SPring-8

I. Introduction

It was the last year that SPring-8 celebrated the 20th anniversary since its start of operation in 1997. SPring-8 was stably operated throughout 2017 with the total operation time of the accelerator complex and the total user beam time of 5281.6 h and 4478.7 h, respectively, with the total down time of 29 h. SPring-8 had to complete all its operations by the middle of February 2018.

Regarding its research proposal system, SPring-8 designated the Cross-SR Facility Use Proposals for Industrial Application as a priority field of the priority research program on 25 September 2017. Concerning the contract beamlines, there were five interim reviews conducted for Research Center for Nuclear Physics, Osaka University (BL33LEP I), and the project was authorized to continue. Upon the expiration of their contract terms, reviews were also conducted for SUNBEAM Consortium (BL16B2, BL16XU), Hyogo ID (BL24XU, Hyogo Prefecture), and their proposals for the next term were approved.

At present, SPring-8 users number is as many as 13,000, all of whom are members of the SPring-8 User Community (SPRUC).

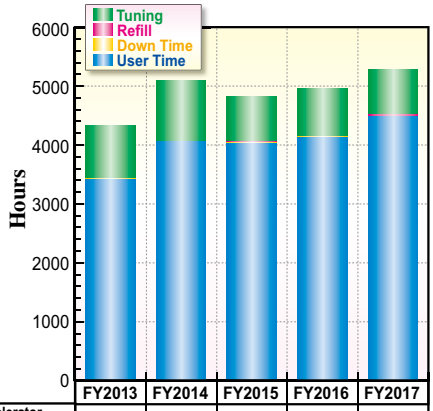
It is important for SPring-8 to jointly organize scientific events with SPRUC, such as the SPring-8 Symposium, to facilitate dialogue between users and the facility staff. In 2017, the SPring-8 Symposium was held at Hiroshima University on September 4–5, with a participant number of 267. SPring-8 also accelerates communication between users and the industry. The Joint Conference on Industrial Applications of SPring-8 was held in Kawasaki on August 31 to September 1, 2017, with 258 participants. As part of its continuous effort towards fostering of human resources in synchrotron sciences, SPring-8 organized the 17th SPring-8 Summer School with 90 students of graduate schools nationwide, in cooperation with Hyogo University, Kwansei Gakuin University, the University of Tokyo, Okayama University, Osaka University, Japan Atomic Energy Agency, National Institutes for Quantum and Radiological Science and Technology, and RIKEN. Furthermore, SPring-8 and SPRUC organized the 1st SPring-8 Autumn School with 43 participants which included 3rd year university students and researcher of companies.

II. Machine Operation

The operation statistics for the last five fiscal years are shown in Fig. 1. In FY2017, the total operation time of the accelerator complex was 5281.6 h. The operation time of the storage ring was 5270.4 h, 85.0% of which (4478.7 h) was for SR experiments. This excellent figure of the user time represents a storage ring availability of 99.3%, and a remarkable availability higher than 99% has been accomplished throughout the last five fiscal years. The downtime resulting from failure accounted for 0.64% (28.7 h) of the total user time. The intensity of the light source, i.e., the stored current is kept extremely stable within 0.1% thanks to the top-up operation, in which the current is filled up at any time on demand. In 93.4% of the user time in FY2017 the stored current stayed at 100 mA by the top-up operation, but in 5.8% at 70 mA as a result of failure of the RF system.

The variety of operation modes for SR experiments is one of the characteristics of SPring-8. The operation modes are grouped into several-bunch, and hybrid-filling modes. Several-bunch mode consists of equally spaced bunches or bunch-trains, i.e., 203 bunches, or 29 trains of 11 bunches, and hybrid-filling mode is composed of long bunch train and isolated single bunches as shown in Table 1, where a share of each operation mode is also shown. An isolated bunch impurity is routinely maintained better than 10^{-8} in the top-up operation by the bunch cleaning in the booster. The bunch current is also kept constant within 1% by means of the top-up operation. In the operation of the “11/29-filling+1single bunch” mode in the 8th cycle, failure of the timing system incurred a shift of the injection timing signal by one RF bucket, and it disabled us from maintaining the 5 mA single bunch for about 40h.

Table 2 summarizes the beam parameters of the storage ring.



	FY2013	FY2014	FY2015	FY2016	FY2017
Accelerator Operation Time	4330.0	5099.3	4817.9	4951.7	5281.6
Storage Ring Operation Time	4265.4	5080.7	4804.8	4941.1	5270.4
Tuning & Study (Acc. & BL)	898.0	1019.3	767.2	803.1	769.6
Refill	3.5	5.1	5.3	3.4	4.6
Down Time	20.0	17.1	16.8	23.1	28.7
Mean Time Between Failures	213.0	163.2	202.8	229.2	194.7
Achieved User Time	3408.5	4057.8	4033.9	4125.5	4478.7
Planning User Time	3432.0	4080.0	4056.0	4152.0	4512.0
Availability (%)	99.3	99.5	99.5	99.4	99.3

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

Table 1. Operation modes in FY2017

	Single bunch current (mA)	Share of operation time (%)
203 bunches		18.1
4 bunch-train × 84		7.4
11 bunch-train × 29		20.7
1/7-filling + 5 single bunches	3	8.0
2/29-filling + 26 single bunches	1.4	3.2
1/14-filling + 12 single bunches	1.6	14.4
4/58-filling + 53 single bunches	1	6.4
11/29-filling + 1 single bunch	5	21.8

Table 2. Beam parameters of SPring-8 storage ring

Energy [GeV]	8
Number of buckets	2436
Tunes (ν_x / ν_y)	41.14 / 19.34
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]	14.4** ~ 16
Momentum acceptance [%]	3.2 (~256 MeV)
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 [hr]:	
100 mA (multi bunch)	~ 250
1 mA (single bunch)	~ 30
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
** Power saving mode
*** With bunch-by-bunch feedback

III. Beamlines

The SPring-8 storage ring can accommodate up to 62 beamlines: 34 insertion devices, 4 long undulators, and 24 bending magnets. At present, 57 beamlines are in operation, covering a wide variety of research fields involving synchrotron radiation science and technology. The beamlines are classified into the following three types.

(1) Public Beamlines (26 beamlines operating)
(2) Contract Beamlines (19 beamlines operating)
(3) RIKEN Beamlines (12 beamlines operating)

There are now 26 public beamlines in full operation. The beamlines that are proposed and constructed by external organizations, such as universities, research institutes, private companies and consortiums, are called contract beamlines and are exclusively used by the contractors for their own research purposes. At present, 19 contract beamlines are in operation. The beamlines constructed by RIKEN except for public beamlines are called RIKEN beamlines, and are mainly used for RIKEN's own research activities, with partial availability for public use. RIKEN is now operating 12 beamlines.