

'STAR SHAPED' MULTI-LOOP RADIO-FREQUENCY COIL DESIGN WITH IMPROVED B1 PENETRATION FOR X-NUCLEI IMAGING

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Introduction: Single-loop surface transmit/receive (T/R) coils are common among X-nuclei imaging applications to provide high local SNR, but often are either depth- or B1-limited on clinical scanners. By exploiting the solenoid effect, an N-loop design could theoretically increase the on-axis magnetic flux by a factor of N, resulting in greater B1 fields and improved receive sensitivity. A novel multi-loop 'Star-Shaped' design is proposed which reduces the coupling between overlapping loops to enhance depth B1 penetration while increasing depth and maintaining volume coverage.

Methods and Results: A proof-of-concept ²³Na transmit/receive multi-loop 'star-shaped' coil was built for a 7T Varian preclinical MRI system which boasts greater transmit B1 and improved receive sensitivity over the corresponding single-loop coil, (Figure 1). A series of Gradient Echo (GRE, 160ms TR, 1.9ms TE, 100x0.78x0.78 mm³ voxel size) projection images of saturated aqueous NaCl were obtained for both multi-loop and single-loop coils to determine power required for 90 degrees flip per voxel [1]. The measured B1 field profile is compared with the calculated H-field from 3D EM simulations using CST Microwave Studio, (Figure 2). A diagonal 1D plot of B1 field is fit to the expected drop off; proportional to the reciprocal of distance from coil, and overlaid with the normalised simulated H-field, (Figure 3). The multi-loop design indicates roughly a 70% B1 field increase over the single loop design at the centre of the phantom.

Conclusions: With a greater B1 field penetration in the proof-of-concept sodium coil, the design will be demonstrated for in-vivo Hyperpolarized ¹³C Cardiac imaging. Future work will implement this coil into a clinical design for increased sensitivity of the human heart.

References:

[1] Insko EK, Bolinger L. Mapping of the radiofrequency field. *J Magn Reson* 1993;103:82– 85.3

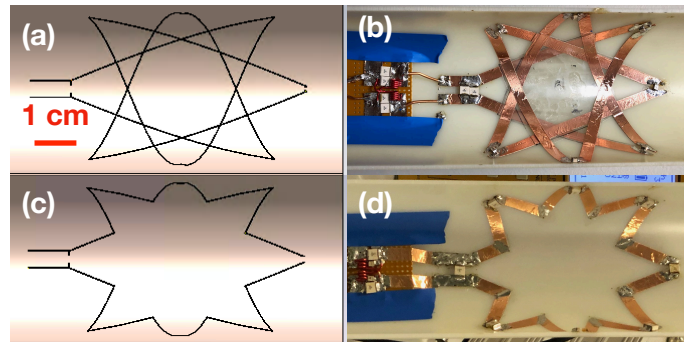


Figure 1: Row 1: Multi-loop coil, CST model (a), photo (b), Row 2: Single-loop coil, CST model (c), photo (d).

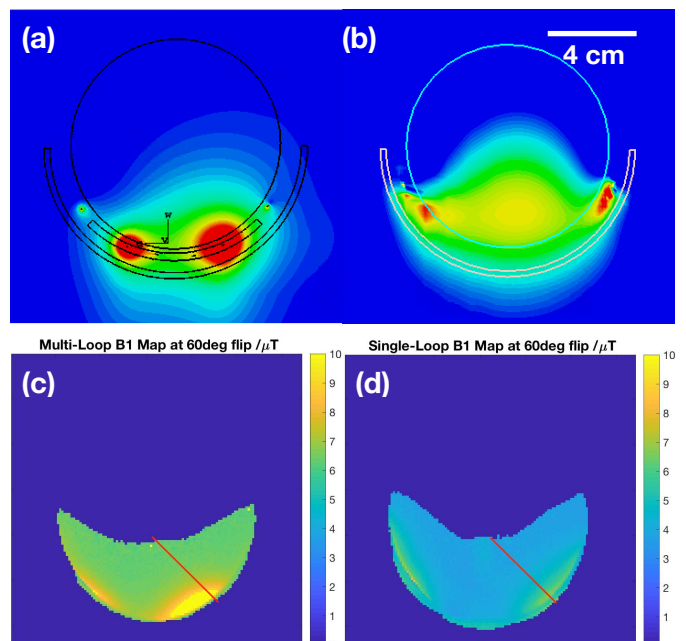


Figure 2: Row 1: EM Simulation H-field, multi-loop coil (a), single-loop coil (b), Row 2: B1 map, multi-loop coil (c), single-loop coil (d).

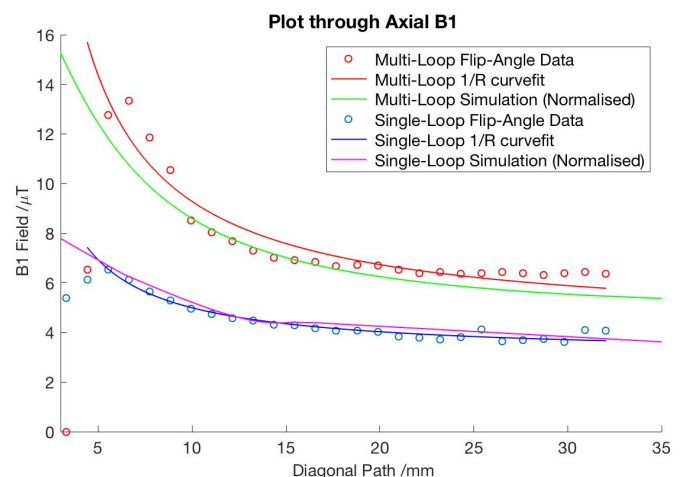


Figure 3: B1-field through diagonal distance in axial plane (red line, Figure 2c, 2d), with reciprocal curve fit and simulated H-field for multi-loop and single-loop coils.