Coaxial Magnetic Resonance Tomograph (P-911)

Key facts

- coaxial tubular arrangement for patient positioning
- freely adjustable position and size
- radio frequency (RF) exposure reduced to investigation area only
- reduced global SAR and background noise
- operation at any frequency possible, even simultaneously

Background

Brunner et al. describe a "Travelling-wave nuclear magnetic resonance" (Nature 457, 994-998, 19 February 2009) concept, which comprises a travelling high-frequency wave coupled to the tomographic device. The geometry of the wave is shaped such that the travelling wave is transmitted within the hollow interior of a cylinder with minimum attenuation. In contrast, high frequency resonators do not result in a pattern of standing waves as long as reflections of the waves are suppressed within the volume to be investigated.

Technology

The invention proposes to use the above mentioned travelling-wave concept, but to couple high frequency waves only to an object to be investigated. However, in contrast to the prior art, the high-frequency device enables coupling in RF waves targeted on a particular section of interest of the object. This offers the advantage that the excluded parts are not unnecessarily exposed to the RF waves and do not contribute to RF exposure limit calculations, which allows for a coupling in of a larger dose of the RF energy at a location where it is required.
The hardware is adjusted for this application, see Figure 1 below. The MRI device has a coaxial arrangement of tubular elements.

Development Stage

A research system using high-frequency coils in MRI has been tested successfully in pilot studies.

Applications and Commercial Opportunity

The Technology can be used for developing and distributing a new generation of MRTs employing a coaxial arrangement.

Advantages

- only areas of interest are exposed to RF
- patient's head or feet are not exposed
- no limiting frequency for MRI. This offers the opportunity to use different nuclei for MRI or MRS, including 1 H, 23 Na, 31 P, 13 C, 3 He, 7 Li or 17 O.
- patients exposed to MR imaging with different nuclei can stay in position. The images are co-registered intrinsically.
- imaging artifacts and background noise are suppressed by restricting both spin excitation and signal reception

Inventors

The invention was jointly conceived by Rainer Umathum, Stefan Alt, Marco Müller, and Michael Bock of the Division of Medical Physics in Radiation Oncology (E040).

Intellectual Property

An international PCT (WO2011107442) patent application "Coaxial Magnetic Resonance Tomograph" was filed March 1st, 2011 and entered into national/regional Phase before the patent offices in the USA and Europe.

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Reference

"Coaxial waveguide MRI" in Magn Reson Med. 2011 Oct 21. doi: 10.1002/mrm.23069. by Alt S, Müller M, Umathum R, Bolz A, Bachert P, Semmler W, Bock M.

http://onlinelibrary.wiley.com/doi/10.1002/mrm.23069/abstract

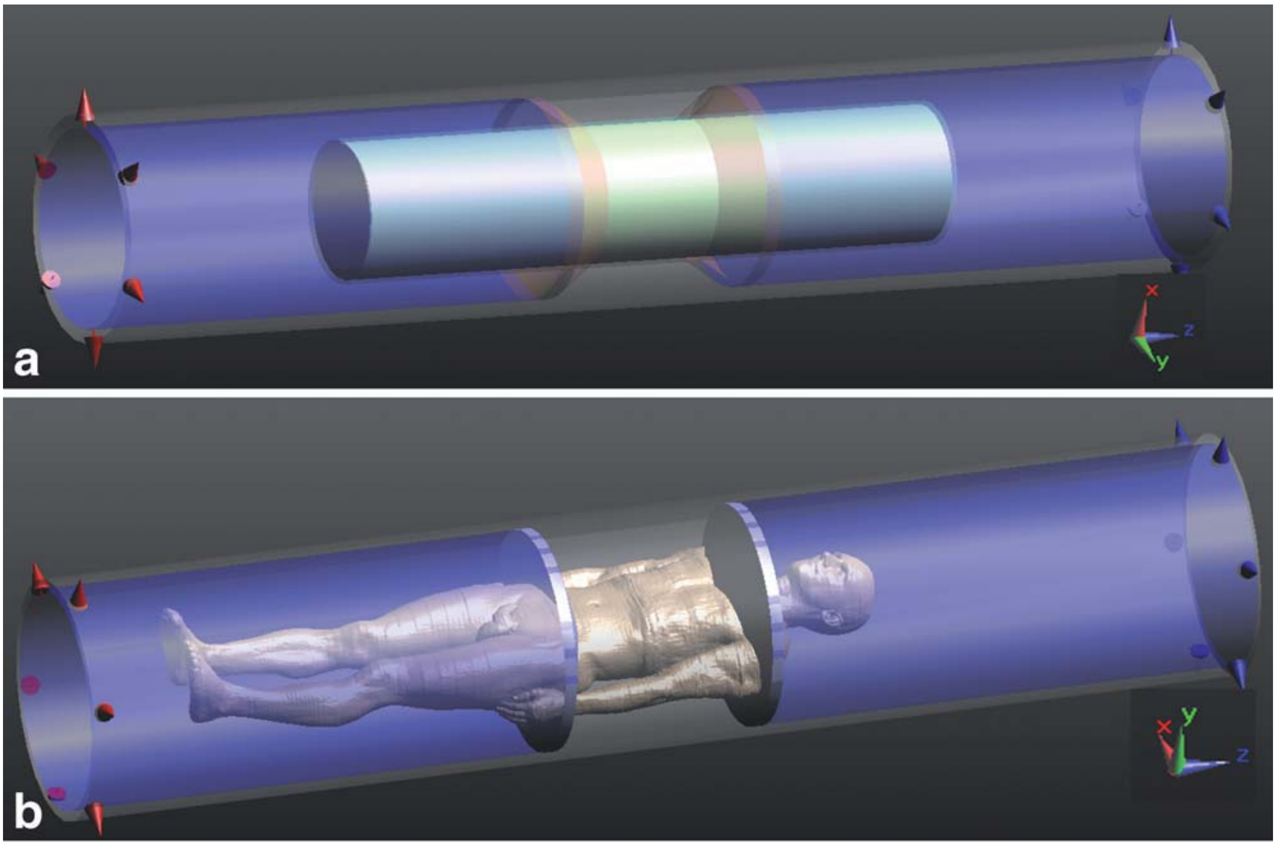

FIG. 1. Simulation setups for the prototype loaded with the cylindrical phantom (a) and a waveguide loaded with the virtual family phantom "Duke" (b). The waveguide in (a) is half the size of that in (b). Both setups are excited by the six edge sources (red) on the left. Excessive energy is dissipated in the resistors (blue) on the right after passing through the waveguides.

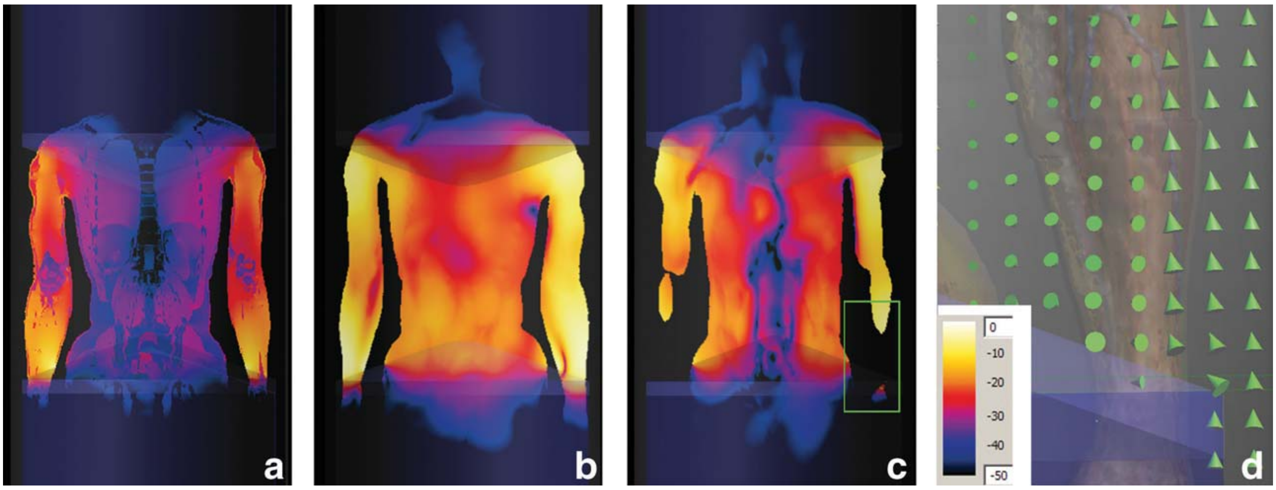

FIG. 2. Field distributions of the simulation with the virtual family phantom. The SAR distribution through the center of the body is shown in (a). Exposure is almost completely concentrated in the imaging gap. The excitation field Bþ1 is shown within two coronal slices through the body (b, c). The central signal void is seen in (c), while the other slices show a more homogeneous field distribution. In (d) the region indicated in (c) is magnified and the energy flux depicted by the pointing vectors is shown. While the energy flows in the propagation direction near the edge of the conductor, it bends toward the body surfaces near the phantom.