SPring-8

I. Introduction

General

As one of the most advanced COEs of photon science in the world, SPring-8 was fully operational during FY2013. The accelerator complex ran reliably with an extremely short downtime of 20 hours and an annual operation time of 4265 hours as described in the following chapters. Due to this excellent availability, the total number of users visiting SPring-8 in FY 2013 for their experiments was 13,381, bringing the total since the inauguration in 1997 to 168,107. By using the achievements of R&D, the electron storage ring began operating with a lower emittance in May 2013. To improve energy efficiency, the cooling water and air-conditioning systems of the accelerator complex were completely renovated in the beginning of 2014.

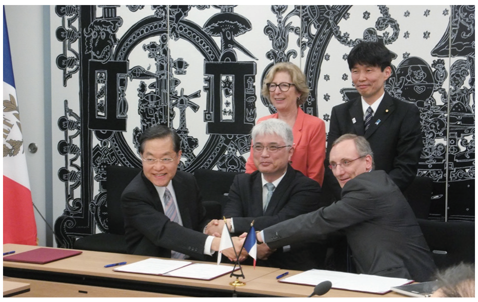
Review

At the national level, the Ministry of Education, Culture, Sports, Science and Technology conducted an intensive review of SPring-8 from April–September 2013. According to the official report, the committee identified five priorities for the next five years:
(1) SPring-8 should deepen its cooperation with the user community, promote its infrastructure upgrades and users support, expand the user base, and enhance human resource development in related areas.
(2) By offering opportunities for technology exchanges, SPring-8, as a COE of Japan, should organically link "knowledge" and "challenge" that universities, research institutes and companies possess, thereby promoting innovative research outcomes.
(3) In parallel to strengthening international collaborations, SPring-8 should cooperate with the *Photon Beam Platform* as well as other *Specific Advanced Large Research Facilities* in Japan, and attempt to create novel users and to strengthen user support.
(4) RIKEN and JASRI, as the owner and the Registered Institution of Facilities Use Promotion of SPring-8, respectively, should enhance their self-inspections in a unified manner.
(5) Systematically maintaining its scientific infrastructure further to realize stable operations, SPring-8 should improve its operational efficiency and attempt to elongate its user time.

As the Registered Institution of Facilities Use Promotion of SPring-8, JASRI itself also conducted interim reviews for the following contact beamlines; (i) BL07LSU University-of-Tokyo Synchrotron Radiation Outstation (The University of Tokyo), (ii) BL15XU WEBRAM (National Institute for Materials Science), (iii) BL16XU SUNBEAM ID (SUNBEAM Consortium), (iv) BL16B2 SUNBEAM BM (SUNBEAM Consortium), (v) BL24XU Hyogo ID (Hyogo Prefecture), (vi) BL33XU TOYOTA (TOYOTA Central R&D Lab., Inc.), and (vii) BL44XU Macromolecular Assemblies (Institute for Protein Research, Osaka University). In reference to their excellent organizations and outstanding achievements, JASRI approved the continuations of all the beamlines reviewed.

International Collaborations

When the French President, Monsieur Francois Hollande, visited Japan, there was a signing ceremony held at the French Embassy in Tokyo in June 2013, in order to conclude a Memorandum of Understanding between SOLEIL, RIKEN SPring-8 Center, and JASRI. Also in attendance were Mr. Ichita Yamamoto, Minister of State for Science and Technology Policy, and the French Minister for Higher Education and Research, Mrs. Geneviève Fioraso.



Signing ceremony held at the French Embassy in Tokyo in June 2013 to conclude a Memorandum of Understanding between SOLEIL, RIKEN SPring-8 Center, and JASRI.

To mutually advance research and achievements through regional collaboration, the Asia-Oceania Forum for Synchrotron Radiation Research has played an

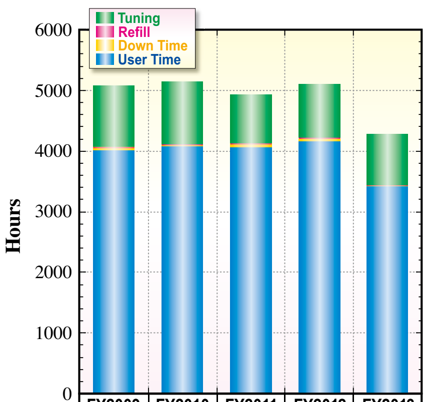
Asia-Oceania Forum for Synchrotron Radiation Research 2013 held on September 21-24, 2013 at Himeji.

important role. Started in 2006 at KEK, Japan, the member states have organized an annual forum. The forum returned to Japan when the Japanese Society for Synchrotron Radiation Research and SPring-8 co-hosted it in combination with the Cheiron School, calling the entire event the Cheiron Week. Honored by the presence of Mr. Kisaburo Tokai, the Chairman of the Special Committee on Promotion of Science and Technology, and Innovation, the House of Representatives, the forum was held September 21-24, 2013 at Himeji. For the 160 participants, the forum was highly informative, especially for young scientists and engineers from the region.

II. Machine Operation

The operation statistics for last five fiscal years are shown in Fig. 1. In FY2013, the total operation time of the accelerator complex was 4280.9 h. The operation time of the storage ring was 4265.4 h, 79.9% of which (3408.5 h) was available for SR experiments. The downtime resulting from failure accounted for 0.58% (20 h) of the total user time, and no great loss of user time exceeding several hours occurred. The operation time for FY2013 was about 1000 h less than a typical fiscal year, due to the large-scale renovations of the aging utilities of the cooling water and air-conditioning system. However, with the top-up injection, a high availability (ratio of net user time to the planned user time) was achieved (e.g., 99.3% for FY2013). The total tuning and study time of 852.5 h was used for machine tuning, for the studies of the linac, booster synchrotron and storage ring, and also for the beamline tuning and study.

Operations in two different filling modes were provided for the following user time: 54.6% was several-bunch mode, such as the mode of 29 equally spaced trains of 11 bunches) and 45.4% was hybrid filling mode, such as the mode of 1/14-partially filled multi-bunch with 12-isolated bunches. The multi-bunch mode was not operational in FY2013, and the several bunch mode was the predominant filling mode. The 203-bunch mode and the mode of 29 equally spaced trains of 11 bunches reached 25.8% and 28.8% of the total user time, respectively. The new hybrid-filling mode of 11/29-partially filled multi-bunch with a 5.0-mA isolated bunch. For the hybrid filling mode, 1.6 mA, 3.0 mA, or 5.0 mA is stored in each isolated bunch. An isolated bunch impurity better than 10^{-10} is routinely maintained in the top-up operation. Table I summarizes of the useful beam parameters of the storage ring, while Table II summarizes the beam filling patterns.



	FY2009	FY2010	FY2011	FY2012	FY2013
Accelerator Operation Time	5168.8	5125.6	4918.6	5078.8	4280.9
Storage Ring Operation Time	5035.4	5096.3	4904.2	5063.1	4265.4
Tuning & Study (Acc. & BL)	1019.1	1026.6	803	884	852.4
Refill	6.3	5.0	4.4	5.2	3.5
Down Time	34.8	27.5	57	39.2	20
Mean Time Between Failures	122.9	178.4	117.7	107.7	214.5
Achieved User Time	4014.9	4071.6	4058.5	4155.6	3408.5
Planning User Time	4056.0	4104.0	4120.0	4200.0	3432.0
Availability (%)	99.0	99.2	98.5	98.9	99.3

Fig. 1. Operation statistics for most recent five fiscal years.

Table I. Beam parameters of SPring-8 storage ring

Energy [GeV]	8
Number of buckets	2436
Tunes (ν_x / ν_y)	40.14 / 19.35
Current [mA]:	
single-bunch	12
multi-bunch	100
Bunch length (σ) [psec]	13
Horizontal emittance [nm·rad]	2.4 *
Vertical emittance [pm·rad]	4.8 *
Coupling [%]	0.2
RF Voltage [MV]	16
Momentum acceptance [%]	~3
Beam size (σ_x / σ_y)* [μm]	
Long ID section	333 / 7
ID section	316 / 5
BM1 section	94 / 12
BM2 section	100 / 12
Beam divergence (σ_x' / σ_y')* [μrad]	
Long ID section	8 / 0.7
ID section	9 / 1.0
BM1 section	58 / 0.5
BM2 section	68 / 0.5
Operational chromaticities (ξ_x / ξ_y)	+2 / +2 **
Lifetime [h]:	
100 mA (multi-bunch)	~200
1 mA (single-bunch)	~20
Horizontal dispersion [m]:	
Long ID section	0.153
ID section	0.146
BM1 section	0.039
BM2 section	0.059
Fast orbit stability (0.1 – 200 Hz) [μm]:	
horizontal (rms)	~4
vertical (rms)	~1

* Assuming 0.2% coupling
** With bunch-by-bunch feedback

Table II. Filling patterns in FY2013

	bunch current (mA)	lifetime (h)
203 bunches	0.5	25 ~ 30
11 bunch-train × 29	0.3	35 ~ 50
11/29 - filling + 1 single bunch	5.0 (single)	40 ~ 50
1/7 - filling + 5 single bunches	3.0 (single)	18 ~ 25
1/14 - filling + 12 single bunches	1.6 (single)	18 ~ 25