Status of Quench Analysis @ 18-04-2011 00:06:44 LT

Annika Nordt BE-BI-BL

MPP 13th of May 2011

Overview

1) Information on the event

2) Loss distributions, estimated nr. of lost protons

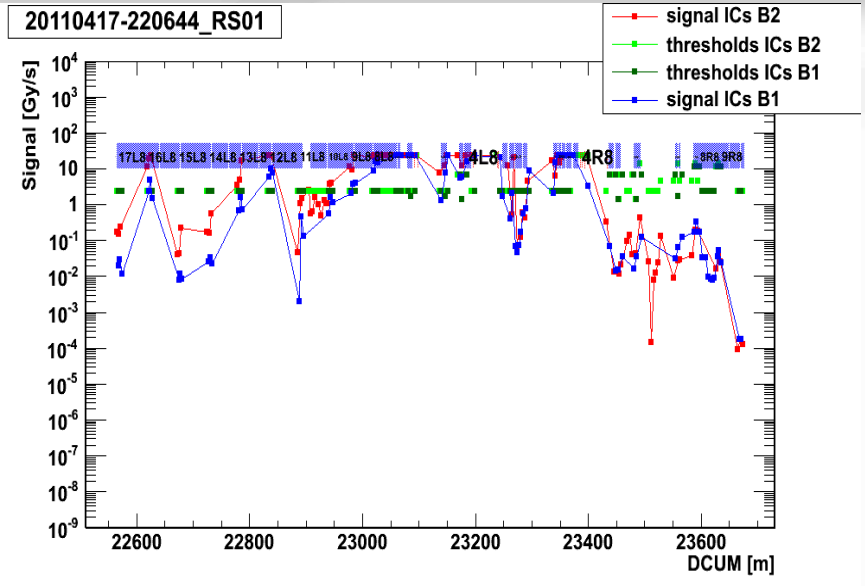
3) Signals in SEMs

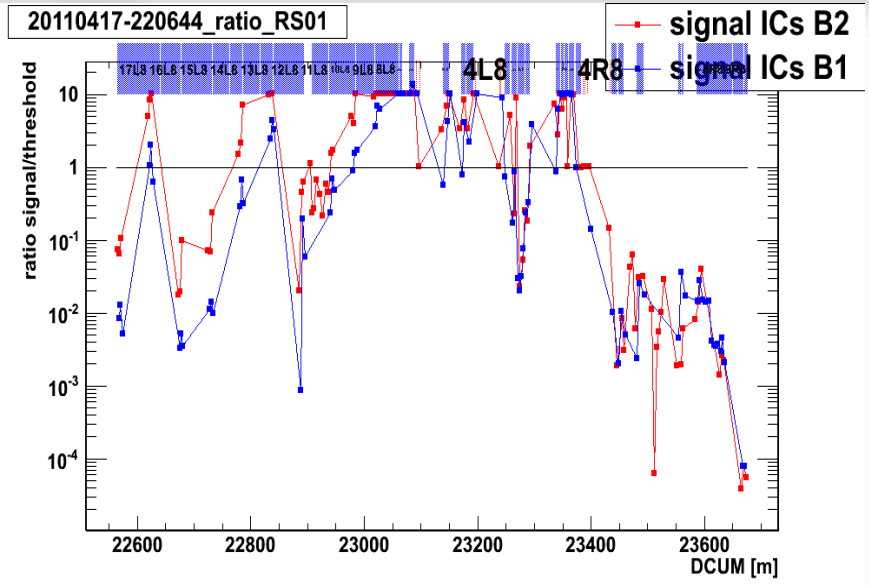
4) Conclusion

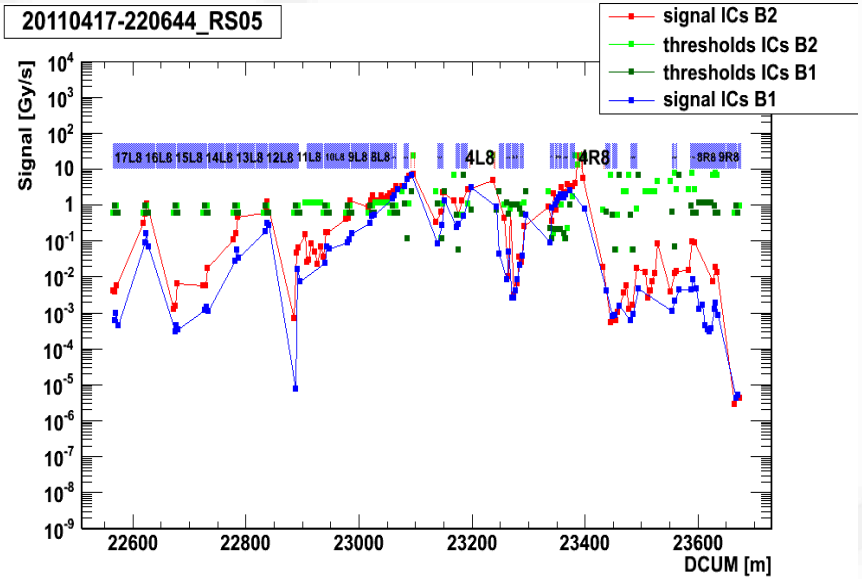
MKI Kicker Breakdown

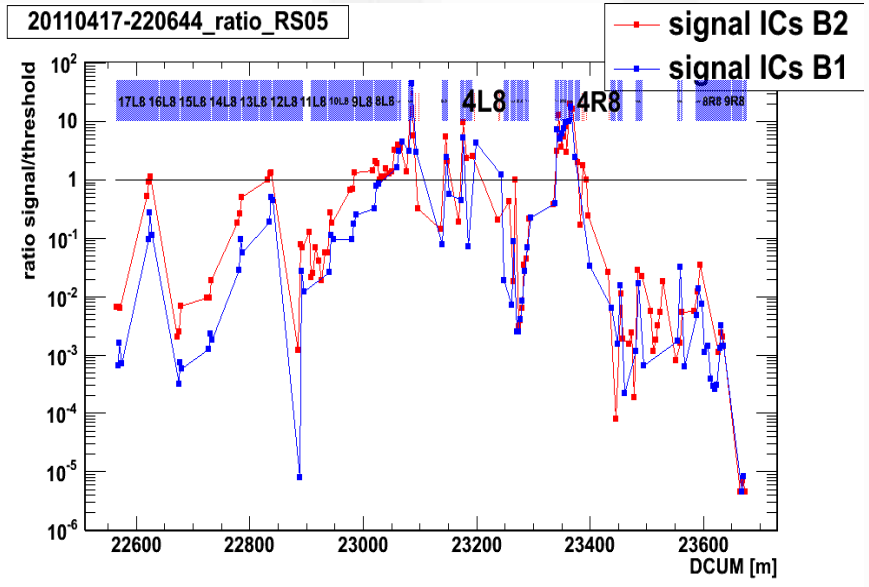
1) A flashover occured on the B2 MKI magnet D while injecting 72bunches
   quench heaters were fired for 11 magnets, closure of vacuum valves,
   extensive losses in IR8 and in arc 7-8, 139 BLMs triggered beam abort
   the flashover (spark) caused a grazing incidence (coincided
   with high transmission and large amplitude oscillations into
   LHC at 6-7 sigma amplitude
2) 2 trains of 36 bunches spaced by 2.2 µsec had been injected,
   the first batch had been injected ok, the breakdown had
   occured after 1.8 µsec. the breakdown had happened earlier than 4 µsec
   after the start of the kicker pulse,since all 36 bunches
   of the 2nd batch had been kicked badly with +-5mm oscillations
3) the arc BPMs had triggered, meaning that more than 2e10ppb had been
   transmitted beyond the TDI, the FBCT signal in the dump line
   indicated about 1e12p had been missing, or half of a 36 bunch batch,
   suggesting a perfect grazing incidence
4) 9 Dipoles quenched:
   A8L8, B8L8, A9L8, B9L8, B12L8, C12L8, A13L8, C13L8, C16L8
   2 MQ magnets quenched:
   RQX.R8, Q6L8
   Quenchinos: A13L8, C16L8
5) We expect 0.7e12p being lost during this event (36b*2e10ppb=0.7e12p)

Event Overview









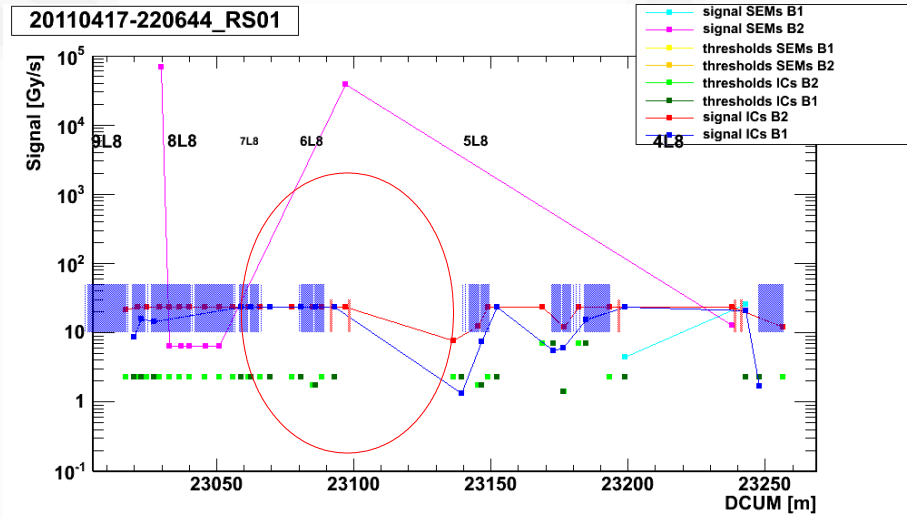
Quench on Q6L8 (I)

Beam 2 monitors:
Use ratios of IC's for B2 on TCLIB and last B2 MQ monitor on 05L8: TCLIB/05L8B2I30_MQM from injection
Before MKI failure:
TCLIB / 05L8B2I30_MQM = 1.3e4
Therefore we could **expect 99320** Gy/s on the TCLIB monitor:
- IC is saturated
- **SEM** (@ same dcum): **38044 Gy/s**
- SEM measures 2.6 times less

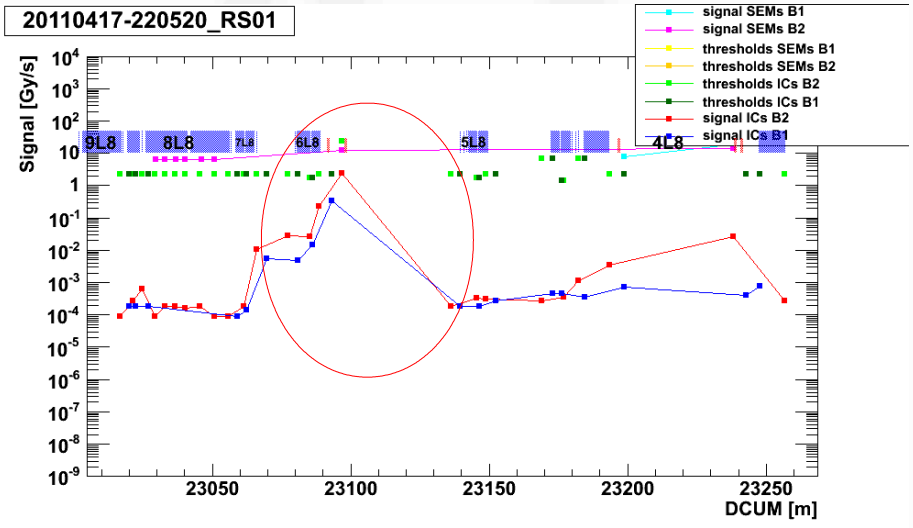
Beam 1 monitors:
Use ratios of IC's for last B1 monitor on 05L8 and first B1 MQ monitor on 06L8: TCLIB/05L8B2I30_MQM from injection
Before MKI failure:
06L8.B1E30 / 05L8.B1E10_MQM = 1.9e3
Therefore we could **expect 2460** Gy/s on the first Q6L8 monitor:
- IC is saturated
- no SEM

Assumed losses on middle monitor of Q6L8:
a) B2I20: 1125 Gy/s (99kGy/s, pred.)
b) B2I20: 431 Gy/s (38kGy/s, meas.)
Calibration (from simulations): 4.57e-13Gy/p
Leading to
a) 9.9e10p lost
b) 3.8e10p lost

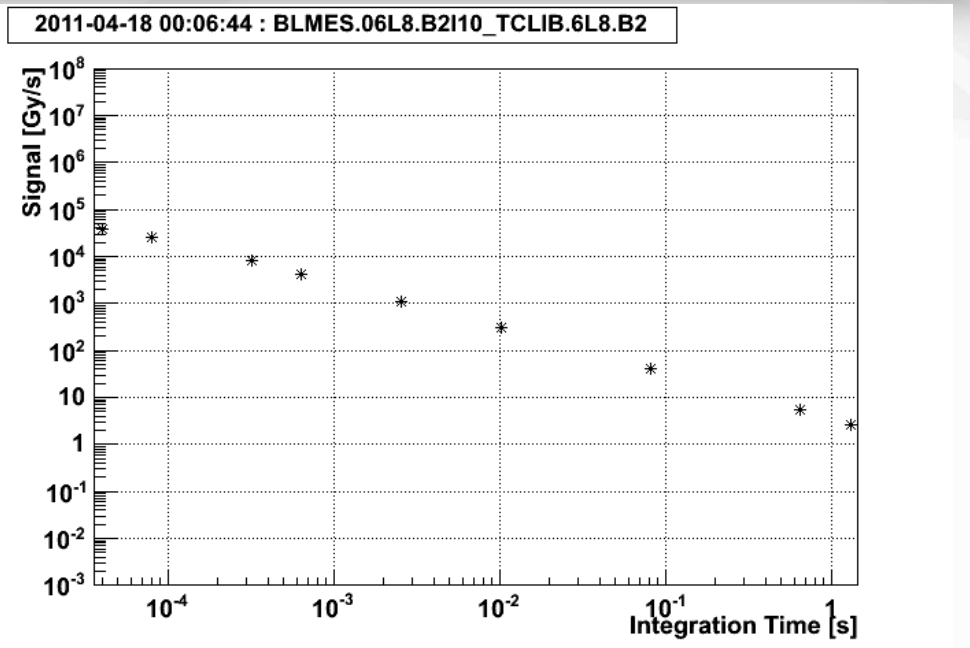
MKI failure: quench on Q6L8



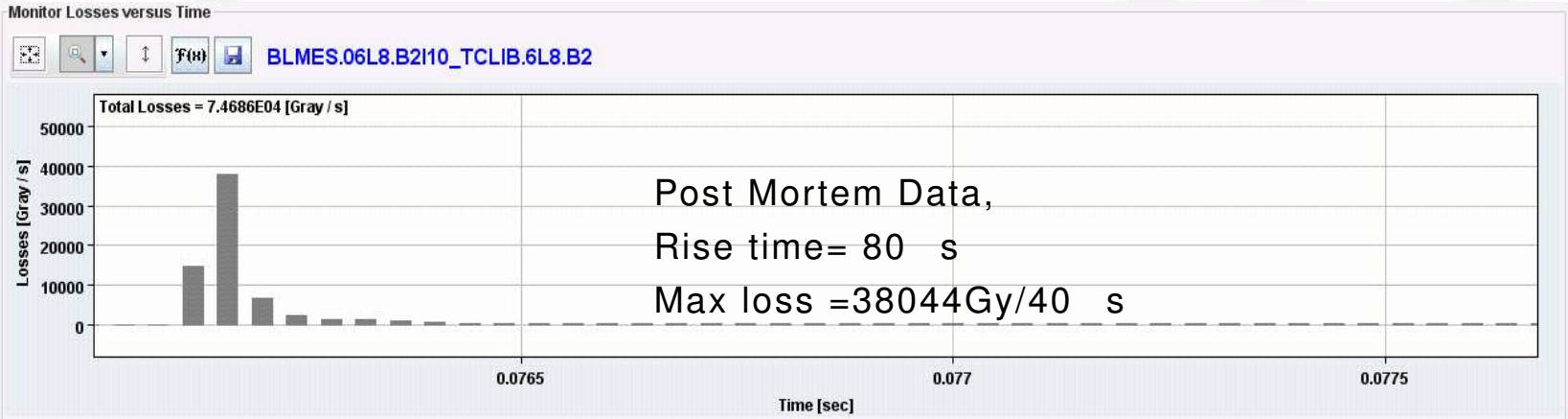
1 injection before quench



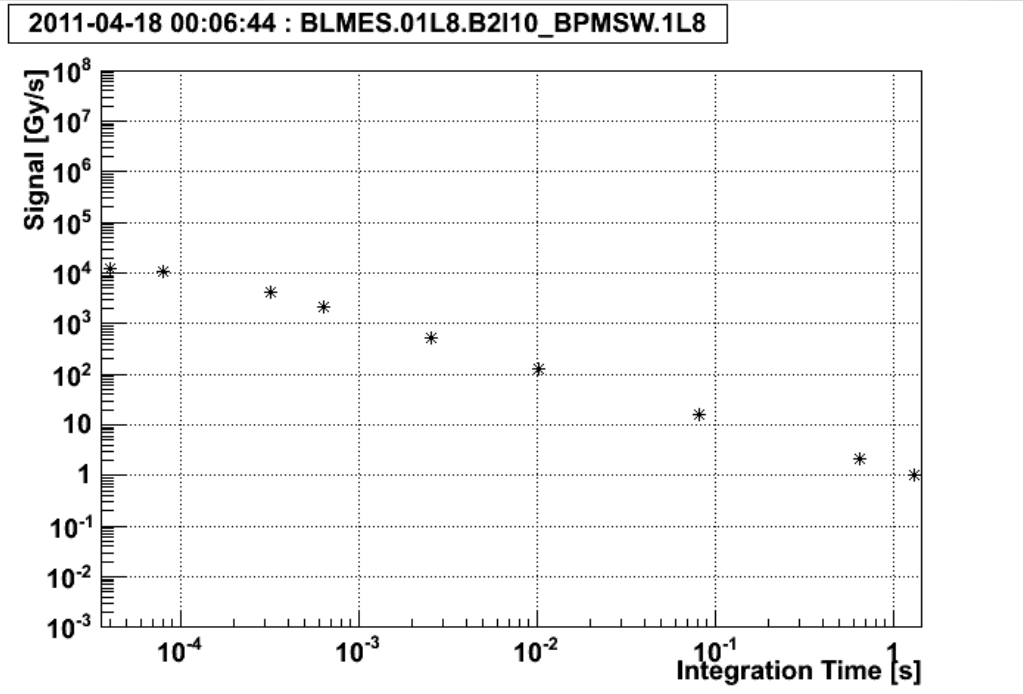
SEM Performance in 06L8 on TCLIB



Max.Loss: 38044Gy/s
Mean noise: 11+-4Gy/s
Max. noise spikes: 800-1000 Gy/s

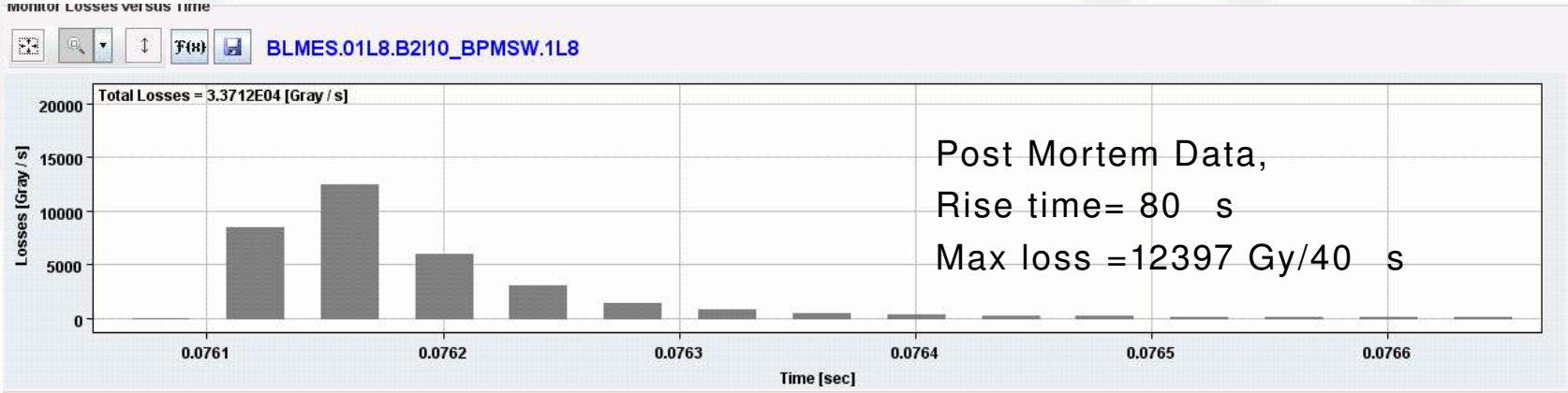


SEM Performance in 01L8 on BPMSW



Max.Loss: 12397Gy/s
Mean noise: 10-15 Gy/s
Max. noise spikes: 800-1000 Gy/s

Dcum = 23293.7



Quench on MBA and MBB in 08L8

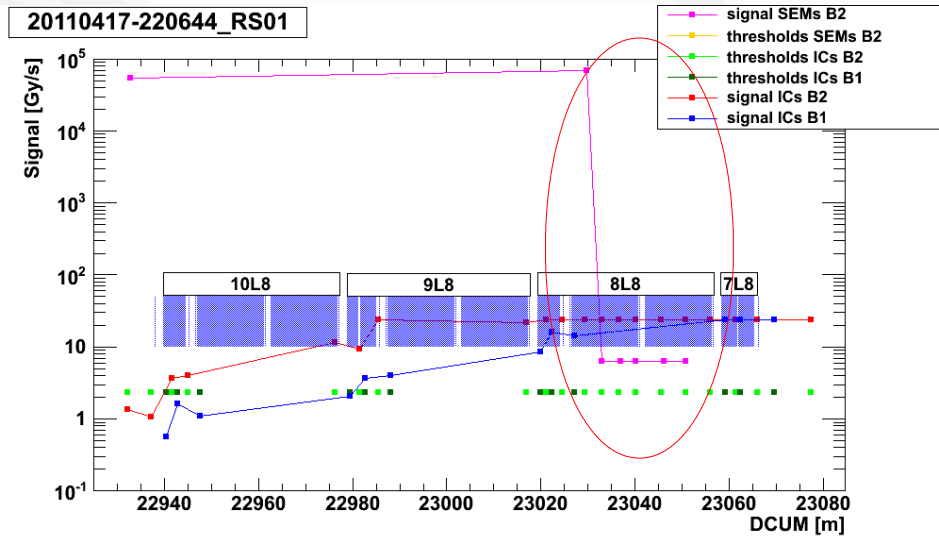
Beam 2 monitors:
3 IC +SEM for MBA, 3 IC + SEM for MBB,
3 IC on MQML
All IC saturated except B2I30 MQML,
1 SEM gives a signal

Use ratios of IC's for B1/B2 on
08L8, 09L8, 10L8 (1.,2.,3. position)
Therefore we could **expect**:
B2I10 MQML: ~80-100Gy/s (sat)
B2I20 MQML: ~30-40 Gy/s (sat)
B2I30 MQML: 21.7 Gy/s (meas)
Assumed losses on middle monitor of MBA:
a) 100-120 Gy/s
b) SEM meas: 68100 Gy/s (?)
Calibration (from simulations): 6.3e-13Gy/p
Leading to
a) 6-8e9p lost
b) 4.3e12p lost

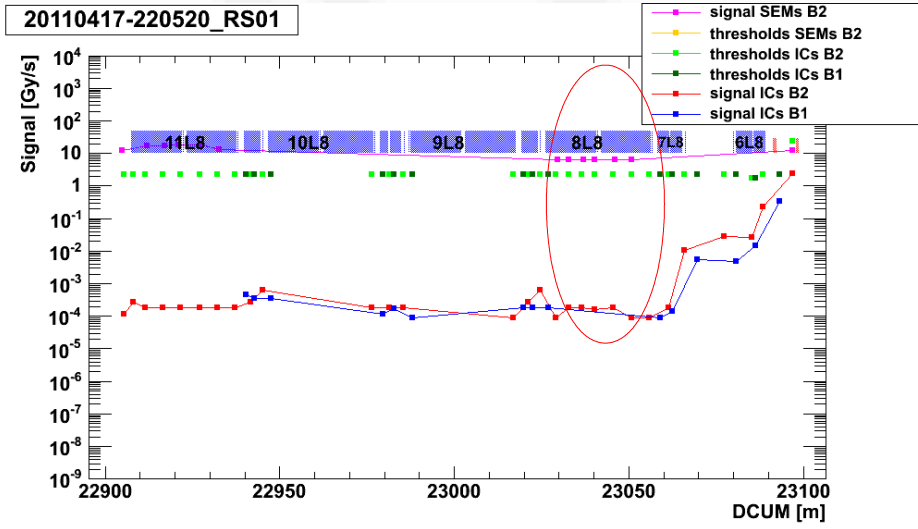
Probably the same #p were lost on MBB

SEM scenario is not realistic,
since we expect 1e12p lost in total

MKI failure: quench on A,B 8L8



1 injection before quench



Quench on MBA and MBB in 09L8

BLMs:
6 IC (B1,B2), no SEM
Only B2I10 MQM saturated,

Use ratios of IC's for B1/B2 on
09L8, 10L8 (1.,2.,3. position)
Therefore we could **expect**:
B2I10 MQM: ~40Gy/s (sat)
B2I20 MQM: 9.42 Gy/s (meas)
B2I30 MQM: 11.7 Gy/s (meas)

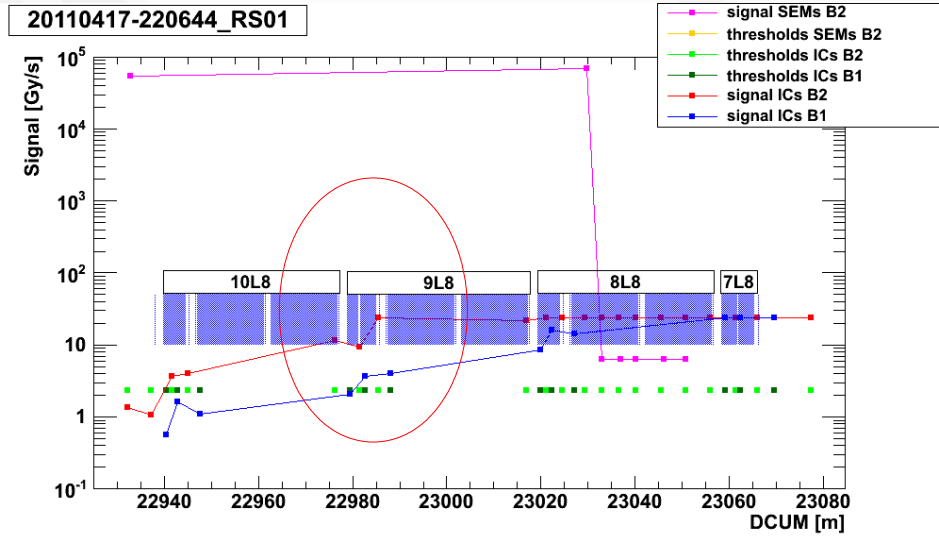
Assumed losses on middle monitor of MBA:
a) 40-50 Gy/s

Calibration (from simulations): 6.3e-13Gy/p

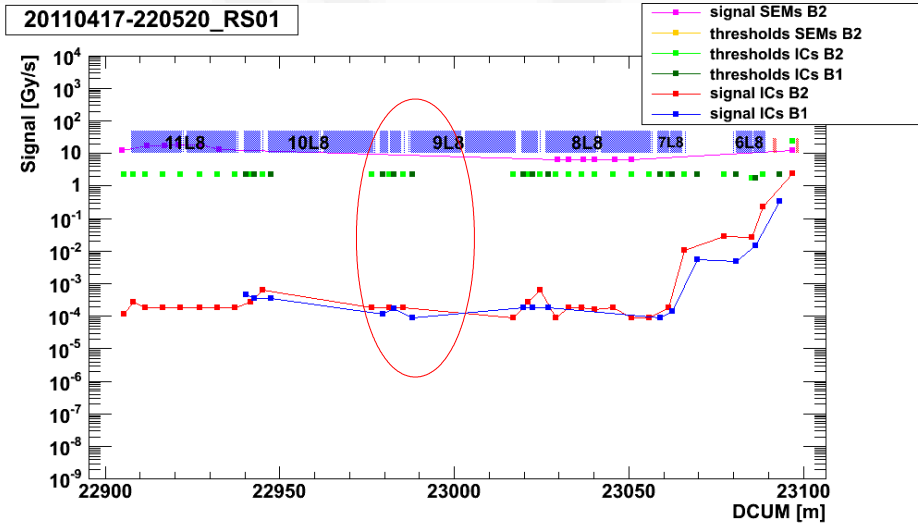
Leading to
a) 2.5-3e9p lost

Probably the same #p were lost on MBB

MKI failure: quench on A,B 9L8



1 injection before quench



Quench on MBs in 12L8

BLMs:
6 IC (B1,B2), no SEM
B2I10+B2I20 12L8 MQ saturated,

Use ratios of IC's for B1/B2 on
14L8, 13L8 (1.,2.,3. position)
Therefore we could **expect**:
12 L8 B2I10 MQ: ~100 Gy/s (sat)
12 L8 B2I20 MQM: ~30 Gy/s (sat)
12 L8 B2I30 MQM: 22.7 Gy/s (meas)

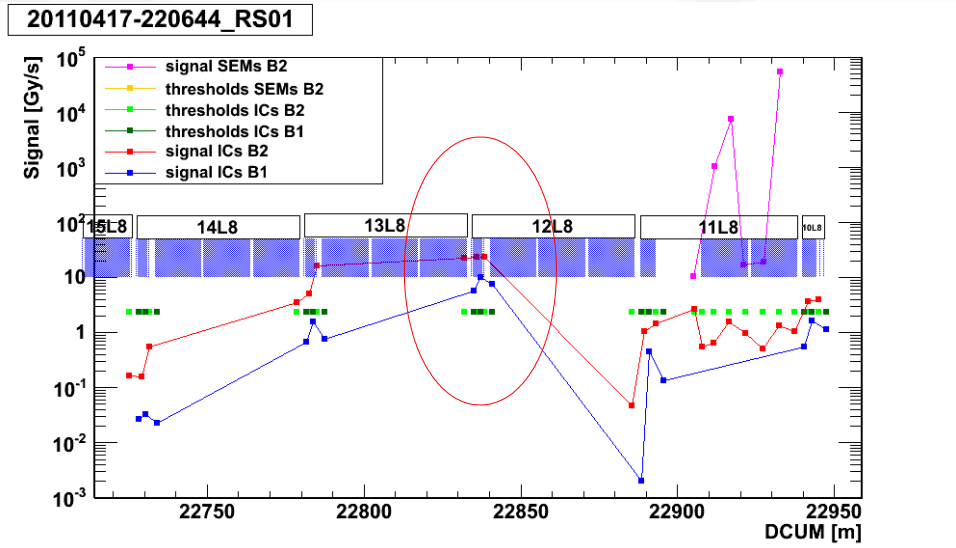
Assumed losses on middle monitor of MBA:
a) 100-120 Gy/s

Calibration (from simulations): 6.3e-13Gy/p

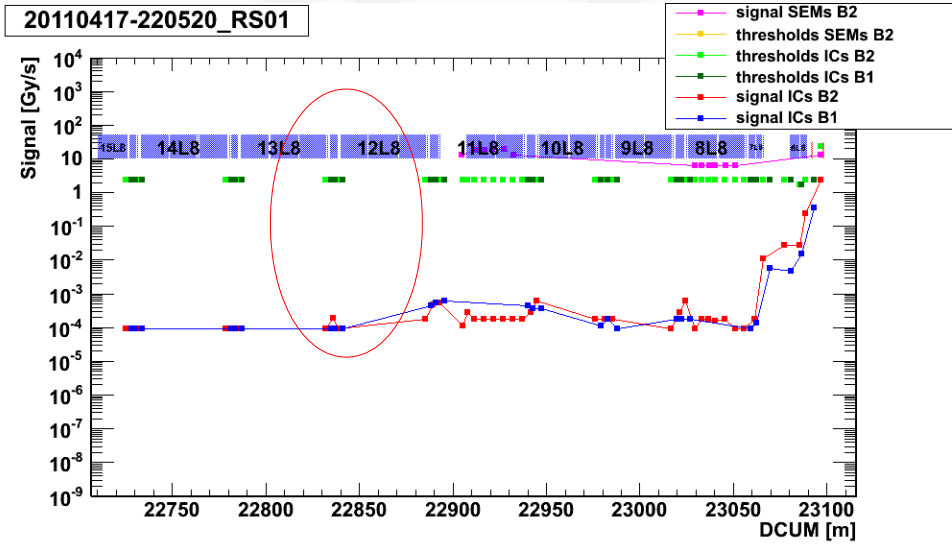
Leading to
a) 6-8e9p lost

Probably the same #p were lost on MBB

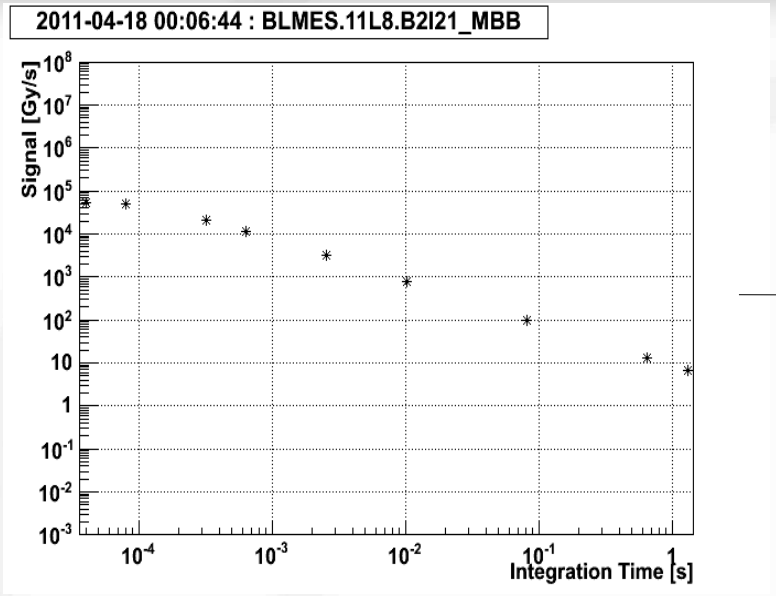
MKI failure: quench on B,C 12L8



1 injection before quench



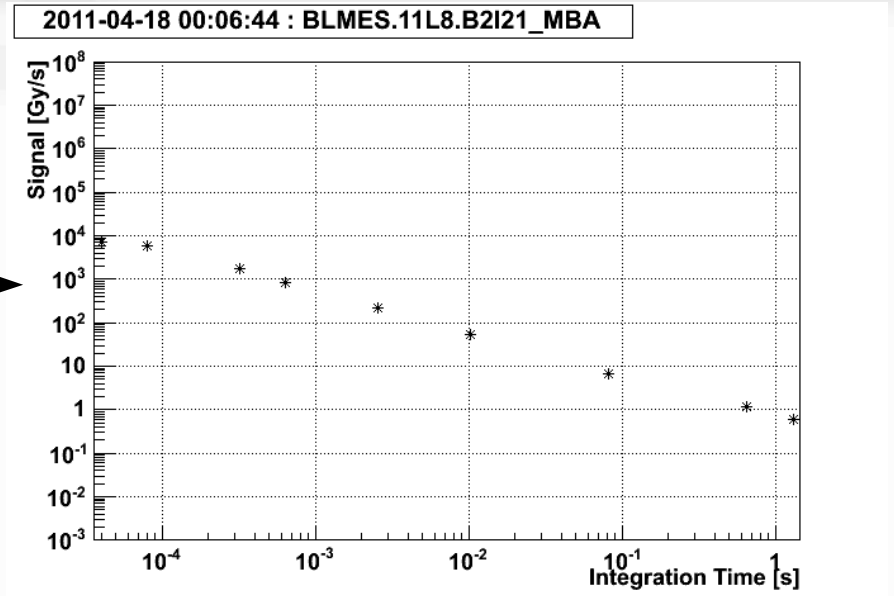
SEMs in 11L8



Beam 2

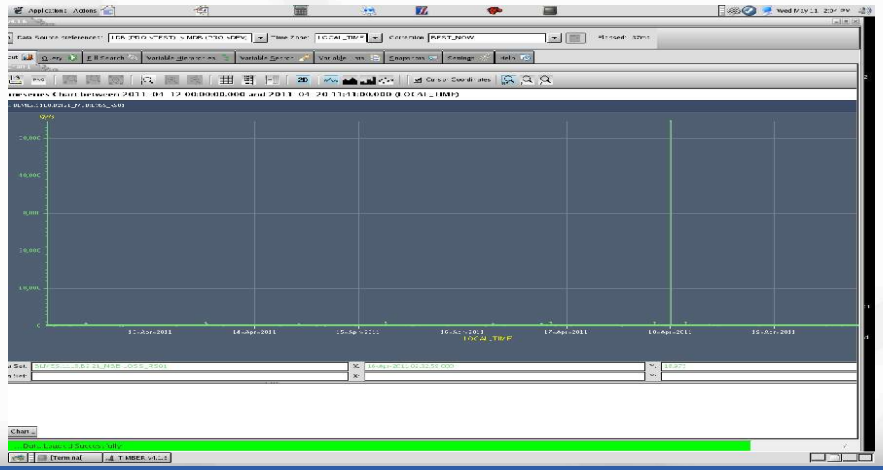
Distance 15.66m

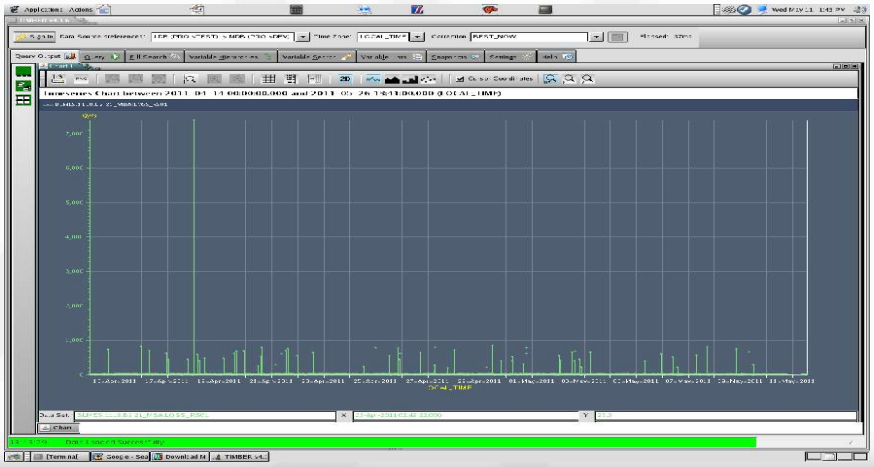
Loss ratio: 7.4



BLMES.11L8.B2I21_MBB 22932.768m
Max.Loss: 54572.1Gy/s
Mean noise: 18+-4Gy/s
Max. noise spikes: 800-1000 Gy/s

BLMES.11L8.B2I21_MBA 22917.106m
Max.Loss: 7393.9 Gy/s
Mean noise: 20+-4Gy/s
Max. noise spikes: 800-1000Gy/s

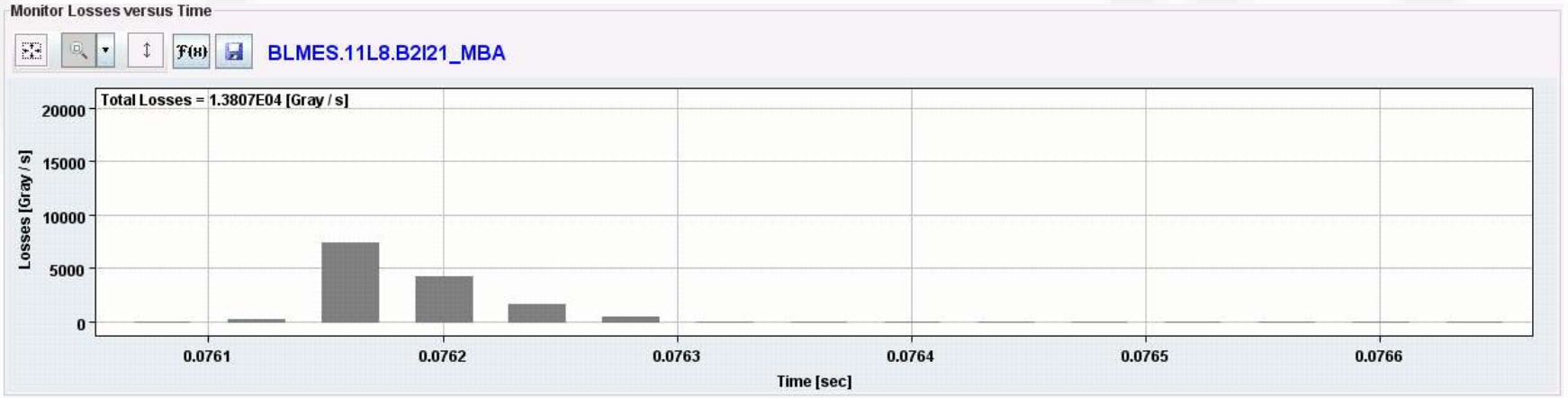




SEMs in 11L8

BLMES.11L8.B2I21_MBB 22932.768m

BLMES.11L8.B2I21_MBA 22917.106m



Quench on MBs in 13L8

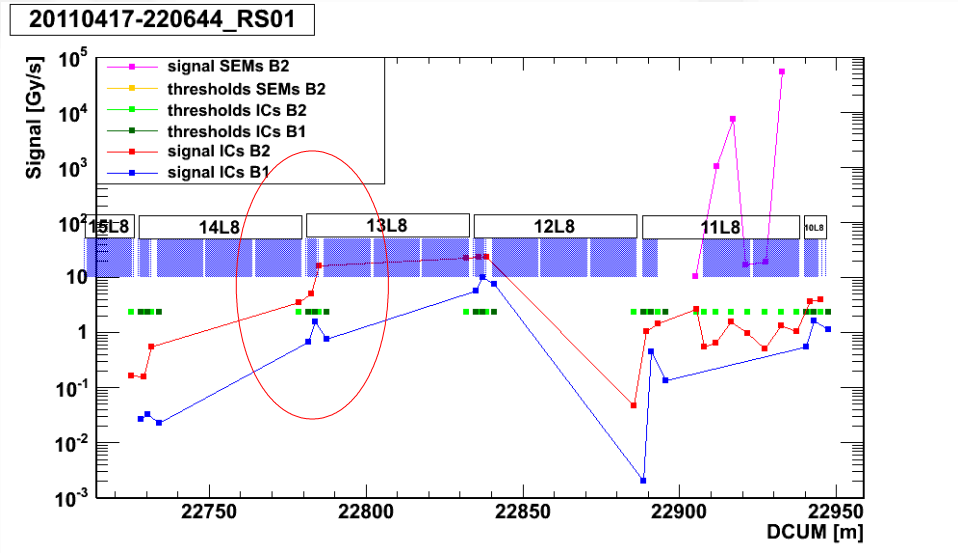
BLMs:
6 IC (B1,B2), no SEM
No IC saturated

Losses on B2 MQ monitors close by:
a) C: 16.5 Gy/s (13 L8 B2I10)
b) A: 22.7 Gy/s (12 L8 B2I30)

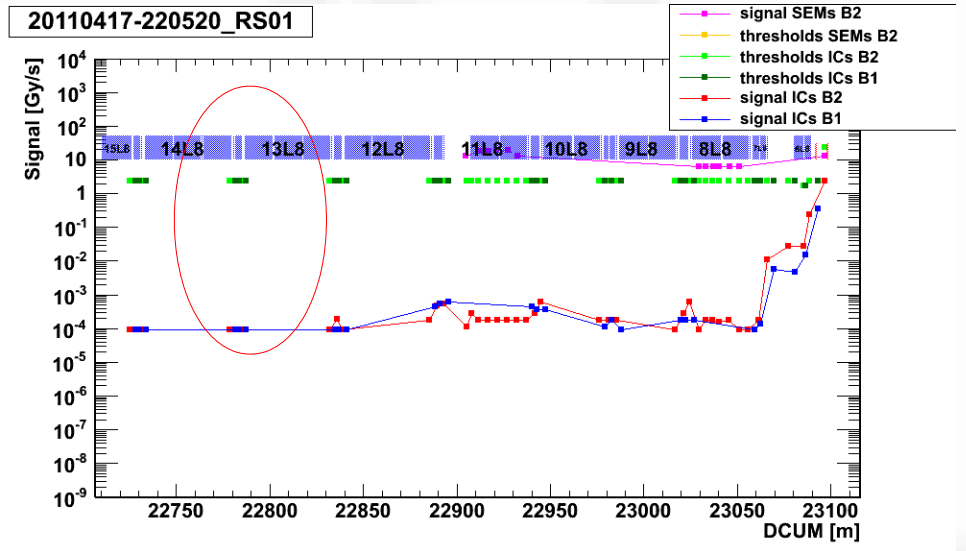
Calibration (from simulations): 6.3e-13Gy/p

Leading to
a) 1e9p lost
b) 1.4e9p lost – quenchino!
quench level at 2-4e9p for quenchino

MKI failure: quench on A,C 13L8



1 injection before quench



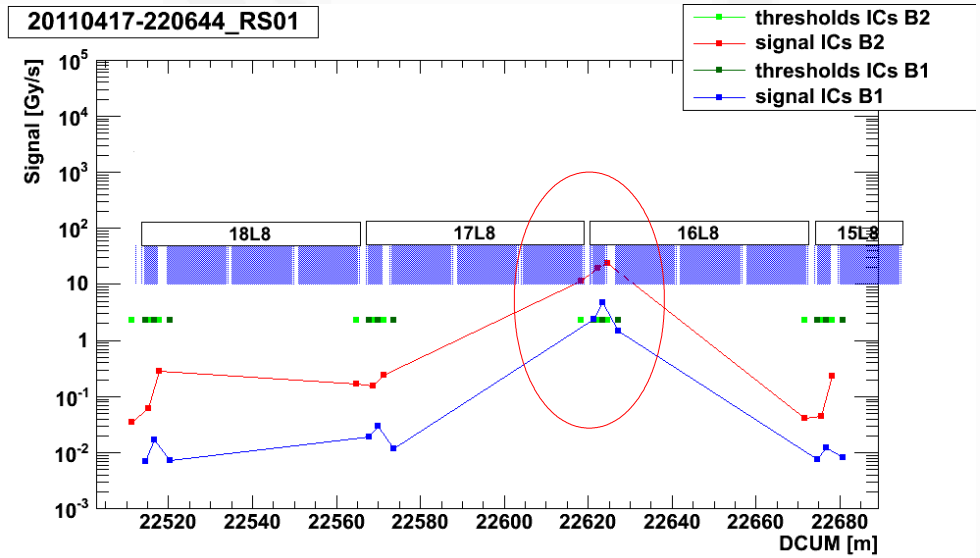
Quench on MB in 16L8

BLMS:
6 IC (B1,B2), no SEM
No IC saturated

Losses on B2 MQ monitors close by:
a) C: 23.5 Gy/s (16 L8 B2I10)
Calibration (from simulations):6.3e-13Gy/p

Leading to
a) 1.5e9p lost: – quenchino!
quench level at 2-4e9p for quenchino

MKI failure: quench on C 16L8



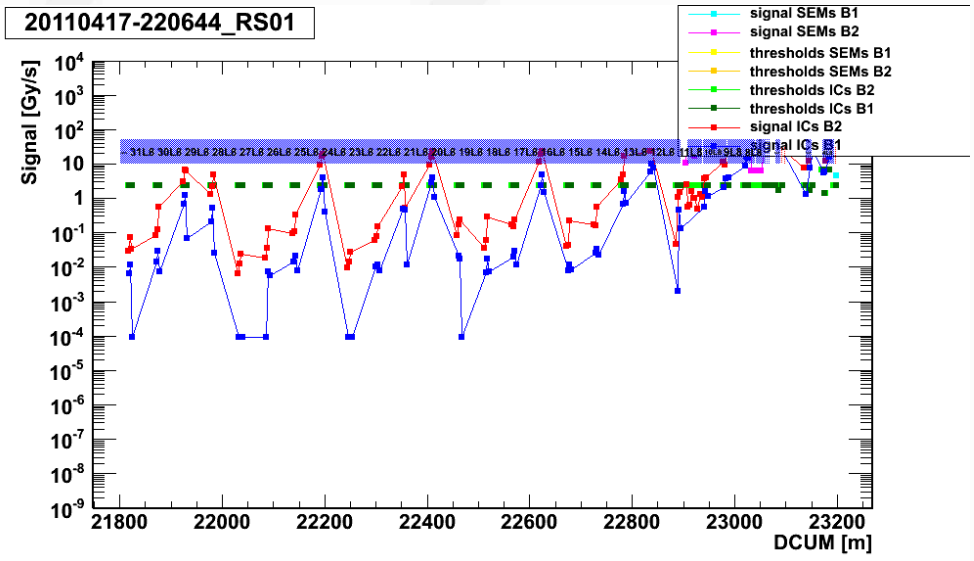
In total for L8:
3.8-9.9e10p (6L8)
+ 6-8e9p (08L8)
+ 6-8e9p (08L8)
+ 2.5-3e9p (09L8)
+ 2.5-3e9p (09L8)

In total for L8:
+ 6-8e9p (12L8)
+ 6-8e9p (12L8)
+ 1e9p (13L8)
+ 1.4e9p (13L8)
+ 1.5e9p (16L8)

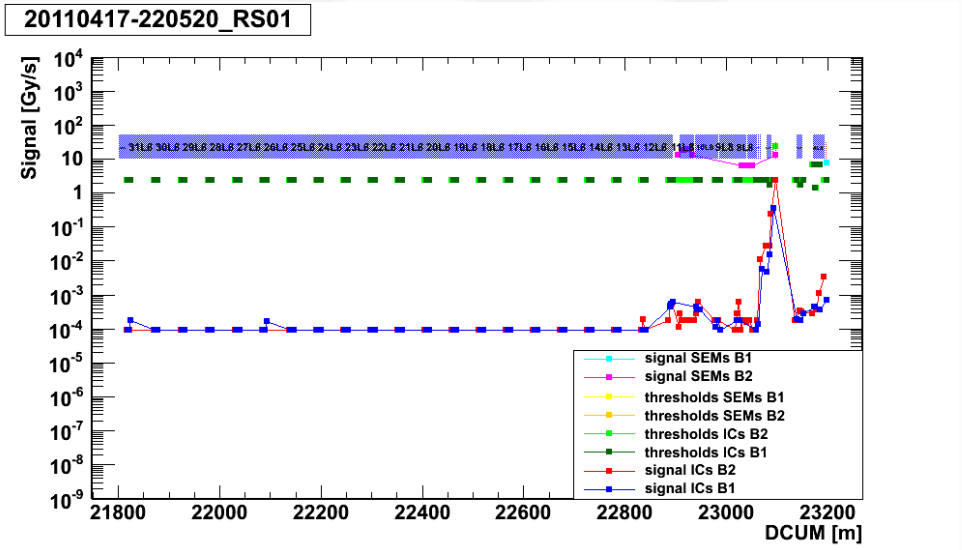
So, we lost at least 7-14e10p in L8

Losses in the ARC L8 during Quench

L8 ARC during MKI failure



L8 ARC 1 injection before



Losses on Triplet in R8 during Quench

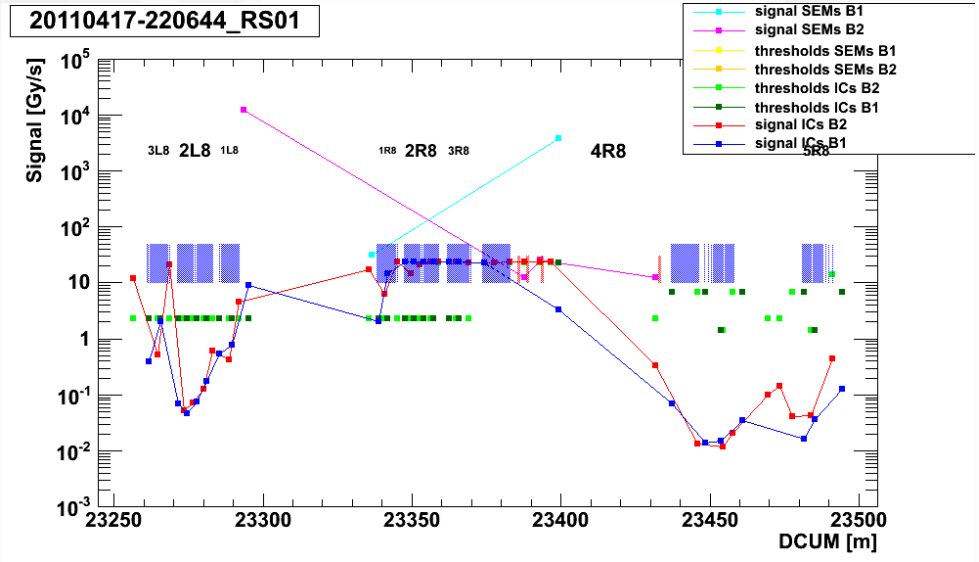
BLMS:
Use 2 pos MQXB B2 monitor, not saturated

Calibration (from simulations):6.3e-13Gy/p

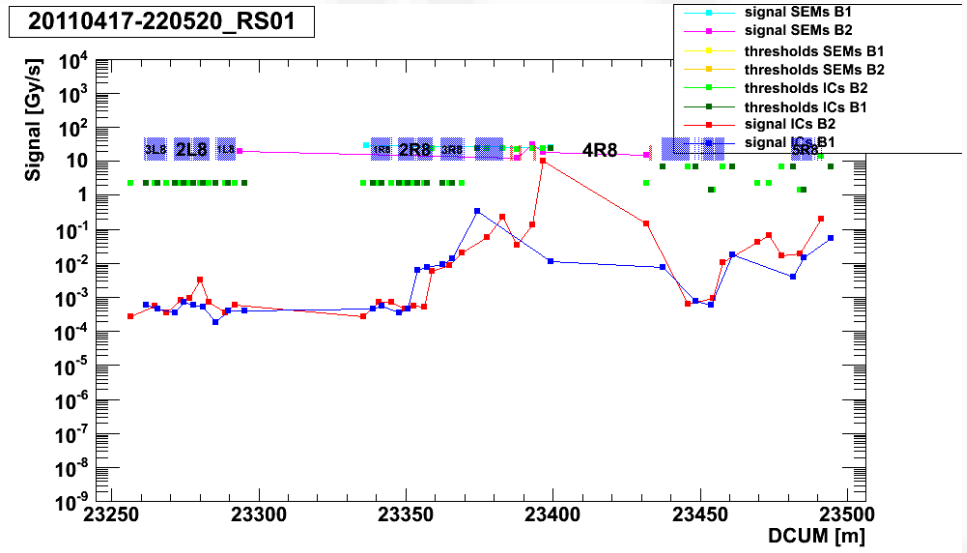
Leading to
a) 1.5-5e9p lost

This needs more analysis

Triplets in R8 during MKI failure



Injection before



Conclusions

Using the ratios of several BLMs in different cells for B1, B2 it is partially possible the re-constructed losses on saturated ICs

Out of this re-constructed losses it can be discussed whether filter and what type of filter could be installed at same 'critical' locations

Some thresholds could be re-checked (on 3rd position, where we use max. thresholds)

In total at least 0.3e12p were lost (calculation) and we expected 0.7e12p

1 SEM gave reasonable readings (on TCLIB)

Other SEMs gave a signal as well but the correlation with ICs is not clear, needs to be investigated in more detail