

PURDUE ENGINEERING IN INDIANAPOLIS DISTINGUISHED LECTURE SERIES

A WORLD OF WEIRD:



NUCLEAR MAGNETIC RESONANCE (NMR) & MAGNETIC RESONANCE IMAGING (MRI) AT 6.5 mT

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Abstract: A promising approach to portable magnetic resonance imaging (MRI) is operation at low magnetic fields, where cost-effective electromagnets and simple permanent magnet arrays become practical. However, MRI in the low- (<0.1 T) and ultra-low-field (<0.01 T) regimes is inherently challenging due to intrinsically low Boltzmann polarization, leading to low signal-to-noise ratio (SNR). Despite these limitations, we have developed signal acquisition and processing techniques that enhance SNR and image quality in scanners operating as low as 6.5 mT (0.0065 T). Machine learning (ML) has emerged as a critical enabler of low-field MRI, leveraging low-cost embedded GPUs for real-time data processing. We will present ML-based approaches for reducing noise, increasing attainable information per unit time, and solving highly undersampled, low-SNR inverse problems, including our deep learning domain transformation method, AUTOMAP, and its role in improving image reconstruction. We will also explore ML-driven strategies for optimal experimental design, with applications in both MRI and NMR spectroscopy, demonstrating cases where AI-enhanced low-field methods rival or surpass high-field performance in specific tasks. In clinical applications, we will showcase the use of super-resolution techniques to improve segmentation in bedside neuroimaging at 64 mT. We will highlight both the promise and the limitations of ML in portable MRI, addressing challenges in robustness, interpretability, and clinical deployment. In addition, we will discuss several classes of MRI and even NMR spectroscopy experiments enabled by operation at low magnetic field, which can outperform what can be done with high-field instruments.

Short Bio: Dr. Matt Rosen is a physicist, tool-builder and inventor whose research bridges the spectrum from fundamental physics to applied bioimaging work in the field of MRI. The Rosen Lab focuses on new methods and tools to enable unconventional approaches to MRI scanner construction. In addition, Dr. Rosen Co-directs the Center for Machine Learning at the Martinos Center. Dr. Rosen is a Fellow of the American Physical Society, a Fellow of the International Society of Magnetic Resonance in Medicine and was named Distinguished Investigator by the Academy for Radiology & Biomedical Imaging Research in 2023. He is the Kiyomi and Ed Baird MGH Research Scholar, and an Associate Professor of Radiology at Harvard Medical School. He is the Founder of five companies including Hyperfine, which has developed the world's first portable MRI scanner which can be used at the patient bedside by virtue of its operation at low magnetic field. He has served on the scientific advisory boards of nine companies since 2014. He is the Startup Innovation Expert for MGB Enterprise Radiology (ERIE).

**FRIDAY, APRIL 18TH • 2:00 PM EST
INNOVATION HALL (IO) 105, PURDUE INDY**

REFRESHMENTS WILL BE SERVED PRIOR TO THE TALK



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