Construction of a Vacuum Ultraviolet Spectroscopy Beamline

Masashi Yoshimura[1], Shin Imada[2], Kensei Terashima[2], Yuta Miyata[2], Hiroki Eto[2], and Toshiaki Ohta[3]

1) Research Organization of Science and Engineering, Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu 525-8577, Japan[2]

2) Department of Physics, Faculty of Science and Engineering, Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu 525-8577, Japan

3) The SR Center, Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu 525-8577, Japan

Vacuum Ultra Violet (VUV) lights from several eV to several ten eV are used to characterize electronic states of materials. Fabrication technique with VUV is interesting in photo-induced chemical reaction and lithography because VUV lights apply strong effect to chemical products and biological cells for example UV sterilization. VUV light cannot use without vacuum condition since materials constructing air absorbed the light. That light is created by laboratory light sources but that makes only single energy light, for example He light source makes only two energy He I (21.2eV) and He II (42.8 eV). Synchrotron radiation is powerful light source for VUV light because the SR light has high brightness and continual energy from infrared to x-ray. Soft x-ray and infrared spectroscopy beamline were already built in Ritsumeikan University SR center. We built a new beamline for VUV experiments. Therefore, SR center covers monochromatic lights from infrared to x-ray. In this note, we report the outline of the VUV beamline.

The VUV beamline adopts Seya-Namioka type optical system, consisting of a pre-focusing mirror, an entrance slit, three set of gratings, an exit slit, and post-focusing mirror (figure 1). The beamline was originally designed and constructed in KEK-PF (BL-7B) and has been used until June 2009 as a property of the University of Tokyo [1]. It was

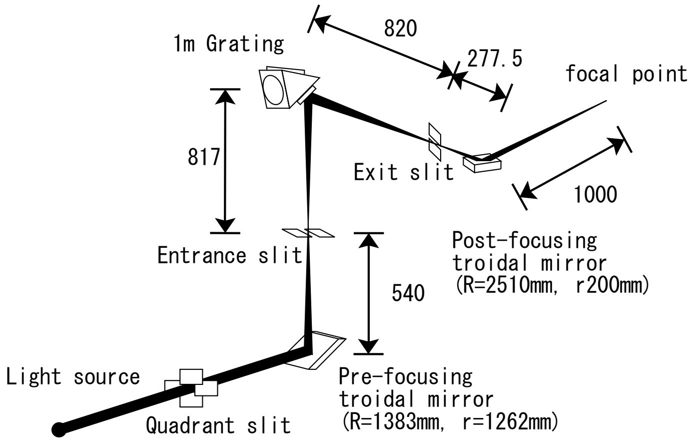

Figure 1. Outline of optical system in beam line 1. The beam line was constructed by Seya-Namioka monochrometor including two optical mirrors. The monochromatic light focuses at 5700 mm from SR light source.

generously donated to our SR center and we reconstructed the beamline so as to match in the small SR center by modifying the optical system. In the Photon Factory, it was installed at a mezzanine floor of beamline with the distance from the pre-focusing mirror to the entrance slit of monochromator, 2240 mm. However, in the SR center, there is no space to construct a mezzanine floor. The distance in SR center was designed 540 mm for constructing the new system at 1000 mm height from ground. Moreover, the focal point is 1000 mm after post-focusing mirror. We designed a new pre-focusing troidal mirror that fills above attribute. The monochrometor is composing by Seya-Namioka mount with blazed gratings. The grating holder can keep three gratings and change the active grating without braking vacuum condition. For the experiments using VUV light, the beamline prepare an experimental station for photoelectrons spectroscopy. Likewise, an experimental port for irradiation to a sample will be provided.

BL-1 makes monochromatic light that energy range is 5 ~ 50 eV by three gratings that have different blazed angle. Figure 2 shows photon flux that was measured by 1 cm^2 photodiode at focal point. Each gratings G1 (λ_b= 96 nm), G2 (λ_b = 160 nm), and G3 (λ_b = 38 nm) cover the energy range as 5 ~ 15 eV, 10 ~ 25 eV, and 15 ~ 50 eV, respectively. The photon flux is 1×10^{11} photon/seconds approximately. The beam size was measured by knife-edge method at focal point. Figure 3 shows the beam shape that measured with phosphorescent by irradiating the 22.5 eV light onto fluorescent-coated substrate. The beam size is 4 $mm^H \times 2\ mm^V$. This result is larger than designed size (2 $mm^H \times 2\ mm^V$) by ray tracing. Therefore, we are continuing the adjusting of optical elements.

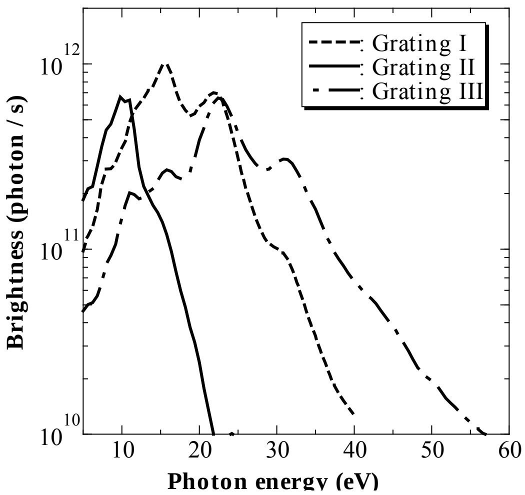

Figure 2. Photon flux intensity at focal point. The photon flux is 1×10^{11} ~ 1×10^{12} photon/seconds.

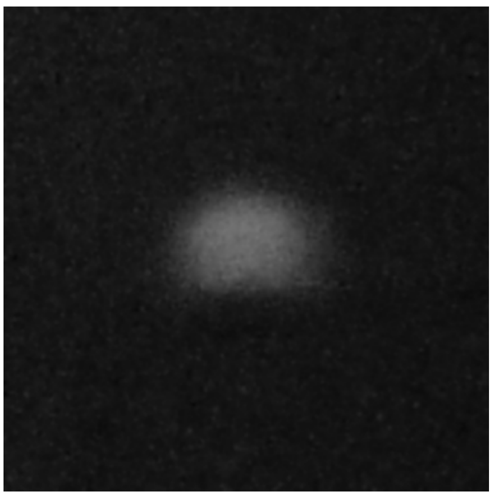
Figure 3. Beam shape at focal point. The beam size is 4 mm (Horizontal) and 2 mm (Vertical).

References

(1) H. Namba, M. Masuda, H. Kuroda, T. Ohta, H. Noda, *Rev. Sci. Instrum.*, **1989**, *60*, 1917.