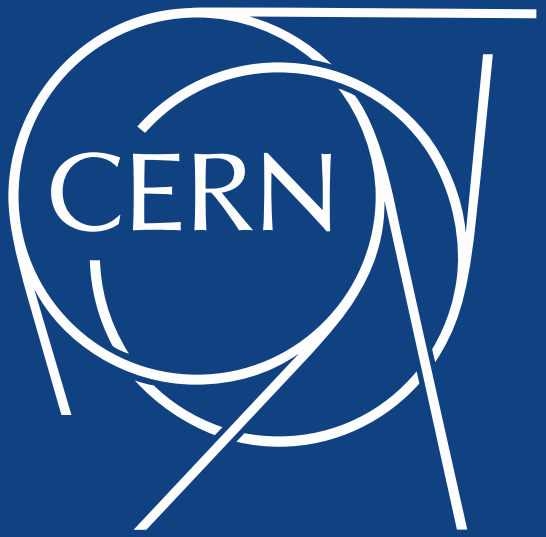
CERN

Upgrade, IST and Powering tests of the Quench Detection System

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Outline

- Activities during LS1
- Resources
- Planning
- IST
- Negative/Positive examples
- Technical issues
- Improvement/Changes
- CSCM
- Expert overload
- Conclusion

Activities during LS1 I

- DQLPU-A upgrade (covered in Vincent's talk)
- nQPS upgrade, testing, commissioning
  - DQQDS firmware upgrade/testing/commissioning
  - mDQQBS production/integration/commissioning
  - DQAMGS crate controller firmware upgrade
- IPQ/IPD protection upgrade
  - nDQQDI board integration/commissioning
  - DQQDC firmware update
  - DQAMG crate controller firmware update
- CSCM, protection/DAQ hardware, support
- Warm BB measurements
- R2E relocation P1&5 (and clean-up afterwards)

Activities during LS1 II

- IST/Hardware commissioning of all LHC QPS systems
- Development of new 600A quench detection board
- Finalizing/production of nDQQDI boards
- Introduction of new controls interface for all EP QPS equipment in LHC
- Software tools development for IST/HWC
- Extended tests:
  - nQPS signal and heater trigger cable verification
  - Quench heater measurement campaign (reference discharges)
  - 600A IST with extended interlock tests
  - UPS tests (verification of redundant UPS connection)

Activities in numbers

- Boards reprogrammed: **15300**
- Boards tested in lab: 12k+
- nQPS cables verified: 6500
- Interlock tests performed: **23000**
- All quench Heaters tested: 6000
- Update of almost ALL firmware (mostly safety critical code!)

➔ The complete QPS was touched !

Resources

Initially available

- 2 Experts
  (partially loaded with other business)
- 2 Tunnel experts
  (partially busy with DQLPU-A testing)
- 2 Technicians (lab support, reprogramming)
- Vito: programmed > 6k circuit boards alone..
- AGH people: nQPS reinstallation (main support DQLPU-A see Vincent's talk)

Injected later:

- Student for testing & software development
- Edward's team + Zinur: (cable checking)
- Bozhidar/Edward/Zinur: HDS testing
- AGH people: lab testing support

Planning

- No effective long-term planning in LS1 for non- DQPLU-A activities
- From Summer 2014 all activities were driven by machine sector availability
- Fine grained planning was fully defined by availability of equipment & experts
  - ➔ Activities were fully “machine driven”
  - ➔ Ad-hoc decisions and strategies to face the tasks to complete
- Ad-hoc injection of resources for activities which reached “out-sourceable” state
  - Interlock tests, HDS tests, Cable checking

➔ **We were “driven” by LS1 instead of driving it** !

IST (individual system tests)

- Expert work, creating bottle-necks
- Certain tests started with poor software support, situation improving during HWC
- Comprised partially of new or enhance tests which absorbed expert time to establish
- RB IST was running relatively smooth after the first 2-3 sectors:
  - Established procedures
  - Software tools supported tests
  - Tasks outsourced & people trained

Negative examples

- Polarities and wiring of 600A current sensors was a complete mess after R2E relocation
  → Took considerable amount of time to sort out (Expert tunnel + System Expert + Mp3)
- IPQ/IPD upgrade not very smooth due to lack of preparation time / sub-optimal organization
- Very rough start of MB/MQ activities due to new controls

Positive examples

- Mains commissioning after 3-4 sectors
  - After procedures/software/resources present, things went smooth
- Finally system arrived in **stable** operation ON TIME
- CSCM completed in 8 sectors

Technical issues (rough overview)

- Controls system underwent major update of middle ware (FESA3)
  - Update rendered old tools useless
  - New version available shortly before IST started
- Firmware of crate controllers for nQPS and IPQ/IPD not very mature due to missing test benches/time (larger scale, final controls etc.)
  - Not feasible in time due to unavailability
- Tools to facilitate commissioning had been developed “on the fly” during the commissioning campaign

  ➔ Expert time lost during “manual” tests (e.g. Interlock tests, UPS test etc)

- Instrumentation cables lacking proper labels on DFB side

Improvements/Changes

- Adapt overall program to resources (apply a more pessimistic view)
- Freeze program well ahead
  - Proper preparation possible
- Establish detailed procedures for IST steps
  - Test procedures in test bed
  - Use final software/firmware
  - Have supporting software tools ready and tested !
- Software libraries and controls system need to be available and stable well ahead

CSCM

- Was not accounted for in original planning (long uncertainty)
- Increased testing time of DQLPU-S considerably
- Delayed other activities
- Development of safety-critical code in very short time
- Rough start due to difficult system configuration caused by new controls system

  ➔ Absorbed one expert 100% in the beginning
- Similar to MB/MQ commissioning, after the first few sectors things went smooth

Expert overload

- Most tasks of LS1 required close expert support
- Little established routine work which could have been easily outsourced
- After the first sectors some tasks could be outsourced
  - Interlock tests → section internal
  - nQPS heater trigger cable verification → ELQA
  - Quench heater discharge tests → EE section
  - CSCM support → PE section

Expert overload II

- Time sharing between powering tests and IST created considerable expert overload (around xmas 2014..Jan 2015)
- PM data quality was not sufficient for MP3 analysis (lots of support required)
- Poor issue tracking increased the problem (double reporting etc.)
- All experts clearly overloaded, fatigue towards end:
  "…ok crate B17L9"
  (DANGER: leads to mishaps !)

Postponed Tasks

- IPQ crate disentanglement
- IPQ bus-bar supervision
- 600A R2E upgrade
- DQQLC recovery after power cut

Conclusion

- Reduce activities to a realistic amount
- Establish procedures well AHEAD start of activities
  - → Allows allocation of resources before
  - → Routine jobs can be planned better
- Have software tools available*
  - → With our system size, automation is crucial !
- Establish larger scale test benches to avoid surprises in the machine*
- “Freeze” LS program well ahead of time
- “Spare” the experts for “unforeseen” issues (which will come up !)

* Not possible due to late availability of software libraries