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International Society for Magnetic Resonance in Medicine • www.ismrm.org

ISMRM Workshop on Moving Forward with Intravoxel Incoherent Motion Modeling for Diffusion-Weighted MRI: An Attempt at Consensus

26-28 MARCH 2024

Friedrich-Alexander-Universität Erlangen-Nürnberg
Erlangen, Germany

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ORGANIZING COMMITTEE

Chair:

Oliver J. Gurney-Champion, Ph.D.
Amsterdam University Medical Centers
Amsterdam, The Netherlands

Committee Members:

Christian Federau, M.D.
AI Medical
Zollikon, Switzerland

Denis Le Bihan, M.D., Ph.D.
Neurospin
Saclay, France

Mami Iima, M.D., Ph.D.
Kyoto University Graduate School of Medicine
Kyoto, Japan

Eric E. Sigmund, Ph.D.
New York University Langone Health
New York, NY, USA

Oscar Jalnefjord, Ph.D.
Gothenburg University
Gothenburg, Sweden

Andreas Wetscherek, Ph.D.
The Institute of Cancer Research
London, England, UK

Jacobus F. A. Jansen, Ph.D.
Maastricht University
Maastricht, The Netherlands

Dan Wu, Ph.D.
Zhejiang University
Hangzhou, China

Frederik Bernd Laun, Dr. rer. nat.
University Hospital Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg
Erlangen, Germany

Susi Rauh, M.Sc. (Trainee Observer)
Leiden University Medical Center
Leiden, The Netherlands

OVERVIEW

Intravoxel incoherent motion (IVIM) imaging provides a means for non-invasive simultaneous assessment of tissue water diffusion and perfusion characteristics by MRI without the need for an exogenous contrast agent. There is growing literature on IVIM supporting its value, with an exponential increase in the number of publications in the last decade. However, published results are to some extent contradicting, possibly due to methodological variations, thereby hindering the clinical adoption of the technique.

This workshop aims to bring together scientists and clinicians interested in IVIM to start the move towards consensus on the clinical and research use of IVIM. The workshop will include lectures, scientific presentations (orals and posters), and panel and roundtable discussions. Topics will span from the basics of the IVIM technique to common application in various body regions, to state-of-the-art methods for acquisition and processing, to validation and quality control, to future clinical applications, and novel developments such as flow-compensated IVIM. A significant portion of the workshop will be dedicated to activities aiming to facilitate starting the work on consensus—in particular, sessions enabling discussions in both larger and smaller groups.

TARGET AUDIENCE

The main topic is intravoxel incoherent motion (IVIM), and the workshop caters to those interested in IVIM. This workshop is designed for researchers (including Ph.D. candidates, postdocs, and professors), clinicians (e.g. radiologists), MR technologists, government regulatory experts, nonprofit and academic groups interested in IVIM, and members of the ISMRM Diffusion, ISMRM Perfusion, and ISMRM Quantitative MR Study Groups.

EDUCATIONAL OBJECTIVES

Upon completion of this activity, participants should be able to:

- Review the fundamentals of IVIM imaging, from theory to acquisition to processing to clinical implementation;
- Describe the latest advances and insights in IVIM imaging;
- Examine what diseases and disease sites are low-hanging fruit for IVIM;
- Apply the use of IVIM in future research studies; and
- Collaborate on the formation of IVIM guidelines and consensus statement.

SPEAKER UPLOAD INFORMATION (Audiovisual Preview)

Uploading presentations is available on a first-come, first-served basis. Hours are:

- Tuesday, 26 March: 07:00-08:45
- Wednesday, 27 March: 07:00-08:00
- Thursday, 28 March: 08:00-09:00

Please see program for additional times (breaks & lunch).

PROGRAM CREDIT DESIGNATION

The International Society for Magnetic Resonance in Medicine is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. The International Society for Magnetic Resonance in Medicine designates this live activity for a preliminary maximum of 10.0* *AMA PRA Category 1 Credit™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The American Medical Association has an agreement of mutual recognition of Continuing Medical Education (CME) credits with the European Union of Medical Specialists (UEMS), the accreditation body for European countries. Physicians interested in converting *AMA PRA Category 1 Credits™* to UEMS-European Accreditation Council for Continuing Medical Education CME credits (ECMECs) should contact the UEMS at mutualrecognition@uems.eu.

Activities certified for A*MA PRA Category 1 Credit*™ that take place within a member country of the UEMS are not eligible for conversion to ECMECs under this agreement.

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The International Society for MR Radiographers & Technologists (ISMRT), A Section of the ISMRM, is recognized by the American Registry of Radiologic Technologists (ARRT) as a Recognized Continuing Education Evaluation Mechanism (RCEEM). This workshop does not offer CE credits.

CLAIMING CREDIT

To obtain your Certificate of Participation for this workshop, log into the ISMRM membership portal at www.ismrm.org, then click the "My Meeting Evaluations" menu option, select "View Meeting Evaluation" by the appropriate meeting name, and follow the instructions provided.

CERTIFICATE OF PARTICIPATION

To obtain your Certificate of Participation for this workshop, log into the ISMRM membership portal at www.ismrm.org, click the "Session Evaluations for Certificates" menu option, select "Begin Evaluation" next to the appropriate meeting name and follow the instructions provided.

DECLARATION OF FINANCIAL RELATIONSHIPS

The ISMRM is committed to:
1. Ensuring balance, independence, objectivity, and scientific rigor in all Continuing Medical Education programs; and
2. Presenting CME activities that promote improvements or quality in healthcare and are independent of commercial interests.

Therefore, it is the policy of the Society that any person who has influence over the content of a program designated for AMA PRA Category 1 Credits™ must disclose any real or apparent financial interest or other relationship (i.e., grants, research support, consulting fee, royalty, honorarium for promotional speakers' bureau, ownership interest) that they or their spouse/partner have had in the last 12 months with "any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients."

The ISMRM does not imply that such financial interests or relationships are inherently improper or that such interests or relationships would prevent the speaker or organizer from making an objective contribution. However, it is imperative that such financial interests or relationships be identified so that potential conflicts can be resolved before the program, and participants at the CME activity may have these facts fully disclosed in advance. It then remains for the audience to determine whether an individual's outside interests may reflect a possible bias in either the exposition or the conclusions presented.

Following are the names of all presenters, committee members, and other organizers who had influence upon program content. If individuals have disclosed real or apparent financial interests or relationships, the interests or relationships are described. All potentially relevant relationships have been mitigated appropriately.

ORGANIZERS

Christian Federau, M.D. ..... No relevant relationships to disclose
Oliver J. Gurney-Champion, Ph.D. ..... No relationships to disclose
Mami Iima, M.D., Ph.D. ..... No relationships to disclose
Oscar Jalnefjord, Ph.D. ..... No relevant relationships to disclose
Jacobus Jansen, Ph.D. ..... No relationships to disclose
Frederik Bernd Laun, Dr. rer. nat. ..... Scan time, Co-Supervision of Ph.D. Students: Siemens; Ownership Interest/Co-Founder: HQ Imaging
Denis Le Bihan, M.D., Ph.D. ..... No relationships to disclose
Dan Wu, Ph.D. ..... No relationships to disclose
Susi Rauh, M.Sc. ..... No relationships to disclose
Eric E. Sigmund, Ph.D. ..... No relationships to disclose
Andreas Wetscherek, Ph.D. ..... No relevant relationships to disclose

MODERATORS

Walter Backes, Ph.D. ..... No relationships to disclose
David Buckley, Ph.D. ..... No relationships to disclose
In-Young Choi, Ph.D. ..... No relationships to disclose
Christian Federau, M.D. ..... No relationships to disclose
Moti Frieman, Ph.D. ..... No relationships to disclose
Oliver J. Gurney-Champion, Ph.D. ..... No relationships to disclose
Oscar Jalnefjord, Ph.D. ..... No relevant relationships to disclose
Jacobus Jansen, Ph.D. ..... No relationships to disclose
Frederik Bernd Laun, Dr. rer. nat. ..... Scan time, Co-Supervision of Ph.D. Students: Siemens; Ownership Interest/Co-Founder: HQ Imaging
Denis Le Bihan, M.D., Ph.D. ..... No relationships to disclose
Phil Lee, Ph.D. ..... No relationships to disclose
Mira Liu, Ph.D. ..... No relationships to disclose
Camila Munoz, Ph.D. ..... No relationships to disclose
Susi Rauh, M.Sc. ..... No relationships to disclose
Carlo Pierpaoli, M.D., Ph.D. ..... No relationships to disclose
Gregory Simchick, Ph.D. ..... No relationships to disclose
Julia Stabinska, Ph.D. ..... No relationships to disclose
Andreas Wetscherek, Ph.D. ..... No relevant relationships to disclose

SPEAKERS

Christian Federau, M.D. ..... No relevant relationships to disclose
Martijn Froeling, Ph.D. ..... No relationships to disclose
Oliver J. Gurney-Champion, Ph.D. ..... No relationships to disclose
Diego Hernando, Ph.D. ..... No relevant relationships to disclose
Sila Kurugol, Ph.D. ..... No relationships to disclose
Frederik Bernd Laun, Dr. rer. nat. ..... Scan time, Co-Supervision of Ph.D. Students: Siemens; Ownership Interest/Co-Founder: HQ Imaging
Denis Le Bihan, M.D., Ph.D. ..... No relationships to disclose
Alexandra Ljimani, M.D. ..... No relationships to disclose
Maria Ljungberg, Ph.D. ..... No relationships to disclose
James O'Connor, M.D., Ph.D. ..... No relationships to disclose
Naoki Ohno, Ph.D. ..... No relationships to disclose
Susi Rauh, M.Sc. ..... No relationships to disclose
David Reiter, Ph.D. ..... No relationships to disclose

SPEAKERS (CONTINUED)

Amita Shukla-Dave, Ph.D.....No relationships to disclose
Paulien Voorter, M.Sc.....No relationships to disclose
Andreas Wetscherek, Ph.D.....No relevant relationships to disclose
Peter T. While, Ph.D.....No relationships to disclose
Hui Gary Zhang, Ph.D.....No Relationships to disclose

ABSTRACT PRESENTERS

Ignasi Alemany, Ph.D. Candidate.....No relationships to disclose
Zyad Almutlaq, M.Sc.....No relationships to disclose
Cemre Ariyurek, Ph.D.....No relationships to disclose
Dibash Basukala, Ph.D.....No relationships to disclose
Scott Edwards, M.Sc.....No relationships to disclose
Oscar Jalnefjord, Ph.D.....Employment: Wellspect HealthCare
Jonas Jasse, M.Sc.....Grants/Research Support: Doctoral grant from the Jürgen-Manchot-Stiftung
Misha Kaandorp, M.Sc.....No relationships to disclose
Muge Karaman, Ph.D.....No relationships to disclose
Sumit Kaushik, Ph.D.....No relationships to disclose
Noga Kertes, B.Sc.....Grants/Research Support: NIH R01 LM013608, R01 EB019483, R01 NS124212, & R01 NS121657; United States-Israel Binational Science Foundation (BSF) 2019056
Daan Kuppens, M.Sc.....No relationships to disclose
Alfonso Lema-Dopico, Ph.D.....Grants/Research Support: NIH
Mira Liu, Ph.D.....No relationships to disclose
Martin Loh, M.Sc.....No relationships to disclose
Camila Munoz, Ph.D.....No relationships to disclose
Candido Otero Moreira, M.Sc.....No relationships to disclose
Ramesh Paudyal, Ph.D.....Grants/Research Support: NIH
Elina Petersson, M.Sc.....No relationships to disclose
Ivan A. Rashid, M.Sc.....No relationships to disclose
Louise Rosenqvist, M.Sc.....No relationships to disclose
Suraj Serai, Ph.D.....No relationships to disclose
Mohammed Salman Shazeeb, Ph.D.....No relationships to disclose
Eric Sigmund, Ph.D.....Grants/Research Support: NIH
Gregory Simchick, Ph.D.....No relationships to disclose
Julia Stabinska, Ph.D.....No relationships to disclose
Christoph Stuprich, M.Sc.....No relationships to disclose
Thomas Andreas Thiel, M.Sc.....No relationships to disclose
Noa van der Knaap, M.Sc.....No relationships to disclose
Paulien Voorter, M.Sc.....No relationships to disclose

ISMRM STAFF

Rhiannon Pinson.....No relationships to disclose
Melissa Simcox.....No relationships to disclose

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ANNUAL MEETING & EXHIBITION

Singapore

04-09 MAY **2024**

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Day 1: TUESDAY, 26 MARCH 2024 *(4.0 CME Available)*		
07:00	Registration & Speaker Upload Available	
	Session 1: What Is Intravoxel Incoherent Motion?	
	Moderators: Camila Munoz, Ph.D. & TBA	
08:45	Welcome	Oliver J. Gurney-Champion, Ph.D. Amsterdam University Medical Center Amsterdam, The Netherlands
09:00	*The Invention of IVIM*	Denis Le Bihan, M.D., Ph.D NeuroSpin Gif-Sur-Yvette, France
09:30	*How Does IVIM Work?*	David A. Reiter, Ph.D. Emory University Atlanta, GA, USA
10:00	Break & Speaker Upload Available	
10:30	*What Is Perfusion & How Does It Relate to What We Measure with IVIM?*	Sila Kurugol, Ph.D. Harvard Medical School & Boston Children's Hopsital Boston, MA, USA
11:00	*Lessons Learned from Standardization Initiatives*	Ramesh Paudyal, Ph.D. Memorial Sloan-Kettering Cancer Center New York, NY, USA
11:30	Panel Discussion	
12:00	Lunch & Speaker Upload Available	
	Session 2: What Acquisition Settings Should I Use?	
	Moderators: Frederik Bern Laun, Dr. rer. nat. & Mira Liu, Ph.D.	
13:30	*Acquisition Settings: Brain*	Paulien Voorter, M.Sc. Maastricht University Maastricht, The Netherlands
14:00	*Acquisition Settings: Body*	Diego Hernando, Ph.D. University of Wisconsin-Madison Madison, WI, USA
14:30	*Acquisition Settings: MSK*	Susi Rauh, M.Sc. Leiden University Medical Center Leiden, The Netherlands
	Moderators: Oscar Jalnefjord, Ph.D. & Gregory Simchick, Ph.D.	
	Proffered Papers - Oral Session	
15:00	*Prandial Effects on 2D (b-M1) Optimized IVIM Quantification in the Liver*	Gregory Simchick, Ph.D University of Wisconsin-Madison Madison, WI, USA
15:10	*Characterizing Penumbral Tissue Death Using Intravoxel Incoherent Motion MRI in a Canine Large-Vessel Occlusion Model*	Mohammed Salman Shazeeb, Ph.D. University of Massachusetts Chan Medical School Worcester, MA, USA
15:20	*IVIM with Phase-Cycled Stimulated-Echoes for Simultaneous Cardiac Diffusion Tensor & Perfusion MRI*	Camila Munoz, Ph.D. Imperial College London London, England, UK
15:30	Break & Speaker Upload Available	

16:00	Consensus Statements	Mami Iima, M.D., Ph.D. & Eric E. Sigmund, Ph.D.
16:30	Panel Discussion	
17:00	Break & Speaker Upload Available	
	Moderators: Oliver J. Gurney-Champion, Ph.D. & Susi Rauh, M.Sc.	
17:30	**Power Pitch Session** *(No CME Available)*	
	Assessment of Brain Cooling Effects on Perfusion in a Dog Large-Vessel Occlusion Model Using Intravoxel Incoherent Motion MRI	Mohammed Salman Shazeeb, Ph.D. University of Massachusetts Chan Medical School Worcester, MA, USA
	Improving Accuracy & Precision of IVIM Parameter Estimates with B-Value Optimization	Elina Petersson, M.Sc. University of Gothenburg Gothenburg, Sweden
	In-Silico Investigations of the Relaxation Time Effects on IVIM Quantification of the Kidney	Julia Stabinska, Ph.D. Kennedy Krieger Institute Baltimore, MD, USA
	Toward Optimal Fitting Parameters for Multi-Exponential DWI Analysis of the Kidney: A Simulation Study Comparing Different Fitting Algorithms	Jonas Jasse, M.Sc. University Hospital Düsseldorf Düsseldorf, Germany
	Evaluation of the Effect of Fitting Algorithm on the Bias & Precision of IVIM Parameters in Breast Cancer: A Simulation Study	Zyad Almutlaq, M.Sc. University of Leeds Leeds, England, UK
	A Comparative Analysis of Optimal b-Value Sampling Strategies in IVIM DWI with Full & Reduced Field-of-View for Soft Tissue Sarcoma	Muge Karaman, Ph.D. University of Illinois at Chicago Chicago, IL, USA
	Velocity Compensated Intravoxel Incoherent Motion Imaging in Human Skeletal Muscle	Christoph Stuprich, M.Sc. University Hospital Erlangen Erlangen, Germany
	A Computational Model of the Cardiac Microstructure & Microvasculature	Ignasi Alemany, Ph.D. Candidate Imperial College London London, England, UK
	Accelerating Readout-Segmented EPI for IVIM Using Deep Learning	Sumit Kaushik, Ph.D. St. Olav's University Hospital Trondheim, Norway
	Acquisition-Independent IVIM MRI Parameter Estimation Using Neural Controlled Differential Equations	Daan Kuppens, M.Sc. Amsterdam University Medical Center Amsterdam, The Netherlands
	Evaluation of a Deep Learning-Based Image Reconstruction Method for Intravoxel Incoherent Motion DW-MRI in Head & Neck Cancers	Ramesh Paudyal, Ph.D. Memorial Sloan Kettering Cancer Center New York, NY, USA
18:00	Poster Session *(No CME Available)*	
19:00	Adjourn	
19:30	Networking dinner	

Day 2: WEDNESDAY, 27 MARCH 2024 *(4.0 CME Available)*		
07:00	Registration & Speaker Upload Available	
Session 3: What Will Be the First Clinical Applications?		
Moderators: David Buckley, Ph.D. & TBA		
08:00	*Oncological & Functional Low-Hanging Fruit: Brain*	Christian Federau, M.D. AI Medical Zollikon, Switzerland
08:30	*Oncological & Functional Low-Hanging Fruit: Body*	Alexandra Ljimani, M.D. Institute of Diagnostic & Interventional Radiology Düsseldorf, Germany
09:00	*The Road to Clinical Introduction*	James O'Connor, M.D., Ph.D. The Institute of Cancer Research London, England, UK
09:30	Break & Speaker Upload Available	
Moderators: Christian Federau, M.D. & Denis Le Bihan, M.D., Ph.D.		
	Proffered Papers - Oral Session	
10:00	*Long-Term Microvascular Hypoperfusion in COVID-19 ICU Survivors: A Prospective Multi-B-Value DWI Study*	Noa van der Knaap, M.Sc. Maastricht University Medical Center Maastricht, The Netherlands
10:10	*Assessment & Prediction of Renal Function with Non-Contrast MRI in Patients Undergoing Surgical Management of Solid Renal Masses*	Mira Liu, Ph.D. Icahn School of Medicine at Mount Sinai New York, NY, USA
10:20	*Quantitative Intravoxel Incoherent Motion DW-MRI & Surgical Pathology for Stratifying Tumor Aggressiveness in Papillary Thyroid Carcinomas*	Alfonso Lema-Dopico, Ph.D. Memorial Sloan Kettering Cancer Center New York, NY, USA
10:30	Consensus Statements	Mami Iima, M.D., Ph.D. & Eric E. Sigmund, Ph.D.
11:00	Panel Discussion	
11:30	Lunch & Speaker Upload Available	
Session 4: What Do We Practically Need To Get IVIM into the Clinic?		
Moderators: Phil Lee, Ph.D. & Carlo Pierpaoli, M.D., Ph.D.		
13:00	*What Do We Need Technically To Get IVIM in the Clinic (What Do We Need from the Vendor?)*	Martijn Froeling, Ph.D. University Medical Center Utrecht Utrecht, The Netherlands
13:30	*Validation*	Maria Ljungberg, Ph.D. Sahlgrenska University Hospital Gothenburg, Sweden
14:00	*Quality Control & Phantoms*	Naoki Ohno, Ph.D. Kanazawa University Kanazawa, Japan
14:30	Break & Speaker Upload Available	

Moderators: Moti Freiman, Ph.D. & Jacobus Jansen, Ph.D.		
	Proffered Papers - Oral Session	
15:00	*Spatial Profiling of Parameters Derived from Diffusion-Weighted Magnetic Resonance Imaging in the Healthy Human Kidney*	Eric Sigmund, Ph.D. New York University Langone Health New York, NY, USA
15:10	*Retrospective Deep Neural Network Analysis of Intravoxel Incoherent Motion (IVIM) Breast Tumor MRI*	Dibash Basukala, Ph.D. New York University Langone Health New York, NY, USA
15:20	*Towards Reproducible Intravoxel Incoherent Motion (IVIM) Analysis: The ISMRM Open-Science Initiative for Perfusion Imaging*	Oscar Jalnefjord, Ph.D. University of Gothenburg Gothenburg, Sweden
15:30	Consensus Statements	Mami Iima, M.D., Ph.D. & Eric E. Sigmund, Ph.D.
16:00	Panel Discussion	
Moderators: Oliver J. Gurney-Champion, Ph.D. & Susi Rauh, M.Sc.		
16:30	**Proffered Papers - Oral Session**	
	Dual-Echo EPI Distortion Corrected Abdominal DWI for Improved IVIM Parameter Estimation in Crohn's Disease	Cemre Ariyurek, Ph.D. Boston Children's Hospital & Harvard Medical School Boston, MA, USA
	Characterization of Solid Renal Masses with Functional Non-Contrast MRI in Patients Undergoing Surgical Management	Mira Liu, Ph.D. Icahn School of Medicine at Mount Sinai New York, NY, USA
	Multi-Exponential Diffusion Image Analysis (MEDIA) of the Human Kidney: A Clinical Feasibility Study	Jonas Jasse, M.Sc. University Hospital Düsseldorf Düsseldorf, Germany
	Spectral Diffusion Analysis of Prostate in Patients with Prostate Cancer Lesions	Thomas Andreas Thiel, M.Sc. University Hospital Düsseldorf Düsseldorf, Germany
	Flow-Compensated Measurements of the Prostate on a Clinical 33 mT/m Wide-Bore System	Ivan A. Rashid, M.Sc. Lund University Lund, Sweden
	Optimized 3D (b-M1-TE) Data Acquisition for Repeatable IVIM & R2 Quantification in the Liver	Gregory Simchick, Ph.D. University of Wisconsin-Madison Madison, WI, USA
	Effect of Simultaneous Multislice Imaging & Repetition Time on Biexponential Liver Intravoxel Incoherent Motion	Martin Loh, M.Sc. University Hospital Erlangen Erlangen, Germany
	The Relationship Between Parameters Measured Using IVIM & DCE-MRI in Patients with Breast Cancer Undergoing Neoadjuvant Chemotherapy: A Longitudinal Cohort Study	Zyad Almutlaq, M.Sc. University of Leeds Leeds, England, UK
	IVIM-Morph: Motion-Compensated Quantitative Intra-Voxel Incoherent Motion (IVIM) Analysis for Functional Fetal Lung Maturity Assessment from Diffusion-Weighted MRI Data	Noga Kertes, B.Sc. Technion - IIT Haifa, Israel
	Can IVIM Quantify Skeletal Muscle Perfusion in Physiological Units?	Scott Edwards, M.Sc. Emory University Emory, GA, USA
17:00	Poster Session *(No CME Available)*	
18:00	Adjourn	

Day 3: THURSDAY, 28 MARCH 2024 *(2.0 CME Available)*		
08:00	Registration & Speaker Upload Available	
Session 5: Modelling & Processing of IVIM Data		
Moderators: Julia Stabinska, Ph.D. & Andreas Wetscherek, Ph.D.		
09:00	*Advanced Acquisition & Modelling*	Andreas Wetscherek, Ph.D. The Institute of Cancer Research London, England, UK
09:30	*Preprocessing & Fitting Data*	Peter T. While, Ph.D. St. Olav's University Hospital Trondheim, Norway
10:00	*Advanced Processing Topics*	Hui Gary Zhang, Ph.D. University College London London, England, UK
10:30	Break & Speaker Upload Available	
Moderators: Walter Backes, Ph.D.		
	Proffered Papers - Oral Session	
11:00	*Characterizing Blood & Cerebrospinal Fluid Flow by the D* Tensor Derived from Cerebral Intravoxel-Incoherent-Motion Diffusion-Tensor-Imaging*	Paulien Voorter, M.Sc. Maastricht University Medical Center Maastricht, The Netherlands
11:10	*Incorporating Spatial Information in Deep Learning Parameter Estimation Applied to IVIM*	Misha Kaandorp, M.Sc. St. Olav's Hospital Trondheim, Norway
11:20	*Modelling the Intermediate Flow Regime in Flow-Compensated Intravoxel Incoherent Motion MRI*	Louise Rosenqvist, M.Sc. University of Gothenburg Gothenburg, Sweden
11:30	Consensus Statements	Mami Iima, M.D., Ph.D. & Eric E. Sigmund, Ph.D.
12:00	Panel Discussion	
12:30	Lunch & Speaker Upload Available	
Session 6: A Vendor's Perspective		
Moderators: Carlo Pierpaoli, M.D., Ph.D.		
14:00	*IVIM in the Clinic: A Vendor's Perspective: What Do They Need from Us & What Can We Offer? (No CME Available)*	Neil P. Jerome, Ph.D. Siemens Healthineers Trondheim, Norway
14:30	General Workshop-Wide Consensus Updated	
15:00	Panel Discussion	
15:30	Awards	
16:00	Adjournment	

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Dibash Basukala, Ph.D.

Scott Edwards, M.Sc.

Daan Kuppens, M.Sc.

Mira Liu, Ph.D.

Camila Munoz, Ph.D.

Louise Rosenqvist, M.Sc.

Noa van der Knaap, M.Sc.

Posters

POSTER	TITLE	AUTHOR
Optimization & Deep Learning		
1	*Assessment of Brain Cooling Effects on Perfusion in a Dog Large-Vessel Occlusion Model Using Intravoxel Incoherent Motion MRI*	Mohammed Salman Shazeeb, Ph.D. University of Massachusetts Chan Medical School Worcester, MA, USA
2	*Improving Accuracy & Precision of IVIM Parameter Estimates with B-Value Optimization*	Elina Petersson, M.Sc. University of Gothenburg Gothenburg, Sweden
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4	*Toward Optimal Fitting Parameters for Multi-Exponential DWI Analysis of the Kidney: A Simulation Study Comparing Different Fitting Algorithms*	Jonas Jasse, M.Sc. University Hospital Düsseldorf Düsseldorf, Germany
5	*Evaluation of the Effect of Fitting Algorithm on the Bias & Precision of IVIM Parameters in Breast Cancer: A Simulation Study*	Zyad Almutlaq, M.Sc. University of Leeds Leeds, England, UK
6	*A Comparative Analysis of Optimal b-Value Sampling Strategies in IVIM DWI with Full & Reduced Field-of-View for Soft Tissue Sarcoma*	Muge Karaman, Ph.D. University of Illinois at Chicago Chicago, IL, USA
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8	*A Computational Model of the Cardiac Microstructure & Microvasculature*	Ignasi Alemany, Ph.D. Candidate Imperial College London London, England, UK
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10	*Acquisition-Independent IVIM MRI Parameter Estimation Using Neural Controlled Differential Equations*	Daan Kuppens, M.Sc. Amsterdam University Medical Center Amsterdam, The Netherlands
11	*Evaluation of a Deep Learning-Based Image Reconstruction Method for Intravoxel Incoherent Motion DW-MRI in Head & Neck Cancers*	Ramesh Paudyal, Ph.D. Memorial Sloan Kettering Cancer Center New York, NY, USA
Clinical Applications & Body		
12	*Dual-Echo EPI Distortion Corrected Abdominal DWI for Improved IVIM Parameter Estimation in Crohn's Disease*	Cemre Ariyurek, Ph.D. Boston Children's Hospital & Harvard Medical School Boston, MA, USA
13	*Characterization of Solid Renal Masses with Functional Non-Contrast MRI in Patients Undergoing Surgical Management*	Mira Liu, Ph.D. Icahn School of Medicine at Mount Sinai New York, NY, USA
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Posters

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15	*Spectral Diffusion Analysis of Prostate in Patients with Prostate Cancer Lesions*	Thomas Andreas Thiel, M.Sc. University Hospital Düsseldorf Düsseldorf, Germany
16	*Flow-Compensated Measurements of the Prostate on a Clinical 33 mT/m Wide-Bore System*	Ivan A. Rashid, M.Sc. Lund University Lund, Sweden
17	*Optimized 3D (b-M1-TE) Data Acquisition for Repeatable IVIM & R2 Quantification in the Liver*	Gregory Simchick, Ph.D. University of Wisconsin-Madison Madison, WI, USA
18	Withdrawn by author	
19	*Effect of Simultaneous Multislice Imaging & Repetition Time on Biexponential Liver Intravoxel Incoherent Motion*	Martin Loh, M.Sc. University Hospital Erlangen Erlangen, Germany
20	*The Relationship Between Parameters Measured Using IVIM & DCE-MRI in Patients with Breast Cancer Undergoing Neoadjuvant Chemotherapy: A Longitudinal Cohort Study*	Zyad Almutlaq, M.Sc. University of Leeds Leeds, England, UK
21	*IVIM-Morph: Motion-Compensated Quantitative Intra-Voxel Incoherent Motion (IVIM) Analysis for Functional Fetal Lung Maturity Assessment from Diffusion-Weighted MRI Data*	Noga Kertes, B.Sc. Technion - IIT Haifa, Israel
22	*Can IVIM Quantify Skeletal Muscle Perfusion in Physiological Units?*	Scott Edwards, M.Sc. Emory University Emory, GA, USA

Take the 5-minute on-site survey!

See the registration desk for questions.

This survey is not for CME credits.

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