



Recap of BLM threshold changes in 2023 due to failure in VMBG in LSS1 & related studies

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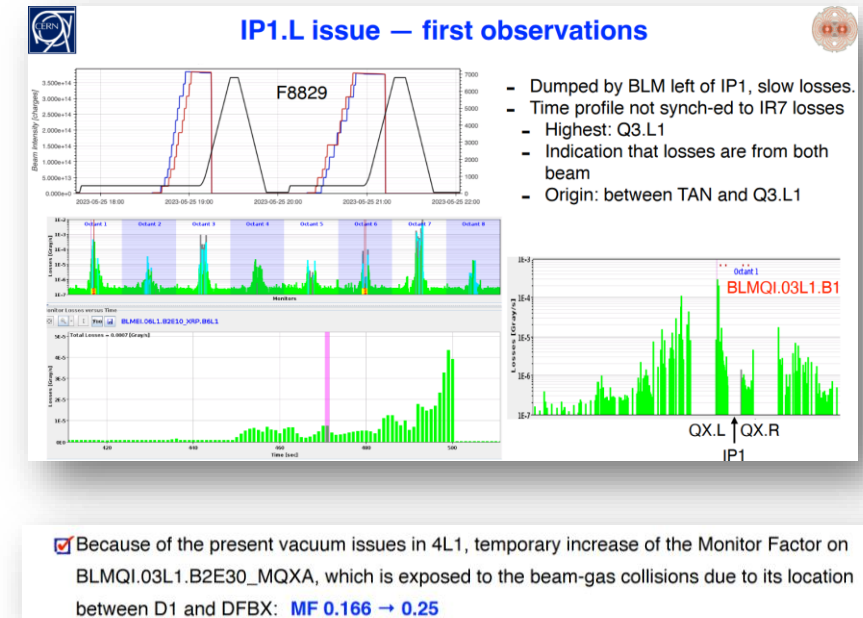
Outline

- **Looking back at 04L1 incident in May 2023:**
 - Chain of events from BLM threshold perspective
 - Q3 quench risk assessment (for beam-gas collisions in 04L1)
- **Take-away messages**

Chain of events from the BLM thresh. perspective

- **Thu 25/05/2023** – first occurrence 04L1 issue
 - Beams dumped few times by BLMQI.03L1.B2E30_MQXA due to beam gas collisions
- **Sun-Mon 28-29/05/2023** – intervention to replace module
- **From Mon 29/05/2023** – beam operation resumes
 - Still significant beam-gas collisions while pressure levels are slowly recovering from fill-to-fill
 - Stored intensity has to be limited to avoid BLM dumps
- **Wed 31/05/2023** – **BLM thresholds at Q3 changed**
 - Monitor Factor of BLMQI.03L1.B2E30_MQXA increased from **0.16** to **0.25**, after discussion between OP, BLMTWG, MPP and machine coordinators

Report by machine coordinator in LMC (31/05) – S. Redaelli:



Chain of events from the BLM thresh. perspective

- **Thu 01/06/2023 – still some intensity limitation**
 - Request by machine coordinator to further increase thresholds
 - Agreed with MPP that need to **study the quench risk of the triplet** before any further change

Triplet quench must be avoided!!

Dear all

Email exchange 01/06

We have just put a fill of 1650b into the machine which reached 70% of dump threshold (with the increased Monitor Factors).

And a question to Anton and Daniel: any prospect to increase further the monitor factor for **BLMQI.03L1.B1?**

Cheers

<anonymous machine coordinator>

Before increasing the MF further, we would need to understand a bit better the impact of the beam-gas collisions on the triplet. This would need some further discussions. If possible, we are also trying to do some studies.

Cheers, Anton

- **Sun 04/06/2023 – completed dedicated FLUKA studies**
 - Circulated results (quench risk assessment) to MPP
- **Mon 05/06/2023 – offline discussion MPP+BLMTWG**
 - **But: vacuum levels had conditioned more** → **need for threshold increase was less compelling**
 - Decided not to change thresholds

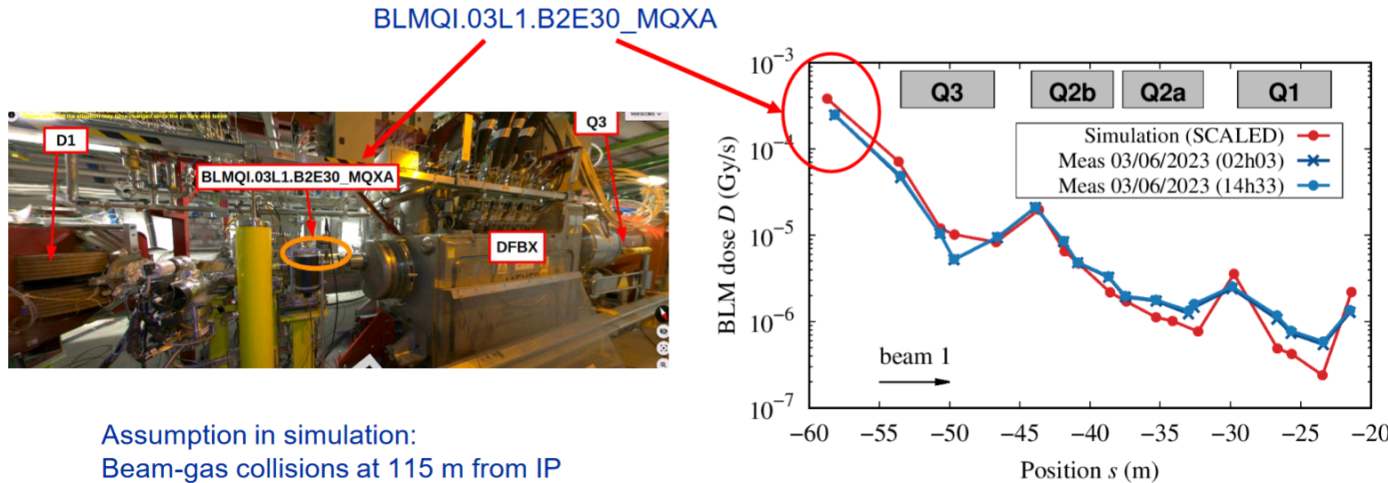
Normally, it is not granted to get results that quickly!

Quench risk assessment (04L1) in June 2023

Why did we need to assess the risk of Q3 quenches? BLM thresholds for MQXAs are set for a different loss scenario (direct proton losses on aperture) → BLM signal and power density in coils are different compared to beam-gas collisions

Benchmark of simulated BLM pattern

Comparison of simulated and measured BLM patterns at the triplet L1 (simulations were arbitrarily scaled to match the measured patterns)



Step 1:

Simulation benchmark of BLM signals due to 04L1 beam-gas collisions

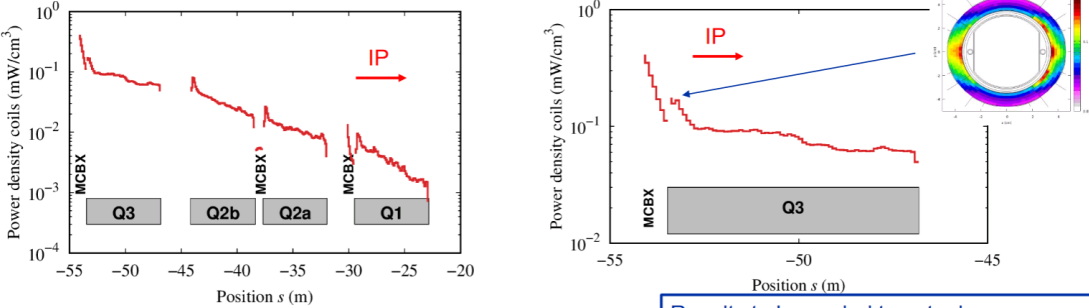
→ provides confidence that we can predict power density in Q3

Quench risk assessment (04L1) in June 2023

Power density in coils due to beam gas collisions

Projected power density in *inner* coils for 4×10^{14} protons (=2500b, 1.6×10^{11} ppb) at 6.8 TeV, for a gas pressure measurement of 1×10^{-8} mbar in VGI.628.4L1.X

At this pressure, the power density is estimated to reach 0.4 mW/cm^3 in the MCBX and about 0.2 mW/cm^3 in Q3 (MQXA) (values radially averaged in inner coils)

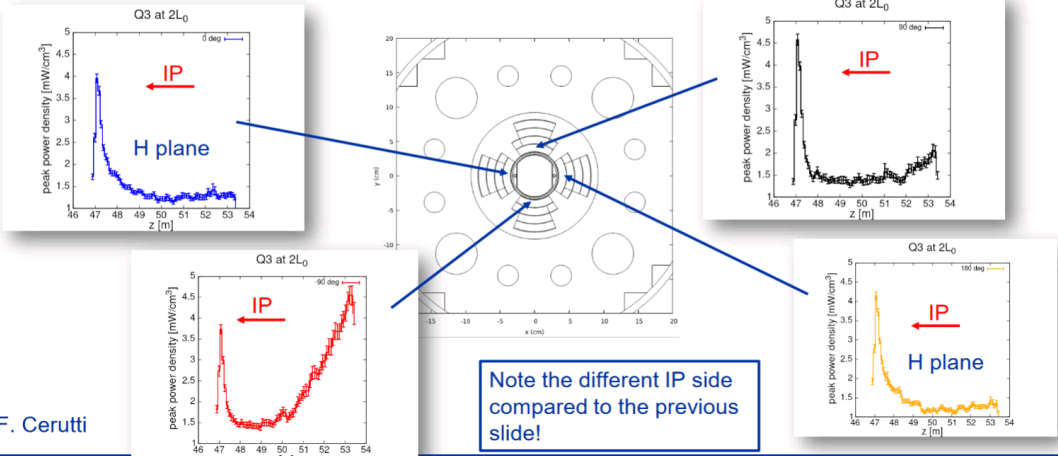


Results to be scaled to actual gas pressure!

Step 2: comparison of power deposition from 04L1 beam-gas collisions with power deposition from pp collisions in IP1 (assuming certain gas pressure!!)

Power density in coils due pp collisions

pp-collision debris induced power density in *inner* Q3 coils for $L=2 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$



F. Cerutti

Note the different IP side compared to the previous slide!

Concluded that beam-gas collisions should not quench the triplet for the pressure observed at that time.

Take-away messages

- The impact of a 04L1-like event in terms of beam-gas collisions depends strongly on the location where the incident occurs
- It makes a big difference if there is a collimator nearby or a superconducting magnet (and of course the distance matters)
- It is difficult to prepare for/study all possible cases beforehand since the real circumstances can vary significantly from case to case
- However, depending on the situation, we can rely on our past experience (or studies)
- Nevertheless, some time is needed to analyse the situation

Take-away messages

- When such an event occurs, the **situation can be quite dynamic**, and *there is pressure to restore asap the machine performance*
- Evidently, the BLM thresholds should not limit the machine performance if compatible with safe operation BUT we **must follow a certain procedure** (even if it is “only” a Monitor Factor change):
 - Organize a discussion between the relevant bodies (BLMTWG, MPP, OP, etc.)
 - Assess if all risks are understood and can be quantified (e.g. quench)
 - Decide if further studies are needed (e.g. energy deposition, tracking) *In May/June 2024, could react in a timely manner (few days for studies), but this may highly depend on the availability of people (e.g. if during holiday period)*
 - Only once we have collected all the elements, we can recommend a threshold change
- Of course, we already follow these steps, but still recommend to formalize this (e.g. written procedure) for special events like 04L1



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