# Improved Proton MRS at 1.5 T with a Transverse Field RF Surface Coil

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**Introduction:** Clinical MRS studies in humans [1] are usually performed with standard axial field RF surface coils (circular or rectangular loop). MRS applications [2] require high sensitivity from tissues located at some distance from the coil surface and low contamination from deeper tissues. Transverse field RF coils, comprising one [3] or two [4-5] linear elements centrally positioned, were recently developed to overcome sensitivity and/or selectivity limitations. In this work, we report the use of a versatile figure-of-eight (FO8) transverse field RF surface coil that improves proton MRS at 1.5 T.

**Methods and Results:** Figure 1 shows a 1.5 T prototype of a RF FO8 coil (2R=10cm, 2s=1cm) tuned at 63.87 MHz (1H) and tested with a GE SIGNA LX 9.0 scanner. For comparison purpose, a standard circular loop (CL) RF coil (2R=10 cm) was built. Each RF coil was used for MRI localisation, field shimming, and 1H spectroscopy on the same VOI. SPGR images (TE/TR=7/50, tck=1.5 mm, slice spacing 0.5 mm, FOV=16cm x16cm, NEX=2, 22 coronal slices) of a cylindrical phantom (doped water), positioned at 2 mm from the RF coil, were acquired with low flip-angle ($\alpha$=10°) using the FO8 or CL coils. Tuning/matching parameters of the two coils were practically identical. The coronal images of Fig.2, located at about 8 mm from the coil plane, show that the FO8 coil produces higher MRI signal amplitude in the central region of the slice (corresponding to the two linear elements) as compared to the CL coil. To quantify the MRI sensitivity along the A/P direction (coil z-axis), the signal in a small ROI (6x6 pixels) at the centre of each of the 22 slices was calculated. Along the A/P direction the FO8 coil produces a higher $B_1$ sensitivity (max gain of about 2.5) as compared to the CL coil, in a region near the coil surface (z<17 mm). For A/P>17 mm the $B_1$ amplitude of the FO8 coil decreases more rapidly with respect to the CL. The noise level, calculated in a background region (6x6 pixels) of the SPGR coronal images is practically the same for both coils. Axial fast GE images of a human calf, positioned at 2 mm from the coil plane, were acquired with the FO8 and CL coils, as shown in Fig. 3. We observed an MRI signal amplitude increase of about 1.3 with the FO8 coil. Moreover, the images clearly show a more pronounced selectivity obtained with the FO8 coil. To show the sensitivity benefits of the FO8 coil for proton MRS, we acquired 22 PRESS spectra with the cylindrical phantom (TE=26 ms, TR=1200 ms, FOV=16 cm, NEX=8) positioning each voxel (4*4*4 $mm^3$) at the centre of the coronal slices. Typical 1H spectra obtained at A/P=5mm with the FO8 (A) and CL (B) RF coils are reported in Fig. 4. The area under the peaks was quantified and its dependence along the A/P direction is shown in Fig. 5. The normalised 1H spectra amplitude show that the FO8 coil allows a better sensitivity within 15 mm from the coil plane and a more pronounced amplitude decrease for a larger A/P dimension. In conclusion, transverse field FO8 surface coil are useful to improve the MRS sensitivity *and* selectivity along the A/P direction at 1.5 T. This should be of benefit in several clinical applications, as in 31P MRS metabolic studies of human calf muscles and 1H human brain spectroscopy, where it is necessary to reduce or eliminate contamination problems.

**References:** [1] Meyerspeer M et al. *MRM 49:620-625* (2003). [2] Zaniol P et al. *Physica Medica 8:87-91* (1992). [3] Boskamp E, *USP 4,816,765* (1989). [4] Alfonsetti M et al. *MAGMA 16, supp.1:224-225* (2003). [5] Alfonsetti M et al. *MAGMA 16, supp.1: 225-226* (2004).

Figure 1. Circular figure-of-eight (FO8) surface coil (2R=10 cm, 2s=1 cm) 1.5 T prototype.

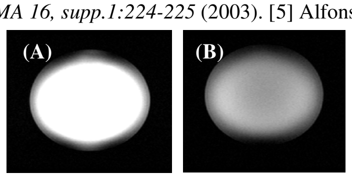


Figure 2. SPGR coronal images of a cylindrical phantom obtained with the FO8 (A) and CL (B) coils.

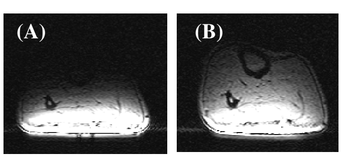


Figure 3. Axial fast GE images of a human calf obtained with the FO8 (A) and CL (B) coils.

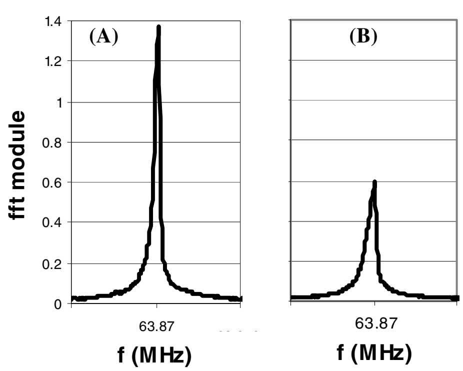


Figure 4 PRESS 1H voxel spectra, (voxel of 4x4x4 $mm^3$) obtained at the A/P position of about 5 mm with the the FO8 (A) and the CL(B) coils.

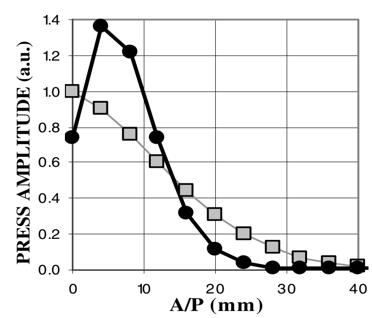


Figure 5. PRESS signal amplitude along the A/P direction for the FO8 (circles) and the CL (squares) coils.