

The MGH/HST  
Athinoula A. Martinos Center for Biomedical Imaging



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## Introduction

Since it was officially launched in 2000, the Martinos Center has grown dramatically to become the world's leading biomedical imaging facility. Continually advancing the state-of-the-art, the Center has expanded beyond its nuclear magnetic resonance (NMR) roots to incorporate a broad range of imaging modalities, including magnetic resonance imaging (MRI) and spectroscopy (MRS), magnetoencephalography (MEG), electroencephalography (EEG), optical, and positron emission tomography (PET) imaging.

These advances have been made possible, in large part, by the great generosity of the Martinos family, whose gift has enabled the Center to draw to its faculty innovative researchers and to build a repertoire of technologies virtually unmatched anywhere else in the world. The initial gift, supplemented by research funding procured through federal agencies and private foundations, has engendered some of the very finest biomedical imaging research.

In April 2007, Drs. Bruce Rosen and A. Gregory Sorensen presented to the MGH administration, including Dr. Peter Slavin, President, and Dr. Richard Bringham, Vice President for Research, a review of the Martinos Center's activities over the past seven years and plans for the new Human Molecular Imaging expansion. The presentation, which included overviews of historical investments made in the Center, the return on those investments, and research initiatives that the Center has supported, was an opportunity to take a look back at the course traveled these past seven years, review the Center's many successes, and take stock in priorities for future initiatives.

The Martinos Center currently supports 11% of research activity at the Massachusetts General Hospital, and more than \$100 Million in grant money goes to imaging time for MGH researchers outside the Martinos Center, from departments such as Anesthesia, Neurology, Psychiatry, Radiology, Surgery, and the Center for Integration of Medicine and Innovative Technology. The MGH institutional investment, together with the Martinos gift, have supported more than \$240 Million in research grants from within and outside the Center in just the past five years. In 2006 alone, Martinos Center investigators raised approximately \$32 Million in research support.

Building on the repertoire of sophisticated multimodal imaging tools now available, the Center is embarking on an exciting new program of research in human molecular imaging. This program will support roughly \$65 Million per year for 134 research grants from across the MGH and will be instrumental in providing the momentum for translational research in human molecular imaging. The construction of key facilities for this new area of research is, of course, vital. The Martinos Center and MGH leaders have already raised \$45 Million in equipment and facilities, and have laid the groundwork for raising the money needed to complete the final stages of this expansion that will open new directions in biomedical imaging at the Athinoula A. Martinos Center for Biomedical Imaging.

## Building 75

Adjacent to the Center's primary location in Building 149, the roughly 32,000 square feet of space in Building 75 will nearly double the current size of the Martinos Center. This new space will accommodate existing research programs such as the Cognitive Neuroscience and Cardiac MR imaging groups, and new programs such as Human Molecular Imaging and a new RF coil core facility. Building 75 will also house state-of-the-art laboratories for PET chemistry and MRI contrast agent development, animal housing, and tissue culture facilities. Three new MRI scanners will be installed in Building 75: an ultra-high-resolution 15 Tesla scanner for small animal imaging, a 3 Tesla scanner for dedicated engineering work, and a 7 Tesla system for translational research. The building has undergone extensive renovations in recent months, and construction is on schedule to permit on-time occupancy of the second floor by mid-2007. The first floor, which will accommodate the imaging equipment, requires more extensive renovation, but will be ready for occupancy by year's end. Twelve large conduits for telephone/data connections have been installed, including dedicated fiber optic lines for high-speed data transmission to a new supercomputer that will be installed in Building 149. A new power transformer and a new HVAC chiller have been installed outside the building. Inside, the contractor has gutted the far end of the building in preparation for the installation of the new MRI scanners. Five existing vented fume hoods have been removed and are being replaced with 13 new, low-flow, high-efficiency hoods that will more than double capacity.

The capabilities that will be afforded through the new facilities in Building 75 will provide the Martinos Center with vital new resources that will allow the continued growth, development, and success of the Center. This expansion project will thus serve to deepen and broaden collaborations between the MGH and the Harvard/MIT Division of Health Sciences and Technology.



Recent photographs of the renovations under way in Building 75.

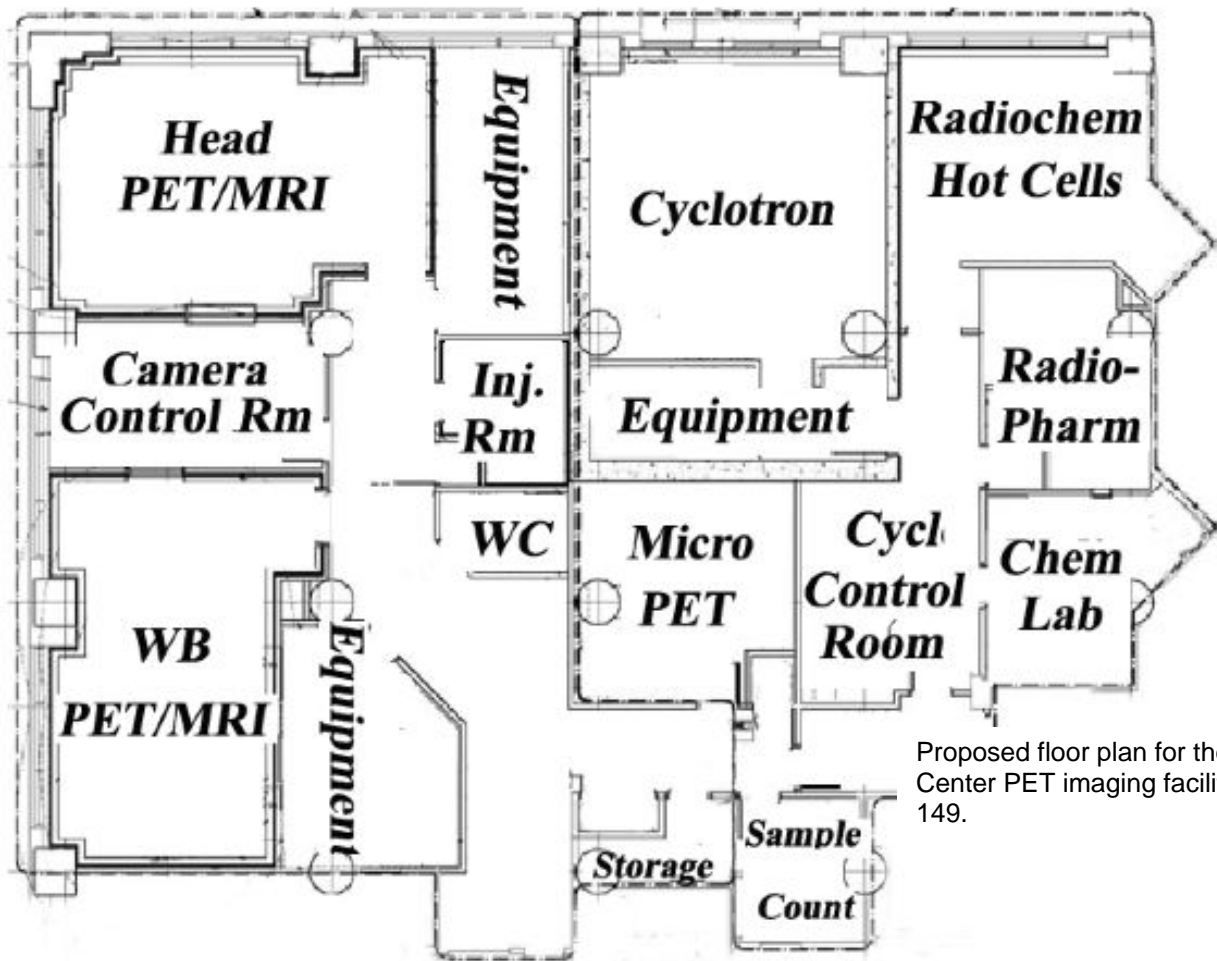
## PET Imaging at the Martinos Center

Positron Emission Tomography (PET) is a developing imaging program at the Martinos Center and part of the broader program of molecular imaging. The mission of PET research at the Martinos Center is to design, synthesize, radiolabel, and assay molecules that can be used to investigate physiological and pathological functions in living cells, tissues, and organs.

Two new PET scanners are currently planned for installation in Building 149, including two of the world's first combined PET/MRI devices. To support this program, Building 75 will host a cyclotron, capabilities for PET radiopharmaceutical chemistry development (predominantly nonradioactive or "cold" chemistry, a key developmental precursor to "hot" chemistry), post-processing of multimodal PET/MRI data, and quantitative

image analysis. The new bench space offered in Building 75 will provide crucial resources for facilitating this science and establishing HST's only dedicated research PET program.

Development of the floor plan for the PET facility is in the final stages. Once approval is granted by the Hospital administration, the architects will prepare detailed construction drawings. Before construction can begin, however, we must complete financing for this major new facility and seek approval from the National Institutes of Health and the National Center for Research Resources. We expect to be able to procure funding and complete construction on this new facility sometime in 2008.



Proposed floor plan for the Martinos Center PET imaging facility in Building 149.

## Molecular Imaging at the Martinos Center

A major new initiative at the Martinos Center, and an increasingly essential part of our research agenda, molecular imaging is the centerpiece of the facilities expansion in Buildings 75 and 149. This burgeoning area of research, which relies on the use of PET and MRI technology as well as associated chemistry to enable targeted, noninvasive detection of human (and animal) pathologies, will be crucial to maintaining the Center's scientific leadership. Part of

this effort will be providing a core analytical chemistry facility to support the synthesis and characterization of new molecular imaging probes. New lab space in the Building 75 expansion will house this facility. This lab, headed by Dr. Peter Caravan, will also pursue research in 4 areas.

**Molecular imaging of fibrosis.** Fibrosis is the development of excess connective tissue (mainly collagen) in an organ. A response to tissue damage, fibrosis occurs in many diseases: pulmonary fibrosis as a result of lung damage from smoking, asbestos, or other contaminants; liver fibrosis occurs in hepatitis and cirrhosis; cardiac fibrosis occurs as a result of infarction and in cardiomyopathy. Some new therapies may have potential for reversing fibrosis, but few methods exist for noninvasively monitoring such therapy. Dr. Caravan's group is interested in developing probes to identify and quantify fibrosis. They have developed a collagen-specific MRI agent shown to enhance myocardial infarction, which they will apply in other disease models where fibrosis is present to detect and quantify fibrosis and monitor response to therapy. The group is also developing multimodal MRI-optical probes based on this design.

**Probes for high-field cardiovascular MRI.** Traditional T1 relaxation probes are less potent at high magnetic fields and often have greater effect on T2 as magnetic field increases. However, T1 relaxation is a very useful contrast mechanism, and T1 relaxation agents are capable of increasing signal and reducing scan times. Dr. Caravan's group is developing potent T1 relaxation agents for use with very high-field imaging at magnetic fields of 7 Tesla and above. These agents may be applied for imaging coronary vessels, atherosclerotic plaque, myocardial infarction and remodeling, thrombosis and clot lysis, perfusion, blood volume, and cardiomyopathy.

**Platform technologies for molecular MR probes.** Compared to nuclear imaging methods, MRI offers excellent spatial resolution, involves no radiation, and MR probes are stable, nonradioactive compounds. However MR probes typically have detection limits several orders of magnitude higher than gamma emitters, which limits the capabilities of MRI for imaging at the receptor level. Dr. Caravan and colleagues are exploring different mechanisms for generating image contrast by exploiting probes that affect chemical exchange or chemical shift. We are also developing MRI probes that are sensitive to their environment and can function in conditions such as tissue oxygenation.

**Positron labeled chemotherapeutics for combined PET/MRI studies of response to therapy.** We are interested in understanding why some cancer patients respond better to chemotherapy than others and particularly why some drugs work better in combination. With Dr. Sorensen, Dr. Caravan's group is initiating a program to

introduce carbon-11 labels into drugs used for patients with brain tumors. This project will use a new combined MRI/PET device for which the Center has recently been awarded funding (see Shared Instrumentation Grants, below), to perform dual modality imaging to address such questions as extent of drug uptake, tumor angiogenesis, and vascular permeability. Exploring these questions should help us to better understand these mechanisms of action, which hopefully will aid clinicians in guiding therapy for patients.

## RF Coil Core

The RF coil development work taking place at the Martinos Center has already made the MGH a recognized center of expertise in cutting-edge RF coil design. The availability of such state-of-the-art RF coils for brain and heart imaging has also served to bolster a variety of efforts within the research communities of Harvard University, MIT, and the MGH. The purpose of the RF coil core at the Martinos Center is to build on these considerable strengths, facilitate the development of new coil technologies, and improve the dissemination of specialized RF coils within the research community. The RF coil lab will move into new space in Building 75.

To make the most of the core's expanded capabilities, we will hire two new technicians; one with electronics expertise for construction and testing of the RF antennae and electronics, and another to focus on mechanical work for the creation of substrates and housings for the RF coils. The addition of new staff will allow the core to be more responsive to researchers' requests for specialized coils, improving efforts to push forward with new designs and publishable RF coil research. The new facility in Building 75 will permit consolidation of the various resources already present at MGH—including the circuit board router, network analyzers, workbench space, materials stock, and tools—and enable better management of these resources. The RF core, comprising the new facility and new technical staff, will also be better positioned to host visiting researchers who are coming to the Martinos Center in increasing numbers to learn from the Center's coil building experts. Dr. Graham Wiggins, who has been appointed Director of the new RF coil core, will be responsible for hiring, training, and managing the coil core technical staff as well as for overall management of the core's activities.

## New Funding

### **Shared Instrumentation Grants**

Martinis Center investigators were awarded funding for the purchase of a number of new instruments in 2006 and early 2007. These grants, awarded through the National Center for Research Resources Shared Instrumentation and High-End Instrumentation Grant Programs to support the purchase or upgrade of shared-use instrumentation, allow the Center to purchase highly sought-after equipment that will substantially impact the efficiency of a number

of actively funded research projects. Funding received for the purchase of four new instruments will directly support the developing molecular imaging program.

**500 MHz NMR Spectrometer for Molecular Imaging Applications (S10RR023385-01, Rosen).** This instrument will be crucial to facilitating the development and synthesis of novel molecular imaging contrast agents and to identifying biomarkers for specific disease states and biological processes. The NMR spectrometer will serve a large, NIH-funded, geographically diverse user community that encompasses a variety of biomedical disciplines. This new equipment will greatly expand our capacity to serve the local NIH-funded user community and will offer important analytical chemistry capability to a growing user base with molecular imaging interests. In particular, the instrument will allow rapid characterization of intermediates in reaction pathways of novel molecular imaging probes currently being developed and identification of biomarkers of disease states. Solution NMR spectroscopy capabilities include development and synthesis of dual MRI-histology contrast agents for brain molecular imaging, novel blood-brain barrier-permeable contrast agents for brain molecular imaging, amyloid plaque-targeting contrast agents for Alzheimer's disease studies, targeted drug delivery vehicles, lymph node-specific contrast agents, as well as identification of biomarkers associated with stroke and Alzheimer's disease. Possible HR-MAS NMR spectroscopy applications include identifying biomarkers of breast cancer, inflammatory response in burn tissue, HIV-injured brain tissue, and osteoporosis.

**F-18 Synthesizer (S10RR023452-01, Brownell).** The MGH PET imaging program supports research questions of fundamental importance in fields such as experimental pharmacology, tumor biology, molecular imaging, and cognitive neuroscience. The F-18 synthesizer will provide a critical component in our ability to procure radioligands for use with the High Resolution Research Tomograph (HRRT)-PET system that will be installed in the Martinos PET facility. It will likewise allow us to meet the increasing demand for F-18-labeled radiopharmaceuticals for preclinical animal studies that use the microPET imager. With the existing PET facilities on the main campus now critically overburdened, the F-18 synthesizer resource will immediately increase the efficiency, accessibility, and innovation of research programs.

**7T Translational MRI System (S10RR019371-01A2, Sorensen).** This 7 Tesla translational MRI device (a small animal system [7T/30 cm] with a clinical console) will allow users to translate between human and animal imaging by providing the same interface for both. The new system composed of Siemens Medical Solutions and Bruker components, matches the computers, RF system, and user interface of the human equipment already in use at the Martinos Center, but also has many additional features, including 32 RF receiver channels, multiple advanced pulse

sequences, tailored RF coils for rodent imaging, and strong gradient performance. The system was designed from the ground up to marry the existing "SynGo" clinical console with an animal magnet, an application led by the Martinos Center. This instrument will allow our many researchers who engage in human research to apply their imaging skills in animal models, allow us to extend to animal researchers the technical work carried out in human instruments, and expand the instrumentation available to researchers. Above all, this instrumentation will promote our ability to rapidly translate developments carried out on animal systems to human use. By extending interactions between our animal and human research groups, use of this MRI system will greatly speed our funded research.

**Combined MRI/PET Imager for Simultaneous Acquisition of PET/MRI (S10RR022976-01, Jenkins).**

Magnetic resonance imaging (MRI) provides exquisite soft tissue contrast. Positron emission tomography provides exquisite molecular and biochemical information, but often lacks anatomic contrast. The feasibility of combining MRI and PET in a single scanner has been experimentally documented, but the high magnetic field creates many challenges in engineering such an instrument. This prototype PET-MRI scanner to be built by Siemens-CPS Instrumentation will allow for collection of high-quality soft-tissue anatomic contrast using 1.5T MR while simultaneously acquiring high-quality PET data with spatial resolution on the order of 3 mm from a concentric PET detector. This novel scanner will afford investigators the opportunity of working out in detail the limitations and advantages of such a system, and thereby to help tailor future-generation scanners. With devices such as this possibly representing the future of PET imaging, our ability to employ this combined system for both basic science and clinical research will provide the Martinos Center an unparalleled opportunity to improve the quantitative accuracy of PET.

**Other New Instrumentation.** As we reported last year, the Center was awarded funding for a new horizontal bore 15T MRI system and for a new 3T MRI scanner for dedicated engineering research and development work. The custom high-field 15T system, currently on order and scheduled for installation by the end of 2007, will provide exceptionally enhanced capacity for neuroimaging, cardiovascular imaging, tissue engineering, and orthopedics research. And, by helping to alleviate some of the limitations related to the Center's currently overburdened small-bore MR scanners, the new 15T MRI system will open new avenues of research. The new 3T system, which by freeing imaging time on the existing scanners will expand capacity for human basic and translational research, is scheduled for installation in Building 75 later this summer. Finally, a new supercomputer will enable analysis of imaging data collected from scanners in both Building 75 and Building 149. It is expected to be the fastest such computer in the northeastern United States.

## **Advanced Multimodal Neuroimaging Training Grant**

In September 2006, the Martinos Center received funding for a major interdisciplinary initiative for training in neuroimaging that rests on collaboration between faculty members in the Department of Psychology at Harvard University, the Program in Neuroscience at Harvard Medical School, the Harvard-MIT Division of Health Sciences and Technology, the Department of Brain and Cognitive Sciences at MIT, and the Athinoula A. Martinos Center for Biomedical Imaging at Massachusetts General Hospital. The Advanced Multimodal Neuroimaging Training Program aims to train scientists who are focused on basic and clinical neuroscience questions and armed with the necessary physical science knowledge, and computational and team science skills to position them for major contributions using and developing neuroimaging tools. This training program, unique in its efforts to unite trainees whose backgrounds include quantitative, engineering, physical and chemical sciences as well as biomedical and biological sciences, aims to prepare a new generation of scientists whose broad-based training comprises fundamental neuroscience, the technologies and analytic methods of in vivo neuroimaging, and application of those technologies for understanding crucial questions in neuroscience. In addition to formal research training for graduate students, this program also provides outreach educational opportunities for scientists at various stages of career development, offering a new short course in multimodal neuroimaging and mentored research “sabbaticals” at the Martinos Center.

## **Faculty**

We are pleased to welcome a number of new investigators who were appointed to faculty positions at the Martinos Center this past year. Several others received well-deserved promotions. We also welcomed this year investigators from other institutions.

## **New Faculty Appointments**

**Randy Buckner, PhD**, Professor of psychology at Harvard University and a member of the new Harvard Center for Brain Science, was appointed Lecturer in Radiology at MGH in May 2006. Formerly an Associate Professor of psychology, neurobiology, and radiology at Washington University in St. Louis, Dr. Buckner came to Harvard in 2005. Dr. Buckner earned his PhD from Washington University and completed postdoctoral fellowships there and at Harvard Medical School before being appointed Assistant Professor of psychology and neurobiology at Washington University in 1997 and Assistant Professor of radiology in 1998; he was promoted to Associate Professor in all three departments in 2001. Dr. Buckner’s research involves neuroimaging to explore brain areas involved in human memory. His work has been instrumental in changing the way researchers use functional

magnetic resonance imaging (fMRI) to view brain activity. He has played a leading role in the development of event-related fMRI, which allows scientists to correlate neural data to subjects' responses during experiments. Dr. Buckner was awarded the Wiley Young Investigator Award for Human Brain Mapping in 1999, the Cognitive Neuroscience Society's Young Investigator Award in 2002, and was named a fellow of the American Psychological Association in 2004. Dr. Buckner is also an investigator for the Howard Hughes Medical Institute.

**Peter Caravan, PhD**, joined the Martinos Center as Instructor in Radiology at Harvard Medical School and Assistant in Neuroimaging at MGH in April 2007. Previously a Senior Principal Scientist responsible for MRI contrast agent research at Epix Pharmaceuticals, Dr. Caravan received his PhD in coordination chemistry at the University of British Columbia under the mentorship of Professor Chris Orvig. After postdoctoral work in high pressure NMR at the Université de Lausanne, Dr. Caravan joined Epix in 1998. At Epix, he performed a series of mechanistic studies to support the new drug application of gadofosveset, a serum albumin-targeted MRI contrast agent approved for imaging arteries and veins. He was co-inventor of EP-2104R, a fibrin-targeted agent for MR imaging of thrombus, which has advanced into clinical trials. Dr. Caravan led molecular MR imaging programs in myocardial perfusion, myocardial infarction, atherosclerosis, and lymph node imaging, as well as platform technologies to improve the sensitivity of MRI probes.



**Ji-Kyung Choi, PhD**, was appointed Instructor in Radiology at Harvard Medical School and Assistant Chemist in Radiology at MGH in March 2006. After completing her PhD in biophysics at Boston University, Dr. Choi came to the Martinos Center as a Research Fellow in 2001. Dr. Choi's research focuses on pharmacological magnetic resonance imaging (phMRI) and in vivo and in vitro  $^1\text{H}$  magnetic resonance spectroscopy (MRS) as well as the use of these methods to better understand the neurochemistry of both normal and diseased brains. Dr. Choi's current research objectives include exploiting phMRI techniques to map acetylcholine and other neurotransmitter receptors in the brain and examine their response to stimuli such as nicotine. Dr. Choi has also conducted extensive studies in models of neurodegenerative diseases such as Alzheimer's disease and amyotrophic lateral sclerosis (ALS, or Lou Gehrig's Disease) using MRS to study disease progression and possible therapeutic interventions.

**Karl Helmer, PhD**, joined the Martinos Center as Assistant in Neuroimaging at MGH and Instructor in Radiology at Harvard Medical School in February 2006. He is the project manager for the Morphometry BIRN, a 10-institution collaboration whose charge is to develop tools and database infrastructure to support multi-site trials for

the neuroscience community. He is also involved in methods development for the processing of diffusion tensor imaging data. Previously he was a Research Assistant Professor in the Biomedical Engineering Department at Worcester Polytechnic Institute. Dr. Helmer received his PhD in nuclear physics at the University of Rochester studying heavy-ion transfer reactions. His postdoctoral work at WPI used diffusion NMR to characterize porous media in collaboration with researchers at Schlumberger-Doll Research. As a Research Assistant Professor he adapted the porous-media NMR methods to detect and characterize pathology and the effect of the subsequent treatment in murine tumor models and rat models of stroke. This work also involved  $^{19}\text{F}$  NMR to study changes in tumor oxygenation status in response to tumor growth and treatment using exogenous tracers. In addition, he was involved in clinical fMRI studies focused on the evaluation of networks in normal and Alzheimer's populations. He has also published MRI-based studies of water movement in a static and dynamic tensile loading model of rabbit Achilles tendons.



**Phillip Zhe Sun, PhD**, joined the Martinos Center as Assistant Professor in Radiology at Harvard Medical School and Assistant in Neuroimaging at MGH in September 2006. Dr. Sun received his bachelor's degree in applied physics from Peking University and earned his PhD in Radiological Science from Harvard-MIT Division of Health Sciences and Technology under the mentorship of Professor David Cory. During his graduate study, Dr. Sun proposed a magic asymmetric gradient diffusion technique that allowed accurate characterization of complex porous media, where severe heterogeneity has eluded conventional MRI approach. After completing his PhD, Dr. Sun joined the neuroimaging group led by Professor Peter van Zijl at Johns Hopkins University School of Medicine for postdoctoral training in stroke imaging; he became a Research Associate in Radiology at Hopkins in 2004. Dr. Sun's research has elucidated the mechanism of the recently proposed endogenous pH imaging and has led the field of noninvasive pH MRI of acute stroke. At the Martinos Center, Dr. Sun will translate pH MRI to study tissue metabolism changes during human acute stroke while also continuing to develop novel MRI techniques in animal models.

### **Faculty Promotions**

**Helen D'Arceuil, PhD**, Assistant Professor in Radiology at Harvard Medical School, May 2006

**Nouchine Hadjikhani, MD**, Associate Professor in Radiology at Harvard Medical School and Assistant in Medical Imaging at MGH, January 2006

**Kathleen Hui, MD**, Assistant Professor in Radiology at Harvard Medical School, January 2006

**Anna Moore, PhD**, Associate Professor in Radiology at Harvard Medical School and Assistant in Cell Biology at MGH, September 2006

### **Non-MGH Employee Appointments and Promotions**

**Jitendra Sharma, PhD**, a Research Scientist at the Picower Institute for Learning and Memory at MIT, was appointed Instructor in Radiology at Harvard Medical School and Assistant in Neuroscience in Radiology at MGH, March 2006

**Yi-Qiao Song, PhD**, a Principal Scientist at Schlumberger-Doll Research, was appointed Instructor in Radiology at Harvard Medical School and Assistant Chemist in Radiology at MGH, September 2006

**Christina Triantafyllou, PhD**, Assistant Director of the Martinos Imaging Center at the McGovern Institute for Brain Research at MIT, was appointed Instructor in Radiology at Harvard Medical School and Assistant in Neuroscience in Radiology at MGH, August 2006

### **Faculty Awards**

**Dr. Maria Angela Franceschini** was one of six women researchers at MGH to be named a Claflin Distinguished Scholar for 2006. These awards, funded by the MGH Executive Committee on Research and named for honorary MGH trustee Jane D. Claflin, recognize the particular challenges of women researchers who are balancing research productivity and family responsibilities.

**Dr. Fa-Hsuan Lin** was awarded the 2006 Sam Williamson Prize in Biomagnetism Research at BIOMAG2006, the 15<sup>th</sup> International Conference on Biomagnetism in Vancouver, Canada. This prize, established in honor of Dr. Samuel Williamson, is awarded to a junior scientist in recognition of outstanding contributions to the field of biomagnetism.

### **Training & Education, Events**

The Martinos Center is home not only to world-class research facilities, but also to premier training and education. Drawing on the extensive expertise of our faculty, fellows, and research staff, the Center offers a variety of courses on the many imaging modalities and data analysis methods used in the Center.

### **Courses**

**Short Course in Multimodality Imaging.** A key component of the short-term education program of the Harvard/MIT/MGH Advanced Multimodal Neuroimaging Training Grant (see pg. 11 for a description of this new

training program) is a two-week short course that parallels and is built on the model of the very successful Visiting Fellowship Program in Functional MRI. This course, which opens with a conceptual introduction that addresses the spatial, chemical, and temporal sensitivities and limitations of the various neuroimaging modalities and their clinical research applications, aims to meet the needs of a wide range of participants whose prior experience varies from amateur to expert. The course provides didactic instruction on the technical bases and physiological sensitivities of the many advanced imaging modalities available at the Martinos Center, among them nuclear magnetic resonance and magnetic resonance imaging (including fMRI and pharmacological fMRI [phMRI]), positron emission tomography (PET), electroencephalography (EEG) and magnetoencephalography (MEG), near-infrared spectroscopy and diffuse optical tomography (NIRS-DOT), transcranial magnetic stimulation (TMS), and diffusion tensor (DTI) and diffusion spectrum (DSI) imaging. Each session includes an overview of the technology and its applications, experimental design considerations, and approaches for data analysis and interpretation. The course also includes a tutorial and workshop for the FreeSurfer and FSLFast data analysis software developed at the Martinos Center. Participants design and conduct experiments using these imaging and analysis techniques; then, at the end of the second week of the course, have an opportunity to present their results. Guest lecturers are invited to speak on topics currently under investigation using these tools and to discuss future directions for technology development and application.

The first course, for which we received 42 applications for 24 participant slots, will be held June 18–28, 2007, at the Martinos Center. Faculty participating in this first short course will be drawn from the rich body of expertise at the Martinos Center, including:

Functional and Structural MRI

Bruce Rosen, MD, PhD

Lawrence Wald, PhD

Joseph Mandeville, PhD

Non-Human Primate fMRI

Wim Vanduffel, PhD

Clinical Imaging

Reisa Sperling, MD

A. Gregory Sorensen, MD

Optical Imaging

David Boas, PhD

Maria Angela Franceschini, PhD

Electroencephalography and Magnetoencephalography

Matti Hamalainen, PhD

John Belliveau, PhD

PET and phMRI

Anna-Liisa Brownell, PhD

Bruce Jenkins, PhD

Data Analysis

David Salat, PhD

Bruce Fischl, PhD

Randy Buckner, PhD

**fMRI Visiting Fellowship Program.** The five-day fMRI Visiting Fellowship Program, now in its 13<sup>th</sup> year, was offered three times in 2006. Attendees—including graduate students, basic and clinical science researchers, and physicians—receive a firm grounding in the fundamentals of fMRI, primarily the basic physics of magnetic resonance imaging, the biology and biophysics of the hemodynamic responses to neural activity, data analysis (both exploratory and statistical analyses), stimulus presentation and response recording in the context of high magnetic fields and electromagnetic pulses, and design of perceptual and cognitive experiments. A special emphasis of the course is the design and implementation of perceptual and/or cognitive experiments, which allows participants the opportunity to engage in small group collaboration to design fMRI experiments. In 2006, sessions were held March 6–10, June 26–30, and October 2–6.

**APA Advanced Training Institute in Functional MRI.** The American Psychological Association (APA) sponsors an Advanced Training Institute in Functional MRI, also held at the Martinos Center. An intensive introduction to the field of fMRI, the course provides training and hands-on experience in experimental design and data analysis. The course meets annually and enrolls 40 participants selected from a pool of applicants from across the United States. Although specifically designed to meet the needs of active researchers new to fMRI, the course is open to advanced graduate students, postdocs, and junior faculty. Typically, roughly one-quarter of attendees are graduate students. In 2006, the APA course met May 21–26.

**Short Course in fMRI Statistics.** The Short Course in fMRI Statistics addresses the mathematics of fMRI analysis, focusing on analysis of the time series from a single voxel using what is known as the general linear model. This advanced class emphasizes theory and is intended for users already well acquainted with fMRI analysis. The course was held April 26 & 27, 2006.

**NIRS-DOT Visiting Fellowship Program.** The NIRS-DOT Visiting Fellowship Program, in its sixth year, is an introductory course on the fundamentals of near-infrared spectroscopy and diffuse optical tomography (NIRS-DOT). The two-day course offers hands-on exercises for applying optical techniques to the study of brain activity and covers such topics as the physics of diffuse optical tomography and imaging of the brain, instrumentation, basics of experimental design, and potential clinical and research applications. In 2006, the session was held November 16 & 17.

**MRI 2007: Clinical Updates and Practical Applications.** MRI 2007 was held at the Westin Casuarina Resort, on the island of Grand Cayman, February 19–23, 2007. The Clinical Updates course, designed to bring MR radiologists

and technologists up to date on clinical advances in MRI, featured presentations by experienced radiologists on the latest techniques available in the field.

## Events

**Martinos Center Retreat 2006.** Members of the Martinos Center gathered for the annual retreat at Castle Hill in Ipswich, MA, on Tuesday, September 12, 2006. Among the talks that day were a brief “State of the Center” update by Dr. Rosen; overviews of the Center’s MR, MEG, optical imaging, and computational resources; and a data blitz of new results produced by several of the research programs that utilize the many tools available at the Center. Among the presenters were representatives from the Departments of Psychiatry and Neurology at MGH as well as collaborators from Harvard and MIT. Two major topics flavoring those talks were plans to incorporate PET into the Center’s research imaging repertoire, and the expansion into new lab and office space in Building 75. Adding a new twist, the day also featured informative talks by legal and industry experts on the transfer of technologies from



Left: Dr. Rosen and Dr. Hamalainen discuss the finer points of multimodality imaging.

Below: Graduate students get to know one another and their research interests.



laboratory to clinic.

**HST Forum.** The Martinos Center hosted the 20<sup>th</sup> Annual HST Forum on March 8, 2007. This year's event, which drew approximately 200 attendees from throughout the HST community, featured a poster session in which HST graduate students had an opportunity to present their research and engage in stimulating discussions with their peers and mentors. Dr. Rosen, himself an HST alumnus, also spoke on the imaging innovations taking place at the Martinos Center.

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