LHC Installation and Commissioning Committee
Summary of meeting 2008-08 held on 4th July 2008

Present: see annex 1

Main topics of this meeting:

- Hardware baseline
- Cool down of the machine
- Hardware commissioning
- DSO tests

1. Comments on the summary of ICC 2008-07

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 the end of the first week of August.

4. Hardware baseline

S.Chemli presented the Engineering Specifications and Engineering Change Requests presently in circulation.

LHC-EO-ES-0002 ELECTRICAL SUPPLY OF THE TECHNICAL NETWORK FOR THE LHC MACHINE: STATE AND MODIFICATIONS REQUIRED
(A.Funken) **Released 2008-06-24**

LHC-C-ES-0012 FIDEL - The Field Description for the LHC
(N.Sammut) **Released 2008-06-24**

LHC-C-ES-0013 DÆMON INFRASTRUCTURE FOR THE LHC
(S.Gysin) **Released 2008-06-24**

LHC-E-ES-0003 LHC STATIC VAR COMPENSATORS (SVCs) COMMISSIONING
(C.Jach) **Released 2008-06-24**

LHC-MPP-HCP-0070 SECTOR 5-6 POWERING SPECIFICITIES FOR 600 A CIRCUITS (W. Venturini Delsolaro) **Released 2008-06-24**

LHC-MPP-HCP-0029 Powering specificities for 13 kA Dipoles circuits Sector 1-2
(A.Verweij) **Released 2008-07-03**

LHC-MPP-HCP-0037 Powering specificities for 13 kA Dipoles circuits Sector 2-3
(A.Verweij) **Released 2008-07-03**

LHC-MPP-HCP-0013 Powering specificities for 13 kA Dipoles circuits Sector 7-8
(A.Verweij) **Released 2008-07-03**

LHC-MPP-HCP-0021 Powering specificities for 13 kA Dipoles circuits Sector 8-1
(A.Verweij) **Released 2008-07-03**

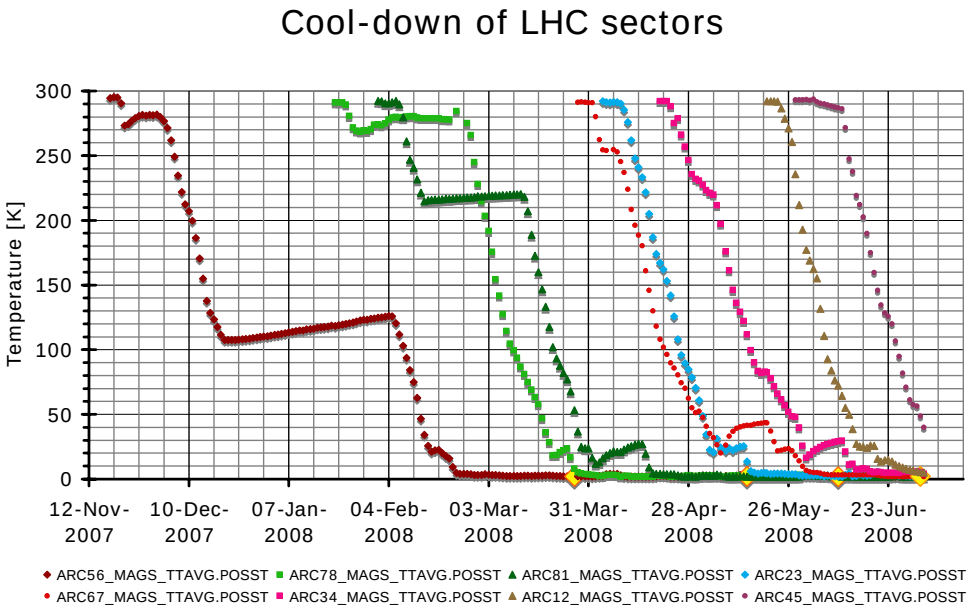
LHC-PM-HCR-0003 Report of the Sector 45 Powering Test Review held on 28th February 2008 (M.Solfaroli Camillocci) **Released 2008-06-24**

LHC-MQXA-EC-0001 Change of protection and interlock scheme for the main quadrupole circuits of the LHC inner triplets (S.Feher) **Accepted 2008-07-03**

5. Hardware Commissioning

5.1 S.Claudet summarised the LHC cryogenics situation.

Three sectors (5-6, 7-8 and 8-1) have seen extensive powering activities while in two more (2-3 and 6-7) powering is about to start. Sectors 3-4 and 1-2 are in cryogenic tuning and the final sector, 4-5, is about to enter liquid helium conditions. The summary plot for the cool down of all eight sectors is shown below.



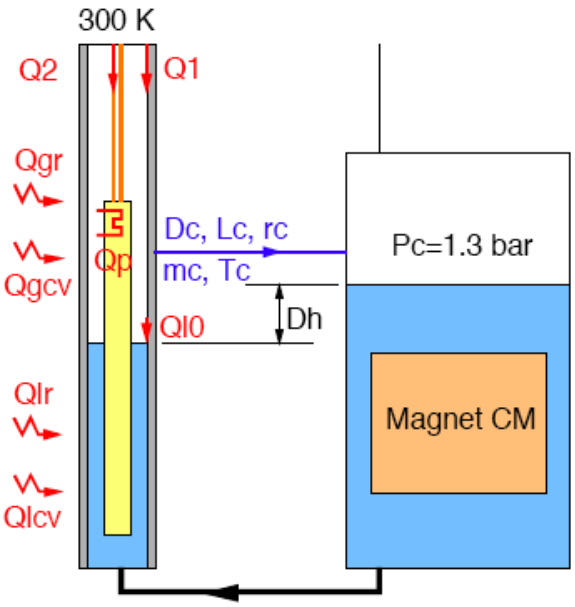
Sector 5-6 has been at operating temperature since early March. Following the power tests and dipole training campaign, the sector was handed over to Operations in June. For the last 4 weeks conditions have been vary stable, including a 10-day period where no cryogenic intervention was needed to maintain good operational conditions. While the availability has been very high in these last weeks, improvements are needed in two areas, namely failure rates of critical services and recovery times from such failures.

In sector 7-8, a new version of cold compressor controls was downloaded in mid-June with good results. In sector 8-1 the conditions for the arc have been good, but there are difficulties with the stand alone magnets, with only 1 out of 6 released for powering. Powering in both of these sectors has to stop now for the intervention on the electronics located in UX85 (see below).

Sector 2-3 suffered a large air leak into the QUI which required intervention. For the stand alone magnets in this sector 3 out of 4 are OK. Three elements (DFBMC.5R2, Q6R2 and Q6L3) show high heat leaks and it is difficult to control the level. The arc is ready for powering. Sector 6-7 will all be delivered for powering in week 28.

In sector 3-4 there is a worry over another possible problem in the Y line (as has been discovered in sector 7-8 and 8-1) which will locally slow down cooling by helium flow. Cryogenic conditions for the RF cavities left of point 4 have been good for two weeks, and low power tests have been completed. Conditioning has started and already reached about half of nominal field gradients.

As mentioned, liquid helium level control in some of the stand alone magnets is giving trouble in various sectors, and efforts are ongoing to understand and cure the problem. A first element in this is the capillary linking the level gauge to the magnet cold mass; if the diameter of this is too small a pressure difference is created which in turn leads to a difference in the levels in the two parts, as indicated in the sketch. A second issue is the position of the helium inlet and outlet ports in the cold mass, which appear too low to permit operation with full liquid coverage of the superconducting coil.



The topic will be treated in detail in a forthcoming MARIC, where short term solutions (for 2008) and long term solutions will be explored.

The control electronics located in UX85 has been identified as being at high risk to radiation damage from particles emanating from IP8. Consequently, now that the power testing is well advanced in both of the adjacent sectors, it has been decided to go ahead with the intervention to move the equipment to a safe place. The work will be done in two phases, the first starting now and the second sometime during the winter shutdown. The strategy adopted is to empty the liquid helium from sectors 7-8 and 8-1, and then maintaining a temperature around 10K with cold helium gas. The absence of liquid helium will make the system easier to handle in case of stops for whatever reason and will allow consolidation work to be undertaken in parallel. Following the intervention, sector 8-1 is expected to be cold again by the end of July with sector 7-8 following one week later.

Now that the whole machine is (almost) cold, a clearer picture is emerging of the overall helium inventory and electrical power consumption. For the former, the total amount of helium for the machine is now 125 tonnes, of which 95 are in the machine, 22 are in gaseous storage (out of 50 available) and 8 are in liquid storage (out of 25 available). For the latter, we are now expecting to consume some 20 to 22 MWh/month during the summer, in line with expectations.

P.Lebrun suggested that it would also be interesting to monitor the electrical consumption of the cryogenic system in terms of power, since this is the limiting parameter during the winter.

L.Evans pointed out that every effort should be made to bring sectors 7-8 and 8-1 back online as early as possible, so that the power tests can be finished and the sectors handed over to Operations.

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

In Sector 7-8 the hardware commissioning is almost complete, with two systems needing particular mention.

On the Main Dipole string, 4 magnet quench detectors tripped after two energy extraction switch openings. Studies showed that this was due to the unbalanced distribution of the eddy currents in the two apertures. The QPS threshold for the local quench detectors of these magnets has been raised from 100mV to 250mV.

On the Inner Triplet;

- Ice formation around one of the 600A leads. This was due to a malfunctioning valve and the problem is fixed.
- Following the experience on this DFBX, a general campaign for all the sectors hosting inner triplets has been planned in order to improve the anti-condensation system of the corrector leads.
- Two 600 closed orbit correctors of the triplet were successfully commissioned.

In Sector 8-1 the commissioning is well advanced, with the notable exception of the inner triplet and stand alone quadrupoles. On the Main Dipole circuit, some issues prevented powering during the first days and one is worthy of note. An earth fault occurred due to a contact between a DC cable water pipe and some grounded support. The intervention took a couple of days and a global check around the whole machine has been started by TS-EL to find similar cases.

L.Evans clarified that the magnets that quenched in sector 7-8 are all from early series production, using cable that was difficult to match electrically between the two apertures. Since the quench detection system is based on detection of any imbalance between the two apertures, it is more sensitive in these magnets. A method is under development to identify these magnets without the kind of dramatic quench that occurred in sector 7-8, and the QPS threshold will then be raised on all magnets found.

5.3 G.Arduini summarised the Operations testing in Sector 56.

The sector was released by Hardware Commissioning on Wednesday June 18th. All circuits were available except for the Triplet Correctors, RTQX1 (not yet commissioned) and RMSD.B1/2 (cooling circuit was closed). The 600A circuits had been commissioned with the old version of the QPS firmware with lower ramp and acceleration rates. These have been re-tested after the reload of the QPS firmware. So far 7 power circuits are still limited to less than 0.1 A/s2 and 3 A/s (including RSD/F.B1) and tuning of the QPS might be required.

The tests are based on running the sector through the full operational sequence of pre-cycle, injection, ramp, squeeze, coast and ramp down, while checking such things as software interlocks, alarms, power convertor synchronization etc. Furthermore these tests are made using functions generated with the fullest possible model of the machine, including all data from the Field Description for the LHC (FiDeL). The betatron squeeze is being optimised based on results obtained from the tests; so far the squeeze from β^* of 11m to β^* of 0.55m is lasting some 20 minutes, and the limiting circuits are being investigated. Further tests foreseen in coming weeks are;

- Pre-cycle functions for octupoles (degauss) and sextupoles
- Injection decay and snap-back
- Trim incorporation
- Squeeze to intermediate points, trim and incorporation
- Orbit corrections
- Tune and chromaticity modulations simulating the feedback
- Separation and crossing bumps
- Ramp abort
- Slow abort
- Heat run (after clean-up of the cooling filters)
- EMC with BLMs, BPMs and collimators
- Vacuum (in the available sectors, likely LSS3/7)

- Screens (in the whole ring)

These tests will be coordinated with remaining work needing access in the sector, in particular on the inner triplet assemblies. The access system is being used extensively in this, and still needs a lot of support from the specialists. Furthermore, all personnel should be aware that we are coming out of the installation phase, and more discipline is needed when accessing the machine.

6. Closing the Machine (DSO tests)

G.Roy presented the LHC Access Safety Tests needed before injection of first beam.

The functionality to be tested can be broken down into three categories

- Intrusion into the machine when in “beam” mode
- Éléments importantes de Sécurité (EiS) going unsafe when in “access” mode
- Auxiliary functions
    - Patrols
    - Singular passage through PAD
    - Detection of personnel in MAD
    - Mode change and procedure applied
    - Connection to BIC and LBDS

The auxiliary functions, apart from the last one, are routinely used during normal access operation, and the frequent usage ensures de facto testing. Regular reports by operators on problems and dysfunctions are treated by the specialists as they arise. However, all must all be functionally safe before starting the DSO tests.

Tests of the EiS have to demonstrate the following functionality

- If during access, **one EIS leaves its SAFE position**, further access cannot be allowed and **all access points are blocked for entry**
- If during access, **two EIS of the same chain** leave their SAFE positions, **all access points are blocked for entry** and **evacuation of the entire LHC** is triggered.

The EiS are logically grouped into 3 categories, in order to;

- evacuate the beams (LBDS)
- prevent beam circulation (3 EIS)
- prevent beam injection (2 x 3 EIS)

All 9 EiS and combinations thereof have to be tested, and this must be done with the machine in “access” mode. This work will impact on the whole machine and experimental areas, but should be done in a short time (of order one day).

By far the most complex series of tests to be done is that for intrusion. The basic principle here is that no-one can be present in an interlocked area when beam is, or could be, present. In case of **detected intrusion**, the access system interlocks the EiS, which must be driven to a state which is **SAFE** for personnel presence. The following method has to be applied;

- Close the LHC in “beam” mode (patrols, closure, key transfer, etc,)
- Set all EIS to UNSAFE from CCC controls
- Open or force-open a door (each door in turn, one at a time)
- Verify that all EIS receive the veto and go to SAFE state
- Close and arm the door, patrol the area
- Repeat the process for all doors

The scale of the system makes these tests potentially lengthy. There are more than 300

doors to be tested, each time from a clearly established state. Furthermore each test requires that the EiS go to a SAFE state, which means heavily exercising these systems.

Various strategies are being explored both to speed up the exercise and to reduce the load on the EiS. This will result in a detailed test protocol that should be finalised in the coming 2 weeks. This will then be reviewed and approved by the safety commission in order to be ready for implementation in the last week of July at the earliest. Present estimates require several shifts to complete the test program.

L.Evans commented that these mandatory tests will clearly have an impact on the whole machine and experimental areas, and need careful coordination. The experiments in particular should be informed of the implications and scale of the tests. **R.Aymar** added that it would be better to develop the details further (in the coming week or two) before presenting to the experiments.

7. AOB

K.Foraz informed the committee of the need for a campaign to clean up the tunnel before beam is injected, and presented the following tentative planning.

- Sector 56 done except evacuation in LSS5R
- Sector 12 from 4/7 to 9/7
- Sector 45 (excl. RA) from 10/7 to 14/7
- RA43-RA47 from 14/7 to 15/7
- UJ56 – UL5 from 14/7 to 15/7
- US45 – UL4 from 16/7 to 18/7 (UX45 to be confirmed)
- Sector 81 from 16/7 to 21/7
- Sector 78 from 28/7 to 31/7
- Point 7 from 1/8 to 4/8
- Sector 67 from 5/8 to 8/8
- US65 – UX65 - UL6 from 5/8 to 6/8
- Sector 34 from 11/8 to 15/8
- Sector 23 from 18/8 to 21/8
- US25 – UL2 from 18/8/ to 19/8
- Point 3 from 20/8 to 21/8

Next Meetings

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

Friday 18th July 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 1st August 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