Experience with BLMs

B. Dehning
CERN BE/BI

Structure of threshold LSA database

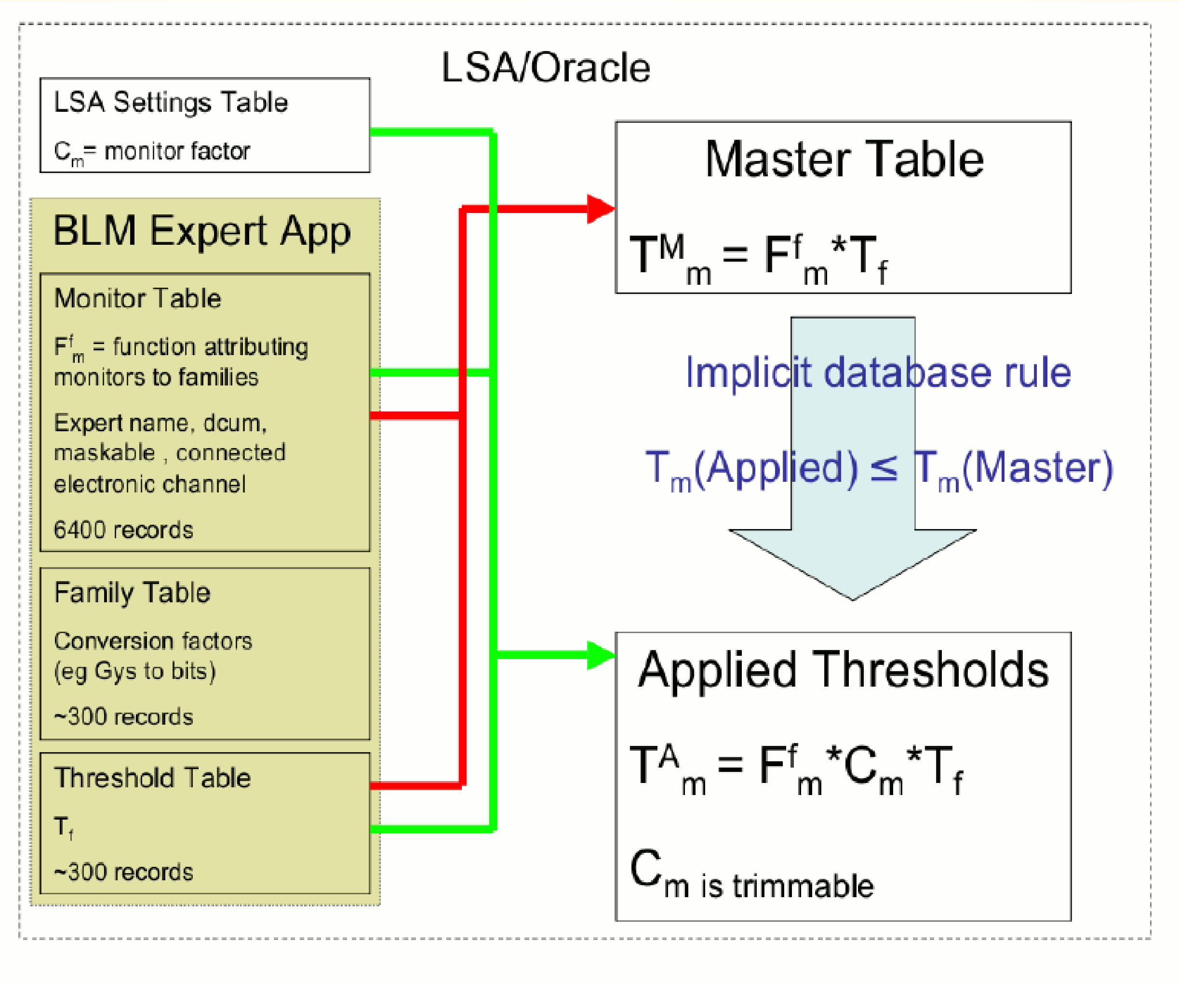


Figure 1: Structure of LSA tables.

Content

- Hardware nonconformities and safety
  - Equipment failures
  - IP 3 signal cross talk
  - IP 2 sanity check failures
  - SEM signal
- Maximum of Acquisition Range
- Monitors with Filter
- Thresholds
  - Global view
  - Generation
  - LSA developments
- MPP test remaining
- Audit

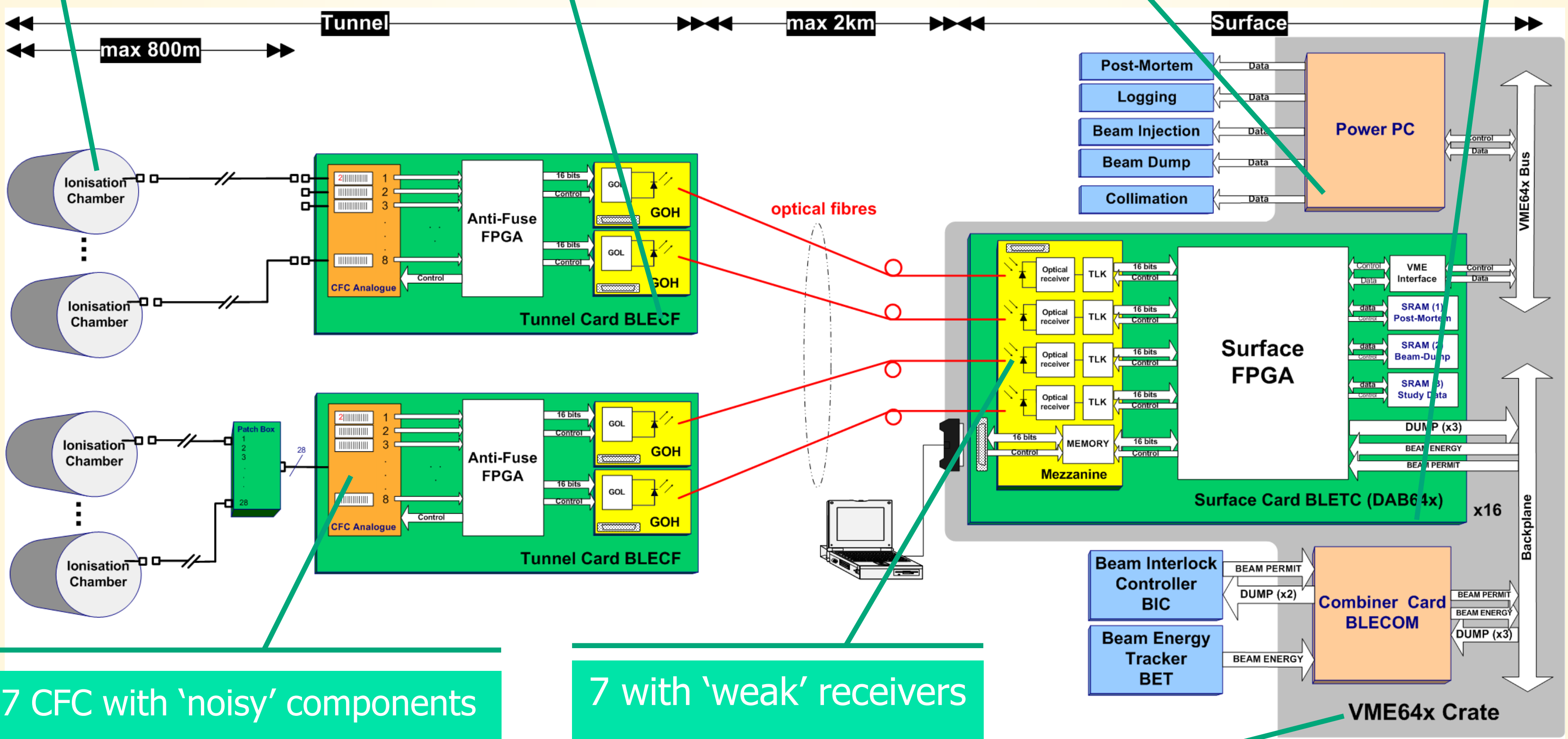
Overview of H/W Failures (since Feb. 2010)

9 IC with bad soldering
(out of 3700)

9 GOH with low power
1 damaged connector
out of 1500

2 failed CPU RIO3
out of 25

2 with failed SRAM
out of 350



7 CFC with 'noisy' components
2 cards with bad soldering
out of 359

7 with 'weak' receivers
out of 1500

1 VME Power Supply, out of 25

Number of failures regarded as manageable

System degradation analysis (I)

System Component & Action:

- Ionisation Chambers
  - Sanity checks [once daily + 200 dur. tech. stop]
  - Check of all spares [opening ~300 monitors]
- Current-to-Frequency Converter
  - Noise & Offset [technical stop]
- Optical links
  - Statuses & Errors [daily + weekly]

Criticality:

- Degradation in between of sanity checks: fast losses cannot correctly detected [reliability]
- High noise/offset can give false dump requests [availability]
- Lost packets provoke spurious dump requests [availability]

System degradation analysis (II)

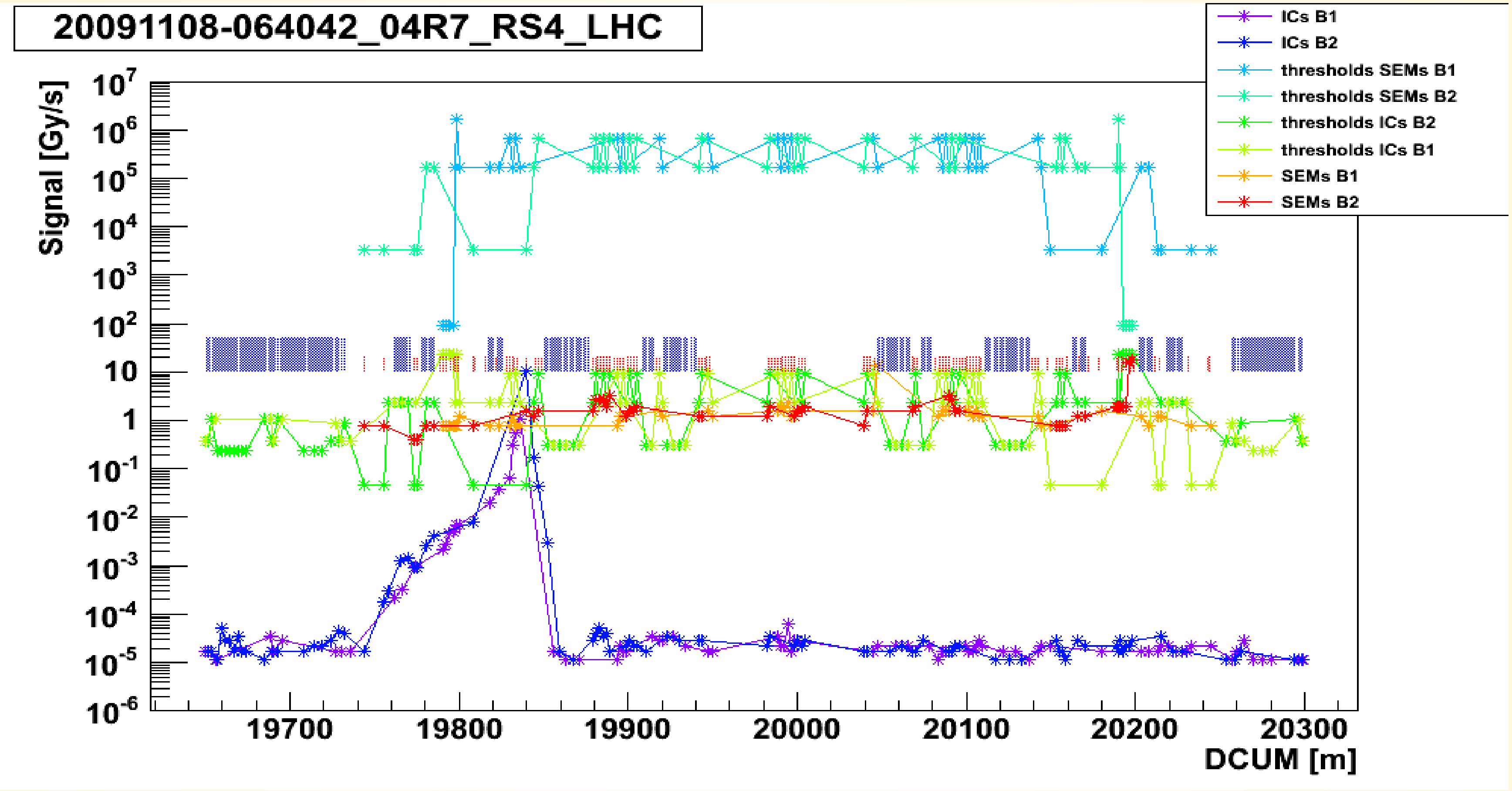
Future Actions (increase availability):

- Improve the analysis tools to achieve:
  - Better combination of results
  - Better display of results
  - Automation
  - Historical comparisons

- Large scale test of Optical Links:
  - Measure optical power of all links a few times
  - Understand if there is degradation over time
  - Understand if there is correlation with temperature OK

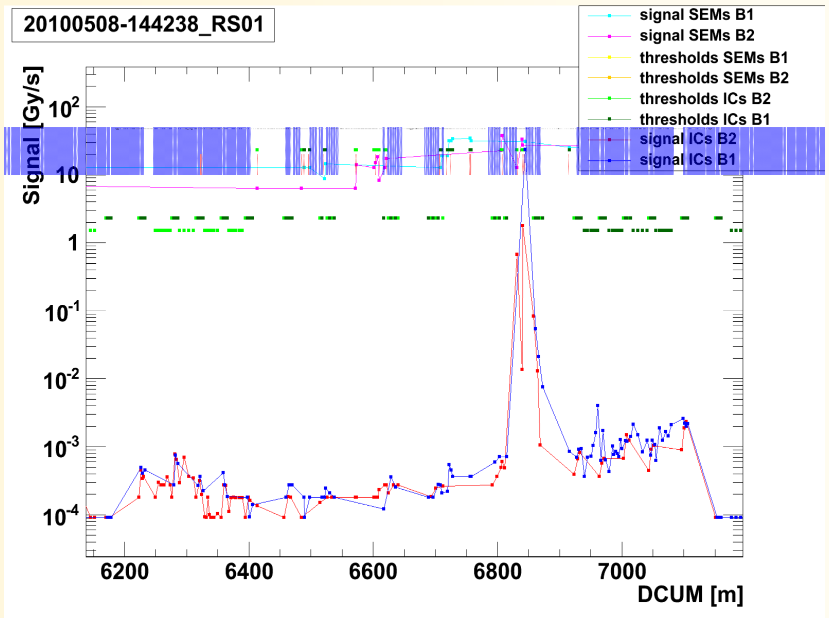
Comparison of BLM Monitor Behaviour between IR 3 and IR 7 (I)

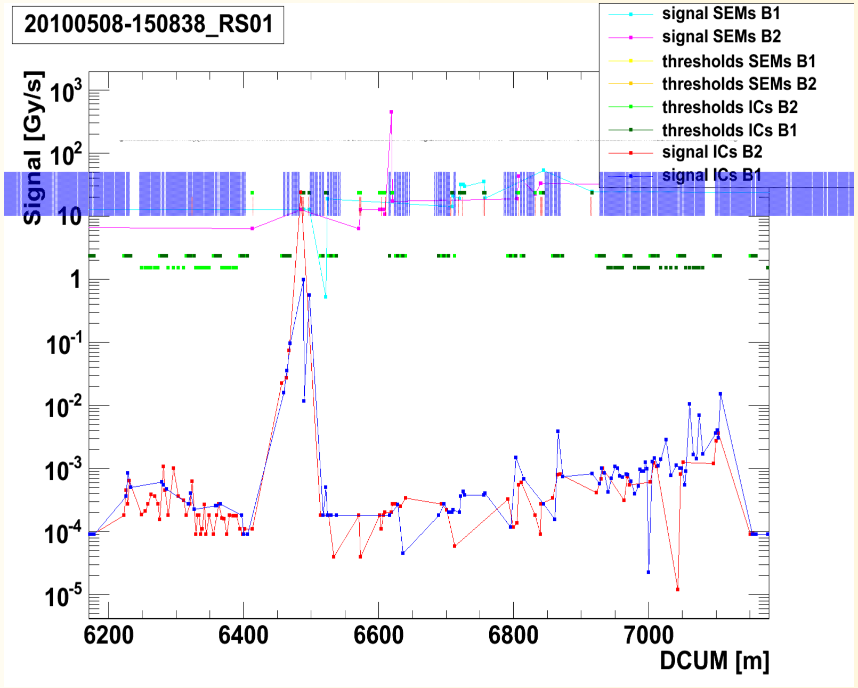
Shooting on TCLA in IR 7



Comparison of BLM Monitor Behaviour between IR 3 and IR 7 (II)

Shooting on TCLA in IR 3 (beam 1 and beam 2)





The measured losses are equal in IP3 and in IP7 and they are equal for Left and Right side in IP3

→ Functionality of the system is given and protection can be assured

Comparison of BLM Monitor Behavior between IR 3 and IR 7 (III)

Actions being taken so far:

- Checked network structure
- HV on the front ends is stable, variation < 50 V (Unom=1.5kV)
- It can be not excluded that the effects come from signal cables
- Expected non-conformity in HV distribution
- Investigations and analysis ongoing, need more detailed studies

- Additional installations being done in order to investigate noise

1) Installation of batteries on spare channels:

- BJBAP.A6R3 Channel 7: connected battery with 1.5μA
- BJBAP.A8R3 Channel 7: connected battery with 1.5μA
- BJBAP.B8R3 Channel 7: connected battery with 1.5μA

2) Installation of cable + T splitters + HV resistors on spare channels:

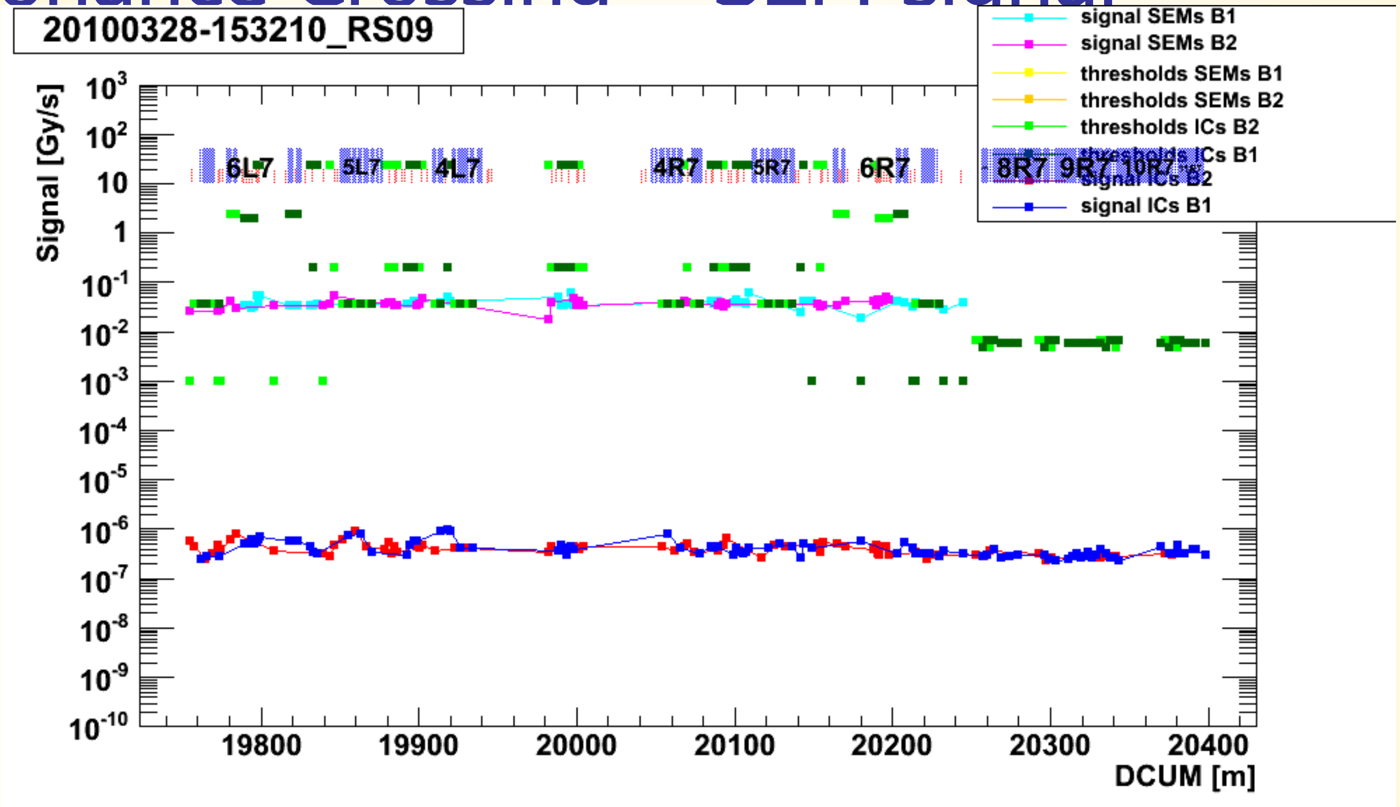
- BJBAP.A6R3 Channel 8: HV via 100Mohm 15μA
- BJBAP.A8R3 Channel 8: HV via 100Mohm 15μA
- BJBAP.B8R3 Channel 8: HV via 100Mohm 15μA

IP2 Sanity Check Nonconformity

- Observation: sequencer initiated sanity check does not start
- Consequence: timer reset is not done, no beam permit given

- Beam permit generation is independent of sequencer
- Non conformity is not safety critical

Resonance Crossing – SEM signal



No signal from SEM expected: probable due to ionization in air, more investigations needed

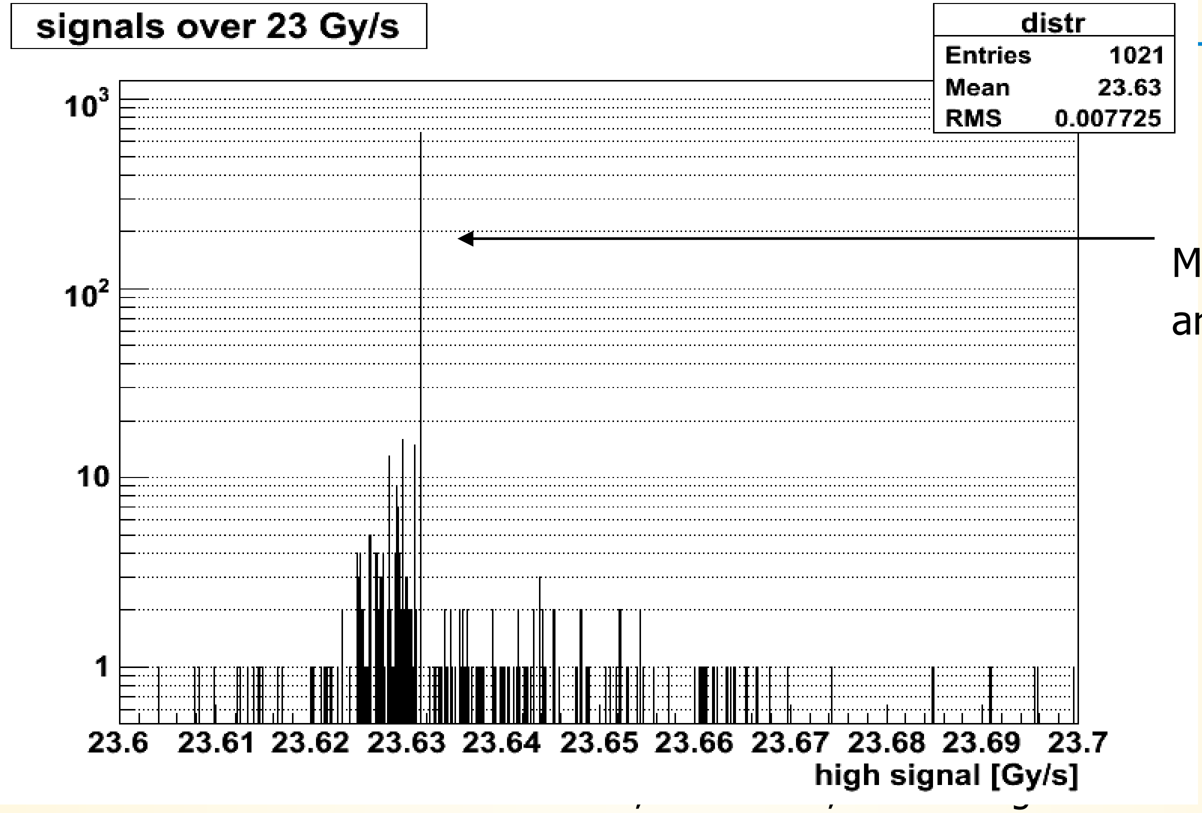
Maximum Values in the BLMs during Operation in 40 µs

Calibration: 1mA = 200 counts * 1024 = 204800 BITS

The counter is able to count up to: 255 counts * 1024 = 261120 BITS = 23.631 Gy/sec

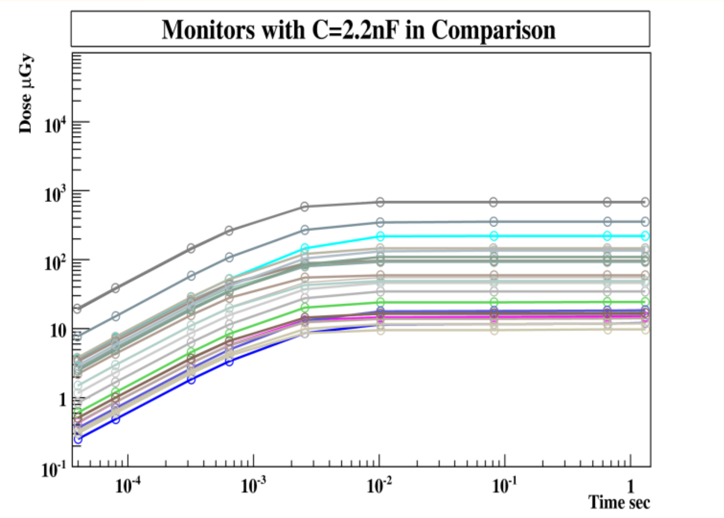
Absolut maximum (including ADC): 255 counts * 1024 + 1023 = 262143 BITS = 23.724 Gy/sec

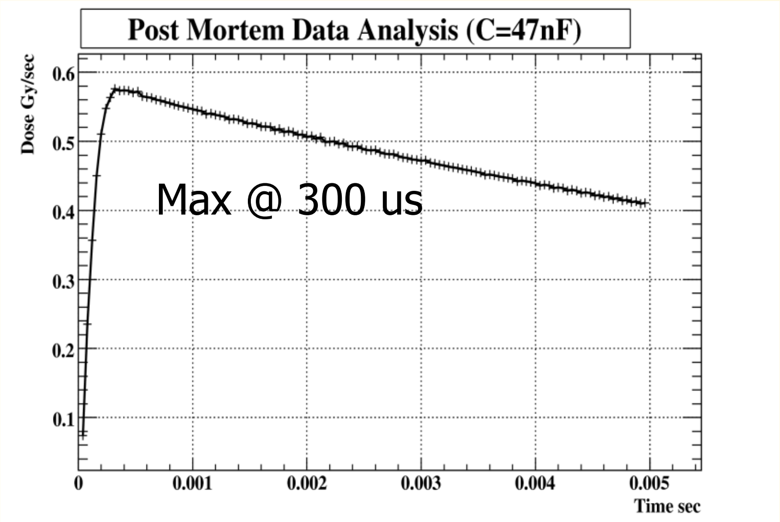
Restriction c… TS = 23.168 Gy/sec

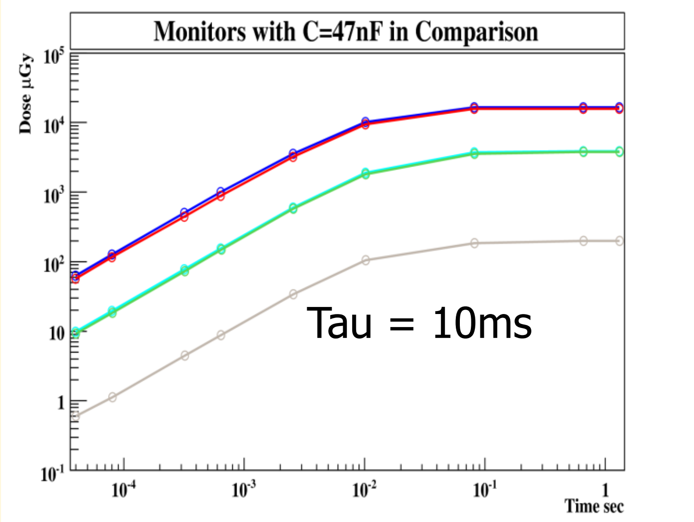


Mostly 23.631 Gy/sec are measured

Filter Monitors







Checking performance and behavior:

1) Check with beam that filters are installed at the defined channels (done)

2) Determination of rise time (time needed to collect 100% of the charges (use PM data) (missing for IP6)

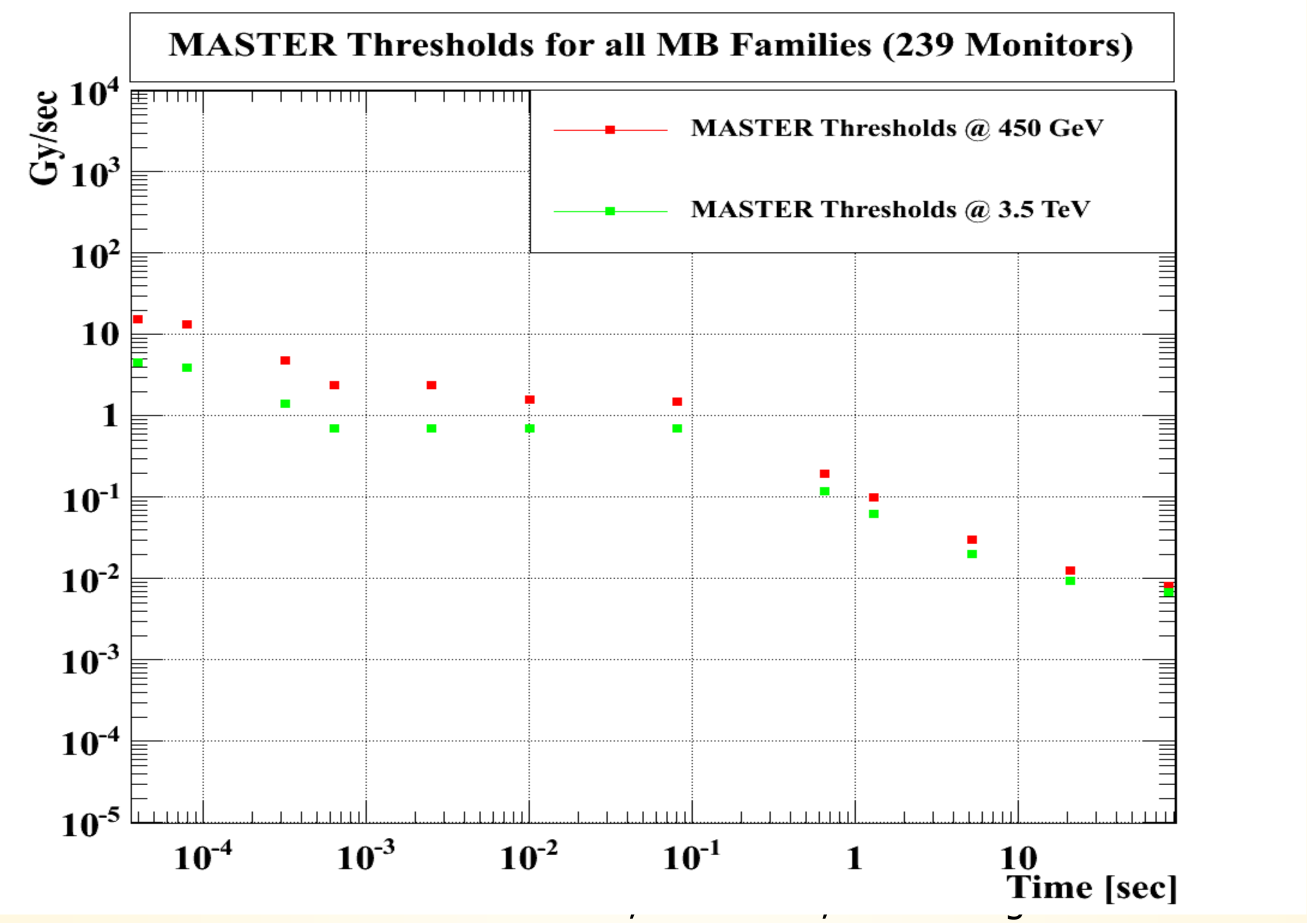
3) Determination of ratio filter/non-filter amplitude, i.e. height of signal (partially done)

Thresholds for MB Monitors

239 MBB and MBA monitors (5 families according to position)

All monitors have the same thresholds, no difference for positions 1,2,3

Monitor factor = 0.1



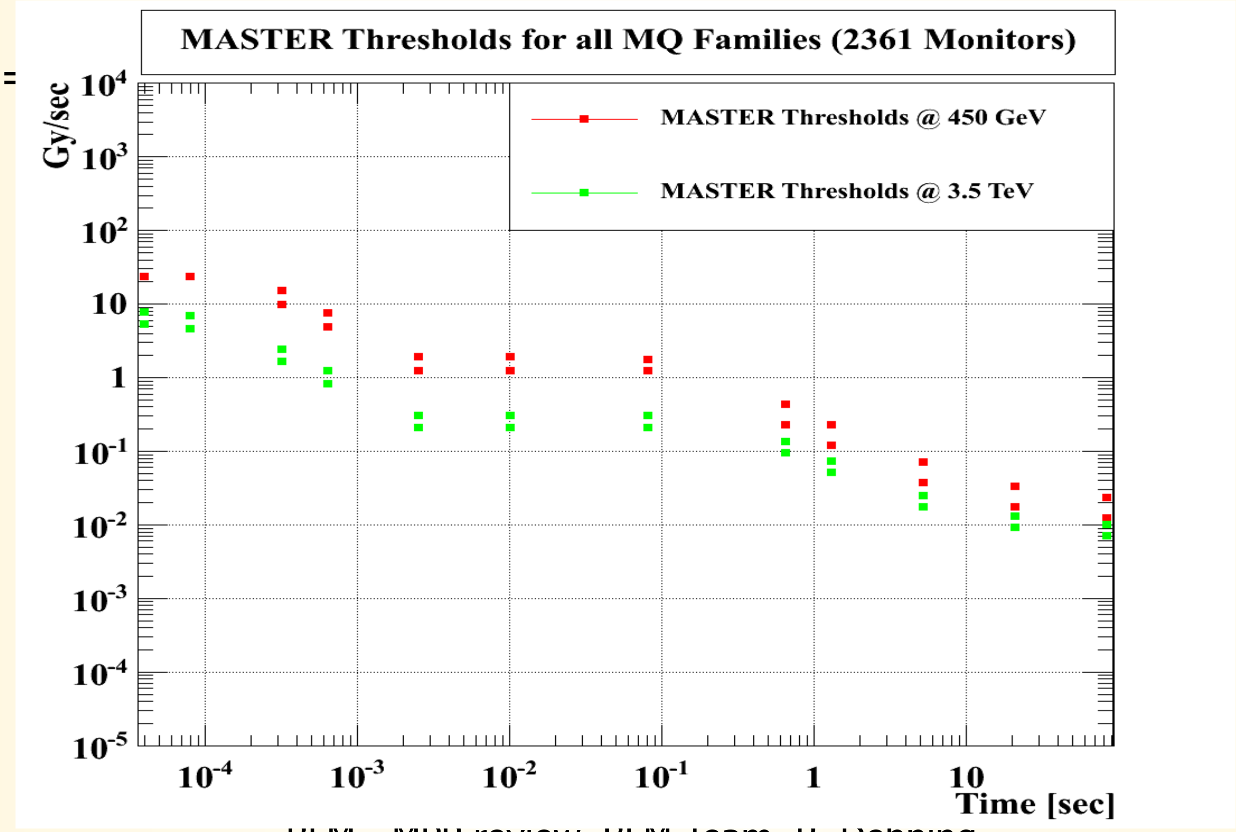
Thresholds for MQ Monitors

2361 MQ monitors (18 families according to position 1,2,3 in LSS, DS, ARC)

Monitors in position 2,3 have the same thresholds and are ~ 30% smaller than for position 1

No difference for LSS, DS, ARC

Monitor factor =



Thresholds for MQM Monitors

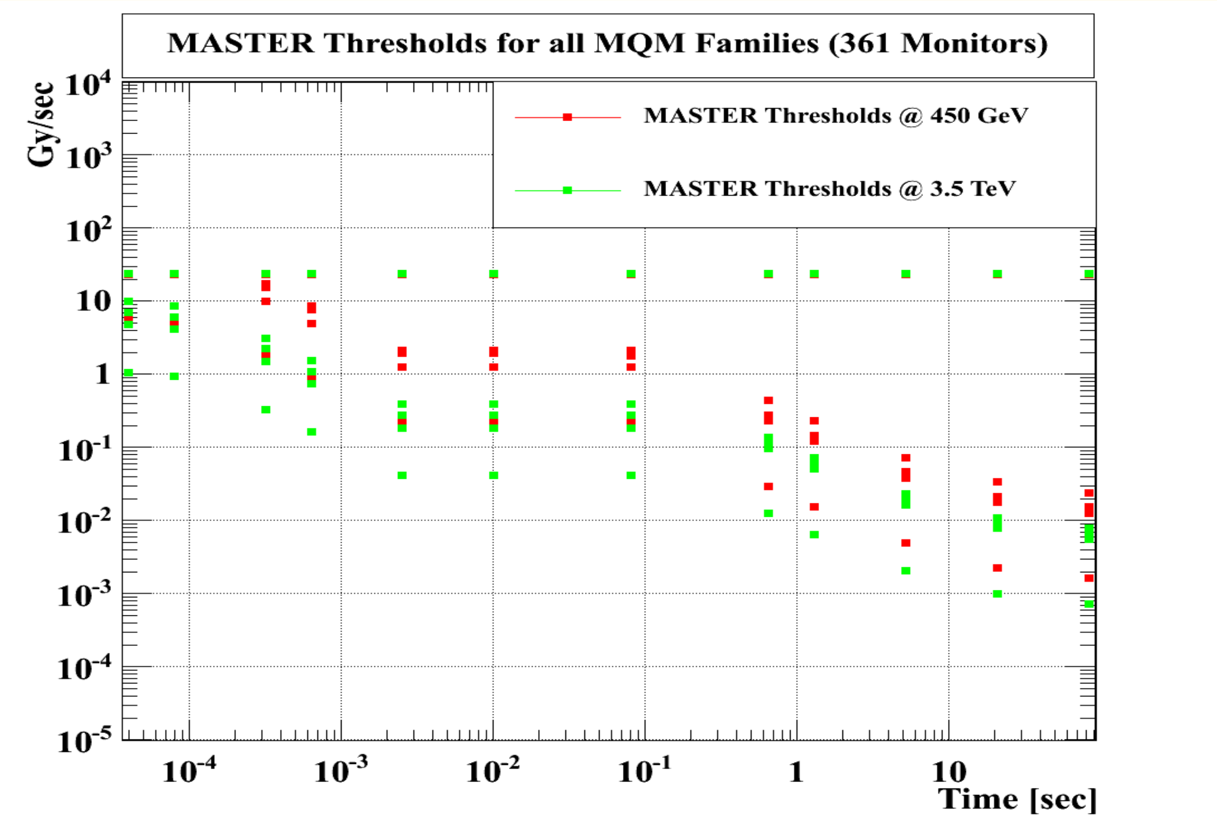
361 MQM monitors (12 families according to position 1,2,3 in LSS, DS)

Thresholds in LSS: pos. 1 > pos. 2 (~90% smaller) , pos. 3 at maximum

Thresholds in DS : pos. 1 > pos. 2 (~30% smaller) , pos. 3 same thresholds as in pos. 2

LSS pos.1 > DS pos.1 (~

Monitor factor = 0.1



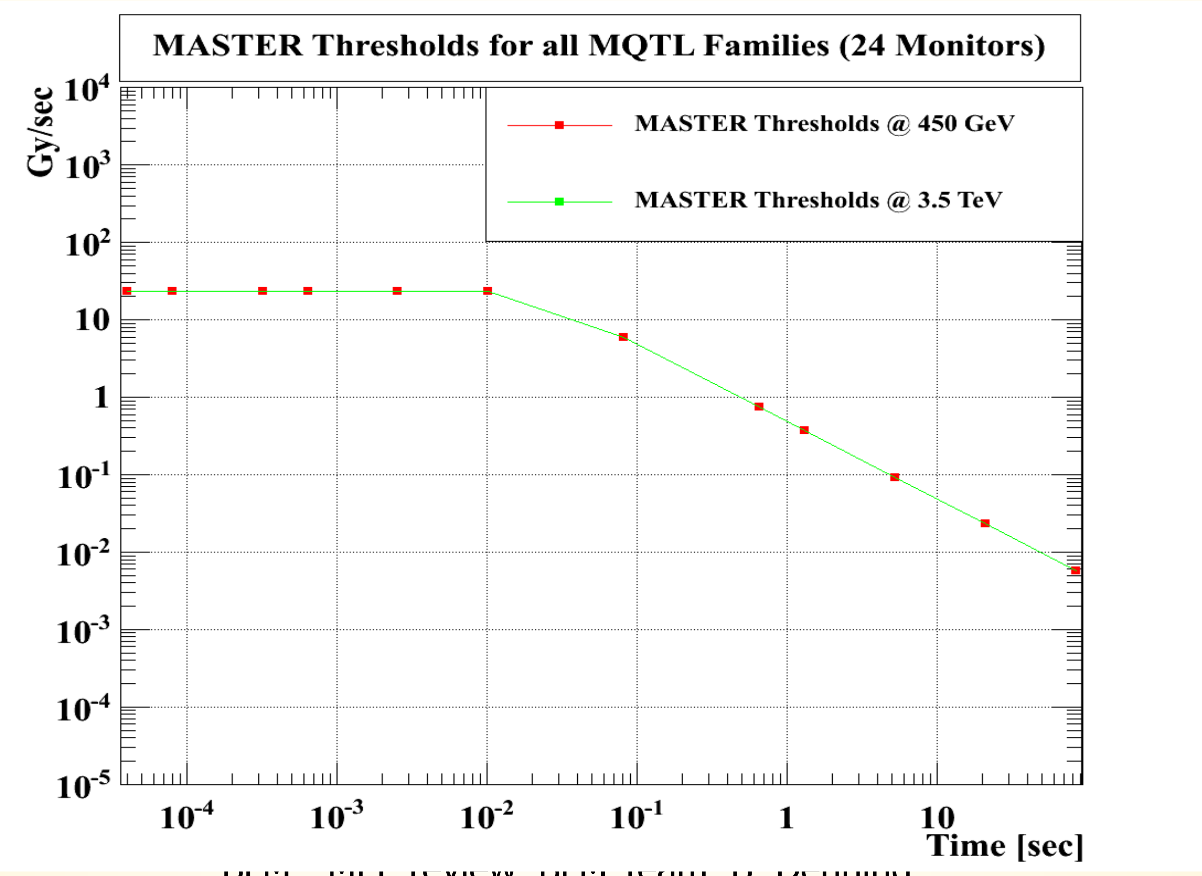
Thresholds for MQTL Monitors

24 MQTLH monitors (6 families according to position 1,2,3)

No difference for position, non-linear energy dependence (change only above 3.5 TeV)

Monitor factor = 0.1

Thresholds need t



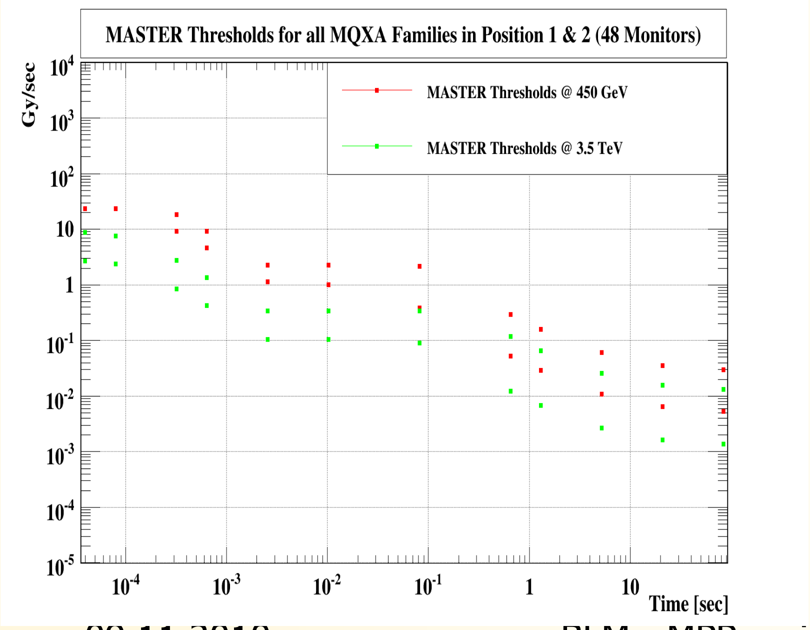
Thresholds for MQXA Monitors

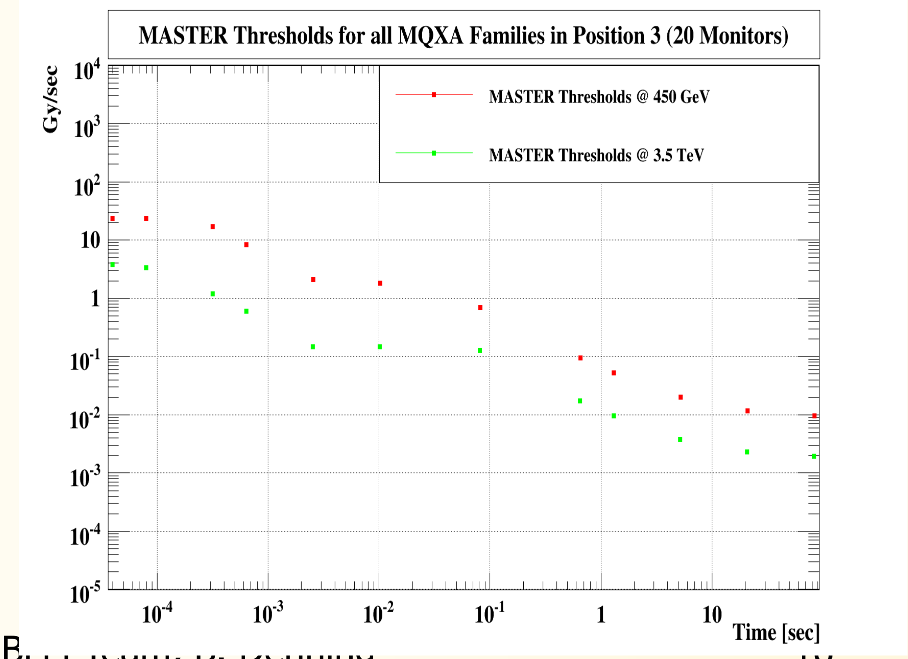
80 MQXA monitors (8 families according to position 1,2,3 and special positions)

Thresholds in pos. 1 > pos. 2 (~70 % smaller) < pos. 3 (~25% higher)

Thresholds in special positions are at maximum

Monitor factor = 0.1



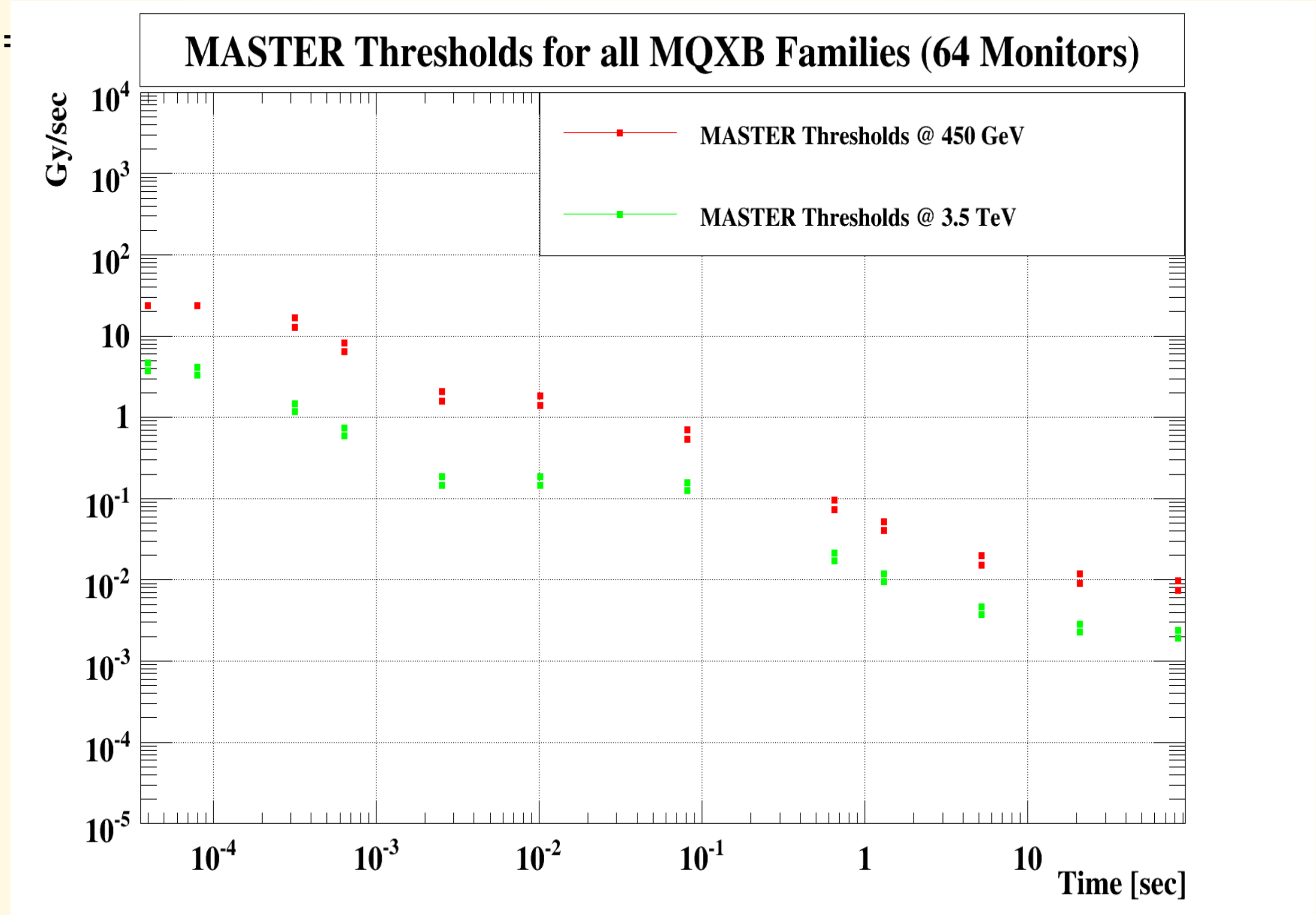


Thresholds for MQXB Monitors

64 MQXB monitors (4 families according to position 2,3)

Thresholds in pos. 2 < pos. 3 (~25 % higher)

Monitor factor =

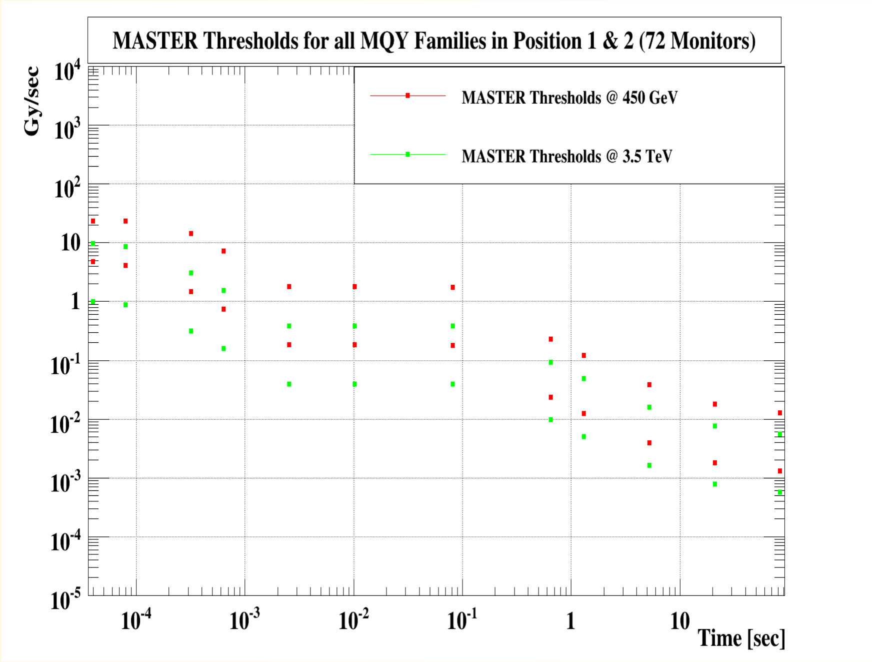


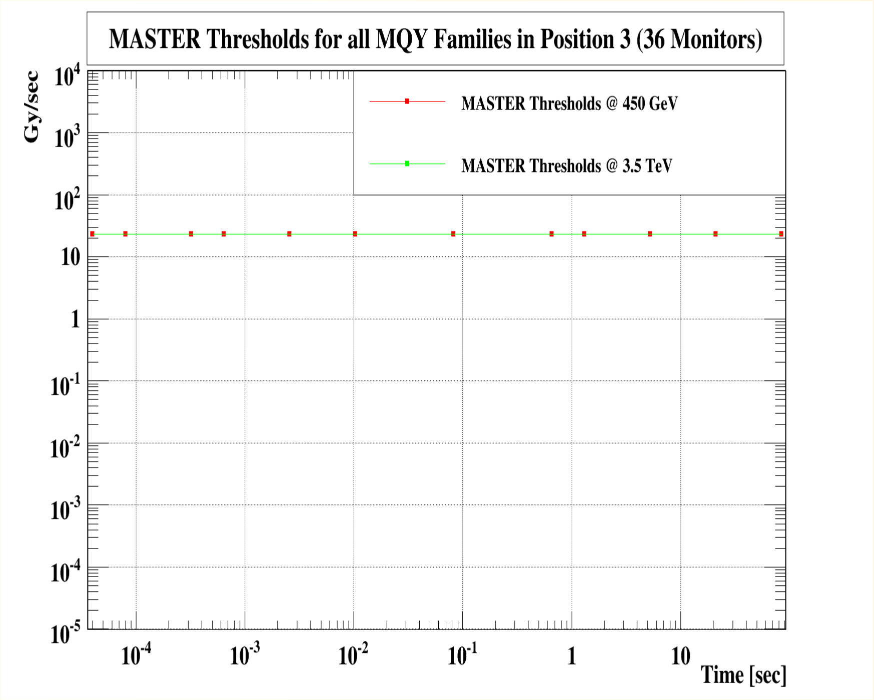
Thresholds for MQY Monitors

108 MQY monitors (6 families according to position 1,2,3 in LSS)

Thresholds in pos. 1 > pos. 2 (~90 % smaller), pos.3 at maximum

Monitor factor = 0.1





BLM – MPP review

- Hardware nonconformities and safety
  - Equipment failures
  - IP 3 signal cross talk
  - IP 2 sanity check failures
  - SEM signal
- Maximum of Acquisition Range
- Monitors with Filter
- Thresholds
  - Global view
  - Generation
  - LSA developments
- MPP test remaining
- Audit

EDMS Portal

Home | Help | Login - *GUEST*

PROJECTS ▾ DOCUMENTS ▾ EQUIPMENT ▾ BUILDINGS & SITES ▾ SAFETY ▾ BLM-ECR Search

Search Results [16 Documents]

DOCUMENTS [Advanced Search]

[Show Only First 5]

	1072925 v.1	LHC-BLM-ECR-0001	Installation of LIC prototype	Eva Barbara HOLZER	Implemented
	1074732 v.1	LHC-BLM-ECR-0003	Filter installation MQML, MQM and MSI external ICs for higher intensity ...	Eva Barbara HOLZER	Released
	1078958 v.1	LHC-BLM-ECR-0007	TDI thresholds	Eva Barbara HOLZER	In Work
	1085590 v.1	LHC-BLM-ECR-0011	Threshold changes injection regions RC filter monitors	Eva Barbara HOLZER	In Work
	1099715 v.1	LHC-BLM-ECR-0013	Warm Magnet Thresholds	Eva Barbara HOLZER	In Work
	1078963 v.1	LHC-BLM-ECR-0008	Over-injection MBX thresholds (position 1 and 2)	Eva Barbara HOLZER	In Work
	1073949 v.1	LHC-BLM-ECR-0002	TCLA threshold changes	Eva Barbara HOLZER	Under Approval
	1086330 v.1	LHC-BLM-ECR-0012	TCTVB injection region thresholds	Eva Barbara HOLZER	In Work
	1078955 v.1	LHC-BLM-ECR-0006	IP6 filter installation and threshold adjustment (MSD, TCD)	Eva Barbara HOLZER	In Work
	1085588 v.1	LHC-BLM-ECR-0010	TCLA IP7 and TCT at IP1, 2, 5 and 8	Bernd Dehning	Under Approval
	1074768 v.1	LHC-BLM-ECR-0004	Installation RC filters behind TCPs in IP3 and IP7	Eva Barbara HOLZER	Under Approval
⊖	1100873 v.1	LHC-BLM-ECR-0014	TCSG IP6 new monitors for measurement only with big filter	Eva Barbara HOLZER	In Work
	1078988 v.1	LHC-BLM-ECR-0009	Monitors not connected to BIS and/or with maximum thresholds	Eva Barbara HOLZER	Under Approval
	1074965 v.1	LHC-BLM-ECR-0005	Over-injection TDI changes including RC filter installation (ECR BLM)	Eva Barbara HOLZER	Under Approval
⊖	1100881 v.1	LHC-BLM-ECR-0015	Installation of 3 LIC prototypes 21.10.2010	Eva Barbara HOLZER	In Work
	1072660 v.1		LHC BLM ECRs - Documentation of implementation in EDMS	David WIDEGREN	Released

CERN – European Organization for Nuclear Research EDMS 5.0 © CERN – 2010.11.09 08:11:39

CERN
CH-1211 Geneva 23
Switzerland

the
Large
Hadron
Collider
project

LHC Project Document No.
LHC-BLM-ECR-0010

EDMS Document No.
1085588

Engineering Change requested by (Name & Div./Grp.) :
B. Dehning BE/BI

Date: 2010-April-30

Engineering Change Request – BLM
TCLA IP7 and TCT at IP1, 2, 5 and 8

Brief description of the proposed change(s) :

Master table thresholds for TCLA C and D in cell 6 and TCLA A and B in cell 7 have been increased by a factor 10 and the monitor factors have been changed from 1.0 to 0.1 on 14.06.2010.

Master table thresholds for all TCT collimators have been increased by a factor 10 and the monitor factor have been changed from 1.0 to 0.1 on 14.06.2010.

The nominal threshold settings are identical compared to previous settings for running sums larger than 4 (3) at 3.5 TeV, it is possible to change them by a factor 10 up using the "LHC BLM Threshold Factor Editor" program.

Equipment concerned :	***Drawings concerned :***	***Documents concerned :***
LHC BLM		
PE in charge of the item : **Bernd Dehning**	***PE in charge of 'user system' :*** **Ralph Assmann**	***MPP representative :*** **Jorg Wenninger**
Decision of the PE: ☐ Rejected. ☐ Accepted by PE, no impact on other items. *Actions identified by Project Engineer* ☑ Accepted by PE, but impact on other items. *Approval from Project Engineers of 'user system' required*	***Decision of the PE of the 'user system':*** ☐ Rejected. ☑ Accepted by the PE of the 'user system' *Actions on 'user system' identified by PE of 'user system'*	***Decision of the MPP representative:*** ☐ Rejected. ☑ Accepted by MPP representative.

Threshold Generation

Current:

- Code written in C (object oriented source code, Macros to create thresholds)
- Code needs to be debugged in detail and needs to be improved
- For each family we use one specific Macro
- Source code, macros and threshold files are stored in SVN with given version
- Automatic versioning needs to be implemented
- Documentation of all changes (stored in SVN): automatization needed
- ECR for each change that needs to be signed by the responsible persons (needs further improvement)

Planned:

- Change to fully object oriented threshold code (C++ or python)
- Implementing algorithms and parametrization on LSA level, thresholds generation directly in LSA

Checks:

- Maximum BITS (code, application, LSA level)
- Decrease with energy and with integration time

LSA Developments

- Internal LSA DB Constraints [improvement]
  - Most of them already reviewed
  - Need to add more complex/powerful constraints
- Internal LSA DB Check for disabled channels [available]
  - Based on monitor criticality and adjacent disabled channels
  - Each monitor is being tagged on its criticality
  - Current version blocks commits on rules violation
  - Needs review of the monitor tags (e.g. collimator monitors can be disabled atm)
- Roll-Back of commits
  - Complete :: using DB Retention functionality [available]
    - Currently available max 24h after commit has been made
    - Only by DB expert (i.e. CO/DM)
  - Partial :: using history tables [under development]
    - Flags (masking, connection_to_BIS, …)
    - Family (threshold values)
    - Monitor (classification to family, other settings)

Predefined Procedures (Audits) - what is not done

- MPS Aspects of the Beam Loss Monitor System Commissioning
- Management Procedure of the LM System Settings

- Procedure/Implementation for generation of thresholds
- Direct dump not tested, high intensity needed (electrically done)
- Update of thresholds – two person procedure executed in the control room, enforced by program (will be implemted) OK

MPS checks

Beam Commissioning Tests (only those still pending)

- Interface of direct BLMs with the LBDS
  - Reduce the voltage setting of the abort threshold.
  - Dump the injected beam on the collimator TCDQ and TCSG (with local bump)
  - 2 hours and 2 accesses

- Provoked quench for transient losses
  - 'recovering quench' detected with the nQPS
  - The losses are recorded and compared to the expected quench level
  - 1 hour/magnet type = 4 hours

- Provoked quench for steady-state losses
  - 'recovering quench' detected with the temperature sensors
  - The losses are recorded and compared to the expected quench level
  - 1 hour/magnet type = 4 hours

More info: https://espace.cern.ch/LHC-Machine-Protection/

System latency (2009 – 02/2010)

Analysed several Beam Dumps in detail.

Difference in time between the bunch at injection kicker magnet and the break of the beam permit loop (by the BLMS) recorded at the BIC was always between **100** and **130 µs**.

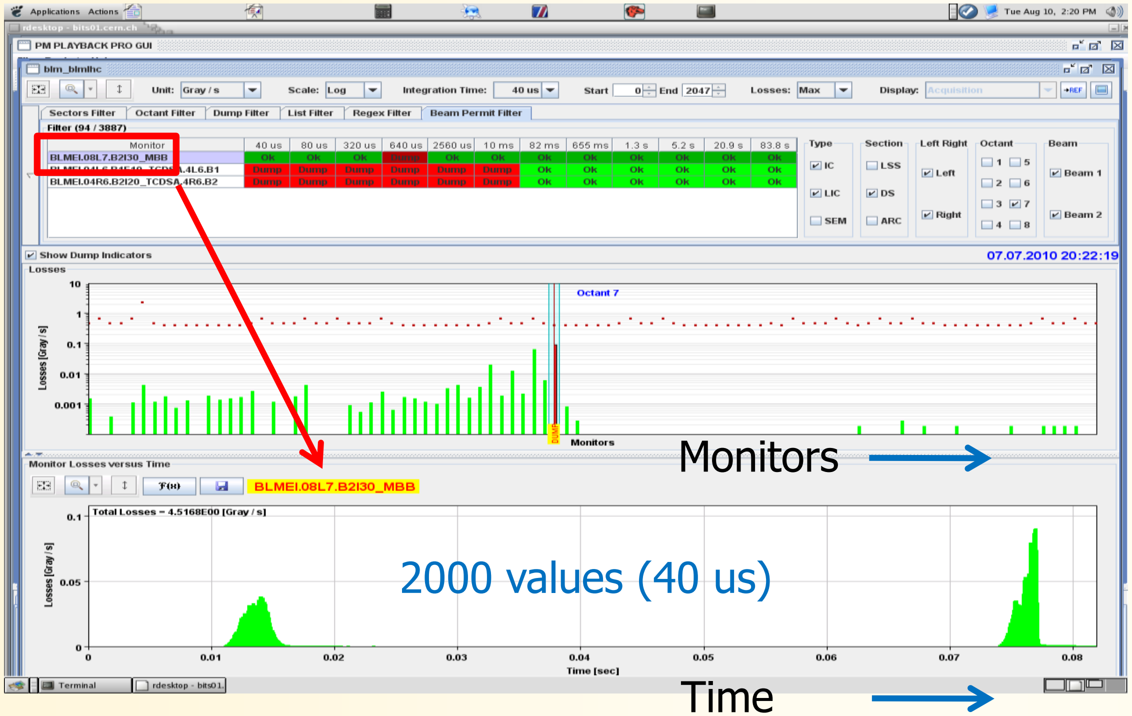
- Time of flight:
  - MKI => monitor = **10 µs**
  - monitor => acq. electronics (0.5 km cable) = **3 µs**
  - Acq. => processing electronics (1 km fibre) = **3 µs**
- Detection of change in frequency in the daisy-chain = **5 µs**
- Integration in the acquisition electronics = 40 µs.
- Decision at the BLETC (for fast losses) is taken every 40 µs.
- Processing of data to decide < 1 µs.

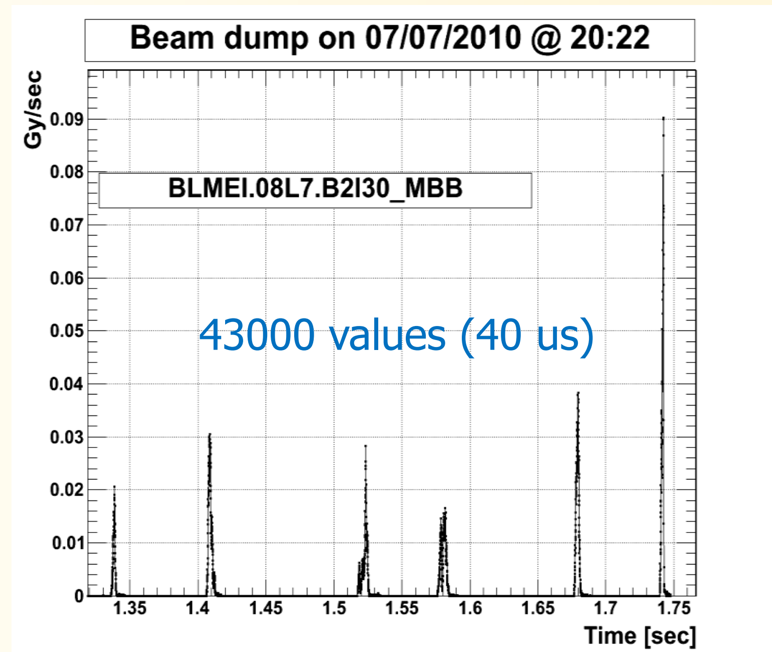
Post Mortem Data (some examples)

Loss in a bending magnet

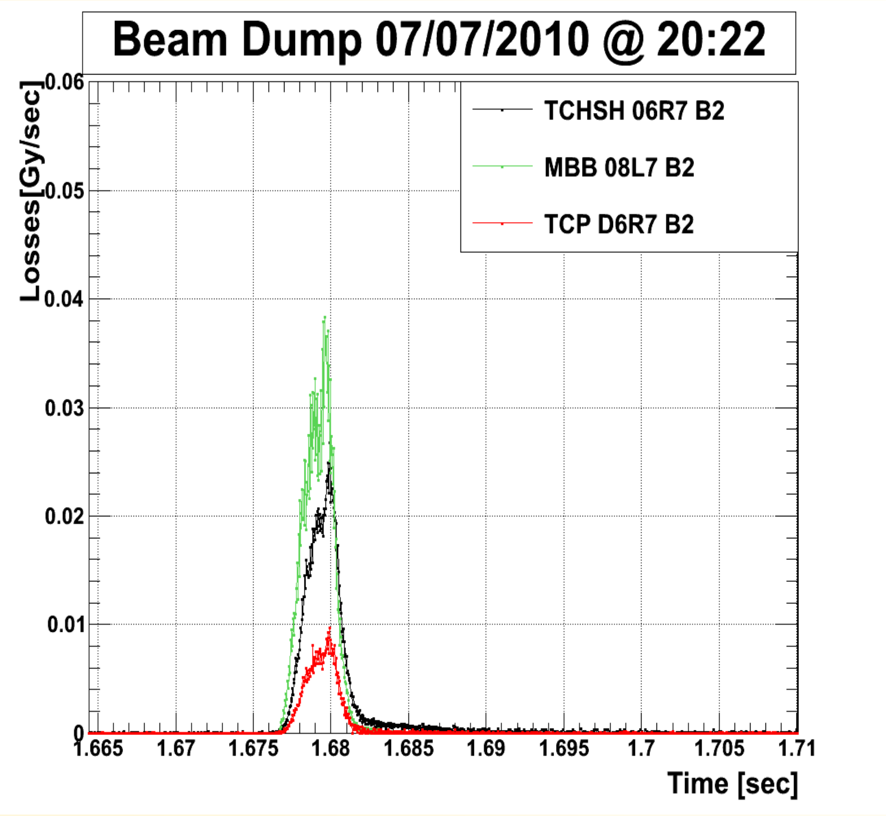
PM application: BLM data of 0.082 sec
online available

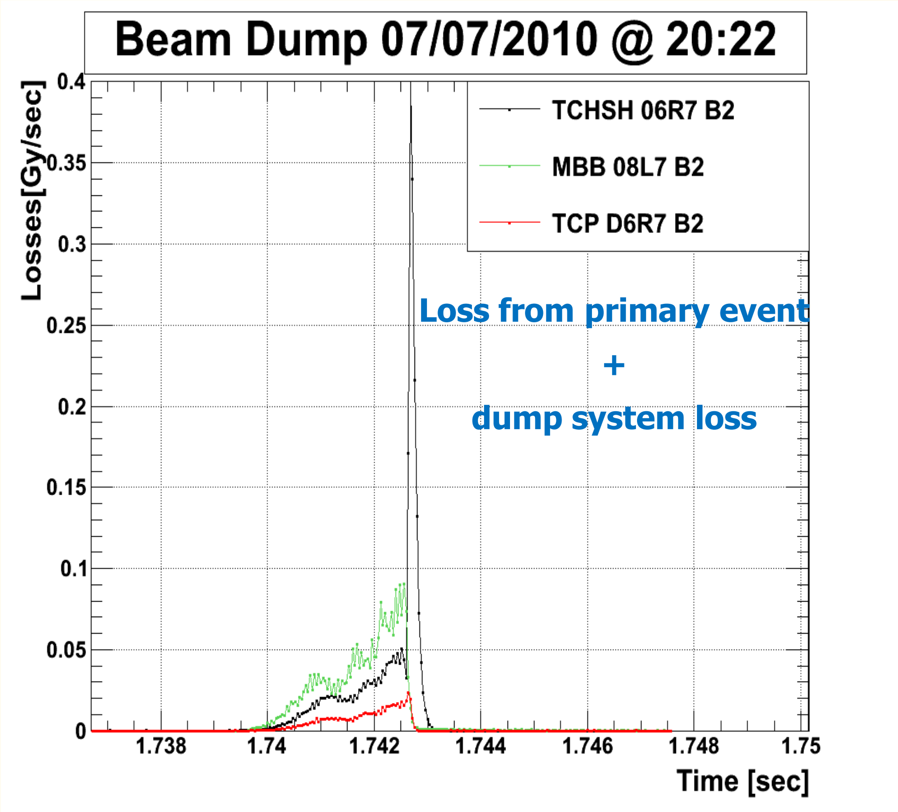
Longer PM buffer: BLM data of 1.72 sec
offine available



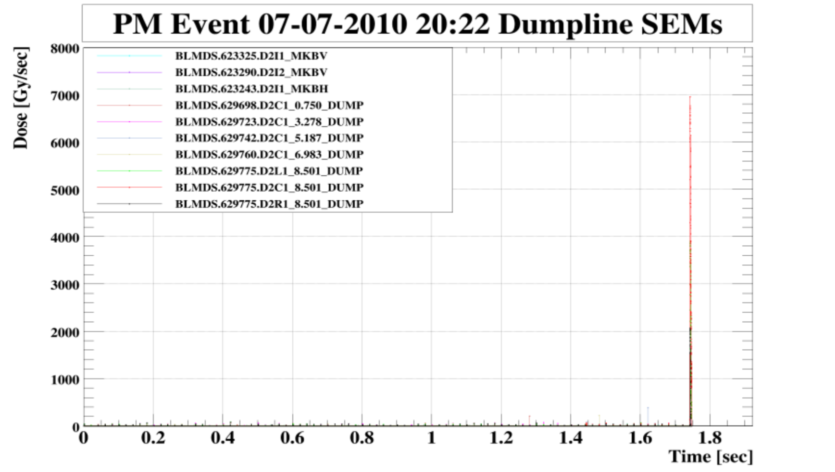


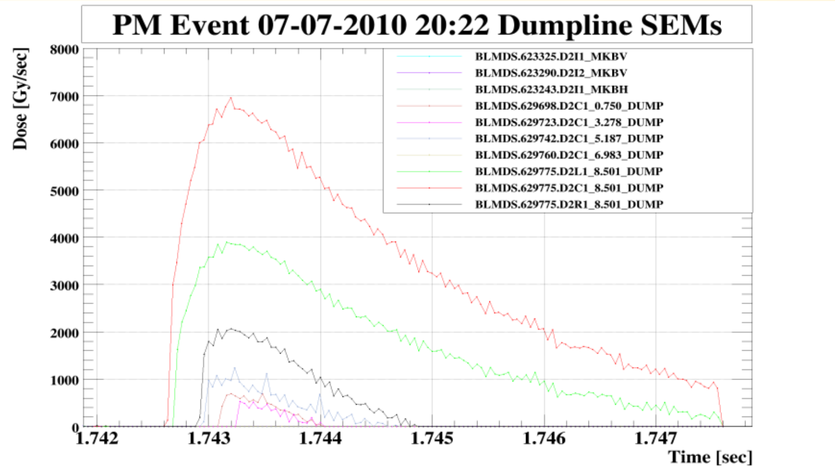
Post Mortem Data (some examples), Zoom

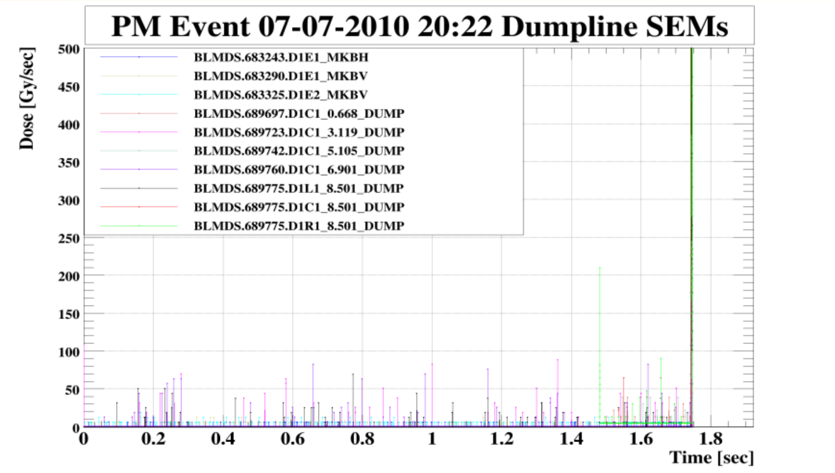


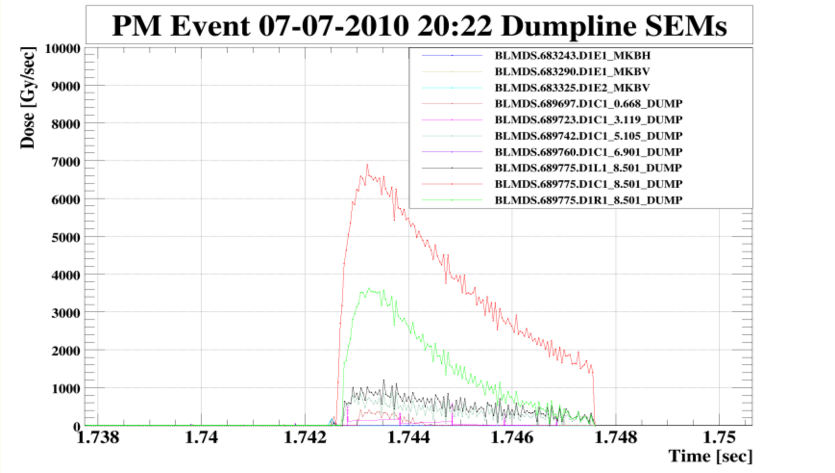


Post Mortem Losses in Dump Line and Dump, Secondary Emmission Monitors



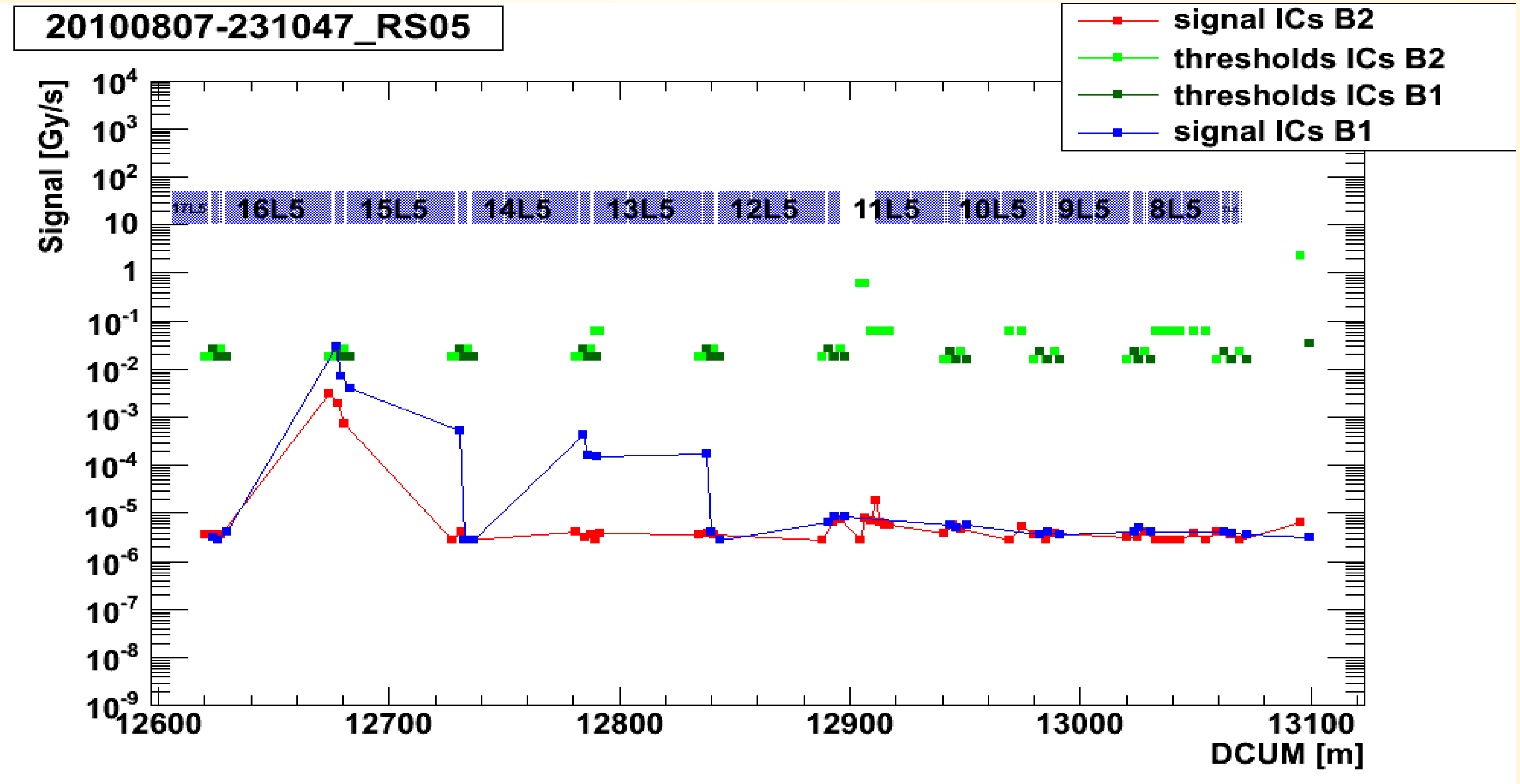






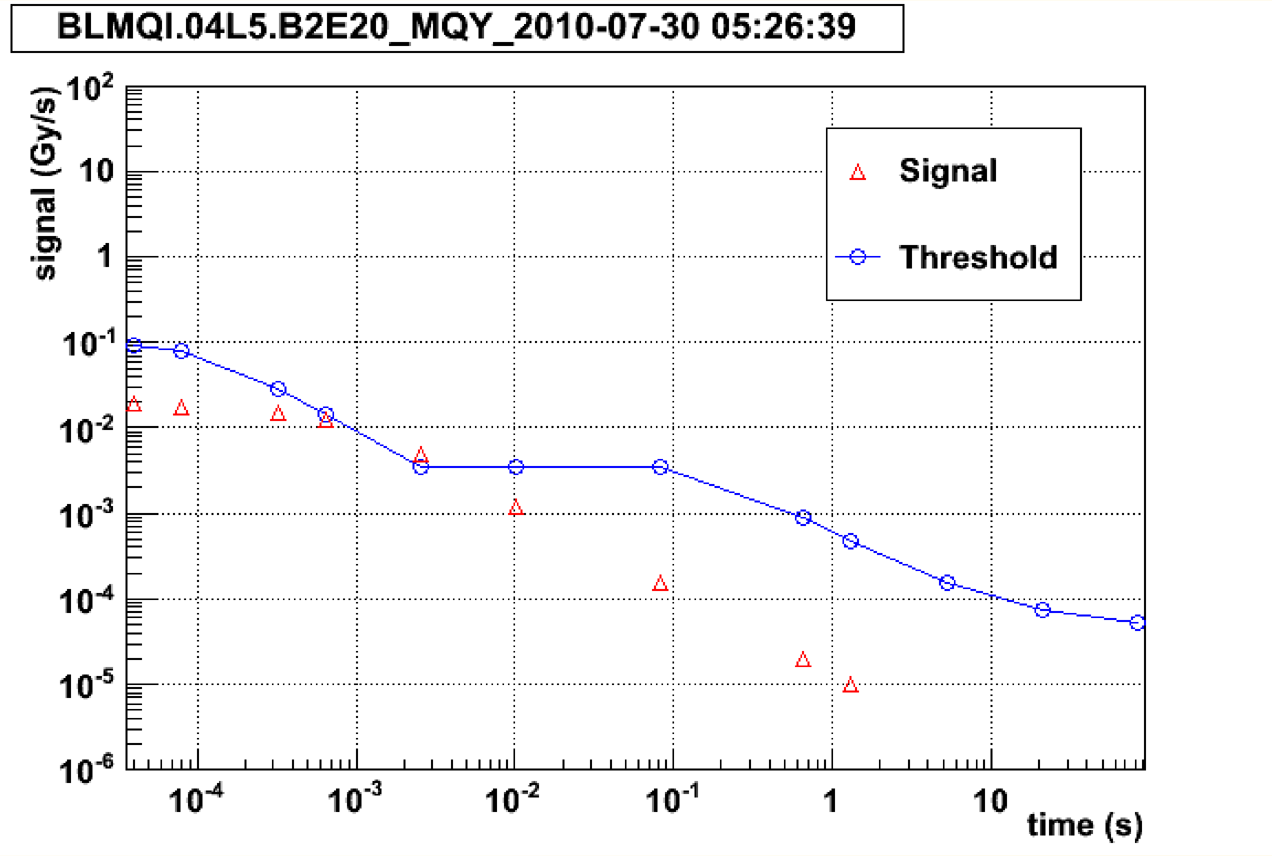
Logging Data Base Data (fast event)

- Beam 1 loss (from left to right)
- Loss monitor of B1 at MQ 15 over threshold
- Beam 2 monitors measure about 5 times lower loss
- Shown average value over 2.5 ms (maximum in 1.3 s)



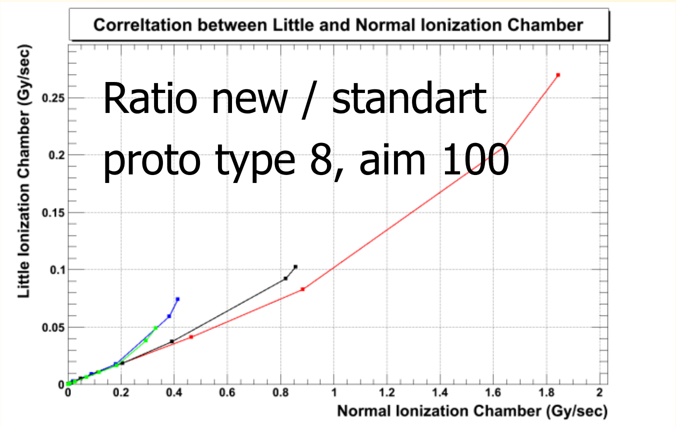
Threshold and Loss Data versus Averaging Duration

- Online Display and Logging data base Storage
- Data reduction in surface electronics
  - Averages from 40 us to 660 ms == every 1.3 second max value in last 1.3 s
  - Average 1.3 s directly stored
  - Average 83 s every minute
  - Logging 40 GByte / day
- Reconstruction of duration of events possible by max value shapes (identification of kink)

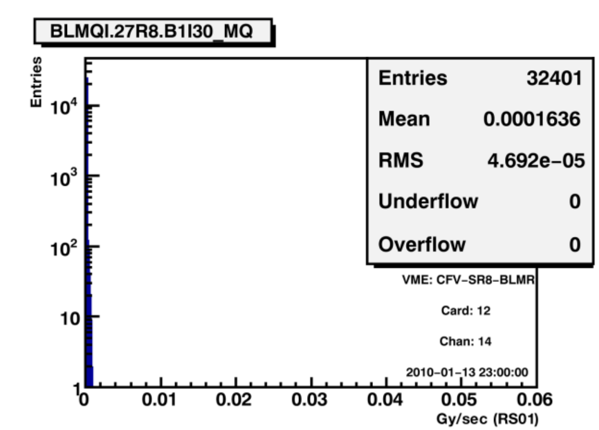


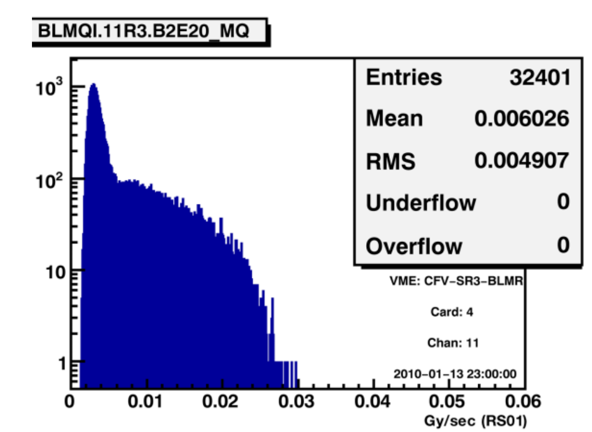
BLM System Upgrades

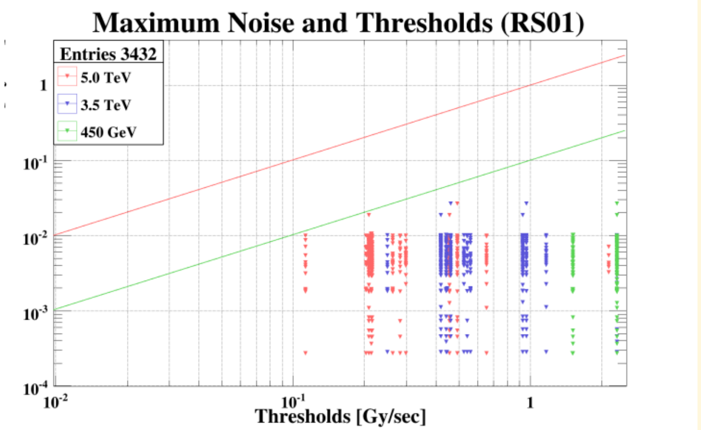
- Online program predicting loss characteristics and likely loss origin, PhD
- Long cable issue in IP3
- Development of an Detector with intermediate measurement range
- New cables for noise channels (7 TeV operation)



Data set: 8.1.2010-15.1.2010





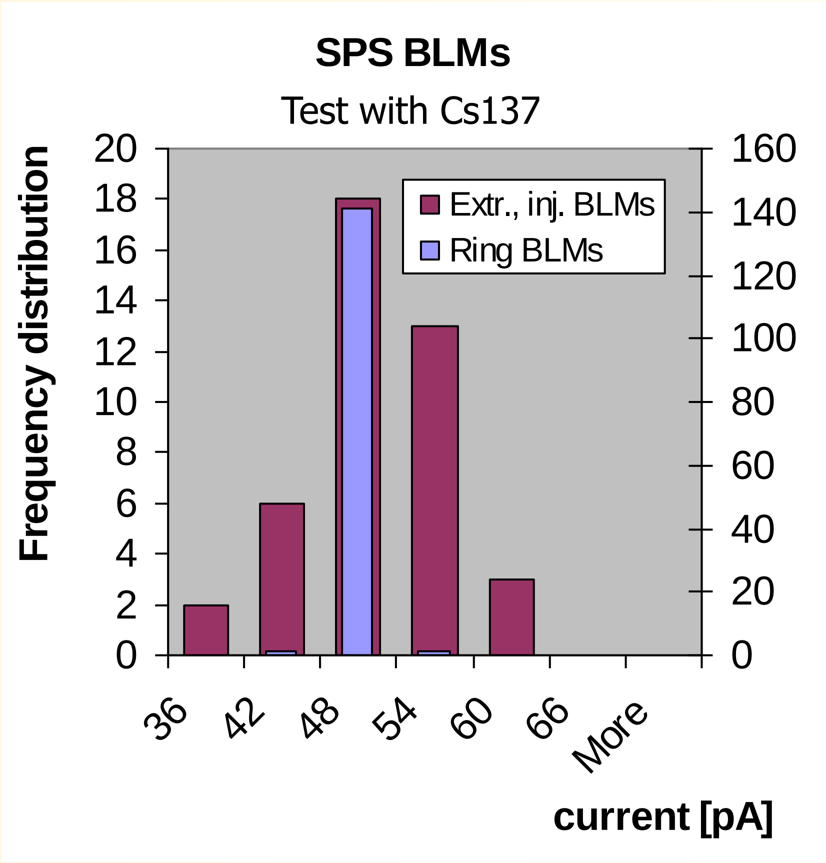


Summary

- No evidence has been found that a single beam loss event has been missed
  - The initial threshold settings have to be sufficiently conservative in order not to damage the LHC magnets. During the initial runs of the LHC, they must then be iteratively adjusted. (Audit report 2008)
- The hardware failures never caused a degradation of the reliability of the system
- False dumps
  - The number of hardware failures are as expected (reliability and safety study, PhD. G. Guaglio)
  - No noise events

Spare Slides

Gain Variation of SPS Chambers



Total received dose:

ring 0.1 to 1 kGy/year

extr 0.1 to 10 MGy/year

- 30 years of operation
- Measurements done with installed electronic
- Relative accuracy
  - $\Delta\sigma/\sigma$ < 0.01 (for ring BLMs)
  - $\Delta\sigma/\sigma$ < 0.05 (for Extr., inj. BLMs)
- Gain variation only observed in high radiation areas
- Consequences for LHC:
  - No gain variation expected in the straight section and ARC of LHC
  - Variation of gain in collimation possible for ionisation chambers

Status of Threshold Settings

Nr	Elements	Thresholds
1	MB	Detailed Geant4 and FLUKA simulations, Quench tests on LHC
2	MQ	Detailed Geant4 simulations.
3	MQXA, MQXB (triplets)	Detailed FLUKA simulations (at 7 TeV only)
4	B1.3B_MQXA B2.3B_MQXA	Max. thresholds New simulations are done – to be revised
5	MQY	Quench Levels rescaled from MQ simulations, new Geant4 simulations and loss maps may be needed, monitors in position 3 have max. thresholds. Data analysis standalone magnet needed.
6	MQM, MQML, MQM at 4.5 K	Quench Levels rescaled from MQ simulations, analysis loss maps needed (as for MQY), Monitors in position 3 have max. thresholds
7	MQTLH	Quench Levels rescaled from MQ simulations (a setting error spotted, to be corrected asap)
8	MBRB, MBRC	Basic simulations for loss pattern generated by Wire Scanner, but thresholds are rescaled from MB
9	MBX	Quench Levels rescaled from MB + ECR's for over-injection issues More detailed analysis for over-injection needed
10	Collimators	EDMS 995569 + ECRs, systematic study of signal per lost proton needed

Good knowledge — To be checked with data — More simulation — Will be changed next — Disconnected from BIS

11	TDI	Thresholds based on input from Brennan + analysis results Detailed simulations have been started (but no results yet)
12	TCD	Max. thresholds Need info from experts (who?)
13	MSI/D	Damage conditions agreed with Jan + Geant4 simulations (being revised now)
14	MKI/D	Max. thresholds Need info from experts
15	Dump line	Disabled ,i.e. disconnected from BIS Analysis needed in order to determine thresholds
16	MQW	The same thresholds as for MSI/D
17	MBW	Max. thresholds (can they be re-scaled (BLM signal due to geometry) from MSI?)
18	TAN	Max. thresholds Need info from experts
19	Roman pots (XRP)	Like TCT,TCLA thresholds + FLUKA simulations for BLM signal
20	On missing magnet in DS (LYRA)	FLUKA simulations
21	DFB	The same thresholds as for MB

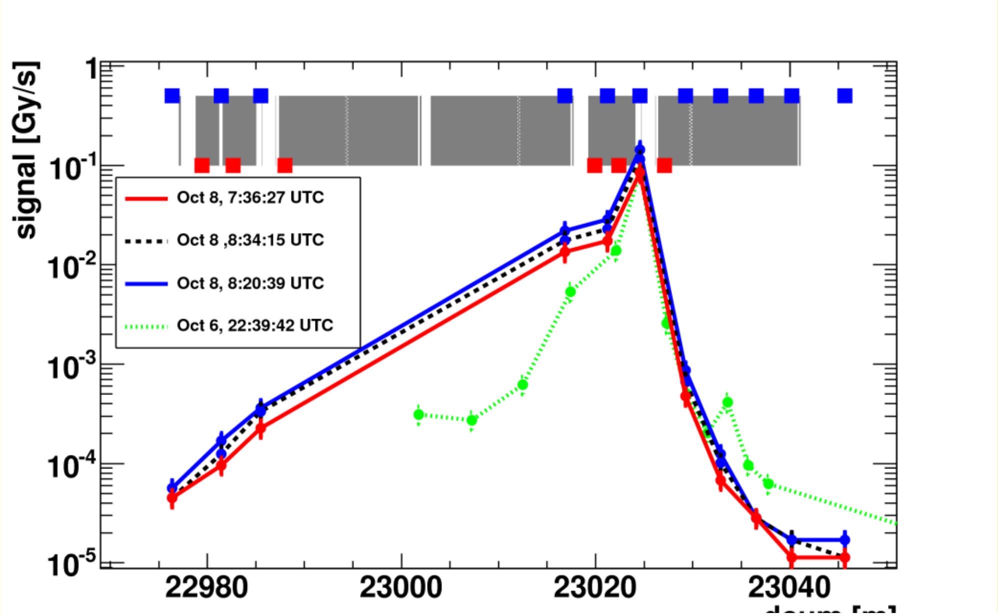
Good knowledge To be checked with data More simulation Will be changed next Disconnected from BIS

22	TCSM + TCHS + TCAPA	Disabled ,i.e. disconnected from BIS, since element not installed
23	All SEM	Disabled ,i.e. disconnected from BIS Analysis needed
24	BSRTM +BGI	Thresholds as for MSI/D
25	MBWMD	Max. thresholds Need info from experts

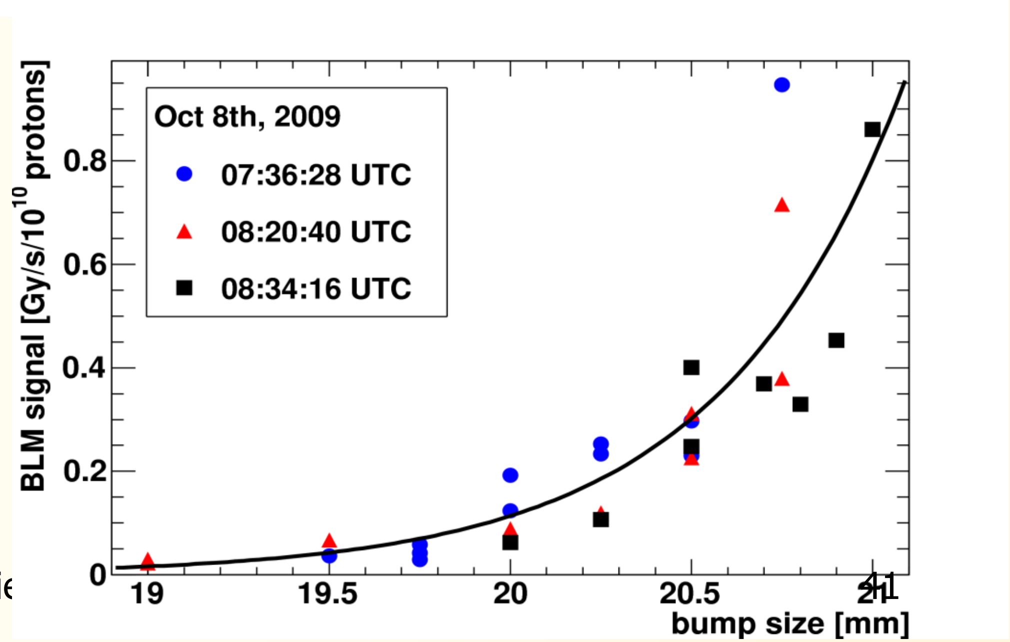
Good knowledge   To be checked with data   More simulation

Will be changed next   Disconnected from BIS

Thresholds Test with 3 corrector orbit bump measurements



- 3 corrector bump already used during threshold tests
- Top: BLM signal at trigger level vs dcum
- Bottom: BLM signal vs bump size
- Beam position reproducibility is estimated to 150 μm peak to peak, max BLM signal variation 50 %



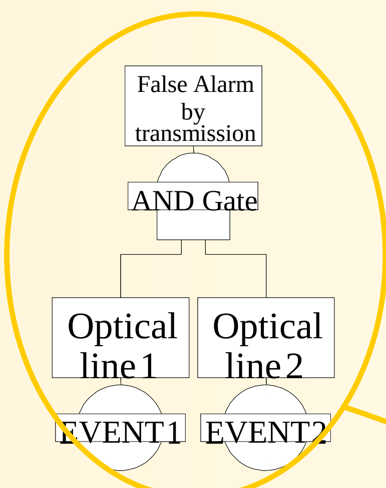
Fault Tree Analysis

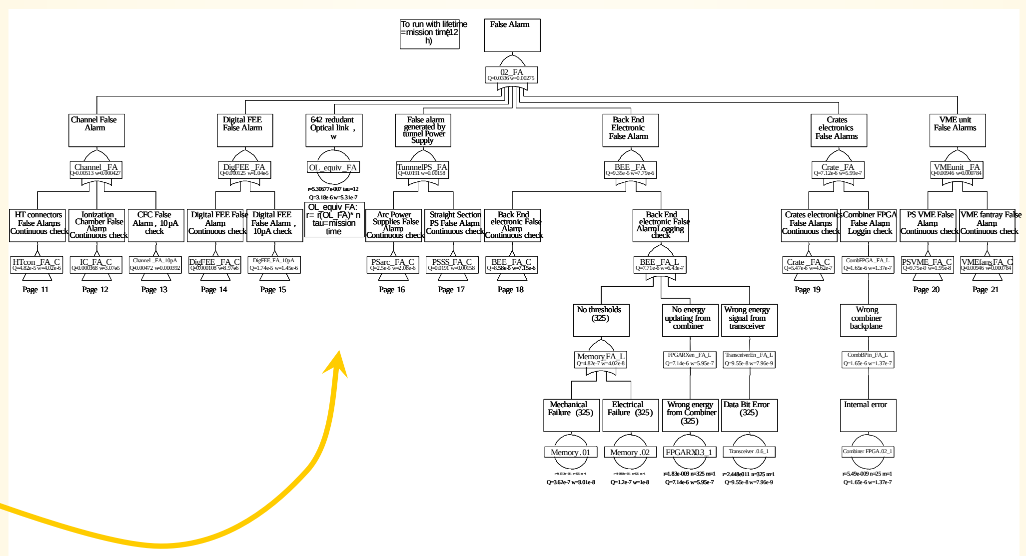
- Almost 160 Failure Modes have been defined for the BLMS using the FMD-97 standard.

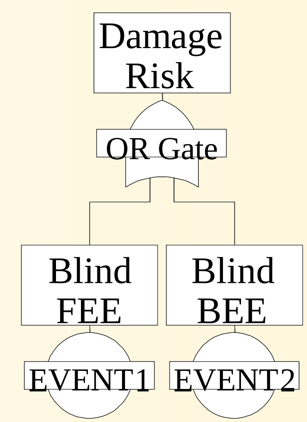
Three Ends Effects:

1. Damage Risk: probability not to be ready in case of dangerous loss.
2. False Alarm: probability to generate a false alarm.
3. Warning: probability to generate a maintenance request following a failure of a redundant component.

- **The probability to have an Failure Mode A, Pr{A}, is calculated per each Failure Modes of the FMECA, given the hazard rate, the repair rate and the inspection period .**







Fault Trees Results

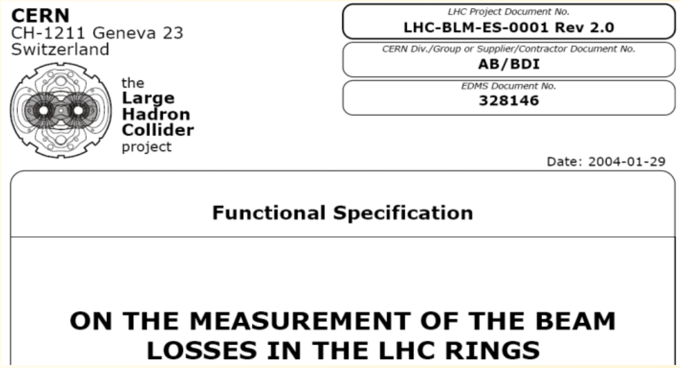
- The <u>probabilities to fail (unavailability)</u> for the BLMS have been calculated.
- Per each End Effects, the <u>major contributors</u> to such probabilities have been pointed out too.

	Consequences per year	Weakest components		Notes
Damage Risk	$5 \cdot 10^{-4}$ (100 dangerous losses)	Detector Analogue electronics	(88%) (11%)	Detector likely overestimated (60% CL of no failure after $1.5\ 10^{6}$ h).
False Alarm	13 ± 4	Tunnel power supplies VME fans	(57%) (28%)	Tunnel power supplies likely underestimated (see sensitivity example).
Warning	35 ± 6	Optical line VME PS	(98%) (1%)	LASER hazard rate likely overestimated by MIL.

Content

- Specification
- Concept
- Hardware failures
- System tests
  - Firmware
  - With beam (delays)
  - Online (Sanity Check)
- Post mortem data
- Logging data

Beam Loss Monitor Specification


CERN
CH-1211 Geneva 23
Switzerland

the Large Hadron Collider project

LHC Project Document No.
LHC-BLM-ES-0001 Rev 2.0

CERN Div./Group or Supplier/Contractor Document No.
AB/BDI

EDMS Document No.
328146

Date: 2004-01-29

Functional Specification

ON THE MEASUREMENT OF THE BEAM LOSSES IN THE LHC RINGS

5. USE OF THE BLM'S FOR MACHINE PROTECTION

The strategy for machine protection impacts on the BLM design in two ways, its time response and the reliability.

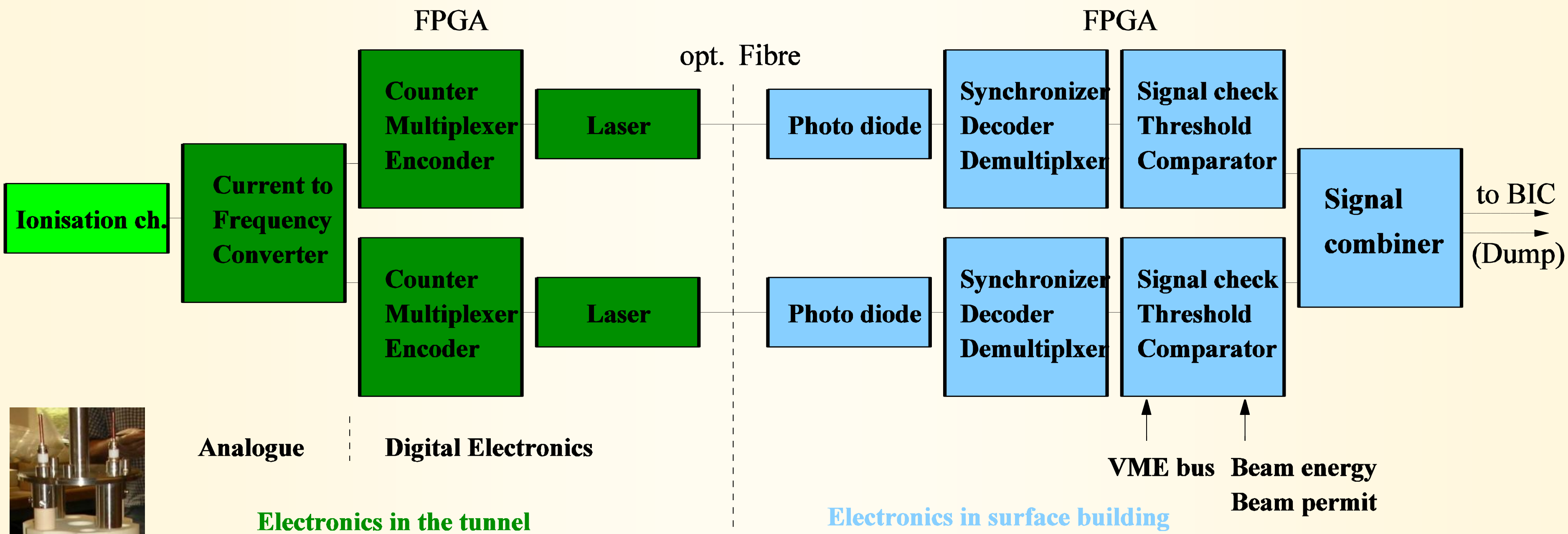
Protection of the machine from beam losses has two aspects:

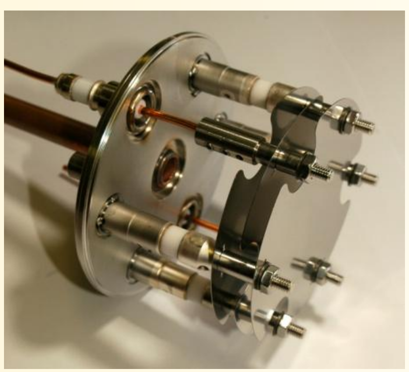
- protection against beam losses that could lead to damage of equipment,
- protection against beam losses that could lead to a quench of a magnet.

Since a repair of superconducting magnets would take several weeks, the protection against damage has highest priority and damages should be strictly avoided (**SIL 3, 1E-8 to 1E-7 1/h**).

In case of a quench, the quench protection system would prevent equipment damage. However, the beam would be lost and re-establishing operation would take several hours. Therefore the number of quenches should be minimized.

Beam Loss Measurement System Layouts

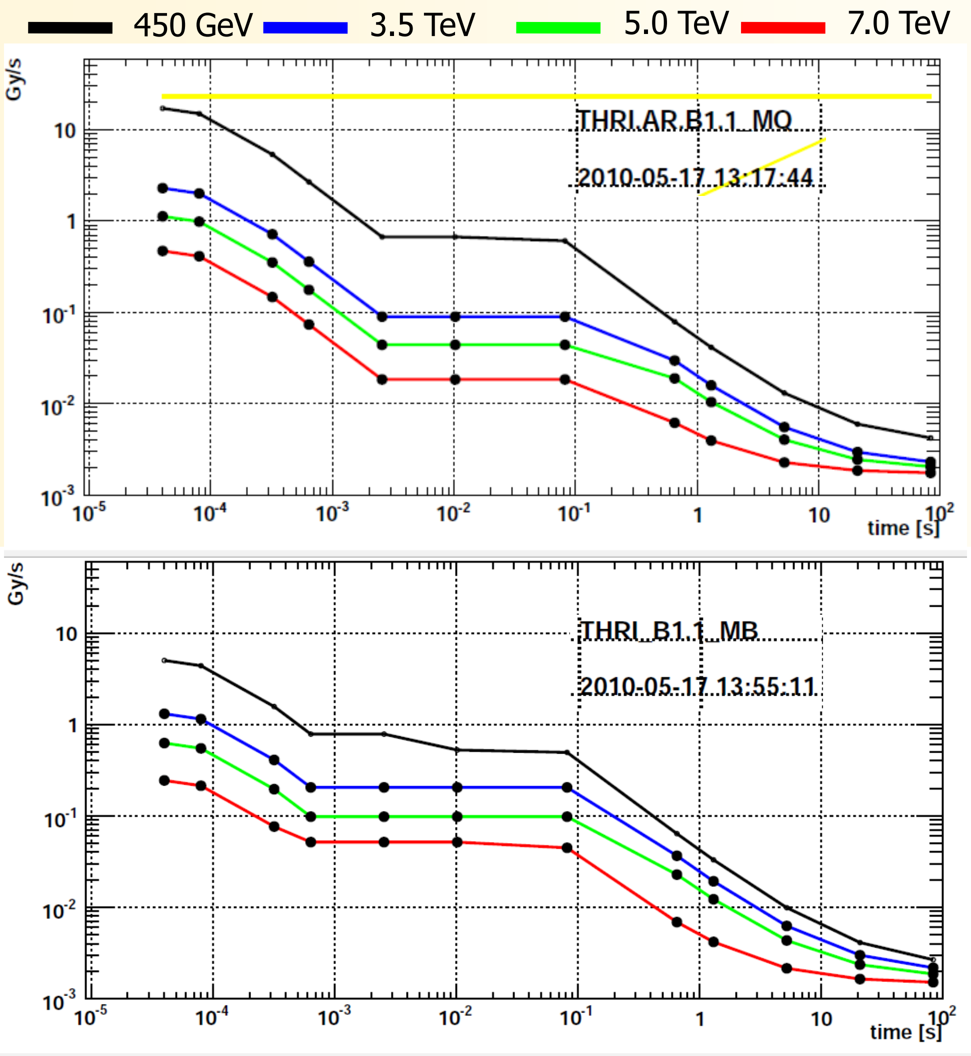




- Ionisation chamber
  - Function: observation and interlock
  - 3700 installed
  - Over 90 % connected to interlock/dump system
- Secondary emission detector
  - Function: observation
  - 300 installed

Quench and Damage Levels

Quadrupole and bending magnet thresholds

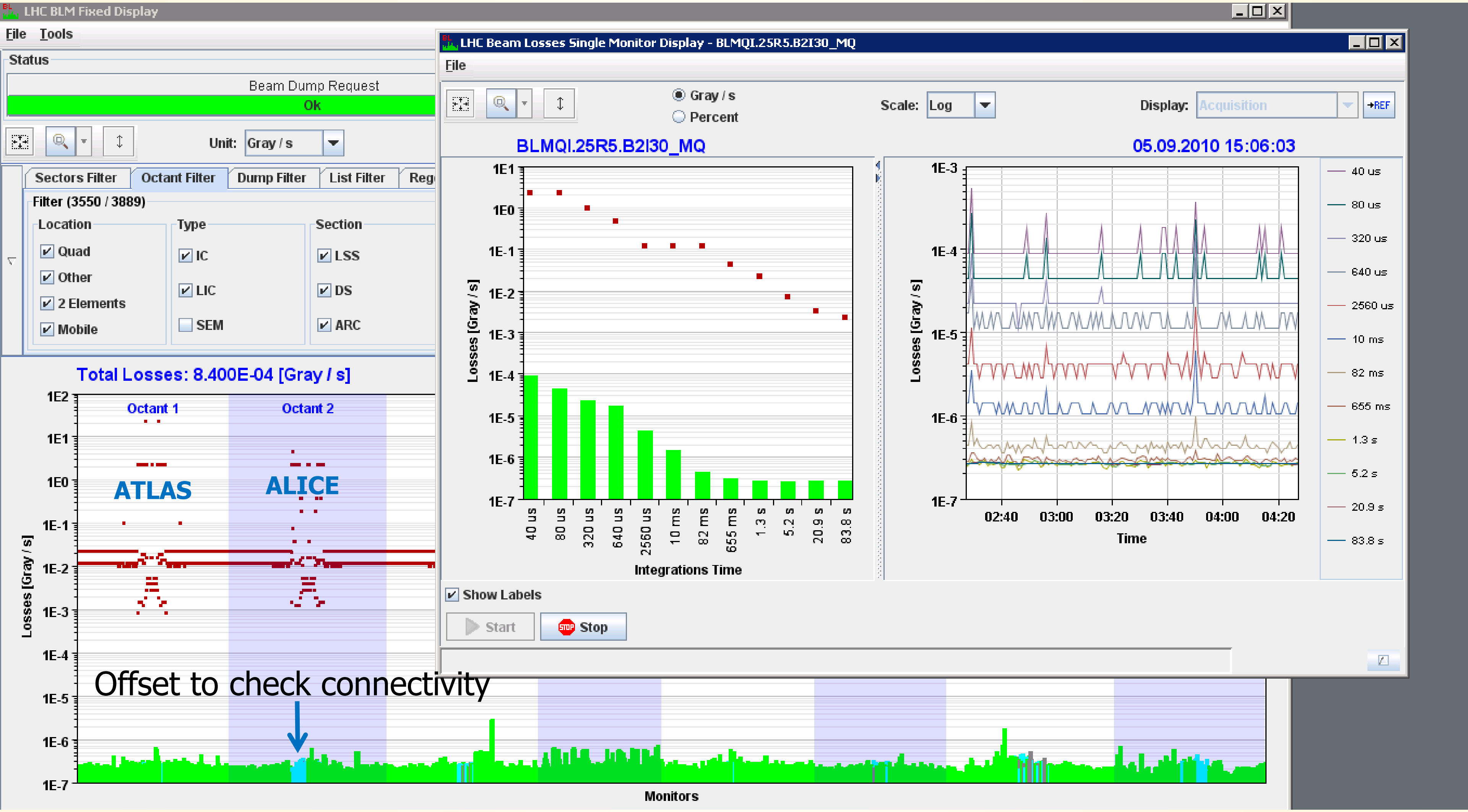


Specifications

- Time resolution ½ turn, 40 us
- Average calculation loss:
  - 12 values, 40 us to 83 s
- Max amplitude 23 Gy/s
- Min amplitude
  - 1E-4 Gy/s @ 40 us
  - 3E-7 Gy/s @ 1.3 s
- Dynamic
  - 2E5 @ 40 us
  - ~ 1E8 @ 1.3 s
- Damage level
  - 2000 Gy/s @ 1 ms
- All channels could be connected to the interlock system
- Thresholds
  - Loss duration dependent, 12 values
  - Energy dependent, 32 values
  - About 1.5 E6 thresholds

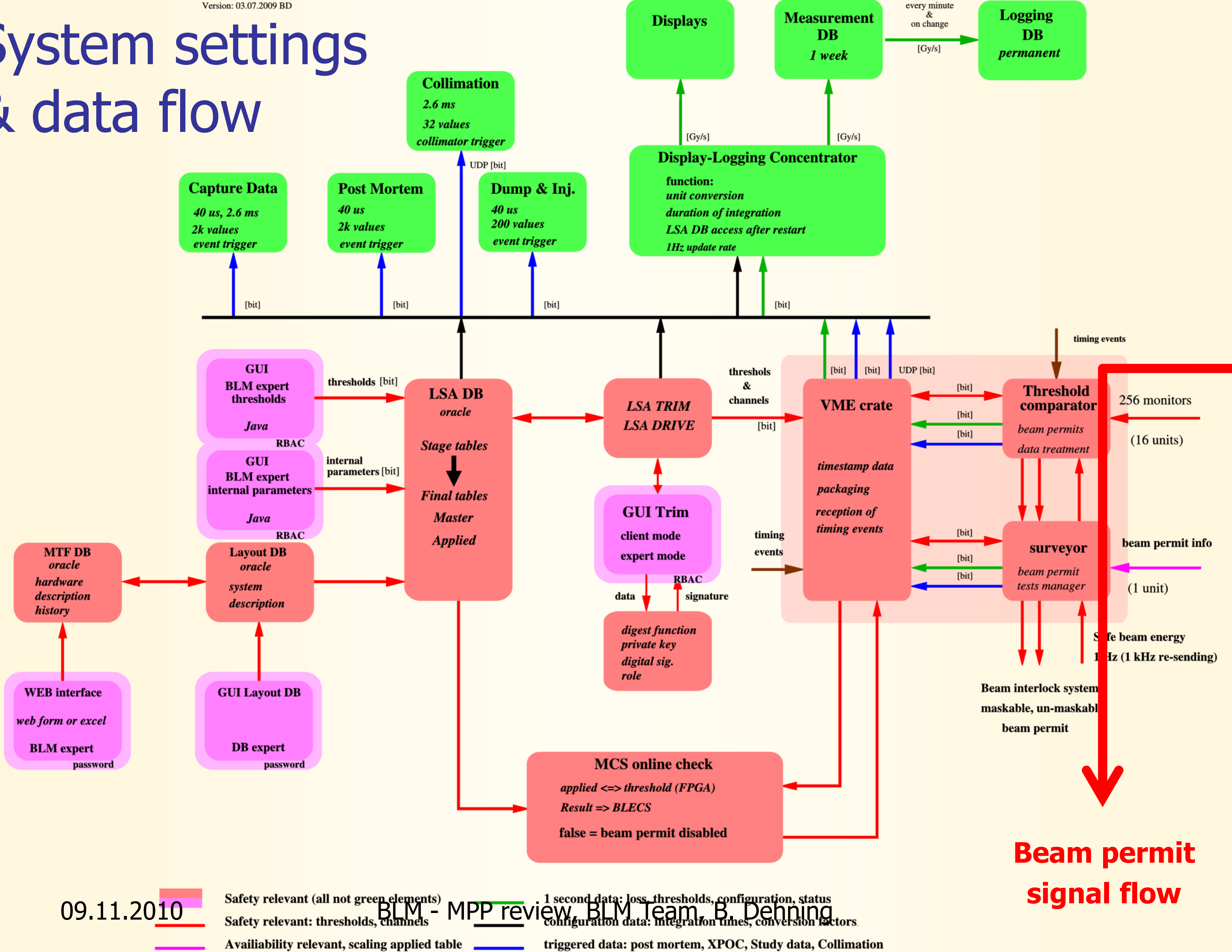
BLM Online Display

LHC @ 450 GeV



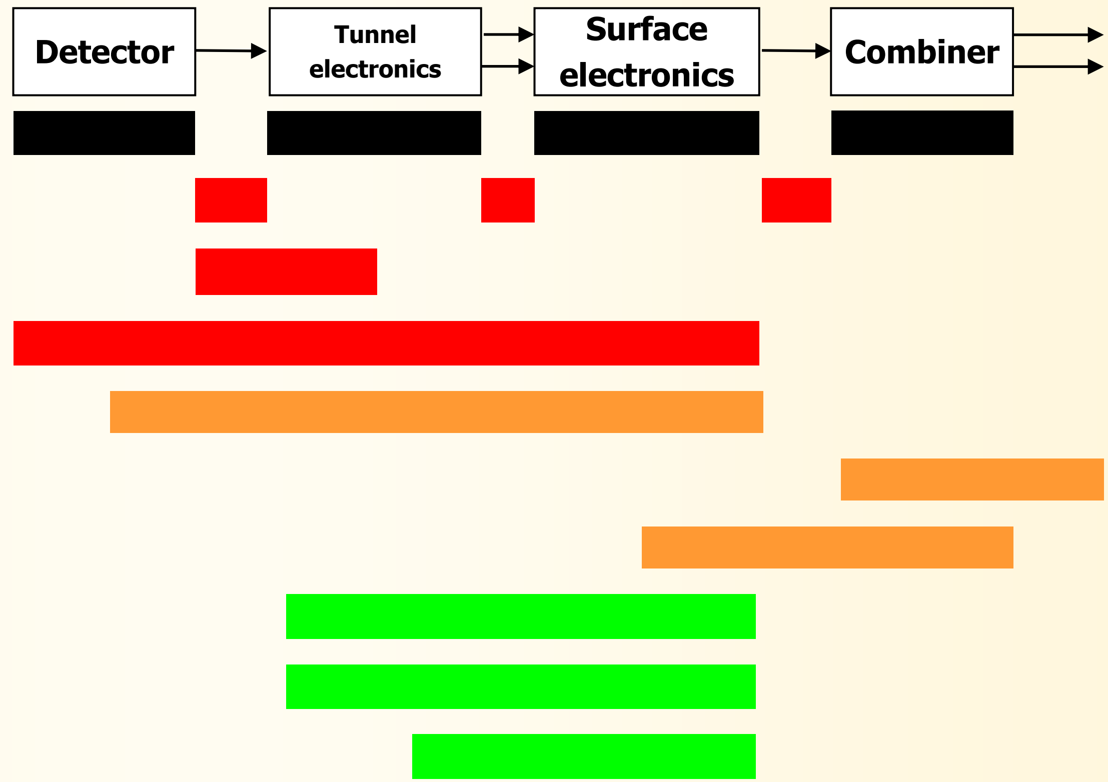
Offset to check connectivity

System settings & data flow



Functional Tests Overview

PhD thesis G. Guaglio



- Functional tests before installation
- Barcode check
- Current source test
- Radioactive source test
- HV modulation test
- Beam inhibit lines tests
- Threshold table data base comparison
- Offset to check connectivity (10 pA test)
- Double optical line comparison
- System component identity check

Inspection frequency:

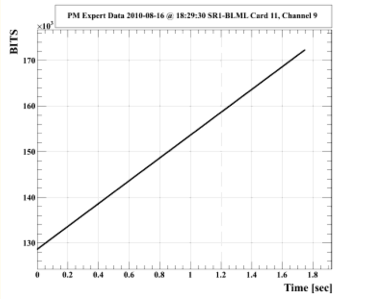
■ Reception ■ Installation and yearly maintenance ■ Before (each) fill ■ Parallel with beam

System Verification Tests
Surface Electronics Firmware Tests

Automatic on Vertical Slice Test system (before releasing new firmware)

Using front-end electronics emulator

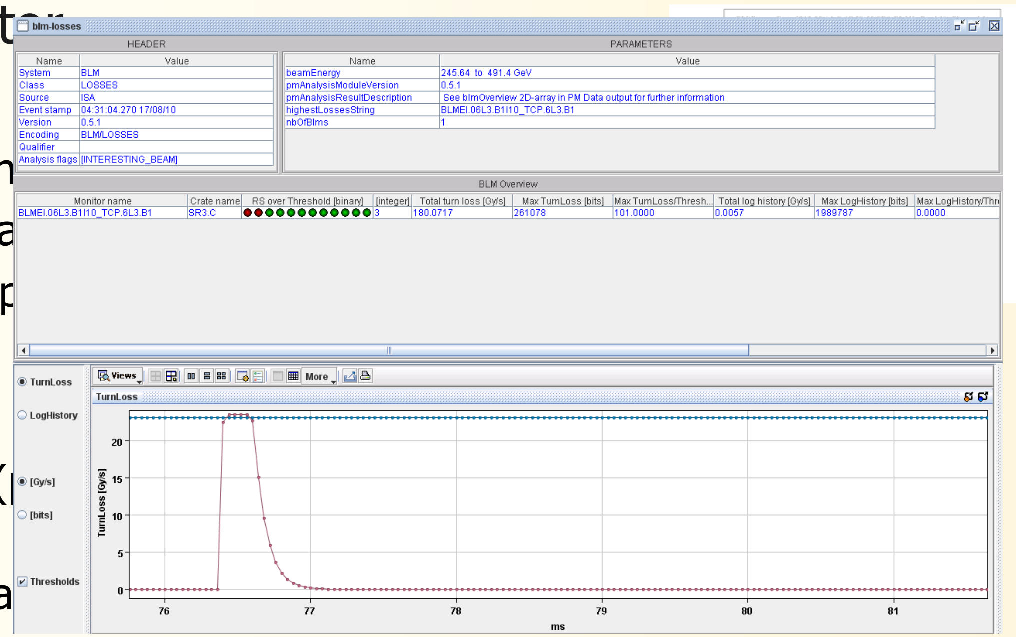
- Lab tests
  - Exhaustive Threshold triggering tests [also in LHC done]
  - Optical Link Reception and Status tests
  - Linearity, impulse, and some predefined patterns of input signals check



- Beam tests
  - injected low intensity beams (pilot), debunched them and dumped with the operator switch.
  - closed one of the collimator jaw of a TCP at point 3 and injected 3 times pilot beam 1.

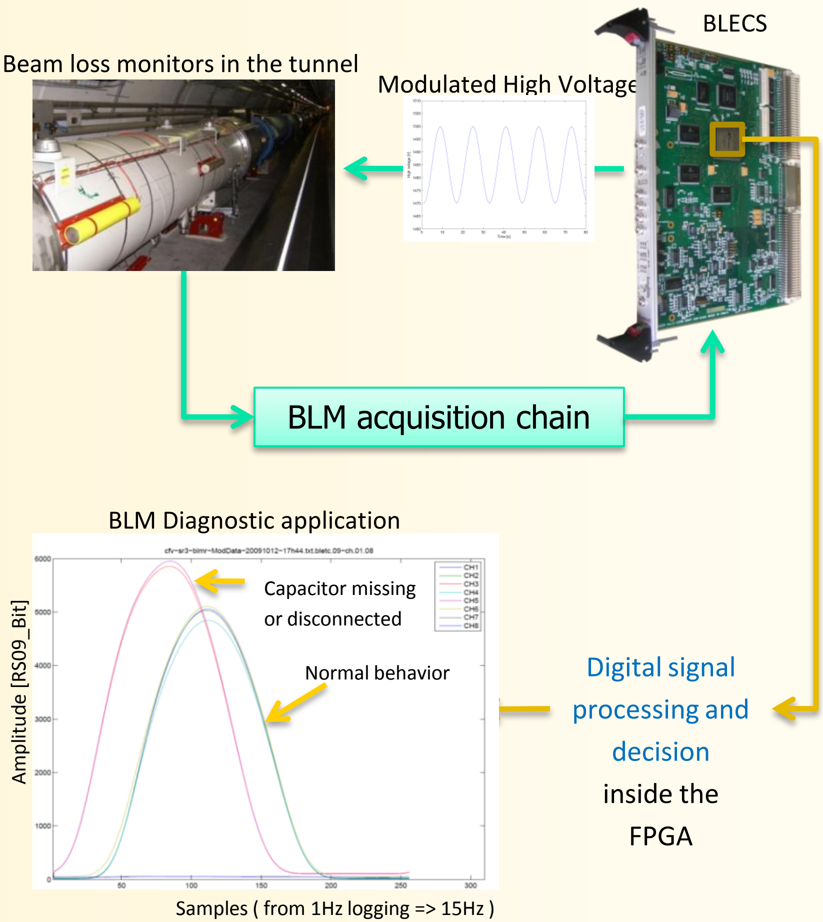
System Verification Tests
Surface Electronics Firmware Tests

- Automatic on Vertical Slice Test system (before releasing new firmware)
- Using front-end electronics emulator



times pilot beam 1.

System Tests == Sanity Checks



- Decision of pass or fail in surface electronics FPGA (combiner)
- Every 24 h required, (beam permit inhibit if time limit exceeded
- Tests
  - Comparison between data base and backend electronics (MCS)
  - Internal beam permit line test (VME crate)
  - Connectivity check (modulation of chamber HV voltage supply amplitude an phase limit checks
  - Duration of test: about 7 minutes