# SPring-8 BL10XU Evaluation Report

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**Preface:**

The report on BL10XU evaluation was prepared on the basis of the comments and suggestions from the individual committee member, a two-day on-site inspection on January 13 and 14, 2003, the presentation of beamline staffs and the subsequent discussion among the evaluation committee members. Two overseas members did not participate in either the on-site inspection or the committee meeting. Their appreciated comments and suggestions are reflected in preparation of the report.

## I. Technical status of the beamline and experimental stations:

The beamline is shared by two different types of experimental stations: the high-pressure experimental station and the high-brilliance XAFS experimental station. They are aligned in a tandem configuration. High-brilliance light from a SPring-8 standard in-vacuum undulator is monochromatized with a double-crystal monochromator and conducted to the experimental stations through two parallel mirrors. A newly developed X-ray lens is very effective in focusing the incident light to make high-brilliance light at sample position. It makes possible to perform high-pressure experiment with a light element specimen or ultra high-pressure experiment with a very small specimen. Both stations are equipped and maintained by beamline staffs, who also support beamline users to achieve the proposed experiments efficiently and successfully in assigned beamtime.

At the high-pressure experimental station, a diamond anvil cell (DAC) is equipped for high temperature and low temperature measurements at pressures above 100 GPa. A He-gas refrigerator and a double-sided YAG-laser heating unit cover a wide range of temperature from 10 K to 3000 K. In addition to a conventional clamp-type DAC, a gas controlled DAC is equipped at the station, which enables remote-control of the sample pressure in high or low temperature condition.

The XAFS station utilizes X-rays with energy of 6-35 keV supplied from a SPring-8 standard undulator. An SSD consisting of 100 elements was newly developed to integrate faint signals. XAFS spectra with high S/N ratio are successfully measured for diluted system or surface, allowing efficient determination of local structure.

**1. How do you evaluate the present status, performance and technical**

**development?**

The front-end components and the optics of the beamline are well equipped and operated to produce satisfactorily experimental results for the ordinary subjects proposed by users. The characteristic features of the third generation SR, however, are not fully utilized at this beamline. The optics can be further improved, for instance, by using a liquid nitrogen cooled monochromator, a focusing mirror and relevant components. Priorities should be discussed for the future improvement in the light of scientific importance, cost performance and other factors.

**2. Are the beamline and apparatus adequate for a 3rd generation SR facility?**

The high-pressure experimental station is well equipped and adequate for a third-generation SR facility. The station enables the users to make high and low temperature experiments routinely at a 100 GPa region. The station provides hydrostatic environment with He-gas pressure transmitting medium, which allows precise structural measurement over a wide pressure region.

The high-brilliance XAFS station is originally designed for site-selective structural study, for example, of dilute system. But the advanced facility is not widely recognized among the users and hence less frequently used.

**3. Are the experimental stations user-friendly?**

3-1 High-pressure experimental station:

As the high-pressure technique contains tedious and delicate procedure, data analysis and system control should be fully standardized and automated in order to concentrate to the high-pressure experiment itself. Some improvements are further required for the station to achieve user-friendly environment for non-specialist of high pressure experiment;

(1) unification of the systems for data analysis and machine control,
(2) quick setting and adjustment of the laser-heating DAC system,
(3) semi-automation of pressure control below 20GPa region by the gas-driven DAC .

3-2 High-brilliance XAFS experimental station:

The station is not satisfactorily equipped and operated user-friendly. The measurement system with the 100-element SSD seems too much specified for the public use. Less effort have been made to expand the number of users because of the delay in its install at the station. As a result, the user group is still small and the number of submitted proposals is very limited.

**4. Comments or recommendations for technical improvement**

It is evaluated that the improvement of the high-pressure apparatus and technique has continuously been conducted by the beamline staff: they are introduction of synthetic diamond plate for wider X-ray window and gas-driven DAC for remote controlling of pressure. The DAC technique, though, has a room to be improved or developed at the high-pressure station. The laser heating technique with a DAC is one of the promising candidates of future advancement. It is recommended to organize a system to update the software for system operation and data analysis for more user-friendly service.

**II. Research activity:**

**1. How do you evaluate the scientific activities of users at the BL? Did any outstanding research projects appear?**

It is sure that the scientific activity of BL10XU is the top by the world standards. Five-year development of the stations ends up to produce world's leading results. More efforts are still required to produce further outstanding results showing the performance as a third-generation SR facility.

The scientific activity of each station may be evaluated on the scale of A(outstanding), B(exciting), and C(interesting).

1-1 High-pressure experimental station:

The present activity of the station is ranked at B(exciting). It is highly expected to rise up to rank A(outstanding) in the very near future.

1-2 High-brilliance XAFS experimental station:

The scientific activity is ranked at B(exciting). In spite of the limited beam time, some excellent results have been achieved. But, it should be pointed out that the user is very limited.

**2. How do you evaluate the contribution of the BL to developments in the relevant field?**

2-1 High-pressure experimental station:

The evaluation is ranked at B(exciting). The station plays a central role in high-pressure experiment over wide research field including solid state physics, materials science, earth science etc. Scientific papers have continuously been produced at the station but those with high impact are few.

2-2 High-brilliance XAFS experimental station:

The contribution is ranked at B(exciting). Remarkable results have been obtained for the local structural study in diluted system. However, excellent results, which can be produced only with the 100-element SSD, have not appeared yet. It is very important to conduct a cutting edge research, but at the same time it is required to enroll wider range of researches to this public-use station.

**2. Is there any other scientific field to be explored by utilizing the BL?**

It does not seem necessary to apply this beamline to other field.

**III. Utilization and supporting system for users:**

**1. How do you comment on the utilization status such as adaptation rate of proposals and so on?**

The average shift assigned to the adapted subject is approximately nine, which seems not sufficient to yield satisfactory results for the general users who are still not well trained on operation of the station facility. Some proposals would be selected as year-round subjects to guarantee sufficient beam time.

1-1 High-pressure experimental station:

The number of applied subjects seem to level off for the latest four terms from 2001A to 2002B, and is expected to last in the next several years. The adaptation rate is adequate and readjustment is not required.

1-2 High-brilliance XAFS experimental station:

The number of applied subjects is less than ten in each term of 2001A - 2002B,

showing no tendency of future increase. The issue behind it would be carefully examined to improve or reform the facility.

Maintenance of the peripheral apparatuses such as high temperature system or low temperature system is an issue to be solved immediately in the future at this station. The high-pressure station, for example, is equipped with a number of experimental apparatuses, temperature or pressure measuring devices and controlling units. To maintain steadily and efficiently these apparatuses with a help of the users, they should be classified into several categories,

A: all the users can operate freely,
B: the trained users can operate,
C: the cooperative researchers can operate freely,
D: the maintenance is performed by the users.

**2. Is the beamtime adequately allocated to users?**

Yes.

**3. Have you any comment on the supporting system including personnel?**

The stations have a serious shortage of man power. Three or four assistants including postdoctoral fellows would be involved additionally.

**IV. Future technical and scientific developments:**

**1. Would you recommend major technical improvement or development of the BL, or reconstruction? We also would like to invite your comments on our future plans.**

1-1 High-pressure experimental station:

The station has developed the distinctive techniques for steady generation of ultra-high pressure up to 100 GPa at high and low temperatures. However, some of them are catch-up techniques which have originally been developed at ESRF or APS, although each technique has significantly been improved by the beamline staffs. Development of original and challenging technique should be promoted.

Construction of advanced user-friendly system is urgent to expand the user community and hence extend the scientific field. There are a number of people who are potentially interested in high-pressure structural measurement. The station makes effort to attain their participant in the user community.

1-2 High-brilliance XAFS experimental station:

A basic concept of this station should be made up by the facility. One possible recommendation is to promote the station activity by demonstrating the performance of 100-element CCD system. This would lead to expansion of the user community and hence reinforce the future operation and management of the station.

**2. How do you recommend for the future direction of research at the BL?**

The beamline is shared by the two stations; the high-pressure experimental station and the high-brilliance XAFS experimental station. There is neither scientific nor technical reason for sharing the beamline between the totally different two stations. Replacement or re-equipment of the stations would be planed in the next phase program of SPring-8.

**V. Summary of recommendation:**

(1) BL10XU should be dedicatedly used for the high-pressure study as a third-generation SR facility. It should be quite important to develop a system for easy data collection under pressure without loosing the high performance. It is also emphasize that technical developments such as an X-ray focusing lens made of Be or a new SPring-8 standard DAC should be kept continuously.

(2) The high-brilliance XAFS experimental station will be relocated to another beamline. In order to obtain high performance at the new XAFS station, it is essentially important to set the future perspective by indicating pilot data on dilute system using 100-element SSD. Sharing the beamline with the high-pressure station should be dissolved.

(3) The high-pressure station will be further equipped user-friendly to expand the user community and extend the research field.

(4) A liquid-nitrogen cooling system of the monochromator is expected to highly improve the brightness. Replacement to a liquid-nitrogen cooling system is recommended by taking the cost performance in consideration.

(5) It is desirable to set a rule for the maintenance, control, development and accountability of the station facilities among the beamline staffs and users.

(6) Single-crystal diffraction system would be set up at BL10XU or other station in Spring-8 to perform pioneer structural material science at high pressure.

(concluded)