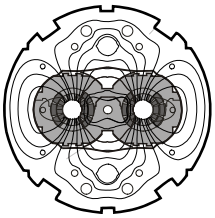
**CERN**
CH-1211 Geneva 23
Switzerland



the
**Large**
**Hadron**
**Collider**
project

*LHC Project Document No.*
**LHC-FS-TIM-0001.00 rev 0.00**

*CERN Div./Group or Supplier/Contractor Document No.*
**AB-OP**

*EDMS Document No.*
**123456**

Date: 2006-05-17

## Functional specification

# BEAM LOSS MONITORS – HIGH LEVEL OPERATIONAL REQUIREMENTS

***Abstract***

This document describes the high level LHC operational requirements for the LHC beam loss monitor system.

| ***Prepared by :*** | ***Checked by :*** | |
|---|---|---|
| **Mike** | | |

## *History of Changes*

| *Rev. No.* | *Date* | *Pages* | *Description of Changes* |
|---|---|---|---|
| 0.1 | 21 April 2006 | | First draft |

## *Table of Contents*

# 1. INTRODUCTION

There are approximately 4000 beam loss monitors distributed around the LHC ring with different monitors for the two beams; there is also the possibility of movable BLMs. The monitors are essentially passive devices, and can potentially generate a huge amount of data. There are various integration times at the front-end level ranging from 40 µs to seconds, with the full system capable of pushing up around 44,000 values at 1 Hz.

The monitors are connected to the Beam Interlock System (BIS) and will dump the beam if losses pass an energy dependent threshold level. Secure adjustment of dump thresholds is required.

Postmortem (PM) buffers are also present at the front-end level which can give fine time resolution loss measurements in the case of a beam dump. Fine time resolution data is also available for non-PM retrivial. The front-end crates have BOBR timing card which are connected to the BST which will allow synchronised acquisition.

This document aims to clarify the high level operational requirements of this critical system.

# 2. CONCENTRATION

The essential architecture has up to 256 monitors or channels connected to a gateway machine using FESA. This gateway is responsible pushing the combined data from its associated channels to the top level. This it can do through CMW, a postmortem API, or potentially, a real time channel.

Most top level clients are interested in a coherent data sample from the whole ring. Thus the data from the gateways has to be sensibly combined, or concentrated, before being re-published as a coherent whole.

| No. | Requirement | Priority |
|---|---|---|
| C.R1 | The data published from the individual gateways shall be combined and re-published using a standard controls API (i.e. JAPC). The data shall be combined and re-published at 1 Hz; the temporal coherency of the data shall be ensured.<br>Concentration shall deal with faulty monitors, drop-outs, bad data in a pre-agreed and standard fashion. To be established. | Critical |
| C.R2 | The BLM expert name shall be used to label the data. (Among other things this shall allow the BPM sector to be established.) | Expected |

# 3. POST MORTEM

A postmortem API exists which permits the pushing of postmortem data from the gateway.

| No. | Requirement | Priority |
|---|---|---|
| PM.R1 | The PM buffers shall be pushed to the high level automatically on receipt of a PM event. | Critical |
| PM.R2 | The buffers should be available for browsing and analysis 1-2 minutes after a post-mortem event. | Expected |
| PM.R3 | Detailed post PM analysis requirements to be specified.<br>Automatic scan of buffers to identify monitors at or near threshold as a minimum. | Expected |
| PM.R4 | Any interaction of a given BLM with the machine protection system shall be flagged immediately. | Critical |

## 4. FIXED DISPLAY

The fixed display(s), although configurable, are not usually interactive.

| No. | Requirement | Priority |
|---|---|---|
| FD.R1 | A meaningful summary of the beam loss situation for the whole ring shall be provided. | Critical |
| FD.R2 | Update rates should be around 1 Hz. | Expected |
| FD.R3 | The ability to disoplay normalized loss rates should be provided. i.e. values normalised to a % of the threshold level. This should be an option. | Critical |
| FD.R4 | Thresholds and warning levels should be displayed. | Critical |
| FD.R5 | Moving averages should be possible and optional history plot shall be available. | Expected |
| FD.R6 | More specialised FDs should be available showing more detailed information in critical regions. For example, coincidence signals from several nearby quadrupoles | Expected |
| FD.R7 | The integration times displayed for each monitor should be configurable. Typically 3 different integration times will be visible. | Expected |
| FD.R8 | Display shall group BLMs into sectors/LSS. | Expected |
| FD.R9 | Conversion and display in Grays shall be possible if required. Conversion to Gray shall be done at the high level. | Expected |
| FD.R10 | If a BLM is masked in the interlock system, this fact shall be indicated on the Fixed Display. | Expected. |

## 5. APPLICATION

| No. | Requirement | Priority |
|---|---|---|
| A.R1 | A fully dynamic application allowing detailed look at any selection of any monitors: shall include RT data and recent history | Critical |
| A.R2 | All status flags, threshold levels, alarms shall be browsable. | Expected |

## 6. LOGGING

Two areas:

- Slow logging – data reduced 1 Hz logging – foreseen to push to central LHC logging database.
- Data from synchronised acquisition of fine time resolution data (study data) – not foreseen to push to logging database.

From Measurement and Logging DB it is more preferable to log scalar values than arrays, because of: better performance, more flexible filtering, and correlation of logged data with other data. However possible explosion of number of data items should be considered.

There is a special test mode of BLM operation in which Measurement DB filters (and also logger filters) should be disactivated (all data should be logged). Such tests can beperformed for a short period of time, even every day. Initial idea to handle this is to attach additional field/flag intothe Acquisition property which will determine whether this is a test data or not. Every time this flag changes – the concentrator/logger[TbD] could switch on/off all filters.

| No. | Requirement | Priority |
|---|---|---|
| L.R1 | Channel names are predefined and expected to respect LHC naming conventions | Critical |
| L.R2 | Measured and calculated loss rates at 1 Hz for different integration periods to be logged. | Critical |
| L.R3 | Data is expected to be time stamped with UTC | Critical |
| L.R4 | Data filtering and reduction would be very useful – either at source or at the high level. Imagine this being done by the measurement database before pushing to logging database. | Expected |
| L.R5 | Threshold tables to be logged at published frequency. | Critical |
| L.R6 | Need to be able to cross-correlate against other systems | Critical |
| L.R7 | Logging frequency should be mode dependent | Expected |
| L.R8 | Status for each card (16 channels – 32 values) shall be logged independently of the concentration mechanism. Logging on change. | Critical |
| L.R9 | It should be configurable which of the 12 loss values should be logged (together with corresponding thresholds). This would be a first filtering, before the data is logged. Initially all 12 values will be logged to get some experience.<br>Information about which values should be logged will be stored in a BLM dedicated table in LSA DB. We'll need an application to modify this information; it will be probably the same application as the one used to modify (trim) thresholds values. | Expected |
| L.R10 | Not all published BLMs should be logged to the Measurement/Logging DB. Information about which BLMs should be logged will be stored in BLM dedicated table in LSA DB. We'll also need an API to retrieve this information from LSA DB. Such API will be used by concentrator/logger[TbD] in order to filter unnecessary BLMs. | Expected |

## 7. XPOC DATA

The contents of the XPOC data buffer shall be acquired systematically on receipt of a beam dump event and on request. The data thus acquired shall be archived for access by the high level XPOC analysis facilites.

## 8. STUDY DATA

The contents of the study data shall be acquired systematically and on request. The data thus acquired shall be archived with coherent retrieval facilities available.

| No. | Requirement | Priority |
|---|---|---|
| SD.R1 | It shall be possible to trigger the acquisition of the 40 µs buffer on request (triggered via timing system). This should not be associated with a post mortem event. This acquisiton shall not comprimise the postmortem buffers. | Critical |

## 9. REAL TIME ACQUISITION

Real-time feed at of what at what Hz?

## 10. INTEGRATION INTO OPTIMIZATION PROCEDURES

Collimator optimisation - local acquistion – all this should be buffered and logged. Requirements?

## 11. MANAGEMENT OF CRITICAL SETTINGS

| No. | Requirement | Priority |
|---|---|---|
| CS.R1 | A database repsoitory for the threshold levels shall be provided. Import facilities of external data shall be provided. Both applied and master threshold data shall be stored. | Critical. |
| CS.R2 | A secure means of changing the threshold levels shall be provided. This will pass via the LSA database and the MCS system. The threshold table for an individual BLM shall be treated as a coherent whole. | Critical |
| CS.R3 | A dedicated application for changing the threshold levels shall be provided. This will provide the ability to make changes at the individual beam loss monitor level or on the level of BLM families. | Expected |

## 12. MISCELLANEOUS

- Alarms – the SSIS shall monitor beam loss levels and raise alarms if the levels approach a given fraction of the threshold level.
- Malfunctioning, disable monitor.
- Operational checks before beam – interface to sequencer.
- Infrastructure – a dedicated server(s) shall be provided to ensure sufficient resources for display and acquistion programs.

## 13. REFERENCES

[1]