Storage Ring

1. Magnets

We are planning to build four straight-sections of 30 m in the storage ring. In order to realize such long straight-sections, 64 quadrupole-magnets and 44 sextupole-magnets have to be re-arranged and 16 power supplies for the sextupole-magnets and 36 power supplies for the quadrupole-magnets will have to be manufactured. New, long pedestals of 8m length each are designed to mount the 6 quadrupole-magnets per pedestal, which will be placed at both ends of the long straight-sections. These 30m-long straight-sections are going to be fitted in the summer shutdown in 2000.

2. RF System

The fourth and last RF station to be constructed (named the A-station), has been put into operation. The total RF voltage became 16 MV from 12 MV, and the resulting beam lifetime increased to 140 hours from 100 in the case of a 24/29 filling multi-bunch mode at the stored current of 100 mA. Two klystrons were installed in the A-station, and each drives four single-cell cavities. Turning off RF power in one of the two klystrons with some interlock signals leads to a loss of 2 MV, but does not cause the loss of stored beam. The beam operation became more stable. The number of beam aborts triggered by the RF system was ten times greater this year (1999). The cause of there incidents can be broken down as; six times due to circulator arcing, three times due to low water flow rate in the photon absorbers in the RF section, and once due to RF power reflection from a cavity. This type of arc detector has a tendency to an incorrect action, so all the arc detectors were replaced by a new type with a lower detection efficiency during the summer shutdown. The circulator arcing problem has not been observed since then. The flow switches have gradually degraded during the past three years of machine operation. It is planned to replace them with more reliable products.

3. Vacuum

3.1 Improvements

The indicated vacuum pressure values shown by the ionization pressure gauges are uncorrected. These are influenced by radiation and photoelectrons. Some improvements are continuing to suppress the interference from these; radiation shields were carried out around the vacuum casing of the ionization pressure gauges, elbow pipes were installed between the main vacuum chamber and the vacuum casing of the ionization pressure gauges.

The cables for the ionization pressure gauges were damaged due to radiation. The damaged part of the cables will be repaired in the summer shutdown in 2000.

Aluminum pipes for cooling water and super-heated water for chamber baking are corroded due to misuse of thermal insulating materials, the adhesive in which contains chlorine. These insulators have been removed from the pipes and some pipes have been replaced.

3.2 Vacuum Components for IR Beamline

The beamline BL43IR was designed and constructed for application in various experiments using synchrotron radiation in the infrared region from a bending magnet in the SPring-8 storage ring. The wavelength region used at the experimental station is from 5 to 1000μm. The components for this beamline were installed at the summer shutdown in 1999.

The new vacuum chambers for the bending magnet section and crotch absorber section of the storage ring (BM2C and CR2) were designed and fabricated. The BM2C consists of a beam chamber, a slot-isolated antechamber in which a NEG strip is installed, and a rectangular pump channel in which a distributed ion pump is installed. In order to guarantee the required vertical acceptance, the slot height of BM2C was expanded and tapered in comparison with a normal BM2C.

The CR2 chamber is equipped with a non-water-cooled mirror to steer the infrared rays for a transport channel of the beamline, and two water-cooled X-ray absorbers fitted both in front of and behind the mirror. The mirror was made from an oxygen-free copper, which was coated with gold. The horizontal and vertical acceptance of the mirror are 18.5mrad and 5mrad, respectively. In order to avoid the deformation of the mirror by the high heat load of synchrotron radiation on the orbit plane, which is 3.6kW at a stored current of 100mA, there is a slot, ±1mm in width. The synchrotron radiation with a high heat load on the orbit plane is passed through the slot, and then it is absorbed by a fixed-type absorber with water-cooling behind the mirror. Another water-cooled absorber in front of mirror is used to protect the reflection plane of the mirror, which is moved by compressed air.

4. Beam Diagnostics

4.1 Button Pickups

Optical fiber cables were installed from four points along the storage ring to one point where some of the electronics circuits and devices for beam diagnostics were placed. The purpose of the installation was to receive correlated information about beam motion from different parts of the storage ring. There were four places where sets of four button pickups were attached to the vacuum chamber. The pickups are no different to normal BPM pickups which are used for the measurement of the closed orbit distortion. The signals from the pickups were processed and converted to analog signals the voltage outputs of which were proportional to the horizontal and vertical beam motion. Although the amplitudes were small, some structures in the frequency domain signals were observed in those analog signals, especially in the frequency region below 100 Hz. To help distinguish the sources of these structures: the beam motion, environmental noises and noises generated in the signal processing electronics, etc., it was important to have correlated information of signals from different places along the storage ring. The signals from different parts of the storage ring should be observed simultaneously to correlate the data. Cable assemblies bundled with four optical fibers were stretched from each of the four observation points to the point where all the four assemblies gathered. As a result of the installation of the optical fiber cables, it became possible to simultaneously transmit at most four analog signals from one of the four points to the point of signal collection. Analog signals could be transmitted through these optical fibers, from electric to optical signal converters (E/O) and from optical to electric signal converters (O/E). The specifications of these E/O and O/E modules are, the frequency range of analog signals: DC to 300 kHz (-3dB) and the input and output voltage range: ±1V. Using these fibers, correlation was observed with an FFT analyzer, and found to be strong below 10 Hz in the horizontal direction signals throughout the storage ring. The components which exhibited a strong correlation should originate from beam motion. Although the sources of the beam motion have not yet been identified, we expect the optical fiber cable system will help greatly to identify the source.

4.2 Beam Size Measurement Using Interferometer

We have been measuring the beam size of the storage ring with interferometric technique since July 1999. All the instruments for the interferometer are installed at the end of the photon extraction line of the No. 14 cell in the storage ring tunnel. We use two mirrors to steer visible synchrotron radiation from the bending magnet to the interferometer. A water-cooled X-ray absorber in front of the mirror absorbs the heat power to the mirror in vacuum. The mirror is not water-cooled to reduce the vibration. We used a view window made of sapphire glass 4mm thick. Since the window was a large transmitted wavefront error, we changed it for fused silica glass 12mm thick with a small transmitted wavefront error $\lambda/8$ (λ=632.8nm). The interferogram formed by a diffracting mask with double slit was imaged on a CCD camera by two achromatic doublet lenses. The exposure time is 30ms. The monochromatic light was obtained by a bandpass filter attached to the CCD camera. The center wavelength is 441.6nm and the bandwidth is 10nm FWHM. The measured minimum vertical beam size so far was about 20μm. The observing wavelength is visible at 441.6 nm, which limits the resolution.

The set-up will be upgraded in Jan. 2000. The conventional double-slit in the initial set-up will be replaced by a newly developed quad-slit for simultaneous horizontal and vertical beam size measurements. We will install a fast gated CCD camera to measure instantaneous beam size.

4.3 Beam Diagnostics Beamline BL38B2

The beamline BL38B2 is planned for accelerator beam diagnostics and R&D of accelerator components. The manufacturing of UHV components of the BL38B2 front end was completed, and they were installed in the accelerator tunnel during the summer shutdown in 1999. The radiation-shielding hutch of BL38B2 consists of one long optics hutch of 18m length, which was constructed in the experimental hall in August 1999.

The design and manufacturing of transport channel of BL38B2 started, which will be installed in the next year. The transport channel of BL38B2 consists of the visible/UV light transport line and the X-ray transport line. The visible and UV light is picked off by a mirror in a vacuum chamber put between the front end and the X-ray transport line. The visible/UV light picked off is transported in the bent shielded pipe out of the optics hutch to a dark room in the experimental hall. In the dark room, observations of longitudinal characteristics of the electron beam are planned. For example, single bunch impurity will be measured with the gated photon counting method which utilizes fast pockels cells for switching light pulses, and bunch length will be measured by a streak camera. In the X-ray transport line, it is planned that both the monochromatic X-ray and the white synchrotron radiation can be used. The X-ray transport line will include a double crystal monochromator, which can be moved off the beam axis when use is made of white synchrotron radiation. In the X-ray transport line, measurement of the horizontal and the vertical beam size of the electron beam with an X-ray zoneplate is planned. R&D of accelerator components are planned in the X-ray line. For example, it is planned to study the effects of synchrotron radiation to cooling water in vacuum chamber components such as absorbers.