

## II. Machine Operation

The operation statistics for the last five fiscal years are shown in Fig. 1. In FY2022, the operation time of the storage ring was 5259.3 h, 84.0% of which (4416.0 h) was devoted to the SR experiments. This excellent figure for the user time represents a storage ring availability of 99.5%. The total downtime caused by failures amounted to 19.7 h accounting for 0.45% of the total user time. For 99.4% of the user time in FY2022, the stored beam current was maintained at 100 mA via the top-up operation wherein the stored beam was filled up on demand at any time. Extreme stability of the light source intensity better than 0.1% was provided by the top-up operation.

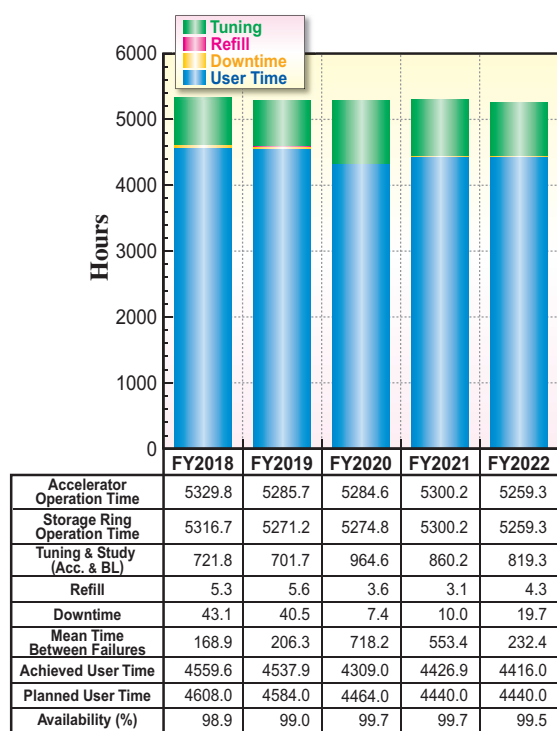


Fig. 1. Operation statistics for five most recent fiscal years.

Table 1. Operation modes in FY2022

	Single bunch current (mA)	Share of operation time (%)
203 bunches		39.5
4 bunch-train × 84		7.0
11 bunch-train × 29		17.8
1/7-filling + 5 single bunches	3	6.5
2/29-filling + 26 single bunches	1.4	0
1/14-filling + 12 single bunches	1.6	6.5
4/58-filling + 53 single bunches	1.0	3.2
406 × 11/29-filling + 1 single bunch	5	19.5

The variety of operation modes for SR experiments is one of the characteristics of SPring-8. The operation modes are classified into two types: several-bunch and hybrid-filling modes. The several-bunch mode comprises equally spaced bunches or trains of bunches such as 203 bunches or 29 trains of 11 bunches. Whereas, the hybrid-filling mode is composed of a long train of bunches and isolated single bunches. Sufficient isolated bunch purity is maintained by the SACLA linac's spurious bunch sweeper and the storage ring's bunch cleaning system. The operation modes of SPring-8 are listed in Table 1, along with a share of each operation mode for FY2022. Table 2 summarizes the beam parameters of the storage ring.

Table 2. Beam parameters of SPring-8 storage ring

Energy [GeV]	8
Number of buckets	2436
Tunes ( $\nu_x / \nu_y$ )	41.14 / 19.325
Current [mA]:	
single bunch	12
multi bunch	100
Bunch length ( $\sigma$ ) [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 ( $\sigma_x / \sigma_y$ )* [ $\mu\text{m}$ ]	
Long ID section	333 / 7
ID section	316 / 5
BM1 section	94 / 12
BM2 section	100 / 12
Beam divergence ( $\sigma_x' / \sigma_y'$ )* [ $\mu\text{rad}$ ]	
Long ID section	8 / 0.7
ID section	9 / 1.0
BM1 section	58 / 0.5
BM2 section	68 / 0.5
Operational chromaticities ( $\xi_x / \xi_y$ )	+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) [ $\mu\text{m}$ ]:	
horizontal (rms)	~ 4
vertical (rms)	~ 1

\* Assuming 0.2% coupling

\*\* Power saving mode

\*\*\* With bunch-by-bunch feedback