1 Outline of the Accelerators

Photon Factory operates two storage rings, the PF Storage Ring (2.5 GeV) and PF-AR (Advanced Ring; 6.5 GeV), for synchrotron radiation experiments. Both the rings store electrons injected from the common injector LINAC (Linear Accelerator) of KEK, which also provides electrons and positrons to the KEK B-Factory. Machine parameters of the two rings are summarized in Table 1 and available spectral distribution of synchrotron radiation from the various insertion devices and the bending magnets are shown in Fig. 1. Parameters of the light sources are listed on Table 2. The annual operation schedule in FY2002 is shown in Fig. 2. The PF ring was run in single-bunch operation and in 3-GeV operation for a few weeks each, while the PF-AR was operated regularly in single bunch mode at 6.5 GeV except for special operation for medical applications (5.0 GeV). Operation statistics as well as research and development work on the PF ring and the PF-AR will be described in the following sections.

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

		PF Ring	PF-AR
Energy		2.5 GeV	6.5 GeV
Injection Energy		2.5 GeV	3.0 GeV
Stored current		450 mA	55 mA
Natural emittance		36 nm-rad	290 nm-rad
Circumference		187 m	377 m
RF frequency		500.1 MHz	508.6 MHz
Harmonic number		312	640
Bending radius		8.66 m	23.2 m
Energy loss per turn		0.4 MeV	6.66 MeV
Tune			
	Horizontal	9.60	10.15
	Vertical	4.28	10.21
Damping time			
	transverse	7.8 ms	2.5 ms
	longitudinal	3.9 ms	1.2 ms
Momentum compaction factor			
		0.0061	0.00129
Natural chromaticity			
	Horizontal	−12.5	−14.3
	Vertical	−12.3	−13.1
Natural bunch length		10 mm	18.6 mm
Number of bunches		280	1
Beam lifetime		50 hr (at 400 mA)	20 hr (at 40 mA)

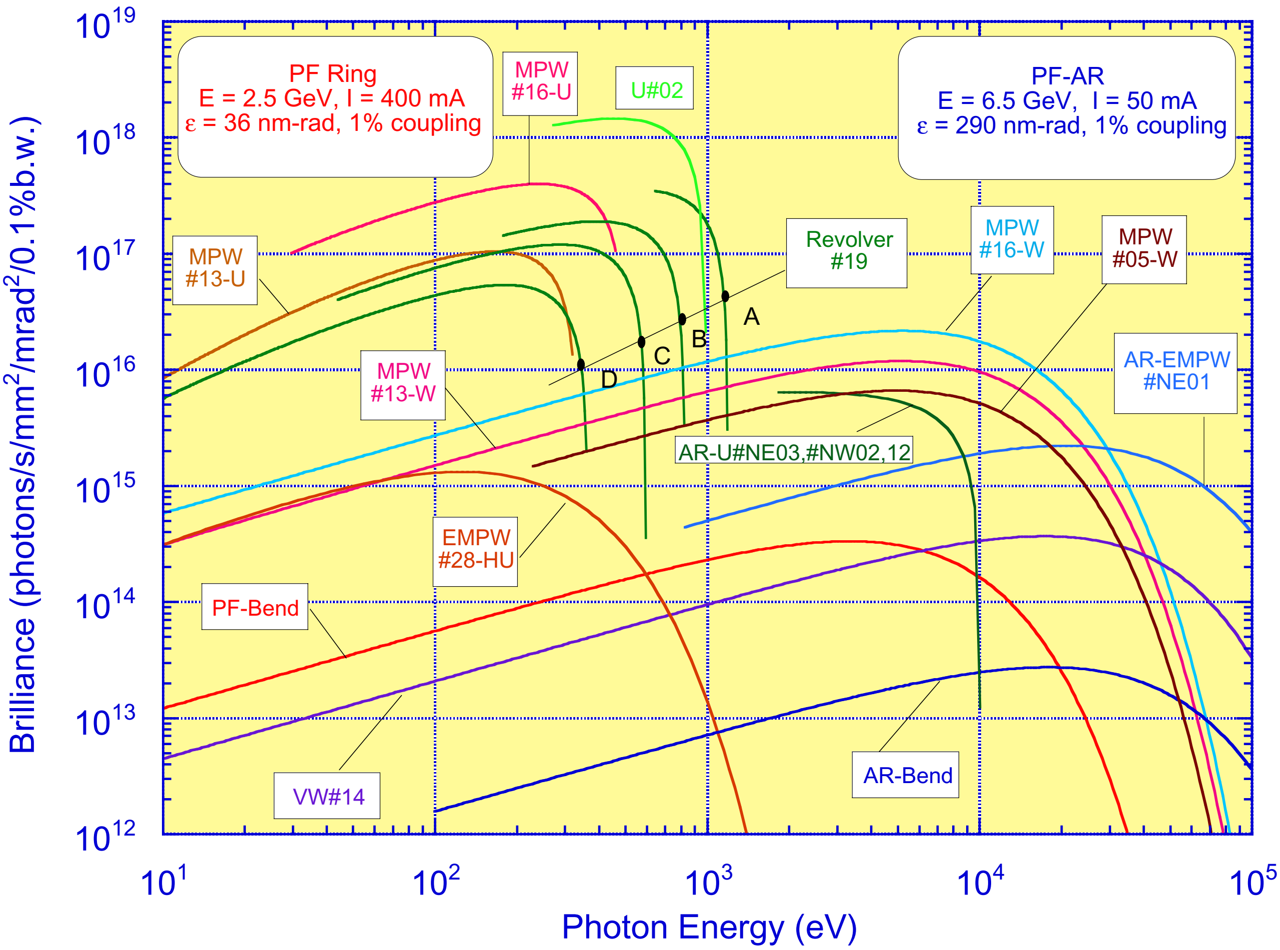
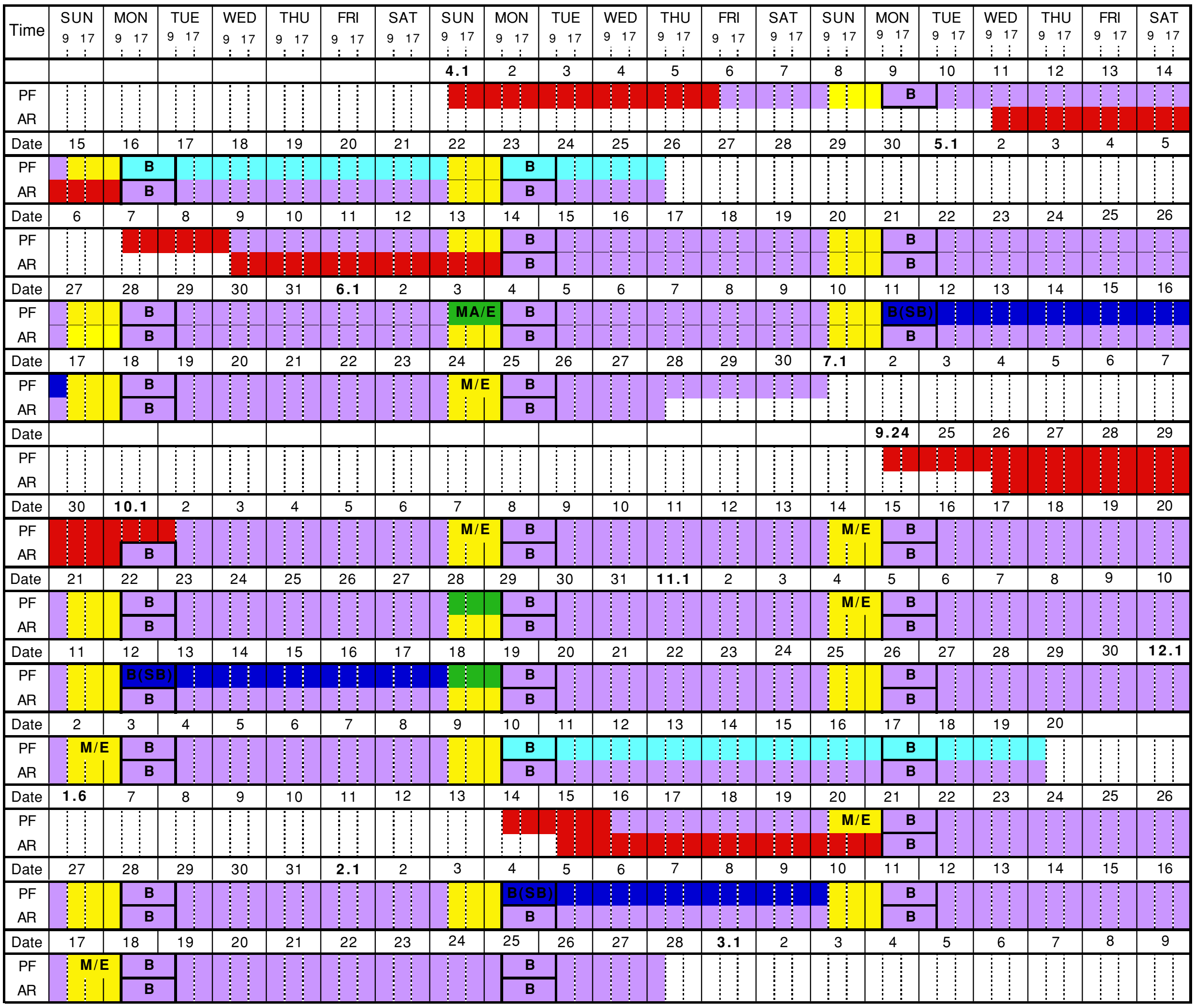


Figure 1
Synchrotron radiation spectra available at the PF Storage Ring (2.5 GeV) and the PF-AR (6.5 GeV). Brilliance of radiation vs. photon energy for the insertion devices (U#02, MPW#05, MPW#13, VW#14, MPW#16, Revolver#19 and EMPW#28) and the bending magnet (PF-Bend) of the PF Storage Ring, and for the insertion devices (EMPW#NE1, U#NE03, U#NW02 and U#NW12) and the bending magnet (AR-Bend) of 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 (wiggler mode of EMPW#28 and undulator mode of AR-EMPW#NE01 are 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. Spectra of Revolver#19 are shown for four kinds of period. Please note that not the first harmonic but the third or fifth harmonic is used for X-ray experiments at AR-NE3, AR-NW2 and AR-NW12 beamlines.

Table 2 Insertion devices

Calculated spectral performances of the bend source and all the insertion devices at the PF Storage Ring (2.5 GeV, 400 mA) and the PF-AR (6.5 GeV, 50 mA). λ_u: period length, N: 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,
$\varepsilon_1/\varepsilon_0$: photon energy of the first harmonic (critical energy in the case of bend source or wiggler), D: photon flux density (photons/s/mrad^2/0.1%b.w.), B: brilliance (photons/s/mm^2/mrad^2/0.1%b.w.), P_T: total radiated power, dP/dΩ: power in unit solid angle. Different operating modes of undulator and wiggler are denoted by -U and -W, respectively.

Name	λ_u cm	N	L m	$G_y(G_x)$ cm	$B_y(B_x)$ T	Type of magnet	σ_x mm	σ_y mm	σ'_x mrad	σ'_y mrad	$K_y(K_x)$	$\varepsilon_1/\varepsilon_c$ keV	D	B	P_T kW	dP/dΩ kW/mrad^2
PF Storage Ring																
Bend					0.96		0.39	0.059	0.186	0.013		4	4.80E+13	3.31E+14		0.081
U#02	6	60	3.6	2.8	0.4	H(NdFeB)	0.42	0.042	0.084	0.008	2.3	0.27	1.48E+17	1.28E+18	0.95	3.93
U#05-W	12	21	2.5	2.64	1.4	H(NdFeB)	0.85	0.056	0.088	0.008	16	5.9	2.00E+15	6.61E+15	7.85	4.91
MPW#13-W	18	13	2.5	2.71	1.5	H(NdFeB)	0.86	0.019	0.117	0.018	25	6.2	1.29E+15	1.18E+16	8.64	3.38
MPW#13-U											2	0.108	1.08E+16	9.25E+16	0.055	0.25
VW#14				5	5	S.C.	0.58	0.036	0.083	0.01		20.8	4.84E+13	3.67E+14		0.42
MPW#16-W	12	26	3.12	1.9	1.5	H(NdFeB)	0.42	0.042	0.084	0.008	16.8	6.2	1.03E+15	8.95E+15	10.89	6.46
MPW#16-U											2	0.163	4.23E+16	3.63E+17	0.16	0.74
Revolver#19	5	46	2.3	3	0.28	H(NdFeB)	0.85	0.056	0.088	0.008	1.3	0.639	1.05E+17	3.47E+17	0.28	1.89
	7.2	32			0.4	H(NdFeB)					2.7	0.176	4.39E+16	1.44E+17	0.56	1.92
	10	23			0.54	H(NdFeB)					5	0.0437	1.28E+16	4.01E+16	1.02	2.02
	16.4	14			0.62	P(NdFeB)					9.5	0.0078	1.71E+15	4.29E+15	1.35	1.41
EMPW#28-W	16	12	1.92	3(11)	1(0.2)	P(NdFeB)	0.58	0.036	0.083	0.01	15(3)	4.1(90%)	3.07E+14	2.28E+15	2.84	0.46
EMPW#28-U											3(3)	0.182(99%)	1.81E+16	1.33E+17	0.03	0.087
PF-AR																
Bend					0.94		1	0.2	0.593	0.036		26	3.25E+13	2.59E+13		0.34
EMPW#NE1W	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	17.7
EMPW#NE1U											3(3)	0.25(97%)	3.41E+15	4.70E+15	0.35	0.77
U#NE3	4	90	3.6	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3	1.8	1.01E+16	6.09E+16	3.09	25.7
U#NW2	4	90	3.6	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3	1.8	1.01E+16	6.09E+16	3.09	25.7
U#NW12	4	95	3.8	1	0.8	P(NdFeB)	1.57	0.17	0.312	0.029	3	1.8	1.07E+16	6.38E+16	3.26	27.2



PF: PF ring
AR: PF-AR

Tuning and ring machine study
Short maintenance and/or machine study
Ring machine study
Experiment using SR
Single bunch operation at 2.5 GeV
Multi bunch operation at 3.0 GeV
M/E — Short maintenance (~3 hours) and user experiment
B — Bouns time during maintenance of injector LINAC

Figure 2
Timetable of the machine operation in FY2002.