Icahn School of Medicine at Mount Sinai

Translational & Molecular Imaging Institute

tmii.mssm.edu

Spring 2018

THE POWER OF IMAGING

The **Imaging Research Center** is the backbone of the Translational & Molecular Imaging Institute at the Mount Sinai Health System. Housed on three floors of Mount Sinai's Leon and Norma Hess Center for Science and Medicine, the Center enhances the use of seamless diagnostics and treatment methods for our patients. Built with strategic growth in mind, the space is designed to be flexible. It contains today's leading-edge research and clinical equipment while providing room for the evolution of clinical and research platforms as new technologies emerge in the coming years.

Many scientists study changes in the world. Our scientists *create* changes in the world.

The Center serves as a research catalyst for a new generation of translational and molecular imaging methodologies. As a service to the Mount Sinai community, the Center applies and validates imaging modalities, in both pre-clinical basic science and clinical research settings, to:

- Improve diagnostic accuracy
- Increase the understanding of disease mechanisms
- Measure therapeutic efficacy
- Provide education and training opportunities for students and postdoctoral research and clinical fellows

An essential component of the vision of Valentín Fuster, MD, PhD, Dean Dennis Charney, MD, and Burton Drayer, MD, *the Imaging Research Center offers bold technology and challenges our definition of what is possible.* Led by renowned scientist Zahi A. Fayad, PhD, the Imaging Research Center provides physicians with previously unavailable images of patients' internal organs, necessary for non-invasive diagnostics to treat cancer, brain, and cardiovascular diseases.

THE NEXT STAGE OF EVOLUTION

On the lower levels of the Hess Center, the Imaging Research Center has an extensive and expanding inventory of imaging facilities and equipment, including related patient exam rooms, laboratories, and testing rooms. Physician-scientists who work in this space have a major impact on the science of imaging and its ongoing refinement—from the development of new visualization technologies to improved contrast agents that help investigators see novel therapeutics at work.

The Imaging Research Center has recruited several top-notch faculty members in cardiovascular imaging, neuroimaging, cancer imaging, and nanomedicine to parallel the expansion of translational medicine at Mount Sinai. Consequently, we have created one of the finest, most innovative imaging programs in the world.

3T Skyra

Vevo2100 Micro-Ultrasound System

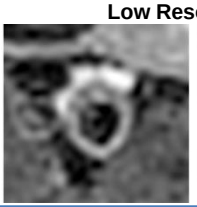
Bruker Micro MRI 7T

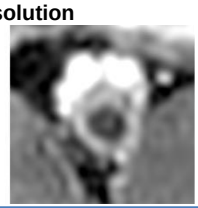
MR Simulator

Utilizing technology that *allows us to look deeper into the human body than ever before*, our physician-scientists are studying disease models to improve the early detection and treatment of cancer and developing non-invasive methods that allow for the early detection, prevention, and treatment of cardiovascular disease.

Low Resolution

3T

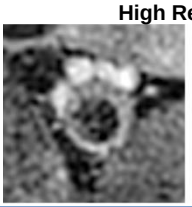




7T

High Resolution

3T



7T

Combination PET/MRI:

- Used for heart, brain, and cancer imaging
- Completely non-invasive, whole body, dual system
- Enables scientists to develop novel methods for targeted imaging and drug delivery to improve the diagnosis and treatment of a range of diseases

7 Tesla ultra-high field MRI:

- The next generation of human MRI that offers special resolution
- Allows physicians to detect early brain disease or cancerous tumors
- Physicians can assess diseases non-invasively at never-before-seen resolution and magnification
- No other institution in the United States is working with a 7 Tesla for cardiovascular disease

Somatom Force CT:

- A novel dual-source Somatom Force CT for faster and lower dose imaging
- The system is available for human and large animal research

These high performance systems are critically important for ongoing research and they enable us to support increasing numbers of imaging projects from around the Mount Sinai community. Such advanced technologies also help us maintain our competitive edge in the recruitment of the very best scientists and clinicians to Mount Sinai. But most importantly, they are invaluable tools for refining our ability to provide the best patient care available.

IMAGE ANALYSIS CORE

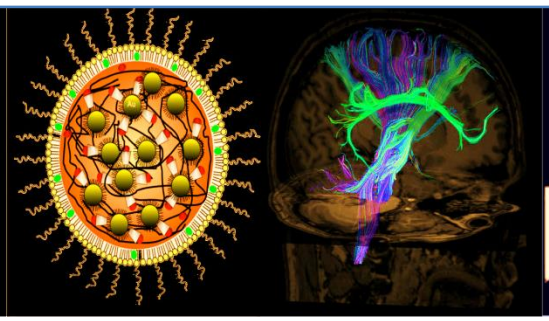
Currently, we have over 50 members with expertise in all aspects of translational imaging research. Our Biomedical and Electrical Engineers and Radiologists are leading experts in their fields. Our highly skilled staff provides a full suite of support services for image acquisition, image analysis, scheduling, and performance of the proposed experiments.

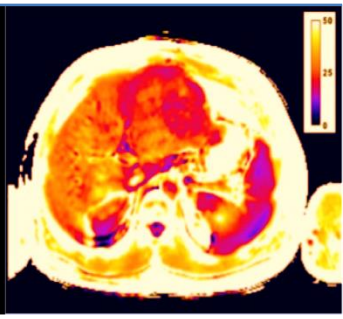
TMII provides image analysis support through the Image Analysis Core. This Core consists of IT personnel, software engineers, imaging physicists, research assistants, and other support personnel. Expert consultation for research projects including protocol design, specialized pulse sequences, special image acquisition hardware (coils), and custom-made functional MRI stimulus hardware are all supported.

Comprehensive project-based image analysis is also provided, as well as image analysis training for those researchers who want to learn more about image analysis in general. Training ranges from regular classroom-based graduate coursework taught by TMII faculty to hands-on training on the use of specific software packages.

The image analysis room is equipped with a large viewing display and more than 15 high performance workstations are open for researchers to learn or perform image analysis.

A PICTURE OF DISEASE





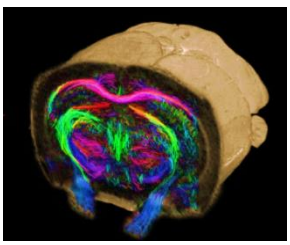


Figure 1.1: Metabolic syndromes

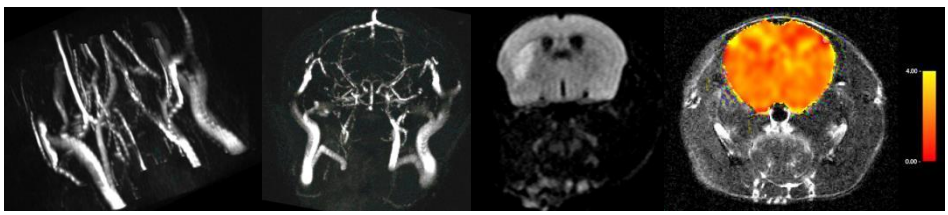


Figure 1.2: Neovascularization—Stroke

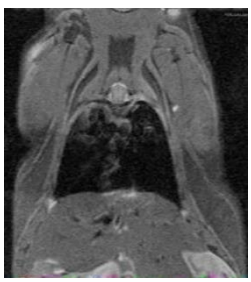


Figure 1.3: Lung Tumor

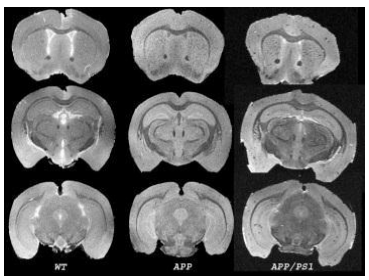


Figure 1.5: Alzheimer's disease

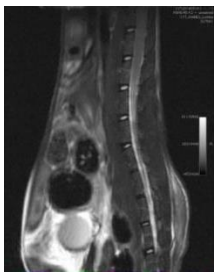
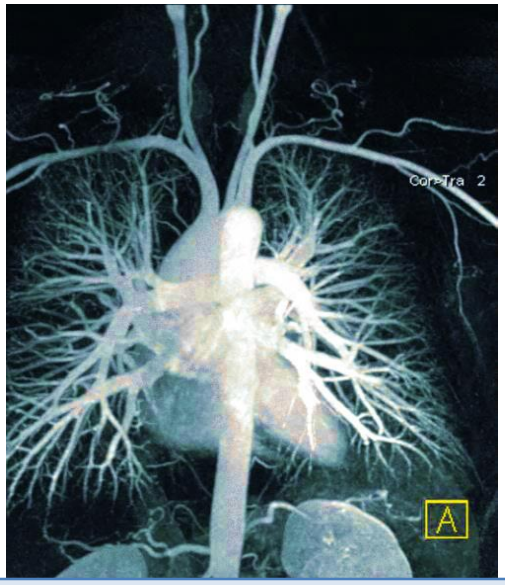
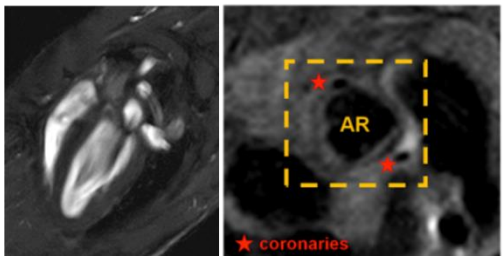


Figure 1.4: Multiple Sclerosis

A WORLD OF POSSIBILITIES

Imagine a world…*where we can detect a heart attack before it strikes.*





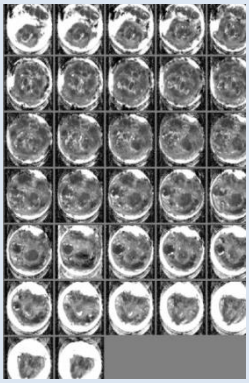
We can. Cardiovascular disease is the leading cause of death worldwide, mostly because of the widespread lack of recognition and treatment of individuals with risk factors for atherosclerosis, a thickening of the arterial wall of the heart that decreases blood supply leading to heart disease and strokes.

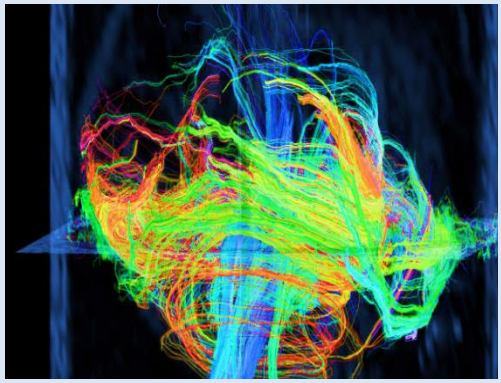
The **Cardiovascular Imaging Research Program** is developing and applying new imaging approaches that allow the assessment not only of the structure of blood vessels, but also of the composition of the vessel walls—enabling abnormalities in the arteries to be observed down to the cellular and molecular level.

Imagine a world…*where we can find a cancer before it's malignant.*

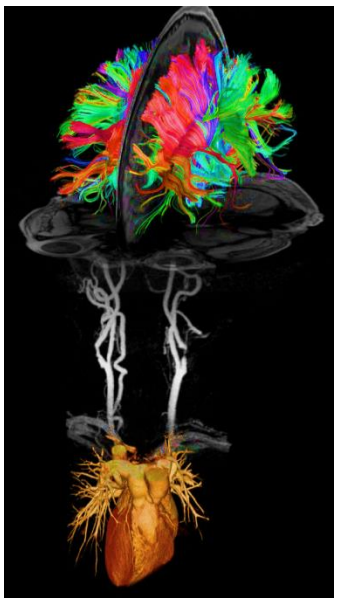
We can. Primary liver cancer has significantly increased in incidence over the last 10 years in the United States. In New York City the incidence rate is much higher. 17 out of 100,000 men in NYC are affected, compared to 5 out of 100,000 men in North America.

The **Cancer Imaging Research Program** is developing new imaging methods that will allow clinicians not only to see where a tumor is located in the body, but also to visualize the expression and activity of specific molecules that influence tumor behavior and/or response to therapy.

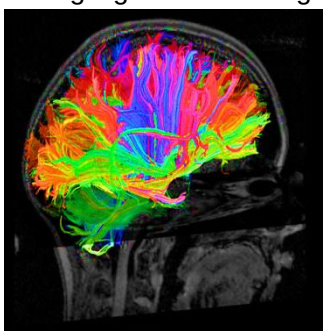


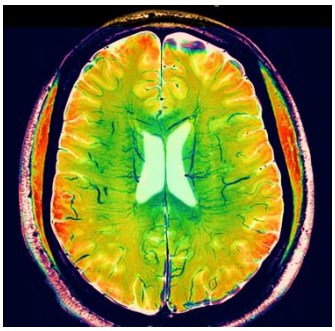


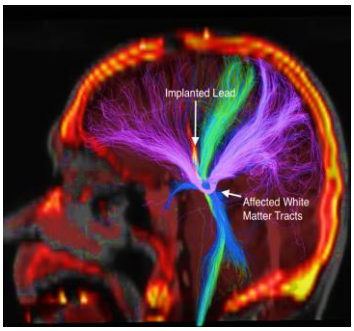
Imagine a world…*where we can see the injured tissue at the onset of Alzheimer's disease.*



We can. The living brain is one of the last frontiers of research. Far more complex and mysterious that any other organ, the brain's 100 billion nerve cells form hundreds of trillions of nerve connections. Yet we cannot examine it by touch without risking significant damage.







The **Neuroimaging Research Program** is developing novel imaging techniques to elucidate changes in brain structure, metabolism, and function in the presence of disease. This method is so effective that 90% of brain research has come to rely on advanced imaging for new discoveries.

SCIENTISTS

Fayad Lab

Zahi A. Fayad, PhD
Professor of Radiology and Medicine (Cardiology)
Director, Translational and Molecular Imaging Institute
Director, Cardiovascular Imaging

Dr. Fayad's laboratory is dedicated to the detection and prevention of cardiovascular disease and conducts interdisciplinary and discipline bridging research, from engineering to biology, which includes pre-clinical and clinical investigations. The focus of this lab is to develop and use innovative multimodality cardiovascular imaging including to study, prevent and treat cardiovascular disease, including: Magnetic Resonance Imaging (MRI), computed tomography (CT), and positron emission tomography (PET), as well as molecular imaging and nanomedicine. Dr. Fayad's focus at Mount Sinai is on the noninvasive assessment and understanding of atherosclerosis.

Claudia Calcagno, MD, PhD
Fayad Lab

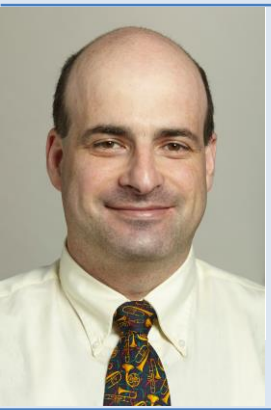
Dr. Calcagno is an Instructor at the Translational and Molecular Imaging Institute at Mount Sinai. She holds an MD from the University of Genova, Italy (2004) and a PhD in Computational Biology from New York University/Mount Sinai. Her research is focused on the development and validation of non-invasive, quantitative imaging techniques in animal models (mice, rabbits, pigs) of cardiovascular disease. More specifically, her expertise is in dynamic contrast enhanced (DCE) MRI to measure microvasculature/permeability, and PET imaging to measure inflammation, two of the hallmarks of high-risk atherosclerotic plaques.

Her current projects are focused on the development of 3 dimensional (3D) imaging combined with cutting edge fast image acquisition and reconstruction methods for the accurate, extensive quantification of these parameters in large vascular territories.

Balchandani Lab

Priti Balchandani, PhD
Associate Professor of Radiology
Director, Advanced Neuroimaging Research Program

Dr. Priti Balchandani is an Associate Professor in the Department of Radiology and Neuroscience at the Icahn School of Medicine at Mount Sinai. She also serves as the Director of the The Advanced Neuroimaging Research Program (ANRP) at the Translational and Molecular imaging institute. The mission of ANRP is to develop novel imaging technologies and apply them to diagnosis, treatment and surgical planning for a wide range of diseases, including epilepsy, brain tumors, psychiatric illnesses, multiple sclerosis and spinal cord injury.
For her primary research, Dr. Balchandani's team focuses on novel radio frequency (RF) pulse and pulse sequence design as well as specialized hardware solutions such as parallel transmission. These techniques are ultimately applied to improve diagnosis, treatment and surgical planning for a wide range of neurological diseases and disorders. Some clinical areas of focus for Dr. Balchandani's team are: improved localization of epileptogenic foci; imaging to reveal the neurobiology of depression; and development of imaging methods to better guide neurosurgical resection of brain tumors.



Lazar Fleysher, PhD
Imaging Core

Owing to his diverse training in physics and mathematics, Dr. Fleysher has made significant contributions in the fields of MR data acquisition, image reconstruction, experiment design, protocol optimization, post-processing and statistical data analysis. Accordingly, he is a co-author on 40 scientific peer-reviewed publications and two patents.

More recently, .Fleysher developed an MRI sequence, acquisition and reconstruction protocol for intracellular sodium imaging. This method, implemented for brain imaging on human 7.0 Tesla scanners, has been applied to the study of healthy subjects and patients with multiple sclerosis. It has the potential to provide clinicians and scientists with a tool to investigate and monitor pathological processes and treatment response at a cellular level.

SCIENTISTS

Mani Lab

Venkatesh Mani, PhD
Assistant Professor of Radiology
Director, Cardiovascular Imaging Clinical Trials Units (CICTU)

As a TMII faculty member and CICTU Director, Dr. Mani works to translate novel multi-modality imaging techniques for use in multicenter clinical trials. His main interests are in imaging of cardiovascular diseases, specifically focusing on atherosclerosis, thrombosis and their complications using FDG-PET, CT and MRI. The CICTU is composed of clinicians, image processing and programming experts, image analysts, data managers, IT personnel and research coordinators.

It is a modern hybrid between a contract research organization and an imaging core lab. They undertake and manage all aspects of clinical trials, from scientific conduct to administrative management. CICTU's tasks span from industry or federally sponsored multicenter clinical trials to the support of individual investigators interested in using imaging endpoints for their work.

Mulder Lab

Willem J.M. Mulder, PhD
Associate Professor of Radiology
Director, Nanomedicine

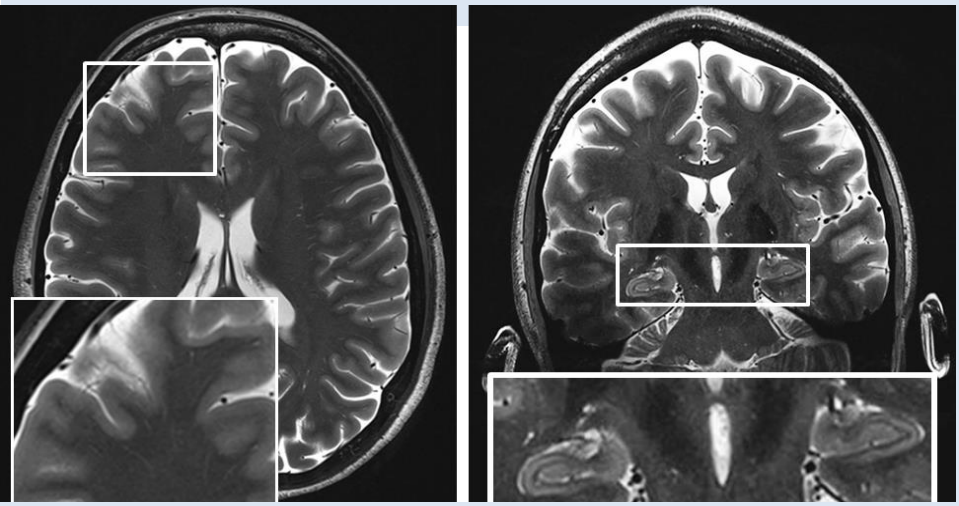
The Nanomedicine Laboratory's mission is to develop and advance nanomedicinal approaches to allow a better understanding, identification and treatment of the most detrimental pathologies today: cardiovascular disease and cancer. The research projects range from fundamental, including nanotechnologies to better understand lipoprotein biology, to translational, with one of the developed nanotherapies being in clinical trials.

Carlos Perez-Medina, PhD
Mulder Lab

Dr. Perez-Medina's work revolves around the development of radiolabeling strategies for nanoparticles with a view to evaluate their in vivo behavior and non-invasively visualize their bio distribution by positron emission tomography (PET) imaging. Thus far we have been able to successfully radiolabel liposomal and high-density lipoprotein (HDL) nanoparticles with the long-lived, PET-active isotope zirconium-89. We have tested both nanoparticles in different animal models of cancer and cardiovascular disease with outstanding results that warrant further investigation. We are currently working on PET imaging tools to evaluate nanotherapy in a non-invasive manner as well as novel ways to assess vascular inflammation in the context of cardiovascular disease.

Philip Robson, PhD
Fayad Lab

Dr. Robson is an Instructor of Radiology in the Translational and Molecular imaging Institute and is a member of the Cardiovascular Imaging group. Dr. Robson's research includes the development of hybrid positron emission tomography (PET) magnetic resonance (MR) imaging technology and its applications in cardiovascular disease, including coronary and carotid artery disease, cardiac sarcoidosis and other cardiomyopathies. His work has led to some of the first successful applications of imaging the activity of micro-calcification and inflammation in atherosclerotic plaque in the coronary arteries using 18F-fluoride and 18F-FDG PET/MR imaging and the development of combined PET and MR protocols for evaluating cardiac sarcoidosis and amyloidosis. He is currently working on methods for MR-based motion correction of PET data, MR-based attenuation correction and complementary anatomical and functional cardiac MR imaging for optimizing cardiac and coronary PET/MR imaging. Dr. Robson's research includes partnerships with clinical investigators in the Cardiovascular Institute as well as national and international collaborators. Before joining Mount Sinai, Dr. Robson worked as a postdoctoral fellow at Beth Israel Deaconess Medical Center and Harvard Medical School in Boston, MA. He was awarded doctoral and undergraduate degrees in Physics by the University of Cambridge, UK.



High resolution T2 -weighted images of the brain. The cerebral cortex and hippocampus, where epileptogenic abnormalities are often located, are visualized in fine detail.

Ultra-High Field Imaging in Epilepsy

Epilepsy adversely affects **almost 3 million people** in the United States.

15%-30% of these individuals do not respond to medication and may be candidates for surgical intervention.

Due to excellent soft tissue contrast and high-resolution visualization of brain anatomy, magnetic resonance imaging (MRI) plays a vital role in the preoperative localization and characterization of brain abnormalities for patient undergoing epilepsy surgery.

Tang Lab

Cheuk Y. Tang, PhD
Director, Neurovascular Imaging Research
Associate Director, Imaging Science Laboratories
Director, In-Vivo Molecular Imaging SRF

Dr. Tang's lab is involved with the research and development of novel imaging strategies for the study of neuro-psychiatric diseases. The work consists of both hardware and software development. The lab develops novel image analysis software approaches to integrate functional and structural connectivity using DTI, DSI and fMRI. The lab has also developed novel technologies (e.g. olfactory meter, real time fMRI) in use for the study of memory, OCD and mood-disorders.

Taouli Lab

Bachir Taouli, MD
Professor of Radiology and Medicine
Director, Cancer Imaging

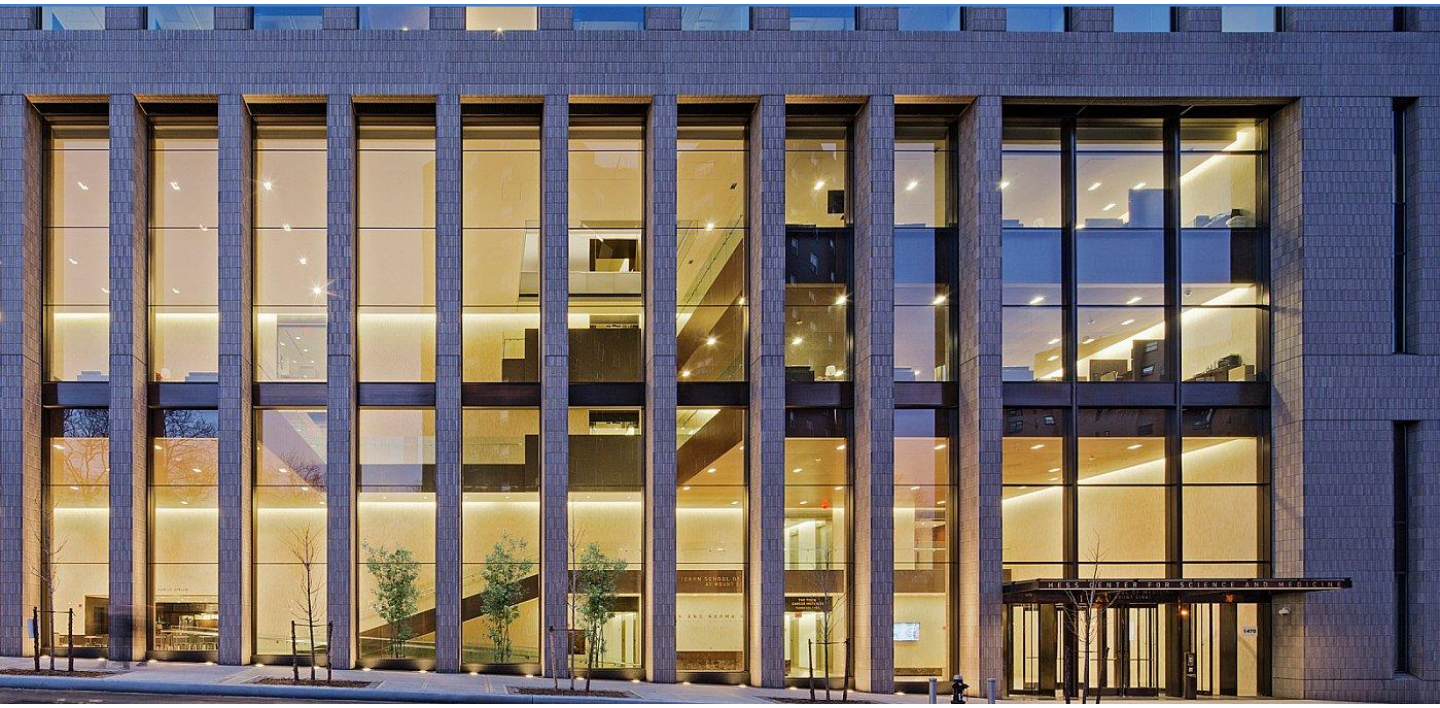
The Quantitative Body Imaging Group develops, tests and validates quantitative MR imaging techniques applied to body imaging. Our current research includes the optimization and validation of novel functional MRI techniques applied to diffuse and focal liver diseases, including diffusion-weighted MRI, dynamic contrast enhanced MRI, MR Elastography, flow quantification, spectroscopy and multi echo Dixon methods.

Xu Lab

Junqian Xu, PhD
Assistant Professor, Radiology, Neuroimaging

Dr. Xu's lab develops quantitative and functional magnetic resonance (MR) techniques and applies them to study neurometabolism and neuropathophysiology. Our current projects are to develop: (1) fast MR imaging and spectroscopy methods for quantitative neuroimaging, (2) reliable MR techniques for functional assessment of spinal cord, and (3) a "Connectomic" imaging approach for tissue recovery, repair and clinical outcomes in multiple sclerosis.

LEADERSHIP



Dr. Zahi A. Fayad is Director of the Imaging Research Center and the Translational and Molecular Imaging Institute, Director and Founder of the Eva Morris Feld Imaging Science Laboratories, and Director of Cardiovascular Molecular Imaging Research at the Icahn School of Medicine at Mount Sinai. He is a world leader in the development and use of multimodality cardiovascular imaging including: cardiovascular magnetic resonance (CMR), computed tomography (CT), positron emission tomography (PET). He holds twelve U.S. and worldwide patents and/or patent applications.

Dr. Fayad is the recipient of multiple prestigious awards and was recently honored with the John Paul II Medal from the City of Krakow, Poland, in recognition of the potential positive impact of his work on humankind and he holds the title of Honorary Professor in Nanomedicine at Aarhus University in Denmark. In 2013, he was elected Fellow of the International Society of Magnetic Resonance In Medicine, Magnetic Resonance Imaging, received a Distinguished Reviewer from Magnetic Resonance in Medicine, and was selected as an Academy of Radiology Research, Distinguished Investigator. In 2014 his alma mater, Bradley University, awarded him its highest honor, the Centurion Society Award, for bringing national and international credit to his university.

Dr. Fayad has authored more than 300 peer-reviewed publications, 50 book chapters, and more than 400 meeting presentations. He is currently the principal investigator of four federal grants/contracts funded by the National Institutes of Health's National Heart, Lung and Blood Institute and the National Institute of Biomedical Imaging and Bioengineering, with a recent large award from NHLBI to support the Program of Excellence in Nanotechnology. In addition, he serves as principal investigator of the Imaging Core of the Mount Sinai National Institute of Health (NIH)/Clinical and Translational Science Awards (CTSA).

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If you wish to make a donation to support the Translational & Molecular Imaging Institute, please contact:
Cassandra Kamarck, Office of Development
646.605.89794 or cassandra.kamarck@mountsinai.org