SPring-8 Beamline Review Committee Report
on
High Energy Inelastic Scattering Beamline
(BL08W)

Report to the Director General of Synchrotron Radiation Research Laboratory

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1. Introduction

A meeting of the SPring-8 beamline review committee on the High Energy Inelastic Scattering Beamline (BL08W) was held at SPring-8 on November 7-8, 2002.

The committee received the following written materials in advance;

1)Beamline Report BL08W (High Energy Inelastic Scattering Beamline),
2)Supplement (Selected Reprints & List of User Experiments),
3)SPring-8 Overview.

All committee members then submitted their individual reports to the chairman prior to the meeting.

A group of 4 domestic members attended the committee meeting: N. Shiotani (IMSS, KEK), A. Iida (IMSS, KEK), T. Hyodo (Univ. of Tokyo), and Y. Murakami (Tohoku Univ.). On the afternoon of November 7, H.Suematsu (JASRI) presented an overview of the SPring-8 facility, and then Y.Sakurai (JASRI) gave a detailed explanation on the BL08W beamline, including a beamline tour. The evening of November 7 was reserved for an executive session. On the morning of November 8, there was a question-and-answer session. Then, another executive session was held to complete the discussion and to prepare the draft of this report, referring to the individual reports from the overseas members: J. R. Schneider (HASYLAB, DESY) and P. Suortti (Univ. of Helsinki).

The "BL08W Beamline Report" describes the following three main subjects:

1)The primary research activity of BL08W is scientific investigations on the electronic and magnetic structures of materials using Compton scattering techniques. Its secondary activity is the application of X-ray fluorescence (XRF) analysis to archaeology and forensic science. A few experiments on nuclear excitation have been also carried out.

2)The above-mentioned activities were made possible by the successful installation of the beamline hardware: an elliptical multipole wiggler (EMPW), an asymmetric Johann monochromator, a doubly-bent monochromator, magnetic Compton and high-resolution Compton spectrometers as main instruments, cryo-magnet systems for sample environment, etc. The EMPW produces intense X-rays with an energy range between 100 keV and 300 keV. All the hardware components have been newly designed and manufactured to be fit for the third-generation synchrotron radiation facility.

3)Research strategies for the next five years (future plans).

The evaluation results and the comments on the beamline hardware, the research outputs, and the future plans are summarized in Section 2, and the summary of recommendations are given in Section 3.

2. Executive Summary

2.1 Beamline Hardware

1)A characteristic of the large-scale 3rd generation synchrotron radiation facility is its capability to produce intense, linearly or circularly polarized X-rays in the energy range of higher than 100 keV with a suitable insertion device. The EMPW with the unique array of permanent magnets was chosen as an insertion device and was constructed for the BL08W beamline. The choice is adequate since it was almost a unique solution under the international level of instrumentation at that design phase.

2)The asymmetric Johann monochromator and the doubly-bent monochromator were well designed and manufactured so as to fit the intended use. If we cite a point for improvement, the integral reflecting power of high-index reflections is fairly small for high-energy X-rays because of their very narrow intrinsic width of Bragg diffraction. The committee expects that an attempt to widen the intrinsic width, by producing internal stress in the Si crystal, works for increasing the photon flux at a sample position.

3)The BL08W beamline is one of the best equipped facilities with respect to magnetic Compton scattering instrumentation and control of the sample environment.

4)The high-resolution Compton scattering spectrometer, which was designed and constructed for use at an energy of 115 keV, is only one instrument that is capable of measuring the Compton scattering spectra of a variety of compounds including high-Z elements. Concerning the spectrometer, an immediate improvement is needed for the position sensitive detector (PSD). It was a good start with a large-volume Ge SSD with four slits as the PSD. However, the temporal PSD does not make full use of the spectrometer's capability. We urge that the 128-element microstrip Ge PSD (128-PSD), now under development, should be completed immediately. The panel also recommends that an X-ray CCD camera system is used as an alternative device until the completion.

5) The aim of the high-energy XRF analysis program at SPring-8 is to develop a technique for detecting K-emission lines of heavy elements up to uranium. In spite of a simple setup, the apparatus has been employed for qualitative analyses. It is thus understood that the aim has been almost attained.

2.2 Research Outputs

1) Magnetic Compton scattering:

There are many publications with high quality during the past two years. In particular, the works on CMR and GMR materials and Heusler alloys are scientifically important and deserve evaluation with a high value. Those studies discuss the underlying physics in terms of quantitative comparisons between the experiment and theory, which is one of the advantages of magnetic Compton scattering over other spectroscopic techniques.

2) High-resolution Compton scattering:

Despite the fact that the spectrometer does not have full performance, three papers have been published in a short time, less than two years after it was open for public use. As described in the "Beanline Report BL08W" (see Table 4.2), many hot materials have been measured using the temporal PSD. We expect that these works will be published soon. The committee therefore understands that the scientific output is on the rise.

3) X-ray fluorescence analysis and nuclear excitation:

High-energy XRF analysis has been established as a technique for qualitative analysis, and has been applied for archaeology and forensic science. The fact that the technique has opened a new window for practical use is highly evaluated. Nuclear exc itation is a very fundamental field. The panel recognizes the nuclear excitation research program as a promising attempt using high-energy X-rays.

2.3 Future Plans

1) Magnetic Compton scattering spectroscopy is one of the indispensable tools for studying magnetic materials. It provides reliable information on not only the spin moment but also the orbital state, which is inaccessible to a neutron scattering technique. The research program using magnetic Compton scattering should be maintained. The proposal for developing a high-resolution magnetic Compton scattering technique is highly evaluated. The successful development will allow for more quantitative discussions on the relationship between the magnetic and electronic structures in hot materials.

2) Three-dimensional reconstruction of electron momentum density is essential for fermiology. For the reconstruction, a few dozens of Compton profiles have to be measured on a sample. Since the measurements need a considerably long beamtime, the PSD development is a most immediate task.

3) Successful development of a magnetic Compton scattering technique under high-pressure will produce very fruitful scientific results, but would be a very difficult and challenging task in light of current X-ray beam size.

4) It is meaningful to expand the controllable range of sample temperature and applied magnetic field.

5) Success of the ultra high-resolution project depends on the choice of the incident X-ray energy. If a low energy is chosen because of its technical easiness, the choice may break the impulse approximation. It will bring a complication into the interpretation of experimental results. Therefore, the project must be planned very carefully. We stress the importance of specifying the research target. The committee recommends that the project start with a technical feasibility study including a selection of insertion devices.

6) Band-calculation programs are inevitable for interpreting experimental results. The use of the programs without any understanding may lead to a wrong interpretation of the results. The panel recommends that a knowledgeable engineer or scientist should be appointed as a scientific and technical consultant.

7) The high-energy XRF analysis program should be maintained. The committee comments that it is the time for attempting to step up from qualitative to quantitative analyses using high-energy X-rays.

3. Summary of Recommendations

The review committee concludes that the BL08W beamline should be maintained and the present research programs should be further developed.

Compton scattering techniques provides fundamental information on the electronic and magnetic structures of materials. The research activities over the past five years at BL08W deserve high evaluation remarks from a global perspective. The high-energy XRF analysis has largely augmented the value of SPring-8.

Regarding the beamline operation and user-friendness, there is no particular improvement pointed out by the committee members.

Finally, we summarize the recommendations for the future developments:

1) Human and financial resources should be concentrated on developing the position sensitive detector.

2) The users communities need to enlarge for the both fields of Compton scattering and X-ray fluorescence (XRF) analysis. There are not so many research scientists in the field of Compton scattering. Regarding the XRF analysis, the limited number of users is properly attributed to the fact that it is a new technique that has been practically developed at SPring-8 for the first time. Successive publication of high-quality data is important in order to attract notice from potential users. Collaborations with the new users will increase the number of users at BL08W.

3) The scope of the research activity should be widen in both aspects; one is connected to materials (e.g. Heavy-element compounds, oxides, low-dimensional materials, magnetic multilayers) and the other to science (e.g. physics of strongly correlated systems).