SELF TESTING FUNCTIONALITY OF THE LHC BLM SYSTEM

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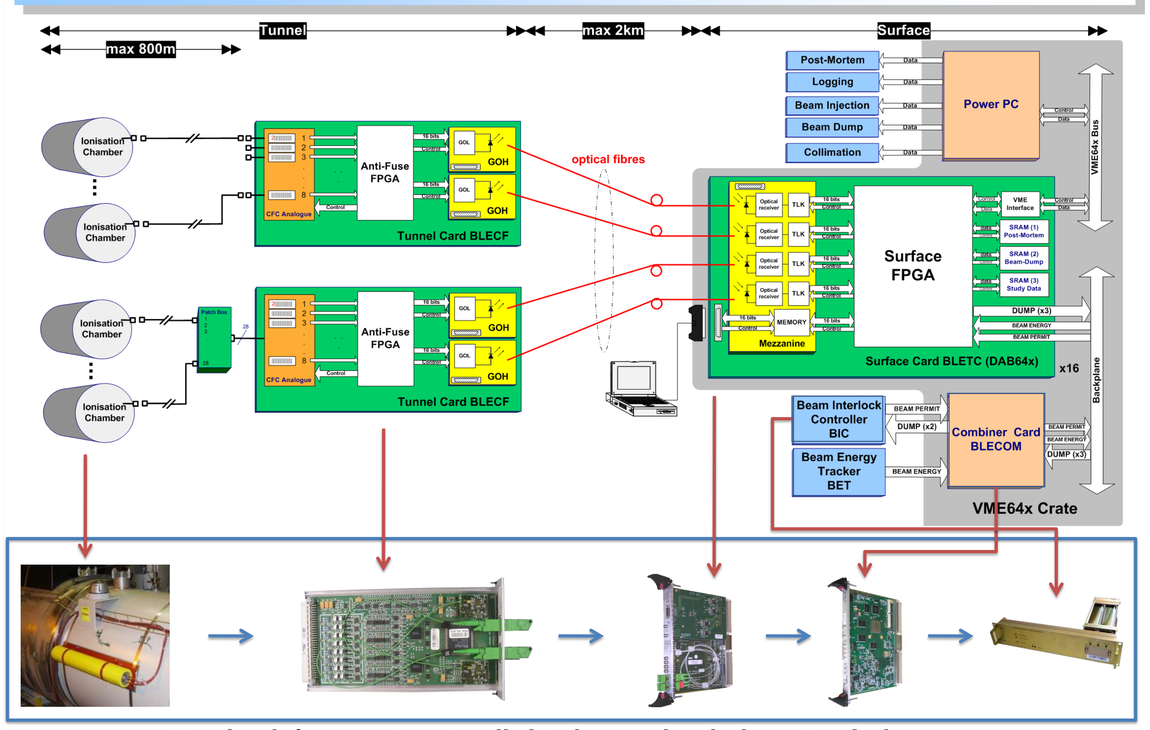
Abstract: The reliability concerns have driven the design of the LHC BLM system from the early stage of the studies up to the present commissioning and the latest development of diagnostic tools. To protect the system against non-conformities, new ways of automatic checking have been developed and implemented. These checks are regularly and systematically executed by the LHC operation team to insure that the system status is after each test "as good as new". The sanity checks are part of this strategy. They are testing the electrical part of the detectors (ionisation chamber or secondary emission detector), their cable connections to the front-end electronics, further connections to the back-end electronics and their ability to request a beam abort. During the installation and in the early commissioning phase, these checks have shown their ability to find also non-conformities caused by unexpected failure event scenarios. In every day operation, a non-conformity discovered by this check inhibits any further injections into the LHC until the check is run successfully again.

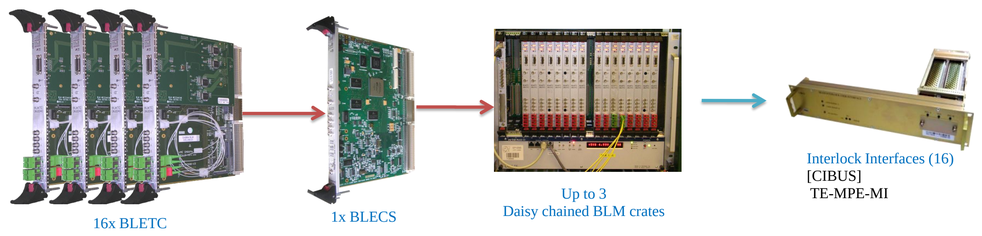
LHC BLM OVERVIEW



Signal path from monitors installed in the tunnel to the beam interlock system

INTERNAL BEAM PERMIT CHECK

The beam permit check ensure that all Thresholds Comparators are able to fire the beam dump and that is correctly passed through the daisy chaining of VME crates. The last cable before the machine interlock interface (BLECS) is under the responsibility of the Machine Interlock section.



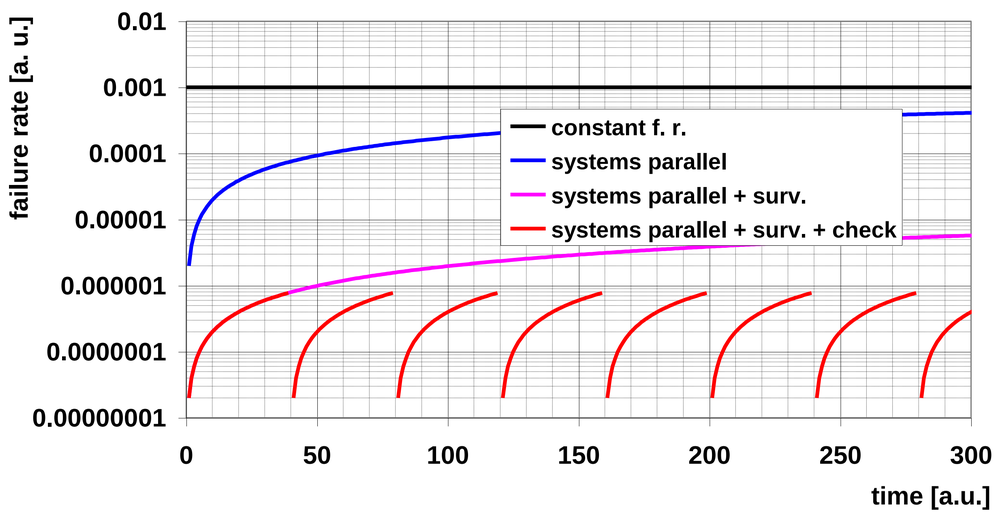
16x BLETC — 1x BLECS — Up to 3 Daisy chained BLM crates — Interlock Interfaces (16) [CIBUS] TE-MPE-MI

CONNECTIVITY CHECK

The connectivity check ensures that all monitors are supplied with high voltage and that the acquisition chain is functioning. The check is able to recognize if the correct type of monitor i.e. ionization chamber or secondary emission monitor is installed according to the defined layout structure. In addition, it can discover defects on the critical high voltage filter used to provide the fast local charges.

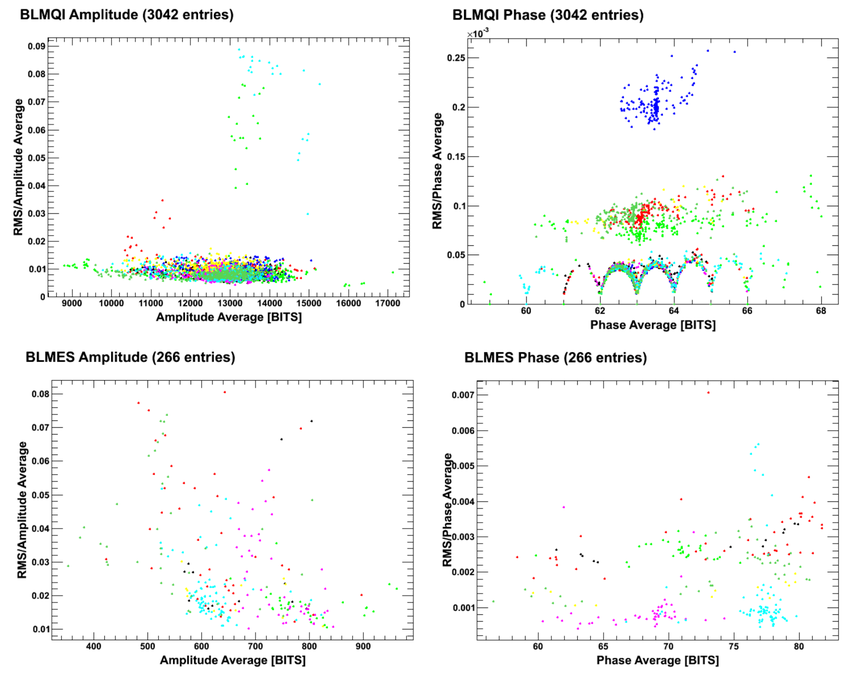
RELIABILITY STRATEGY

Reliability increase on the BLM LHC is achieved by regular checking of the integrity of the system (every 24h). If not initiated on time, these checks are blocking the next injection on the level of the hardware (no bypass possible).



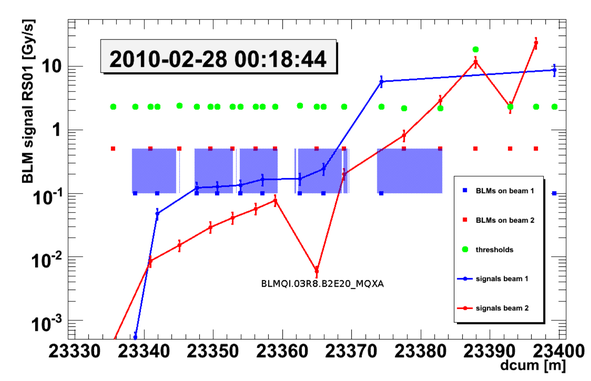
Failure rate vs. time for different scenarios

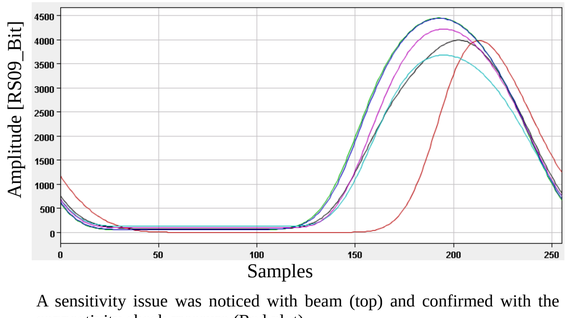
MEASUREMENTS REPEATABILITY



Repeatability of the connectivity check over 200 measurements for ionization chambers (BLMQI) and SEM (BLMES)

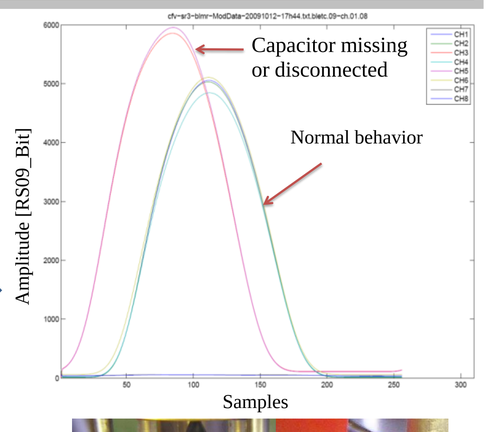
NON-CONFORMITIES FOUND ON THE INSTALLATION





A sensitivity issue was noticed with beam (top) and confirmed with the connectivity check measure (Red plot).

Type of non-conformities	Occurrences	Deviation from the expected behavior
Chamber filter disconnected or badly soldered	27	9%-33%
Tunnel card (BLECF) non-conform behavior on one or more channel	4	10%-30%
High voltage distribution box	1	Large
Connection of monitor on the wrong channel	2	Large
Monitor not supplied with high voltage	4	Large



Non-conformity discovered during commissioning (top). After opening the monitor, the source was found (capacitor not soldered)

KEY POINTS

The sanity check is integrated to the LHC pre-injection sequence executed at least every 24 hours. In case of non-conformity, the LHC BLM system blocks the next injection.

The modulation voltage is now 100Vpp and 60mHz, which minimize the impact of this check on the system (no offset increase as in the first implementation).

The high repeatability of the connectivity check measurements allows detection of wider range of defects than expected (cables, monitors, electronics).

The internal beam permit check verifies the ability of the threshold comparators to initiate the dump request signals.

The external beam permit check verifies the ability of the beam dump request to be transmitted and received by the beam interlock system.

The reliability of the BLM system has been enhanced by including a plethora of automatic and regularly executed checks.

Complementary information

" LHC BLM single channel connectivity test using the standard installation", B. Dehning, E. Effinger, J. Emery, G. Ferioli, H. Ikeda, E. Verhagen, C. Zamantzas, Proceeding of DIPAC'09, Basel, Switzerland
"*LHC BLM Audit",* 10. June to 1. July 2008, Geneva, Switzerland (http://ab-div-bdi-bl-blm.web.cern.ch/ab-div-bdi-bl-blm/Audit/audit.htm)
" *Single Gain Radiation Tolerant LHC Beam Loss Acquisition Card",* E. Effinger, B. Dehning, J. Emery, G. Ferioli, C. Zamantzas, Proceeding of DIPAC'07, Venice-Mestre, Italy
"The LHC Beam Loss Monitoring System's Surface Building Installation", C. Zamantzas, B. Dehning, E. Effinger, J. Emery, G. Ferioli, Proceeding of LECC'06, Valencia, Spain

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