SIMULATION OF ^{23}NA BIRDCAGE RF COIL FOR SMALL ANIMAL ^{23}NA MRI

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In our previous study [1], we conducted the *in vitro* MR experiment at 7.05T preclinical MR scanner Bruker Biospec 70/30 USR, which consisted in ^{23}Na MRI of the phantoms with different NaCl and gelatine concentrations and measurement of ^{23}Na T_1 and T_2 parameters. We used the modified proprietary transceiver surface RF coil originally tuned to the Larmor frequency of ^{13}C nuclei. The ^{23}Na MR images obtained with this coil are characterized by high SNR in regions near the coil but also high non-uniformity because of inhomogeneous magnetic transmit (B_1^+) field generated by the surface coil. It is known that volume birdcage coils are good solution when high B_1^+ homogeneity is necessary. Another advantage of such volume coils is the possibility to scan the whole body in single MR experiment.

In this work, we aimed at simulation of the transceiver birdcage high-pass quadrature RF resonator tuned to the resonance frequency of ^{23}Na nuclei at 7.05T constant magnetic field (f_{res} = 79.57 MHz). The simulation was performed in the CST Microwave Studio software [2]. The coil geometrical parameters were chosen to fit the magnet core diameter, cover the whole body of small animal (rat, mouse) and have high filling factor: coil outer diameter = 10 cm, RF shield internal diameter = 12 cm, 8 rectangular copper rungs, rung length = 20 cm, rung width = 1 cm, end-ring segment width = 1 cm, copper foil thickness = 1 mm. The capacitance values for 16 fixed-value capacitors which have to be placed in the gaps on the end-ring segments between the rungs were defined using the BirdcageBuilder application [3]: C = 77.64 pF. These capacitance values were introduced into the coil model in the CST. Two stimulation ports were set on one end-ring as shown in Fig. 1. These ports were used to send the electric signals to the coil with the phase shift = 90°. The simulation was carried out for two cases: empty coil and loaded coil. A uniform phantom containing 45 mM NaCl solution was chosen as the load. The results of the simulation included surface current distribution, electric and magnetic fields generated by the coil, S-parameters, Q-factor, and also SAR distribution in case of the loaded coil. The coil was tuned to 79.57 MHz and matched to 50 Ω which is a typical characteristic impedance of coaxial cables used in MRI.

The simulation of RF coil allows us to optimize the process of coil development and save our time and resources. The simulation results obtained in this work will be used to build the ^{23}Na transceiver birdcage high-pass quadrature RF coil for the purpose of study the sodium-dependent biochemical processes in small animals.

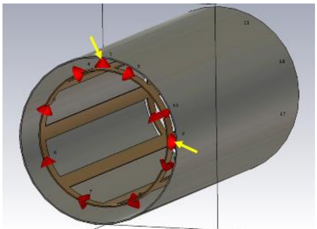

Fig. 1. View of the simulated ^{23}Na birdcage coil with the RF shield. The red elements are discrete ports. The yellow arrows point out two external ports which are used for excitation. The other ports are used to be the fixed-value capacitors

References

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