

# **1 Status of Beamlines at the Photon Factory, KEK**

## **1.1. Beamline 18A**

The beamline 18A has been dedicated to photoemission experiments to investigate electronic structures of surfaces and interfaces of metals, semiconductors and those of adsorbed by various atoms and molecules. The beamline is equipped with a constant deviation angle grazing incidence monochromator. The monochromator covers the photon energy range from 15 to 170 eV with resolving power of more than 1000.

At the end-station, two commercial angle-resolved photoemission spectrometers are installed. The one is VG ADES500. The other is VG Scienta SES-100 with the rotational flange and the linear transfer mechanism. By the installation of Scienta SES-100, the end-station now provides opportunities of photoemission experiments such as,  $k_x$ ,  $k_y$ ,  $k_z$ -band mapping,  $k_x$ ,  $k_y$ ,  $k_z$  Fermi surface image with high energy (2.2 meV) and angle resolution ( $<0.2^\circ$ ), and polarization dependent measurements.

At the sample preparation chamber, samples can be heated by a direct current heating or electron bombardment, and cooled by a closed cycle He Cryostat below 100 K. By the load-lock and sample transfer systems, samples can be changed without breaking ultra high vacuum (UHV). Evaporators also can be replaced without breaking UHV by a system combined valves and differential pumping. The other surface evaluating and preparing apparatuses, LEED, XPS, Sputter-gun, Quadrupole mass spectrometer, quartz thickness monitor are also equipped.

Recent works performed at this beamline were Fermi surface and band mappings by angle-resolved photoemission (ARPES) measurements of (1) surfaces and thin films with strong spin-orbit interaction inducing the Rashba effect, (2) one-dimensional system or nano-scale materials fabricated on Si surfaces by metal or gas adsorption, (3) magnetic materials such as magnetic semiconductor or transition metal silicides, and so on.

## **1.2. Beamline 19A**

The beamline 19A is an undulator beamline equipped with a constant deviation angle grazing incidence monochromator and covers the output photon energy from 20-250 eV and is dedicated to the spin- and angle-resolved photoemission (SARPES) experiments. The quality of the monochromator at BL19A was improved by adjusting the alignment

of optical elements in 2009.

At the end-station of this beamline, a high-energy resolution photoelectron analyzer (PHOIBOS 150, SPECS GmbH) is equipped together with high efficient spin detector associating very low energy electron diffraction (VLEED). The system is designed to provide high stability, high-energy resolution and high efficiency of spin detection for spin-resolved photoemission experiments. The end-station also consists of a manipulator with He cryostat ( $<60$  K), a preparation chamber equipped with surface preparation apparatuses (LEED, AES, sputter-gun and others) and a load-lock chamber. The new spin polarimeter achieved approximately 100 times higher efficiency than a conventional Mott detector. The figure of merit of it is about  $1.9 \times 10^{-2}$  with Sherman function of 0.4, which enables us to measure SARPES spectra with relatively high-energy resolution ( $\sim 50$  meV).

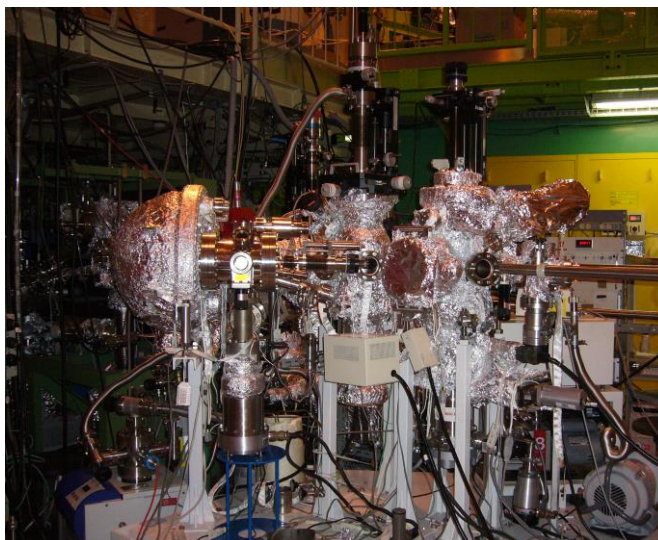


Figure shows the new SARPES system at BL19A.

Recently, the VLEED spin system has been utilized to obtain precise information on spin-dependent electronic structures of surfaces and thin films with strong spin-orbit interaction inducing the Rashba effect and topological insulators.

### 1.3. Beamline 19B

The beamline 19B is an undulator based soft X-ray beamline. In this beamline, measurements of X-ray emission spectroscopy (XES), X-ray absorption spectroscopy (XAS) and X-ray photoemission spectroscopy (XPS) are available. This beamline has a plane grating monochromator with varied line spacing plane gratings (VSPG). The available photon energy is from 70 to 400 eV. At the end-station, a soft X-ray emission spectrometer and an angle-integrated photoemission spectrometer (CLAM4,  $E/\Delta E = 50 \sim 200$ ) are installed. X-ray absorption can be measured by the two ways; the electron yield using the sample current, the photon yield using the Si-photodiode. Samples can be cooled down to 20 K using a manipulator with a He-refrigerator. The soft X-ray

emission spectrometer is Rowland-circle grating emission spectrometer. It has a fixed (100  $\mu\text{m}$ ) entrance slit and two interchangeable gratings to cover the photon energy from 50 to 1200 eV. The energy resolution of the XES is about 70 meV at 100 eV. Recently, we have improved the software for the emission spectra measurement, which makes it possible to analyze the emission image data with higher energy resolution.

The beamline 19B was closed in March, 2013.