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72nd 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   Reactivation of ATLAS BCM Experience with improved logic – (A. Gorisek)

- There are 4 BCM detectors installed inside the volume of the PIXEL detector on every side of ATLAS.

- The ATLAS BCMs are used to protect against anomalous beam behavior and large losses. Therefore the new firmware version can distinguish between interactions and background. The time resolution of the BCMs is < 10ns. Therefore one can even trigger on special events. In addition they can be used to monitor the collision rate and background, as well as perform bunch-by-bunch luminosity measurements.

- Due to the ns time resolution the BCM system can distinguish between signals before collision ("out-of-time" signals) and signals, which are measured during the interactions ("in-time" signals).

- The biggest part of the signals in the BCMs comes from the collisions and only a very small part from the background.

- There were two BLM dumps from Atlas in 2011: 31.07. and 17.08.2011. Both events had an UFO like time structure. At these events the BCM abort signal was still increasing. When the BLM fired the interlock, the BCM signal was still very low (far from saturation).

- Event 31.07.2011 (the other event was similar):
  - The abort condition for the BLMs was 230 hits on both sides (A, C) and in two channels.
  - The BCM low gain channel, which is used for the beam abort, was at about 14% of the saturated signal, when the beam was dumped.

About 100MIPs are needed to reach the dump threshold of the BCM.

- Andrej explains the old beam abort conditions for the BCM: 3 Signals in BC out of 4 connected to ROD0 in coincidence with the same condition in ROD1 would trigger. There was no distinction between "in-time" or "out-of-time" signal. This means that also signals coming from the collisions could cause a trigger.

- BCM - beam abort conditions – new logic: It is required that 3 "in-time" signals on one side (A or C) coincide with 3 "out-of-time" signals on the other side (C or A) out of the 4 channels per side to trigger a beam dump (2 events after one another). This makes sure that no collision signals can trigger the BCM.

- The new system (RODs) has been in place since August 2012 without being connected to the BIC. Assuming a Poisson distribution with 39 million events the frequency of 3 coincident "out-of-time" hits is $\sim 10^{-5}$ in the past 55 days. 40 counts of 3 "in-time" events on A or C.

- There is no indication for any operational problems. No beam dumps would have been triggered – except during dumps.

- The ATLAS BCM was activated on Monday, 03.12.2012, which gives the last opportunity to gain experience with beam before LS1.

Discussion:

- Markus asks if any changes in the BCM signals were observed since the beginning of the scrubbing run. Andrej responds that no increase in the event rate was seen.

- Markus asks if the correct feed through of the interlock signal to the ATLAS control system was tested after the re-activation. Andrej answers that this has not been done at this activation, but several times earlier. Markus comments that this should maybe re-tested. Ruediger states that one could maybe lower the threshold in the BCM such to trigger a beam abort. This would allow testing the correct functioning through the whole beam abort chain.

1.2 Redundant channel for triggering of LBDS (S. Gabourin)

- Stephane reminds us on the layout of the beam permit loops in the LHC.
- LBDS synchronous trigger: The Trigger synchronization loops (A, B) can trigger a synchronous dump. The system is fully redundant, except for the common 12V powering system.
- The common failure mode in the 12V line on the VME bus of the TSU crate will be mitigated in LS1.
    - o Markus asks where the cards are distributed physically. Stephane responds that the cards are all in the BIS crates.
    - o Ruediger wants to know, who was in charge of writing the software for the beam frequency signal. None of the people in the meeting can answer this question.
- Asynchronous beam dump trigger: if there is a problem with the trigger fan out, the TSU signal will trigger an asynchronous dump 200us after the synchronous dump request.
    - o Ruediger asks where the re-triggering boxes are physically placed. This will be shown later in the talk.
- A new BIS - re-trigger line will be installed. It will trigger an asynchronous beam dump with a delay of 250us after the dump request. This re-trigger is derived from the BIS-generator card (CIBG).
- The trigger delay units will be installed in the BIC racks (UA63 for B1, UA67 for B2). This channel needs to have a high dependability, not to trigger asynchronous beam dumps unnecessarily.
    - o Jorg asks if the direct dump BLM is connected to the TSU and therefore is still synchronized. Jan confirms this.
    - o Markus comments that the availability of this re-triggering line could be checked after each dump in the post mortem. Ruediger mentions that 1 asynchronous dump per ten or twenty years from this re-triggering unit maybe acceptable, but not more.
    - o Bruno comments that the re-triggering is made by an analogue delay, as used in the other triggers. This system is highly reliable.
    - o Markus comments that this channel needs to be actively triggered (i.e. high active). Therefore if it is unplugged it will not trigger.

- o Jan comments that it is not clear if a 1-out-of-2 or 2-out-of-2 redundancy is best for the dependability of this implementation. Markus responds that the requirements for e.g. a highly reliable BIS design and this additional link are quite different, thus alternatives to the 1oo2 option should be looked at.

- There is an upgrade planned for the CIBG board to integrate a third channel (for the re-triggering). This new CIBG boards + firmware could then probably also be used in the SPS.

  - o Markus points out that the solution with a re-design of the CIBG is new to him. This could be one solution, as a re-design was anyhow foreseen for the near future. One could maybe already now use the beam permit signal in the current CIBG boards. A re-programming may therefore be sufficient.

  - o Jorg comments that there is no re-triggering channel in the SPS, but a new CIBG should still probably be used.

  - o Stephane asks, if it is really needed to re-design the BIS CIBG for the re-triggering. Jan responds that the TSU is very complex. Although its design was done very carefully, a few faults were identified. Therefore a simple redundant asynchronous triggering line needs to be installed.

  - o Jorg mentions that there was earlier a discussion to have a better access to the dump triggering in case of a non-working transmission of dump requests. The BIC-CIBG re-triggering solution is very much in line with this request.

  - o Ruediger enforces that the additional BIC dump re-triggering has the highest priority from MPP for LS1.

1.3   Q20 TCDI settings – (J. Uythoven)

- Jan reminds us on the presentation given at the LMC on the 21.11.2012 on the same topic.

- After TS3 the optics in the SPS was changed to the so-called Q20 optics (from Q26) and the transfer lines had to be re-matched. The change of the

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beta-functions at the TCDIs was expected to be small. No explicit verification of the TCDI settings was done within the injection team.

- In preparation of another LMC presentation on losses in the transfer line, it was discovered that the protection with the new beta-functions in the transfer line was not as good as it should have been. Differences in the settings up to 1.3 sigma on some collimators were found.

- After this discovery the TCDIs were immediately moved to the corrected settings and validated with beam.

- Conclusions from ABT:
    o It was only assumed that the optics wouldn't change significantly in the TL.
    o Optics had never been changed in the TL before.
    o As the trajectory could be steered back to the Q26 trajectory, the above assumptions were thought to be correct. Normally there is no need for a re-setup if optics doesn't change.
    o The procedure agreed in LMC for the optics change was not followed.
    o No clear responsibility in ABT for TL setup and checks.
    o Quick test was used to make the new optics operational as quickly as possible.
    o No regular meetings in ABT, thus, there was no discussion about possible risks for machine protection.
    o Communication of procedures and a checklist by email is not good enough.

- Proposed improvements:
    o Define clear responsibilities. One person with the overall responsibility, defined ad hoc per case.
    o Formal preparation, with discussion, what the machine protection implications are.
    o Define procedures, put them into an EDMS document and send to (r)MPP.
    o This should be applied to in case of any change in machine operation, change of optics, MDs, … .

- In case of urgent hardware problems (e.g. masking LBDS signals) force the people to sit together and write the procedures down.
- Use a template of key questions.
- The 25ns was used as a test case to go through the procedure. It was discovered, that a meeting one week in advance is too late to go through all discussions and the formal approval. But clearly there was a lot of feedback from experts. The document was left as procedure in the CCC.
- There is a formal role of approval for (r)MPP for these changes. This should also be applied for MDs (already in place), other equipment groups and special machine events (like ions).
- There is a specific solution foreseen for the TCDI: position interlock limits, based on dynamic beta's and limits in sigma. Glen will look into this ABT project for LS1.
  - Jorg comments that one needs to be very careful not to block the whole SPS extraction with such a check.
  - Richard comments that this type of check could be done with a mapping.
  - Ruediger comments that is clearly not a fast project. There are two years to find a reasonable solution.
  - Jorg mentions that one solution could be to put the transfer lines into the SPS (instead of the LHC).
  - Ruediger states that one could look also into a more generic tool, as a comparable problem (timing issue) recently appeared. In addition this tool could also cover the ring aperture. At some point this ABT project should be broadly discussed and become a formal project.
  - Markus comments that in case it is not possible to have an automatic check tool this needs to be done by procedures.
  - Jan points out, that clearly MPP should have been sitting down, before putting Q20.

Discussion:

- Ruediger comments that the handling of MDs will be discussed in the upcoming MPS workshop document. In general a longer preparation time with detailed MD requests is required. Giulia states that for MD4 there was no dedicated meeting to discuss all the MD requests. This was one reason for the late changes.

- Richard asks about the dump procedure, in case the TDI falls into the beam. The majority of people in the meeting assume that this can be captured by the BLMs, if the LVDTs do not dump before the jaws touch the beam.

- Roberto Losito presented the details of the TDI "falling" into the beam in the last LMC.

1.4   Miscellaneous

- Richard asks if the BLM thresholds in the IP8 triplets should be reviewed before the end of LS1. Jorg responds that this applies also to the other triplets. The thresholds clearly need to be reviewed. The BLM signal levels in IP8 are higher then in the other IPs, as there are neither TAN nor TAS installed in IP8. Ruediger mentions that one also should talk to cryogenics, if there is sufficient cooling power.

- **Action:** Outlook for 7TeV thresholds in triplet to be discussed in MPP workshop in March.

- **Action**: Talk of Antonello on abort gap population monitoring for MPP beginning of January.

- Ruediger mentions that there are student projects planned to look into certain dependability aspects of the machine protection systems.(redundant BIS-LBDS link, powering system,...) This is a collaboration with the University of Stuttgart. This will be discussed in the next TE-MPE section leader meeting. OP and ABT should be involved in the supervision.