Individualized magnetoencephalography using optically pumped magnetometers with an anatomy derived sensor holder

Anna Jodko-Władzińska, Warsaw University of Technology, Warsaw, Poland and Physikalisch-Technische Bundesanstalt, Berlin, Germany, anna.jodko-wladzinska@ptb.de
Taoxi Yang, Ludwig-Maximilian Universität, München, Germany, yangtaoxi_ytx@hotmail.com
Rüdiger Brühl, Physikalisch-Technische Bundesanstalt, Berlin, Germany, ruediger.bruehl@ptb.de
Patricia Cotic, Institute of Mathematics, Physics and Mechanics, Ljubljana, Slovenia, patricia.cotic@imfm.si
Lutz Trahms, Physikalisch-Technische Bundesanstalt, Berlin, Germany, lutz.trahms@ptb.de
Vojko Jazbinšek, Institute of Mathematics, Physics and Mechanics, Ljubljana, Slovenia, vojko.jazbinsek@imfm.si
Tilmann H. Sander, Physikalisch-Technische Bundesanstalt, Berlin, Germany, tilmann.sander-thoemmes@ptb.de

Measuring magnetic fields of the human brain is mainly done by Superconducting Quantum Interference Device (SQUID) sensor arrays requiring expensive cooling. A room-temperature alternative for SQUIDs are single unit Optically Pumped Magnetometers (OPM). Due to flexible wiring and small dimensions of commercial OPMs a comparable signal-to-noise ratio is expected between the two types of sensors.

To place the single unit OPMs in great proximity to the brain sources we extracted the head surface from anatomical magnetic resonance images of each subject. This surface served as the input data for a CAD model for each individual subject with added sensor slots. The holder was 3D-printed with flexible PLA filament.

Fifteen dual channel OPMs were inserted into the head-shell sensor holder covering a region between F3 and P3 and centered around C3 (naming as 10-20 system of EEG electrode placement). Measurements were performed in an Ak3b magnetically shielded room with a static magnetic field below 20 nT in the measurement volume. The OPM-MEG signal was recorded as subjects performed a listening and finger tapping synchronization task. Stimuli were clicks (80 dB, duration 20 ms) presented binaurally via tube earphones. In a second paradigm 250 pure 1 kHz sine tones were presented (500 ms duration, 90 dB). OPM signals saturated if the OPM sensitive direction pointed in the vertical direction of the room, this did not occur for the in plane directions.

The data showed the M100 brain response 100 ms after stimulus onset for the pure tones, the cognitive paradigm with the click tones did not yield a clear M100. The M100 of the click tones was observed before in an SQUID-MEG study. This suggests, that the signal-to-noise ratio is still lower for the OPMs in these pilot measurements. Nevertheless the anatomy derived individualized sensor holder provided comfortable measurement with on-scalp sensors.