Homogeneity Improvement Using A 2 Port Birdcage Coil

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Introduction:

Shading effects in MRI at higher field strength is a common issue [1]. Several techniques [2, 3, 4] and applications [5, 6] have been proposed to solve these problems. Especially for clinical systems it is important to have a solution to improve image quality and not to exceed the legal SAR limits. The use of parallel transmission techniques [7, 8] is a possible solution, but it implies costly hardware efforts. It also holds the risk of local SAR hot spots due to the superposition of the fields and there is still more research necessary to overcome this issue. In this study we investigated, which improvements are possible using a conventional circular polarized body Coil (birdcage type). In most scanners the two ports of the body coil are fed with equal amplitude and a 90 degree phase shift, to produce a circular polarized field. At low frequencies this yields in a homogenous field distribution even in patients. But at higher frequencies (3 Tesla and more) the interaction of the fields with the patients needs different feeding. Probably there is a better phase difference and amplitude weighting to get better results than with 90 degree feeding. [9]

Method:

A 16 rung high pass birdcage for whole body imaging was modelled in a FIT program [10]. The coil was tuned to 123.2 MHz and two excitation ports with an impedance of 50 Ohm were connected to the coil. Each of the two ports could be excited separately; the resulting fields were combined and analyzed in the post processing. While this setup produces a homogenous circular polarized field in the empty coil using the conventional CP- feeding (90degree/equal amplitude), this is different with human models inside the coil. The results were evaluated using a male and a female human model, both in different positions of the models inside the coil. Additionally several port configurations were evaluated.

Fig 1 shows the B1- distribution in the human model, when the conventional CP feeding is used. The areas with low flip angles are obvious. Now the phase difference for the feeding ports was varied between 0 and 360 degree and also the amplitude relation was modified from –21 dB to 21dB. The resulting field distributions were analyzed concerning B1-homogeneity (standard deviation). Additionally the necessary input power for all combinations was calculated to generate an average field of 11.7 µT. As a result it could be seen that there is an improvement in homogeneity possible (Fig 2) and the power deposition into the patient can be reduced (Fig 3).

Conclusion:

The simulation results show that the field homogeneity and the power deposition in a patient can be optimized even if a conventional birdcage with 2 feeding ports is used. Therefore it is necessary to change the weighting for the two ports. A trend is observed that with P2/P1 > 2dB yields in better results concerning field homogeneity and power deposition.

	Abdomen in centre of the coil				Head in centre of the coil			
	Stddev/ mean	Power in Patient	Power Port 2/Port 1 (dB)	Phase P2 – P1	Stddev/ mean	Power in Patient	Power Port 2/Port 1 (dB)	Phase P2 – P1
Conventional	19,3	3639	0	90	14,8	1034	0	90
Best homogeneity	11,9	3418	6	120	13,9	1299	5	60
Lowest power	14,4	3262	2	130	16,6	768	2	130

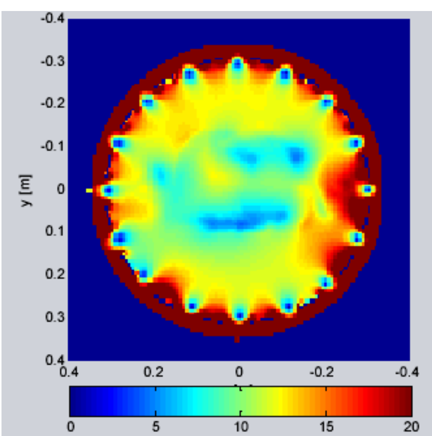

Fig 1: B1 distribution for CP excitation

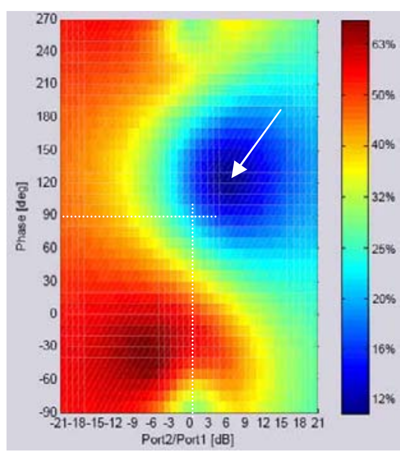

Fig 2: relative standard deviation in % for possible phase and amplitude weighting

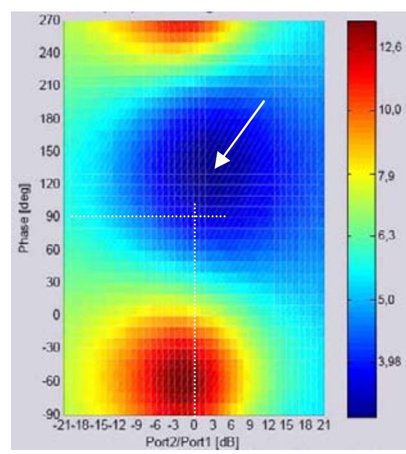

Fig 3: total power [kW] into the human model for average field strength of 11.7 µT for possible phase and amplitude weighting

References:

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