

## II. Machine Operation

The operation statistics for the last five fiscal years are shown in Fig. 1. In the FY2014, total operation time of the accelerator complex was 5099.3 h. The operation time of the storage ring was 5080.7 h, 79.9% of which (4057.8 h) was available for SR experiments. The downtime resulting from failure accounted for 0.42% (17.1 h) of the total user time, and no great loss of user time exceeding several hours occurred. Although the operation time for FY2013 was about 800 h less than that for a typical fiscal year due to the large-scale renovations of the aging cooling water and air-conditioning systems, that for FY2014 was restored to the average.

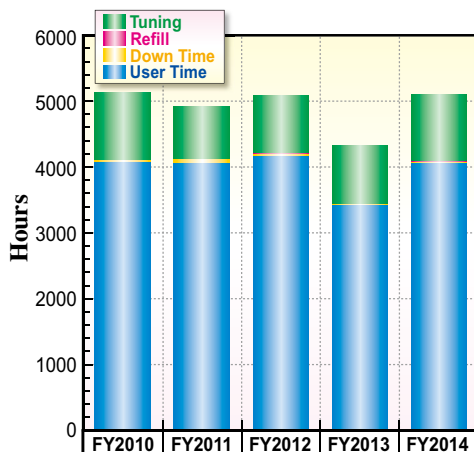
A variety of operation modes is one of the characteristics of SPring-8. The operation modes are grouped into the multi-bunch mode, several-bunch mode, and hybrid-filling mode. There has been no user operation with the multi-bunch mode since FY2011. The several-bunch mode consists of equally spaced bunches or bunch-trains, i.e., 203 bunches, or 29 trains of 11 bunches, and the hybrid-filling mode is composed of a long bunch train and isolated single bunches, as shown in Table 1, where the shares of user time of the operation modes are also shown. The new operation mode of

11/29-filling + 1 single bunch, which started user operation in 2012, plays an important role. A bunch impurity of less than  $10^{-8}$  is routinely maintained in the top-up operation. Table 2 summarizes the useful beam parameters of the storage ring.

Table 1. Beam parameters of SPring-8 storage ring

Energy [GeV]	8
Number of buckets	2436
Tunes ( $\nu_x/\nu_y$ )	41.14 / 19.34
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]	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 [h]:	
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  
 \*\* With bunch-by-bunch feedback



	FY2010	FY2011	FY2012	FY2013	FY2014
Accelerator Operation Time	5125.6	4918.6	5078.8	4330.0	5099.3
Storage Ring Operation Time	5096.3	4904.2	5063.1	4265.5	5080.7
Tuning & Study (Acc. & BL)	1026.6	803.0	884.0	898.0	1024.7
Refill	5.0	4.4	5.2	3.5	5.1
Down Time	27.5	57.0	39.2	20.0	17.1
Mean Time Between Failures	178.4	117.7	107.7	213.0	163.2
Achieved User Time	4071.6	4058.5	4155.6	3408.5	4057.8
Planning User Time	4104.0	4120.0	4200.0	3432.0	4080.0
Availability (%)	99.2	98.5	98.9	99.3	99.5

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

Table 2. Filling patterns in FY2014

	Single bunch current (mA)	Share of operation time
203 bunches		22.4%
11 bunch-train × 29		31.8%
1/7-filling + 5 single bunches	3 mA	10.0%
2/29-filling + 26 single bunches	1.4 mA	0.0%
1/14-filling + 12 single bunches	1.6 mA	12.4%
4/58-filling + 53 single bunches	1 mA	2.9%
11/29-filling + 1 single bunch	5 mA	20.6%