DESIGN OF THE MAGNETIC SEPTUM OF CSR

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1. Preface:

In order to satisfy the requirement of the beam injection and extraction of CSR, four magnetic septums will be used in the accelerator. In the process of design, the shape of the lamination was optimized by the result of the 2-D magnetic field calculation. Also, in order to decrease the leakage field and obtain a satisfied field distribution, a special auxiliary coil and a shield iron plate was considered and as well as the construction of the septum leg was treated in a special way. As a result, the leakage field is almost zero and the homogeneity is less than 0.1% even in the area very near to the septum leg. As shown in Table 1.are the parameters of the four magnetic septums used in the HIRFL-CSR.

Table 1.

septum / parameter		CSRm In.	CSRm Ex.	CSRm Ex.	CSRe In.
Aperture (mm×mm)		40×40	40×40	40×50	40×65
Bg(Gs)		8400	4300	12800	7500
Field homogeneity (%)		0.1	0.1	0.1	0.1
Fringe field in ring (%)		0.1	0.1	0.1	0.1
Length (mm)		1130	1000	2000	1600
Radius (mm)		3600	25000	8350	11200
Angle (mrad)		315	40	240	145
Sept. wid (mm)		20	10	30	18
Gap(mm)		65	65	65	65
Main coil	NI(Max)	22400A	22400A	22400A	22400A
	Current	2500A	2500A	2500A	2500A
	Resistance	16M ω	7M ω	40M ω	16m Ω
	Voltage	40V	17.5V	100V	40V
	Power(max)	100Kw	43.75kW	250Kw	100kW
	Turn	9	9	9	9
	Water pressure	10Kg/cm^2	10kG/cm^2	10kG/cm^2	10kG/cm^2
Corr. Coil	NI(Max)	110	60A	180A	110A
	Current	7.4A	4A	12A	7.4A
	Turn	15	15	15	15

2. Construction of the magnetic septums

As shown in figure 1. is the cross-section of the magnetic septum of CSRm extraction. In order to keep the fringe field in the ring less than 4×10-4 T, a auxiliary coil and a shield iron plate was used. As the currents increase in the coils ,the flux density in the gap increases too . But because of the opposite direction of the two flux in the shield iron plate (auxiliary and main) and the magnetic resistance of auxiliary flux is more smaller, it is possible to adjust the current of the auxiliary coil to cancel the flux in the shield iron plate .Thus the leakage flux out the shield iron plate be canceled too .As shown in Fig2. is the Cross-section field distribution of the

CSRm Ex. Septum. The fringe field out of the shield iron plate and in the ring was canceled thoroughly.

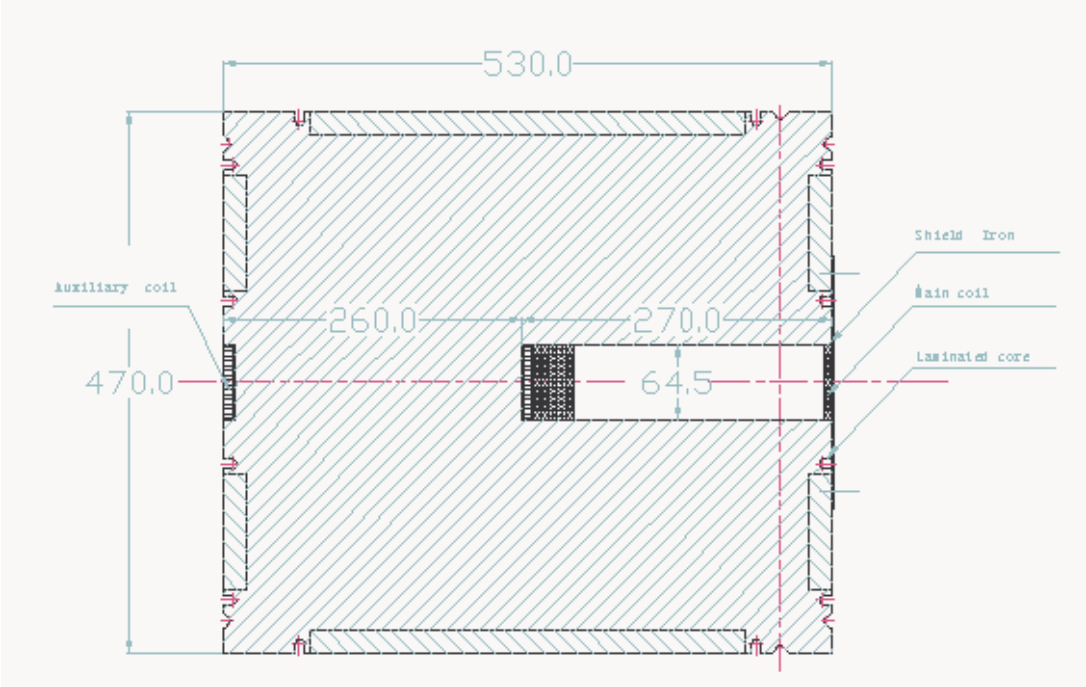

Fig 1. Cross section of the CSRm Ex. magnetic septum

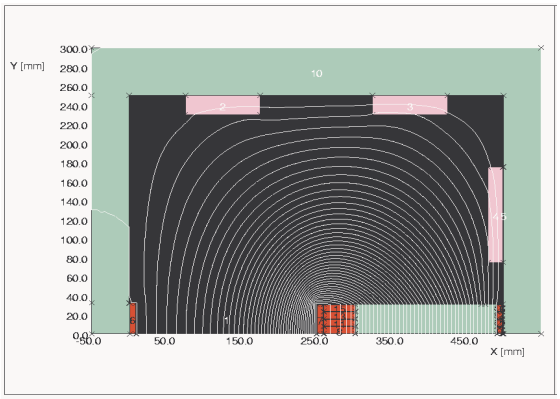

Fig2. Cross-section field distribution of CSRm Ex. septum

3.Field calculation and optimize

According to the field calculation of the 2-D Opera, if the coil was constructed as the ordinary one, etc. the thickness of the conductor insulation is 0.75mm and the ground insulation is 0.5mm , though the fringe field can be canceled thoroughly, as shown in figure 3., the field distribution in the aperture will not be satisfied. As shown in figure 4., the field in the area near the septum leg is more higher than that in the good field region in the gap of the magnetic septum. This is because of the current in the septum leg conductor. Every conductor with current in it has magnetic field surround it and if put the conductor in a magnetic field, the magnetic field surround the conductor will affect the magnetic field in which it as placed. As shown in figure 5. is the Field distribution of CSRm Ex. near septum leg along Y-direction. There is a small field peak corresponding every conductor.

Apparently, these small field peaks corresponding the conductors are set off by the current in the conductors .We can decrease these peaks by reduce the thickness of the conductor insulation and the ground insulation. As shown in Fig6. is the field distribution near septum leg along Y-direction of which the thickness of conductor insulation and ground insulation is 0.15mm. The peaks were decreased roughly and thus the corresponding distribution along X-direction is perfect too. As shown in Figure 7.

Fig3. 2-D field distribution of CSRm Ex. Septum along X-direction

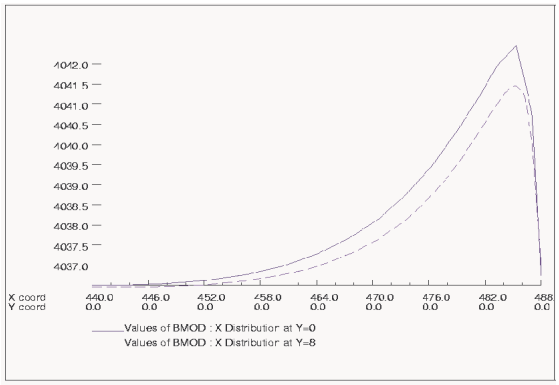

Fig4. Field distribution of CSRm Ex. in aperture along X-direction

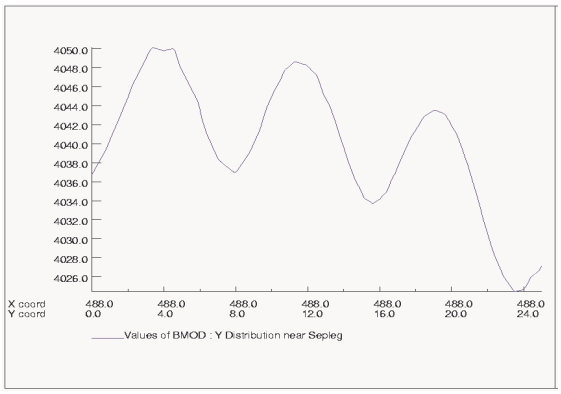

Fig5. Field distribution of CSRm Ex. near septum leg along Y-direction

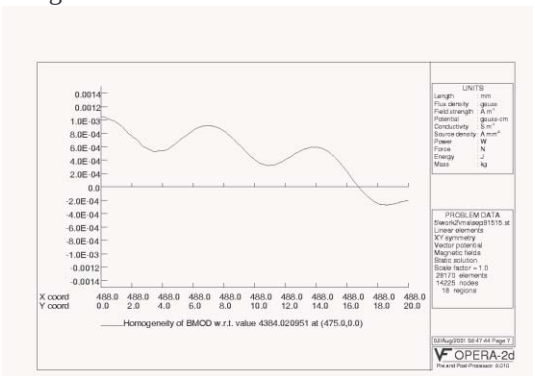

Fig6. Optimized field distribution near septum leg along Y-direction

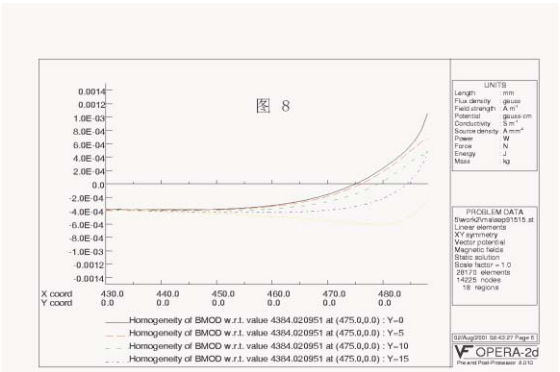

Fig7. Optimized field distribution in aperture along X-direction

4.Result

By using the correction coil and shield iron plate, the fringe field in the ring can be reduced less than 4×10^{-4}T and by reduce the thickness of the conductor insulation and the ground insulation can obtain the perfect field distribution.

References

[1] L.G.Ratner,R.J.Lari,J.A.Bywater,E.C.Berrill,"Design of a low fringe field septum magnet for use at the CERN-ISR".

[2] J.A.Satti and S.D.Holmes, "A pulsed septum magnet for the Fermilab antiproton source".