[Emerging Device Technology](#) > **MRI Coils**

Magnetic resonance imaging (MRI) is an imaging technique used primarily in medical settings to produce high quality images of human body. Clinically, high field 1.5T MRI system is used. The whole system is large, usually occupying a room and the patient has to lie down on a computer-controlled table when images are being taken.

In addition to a large magnetic field there are radio frequency coils which form the image. It is these coils which provide the information to form the images and can be enhanced using superconducting materials. Imaging procedures are carried out through a computer, which controls all components on the imager. Figure 1 shows an example of MRI image of a human knee.

Figure 1 An example of MRI image of a human knee

The MRI work, which started in collaboration with South Bank University, has been focusing on the design of the receive coils. The objective of the work at South Bank University is to build a low field (0.1T) small MRI system for scanning human wrist and knee. The coil is required to be resonant at 4MHz. Because it is a low field system, a superconducting coil is advantageous as it has very small conductor loss and therefore can offers better signal-to-noise ratio and improved sensitivity as compared with a copper coil. In the following, the design of the coil will be discussed; some practical aspects concerning the coil tuning will be highlighted.

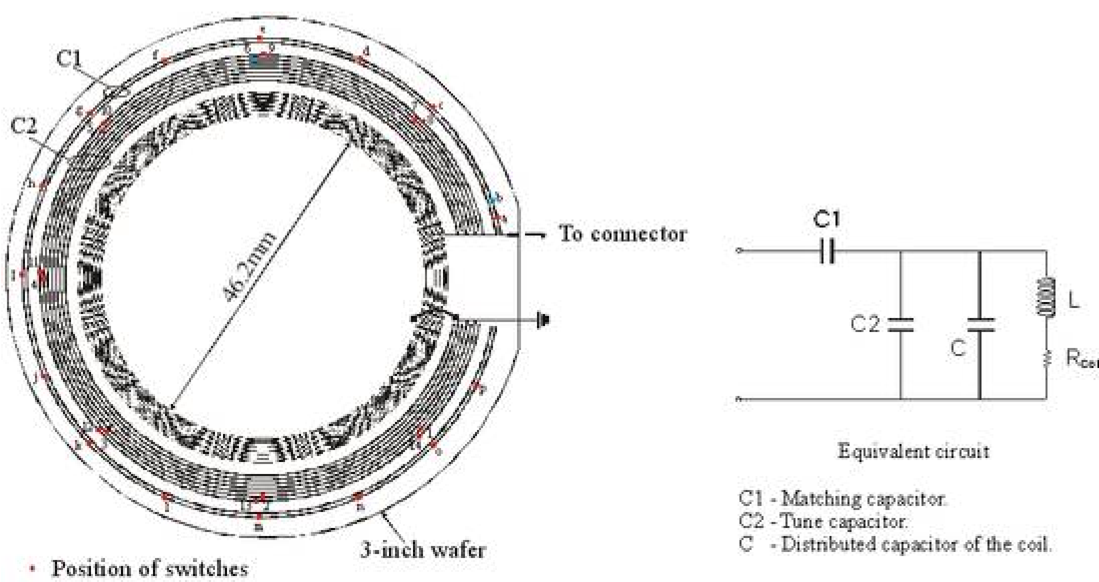

Figure 2 Layout of a superconducting receive coil, with the equivalent circuit on the right

Shown in Figure 2 is a new idea of a superconducting receive coil. The coil is to be made of thin film superconductors patterned on a 3-inch diameter sapphire substrate. The equivalent circuit of the coil is shown on the right. At the centre of the receive coil is an 18 turn spiral inductor, with an innermost diameter of approximately 46mm. Two capacitors, C2 and C1 are included in the design and this is explained in the next paragraph. These capacitors are designed to wrap around the spiral inductor in an inter-digital form.

During the procurement of an MRI image, variations in the size and tissue composition of the anatomy placed in an imaging coil affect the performance of the RF coil. For these reasons, the RF coil should be tuned in order to account for the loading effects. Tuning of the coil entails adjusting two types of capacitors. One capacitor (C1) is called the matching capacitor and the other called tuning capacitor (C2). The matching capacitor matches the impedance of the coil together with the imaged object to that of the 50W cable coming from the spectrometer. The tuning capacitor holds the resonance frequency of the RF coil to 4MHz.

The research group proposes tuning the coil using switches. Also shown in the diagram are the positions switches on inter-digital fingers, lengthening or shortening the fingers to change the capacitances. These switches are to be made out of MEMS switches (Micro-Electro-Mechanical System). Some studies are underway to investigate:

(1) the changes in the resonant frequency and the input impedance of the coil caused by the loading effects and
(2) the amount of tunings needed in order to correct these effects.

In order to validate the design principles, a similar copper coil has been designed, fabricated and measured. The coil was made out of copper on a RT Duroid 6010.2 substrate with a permittivity of 10.2 and a thickness of 1.27mm. Figure 3 shows a picture of the copper coil.

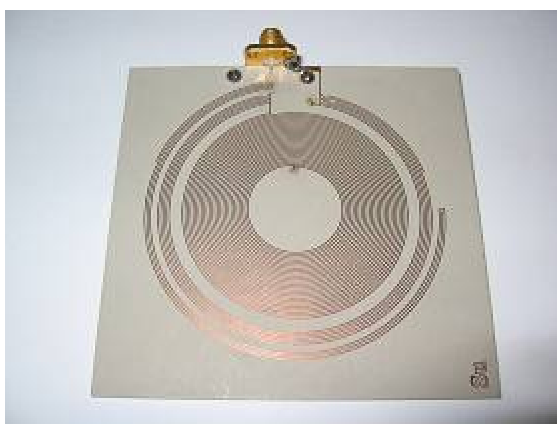

Figure 3 Layout of a copper coil

Figure 4 shows measured performance of the coil. The phase changes abruptly at resonance, which is expected. The coil shows a resonance frequency at 4.1MHz and an input impedance of about 50Ω.

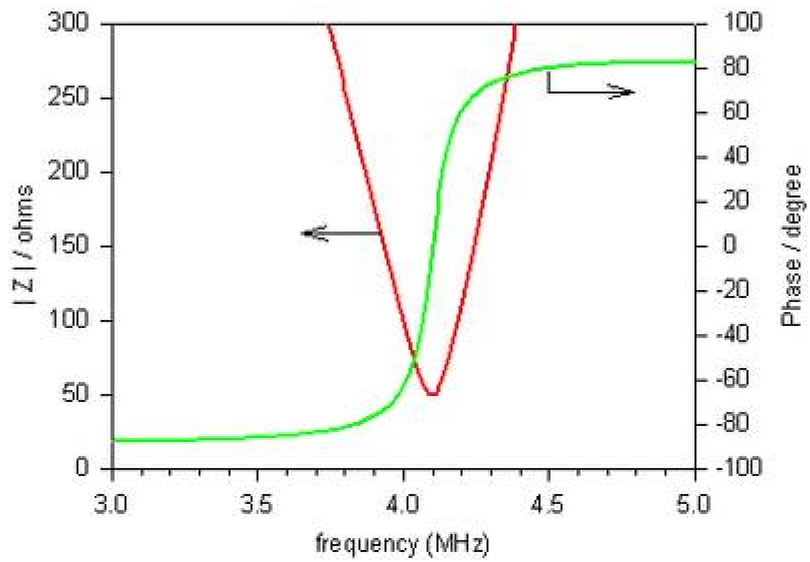

Figure 4 Measured magnitude and phase of the input impedance, Z of the coil.