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School of
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Sinai

WHAT'S NEW

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Translational & Molecular Imaging Institute

Fall 2018
Issue 15

tmii.mssm.edu

Message from the Director

You will notice as you read this fall issue of the TMII newsletter that it has been a very active year by our Institute and our collaborators. We have new developments such as the new TMII bioinformatics and image analysis tools well in place with new imaging processing pipelines in neuro, cancer and cardiac imaging. We will continue to invest in this area with new tools and faculty and staff recruits in the goal to enhance our imaging core and help our end users. Our collaborations with Life Services have lead to a new specialized whole body coil for 7T MRI with exquisite human images. This unique effort was lead by the Advanced Neuroimaging Research Program (ANRP) and

many others at TMII. Please read about other exciting ANRP 2018 advanced features in this newsletter. Other featured developments are new PET/MR motion correction techniques by one of our trainees George Soultanidis which are very promising for many clinical applications including cardiovascular and body imaging. I am thrilled about our 9th annual TMII Symposium scheduled for April 26, 2019 celebrating impactful engineering efforts in medical imaging such as the 11.7 Tesla whole body MRI scanner, the whole body PET scanner, low field and super fast MRI using AI/ML reconstructions techniques, and new nano materials and methods for improved imaging.

We will be soliciting contributions again for the 3rd annual "Windows to Our Body" exhibit on April 25 with the usual animated reception. Finally, huge congrats to the Manis (Claudia Calcagno and Venky) with the welcoming of Maya Sofia-Elena who already is an active member of the TMII family and very robust presence at the TMII halloween party (tmii.mssm.edu/gallery/tmii-2018-halloween/). I wish you a great TMII newsletter read.



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Professor of Radiology and Medicine
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WHAT'S NEW?

TMII News & Updates

Hot off the presses

Dr. Willem Mulder, director of the TMII Nanomedicine program, and colleagues have just published "Inhibiting Inflammation with Myeloid Cell-Specific Nanobiologics Promotes Organ Transplant Acceptance" in the Nov 6th edition of *Immunity*. doi.org/10.1016/j.immuni.2018.09.008

Also recently published by the Mulder lab, a review of "Nanoimmunotherapy to treat ischaemic heart disease" in the September 12th edition of *Nature Reviews (Cardiology)*. doi.org/10.1038/s41569-018-0073-1

In conference news

There was a strong showing from TMII at this year's Joint Annual Meeting ISMRM-ESMRMB with 28 poster and oral presentations. Congratulation should be go out to Drs. Bachir Taouli and Matilde Inglese - newly minted fellows of the society.

At the 104th Scientific Assembly and Annual Meeting of the Radiological Society of North America at the end of November, Dr. Kambiz Nael will be presenting his work with TMII and collaborators at Siemens Healthineers on: "Automated Detection of Abnormality in Multi-Parametric Brain MRI Using an Artificial Intelligence 3D Pipeline."

Save the date!

The 9th Annual TMII Symposium has been scheduled to be held April 26, 2019 at the ISMMS Davis Auditorium. The welcome reception and art show will again be on the night before the symposium. See the flyer on the following pages and check back for more details.

Welcome

Lastly, we're excited to welcome the newest editions to the TMII family.

On 6/26/2018 Gordon Xu and his family welcomed Ezabelle Simiao Lin.

On 9/20/2018 Claudia and Venky Mani welcomed Maya Sofia-Elena at 6:06 pm weighing in at 6 lb 6 oz.

UPCOMING EVENTS

PPG Seminar Series

> December 8, 2018, 2pm - 3pm, Hess Seminar Room A: Rasha Hammamieh, PhD - Director, Integrative Systems Biology, US, Army Medical Research and Materiel Command, USACEHR- *Systems Biology Approaches to Post-traumatic Stress Disorder*

TMII 4th Annual Medical Imaging and Bioengineering Lecture

> December 13, 2018, 2pm - 3pm, Hess Seminar Room A: Anette Christ, PhD - UMass Medical School *Mechanisms underlying the epigenetic reprogramming of innate immune cells during Western Diet feeding*

9th Annual TMII Symposium

> April 26, 2019, 8am - 5pm, Hess Davis Conference Center: tmii.mssm.edu/TMII2019 for more details

For more information on these and other events go to: <http://tmii.mssm.edu/blog>

Noninvasive assessment of severity of portal hypertension with multiparametric MRI

Bachir Taouli, MD

Bachir Taouli is Professor of Radiology in the Department of Radiology and the Translational and Molecular Imaging Institute at the Icahn School of Medicine at Mount Sinai, New York. He is a clinician scientist with expertise in the application of advanced MRI sequences to diffuse liver disease/liver cancer and abdominal/pelvic malignancies. He has been continuously NIH funded since 2010. The general focus of his lab is to develop novel acquisitions and post-processing techniques in MRI of the abdomen and pelvis, in liver diseases/liver cancer, prostate cancer and inflammatory bowel disease.

Recently, his group has been investigating advanced MRI methods including MR elastography of the liver and spleen (Fig. 1), and 4D flow phase-contrast MRI (Fig. 2) for prediction of degree of portal hypertension in patients with cirrhosis. Portal hypertension is a common complication of liver cirrhosis, due to increased intrahepatic vascular resistance

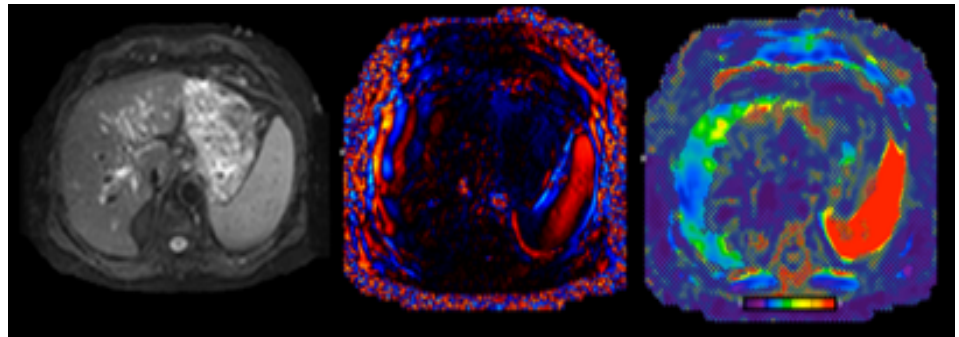


Fig. 1: MRE magnitude, wave and stiffness maps from a 65 yr old male with portal hypertension secondary to nonalcoholic steatohepatitis. Long wavelengths in the spleen correspond to dramatically increased spleen stiffness (13.2 kPa). Liver stiffness is also slightly increased (3.1 kPa). Non-gridded area in the stiffness map indicates areas of reliable stiffness measurement.

and increased hepatic microcirculation. Portal hypertension results in esophageal varices (which carry high risk of bleeding), ascites and renal dysfunction. The definitive diagnosis of portal hypertension is based on hepatic venous pressure gradient measurement, which is invasive. Cirrhosis may be also associated with lower portal venous flow and velocity due to increased parenchymal resistance to flow, and increased hepatic artery flow secondary to an arterial buffer response that can be measured on phase-contrast 4D flow MRI. Elastography is already an established non-invasive method for diagnosing liver fibrosis via viscoelastic measurement

of the liver. MR elastography consists of imaging shear waves propagating through tissues in order to quantify stiffness, showing increased liver stiffness measurements with increased liver fibrosis stage. 4D flow MRI mapping using phase-contrast pulse sequences with 3D vascular coverage and 3-direction velocity encoding is a promising technique for comprehensive hemodynamic analysis by providing both co-registered anatomic and hemodynamic information in cirrhosis and portal hypertension. The ultimate goal of the project is to decrease the need for invasive pressure measurements, by using a combination of liver/spleen stiffness measurements and flow quantification in the splanchnic circulation. This work is supported by the National Institute of Diabetes and Digestive and Kidney Diseases Grant # 1R01DK113272.



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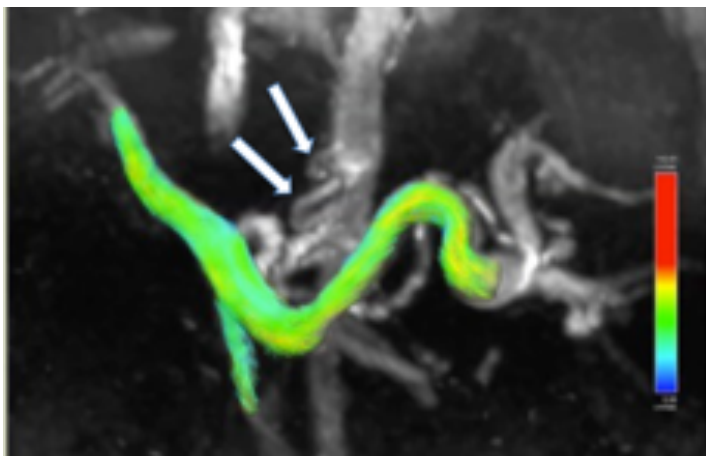


Fig. 2: Streamline display from 4D flow data in a patient with cirrhosis (F, 58 y) showing portal vein, enlarged splenic vein and gastroesophageal varices (arrows).

CORE SPOTLIGHT

TMII Bioinformatics - Image Analysis

TMII and the cancer core have recently implemented new tools for analysis. circleCV is a maker of modular cardiovascular imaging analysis software for quantitative analysis of cardiac MRI and CT images, and for interventional planning. The circleCV 4D flow module will be available in TMII for the analysis of phase contrast MRI "4D flow" datasets. It is equipped to handle large DICOM format datasets (magnitude and phase images with 3-directional encoding) acquired on any scanner from any vendor. In the initial workflow

steps, it allows cropping of large datasets to regions of interest and performs eddy current and anti-aliasing corrections of the phase images before quantification. It provides automatic vessel segmentation, but also allows the option of semi-automatic centerline extraction, so the user can identify smaller vessels missed by the automatic segmentation.

Mint Lesion software assists Radiologists with image-based diagnosis and treatment response assessment of oncological disease.

The software implements various guidelines and response evaluation criteria, such as RECIST1.1, irRECIST and Cheson and allows for the assessment of objective response to therapy. Using the built-in response guidelines allows for the documentation of size assessment of changes in solid tumors using all forms of radiological imaging. The Mint Lesion software generates much more information than the excel or paper assessments, including graphs of tumor progression, images of target lesion and location of lesions.



9th Annual TMII Symposium

April 26, 2019

Davis Conference Center
Hess Center for Science & Medicine
Icahn School of Medicine at Mount Sinai
New York, NY

Cancer & Body Imaging
Simon R. Cherry, PhD
University of California, Davis

Cardiovascular Imaging
Mehmet Akçakaya, PhD
University of Minnesota

Nanomedicine
Mikhail G. Shapiro, PhD
California Institute of Technology

Neuroimaging
Matthew Rosen, PhD
Massachusetts General Hospital

Keynote Speaker
Denis Le Bihan, MD, PhD
French Atomic Energy Commission (CEA)

Icahn School of Medicine at Mount Sinai
Translational and Molecular Imaging Institute

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Image Credit: Andrew Shiue

IMAGING SPOTLIGHT

TMII Collaboration Leads to New Specialized Coils for Human 7 Tesla (7T) MRI TMII Faculty Leading the Effort

Through a NIH STTR collaboration between Life Services, LLC and TMII, tests were run on new radiofrequency (RF) coil technology to make 7T body MRI possible. The company designed, built and bench tested the coil. Then, with help from the TMII Ultra-High Field group, the coil was tested in the 7T MRI at TMII for a final quality assurance check.

Following a Phase I project, all specific aims were accomplished to demonstrate the feasibility of safely and successfully imaging the human body for the first time with commercially available technology at 7T. This technology incorporated a number of innovations including automatic tuning and matching, and multi-channel transmit RF field shimming.

Unlike the whole body coil built into the bore of clinical magnets,

the RF coil technology developed here is easily retrofitted to existing systems, atop the patient table and fitting closely to the body for improved efficiency.

This Phase II collaboration delivered an improved device with the built-in, multi-channel dedicated power amplifiers required to drive it. Because this technology offers advantages of multi-channel RF field control, optimization, and efficiency, it would bring new advantages to 3T clinical imaging as well.

In mid July of this year, the coil was used to

produce TMIs first in human images at 7T. The project will now enter into the phase aimed at optimizing acquisition for applications in cardiovascular, prostate, liver and spine imaging.

TMII and ANRP will be working with Life Services, LLC on another project to help elucidate other more elusive nuclei. In addition to coils tuned to hydrogen (H), Life Services, LLC also specializes in coils designed to pick up signals from sodium atoms. Due the higher signal to noise at 7T, the low concentration of sodium (Na) in the body becomes easier to

detect. Once completed, this dual tuned H/Na head coil will be crucial in numerous applications, including aiding in the detection of

pathologies and metabolic activity in multiple sclerosis.



First human body imaging using a parallel transmit / receive body coil at 7 Tesla.

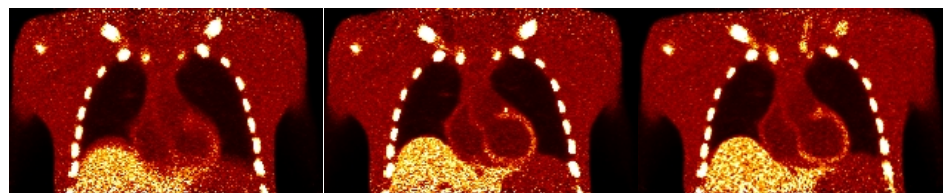
Unlocking the Quantitative Potential of PET-MRI

George Soultanidis, PhD

Dr. George Soultanidis is a postdoctoral research scientist at the Cardiovascular Imaging Lab of Prof. Zahi A. Fayad at TMII since February 2018. His research interests aim towards the development and implementation of novel methods to improve PET quantification. His focus is to tackle the important issues of PET imaging, through the evaluation of existing methodologies and the implementation of new techniques.

The primary tool to achieve this goal is PET-MRI, a truly simultaneous system. The aim is unlocking the full potentials of this modality, leading to more accurate quantification of PET images and increase of image assessment. An equally important goal is to enhance the role of preclinical PET imaging and its translational potentials towards clinical practice

George is a biomedical engineer with M.Sc. in medical physics. He received his PhD on phantom studies for the development and assessment of motion correction in simultaneous PET-MRI at the Division of Imaging Sciences and Biomedical Engineering at King's College London, United Kingdom. He moved in 2016 as a postdoctoral research assistant at the University of Hull, where he utilized his phantom development knowledge to design and develop a small animal phantom for preclinical radiotherapy purposes.



Motion correction of simulated coronary lesions using Reconstruction Transform Average (RTA) methodologies

George's aim at TMII include the development and implementation of cardiovascular PET-MRI imaging methods, by tackling standing issues like cardiorespiratory motion and 4D PET attenuation correction methods. The purpose is to detect as well as quantitate the molecular processes of inflammation and microcalcification in carotid, aortic and coronary atherosclerotic human plaques using ¹⁸F-FDG, ¹⁸F-NaF and any other viable PET tracer.

Towards the improvement of coronary plaques imaging, George works with clinical data and realistic simulation studies. He evaluates existing toolkits and novel approaches, translatable to daily practice.

In addition, George is interested in the improvement of preclinical PET imaging and use it as a test ground for further

development and implementation of PET quality correction algorithms. His research is primarily supported by NIH R01, acquired by the cardiovascular Imaging Lab. His current work is the development of a 4D motion correction workflow, with the addition of Motion Compensated Image Reconstruction for PET imaging, by taking advantage of the simultaneous nature of a PET-MRI system. A development to this direction will be beneficial to a variety of applications utilizing a PET-MRI system.



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ANRP Profile

Recent Developments

The Advanced Neuroimaging Research Program (ANRP) has been hard at work in 2018.

The group has been identifying and investing in specialized resources to expand the technical capabilities for advanced brain imaging at ISMMS. The new Borg Queen server, installed this year, is dedicated for the intense computational needs and storage requirements for neuroimaging. This server contains a total of 128 cores of AMD 2.0GHz CPU, 1TB of RAM, 3 x NVIDIA GTX 1080 Ti GPUs with 11GB memory each, plus 540TB of storage

In the MRI hardware department, the ANRP helped

acquire a parallel transmit/receive 32 channel head coil and a dual-tuned hydrogen/sodium 8 channel head coil.

The group continues to develop optimized sequences for high resolution functional and structural imaging at both 3T and 7T. New sequences have been developed for

ASL, FGATIR and advanced spectroscopic imaging of cellular loss and neurotransmitters.

ANRP has developed and implemented a smart pre-processing pipeline structure called SAPIENT in order to provide standardized preprocessing across the

scanners. They are also testing out a data management service with an external vendor, Flywheel, to determine the most efficient method for data storage and pre-processing of neuroimaging data for investigators.

ANRP director, Priti Balchandani, has been an active mentor and co-investigator on several new grants submissions, ranging from K awards, to R21 and R01, by PIs in Psychiatry, Neurology at Sinai as well as Bioengineering at collaborating institutions.

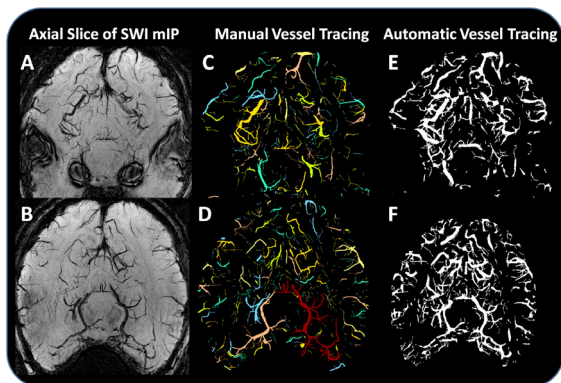
Lastly, while recent recruiting efforts have provided much needed expertise in graph theory, IT management and machine learning, ANRP continues to seek new, energetic investigators to compliment and advance the groups expertise in image processing and deep learning.



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Associate Professor

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Comparison of manual and automated segmentation. (A) and (B) axial slices of the 7T Susceptibility Weighted Image minimum intensity projection. (C) and (D) manually segmented vessels from the slices (E) and (F) result of automated vessel tracing on the same slices

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