WIDE APERTURE Q MAGNET WITH END CUT SHAPING

M. Kumada, H. Someya, I. Sakai and H. Sasaki

National Laboratory for High Energy Physics
Oho-machi, Tsukuba-gun, Ibaraki-ken

The prototype magnet for 500 Mev proton new beam line from the Booster Synchrotron is designed and constructed. Bore radius of the magnet is 57 mm and pole width is 96 mm. Figure 1 illustrates the octant and cross section of the magnet. Coordinate is taken right-handed,where s-axis is along the central orbit lying in the midplane (the xs plane) and z-axis is perpendicular to the midplane. As is shown, the pole profile of the pole tip is extended to outer direction to increase the good field region. The pole profile is mostly hyperbolic except the profile at the ends in xz plane where it is terminated with a straight line. The calculation of the field gradient is performed with LINDA[1) program with 5 mm mesh. Calculation is done so that the good field region should be as possible as wide at the level of the field gradient of 6 T/m with shim as its main parameter.

The end of the magnet is cut with a plane from the view point of simple fabrication. The end shape is determined by repeating the process of trial and error. The parameters for end cut was Δs and Δh, which are cutting length as shown in Fig.1.

The distributions of the field gradient and the effective length are obtained by twin pendulum coil method.[2) Figure 2 shows the distribution of the relative distributions of the field gradient and Fig.3 shows that of the effective length normalized at the center respectively.

The field gradient observed by the field measurement has sextupole and octupole field which is not expected from the calculation with LINDA. The deviations might be explained by the fabrication error of the pole profile δz. Suppose actual pole profile is expressed as

$$z = \frac{a}{x} + \delta z = \frac{a}{x} + \varepsilon_0 + \varepsilon_1 x$$

where $a = 1.625 \times 10^3\ \mathrm{mm}^2$. By assuming new equi-potential line defined by above equation, multipole field normalized at the central orbit can approximately be written as,

$$g(x)/g(0) = 1 + \frac{\varepsilon_0}{a}x + \frac{\varepsilon_1}{a}x^2 \; .$$

In order to account for the deviation by the fabrication errors, ε_0 and ε_1 should be; $\varepsilon_0 \simeq 20\ \mu\mathrm{m}$ and $\varepsilon_1 \simeq 1$ mrad. The geometrical error of the pole profile and setting[3) is consistent with the results of the field measurement.

For obtaining linear effective length, measurements were performed with various end shapes. The good field half-aperture could be extended by 60 mm compared with that without end cut. When we set a criterion of the good field half-aperture to be within ±0.5 %, it is 96 mm for the field gradient and 93 mm for the effective length.

References

1) K. Endo and M. Kihara, "Manual of magnetostatic program LINDA", KEK,Acc.-1(1972).
2) M. Kumada, I. Sakai, H. Someya and H. Sasaki, "Flux meter for field gradient with pendulum", contributions to this conference.
3) Y. Higashi, private communication.

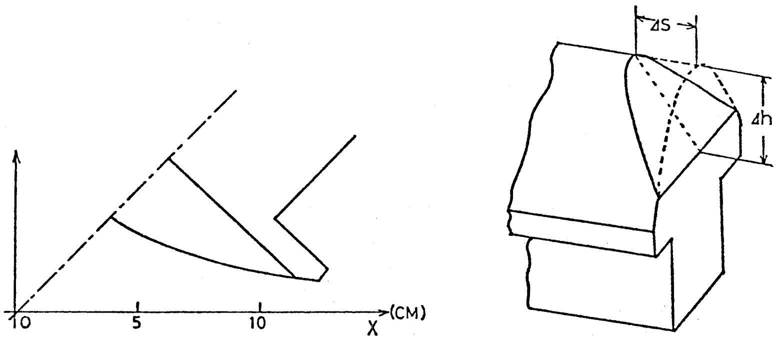

Fig.1 Pole profile and end shape

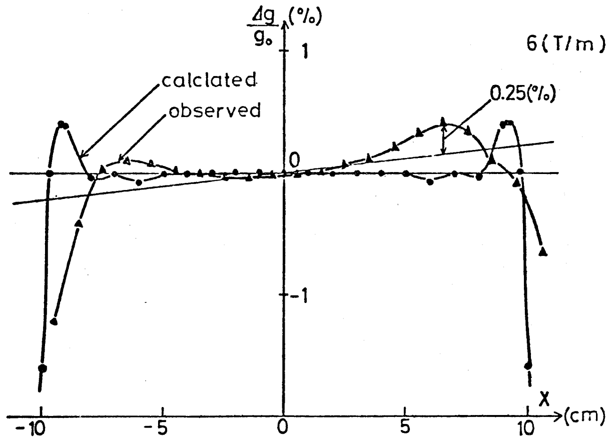

Fig.2 Distribution of the field gradient

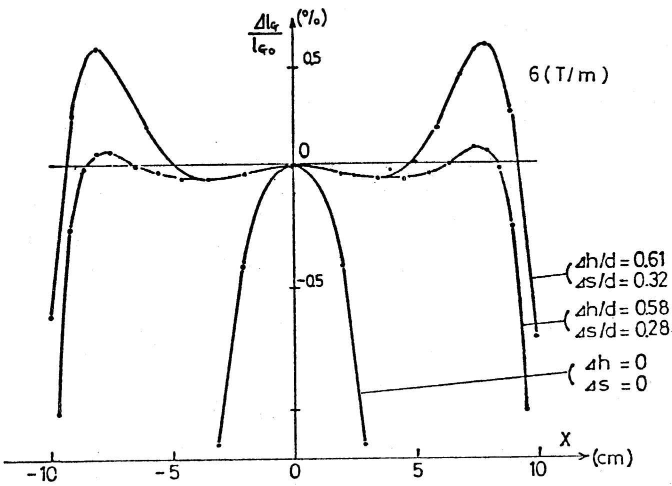

Fig.3 Distribution of the effective length d; Bore radius