

6 Summary of Experimental Stations

About 70 experimental stations are operated at the PF Storage Ring and the PF-AR, as shown in Figs. 1 and 2. Two thirds of the stations are dedicated to research using hard X-rays, with the remaining one third used for studies in the VUV and soft X-ray energy regions. Tables 1 and 2 summarize the areas of the research carried out at experimental stations at the PF storage ring and PF-AR.

The specifications in terms of optics and performance of each experimental station differ according to experimental requirements and methodology. Tables 3 and 4 list the details of the optics of the hard X-ray stations and the soft X-ray / VUV stations. The principal performance parameters, including energy range, energy resolution, beam-spot size, and photon flux at the sample position are shown.

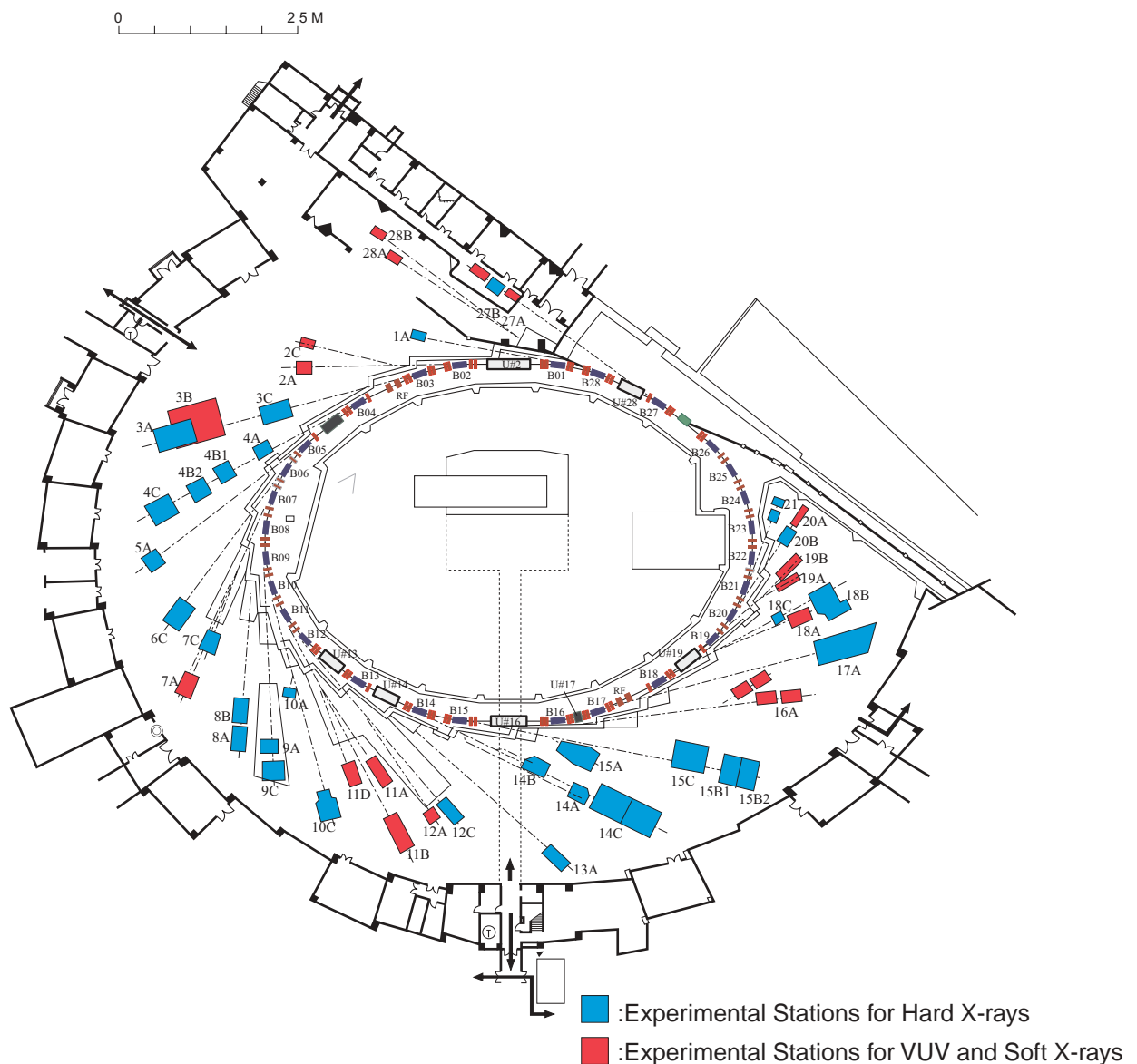


Figure 1
 Plan view of the PF experimental hall, showing hard X-ray experimental stations (blue), and VUV and soft X-ray experimental stations (red).

Table 1 Complete list of experimental stations at the PF Storage Ring.

Experimental Station	Person in Charge
BL-1 A*** Macromolecular crystallography	N. Matsugaki
BL-2 (Undulator) A Soft X-ray spectroscopy C Soft X-ray spectroscopy	Y. Kitajima J. Adachi
BL-3 (A: Short Gap Undulator) A X-ray diffraction and scattering station for materials science B VUV and soft X-ray spectroscopy C Characterization of X-ray optical elements/White X-ray magnetic diffraction	H. Nakao A. Yagishita K. Hirano
BL-4 A Trace element analysis, X-ray microprobe B1 Micro-crystal and Micro-area structure analysis B2 Powder diffraction C X-ray diffraction and scattering	A. Iida A. Nakao A. Nakao H. Nakao
BL-5 (Multipole Wiggler) A Macromolecular crystallography	Y. Yamada
BL-6 A Macromolecular crystallography C X-ray diffraction and scattering	N. Igarashi H. Kawata
BL-7 A [RCS] Soft X-ray spectroscopy B* [RCS] Surface photochemical reaction and angle-resolved photoelectron spectroscopy C X-ray spectroscopy and diffraction	J. Okabayashi [RCS], K. Amemiya J. Okabayashi [RCS], K. Amemiya H. Sugiyama
BL-8 A B X-ray powder diffraction under extreme condition	A. Nakao A. Nakao
BL-9 A XAFS C X-ray versatile station	M. Nomura M. Nomura
BL-10 A X-ray diffraction/scattering C Small-angle X-ray scattering of solution sample	A. Nakao N. Igarashi
BL-11 A Soft X-ray spectroscopy B Surface EXAFS, soft X-ray spectroscopy C** VUV spectroscopy (solid state) D VUV and soft X-ray photoelectron spectroscopy for solid	Y. Kitajima Y. Kitajima K. Ono K. Ito
BL-12 A Characterization of VUV-SX optical elements, soft X-ray spectroscopy C XAFS	A. Yagishita M. Nomura

Experimental Station	Person in Charge
BL-13 (Undulator) A Soft X-ray photoemission spectroscopy and XAFS	K. Mase
BL-14 (Vertical Wiggler) A Crystal structure analysis and detector development B High-precision X-ray optics C****X-ray imaging C2* High-pressure and high-temperature X-ray diffraction (MAX-III)	S. Kishimoto K. Hirano K. Hyodo T. Kikegawa
BL-15 A Small-angle X-ray scattering of muscle and alloys B1 White X-ray topography and X-ray experiments for general purpose B2 Surface and interface X-ray diffraction C High-resolution X-ray diffraction	N. Igarashi H. Sugiyama H. Sugiyama K. Hirano
BL-16 (Variable Polarization Undulator) A Soft X-ray spectroscopies with circular and linear polarization	K. Amemiya
BL-17 (Short Gap Undulator) A Macromolecular crystallography	N. Igarashi
BL-18 A [ISSP] Angle-resolved photoelectron spectroscopy of surfaces and interfaces B General purpose (X-ray) C High pressure X-ray powder diffraction (DAC)	A. Kakizaki [ISSP], A. Yagishita N. Igarashi T. Kikegawa
BL-19 (Revolver Undulator) A [ISSP] Spin-resolved photoelectron spectroscopy (Mott detector) B [ISSP] Soft X-ray emission spectroscopy	A. Kakizaki [ISSP], A. Yagishita A. Kakizaki [ISSP], A. Yagishita
BL-20 A VUV spectroscopy B [ASCo.] White and monochromatic beam general-purpose X-ray station	K. Ito M. Cheah [ASCo.], H. Kawata
BL-21 [Light Source Division]Beam position monitoring	K. Haga [Light Source]
BL-27 (Beamline for experiments using radioisotopes) A Radiation biology, soft X-ray photoelectron spectroscopy B Radiation biology, XAFS, X-ray diffuse scattering	K. Kobayashi N. Usami
BL-28 (Elliptical / Helical Undulator) A High-resolution VUV-SX beamline for angle-resolved photoemission B High-resolution VUV-SX spectroscopy	K. Ono K. Ono

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* shutdown at the summer of 2009.
** shutdown at the end of FY2009.
*** set up at the FY2009.
**** renamed as 14C after the summer of 2009.

Table 2 List of experimental stations at the PF-AR.

Experimental Station	Person in Charge
AR-NE1 (Multipole Wiggler) A Laser-heating high pressure X-ray diffraction and nuclear resonant scattering (DAC)	T. Kikegawa
AR-NE3 (Undulator) A Macromolecular crystallography	Y. Yamada
AR-NE5 C High pressure and high temperature X-ray diffraction (MAX-80)	T. Kikegawa
AR-NE7 A High pressure and high temperature X-ray diffraction (MAX-III), X-ray Imaging	K. Hyodo
AR-NW2 (Undulator) A XAFS/Dispersive XAFS /Time-resolved-X-ray diffraction	M. Nomura
AR-NW10 A XAFS	M. Nomura
AR-NW12 (Undulator) A Macromolecular crystallography	N. Matsugaki
AR-NW14 (Undulator) A Time-resolved X-ray diffraction, scattering and absorption	S. Adachi

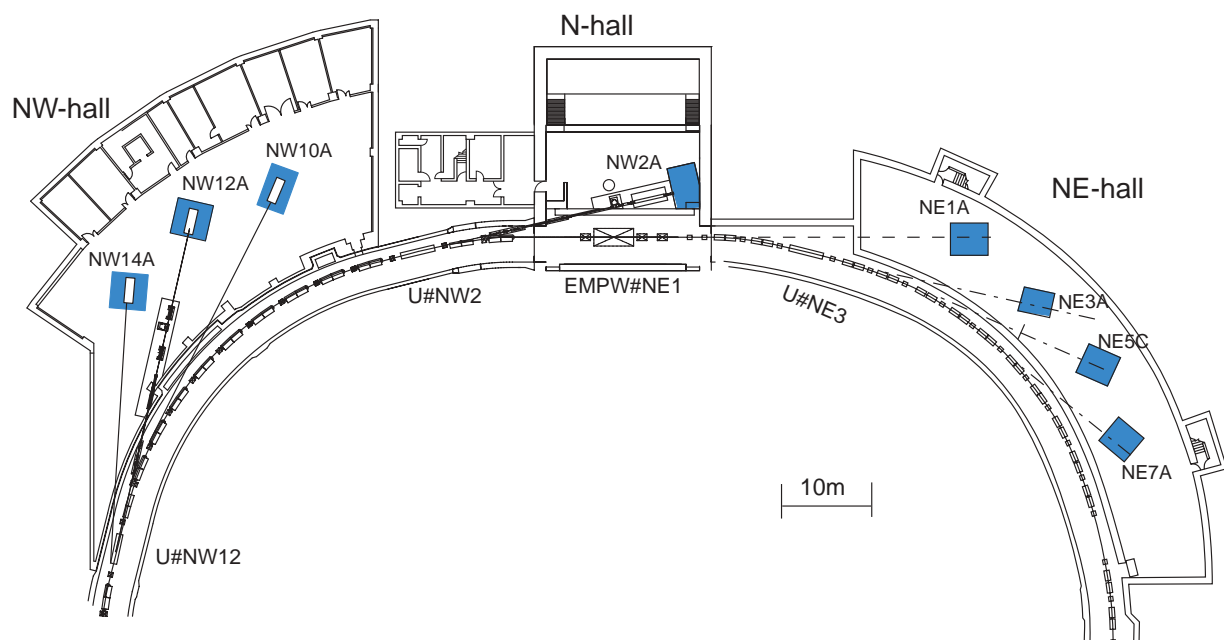


Figure 2
Plan view of beamlines in the PF-AR north-east, north, and north-west experimental halls.

Table 3 Specifications of X-ray beamline optics.

Branch Beamline	Horizontal Acceptance (mrad)	Type of Monochromator	Mirror	Photon Energy (keV)	Beam Size (H×V) (mm)	Photon Flux at Sample Position (/s)	Energy Resolution ($\Delta E/E$)×10 ⁻⁴	Reference
BL-1A**	0.2	Channel-cut Si(111) Liquid N ₂ Cooling	Bimorph Si Rh-Coated Si Rh-Coated	3.7 ~ 4.5 11 ~ 13	0.07×0.02	1×10 ¹⁰ (0.01×0.01 mm ²)	~ 2	
BL-3A	1	Flat Double Crystal Si(111)	Bent Cylinder	4 ~ 14	0.7×0.2	6×10 ¹²	~ 5	
BL-3C	1.75	Double Crystal Si(111)	None	4 ~ 20 or white	20×6(mono) 0.1×0.1(white)			
BL-4A	6	Double Crystal Sagittal Focusing	Vertical Focusing Mirror	4 ~ 20	50×4 4×1		~ 2	1
BL-4B1	4.5	Double Crystal Si(111)	None	4 ~ 35	50×5		~ 2	2
BL-4B2	4.5	Double Crystal Si(111)	Bent Cylinder	6 ~ 20	13×2		~2	3, 4
BL-4C	2	Flat Double Crystal Si(111)	Bent Cylinder	5 ~ 19	0.7×0.5		~5	5, 6
BL-5A	0.5	Micro-Channel Double Crystal Si(111)	Bent Plane Si Rh-Coated Bent Cylinder Si Rh-Coated	6.5 ~ 17	1.2×0.4	3×10 ¹¹ (0.2×0.2 mm ²)	~2	
BL-6A	1.2	Bent Si(111) ($\alpha = 7.5^\circ$)	Bent Plane ULE	9.5 ~ 13.5	0.5×0.25 (12.7keV)	1×10 ¹⁰ (12.7keV, 450mA, 0.2×0.2 mm ²)	~10	7
BL-6C	2	Flat Double Crystal Si(111)	Bent Cylinder	5 ~ 12 (~25 non-Focus)	1.2×1.2			
BL-7C	4	Double Crystal Si(111) Sagittal Focusing	Double Mirror Fused Quartz Focusing	4 ~ 20 (4 ~ 13)	5×1	1×10 ¹⁰ /6mm ² (8 keV, 300 mA) (1×10 ¹¹ when focused)	~ 2	8 - 10
BL-8A	2.22	Flat Double Crystal Si(111)	Bent Cylinder	5 ~ 19	0.82×0.52	3.2×10 ¹¹ (12.4keV, 400mA)	~ 5	29
BL-8B**	2.21	Flat Double Crystal Si(111)	Bent Cylinder	5 ~ 19	0.75×0.45	2.2×10 ¹¹ (12.4keV, 400mA)	~ 5	29

Branch Beamline	Horizontal Acceptance (mrad)	Type of Monochromator	Mirror	Photon Energy (keV)	Beam Size (HxV) (mm)	Photon Flux at Sample Position (/s)	Energy Resolution ($\Delta E/E$) $\times 10^{-4}$	Reference
BL-9A	3	Double Crystal Si (111)	Collimating and Focusing Bent Conical Mirrors (Rh-Coated) Double Flat Mirror (Rh/Ni-Coated)	2.2 ~ 15	1x0.3	4×10^{11} (9 keV, 300 mA)	2	11, 12
BL-9C	3.5	Double Crystal Si(111)	Bent Cylinder Rh-Coated Si	4 ~ 23 or white	1x1	5×10^{10} (9 keV, 300 mA)	~ 2	
BL-10A	1	Si(111), Si(311) Quartz(100), PG(002) Curved Si(111) ($\alpha \sim 4^\circ, 8^\circ$)	Plane Pt coated Fused Quartz	5 ~ 25	10x3		10 ~ 5	13
BL-10C	4	Double Crystal Si(111)	Bent Cylinder	4 ~ 10	1.2x0.2	$\sim 10^{11}/1.5\text{mm}^2$ (8 keV, 400 mA)	2	
BL-12C	2	Double Crystal Si(111) Si(311)	Bent Cylinder	6 ~ 23	0.65x0.4	$5 \times 10^{10}/1\text{mm}^2$ (8 keV, 300mA) w.Si(111)	~ 2	14
BL-14A	1.28 (Vertical)	Double Crystal Si (111) Si (311) Si (553)	Bent Cylinder Rh-coated Fused Quartz	5.1 ~ 19.1 9.9 ~ 35.6 22.7 ~ 84.5	2x1 at focus 5x38		2	15
BL-14B	2.2 (Vertical)	Double Crystal Si(111),	None	10 ~ 57	5x14		2	
BL-14C	1.96 (Vertical)	Double Crystal Si(111), Si(220)	None	5 ~ 100 or white	6x70		2	16, 17
BL-15A	2	Bent Crystal Ge(111) ($\alpha = 8.0^\circ$)	Bent Plane, Fused Quartz Pt-coated	8.0 (fixed)	0.5x0.25	$9 \times 10^{10}/\text{mm}^2$ (8.0 keV, 350 mA)	~ 10	18
BL-15B1 B2	2	Double Crystal Si (111)	Bent Cylinder	5 ~ 20 or white	0.6x0.4	$10^{11}/1\text{mm}^2$ (8.0keV, 350mA)	~ 2	
BL-15C	2	Double Crystal Si (111)	None	4 ~ 30	60x6			

Branch Beamline	Horizontal Acceptance (mrad)	Type of Monochromator	Mirror	Photon Energy (keV)	Beam Size (H×V) (mm)	Photon Flux at Sample Position (/s)	Energy Resolution ($\Delta E/E$)×10 ⁻⁴	Reference
BL-17A	0.1 ~ 0.2	Double Crystal Si(111) Liquid N ₂ cooling	Bent Plane Si Rh-Coated Bent Plane Si Rh-Coated	6 ~ 9 11 ~ 13	0.25×0.04	10 ¹⁰ (12.4 keV, 450mA, 0.02×0.02mm ²)	~2	19, 20
BL-18B	2	Double Crystal Si(111)	Plane and Bent Cylinder	6 ~ 30			~2	
BL-18C	1	Double Crystal Si(111)	Cylinder Fused Quartz, Pt-coated	6 ~ 25	0.07×0.04		~2	
BL-20B [ASCo.]	2	Channel Cut Si(111) Channel Cut Si(311) Sagittal Focusing Si(111) Double Crystal	None	4.5 ~ 21 10 ~ 36 4.5 ~ 25	25×2 25×1.5 0.6×1		~ 2 ~ 1 ~ 2	21
BL-27B	4	Double Crystal Si(111)	None	4 ~ 20	100×6		~ 2	22
AR-NE1A	0.28	Micro-Channel Double Crystal Si(111), High-resolution Channel Cut Si(4,2,2,)&(12,2,2)	Bent Plane W/C Multilayer Coated Si	6 ~ 50	0.1×0.1	6×10 ¹¹ (14.4keV)	~ 2	
AR-NE3A	H:0.2 V:0.1	Double Crystal Si(111) Liquid N ₂ Cooling	Pre-Mirror Bent Flat Si Rh-Coated Post-Mirror Bent Cylinder Fused Quartz Rh-Coated	6.5 ~ 17	0.8×0.2	8×10 ¹¹ (0.2×0.2mm ²)	~ 2	30 31
AR-NE5C	3	Double Crystal Si(111)	None	30 ~ 100 or white	60×5		5	23
AR-NW2A	H:1.0 V:0.2	Double Crystal Si(111) Liquid N ₂ Cooling	Bent Cylinder Si Rh-Coated Bent Flat Si Rh-Coated	5 ~ 25	0.6×0.2 ~10×0.06	6×10 ¹²	~2	24-26
AR-NW10A	1.2	Si(311)	Pt-Coated Bent Cylinder	8 ~ 42	2.2×0.5	1×10 ¹⁰	~1	27

Branch Beamline	Horizontal Acceptance (mrad)	Type of Monochromator	Mirror	Photon Energy (keV)	Beam Size (HxV) (mm)	Photon Flux at Sample Position (/s)	Energy Resolution ($\Delta E/E$) $\times 10^{-4}$	Reference
AR-NW12A	H:0.3 V:0.1	Double Crystal Si(111) Liquid N ₂ cooling	Pre-Mirror Bent Flat Si Rh-Coated Post-Mirror Bent Cylinder Si Rh-Coated	6.5-17	1.3x0.3	2x10 ¹¹ (0.2x0.2 mm ²)	~2	
AR-NW14A	H:0.3 V:0.1	Double Crystal Si(111) Liquid N ₂ Cooling	Bent Cylinder Rh-Coated Bent Flat Rh-Coated	4.9 ~ 25	0.45x0.25	5x10 ¹²	~2	28

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* shutdown during FY2009.

** set up at the FY2009.

REFERENCES

- [1] A. Iida *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1373.
 [2] K. Ohsumi *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1448.
 [3] Powder Diffraction User Group, *KEK Report*, **94-11** (1995).
 [4] H. Toraya, H. Hibino and K. Ohsumi, *J. Synchrotron Rad.*, **3** (1996) 75.
 [5] H. Iwasaki *et al.*, *Rev. Sci. Instrum.*, **60** (1989) 2406.
 [6] *Photon Factory Activity Report 1995*, **#13** (1996) E-1.
 [7] N. Sakabe *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1276.
 [8] M. Nomura and A. Koyama, *KEK Internal*, **93-1** (1993).
 [9] M. Nomura *et al.*, *KEK Report*, **91-1** (1991).
 [10] M. Nomura and A. Koyama, in "X-ray Absorption Fine Structure", ed. by S. S. Hasnain, Ellis Horwood, Chichester, 1991, p.667.
 [11] M. Nomura and A. Koyama, *J. Synchrotron Rad.*, **6** (1999) 182.
 [12] M. Nomura and A. Koyama, *Nucl. Instrum. Meth.*, **A467-468** (2001) 733.
 [13] S. Sasaki, *Rev. Sci. Instrum.*, **60** (1989) 2417.
 [14] M. Nomura and A. Koyama, *KEK Report*, **95-15** (1996).
 [15] Y. Satow and Y. Iitaka, *Rev. Sci. Instrum.*, **60** (1989) 2390.
 [16] *Photon Factory Activity Report 1999*, **#17** (2000) A 92.
 [17] *Photon Factory Activity Report 1999*, **#17** (2000) A 103.
 [18] Y. Arneima *et al.*, *Nucl. Instrum. Meth.*, **208** (1983) 471.
 [19] N. Igarashi *et al.*, *AIP Conf. Proc.*, **879** (2007) 812.
 [20] N. Igarashi *et al.*, *J. Synchrotron Rad.*, **15** (2008) 292.
 [21] R.F. Garret *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1351.
 [22] H. Konishi *et al.*, *Nucl. Instrum. Meth.*, **A372** (1996) 322.
 [23] T. Kikegawa *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1335.
 [24] T. Mori *et al.*, *AIP Conf. Proc.*, **705** (2004) 255.
 [25] H. Kawata *et al.*, *AIP Conf. Proc.*, **705** (2004) 663.
 [26] Y. Inada *et al.* *AIP Conf. Proc.*, **879** (2007) 1230.
 [27] M. Nomura *et al.*, *AIP Conf. Proc.*, **882** (2007) 896.
 [28] S. Nozawa *et al.*, *J. Synchrotron Rad.*, **14** (2007) 313.
 [29] A. Nakao *et al.*, *AIP Conf. Proc.*, 1234 (2010) 367.
 [30] Y. Yamada *et al.*, *AIP Conf. Proc.*, 1234 (2010) 415.
 [31] M. Hiraki *et al.*, *AIP Conf. Proc.*, 1234 (2010) 673.

Table 4 Specifications of VUV and soft X-ray beamline optics.

Beamline	Acceptance or $H \times V$ (mrad) Undulator Parameters	Type of Monochromator	Groove Density (ℓ/mm)	Energy Range (eV)	Beam Size $H \times V$ (mm)	Resolving Power ($E/\Delta E$) Photon Flux (photons/s)	Reference
BL-2A Undulator	$K = 0.5 \sim 2.2$ $\lambda_u = 6$ cm	Double Crystal InSb (111), Si (111)	—	1740 ~ 5000	$< 1\phi$	2000, 8000 10^{11}	1 - 4
BL-2C Undulator	$K = 0.55 \sim 2.2$ $\lambda_u = 6$ cm	Varied-Line-Space Plane Grating	1000 2200	250 ~ 1400	0.9×0.1	5000 ~ 10000 $10^{11} \sim 10^{10}$	5 - 7
BL-3B	10×2	Grazing Incidence $R = 24$ m $\alpha + \beta = 165^\circ$	200 600 1800	10 ~ 280	$< 2\phi$	200 ~ 3000 $10^{12} \sim 10^9$	8, 9
BL-7A [RCS]	6×1	Varied-Line-Space Plane Grating	300 650	50 ~ 1300	2.5×0.5	1000 ~ 9000 $10^{12} \sim 10^9$	10
BL-7B* [RCS]	6×4	1m Seya-Namioka	1200 2400	5 ~ 50	1×1	1000	11
BL-11A	5×1	Varied-Line-Space Plane Grating	300 800 1200	70 ~ 1900	2×1	500 ~ 5000 $10^{12} \sim 10^9$	12 - 15
BL-11B	4×0.6	Double Crystal InSb (111), Si (111)	—	1724 ~ 5000	5×2	2000 10^{10}	3, 16, 17, 31
BL-11C*	4.8×3	1m Seya-Namioka	1200	4 ~ 35	$\sim 1\phi$	1000	18
BL-11D	4×2	Grazing Incidence Varied Deviation-angle On-Blaze Mount $R_1 = 52.5$ m $R_3 = 22.5$ m	2400	60 ~ 245 200 ~ 900	1×0.1	2000 10^{11}	19
BL-12A	2.2×0.34	Grazing Incidence $R = 2$ m $\alpha = 88^\circ$	1200	30 ~ 1000	2×3	1000 10^9	20
BL-13A Undulator		Variable-included-angle Varied-line-spacing plane grating	300 1000	30 ~ 300 100 ~ 1200	$\sim 0.2 \times 0.1$	4000 ~ 10000 $10^{11} \sim 10^9$	21
BL-16A Undulator	$K_{\max} = 2.37$ (Circular Polarization) $K_{\max} = 3.12$ (Horizontal Linear Polarization) $K_{\max} = 1.98$ (Vertical Linear Polarization) $K_{\max} = 1.73$ (45-deg Linear Polarization) $\lambda_u = 5.6$ cm	Variable-included-angle varied-line-spacing plane grating	500 1000	250 ~ 1500	$\sim 0.2 \times 0.1$	4000 ~ 8000 $10^{12} \sim 10^{11}$	30, 32
BL-18A (ISSP)	2×2	Grazing Incidence $R = 3$ m $\alpha + \beta = 160^\circ$ $R = 6.65$ m $\alpha + \beta = 167.5^\circ$	300 600 1200	15 ~ 150	$< 1\phi$ β	1000~2000 $10^{11} \sim 10^9$	23

Beamline	Acceptance or H × V (mrad) Undulator Parameters	Type of Monochromator	Groove Density (l/mm)	Energy Range (eV)	Beam Size H × V (mm)	Resolving Power ($E/\Delta E$) Photon Flux (photons/s)	Reference
BL-19A Revolver Undulator (ISSP)	K = 1.0 ~ 9.0 $\lambda_u = 16.4$ cm K = 0.5 ~ 1.25 $\lambda_u = 5$ cm K = 0.5 ~ 2.5 $\lambda_u = 7.2$ cm	Grazing Incidence R = 2 m $\alpha + \beta = 160^\circ$ R = 4 m $\alpha + \beta = 170^\circ$	600 1200 600 1200	12 ~ 250	< 0.7 ϕ	1000 10^{12}	24, 25
BL-19B Revolver Undulator (ISSP)	K = 1.0 ~ 5.0 $\lambda_u = 10$ cm	Varied-Line-Space Plane Grating	800 2400	10 ~ 1200	< 0.5 ϕ	400~4000 $10^{12} \sim 10^{11}$	25 - 27
BL-20A	28 × 5	3m Normal Incidence	1200 2400	5 ~ 40	2 × 1	300 ~ 30000 $10^{12} \sim 10^8$	28
BL-27A	5 × 0.5	Double Crystal InSb (111)	—	1800 ~ 4000		2000	29
BL-28A/B Helical Undulator	K _x = 0.23 ~ 3 K _y = 0.23 ~ 6 $\lambda_u = 16$ cm	Varied-Line-Space Plane Grating	400	30 ~ 300	0.15 × 0.05	30000 10^{12}	30

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* shutdown during FY2009.

REFERENCES

- [1] H. Maezawa *et al.*, *Nucl. Instrum. Meth.*, **A246** (1986) 310.
[2] Y. Kitajima *et al.*, *Rev. Sci. Instrum.*, **63** (1992) 886.
[3] Y. Kitajima, *J. Elec. Spec. Relat. Phenom.*, **80** (1996) 405.
[4] Y. Kitajima, *J. Synchrotron Rad.*, **6** (1999) 167.
[5] Y. Yan and A. Yagishita, *KEK Report*, **95-9** (1995).
[6] M. Watanabe *et al.*, *Proc. SPIE*, **3150** (1997) 58.
[7] M. Watanabe *et al.*, *Nucl. Instrum. Meth.*, **A467-468** (2001) 512.
[8] A. Yagishita *et al.*, *Nucl. Instrum. Meth.*, **A306** (1991) 578.
[9] S. Masui *et al.*, *Rev. Sci. Instrum.*, **63** (1992) 1330.
[10] K. Amemiya *et al.*, *J. Elec. Spectrosc. Relat. Phenom.*, **124** (2002) 151.
[11] H. Namba *et al.*, *Rev. Sci. Instrum.*, **60** (1989) 1917.
[12] K. Amemiya *et al.*, *J. Synchrotron Rad.*, **3** (1996) 282.
[13] K. Amemiya *et al.*, *Proc. SPIE Proceedings*, **3150** (1997) 171.
[14] Y. Kitajima *et al.*, *J. Synchrotron Rad.*, **5** (1998) 729.
[15] Y. Kitajima *et al.*, *J. Elec. Spectrosc. Relat. Phenom.*, **101-103** (1999) 927.
[16] T. Ohta *et al.*, *Nucl. Instrum. Meth.*, **A246** (1986) 373.
[17] M. Funabashi *et al.*, *Rev. Sci. Instrum.*, **60** (1989) 1983.
[18] *Photon Factory Activity Report 1982/1983*, (1984) V-15.
[19] *Photon Factory Activity Report 1997*, **#15** (1998) A 101.
[20] *Photon Factory Activity Report 1992*, **#10** (1993) I-2.
[21] K. Mase *et al.*, *AIP Conf. Proc.*, 1234 (2010) 703.
[22] H. Shimada *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1780.
[23] S. Suzuki *et al.*, *Activity Report of SRL-ISSP*, **60** (1989).
[24] A. Kakizaki *et al.*, *Rev. Sci. Instrum.*, **60** (1989) 1893.
[25] A. Kakizaki *et al.*, *Rev. Sci. Instrum.*, **63** (1992) 367.
[26] M. Fujisawa *et al.*, *Nucl. Instrum. Meth.*, **A467-468** (2001) 309.
[27] M. Fujisawa *et al.*, *Nucl. Instrum. Meth.*, **A467-468** (2001) 313.
[28] K. Ito *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 2119.
[29] H. Konishi *et al.*, *Nucl. Instrum. Meth.*, **A372** (1996) 322.
[30] K. Amemiya and T. Ohta, *J. Synchrotron Rad.*, **11** (2004) 171.
[31] T. Iwazumi *et al.*, *Rev. Sci. Instrum.*, **66** (1995) 1691.
[32] K. Amemiya *et al.*, *AIP Conf. Proc.*, 1234 (2010) 295.