Session 4:
LHC BLM Thresholds for Run 2

R. Bruce, D. Wollmann

Contents

- Based on our experimental and theoretical understanding of beam losses and quenches/damage: **what strategy should be adopted for the Run 2 BLM thresholds?**

- *Overview of BLM system* (E.B. Holzer)

- *BLM thresholds in the arc* (A. Lechner)

- *BLM thresholds at collimators* (S. Redaelli)

- *BLM thresholds close to experiments* (L. Esposito)

BLM system

- BLMs split on many families: arc, LSS, DS, collimators ….
- Types of BLMs: ionization chamber (IC), Litle ionization chamber (LIC), Secondary Emission monitor (SEM)
- Very large system: 1.5 million thresholds!

Thresholds on Cold Magnets – Run 2

- BLM signal at quench:

$$\mathrm{BLMSignal@Quench}(E,t) = \frac{\mathrm{BLMResponse}(E,t) * \mathrm{QuenchLevel}(E,t)}{\mathrm{EnergyDeposit}(E,t)}$$

FLUKA

QP3

- The **master threshold** is a multiple of the BLMSignal@Quench

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

Operational experience and quench tests

General remarks on post-LS1

- Thresholds up to 4 TeV very well established
  - Ensure that there are no drastic changes up to 4 TeV
- Post-LS1: Injection regions:
  - Grouping most limiting BLMs in crates that can be blinded
  - Replacing SEMs with new LICs, but cannot trigger beam dump
- Risk of higher noise level at 7 TeV
- New factors between quench level and master/applied thresholds?
  - Beware of human errors – 1.5 million threshold values
  - Exhaustive table of safe-from-damage levels could help

Arc thresholds

- Arc thresholds: set to catch UFOs, orbit bumps, gas leaks

BLMs at MQ:

	RS01-RS0?	RS0?-RS12
<4 TeV	Orbit bump	Orbit bump
≥4 TeV	UFOs	Gas leak† / Orbit bump?††

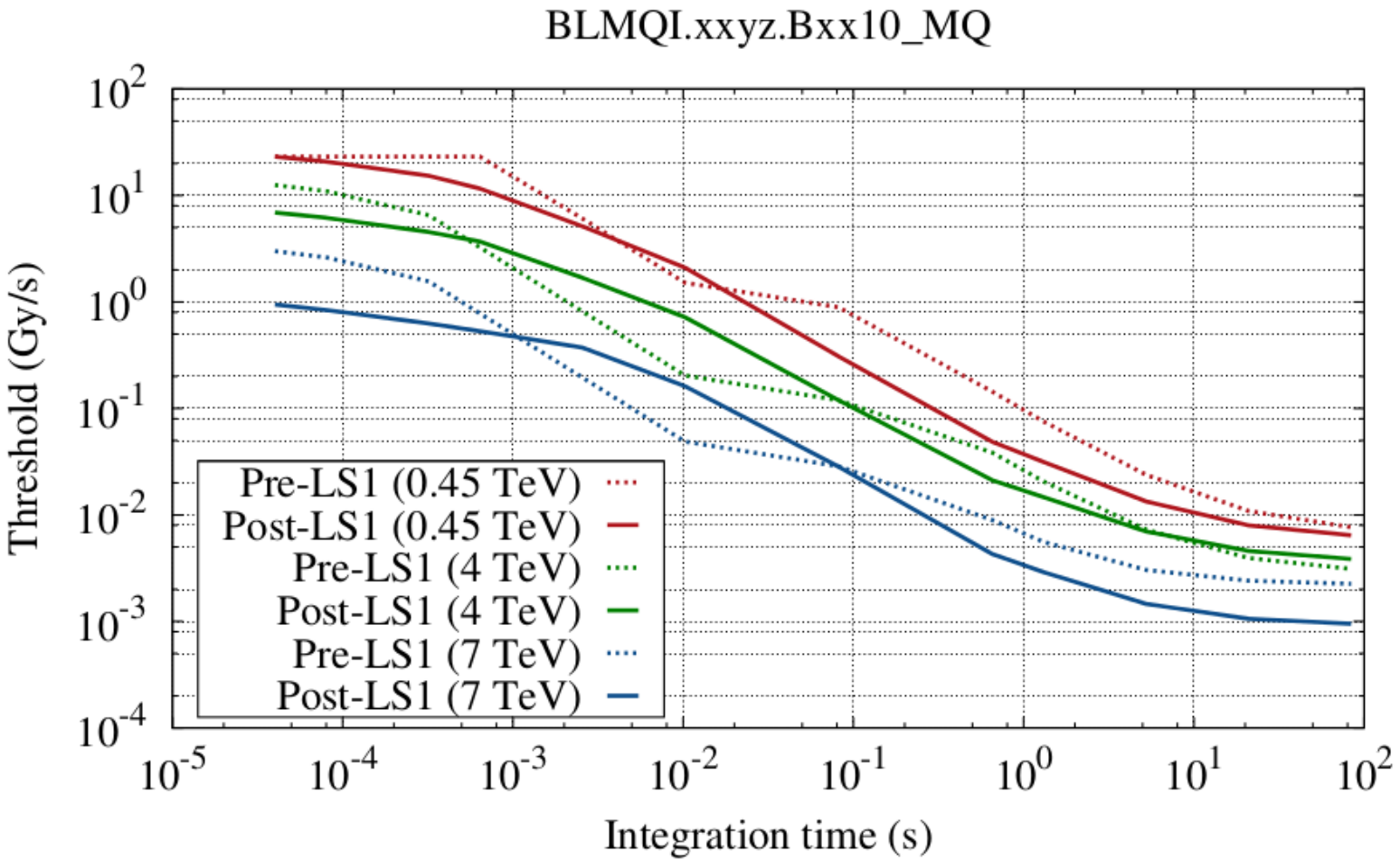
A. Lechner

Arc BLMs

- Relocation of arc cells BLMs in LS1 to more efficiently detect UFOs.
- Thresholds based on FLUKA + QP3 simulations
  - Ad-hoc factor added based on quench test
  - Always taking the limiting scenario among the loss sources
- Arc cell BLMs split in 3 families

A. Lechner

Run 1 vs post Run 2



A. Lechner

DS + straight section

- **DS:** same as for the arc, but some ad-hoc adjustments for ion runs to horizontal MB BLMs
  - Discussion: Check long running sum for debris
- **Straight section:** same strategy as for arc, but Q3 adjusted for debris in long running sums
  - Discussion: Check also Q4-Q6 for debris?
  - D1/D2: UFOs only

A. Lechner

BLM thresholds at collimators

- BLM thresholds should protect against damage of collimators. 6 families:

BLM-THRE category	Included collimator types/designs	Description	Num.
TCP_THR	TCP IR3/7	CFC/60cm	8
TCSG_THR	TCSG IR3/7 + TCLI IR2/8	CFC/1m	34
TCSP_THR	*TCSP IR6*	*CFC/1m/BPM*	*2*
TCLA_THR	TCLA IR3/7 + TCL6 IR1/5	W/1m	22
TCTP_THR	*TCTP IR1/2/5/8*	*W/1m/BPM*	*16*
TCL-Cu_THR	TCL IR1/5	Cu/1m	8

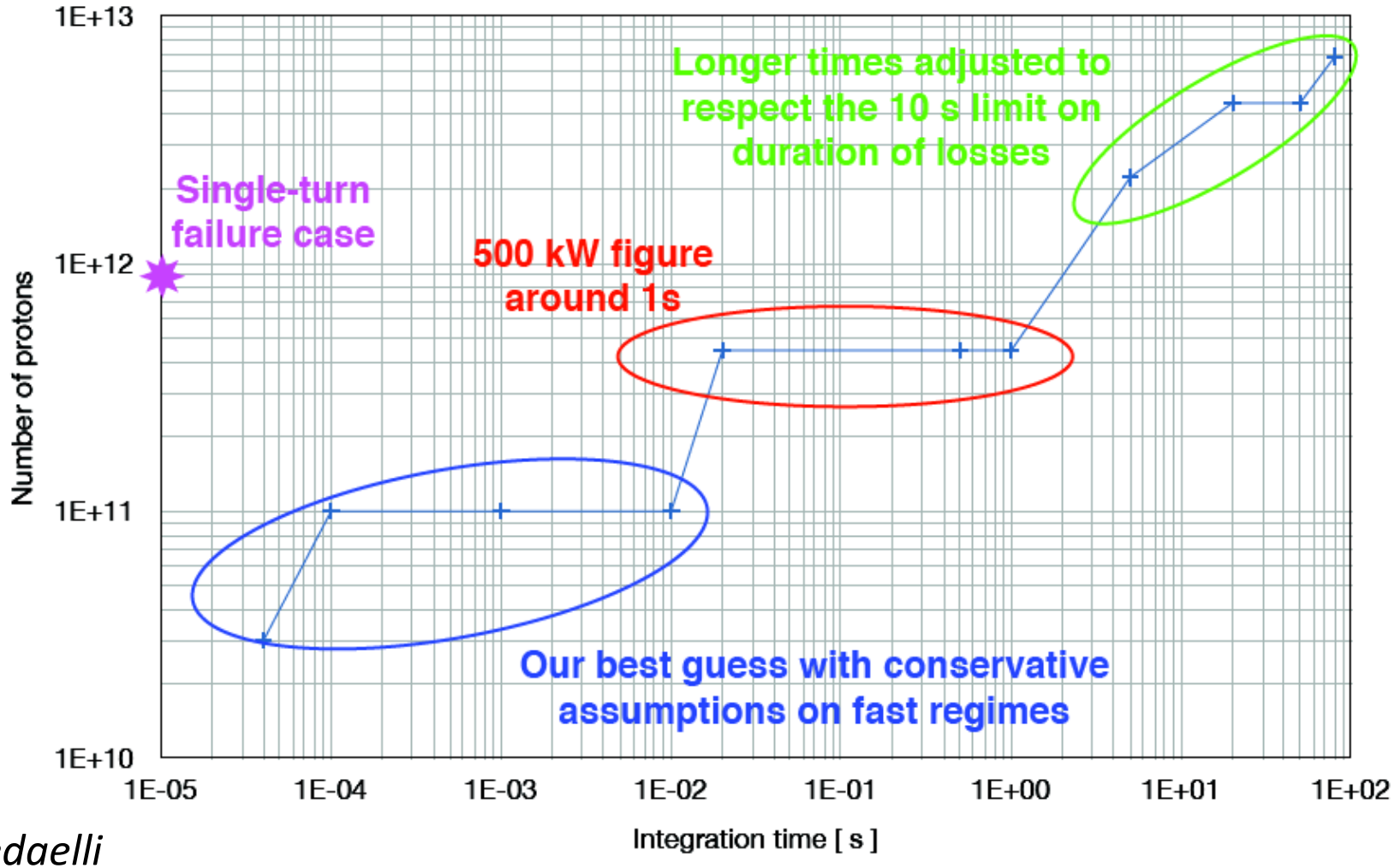
S. Redaelli

Run 2 strategy

- Start-up thresholds to be re-calculated using the updated damage limits (p) for TCP's
  - Apply safety factors to other families (lower thresholds!)
- With the first beam loss maps, establish factors for threshold settings in units of beam losses (e.g. 500 kW – can we go higher?)
  - Need to *verify that new values do not exceed safe limits* of individual collimators
- Apply changes for cross-talk effects

S. Redaelli

TCP thresholds vs integration time



S. Redaelli

BLM thresholds at inner triplets

- Triplet Loss scenarios:
  - Luminosity debris: FLUKA + QP3 used to estimate BLM signal at quench level in triplet
    - Well-known source, successful benchmark with Run 1 data
  - Q2B loss scenario: losses in Q2 due to faulty collimator settings
    - Updated studies missing
  - UFOs and orbit bumps as for the arcs

L. Esposito

MQX quench limit

- Significantly higher quench limit found in recent studies (showing luminosity debris)

Magnet	MQPD	Luminosity 1E+34		Luminosity 2E+34		Luminosity 5E+34	
		[$cm^{-2} \cdot s^{-1}$]		[$cm^{-2} \cdot s^{-1}$]		[$cm^{-2} \cdot s^{-1}$]	
		DPD	ratio DPD/MQPD	DPD	ratio DPD/MQPD	DPD	ratio DPD/MQPD
	[mW/cm3]	[mW/cm3]	-	[mW/cm3]	-	[mW/cm3]	-
MQXB	**19.743**	4.250	0.215	8.500	0.431	21.250	1.076
MQXA	**50.394**	3.400	0.067	6.800	0.135	17.000	0.337

- Was 18 mW/cm3 for MQXA and 13 mW/cm3 for MQXB

L. Esposito

Strategy for triplet BLMs

- Q2: compare debris with Q2B loss scenario
  - Optimize thresholds for allowing luminosity and where possible protect for the Q2B scenario
- Q1 & Q3: set up as the arc, with UFOs and orbit bump as loss scenario
  - Should be checked vs luminosity debris to ensure no dumps in physics