Development of the nondestructive SR beam monitor using compton scattering

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Abstract

We construct the nondestructive SR beam position monitor of new conceptual design using the compton scattering. In order to measure the position of the SR beam, we use the low energy electron beam(<10KeV,100mA).

The electron beam emitted from the electron gun is injected into the SR beam, and collide with the SR beam, and then electron beam is recoiled by the compton scattering, therefore, the amount of the recoil electron in the direction of the electron beam collector become as decreasing.

Using this phenomena, the position of the SR beam is measured by the variations of collector current.

1 Introduction

The SPring8 is the facility of the third generation synchrotron radiation in the X-ray region. The accelerator complex is composed of 1GeV linear accelerator, 8GeV synchrotron and storage ring. Spring8 has three accelerators and 61 SR beam beamline. Among the SR beamlines, 38 beamlines from insertion devices and 23 beamlines from bending magnets will be available.

In order to operate the storage ring, the measurement of the position of the SR beam is very important problem in the research and development using the SR beam. The blade SR beam position monitors has been used in the field of the SR beam position measurement because of its simple structure.

In the near future, the fours straight sections will be constructed the magnet free space of 30m by rearrangement of the quadruple and sextuple magnets. In this free space, very long undulators will be installed and then the brilliance of the SR beam become incomparably larger. It is impossible to measure the position of the SR beam(by convenient method), because the SR beam will damage against the blade SR position monitor. Therefore, nondestructive SR beam position will be needed.

To measure the position of the SR beam, we check in the change of current of the electron beam collide with the SR beam. The current of the electron beam is decreased by the compton scattering. Nondestructive SR beam monitor has been studied using the colliding of the SR beam and electron beam.

In this paper, we describe the equipments and simulation results of nondestructive SR beam position monitor for spring8.

2 Conceptual Design and Construction

The monitoring system consists of the electron gun(10KeV,100mA), high voltage regulator, vacuum chamber, ion pomp, electron beam collector, average current meter and so on. Figure 1 shows the block diagram of the nondestructive SR beam position monitor. The low energy electron beam is injected into the SR beam. After the interaction, the low energy electron beam is recoiled by the SR beam. and then the SR beam position is recognized as the electron beam current decreasing.

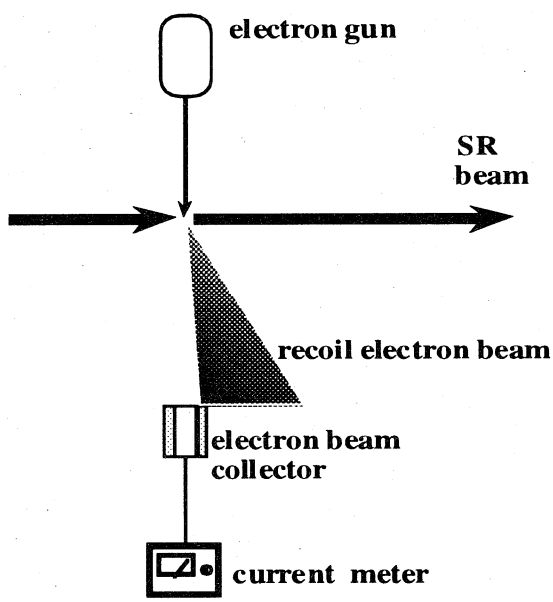

Fig. 1 Schematic Picture of Nondestructive SR Beam Position Monitor using Recoil Electron

High voltage is supplied by the stabilized power source. The vacuum of this monitor must be kept at the

same order(10^{-10} torr) as that of the storage ring. In order to realize the pressure of 10^{-10} torr, pumps are installed.

Two 100l/s ion pump are installed for the main pumping. A 250l/s turbo molecular pump is used for rough pumping. The electron beam collector is mounted on a feedthrough connector which is welded on a frange, and it is easily exchangeable. Also, microchannnel-plate image intensifier(MCPII) is used as the electron beam collector.

3 Design of Electron Beam and collector

The electron beam is focused into the interaction point by electric lens in order to define the interaction area in a small spot as to measure the position of the electron beam precisely at the interaction point. The electron beam emitted from electron gun is focused within 2mm diameter at interaction point. the maximum averege current of the electron beam is 10mA.

To consider the S/N ratio, the electron beam collector size should be small enough to effectively exclude the recoil electron.

Moreover, the amount of the recoil electron in the direction of the electron beam collector is small, so that the recoil can be effectively recognized as electron beam current decreasing.

Instead of the small beam collector, the microchannel-plate(MCP) image intensifier(II) will be used as the electron beam collector. By the way, the MCPII has a high sensitivity for the electron, and will be operated as a high gain amplifier by the applied high voltage. Hence, the MCPII has an exponentially growing gain as a function of the voltage. When improved S/N ratio is required, these could be achieved by a averaging a number of recoil electron.

4 Simulation Results of Recoiling Angle of Electron

The cross sectional area of compton scattering is proportional to the number of the electron beam, therefore, the electron beam should be large enough to store the sufficient number of the electron beam. The recoiling angle of the electron is calculated by the compton scattering theory [1]. Figure 2 shows the simulation results of distribution of intensity of the recoil electron in each other SR beam energy. The distribution of the intensity is normalized by the value integrated from 0 to 90 deg. We calculated the recoiling angle of the electron beam against changing energies of the SR beam. As the simulation results, the intensity of recoil angle are not so much varied even if the SR beam energy is varied of 1-100KeV [2].

According to simulation results, the position of the SR beam will be measured in spite of changing energy of the SR beam.

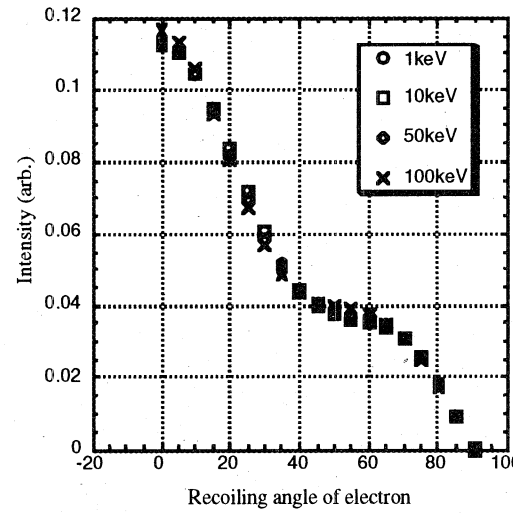

Fig. 2 Simulation Result of Distribution of Recoil Electron

Conclusions

We performed a conceptual design of the nondestructive position monitor of the SR beam. As the preliminary experiment, we will challenged the measurement of the recoil electron excited by high power laser. However, the energy of the laser beam is very lower than that of SR beam. therefore, the angle of recoil electron become smaller. and it is rather difficult to detect the difference of the angle of the recoil electron.

In our near future plan, the performance of the SR beam position monitor using the compton scattering will be checked by using the SR beam(1-100KeV) from the storage ring.

Acknowledgement

We wish to thanks Dr H. Yokomizo and Dr N. Kumagai for helpful suggestions.

References

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2)T. Kobayashi, T. Kudo ; A new concept for photon beam monitoring, SPring8 annual report 177(1997)