Computed SNR of a phased-array of two PERES coils outperforms that of two circular coils

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Introduction. Phased-array of coils have been widely accepted since their introduction in 1990 [1], due to their high *SNR* over large volumes of interest. A new coil configuration has recently been proposed based on the magnetron tube and called Petal Resonator Surface (PERES) coil [2]. In this research, a theoretical comparison of the phased-array coil performance of the popular circular coil and the PERES coil is presented. The formalism described in [1] is used together with the quasi-static approach [3] to compute the *SNR* of both coil designs.

Method. The theoretical comparison was carried out based on the phased-array *SNR* formula for two coils described in [1]. Using the quasi-static model the PERES coil *SNR* was calculated:

$$SNR_{PERES} = \frac{MV\cos(\omega)}{\sqrt{(kT\,\Delta f\,\sigma)}}\sqrt{\frac{3a_{petal}N}{16l\,(a_{petal}^2+zp^2)^3}} \quad [1]$$

where a_{petal} is the petal radius, N is the number of petal coils, $l\ a_{petal}=b_{PERES}$ (b_{PERES} is the total coil radius), ω=0, *zp* is the depth for both coils as in Fig. 1, and *M*, *V*, *T*, *k*, Δ*f* and σ are defined in [3]. Considering PERES coil SNR together with the circular coil *SNR* reported in [3], and assuming there is no interaction between coils and that the coils are arranged as shown in Fig. 1, the optimum *SNR* for each coil configuration are:

$$SNR^2_{PERES} = \gamma_1 (b^2_{PERES}\, a^3_{petal}\, N)^{1/2}\left(\frac{1}{(a^2_{petal}+zp^2_{coil\,1})^3}+\frac{1}{(a^2_{petal}+zp^2_{coil\,2})^3}\right) \quad [2],\qquad SNR^2_{circular} = \gamma_2\, b^{5/2}_{circular}\left(\frac{1}{(b^2_{circular}+zp^2_{coil\,1})^3}+\frac{1}{(b^2_{circular}+zp^2_{coil\,2})^3}\right) \quad [3]$$

where γ_1 and γ_2 represent all those constants in the quasi-static model, and $b_{circular}$ is the circular-shaped coil radius and b_{PERES} is the total radius of PERES coil. To compare coil performance at different points it was assumed that $b_{PERES} = b_{circular} = 10$ cm.

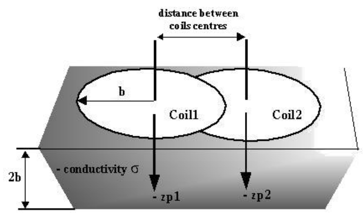

Figure 1. Coil geometry for calculation of *SNR*-vs-distance profiles. Shown are two circular coils with radius, $b_{circular}$ =10 cm.

Results and Discussion. From Eq. [2] profiles of the *SNR* for a phased-array of PERES coils were computed at different distances along a centre line, with the following dimensions: b_{PERES} = 10 cm, a_{petal} = 1 cm and N = 3. Coils were overlapped and SNR profiles for three different coil separations were calculated and are shown in Fig. 2. To compare the optimum *SNR* performance, circular-shaped coil *SNR* profiles were calculated and plotted together with the PERES coil profiles for a point at 5 cm and these are shown in Fig. 3. Theoretical *SNR*-vs-position profiles of Fig. 3 show good uniformity despite the fact that PERES coil design has a complex configuration. The array of two PERES coils is able to achieve up to a 110% theoretical improvement on the coil performance of a similar array of circular-shaped coils. Fig. 3 demonstrates that PERES coil profiles have a better penetration capacity compared to the circular coil. Therefore, the *SNR* of a phased array of two PERES coils has a better performance than a phased array of two circular-shaped coils.

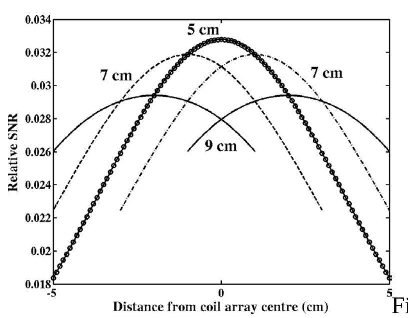

Figure 2. Comparison of SNR-vs-distance profiles of an array of 2 PERES coils (b_{PERES} = 10 cm, a_{petal} = 2 cm, and N = 8). The SNR profiles were computed along a line parallel at 5 cm from the array plane at coil centre separations 5, 7 and 9 cm.

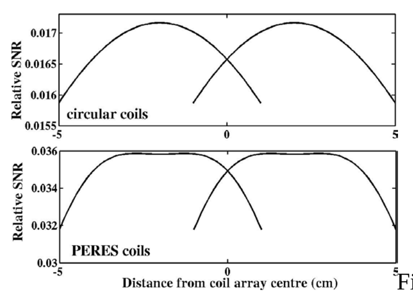

Figure 3. Comparison of SNR-vs-distance profiles between an array of 2 circular and 2 PERES coils. The SNR profiles were along a line parallel at 5 cm from the array plane, with a 9 cm separation as in Fig. 2.

References

1. Roemer, et al, Magn Reson Med 16, p. 192, 1990.
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3. Wang J, et al, IEEE Trans Biomed Eng, 42, p. 908, 1995.

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