Introduction

When the beam intensity of the 12 GeV proton synchrotron is increased, oscillations occur in the radial direction of the beam, and the beam loss increases at the phase transition. The beam loss at the transition point was due to the RF feedback system on RF acceleration. The ordinary electrostatic pickup IP used for RF feedback system was replaced with a new large size pickup. Improvements were made in the following respects: 1. large size to obtain high signal to noise ratio, 2. no side walls to eliminate the noise due to beam hitting, 3. smooth ground for the shield electrode, 4. minimization of the distance between the electrode and vacuum feedthrough and the insertion of an oscillation damping resistor between them, 5. calibration wires were installed between the sensing electrode and the shield electrode. Electrode signals were processed by an average type rectifier and normalizer. The position signal was fed to an RF system through an analogue isolator. This paper deals with the modifications in the beam position feedback of the RF system.

Improved pickup

Fig.1 shows a new pickup electrode schematically. The new pickup electrode has a rectangular cross section and is 320 mm wide, 70 mm high and 320 mm long. The electrode is made of 304 stainless steel. The diagonally cut electrodes are insulated from the shielding electrodes by ceramic rings. Amplitude of the pickup signal is increased about three times because of the longer electrode. The gap between pickup electrode and shield electrode was increased to make stray capacitance smaller. The stray capacitance of each pickup electrode is 160 pF. There is no balancing capacitance to balance the stray capacitance. The clearance of the pickup electrode and the shield electrode were adjusted precisely by insulated screw. If the balancing capacitance is installed on the outside of the vacuum chamber, small and fast oscillation is observed. The new pickup electrode is parallel diagonally cut electrodes with no side walls in order to eliminate the noise due to lost beam hitting. To obtain linearity of the sensitivity in the radial direction, a wide electrode is necessary. A smooth ground for the shield electrode is important for reduce the oscillation due to stray inductance and capacitance. The wall current must flow smoothly on the inner surface of the shield electrode, so that the beam bunching is not disturbed. The distance between the electrode and the vacuum feedthrough is minimized. To reduce the small and high frequency oscillation due to the inductance of the air interface, as damping resistor of 50 ohm is inserted between the pickup electrode and the cable driver. BNC-JF type vacuum feedthrough is used for the vacuum and air interface. A thick stainless steel window frame, of inner size smaller than the aperture of the pickup electrode, was placed upstream and downstream of the pickup electrode in order to suppress secondary charged particles. Calibration wires are installed between the pickup electrode and the shield electrode. These calibration wires are useful to check the position electronics.

The pickup electrode is connected to the average type normalizer via a cable driver and pair of low loss coaxial cables (10D2W) of about 250 m long. The input impedance of the cable driver is 2.2 kΩ and the output impedance is 50 Ω.

A typical beam bunch signal is shown in Fig.2. The amplitude of the bunch is about 1 V at injection. The noise level is less than 10 mV. A typical beam bunch shape of an ordinary pickup is shown in Fig.3.

Signal processing

A block diagram of the improved position for AR feedback is shown in Fig.4. Old type position monitor consist of the pulse transformer, 100 nsec rise time integrator, fast amplifier and attenuator between the

Fig.2 Typical beam bunch signal in front of the normalizer at the phase transition. (a) 50 ns/div, (b) 100 ns/div, and (c) 500 ns/div.

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Fig. 4 A block diagram of the improved position monitor for AR feedback in the RF system.

Fig. 5a Before improvement of AR feedback system. top: beam intensity, bottom: beam position after acceleration start. 50 msec/div.

Fig. 5b top: beam intensity, middle: beam position, bottom: fast intensity, 10 msec/div. 2f₀ oscillation is observed.

Fig. 6a After improvement of AR feedback system. top: beam intensity, middle: fast intensity, bottom: beam position.

Fig. 6b After improvement of AR feedback system without 2f₀ feedback. top: beam intensity, middle: fast intensity, bottom: phase jump, 10 msec/div.

Fig. 7 After improvement of beam position monitor in AR feedback system of RF. top: beam intensity, middle: fast intensity, bottom: beam position.
