Accuracy and Reliability of a multi-channel OPM MEG System for pre-surgical planning.

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Clinically, electrical stimulation of the median nerve is used to located primary sensory cortex during surgical planning [1]. Many of the patient groups (such as children) who would benefit from such surgical planning are however poorly served by conventional cryogenic MEG systems, built for adult head sizes. This is a barrier to the successful translation of MEG in this setting. Optically Pumped Magnetometers (OPMs) give us the possibility to not only position the sensors to fit any head size, but also offer increased signal amplitude relative to SQUIDs [2]. Here we present the first simultaneous multi-channel recordings of this median nerve response with a view to assessing accuracy and reliability in a clinical setting.

We recorded MEG data using OPMs housed in a 3D printed scanner-cast positioned over the subject's primary somatosensory cortex [2]. We made 13 simultaneous radial field measurements at 6.5mm offset from the scalp surface using QuSpin sensors within a mu-metal shielded room sited in central London with approximately 20nT residual static field. Data from 8 SQUID magnetometer channels were recorded simultaneously and used for reference noise cancellation. We used a non-linear optimization to explain the averaged recorded data using a single dipolar source. The localisation reliability was assessed using a bootstrapping procedure.

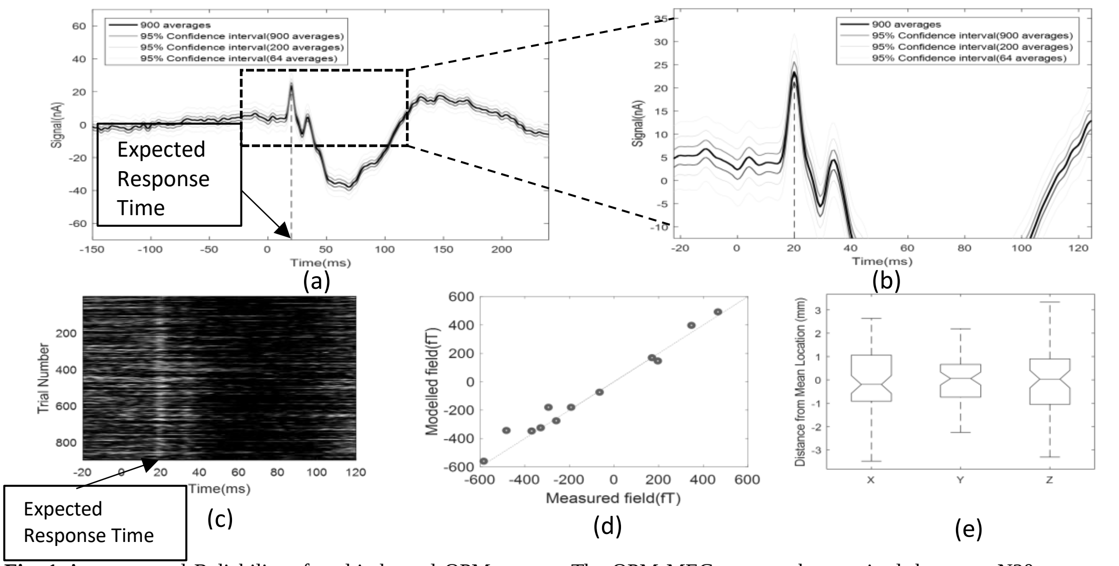

Fig. 1 Accuracy and Reliability of multi-channel OPM system. The OPM MEG system characterised the mean N20 response magnitude (~23 nAm) with ~ 4nAm margin of error (a). The N20 response is expected to occur approximately 20ms post stimulation, which the OPM system accurately detects (b). The pattern is also visible at a single trial level (c). A single dipole fit is able to accurately model the observed magnetic field (d). The observed localisation of the dipole is reliable within ~2-3mm (e)

e. With confidence intervals as a function of the number of averaged trials. Panel c shows the data at a single trial level. Panel d shows that a single dipole fit was able to accurately model the measured field with standard error of ~7%. The mean location was estimated at coordinate (MNI): 50, -22, 46 with variability ~ 2-3mm (Panel e) within primary sensory cortex.

These results suggest that OPMs could provide accurate, reliable and cryogen-free clinically useful information.

References

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[2] Boto, E., Meyer, S. S., Shah, V., Alem, O., Knappe, S., Kruger, P., … Brookes, M. J. (2017). A new generation of magnetoencephalography: Room temperature measurements using optically-pumped magnetometers. NeuroImage, 149, 404–414.