A STUDY OF DOUGHNUT-LESS SYNCHROTRON MAGNET

S. Asaoka, M. Kasuya, T. Morimoto, M. Mutou,
K. Ukai, K. Yoshida and M. Yoshioka

Institute for Nuclear Study, University of Tokyo

One of the most simple way to go over the maximum energy of the circular accelerator would be to shorten the pole gap of the magnet and to get stronger guiding field without changing the power supply for the magnet. On the other hand, one must suppress the betatron oscillation by improving the emittance of the beam from the injector, or must compesate for the loss of the space for the beam by remodeling the vacuum chamber ("doughnut").

It has been proposed to accelerate the electron up to 1.8 GeV by applying above method to 1.3 GeV electron synchrotron at the Institute for Nuclear Study, University of Tokyo (INS)[1]. As the pole piece of the INS synchrotron is demountable from the yoke of the magnet, one can perform the narrower gap simply by replacing the pole piece with new one. The INS synchrotron is an alternating gradient type and the pole gap width at the central orbit is 54 mm, which should be shortened to 30 mm to realize the magnetic field required for keeping 1.8 GeV electron on the orbit.

The useful aperture for the beam, however, would be prohibitively narrow for the new magnet if one would maintain the usual vacuum chamber. In fact, only 33 mm is useful in 54 mm gap of the existing magnet. Thus we have developed a prototype of doughnut-less synchrotron magnet.

Si-coated steel sheet, G08(JIS C2553) is employed as the material of the pole piece to get satisfactory B-H characteristics at very high magnetic field. The profile of the new demountable pole-piece has been determined by use of the computer program "TRIM" so as to secure the n-value constant region as well as the necessary field strength. The calculated distribution of the n-value is shown in Fig. 1. The region in which the error of the n-value is less than 1 % is almost as wide as the existing magnet.

The pole piece is further divided into two parts, and the cusps of both pole form a part of the vacuum chamber wall, as seen in Fig. 2. The stainless steel sheets of 17 mm thickness seal up the vacuum space inside and outside the gap, and also support the pole pieces against the atmospheric and magnetic pressure. All the parts consisting the vacuum chamber are stuck with epoxi- resin having the resistence against the radiation of about 8×10^8 rad. Since the use of epoxi-resin is avoided at the median plane of the magnet, where the radiation level is highest, one can expect for about five years running.

To be free from heating problems caused by eddy current, the chamber walls should be electrically insulated with each other. Then the end flanges for connecting the modules are made of metalized ceramics.

The characteristics of the model chamber under the influence of alternating magnetic-field will be reported in near future.

Fig. 1

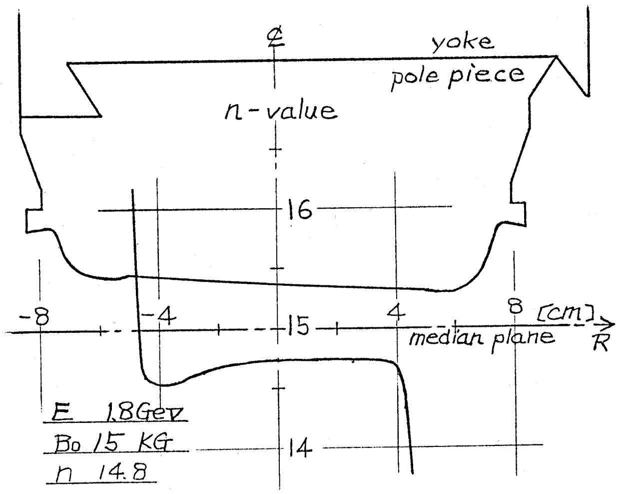
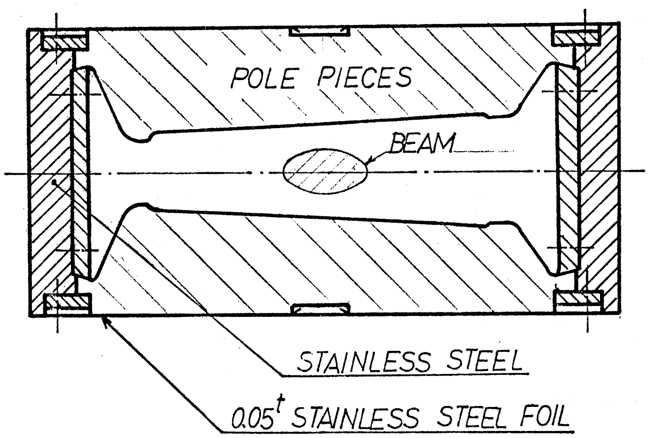


Fig. 2



Reference

1) H. Sasaki, T. Kamei; Genshikaku Kenkyu 13 (1968) 352