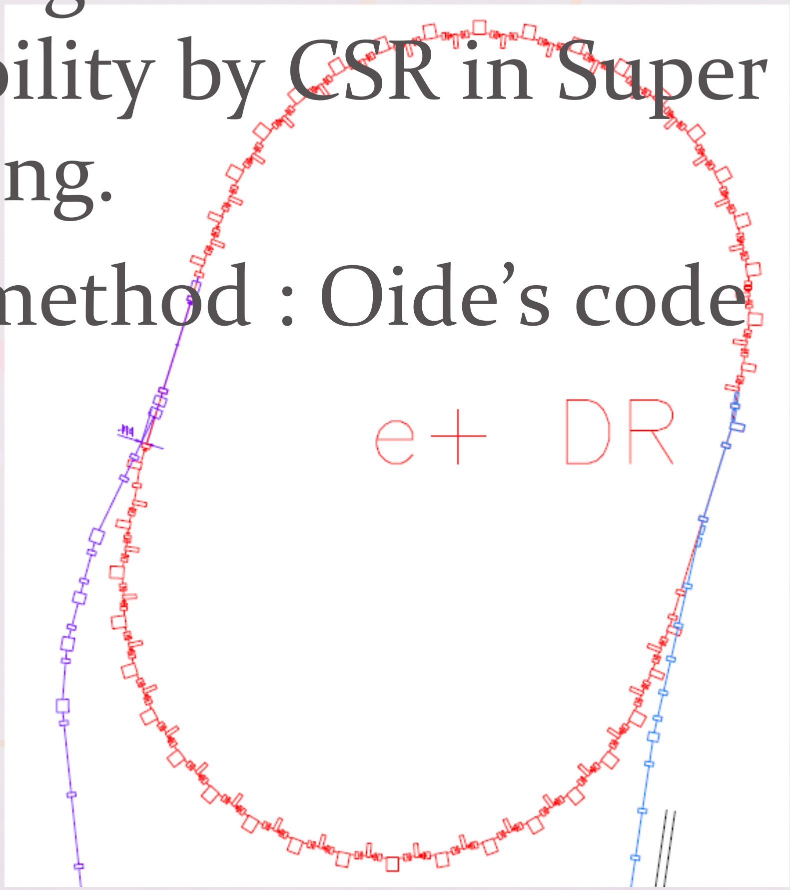
CSR @ SuperKEKB Damping Ring

H.Ikeda
2010/11/08 : CSR mini WS

- Calculation of Longitudinal microwave instability by CSR in Super KEKB damping ring.
- CSR calculation method : Oide's code

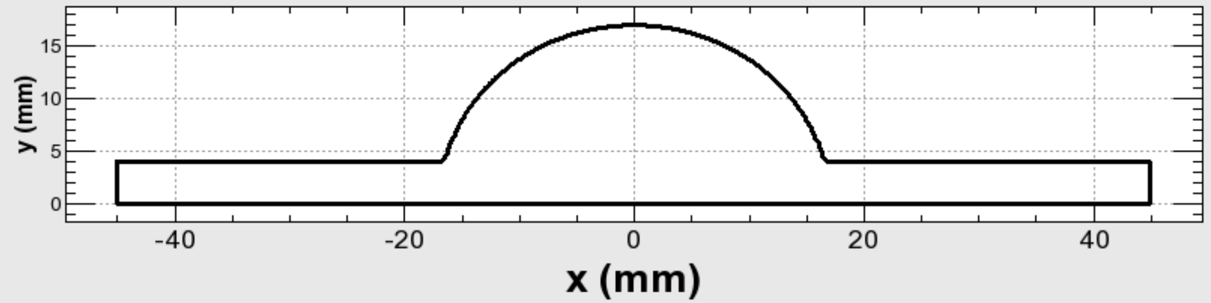


DR parameter

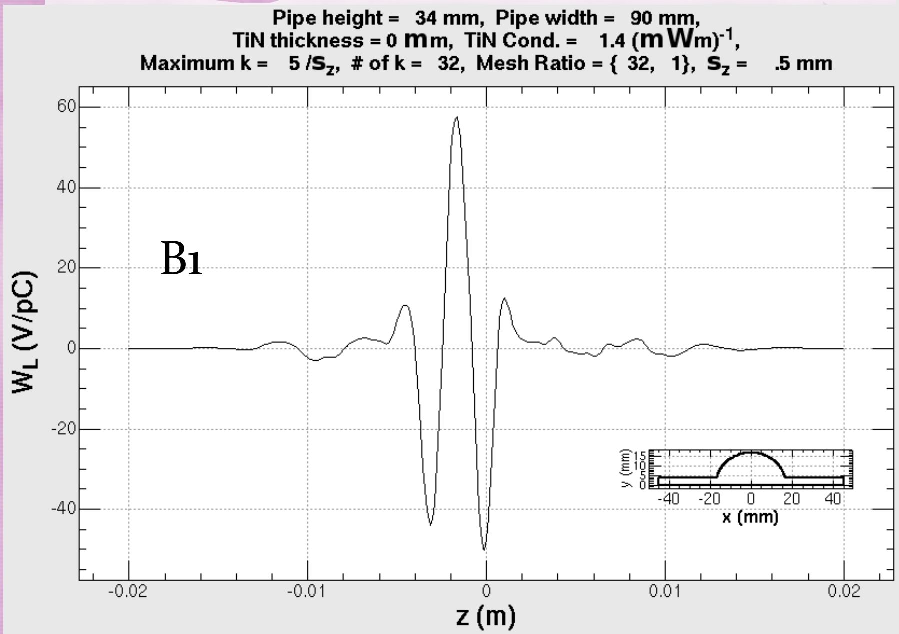
Parameter	Ver2002 (Vc=1.4MV)	Unit
Bunch length	6.53	mm
Synchrotron tune	.02569	
Energy	1.1	GeV
Number of bunches	4	
Circumference	135.50207	m
Maximum stored current	70.8	mA
Damping rate	0.0415×10^{-3}	
Energy spread	5.53×10^{-4}	eV

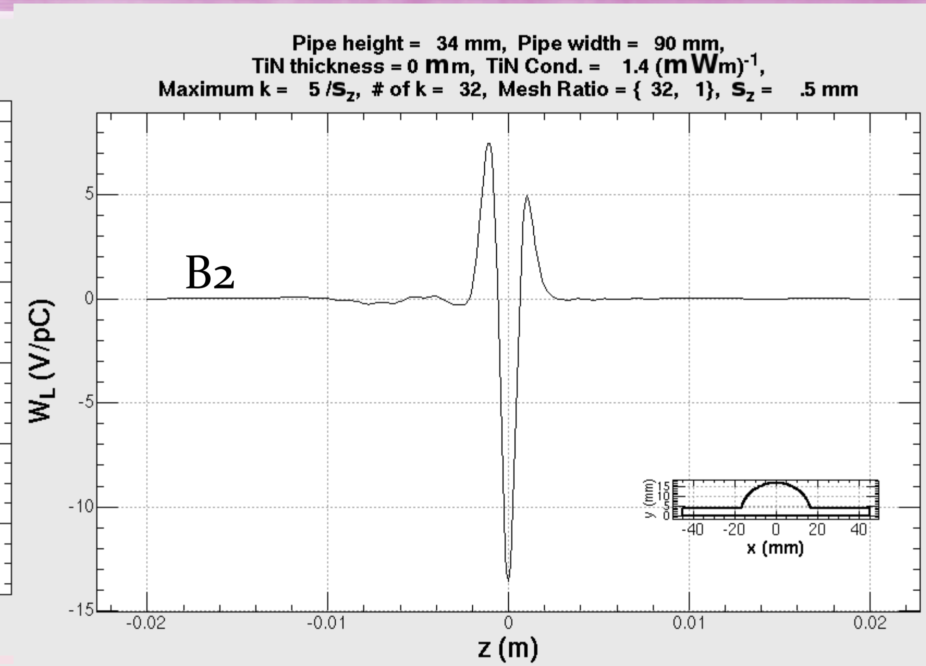
CSR calculation

- Model : ante-chamber (single bend :ver2002)+ infinite straight pipe
  - $32 \times B1 + 38 \times B2 + 6 \times B3 + 2 \times B4$
  - $\sigma z = 0.5mm$



Bend	Length[m]	Bending angle	F1[m]	# of elements
B1	.7424811724100523	.276792304281	.1494616246506949	32
B2	.28654039019399097	.0968773064984	.1320718325647242	38
B3	.39208451642982994	.124603294562	.13861629436763273	6
B4	.4793512530881169	.152189009719	.13926216449400475	2


Pipe height = 34 mm, Pipe width = 90 mm,
TiN thickness = 0 mm, TiN Cond. = 1.4 (mWm)-1,
Maximum k = 5 /sz, # of k = 32, Mesh Ratio = { 32, 1}, sz = .5 mm
B1
WL (V/pC)
z (m)
y (mm)
x (mm)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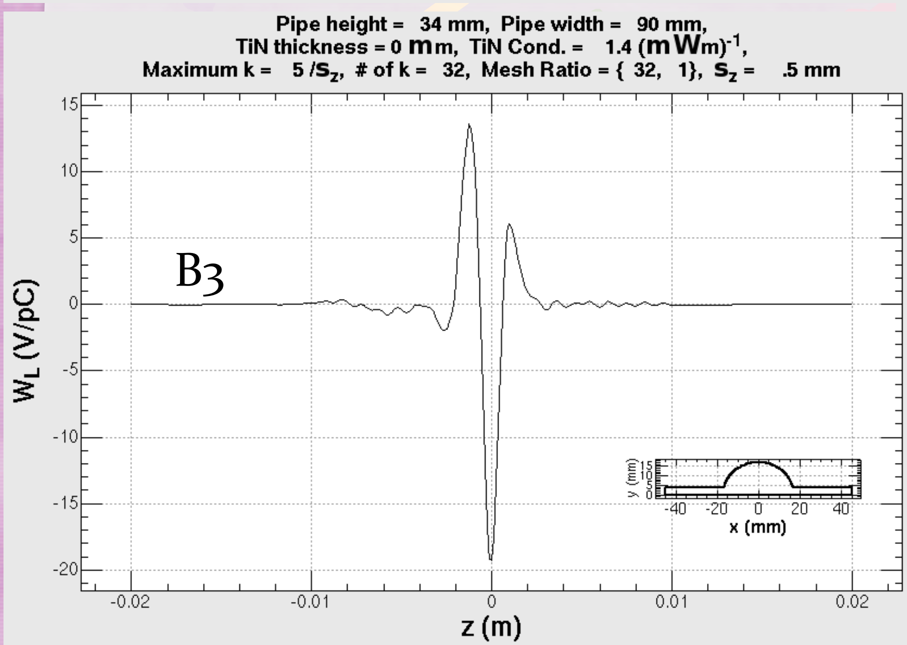
B2
WL (V/pC)
z (m)
y (mm)
x (mm)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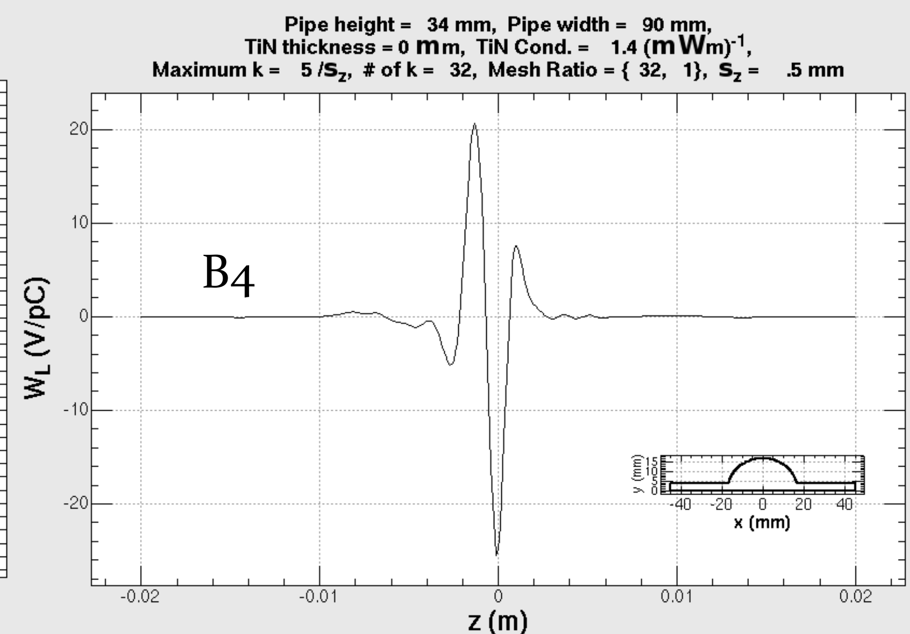
B3
WL (V/pC)
z (m)
y (mm)
x (mm)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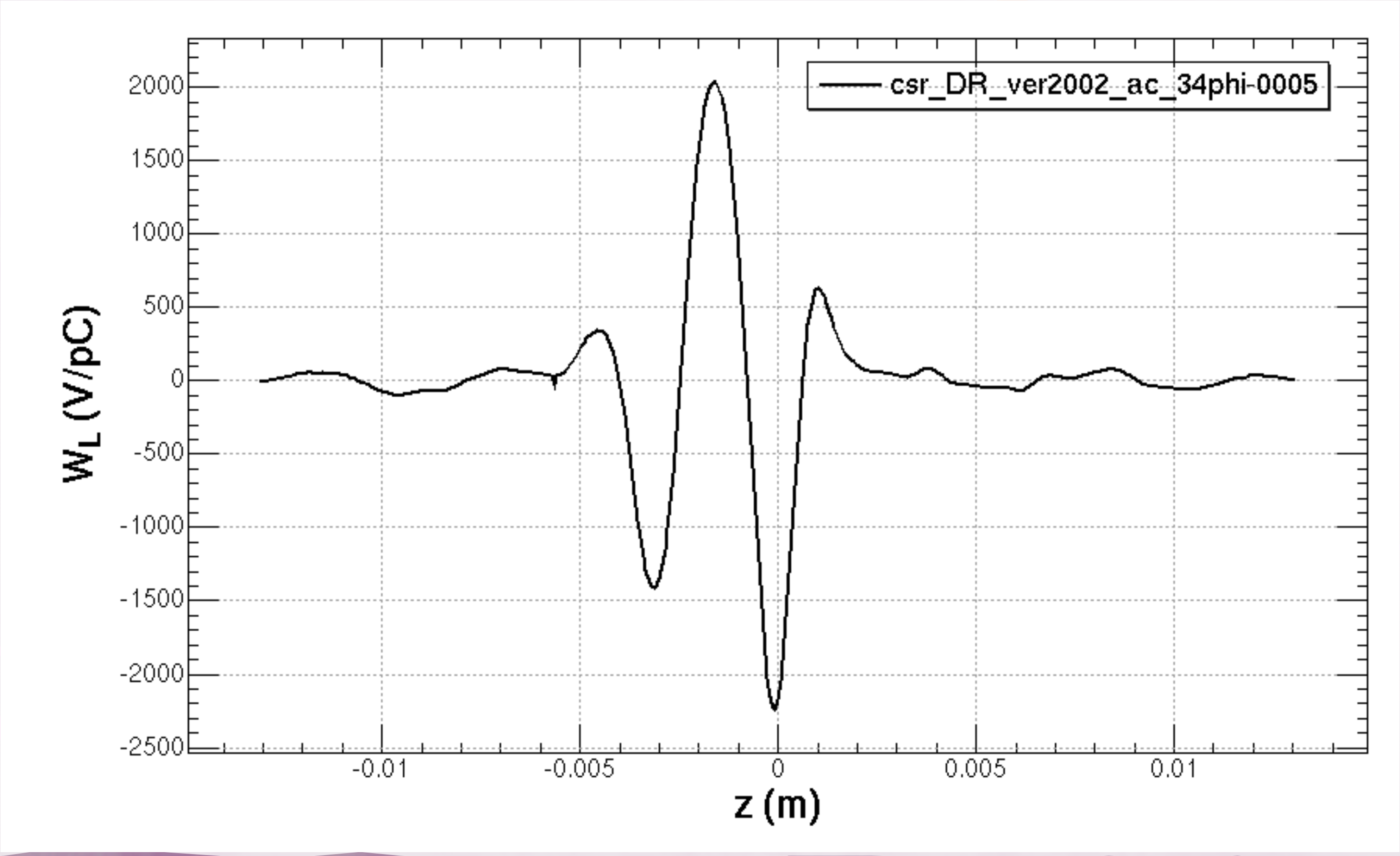
Maximum k = 5 /sz, # of k = 32, Mesh Ratio = { 32, 1}, sz = .5 mm
B4
WL (V/pC)
z (m)
y (mm)
x (mm)

Sum of all magnets

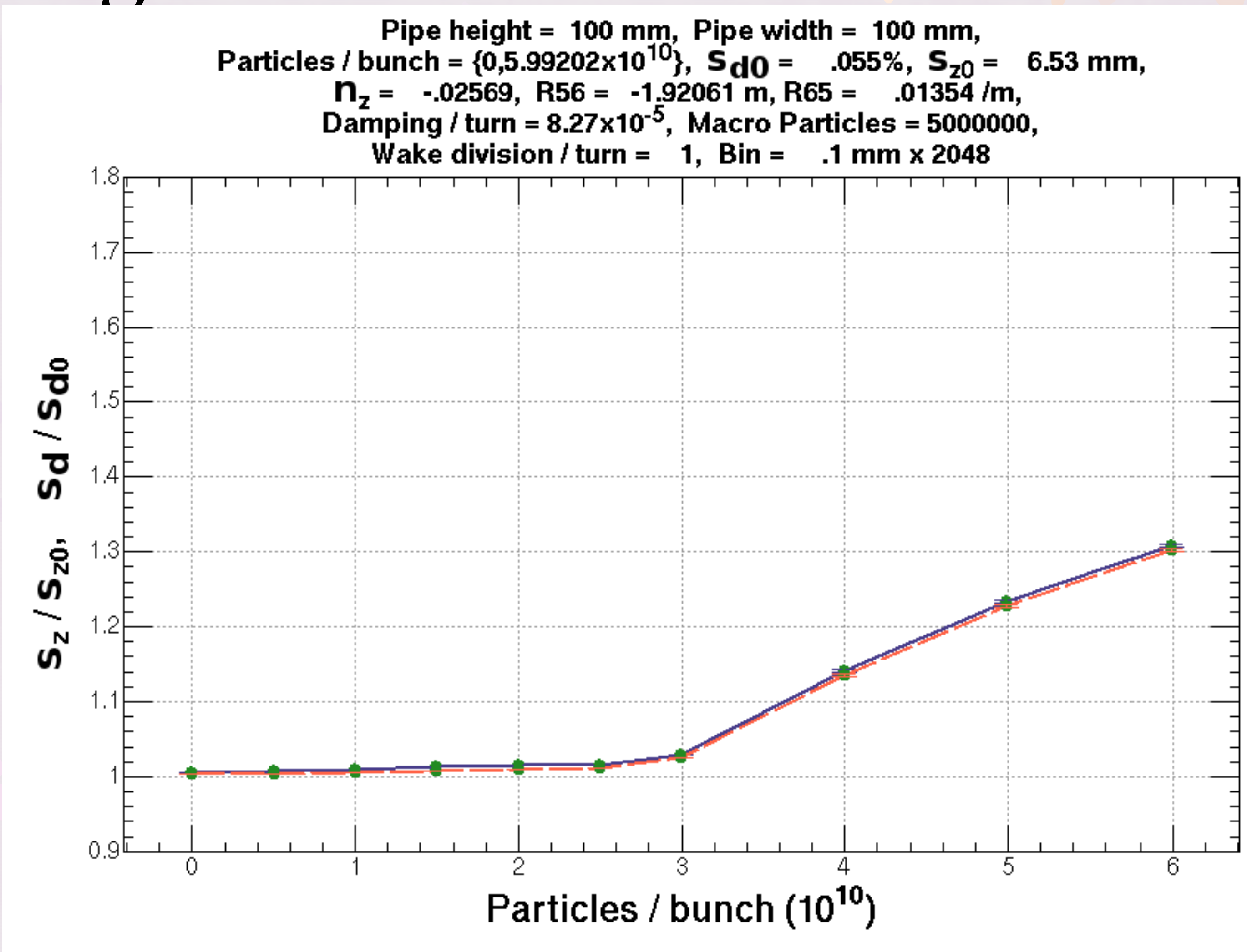
- $32 \times B1 + 38 \times B2 + 6 \times B3 + 2 \times B4$



Longitudinal microwave instability

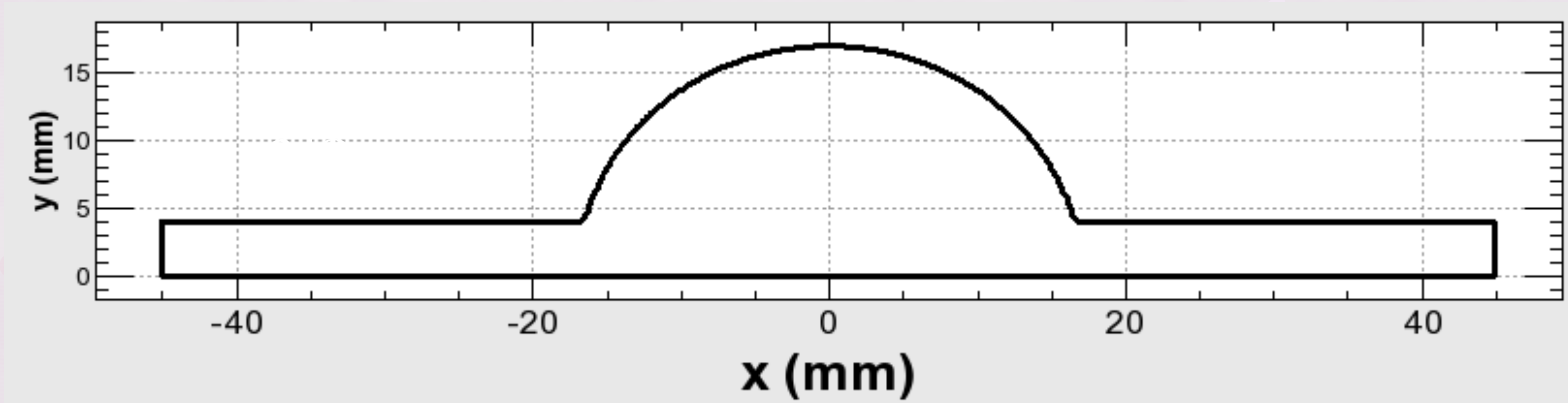
- Calculation of the longitudinal microwave instability by multi particle tracking（by Oide code）
  - Number of particles for tracking : 5,000,000
  - Current：0-6x10^{10}
  - Number of turn：45,000～50,000

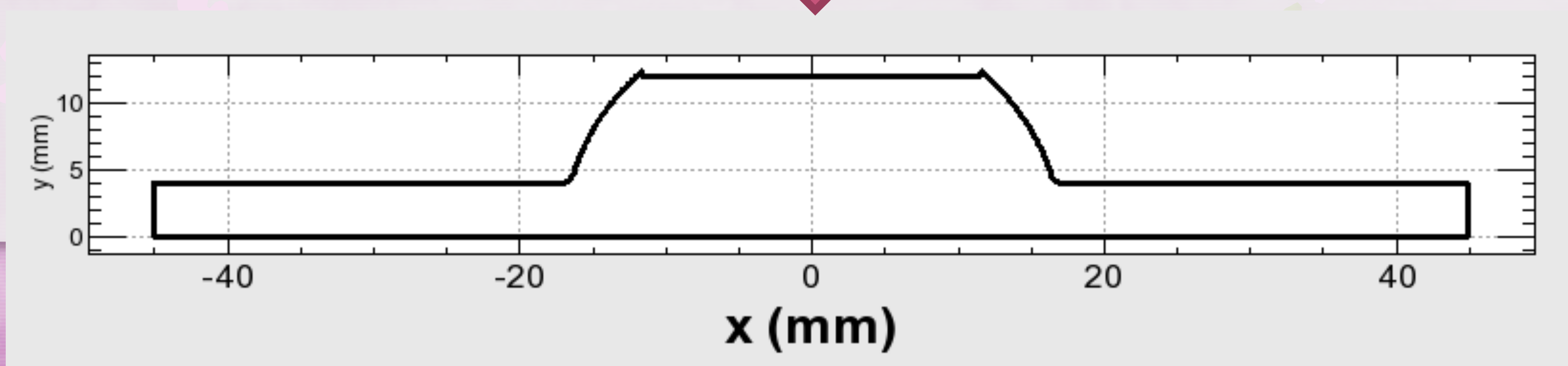
Longitudinal microwave instability

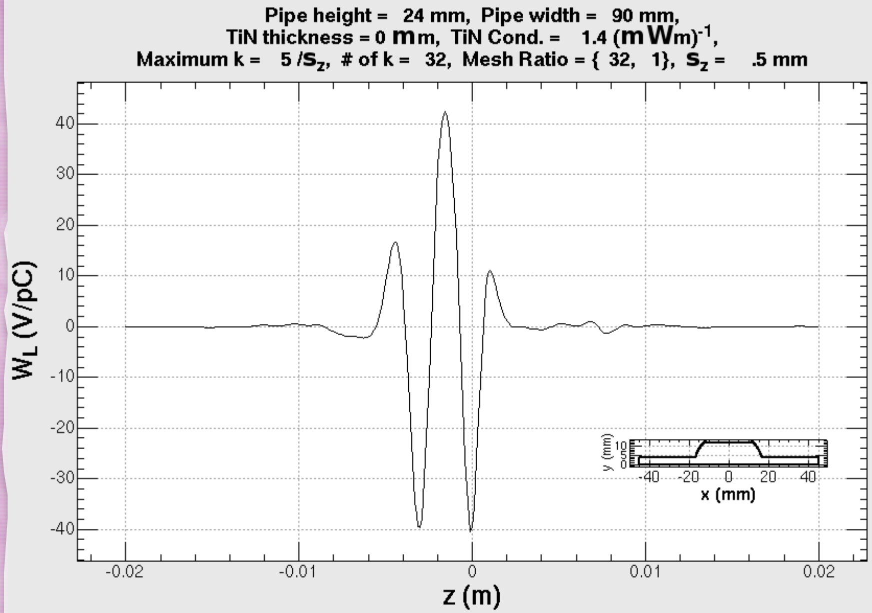


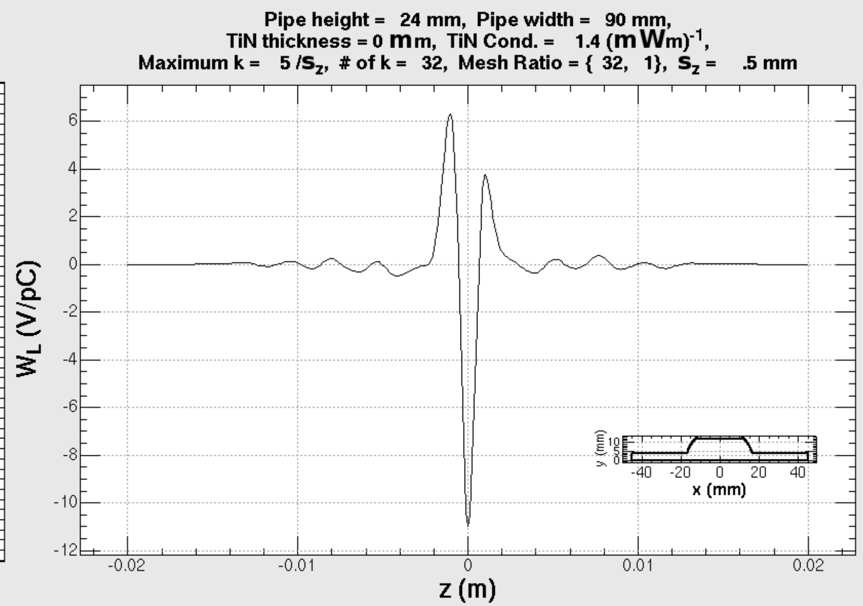
Chamber の形状を変えてCSRを計算してみる。

- 使用code : Numerical Calculation-Oide's code
- chamber形状:






Pipe height = 24 mm, Pipe width = 90 mm,
TiN thickness = 0 μm, TiN Cond. = 1.4 (μΩm)-1,
Maximum k = 5 /σz, # of k = 32, Mesh Ratio = { 32, 1}, σz = .5 mm
WL (V/pC)
z (m)
y (mm)
x (mm)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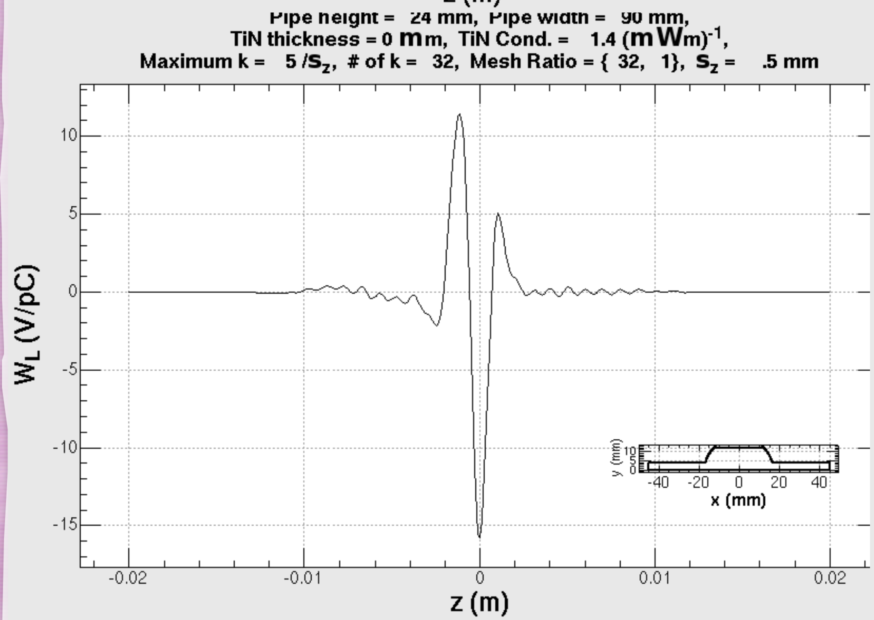
z (m)
y (mm)
x (mm)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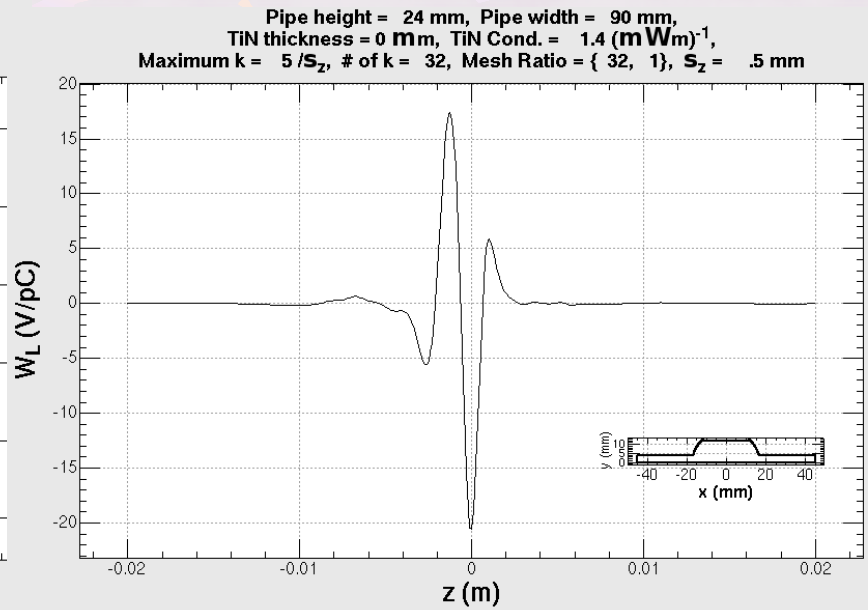
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WL (V/pC)
z (m)
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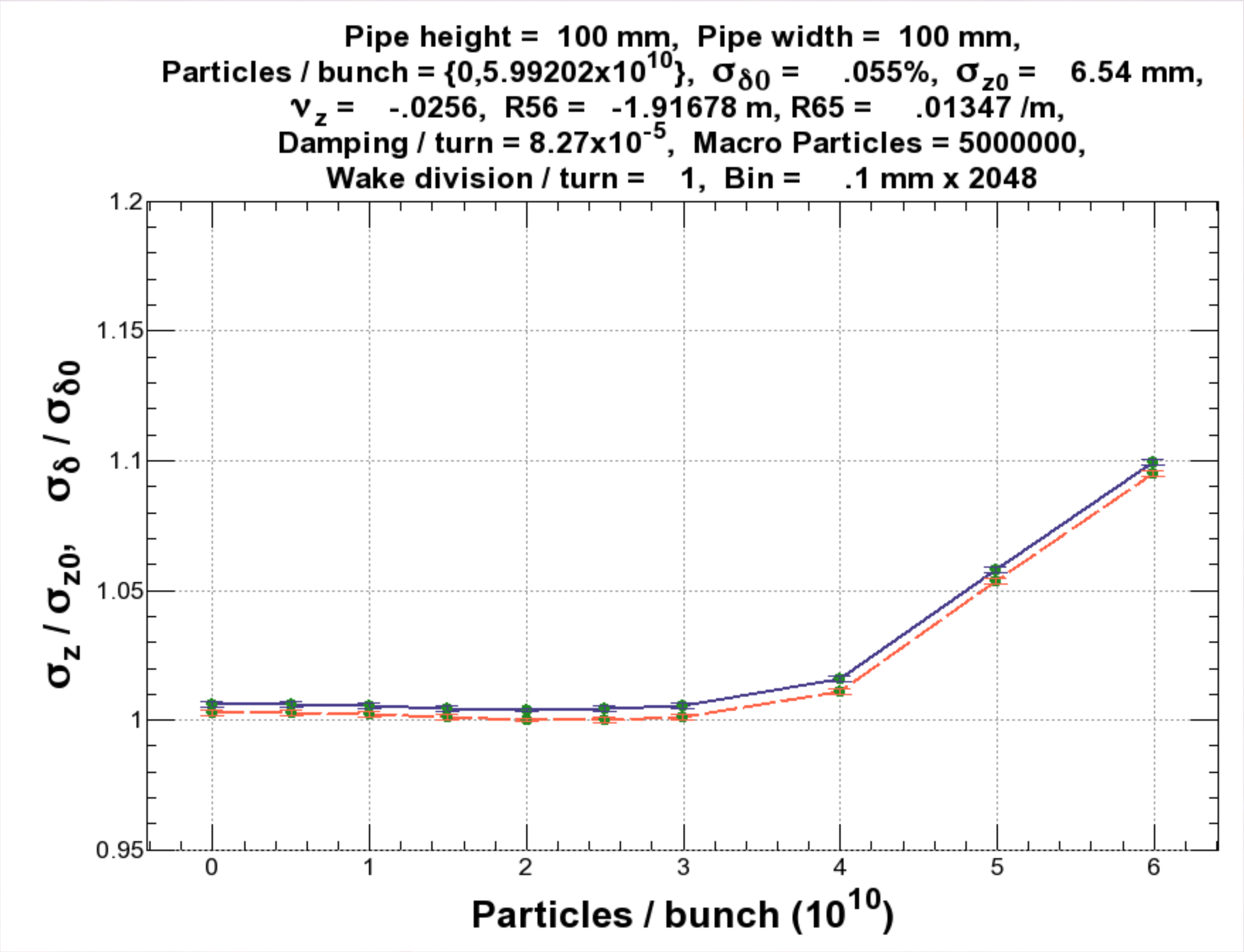
Pipe height = 100 mm, Pipe width = 100 mm,
Particles / bunch = {0,5.99202x10^10}, σ_δ0 = .055%, σ_z0 = 6.54 mm,
ν_z = -.0256, R56 = -1.91678 m, R65 = .01347 /m,
Damping / turn = 8.27x10^-5, Macro Particles = 5000000,
Wake division / turn = 1, Bin = .1 mm x 2048
σ_z / σ_z0, σ_δ / σ_δ0
Particles / bunch (10^10)
1.2
1.15
1.1
1.05
1
0.95
0
1
2
3
4
5
6

- Old version

summary

- Microwave instability caused by CSR was calculated for Super KEKB Damping Ring. It causes 12% bunch lengthning.
- Changing of chamber shape is effective to keep the bunch length, but it is difficult from the point of view of hardware.

Future Plan

- CSR calculation using all of the magnet components.

Future Plan

- Beam Test @ ATF

  F.Zimmermann suggested to study as follows.

  - directly observation the microwave radiation (Aryshev_san can install microwave detectors)
  - monitoring the bunch length and shape by streak camera
  - extract ion the bunches and measure its energy spread with a wire scanner in the extraction line by scaling over many such bunches, and doing so for different bunch intensities.
  - We can see a kink in the bunch length versus bunch intensity curve, and at the same time an increase in energy spread, plus the emission of microwaves, all happening at the same bunch intensity.