15th Plenary Meeting of the LHC Resource Review Boards, 21st Oct 2002

Documents **CERN-RRB-2002-nnn** can be found at **http://web.cern.ch/Committees/LHCRRB/RRB/**

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1. Welcome and Introduction *Chairman, R.J. Cashmore, Director for Collider Programmes*

The Chairman welcomed RRB delegates and encouraged them to sign up for visits to ATLAS or CMS and, for the first time, ALICE. He explained that Philippe Lebrun, LHC Division Leader, would be presenting the Machine Status report in place of Lyn Evans, LHC Project Leader, because a Machine Review meeting was coinciding with the RRB meeting.

2. Status of the LHC Machine *Ph. Lebrun, LHC Division Leader*

Report available on the LHCRRB/RRB website as *CERN-RRB-2002-150.pdf*

Installation of the tunnel infrastructure is proceeding according to the revised planning and an 'installation coordination' group is being set up in EST Division. Important milestones for starting installation occur in June 2003 for the first QRL (cryoline) in sector 7-8, and April 2004 for the first octant of cryomagnets.

- *Civil engineering CE*

Most underground areas are either fully excavated or fully excavated and concreted. All CE for the machine will be finished by June 2003 and the caverns will be delivered on schedule, ATLAS on 15th April 2003, CMS on 1st July 2004. This constitutes major progress given the difficulties experienced with the CE contracts.

- *Injectors and electron cloud studies*

A successful 'scrubbing' run has been carried out at the SPS in which the beam itself reduced the secondary emission yield of electrons from the beam pipe inner surface by several orders of magnitude over a period of a few days. This process is crucial to avoid the build-up of electron clouds that can cause instabilities in the circulating proton beams. The studies will continue.

The impedance reduction program has demonstrated that, even without the 200 MHz r.f. system in the LHC, high quality beam transfer from the SPS can be achieved (short bunches with low emittance and no longitudinal blow-up).

- *Magnets*

The LHC uses more than 6,000 magnets, of which 1,232 are main dipoles and 400 main quadrupoles, the rest being correctors.

Dipole coil production and collaring is now fully industrial and additional tooling is being commissioned. Production startup for cold mass assembly was slower than foreseen but production will now ramp up in all 3 firms with ~ 40 dipoles completed by end 2002, the first octant completed by September 2003 and full production rate reached in February 2004. Of the 14 pre-series dipoles tested for quenching, one had a cable defect that is being repaired, 6 reached nominal current without quenching, 6 after one quench and 1 after 2 quenches. This represents a very satisfactory confirmation of the soundness of the basic design.

The ramp-up of cable production has been hampered by industrial problems – flooding of a subcontractor's premises and a major breakdown of a cabling machine. The trend is now improving – a second cabling machine will become fully operational early in 2003 and a machine in the US will be used by one of the companies. In the meantime, companies are being asked to accumulate strands; CERN has a stockpile sufficient for ~ 100 dipoles.

Concerning the quadrupoles, Saclay colleagues and CERN staff are to be congratulated on the design quality and technology transfer. The first two industrial series quadrupoles both exceeded the nominal power of 223 T/m before quenching and, after fixing a problem in the current lead outside the magnet, the second unit reached the ultimate 241 T/m without a further quench.

- *Cryogenics*

Four new 4.5 K refrigerators are at CERN. The Air Liquide AL plant at P 18 is operational and the P 4 plant is being commissioned. Installation of Linde plants is complete at P 6 and underway at P 8. Of the associated, somewhat novel 1.8 K cold compressors, the AL preseries commissioning is underway while the IHI/Linde preseries have been successfully commissioned and series production of a further 3 units has started.

Delays in the delivery of the vertical transfer lines due to the insolvency problem of Babcock Borsig can be absorbed. The QRL main cryoline project is proceeding well and installation of the first octant should start in June 2003. Manufacture of the interconnection boxes has started.

- *String 2*

Validation of complete 'cells' – 6 dipoles and 2 quadrupoles – has continued with string 2 ramped to nominal current at 1.9 K continuously since May without quench. These studies constitute an extensive test program of multi-magnet behaviour.

- *Contract problems*

A number of recent cases of insolvency or near insolvency have created difficulties that needed prompt action. Items affected have been the dipole bottom trays (EWK), cryogenic feed boxes for magnet tests (Air Liquide), tunnel and transfer line transport vehicles, vertical cryogenic transfer lines and pre-series and series dipoles (Babcock Nöll Nuclear, a subsidiary of Babcock Borsig) and cryostating of short straight sections (Balcke Dürr Systems, a subsidiary of Babcock Borsig). Remedies range from renegotiating or replacing contracts to transferring certain activities to CERN. Some delays can be absorbed in the installation planning schedule and some work can proceed normally despite the difficulties.

D. Fournier (IN2P3) asked for more information on series dipole tests. Lebrun explained that contractual milestones require dipoles to be tested as they arrive at CERN. This will be done in a 12-bench test station, with 3 shifts working 7 days per week. In the present pre-series tests, magnets can stay on the benches more-or-less as long as required, but at full test capacity the 'standard test schedule' foresees each magnet occupying one bench for one week: 1 day for connection, 1 day for cool-down to 1.9 K, 2 days of quench training, 2 days of field measurements and 1 day for warm-up.

3. LHC Computing *H-F. Hoffmann, Director for Scientific Computing*

The LHC Computing Grid LCG will be a globally distributed networked system comprising a Tier 0 centre at CERN for data recording and reconstruction, a small number of Tier 1 centres at CERN and elsewhere offering a wide range of storage and analysis activities with emphasis on data-intensive batch processing, Tier 2 centres providing reliable batch and interactive services for analysis and simulation, and Tier 3 facilities offering local interactive analysis and simulation.

The idea of a computing grid is that each user employs a cluster of facilities without needing to know where the data and processing capacity are, how things are interconnected, details of the different hardware employed or of any conflicting policies of equipment owners and managers. Funding Agencies are requested to provide free access to LCG facilities for authorised LHC physicists in the same spirit as for the LHC machine and detectors.

In September 2001, the CERN Council approved Phase I of the LCG project. This aims to have, by 2005, in the CERN Tier 0 centre plus CERN and Regional Tier 1 centres, 10% of the computing capacity required in 2008, estimated to be 69,000 'K S1200' processors.

Hoffmann gave details of the LCG project organisation, areas of work, planning, resources, and level 1 milestones; these will be discussed in full at the Computing RRB. The LCG TDR, to be submitted to the LHCC in mid-2005, will be available in draft form to FAs ahead of that date to allow them to adjust their funding levels accordingly.

The personnel situation for Phase 1 does not seem to be critical. About 50 staff have been recruited using special contributions and there are additional commitments from several countries, leaving ~ 50 FTE years uncovered, of which some 40 are already expected to be found. In addition to LCG personnel, IT Division will supply ~ 430 FTE-years for LHC computing between 2001 and 2005. However, there is a mismatch in the staffing profile when going from Phase 1 to Phase 2. Short-term staff are relatively easy to find during the R&D phase because of the widespread interest in grid technology. However, for maintenance and operation of the production facilities in Phase II, long-term staff are needed and it is hoped that, for CERN, these can be found within the Laboratory's personnel planning. For material funding at CERN, there is about 9 MCHF missing for Phase I, and about 20 MCHF for Phase II.

Several countries that do not yet have formal relations with the LCG have contributed significantly to the Data Challenges DCs of the LHC experiments, DCs that are becoming more and more integrated with an LCG approach. For example, 13 CMS collaborating institutes participated in a spring 2002 DC with CERN providing only 15% of the resources, while in summer an ATLAS DC involved 37 institutes in 18 countries.

Hoffmann defined the job of the C–RRB as that of overviewing LCG resources invested by FAs over and above their agreed contributions to the basic CERN budget and to the LHC experiments. During Phase I, resource investments linked to deliverables will be specified in collaboration agreements signed between CERN and FAs or institutes, as appropriate. For Phase II, resource investments will be governed by Memoranda of Understanding, also signed between CERN and FAs or institutes. It is hoped that all FAs contributing to Phase I will be represented at the April 2003 C-RRB.

All in all, the LCG project is in good shape. The staff build-up has been faster than hoped for and the specification of formal requirements is proceeding well. However, materials funding at CERN is a still problem needing substantial help if it is to be solved. The target of deploying a pilot LCG service in 2003 may be too ambitious; there is not yet enough experience with grid middleware and the project has to catch up with the scale of the 2002 physics Data Challenges. The LCG efforts at CERN are typical of what experiments call 'Common Projects' and need to be shouldered together.

4. Towards a new LHC Completion Plan *L. Maiani, Director-General*

Report available on the LHCRRB/RRB website as *CERN-RRB-2002-149.ppt*

In-depth analyses of the organisation and functioning of CERN and of the LHC Project have been carried out following the sizeable LHC cost overruns announced last year. An External Review Committee ERC appointed by Council in December 2001 presented its Report (CERN/2444) in June 2002 . Council accepted the ERC's recommendations, noting that they were coherent with the findings of CERN's internal Task Forces, the new LHC Status Report and CERN's Medium-Term Plan presented in June.

Management has submitted an Action Plan to implement the ERC recommendations in the short and medium term and continues to pursue a balanced package of measures to overcome the crisis. The Medium-Term Plan 2003-2006 includes savings in normal operations, a reduction of the non-LHC programme, a revision of the LHC schedule to be in line with the actual status of industrial contracts, and the prolongation of the LHC loan repayment period to 2010. The Action Plan and Medium-Term Plan constitute a coherent set of concrete steps to adapt CERN to the challenges posed by LHC construction. At the end of 2002, Management will present a revision of the 1996 agreement, including a review of CERN manpower, as a new basis for LHC completion for a grand total cost of 4.55 BCHF (3.077 for machine hardware, installation and experimental areas, 0.277 for tests and pre-operation, .068 for injectors, 0.988 for personnel, and 0.140 contingency). Tests and pre-operation and the LHC injectors are items that were originally implicitly taken to be part of CERN's baseline program. An External Panel chaired by J. Peoples (FNAL) will review the costs and schedule annually (its first meeting coincided with the October 2002 RRB).

The fraction of CERN's material budget spent on the LHC will increase from 51% in 1999 to 75% in 2003. During 2003 - 2010, 70 - 80% of CERN's total resources, personnel plus material, will be devoted to the LHC machine and experiments. In cutting back the non-LHC programme, a limited number of ring-fenced activities have been retained to ensure a minimum of scientific diversity: low energy antiprotons, low energy nuclear and neutron physics, COMPASS and the long base-line neutrino beam CNGS. Antihydrogen production at low energies has recently had a series of notable successes; COMPASS had a satisfactory year of running in 2002 with 5,000 million events collected for analysis; construction of the CNGS line progressed smoothly and first beams should be delivered in May 2006. CERN's future is protected by the continuation of CLIC and its test facility CTF3, and the design of the super-conducting Proton Linac. This restricted non-LHC programme is supported by CERN's scientific advisory bodies and has been approved by the Research and Management Boards.

The DG then gave an overview of the LHC status, thanking Orsay along with Saclay for their work on the quadrupoles. He singled out for special mention some of the important equipment made by non-Member States that is arriving at CERN according to agreed schedules (illustrated by several photographs in the presentation): octupoles - twin quadrupoles - from Canada, super-conducting correction magnets for the cryodipoles from India, warm dipoles and quadrupoles for the transfer tunnels from Russia, super-conducting quadrupoles for the straight sections from Japan that are being tested and integrated with US quadrupoles at FNAL before they are shipped to CERN, while beam separation dipoles are under test at BNL.

As for the LHC detectors, they will all be ready for April 2007. ATLAS and CMS are well into construction with over 50% of their budgets spent, ALICE and LHCb are beginning construction, while TOTEM will submit its TDR within a year. He expressed satisfaction with the RRB's important decision to circulate M&O MoUs for signature and with the fact that M&O costs are starting to be covered by the FAs.

Since early 2001, integrated planning of the LHC Machine, Experimental Areas and Detectors has been carried out at bi–monthly meetings chaired by the DG and attended by top management from the LHC project, the experiments and CERN. This assures the direct exchange of information, early detection of problems and monitors the construction schedule. Experimental milestones etc., are regularly reviewed by the LHCC and CMS and ATLAS have recently had their first Installation Reviews, with ALICE and LHCb to follow in spring 2003. The LHCC found CMS installation planning to be in good shape and noted good planning for what will be the enormous task of installing ATLAS.

For the heavy ion programme, a workshop in June 2002 established priorities for the first years of running, starting with p-p collisions, followed by a couple of 'years' of Pb-Pb (1 HI year = 10**6 seconds ≈ 1 month / year), then ~ 1 HI year of p-Pb, and afterwards light ion collisions e.g. Ar-Ar.

Summarising, the DG emphasised that CERN is committed to having LHC start up in 2007 with a reliable machine and detectors. The Laboratory is now fully engaged in LHC construction, except for a reduced but effective non-LHC scientific programme, and is firmly linked to the future of high energy physics though the ongoing R&D programme for CLIC.

Discussion

T. Kondo (JP):	would the DG elaborate on his report that the Installation Review found CMS to be in 'good shape' whereas it saw ATLAS as an 'enormous task'.
R.J. Cashmore:	the DG was quoting something I said at the recent SPC reflecting the fact that the massive scale of installing ATLAS is now fully appreciated by everyone in the laboratory, not just ATLAS. The Committee found that ATLAS has very good plans to make it happen.
S. Bethke (DE):	concerning the HI schedule, what will ATLAS and CMS do during HI runs?
RJC:	ATLAS and CMS have their own HI programs and they participated in the discussions. The workshop was held to clarify the sequence that the experiments wanted for HIs, benefiting from the RHIC experience. The priorities were agreed to be Pb-Pb collisions followed as soon as possible by p–Pb (possibly interleaved with Pb-Pb) with ~ 1 month of running per year

There being no further discussion the Chairman brought the meeting to a close.