LHC Installation and Commissioning Committee
Summary of meeting 2008-07 held on 6th June 2008

Present: see annex 1

Main topics of this meeting:

- Hardware baseline
- Cool down of the machine
- Power tests
- Training campaign of the dipole magnets

1. Comments on the summary of ICC 2008-05

There were none.

2. Matters arising

There were none.

3. General information

L.Evans informed the committee that the target date for closure of the detectors and the experimental caverns is now delayed by 2 weeks to the end of July.

4. Hardware baseline

S.Chemli has replaced **R.Saban** as the custodian of the LHC hardware baseline. He presented the Engineering Specifications and Engineering Change Requests presently in circulation.

LHC-TC-ES-0001 DOCUMENTATION OF HARDWARE PARAMETERS FOR THE 2008 LHC COLLIMATORS (R.Chamizo, S.Redaelli, T.Weiler) **Released 2008-05-20**

LHC-C-ES-0012 FIDEL - The Field Description for the LHC
(N.Sammut) **Released 2008-05-26**

LHC-TC-TP-0001 COLLIMATOR FINAL ASSEMBLY AND HARDWARE COMMISSIONING FOR LHC (O.Aberle, R.Assmann, R.Chamizo, J.Lettry, R.Losito, S.Redaelli, T.Weiler) **Released 2008-06-03**

LHC-MPP-HCP-0005 TEST PROCEDURE AND ACCEPTANCE CRITERIA FOR THE 80 A AND 120 A DIPOLE CORRECTOR CIRCUITS
(G.D'Angelo, D.Nisbet, M.Zerlauth) **Released 2008-05-14**

LHC-MPP-HCP-0006 Test Procedure and acceptance criteria for the 60 A Corrector Circuits (G.D'Angelo, G.De Rijk, C.Fernandez Robles, D.Nisbet, M.Zerlauth) **Released 2008-05-14**

LHC-MPP-HCP-0003 TEST PROCEDURE AND ACCEPTANCE CRITERIA FOR THE 600 A CIRCUITS (A.Ballarino, B.Bellesia, G.Coelingh, C.Fernandez Robles, V.Montabonnet, S.Sanfilippo, W.Venturini Desaloro, A.Vergara, M.Zerlauth) **Released 2008-05-14**

LHC-ZDC-HCP-0003 THE COMMISSIONING OF THE HARDWARE IN THE LHC SECTORS: COMMISSIONING OF THE ATLAS ZDC DETECTORS
(D.Macina, A-L.Perrot, S.White) **Released 2008-05-20**

LHC-MPP-HCP-0053 SECTOR 4-5: POWERING SPECIFICITIES FOR 13 KA DIPOLES CIRCUITS (A.Verweij) **Released 2008-06-04**

LHC-MPP-HCP-0015 Sector 7-8: Powering specifities for 600A circuits (W.Venturini Delsolaro) **Approval closed 2008-06-03**

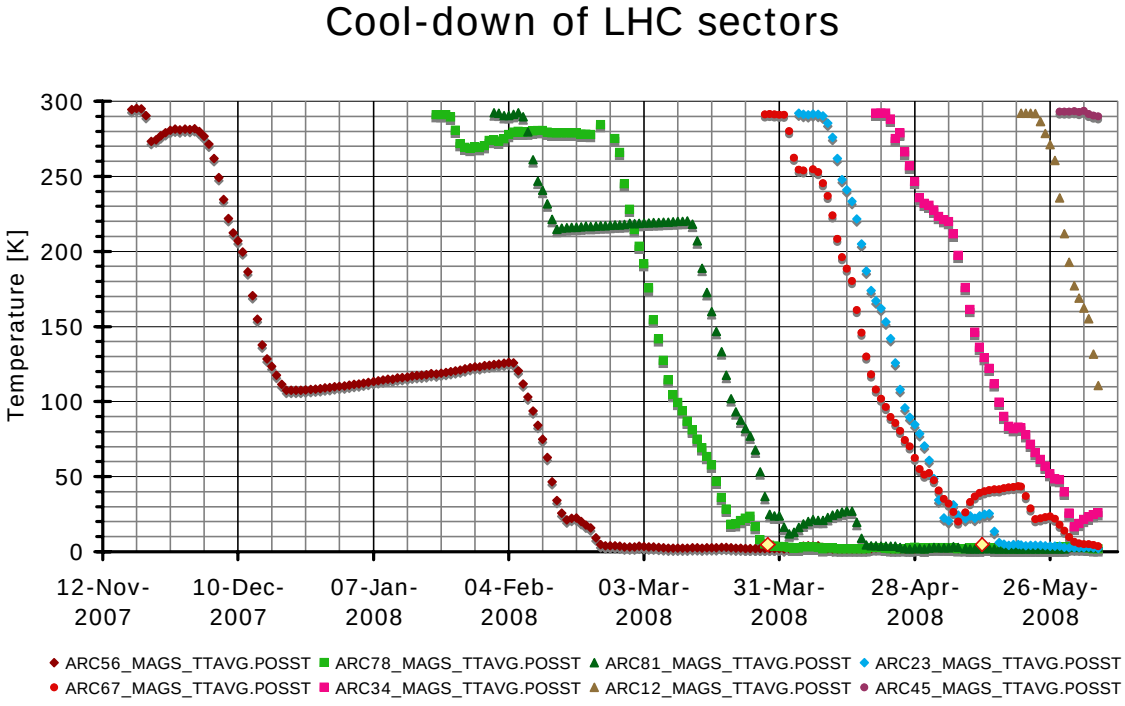
LHC-MPP-HCP-0070 SECTOR 5-6: POWERING SPECIFICITIES FOR 600 A CIRCUITS (W.Venturini Delsolaro) **Approval closed 2008-06-03**

LHC-QIT-EC-0001 Consolidation of the voltage withstand level for the measuring chain of the current leads thermometers (J.Casas-Cubillos) **Under approval 2008-06-03**

5. Hardware Commissioning

5.1 S.Claudet summarised the LHC cryogenics situation.

Powering activities are ongoing in sectors 56 and 78; sectors 81, 23 and 67 are in cryogenic tuning at low temperature; sectors 34 and 12 are cooling down and sector 45 is undergoing cool down of the heat shield to check the evolution of a small leak before cooling of the cold masses starts.



In **Sector 56**, the training campaign of the dipole magnets has to be closely followed by the cryogenics teams. For natural quenches around 11kA, where one dipole quenches with subsequent effects on neighbouring magnets, the recovery time is around 7 hours. For provoked multiple quenches of 3 or 4 magnets around the arc, the effects are of course larger and take around 14 hours to recover. There have been interruptions to the training program due to electrical problems. A transformer in US65, which had shown trouble in May, was fixed during a stop for other reasons in early June. Another persistent problem in point 6 has been the overheating of 24V DC power supplies. A short-term solution to this has been to install temporary ventilation of the racks, and further investigations are ongoing in collaboration with TS/EL and AB/PO (possible rearrangement of the racks, searching for weaknesses in the power supply components).

In **Sector 78**, power tests have been interrupted with problems with frequency drive cards and 24V relays, both of which have now been solved. Cooling issues have also required attention in point 8, and collaboration between the cryogenic team and TS/CV is ongoing. The Q5 left of point 8 could not take more than a few hundred amps and, during a stop due to electrical power problems in late May, investigations revealed an alignment abnormality between the DFBMC and the magnet. The supposition was that this could cause insufficient helium cooling to busbars, and a subsequent realignment (raising the DFB by 20mm to put it at the correct level with respect to the floor as opposed to the beam line) indeed fixed the problem. Similar cryogenic links are being checked around the machine.

L.Evans asked if the corrector magnet that previously could not be powered in the Q5 assembly had by any chance recovered following this intervention. It has not, so the warm magnet replacement will continue to be used instead.

In **Sector 81**, after some delays due to power cuts and other reasons, conditions for powering are still not stable. More work is needed on the helium level gauges for the stand alone magnets; this is the same work that was already needed in sectors 56 and 78, but further measures may be necessary here.

In **Sector 23**, the cool down has progressed well and cryogenic work in the arc at 2K is starting.

Sectors 67 and 34 both have ex-LEP 4.5K units, which take longer to optimise than newer equipment as extra measures are needed. On top of this, one of the turbines in sector 67 has a leak and will have to be returned to the manufacturer. This will not stop progress but will limit capacity during the repair.

More generally, a number of interventions which potentially impact on the cryogenics were recalled:

- Replacement of the beam dump dilution kickers of beam 2 in sector 56
- Scheduled UPS maintenance to come in weeks 19 to weeks 25
- Static VAR Compensator to come in weeks 20 to weeks 25 and others
- Water loops in caverns: Consolidations made by TS/CV, to be foreseen as well at point 6 rather quickly
- UX85 controls electronics intervention being prepared for July

L.Evans added that decisions on whether or not to intervene this year on the water and electronics in points 6 and 8 respectively will be taken within the next two weeks, when developments elsewhere in the project become clearer. The interventions to replace the beam dump dilution kickers in point 6 have been delayed by one week to allow the dipole training program in sector 56 to continue. The work will be done from June 18th.

5.2 A.Vergara summarised the Status of ongoing power tests.

The dipole training campaign in **Sector 56** has now pushed the attainable current in the dipole string to 11153A which corresponds to beam energy over 6.5TeV. However to achieve this it has taken over one month and almost 30 training quenches, nearly all of which have occurred in magnets from one manufacturer, Noell. As already referred to in the cryogenic report, forced quenching of Noell magnets is recently being tried as a method of reducing the elapsed time needed to reach 7TeV.

Elsewhere in sector 56 activities continue on the triplet magnet assembly, and training of the QF and QD quadrupole strings to 7TeV beam energy is still to be done although this should be rather quick (a single training quench in early may reached 11280A or almost 6.7TeV).

In **Sector 78**, power tests progressed well for ten days until interruptions from the electrical networks and others perturbed the cryogenic conditions for more than a week. Tests are now continuing and are about 80% complete. Little has been done to date on the triplet magnets and the main strings have not yet been powered to high currents.

The status of the different categories of circuit is summarised;

- 60 A
  - ALL commissioned
- 80/120 A
  - ML8 – ALL commissioned
  - ARC – 17 out of 20 circuits brought to PIC2
- 600 A
  - ALL ARC circuits to nominal
- ML8
  - RD2.L8 commissioned
  - RQ5.L8 commissioned
  - RQ4.L8 commissioned
- DS
  - 3 out of 5 brought to nominal
- RB, RQs
  - Brought to 760A and 2kA respectively

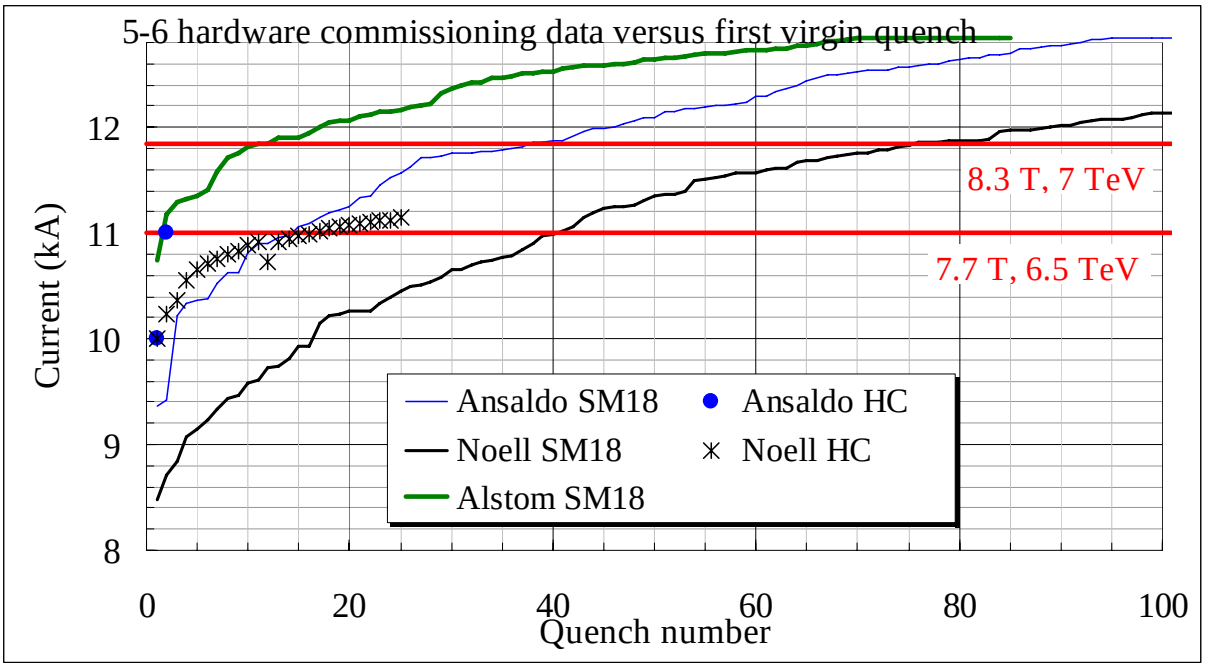
L.Evans suggested that once the hardware commissioning for 5TeV operation is complete, we should embark on a dipole training campaign in sector 78 too. While this sector contains less Noell magnets than sector 56, the ones it does have are mostly from the early series production and so could provide interesting data for the understanding of the behaviour of these magnets. **S.Claudet** commented that because we are using ex-LEP cryogenic equipment for cooling this sector, recovery times after a quench could be longer than in sector 56.

5.3 **E.Todesco** summarised the Quench campaign in Sector 56.

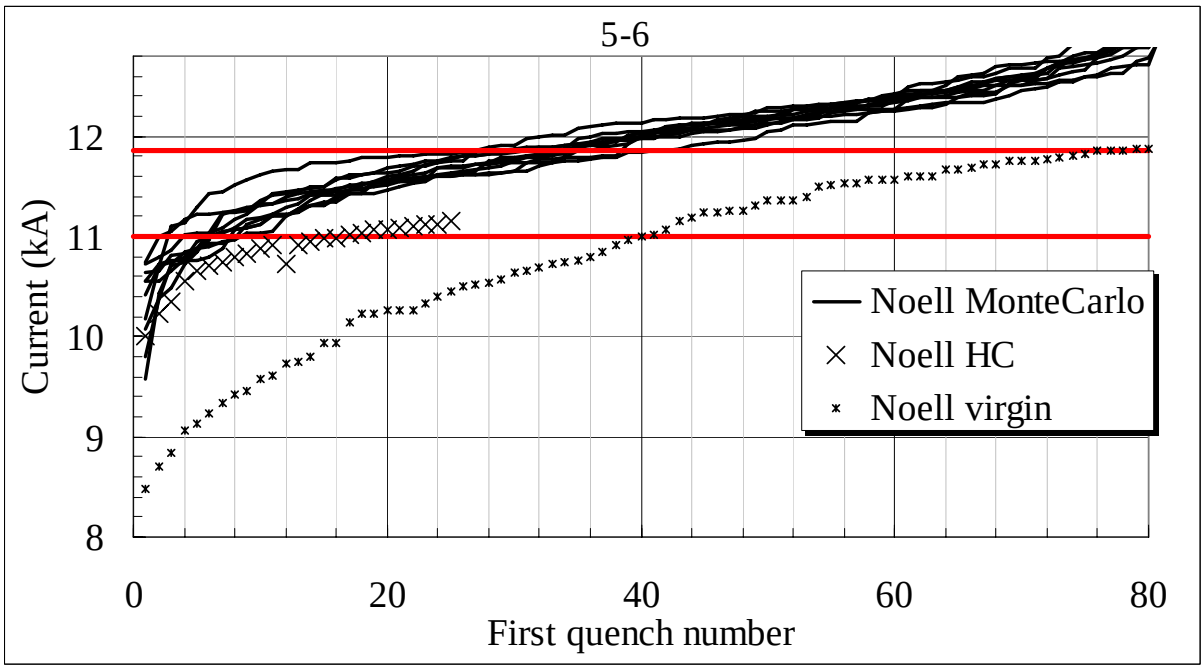
The campaign to train the dipole string in sector 56 to the 7TeV equivalent current of 11850A has shown some unexpected behaviour. Based on data from the SM18 tests on individual magnets, it was expected that the first quenches in the tunnel would occur at around 11kA and that some 25 to 30 quenches would be needed for the 154 dipoles in the string to reach nominal. Instead, first quenches occurred at around 10kA and after almost 30 quenches the current reached is 11.15kA, some 6% short of nominal. Furthermore, of the quenches seen to date have nearly all been in Noell magnets, with just 2 from Ansaldo and none from Alstom.

The expectations mentioned are based on an analysis of the 136 dipoles that underwent a thermal cycle in the SM18 test program. After such a cycle, there was an 80% reduction in the number of quenches to get to nominal compared to first training. In other words it was expected that 20% of quenches would be needed to regain nominal performance in the tunnel, which for one sector corresponds to some 30 magnets since according to SM18 data magnets need an average of one quench to reach nominal.

The data in sector 5-6 relative to the SM18 data of the dipoles when tested as virgin magnets are shown in the plot below. In case of a total loss of memory of the SM18 training, around 130 quenches would be needed to reach nominal current. It should be noted that the curves for the first virgin training quenches from SM18 data are somewhat distorted in sector 56 by the fact that there are a higher than average number of Noell magnets in this sector (84 compared to 154/3 or around 50). If one considers a sector with equal distribution of magnets by supplier the picture changes, showing Ansaldo and Noell having a similar behaviour, and Alstom a better one. This does not however change the difference between expectation and reality, and a more critical look at the data is required.



A more refined approach is to start from the SM18 data of the virgin magnets and apply the correlation between the first virgin quench and the first quench after the thermal cycle measured in SM18. Unfortunately, the statistics available is low (and possibly biased), but a Monte Carlo simulation can be done. The results for Noell magnets are shown in the plot below. With this refined model, quantitative results for the first 10 or so quenches are good, but then the data from the training campaign fall below and are presently some 400A to 600A below the model. Noell magnets have lost some memory, but not completely.



Clearly more work is needed, both on understanding the matter and rectifying it. The present approach will be continued to better understand the developing situation in sector 56 and to study the distributions in coming sectors. A training campaign in sector 78 would provide precious additional information for this.

Beyond this, other actions are foreseen

- Critically review the production data of the magnets
- Find tools to speed-up training, with three proposals under evaluation by Magnet Performance Panel
    1. Increasing the temperature (P. Lebrun)
    2. Overshooting with current to have more quenches at the same time (R. Schmidt)
    3. Shaking the Noell magnets with a chain of provoked quenches at high current (L. Evans, after an old work by A. Siemko [Trans. Appl. Magnetics **32**, (1994) 2089])
        - Tried on 4th June (3 quenches at the same time) and on 5th June (4 quenches)

L.Evans commented that the second of these ideas looks interesting, but it is not without risk and needs careful preparation. If not used now it could play a role in the 08/09 shutdown. In the meantime provoked quenches of multiple magnets will be pursued.

6. AOB

V.Mertens confirmed that the BT group are ready for the exchange of the beam 2 dump dilution kickers. Now that this has been delayed to prolong the quench training campaign in sector 5-6 the time will be used to pre-investigate the damage as much as possible in situ. The intervention will be made without breaking the circulating beam vacuum. He reported also that 3 of the 4 MKB magnets of beam 1 also suffered a high voltage breakdown during pulsing at 7TeV. Investigations are ongoing. For the time being their voltage is clamped to 5.2TeV equivalent.

E.Ciapala confirmed that the RF group are ready to start conditioning and tuning work on the cavities to the right of point 4 and are waiting for the sector 34 cryogenics. The cavities to the left of point 4 need a further 2-3 weeks for optimisation of loops.

V.Mertens commented on the recent beam commissioning of the TI8 line. On Saturday May 24th the first shot passed again straight down to the end of the line, and some 70% of the test program could be completed before a fault on the 18 kV line supplying TI8 and CNGS brought things to a halt. It was also noted that due to the low total beam intensity used the resulting new radiation zone was restricted to an area 10 m in direction of IR8, and about 20 m in direction of IR1. This radiation zone does not include the passage alongside the LHC.

P.Proudlock added that the fault on the power line has been located to a splice and had been repaired, and that this is the second such fault on this cable which was only installed in 2003.

R.Assmann commented that local hardware commissioning of the installed collimators is around 80% complete and that remote control has been successfully tested. Collimator jaw positioning and surveillance was demonstrated to within 30 micron for the first 7 collimators in IR3 by executing a realistic 30 minute ramp function, fully meeting specification. In laboratory tests lifetime issues have been observed for the mechanical system (external to vacuum) of early series production collimators. It is expected that some collimators in the tunnel will show a similar lifetime reduction after extensive usage (they presently work without problems). 28 out of the 120 collimators are potentially affected with the 10 most severe locations having a predicted reduction in lifetime from 20 years to 1-2 nominal years (depending on the number of cycles per year). This will have no impact for this year, and the problem will be rectified in time for the 2009 run.

P.Collier informed the committee that the DSO tests foreseen for this weekend have had

to be postponed due to the state of the access system. It is hoped that the problems can be resolved in order to allow the tests to be made next week.

S.Baird announced that the LHC shutdown work will be organised by the ABP/RTL team already looking after the shutdowns of the other machines.

Next Meetings

The next informal meeting of the LHC ICC is scheduled to take place on

Friday 20th June 2008 at 10.00 h

Representatives of all groups should be present and prepared to bring up any issue they feel important.

The next formal meeting will take place on

Friday 4th July 2008 2008 at 10.00 h

Provisional Agenda

- Matters arising
- General information
- Hardware baseline
- Hardware commissioning

Reported by Roger Bailey.

Distribution:

Via e-mail to members, those present and mentioned.

All minutes and attachments are available at:
http://lhc.web.cern.ch/lhc/Installation_Commissioning.htm