ELQA during LS1 – the “unexpected” activities

- New developments
- Exceptional NCs
- Other tests

Pre-conclusion

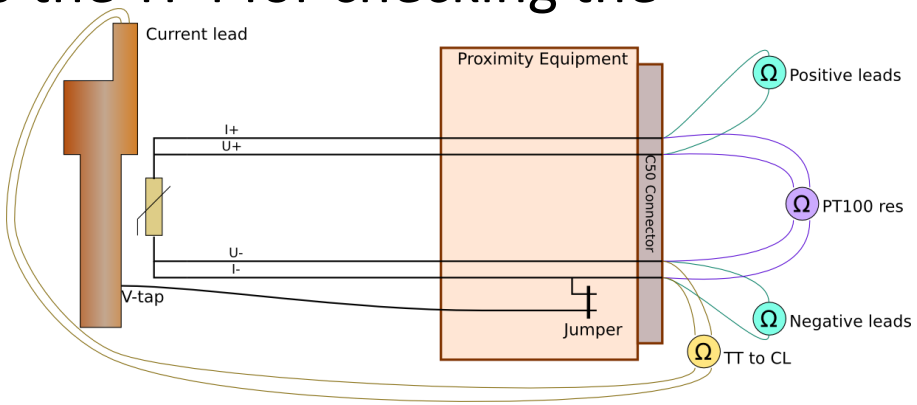
- These activities have not been planned
- Resources had to be taken out from the planned activities (like LS1-PAQ, documentation writing)
- Many times we relied on flexibility and commitment of people
- Many of these tasks were carried out in parallel, which only increased the workload on key people
- Each of these tasks is an example of what could be improved for the future
- **Next time LS should not be a crash program!**

New developments

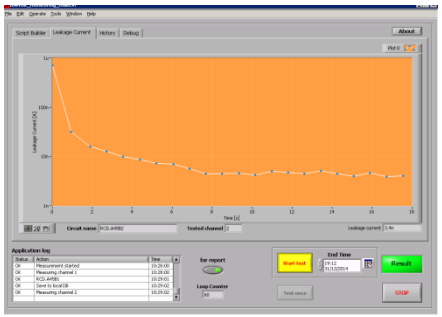
- New tests in the TP4 for checking the modified PEs,
- Design of precision current transformers,
- Tester for the precision current transformers,
- Test system for 600 A EE systems,
- Probe for the LHC tunnel temperature profile measurement for warm bus-bar measurement compensation,
- Upgrade of the insulation monitoring system (used during thermal cycles)
- Development of the MPE stand for CERN open days,
- Measurement system for the heat runs,
- Simple tester for power cables in DYPB racks,
- Dipole diode lead measurement system.

New developments

- Introduction of new tests into the TP4 for checking the modified PEs
  - Unforeseen activities on PEs



- Upgrade of the insulation monitoring system for warm-up and cool-down
  - Too many sectors in parallel,
  - Not enough HV crates

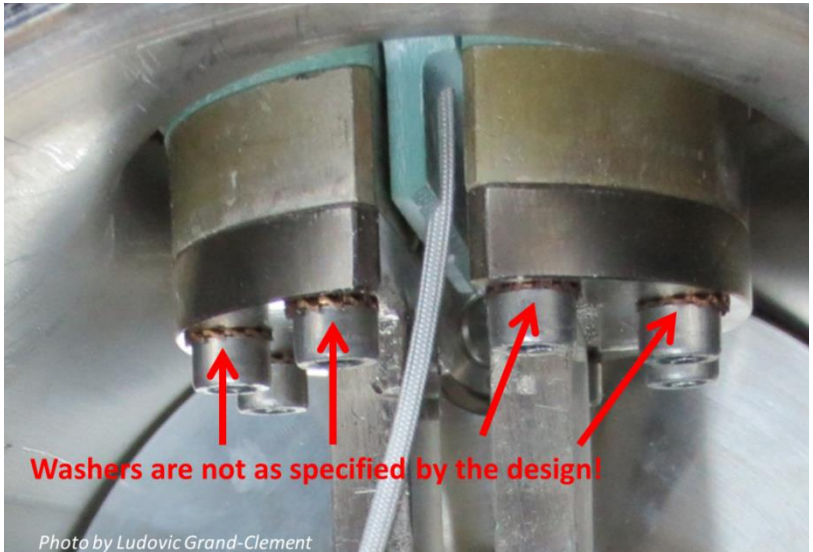


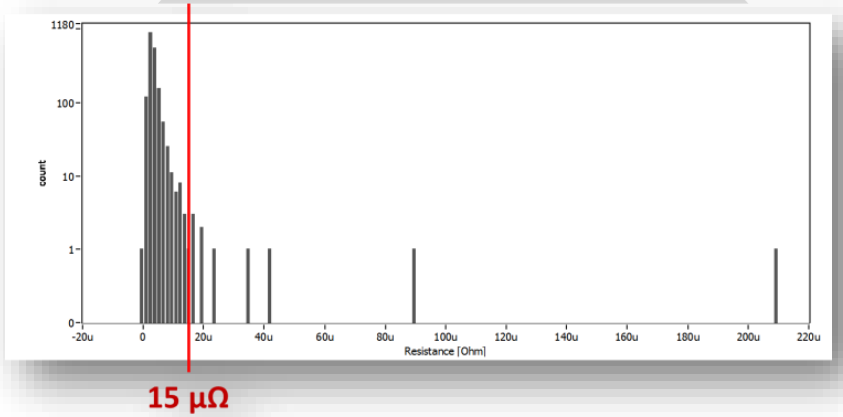
- LHC tunnel temperature profile measurement for warm bus-bar measurement compensation
  - New type-test measurements

Dipole diode lead measurement

- Development of the measurement system
- Execution of the measurement in every dipole magnet in the LHC tunnel
  - Huge resistance found in half-moons of A15L8,
  - 30 NCs in total, all treated.
- Measurements carried out late in the evening
- 3 persons during >3 months + development, coordination and data analysis

Necessary to ensure some flexibility in case of such unforeseen tasks





Non-conformities

- NCs are expected in such a large project
- ELQA is there to find NCs

  (I shouldn't bring any NCs in such case into this presentation, but…)
- We hope that there are not many NCs
- We hope that the NCs are simple
- The planning includes some time for NCs, but not much
- From time to time we find an unexpectedly serious case
- Planned becomes unplanned

Some examples will follow…

ELQA exceptional NCs

- RCS.A56B2 (DFB) ground fault
- RB.A78 (DFB) ground fault
- RQTF.A81B1 ground fault
- Short between RCD.A78B2 and RCO.A78B2
- **RCS.A34B2 ground fault**

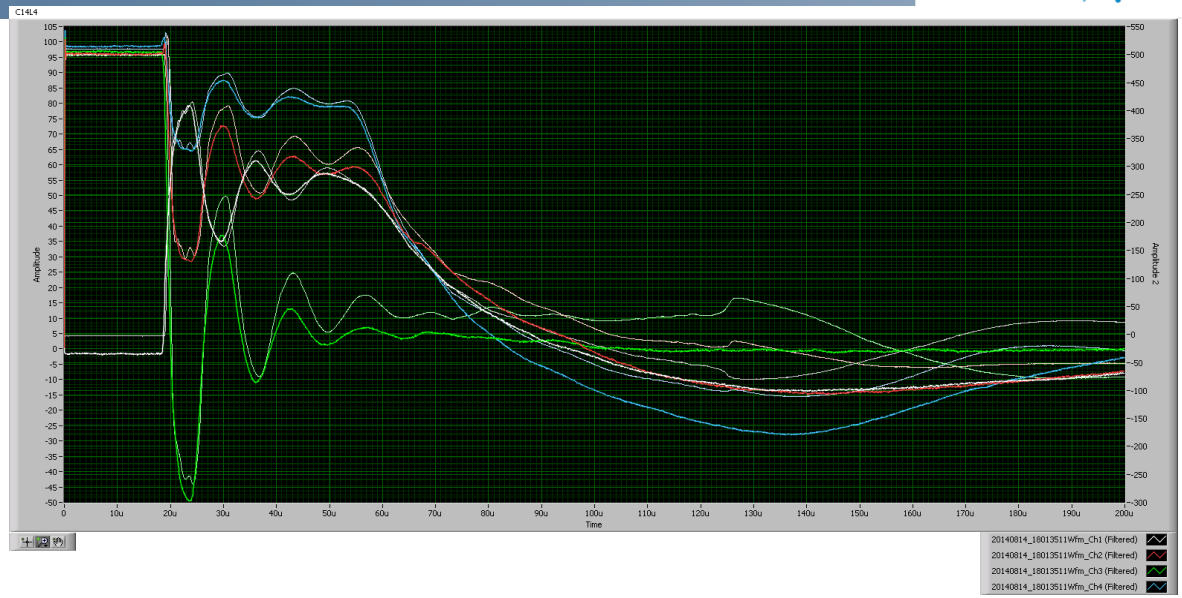
- **IT R2E**
- **RB.A67 first HV test at 2.1 kV with all instrumentation connected…**

These are only selected NCs that took more time and resources than expected! ***It is not a complete list!***

RCS.A34B2

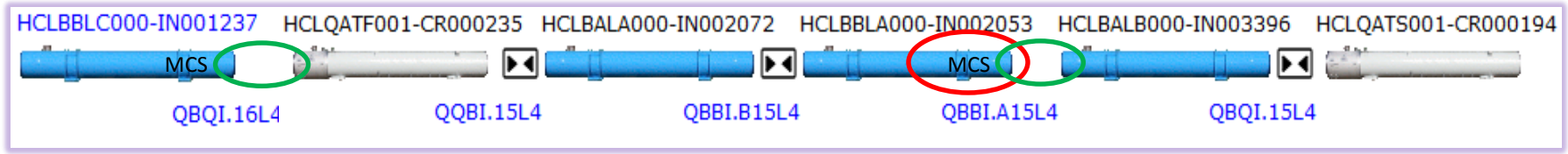
Investigation,
Recommendation,
Retest.

- Breakdown in multiple places at HV
- Development of special time domain methods was necessary



Opened IC (Spool #10 cut)

Opened IC (Spools #8, #9 & #10 cut)

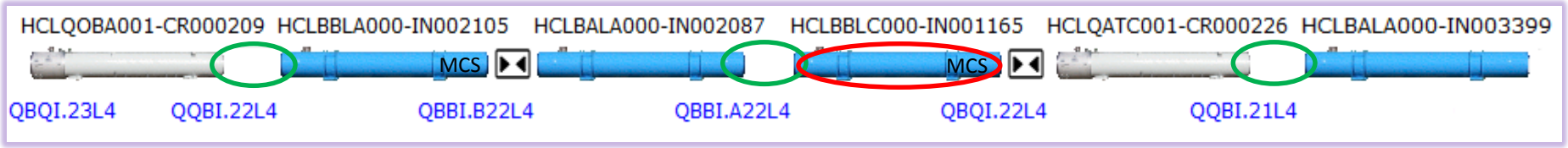


Fault located in one of this MCS leads

Opened IC (Spool #10 cut)

Opened IC (Spools #9 & #10 cut)

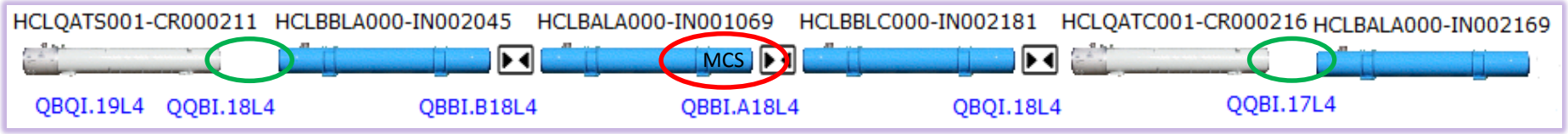
Opened IC (Spool #10 cut)



Opened IC (Spool #9 cut)

Fault located in this segment

Opened IC (Spool #9 cut)



Estimated place for the fault

IT R2E

- Systematic swap of pins in V-tap cables of correctors,
- Swaps of pins in the CL heating system
  - Discovered during the first run: all fuses were blown…
  - Systematic pin swaps discovered
- Additional tests of the cables as the company did not test their work (or tested incorrectly)
  - Many badly crimped pins
  - Many insulation faults
- This should have been given back to the company that did the work, but it would have delayed the project.

Liaising with companies at the earliest stages possible

- **Include intermediate tests**

First HV test at 2.1 kV on RB after SMACC

RB.A67

- All instrumentation connected (incl. nQPS)
- Number of QPS crates damaged
  - Fire and smoke in some of them…
- Weakness in the nQPS board design identified
- New, much more complicated test procedure introduced
- Should have passed smoothly within 1 afternoon (as it was before SMACC), but… it took more than two weeks to complete.
- Development of protection diodes for the 2.1 kV test
  - Development of a tester for these special voltage limiters

To be improved:

- Required profound testing before mass production,
- Improve testing before installation in the tunnel.

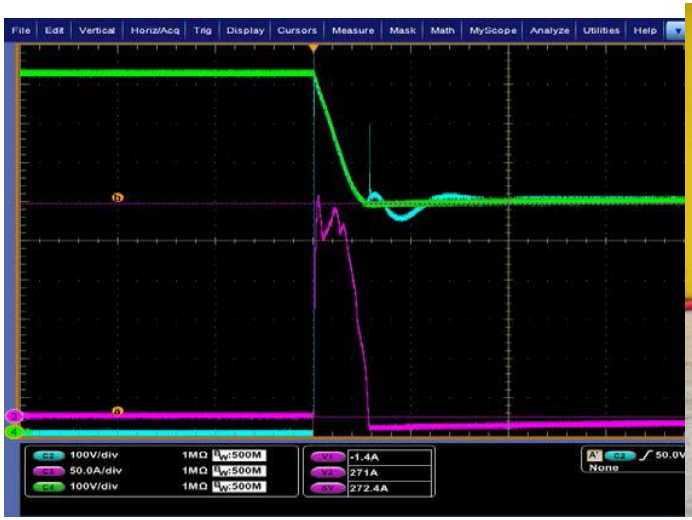
NCs coming from the powering tests

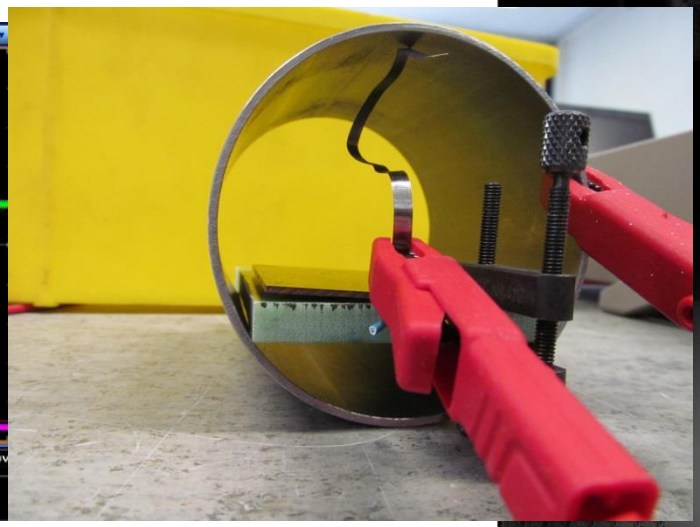
- Analysis of faulty RCO.A78B1 and RCO.A81B2 incl. recommendations
- Reconfiguration and retest of QH damaged during the discharge campaign or quenches,
- Ground fault in sector 5-6
  - Event analysis
  - Development and deployment of a special measurement system for the detection of the ground fault – if it reappears (incl. procedure)
- ROD.A56 precision resistance measurement,
- Ground fault in sector 3-4 event
  - Analysis and fault location
  - Ground fault burning

Ensure resources BEFORE and AFTER the LS

Ground fault in S3-4

- The fault appeared after a training quench
- Known weakness at the level of half moon connectors
- In-depth analysis and precise location
- Successful fault burning
- Together with TE-MPE-EP section





Be prepared for such events!

- It may appear with any quench!

Other tests

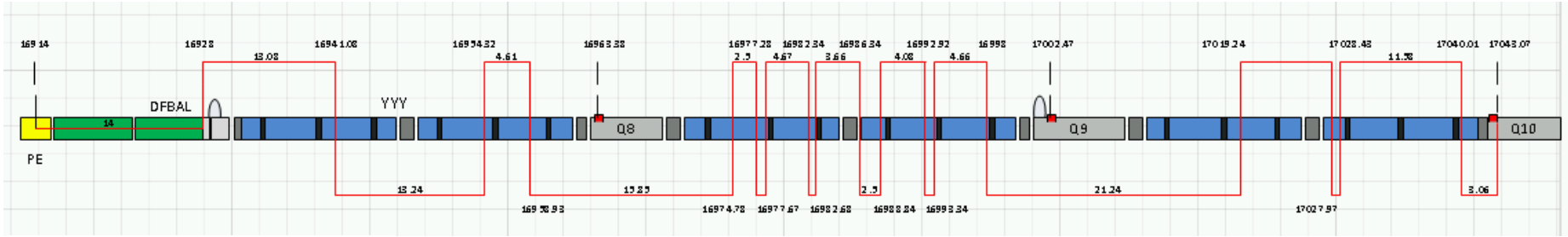
- **ELQA before/during/after CSCM**
  - Incl. DC cables connection and disconnection
- 120A circuits HV testing: systematic additional effort during a special procedure required by the weak V-tap Fischer connector
- DYPB fuse test and selection of the best product
- Cable testing/assembly for the upgraded DYPB racks
- Tests of flooded QPS cables in the LHC tunnel

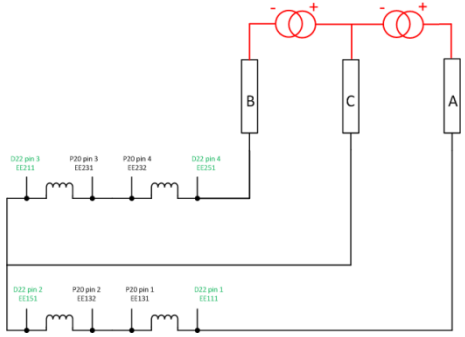
Flexibility is necessary!

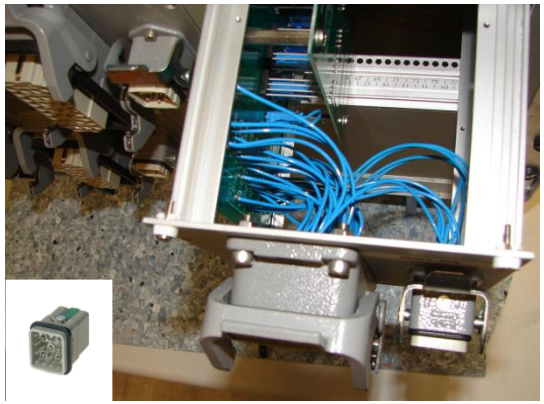
Other activities:

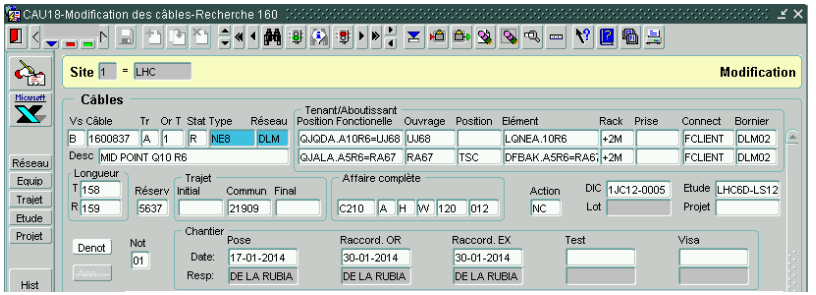
- **PE modification on IPQs** (reducing the number of exceptions in the layout)
- Preparation of cabling for the QPS tests
- Preparation of new cable segments between the current leads and proximity equipment

IPQ project *(courtesy of Edward Nowak)*









The midpoint inversion affects the following circuits.

Circuit type	Circuits
RQ4	RQ4.L2 RQ4.L5 RQ4.L8 RQ4.R1 RQ4.R2 RQ4.R8
RQ5	RQ5.L1 RQ5.L2 RQ5.L4 RQ5.L8 RQ5.R5 RQ5.R8
RQ6	RQ6.L1 RQ6.L4 RQ6.L5 RQ6.R1 RQ6.R2 RQ6.R5 RQ6.R8
RQ7	RQ7.L1 RQ7.L5 RQ7.R1 RQ7.R2 RQ7.R4 RQ7.R5 RQ7.R8
RQ8	RQ8.L2 RQ8.L4 RQ8.L6 RQ8.L8 RQ8.R6
RQ9	RQ9.L1 RQ9.L5 RQ9.R1 RQ9.R2 RQ9.R4 RQ9.R5 RQ9.R8
RQ10	RQ10.L2 RQ10.L4 RQ10.L6 RQ10.L8 RQ10.R6

PE modification and its test:
12 DFBAs in the lab 30-3-025

DFBLs and DFBMs in the LHC tunnel
19 circuits in total on 15 different PEs

Unique QPS interface towards
the DFBs current lead
configurations ACB and BCA

Summary!

Worked well

- We managed to complete all these tasks on time
  - Not everything can be planned in advance,
  - Many of these unplanned tasks were of a critical importance and without them there would have been a large delay…
- Offices in 622, lab in 282, lab in 30,
- Cars given to the collaboration and the car pool,
- Cracow collaboration contract extension until March 2015
  - The campaign was supposed to be almost finished by the end of 2014, but… Many issues occurred and eventually we could make it only thanks to that extension…
  - Should have been included in the planning from the beginning (was, but was refused…)
  - Last minute extension was not easy for the collaborators to handle (many considered refusing)…

Problems

- Safety and yellow papers – not perfectly transparent
  - Happened that we didn't have the papers and worked on circuits…
  - Happened that we had the papers and circuits were powered…
    - Do we still have some yellow papers?
- Coactivity – typical problem in the tunnel
  - Solved by flexibility of HNINP colleagues
    - Work late in the evening/night or early in the morning ,
    - Some collaborators (i.e. Jaromir) worked two shifts per day with no additional gratification. Many projects wouldn't have been completed without this!
- Unclear assignment of QPS cables to slots on PE
  - Connection errors discovered during powering tests,
  - Errors in the documentation (improvements to be foreseen),
  - Should cables going to QPS racks be included in ELQA procedures?
- Limited resources for documentation drafting!
  - Contracts finished, people left…

Conclusion

- Avoid crash programs
- Make sure there is enough time to treat NCs
- Avoid giving too many tasks at the same time to one person
- Don’t count on exceptional flexibility and commitment of collaborators
- Allocate resources before and after the LS
- Allocate resources such that there is enough flexibility for unplanned activities
- Foresee proper testing of every modified component at every stage of work