Parallel Transmission with an 8 channel Whole Body System at 3 T

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Introduction:

Parallel transmission techniques have been investigated in the last few years [1, 2, 3]. It has been shown that there are some advantages, especially at higher frequencies. Nevertheless investigations were limited on phantoms, because parallel transmission has some challenges concerning the measurement of the coil profiles in vivo and concerning the power supervision to keep SAR within the legal limits. An 8 channel transmit setup to overcome the B1 Inhomogeneity problems which arise with increasing field strength was demonstrated in [4, 5].

Method:

We extended the set up on the Siemens TRIO, A TIM System, equipped with an 8 channel TX Array [6] and integrated an 8 channel transmit/receive body coil. The copper layout of the original birdcage style coil was not modified, but we added more feeding ports to build the 8 channel coil. The decoupling between the coil elements was adjusted using capacitors in the rungs and end rings (Fig. 1). The slotted copper shield for the body coil is laminated into the gradient coil.

For transmission the coil elements where connected via T/R switches to the amplifiers, in the receive path we used a Butler matrix [7] to combine the coil elements to a homogenous receive mode. This receive mode is comparable to the receive mode of a standard CP-birdcage coil and this is advantageous when acquiring the B1 profiles for the different coil elements. Local receive coils can also be used to measure the B1 profiles. A directional coupler was integrated into each transmit channel to measure the transmitted forward and reflected power. The power meter reports the measured values to a supervision monitor (PALI), which switches of the amplifier if any one of the channels exceeds the limits. In addition all channels are switched off if one of the amplifiers fails or reports an error.

Results:

The power limits for measurements on volunteers were determined using a simulation tool [8] based on the Finite Integration Technique (FIT). A human voxel model was positioned inside the coil and the field distribution for all ports was calculated. The worst case SAR was calculated keeping the power amplitude at the ports identical, but varying the phases. From this result the 6 min limit for the whole body SAR was scaled down to keep the local SAR below the legal limits. These reduced whole body power values then were used for the supervision of the transmitted power. E.g. for torso measurements the transmitted power for all channels together was limited to 17,2W for a 70kg volunteer averaged over 6 min.

For the experiments different RF pulse and gradient pulse sequences [9] have been used either to excite a ‘TIM TX’ logo in an oil phantom (Fig 2) or to excite a homogenous slice in a volunteer (Fig 3) The combination of parallel transmit and multi channel receive was also demonstrated, While we received the B1 profiles with the 8 channel BC (in CP mode) in order to achieve flat maps, we received the TX sense image with the 12 channel Head Matrix coil to increase SNR (Fig 2).

Conclusion:

It is possible to acquire human images with an 8 channel TX body coil safely. Parallel transmission techniques can be combined with parallel receive to reduce measurement time. The use of local receive coils increases image quality.

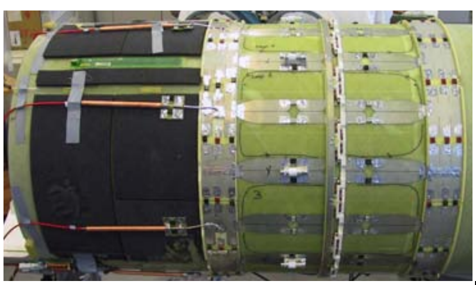

Fig 1: prototype of the 3 Tesla 8 channel body coil for transmit and receive with detuning circuits

Fig 2: parallel excitation with the body coil and receiving with the 12 channel head matrix coil, spiral trajectory with 4x acceleration

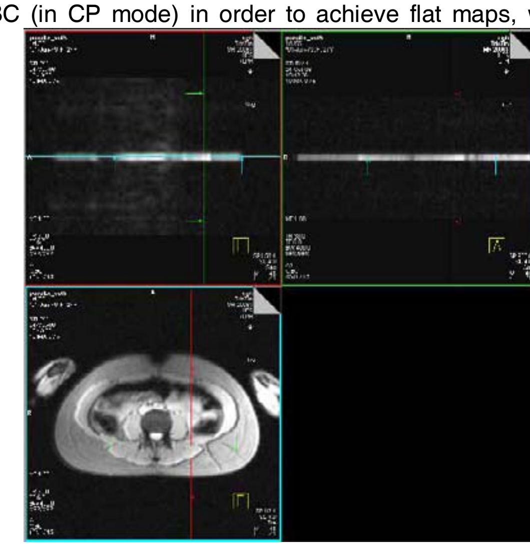

Fig 3: parallel excitation and receive with the body coil, 3D excitation with spokes trajectory

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