Optimal positioning of limited number of OPM sensors in MEG

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Standard magnetoencephalographic (MEG) systems are based on a large arrays of SQUIDs (superconducting quantum interference devices) that measure MFMs (magnetic field maps) produced by electrical currents in the brain. These systems need expensive cooling and have fixed sensor locations. As an alternative, OPMs (optically pumped magnetometers) operate on the room temperature and can be placed individually much closer to the head surface. In the standard MEG recordings, we typically encounter the problem of redundancy and uniqueness of signal information contained in a large number of sensors. In this study, we applied the iterative statistical technique (IST) developed by Lux [1] to estimate a transfer matrix that optimally determined measured MFMs from a limited array of measuring channels. This estimator minimizes the RMS error of the estimated map and is based on iteration where on each step the channel that has the highest correlated power with all other channels is selected. We first apply IST on data sets of 14 AEFs (audio evoked fields) measured on 8 healthy volunteers by SQUID MEG system consists of 125 gradiometers measuring only radial component of the magnetic field normal to the head surface. Since we have not had enough OPMs yet to measure full MFMs, we made simulation of OPMs detecting both radial and tangential components of the magnetic field on 80 measuring sites close to the head surface. Simulated OPM MFMs were calculated from MNE (minimum norm estimation) of current distribution of the brain surface calculated from MFMs measured by SQUID MEG system. We have tested IST on various protocols, like taking into account the whole head MFMs or only one side of the head, measuring only one component or combination of both for OPM data, fixing some measuring sites in advance, etc. In all cases we found than most of the information content is in the first 15 to 20 optimally selected channels. The database of our study consisted of measurements and simulations of AEF signals, which have mainly focal origins. The natural extension of this study could include signals that have more complex sources.

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