Detection of beam losses in the triplet and cold BLM sensitivity

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Outline

- Introduction
- Calculation setup
  - Layout and optics
  - Loss scenario
- Results
  - Peak power density in coils
  - BLM response
  - “cryoBLM” response
- Summary

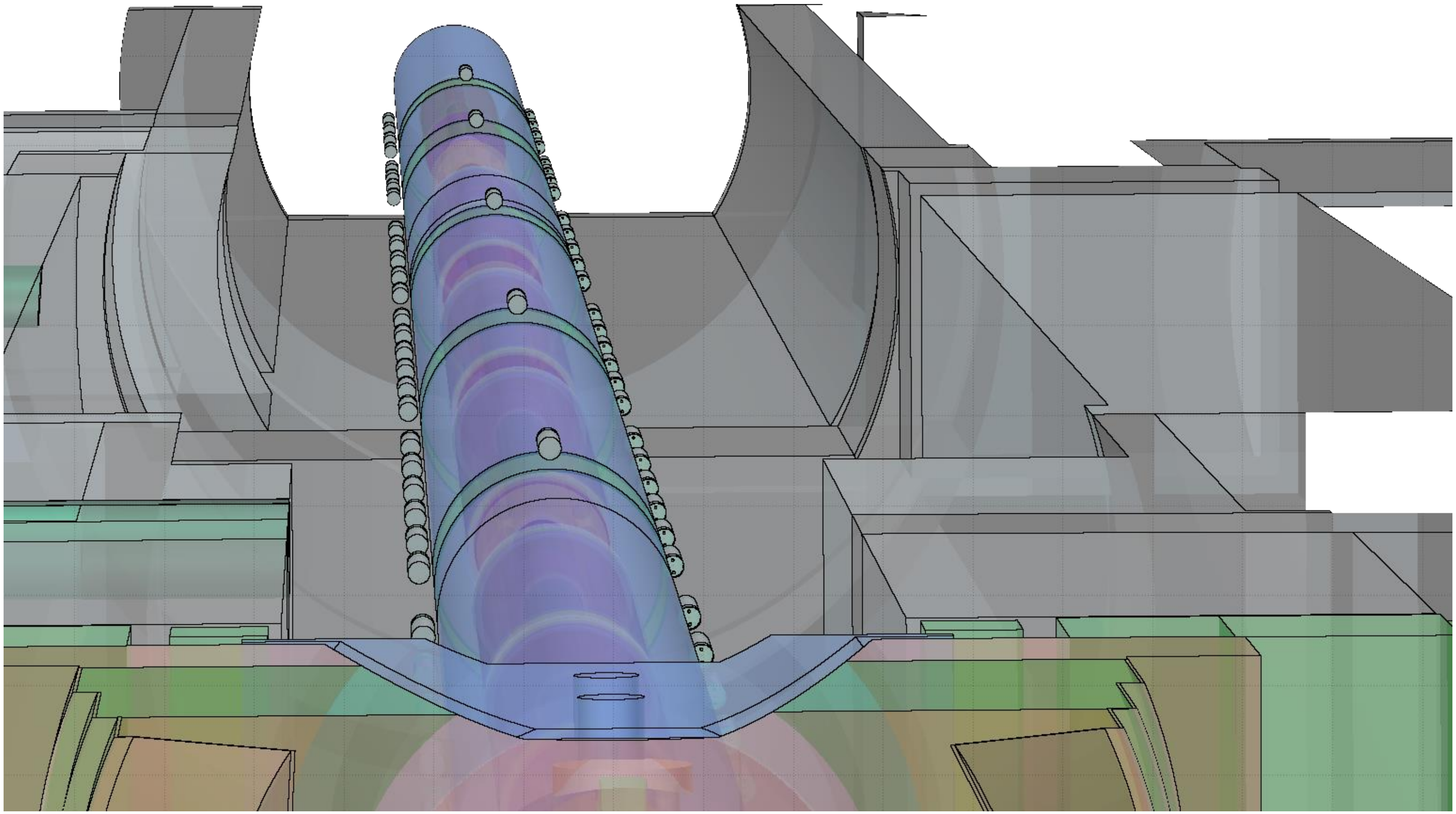
Introduction

- Previous study presented at cryo-BLM integration kick-off meeting (05/12/2016, A. Mereghetti, M. Sapinski) https://indico.cern.ch/event/592778/
  - **Objective:** to set triplet BLM thresholds capable of identifying the onset of abnormal losses on top of the usual debris signal and trigger a beam dump before quench
  - **Conclusion:** the signature from the abnormal steady-state loss was recognizable, but did not fully stand out against the debris signal; a single value of BLM threshold could not be assigned to all triplet BLMs
- New elements:
  - **Relation between local and global loss rate** is now known
  - The presence of **Inermet shielding in the triplet beam screen** requires higher losses in order to induce a quench
- Goals of this study:
  - Calculation of BLM pattern in the HL triplet for <u>stable operation</u> (v1.3) and for a <u>loss scenario</u> in IR5
  - Evaluation of “cryoBLM” effectiveness with respect to conventional BLMs

Layout, optics and loss scenario

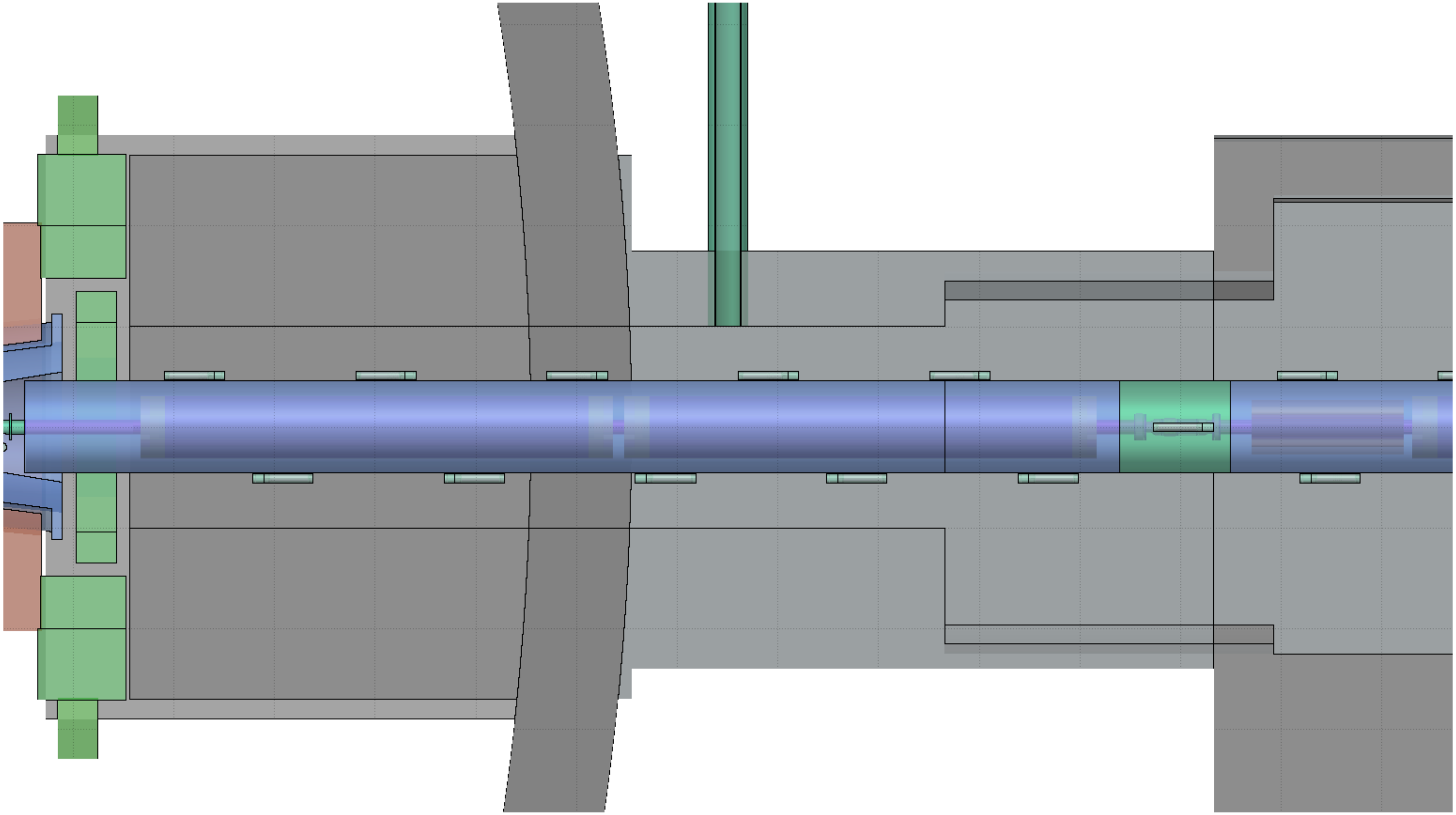
Simulated geometry (triplet-D1)

- HL-LHCV1.3 (255μrad half crossing angle, β^*=20cm)



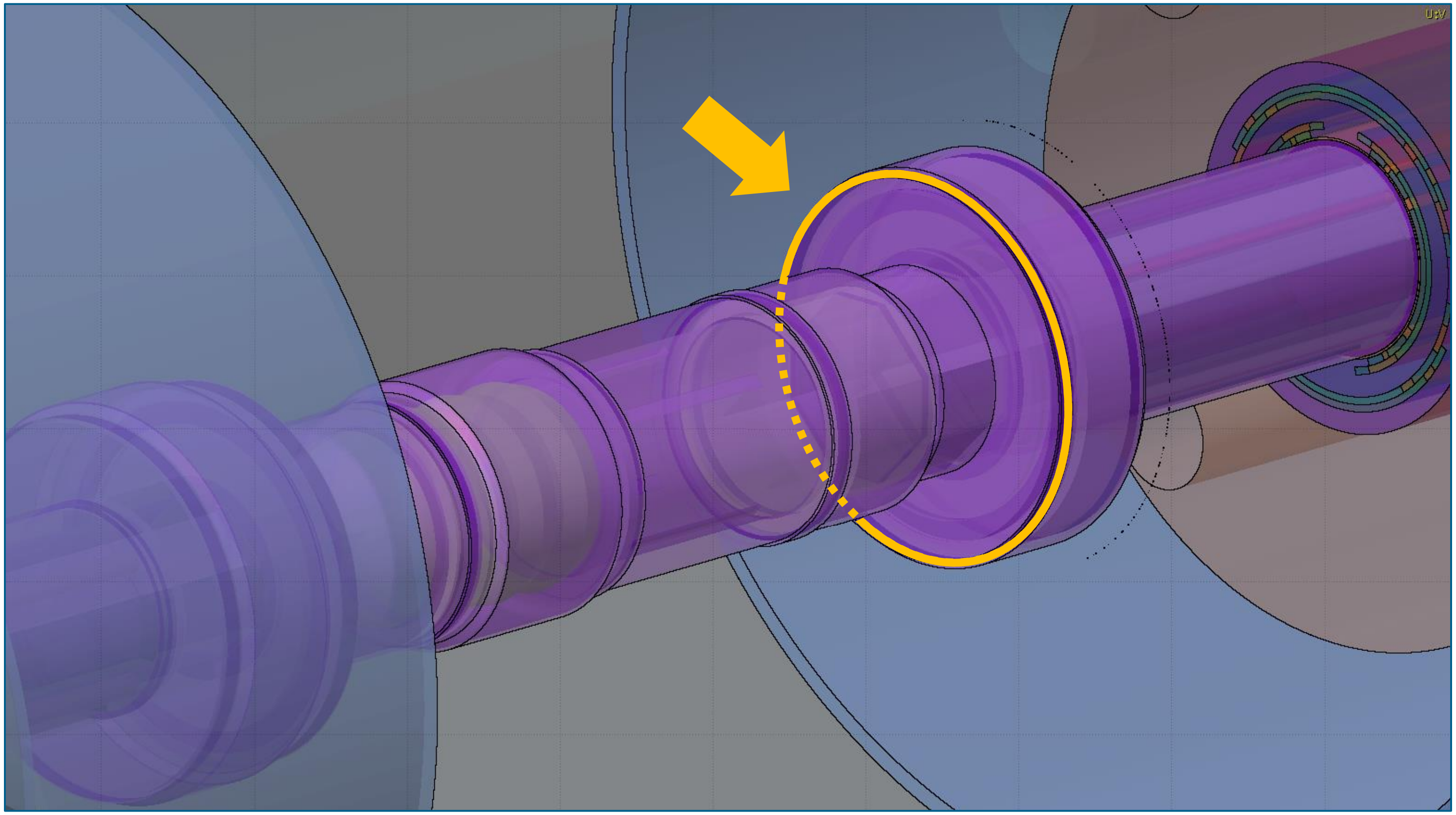
Simulated geometry (triplet-D1)

- Several BLMs placed to obtain a finer-grained information



Scoring for "cryoBLMs"

- Additional scoring added on the interconnect flanges to represent a reasonable cryoBLM location

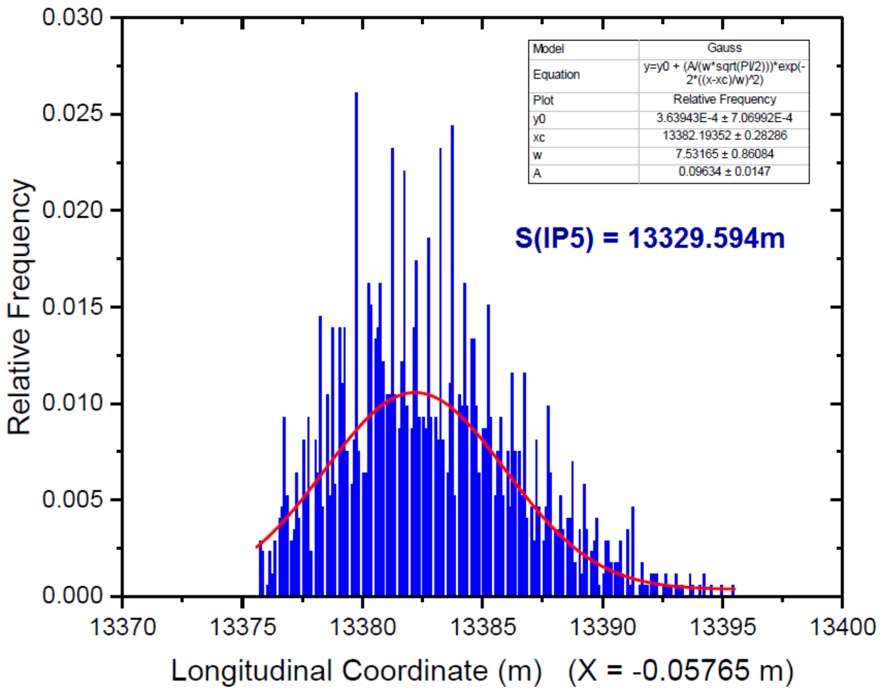


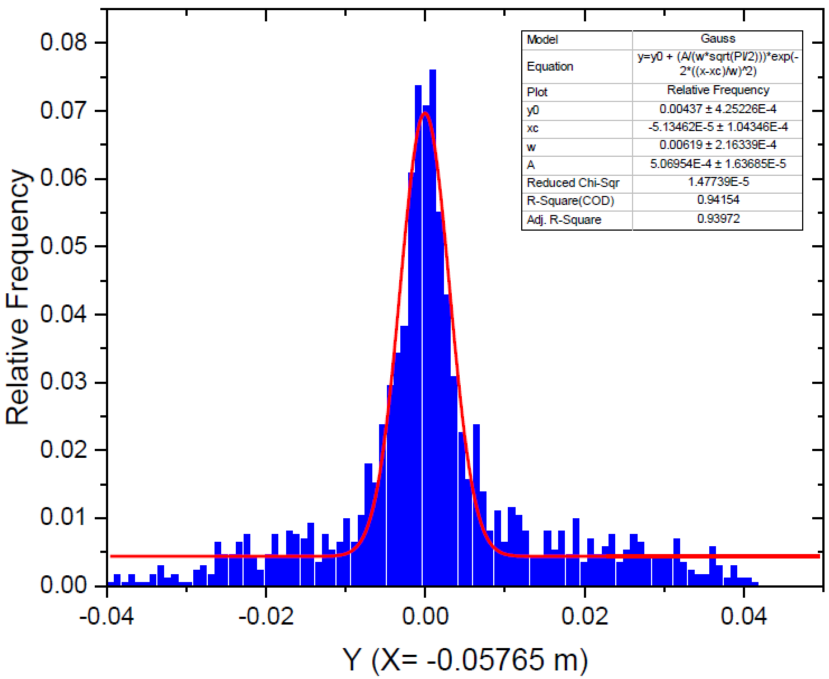
Loss scenario

- Tracking calculations performed by Y. Zou & A. Mereghetti with:
  - 7.0 TeV beam momentum, β^*=15cm, 295μrad half crossing angle
  - Open TCTs in IR1/2/5/8
    - Aim: to simulate missing protection from TCTs
  - Open TCLA in IR7, TCSG in IR6, TCDQ in IR6
    - Aim: to increase losses in the triplet
  - TCLs open
- Highest losses recorded right of IP5 (incoming beam)

Loss scenario

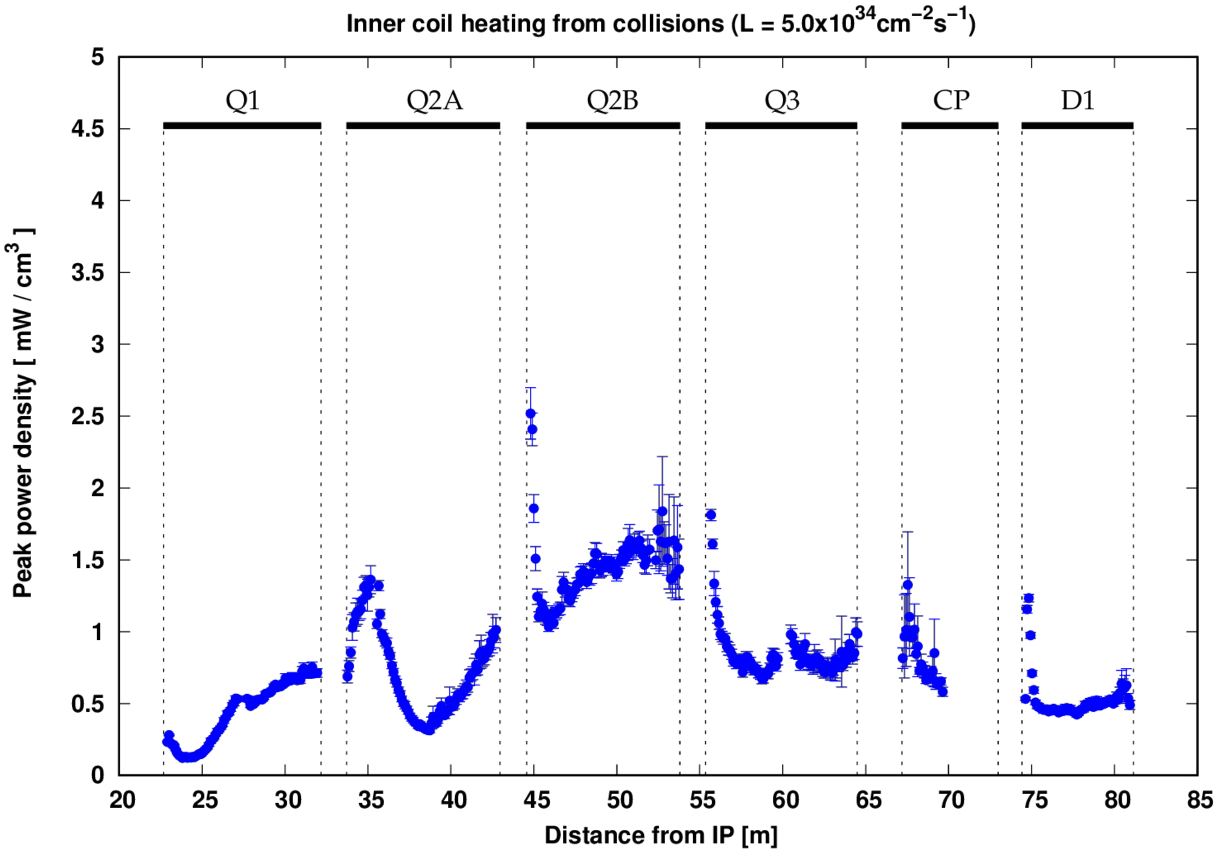
- Only losses on horizontal plane were considered (dominant contribution)
- In FLUKA, events were sampled from the fitted distributions in s, x, x', y, y'





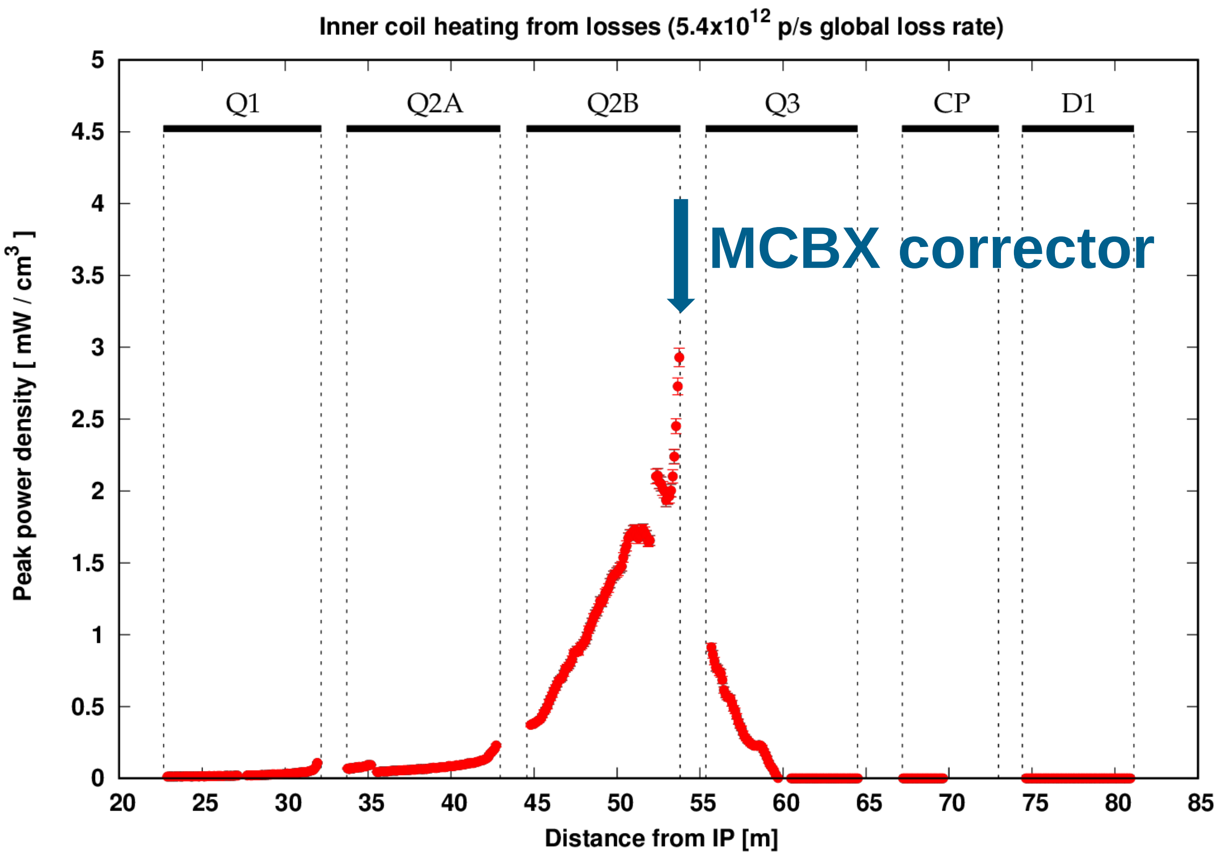
- Losses concentrated **between Q3 and Q2B**

Triplet-D1: Peak power density profile (Debris, L=5.0x10^{34} cm^{-2} s^{-1})



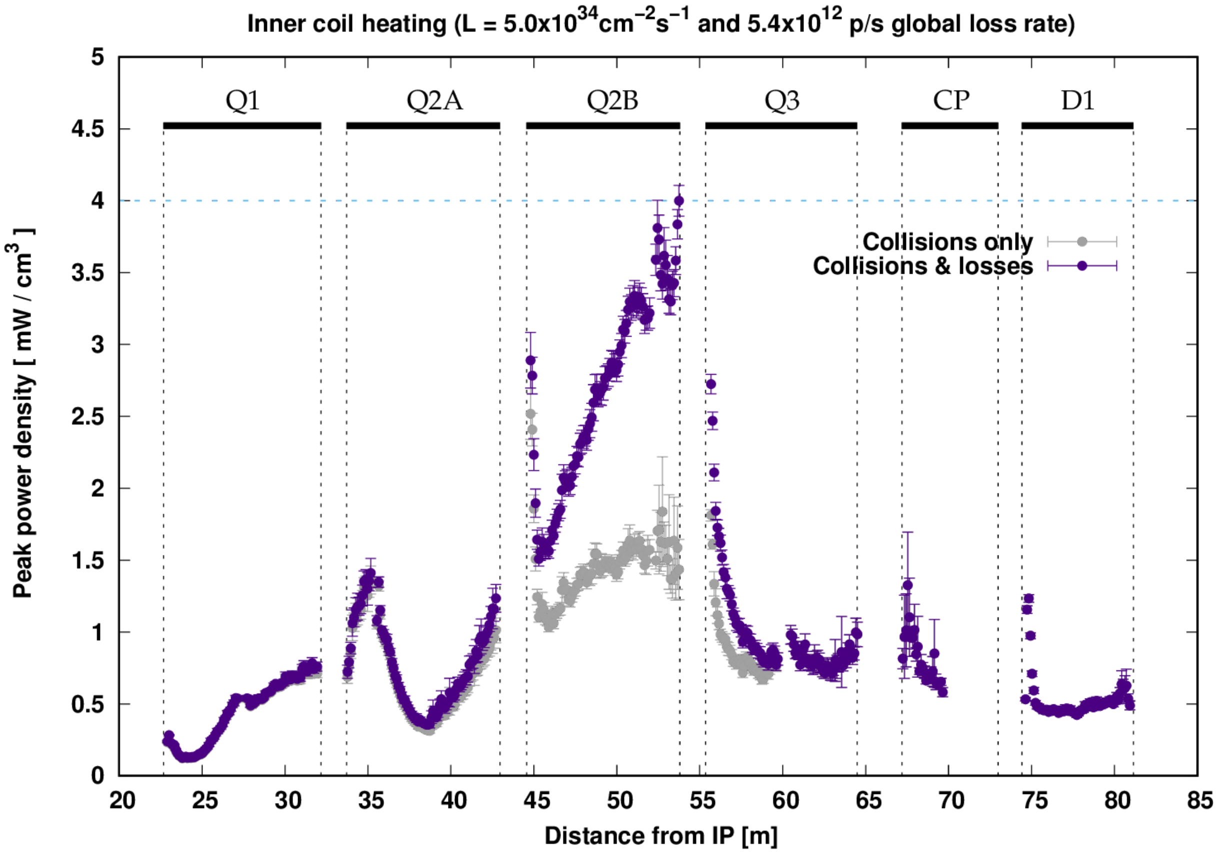
HiLumi HL-LHC PROJECT

Triplet-D1: Peak power density profile (Losses)



- Normalised in order to reach the 4mW/cm^3 design limit in the MCBX corrector when added to the debris load

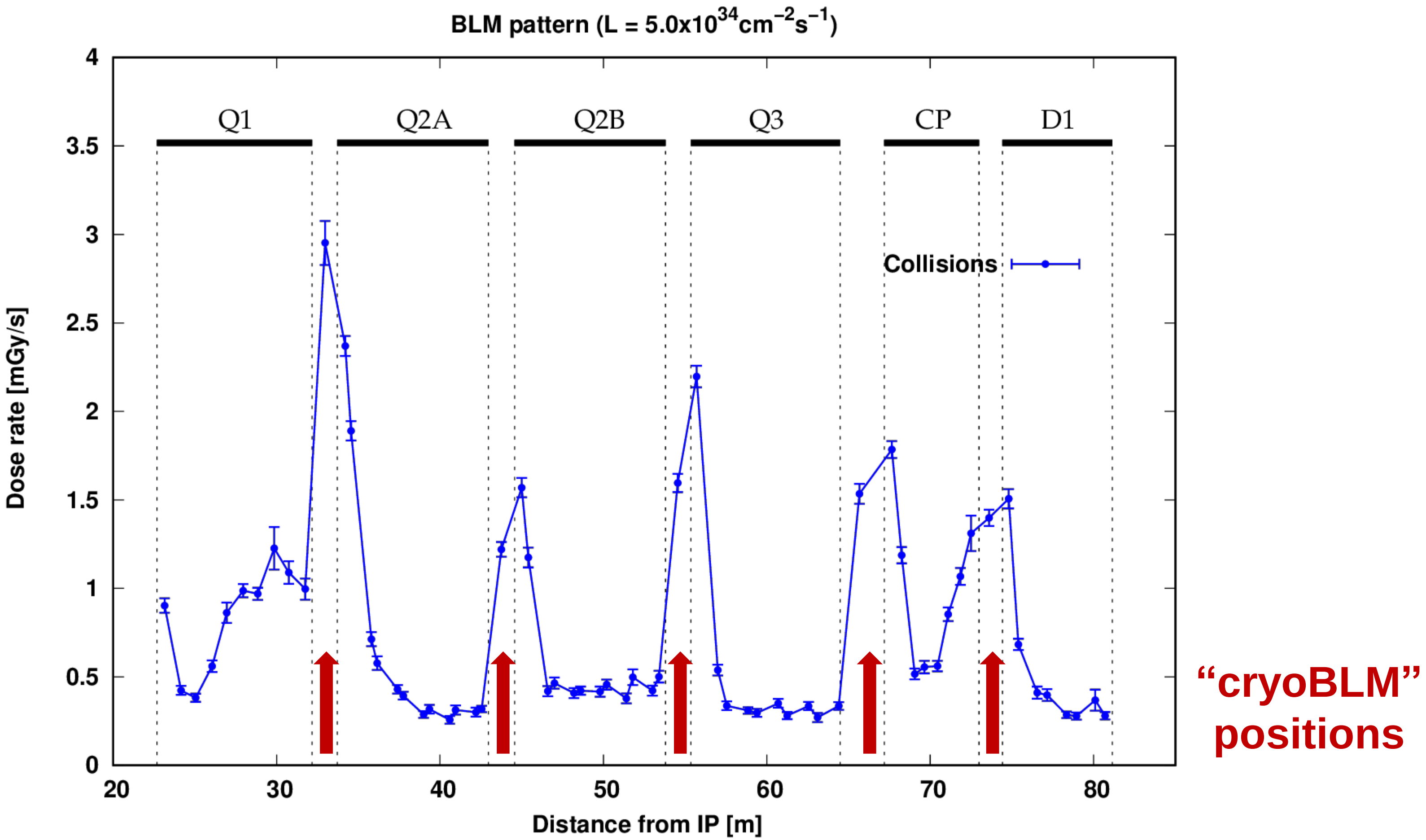
Triplet-D1: Peak power density profile (Debris and losses, $4mW/cm^3$ maximum value)



- Corresponds to 3.0×10^8 p/s lost locally ➔ **5.39×10^{12} p/s global loss rate**
- **Two minutes** of beam life-time, ~6 MW of power lost
- **Such an abnormally low life-time is dumped in the collimation system, hence local detection is not essential**

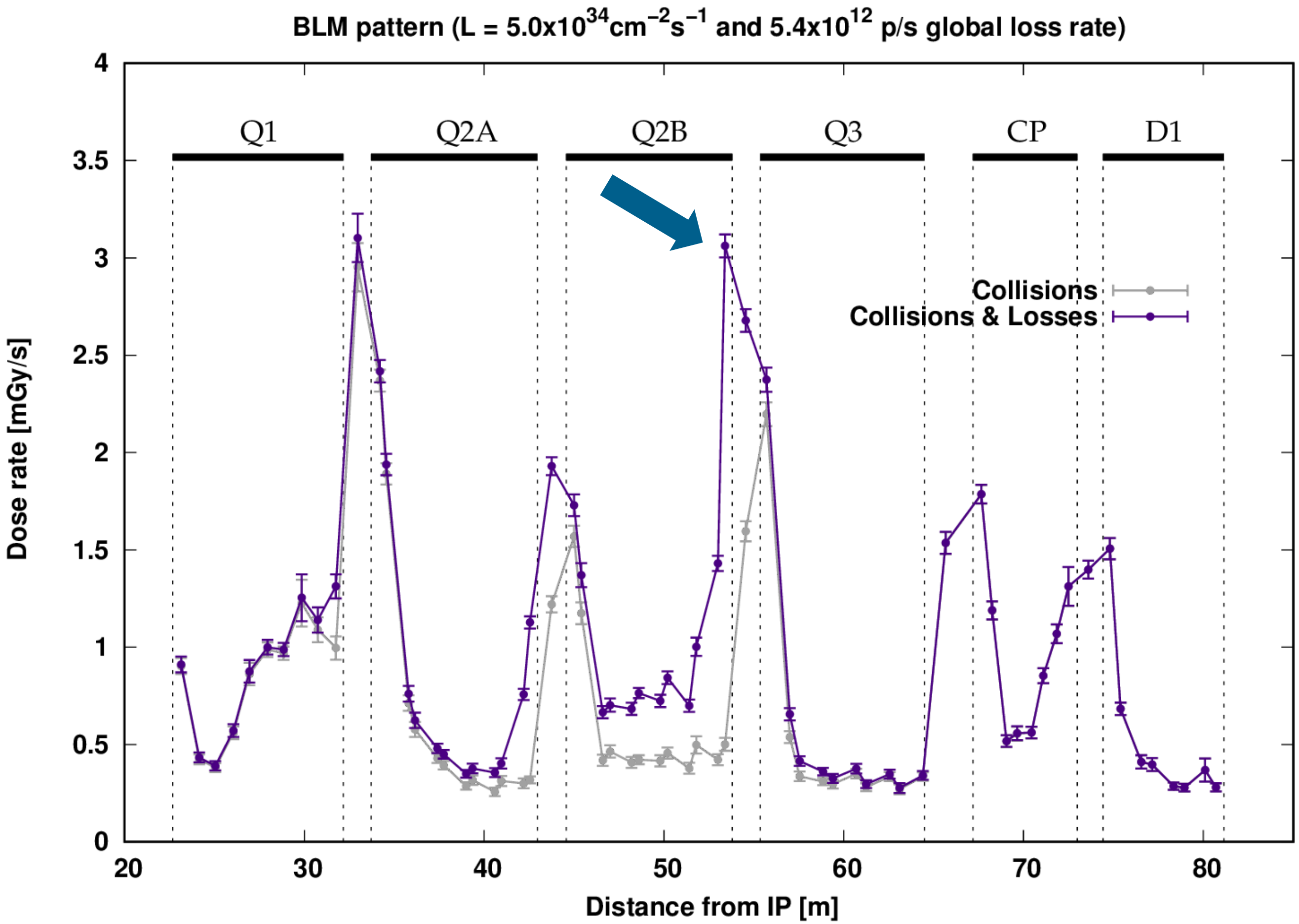
BLM pattern

Normal BLM response to collision debris



- This high-resolution pattern could guide the optimisation of the BLM placement

Normal BLM response: debris and losses



- Highest sensitivity at end of Q2B

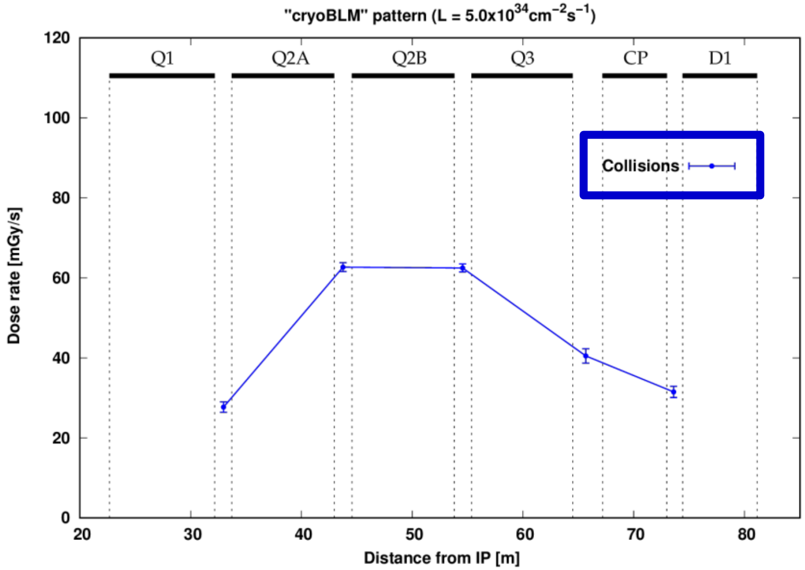
“cryoBLM” response: debris vs. losses comparison

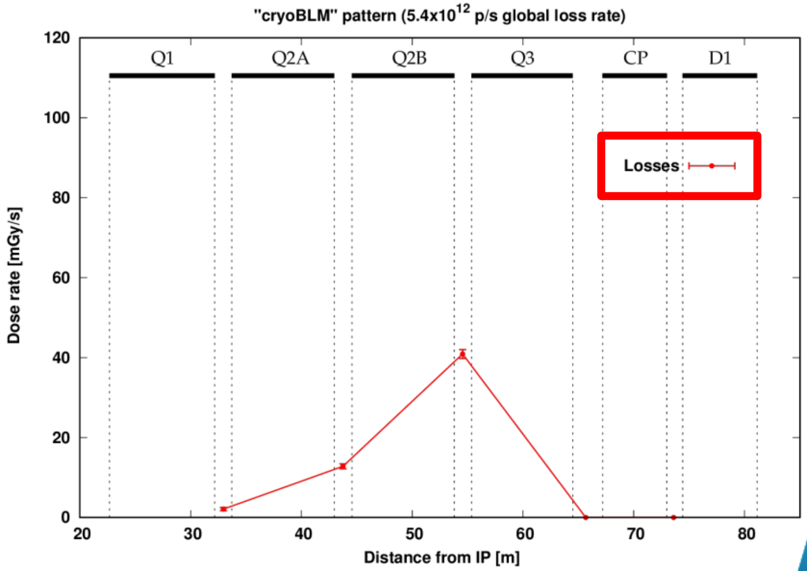
- **N.B.:** “cryoBLM” values have a strong azimuthal dependence → their exact placement is critical

“cryoBLM” values (debris)

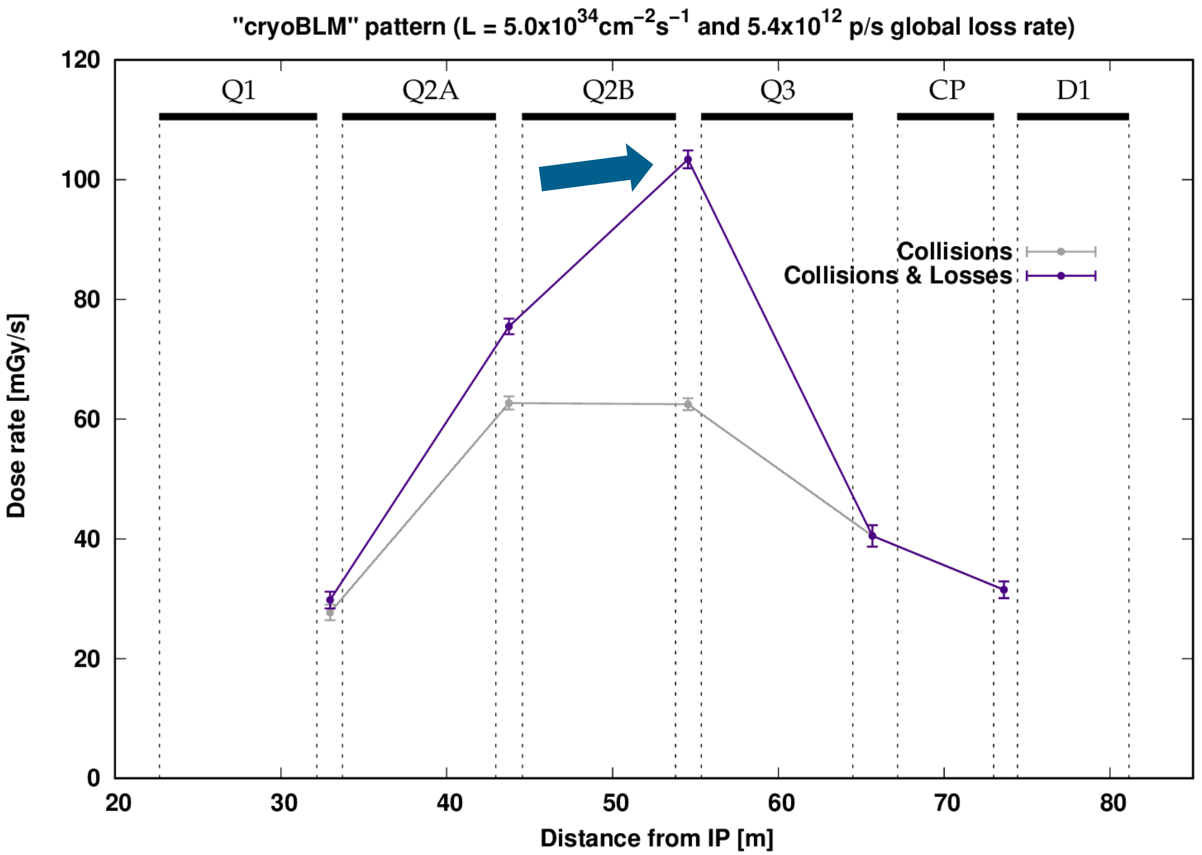
Dist. from IP [m]	Min. [Gy/s]	Max. [Gy/s]
32.97	0.018	**0.028**
43.75	0.021	**0.064**
54.55	0.026	**0.065**
65.67	0.019	**0.039**
73.6	0.019	**0.032**

- The maximum values were considered for this study





“cryoBLM” response: debris and losses



- Highest sensitivity also at end of Q2B
- Not comparable to the normal BLM sensitivity gain due to the less favourable positioning

Summary

- Abnormal losses would only represent an operational threat in the triplet for beam life-times that are sufficiently low to induce a dump in the collimation region by design
- Even for the corresponding extreme loss rate, the presence of cold BLMs does not necessarily increase the detection sensitivity compared with what could be achieved with conventional BLMs, whose placement is less constrained and can be optimised to maximise pattern changes