R&D Beamline (BL47XU)

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1. Introduction

An x-ray undulator beamline (BL47XU) is allocated to the first 'R&D beamline' which is to serve both scientific and technical R&D's for novel utilization of x-ray undulator beam. Using the in-vacuum standard undulator for SPring-8, the X-ray energies for the 1st harmonics and 3rd harmonics are 9~18 keV and 27~54 keV, respectively.

Although the research subjects for this beamline should be changed with the development of the SPring-8 facility, the tentative mission at the initial phase will be those R&D's for (i) novel optics, (ii) various imaging techniques and their applications, (iii) methodology for electron beam emittance measurement using emitted synchrotron radiation in the hard x-ray region, and the related instrumentation.

Here we describe tentative R&D program using this beamline and some more details of the diffractometer, the detector, the data acquisition and the control system.

2. Optics R&D Program

R&D of optical elements to be used in the various SPring-8 beamlines will be one of the main targets for this beamline. We will develop state-of-arts optical devices which control Momentum (Δq), Energy (ΔE), Position (Δr), Polarization ($\Delta \varepsilon$), and Phase ($\Delta \phi$) of the X-ray beam. The R&D of optics involves the following three aspects, (i) development of novel optics by new photon-material interaction, (ii) improvement of the resolutions of the optics, and (iii) novel applications of the optics.

The R&D on the perfect crystals will be done using this beamline in order to get high energy-resolution monochromators (high $E/\Delta E$), and high quality beam expanders or beam collimators used in X-ray topography and so on (high $q/\Delta q$). High quality beam expanders using asymmetrical crystals are also important for generating quasi-parallel X-rays needed for the X-ray interferometers. R&D of polarizers and phase retarders are also planned to obtain high linear & circular polarization (high $\varepsilon/\Delta\varepsilon$). Several beamlines require hard X-ray μ-focusing elements, R&D for such elements will be done as well (high $r/\Delta r$). This research is related to another target, that is the X-ray imaging techniques and their applications.

The evaluation of various cooling systems will be carried out as well for solving the high-heat load problem.

3. Emittance Measurement Program

The precise measurement of the electron beam emittance is the other important task required at this beamline. Due to the extremely low vertical emittance of SPring-8, we need a careful R&D for the methodology of its measurement. We are planning to measure the X-ray emittance by several methods, e.g. by a pin-hole array, by perfect crystals, and so on.

4. Instrumentation, Data Acquisition and Control

The beamline has one optics hutch and two tandem experimental stations (Fig.1). In the optics hutch, standard transport channel components for X-ray undulator are to be installed, such as a silicon double crystal monochromator, a gamma-ray stopper, slits, view ports, and a beam shutter. Total reflection mirrors will not be installed to avoid the degradation of coherence of the beam.

In each of the experimental stations, multiple-axis high precision diffractometers (Fig.2) has been designed on the basis of the similar diffractometer operating at the Photon Factory[1]. At present, one experimental station is to be used for the researches on hard x-ray microscopy while the other for the optics R&D as well as the emittance measurement.

These two experimental stations will be connected by a vacuum pipe. The third experimental hutch downstream (at ~80m from the undulator source) is also discussed which will be used for the X-ray emittance measurement using a pin-hole array.

The diffractometers are equipped with scintillation counters, ionization chambers, and SSDs. A high position resolution (~10 μm) X-ray CCD is planned to be installed for the emittance measurement. The signal processing of the detectors is, at present, made by standard NIM electronics and interfaced to a VME-based data acquisition system and control system. All diffractometer motions are driven by stepping motors.

References

[1] T. Ishikawa, Rev. Sci. Instrum. **63**, 1015-1018, 1992

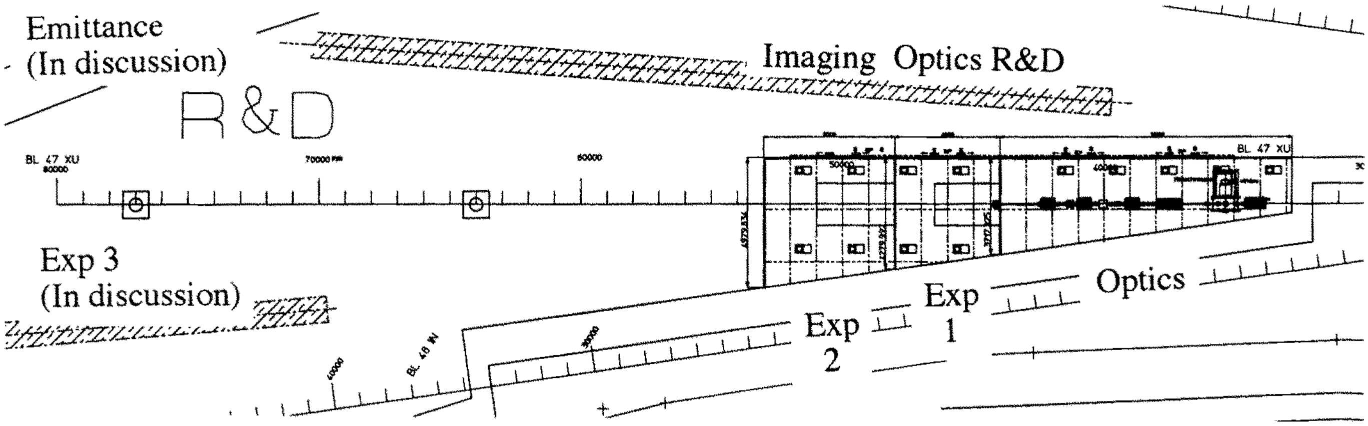

Fig.1. Hutch layout of the R&D beamline

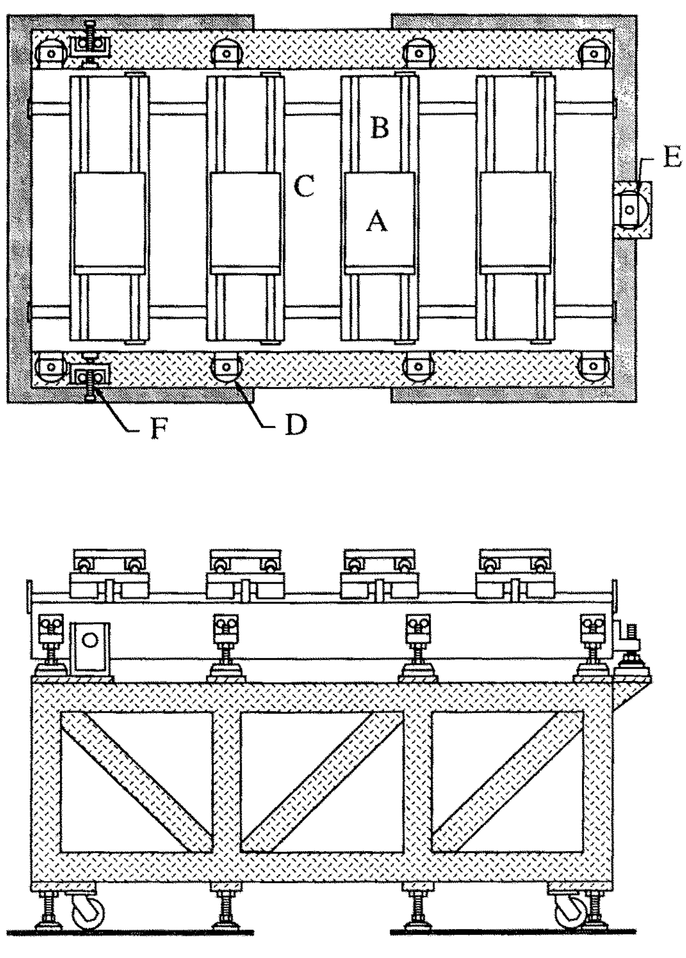

Fig.2. Multiple-axis high precision diffractometers planned to be installed in experimental stations.