133rd Meeting of the Machine Protection Panel

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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#132's minutes

- Actions from 132th MPP:
  - Develop PC interlock further, EYETs and beyond.
  - Monitor factor changes for the BLM worked nicely for the last 2.5km optics run.
    - Daniel asked what is planned in preparation of the 2.5km run after TS2.
    - Jan answered the BLMs will be masked because safe beam will be used.
    - Markus suggested for the BLM team to get in touch with Massimo as MC.
    - M. Kallikoski added that for the moment the database is down due to the TS and no changes can be performed. When the database is back first the foreseen changes have to be implemented before adding changes for the roman pots.
    - Daniel concluded the 2.5km run will be followed by re-validations and an intensity ramp-up, thus, no high intensity runs are directly after the special run. This gives also more time to revert the monitor factors for the roman pots.
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 Powering perturbation to the warm D1 magnet circuits, consequence on orbit, FMCM threshold, prospects for 2.5km and ATS optics (M. Valette)

- The D1 magnet allows the combination/separation of beams in the parallel plane; a failure in the circuit is the fastest in the LHC excluding kickers.
- Redundant protection is provided by the BLMs and the FMCM. The FMCM derives a current change from a voltage measurement and is very sensitive. 12 LHC magnets are protected by it. Experiments during the 2016 commissioning verified that the FMCM would trigger a dump 23ms before the experiments' BCMs or the BLMs trigger.

- 2016 the beams were dumped 29 times by the FMCM due to network perturbations. Among these 17 times only the FMCMs saw the perturbations and in 5 case, only the D1L/R5 triggered.
- In order to improve availability, the possibility of a relaxation of the thresholds was reviewed and presented in June in the LMC. The presented studies were performed to update earlier studies with the current 2016 LHC and future ATS optics
- A new optics model was designed to have faster simulations with a large number of particles assuming linear optics based on transfer matrices. It is valid for simulations running over few hundreds of turns and with beam orbit moving below a couple of sigmas in this time.
- First results for a D1 failure with current optics show the beam would move by two sigmas in a hundred turns. 2E13 p+ would be lost in the collimation systems. An outlook for the ATS or 2.5km optics shows this failure is less worrying due to the smaller beam size at the position of the D1. These simulations nonetheless show that the BLM thresholds in 40us RS, which were designed to allow a redundant protection with the BLMs is no longer protecting against such failures.
    - Alessio commented that due to the electronic limit this redundant protection against a D1 failure is not visible in the BLMs of the TCP collimators, since RS01-RS05 have thresholds at the electronic limit. This implies that at the primary bottleneck of the collimation system the BLM thresholds behaves over-protecting against this failure scenario. Similarly, other BLM families at collimators have RS01 through RS03 at the electronics limits. The others not affected by this limitation do not show any sign of implementation of redundant thresholds.
    - Daniel concluded that this point should be discussed in the CollWG including experts from the MME group.
- In order to study if the FMCM thresholds could be relaxed, the trigger delay due to an increase of the thresholds by a factor 2, 3, 4, 5, 10 was simulated. The thresholds could be relaxed by a factor 4. This would allow still dumping before the BLMs (10.24ms Running Sum) would trigger and well before the damage level of the collimation system is reached.
    - Jan commented a double failure in the D1 circuit has to be envisioned since the losses would rise faster in that case.
        - Taking this into account the thresholds could still be relaxed by a factor 3.
    - Ivan commented that from the statistics on the FMCM dump in 2016, one would need to relax the thresholds by a factor 5 to gain in availability.
    - Roderik asked what the phase advance between the D1 and the TCPs were and if losses on the secondaries had to be taken into account.
        - The phase advance is 90 degrees so losses will first appear on the TCPs.
    - Markus commented that with the planned upgrade of the power converters for the RD1 and RD3/4 in the upcoming EYETS there is no

urgency to relax the FMCM thresholds. Nevertheless, it would be good to study and possibly test the future power converter and their sensitivity to disturbances.
    - Daniel concluded this study should be extended to RD34.

Action: study the effect of a RD34 failure on the orbit and the associated FMCM thresholds (M. Valette)

Action: Study / test sensitivity and ripple of new power converters. (MPE-MI)

Action: Derive updated FMCM thresholds from the tracking studies and the power converter tests for after the EYETS (MPE-MI, MPP)

AOB – MKI erratic on 2/9/2016 (W. Bartmann)

- Beam conditions at the moment of the erratic:
    - 876 circulating bunches
    - Erratic on the main switch of MKI2D while charging the PFN voltage at 35 kV (full charge 50 kV).
    - Other MKIs fired within 2 µs as expected.
- 18% of nominal kick for about 2 µs – half a batch of circulating beam grazing on lower TDI jaw; afterwards reaching 70% of nominal kick, which led 3.5 batches with high impact on TDI.
- Q2 quenched, D1 and Q3 didn't. The vacuum valves closed consequently.
    - Jan asked which valves closed.
    - Anton answered probably the TDI valves because of the pressure spike and commented they have not closed during erratics before.
    - Markus asked if it is normal to have quenched the Q2.
    - Anton answered this is really surprising and not predicted by the current FLUKA simulations.

Action: Verify which vacuum valves closed (TE-ABT)

- Wolfgang shows the field vs the timing of the batches.
- The high losses in the Q2 are still unexplained.
    - Anton added with high impact parameter it is all the more surprising.
    - Daniel commented the current in the Q1/Q3 were 300-400 A and in the Q2 around 750 A, thus the Q2 had the highest current.
- The bunch count on the TDE shows the right number of bunches missing: 210, which is consistent with the observed losses around the TDI and the synchronization with the batches.
- In summary: this is an accepted failure case but it happened at low PFN voltage, and with strangely high losses in Q2. The interpretation of the losses is not trivial, as many of the BLMs were saturated during the event.
    - Anton commented that one need to take into account that the BLM thresholds have been set for different loss scenarios than an erratic MKI firing.

Action: Further understand the quench of Q2 (BLMTWG, MP3).

AOB – interlocking of laser emittance meter in L4 BMLEM

- A brief reminder of the concept was given: measuring the L4 beam emittance via a profile measurement of an H_0 beamlet created by laser scraping scanning through the beam, allowing to reconstruct the transverse phase space.
- The H_0 atoms are detected by 2 striped diamond detector covering the horizontal and vertical planes.
    - Daniel asked how long a measurement will take.
    - The measurement is performed with one shot per L4 pulse, requiring about thirty shots. Thus, the whole procedure takes a couple of minutes.
- Since this measurement uses a beamlet composed of 1 particle per million it is considered as non-destructive.
- There are two different instruments, one at the first dipole with the diamonds being mounted in the dump line and one after the second dipole with the laser being between dipoles.
- The lasers are not dangerous for the beam but the diamonds can't take the L4 beam so they have to be protected.
- The second instrument doesn't need protection because the first and second dipole are powered in series, thus, no charged L4 beam can reach the position of the diamond detectors.
- The first instrument needs to be in its "out" position if the beam destination is the main dump.
- End switches allow interlocking the beam if the detectors are not in parking position. For redundancy there are 2 switches per detector (h and v) and their signals are sent to the klystron gallery.
- The system is still under development and will be installed in spring 2017. Currently the cables are being pulled.
    - Daniel asked if the signals are combined for the BIS.
    - Markus added that combining the signals of the redundant out switches is good as it helps avoiding inconsistencies between channel A and B, which the BIS would otherwise interlock.
    - Matthieu asked if there was anything to prevent the insertion in operation towards the main dump, for availability concerns.
    - This would be done on the software level and part of the control system.

AOB - all

- One topic from LMC, on luminosity quench for the performance reach of ATLAS and CMS, will be discussed offline next week. In the meantime the request has been dropped by the experiments. Nevertheless, the proposed procedure for such a test will be discussed together with the Collimation team in preparation of the intensity ramp-up after the 2016/17 EYETS.