127th 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#126's minutes

- Actions from 126th MPP:
  - Discuss the protection and hierarchy (incl. phase advance between MKD and TCTs) for 2.5km optics (MPP, Coll, OP).
- No additional comments were received on the minutes; they are therefore considered approved.

1.2 Orbit interlocking strategy, interlock values and status of PC Interlock (J. Wenninger)

- The interlock settings of the SIS are stored in one non-multiplexed beam process (with settings independent of machine configuration) and 3 beam processes: one for injection settings, over cycle settings and stable beams settings.
- All orbit related interlocks acting on the beam permit are masked once the setup beam flag (SBF) is active.
- Most orbit related interlocks that act on the injection permit are equally masked if SPS intensity is below 5e11p+.
- Active interlocks are divided between global and local orbit interlocks and further sub-divided into b1 & b2 and in some cases horizontal and vertical
- An interlock configuration includes: reference position, window, status and the number of BPMs out of tolerances to trigger permit removal:
  - injection 10 bpm, +/-2mm
  - cycle 10 bpm, +/-1mm
  - Stable beams 10 bpm, +/-0.6mm.
    - Equivalent to an orbit change of 2σ in the dump region.
  - there is room to tighten these thresholds
    - Daniel: where are we sitting now?
    - Jorg: between +/-20% of these threshold in regular operation
- For the local interlocks around the injection region: +/-0.6mm and only 2 BPMs out of tolerance are needed to remove injection permit, it is active when injecting probes.
- For the local interlock in IR6, to ensure the beam doesn't move away from TCDQ and exposes TCTs:

    - Single sided interlock
    - Tolerance: 1σ at injection, 2.5σ at FT, which is actually bigger than the actual retraction of the TCTs from the TCDQ, justified by the (since recently) close to zero phase advance between MKDs and TCTs.
    - Permit removed when both BPMs are out of tolerance
    - Should be replaced by an interlock on the collimator BPM on TCSP (already in place, but still masked)
        - Daniel: The orbit interlocks use the BPM readings averaged over 20ms?
        - Jorg: Here the 1s average is used.
- Active COD interlocks are global COD interlocks at injection, cycle and flat top, COD failure interlocks for 60A circuits and the triplet orbit correctors (MCBX) current interlocks.
- Global interlocks are configured by beam and plane.
    - A reference kick, tolerance window and status is required per COD.
    - In every case two CODs outside the limits will induce a beam dump.
- MCBX interlock: introduced in 2008 when it was discovered that when injecting into an empty machine if MCBX is powered in a wrong way one could shoot beam into the detectors of the experiments.
    - A limit of 50A (~150 µrad) is in place as a last line of defence.
- The triplet positions are also interlocked since they can have an equivalent effect as a wrong powering of the MCBX.
    - Injection is inhibited if the triplet is in the wrong position.
    - The reference is established at the beginning of a run.
    - Tolerances are +/- 250µm at injection, for stable beam it is +/-10µm.
        - Daniel: what happens in case of a survey team intervention?
        - Jorg: Andrea knows we are interested in absolute position so he sends me numbers after each intervention.
- The 752 60A arc orbit correctors (MCBH and MCBV) were decided not interlocked by through the PIC to reduce cabling costs. Thus, there exists no hardware interlock for these circuits but a SW implementation (based on the CRYO_MAINTAIN_60A).
- The beam permit is removed if the kick is >5µrad (triggers regularly around the year)
    - A limitation comes from SEUs as no PC status is published anymore by the gateway, instead a CMW exception is thrown. Currently these exceptions are ignored.
    - Without decoding these exceptions, it is not possible to know if there is a true fault or not.
- COLL BPM interlock needs information from the applied optics. There is a table in the settings with beta* values, the reference emittance is set to 3.5µm, it calculates the beam size, normalizes BPM signals and then compares to the threshold.
    - The interlocks are operational but currently masked.
    - Currently used limits: 4σ except 1σ in IP1, 1.5σ in IP6, 2.5σ in IP8.

Action Coll WG: Review experience with Coll BPMs and propose interlock settings and an appropriate moment to activate.

- During the year the local orbit interlocks in IR6 should be replaced by an equivalent interlock on the COLL BPMs at the TCSP.
- PC interlock was designed to improve the CODs interlocks in 2012.
    - It would track time dependent interlock functions instead of 3 static values.
- PC interlock server provides one interlock status for all CODs, initially just one interlock for both CODs and Quads.
    - Jorg: this is more powerful than what we are doing now, we could unmask it and retire some old interlocks. I think it is ready now.
    - Daniel: does this require more complicated setups in the future, as functions need to be configured?
    - Jorg: These functions can be easily derived during the beam setup. Thus, there is no reason not to do it, we have never seen any hiccups.
    - Markus: unmasking means you have to redeploy the SIS?
    - Jorg: No re-deployment is needed; this is a very fast operation in the control room. Kajetan was happy with these slides, we should go ahead and do it in the next two weeks.

Action: Markus: check PC interlock server status and experience with stability, and Kajetan —> afterwards activate the PC interlock for the CODs around TS1.

- The PC interlock on Quads follows the same principle as the CODs, sends a separate signal to SIS.
    - Interlock tolerances have been tightened since the beginning of May
    - This week, even tighter settings should be set, ~5deg phase in the triplets.
        - Markus: what does this 5deg per circuit translate to in total phase shift?
        - Jorg: This is to be clarified by Kajetan. Nevertheless we should not set the limits initially too tight.

Action (Kajetan): Propose interlock limits of the Quad PC interlock to MPP.

Action (OP, COLL, TOTEM): Propose local orbit interlock for the TOTEM bump.

- 60A SEU failure mitigation: with current configuration an SEU of a COD with 5µrad kick will dump because of SIS COD interlock, SIS orbit interlock and BLMs at collimator positions.
- In order to rescue the beam in stable beams after an SEU we must stop the interlock on the CODs and wait a few minutes for the transient to pass.
- Action sequences: recognize faulty corrector, remove it from correction configuration recalculate SVD of the response matrix, and restart correcting the orbit.
- If one only focus on one beam and plane, it should take 2-3 seconds.
- Two example of tests carried out.

- A first test on H orbit, correction was not good enough.
- V orbit should be ok, could be finished off by manual correction after transient.
  - Jorg: no SEU yet, usually 1 per fb^{-1}
  - Jorg: we can now make a proposal on the interlock values by the end of next month.

1.3 Requested AFP/TCL studies (M. Trzebinski)

- This is a proposal for the insertion strategy of AFP and TCLs to study radiation impact of AFP onto the ALFA electronics and extend the AFP acceptance.
- The first proposal would require moving TCL5, TCL6 and AFP. This would be a one-time study and can be done with 3b.
- The radiation in ALFA is mainly due to the TCL6.
- The proposal and the current approach which was done until 600b can be seen in the tables (see slides).
- AFP is losing a significant acceptance when the TCL collimators are closed (mostly 4 & 5), which makes AFP especially insensitive events of high ξ, i.e. mass. As these events are really interesting the goal is to improve this acceptance. Since the losses in TCL4 and 5 are highly correlated, one would need to open both collimators to improve acceptance. (see plots on slide 5)
- Second proposal: open TCL4 and 5 up to 25σ, one could do 21/45 and then 27/55, while monitoring AFLA for safety.
  - Jorg: the TCLs are not installed to be opened, one has to check the cleaning efficiency.
  - Roderik: we have to check offline the numbers with COLL.
  - Daniel: To get input from all relevant parties, the proposal should be summarized in an MD like procedure, which then can be distributed and approved.
  - Maciej: A document summarizing the presented request has already been prepared and was circulated in the ATLAs community. It will be sent on Monday.
  - Roderik: in the current plan you don't want to have them more open than designed.
  - Maciej: correct, we want to see the effect of opening them more.
  - Daniel: we need to give the people time to digest your proposal and do a round of approval.
  - Jamie: AFP should follow the standard procedure and these tests should be done in the ramp up after TS1, there is some time pressure to converge to a proposal due to the TS1 next week, to be seen with ATLAS run coordination.
  - Roderik: if you want to do this with 3b it is ok, TCLs are not needed and you can open them a lot.
  - Jamie: there are 15 minutes between steps, so it wouldn't last hours. I don't understand if this is for tests only or for future settings? Steady state setting is difficult because at high intensity TCLs have to be closed.

- Daniel: at the end of TS1 it is doable for tests. We need to make sure than we don't do it with more than 3b.
- Roderik: what is your plan exactly?
- Maciej: we could do this with low intensity to get arguments to ask for it in normal operation.
- Daniel: high intensity tests to confirm acceptance measurements can only be done after a first 3b validation fill. This step will however require an independent document and preparation (including e.g. COLL sequences for movement & modification of COLL limits as SBF cannot be used above 3b).
- Jamie: can't we try this with simulation and not use the full machine as a test bench?
- Daniele Mirarchi: we did some simulations presented on COLLWG#200, as well as some EoF studies in September.
- Daniel: would be good to contact Daniele and check with him. If no additional comments, we go for this.

Action: prepare procedure for the proposed study 1) new insertion proposal (to be used after TS1); 2) measure acceptance versus TCL positions.

1.4 Recent observations in diamond detectors signal in the SPS extraction and LHC injection regions during 72b injections (F. Burkart)

- Intro on layout and reminder on dBLM characteristics and goals (see slides).
- The high losses in the injection region of the LHC during 72b train injections come from recaptured beam in front and behind the extracted bunches.
- We can see the extracted particles sweeping over the TDE and the extraction channel.
- Some particles at the beginning of the rising edge of MKE make another turn in the SPS and one can see their loss signature 23µs later in the SPS dBLM data.
  - Jan: where is this dBLM exactly?
  - Florian: 40 cm downstream of the TDI.
- The losses from recaptured beam present a 5ns structure (200MHz) this identifies that it is recaptured beam from the SPS.
  - Are there no losses on the LHC pipe during MKI flat top?
  - We only see the tails being scraped in IP7.
- The MKI flat top is long so we see recaptured beam being cleaned at the next injection during the MKI rise time.
- These measurements also allow empirical confirmation of the MKI rise time.
- Last week: really high loss signals were recorded at the beginning of MKI FT, when ghost bunches were impacting on the TDI.
- The difference between B1 and B2 comes from the fact that the FT of MKE in LSS4 is longer.
- We also see long plateau losses before the MKI rise and after the fall, coming from recaptured beam in the SPS.

- Empty kicks were performed before injection to clean and reduce the losses during injections. Losses during these empty kicks indicate that there are particles/bunches injected into the LHC after the train and then stored.
  - Example on B1 from 27/05 between 3:01-3:04AM injections in the LHC, one can see a 25ns structure during the MKI rise time.
    - Jorg: could be dark bunches (very low intensity) making it all the way from the LINAC or the bunch splitting in the PS that could make extra bunches.
- B2 data from the same day are much cleaner.
- The situation is probably much better for 288 bunch injections (as seen also in the past).
- Open question of the timing of the injection gap cleaning?
    - Daniel: The plots show saturation effects. Are these due to settings of the scope or limitations in the readout chain electronics?
    - Florian: It's mostly due to the settings in the scope, which need optimising.
    - Daniel: it's good that the data are in PM, everybody can now access and use them.

Action: Make the diamond data more broadly available, e.g. in the IQC.

AOB - Status update of MPS commissioning procedures

- Quite some progress since Chamonix, thanks to everyone.
- The final commissioning procedures including the comments from the approval are still missing for five systems (BLM, INJ, LBDS, VAC and SMP). This was also mentioned in the LMC yesterday. It would be good to do a last effort and finalize the procedures.

AOB - General

- Depending on TS1 status next week, we can have a meeting next Friday 3rd otherwise it will be on the 10th. TOTEM will talk about the 500µm margin they want to remove before high luminosity fills.