The LHC
Beam Loss Monitoring System

Follow-up report on the Audit held from June 10th to July 1st 2008

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1 Executive Summary

In September 2006, the Beam Loss Monitoring System (BLM) has been audited by a team of experts external to the BLM team [1]. Generally, the auditors found that the design and implementation of the BLM is sound, complete, straight-forward, and, in particular, conform to the requirement of a high inherent level of safety, reliability and availability. However, quite a number of substantial recommendations have been made.

Since then, the BLM team has implemented a series of mitigations which have been reviewed by a subsequent follow-up meeting. This report summarizes this follow-up meetings and comments on the implemented mitigations as seen by the Follow-Up Board.

Basically, the BLM team has made big efforts and achieved very good results, in particular in the area of simulations. The Follow-Up Board considers 31 (out of 46) recommendations of the initial audit as properly and sufficiently implemented. This includes most of the major ones. Most of the remaining, open recommendations are pending implementation during 2009. Of those, the Board would like to express particular concern about the lacking procedures for changing threshold and configuration values in the Master and Stage tables. This includes the lack of software tools to detect erroneous values as well as to identify locations with too many disabled BLMs. Nevertheless, the Follow-Up Board is confident that the BLM team will properly implement the open recommendations

2 Detailed Conclusions by the Board

After discussions with the BLM Team, the Follow-Up Board came to the following conclusions with respect to the implemented mitigations as requested in [1]. The numbering scheme adheres to the items listed in [1]. **Pending major points and issues are marked in bold.**

1. Summarize the results of all beam loss scenarios: *During the 2008 important measurements with the BLMs have been performed. These measurements lead to a better understanding of the simulations and will allow for improved predictions of the expected BLM responses. Even if these simulation studies are now complete, the Board was not able to judge whether the locations and distribution of BLMs within the LHC tunnel have finally been validated and confirmed.*

2. Study saturation effects: *OK*

3. Determine baseline shifts to BLM signal: *Pending*

4. Add more detailed description of materials and geometry: *OK*

5. Adjust initial threshold settings during initial LHC runs: *OK*

6. Propose dedicated test procedures: *OK*

7. Produce documentation on initial master table definition: *OK*

8. Deploy application to minimize erroneous values: *Pending*

9. Cover conditions to deploy Stage Tables: *OK*

10. Deploy application to handle "maskable" and "disable" flags: *According to the BLM Team, the "maskable" flags will not be used. However, the Board would like to stress that monitoring the "disable" flag is mandatory.*

11. Provide alerts if a region is undermined: *Pending*

12. Deploy authentication measures: *OK*

13. (Point has been removed): *OK*

14. Implement on-disk back-ups: *OK, even if on-disk back-up have not been implemented, since the back-up of data bases follows the standard good practices of the IT/DES group. These good practices, including weekly recovery tests, are applied for all IT/DES managed data bases and considered sufficient by the Board.*

15. Investigate merging MTF and Layout DB: *OK. The Board acknowledges that this is a design issue unrelated with the BLM.*

16. Obtain SLA with IT DB: *This has been rejected by the involved groups. The Board disagrees with this decision.*

17. Obtain SLA with BE/CO/DM: *This has been rejected by the involved groups. The Board disagrees with this decision.*

18. Study HV stability: *OK*

19. Produce documentation on calibration of SEMs: *OK*

20. Increase spare stock: *OK*

21. Conduct accelerated thermal aging tests: *Pending*

22. Develop remote reset mitigations: *OK*

23. Perform accelerated testing of power supplies in SSS: *Pending*

24. Perform accelerated testing of power supplies in arcs: *Pending*

25. Plan for contingency: *OK*

26. Ensure low partial load of redundant power supplies: *OK*

27. Provide overview of all electrical circuits: *OK*

28. Analyse impact on RC circuits on signal quality: *OK*

29. Agree on set of design rules: *Pending*

30. Correct undefined states: *OK*

31. Design PASS/FAIL regression test: *OK*

32. Conduct complete review: *Pending.*

33. Use software repository: *OK*

34. Conduct Walkie Talkie tests: *Pending, although no problems have been seen so far in the injection regions.*

35. Determine sensitivity of front-end to noise: *OK*

36. Determine impact of fringe fields: *OK*

37. Perform independent TID/NIEL/SEE tests: *OK*

38. Determine whether the overall system is susceptible to SEE: *OK*

39. Perform analysis of SEUs on the FPGA: *Pending*

40. Determine failure rates of power supplies: *OK*

41. Use input testers: *OK. The Board acknowledges the residual risk of failing connections due to the usage of input testers. As long as the radioactive source tests are performed, the usage of input testers can be omitted.*

42. Start as soon as possible full scale tests: *OK*

43. Perform combined system tests: *Pending.*

44. Use simulated energy values for tests: *OK*

45. Set-up vertical slice test: *OK. The Board agrees with the plans for a vertical slice tests bench at point 1.*

46. Use archiving scheme: *OK*

3 References

[1]   Miguel Anjo et al., "The LHC Beam Loss Monitoring System − Report on the Audit held from June 10th o July 1st 2008", July 1$_{st}$ 2008, Rev. 1.1