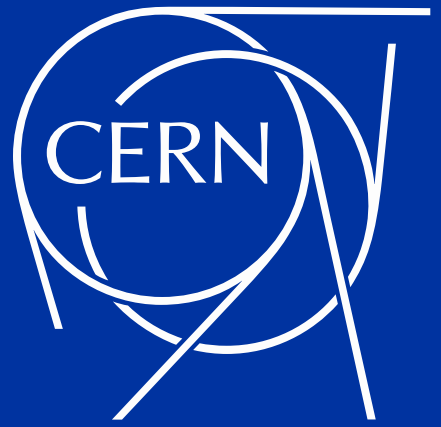


BLM threshold changes for MD7224 proton collimation QT (6.8 TeV)

A. Lechner, B. Salvachua, S. Morales Vigo, M. D’Andrea on behalf of the QT team

rMPP - 28/10/2022

Introduction

- Thresholds in regular operation:
  - The present IR7 BLM threshold strategy allows for a power loss of up to 200 kW for 20 s (RS11) and a power loss of 40 kW for up to 80 s (RS12).
  - These settings (200kW/40kW) correspond to a Monitor Factor of 0.4, while a power loss of 500 kW in RS09-11 (100 kW in RS12) can in principle be accommodated by raising the Monitor Factor to 1.0.
  - In practice, the present thresholds might limit the power loss to less than 500 kW even if the Monitor Factor is raised to 1.0 → need a few corrections to BLM response factors in the new threshold model (will be implemented in the YETS, i.e., after the QT).
- Quench test (QT):
  - The QT aims for a constant power loss of **1 MW** for a duration of **O(10s)**
  - We therefore need to increase the thresholds for many families in IR7 and IR6

Overview of concerned equipment

- Number of BLMs in IR7 (+DS) needing threshold changes:
  - Primary collimators (1x TCPPM, 1x TCP)
  - Secondary collimators (6x TCSPMs, 11x TCSGs)
  - Active absorbers (5x TCLAs)
  - Warm quadrupoles (6x MQWs)
  - Cold magnets (3x Q6, 1x MB.9)
- Number of BLMs in IR6 needing threshold changes
  - Protection absorbers (1x TCSP)
  - Cold magnets (3x Q4, 2x Q5)

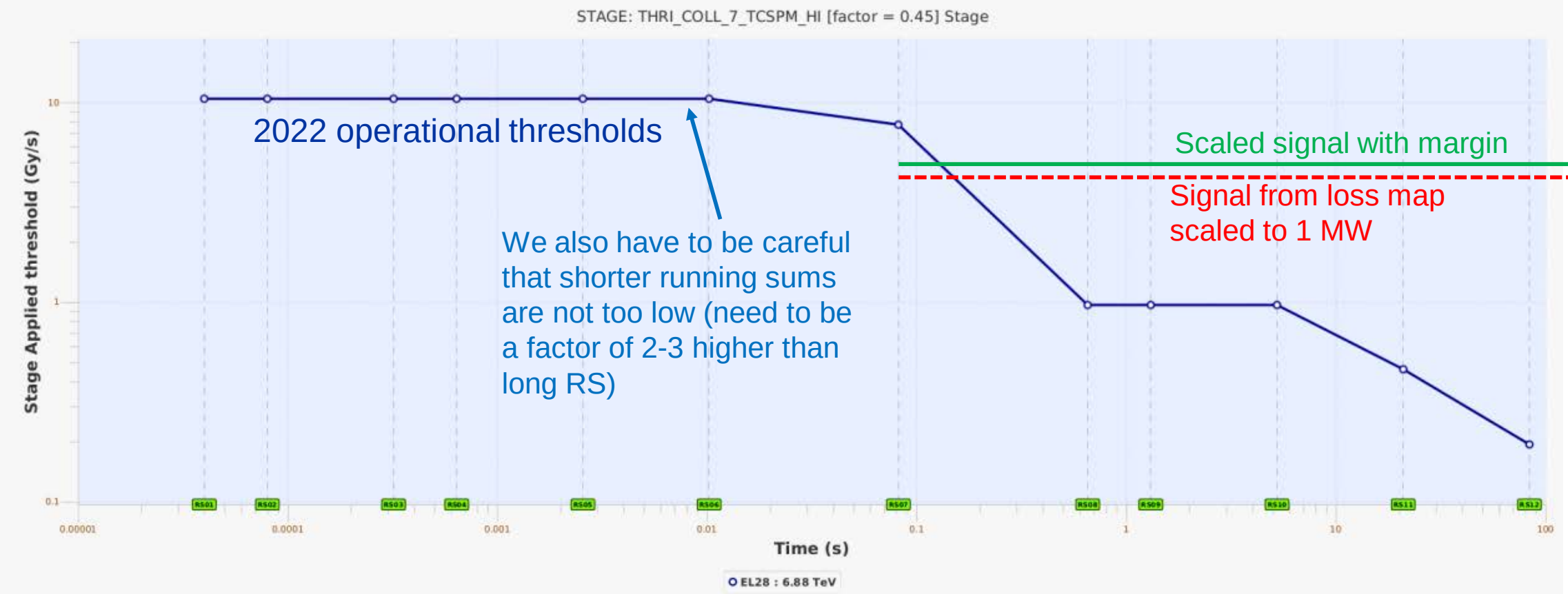
Scaling of thresholds

- The thresholds are being scaled from following loss maps:
  - **Nominal settings:**
    - Timestamp: 2022-06-29 01:36:25
    - Estimated power loss: 6.5 kW (for RS08)
  - **Relaxed settings:**
    - Timestamp: 2022-08-11 17:26:25
    - Estimated power loss: 6.9 kW (for RS08)
- We propose to use one **single set of BLM thresholds for both collimator settings in the Quench Test** (taking for each BLM the most limiting response from both loss maps)
  - This shall reduce the risk of possible errors during the implementation

Scaling of thresholds

- Margin:
  - The thresholds **have to be set** for a power loss **somewhat higher than 1 MW**, in order to avoid premature dumps during the quench test
  - This margin shall also account for possible uncertainties in the scaling of thresholds from loss maps (loss maps were for kW losses) → this applies in particular for BLMs close to the noise level
  - Have a tentative list of the required margin for each BLM family (typically **1.2** and **1.5**) but these factor still have to be finalized
- In most cases it is not sufficient to change the Monitor Factor, but we need to change master thresholds
  - Will create new BLM families, which derive from original families (adding suffix _**QT22**)
  - The changes will only be implemented in Energy Level 28 (=energy level active at 6.8 TeV)
  - For each new family, a correction in the long RS will be introduced (which is determined by the most limiting BLM in the original family)

Example: TCSPM (HI family)



Concerned BLMs (collimators in IR7)

To be finalized and cross-checked

Tables are purely the scaled signal-threshold ratios RS08 at 1 MW wrt 2022 thresholds (**without margin yet**)

	Expected signal-threshold ratio **<0.3**
	Expected signal-threshold ratio **≥0.3** and **<0.8**
	Expected signal-threshold ratio **≥0.8** and **<1.0**
	Expected signal-threshold ratio **≥1.0**

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nominal	Relaxed
BLMTI.06L7.B1E10_TCP.D6L7.B1	THRI_COLL_7_TCPPM	3.601068332	0.4	1.440427333	<0.1	<0.1
BLMTI.06L7.B1E10_TCP.C6L7.B1	THRI_COLL_7_TCPPM	3.601068332	*0.5*	1.800534166	<0.1	<0.1
BLMTI.06L7.B1E10_TCP.B6L7.B1	THRI_COLL_7_TCP	2.806213245	*0.5*	1.403106623	<0.1	<0.1
BLMTI.06R7.B2I10_TCP.B6R7.B2	THRI_COLL_7_TCP	2.806213245	*0.5*	1.403106623	4.11	4.59
BLMTI.06R7.B2I10_TCP.C6R7.B2	THRI_COLL_7_TCPPM	3.601068332	*0.5*	1.800534166	2.10	2.77
BLMTI.06R7.B2I10_TCP.D6R7.B2	THRI_COLL_7_TCPPM	3.601068332	0.4	1.440427333	<0.1	<0.1

+5 TCLA BLMs

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMTI.06L7.B1E10_TCSG.A6L7.B1	THRI_COLL_7_TCSG_HI	2.790817043	0.4	1.116326817	<0.1	<0.1
BLMTI.06L7.B2I10_TCSPM.6L7.B2	THRI_COLL_7_TCSPM_HI	2.147244588	0.4	0.858897835	0.41	0.19
BLMTI.06L7.B2I10_TCSG.6L7.B2	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	0.10	<0.1
BLMTI.05L7.B2I10_TCSPM.E5L7.B2	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	2.93	1.52
BLMTI.05L7.B2I10_TCSG.E5L7.B2	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.97	0.67
BLMTI.05L7.B2I10_TCSG.D5L7.B2	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.83	0.60
BLMTI.05L7.B1E10_TCSG.B5L7.B1	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	0.22	0.17
BLMTI.05L7.B1E10_TCSG.A5L7.B1	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	0.31	0.24
BLMTI.05L7.B2I10_TCSG.B5L7.B2	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	0.17	0.13
BLMTI.04L7.B1E10_TCSG.D4L7.B1	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	<0.1	<0.1
BLMTI.04L7.B2I10_TCSG.A4L7.B2	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	1.04	0.79
BLMTI.04L7.B1E10_TCSG.B4L7.B1	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.56	0.45
BLMTI.04L7.B1E10_TCSPM.B4L7.B1	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	0.93	0.74
BLMTI.04L7.B1E10_TCSG.A4L7.B1	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.91	0.73
BLMTI.04R7.B1E10_TCSG.A4R7.B1	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	1.53	1.20
BLMTI.04R7.B2I10_TCSG.A4R7.B2	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	1.33	1.03
BLMTI.04R7.B2I10_TCSPM.B4R7.B2	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	1.28	1.03
BLMTI.04R7.B2I10_TCSG.B4R7.B2	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.23	0.20
BLMTI.04R7.B2I10_TCSPM.D4R7.B2	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	1.05	0.93
BLMTI.04R7.B2I10_TCSG.D4R7.B2	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	2.91	2.51
BLMTI.05R7.B1E10_TCSG.B5R7.B1	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	1.83	1.64
BLMTI.05R7.B2I10_TCSG.A5R7.B2	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	2.36	2.11
BLMTI.05R7.B2I10_TCSG.B5R7.B2	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	1.41	1.28
BLMEI.05R7.B1E10_TCSG.C5R7.B1*	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.60	0.58
BLMTI.05R7.B1E10_TCSG.D5R7.B1	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.24	0.25
BLMTI.05R7.B1E10_TCSG.E5R7.B1	THRI_COLL_7_TCSG_LO	0.596146782	0.4	0.238458713	0.18	0.19
BLMTI.05R7.B1E10_TCSPM.E5R7.B1	THRI_COLL_7_TCSPM_LO	0.529908858	0.4	0.211963543	0.15	0.16
BLMTI.06R7.B1E10_TCSG.6R7.B1	THRI_COLL_7_TCSG_ME	1.726600875	0.4	0.69064035	3.09	3.09
BLMTI.06R7.B1E10_TCSPM.6R7.B1	THRI_COLL_7_TCSPM_HI	2.147244588	*0.45*	0.966260065	3.53	3.51
BLMTI.06R7.B2I10_TCSG.A6R7.B2	THRI_COLL_7_TCSG_HI	2.790817043	*0.45*	1.25586767	3.97	4.01

Concerned BLMs (warm/cold magnets in IR7)

Tables are purely the scaled signal-threshold ratios RS08 at 1 MW wrt 2022 thresholds (**without margin yet**)

To be finalized and cross-checked

	Expected signal-threshold ratio **<0.3**
	Expected signal-threshold ratio **≥0.3** and **<0.8**
	Expected signal-threshold ratio **≥0.8** and **<1.0**
	Expected signal-threshold ratio **≥1.0**

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMQI.06L7.B2I30_MQTL	THRI.IP37.P3_MQTL	23.168	1	23.168	<0.1	<0.1
BLMQI.06L7.B1E10_MQTL	THRI.IP7.P1_MQTL_FT	0.004215845	0.4	0.001686338	0.24	0.18
BLMQI.06L7.B2I20_MQTL	THRI.IP7.P2_MQTL_FT	0.004145186	0.1	0.000414519	4.02	2.97
BLMQI.06L7.B1E20_MQTL	THRI.IP7.P2_MQTL_FT	0.004145186	0.1	0.000414519	1.75	1.30
BLMQI.06L7.B2I10_MQTL	THRI.IP7.P1_MQTL_FT	0.004215845	0.4	0.001686338	2.38	1.94
BLMQI.06L7.B1E30_MQTL	THRI.IP37.P3_MQTL	23.168	1	23.168	<0.1	<0.1
BLMQI.06R7.B2I30_MQTL	THRI.IP37.P3_MQTL	23.168	1	23.168	<0.1	<0.1
BLMQI.06R7.B1E10_MQTL	THRI.IP7.P1_MQTL_FT	0.004215845	0.4	0.001686338	<0.1	<0.1
BLMQI.06R7.B2I20_MQTL	THRI.IP7.P2_MQTL_FT	0.004145186	0.1	0.000414519	0.17	0.21
BLMQI.06R7.B1E20_MQTL	THRI.IP7.P2_MQTL_FT	0.004145186	0.1	0.000414519	<0.1	<0.1
BLMQI.06R7.B2I10_MQTL	THRI.IP7.P1_MQTL_FT	0.004215845	0.4	0.001686338	<0.1	<0.1
BLMQI.06R7.B1E30_MQTL	THRI.IP37.P3_MQTL	23.168	1	23.168	<0.1	<0.1

+1 dipole BLM in cell 9L7

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMQI.05L7.B1E10_MQWA.D5L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.05L7.B2I10_MQWA.C5L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.10	<0.1
BLMQI.05L7.B1E10_MQWB.5L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.05L7.B2I10_MQWA.B5L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.16	<0.1
BLMQI.05L7.B1E10_MQWA.A5L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.17	<0.1
BLMQI.04L7.B2I10_MQWA.E4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.04L7.B1E10_MQWA.D4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.04L7.B2I10_MQWA.C4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.04L7.B1E10_MQWB.4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.04L7.B2I10_MQWA.B4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	<0.1	<0.1
BLMQI.04L7.B1E10_MQWA.A4L7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.22	0.18
BLMQI.04R7.B2I30_MQWA.A4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.27	0.25
BLMQI.04R7.B1E10_MQWA.B4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.19	0.17
BLMQI.04R7.B2I20_MQWB.4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.37	0.35
BLMQI.04R7.B1E20_MQWA.C4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.38	0.35
BLMQI.04R7.B2I10_MQWA.D4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.65	0.61
BLMQI.04R7.B1E30_MQWA.E4R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	1.01	0.93
BLMQI.05R7.B2I30_MQWA.A5R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.99	1.03
BLMQI.05R7.B1E10_MQWA.B5R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	0.76	0.78
BLMQI.05R7.B2I20_MQWB.5R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	1.41	1.46
BLMQI.05R7.B1E20_MQWA.C5R7	THRI.IP7_MQW_FT	0.277588566	0.4	0.111035427	1.19	1.22
BLMQI.05R7.B2I10_MQWA.D5R7	THRI.IP7_MQW_FT	0.277588566	*0.6*	0.16655314	3.84	3.83

Concerned BLMs (TCSP and cold magnets in IR6)

Tables are purely the scaled signal-threshold ratios RS08 at 1 MW wrt 2022 thresholds (**without margin yet**)

	Expected signal-threshold ratio **<0.3**
	Expected signal-threshold ratio **≥0.3** and **<0.8**
	Expected signal-threshold ratio **≥0.8** and **<1.0**
	Expected signal-threshold ratio **≥1.0**

To be finalized and cross-checked

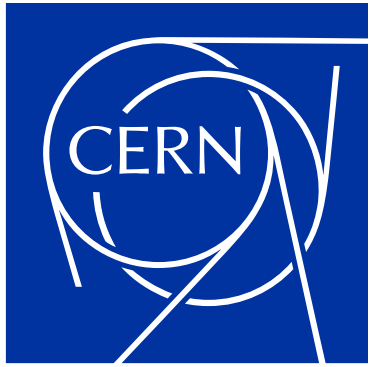
BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMTI.04L6.B2I10_TCSP.A4L6.B2	THRI_TCSG	0.047629514	1	0.047629514	1.46	1.36
BLMTI.04L6.B2I11_TCSP.A4L6.B2	THRI_TCSG_RC	23.168	0.1	2.3168	<0.1	<0.1
BLMTI.04R6.B1E10_TCSP.A4R6.B1	THRI_TCSG	0.047629514	1	0.047629514	<0.1	<0.1
BLMTI.04R6.B1E11_TCSP.A4R6.B1	THRI_TCSG_RC	23.168	0.1	2.3168	<0.1	<0.1

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMQI.04L6.B2I30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	0.76	0.83
BLMQI.04L6.B1E10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	0.56	0.57
BLMQI.04L6.B2I20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	1.24	1.47
BLMQI.04L6.B1E20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	0.56	0.53
BLMQI.04L6.B2I10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	3.75	4.34
BLMQI.04L6.B1E30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	0.10	0.10
BLMQI.04R6.B2I30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	<0.1	<0.1
BLMQI.04R6.B1E10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	<0.1	<0.1
BLMQI.04R6.B2I20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	<0.1	<0.1
BLMQI.04R6.B1E20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	<0.1	<0.1
BLMQI.04R6.B2I10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	<0.1	<0.1
BLMQI.04R6.B1E30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	<0.1	<0.1

BLM name	BLM family	Master thresholds RS08 (Gy/s)	MF	Applied thresholds RS08 (Gy/s)	Signal-threshold ratio RS08@1 MW	
					Nom.	Rel.
BLMQI.05L6.B2I30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	0.14	0.15
BLMQI.05L6.B1E10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	<0.1	<0.1
BLMQI.05L6.B2I20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	0.96	1.11
BLMQI.05L6.B1E20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	<0.1	0.10
BLMQI.05L6.B2I10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	3.85	4.43
BLMQI.05L6.B1E30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	<0.1	<0.1
BLMQI.05R6.B2I30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	<0.1	<0.1
BLMQI.05R6.B1E10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	<0.1	<0.1
BLMQI.05R6.B2I20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	<0.1	<0.1
BLMQI.05R6.B1E20_MQY	THRI.LS.P2_MQY	0.004382025	0.5	0.002191013	<0.1	<0.1
BLMQI.05R6.B2I10_MQY	THRI.LS.P1_MQY_FT	0.004382025	0.4	0.00175281	<0.1	<0.1
BLMQI.05R6.B1E30_MQY	THRI.LS.P3_MQY	0.0876405	0.333	0.029184287	<0.1	<0.1

Finalization/documentation/implementation

- ECR: is in advanced drafting stage, but still needs to be finalized
- BLMTWG meeting
  - We plan a BLMTWG meeting in the second week of Nov (7^{th} to 11^{th} of Nov) to discuss the final numbers
  - We encourage participation of MPP and the collimation team in this meeting
- Implementation and roll-back:
  - The new BLM threshold families have to be created by the database experts (potentially in advance of the BLMTWG meeting)
  - The corrections will be introduced in the new families after the BLMTWG meeting, but **ahead of the quench test**
  - The concerned BLMs will assigned to the new families **at the beginning of the quench test** (in addition MFs will be changed at this moment)
  - After the quench test and **before regular operation resumes** the BLMs will be assigned back to their original families and the MF will be reverted to the original value



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