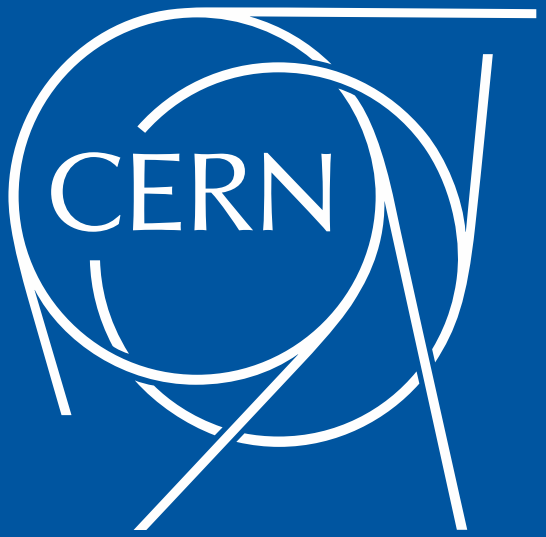
CERN

Machine Protection Workshop revisited

Open issues, progress and decisions on major topics

D. Wollmann, M. Zerlauth

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Outline

- Material damage / Failure scenarios
- Moveable devices
- Injection / LBDS
- Circuit related protection / Electrical distribution
- Beam Instrumentation
- Operation / Software tools
- Commissioning / Revalidation of MP Systems / rMPP

Introduction

- Multitude of follow-ups for LS1 from MPP workshop (03.2013). Work done in many different teams and results presented in this workshop.
- Overview of most relevant topics. Other topics can be found in the appendix of this presentation.
- 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
- Classification:
  - Done
  - Ongoing (on track for restart)
  - On critical path

  - Will come during Run2
  - Discarded / Postponed

Material damage / Failure scenarios

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

Proposal compiled → **Laurette's talk (5.5)**.

- Review / update LHC failure scenarios and expected damage (single/two kicker pre-firing leading to asynchr. beam dumps).

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

- Understand protection level of triplet with presently allocated margins between TCT and triplet apertures.

Iteration on existing study to be performed.

- Update damage limit for tungsten collimators with realistic impact distributions.

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).

→ **Gianluca's talk (3.3).**
Functional specs for use of buttons distributed.

- Improve collimation qualification strategy (reduced RF frequency changes, number of qualifications)

→ **Gianluca's talk (3.3).**

- TCDQ upgrade of position measurement and controls: separation of position control and interlocking. Gap interlock in BETS

- Controls and interlock logic have been separated.
- LVDTs replaced by potentiometer, third potentiometer for BETS.

→ **Nicola's talk (3.5)**

- TCT position limits as function of separation.

Prepared, but will not be implemented.
→ After validation, buttons should do the job.

Injection / LBDS

Redundant BIS-LBDS retriggering

Installed and being tested in the LHC. (EMDS1368669)
→ **Nicolas' talk (3.5)**

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

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

Interlocking of SPS-LHC beam transfer (timing).

Issue mitigated in new LHC central timing. To be deployed on 27th October.
→ **Delphine's talk (4.1)**

- Consolidation of LBDS redundant powering and TSU configuration.

New configuration implemented.
To be tested during UPS powering test campaign.
→ **Nicolas' talk (3.5)**

- MSI current, TDI gap interlocking in BETS.

All cables pulled. Installation progressing: TCDQ in coming weeks, MSI in summer, TDI for 2015 with calculated gap from LVDT.
→ **Wolfgang's talk (3.4)**

Injection / LBDS

- Refurbishment of TDI (redundant gap measurement).

Significant refurbishment of TDIs. Redundant gap measurement will be installed on spares, aim to be installed in Xmas break 2015/16.
→ **Wolfgang's talk (3.4)**

- TDE block: pressure rise in case of repeated dumps @6.5/7TeV may cause pressure rise above the venting level.

Not critical for run2, as enough reserve on N_2-bottle in case of limited venting.

- Upgrade of MKIs.

MKIs program executed as planned:

- Impedance reduction by additional stripes.
- Improved cleaning to reduce UFOs.
- NEG coating of by-pass tubes.

→ **Wolfgang's talk (3.4)**

Circuit related protection

Full revalidation of QPS systems, due to complete dismantling.

Starting soon.

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

MSS (Magnet Safety System) redesigned. CMS, LHCb (ATLAS?, ALICE?) will be interlocked for fast aborts.
60A: PVSS logic corrected, PP60A telegram changes

- QPS: Implementation of critical upgrades: remote download of firmware improvements.

Not planned during LS1. Partially during run2, latest with QPS2.
→ **Ivan's talk (5.2), Matteo's talk (6.2)**

- QPS: Mitigations to decrease system vulnerability: sanity checks, dependable configuration tools, enhanced automatic analysis, enforced validation after changes.

Improved supervision for parameter management and remote config implemented in HW. SW tools under development.
→ **Ivan's talk (5.2), Matteo's talk (6.2), Delphine's talk (4.1)**

Circuit related protection

- FMCM: improve rejection of network disturbances on sensitive items, dependability analysis.
- Extend PC interlock to other (non-COD) PCs.

RD1 PC will be replaced in Xmas break 2015/16, Budget for RD34 PC pending.
→ **Ivan's talk (5.2)**

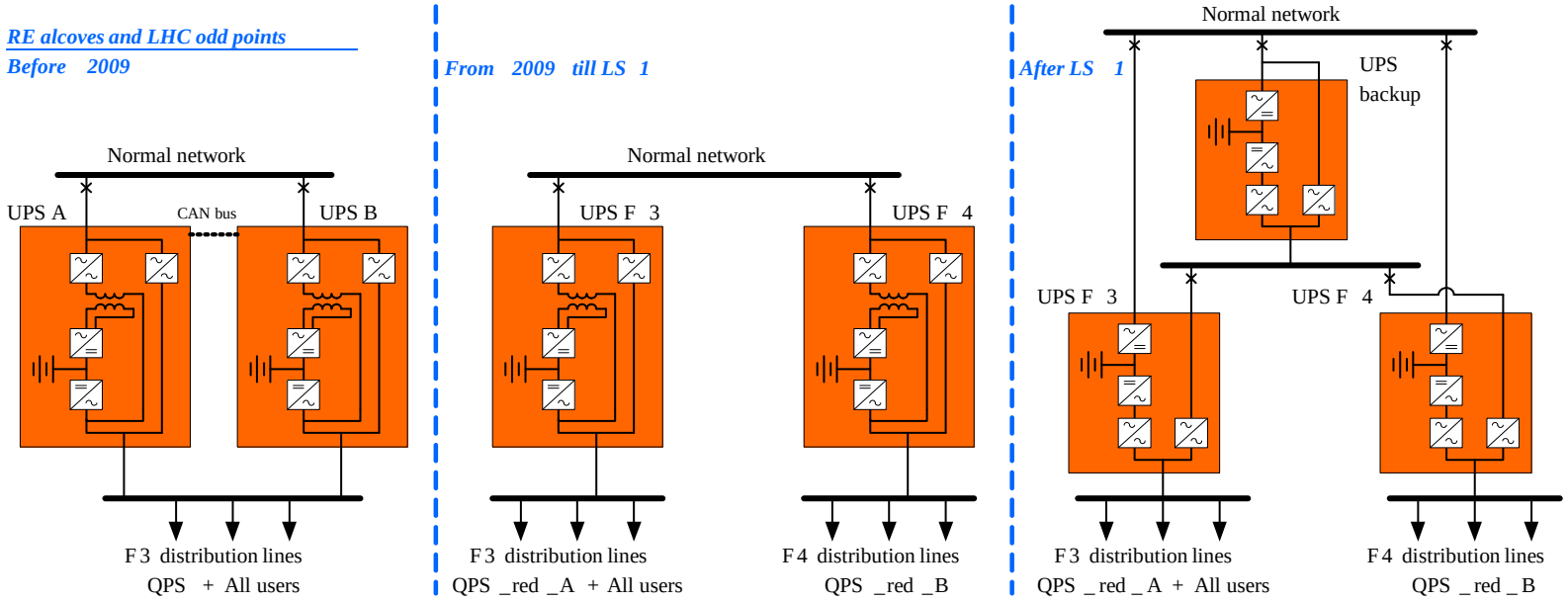
First improve COD tolerances (functions), then implement quadrupoles. → autumn.

Electrical distribution

- UPS consolidation: perform full-scale test of redundant powering for MP systems.
- UPS consolidation + new switching frequency.

Preparations ongoing, scheduled, pre-tests performed.

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



Courtesy V.Chareyre

Beam instrumentation

Fast Beam Current Change Monitor (FBCCM) (improved redundancy in beam loss detection after LS1).

HW under test in lab. Performance to be seen with beam in 2015.

→ **Enrico's talk (5.4)**

BPMS (IR6) improved dynamic range (improve availability and machine safety).

HW mitigations performed. Expected sensitivity threshold 2e10p/bunch

→ **Enrico's talk (5.4)**

- BPMS data to XPOC

XPOC data, which are in PM already used in TCDQ module. Will be optimized during Run2.

→ **Enrico's talk (5.4)**

- BSRA: Reliable abort gap monitoring system; automatically initiating cleaning and dump.

EDMS1337184

- BSRT: Solve problem of heating mirrors.

→ **Enrico's talk (5.4)**

BLM

HIGH PRIORITY! Full revalidation of BLM systems, due to complete dismantling.	Starting soon.
HIGH PRIORITY! BLM: LICs in injection region.	EDMS document in preparation (LICs). → **Mariusz' talk (5.3)**
HIGH PRIORITY! BLM: blindable crates for injection	VHDL code for blindable crates under development. Deployment strategy to be agreed. → **Wolfgang's talk (3.4)**
HIGH PRIORITY! BLM: Review of thresholds	BLMTWG → **Mariusz' talk (5.3)**
HIGH PRIORITY! BLM: Displacement of monitors (arcs, …)	→ **Mariusz' talk (5.3)** EDMS1307356
• BLM: Threshold generation in LSA.	→ **Mariusz' talk (5.3)**
HIGH PRIORITY! BLM – XPOC separated buffers for B1/B2	To be confirmed after hardware tests by BLM team. → **Mariusz' talk (5.3)**

Operation / Software tools

Tracking of changes in MP systems (HW exchange, expert masking, …), software tools, procedures.

- SIS: review interlocks (which interlocks are still required, new interlocks, replace by HW interlock?)
- Follow-up of beam induced heating.

Tracking in ACCTEST ‘work in progress’
→ **Laurette’s talk (5.5)**

Proposal presented to 85th MPP.
→ **Ivan’s talk (5.2)**

First proposal for improved supervision presented to 91st MPP (Benoit).
→ **Juan’s talk (2.2)**.

Commissioning / Revalidation of MP Systems / rMPP

Review / update commissioning procedures:

- Update existing commissioning procedures.
- 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).
→ **Laurette's talk (5.5)**

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

TBD over summer.

- Implementation of a fault tracker.

AFT for LHC will be available at start-up.
→ **Andrea's talk (5.6)**

Conclusion

- Impressive **amount of work** has already been done in the different MP systems following Run1 experience.
- Still a lot to be finished, but the vast majority of defined actions and mitigations is **on track for the commissioning / restart**.
- **Re-commissioning procedures** for MP systems being updated as **vital input** to update the follow-up / tracking of commissioning steps.
- Additional **work identified** on operational and software tools.
- **Experience with beam** will have the final word (collimators with buttons, blindable crates, …).

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Appendix - Moveable devices

- Roman pots (HW changes, interlocks and re-commissioning procedures)
- 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.

Changes in XRPs presented to 86th MPP (M. Deile). To be followed-up

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

Not obvious how to implement.

TBD

TBD

No installation planned Decision taken in LMC.

Appendix - 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)
- Beam position in TCSG (IR6) interlock from SIS to BIS.
- MKB vacuum interlock.
- Review number of (test)-pulses in local mode and necessity

During commissioning with beam 2015.

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

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.

Appendix - Circuit related protection

- COD current checks from SIS to PC-Interlock.
- Revisit dependability studies for circuit protection.
- Review strategy of circuit classification (maskable / non-maskable / transparent).

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

Studied quench loop → thesis of S. Guenther.

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

→ **Ivan's talk (5.2)**

Appendix - Beam instrumentation / Feedbacks

- Q-feedback versus QPS thresholds.
- Improved reliability of OFB.
- Check BPM functionality before every fill (sanity check).

Increase of threshold expected, due to low operational currents.

→ **Thibaut's talk (4.5)**

TBD

Appendix - Operation / Software tools

IQC: improve to require fewer requests (warning levels / latching).

Facilitation of loss-map checks.

Improvements to be discussed.

TBD

Appendix - Operation / Software tools

- Applications for BLM system (internal parameters, management, status, monitor factors)

→ **Mariusz' talk (5.3)**

- Additional running-sums and higher resolution of BLMs in PM.

Implementation planned
43k samples in RS01 (40us).

- Aperture meter and online model for ring and transfer lines.

→ **Delphine's talk (4.1)**

- 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, … .

→ **Ivan's talk (5.2)**

Appendix - Operation / Software tools

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

Appendix – MP procedures / MPP/ Powering tests / MDs

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

Second half of 2014

MD documents: Propose table of required information.

Second half of 2014

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

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

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)
- BLMTWG: BLM Threshold WG (E.Holzer, B.Auchmann)
- MP3: LHC Magnet circuits, Powering and Performance Panel (A.Verweij, G.Willering)
- AWG: Availability Working Group (B.Todd, L.Ponce)