Machine Protection Working Group

Minutes of the 56th meeting, held 5th May 2006

Present: R. Assmann, R. Bailey, D. Bolian, B. Dehning, R. Denz, S. Hutchins, D. Kramer, R. Lauckner, V. Montabonnet, L. Ponce, B. Puccio, P. Pugnat, L. Serio, R. Schmidt, R. Steinhagen, B. Todd, J. Uythoven, J. Wenninger, C. Vernich, M. Zerlauth.

Meeting Agenda:

- Issues Around the 'Cryo OK' Signal [RD]
- LHC Abort Gap Monitor [SH]
- LHC Workshop at Divonne – Beam Related Commissioning [RS]

R. Schmidt began the meeting; there were no comments or additions to the previous minutes.
R. Schmidt relayed information confirming that it is extremely unlikely that the LHC sector test originally proposed for the end of this year would take place before 2007.

Issues around the Cryo OK signal [RD]

R. Denz made a presentation describing the issues surrounding the implementation and function of a Cryo OK signal. Traditionally Cryo OK has been used as a power permit, being required to start powering, but not being used to abort powering, this has been carried out by operators reading supervision data and manually aborting the powering. In the LHC this approach is not adequate, where an absence of Cryo OK is needed to automatically force a slow power abort; this will avoid quenches and will keep the behaviour of LHC magnets consistent, as even a small temperature change will affect the field strength of a superconducting magnet. **R. Schmidt** asked that this effect be quantified. An automated request for slow abort has the advantage that the Cryogenics operation can be left unmanned, **L. Serio** said that a disadvantage of an automatic sequence cold be a reduced system availability, **R. Denz** qualified this by describing the situations leading to a Cryo slow abort, all of which are events that should definitely result in a sub-sector being powered down, as they all rapidly lead to a quench.

R. Denz continued to describe three different methods for the interconnection between Cryo and PIC, progressively becoming more reliable:

1. Cryo Supervision to PIC Supervision
2. Cryo PLC to PIC PLC via Ethernet
3. Cryo PLC to PIC PLC via a dedicated hardware channel

R. Denz summarised that the intended action is to eventually link the Cryo and PIC PLCs via Ethernet, implementing a data-transfer and safety watchdog to ensure safe operation. LHC Hardware Commissioning will be used to determine the correct settings for the system and the link will be activated before the LHC is put into operation. **L. Serio** suggested that Cryo OK could be considered as effecting availability of the LHC rather than the safety of the LHC, **R. Denz** added that having an automated procedure like this would make the running of the LHC smoother.

R. Steinhagen added that special care should be taken not to over design the safety watchdog, as a known bug exists in CISCO routers (~140 in LHC) and switches (~1400 in LHC) that can lead to data loss lasting several seconds that could result in timeouts leading to unnecessary slow aborts.

Action: Quantify the effects of small temperature changes on field Characteristics of relevant LHC Magnets [AT-MTM et al]

LHC Abort Gap Monitor [SH]

S. Hutchins made a presentation introducing the Abort Gap Monitor to be used in the LHC, in principle the device monitors the synchrotron radiation from the D3 magnet and undulator, taking 33 samples spaced at 100ns intervals in the 3.3us abort gap. The beam current is used to compensate for variations in the synchrotron radiation from the sources due to various environmental effects, essentially normalising the abort-gap content to the total number of protons in the ring, this leads to a direct value of the number of protons present in the abort gap. **S. Hutchins** showed the results of calculations that mean the device has to be able to detect as few as 7 photo-electrons at 7TeV. This year the current implementation of the Abort Gap Monitor is to be tested in the SPS beam at flat-top to try and give some performance figures with respect to the existing SPS equipment.

S. Hutchins asked whether the output of the AGM should be used to trigger a Beam Dump, or whether the results should just be made available for evaluation. **Various members** suggested that the function of the AGM is not safety critical explaining that even if the abort gap was found to be dirty, cleaning procedures could be initialised to clean it. **R. Schmidt** suggested that the AGM should be used after an injection to be sure that the abort gap is good before ramping the machine energy.

R. Schmidt questioned how the abort gap sampling procedure is to be synchronised to the abort gap, **S. Hutchins** explained that the Beam Synchronous Timing is used to trigger before the abort gap, **R. Lauckner** and others suggested that the source of the synchronisation should be the same as that used for the beam dump system, which is a direct RF output signal in IR6.

J. Wenninger asked how the mirrors that are used to align the monitor are interlocked, and whether SPS still had mirrors inside, **S. Hutchins** said that SPS alignment mirrors will not be used until around August this year, and in LHC the alignment mirror is on a periscope that is well interlocked.
R. Schmidt asked that clarification be made to ensure that this periscope is attached to the Beam Interlock System.

Action: LHC Sequencer should check abort gap before allowing ramp [Various]
Action: Determine the interlocking strategy for the LHC AGM Mirror [SH]

LHC Workshop at Divonne – Beam Related Commissioning [RS]

R. Schmidt made a presentation concluding the information for the MPWG discussed in the LHC @ Divonne workshop, specifically focused on the LHC Beam Related Hardware Commission. For the Machine Protection System Commissioning it needs to be decided what commissioning will need to

be done, and by whom. This information needs to be discussed in the LHC Commissioning Working Group (LHCCWG) and then passed on to the LTC.

R. Schmidt explained that it is widely understood the LHC MPS is a significant factor in the overall operation of the LHC, the MPS should be commissioned before general beam operation is allowed, and only by close collaboration between machine protection experts and a commissioning team will this be carried out successfully. Currently two groups exist that discuss commissioning: MPWG and LHCCWG, ideally the commissioning would be discussed in only one forum; this means that a choice must be made for the future of the beam related hardware commissioning:

1. Things between MPWG and LHCCWG can be left as they are
2. The MPWG can be stopped, moving everything to the LHCCWG
3. The topics related to commissioning can be migrated to the LHCCWG

R. Schmidt suggested that option three is preferred, and proposed the creation of a Machine Protection Team to undertake some of these functions, although the exact mandate and application of such a team is still to be discussed.

R. Schmidt continued by describing a list of topics arising from the LHC Workshop at Divonne that are still to be completed:

Management of Critical Settings: Specification is approved, next steps need to be decided and taken to implement this system.
Action: Organise the next steps for the MCS project […]

System Access from Inside / Outside CERN: A strategy is needed to ensure safe operation; currently **P. Charrue** is responsible for this. **Various members** brought up the difficulty of implementing this system, FESA development means such a low level change cannot be implemented easily, **J. Wenninger** suggested that a prototype system be created and implemented as soon as possible, **R. Assmann** expressed some concern that a rough system be used for such critical functions, **J. Wenninger** agreed, but suggested that work on securing the access could not start before 2007 unless decisive steps were taken now, in parallel with other system development. **R. Lauckner** added that eventually this system will be on the LHC critical path, and steps should be taken to ensure that it is implemented, even if this implies using a rough 'bricolage' to start with.
Action: Understand the implications of improving the safety of system access. […]

Machine Protection Systems required at Different Operational Stages: The LHC MPS will become available in stages, in coordination with the installation of the accelerator; **R. Schmidt** explained that a level of coordination is needed with the MPWG to ensure that the required systems are ready when they are needed.
Action: Coordinate an action plan ensuring that the MPS will be ready as required […]

Operation of Systems Connected to LBDS: Coordination needs to be maintained for the various groups concerned with the LBDS.
Action: Ensure coordination is maintained between LBDS and connected systems [LBDS]

Operation of Beam Cleaning System: A controls system is still needed for this system this includes management of critical settings for the collimators.
Action: Coordinate and plan controls for Collimations [Collteam + …]

Collimator Critical Settings: Critical Settings of the Collimators need to be calculated in detail.
Action: Calculate Collimator Critical Settings [Collteam + …]

LHC Beam Loss Monitor System: Commissioning and operational scenarios need to be developed for this system.
Action: BLM Operational Scenarios and Commissioning Strategy to be defined [LHCCWG]

Machine Protection System Commissioning: Procedures need to be written and verified for each part of the Machine Protection System, in a similar manner to that of the current Hardware Commissioning. **R. Lauckner** noted that written proof of testing is also likely to be required.
Action: Agree upon approach and formalise procedures for MPS Commissioning [LHCCWG]

Staged Commissioning: testing and acceptance criteria need to be defined for stages of commissioning, ensuring that all criteria are met and that the next commissioning stages are only undertaken when fully organised.
Action: Plan for staged commissioning [LHCCWG]

R. Schmidt then continued to describe some of the upcoming topics for the Machine Protection System, things that still need to be carried out in the LHC MPWG:

Grid Failures: Due to Thunderstorms / brownouts / blackouts various sections of the LHC may lose power. It needs to be understood how systems that are on UPS react, **R. Assmann** added that systems that are not on UPS such as the collimators need to be studied too, **M. Zerlauth** noted that preliminary studies show that the FMCM should be the first to detect this kind of event.

Moveable Objects: All objects that can move and touch the beam are to be interlocked, for examples, moveable detectors and wire scanners. A presentation should be made detailing the interlocking strategy for these elements. **R. Assmann** noted that the TOTEM experiment is to fall under the jurisdiction of the Collimation Controls.
Action: Document and Clarify studies regarding Moveable Objects [MPWG]

Extra Beam Instrumentation for Interlocking: various devices exist that are intended as interlock channels, but aren't actually completed, examples are the Beam Position Monitors in IR6 and Beam Current Transformers
Action: Document and Clarify progress regarding extra Beam Instrumentation [MPWG]

Experiment Interlocking: LHC Experiments need to be interlocked, this is still a topic being discussed.
Action: Document and Clarify progress regarding Experiment Interlocking [MPWG]

Safe Machine Parameters: For flexible machine operation the SLP project needs to be implemented.
Action: Document and Clarify progress regarding SLP [MPWG]

BLM Thresholds: BLM operation needs to be carried out with reference thresholds, the strategy for implementing these needs to be decided, as well as a suitable method to commission these settings.
Action: Plan BLM Thresholds [MPWG]

Other key items to provide information about are:

Interlock References and Tolerances
Software Interlock system
CNGS and Transfer Line Systems used in 2006
Closed Orbit and Machine Protection

R. Schmidt then continued by explaining some other key milestones that should be achieved within the MPWG. The various parts of the machine protection system that are needed at various times need to be organised, ensuring that the LHC MPS is delivered on time; this includes preparing the commissioning of the LHC MPS.

R. Schmidt continued to explain that the redundancy existing in the LHC MPS should be studied: looking into failure scenarios, and the reaction of the system to double failures, and the identification of common mode failures, this includes an analysis of worst case failures of the LHC, and procurement of spare material in the case of vast damage.

R. Schmidt concluded by adding that a core team of Machine Protection Specialists is needed, with tools to optimise system performance, this team would be responsible for undertaking the analysis of the commissioning required of the MPS, writing procedures, and presenting proposals to the LHCCWG, where LHCCWG and the MP Experts could then report to the LTC.

R. Schmidt also noted that the training of EICs regarding the Machine Protection is important, **R. Assmann** suggested that a more formal approach should be taken to EIC training, giving some ideas about EIC requirements in a small presentation

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Next Meeting
TBC

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