

# FLUKA Energy deposition simulations for quench tests

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On behalf of the FLUKA team

With essential input from R. Bruce, S. Redaelli , B.M. Salvachua  
On behalf of the Collimation team

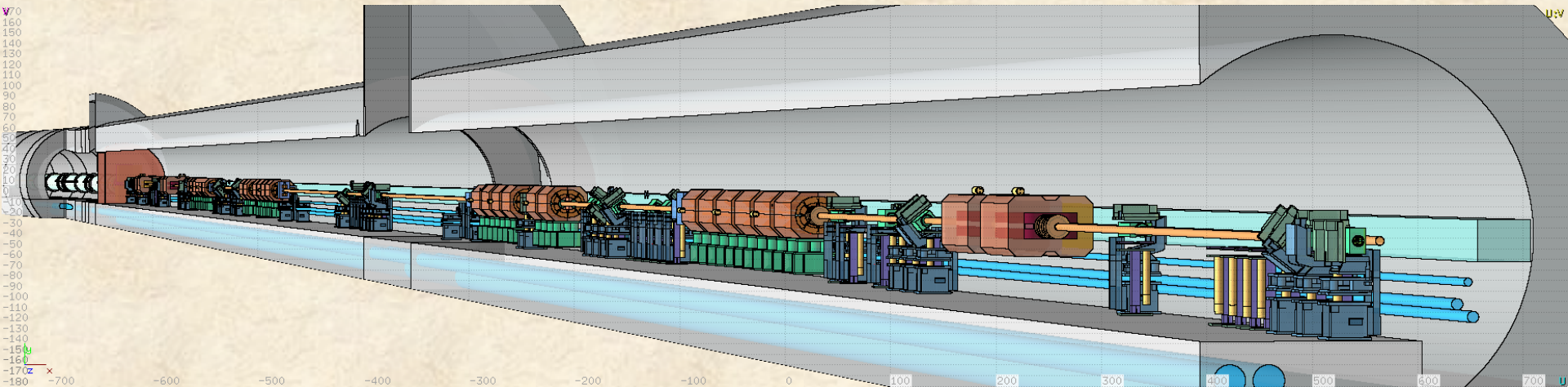
# Talk Overview

- IR7 modeling
- SixTrack (beam tracking) and FLUKA (interaction and secondary shower) interplay
- 4TeV (February 2013 quench test) and 6.5TeV (post-LS1 operation)
  - Warm Section Simulation
  - Cold Section Simulation (peak power (dose) in the SC coils, BLM pattern)

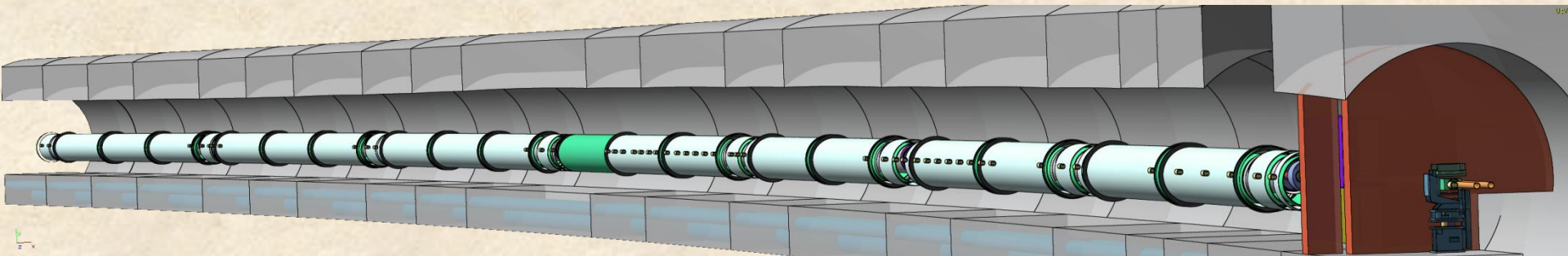
# IR7 FLUKA geometry

Beam 2 (internal)

- Long Straight Section




- Left Dispersion Suppressor + Arch up to cell 14

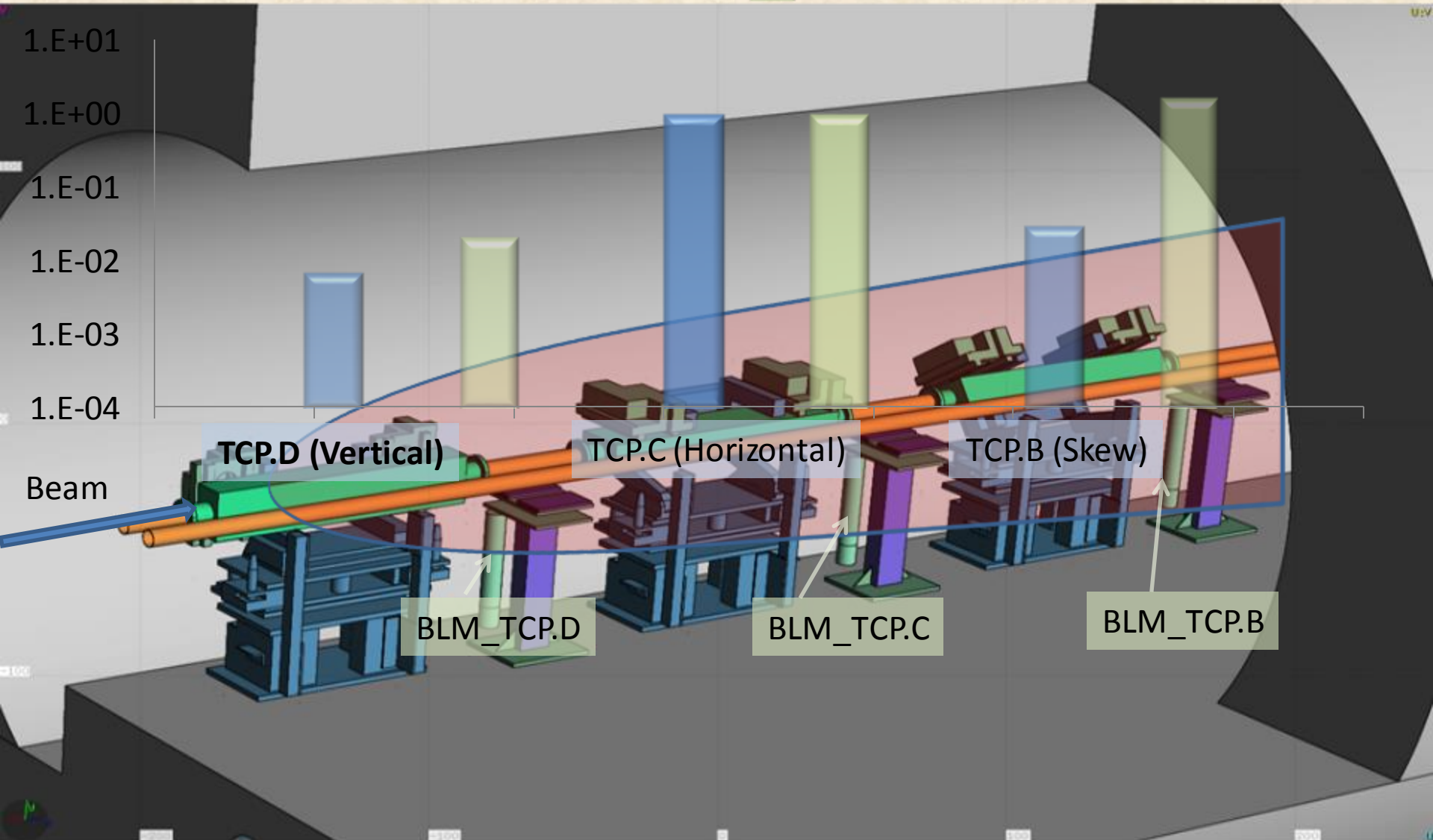


# BLM response factors

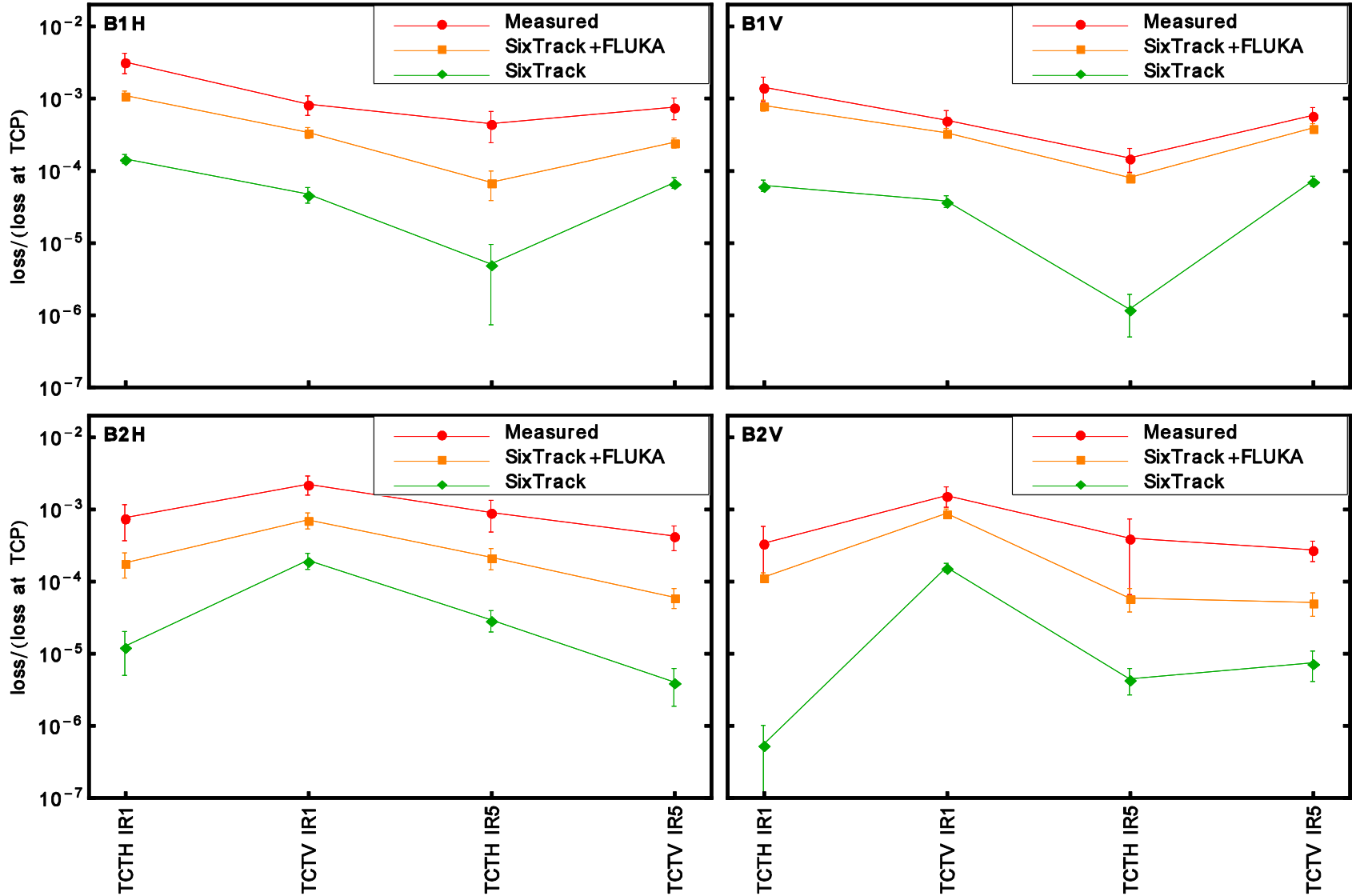
- Significant differences in BLM response depending on many parameters:
  - Position of the BLM
  - Geometry surrounding the BLM
  - Crosstalk shower
- Correspondence between monitor signal (what we see) and relevant quantities (what we care about, e.g. energy deposition in the coils) not universal

# SixTrack and FLUKA interplay

 # Sixtrack Hits normalised to TCP.C     BLM Signal normalised to BLM\_TCP.C



# BLMs at the TCTs



# Warm Section Simulation

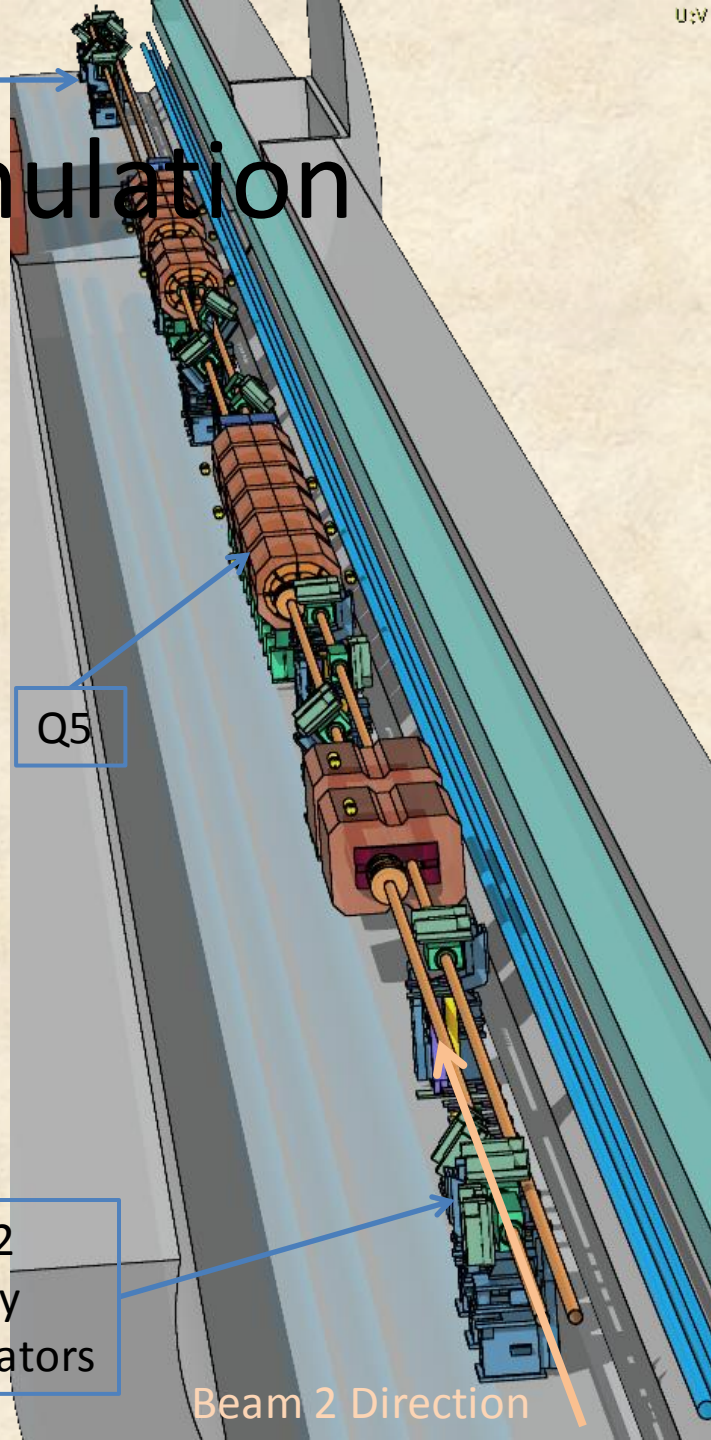
- Horizontal loss scenario (main impact on TCP.C)
- At 4 TeV peak loss rate of  $1.6 \cdot 10^{12}$  p/s (1MW)
- At 6.5 TeV peak loss rate of  $4.5 \cdot 10^{11}$  p/s (0.2h beam lifetime)

IP7

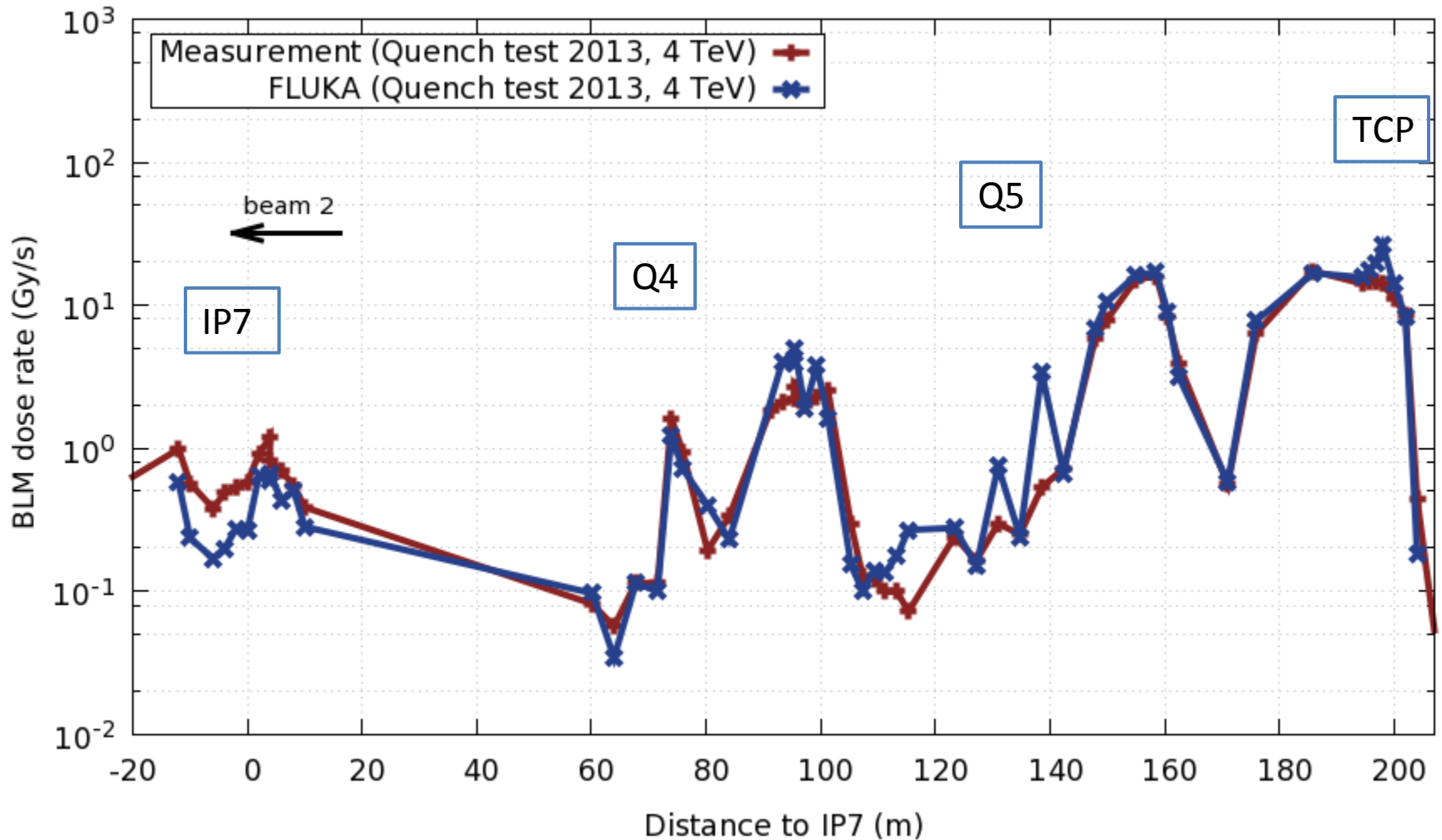
Q5

Beam 2  
Primary  
Collimators

Beam 2 Direction



# Warm Section Simulation



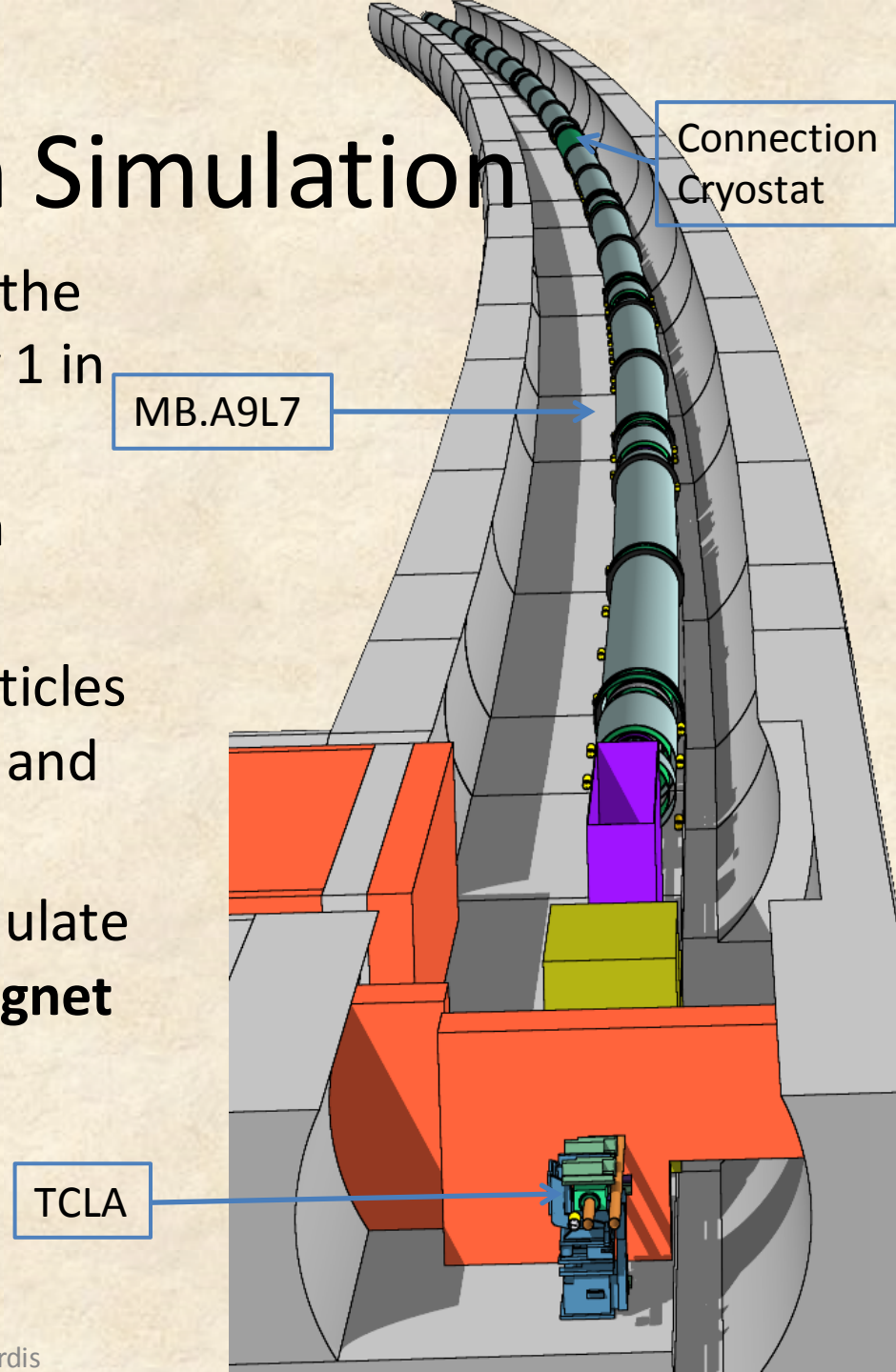


# Cold Section Simulation

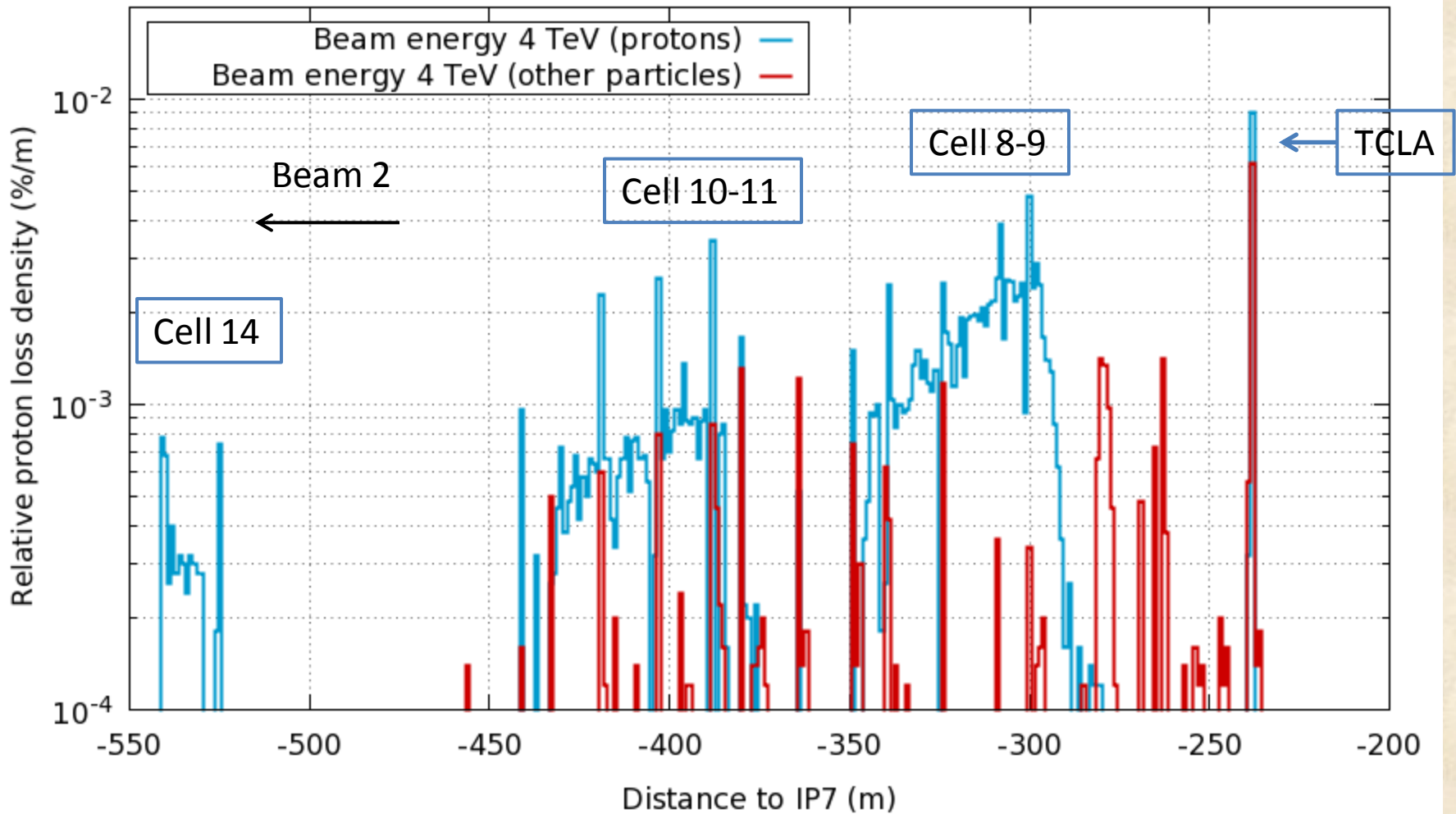
- For every 1000 of protons lost in the Primary collimators we have only 1 in the DS

2 step Simulation to acquire enough statistics:

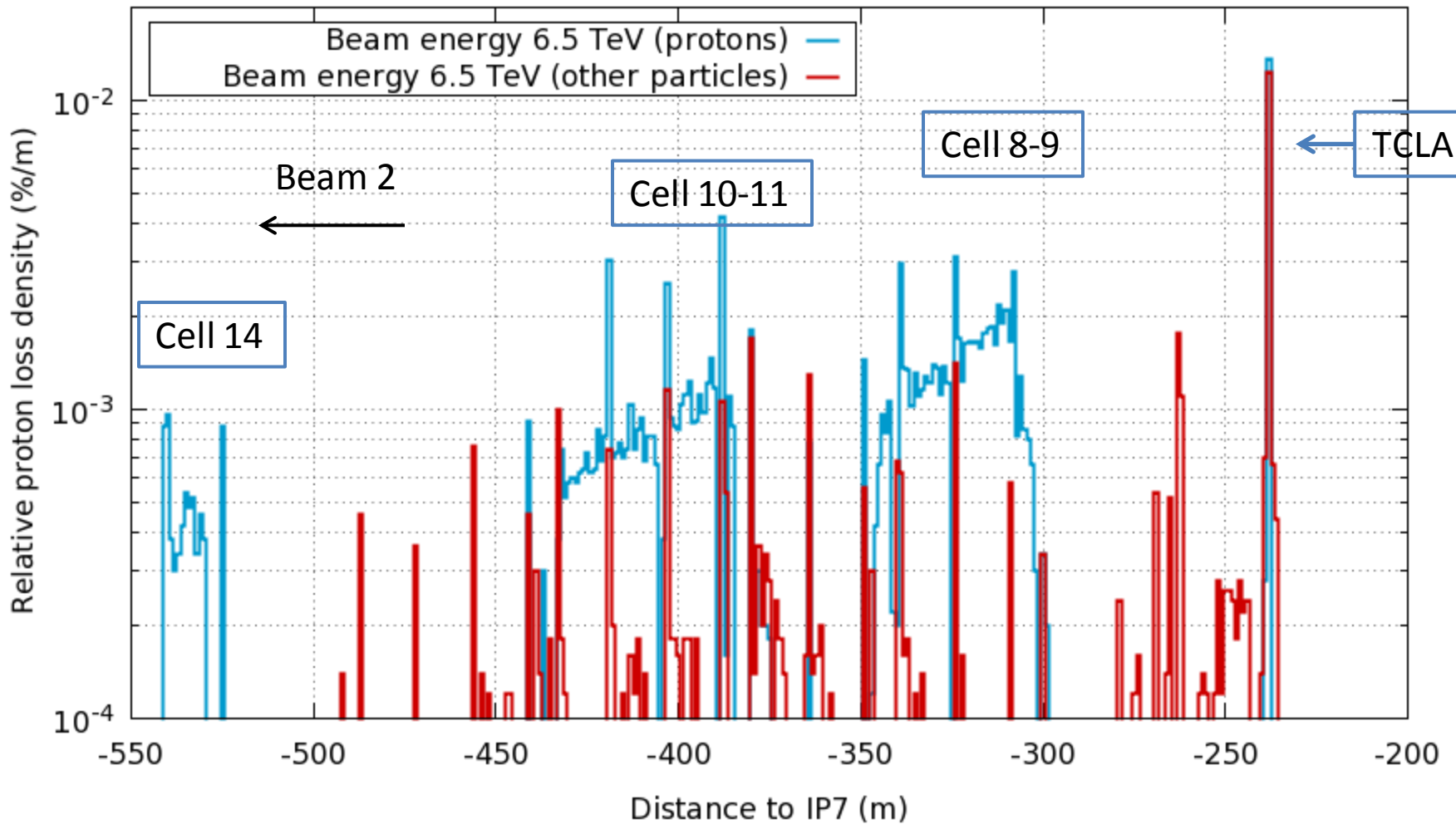
- Generation of **distribution** of particles impacting the aperture at the DS and TCLA
- Use the above distribution to simulate the energy deposition on the **Magnet Coils** and BLM response



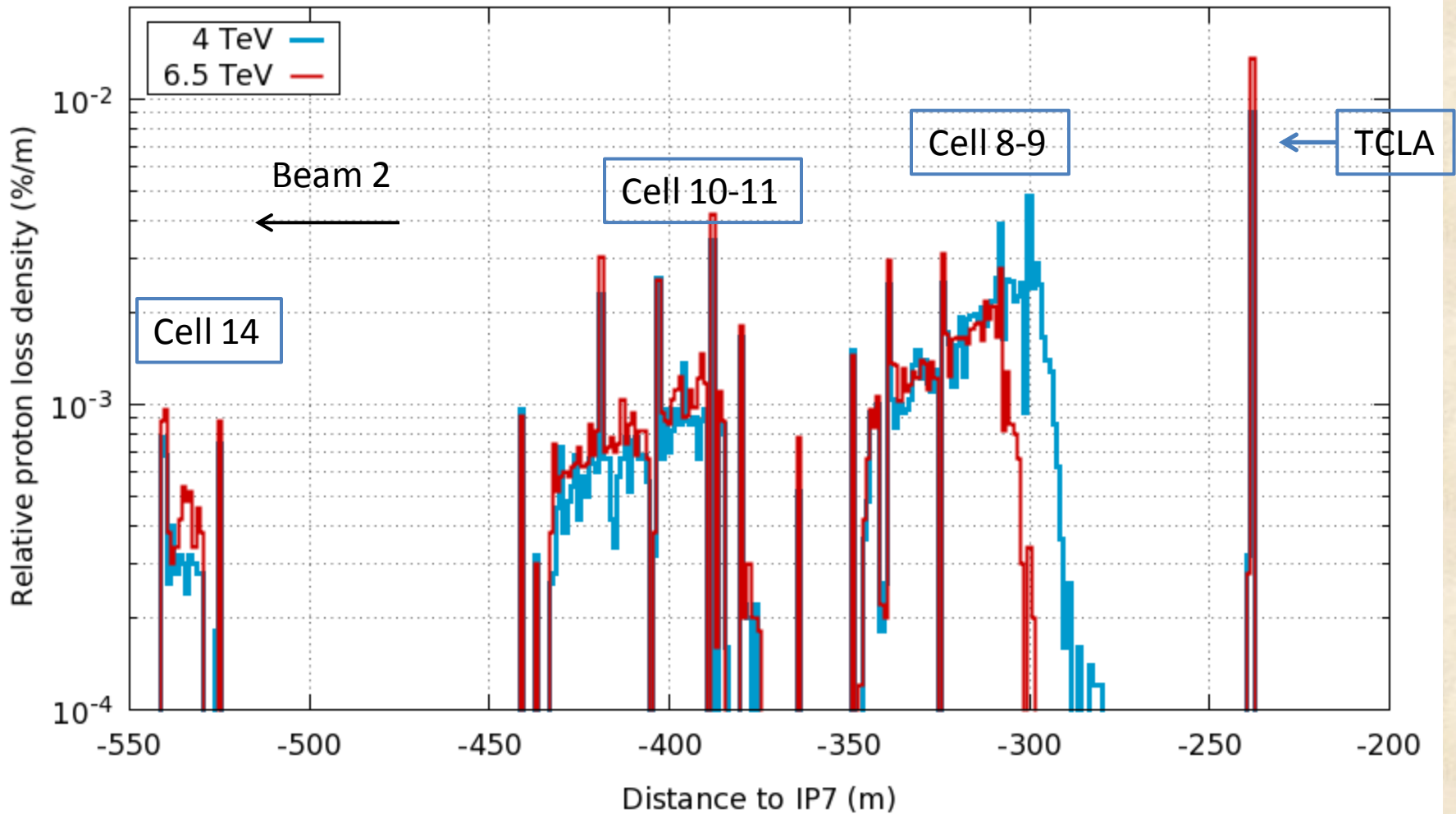
# Distribution of impacts TCLA -> Cell14



# Distribution of impacts TCLA -> Cell14

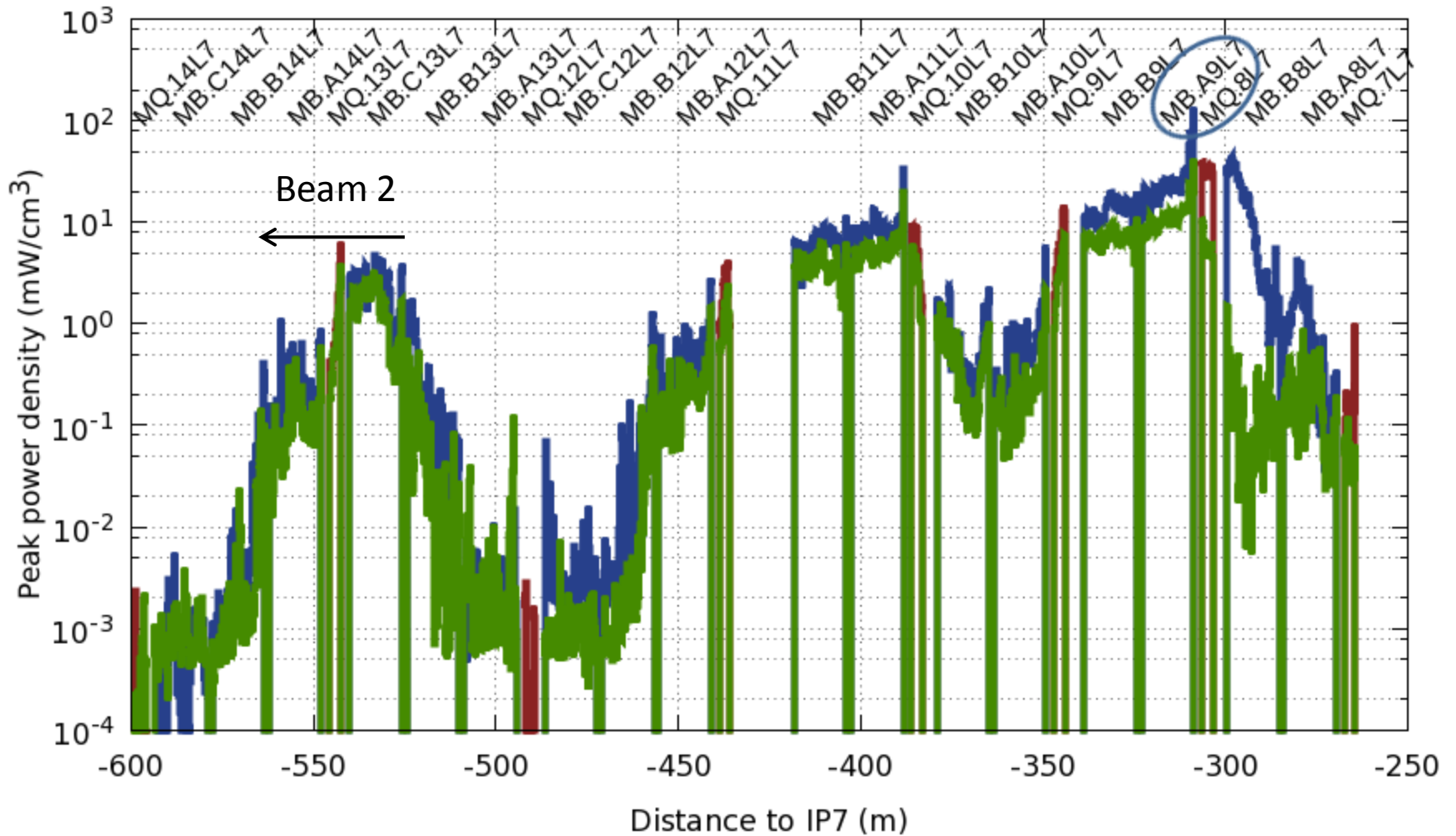


# Distribution of impacts TCLA -> Cell14

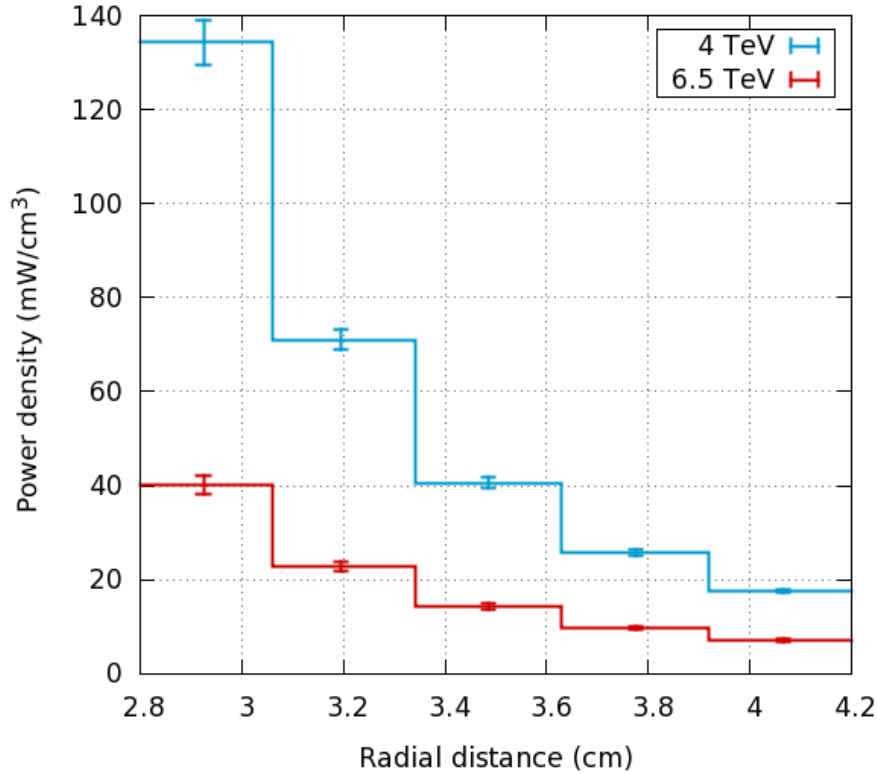


# Magnet coils energy deposition

  4 TeV Quench Test       6.5 TeV (0.2 h beam lifetime)

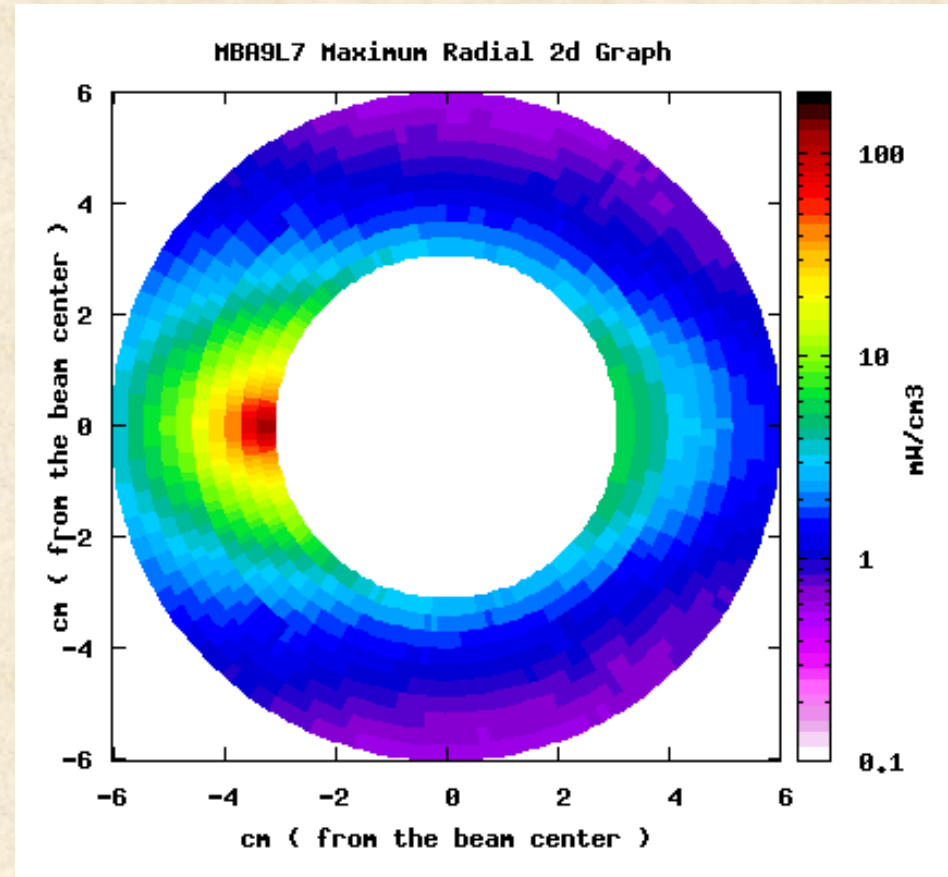


# Cold Section Simulation

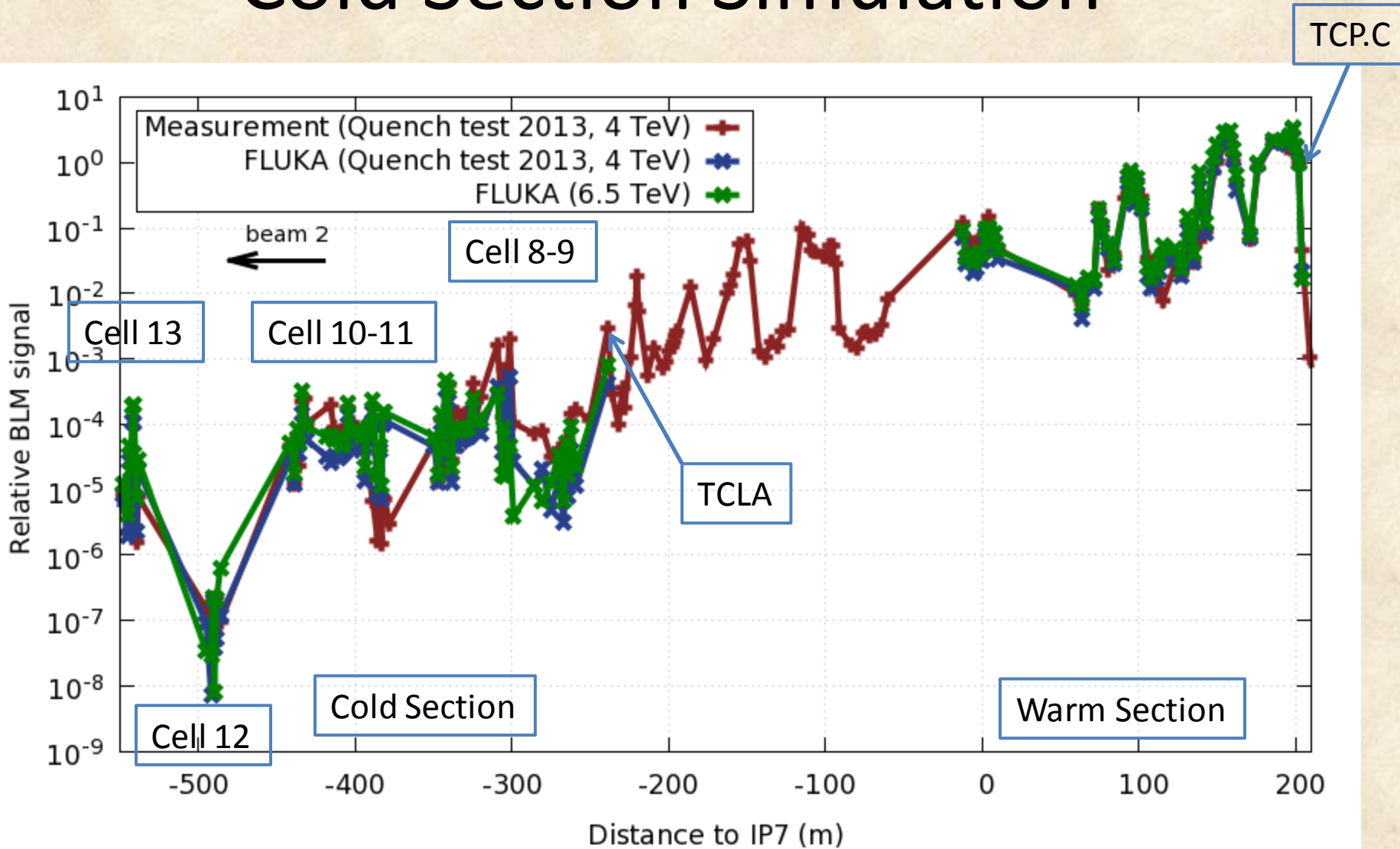


Total Power on MB9.A : 280 W

Total Power on MQ8 : 70 W



# Cold Section Simulation



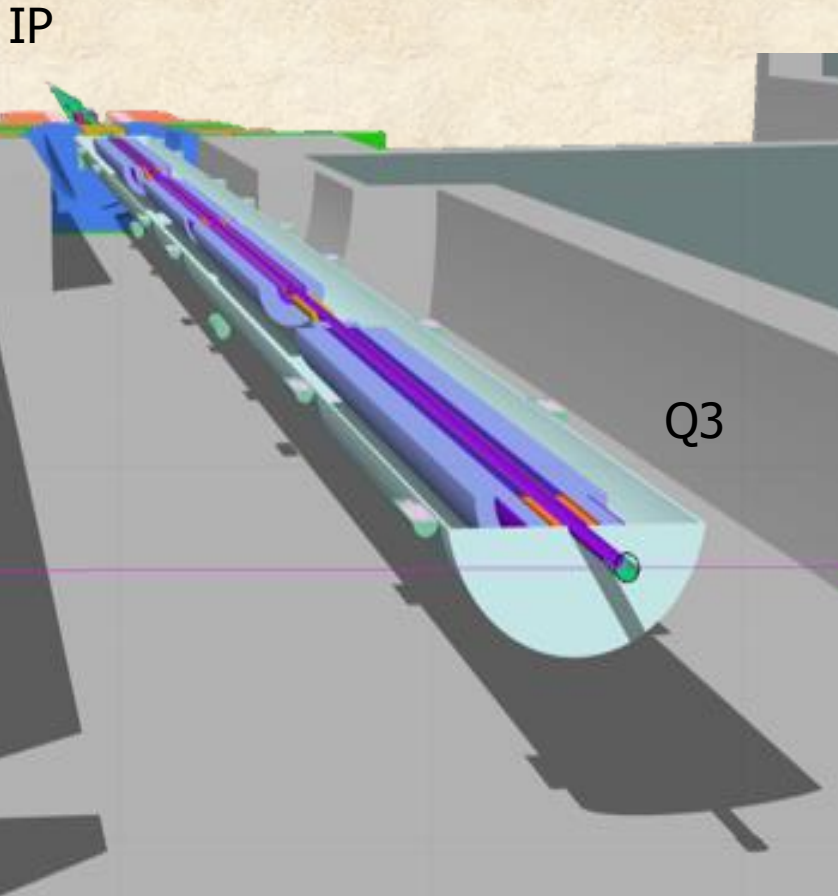
Values are normalised to the signal of the BLM at the TCP.C (horizontal)

# Conclusions

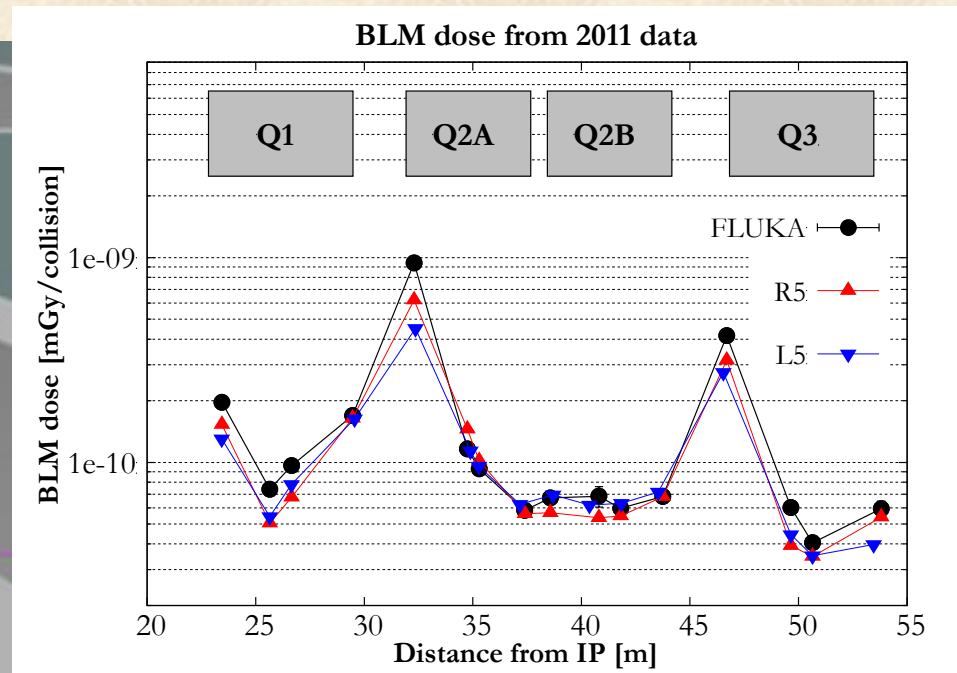
- The quench test at 4TeV was investigated, yielding an encouraging agreement with respect to the measured BLM pattern and a peak power in magnet coils compatible with the lack of quench (see Arjan's talk)
- The study at 6.5 TeV gives an estimate of peak power as a function of beam lifetime and allows to relate it to the BLM signal



# FLUKA simulation benchmark against Inner Triplet BLM response



BLM response along IR5 triplet



BLM dose per collision assuming CMS luminosity measurement and 73.5 mb proton-proton cross-section from TOTEM [1]

[1] EPL, 96 (2011) 21002