OPM-MEG, the Next Generation of Functional Neuroimaging

From Data Acquisition to Analysis

MAG4Health

With the participation of

Dr. Caroline Witton & Her Team, Aston University

Programme

12th May, 2025

Welcome

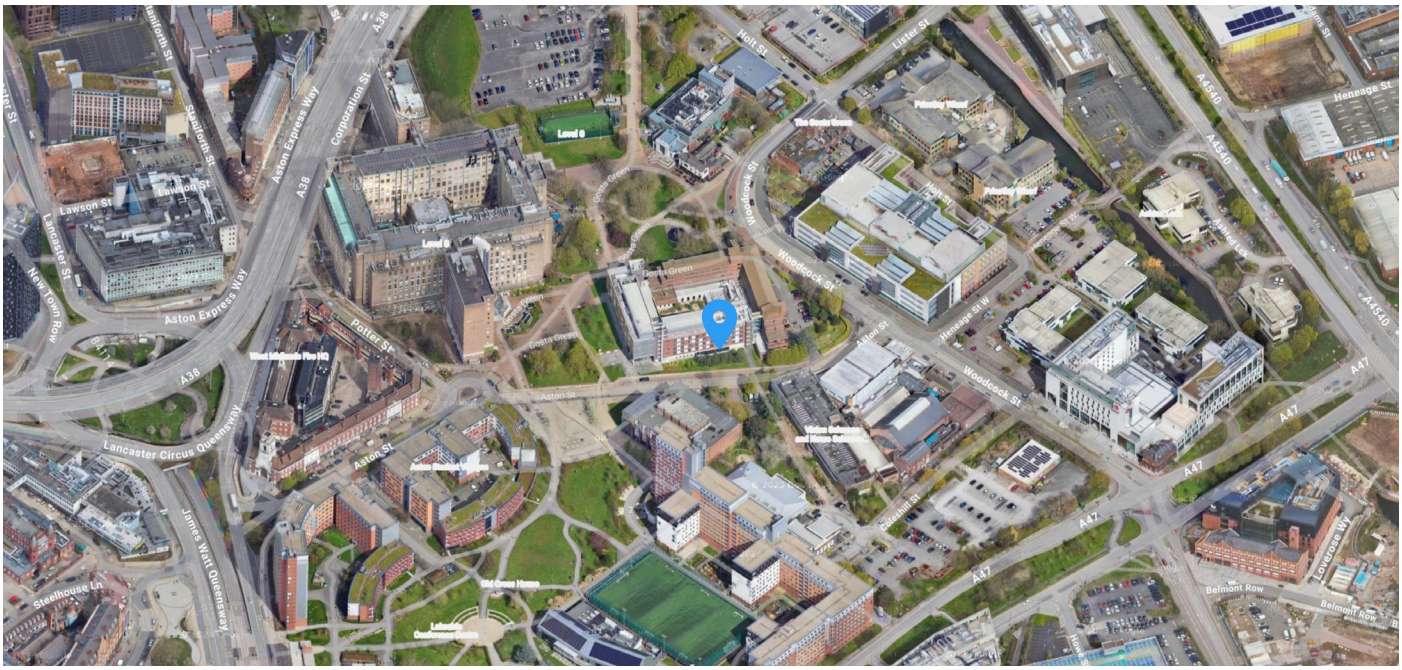
This workshop, proudly supported by Brainbox, will bring together leading experts in **MEG technology and neuroscience research**. It offers a unique opportunity to get a glimpse into the MAG4Health Quantum-based **optically pumped magnetometers MEG (OPM-MEG)** and gain insight into the full data acquisition and analysis pipeline used in cutting-edge MEG research.

Date: Monday, 12th May 2025
Time: 08:00 - 18:00

Location
Meeting Room 145
Conference Aston Ltd,
Aston University,
Birmingham,
B4 7ET
https://www.conferenceaston.co.uk/

Reception office: +44(0) 121 204 4300

Lab tour at Institute of Health
and Neurodevelopment
(Building #8)



Speakers
Dr. Caroline Witton, Aston University
Dr. Arjan Hillebrand, Amsterdam UMC
Dr. Alejandra García Colomo, Universidad Complutense de Madrid
Prof. Gareth Barnes, UCL

Travel Guidelines

Bus
If you're planning on travelling by bus, timetable information is available from Travel West Midlands.

Numerous buses stop at Aston University.

Coach
If you're planning on travelling by coach, timetable information is available from National Express. The nearest coach station is in Digbeth, and it is a 20-minute walk through the city centre to Aston University.

Rail
The Aston University campus, in Birmingham city centre, is just a ten-fifteen minute walk or a five minute taxi ride from New Street, Snow Hill and Moor Street train stations, with a number of routes to the majority of UK destinations. Taxi ranks are available outside each station.

Tram
If you're planning on travelling by tram, journey planner and timetable information is available from West Midlands Metro. The nearest stations are 6-10 minutes away from campus:
- Bull Street
- Corporation Street
- Grand Central New Street

Car
The University can be accessed from:
- M6, Junction 6 (Aston Expressway)
- M5, Junction 3 (Hagley Road)
- M42, Junction 6 (Coventry Road)

Book Car Parking online

Onsite parking must be booked and paid for, online, prior to arrival. A valid Vehicle Registration Number is required when booking.
A map and car park access code will be emailed in the confirmation.
Book car parking online: www.conferenceaston.co.uk/carparking
If our car park is fully booked, nearby pay and display parking is available at Millennium Point.

Details can be found at www.conferenceaston.co.uk

Pre-booking not required.

If you have any trouble reaching the workshop site, please call Emilie Viey, CBO MAG4Health: +33 7 77 68 76 14.

Programme

08:00	**Registration & Coffee**
08:45	**Opening Session** Dr. Caroline Witton & Dr. Etienne Labyt
09:00	***OPM-MEG for Research and Clinical Practice in Epilepsy and Beyond*** Dr. Caroline Witton
09:45	***Optically Pumped Magnetometry in Clinical Populations*** Dr. Arjan Hillebrand
10:30	**Coffee Break**
10:45	***Magnetoencephalography and Plasma Biomarkers: Unravelling Early Functional Alterations in Alzheimer's Disease*** Dr. Alejandra García Colomo
11:30	***New Questions for Optically-Pumped Magnetometers*** Prof. Gareth Barnes
12:15	**Lunch Break**
13:30	**OPM-MEG Lab Tour by Group of 10 Persons** Led by Dr. Caroline Witton and Her Team
16:00	**Coffee Break**
16:15	**OPM-MEG Data Analysis** MAG4Health
17:15	**Q&A Session and Close** Dr. Caroline Witton & Dr. Etienne Labyt

Abstracts

OPM-MEG for Research and Clinical Practice in Epilepsy and Beyond
Dr. Caroline Witton

Abstract:
In this talk I will discuss how OPM-MEG can improve the understanding of, and clinical care for, patients with epilepsy and other brain disorders. As well as outlining the distinctive features of 4He OPMs, I will draw on examples from our paediatric clinic that is jointly run at Aston with Birmingham Children's hospital, and show how OPM-MEG can fit into an integrated care pathway. I will also discuss the future challenges and opportunities which need to be addressed in order to realise the potential for OPMs to bring MEG to the forefront of clinical practice and research.

Biography:
Caroline Witton is a cross-disciplinary scientist who is interested in children's brain development in health and disease, and most recently in how magnetoencephalography can be applied to improve neurodevelopmental outcomes through research and clinical practice. She is the Scientific Lead for MEG at Aston's Institute for Health and Neurodevelopment.

Abstracts

Optically Pumped Magnetometry in Clinical Populations
Dr. Arjan Hillebrand, Amsterdam UMC

Abstract:
Optically Pumped Magnetometers (OPMs) provide unprecedented opportunities for neurophysiological studies in neurological and psychiatric diseases: the measurement of Magnetoencephalography (MEG) directly on the scalp improves signal quality when compared to, e.g., electroencephalography (EEG) and cryogenic MEG, and allows for both lifespan compliance (newborn-to-elderly) and patient movement during scanning. In this talk, I will describe our initial experience in setting-up an OPM-based MEG system in a clinical environment, as well as the utilisation of this pilot system in patients with refractory epilepsy. I will furthermore describe how an OPM-MEG system can be used to study neurodevelopment in children who were born prematurely, and to study the effects of electroconvulsive therapy in patients with major depressive disorder. Finally, I will describe our plans to optimise a whole-head OPM-MEG system, and the use of OPM- MEG earlier in the clinical care-path of epilepsy, namely for the diagnosis of epilepsy. Here, the improved signal quality is expected to increase the diagnostic yield for patients who had a first seizure, eliminating the need for repeated routine-EEGs and/or EEG after sleep deprivation, enabling an earlier start of effective treatment, preventing that treatment is wrongly denied, and most importantly improving patient outcomes and quality of life.
Overall, we envisage that the rapid development of this technology will open-up new areas for neuroscientific research using naturalistic settings, research into disease mechanisms, and improved diagnosis and prognosis in clinical populations, including patients with epilepsy, dementia or mental health illnesses.

Biography:
Arjan Hillebrand obtained his degree in applied physics from the University of Twente (The Netherlands). In 1996 he moved to Aston University in Birmingham, where he received his PhD in 2000. His PhD work involved the development of new methodology for Magnetoencephalography (MEG), focussing on source reconstruction approaches. In 1999 he was appointed as a research fellow, (tenured in 2002) to direct and support research with the newly installed whole-head MEG system at Aston University. In 2007 he became a lecturer, MEG systems manager, and in 2008 director of the MRes in Psychological Research Methods. In 2008 he moved to Amsterdam UMC to direct the use of MEG in the clinic and for research. He currently is associate professor, focussing on the use of (OPM-) MEG to characterise functional brain networks in health and neurological disorders, with particular attention to epilepsy.

Abstracts

Magnetoencephalography and Plasma Biomarkers: Unravelling Early Functional Alterations in Alzheimer's Disease

Dr. Alejandra García Colomo

Abstract:

The definition of Alzheimer's disease (AD) as a biological continuum enabled the identification of distinct stages preceding dementia (Jack et a., 2018). This framework highlights the importance of early identification, which could facilitate the implementation of disease-modifying interventions. Consequently, the search for early biomarkers began. Electrophysiological parameters and blood- based markers are promising candidates for their elevated sensitivity to early alterations.

In this talk, we will discuss the electrophysiological alterations associated with plasma p-tau231 (i.e. an Aβ proxy) and neurofilament light chain (NfL; a marker of neurodegeneration), among cognitively unimpaired (CU) individuals (Ashton et al., 2021; Jack et al., 2024; Leuzy et al., 2022).

Methods: The sample for the discussed studies consisted of cognitively unimpaired (CU) individuals, with varying levels of AD risk due to their family history. The individuals included in the present studies had available 1) a baseline magnetoencephalography (MEG) recording; 2) a follow-up MEG recording (approximately 3 years apart); 3) plasma p-tau231 and NfL determinations, and 4) a T1- weighted magnetic resonance image (MRI).

MEG and T1 MRI data were used to calculate source-level connectivity through amplitude-envelope correlation. From these, connectivity parameters, a centrality score and graph theory analysis parameters were calculated and correlated with the plasma p-tau231 and NfL concentrations.

Results: Functional connectivity and network parameters demonstrated early associations with plasma p-tau231 concentrations, including increased alpha-band connectivity in AD-vulnerable regions such as the precuneus, along with a dual centrality shift in the theta and gamma frequency bands, and a shift towards a more integrated network. Additionally, NfL concentrations also showed a negative association with theta-band connectivity.

Conclusions: Overall, FC metrics and network metrics revealed early and incipient alterations, congruent with the expected changes from the initial stages of AD stages and consistent with an excitation/inhibition imbalance associated with increasing p-tau231 concentrations. Likewise, we found early FC reductions consistent with underlying neurodegeneration (Sepulcre et al., 2017; Stam et al., 2014).

References:

Ashton, N. J., Pascoal, T. A., Karikari, T. K., Benedet, A. L., Lantero-Rodriguez, J., Brinkmalm, G., ... & Blennow, K. (2021). Plasma p-tau231: a new biomarker for incipient Alzheimer's disease pathology. Acta neuropathologica, 141, 709-724.

Jack Jr, C. R., Bennett, D. A., Blennow, K., Carrillo, M. C., Dunn, B., Haeberlein, S. B., ... & Silverberg, N. (2018). NIAAA research framework: toward a biological definition of Alzheimer's disease. Alzheimer's & dementia, 14(4), 535-562.

Jack Jr, C. R., Andrews, J. S., Beach, T. G., Buracchio, T., Dunn, B., Graf, A., ... & Carrillo, M. C. (2024). Revised criteria for diagnosis and staging of Alzheimer's disease: Alzheimer's Association Workgroup. Alzheimer's & Dementia, 20(8), 5143-5169.

Leuzy, A., Mattsson-Carlgren, N., Palmqvist, S., Janelidze, S., Dage, J. L., & Hansson, O. (2022). Blood-based biomarkers for Alzheimer's disease. EMBO molecular medicine, 14(1), e14408.

Sepulcre, J., Sabuncu, M. R., Li, Q., El Fakhri, G., Sperling, R., & Johnson, K. A. (2017). Tau and amyloid β proteins distinctively associate to functional network changes in the aging brain. Alzheimer's & Dementia, 13(11), 1261-1269.

Stam CJ. Modern network science of neurological disorders. Nat Rev Neurosci. 2014 Oct;15(10):683–95.

Biography:

Alejandra García Colomo is a PhD student in Psychology at the Complutense University of Madrid uner the supervision of Dr. Fernando Maestú. As a member of the Center for Cognitive and Computational Neuroscience, her research has focused on studying electrophysiological patterns, measured with magnetoencephalography, associated with risk and protective factors for Alzheimer's disease, such as blood-based pathology biomarkers and nutritional patterns.

Abstracts

New questions for OPMs
Prof. Gareth Barnes, UCL

Abstract:
With OPMs it becomes possible to address neuroscientific questions traditionally difficult to pose within classic neuroimaging paradigms. We are using OPMs to study individuals during more natural behaviour, and taking advantage of their flexibility to quantify brain-heart or brain-spinal cord interactions. I will outline some recent work and offer some perspectives on the exciting challenges ahead.

Biography:
Gareth Barnes is one year older than Magnetoencephalography. He worked on early superconducting systems predominantly at Aston University from 1992 until 2008. In 2009 he moved to University College London where he currently works across cryogenic and OPM-based neuroimaging systems.

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