MASSACHUSETTS GENERAL HOSPITAL

Harvard-MIT Health Sciences & Technology

MGH/HST Athinoula A. Martinos Center for Biomedical Imaging

Research Fellowships in Novel Acquisition Strategies and Hardware Development for Diffusion MRI

ACQUISITION POST-DOC: A post-doctoral position to develop acquisition strategies for diffusion MRI is available at the Martinos Center for Biomedical Imaging, Massachusetts General Hospital (MGH) and Harvard Medical School (HMS) in Boston under the supervision of Dr Susie Huang and Dr Berkin Bilgic. This fellowship in image encoding and sequence development will be supplemented with further training in clinical translation and application in neuroscientific imaging through a team of collaborating faculty at MGH/HMS.

The position will capitalize on state of the art clinical 3T magnets (Siemens: Vida, Prisma, Skyra; GE: Premier), while the developed software technologies will be able to take advantage of additional cutting edge hardware systems housed at the Martinos Center, such as the unique Connectome 2.0 magnet (with 500 mT/m maximum gradient and 600 T/m/s slew rate), Terra and Magnetom 7T scanners, two MR-PET scanners, Skope field monitoring systems, combined B0 shim/radiofrequency "AC/DC" coils as well as a multi-channel TMS head coil. Additional systems that will become operational within a year include a Cima.X scanner (with 200 mT/m gradients) as well as an "Impulse" gradient update that will push the Terra's gradient specifications to 200 mT/m max gradient and 900 T/m/s slew rate. This synergistic approach that combines software and hardware technologies exemplifies the collaborative environment at the Martinos Center.

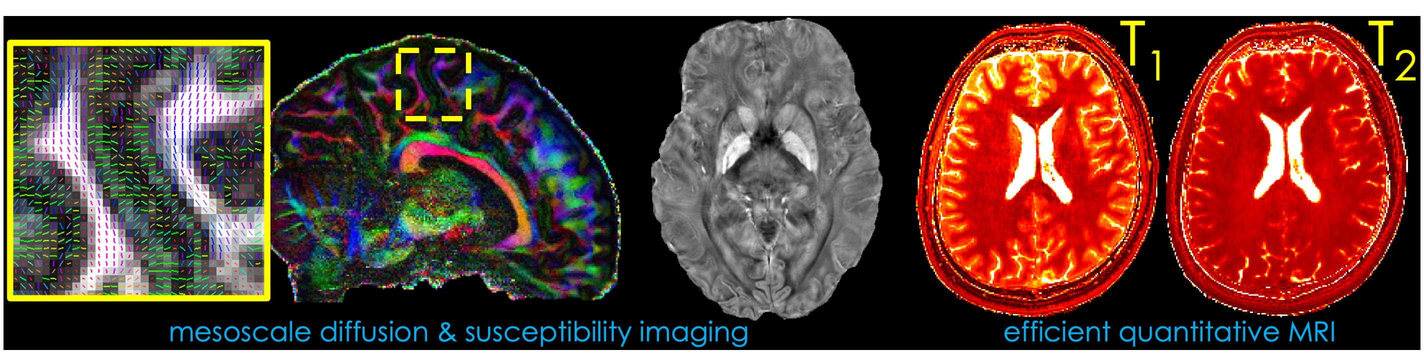
The acquisition methods that will be explored span a wide range of applications in neuroimaging (e.g. aging, neurodegenerative diseases) and contrast mechanisms (e.g. diffusion, relaxometry, susceptibility). Potential research foci include,

i. high-resolution neuroimaging at the mesoscale to examine the structural architecture of the cortex,
ii. efficient quantitative imaging to map biophysical tissue parameters and probe tissue composition,
iii. development of novel readout strategies to exploit Connectome 2.0's ultra-high gradient amplitude and slew rates,
iv. incorporation of field monitoring into the reconstruction to boost the fidelity of such novel readouts.

The 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 e.g. GE Healthcare and Siemens Healthineers in translating new technologies into commercial products. An example of technology that has been successfully translated is the wave-CAIPI technique for efficient high-resolution imaging, which has been distributed to a large number of research and clinical sites worldwide and is now a Siemens product.

A PhD in electrical/biomedical engineering, physics, or a related field is required. The 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 pulse sequence programming. Experience with Pulseq (using Matlab or Python), and Siemens IDEA and GE EPIC environments are desirable.

Application: Enquiries may be directed to Drs. Huang (susie.huang@mgh.harvard.edu) and Bilgic (bbilgic@mgh.harvard.edu). Applicants should send a CV, cover letter and contact information of referees. The position is full-time with benefits and is available immediately. MGH is an Equal Opportunity/Affirmative Action Employer.



HARDWARE POST-DOC: A post-doctoral fellowship is available in the MRI Physics & Instrumentation Group at MGH, focused primarily on hardware development for concurrent brain stimulation, spatial encoding, and functional MRI recording using an array of multipurpose coils. Under the auspices of a new BRAIN Initiative UG3/UH3 grant, we will explore the MRI spatial encoding capabilities of multi-turn coils that were originally developed for transcranial magnetic stimulation (TMS). Up to 16 three-axis TMS coils (48-ch total) will be positioned around the head to enable stimulation and encoding across the whole brain with high efficiency. Proposed applications include zoomed high-resolution fMRI with concurrent TMS stimulation as well as local diffusion encoding with very high G_{max} and b-values in gray matter close to the TMS coils (>1 Tesla/meter). By "shining the light where you need it", the project aims to study diffusion microstructure at spatial scales that were previously only achievable on preclinical scanners. In addition to diffusion MRI studies of brain architecture, the system will also be used for causal mapping of brain networks using multi-channel TMS with concurrent fMRI inside the scanner. The system will allow multiple brain areas to be stimulated either simultaneously or sequentially, with interleaved whole-brain fMRI acquisitions to study changes in activity in response to the neuromodulation.

The grant is led by a team of Co-PIs including Jason Stockmann (hardware and encoding strategies), Aapo Nummenmaa (TMS and modeling), Berkin Bilgic (flexible encoding strategies and recon), and Susie Huang (diffusion encoding/analysis).

The post-doc will be expected to help with setting up the new system, which is called "**ARES^2**: **A**rray for **R**eceive, **E**ncoding, **S**himming, and **S**timulation". Tasks may include (i) joint optimization of a new TMS coil winding pattern for stimulation and spatial encoding; (ii) setting up proof-of-concept experiments on the scanner, and (iii) integration of ARES^2 coils with a TMS-compatible RF receive array. There will then be opportunities in years 3 and 4 of the project to be involved in applications of ARES^2 to causal brain mapping. The post-doc is also welcome to propose new uses of ARES^2 to exploit its unprecedented flexibility for brain stimulation and MRI spatial encoding.

To achieve the aims of this multi-faceted project, the post-doc will have the opportunity to collaborate with and learn from a diverse team including experts in areas such as Peripheral Nerve Stimulation simulations (Mathias Davids), diffusion microstructure modeling (Hong-Hsi Lee), TMS-compatible RF coil design (Lucia Navarro de Lara), and MRI hardware and systems integration (Larry Wald).

The post-doc will have the opportunity to collaborate with members of our group on the Connectome 2.0 project. In particular, the capability of ARES for probing gray matter microstructure can be compared against the C2.0 scanner.

A PhD in electrical engineering, physics, or a related field is required. Experience with radiofrequency circuit simulation, fabrication, and testing is desirable but not essential. Background in the following areas are also helpful: CAD design for additive manufacturing (3D printing); Printed Circuit Board Layout; power electronics; and controls. Good working of knowledge of either Matlab or Python is important. Some experience with Siemens IDEA programming environment is helpful but not required.