Stability of the Self-field for YBCO Coated-sheet Magnet

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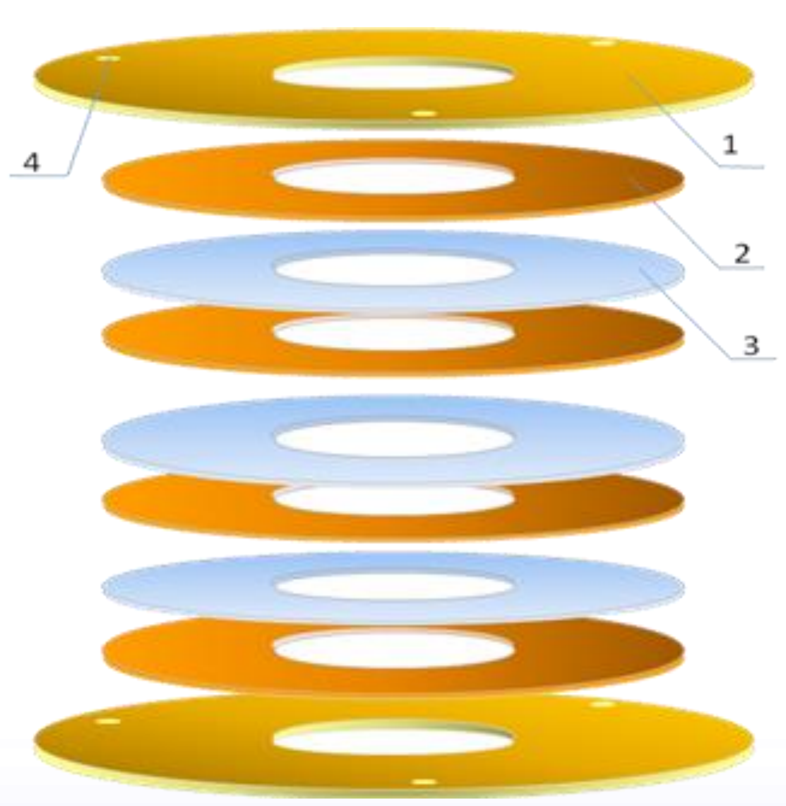
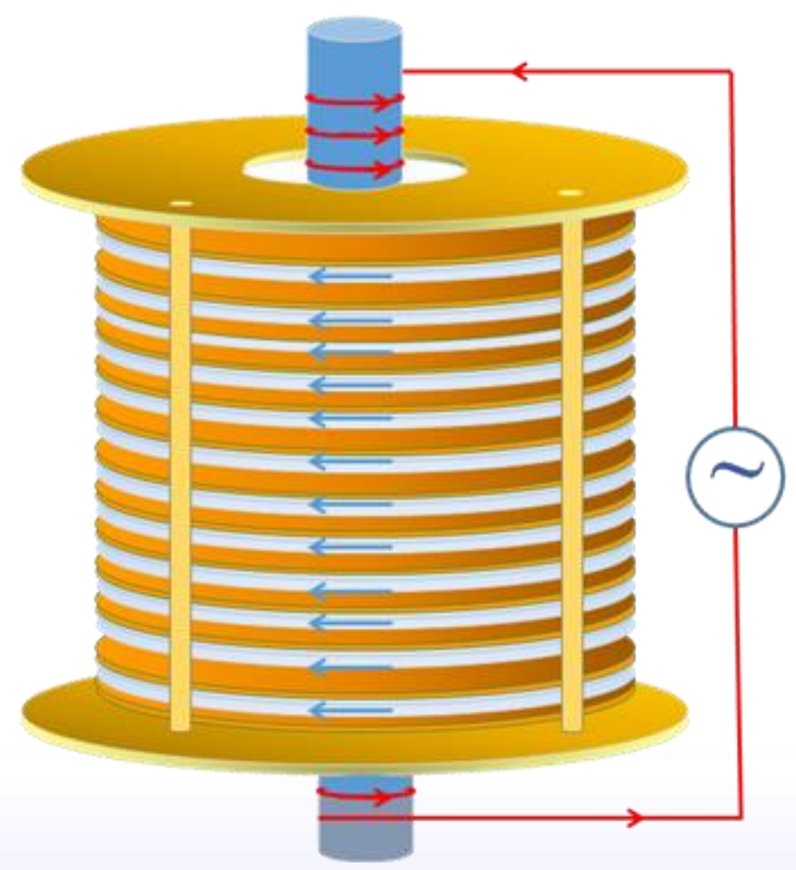
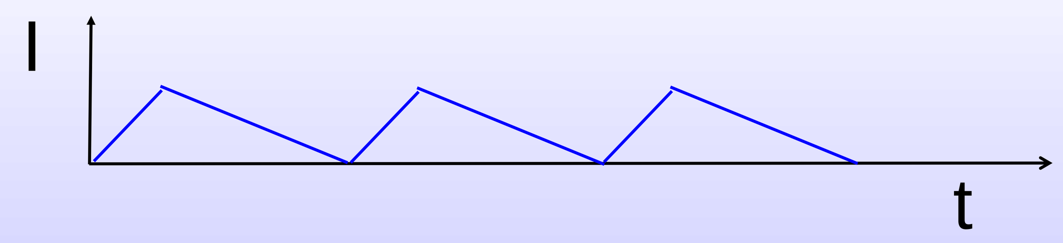
I.Introduction

This paper describes a conception design of YBCO coated-sheet magnet, which is assembled by some YBCO coated ring sheets and ring insulators, with same inner and outer diameters by stacking interactively. Each YBCO coated sheet is with superconducting surface upwards.



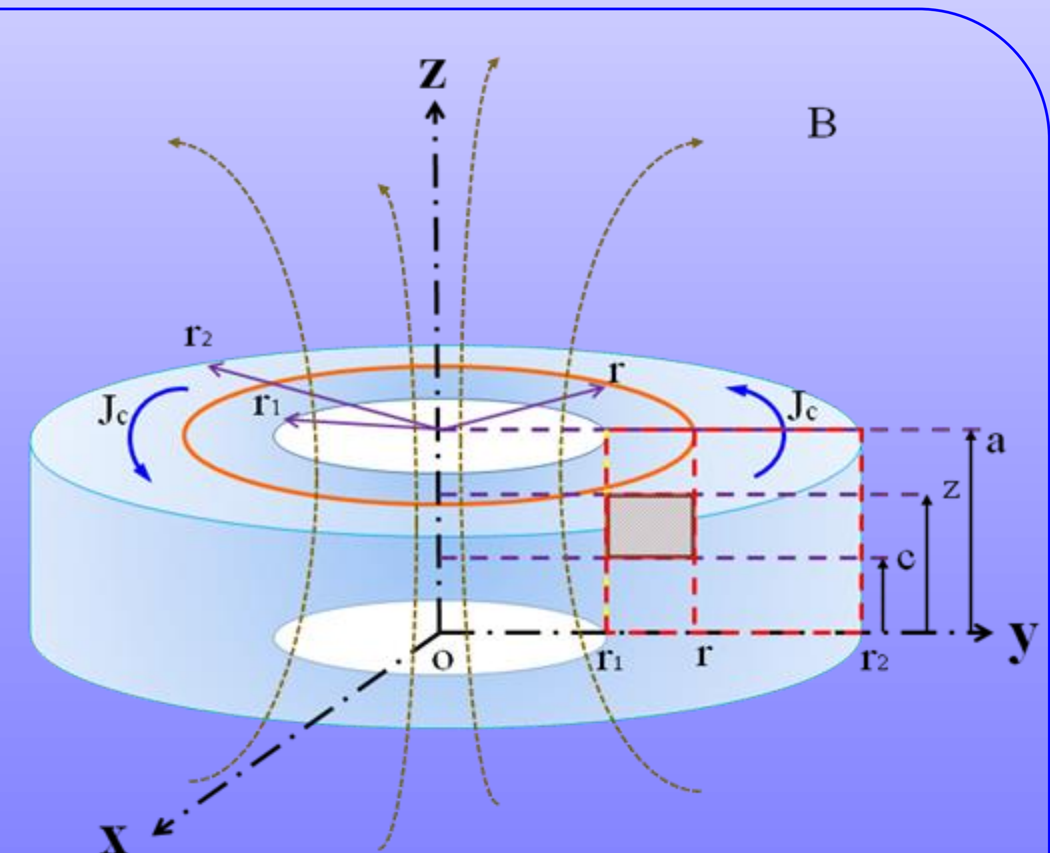




Schematic view of YBCO coated sheets bitter coil:
1 - flange,
2 - insulator,
3 - YBCO coated sheet,
4 - flange positioning hole

II. Model of the self-field stability

We investigate its self-field stability by injecting a pulse of heat ΔQ per unit volume into one sheet. The critical current density will be reduced by ΔJ_c when the temperature rise $\Delta\theta$ in this process so that the screening currents will enter the flux flow regime and will start to decay, generating heat.



Self-field effect in one YBCO coated sheet

$$\delta\varphi(y,z)=\int_c^z \Delta B(y,z)dz$$

$$\Delta Q=\frac{1}{a(r_2-r_1)}\int_{r_1}^{r_2}\int_c^a \delta\varphi(y,z)\lambda J_c dzdy$$

$$\beta_t=\frac{\mu_0\lambda^2 J_c\Delta J_c}{4\pi\gamma C\Delta\theta}=\frac{(r_2-r_1)a}{\int_{r_1}^{r_2}\int_c^a \delta\varphi(y,z)dzdy}.$$

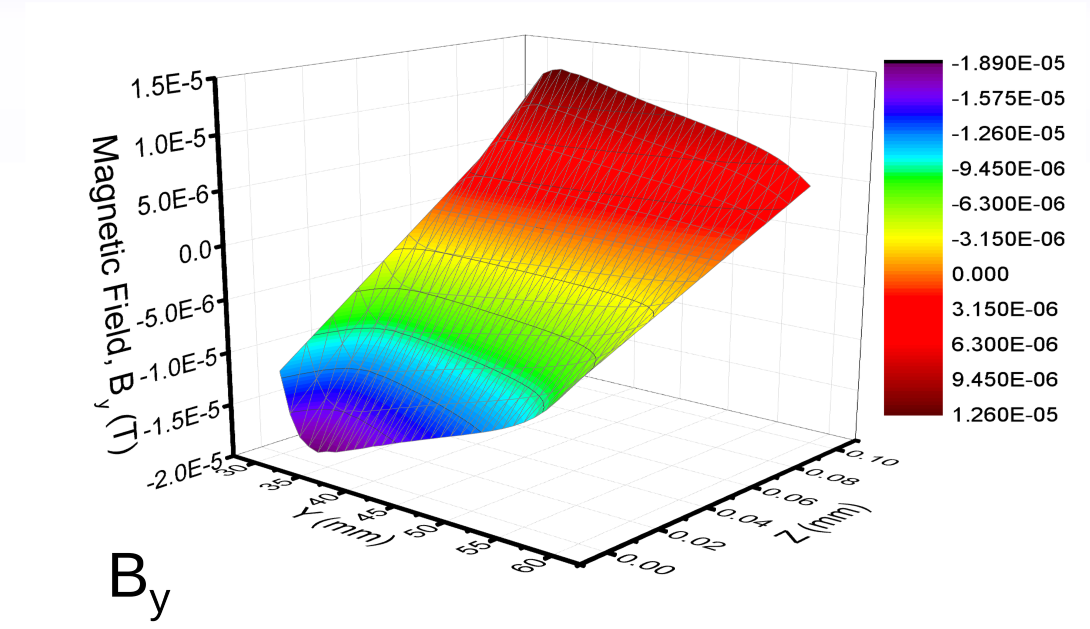
$$\Delta Q_s+\Delta Q=\gamma C\Delta\theta$$

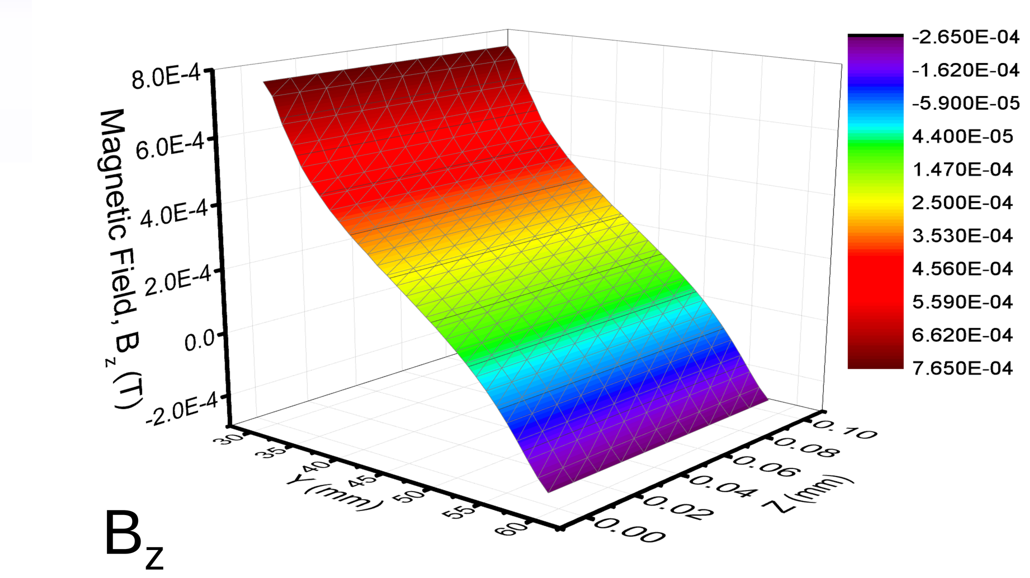
$$B(z)=\int_{r_1}^{r_2}\int_c^a \frac{\mu_0 R\lambda J_c}{4\pi}\int_0^{2\pi}\frac{R-y\sin\varphi}{(R^2+(z-z')^2+y^2-2Ry\sin\varphi)^{3/2}}d\varphi dz' dR$$

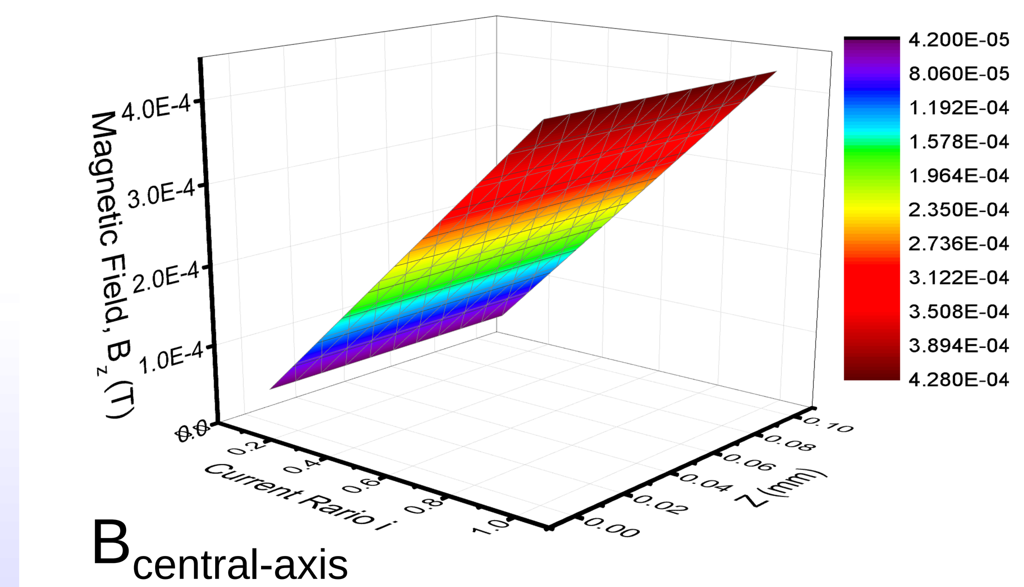
$$B(y)=\int_{r_1}^{r_2}\int_c^a \frac{\mu_0 R\lambda J_c(z-z')}{4\pi}\int_0^{2\pi}\frac{\sin\varphi}{(R^2+(z-z')^2+y^2-2Ry\sin\varphi)^{3/2}}d\varphi dz' dR$$

$$i=I_t/I_c=1-c/a$$

III. Magnetic Field & Self-field Stability







Parameters in field simulation:

77K,

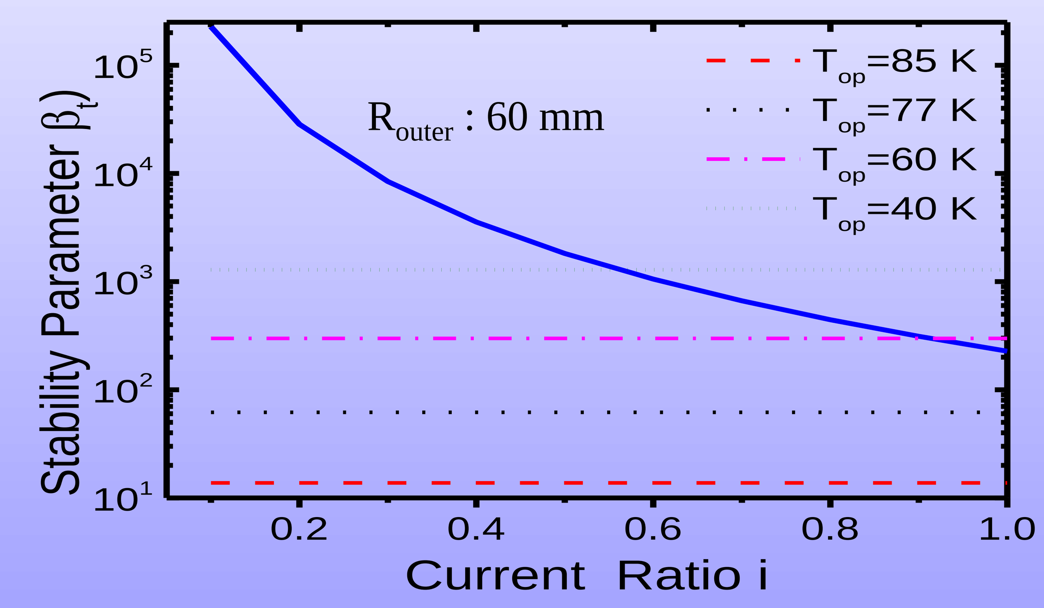
0.8Ic,

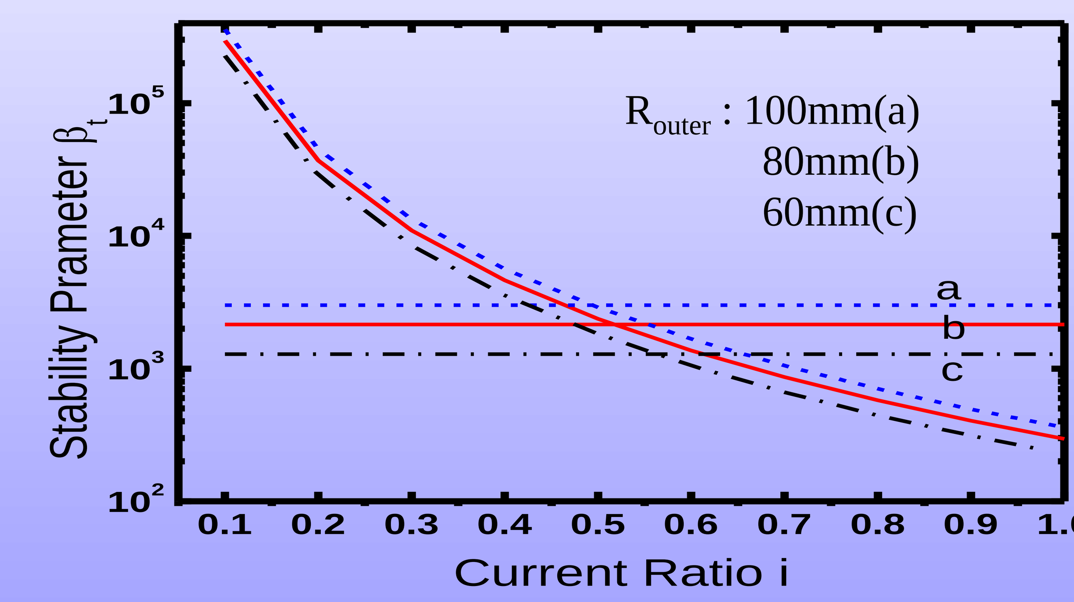
λ=1%

r_{inner} : 30mm

r_{outer} : 60mm,

$a_{Thickness}$: 0.1mm





Parameters in stability simulation:

40K, λ =100%, R_{inner} : 30mm, $a_{Thickness}$: 0.1mm

IV. Conclusion

This paper introduced a conception of YBCO coated sheet magnet. Actually, this magnet may be constructed by Re(Y, Sm, and Nd)BCO coated conductor. Expected central magnetic field can be obtained simply by adding a proper number of this coated sheet.

Liquid nitrogen can be used to provide a low temperature environment. This YBCO coated-sheet magnet is assumed to have simple structure, easy operation, and small power consumption by combining the advantages of flux pump, cryogenic liquid nitrogen, and YBCO coated conductor.

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