68th Meeting of the Machine Protection Panel

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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/

1.1 Collimation: How to avoid wrong collimator settings (e.g. beam centers) after alignments? – (S. Redaelli / G. Valentino)

- Collimator settings are heavily interlocked but necessary human input can lead to errors.
- There were two problems found after the alignment in the beginning of the 2012 run:
  - TCT collimators in IR2 had the wrong centre, which was caused by a human error in the input of the settings. Caused worries, but as only the vertical plane was affected it was uncritical for protection.
  - 2 collimators in IR3 had wrong centres, due to a human error and a bug in the setting generation tool.
- Collimator interlocks: inner and outer position thresholds cause beam dumps in case of a violation. In addition there are redundant maximum gap versus energy and betastar limits.
- Validation procedure applied so far: Settings are established during alignment campaigns (beam offsets / centres). The actual jaw settings are either generated with external tools and loaded into LSA or directly created within LSA. Afterwards a manual verification by different collimation team members is performed and systematic checks of transition settings (e.g. injection to ramp, etc.) are performed.

- All settings are verified by low-intensity cycles and by loss maps in the different machine configurations.
- In addition online tools for verifying the collimator gaps are available in the CCC.
- The error in the TCT centres in IR2 was discovered during the analysis of beam centre variations from logged data. A wrong sign in the jaw position caused the error. The settings were wrong by up to 4 sigma. As the error appeared in a vertical collimator the machine was still safe, although the leakage into the affected TCTs was significantly higher.
- Measures taken to avoid future issues: The setup sheet is created automatically during the semi-automatic alignment.
- A setting checker software was developed (not available in the CCC yet), which reads the centres from the alignment Excel sheet, then these are compared to the collimator positions logged in the database. In addition the tool exports the settings used in LSA. These three sets of data are then compared.
    - Verena asks if this tool could also check the consistency of the interlock limits. Stefano answers that this is not yet done, but could be easily implemented.
- Future development:
    - Calculate LSA centres from jaw-set-values.
    - Implement the possibility to select between measurement and logging database. This will allow to make the check with fills older than 6 days.
    - Extend the tool for online checks to compare the machine at a time with the reference setup.
    - Tables will be implemented in LSA to store directly the measured jaw position.
    - Could be used to compare LSA and database positions after a power cut.

Discussion:

- Daniel asks if it would make sense to run this checking tool more regularly in the future? Stefano replies that this tool will probably be used to verify the collimator settings for the checklist. It is probably not useful to run this tool at every fill.
- Joerg comments that still all depends on the correct setup.
- Nicola asks why does one have to use an excel sheet and cannot directly use LSA? Stefano explains that the collimator settings are calculated with external tools from the data found during the alignment. Only after this treatment the settings are ready for LSA and can be implemented.
- Bernd comments that the BLM thresholds were so far calculated in an external C++ tool. Soon the functional dependencies will be implemented into an oracle database and only input parameters will be changeable via a GUI. Stefano mentions that he is also thinking about something comparable for the collimators. This would probably mean to implement the calculation of the jaw settings directly from the setup data within LSA.

1.2 Cryogenic BLMs (C. Kurfuerst)

- Cryogenic BLMS are still in the R&D phase.
- Motivation: At 7 TeV and nominal luminosity dangerous loss signals could be masked in the triplets by the debris from the IP. This triggered the idea to place BLMs closer to the beam pipe (loss location), i.e. in the cold mass.
- Investigated detectors are silicon detectors, diamond detectors and liquid helium ionization chambers.
- Diamonds are interesting especially for machine protection, as they have ns time-resolution.
- Warm and cold beam test were performed in the PS beam test area.
- Silicon, Diamond and LHe chambers were tested in a cryostat. In addition CIVIDEC diamonds were tested at room temperature.
- Results for the silicon detectors: Drift time of electrons and holes is reduced by 54% at 4.2K compared to room temperature. At 4.2K the drift speed comes close to its saturation velocity. The drift speed for electrons and holes gets close.

- In principle diamond detectors show the same behavior. But as the drift speed of electrons and holes in diamonds is closer to the maximum velocity at room temperature compared to silicon, the change of the drift speed at 4.2K is smaller than for silicon (28% compared to 54%).
- Liquid helium ionization chambers have a charge collection time of several 100μs. They therefore cannot resolve ns and are mainly interesting for steady state losses.
- Main disadvantage for Si detectors is the relatively high leakage current at room temperature during irradiation (~45μA at 100V with 1e15p/cm^2). At cold temperature this leakage should be significant lower. The radiation hardness tests at cold will be repeated in November.
- To gain first experience two silicon and two diamond detectors will be installed during LS1 in the Q7.R3, which is currently assembled on the surface (installation in October 2012). This magnet will replace the one currently installed in the tunnel.
    - Mariusz explains that BI is allowed to install another cold BLM into an MB. The idea would be to put it into a place with high losses.

Discussion:

- Bernd comments that Christoph looks into DC signals, as these detectors have a bunch-by-bunch resolution. The currently used standard LHC electronics is too slow for that.
- Nicola asks how fast the current electronics is. Christoph responds it is 40us. Bernd mentions that if we go to IR1 we could also use another solution and would not depend on the standard LHC electronics.
- Marius comments that it would be possibility to install another detector in the DS of IR7.

1.3 SPS: Fast extraction from LSS2, using the injection kickers in LSS1 - MD Results – (V. Kain)

- It is difficult to put extraction kickers directly into LSS2. Therefore a non-local extraction scheme is under investigation. The extraction kickers in

LSS1 or LSS6 (or possibly LSS4) could be used. At the moment the focus of the study is the MKP in LSS1.

- Using the MKP in LSS1 would create a big beam oscillation between LSS1 and LSS2, where the beam would be extracted with an extraction bump.
    - Jorg comments that there is not a lot of space in the aperture to the 5sigma envelope.
- Aperture quantification with SPS orbit simulations: The bumped beam has about 5.1-5.2 sigma, the extracted beam 3.7-3.8 sigma.
- Currently there were no show stoppers identified but many aspects need still to be considered:
    - Kicker upgrade, timing and controls
    - BI in transfer line and extraction region.
    - Machine protection: Interlocking of SPS ring and lines.
    - First beam about 2017.
- Critical aspects, which are specific to the LSS2 fast extraction:
    - Accidental large orbit bumps in the SPS arc.
    - Phase advance changes due to high amplitudes. Measurements show that this effect is negligible.
    - Design of machine protection systems.
- First measurements were performed in the SPS on 04.09.2012.
- Phase advance measurements do not show that the phases scatters within +-15 degree around the expected value of 20.5 degree. This is considered to be small. Note the measurements were quite noisy.
- Verena shows the LSS6 Master BIC, which decides between different beams. The BIC solution for LSS1 could be comparable and decide between injection and LSS2 extraction.
    - Jorg comments that one also needs to take into account LSS3, which interlocks the major part of the SPS magnets. Verena responds that this comes clearly on top of the described solution.
- The interlock controllers could be done comparable to the ones in LSS4 or LSS6: using local slave BICs and cables from LSS2 to LSS1 for a slave BIC results.
- To be defined, which equipment needs interlocking:

- Bumpers, septa, ZS out, orbit bump for circulating beam with BPMs.
- Transfer line power converter, trajectory and BLMs.
- Target.
- Orbit in arcs between kicker and LSS2.
- Tune phase advance via PC interlock.
- Intensity interlock.
  - Jorg comments that this needs to be done in hardware. In addition the other magnet currents also need to be interlocked.

- Extraction kicker in LSS6: As the kicker strength is limited in LSS1 one could also use LSS6. This solution would also need to cover the future short base line neutrino facility and laguna.
- The LSS6 Master BIC is already full. This needs a detailed investigation. And there is also AWAKE to be counted in. It is not impossible to go to LSS6, but probably not the favorite solution.
- Beam results for LSS1-LSS2 MD:
  - 17.09.2012, 110GeV, LHC pilot and nominal bunch. The LSS1 – LSS2 extraction works on paper and in principle
- Further test:
  - LSS1-LSS2 with more realistic beams and aperture checks.
  - LSS6-LSS2, 440 GeV with HiRadMat beam.
- Conclusion: Fast extraction works on paper and was tested with low intensity beam. Two solutions LSS1-LSS2 or LSS6-LSS2.
- Machine protection seems conceptually easier for LSS1, but should also be possible with LSS6. Interlocking on orbit and orbit correctors is critical. The non-local extraction would mean long cables. LSS2 /TT20 equipment (instrumentation and power converters) needs upgrade to be interlocked.

Discussion:

- How difficult would it be to upgrade for a local extraction instead of the non-local scheme?

- Jorg comments that LSS1 seems to be easier to upgrade, were as LSS6 upgrade would not be transparent to the rest at all.

1.4 Miscellaneous

- Jorg mentions the additional three cold loss spikes right of IR7 and 8, which have been measured in the recent B1 loss maps. The reason for these spikes is not understood. As they are significantly below the leakage in the dispersion suppressor they should not cause any problem. It would still be good to understand what the source of this change is. Therefore, it is planned to repeat some betatron loss maps in the coming weeks.