Load on Q6 and Q7 for the primary beam impacting on the TCLIB

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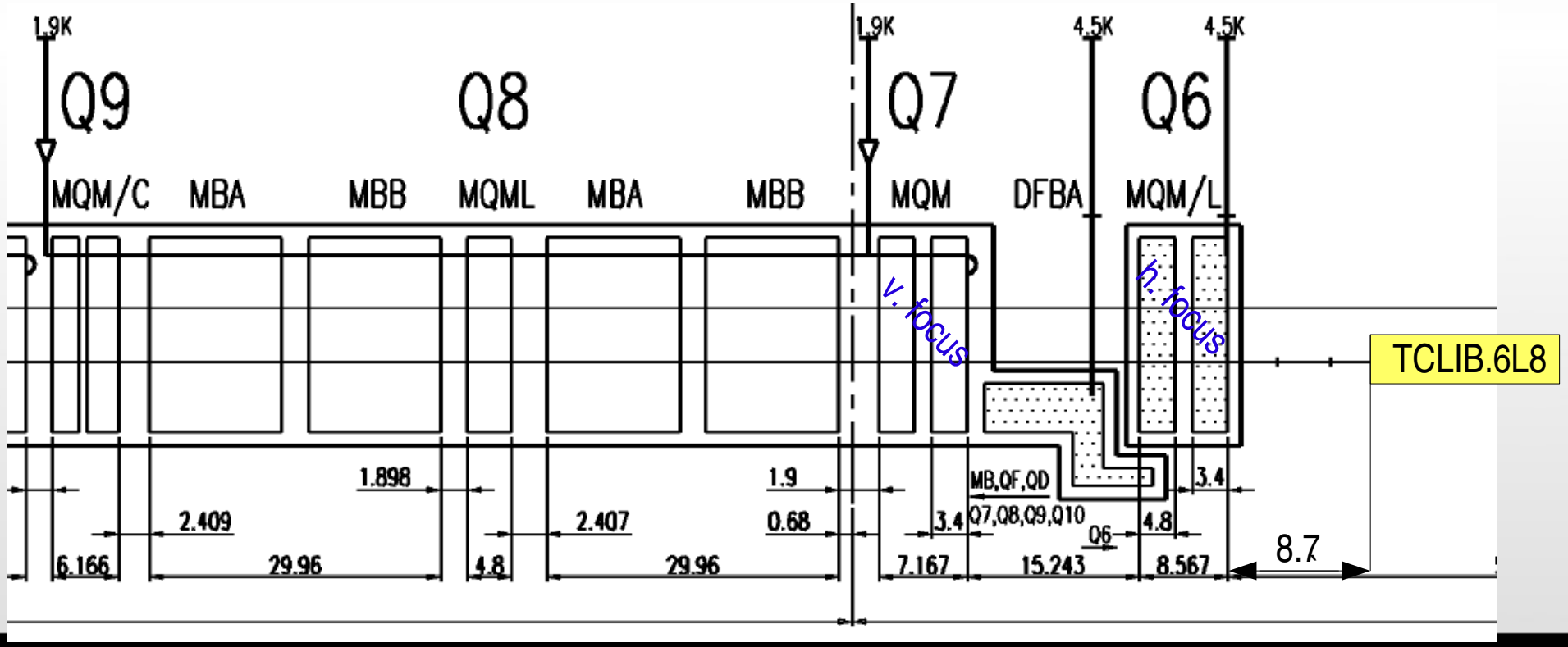
Background of this study

- April 18th 2011: 36 bunches of beam 2 impacting TDI and TCLIB due to lower kicker deflection
- Quench of 11 magnets downstream magnets

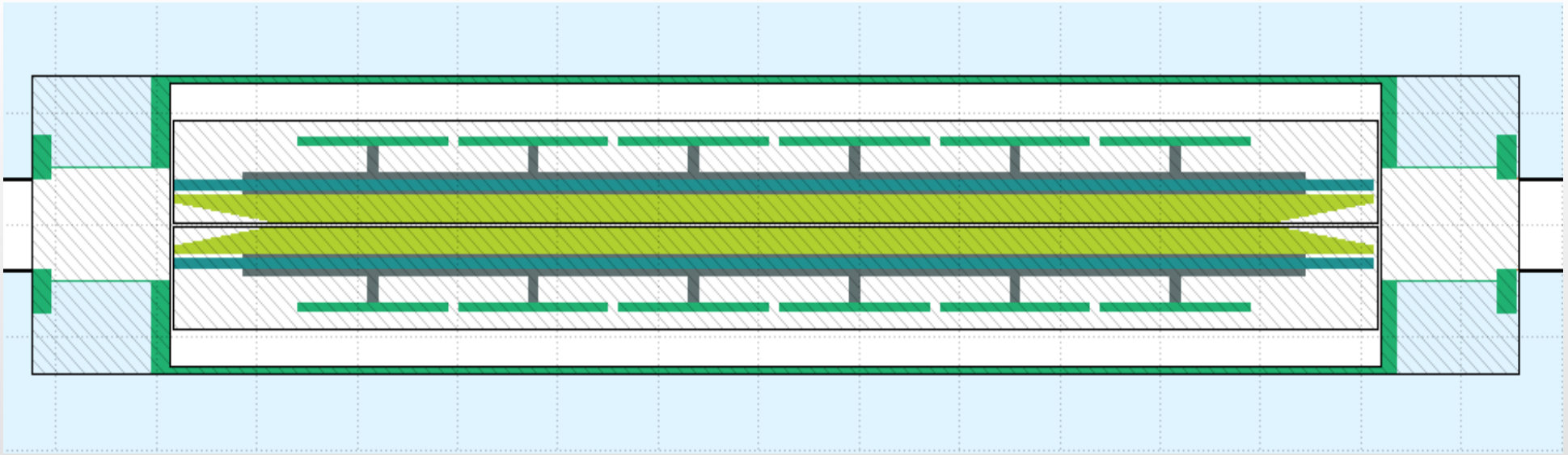
Beam Line

- Geometry build using “LineBuilder” (V. Boccone, A. Mereghetti, R. Versaci and others)
- Beam line build for longer section, but particle tracking and scoring reduced to the relevant region:
  - From TCLIB.6L8 to MQMC.9L8



TCLIB - jaw position

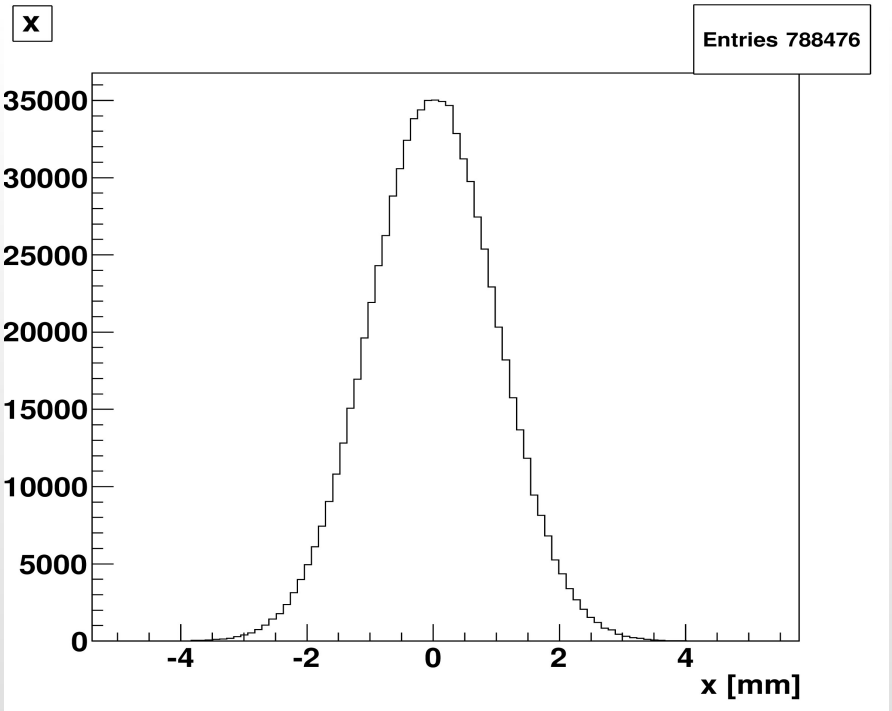
- Half Gap = 1.9 mm (corresponds to 7σ using σ = 270μm)
  - The exact same value as used for producing the sample of impacting particles.
- Jaws placed symmetrically

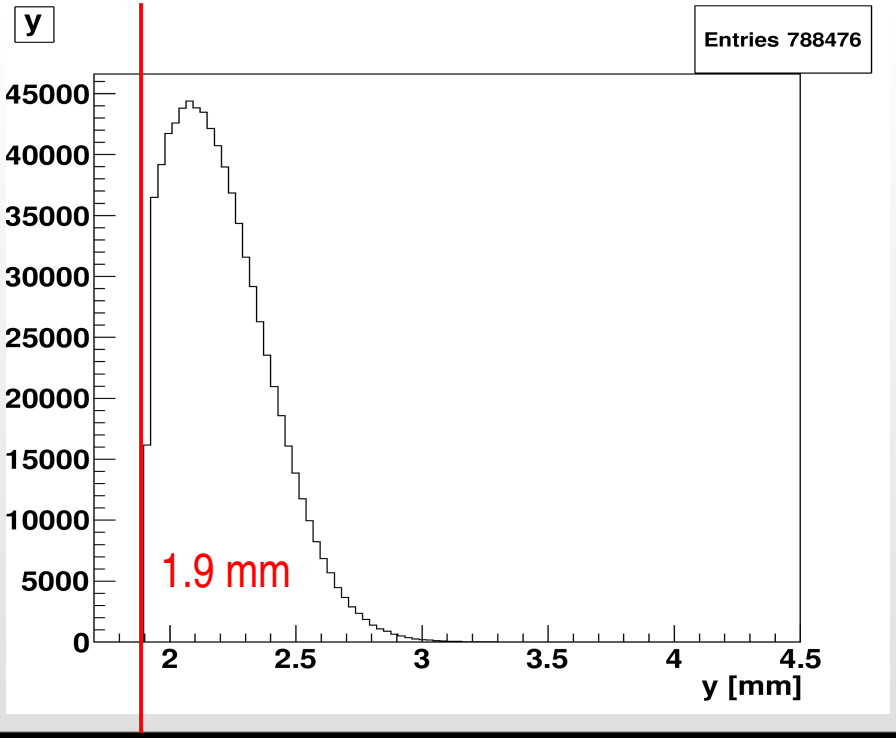


Beam conditions

- Sample of ~ 7.9 x 10^5 protons @ 3.5 TeV
  - Position: the first interaction in TCLIB.6L8 upper jaw
  - Each particle forced to interact there.
  - NOTE: Graphite λ_{inel}= 42.95 cm for protons @ 3.5 TeV

→ interaction probability = $1 - e^{-\left(\frac{100\,cm}{42.95cm}\right)} = 0.9$





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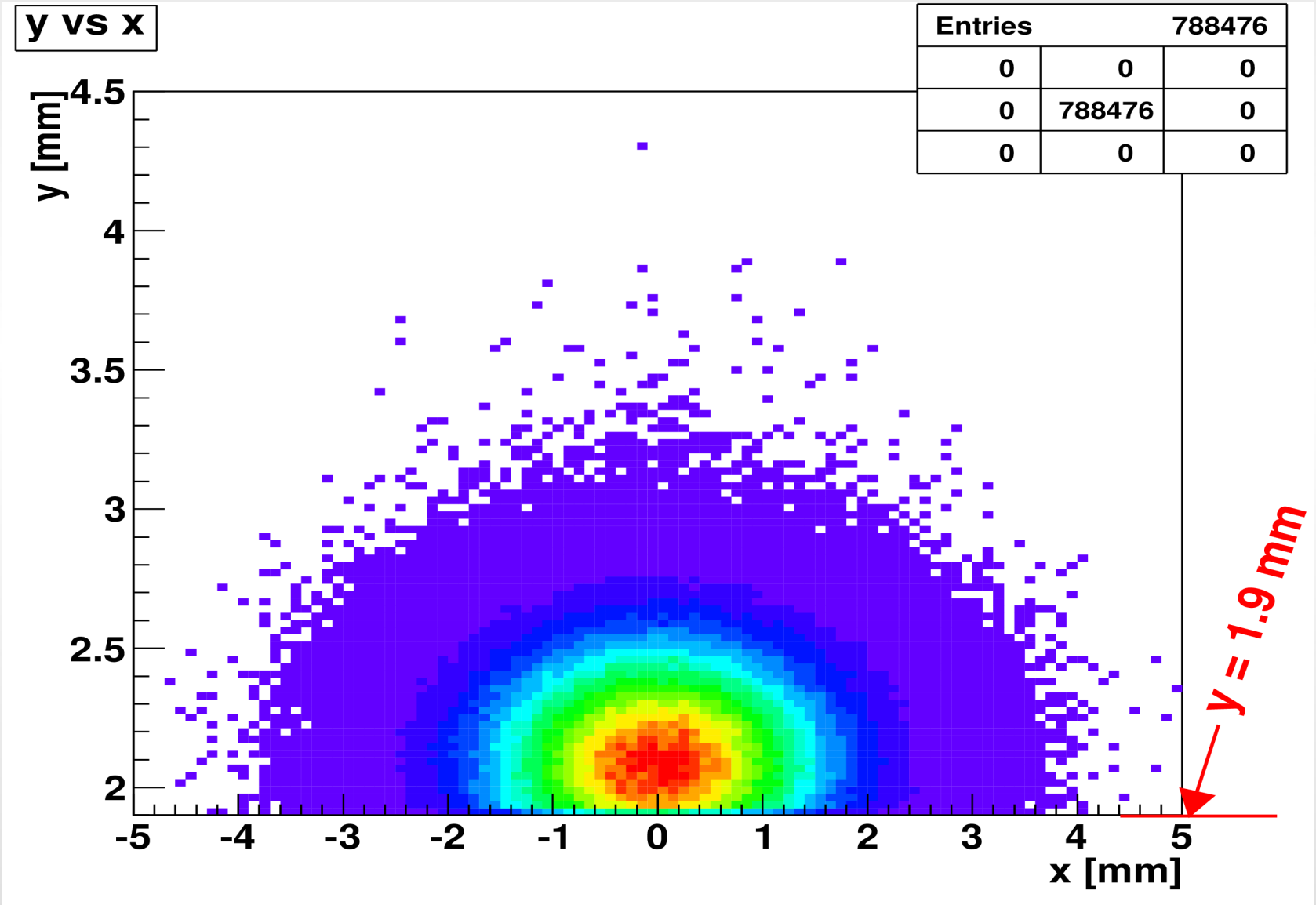
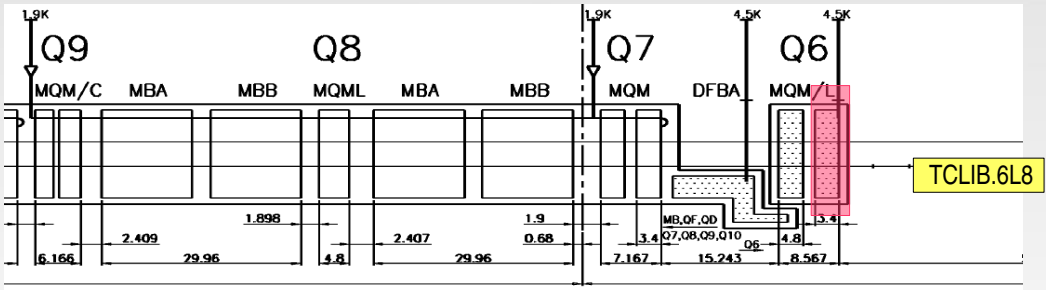
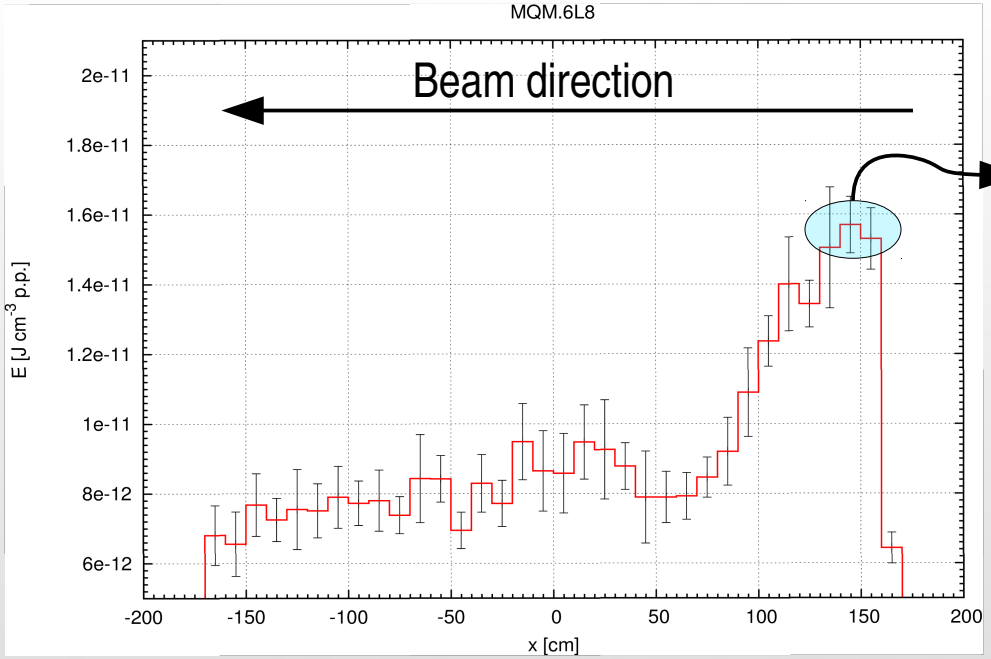


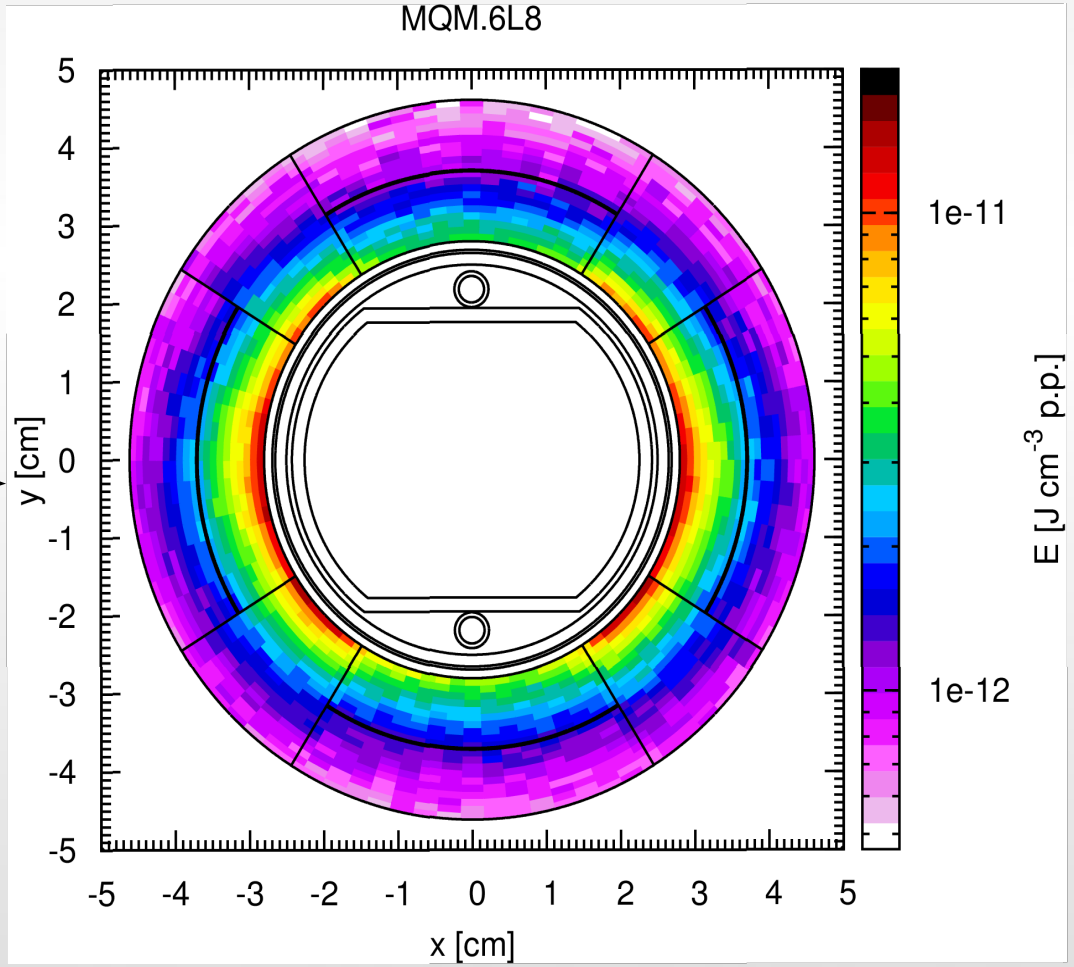
MQM.6L8

- Highest energy deposition in:
  - Beam: beam 2 side (inner)
  - Coil: horizontal inner layer

E_{max}=1.6x10^{-11} (± 5 %) J cm^{-3} per interacting primary



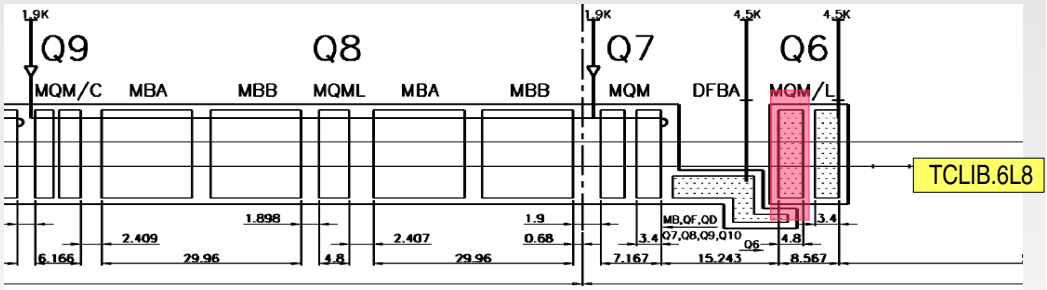


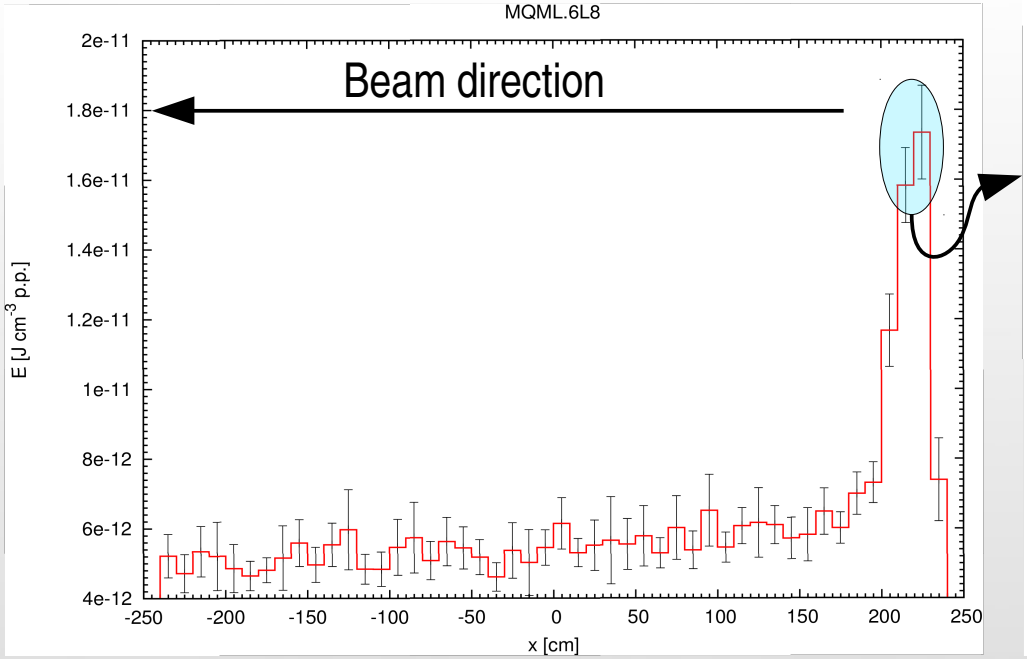


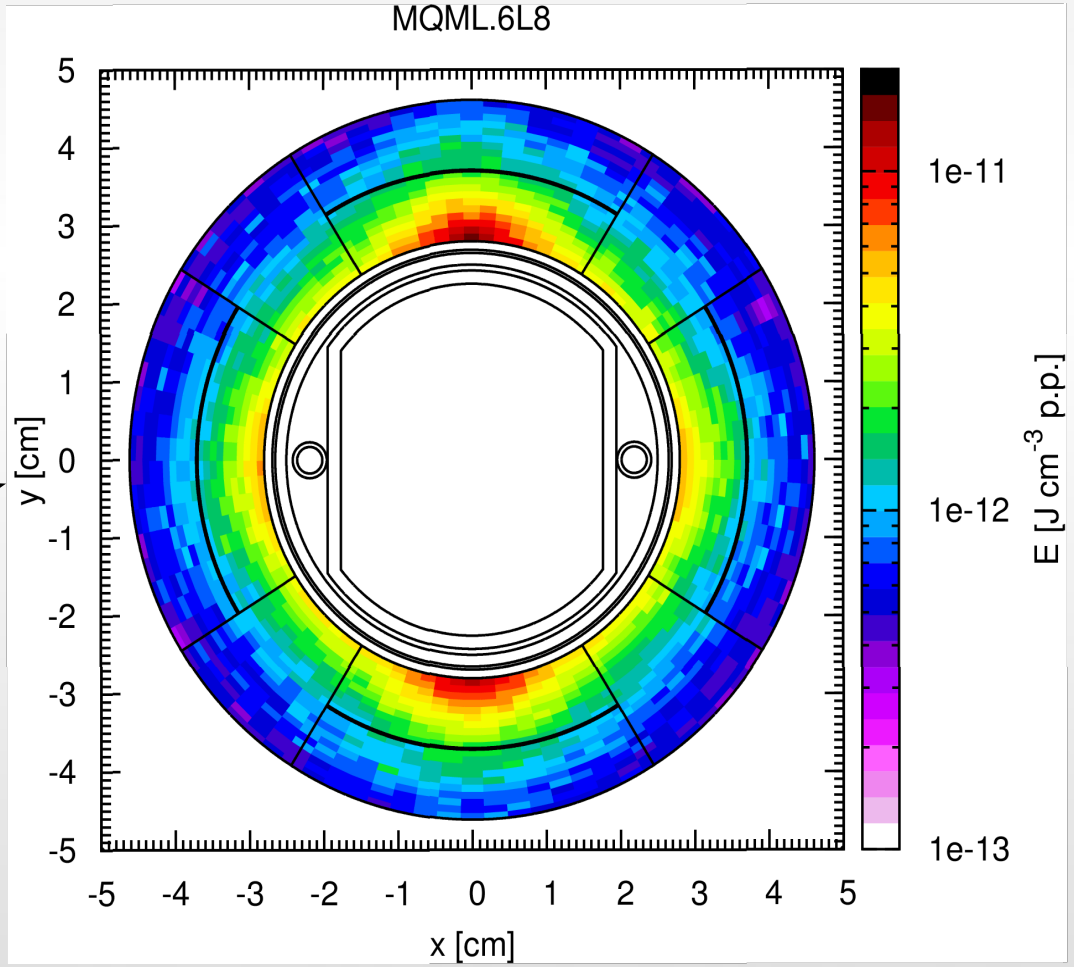
MQML.6L8

- Highest energy deposition in:
  - Beam: beam 2 side (inner)
  - Coil: inner layer, upper

E_{max}=1.7x10^{-11} (± 8 %) J cm^{-3} p.i.p.



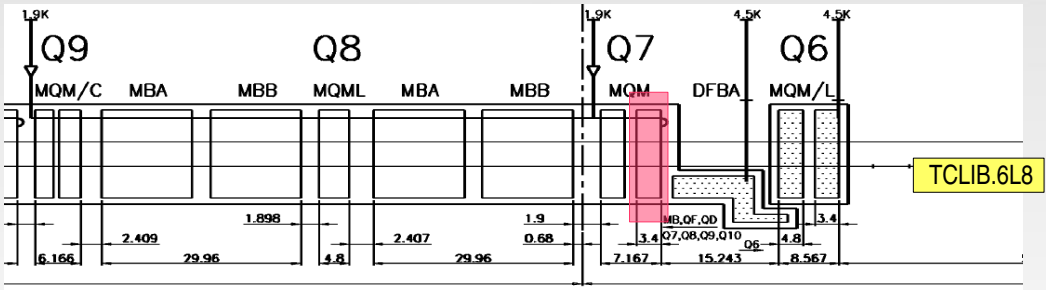


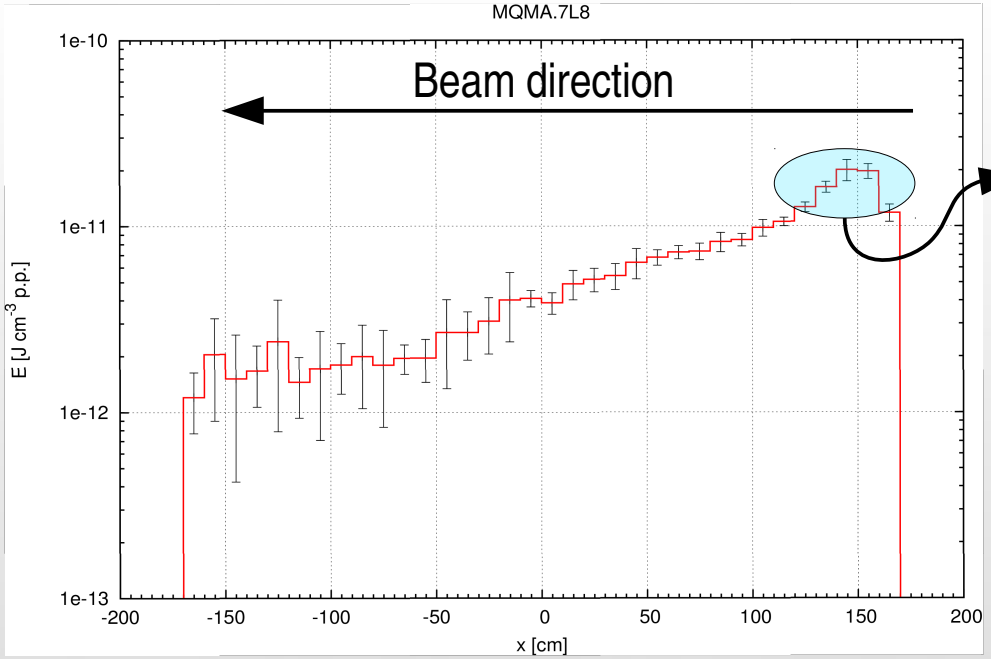


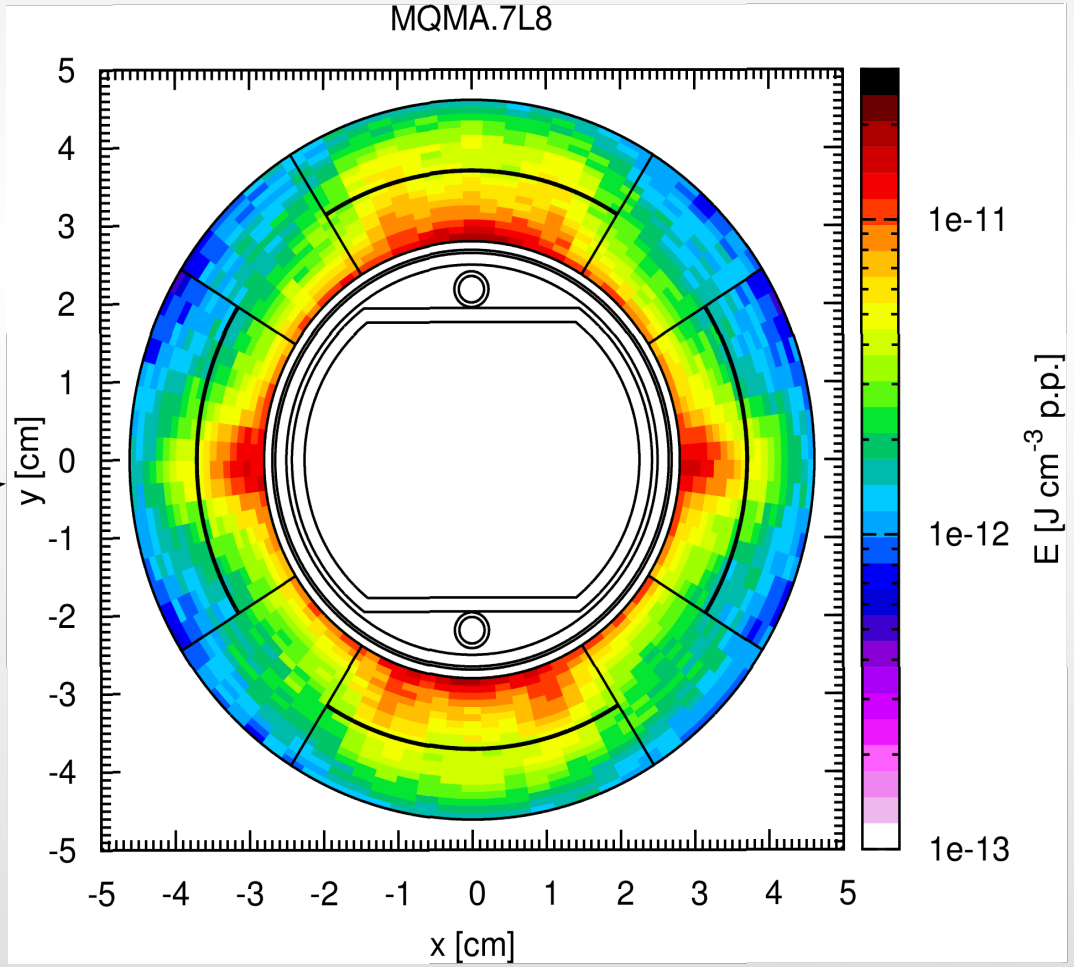
MQM.A7L8

- Highest energy deposition in:
  - Beam: beam 2 side (inner)
  - Coil: inner layer

E_{max}=2.0x10^{-11} (± 9 %) J cm^{-3} p.i.p.



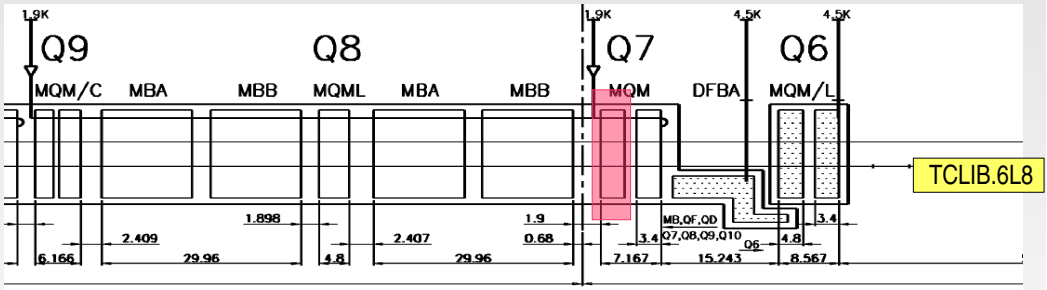


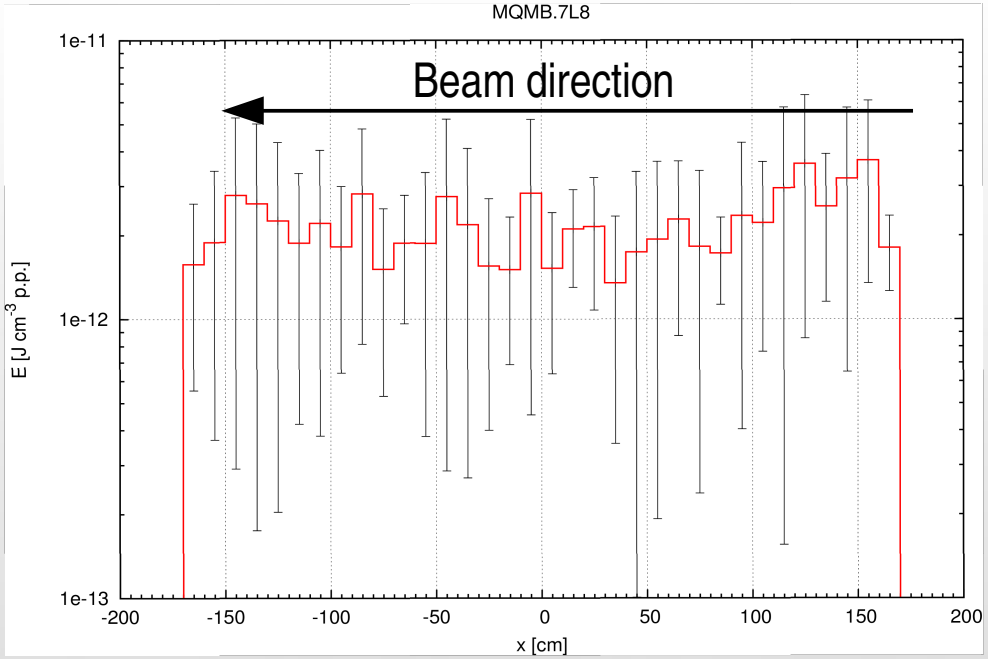


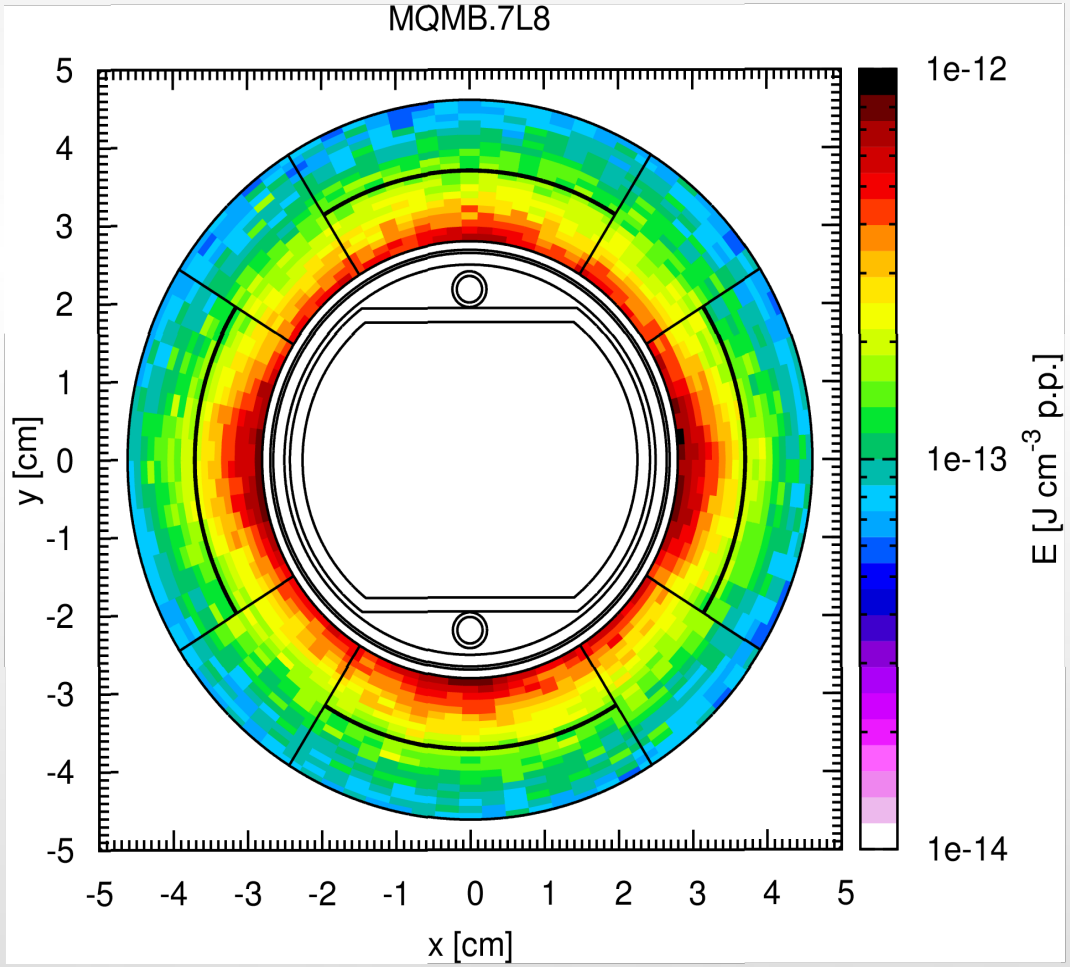
MQM.B7L8

- Highest energy deposition in:
  - Beam: beam 2 side (inner)
  - Coil: inner layer

E_{max}=2.9x10^{-12} J cm^{-3} p.i.p.



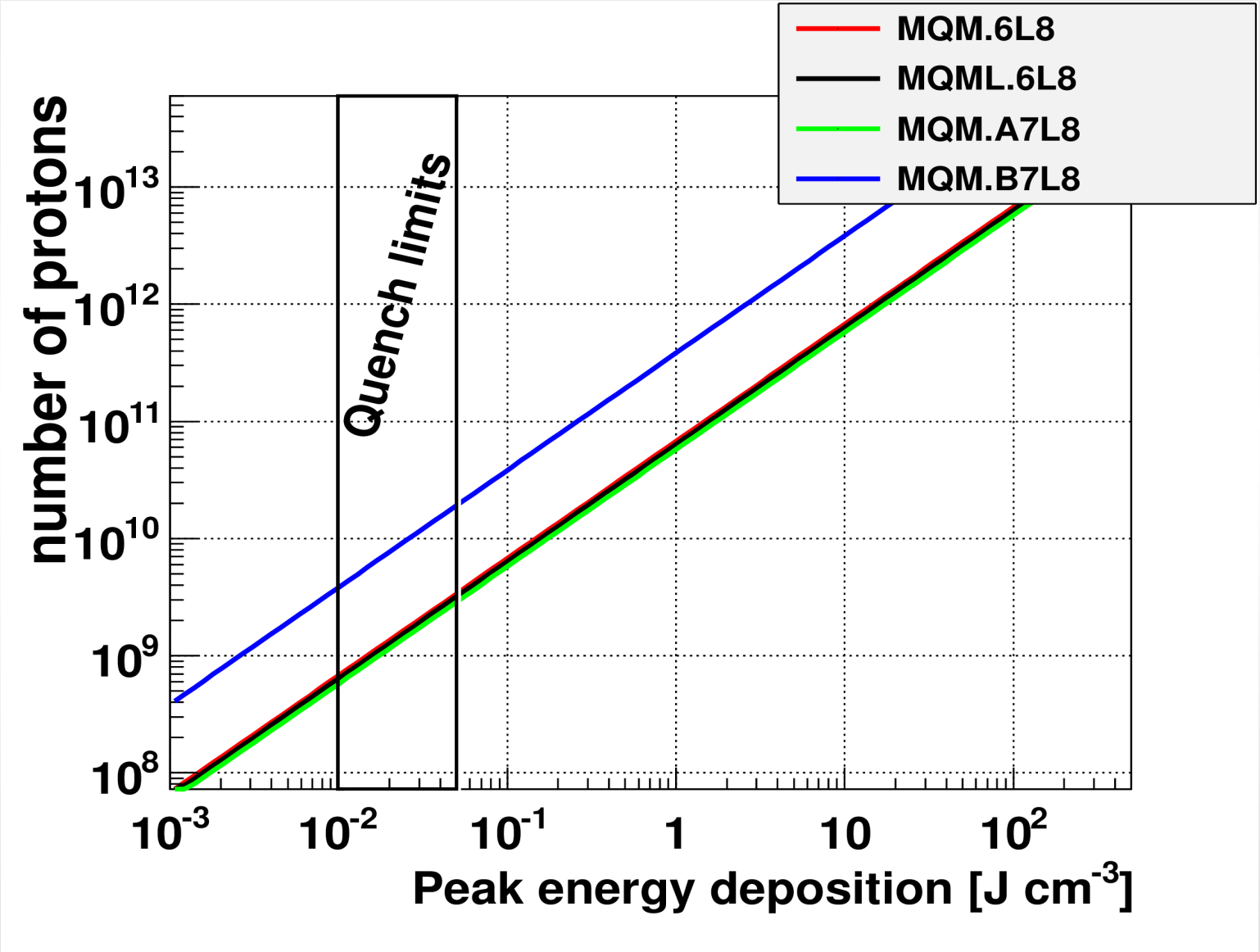




Q6 and Q7 results normalized

	MQM.6L8	MQML.6L8	MQM.A7L8	MQM.B7L8
Per interacting primary [J cm^{-3}]	**1.6×10^{-11}**	**1.7×10^{-11}**	**2.0×10^{-11}**	**2.9×10^{-12}**
Per bunch [J cm^{-3}] (1.15×10^{11} prot.) Note: only 90% interact	**1.7**	**1.8**	**2.0**	**0.3**
288 bunches [J cm^{-3}] Note: only 90% interact	**477**	**506**	**596**	**86**

Peak Energy deposition vs. number of protons



Systematic Uncertainties

Factor for integral quantities	**Factor** for punctual quantities	**Origin**	**Reason**
0.7-1.5	**0.7-1.5**	Grazing impact	Jaw roughness dependence on the angular distribution at zero degrees
0.8-1.2	**0.5-2**	FLUKA physics	Interaction extrapolation at 3.5 TeV
0.9-1.1	**0.75-1.5**	FLUKA machine model	Geometry description

Imperfections have to be taken into account

e.g.: collimator tilting, magnet displacement, field accuracy

Imperfections discussed in:

V. Vlachoudis & A. Ferrari, LCWG meeting,2-3-2009

F. Cerutti, CDR LHC Phase II Collimation, 2-4-2009

F. Cerutti, LCWG meeting, 10-5-2010

C. Bracco, “Commissioning scenarios and tests for the LHC collimation system” EPFL thesis #4271 (2009)

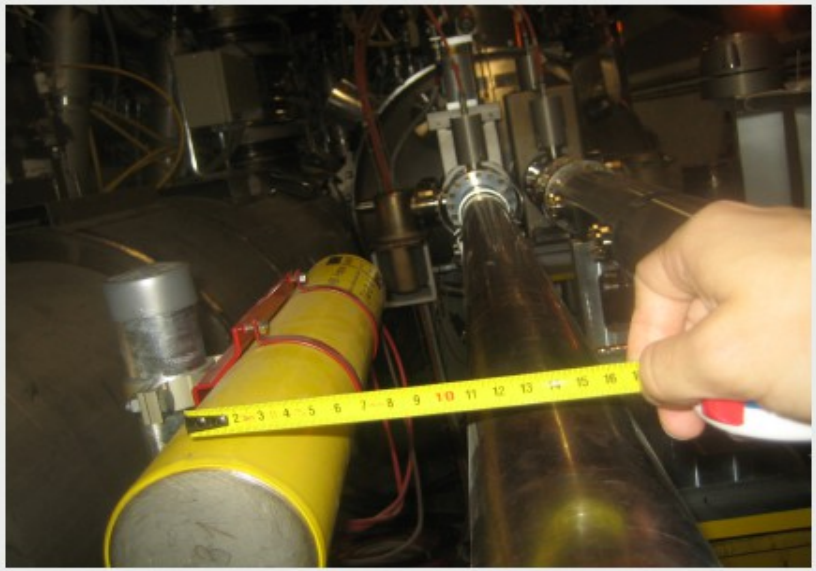
BLMs in the region

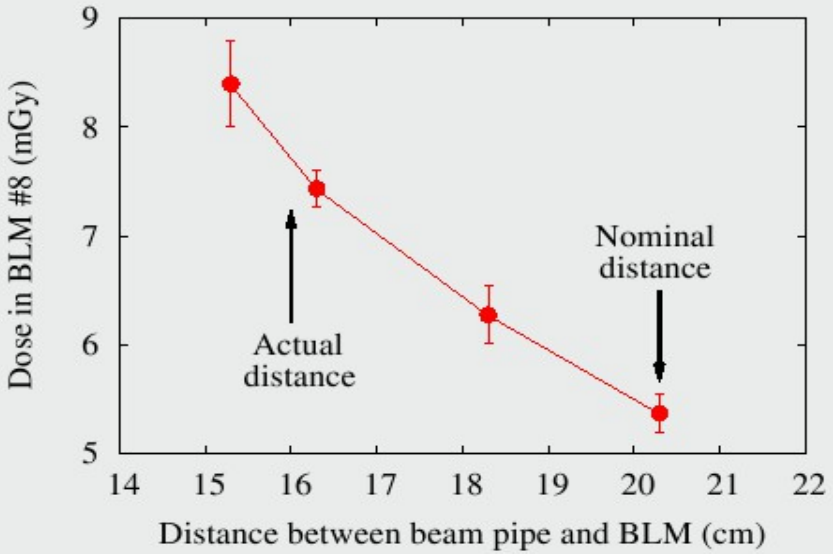
- The BLMs close to the quadrupoles were saturated during tests
- Not safe to use BLMs far downstream

Slide from A. Lechner

Impact on signal in BLM #8

- Additional components (in particular warm vacuum modules and cold mass end cap) partially shield radiation field
  $\longrightarrow$ **Dose decrease of ≈40%**
- Actual distance between BLM and beam pipe significantly smaller than nominal value in layout database
  $\longrightarrow$ **Accounting for actual position yields dose increase of ≈30% due to strong radial field gradient (see plot)**





Energy deposition overview