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Docent Hannu Eskola Appointed as Associate Professor of Medical Electronics

Dr. Tech., Docent Hannu Eskola was appointed by the Governing Board of Tampere University of Technology as Associate Professor of Medical Electronics on 16th January, 1995.

Hannu Eskola was born in 1954, received the degrees of MSc (Eng) and Dr. Tech. in 1979 and 1983, respectively. Since 1980 he has served as hospital physicist for 9 years at Tampere and Kuopio University Hospitals, 1990-91 he served as Acting Professor of Bioelectromagnetism at the Ragnar Granit Institute. He has held several part-time teaching positions and has conducted several large projects in the field of bioelectromagnetism. He also has the competence of hospital physicist.

Hannu Eskola is a member of the Board of Finnish Hospital Physicists and the Qualification Committee of Hospital Physicists. In 1989-1994 he served as Treasurer and Member of the Board of the Finnish Society for Medical Physics and Biomedical Engineering.

Associate Professor Eskola's special research interests are in modelling of bioelectric and biomagnetic phenomena. He has been active mostly in the field of clinical neurophysiology. He has published about 80 scientific publications and 20 teaching materials and reports.

Ragnar Granit Institute Started its Activity in the Research Center of the Finn-Medi Technology Center

On 10.3.1995 the Ragnar Granit Institute celebrated the official opening of its research laboratory at the Research Center of the Finn- Medi Technology Center.

The Finn-Medi Technology Center building was completed at the end of 1994. It is located at the Tampere University Central Hospital and is connected to it through a corridor. In this building there is located a Research Center where a total area of some 1000 m² has been allocated for three co-operating partners: Tampere University of Technology, Tampere University Hospital and the State Technical Research Centre VTT. The Ragnar Granit Institute is located in the area reserved for the TUT which is about 350 m². In this space there are 5 offices for scientists, four large research laboratory rooms, a seminar room for some 35 people and some storage rooms. For the common use of all the three partners there is also a meeting room and coffee room.

It is planned that the four laboratory rooms will be equipped with good facilities for research on bioelectromagnetism. These will include: neurophysiological, electro- magnetocardiological and multimodality imaging laboratories. The equipment should be bought jointly by all the co-operating partners for common research projects.

In the Finn-Medi building there are also located neurophysiological and cardiological laboratories of the Tampere University Hospital, research facilities of Tampere University, and activities of the Finnish Red Cross. Space has also been reserved for high technology industry.

Research Projects at the Ragnar Granit Institute: 4. The Ability of the EEG and the MEG to Focus their Measurement Sensitivity

Introduction

It is generally believed that because the skull has high electric resistivity but is transparent to magnetic field, the EEG would be worse in focusing its sensitivity in a small region than the MEG. We have calculated the ability of both techniques to focus their measurement sensi tivity in the brain region using the inhomoge neous spherical head model.

Method

We have defined the concept of half-sensitivity volume (HSV). This is the volume where the magnitude of the measurement sensitivity is one half or more of the maximum sensitivity in the source (brain) region. This is a figure of merit indicating how well the sensitivity is focused. This calculation method gives the result on the superficial region of the cortex.

We calculated the HSV for different EEG and MEG leads as a function of electrode dis tance and gradiometer baseline (Fig. 1). The EEG leads were two- (Fig. 2) and three electrode leads with point-electrodes. The three- electrode lead is formed by one electrode at the center and two electrodes symmetrically on both sides connected together as the other terminal. The MEG leads were axial and planar gradiometers with 10 mm coil radii and 20 mm recording distance (Fig. 3). This recording distance is in practice the minimum which can be achieved with helmet-type MEG recorders.

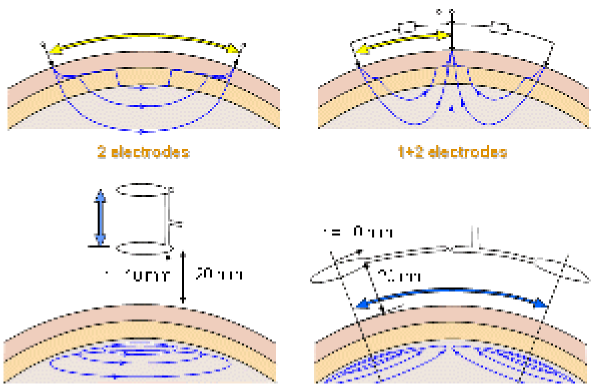

Figure 1. Variations of electrode distance for A) two- and B) three electrode EEG and gradiometer baseline for C) axial and D) planar gradiometers.

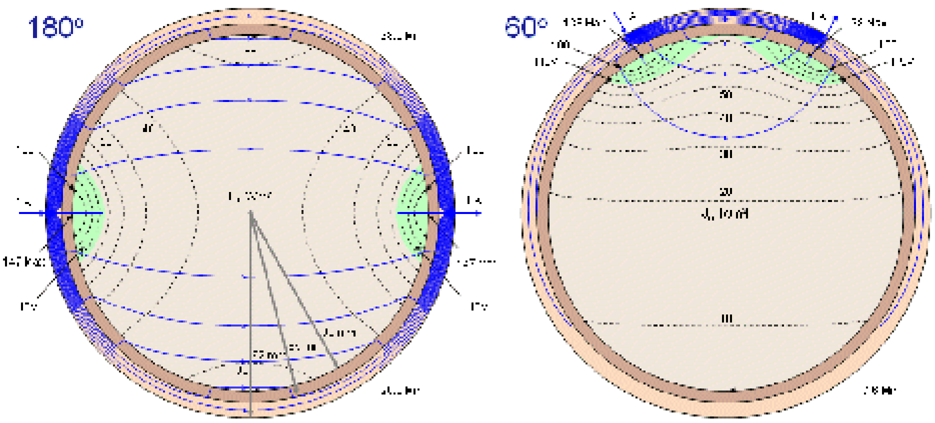

Figure 2. Lead fields of two-electrode EEG leads with A) 180 and B) 60 degrees separations.

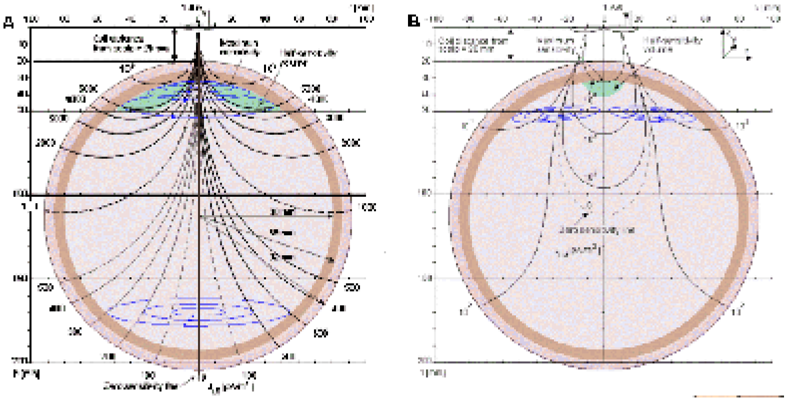

Figure 3. Lead fields of A) axial magnetometer and B) planar gradiometer MEG leads.

We also calculated the HSV for small MEG coils of 1 mm radius with short recording distances. The ultimate limit of 0 mm can never be reached with a superconducting system but a distance of 1.5 mm can be achieved with a micro-SQUID system having a very limited number of channels.

Results

The minimum HSV is, of course, achieved with shortest separation (Fig. 4). For 3- and 2-electrode EEG leads and for planar and axial gradiometer MEG leads the HSVs are at 1 degree separation 0.2, 1.1, 3.4, and 21.8 cm3, respec tively. With 1 mm coil radius and 0, 5, 10, 15 and 20 mm recording distances the HSVs are 0.2, 0.5, 1.0, 1.7 and 2.7 cm3, respectively (Fig. 5). Increasing the separation increases the HSV but it does not change significantly for recordings less than 10 separation. Short separation will, of course, also decrease the signal amplitude. The -3dB signal amplitude is reached at about 15 to 20 degree separation.

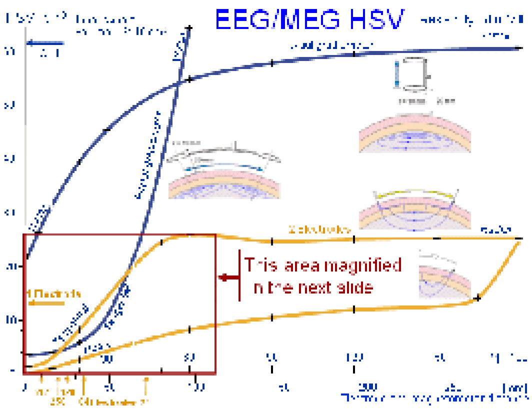

Figure 4. Half-sensitivity volumes of two- and three-electrode EEG leads and axial and planar gradiometer leads as a function of electrode distance/gradiometer baseline of 0 - 180 degrees.

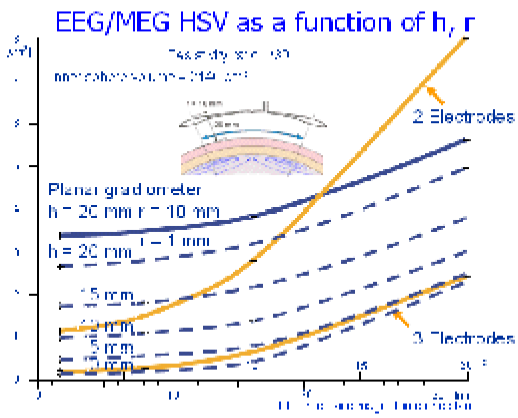

Figure 5. Half-sensitivity volumes of two- and three-electrode EEG leads and planar gradiometer leads as a function of electrode distance/gradiometer baseline of 0 - 20 degrees.

With short separation the sensitivity of the 2- and 3-electrode EEGs are mainly tangential and radial to the head, respectively. The sensitivities of both axial and planar gradiometers are always tangential to the head. Thus with the electric methods it is possible to measure all the three orthogonal components of the electric activity of the cortex, i.e. the two tangential ones and the radial one. With the magnetic methods it is possible to measure only the two tangential components. The sensitivity distributions of the two-electrode EEG and the planar gradiometer are very similar. Thus they detect very similar source distributions. The sensitivity distribution of the axial gradiometer has the form of a vortex and is thus different from those of the planar gradiometer and the electric methods.

Conclusion

Under 20 mm separation the EEG has smaller focus than the whole-head planar gradiometer MEG system and EEG is thus able to measure the electric activity of the brain from a more concentrated region. To reach the HSV of the 2-electrode EEG with the shortest separation, less than 10 mm recording distance has to be used with a planar gradiometer of 1 mm coil radius. This is not possible to realize in whole-head MEG measurement systems.

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