# 134th Meeting of the Machine Protection Panel

Participants: J. Boyd, C. Bracco, G. Bregliozzi, M. Kallikoski, D. Lazic, M. Rijssenbeek, A. Rossi, C. Schwick, J. Uythoven, M. Valette, 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#133's minutes

- Actions from 133rd MPP:
  - study the effect of a RD34 failure on the orbit and the associated FMCM thresholds. (M. Valette)
  - Study / test sensitivity and ripple of new RD1 power converters. (MPE-MI)
  - Derive updated FMCM thresholds from the tracking studies and the power converter tests for after the EYETS. (MPE-MI, MPP)
  - Verify which vacuum valves closed during the MKI erratic. (TE-ABT)
  - Further understand the quench of Q2 during the MKI erratic. (BLMTWG, MP3)
- Markus commented on the validation of the new power converter type for RD1/RD34: the good news is EPC received the converter and lab tests are planned in conjunction with an FMCM on it.
  - Jorg asked how one would simulate network perturbations on it.
  - Markus answered that this could be achieved by simulating interruptions of one/several phases of the AC powering.
- No additional comments were received on the minutes; they are therefore considered approved.

## 1.2 Operational and interlocking strategy for beam-beam wire compensators in IP5 (TCT, TCL) (A. Rossi)

- The BBWC demonstrator is taking advantage from the location of the TCT and TCL to attempt a compensation of the Long Range Beam-Beam effect, as it was demonstrated already in the Tevatron.
- In the LHC, it would be demonstrated with a strong and a weak beam (B2) on which the wires would act.
- The collimators allow the mechanical integration and cooling of the wire
  - Jorg asked if all 5 axis of the collimator would be available in these locations.
    - Adriana confirmed that in these slots no obstruction from other equipment exists for the 5th axis movement. The collimator step motors will allow approaching the beam with an accuracy below 20 µm.

- During the review last year in Lyon it was decided to install the wires at first only in IP5 (CMS). This would be done by replacing the jaws of standard collimators with one featuring the integrated wire, one left (TCL) and one right (TCTH) of IP5.
- The wire is inserted in the collimator with a Glicop support, everything is done so the collimator can withstand the heat and provide sufficient cooling for the wire. The TCT and TCL functionality would be maintained. For the MDs where one would test these wires the collimators would not be used as such and be placed much closer to the beam.
    - Jan asked some precision on the orange component visible on slide 4.
        - It is a T-shaped support with brazing, allowing for support/clamping and cooling of the wire.
- Protection and interlocks: a temperature sensor on the collimator jaw and a voltage measurement on the wire will allow for diagnostics and interlocking in case of temperature runaway; the decision electronics will be implemented in a PLC and interlocked via the WIC nearby.
- The temperature of the collimator will reach 50 degrees; the hottest spot on the wire, not directly cooled because outside the jaw, would be at 400 degrees.
- Tests in vacuum are being conducted now. Measurement of the temperature of the wire will allow defining the algorithm to protect the wire if the voltage drop across it is used as an integral measurement of the wire temperature.
    - Giuseppe asked if it is the same thermocouple as for the collimators.
        - It will be a different one intended for higher temperatures. This is a different setting than the operational one (in operation only measurement on the collimator jaw). The worst case would be to melt the wire but it is cased in steel so it won't deteriorate the collimator nor the beam vacuum. Only the beam-beam compensation would be lost. The beam will be dumped if the collimator jaw temperature reaches 50 degrees.
    - Jan commented one would have to make sure the power in the wire is also cut via the WIC.
        - The wire will come with a dedicated protection system measuring the voltage. There is a month's delay with these first interlock tests, so the definitive values for the self-protection algorithm are to be confirmed.
    - Markus added it would be good to check the protection algorithm can deal with eventual voltage spikes during ramp up and down.
        - 300A should be ok as long as there is cooling.
    - Markus raised the concern that the PLC sees the full voltage of the PC, it could also see the full PC current in case of a short in these instrumentation's wiring. One would have to protect appropriately these voltage pickups to the PLC and the operator installing this instrument.
- Another aspect is the protection of operations from the wire: to protect from switching on the power converter by mistake, the maximum current is set at

300 and $\frac{dI}{dt}$ at 10A.s$^{-1}$. The kick from the wire in all the operational scenarios is always less than half a σ (2.6 µrad at injection).

- Jorg commented the interlock on the corrector downstream is 15 µrad, so this is a very small kick.
  - A SIS interlock will be implemented to dump the beam in case a state change is detected outside the MD period. This is considered sufficiently fast to dump the beam before the max kick is applied.

- During MDs, the collimator would sit as close as 4σ: if the current drops by accident it will be very fast but only safe beam will be in the machine and the kick will still be small: 0.8 σ.
  - Jorg added such a kick is even difficult to measure.
    - The max kick is always below the beam-beam effect which is 1.1 σ.
  - Markus asked about the connection to the WIC and the fact there is no difference between essential and non-essential magnets, which means if the system is broken it may prevent beam operation until this functionality is decoupled in the latest version of the WIC code (intended for deployment during the EYETS).
  - Jan added with these specifications, one would not want to dump if this fails. He also asked if the specifications for the WIC have been prepared.
    - Adriana will come back to MPP to present once the specs will be prepared.
  - Jorg concluded that – should an additional RBAC role be created for these 2 converters - the OP team should be assigned this RBAC role during MDs to ease operations.
  - Markus added one should check with EPC if an additional RBAC role can be easily undone at some point.

**Action: Prepare specifications for WIC interlocking of wire temperature via resistance / voltage supervision and present to MPP after the protection electronics and algorithm has been designed and tested (Coll-team, Adriana).**

### 1.3 Planned changes in $N_2$ pressure measurements of the TDE during EYETs and possible hardware interlocks (G. Bregliozzi)

- Some small modifications will be done on the dump line to have a better $N_2$ pressure measurement on the dump. The current system was relying only on the leak detection in the high pressure area.
- The new equipment will be installed in front of the vacuum to high pressure windows with an adaptation section on the pumping flange. A new piezo and Pirani gauge will be installed and the relief valve will be moved.
- Consequences: a better reading on the pressure in the TDE, more stable level for the 150 millibar overpressure.
- No Hardware interlock is foreseen as of today. The request should come from the equipment owner (STI) or OP.

- The system has a lot of inertia; it goes up to atmospheric pressure in days.
  - Jan asked if there have been some leaks.
    - Giuseppe confirmed that this was the case, typically a few millilitres per second leaks, the bottle was compensating it.
  - Jan stated if everybody agrees, one could have a HW interlock in this just like in the ring. If the valves are closed and the pressure rises in the CTD we should dump the beam.
    - We would already dump the beam if the overpressure is too low.
  - Guiseppe added that if there is a problem the beam will be dumped.
  - Jan answered if there is an interlock one could also prevent injection, for something this critical one doesn't want to rely solely on the SIS.
    - Jorg commented if one wants to go beyond the software level for such an interlock it should be included in the Vacuum interlock. Another way of doing it is to include this second signal in the Dump interlock.
  - Markus said there would be a possibility to do so (as the signal seems already to be routed to the VAC controller in UA63/UA67) and asked Guiseppe to follow this up.
  - Jan added one doesn't want to be pulsing the MKB on local when the vacuum is too bad.

**Action: Study possibility to connect new TDE pressure measurement to VAC controller in UA63/UA67 and implement a HW interlock via the vacuum system (Guiseppe).**

**AOB – Switch repairs on AFP roman pot (M. Rijssenbeek)**

- M. Rijssenbeek asked the MPP to state on his request: There has been a repair on a wire of the end switch on one of the AFP roman pots. It was done by re-soldering it. AFP asks if they need a revalidation for this.
  - Markus believes that there is no need for this, as neither the position nor the interlock limits of the pot were touched; so does Jorg.
  - Markus commented the Roman pots will not be used anymore this year.
  - Jamie concluded AFP should be inserted in the 10b fill during BSRT revalidation, this should be enough for validation.
    - Answer from MPP: the latter protocol is approved.
- Jamie brought up the fact that the ion run and especially the intensity ramp up has to be prepared.
  - Markus commented John has sent MPP the intended program.
  - Jorg added that the requested proton intensity/b is still under discussion (1E11 vs 2-4E10).
  - This subject will be discussed on Monday during LPC.