HTS Volume Coil with Improved Imaging Volume

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Abstract

In this abstract, a multi-turn 5.5" large HTS solenoid volume coil & compact cryostat prototype with improved field-of-view (FOV) & high SNR is presented. Although HTS thin-film phased array coil [1] has been demonstrated to increase imaging volume, coupling & isolation between multi-coil, tuning & matching element require complex operation. The result shows the possibility of future large HTS volume coil with compact cryostat for human neuro-imaging with increased FOV & SNR.

Introduction

Small HTS tape volume tape coil has been demonstrated [2] to achieve higher quality factor (Q-factor) over conventional copper coils to improve image SNR or reduce imaging time [3]. Typical HTS coils are surface coils made of HTS thin film or small HTS volume coil made of HTS tape to achieve high SNR improvement. However, imaging area is limited by the coil dimension thus penetration depth. In our work, a multi-turn 5.5" HTS volume coil cooled by compact cryostat with improved imaging volume & high SNR is first demonstrated.

Materials & Methods

A 4-turn 5.5" fully etched HTS solenoid coil is fabricated with commercially available silver-alloy sheathed Bi-2223 HTS tape (5mm wide, 15mm turn-turn spacing) and soldered with high quality capacitors from American Technical Ceramics (ATC). The equivalent LC circuit has a resonance frequency of 12.854MHz for 0.3T imaging. A compact thermal insulated cryostat was constructed. The coil is immersed into liquid nitrogen (LN) for cryogenic cooling. Rail guided tuning & pickup coil are used to couple the signal from the HTS coil. The images were acquired on a 0.3T open MRI system (Magsonance, Time Medical System). The phantom was placed inside the thermal insulated volume coil so as to obtain the best filling factor. The images are taken with gradient echo sequence (FOV: 15cmx15cm, TR=400ms, TE=12ms, NEX=4, ST=4mm). To evaluate the performance of the HTS volume coil, images were also acquired with a single turn HTS tape coil, a volume copper coil and a cool volume copper coil with the same dimension for comparison. We have also imaged a Shanghai Hairy Crab and the wrist of a normal adult volunteer with all coils.

Results

The SNR and Q values for the phantom images of different coils are given in the following table:

	Q			SNR
	Unloaded, outside magnet	Unloaded, inside magnet	Loaded (phantom) inside magnet	
Volume Copper	200	146	132	28.67
Cool Volume Copper	775	370	305	48.68
Single-turn HTS	1853	640	613	82.23
Volume HTS	2200	749	714	90.02

From the measured phantom data, the imaging area (with 3dB intensity attenuation) along the long axis of the 4-turn HTS volume coil (12.5cm) is 2.5 times larger than the single turn HTS tape coil (5cm). The average SNR ratio between the HTS volume coil and the room temperature copper coil in phantom images is 310%. The comparison on Shanghai Hairy Crab images is given below.

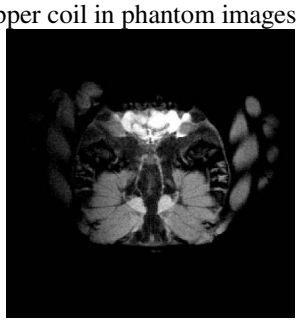

Fig.1a. Volume Copper

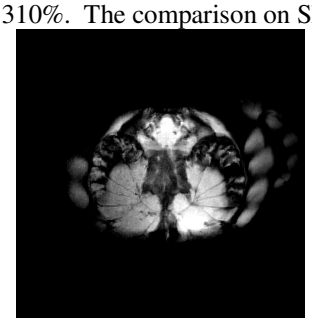

Fig.1b. Cool Volume Copper

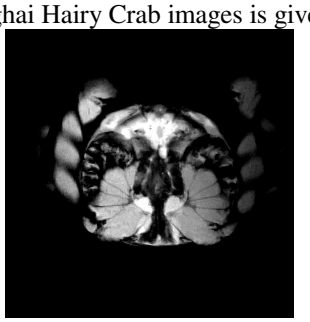

Fig.1c. Volume HTS

Conclusion

A new prototype of a large multi-turn volume HTS coil has been realized for imaging with improved FOV. It demonstrates a 250% increase in imaging volume over single turn HTS tape coil and retains ~300% SNR gain. With advancement in building larger HTS volume coil & compact cryostat system for in-vivo MRI studies, future work will be carried out to build a HTS volume coil& cryostat for human neuro-imaging with increased sensitivity & SNR.

References

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