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Estimate of the Strong and Uniform Magnetic Field Generated by Face-to-Face HTS Bulk Magnet System

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Background

The HTS bulk magnets exhibit quite peculiar distributions of the trapped magnetic fields (Oka et al. (2000)). Nakamura et al. (2007) succeeded in detecting the NMR signals in the bore of the piled-up bulk magnets for the first time in the world. Ogawa et al. (2011) showed us the MRI picture of an embryo of a mouse with use of the same system. To expand the practical application areas of bulk magnets, we aim to estimate the uniformity of magnetic field in the gap between the face-to-face magnetic (Oka et al. (2014)). In this paper, the bulk magnets were activated by the pulsed field (PFM). The performances of the uniformity are discussed from the view point for the compact NMR devices which have been never realized in the past.

270MHz (-6T)

200MHz (4.7T)

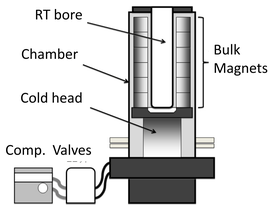
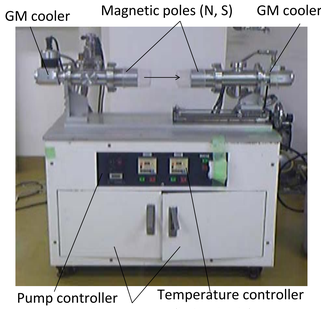
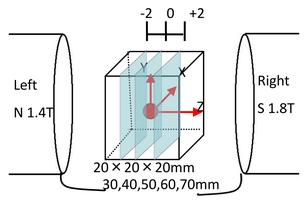
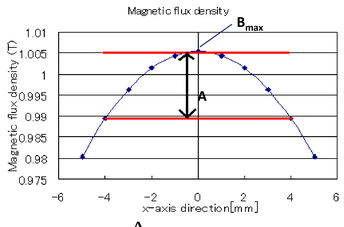


Illustration of hollow-type bulk magnet

Experimental





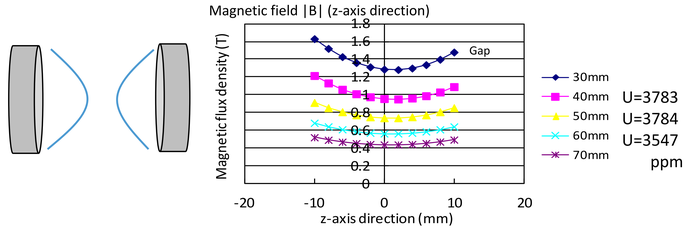


$$U = \frac{A}{B_{max}} \times 10^6 \quad (ppm)$$

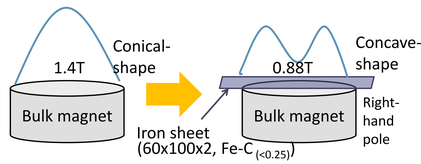
- Gd123 bulk magnets manufactured by Nippon Steel Co. and Dowa Mining Co.
- 60 mm in diameter and 15 mm in thickness
- The PFM less than 7 T were applied by IMRA method (Oka (2007))
- The bulk magnets emitted 1.8 T (N) and 1.4 T (S) at each pole surface
- The gap is settled less than 70 mm

Results and Discussions

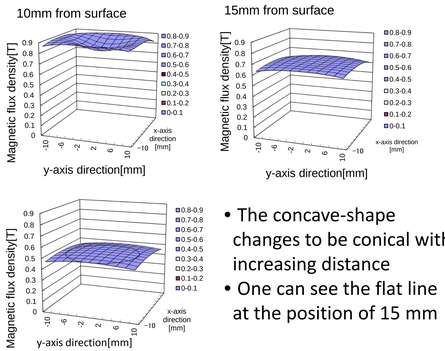
Uniformity at the centre of the gap



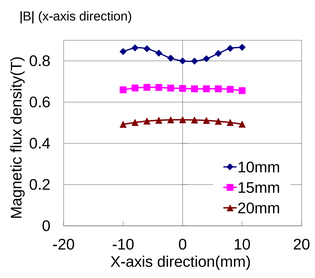
Variation of trapped field



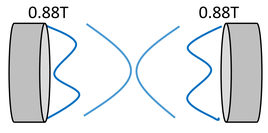
- In order to make the distribution smooth, we attached an iron plate of 2 mm in thickness on the right-side pole surface generating 1.8 T



- The concave-shape changes to be conical with increasing distance
- One can see the flat line at the position of 15 mm

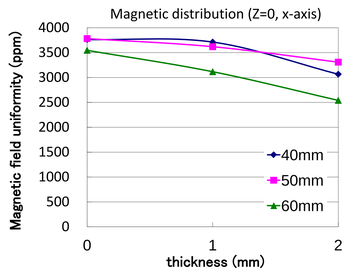


Concave and Concave

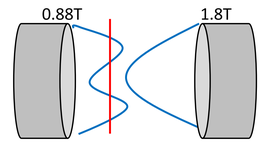


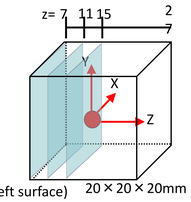
d=60	B(T)	U(ppm)
-2	0.477	2516
0	0.472	2541
2	0.473	2536

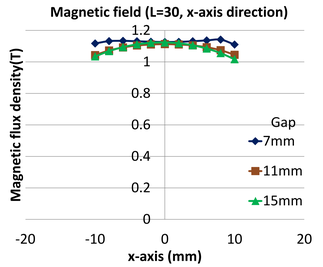
- When settled face-to-face, we obtained 2,516 ppm of 0.477 T at 60 mm gap

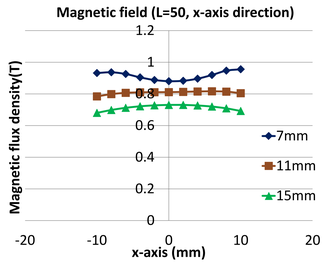


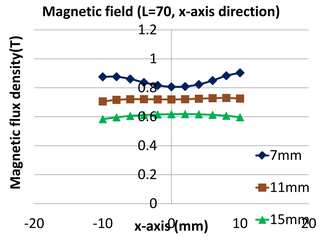
Concave and Conical



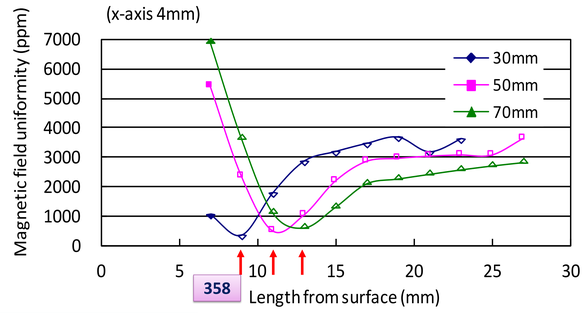








- The iron plate is only on the left-hand side
- The concave and conical shapes were precisely coupled between the gaps of 30 – 70 mm
- The profile in every gap has a minimum point respectively
- The most uniform distribution of 358 ppm of 1.11 T 9 mm in the 30 mm gap
- The performance exceeded the level of 1,500 ppm, which would enable us to observe the NMR signals



Conclusion

- The uniformity of the magnetic field was improved when the concave and conical magnetic field distributions were coupled together with use of an iron plate on the pole surface
- The most uniform distribution was 358 ppm of 1.11 T for *B* at 9 mm distant from the magnetic pole
- The minimum values lies in the valleys in the regions from 9 to 13 mm distant from the pole surface.
- The distributions must be improved when we adjust the peaks more precisely.

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