1 Outline of the Accelerators

The Photon Factory manages two light sources: the 2.5 GeV PF and the 6.5 GeV PF-AR. Although the former belongs to the Photon Factory and is operated by the Light Source Division, the latter is operated by the Accelerator Laboratory for the historical reason that it was constructed as a booster synchrotron for the TRISTAN collider for particle physics, and only parasitically used as an X-ray source. The two rings are provided with electrons by the KEK linear accelerator. The injection energy of 2.5 GeV of the PF ring is its operation energy, whereas it is necessary to ramp the energy of the PF-AR from its injection energy of 3 GeV to its operation energy of 6.5 GeV.

The machine parameters of the two rings are tabulated in Table 1, and spectral distributions of SR from the bending magnets and the insertion devices are shown in Fig. 1. Calculated spectral performances are listed in Table 2.

In FY2007 the PF ring was predominantly run in multibunch mode at 2.5 GeV, with some operation time also devoted to single-bunch top-up mode at 2.5 GeV and 3 GeV multibunch mode. On the other hand, the PF-AR was operated in single-bunch mode at 6.5 GeV throughout the year.

Table 1 Principal beam parameters of the PF Ring and PF-AR.

	PF ring	PF-AR
Energy	2.5 GeV (3 GeV)	6.5 GeV
Natural emittance	34.6 nm rad	293 nm rad
Circumference	187 m	377 m
RF frequency	500.1 MHz	508.6 MHz
Bending radius	8.66 m	23.2 m
Energy loss per turn	0.4 MeV	6.66 MeV
Damping time		
Vertical	7.8 ms	2.5 ms
Longitudinal	3.9 ms	1.2 ms
Natural bunch length	10 mm	18.6 mm
Momentum compaction factor	0.00644	0.0129
Natural chromaticity		
Horizontal	–12.9	–14.3
Vertical	–17.3	–13.1
Stored current	450 mA	60 mA
Number of bunches	280	1
Beam lifetime	40 hr (at 450 mA)	15-20 hr (at 60 mA)

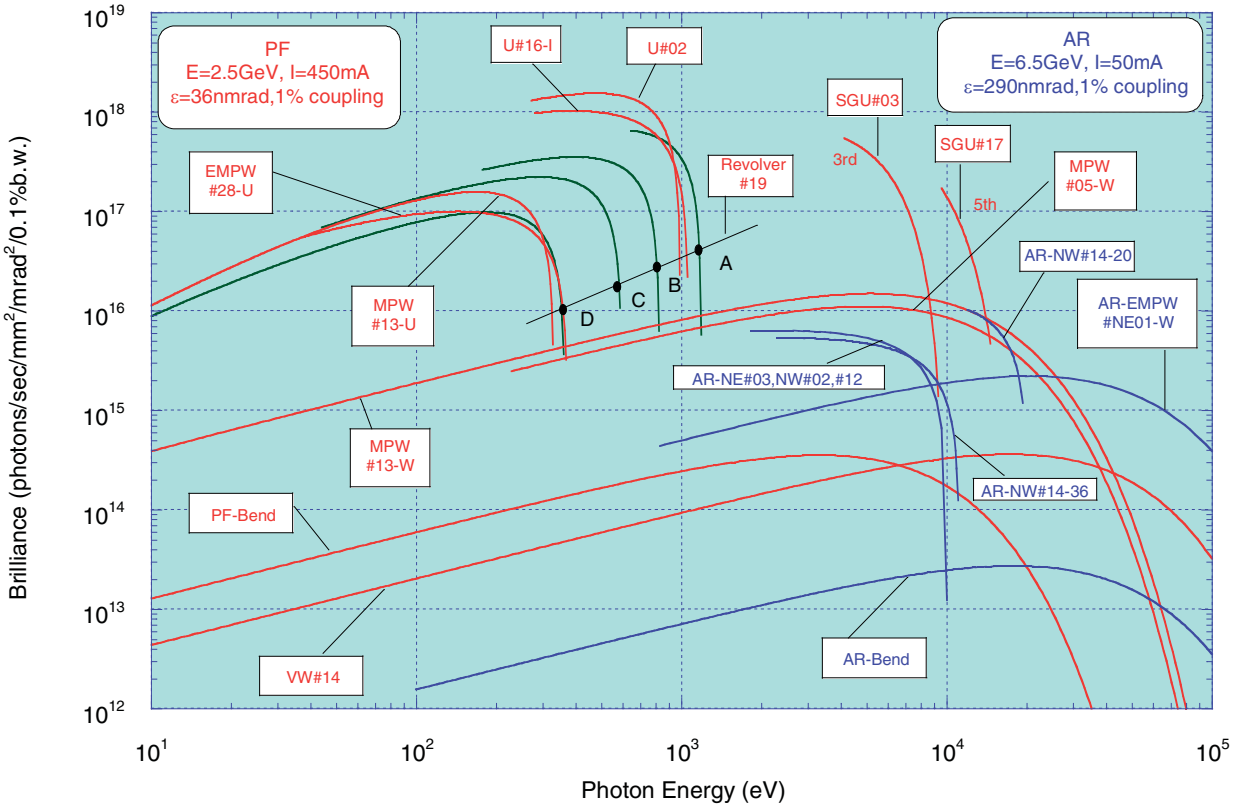

Figure 1
Synchrotron radiation spectra available at the PF Storage Ring (2.5 GeV) and the PF-AR (6.5 GeV). Brilliance of the radiation vs. photon energy are denoted by red curves for the insertion devices, U#02, SGU#03, MPW#05, MPW#13, VW#14, U#16-1, SGU#17, Revolver#19 and EMPW#28, and bending magnets (PF-Bend) at the PF Storage Ring. Blue curves denote those for the insertion devices, EMPW#NE01, U#NE03, U#NW02, U#NW12, U#NW14-36 and U#NW14-20, and the bending magnets (AR-Bend) at the PF-AR. The name of each source is assigned in Table 2. Several insertion devices have both undulator and wiggler modes, which are denoted by U and W, respectively (the undulator mode of MPW#05 and AR-EMPW#NE01 is not shown). The spectral curve of each undulator (or undulator mode of multipole wiggler) is a locus of the peak of the first harmonic within the allowance range of K parameter. For SGU#03 and SGU#17, spectra are shown for the first, third and fifth harmonic regions. Spectra of Revolver#19 are shown for four kinds of period.

Table 2 Insertion devices.

Name	E/I	λu	N	L	Gy(Gx)	By(Bx)	Type of magnet	σ_x	σ_y	$\sigma_{x'}$	$\sigma_{y'}$	Ky(Kx)	$\varepsilon_1/\varepsilon_c$	D	B	P
	GeV/mA	cm		m	cm	T		mm	mm	mrad	mrad		keV			kW
PF	2.5/450															
Bend								0.41	0.059	0.178	0.012		4	5.38E+13	3.48E+14	
U#02		6	60	3.6	2.8	0.4	H(NdFeB)	0.65	0.042	0.054	0.008	2.3		2.73E+17	1.55E+18	1.07
SGU#03		1.8	26	0.5	0.4	1	P(NdFeB)	0.6	0.012	0.088	0.029	1.68		2.50E+16	5.44E+17	0.82
MPW#05-W		12	21	2.5	2.64	1.4	H(NdFeB)	0.71	0.045	0.078	0.009	16	5.9	2.22E+15	1.10E+16	8.83
MPW#13-W		18	13	2.5	2.71	1.5	H(NdFeB)	0.74	0.02	0.094	0.019	25	6.2	1.45E+15	1.47E+16	9.73
MPW#13-U												2		1.70E+16	1.57E+17	0.06
VW#14					5	5	S.C.	0.53	0.045	0.128	0.008		20.8	5.42E+13	3.59E+14	
U#16-I		5.6	44	2.5	2.1	0.6(0.38)	P(NdFeB)	0.654	0.042	0.055	0.008	3(2)		1.03E+18	1.82E+17	0.88
SGU#17		1.6	29	0.5	0.4	0.92	P(NdFeB)	0.6	0.012	0.088	0.029	1.37		7.88E+17	1.71E+17	0.69
Revolver#19		5	46	3.6	2.8	0.28	H(NdFeB)	0.7	0.045	0.078	0.009	1.3		1.31E+17	6.48E+17	0.31
		7.2	32			0.4	H(NdFeB)					2.7		7.17E+16	3.52E+17	0.63
		10	23			0.54	H(NdFeB)					5		4.53E+16	2.22E+17	1.15
		16.4	14			0.62	P(NdFeB)					9.5		2.02E+16	9.81E+16	1.52
EMPW#28-U		16	12	1.92	3(11)		P(NdFeB)	0.53	0.045	0.127	0.008	3(3)		1.55E+16	1.00E+16	0.26
PF-AR	6.5/50															
Bend								1	0.2	0.593	0.036		26	3.25E+13	2.59E+13	
EMPW#NE1-W		16	21	3.36	3(11)	1(0.2)	P(NdFeB)	1.07	1.07	0.268	0.032	15(3)	28(90%)	1.53E+15	2.12E+15	4.6
EMPW#NE1-U												3(3)		3.41E+15	4.70E+15	0.35
U#NE3		4	90	3.6	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3		1.08E+16	6.39E+15	3.09
U#NW2		4	90	3.6	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3		1.08E+16	6.39E+15	3.09
U#NW12		4	95	3.8	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3		1.08E+16	6.39E+15	3.26
U#NW14-36		3.6	79	2.8	1	0.8	P(NdFeB)	1.35	0.14	0.338	0.036	2.8		6.41E+15	5.41E+15	2.6
U#NW14-20		2	75	1.5	0.8	0.63	P(NdFeB)	0.75	0.07	0.383	0.038	1.17		6.41E+15	5.41E+15	0.78

Calculated spectral performances of the bend source and all the insertion devices at the PF Storage Ring (2.5 GeV, 450 mA) and the PF-AR (6.5 GeV, 50 mA). λ_u: period length, N: the number of the periods, L: length of undulator or wiggler, $G_y(G_x)$: minimum vertical (horizontal) gap height, $B_y(B_x)$: maximum vertical (horizontal) magnetic field, Type of magnet, H: hybrid configuration, S.C.: super conducting magnet, σ_x,σ_y: horizontal or vertical beam size, σ_x',σ_y': horizontal or vertical beam divergence, $K_y(K_x)$: vertical (horizontal) deflection parameter, D: photon flux density (photons/sec/mrad^2/0.1%b.w.), B: brilliance (photons/sec/mm^2/mrad^2/0.1%b.w.), P_T: total radiated power. Different operating modes of undulator and wiggler are denoted by -U and -W, respectively.