LHC Installation and Commissioning Committee
Summary of meeting 2008-04 held on 11th April 2008

Present: see annex 1

Main topics of this meeting:

- Hardware baseline
- Hardware commissioning
- Radiation issues on electronics

1. Comments on the summary of ICC 2008-03

There were none.

2. Matters arising

There were none.

3. General information

R.Aymar informed the committee that the open days on April 5 and 6 were a big success. **L.Evans** added that recovery from this event, particularly for the cryogenic systems, was well organised to minimise the delay, and now that this is behind us we can push on with getting the machine ready for beam.

4. Hardware baseline

R.Saban presented the Engineering Specifications and Engineering Change Requests presently in circulation.

LHC-LI-EC-0001 INTRODUCTION OF SAMPLES IN THE ARC INTERCONNECTIONS
(L.Ulrici) **Under approval until 2008-04-23**

This Engineering Change Request needs urgent attention in order to allow implementation in the coming weeks. **P.Lebrun** mentioned that he has commented the document in circulation, requesting to check that the effect of placing ferromagnetic samples close to the LHC beams is innocuous.

5. Hardware Commissioning

5.1 S.Claudet summarised the LHC cryogenics situation.

Sector 56 is being progressively released for commissioning of the circuits. LSS-6L has been available for powering since mid-March, allowing the Q4 Q5 and correctors to be commissioned before end of March. The arc was superfluid in late March, and after the interruption from the open days, was again able to establish the Cryo OK signals from April 9th. In LSS-5R, an intervention on the level gauge of the Q5 was made during the commissioning stop during the open days, and the situation is now under evaluation; it looks better, but it not yet clear if the improvement is sufficient. For the triplet, the DFBX is in stable condition for ELQA, and work is ongoing on the current leads.

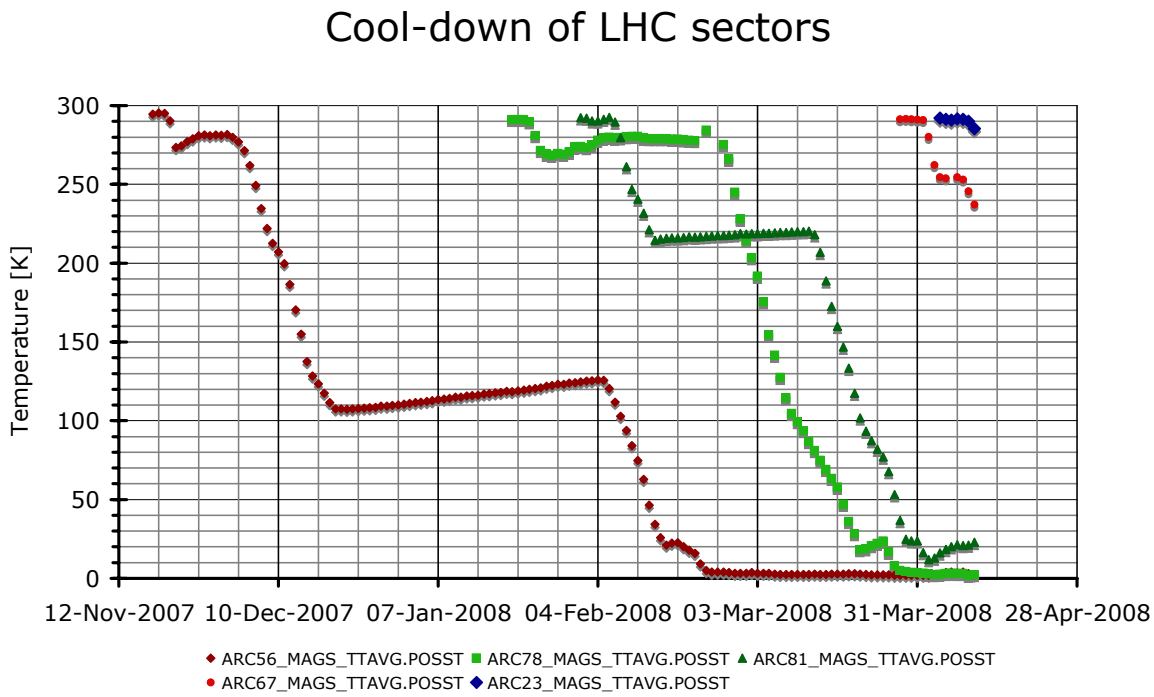
Looking at maintaining sector 56 below 2K since mid February, 7 stops were enumerated, and the Mean Time Between Failures looks similar to that experienced in sector 45; it looks difficult to have more than 11 days of continuous operation below 2K.

In **Sector 78** good progress is being made, with the arc superfluid just 6 days after

liquid helium was achieved, thanks to very good process control. The time to reach 15mbar is compromised by the weak sub cooler from the ex LEP system. The arc magnets are expected to be ready for powering tests in week commencing April 21st. For the other magnets, the time depends mostly on the helium levels. For the triplet, an evaluation of additional instrumentation is underway, and here a strategy is needed. It would be better to do this for all triplet assemblies in the machine, but the present situation is that this is needed already in sectors 56 and 78, with 81 not far away.

In **Sector 81** progress toward filling with liquid helium was slowed first by a last minute mechanical problem and then by a helium leak to a 4.5K refrigeration cold box. Luckily this leak was in the last turbine of the chain and it is possible to isolate this and continue operation with only slightly reduced capacity.

Around the machine there are now 5 sectors below room temperature as shown below. Taking account of the end of year stop (sector 56) and the repair of the Connecting Cryostats (sectors 78 and 81), the slopes are compatible with 6 weeks from room temperature to 2K. In sector 56 a further 4 weeks was needed for tuning the system before cryo OK for powering was possible.



L.Evans asked if the cryogenics teams are still on track for having the whole machine at operating temperature in mid-June. **S.Claudet** replied that taking the figure of 6 weeks from room temperature to 2K, and allowing 2 weeks of cryo tuning, sector 45 would be ready for hardware commissioning in the first half of July.

5.2 **J-P.Tock** summarised the Consolidation activities.

The repair of the Connecting Cryostats proceeds well, with 5 sectors now complete. Of the remaining 3, sector 34 will be completed ~now, sector 45 in week commencing April 21st and sector 56 whenever the sector is warmed up for whatever reason.

Numerous activities are ongoing in the recently warmed up **Sector 45**, as summarised in the table below. The number of Plug in Modules that failed during warm up was 12, comparable to sector 78, and all of QQBI type. While this is good news, two concerns were noted. Firstly, on one occasion just one RF finger had buckled and in such a way that the Sputnik could almost pass the obstacle. Secondly, endoscope examinations of

the beam screens showed several pieces of plastic inside the beam screen, evidently a relic of the packing material. Some of these have been removed while others have disappeared, or more likely have been displaced by air flows. If they are still inside the beam pipe, they must be in beam 1 between Q7 and Q30 right of point 4. An endoscope examination of this region can and will be made within the overall schedule for consolidation of sector 45 as defined by the installation of the triplet. A more global examination for plastic debris would not fit with the present schedule, with some 3 weeks delay estimated.

L.Evans commented on these two concerns. If the ball would pass a single buckled finger, so would the beam, albeit with the help of an orbit bump if necessary. Any pieces of plastic would be vaporised by the beam so we should not delay start-up to search for these.

As a less invasive option to the Sputnik method for finding obstacles in the beam pipe, photometry tests are being made using the buckled fingers as a target. Preliminary results are encouraging, with the system able to detect a single buckled finger at a distance of 1km. Further improvements are possible, and while more analysis is needed this method looks very promising for the future.

Overall the repair work is on schedule for the sector to be ready for cool down mid May.

P.Lebrun commented on the 3 non conformities in the Y lines, insisting that they should be followed up with the company concerned.

Sector 4-5 Consolidation			Schedule	Remark
1	Plug-in modules	12 failed PIMs localised / 20 cut	Critical	Extra openings for plastic pieces removal
2	Photometer test	Completed	OK	Positive results / To be analysed
3	Y lines	3 reinserted / one extra leak	OK	In IC in all cases
4	Helium guards	20 to be repaired / 60 % done	OK	Not a priority
5	Leaks	1 disappeared / 1 under repair	OK	Diode container under rewelding
6	Triplet 5L	Jumper cryolines under welding	OK	DFBX/Q3 IC under closure
7	Q5R4	Short repaired / Under closure	OK	Radial motion not yet understood
8	Connection Cryostats	Electrical insulation reinforced	OK	Under closure
9	CC splices	Not critical	Done	
10	DFBs cables	Not to be done	NA	

SC-RP has made a proposal (see ECR of section 4) to introduce samples of various materials in the LHC environment in order to allow experimental verification of the effects of induced radioactivity. The data gathered would be useful for maintenance of parts, would help to estimate the final waste zoning and provide a comparison with models. The samples would be assembled in a cylindrical aluminium box which would be positioned between the two beam pipes.

L.Evans had no objection to this so long as no ferromagnetic materials were involved since this could possibly create field perturbations.

5.3 M.Solfaroli summarised the Status of Sector 56 power tests.

With the exception of the DFBX, all DFBs were commissioned by mid March. The DFBX had conditions for ELQA at the end of March. Since then the high current leads have been released for powering while for the low current leads the cooling needs to be tuned. In LR5 the Q5 is expected to be released following modifications to the helium level gauges.

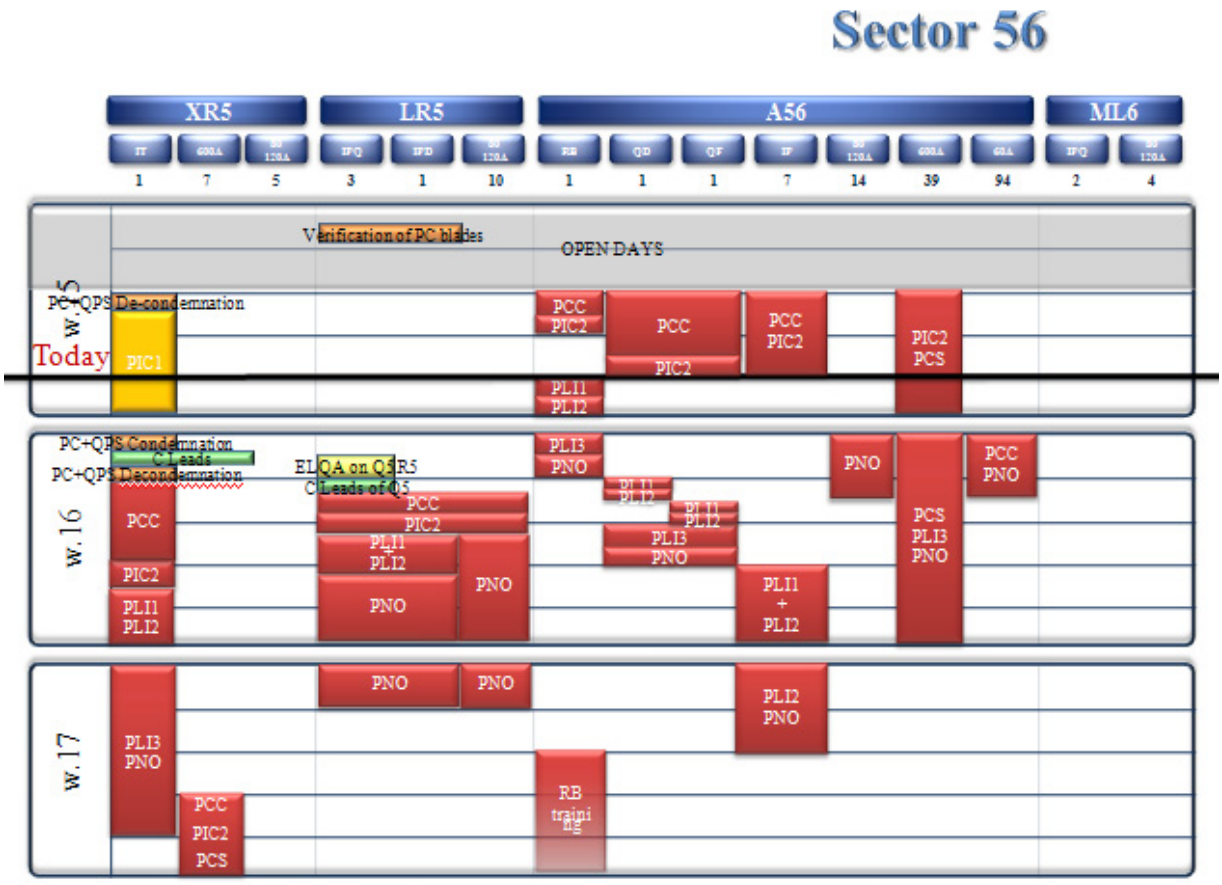
Electrical Quality Assurance has been completed on ML6 (March 11th) the arc (March 26th) LR5 (March 31st) and the triplet (March 31st). No non conformities have been discovered so far.

The full sequence of tests is recalled;

- PIC1 power interlock controller check without current
- PCL current lead verification
- PCC power convertor configuration
- PIC2 power interlock controller check with current
- PLI1 powering to injection current
- PLI2,3 powering to intermediate current
- PNO powering to nominal

The stand alone magnets in ML6 have been fully commissioned to nominal in March. For the main dipoles the PIC2 has been successfully performed. For the QF and QD strings, PCC is ongoing. For the individually powered quads PIC2 has been successfully performed for all except Q9.R5. For the 600A circuits PIC2 has been done for all except those not needed for the 5TeV run. For the 80/120A circuits, all but 1 have successfully passed PIC2, while the 60A circuits await the cool down of the beam screens. Finally, the triplet is blocked due to power convertor readiness and QPS-PIC interface problems.

The planning for the powering is shown below. If this is followed, it will allow the bulk of sector 56 to be finished before the effort switches to sector 78 in late April. Training of the dipoles in 56 will continue through May to see how much is needed to reach nominal performance.



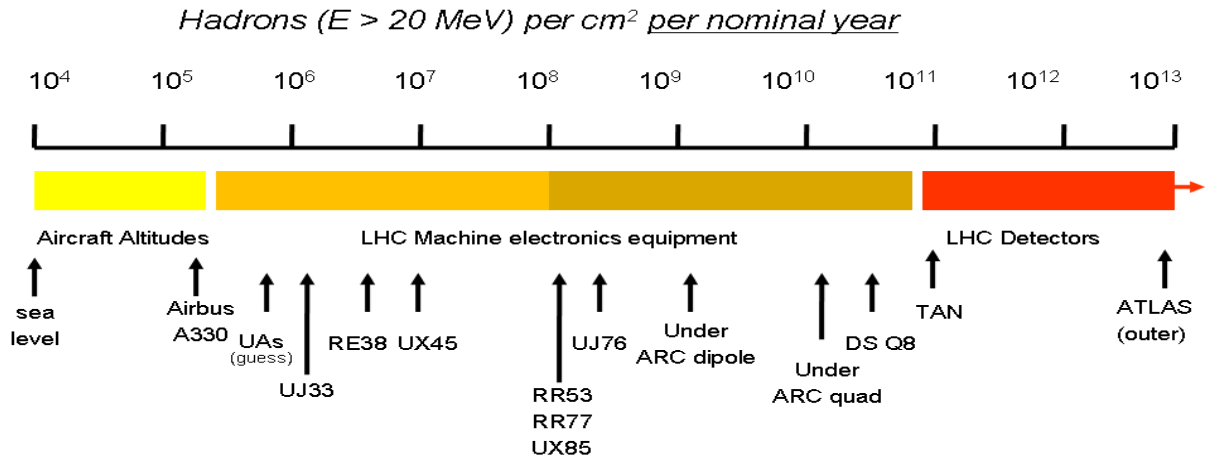
6. Radiation effects on electronics

L.Evans introduced the subject by reminding the committee that although much work has been done to avoid radiation damage to LHC equipment, the SPS CNGS experience has served as a wake up call on what could go wrong, and we now need to reconsidere the LHC situation. **T.Wijnands** then summarised the present understanding of Accelerator equipment exposed to radiation in the LHC tunnel and underground areas.

Radiation damage effects fall into three categories; Total Dose, Displacement and Single Events Errors. Single Event Errors, both hard and soft, are the main issue and the rate depends on flux of hadrons with energies > 20MeV. PLCs, consisting of a power supply, CPU and I/O modules, are particularly at risk. The solution chosen for the LHC is to make the power supply and I/O modules radiation hard, and move the CPU to the sanctuary of the surface (or at least away from radiation areas).

Monitoring will be of utmost importance and a Radiation Monitoring system (RadMon) has been developed and is being deployed, with some 400 devices in the tunnel, underground areas and the experimental caverns. Data from this system will be available in the CCC through the standard packages Timber and Meter.

The expected rates in the various underground regions for a nominal year of LHC operations are summarised below, where 10^8 hadrons per year is considered the rate above which measures have to be taken (radiation hard or move).



A similar picture exists for the CNGS facility, with the rates expected in the CNGS technical gallery, the CNGS electronics and the CNGS mezzanine. However, after just 2 days or operation in late 2007, Single Event Error failures occurred in two out of three of these zones, at rates one or two orders of magnitude less than expected. With this in mind, a critical look at the above picture for LHC has been made and certain zones of the LHC are now considered to be at risk (in order of priority);

- UJ76, RR77 and RR73 at point 7 (sensitive equipment in zones, shielding needed)
- UX85 at point 8 (industrial controls in line of sight from IP8, luminosity driven)
- RRs around points 1 and 5 (controls electronics, more shielding needed)

It is now considered that if nothing is done, situations as encountered in CNGS are likely to happen in these zones. A crash progam could establish an inventory, clean up the zones, prepare back-up solutions, fill holes in shielding and optimise radiation monitoring.

L.Evans commented that the UX85 situation is known since some time and that plans are in place to improve it. **S.Claudet** added that action is foreseen in two phases. Phase I would involve moving PLCs out to an adjacent zone, but this would require a 3-5 week window to empty sectors 78 and 81 of helium. Phase II concerns the controls of the valves and has yet to be decided. **L.Evans** concluded that it is not reasonable to consider stopping the commissioning program now to do this, but that the intervention should be planned so that we are ready in case a window presents itself; in the meantime we will have to live with the situation.

For other zones, **L.Evans** commented that in 2008 very little can be done, but beam intensities and luminosities will in any case be orders of magnitude below nominal. Monitoring should provide some real data on these issues, and equipment groups should prepare for action (shielding or otherwise) in the 2008/9 shutdown.

S.Myers asked if it would be possible to displace one of the key sources of radiation (the betatron collimation system in IR7) to elsewhere in the machine, such as to point 3. This option should be investigated.

S.Weisz was nominated as contact person for all matters related to shielding and **T.Wijnands** for more general aspects of monitoring and protection (Mr. Radiation).

Next Meetings

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

Friday 25th April 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 9th May 2008 2008 at 10.00 h

Provisional Agenda

- Matters arising
- General information
- Hardware baseline
- Hardware commissioning
- Radiation tolerance of LHC equipment

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