NATIONAL HIGH MAGNETIC FIELD LABORATORY
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Augmented Tune/Match Circuits for High Performance Dual Nuclear Transmission Line Resonators

Erickson, M.G. (University of Florida, Division of Infectious Diseases and Global Medicine)

Introduction

This year was dedicated to planning of coil construction, and presentations. The new design was presented at the 5th International Workshop on Metabolic Imaging at the University of Pennsylvania on October 18, 2018 as a talk titled ***Shunt, Don't block: A New Approach to Dual Nuclear Coil Design.***

In addition, the author wishes to report a preliminary design for a Zenneck wave probe. Combined with a properly engineered ground plane, this device may find novel applications in MRI. The Zenneck wave represents an alternate solution of Maxwell's Equations; it is a trapped surface wave with many interesting attributes. One such possibility would be to have an MR scanner with no body coil, but instead a set of wireless coils constructed from metamaterials, said coils operating in meaningful synchrony with the Zenneck probe. If reciprocity holds, this would be a workable configuration. The Zenneck probe scheme may be seen in Figure 1.

Experimental

Permanent coils planned for the lab include a 38 mm ID volume coil suitable for rat and mouse imaging on the 4.7T magnet. Also, a set of modular surface coils that will allow users to rapidly set up for $^{1}H/^{13}C$, $^{1}H/^{31}P$, or $^{1}H/^{23}Na$ imaging and/or spectroscopy. It may be desirable to include the modular surface coils as part of the annual AMRIS RF/Coil design class, at least for one ^{1}H/X pair. Conductive rings of various convenient diameters will be milled on copper clad Rexolite 1422 substrate as before.

A simple but potentially useful variation in the surface coil design has been developed. For small loops, say 3 cm ID or less, there would be no real need for hybrid termination stubs. Instead, the loop would be closed (shorted) on one end. As before, the opposite end of the loop would be bonded to the two augmented T/R circuits, one for ^{1}H and one for X. Loss of efficiency will be minimal, but much will be gained in compactness, economy, and simplicity.

The author has also found a way to make high performance "sleeve baluns" with no ferrite beads. This involves "dipping" the sleeve to the desired resonance frequency with a VHF/UHF grid dip oscillator. A small short bar is place across conductive sleeve and coaxial cable shield. The resonant frequency is then probed with the grid dip oscillator. This is an attractive option, for many workers are reluctant to have ferrites near an MRI magnet. Low loss sleeve baluns are easily constructed using appropriate lengths of low loss coax nested in thin walled copper pipe (sleeve).

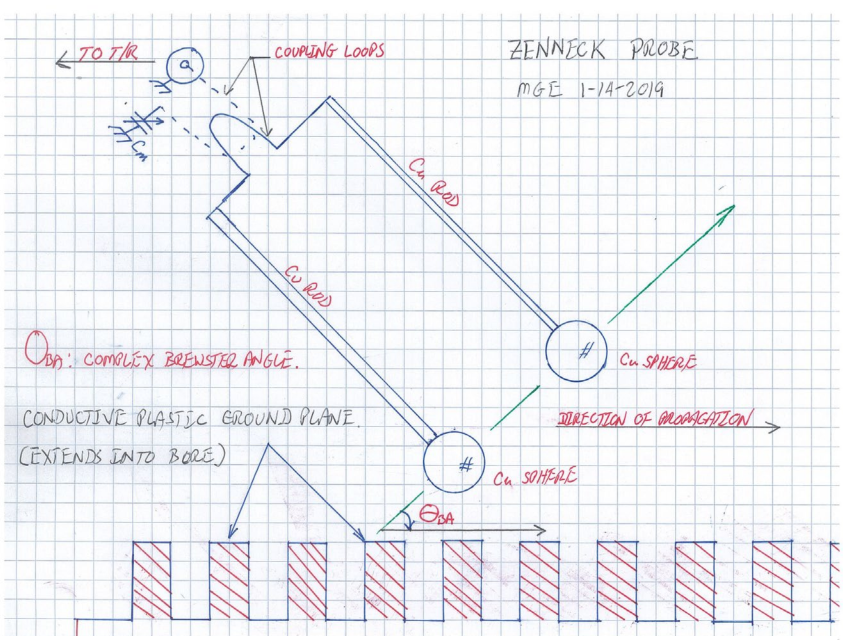

Fig.1 A Zenneck wave probe. The Zenneck transmission line probe launches the Zenneck wave down the engineered ground plane. Ground plane may be made from conductive plastic, colloidal graphite coated polyfoam, etc. Note that ground plane extends into the magnet bore. Wireless coils in the bore may couple with the Zenneck wave field.

Results and Discussion

No formal results for this year.

Conclusions

Final designs for the "production versions" of the new dual nuclear resonator are near completion. This year will focus on construction and testing. The author also anticipates submission of a manuscript to MRM or some other suitable publication.

A preliminary design for a Zenneck wave generator has been completed, and will be tested in 2019. If Zenneck waves are successfully generated, workers at AMRIS will attempt MRI experiments as soon as possible. As an aside, Zenneck waves may find utility as a method of wireless communication between consoles, scanners, amplifiers, etc.

Acknowledgements

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