Summary of the LHC Main Ring Committee [MARIC] meeting held on 4 February 2004

Present: V. Baglin, R. Bailey, V. Chohan, P. Ciriani, P. Collier, L. Evans, K. Foraz, P. Frandsen, C. Hauviller, R. Herzog, N. Hilleret, Ph. Lebrun, K.-H. Mess, A. Poncet, K. Potter, P. Proudlock, P. Rohmig, L. Rossi, L. Tavian, Th. Tortschanoff, L. Walckiers

Main topics: Thermal cycling of the beam screens; Conclusions of the December 2003 review of cryomagnet tests

1. General information

L. Evans reported from a discussion he had with the Director General on the general planning until the completion of the LHC. From the current perspective it appears that all hardware will be available as planned, but that the installation and commissioning of all components in the tunnel may be a big problem. Already a delay of nine months has to be made up over the next three years. The Director General is aware that changes are needed and he proposed to plan without resource limitations. At the moment keeping the schedule is more important than cost issues, which is a major change of perspective. Industrial contracts and contract labour may be extended as needed, requests for recruiting can be issued. In addition the external review committee proposed not to run the accelerators in 2006, which would free further resources. Ph. Lebrun noted that it will be necessary to resize installation contracts, in particular for the interconnection work. The sectors could be installed in three shifts with three fronts advancing at the same time. A new schedule will be discussed at the end of March when Air Liquide will finish the installation of the QRL in the first sub-sector. Ph. Lebrun also noted that delays in recruitment are occurring with Morges 3 posts still not filled, thus leading to insufficient resources for current work.

2. Update on

2.1 Main component deliveries

The following comments were made to the dashboards in the annex:

Cable 1: L. Rossi noted that organisational problems at Brugg had caused some delay.

Cable 2: A gap between manufactured strands and cables exists. It takes time to close it.

Steel collars: Their production is still of concern. More than shown have been punched, but they are not yet measured. At the moment only a two week stock exists for dipole production. Malvestiti will set up a second production line.

Laminations: Some stock was used to use some laminations which have been produced 2 ½ years ago and became rusty. For the required production rate currently one week per month of punching is sufficient.

Heat exchanger tubes: They arrive in time and on budget – in-sourcing works!

Dipole end covers: High quality and low cost was achieved for this item.

Half shells: A lot of shells exist, but approval takes time. No delay anticipated.

Cold bore tubes: A decision on spares is needed, because the production will soon finish.

Cold masses: The Christmas shut down had no effect on the production rate. A high rate is possible if all components are available.

Quadrupole cold masses: The production is picking up, two will soon arrive per week. A lot of bare magnets are on stock, which need to be cryostated. Non-conforming MQ busbars will be repaired at Accel.

Cryodipole overview: A. Poncet noted that a storage problem exists with already cryostated dipoles which cannot be tested yet.

Busbars: The delivery of busbars for the SSSs is under way. K.-H. Mess noted that difficulties exist with the busbars for the Dispersion Suppressor regions.

MCS correctors: The production progresses well at both suppliers.

MCDO correctors: 40 correctors arrive each month from India, where the production will finish at the end of the year. Tesla made 50 magnets, but is badly behind.

MSCB correctors: 55 correctors were so far delivered. The production rate is slightly below requirements.

MCBC correctors: Currently four are delivered per month.

MCBY correctors: The first ones will arrive in February, but a big problem with the wire exists. In the middle of some storage spools the insulation of the wire was damaged. Alsthom is prepared to produce a new batch, but this will take at least 5 months. Currently it appears that there will be a shortage of MCBY magnets in the summer.

MCBX correctors: Sigmaphi is short of wire by ½ billet.

MO correctors: The production is progressing well, it will finish in December 2004.

MQM magnets: So far 12 magnets have been produced plus three MQYs. Sufficient cable exists.

MQT and MQS correctors: The cryotesting at Ansaldo has stopped because of problems with the heat exchanger. Testing at ENEA could be considered as an alternative.

Diode packs: Delivery occurs as planned. Testing at ENEA could be accelerated to free the equipment there for other tests.

Interconnection bellow sets: Currently 50 are tested per week without any leaks detected.

Cryogenics overview: L. Tavian noted that a leak exists at the QUI box foreseen for Point 4. A delivery delay of this box becomes critical. The first two DFBs are under production. All quench valves should be delivered by May 2005. Sufficient pre-fabricated QRL modules are available, but the installation is delayed.

BPM bodies: The first bodies from a new contractor should arrive in March.

Beam screens: Paperwork needed for payment causes delays.

Beam screen testing: Testing is currently too slow, but will accelerate soon.

Turbo molecular pumps: They arrive as scheduled.

Finally Ph. Lebrun encouraged the integration of other components into the dashboards.

2.2 LHC installation

K. Foraz presented an update of LHC installation and follow up of planning (see attached slides). Among the many activities ongoing in all parts of the tunnel are:

A test of the cryo-magnet transport vehicles & transfer tables in sector 1-2.

Water was leaking in RE38 and spraying on electrical components. The leak was fixed provisionally, but the main drain needs to be cleaned urgently!

In TI8 50 quadrupoles have been installed and aligned and 2 dipoles installed.

In general some problems occurred, but a number of very important tasks were achieved. The general services and transport are on schedule. Discussions with Air Liquide on the installation of the QRL in sector 7-8 are ongoing. We expect a real effort from AL to enable the main project milestones to remain within schedule. However, for the installation of machine elements in sector 7-8 a global shift of about ten weeks is now foreseeable.

2.3 LHC Technical co-ordination

P. Proudlock reported about worries concerning the installation of the LHC. The cable store platform in Prevessin will be reused for LHC dipoles after cable drums are moved to a neighbouring area.

2.4 TS matters

P. Ciriani mentioned that the beam screen coating is now progressing well. Two DFBs will be built in the main workshop this year. Two prototypes of collimators have been made recently.

2.5 AB matters

P.Collier said that the notes from the Chamonix meeting have to be analysed, in particular concerning the question of reference magnets.

2.6 Main magnet tests

L. Walckiers explained that the testing in SM18 restarted on 26 January after the Christmas shut-down. The renewal of the control room during the shut-down has caused some start-up problems. A power supply failed on Friday evening after 2 quenches and could not be repaired immediately. On-call services for the power supply and the control systems will be needed in the future. Over the last weekend leaks appeared on the anti-cryostats of the CFB. TBE1 was repaired so that there are now 7 MB benches and 1 MQ bench operational. Since the start-up 3 magnets were tested. An automatic logbook will be operational within two weeks, including a new Task Tracking System. The streamlining of the SSS test programme proves more difficult than expected. At the moment SSS8 is cold.

2.7 String 2

The disassembly and cutting of the QRL is in progress.

3. Thermal cycling of the beam screens

*3.1 The vacuum case (**V. Baglin**)*

During the operation of the LHC, photon, electron and ion bombardment on the beam screen causes molecular desorption. In the cryogenic elements, however, the desorbed molecules largely remain pumped on the beam screen. An equilibrium between the desorption caused by particle bombardment and the cryogenic pumping is reached with a few tens of monolayers of CO and CO_2 after 200 days of operation. If more gas is pumped to the cryogenic walls than the equilibrium number of monolayers, a vacuum transient (increase in pressure) occurs once the irradiation starts. This effect was shown in tests with hydrogen.

String 2 temperature data show that in case of a quench in a magnet CO (and possibly CH_4 and CO_2) is released over a length of about 50 m, because of the increase of the beam screen and cold bore temperatures to 30 – 40 K. The released gas condenses onto about 2 m long regions of the cold bore next to the quenched section, where several tens of monolayers build up. Once a beam is injected into the LHC, a vacuum transient occurs at these locations. With a high beam current the heat load in these regions coming from electron clouds can be as large as 1.5 W/m, thus creating a risks of quench in the magnet concerned. After one hour the molecules

would be redistributed and the pressure return to low levels. The quench risk can be reduced with a low beam current for about 20 hours, but this is evidently undesirable. Removing the CO by beam screen heating can improve this situation.

The 'local' excess coverage can be removed by heating the beam screens of three half-cells (one beam screen cooling loop extends over one half-cell). During this operation the cold bore temperature remains at 1.9 K. In addition the 'distributed' equilibrium coverage of an entire continuous cryostat (DS+arc+DS) can be removed by warming up the whole beam screen. If done in an advancing manner, the gas will be 'pushed' out. The beam screen regeneration process is expected to last about 8 hours.

*3.2 The cryogenic solution (**L. Tavian**)*

The heating of the beam screens can be achieved by installing a heater cartridge, as the one proposed in Engineering Change Request LHC-QIH-EC-0003, at the inlet of the beam screen cooling loops. If operated with 50 V, they generate 25 W of heat and do not need any external regulation. The integrated temperature sensor automatically protects the element. This solution is within the current Cost to Completion budget. With a temperature controlled power supply the same elements could be operated at up to 140 V, thereby generating 200 W of heat. Such a modification would cost about 350 kCHF for the whole machine. The higher power would lead to a reduced regeneration time.

MARIC endorsed the solution proposed by L. Tavian.

4. Conclusions of the December 2003 review of cryomagnet tests (Ph. Lebrun)

Although the rate of cryomagnet reception tests increased remarkably during 2003, the tests are still not capable to keep up with the production rate of cryomagnets. Because this situation was foreseen from 2002, it was decided to follow this critical topic closely, in particular by a review of reception tests on 23 July 2003 and by a second review on 16 December 2003. Although it provided comprehensive data on test operations and obtained results, the last review proved inconclusive, because of insufficiently processed or inhomogeneous data and lack of time for discussion. An ad hoc meeting of the Group Leaders concerned on 9 January 2004 was called to provide decisive answers to a list of questions raised by the review.

The review and the meeting on 9 January came to the following conclusions and actions to be taken:

90 magnets were tested in 2003, which is unfortunately still insufficient, because a backlog of 85 untested magnets built up until the end of December 2003.

The magnets are occupying the test benches still about twice as long as planned, with delays occurring at all phases of the test sequence:

Connection and removal: 24 h are planned, but on average it takes 30 h. In addition there is a 33 h waiting time. ICS shall connect and remove magnets also on the weekends. A. Poncet remarked that this is now implemented.

For the pump down 12 h are planned, but 16 h were observed on average in 2003. L. Tavian noted that this now takes 10.5 h.

Leak testing was planned to occur in the shade of the pump down, but took on average 15 additional hours. L. Tavian shall review and enforce the leak testing procedure by ALLS.

24 h were planned for the cool down and 12 h for the warm up, but it took on average 46 h and 32 h respectively. L. Tavian remarked that the mass flow-rate will be increased by raising the circulator suction pressure will be adjusted and that a third circulator is on order.

36 h were allocated to cold tests, but an average duration of 72 h was observed, due to the fact that more than two high-field quenches and thermal cycles were executed, the sequencing between

benches was not optimal and there was insufficient co-ordination between teams. L. Tavian said that giving the cryo-ok flag seems now correct. L. Walckiers remarked that the Task Tracking System will be operational soon.

The total cryogenic capacity at the test stations allows for six high-field quenches and two to three magnet sub-coolings a day. The large number of high-field quenches per magnet resulted in long test periods, although two high-field quenches per magnet are sufficient to assess the electrical integrity of a magnet. No strong technical case exist for retraining, so no thermal cycles should be executed with well-behaving magnets. L. Walckiers and L. Rossi have revised the procedures and flow charts for the power tests. The last warm-up quench shall be triggered at nominal current or less.

Magnetic measurements at cold and warm show adequate correlations for the multipoles. Two important measurements are the ones of the field integral and the field angle. There is good correlation between the field angles of the two apertures. L. Walckiers and his group consider to replace the long shaft with the stretched wire method for a large fraction of the series. Cold magnetic measurements will only be performed on a limited sample of magnets.

Management and organisational issues were addressed as well. L. Walckiers will reaffirm the responsibilities and authorities of the Test Operation section leader and the Shift leaders. The authority of the Test Operation section leader over the equipment support teams in MTM and other groups as well as industrial support will be re-asserted. The consultative scientific role of the test co-ordinators will be clarified. The operators, shift leaders and test co-ordinators will be adequately trained. The representation and functioning of the weekly Test Operation meeting will be improved. Test assessment and follow-up tools will be developed and implemented.

The start of operations after the Christmas shut down happened as planned, seven benches are operational and an eighth will be operational in mid February. Benches B1 and B2 will become available in mid March and benches A1 and A2 at the end of April. Benches D1 and D2 will later be allocated to tests of the arc SSSs. Current planning aims at 160 dipoles and 50 SSS tested by August 2004. From September 2004 two magnets shall be measured per day.

To catch up with the existing backlog of mostly cross-section 2 dipoles, four benches shall be allocated to test these magnets. On about 20% of them magnetic measurements shall be made. L. Rossi shall establish a detailed test program of all backlog magnets.

Robert Herzog

Next meeting: 18 February 2004