Design study of a coil configuration for a lightweight superconducting magnet in heavy-ion beam rotating gantry

Tetsuhiro Obana

National Institute for Fusion Science, Toki, Japan

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1. Introduction

■ A superconducting magnet with active shielding has been proposed for use in a heavy-ion beam rotating gantry in order to decrease weight.

■ The design study of three-dimensional coil configuration for the superconducting magnet was conducted [1].

■ This poster describes the details of the designed coil configuration and the magnetic field distribution generated by it. In addition, the influence of cooling-down on coil deformation is described.

2. Details of coil configuration

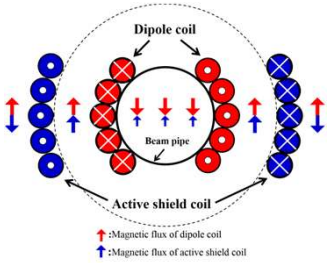


Fig. 1 Concept diagram of a dipole coil with an active shield coil.

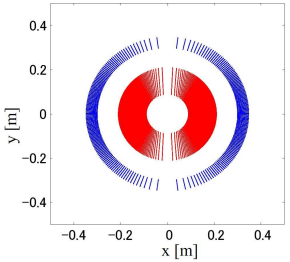


Fig. 2 Cross-section of the dipole and active shielding coils.

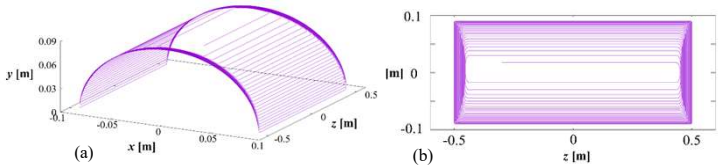


Fig. 3 A bird's eye view (a) and the top view (b) of the first layer upper dipole coil winding.

Table 1. Parameters of the dipole coil and the shielding coil.

	Dipole coil	Shielding coil
Inner radius	90 mm	300mm
Outer radius	210 mm	350 mm
Layers	61	25
Turn	6954	3000
Coil current	217 A	249 A

3. Magnetic field calculation

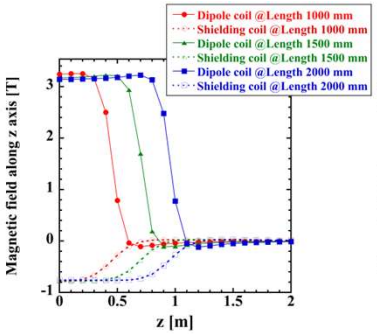


Fig. 4 Magnetic field distributions on the mid-plane along the z-axis of dipole and shielding coils for each coil length.

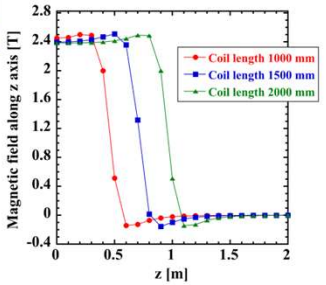


Fig. 5 The results of summing the magnetic field distributions along the z-axis of the dipole and shielding coils for each coil length.

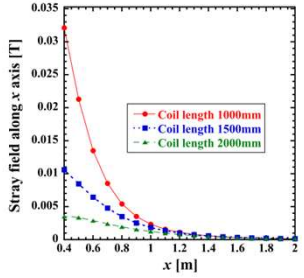


Fig. 6 Stray magnetic fields on the x-axis for each coil length at the coil center (z=0mm).

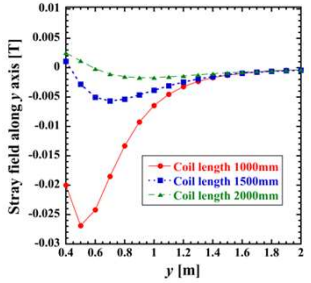


Fig. 7 Stray magnetic fields on the y-axis for each coil length at the coil center (z=0mm).

4. Influence of cooling down on coil deformation

■ We investigated the deformation of the coil when the magnet was cooled from room temperature (300K) to operating temperature (5K).

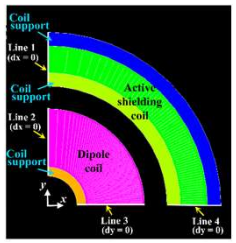


Fig. 8 FEM model for the thermal stress analysis.

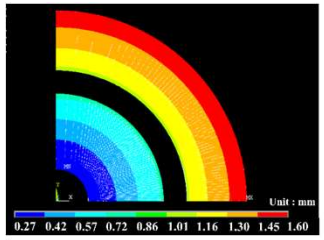
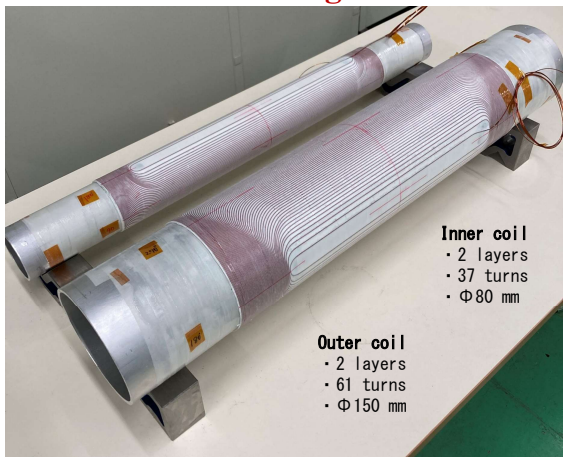


Fig. 9 Displacement distribution of the coil cross-section in the first quadrant due to cooling down.

Table 2 Size of coil support for the dipole and shielding coils.

	Inner radius	Outer radius
Inner support for dipole coil	65 mm	85 mm
Inner support for shielding coil	265 mm	295 mm
Outer support for shielding coil	355mm	385 mm

5. Coil winding test



6. Conclusion

■ The effect of the coil end section on magnetic field distributions increases as the coil length decreases.

■ The maximum deformation of the coil cross-section is a few millimeters when cooled from 300 K to 5 K.

Acknowledgements

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Reference

[1] T. Obana, "Investigating the Effect of Coil Length, Alignment Errors and Cooling Down on a Superconducting Magnet With Active Shielding for Rotating Gantry" IEEE Trans. Appl. Supercond., vol.34, no.5, 2024, Art. ID 4401105.