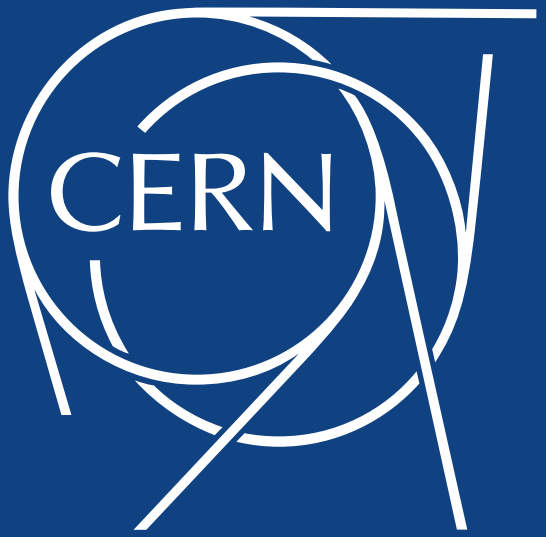
CERN

BLM Threshold Changes Related to Multiple UFOs (MUFOs)

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Summary of loss events observed in 15R8 (Beam 2)

Loss events before detecting obstacle:

Date	Time	Comment	Energy (TeV)	Time since injection	Time at flat-top	Intensity during event	Bunches	Intensity loss (BCT)
12-Apr	13:10	dump	6.5	0h50	0h20	8.20E+09	1	
12-Apr	15:29	no dump	0.45	at inj.	-	8.30E+09	1	
12-Apr	21:13	no dump	0.45	at inj.	-	2.40E+09	1	
12-Apr	21:38	no dump	0.45	at inj.	-	7.90E+09	1	
13-Apr	00:24	no dump	3	-	-	8.30E+09	1	8.00E+08
13-Apr	04:13	quench	6.5	2h30	0h40	8.00E+09	1	
13-Apr	16:24	no dump	0.45	0h18	-	6.70E+09	1	5.00E+08
→ No unexpected aperture bottleneck found when applying vertical orbit bumps (450 GeV)								
14-Apr	09:22	quench	6.5	0h50	0h15	6.90E+09	1	
14-Apr	22:14	no dump	0.45	at inj.	-	3.00E+09	1	
→ New BLM thresholds in cell 15R3 (reduced by a factor 2.2)								
15-Apr	07:19	dump	6.5	2h00	1h20	1.00E+10	1	
15-Apr	18:33	no dump	0.45	at inj.	-	6.70E+09	1	
15-Apr	20:43	no dump	0.45	at inj	-	6.90E+09	1	
15-Apr	20:52	no dump	0.45	0h09	-	6.60E+09	1	9.40E+08
→ Additional BLMs installed along MB.C15R8 to narrow down loss location								
16-Apr	00:03	dump	6.5	3h15	1h15	5.20E+09	1	
16-Apr	02:03	no dump	0.45	at inj.	-	1.20E+10	1	
17-Apr	00:53	no dump	0.45	at inj.	-	8.50E+09	1	
17-Apr	00:55	no dump	0.45	0h03	-	8.36E+09	1	9.00E+08
17-Apr	03:41	dump	6.5	1h05	0h35	1.00E+10	1	
17-Apr	04:52	no dump	0.45	at inj.	-	1.00E+10	1	
17-Apr	04:53	no dump	0.45	0h01	-		1	1.30E+09

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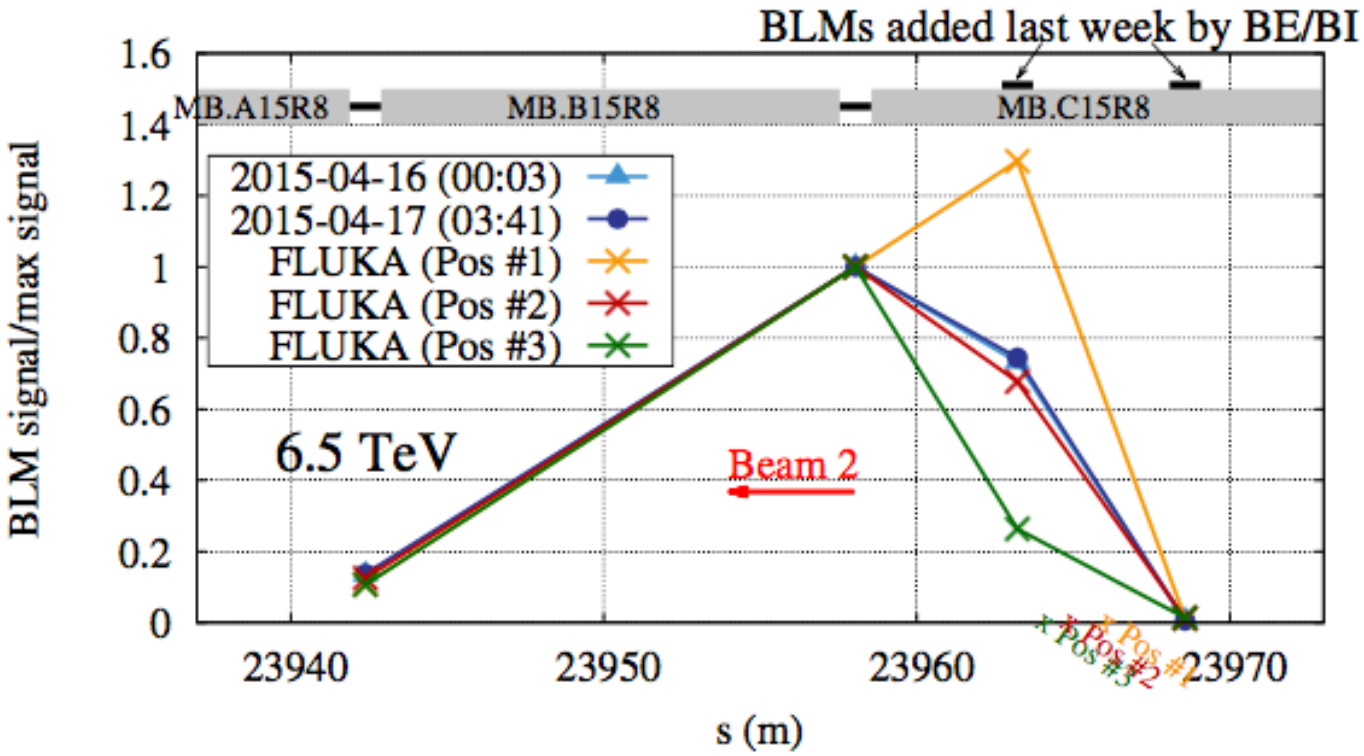
6.5 TeV 450 GeV Injection

Localization inside MB.C15R8

The BLM pattern generally provides a very good indication of the loss location:



Already a shift of ±1 m would result in a quite different BLM pattern.

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BLM Sensitivity in MUFO Location

The BLM sensitivity is ~2x better in the MUFO location than in the point for which thresholds are set. (Note: Plot is for Beam 1)

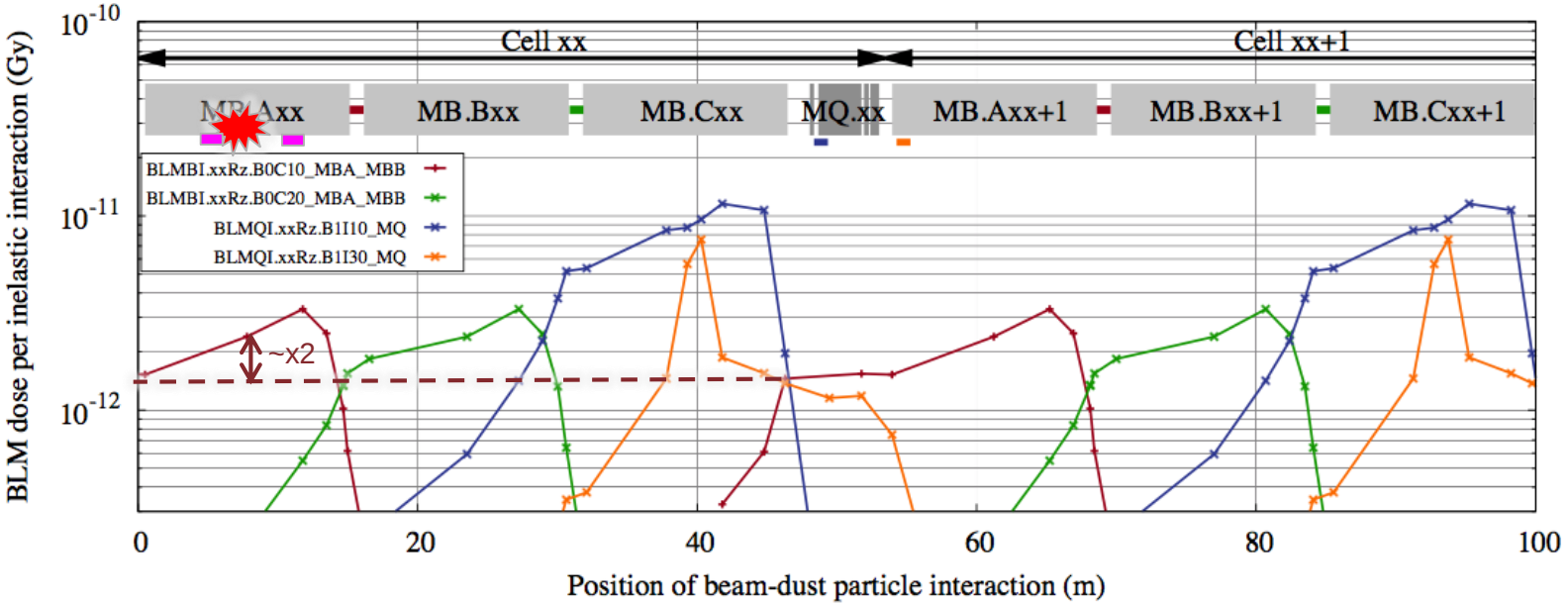

Figure: Dependency of BLM signals on the dust particle position in the Beam 1 vacuum chamber as predicted by particle shower simulations (for protons at 7 TeV). Results apply to an arbitrary arc cell located on the right of an interaction point, with Beam 1 as the internal beam and the MQ focussing on the horizontal plane. Signals of BLMs on the other beam are not shown. All signals are expressed per inelastic proton-nucleus interaction. The beam direction is from the left to the right.

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What have we learned about Thresholds?

- Our uncertainty on the thresholds was x4, thresholds being set at the optimistic upper bound.
- The loss scenario for which thresholds were set were SINGLE UFOs, NOT MUFOs.
- Quenches occurred after 7 and 4 loss spikes, respectively, and thresholds were lowered by 2.2 for the affected BLMs only.
- No direct conclusions for the single-UFO scenario can be drawn from the observation of MUFO quenches!
- One dump occurred without quench after a single spike at thresholds lowered by 2.2, i.e., 4.4 times below the expected BLMSignal@Quench for that loss location.
- This is below the range of uncertainty, i.e., it does not provide an improved lower bound for UFO quench thresholds.

In short: We haven't learned much yet.

The Role of the MonitorFactor

Threshold formulas:

$$\mathrm{MasterThreshold}(E,t) = 3 * \mathrm{BLMSignal@Quench}(E,t) * \mathrm{AdHoc}(E,t)$$

$$\mathrm{AppliedThreshold}(E,t) = \mathrm{MonitorFactor} * \mathrm{MasterThreshold}(E,t)$$

We use the MonitorFactor ∈ (0…1]:

1. To define the threshold wrt. the assumed BLMSignal@Quench (e.g. 0.333 for arc and DS, and 0.1 on all other SC magnets);
2. To temporarily account for a new loss scenario (e.g., MD tests, the occurrence of MUFOs, etc.);
3. In rare cases we run with MonitorFactor = 1 and adequately reduced MasterThreshold in order to minimize the impact of the electronic limit (i.e. MasterThreshold ≤ 23 Gy/s).

In Case 2, if the loss scenario becomes permanent, a new BLM family should be created and the MasterThreshold should be set for the new scenario. Otherwise MonitorFactors should be returned to normal.

Next steps for thresholds in 15R8

Ever since the aperture restriction is manifest on the bottom of the beam screen, no more MUFOs have been observed.

We therefore propose to

1. Keep thresholds lowered while the loss location is actively investigated with beam.
2. Raise the MonitorFactor back to 0.333 afterwards, provided the MUFO scenario is not observed again.

Moreover, we will attempt to model MUFO events in order to learn more about our electro-thermal model of beam-induced quenches.