# Status of UVSOR

# Status of the UVSOR Accelerator Complex in 1997

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## 1. General

The UVSOR storage ring has been operated without serious hardware troubles in 1997. Because of continuous efforts for replacement of old devices, particularly power supplies for pulse magnets, in these years, malfunction of devices has become fewer. In addition, troubles on the control circuite for the booster synchrotron is now able to be fixed smoothly because spare parts for most of core circuites have been secured. Operation time in each month is shown in Fig. 1. Because there ware 4 shut-off terms in seasons, large flutcuation is apparently seen. However the most of scheduled machine time was consumed properly.

Beam injection is performed twice per day at 9 am and 1 pm. On the third day in a week, an additional injection is at 5 pm. The maximum beam current is limited to be 240 mA by optical elements of SR beam lines, then approximately 120 mA remains at the time of next injection. However after the last injection, the machine time is often extended, so that the averaged beam current in the machine time is about 100 mA as shown in Fig. 2.

Troubles concerened in the booster synchrotron are still large portion in the time lost. As mentioned above, there was no serious situation because most of troubles were fixed rapidly. Although we lost 10-hour machine time because of a trouble of a computor software, this was also not serious trouble. Among additional equipments a couple of major problems were occured on the superconducting wiggler. In January, a trouble happened in a compressor for the 4 K refrigerator, which was fixed perfectly in May. However another trouble occured on a control system of an old power supply fro the magnets. Because ICs in the system were old commercial ones, it took a long time to obtain a substitution and the system came back after the summer. The superconducting system of the wiggler had been apparently working well for a while, a failure to keep the liquid He in

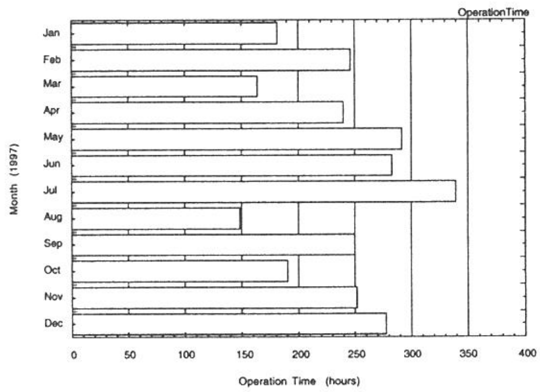



Fig. 1 Integrated operation time per month in 1997.

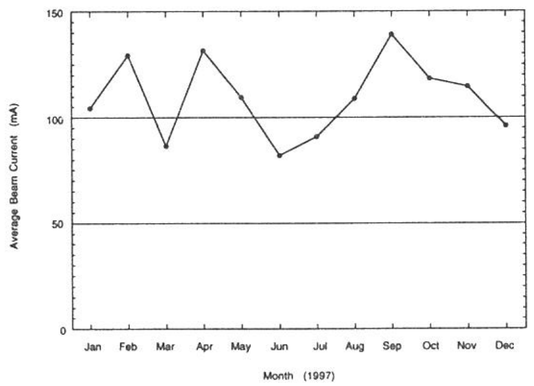



Fig. 2 Averaged beam current in each month.

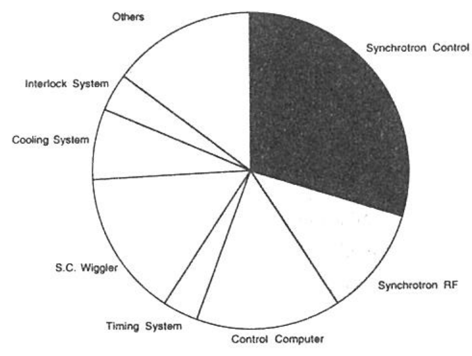



Fig. 3 Time lost per devices

the system occured again. At the moment the wiggler is in shut-off to be investigated. Because the system seems to have no malfunction, capability of the refrigerator may become below a heat intrusion. A basic measure will be implemented.

## 2. Lifetime and Ring Vacuum

In the spring shut-off term, a part of the ring beam chamber was replaced. The vacuum was recovered quickly, and the lifetime of the beam became a same level as the last year by the summer. However frequent leakage of the vacuum from a beam line occured in the fall, so that the lifetime became less again. Moreover an effect of the ion trap was seen very much, and then the vertical beam size had been not stabilized for a long time. Although the effect still remains, the partial filling of the bunches and an RF clearing against the ions are working effectively at the moment.

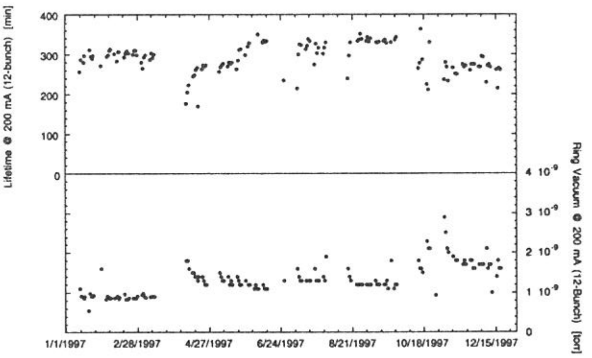
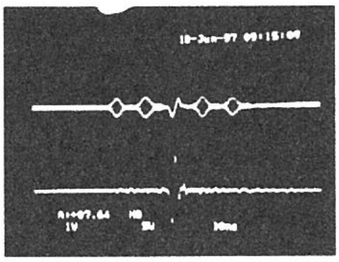


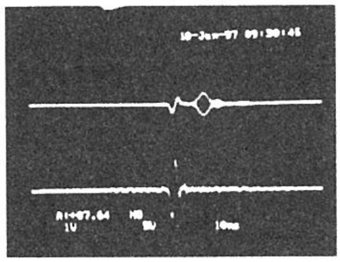

Fig. 4 Lifetime and average ring vacuum at 200 mA with the 12-bunch mode.

## 3. Transverse Resonance Kicker

To improve the beam handling on the storage ring, a transverse resonance kicker (TRK) system has been developed. In the normal multi-bunch operation, 3/4 filling mode is used to reduce an effect of the ion-trapping. Electron bunch filling was controlled by selecting the RF bucket using a timing control system for the fast kicker extraction of the booster synchrotron so far. However it was difficult to erase specific bunches so that the transverse beam instability due to ion-trapping has been not completely damped and the purity of single-bunch mode has been not very well. The TRK system generates electromagnetic field with a very short duration less than 3 ps. To avoid distortion of the pulse due to reflection, whole system including electrodes and a vacuum chamber was designed to be matched to the intrinsic impedance of 50 Ω. The short pulse is synchronized with the revolution of a specific bunch, which is, moreover, modulated by the betatron oscillation frequency. Because the electron momentum on the ring is high, a huge power is required to kick out the bunch at once. Meanwhile, using the TRK system the electron bunch is transversely kicked at each turn, and the amplitude of betatron oscillation grows rapidly even with a relatively low kick power. The electrons finally may touch the wall of vacuum chambers or go out of the dynamic aperture. As a result, for example, the impurity ratio of the single bunch became less than $10^{-4\sim5}$ by sweeping the satellite bunches using the TRK.



A



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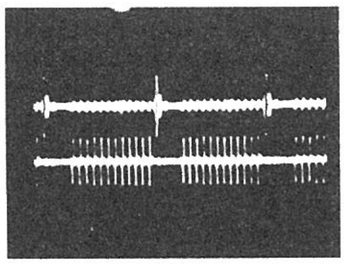

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Fig. 5 RF signals in TRK and the bunches. During the single bunch injection (A), in the single bunch operation (B) and in the 14 bunches mode.

## 4. Conclusion

The 15-year old machine is still working well. Nevertheless our goal is not only to maintain the machines but also to improve them to have competitive performance. In the forthcoming year, parts of the beam chamber of the ring will be modified for issues of both the vacuum and the coupling impedance. These continuous improvements may be the motive power to survive in the world.

# ACCELERATOR COMPLEX

## Injection Linac

| | |
|---|---|
| Energy | 15 MeV |
| Energy Spread | ~ 1.6 MeV |
| Frequency | S-band 2.856 Hz |
| Acceleration | 2π/3 Traveling Wave |
| Length | 2.5 m |
| Klystron Power | ~ 1.8MW |

## Booster Synchrotron

| | |
|---|---|
| Lattice Type | FODO |
| Energy | 600 MeV |
| Beam Current | 32 mA (8-bunch filled) |
| Circumference | 26.6 m |
| Super Cell | 6 |
| Bending Radius | 1.8m |
| Betatron Number | 2.25 (horizontal)<br>1.25 (vertical) |
| Momentum Compaction $\alpha$ | 0.138 |
| Harmonics | 8 |
| RF Frequency | 90.115 MHz |
| Repetition Rate | 2.6Hz |

## Storage Ring

| | |
|---|---|
| Lattice Type | Chasman-Green |
| Energy | 750 MeV |
| Critical Energy | 425 eV |
| Circumference | 53.2 m |
| Super Cell | 4 |
| Bending Radius | 2.2 m |
| Betatron Tune | 3.16 (horizontal)<br>2.64 (vertical) |
| Momentum Compaction $\alpha$ | 0.032 |
| Harmonics | 16 |
| Emittance | $1.15\ 10^{-7}$ m rad (horizontal)<br>$1.15 \times 10^{-8}$ m rad (vertical) |
| Beam Size | 0.39 mm (horizontal)<br>0.26 mm (vertical) |
| Bunch Length | 170 ps (at zero current) |
| Beam Current | Multi-Bunch 200 mA<br>Single-Bunch 50 mA |
| Lifetime | 4 h at 200mA<br>9 h at 100mA |

## Additional Equipment

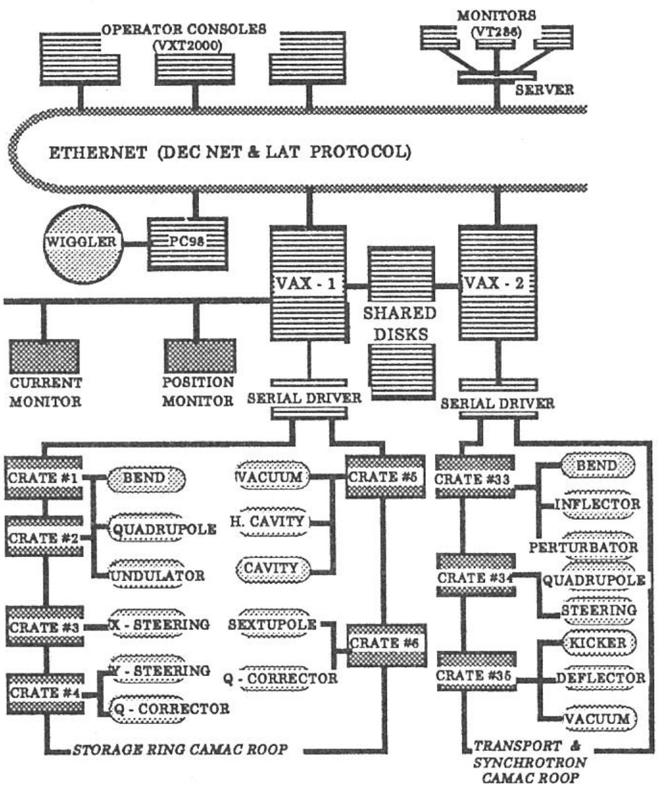
| | |
|---|---|
| Higher - Harmonic Cavity | 3 × 90.115 Mhz |
| Superconducting Wiggler | 4 T (maximum) |
| Undulator | for SR |
| Optical Klystron | for FEL |

## Control System

Preface: Based on Dual-Host system with CAMAC loop and friendly man-machine interface

Architecture

| | |
|---|---|
| CPU | VAX4000 (× 2) |
| OS | VMS |
| Connection | DECNET & Local Cluster |
| Operator Console | X - Servers (VXT200 × 3) |
| Status Monitors | VT286s + Macintosh |
| Interfaces | CAMAC serial loop |
| | GPIB for Beam Monitors |
| | RS232C for Host CPU of Wiggler |
| Languages | FORTRAN, C, Pascal |




### Scheme of Accelerator Control System "UCOSS"

# Beam Lines in 1997

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In recent years, improvements and trials have been carried out in order to obtain better performance and new scientific achievements. The UVSOR have organized workshops and discussed the improvements and upgrade of beam lines with users. About one third of beam lines has been upgraded in a couple of years. A Seya-Namioka monochromator at beam line 7B was replaced by a 3-m normal-incidence monochromator to improve a resolving power and spectral range for solid state spectroscopy. Another one at beam line 2B2 was also replaced by a Dragon-type monochromator for gaseous experiments in VUV and EUV ranges. A multi-layer monochromator was installed to beam line 4A for photochemical reaction experiments. These monochromators are now under commissioning. A glancing-incidence monochromator (a 15-m SGM monochromator) at BL8B1 was operational mainly for gaseous experiments in EUV region with a TOF-Mass spectrometer, besides the use for solid-state spectroscopy. A Bruker FT-IR interferometer and an old FT-FIR of a Martin-Puplett type at beam line 6A1 were used for solid-state experiments in the wide wavelength range from near infrared to millimeter wave. A new monochromator (SGM-TRAIN) at beam line 5A, which has been constructed for the use of circularly polarized light from the helical undulator, was opened in 1997 for photoemission experiments in EUV range.

Therefore, seventeen experimental stations were operational in 1997, while three stations are under commissioning. The UVSOR facility will soon have twenty stations operational; two soft-x-ray stations equipped with a double-crystal monochromator, eight extreme ultraviolet stations with a glancing incidence or a plane-grating monochromator, four vacuum-ultraviolet stations with a Seya-Namioka-type or a normal incidence-type monochromator, two (far) infrared stations equipped with a FT interferometer, a multi-layer monochromator, and three white-light stations without any monochromator.

Several trials with lots of efforts have been carried out to achieve new scientific and experimental findings. In 1997, the two-photon excitation experiment was successfully carried out at BL1B with the combination of YAG laser and VUV photons. New spectroscopy taking advantage of synchronization of photon pulses between undulator radiation and laser was also succeeded in gaseous phase at BL3A2. New experiments with an electron-ion coincidence (EICO) method to investigate SR-induced desorption on solid surfaces were actively conducted at beam line 2B1. Photochemical reaction experiments on semiconductors and Diamond were carried out at BL3A1, 4B, and 8A. Infared reflection at high pressure and magnetic circular dichroism in high magnetic field were successfully studied with FT-IR and FT-FIR at BL6A1. Several photoemission experiments were actively conducted to investigate electronic structures: Two-dimensional photoemission experiments for solid and gaseous molecules at BL1A and BL3B, respectively, Angle-resolved spectroscopy on molecular films at BL8B2, Photoelectron microscopy on magnetic specimens at BL5B or BL7A, and Spin- and angle-resolved photoelectron spectroscopy at BL5A. A YB66 crystal was used for soft x-ray experiments at BL7A, where focussing mirror system is under installation.

There were lots of troubles, especially water-related troubles, in 1997. Since the concrete wall in the basement had many old cracks, the water leakage in the room for electricity happened often in rainy and typhoon seasons. A water pump in the second cooling-circulation system was broken. The pressure in the pre-mirror chamber at BL8B1 became worse suddenly due to a water leakage from the cooling pipe for the pre-mirror. These are common problems to old facilities in the world. On the other hand, we had several troubles due to careless actions by users in 1997. Water from the loosely connected hoses was splashed at BL2A and BL8B2. The air was introduced in the monochromator chamber at BL7A during exchanging specimens. Similar air-leak trouble happened at BL6A1. The viton o-ring in the gate valve was melt during baking procedures at BL8A.

These accidents pushed us to confirm the alarm/emergency call system and also the education/safety system for beginner users. The second version of the UVSOR guidebook was published for this purpose. The UVSOR facility strongly asks all users to conduct their experimental procedures according to the beam line manuals and the guidebook.

The persons who want to use the open and the in-house beam lines are recommended to contact with the following station master or supervisor and the representative, respectively. The persons who want to know updated informations of the UVSOR facility are recommended to open http://www.uvsor.ims.ac.jp/.

Table I. Station masters and supervisors of open beam lines

| Beam Line | Station Master | Sub Master | Supervisor |
|---|---|---|---|
| 1B | M. Hasumoto | S. Tanaka | M. Kamada |
| 2B1 | S. Tanaka | M. Kamada | M. Kamada |
| 3A1 | M. Kamada | K. Hayashi | M. Kamada |
| 3A2 | N. Kondo | T. Gejo | T. Kinoshita |
| 5A | S. Tanaka | M. Hasumoto | M. Kamada |
| 5B | S. Kimura | M. Hasumoto | T. Kinoshita |
| 6A1 | S. Kimura | O. Matsudo | M. Kamada |
| 7A | T. Kinoshita | O. Matsudo | T. Kinoshita |
| 7B | T. Kinoshita | M. Hasumoto | T. Kinoshita |
| 8A | T. Gejo | N. Kondo | T. Kinoshita |
| 8B1 | T. Gejo | N. Kondo | T. Kinoshita |

Table II. Representatives of in-house beam lines.

| Beam Line | Representative | Department/Facility |
|---|---|---|
| 1A | N. Kosugi | VUV Photo Science |
| 2A | N. Kosugi | UVSOR |
| 2B2 | K. Mitsuke | VUV Photo Science |
| 3B | K. Mitsuke | VUV Photo Science |
| 4A | T. Urisu | VUV Photo Science |
| 4B | T. Urisu | VUV Photo Science |
| 6A2 | M. Kamada | UVSOR |
| 6B | K. Yakushi | Molecular Assemblies |
| 8B2 | N. Ueno | VUV Photo Science |

# *BL1A*

## Soft X-Ray Beamline for Photoelectron-Photoabsorption Spectroscopy

BL1A is a soft x-ray beamline for photoelectron-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 crystals such as β-alumina, beryl, quartz, InSb and Si crystals. The throughput spectra of the beryl (10$\bar{1}$0) and InSb (111) crystals are shown in Fig.1. Typical energy resolution ($E/\Delta E_{h\nu}$) of the monochromator is about 1500 when we use a pair of beryl or InSb crystals.

For photoelectron-photoabsorption spectroscopy, an ultra-high-vacuum (UHV) apparatus is connected. The top view of the apparatus is shown in Fig. 2. It is equipped with a high-performance electron analyzer (SES-200, SCIENTA Co.). The pass energy ($E_p$) can be varied between 1 and 500 eV and typical resolving power ($E_p/\Delta E_{elec.}$) is more than 1000. Using the apparatus, resonant photoelectron spectra for solid samples can be obtained with the total energy resolution ($\Delta E_{total}$) of ~0.7 eV around hν=1000 eV.

### Reference


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

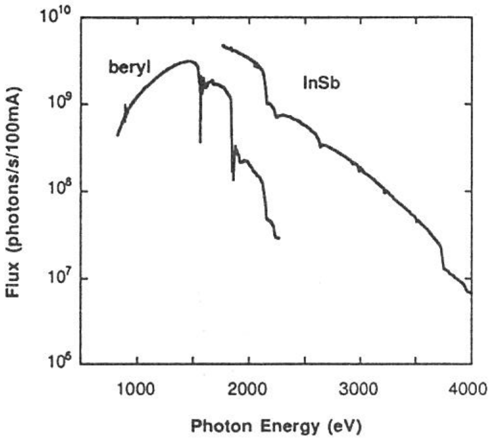




Figure 1. Throughput spectra of the double crystal monochromator at the BL1A.

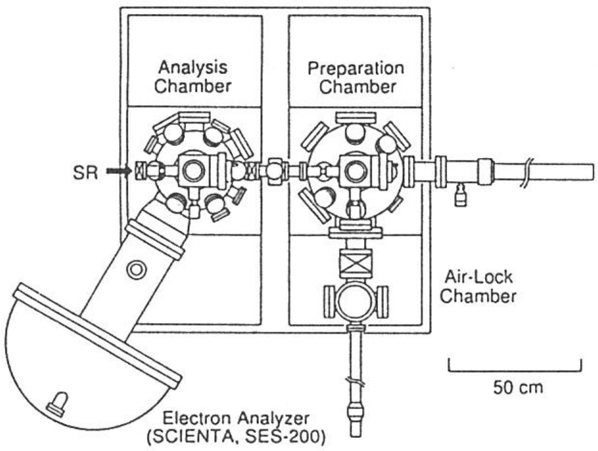



Figure 2. Top view of the UHV apparatus for photoemission-photoabsorption spectroscopy.

### Specification

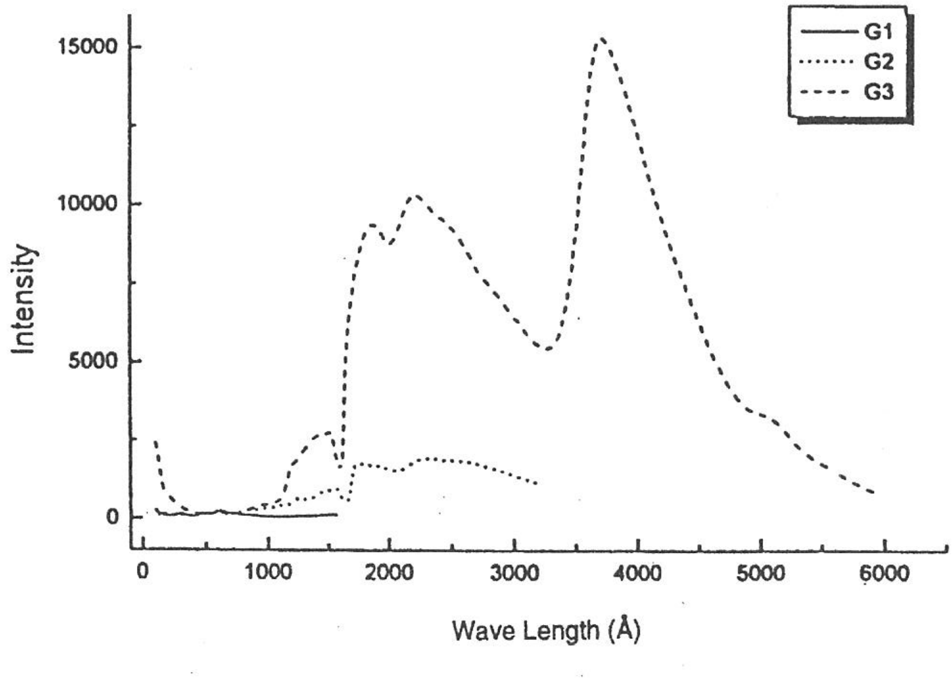
| | |
|---|---|
| Monochromator | : double crystal monochromator ($\theta_B$=70-20°) |
| Monochromator crystals (2d value, energy range) | : β-alumina (22.53Å, 585-1609eV), beryl (15.965Å, 826-2271eV), quartz (8.512Å, 1550-4000eV), InSb (7.481Å, 1764-4000eV), Si (6.271Å, 2104-4000eV) |
| Resolution | : E/ΔE=1500 for beryl and InSb |
| Experiment | : photoelectron-photoabsorption spectroscopy for solid |

# *BL1B*

## Seya-Namioka Monochromator for General Purpose in VUV Region

The beam line 1B has been used for many experiments such as absorption, reflectivity, photo-ionization, and luminescence in condensed phase. The system consists of a pre-mirror, a 1-m Seya-Namioka type monochromator, and a post-mirror. Three gratings with 600, 1200, and 2400 gr/mm can cover the wavelength range from 40 nm to 650 nm, and two post mirror make it possible to change the focus point. A long-focus mirror is usually used with a LiF window to separate a main chamber for spectroscopy in liquids and biospecimens, while a short-focus mirror is suited to solid-state spectroscopy. The output flux from this monochromator is about $10^{10}$ phs/s around 200 nm with 0.1 mm slits. The spectral distributions obtained with three gratings are shown in the figure, although they are not the best data because of the contamination of the mirrors and gratings due to the recent careless accident.

A second monochromator (Spex 270M) and a LN-cooled CCD detector (Princeton Inc.) are available for luminescence experiments, together with a liquid helium-flow type cryostat. A time-resolved system to observe luminescence and excitation spectra with three time-gates is also possible. The decay measurement is one of the highlights of this station. A couple of weeks are supplied for the decay measurements under single bunch operation. A TAC system is therefore one of the standard instruments at this beam line.



# *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 80-120 nm 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 fig. 1. No filter is used between 30 and 80 nm since the photon flux at λ<40 nm is very weak (see fig. 1). The gas filter and cell are placed in a main chamber which is evacuated by a 5000 *l*/s diffusion pump (Varian, Model VHS10). 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 life time can be measured.

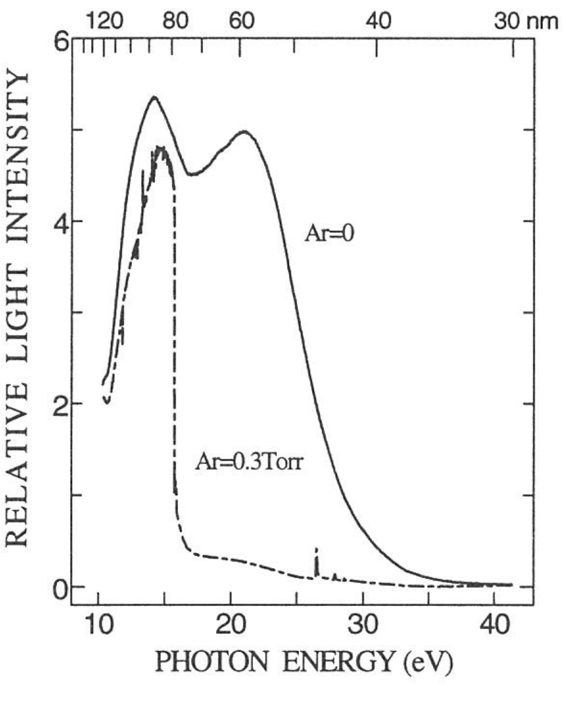



**Fig. 1. Transmitted $I_0$ intensity with and without an Ar gas filter.**

### Specification

| | |
|---|---|
| Monochromator : | 1-m Seya |
| Wavelength range : | 30-400 nm |
| Resolution : | $\Delta E/E \cong 10^{-3}$ at 100 nm |
| Grating : | 1200 *l*/mm blazed at 96 nm |
| 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 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. A 2400 l/mm grating has been installed since April 1994, and was replaced by a 1800 l/mm grating at March 1997. 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 by the use of the 1800/mm grating. 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 $1\times10^{-10}$ Torr. A double-pass CMA, 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 the 'in-situ' measurements. 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 treatments (e.g. cleaving, filing, and deposition) can be made.

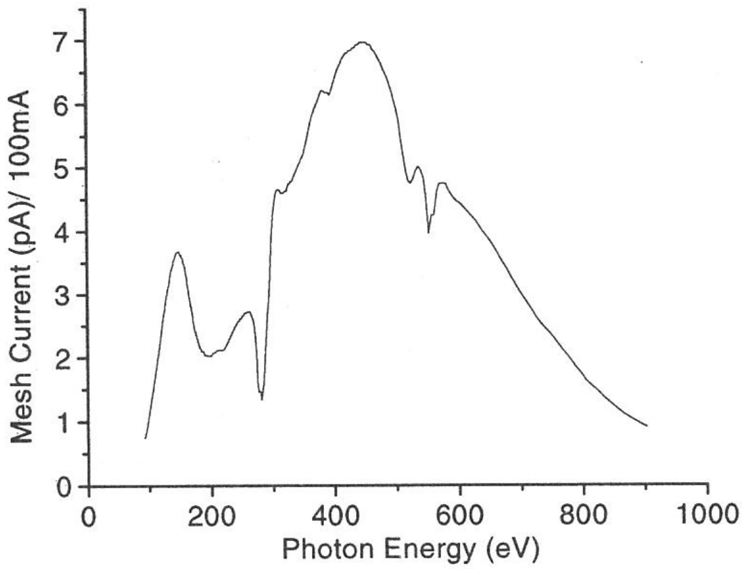



*Figure 1. Photoelectron yield measured by the use of the Au mesh*

**Specification**

| | |
|---|---|
| Monochromator | :2m grasshopper type |
| Energy range | :95-1000 eV ( 1800 l/mm) |
| Resolution of photon | :<0.4eV at 300eV (1800 l/mm) |
| Resolution of photoelectron | :<0.3eV (hv=150eV) |

Experiment : Photoelectron spectroscopy, X-ray absorption spectroscopy,

# *BL3A1*

## Irradiation Port with Undulator Radiation

The beam line 3A1 has been used for various kinds of experiments need intense undulator radiation. In recent years, photo-desorption, photo-chemical reaction, SR-CVD, photo-etching, irradiation damage effects in condensed phase, light amplification induced by core-level excitation, and so on have been carried out at this beam line. The luminescence from High-Tc superconductors and fullerens, the fluorescence yield of which is not high enough at beam lines for bending radiation, has been observed. A combination experiment with undulator radiation and a diode laser has been successfully conducted for time-response measurement of SR-induced desoprtion.

A planar-type undulator installed in a long straight section of the UVSOR storage ring provides an intense quasi-monochromatic radiation to beam lines 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 52 eV can be covered by the fundamentals with a K-value from 0.62 to 3.6, although higher harmonics are mixed into the spectral distribution in case of high K-values.

The beam line 3A1 has no monochromator between the undulator and a sample chamber. The radiation is introduced by a toroidal focusing mirror into sample chamber through a pinhole of 1 mm in diameter and metallic filter (Al, Sn, and In). A gold mesh is always installed in the sample chamber to monitor the incident photons. A typical spectrum distribution measured by the monochromator at BL 3A2 is shown in the figure, where the undulator gap is 60 mm and the photon flux is estimated to be about $10^{14}$-$10^{15}$ phs/s on the samples.

A differential pumping system can be provided for the users who want to use gaseous materials. A second monochromator (Jobin-Yvon HR-320), another VUV monochromator ( home-made one of normal-incident type), and a helium storage-type cryostat are available for luminescence experiments. A TAC system is also one of the standard instruments of this beam line. For liquid- or gaseous-phase experiments, $MgF_2$ windows can be installed to separate the sample chamber from the beam line.

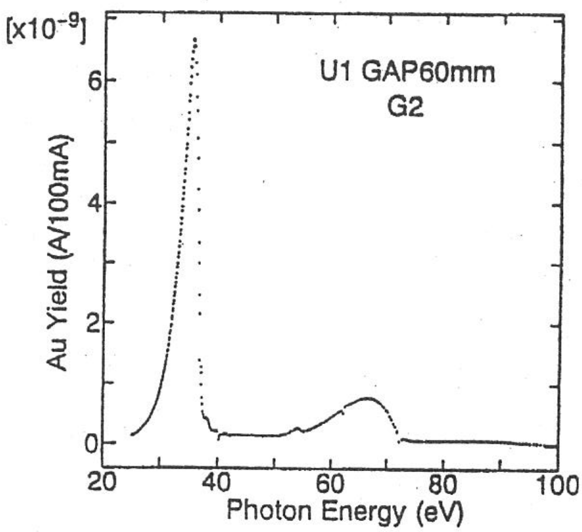
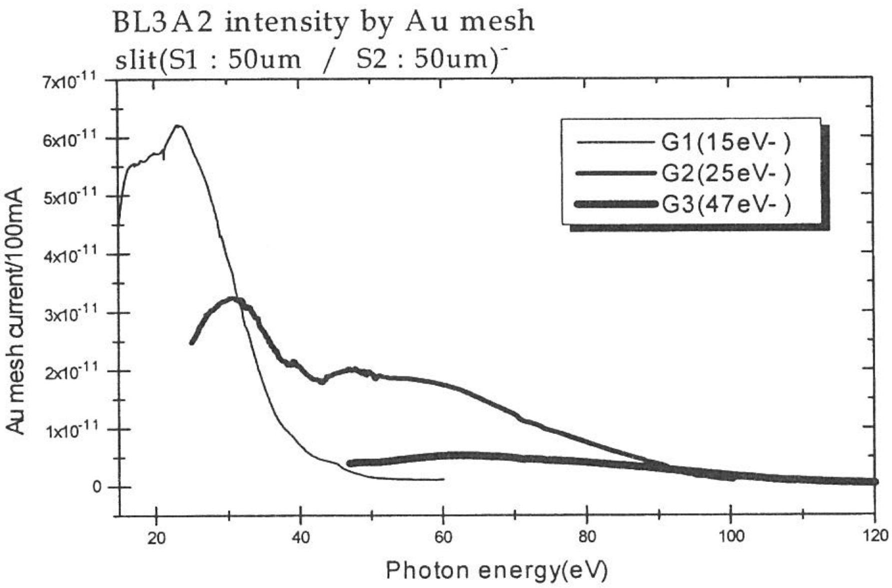



Fig. 2 Typical spectrum of undulator

# *BL3A2*

## Gas-Phase Dissociative Photoionization Apparatus

This machine has been constructed to study the formation of multiply-charged ions and their dissociation processes. The monochromator is constant-deviation grazing-incidence type with 2.2m focal length and covers wide wavelength region(10-100nm) where many kinds of molecules and multiply-charged ions are effectively measured. 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 (TOFM) equipped with automatic data acquisition system for photoion-photoion coincidence measurements. For full understanding of dissociative multiple photoionization, we detect 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.




**Specifications**

| | | |
|---|---|---|
| monochromator | : | 2.2m Constant-Deviation Grazing-incidence |
| Spectral range | : | 10 - 100nm (15eV - 120eV) |
| Resolution | : | 550 - 800 (0.03eV - 0.18eV) |
| Mass spectrometer | : | 300 |
| Length of the drift tube | : | 0.2 - 1m |
| Rotatable angle | : | 0 - 90° with respect to the photon beam |

# 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 (*e.g.* Fig. 1), contains rich information on photoionization dynamics and properties of superexcited states. A great variety of interesting high-lying states involved in autoionization have been studied as follows: (1) a bound valence state of nitric oxide whose autoionization gives rise to a number of irregularly spaced peaks in its photoionization efficiency curve,[1] (2) the $(3\sigma_g)^{-1}(3\sigma_u)^1$ valence state of acetylene which dominates photoionization cross section and leads to strong vibrational excitation,[2] (3) Rydberg states of nitric oxide which undergo dissociation into N** + O($^1D^e$, $^3P^e$) followed by autoionizing transitions of the superexcited nitrogen atoms,[3] and (4) multiple-electron-excited Rydberg states of carbonyl sulfide which are primarily produced by conversion from the Rydberg states converging to $OCS^+(B^2\Sigma^+)$ and subsequently dissociate into S** + $CO(X^1\Sigma^+)$ giving rise to autoionizing transitions of the superexcited sulfur atoms.[4]


1) K. Mitsuke *et al.*, *J. Electron Spectrosc. Rel. Phenom.* **79**, 395 (1996).
2) H. Hattori and K. Mitsuke, *ibid.* **80**, 1 (1996); H. Hattori *et al.*, *J. Chem. Phys.* **106**, 4902 (1997).
3) Y. Hikosaka *et al.*, *ibid.* **105**, 6367 (1996).
4) Y. Hikosaka *et al.*, *ibid.* **107**, 2950 (1997).

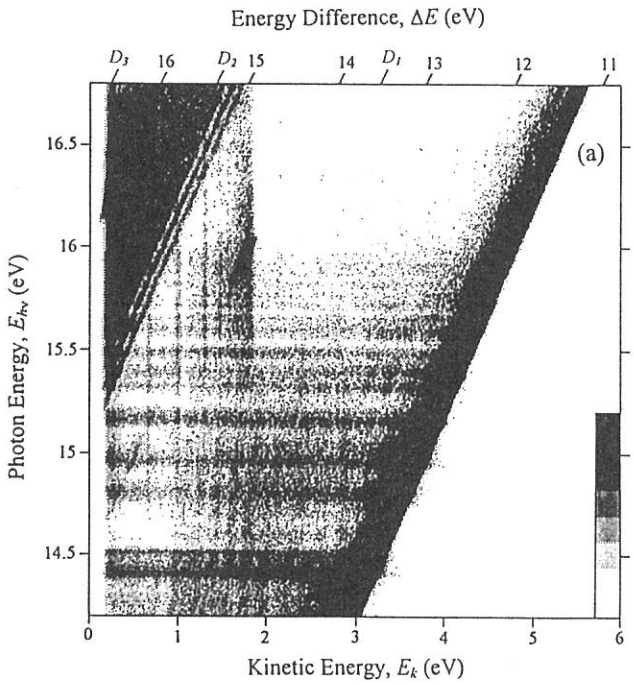




**Figure 1.** Two-dimensional photoelectron spectrum of OCS taken at the photon energy range from 14.2 to 16.8eV. The electron yield is presented by the plots with eight tones from light to dark on a linear scale.[4]

### Specification

Monochromator : 3 m normal incidence
Wavelength range : 30 - 200 nm
Resolution : 0.007 nm at 100 nm

# *BL4A*

## Multi-Layered Mirror Monochromator Beam Line for Synchrotron Radiation Stimulated Processing Study

This beam line is now under construction. Synchrotron radiation stimulated reaction has been studied actively during the last decade. The excitation energy dependence of the reaction, however, is a difficult data to obtain, due to that it requires a large number of monochromatised photons which is not supplied by the conventional monochromator beam lines. This beam line is designed to supply $10^{13}$ to $10^{14}$ monochromatised tunable photons/s with 3–5 % resolutions, by using a double crystal type multi-layered mirror monochromator. The multi-layered mirrors now considered are Mo/Si for 50–90 eV and Mo/C or Mo/$B_4C$ for 90–150 eV ranges. The calculated reflectivities for a Mo/Si mirror is shown in Fig. 1. The background photons of the lower energy region can be removed by a metal thin film filter.The beam spot size at the focussed point (sample surface in the reaction chamber) is about 2x3 $mm^2$. For the energy range of 200–500 eV which is covered by this beam line, however, the reflectivity of the multi-layered mirror is generally low, and development of the high efficiency mirror is required.

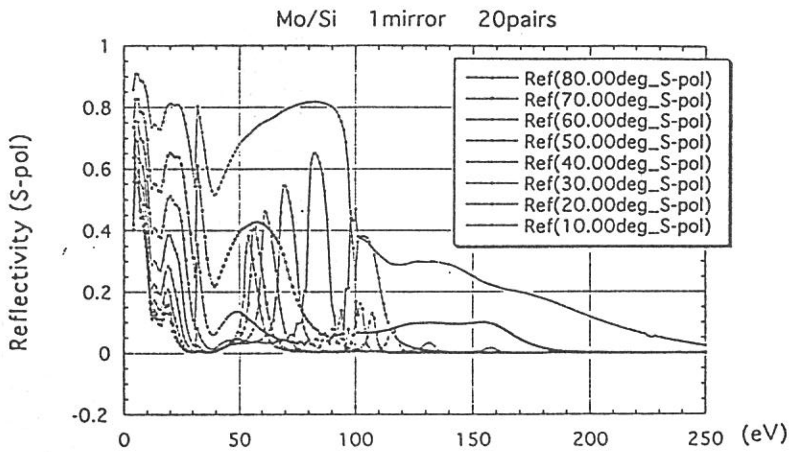



Fig. 1 Calculated reflectivities of the Mo/C multi-layered mirror.

### Specifications

| | |
|---|---|
| Monochromator | :Multi-layered mirror monochromator |
| Wavelength range | :50–150 eV |
| Resolution | :3–5 % |
| Experiments | :Excitation energy dependence of the SR processing |

# *BL4B*

## Synchrotron Radiation Stimulated Processing Beam Line

Several kinds of synchrotron radiation stimulated processing experiments can be conducted using this beam line. The reaction gases up to about 0.1 torr can be used by the differential vacuum pumping. Reaction apparatus shown in Fig. 1 is consisted of four ultra high vacuum chambers, which is used for etching and chemical vapor deposition (CVD) experiments, Si gas source molecular beam epitaxy (MBE) experiments, sample storage, and air-locked sample introduction. The infrared reflection absorption spectrum measurement system is equipped to the reaction chambers to monitor the surface reaction *in situ*. The SR stimulated chemical reaction of surface submonolayer hydrogen on Si(100) have been successfully monitored recently [1].

[1] A.Yoshigoe, K.Mase, Y Tsusaka, T.Urisu, Y.Kobayashi, and T.Ogino, Appl. Phys. Lett. 67 (1995) 2364.

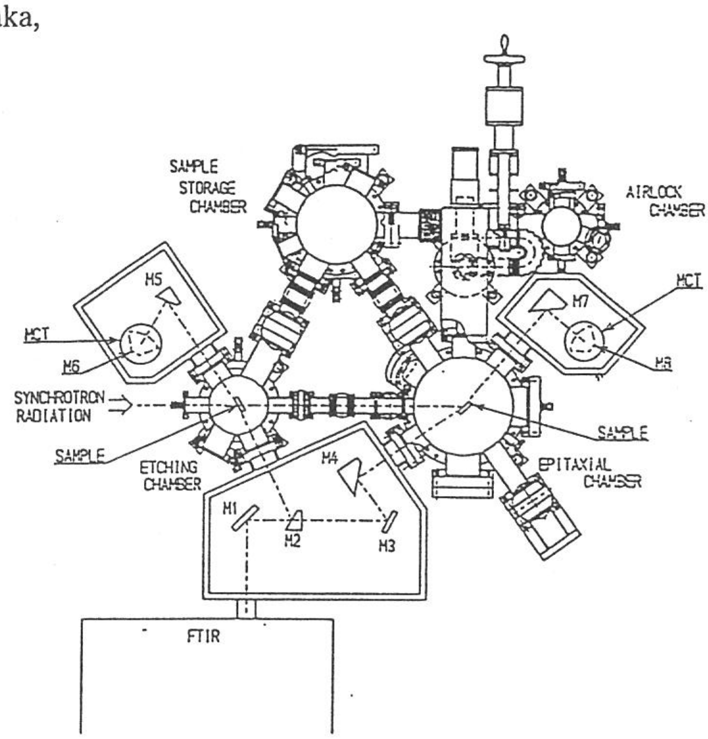



Figure 1. Reaction apparatus

### Specification

| | |
|---|---|
| Monochromater | : white beam reflected by bent-cylindrical mirror with grazing incidence angle of 2 degrees. |
| Wavelength range | : 1–100nm |
| Experiments | : SR–stimulated processing |

# BL 5A

## Photoelectron Spectrometer for Solids and Surfaces

The beamline 5A is designed for spin- and angle-resolved photoelectron experiments for solids and surfaces with the circularly polarized synchrotron radiation from a helical undulator and for high-resolution photoelectron experiments 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 linear and circular polarization, (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
(two glancing-incidence and one normal-incidence)
Energy Range: 5-250 eV
Resolution: 0.5-80 meV with slits of 0.01mm
Flux: $3\times10^{10}$ phs/sec at 120 eV with slits of 0.1 mm
(for bending manget radiation)

*2) Main Instruments*

Two-levels UHV chamber ($1\times10^{-10}$ Torr)
Hemi-spherical electron-energy analyzer
(OMICRON HR-125)
Spin- and Angle-resolved spectrometer
(low-energy diffused scattering type)
LEED of reverse type (OMICRON)
Ion-gun (ULVAC-Phi)
He-lamp for UPS
Low-temperature cryostat (>30 K)

*3)Helical Undulator (Optical Klystron)*

| | |
|---|---|
| Number of periods | 18 |
| Period length, □u | 110 mm |
| Length of dispersive part | 302.5 mm |
| Total length | 2351.2 mm |
| Deflection parameter, Kx,y | 0.07-4.6 (helical mode) |
| Deflection parameter, K | 0.15-8.5 (planar mode) |
| Fundamentals | 2-45 eV (Circular polarization) |

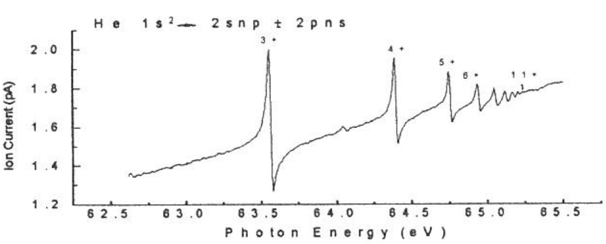



Fig. 1 He ionization spectrum

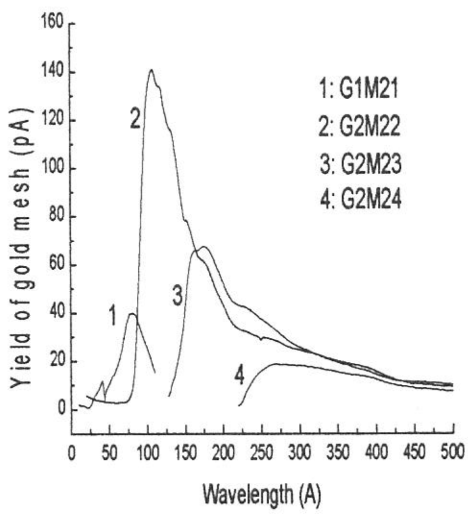



Fig. 2 Typical spectral distribution

*Refs: M. Kamada et al., Rev. Sci. Instrum. 66, 1537 (1995), N. Takahashi et al., Jpn. J. Appl. Phys. 35, 6314 (1996).*

# BL5B

## Calibration Apparatus of Optical Elements

BL5B has been constructed to calibrate optical elements. The beam line consists of a plane grating monochromator (PGM) and three chambers (Fig. 1). The chamber A is used for calibration of optical elements, the camber B for optical measurements of solids and the chamber C for photo-stimulated desorption (PSD) experiments. The chamber C is sometimes changed to a chamber for photoemission microscopy.

The calibration chamber is equipped with a goniometer. The goniometer, which was installed for the characterization of optical components, has six degrees for freedom; 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 (s- or p-polarization).

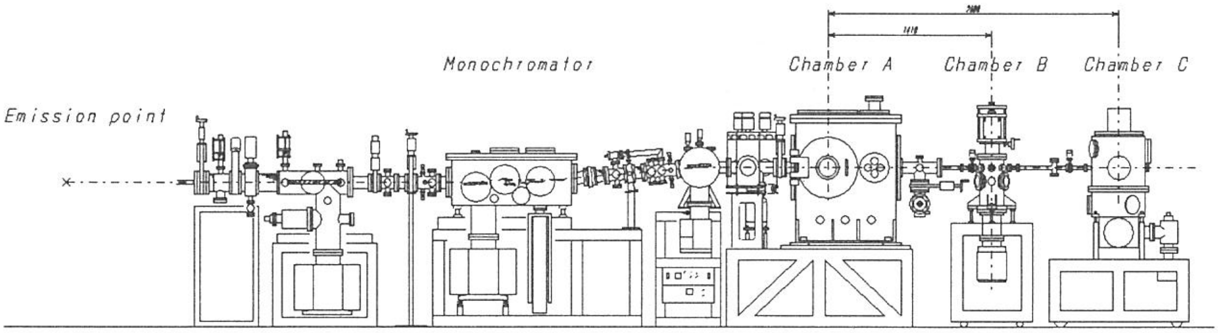



**Figure 1.** Schematic figure of BL5B spectrometer system.

**Specification**

Monochromator: Plane grating

Wavelength range: 2 - 200 nm (Fig. 2)

Resolution: $\lambda / \Delta\lambda = 300 \sim 500$

Experiments: Calibration of optical elements, absorption of solids, photo-stimulated desorption from rare gase solids, photoelectron microscopy.

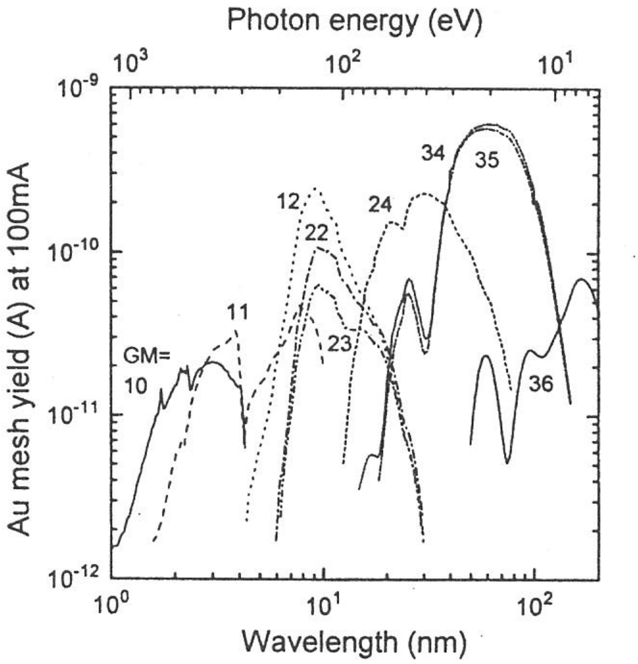



**Figure 2.** Throughput spectra of BL5B detected by a gold mesh (84% transmission).

# *BL6A1*

## Fourier-Transform Middle- and Far-Infrared spectrometers for Solids

UVSOR covers very wide energy range from soft x-ray to millimeter wave. BL6A1 was constructed in order to cover a long wavelength part in the spectral distribution of UVSOR from near-infrared to millimeter wave. Beam line is composed of two kinds of interferometers, a Martin-Puplett type (SPECAC) and a rapid-scan type (Bruker).

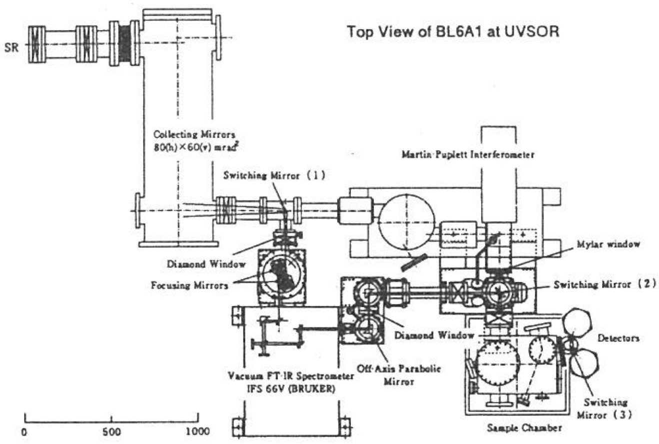



Figure 1. Top view of BL6A1.

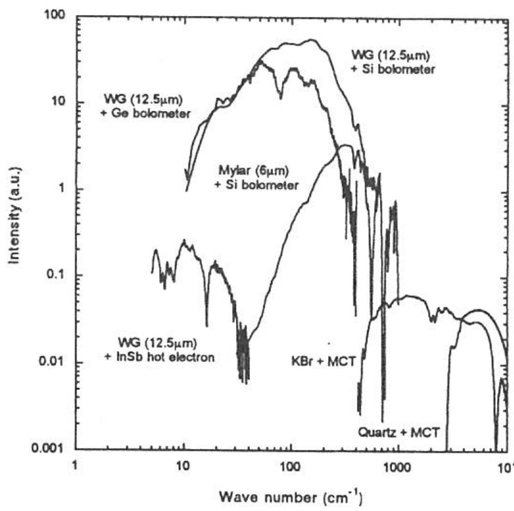



**Figure 2.** Throughput spectra of BL6A1.

**Specification**

Monochromator: Martin-Puplett type and rapid-scan type interferometers

Detectors: Si bolometer (20 - 1000 $cm^{-1}$)

Ge bolometer (with polyethylene window, 30 - 300 $cm^{-1}$)

Ge bolometer (with quartz window,10 - 200 $cm^{-1}$)

InSb hotelectron bolometer (2 set, 5 - 50 $cm^{-1}$)

MCT (400 - 10000 $cm^{-1}$)

Photovoltaic type MCT (400 - 4000 $cm^{-1}$, time response: 10 nsec)

Wavelength range: 0.5 mm - 33 μm (5 - 300 $cm^{-1}$) by Martin-Puplett interferometer

20 - 1 μm (50 - 10000 $cm^{-1}$) by rapid-scan interferometer

Resolution: $\lambda / \Delta\lambda$ = 500 - 20000

Experiments: Temperature dependence of reflectivity and transmission spectra, absorption under high pressure (up to 20 GPa), reflectivity under magnetic field (up to 8 T), time-resolved spectroscopy.

# *BL6A2*

## Photoelectron Spectrometer for Solids and Surfaces

A Plane Grating Monochromator (PGM) consists of pre-mirrors, a plane grating, focusing mirror, and a post-mirror, with an exit slit only. It covers the wide spectral range from 2 to 130 eV with exchanging two gratings and 5 focusing mirrors. A typical spectral distribution is shown in the figure, where the numbering indicates the combination of the grating and the mirror. 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. The overall resolution of the integrated type analyzer is about 0.3 eV, while the angle-resolved hemispherical analyzer has a resolving power of 100 with an angular resolution of 1.1° in two axes. The optical system including an ICCD detector can be installed. The standard instruments for surface analysis such as Auger, LEED, Ion gun, and gas doser are installed in the analyzing chamber, the base pressure of which is $1.2 \times 10^{-10}$ Torr. The samples are transferred from an air-lock chamber to the analyzing chamber through a preparation chamber.

**Specifications**

1) Monochromator

Type: Plane Grating Monochromator (no entrance slit)

Range: 2-130 eV

Resolution: 0.015-0.3 eV  with slit of 0.3 mm

Flux: $10^{11}$ phs/s/100 mA at 90 eV with 0.1mm slit

2) Main Instruments

Angle-integrated Cylindrical Analyzer

(home made, ΔE=0.3 eV)

Angle-Resolved Hemi-Spherical Analyzer

(home made, E/ΔE=100  Δθ=1.1°  Two-axes)

Second Monochromator (Jobin-Yvon HR-320)

ICCD (Princeton Instrum.)

Preparation Chamber

Air-lock chamber for quick insertion

LEED of Reverse type (OMICRON)

Ion-gun of Differential type (ULVAC-Phi)

Auger (ULVAC-Phi)

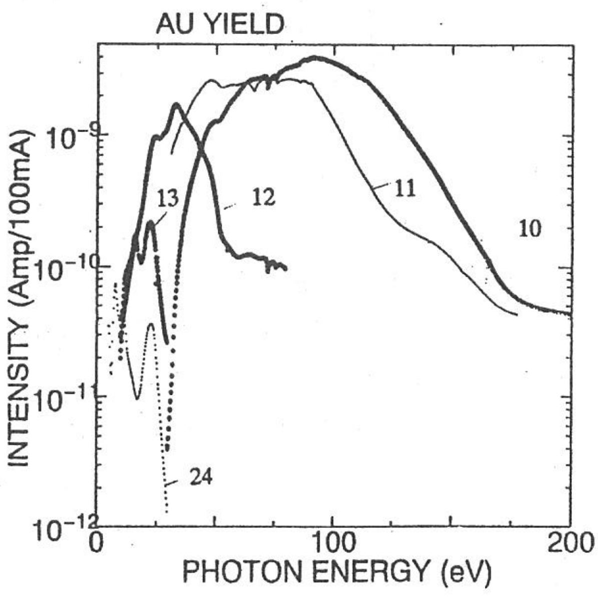



Fig. 1 Typical spectral distribution

# *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 ($1\times10^{-9}$ 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.

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 $T_c$.

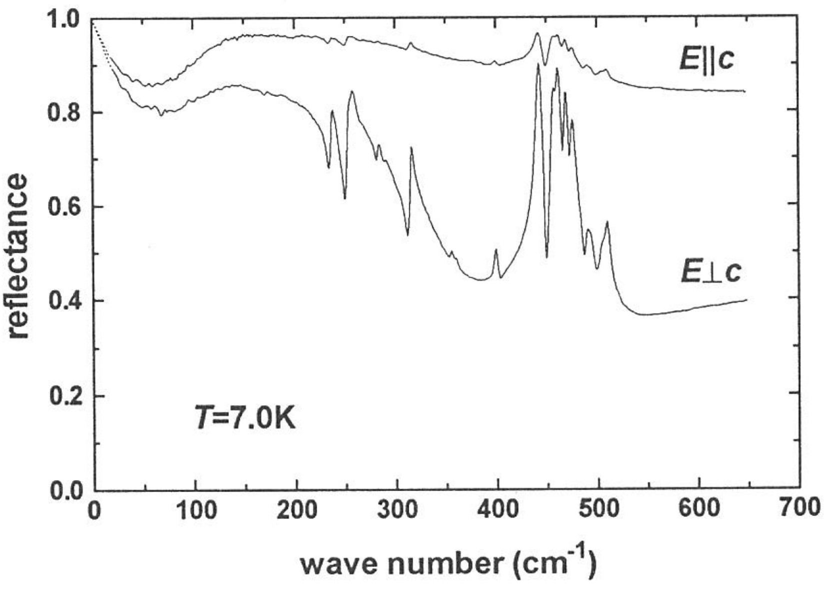



Figure 1. Polarized reflectance of β"-$(BEDT\text{-}TTF)_2AuBr_2$ measured at 7.0 K.

**Specification**

| | |
|---|---|
| Interferometer | : Michelson type |
| Spectral range | : 6 - 10,000 $cm^{-1}$ |
| Resolution | : better than 0.1 $cm^{-1}$ |
| Experiment | : reflectance and transmittance of solid state |

# BL7A

## Soft X-ray Spectrometer for Solids

The beam line BL7A equipped with a double crystal monochromator (DXM) was constructed for the spectroscopic research of solids in the soft X-ray region, where both the bending magnet and the 4T wiggler radiations are provided. The schematic drawings of the beam line and scanning mechanism of the double crystal monochromator are shown in Figure 1. When we use the relatively lower photon energy light (less than 1.7keV), we use the bending magnet line whereas the wiggler line is used for higher energy experiments. Recently, we have succeeded to measure soft X-ray spectra by using YB66 monochromator crystal, which is known to be one of the best monochromator crystals covering soft X-ray region from 1.1 to 2keV with higher performance. Further improvements of the beam line, for example, installation of the focusing mirror system and the new software etc., are in progress.

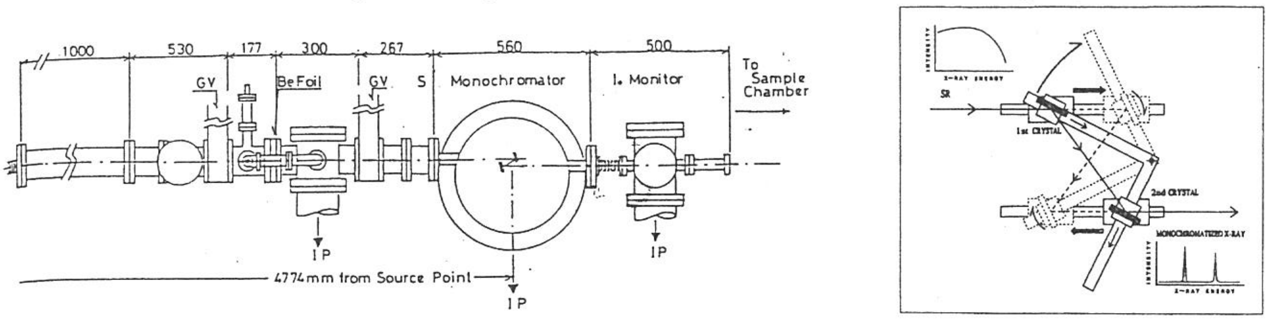



Figure 1. The schematic drawings of the beam line and scanning mechanism of the double crystal monochromator at the BL7A.

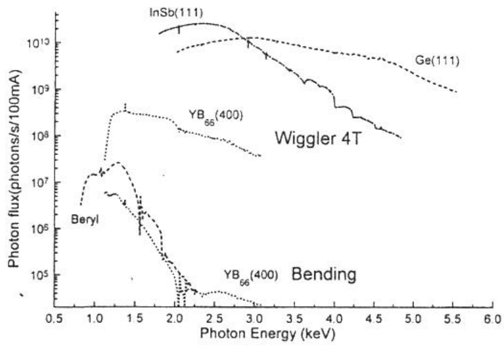



Figure 2. Throughput from the double crystal monochromator with typical monochromator crystal.

### Specification

Monochromator : Double Crystal Monochromator

Monochromator crystals and covered photon energy:

$\beta$-$Al_2O_3$ (0.58-1.74keV), Beryl (0.82-2.27keV), YB66(400) (1.12-3.08keV), Quartz-Y(1010) (1.53-4.26keV), InSb(111) (1.74-4.85keV), Ge(111) (2.00-5.55keV).

Typical resolution : 0.46eV (Beryl Crystal, E=860eV)

Experiments : X-ray absorption spectroscopy (by photoelectron total yield and/or fluorescence)

# *BL7B*

## 3m Normal Incidence Monochromator for UV, VIS and IR Spectroscopy of Solids

The beamline BL7B is now under reconstruction. The 1m Seya-Namioka type monochromator is replaced to the 3m normal incidence monochromator (3m NIM; McPherson upgrade model of 2253) for the extended researches of the highest level with the higher resolution and intensity, the wider wave-length region available and so on. It will be also possible to utilize the linear and circular polarization inherent in synchrotron radiation (SR) and to realize some combined experimental systems, for example, with the synchronized laser to SR pulse or with the extended field. The outline of the new beamline is shown in Figure 1. The main parts of the system are a pre-mirror focusing system, a 3-m NIM and a post-mirror focusing system. The light from 50 to 1000 nm wavelength region is covered by changing three gratings *in situ*. Each spherical grating is original laminar type fabricated on $SiO_2$ and has effective grooved area of 120x40mm$^2$. The 2 focusing positions are available for the experiments. At the position between 2 positions, LiF or MgF2 window valve is installed. Therefore, the measurements for the organic materials, liquid and biochemical ones are possible at the 2nd focal position.

After the final adjustment and test run, this beamline will be used for absorption, reflection and fluorescence measurements on various materials with higher performance (high energy resolution, high intensity, well-polarized light, short repetitive pulse light) not only in the VUV region but also in the near UV, VIS and near IR region.

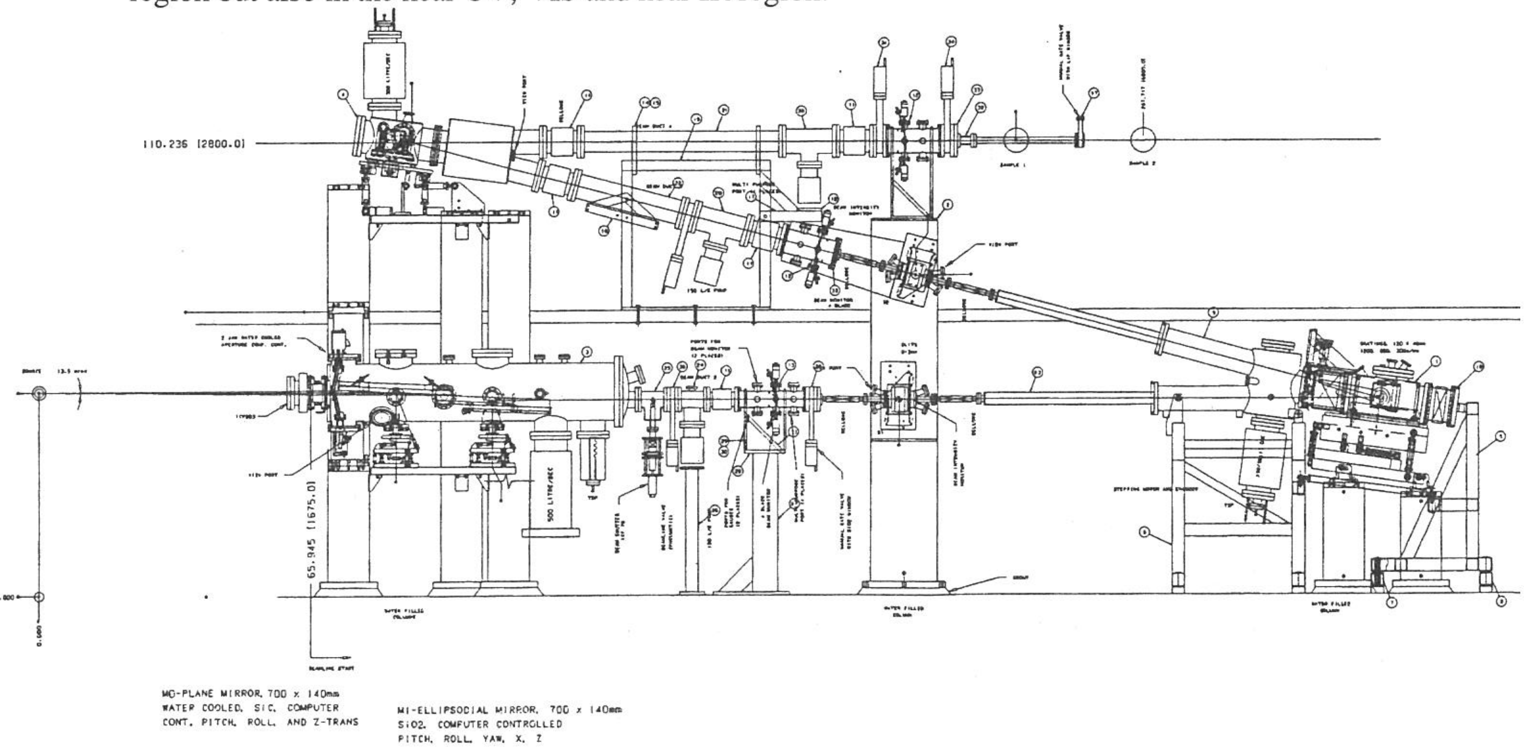



Figure 1. The outline of the side view of the new beamline BL7B.

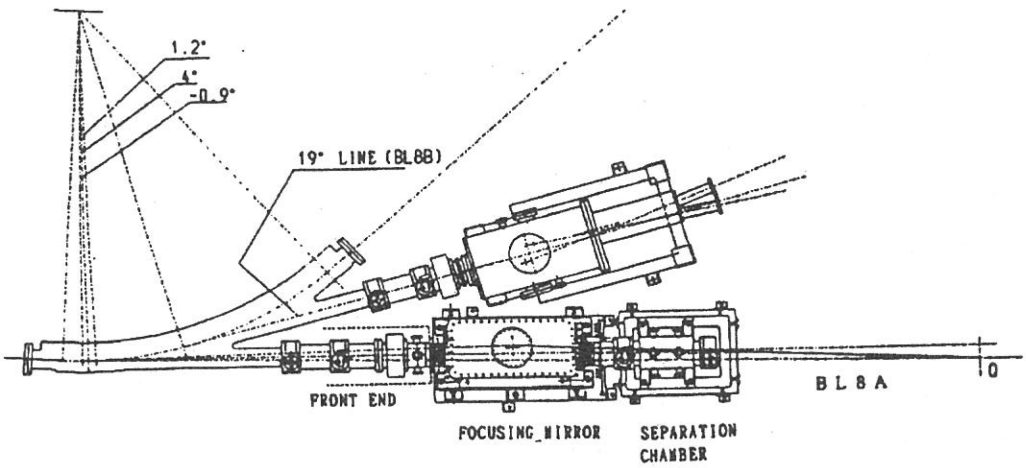
### Specification

| | |
|---|---|
| Monochromator | : 3m Normal Incidence Monochromator |
| Wavelength range | : 50nm-1000nm |
| Typical resolution | : $E/\Delta E$=4000-23000 for 0.01mm slit |
| Experiments | : Absorption, reflection, fluorescence spectroscopy mainly for solids |

# *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 unfocussed 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 differential pumping system, gas pressure at the reaction chamber upto 0.5 torr can be used while keeping ultra high vacuum at the premirror chamber.




|← 2500mm →|← 2807mm →|

UP VEW OF BL8A

**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 $\phi$ 3 mm aperture before sample)

Focused beam : 7.7 mrad (horizontal) × 8 mrad (vertical)
Beam spot size at focu : 3 mm (horizontal) × 2 mm (vertical)
Source - mirror distance : 2500 mm
Mirror - focus distance : 2807 mm

# *BL8B1*

## Photoabsorption and Photoionization Spectrometer

Last year a new beam line BL8B1 was constructed for observation of high resolution photoabsorption and photoionization experiments in the photon energy range from 30 to 800 eV, which includes the 1s core excitation energy of C, N and O atoms. For high resolution measurement among these energy, a constant-deviation constant-length spherical grating monochromator (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) has been employed, whose entrance and exit slit positions and directions of incident and exit photon beams do not change during its scan. Consequently, it provides us with an resolution (E/ΔE) of 4000 at 400 eV and of 3000 at 245 eV. A drain current of gold foil reveals the absolute photon flux normalized by an ring current when two slit widths are 10 μm (Fig. 1).

Being Equipped at the downstream of the mono - chrometer, an chamber with a time-of-flight ion detector and a photoelectron detector allows us to measure photoelectron - photoion coincidence (PEPICO) and photoion - photoion coincidence (PIPICO) spectra. Measurements of absorption, electron yield and emission spectra of solid samples are also available.

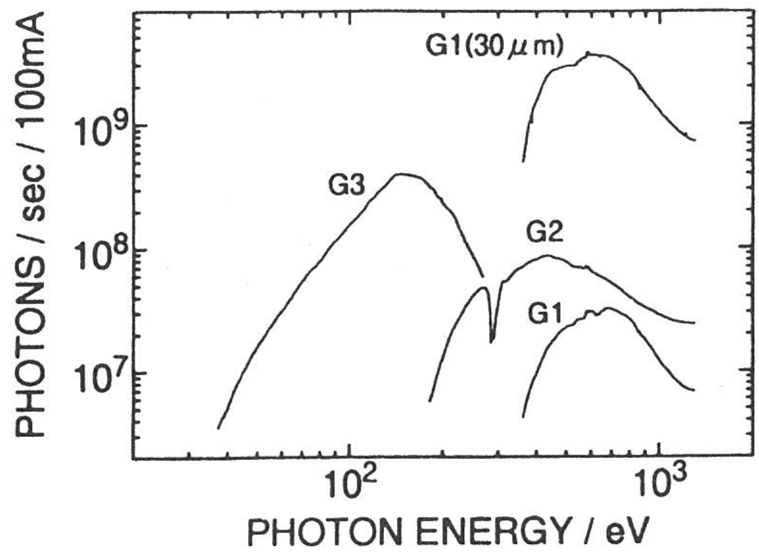



**Figure 1.** Absolute photon fluxes measured by a drain current of gold foil

**Specification**

| | |
|---|---|
| Monochrometer | : 2.2 m constant-deviation grazing incidence |
| Wavelength range | : 30 to 800 eV |
| Resolution | : E/ΔE = 4000 at 400 eV and 3000 at 245 eV |
| Available Experiments | : Measurement of photoabsorption and photoionization spectra for gas and solid sample |

# *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 solid such as molecular crystals, organic semiconductor, 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 manipulator for temperature dependence (base pressure $3\times10^{-10}$ Torr), a cleaning chamber (base pressure $2\times10^{-10}$ Torr), and a sample evaporation chamber (base pressure $3\times10^{-10}$ Torr). The cleaning chamber is equipped with back-view LEED/AUGER, $Ar^{+}$ gun and an infrared heating units. The PGM consists of pre-mirrors, a plane grating, focusing mirror, and a post-mirror, with an exit slit. It covers the wide range from 2 to 150 eV with exchanging two gratings (G1; 1200 l/mm, G2; 450 l/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 $1\times1\text{mm}^2$. The energy resolution at a slit width of 100 μm was found to be 0.004 - 0.3 eV in the wavelength range from 2 to 130 eV. A hemispherical electron energy analyzer of 25 mm mean radius with an angular resolution of 2° can be rotated around vertical and horizontal axes. The sample mounted on a manipulator can be also rotated around two axes.

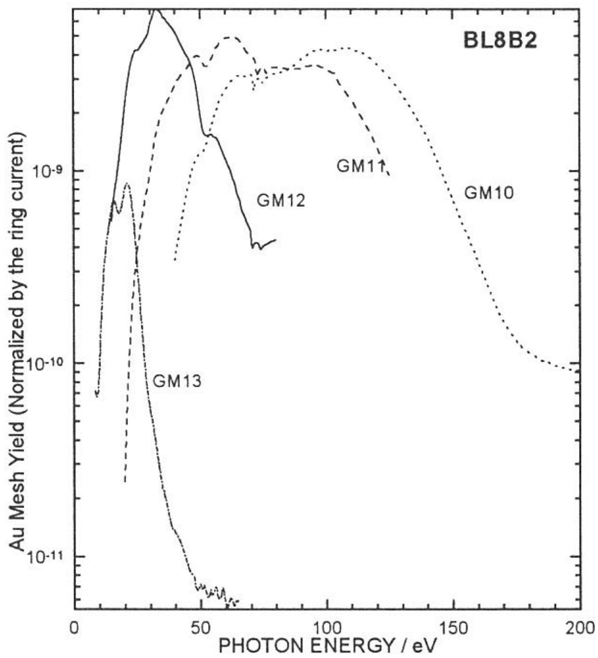



Figure Throughput spectra of plane-grating monochromator at BL8B2 with 100 μm exit slit.

### Specification

| | |
|---|---|
| Monochromator | : plane grating monochromator |
| Spectral range | : 2 - 130 eV |
| Resolution | : 0.25 eV at 40 eV, as determined by the Fermi edge of gold. |
| Experiment | : Ultraviolet Photoelectron Spectroscopy for various organic solids |
| Polarization | : 85~91 % at 5000 Å |

In-house beam lines

| | 3/31 | 4/6 | 14 | 21 | 28 | 5/5 | 12 | 19 | 26 | 6/2 | 9 | 16 | 23 | 30 | 7/7 | 14 | 21 | 28 | 8/4 | 11 | 18 | 25 | 9/1 | 8 | 15 | 22 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 A | | | Kosu | gi | | | | | | | | | | | | | | | | | | | | | | | |
| 2 A | | | | | | | | | | | | | | | | | | Kand a | | | | | Hikit | a | Taba | yashi | |
| 2B2 | | | Yosh ida | Mizu tani | Niik ura | Mits uke | | | | | | | | | | | | | | | | | | | | | |
| 3 B | | | Hatto ri | Hiko saka | Mits uke | | | | | | | | | | | | | | | | | | | | | | |
| 4 A | | | Urisu | Meka | ru | | | | | | | | | | | | | | | | | | | | | | |
| 4 B | | | Urisu | Irfan | | | | | | | | | | | | | Yosh | igoe | | | Yosh | igoe | Hira | mats | u | | |
| 6A2 | | | main | tenan | ce | | Mizu | tani | | Itoh | | | | | Taka | gi | | | | | Fuzi wara | Terek in | | | | | |
| 6 B | | | | | | Tahar | a | | | Kaya | ma | | | | | Tahar | a | | | | Kaya | ma | Tahar | a | | | |
| 8B2 | | | Ueno | | | | Aki moto | Hino | | Ueno | | Ishii | | | Aki moto | Ueno | | Ishii | | | Ishii | Ueno | | Ishii | Uen | o | |
| Machi -ne | *shut* | *down* | | | *single* | | | | | | | *single* | *main tenan ce* | *machi-ne study* | | | | | *shut* | *down* | | | | | | | *shut down* |

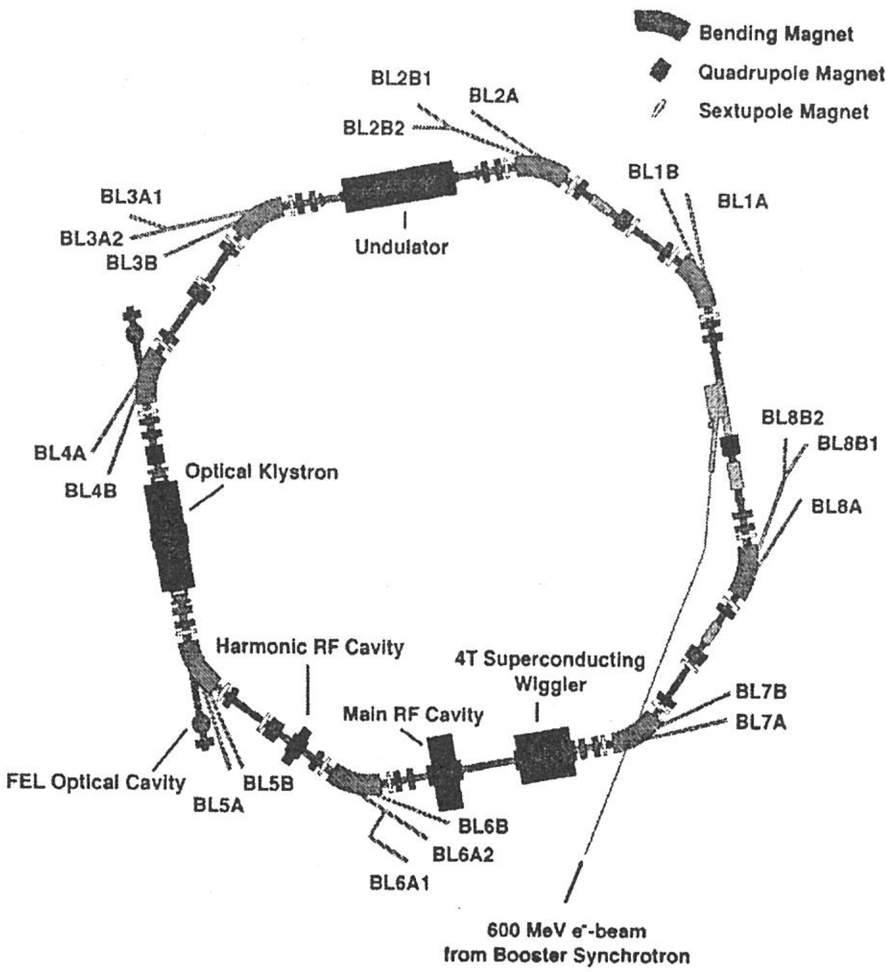
| | 10/6 | 13 | 20 | 27 | 11/3 | 10 | 17 | 24 | 12/1 | 8 | 15 | 22 | 29 | 1/5 | 12 | 19 | 26 | 2/2 | 9 | 16 | 23 | 3/2 | 9 | 16 | 23 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 A | | Kosu | gi | | | | | | | | | | | | | | | | | | | | | | | |
| 2 A | | | | | | | | | | | | | | | | | | | | | | Kand a | Taba yashi | | | |
| 2B2 | | Mizu Niiku Mits | tani ra uke | | | | | | | | | | | | | | | | | | | | | | | |
| 3 B | | Hatto Hiko Mits | ri saka uke | | Yosh | ida | | | Hatto Hiko Mits | ri saka uke | | | | | | | | | | | | | | | | |
| 4 A | | Meka Miya Urisu | ru mae | | | | | | | | | | | | | | | | | | | | | | | |
| 4 B | | Hira Urisu | matsu | | | | | | | | | | | | Hira mats u | | Urisu | | Noda | | Urisu | | | | | |
| 6A2 | | Itoh | | | Mizu tani | | | | Fuzi wara | | | Itoh | | | Fuzi wara | | | | Fuzi wara | | maint | enanc | e | | | |
| 6 B | | Tahar a | Kaya ma | | | | | | | | | | | | | | | | | | | | | | | |
| 8B2 | | Ueno | | | Aoki | | Seki | | Akim oto | Miya zaki | Aoki | Haseg awa | | | Akim oto | Hase gawa | Hino | | Seki | Ueno | | Miya zaki | Aoki | | | |
| Machine | *shut down* | | | *machi ne study* | | | | | | | | *single* | *shut* | *down* | | | | | | | | | | *shut* | *down* | |

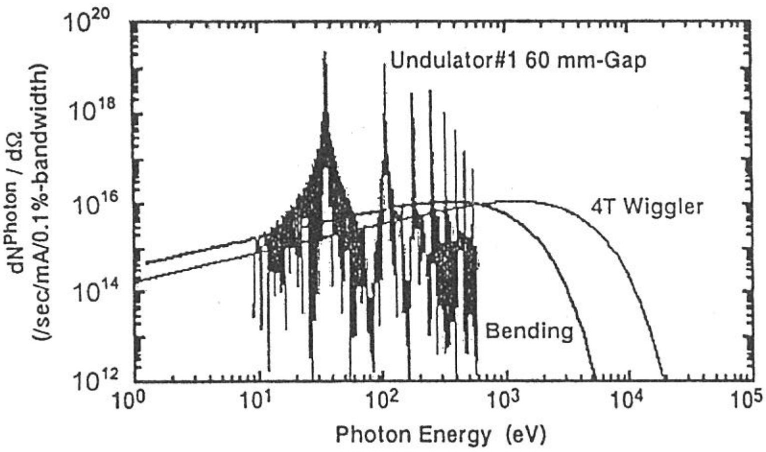
Open beam lines

| | 3/31 | 4/6 | 14 | 21 | 28 | 5/5 | 12 | 19 | 26 | 6/2 | 9 | 16 | 23 | 30 | 7/7 | 14 | 21 | 28 | 8/4 | 11 | 18 | 25 | 9/1 | 8 | 15 | 22 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 B | | | main tenance | Ashi | da | Fuji | ta | Arim | oto | Tanig | uchi | | | | K.Na | kaga wa | Y.Oh | ki | | | Kim | ura | Ohni shi | Kawa i | Kuro sawa | Ejiri | |
| 2B1 | | | main | tenance | Tana | ka | | Sekit ani | Mase | | Y.Oh uchi | | | | Naga | oka | Naga sono | Sekit ani | | | Edam | oto | | Fuku | da | Takah ashi | |
| 3A1 | | | Tere | khin | | Mits | uke | | | | | Haya shi | | | Haya | shi | | main tenance | | | | Yosh | ida | | | | |
| 3A2 | | | Mits | uke | | Mits | uke | | | | | Masu -oka | | | Masu | oka | Mits uke | main tenance | | | | | Gejo | Koya | no | | |
| 5 B | | | Kum agai | | Tune ta | Kum agai | Tune ta | Saku rai | Arak | awa | Eji ma | Tune ta | | | Eji ma | Kim ura | Kino | shita | | | Kino | shita | | Tune ta | M.Na | kamu ra | |
| 6A1 | | | Kim | ura | | Kimu | ra | Nanb | a | | Oka | mura | | | Soda | | Saru kura | Sou ta | H.Naka gawa | | Y.Naka mura | Ohta | | Awan | o | H.Nak agawa | |
| 7 A | | | Hase | gawa | | | | Sota ni | Hasega wa | Fuku i | Mura ta | | | | | Fuku i | Ucti | moto | | | H.Yo shida | Kita mura | Mats | ukaw a | | | |
| 7 B | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 A | | | Ishig | uro | | Ishig uro | Goto | | | Shob | atake | | | | Shob atake | Asak | a | H.Ito h | | | H.Ito h | Gejo | Oga | wa | | | |
| 8B1 | | | | | | | Yama moto | Gejo | | Ibuki | Hiray a | | | | Wata nabe | Gejo | | Yama moto | | | Nakai | Ibuki | | Wata nabe | | | |
| machine | *shut* | *down* | | | *single* | | | | | | | *single* | *Maintenance* | *machine study* | *wigg* | *ler* | | | *shut* | *down* | *wigg* | *ler* | | | | | *shut down* |

| | 10/6 | 13 | 20 | 27 | 11/3 | 10 | 17 | 24 | 12/1 | 8 | 15 | 22 | 29 | 1/5 | 12 | 19 | 26 | 2/2 | 9 | 16 | 23 | 3/2 | 9 | 16 | 23 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 B | | maint | enance | | Wata | nabe | Arim | oto | Kimu ra | Y.Oh | ki | | | | K.Ta | naka | Kuro sawa | Ogaw | a | Suga i | Ohno | Fuzit | a | | | |
| 2B1 | | Y.Oh uchi | Take moto | | Take moto | maint enance | S.Tan | aka | Naga oka | K.Na | kaga wa | | | | Kawa | i | Mats | ushi ma | | Mase | | Naga sono | Seki tani | | | |
| 3A1 | | Yosh | ida | | Yosh | ida | | Yoshi da | | | Kitau ra | | | | Mits | uke | | maint | enance | Mits | uke | | | | | |
| 3A2 | | maint | enance | | Koya | no | | | Gejo | Masu | oka | | | | Mits | uke | | Mits | uke | Mits | uke | | | | | |
| 5 A | | Kama | da | | Ichik | awa | | Tanak | a | Soda | | | | | | Soda | | Kama | da | | Tanak | a | | | | |
| 5 B | | Tune ta | M.Na kamura | | Urisu | Tune ta | Ouch i | Kum agai | Tune ta | Nibe | Haya shi | Tune ta | | | Kum agai | Araka | wa | Saku | rai | Kim ura | Kinos | hita | | | | |
| 6A1 | | Kimu ra | Nanb a | | Nanb | a | | Ohta | | Ikeza | wa | Kim ra | | | Kimu | ra | | | Oka | mura | Y.Nak amura | H.Na | kaga wa | | | |
| 7 A | | maint | enance | | H.Yo | shida | Kita mura | T.Yos hida | Hase gawa | Ume saki | | | | | Fuku | i | H.Yo shida | Yao | Sota ni | Mura ta | Waki ta | Ume saki | Kita mura | | | |
| 7 B | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 A | | Ogaw | a | | Ogaw | a | H.Ito | h | maint enance | Shob | atake | maint enance | | | Shob | atake | Ishig | uro | | | Goto | | | | | |
| 8B1 | | Uchi moto | | | Saito | Inoue | Hira ya | | Wata nabe | Yama moto | Ibuki | Imada | | | | Gejo | | Wata nabe | Yama moto | Kosu gi | Ibuki | | Kiha ra | | | |
| machine | *shut down* | | | *machine study* | | | | | | | | *single* | *shut* | *down* | | | | | | | | | | *shut* | *down* | |

## The UVSOR 750 MeV Storage Ring




On-Axis Photon Intensity with 750 MeV-Electrons