FLUKA studies on the LHC Asynchronous Beam Dump

Roberto Versaci,

V. Boccone, B. Goddard, A. Mereghetti,

R. Schmidt, V. Vlachoudis

CERN 30 September 2011

Outline

Motivations

Simulation description

Quantities studied

Systematic uncertainty

Results

Mitigations

Future studies

Motivations

Answer two "simple" questions:

How many magnets are going to quench
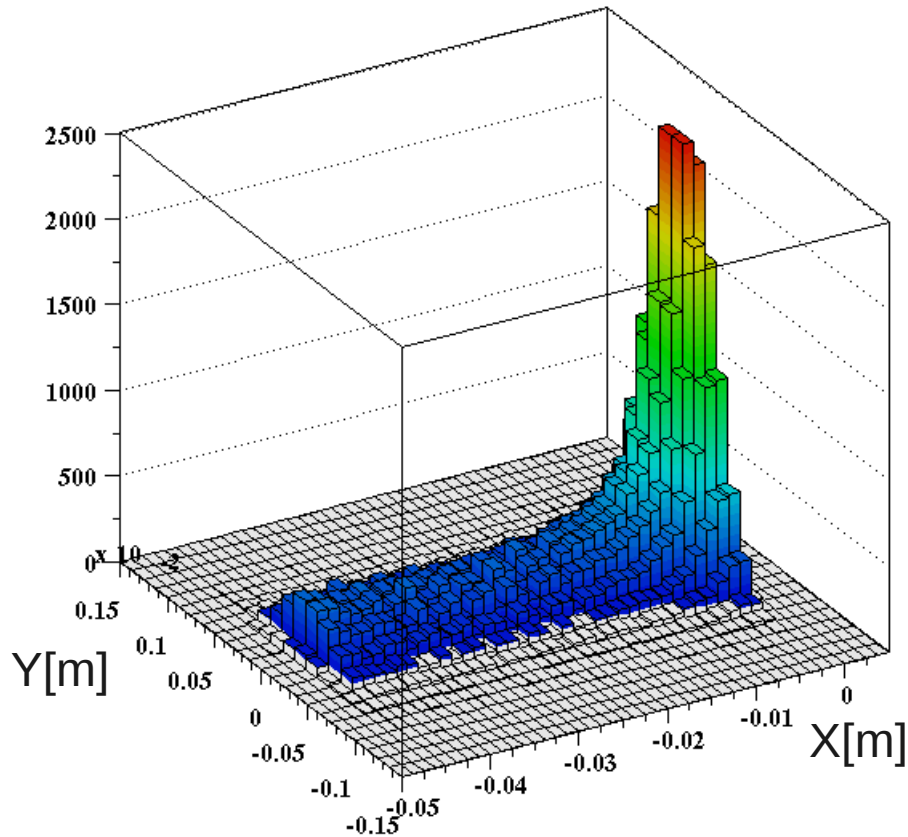in the event of an asynchronous beam dump?

Are there possible mitigations?
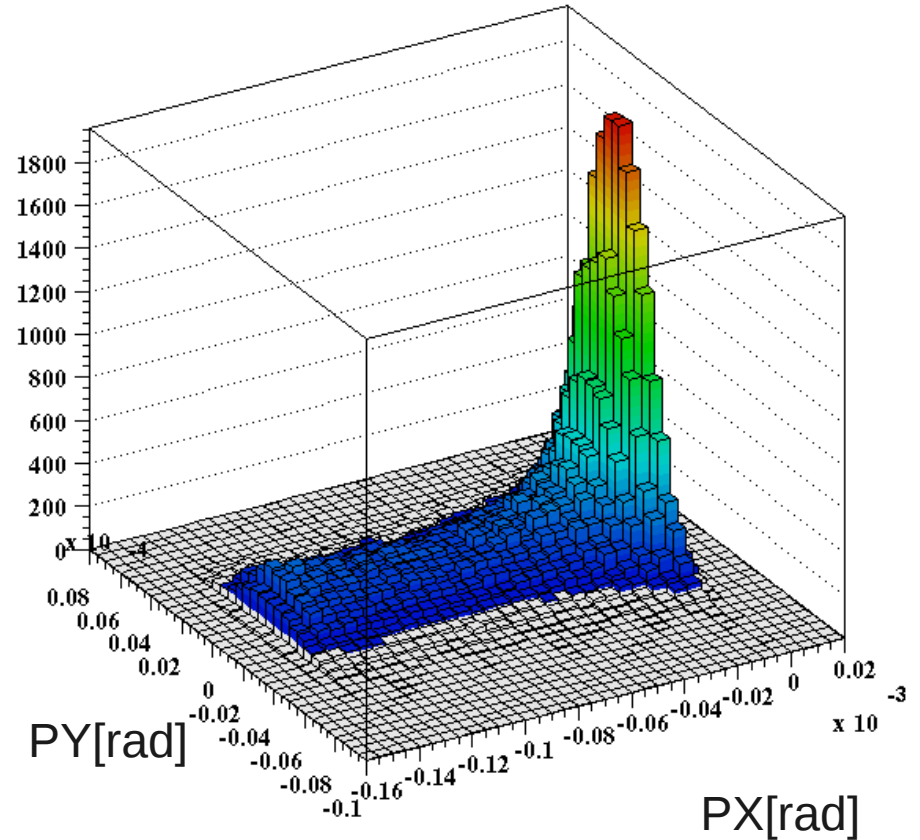(Possible insertion of a tertiary collimator)

Beam description

About 4.86 · 10^{12} protons of **4.5 TeV** are "lost"

Distributions in front of the **TCDQ.4R6** first collimator (TCDQA)

Coordinates

Divergence angles

Beam description

About $4.86 \cdot 10^{12}$ protons of **4.5 TeV** are "lost"

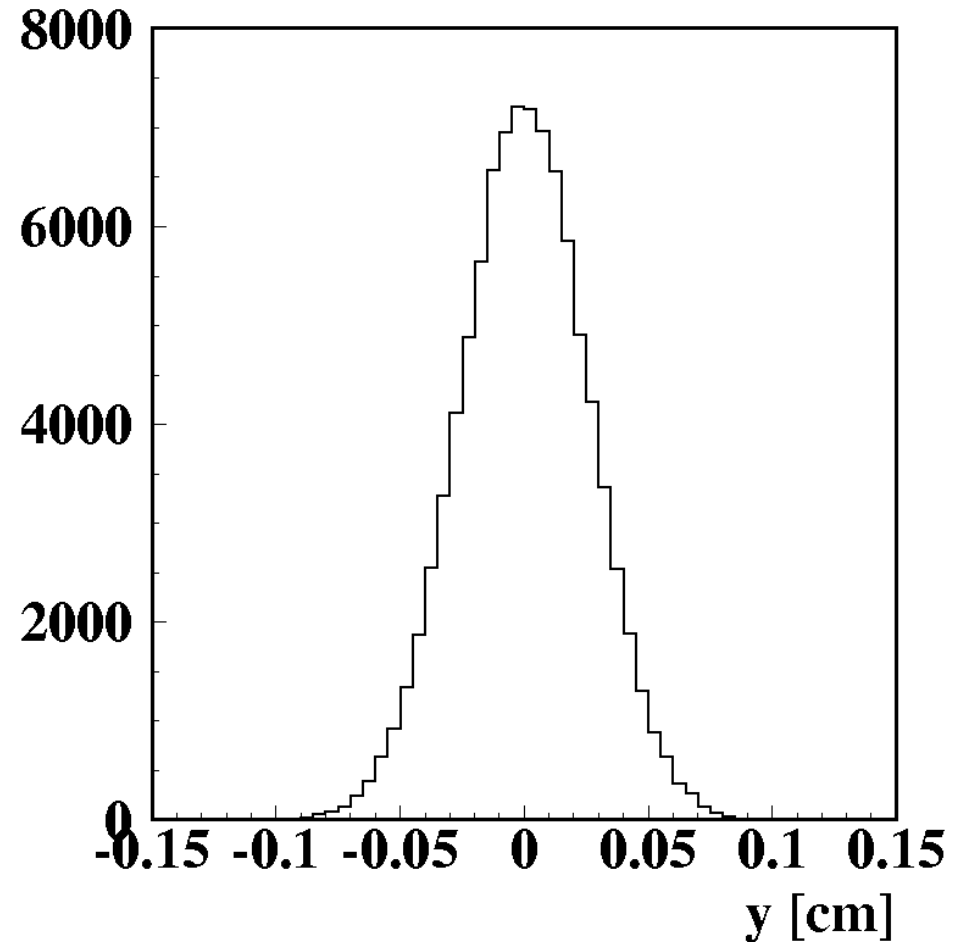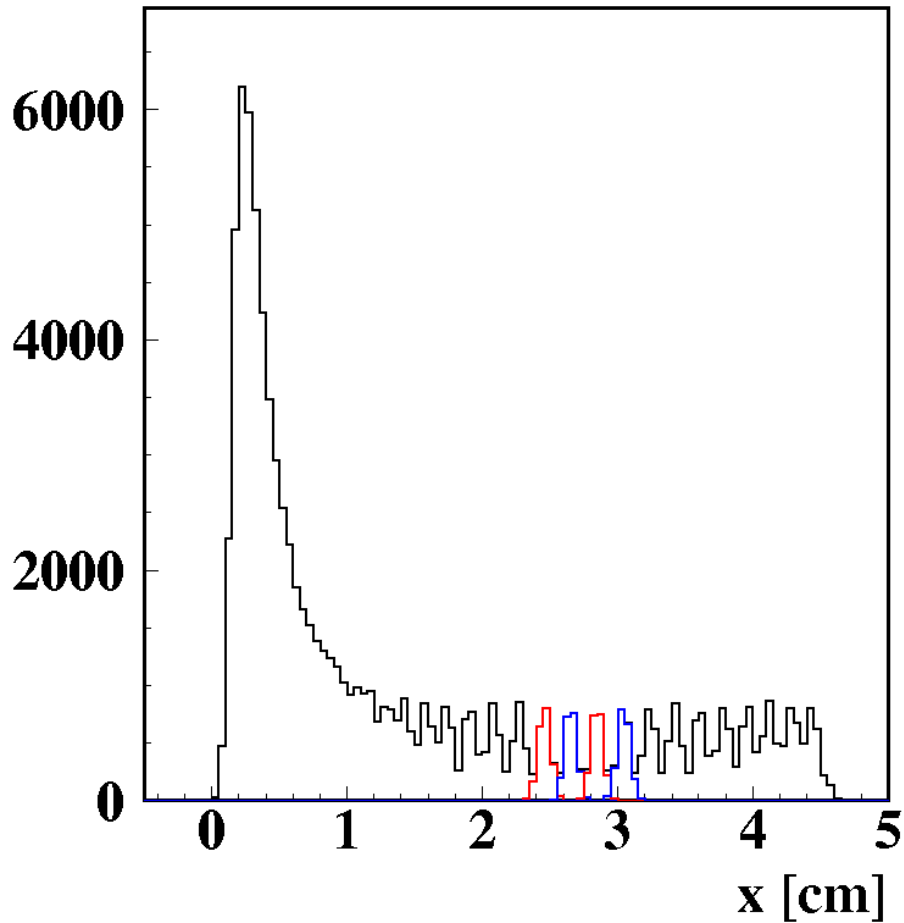Distributions in front of the **TCDQ.4R6** first collimator (TCDQA)

Coordinates

Beam description

About $4.86 \cdot 10^{12}$ protons of **4.5 TeV** are "lost"

Distributions in front of the **TCDQ.4R6** first collimator (TCDQA)
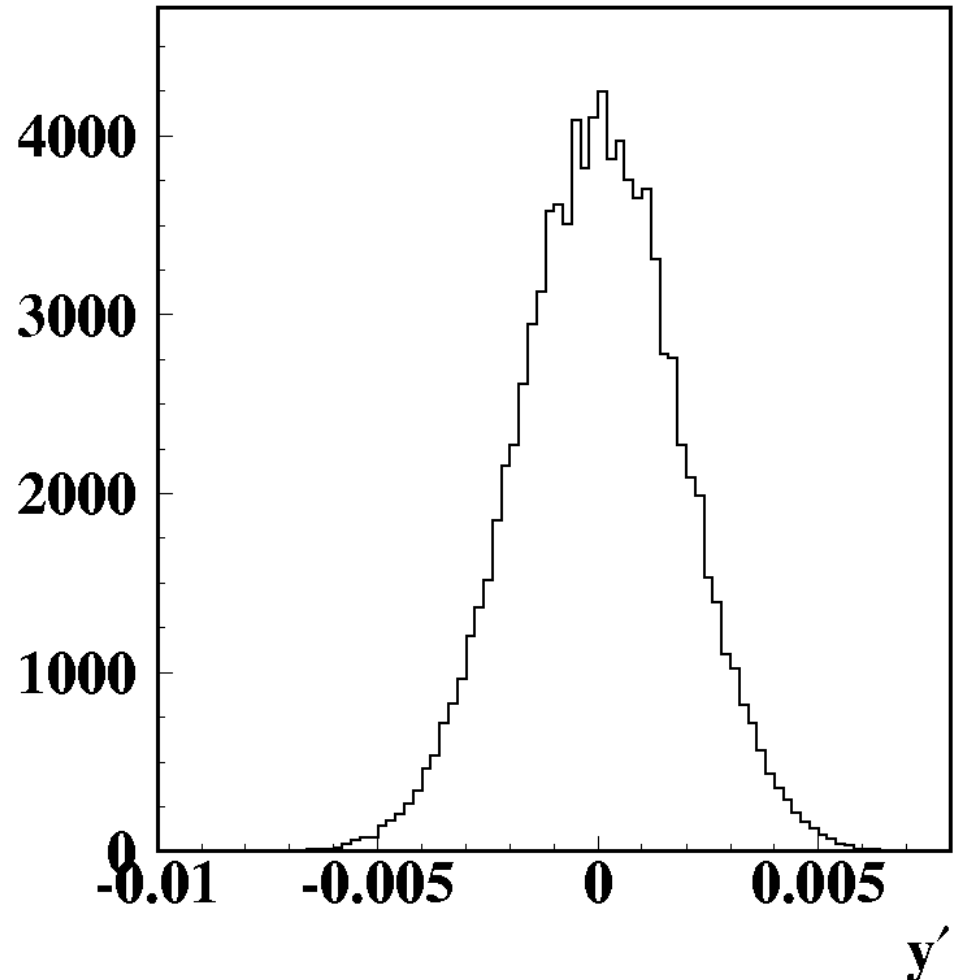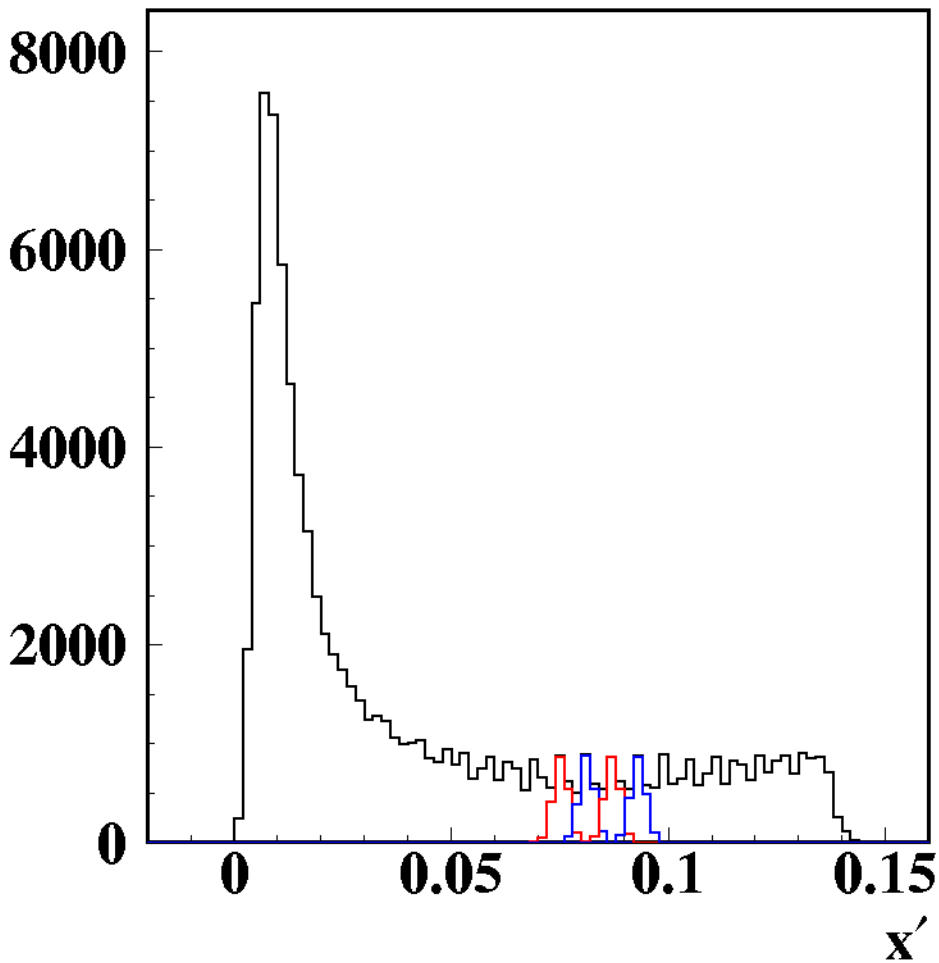

Divergence angles

FLUKA model

Geometry is based on the IR6 optics available on the web

http://proj-lhc-optics-web.web.cern.ch/
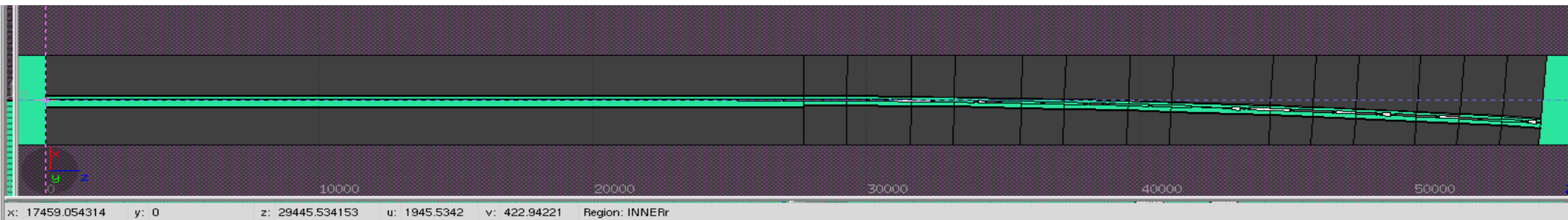
proj-lhc-optics-web/V6.500/Collision/IR6.html

About 550 meters long

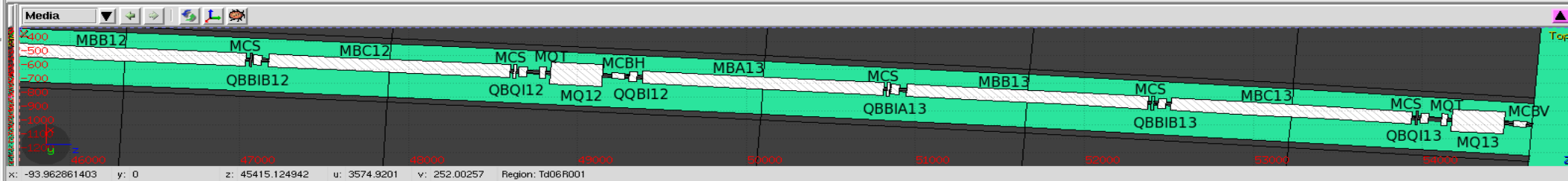Only **Beam 1** considered

~90 millions of simulated protons

IP6

C13.R6

◄——————————— ~550 meters ———————————►

x: 17459.054314   y: 0   z: 29445.534153   u: 1945.5342   v: 422.94221   Region: INNERr
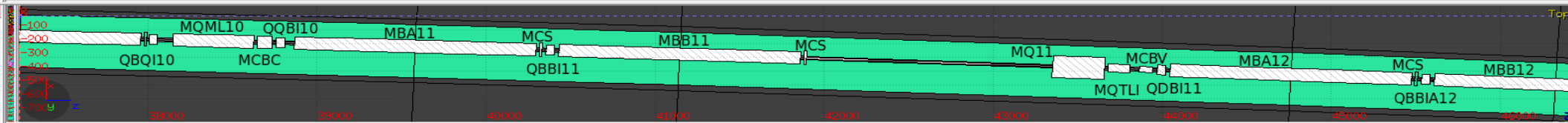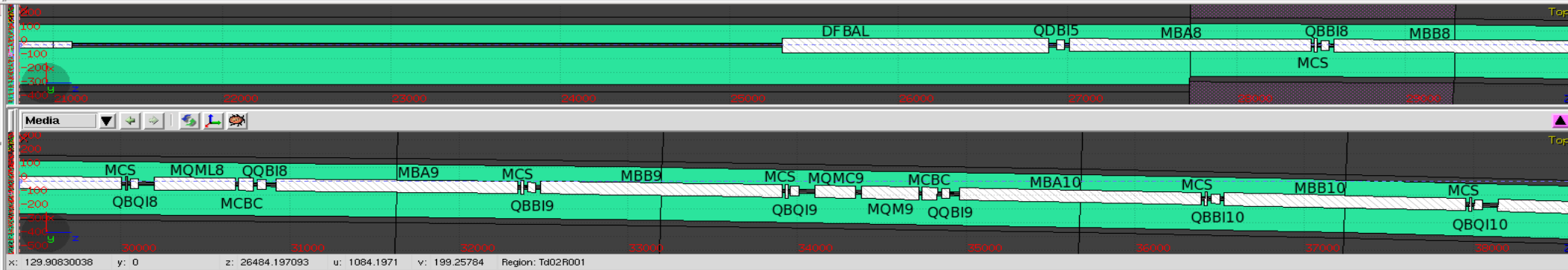
FLUKA model

FLUKA model

Quantities studied

Total and Maximum peak of energy deposition in magnet coils
   (dipoles and quadrupoles)

Total and Maximum peak of energy deposition in the busbars
   (interconnects and DFBA)

Beam profile
   (Exit of MCBY.5R6 and DFBAL.5R6)

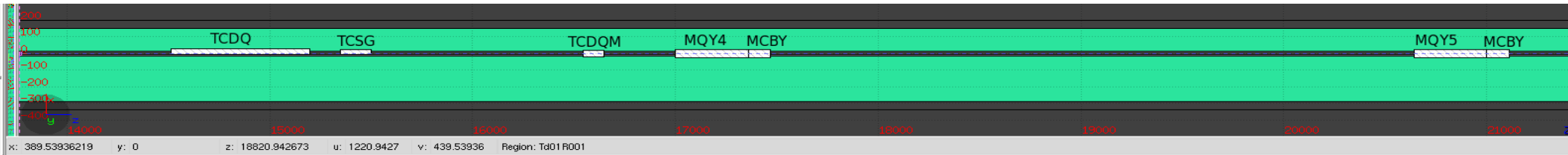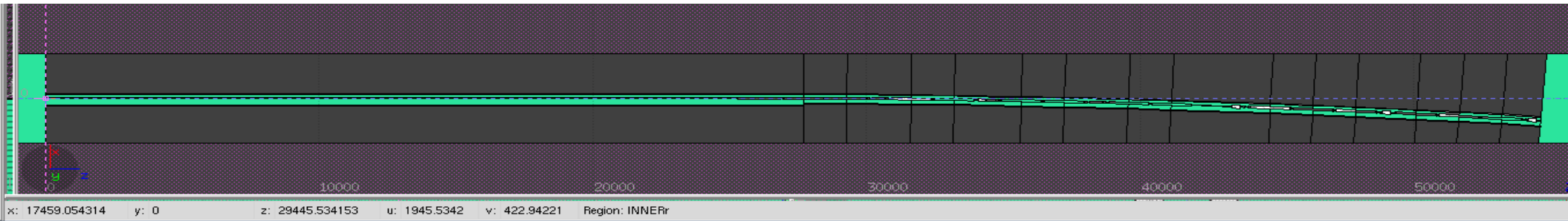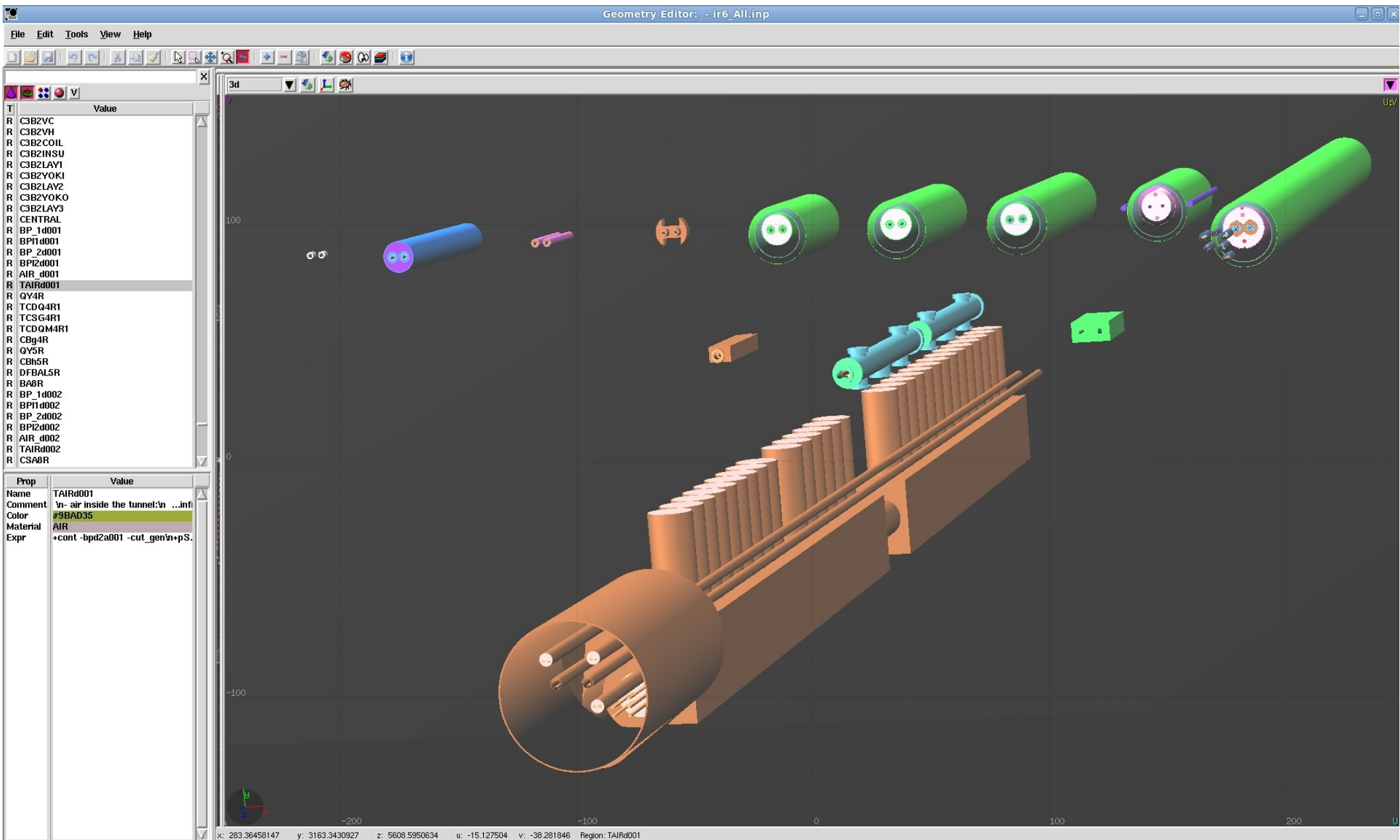# Systematic Uncertainties

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 4.5 TeV
0.9-1.1	0.5-2	FLUKA machine model	Description of a large sector

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)

Maximum Peak of Deposited Energy
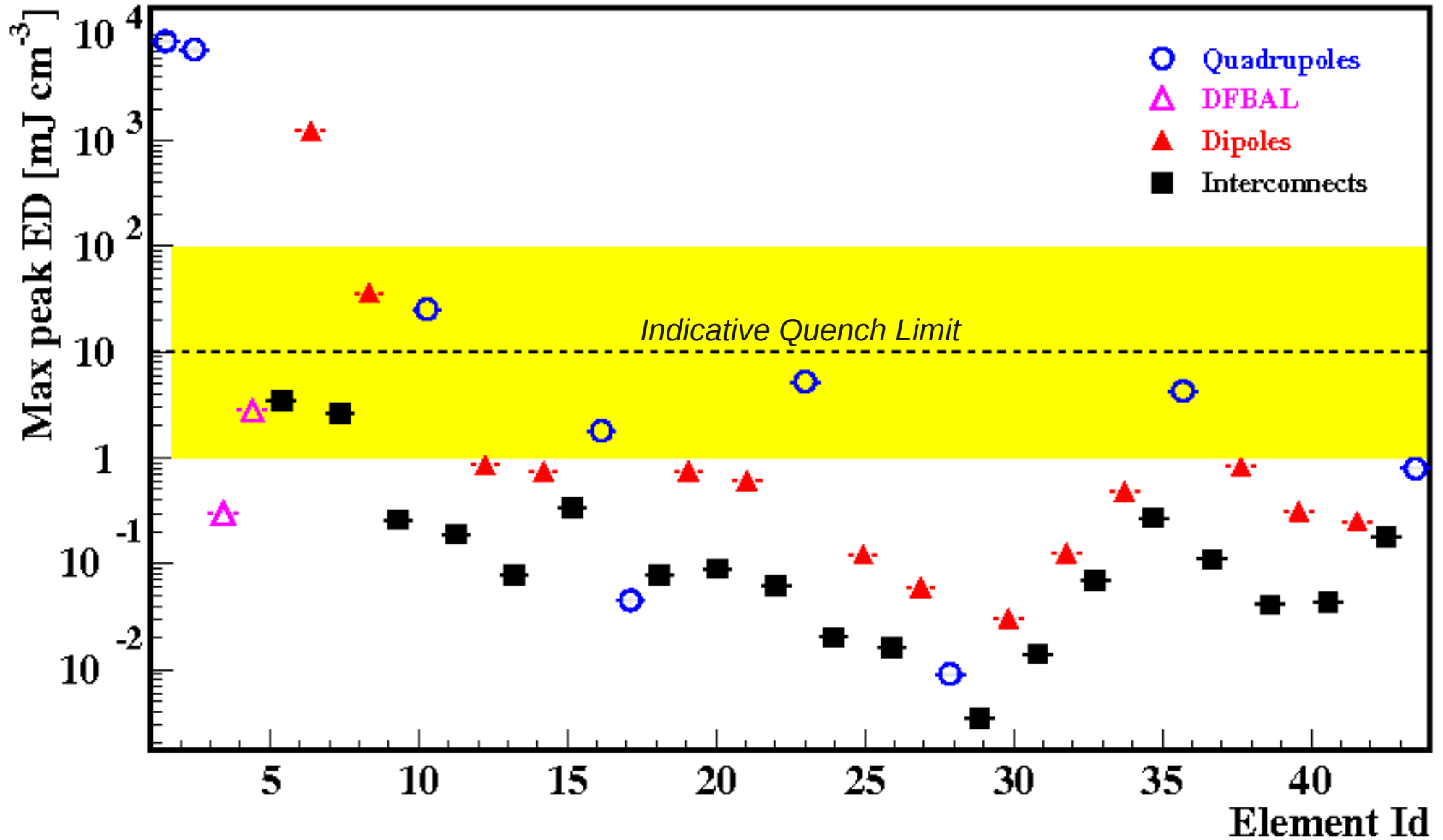
Statistical error bars are smaller than the marker size

Systematic uncertainty shown by means of the yellow box

Maximum Peak of Deposited Energy
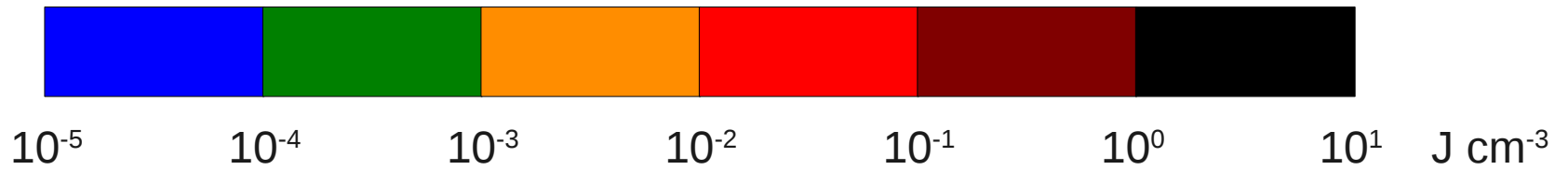
Tertiary collimator insertion

Useful to intercept the protons lost in the Dispersion Suppressor

To be located between MCBY.5R6 and DFBAL.5R6

Cannot be closer than 8σ

Can intercept also part of the proton exiting the DS

Tertiary collimator insertion

Beam profile at the exit of MCBY.5R6

~80% protons

Beam profile at the exit of DFBAL.5R6

~66% protons

Future studies
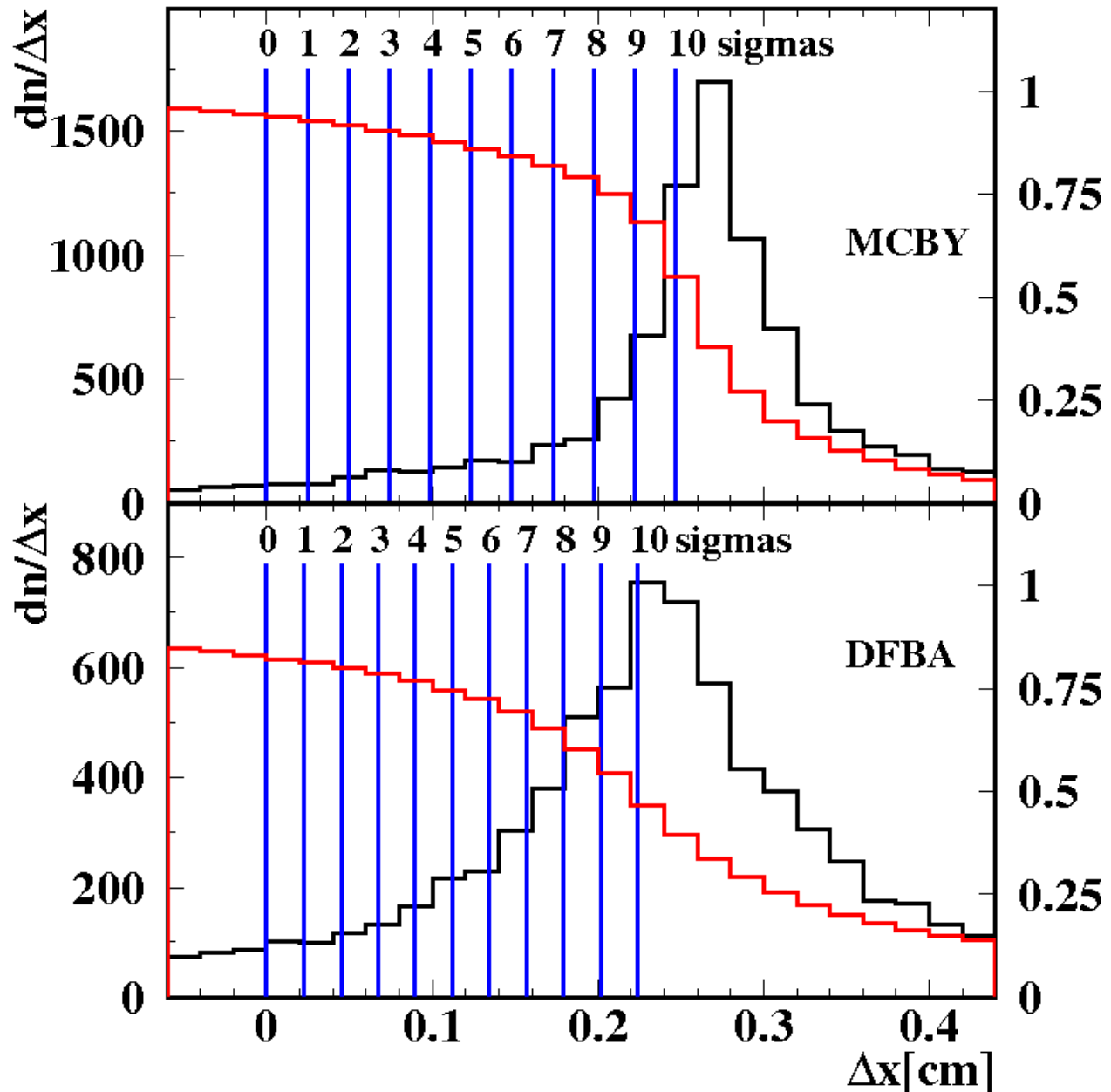
New series of simulations with 7 TeV beam

Investigation of other possible mitigations:

Longer TCDQ (3 modules)
TCLA insertion upstream the TCDQM

# Spare slides

Table of Deposited Energy

Element Id & Name	Max. Peak [mJ cm^{-3}]	Total [J]	Element Id & Name	Max. Peak [mJ cm^{-3}]	Total [J]
1 MQY.4R6	$8.7(3) \cdot 10^3$	2524(4)	23 MQML.10R6	5.25(5)	4.599(5)
2 MQY.5R6	$7.2(4) \cdot 10^3$	2596(7)	24 QQBI.10R6	0.020(2)	0.0004(1)
3 DFBAL.5R6$_{off-beam}$	0.30(1)	0.0887(4)	25 MB.A11R6	0.122(2)	3.568(5)
4 DFBAL.5R6$_{on-beam}$	2.8(1)	0.110(5)	26 QBBI.11R6	0.016(2)	0.0002(1)
5 QDBI.8R6	3.5(2)	0.85(2)	27 MB.B11R6	0.060(1)	0.651(4)
6 MB.A8R6	$1.23(1) \cdot 10^3$	2829(1)	28 MQ.11R6	0.0091(1)	0.1323(6)
7 QBBI.A8R6	2.6(1)	0.32(1)	29 QQBI.11R6	0.0034(3)	0.00008(2)
8 MB.B8R6	36.2(3)	560.0(1)	30 MB.A12R6	0.0301(4)	1.625(5)
9 QBQI.8R6	0.26(1)	0.019(1)	31 QBBI.A12R6	0.014(1)	0.00042(5)
10 MQML.8R6	25.6(2)	26.58(1)	32 MB.B12R6	0.126(1)	6.011(8)
11 QQBI.A9R6	0.19(2)	0.007(2)	33 QBBI.B12R6	0.069(6)	0.0016(3)
12 MB.A9R6	0.86(1)	43.60(1)	34 MB.C12R6	0.48(1)	54.73(3)
13 QBBI.9R6	0.079(1)	0.0031(3)	35 QBQI.12R6	0.27(2)	0.010(1)
14 MB.B9R6	0.75(1)	33.62(1)	36 MQ.12R6	4.3(1)	9.706(6)
15 QBQI.9R6	0.34(3)	0.008(2)	37 QQBI.12R6	0.11(1)	0.006(1)
16 MQMC.9R6	18(4)	4.5(4)	38 MB.A13R6	0.82(1)	28.25(1)
17 MQM.9R6	0.045(3)	4.37(1)	39 QBBI.A13R6	0.041(2)	0.0018(3)
18 QQBI.9R6	0.078(7)	0.005(1)	40 MB.B13R6	0.31(1)	15.04(1)
19 MB.A10R6	0.75(1)	36.49(1)	41 QBBI.B13R6	0.044(4)	0.0018(3)
20 QBBI.10R6	0.089(5)	0.0031(3)	42 MB.C13R6	0.25(1)	19.11(1)
21 MB.B10R6	0.61(1)	26.82(1)	43 QBQI.13R6	0.18(2)	0.005(1)
22 QBQI.10R6	0.061(5)	0.0025(3)	44 MQ.13R6	0.79(2)	1.879(3)

Results: fluence

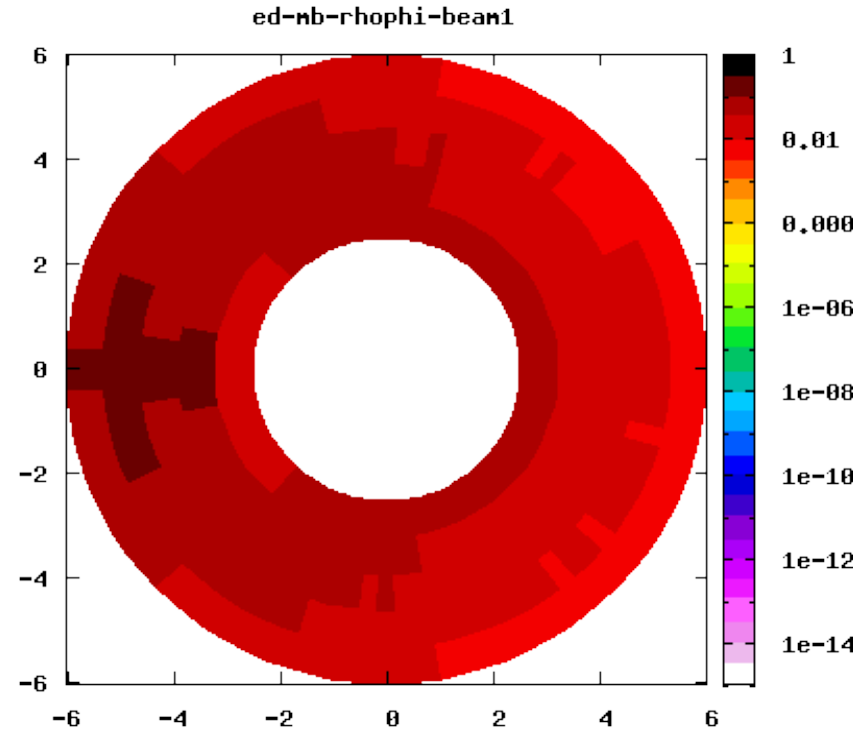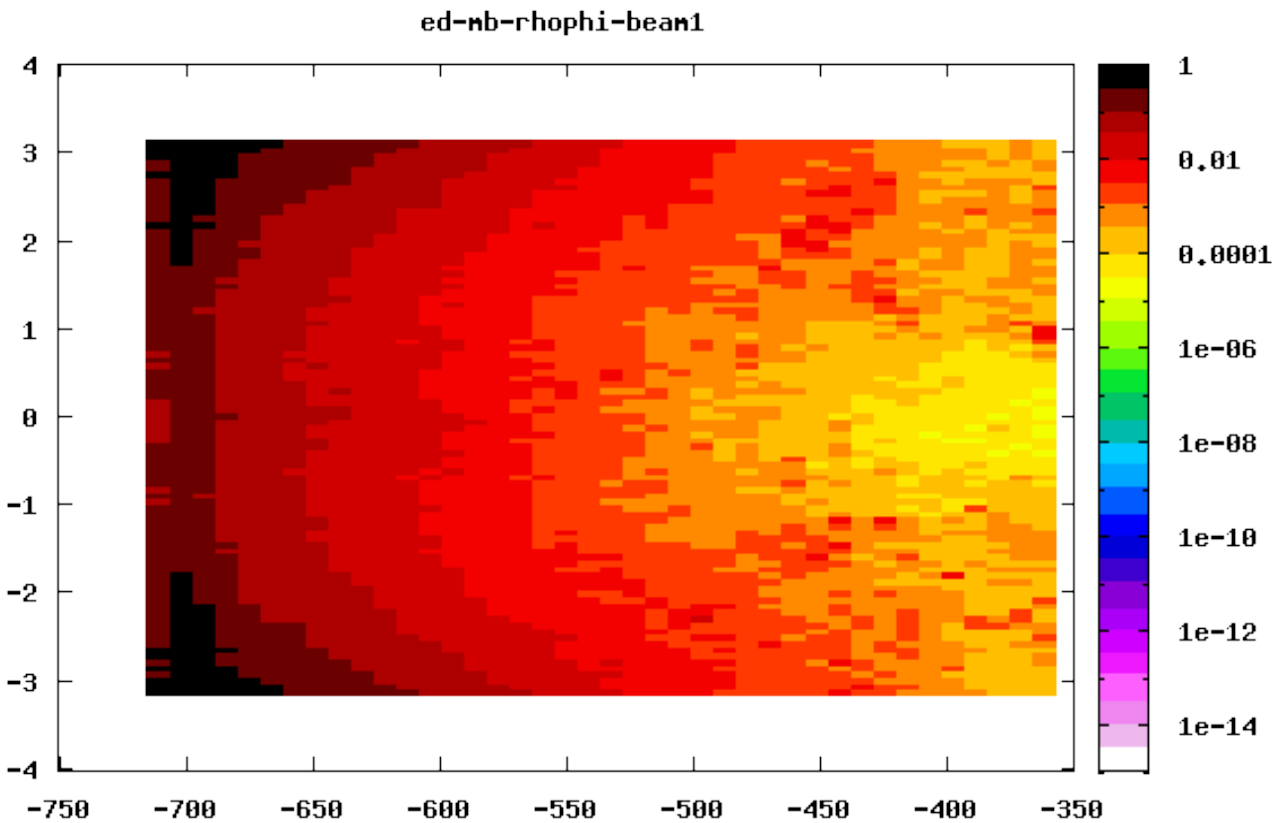35% of protons dumped pass cell 13R
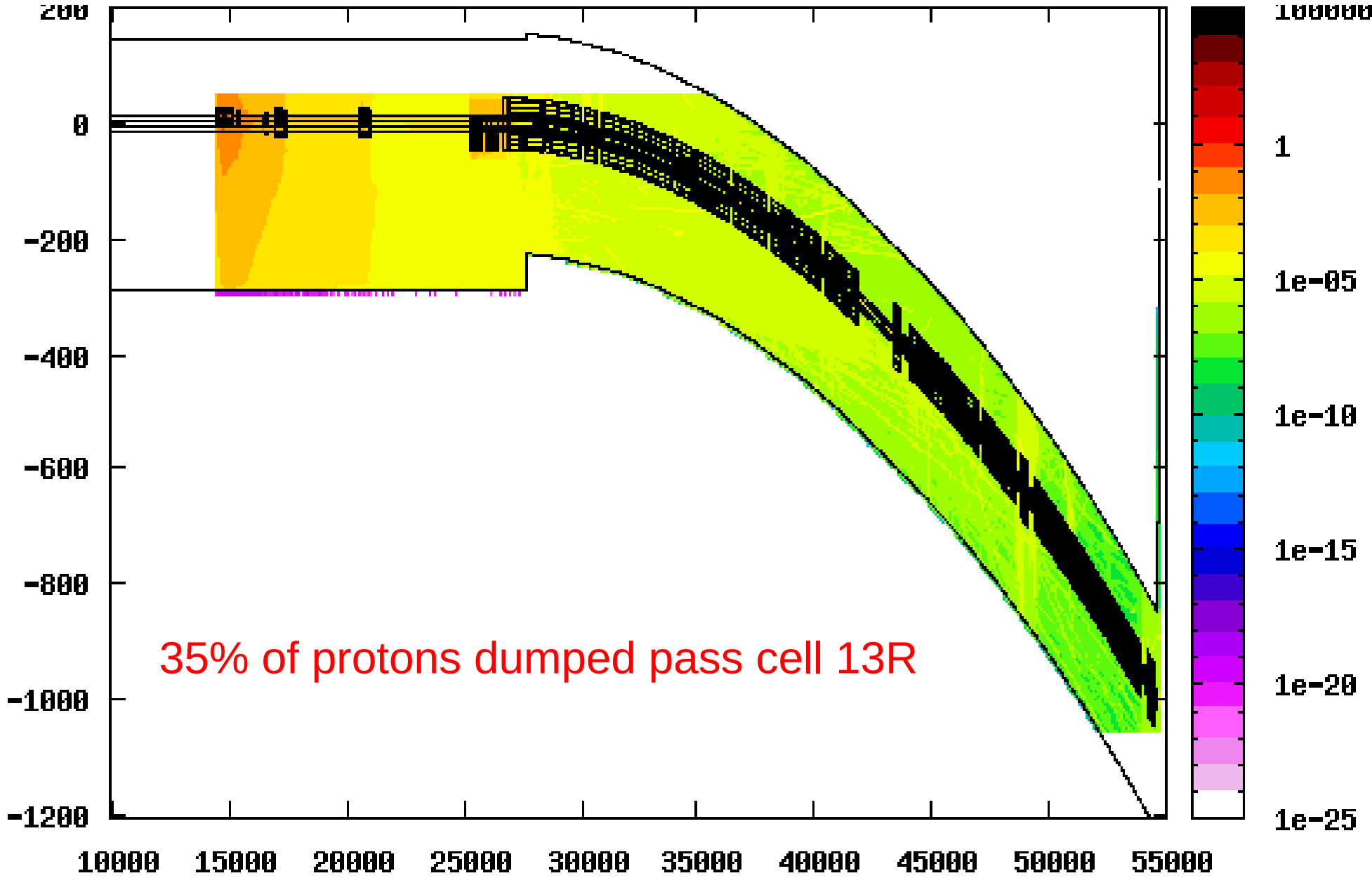
MB Model

Cylindrical scoring over the coils
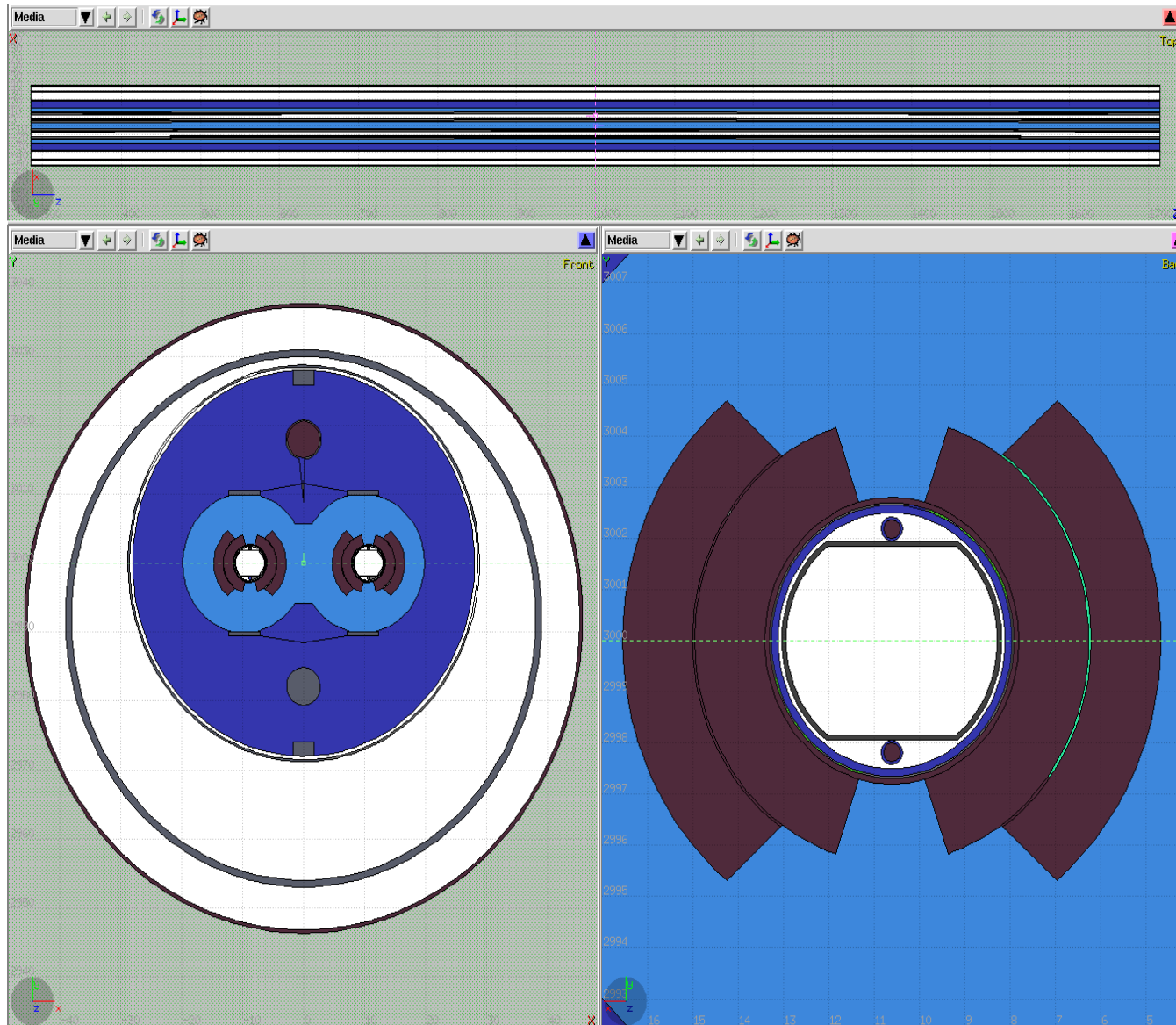
MB Maximum Deposited Energy

First part of the MBA8 (beam 1)

IC Model

Cartesian scoring over the busbars