

II. Machine Operation

The operation statistics for the last five fiscal years are shown in Fig. 1. In FY2019, the total operation time of the entire SPring-8 accelerator complex was 5285.7 h. The operation time of the storage ring was 5271.2 h, 86.1% of which (4537.9 h) was devoted to SR experiments. This excellent figure for the user time represents a storage ring availability of 99.0%. The total downtime caused by failures amounted to 40.5 h, accounting for 0.89% of the total user time. For 99.5% of the user time in FY2019, the stored beam current was maintained at 100 mA by the top-up operation wherein the stored beam was filled up on demand at any time. The extreme stability of the light source intensity better than 0.1% was provided by the top-up operation.

The variety of operation modes for SR experiments is one of the characteristics of SPring-8. The operation modes are classified into two types, the several-bunch and hybrid-filling modes. The several-bunch mode consists of equally spaced bunches or trains of bunches such as 203 bunches or 29 trains of 11 bunches. The hybrid-filling mode is composed of a long train of bunches and isolated single bunches. The isolated bunch current is kept constant within 1% through the top-up operation. The isolated bunch impurity is routinely maintained better than 10^{-8} by the bunch cleaning system in the booster. The operation modes of SPring-8 are listed in Table 1 with the share of each operation mode in FY2019. Table 2 summarizes the beam parameters of the storage ring.

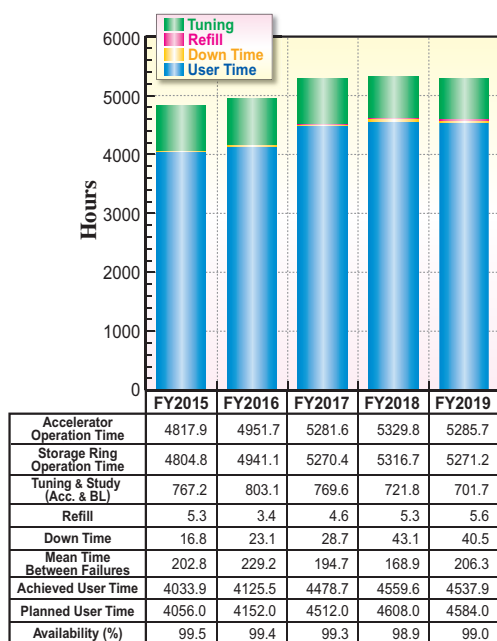


Fig. 1. Operation statistics for last five fiscal years.

Table 1. Operation modes in FY2019

	Single bunch current (mA)	Share of operation time (%)
203 bunches		31.4
4 bunch-train × 84		3.1
11 bunch-train × 29		22.5
1/7-filling + 5 single bunches	3	7.3
2/29-filling + 26 single bunches	1.4	3.1
1/14-filling + 12 single bunches	1.6	9.4
4/58-filling + 53 single bunches	1.0	2.1
11/29-filling + 1 single bunch	5	20.9

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 [μ m-rad]	4.8*
Coupling [%]	0.2
RF Voltage [MV]	14.4** ~ 16
Momentum acceptance [%]	3.2 (~256 MeV)
Beam size (σ_x / σ_y)* [μ m]	
Long ID section	333 / 7
ID section	316 / 5
BM1 section	94 / 12
BM2 section	100 / 12
Beam divergence (σ'_x / σ'_y)* [μ rad]	
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) [μ m]:	
horizontal (rms)	~ 4
vertical (rms)	~ 1

* Assuming 0.2% coupling

** Power saving mode

*** With bunch-by-bunch feedback