The RAGNAR GRANIT

INSTITUTE NEWS

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Season's Greetings

The personnel of the Ragnar Granit Institute thank all their friends for good co-operation during 1997 and wish everyone a Merry Christmas and a successful New Year 1998.

Information on Contributions of the RGI to Bioelectromagnetism

RGI has opened a Web Page which includes information on the contributions of the RGI to the field of bioelectromagnetism and other subjects. It also includes a column entitled *"Tutorial Lectures and Scientific Contributions of the RGI on Bioelectromagnetism"*.
www.cc.tut.fi/~malmivuo/BEM/bem.htm.

2nd International Conference on Bioelectromagnetism in Melbourne, February 1998

The 2nd International Conference on Bioelectromagnetism (ICBEM) will be held at Monash University in Melbourne, Australia 15.-19.2.1998. President of the Conference will be Professor **Irena Cosic**. The Conference will be organized under auspices of the International Society for Bioelectromagnetism (ISBEM) and in co-operation with IEEE-EMBS and IFMBE. Professor **Jaakko Malmivuo**, President of ISBEM serves as Co-Chairman of the Scientific Committee and Member of the International Advisory Committee. The First ICBEM was organized by the RGI in June, 1996 in Tampere.
www.monash.edu.au/oce/icbem.htm

4th Ragnar Granit Symposium on Bioimpedance

The 4th Ragnar Granit Symposium, entitled "*Bioimpedance, New Promises*" took place on 9. - 10.10.1997. The Chairman of the Organizing Committee was Dr **Jari Hyttinen** from the RGI. The Symposium was held at the RGI's Biomedical Engineering Research Center. It was organized in co-operation with the Finnish Society for Medical Physics and Medical Engineering and the RGI.

Some 30 persons participated in the Symposium. In addition to the Finnish speakers, the international invited speakers were Professor **Brian Brown** from Sheffield, England and Professor **Jüri Vedru** from Tartu, Estonia. The Proceedings of the Symposium will be published and will be available from the RGI.

5th Ragnar Granit Symposium on Volume Conductor Modelling

The 5th Ragnar Granit Symposium was held in Chicago on 29.10.1997. Its subject was *"Modelling the Electric and Magnetic Fields of the Thorax and the Head"* and it was organized as a Workshop preceding the Annual Conference of the IEEE-EMBS. The Chairman of the Organizing Committee was Professor **Jaakko Malmivuo**. It was organized in co-operation with the International Society for Bioelectromagnetism.

Some 35 persons participated in the Workshop. The lecturers were experts from USA, Canada, The Netherlands and Finland. Thee Proceedings of the Workshop will be published and will be available from the RGI.
www.cc.tut.fi/~malmivuo/CHICAGO/index.htm

Rami Lehtinen Defended his Doctoral Thesis

On 14.11.97, Lic.Tech. **Rami Lehtinen** defended his Doctoral Thesis entitled: "*Improved Detection of Coronary Artery Disease by Computerized ST-Segment Depression/Heart Rate Analysis of the Exercise Electrocardiogram*". Professor, M.D. **Markku Nieminen** from Helsinki University and Associate Professor, Ph.D. **Leif Sörnmo** from Lund University served as examiners. Professor **Jaakko Malmivuo** served as Custos.

In this research work it was developed a significantly better method to diagnose the ischemic heart disease with a computerized analysis of the exercise ECG-test. When the diagnostic performance of the exercise test has until now been about 70-75%, this new method, called ST/HR-hysteresis, achieves a diagnostic performance of 89%.

The results were obtained with a clinical population consisting of 444 exercise-tested patients and subjects; 162 patients with coronary angiography-proved significant coronary artery disease, 221 patients with low likelihood of CAD, and 61 middle-aged asymptomatic subjects. The results of this research will be tested in an international multicenter study.

Three Licentiate of Technology Degrees Completed at the RGI

Jafar Keshvari 25.4.1997. "*An Eccentric Spherical Model with Analytical-Mathematical Method to Study DC Potential Distribution around the Eye.*"

Pasi Kauppinen 25.4.1997 "*Measurement Properties of Impedance Cardiography - FDM Computer Model Studies.*"

Tomi Kauppinen 13.6.1997. "*Comparison between Iteration and Back-projection based on Emission Tomography Reconstruction Methods.*"

Survey of Persons having Studied Biomedical Engineering at the RGI since 1976

We make a survey of those persons who have studied Biomedical Engineering at RGI since 1976. Their total number is 275. The review's purpose is to find out

- how fast the persons were employed
- the type of the persons' employer
- location of the employer
- position and duties of the persons
- how their education meets their duties
- general comments and feedback.

We received replies from 206 persons (75%). Of those who replied, almost one half is working related to the field of biomedical engineering. The other half is working mainly in electronics and telecommunications.

Half of the persons got their job from Tampere Region. Half of the rest got a job from Helsinki Region, half of the rest from Turku. And the rest were scattered throughout the world.

The total numbers of various theses and degrees made at the RGI since 1976 are: M.Sc.(Eng.) 140; Lic.Tech.18; Dr. Tech. 6; Ph.D. 1 and in addition: M.D. 2.

The survey is being performed by Lic. Tech. **Jari Viik**. Detailed results will be published as Reports of the RGI, both Finnish and English editions. The report may be subscribed from the Institute Secretary Soile Lönnqvist. It will also be available on the Web at the BEM Info.

Survey on Clinical Studies Comparing EEG and MEG

The RGI has made a survey of clinical studies comparing the diagnostic performances of EEG and MEG. The motivation for this came from our theoretical work, where we compared the sensitivity distributions of EEG and MEG in a spherical model: J. Malmivuo, V. Suihko and H. Eskola: "*Sensitivity Distributions of EEG and MEG Measurements.*" IEEE TBME 44/3, 1997, pp. 196-208. (See also RGI News, Vol. 2, No 1. 15.03.1995.)

In this work we published two results which contradict the general ideas about the properties of EEG and MEG:

1) *It is believed that because the skull is transparent to magnetic fields, the MEG should be spatially more accurate than the EEG.*

By using the half-sensitivity volume concept we found that planar gradiometer MEG has about the same spatial resolution as the EEG. MEG using axial gradiometer is an order of magnitude worse in spatial resolution.

2) *It is believed that the MEG measures a source complementary to the EEG.*

In 1987 we published the sensitivity distributions of axial and planar gradiometers (J. Malmivuo, J. Puikkonen, "*Sensitivity Distribution of Multichannel MEG Detectors*", in Abstr. 6th Internat. Conf. Biomagnetism, Tokyo, 1987). This article demonstrates that the sensitivity distribution of planar gradiometer MEG closely resembles that of EEG. Thus the planar gradiometer MEG does not detect a source complementary to that of the EEG.

In addition to these two results, four other features of the MEG are not very favorable:

3) *In the MEG there is no need to fix the electrodes on the patient's scalp.*

This benefit is marginal. Today, in EEG recording, a specific electrode cap is used which enables some 100 electrodes to be attached within 10 to 15 minutes. When using two electrode caps, electrodes can be attached to one patient while another patient is measured. Furthermore, the electrode cap gives rather good freedom for the patient to move the head. The MEG dewar fixes the patient's head to a certain position and orientation.

Today, MEG manufacturers provide an option to measure the EEG simultaneously with the MEG. Thus the EEG-electrodes are also fixed when using the MEG.

4) *The MEG measures only the two tangential components of the bioelectric source while the EEG measures all the three orthogonal components, including the radial one.*

All these three components can be measured separately with different EEG leads. Obtaining more information from the source with the EEG measurement is clinically favorable.

5) *The MEG can be measured only in a specific magnetically shielded room.*

It is the magnetically shielded room which limits the application of the MEG to a specific laboratory environment. Due to the physical size of the MEG instrumentation this shielded room must be so large that it does not fit to the normal hospital floor height but needs a special room which is usually located further away from the clinic of neurophysiology.

The EEG can be easily recorded anywhere and the recording can be sent for analysis on diskette or in real time if the computer facilities and the expertise are not available at the recording site.

6) *MEG instrumentation is at least an order of magnitude more expensive than the EEG instrumentation with the same number of channels.*

If the EEG is measured in connection with the MEG, the same computer and software facilities can be used. The higher price of the MEG comes from the additional cost of the superconducting coil system, the helmet type dewar, its gantry, the liquid helium supply, the magnetically shielded room and the special laboratory space it needs.

Observations (1) and (2) were obtained with a theoretical study. The rest are self evident disadvantages due to the different technology in the instrumentation. To justify the higher price of MEG instrumentation there should be clinical evidence of its superiority at least in some areas of neurophysiological research and clinical diagnosis.

In the clinical sciences the properties of a diagnostic method or the therapeutic effect of a medicine must be investigated with patient groups which are large enough to fulfill statistical criteria. Usually a group of 100 normals and 100 patients in each disease category is considered adequate. In some preliminary tests the number may be 20.

This is the reason why we wanted to conduct the survey and identify such studies in which the properties of the EEG and MEG are compared in a scientifically adequate clinical study. To our great surprise we found that, though over 40 large scale MEG installations exist in the world, **there is not even a single clinical study which compares the diagnostic performance of the EEG and the MEG even with groups of 20 normals and 20 patients!**

Because the theoretical studies and comparisons of the technical properties of these methods give a good reason to suspect that the MEG perhaps, is not significantly better diagnostic method than the EEG despite of its higher price, the properties of these two methods should be compared urgently in adequate clinical studies. Otherwise there is a risk that we will loose the support of neurologists and other physicians for MEG. There is also a risk that the companies manufacturing MEG instruments may loose customers and MEG research groups may loose financial support for their research.

The situation with magnetoCARDIOgraphy seems to be more favorable. The only study on MCG which has a clinically adequate number of subjects has been done at the RGI: Sakari Oja: "*Vector Magnetocardiogram in Myocardial Disorders*". Acta Universitatis Tamperensis Ser. A, Vol. 382, 1993 (MD Thesis). It shows that combining the ECG and the MCG may decrease the number of incorrectly diagnosed patients by one half. Analyses were based on a material of 290 normal subjects and 259 patients with different diagnostic entities.

We would like to draw your attention to a more detailed discussion of these topics in the Web at the address provided by the RGI: *www.cc.tut.fi/~malmivuo/BEM/bem.htm*

Jaakko Malmivuo