# LHC Heavy-Ion Collimation Quench Test MD

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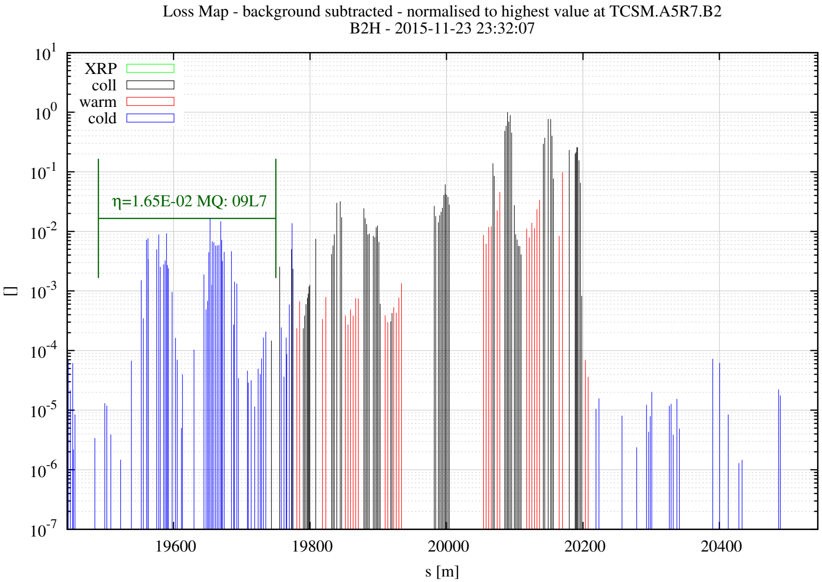
# Introduction

- Heavy-ion beams : high collimation losses in the IR7 DS
- Might limit the achievable beam intensity : risk of quenches
- Knowledge of the quench limit important for :
  - Determining intensity limitations
  - Study of upgrade scenarios
  - Setting of BLM thresholds
- Dedicated test required for ion beams
- Previous ion quench tests finished without quench (tune resonance crossing)

# B2H loss map at flat top



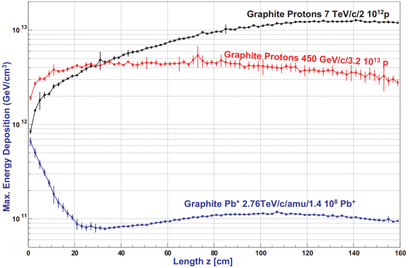
# Attempted beam power loss

- Magnet with highest BLM signal : MQ9L7 [BLMQI.09L7.B2I10_MQ]
- Loss map : peak BLM signal / BLM threshold $\approx 6 \times 10^{-3}$
- BCT : intensity drop corresponds to 123 W peak power loss
- Required power load to reach appl. BLM threshold $\approx$ 20 kW
- Monitor factor at this location $MF = 0.499$ with master threshold set to 0.3
- Primary power required to reach BLM signal at assumed quench limit for UFO events (at MQ) :

$$P_q \approx 13.5\,\mathrm{kW}$$

# Maximum beam power loss

- Peak energy deposition for ions about 10 times larger than for the same number of proton charges at the equivalent energy




Taken from LHC Design Report

- Limit max power load on the TCP based on $P_{max}^{proton} = 1000\,\mathrm{kW}$ (proton limit)

$$\boxed{P_{max}^{ions} = 0.1 \times P_{max}^{proton} = 100\,\mathrm{kW}}$$

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   - Single bunch excitation then larger and larger fractions of a train

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3. Third and fourth fill with 8x24 bunches each ; increase in steps until quench or 100kW is reached

- Full excitation window must fit between bunch trains
- ADT window length is kept : move into the train step by step

# Overview of fills

| Fill | $n_B$ | E [Z TeV] | $P_{max}$[kW] |
|---|---|---|---|
| 1 | 8 | 0.45 | $\approx 0.1$ |
| 2 | 8 + 4x24 | 6.37 | 13.5 |
| 3 | 8x24 | 6.37 | 50 |
| 4 | 8x24 | 6.37 | 100 |

- One bunch of $10^{10}$ charges carries $\approx 10\,\text{kJ}$
- If lost continuously over 10s $\approx 1\,\text{kW}$
- Interlock if bunch intensity $< 3 \times 10^9$ charges
- To generate losses of 13.5 kW over 10s we need 20 bunches

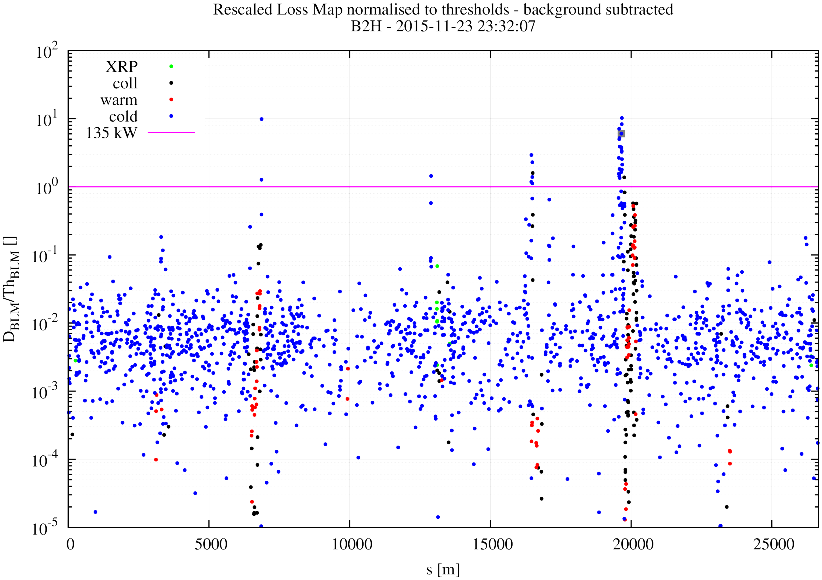
# BLM thresholds

- BLMs at cold elements : master table (MT) increased x10 and MF are kept as they are

$\rightarrow$ Allows some further margin to increase losses and keep changes as simple as possible

- BLMs at selected collimators : few collimators need thresholds at selected RSs to be slightly increased

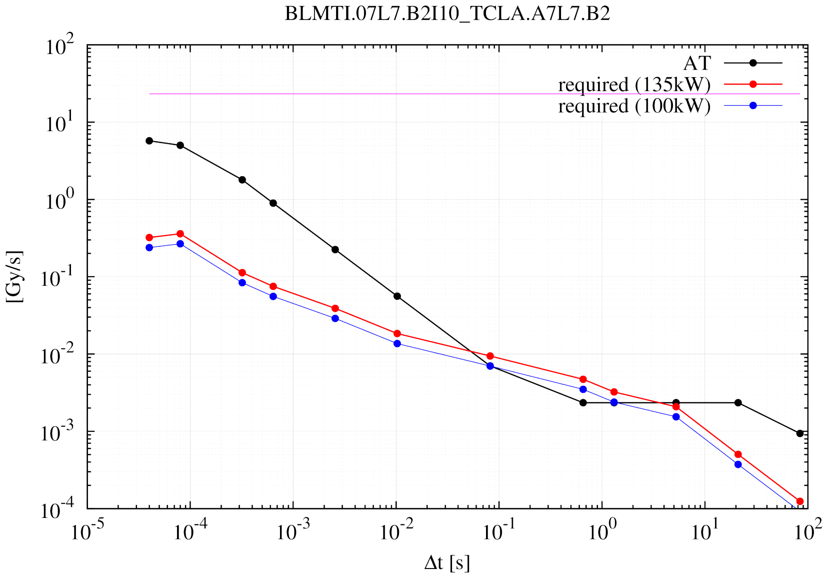
# BLM thresholds



# Conclusions

- Strategy identical as for protons
- Maybe more flexibility : smaller amount of beam loss required to reach the same power load in cold magnets
- BLM master table increased 10 times
- Possibly 4 fills in which we may reach a beam power loss of up to 100 kW

# Backup


BLMTI.07L7.B2I10_TCLA.A7L7.B2
AT
required (135kW)
required (100kW)
[Gy/s]
Δt [s]
$10^{2}$
$10^{1}$
$10^{0}$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$