Locations of Beam Loss Monitors based on proton loss maps

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   - in the arcs
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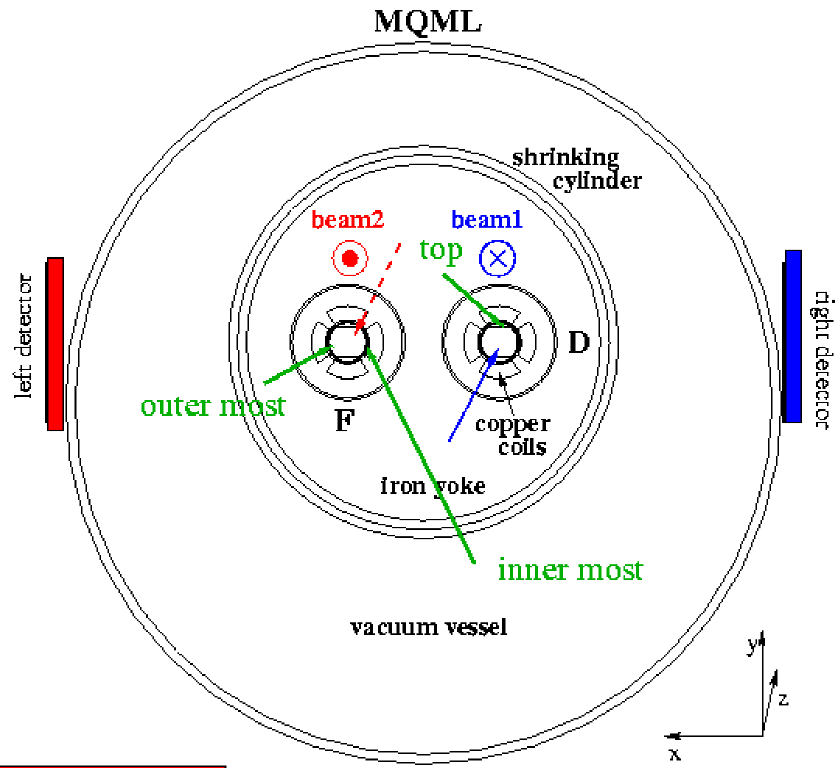
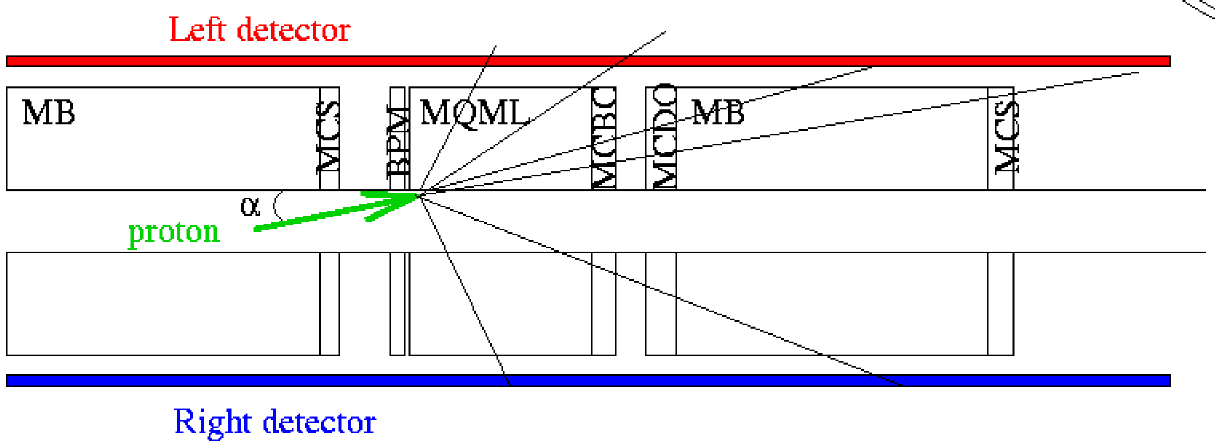
1. Principle of the simulation

- Loss maps given by R. Assmann team (C. Bracco, S. Redaelli, G. Robert-Demolaize)
- GEANT 3 simulation of the secondary shower created by a lost proton impacting the beam pipe
- scoring of the number of secondary particles entering the chamber
- then simulation of the detector response to the spectra registered in the left and right detector (M. Stockner with G4)

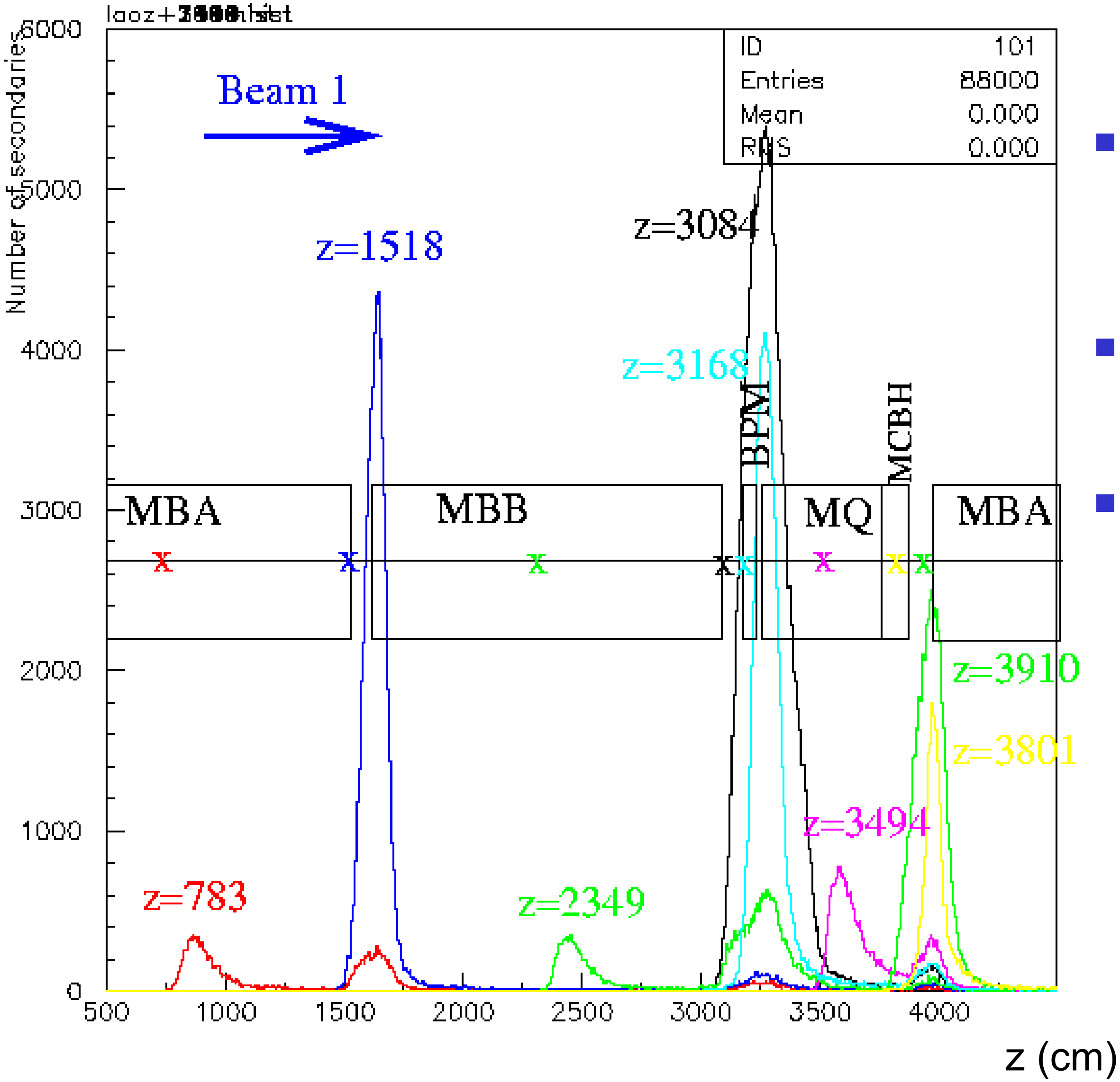
Geometry description

- 500 protons same z position and same energy
- impacting angle is 0.25 mrad
- longitudinal scan performed to optimize the BLM location
- Transverse impact positions: outermost, innermost, top



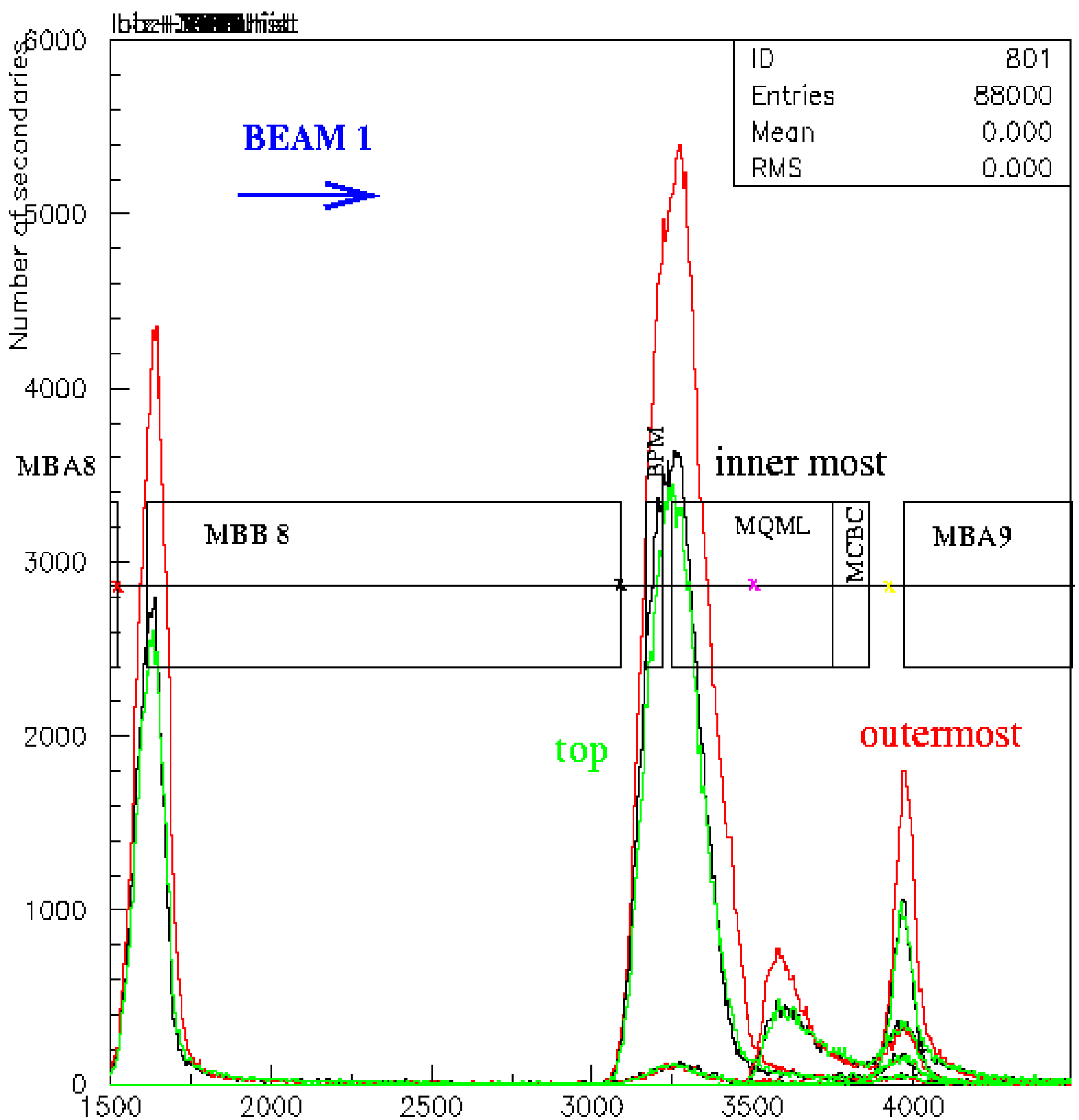


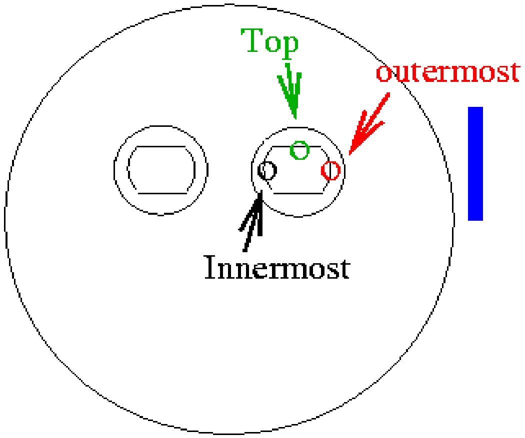
Typical result



- Maximum of the shower ~ 1m after impacting point in material
- increase of the signal in magnet free locations
- factor 2 between MQ and MB

Dependence on transverse position

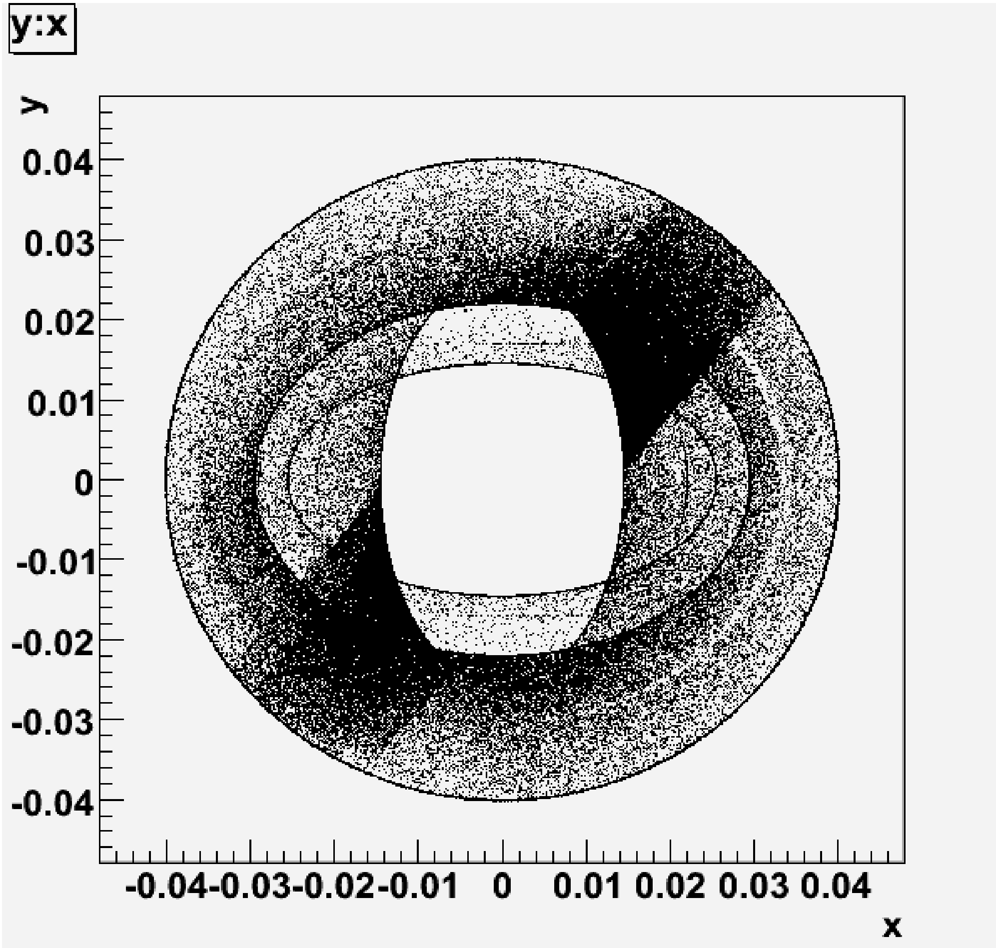




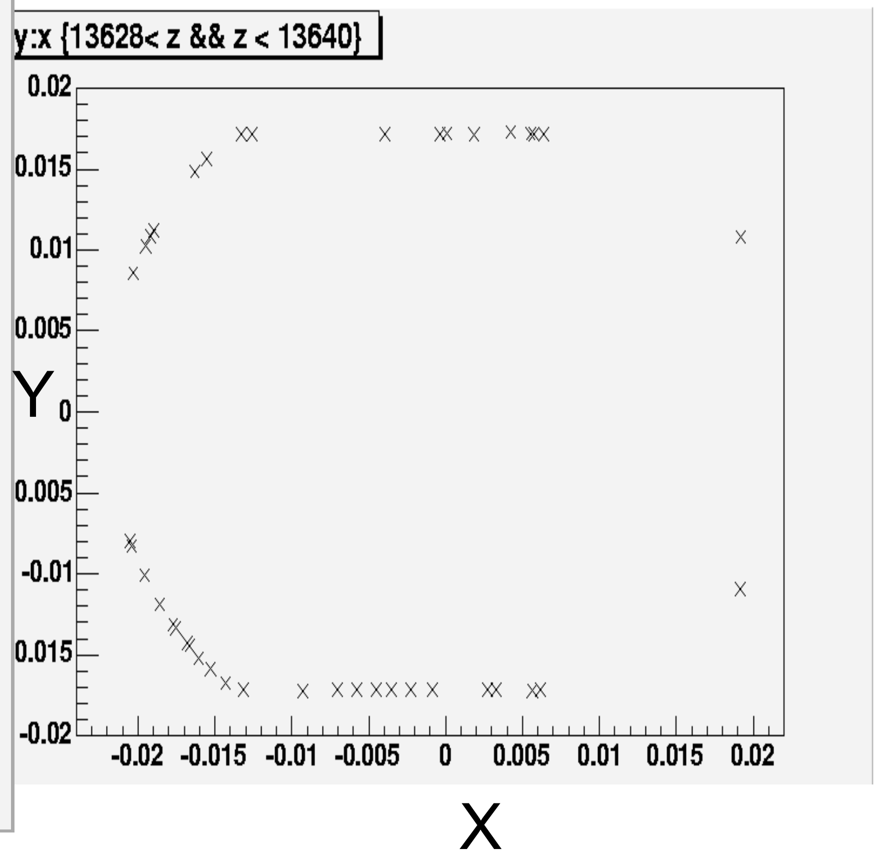
- about 40 % less signal between outermost and top/innermost
- less than 10% between top and innermost
- unavoidable source of uncertainty

Transverse distributions of losses

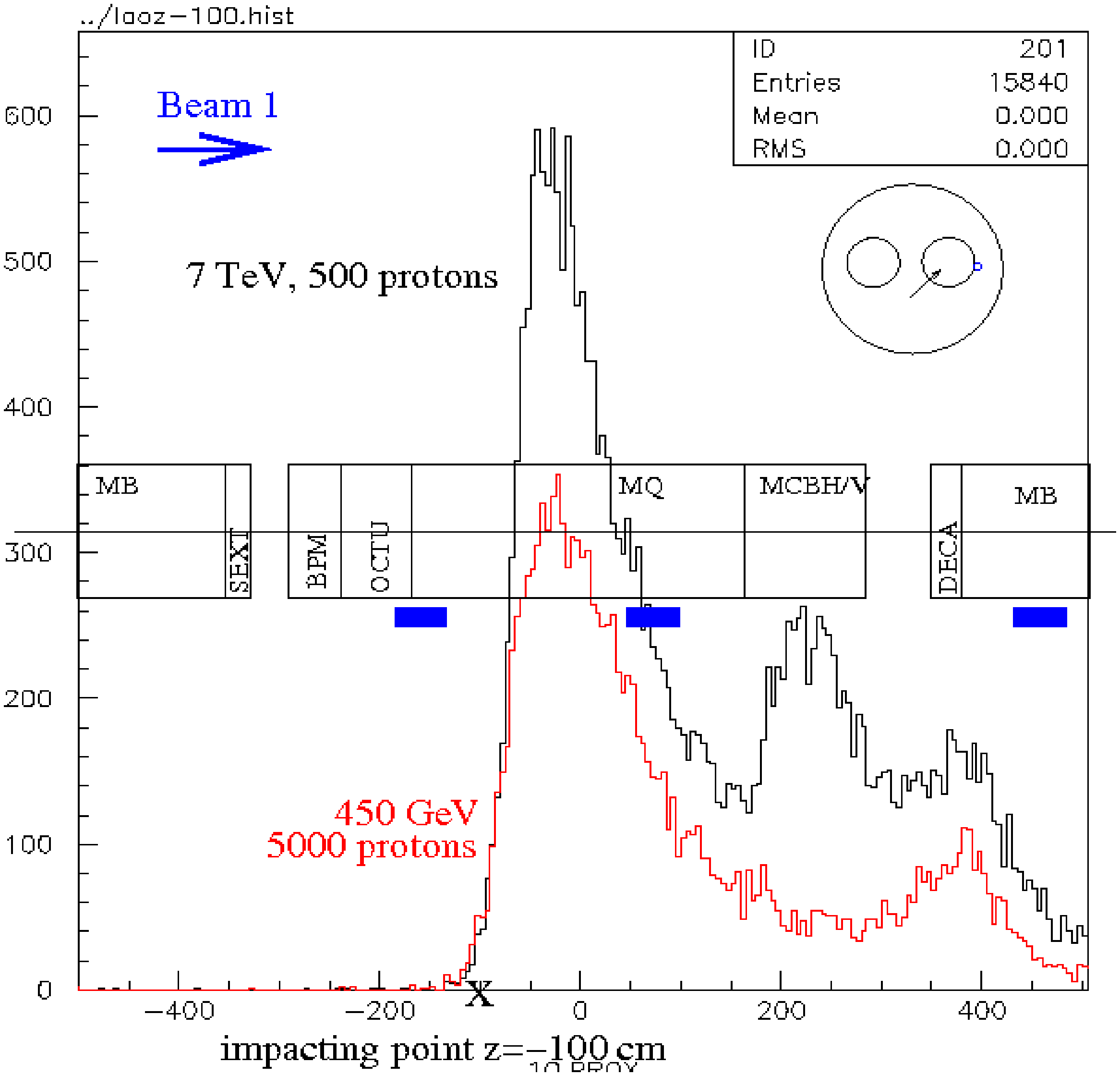
the whole LHC
(beam 2,Hor. halo, injection optics)



Q5R8
(beam1)

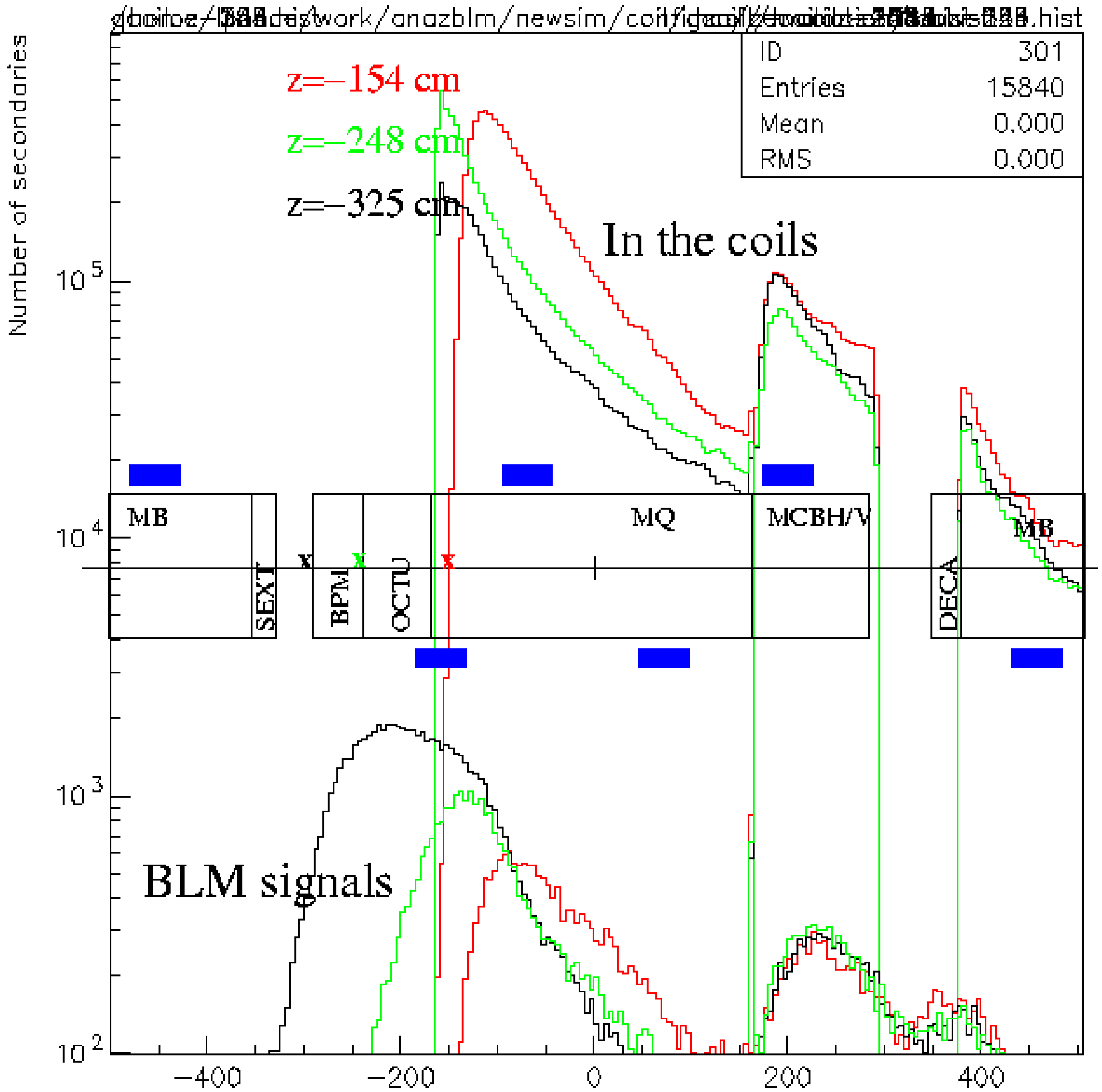


Dependance on beam energy



- Position of the peak outside the cryostat independent on beam energy
- about 20 times less signal at injection inside the quad
- energy ratio depend on impacting point

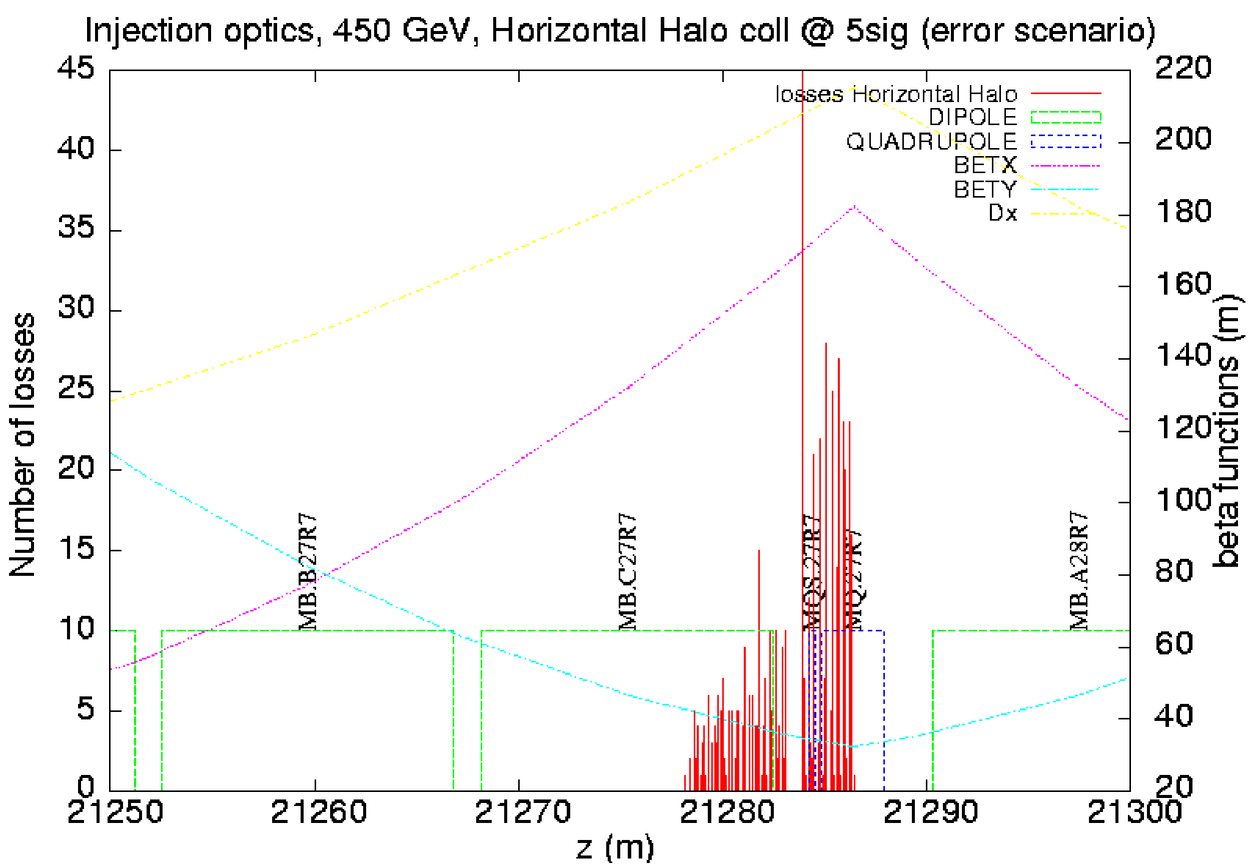
Energy Deposition in Coil and Detector



- Secondaries crossing the full volume of magnet coil
- preliminary results, only 10 protons
- reached limitation of the code, need to migrate to G4.
- peak position in the coil in agreement with note 44 (40 cm from impact)

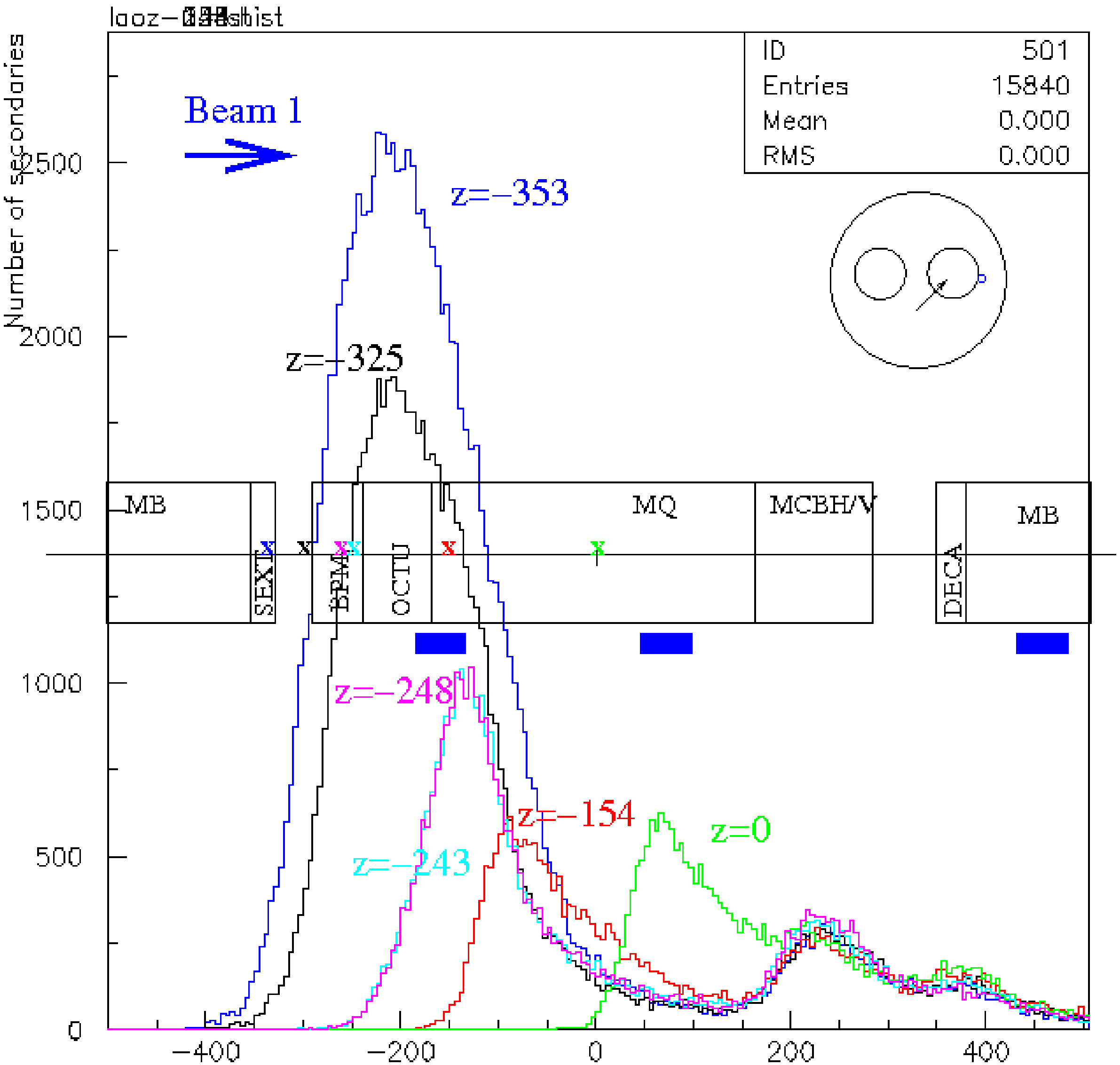
2. Position in the ARCS

- Example of topology of Loss (MQ27.R7)
- Peak before MQ at the shrinking vacuum pipe location (aperture limit effect)
- End of loss at the centre of the MQ (beam size effect)



More simulation are needed to get better evidence (higher populated tertiary halo)

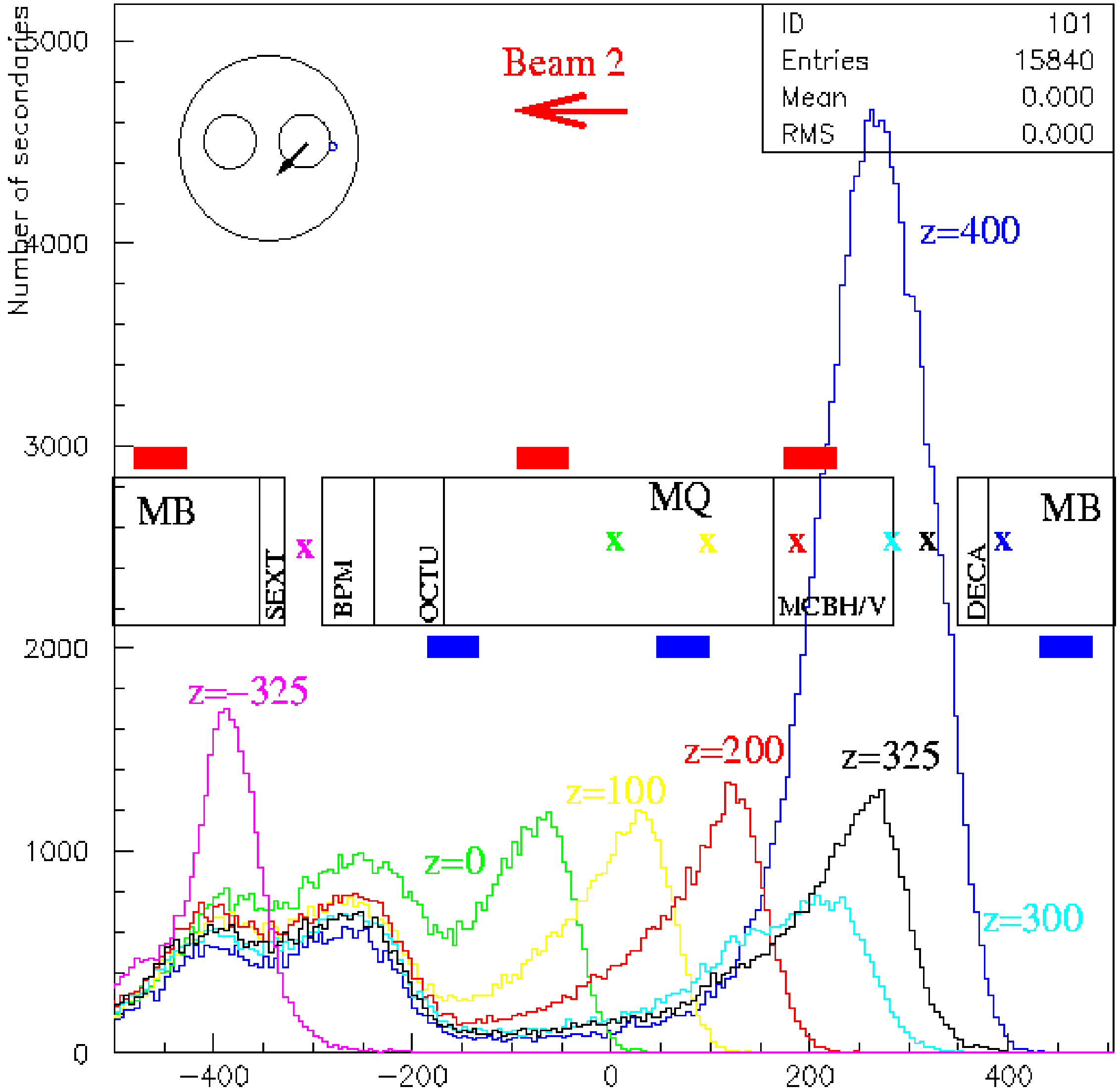
Particle Shower in the Cryostat



Position of the detectors optimized to:

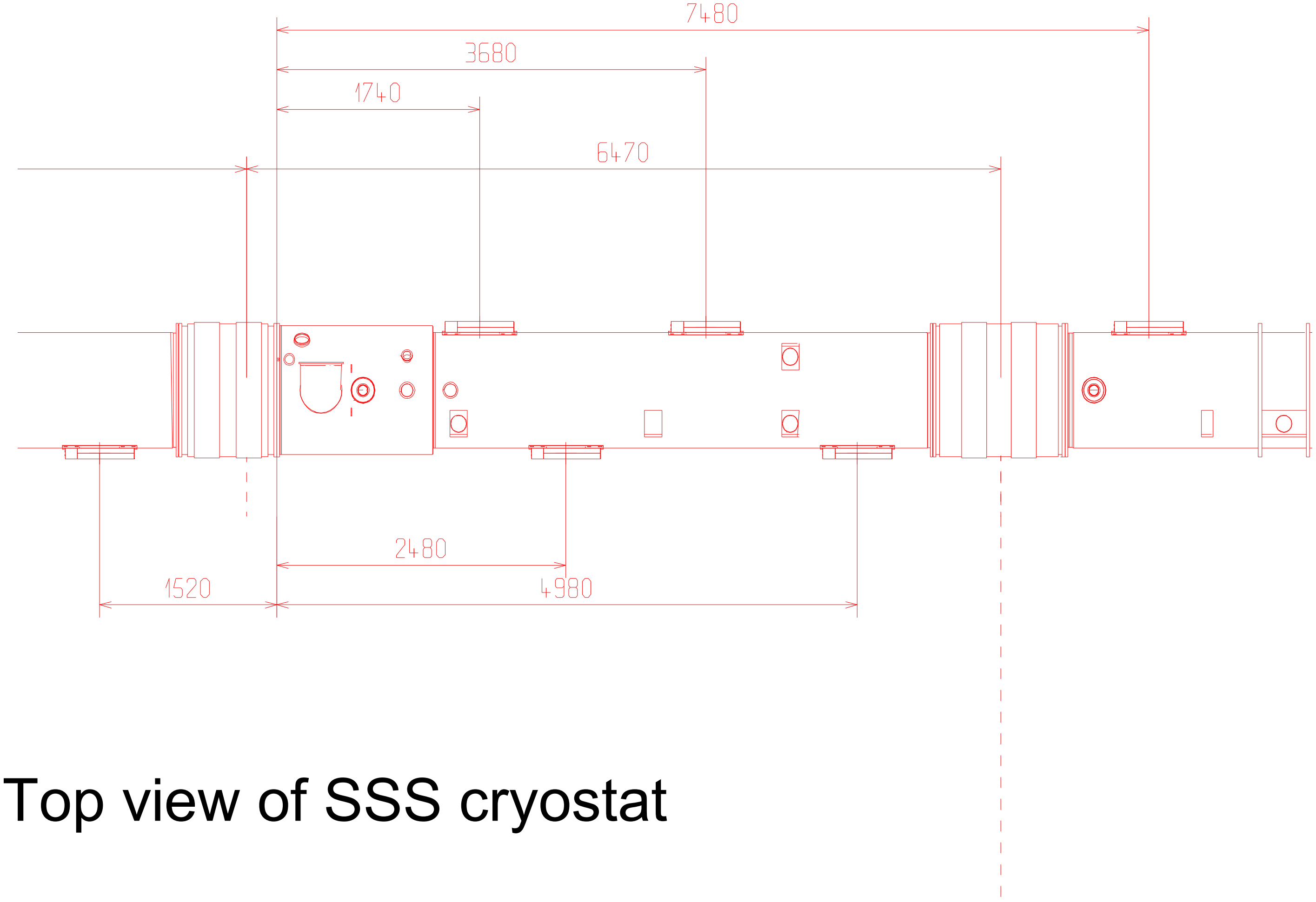
- catch the losses:
  - MB-MQ transition
  - Middle of MQ
  - MQ-MB transition
- minimize uncertainty of ratio of deposited energy in the coil and in the detector
- B1-B2 discrimination

for beam 2



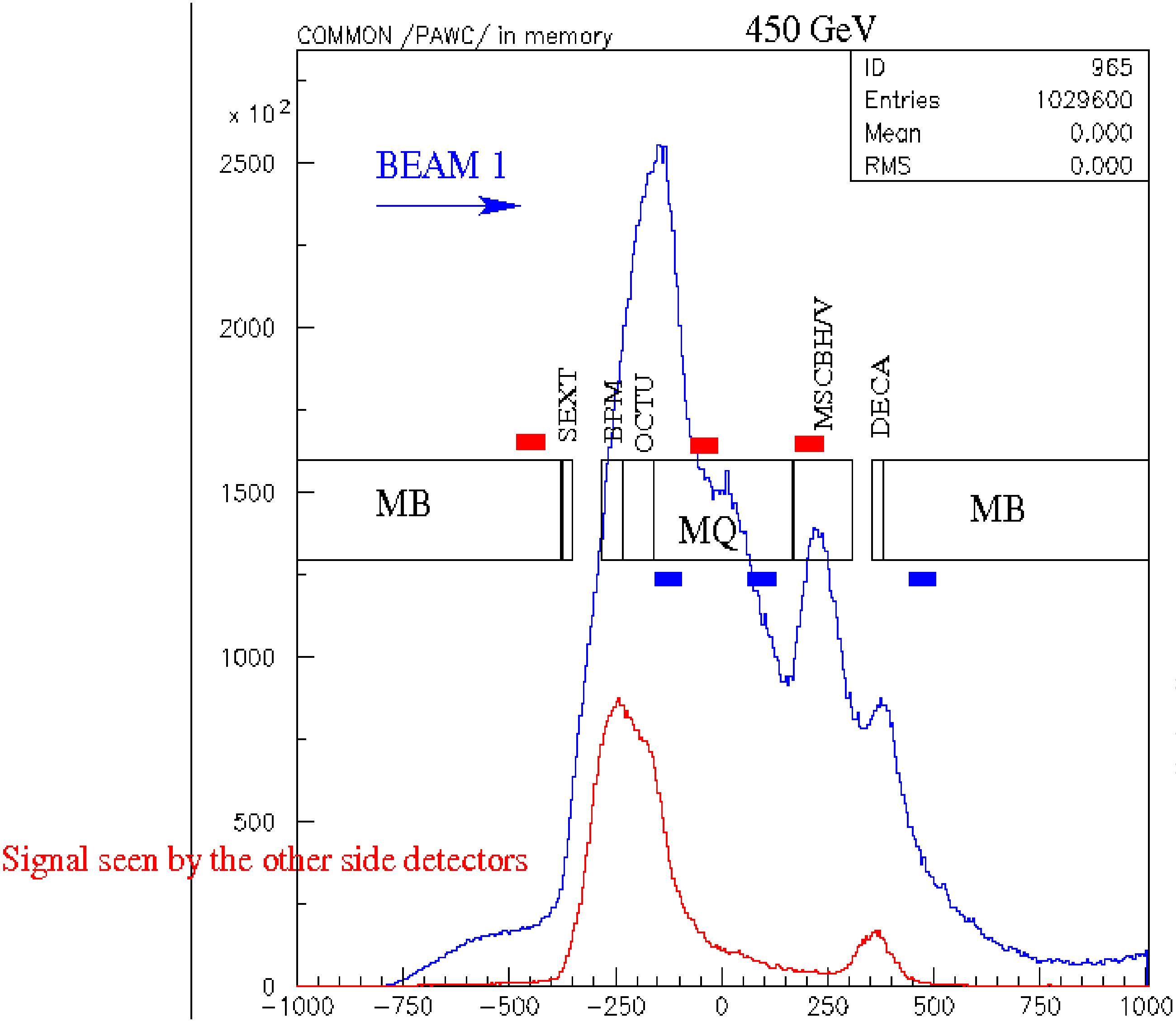
- Same assumptions for beam 2 for loss locations
- Same positions for the detectors wrt the physical apertures

Position after integration

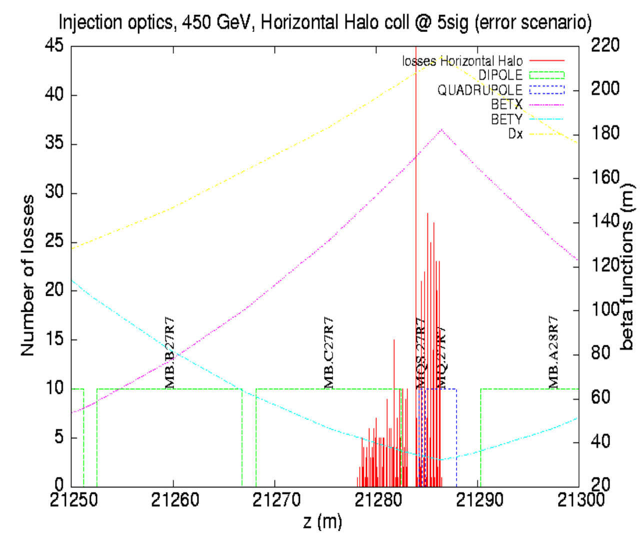


Top view of SSS cryostat

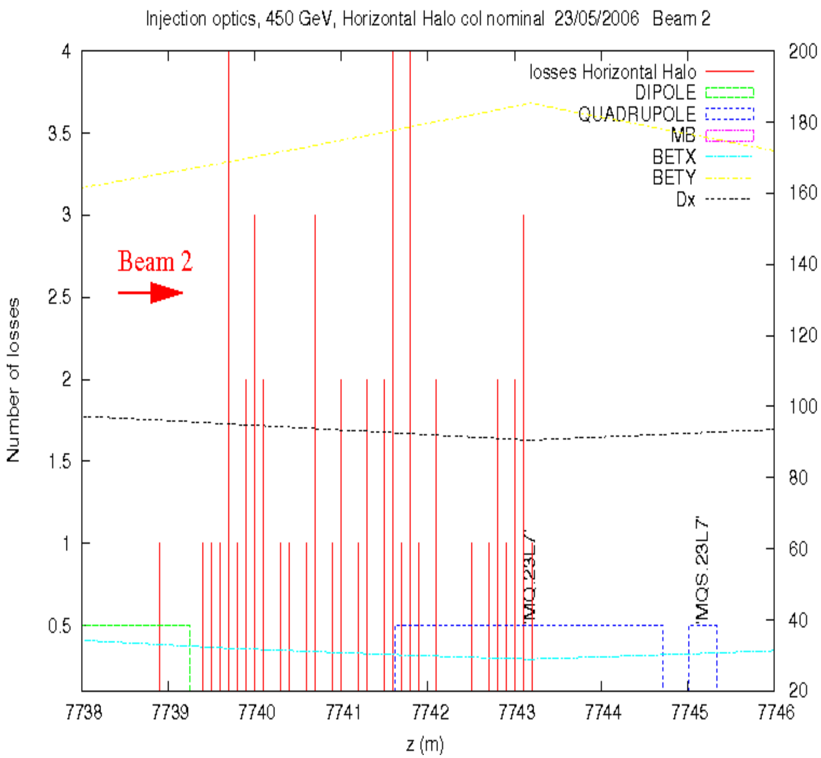
"Integrated" signal seen by the BLMs

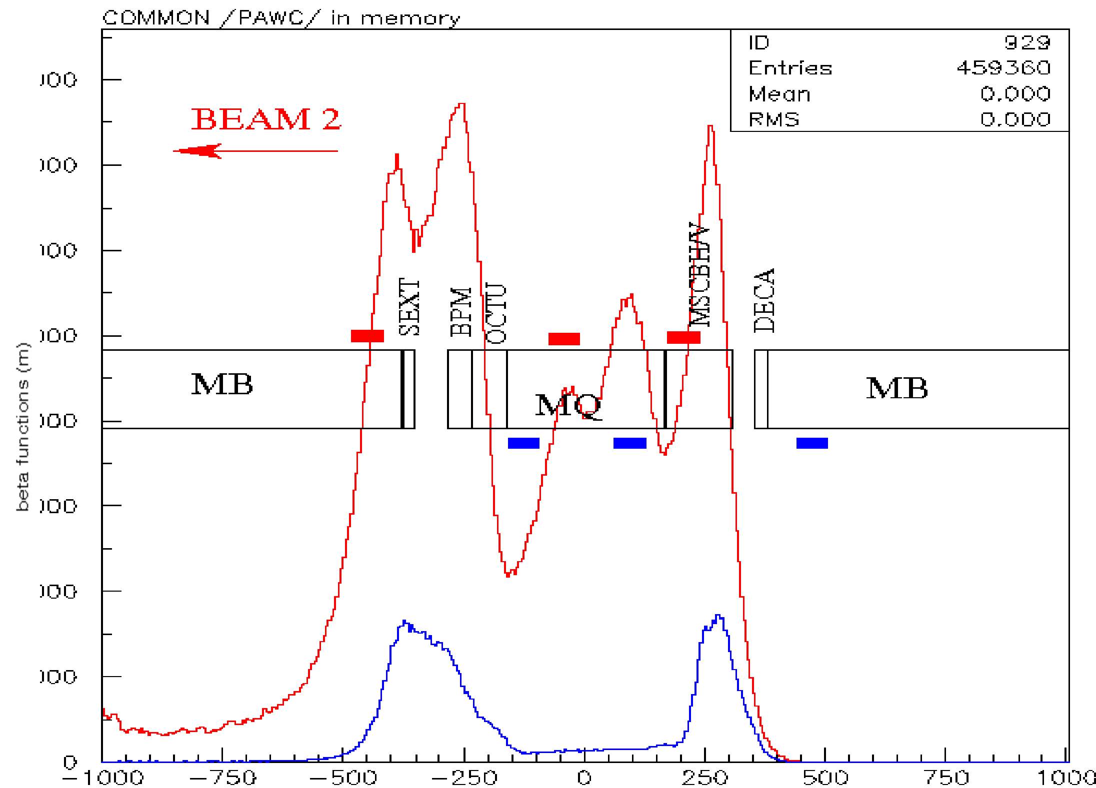


- Sum of the weighted contribution of all locations for realistic signal



MQ23L7 for beam 2

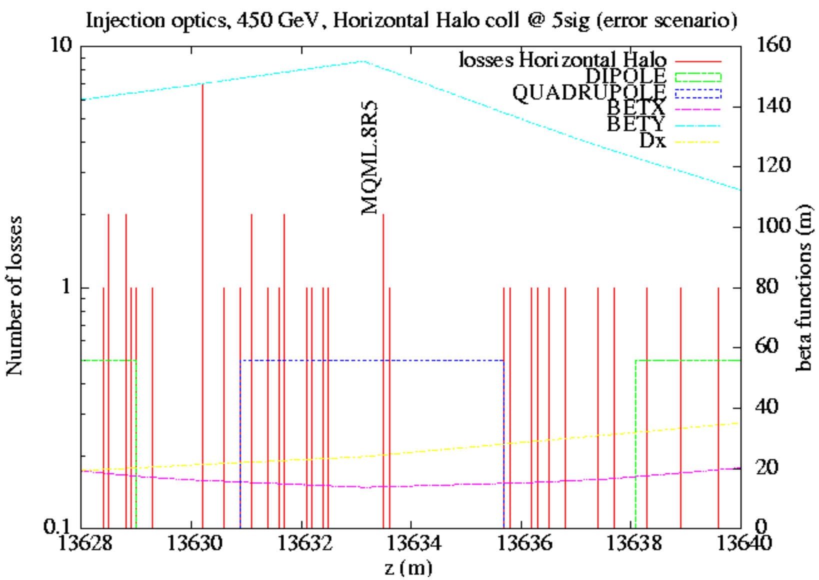




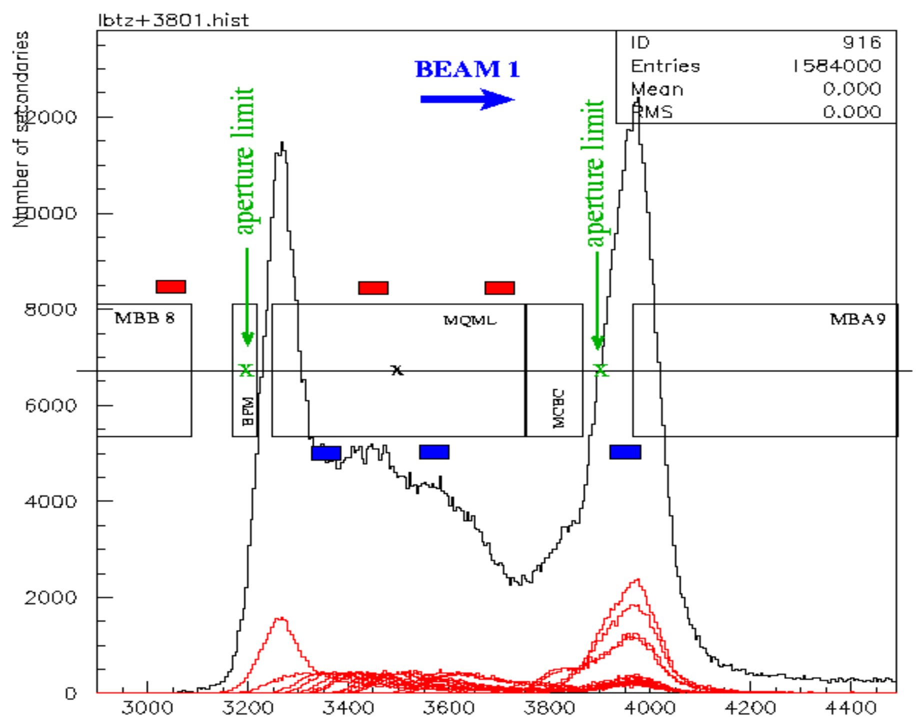
- Low cross-talk signal
- Good discrimination between B1 and B2

Positions in the LSS

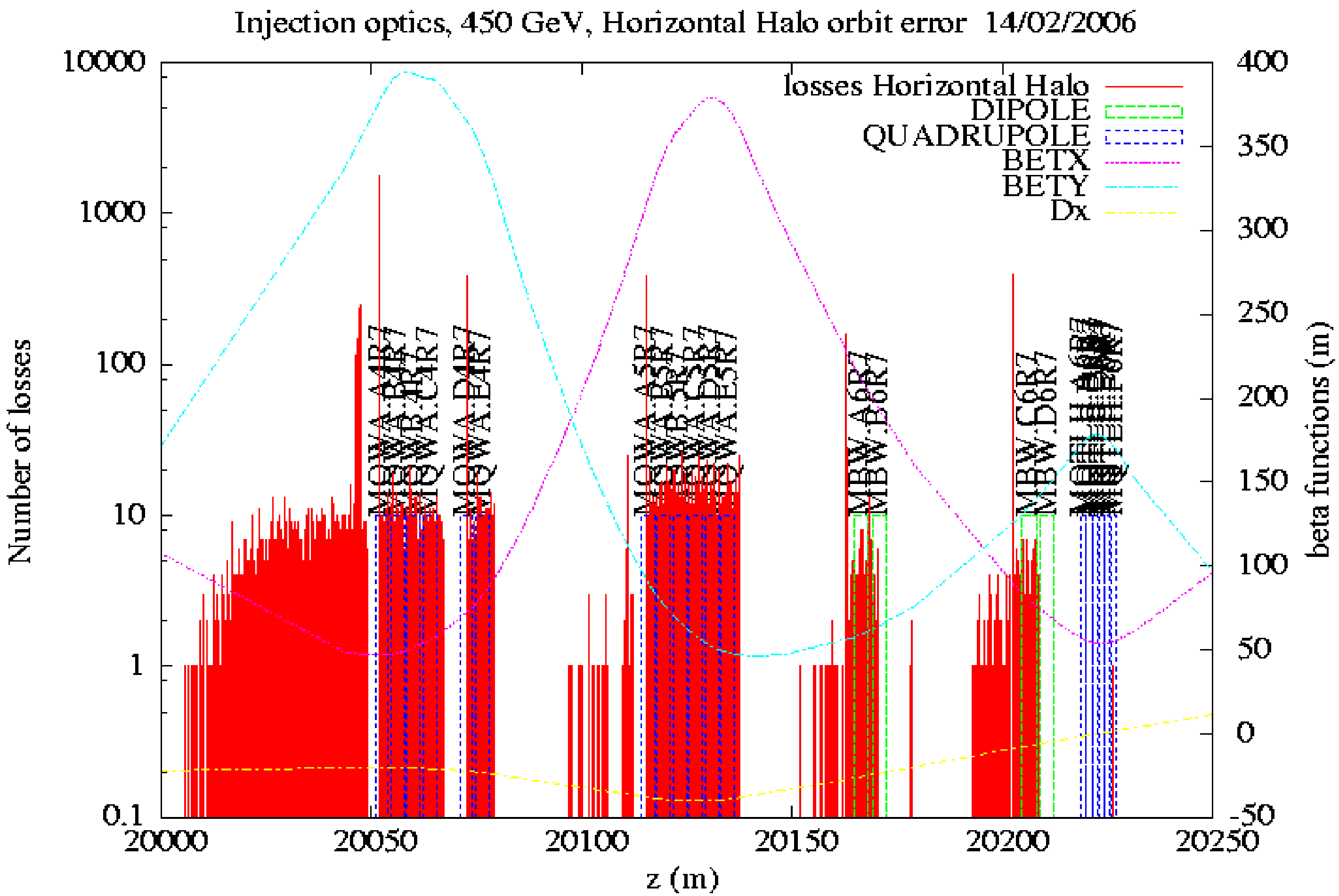
- Loss pattern in DS look like in the arcs.
- So same rules for placement in conjunction with the integration possibilities : 1 m after the interconnection bellows, 50 cm after the magnetic centre



Zoom on Q8R5

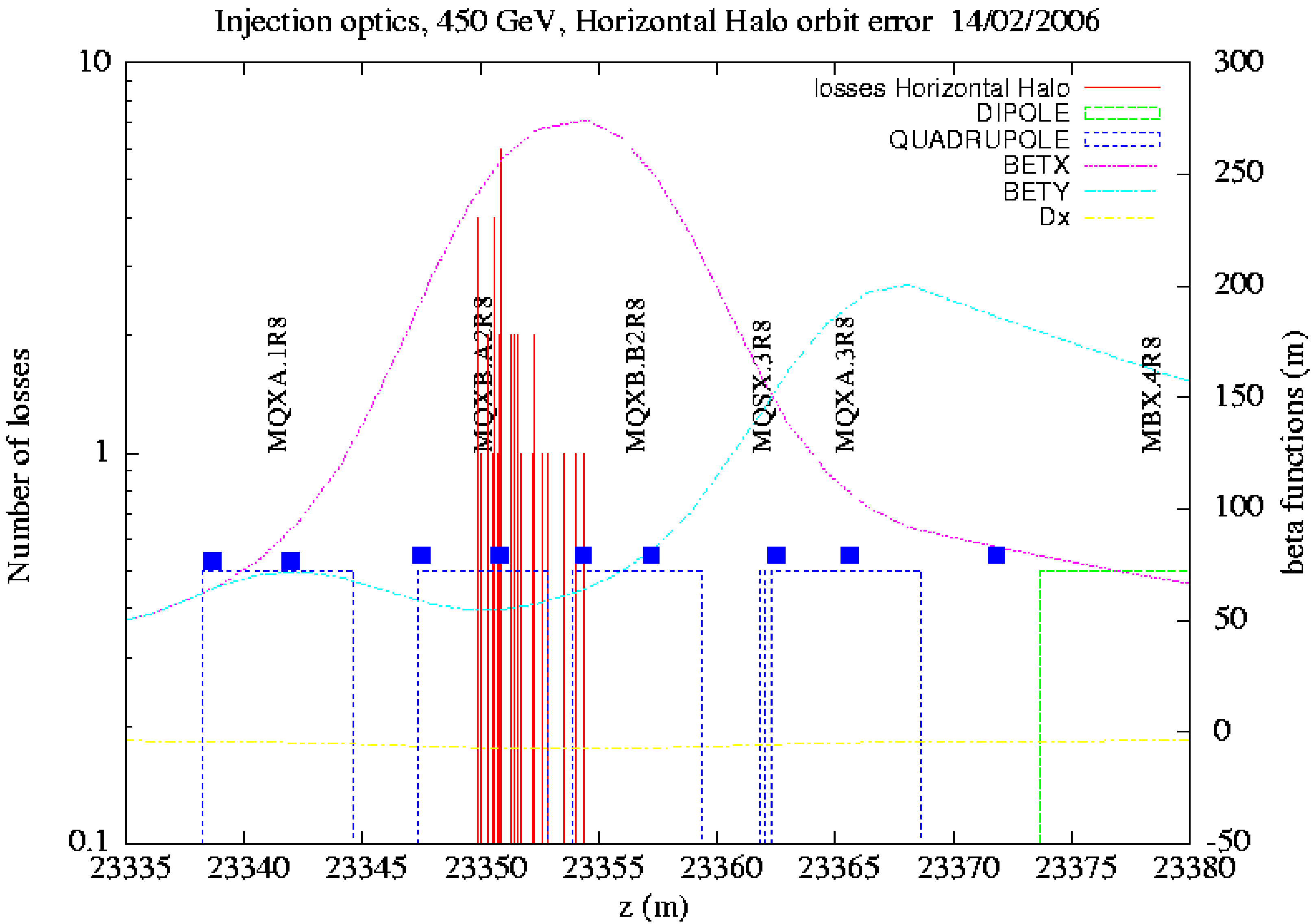


Position in the IRs

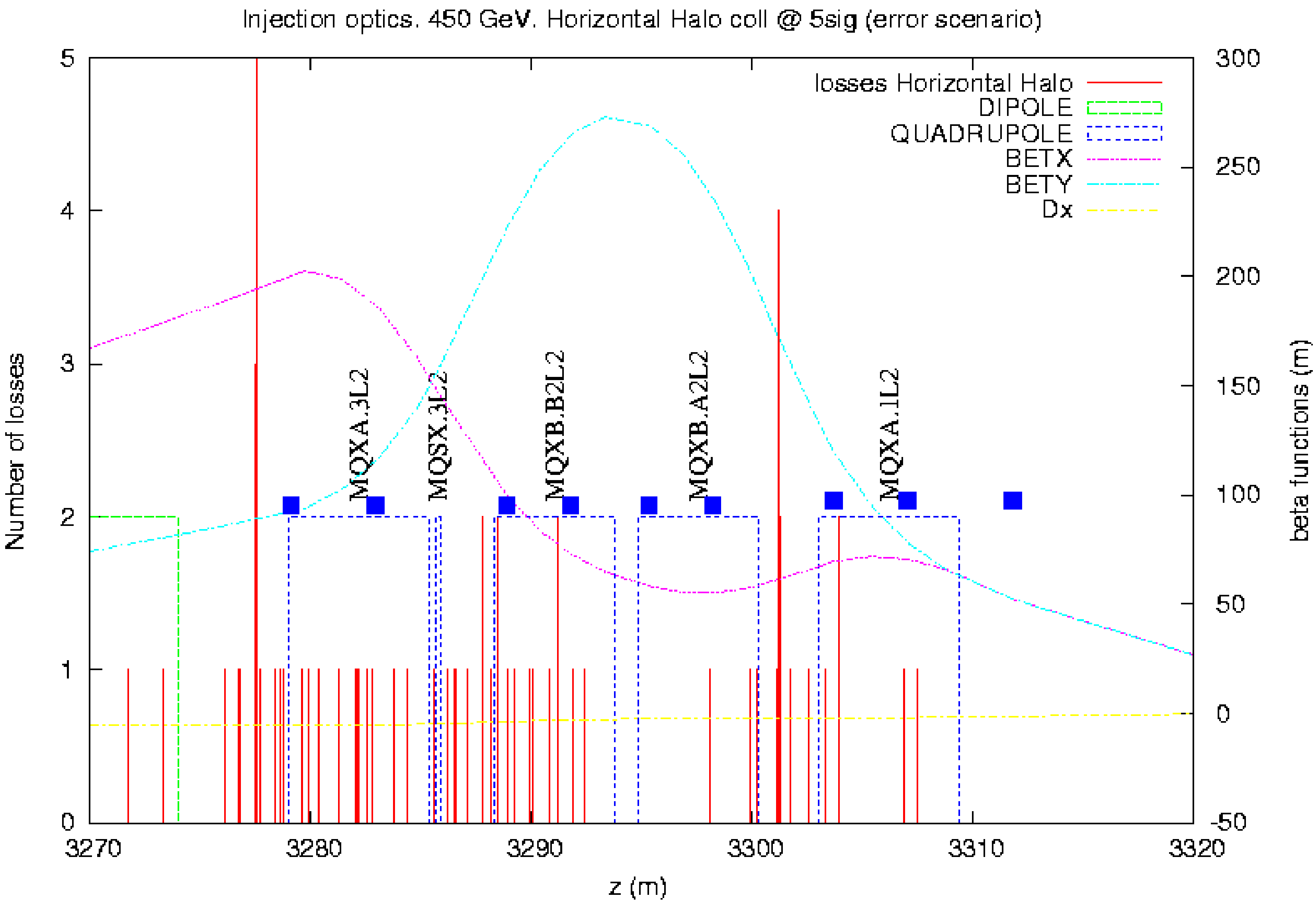


- Loss patterns has to be checked element by element
- try to keep the same configuration as in the arcs

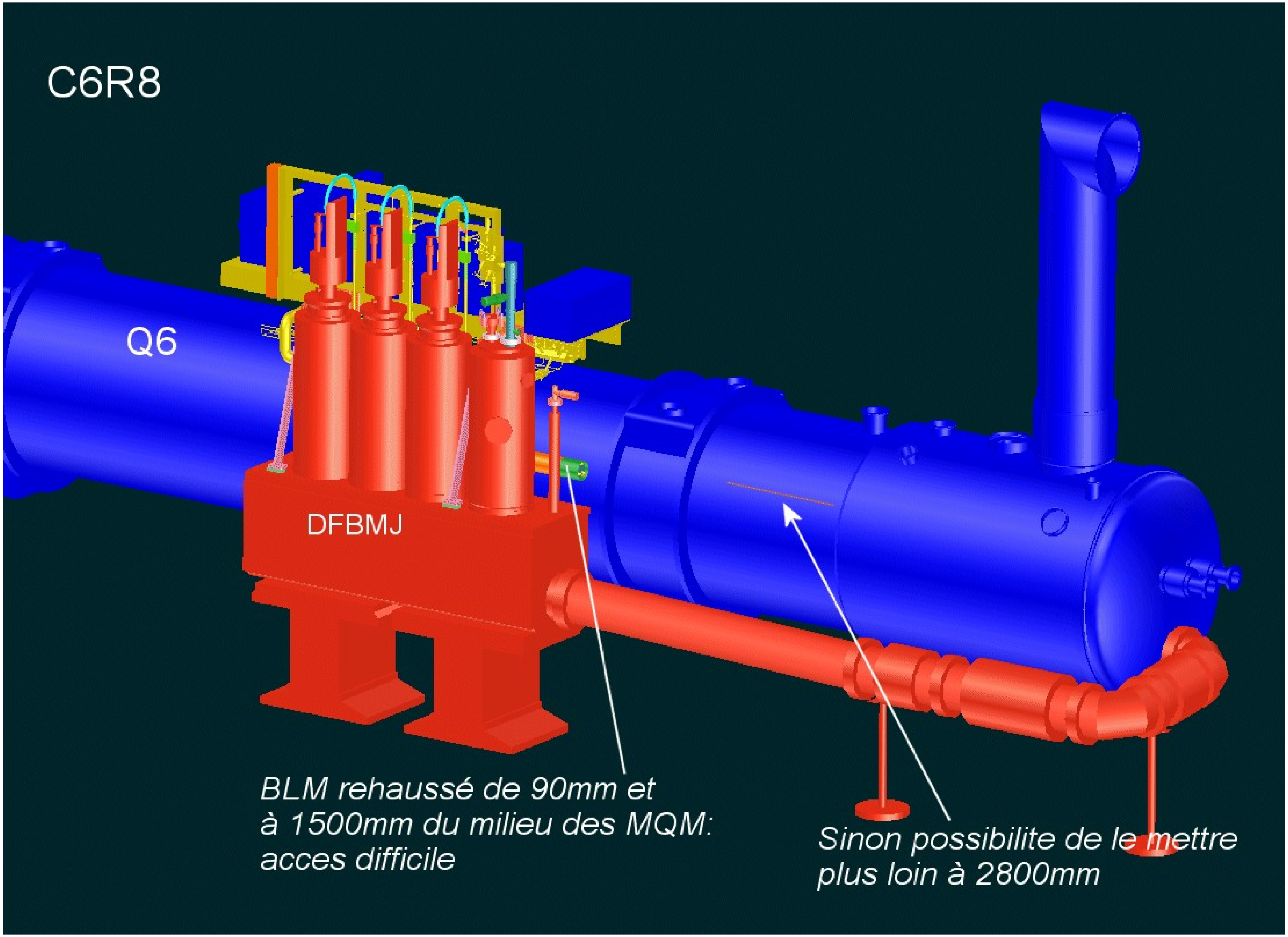
Positions at the triplets



another exemple

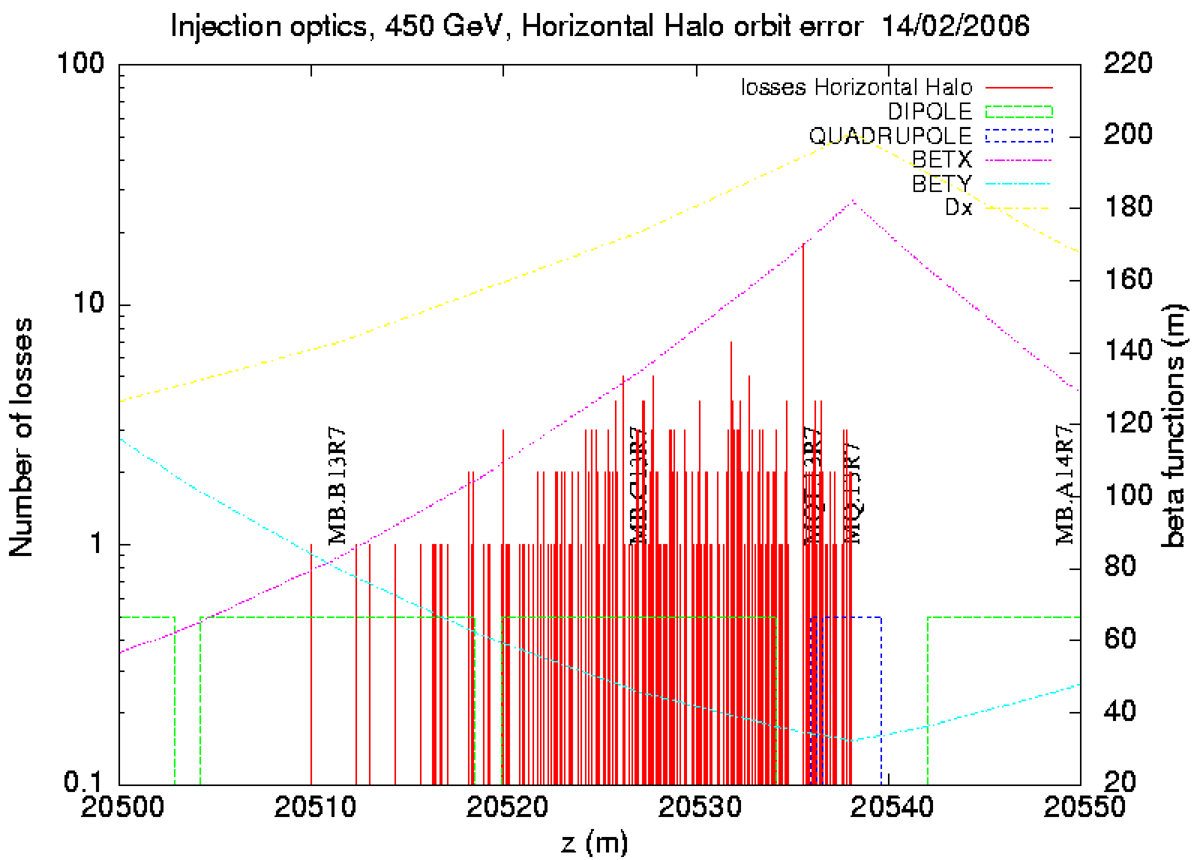


The reality!

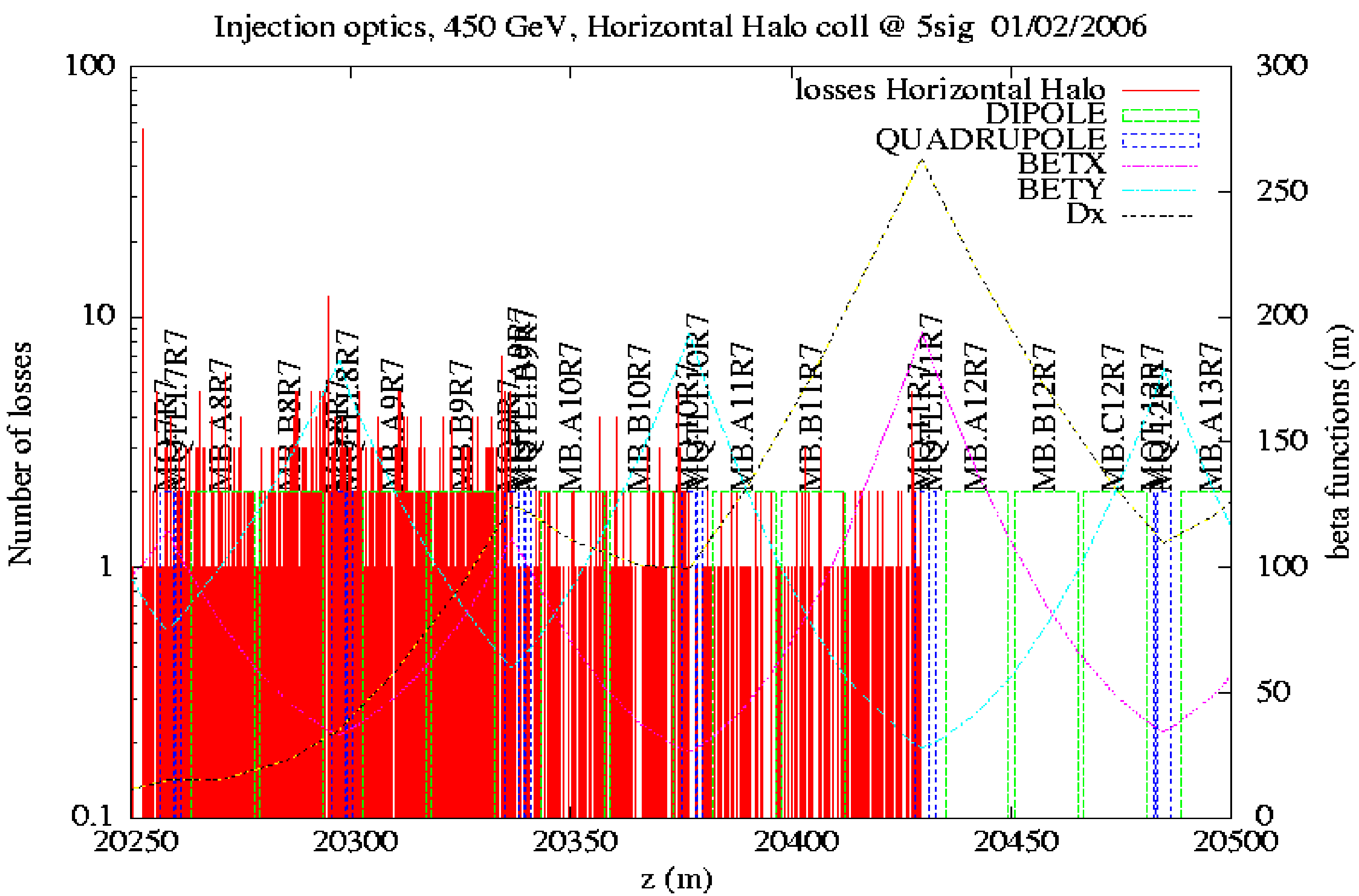

C6R8
Q6
DFBMJ
BLM rehaussé de 90mm et
à 1500mm du milieu des MQM:
acces difficile
Sinon possibilite de le mettre
plus loin à 2800mm

3. Some special requirements

- Additional monitors for MB.C13R7



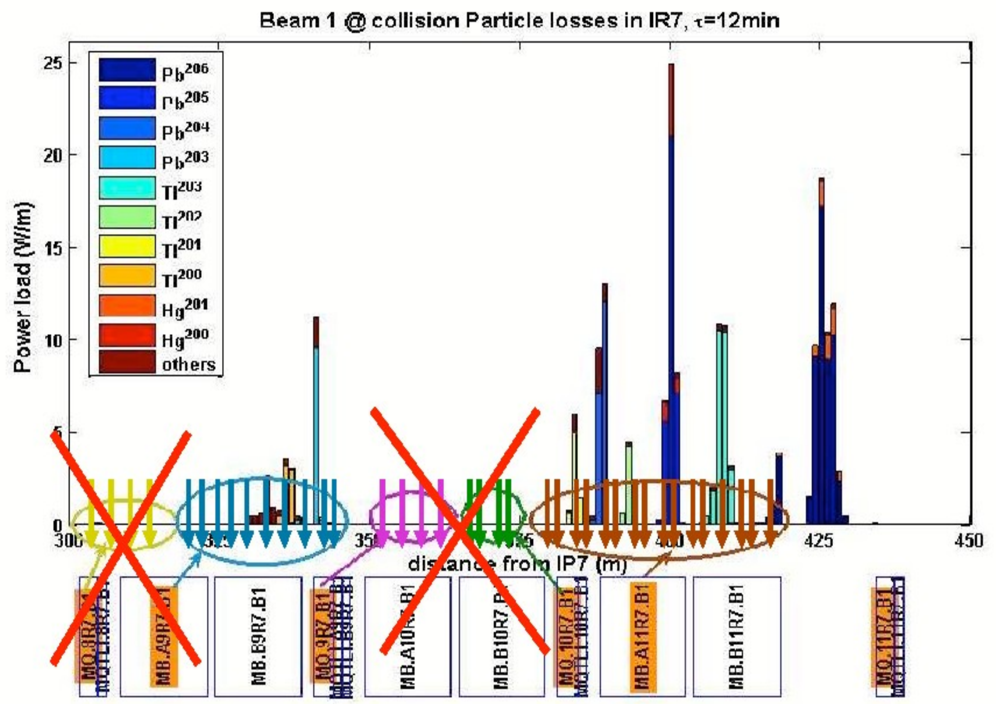
Position in the DS IR7



- peak before the MQs and losses all along the magnets

For ions:

- Some special loss locations for the ions (G. Bellodi, H. Braun):



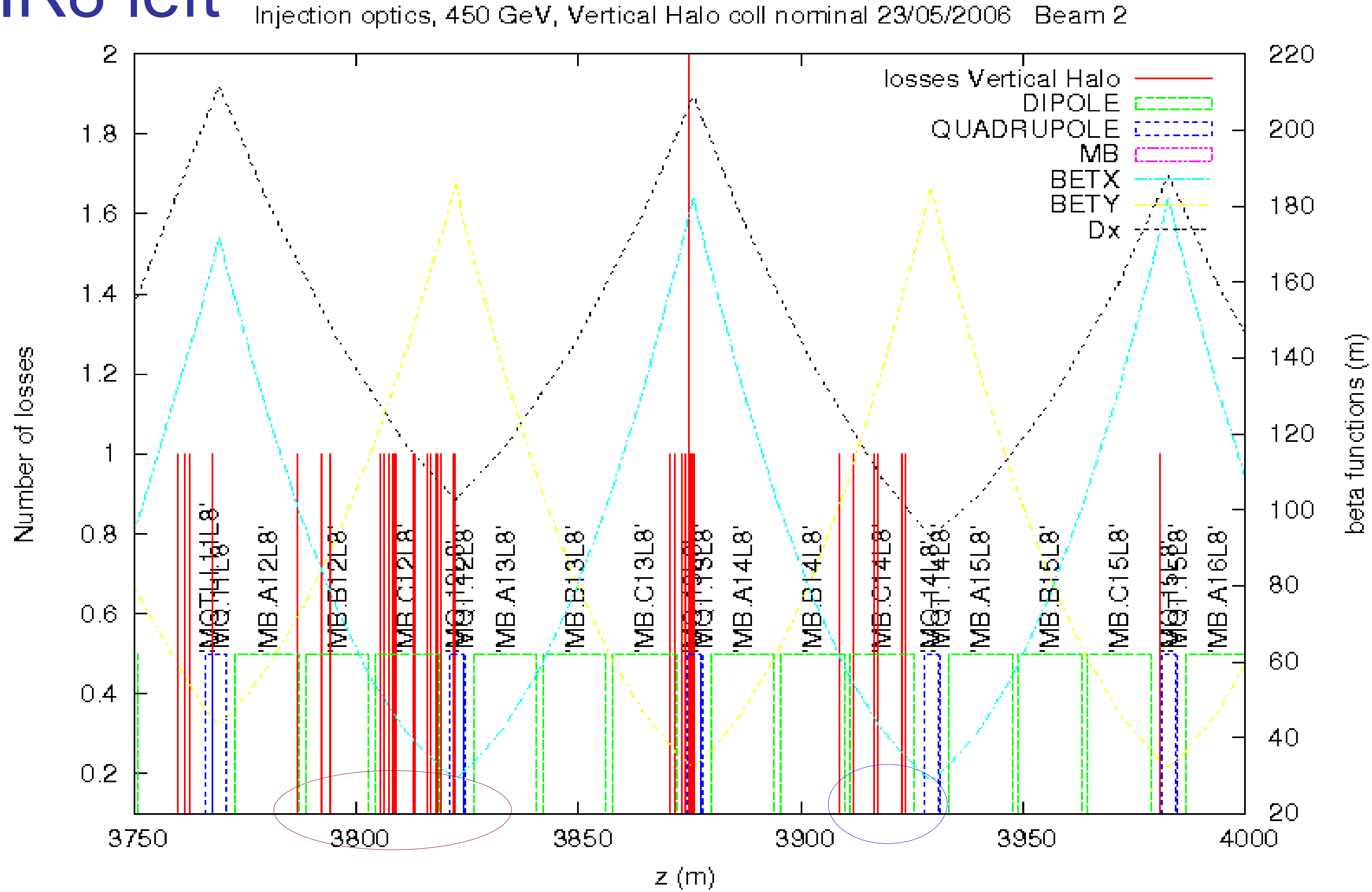
- DS IR7: additional monitors in cells 9 & 11

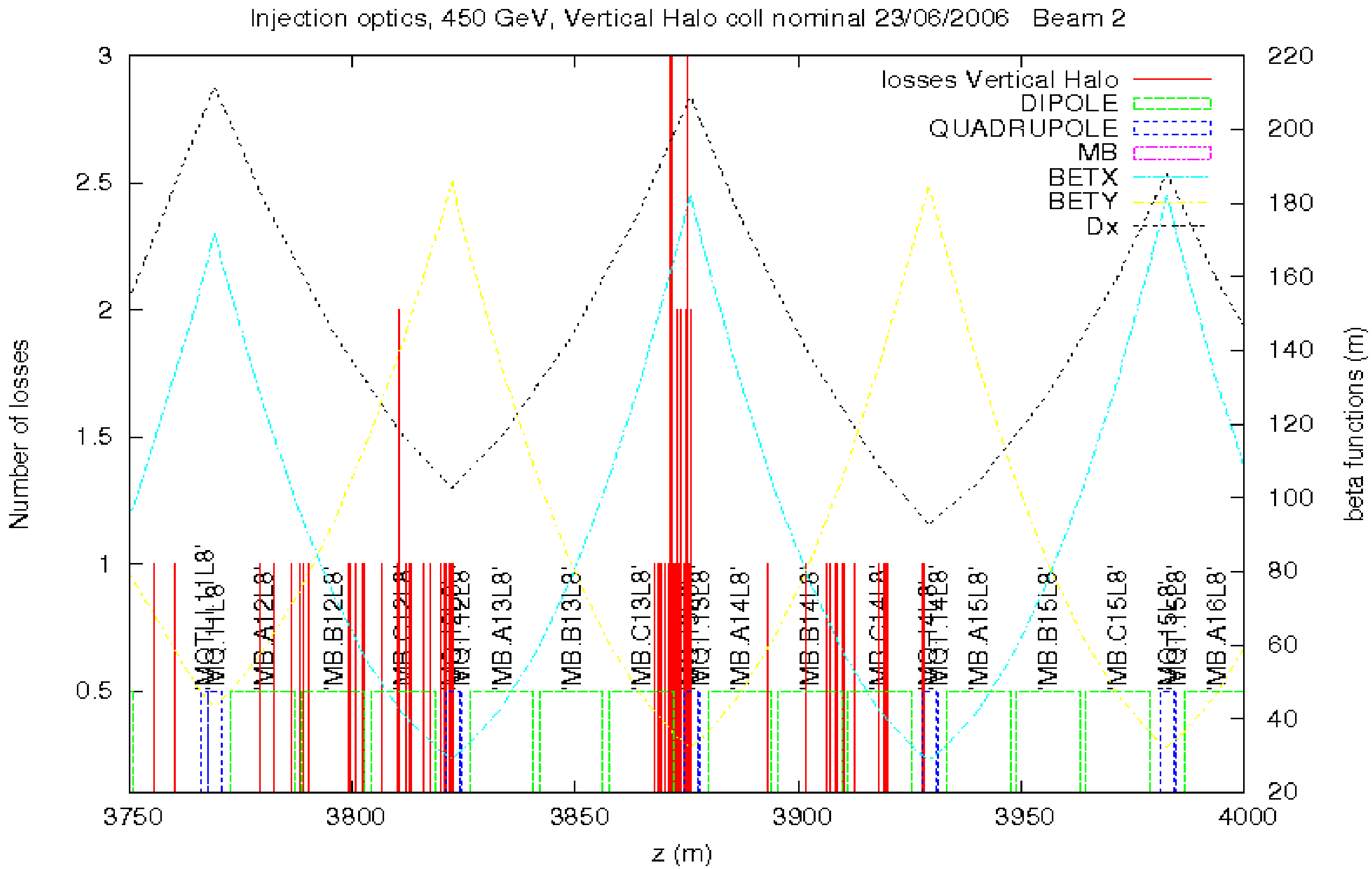
- arc region: cell 13 & 19 left

- + Electron capture by pair production (J. Jowett, S Gilardoni): cells 11 & 13 in IR1 and IR5, cells 10 & 12 in IR 2

Some new locations for beam 2??

IR8 left

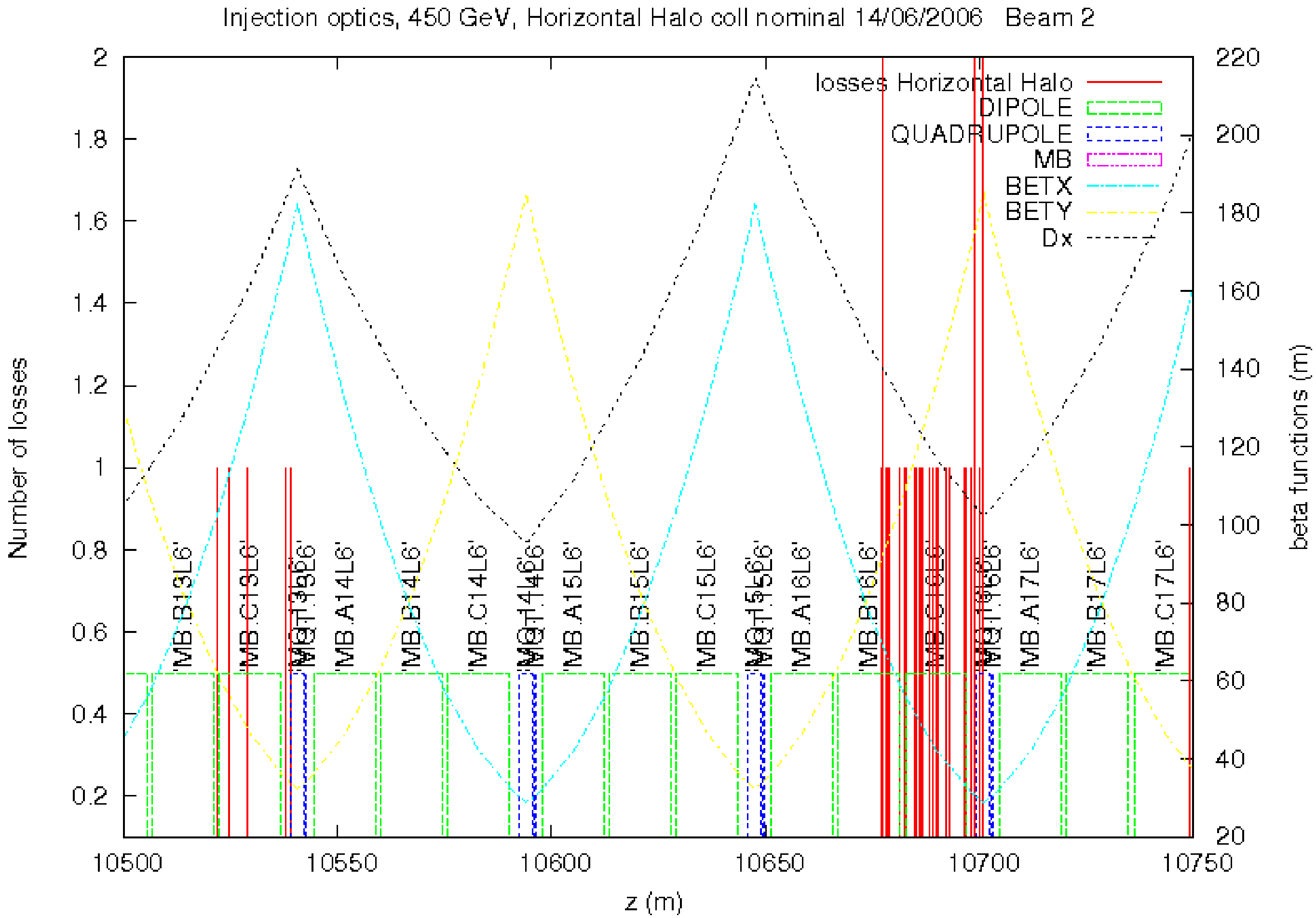




- latest simulation: pattern slightly different
- what is the change in the simulation?
- realistic case?

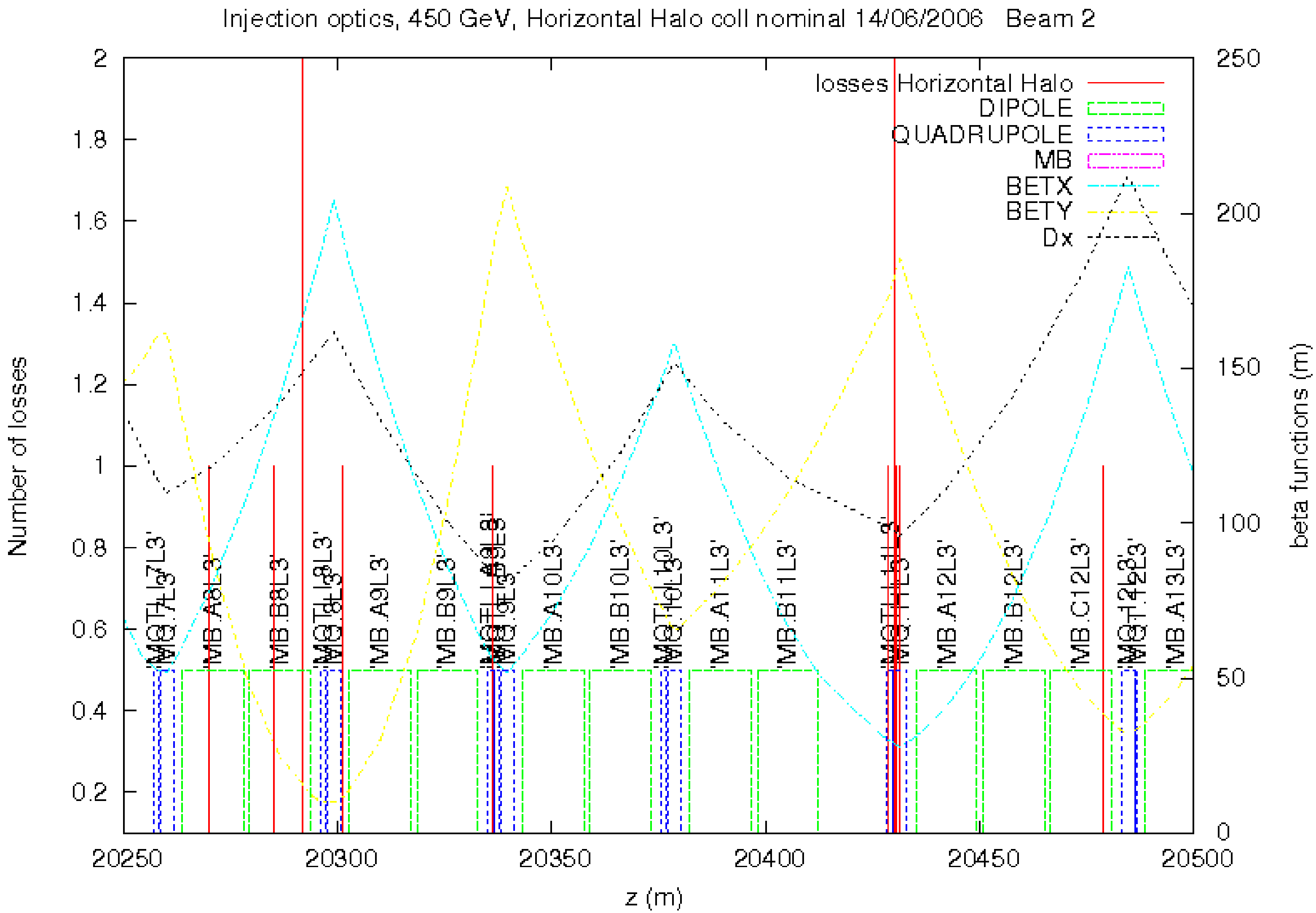
- peaks in dipole without peak in following quad : danger?
- losses induced by scattering on the TDI : not relevant after injection

IR 6 left



- losses induced by the TCDQ?
- will be “seen” by monitors on the TCDQ?

IR3 left



Injection optics, 450 GeV, Horizontal Halo coll nominal 14/06/2006 Beam 2
losses Horizontal Halo
DIPOLE
QUADRUPOLE
MB
BETX
BETY
Dx
Number of losses
beta functions (m)
z (m)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
250
200
150
100
50
0
20250
20300
20350
20400
20450
20500
'MB.A8L3'
'MB.B8L3'
'MB.A9L3'
'MB.B9L3'
'MB.A10L3'
'MB.B10L3'
'MB.A11L3'
'MB.B11L3'
'MB.A12L3'
'MB.B12L3'
'MB.C12L3'
'MB.A13L3'

Conclusions

- Positions for the arcs and dispersion suppressors: 6 monitors per quad (3 per beam)
- Positions in the IR to be finalized, based on same rules, but the integration has to be done element by element
- Some special requirements added. Some more?
- need loss maps with B-beating + orbit bumps + error scenarios for completeness of machine protection