60th 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 BLM HV issue in IR7 – (E. Nebot del Busto)

- Due to slightly increased losses wrt to earlier fills ,the HV (nominal 1500V) for some ionization chambers in IR7 dropped during normal operation below the threshold (1440V) and caused during the ramp the loss of the 2 last fills before TS1.
- 5 cards right of IR7 were identified to be affected and the threshold voltages have been adjusted from 1440V to 950V by replacing a resistor in the backplane (BJBHT.A5R7, BJBHT.A6R7, BJBHT.C6R7 , BJBHT.D6R7, BJBHT.E6R7). To keep the symmetry the equivalent 5 cards left of IR7 were also adjusted (BJBHT.A5L7, BJBHT.A6L7, BJBHT.C6R7 , BJBHT.D6L7, BJBHT.E6L7).
- The adjusted cards have been installed and tested in the tunnel by closing close-by primary collimators and verifying the correct triggering of the card.

Discussion:

- Jan asks how the BLM reading/signal is affected when the voltage goes below 1000V. Eduardo explains that the reading is not affected by voltage in this level. Barbara explains that earlier test showed that the ionization chambers still work down to 200V, but saturation due to space charge effects might start earlier. **Action**: Barbara will distribute the documentation of these tests.

- Jan mentions that the thresholds were probably set close to the operation voltage to identify possible problems with the HV when they start to appear. Lower threshold voltages would mask these.
- Ruediger points out that the protection functionality of these BLMs needs to be tested after this change.
- Functionality tests are foreseen with beam after the TS1. The tests will be performed left and right of IR7, i.e. with B1 and B2.
- **Action:** Markus points out that this topic needs to be re-addressed in the coming week by checking the data recorded with the lower ionization chamber voltages.

1.2 Performance of LIC detectors in the LHC and planned replacement of SEMs by LICs for certain areas (E. Nebot del Busto)

- The motivation to install LICs (little ionization chambers) instead of ICs was to gain in dynamic range of the BLM system. It was seen as a possibility to reach a factor 5 margin between the dump thresholds and the average losses during injections.
- There are 3 LICs installed downstream of a secondary collimator in IR7 (TCSG.A6R7.B2). In total seven ionization chambers have been replaced by LICs in the injection region during the shutdown.
- Data taken during the technical stop show relatively high noise in the BLML monitors.
- Data from the BLMLs in IR7 from October 2011 show a linear correlation between the standard ionization chambers and the LICs for slow losses.
- In the injection region the BLMLs show unexpected large signals during injections. Therefore the threshold of some of these monitors needed to be deactivated to avoid stopping operation.
- It was decided to test additional LICs at MSI 06L2, where 6 SEMs were replaced by LICs to gain experience. Compared to the SEMs in the same position in IP8 the noise level of the LICs is significantly lower.
- The agreement of the measured BLM signals during 144 bunch injection this year (with LICs) and last year (normal BLMs) at the TDIs, MSIs and MBXB was in the order of a factor 2.

- LICs at MQML record systematically large signals. These monitors are under investigation of gas purity and filling pressure.

Discussion:

- The question is raised if the different reading/behavior of different LICs maybe affected by different designs between different production batches? Eduardo answers that there are different production batches with the same design. There is no correlation of the different readings to the LICs from different batches.
- Verena points out that even the factor of 2 (not considering the factor 17 in the MQML) is still relatively high. Eduardo replies that this factor was also observed in experiments without beam. There is a good linearity between the ICs and the LICs, but above a certain radiation a sudden steeper slope was observed. This behavior is not understood.
- Markus ask if there was any other test done with the MQML monitors, e.g. connecting to a different card? No other tests were performed so far.
- Verena points out that we need to know relatively soon if the LICs will operate reliable for 25ns operation, as the increase in dynamic range will then be needed for the BLM system. Otherwise one would need to come back to the proposed sunglasses for the IC in the injection regions.
- Ruediger proposes to perform tests with the LICs (and also the SEMs) under controlled conditions e.g. in HiRadMat. This could be easier than during the changing conditions in a running accelerator.
- **Action:** This topic needs follow-up by MPP and will be re-addressed in a future MPP meeting.

1.3 Introduction into the observed mechanical deformation of the TDI jaws due to heating – (R. Losito)

- For TDI.4R2 the LVDT2 has been moved to a point symmetric to the motorization axis. A real jaw deformation should now give an opposite drift on the two LVDTs.
- The first drifts in the LVDT sensors of the TDI were observed in March 2011. Checks at other collimators in the same area ruled out the possibility that the changes could be due to external magnetic fields. The

measured temperatures at the TDI and the change in LVDT signal are well correlated (data from December 2011, after end of the run).

Discussion:

- Ruediger points out that the correlations shown for December were after the end of the beam operation.

1.4 Overview on the current interlock situation of the TDI position during the different modes of operation. Do we need to have other / more interlocks to ensure the correct position of the TDI? – (W. Bartmann)

- The TDI position thresholds are kept constant during the full machine cycle. If the jaws are outside the outer limits, the injection is prohibited, but the jaws can still be moved. If the inner limits are violated the jaws are stopped and the beam is dumped.
- Redundant energy interlocks are in place for the TDIs and TCLIs.
- The MKI is set to standby before opening the TDI and TCLIs by the sequencer.
- For the run 2012 a separated beam process for settings of the injection protection devices was created. This avoids repeated copying of these settings, and is considered to be safer than the previous method.
- The observed changes in LVDT signal (symmetric in the two LVDTs on one side of the device) indicate a deformation of the jaw.
- Compared to last year the position interlocks are tighter this year. This is the reason why the described behavior became obvious only this year, although the TIMBER data show a comparable behavior last year.
- The TDI jaws heat up during physic and cool down without beam or during other operation modes. This behavior can be nicely seen in an example before the MD1 block 2012.
- Measurements with warm jaws have shown that both TDI jaws were found at 6.8 sigma instead of 6.4 sigma for B2 and 6.2 / 6.8 sigma for the left and right jaws in B1. The measurements will be repeated with cold jaws (after the TS) and again with warm jaws.

- Measurements of the jaw angle showed the same results as during commissioning with beam. A cooling down of the jaws during the measurements maybe caused this.
- The aperture currently protected with the current TDI settings is 7.5 sigma. The upper limit for the position interlock for mis-kicked injected beams is 0.5 sigma.
- There is a proposal to put a gap interlock for the TDI into the BETS interlock. Problem: there is currently no independent gap measurement for the TDI. A solution could be the calculation of the difference signals between the LVDT on the different jaws. In addition one could interlock on the average of the signals.
- The measurements performed so far indicate a possible deformation to the beam, which is considered to be the safe direction.
- There is yet no clear correlation between the LVDT drift and a possible jaw deformation. Therefore it is proposed to keep the current thresholds until the behavior is sufficiently understood.

Discussion:

- Jorg mentions that the margins for orbit bumps can possibly be tightened. Unfortunately this would also mean that in case of a problem with a BPM an immediate repair would be required.
- Jan asks Roberto if it is possible to install independent gap measurements at the TDIs. Roberto replies that as the motors are installed on different sides, one would need a level arm of ~1.5m. The accuracy of this measurement would probably be in the order of millimeters. For comparison in other collimators an accuracy of 50 μm is achieved over level arm of 35mm.
- Markus points out that it is the right strategy to keep the current position limits until the behavior is sufficiently understood. Then using the average of the LVDT signals maybe a solution for the problem. In addition to that the position limits should be kept in place, but maybe loosened.
- Alessandro points out that with interlocking on the average of the LVDT reading would mask the problem, but not solve it.

- Wolfgang points out that with the averaging and the position interlock it will be easier to identify in the CCC the problem (position has moved, deformation of the jaw, …) and to understand if operation is safe or not.
- Jorg mentions that to loosen the hardware interlock and the introduction of tighter software interlocks for the calculated average and gap could also be a solution.
- The heating of the jaws seems to appear in particular during physics.
- Jorg points out that the parking position of the TDI during physics was changed last year from 20 to 55 mm. A comparison of the heating / deformation for these two gaps may help to understand the sources of the heating. **Action:** Jan will look into this.
- Roberto mentions that a deformation of ~400 μm may agree to a change of about 30 to 40K in the jaws.
- Ruediger asks if the temperature sensors could be installed directly on the tank of the TDI to improve the accuracy of the measurement?
- **Action: This discussion should be taken up next week either in rMPP or amongst a small number of people.**

1.5 LHCb observations during injection kicker MKI-field breakdown – (R. Jacobsson)

- The losses due to beam oscillations of the partially kicked train was observed to be worst in the second turn in LHCb.
- The BCM measured a factor 100 above the dump threshold at injection.
- A problem with the TDI alignment is a major worry for LHCb.

Discussion:

- It is commented that the no kick-case is safely interlocked with the current interlocks. Losses due to this go into the center of the TDI and are therefore well absorbed.

1.6 RP movement problems and update on commissioning status of changes required by MP – (M. Deile)

- During RP alignments a problem with movements < 30μm was discovered. The reason for this behavior was traced down to a too long

gate time for the acceptance trigger in the FPGA, which was introduced for testing and hadn't been removed before operation. The activation time of the trigger is now reduced to 15ms.

- The correct movement of the RPs has been checked extensively with different step sizes down to 10μm for TOTEM and Alfa. The maximum deviation observed was 5μm. Even some tests with 5um step size were tested.
- The bypass boxes have been commissioned in the current TS. All tests have been performed and documented in the elogbook. In addition the interlock report has been updated for TOTEM.
- The Alfa LVDT bypass box was modified to a system with one key (instead of previously 4 keys)
- In addition to the MP tests the CCC software used for beam based alignments has been improved, which helps to improve its usability and therefore the availability of the RPs.

Discussion:

- Roberto points out that the reduction of the trigger gate cannot be a long-term solution, as other problems may appear in a few months when the movement speed is increased. Mario responds that in future it is foreseen to trigger on the rising edge of the pulse.
- The keys for the Alfa and Totem bypass boxes will be given to OP (Jorg).
- The bypass boxes keys can be taken out when in bypass and should then be returned to the CCC.
- Markus points out that the open machine protection issues have now been successfully addressed. It should be checked if the alignment from the beam commissioning is still valid for the RPs. Mario replies that from the 4 horizontal pots, 3 are in good agreement to the centers seen in 2011. The alignment has therefore only partly to be repeated. In Alfa one station is affected, i.e. 2 pots have to be set up.
- Jorg points out that due to the horizontal small beam size the minimum horizontal position for the RPs should be the TCT settings plus 6 sigma,

i.e. 15 sigma. In vertical TCT setting plus 3 sigma, i.e. 12 sigma, is sufficient due to the absence of strong kicks in this plane.

- Loss maps should be performed with the nominal settings of the pots.