

Appendix A

Summary of Experimental Stations

(May 31, 2006)

Table A.1. Public beamlines.

	Name of Beamline	X-rays at Sample				Areas of Research
		Energy Range [keV]	Energy Resolution $\Delta E/E$	Photon Flux [photon/s]	Beam Size [mm]	
Public Beamlines						
BL01B1	XAFS	3.8 ~ 113	$3 \times 10^{-5} \sim 2 \times 10^{-4}$	$10^9 \sim 10^{11}$	-	<ul style="list-style-type: none"> • XAFS in wide energy region (3.8 to 113 keV) • XAFS of dilute systems and thin films • Time resolved XAFS by quick scan
BL02B1	Single Crystal Structure Analysis	5 ~ 115	10^{-4}	10^{12}	$3(H) \times 0.1(V)$	<ul style="list-style-type: none"> • Single crystal structure analysis in X-ray wide energy range • Precise X-ray diffraction analysis of the lattice or charge modulation originated from the phase transition at low temperatures
BL02B2	Powder Diffraction	12 ~ 35	Si(111) : $\sim 2 \times 10^{-4}$	$\sim 10^{11}$	-	<ul style="list-style-type: none"> • Charge density level structures closely related with physical properties for crystalline materials • Structural aspects of phase transition • Ab initio structure determination by powder diffraction • Structural refinements by Rietveld method
BL04B1	High Pressure and High Temperature Research	20 ~ 150	White radiation	-	$0.05(H) \times 0.05(V) \sim 10(H) \times 10(V)$	<ul style="list-style-type: none"> • Determination of phase relation • Equation of state of mantle • Viscosity of melts • Kinetics of mineral transformation • Rheology of mantle minerals • Structure of melts and glasses at high pressures
BL04B2	High Energy X-ray Diffraction	Si(111) : 37.8 Si(220) : 61.7	10^{-3}	2.2×10^{10} (37.8 keV, Flat) 7.1×10^{11} (37.8 keV, Bent)	$0.22(H)$ (37.8 keV) $0.38(H)$ (61.7 keV)	<ul style="list-style-type: none"> • Structural analysis of glass, liquid, and amorphous materials • X-ray diffraction under ultra high-pressure • Precise single crystal structure analysis
BL08W	High Energy Inelastic Scattering	Si(620) : 174 ~ 270 Si(777) : 270 ~ 300	$\sim 2 \times 10^{-3}$	5×10^9 (300 keV)	$1(H) \times 3(V)$	<ul style="list-style-type: none"> • Magnetic Compton scattering • High-resolution Compton scattering • High-energy Bragg scattering • High-energy fluorescent X-ray analysis
BL09XU	Nuclear Resonant Scattering	Si(400) : 100 ~ 120 6 ~ 100	$< 1 \times 10^{-3}$	1×10^{13} (100 keV) 2.4×10^{13} (14.4 keV)	$2(H) \times 1(V)$ $2.7(H) \times 1(V)$	<ul style="list-style-type: none"> • Lattice dynamics by using nuclear inelastic scattering • Time domain Mössbauer spectroscopy, especially under the extreme conditions • Coherent X-ray optics using nuclear resonant scattering • Nuclear excitation by electron transition (NEET) • Surface structures and residual strain analysis
BL10XU	High Pressure Research	18 ~ 35	10^{-4}	$\sim 1 \times 10^{13}$	$0.01 \sim 1$ diam.	<ul style="list-style-type: none"> • Structure analysis and phase transitions under ultra high pressure (DAC experiment) • Earth and planetary science

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		Energy Range	Energy Resolution	Photon Flux	Beam Size		
		[keV]	$\Delta E/E$	[photon/s]	[mm]		
BL13XU	Surface and Interface Structures	7 ~ 32	10^{-4}	-	0.03 ~ 0.1	<ul style="list-style-type: none"> Atomic-scale structure analysis of a crystal surface, an ultra-thin film and a nanostructure Surface structure analysis under thin-film growth Analysis of nanostructures grown at a vacuum/solid, liquid/solid, and solid/solid interface 	
BL19B2	Engineering Science Research	3.8 ~ 72	10^{-4}	10^9	-	<ul style="list-style-type: none"> XAFS in wide energy region Residual stress measurement, Structural analysis of thin film, Surface, Interface Powder diffraction X-ray imaging 	
BL20XU	Medical and Imaging II	7.62 ~ 113	$\sim 10^{-4}$	$10^{13}/\text{mm}^2$ (@EH1)	1.4(H) \times 0.7(V) (@EH1) 4(H) \times 2(V) (@EH2)	<ul style="list-style-type: none"> Micro-imaging : Hard X-ray microbeam/scanning microscopy, imaging microscopy, micro-tomography, phase-contrast microtomography with Bonse-Hart interferometer, X-ray holography, coherent X-ray optics, and other experiments on X-ray optics and developments of optical elements Medical application : Micro-angiography, refraction-enhanced imaging, radiation therapy, phase-contrast CT using interferometer Ultra-small angle scattering 	
BL20B2	Medical and Imaging I	Si(311) : 8.4 ~ 72.5 Si(111) : 5 ~ 37.5 Si(511) : 13.5 ~ 113.3	$\sim 10^{-4}$	-	75(H) \times 5(V) (Si(311), @Exp. Hall) 300(H) \times 20(V) (Si(311), @Biomedical Imaging Center)	<ul style="list-style-type: none"> The medical research mainly involves micro-radiography, micro-tomography and refraction-contrast imaging on biological specimens and small animals. Imaging techniques involve the evaluation and development of various kinds of optical elements for novel imaging techniques. 	
BL25SU	Soft X-ray Spectroscopy of Solid	0.22 ~ 2	$E/\Delta E > 10^4$	$> 10^{11}$	0.4 diam.	<ul style="list-style-type: none"> Observation of electronic structures by photoemission spectroscopy (PES) Observation of electronic band structures by angle resolved photoemission spectroscopy (ARPES) Magnetic state study by magnetic circular dichroism (MCD) of soft-x-ray absorption Element-specific magnetization curve measurements by MCD Analysis of atomic arrangements by photoelectron diffraction (PED) Observation of Magnetic domains by photoelectron emission microscope (PEEM) 	

	Name of Beamline	X-rays at Sample				Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size	
		[keV]	$\Delta E/E$	[photon/s]	[mm]	
BL27SU	Soft X-ray Photochemistry	0.2 ~ 2	A and B branches : $E/\Delta E > 10^{15}$ $\sim 10^2$	$> 10^{15}$	$4(H) \times 2(V)$	<i>Industrial research --- B branch</i> <ul style="list-style-type: none"> • Growth of thin film of functional material • Micro fabrication by functional material etching <i>Atomic and molecular spectroscopy --- C branch (C1, C2 station)</i> <ul style="list-style-type: none"> • Search of novel photochemical processes • High resolution atomic and molecular electron spectroscopy • Complete determination of electronic decay channel • Dissociation dynamics of inner-shell excited molecules • Site-specific dissociation processes of isolated molecules <i>Surface analysis and solid state physics --- C branch (C3 station)</i> <ul style="list-style-type: none"> • Search of electronic structure of solids • Elucidation of electronic state of molecule on surface
		0.3 ~ 2.8	C branches : $E/\Delta E > 10^4$	$> 10^{11}$	$0.2(H) \times 0.2(V)$	
BL28B2	White Beam X-ray Diffraction	> 5	White radiation	-	$30(H) \times 10(V)$	<ul style="list-style-type: none"> • White X-ray diffraction • Time-resolved energy-dispersive XAFS (DXAFS) for studies of chemical and/or physical reaction process.
BL35XU	High Resolution Inelastic Scattering	8 ~ 50 (fundamental to 5th)		Optics Dependent		<ul style="list-style-type: none"> • Dynamics of materials including phonons, Glass transitions, Liquid dynamics, Diffusion, etc. • Methods of investigation include inelastic X-ray scattering (IXS) and nuclear resonant scattering (NRS).
BL37XU	Trace Element Analysis	A branch : 5 ~ 37 B branch : Si (111) : 75.5	2×10^{-4}	A branch : $10^{12} \sim 10^{13}$ B branch : $10^{10} \sim 10^{12}$	A branch : $2(H) \times 0.7(V)$ B branch : $3(H) \times 0.5(V)$	<ul style="list-style-type: none"> • X-ray microbeam spectrochemical analysis • Ultra trace element analysis • High energy X-ray fluorescence analysis
BL38B1	Structural Biology III	6.5 ~ 17.5	$\sim 2 \times 10^{-4}$	$10^{10} \sim 10^{11}$	-	<ul style="list-style-type: none"> • Monochromatic data collection for routine macromolecular crystallography
BL39XU	Magnetic Materials	5 ~ 37	2×10^{-4}	4×10^{13}	$2(H) \times 0.6(V)$	<ul style="list-style-type: none"> • X-ray magnetic circular dichroism (MCD) spectroscopy • Element-specific magnetometry • X-ray emission spectroscopy and its magnetic circular dichroism • Resonant or non-resonant magnetic scattering
BL40XU	High Flux	8 ~ 17	0.017	10^{15} (12 keV)	$0.25(H) \times 0.04(V)$ (with mirror)	<ul style="list-style-type: none"> • Time-resolved diffraction and scattering experiments • X-ray speckle • X-ray fluorescence trace analysis
BL40B2	Structural Biology II	6 ~ 17.5	10^{-4}	$\sim 10^{11}$ (12 keV)	$0.25(H) \times 0.2(V)$	<ul style="list-style-type: none"> • Small angle X-ray (solution) scattering
BL41XU	Structural Biology I	6.5 ~ 37	$< 2 \times 10^{-4}$	10^{13}	$0.1(H) \times 0.1(V)$	<ul style="list-style-type: none"> • Structural biology • Macromolecular crystallography • Ultra-high resolution structural analysis

	Name of Beamline	X-rays at Sample					Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size		
		[keV]	$\Delta E/E$	[photon/s]	[mm]	[mm]	
BL43IR	Infrared Materials Science	Wave num. 100 ~ 20000 cm^{-1}	0.0063 cm^{-1}	-	-	<ul style="list-style-type: none"> Infrared microspectroscopy Magneto-optical spectroscopy Infrared surface science Absorption and reflection spectroscopy Time-resolved experiments with pulsed laser and SR (pump and probe) 	
BL46XU	R&D (2)	12 ~ 25 (fundamental)	10^{-4}	4.6×10^{12}	$< 1(\text{H}) \times 1(\text{V})$	<ul style="list-style-type: none"> Insertion devices R&D Resonant and non-resonant magnetic scattering structural analysis 	
BL47XU	HXPES, MCT	5.2 ~ 37.7	$\sim 2 \times 10^{-4}$	2×10^{13} (18 keV)	1.2(H) \times 0.3(V) (18 keV, 40 m from source)	<ul style="list-style-type: none"> Microtomography Microbeam 	

Table A.2. RIKEN beamlines.

	Name of Beamline	X-rays at Sample					Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size		
		[keV]	$\Delta E/E$	[photon/s]	[mm]	[mm]	
RIKEN Beamlines							
BL17SU	RIKEN Coherent Soft X-ray Spectroscopy	0.1 ~ 3 (designed)	$E/\Delta E > 10^4$	-	$0.5(\text{H}) \times 0.5(\text{V})$	<p><i>Spectroscopic study on multiply charged ions --- A1a station</i></p> <ul style="list-style-type: none"> Photoabsorption study on multiply charged ions Fundamental research for X-ray astronomy using synchrotron radiation <p><i>High resolution photoemission spectroscopy --- A2 station</i></p> <ul style="list-style-type: none"> Angle-resolved photoemission (ARPES) study using soft X-rays to observe 'bulk' band structure In situ ARPES measurement on strongly-correlated transition-metal oxide thin films fabricated by laser MBE method <p><i>Soft X-ray emission spectroscopy for solid and biological samples --- A3 station</i></p> <ul style="list-style-type: none"> Soft X-ray emission study on transition metal compounds to study electronic correlations in solids Study of the electronic structure of biological samples by soft X-ray emission spectroscopy 	
BL19LXU	RIKEN SR Physics	7.2 ~ 18 (fundamental) 22 ~ 51 (3rd)	$\sim 10^{-4}$	2×10^{14}	$1.5(\text{H}) \times 0.8(\text{V})$ (@EH2)	<ul style="list-style-type: none"> This beamline is open for any research field requiring the highly brilliant X-ray beam 	
BL26B1&B2	RIKEN Structural Genomics I & II	6 ~ 17	$\sim 10^{-4}$	$\sim 10^{11}$ (12 keV)	-	<ul style="list-style-type: none"> Structural genomics research based on single crystal X-ray diffraction 	
BL29XU	RIKEN Coherent X-ray Optics	4.4 ~ 37.8	$\sim 1.3 \times 10^{-4}$	6×10^{13} (10keV)	$0.72(\text{H}) \times 1.3(\text{V})$ (@EH1) $10(\text{H}) \times 30(\text{V})$ (@EH3)	<ul style="list-style-type: none"> X-ray optics, especially coherent X-ray optics 	
BL44B2	RIKEN Structural Biology II	6 ~ 18	$\sim 10^{-4}$	4×10^{10} (12.4 keV)	$0.17(\text{H}) \times 0.15(\text{V})$	<ul style="list-style-type: none"> Macromolecular crystallography 	

	Name of Beamline	X-rays at Sample				Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size	
		[keV]	$\Delta E/E$	[photon/s]	[mm]	
BL45XU	RIKEN Structural Biology I	6.8 ~ 14 (@SAXS station) 7.5 ~ 14 (@crystallography station)	$< 10^{-4}$ (@S St.) $< 10^{-4}$ (@P St.)	$\sim 2 \times 10^{11}$ (@S St.) $\sim 2 \times 10^{11}$ (@P St.)	$0.3(H) \times 0.2(V)$ (@S St.) $0.3(H) \times 0.2(V)$ (@P St.)	<ul style="list-style-type: none"> • SAXS-station: Time-resolved structures of non-crystalline biological materials such as protein, nucleic acid solutions, membrane, muscle, and micelle system under various conditions, are studied by using small-angle scattering and diffraction technique. • PX-station: Macromolecular crystallography optimizing multiwavelength anomalous diffraction (MAD) method

Table A.3. Contract beamlines.

	Name of Beamline	X-rays at Sample				Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size	
		[keV]	$\Delta E/E$	[photon/s]	[mm]	
Contract Beamlines						
BL11XU	JAEA Quantum Dynamics	6 ~ 70	10^{-4}	-	-	<ul style="list-style-type: none"> • Nuclear Resonant Scattering • Surface and interface structure with MBE • Inelastic scattering • XAFS
BL12XU	NSRRC ID (NSRRC)	4.5 ~ 35	Optics Dependent	-	-	<ul style="list-style-type: none"> • Elementary electronic excitations, quasiparticle behaviors, and electron-correlation effects in correlated electron systems investigated using high resolution non-resonant or resonant inelastic X-ray scattering • Local electronic structure of molecular solids of low-Z elements (e.g., biomaterials) investigated by high resolution near-edge X-ray Raman scattering • Phase transitions under high-pressure, low and high temperatures • Materials science using high-resolution X-ray absorption and emission spectroscopy • X-ray physics and optics
BL12B2	NSRRC BM (NSRRC)	5 ~ 70 (monochromatic) 5 ~ 90 (white)	$\sim 10^{-4}$	$10^{10} \sim 10^{12}$	$0.25(H) \times 0.25(V)$	<ul style="list-style-type: none"> • X-ray absorption spectroscopy • Powder X-ray diffraction • High resolution X-ray scattering • Protein crystallography
BL14B1	JAEA Materials Science	5 ~ 90 (monochromatic) 50 ~ 150 (white)	Si (111) : 10^{-4} Si (311) : 3×10^{-5} Si (511) : 7×10^{-6}	$10^{10}/\text{mm}$ $10^{13}/\text{mm}$	$1(H) \times 1(V)$	<ul style="list-style-type: none"> • Materials science at high pressure • Structure physics

	Name of Beamline	X-rays at Sample					Areas of Research
		Energy Range	Energy Resolution	Photon Flux	Beam Size		
		[keV]	$\Delta E/E$	[photon/s]	[mm]		
BL15XU	WFERAM (National Institute for Materials Science)	1 ~ 60	10^{-4}	$10^{12} \sim 10^{13}$	~ 0.8 diam.		<i>Highly precise characterization of advanced materials</i> <ul style="list-style-type: none"> High resolution X-ray photoemission microscopy High energy excitation X-ray photoelectron spectroscopy High resolution X-ray emission spectroscopy Highly precise X-ray powder diffraction study and ultra-small angle scattering Characterization of thin films for ULSI, optical and magnetic devices, secondary batteries, fuel cells, catalysts, functional materials, and structural materials.
BL16XU	Industrial Consortium ID (Industrial)	4.5 ~ 40	10^{-4}	$> 10^{12}$ (normal) $\sim 10^{10}$ (focusing)	1 diam. 1 μ m diam.		
BL16B2	Industrial Consortium BM (Industrial Consortium)	4.5 ~ 113	10^{-4}	$\sim 10^{10}$	~ 0.1(H) \times 0.1(V) (with mirror) ~ 40(H) \times 2(V) (without mirror)		<ul style="list-style-type: none"> Characterization of industrial materials, such as metal and oxide films, semiconductor crystals, etc., by XAFS, topography and other methods
BL22XU	JAEA Quantum Structural Science	3 ~ 70	10^{-4}	2×10^{13}	2(V) \times 3.2(H) (@EH3) 0.4(H) \times 0.5(V) (focusing @EH3)		<ul style="list-style-type: none"> Materials science at high pressure Resonant X-ray scattering (activity at RI laboratory)
BL24XU	Hyogo ID (Hyogo Prefecture)	-	$< 10^{-4}$	$\sim 10^{12}$	< 1 (H) \times 1(V)		<ul style="list-style-type: none"> Structure analysis of small bio-crystals for industry Surface/interface analysis of metallic materials for industry (fluorescent X-ray analysis and strain measurements) Microbeam formation studies for materials and life science
BL23SU	JAEA Actinide Science	0.5 ~ 3 (circular polarization)	10^{-4}	10^{11}	2(H) \times 1(V) (@Exp. hall) 0.2 diam. (@RI lab.)		<ul style="list-style-type: none"> Surface chemistry with supersonic molecular beam Biophysical spectroscopy Photoelectron spectroscopy (activity at RI laboratory) Magnetic circular dichroism (activity at RI facility)
BL32B2	Pharmaceutical Industry (Pharmaceutical Consortium for Protein Structure Analysis)	7 ~ 17	$\sim 10^{-4}$	$\sim 10^{10}$ (12 keV)	0.2(H) \times 0.2(V) (12 keV)		<ul style="list-style-type: none"> Protein structure analysis for structure-based drug design: It means design and optimization of new leading compounds based on pharmacodynamic action mechanism elucidated at the molecular level which obtained from a detailed interaction analysis of receptor-drug complexes, etc.
BL33LEP	Laser-Electron Photon (RCNP, Osaka University)	1.5 ~ 2.4 GeV (tagged photon)	-	3×10^6 (1.5 ~ 2.4 GeV)	-		<ul style="list-style-type: none"> Meson photoproduction from nucleon and nucleus Photoexcitation of hyperons, nucleon resonances, and other exotic states Photonic nuclear reactions Beam diagnoses Test and calibration of detectors with GeV photon beam
BL44XU	Macromolecular Assemblies (Institute for Protein Research, Osaka University)	9 ~ 16	2×10^{-4}	10^{12}	0.5(H) \times 0.08(V)		<ul style="list-style-type: none"> Crystal structure analysis of biological macromolecular assemblies (e.g. membrane protein complexes, protein complexes, protein-nucleic acid complexes, and viruses)

Table A.4. Accelerator beamlines.

	Name of Beamline	X-rays at Sample			Beam Size [mm]	Areas of Research
		Energy Range [keV]	Energy Resolution $\Delta E/E$	Photon Flux [photon/s]		
Accelerator Beamlines						
BL05SS	Accelerator Beam Diagnosis					<ul style="list-style-type: none"> • Accelerator science • Accelerator beam diagnostics • R&D of accelerator components • Production of MeV γ-ray photons
BL38B2	Accelerator Beam Diagnosis	4.0 ~ 14.2	$\sim 10^{-4}$	$10^{10} \sim 10^{12}$	-	<ul style="list-style-type: none"> • Accelerator science • Accelerator beam diagnostics • R&D of accelerator components • Production of MeV γ-ray photons