Application of EEG/MEG analytical methods to magnetic nanoparticle imaging

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Imagining of magnetic nanoparticles (MNPs) is expected to be a new biomedical technique for imaging of targets, e.g. cancer cells[1]. We previously propose an MNP imaging method that uses multiple magnetic sensors; this method is referred to as "magnetic nanoparticle tomography" (MNT)[2,3]. We used multiple pickup coils, or magnetic sensors, to achieve imaging in accordance with signal processing techniques used in electroencephalography (EEG) and magnetoencephalography (MEG). In this paper, we apply the techniques and compare the imaging performances.

Figure 1 shows the experimental setup. The Resovist MNP sample containing 100 μgFe was arranged in the AC magnetic field generated using an excitation coil. The third harmonic magnetic field from MNPs were detected using 16 pickup coils. To improve the sensitivity, the cancelation circuit for the fundamental magnetic field was employed. Then, the two-dimensional concentration map of the MNP sample was obtained by solving an inverse problem. In this paper, we chosen non-negative least squares (NNLS) method and minimum variance spatial filter (MV-SF). The former one is often used in magnetic particle imaging (MPI) analytical methods[1-3], whereas the latter one is often used in EEG/MEG analytical methods[4].

Figure 2 shows the result of the reconstructed map when the MNP sample was set at $(x, y, z) = (0,0,-25\ \text{mm})$. As shown in Fig. 2(a), a sharp signal peak is observed in the vicinity of the sample position using NNLS method, however, several artifacts also appear. In contrast, as shown in Fig. 2(b), the signal peak is observed in the vicinity of the position and the artifacts do not appear using MV-SF. The result indicates that EEG/MEG analytical methods such as MV-SF is useful for estimating MNP sample position.

Acknowledgments
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Reference
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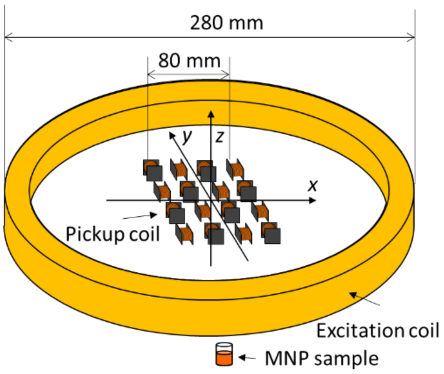

Fig. 1 Overview of the experimental setup.

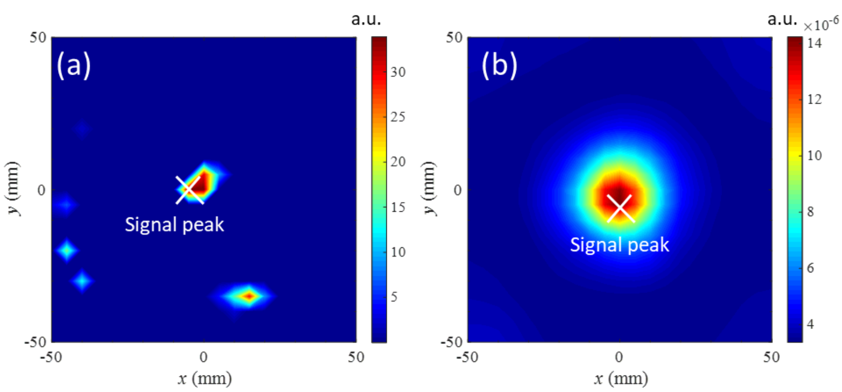

Fig. 2 Result of reconstructed map. (a) NNLS and (b) MV-SF