

Machine Protection Workshop revisited

Open issues, progress and decisions on major topics

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Acknowledgments: J. Uythoven, J. Wenninger, R. Denz,
S. Gabourin, G. Valentino, R. Bruce, MPP Members,
Participants and speakers of the MPP workshop 2013, ...

Disclaimer

- Overview of follow-ups with focus on commissioning and restart of the LHC. Items for the longer term (LS2 and beyond) have been left out.
- Based on session summary papers and summary to LMC.
- Short status for each item → further input needed in several cases.
- To be completed for Evian.

Outline

- Multitude of follow-ups for LS1 from MPP workshop (03.2013) on:
 - Material damage / failure scenarios
 - Moveable Devices
 - Injection / LBDS
 - Circuit related protection / Electrical Distribution
 - Beam Instrumentation
 - Operation / Software tools
 - Commissioning / Revalidation of MP Systems / MPP

Introduction






Multitude of follow-ups for LS1 from MPP workshop (03.2013) on:

- Material damage / failure scenarios
- Moveable Devices
- Injection / LBDS
- Circuit related protection / Electrical Distribution
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Priorities

- Item which must be completed before commissioning / re-start
- Work will commence and be followed-up but might extend beyond end of LS1 / be optional for LS1 startup
- Review open issues, progress and decision on major topics.

- Classification:
- | | | | |
|--------------------|---|-------------------------|---|
| • Done |  | • Will come during Run2 |  |
| • Ongoing |  | • Discarded / Postponed |  |
| • On critical path |  | | |


Material Damage / failure scenarios

HIGH PRIORITY! Review SBF equations (onset of damage depending on beam emittance and impact distribution, operational scenarios in view of MP and collimation).


- Review / update LHC failure scenarios and expected damage (single/two kicker firing, asynch. beam dumps).
- Understand protection level of triplet with presently allocated margins between TCT and triplet apertures.
- Update damage limit for tungsten collimators with realistic impact distributions.

Proposal compiled
→ Details see special presentations



Ongoing. Asynch. 
dump studies for TCT
damage presented by
L. Lari to 83rd and 85th
MPP.

???

Ongoing (Coll, EN-
MME). Updated 
numbers expected in
second half of 2014

Moveable devices



How to use collimators with buttons (interlocking, linking of LVDT-gap and button measurement, functional spec on how to use buttons).

- Improve collimation qualification strategy (reduced RF changes, number of qualifications)
- TCDQ upgrade: separation of position control and interlocking.
- TCT position limits as function of separation.

Functional specs for use of buttons in preparation. 😊

Ongoing.
→ Details in special presentation. 😊

3rd block, Resolvers as redundant measurement 😊

??

Implementation prepared (Coll low- level, telegrams reserved) as fall back solution, in case buttons will not work as expected.



Moveable devices

- Improved setting verification (plausibility checks).
- Protect changes of beam process.
- Improved handling of critical settings (only during day time ...).
- More responsibility for shift crews to validate machine protection critical systems.
- Fast vacuum valves.

Application available in Coll-team, to be deployed in CCC. 😊

Not obvious how to implement. 😐

TBD 😐

TBD 😐

No installation planned. Decision taken in LMC xx 😊


Injection / LBDS


HIGH PRIORITY! Redundant BIS-LBDS retriggering


HIGH PRIORITY! TCDIs: interlock transfer line optics via virtual beta* limit.

HIGH PRIORITY! Interlocking of SPS-LHC beam transfer.

- Consolidation of LBDS redundant powering.
- MSI current, TDI gap, TCDQ gap interlocking in BETS.


Reliability analyses finished. Production ongoing. CIBDS (V2) installed in tunnel for LBDS reliability run. (EMDS1368669) 

Functionality implemented in Coll. Low-level, telegram reserved. Final implementation autumn 2014. 

Issue mitigated in new LHC central timing. To be deployed on 27th October. 

Mitigations implemented and LBDS in reliability run???



All cables pulled. Installation progressing: TCDQ in coming weeks, MSI in summer, TDI for 2015 with calculated gap from LVDT. 

Injection / LBDS

- Refurbishment of TDI (redundant gap measurement).
- TDE block: pressure rise in case of repeated dumps @6.5/7TeV may cause pressure rise above the venting level.
- Beam position in TCSG (IR6) interlock from SIS to BIS.
- MKB vacuum interlock.
- Review number of (test)-pulses in local mode and necessity

Significant refurbishment of TDIs. Redundant gap measurement will be installed on spares ready to be installed in Xmas break 2015/16. 😊

Not critical for run2, as enough reserve on N₂-bottle in case of venting. 😊

To be decided after first signals with beam. 😊

Gauges and pumps have been replaced. Under study, if required improvement was achieved. 😊

Reliability program has been defined with this consideration. 😊

Injection / LBDS

- Scan of MKD waveform with beam and direct BLM dump test @injection
- Improve transparency in case of operation in “degraded” mode (reduced redundancy)
- Upgrade of MKIs.

During commissioning with beam 2015.



Procedure in place in case of PC replacement, which should avoid enlarging of tracking and interlock windows.



MKIs have been upgraded and installed in LHC. ???



Circuit related protection / Electrical Distribution



Full revalidation of QPS and BLM systems, due to complete dismantling.



Interlocking of fast power aborts for CMS, LHCb and 60A correctors.

- Perform specific powering test (e.g. CSCM) to identify potential limitations for post LS1 operation.
- QPS: Implementation of critical upgrades: remote download of firmware improvements.
- QPS: Mitigations to decrease system vulnerability: sanity checks, dependable configuration tools, enhanced automatic analysis, enforced validation after changes.

Starting soon.



CMS?; LHCb?

60A: PVSS logic corrected, PP60A telegram changes

Planned for sector 5-6 in June??



Not planned in LS1.

Partially during run2, latest with QPS2.



Improved supervision for parameter management and remote config implemented in HW. SW tools to be developed.





Circuit related protection / Electrical Distribution


- FMCM: improve rejection of network disturbances on sensitive items, dependability analysis.
- UPS consolidation: perform full-scale test of redundant powering for MP systems.
- UPS consolidation + new switching frequency.
- COD current checks from SIS to PC-Interlock.
- Extend PC interlock to other (non-COD) PCs.


Not before run 2.



Preparations ongoing, scheduled, pre-tests performed. 


factor 5 lower noise, 8kHz → 7kHz, final tests with ADT 10/11.2014 


CODs already checked in PC-Interlock. Will be removed from SIS. 

First improve COD tolerances (functions), then implement quadrupoles. → autumn. 

Circuit related protection / Electrical Distribution

- Revisit dependability studies for circuit protection.
- Review strategy of circuit classification (maskable / non-maskable / transparent).

Studied quench loop →
thesis of S. Guenther. 

Done for PIC in
agreement with ABP, 
apply also to Cryo, OP?
see 87th MPP

Beam instrumentation

HIGH PRIORITY! Beam Current Change Monitor (DIDT) (improved redundancy in beam loss detection after LS1).

HIGH PRIORITY! BPMS (IR6) improved dynamic range, PM buffers to XPOC (improve availability and machine safety).

- BLM: LICs in injection region + blindable crates.

HIGH PRIORITY!

HIGH PRIORITY!

BLM: Review of thresholds

- BLM: Displacement of monitors (arcs, ...)

HW under test in lab. Performance to be seen with beam in 2015. → Enrico's talk.



HW mitigations performed. Expected sensitivity threshold $2e10p/bunch$ → Enrico's talk



EDMS document in preparation (LICs).



VHDL code for blindable crates under development, but maybe tight for restart.

BLMTWG → Marius' talk



EDMSxxx?? → Marius' talk




Beam instrumentation / Feedbacks

- BLM: Threshold generation in LSA. Implementation ongoing???
 - BSRT: Reliable abort gap monitoring system, which can also initiate cleaning and dump. → Marius' talk.
 - BSRT: Solve problem of heating mirrors. Ongoing, EDMS1337184 → Enrico's talk
 - Q-feedback versus QPS thresholds. BSRT was redesigned. → Enrico's talk.
 - Improved reliability of OFB. ☺ Increase of threshold expected, due to low operational currents.
 - Check BPM functionality before every fill (sanity check). Development only starting ~09.2014 ☹
- ???

Operation / Software tools


- HIGH PRIORITY!** Tracking of changes in MP systems (HW exchange, expert masking, ...), software tools, procedures.
- HIGH PRIORITY!** XPOC: improved/ reduced number of false latching (warning levels / latching)
- HIGH PRIORITY!** IQC: improve to require fewer requests (warning levels / latching).
- HIGH PRIORITY!** Facilitation of loss-map checks.
 - SIS: review interlocks (still required, new , replace by HW interlock?)
 - Follow-up of beam induced heating → Benoit's talk


Acctest, procedures??
ongoing

Separate buffers requested for BLMs (to be tested 09.2014). 

Improvement not obvious.

???

Proposal presented to 85th MPP. 

First proposal for improved supervision presented to 91st MPP. → Benoit's talk 

Operation / Software tools

- Applications for BLM system (internal parameters, management, status, monitor factors) ???
- Additional running-sums and higher resolution of BLMs in PM. Implementation planned for ???
- Aperture meter and online model for ring and transfer lines. ???
- Testing of BIS inputs: automatically, manually: ???
 - Regular re-check of BIS-channels (once per year?).
 - Review BIS-channel triggering from TIMBER after dumps, during ramp-down, access,

Operation / Software tools

- Masks/SFB consistency check before beginning of ramp to avoid false dumps. ???
- Additional PM modules. ???
- Review Alarms in LASER, Review / Improve fixed displays, Review SIS GUI. ???
- Software tools to help shift crew to identify unsafe machine states (BLM reference readings, etc.). ???

Commissioning / Revalidation of MP Systems / MPP / MDs

HIGH PRIORITY!

Review / update commissioning procedures:

- Update existing commissioning procedures.
- ACCTEST framework for commissioning and revalidation tracking.
- Define (non-negotiable) re-validation tests for MP systems in case of system changes as function of risk (asynch. Dump, loss maps, PC/QPS tests after interventions → enforce procedure)

Discussion of revised commissioning procedures for MP systems ongoing in MPP (~50% done). Acctest will be used partially for commissioning.



HIGH PRIORITY!

rMPP after LS1 with updated membership and rMPP piquet (dump analysis, follow-up operational issues, contact to coordinators and operational crews).

tbd



HIGH PRIORITY!

Review / Update MP procedures for OP (incl. training of shift crew).

tbd



HIGH PRIORITY!


MD documents: Propose table of required information.

tbd




Commissioning / Revalidation of MP Systems / MPP / Fault tracking

- Powering tests: more automatic analysis tools needed.
- MPP <-> MP3 improved interplay for issues related to the protection of the magnet powering systems.
- Implementation of a fault tracker.

Review of powering procedures ongoing,  automatics tools will be updated thereafter.



Accelerator Fault Tracking project started. AFT for LHC  will be available at start-up.



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Follow-up assignments

- Detailed work often done outside 'large' Working Groups like MPP/LBOC/CollWG/..., the latter assume however responsibility of final reporting/follow-up of action
- MPP: Machine Protection Panel (M.Zerlauth, D.Wollmann)
- LBOC: LHC Beam Operations Committee (J.Wenninger, G.Arduini)
- COLL: LHC Collimation Working Group (R.Bruce, A.Rossi)
- LIBD: LHC Injection and Beam Dumping WG (J.Uythoven et al)
- QTAWG: Quench Test Analysis WG (M.Sapinski, B.Auchmann)
- MP3: LHC Magnet circuits, Powering and Performance Panel (A.Verweij, G.Willering)
- AWG: Availability Working Group (B.Todd, L.Ponce)

Machine Protection Workshop revisited

Open issues, progress and decisions on major topics

- **Material damage / failure scenarios**
 - Review of SFB equations.
 - Review operational scenarios in view of MP and collimation
- **Moveable Devices**
 - How to use collimators with buttons (interlocking, LVDT-button measurement, functional spec).
 - TCT position limits as function of separation.
 - Improved settings verification.
 - Fast vacuum valves.
 - Beta* leveling: scale losses at TCTs versus thresholds in the BCMs of the experiments.
- **Injection / LBDS**
 - Redundant BIS-LBDS retriggering.
 - Consolidation of LBDS redundant powering.
 - TCDIs: interlock transfer line optics via virtual beta* limit.
 - TDI, TCDQ interlocking in BETS.
 - Refurbishment of TDI (redundant gap measurement).
 - Interlocking of SPS-LHC beam transfer.
 - MKB vacuum interlock.
- **Circuit related protection / Electrical Distribution**
 - Interlocking of fast power aborts for CMS / LHCb / 60A corrector states in BIS to ensure redundancy.
 - QPS: mitigations to decrease vulnerabilities.
 - UPS (verify redundant powering).
 - Consistent classification of circuits as maskable / non maskable / transparent.
 - FMCM: RD1/RD34 improve PC regulation to reduce sensitivity to network perturbations.
- **Beam Instrumentation**
 - BLMs (displacement, new thresholds, LICs for Inj., threshold generation in LSA).
 - DIT.
 - BPMS (IR6).
 - Q-feedback versus QPS.
- **Operation / Software tools**
 - Improved XPOC and IPOC.
 - Tracking of HW changes in MP systems
 - Aperture meter and online model
 - More responsibility for shift crews to validate MP critical systems (e.g. facilitating loss map checks)?
- **Commissioning / Revalidation of MP Systems / MPP**
 - Review / update commissioning procedures and tracking of commissioning progress
 - Maintain rMPP including rMPP piquet.
 - Review /Update MP procedures for OP
 - MD documents

