

Twentieth Meeting of the LHC Machine Advisory Committee held on 7-9 December 2006

EXECUTIVE SUMMARY

Thursday

07/12/06

Open Session

M. Tigner	Introductory remarks
L. Evans	Current status of LHC project
L. Rossi	LHC magnet procurement and measurements
R. Bailey	Beam commissioning plans, 2007 and 2008
R. Jones	Beam instrumentation overview
G. Arduini	Status and performance of LHC injector complex

Friday

08/12/06

Closed Session

R. Schmidt	Machine protection update
R. Assmann	New LHC collimation installation schedule & impact on 450 GeV & 7 TeV run
R. Assmann	Phase-2 collimation concepts
S. Weisz	Installation status
R. Saban	Hardware commissioning status
W. Hofle	Transverse damper electronics & noise analysis
C. Carli,	Achieving nominal ion beam, PS ion progress
D. Manglunki	
M. Harrison	Summary of cost and schedule review <i>Visit to SMI2 and to installation in Point 4</i>

Saturday

09/12/06

Closed Session

Executive Session
General discussion and
summing up

The presentation material is available at <http://cern.ch/mgt-lhcmac/lhcmac20/Agenda.htm> .

Summary

The MAC congratulates the LHC team and its leadership on the impressive progress towards completion of LHC construction since our last meeting. In spite of continuous challenges in delivery schedules and quality control, equipment is being installed in the tunnel at a rate making likely its completion in March 2007 as scheduled. A further challenge has been encountered in the heat exchanger for the low beta quads with an as yet unknown impact on the hardware commissioning schedule. We are confident that this recent challenge will be met with the professionalism and expedition consistently exhibited by the team.

In sum, the information derived from our current review justifies a very positive outlook for timely completion of construction and initial operation as scheduled by the end of 2007. The MAC recommends holding to the 450-GeV run plan and extending the run as long as necessary to meet its goals, as an important step towards nominal operation.

Magnets

Highest commendations to the Magnet Group for procuring and testing the entire suite of LHC magnets in the face of great difficulties and in time for installation per schedule. Especially noteworthy is the maintenance of consistent high quality throughout. Documentation of this experience will give valuable information to other large-scale accelerator projects. We look forward to system test verification of magnet stability and reliability.

Beam Commissioning Plans

We are pleased to see the thoroughness of the work of the LHC Commissioning Working Group, LHCCWG, in laying plans for commissioning of the LHC. The general strategy for the initial 2007 run at 450 GeV is sound. The expressed goals are appropriate. The MAC urges the leadership of the laboratory to give high priority to completion of the thorough and systematic investigation of beam and system behavior before beginning the shutdown for hardware commissioning to high energy operation. This may well mean extending the run into 2008. We urge particularly that careful study of beam capture and stabilization during ramping to some modest energy above 450 GeV be carried out before the shutdown to investigate snapback effects. Initial experience with the collimator system adjustment will also be valuable. Wide experience shows that from such systematic studies many things will be learned about controlling the machine properly. Further, inadequacies and important but unanticipated malfunctions will be revealed so that they may be rectified during the shutdown.

Beam Instrumentation

The detailed preparation of the instrumentation needed for the initial run is impressive. Beam-position monitor and beam-loss monitor (BLM) systems are well on their way to being ready for the initial run. Pioneering work in continuous tune, coupling, chromaticity and emittance monitoring by baseband Q meter (BBQ), phase-lock loop (PLL) and synchrotron-light diagnostics has been done with significant testing both at SPS and at RHIC. Further functionality development is to be expected during the initial run. These efforts will pay off handsomely in obtaining early luminosity under safe operating conditions. The committee notes that significant quantities of electronics remain to be delivered and checked out.

Status and Performance of the Injector Complex

Preparations for the initial run appear to be in good order. Some work towards achieving high intensity for future runs has also been carried out, revealing a few challenges. The MAC suggests that focus should now shift to achieving high quality, bunch-to-bunch uniformity and reliability of operation at the lower intensities needed for early runs. Potential consequences of non-uniform injections may lead to excessive beam inhibits and detector backgrounds. Experience at other colliders bears out the basis for this concern. Given the age of the injector complex, continued preventive maintenance will be important. Electron cloud is still an issue at the SPS, especially for reaching nominal current in the LHC. Continued studies are encouraged.

Machine Protection System (MPS)

The focus of the report, as requested, was on the Audit of the Beam Interlock System (BIS) plans and implementation. We are very favorably impressed with the concept and implementation of this audit using experts able to invest significant time in close study of the elements and integration of this all important system. We are also very pleased at the positive report of the audit committee and the responses of the BIS team. A machine-protection working group for commissioning has been formed, reporting to the LHCCWG, and the system appears well on its way to being ready for the initial run.

With the success of the Audit approach made clear here, it may well be worth considering the same approach for other crucial components of the MPS, such as the abort kicker system and its associated trigger mechanisms.

Valuable experience was gained by testing subsystems and components with CNGS beam. The committee encourages integration of further subsystem tests in the LHC hardware commissioning programme.

Collimation System

The MAC is impressed with the professional response to the serious quality lapses at the supplier for the collimators needed in the initial and subsequent run. While not yet assured, it appears likely that the number of qualified collimators needed for the initial run will be in hand despite the substantial quality challenges earlier encountered.

The ability of accurately positioning the collimator system in a programmed feed forward manner appears very good. We suggest that plans be developed for implementing feedback in addition, so as to accommodate the inevitable orbit and lattice function changes accompanying typical operation of a collider. This type of feedback proved essential at existing facilities. The issue of detector background during commissioning will require serious attention.

The MAC also suggests that some thought be given to implementation of an integrated loss monitor for normalization of the individual BLM signals. This could help in proper utilization of the local loss information because of their wide variations from place to place in the ring.

Also some attention to the collimation that will be needed for nominal and upgraded operation is presently being given, with special additional help coming from SLAC and the LARP program. Considerable R&D remains to be done. Experience from phase-1 operation will likely be a significant guide for the final phase-2 design.

Installation Status

Progress here is very impressive indeed and the team is to be highly congratulated. With the exception of the low beta quads and their as yet unknown influence on the schedule, it appears that the installation will be essentially complete in March. The great ingenuity in accommodating delivery obstacles and highly professional planning is much to be praised.

Hardware Commissioning

Good progress has already been registered in this area. Cool down and pressure tests done so far presage well for the efficient commissioning of the complete ring. When the first sector commissioning is accomplished, one will have the information needed for final schedule projections.

The committee notes that parts of the hardware commissioning will extend into 2008, beyond the current contracts of temporary trained commissioning manpower.

Transverse Damper System

This system appears to be in good shape to deliver needed performance. Potential challenges to adequate damping without excitation of emittance growth are well understood and solutions will evolve with growing operational experience.

Progress with Ions

The MAC congratulates the team to the great progress in the performance of LEIR and the PS with lead ions, achieving Early Ion Beam parameters for the LHC. In light of the anticipated short ion running periods in the LHC, some action is still needed in LEIR and the PS to provide beam reliably and reproducibly. We look forward to the ion commissioning in the SPS, scheduled for 2007. This should include a test of an LHC collimator with ion beams in the SPS.

Next Meeting

The dates for the next meeting were agreed to be 7-9 June 2007.

Items suggested for the agenda are:

- experimental background control / machine-detector interface
- collimation-system update & plans for automated collimator operation
- abort gap cleaning
- beam quality in injectors
- update on beam commissioning plans
- MPS commissioning status

Annex 1:

Members of the Committee

Dr Norbert Angert	Gesellschaft für Schwerionenforschung (GSI), Darmstadt, Germany
Dr Helen Edwards	Fermilab, Batavia, USA
Dr Wolfram Fischer	Brookhaven National Laboratory (BNL), Upton, USA
Dr Michael Harrison	Brookhaven National Laboratory (BNL), Upton, USA
Dr Shin-Ichi Kurokawa	High Energy Accelerator Research Organization (KEK), Japan
Dr David McGinnis	Fermilab, Batavia, USA
Professor Carlo Pagani	Universita di Milano and Istituto Nazionale di Fisica Nucleare (INFN), Italy
Dr Claus Rode (excused)	Jefferson Lab (JLAB), Newport News, USA
Professor Alexander N. Skrinsky	Budker Institute for Nuclear Physics (BINP), Novosibirsk, Russia
Professor Sergio Tazzari	Universita di Roma II and Istituto Nazionale di Fisica Nucleare (INFN), Italy
Professor Maury Tigner (Chairman)	F.R.Newman Laboratory for Elementary Particle Physics, Cornell University, USA
Dr Ferdinand Willeke (excused)	Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany

CERN representation:

Dr Robert Aymar	Director-General
Dr Jos Engelen	Chief Scientific Officer
Dr Lyn Evans	LHC Project Leader
Dr Philippe Lebrun	AT Department Head
Dr Steve Myers	AB Department Head
Dr Frank Zimmermann	Scientific Secretary