Measurement of the Frequency Shift and Spread of the Betatron Oscillation

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The vertical beam size of the stored electron beam in the superconducting synchrotron radiation source AURORA at the SR Center is as small as about 10 microns [1]. Small beam size is very effective for synchrotron radiation applications, but the disadvantage of a short lifetime cannot be ignored. Therefore, during normal user operation, the beam size is controlled by the RFKO method based on betatron oscillations [2]. The frequency of the betatron oscillation is determined by the magnetic field gradient, but frequency shift and frequency spread occur due to the effects of vacuum, electron density in the beam bunch, and other factors. In order to keep the beam size constant, it is necessary to investigate the amount of shift and spread of the betatron frequency for each operating condition.

The measurements were carried out at the monitor beamline BL-16. The detection system employed was a SiC gold-coated mirror, an Al mirror, a photodiode module, and a spectrum analyzer. For the RFKO method, a signal generator, an amplifier, and an electrode plate installed on the beam orbit were used. Figure 1 shows a schematic diagram of the measurement system.

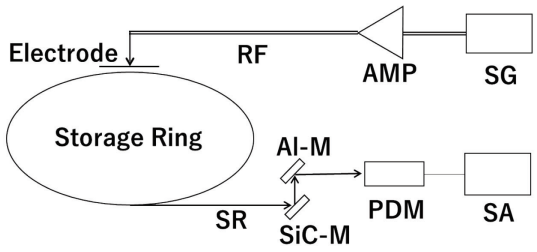

Figure 1 Schematic diagram of the measurement system. Electrode and SiC mirror are in vacuum chambers.

Figure 2 shows the measurement results as a function of stored beam current. The blue circles and red squares show the frequency shift and the frequency spread, respectively. The vertical beam size (σ_y) during the measurement was controlled to 130 μm by the RFKO method. It can be seen that both the frequency shift and the frequency spread decrease dependent on the decrease of the beam current. The results of the measurement dependent on the beam size are shown in Figure 3. The vertical beam sizes were controlled by the magnitude of the oscillation amplitude from the signal generator. The stored beam current at measurements is about 95 mA. From figure 3, we can see that the frequency shift and the frequency spread decrease depending on the beam size. The above results show that the frequency shift and the frequency spread increase with the electron density in the beam bunch. However, they are not always linearly proportional. We guess that the ion trapping influences them.

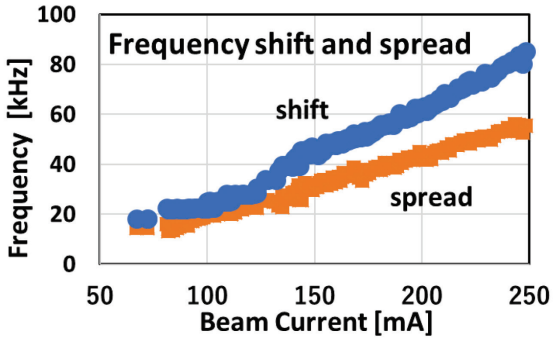

Figure 2 Frequency shift and spread of betatron oscillation as a function of stored beam current.

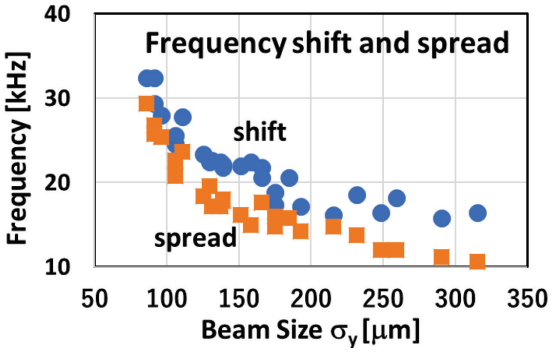

Figure 3 Frequency shift and spread of betatron oscillation as a function of vertical beam size.

References

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[2] I. Sakai, Y. Yamamoto, T. Mitsuhashi, D. Amano and H. Iwasaki, *Nucl. Instrum. Methods,* **A 480** (2002) 373-378.