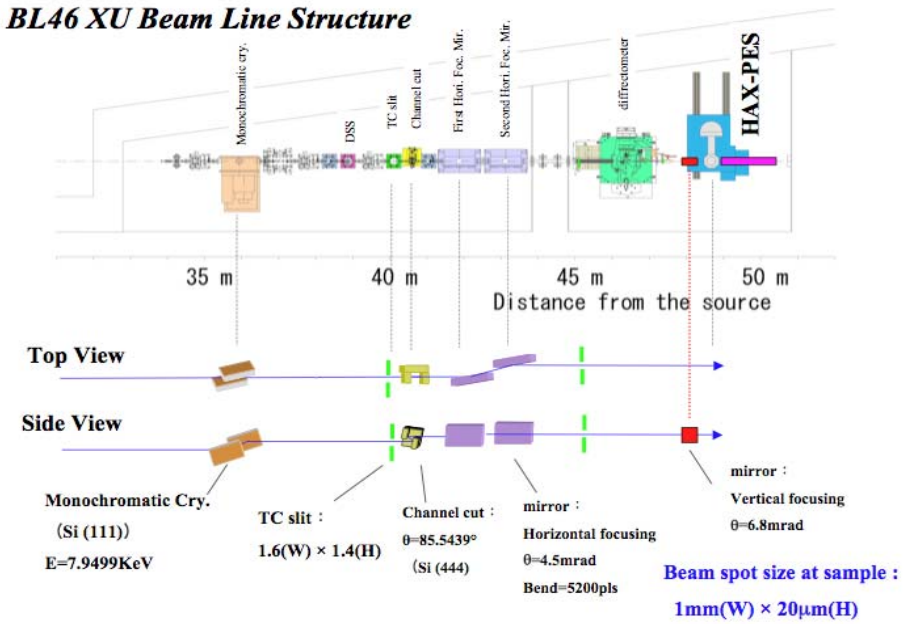
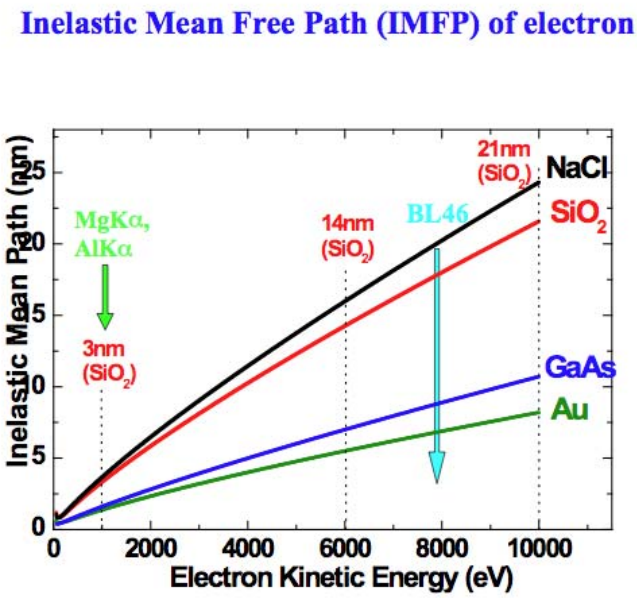
BL46XU Hard X-ray Photoelectron Spectroscopy (HAXPES)

BL46XU is an undulator beamline dedicated for promoting the use of synchrotron radiation by industrial users. The light source is an in-vacuum undulator and optics adopts a Si (111) direct water-cooled inclined double-crystal monochromator. The tunable energy range is 6-35 keV. Two Rh-evaporated mirrors (70 cm length, reflection direction is horizontal) are placed in the most downstream part of the optics hutch to eliminate higher harmonics. The mirrors have curvature for horizontal light focus. A Si (111) channel-cut monochromator is placed between the double crystal monochromator and the mirrors to get incident X-ray with fine energy resolution for hard X-ray photoemission spectroscopy.

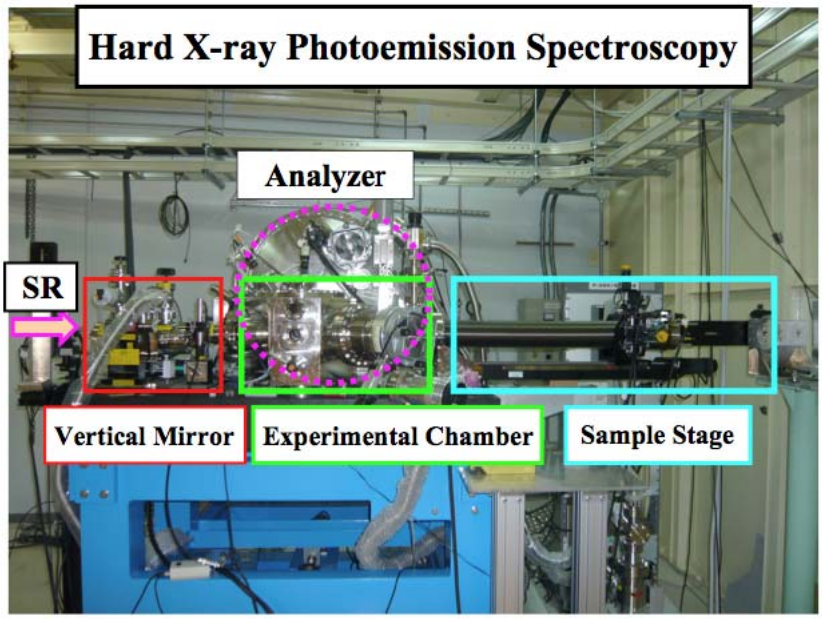


Hard X-ray Photoemission Spectroscopy (HAXPES) has a large detection depth that is advantageous to observe the bulk electronic states of a sample in a non-destructive manner. In the conventional photoemission spectroscopy such as ultraviolet and X-ray photoemission spectroscopies (UPS and XPS), the relatively low energy photon ranging from several-tens of

eV to 1.5 keV is used for the excitation source. One of the disadvantages of these VUV/soft-X-ray methods is that the obtained data is strongly dependent on the surface condition of the sample because the detection depth is shallow due to the short inelastic mean free path of photoelectrons inside the solid material. Therefore, it has been difficult to observe bulk electronic states that contribute to the solid-state properties. One solution for this has been depth-profiling with sputtering. However, there is a concern about the property changes caused by the sputtering process. In HAXPES, using the hard X-ray (6-10 keV in our system) as the excitation source, we can achieve the probing depth of as deep as around 20 nm that enables us to observe the bulk electronic states non-destructively. The high brilliant synchrotron radiation of SPring-8 and high performance electron energy analyzer compensate for the low photoemission cross-section at high photon energy enables us to acquire the HAXPES spectrum in a reasonable measuring time.



The HAXPES system at BL46XU is equipped with a VG-SCIENTA photoelectron energy analyzer, R-4000. Besides standard bulk-sensitive measurements, we can get a surface-to-bulk profile of electronic states in angle-dependent photoemission spectroscopy experiments where probing depth can be controlled by changing the detection angle of photoelectrons to the sample surface.



The aim of this course is to learn a principle of HAXPES and gain experience of measuring photoelectron spectra of various materials with 8 keV monochromated X-ray.

On the practice at the beamline, we are planning to conduct followings.

1. Explanation of X-ray optics for HAXPES
2. Explanation of HAXPES and vacuum systems.
3. Sample preparation.
4. Measurement, followed by data analysis.