Longitudinal and Transverse Impedance of The SPring-8 Storage Ring

T. Nakamura
SPring-8, Kamigori, Ako-gun, Hyogo 678-12, Japan

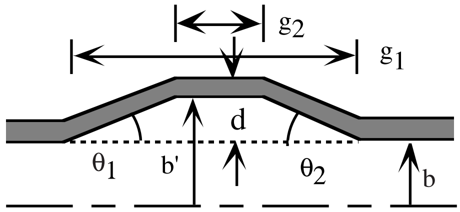

Figure 1. Dimension of two-dimensional models

Table 1. Dimensions of two-dimensional models of elements of the vacuum chamber.

element	dimension [mm, rad]						
	b	b'	d=|b'-b|	g_1	g_2	θ_1	θ_2
RF cavity	50	250	200	220	220	90	90
weldments	20	22	2	0.2	0.2	90	90
flanges*	20	23	3	0.5	0	-	90
offsets	20	20.5	0.5	-	0	0	90
ID† section	20	5	15	-	-	5	5
transition at RF section	20	50	30	-	-	10	10
absorbers at RF section	50	35	15	-	-	10	10
BPM††	20	-	-	0.5	0.5	90	90

†: ID is Insertion Device, ††: BPM is Beam Position Monitor, *:with RF contact finger

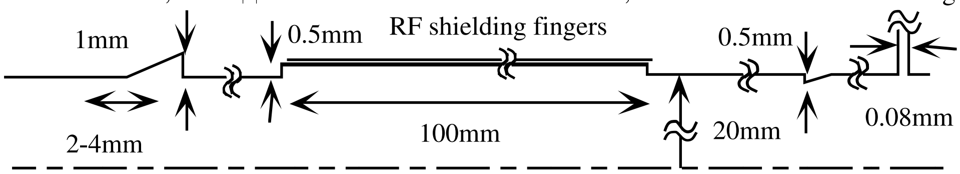

Figure 2. Shape of a valve

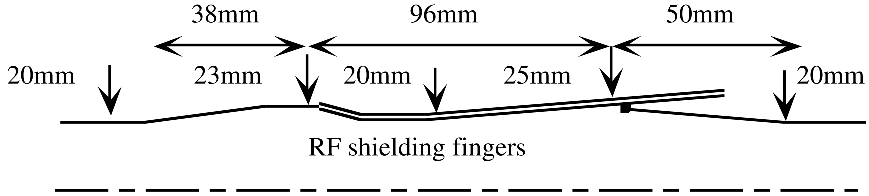

Figure 3. The shape of a bellows.

Table 2. Dimension of slots

slot size[mm]	height	length	depth
between RF contact fingers	1	1~100	1
to antechamber	10 ~ 12	-	> 20
slot to DIP†	2	50	4

†: DIP is Distributed Ion Pump

Table 3. Impedance of the SPring-8 Storage Ring (βy :Hybrid Lattice)

Elements	Number of Elements	Total Impedance Simulation longitudinal [Ω]	Total Impedance Simulation Transverse [Ω/m]	d/min.{b,b'} [mm/mm]	βy [m]
RF cavities	32	$1.2\times10^{8}\frac{1+i}{\sqrt{\omega}}$	$2.4\times10^{19}\frac{1+i}{\omega\sqrt{\omega}}$	54 / 50	7.8
weldments	2000	$-8.0\times10^{-9}\ i\omega$	$-1.2\times10^{4}\ i$	20 / 20	17
flanges†	700	$-5.3\times10^{-9}\ i\omega$	$-0.8\times10^{4}\ i$	20 / 20	17
offsets	2700	$-15.2\times10^{-9}\ i\omega$	$-2.3\times10^{4}\ i$	20 / 20	17
bellows†	400	$760-13.6\times10^{-9}\ i\omega$	$7.9\times10^{14}/\omega-1.4\times10^{4}\ i$	24 / 20	17
BPMs	300	75	$5.3\times10^{13}/\omega$	29 / 20	17
transitions at RF	4 pair	$-1.8\times10^{-9}\ i\omega$	$-0.07\times10^{4}\ i$	31 / 20	8
absorbers at RF†	8	$-1.4\times10^{-9}\ i\omega$	$-0.03\times10^{4}\ i$	37 / 35	8
ID sections	40	$-7.6\times10^{-9}\ i\omega$	$-4.6\times10^{4}\ i$	10 / 5	8
valves†	100	$40-2.3\times10^{-9}\ i\omega$	$6\times10^{13}/\omega-0.34\times10^{4}\ i$	20 / 20	17
beam pipe transition (70-90-70)	150	$--2.4\times10^{-9}\ i\omega$	-		
pumping slots	3000	$-0.76\times10^{-9}\ i\omega$	-	-	17
slots to antechamber	500	$-0.38\times10^{-9}\ i\omega$	-	-	17
slots between RF fingers	24000	$-0.76\times10^{-9}\ i\omega$	$-0.05\times10^{4}\ i$	-	17

† : These elements have RF shielding fingers.

Table 3. Loss parameters of a single element

Bunch Length [r.m.s.]	loss parameters [V/C] 3 mm	5 mm	10 mm
an RF cavity	8.07E+11	6.43E+11	4.82E+11
a weldment	5.02E+09	2.78E+08	1.88E+07
a flange	6.61E+08	8.09E+07	7.58E+06
an offset	2.81E+09	8.69E+08	1.21E+08
an ID section†	6.93E+10	1.11E+10	1.36E+09
a transition at RF	8.57E+11	1.56E+11	1.16E+10
an absorber at RF	2.56E+11	1.22E+11	3.87E+10
bellows	9.81E+10	4.14E+10	9.57E+09
a valve	1.50E+10	6.04E+09	9.60E+08
a slot opening	9.65E+08	1.08E+08	1.88E+06
Total (One Turn)	8.28E+13	3.69E+13	1.77E+13

The loss parameters and the parasitic loss power caused by them for different bunch length is shown in Table 3 and Table 4, respectively.

The expected natural bunch length is 3.5-5mm.

Table 4. Parasitic Loss Power of a single elements at the stored current of 100mA=5mA/bunch×20 bunch

Bunch Length [r.m.s.]	Parasitic Loss Power [W] 3 mm	5 mm	10 mm
an RF cavity	1932.75	1539.97	1154.38
a weldment	12.02	0.67	0.05
a flange	1.58	0.19	0.02
an offset	6.73	2.08	0.29
an ID section	165.97	26.58	3.26
a transition at	2052.50	373.62	27.78
an absorber at	613.11	292.19	92.69
bellows	234.95	99.15	22.92
a valve	35.92	14.47	2.30
a slot opening	2.31	0.26	0.00
Total (One Turn)	1.98E+05	8.84E+04	4.24E+04

7. Reference

[1] T. Nakamura, “Estimation Scheme of Longitudinal and Transverse Impedance,” SPring-8 Annual Report 1995.

[2] W. Watanabe, et al. ,"Vacuum Chamber and Crotch Absorber for the SPring-8 Storage Ring Vacuum Chamber," Conference Record of the 1993 IEEE Particle Accelerator Conference, Vol.5, pp.3845-3847.

[3] T. Nakamura, “Characteristics of Impedance of Small grooves,” SPring-8 Annual Report 1995.