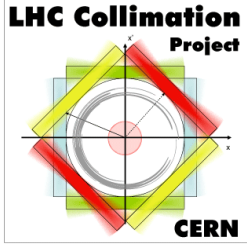

CERN

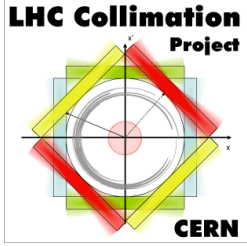
Proposal for IR7 Threshold Changes for the 2016 p-Pb Run

A. Mereghetti, on behalf of the LHC Collimation Team

Summary of Discussions So Far



- p-Pb / Pb-p run at 6.5 Z TeV:
  - Adjust BLM thresholds based on ion collimation quench test of 2015 (*@6.37 Z TeV*):
    - IR7 DS, based on LM when quench took place;
    - IR7 collimators (actually, TCP only), in order to dump on collimators before dumping on cold BLMs (D.Wollmann);
- p-Pb run at 4 Z TeV:
  - Can we adjust the BLM thresholds in a way similar to the one for 6.5 Z TeV?
  - Based on available info:
    - Use past qualification LMs at 4 Z TeV (2013);
    - Linear scaling of key quantities (e.g. quench level, endep profile in SC coils, …);

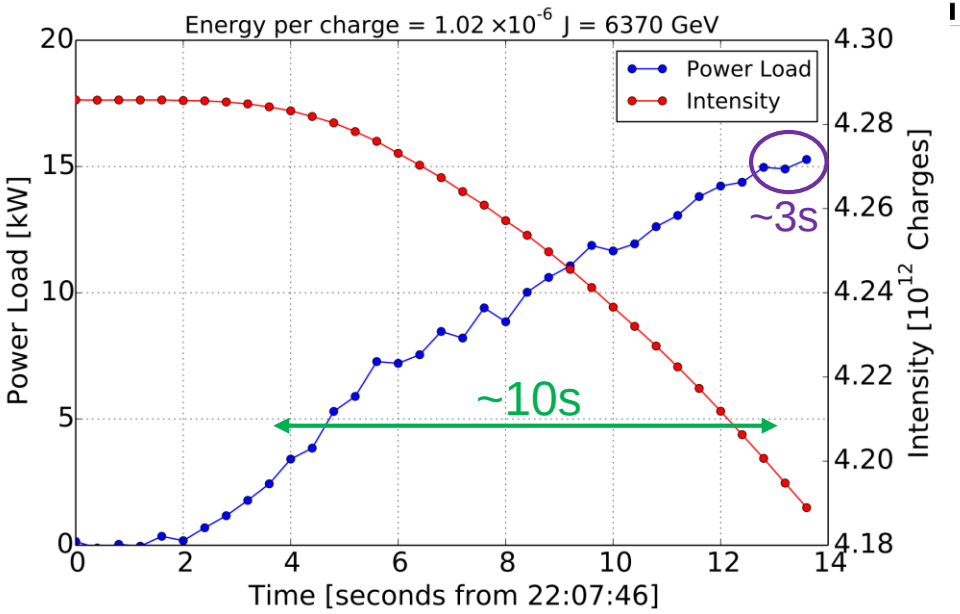


6.5 Z TeV

Recap Of 2015 Ion Coll Quench Test

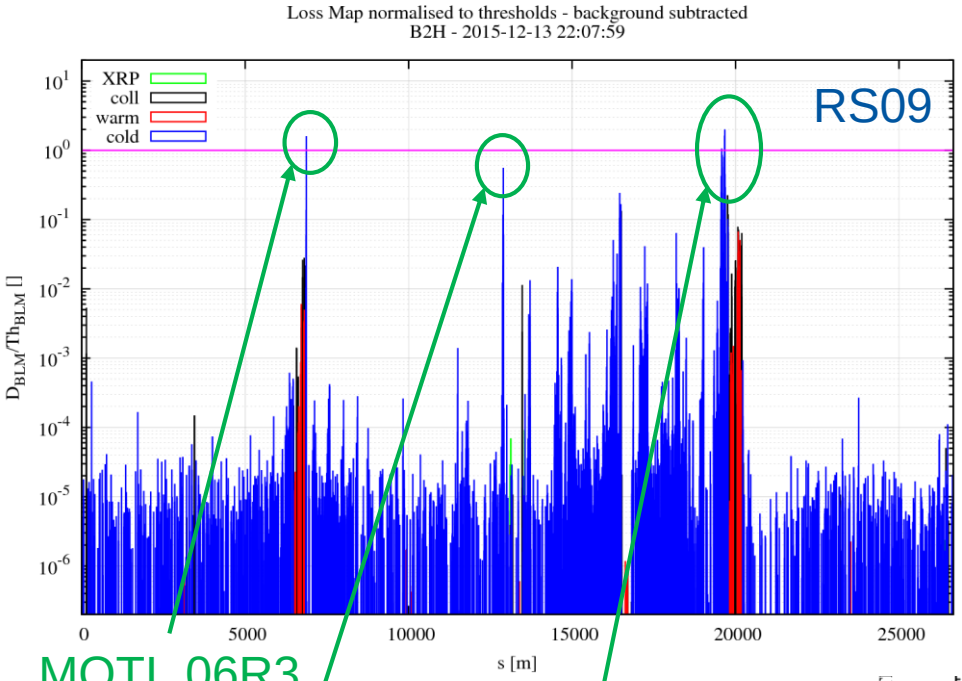
- Quench test performed inducing controlled losses (ADT) on B2H;
  → losses achieved with a relatively slow ramp, in the effort of "reproducing" steady state;
- Managed to quench MBB.9L7.B2 with ~10s of excitation up to 15 kW;
  → Representative of steady state?

Reports: 199th (2016-01-22) and 201st (2016-03-07) Coll WG Meetings, CERN-ACC-NOTE-2016-0031



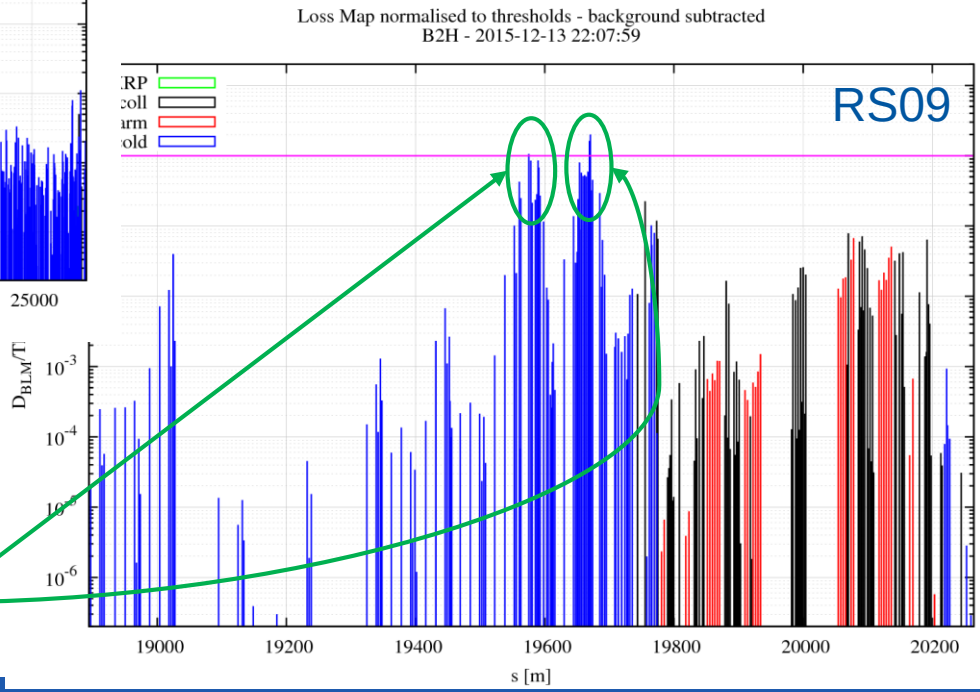
Time stamp	2015-12-13 22:08 (fill #4723)
P_L [kW] (50Hz BCT data)	15
Losses	1.47 10^{10} charges/s (i.e. 3.3 10^{10} nucleons/s or 1.79 10^{10} ions/s - ~2.6 nominal bunches /s)
η_{max} (during test) []	2.25 10^{-2} @BLMEI.09L7.B2I30_MBB
P_{DS} [W]	340
Result	MBB.9L7.B2 quenched
IR7 collimator settings	2015 operational, i.e.: 5.5σ (TCP), 8σ (TCSG), 14σ (TCLA)

Adjust BLM Thresholds in IR7 DS



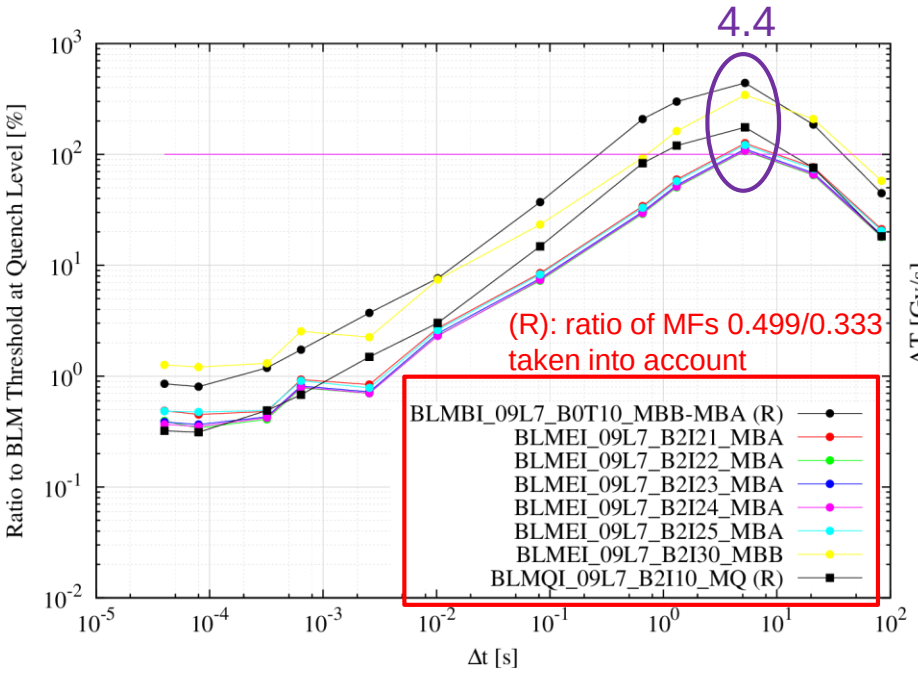
Ratio of BLM signals just before the dump (noise-subtracted) and BLM thresholds *used during ion operation* in 2015 (fill #4671, 2015-11-28, physics);

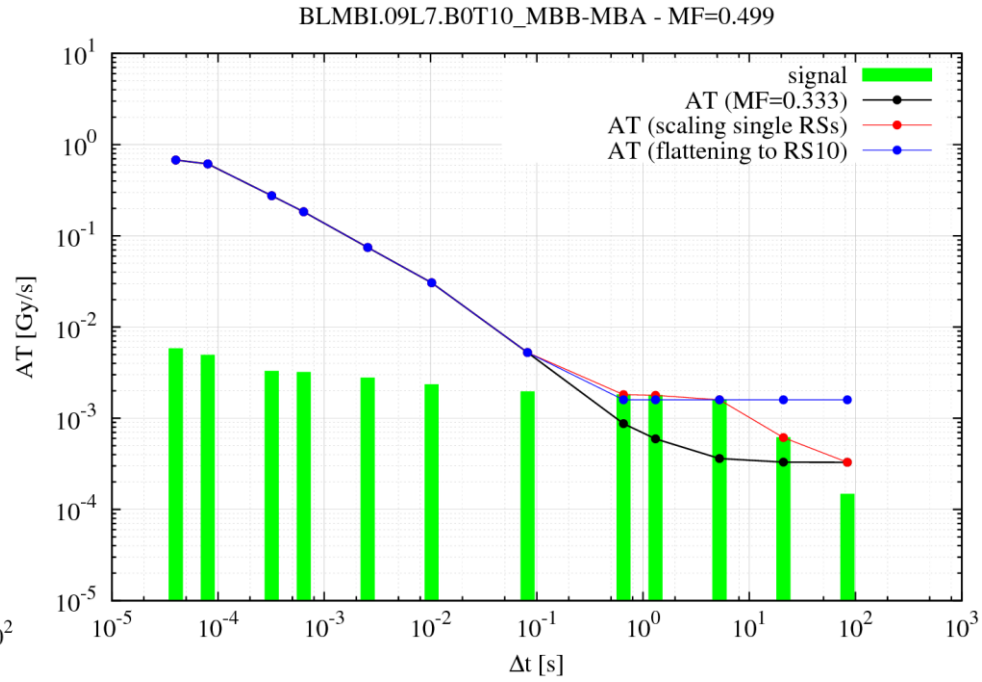
→ MF=0.499@MBMBs and MQ/MQM P1/2 as temporary measure against UFO-induced dumps ***NOT*** taken into account in these plots!



Adjust BLM Thresholds in IR7 DS (II)

Ratios to BLM thresholds at assumed quench level, i.e. when MF=0.333





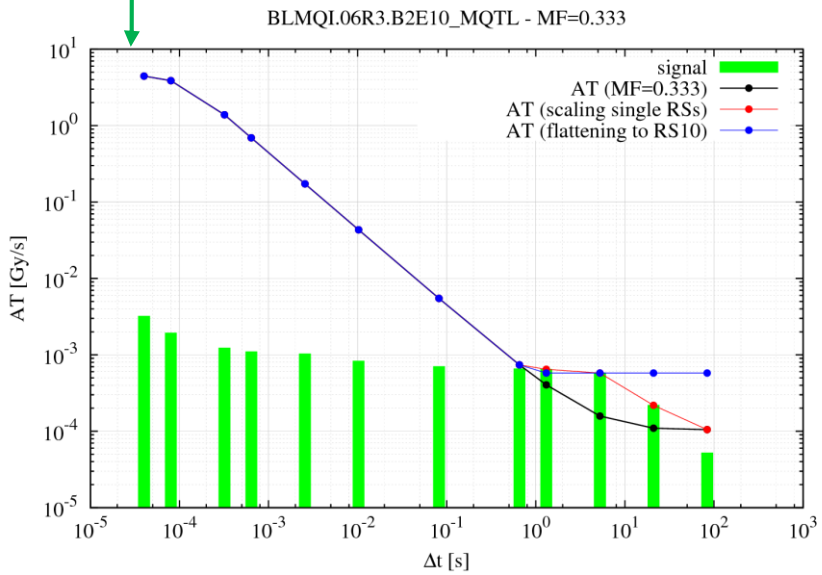
- RS10 (5.24s) in general requires the largest changes;
- Possible correction:
  - Flattening out at RS10 → "steady state" correction acceptable?
  - RS08 and RS09 occasionally need to be increased independently;

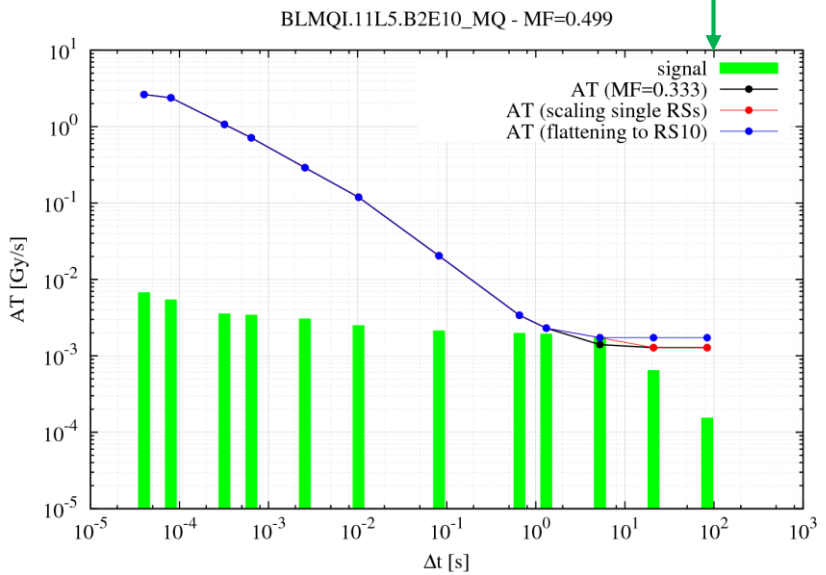
Adjust BLM Thresholds in IR7 DS (III)

Ratios to BLM thresholds at assumed quench level, i.e. when MF=0.333

BLMs requiring threshold change

		F		
BLM name	**MF**	**RS08**	**RS09**	**RS10**
BLMEI_09L7_B2I22_MBA	0.333	0.290787	0.504403	1.07131
BLMEI.09L7.B2I24_MBA	0.333	0.295333	0.51246	1.08626
BLMEI.09L7.B2I23_MBA	0.333	0.303822	0.527066	1.1189
BLMEI.09L7.B2I25_MBA	0.333	0.330602	0.573646	1.21811
BLMQI.11L5.B2E10_MQ	**0.499**	**0.581108**	**0.836897**	**1.22949**
BLMEI_09L7_B2I21_MBA	0.333	0.341336	0.592673	1.25915
BLMBI_11L7_B0T10_MBB-MBA	**0.499**	**0.709006**	**1.01829**	**1.50044**
BLMBI_11L7_B0T20_MBA-LEIR	0.333	0.733413	1.05769	1.55198
BLMQI.09L7.B2I10_MQ	**0.499**	**0.831845**	**1.20048**	**1.7532**
BLMEI.11L7.B2I30_MBB	0.333	0.489809	0.852761	1.79986
BLM2I_11L7_B2I24_MBA_MBA	**0.499**	**0.731396**	**1.27328**	**2.68778**
BLMEI.09L7.B2I30_MBB	0.333	0.933428	1.62142	3.44076
BLMQI.06R3.B2E10_MQTL	0.333	0.887987	1.59592	3.65819
BLMBI_09L7_B0T10_MBB-MBA	**0.499**	**2.07876**	**2.99564**	**4.40435**





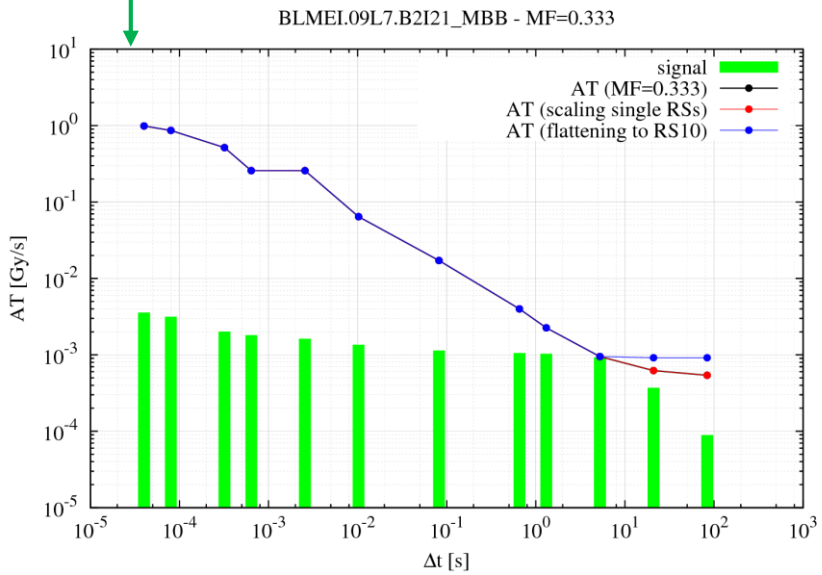
Adjust BLM Thresholds in IR7 DS (IV)

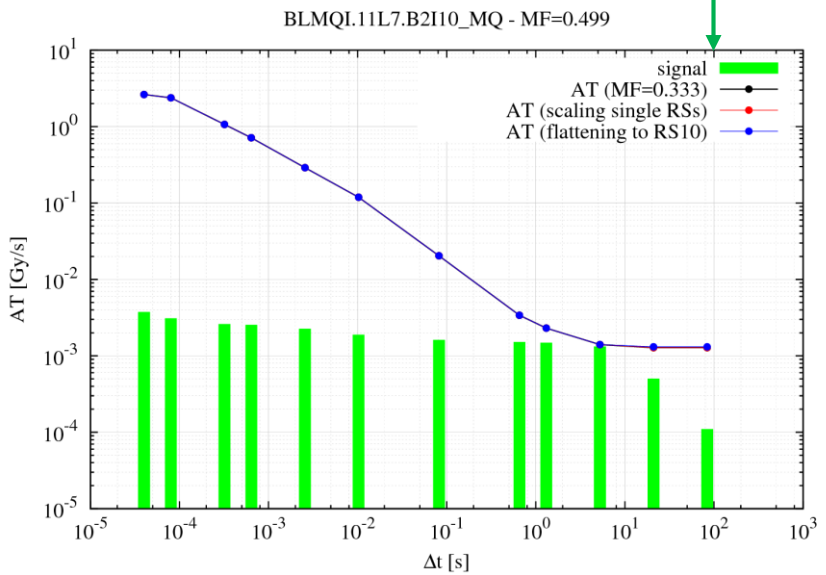
Ratios to BLM thresholds at assumed quench level, i.e. when MF=0.333

BLMs that could have thresholds optionally changed

BLMs with signal/threshold ratio > 0.5 for any RS

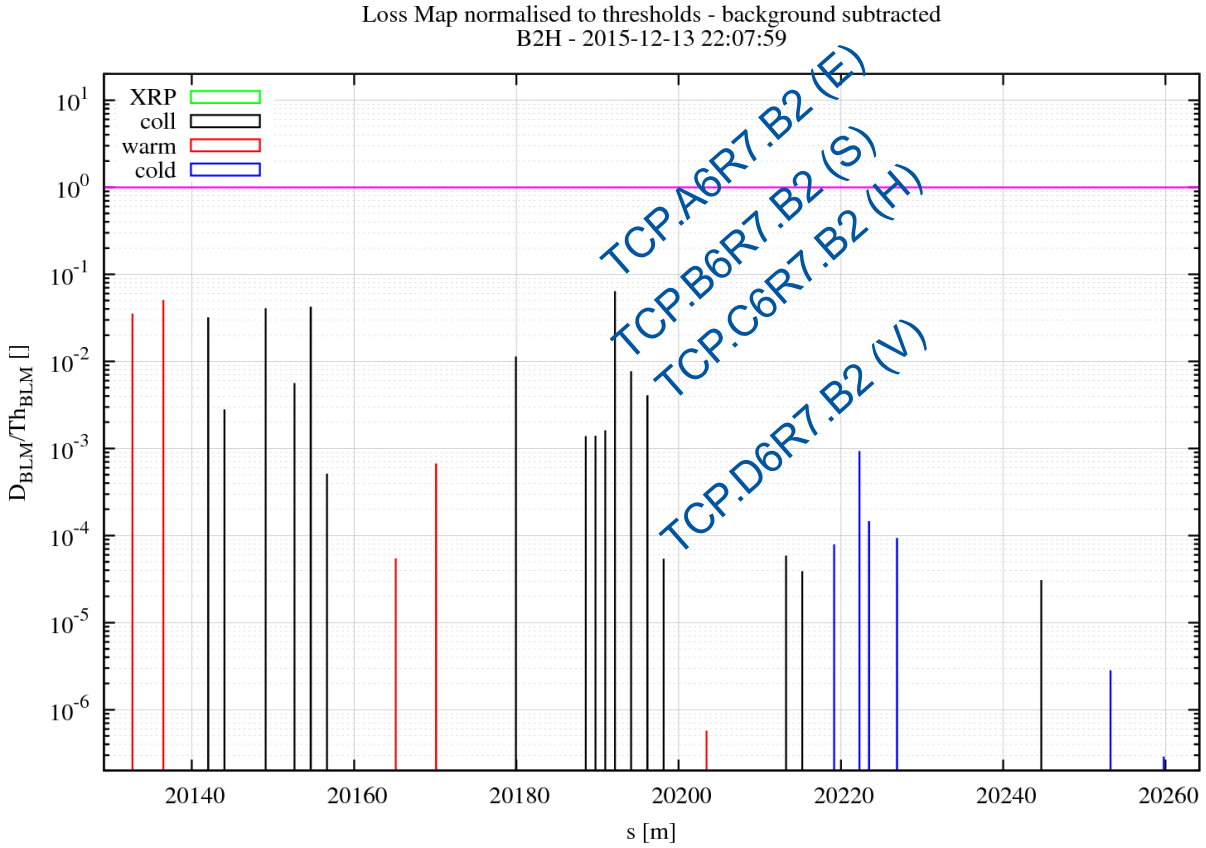
		F		
BLM name	**MF**	**RS08**	**RS09**	**RS10**
BLMEI.11L7.B2I25_MBB	0.333	0.155104	0.269818	0.569654
BLMEI.11L7.B2I21_MBA	0.333	0.162973	0.283856	0.600308
BLMEI.09L7.B2I22_MBB	0.333	0.183985	0.319639	0.679951
BLM2I_11L7_B2I22_MBA_MBA	**0.499**	**0.202445**	**0.352911**	**0.744907**
BLMQI.11L7.B2I10_MQ	**0.499**	**0.443288**	**0.639249**	**0.936049**
BLMEI_09L7_B2I21_MBB	0.333	0.261115	0.453575	0.966629





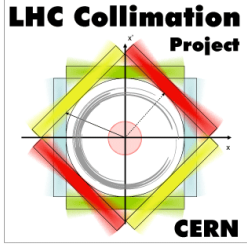
Adjust BLM Thresholds at IR7 TCPs

Let's set BLM thresholds at IR7 TCP collimators such that we dump on collimators instead of on cold BLMs in the IR7 DS;



At least a factor ~100 would be needed…

→ Aren't we going to dump too early with protons?



4 Z TeV

Adjust BLM Thresholds

- Idea: let's use 2013 qualification loss maps to extrapolate BLM signals at quench;
- …but no quench due to ion collimation took place at 4 Z TeV:
  - No measured beam power loss leading to quench;
  - No clear target of beam power loss for scaling LMs;
- Let's scale linearly (!!) what we know from 2015 quench test:

Power loss at worst location in IR7 DS estimated via LM (ie BLMs)

$$P_{DS} = \eta \times P_L \overset{!}{\equiv} P_Q$$

Power in SC coil at worst location

Cleaning inefficiency at worst location in IR7 DS estimated via LM

Beam power loss

Scaling of endep in SC coil with beam energy necessary to quench:

$$P_{Q,4ZTeV} = P_{Q,6.5ZTeV} \times F_{QL} \times F_{ED}$$

Scaling of quench limit with beam energy

Change of endep map due to beam energy

Extrapolated beam power loss at quench at 4 Z TeV:

$$P_{LQ,4ZTeV} = P_{LQ,6.5ZTeV} \times F_{QL} \times F_{ED} \times \frac{\eta_{6.5ZTeV}}{\eta_{4ZTeV}}$$

Adjust BLM Thresholds (II)

$$P_{DS} = \eta \times P_L \overset{!}{\equiv} P_Q$$

Usual assumption about BLM signals: they are supposed to reflect what happens to SC coils…

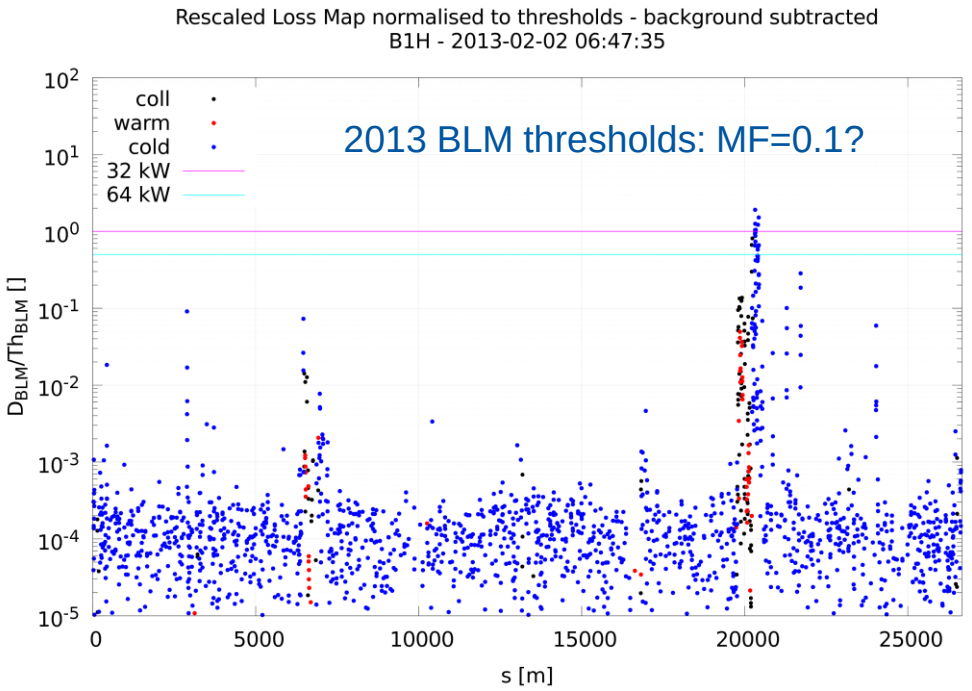
$$P_{LQ,4ZTeV} = P_{LQ,6.5ZTeV} \times F_{QL} \times F_{ED} \times \frac{\eta_{6.5ZTeV}}{\eta_{4ZTeV}}$$

Only B2H at 2.25 x 10^{-2}

F_{QL}=1.63 @ 3.5 Z TeV (P.D.Hermes, 2016-09-14 – slide #6);
F_{ED}=1 (arbitrary, without strong indications from simulations);

Case	η [x10^{-2}]	P_{LM} [kW]	P_{LQ} [kW]
B1H	1.74	2.53	32.0
B1V	1.12	2.05	49.6
B2H	2.08	2.93	26.7
B2V	1.37	1.20	40.7

NB: P_{LM} estimated with:
- calib: from RS12 and total intensity loss;
- P_{LM} ~RS09/calib;



Adjust BLM Thresholds (III)

name	s [m]	threshold at QL [Gy/s]	ratio new/current []	current threshold [Gy/s]	LM case	Ratio @ 6.37 Z TeV (RS10)
BLMEI.09R7.B1E21_MBA	20311.16	1.78E-03	1.06	1.68E-03	B1V	
BLMEI.09R7.B1E24_MBB	20329.16	1.82E-03	1.08	1.68E-03	B1V	
BLMQI.11R7.B1E21_MQ	20430.99	2.10E-03	1.09	1.92E-03	B1V	
BLMEI.09L7.B2I24_MBA	**19659.16**	**1.87E-03**	**1.11**	**1.68E-03**	**B2V**	**1.09**
BLMEI.09R7.B1E22_MBB	20324.16	2.15E-03	1.28	1.68E-03	B1V	
BLMEI.09R7.B1E23_MBB	20326.66	2.33E-03	1.38	1.68E-03	B1V	
BLMEI.09R7.B1E22_MBA	20314.16	2.42E-03	1.44	1.68E-03	B1V	
BLM2I.11R7.B1E23_MBB_MBB	20405.65	2.43E-03	1.44	1.68E-03	B1V	
BLMQI.09R7.B1E10_MQ	20335.33	6.31E-03	1.51	4.19E-03	B1V	
BLMEI.11L7.B2I30_MBB	**19589.74**	**2.54E-03**	**1.51**	**1.68E-03**	**B2V**	**1.80**
BLMQI.15L7.B2I10_MQ	19345.37	2.14E-03	1.53	1.40E-03	B2H	
BLMEI.09R7.B1E23_MBA	20316.66	2.63E-03	1.56	1.68E-03	B1V	
BLMQI.11L7.B2I10_MQ	19560.42	2.30E-03	1.65	1.40E-03	B2V	
BLM2I.11L7.B2I24_MBA_MBA	**19578.31**	**2.80E-03**	**1.66**	**1.68E-03**	**B2V**	**2.69**
BLMEI.09R7.B1E21_MBB	20321.66	3.07E-03	1.82	1.68E-03	B1V	
BLMEI.09L7.B2I30_MBB	**19669.16**	**3.14E-03**	**1.86**	**1.68E-03**	**B2V**	**3.44**
BLMQI.11R7.B1E10_MQ	20428.58	1.08E-02	2.57	4.19E-03	B1V	
BLMEI.09R7.B1E30_MBA	20319.16	4.70E-03	2.79	1.68E-03	B1V	
BLMQI.09L7.B2I10_MQ	**19653.66**	**5.99E-03**	**4.29**	**1.40E-03**	**B2H**	**1.75**

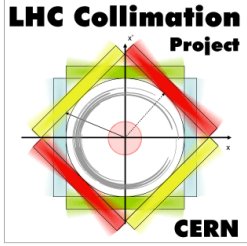
Ratios wrt to 2013 BLM thresholds → MF=0.1?

Conclusions

- Presented first ideas on how to set BLM thresholds in IR7 for 2016 p-Pb run;
- 6.5 Z TeV:
  - Let's re-use the info available from ion collimation quench test (6.37 Z TeV);
  - DS:
    - Flattening out according to RS10;
    - Local correction of RS08/RS09 based on LM at quench;
    - BLMs have been identified wrt 2015 operational thresholds → BLM team to sort out families!
  - IR7 collimators:
    - Let's dump on collimators before dumping on cold BLMs in IR7 DS;
    - Let's modify only TCP BLMs (simplest solution) → required factor 100!
    - Most probably, not popular solution due to ease of reaching thresholds with proton beam;

Conclusions (II)

- 4 Z TeV:
  - Let's use the 2013 qualification loss maps;
  - Let's assume as max allowed power loss the 2015 quench power loss, linearly scaled according to:
    - Quench limit;
    - Endep profile in SC cable;
  - BLMs have been identified wrt 2013 operational thresholds → BLM team to sort out families!
- How to harmonize the two set of changes?



Reserve Slides