ELECTRICAL QUALITY ASSURANCE
D. Bozzini

The electrical integrity and the safe operation of the superconducting electrical circuits are crucial issues for the successful commissioning with and without beam and for the operation of the LHC machine. Beam based measurements may require in-situ verification of the magnet polarities. The detection, diagnostics, repair and re-qualification of electrical faults and the verification of magnet polarities will inevitably have an impact on the machine availability.

The experience gained during the String experiments shows that we ought to be prepared for unpredictable faults of any nature requiring interventions even including the opening of interconnections. The experience needed for the ELQA activities during beam commissioning will be acquired during the phases of assembly and hardware commissioning. The success of the ELQA is based on the availability of experienced and well trained personnel. As of spring 2007 the resources allocated to the ELQA activities are, however, not assured.

REPORT FROM THE MAGNET POLARITY COORDINATOR
S. Russenschuck

At an international review on the electrical quality assurance (ELQA) for the LHC, it was recommended that the coherence between magnet construction and measurement on one side, and the magnet interconnection according to the layout database with the hard and software for the electrical quality assurance (ELQA) on the other side must be established. The same understanding and application of the engineering specification for LHC magnet polarities by all teams involved has to be ensured. Therefore a Magnet Polarity Coordinator was appointed. The first status report was concerned with the confusion resulting from the same multipole field error definition in the two different reference frames (magnet measurement frame and moving frame of Beam 1 for beam physics calculations) which may result in polarity errors of the vertical orbit correctors and a wrong treatment of measured skew multipole errors in the beam physics program MAD.

Unlike stated in an older version of the EDMS document No. 90042, the polarity conventions do not follow the beam physics conventions. The polarity conventions are compatible with the conventions in the Beam 1 frame as far as the normal multipoles are concerned. They are not coherent with the MAD conventions for the skew multipoles.

The second subject treated in the presentation was the worry about the polarity of the main quadrupoles, as the approved layout drawing turned out to be wrong. The error was corrected in the production drawing for the cold mass integrator. As obviously the design of the magnet interconnections and bus bar routings was not done according to the approved layout, the polarity is correct for the series production of the magnets.

Finally, the concern about the continuity of the bus bars for the spool piece corrector magnets was expressed. The routing of the spool piece bus bars within the quadrupole cold mass makes continuity errors very likely and consequently these errors were detected in a test campaign at the cold mass integrator’s premises. An automatic test equipment for the series testing of all spool piece bus bars has thus been designed and will be used for the verification of the circuits prior to the installation of the magnets in the LHC tunnel.

QUENCH PROTECTION SYSTEM
R. Denz

The LHC quench protection system QPS will be fully operational prior to beam commissioning. Although all QPS equipment is designed for high reliability and availability, triggers of the protection system which normally result in an accelerator stop, will occur in case in a significant number of QPS failure modes.

Consequently, interventions (although time consuming) cannot be avoided. The QPS data acquisition system provides valuable information on the status of the LHC cold mass and possible failures inside.

Magnets close to the interaction point are well covered by QPS but should not be necessarily regarded as “beam loss monitors”.

SUMMARY: OTHER ISSUES AFFECTING BEAM COMMISSIONING
Stephan Russenschuck, Rh. Jones, CERN, Geneva, Switzerland.
CONSEQUENCES OF RF SYSTEM FAILURES DURING LHC BEAM COMMISSIONING

T. Linnecar

The LHC RF system is comprised of 2 cryogenic modules per beam, each of which houses 4 superconducting, 400MHz cavities. The following possible failure scenarios were identified (in order of increasing seriousness):

• Loss of control of a single cavity due to a loop electronics problem or an RF power system failure (but not HT).
• Loss of several cavities due to multiple failures of the above type, or an HT problem which would lead to the loss of all four cavities in one module.
• Removal of one module due to a beam-vacuum leak, insulation vacuum leak, power or HOM coupler failure.

For up to ½ nominal intensity with 25ns spacing or nominal intensity with 75ns spacing, the beam will probably survive the trip of 2-3 cavities. At half of these beam currents the beam can survive a trip of one complete module. To cope with this it is necessary to work at or near half de-tuning and slightly below the optimum $Q_{ext}$. In addition, when control of a cavity is lost with beam in the machine, the tuner and coupling should be blocked.

Up to half nominal intensity a new injection can take place with up to 4 cavities off, if control of the tuner and coupling is retained. For this to work, the tuning is set to ~ half de-tuning and $Q_{ext}$ is made as small as possible on the dead cavities.

INITIAL COMMISSIONING OF CRITICAL BEAM INSTRUMENTATION SYSTEMS

B. Holzer

A well defined installation and test procedure combined with the use of pre-formed coaxial cables should ensure that the number of BPM polarity errors within the cryostat is very low. All cabling errors before the front-end electronics will be impossible to verify remotely after installation, but can be detected with beam and visually inspected. Errors after the electronics are easier to track down and should be spotted during hardware commissioning.

It was stressed that good database management is required both during installation and commissioning. In particular, the BPM output ports have to be matched to the beam1 and beam2 locations, which change from sector to sector, and within a sector for rotated cryostats. During operation the right calibration and linearization factors from the database have to be applied for a given BPM and its associated electronic cards.

For the BLM system normal beam operation does not allow checks for availability, channel mix-up or position errors. During installation each chamber will therefore be individually tested with a source to verify the channel matching and chamber gain. It will also be possible to put a high voltage modulation on all chambers before injection to check the availability of the system as a whole.

A sector test is considered useful for commissioning both BPM and BLM systems. In particular, for the BLM system it would allow quench level calibration and verification of longitudinal loss patterns. Considering the complexity of these systems and the time needed to implement changes or fix problems, the earlier full systems tests are performed the better.

THE ESTIMATION OF INDIVIDUAL AND COLLECTIVE INTERVENTION DOSES FOR THE LHC BEAM CLEANING INSERTIONS

M. Brugger

It is very important at this stage of the LHC development to identify critical interventions in order to suggest improvements and perform possible optimisation. This is required to prepare the staged installation of various LHC components, to prepare the contracts for external companies intervening in high radiation areas (who have to be certified) and to collect input for INB reports.

Detailed Monte-Carlo simulations are now available for the IR7 collimator region, which is expected to be one of the most radioactive areas in the LHC. Intervention scenarios have been collected from most groups involved in this region, from which individual and collective dose rates have been estimated. This has enabled several optimisations to be proposed, such as the use of chain clamps (reducing the individual dose by 2/3) and permanent bake-out equipment (reducing the individual and collective dose by a factor 5).

If the results from IR7 are compared to SPS experience, it becomes clear that we will face significantly higher individual and collective doses in the LHC. Without improvements long down-times will have to be accepted, at least for collimators showing the highest remanent dose rates.

THE LHC ACCESS SYSTEM: WHY DO WE PUT DOORS?

L. Scibile

The LHC access system is comprised of two parts, a highly reliable interlock safety system and an industrial access control system. It is there to protect personnel...
during beam operation and allow access to the machine when certain safety conditions are met.

The access control system is there to identify and authorise the user and allow automatic or remote access control. This contract is in place and site acceptance is expected for June 2005.

The access safety system is a distributed, highly reliable interlock system (Safety Integrity Level SIL 3). Prototyping of the hardware and software architecture is underway. This system will be completely tested before the cold check out. For the time being this is in line with the LHC planning, with no major technical issues left to be solved.

There is a special request to the AB Department to finalise the list of equipment which needs to be interlocked with the access system.