

## II. Machine Operation

The operation statistics since the facility was opened to users are shown in Fig. 1. In 2009, the total operation time of the accelerator complex was 5025.9 hours. The operation time of the storage ring was 4990.4 hours, of which 79.5% (3967.9 hours) was made available for SR experiments. The down time resulting from failure accounted for 0.87% (34.4 hours) of user time; in 2009, no great loss of user time exceeding several hours occurred. Since 2004, there has been no injection time because top-up injection was introduced. Concerning user service operation, a high availability (ratio of net user time to planned user time), e.g., 99.0%, was achieved in 2009. The total tuning and study time of 1023.6 hours was used for machine tuning, for the study of the linac, booster synchrotron and storage ring, and also for beamline tuning and study.

Operations in three different filling modes were provided for the following user time: 14.3% in the multi-bunch mode, 40.2% in the several bunch mode, such as the 203-bunch mode (203 equally spaced bunches), and 45.5% in the hybrid filling mode, such as a 1/14-partially filled multi-bunch with 12-isolated bunches. In 2009, the several bunch mode was the dominant filling mode. In particular, the 203-bunch mode reached 23.9% of the total user time. For the hybrid filling mode, 1.0 mA, 1.4 mA, 1.6 mA, or 3.0 mA is stored in each isolated bunch. An isolated bunch impurity lower than  $10^{-10}$  is routinely maintained in the

top-up operation. Table I shows a summary of the useful beam parameters of the storage ring. Table II shows a summary of the beam filling patterns.

Table I. Beam parameters of SPring-8 storage ring

|   |                          |
|---|--------------------------|
| Energy [GeV]  | 8                        |
| Number of buckets   | 2436                     |
| Tunes ( $\nu_x / \nu_y$ )   | 40.15 / 18.35            |
| Current [mA]:   |                          |
| single bunch  | 12                       |
| multi bunch   | 100                      |
| Bunch length ( $\sigma$ ) [psec]  | 13                       |
| Horizontal emittance [nm-rad]   | 3.4 *                    |
| Vertical emittance [pm-rad]   | 6.8 *                    |
| Coupling [%]  | 0.2                      |
| RF Voltage [MV]   | 16                       |
| Momentum acceptance [%]   | $\pm 3$ ( $\pm 240$ MeV) |
| Beam size [ $\mu\text{m}$ ]: ( $\sigma_x / \sigma_y$ ) <sup>a</sup> [ $\mu\text{m}$ ]             |                          |
| Long ID section   | 294 / 10                 |
| ID section  | 301 / 6                  |
| BM section  | 107 / 13                 |
| Beam divergence [ $\mu\text{rad}$ ]: ( $\sigma_x' / \sigma_y'$ ) <sup>a</sup> [ $\mu\text{rad}$ ] |                          |
| Long ID section   | 13 / 0.7                 |
| ID section  | 12 / 1.1                 |
| BM section  | 56 / 0.6                 |
| Operational chromaticities: ( $\xi_x / \xi_y$ )   | +2 / +6 **               |
| Lifetime [h]:   |                          |
| 100 mA (multi-bunch)  | ~200                     |
| 1 mA (single bunch)   | ~20                      |
| Horizontal dispersion [m]:  |                          |
| Long ID section   | 0.103                    |
| ID section  | 0.107                    |
| BM section  | 0.032                    |
| Fast orbit stability (0.1 – 200 Hz) [ $\mu\text{m}$ ]:  |                          |
| horizontal (rms)  | ~4                       |
| vertical (rms)  | ~1                       |

\* Assuming 0.2% coupling for "Low Emittance Optics"  
\*\* With bunch-by-bunch feedback

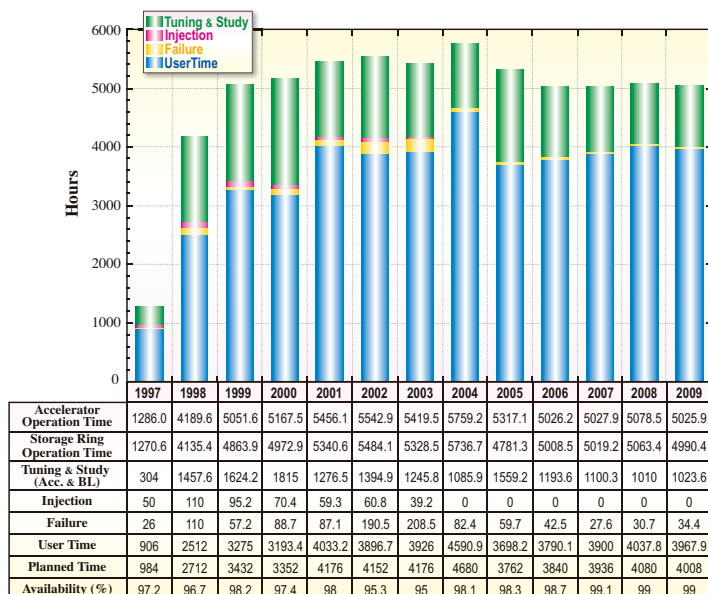


Fig. 1. Operation statistics since the facility became available to users.

Table II. Filling patterns

|                                    | bunch current (mA) | life time (h) |
|------------------------------------|--------------------|---------------|
| Multi-bunch (160 bunch-train × 12) | 0.05               | ~ 200         |
| 203 bunches                        | 0.5                | 25 ~ 30       |
| 11 bunch-train × 29                | 0.3                | 35 ~ 50       |
| 1/7 - filling + 5 single bunches   | 3.0 (single)       | 18 ~ 25       |
| 1/14 - filling + 12 single bunches | 1.6 (single)       | 18 ~ 25       |
| 2/29 - filling + 26 single bunches | 1.4 (single)       | 18 ~ 25       |
| 4/58 - filling + 53 single bunches | 1.0 (single)       | 18 ~ 25       |