High Energy Inelastic Scattering

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1. Light Source

An elliptical multipole wiggler (EMPW) is going to be installed in this beamline, and high energy circularly polarized intense x-rays up to 300 keV will be utilized for x-ray inelastic scattering experiments[1]. A new type EMPW has been developed[1,2], and the designing work has entered its final stage. The critical energy of the EMPW is 44 keV at a gap of 20 mm. Maximum Brilliance of 2.1 x 10^{17} and 6.9 x 10^{15} photons/s/0.1%b.w./mr^2/mm^2 are expected at 100 keV and 300 keV, respectively, for the 20-mm gap operation. The total power of the EMPW is estimated to be 17.7 kW. The x-rays spread 1.48 mrad in a horizontal direction and 0.19 mrad in a vertical direction, where the radiation power is ten times smaller than the peak power. A degree of circular polarization of 89 % can be achieved at 100 keV and 300 keV with brilliance 2 x 10^{16} and 5 x 10^{14} photons/s/0.1%b.w./mr^2/mm^2, respectively.

2. Front End

Contrary to another beamlines of SPring-8, where most of components are standardized, elements of this wiggler beamline are specially designed to overcome high heat load and wide spread of x-rays from the EMPW. The total length of the front end is 19 m. Characteristic components of this beamline are a main mask place at a 20.5-m position from the source point, an absorber (23-m position) which reduces the heat load to a main beam shutter at a down stream, graphite (30-mposition) and metal filters (31-m position) which cut low energy x-rays below 25 keV. The front end is terminated by a beryllium window. These components are cooled by water circulated at a temperature of 30 °C with a flow rate of 30 L/min. The main mask is consist of Glidcop blocks of 500 mm long, through which a rectangular tapered channel is shaped with dimensions 24 mm x 56 mm wide at the entrance side and 8 mm x 34 mm wide at the exit side. The main mask is designed to withstand a direct heat load of 17.7 kW with a power density of 403 W/mm^2. The absorber is consist of tapered Glidcop blocks. When the main beam shutter is closed, white x-rays are partly absorbed by this absorber. The graphite filter is followed by the metal (Cuor Al) filter.

3. Optics

Two monochromators have been considered according to two experimental branches, one for experiments using 100 - 150 keVx-rays and the other for experiments using 300 keV x-rays[1]. A water-cooled doubly bent Si(400) monochromator has been developed for the 100-150 keV branch, and heat-load effects on the monochromator has been computer simulated. The results show a serious distortion of the radius of curvature (600 m) of the Si crystal, and suggest further improvement of cooling against 300 W heatload. For the 300-keV branch a three-to-one asymmetric Si(771) Johann-type monochromator with a radius of curvature 750 m has been designed. According to a computer simulation, an expected 320-W heat load induces distortion of the radius of curvature less than 5 %, which is satisfactory to a required energy resolution ΙE/E of 5 x 10^{-3} and a beam-spot size of 1mm x 3 mm at a sample position, which is 51 m from the source position.

4. End Station

Two stations are prepared for 300-keV experiments and 100-keV experiments as shown in Fig. 1. In the front experimental station (SA) magnetic Compton-scattering experiments will be carried out using a Ge solid-state detector, and in the rear station(SB) high resolution Compton scattering measurements will be made using a crystal analyzer. A quick reversible superconducting magnet, which will be placed in SA, can change the field from 3T to -3T within 5 sec. To carry out a long-run accumulation, a small liquid-He generator will be directly connected to the magnet vessel to return back evaporated liquid He to the vessel. This closed circuit system will maintain the continuous operation of the magnet more than a week without transferring liquid He from an another container.

For magnetic Compton-profile measurements with 300-keV x rays, a segmented 15-mm thick planer-type Ge solid-state detector will be used. Since a scattering angle near 180 is promising for the measurement, a doughnut-type detector(ten segmented Ge elements arranged in a ring) is designed. The incident x-rays will pass through a hole at the center of the ring. In the case of the 300-keV incident energy, a Compton profile will be in an energy region between 90 keV and 170 keV. The detector however has energy-dependent counting efficiency above 100 keV. The calibration of the counting efficiency of the Ge detector will be made with the aid of a large Ge detector having reliable counting efficiency in these energy region. The momentum resolution is expected to be 0.5 atomic units (a.u.).

It is a promising challenge to construct a high-resolution Compton-profile pectrometer using a Caucios-type crystal analyzer together with a position sensitive detector which will be performed with a momentum resolution around 0.1 a.u. There are still technical problems for this challenge including a doubly bent monochrometer with a relative energy resolution $\Delta E/E$ better than 10^{-3} and a position sensitive detector for x-rays around 100 keV.

References

[1] N. Sakai, SPring-8 Project, Scientific Program No. 2, 1995, pp. 3-12 (1995).

[2] X.-M. Marechal, T. Tanaka and H. Kitamura; SPring-8 Annual Report 1994, pp. 158-159 (1995).

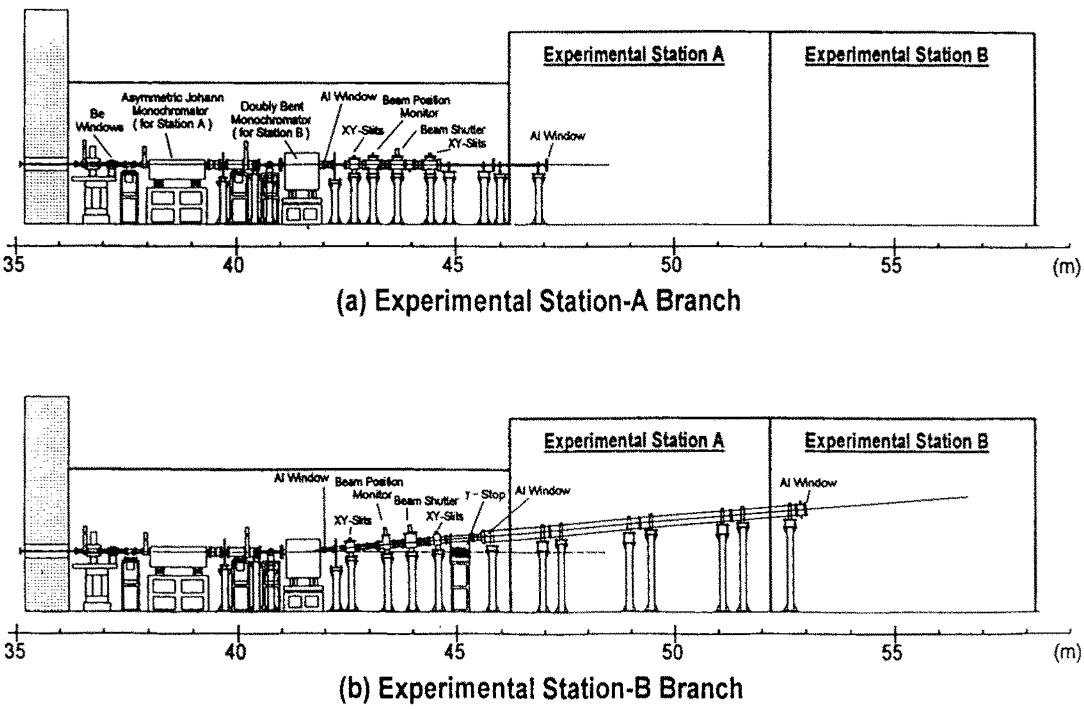

Fig. 1. Side views of two experimental stations, A and B. A monochromator for SA station deflects x-rays horizontally. A scale indicates the distance from the source point.