

APCST ID (BL12XU)

1. Introduction

This beamline is part of the Taiwan X-ray facility at SPring-8, and is designed to exploit the unique characteristics of SPring-8 as a high-energy and high-brilliance X-ray source. It will be a dedicated beamline for inelastic X-ray scattering (IXS) with variable energy resolution *from* high (0.1 – 1 eV) to ultra-high (1 – 10 meV) resolution regimes. A secondary purpose is for high Q-resolution scattering and X-ray physics and optics.

The conceptual design has now been completed. The hutches and utilities have been constructed together with those for the APCST bending-magnet beamline BL12B2. In the present article, we will briefly describe the scientific program, and the key concepts and components of the beamline.

2. Scientific Program

Three classes of IXS experiments are planned:

- *High-resolution inelastic X-ray scattering*: The focus is on the study of single-particle as well as collective electronic excitations in a variety of materials.
- *High-resolution X-ray resonant Raman scattering*: The emphasis is to explore the large resonant enhancement of the inelastic scattering cross sections to study high-Z elements where strong sample absorption still poses a major problem.
- *Ultra-high-resolution inelastic X-ray scattering*: The focus is on the study of lattice dynamics in bio materials and very low energy electronic excitations in strongly correlated systems.

We further plan to extend both high and ultra-high resolution IXS to studies of materials under high pressure, high magnetic fields, and extreme temperatures. The focus is on the pressure-induced phase transitions of materials.

The scientific program for high Q-resolution scattering will be for general purposes, and will include crystallography, surface scattering, magnetic scattering, small angle scattering, and coherent scattering. For X-ray physics and optics, the projects currently planned are micro focussing optics, fast timing optics, and non-linear multi-photon X-ray effects.

3. Beamline Overview

This beamline takes X-ray photons from a SPring-8 standard insertion device with a magnet period of 32 mm [1]. The front end is modified from the SPring-8 standard to handle up to 18 kW of total power [2]. This gives us the option of changing the undulator to gain more flux in the future.

The beamline is divided functionally into two parts (Fig.1). Part I consists of a single-bounce diamond

monochromator located 41 m from the source point and a side hutche, where a monochromatic beam of 1-eV energy width will be provided for crystallography and high Q-resolution (fixed energy) scattering experiments. The diamond monochromator employs four scattering geometries using semitransparent diamond (111) and (100) crystals [3] in order to cover a wide energy range of 7.8 – 32 keV with a scattering angle range of 25 – 45 degrees. The end station will be a custom-built diffractometer installed on a movable stage along a circular track to maintain a constant distance from the diamond monochromator over the entire scattering angle range.

Part II is the main part of the beamline, which will be dedicated for inelastic X-ray scattering experiments with high and ultra-high energy resolution. It takes the photon beam transmitted through the diamond monochromator, and contains five major optical elements (Fig. 1). They include a high heat-load double-crystal monochromator (DCM), a collimating mirror/CRL (compound refractive lens), a high-resolution monochromator (HRM), a phase retarding plate, and a focussing mirror/CRL. Naturally, the main beamline also offers the possibilities for (variable energy) high Q-resolution scattering, coherent scattering, and imaging experiments. The high-heat load DCM will be cryogenically cooled to accept the full power of the central cone radiation of the undulator. It will be based on existing devices recently demonstrated at SPring-8 [4]. The collimating mirror collimates the pre-monochromatised beam in order to improve the throughput and the energy resolution of the output beam from the HRM. The relative energy bandwidth ($\Delta E/E$) of the HRM will be in the range of 10^{-5} to 10^{-7} . This can be accomplished by using a design that allows for easy exchange of channel-cut crystal pairs from either a two-bounce to an in-line or nested four-bounce crystal monochromator [5]. The phase retarding plate is used only to generate circularly polarised light for magnetic studies. The HRM will be accommodated on a high-precision optics table with temperature acclimatisation to $\leq \pm 0.01$ K at room temperature in order to achieve stable output beam at 10-meV energy resolution. Finally the focussing mirror/CRL focuses the beam onto the sample position of the spectrometer.

The main beamline will be optimised to operate in two regimes. The first regime uses primary beam energies in the range of 5 – 15 keV with an energy resolution in the order of 0.1 – 1 eV, whereas the second regime employs 20 – 30 keV photons with an energy bandwidth in the order of 10 – 100 meV. The beamline layout remains practically the same with changes only to the choice of crystals in the HRM and the analyser. A few HRM options will be made available to facilitate different experiments. Furthermore, Be CRL's will be used to replace the collimating and focussing mirrors for operations above

