FETS Meeting
MEBT Status

Royal Holloway University

14 November 2012

Main issues

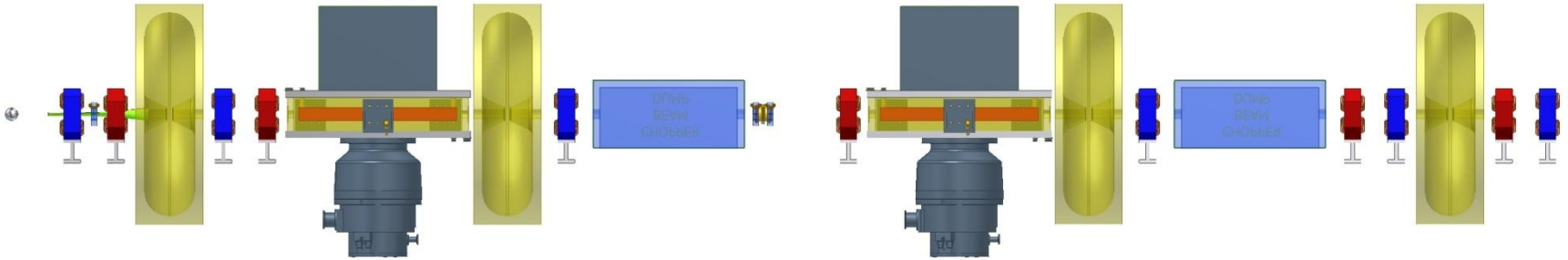
❖**A second lattice For MEBT was presented on 22 August 2012, at University of Warwick**

❖The original motivation: more space for diagnostic(especially, at the interesting places to do diagnostics (for instance one BMP should be between chopper and dump as this will be indicating chopping...), less beam power density on the dumps and to make it cheaper as the funding is limited.....

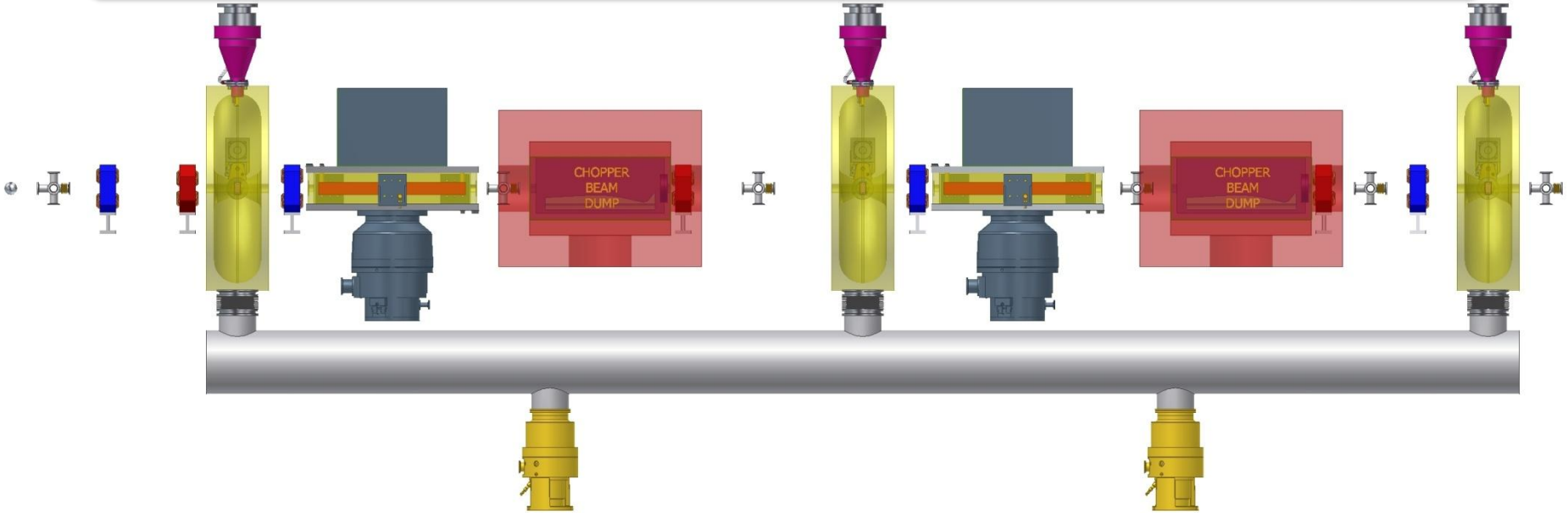
❖**A comparison of the first and second lattice features is done.**

❖**Considerable Improvement on the new lattice has been achieved since then.**

Original Lattice without diagnostics.



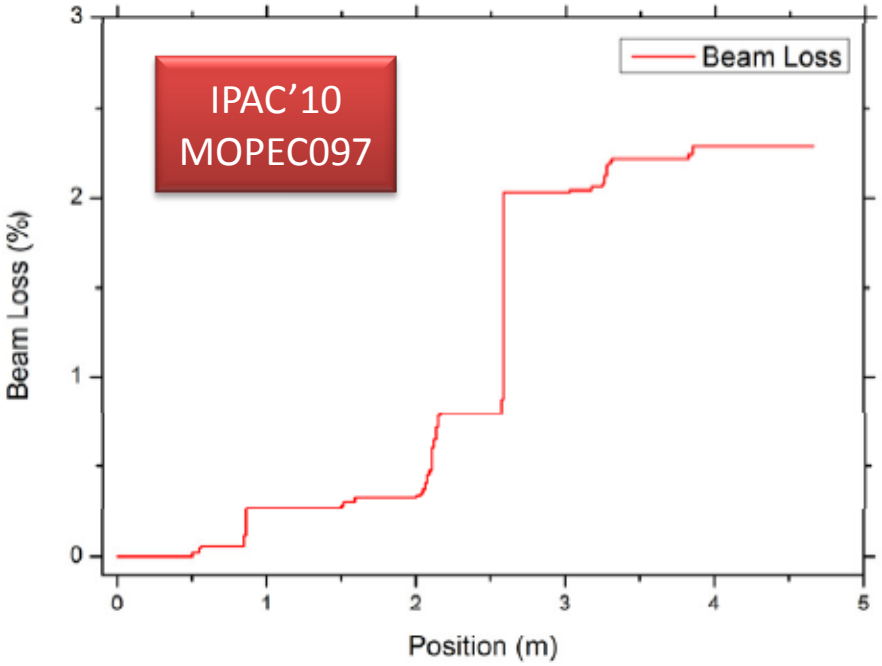
New scheme including Beam Position Monitors, beam pipe bellows and 100mm thick lead shielding around the Chopper Beam Dumps.

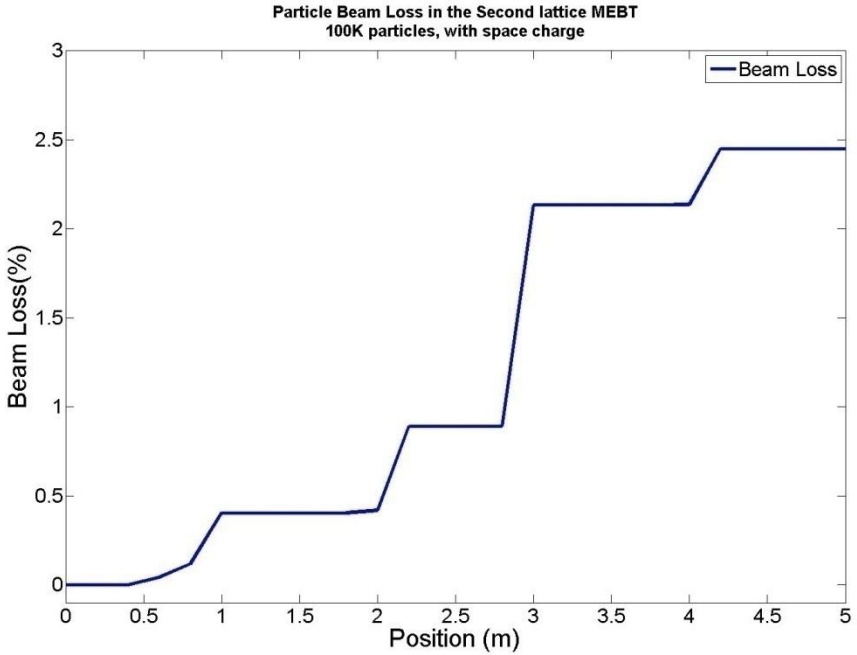


A few main parameters for comparison

Parameters	First Lattice	Second lattice
Original Emittance	0.25 pi mm-mrad(theory)	0.30 pi mm-mrad(realistic)
Total Gradient of the whole 11 quads in the 1st and 7quads in the 2nd lattice:	15.6+19.0+20.5+17.9+6.56+7.2+6.4+16+16.8+10.4+8.8 =145.16 T/m	15.5+16.5+10.45+5.2+8.1+8+7 = 70.75 T/m
Total sum of v^2 for the 4 cavities of the 1st and 3 cavities of the 2nd lattice:	$(9.4600*10^4)^2$ + $(8.1700*10^4)^2$+ $(6.8800*10^4)^2$+ $(5.3750*10^4)^2$= 2.3247e+010 v^2	$(9.4600*10^4)^2$+ $(8.6000*10^4)^2$ $(8.1700*10^4)^2$= 2.3020e+010 v^2
Chopping plane:	X plane (parallel to ground)	Y plane (perpendicular to ground)

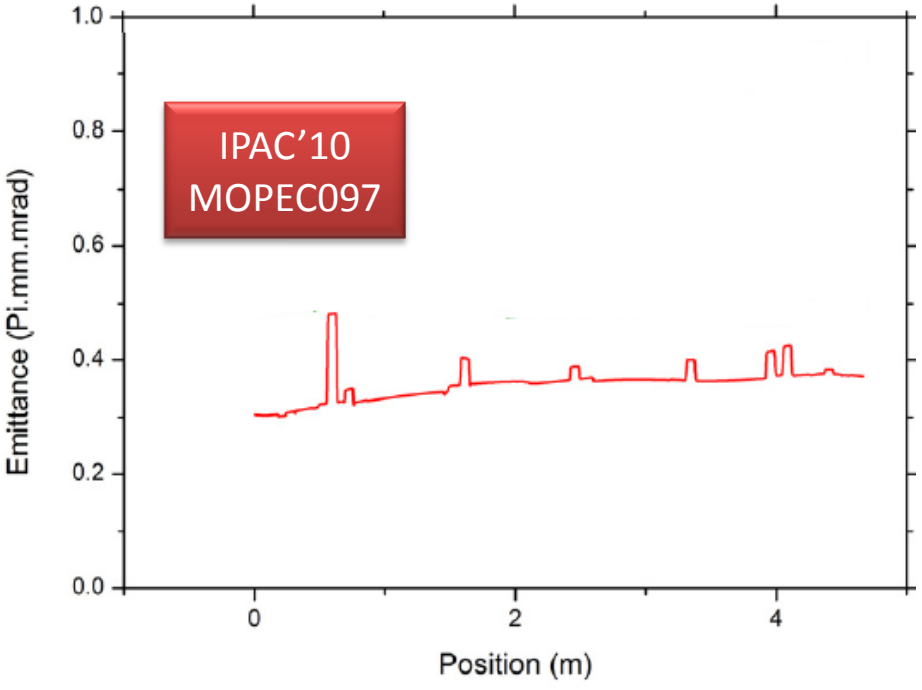
Loss comparison between the two lattices

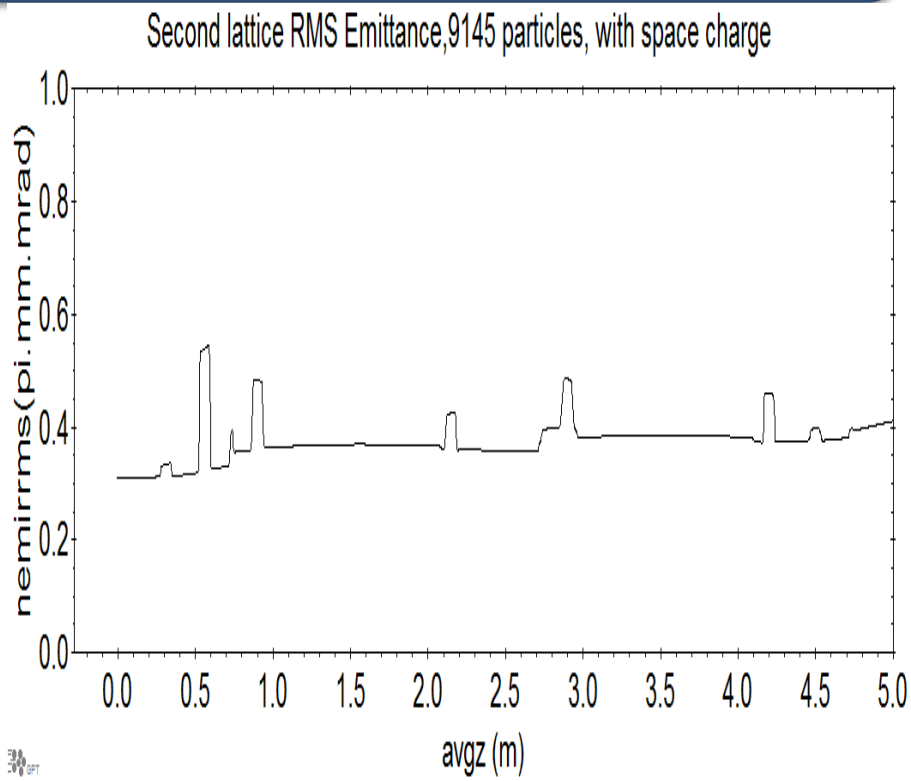




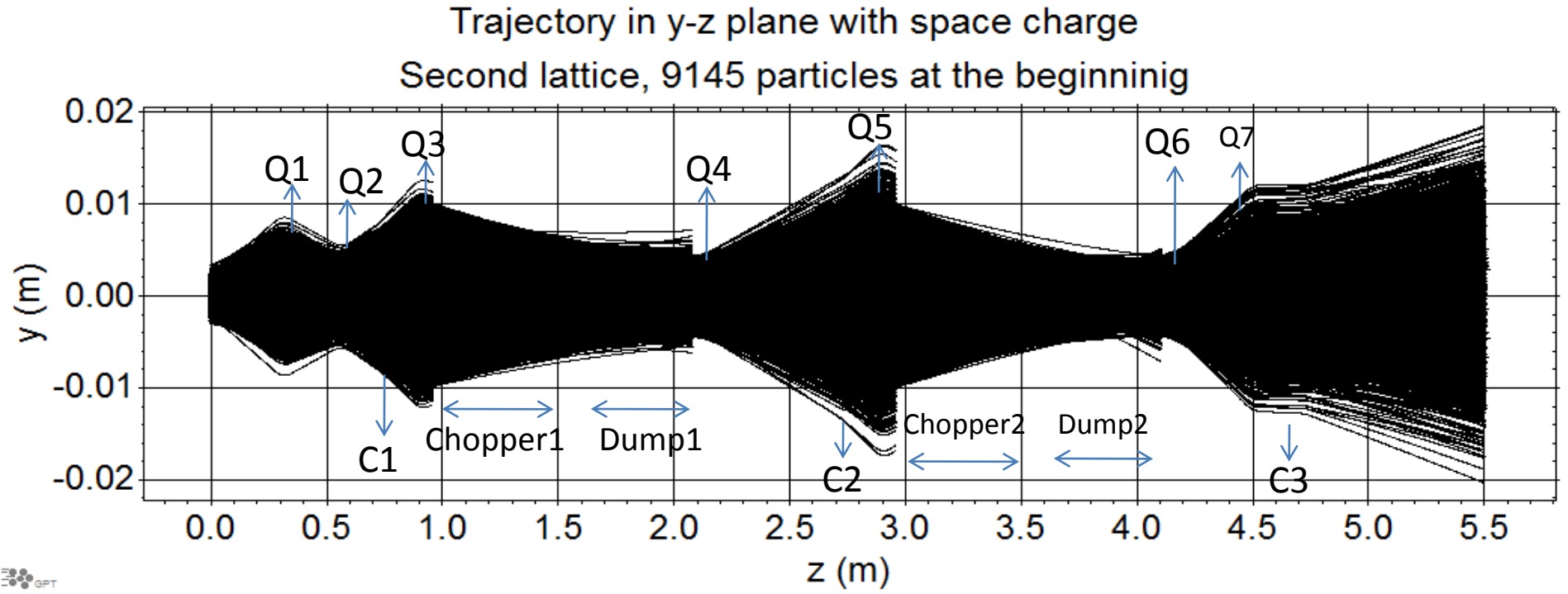
First lattice on the left and second lattice on the right

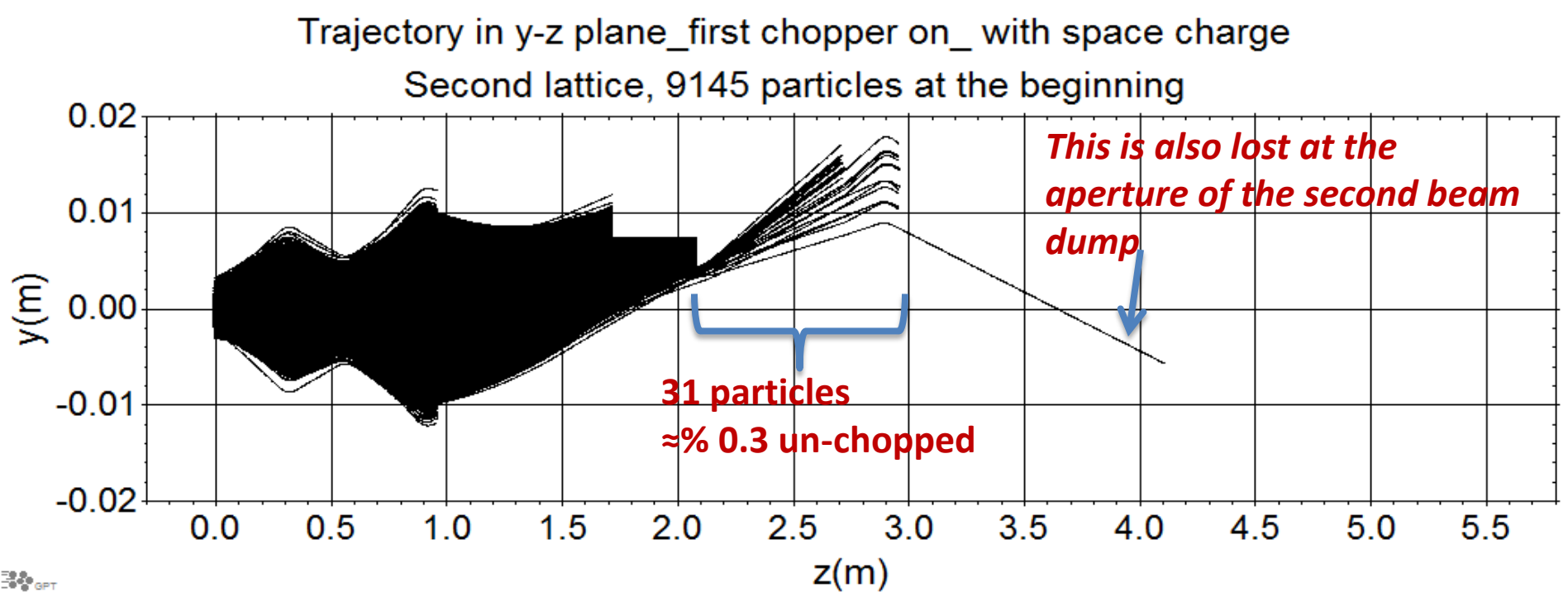
Comparison between emittance evolutions in the MEBT

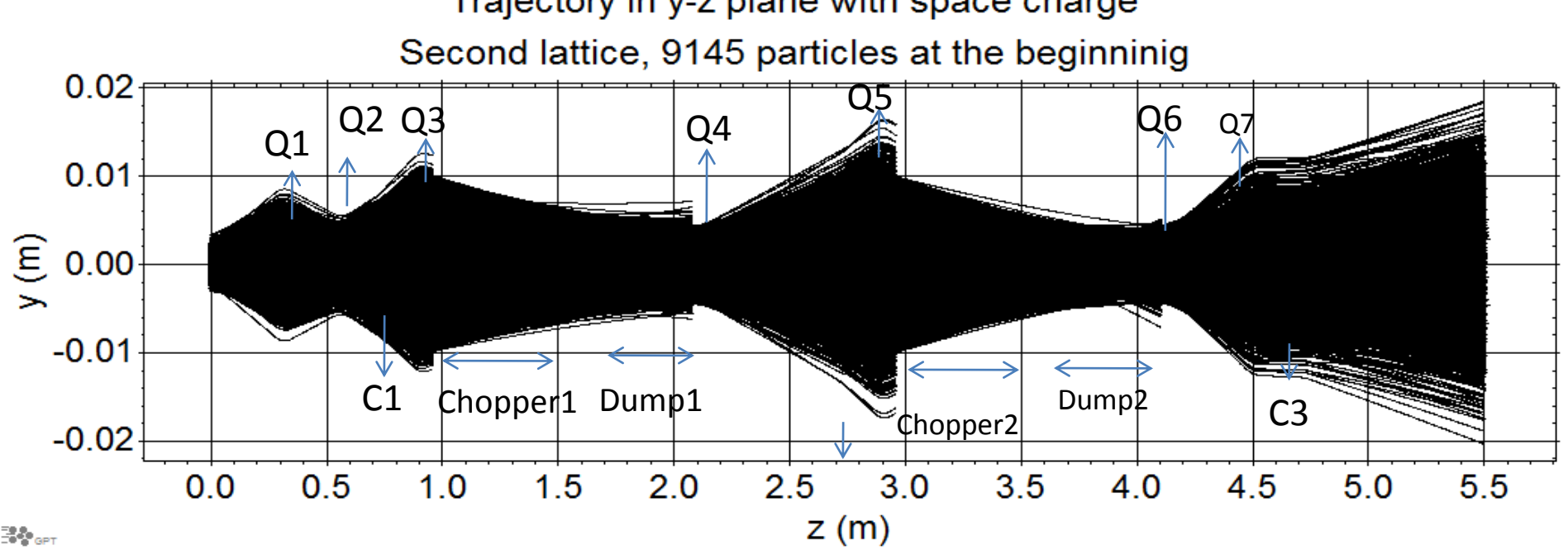


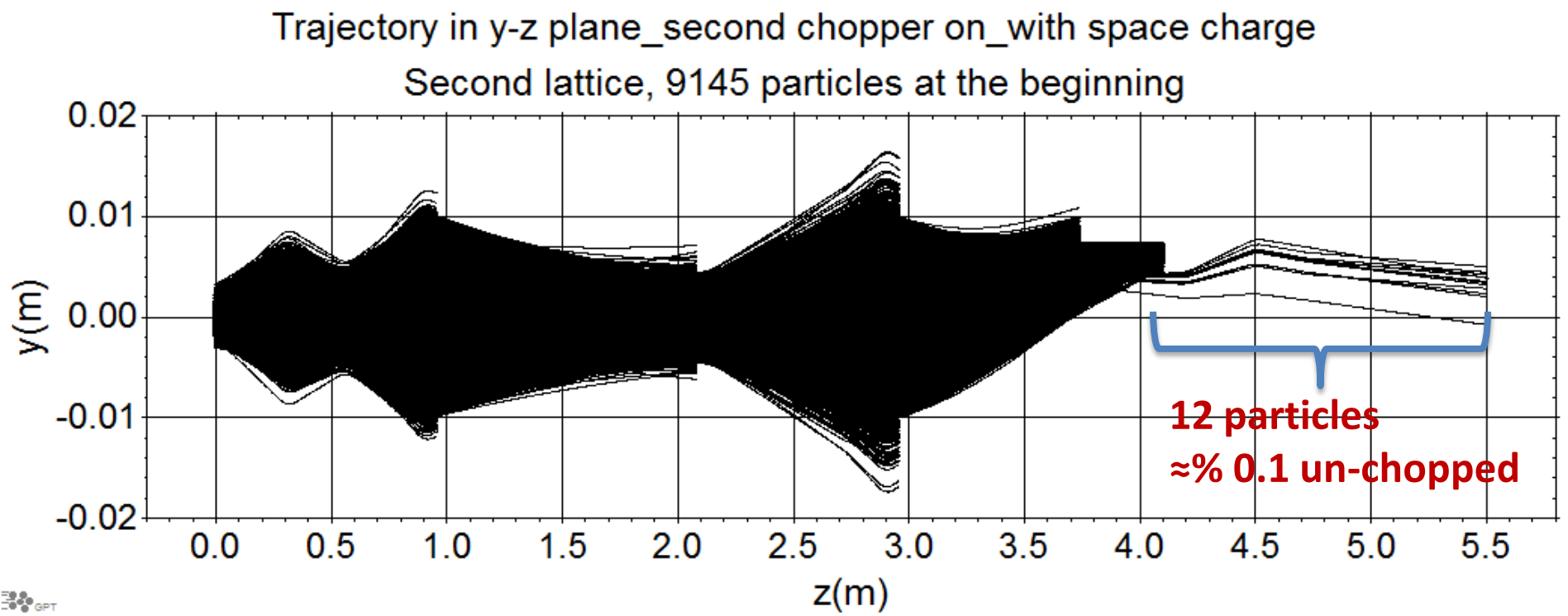


First lattice on the left and second lattice on the right


Trajectory in y-z plane with space charge
Second lattice, 9145 particles at the beginnig
Q1
Q2
Q3
Q4
Q5
Q6
Q7
C1
C2
C3
Chopper1
Dump1
Chopper2
Dump2
y (m)
z (m)
0.02
0.01
0.00
-0.01
-0.02
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5


Trajectory in y-z plane_first chopper on_ with space charge
Second lattice, 9145 particles at the beginning
This is also lost at the aperture of the second beam dump
31 particles
≈% 0.3 un-chopped
y(m)
z(m)
0.02
0.01
0.00
-0.01
-0.02
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5


Trajectory in y-z plane with space charge
Second lattice, 9145 particles at the beginnig
Q1
Q2
Q3
Q4
Q5
Q6
Q7
C1
Chopper1
Dump1
Chopper2
Dump2
C3
y (m)
z (m)


Trajectory in y-z plane_second chopper on_with space charge
Second lattice, 9145 particles at the beginning
12 particles
≈% 0.1 un-chopped
y(m)
z(m)

For a full comparison of 1st and 2nd Lattice,
we need to use in the old lattice (Ciprian please)

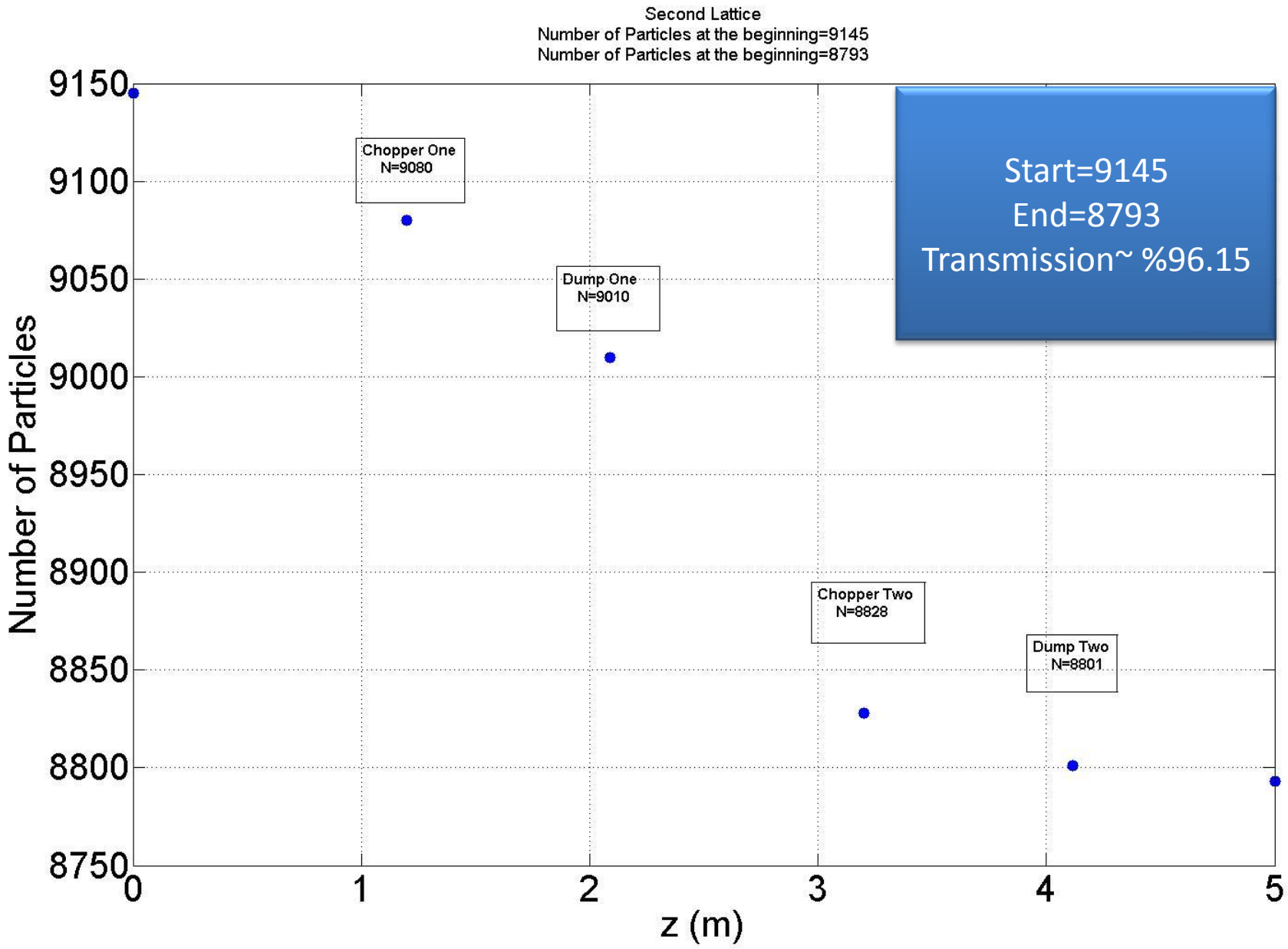
- *The output emittance of the RFQ,*
- *Chop in the other plane,*
- *The power density average and maximum at the beam dumps.*

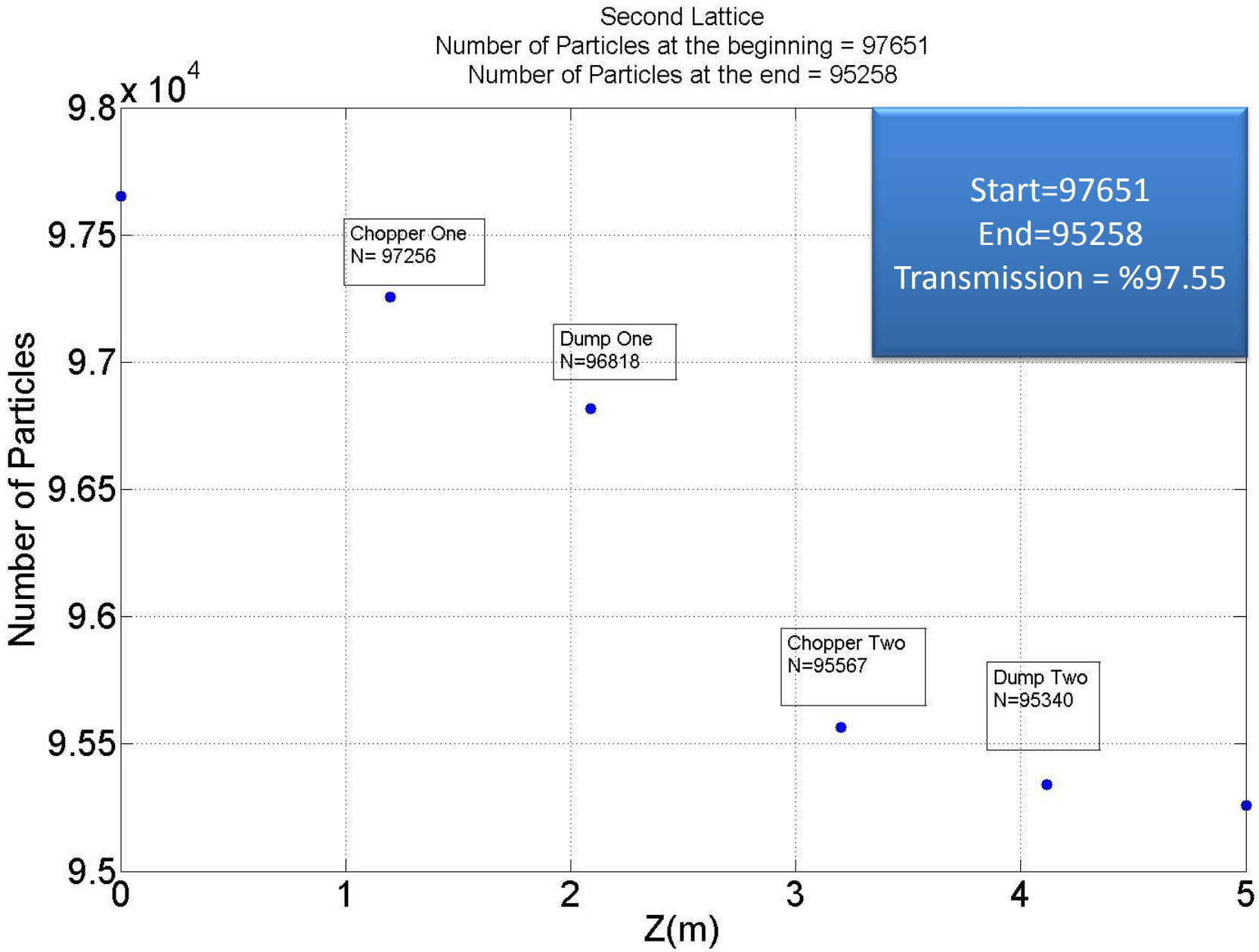
To do list:

- *Field maps for the components,*
- *Power transferred to the dumps,*
- Error studies
- *Effect of temperature rise on the frequencies (for tuning of cavity in RF design the frequency temperature dependence needs evaluation).*

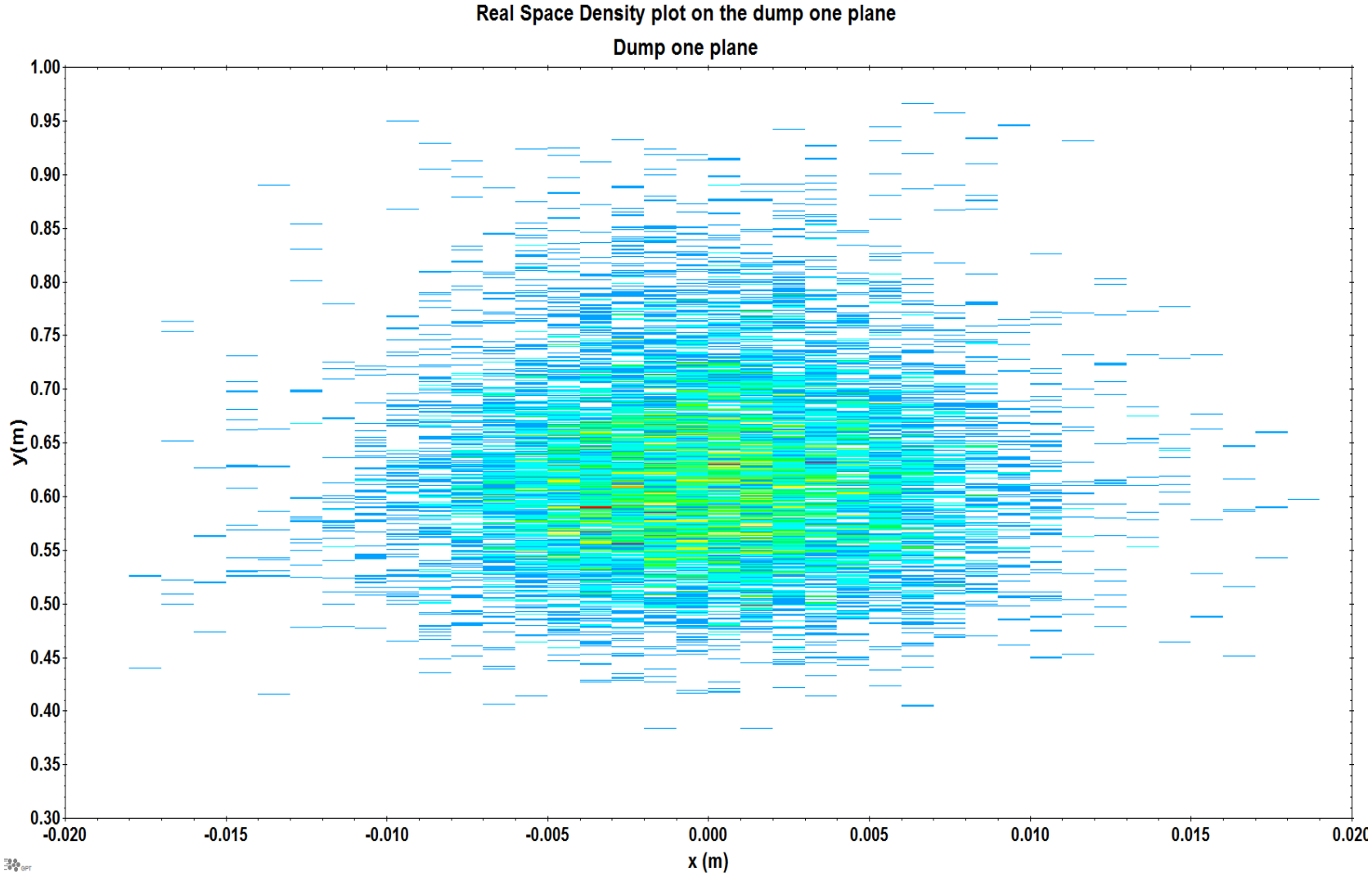
Thank you

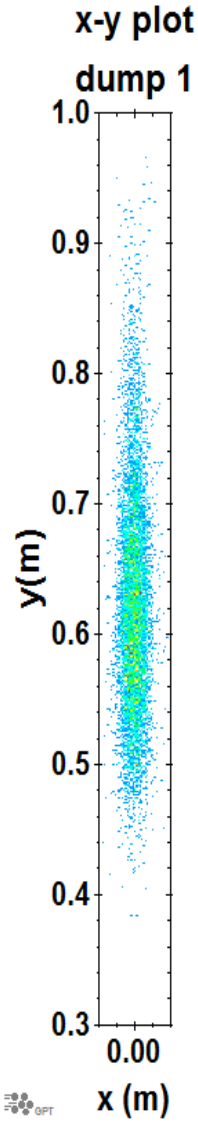
Back up slides

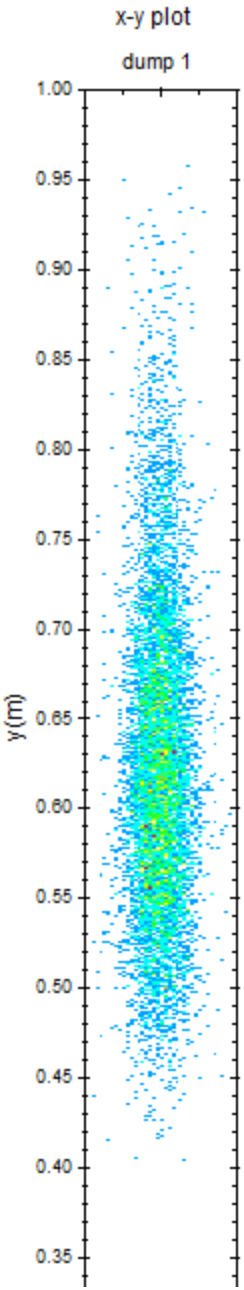

Second Lattice
Number of Particles at the beginning=9145
Number of Particles at the beginning=8793
Number of Particles
z (m)
9150
9100
9050
9000
8950
8900
8850
8800
8750
0
1
2
3
4
5
Chopper One
N=9080
Dump One
N=9010
Chopper Two
N=8828
Dump Two
N=8801
Start=9145
End=8793
Transmission~ %96.15


Second Lattice
Number of Particles at the beginning = 97651
Number of Particles at the end = 95258
x 10^4
9.8
9.75
9.7
9.65
9.6
9.55
9.5
Number of Particles
0
1
2
3
4
5
Z(m)
Chopper One
N= 97256
Dump One
N=96818
Chopper Two
N=95567
Dump Two
N=95340
Start=97651
End=95258
Transmission = %97.55

Information from screen at chopper dump 1







Modify plot settings

General | X-Axis | Y-Axis | Margins and Sizes | Statistics | Scatter | Density

Options

Horizontal bins: 40

Vertical bins: 700

Horizontal blur: 0

Vertical blur: 0

Grayscale

Weight

Scale by bin area

Scaling

Automatic scaling

Manual scaling

Min: 0

Max: 9

Advanced options

Palette entries: 1024

Zero to white

Read from file

Browse...

Load Template...

OK

Cancel

Help

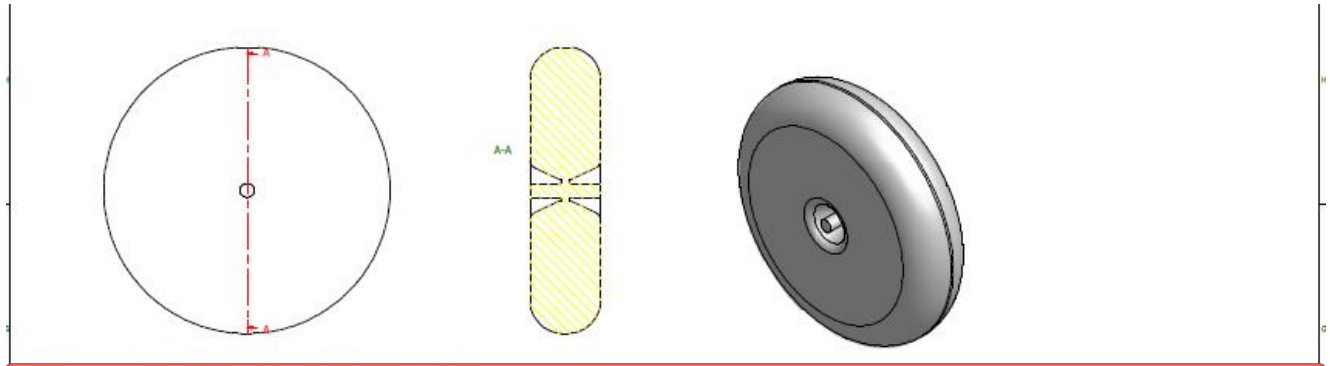
First Rough Calculation of the Energy Distribution on the Dump Plane

Xmin and Xmax	-20 mm and 20 mm
Ymin and Y max	300 mm and 1000 mm
Number of horizontal and vertical bins	40 And 700
Bin area	1 mm^2
Q total	Q=I*T=(60e-3)*(1/324e6)=-1.85185e-10 c
Number of Macro particles	≈10000 (number of particles in the input file by ourselves)
Number of individual particles	nps=((Qtotal/q)/(n macro par))≈10^5
Maximum number of Macro-Particles in bin	≈10 (In fact we read what GPT shows in "scaling" Min=0 and Max=9). Min is blue parts in the density plot, while Max is the red parts in the density plot. GPT shows Min=0 and Max=9 if we specify Horizontal bins=40 and vertical bins=700. Therefore Max is 9, which we roughly say 10.
Energy of each particle	3 MeV or ≈ 5 *10^{-13} Joule
Energy absorption in one RF period in one bin (3 ns)	5 *10^{-13} *10*10^5 Joule/1 mm^2 =5*10^{-7} Joule/mm^2
Total absorption(per second)	5 *10^{-7}*(324 *10^6) Joule/1 mm^2

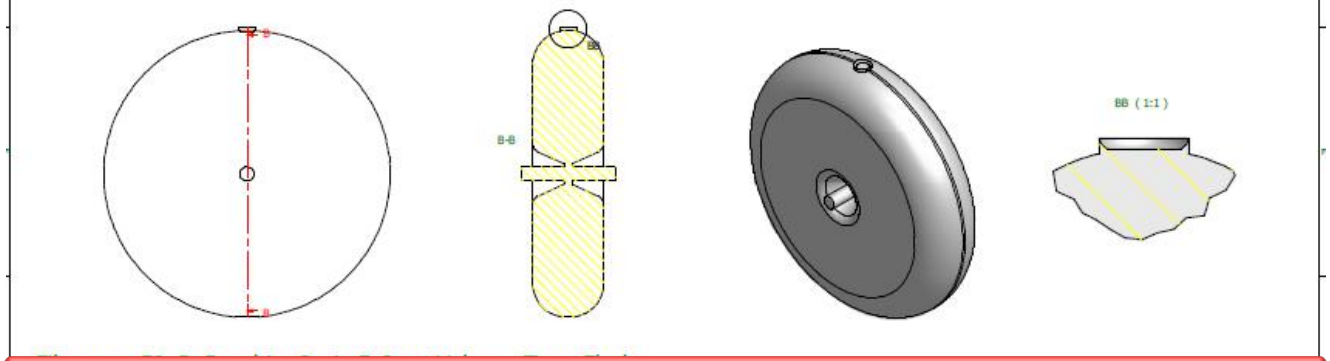
Variation of Re-bunching Cavity as a function of the tuner Positions.

A few models have been created as show on the right.

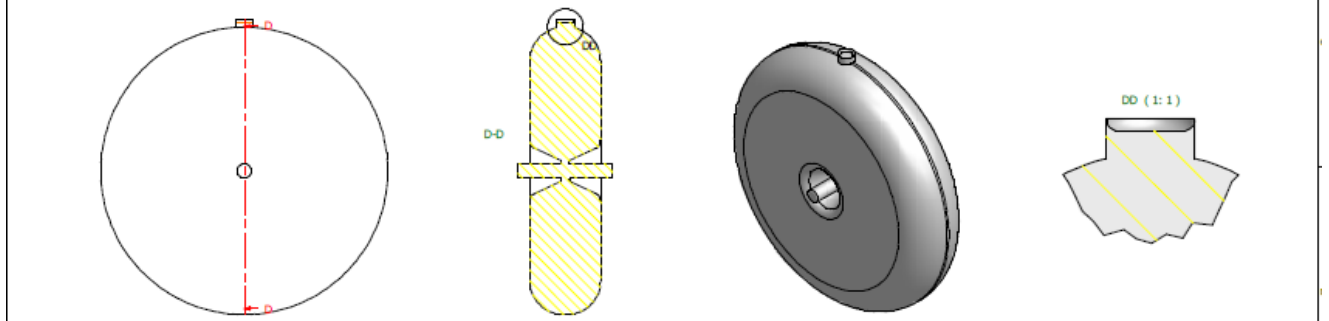
The tuner diameter used is 37,5mm which is the same as used on the RFQ.
The tuner drive range is 50mm.



No tuner or port- our baseline model



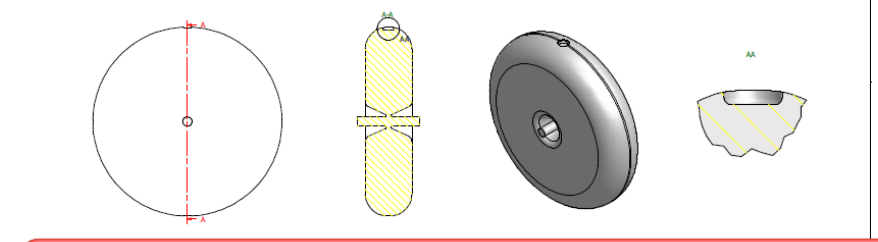
Tuner face sitting flush with the inside face of the cavity



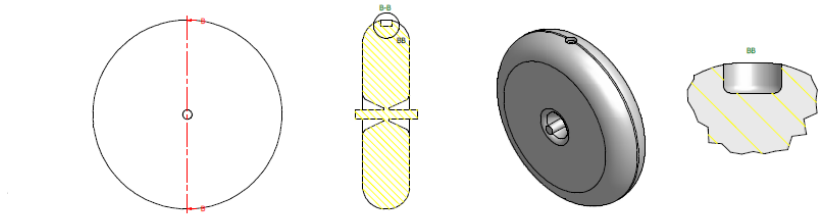
Tuner face up inside the tuner port by 10 mm

The re-bunching cavity frequency will drift also due to temperature rise and hence cavity growth.

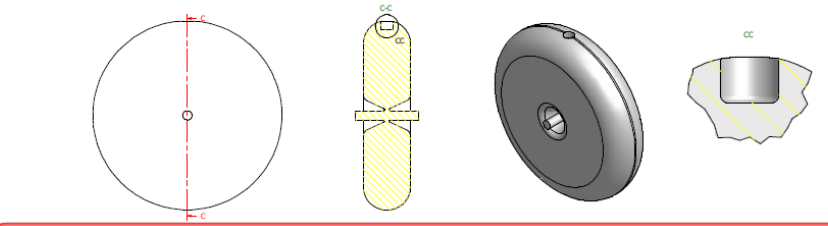
Need to simulate the cavity growth due to a temperature rise (of 20 -50 degrees above ambient).



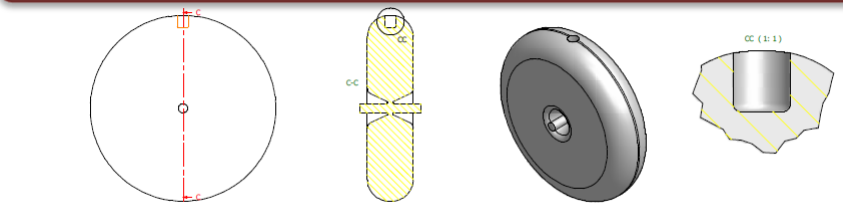
Tuner face poking into the cavity by 10 mm



Tuner face poking into the cavity by 20 mm



Tuner face poking into the cavity by 30 mm



Tuner face poking into the cavity by 40 mm

Cavity Frequency shows a sort of linear behaviour as function of Tuner Position