

1. INTRODUCTION

Since 1982, the Photon Factory (PF) has been serving as a national facility for synchrotron radiation research covering a wide range of wavelength from vacuum ultraviolet to hard X-rays. It is the second dedicated synchrotron radiation source in Japan, and the first one to support X-ray users. It has two storage rings; the 2.5-GeV PF Storage Ring and the 6.5-GeV PF Advanced Ring (PF-AR). The former was constructed as a second generation synchrotron radiation source, and the first photon came out in 1982. For these several years, a number of efforts have been made to improve the 2.5-GeV Ring. With the high brilliance project in 1997, the emittance was reduced from 130 nmrads to 36 nmrads. During the 6.5-months shutdown in 2005, the number of straight sections was increased from 10 to 14, among which 4 short straight sections were created and 10 straight sections were lengthened. In parallel with the upgrade of the 2.5-GeV Ring, a number of beamlines have been improved and reconstructed, with a preference for the beamlines equipped with insertion devices and well refined optics. The stability and reliability of the 2.5-GeV Ring is of world-class; 1) the beam position is well controlled with the original feedback system developed at the PF, 2) the initial stored current is 450 mA with the long lifetime of 60 hrs, and 3) accidental or unexpected shutdown is less than 2% of the scheduled operation time.

The PF-AR was originally constructed as a booster for the 30-GeV main ring of the TRISTAN project (e^+e^- collision project in high energy physics) and had been used as a parasitic synchrotron radiation source since 1987. Later in 1997, it was converted to a dedicated single-bunch electron storage ring for synchrotron radiation research. With the improvement of vacuum system accomplished in 2002, the lifetime of the stored electrons has been increased up to 15 hrs at 60 mA. The injection is regularly taken place twice a day. A new experimental floor at the northwest corner of the PF-AR was constructed in 2001, in which two undulator based beamlines and one bending source beamline have been installed.

In the past decade, these two rings have been operated 5,000-5,400 hrs per year, except for 2005. There are 59 experimental stations on the 2.5-GeV Ring and 10 on the PF-AR. There are about 700 active approved proposals, and 3000 registered users in every fiscal year except for 2005, in which we had a long shutdown of nine months. The number of scientific publications based on these proposals is around 500 per year for these several years.

It is very important for the Photon Factory to be reviewed periodically, for example, every 5-6 years. We had two major external reviews in 1996 and 2001, and the present review is the third one. The first review committee, chaired by Prof. Akito Arima, acknowledged that the PF had contributed to the evolution of synchrotron

radiation activities in Japan, including the development of accelerator technology, experimental instrumentation, beamline technology and new experimental methodologies. Furthermore, the committee made some advisory recommendations on the way forward of the PF: (1) to promote in-house staff's opportunities for their own researches, (2) to encourage project-type research, (3) to promote international collaborations, and (4) to make a further and stronger commitment to the education of graduate students. The committee also pointed out that the PF should start discussions about a new synchrotron radiation facility with a third or fourth generation light source. The second committee, directed by Prof. Haruo Kuroda, evaluated the activities mainly in the period 1996-2000 and gave the recommendations as follows: (1) investigation of a new light source replacing the present two storage rings, (2) concentration on carrying out material and life science rather than the effort aiming at the forefront of synchrotron radiation science, (3) realization of beamlines dedicated for a specific purpose equipped with a well served environment, (4) contribution to the society with substantial publicity activities, activation of industrial application of synchrotron radiation, and service of wide-use beamlines, (5) activation of the scientific activities by the in-house staff members of the PF. The actions of the PF to the advisory recommendations raised by these two review committees are found in the brief summaries of the PF activities prepared for the review committee held in 2001 and the present committee.

New third-generation light sources have been and/or are being constructed around the world, such as SLS, DIAMOND and SOLEIL in addition to ESRF, APS, ALS, BESSY II and Elettra. In Japan, SPring-8, a third-generation X-ray light source, became operational in 1997 and experimental opportunities for Japanese X-ray users have almost doubled. It is very sure that the success of the Photon Factory promoted to realize the SPring-8, where they made full use of ripe experience to handle SR acquired at the PF. It should be mentioned that construction of small synchrotron radiation facilities in Japan are strongly associated with the high level scientific output at the PF. As advised by the second review committee, the role of the PF in the Japanese synchrotron radiation community can not be the same now as it was before the construction of SPring-8. It is already 24 years since the first SR beam was extracted from the 2.5-GeV Ring. Accordingly, the hardware and design concept of the PF facilities become old. Construction of a new light source is essential to solve this problem. The discussion of the new light source was started in 1997 after the first review committee, and we have just arrived at a point to propose an energy recovery linac (ERL) as a next light source of the PF. The details of ERL will be mentioned later in this report. There are a lot of technological difficulties to be solved, and it may

take several years to realize an ERL of several GeV, which can supply spatially coherent beam up to hard X-ray region. In parallel with the feasibility study by a prototype ERL of a few hundred MeV, we are about to make the best use of the lengthened and newly created straight sections of the 2.5-GeV Ring. Renewal of the beamlines and undulators at the two 9-m straight sections is very important to support the activities of material science using VUV and soft X-ray beam. The four short straight sections are attractive for X-ray research fields with short gap undulators.

The PF would like to receive, from the present review committee, comments and advice that will be useful and helpful in making better plans to improve the facilities and activities of the PF, and also in establishing strategies for our future directions. A review of beamlines would certainly be useful in obtaining information and guidelines for redistributing resources and manpower.

In this report, we summarize the activities of the Photon Factory mainly for the period 2000-2005, and the future plans involving a possible light source of the next generation. Following the Introduction, in Chapter 2, we show the present status of the Photon Factory, in which we touch on the organization, the user experimental program, the in-house staff members' research activities, the international collaboration and the educational program. In Chapter 3 is shown the detailed description of light source development for these several years done at the 2.5- and 6.5-GeV storage rings. In Chapter 4, we mention the development of beamlines, including replacement and improvement of the old and less effective ones. Scientific activities in various research fields for the period 2000-2005 are summarized in Chapter 5. Finally, in Chapter 6, we would like to refer to the future prospect of the Photon Factory, laying emphasis on a possible ERL based light source of the next generation.

Finally, we would like to express our sincere gratitude to all of those who prepared the manuscripts for this report.