



# Ultra-Low Field Nuclear Magnetic Resonance: A New MRI Regime

By Robert Kraus, Michelle Espy, Per Magnelind, Petr Volegov

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**Ultra-Low Field Nuclear Magnetic Resonance: A New MRI Regime** By Robert Kraus, Michelle Espy, Per Magnelind, Petr Volegov

This book is designed to introduce the reader to the field of NMR/MRI at very low magnetic fields, from milli-Tesla to micro-Tesla, the ultra-low field (ULF) regime. The book is focused on applications to imaging the human brain, and hardware methods primarily based upon pre-polarization methods and SQUID-based detection. The goal of the text is to provide insight and tools for the reader to better understand what applications are best served by ULF NMR/MRI approaches. A discussion of the hardware challenges, such as shielding, operation of SQUID sensors in a dynamic field environment, and pulsed magnetic field generation are presented. One goal of the text is to provide the reader a framework of understanding the approaches to estimation and mitigation of low signal-to-noise and long imaging time, which are the main challenges. Special attention is paid to the combination of MEG and ULF MRI, and the benefits and challenges presented by trying to accomplish both with the same hardware. The book discusses the origin of unique relaxation contrast at ULF, and special considerations for image artifacts and how to correct them (i.e. concomitant gradients, ghost artifacts). A general discussion of MRI, with special consideration to the challenges of imaging at ULF and unique opportunities in pulse sequences, is presented. The book also presents an overview of some of the primary applications of ULF NMR/MRI being pursued.

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### Editorial Review

#### Review

"*Ultra-low field Nuclear Magnetic Resonance* is an emerging field that is filled with challenges, research opportunities, and potential applications. The authors, established pioneers in ULF NMR/MRI (milli-Tesla to micro-tesla range), have written an outstanding overview of the field itself and the associated methods and potential applications. *Ultra-Low Field Nuclear Magnetic Resonance* is an exquisitely detailed yet highly readable resource that will also be an outstanding reference for future research. In NMR and MRI, everything comes with a tradeoff. The insightful researcher understands these tradeoffs. Here, these unique tradeoffs at low field are described with clarity and rigor that will enable the new researcher to delve in, and the general reader to understand what exciting applications are possible. There is a place for ULF and it's growing!" -- Peter A. Bandettini, PhD, Chief, Section on Functional Imaging Methods, National Institute of Mental Health

"Structural and functional brain imaging with MRI has revolutionized clinical and cognitive neuroscience, with increased resolution being driven by increasing field strength. This comprehensive, clear and unique textbook sets forth the opposite approach: radically decreasing field strength. Rigorous but accessible, this book honestly discusses the limitations and challenges, both theoretical and practical, of this new imaging paradigm, with a wide range of potential applications, from security screening to tomographic imaging of neural currents. Essential reading for those who are considering entering this field, this book will also provide a valuable new perspective to those who work in high field MRI."-- Eric Halgren, PhD, Professor of Radiology, Neurosciences, and Psychiatry, University of California-San Diego

"The topic might seem an unlikely one-the last three decades have witnessed a steady march to larger and larger magnets for MRI, particularly for applications in the brain. Enter Robert Kraus and his colleagues at Los Alamos, who have bucked this trend and pioneered a largely new universe of methods and applications possible at field strengths hundreds to thousands of times smaller. Their new book presents a comprehensive and detailed look at all facets of the challenges and opportunities present in this new regime...a relaxed and approachable style for the interested neuroscientist but with more than sufficient analytic depth to keep a graduate physics class busy, the book is a treasure trove of concepts and analysis that form a wonderful jumping off point for discussions on why we should always challenge existing dogma, and embrace the power of asking 'why not?'" -Bruce R. Rosen, MD, PhD, Laurence Lamson Robbins Prof. of Radiology, Mass. General Hospital and Harvard Medical School

#### About the Author

The authors are or have recently been members of the Los Alamos "SQUID Team" that pioneered a variety of Ultra-Low Field MRI applications including ULF MRI in conjunction with MEG (magnetoencephalography) for concurrent imaging of anatomy and function in the human brain, and ULF

Relaxometry used to detect dangerous substances in security screenings.

## **Users Review**

### **From reader reviews:**

#### **Cindy Johnson:**

Have you spare time for just a day? What do you do when you have much more or little spare time? Yeah, you can choose the suitable activity intended for spend your time. Any person spent their particular spare time to take a go walking, shopping, or went to the Mall. How about open or maybe read a book eligible Ultra-Low Field Nuclear Magnetic Resonance: A New MRI Regime? Maybe it is to be best activity for you. You recognize beside you can spend your time with the favorite's book, you can smarter than before. Do you agree with their opinion or you have different opinion?

#### **Catherine Hudson:**

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#### **Gerald Wright:**

Spent a free time for you to be fun activity to try and do! A lot of people spent their spare time with their family, or their own friends. Usually they undertaking activity like watching television, planning to beach, or picnic inside the park. They actually doing same thing every week. Do you feel it? Will you something different to fill your own personal free time/ holiday? Can be reading a book can be option to fill your free of charge time/ holiday. The first thing that you will ask may be what kinds of e-book that you should read. If you want to try look for book, may be the publication untitled Ultra-Low Field Nuclear Magnetic Resonance: A New MRI Regime can be great book to read. May be it could be best activity to you.

#### **Catherine Stoltenberg:**

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