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Design of a four-channel array coil for dual high-resolution rat knee MR Imaging

A.-L. Perrier, J.-C. Goebel, A. Pinzano, E. Roeder, P. Gillet, D. Grenier, O. Beuf

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Introduction

Background:

- multi-channel coils used
 - ☺ to improve Signal-to-Noise Ratio (SNR)
 - ☺ to increase spatial and/or temporal image resolution
- Recent decoupling techniques based on common conductor
 - ☺ do not require additional preamplifier for the decoupling between elements
 - ☺ conception of two-channel surface transceiver coils (1-2)

Objectives:

- To develop a topology of a four-channel coil array based on common conductor decoupling technique (3)
- To achieve simultaneous acquisition of both rat knee joints at 7T

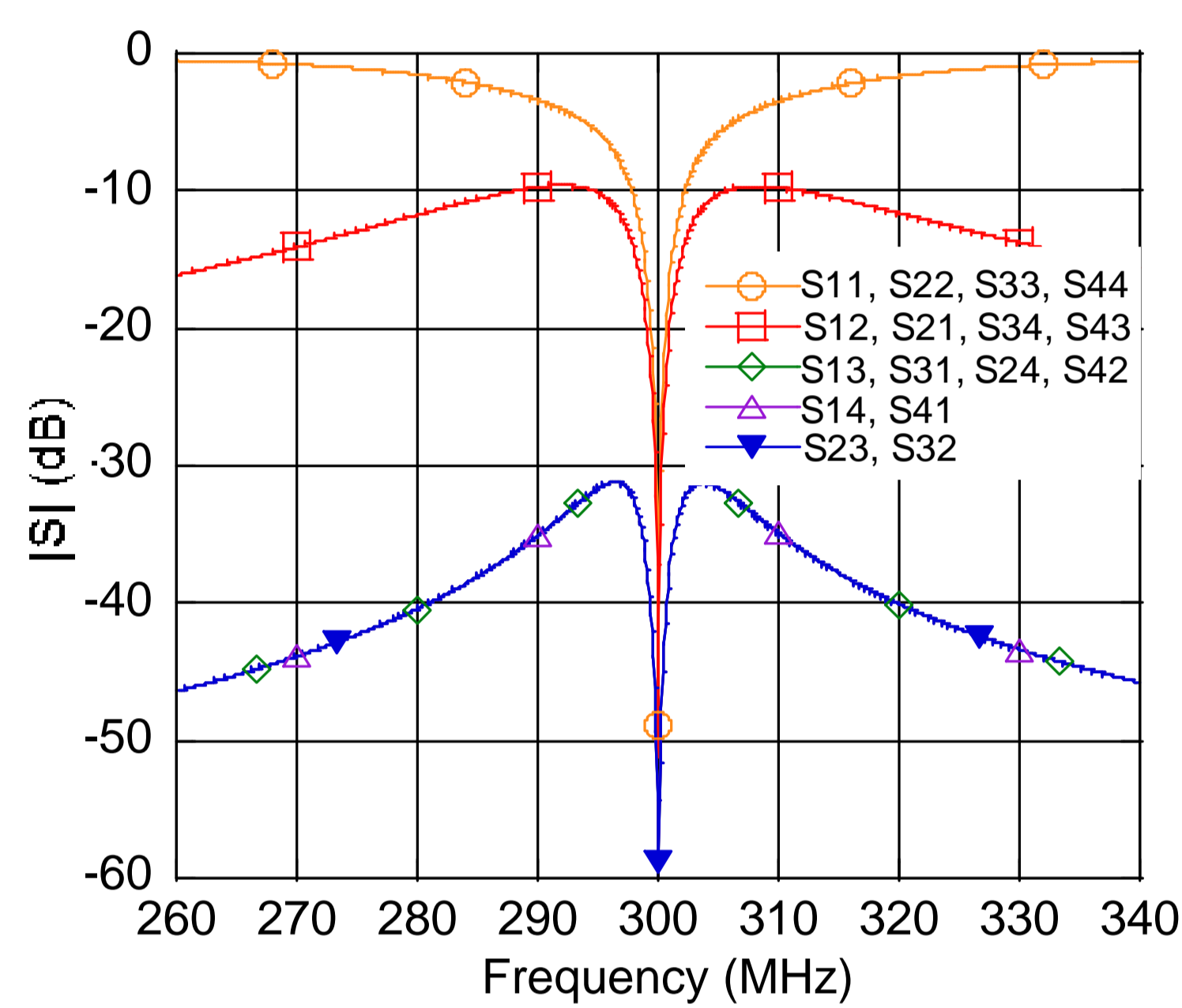
Results

S-parameters

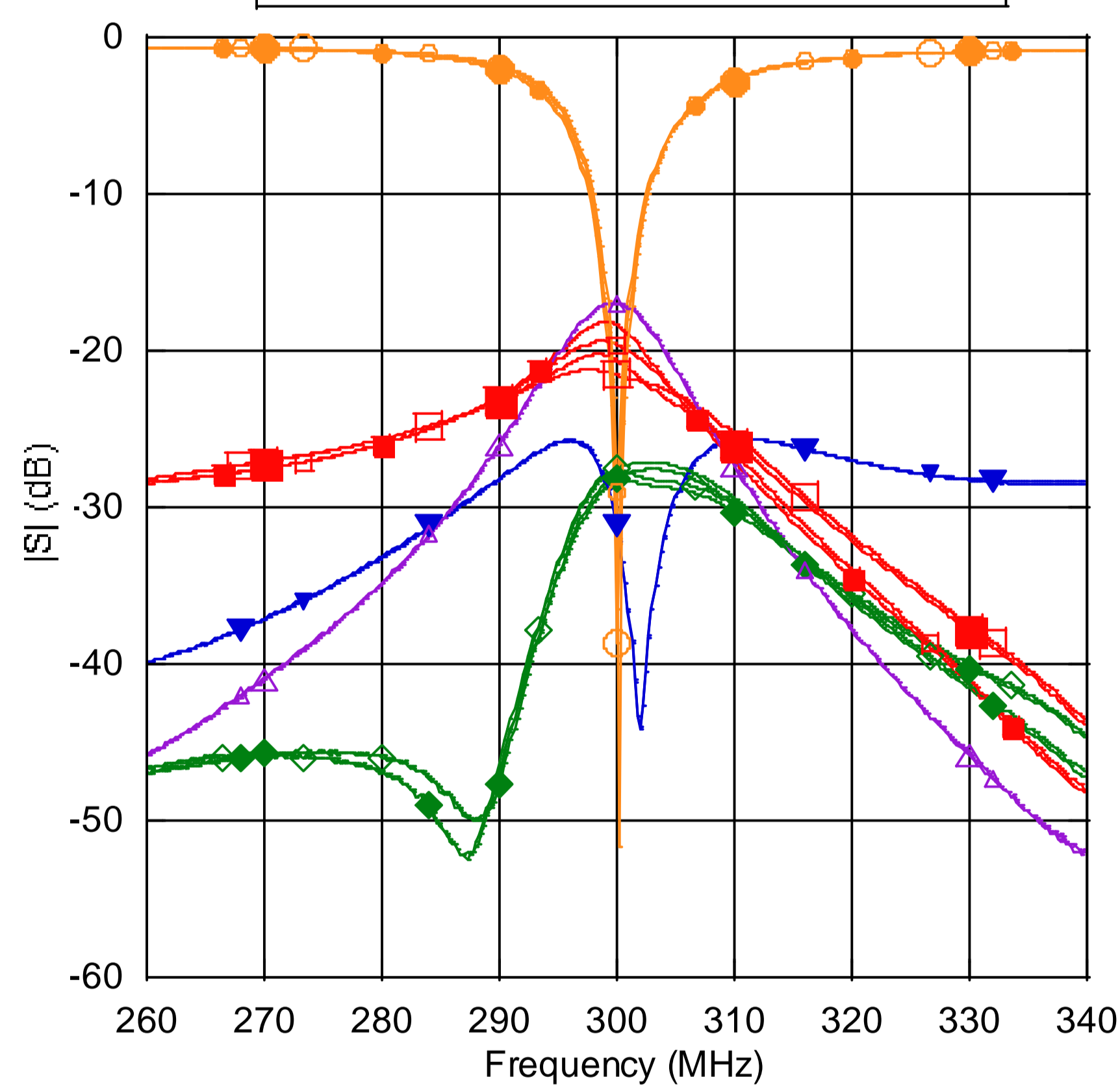
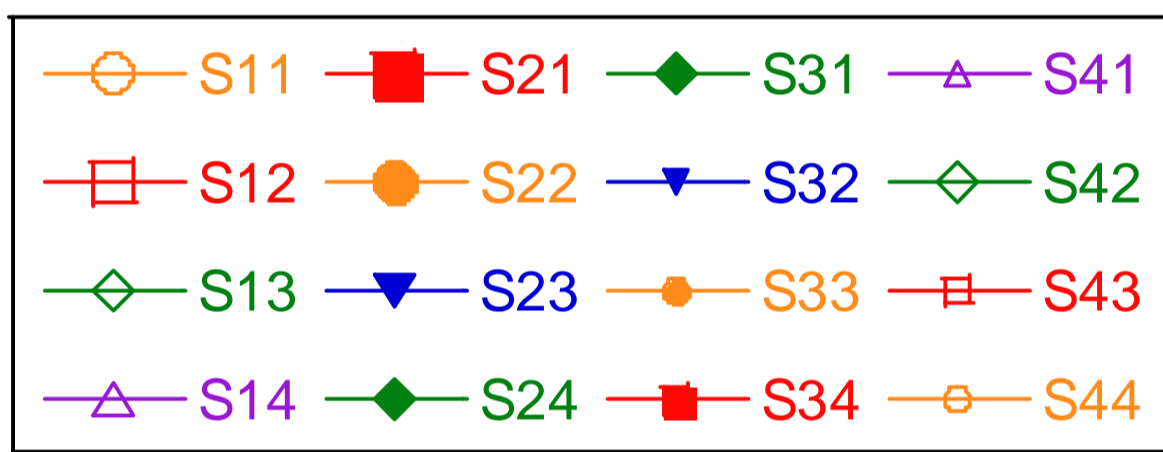
circuit simulations

$L_a=L_b=L_c=10$ nH
 $C_c=C_d=28.1$ pF
 $R=1.1$ Ω
 $C_a=4.5$ pF
 $C_e=24.2$ pF

$|S| < -50$ dB at 300 MHz
 $Q=26$



measurements



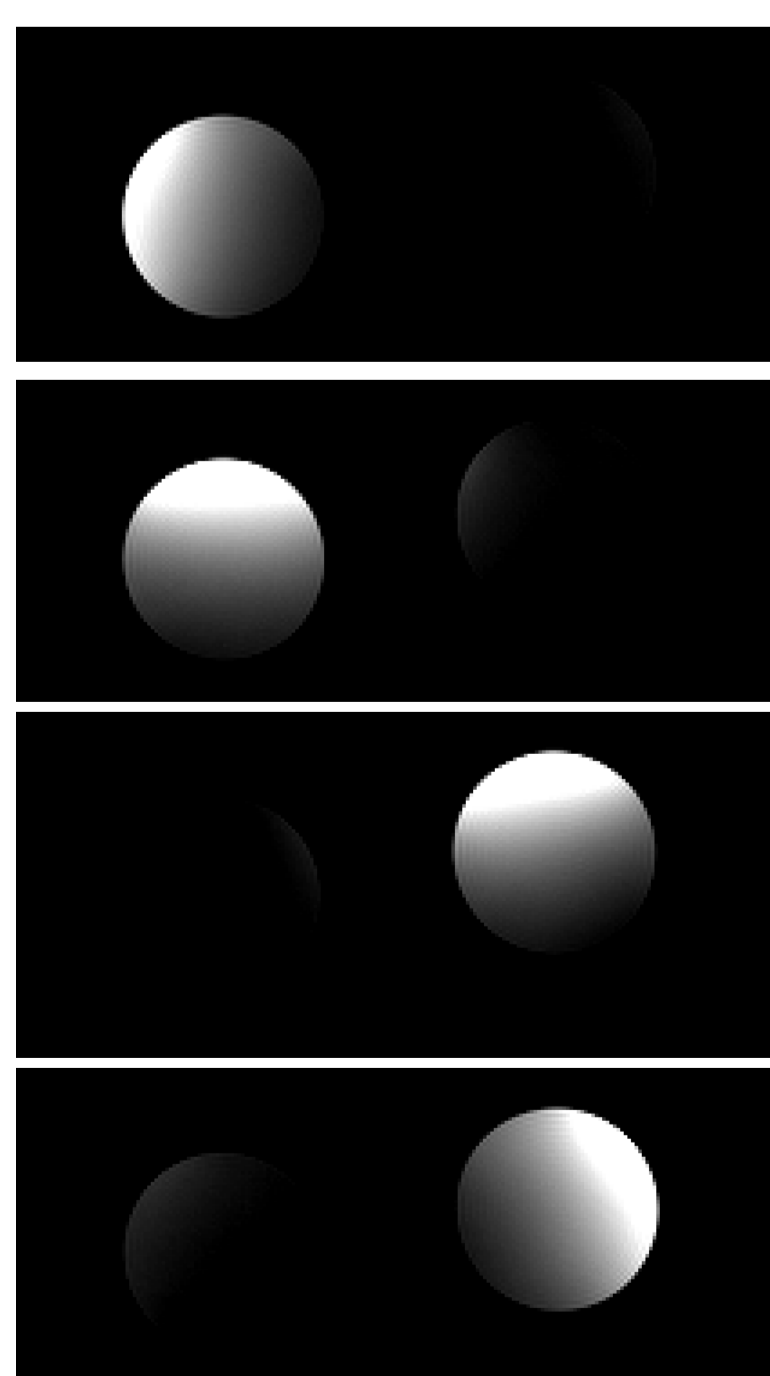
Two cylindrical phantoms filled with saline water solution (NiSO₄ 1.25 g/L and NaCl 5 g/L) to mimic loading of rat limbs

Loop	1	2	3	4
Tuning (V)	-0.3	-1.3	-1.2	-0.3
Ce (pF)	25	16	17	24
Matching (V)	-9	-12.4	-12.2	-8.4
Ca (pF)	6	4	4	6
Q	42	40	41	43

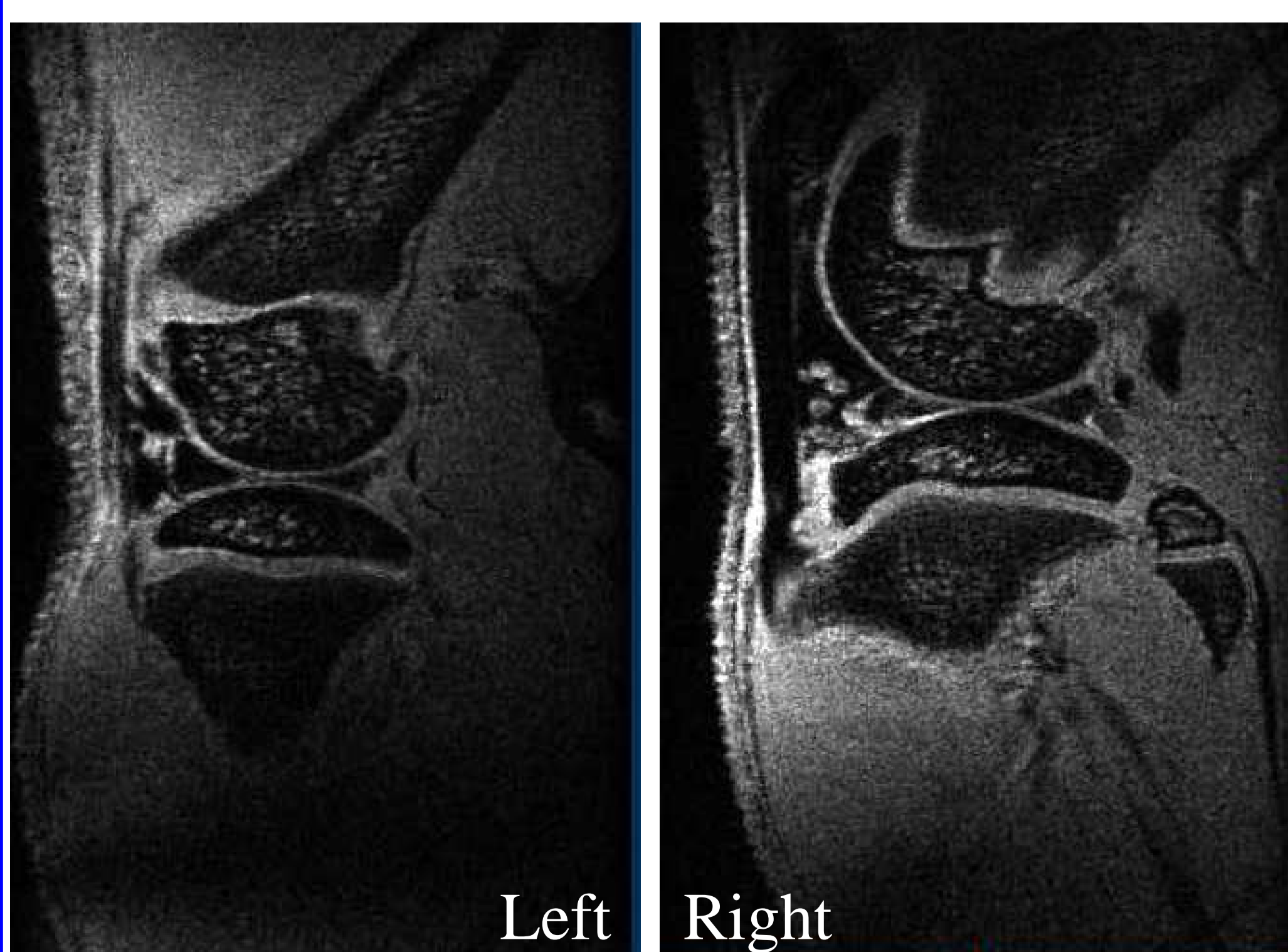
At 300 MHz
 $|S_{ii}| < -30$ dB
 $|S_{ij}| < -17$ dB

HR-MRI

Image of each individual channel on cylindrical phantoms



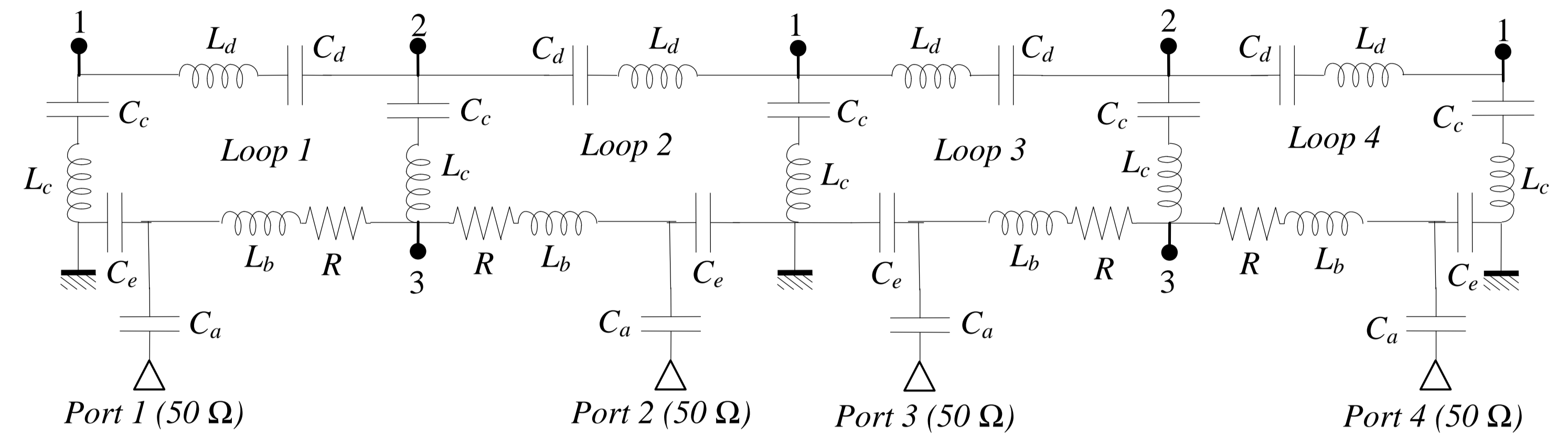
Images from simultaneous imaging of both rat knee joints
 49x49x98 μm^3 voxel size; 1h22min scan time



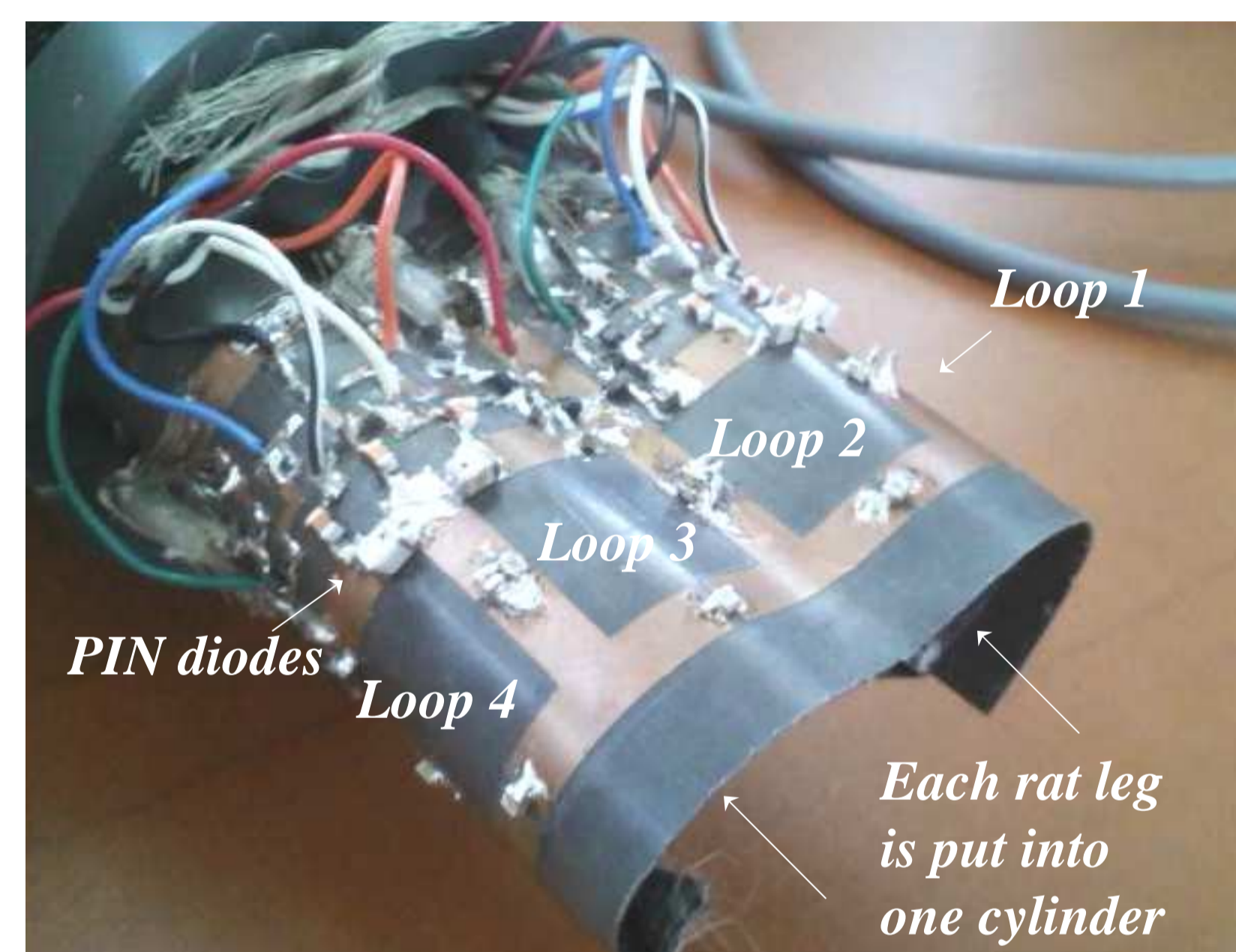
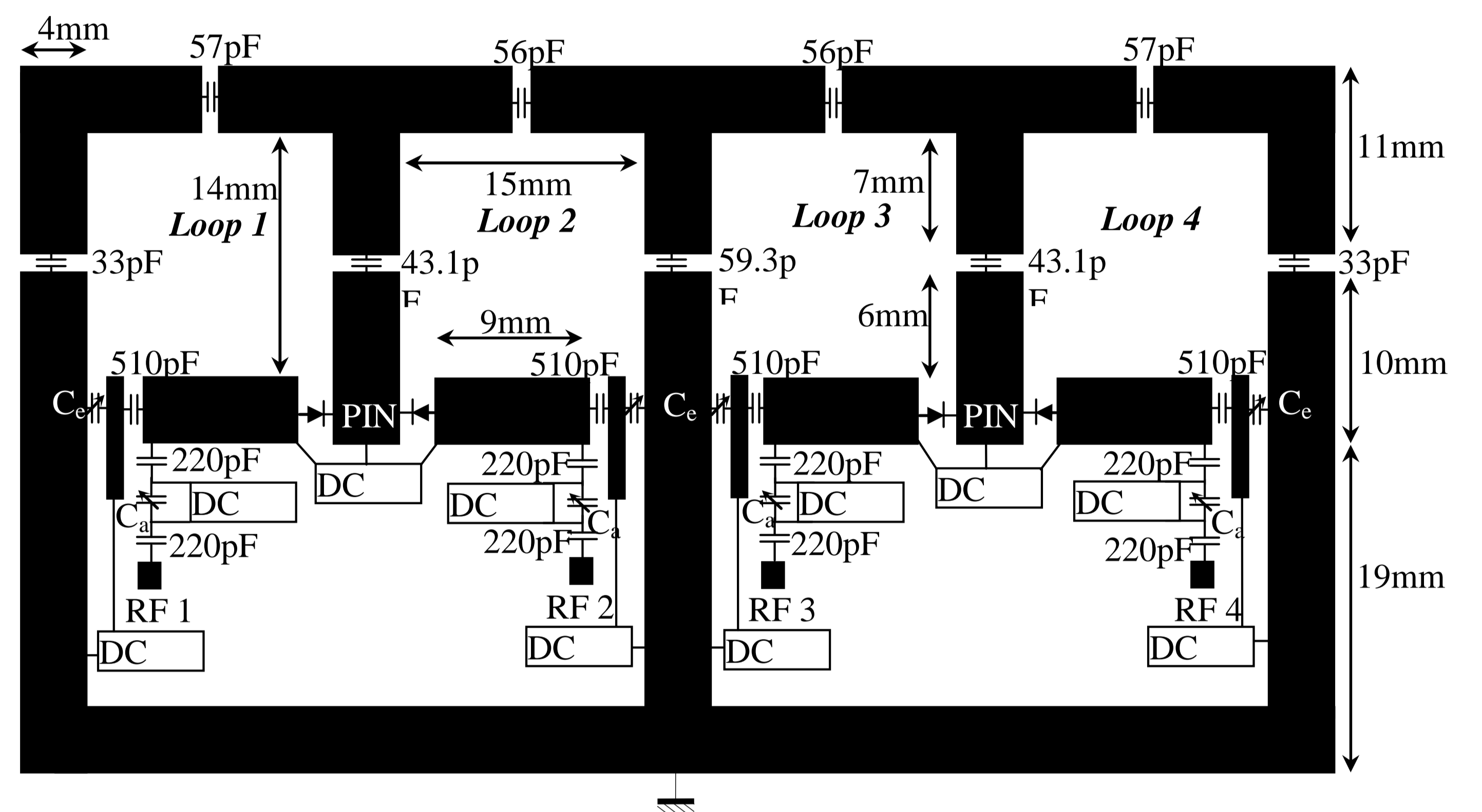
➤ The application of the coil can be found at poster 5201: "Bio-integration assessment of rat knee cartilage repair using in vivo MRI at 7T"

Material and method

Equivalent electrical circuit



Design



Circuit of the coil array:
 •Substrate: RT/Duroid 5880
 •Copper: 35 μm thickness
 •diode PIN: DH80055
 •Varicap: BB149

Experimental configuration of MRI

7T Bruker system

- transmission: linear birdcage coil with 112 mm outer diameter and 72 mm inner diameter
- receiver: the designed four-channel coil array
- 3D FLASH sequence: 30° flip angle, 50ms TR, 3.6ms TE, 27.8kHz receiver bandwidth

Conclusion

- ☺ Validation of an equivalent electrical circuit of a four-channel coil array based on common conductor decoupling technique
- ☺ Design of a four-channel surface coil array with a particular wave-like topology for simultaneous dual rat knees imaging at 300 MHz.
 - ☺ matching better than -30 dB
 - ☺ decoupling better than -17 dB between all element pairs
 - ☺ no additional low input impedance preamplifier
 - ☺ no additional capacitive network
- ☺ HR-MRI : Voxel size of 49x49x98 μm^3 with a 1h22min acquisition time for both knee joints

Perspectives

Four-channel transceiver coil array :

- mechanical variable capacitors
- each channel phase and magnitude could be driven to achieve multi-transmit.

[1] D. Gareis et al., Concepts M.R. Part B, M.R. Eng. 29B:20-27 (2006).
 [2] M.A. Dieringer et al., JMRI 33:736-41 (2011).
 [3] A.L. Perrier et al., IEEE Sensors Jour. 12:1801-08 (2012).

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