Design study of the 250 MeV isochronous superconducting cyclotron magnet

Chen Wei

Huazhong University of Science and Technology

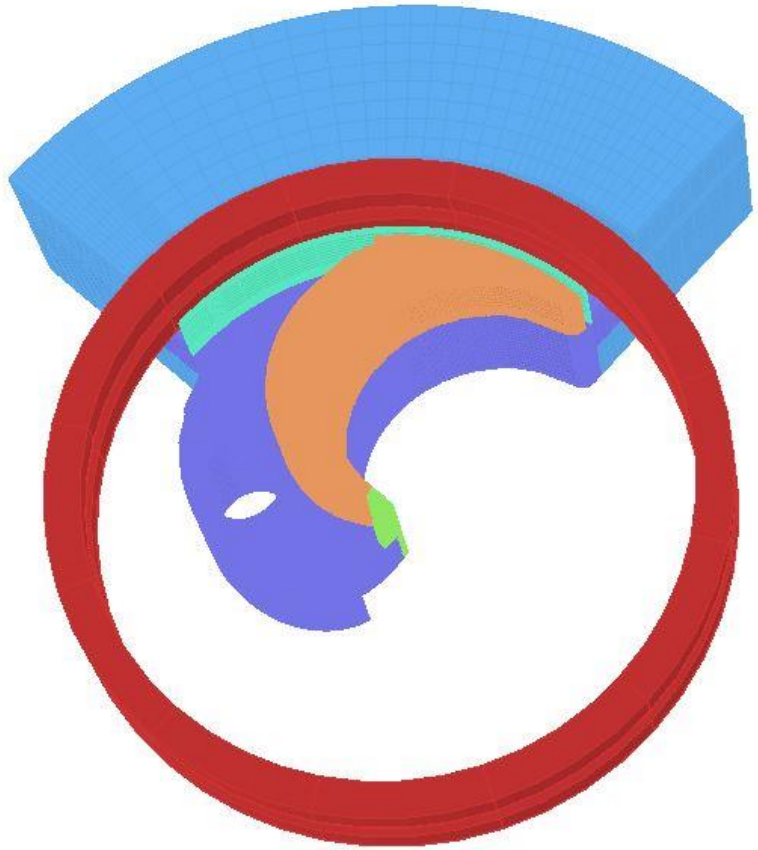
Outline

1. Overall design of the magnet
2. Magnet optimization process
3. Design result

Overall design of the magnet

Table 1. Main parameters of the magnet

Design parameter	Value
Extraction energy	250 MeV
Ion source	Internal P.I.G. source
Injection / extraction field	2.4 / 3.1 T
Spiral angle (maximum)	66 degrees
Pole gap at hill	5 cm
Valley gap	64 cm
Pole radius	85 cm
Yoke radius	160 cm
RF frequency	74.5 MHz (harmonic mode=2)
Extraction method	Precessional extraction



Vector Fields
software for electromagnetic design

Magnet optimization process

$$\Delta B(r) \equiv B(r) - B_{\mathrm{iso}}(r) = B(r) \cdot \frac{\gamma^2(r) \cdot \Delta f(r)}{1 + \gamma^2(r) \cdot \Delta f(r)}$$

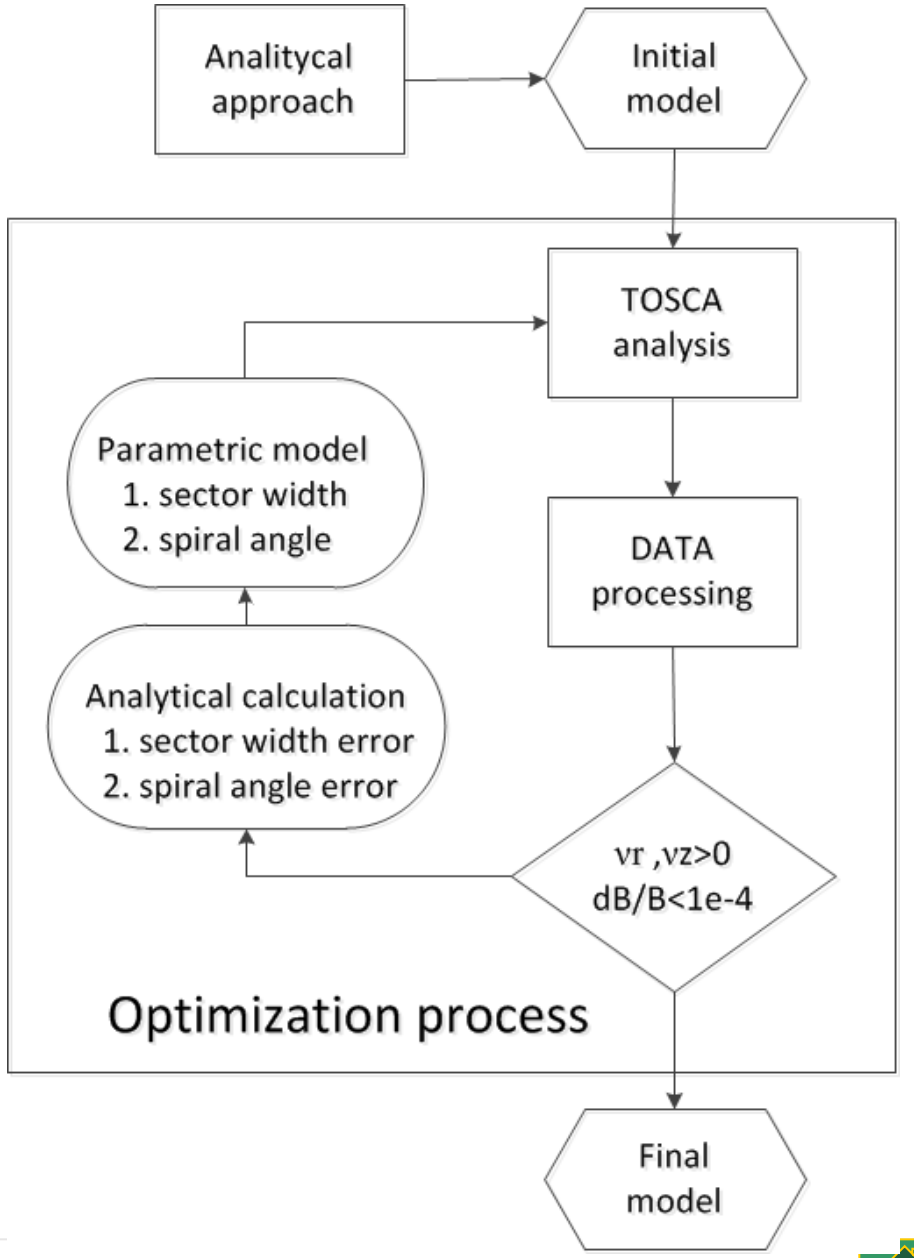
Field isochronism

Hard edge approximation $\quad \Delta\theta(r) \approx \dfrac{\Delta B(r)(2\pi/N)}{B_H(r) - B_V(r)}$

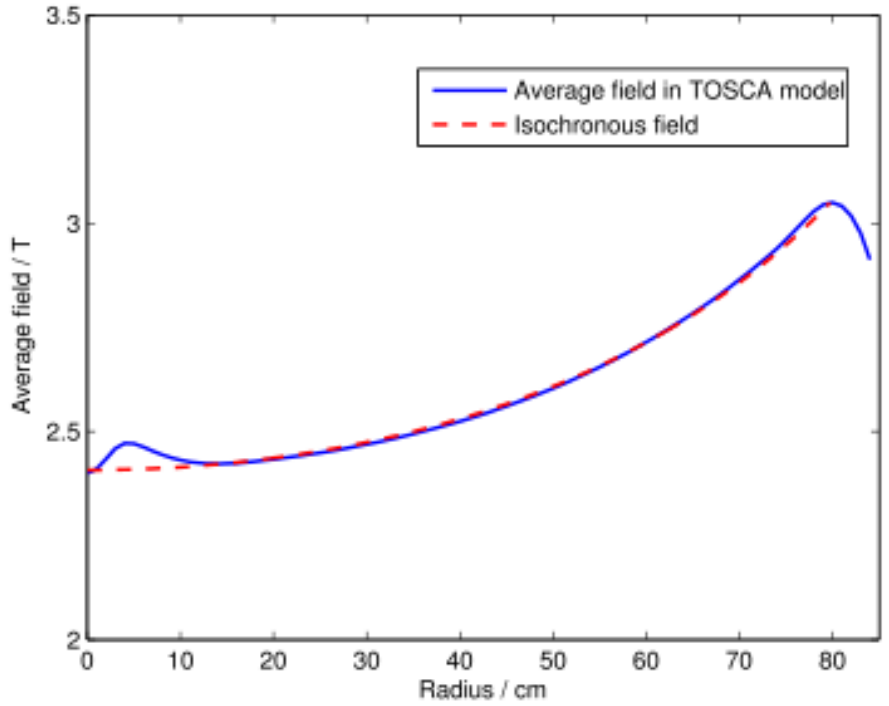
$$\nu_r^2 = 1 + k + \frac{3N^2}{(N^2-1)(N^2-4)} F(1 + \tan^2\xi)$$

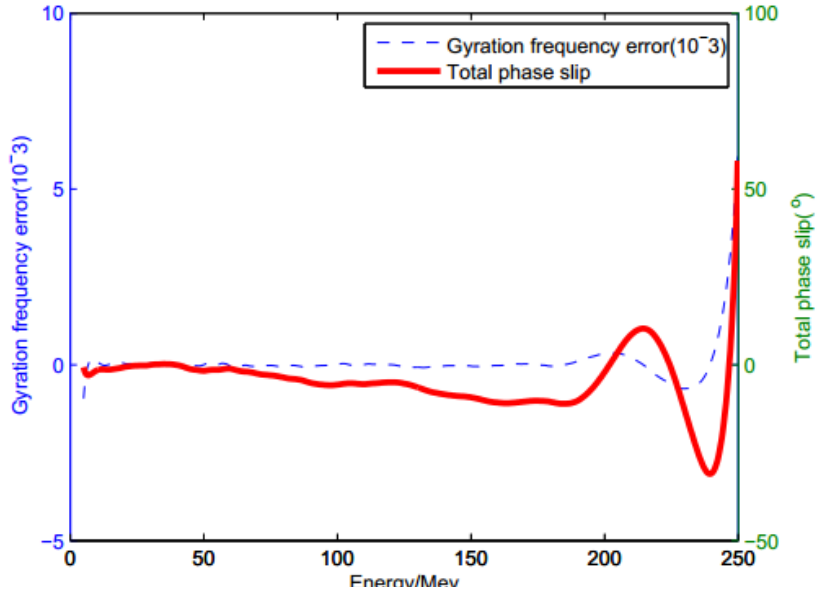
Tune optimization

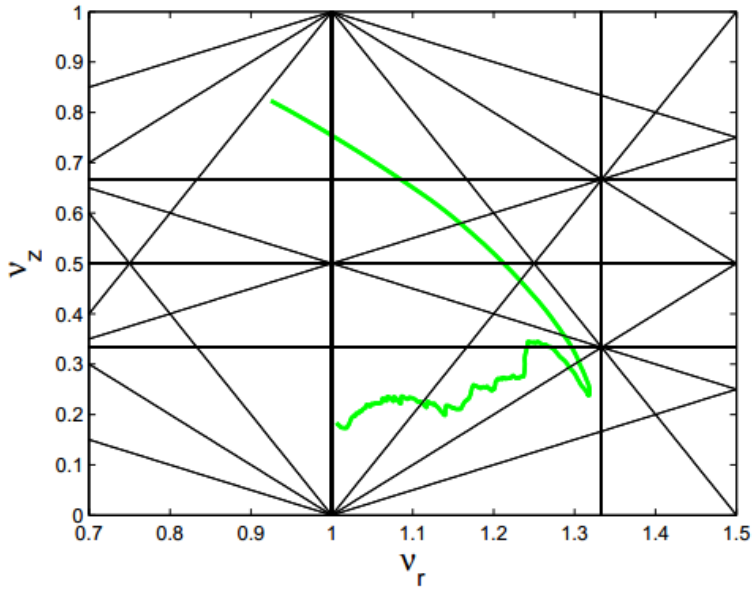
$$\nu_z^2 = -k + \frac{N^2}{(N^2-1)} F(1 + 2\tan^2\xi)$$



Design result







±15◦ total phase slip

This work is based on the proton therapy project, which is proposed in Huazhong University of Science and Technology (HUST).

Thank you