

Detunable RF Coil for Arterial Spin Labeling at 7T

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TARGET AUDIENCE: MRI physicists

INTRODUCTION: Arterial Spin Labeling (ASL) at ultra-high field has the potential for increased SNR/CNR of the perfusion results benefiting from increased spin polarization and blood T1¹. To realize these advantages, one needs to overcome the challenges of increased specific absorption rate (SAR), and B₀ and B₁ inhomogeneity. Particularly, SAR is an important hurdle for continuous or pseudo-continuous ASL due to the use of long RF labeling durations. To address these challenges, we have developed a new RF coil system with separate labeling coils². The separate labeling scheme allows us to reduce SAR by removing RF for the control condition if MT is controlled during the labeling.

MATERIALS and METHODS: A 7T human scanner (Siemens) was used for the study. The new coil consists of two parts: actively detunable 8-ch head coil and 2-ch labeling coil (Fig. 1). We analyzed the B1⁺ map and SAR with xFDTD for deciding the number of channel and the size of the coil. The head coil was designed with an etched pattern printed circuit board and constructed on the elliptic acrylic case (21 cm and 26 cm for x, y-axis). A TTL pulse from the scanner controlled routing of RF power to either the labeling or head coils via an RF switch. PIN diodes were used for the detunable circuitry in the head coil using the same RF switch control³. Detuned level of the head coil was regulated under -34dB by pickup probe. Individual channels of the labeling coil were rectangular in shape (10cm × 10cm). The performance of the active detuning was tested in a phantom and *in vivo*.

RESULTS and DISCUSSION: Fig. 3 shows the results of FLASH images (TR/TE = 6.4/2.8 ms) demonstrating the effects of the detuning in the head coil. Using localized labeling coil reduces B1 inhomogeneity, and improves RF penetration in the carotids. The mean SNR measurements (ROI: red circles) in the phantom were 255.95 (when the head coil was used for excitation and reception; Fig. 3a), 24.16 (when the labeling coil was used for excitation and the head coil was used for reception without detuning; Fig. 3b), and 5.76 for the same condition as in Fig. 3b with detuning (Fig. 3c). In the subject, SNR was 91.29 for the head coil (Fig. 3d), 19.47 for the labeling coil without detuning (Fig. 3e), 8.18 for the labeling with detuning (Fig. 3f). These results demonstrate that the active detuning significantly reduces the coupling between the two coils. This reduced coupling will decrease MT effect in the head during the ASL labeling. By properly controlling for MT, no control RF is necessary for ASL, which substantially reduces SAR.

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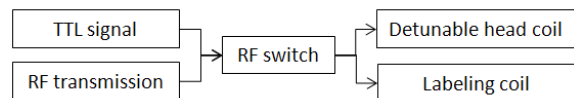


Fig.1 ASL system configuration

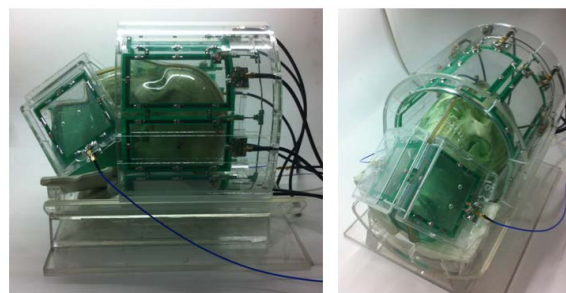


Fig.2 Photo of the labeling and head coil

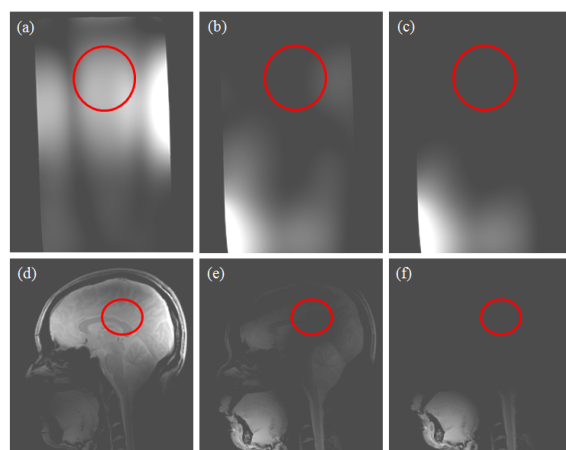


Fig.3 Head coil excitation/reception (a, d) and label coil excitation/head coil reception without detuning (b, e) and with detuning (c, f)