Non-Invasive Functional-Brain-Imaging with an OPM-based Magnetoencephalography System

Amir Borna[1], Tony R. Carter[1], Anthony P. Colombo[1], Yuan-Yu Jau[1], Jim McKay[2], Samu Taulu[3], Julia M. Stephen[4], and Peter D. D. Schwindt[1]

[1] Sandia National Laboratories, Albuquerque, NM 87123, USA

[2] Candoo Systems Inc., Coquitlam, BC V3C 4N6, Canada

[3] University of Washington Seattle, WA 98195, USA

[4] The Mind Research Network, Albuquerque, NM 87106, USA

Abstract

Based on our in-house optically pumped magnetometer (OPM) [1] we have developed a magnetoencephalography (MEG) system presented in [2, 3]. We have updated our MEG system presented in [2] and have addressed its sensors' gain and sense-angle stability compromising the localization capability of the overall MEG system. The 20-channel OPM-based MEG system conforms to the subject's scalp with a standoff of about 12 mm. We have conducted two MEG experiments on three subjects: somatosensory evoked magnetic field (SEF) and auditory evoked magnetic field (AEF) using our OPM-based MEG system and a commercial MEG system based on superconducting quantum interference devices (SQUIDs). We have cross validated the robustness of our system by calculating the distance between the location of the equivalent current dipole (ECD) yielded by our OPM-based MEG system and the ECD location calculated by the commercial SQUID-based MEG system. We achieved sub-centimeter accuracy for both SEF and AEF responses in all three subjects. Within the next two months we have plans to study the tonotopic organization of the auditory cortex in 6 subjects. Audio frequency is topographically mapped in the auditory cortex and using this study we expect to assess and experimentally verify the resolution limit of our MEG system.

[1] Colombo AP, Carter TR, Borna A, Jau Y-Y, Johnson CN, Dagel AL, et al. Four-channel optically pumped atomic magnetometer for magnetoencephalography. Optics Express. 2016;24(14):15403-16.

[2] 14. Borna A, Carter TR, Goldberg JD, Colombo AP, Jau YY, Berry C, et al. A 20-channel magnetoencephalography system based on optically pumped magnetometers. Physics in Medicine and Biology. 2017;62(23):8909-23.

[3] Amir Borna, Tony R. Carter, Anthony P. Colombo, Yuan-Yu Jau, Jim McKay, Michael Weisend, Samu Taulu, Julia Stephen, Peter D. D. Schwindt, "Non-Invasive Functional-Brain-Imaging with a Novel Magnetoencephalography System," Submitted to IEEE Trans. on Medical Imaging, 2019. arXiv:1812.02813 2018. Available from: https://arxiv.org/abs/1812.02813