TcSUH Bi-Weekly Seminar

Signal-to-noise ratio in magnetic resonance imaging (MRI); safety issues with high magnetic fields and benefits of using superconducting rf coils/arrays

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Thursday, April 11, 2019

Room 102, Houston Science Center - 12:00 p.m. – 1:00 p.m.

ABSTRACT: Magnetic resonance imaging (MRI) has proven to be a great success as a non-destructive, non-ionizing, and non-invasive imaging modality for both clinical and research applications. The main MRI limitation is an intrinsically weak radio-frequency (*rf*) signal from nuclei, which makes MRI a signal-to-noise ratio (SNR) "always hungry" technique. One of the ways to increase the SNR, which consequently would result either in higher resolution or in shorter scanning time, is to increase *rf* signal by increasing magnetic field strength. Such trend of increasing static fields in MRI magnets is clearly seen since early 1980's. The possibility that some health hazard may be associated with exposure of the human body to the ever-stronger magnetic and electromagnetic *rf* fields in MRI has been voiced since early 1970's. Here we will address this issue and show a physical mechanism behind magnetic field interactions with tissues, cells, organelles, and cytoskeletons. As an example, we will describe profound changes in the shapes and molecular signatures of immune cells, particularly macrophages, when exposed to magnetic fields.

The other way to increase the SNR is to reduce noise of the MRI systems. Such noise floor is associated with Johnson-Nyquist thermal noise. The discovery and development of high-critical temperature superconducting (HTS) materials led to successful attempts to build practical MRI coils with highly improved SNR. We will address certain aspects of high-Q superconducting resonators used as receivers and we will also discuss the improvements from potential implementation of flexible HTS tapes. Several cooled copper and superconducting coils and array designs for both small animals (4.7 T and 7 T) and some clinical applications (3 T) will be presented.

BIO: JAREK WOSIK, Ph.D., graduated in Physics with MS from the Warsaw University and with PhD from the Institute of Physics of Polish Academy of Sciences in Warsaw. Currently he is a Research Professor of Electrical and Computer Engineering at the University of Houston. He has an accomplished research on the fundamental properties and applications of magnetic, dielectric, superconducting and dielectric materials at *rf* and microwave frequencies. His current activity focuses on: 1) investigation of rf heating efficiency of nanoparticles for hyperthermia cancer treatment and for drug delivery; 2) focusing rf electromagnetic waves using time-reversal techniques; and 3) interaction of dc and ac magnetic fields with immune cells (macrophages). Dr. Wosik's extensive experience in designing high frequency resonators has led to a pioneer work on superconducting MRI coils and coil arrays of superior sensitivity. http://www.ee.uh.edu/faculty/wosik

RSVP by Wednesday at Noon to bdherndo@central.uh.edu for Vietnamese sandwiches.

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