Use of Bi-2223 HTS tapes as RF coils for 1.5T MRI

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Introduction: It is well known that HTS films used for RF coils can significantly improve the SNR of MR images [1], especially for low field MRI with small samples. Bi-2223 HTS tape is a potential material for RF coils due to the advantages of easier fabrication, easier frequency adjustment, and much lower cost over HTS films. Although it has been reported that the resistivity of Bi-2223 tapes is in the same order of $10^{-9}\Omega$m as copper in the field perpendicular to the tape surface at 15T at 77K [2], as for RF coils, HTS tapes show much lower resistivity than cooper because HTS tape orientation in MRI is not perpendicular to B_0 and the field strength is much lower than 15T. HTS tape coils has been demonstrated successfully for low field application at 0.21T [3], but its performance for typical high field MRI of 1.5T has not been verified so far.

Method: The tape was bent into a circle and an ATC 100B capacitor was soldered at both ends to form the surface coil. The tape sheath was removed by ammonium hydroxide and hydrogen peroxide [4] to avoid screening of the superconducting phase from RF signal. A copper coil with the same size was fabricated for SNR comparison. The experiment setup for imaging is shown in Fig. 1. A custom-made glass vacuum vessel was used as cryostat. Matching was accomplished by adjusting the relative position of a pick-up coil mounted on the vessel to the HTS coil. A 4-inch diameter cylindrical phantom to simulate human muscles (εr=70.5 and S=0.68S/m) [5] was imaged on a GE Signa LX 1.5T MRI. A spin-echo sequence with TR=120 ms, TE=3.4 ms, and NEX=1 was used for imaging. Power settings were determined by stepping through a range of transmit attenuation values in the prescans. The optimum transmitted power was set to maximize the signal amplitude. The FOV, the slice thickness and acquisition matrix size were 15*15cm, 5mm and 256*256 respectively. The coronal phantom images obtained from about 1.4 cm below the coil surface and their corresponding intensity histograms are shown in Fig. 2.

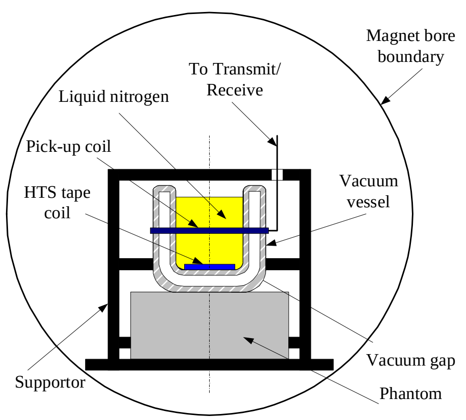
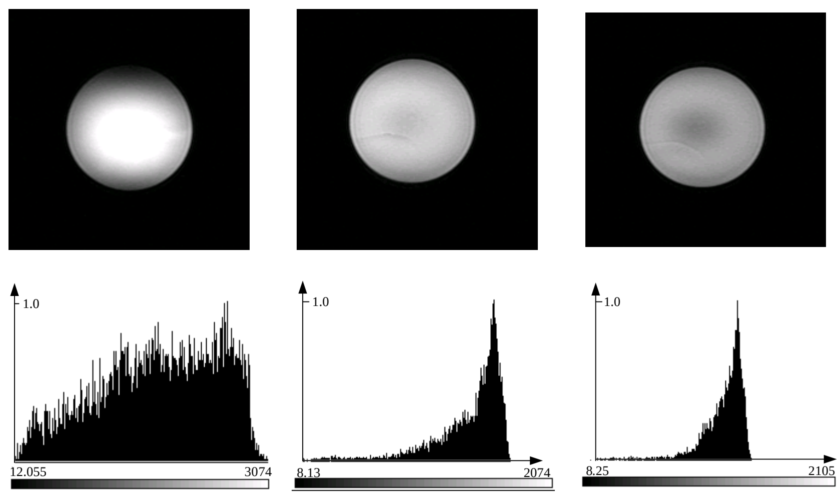


Fig. 1. Experiment setup for imaging at 1.5 T



HTS   Copper at 77K   Copper at 300K

Fig. 2. Coronal phantom images and intensity histograms comparison

Results and Discussion: The noise region was selected as the whole background and the signal region was selected as the circular region covering the phantom. Signal intensities along the horizontal axis extracted from the images were plotted in Fig. 3. The HTS tape coil obtained an average SNR improvement of 1.11-fold over the copper coil at 77 K, and 1.36-fold over the copper coil at room temperature. Although this 36% SNR improvement at 1.5T is not as significant as that at low field of 0.21T, it is still very helpful for high field applications.

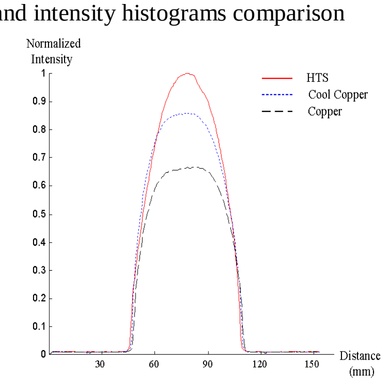


Fig. 3. Plots of intensities along the horizontal axis extracted from images

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