Beam Loss Monitoring

Bernd Dehning

CERN BE-BI

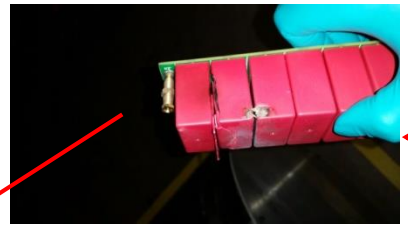
for the BLM team

Content

- BLM incident at IP6
- BLM nonconformities
- Signal filter
- Threshold update schedule
- Threshold checks

BLM internal beam abort request 03.05.2015 13:24:50

- Incident with the damage of 18 BLM signal channels and componets
- Date 03.05.2015
  - Three periods of 20 to 30 minutes observed with high voltage disturbance
  - First period:
    - beam dumped by monitor BLMQI.21R6.B1E10.MQ, 13.24.50
    - higher signal already observed in the whole octant, 13.24.31
    - change in HV current observed at 13.23.52



1M HV resistor burned
As consequence of the
broken the capacitors
1 capacitors broken

17 channels
6 channels
12 BLECF to repair
1 HV Filter box replaced
8 Filter capacitors exchanged

2 input filter capacitors broken TD62.1 (5,6)
8 input filter capacitors broken

1 channel

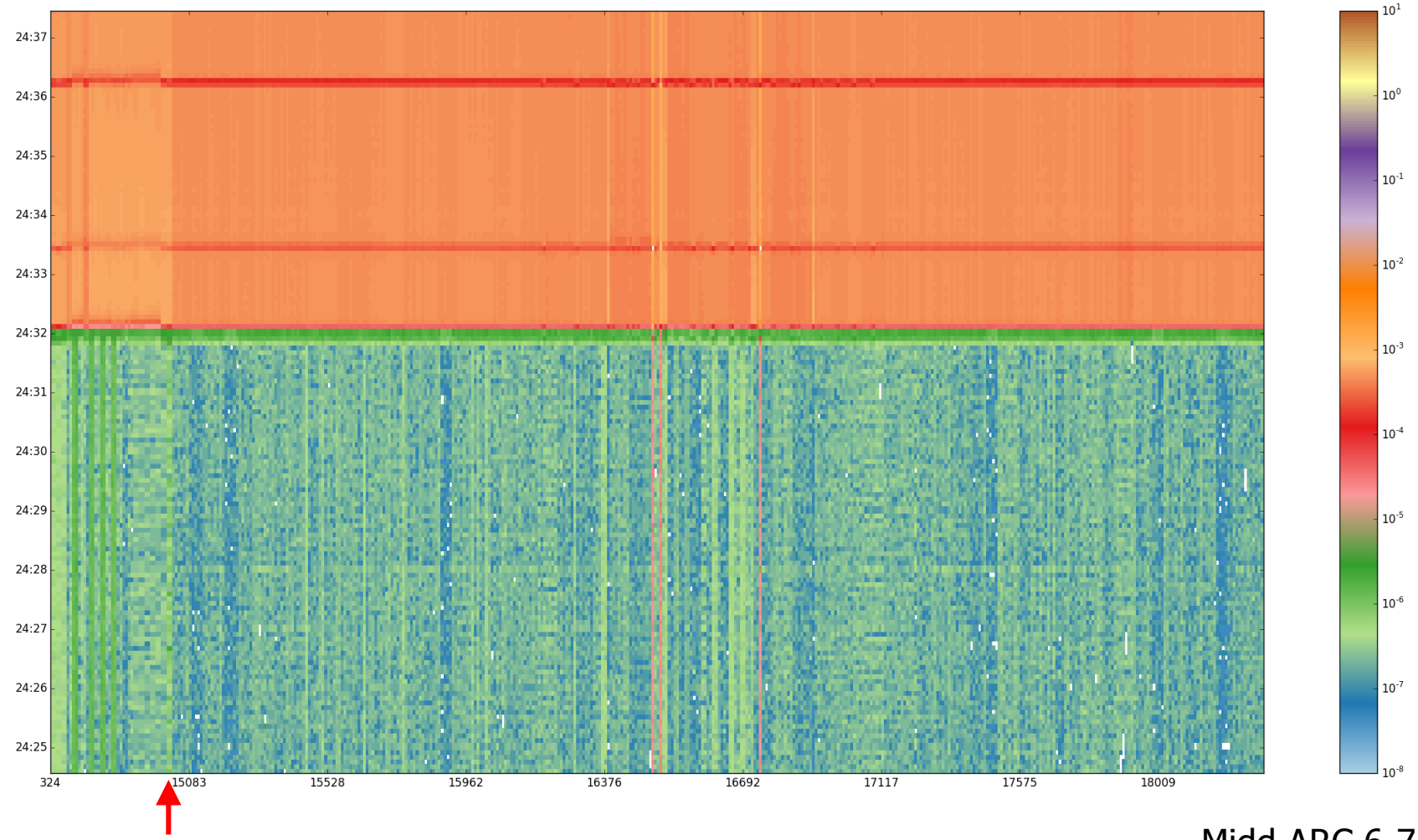
UJ63 BY03

SR6 BY02

Point 6L

HT SEM Boite Jonction Analog

BLM signal (color code) vs time vs DCUM (II zoom)

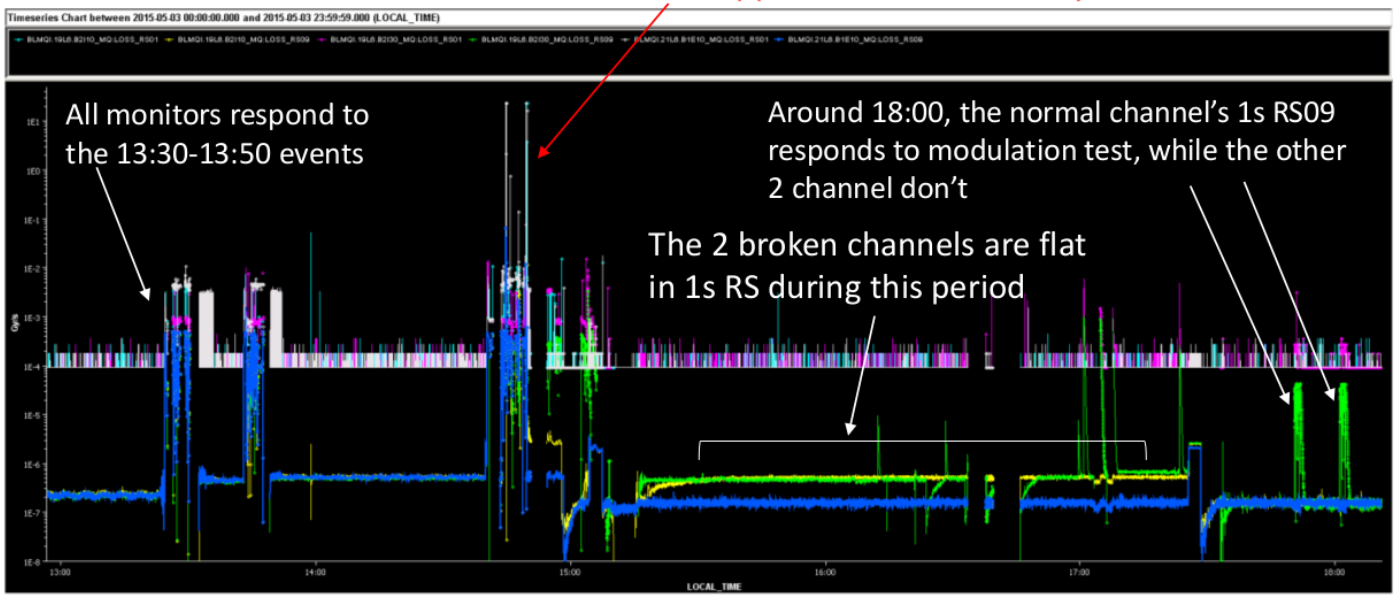


Three Periods of 20 to 30 Minutes

2015-05-03 IP6 HV flash event

RS01 (40us) and RS09 (1.2s)From CFV-SR6-BLML crate
1 normal channel:
BLMQI.19L6.B2I30_MQ (card 7,ch 9)
2 reported broken channels:
BLMQI.19L6.B2I10_MQ (card 7,ch 13)
BLMQI.21L6.B1E10_MQ (card 8,ch 10)

The 40us RS of the 2 broken channels go in saturation, I would suppose this is where they broke



Summary and foreseen actions

- Observations
  - Damage of several tunnel digitizer cards input circuits
  - Damage of filter components
  - Damage could not come from BLM equipment, because of power needed for the damages, several tenth of ampere in 100 us
  - On BLM HV network > 1900 V measured and not supplied by BLM power converters
- Comparison with LS1 event
  - 30th September at around 00:50 UTC and lasted about 15 minutes
  - Very similar damages and signals on BLM channels
- Investigation
  - Try of determination of entry location of high voltage pulse by data analysis: **no entry location found**
    - From the Sunday event postmortem data are stored
    - Ongoing; delayed increase of the BLM signal of dump line monitors (likely pulse entry location not on BLM HV cables of dump line)
- Action
  - Installation of a overvoltage protection on the tunnel cables
    - In preparation: **will be done in TS1**
  - Preventive exchange of HV cables in IP6 during TS1, **will be done in TS1**
    - Inspection of HV cables in SR6 done, BLM HV cables and 18 kV cables in same cable try
  - Insulation measurements foreseen of BLM HV cable shielding against ground: **will be done in TS1**
    - Condemnation of LBDS system and SR6 power converters needed

LHC BLM Issues Since Startup 2015

- Beam dump due to BLM-SIS communication (x4)
  - More info: BIBML-1027 [2015/06/02], BIBML-1039 [2015/06/06], BIBML-1040 [2015/06/07], BIBML-1042 [2015/06/09]
  - New version of the FESA server deployed 10/06 PM that prioritises differently data readout and transmission.
  - No errors have been observed, but UFO Buster triggers were disabled
- Logging data perturbed/missing when MCS Online check execution
  - Issue prevents the correct execution of the daily threshold check
  - Fixed with FESA server release of 10/06 PM
- Sanity checks don't get registered correctly in the BLECS
  - More info: BIBML-937
  - Sequencer correctly shows all checks as passed, but the combiner has not received the result. Thus, no release of beam permit happens
  - Confusing for OP; we have been called to investigate several times.
  - We hope to be fixed in TS#1 release.
- CISV shown crates falsely in error after crate reboot
  - More info: BIBML-1032
  - DIAMON shows the crate in red (error); very confusing for OP, they called to know if action needs to be taken
  - Don't know the reason but a consecutive reboot fixed it.
  - Under investigation with TE and DIAMON team.

BLM Signal Filter to Extent Upper Limit of Dynamic Range

- **Status filter checking 11.6.2015 (Barbara)**
- injection region beam 1: IP2
  - all filters on IC checked by Matti,
  - he found one small filter missing
  - no IC where a filter was installed by mistake (checked all readout cards where at least one filter was installed)
- injection region beam 2: IP8
- same as above, but the presence of 6 filters he could not verify (not enough losses)
- Barbara checked (but cannot distinguish between small and big filter!):
  - Losses close to noise level, nevertheless:
    - 5 of the 6 locations do have some filter installed
    - The 6th one has possibly a filter installed (BLMQI.04R8.B2E10_MQY)
    - One of the filters looks strange (BLMTI.04R8.B1I10_TDI.4R8.B1):
      - Should be small, but has a rather long decay time and a very long rise time

Filter Channel List IP8

Card	Monitor	DCUM	Card Channel	Filter	test	event
BJBAP.A6R8	BLMEI.06R8.B2E10_MSIB	2352878	14	small		
BJBAP.A6R8	BLMEI.06R8.B2E20_MSIB	2352433	13	small		
BJBAP.A6R8	BLMEI.06R8.B2E30_MSIB	2351988	12	small		
BJBAP.A6R8	**BLMEI.06R8.B2E10_MSIA**	2351543	11	small	some filter	
BJBAP.A6R8	**BLMEI.06R8.B2E20_MSIA**	2351098	10	small	some filter	
	BLMEI.06R8.B2E30_MSIA			small	some filter	
BJBAP.D4R8	BLMQI.04R8.B1I30_MQY	2346082	6	no		
BJBAP.D4R8	**BLMQI.04R8.B2E10_MQY**	2345768	5	small	probably some filter	
BJBAP.D4R8	BLMQI.04R8.B2E20_MQY	2345432	4	no		
BJBAP.D4R8	BLMQI.04R8.B1I20_MQY	2345375	3	no		
BJBAP.D4R8	BLMQI.04R8.B1I10_MQY	2344841	2	no		
BJBAP.D4R8	BLMQI.04R8.B2E30_MQY	2344591	1	no		
BJBAP.D4R8	BLM2I.04R8.B1I10_MBRC_MBRC_S	2344236	108	no		
BJBAP.D4R8	BLM2I.04R8.B1I10_MBRC_MBRC	2343728	8	no		
BJBAP.D4R8	**BLMTI.04R8.B2E10_TCTPH.4R8.B2**	2343179	7	small	some filter	
BJBAP.A4R8	**BLMTI.04R8.B1I10_TDI.4R8.B1**	2340023	7	small	looks strange - big filter??	IQC on TDI 10/06/15 20:11:41.485+238525
BJBAP.A4R8	BLMTI.04R8.B2E10_TDI.4R8.B2	2339664	6	small		
BJBAP.A4R8	BLMTI.04R8.B2E20_TDI.4R8.B2	2339294	5	BIG		
BJBAP.A4R8	**BLMEI.04R8.B2E10_MBXB**	2338280	3	small	filter	IQC on TDI 10/06/15 20:11:41.485+238525
BJBAP.A4R8	BLMQI.03R8.B1I30_MQXA	2337431	1	small		

Prioritized List of Threshold Updates (Barbara, Bernhard)

1. Arc and DS thresholds (UFO-induced quenches, new BLM locations).
2. Injection regions (New monitors/monitor configurations).
3. Inner triplets, IPQs, IPDs (updated beam-loss scenarios, quench levels).
4. Remaining injection-region monitors (beam-loss scenarios, quench levels)
5. MQWs (improved beam-loss scenarios, new damage-level analysis).
6. Collimators near experiments (FLUKA models, updated damage levels)
7. Remaining collimators (FLUKA models, updated damage levels)
8. DS-region horizontal BLMs on MBs at aperture bottlenecks (dispersion) and for ion runs
9. Roman pots, kickers, septa, MBWs, new scenario for Q1.

In absence of updates, pre-LS1 thresholds apply.

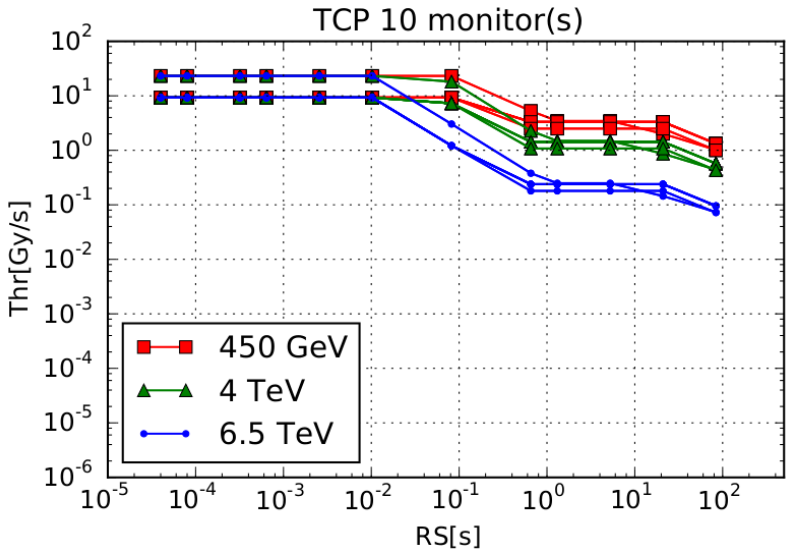
Green: Deployed since Run 1.

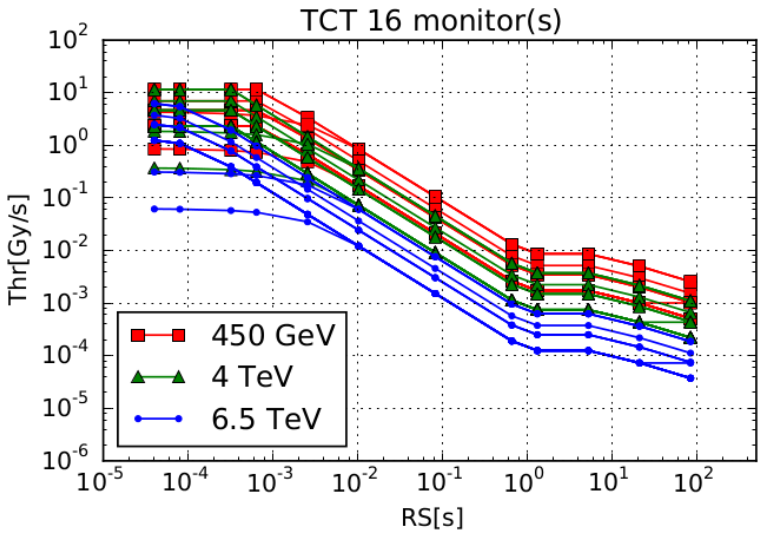
Blue: Analysis complete. To be implemented in TS1.

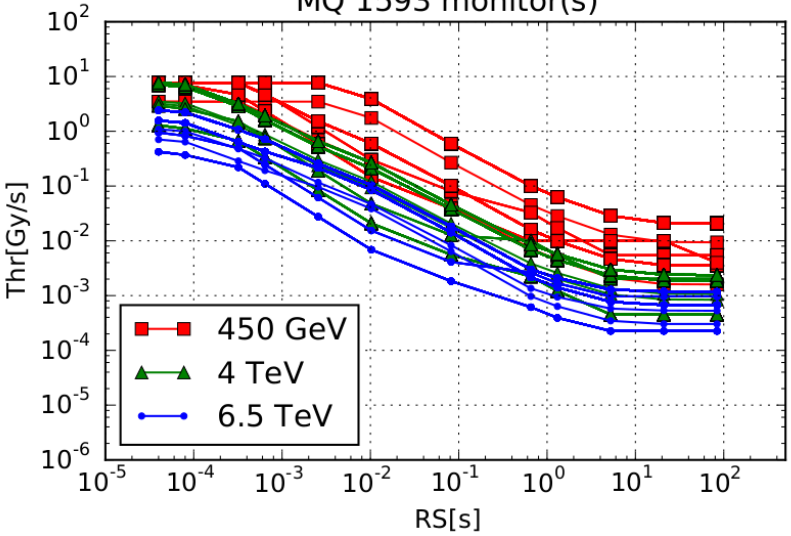
Violet: Analysis approaching completion. To be implemented "en-bloc" in TS 2 or earlier.

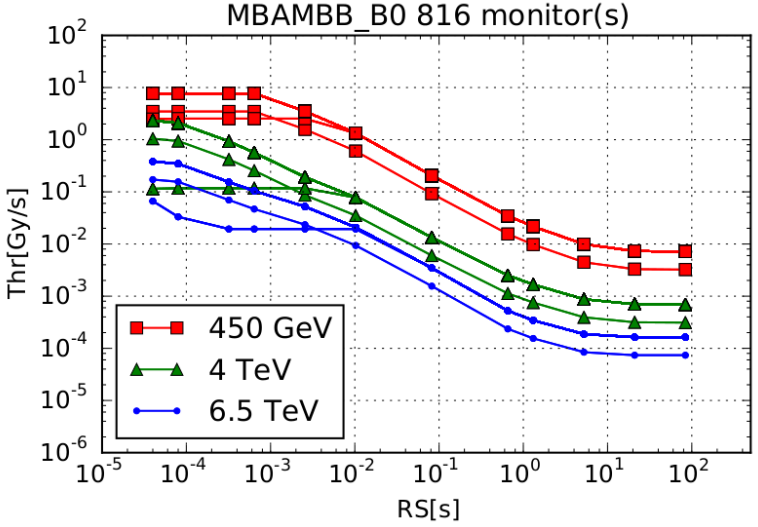
Orange: Analysis not yet started.

Check of Beam Abort Thresholds (logging data base) (I)



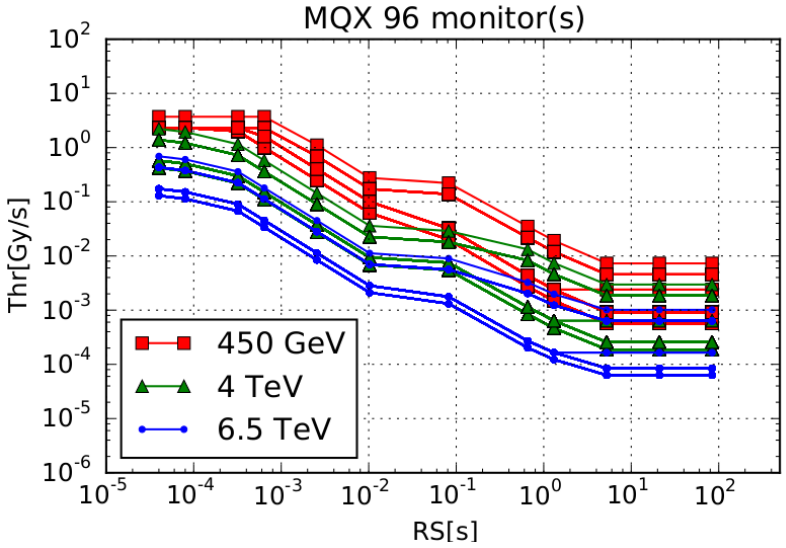


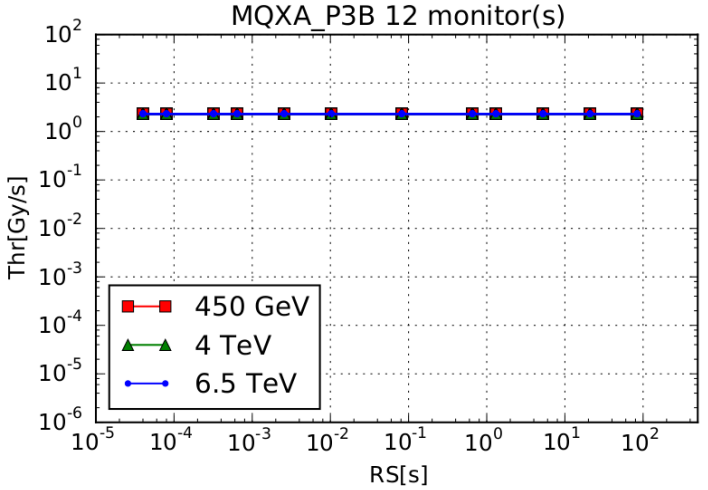


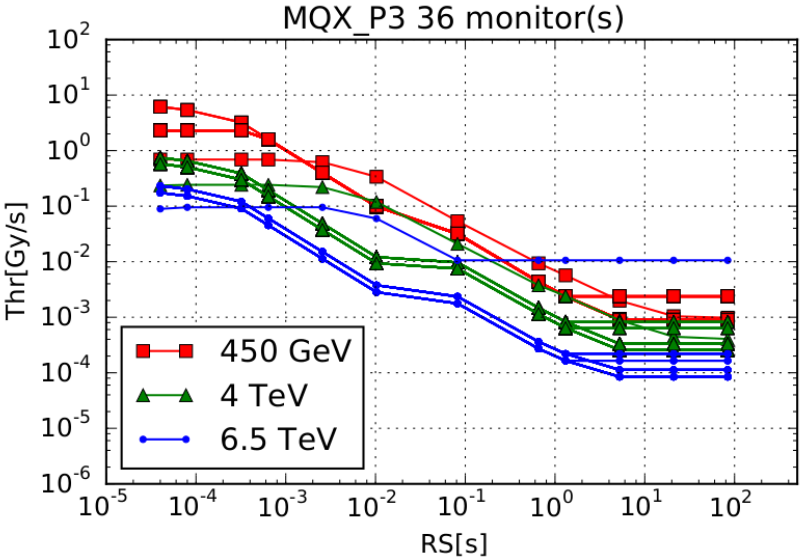


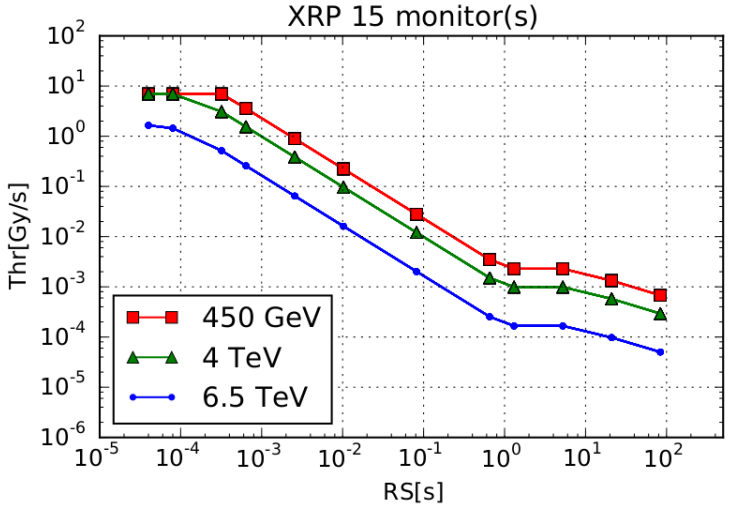
Chen Xu

Check of Beam Abort Thresholds (logging data base) (II)









Plots are available for all elements

Chen Xu

TS1 Activity

- XPOC/PM buffers update & Injection Interlock Inhibit for the two crates looking at injections
  - Not sure yet if they will be deployed though. We will finish tests middle of the TS and we will take the decision then.
  - Note, if we go ahead, we will need the MPS tests with beam (~4 h).
- Earth measurements at several places to investigate low signal variation in IP4 an IP5
- Installation of filters and check of filters
- Update of settings, channel names, …
- Update of thresholds

Summary

- The incident on the BLM system is mitigated by hardware changes and continued investigation
  - The reason causing the event has not been found
  - HV changes are surveyed every 10 seconds, which ensures that the system availability is checked
- Low signal variation are investigated during TS1
- Other occurred nonconformities effected the uptime of the system
  - Mitigations are employed or will be employed during TS1
- Filter have been checked (few are missing), no critical nonconformities have been found
  - Filter checks and installations will be continued during TS1
- Applied BLM thresholds have been checked globally, no nonconformity has been found
- A threshold update table has been given
- Automatic disabling protection is not activated yet