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Influence of the shape of soft-iron yoke on trapped field performance of HTS bulk

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1. Introduction

Background

- A REBCO bulk superconductor is able to generate a several-tesla-class magnetic field by cooling and excitation.
- To promote the industrial applications of bulk magnets going forward, improving the ease of magnetization as well as the trapped magnetic field are important problem.
- In our previous study, we investigated to improve the trapped magnetic field in the bulk magnet system by simple method in which the size of soft-iron yoke was increased [1].
  - ➢ A trapped field could be increased by enlarging the yoke.

  ⇩

  Magnetic field exposure time was extended, and temperature rise was suppressed. = long-pulse method [2].

Purpose of this study

- The shape of soft-iron yoke is changed for the purpose of reducing the volume of soft-iron yoke. ⇨ This leads to a decrease in overall weight of the bulk magnet system.
- The influence on trapped field performance is investigated by PFM experiment using the ring- and disk-shaped yokes.
- There is concern for a reduction of trapped field due to a decrease in the volume of soft-iron.

[1] K. Yokoyama and T. Oka, EUCAS2019, 1-MP-CU-S18, Glasgow, 2019.
[2] H. Fujishiro, M. Kaneyama, K. Yokoyama, T. Oka and K. Noto, Jpn. J. Appl. Phys., 44, pp. 4919-4925, 2005.

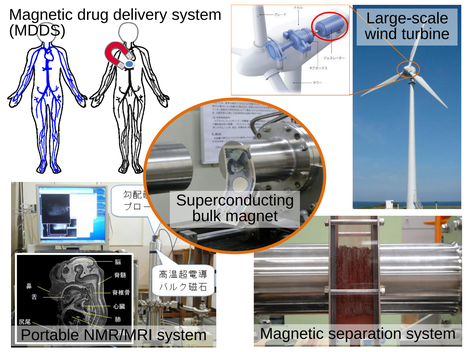


Fig. Examples of applications of bulk magnet

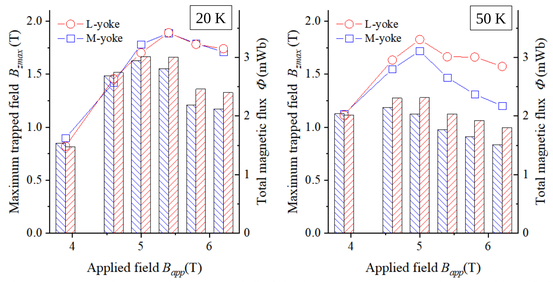


Fig. Comparison of trapped fields between L- and M-yokes [1]

2. Experimental

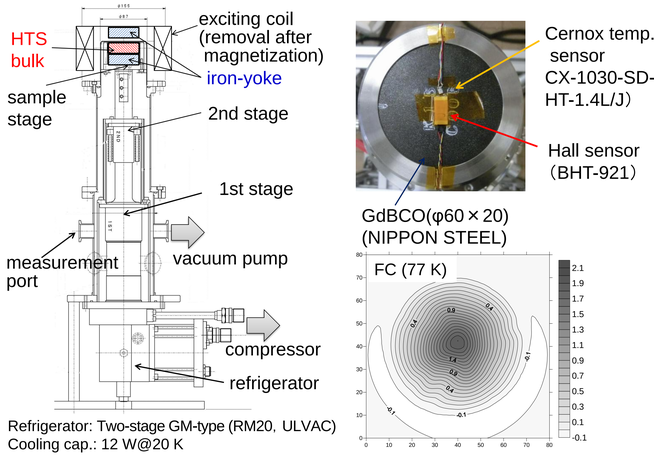


Fig. Schematic of the bulk magnet system

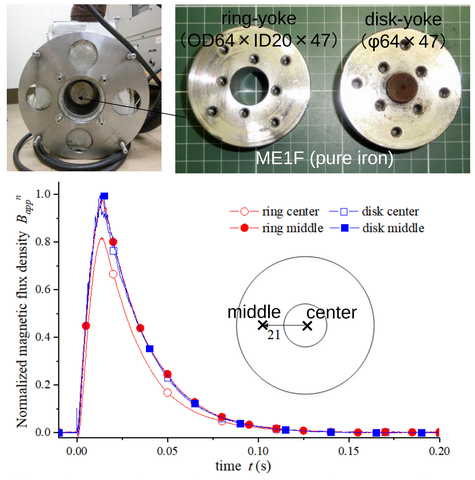


Fig. Comparison of pulse shape between ring- and disk-yokes

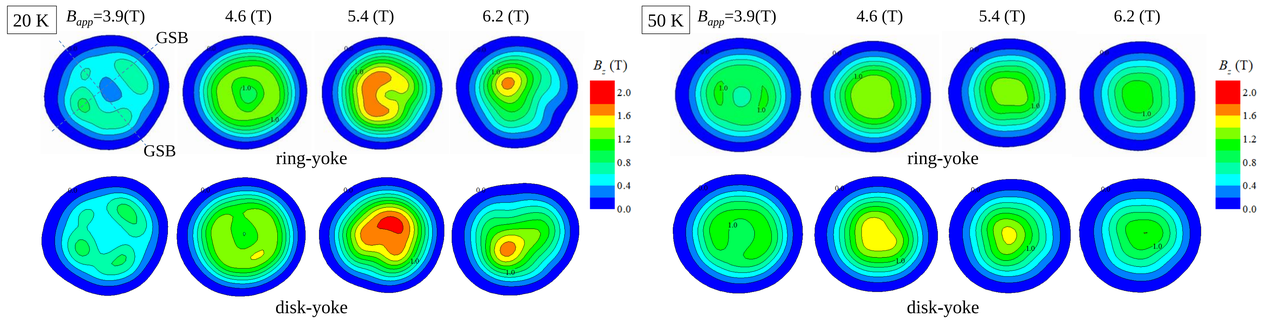
Experimental method

A single pulsed field was applied and flux density on the bulk surface was monitored. After the magnetization, trapped field distribution was measured on the vessel surface.

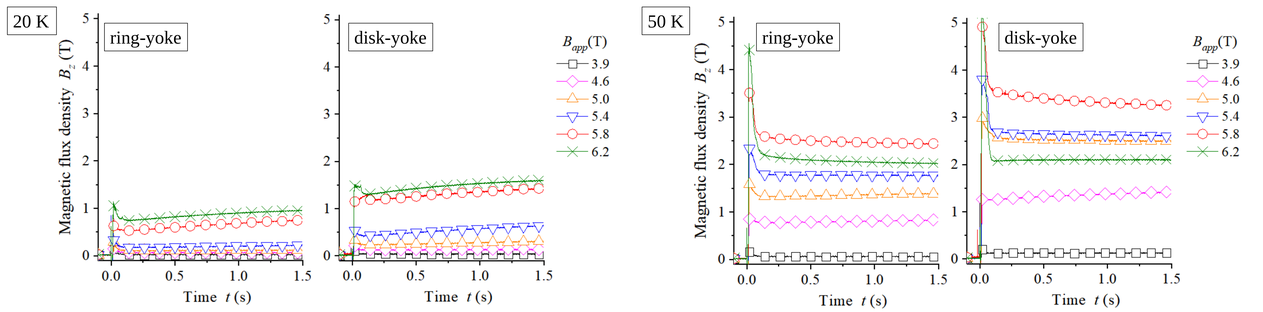
- Applied field: B_{app}=3.9, 4.6, 5.0, 5.4, 5.8, and 6.2 T
- Flux density was monitored on the bulk surface with a Hall sensor(BHT-921, F.W.BELL) (sampling rate: 100 μs).
- A three-dimensional Hall sensor (HGT-3030, LakeShore) was scanned on the vessel at a 2-mm pitch.
- A total magnetic flux was calculated using the measured flux distribution data.

3. Results and discussion

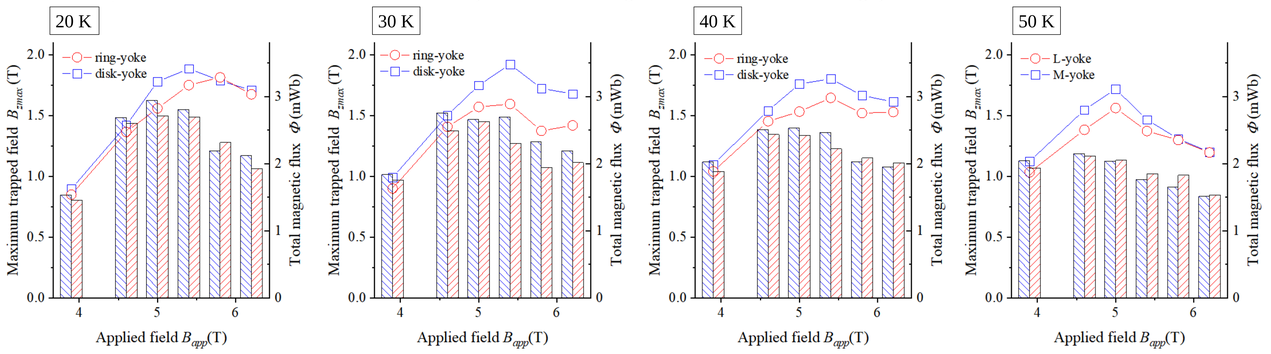
A. Comparison of trapped field distributions between ring-yoke and disk-yoke



B. Comparison of time responses of magnetic flux density between ring-yoke and disk-yoke



C. Comparison of the maximum flux density and total magnetic flux between ring-yoke and disk-yoke



4. Conclusions

- We investigated the influence of the shape of soft-iron yoke on the trapped field performance of HTS bulk activated by pulsed field magnetization (PFM).
- A ϕ60-mm GdBCO bulk was magnetized using ring-shaped and disk-shaped yokes.
  - The amplitude of applied field at the center of bulk was approximately 20% lower than that at the peripheral part when using the ring-yoke. (cf. both values were equal when using the disk-yoke.)
  - Maximum flux density B_{zmax}: The B_{zmax} of ring-yoko was lower than that of disk-yoke at all temperatures and applied fields.
  - Total magnetic flux Φ: Although the Φ value of ring-yoke was lower than that of disk-yoke at low temperature, both values are almost equal at high temperature.

  ⇨ These results provide the possibility of reducing the weight of the entire system while maintaining the high trapped field by decreasing the volume of soft-iron yoke.