Optically Pumped Magnetometer - Magnetoencephalography (OPM-MEG) potential applications for clinical research

Friday 19th September 2025 09:30 - 15:45
Institute of Mental Health, NG7 2TU

BNA British Neuroscience Association

the institute of mental health Nottingham

A one-day research symposium funded by British Neuroscience Foundation and supported by the Institute of Mental Health, Nottingham

Event Programme

09:30	Registration and refreshments
10:00	**Introduction** - John Tully
10:10	**A brief history of OPM-MEG** - Matthew Brookes
10:30	**OPM-MEG basic technology and principles** - Niall Holmes
11:15	**OPM-MEG potential applications in Neuroscience** - Marion Brickwedde
12:00	Lunch
12:45	**OPM-MEG to investigate MS, Parkinsons and Epilepsy** - Nikos Evangelou
13:15	**OPM-MEG in Tourette's** - Mairi Houlgreave
13:45	**OPM-MEG in antisocial personality disorder and psychopathy (EmpaMEG)** - John Tully
14:15	Break and refreshments
14:30	**Measuring biological, cognitive and network effects of neuromodulation** - Marcus Kaiser
15:00	**Question & answer session**
15:45	Event close

Welcome

A very warm welcome to this one-day symposium on OPM-MEG in clinical populations, which is funded by a bursary from the British Neuroscience Association and supported by the Institute of Mental Health, Nottingham.

OPM-MEG is an exciting novel technology with many potential applications, particularly in neurological and psychiatric conditions. Already, it has been employed in multiple studies in youths with epilepsy, and in a smaller number of studies in adult clinical samples. To date, however, its full potential to identify markers of disease progression and treatment remains underexplored. We aim to address this in the current forum, by bringing together scientists and clinical researchers to highlight recent developments and identify pathways to implement this technology into new clinical research programmes.

We hope you very much enjoy the day and that it will inspire you to explore using OPM-MEG in your own research!

Dr John Tully, Conference convenor

A brief history of OPM-MEG

Professor Matthew Brookes

Professor Matthew Brookes' research is focussed on the development and application of multi-modal functional brain imaging. His long-standing primary area of interest has been Magnetoencephalography (MEG), and he has developed new methods for mathematical modelling of MEG data, in particular to enable source localisation, and to measure functional connectivity. His research has been supported by major grants from the EPSRC, Wellcome, and MRC.

Matt was instrumental in the development of OPM-MEG, receiving an OBE in acknowledgement of his contribution in 2023. He will give a broad overview of the story of the development of the technology through to its use in human samples.

OPM-MEG: Basic technology and principles

Dr Niall Holmes

Dr Niall Holmes holds a Mansfield Research Fellowship and a proleptic lectureship in the School of Physics and Astronomy at the University of Nottingham. He has worked on the development of magnetoencephalography using optically pumped magnetometers (OPM-MEG) at UoN for 8 years, with a particular focus on magnetic field shielding and control in hardware and software. His work led to the formation of Cerca Magnetics Limited, a UoN spinout company commercialising OPM-MEG technology where he is co-founder and scientific advisor.

This talk will discuss the key principles of OPM-MEG from system setup to results. Outlines of sensor operation, magnetic shielding, data collection, data processing, system performance (and resolution) and the range of possible experiments will be provided.

OPM-MEG: Potential applications in Neuroscience

Dr Marion Brickwedde

Optically pumped magnetometers (OPMs) are an emerging technology with the potential to enhance the quality and applicability of electrophysiological brain imaging. In this talk, Marion will discuss the benefits of OPM-MEG compared to SQUID-MEG and electroencephalography (EEG), for the investigation of psychiatric and neurological condition, followed by a summary of pioneering studies of OPMs in healthy populations. Preliminary data will be presented that demonstrates signal-to-noise ratios were significant with OPM-MEG compared to EEG and SQUID-MEG in healthy participants, and assesses the visual gamma response to moving ratings in a sample (n=22) of patients with Schizophrenia.

Dr Marion Brickwedde is a neuroscientist at new OPM center at the German National Metrology Institute (PTB) and the University Hospital Charité in Berlin. Her research centres around the mechanisms underlying oscillatory brain activity and their deficits in clinical populations. She completed her PhD, investigating the role of neural oscillations for plasticity, at the International Graduate School of Neuroscience (IGNS) at Ruhr University Bochum. She then developed her interest in OPM-MEG at the Centre for Human Brain Health (CHBH) at Birmingham University.

OPM-MEG in MS, Parkinson's Disease and Epilepsy

Professor Nikos Evangelou

Professor Evangelou trained as a Neurologist in Oxford and Nottngham. Since 2003, he has been a Consultant Neurologist at Nottingham University Hospital, and in 2011, joined the University of Nottingham as a Clinical Associate Professor in Neurology. He obtained his DPhil in Oxford, studying axonal damage in MS with MRI and histopathology. This year, he was appointed Chair and Clinical Professor of Neurology at Nottingham Medical School.

Professor Evangelou leads a translational group of clinicians and scientists aiming to better understand the pathophysiology of Multiple Sclerosis and how to better improve management. He is Co-PI of the multi-centre DELIVER-MS, investigating MS interventions across US and UK sites. His OPM-MEG work extends to Parkinson's Disease and Epilepsy as well as MS. In this talk, he will give an overview of his OPM-MEG in each of these areas, and discuss its potential follow-on studies.

OPM-MEG in Tourette's Syndrome

Dr Mairi Houlgreave

Dr Houlgreave completed a BSc in Neuroscience at the University of Bristol and an MSc in Computational Neuroscience at the University of Birmingham. Mairi's PhD was under the supervision of Stephen Jackson and Matthew Brookes at the University of Nottingham where she focused on identifying the regions involved in the urge-to-act as well as the modulatory effects of median nerve stimulation. She is now continuing her work focusing on exploring the neural correlates and oscillatory dynamics of tics and the urge-to-tic in Tourette Syndrome.

This talk will introduce the difficulties involved in scanning participants with hyperkinetic movement disorders like Tourette Syndrome (TS) and cover the current literature looking at the generation of tics using electrophysiological techniques. The talk will focus on data from two studies, using OPM-MEG. The first looked at the oscillatory dynamics of voluntary movement in participants with TS and matched controls. The second explores the oscillatory dynamics of tics in TS.

Antisocial personality disorder and psychopathy (EmpaMEG)

Dr John Tully

Violent crime has enormous cost for society, and the majority is commited by men with antisocial personality disorder. About one-third of these men also have psychopathy, and offend earlier, more widely, and more severely, throughout the lifespan, and have particular deficits in empathy. Strong genetic evidence suggests considerable heritability for these disorders but a lack of understanding of the mechanistic basis has hampered the development of effective treatments, including those targeting empathy deficits. This talk will give an outline of the MRC-funded EmpaMEG project, which will utilise OPM-MEG, alongside MRS, electroretinography, and a neuropsychology battery, to probe the neural basis of empathy deficits in violent offenders with ASOD+/-P.

Dr Tully is a clinical academic in forensic psychiatry. He completed his PhD as a Wellcome Clinical Research Training Fellow in the neurochemistry of antisocial personality disorder and psychopathy at the Institute of Psychiatry, Psychology and Neuroscience, Kings College London. He is currently a Medical Research Council Clinician Scientist Fellow and Clinical Associate Professor in Forensic Psychiatry at the University of Nottingham. As a clinician, he works as a consultant forensic psychiatrist in Nottinghamshire Healthcare NHS Foundation Trust community forensic service.

Measuring biological, cognitive and network effects of neuromodulation

Professor Marcus Kaiser

Human connectomes are individual like fingerprints. The effect of stimulation not only depends on the target region, but also on its connectivity profile within functionally relevant circuits. To understand the role of a personalised approach, Marcus and his team developed a whole-brain model to represent fMRI changes, enabling them to investigate how transcranial ultrasound stimulation-induced effects propagate throughout the brain with increasing stimulus intensity.

This talk will outline how this approach can be extended towards closed-loop stimulation with a goal towards applications in mental health (schizophrenia and depression). Measurements of biological stimulation effects currently include EEG and fMRI but could potentially be extended to OPM-MEG recordings.

Finally, the talk will discuss ultrasound stimulation at-home. This is already possible for vagus nerve stimulation: for example, using the Zenbud system led to a 79% remission rate for anxiety. However, future development might lead to mobile transcranial ultrasound devices.

Professor Marcus Kaiser is Professor of Neuroinformatics at the University of Nottingham. His aim is to develop ultrasound interventions for cognitive improvements in severe mental health (depression and schizophrenia). He is author of the MIT Press book ‘Changing Connectomes’. Marcus is principal investigator for the closed-loop neuromodulation for mental health MRC programme grant, co-director of the IMH Centre for Translational Neuroscience and co-director of the Centre for Neurotechnology, Neuromodulation, and Neurotherapeutics.

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