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## Summary of Experimental Stations

There are 70 experimental stations attached to the PF storage ring and the PF-AR, as shown in Figs. 1 and 2. Two thirds are dedicated for research using hard X-rays, while the remaining one third are used in the VUV and soft X-ray regions. Tables 1 and 2 summarize the research areas carried out in these experimental stations for the PF storage ring and PF-AR, respectively.

Each experimental station has a different specification in optics and performance depending on the methodology performed. Tables 3 and 4 list the optics of hard X-ray and soft X-ray or VUV stations, respectively, together with the principal performances, such as energy range, spot size, photon flux and energy resolution.

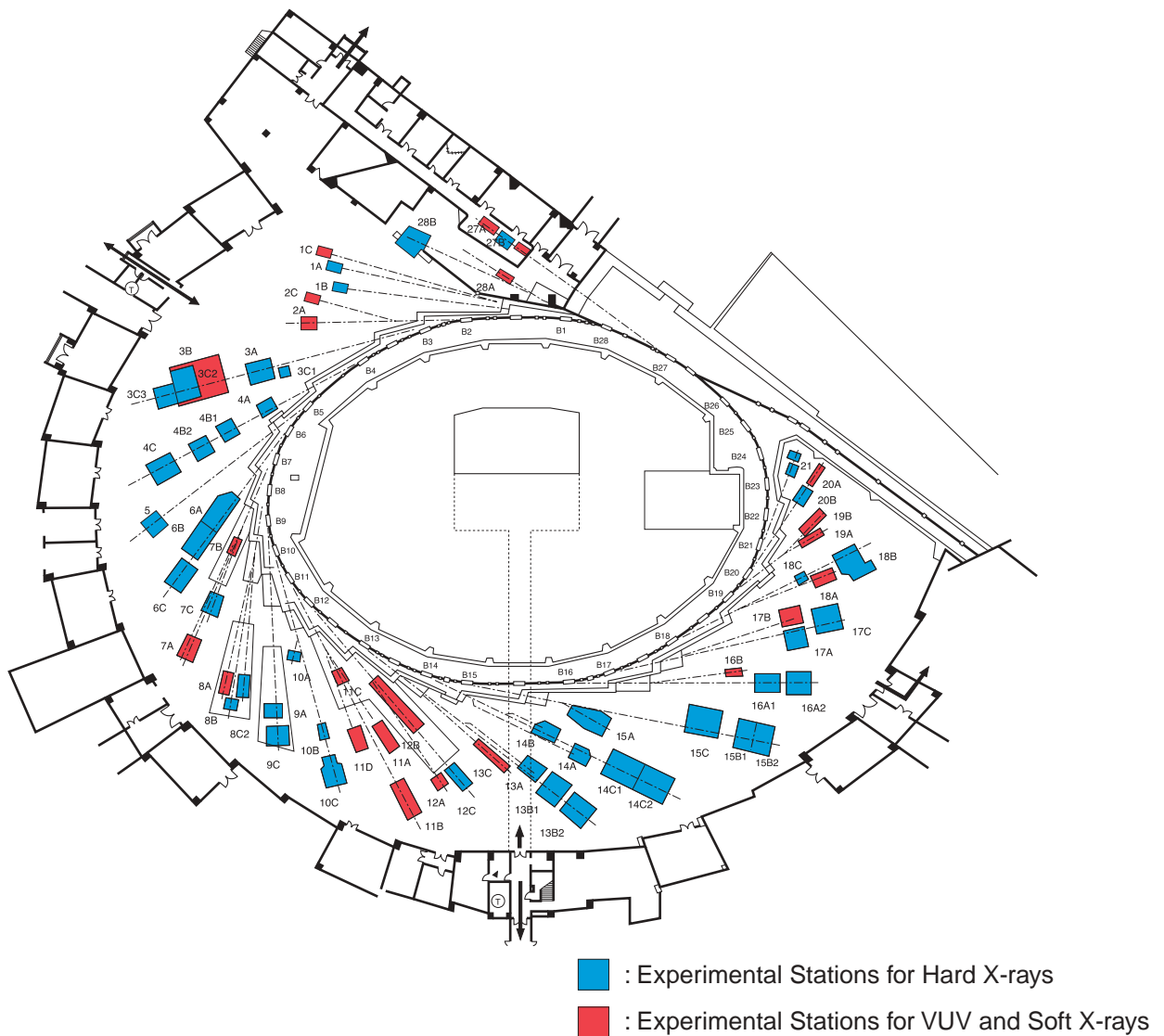


Figure 1  
Plan view of the PF experimental hall.

Table 1 List of experimental stations at the PF Storage Ring.

Experimental Station	Spokesperson
BL-1 A Crystal structure analysis beamline of collaborative B X-ray powder diffraction under extreme condition C VUV and soft X-ray photoelectron spectroscopy	H. Sawa H. Sawa K. Ono
BL-2 (Undulator) A Soft X-ray spectroscopy C Soft X-ray spectroscopy	Y. Kitajima A. Yagishita
BL-3 A X-ray diffraction and scattering B VUV and soft X-ray spectroscopy C1 X-ray diffraction C2 Characterization of X-ray optical elements C3 X-ray magnetic Bragg scattering by means of white X-rays	M. Tanaka Y. Azuma H. Adachi, H. Kawata M. Ando H. Adachi, H. Kawata
BL-4 A Trace element analysis, X-ray microprobe B1 Micro-crystal and -area structure analysis B2 Powder diffraction C X-ray diffraction and scattering	A. Iida K. Ohsumi M. Tanaka Y. Wakabayashi
BL-5 (Multipole Wiggler) A Macromolecular crystallography	N. Matsugaki
BL-6 A Macromolecular crystallography B [SBSP] Macromolecular crystallography C [SBSP] Macromolecular crystallography by Weissenberg camera	N. Igarashi N. Sakabe [SBSP], M. Hiraki N. Sakabe [SBSP], M. Kawasaki
BL-7 A [RCS] Soft X-ray spectroscopy B [RCS] Surface photochemical reaction and angle resolved photoelectron spectroscopy C X-ray spectroscopy and diffraction	K. Amemiya [RCS], K. Ito K. Amemiya [RCS], K. Ito T. Iwazumi
BL-8 A [Hitachi] Soft X-ray spectroscopy B [Hitachi] EXAFS C [Hitachi] X-ray tomography and X-ray microscopy	K. Ogata [Hitachi], K. Mase K. Ogata [Hitachi], K. Mase K. Ogata [Hitachi], K. Mase
BL-9 A XAFS C X-ray versatile station	M. Nomura M. Nomura
BL-10 A X-ray diffraction/scattering B XAFS C Small-angle X-ray scattering of solution sample	M. Tanaka N. Usami K. Kobayashi
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. Ono
BL-12 A Characterization of VUV-SX optical elements, soft X-ray spectroscopy B VUV high-resolution spectroscopy C XAFS	A. Yagishita K. Ito M. Nomura

Experimental Station	Spokesperson
BL-13 (Multipole Wiggler/Undulator) A Laser-heating high-pressure and high-temperature X-ray diffraction (DAC) B1 Surface-sensitive XAFS, X-ray diffraction B2 High-pressure and high-temperature X-ray diffraction C Soft X-ray photoemission spectroscopy and XAFS	T. Kikegawa T. Kikegawa T. Kikegawa K. Mase
BL-14 (Vertical Wiggler) A Crystal structure analysis and detector development B High-precision X-ray optics C1 Medical applications and general purpose (X-ray) 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 magnetic Bragg scattering B2 Surface and interface diffraction C High-resolution X-ray diffraction	R. Kato H. Sugiyama H. Sugiyama K. Hirano
BL-16 (Multipole Wiggler/Undulator) A1 General purpose (X-ray) A2 X-ray diffraction and scattering B Soft X-ray spectroscopy	Y. Wakabayashi Y. Wakabayashi J. Adachi
BL-17 A [Fujitsu] XAFS B [Fujitsu] Photochemical vapor deposition C [Fujitsu] Grazing incident X-ray diffraction, X-ray fluorescence analysis	N. Awaji [Fujitsu], A. Iida N. Awaji [Fujitsu], A. Iida N. Awaji [Fujitsu], A. Iida
BL-18 A [ISSP] Angle-resolved photoelectron spectroscopy of surfaces and interfaces B Macromolecular crystallography C High pressure X-ray powder diffraction (DAC)	T. Kinoshita [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	T. Kinoshita [ISSP], A. Yagishita S. Shin [ISSP], A. Yagishita
BL-20 A VUV spectroscopy B [ANBF] White and monochromatic beam general purpose X-ray station	K. Ito G. Foran [ANBF], K. Ohsumi
BL-21 [Light Source Division] Beam position monitoring	M. Kobayashi [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 Multipole Wiggler / Helical Undulator) A VUV and soft X-ray spectroscopy with circularly polarized undulator radiation B Spectroscopy and scattering with circularly polarized X-rays	T. Koide T. Iwazumi

SBSP Structural Biology Sakabe Project, Foundation for Advancement of International Science  
RCS Research Center for Spectrochemistry, the University of Tokyo  
ISSP Institute for Solid State Physics, the University of Tokyo  
ANBF Australian National Beamline Facility

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

Experimental Station	Spokesperson
AR-NE1 (Elliptical Multipole Wiggler / Helical Undulator) A1 High-resolution Compton and magnetic Compton scattering A2 Coronary angiography B Spectroscopy with circularly polarized soft X-rays	H. Kawata K. Hyodo T. Koide
AR-NE3 (Undulator) A Nuclear resonant scattering	X. Zhang
AR-NE5 A Medical applications B Bunch-purity and beam-position monitoring C High pressure and high temperature X-ray diffraction (MAX-80)	K. Hyodo S. Kishimoto T. Kikegawa
AR-NE9 B [Accelerator Laboratory] Vacuum science and technology	K. Kanazawa [Acc.Lab.]
AR-NW2 (Undulator) A XAFS/Dispersive XAFS /True-resolved-X-ray diffraction	H. Kawata
AR-NW12 (Undulator) A Macromolecular crystallography	N. Matsugaki

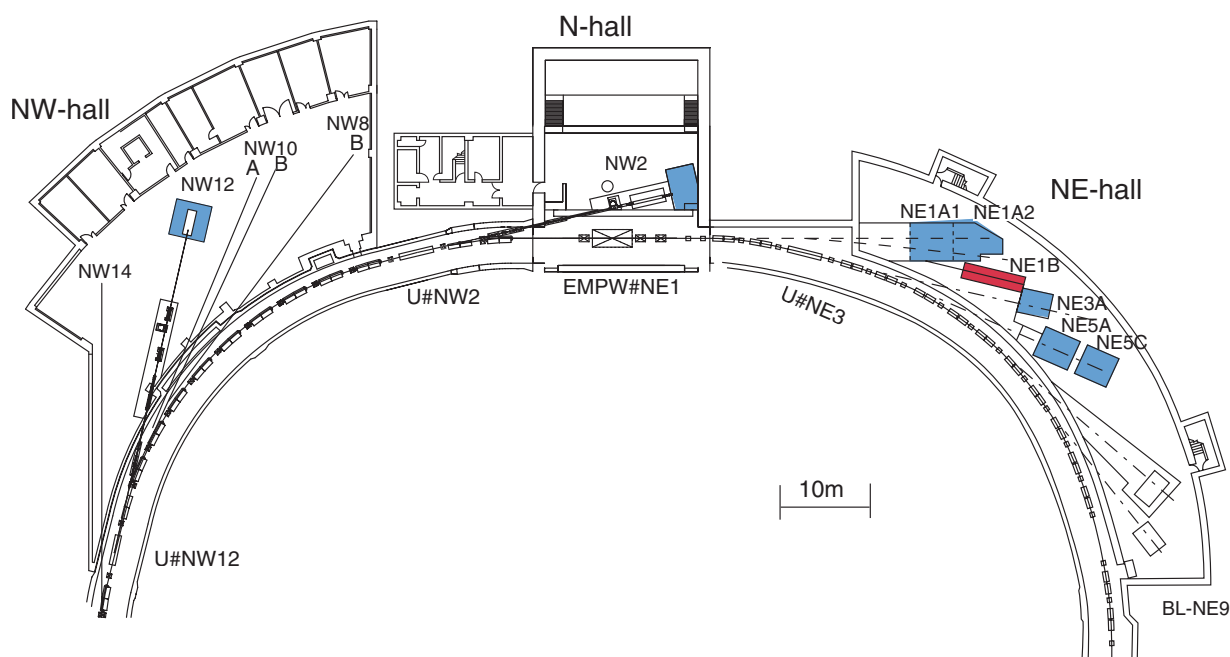


Figure 2  
Plan view of the beamlines in the PF-AR north-east, north, and north-west experimental halls.

Table 3 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 <sup>-4</sup>	Reference
BL-1A		Flat Double Crystal Si(111)	Bent Cylinder	5 ~ 20	0.7×0.3	4×10 <sup>11</sup> (8.3 keV, 400 mA)	~ 5	
BL-1B	2	Flat Double Crystal Si(111)	Bent Cylinder	6 ~ 21	0.7×0.5	8×10 <sup>10</sup> /4mm <sup>2</sup> (8.3 keV, 300 mA)	~ 5	1
BL-3A	4	Double Crystal Si(111) Sagittal Focusing	Collimating Focusing Mirrors (Fused Quartz)	6 ~ 20	100×5 2×1		~ 2	2 - 4
BL-3C2	2	Double Crystal Si(111), Si(311)	None	4 ~ 20 6 ~ 34	5×2	1×10 <sup>10</sup> 2×10 <sup>9</sup>		
BL-3C3	2	Double Crystal Si(111)	None	5 ~ 30 or white	20×4 0.1×0.1			
BL-4A	6	Double Crystal Sagittal Focusing	None	4 ~ 20	50×4 4×1		~ 2	5
BL-4B1	4.5	Double Crystal Si(111)	None	4 ~ 35	50×5		~ 2	6
BL-4B2	4.5	Double Crystal Si(111)	Bent Cylinder	6 ~ 20	13×2		~2	7, 8
BL-4C	2	Flat Double Crystal Si (111)	Bent Cylinder	5 ~ 19	0.7×0.5		~5	9, 10
BL-5A	2	Micro-channel Double Crystal Si(111)	Bent Plane Si Rh-coated Bent Cylinder Si Rh-coated	6.5 ~ 17	1.2×0.4	6.6×10 <sup>11</sup> (12.7keV, 450mA, 0.2×0.2 mm <sup>2</sup> )	~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 <sup>10</sup> (12.7keV, 450mA, 0.2×0.2 mm <sup>2</sup> )	~10	11
BL-6B [SBSP]	1	Bent Si(111)	Bent Plane Si Pt-coated		1.7×0.2			12
BL-6C [SBSP]	2	Bent Si (111)	Bent Plane Si Pt-coated					13
BL-7C	4	Double Crystal Si (111) Sagittal Focusing	Double Mirror Fused Quartz Focusing	4 ~ 20 (4 ~ 13)	5×1	1×10 <sup>10</sup> /6mm <sup>2</sup> (8 keV, 300 mA) (1×10 <sup>11</sup> when focused)	~ 2	14 - 16
BL-8C	5	Channel-Cut Si(220), Si(111), Si(400)	None	5 ~ 40	50×5	6×10 <sup>8</sup> /mm <sup>2</sup> (10 keV, 300 mA)	~2	

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 <sup>-4</sup>	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	1×0.3	4×10 <sup>11</sup> (9 keV, 300 mA)	2	17, 18
BL-9C	3.5	Double Crystal Si(111)	Bent Cylinder Rh-coated Si	4 ~ 23 or white	1×1	5×10 <sup>10</sup> (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	10×3		10 ~ 5	19
BL-10B	2	Channel-Cut Si(311)	None	6 ~ 30	5×1	1×10 <sup>9</sup> /7mm <sup>2</sup>	1	
BL-10C	4	Double Crystal Si(111)	Bent Cylinder	4 ~ 10	1.2×0.2	~10 <sup>11</sup> /1.5mm <sup>2</sup> (8 keV, 400 mA)	2	
BL-12C	2	Double Crystal Si(111) Si(311)	Bent Cylinder	6 ~ 23	0.65×0.4	5×10 <sup>10</sup> /1mm <sup>2</sup> (8 keV, 300mA) w.Si(111)	~ 2	20
BL-13A	1	Double Crystal Si(111), Ge(111)	Cylinder Pt-coat Fused Quartz	30	0.045×0.032	5×10 <sup>10</sup> /1mm <sup>2</sup>	~ 2	21
BL-13B1 B2	4	Double Crystal Si(111), Si(220) Sagittal Focusing	Bent Plane Fused Quartz	4 ~ 30	4×1		~ 2	22
BL-14A	1.28 (Vertical)	Double Crystal Si (111) Si (311) Si (553)	Bent Cylinder Pt-coated Fused Quartz	5.1 ~ 19.1 9.9 ~ 35.6 22.7 ~ 84.5	2×1 at focus 5×38		2	23
BL-14B	2.2 (Vertical)	Double Crystal Si(111),	None	10 ~ 57	5×14		2	
BL-14C1 C2	1.3 (Vertical)	Double Crystal Si(111), Si(220)	None	5 ~ 100 or white	6×35		2	24, 25
BL-15A	2	Bent Crystal Ge(111) ( $\alpha = 8.0^\circ$ )	Bent Plane, Fused Quartz Pt-coated	8.0 (fixed)	0.5×0.25	9×10 <sup>10</sup> /mm <sup>2</sup> (8.0 keV, 350 mA)	~ 10	26
BL-15B1 B2	2	Double Crystal Si (111)	Bent Cylinder	5 ~ 20 or white	0.6×0.4	10 <sup>11</sup> /1mm <sup>2</sup> (8.0keV, 350mA)	~ 2	
BL-15C	2	Double Crystal Si (111)	None	4 ~ 30	60×6			

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 <sup>-4</sup>	Reference
BL-16A1 A2	1	Double Crystal Si(111) Sagittal Focusing	Bent Plane (Rh on Si) and Bent Plane (Rh on SiC)	4 ~ 25	1.2×0.5	~1×10 <sup>13</sup> (8.3 keV, 300 mA)	~ 1	27
BL-17A [Fujitsu]	4	Double Crystal Si(111)	None	5 ~ 13	100×10		~ 2	28
BL-17C [Fujitsu]	1	Double Crystal Si(111)	None	5 ~ 13	20×5		~ 2	29
BL-18B	2	Double Crystal Si(111) Si(220) Ge(111) Ge(220)	Bent Cylinder Fused Quartz, Pt-coated	6 ~ 30	0.6×0.4	1.5×10 <sup>9</sup> (12.4 keV, 300 mA, 0.2×0.2mm <sup>2</sup> )	~ 2	30
BL-18C	1	Double Crystal Si(111)	Cylinder Fused Quartz, Pt-coated	6 ~ 25	0.07×0.04		~2	
BL-20B [ANBF]	2	Channel Cut Si(111) Double Crystal Sagittal focusing Si(111)	None	4 ~ 25	26×3		~ 2	31
BL-27B	4	Double Crystal Si(111)	None	4 ~ 20	100×6		~ 2	32
BL-28B	H: 4 V:0.2	Double Crystal Si(111) Si(220) InSb(111)	Pre-mirror Bent Cylinder Si Pt- & Ni-coated Post-mirror Bent Plane Fused Quartz Pt- & Ni-coated	2 ~ 10	2.0×0.2	3×10 <sup>10</sup> (9 keV, 300mA Si(220) Pc ~ 0.5)	~ 2 (Si(111))	33
AR-NE1A1	2	Double Bent Crystal Si(111) Si(400)		40 ~ 70 80 ~ 160	2×0.5	2×10 <sup>13</sup> (60 keV, 35mA)	8	34 - 36
AR-NE1A2	2	Asym. cut Single Crystal Si(311)		33 ~ 38	75×120 ~140	10 <sup>10</sup> (33 keV)	60	
AR-NE3A	H:0.3 V:0.03	Double Crystal Si(111) High-resolution Monochromator Nuclear Monochromator of Single Crystal <sup>57</sup> Fe <sub>2</sub> O <sub>3</sub> (777)		5 ~ 25 8 ~ 26 14.4	15×2	1×10 <sup>3</sup> (14.4 keV)	1 5×10 <sup>-3</sup> 1×10 <sup>-7</sup>	37

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 <sup>-4</sup>	Reference
AR-NE5A	10	Asym.Cut Single Crystal Si(311), Si(511) ( $\alpha= 4^\circ \sim 6^\circ$ )		20 ~ 60	150×80	5×10 <sup>8</sup> (33.2 keV)	60	38, 39
		Double Crystal Si(311), Si(111), Si(220)		20 ~ 100	100×3			
AR-NE5C	3	Double Crystal Si(111)	None	30 ~ 100 or white	60×5		5	40
AR-NW2A	H:1.0 V:0.2	Double Crystal Si(111) Liquid N <sub>2</sub> cooling	Bent cylinder Si Rh-coated	5 ~ 25	0.6×0.2	6×10 <sup>12</sup>	~2	41, 42
			Bent flat Si Rh-coated		~10×0.06			
AR-NW12A	H:0.3 V:0.1	Double Crystal Si(111) Liquid N <sub>2</sub> cooling	Pre-Mirror Bent flat Si Rh-coated Post-Mirror Bent cylinder Si Rh-coated	7 ~ 17	1.4×0.18 1.3×0.3	2×10 <sup>11</sup> (0.2×0.2 mm <sup>2</sup> )	~2	

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Table 4 VUV and soft X-ray beamline optics.

Beamline	Acceptance H × V (mrad) or Undulator Parameters	Type of Monochromator	Groove Density ( $\ell/\text{mm}$ )	Energy Range (eV)	Beam Size H × V (mm)	Resolving Power ( $E/\Delta E$ ) Photon Flux (photons/s)	Reference
BL-1C	5 × 3	Varied-Line-Space Plane Grating	300 600 1200	20 ~ 60 40 ~ 120 80 ~ 240	1 × 1	1000 ~ 10000 10 <sup>11</sup> ~ 10 <sup>9</sup>	1
BL-2A Undulator	K = 0.5 ~ 2.2 $\lambda u = 6$ cm	Double Crystal InSb (111), Si (111)	—	1740 ~ 5000	< 1 $\phi$	2000, 8000 10 <sup>11</sup>	2 - 5
BL-2C Undulator	K = 0.55 ~ 2.2 $\lambda u = 6$ cm	Varied-Line-Space Plane Grating	1000 2200	250 ~ 1400	0.9 × 0.1	5000 ~ 10000 10 <sup>11</sup> ~ 10 <sup>10</sup>	6 - 8
BL-3B	10 × 2	Grazing Incidence R = 24 m $\alpha + \beta = 165^\circ$	200 600 1800	10 ~ 280	< 2 $\phi$	200 ~ 3000 10 <sup>12</sup> ~ 10 <sup>9</sup>	9, 10
BL-7A [RCS]	6 × 1	Varied-Line-Space Plane Grating	300 650	50 ~ 1300	2.5 × 0.5	1000 ~ 9000 10 <sup>12</sup> ~ 10 <sup>9</sup>	11
BL-7B [RCS]	6 × 4	1m Seya-Namioka	1200 2400	5 ~ 50	1 × 1	1000	12
BL-8A [Hitachi]	0.5 × 1	SX700 Plane Grating	1221	38 ~ 2300	5 × 1	2000 10 <sup>10</sup>	
BL-8B [Hitachi]	3 × 0.5	Double Crystal InSb (111), Si (311)	—	1700 ~ 14000	1.9 × 0.5	5000	13
BL-11A	5 × 1	Varied-Line-Space Plane Grating	300 800 1200	70 ~ 1900	2 × 1	500 ~ 5000 10 <sup>12</sup> ~ 10 <sup>9</sup>	14 - 17
BL-11B	4 × 0.6	Double Crystal InSb (111), Ge (111)	—	1760 ~ 3910	5 × 2	2000 10 <sup>10</sup>	4, 18, 19
BL-11C	4.8 × 3	1m Seya-Namioka	1200	4 ~ 35	~1 $\phi$	1000	20
BL-11D	4 × 2	Grazing Incidence Varied Deviation-angle On-blaze Mount R <sub>1</sub> = 52.5 m R <sub>3</sub> = 22.5 m	2400	60 ~ 245 200 ~ 900	1 × 0.1	2000 10 <sup>11</sup>	21
BL-12A	2.2 × 0.34	Grazing Incidence R = 2 m $\alpha = 88^\circ$	1200	30 ~ 1000	2 × 3	1000 10 <sup>9</sup>	22
BL-12B	5 × 3.6	6.65 m Off-Plane Eagle	1200 4800	5 ~ 30	—	2.5 × 10 <sup>5</sup> 10 <sup>4</sup>	23 - 25

Beamline	Acceptance or $H \times V$ (mrad) Undulator Parameters	Type of Monochromator	Groove Density ( $\ell/\text{mm}$ )	Energy Range (eV)	Beam Size $H \times V$ (mm)	Resolving Power ( $E/\Delta E$ ) Photon Flux (photons/s)	Reference
BL-13C Undulator	$K = 0.3 \sim 4.2$ $\lambda u = 18 \text{ cm}$	Grazing Incidence $R = 50 \text{ m}$ $\alpha + \beta = 173.2^\circ$	350 750	70 ~ 500 150 ~ 1000	$5 \times 1$	1000 ~ 6000 $10^{12} \sim 10^{10}$	26, 27
BL-16B Undulator	$K = 0.5 \sim 5.75$ $\lambda u = 12 \text{ cm}$	Grazing Incidence $R = 24 \text{ m}$ $\alpha + \beta = 168.6^\circ$	400 900 2000	40 ~ 550	$< 1\phi$	1000 ~ 10000 $10^{12} \sim 10^1$	28 - 30
BL-17B (Fujitsu)	$8 \times 1$	Toroidal Mirror	—	—	$10 \times 1$	—	—
BL-18A (ISSP)	$2 \times 2$	Grazing Incidence $R = 3 \text{ m}$ $\alpha + \beta = 160^\circ$  $R = 6.65 \text{ m}$ $\alpha + \beta = 167.5^\circ$	300 600 1200 500	15 ~ 150	$< 1\phi$	1000~2000 $10^{11} \sim 10^9$	31
BL-19A Revolver Undulator (ISSP)	$K = 1.0 \sim 9.0$ $\lambda u = 16.4 \text{ cm}$ $K = 0.5 \sim 1.25$ $\lambda u = 5 \text{ cm}$ $K = 0.5 \sim 2.5$ $\lambda u = 7.2 \text{ cm}$	Grazing Incidence $R = 2 \text{ m}$ $\alpha + \beta = 160^\circ$  $R = 4 \text{ m}$ $\alpha + \beta = 170^\circ$	600 1200 600 1200	12 ~ 250	$< 0.7\phi$	1000 $10^{12}$	32, 33
BL-19B Revolver Undulator (ISSP)	$K = 1.0 \sim 5.0$ $\lambda u = 10 \text{ cm}$	Varied-Line-Space Plane Grating	800 2400	10 ~ 1200	$< 0.5\phi$	400~4000 $10^{12} \sim 10^{11}$	33 - 35
BL-20A	$28 \times 5$	3m Normal Incidence	1200 2400	5 ~ 40	$2 \times 1$	300 ~ 30000 $10^{12} \sim 10^8$	36
BL-27A	$5 \times 0.5$	Double Crystal InSb (111)	—	1800 ~ 4000		2000	37
BL-28A Helical Undulator	$K_x = 0.23 \sim 3$ $K_y = 0.23 \sim 6$  $\lambda u = 16 \text{ cm}$	Grazing Incidence $R = 2 \text{ m}$ $\alpha + \beta = 160^\circ$  $R = 4 \text{ m}$ $\alpha + \beta = 170^\circ$	600 1200 600 1200	30 ~ 250	$< 0.5\phi$	1000 $10^{10}$	38
AR-NE1B Helical Undulator	$K_x = 0.2 \sim 3$ $K_y = 0.2 \sim 6$ $\lambda u = 16 \text{ cm}$	Grazing Incidence $R = 10 \text{ m}$ $\beta = 89^\circ$	1200 2400	250 ~ 1800	$\sim 0.8 \times 0.2$	1000~5000 $10^{11} \sim 10^9$	39, 40

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