D. Wollmann

57th Meeting of the Machine Protection Panel

Chair: M. Zerlauth

Participants:
R.W. Assmann, N. Bacchetta, J. Baechler, T. Baer, J. Blanco, F. Cerutti, B. Dehning, M. Deile, A. Di Mauro, B. Gorini, K. Hiller, L. Lari, E. Nebot, A. Nordt, G. Papotti, S. Ravat, R. Schmidt, J. Uythoven, J. Wenninger, D. Wollmann

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/MPP-Minutes-2012.html

1.1   Roman Pots - Follow up of improvements deployed during X-mas break – (M.Deile)

- Common presentation for TOTEM & ALFA and summary of EDMS document 1203969.

- Motivation of RP improvements:
    o Problems in the motor step counter reset procedure.
    o RP extraction (Stable_Beams=0, Override=0) even when RPs in HOME position
    o Lesson from incident in 11.2011 (ALFA)
    o Operation deadlock due to hardware fault (TOTEM FESA FEC)

- What was done:
    o Modified Finite State Machine. Commissioning tests were performed for TOTEM and are currently performed for ALFA. Results of these tests can be found in the Collimation elogbook.
    o Improved step counter reset procedure (OUT stopper & HOME switch ➔ stop movement; IN stopper & NOT Home witch ➔ stop movement). Test results of this procedure can be found in the collimation (TOTEM) and OP (ALFA) elogbook.
    o Modification in Interlock logic. NOT_BACK_HOME was defined to avoid a false spring extraction, when all RPs are in home position.

D. Wollmann

- o LVDT Bypass Box: The idea is to have the possibility to bypass the LVDT position interlocks, if and only if the RP motors are disabled. The keys to activate these functions will be placed in the CCC. The bypass boxes are installed in the respective IPs. The design is failsafe, i.e. if 24V power supply in the bypass box fails, the LVDT position interlock stays active. For details see EDMS note 1183242 by Xavier Pons.
- FESA switch-over box (TOTEM only): Two FESA FEC have been installed, to improve availability of TOTEM. In case of a communication loss to FESA1, which will block the movement of the RPs, this allows to switch to FESA2. This module will then boot and allow the movement of the RP again.
- Wish list for CCC top level application:
  - o Display redundant inner limits.
  - o Human-understandable error messages.
  - o Improvement in naming conventions.
  - o Update out switch button positions and rename to OUT stopper.
  - o Add button for real OUT Stopper.
  - o Add beam based alignment tab to production version.
  - o Display difference between motor and LVDT
- Homework for LS1:
  - o Commission resolver measurements.
  - o Add warning level to the "new" redundant inner limits (needs FESA work).
  - o Add emergency extraction button to CCC application (update of FESA needed).

Discussion:

- Ruediger: Who is responsible for the software. Answer: Low level is done by Sylvain, top level by OP/Collimation (Stefano).
- What is the reason for the state ARMED? Ralph comments that this is an important state to synchronize the movement of the different devices. Currently this is not exploited with the RPs as they are moved one by one,

but as soon as the RP systems work fully reliable this should be used. Moving the RPs in a sequence and in parallel is only possible due to the ARMED state.

- Bypass box: There is an independent injection permit from TOTEM (for ALFA it is daisy-chained with the ATLAS injection permit and thus not directly visible to the CCC). Only if the RPs are out, the beams can be injected into the LHC. To get also an independent injection permit signal for ALFA, some additional hardware has to be installed and connected to the injection BICs. This should be foreseen for LS1.

- The FESA switch-over boxes are in IP5. Markus comments that it maybe worth to do the commissioning tests with both FEC boxes. Mario points out that this may not be needed, as the FEC boxes load the compiled, unique binary from the server, thus, there is no risk of different software versions.

- Error messages in the top level applications: Jorg and Markus comment that the error messages are standardized. The display could be adjusted to only show the most important first line, but operators are used to this kind of (long) Java exceptions.

- Is there a cross-check between LVDT, resolver and step counter? The resolvers are not commissioned. Sylvain has implemented a comparison between LVDT and step counter, but at a loose level, i.e. 0.5 mm.

- It is important to display the redundant inner limit in the CCC application. Ralph comments that it would be helpful to have one plot with all limits.

- A warning level for the redundant inner limit would avoid unnecessary dumps, as hitting this limit would cause an automatic extraction of the pots.

- Markus comments that TOTEM and ALFA should define priorities to the wish list for Stefano.

- Markus asks, when the ALFA bypass-box will be finished and installed/commissioned? Mario answers, that Xavier is currently modifying the existing boxes with the exact circuitry as in the TOTEM box. If it doesn't get ready before the start of the machine the test of this box can only be done during a technical stop.

- Jorg requests from Mario to bring the bypass box key to the CCC as soon as we have beam in the machine.

- The beam mode tests with TOTEM and ALFA should be performed in parallel. Jorg comments that this should be envisaged for the coming weekend during the day (probably Sunday).

- Markus requests to send the report of the changes as soon as possible to the MPP distribution list, to give the people enough time to go through it in detail.

1.2 Overview of single bunch asynchronous dump failures on collimators (L. Lari)

- Each MKD was studied separately to identify the failure cases, which cannot be caught by the TCDQ.

- Input for the studied cases is the 2012 optics (4 TeV) from ABP, with the so-called tight collimator settings.

- A 1.5mm misalignment of the TCSG was assumed, which is equivalent to a kick of $1.7\mu rad$. The bottlenecks in B1 in this case are the TCSGs in IR7. For B2 the bottleneck is the TCP in IR7.

- Next steps are to simulate these worst cases using a Gaussian and a (measured) realistic beam distribution with SixTrack. In addition there is an ongoing study considering magnet errors. Furthermore the change of the collimator aperture will be studied.

Discussion:

- Jan comments if one kicker spuriously fires the other MKDs will be re-triggered soon afterwards, so a single MKD firing is a non-realistic case. Ralph answers that this approach is valid as the collimation team is mainly interested into identifying the phase-space holes, which could cause a single bunch to hit a TCT.

- Rudiger asks, when the other kickers would follow the failure of one MKD? RWA, Jan: The rising time is about $0.9\mu s$. This discussed study only considers the first bunch, which can escape the TCDQ in such a failure case.

D. Wollmann

- Jorg comments that assumed the TCDQ alignment error (~1.5mm) could be caused by the orbit, i.e. we would also see an offset at the TCSG in IR6. Ralph comments that if we assume the IR6 TCSG at the correct position there would be no failure scenario. The failure case needs to assume that TCDQ and TCSG are bypassed.

- DW comments that it is surprising to have the TCP in IR7 as bottleneck for B1, as the phase advance between MKD and TCP should not be favorable (~50 degree). Ralph comments that the result of the study shows that we do not need to worry about the TCTs in IP1 and IP5. The TCPs and the TCSGs in IR7 can take the hitting of a bunch.

- It is clarified that only a few percent of the beam would end up at the TCTH in IR2, if all collimators in IR7 are open. In the second turn the remains of this bunch should be dumped.

- Jorg comments that we don't see any losses in IR3. Could we move them further in to increase the off-momentum protection? Ralph answers that this is an option to be considered. The only drawback could be that this would increase the impedance. Jorg adds that we should not spoil the chromaticity measurements during operation, by putting IR3 collimators (momentum cleaning) too far in.

- Bernd comments that a plot with impacting beam normalized to the destruction limit of the respective collimator could ease the interpretation of the results.

1.3   Calculations of margins in collimation hierarchy – (R.W. Assmann / R. Bruce)

- Collimation hierarchy margins in IR7 are not critical for machine protection, as a violation would lead to a reduced cleaning and in the worst case to spurious dumps.

- In 2010 and 2011 the margins in IR7 were calculated by keeping the same retraction as at injection, to provide room for machine imperfections

- For 2012 reduced margins based on empirical studies are proposed.

- If margins IR6-TCTs-aperture are violated, sensitive equipment might be exposed during the unlikely case of an asynchronous dump. These critical margins were calculated based on in-depth analysis of previous runs.

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- How are the margins defined:
    - Measured orbit with 99% confidence interval (~3sigma probability), result: 1.1σ needed between IR6-TCT and TCT-aperture.
    - β-beat: assuming 10% larger beta at the TCT and 10% smaller beta at IR6. Between TCT and triplet a β-beat error is not added as there β-function is closely connected.
    - Collimator positions: 40μm
    - Setup errors: 10μm
    - Luminosity scans 0.2σ
- So far assumed a linear summing. Now the errors are considered as statistically independent random errors and are added quadratic. Note: The luminosity scan margin is added linearly. Additional 0.4σ between TCT and IR6 have been added to get enough margin for the orbit interlock in IR6.
- What can happen:
    - Asynchronous dump (probability 10^{-7} per second)
    - IR6 and TCT out of orbit tolerance (10^{-2})
    - Maximum β-beat at IR6 and TCT (10^{-2})
    - Both errors into the same direction (0.25)
        - This could cause a single bunch hitting the TCT, which would "only" cause a groove in the TCT.
    - TCT out of tolerance with respect to triplet aperture (10^{-2})
    - Fully squeezed and separated
    - Beam with additional offset as reserved for van-der Meer scans
        - Then triplet aperture can be hit by a fraction of a bunch, if conditions for the TCT hit are met.
- Conclusion: It is extremely unlikely that anything happens.

Discussion:

- One asynchronous dump per year was assumed for 7TeV.
- Jorg comments that the TCT margins are only true for IP1 and IP5. If we go back to the old separation we need more margin for the IP2. Ralph

answers that in this case we could open the IP2 TCTs to the real protection settings in IP2.

- Jorg asks if it would not be better to open the TCTs a bit further (keep them for local protection) to transfer some losses from them to IR7. Ralph replies that currently collimators are considered for passive protection and therefore put as close as possible in during operation.

- Markus comments that therefore we keep the BLM thresholds in the TCTs as last year, to catch a possible problem with the BLMs.

- Jorg proposes to perform the asynchronous dump tests with the TCTs moved closer to the beam to learn more about the real margins, i.e. repeat the tests we did in 2011 when going to 1m β*.

- Mike comments that 99% for bad orbit would mean one fill with a bad orbit offset per year. Ralph answers that this is only one failure and leaves us with a lot of redundancy.

- Mike comments that the β−beat is very stable and we could therefore use the measured β−beat. Ralph answers we would then gain more margin for β*.

- Mike: Do you really believe that the setup errors are only 10μm?

- Ruediger: A more dangerous case would be a bump developing during operation at the triplet, an asynchronous beam dump causing a bunch hitting a collimator, which then could cause a quench of several magnets

- Ruediger proposes to measure the β in IR6 and put the TCDQs and TCSGs tighter, if possible.

1.4   Miscellaneous

The next meeting will take place on the 23rd of March. During the 'MPP slot' on the 16th of March, a meeting on Quench margins will be held (see announcement of M. Szapinski).