MINUTES – ACCEPTANCE MEETING FOR LHC MAGNETS BUILT AT BNL

Magnet: D1L101
Date of meeting: 29 January 2004
Date of these minutes: 30 January 2004
Attending: M. Anerella, J. Cozzolino, J. Durnan, J. Escallier, H. Hocker, A. Jain, J. Muratore, S. Plate, C. Porretto, P. Wanderer, E. Willen

Summary.

The acceptance committee previously reviewed this magnet in March 2003 and May 2003. Since the last review, the magnet has been cold-tested to check whether the high-resistance short between one of the two strip heaters and the magnet coil affected the magnet operation (including quench performance). It was concluded that the heater-to-coil short did not affect the magnet operation during the cold test. The committee also reviewed the field quality data, which indicated that the yoke keys were stainless steel, whereas they should have been magnetic steel. The effects on the multipoles were judged to be small. The transfer function is lower by ~ 0.2%, so a different current will be needed. The field quality data also contained adjusted values for the transfer function arising from recalibration of the measurement of the current.

The BNL magnet acceptance committee concludes that the magnet can be used in the LHC. However, because of the high-resistance short, it should be designated as the spare D1.

Quench test results.

J. Muratore showed the quench data for this magnet. A plot of the data is available at http://www.bnl.gov/magnets/LHC_Acceptance/Quench_Plot_D1L101.pdf. The new data are the last two spontaneous quenches (quenches #12 and #13), made during the third cold test period of the magnet, in December 2003. Both quenches were above the current needed for 7.56 TeV operation. Muratore also reported that the magnet was cycled eight times to 6.4 kA, and held for an hour at 6.4 kA without quenching.

The magnet was at room temperature for 23 months prior to December 2003. During the December 2003 quench tests, the current version of the warm bore tube was installed and evacuated. Quenches #12 and #13 were slightly lower than quenches #10 and #11 (when no warm bore tube was installed in the magnet) and much better than previous quenches (when the initial version of the warm bore tube, with a higher heat leak, was installed).

Muratore also reported information needed to assess whether the high-resistance short between one of the heaters and the coil had an effect on magnet performance. He said that he found no anomalies in the voltage traces (e.g., $V_{upper\ coil} – V_{lower\ coil}$) that are recorded during each quench. After each quench, the coil was hipotted to the standard cold hipot voltage, 500V, and passed (i.e., $I < 10\mu A$). The magnet had expectedly low MIITS (~ 9 – 10 x 10^6 A^2 s). After warmup, the magnet passed a warm hipot (1 kV, $I < 10\ \mu A$). Overall, Muratore said that he found no effect of the high-resistance short on performance.

Electrical test results.

J. Escallier reported the following values of the high-resistance short between one of the heaters and the coil:

6 kΩ -- initial measurement (March 2003)
13 kΩ -- following pump and purge with dry nitrogen (March 2003)
76 kΩ -- following cold test (December 2003)

These measurements were made at room temperature.

S. Plate reported (email to P. Wanderer, 29 January 2004) that the inoperable temperature sensor (noted in the D1L101 minutes of 2 May 2003) had been replaced.

Field Quality results.

Animesh Jain showed a summary of the field quality data for all the D1 magnets, including cold measurements of D1L101 made in December 2003. His talk can be found at http://www.bnl.gov/magnets/LHC_Acceptance/D1LFQSummary29Jan2004.pdf. The measurements of the normal sextupole and decapole indicate that the keys used to lock the yoke laminations were stainless steel (as used in RHIC), not the planned (magnetic) steel. The stainless steel keys also reduced the transfer function at high fields. See footnote [1] for a discussion of the key material used in the other LHC magnets.

Because D1L101 has stainless steel keys, it cannot be used for calculating the warm-cold correlations for the three D1 magnets that do not have cold field quality data. P. Wanderer noted that, at injection current, the field quality data of D1L101 are consistent with that of D1L103, as would be expected.

The transfer function data shown by Jain also included corrections arising from a recent recalibration of the DCCT used to measure the current.

Accelerator Physics analysis.

F. Pilat was unable to attend the acceptance meeting. Later, she and Jain reviewed the field quality data, and she sent her comments via email to Wanderer (30 January 2004):

1. The -6 units of sextupole at full field is outside the nominal specs but it could be locally compensated by a corrections sextupole if needed. It is not too different from the -4.5 units measured, and accepted, in D1L103.
2. The decapole is outside the specs but in the good direction (smaller) so no problems.
3. The transfer function difference of 0.22% has potential operational consequences, as it can affect machine geometry at that level. If the D1L is powered independently, that can be fixed by adjusting the current level, if not, a corrector shunt supply should be considered.
4. In the light of the above points and other slight problems of the magnets in other areas, we should recommend D1L101 as a spare.

Engineering, QA review.

J. Cozzolino said that information about the material used in the yoke keys was reported in DR-1153. S. Plate confirmed that LHC had previously accepted the waiver on the pipe positions in the interconnect region.

H. Hocker stated that the only unresolved issue was LHC's decision on the waiver for the high-resistance short between the heater and the coil. R. Ostojic stated, via email, that LHC will decide after reviewing the minutes of this acceptance meeting.

Safety.
J. Durnan said that the recent testing had not changed the safety approval of the magnet.

Survey.
S. Plate reported that the survey data were sent to D. Missiaen on 2 May 2003.

Footnote.
[1] From P. Wanderer: We know from cold measurements that D1L103 has the correct keys. We need to be certain of the keys used in D1L102, which was not measured cold. The engineering and QA staff have examined the MAPS and travelers for D1L101. These documents give no indication of the error. A count of both types of keys in our stockroom indicates (but does not prove) that only D1L101 has ss keys. Fortunately, J. Cozzolino has found that by sliding a strong permanent magnet over the surface of the shell, one can determine unambiguously which key material was used. A check of all cold masses at BNL indicates that the correct keys were used in all other magnets. D1L102, D1L104, and D1L105, which are at CERN, can be checked in a similar fashion. These topics are discussed fully in DR-1153.