UVSOR

Present Status of Light Source and Beam Lines

Status of the UVSOR Accelerator Complex in 1994

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In 1994, the UVSOR storage ring and its accelerator complex were operated for almost a whole year except some minor unexpected shutdowns and two-week shutdown terms for hardware maintenance in Spring and Summer. Scheduled beam time was properly consumed as shown in Fig. 1. In Spring shutdown term, a new power supplier for the deflector magnet in the synchrotron replaced the old one. Severe drift of output current from the old power supplier had disturbed stable beam injection for long time. Both control systems of the deflector and the fast kicker were also improved by connecting with the CAMAC highway of the computer control system, and extraction of the accelerated beam is now very stabilized with the new power supplier and the control system.

Progress in operation of the superconducting 4T wiggler has been under way since it was installed. The wiggler operation has become into routine operation because a hardware trouble concerning a helium leakage was almost fixed. The operation time of the wiggler in multi-bunch mode increased by 10 % of whole beam time over the last year. The beam orbit with the wiggler operation has been also improved by a computer code of multi-dimensional iterative optimization method that is linked with a control system "UCOSS".

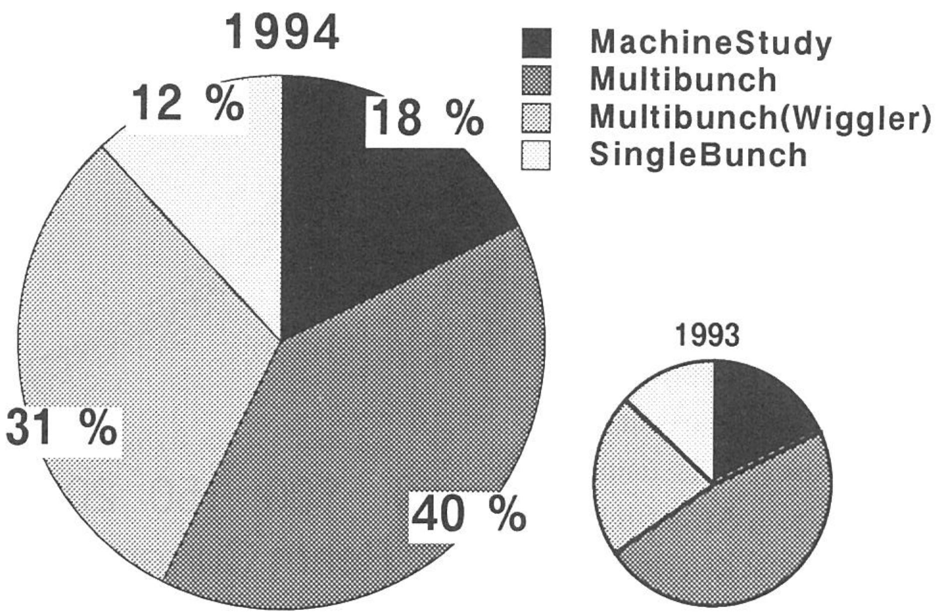

Fig. 1 Machine time consumption in 1994. Summarized a term from January to December.

Because of ambiguity of the ring parameters, the orbit correction has not been completed yet. This method is, however, a quite powerful tool (see Fig. 2), so that correction for the wiggler operations with low magnetic fields (2 T or 1.5 T) will be hopefully achieved.

The double-cavity rf system has been used in the whole beam time even single-bunch mode. Although there was a trouble in operation of the harmonic cavity due to the beam-induced field, the beam has become stable by changing the operation method after the machine study in April. Typical beam lifetime in multi-bunch mode is 4 hours at 200 mA and 8 hours at 100 mA as shown in Fig. 3. It should be noted that a partial filling technique is normally used to suppress an effect of ion-trapping (among 16 buckets, 13 buckets are filled), therefore stored current in one bucket is relatively higher than previous operation, and the vertical beam size is almost same as that in single-bunch mode. Because control of the harmonic cavity has been mannually operated, a suitable control software is necessary and now under developing.

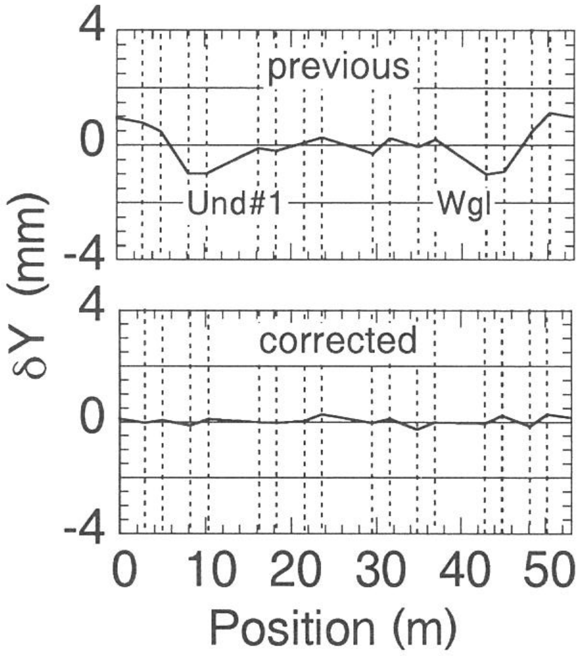

Fig. 2 Beam orbit correction (vertical) for the 4 T wiggler operation.

We experienced serious hardware failures for the inflector and a control system of the synchrotron. It was concluded that both cases were caused by deterioration of electric devices, i.e., condensers and ICs. Since such parts are for specific purposes, it is usually difficult to fix. An efficient counterplan against deterioration is highly desired.

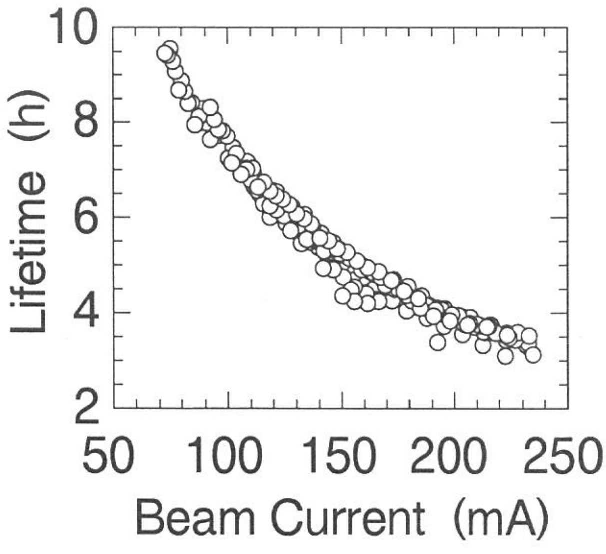

Fig. 3 Beam lifetime in multi-bunch mode plotted as a function of the beam current. Data were taken for a week in December.

Beam Lines in 1994

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In 1994, eighteen beam lines were operational. The open beam lines (1B, 2B1, 3A1, 3A2, 5B, 6A1, 7A, 7B, and 8A) were used by 126 outside groups, while the in-house beam lines (1A, 2A, 2B2, 3B, 4A, 4B, 6A2, 6B, and 8B2) were used by the groups in IMS as well as 28 outside collaborationg groups. The beam times used in 1994 are listed in the following tables (in Japanese).

Besides them, a 15-m Constant Deviation Monochromator covering the spectral range of 30-600 eV is now ready for gas-phase and solid-state experiments at beam line 8B1. Another new monochromator (SGM-TRAIN) which is a combination of the improved version of the constant deviation monochromator and the normal incidence monochromator is under construction at beam line 5A.

The UVSOR facility is opened to all researchers from universities and goverment research-institutes. Beam times are available for the private companies with the payment of the beam-time fee. Foreign researchers can use the beam time in the collaboration with Japanese researchers. In 1994, many foreign researchers visited the UVSOR facility to carry out their experiments at 2B1, 3A1, 5B, 6A1, and 6A2.

The station master system introduced three years ago to support systematically a variety of experiments will be continued for future with a slight change in the member list. All users for open beam lines(*) are requested to contact with the following station masters and/or the supervisers to discuss the action plans of the experiments in details.

Beam Line	Station Master	Sub Master	Supervisor
1B	M. Hasumoto	S. Tanaka	M. Kamada
2B1	S. Tanaka	E. Nakamura	M. Kamada
3A1	M. Kamada	A. Hiraya	M. Kamada
3A2	E. Nakamura	A. Hiraya	T. Kinoshita
5B	S. Kimura	M. Hasumoto	T. Kinoshita
6A1	O. Matsudo	S. Kimura	M. Kamada
7A	O. Matsudo	T. Kinoshita	T. Kinoshita
7B	T. Kinoshita	M. Hasumoto	T. Kinoshita
8A	K. Sakai	T. Kinoshita	T. Kinoshita
8B1	A. Hiraya	E. Nakamura	T. Kinoshita

*The persons who wish to use the in-house beam lines are recommended to contact with the representative of each beam line, which is listed in the Appendix of the UVSOR Activity Report.

The open beam lines

	3/28	4/4	4/11	4/18	4/25	5/2	5/9	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26
1 B		中	川英	平	木			中	川和	関	整備	伊	藤	太	田	藤	田	江尻	林			林	黒	沢	整備	神	野
2B1		田中	松	木				田	中		細	野		田	中		大内 幸	松	川				小	林光		大内 伊	
3A1		鎌田	林						林		鎌	田				吉	田					宮永		西	尾		宮永
3A2			(平	谷)						増	岡	(長岡)					伊	吹				増	岡	小	谷	野	
5 B			山	下	臨時 石黒(木村)			荒	川		林		木村	井上	見	附	林		追加 山下			岡野	山	下	小	川	岡野
6A1			木	村					難	波		小林	整備	浅	香		鈴	木	追加 難波				淡	野	追加 難波	小林	整備
7 A			吉田郷	臨時 村	田				吉田郷	長谷川貞		追加 吉田郷	渡	辺		川副	長谷	川貞						中	井	(渡	辺)
7 B		谷	口	北村	植田			植田	橋本	大	野	大	木	橋本	那須	桜	井	池	沢			窪田	北村	川副	福井(川副)	那須	窪田
8 A			石	黒	森田			森	田	後	藤			伊	藤		木	原						木	原		
マシン		単バンチ				マシン	スタディ						単バンチ	ウィグラー(4T)						保守	点検	単バンチ	ウィグラー(4T)				単バンチ

The in-house beam lines

	3/28	4/4	4/11	4/18	4/25	5/2	5/9	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26
1 A		小	杉	(髙	田)				小	杉	(髙	田)		直	江	細	川	小杉 (髙	田)			小	杉	(髙	田)		
2 A				正畠	田林			正	畠					正	畠		神	田	田林				笠井	松下			
2B2		見	附	(吉	田)			見	附	(吉	田)	荻野	見	附	(吉	田)						見附 (吉	田)	荻野	見	附 (吉	田)
3 B		見	附	(服	部)					見	附	(服	部)									見	附	(服	部)		
4 A			西	尾				西	尾	イル	ファン	西	尾		今	泉	西尾	宇理須	西尾			宇理須	イル	ファン	今	泉	
4 B			大	橋				正	畠	宇	理	須		大	橋	宇	理	須	大橋			宇理須	大橋	宇	理	須	
6A2		鎌	田 (藤	井)				木	村	藤井	岩	佐	森			山	田	浅	野				鎌	田	福	井	
6 B		薬	師	(鵜	川)					薬	師	(鵜	川)										薬	師	(鵜	川)	
8B2			関		長谷川			髙	橋	上野	関			口	野		宮	崎	長谷川			関		上野	高橋	長谷川	
マシン		単バンチ				マシン	スタディ						単バンチ	ウィグラー(4T)						保守	点検	単バンチ	ウィグラー(4T)				単バンチ

		10/3	10	17	24	31	11/7	14	21	28	12/5	12	19	26	1/2	9	16	23	30	2/6	13	20	27	3/6	13	20	27
1 B		太	田	中川 和		平	木	吉	成	伊	藤 稔	中川 英	林 哲			辻林	大	野	神野	黒沢	中川 和						
2B1		松	島			松	本			関	大内					田	中			川	瀬						
3A1		西	尾			吉	田		中川 英	鎌	田		鎌			田		林 浩			西川						
3A2							川崎		窪田		増	岡	小谷 野				川崎	増	岡	小谷	野						
5 B		林 浩					池沢	木村	岡野	山	下	岡野	山下			木村	荒	川	見	附	山下						
6A1		フェルナ	ンド	木村		難	波				小林		木村				木村	小林	浅	香							
7 A		植田 Ge	吉田 Ge郷	長谷川Ge		セッティング	長谷川	長谷川B		松 B	川		吉田 B郷				渡辺 B	吉田 B郷	村田 コルツ	渡辺 B	吉田 郷						
7 B		桜	井	西井		藤田	福井	宮	永	服部	谷	口	大木				細野	木村	西井	武部	那須						
8 A		木	原				伊	藤 寛	森	田		小	川		1/5	後	藤		石	黒							
マシン		ウィ	グラ-	(4T)	マシンスタディ				単パンチ			単パンチ		シャダウ	ットン	単パンチ						真	空シャ	改ット	造ダウ	ン	

		10/3	10	7	24	31	11/7	14	21	28	12/5	12	19	26	1/2	9	16	23	30	2/6	13	20	27	3/6	13	20	27
1 A		小	杉			小	杉			小	杉		小杉				小	杉	田中	小	杉						
2 A		田林								河	野		河野				田林		伊吹	神田	伊吹						
2B2		吉	田			吉	田										吉	田		鵜飼	吉田						
3 B		服部	彦坂			服部	彦坂										服部	彦坂									
4 A		イル	ファン	今泉		今泉	津坂	緒方	津坂	緒	方	今	泉			イル	ファン	緒	方	宇理	須						
4 B		吉越	大橋	永園		吉越	大橋	永園		吉越	宇理 須		大橋				正	畠	永園	吉	越						
6A2		広	瀬			Chu	yong		広瀬	木	村		鎌田		1/6		Sco			CAI							
6 B		薬師	鵜川			薬師	鵜川			薬師	鵜川		薬師 鵜川				薬師	鵜川									
8B2		長谷川	高橋	上野		川副	上野	宮崎	石井	日	野	石	井			宮崎	高橋	宮崎	長谷川	石井	宮崎						
マシン		ウィ	グラー	(4T)	マシンスタディ				単パンチ			単パンチ		シャダ	トウン	単パンチ						真	空シャ	改ト	造ダウ	ン	

BL1A Soft X-Ray Beamline for Photoemission-Photoabsorption Spectroscopy

BL1A is a soft x-ray beamline for photoemission-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 kind of crystal. The throughput spectra of the monochromator crystals are shown in Fig.1. In the energy range from 830 to 1800 eV, a pair of beryl crystals is used with the typical energy resolution ($E/\Delta E$) of 1500. Beryl is known to be damaged easily by x-ray irradiation. We have found that the beam intensity from a new beryl crystal is reduced to about 60% of the initial value after 8 hours irradiation due to the damage. The energy width is broadened by about 20 % at the same condition. In order to obtain spectra efficiently, the irradiation area on the first monochromator crystal is changed every day by moving the crystal position. We are planning to coat the crystal surface thinly with Al and/or insert the Al filter to suppress the x-ray irradiation above Al K-edge (1560 eV).

Recently, a new ultra-high-vacuum (UHV) apparatus for photoemission-photoabsorption spectroscopy has been constructed at the beamline. The detailed design and performance are reported in this issue. The apparatus is equipped with a high-performance electron analyzer (SES-200) manufactured by SCIENTA. Using the apparatus, it has become possible to measure the resonant photoemission spectra. The soft x-ray absorption spectra can be measured in the electron and fluorescent x-ray yield modes. The electronic structure of transition metal compounds and catalytic samples has been studied by the methods.

Reference

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

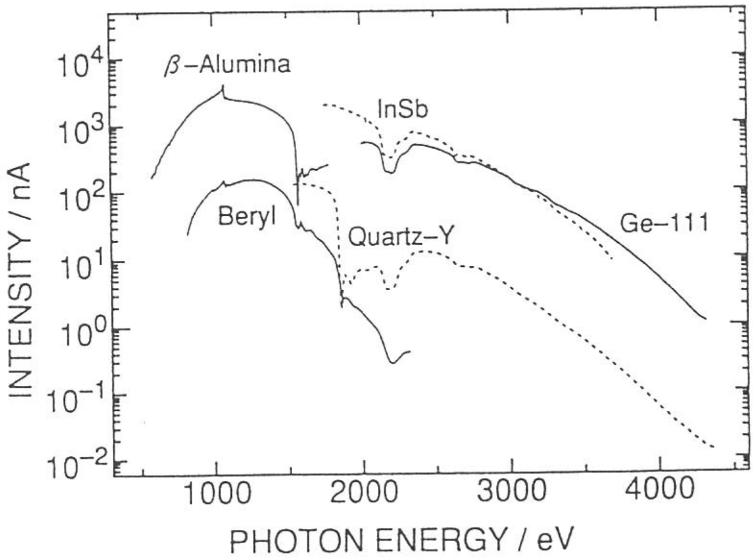


Fig.1. Throughput spectra of double crystal monochromator at BL1A measured by using an electron multiplier with Au first dynode. Intensity is normalized by 100 mA ring current.

BL1B and BL7B: Seya-Namioka Monochromator

BL1B and 7B are beamlines for standard optical measurements in the visible to vacuum ultraviolet region. There in no particular difference among these two beamlines. The multipurpose UHV chamber is nstalled at the focal point of the Seya-Namioka monochromator. It is easy to handle and obtain optical spectra (absorption, reflection, emission, and excitation, etc.). Samples usually measured are solids, but it is possible to measure the liquid, gases, and biological samples with a LiF window.

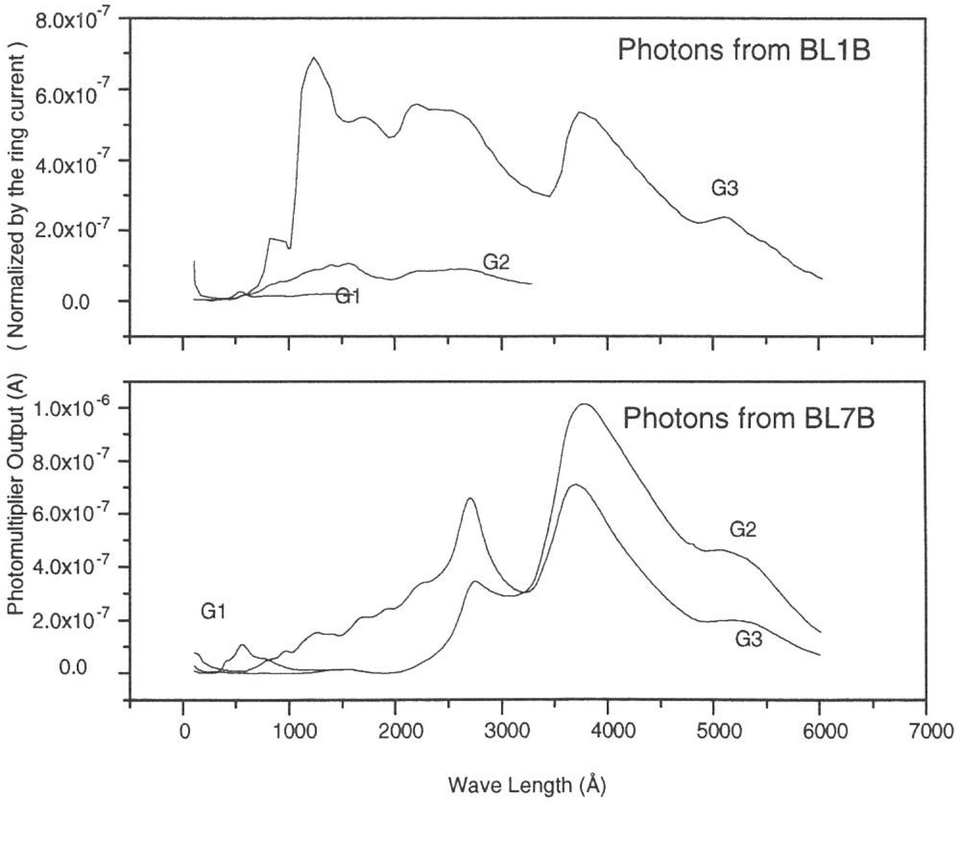
These can also be used for the time-resolved measurements, for instance, an investigation about lifetime of luminescence, when the UVSOR storage ring is operated in the single-bunch mode.

Summary of the specification are listed in Table 1. It is noted that the No.2 grating (G2) in BL7B have been 600 /mm in spite of 1200/mm since January 1994.

Gratings	:G1;2400, G2;1200, G3;600 /mm (Changeable in the vacuum)
Spectral range	: 300 ~ 6500 Å
Resolution	: ~1 Å
Period	: 178 ns (Single bunch operation)
Bunch length	: 0.4 ns (Single bunch operation)

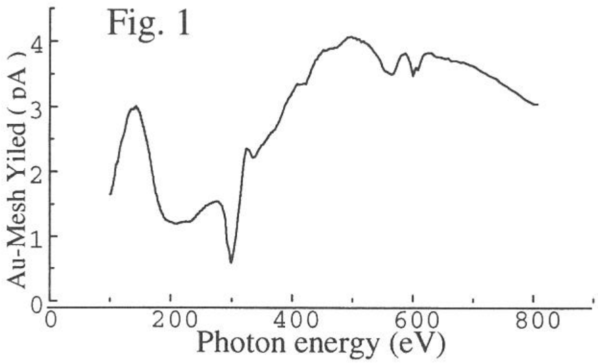
Table 1

The overall spectra from the monochromators are shown below.



BL2B1: Soft-X ray beamline for solids and solid surfaces

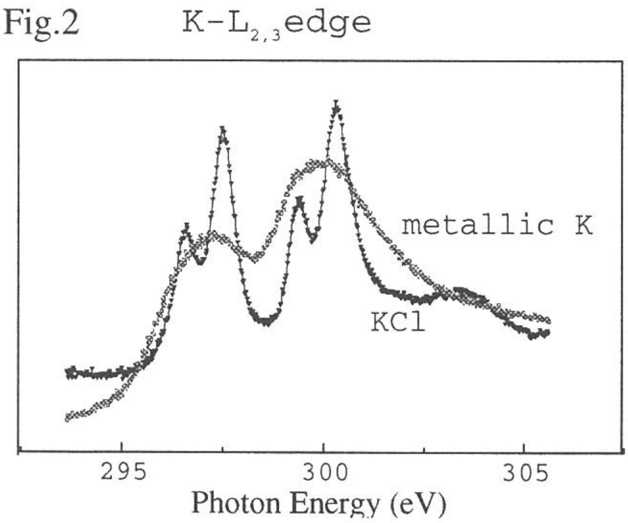
BL2B1 is a beamline in order to study solids and solid surfaces by the use of photoabsorption and photoelectron spectroscopy. A 2-meter grazing incidence monochromator ('Grasshopper' type, Mark XV; Baker Manufacturing Co.) is installed. Three kinds of grating are prepared (600, 1200, 2400 l/mm), and 2400 l/m has been installed since April 1994. The energy range for this grating is from 95 eV to 1000 eV. The resolving power is better than 600 at C-K edge (about 290 eV). Figure 1 shows the photoelectron yield from the Au mesh (10%-transmission) located near the position of a sample. The dip around 300 eV is due to carbon contamination of optical elements.



The analyzing chamber is installed at the focusing point of the monochromized light. The pressure is less than $1x10^{-10}$ Torr. A double-pass CMA with a coaxial electron gun, a LEED optics, an ion-gun for sputtering, and a sample holder which can be cooled with liquid nitrogen and heated, etc. are equipped for 'in-situ' measurements in the analyzing chamber. The photoelectron spectroscopy including CIS (Constant initial state spectroscopy), CFS (Constant final state spectroscopy) can be measured using CMA which is controlled by a personal computer. Samples can be transferred to the analyzing chamber from the air, through the preparation chamber in which sample treatment (e.g. cleaving, filing, and deposition) can be made.

Figure 2 shows an example of spectra measured at BL2B1. These are K-$L_{2,3}$ edge absorption spectra of KCl and metallic K films deposited on the sample holder made of Mo. Spectra are measured via a partial photoelectron yield by the use of the CMA. The spin-orbit splitting (L_2 and L_3) of the initial state of metallic K and KCl are clearly observed, and the splitting due to the final state of KCl are also clearly observed.

Fig.2



BL3A1 Irradiation Port with Undulator Radiation

A planar-type undulator installed in a long straight section of the UVSOR storage ring provides an intense quasi-monochromatic radiation to the beam line 3A1 or 3A2. The undulator consists of 24 sets of magnets, a period length of which is 80 mm. The photon-energy range from 8 to 50 eV can be covered by the fundamentals, although the large amounts of higher harmonics are mixed into the spectral distribution with increasing the K-value. The beam line 3A1 has no monochromator between the undulator and a sample chamber. The undulator radiation is introduced into samples through a pinhole (1 or 2 mm in diameter before the premirror chamber), a toroidal focussing mirror, another pinhole(1 mm in diameter near the sample chamber), and filters (Al, Sn, and In). A three-stage differencial pumping system is available to be installed for the experiments such as etching and CVD. A typical spectrum distribution measured at BL 3A2 is shown in Fig. 2, where the undulator gap is 60 mm and the value of photon flux is 10^{14}–10^{15} phs/s/mm^2.

A variety of experiments by using the intense undulator radiation such as photo-desorption, SR-CVD, photo-etching, and light-amplification induced by core-level excitation have been carried out in recent years. The irradiation effects of vacuum ultraviolet radiation to useful semiconductors and amorphous materials have also been measured at this station. The luminescence from high-T_c superconductors, the fluorescence yield of which is very low, can be obtained with the undulator radiation. The decay time measurements of luminescence have also been carried out on many samples under single-bunch operation.

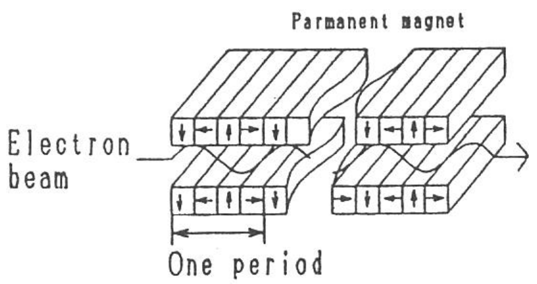


Fig. 1 Schematic drawing of undulator

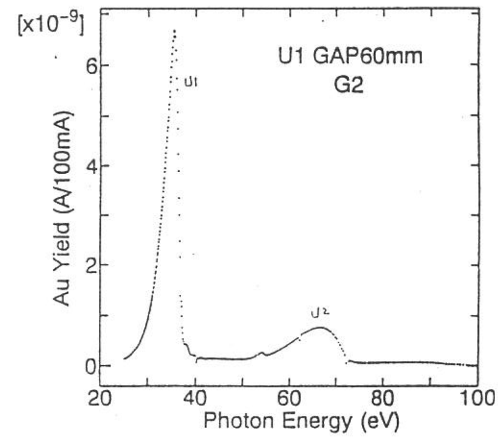
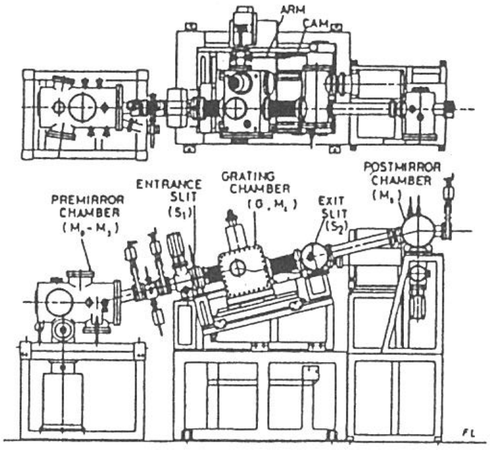


Fig. 2 Typical spectrum of undulator

BL3A2 Gas-Phase Dissociative Photoionization Apparatus

This machine has been constructed to study the formation of multiply-charged ions and thier dissociation processes. The monochromator is constant-deviation grazing-incidence type with 2.2 m focal length and covers wide wavelength range from the region around the first ionization potentials of almost all molecules (~ 100 nm) to the region where multiply-charged ions are effectively produced (~10 nm). High intensity photon beam is available by introducing the radiation emitted from the undulator to the monochromator. The apparatus contains an angle-resolved time-of-flight mass spectrometer (TOFMS) equipped with automatic data acquisition system for photoion-photoion coincidence measurements. For full understanding of dissociative multiple photoionization, we detcet the coincidence signals of two fragment ions produced from a parent ion, evaluate the kinetic energy release in "Coulomb explosion", and measure the angular distributions for the fragment ions. The sensitivity with respect to high-speed ions (several tens of electron volts) is much improved in comparison with commercial TOFMS.



Application

This apparatus allows us to measure the partial cross sections for the multiple ionization of polyatomic molecules and the branching ratios for various fragment channels. On the basis of the kinetic energy distribution of the fragment ions, we have discussed the detail of dissociative potential energy surfaces relating to double photoionization.

Specifications

Monochromator	: 2.2 m constant-deviation grazing-incidence
Spectral range	: 10 - 100 nm
Resolution	: 0.009 nm at 13 nm
Mass spectrometer	: double-field time-of-flight type
Mass Resolution	: 300
Length of the drift tube	: 0.2 - 1 m
Rotatable Angle	: 0 - 90° with respect to the photon beam

BL5B Calibration Apparatus of optical elements

BL5B has been constracted to calibrate optical elements. The beam line consists of a plane grating monochromator (PGM) and a calibration chamber (Fig. 1). The calibration chamber is equipped with a goniometer. The beam line is able to accommodate an additional experimental apparatus downstream after the chamber. The spectral range of the PGM is 2 - 240 nm (Fig. 2) and the resolution is 500 ± 200 in this range. The volume of the calibration chamber is ~ 0.5 m^3, and the pumping system evacuates the chamber to a operating pressure (less than 3×10^{-5} torr) from the atmosphere during ~ 1 hour. The goniometer, which was installed for the characterization of optical components, has six degrees of freedom: coaxial rotations of sample and detector, X-Y translation of a sample, and interchange of samples and filters. They are driven by vacuum pulse motors. Since the polarization of SR is essential for such measurement, axis of the rotation can be made in either horizontal or vertical direction.

By using the chamber, and also by using the ultrahigh vacuum chamber on the beam line downstream, various researches such as 1) calibrations optical components, 2) measurements of reflectivity spectra of materials in the photon energy range 10 - 200 eV, 3) measurements on photo-stimulated desorption from solid rare gases condensed on a cryogenic surface, and 4) time resolved detection of photoemission after the irradiation of VUV light using an electron streak camera, have been carried out.

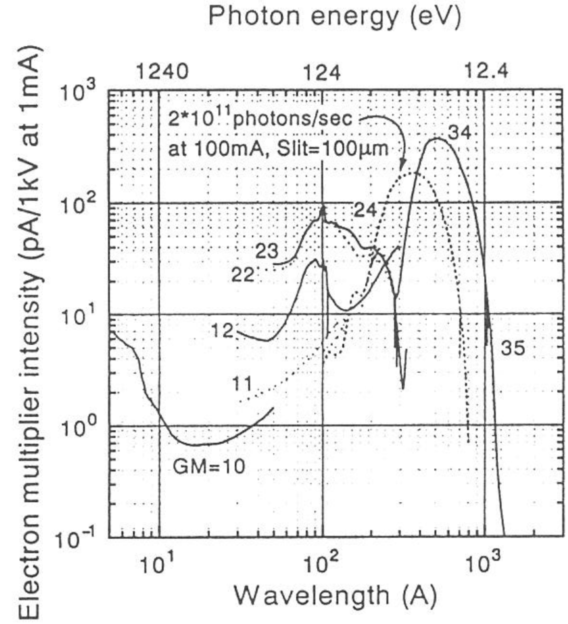


Fig. 2. Throughput spectra of BL5B detected by an electron multiplier.

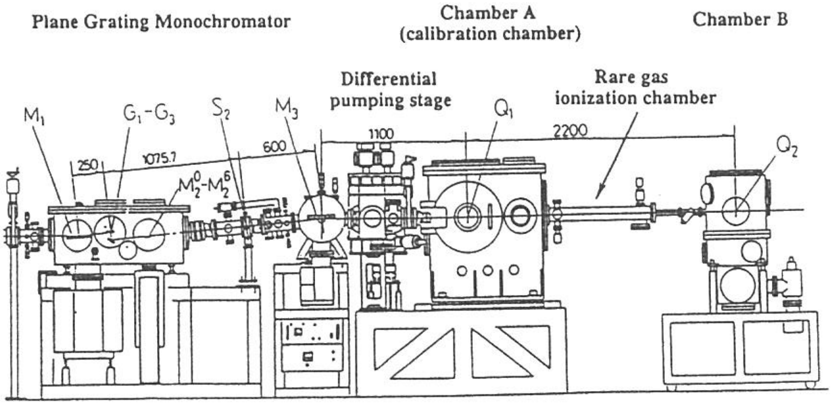


Fig.1. Schematic figure of BL5B spectrometer system.

BL6A1 Fourier Transform Far-Infrared Spectroscopy

Although the synchrotron radiation (SR) is a strong light source in the vacuum ultraviolet region, the spectral distribution extends down to the far-infrared region. Since the bunch of electrons is very small, the brightness is higher than a conventional light source. This property of SR is powerful especially for small samples. As a matter of fact the intensity of UVSOR is 10 times larger than the high-pressure mercury lamp when the sample size is smaller than 3 mm. The far-infrared spectrometer of BL6A1 was constructed to measure the absorption or reflection of such a small size.

Specification

method	:transmission or reflection
spectral range	:33 μm ~ 2 mm (300 ~ 5 cm^{-1}, 37 ~ 0.6 meV)
resolution	:0.1 cm^{-1}
temperature	:9 ~ 350 K
pressure	:0 ~ 20 GPa (using a diamond anvil cell)

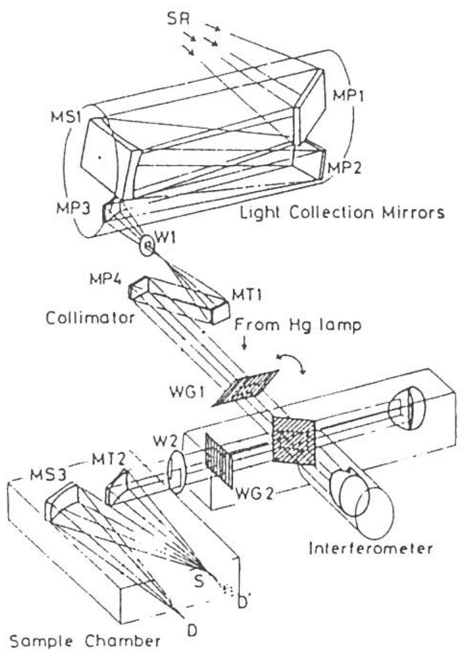


Fig. 1. Schematic drawing of spectroscopic system.

It becomes possible by using UVSOR as a light source to do the spectroscopic study in the far-infrared region on small samples. Recently many attractive materials such as copper oxide superconductors, strongly correlated electron systems, superionic conductors and so on are investigated. Since SR is a highly collimated, it is powerful for the spectroscopic experiment at low-temperature, under high-pressure and under high-magnetic field where the solid angle is restricted to a small range.

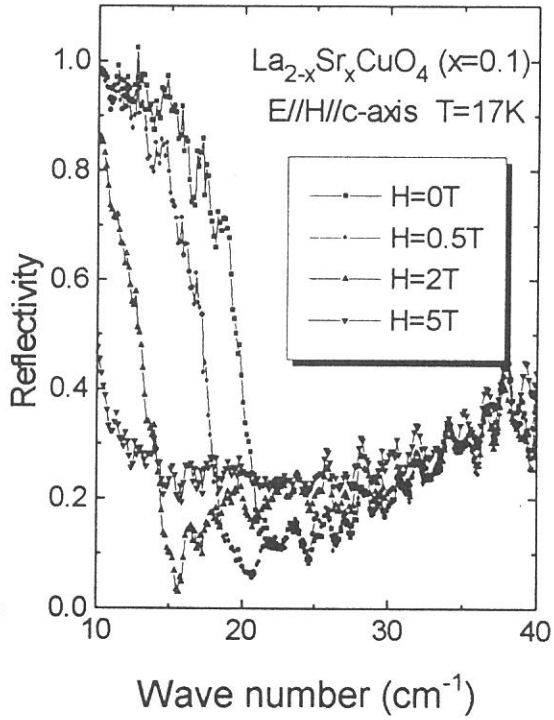


Fig. 2. Reflectivity spectra of $La_{2-x}Sr_xCuO_4$ (x ~ 0.1) under magnetic field.

BL6A2 Photoelectron Spectrometer for Solids and Surfaces

A Plane Grating Monochromator (PGM) consists of pre-mirrors, a plane grating, focussing mirror, and a post-mirror, with an exit slit. It covers the wide spectral range from 2 to 130 eV with exchanging two gratings and 5 focussing mirrors. A typical photon flux is about 10^{11}phs/s/100 mA at 90 eV with a resolving power of 700. Angle-integrated and angle-resolved photoelectron spectrometers are available at BL6A2. The overall resolution of the angle-integrated cylindrical retarding-field analyser is fixed to be 0.3 eV, while the angle-resolved hemispherical analyser has a resolving power of 100 with an angular resolution of 1.1°. The optical system including an ICCD system can be installed to detect the fluorescence from the samples through a quartz lenze and a sapphire window. The standard instruments for surface analysis such as Auger, LEED, Ion gun, and Gas doser are installed in the analysing chamber, the base pressure of which is $1.2x10^{-10}$ Torr. The samples are transfered from an air-lock chamber to the analysing chamber through a preparation chamber.

The photoelectron spectroscopy is a powerful method to know the occupied states of many materials. The III-V semiconductors, layered materials, dielectric films, and metallic substances have been investigated at BL6A2, as well as the clean and adsorbed surfaces of semiconductors (Si, Ge, and GaAs). The angle-resolved photoelectron spectra have also been observed to know the band dispersion. Moreover, the time response of the photo-desorption of excited-state alkali atoms from alkali halides has been observed by using the TAC system under a single-bunch operation.

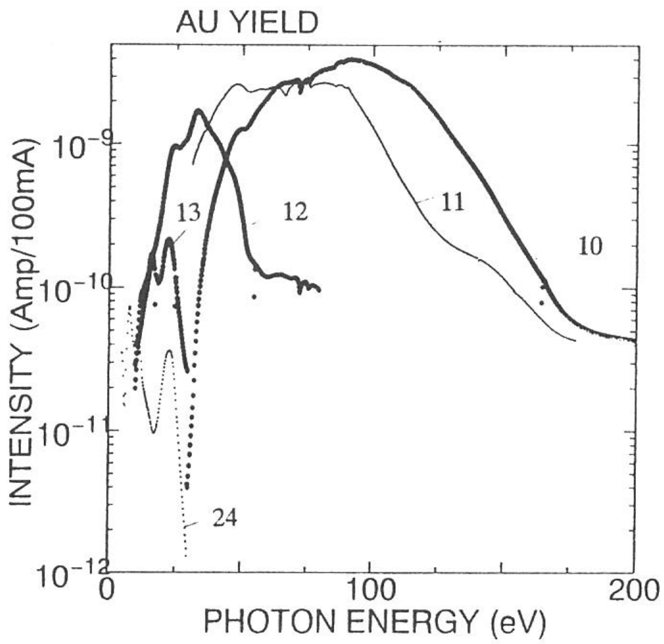


Fig. 1 Typical spectral distribution

BL6B Fourier-Transformed Far-Infrared Spectrometer

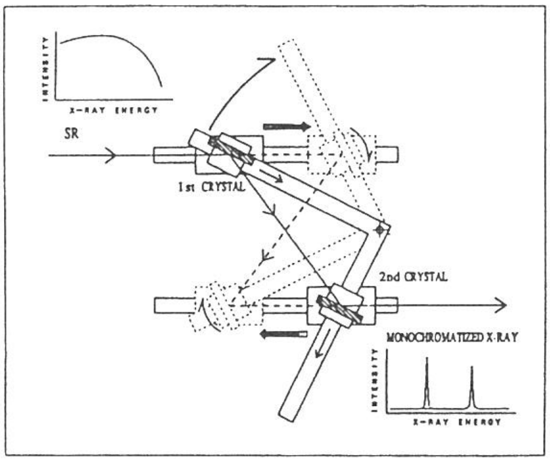
BL6B has been designed to measure reflectance on small samples with high precision over FIR-IR regions. The optical system of BL6B consists of the following three parts: (1) beamline optics in ultrahigh vacuum (1×10^{-9} Torr), equipped with interchangeable four kinds of exit-window without breaking the vacuum, (2) adjusting optics between the beamline and a spectrometer, (3) a Bruker IFS-113v spectrometer, which offers automatic change of six beam-splitters under vacuum (~5 Torr). A reflectance unit is placed into a sample compartment of the spectrometer, also in the vacuum atmosphere. Temperature dependence can be traced with a LHe flow type cryostat from room temperature down to 4 K. An infrared microscope is applied, if necessary, to obtain accurate reflectivity on samples smaller than millimeter size. Table 1 summarizes the optical elements used in each wave-number range.

range (cm-1)	source	beam-splitter	optical filter (cut-on)
2000-10000	Tungsten	Si on CaF_2	none
500-5000	Globar	Ge on KBr	none
150-650	Hg lamp	Mylar 3.5μ	700 cm^{-1}
70-220	Hg lamp	Mylar 12μ	700 cm^{-1}
20-80	Hg lamp	Mylar 23μ	100 cm^{-1}
6-30	SR	Mylar 125μ	35 cm^{-1}

Table 1. Optical elements.

BL6B is specially suitable for the study of optical properties of organic conductors because available size of the crystals is usually very small. We are now investigating the electronic structure of organic conductors that have a single-particle gap appeared in far-infrared region, caused by SDW, CDW, or superconducting transition. The superconducting character is also discussed through the change of reflectivity versus the temperature around the T_c.

BL7A Soft X-ray Spectrometer for Solids



In the soft X-ray region from 0.5 to 5 keV, there exist 1*s* core absorptions of light atoms from oxygen to calcium which take important role in the various fields of chemistry (organic, inorganic, catalytic, and biological) and other core absorptions of heavier atoms. By measuring the X-ray absorption, and the emission of electrons, X-ray fluorescence, and UV-visible light after the excitation of 1*s* or other core electrons of these atoms, structural and dynamical information of molecules, solids and catalysts, can be obtained. The soft X-ray beam line BL7A equipped with a double crystal monochromator (DXM) was constructed for the spectroscopic research in the soft X-ray region. The DXM at BL7A was designed to realize the constant offset and constant direction during the scanning of the X-ray energy. As shown in the figure two crystals move along each arm of an L-shaped base. The first crystal's surface is mounted parallel to one arm while the second crystal's surface is mounted perpendicular to another arm so that two surfaces should be parallel. The reflection points of the first crystal and second crsytal move along the incident SR beam axis and along the monochromatized X-ray beam axis, respectively. The rotation center of the L-shaped base (cross point of the extension line of the first crystal's surface and the normal line of the second srystal's surface at the reflection point) is fixed on the bisectional level of the incident SR beam and the monochromatized X-ray beam. By rotating the L-shaped base, incident angle to the crystal's that is, X-ray energy can be changed with keeping the offset and direction of the X-ray constant.

Specification

Scanable energy range :

CRYSTAL (MULTILAYER)	2*d*/Å	energy range (1 2 3 4 5)
KAP	26.64	0.49 — 1.36
(W/B_4C)	25.7	0.51 — 1.41
Mica	19.8	0.66 — 1.83
Beryl	15.965	0.82 — 2.27
Quartz-Y(10$\bar{1}$0)	8.512	1.53 — 4.26
InSb-111	7.481	1.74 — 4.85
Ge-111	6.532	2.00 — 5.55

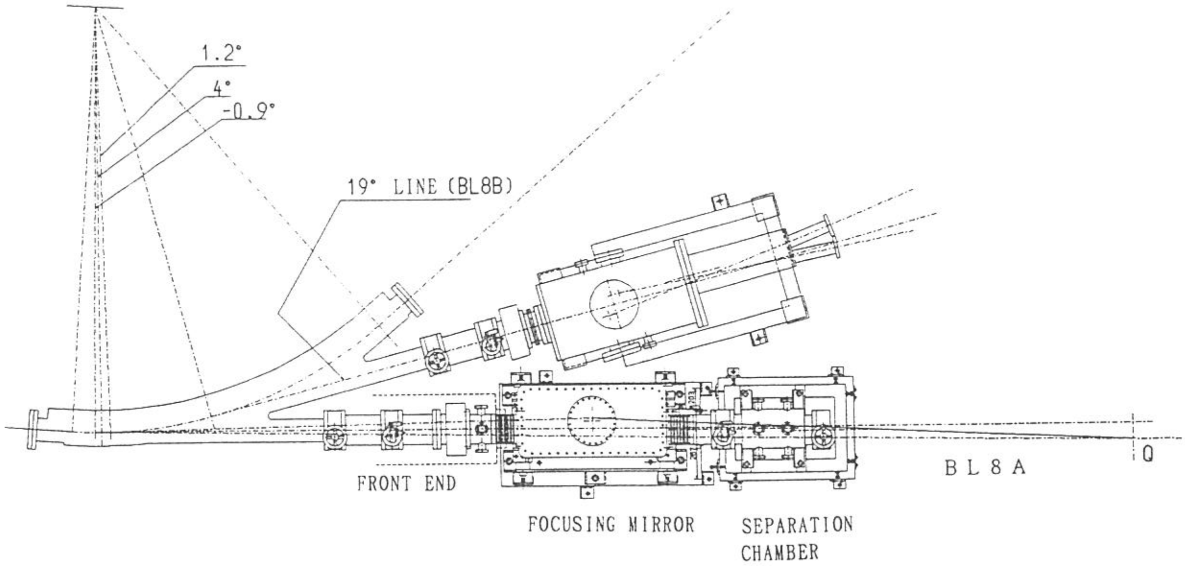
Resolution : 0.46 eV (Crystal = Beryl, E = 860 eV)

Measurements : Transmission, total photoelection yield

Sample : Gas, solid (room temp. - 20 K)

BL8A Free Port

This beamline was constructed as a free port to which user can connect their own instruments. The beamline consists of a front end, a focusing premirror chamber and a separation chamber. Both focused and unfocused beam can be used. A general purpose reaction chamber and a two (or three) stage differential pumping system are available for the experiments that use gas samples without window. With using three stage diffrential pumping system, gas pressure at the reaction chamber upto 0.5 Torr can be used while keeping ultra high vacuum at the premirror chamber.



specification

spectral range: whole range of synchrotron radiation from UVSOR

Acceptance angle

Unfocused beam: 25 mrad (horizontal) × 8 mrad (vertical)
0.6 mrad (horizontal) × 0.6 mrad (vertical)
(with 3mmϕ aperture before sample)

Focused beam: 7.7 mrad (horizontal) × 8 mrad (vertical)

- Beam spot size at focus : 3 mm (horizontal) × 2 mm (vertical)
- Source - mirror distance: 2500 mm
- Mirror - focus distance: 2807 mm

Application

SR assisted Chemical Vapor Deposition

SR assisted Etching

Radiation damage

Soft X-ray microscopy

Accumulated photon echo

BL8B1 Photoabsorption and Photoionization Spectrometer

BL8B1 is the beamline for high resolution photoabsorption and photoionization experiments mainly in the photon energy range from 200 to 800 eV where the 1s core absorption of C, N, O atoms exist. For this purpose a constant-deviation constant-length spherical grating monochromator (CDCL-SGM) with three interchangeable gratings was constructed at this beamline. The CDCL-SGM has simple scanning mechanism with fixed position of both the entrance and exit slits, as well as fixed direction of incident and exit photon beams. The monochromator covers 30 ~ 800 eV by using three gratings (G1: R=15m; 1080 l/mm, G2: R=15m; 540 l/mm, G3: R=7.5m; 360 l/mm) with photon flux of 10^8 - 10^9 photons/sec for 10 μm slits and at 100 mA ring current (Fig. 1). Absolute photon flux was evaluated from drain current of gold foil with assuming constant quantum efficiency of 0.073. In the photon energy range from 180 to 800 eV, observed resolutions ($E/\Delta E \approx 4000$ at 400 eV, $E/\Delta E \approx 3000$ at 245 eV) with 10μm slits agree well the calculated values (Fig. 2).

Several types of gas phase experiments are possible with using an experimental chamber equipped with a photoelectron detector (total- or threshold-), a time-of-flight ion detector, and a built-in VUV monochromator for emission detection (under preparation). An example of fragment-ion mass spectrum of core-excited molecule is reported in this issue (BL8B1). It is also possible to measure absorption, electron yield, and emission spectrum of solid samples.

1. Absorption spectrum with transmission mode
2. Total electron yield and/or total ion yield spectrum
3. Emission spectrum (Visible to VUV) and emission excitation spectrum
4. Time-of-flight mass: photoelectron-photoion coincidence (PEPICO)
5. Photoion-photoion coincidence (PIPICO)

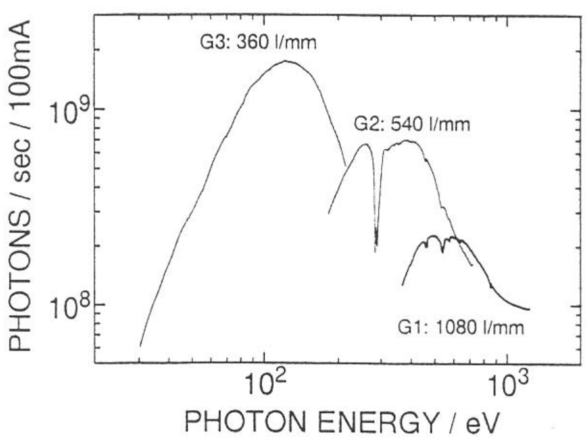


Fig. 1. Throughput spectra (absolute photon flux) of CDCL-SGM for three gratings with 10μm slits and at 100mA ring current.

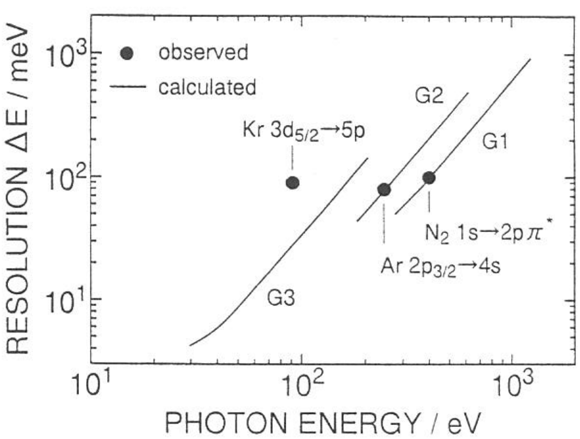


Fig. 2. Energy resolution of CDCL-SGM for three gratings with 10 μm slits. Solid lines: calculated values, filled circle: observed values.

BL8B2 Angle-resolved UPS system

An angle-resolved ultraviolet photoemission spectroscopy (ARUPS) system at BL8B2 is shown in Fig.1. The ARUPS system consists of a preparation chamber with a glove box, a measurement chamber with an accurate manipulator for temperature dependence, a new cleaning chamber and a new sample preparation chamber. The new cleaning chamber are also equipped with LEED/AUGER, Ar^+ gun and an infrared heating units. Each chamber is evacuated by a combinaton of a sputter ion pump, a turbo-molecular pump and a Ti getter pump with a final pressure of 10^{-8}Pa range. Synchrotron radiation from UVSOR is monochromatized by plane-grating-monochromator (PGM) which supplies radiation in the energy range of 2-150eV. This range covers the whole valence excitation of various solids. A hemispherical electron-energy analyzer of 25mm mean radius can be rotated around vertical and horizontal axes. The sample mounted on a manipulator can be also rotated around two axes. The spot size of the zeroth-order visible light at the sample is focused less than $1 \times 1 mm^2$. The total resolution is less than 0.3eV, as determined by measuring the Fermi edge of gold. The sample are prepared on a small disk of 10mm in diameter by methods such as vacuum evaporation and cleavage in the preparation chamber or the glove box under Ar atmosphere.

The ARUPS system at BL8B2 are designed for measuring various organic solids such as molecular crystals and conducting polymers. Then, we measured ARUPS spectra of copper phthalocyanine (CuPc) thin films deposited on MoS_2 surface. The freshness of the cleaved MoS_2 surface was confirmed by ARUPS and low energy electron diffraction (LEED) measurments before the film deposition. By comparing the results of LEED and ARUPS measurements, we determined the orientation of the CuPc molecules on the MoS_2 surface by the quantitative analysis of the observed angular distribution using the IAC (Independent Atomic Center) approximation method.

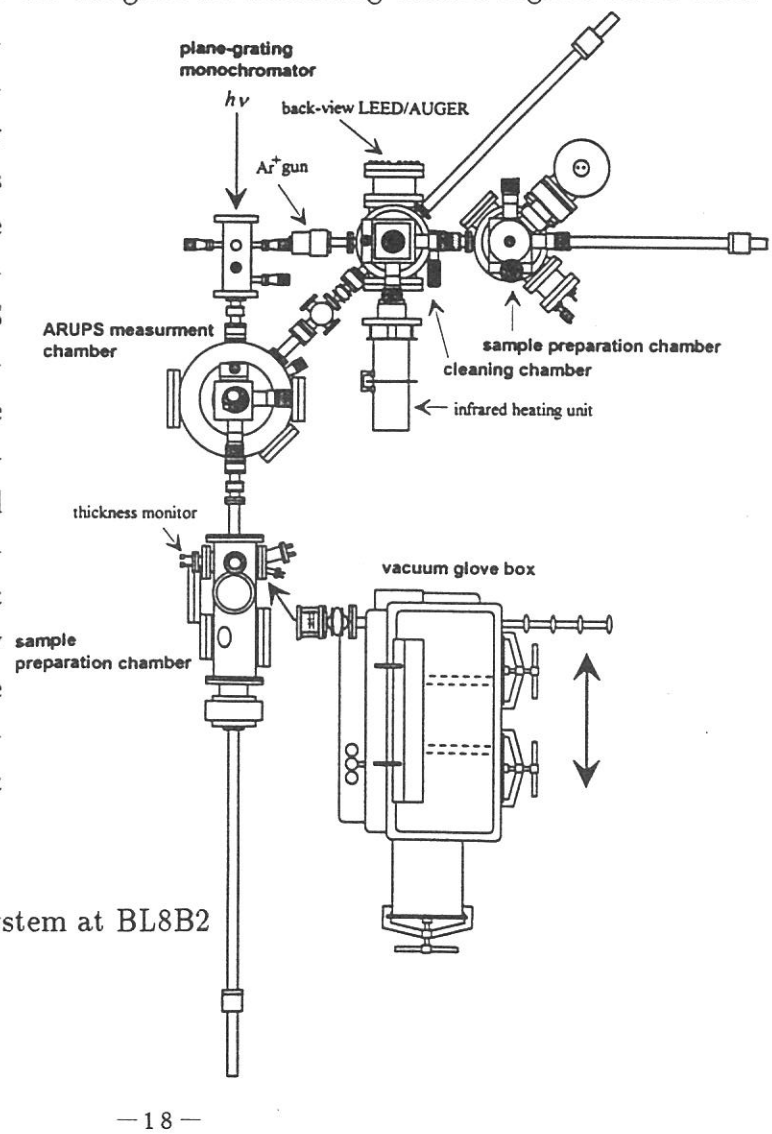


Fig.1 The top view of ARUPS system at BL8B2