Accelerator Division -General-

1. Machine Operation

The major studies in this year have been to improve the beam performance and to increase the beam availability (the integrated brilliance) as high as possible. SPring-8 is being operated at a maximum beam current of 100 mA by two- or three-week period for one cycle. The total operation time is about 5050 hours. About 68% of the operation time is available to the users, 23.5% is dedicated to the tuning of accelerators and photon beamlines, and the remaining 8.5% is used to the machine study to improve the beam performance. The beam availability for the user service is about 96% and the remaining 4% is machine failure (1.7%) and beam refill time (2.3%).

The storage ring is being operated by three kinds of filling pattern as follows,

- multibunch mode with a partial filling such as 24/29 filling,
- several bunch mode such as 21 bunch mode (21 equally spaced 3 or 7 bunches train),
- hybrid mode such as (several bunch mode + multibunch mode).

50 % of the total user time was operated by the multibunch mode to eliminate an emittance growth of the electron beam due to an ion-trapping effect. 25% was done by the several bunch modes and the remaining 25% was done by the hybrid mode. Standard bunch current is 0.05 mA/bunch in the multibunch mode and 0.5 to 2mA/bunch in the several bunch modes. The maximum bunch current in a single bunch mode is about 16 mA. This current is limited by the deterioration of vacuum pressure due to heating of the bellows port.

Electron beam refilling is done twice a day while operating in the several bunch modes and once a day in the multibunch mode. Beam refilling does not always require killing the stored beam. The refill consists of a topping-up with an injection efficiency of more than 97% under a vertical acceptance of ±7.5mm. Each refilling time is about 25 minutes.

2. Beam Performance of Storage Ring and Upgrades

Last summer, the optics of the storage ring was changed from the hybrid optics to "HHLV" optics. The hybrid optics has a high horizontal β value at the straight section of every odd cell, and a low horizontal β value at every even cell. This optics was optimized for the beam commissioning to reduce the effect on beam instability due to the installation of RF cavities and wigglers in the low β section. The HHLV optics has "<u>H</u>igh <u>H</u>orizontal β value and <u>L</u>ow <u>V</u>ertical β value" at all straight sections, and was installed to improve effectively the brilliance for undulator use at the low beta section in the hybrid optics. After fine-tuning of the HHLV optics, the beam performance has achieved comparable level to hybrid optics.

A fourth RF station has been installed in the storage ring to improve the Touschek lifetime, especially in several bunch modes. Due to this installation, the total beam lifetime in HHLV optics has been improved from 11 hours to 32 hours in the several bunch modes with a coupling ratio of 0.1%, beam current of 1mA/bunch and an RF voltage of 16MV. In the multibunch operation mode, lifetime has been improved from 100 hours to 160 hours with a coupling ratio of 0.1%, a beam current of 100mA with 0.05 mA/bunch and an RF voltage of 16MV. In this multibunch case, the lifetime due to gas scattering and the Touschek lifetime are about 220 hours and 700 hours, respectively.

2.1 Other Research and Developments

- Improvement of a orbit stability: the temperature fluctuation of cooling water in magnet and vacuum systems was stabilized within 0.3 degree by replacing the step response curve of the control logic in cooling system with a continuous response curve.
- Construction of a beam diagnostic's beamline (BL38B2) to investigate the performance of the electron beam and to perform R&D on accelerator components such as an analysis of the heat load.
- Development of injection septum magnets with high magnetic performance and understanding of beam loss process at injection porch to install a top-up operation.
- Correction of vertical dispersion by installing 24 skew quadrupole magnets in arc section.

3. Beam Performance and Upgrade of Linac and Synchrotron

3.1 Linac

The beam qualities of the linac have been studied in detail since the beam commissioning of 1996 and various improvements have been carried out up to today. There are:

- Fine tuning of optics
- Stabilization of the RF power and RF phase due to the reduction of the temperature fluctuation of the atmosphere and cooling water in the klystron gallery.
- Installation of a chicane in the downstream of the last accelerator guide to monitor the injection energy of electron beams into the synchrotron.

As a result of these improvements, a horizontal and vertical beam emittance of 0.5πmmmrad and 0.3πmmmrad, respectively were achieved at 1GeV, and the output energy was stabilized within ±0.03%

(1σ).

Also, to improve the reliability of the RF system and the beam performance, the following developments have been carried out.

- A stable compact pulse modulator used a high voltage power supply by IEGT has been developed and the test will start in next year.
- A photo cathode RF gun with a single cell cavity was assembled in a test stand and high-power up to 18MW was fed into the cavity. A maximum electric-field gradient of 127MV/m was achieved on the cathode. The photoelectrons were extracted by irradiation of UV laser and the beam test is in progress.

3.2 Synchrotron

A single bunch beam was formed by RF knockout (rf-KO) at the injection porch of the synchrotron since the beam commissioning of December 1996. To improve the purity of the single bunch beam in the storage ring, a high power rf-KO system was installed and the time interval of the injection porch was increased. Consequently, an impurity level of less than 2×10^{-8} was achieved in the storage ring

4. Development of Control System

The integration of the synchrotron control system to the SPring-8 standard system was finished in last year, and the new system started operation on January 1999. The year 2000 problem was the major problem to be solved before the first day of January 2000. This summer, the accelerator operations were simulated as an exercise of the Y2K problem and the Y2K readiness of the control system was confirmed.