Beam Monitors for The SPring-8 Linac

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The beam monitors of the SPring-8 Linac are used for the beam transportation and for the diagnostics of principal beam characteristics. Profile monitors are mainly used for the beam transportation. Beam characteristics such as transverse emittance, energy, average peak current and microbunch length are measured at three locations; at the preinjector, around (before or after) the electron-positron converter and at the Linac-Synchrotron beam transport (LSBT) line [1].

The profile monitor for the beam transportation has a fluorescent screen AF995R (DESMARQUEST). The screen center can be recognized as the center of object which is composed of holes on the screen. The profile monitor is placed by the quadrupole magnet in principle. And the screen center is aligned to the quadrupole magnet center within 0.2mm. A beam profile is observed by CCD camera which is covered by the radiation shield of lead. Light from the screen is reduced using an ND filter to avoid the saturation of CCD. Total 26 profile monitors are planed to be installed all over the Linac.

The transverse emittance is measured by two different methods [2]. One is a method using a slit and a profile monitor. The profile monitor has a single wire grid. The phase space is scanned directly. This type of emittance monitor is used at the preinjector. The other is a method using the three profile monitors which has five wire grids. This type of emittance monitor is used before the converter and at the LSBT line. An analog processor which detects the secondary emitted charge from the wire grid has been developed. Because the secondary emission rate is quite low, a high gain charge sensitive amplifier CS-507 (CLEAR-PULSE) is employed. The CS-507 has a sensitivity of 1V/pC nominally. The sensitivity can be reduced by attaching an extra capacitor. The sensitivity is designed as 1V/pC, 0.01V/pC and 0.1V/nC.

The absolute beam energy and its spread are measured by spectrometer. A spectrometer is composed of a bending magnet and a profile monitor. The profile monitor must be located at a large dispersive section. At the LSBT line a horizontal profile monitor which has nine wire grids is employed. An analog processor is the same as the emittance monitor's one. The position and the FWHM are obtained pulse by pulse. If a slit and a current monitor are employed instead of the profile monitor the slit must be located at the large dispersive section. This type of energy monitor is planed to be installed at the preinjector and before the converter. The current monitor at the preinjector is a Faraday cup. And the current monitor before the converter is a secondary emission monitor which is composed of emission foils and extraction electrodes. Current from the current monitor is detected by the picoammeter model 487 (KEITHLEY).

A resonant cavity type (TM_{110} like mode) beam position monitor is planed to be installed after the spectrometer of the LSBT line. This is used for energy monitoring without beam interception. The signal process is the detection of a 2856MHz component using a double balanced mixer. And a waveform is observed using an oscilloscope.

A wall current monitor or a current transformer offers the advantage of nondestructive average peak current measurement. The electron gun generates a nanosecond beam which is required to provide a single bunch in the Storage Ring. In order to measure such a short-pulse-width beam a wall current monitor was developed [3]. It is composed of a ring-type ceramic resister ASW (TOKAI) with a resistance of ~2W connected across the ceramic insertion, a signal pick up and a loading magnetic toroid FT-1M (HITACHI METALS). Its rise time is about 250ps. The electron gun also generates a microsecond beam. For a long-pulse-width beam the current transformer model 2100 (PEARSON) is employed. Total 8 wall current monitors and 7 current transformers are planed to be installed.

In order to measure the microbunch length with the smallest error the observation of Cherenkov radiation by the streak camera is preferable. The Cherenkov light is generated in the air. In order to minimize the error the beam is extracted to the straight forward. Of course vacuum vent is required into the vacuum chamber of the beam line. All elements for the light transportation are metal surface mirrors. And the focusing element is a type of the Newtonian telescope. The streak camera is C3735-01 (HAMAMATU). A timing module which synchronizes the camera trigger with the appropriate phase of 2856MHz was developed using GaAs logic. The microbunch length monitors are planed to be installed at the preinjector and at the LSBT line.

References

[1] K.Yanagida, et al., 1992 Linear Accelerator Conf. Proc., 665, (1992).
[2] K.Yanagida, et al., 1994 Linear Accelerator Conf. Proc., 920, (1994).
[3] K.Yanagida, et al., JAERI-M 94-078 (1994).