

Table IV. Beam parameters of SPring-8 storage ring

Energy [GeV]	8
Number of buckets	2436
Tunes (ν_x / ν_y)	40.15 / 18.35
Current [mA]:	
single bunch	12
multi bunch	100
Bunch length (σ) [psec]	13
Horizontal emittance [nm-rad]	3.4 *
Vertical emittance [pm-rad]	6.8 *
Coupling [%]	0.2
RF Voltage [MV]	16
Momentum acceptance [%]	± 3 (± 200 MeV)
Beam size [μm]: (σ_x / σ_y)* [μm]	
Long ID section	294 / 10
ID section	301 / 6
BM section	107 / 13
Beam divergence [μrad]: (σ_x' / σ_y')* [μrad]	
Long ID section	13 / 0.7
ID section	12 / 1.1
BM section	56 / 0.6
Operational chromaticities: (ξ_x / ξ_y)	+2 / +6 **
Lifetime [hr]:	
100 mA (multi-bunch)	~ 200
1 mA (single bunch)	~ 20
Horizontal dispersion [m]:	
Long ID section	0.103
ID section	0.107
BM section	0.032
Fast orbit stability (0.1 – 200 Hz) [μm]:	
horizontal (rms)	~ 4
vertical (rms)	~ 1

* Assuming 0.2% coupling for "Low Emittance Optics"
** With bunch-by-bunch feedback

Table III. Filling patterns

	bunch current (mA)	life time (h)
Multi-bunch (160 bunch-train \times 12)	0.05	~ 200
203 bunches	0.5	25 ~ 30
4 bunch-train \times 84	0.3	35 ~ 50
11 bunch-train \times 29	0.3	35 ~ 50
1/7 - filling + 5 single bunches	3.0 (single)	18 ~ 25
1/14 - filling + 12 single bunches	1.6 (single)	18 ~ 25
2/29 - filling + 26 single bunches	1.4 (single)	18 ~ 25
4/58 - filling + 53 single bunches	1.0 (single)	18 ~ 25

III. Beamlines

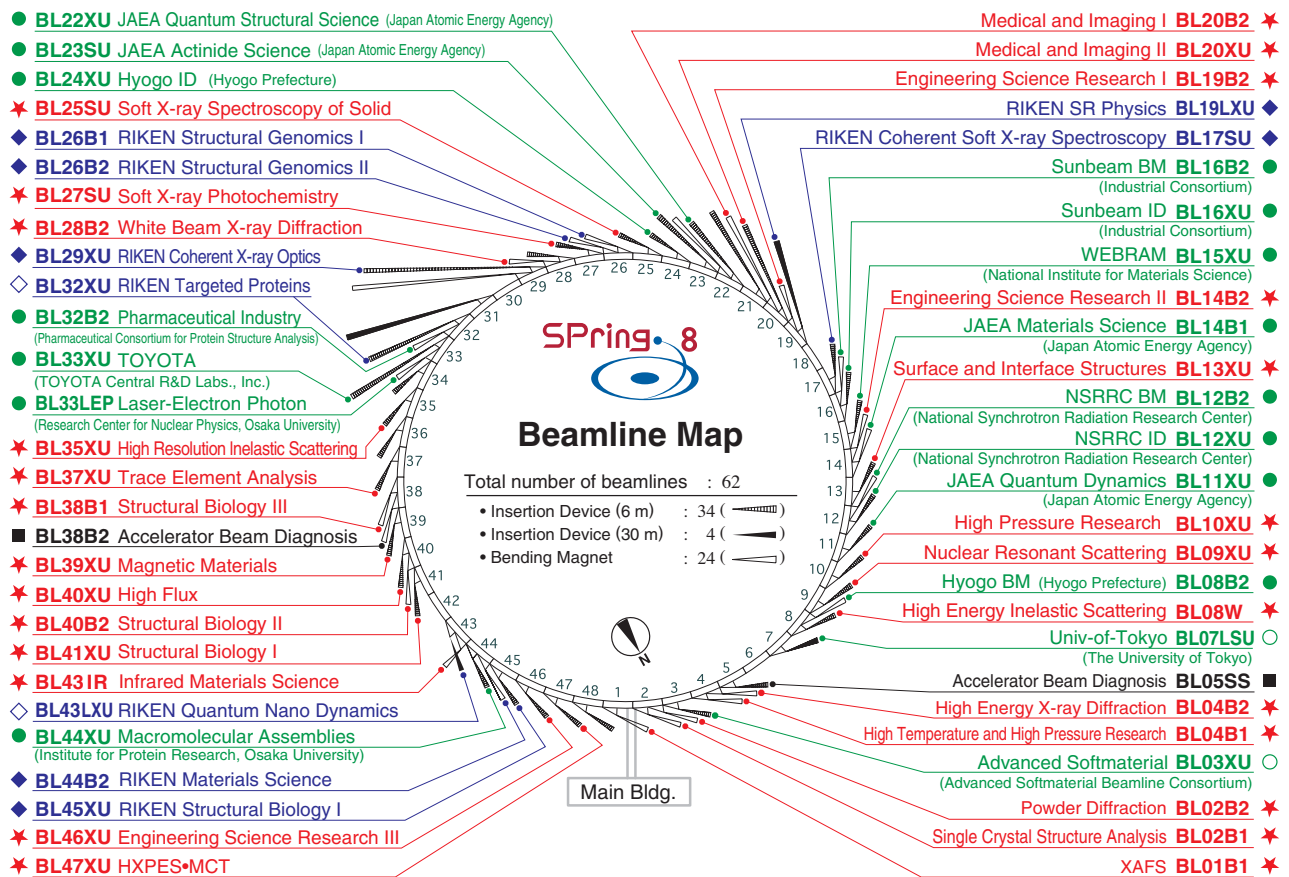
The SPring-8 storage ring can accommodate up to 62 beamlines: 34 insertion devices, 4 long undulators, and 24 bending magnets. At the time of writing, 50 beamlines are in operation, covering a wide variety of research fields of synchrotron radiation science and technology. The beamlines are classified into the following four types:

- (1) Public Beamlines
- (2) Contract Beamlines
- (3) RIKEN Beamlines
- (4) Accelerator Diagnostics Beamlines

There are now 26 public beamlines in full operation. The beamlines, which are proposed and constructed by external organizations such as universities, research institutes, private companies, and so forth, are called contract beamlines, and are exclusively used by the contractors for their own research purposes. At present, 15 contract beamlines

are in operation. The contract beamlines includes NSRRC BM (BL12B2) and NSRRC ID (BL12XU) beamlines, which were contracted by the National Synchrotron Radiation Research Center in Taiwan. These are the first contract beamlines installed at the SPring-8 by a foreign organization. Currently, two new contract beamlines are under construction: Advanced Softmaterial (BL03XU) and Univ-of-Tokyo (BL07LSU) beamlines. Those beamlines constructed by RIKEN are called RIKEN beamlines, and are used for RIKEN's own research activities. RIKEN is now operating seven RIKEN beamlines, and is constructing a new beamline called RIKEN Targeted Proteins (BL32XU). In addition, two accelerator diagnostics beamlines are in operation.

To display the beamline portfolio of the SPring-8, the beamline map is shown in Fig. 2 together with the beamline classification. Research field of each beamline is presented in Table V.



BL: Beamline	IR: Infrared Radiation
B1, B2: Bending Magnets	LEP: Laser-Electron Photon
XU: X-ray Undulator	LXU: Long-length X-ray Undulator
SU: Soft X-ray Undulator	LSU: Long-length Soft X-ray Undulator
W: Wiggler	SS: Straight Section

★ : Public Beamlines
● : Contract Beamlines
◆ : RIKEN Beamlines
■ : Accelerator Diagnostics Beamlines
○ ◇ : Planned or Under Construction

WEBRAM: Wide Energy Range Beamline for Research in Advanced Materials

NSRRC: National Synchrotron Radiation Research Center, Taiwan

HXPES•MCT: Hard X-ray Photoelectron Spectroscopy, Micro-Tomography

Fig. 2. Beamline map.

Table V. List of beamlines

BL #	Beamline Name	(Public Use)	Areas of Research
★ Public Beamlines			
BL01B1	XAFS	(Oct. 1997)	XAFS in wide energy region (3.8 to 113 keV). XAFS of dilute systems and thin films. Quick XAFS with a time resolution of seconds to as tenth seconds.
BL02B1	Single Crystal Structure Analysis	(Oct. 1997)	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 temperature.
BL02B2	Powder Diffraction	(Sep. 1999)	Accurate structure analysis of crystalline materials using powder diffraction data by Rietveld refinements and maximum entropy method (MEM).
BL04B1	High Temperature and High Pressure Research	(Oct. 1997)	Mineral physics at high temperature and high pressure. Energy-dispersive X-ray diffraction and X-ray radiography using the large-volume press.
BL04B2	High Energy X-ray Diffraction	(Sep. 1999)	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	(Oct. 1997)	Magnetic Compton scattering. High-resolution Compton scattering. High-energy Bragg scattering. High-energy fluorescent X-ray analysis.
BL09XU	Nuclear Resonant Scattering	(Oct. 1997)	Lattice dynamics 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	(Oct. 1997)	Structure analysis and phase transitions under ultra high pressure (DAC experiment). Earth and planetary science.
BL13XU	Surface and Interface Structures	(Sep. 2001)	Atomic-scale structural analysis of an ultra-thin film, nanostructure and surface, using in-air measurements (room temperature to 500 °C) and in-vacuum measurements (20 to 1300 K).
BL14B2	Engineering Science Research II	(Sep. 2007)	XAFS in wide energy region (3.8 to 72 keV). XAFS of dilute systems and thin films.
BL19B2	Engineering Science Research I	(Nov. 2001)	Residual stress measurement. Structural analysis of thin film, surface, interface. Powder diffraction. X-ray imaging, X-ray topography. Ultra-small angle X-ray scattering.
BL20XU	Medical and Imaging II	(Sep. 2001)	Microimaging. 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. Microangiography, refraction-enhanced imaging, radiation therapy, phase-contrast CT using interferometer. Ultra-small angle scattering.
BL20B2	Medical and Imaging I	(Sep. 1999)	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	(Apr. 1998)	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).
BL27SU	Soft X-ray Photochemistry	(May 1998)	Industrial research of functional material. Atomic and molecular spectroscopy by high resolution electron spectroscopy. Surface analysis and solid state physics.
BL28B2	White Beam X-ray Diffraction	(Sep. 1999)	White X-ray diffraction. Time-resolved energy-dispersive XAFS (DXAFS). Medical applications. White X-ray topography.
BL35XU	High Resolution Inelastic Scattering	(Sep. 2001)	Material dynamics on ~meV energy scales using inelastic X-ray scattering (IXS) and nuclear resonant scattering (NRS).
BL37XU	Trace Element Analysis	(Nov. 2002)	X-ray microbeam spectrochemical analysis. Ultra trace element analysis. High energy X-ray fluorescence analysis.
BL38B1	Structural Biology III	(Oct. 2000)	Routine data collection for macromolecular crystallography.
BL39XU	Magnetic Materials	(Oct. 1997)	X-ray magnetic circular dichroism (XMCD) spectroscopy and element-specific magnetometry under multiple-extreme conditions. Micro-XMCD. X-ray emission spectroscopy. Resonant X-ray magnetic scattering.
BL40XU	High Flux	(Apr. 2000)	Time-resolved diffraction and scattering experiments. Microbeam X-ray diffraction experiments. Quick XAFS.
BL40B2	Structural Biology II	(Sep. 1999)	Noncrystalline small and wide angle X-ray scattering
BL41XU	Structural Biology I	(Oct. 1997)	Structural biology. Macromolecular crystallography. Ultra-high resolution structural analysis.
BL43IR	Infrared Materials Science	(Apr. 2000)	Infrared microspectroscopy. Magneto-optical spectroscopy.
BL46XU	Engineering Science Research III	(Nov. 2000)	Structural characterization of thin films by X-ray diffraction and X-ray reflectivity measurement. Residual stress measurement. Time resolved X-ray diffraction measurement. Hard X-ray photoemission spectroscopy.
BL47XU	HXPES·MCT	(Oct. 1997)	Hard X-ray photoelectron spectroscopy. Projection type micro-tomography. Imaging type micro-tomography. Hard X-ray microbeam/scanning microscopy.

BL #	Beamline Name (First Beam)	Areas of Research
● Contract Beamlines		
BL08B2	Hyogo BM (Hyogo Prefecture) (Jun. 2005)	XAFS in a wide energy region. Small angle X-ray scattering for structural analyses of polymer and nanocomposite materials. X-ray topography. Imaging. Powder diffraction with a high angular resolution.
BL24XU	Hyogo ID (Hyogo Prefecture) (May 1998)	Structure analysis of small bio-crystals for industry. Surface/interface analysis for industry by fluorescent X-ray analysis, strain measurements and grazing incidence X-ray diffraction. Microbeam formation studies for materials and life sciences.
BL12XU	NSRRC ID (National Synchrotron Rad. Res. Center, Taiwan) (Dec. 2001)	High resolution non-resonant or resonant inelastic X-ray scattering. High resolution near-edge X-ray Raman scattering. Phase transitions under high-pressure, low and high temperatures. High-resolution X-ray absorption and emission spectroscopy. X-ray physics and optics.
BL12B2	NSRRC BM (National Synchrotron Rad. Res. Center, Taiwan) (Oct. 2000)	X-ray absorption spectroscopy. Powder X-ray diffraction. High resolution X-ray scattering. Protein crystallography.
BL15XU	WEBRAM (National Institute for Materials Science) (Jan. 2000)	Hard X-ray photoelectron spectroscopy. Highly precise X-ray powder diffraction
BL16XU	Sunbeam ID (Industrial Consortium) (Oct. 1998)	Characterization of thin films for ULSI and magnetic devices, catalysts, functional materials, and structural materials by X-ray diffraction, fluorescence X-ray analysis, X-ray magnetic circular dichroism, and imaging with X-ray microbeam.
BL16B2	Sunbeam BM (Industrial Consortium) (Oct. 1998)	Characterization of industrial materials by X-ray absorption fine structure measurements, X-ray diffraction and other methods.
BL32B2	Pharmaceutical Industry (Pharmaceutical Consortium for Protein Structure Analysis) (Apr. 2002)	Protein structure analysis for structure-based drug design: 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.
BL33XU	TOYOTA (TOYOTA Central R&D Labs., Inc.) (Apr. 2009)	Time-resolved XAFS. Characterization of industrial materials, such as catalysts, secondary batteries, fuel cells.
BL33LEP	Laser-Electron Photon (RCNP, Osaka University) (Jun. 1999)	Meson photoproduction from nucleon and nucleus. Photoexcitation of hyperons, nucleon resonances, and other exotic states. Photonuclear reactions. Beam diagnoses. Test and calibration of detectors with GeV photon beam.
BL44XU	Macromolecular Assemblies (IPR, Osaka University) (May 1999)	Crystal structure analysis of biological macromolecular assemblies (e.g. membrane complexes, protein complexes, protein-nucleic acid complexes, and viruses).
BL11XU	JAEA Quantum Dynamics (Oct. 1998)	Nuclear scattering. Surface and interface structure with MBE. Inelastic X-ray scattering. XAFS.
BL14B1	JAEA Materials Science (Dec. 1997)	Materials science under high-temperature. <i>In situ</i> study on catalysis using dispersive XAFS. X-ray diffraction for structure physics.
BL22XU	JAEA Quantum Structural Science (May 2002)	Materials science under high-pressure. Resonant X-ray scattering. Speckle scattering. Residual stress/strain distribution analysis.
BL23SU	JAEA Actinide Science (Feb. 1998)	Surface chemistry with supersonic molecular beam. Biophysical spectroscopy. Photoelectron spectroscopy. Magnetic circular dichroism.
◆ RIKEN Beamlines		
BL17SU	RIKEN Coherent Soft X-ray Spectroscopy (Sep. 2003)	High resolution photoemission spectroscopy. Soft X-ray emission spectroscopy for liquid and biological samples. Soft X-ray diffraction spectroscopy. Surface science.
BL19LXU	RIKEN SR Physics (Oct. 2000)	Any research field requiring the highly brilliant X-ray beam.
BL26B1	RIKEN Structural Genomics I (Apr. 2002)	Structural genomics research based on single crystal X-ray diffraction.
BL26B2	RIKEN Structural Genomics II (Apr. 2002)	Structural genomics research based on single crystal X-ray diffraction.
BL29XU	RIKEN Coherent X-ray Optics (Dec. 1998)	X-ray optics, especially coherent X-ray optics.
BL44B2	RIKEN Materials Science (Feb. 1998)	Macromolecular crystallography.
BL45XU	RIKEN Structural Biology I (Jul. 1997)	Time-resolved and static structures of non-crystalline biological materials using small-angle scattering and diffraction techniques.
■ Accelerator Diagnostics Beamlines		
BL05SS	Accelerator Beam Diagnosis (Mar. 2004)	Accelerator beam diagnosis. R&D of accelerator components. Production of MeV γ -ray photons.
BL38B2	Accelerator Beam Diagnosis (Sep. 1999)	Accelerator beam diagnosis. R&D of accelerator components.