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Validation and Application of Realistic Head Modelling to MEG

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Introduction

While realistic head modelling is nowadays frequently applied in EEG source analysis, it is only rarely used in the evaluation of MEG measurements. One reason is the lower dependency of MEG signals on the volume conductor geometry.
However, a simultaneous evaluation of EEG and MEG is highly desirable for an accurate source reconstruction when considering the complementary strengths of these two modalities, e.g., their sensitivity to different source orientations. When aiming at a symmetric data fusion of simultaneous EEG and MEG recordings, it is necessary to simulate the magnetic field of neural sources as exact as possible. Thus, the influence of the head geometry on the magnetic field evoked by the volume (or return) currents, the so-called secondary magnetic field, should be taken into account by using realistic head models. This demands the application of numerical approaches.
Therefore, as a first step towards this goal, we investigated the accuracy of different finite element (FE) approaches to the forward problem of MEG and the influence of realistic head modelling.

Methods

Accuracy investigations were carried out in different scenarios. As a first step, we investigated the accuracy of the numerical solutions using both artificial and realistic sensor configurations in sphere models.
Subsequently, we expanded our study to realistic head models, investigating the influence of a detailed simulation of secondary magnetic fields in realistic scenarios.

Results

Using an analytical solution as reference, we show that all tested FE approaches achieve a high accuracy in sphere models for both realistic and artificial sensor configurations. Furthermore, our results indicate that realistic head modelling has a non-negligible contribution for realistic sensor configurations, especially when aiming at a symmetric data fusion of EEG and MEG.