Recap of BLM threshold changes in 2017 and changes planned in the YETS2017/18

A. Lechner, E.B. Holzer, T. Medvedeva, S. Le Naour, A. Mereghetti, D. Wollmann,
C. Zamantzas with previous contributions from C. Xu, M. Kalliokoski

65th BLM Thresholds WG Meeting
Feb 27$^{\text{th}}$, 2018

Contents

**Summary of BLM threshold changes in 2017**

BLM threshold changes planned in YETS 2017/18

- **Sector 12 (315 BLMs, 14 families)**
  - **2016:** BLMs in S12 reduced by a factor of 10/3.333 in Aug. 2016 (UFO/orbit bump)
  - **EYETS 2016/17:** reverted Sector 12 (BLMs at Q10s stayed w/o UFO corr, MF=0.15)

- **IPQ P3 Monitors from Q4 to Q6 in all IRs except IR3/7 (63 BLMs, 3 families)**
  - **2016:** master tables **at electronic maximum** (but MF$\neq$1)
  - **EYETS 2016/17:** applied **same master thresholds as for P1&P2 monitors**, but **20 times higher**; in addition **unified MFs** to 0.333
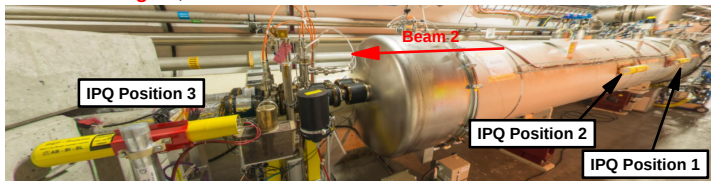
- **ALICE BLMs (3 BLMs, 1 family)**
  - **2016:** not in BIS
  - **EYETS 2016/17:** **added to BIS**, **created new thresholds** based on TDI shots in 2015 and msec TDI losses in Fill 5074 in 2016

Changes in EYETS 2016/17 (2/2)

- **New AFP Roman Pots in cell 6L1, B2 (2 BLMs, 1 family)**
  - 2 new BLMs installed next to the two new pots
  - **EYETS 2016/17:** assigned BLMs to **existing AFP family (cell 6R1)**

- **New low-impedance collimator (coated MoGR) in cell 4R7, B2**
  - Existing BLM renamed to reflect new slot allocation (TCSM $\rightarrow$ TCSPM)
  - **EYETS 2016/17: added to BIS, thresholds at electronic maximum**

- **New crystal collimators in cells 4R7 and 6R7, B2**
  - 2 new BLMs installed next to the new goniometers
  - **Not added to BIS** (note: B1 crystals in 4L7/6L7 do not even have dedicated BLMs)

- **Warm dipole BLMs in IR1 (B1&B2)**
  - 2 BLMs had been installed in TS2 2016 for diagnostic reasons (**not in BIS**)
  - Have been removed in **EYETS 2016/17**

Checks and changes in TS1 2017 (1/3)

- **As usual, in TS1 pp debris-related FT corrections were re-evaluated**
  - Remember our general policy: debris-induced signals **should remain below 30% of the thresholds** (i.e. below the warning level)

- **FT corrections (pp debris) IR1/5 triplet**
  - Last adjustment had been in YETS 2015/16 (**LHC-BLM-ECR-0044**)
  - Found no big change in triplet BLM signals per pp collision in 2017
  - Extrapolation showed that no BLM would be in warning up to $2.0 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$ and only one BLM would be in warning at $2.2 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$
  - **TS1 2017: did not perform any adjustment**, said we would redo analysis once we reach $2 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$ (but then there was 16L2 $\rightarrow$ levelled at $1.5 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$)
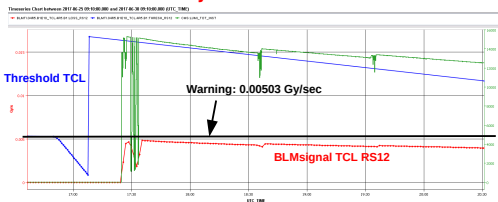
- **FT corrections (pp debris) IR8 triplet**
  - One family (**THRI.IP28.P3_MQXB_FT**) had a FT correction in energy level 26 and 27 (the latter one being active at 6.5 TeV)
  - **TS1 2017: reverted e-level 26 of this family to pre-2016 settings**, **otherwise no adjustments necessary at IR8 triplet** (no warnings up to $5 \times 10^{32} \mathrm{cm}^{-2}\mathrm{s}^{-1}$, also for other spectrometer polarity)

- **FT corrections (pp debris) TCLs IR1/5**
  - TCL.4R5 would have been in warning for lumi $> 1.58 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$
  - **TS1 2017: increased FT correction by 30%** to allow for $2 \times 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ like for triplets

- **FT corrections (pp debris) TCTs IR1/5**
  - Was predicted to reach warning for lumi $> 1.75 \times 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$
  - **TS1 2017: no adjustment done**, but planned to re-evaluate thresholds once we reach $1.7 \times 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ (but then there was 16L2)

- **FT corrections (pp debris) TCTs IR8**
  - TCTPV.4R8 reached **warning levels in long RS ($\geq$8)** in the week before MD1/TS1 2017 (for instantaneous lumi $> 4.4 \times 10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$)
  - **TS1 2017: increased FT correction by 14%** to allow for $5 \times 10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$

- **Q6.R7 (collimation losses):**
  - Warnings during ramp **just before threshold energy level 27** is reached (FT correction not yet active)
  - **TS1 2017: did not perform any changes but suggested to keep an eye on it**, had 1-2 dumps later in the year
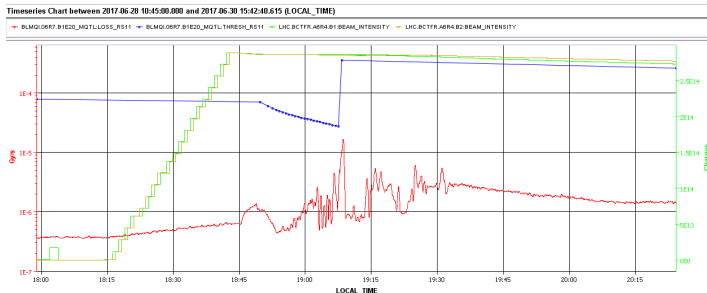
- **IR7 collimators (transient losses related to 16L2):**
  - **One week before TS1 2017: MFs** at **IR7 TCPs**, **TCSGs**, and **TCLAs** were increased from **0.4** to **0.8** (would correspond to a power loss of 400 kW for 1-10 sec and to 80 kW in steady-state conditions, however did not increase MFs at magntes)
  - Beneficial for data collection, but did not prevent 16L2 dumps

BLM threshold changes in 16/17L2 after quench (Aug 2017)
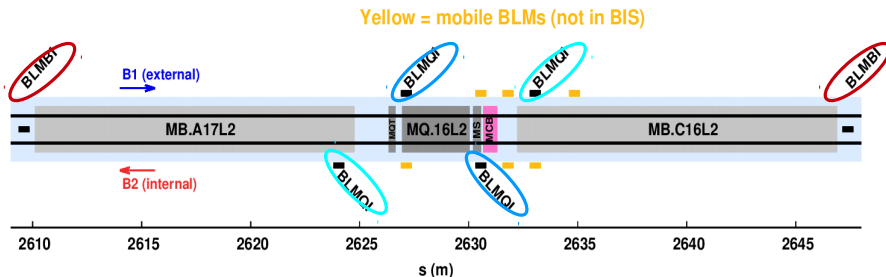
→ **A quench of MB.C16L2 occurred in Aug 2017 (not unexpected, see LMC 19 July 2017)**
→ **Changed Master Tables and MFs on Monday 14/08/2017:**

MB BLMs:

BLMBI:
→ UFO correction removed
→ MF reduced from **0.333** to **0.1**

MQ BLMs (changed for redundancy):

BLMQI (upstream):
→ UFO correction removed
→ MF reduced from **0.333** to **0.1**

BLMQI (downstream):
→ MF reduced from **0.333** to **0.1**
  (had no UFO correction)

BLM threshold changes for 2.51 TeV run (Nov 2017)

- **Collimation losses:**
    - Introduced **FT corrections at the energy level active at 2.51 TeV** in order to allow for 200 kW/40 kW losses (1-10 s / steady state):
        - ⇒ Q4/Q5 in IR6 (P1 monitor)
        - ⇒ Q6 in IR7 (P1 and P2 monitors)
        - ⇒ MQWs in IR7
    - NB: all monitors had FT corrections at 6.5 TeV, i.e. only "_FT" families were concerned
- **Luminosity losses:**
    - **No changes needed in IR1/5** (triplet, TCLs, TCTs)
    - **Two IR8 triplet BLMs (MQXA, P3) found in warning**
        - → MFs were increased (and reverted after the run)

Summary of 2017 threshold changes and ECRs

Reason	Families	# BLMs	ECR
EYETS 2016/17:			
Reverted Sector 12	14 families	**309 BLMs**	**LHC-BLM-ECR-0057**
More physical shape for Q4-Q6 P3 BLM families (except IR3/7), MF unification	THRI.LS.P3_MQM, THRI.LS.P3_MQM_RC, THRI.LS.P3_MQY	**63 BLMs**	**LHC-BLM-ECR-0057**
Created ALICE BLM thresholds based on TDI losses	THRI_ALICE (new)	**3 BLMs**	**LHC-BLM-ECR-0058**
Assigned BLMs at new AFP pots in 6L1 to existing AFP family	THRI.IR1_XRP_FT	**2 BLMs**	**LHC-BLM-ECR-0059**
BLM at low-impedance collimator added to BIS with thresholds at electronic max.	THRI_TCSM	**1 BLM**	**LHC-BLM-ECR-0060**
TS1 2017:			
Increased FT correction at TCT.4R8 by 14% to mitigate pp debris-induced warnings	THRI_TCTVB_OI_RC8	**1 BLM**	**LHC-BLM-ECR-0061**
Increased FT correction at TCLs (Cu) by 30% to avoid pp debris-induced warnings at TCL.4R5	THRI_TCL	**8 BLMs**	**LHC-BLM-ECR-0061**
Removed FT correction from energy level 26 of IR2/8 MQXB (P3) family which remained there by mistake	THRI.IP28.P3_MQXB_FT	**8 BLMs**	**LHC-BLM-ECR-0061**

Summary of 2017 threshold changes and ECRs (cont.)

Reason	Families	# BLMs	ECR
TS1 2017 (continued):			
Increased MF of following families from 0.4 to 0.8 to allow for a better data collection for 16L2-related events	THRI_7_TCP, THRI_7_TCSG, THRI_7_TCSG_F5, THRI.06_7_AB_TCLA, THRI.06_7_CD_TCLA, THRI.07_7_AB_TCLA		**LHC-BLM-ECR-0061**
Aug 2017, after quench in 16L2:			
Removed UFO corrections and reduced MFs in 16L2/17L2	THRI.ARDS_MBMB(_CRIT), THRI.ARDS.P1_MQ(_CRIT), THRI.ARDS.P3_MQ	**6 BLMs**	**LHC-BLM-ECR-0062** (ECR title to be re-named)
Nov 2017 (2.51 TeV run):			
Implemented FT corrections for collimation leakage at 2.5 TeV	THRI.LS.P1_MQY_FT, THRI.IP7.P1_MQTL_FT, THRI.IP7.P2_MQTL_FT, THRI.IP7_MQW_FT	**40 BLMs**	**LHC-BLM-ECR-0063**
Adjusted MFs at IR8 triplet magnets to avoid debris-induced warnings	THRI.IP28.P3_MQXA_FT	**2 BLMs**	**LHC-BLM-ECR-0063**

Changed the thresholds of roughly five times less BLMs than in 2016.

Contents

Wire collimators (TCTs, TCLs)

- **Wire collimator installations:**
  - Installed in EYETS 2016/17: TCTPH.4R5.B2 and TCL.4L5.B2 (**LHC-TC-EC-0007**) **Note:** *previous TCL.4L5.B2 was made of Cu, while the wire collimator is made of Inermet (W-alloy)*
  - **New in YETS 2017/18**: TCTPV.4R1.B2 (existing slot), TCLVW.5L1.B2 (new slot with new BLM) (**LHC-TC-EC-0009**)

- **Reminder of TCL thresholds:**
  - Had one family in 2015 (**THRI_TCL**) but with different MFs to reflect the different TCL materials (Cu in cells 4/5 $\rightarrow$ MF=1.0, W in cell 6 $\rightarrow$ MF=0.1-0.2)
  - YETS 2015/16: split family into two, **THRI_TCL** and **THRI_TCL_W**, the latter including a scale correction, but the applied thresholds were the same as in 2015
  - In 2016-2017, the FT correction of the two families evolved independently, now being a factor of 6.5 higher for the **THRI_TCL** family (applied thresholds)

- **Threshold proposal:**
  - **Proposal YETS 2017/18:** assign the TCL.4L5.B2 BLM and the new BLM at TCLVW.5L1.B2 to **THRI_TCL_W**; will need some adjustment of FT corrections once the lumi is ramped up (for TCL.4L5.B2 expect to reach warning in RS12 at a lumi of $1.40 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$)

- **Solenoid around QBBI.A31L2 + mobile BLM installation in 31L2:**
  - Idea is to investigate a possible correlation between heat load and e-cloud
  - Mobile BLMs and BLM bundles requested to monitor losses (from beam-gas collisions)
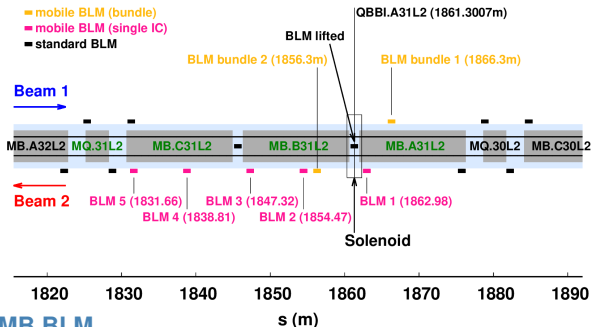
- **Standard MB-MB BLM**
  - The **standard BLM on top of QBBI.A31L2 interconnect will be lifted by 15 cm** (new support) and will be located above the solenoid → will decrease BLM response per proton lost
  - Reminder: in short running sums (up to RS06) the thresholds are a factor of 3 above quench level, in long running sums they are at quench level → decreased response means that thresholds are above quench level in long running sums
  - **Proposal YETS 2017/18: keep thresholds as they are** (and adjust them on the fly in the very unlikely case of a quench)

Reversal of 16L2-related threshold modifications

- **Local threshold modifications in 16L2/17L2:**
  - **Proposal YETS 2017/18: keep the thresholds for the moment**, but to **revert them in TS1** if no abnormal losses are observed
  - NB: the mobile BLMs in 16L2 remain in place

- **Monitor factors of IR7 collimators (16L2-related increase):**
  - Remember: MFs were only increased at IR7 collimators and not at magnets/non-IR7 collimators
  - **Proposal YETS 2017/18: keep the MFs for the moment** until the usual reassessment of FT corrections ($\sim$TS1), then harmonize between IR7 collimators and other elements to allow for a certain power loss

Reversal of FT corrections at 2.5 TeV energy level

- **More general question: shall so-called FT corrections be extented to all energy levels?**
  - Evidently they wouldn't be FT corrections anymore, but we could call them **"steady-state loss (SSL) corrections"**
  - FT corrections are motivated by two kinds of losses: **luminosity debris** and **collimation losses**
  - FT corrections are **empirically corrected once or twice every year** to adjust to operational changes (higher luminosity, different collimator settings)

- **Luminosity debris:**
  - Luminosity losses occur only at top energy
  - Occasionally, reference runs are carried out at different energies (e.g. 1.5 TeV in 2015, 2.51 TeV in 2017), however only little or no adjustment is usually needed
  - Introducing luminosity-related SSL corrections **does not have any advantages** (we cannot anticipate the luminosity and TCL/TCT settings at future reference runs, hence adjustments will anyway be necessary)

- **Collimation losses:**
  - From a logical point of view, SSL corrections can make sense
    - $\Rightarrow$ they would have avoided a few (1-2?) dumps in 2017 (Q6 in IR7)
    - $\Rightarrow$ they might have also saved work for the 2.5 TeV run
  - However in general SSL corrections **would require a much extented re-evaluation every year** based on loss maps at different energy levels (interpolated)
  - Could be incorporated as a new collimation threshold strategy in LS2 (when collimator thresholds will be re-evaluated)?

Other topics

- **Adjustment of old (Run 1) threshold model for DS BLMs on dipoles (horizontal plane)**
  - First loss analysis by Tatiana last year
  - See next presentation

- **TCT threshold verification:**
  - Tracking and shower studies completed
  - EN/MME is progressing on thermo-mechanical simulations
  - Report in Coll WG planned for April 2018

- **Injection losses:**
  - Blindable BLMs foreseen to be tested again in commissioning
  - Need to follow closely if we have a bottleneck in DS (removed some filters of MB-MB BLMs last year)

- **Up to TS1:**
  - As usual, need to reassess all FT corrections (collimation, debris)