

Minutes of the 28th Plenary Meeting of the LHC Resource Review Boards (RRB) (CERN, Geneva, 27 April 2009)

1. Welcome. S. Bertolucci, Director for Research and Scientific Computing

S. Bertolucci welcomed delegates to the 28th Plenary meeting of the RRB. The minutes of the November 2008 (27th) Plenary Session CERN-RRB-2009-006 were approved without comment.

2. CERN Status and News. R. Heuer, Director-General (DG)

R. Heuer reported on the Chamonix workshop in February which defined a schedule for the first injection at the end of September and first collisions at the end of October; he confirmed that the schedule was still valid.

The DG then focussed on the three elements that are driving the schedule: the repairs, the introduction of preventive measures and systems to mitigate the consequences of a similar incident.

- The repairs are almost complete but the magnets still have to be connected underground.
- Having a sophisticated and sensitive quench protection system, able to measure nano-ohm and milli-kelvin, is a *sine-qua-non* for starting the machine; this is well on track with teams from the machine and the experiments working together. In addition all measurements have been rechecked and a few splices which were outside the specification have been repaired.
- At each vacuum port a relief valve with 10 times the previous capacity has been installed, this should prevent collateral damage in the case of a similar incident. If all connections break at the same time a factor of 40 is required. DN200 pressure relief valves have been installed in all warm sectors (50%) of the machine. Installing valves on the cold sectors of the machine would have resulted in additional delay of 6 months; after consultation with external panels, it was decided that the risk was acceptable.

With the exception of sector 34, all the magnets have been tested beyond 5 TeV. For higher energies it would be desirable to have all the DN200 valves installed.

The luminosity will start at low current; 50 pb⁻¹ for the first 100 days, increasing slowly to 200 pb⁻¹ in the second 100 days bringing CERN to the same discovery potential as Fermilab.

It was also decided in Chamonix to run the LHC for one year with no winter shutdown. At the end of the year a heavy ion run is foreseen. During the next shutdown, in winter 2010-11, all the warm magnets must be retrained.

As a result of the incident, manpower was diverted from upgrade work onto repair and consolidation. The delay of one year in the start-up of the machine will have to be passed on to the upgrade.

Looking towards the longer term future of CERN, R. Heuer was concerned about the diversification of physics and reminded delegates that there was an upcoming workshop entitled "New opportunities in the Physics landscape at CERN". This would lead to excellent projects which can only be performed at CERN.

Commenting on the ageing infrastructure of CERN, R. Heuer announced that Restaurant I will be extended during the winter, Restaurant III will be refurbished and general maintenance and repair of buildings will be addressed.

There were no questions or discussion arising from the presentation.

3. LHC Status Report. S. Myers, Director for Accelerators & Technology

S. Myers explained that his talk would centre on progress since the beginning of March.

He showed the schedule which was established in February and reported that, following the workshop in Chamonix and the external panels on QPS and Overall Risk, additional tasks had been added to the schedule: QPS redesign, UPS protection system, additional cables for EN/EL and relief valves on stand-alone, Inner Triplet, DFBL, DFBA and DFBL.

S. Myers then continued with the progress and status, highlighting the new tasks and reporting on solid progress. However, he warned that there were outstanding issues which included: connection of cryostats in the sector 56, installation of the last Short Straight Sections (SSS) and support reinforcement of Long Straight Sections (LSS) elements (DFBA, semi-SAM, IT). Also there are ongoing studies on additional relief valves on DFBA and some components are not yet at CERN (SSS springs, QPS upgrade equipment). He emphasised the excellent collaborative spirit between CERN departments and with teams from outside CERN.

The powering overview in February foresaw a start in week 24 and completion in week 38 but there was no detail on the Powering tests or on the Electrical Quality Assurance. The Enhanced Quench Detection System racks should have been available by the end of April but will only become available at the end of June. To recuperate lost time, it was decided to do everything which could be performed rather than follow a plan. In addition, a small working group is trying to find additional manpower which would allow 24/7 shifts.

Looking at the plan it was clear that the Powering Tests had to be advanced. There is now a schedule which brings sector 34 back from week 41 to 38. In addition, plans are in place to move forward the tests of sectors 78 and 81. A detailed plan for powering, beam injection tests and for beam operation will be presented to the LHC machine committee.

As mentioned by the DG, the beam conditions for physics in 2009-10 are 5TeV/beam. The machine protection system will be tested with beam and the QPS will be commissioned and tested. There may be a pause at 4TeV on the way to 5TeV which will be the limit in 2010.

The Estimated integrated luminosity during first 100 days of operation will be $\approx 50\text{pb}^{-1}$

- Peak L of 5.10^{31} η (overall) = 10% gives $0.5\text{pb}^{-1}/\text{day}$
- Peak L of 2.10^{32} η (overall) = 10% gives $2.0\text{pb}^{-1}/\text{day}$

During next 100 days of operation the integrated luminosity will be $\approx 200\text{pb}^{-1}$ Towards the end of the year an ion run is planned.

S. Myers concluded by stating that:

- There were no delays for the activities in progress but there was a continuous struggle on a daily basis with a variety of problems: e.g. technological, purchasing rules, admin, etc.
- The installation of the last dipole was completed on schedule.
- The DN200s finished in arcs.
- The QPS electronic cards were successfully tested in PSI.
- A new schedule of the Powering Tests is in progress to start earlier and gain time
- Additional consolidations to be scheduled in details (especially reinforcements)
- The timescales for availability of components are:
 - QPS upgrade materials (busbar splice detectors, power supplies, controller boards, crate) – end of June
 - Symmetric quench detectors – August

E. Rabinovici (Hebrew University, Israel) pointed out that some countries were unable to attend the full presentations given in March. S. Myers replied that in the interests of efficiency, it was decided to present an update at the RRB.

S. Bethke (MPI, Germany) asked for more details on the splices and questioned if similar problems had been encountered on other magnets.

S. Myers replied that there were four methods for testing the magnets; the most accurate is a measurement of resistance in a noisy environment and is the basis of the new QPS system, there is also a calometric, the old QPS snapshot and the new ultrasound method.

For reference, the specification of the resistance of the splices is 1.2 nano-ohms inside the magnet and 0.6 nano-ohms outside. Referring to the non-conformities; there was splice with a resistance of 200 nano-ohms which caused the incident in 34. Other magnets with abnormally high resistances of have been examined and found to have a deficiency of solder. Half the machine has been checked at this level of accuracy and about 1/3 are <20 nano-ohms; it is expected to find other abnormally high splice resistances in the second half of the machine. S. Myers then showed photographs illustrating the problem with the splices.

The DG expanded on this reply by stating that CERN was confident that the resistance of all splices can be measured and that values of 20 to 40 nano-ohms were acceptable. However, it is unknown if these splices are mechanically stable and if their resistance will vary with time; it will therefore be essential, after each quench, to re-measure the resistance.

S. Myers continued with the remark that a magnet with a 50 nano-ohms resistance will be measured accurately and the magnet will be run up, quenched and re-measured in many cycles to check the evolution with time. He also stated that two conditions are necessary to produce an incident like 34; firstly the superconducting cable has to have an excessively high resistance and secondly that there has to be a poor contact between the superconducting cable and the copper stabiliser. The first parameter can now be measured; the second requires a resistance measurement accurate to 0.1%; a high-performance system is being tested.

E. Gazis (NTU-Athens, Greece) commented that that Greece was amongst those countries which are provided manpower with a team of 12 members. S. Myers thanked Greece and other countries for their invaluable support.

R. Heuer explained why preventive measures were so important. During the incident in 34, an arc occurred which broke the beam pipe vacuum. If a similar event re-occurred, the helium damage would be prevented, but we cannot prevent a breaking of the vacuum which would affect the whole sector. There are no high-speed valves which react quickly enough in the cold. S. Myers agreed that this would result in long cleanup operation but would not have the same consequences as the incident in 34.

Finishing on a positive note, the DG commented that a lot was learned between the 10th and the 19th September both on the machine and in the experiments. The CERN management was optimistic that the machine and the experiments would start up smoothly in the autumn.