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High-Density OPM-MEG

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Optically pumped magnetometers (OPMs) present an alternative sensor technology for magnetoencephalography (MEG) to cryogenic systems, allowing for flexible, wearable arrays with reduced sensor-to-scalp distances [1]. However, despite rapid progress, current systems have fewer measurement channels (<200) compared to the ˜300 used in cryogenic systems. The potential increase in measured signal and signal-to-noise ratio (SNR) is well documented [2,3,4], but the reduced sensor-to-scalp distances also provide the ability to measure more focal field topographies, ostensibly improving spatial resolution [3]. High-Density (HD) OPM-MEG fundamentally requires sensors to be placed in close proximity to one another. This can introduce crosstalk effects (constructive interference of fields from adjacent sensors) which alter the sensitive axes of the sensors. Here we demonstrate findings from a high-density, high channel count OPM-MEG array, utilising calibration methods, quantifying crosstalk effects, and demonstrating improvements in SNR and spatial resolution.

Recent work [5,6] has demonstrated a calibration procedure using a matrix coil (MC) magnetic field nulling system [7] through generation of well-characterised magnetic fields over the OPM sensor array. We have recently refined this procedure, reducing acquisition time from ˜20 s to ˜1 s and improving run-to-run repeatability, reducing the variation in localisation error from ˜1.5 mm per axis to ˜0.4 mm per axis. From this calibration, the true sensitive axes can be determined (including effects from manufacturing tolerances, ambient environment, and crosstalk interference).

A pilot HD-OPM-MEG study assessed induced responses from a ballistic finger abduction paradigm (2s movement, 4s rest, 50 trials for each finger) in a 192-channel OPM-MEG system in which triaxial sensors (QuSpin, Colorado, USA) controlled by integrated miniaturised electronics [8] and mounted in bespoke high-density helmets (Cerca Magnetics, Nottingham, UK). Our initial results suggest that spatial resolution follows a quadratic relationship with sensor density.

We have also built a 384-channel OPM-MEG with 128 triaxial OPMs. We validated the system performance using a phantom containing 5 magnetic dipoles (Cerca Magnetics Ltd), reconstructing the relative locations of the dipoles to one another with sub-mm accuracy. Future work will use this system, in combination with improved calibration techniques and improved co-registration techniques, to further explore the relationship between spatial resolution with increased channel count and identify the effects of different array designs by using subsets of channels in analysis.

References

[1] Brookes et al. (2022), Trends Neurosci 10.1016/j.tins.2022.05.008
[2] Boto et al. (2018), Nature 10.1038/nature26147
[3] Iivanainen et al. (2017), Neuroimage 10.1016/j.neuroimage.2016.12.048
[4] Hill et al. (2024), Imaging Neuroscience 10.1162/imag_a_00112
[5] Hill et al. (2025), Imaging Neuroscience 10.1162/imag_a_00535
[6] Iivanainen et al. (2022), Sensors 10.3390/s22083059
[7] Holmes et al. (2023), Neuroimage 10.1016/j.neuroimage.2023.1201
[8] Schofield et al. (2024), Imaging Neuroscience 10.1162/imag_a_00283

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