Study of Inelastic Beam Gas for FCCee (mostly for FCCee Z 45.6GeV/beam in this presentation)

O. BLANCO, M. BOSCOLO, H. BURKHARDT
F. COLLAMATI, M. LUCKHOF

FCCee MDI Meeting #15
2018/March/06

First results of Inelastic Beam-gas scattering for the Z run with latest optics
Monte Carlo particle tracking simulation is performed using the MDISIM tool
→ Loss map and loss rates are obtained.

Results will be shown for:

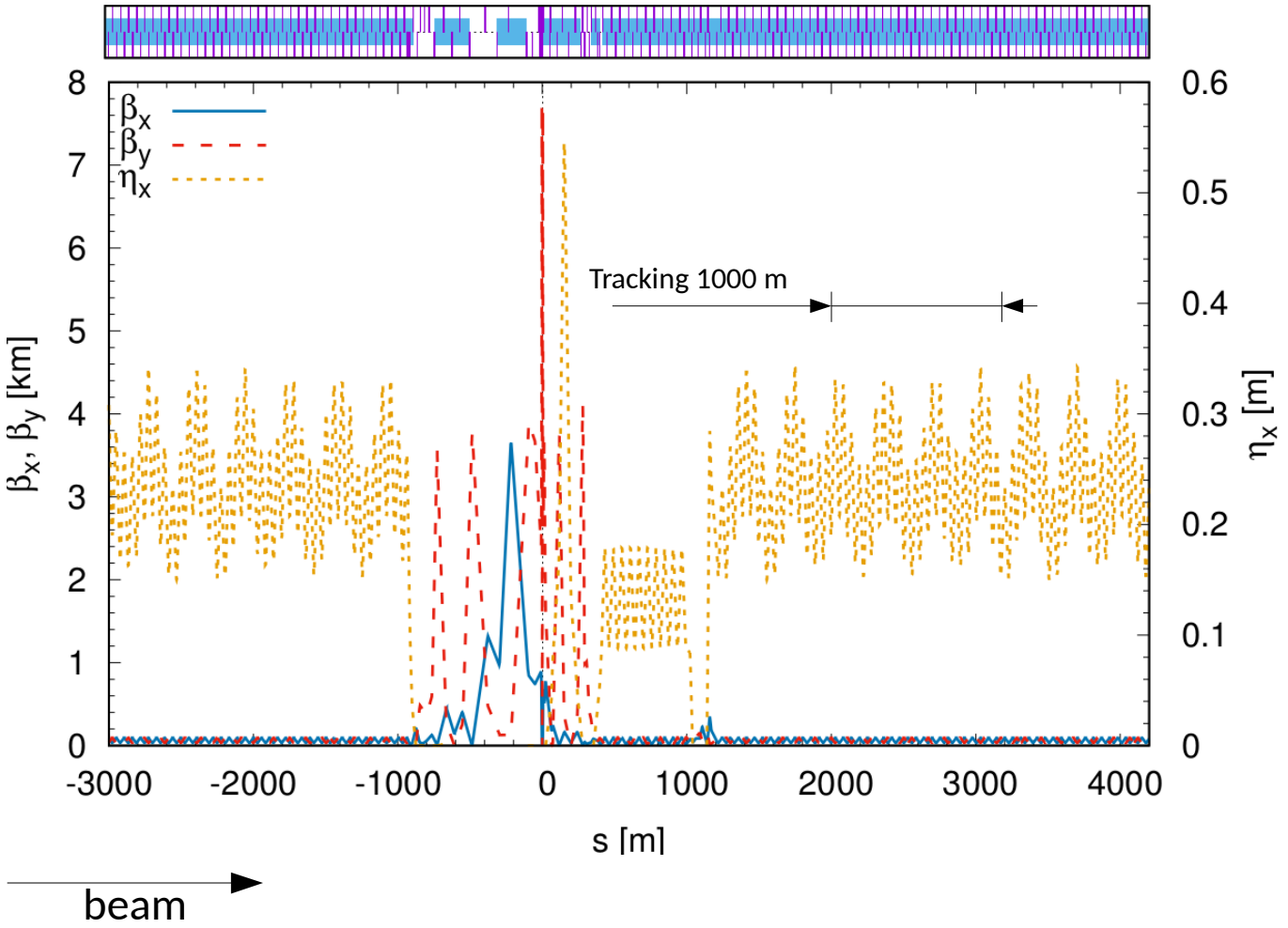
1) arc only at the Z to compare with analitical results
   Gas of H2 and N2 has been considered for now.
2) IR at Z, H, W. I show plots for the Z
   Gas of N2 has been considered for now.

- Note that SR is not considered in the simulation.

Z 45.6GeV/beam
arc

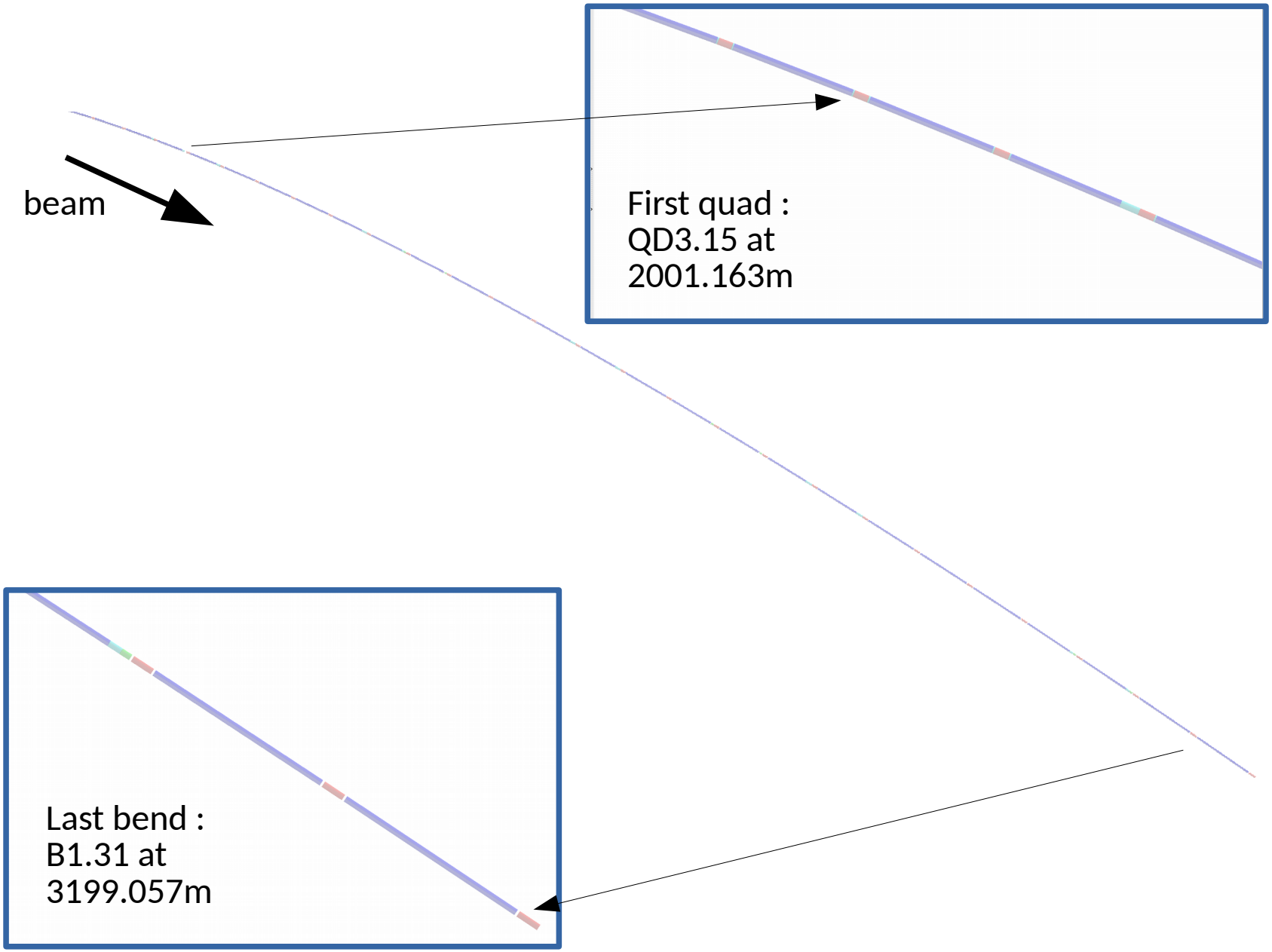
FCCee arc Z 45.6GeV/beam

Lattice : FCCee_z_213_nosol_4.seq (ZOOM)



Constant aperture : 35mm

FCCee Z geometry scalexy 50 :
(scalexy 1 is not displayed correctly, but IS used for the tracking studies)
Tracking starts at 2000m and ends at 3200m = 1200 m in total



WHAT IS THE PARTICLE LOSS RATE IN THE ARC ?

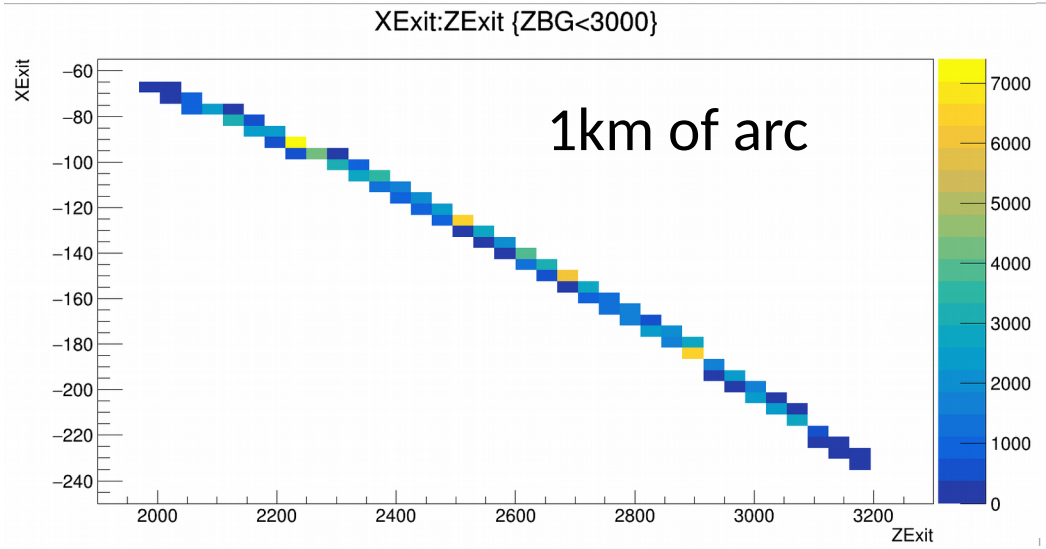
At 45.6GeV/beam : Npart = 1.7e11
Nbunches = 16640

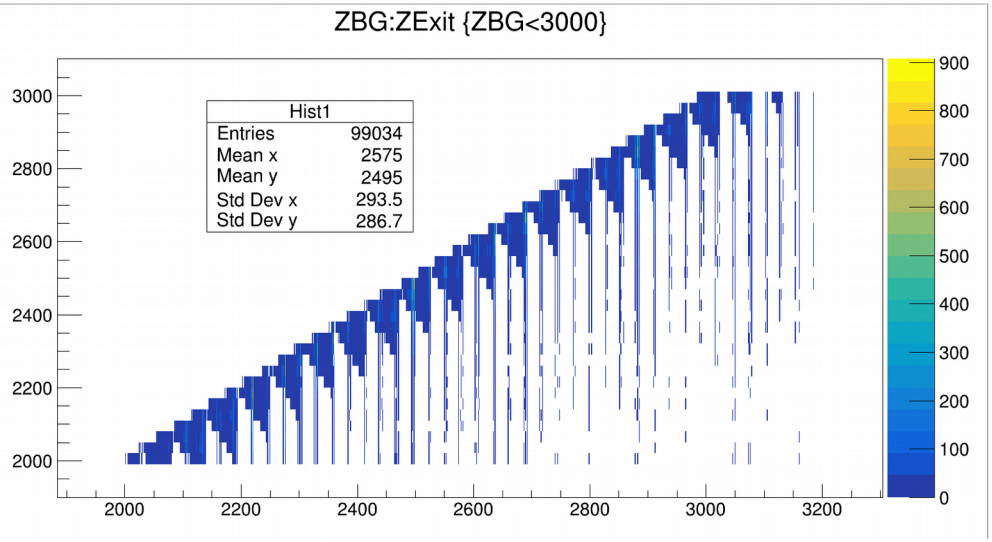
With an energy acc. of 2% and pressure of 10^{-9} mbar

	Scattering Rate/m/beam	
	Expected	Simulation
H2 : 0.328 barn	6.7 KHz	6.2 KHz
N2 : 9.386 barn	192.3 KHz	189.1 KHz

As reference τ=100h → Scattering Rate = 78.6 Khz/m/beam

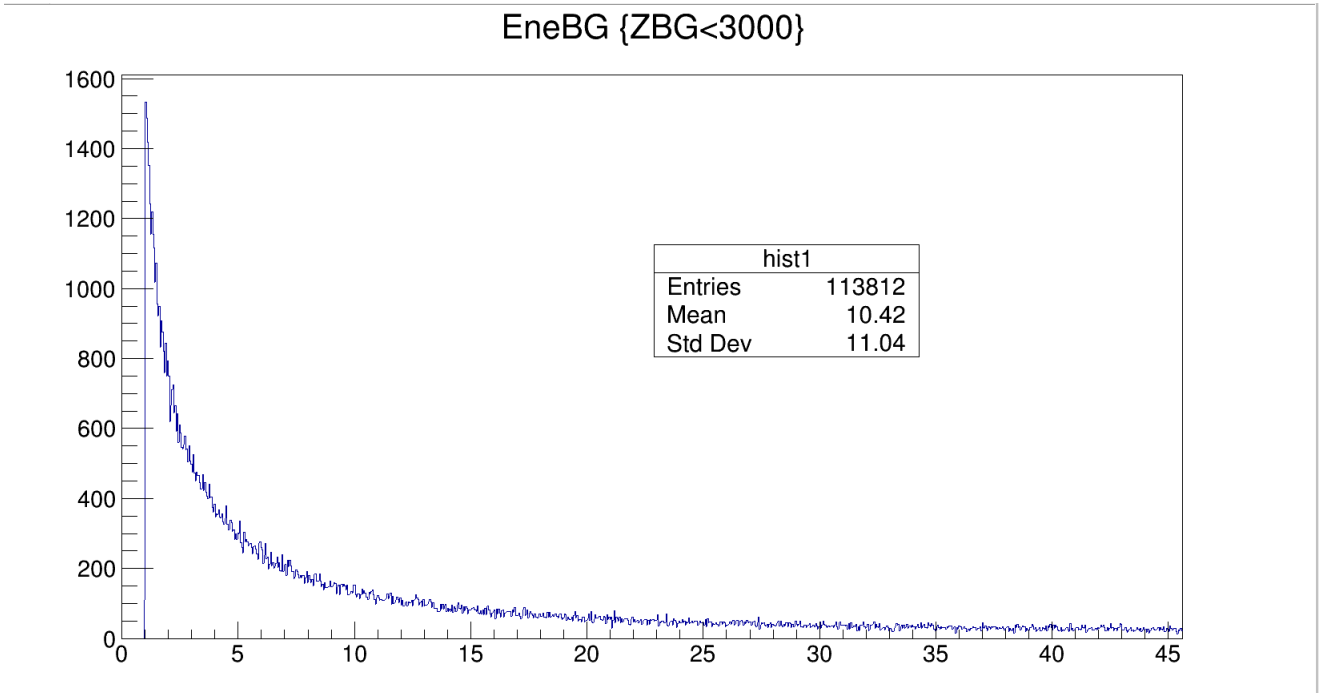
Beam gas particles generated in the arc are lost very soon, in the arc dipoles
100m~200m after interaction





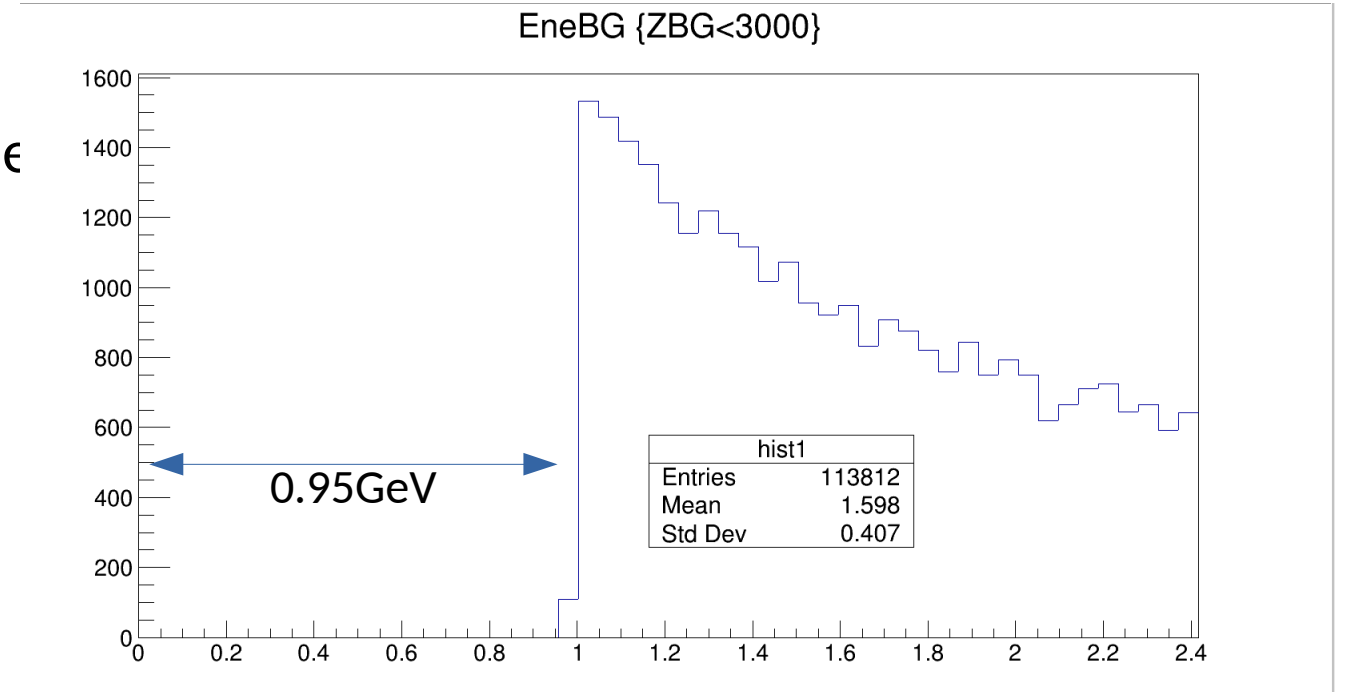
ENERGY EXCHANGE BETWEEN e- and gas ?

Energy loss
In the Beam Gas
event :



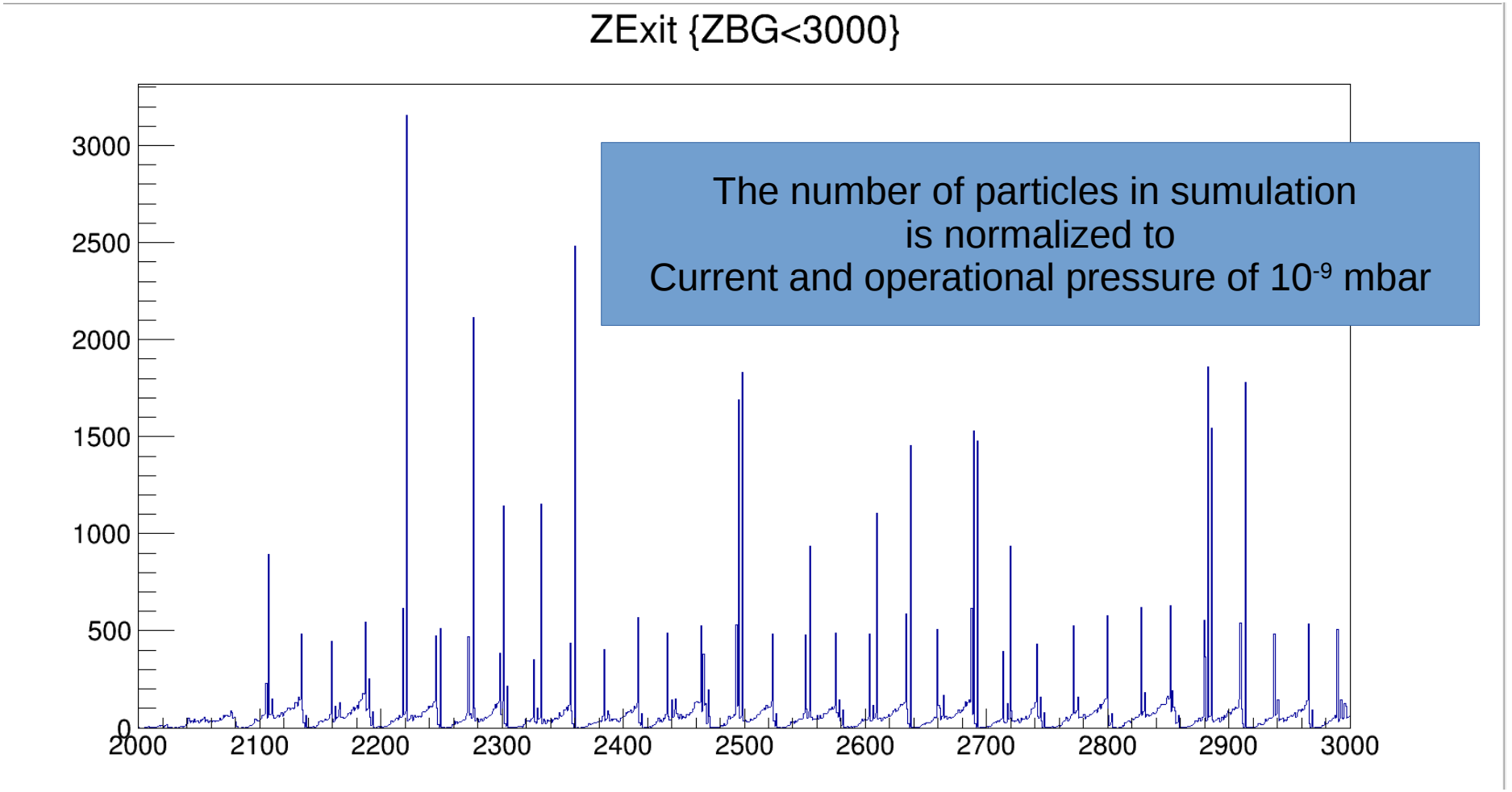
Particles loosing less
Than 0.95GeV continue
In the beam

Energy acceptance
0.95GeV , i.e.
0.95/45.6 = 2.1%



LOCATION OF PARTICLE LOSS ?

Particle distribution
Along Z :
Somehow uniform distribution of the particle loss

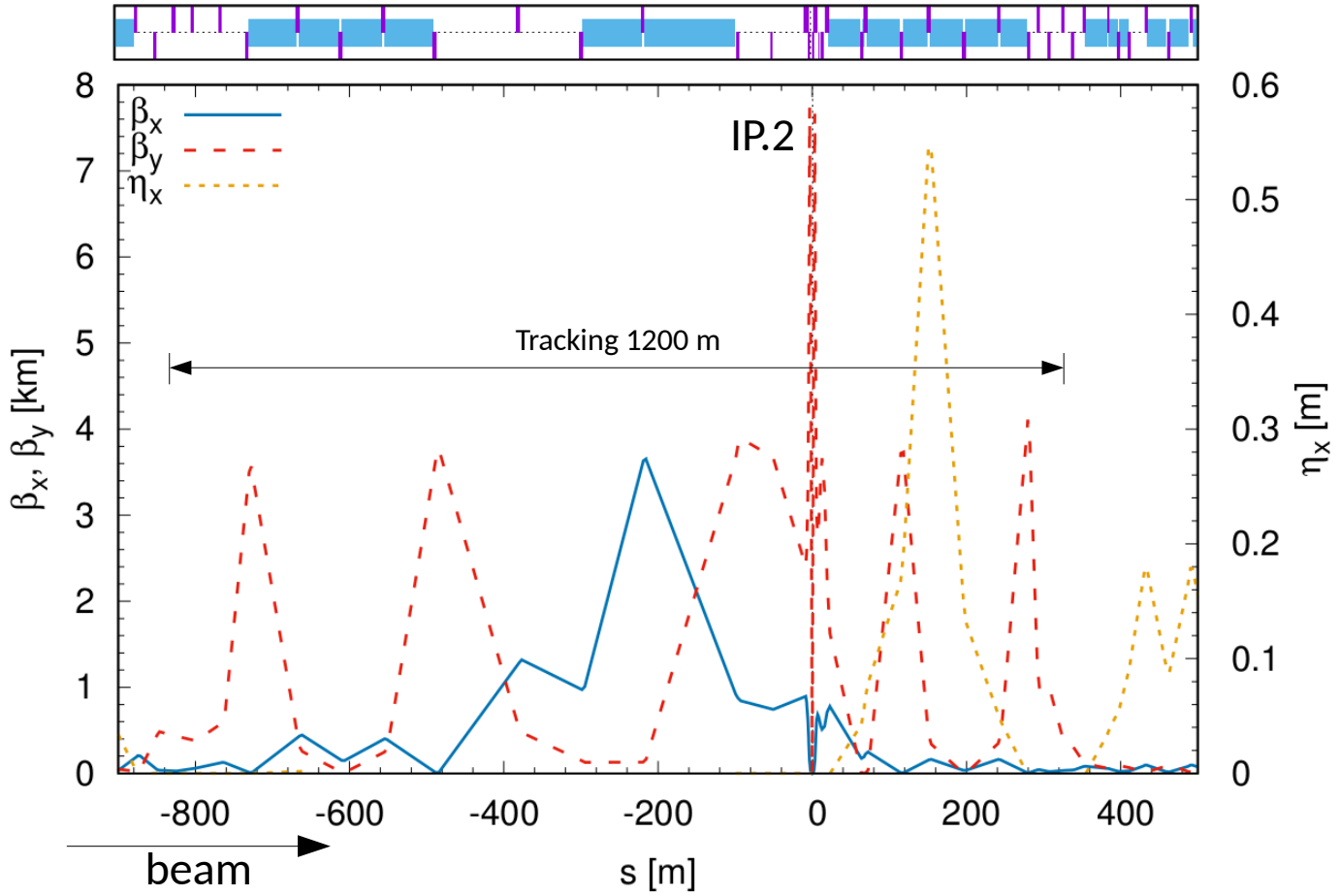


Z 45.6GeV/beam
MDI Region

at all energies the scattering distribution is similar, BUT, rate differs

FCCee Z 45.6GeV/beam

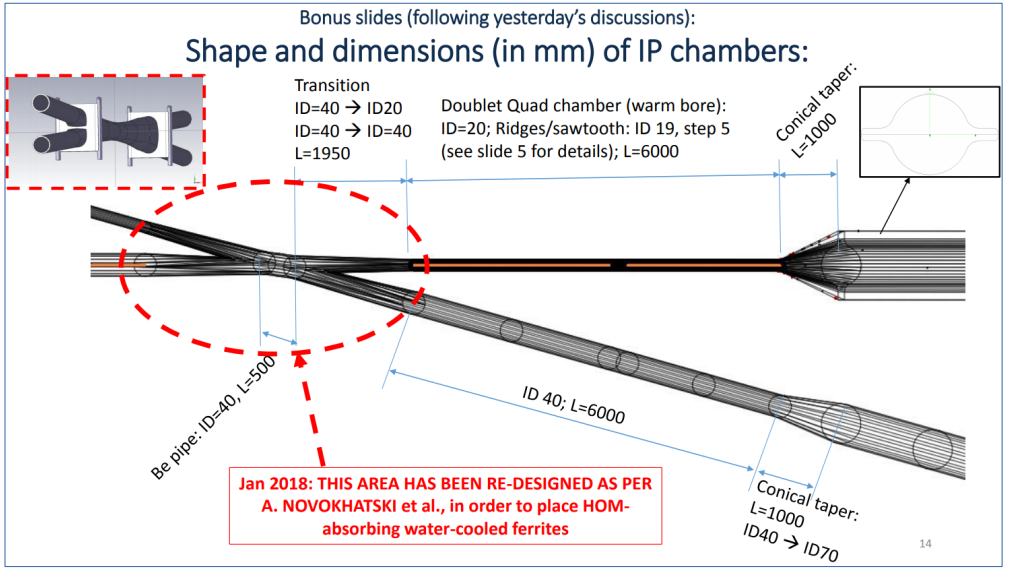
Lattice : FCCee_z_213_nosol_18.seq (ZOOM)

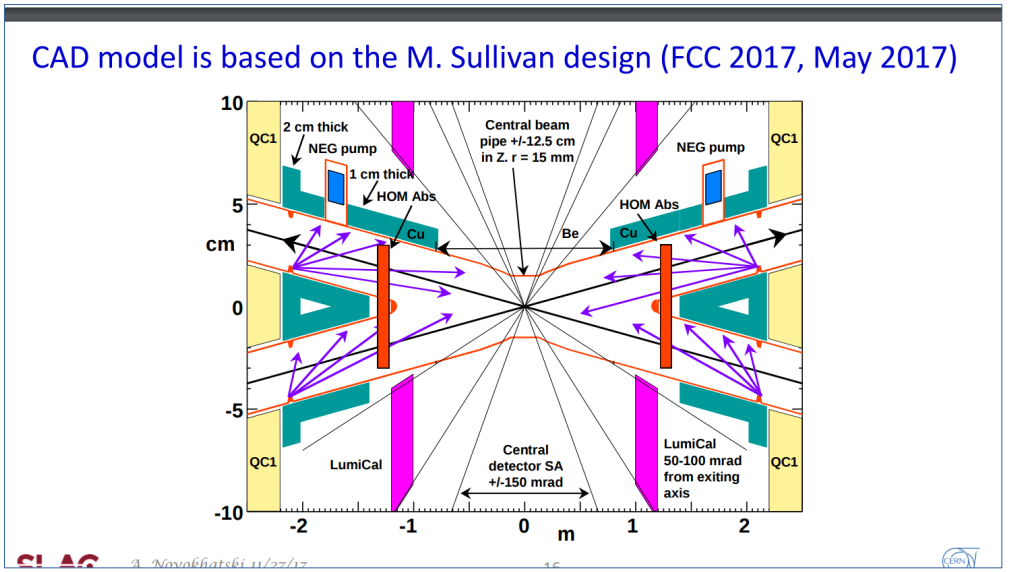


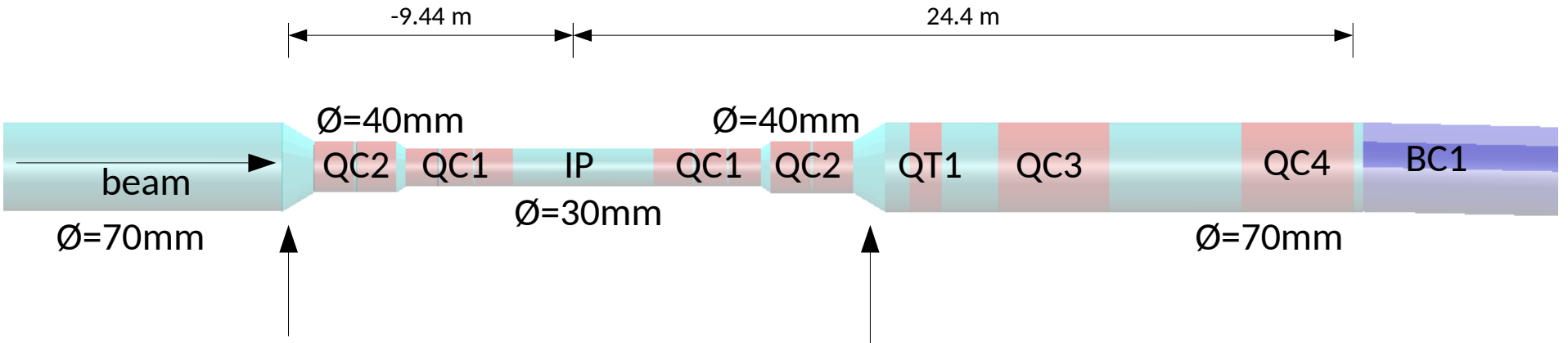
We consider to study from s=-830m to s=370m

Conical Tapers from Kersevan. IR Vacuum Concept.
Workshop on the Mechanical optimisation of the FCC-ee MDI
https://indico.cern.ch/event/694811/timetable/

The details between QC1's have been ignored for the moment

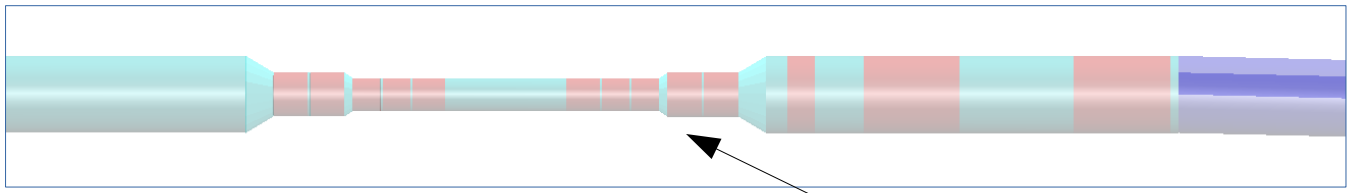






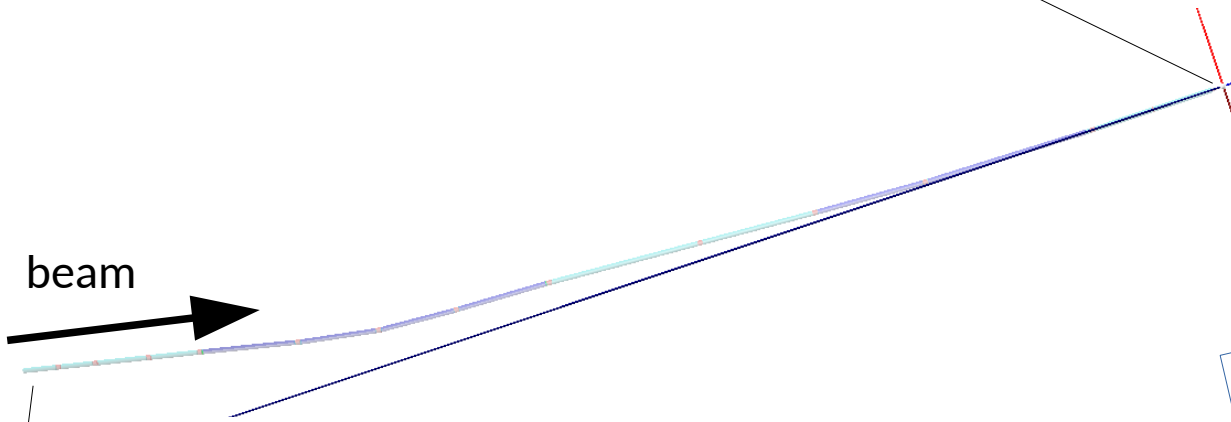
1m of conical taper between pipe diameters of 70mm and 40mm

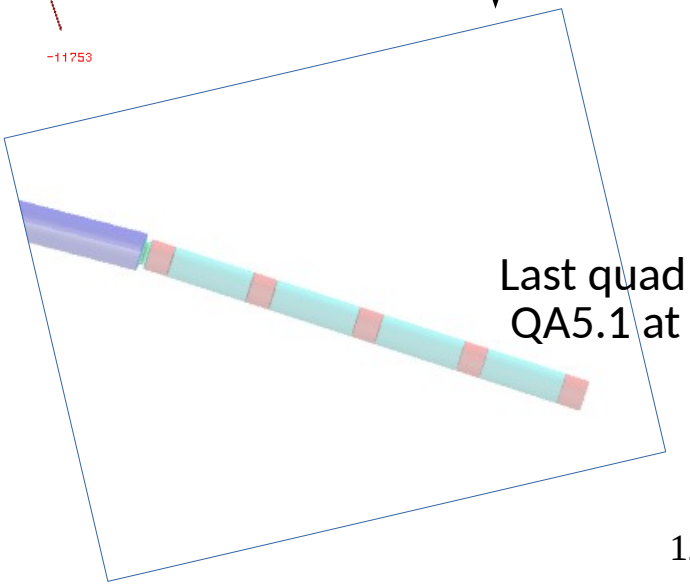
FCCee Z geometry scalexy 50 :
(scalexy 1 is not displayed correctly, but IS used for the tracking studies)
Tracking starts at -830m and ends at 370m = 1200 m in total



IP at 0m

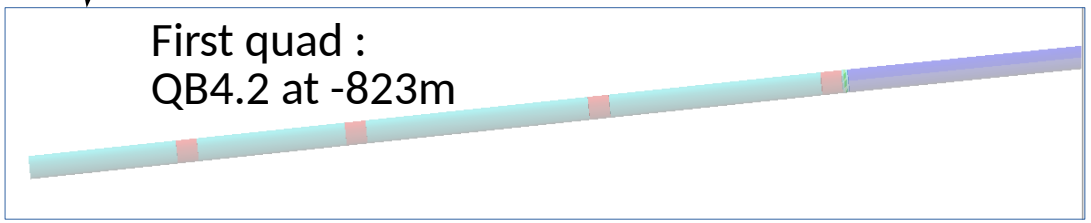
beam





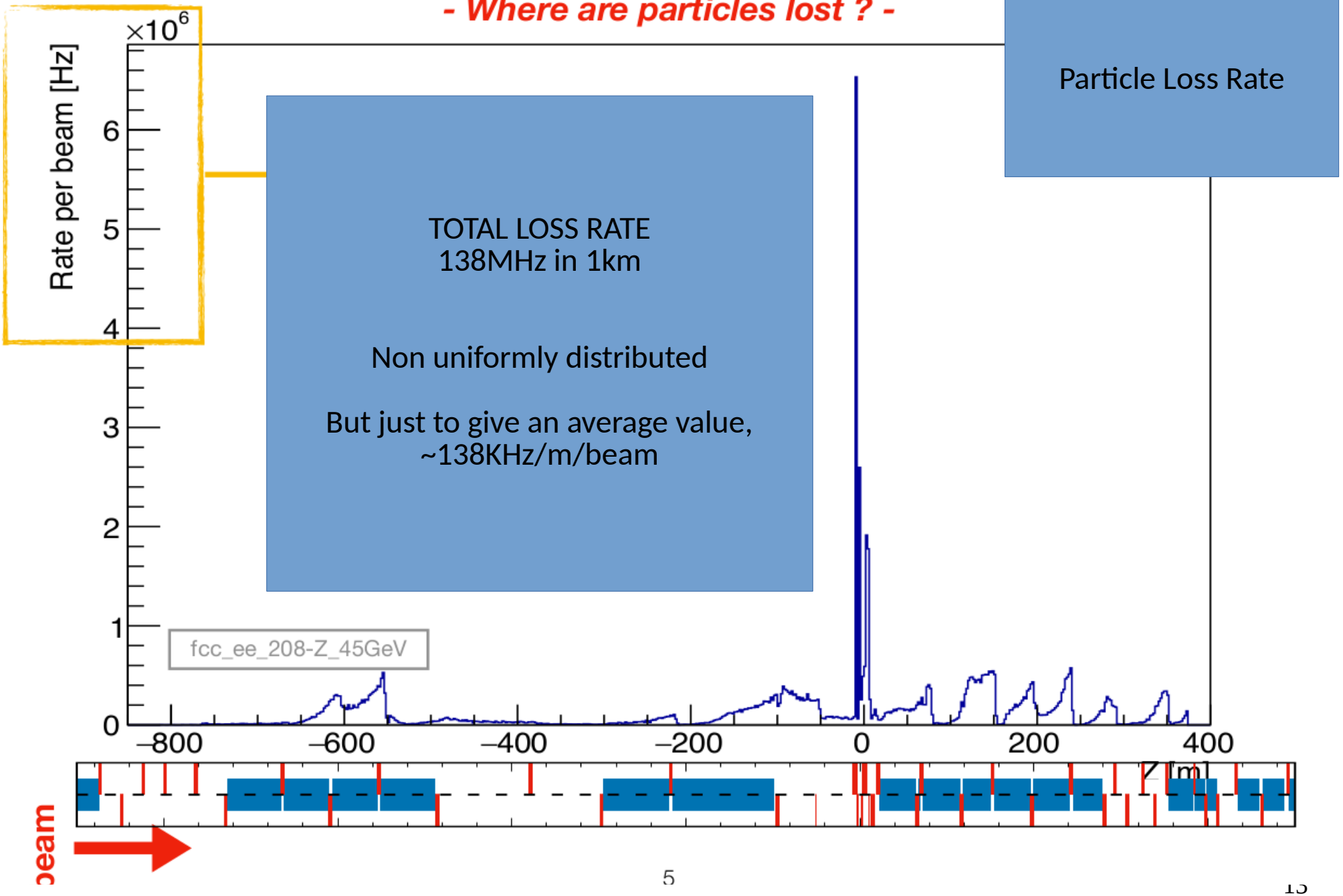
Last quad :
QA5.1 at 336m

First quad :
QB4.2 at -823m



Z "loss map"

- Where are particles lost ? -



Particle Loss Rate

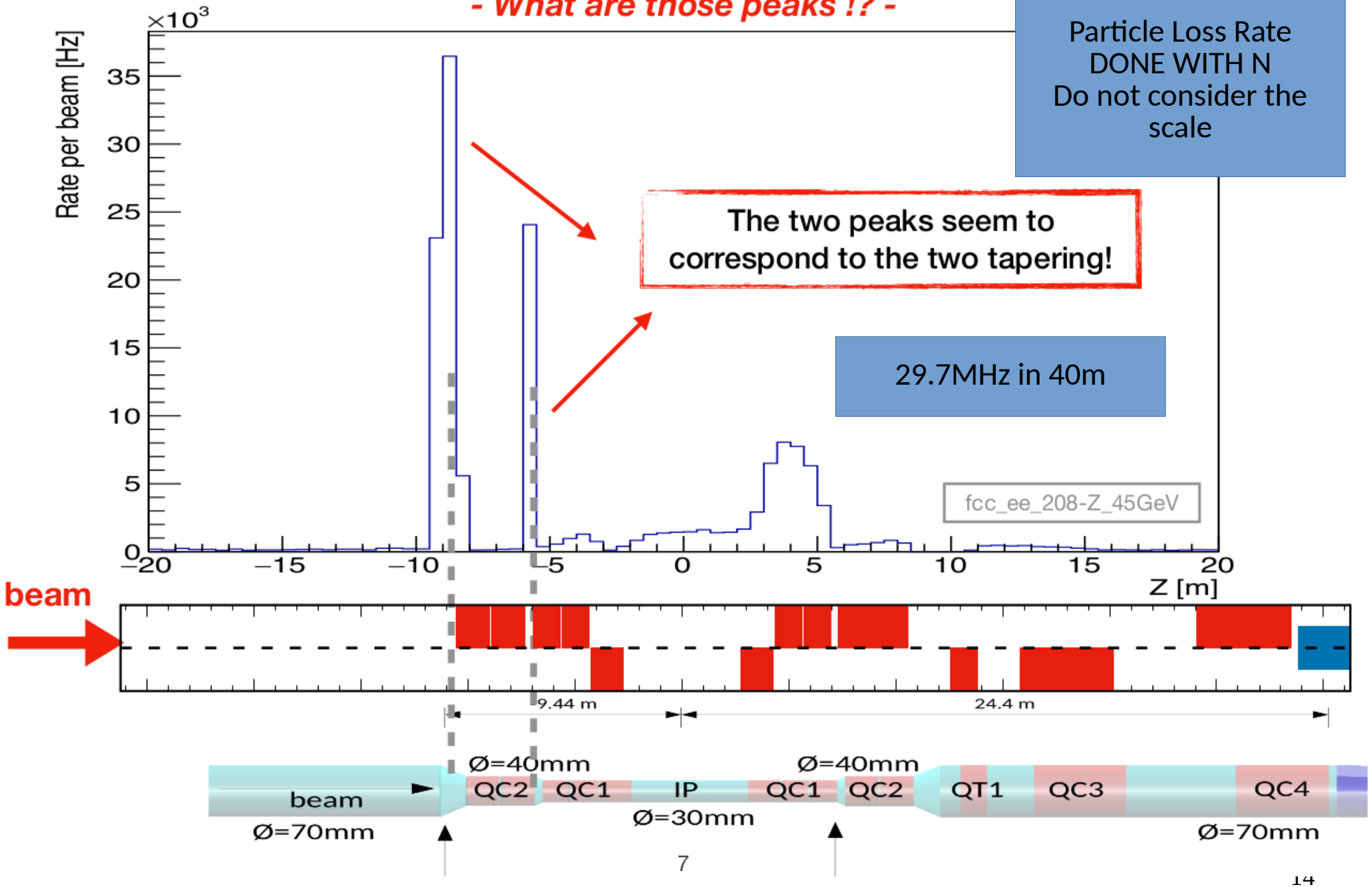
TOTAL LOSS RATE
138MHz in 1km

Non uniformly distributed

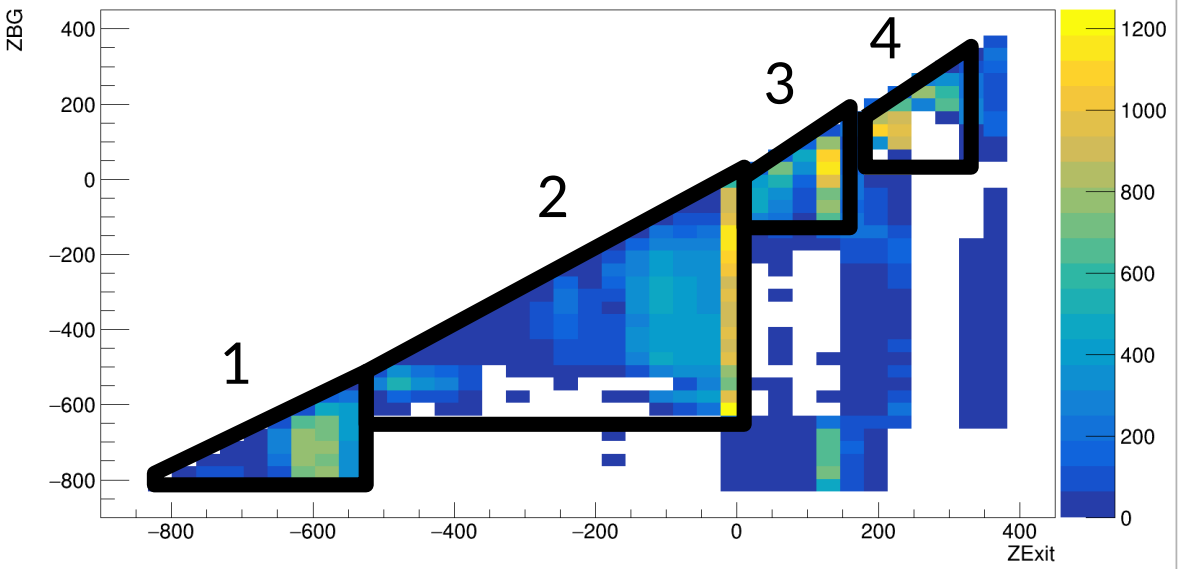
But just to give an average value,
~138KHz/m/beam

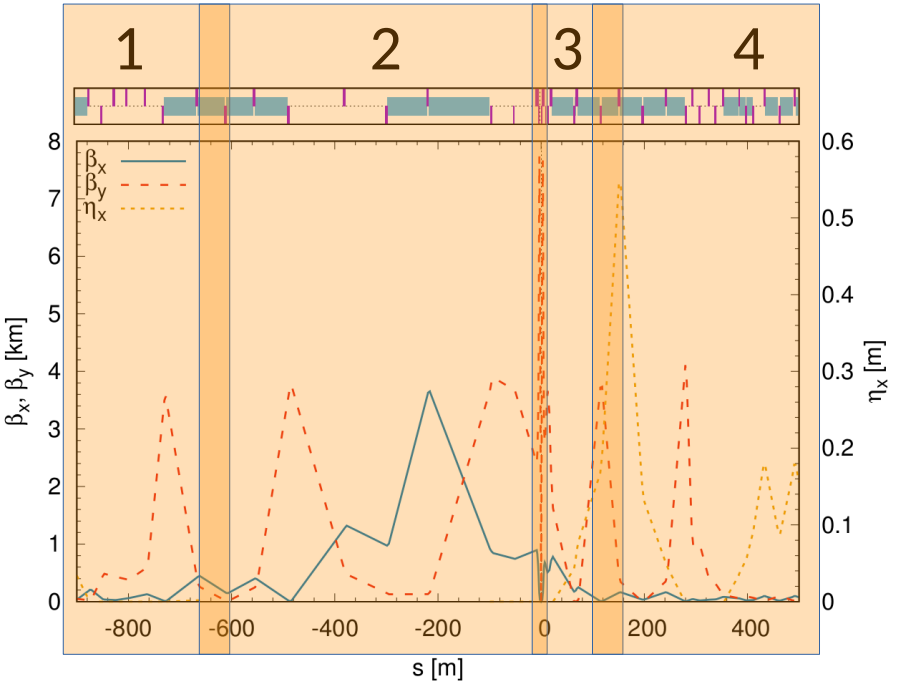
Z “loss map” - ZOOM around IP

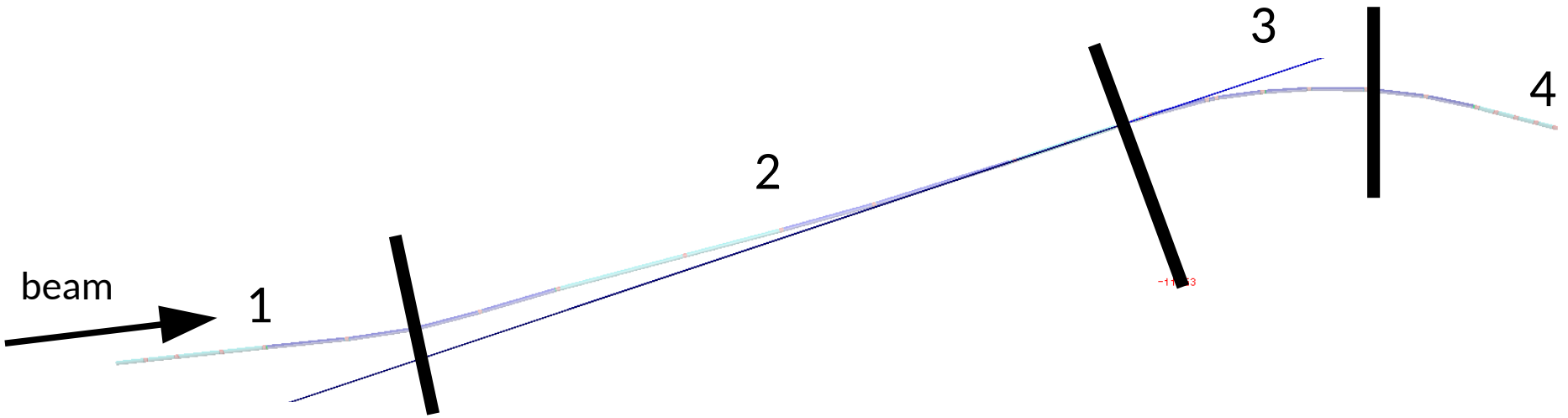
- What are those peaks !? -



Particles hitting near the IP region, AREA 2, come from -600 m upstream. The other regions show beam gas events that produce an immediate particle loss.



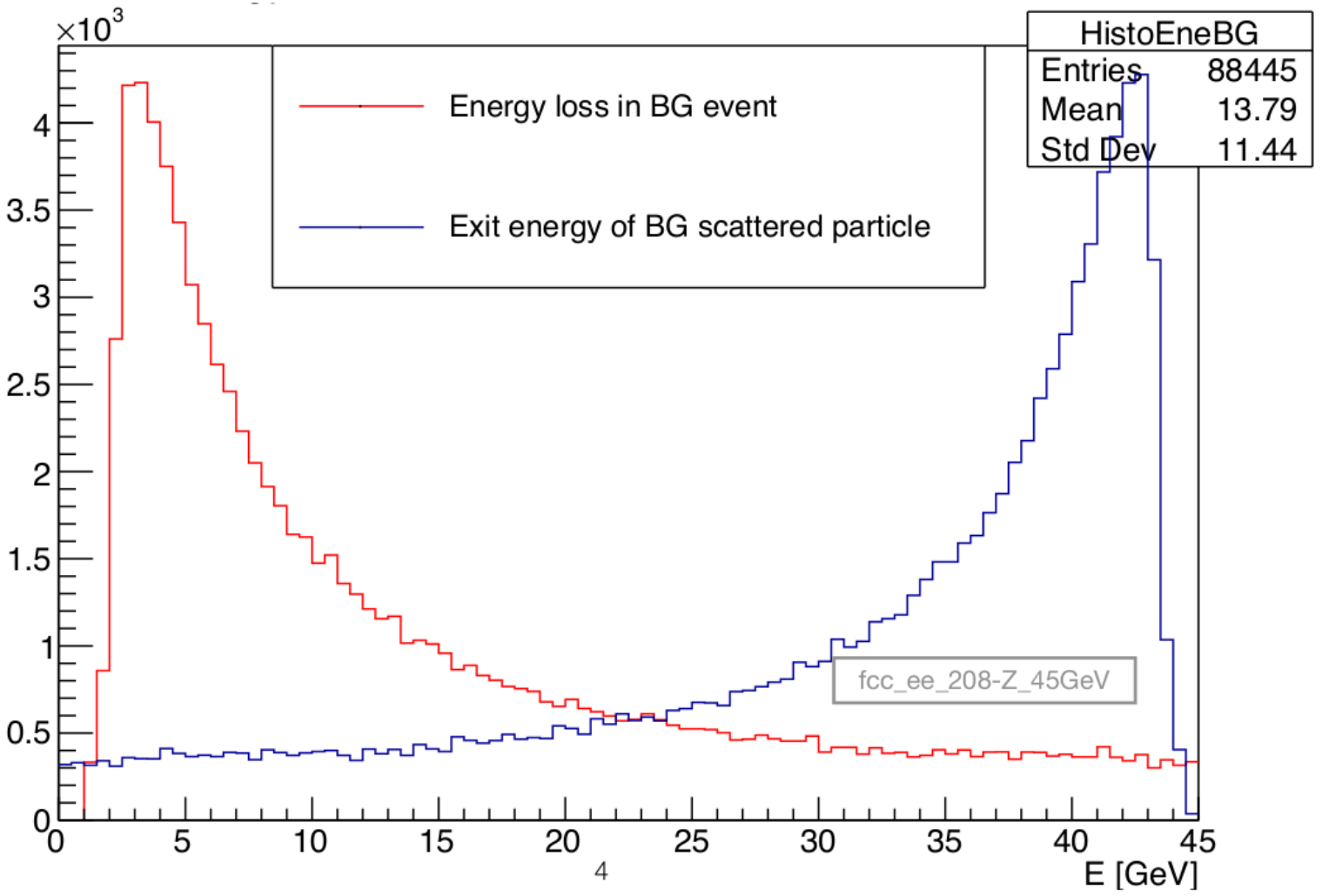




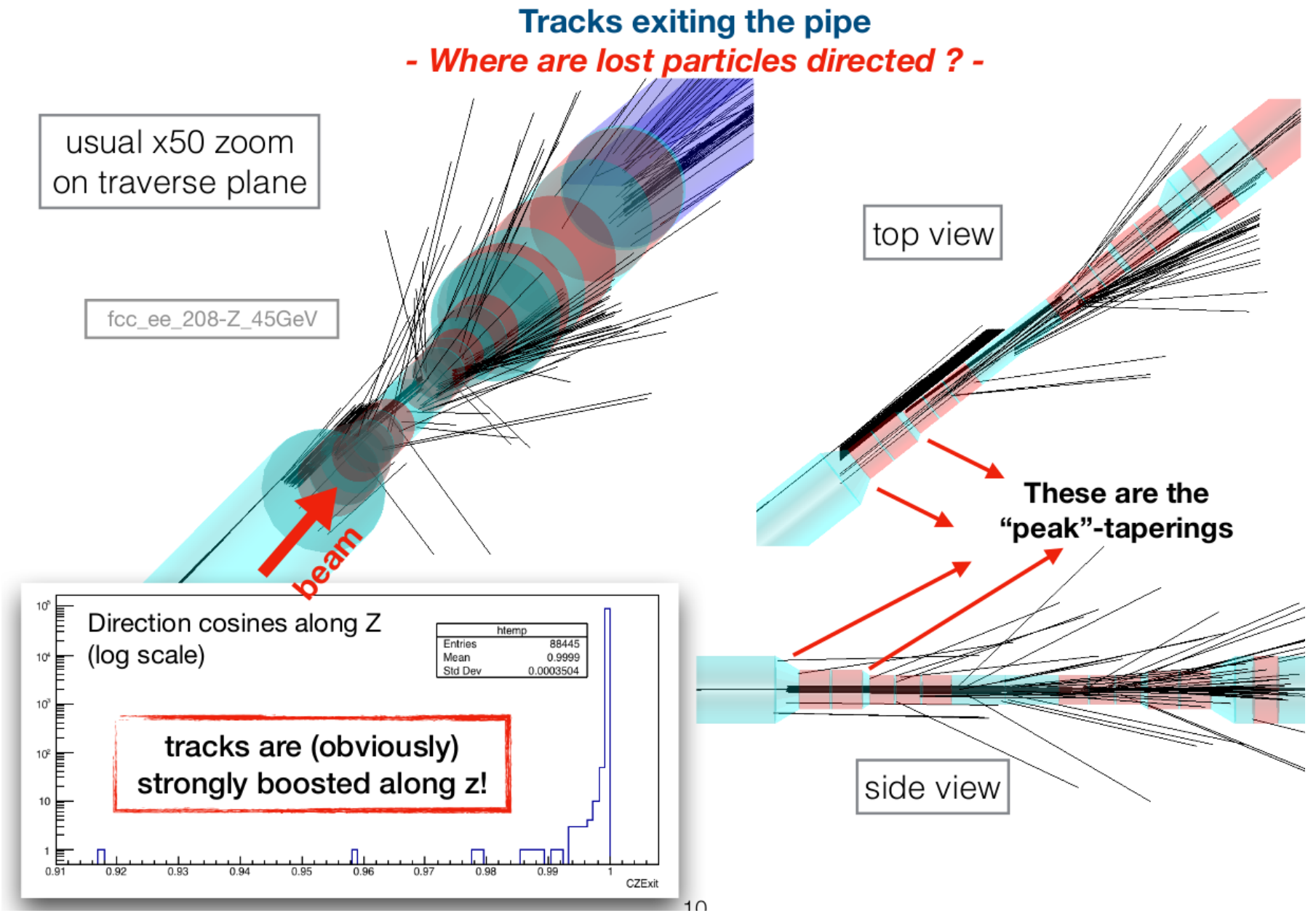
ENERGY OF THE LOST PARTICLES

Energy lost by the primary particle in the interaction with the gas molecule that led to particle loss

Energy of the particles that get lost due to BG when hitting the pipe



DIRECTION OF THE LOST PARTICLES



RATES FOR OTHER ENERGIES

Although, the rate is largely non-uniformly distributed along the MDI region, We show the equivalent scattering rates per energy with N2

	Scat. Rates [KHz/m/beam]	Beam Current [mA]
Z	138	1390
W	14.5	147
H	2.8	29

The lattice version 213 is not available for the t-pole.

CONCLUSIONS

MDISIM allows to get a detailed Loss Map and Loss Rate in the MDI region. For the arc the obtained loss rates are consistent with expectation from analytical formulas.

The geometry in the IR has been approximated with cilinders, and seems good enough for the moment.

A loss rate of 138 Khz/m/beam is found at The Z-pole with N2 at 10^{-9} mbar, Losses are concentrated in the conical tapers.

The study of other energies is on-going,
and points out to the similar loss map with lower rates,
IR losses originate ~600m upstream.

Loss map particles can be tracked in all the sub-detectors, and eventually, if dangerous, remedies could be considered.

BACK UP

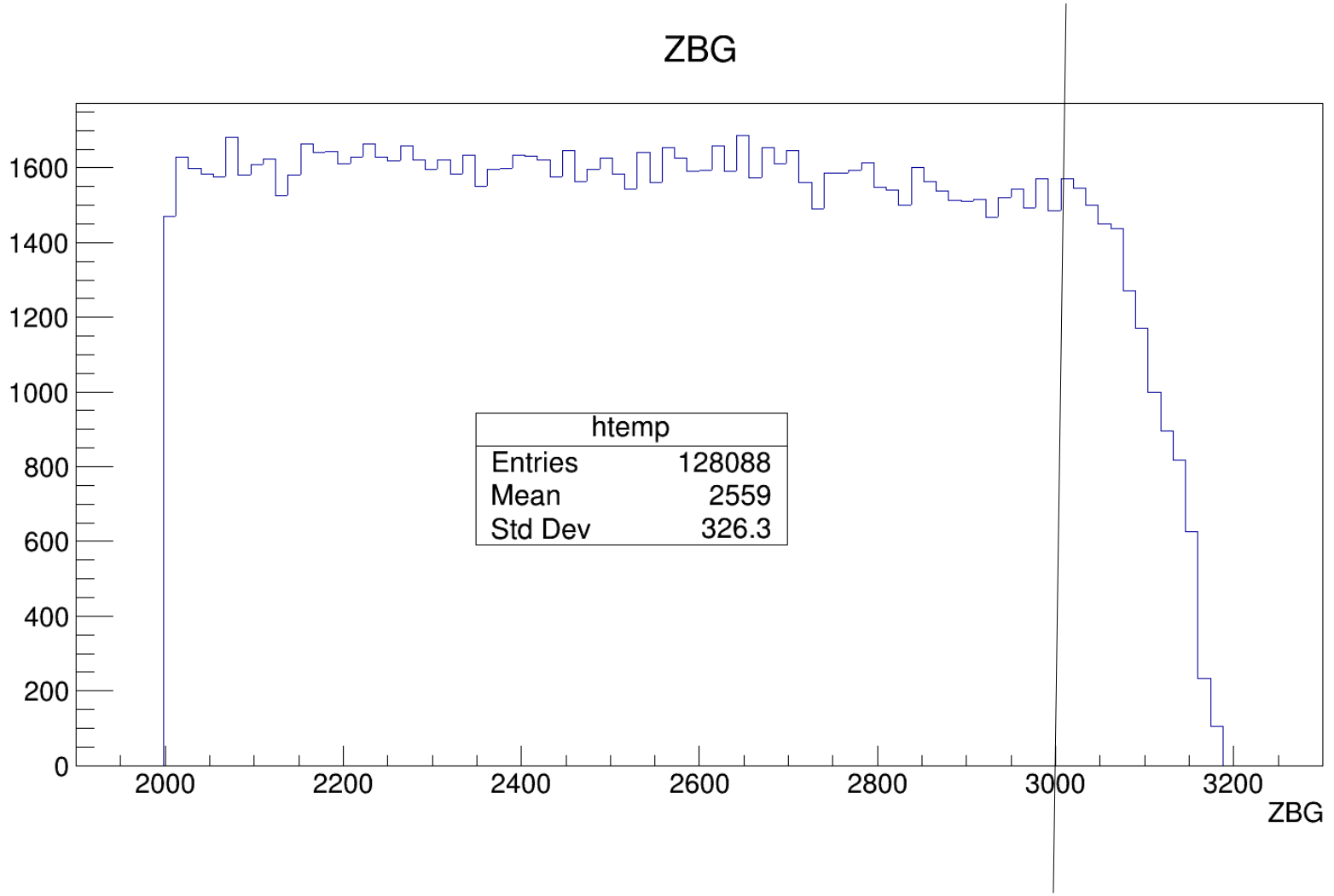
Lattices available in afs is X
Initial studies have been done with the ones marked with X
Latest lattice 213 for the t is now available

All these plots and numbers are available for all these optics/energies

	fcc_ee_208	fcc_ee_213
Z	X	X
W	X	X
H	X	X
T	X	—

Z (Euclidean) is NOT equal to S (C-S coordinates)
ZBG is the location along Z where a Beam Gas Interaction occurs.

It looks pretty flat up to 3000m, I cut at 3000m
For N :113812/1e7 = 1.13% are lost in 1km



WHAT IS THE LOSS RATE FROM BEAM GAS IN THE ARC ?

As calculated by Francesco :

Neloss = NelossMC/NeprimMC . Nebunch . Nbunches . Preal/Pmc

For H the rate is 2.35 MHz per km of arc at 10^{-9} mbar

Neloss = 68724/1e7 . 1.7e11 . 16640 . 1e-9/24.8
= 0.783e3
Rate_eloss = Neloss/Trev = 18.1e3/0.333ms = 2.35 Mhz

For H2 the rate is 6.22 MHz per km of arc at 10^{-9} mbar

Neloss = 90764/1e7 . 1.7e11 . 16640 . 1e-9/12.4
= 2.070e3
Rate_eloss = Neloss/Trev = 18.1e3/0.333ms = 6.22 Mhz

For N the rate is 54.3 MHz per km of arc at 10^{-9} mbar

Neloss = 113812/1e7 . 1.7e11 . 16640 . 1e-9/1.78
= 18.1e3
Rate_eloss = Neloss/Trev = 18.1e3/0.333ms = 54.3 MHz

For N2 the rate is 189.1 MHz per km of arc at 10^{-9} mbar

Neloss = 99034/1e7 . 1.7e11 . 16640 . 1e-9/0.445
= 62.95e3
Rate_eloss = Neloss/Trev = 63.0e3/0.333ms = 189.1 MHz

THE PARTICLE LOSS IS NOT UNIFORMLY DISTRIBUTED

Cumulative distribution of losses