and now caused a problem, it will be removed with an upgrade to the FGC2 CPLD programming during LS1.