# JAERI BL23SU

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## l. Beamline construction

The BL23SU has been constructed to pro-mote applications of synchrotron radiation in radiobiology, surface chemistry, and especially solid-state spectroscopy of radioactive materi-als. The light source of the beamline is re-ferred to as APPLE-II (advanced planar-polarized light emitter), a kind of variable-polarizing undulator. In order to develop spectroscopic studies in those research fields, a grazing-incidence monochromator system using varied line-spacing plane gratings was designed and is now in regulation. The beamline design has already been published or submitted to journals [1-4]. Construction at the actual site in the SPring-8 storage ring building started in July, 1997 and finished in January, 1998. The insertion device for BL23SU (ID23) was installed in the cell 23 of the storage ring in December, 1997. This report describes installation of the beamline components and briefly mentions the commis-sioning situation.

## 2. Light source

The magnetic circuit of the ID23 consists of four permanent magnet arrays. The ID23 can generate a linearly- (horizontal and verti-cal plane), an elliptically-, and a circularly-polarized radiation by providing phase shift to the magnet arrays. The most important per-formance of the ID23 is the switching of right and left circularly-polarized radiation at 0.5 Hz by successful phase-shift driving of the magnet arrays. This feature is expected to promote the study of circular dichroism in spectroscopic research. The variation in in-tegral magnetic field along an electron orbit due to changing the ID gap and phase position distorts the closed-orbit-distortion (COD) of the storage ring. In order to minimize the COD change due to the gap and phase motion, electric currents of steering magnets and long-coils, associated with the ID23, must be opti-mized at every gap and phase position. Lin-ear polarization is currently possible in the entire range of gaps, but operation in the circu-lar-polarization mode is restricted except for a few gap positions. The elliptical-polarization mode is now only possible at the minimum gap of 36 mm. Residual tables of the correc-tion electric currents for the steering magnets and the long-coils will be finished within this year in addition to the achievement of circular-polarization switching at 0.5 Hz.

## 3.Front-end

The front-end of the BL23SU consists of a pre-mask, the 1st gate valve, an adjust-filter, a fast-closing shutter, the 1st ion pump, the 1st screen monitor, the 1st x-ray beam position monitor (XBPM1;XY wire-scan type monitor), a main mask, the 2nd ion pump, an absorber, the 2nd gate valve, the 2nd x-ray beam posi-tion monitor (XBPM2), XY-slits, the 3rd ion pump, the 2nd screen monitor, a beam shutter, and finally the 3rd gate valve in order from the upstream side. The XBPMs and XY-slits are controllable from X-terminals through a BL workstation and a VME system [4], following a common BL-control manner of SPring-8. The main beam shutter (MBS) consists of three components of the absorber, the beam shutter, and the 3rd gate valve. The reason why the gate valve is included in the MBS is due to the absence of a Be window and gas dosing into the experimental stations in this beamline. The monitoring of cooling-water flow, its pressure and temperature at the mask, the absorber, and the XY-slits, which suffer from the most heavy heat-load from the inser-tion device's radiation, is done on the front-end monitor rack set near the optics hutch. The Cu body temperature data of these high heat-load components are also acquired in a computer as well as vacuum pressure observed at each ion pump. The body and water tem-peratures only barely rose due to radiation from the ID23 at a ring current of 20 mA. The front-end pressure measured by the 3rd vacuum gauge (VG3), affected primarily by gas desorption from the XY-slits, was main-tained below $3 \times 10^{-6}$ Pa even at the minimum gap.

## 4. Beam transport channel

The beam transport channel components of the BL23SU are primarily classified into three categories, that is, a soft x-ray monochromator system, RI-protection components, and experimental stations. The monochromator system consists of a vertically-sagittal-focusing cylindrical mirror (Mv), a horizontally-focusing plane mirror with a bending system (Mh), an entrance slit (S1), a spherical mirror (M1/M2), three gratings, an exit slit (S2), and post-focusing cylindrical (M3) and toroidal (M4) mirrors. The orientations of Mv, Mh, and the gratings are controllable by X-terminals as well as the XBPMS and the XY-slits of the front-end [4]. Figure 1 shows the interior of the optics hutch, including the Mv and Mh mirror chambers.

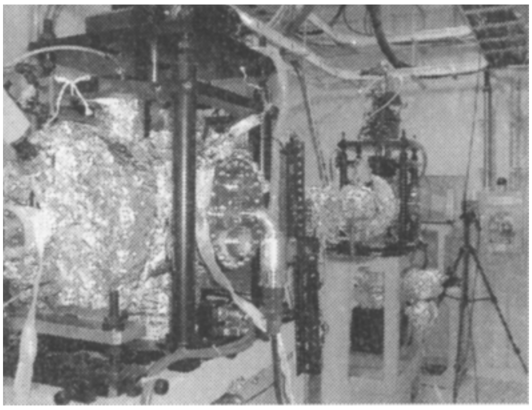

Fig. 1 Hutch interior, indicating pre-focusing mirror chambers of Mv (left) and Mh (Inner part )

The S1 and grating chambers are shown in Fig. 2. The slit position is manually movable with a stroke of about 400 mm along a light axis in order to compensate the focusing-point lag of Mv. The M1, M2 and three gratings are installed in an identical grating chamber. The M1 or M2 is selected manually to set a deviation angle, corresponding to the wavelength region used, coupling with a selection of grating. The alignment of the optics made by using visible radiation. Further accurate alignment of the monochromator system will be achieved by using an actual focusing mirror of Mv.

A soft x-ray beam is introduced into the RI-experiment building through an acoustic-delay line (ADL) shown in Fig.3. The ADL tube has 12 disks with center holes of 50 mm in diameter to provide a slow travel time of 11 ms for shock waves generated accidentally at the downstream end-station [3]. Gas molecules passing through the ADL are stopped by fast-closing gate valves installed in the optics hutch and upstream of the surface chemistry station.

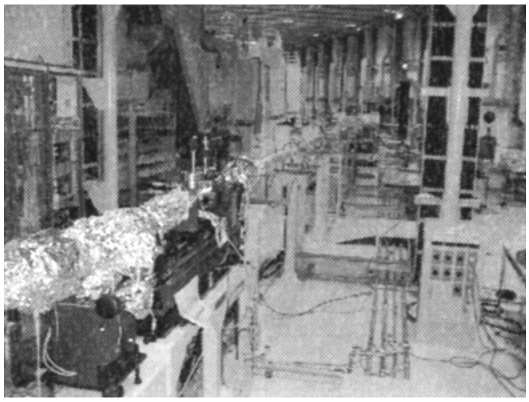

Fig. 2 Entrance slit, S1, chamber (left) and grating chamber (inner part) in experimental hall

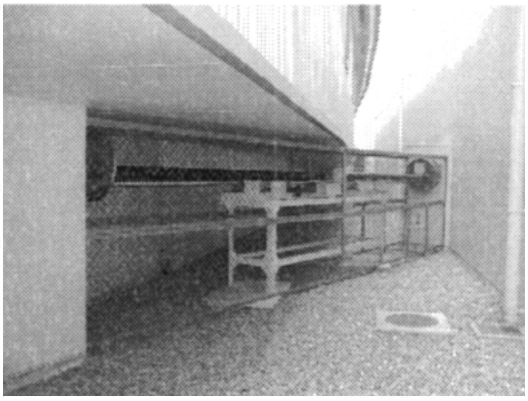

Fig. 3 Connecting tubes for vacuum and electric wires between storage ring building (left) and RI building (right)

The beamline components installed in the RI-experiment hall is shown in Fig. 4. These include an RI-inspection port, a radiation-measurement chamber with a plastic scintillation detector, a liquid-nitrogen gas-trap chamber, a fast-closing gate valve, and finally the M4 mirror. The RI-inspection port is used for periodic inspection of the RI pollution from an end-station set downstream of the M4 mirror. The same type o ports are installed in the optics hutch and downstream of the radiobiology station. On the other hand, the scintillation detector was configured for real-time inspection of RI pollution. An excess count of the detector's output pulse over the restricted level preset causes a local warning of the migration of radioactive materials to the upstream side. The liquid-nitrogen shroud is expected to adsorb radioactive gas molecules. A local warning of the liquid-nitrogen monitor signals a decrease in the liquid-nitrogen amount with a buzzer and a rotating light.

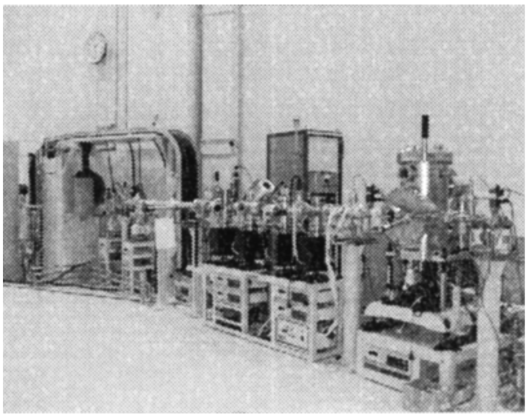

Fig. 4 Beamline in RI experimental hall

**5. Experimental stations**

The study of electronic structures of strongly-correlated electron systems, e.g., actinides, rare-earth and transition-metal compounds, is carried out at the solid-state spectroscopy station. The apparatuses will be installed as an end-station in the RI-experiment hall where unsealed radioactive materials can be used. The end-station consists of a photoelectron spectrometer with a low-temperature cryostat and a magnetic-circular-dichroism apparatus (MCD) with super-conduction magnets. These apparatuses enable us to obtain the electron density of states and information about spin/orbital moments and Coulomb interaction with respect to 5f, 4f, and 3d electrons.

The surface chemistry experimental station has been designed to promote research on new surface reactions induced by the kinetic energy of incident molecules as well as new surface photofragmentations caused by soft x-ray inner-shell excitation. The surface reaction analyses are achieved by using x-ray photoelectron spectroscopy (XPS), supersonic molecular beam technique (SSB), temperature-programmed desorption method (TPD), low-energy electron diffraction (LEED), time-of-flight mass spectrometry (TOF-MS), and electron-ion coincidence measurement (EICO).

The radiobiology experimental station has been designed to study the effects of localized activation in biological molecules for mutation and the function change in the super-molecule structure due to soft x-ray irradiation. In order to identify a chemical reaction path in biological molecules excited by soft x-ray absorpion, an electron-paramagnetic-resonance apparatus (EPR) is inserted into the beamline. It must contribute to in situ detection of rare radical species as intermediate products in DNA-related molecules or aminoacids at the low temperatures.

All experimental stations are in design phase. They will be installed by March 1999 at the latest.

**References**


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