

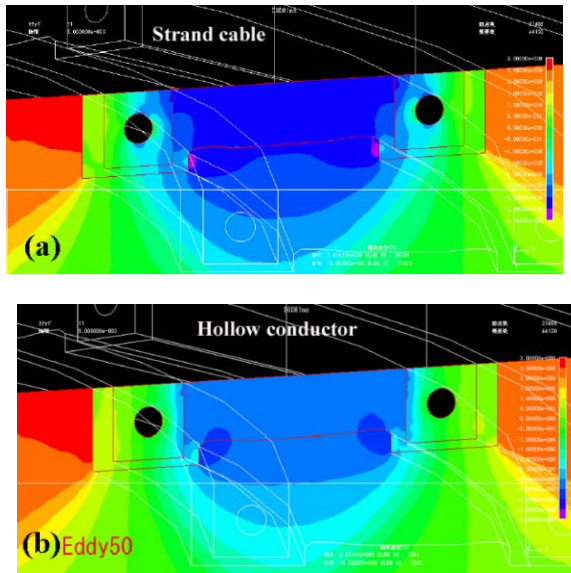


Figure 2: Field distributions at 200 kA excitation for (a) strand cable and (b) hollow conductor.

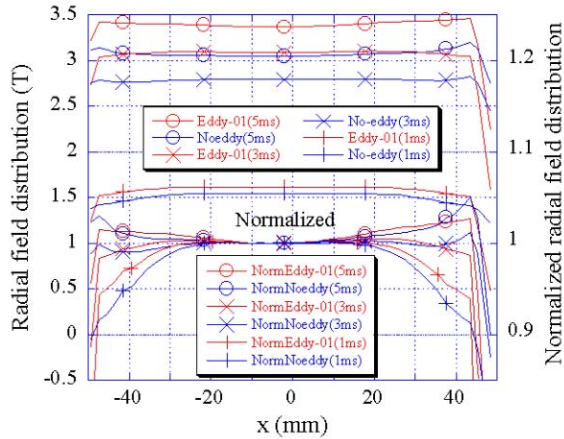


Figure 3: Normalized and absolute field distribution at 1, 3 and 5 msec.

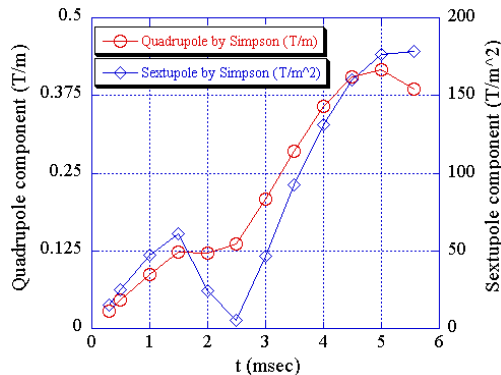


Figure 4: Measured error field components averaged over the dipole with the coil made of the strand cable.

As for the sextupole component, its contribution is so large that it must be corrected by using both the correction windings in the dipole and the sextupole correction magnets. Numerical estimation of the

correction windings is obtained as shown in Fig.5. Its current must be supplied externally opposing to the current induced by the flux linkage from the main coil. Thus, the external loads, both inductor and resistor, to the correction windings will be connected so as to reduce the induced current. Without them it amounts to several thousand amperes.

The sextupole strength by the correction windings is limited by both the current supply and the saturation level of the dipole core. If the core is not saturated, it is possible to excite as far as the power supply allows. From Fig. 4 the core begins to saturate at around 1.5 msec and behaves non-monotonically up to 2.5 msec after when the sextupole component grows due to the gradual increase of the core saturation.

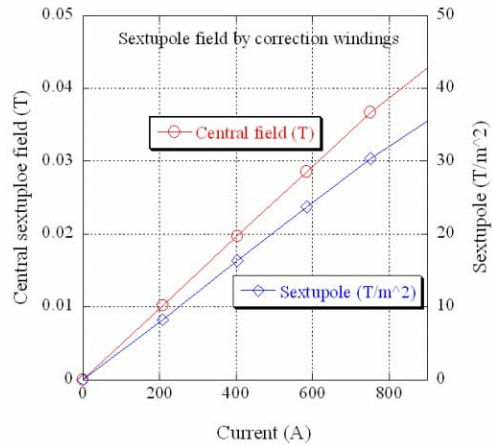


Figure 5: Estimated sextupole strength by the correction windings. The main dipole field is affected by the excitation of the correction windings and it is given as the central field.

Quadrupole Magnet

Four dipoles and four quadrupoles are already manufactured which form the compact synchrotron ring with the DOB lattice as shown in Fig.6. The quadrupole acts as a defocusing element (QD) and the maximum field gradient is 30 T/m at 4 kA to the bore diameter 70 mm and the coil of 5 turns/pole. With this configuration the orbit parameters are shown in Fig.7(a) and (b) at injection (2 MeV) and 200 MeV, respectively. The quadrupole field component of the dipole is reflected but the QD strength is given so as to be proportional to the proton momentum in this case.

RF SYSTEM

Adopting the magnet configuration of Fig.6 without the focusing quadrupole magnet, the RF parameters have changed from the previous lattice design in which the quadrupole triplet was employed [3].

The accelerating frequency range is 2~18 MHz corresponding between 2 MeV at injection and 200 MeV. The required maximum gap voltage is 10 kV for the phase angle of 40 deg. Very short cavity with the length

of 0.4 m, in which there are 2 gaps separated by 0.2 m, could successfully generate the required gap voltage for this wide frequency range [4, 5].

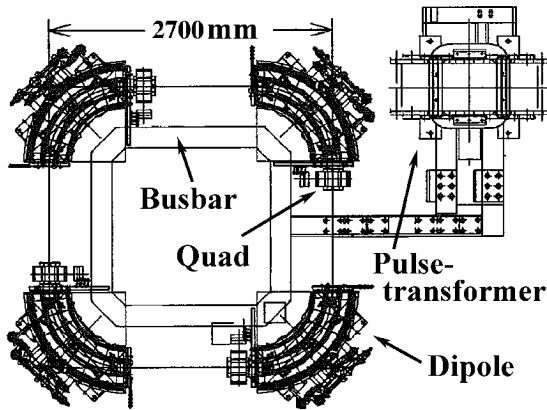


Figure 6: Layout of dipoles and quadrupoles.

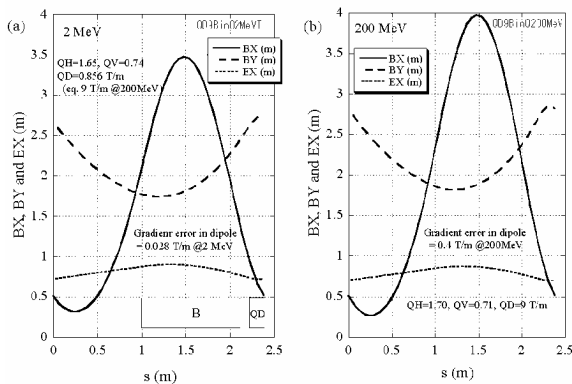


Figure 7: Orbit parameters considering the quadrupole field component of Fig.4 at (a) injection and (b) 200 MeV. The QD strength is assumed to be proportional to the proton momentum for this calculation.

Accuracy of the accelerating frequency is given in Fig.8 assuming the orbit deviation less than ± 1 mm inside the dipole magnet and the peak dipole field of 3 T by 50 Hz half sinusoidal excitation with no saturation. Allowed accelerating frequency error is almost 0.05% and the corresponding maximum clock rate to change the frequency data through the DDS (Direct Digital Synthesizer) is about 3.5 MHz at around 0.5 msec before which the clock rate is not necessary larger than the accelerating frequency. The present low level control system could attain 2 MHz which corresponds to the orbit deviation of ± 2 mm [6].

Similar tight relations are anticipated to the allowed errors for the cavity gap voltage and the phase angle adjustments. It means the very precise RF control is foreseen for the compact synchrotron operation.

In summary this compact proton synchrotron is almost ready to assemble small ring of 9.54m circumference with 4 superperiods of DOB structure for further studies of fine tunings, tracking controls, etc.

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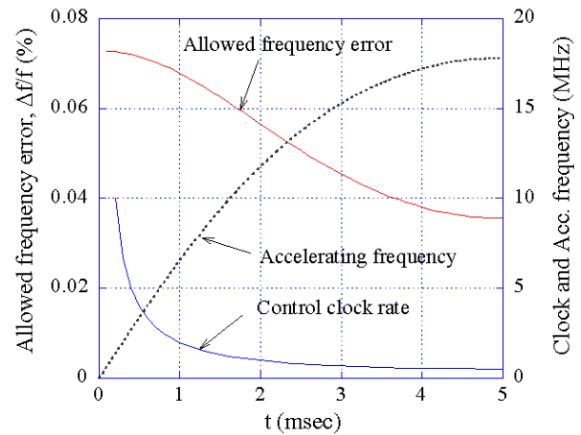


Figure 8: Accelerating frequency accuracy and the required clock rate to control the orbit deviation of ± 1 mm inside the dipole.

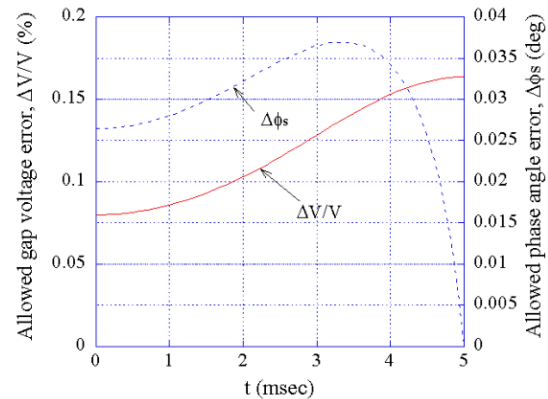


Figure 9: Allowed cavity gap voltage and phase angle errors for the same orbit deviation of Fig.8.

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