**Magnetic Resonance Electric Properties Tomography** **at 21.1 T**

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**Introduction**

 Biological tissues present an anisotropic conductivity and permittivity distribution determined by the electrical properties of numerous interfaces and domains. Magnetic Resonance Electrical Property Tomography (MR-EPT) is a method for quantitative mapping the dielectric properties of tissue [1]. MR-EPT makes use of a standard MRI system and employs post processing of the magnetic field map of the applied RF pulse (B1) to provide a spatial image of permittivity *ε* and conductivity *σ* [2] in three dimensions. Phantom and human experiments have proven the feasibility of MR-EPT at much lower field strengths (< 7 T), with ongoing clinical studies demonstrating encouraging results. We have applied MR-EPT to different phantom studies and have produced the first conductivity and permittivity images of the *in vivo* rat brain at 21.1 T.

**Experimental**

 All scans were performed using the 21.1-T, 900-MHz ultra-widebore magnet at the National High Magnetic Field Laboratory, Animal procedures were approved by the Institutional Animal Care and Use Committee at the Florida State University. Three anesthetized Sprague-Dawley male rats were used. Multislice, 2D Fast Spin Echo (FSE) scan were acquired with TE=12 ms and TR=2.5 s over different flip angles of 60°,120° and 90°.

**Results and Discussion**

 Eq 1. represents the Helmholtz equation taking into account the impact of the local electrical properties of tissue on the B1 field (H+). Recently, accelerated conductivity imaging based on phase imaging only was introduced and successfully tested with healthy volunteers [3]. In this study, the simplified formulas for phase-based conductivity and magnitude-based permittivity given in Eqs. 2 and 3 were employed [4]. The B1 phase data were reconstructed from the 90° FSE image phase **(Fig.1)** by using the transcieve phase assumption, $2φ\left(H^{+}\right)=B\_{1}phase$. A double angle method was used to construct B1 magnitude **(Fig. 2)** from 60° and 120° flip angle maps .In (**Fig.3),** the relative conductivity based on phase information only is displayed, while (**Fig.4)** shows the permittivity.

$k=\frac{-1}{μω^{2}}\frac{∇^{2}H^{+}}{H^{+}} where k=ε-j(\frac{σ}{ω}) $(1) $σ=\frac{1}{μ\_{0}ω^{2}}∇^{2}φ(H^{+})$ (2) $ε=-\frac{1}{μ\_{0}ω^{2}}\frac{∇^{2}|H^{+}|}{|H^{+}|}$ (3)

   

 **Fig.1** Phase map **Fig.2** B1 magnitude map **Fig.3** Relative Permittivity **Fig.4** Relative Conductivity

**Conclusions**

 Future studies need to be done to evaluate the error percentage of using transceive phase assumption for ultra-high fields.

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**References**

[1] Katscher, U., *et al.*, IEEE Trans. Med. Imag., **28(9)**, 1365-1374 (2009).

[2] Haacke, E.M., *et al.*, Phys.Med.Biol., **36(6)**, 723-734 (1991).

[3] Voigt, T., *et al.*, Magn. Reson. Med., **66(2)** (2011).

[4] Katscher, U., *et al.*, Comput. Math. Methods Med., **2013**, 1-11(2013).