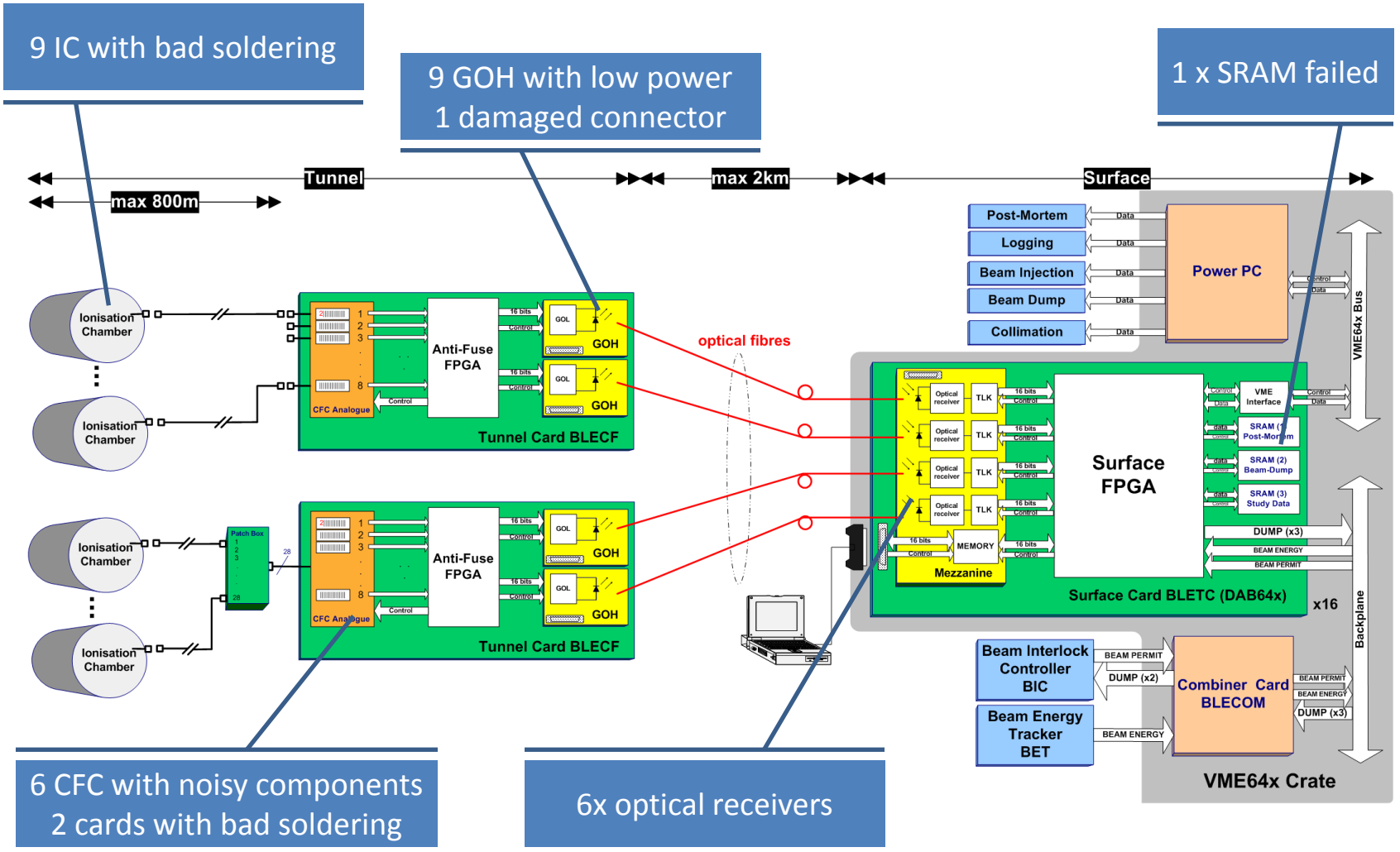
BLM – MPP review

- 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

Overview of failures (since Feb. 2010)



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)

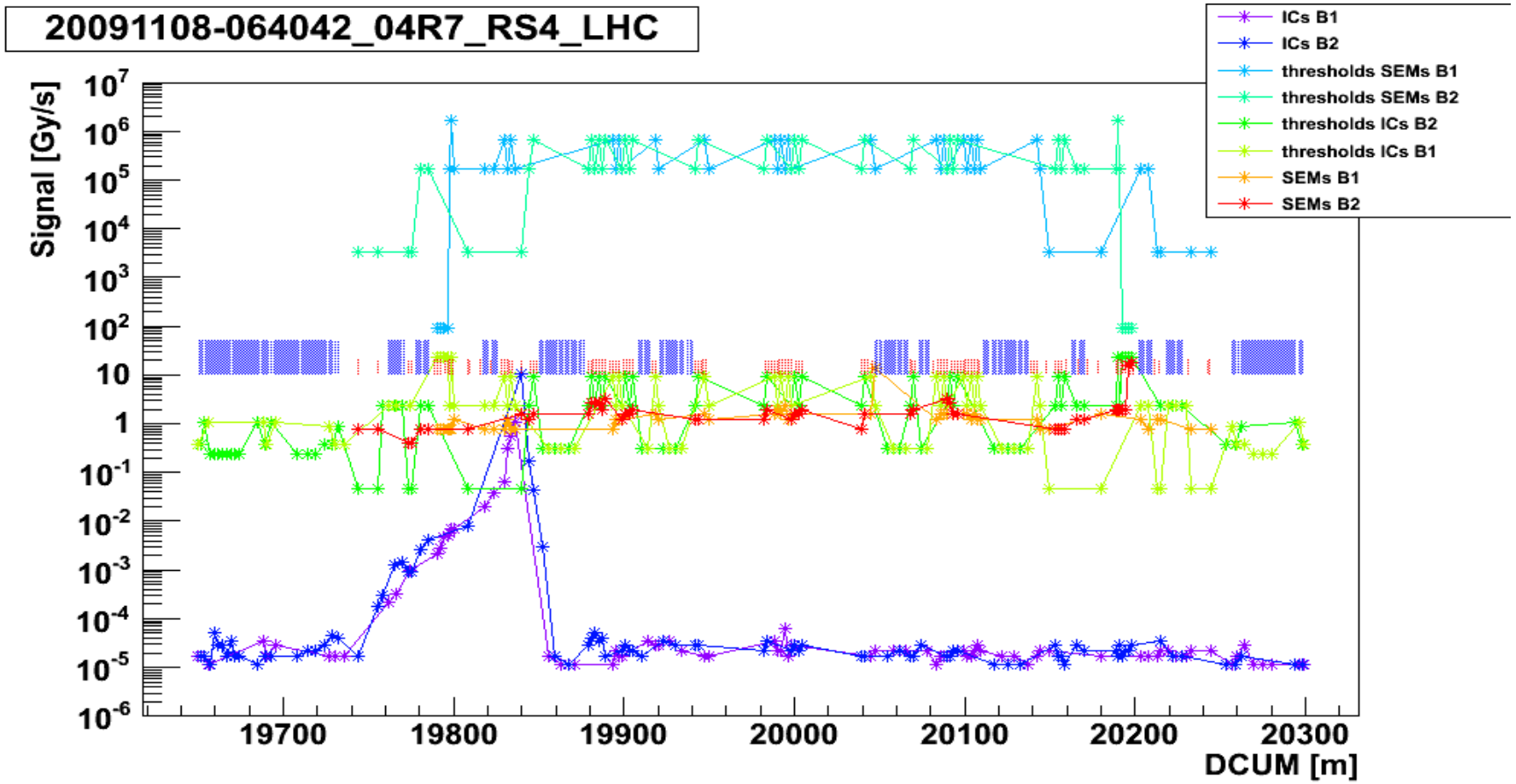
Future Actions (increase availability):

- 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

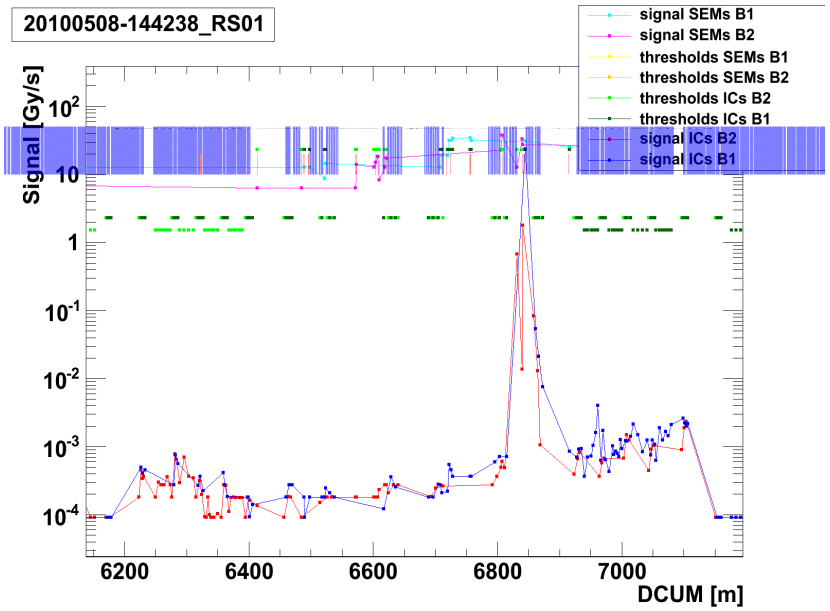
Comparison of BLM Monitor Behaviour between IR 3 and IR 7 (I)

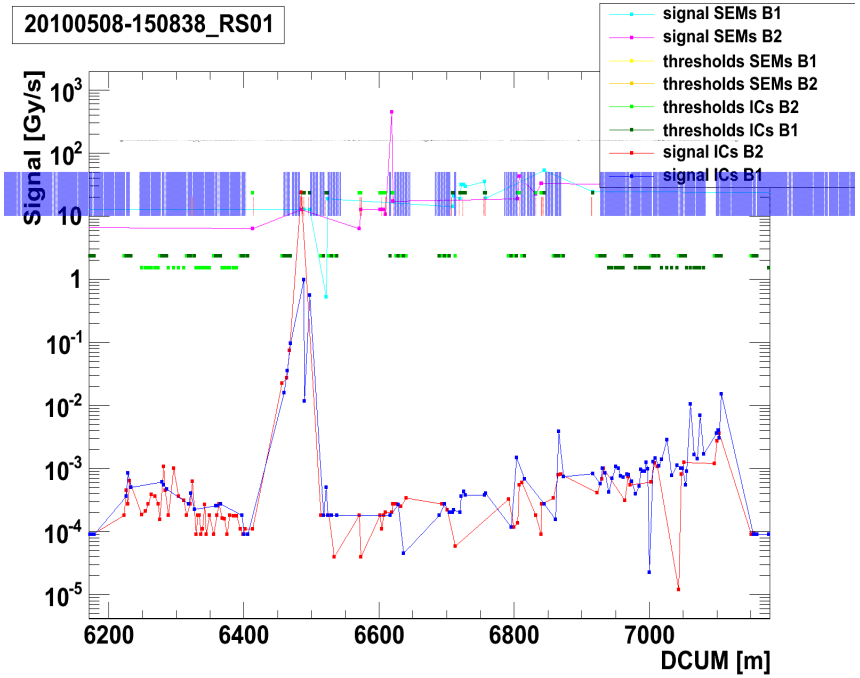
Shooting on TCLA in IR 7



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

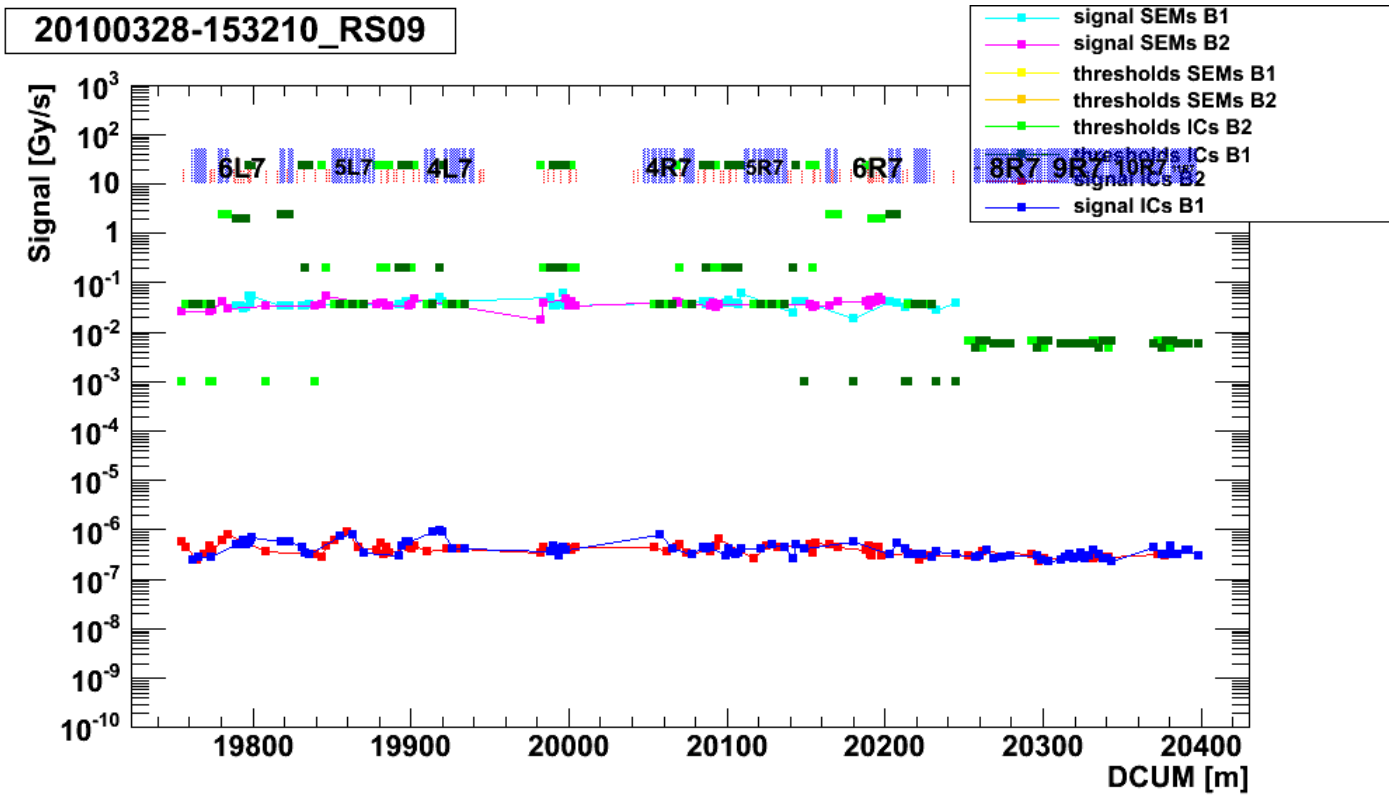
- Beam tests and analysis pending

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

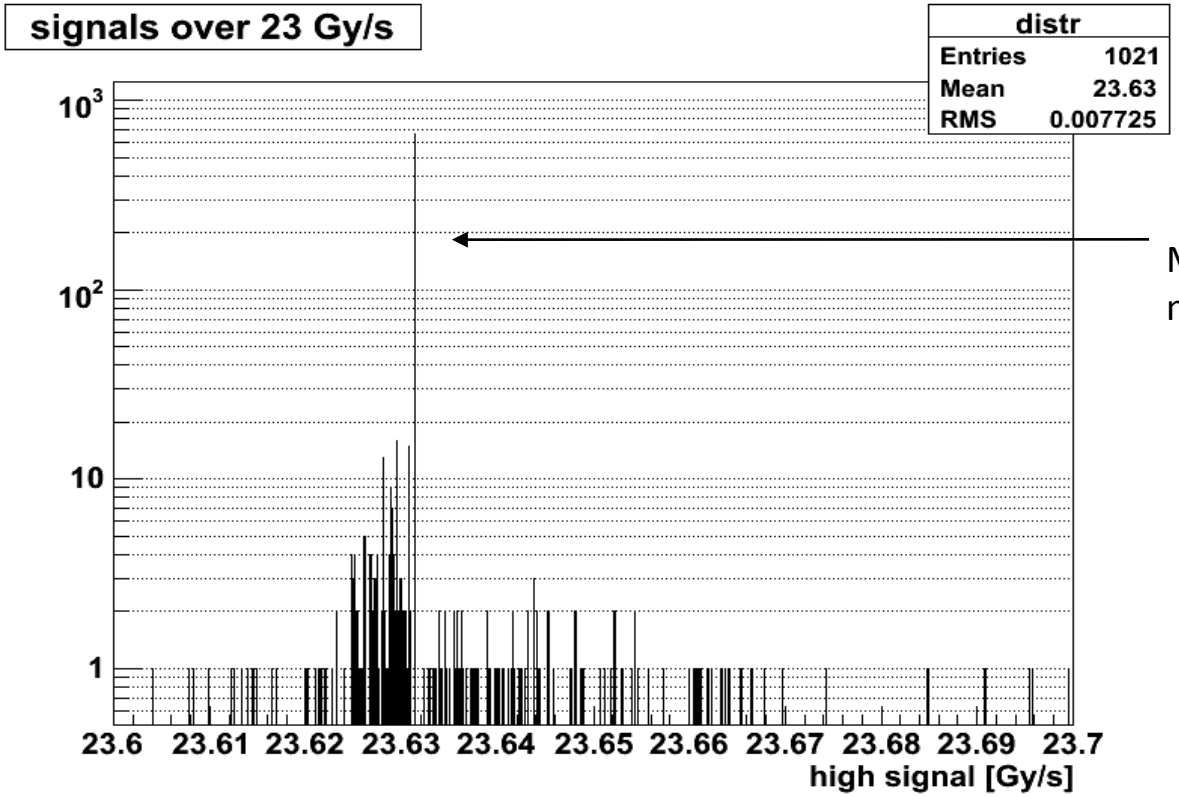
Maximum Values in the BLMs during Operation in 40 µs

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

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

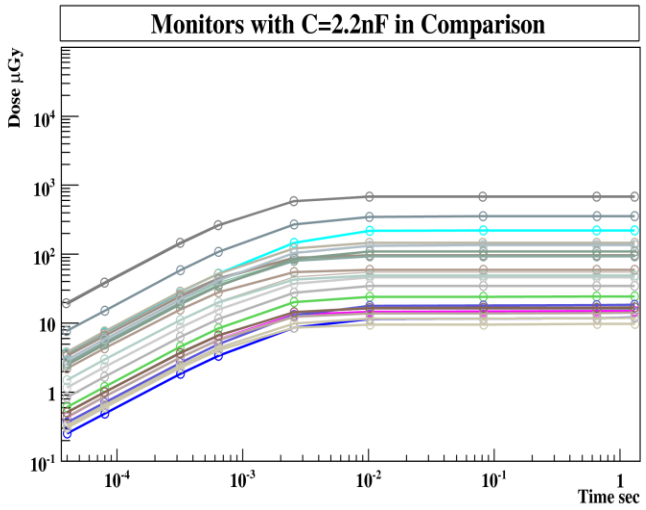
Absolut maximum (including ADC): 255 counts * 1024 + 1023 = 262143 BITS = 23.724 Gy/sec

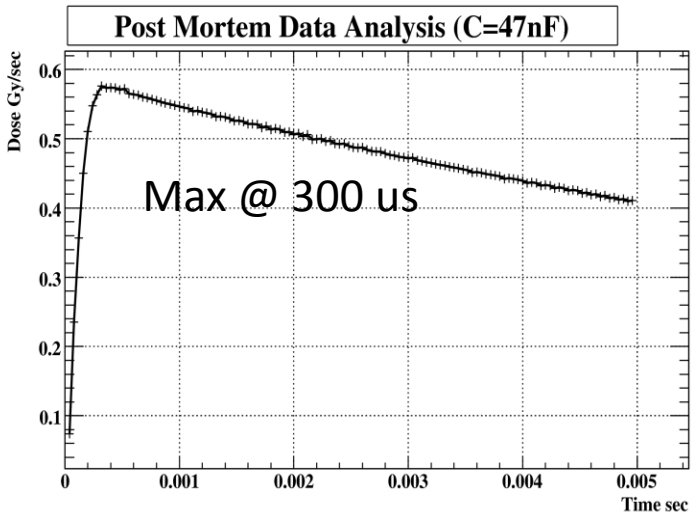
Restriction on LSA level (max. thresholds): 250 counts * 1024 = 256000 BITS = 23.168 Gy/sec

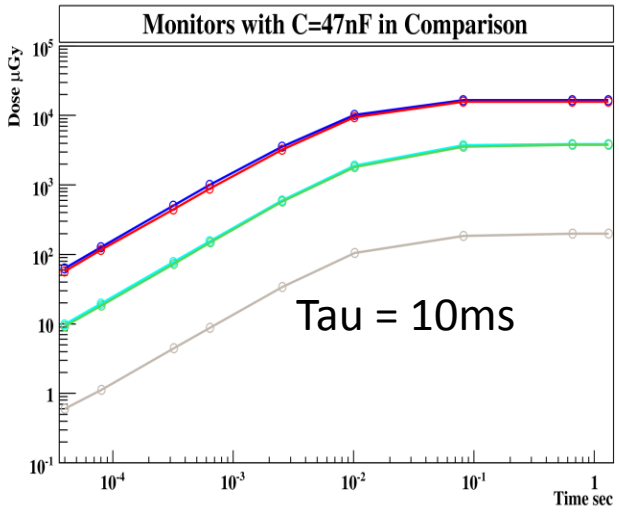


Mostly 23.631 Gy/sec are measured

Filter Monitors







Checking performance and behavior:

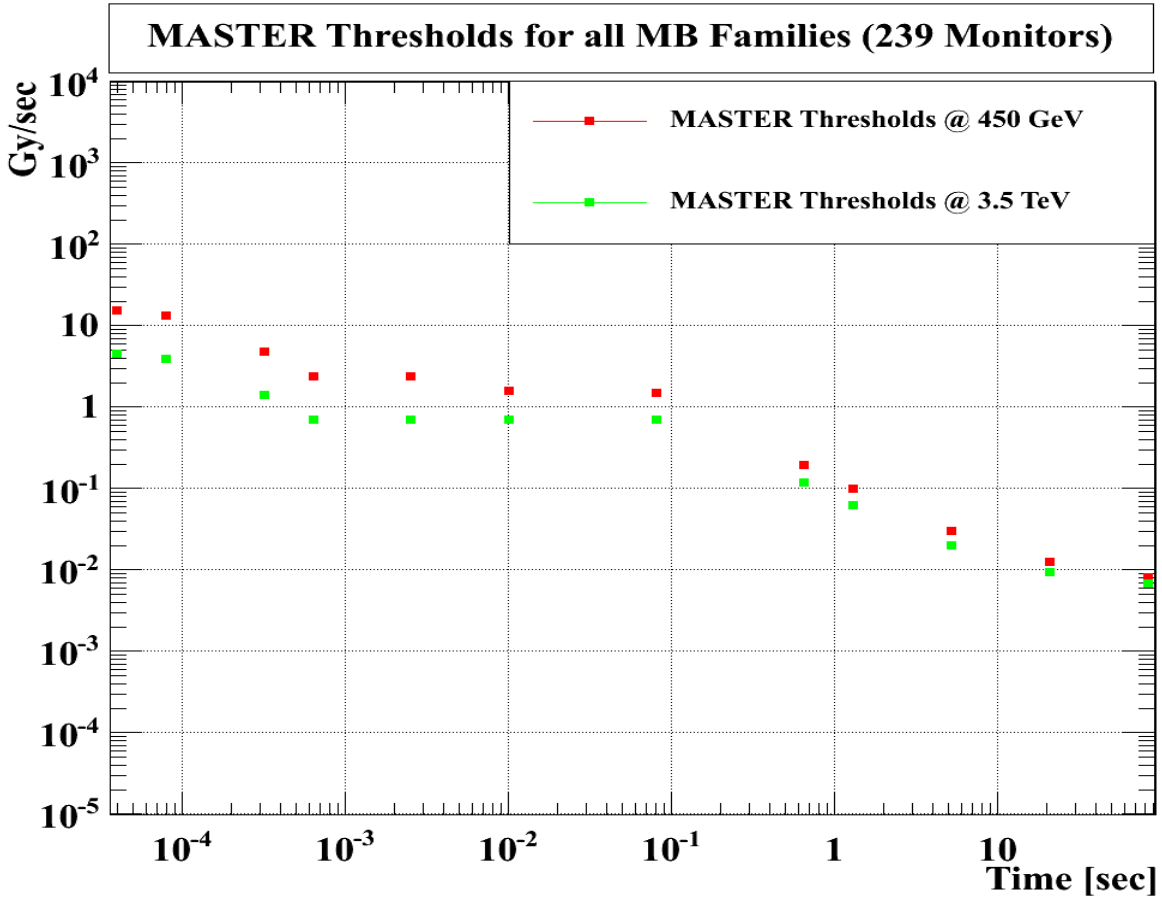
1) Check with beam that filters are installed at the defined channels (done)
2) Determination of rise time (time needed to collect 100% of the charges (use PM data) (missing for IP6)
3) Determination of ratio filter/non-filter amplitude, i.e. height of signal (partially done)

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



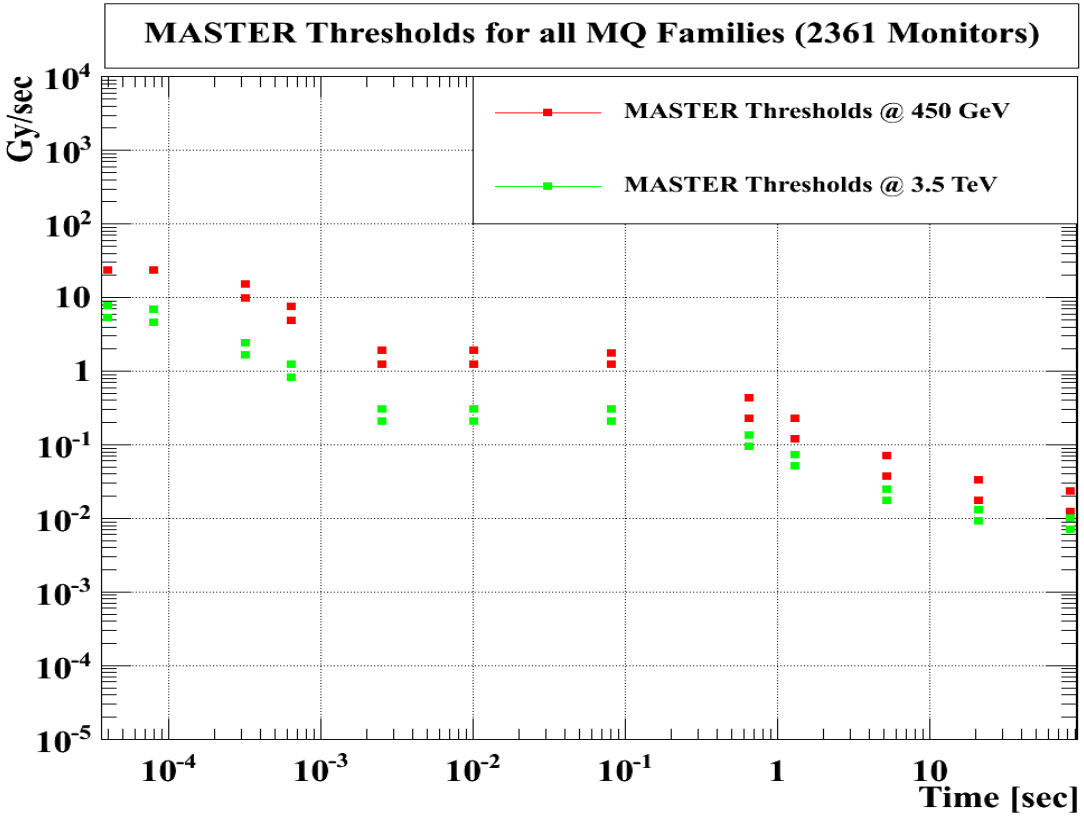
Thresholds for MQ Monitors

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 = 0.1



Thresholds for MQM Monitors

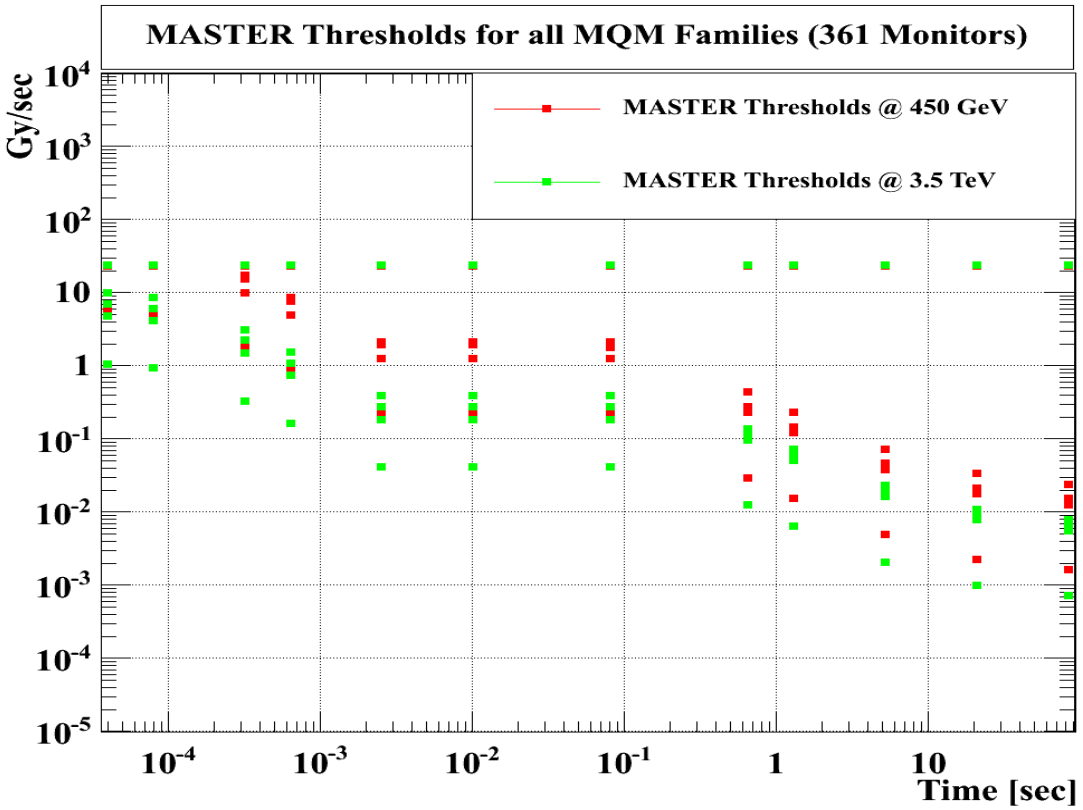
361 MQM monitors (12 families according to position 1,2,3 in LSS, DS)

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 (~50% smaller)

Monitor factor = 0.1



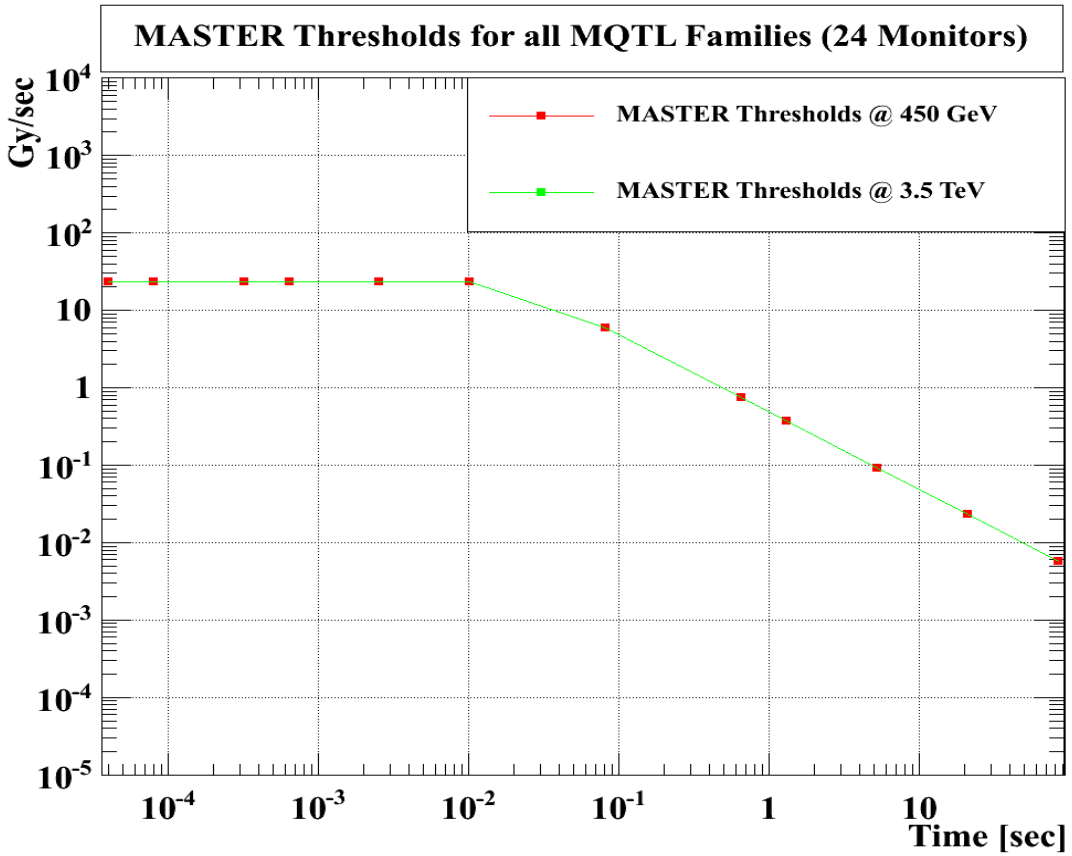
Thresholds for MQTL Monitors

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



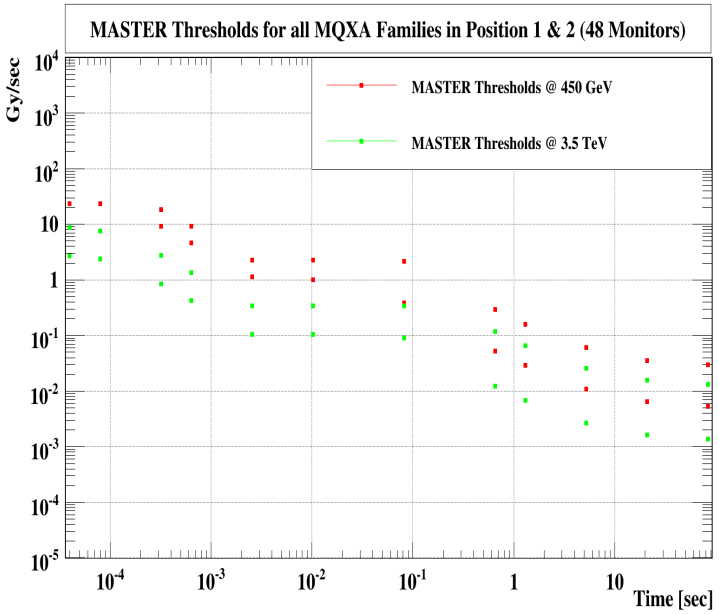
Thresholds for MQXA Monitors

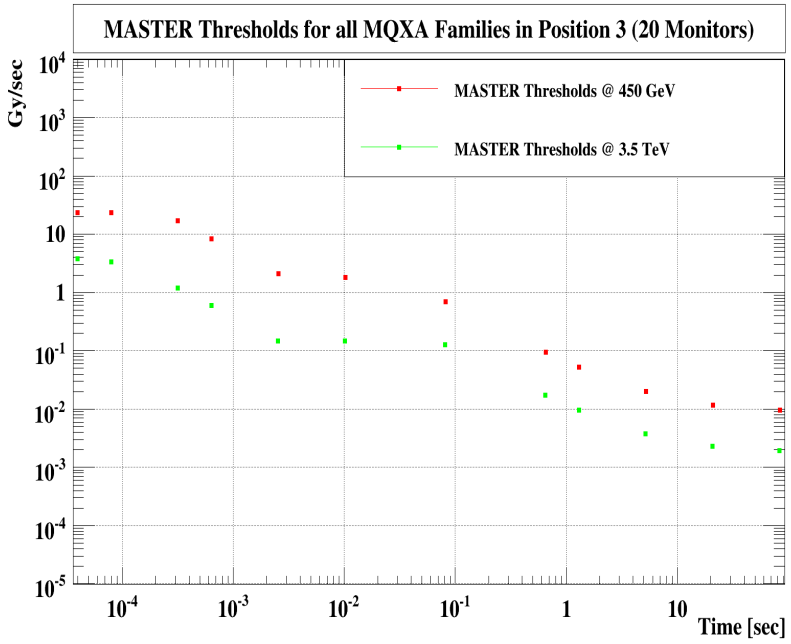
80 MQXA monitors (8 families according to position 1,2,3 and special positions)

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

Thresholds in special positions are at maximum

Monitor factor = 0.1



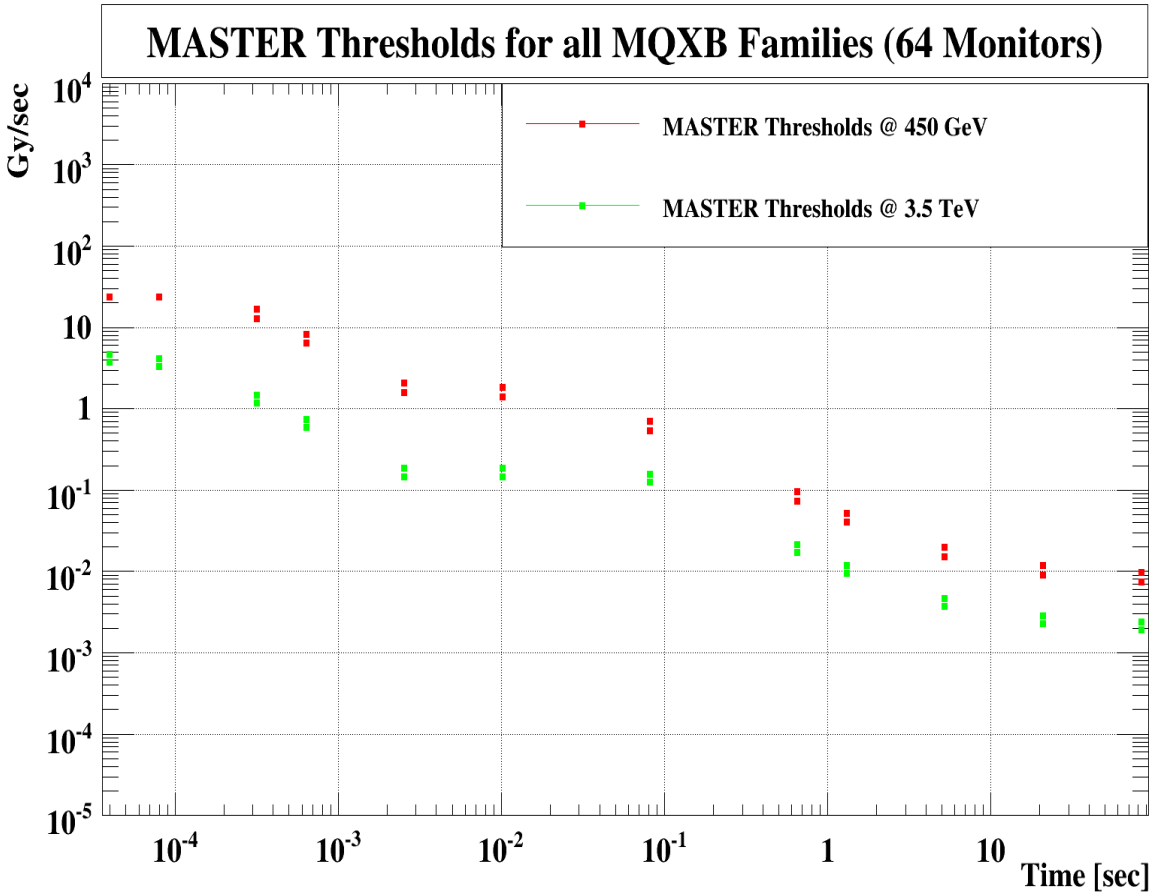


Thresholds for MQXB Monitors

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

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

Monitor factor = 0.1

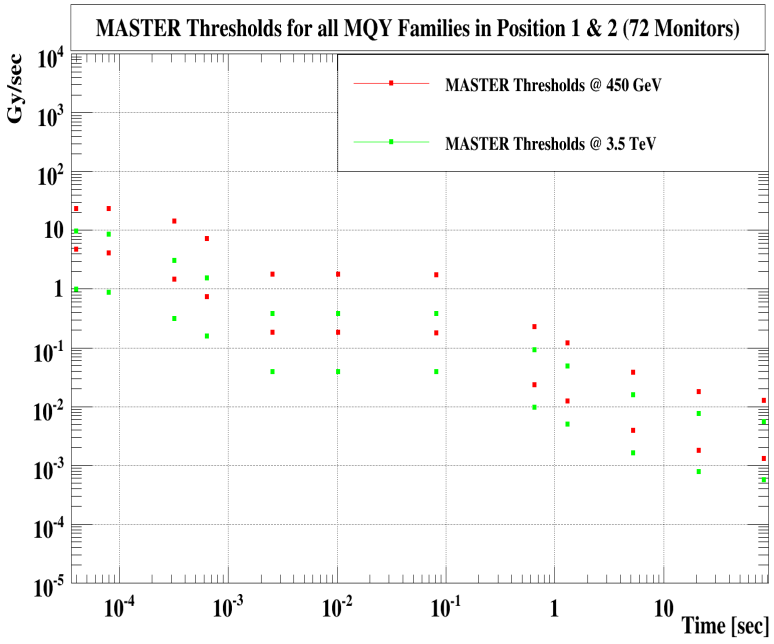


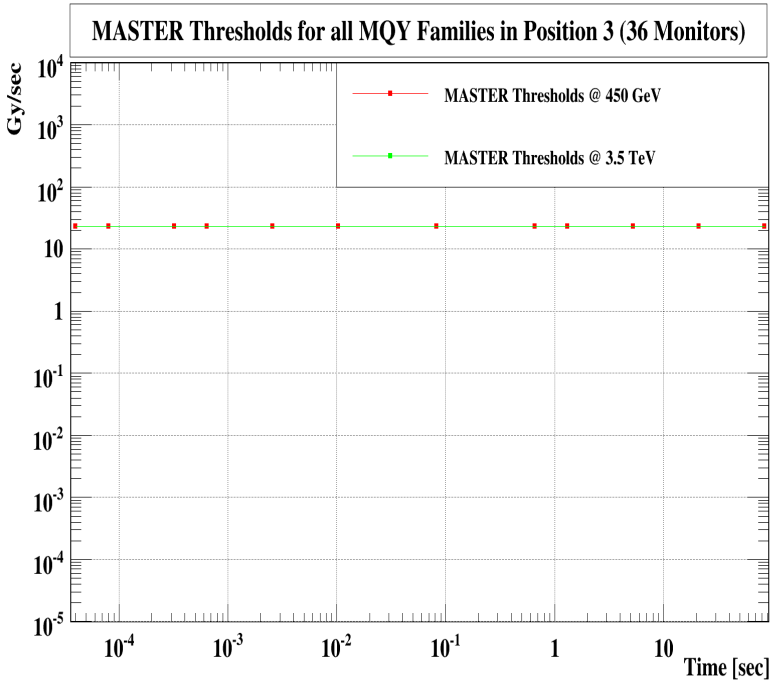
Thresholds for MQY Monitors

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





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

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
- Need more automatic procedures to keep human failures as small as possible

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)

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/

External Audit

Review will seek to:

- assess the **adequacy of the overall** BLM system design with a focus on the programmable parts
- **identify possible weaknesses** in the programmable parts of the mission-critical BLM
- **suggest activities that could increase the level of confidence** that the programmable parts of BLM system performs as intended
- **suggest potential improvements** of the BLM
- provide a **general comparison of the BLM with approaches in industrial systems**.

Date	Responsible	Deliverable
16th August 2010	CERN	Delivery of project documentation
6th September 2010	CSL/CERN	Finalization of site-visit agenda
13th to 16th September 2010	CSL/CERN	On-Site visit - 4 full days
18th October 2010	CSL	Delivery of written report