Research Fellowships in Novel Encoding Strategies and Hardware for Advanced Neuroimaging

Two post-doctoral positions to develop hardware and encoding strategies for efficient brain MRI are available at the Athinoula A. Martinos Center for Biomedical Imaging, Boston, MA, under the supervision of Drs. Jason Stockmann and Berkin Bilgic, with additional mentorship by Drs. Kawin Setsompop and Lawrence Wald. The hardware position will focus on the development of high-channel count RF and $B_0$ shim arrays for improved signal reception, encoding and field control at high and ultra-high fields. The software position will capitalize on this advanced instrumentation to improve the speed, sensitivity and specificity of in vivo brain imaging for neuroscientific and clinical applications. This synergistic approach exemplifies the collaborative environment at the Martinos Center, which houses multiple 7T, 3T, MR-PET systems and the Connectom scanner that will be at the disposal of the research fellows.

Hardware development for local $B_0$ field control

This project aims to optimize, build, evaluate, and apply new hardware for local field control to improve brain imaging. Building on our group’s past experience with 32-channel integrated “AC/DC” RF and $B_0$ shim array coils, we will build a new next-generation close-fitting coil with 64 RF receive channels to enable highly-accelerated parallel imaging at 3T, coupled with 64+ multi-coil $B_0$ shim channels to generate high spatial-order, rapidly switchable magnetic fields inside the head. One major application will be to reduce distortion and signal voids in echo planar imaging (EPI) acquisitions by nulling subject-specific $B_0$ offsets caused by tissue susceptibility interfaces inside the head. However, the technology will also be used to explore a rich space of other potential applications of local nonlinear field control, including spectroscopic imaging, improved lipid suppression, and supplementary spatial encoding. While the project will initially focus on 3T brain imaging, there will also be opportunities to apply the technology on the center’s two Siemens 7T scanners – a “classic” Magnetom scanner as well as a new Terra scanner (installed 09/2019).

The candidate will join a rich and highly collaborative environment within the Magnetic Resonance Physics & Instrumentation Group at MGH, which has broad expertise spanning hardware development, pulse sequence optimization, image reconstruction, and the application of cutting-edge methods to diffusion and functional MRI. The multi-coil shimming work will also unfold in the context of several existing collaborations with other MRI research sites. As such, all hardware and software funded by this project will be documented and made fully open-source to help enable reproducible research across sites.

The desired background is a Ph.D. in electrical engineering, experimental physics, biomedical engineering, or a related discipline. The ideal candidate will have “hands-on” experience optimizing, building, testing, and debugging experimental hardware, with a working knowledge of electronics, especially analog and RF circuits. Fluency with Matlab is required. Experience using Matlab, Python, or other solvers for optimization problems will also be helpful. Prior experience with MRI is desired but not required, since training in MRI physics and scanner operation will be provided at MGH. Other useful skills: Mechanical CAD design for 3D printing; printed-circuit board layout using EAGLE or KiCAD; image processing with tools like Freesurfer and FSL; and graphical user interface development.
Encoding Strategies for Advanced Neuroimaging

This position aims to develop cutting-edge acquisition methods including

i. multi-shot EPI for high-resolution, distortion-free diffusion, functional, structural and quantitative imaging,

ii. scan specific / physics-informed deep learning image reconstruction,

iii. trajectories tailored to take advantage of the high-channel count receive/shim arrays developed in Dr Stockmann’s group,

iv. motion-robust clinical MRI with CT-like table time.

This work will take advantage of the Connectom scanner with ultra-high gradient performance, the two 7 Tesla systems and numerous 3T scanners at the Martinos Center. The technologies being developed should enable highly detailed brain data at unprecedented temporal and spatial resolutions, with a wealth of quantitative information about brain structure and physiology.

This position provides a valuable opportunity to work and collaborate with a diverse group of researchers developing cutting edge technology that will impact both the neuroscience and clinical research communities. This role will also provide an opportunity for a strong academic-industrial partnership with Siemens Healthineers in translating new technologies into commercial products. An example of technology that has been successfully translated is the Simultaneous Multi-Slice (SMS) technique, which has developed and distributed to a large number of research and clinical sites worldwide (www.nmr.mgh.harvard.edu/software/c2p/sms), and is now a Siemens product. Such technology is changing how diffusion and functional MRI are being performed today. Current products that are being jointly developed by our group and Siemens include wave-CAIPI (for efficient high-resolution imaging) and NEATR (for rapid clinical imaging using synergistic model-based and deep learning reconstruction).

A PhD in electrical engineering, physics, biomedical, or a related field is required. Ideal candidate should have a strong analytical background while displaying a high level of creativity. The candidate should have first-hand experience in MR physics, and image reconstruction algorithms and/or pulse sequence programming. Experience with MATLAB is expected. It is also desirable that the candidate has had experience with the Siemens IDEA environment and Keras/Tensorflow platforms.

APPLICATION

Enquiries may be directed to Drs. Stockmann (jstockmann@mgh.harvard.edu) and Bilgic (bibilgic@mgh.harvard.edu). Interested applicants should send a CV, cover letter and contact information of referees.

The positions are full-time with benefits and is available immediately. A two-year time commitment is required. The Massachusetts General Hospital is an Equal Opportunity/Affirmative Action Employer.