Experimental Facilities - General -

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Introduction

Since FY1988, experimental facilities group has been continued R&D of insertion devices, front ends, optics and detectors with domestic and international collaboration. The details are reported to the following sections.

In FY 1992, the Project Team decided to design and construct two "Pilot Beamlines" in order to achieve standardization of various beamline components through design work.

In FY 1993, the beamline committee was formed to evaluate the proposals for the public beamlines and four initial beamlines including two pilot beamlines were selected for the construction. The construction of these four has been started in FY 1994.

SPring-8 Users Society

SPring-8 Users Society was formally established in 1993. More than 920 members (universities: 63%, institutes: 17% and industries: 20%) with 34 groups as shown in Table 1 are joining for promoting the scientific program including R&D and the detailed design of the public beamlines.

Beamlines

Beamlines of the SPring-8 are classified into four groups; public beamlines, contract beamlines, JAERI and RIKEN beamlines, beamlines for machine study and beam monitoring and R&D studies. Public beamlines are, in general, constructed by the SPring-8 and are opened for general users from universities, national laboratories, and industries. Contract beamlines are constructed by authorized organizations with a technical support of the SPring-8 staff and used solely or with the first priority by the staff of the constructing organizations in a fixed period. JAERI/RIKEN beamlines are constructed by them and by their own expenses and used solely by JAERI/RIKEN users. The last ones are constructed by the SPring-8 project team for machine study and beam monitoring, and for the development and test of the beamline components.

It has been planned that ten public beamlines are constructed by FY 1998. It was very important to start immediately the design work of several pilot beamlines by the Project Team. Through the design and construction of team, Project Team must study the technical items common to all the beamlines and promote standardization of common elements. Such a process plays an important role in the construction of the following public beamlines.

Responding to a recommendation made by the Project Advisory Committee, the SPring-8 project team started design two pilot beamlines in Spring 1993 to establish guide lines for the construction of the subsequent beam lines, to standardize the beam line components in the front end channel, optical components, and control system, etc., to test the beam line components at the commissioning phase of the storage ring and to advance the experimental phase.

One of the two pilot beamlines was to be a high energy undulator beamline with an energy range of 9~40 keV. This will be applied for the study of macromolecular crystallography in structural biology. The other was a high energy wiggler beamline with an energy of higher than 100 keV. This will be used to investigate the magnetic Compton scattering of metals and alloys.

The beamline committee was formed in July 1993 to discuss research subjects, technological feasibility, and construction priorities associated with the provision of public beamlines. Some 20 proposals have been submitted to the committee. These proposals fall into five categories, biology and medical application, X-ray and soft X-ray spectroscopy, X-ray scattering and diffraction, structural analysis and X-ray absorption as shown in Table 2.

The following 4 public beamlines including two pilot beamlines, "Undulator beamline for the protein crystallography", "Undulator beamline for nuclear resonant scattering", "Twin helical undulator beamline for soft X-ray spectroscopy of solids" and "Wiggler beamline for high-resolution Compton scattering and magnetic Compton scattering", were selected as the first priorities for the construction. Main parameters of these beamlines such as insertion device, optics, energy range, energy resolution, photon flux and beam size, are shown in Table

3. These four will form the step forwards a total of 10 public beamlines to be constructed by 1998.

In 1994, the construction of four insertion device beamlines, four bending magnet beamlines and two R&D beamlines have been started. The design of insertion device of four public beamlines and two R&D beamlines are finalized. The design of the front end of insertion device and bending magnet beamlines are also finalized except some components of insertion device beamlines. The fabrication of insertion device and front end will be started at April, 1995 and the installation will be finished at March, 1997.

Conceptual design of a double-crystal monochromator with rotated-inclined geometry was made for the use of the initial two undulator X-ray beamlines as well as most following undulator and bending magnet X-ray beamlines. Fabrication and installation of the optical components and experimental stations of four initial beamlines will be finished at March,1997.

Symposium and Workshops

Table 4 shows the list of symposium and workshops organized by The Project Team since 1988.

Table 1 List of specialist groups for the SPring-8

X-ray scattering and diffraction
- X-ray magnetic diffraction and absorption
- Nuclear resonance scattering
- Compton scattering
- Inelastic scattering
- Very small angle X-ray scattering
- Structural phase transition
- Structures of surfaces and interfaces
- Diffuse scattering
- Chemical reactions
- Powder diffraction
- Structural properties of extremely dense materials
- High pressure mineral physics
- High temperature
- Topography

X-ray spectroscopy and absorption
- XAFS
- High energy XAFS
- Spectrochemical analysis
- Photo-excitation new essential process
- Actinides
- Atomic and molecular physics
- Nuclear excitation

Low energy spectroscopy
- Soft X-ray photochemistry of gases and surfaces
- Soft X-ray CVD
- Soft X-ray spectroscopy of solids
- Electronic properties of solids
- Infrared spectroscopy

Biology and medical application
- Biocrystallography
- Structural biology
- Protein crystallography
- Macromolecular small-angle X-ray scattering
- Soft X-ray microscope
- Hard X-ray microscope
- X-ray holography
- Medical and clinical applications

Table 2 List of beamline proposals

Biology and medical application	
Macromolecular small-angle X-ray scattering	(U:6~12 keV)
Time-resolved protein crystallography	(BM:6~40 keV)
Protein crystallography	(U:9~18 keV)
Medical application	(MPW)
X-ray and soft X-rayspectroscopy	
Soft X-ray spectroscopy of solids	(THU:0.5~3 keV)
Soft X-ray photochemistry	(HU:0.1~3 keV)
Spectrochemical analysis	(U:2~20 keV)
Atomic physics	(U:1~25 keV)
Soft X-ray CVD	(U:0.2~3 keV)
X-ray scattering and diffraction	
High energy inelastic scattering	(EMPW:Ec=42.6 keV)
X-ray high precision diffraction topography	(MPW:5~90 keV)
Nuclear resonance scattering	(U:6~75 keV)
Surface and interface structure	(U:6~65 keV)
Diffuse scattering	(U:5~50 keV)
Structural analysis	
High temperature	(MPW:10~100 keV)
Powder and thin-film diffraction	(BM:5~50 keV)
High pressure mineral physics	(MPW:30~150 keV)
Extremely dense state	(U:15~60 keV)
Highly precise molecular crystallography	(U:8~60 keV)
Structural phase transition	(BM:8~50 keV)
X-ray absorption	
Broad energy band XAFS	(BM:3~90 keV)
X-ray magnetic absorption and scattering	(U:3~30 keV)
High brilliance XAFS	(U:4~30 keV)

U: undulator, HU: helical undulator, THU: twin helical undulator
MPW: multi pole wiggler, EMPW: elliptical multi pole wiggler
BM: bending magnet

Table 3 First set of 4 beamlines (Initial beamlines)

	Protein crystallography	High energy inelastic scattering	Nuclear resonant scattering	Soft X-ray spectroscopy of solid
Research subjects	Macromolecular Crystallography	High-resolution Compton scattering Spin-dependent Compton scattering	Time domain Mossbauer spectroscopy Extremely high energy resolution spectroscopy	Spin dependent photoemission spin polarized photoelectron diffraction Circular dichroism
Insertion Device	Undulator (=3.2cm,L=4m, in-vacuum)	EMPW (k=12, Ec=42.6keV)	Undulator (=3.2cm,L=4m, in-vacuum)	Twin helical undulator
Optics	Double-crystal Monochromator (rotated inclined Si) Vertical Focusing Mirror (3:1 focusing) Horizontal Focusing Mirror (6:1 focusing)	Doubly-bent monochromator (100~150keV) Asymmetric Johann monochromator (focus only horizontally) (300keV)	Double-crystal Monochromator (rotated inclined Si)	Grating monochromator (500~1500eV) Crystal monochromator (1~3 keV)
Energy Range	9~18 keV 27keV 38keV	100~150 keV 300 keV	6~25 keV(1st) 15~75 keV(3rd)	0.5 ~3 keV
Energy Resolution	$2x10^{-4}$ (9-18keV) $<10^{-3}$(27keV,38keV)	10^{-4} (100 -150keV) 10^{-3} (300 keV)	ΔE=10-100meV	10^{-4}
Photon Flux	10^{11}~10^{12} photons/sec	10^{13} photons/sec (150 keV)	10^{9}~10^{11} photons/sec	10^{13}~10^{14} photons/sec
Beam Size	0.05mmϕ	<0.5mmϕ	0.3mm(H)x 0.07mm(V)	<0.5mmϕ

Table 4 List of Symposia and Workshops

Symposia

INTERNATIONAL SYMPOSIUM on "X-ray SR an Advanced Science and Technology"

The 1st: What are to be done by the high-energy high-brilliance SR source ?
1988.1.12-13(Osaka)

The 2nd: Biological Science, Materials Science and Industrial Applications.
1990.2.15-16(Kobe)

The 3rd: Surface and Interface Science
1992.3.18-19(Kobe)

The 4th: Frontier of Materials Science on Synchrotron Radiation
1994.3.9-10(Kobe)

Workshops

"The Frontiers of Synchrotron Radiation
-Insertion Devices and Their Applications- "
1991.2.7-8(Kobe)

"SPring-8 Workshop on Atomic Physics at High Brilliance Synchrotron Radiation Facilities"
1992.3.23-24(Himeji)

"The Satellite Meeting of the Fourth International Conference of Biophysics and Synchrotron Radiation"
1992.8.28-29(Kobe)

"International Workshop on Area Detectors"
1993.11.24-26(Harima)

"International Workshop on Imaging"
1995.3.22-24(Wako)