Construction of a Side Beamline of BL12XU for HAXPES

Hard X-ray photoemission spectroscopy (HAXPES) has attracted much interest in recent years among the synchrotron radiation community in the world. SPring-8 has pioneered in developing suitable beamlines and end stations as well as advancing related sciences. The greatest advantage of using hard X-rays from several to above 10 keV over conventional VUV and soft X-rays to undertake photoemission spectroscopy is the increased electron inelastic mean free path of up to about 100 Å. This increased bulk sensitivity has made possible to probe the true bulk electronic structure in many strongly correlated systems in which the surface region has a markedly different electronic structure due to reduced coordination. In addition, the electronic structure of buried interfaces is of high interest but lacked a suitable probe in the past. HAXPES has thus attracted considerable attention for research on device applications. To explore research in these areas, NSRRC has teamed up with a research group at Cologne University in Germany to construct a side beamline at **BL12XU** with a dedicated end station since 2006.

Figure 1 shows the layout of the side beamline. We use a single-bounce diamond monochromator (DM) in the first optical hutch as the first optical component downstream of the front end. Diamond crystal is used because of its high thermal conductivity and low thermal expansion coefficient, so that a much simpler water cooling system can be used. Moreover, the high transmission of diamond would allow us to operate simultaneously the main beamline. Two modes of the DM are implemented. In the transmission Laue mode, a thin diamond (100) crystal is to produce a (111) reflection. The simultaneous use of photons at 10 keV, which are currently heavily used at the main beamline, is possible. In the reflection Bragg mode, a thicker diamond (111) crystal is used also for a (111) reflection, needed particularly for lower photon energies. In the latter mode the third harmonic radiation from the undulator is also available for the main beamline. An additional advantage of using diamond is its low absorption and high reflectivity at the top of the rocking curve for a perfect crystal; this basically increases the transmission efficiency within the intrinsic bandwidth as an optical device. Figure 2 shows the installed DM.

The upper right corner in Fig. 1 presents a schematic of the DM operation. The scattering angle 2θ ranges from 28 to 60 degrees, providing photons from 12.5 keV down to 6 keV. At all energies the diffracted beams converge to a single point inside the experimental hutch. Exactly at this convergence point is situated the pivot point of a rotational platform on which the remaining optical components and the end station are placed. To reduce the energy bandwidth from the output of the DM we adopt a channel-cut design for the high-resolution monochromator (HRM). Only one pair of Si channel-cut is used to minimize the flux loss due to the higher absorption of Si. A large range of photon energy can be used for a given pair of channel-cut providing a continuously tunable photon

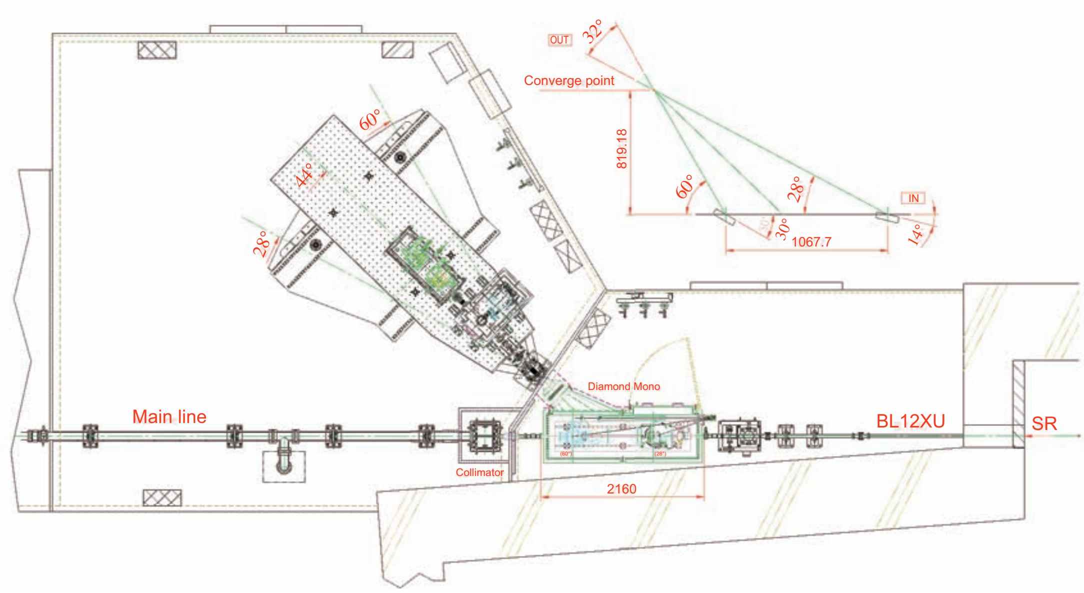

Fig. 1. Layout of the side beamline of BL12XU.

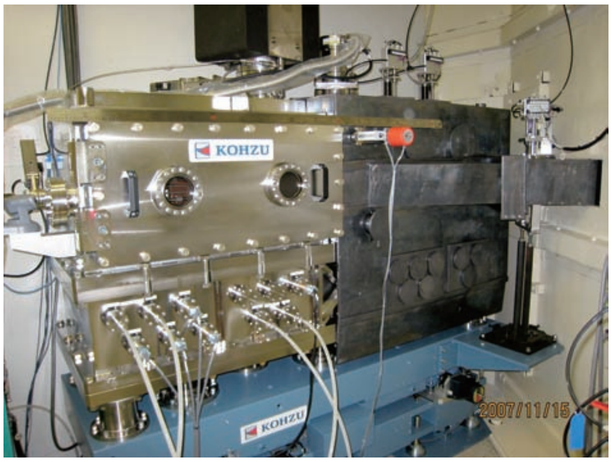

Fig. 2. Installed diamond monochromator in the first optical hutch.

energy for the measurement, at the expense of changing the beam height in addition to altering the platform angle. The former is compensated by applying motorized z-motion to the downstream optical components. In order to achieve sufficiently small beam spots to match the effective acceptance area of the electron energy analyzer we will install a pair of plane-elliptical KB mirrors to focus the beam to 30×30 μm^2 at the sample position in the end station. The sizes of 200 mm at 3 mrad grazing angle for the vertical focusing mirror and 400 mm at 5 mrad for the horizontal focusing mirror collect basically all beams from the undulator source. Both mirrors are coated with Rh to cut the higher harmonics above 12 keV. The whole photon beam from the DM to the end station will be placed under vacuum to eliminate the loss from absorption by air with only a few Be windows to separate chambers with different vacuum. The design concept is to minimize the loss or to maximize the transmission efficiency of all optical components. Figure 3 shows part of the side beamline inside the experimental hutch installed down to the HRM on the rotational platform. The commissioning of the side beamline will start in February 2008.

Fig. 3. High-resolution monochromator installed on the rotational platform in the experimental hutch.

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