Shared-conductor versus overlapped-loop quadrature surface coils: which performs better in human brain at 7T?

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Introduction: Surface coils are used where SNR is more critical than uniform B_1 coverage of the sample, typically for spectroscopy. Quadrature surface coils using a pair of optimally overlapped loop-coils offer high sensitivity and good penetration into the sample [1]. A new quadrature surface coil design was recently introduced, utilising a shared-conductor between two adjacent loops [2]. With this design, coil-coupling is minimised by adjusting the capacitor on the shared conductor. This abstract compares the two coil designs for use in the human head at 7 Tesla/300 MHz.

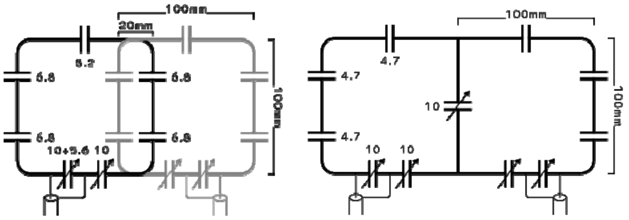

Figure 1: (a) traditional overlapped and (b) shared conductor surface coil designs. Capacitor values are given in

Methods: A surface coil of each design was built from 3mm diameter copper wire with capacitors as shown in fig.1 (100E, ATC; SGNM, Sprague-Goodman), wrapped onto a cylindrical surface (115mm radius). Both coils are shielded (320 × 230mm^2, 160mm radius) and fitted with bazooka baluns close to the loops. The performance of each coil was measured on the scanner bed while loaded with a human head, using a network analyser (E5071C, Agilent).

Experiments were performed on a 7T system (Siemens, Germany). A single subject was scanned in accordance with procedures approved by the local ethics committee. For each coil, the power required for a 90° pulse was calibrated using STEAM in a voxel indicated as yellow box in fig. 3b. B_1 maps were acquired using the double-angle method (60°/120° FA, 200mm FOV, 64×64 matrix, 10s TR) [3]. Anatomical images were acquired (GRE, 200mm FOV, 512×512 matrix, 5mm slice) and SNR maps calculated by smoothing these images (7×7 voxel mean) and dividing by the standard deviation of the noise from a region outside the sample [4].

Results: Coil measurements are shown in table 1 and fig.2, demonstrating good decoupling and sample loading for both coils. The transmit voltage required to produce a 500µs 90° pulse in the STEAM voxel was 94V and 98V for the overlapped and shared-conductor coils, respectively. Fig. 3 shows B_1 maps, PD images and SNR maps for an axial and sagittal slice for each coil.

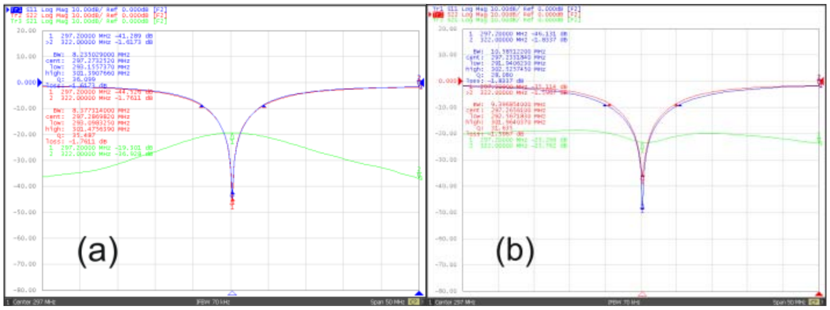

Figure 2: VNA plots for (a) overlapped and (b) shared-conductor probes, (50MHz span, 10dB/div).

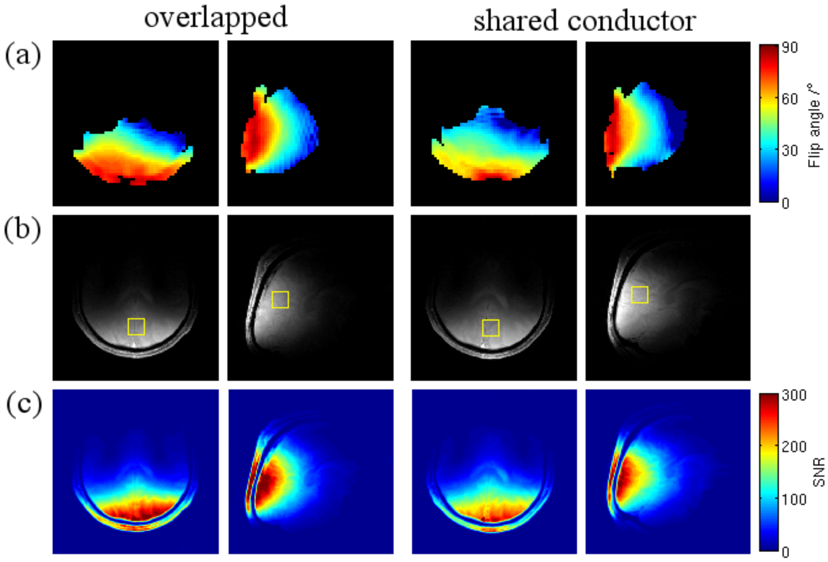

Figure 3: (a) B_1 field maps, (b) proton-density weighted GRE images and (c) SNR maps for the overlapped (left) and shared-conductor (right) coils.

Discussion: Shared-conductor coils are easy to build, as decoupling is optimized after coil construction. However, despite having a slightly larger overall area, field penetration for the shared-conductor design is lower than for the overlapped loops. This is thought to be due to the relatively small overlap between high-sensitivity regions of each individual loop (similar to a non-overlapped orthogonal quadrature pair).

References: [1] Adriany & Gruetter, JMR 125, 178–184 (1997); [2] Gareis et al, CMR 29B(1) 20–27 (2006); [3] Insko et al, JMR A 103: 82–85 (1993); [4] Wiggins et al, MRM 54: 235–240 (2005).

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	S_{11} /dB	S_{21} /dB	Q_U	Q_L	Q_U/Q_L
Overlapped	-41, -45	-19	115, 114	36, 35	3.2, 2.9
Shared Cond.	-46, -35	-23	112, 111	28, 32	4.0, 3.5

Table 1: Matching, coupling and Q-measurements.