169th Meeting of the Machine Protection Panel

The meeting took place on September 14th in 774/1-079.
Participants: R. Bruce, C. Hessler, B. Lindström, N. Martin, Y. Nie, E. Ravaioli, M. Solfaroli, J. Uynthoven, M. Valette, C. Wiesner, J. Wenninger, 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#168's minutes

- No actions from the 168th MPP.
- Some comments were sent by email on the previous minutes, they will be included in the version stored online.

1.2 Update of procedure in case of a non-working beam dump (M. Solfaroli)

- A procedure describing the steps to be taken if a dump cannot be triggered was written before LS1. It did not contain the technical details for safety reasons. These were stored in another document only accessible via the Technical Network with a paper copy available in the CCC. The procedure is not up to date due to changes in the control system and especially in the LBDS and needs to be updated.
- The general strategy is to force open the BIS loop via different users, then, if unsuccessful, to trigger an internal fault in the LBDS. The very last resort is to scrape the beam away. The details are shown on slide 3 of the presentation.
- Due to the new architecture of the LBDS post-LS1, the procedure would not work anymore. This part of the procedure was updated following input from N. Magnin.
- Some of the steps detailed in the procedure are redundant and will just take time in a critical situation. The redundant actions were removed. Matteo proposed that triggering the LBDS via the access system might be added to the procedure.
    - Jorg commented that the access system shuts down the separation dipole and should therefore be avoided, as this will cause major damage, if a significant amount of beam is still circulating.
- For the last resort solution of getting rid of the beam, three strategies were proposed: ADT blow-up, excitation using the 3rd integer resonance, closing in collimators. The first one is the only one having been tested and allows scraping the beam in a controlled way.
    - Jorg commented that for such a procedure to be efficient all operators have to be trained. Daniel added that the appropriate ADT parameters have to be re-validated regularly and this procedure should be tested

regularly (at least once a year, but better around every TS), providing good opportunities for training.
  - Jan asked how much beam was scraped at most during MD performed last year. Matthieu responded that 600 bunches were scraped in 50 minutes at top energy during MD#1828.
  - Roderik proposed to remove the other two methods from the documents as they might lead to instabilities when dumping the beam is unavailable. Matthieu added that closing in the collimators might lead to less efficient cleaning and higher losses in the DS, which should be avoided. Daniel commented that from the recent experience in the SPS the tune resonance approach is too dangerous.
  - Nicolas commented that all the proposed actions on the LBDS would go through the PLC and would not work if the problem originates there. A direct access to the FEC via SSH should also be added to the procedure.
- In conclusion: all items in the procedure should be tested before LS2 and the test documented. Scraping with the ADT will only be tested after LS2 with the ADT in its new configuration. A specific tool for scraping the LHC beam should be made available with an excitation widow covering the whole ring and limited maximum excitation amplitude.

Action (M. Solfaroli & N. Magnin): test LBDS items after TS2.

Action (D. Valuch, MPP): request functionality to open up excitation window of ADT and prepare OP sequence for scraping the full LHC beam.

1.3 Fast failure due to triplet event (03.06., 19:28): update on the field simulations (E. Ravaioli)

- Emmanuele presented an update on simulation efforts to reproduce the triplet quench event from June 3rd. There were two talks on the topic in the previous MPP #168.
- The sequence of the event is as follows: a symmetric quench developed in Q1 right of ATLAS and was not detected before significant losses in IR7 caused a dump. The quench lead to a current change of a few Amperes. The field change lead to transient effects in the magnet and a significant dipole kick on beam 1, which is the focus of this talk.
- An estimation of the total kick from BPM measurements (Björn) leads to 700 µT. The expected kick from the current change and the lowering of the gradient only accounts for 1/3rd of the measured kick on Beam 1 and the other beam should have moved in the same way.
- There are three main transient effects considered in this study: Inter Filament Coupling Currents (IFCC) Inter Strand Coupling Currents (ISCC) and Current Redistribution in the Cable (CRC). Assuming a symmetric quench on the top of the magnet aperture (direction of the outgoing beam), the current change rate hints to a quench volume equivalent to six full turns of the magnet.

  - IFCC with six turns being quenched would give an extra 14-22 µT
  - ISCC would contribute to 26-48 µT
  - CRC could contribute to between 0 and 900 µT depending on the proportion of each turn being quenched.
  - In total, these effects lead to the appropriate kick on both beams if 40% of the effect of CRC is considered.
- In conclusion, the simulation model allows reproducing the current decay rate and the kick on both beams. This requires a fast quench propagation and a large quenched volume for a symmetric quench. Under normal operation conditions, such an event is very unlikely. Temperature recordings indicate that the magnet might have reached the lambda point, i.e. the helium went from super-fluid to normal (T > 2.15 K at the beginning of the quench).
- The results will be documented in an internal note.
  - Roderik asked what triggered the higher bath temperature. A problem with temperature regulation seems to be the cause.
  - Emmanuele added that a large symmetric quench is a good thing from the magnet protection point of view as it limits the hotspot temperature; also, this magnet has an ample margin for protection.
  - Jorg commented that if the LHC continues to operate at the limits of luminosity these events might become recurring and one may want to redefine the Cryo maintain conditions to prevent this from happening with beam in the machine, especially in few of the late detection by QPS.