New Thresholds for BLMs Near Wire Scanners

BLMTWG
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The Wire Scanner Loss Scenario

The loss scenario was studied in detail for the analysis of the 2010 wire-scanner quench test at 3.5 TeV.

The comparison of the QP3 electro-thermal quench-level model and the quench-test analysis showed that the standard cooling model is consistent to within 50% (warranting a safety factor to be taken into account later).

We use the same FLUKA and QP3 models as in the quench test analysis.

TABLE III. Quench-level comparison; FLUKA estimate and electro-thermal MQED estimate in the MBRB coil for the wire-scanner quench test. Lower values in electro-thermal estimates correspond to a reduced cooling model; upper values correspond to the standard cooling model.

v_w [m/s]	N_q/N_w [%]	P. Show. [mJ/cm^3]	El.-Therm. [mJ/cm^3]
0.15	n/a	>18	26-37
0.05	30	20	25-35
0.05	45	30	26-42

No Quench   Quench

TABLE IV. Quench-level comparison; FLUKA bound and the electro-thermal MQED estimate in the MQY coil for the wire-scanner quench test.

v_w [m/s]	Particle Shower Calculation [mJ/cm^3]	Electro-Thermal Estimate [mJ/cm^3]
0.05	>50	52
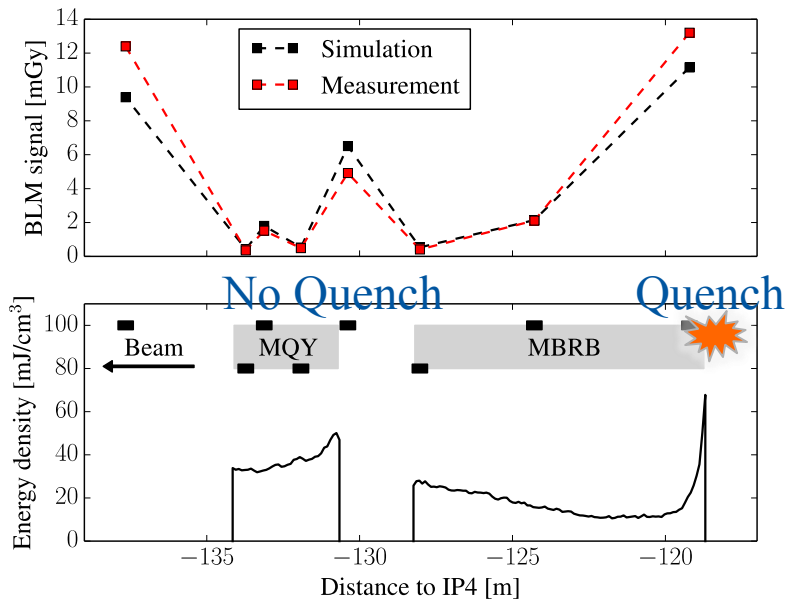
Formulas and Assumptions

Recall the formulas defining the applied thresholds.

$$\text{BLMSignal@Quench}(E, t) = \frac{\text{BLMResponse}(E, t) * \text{QuenchLevel}(E, t)}{\text{EnergyDeposit}(E, t)} \qquad \text{Gy} = \frac{\text{Gy/p} * \text{mJ/cm}^3}{\text{mJ/(cm}^3\text{p)}}$$

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

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

BLMResponse and EnergyDeposit are provided by FLUKA, the D4-QuenchLevel by QP3, and the MonitorFactor = 0.1 to keep a safety factor 3 from the assumed BLMSignal@Quench.

We compute new thresholds for the two monitors on D4 (MBRB) and the two monitors on Q5 (MQY) magnets on the side of the scanned beam.

In the past, also the non-scanned side on Q5, as well as monitors on Q6 (MQY) were equipped with special wire-scanner thresholds. We verified that the new generic thresholds for Q6 and Q5 (non-scanned side) do not limit the operation of the wire scanner. At the same time the wire-scanner specific thresholds on D4 and Q5 (scanned side) provide a redundant protection of D4 from quenching during wire scans.

New Wire-Scanner Families

Monitors in the new families THRI.LS.P1_MQY_WS and THRI.LS.P2_MQY_WS have the same thresholds – those of the larger signal in P1 (separate families are kept for consistency with all other IPQ families). Monitors in the new family THRI.LS_MBRB_WS have identical thresholds – those of the larger signal in P1.
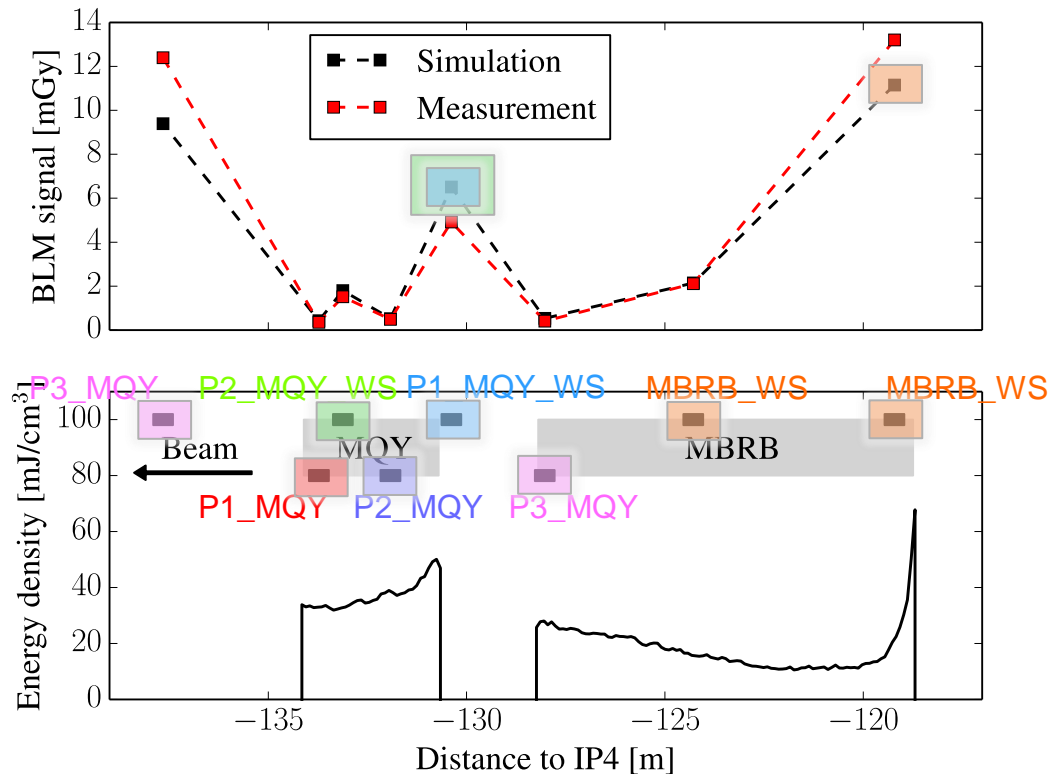
BLM families indicated by colour.

Threshold Comparison

New thresholds provide considerably more latitude for wire scans
(t < 10 ms). Increases in the steady-state integration times are only partly due to the new QuenchLevel model. The rest due to the change of loss scenario.

The old scenario for MBRB was the strong-kick event (single-turn loss!), the new generic scenario is UFOs.

The old scenario for MQY was losses on MB-MQ interconnects for the BLMResponse, and the strong-kick event for the EnergyDeposit, the new generic scenario is the dynamic orbit bump (DOB).

In order not to increase the long-RS thresholds too much wrt. old thresholds wrt. the generic MQY and IPD thresholds, they should be reduced artificially by means of AdHoc corrections (1, 1, 1, 1, 1, 1, 0.7, 0.5, 0.4, 0.2, 0.15, 0.15).
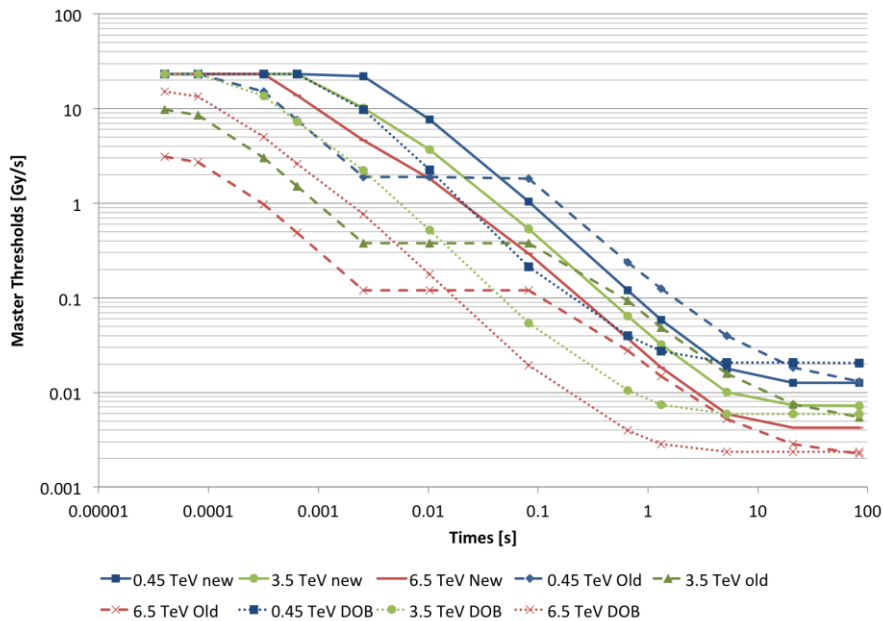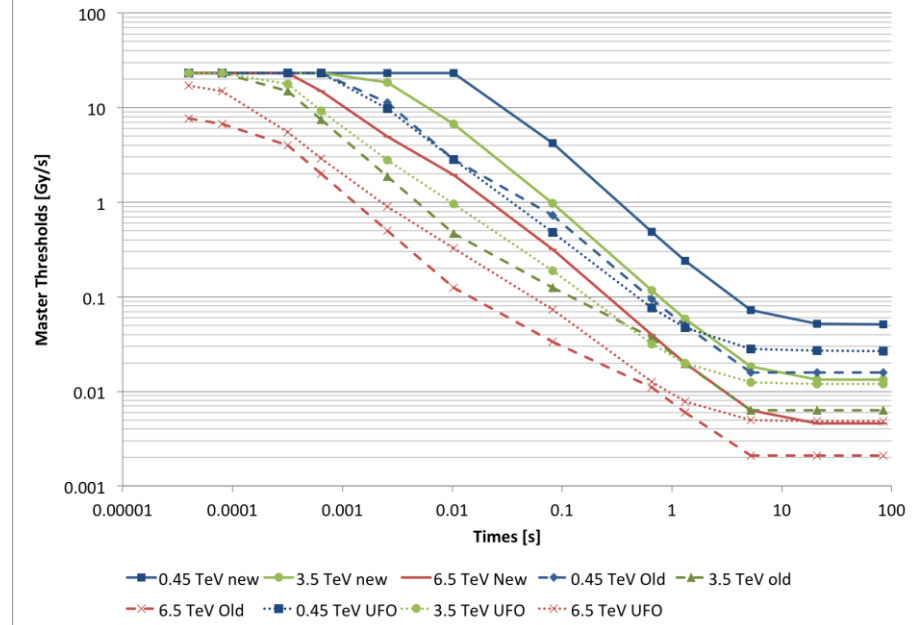
List of New Families and Monitors

New WS families:

THRI.LS.P1_MQY_WS	THRI.LS.P2_MQY_WS	THRI.LS_MBRB_WS
BLMQI.05L4.B2E10_MQY	BLMQI.05L4.B2E20_MQY	BLMEI.05L4.B2E10_MBRB
BLMQI.05R4.B1I10_MQY	BLMQI.05R4.B1I20_MQY	BLMEI.05L4.B2E20_MBRB
		BLMEI.05R4.B1I10_MBRB
		BLMEI.05R4.B1I20_MBRB

Maximum Number of Protons Lost

From $\text{AppliedThreshold}(E, t) / \text{BLMResponse}(E, t)$ we find the maximum number of protons lost per second in a wire scan to trip the BLM thresholds. (Columns ~ RunningSums, Rows ~ EnergyLevels)

P+/s	0.00004	0.00008	0.00032	0.00064	0.00256	0.01024	0.08192	0.65536	1.31072	5.24288	20.97152	83.88608
0.24564	4.27E+12	2.44E+12	1.71E+12	1.71E+12	1.71E+12	1.71E+12	3.11E+11	3.59E+10	1.76E+10	5.33E+09	3.81E+09	3.78E+09
0.4914	4.18E+12	2.39E+12	1.67E+12	1.67E+12	1.67E+12	1.67E+12	2.65E+11	3.06E+10	1.50E+10	4.55E+09	3.25E+09	3.22E+09
0.73716	4.09E+12	2.34E+12	1.64E+12	1.64E+12	1.64E+12	1.64E+12	2.23E+11	2.59E+10	1.27E+10	3.85E+09	2.76E+09	2.73E+09
0.98292	4.01E+12	2.29E+12	1.60E+12	1.60E+12	1.60E+12	1.40E+12	1.90E+11	2.22E+10	1.09E+10	3.30E+09	2.38E+09	2.35E+09
1.22868	3.93E+12	2.24E+12	1.57E+12	1.57E+12	1.57E+12	1.20E+12	1.64E+11	1.92E+10	9.41E+09	2.87E+09	2.07E+09	2.05E+09
1.47444	3.85E+12	2.20E+12	1.54E+12	1.54E+12	1.54E+12	1.04E+12	1.43E+11	1.68E+10	8.22E+09	2.51E+09	1.82E+09	1.80E+09
1.7202	3.77E+12	2.16E+12	1.51E+12	1.51E+12	1.51E+12	9.04E+11	1.25E+11	1.47E+10	7.22E+09	2.22E+09	1.61E+09	1.59E+09
1.96596	3.70E+12	2.11E+12	1.48E+12	1.48E+12	1.48E+12	7.90E+11	1.10E+11	1.30E+10	6.38E+09	1.97E+09	1.43E+09	1.42E+09
2.21172	3.63E+12	2.07E+12	1.45E+12	1.45E+12	1.45E+12	6.98E+11	9.80E+10	1.16E+10	5.69E+09	1.76E+09	1.28E+09	1.27E+09
2.45748	3.56E+12	2.04E+12	1.43E+12	1.43E+12	1.43E+12	6.19E+11	8.73E+10	1.04E+10	5.10E+09	1.58E+09	1.15E+09	1.14E+09
2.70324	3.50E+12	2.00E+12	1.40E+12	1.40E+12	1.40E+12	5.49E+11	7.80E+10	9.28E+09	4.58E+09	1.42E+09	1.04E+09	1.03E+09
2.949	3.44E+12	1.96E+12	1.37E+12	1.37E+12	1.36E+12	4.88E+11	6.98E+10	8.33E+09	4.12E+09	1.28E+09	9.36E+08	9.27E+08
3.19476	3.38E+12	1.93E+12	1.35E+12	1.35E+12	1.20E+12	4.34E+11	6.25E+10	7.49E+09	3.71E+09	1.16E+09	8.47E+08	8.39E+08
3.44052	3.32E+12	1.90E+12	1.33E+12	1.33E+12	1.06E+12	3.85E+11	5.60E+10	6.74E+09	3.35E+09	1.05E+09	7.67E+08	7.59E+08
3.68628	3.26E+12	1.86E+12	1.31E+12	1.31E+12	9.42E+11	3.44E+11	5.05E+10	6.11E+09	3.04E+09	9.56E+08	6.97E+08	6.90E+08
3.93204	3.21E+12	1.83E+12	1.28E+12	1.28E+12	8.35E+11	3.08E+11	4.55E+10	5.56E+09	2.77E+09	8.70E+08	6.34E+08	6.28E+08
4.1778	3.16E+12	1.80E+12	1.26E+12	1.26E+12	7.46E+11	2.77E+11	4.12E+10	5.05E+09	2.51E+09	7.92E+08	5.77E+08	5.72E+08
4.42356	3.11E+12	1.77E+12	1.24E+12	1.24E+12	6.66E+11	2.49E+11	3.74E+10	4.57E+09	2.28E+09	7.21E+08	5.25E+08	5.20E+08
4.66932	3.06E+12	1.75E+12	1.22E+12	1.22E+12	5.93E+11	2.23E+11	3.38E+10	4.14E+09	2.06E+09	6.55E+08	4.77E+08	4.73E+08
4.91508	3.01E+12	1.72E+12	1.20E+12	1.20E+12	5.26E+11	1.99E+11	3.05E+10	3.74E+09	1.86E+09	5.95E+08	4.33E+08	4.29E+08
5.16084	2.96E+12	1.69E+12	1.19E+12	1.19E+12	4.67E+11	1.77E+11	2.75E+10	3.37E+09	1.68E+09	5.37E+08	3.91E+08	3.88E+08
5.4066	2.92E+12	1.67E+12	1.17E+12	1.17E+12	4.13E+11	1.58E+11	2.46E+10	3.02E+09	1.51E+09	4.84E+08	3.51E+08	3.49E+08
5.65236	2.88E+12	1.64E+12	1.15E+12	1.09E+12	3.62E+11	1.39E+11	2.19E+10	2.70E+09	1.35E+09	4.34E+08	3.14E+08	3.13E+08
5.89812	2.83E+12	1.62E+12	1.13E+12	9.46E+11	3.16E+11	1.22E+11	1.95E+10	2.41E+09	1.21E+09	3.87E+08	2.79E+08	2.79E+08
6.14388	2.79E+12	1.60E+12	1.12E+12	8.20E+11	2.74E+11	1.07E+11	1.72E+10	2.14E+09	1.07E+09	3.43E+08	2.47E+08	2.48E+08
6.38964	2.75E+12	1.57E+12	1.10E+12	7.08E+11	2.36E+11	9.29E+10	1.51E+10	1.90E+09	9.41E+08	3.01E+08	2.17E+08	2.18E+08
6.6354	2.71E+12	1.55E+12	1.09E+12	6.06E+11	2.03E+11	8.04E+10	1.32E+10	1.66E+09	8.21E+08	2.62E+08	1.89E+08	1.89E+08
6.88116	2.68E+12	1.53E+12	9.40E+11	5.15E+11	1.72E+11	6.89E+10	1.14E+10	1.44E+09	7.10E+08	2.25E+08	1.62E+08	1.62E+08
7.12692	2.64E+12	1.51E+12	8.50E+11	4.65E+11	1.55E+11	6.26E+10	1.04E+10	1.31E+09	6.49E+08	2.04E+08	1.47E+08	1.47E+08
7.37268	2.60E+12	1.49E+12	8.26E+11	4.52E+11	1.51E+11	6.08E+10	1.01E+10	1.28E+09	6.30E+08	1.98E+08	1.43E+08	1.43E+08
7.61844	2.57E+12	1.47E+12	8.03E+11	4.39E+11	1.47E+11	5.91E+10	9.85E+09	1.24E+09	6.13E+08	1.93E+08	1.39E+08	1.39E+08
7.8642	2.54E+12	1.45E+12	7.81E+11	4.27E+11	1.43E+11	5.75E+10	9.59E+09	1.21E+09	5.96E+08	1.88E+08	1.35E+08	1.35E+08

MQY Position - 2 Cell 6, Old Applied Thresholds for MF 0.5 vs. New MQY DOB for MF= 0.1