KEK R&D for LHC

Plan of 800MHz Cavity

Calculation of 400MHz Cavity

16th September 2009 , LHC-CC09 at CERN

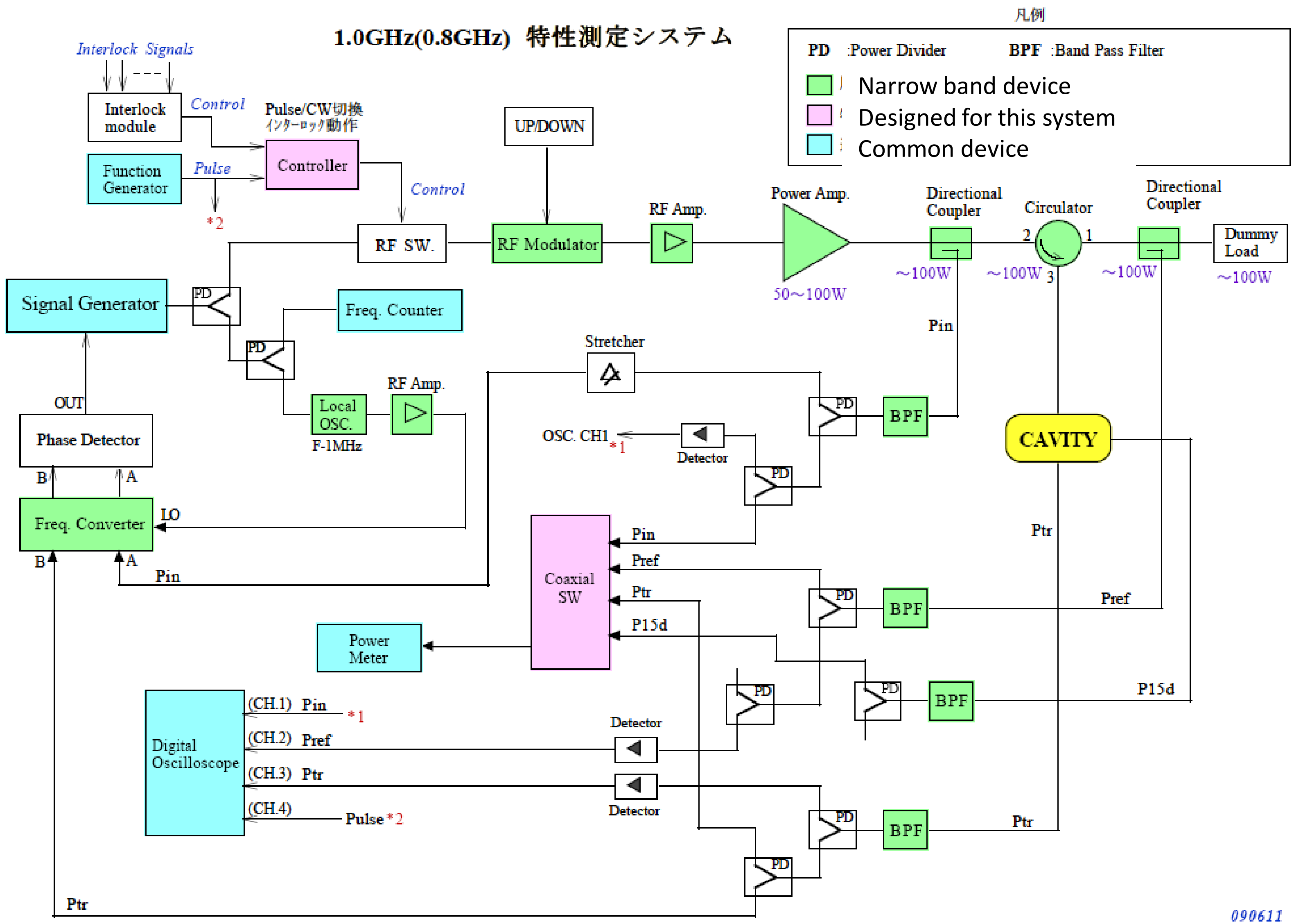
K.Nakanishi

KEK activities (800MHz)

- Oide-san continuously supports our activities.
- New EP system
  - Construction will be completed in January 2010.
  - We will test this EP system for 509 MHz cavities.
  - We can modify this system for LHC CC.
  - HPR system will be also available.
- Vertical cold test for LHC CC
  - Our cryostat is applicable for LHC CC cold test.
  - We are planning to make a new RF system for 800 MHz (next slide).
    - Many 509 MHz components are convertible.
- Aluminum model cavity
  - We will make a aluminum model cavity.
    - To check fittings for new EP system and vertical cold tests.

Atsushi Kabe, KEK

RF system for vertical cold test



Multipacting simulations

- Multipacting simulation was done for 2-cell S-KEKB type cavity by Solyak-san.
- We thank LARP people.
- Multipactings at the opening of the coaxial coupler were found.
- This type of multipacting shoud be two-side, 1/2th-order multipacting.
- We have to increase coaxial gap to avoid the lowest order (n=1/2) multipacting.
  - Increase of gap length gives enough energy to emitted electrons to avoid secondary emission.
- We observed the same type of multipacting in our 509 MHz KEKB crab cavity at the coaxial coupler at low fields.
  - Gap length was large enough to avoid the lowest order.
  - We could process in one hour.

Multipacting on an iris

- Liling-san simulated multipacting for the baseline cavity.
- He found several multipacting levels.
- It is understood that a type of multipacting is a two-side, n-th order one. (n=1/2,3/2,5/2, etc.)
- We observed this type of multipacting in our KEKB crab cavity.
- Multipacting level exists where

$$Bpeak \approx \frac{1}{n}\frac{m\omega}{e}, \mathrm{n} = 1/2$$

This type of multipacting was not severe in our KEKB crab cavity.

Concept of KEK compact crab cavity (e-crab)

- Use lowest mode.

Techniques for single mode cavities are well developed.

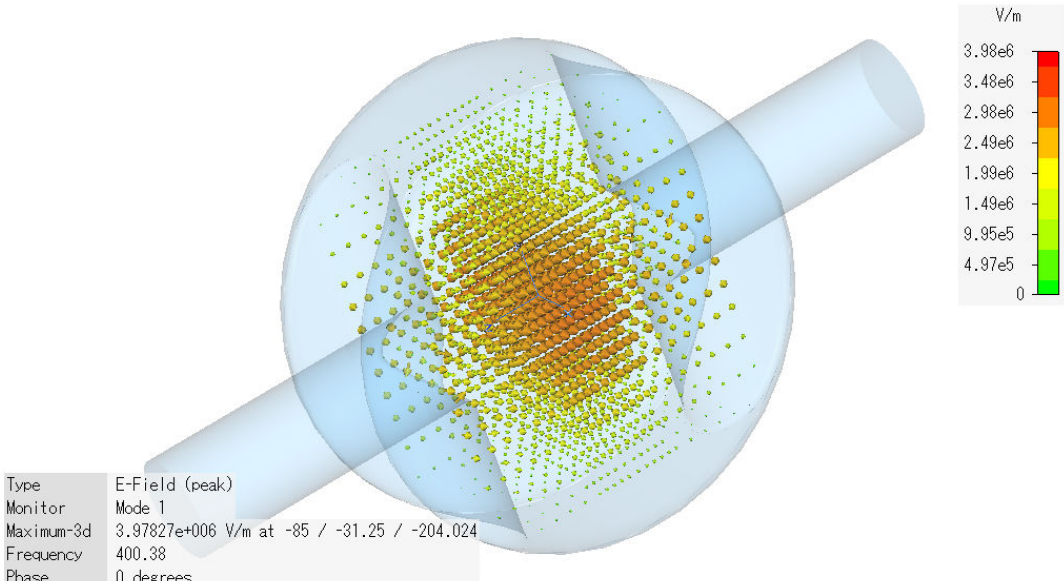
- Use the electric field.

In pillbox cavity, both of electric and magnetic field can kick the beam. The directions are opposite.

- Simple shape

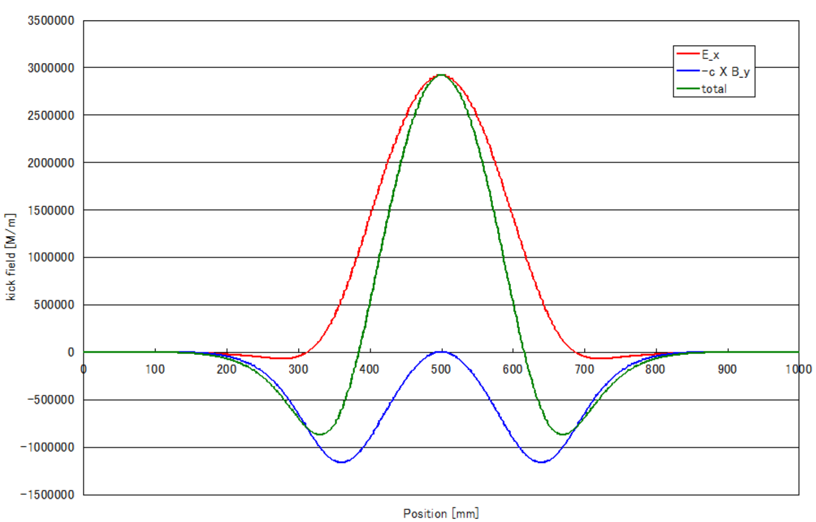
Simple shape is helpful to make clean surface.

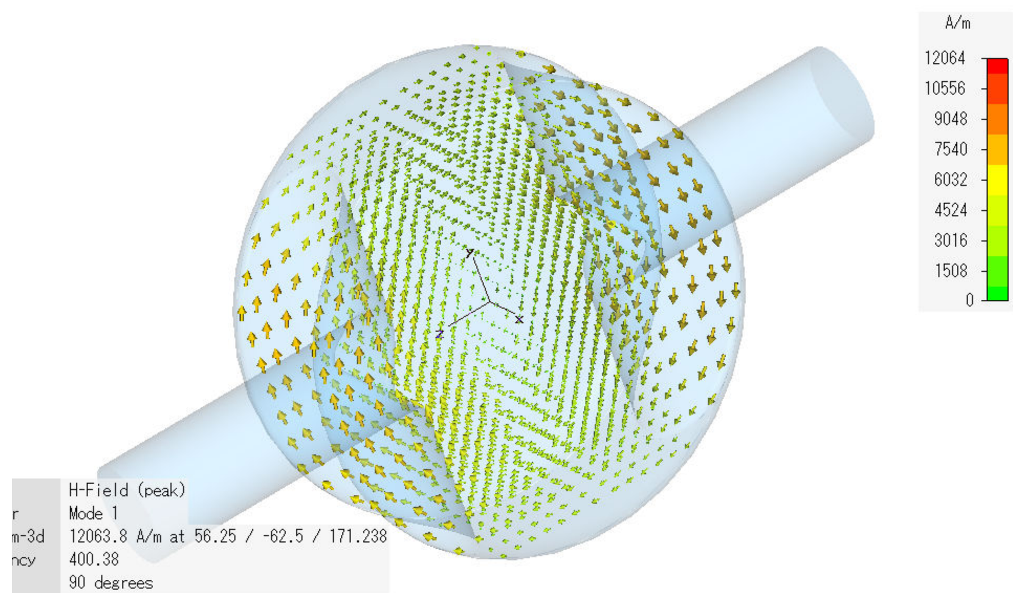
Field distribution



Electric and magnetic field kick the beam opposite directory.

Gap length have to be adjusted to make effective kick voltage.

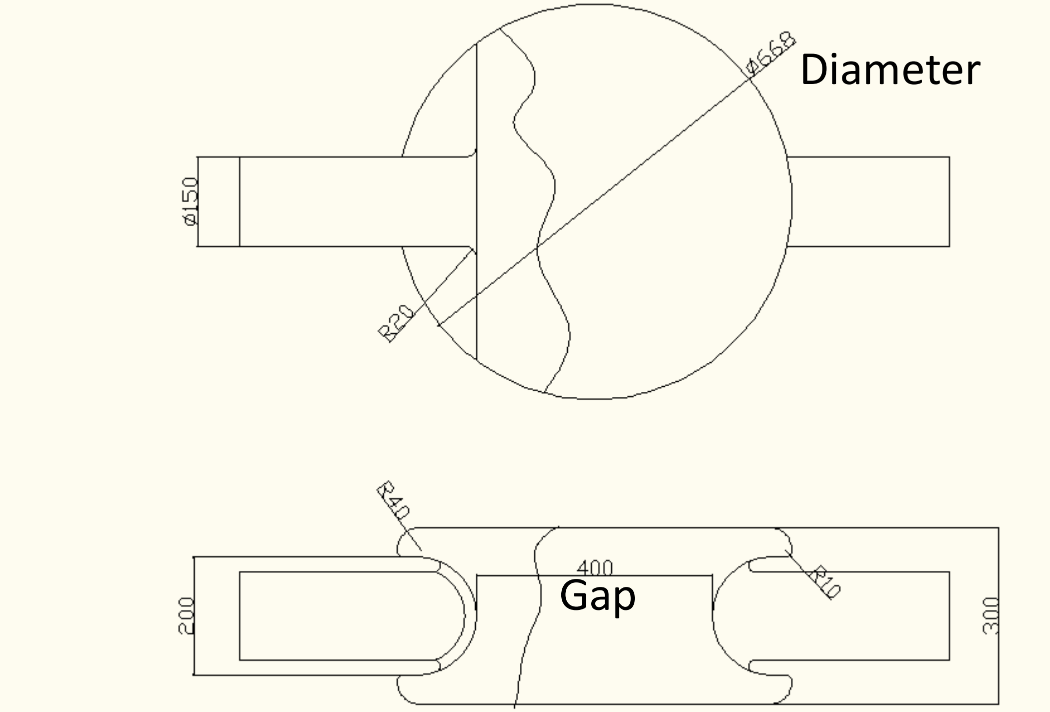


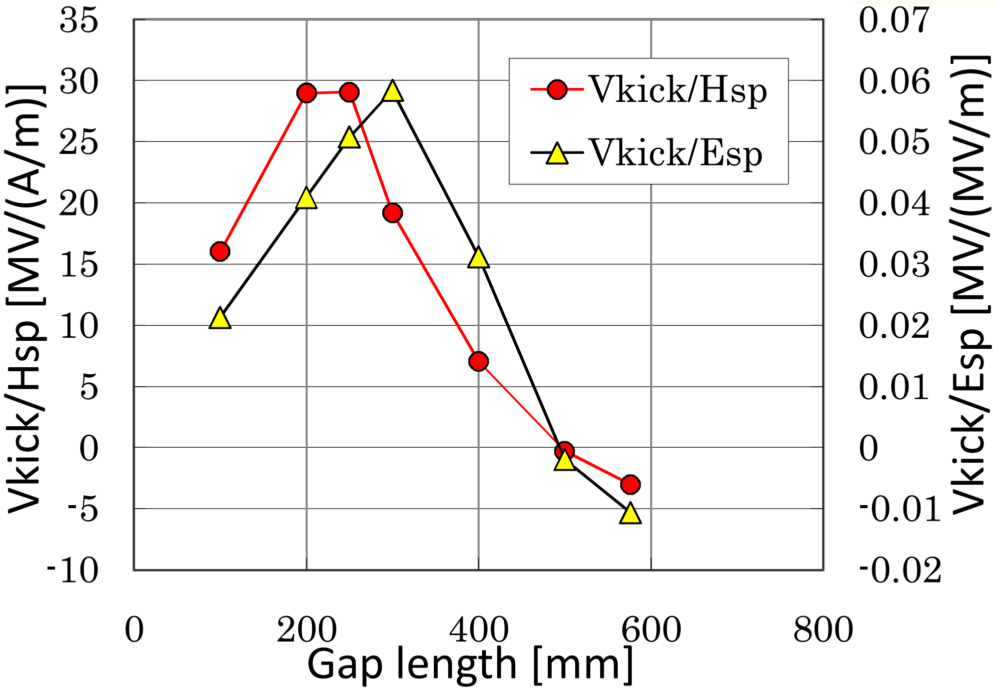


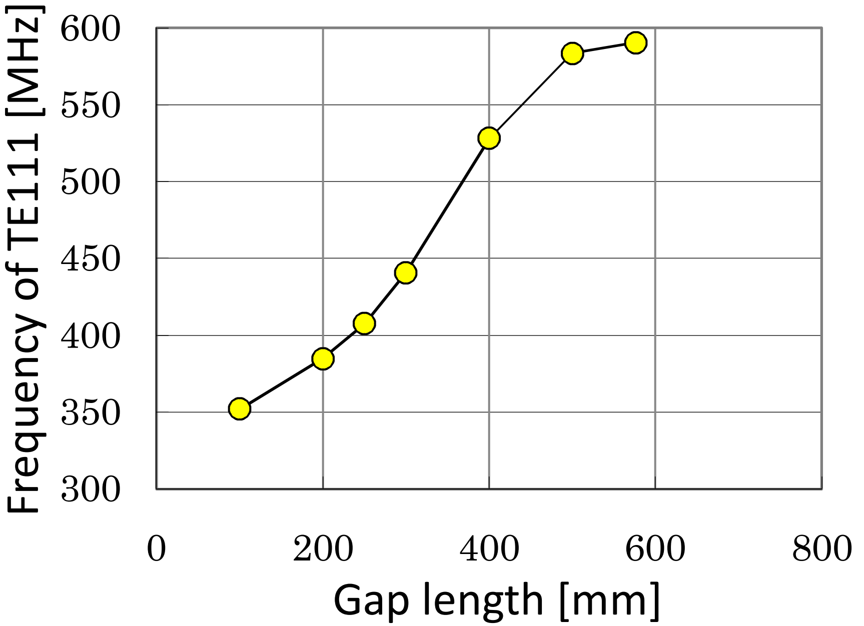
Gap length

- Gap length was chosen to make maximum kick voltage.
- Crab mode (TM010) should be lowest mode.

Gap length -> 300mm







HOM distribution

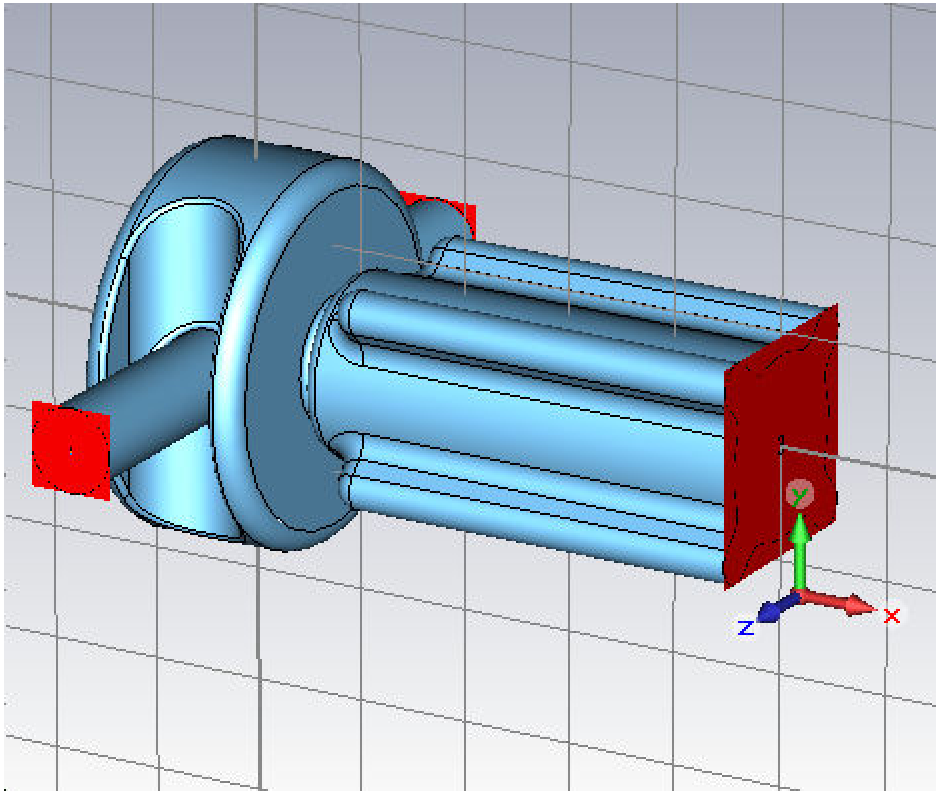
mode	Frequency [MHz]	V_kick [V/J^1/2]	Vz [V/J^1/2]	R_z/Q [Ohm]	E_sp [MV/m/J^1/2]	H_sp [Oe/J^1/2]
TM010*	400.389	238192	0.290838	0	4.08	156
TE111	440.813	0.296713	464509	78	9.27	107
TM011	471.037	0.089472	453144	69	7.74	127
TM110	574.368	40614.4	0.290216	0	8.44	152
TE211	576.627	0.633024	0.123273	0	10.1	484
TM110	587.357	0.131659	0.005841	0	3.26	175
TE211	600.556	0.593295	0.344733	0	10.4	589
TM111	678.981	0.43519	313611	23	7.03	135
TE111	681.778	0.058524	0.05005	0	3.75	130
(TM310)**	700.339	253646	0.466292	0	9.28	229

*:Crab mode

**:mode identification by cartesian coordinates.

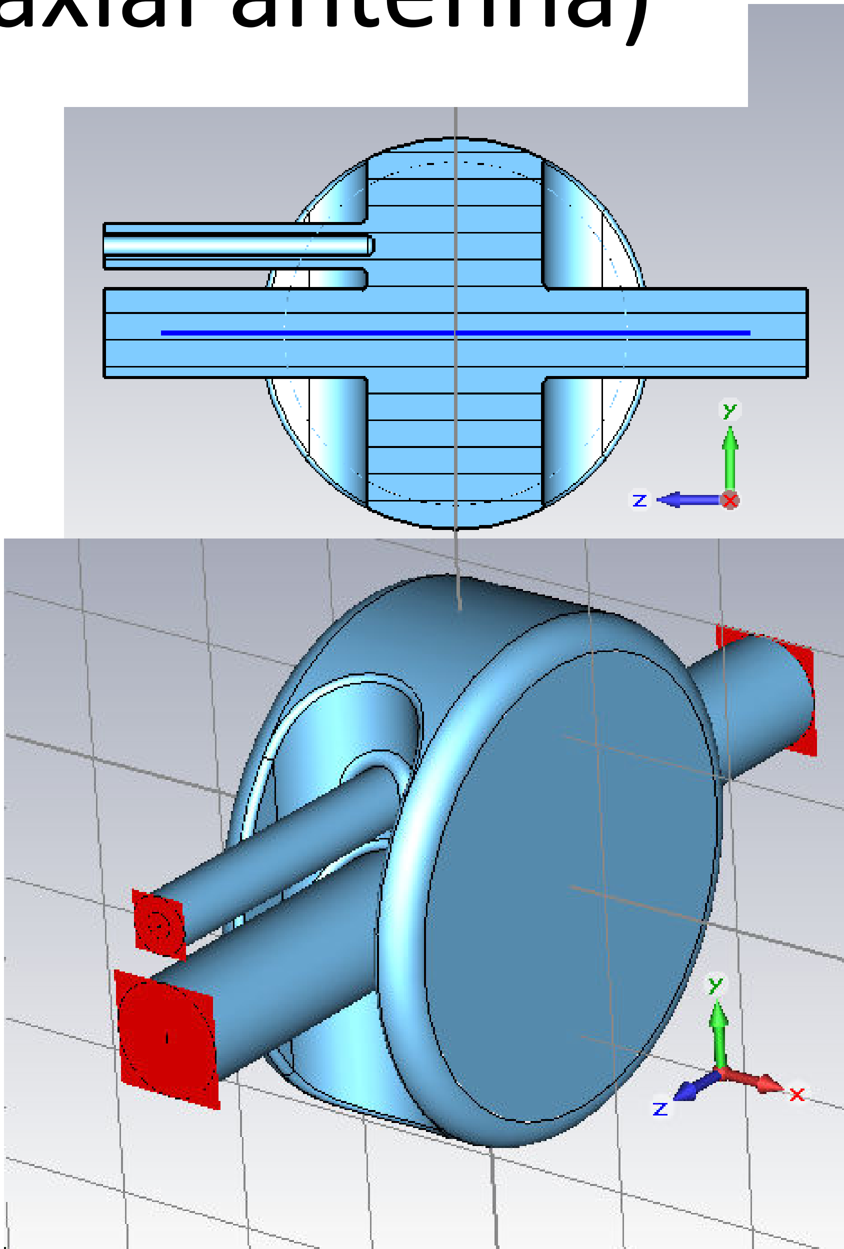
HOM dumping (fluted pipe)

Mode	Frequency [MHz]	Q_L
TM010	403	1.7e10
TE111	436	1260
TM011	473	1.3e10
TM110	568	430
TM110	572	150
TE211	575	1.4e6
TE111	598	4240
TM111	647	650
TM210	699	1500



HOM dumping (coaxial antenna)

Mode	Frequency [MHz]	Q_L
TM010	400	2e10
TE111	440	4700
TM011	471	6700
TM110	574	2e12
TE211	577	2100
TE111	587	1e12
-	601	2800
-	679	1480
-	699	1.23e9
-	741	6410
-	793	2.52e8
-	801	2590



HOM dumping (fulute pipe & coax)

Mode	Frequency [MHz]	Rsh	Q_L
TM010	403	1.1e5	2.4e5
Fulute	421	9.2e-3	17
Fulute	421	7	17
TE111	435	3.6e4	415
TM011	471	4.8e4	731
Fulute	494	4.4e-4	18
Fulute	494	7.6e-2	18

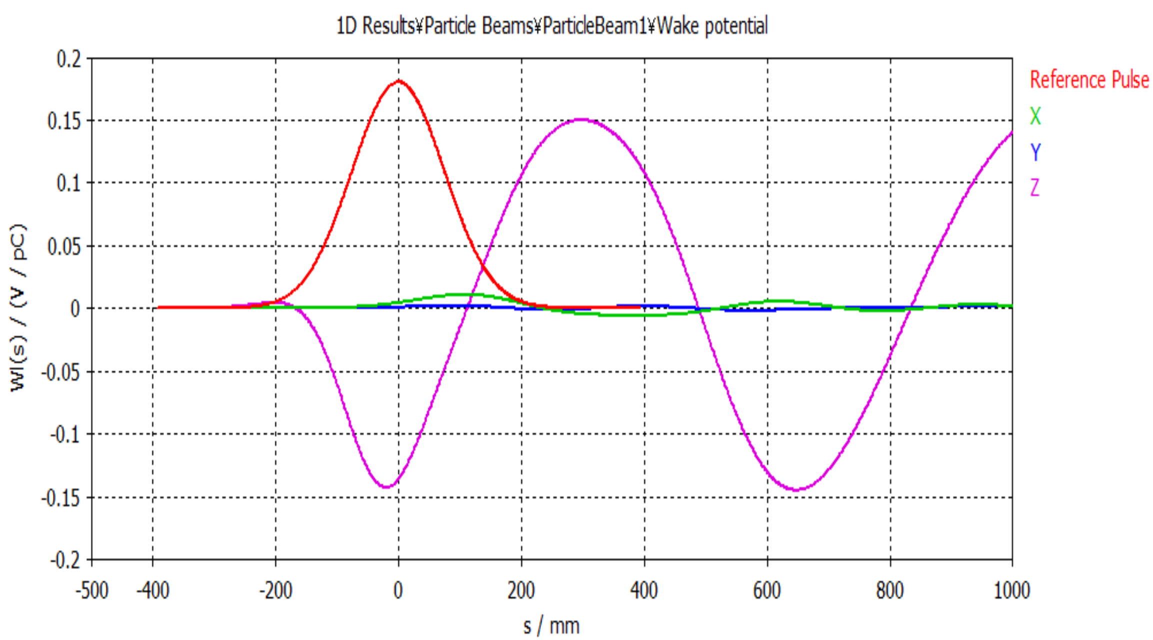
Mode	Frequency [MHz]	Rsh	Q_L

Loss factor

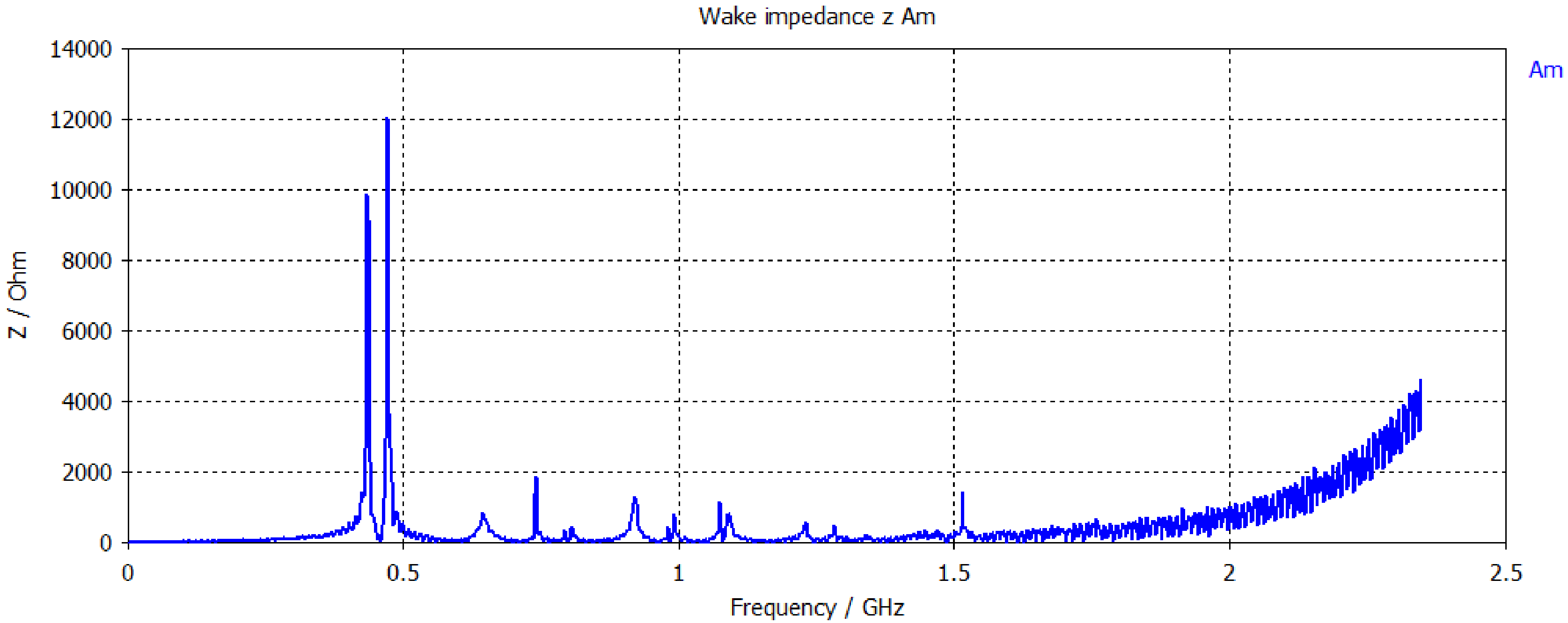
	Loss factor [x10^{-2} V/pC]
Cavity	8.00
With fluted pipe	8.53
With coaxial antenna	8.11
With fluted pipe and coax	8.58

~2.2kV

Sigma	Q
75.5mm	2.72×10^{-8} C

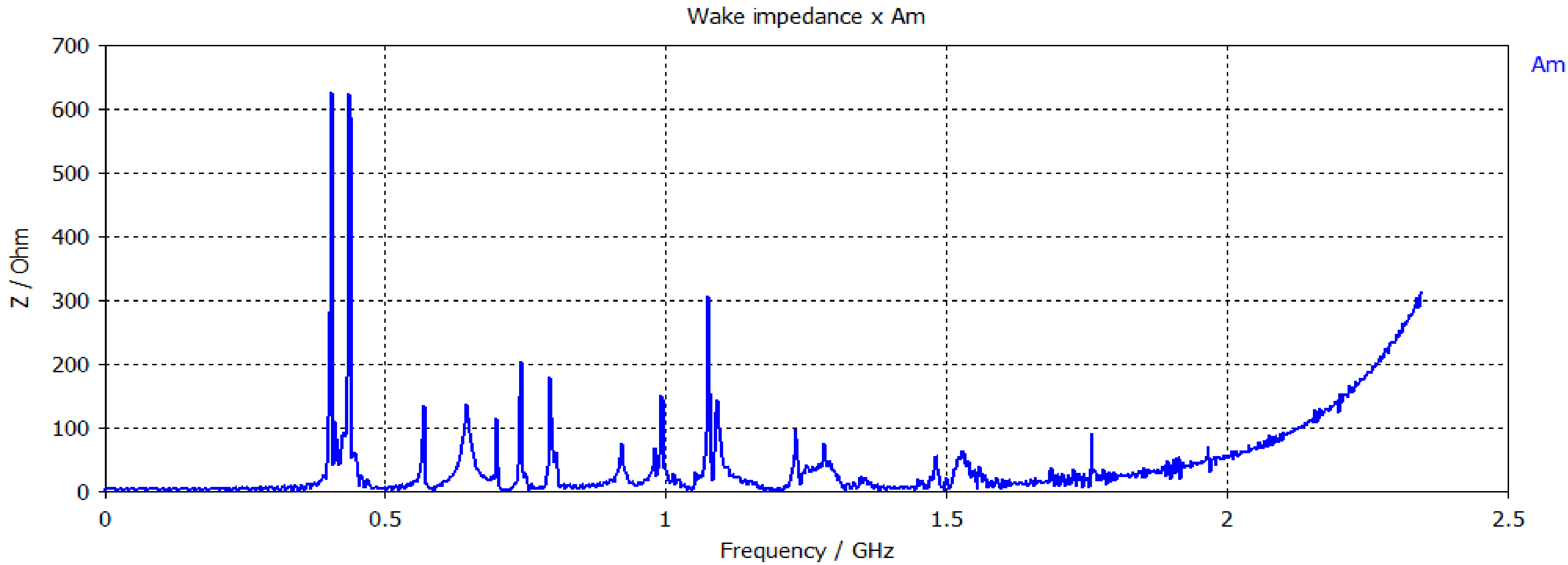


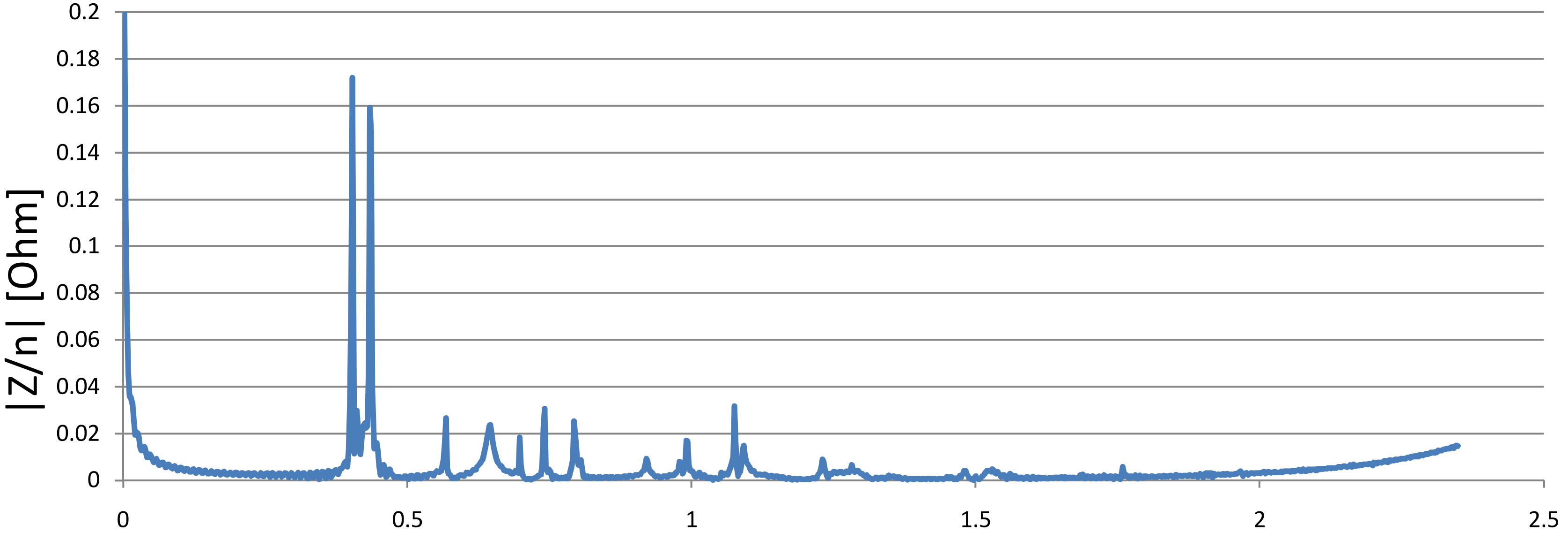
Longitudinal impedance



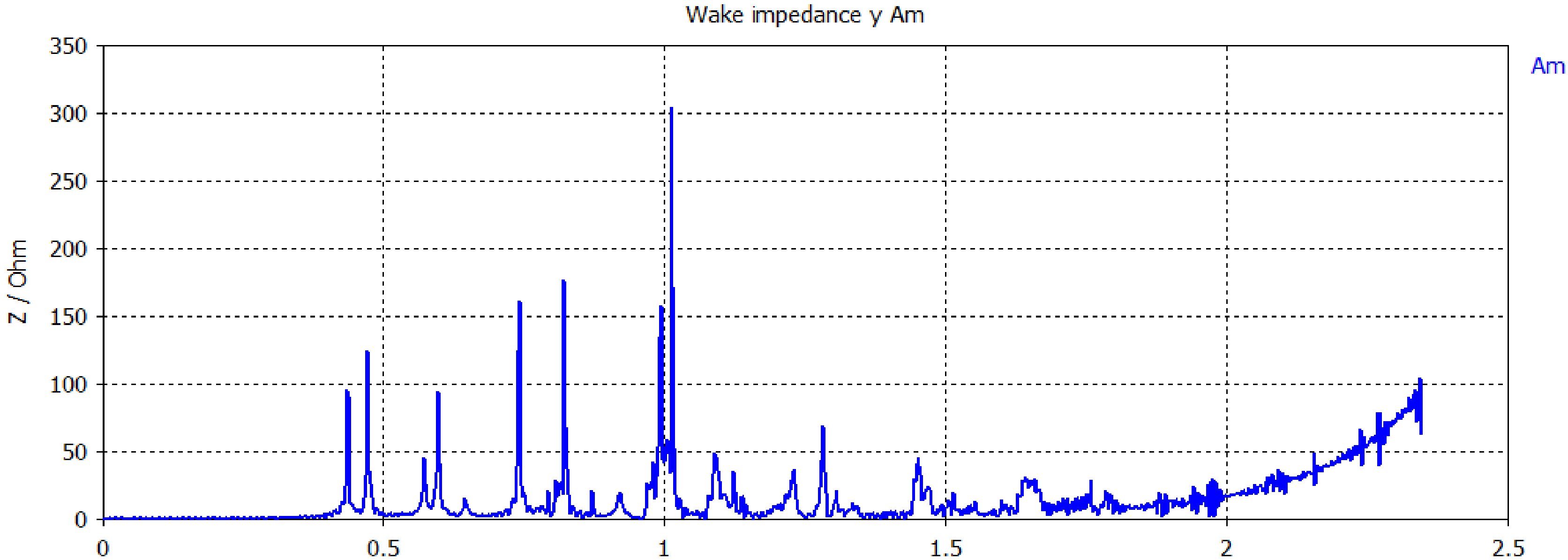
Required impedance < 2kΩ

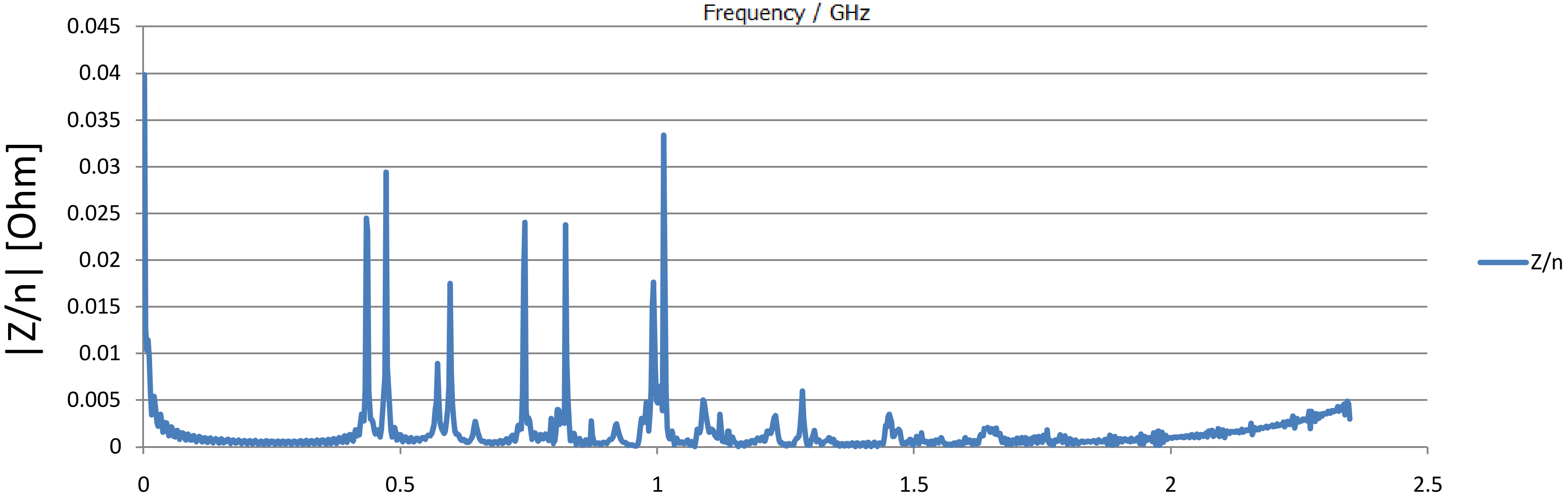
Transverse impedance (Horizontal)





Transverse impedance (vertical)





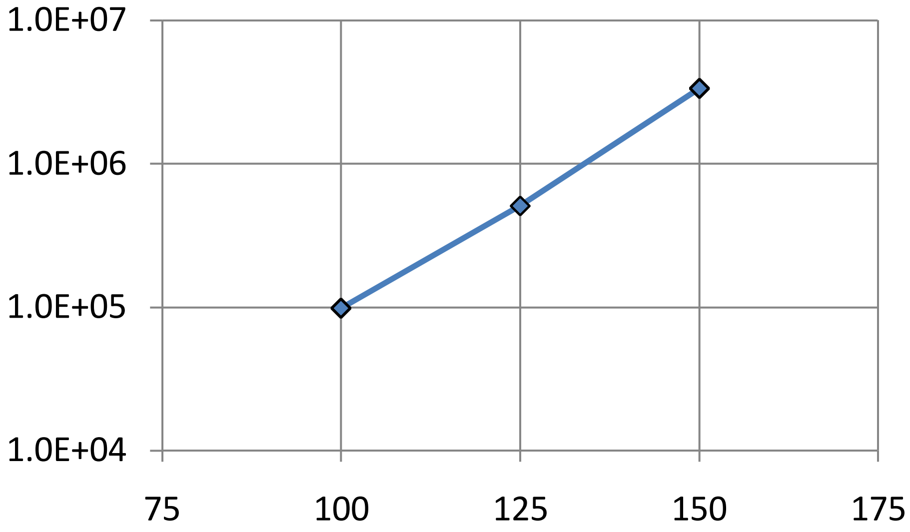
Heat load (just for crab mode)

- In KEKB , Rs of crab cavity was 140nΩ.
- Maximum Esp is 25MV/m.

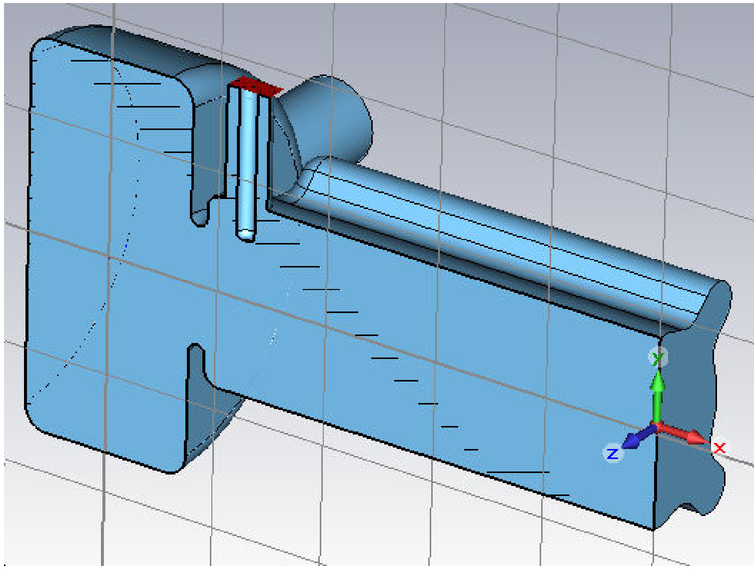
R_s [nΩ]	100~140
E_{sp} [MV/m]	25
H_{sp} [Oe]	843
V_{kick} [MV]	1.13
Stored energy [J]	27.8
Q_0	$9.1 \times 10^8 \sim 1.3 \times 10^9$
Heat load [W]	54~77

assumed

Input coupler



Distance between the input coupler port and beam is assumed as 250mm. 77D standard coaxial component is applied as an input coupler.



Antenna position [mm]	Qext	RF power* [kW]
100	9.8e4	144
125	5.1e5	28
150	3.4e6	4.2

It is required RF power to make 25MV/m Esp.