BL09XU Nuclear Resonant Scattering

This beamline is a standard X-ray beamline with a 32 mm-period linear undulator and a water cooled monochromator. Intense X-rays up to 80 keV can be produced and more than 30 kinds of nuclear levels exist in this energy range mainly. The following researches of nuclear resonant scattering are performed using the high-resolution optics and the time differential measurements in the several-bunch operation; Study of dynamics in materials using nuclear inelastic scattering; Time domain Mössbauer spectroscopy; Coherent X-ray optics using nuclear resonant scattering (NRS).

The following researches are also performed using the multi high-precision goniometer system; NEET, surface study; X-ray non-linear phenomena and; Residual strain analysis.

Area of research

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

Keywords

Scientific field

Mössbauer spectroscopy, Phonon density of states, NEET, Surface, Non-linear, Residual strain

Equipment

High-resolution monochromator, High precision optics, Avalanche photodiode, Fast timing electronics

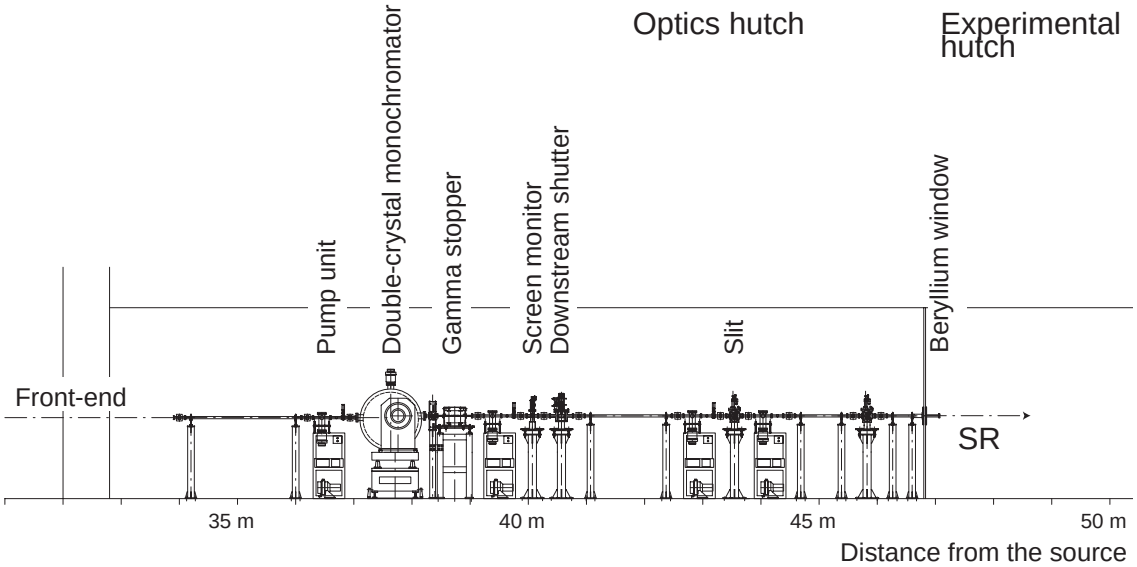
Source and optics

X-rays at sample (50 m from source point)

Energy range	6 ~ 100 keV
Total flux	2.4×10^{13} phs/sec
	(E = 14.4 keV @ 100 mA)
Beam size (2σ)	2.7 mm (h) × 1.0 mm (v)
Divergence (2σ)	0.23 mrad (h) × 0.023 mrad (v)

Experimental stations

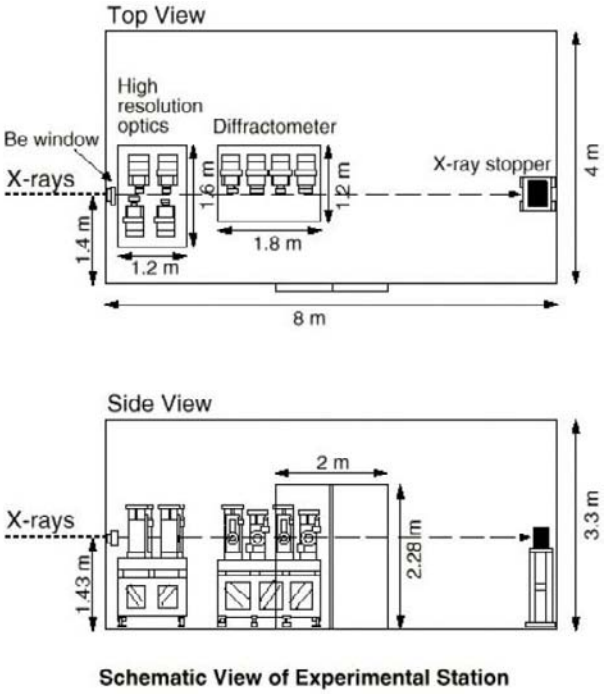
Optical facilities are placed in the experimental hutch which is 8 m long and 4 m wide. Goniometers are arranged on the tables for the high precision X-ray optics. The temperature at the goniometers is kept within a variation of 0.01 degrees by the combination of an air-conditioner and a protective cover which prevents from the flowing air.



Schematic view of beamline

Two kinds of versatile goniometers are prepared. One is a ω-2θ goniometer whose axes are rotated in full circles by the stepping motors with the finest step 0.36 arcsec for ω and 0.72 arcsec for 2θ. The other is a tangential bar-type goniometer with the finest step of 0.005 arcsec by the stepping motor. The surfaces of the tables are polished and the goniometers can be smoothly moved on the tables by air pads under the goniometers. That makes the re-arrangement of the optics quite easy.

High-resolution monochromators used for the research using nuclear resonant scattering are arranged on these high precision goniometers. Three kinds of high-resolution monochromators for 14.4 keV X-rays with different energy resolutions and that for 6.2, 21.5, 22.5 and 29.8 keV X-rays are available at BL09XU. Their specifications and the measured performance are listed in Table 1, respectively. A nuclear resonant inelastic scattering spectrum measured by iron foil is shown in Fig.2.



Schematic View of Experimental Station

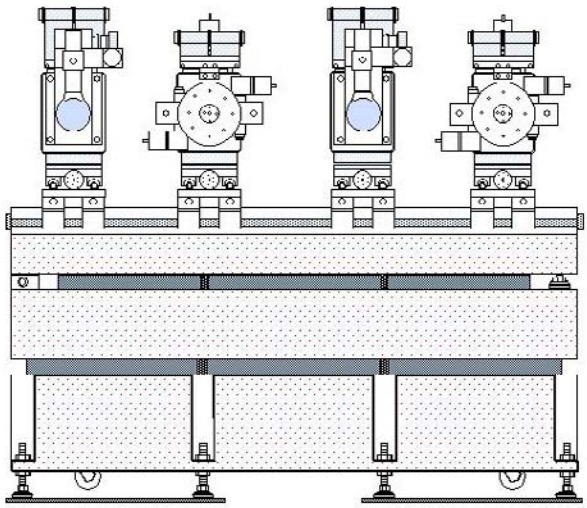


Fig.1. Schematic side view of high precision goniometers

Specifications of experimental station

- Experimental tables
  - 1st : size 130 × 160 × 110 cm^3
  - 2nd : size 180 × 120 × 110 cm^3
  - covered by plastic hutch for precise temperature control
- Precision goniometer
  - horizontal axis, driven by stepping motor
  - stroke : 6 degree
  - resolution : 0.005 arcsec/pulse
- 4-circle diffractometer
- XZ table, XY table
- 4-jaw slit
- Vacuum pump (Scroll and TMP pump)
- Cryostat
- Room temperature controller
- Avalanche photodiode detector, p-i-n photodiode detector, Scintillation detector, Ionization chamber
- NIM Bin, Fast AMP, Power supply, Counter, MCA, Current AMP etc.

Table 1. High-resolution monochromators available at BL09XU

Nucleus	Reflections	E (keV)	ΔE (meV)	Photons/sec/100 mA
^{57}Fe	Si 511 - Si 975 (2 nested channel-cut)	14.4	3.5	4×10^9
^{57}Fe	Si 511 - Si 975 (2 nested channel-cut)	14.4	2.5	1.6×10^9
^{57}Fe	Si 975 - Si 975 (2 flat crystals)	14.4	1.6	5×10^8
^{151}Eu	Si 440 - Si 12 12 8 - Ge 422 (3 flat crystals)	21.5	1.8	4×10^8
^{149}Sm	Si 440 – Si 16 8 8 – Ge 422 (3 flat crystals)	22.5	1.5	1.4×10^9
^{181}Ta	Si 311 – Si 511 – Si 511 (3 flat crystals)	6.2	10.5	4×10^8

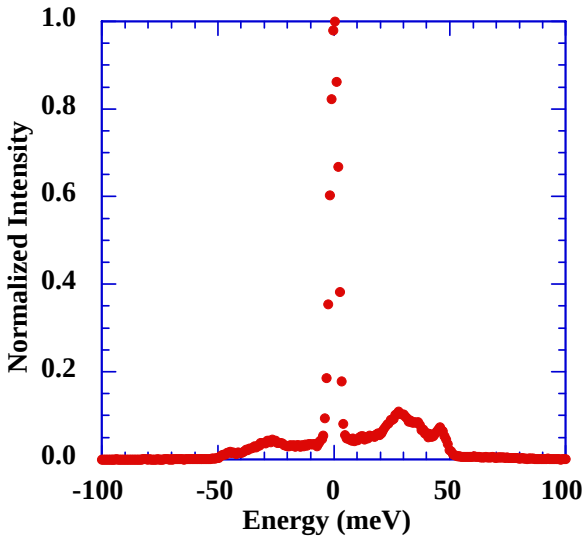


Fig.2. Measured nuclear resonant inelastic scattering spectrum of the α-iron foil

Contact information

Yoshitaka YODA
SPring-8 / JASRI
1-1-1 Kouto, Mikazuki-cho, Sayo-gun, Hyogo 679-5198
Phone : +81-(0)791-58-0832
Fax : +81-(0)791-58-0830
e-mail : yoda@spring8.or.jp