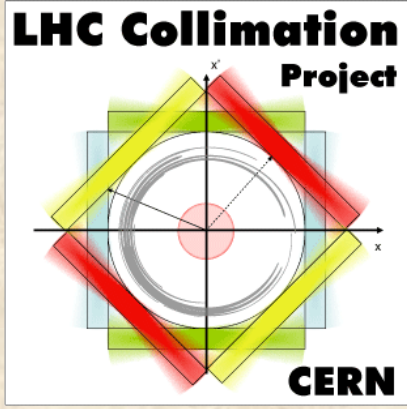

FLUKA energy deposition simulations for the 4TeV collimation quench test and post-LS1 6.5TeV operation

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[2] On behalf of the Collimation team

Acknowledgement

CERN-ATS-Note-2013-XXX MD

4 June 2013
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Results proton collimation quench tests MD at 4 TeV

B.Salvachua, R.Bruce, M.Cauchi, D.Deboy, W.Hofle, E.B.Holzer, D.Jacket, L.Lari, E.Nebot, D.Mirarchi, E.Quaranta, S.Redaelli, M.Sapinski, R.Schmidt, G.Valentino, D.Valuch, J.Wenniger, D.Wollmann, M.Zerlauth, CERN, Geneva, Switzerland

Keywords: LHC, collimation, quench, protons, 4TeV

Summary

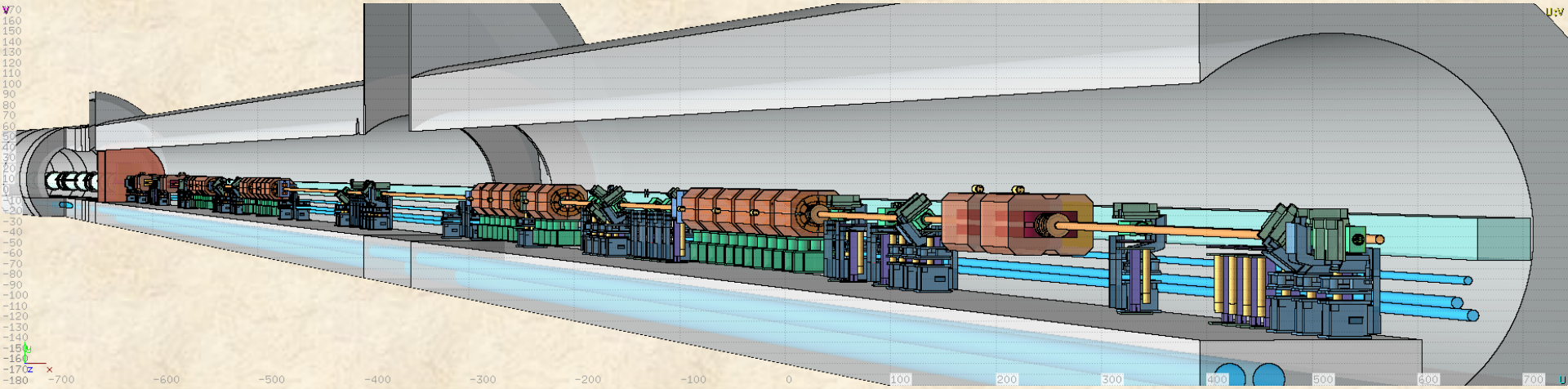
Talk Overview

- IR7 modelling
- SixTrack (beam tracking) and FLUKA (interaction and secondary shower) interplay
- 4TeV (February 2013 quench test) and 6.5TeV (post-LS1 operation)
  - ❑Warm Section Simulation (total power sharing, BLM pattern)
  - ❑DS losses calculation from collimator losses
  - ❑Cold Section Simulation (peak power (dose) in the SC coils, BLM pattern)

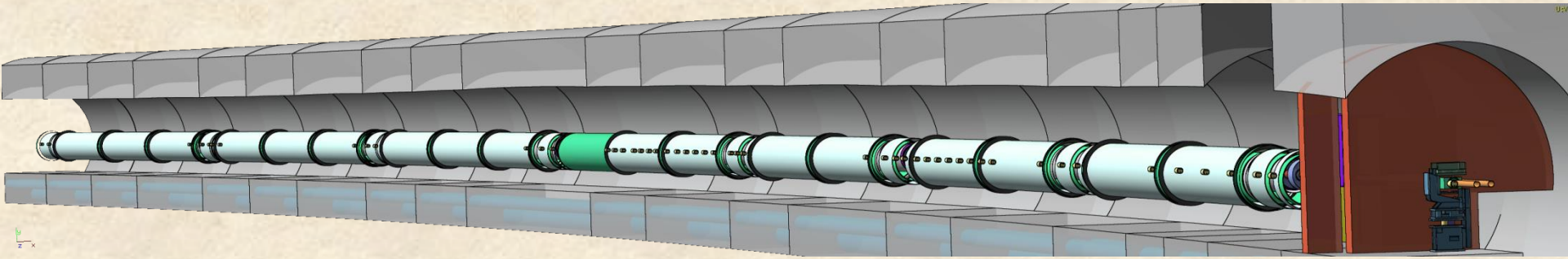
IR7 FLUKA geometry

Beam 2 (internal)

- Long Straight Section



- Left Dispersion Suppressor + Arch up to cell 14

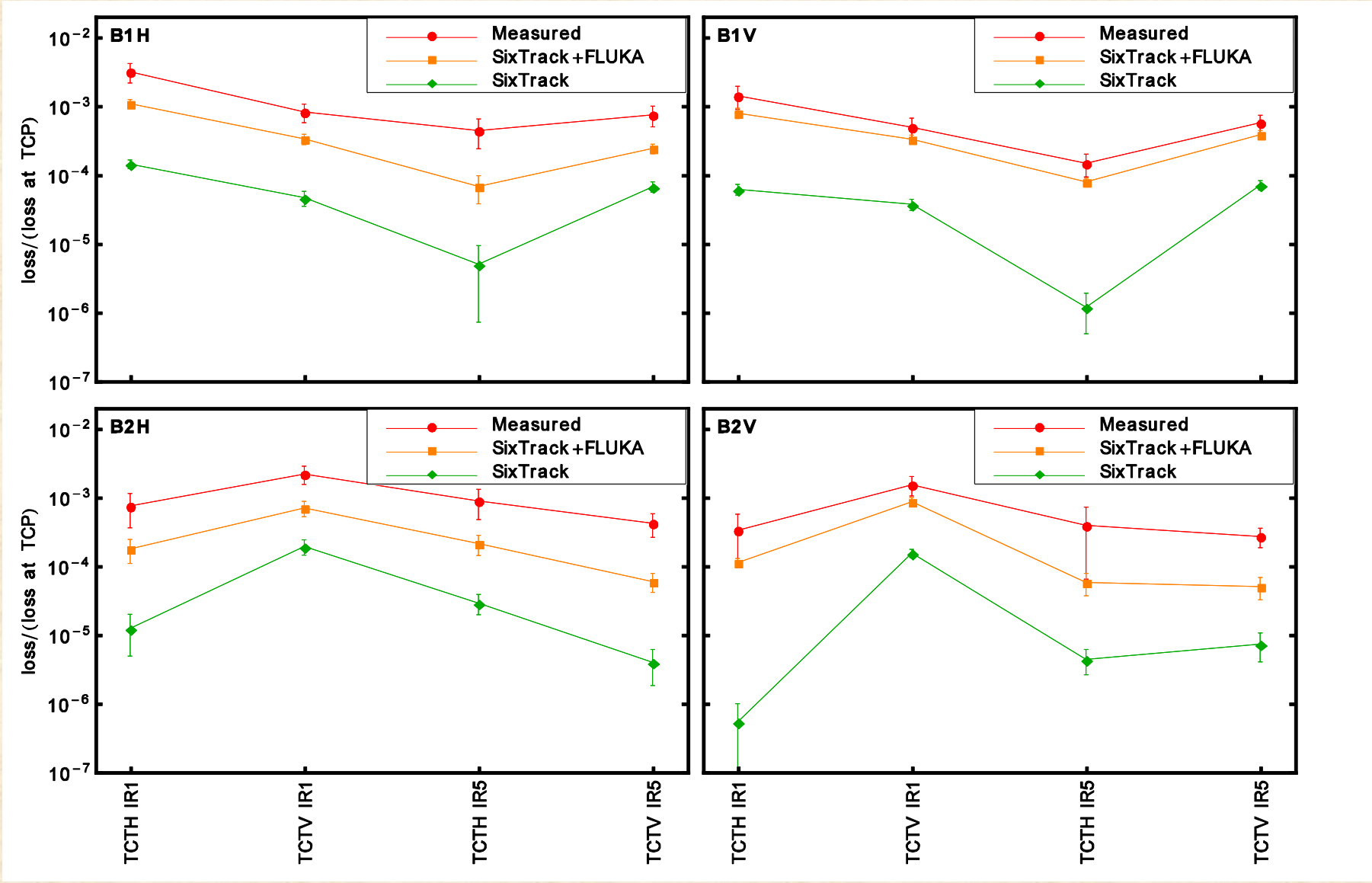


BLM signal factors

- Significant differences in BLM signal depending on many parameters:
  - Position of the BLM
  - Geometry surrounding the BLM
  - Crosstalk shower
- Correspondence between monitor signal (what we see) and relevant quantities (what we care about, e.g. energy deposition in the coils) not universal
- For this reason a Sixtrack (Proton hits on the collimators) + FLUKA (Proton interaction + energy deposition from secondary shower) strategy was adopted in this study

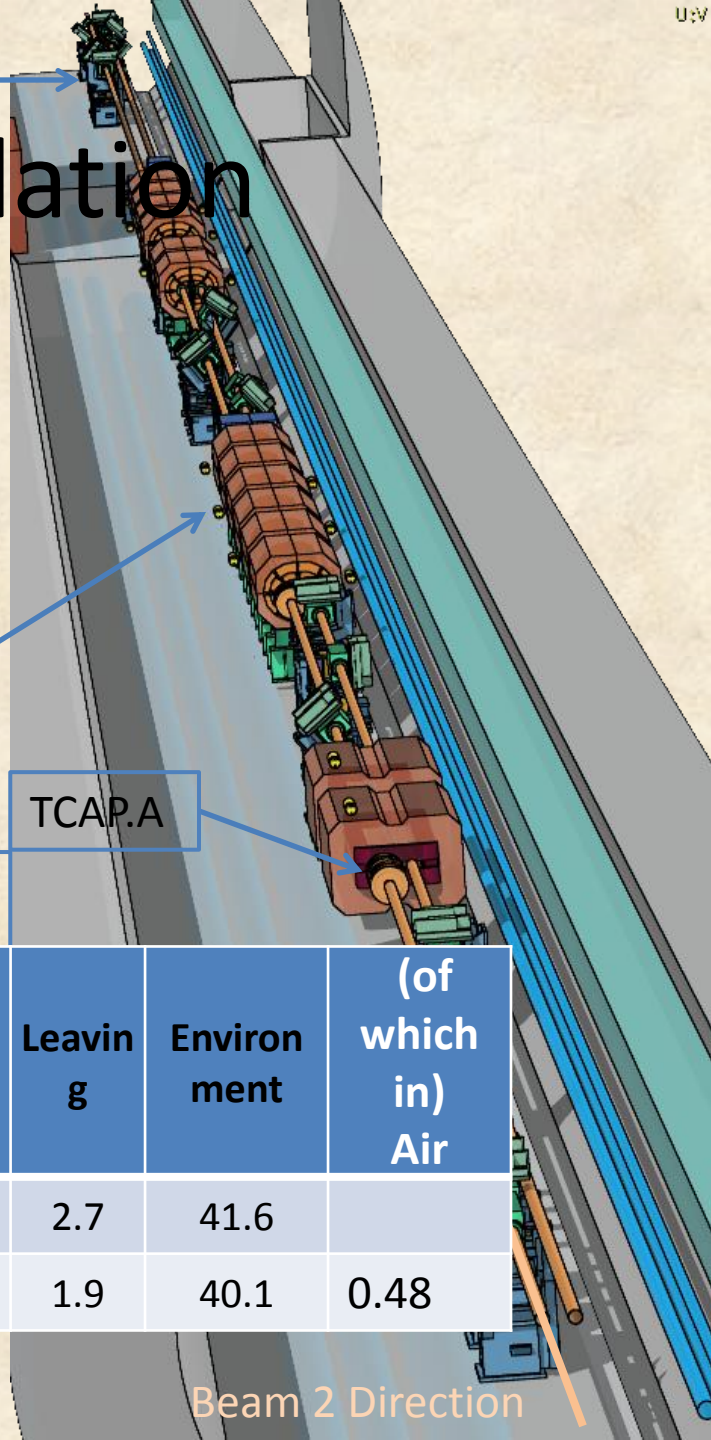
BLMs at the TCTs

R.Bruce et al., Proc. of IPAC13, MOODB202, Shanghai, China, 2013.



Warm Section Simulation

- Sixtrack proton lossmap of a horizontal loss scenario (main impact on TCP.C) directly loaded on the collimators of the Warm Section geometry
- At 4 TeV peak loss rate of 1.6 10^{12} p/s (1MW) , Very relaxed collimator Settings
- At 6.5 TeV peak loss rate of 4.5 10^{11} p/s (0.2h beam lifetime), relaxed

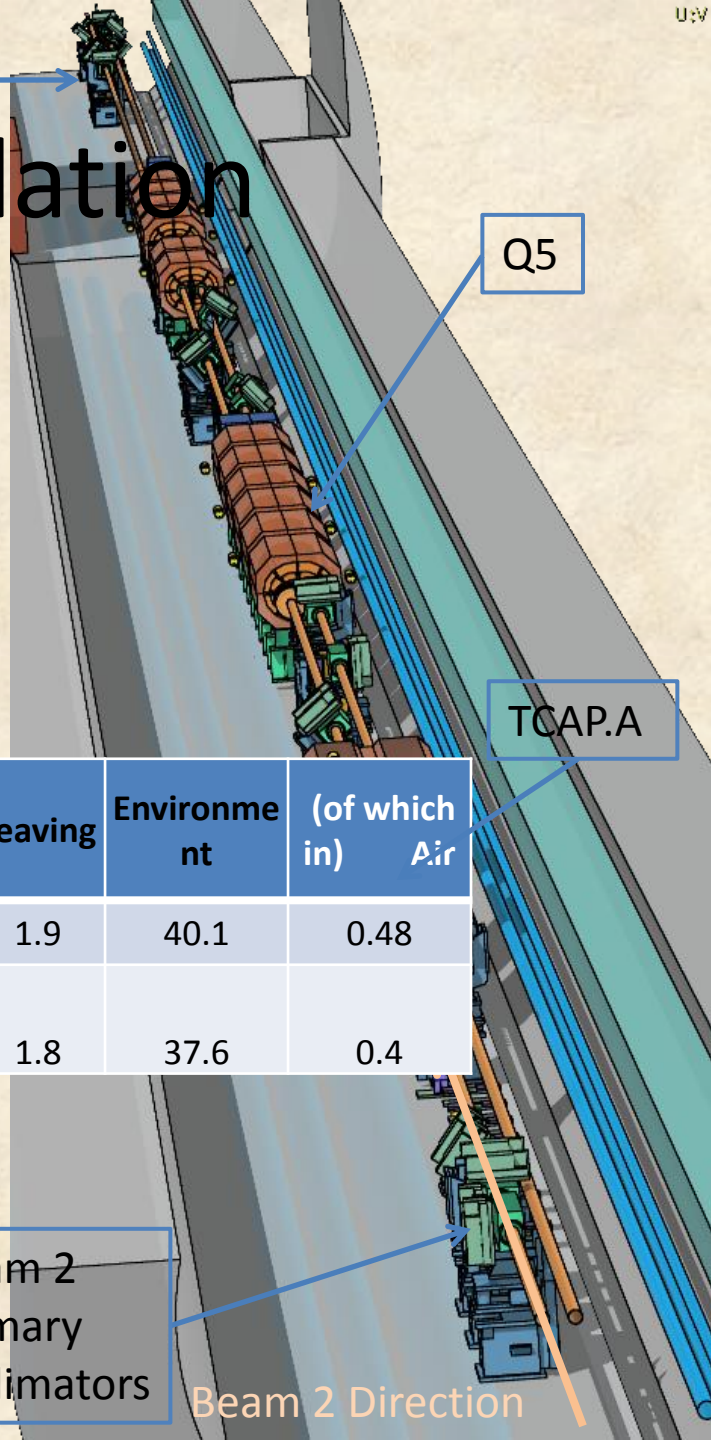


TeV \ %	TCP+TCSG Jaws	TCAP	MBW	MQW	Beam 2 Pipe	E -> m + Neutrinos	Leaving	Environment	(of which in) Air
4	10	12.9	8.5	9.5	8.6	6.2	2.7	41.6	
6.5	10	13.4	8.5	12	8.6	5.5	1.9	40.1	0.48

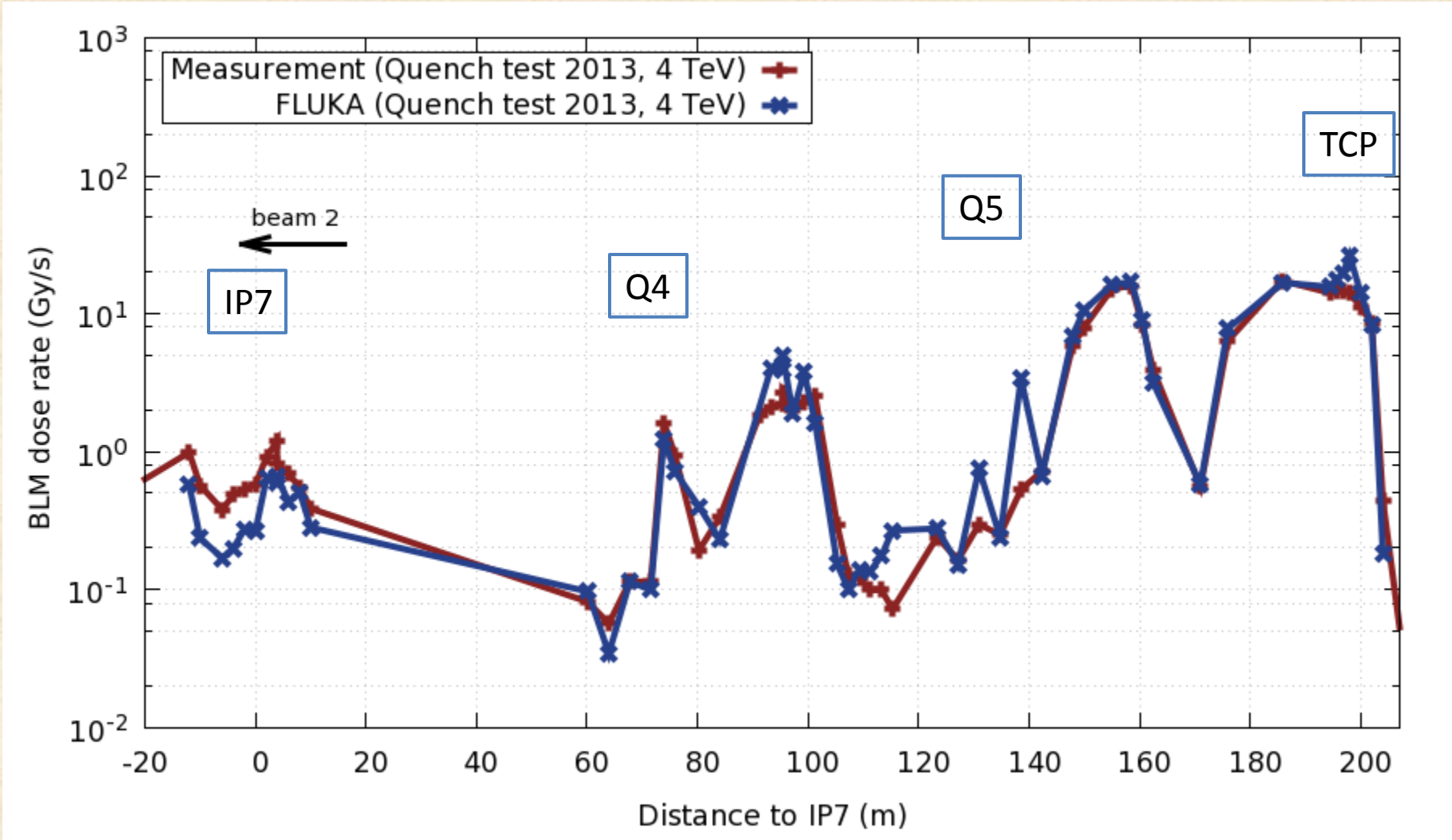
Warm Section Simulation

- At 6.5 TeV peak loss rate of 0.9 10^{11} p/s (1h beam lifetime), relaxed collimator settings (pessimistic scenario)
- Total Power 93.7 kW

% / TeV	TCP+TCSG Jaws	TCAP	MBW	MQW	Beam 2 Pipe	E -> m + Neutrinos	Leaving	Environment	(of which in) Air
6.5	10	13.4	8.5	12	8.6	5.5	1.9	40.1	0.48
6.5 (ABS)	9.4	12.6	8.0	11.2	8.1	5.2	1.8	37.6	0.4



Warm Section Simulation



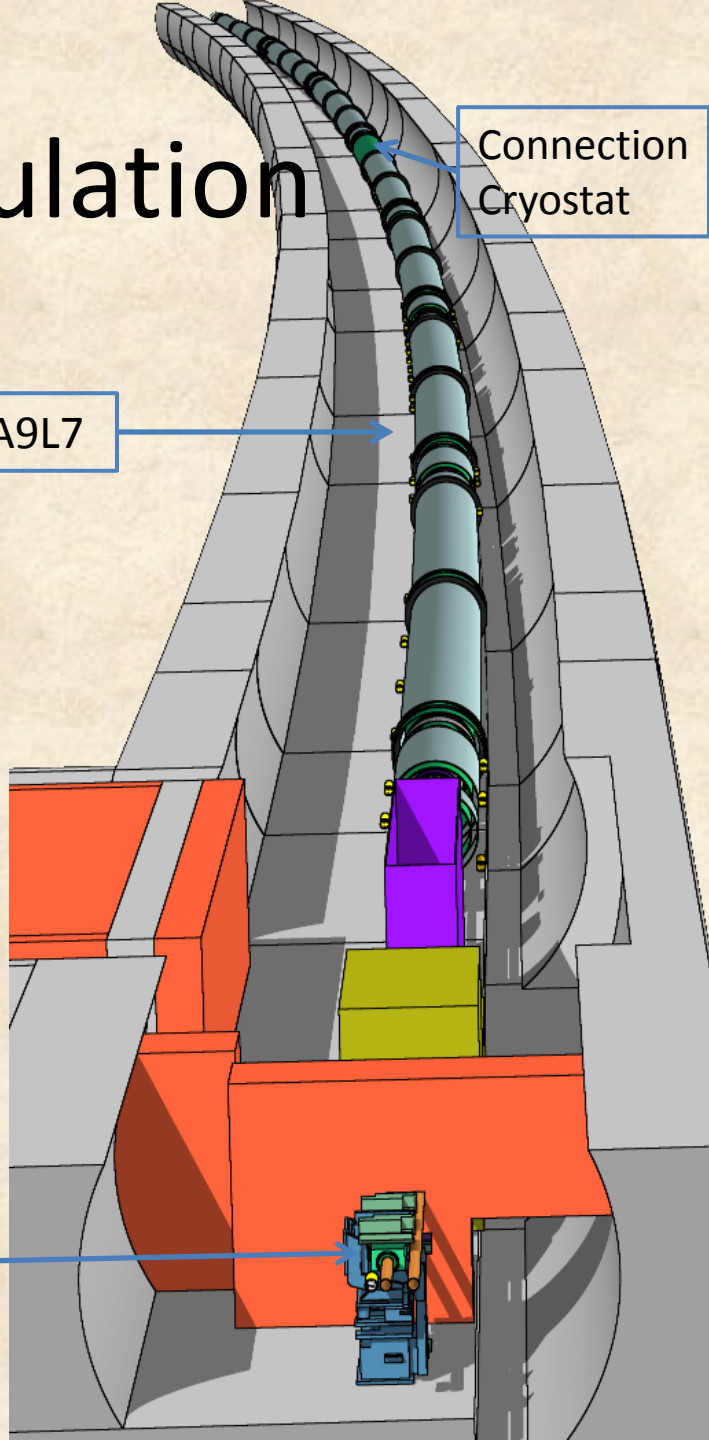
BLM integration Time : Running Sum 1 (40 μs)

Cold Section Simulation

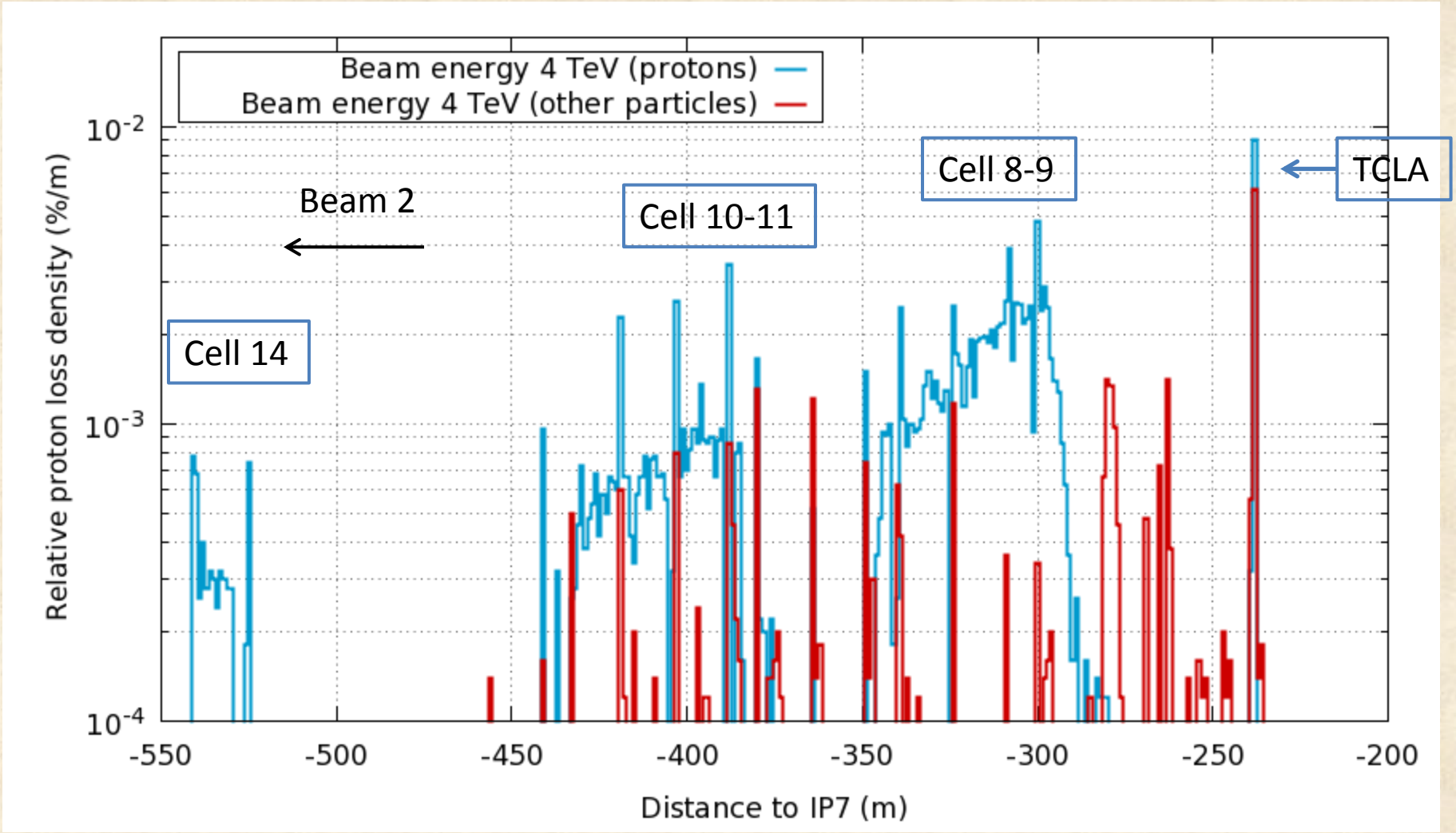
- For every 1000 of protons lost in the Primary collimators we have only 1 in the DS

2 step Simulation to acquire enough statistics:

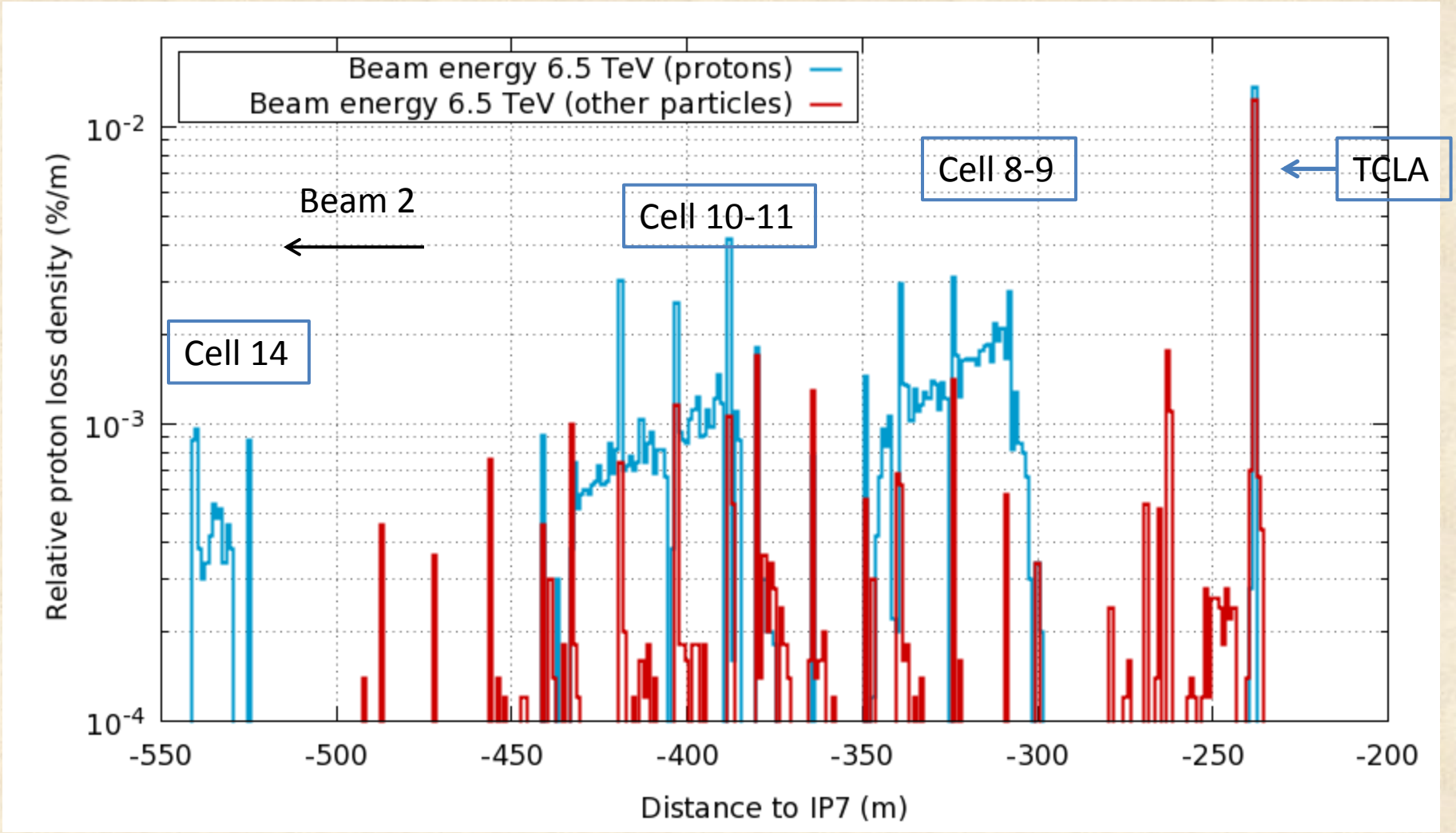
- Generation of **distribution** of particles impacting the aperture at the DS and TCLA, starting from Sixtrack lossmap loaded in all the IR7 collimators
- Use the above distribution to simulate the energy deposition on the **Magnet Coils** and BLM response



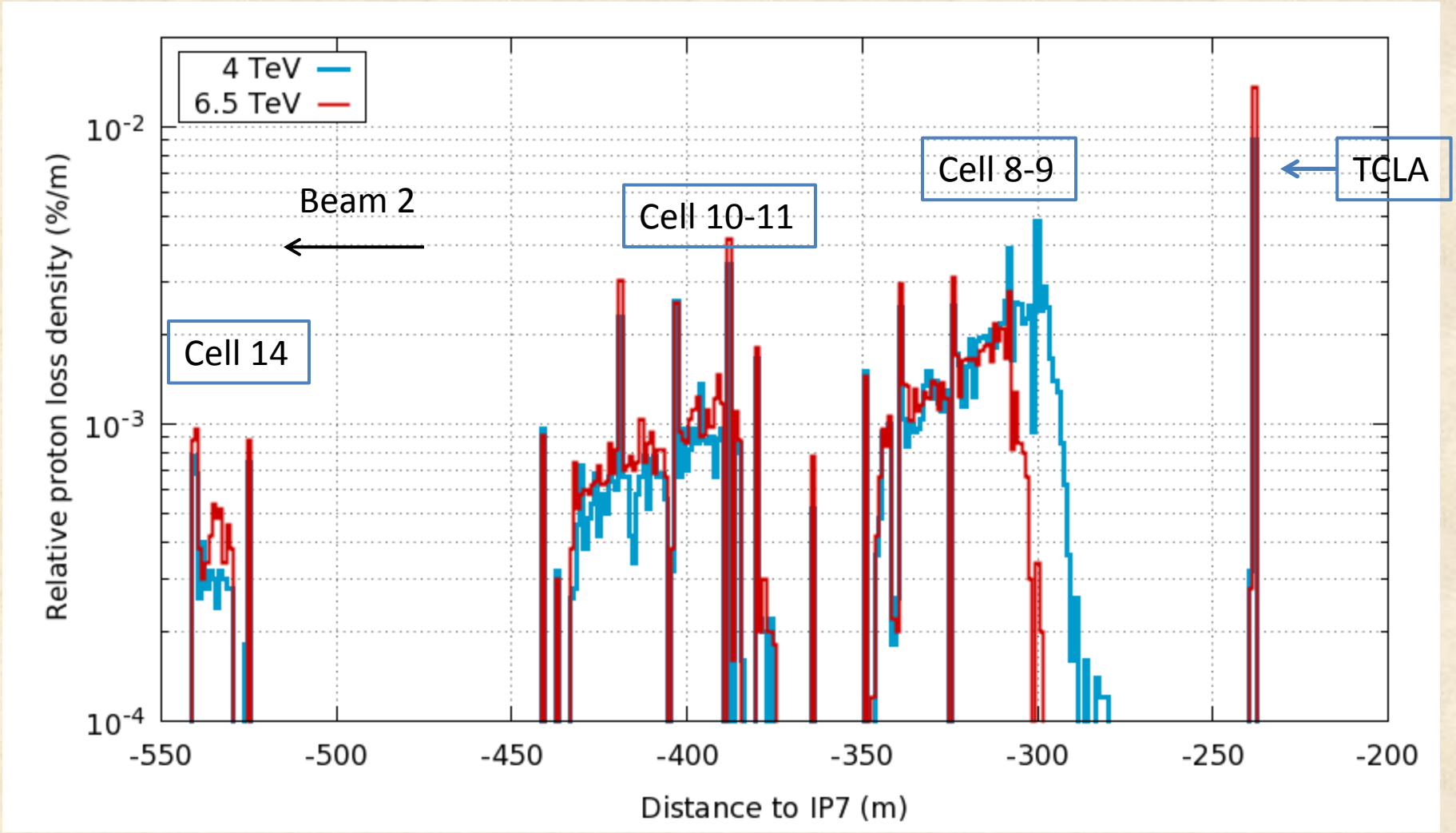
Distribution of impacts TCLA -> Cell14



Distribution of impacts TCLA -> Cell14

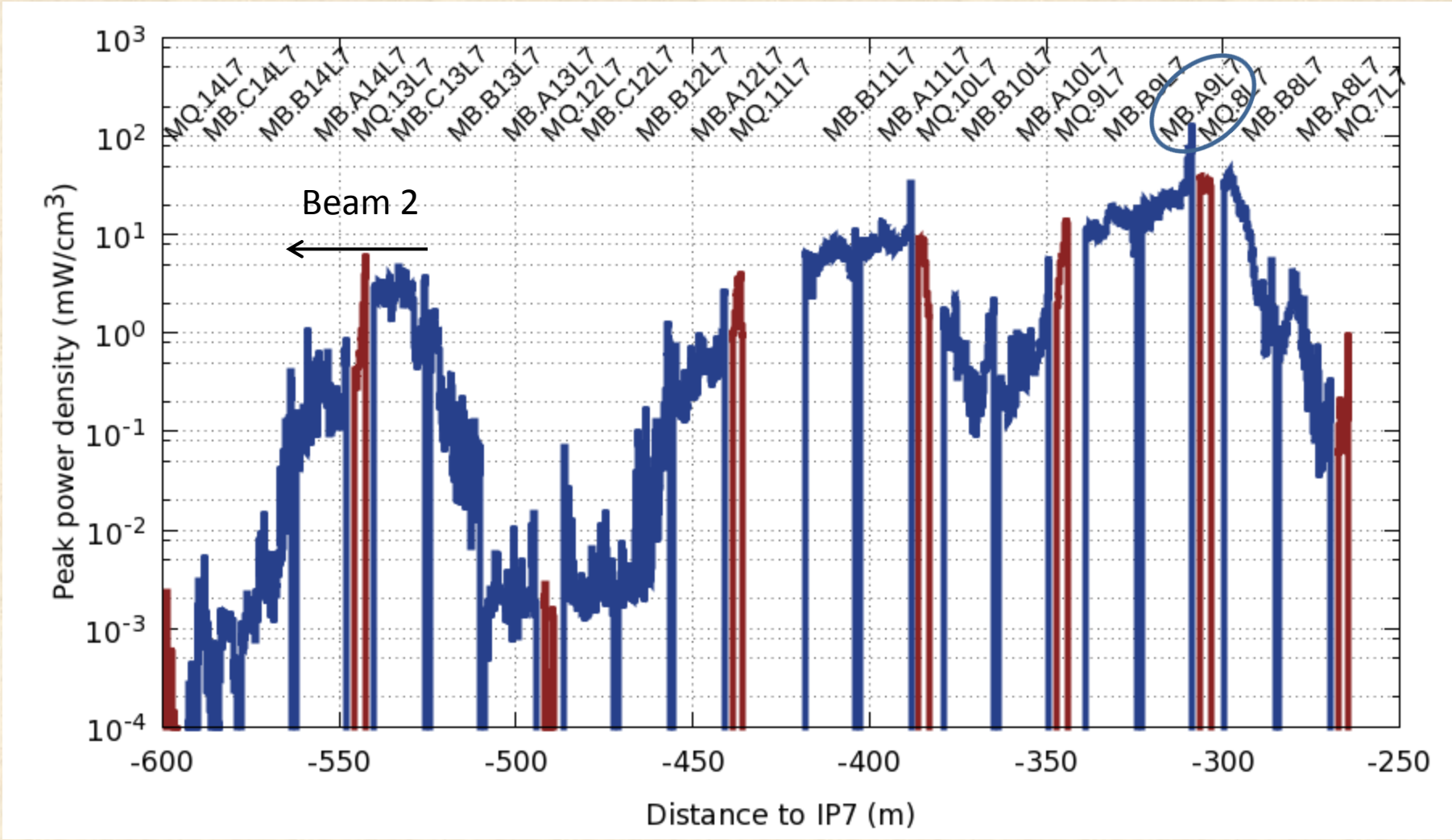


Distribution of impacts TCLA -> Cell14



Magnet coils energy deposition

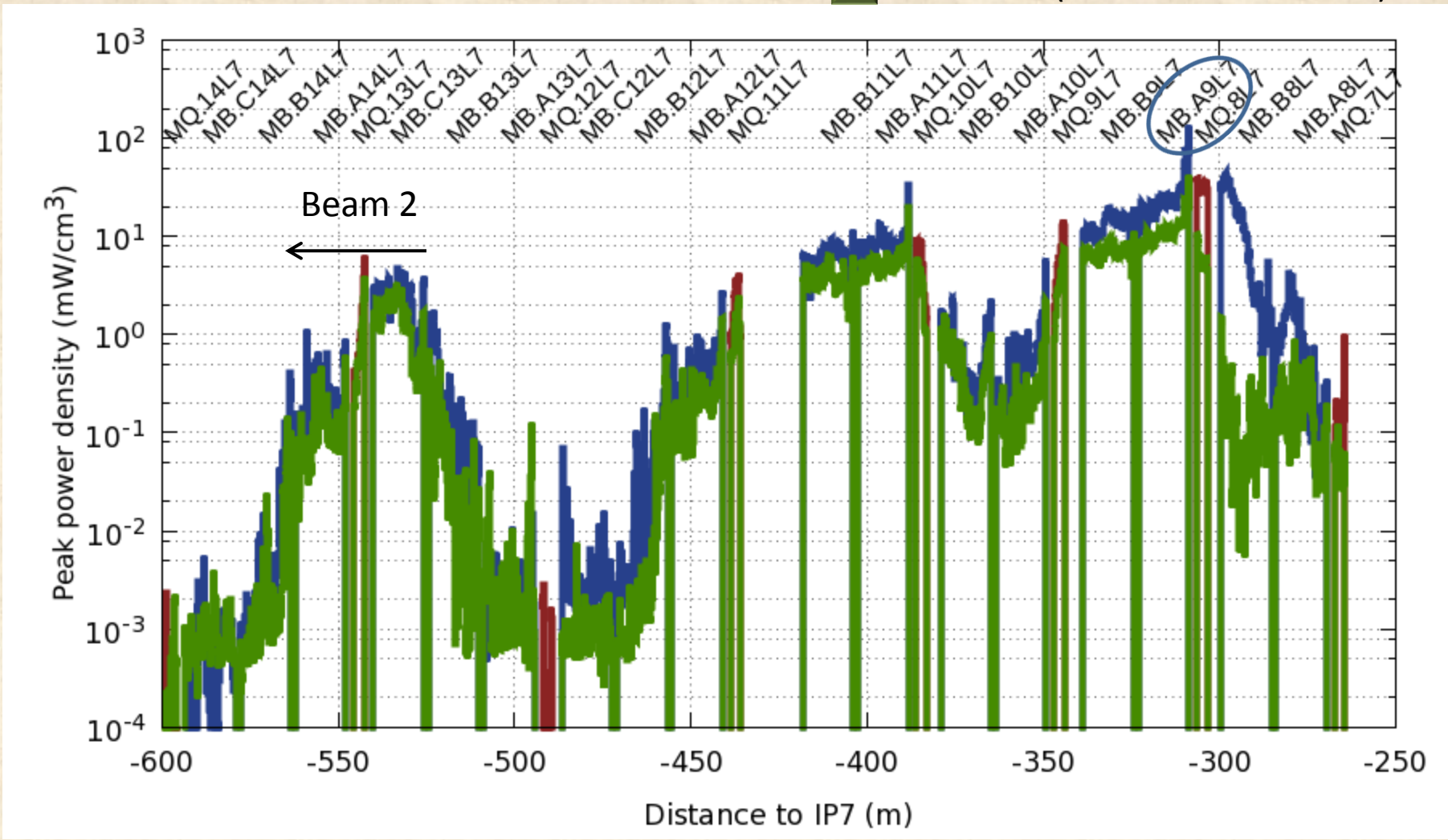
4 TeV Quench Test



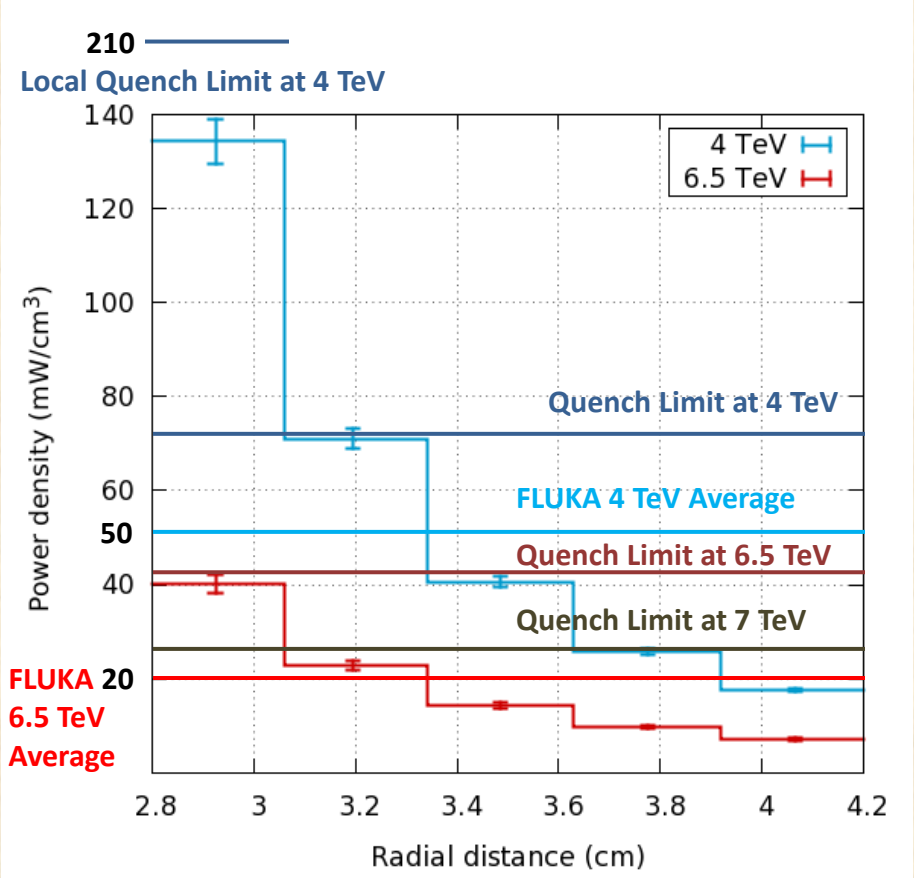
Magnet coils energy deposition

4 TeV Quench Test

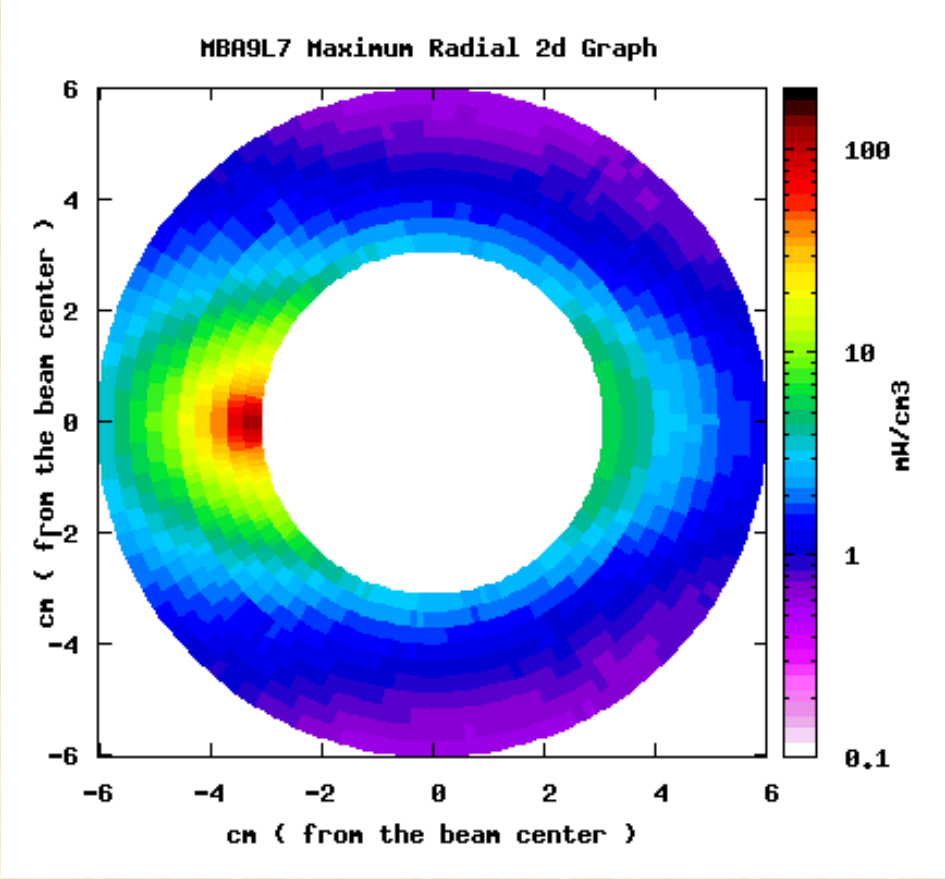
6.5 TeV (0.2 h beam lifetime)



Cold Section Simulation

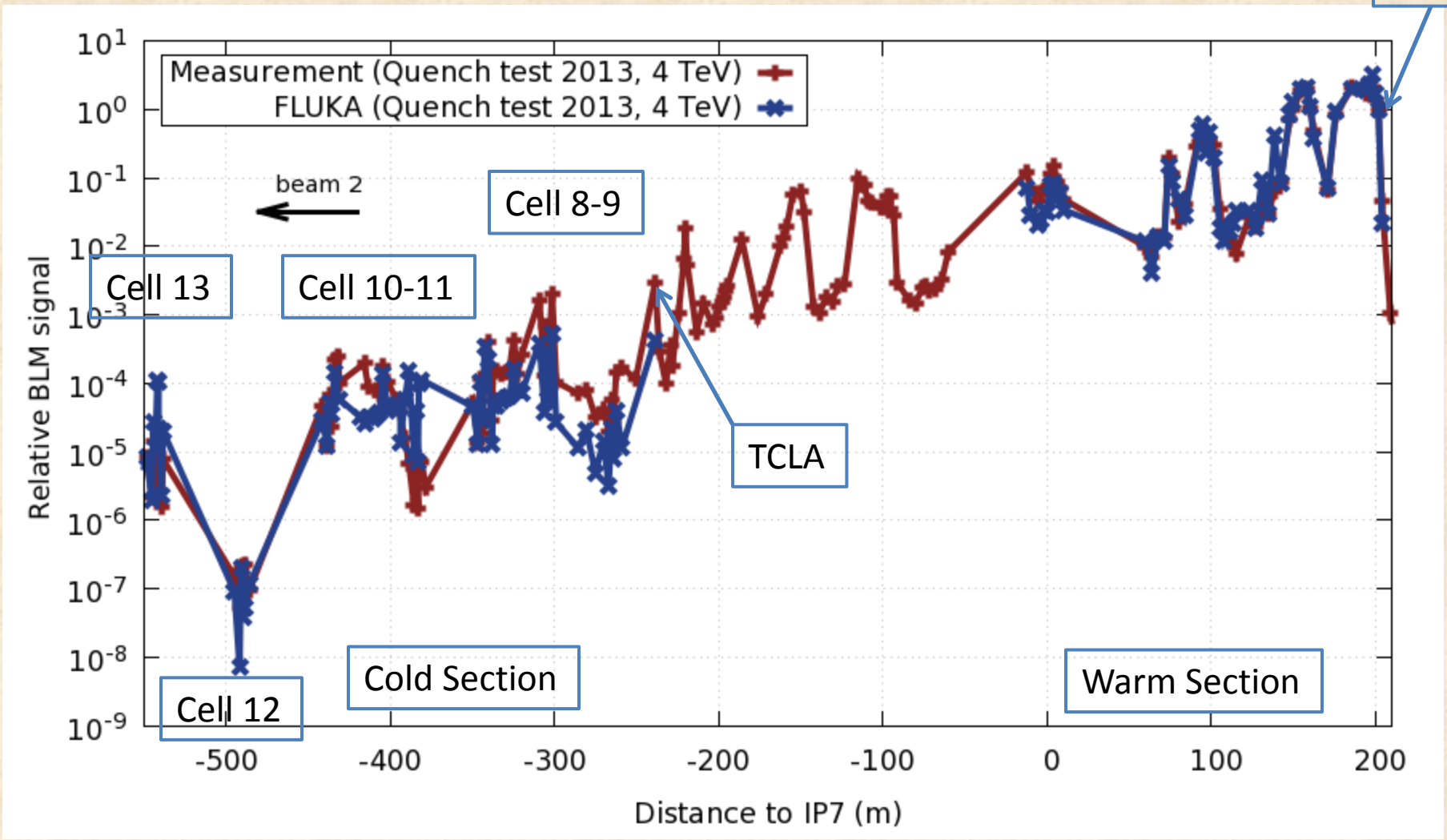


Proton Energy \ Total Power	MB9_A (W)	MQ8 (W)
4 TeV	280	70
6.5 TeV	110	10



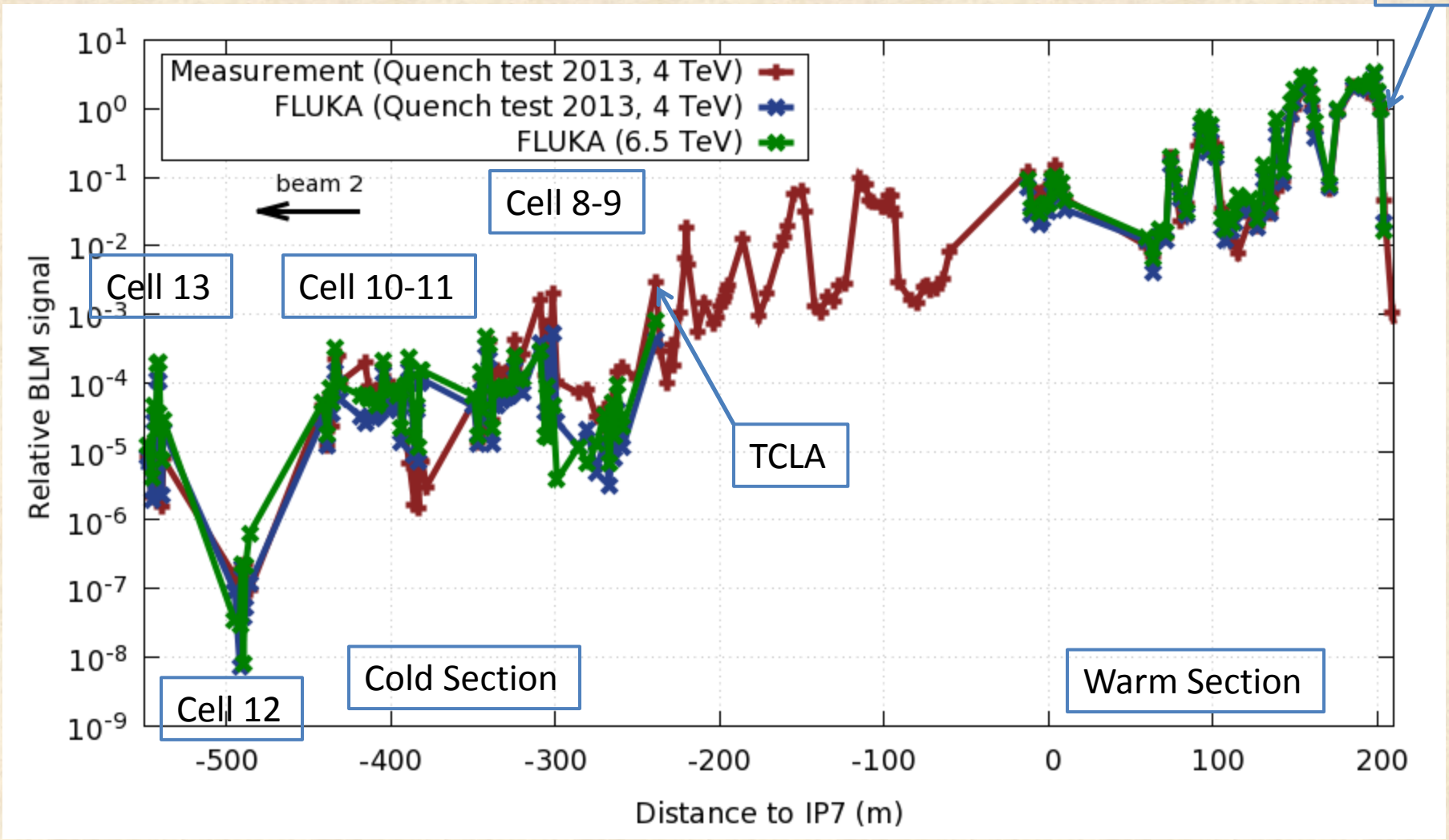
Quench Limit Values from A. Verweij

Cold Section Simulation



Values are normalised to the signal of the BLM at the TCP.C (horizontal)

Cold Section Simulation



Values are normalised to the signal of the BLM at the TCP.C (horizontal)

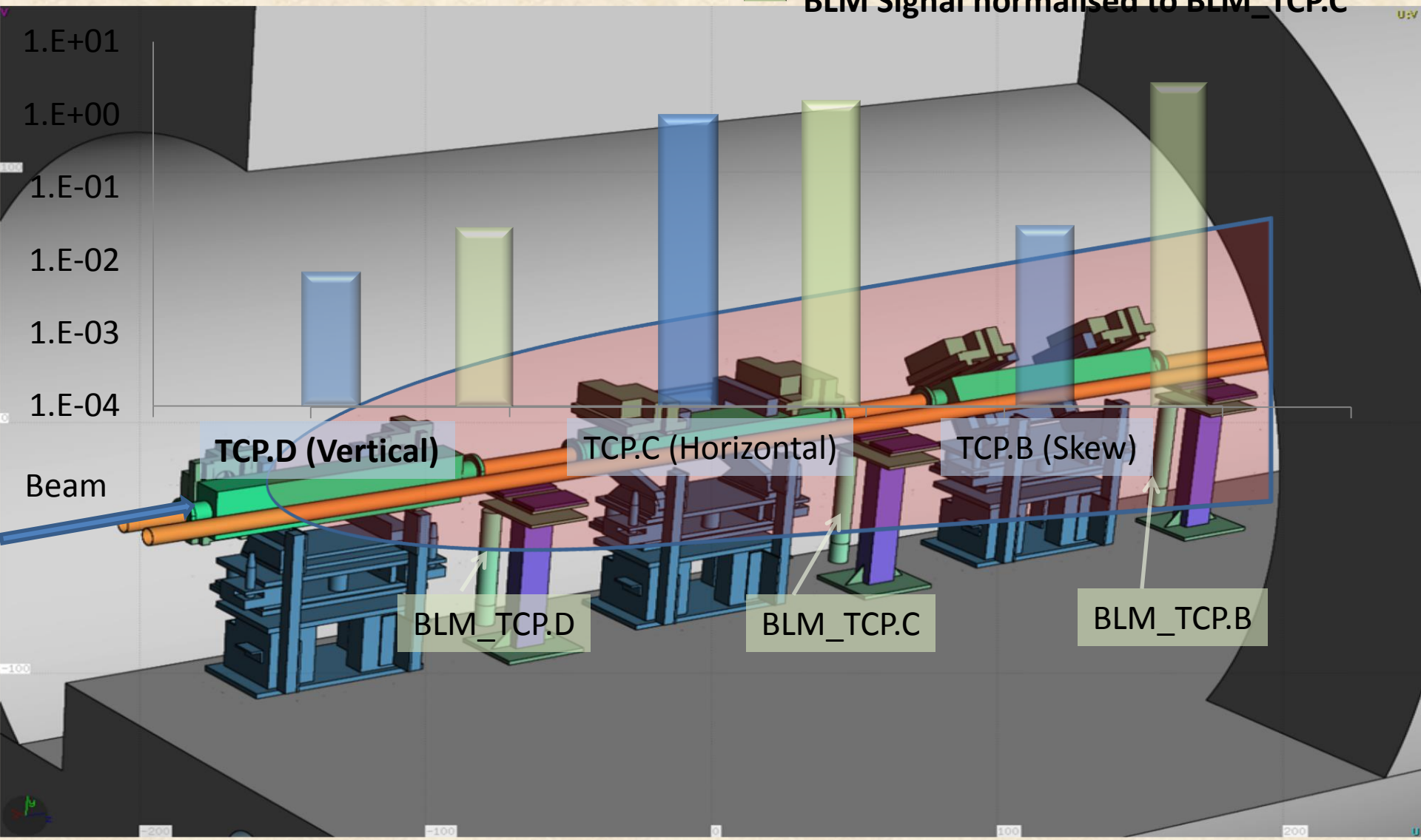
Conclusions

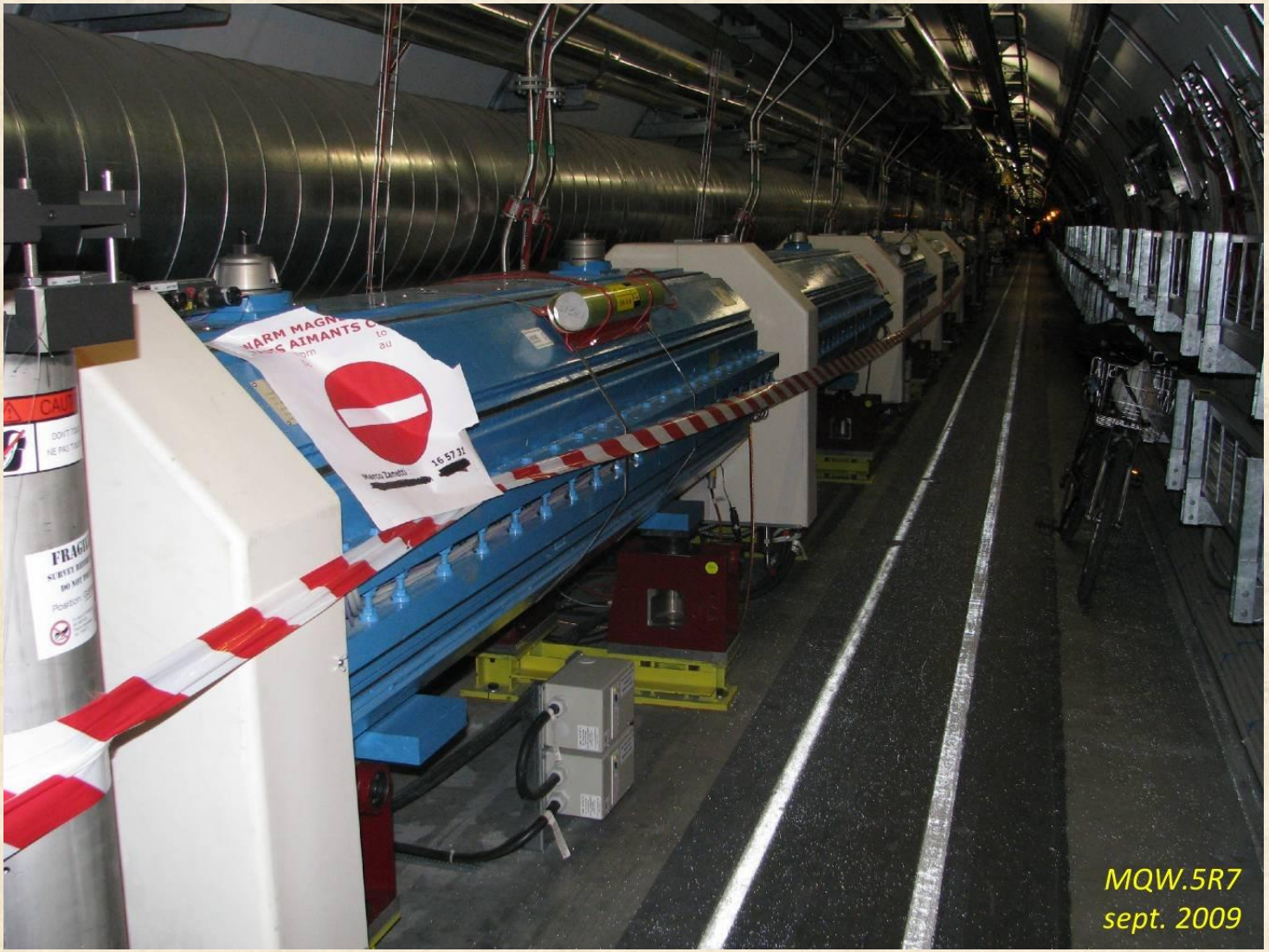
- The quench test at 4TeV was investigated, yielding an encouraging agreement with respect to the measured BLM pattern and a peak power in magnet coils compatible with the lack of quench (see Arjan's calculations)

- The study at 6.5 TeV gives an estimate of peak power as a function of beam lifetime and allows to relate it to the BLM signal

Backup slides

SixTrack and FLUKA interplay




MQW.5R7
sept. 2009