# WEBRAM (BL15XU)

## 1. Outline of WEBRAM

Research on advanced materials using synchrotron radiation was started by NIRIM (National Institute for Research in Inorganic Materials, Science and Technology Agency, Japan) as a research project called "research on ultra-precise materials analysis using third-generation light source" in the 1977 fiscal year. The contract beamline at SPring-8 is an important part of this project and was constructed to promote the project. This contract beamline was designed to provide wide use for advanced substance/materials and was installed in the 1998 fiscal year for a period of two years.

The formal name of the contract beamline is Wide Energy Range Beamline for Research in Advanced Materials (WEBRAM). The outline of the beamline is shown in Fig.1.

The concept of WEBRAM is "wide, bright and simple". Monochromatic photon flux ($\Delta\lambda/\lambda$~0.01%) on samples can be obtained from 0.5keV to 60keV at about $10^{13}$ photons/sec based on the concept of wide energy. The minimum photon energy 0.5keV is nearly equal to the K absorption edge of oxygen, and the maximum 60keV covers the K absorption edge of almost all the rare earth elements. This beamline is simple, and has no mirror system in the optical hutch, so that the degree of parallelization of the X-ray beam at the sample position is expected to be almost the same at the front end or in the area in the upstream. In addition, the extracted beam axis is kept constant. It is now possible to carry out the following tasks in substance / material research ; the analysis of atomic arrangement (10~20keV highly monochromatic photons for crystal structural analysis etc.) and the analysis of atom configuration and electronic structure (0.5~2keV for the photoelectron spectroscopy of valence electrons, 0.5~60keV for XPS, XAFS). This is very advantageous for experiments using special test equipment for analyzing material behavior under extreme conditions such as extra-high pressure.

The beamline has two instrumental features. One is the insertion device as a high-brightness monochromatic light source in the wide energy region. In WEBRAM, the out-of-vacuum revolver type undulator was installed (Fig. 2). This type of undulator has two sets of magnet columns and turret cylinders.

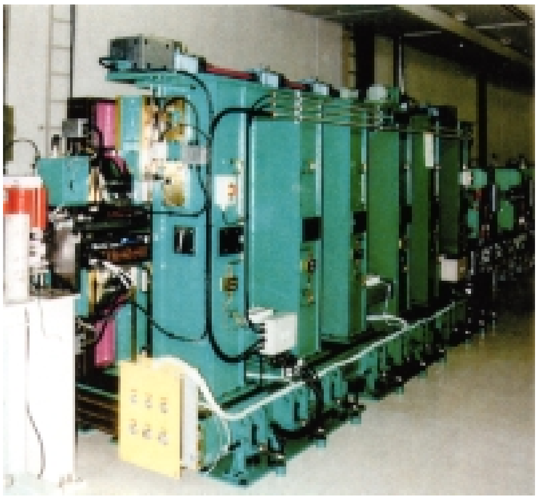

Fig. 2. Out of vacuum revolver type undulator.

The other important feature is the first stage monochromator system for WEBRAM, named "Thomas" and is similar in appearance to the illustration in Fig. 3. It is necessary to monochromatize the high-brightness light with a wide range of 1~60keV, to the level of $\Delta E/E$~$10^{-3}$ or less ($10^{-4}$ or less for structural analysis). Therefore, several crystal monochromators are used according to the energy region. Until now, only a grating monochromator could be used for the high brightness light in the 1~2keV region. In this region, $YB_{66}$(400) is adopted, which is a highly thermostable optical crystal originally developed by NIRIM. This represents the first attempt in the wold to use a crystal as the monochromator of a third-generation light source and involves monochromatization of the region over 1keV by modifying the rotating-inclined type monochromator, which is the SPring-8 standard for the wide energy band. The optical system for these two sets is combined in one enormous spectroscopic system of about seven tons gross weight and installed in the optical hutch. The W/$B_4$C multilayer mirror for the rough monochromatization of the 0.5~1keV photons uses the same mount as the monochrometer for $YB_{66}$. Confirming the performance after

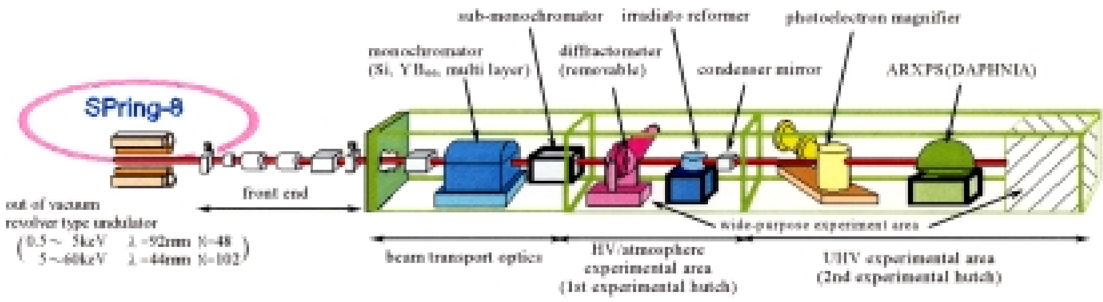


Fig. 1. Outline of WEBRAM.

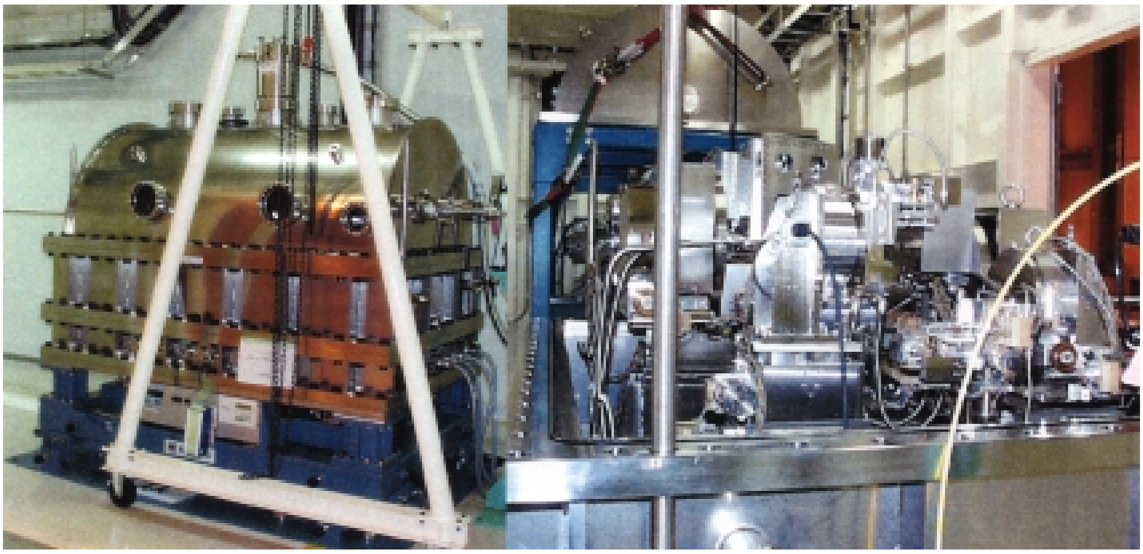

Fig. 3. First stage monochromator.

installation will required several years of R&D.

The support monochromator is used to obtain highly monochromatic light ($\Delta E/E \sim 10^{-3}$) at 0.5~1keV region. This is utilized in the ultra-high-vacuum experimental area and installed downstream in the farthest part of the optical hutch.

The experimental hutch is divided into two regions: the first hutch, a high-vacuum and atmospheric experimental area in the upstream part and the second hutch, an ultra-high-vacuum experimental area in the downstream part. High-precision powder X-ray diffraction equipment and other components are installed in the high-vacuum atmosphere experiment area in the upstream. The X-ray diffraction equipment dose not need to be fixed. It can be change for a simple pipe when the ultrahigh-vacuum experimental area is used. Therefore, this part also plays the role of a wide-purpose experimental area.

The chamber for X-ray irradiation experiments and the condenser mirror is installed for the high-resolution photoelectron microscope.

Angle-resolved photoelectron spectroscopy equipment, which is named "DAPHNIA" (Dual Angle-resolved Photoelectron Intelligent Analyzer), and high resolution photoelectron microscope are installed in the ultrahigh-vacuum experimental area. The equipment to be installed in the wide-purpose experimental area in the farthest part of the hutch will also be formally decided in this fiscal year.

## 2. Present Status of WEBRAM

*2.1 Construction of Beamline*

The undulator beam was confirmed at the screen monitor set up at the end of the beamline on march 22nd, 2000, thus completing the construction phase of WEBRAM (Fig. 4).

Installation of the undulator was finished at the end of August 1999. The first emission from both columns of the magnet was confirmed on December 2nd 1999 (Fig. 5), when it was also confirmed that the light beam was almost on the virtual light axis. During test operation, it was revealed that the revolver was able to move to change the position of the magnet column during the operation of the storage ring under full

Fig. 4. Hutch of WEBRAM.

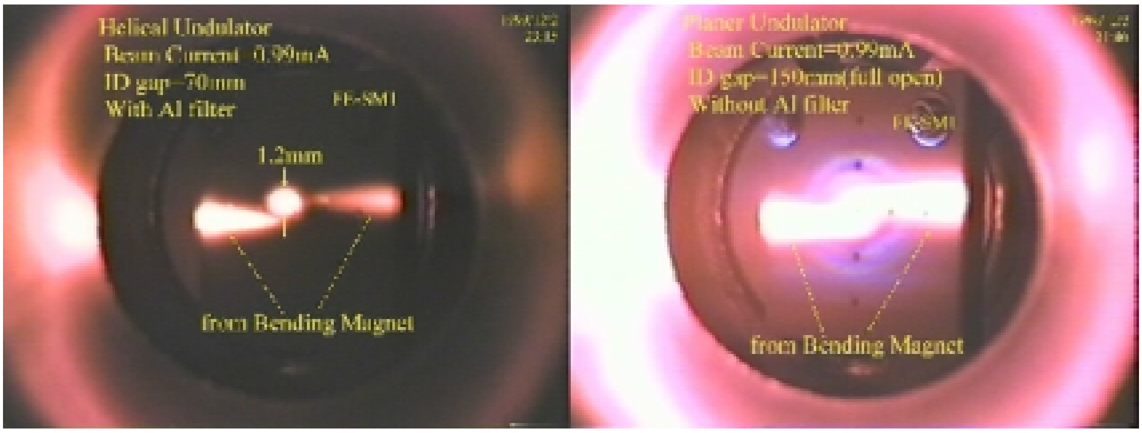


Fig. 5. The spot of the first beam from undulator. (left: helical right: plannar)

current conditions. The commissioning and adjustment of the two types of XBPM and the two front end slit systems were also carried out in parallel, and completed normally.

Installation of first stage monochromator was completed at the end of October 1999. The confirmation of the beam spot (about 11keV) at the beam monitor set up at just after the monochromator on March 7th, 2000.

On the other hand, due to some cooling water trouble concerned with the brake of the analyzing crystal for the first stage monochromator in some beamlines, we received a strong request from SPring-8 management to set up Be windows at the end of the front end part. If this Be window is inserted to the transport channel, WEBRAM cannot provide the beam with any soft X-ray energy region. So, a very thin (~25μm) Be window, which can be fitted or removed from the transport channel independent of vacuum operation, has been planned and designed. The setting up of this window, with the reconstruction of the vacuum and interlock system, will be completed by summer, 2000.

*2.2 Experimental Equipment*

Only the irradiate reformer was installed at the HV/atmosphere experimental area. The test operation of vacuum system and mechanics without light source had already been carried out. The other equipment was still being built at its respective manufactures.

Other off-line equipment, the FE-SEM, the RF magnetron sputtering system, the infrared ray furnace and the AFM, were installed and operated normally.

Sei FUKUSHIMA
Hideki YOSHIKAWA
Atsushi NISAWA (support engineer from Rigaku Denki Kogyo Co.)
(National Institute for Research in Inorganic Materials)

| Light Source | |
|---|---|
| type | out-of-vacuum revolver type undulator |
| Undulator period | 44mm (linear) |
| | 92mm (helical) |
| Number of periods | 102 (linear) |
| | 48 (helical) |
| Energy range | 5keV ~ 60keV (linear) |
| | 500eV ~ 5keV (helical) |
| Brilliance | $2.2\times10^{19}$ at 7.7keV (linear) |
| | $8.2\times10^{18}$ at 2.7keV (helical) |

| X-rays at sample | |
|---|---|
| Energy resolution | $\Delta E/E \sim 10^{-4}$ |
| Photon flux | > $10^{12}$ photons/sec |
| Beam size | > 0.01mm |

| Facilities in Experimental Station |
|---|
| High resolution X-ray photoelectron microscope |
| ARXPS (DAPHNIA) |
| Irradiate reformer |
| High-precision X-ray powder diffractometer |