Current Status of Light Source and Beamlines

UVSOR Light Source in 2001

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1. Machine Operation

In 2001, the UVSOR accelerator complex was operated for 40 weeks (including machine tunings) as scheduled. Monthly statistics of the operation time is shown in Figure 1. Three weeks in this year were assigned for single bunch users operation and other two weeks were dedicated for machine studies. We had four shut down period, around the new years day (two weeks), in spring (three weeks), in summer (three weeks) and in autumn (one week).

In autumn, there were a few troubles on the injector. One was the breakdown of the electron gun. Another was on the function generator of the magnet power supply of the synchrotron. Fortunately they were quickly recovered. The users time was canceled only on two days in total.

Typical operation pattern in a week is as follows. Monday and Saturday morning (from 9 to 13 o'clock), are assigned for machine tunings and machine studies. From Tuesday to Friday, the machine is operated for users. The beam is injected twice a day, at 9 and 13 o'clock. The beam is stopped at 18 o'clock. It can be extended until 21 o'clock as requested by users. On Thursday, the beam is injected additionally at 17 o'clock and is stopped at 21 o'clock. The filling beam current is 250 mA in multi-bunch mode and 70 mA in single bunch mode. Typical beam current histories in both modes are shown in Figure 2.

2. Improvements

2-1. Beam position monitor system

New beam position monitor (BPM) system (Figure 3) was successfully commissioned [1]. This system is capable of measuring the beam position at 16 BPM heads located around the ring, every second with resolution of a few microns.

This system has revealed orbit movements in various time scales. There can be seen slow drift of order of few hundreds of microns in horizontal and vertical can be seen in time scale of hours. There is an orbit movement correlating with the change of the cooling water temperature in a time scale of 10 minutes, which will be described in the following sub-section.

The origins and the mechanisms of these orbit movements are under investigation. We are going to construct an orbit stabilizing system based on this new BPM system.

2-2. Cooling water system

The new BPM system described in the preceding sub-section has revealed an orbit movement in a time scale of 10 minutes. Soon it is found to strongly correlate with the temperature of the cooling water, which is oscillating with amplitude of a few degrees. This large modulation was soon found to be due to a malfunction of the temperature stabilizing system. During the summer shutdown, we replaced the

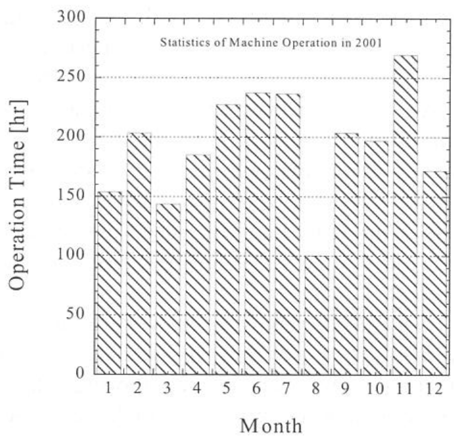


Fig. 1. Monthly statistics of the operation time in 2001.

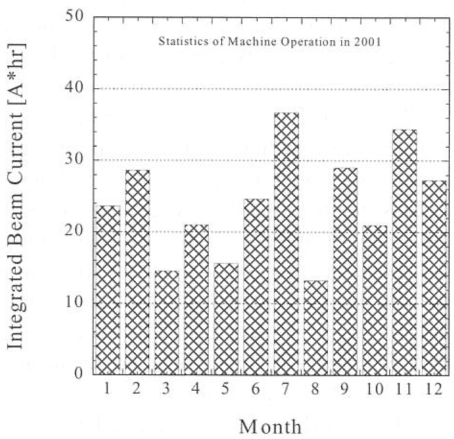


Fig. 2. Monthly statistics of the integrated beam current in 2001.

temperature control unit. The temperature stability was greatly improved as well as the orbit stability.

2-3. High Coupling Operation

In the single bunch mode, the beam lifetime is strongly limited by Touschek effect. To improve the lifetime, we tried a high coupling operation, in which the skew quadrupole magnets were excited to increase the XY coupling. The larger emittance in vertical effectively suppressed the Touschek effect. We could improve the lifetime by a factor of 2. We have tested the high coupling mode during a single bunch users run. Longer lifetime resulted in larger integrated photon flux during a run for many users. However, some users claimed that the larger emittance resulted in lower photon flux in their experiment. We will choose high or low coupling modes depending on the users experiments.

2-4. Survey on the storage ring magnets

As a preparation for the upgrade project [2], we have surveyed the storage ring magnets. This is the first time to survey over the whole ring since its construction. Some modern devices, such as a laser tracker, were used instead of old equipments that were used during the construction. Same method will be used during the reconstruction in the upgrade project.

The results showed that there are global distortions in horizontal plane and in vertical direction. However, the deviations between the neighboring magnets are in the order of a few hundred microns, which was better than expected.

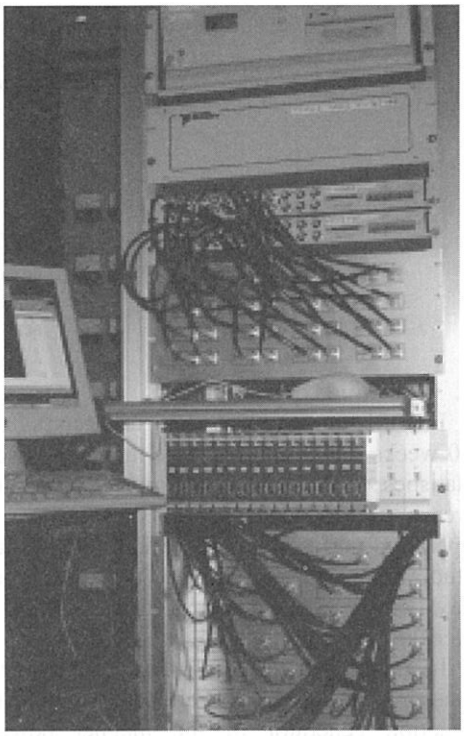


Fig. 3 New Beam Position Monitor System

3. Researches and Developments

3-1. Field measurement on the prototype of the multi-pole magnet for the upgrade project

In the new lattice for UVSOR storage ring [2], which has four new short straight sections and much smaller emittance (27nm-rad), all the quadrupoles and sextupoles will be replaced with combined function magnets, which have capabilities of producing both quadrupole and sextupole fields by utilizing auxiliary windings. A prototype was constructed and the field measurement was done. It was confirmed that the magnet can produce the required field strengths [3].

3-2. Development of In-vacuum undulator

In the new lattice described in the previous section, each straight section has small vertical betatron function, which enables us to install in-vacuum and small gap devices. A prototype of such a device is now under construction. This undulator will be installed at the straight section between B06 and B07, after removing the super-conducting wiggler, in March 2002. A precise field measurement and adjustment were finished. Final Vacuum conditioning is in progress.

3-3. Free Electron Laser

In July 2001, we have achieved 1.2W average output power on UVSOR-FEL in visible region [4]. This is the world highest record of the output power from a storage ring FEL. By using this high power FEL and brilliant undulator radiation in combination, we have succeeded in observing two-photon excitation of Xe atom [5].

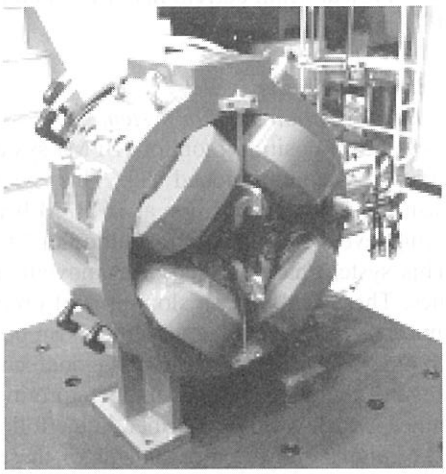
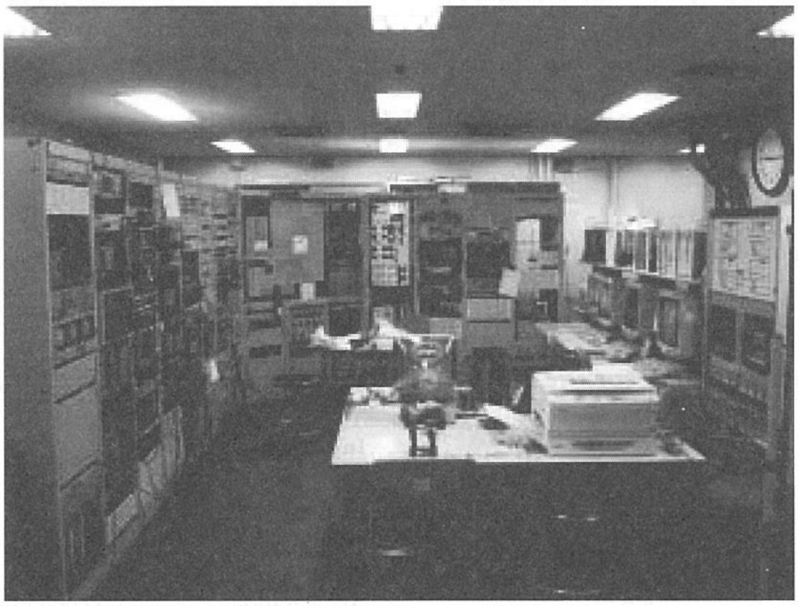


Fig. 4 Prototype of the combined-function multi-pole magnet

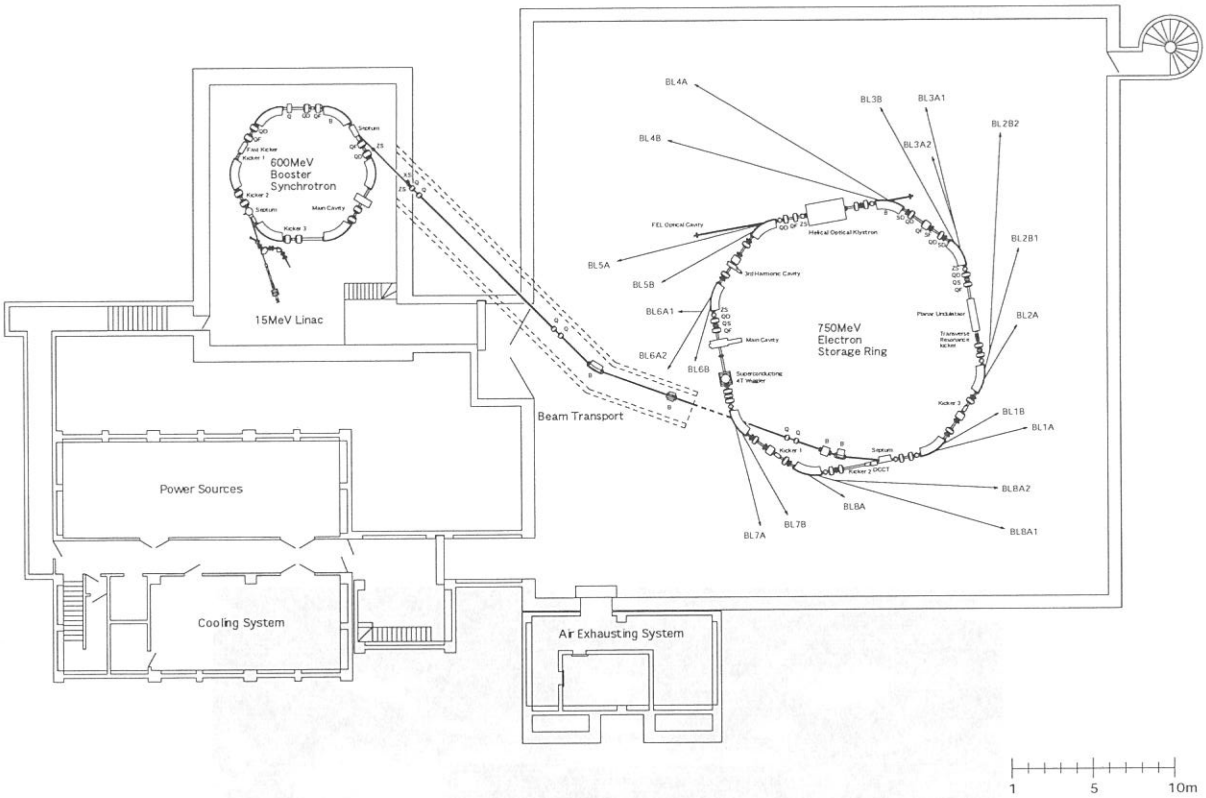
References

[1] K. Hayashi et al., Proceedings of the 13th Symposium on Accelerator Science and Technology, 372-374 (2001)

[2] M. Katoh et al., Nuclear Instruments and Methods in Physics Research A, **467-468** (2001), 68-71
[3] J. Yamazaki et al., in this report
[4] M. Hosaka et al., in this report
[5] T, Gejo et al., in this report



Control Room of UVSOR



UVSOR Accelerator Complex

Parameters of UVSOR Storage Ring

Circumference	53.2 m
Lattice	DBA ×4
Straight Sections	3 m ×4
Beam Energy	750 MeV
Bending Radius	2.2 m
RF Frequency	90.115 MHz
Harmonic Number	16
RF Voltage	46 kV
Mom. Comp. Factor	0.026
Betatron Tunes	(3.16, 1.44)
Natural Energy Spread	4.2×10^{-4}
Natural Emittance	165 nm-rad
Natural Bunch Length	160 psec[#1]
Max. Beam Current	300mA (multi-bunch)[#2] 70 mA (single bunch)

#1) About three times longer with harmonic cavity on

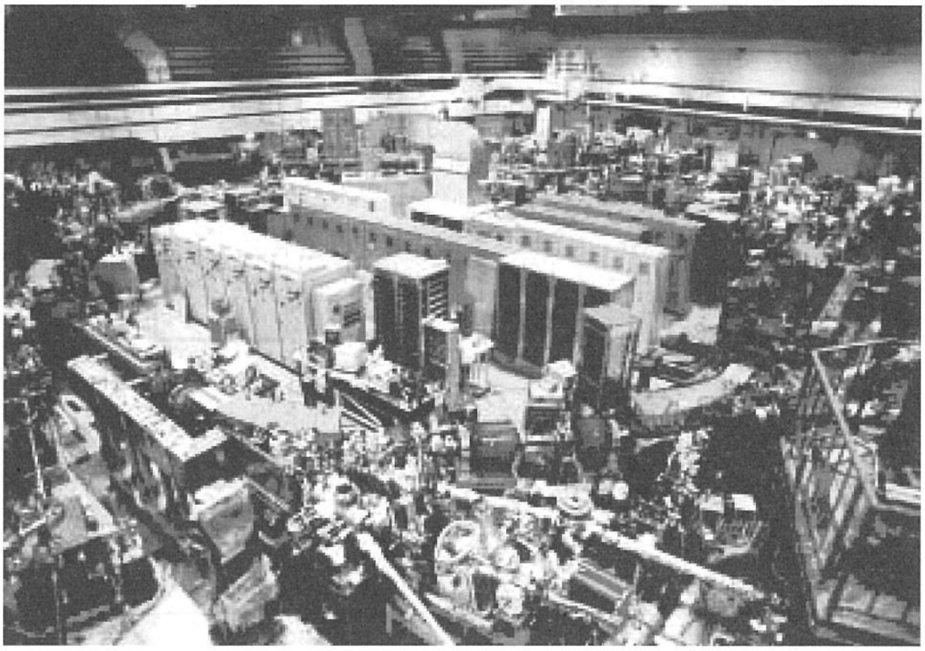
Parameters of UVSOR Injector

Injection Linac

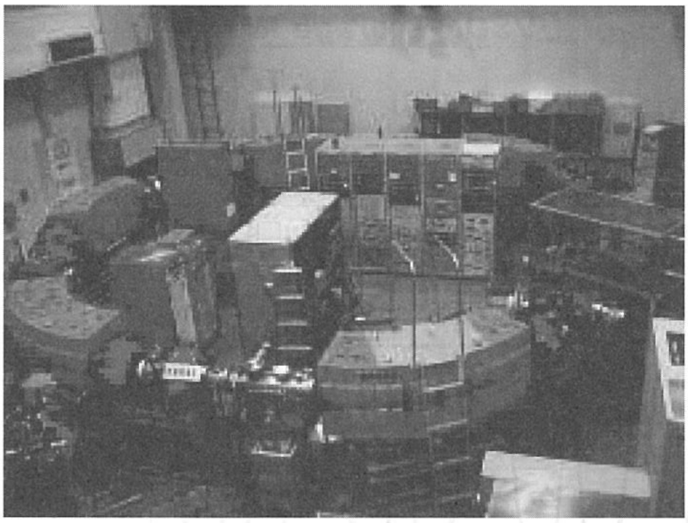
Energy	15 MeV
Length	2.5 m
Frequency	2856 MHz
Acceleration	2π/3Traveling Wave
Klystron Power	1.8 MW
Energy Spread	~1.6MeV
Repetition Rate	2.6 Hz

Booster Synchrotron

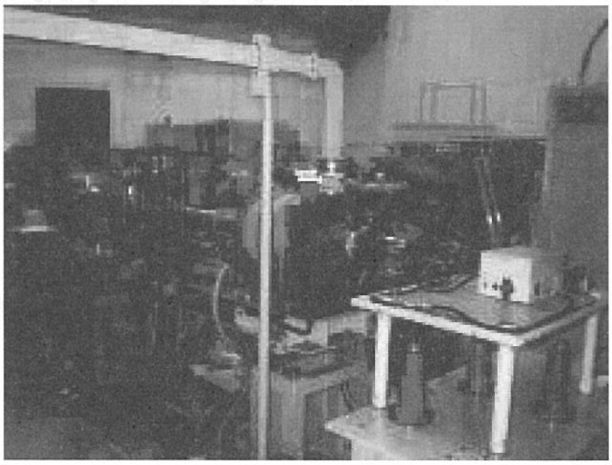
Energy	600 MeV
Lattice	FODO ×8
Circumference	26.6 m
Beam Current	32 mA (8-bunch filled)
Bending Radius	1.8 m
Betatron Tune	(2.25, 1.25)
Mom. Comp. Fac.	0.138
Harmonic Number	8
RF Frequency	90.115 MHz
Repetition Rate	2.6 Hz



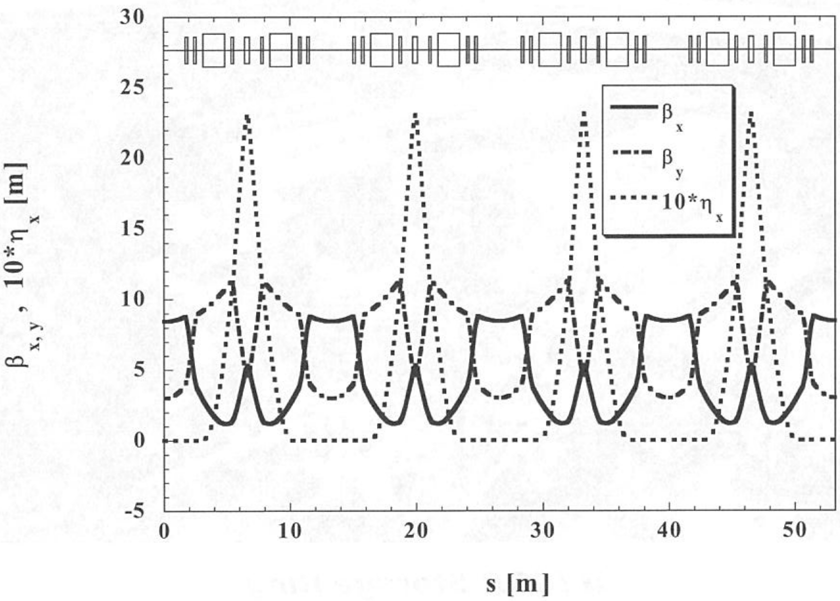
UVSOR Storage Ring



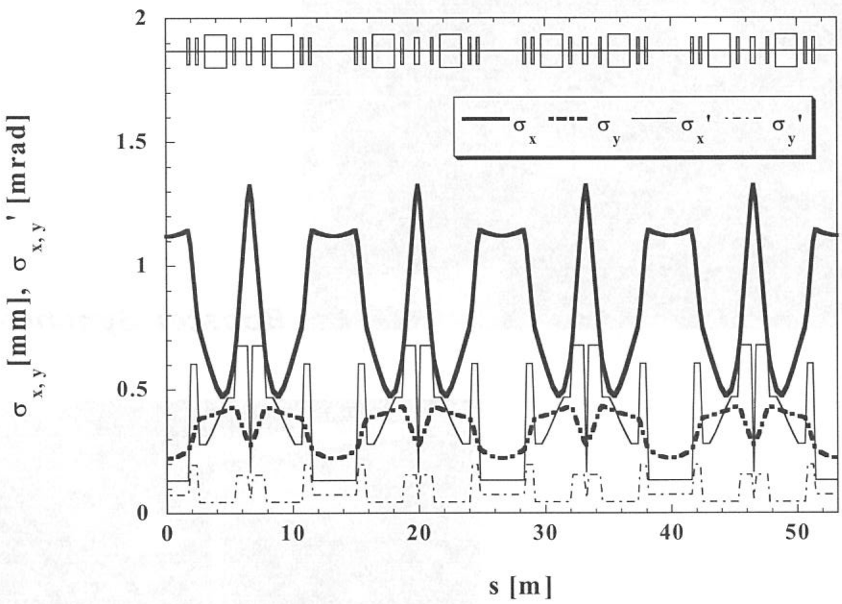
Booster Synchrotron



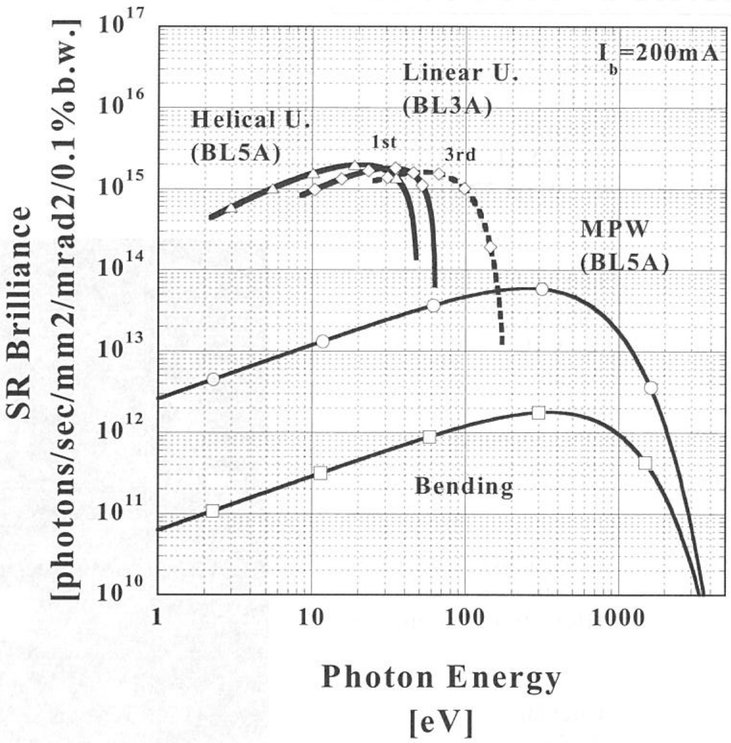
Injection Linac



Optical Functions of UVSOR Storage Ring



Beam Size and Divergence of UVSOR Storage Ring



Synchrotron Radiation Spectra at UVSOR

Light Source Parameters

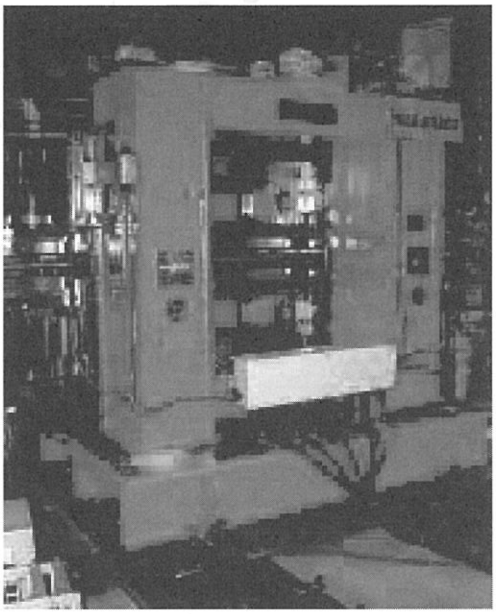
Bending Magnets	
Bending Radius	2.2 m
Critical Photon Energy	425 eV

Linear Undulator (BL3A)	
Number of periods	24
Period Length	84 mm
Total Length	2016 mm
Remanent Field	0.9 T
Magnetic gap	30 – 90 mm
Deflection parameter (K)	0.6 – 3.6

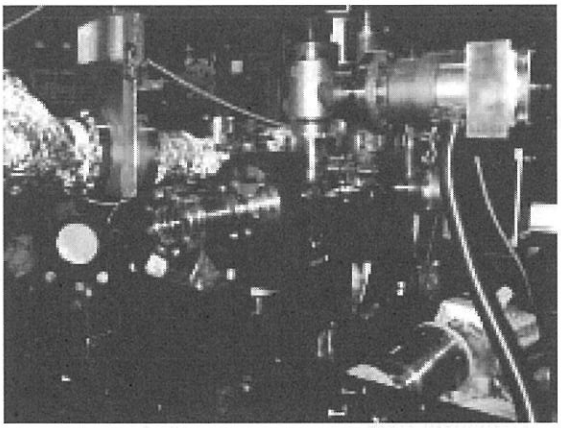
Helical Undulator/Optical Klystron (BL5A)	
Number of periods	18
Period length	110 mm
Length of dispersive part	302.5 mm
Total Length	2351.2 mm
Remanent field	1.3 T
Magnetic gap	30 – 150 mm
Deflection parameter (K)	0.07 – 4.6 (helical mode) 0.15 – 8.5 (linear mode)

Basic Parameters of UVSOR-FEL

Free Electron Laser	
Wave Length	240∼570 nm
Spectral Band Width	∼10^{-4}
Polarization	Circular
Pulse Rate	11.26 MHz
Maximum Average Power	1.2 W (at 570nm)
Storage Ring	
Beam Energy	600 MeV
Natural Emittance	106 nm-rad
Natural Energy Spread	3.4×10^{-4}
Natural Bunch Length	3.4 cm
Number of Bunches	2 or 4
Max. Beam Current	100 mA/bunch
RF Frequency	90.1 MHz
Optical Cavity	
Type	Fabry Perot
Cavity Length	13.3 m
Mirror	HfO_2, Ta_2O_5 multi-layer
Optical Klystron	
Polarization	Circular
Length	2.35 m
Period Length	11 cm
Number of Periods	9 + 9



BL5A Helical Undulator (Optical Klystron for FEL)



Optical Cavity for FEL at BL5A

Beamlines in 2001

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Eight bending magnets and two insertion devices are available for utilizing Synchrotron Radiation (SR) at UVSOR. There is a total of 20 operational beamlines, which are classified into two categories. 11 of them are so-called "Open beamlines", which are open to scientists of universities and research institutes belonging to the government, public organizations, private enterprises and those of foreign countries. The rest of the 9 beamlines are so-called "In-house beamlines", which are dedicated to the use of the research groups within IMS. We have two soft X-rays (SX) stations each equipped with a double-crystal monochromator (DXM), eight extreme ultraviolet (EUV) and SX stations with a grazing incidence monochromator, four vacuum ultraviolet (VUV) stations with a normal incidence monochromator (NIM), one infrared (IR) station equipped with FT interferometers, one station with a multi-layer monochromator, and four non-monochromatized stations for irradiation of white-light. Discussion with users, concerning the improvements and upgrades of the beamlines at UVSOR, has been continuously held as series of UVSOR workshops. As a result, about one third of the beamlines have been upgraded in recent years. More recently, discussion for the rebuilt and rearrangement of several old beamlines has been initiated, on the basis of the review and evaluation report on the present status of UVSOR in 2000. The following is a summary list concerning the status of the beamlines in 2001.

<Open beamlines>

BL1B covers the wavelength region ranging from 650 to 30 nm with the use of a Seya-Namioka type NIM. Standard measurements such as photoabsorption, reflection, and luminescence can be conducted at low temperatures down to 10 K. A variety of sample materials such as liquid, high pressure gases, and bio-specimens etc. can be measured easily by introducing appropriate windows. A second-monochromator system has been upgraded recently. The computer control system of the monochromator as well as the motor drivers has been renewed. The instruments including the multi-channel analyzer and detectors have been improved for time-resolved experiments. Several interesting experiments such as two-photon excitation, photo-reflectance, photoionization of liquid, and others are in progress.

BL2B1 consists of a Grasshopper monochromator, which covers the photon energy region from 20 to 800 eV, a double-pass cylindrical mirror analyzer (CMA), and an electron–ion coincidence apparatus. This beamline has been used mainly for surface science because the experimental chamber is equipped with useful instruments for surface science such as LEED, Auger, Ar-ion gun, and gas-inlet system. Photoelectron spectroscopy and electron–ion coincidence spectroscopy can be carried out on adsorbed surface and bulk material. There was no serious problem with the monochromator and photoelectron spectrometer. However, the performance of the monochromator is far from satisfactory in comparison with more recently constructed monochromators. Discussion with users, concerning the future plan of this beamline, has been initiated in 2001.

BL3A1/BL3A2 can share intense synchrotron radiation from a planar-type undulator. At BL3A1, the intense undulator radiation has been used without the monochromator for SR stimulated processes such as etching and chemical vapor deposition (CVD), light-amplification, desorption, and luminescence experiments. In 2001 two color experiments for Xe atoms utilizing SR from BL3 undulator and Free Electron Laser (FEL) from BL5 optical klystron have been successfully performed on BL3A1. BL3A2 is composed of a constant-length Spherical Grating Monochromator (SGM) and a rotatable time-of-flight (TOF) mass spectrometer for gas samples. Either undulator radiation or dipole radiation can be used as a light source at this beamline. Recently BL3A2 has been mainly used with the undulator radiation for SR-Laser combined experiments in a gas phase. It has been decided that the undulator and beamlines will be renewed in 2003.

BL5A is utilized for photoemission spectroscopy on solids and surfaces in the photon energy ranging from 5 to 250 eV using an SGM-TRAIN monochromator. The beamline is fitted for experiments of both valence bands and shallow core levels. The experimental station is composed of a high-resolution photoelectron spectrometer, and a spin- and angle-resolved photoelectron spectrometer. Apart from SR from a bending magnet, circularly polarized radiation from a helical undulator is available at this beamline. The combined experiments with SR and the powerful laser system consisting of a TiS laser, RegA and OPA have been carried on in recent years. The preparation to use the undulator radiation in the low energy region is under way.

BL5B is mainly used for calibration of various optical elements and detectors in the photon energy region from VUV to SX. There are no similar beamlines at other facilities in Japan. BL5B has been contributing to many fields of research such as astro-science, nano-science, synchrotron science and technology for a long time. The beamline consists of a plane grating monochromator (PGM) and three experimental chambers in tandem, which are utilized for calibration of optical elements using a goniometer, optical measurements of solids, and photo-stimulated desorption experiments. The project for improving the goniometer will begin around the end of the fiscal year of 2001.

BL6A1 is used as a unique IR and FIR beamline. This beamline is composed of FT-IR and FT-FIR interferometers, which covers wide wavelength range from sub-milli to near IR region. Numerous research work on molecular sciences, using different experimental techniques such as high-pressure with a diamond anvil cell, magnetic circular dichroism, and time-dependence, have been carried out. In 2001, a gate valve with a window has been installed in between the experimental and mirror chambers, in order to make alignment of samples with the photon beam without breaking the vacuum condition.

BL7A was constructed at the first construction stage of the UVSOR facility in the mid 1980s for SX spectroscopy. This beamline has been providing SX in the photon energy range from 0.6 to 3 keV without a 4T-wiggler and up to 6 keV with it, using a DXM. However, the 4T-wiggler was shutdown completely due to a mechanical problem on the cryogenic system in 1999. It has been confirmed that the photon intensity from the KTP crystals without the wiggler is almost the same as that from YB_{66} crystals combined with the wiggler. A new in-vacuum undulator will be installed at the straight section, where the wiggler lies, in March 2002. Accordingly, all the activity on this beamline will be transferred to BL1A.

BL7B consists of a 3-m NIM working in the photon energy range from near IR to VUV with a high resolving power. This beamline is mainly used for absorption, reflection, and fluorescence spectroscopy on solids. Although the installation of the monochromator was time-consuming, it has been shown that the performance of BL7B is sufficiently high to carry out spectroscopic investigations on solid samples with high resolution. New software to control the monochromator has been developed and tested in 2001, thanks to Prof. K. Fukui of Fukui University.

BL8A has no monochromator and is simply equipped with a differential pumping stage that makes it useful for measurements on gases as well as on solids. A focusing mirror having toroidal shape can be used to obtain a smaller irradiation area, if necessary. There is no permanent end-station installed at this beamline that enables users to install their own instruments brought from their institute or university. The UVSOR facility will support the installation of the users' experimental setup. Experiments on SR-CVD and SR-etching have extensively been carried out on this beamline in recent years.

BL8B1 is used for coincidence spectroscopy on gas samples in the photon energy range from 30 to 800 eV, where the K-shell ionization thresholds of chemically important elements like C, N, and O lie, using a high-resolution constant-deviation constant-length SGM. The experimental chamber at the end-station is composed of a TOF and a CMA, which makes it possible to perform the coincidence measurements between energy-analyzed electrons and photoions. Total electron yield measurements on solid samples are also possible. In 2001, the front-end valve with a possibility of making the vacuum condition worse, has been replaced. Modification to the scanning mechanism of the monochromator is scheduled in April 2002.

<In-house beamlines>

BL1A has been used for photoelectron spectroscopy on solids in the photon energy region from 600 to 3000 eV, with the use of a DXM. An analyzer chamber is equipped with a high-resolution hemispherical electron energy analyzer (SCIENTA SES200). In 2001, the experimental system has been removed from BL1A. This beamline will be used for XAFS experiments as an open beamline from the fiscal year of 2002.

BL2A was constructed for spectroscopic investigations on gas samples and have produced many scientific results. The monochromator installed at BL2A is a Seya-Namioka type NIM. Recently this beamline has been rearranged for bioscience and has been utilized by bio-scientists in the Okazaki organization. However, it is unfortunate that there has been no activity on this beamline through 2001.

BL2B2 is an EUV and SX beamline used for gas phase experiments. The monochromator is a Dragon-type SGM, which has commissioned in 1999. Angle-resolved ion yield measurements have been performed for SF_6 and rare gases on this beamline. New experiments for fullerene samples have been initiated in 2001.

BL3B consists of a 3-m NIM and an angle-resolved electron energy analyzer with a two-dimensional detector. This beamline has been used for spectroscopic investigations in gas phase, and has been providing interesting results for a long time. However, the performance of the 3-m NIM has become unsatisfactory in recent years. In 2001, the gratings installed were replaced for achieving higher performance.

BL4A1/4A2 are used for investigations on the reaction mechanism of SR stimulated processes. A multilayered-mirror monochromator for investigating the SR etching processes is installed at BL4A1. There is no monochromator but two branch lines (scanning tunneling microscopy (STM) and infrared reflection absorption spectroscopy) on BL4A2. SR assisted desorption processes of SiO_2 on Si substrates have been studied aggressively by STM observations lately.

BL4B is a new high-resolution beamline in the SX region (100 1000 eV). The monochromator is a Varied-line-spacing PGM. This beamline is utilized for various spectroscopic studies with high resolution in the SX range. There is no permanent experimental instrument installed at this beamline. The performance tests have been terminated at the end of January 2001. Several novel results for simple molecules have emerged from this beamline, using photoabsorption, angle-resolved photoion yield spectroscopy, and photoelectron spectroscopy under high-resolution condition in 2001. Very recently, new spectroscopic investigations on surfaces and solids have also begun.

BL6A2 is composed of a PGM and a photoelectron spectromicroscopy equipment (micro-ESCA, VG ESCALAB 220i-XL). The post-focusing mirror system has been completely changed in order to get a smaller spot for the micro-ESCA system. The achievement of the performance has been successfully tested. The femto-second laser system has also been installed to conduct the combination experiments of SR and lasers.

BL6B has been renewed for nano-scale photochemical reaction experiments. There is no monochromator on this beamline. An STM apparatus that can be operated under ultra high vacuum condition (UHV-STM) has been installed at BL6B, in order to make in situ observation for the reaction processes on Si surfaces stimulated by SR irradiation. It is in the planning stage to transfer the UHV-STM instrument to BL7A where the installation of a new in-vacuum undulator is programmed in March 2002.

BL8B2 is utilized for angle-resolved photoelectron spectroscopy on various organic solids such as molecular crystals, organic semiconductors, and conducting polymers. This beamline consists of a PGM, which covers the photon energy region form 2 to 150 eV, a sample preparation, a measurement, and a cleaning chamber. A high-performance multi-channel photoelectron spectrometer has been installed and its coordination has been terminated in 2001.

All users are required to refer to the beamline manuals and the UVSOR guidebook (latest revision in 1999), on the occasion of conducting the actual experimental procedures. Those wishing to use the open and in-house beamlines are recommended to contact the stationmaster/supervisor and the representative, respectively. For updated information of UVSOR, http://www.uvsor.ims.ac.jp/.

Table I. Station masters and supervisors of open beamlines in 2001*

Beamline	Station Master	Sub Master	Supervisor
1B	M. Hasumoto	M. Kamada	M. Kamada
2B1	K. Takahashi	E. Nakamura	M. Kamada
3A1	M. Kamada	E. Nakamura	M. Kamada
3A2	N. Kondo	T. Gejo	E. Shigemasa
5A	K. Takahashi	M. Hasumoto	M. Kamada
5B	M. Hasumoto	N. Nakamura	E. Shigemasa
6A1	E. Nakamura	O. Matsudo	M. Kamada
7A	E. Shigemasa	N. Kondo, O. Matsudo	E. Shigemasa
7B	M. Hasumoto	M. Kamada	M. Kamada
8A	T. Gejo	E. Nakamura	E. Shigemasa
8B1	T. Gejo	N. Kondo	E. Shigemasa

*Before October 2001. Prof. M. Kamada was promoted to Saga University on October 1, and since then the name of "M. Kamada" in Table I is tentatively replaced to "E. Shigemasa".

Table II. Representatives of in-house beamlines in 2001.

Beamline	Representative	Affiliation
1A	N. Kosugi	Dep. VUV Photoscience
2A	N. Kosugi	Dep. VUV Photoscience
2B2	K. Mitsuke	Dep. VUV Photoscience
3B	K. Mitsuke	Dep. VUV Photoscience
4A	T. Urisu	Dep. VUV Photoscience
4B	E. Shigemasa/N. Kosugi	UVSOR/Dep. VUV Photoscience
6A2*	M. Kamada*	UVSOR*
6B	T. Urisu	Dep. VUV Photoscience
8B2	K. Okudaira	Dep. VUV Photoscience

*Before October 2001. The current representative of BL6A2 is Prof. T. Urisu.

Beamlines at UVSOR

Beam Line	Monochromator, Spectrometer	Wavelength Region	Acceptance Angle (mrad) Horiz.	Vert.	Experiment
BL1A	Double Crystal	2.1 - 0.3 nm	4	1	Solid (photoemission)
BL1B	1-m Seya-Namioka	650 - 30 nm	60	6	Solid (absorption)
BL2A	1-m Seya-Namioka	400 - 30 nm	40	6	photoabsorption
BL2B1	2-m Grasshopper	60 - 1.5 nm	10	1.7	Solid & surface (photoemisson)
BL2B2	18-m Spherical Grating	60 - 6 nm	15	6	Gas (photoionization, photodissociation)
BL3A1	None (Filter, Mirror)	(U)	0.3	0.3	Solid & irradiation (photodissociation)
BL3A2	2.2-mConstant Deviation Grazing Incidence	100 - 10 nm (U)	10 0.3	4 0.3	Gas & solid (photoionization & photodissociation)
BL3B	3-m Normal Incidence	400 - 30 nm	20	6	Gas (photoemission)
BL4A1	Multi-Layered-Mirror Monochromator	13 - 23 nm Mo/Si MLMs	16.6	12.8	Irradiation
BL4A2	None				SR-CVD
BL4B	Varied-line-spacing Plane Grating Monochromator	15 - 1.5 nm	7.5	2	Gas (photoionization, photodissociation) & solid (photoemission)
BL5A	None SGM-TRAIN	(OK) 250 - 5 nm	 10	 3	FEL Solid (photoemission)
BL5B	Plane Grating	200 - 2 nm	10	2.2	Calibration, gas (photodissociation) & solid (absorption)
BL6A1	Martin-Puplett FT-IR Michelson FT-IR	3000 - 30 mm 100 - 1 mm	80 80	60 60	Solid (absorption)
BL6A2	Plane Grating	650 - 8 nm	10	6	Solid & surface (photoemission)
BL6B	None		8.3	6	Irradiation
BL7A	Double Crystal	1.5 - 0.8 nm	2	0.3	Solid (absorption)
BL7B	3-m Normal Incidence	1000 - 50 nm	65	10	Solid (absorption)
BL8A	None (Filter)		25	8	Irradiation & user's Instrum.
BL8B1	15-m Constant Deviation Grazing Incidence	40 - 2 nm	10	1.5	Gas (photoionization, photodissociation) & solid (absorption)
BL8B2	Plane Grating	650 - 8 nm	10	6	Solid (photoemission)

SGM-TRAIN: spherical grating monochromator with translating and rotating assembly including normal incidence mount
U: with an undulator
OK: with an optical klystron

BL1A

Soft X-Ray Beamline for Photoelectron-Photoabsorption Spectroscopy

BL1A is a soft X-ray beamline for photoabsorption spectroscopy. The beamline is equipped with a focusing premirror and a double crystal monochromator [1]. The monochromator serves soft x-rays in the energy range from 585 to 4000 eV by using several kinds of crystals such as β-Al_2O_3, beryl, KTP ($KTiOPO_4$), quartz, InSb, and Si crystals. The throughput spectra are shown in Fig. 1. Typical energy resolution ($E/\Delta E$) of the monochromator is about 1500 for beryl and InSb. The apparatus for photoelectron and photoabsorption spectroscopies was removed from the beamline last summer. The experimental setup for photoabsorption spectroscopy of BL7A will be moved to this beamline, which will be opened for the researchers outside IMS from May, 2002.

Reference

[1] A. Hiraya et al., *Rev. Sci. Instrum.*, **63** (1992) 1264.

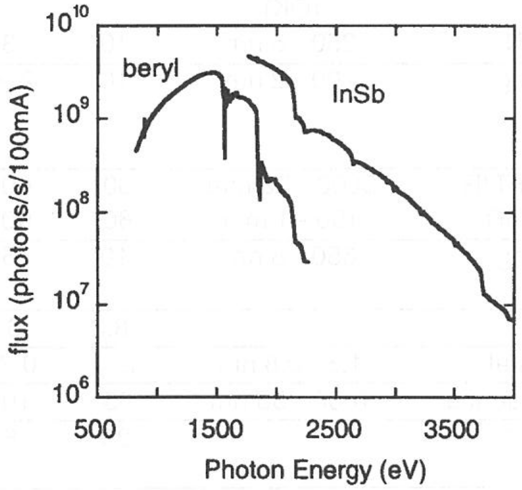


Figure 1. Throughput spectra of the double crystal monochromator at BL1A.

Specification

Monochromator:	double crystal monochromator
Monochromator crystals: (2*d* value, energy range)	β-Al_2O_3 (22.53Å, 585-1609eV), beryl (15.965Å, 826-2271eV), KTP (10.95Å, 1205-3310eV), quartz (8.512Å, 1550-4000eV), InSb (7.481Å, 1764-4000eV), Si (6.271Å, 2104-4000eV)
Resolution:	$E/\Delta E$= 1500 for beryl and InSb
Experiment:	photoabsorption spectroscopy for solid

BL1B

Seya-Namioka Monochromator for General Purposes

BL1B has been constructed to perform various spectroscopic investigations such as absorption, reflectivity, and luminescence in a condensed phase. This beamline consists of a pre-focusing mirror, a 1-m Seya-Namioka type monochromator, and post-focusing mirrors with different focal lengths. Three gratings of 600, 1200, and 2400 l/mm can cover the wavelength region ranging from 40 to 650 nm. The post mirror with a longer focal length is usually used with an LiF window to separate the vacuum condition of the monochromator from a main experimental station, which make experiments for liquids and bio-specimens possible, while the other is mainly utilized for solid-state spectroscopy.

The output flux from this monochromator is about 10^{10} photons/sec. around 200 nm with 0.1 mm slit openings. The spectral distributions for two gratings measured by a conventional photomultiplyer are shown in Fig. 1 A second monochromator (Spex 270M) and a LN-cooled CCD detector (Princeton Inc.) are available for luminescence measurements, together with a liquid helium-flow type cryostat. To perform time-resolved experiments, a TAC system is also available.

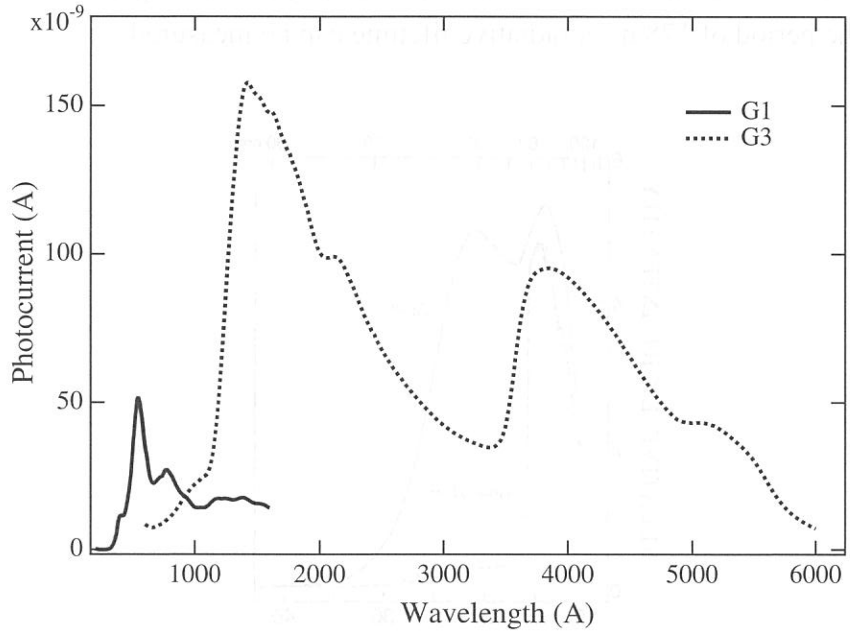


Figure 1. Photocurrent from the Seya-Namioka monochromator on BL1B.

Specification

Monochromator: 1-m Seya-Namioka type
Energy range: 40 to 600 nm (2-30 eV)
Resolution: E/ΔE~ 1000 at 100 nm
Experiments: Absorption, reflection, luminescence spectroscopy for solids

BL2A

Gas Phase Photoabsorption and Fluorescence Spectroscopy

Photoabsorption cross section and fluorescence excitation spectra of gaseous sample are simultaneously measured in a vacuum cell or effusive jet condition. The primary photons in the 30-400 nm region are dispersed by a 1-m Seya monochromator. Higher order light in the 80-120nm range is suppressed by using a long channel with a cross section 2.5 × 5.0 × 170 mm long filled with argon gas at a pressure ~ 0.3 Torr as shown in Figure 1. No filter is used between 30 and 80 nm since the photon flux at λ< 40 nm is very weak (see Figure 1). The gas filter and cell are placed in a main chamber, which is evacuated by a 600 *l*/s turbo molecular pump (SII, STP600C). A LiF window is used for the measurement at the 105<λ< 210 nm range as usual. Thus the total photoabsorption cross section and fluorescence excitation spectra are available in the wide wavelength region 30-210 nm without or with little contamination by the higher order light. Dispersed fluorescence and polarity of emission from the excited fragment are also measurable in addition to the total photoabsorption and emission cross sections. In the single bunch operation of synchrotron radiation with the period of 178 ns, a radiative lifetime can be measured.

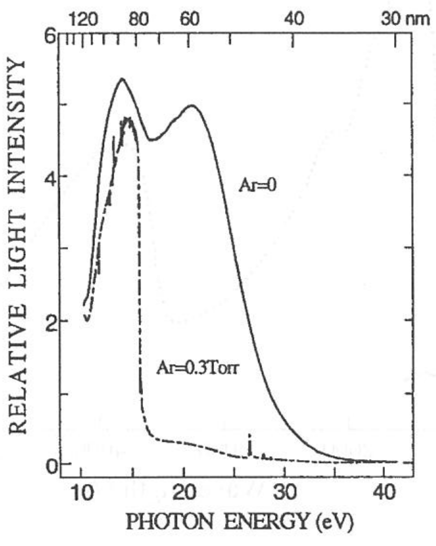


Figure 1. Transmitted I_0 intensity with and without an Ar gas filter.

Specification

Monochromator: 1-m Seya — Wavelength range: 30-400nm

Resolution: $E/\Delta E$= 1000 at 100 nm — Grating: 1200 line/mm blazed at 96nm

Experiments: Vacuum cell or effusive jet, Total photoabsorption cross section, Fluorescence cross section, Dispersed fluorescence, Radiative lifetime, Emission polarity

BL2B1

Soft X-ray Beamline for Solids and Surfaces

BL2B1 has been used for soft X-ray absorption and photoelectron spectroscopies of solids and surfaces. A 2-meter grazing incidence monochromator ('Grasshopper' type, Mark XV; Baker Manufacturing Co.) is installed, which serves soft X-rays in the energy range from 95 to 1000 eV using a 1800 l/mm grating. The resolving power is better than 600 at C K-edge (about 290 eV). A double-pass cylindrical mirror analyzer (CMA), a LEED of reverse type, a quadrupole mass spectrometer, and an ion-gun for sputtering are installed in the analyzing chamber. A pulsed leak-valve and a variable leak-valve are also installed. The samples can be cooled with a liquid helium cryostat. The base pressure of the analyzing chamber is better than 1×10^{-10} Torr. The photoelectron spectroscopy including constant initial-state spectroscopy (CIS) and constant final-state spectroscopy (CFS) can be conducted using the double-pass CMA. Besides these standard photoemission measurements, electron-ion-coincidence (EICO) spectroscopy can be carried out on adsorbed surfaces and bulk materials. In 1999, a new version of an EICO instrument has been installed, resulting in better efficiency on collecting data. The users who plan to perform the EICO measurement should make contact with the EICO users group. The sample preparation chamber equipped with a load-lock chamber is connected to the analyzing chamber. Sample treatments such as cleaving, filing, and deposition can be made under the ultra-high vacuum condition.

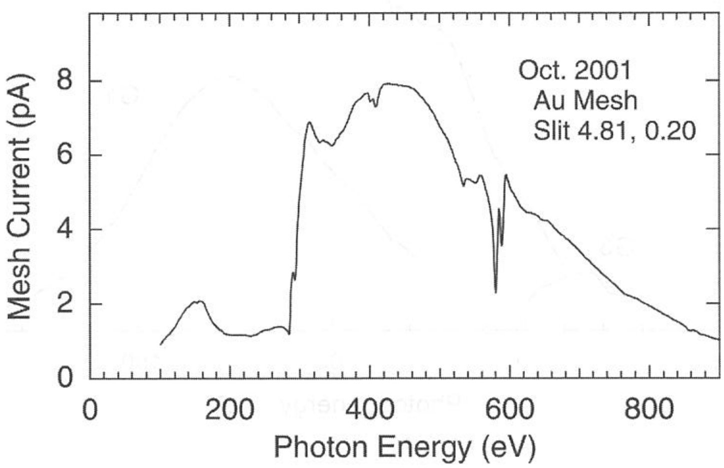


Figure 1. The photoelectron yield from a Au mesh of 90 % transmission located between the refocusing chamber and the sample.

Specification

Monochromator	: 2 m grasshopper type
Energy range	: 95-1000 eV (1800 l/mm)
Resolution of photon	: < 0.4 eV at 300 eV
Resolution of photoelectron	: < 0.3 eV for hν = 150 eV
Experiment	: Photoelectron spectroscopy, X-ray absorption spectroscopy, Electron-ion-coincidence spectroscopy

BL2B2

Beamline for Gas Phase Photoionization and Photodissociation Dynamics

This beamline has been developed for the purpose of studying ionization, excitation and decay dynamics involving inner-valence electrons or 2*p* electrons of the third row atoms. The monochromator is a spherical grating Dragon-type with 18 m focal length. High throughput (1 $\times$ 10^{10} photons s^{-1}) and high resolution ($E/\Delta E$ = 2000 - 8000) are achieved simultaneously under the condition of the ring current of 100 mA [see Fig. 1 and M. Ono *et al.*, *Nucl. Instrum. Meth. Phys. Res. A* **467-468**, 577 (2001)]. A second-order light of 7 % is contained at a photon energy of 45.6 eV (G3).

The optical system consists of two prefocusing mirrors, an entrance slit, spherical gratings (G1, G2 and G3), two folding mirrors, a movable exit slit and a refocusing mirror. The monochromator is designed to cover the energy range of 23 - 205 eV with the three gratings: G1 (2400 lines mm^{-1}, R = 18 m) at 80 - 205 eV; G2 (1200 lines mm^{-1}, R = 18 m) at 40 - 100 eV, G3 (2400 lines mm^{-1}, R = 9.25 m) at 23 - 50 eV. The including angles are 160° for G1 and G2, and 140° for G3. The detailed parameters of the optical elements are described elsewhere [H. Yoshida and K. Mitsuke, *J. Synchrotron Radiat.* **5,** 774 (1998)].

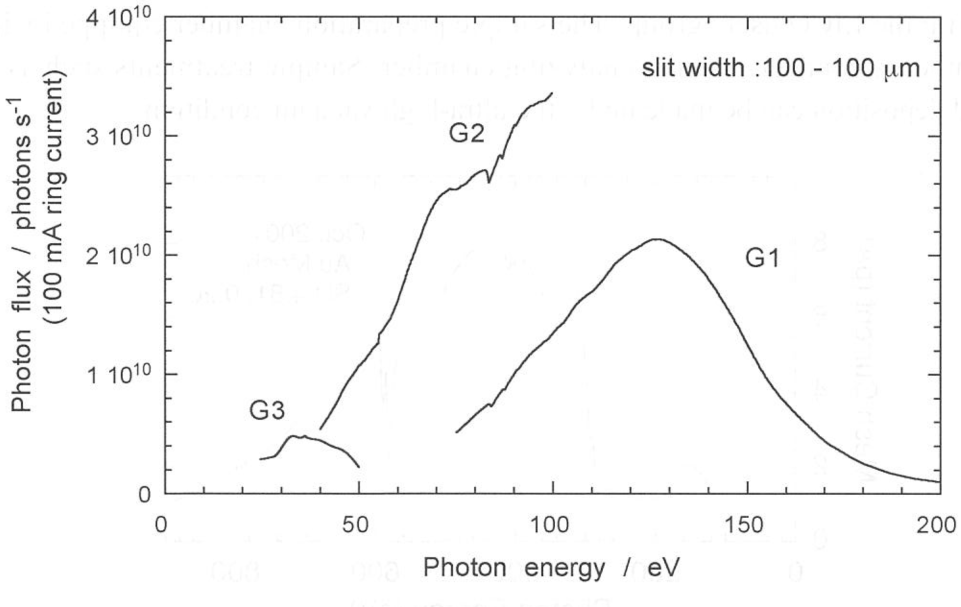


Figure 1. Photon flux at the end station at a 0.1 A ring current when the entrance- and exit-slit widths are set to 100 μm. The SR is provided from a bending magnet.

Specification

Monochromator: 18-m spherical grating grazing-incidence of Dragon-type
Energy Range: 6 – 54 nm (23 – 205 eV)
Resolution: $E/\Delta E$ = 2000 – 8000 (ΔE = 5 – 45 meV)
Experiments: TOF mass spectrometry, Symmetry-resolved photoabsorption spectroscopy, and Two-dimensional photoelectron spectroscopy

BL3A1

Irradiation Port for Undulator Radiation

BL3A1 has been mainly used for irradiation experiments such as photo-chemical reaction, SR-CVD, photo-etching, irradiation damage effects in condensed phase, light amplification induced by core-revel excitation. The experiments that need a very high intensity photon beam, namely, luminescence yield measurements and time-response measurements of SR-induced desorption, are also performed on this beamline.

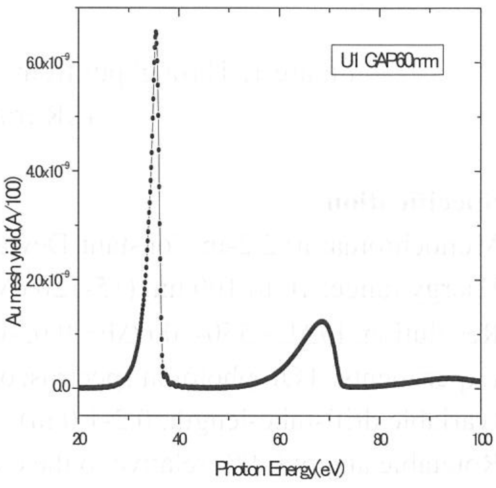
A planar-type undulator installed in a long straight section of the UVSOR storage ring provides an intense quasi-monochromatic radiation to BL3A1. The undulator has 24 periods with a period length of 80 mm. The photon energy ranging from 8 to 52 eV can be covered by the fundamentals with K-values from 0.62 to 3.6, although higher harmonics are also generated at the same time.

This beamline has no monochromator between the undulator and the sample chamber. The radiation is introduced into the sample chamber only by a toroidal focusing mirror through a pinhole with 1 mm in diameter followed by a metallic filter (Al, Sn, or In). A gold mesh is installed in the sample chamber to monitor the photon beam intensity. The photocurrent measured using the monochromator at BL3A2 is shown in the figure below, when the undulator gap was set at 60 mm. The photon flux at the sample position is estimated to be about 10^{14} photons/sec.

A differential pumping system can be utilized for experiments in a gas phase. MgF_2 windows can also be installed to isolate the sample chamber from the beamline, which make experiments for high-pressure gases, liquids, and bio-specimens possible. A monochromator (Jobin-YvonHR-302), a VUV monochromator (home-made, normal-incident type), a helium storage-type cryostat and a TAC system are available.

Specification

Type	: planar-type undulator
Source emittance	: 164 nmrad
Period	: 80 mm
Number of periods	: 24
Magnetic field	: Kmax 3.6
Photon Fulux	: 10^{14} photons/s at 34eV
Energy range	: 8-52eV



BL3A2

Gas-Phase Dissociative Photoionization Apparatus

BL3A2 has been constructed to study the formation of multiply charged molecular ions and their dissociation processes. The monochromator is a constant-deviation grazing incidence type with 2.2-m focal length (2.2-m CDM) and covers wide wavelength region (10-100 nm) where many kinds of molecules and multiply charged ions are effectively measured. Fig. 1 shows the absolute photon flux for each grating installed to CDM, with the use of the dipole radiation. Higher intensity photon beam is available by introducing the undulator radiation to CDM. The apparatus at the end station contains an angle-resolved time-of-flight mass spectrometer equipped with automatic data acquisition system for photoion-photoion coincidence measurements. It has been decided that the undulator and beamline will be renewed in 2003.

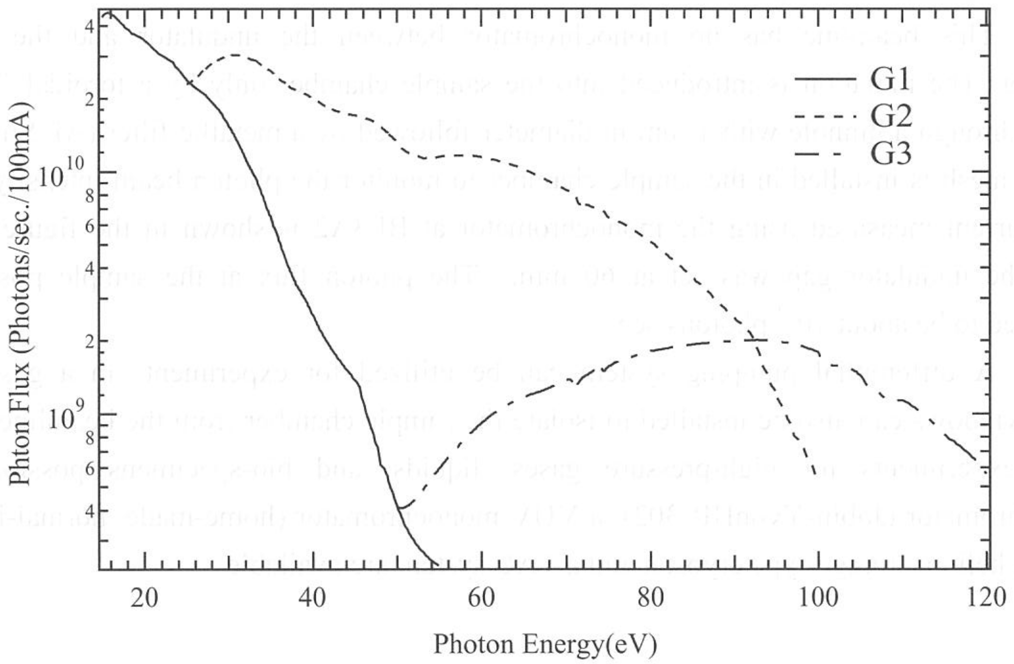


Figure 1. Throughput from the 2.2-m CDM monochromator on BL3A2.
(SR from the bending magnet)

Specification

Monochromator: 2.2-m Constant-Deviation Grazing-incidence
Energy range: 10 to 100 nm (15-120 eV)
Resolution: E/ΔE~ 550-800 (ΔE~ 0.03-0.18 eV)
Experiments: TOF photoion spectroscopy for gaseous targets
(variable drift-tube-length: 0.2-1.0 m)
Rotatable angle: 0-90° relative to the electric vector of SR

BL3B

Beam line for Gas Phase Two-Dimensional Photoelectron Spectroscopy

This beam line is devoted to studies of elementary atomic and molecular processes induced by excitation of valence electrons. A monochromator is a vertically dispersed normal incidence type with 3m focal length and 10° angle between the incident and diffracted photon beams. The maximum wavelength resolution of 0.007nm is narrow enough to separate vibrational levels of excited states for various molecules. A main component in an experimental chamber is a spherical sector electrostatic energy analyzer which has been designed and setup for photoelectron spectroscopy. One can perform two-dimensional photoelectron spectroscopy with good resolution (≤ 30meV) in which the photoelectron yield is measured as a function of both photon energy and electron kinetic energy (binding energy). A two-dimensional spectrum, usually represented as a contour plot, contains rich information on photoionization dynamics and properties of superexcited states. For more details, please see the following papers: K. Mitsuke *et al.*, *J. Electron Spectrosc. Rel. Phenom.* **79**, 395 (1996); H. Hattori and K. Mitsuke, *ibid.* **80**, 1 (1996); H. Hattori*et al.*, *J. Chem. Phys.* **106**, 4902 (1997); Y. Hikosaka*et al.*, *ibid.* **105**, 6367 (1996); Y. Hikosaka*et al.*, *ibid.* **107**, 2950 (1997); **110**, 335 (1999); K. Mitsuke*et al.*, *J. Electron Spectrosc. Rel. Phenom.* **112**, 137 (2000).

Figure 1. Relative photon intensity at the sample point.

Specification

Monochromator: Vertically dispersed normal incidence type with 3 m focal length
Grating: aberration-corrected concave type with 1200 lines/mm grooves
Energy Range: 30 – 200 nm (6 – 40 eV)
Resolution: $E/\Delta E$ = 14000 at 100 nm (ΔE = 0.9 meV) with the slit widths of 10μm
Experiments: TOF mass spectrometry and Two-dimensional photoelectron spectroscopy

BL4A1

Multilayered-mirror monochromator beam line for the study of synchrotron radiation stimulated process

A multilayered-mirror (MLM) monochromator beam line designed specially for synchrotron radiation (SR) stimulated process experiments has been constructed for the first time. The most important point in constructing an MLM monochromator beam line for the study of SR-stimulated processes is the optimization of the beam line optics to obtain a large photon flux. The second most important point is to remove the background existing in the low energy region caused by the total reflection. Optimization concerning the reduction of the low-energy background due to the total reflection has been made for the combination of the Mo/Si MLMs and the C filter. Mo/Si MLMs have a (normal incident) reflectivity of over 60% can be made for the energy region around 100eV, which contains the core electron binding energies of Al and Si (important material in semiconductor processes). The beam line was designed by the criteria; a beam spot size on the sample surface $\geq 3 \times 3$ mm^2, a density of total irradiated photons $\geq 10^{18}$ photons/cm^2 (for an irradiation time of a few tens of minutes to a few hours) and low-energy background ≤ 1 % of the output. [1]

[1] H. Mekaru, et. al., Rev. Sci. Instrum., 70, 2601-2605 (1999).

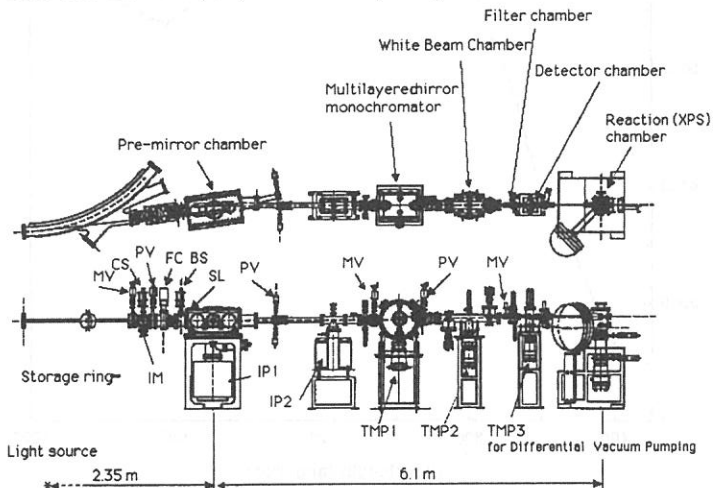


Figure 1. Top and side views of the MLM monochromator beam line (BL4A1) constructed at the UV-SOR facility of the IMS.

Specifications

Monochromator:	Multilayered-mirror monochromator
Wavelength range:	13.3 - 22.5 nm
Resolution:	5 - 9 eV (FWHM)
Experiments:	Excitation energy dependence of the SR processing

BL4A2

SR-CVD beam line

This beam line is used for SR-CVD and photo-etching experiments. The beam line has no monochromator for high photon flux to irradiate and consists of only two mirrors. One is for focussing and the other is for branching. At the beam line, the gas supply and extinction system is equipped for using legally controlled high pressure gasses such as SiH_4, Si_2H_6 and GeH_4. They are commonly used to CVD of semiconductor crystals.

The SR-CVD and photo-etching chambers are connected to the beam line as shown in Fig. 1. In those chambers, IRRAS system is installed to study surface photochemistry on Si surfaces adsorbed by various kinds of molecules.

BL4A2 has one branch for ultra high vacuum STM chamber. Now, the branch is under construction.

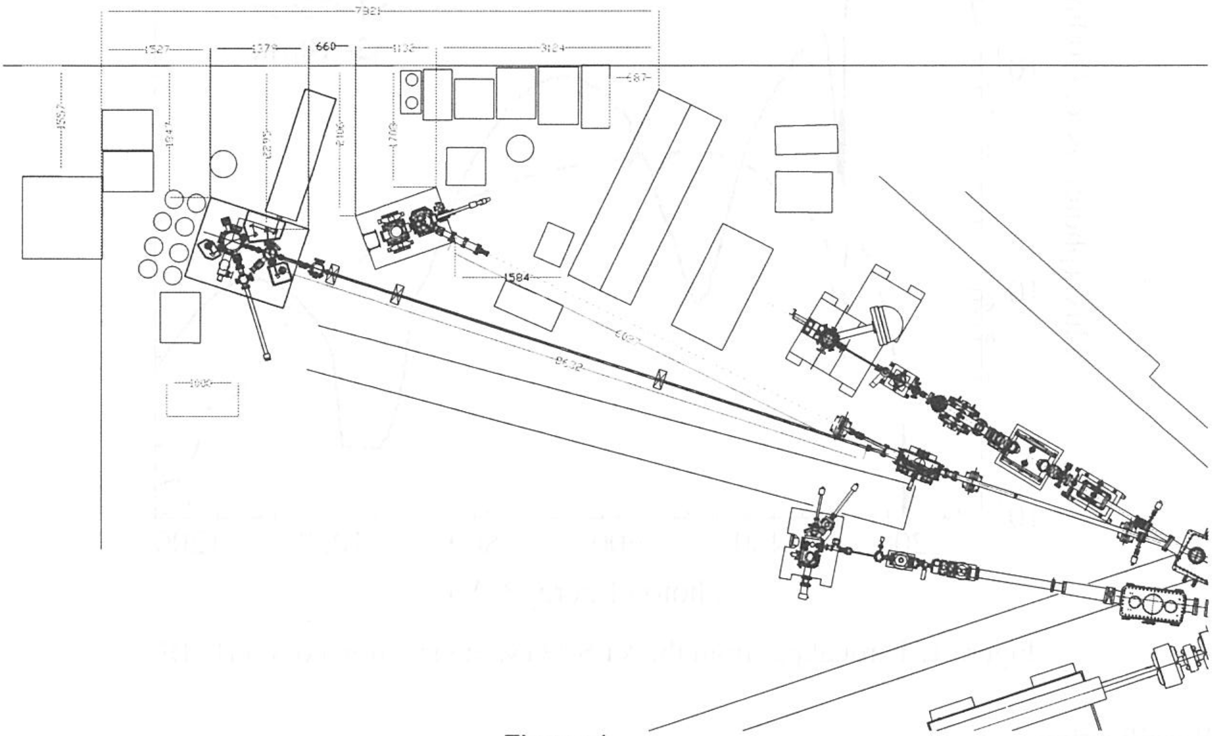


Figure 1.

Specifications

Spectral range: whole range of synchrotron radiation from UVSOR

BL4B

Varied-line-spacing Plane Grating Monochromator for Molecular Soft X-ray Spectroscopy

The beamline BL4B equipped with a varied-line-spacing plane grating monochromator (VLS-PGM) was constructed for various spectroscopic investigations in a gas phase and/or on solids in the soft X-ray range. Two holographically ruled laminar profile plane gratings with SiO_2 substrates are designed to cover the photon energy range from 80 eV to 1000 eV. The gratings with the groove densities of 267 and 800 l/mm cover the spectral ranges of 75-300 and 220-1000 eV, respectively, and are interchangeable without breaking the vacuum. Fig. 1 shows the absolute photon flux for each grating, with the entrance- and exit-slit openings set at 25 and 10 μm, respectively. Under this condition, the corresponding resolving power is expected to be more than 3000.

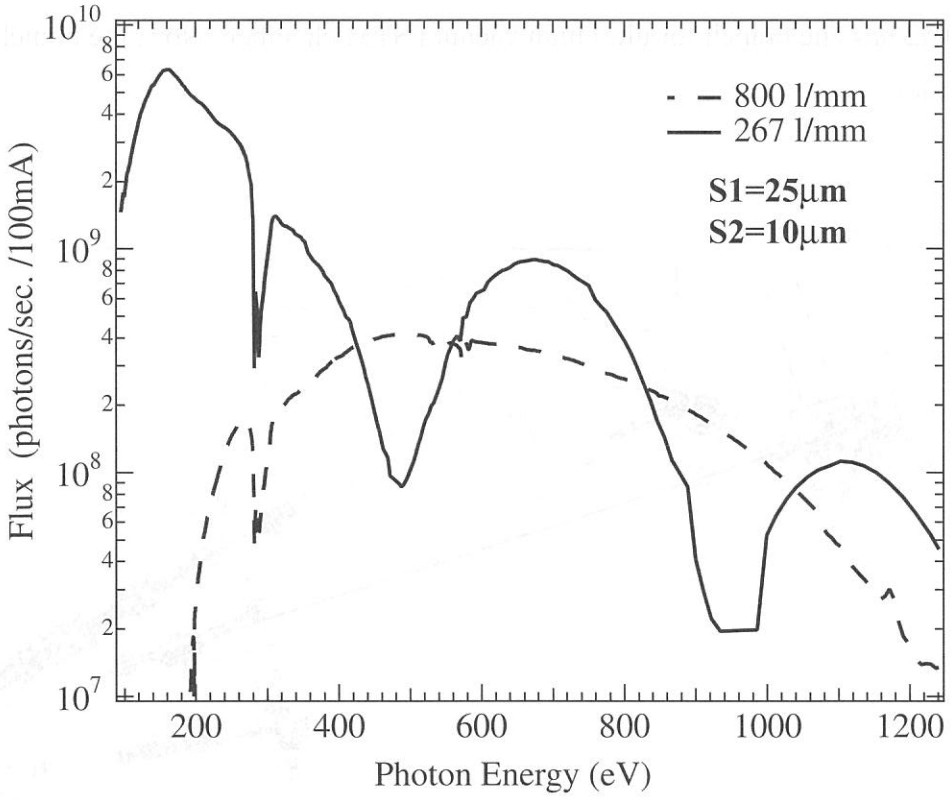


Figure 1. Throughput from the VLS-PGM monochromator on BL4B.

Specification

Monochromator: Varied-line-spacing plane grating monochromator

Energy range: 75 to 1000 eV

Resolution: E/ΔE> 5000 (at maximum)

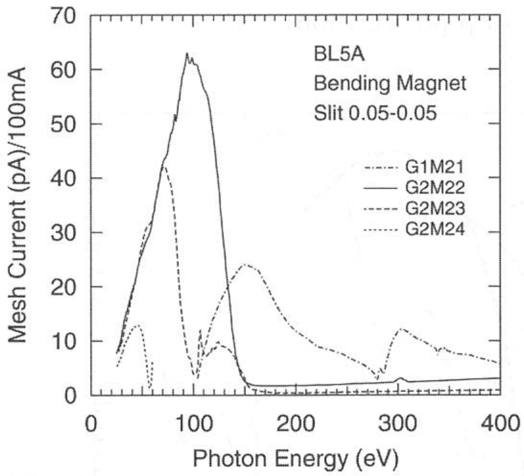
Experiments: Soft X-ray spectroscopy (mainly, angle resolved photoion spectroscopy for gaseous targets and photoelectron spectroscopy for gaseous and solid targets)

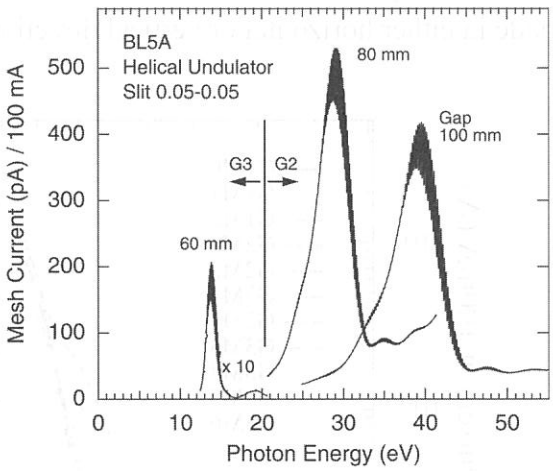
BL5A

Photoelectron Spectrometer for Solids and Surfaces

This beamline is designed for spin- and angle-resolved photoemission study for solids and surfaces with the circularly polarized synchrotron radiation from a helical undulator and for high-resolution photoemission spectroscopy with bending magnet radiation. The beamline consists of a Spherical Grating Monochromator with Translational and Rotational Assembly Including a Normal incidence mount (SGM-TRAIN), a spin- and angle-resolved photoelectron spectrometer, and a high-resolution photoelectron spectrometer.

The SGM-TRAIN is an improved version of a constant-length SGM to aim the following points; (1) wide energy range of 5-250 eV, (2) high resolving power, (3) use of linearly and circularly polarized light, (4) reduction of second-order light, and (5) two driving modes by a computer control. The second-order light is well suppressed by using laminar-profile gratings and combinations of mirrors and gratings.





Specifications

1. Monochromator
   - Type : SGM-TRAIN
   - Energy range : 5-250 eV
   - Resolution : 0.5-80 meV (with slits width of 0.01 mm)
   - Flux : 3×10^{10} photons/s for bending magnet radiation (at 120 eV with slits width of 0.1 mm)
     1×10^{12} photons /s for undulator radiation in MPW mode
2. Main Instruments
   - Two-levels UHV chamber (1×10^{-10} Torr)
   - Hemispherical electron energy analyzer (OMICRON, EA125-HR)
   - Spin- and Angle-resolved spectrometer (low-energy diffused scattering type)
   - LEED of reverse type (OMICRON)
   - Ion-gun (ULVAC-Phi)
   - Low-temperature cryostat (above 30 K)
3. Helical Undulator (Optical Klystron)

Number of periods	18
Period length	110 mm
Fundamentals	2-45 eV (Circularly polarized)

BL5B

Calibration Apparatus for Optical Elements

BL5B has been constructed to perform calibration measurements for optical elements and detectors. This beamline is composed of a plane grating monochromator (PGM) and three end stations in tandem. The most upstream station is used for calibration measurements of optical elements, the middle one for optical measurements for solids and the last for photo-stimulated desorption experiments. The experimental chamber at the most downstream station is sometimes changed to a chamber for photoemission spectroscopy.

The calibration chamber is equipped with a goniometer for the characterization of optical elements, which has six degrees for freedom; X-Y translation of a sample, and interchange of samples and filters. These are driven by pulse motors in vacuum. Since the polaziation of synchrotron radiation is essential for such measurements, the rotation axis can be made in either horizontal or vertical direction (s- or p-polarization).

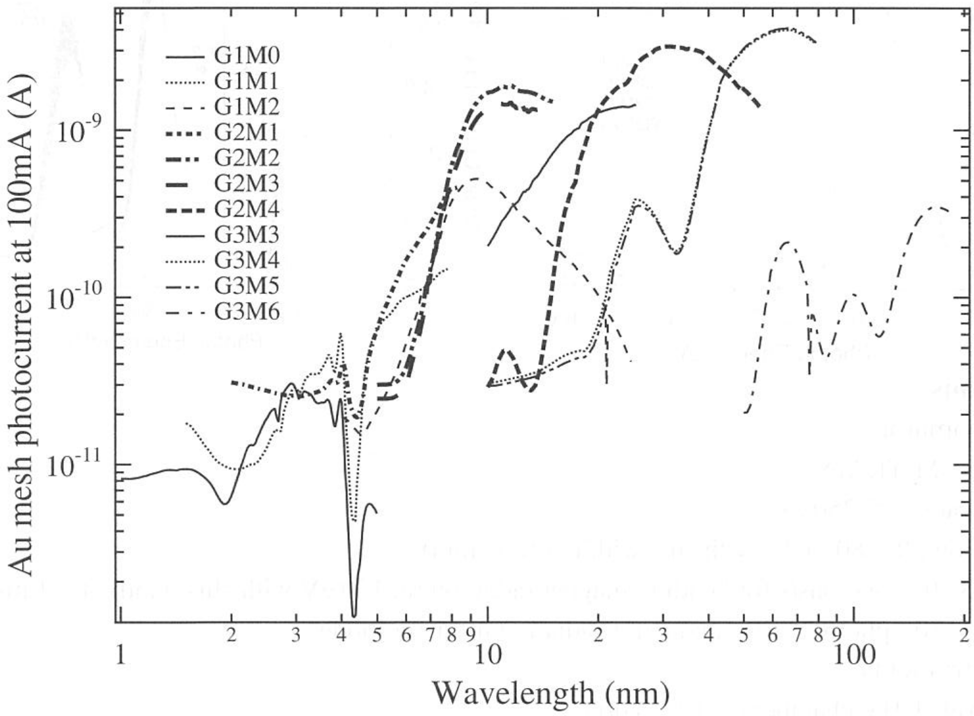


Figure 1. Throughput spectra of BL5B measured by a gold mesh.

Specification

Monochromator: Plane grating

Energy range: 2 to 200 nm (6-600 eV)

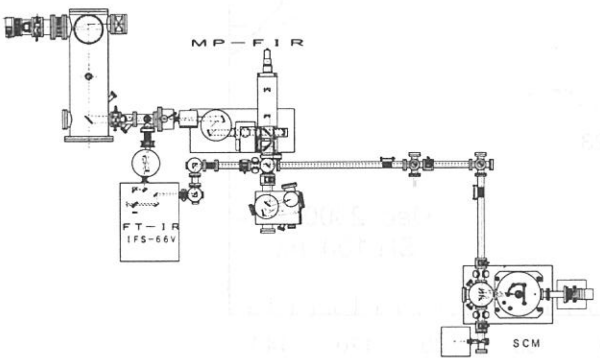
Resolution: E/ΔE~ 500

Experiments: Calibration of optical elements, absorption of solids, photo-stimulated desorption from rare gas solids

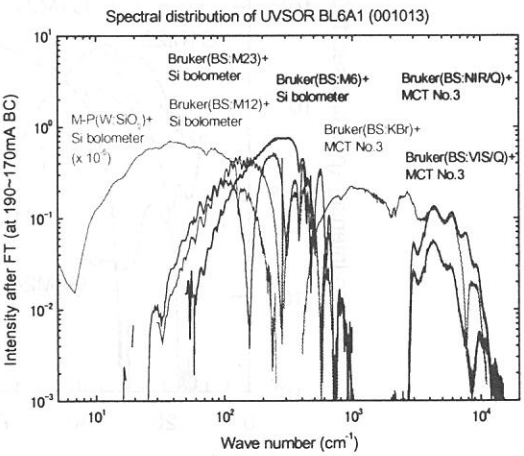
BL6A1

Fourier-Transform Middle and far Infrared spectrometers for solids

UVSOR covers a very wide energy region from a soft-X ray to a millimeter wave. BL6A1 was constructed in order to cover a long wavelength part in the spectral distribution of UVSOR from a near infrared to a milli-meter wave. Beamline are composed of two kinds of interferometers, a Martin Puplett type and a Bruker-IFS66v. The spectrum from 1 μ m to 3 μ m regions is measureable by changing of three kinds of detectors, MCT, Si-bolometer and InSb hot electron detector, according to each available region. Owing to the high brightness of the SR in the long wavelength region, the present spectroscopic system is specially favorable to the transmission and reflection measurements on so tiny specimens..



Top view of BL6A1



Throughput spectra of BL6A1

Spccification

Energy resolution :	500-20000
Energy range :	0.0005-1.5eV
Interferometers :	5-300cm^{-1} by Martin-puplett interferometer
	50-30000cm^{-1} by Michelson type interferometer
Detectors :	Si bolometer(20-1000cm^{-1})
	Ge bolometer(with polyethylene window,30-300cm^{-1})
	Ge bolometer(with quartz window,10-200cm^{-1})
	InSb bolometer(5-50cm^{-1})
	MCT(400-10000cm^{-1}) Photovoltaic type MCT(400-10000cm^{-1},time response10nsec)

BL6A2

Photoelectron Spectro-microscope for Solids and Surfaces

The beamline BL6A2 has been used for photoelectron spectroscopy on solids and surfaces with bending magnet radiation. The beamline consists of a Plane Grating Monochromator (PGM) and a photoelectron spectro-micrometer.

The PGM has several combinations of mirrors and gratings to cover the wide energy range of 2-150 eV with less higher-order light. Since the monochromator has no entrance slit, the resolving power depends on the beam size and the divergence. The beamline has been re-arranged in order to have a small spot for the photoelectron spectro-micrometer. Also the femto-second laser system was installed to conduct the combination experiments with synchrotron radiation and laser.

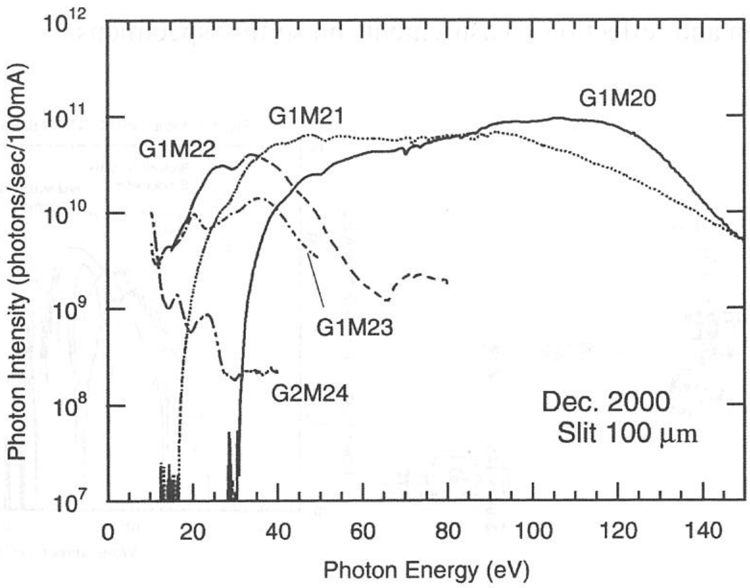


Figure 1. Through-put from the PGM monochromator on BL6A2.

Specifications

Monochromator

Type : Plane Grating Monochromator

Energy Range : 2-150 eV

Resolution : 0.1 eV at 70 eV

Photoelectron spectro-micrometer

Type : ESCALAB 220i-XL (FISONS Instruments)

Spatial Resolution : 20 µm for spectroscopy

: 2 µm for imaging

Others : XPS, LEED, Ion-gun

Laser

Type : Hurricane (Spectra Physics)

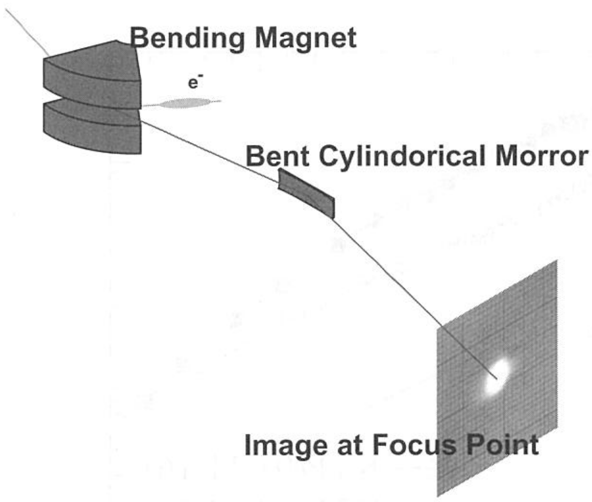
Fundamentals : 750-800 nm

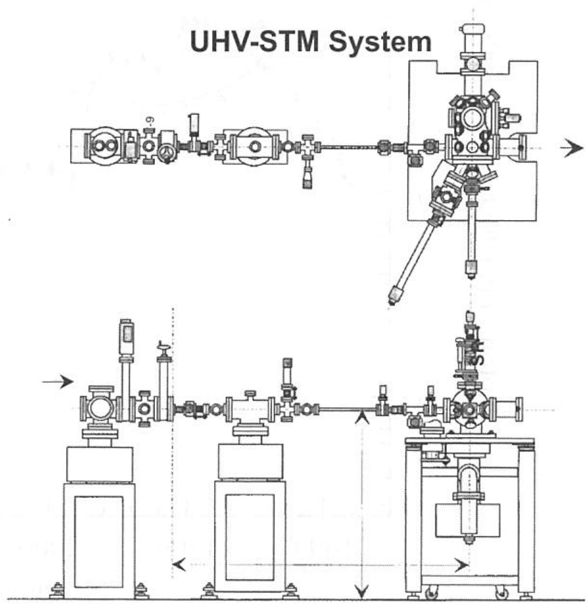
BL6B

UHV-STM beam line

This beam line is constructed for the atom level characterization of the SR illuminated surfaces by the in situ observation of STM. The beam line is very simple and has only one bent cylindrical mirror as optical components for high flux of photons to irradiate.

The STM experimental system designed so that the SR beam can illuminated the sample surface just under the STM chip, the STM observation can be made just after the SR illumination without the sample transfer. The short undulator which is going to be inserted to the strait part of the storage ring and emit the beam for BL7A, is under construction. The beam line and the UHV-STM station are going to be moved to the end of the new BL7A after the completion of the undulator.





Specification

Specification: whole range of synchrotron radiation from UVSOR

Beam spot size at focus point: 4.5 mm x 4.5 mm

BL7A

Soft X-ray Spectrometer for Solids

The beamline BL7A equipped with a double crystal monochromator was constructed for spectroscopic investigation on solids in the soft X-ray range (0.6 to 5 keV). In order to make the NEXAFS experiments at the Mg (~1300 eV) and Al (~1550 eV) *K*-edges possible, a pair of $KTiOPO_4$ [KTP] (011) crystals was. In the past, it has been necessary to use beryl and quartz crystals to approach these two edges. It is found that the photon intensity from the KTP crystals without the wiggler is almost the same as that from the YB_{66} crystals combined with the wiggler.

Fig. 1 shows the absolute photon flux curves for several monochromator crystals over the photon energy range 80$\tilde{0}$4000 eV. The photon energy ranges suitable for Beryl, KTP, InSb, and Ge crystals are 0.83-1.5 keV, 1.2-2.5 keV, 1.8-4.0 keV, and 2.0-4.0 keV, respectively. It has been decided that all the activity on this beamline will be transferred to BL1A during the periodic shut down in the spring of 2002.

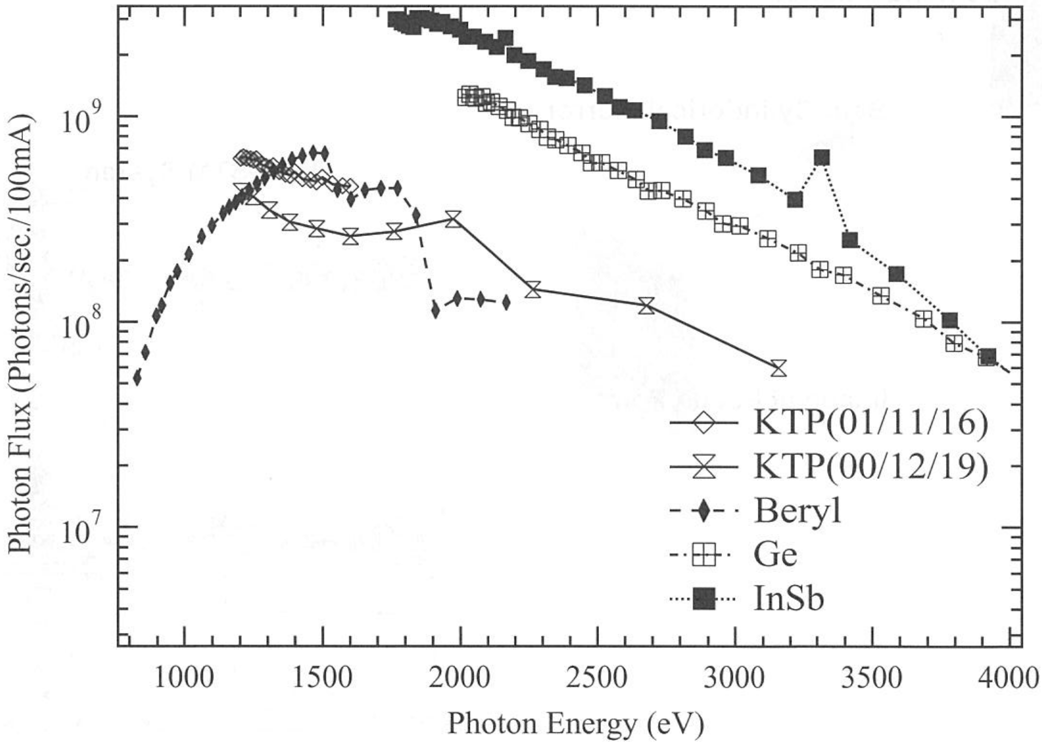


Figure 1. Absolute photon fluxes of main monochromator crystals on BL7A.

Specification

Monochromator: Double-Crystal

Energy range: 0.6~4.0 keV

Experiments: X-ray absorption (by total electron- or fluorescence-yield methods)

BL7B

3-m Normal Incidence Monochromator for Solid-State Spectroscopy

BL7B has been constructed to provide sufficiently high resolution for conventional solid-state spectroscopy, enough intensity for luminescence measurements, a wide wavelength coverage for Kramers-Kronig analyses, and the minimum deformation to the polarization characteristic of the incident synchrotron radiation. This beamline consists of a 3-m normal incidence monochromator which covers the vacuum ultraviolet, ultraviolet, visible and infrared, i.e. the wavelength region of 40–1000 nm, with three gratings (1200, 600, and 300 l/mm). Two interchangeable refocusing mirrors provide two different focusing positions. For the mirror with the longer focal length, an LiF or a MgF_2 window valve can be installed in between the end valve of the beamline and the focusing position.

Fig. 1 shows absolute photon intensity for each grating with the entrance and exit slit openings of 0.5 mm. A silicon photodiode (AXUV-100, IRD Inc.) was utilized for measuring the photon intensitiy and the absolute photon flux was estimated, taking the quantum efficiency of the photodiode into account.

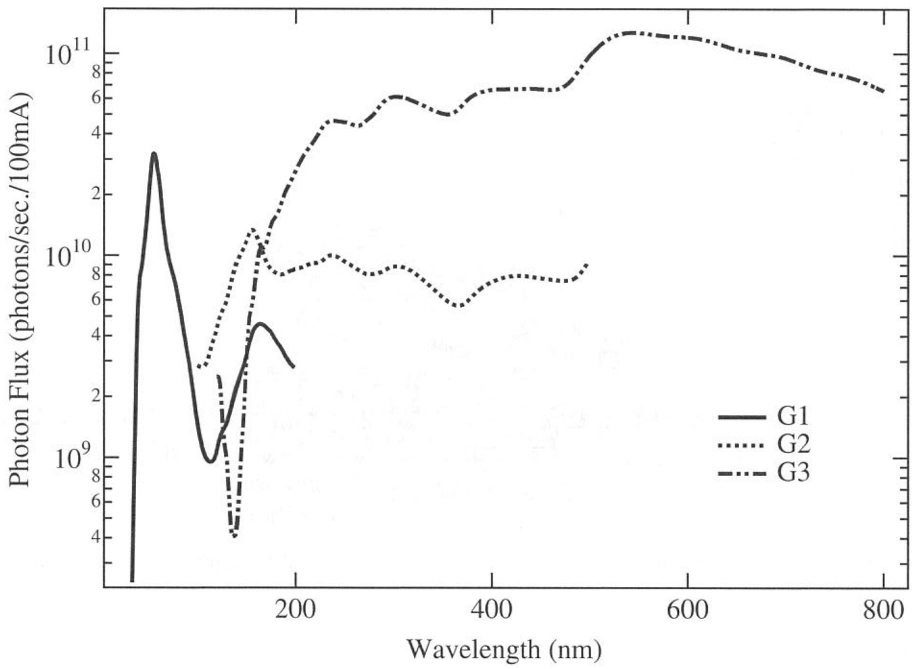


Figure 1. Throughput spectra of BL7B measured by a silicon photodiode.

Specification
Monochromator: 3-m Normal Incidence Monochromator
Energy range: 50 to 1000 nm (1.2-25 eV)
Resolution: E/ΔE= 4000-8000 for 0.01 mm slits
Experiments: absorption, reflection, fluorescence spectroscopy, mainly for solids

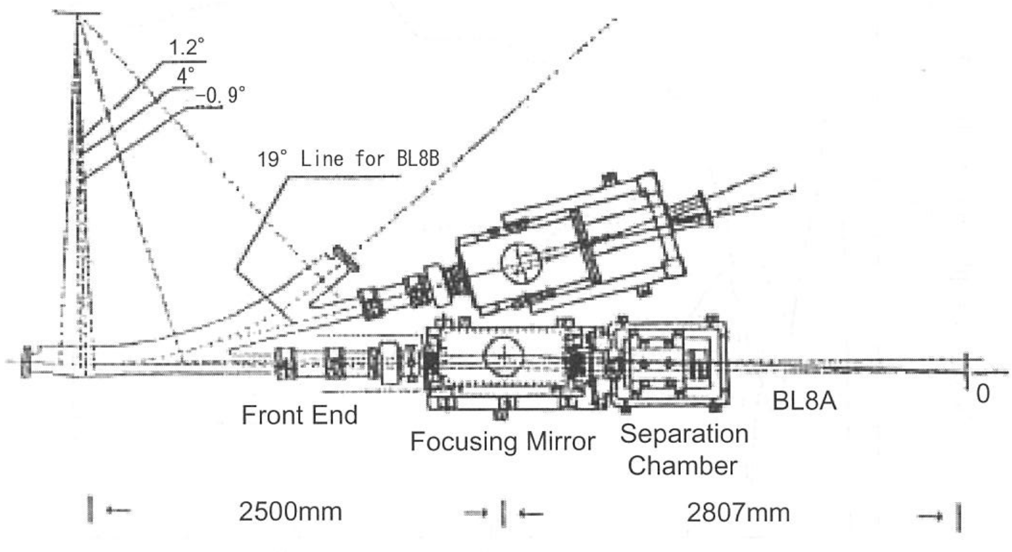
BL8A

Free Port

BL8A was constructed as a free port. Synchrotron radiation is introduced into a sample chamber either directly or through a focusing mirror. Main experiments performed at BL8A are photochemical reaction, SR-CVD, photo-etching, irradiation damage effects in a condensed phase.

Since this beamline has no monochromator between the bending magnet and the sample chamber, the samples brought by users can be irradiated by white light. A gold mesh is installed in the sample chamber to monitor the intensity of the incident radiation.

The beamline consists of a front-end chamber, a focusing pre-mirror chamber and a differential pumping system with three stages. By the use of this system, one can perform various experiments at the reaction chamber under vacuum condition up to 0.5 Torr, while keeping ultra high vacuum at the pre-mirror chamber. This means that any kind of experiment in a gas phase is also possible at the reaction chamber without any windows.



Specification

Acceptal angles (with mirror) : 25 mrad (horizontal) × 8mrad (vertical)

(without mirror) : 7.7 mrad (horizontal) × 8mrad (vertical)

Beam spot size :3mm (horizontal) × 2mm (vertical)

Energy range: Whole energy range of the dipole radiation at UVSOR

BL8B1

Photoabsorption and Photoionization Spectrometer

BL8B1 was constructed for various spectroscopic investigations in a gas phase under high resolution condition in the photon energy range from 30 to 800 eV, where the 1s ionization thresholds of chemically important elements like C, N, and O lie. The monochromator is a constant-deviation constant-length spherical grating type (CDCL-SGM). With three gratings (G1: R = 15 m; 1080 l/mm, G2: R = 15 m 540 l/mm, G3: R = 7.5 m; 360 l/mm), this monochromator is designed to cover the photon energy region of interest mentioned above. The typical resolving powers achieved are about 4000 at 400 eV and 3000 at 245 eV. The absolute photon flux for each grating measured by a silicon photodiode is shown in Fig. 1, with the slit openings of 10 μm.

The experimental chamber with a time-of-flight mass spectrometer and a photoelectron energy analyzer is installed at the downstream of the monochromator. This allows us to carry out photoelectron - photoion coincidence (PEPICO) and photoion - photoion coincidence (PIPICO) measurements. Measurements of absorption, electron yield and emission spectra of solid samples are also feasible.

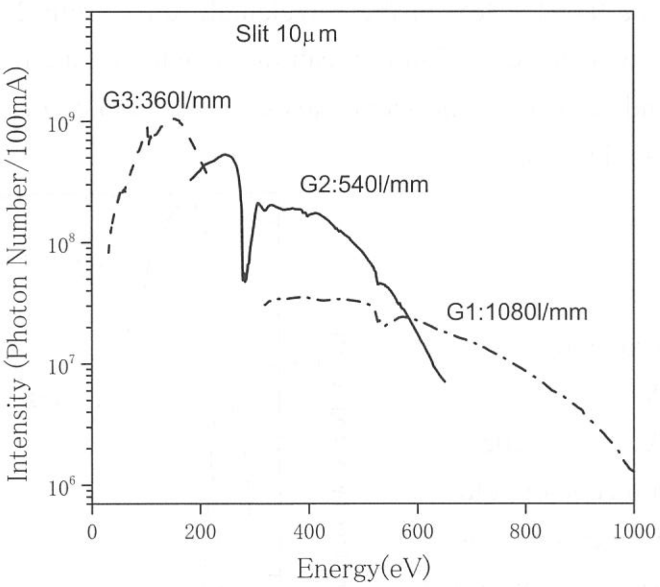


Figure 1. Absolute photon fluxes measured by a Si photodiode

Specification

Monochromator: Constant-deviation constant-length spherical grating type

Wavelength range: 30 to 800 eV

Resolution: E/ΔE = 4000 at 400 eV and 3000 at 245 eV

Available Experiments: Photoabsorption spectroscopy for gas and solid samples, coincidence experiments for gas samples

BL8B2

Angle-Resolved Ultraviolet Photoelectron Spectrometer for Solids

BL8B2 is a beamline for angle-resolved ultraviolet photoemission spectroscopy (ARUPS) system which is designed for measuring various organic solids such as molecular crystals, organic semiconductors, and conducting polymers. The beamline consists of a plane-grating monochromator (PGM), a sample preparation chamber with a fast entry Load-Lock chamber, a measurement chamber with an accurate for temperature dependence (base pressure 1×10^{-10}Torr), a cleaning chamber (base pressure 1×10^{-10}Torr), and a sample evaporation chamber (base pressure 3×10^{-10}Torr). The cleaning chamber is equipped with a back-view LEED/AUGER, an ion gun for Ar^+ sputtering, and an infrared heating unit. The PGM consists of premirrors, a plane grating, focusing mirror, and a post-mirror, with an exit slit. It covers the wide range from 2 to 150eV with exchanging two gratings (G1: 1200l/mm, G2: 450l/mm) and five cylindrical mirrors. The toroidal mirror focuses the divergent radiation onto the sample in the measurement chamber. The spot size of the zeroth-order visible light at the sample surface is about $1\times1mm^2$. The energy resolution at a slit width of 100μm was found to be 0.004-0.3eV in the wavelength range from 2 to 130eV. A hemi-spherical electron energy analyzer of 75mm mean radius with an angular resolution less than 2° can be rotated around vertical and horizontal axes. The sample mounted on a manipulator can be also rotated around two axes.

Specification

Monochromator:
Plane Grating Monochromator
Energy range: 2-150eV
Resolution: 100meV at 40eV as determined by the Fermi edge of gold
Experiment: Angle-resolved photoelectron spectroscopy (ARUPS) for various organic solids
Polarization: 85~91% at 500nm

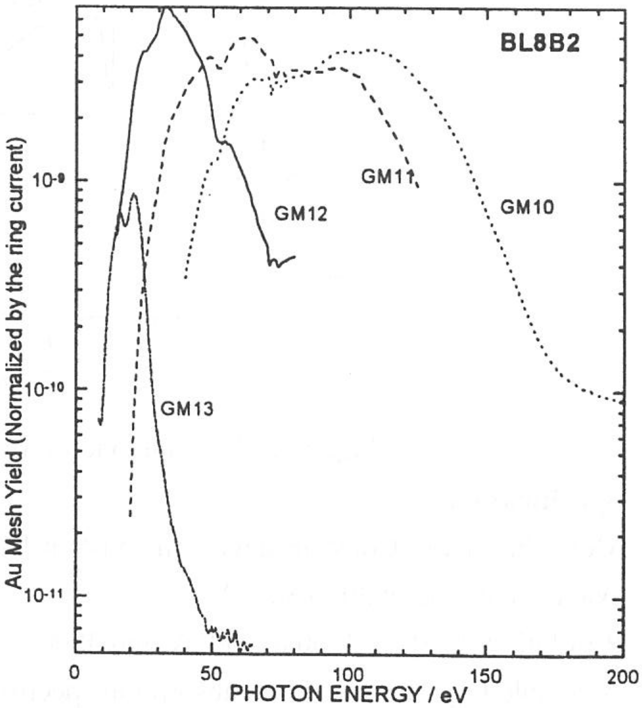


Figure Throughput spectra of plane-grating monochromator at BL8B2 with 100 μm exit slit.