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Low Field set-up for Magnetic Resonance Imaging

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Introduction

A couple of modalities are proposed at low magnetic fields below 1 mT. Namely direct neuronal current detection and T1-contrast at low magnetic fields. Both offer new perspectives in particular in combination with spatial resolved information. To this end we developed a SQUID based MRI system enabling a Larmor frequency range below 1 kHz.

Methods

The measurement system consists of three main components. The magnetic sensor is realized by using a superconducting quantum interference device. To apply all the required magnetic fields and field gradients a coil set-up is placed inclusive current sources. And, a PXI based data acquisition and timing completes the set-up. Each measurement starts with a pre-polarizing of sample volume by applying up to 50 mT. To get the spatial information phase and frequency encoding is used. After the polarization the phase gradient is applied for adjustable time. Then the applied frequency gradient and detection field are inversed repetitively according to the phase time. So, echo signals of samples T2 decrease can be measured.

Results

Starting with phantom studies we prepare three plastic bottles filled with tap water, copper sulphate-solution and hydro ethyl cellulose-solution. They differ in their T1 relaxation time 2.7s, 220 ms and 190 ms, respectively. Here, we present 2D images of our phantoms with a resolution of 1.8mm x 1.4mm taken at Larmor frequencies of 731 Hz and 100 Hz, respectively. By using a fixed polarization time the observable intensities in measurement signal of each sample reflect the different T1-time constants what enables their differentiation in the image.

Conclusion

Phantom measurements with T1 times in the range of human tissue show that imaging at ultra low magnetic fields is possible. Next step is extension of the measurement set-up to perform 3D-imaging and an increase in sensitivity to realize in vivo studies at ultra low magnetic fields.