Machine Operation

The operation statistics since the facility was opened to users are shown in Fig. 1. Recently, the SPring-8 storage ring has been operated on four- or five-week periods for one operation cycle. In 2004 and 2005, long-term operation cycles were also performed. In 2005, the total operation time of the accelerator complex was 5317.1 hours. The operation time of the storage ring was 4781.3 hours, of which 77.3% (3698.2 hours) was made available to the users. The down time due to failure accounted for 1.2% (59.7 hours) of the operation time of the storage ring; in 2005, there was no great loss of user time exceeding several hours. Since 2004, there has been no injection time because top-up injection was being introduced. For the user service operation, a high availability (ratio of net user time to planned user time) was achieved, e.g., 98.3% in 2005. The tuning and study time of 1559.2 hours was used for machine tuning, and the study of the linac, booster synchrotron and storage ring, and also used for beamline tuning and study. From January to March 2005, the storage ring operation was suspended because the roof of the storage ring building, which was damaged by typhoons in September 2004, was under full-scale repair. In 1559.2 hours, 522.4 hours of the beam study of the linac and the booster synchrotron were included during these periods of standstill of the storage ring operation.

The operations in three different filling modes were provided for the user time: 15.9% in the multi-bunch mode, 44.7% in the several bunch mode, such as the 203-bunch mode (203 equally spaced bunches) and 39.4% in the hybrid filling mode such as a 1/12-partially filled multi-bunch with 10-isolated bunches. For the hybrid filling mode, 0.7 or 1.5 mA is stored in each isolated bunch. An isolated bunch purity of better than 10^{-9} is routinely maintained in the top-up operation.

Table I presents a summary of the useful beam parameters of the storage ring. The ring optics was returned to 3 nm·rad low emittance optics in September 2005 for user time with a top-up operation. The low emittance optics was realized by breaking the achromatic condition in the unit cell.

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Accelerator Operation Time	1286	4189.6	5051.6	5167.5	5456.1	5542.9	5419.5	5759.2	5317.1
Storage Ring Operation Time	1270.6	4135.4	4863.9	4972.9	5340.6	5484.1	5328.5	5736.7	4781.3
Tuning & Study (Accel. & BL)	304	1457.6	1624.2	1815	1276.5	1394.9	1245.8	1085.9	1559.2
Injection	50	110	95.2	70.4	59.3	60.8	39.2	0	0
Failure	26	110	57.2	88.7	87.1	190.5	208.5	82.4	59.7
User Time	906	2512	3275	3193.4	4033.2	3896.7	3926	4590.9	3698.2
Planned Time	984	2712	3432	3352	4176	4152	4176	4680	3762
Availability (%)	97.2	96.7	98.2	97.4	98	95.3	95	98.1	98.3

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

Table I. Beam parameters of SPring-8 storage ring.

Energy [GeV]	8
Number of buckets	2436
Tunes (ν_x / ν_y)	40.15 / 18.35
Current [mA]:	
single bunch	10
multi bunch	~100
Bunch length (σ) [psec]	13
Horizontal emittance [nm·rad]	3.4 *
Vertical emittance [pm·rad]	6.8 *
Coupling [%]	0.2
RF Voltage [MV]	16
Momentum acceptance [%]	±2.5 (= ±200 MeV)
Beam size[μm]: (σ_x / σ_y) [μm]	
Long ID section	294 / 10
ID section	301 / 6
BM section	107 / 13
Beam divergence [μrad]: ($\sigma_{x'}$ / $\sigma_{y'}$) [μrad]	
Long ID section	13 / 0.7
ID section	12 / 1.1
BM section	56 / 0.6
Operational chromaticities: (ξ_x / ξ_y)	+2 / +2 **
Lifetime [hr]:	
100 mA (multi bunch)	~ 200
1 mA (single bunch)	~ 15
Horizontal dispersion [m]:	
Long ID section	0.103
ID section	0.107
BM section	0.032
Fast orbit stability (0.1 – 200 Hz)[μm]:	
horizontal (rms)	~ 4
vertical (rms)	~ 1

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

BEAMLINES

The electron storage ring of the SPring-8 accelerator complex can potentially accommodate 62 beamlines (34 insertion devices, 4 long undulators, 23 bending magnets and 1 infrared). Occupying about 75% of its full capacity, there are 48 beamlines currently in operation as shown in Beamline map (Fig. 2) and List of beamlines (Table II).

These beamlines are primarily categorized into following four groups;
(1) Public Beamlines,
(2) Contract Beamlines,
(3) RIKEN Beamlines, and
(4) Accelerator Beam Diagnosis beamlines.

Constructed by JAERI[1] and RIKEN with governmental grants, Public Beamlines have been operated for public use. Now there are 25 public beamlines in operation; 22 X-ray beamlines, two soft X-ray beamlines and one infrared beamline. Among them, three beamlines had been specifically used for R&D. According to the recommendation made by R&D Beamline Review Committee, however, all the R&D beamlines have changed their status to general use since the period of 2005A, although one of them (BL46XU) is still kept for R&D programs as an interim measure.

The contract beamlines are installed, owned,