

BEMS 2001

Otto Petrowicz

23th Annual Meeting of the Bio

BIOTECHNOLOGY

Preliminary remarks

This year's annual meeting of the Bioelectromagnetics Society (BEMS 2001) took place from June 10-14, 2001, at the home turf of the association, that is, in St. Paul, Minnesota, U.S.A. The congress bore the stamp of the current president Frank Barnes and the Technical Program Chair John Male.

The latter described the current situation of the BEMS as follows: 'The BEMS was founded at a time when research in the area of bioelectromagnetics to a huge part was based upon uncertainties concerning the question whether electromagnetic field or radiation exposure caused by men possibly is a health risk. Twenty years after we still are not certain about this. We know that there are effects and the challenge is to understand reason and significance of these effects. For example, we know very little about basic mechanisms of therapeutical use of pulsed fields; we have no exact knowledge of the impact of strong magnetic fields on biochemical reactions and cell function; so far, there are only a few theoretical approaches. On the experimental side, research in future will be influenced by the spectacular new biotechnologies of genome and protein research.'

In his introduction, John Male emphasized the fact that the meeting deliberately was held on a smaller scale also shown by the following BEMS statistics. The overproportional student participation in lec-

tures and poster presentations resulted in a strong competition for the student awards pointing to a new future research interest (see table 1).

The trend towards less lectures of the previous three meetings was confirmed. This time also the number of poster presentations was considerably smaller. Whether this was a consequence of the lack of national/state support or of the high dollar exchange rate is not clear. Concerning the distribution of plenary lectures, lectures and poster presentations of the individual countries there was not much change compared to past annual meetings. In this report, we abstain from the usual direct comparison of U.S. contributions to those of the rest of the world; instead the following table gives a survey of contributions from the various countries. Table 2 is meant to give an impression of the different scientific activities of individual nations in the area of bioelectromagnetics.

As expected, 1/3 of the contributions came from the United States, leading by a wide margin followed by Japan (13%) and, amazingly, by Germany (with 7% of total contributions). Thus, EU contributions with a total number of 70 were nearly as much as those from the United States, a remarkable trend of research efforts. Equally remarkable is the development in countries like Russia and China that show an enormous increase of presented contributions.

electromagnetics Society

Topic foci

As already mentioned, the number of submitted contributions of the BEMS annual meeting 2001 was smaller than before. The centre of attention were three topics:

- Effects of RF and microwaves on the blood brain barrier
- bacteria biofilms and their relevance in medicine; the impact of ultrasound and magnetic fields on this phenomenon
- the controversial discussion of possible DNA damages and development of micronuclei caused by high-frequency fields and microwaves.

Further issues were

- epidemiology
- human and animal experimental studies
- risks of mobile communication
- genotoxicity
- HF dosimetry
- cells and tissue ELF/HF
- medical applications
- models and mechanisms.

The topic foci already show that also the contents of the meeting was more limited also having consequences for the duration of the meeting. Two sessions each took place simultaneously. In total there were 3 plenary sessions and 15 regular sessions, plus two sessions for poster presentations.

Table 1
BEMS statistics - Overview BEMS 1994-2000

	1994	1995	1996	1997	1998	1999	2000	2001
	Copenhagen	Boston	Victoria	Bologna	St. Pete	Long Beach	Munich	St. Paul
mini symposia/ Workshops	2	2	2	28 with 179 lectures	3	3	1	IEEE COMAR Air Force
plenary lectures	-		4	12	2 with 9 contributions	11	3	3
tutorial		2						
lectures	198	122	94	168	86	98	107	92
posters	201	280	238	304	203	170	227	139

symposia/workshops, plenary lectures and poster presentations since 1994 in Copenhagen until this year's event in St. Paul (Minnesota)

Table 2
**Overview contributions
by countries**

Country	lectures	posters	total
U.S.A.	42	36	78
Japan	6	26	32
Germany	7	9	16
Italy	6	5	11
Russia	3	8	11
Canada	67	4	10
United Kingdom	1	9	10
China	2	7	9
Finnland	2	7	9
France	2	7	9
Schwitzerland	7	2	9
Sweden	2	4	6
Norway	1	2	3
South Korea		3	3
Mexico		2	2
Austria	1	1	2
Taiwan	1	1	2
Hungary		2	2
Australia		1	1
Belgium		1	1
Denmark	1		1
Portugal	1		1
Spain		1	1
South Africa	1		1
Ukraine		1	1
Total	92	139	231

Here, we must point to the fact that this report can only refer to those topic sessions the author was able to participate in (that is, not with the events simultaneously taking place). Consequently, the main foci of this report are the following:

- plenary sessions
- blood brain barrier
- epidemiology
- exposure and risk assessment
- human studies
- mobile communication technology
- medical applications
- high-frequency dosimetry.

Preferably, the topic area of mobile radio, that is, the different aspects of high-frequency research, are discussed, added to reviewing important contributions in the area of the low-frequency range (ELF).

Plenary sessions

Magnetic field effects on enzymes and other biological systems: Mechanisms of the radical pair recombination

On the whole, this very theoretical survey contribution gave cause to some doubt concerning the actual relevance for potential health detriments. Even if the effect of radical pair recombination (concerning the low-frequency range) - also of low intensity (< 1 mT) - is one of the best understood mechanisms of biological systems, there are still many unresolved questions (see report prepared by Prof. Glaser. p. 2).

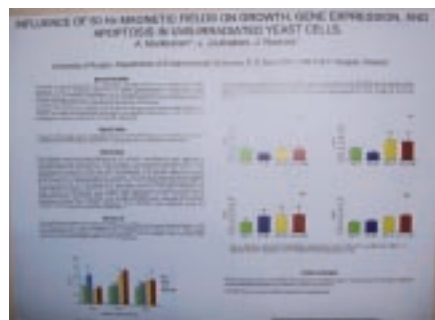


**„All the Bells and Whistles“:
New and revised technologies in the
area of genetic toxicology**

The response of the organism to the increasing number of different environmental agents will mainly occur in the form of cell reactions within the organism. Dr. Ford, the lecturer, via the example of ionising radiation effects to show the response at the respective site as well as possible consequences considering the highly sufficient compensation mechanisms of the whole organism. In view of the high costs of in vivo studies, the lecturer thinks of in vitro experiments as an alternative to learn about dose-dependences and consequences of exposure to environmental agents.

The increasing pressure on research coming from the public to identify environmental dangers - at very small doses as well - requires the application of very refined methods of high sensitivity, of ever increasing interaction range as well as of high statistical solidity.

In his survey, Berry Ford dealt with most recent cell biological methods considering these requirements. Correspondingly, modern array technology is capable to simultaneously analyse 100 up to 10,000 genes. Examples are cDNA expression arrays and protein-based arrays for gene expression analysis. However, not only newly developed analysis methods were presented, but also already introduced techniques adapted to new methods and technology were



referred to, f.e. microfluid and microanalysis method, an outstanding new application of two-dimensional protein electrophoresis of high replicability allowing semi-automated analysis. PCR-based gene analysis methods, too, have been adapted to most recent technical possibilities using semi-automated primer design and mass spectrometric analysis.

As a problem of the new genomic and proteomic technology is seen the lack of evidence of dependence of the gene expression, the protein expression as well as the protein function analysis.

In summary, B. Ford pointed to the achievements so far made, i.e. the enormous improvement of cell biological methods concerning sensitivity, quantitative selectivity (power) and the reduction of material available for analysis up to the single cell. But is this really an advantage in every respect? Increase of sensitivity just did lead to an overestimation of risks and consequences in environmental research. This is shown clearly by public response jumping to conclusions on experimental results f.e. of gene expression caused by EM fields without having information on exact scientific context and interpretation. Such results provoke strong negative reactions up to real fear, anger and distrust. But it is indispensable to precisely understand and correctly interpret effects. Therefore, B. Ford concluded with the suggestion to redefine the term 'no effect level' thus adapting it to new sensitive methods.

**From Frankenstein to the
pacemaker: Reflections on the
history of electricity and life**

This survey lecture rather was a philosophical approach to analyse the achievement of civilisation called 'electricity' and a reflection on its advantages and disad-

vantages as a concrete aspect of the issues in question. The title was deliberately chosen controversial: „From Frankenstein to the pacemaker’. Frankenstein, a monster from English literature created in a ‘cloud of magnetism’, was compared with one of the highest-ranking achievements of medicine, the cardiac pacemaker. Its impact occurs at the interface of electricity and heart, the ‘organ’ representing life more than any other organ. The lecturer David J. Rhees gave a in-detail survey of the meaning of electricity in the history of medicine and pointed to the advances made in the development of cardiac pacemakers and other biomedical technologies. A consequence of these new technological achievements was the uncritical belief in the ‘power of science’ being as naive as the „Frankenstein myth’ itself.

Lecture sessions and poster presentations

Radio frequencies and the blood brain barrier

Especially the symposium around the topic of altered permeability of the blood barrier brain roused great expectations - a topic gaining a lot of attention in the public and discussed very controversially.

First research approaches dealing with altered permeability within the vascular system of the brain at EMF exposure were developed in 1973 by Polyaschuk in the former USSR. Further studies followed in 1975 conducted by Allan Frey and being published in the *Annals of the Academy Press*, New York. Until today around 30 scientific studies were published on this topic. The increase of permeability of the vascular wall concerning f.e. hormones, proteins and peptides passing from blood to the brain is the consequence of an established thermal effect of high-frequency fields. There is also the thesis that also



RF fields of low and very low intensity lead to this effect, too.

A variety of methods was presented giving evidence for the passage of non-physiological matters from the vascular system. A further important aspect was the many methods to affect permeability like f.e. hypertonic NaCl solution, urine matter, heat etc. Of special relevance in this context are tests on horseradish peroxidase. The main focus is on albumin passage - a natural protein with a molecular weight of 69 kD (kilo Dalton) - into the brain, particularly as in certain organs like the lungs it is easily capable to leave the vascular system under physiological conditions as well and to spread in interstitial space. Histological proof of a deposit in the brain were presented. There is also evidence for reverse diffusion of albumin to the vascular system after 20 to 30 minutes. Still unresolved is the question of health relevance of this temporal effect which is generally classified as a thermal

effect. Contrary results were presented by a Swedish study of the workgroup around L.G. Salford detecting an albumin absorption in the brain also at very low SARs of 0.02 W/kg. The study among other things dealt with the question which consequences repeated exposure of the brain caused by the use of mobile phones could have:

- Is there an area within the brain where albumin and smaller molecules including toxic molecules can deposit? If so, does this deposit with time will be a danger?
- Does the increase of permeability lead to autoimmune diseases like f.e. multiple sclerosis?
- Can dendritic bindings be disrupted (Morbus Alzheimer)?
- Can transmitter systems within synapses be damaged?

Here, we deal with a scenario that until now can not be definitely judged because of the contradictory results (no findings at

2 and 0.2 W/kg). It rather gives cause to misinterpretation producing uncertainty and fear in the public.

Epidemiology

Of special importance was the topic area of 'Epidemiology', this year dominated by the Mainzer Group and their 'Germany study'. In German media, this study has already been thoroughly and controversially discussed. There were two standpoints, one group interpreting results as a proof of an interaction between magnetic fields and childhood leukemia; the other saw no connection. As the authors of the study themselves admit: „In spite of the big size of the study our conclusions are based on a small number of cases. Should the detected risk actually be confirmed, the concerned population in Germany would be very small.“ (We abstain from a detailed description of the study and its results; for further information see the authors' report on p. 36). One should bear in mind that the general exposure of the German population - in contrast f.e. to the United States - is relatively small. Only 1.5% of the population participating in the study was exposed to magnetic fields with a field strength of >0.2 µT caused by high-power transmission lines and residential installations.

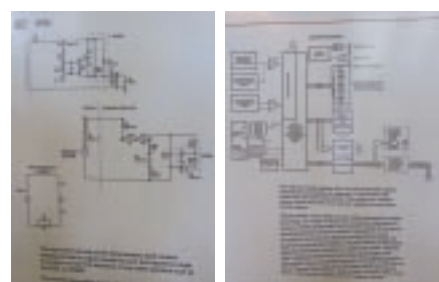
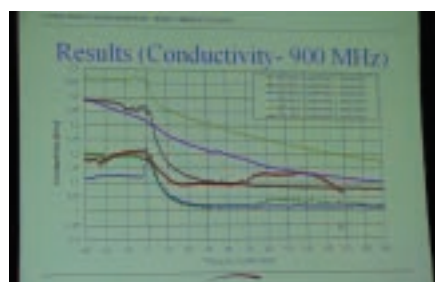
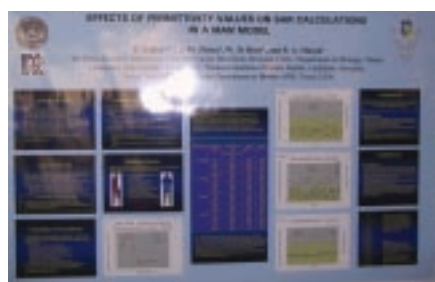
There is only a very slight association between childhood leukemia and 24-hour median magnetic field strength in the total population of 0.2 µT of OR = 1.55 and 95% CI = 0.65 to 3.67. Concerning the 12 exposed cases and 12 controls being exposed to >0.2 µT median residential M-field strength there were an OR = 3.21 and 95% CI = 1.33 to 7.8. Though these are statistically significant, because of the small case number even the authors of the study were very cautious in drawing conclusions.

Further contributions were:

- 'Occupational exposure in Denmark to ELF magnetic fields in relation to casualties caused by neurological diseases'; no association was shown, except concerning Morbus Alzheimer in men and women as well as amyotrophic lateral sclerosis (ALS). For Morbus Parkinson there was no association.
- The 'Study on cancer initiation in the vicinity of high-power transmission lines considering wind direction' already presented in Munich showed a statistically confirmed different incidence of exposed population upwind versus those downwind concerning cancer localisation in mouth and lungs, however no association with stomach and colorectal tumors. Presently, the study is extended to regions in England and will ultimately include 4.9 mil-

lion people. A considerable decrease of the 95 % CI and thus improved statistical results are expected.

- Traditionally, the workgroup from Boulder, Colorado, on the analysis of side effects or 'confounders' during determination of ELF-exposure-dependent childhood leukemia was present. Existing studies give the impression that exposure to volatile organic substances (VOS), that is, air pollution particles stemming from road traffic have a bigger impact on leukemia occurrence than ELF fields per se. Another assumption was that also a combination of environmental pollution among others with mobile phones, ELF fields and other risk factors of daily life play a role here.
 - Two contributions dealt with occupational exposure; further there was a methodological contribution (dosimetry) on better assessment - both prospective and retrospective - of field exposure in power station workers.
 - Apart from that, there was a study in garment workers supposedly exposed to considerable 50/60-Hz fields. Contrary to the expectations of the scientists, only magnetic flux densities between 0.45 and 1.7 µT were detected.
- Few studies shown in poster presentations were of relevance. One study observed leukemia incidence in infant in-



bators. However, there was only weak evidence of an existing risk.

In addition to the presented study on the impact of wind direction a poster gave further information on higher incidence of mouth and lung cancer near high-voltage transmission lines and heavy current facilities. As a possible cause for this air ionisation is suggested.

Exposure and risk

With two exceptions, the contributions of this topic group proved to be of relative small scientific value. The topics dealt with by the group around Niels Kuster of ETH Zürich were:

- a universally applicable flexible exposure protocol for risk studies at 1800 MHz using modulation types of very few Hz up to 5 MHz and for double-blind studies;
- optimised *in vivo* exposure set-ups for risk studies at mobile phone communication frequencies of 902 and 1747 MHz;
- criteria for the selection of specific EMF exposure conditions for bioexperiments in connection with health risk evaluation.

The rest of the lecture contributions dealt with exposure assessment of low-frequency 50/60-Hz fields, f.e. a model-orientated assessment of power density distribution of 60-Hz contact currents comparing adults

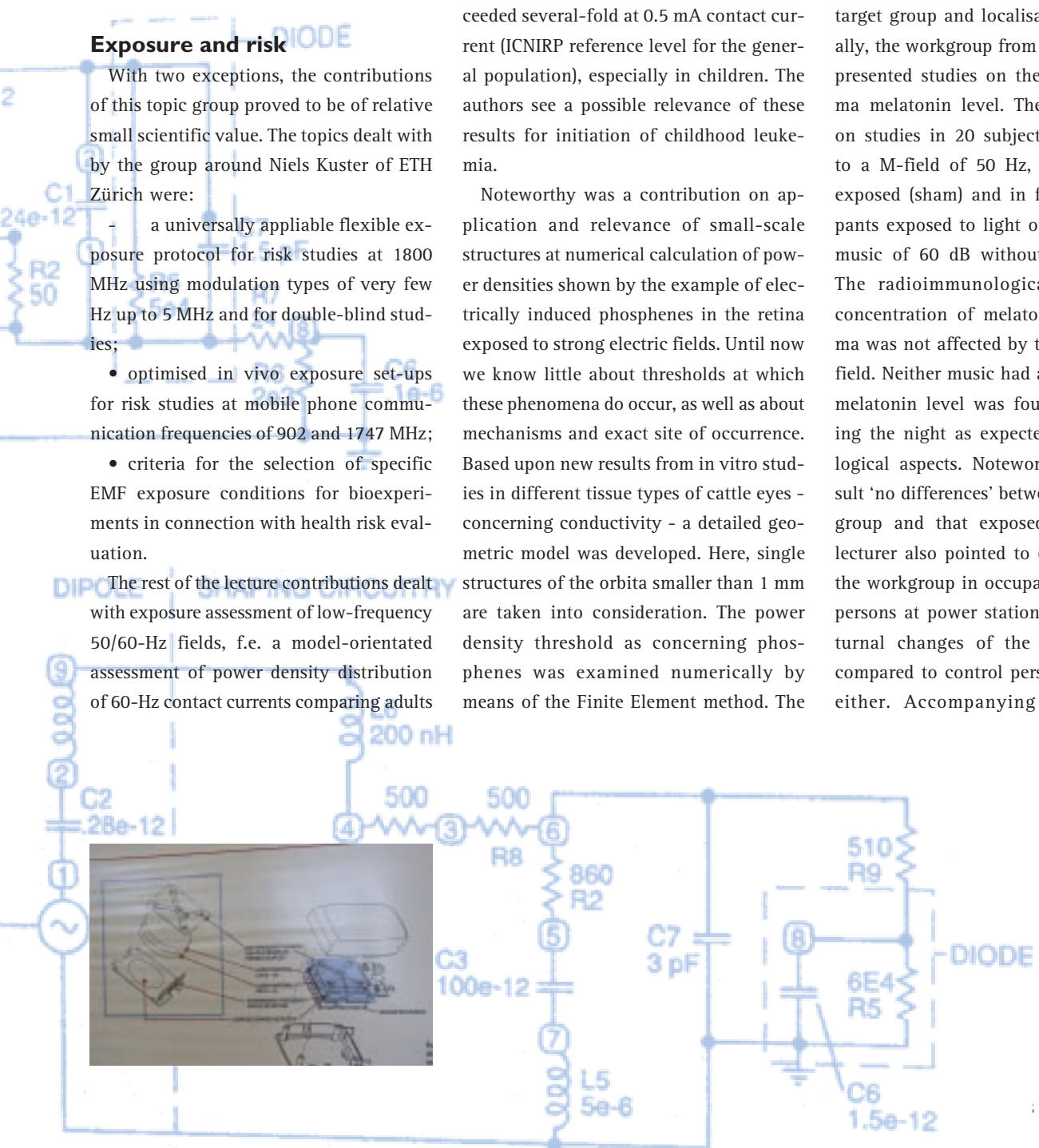
to children. The Scalar Potential Finite Element method (SPFD) was applied. As an orientation value the basic restrictions of ICNIRP guidelines of 10 mA/m² were used; power density of different contact currents at particularly concerned body areas were determined being responsible also for hematopoiesis. The derived power density limit value of 2 mA/m² can already be exceeded several-fold at 0.5 mA contact current (ICNIRP reference level for the general population), especially in children. The authors see a possible relevance of these results for initiation of childhood leukemia.

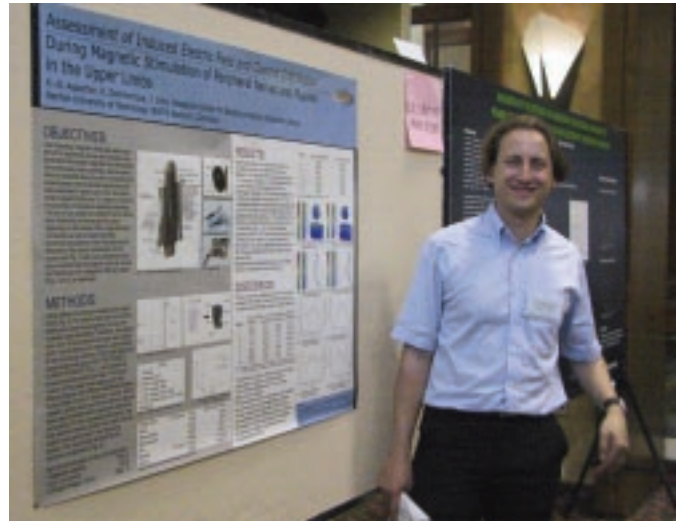
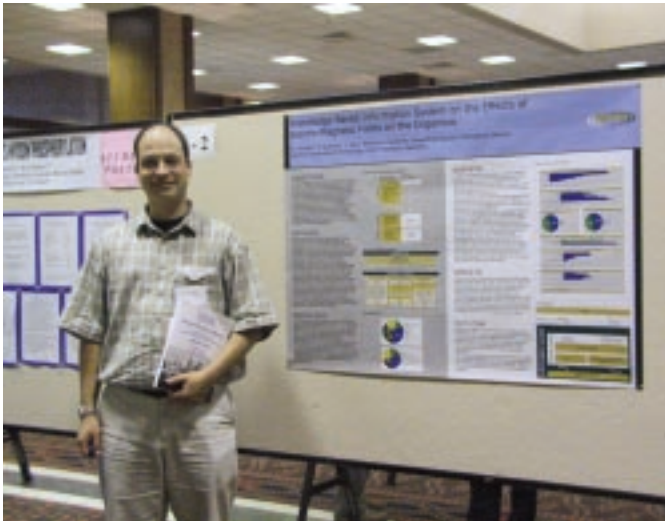
Noteworthy was a contribution on application and relevance of small-scale structures at numerical calculation of power densities shown by the example of electrically induced phosphenes in the retina exposed to strong electric fields. Until now we know little about thresholds at which these phenomena do occur, as well as about mechanisms and exact site of occurrence. Based upon new results from *in vitro* studies in different tissue types of cattle eyes - concerning conductivity - a detailed geometric model was developed. Here, single structures of the orbita smaller than 1 mm are taken into consideration. The power density threshold as concerning phosphenes was examined numerically by means of the Finite Element method. The

result was that rather small structures are responsible for these phenomena concerning power density threshold - a hitherto unknown fact.

Human studies

During this session studies on human with hugely different endpoints were presented, distinguished by frequency range, target group and localisations. Traditionally, the workgroup from Witten-Herdecke presented studies on the nocturnal plasma melatonin level. The group reported on studies in 20 subjects being exposed to a M-field of 50 Hz, 100 µT or non-exposed (sham) and in further 7 participants exposed to light of 200 lux and to music of 60 dB without field exposure. The radioimmunologically determined concentration of melatonin within plasma was not affected by the ELF magnetic field. Neither music had an impact. A low melatonin level was found at light during the night as expected under physiological aspects. Noteworthy was the result 'no differences' between field exposed group and that exposed to music. The lecturer also pointed to earlier studies of the workgroup in occupationally exposed persons at power stations where no nocturnal changes of the melatonin level compared to control persons were found, either. Accompanying cardiovascular





studies as well did not show any impact of magnetic fields.

'Standing balance' was introduced as an ideal model to examine interaction between humans and ELF magnetic fields. Standing balance is an autonomic behaviour. When standing with both legs planted to the ground, it is relatively easy to keep one's balance. However, having to stand on one leg is far more complicated. This very sensitive situation is easily affected by external stimuli, among others by ELF magnetic fields. Also introduced was a measurement system consisting of a capacity plate of 1.6 x 1.6 m by which balance shifts caused by local capacity changes can be recorded locally resolved. Amazingly, first tests have shown that balance-keeping under field conditions distinguished by 'eyes open' and 'eyes closed' improved. This was interpreted as a field effect on the vestibular system. Further studies on this subject are planned.

As during the two previous BEMS meetings this year Eleanor Adair of the Air Force Research Laboratory, Brooks Air Force Base, San Antonio, Texas, again presented studies on the turnover of irradiated energy in participants. The studies show

how input energy affects metabolism at different frequencies (100 MHz, 450 MHz and 2.4 GHz), SAR (2-4 W/kg) and surrounding temperatures (24, 28 and 31(C). The presented additional studies at 100 MHz showed only slight temperature increases, with the exception of ankles and calfs where a temperature rise up to 4(C was measured. Also a stronger perspiration at the back and an increased skin circulation compared to 450 and/or 2450 MHz was documented.

Less spectacular were contributions on pain-soothing effects at mm-wave exposure:

- studies on effects on cardiac pacemakers caused by 50-Hz fields showing that state-of-the-art pacemakers compared to earlier generations are more sensitive to E fields and that under worst-case conditions already fields of 1.5 kV/M RM-S can lead to interferences.
- studies on effects on visual sensitivity of strength and direction of the geomagnetic field.

Also worth mentioning is a contribution on a study on electrohypersensitivity (EHS) conducted in 28 persons claiming to be EHS. Starting point of the study were

possible effects of a 50-Hz magnetic field (0.09-0.11 μ T) on the long-term ECG (24 hs). With the exception of heart rate variability (HRV) none of the examined parameters showed differences between exposed EHS (N=14) and controls (N=14).

The 4 poster presentations of this topic area referred to following studies:

- the studies presented by Eleanor Adair;
- a study on alterations of natural killer cells in connection with the ODC activity in occupationally exposed power station workers. This study claims to be the first of its kind being able to present distinct positive findings. The result was a decrease of ODC activity and the number of natural killer cells by 20-30% in test subjects. However, the authors added that the clinical significance of these findings is unclear and that further research efforts are required.
- a study on changes of the EEG caused by special pulsed 20- μ T ELF magnetic fields in normal participants and
- a pilot study on response intervals in participants at very low field strengths of 900 MHz GSM base stations. The results showed no impact on reaction time performance.



Mobile communication

Selection and order of the contributions on this topic area amazed the audience because of the heterogeneity of the individual reports. Only part of the projects and of the information was of basic relevance.

At least there was an excellent study dealing with radiation characteristics of a mobile radio base station in a complex environment. The starting point were local conditions far removed from the required data as presented by antenna manufacturers. This has consequences particularly for persons working at controlled areas, that is, for technicians responsible for installation and maintenance of base stations. Though simulating tests using FDTD in human models both on near-field and far-field conditions exist, they are of rather general design not considering extreme situations. In contrast, the mentioned contribution simulated such extreme cases (worst-case scenario) and discussed results in connection with ICNIRP guidelines. On balance, the result was that though at highly unfavorable environmental conditions an increase of field strengths was detected, they did not exceed set thresholds.

A research contribution from Italy on base stations dealt with following aspects of base station site selection going beyond usual planning requirements:

- a minimum strain of humans and environment;
- antenna data;
- sufficient coverage;
- sufficient receiving quality;
- protection of landscape and buildings (protection of historical monuments);
- regional characteristics (residential areas, schools, hospitals etc.);
- topography (from sea level to 100 m above sea level).

The background of this study surely are planning difficulties of Italian network operators due to restrictive limit value regulations.

Here, an established calculation model from genetics was used after optimising it for this particular application. Optimisation was documented by example of the city of Ancona. There, too, was a poster providing additional information.

Of interest was the contribution of a Swiss network operator. Here, the subject was a meaningful dose determination in the living space of houses near mobile radio stations. Measuring techniques were dealt with in detail. Traditional isotropic field sensors were judged as inadequate. Better results were shown by the newly developed isotropic probe PBA 10200 of the research center Seibersdorf, Wien. Especially in closed rooms, validation showed good applicability of the antenna and the Add3D system concerning frequency selectivity, replicability and approximate isotropic character.

Quite a lot of attention attracted the efforts of MOTOROLA in the U.S. to develop dosimetric approaches for assessment of mobile phone handsets. A series of re-equipped handsets with integrated electronics was designed to detect and record various parameters of phone use. These are:

- duration of conversation;
- transmission power;
- distance to the head;
- angle towards body axis etc.

The possibilities for use are clear. This way, a great number of exposure parameters can be identified providing exact dosimetric data for epidemiological studies. Further, phoning behavior of the different users is made accessible.

In part, also the poster presentations on the topic of mobile communication and

radio broadcasting were of interest and of high information value. For the very first time, exposure data of mobile radio in Hungary were published including results of 60 sites. As expected, exposure values of the GSM applications is to be judged as very small lying below below ICNIRP recommendations also in extreme situations.

Two contributions were presented by Reg TP in Mainz - the Regulatory Authority for Telecommunications and Posts - dealing with the German site certification procedure and with the frequency spectrum the population is exposed to via radio broadcasting, television, mobile radio and other applications. The result was that at none of 3600 measured sites set limit values were exceeded. In fact, as a rule values were even several thousand times below the limit.

In a further contribution of MOTOROLA Inc. results of studies testing seven radiation shields for cellular phones were presented. The conclusion was that none of the seven shields had the effect claimed by manufacturers.

Medical applications

While during last year's BEMS meeting in Munich a minisymposium on 'Application of electromagnetic fields' took place, this year medically relevant topics played a relatively small role.

Lecture presentations referred to:

- local stimulation of neural tissue by means of non-invasive magnetic field application;
- pain treatment by use of magnetic fields;
- an electroporation method for a controlled medication via the skin;
- use of electromagnetic fields for cytoprotection and gene therapy. This is

based upon the induction of protein hsp70 produced under stress (electromagnetic fields). Here, two aspects are important. On one side, the protein develops as a general response of the cell to different external dangers; on the other side, it can be used for treatment in medicine;

- effects of low-frequency pulsed electromagnetic fields for a stimulation of osteoblast growth in vitro.

All these are highly specialized applications of electromagnetic fields that are - at least concerning magnetic field therapy - partially controversial and biologically as well as physically still only understood to a small extent. Electroporation is a well-used method in molecular biology using permeability of plasma membrane ion channels caused by high field strengths for deposition of a diversity of molecules within the cell.

Concerning the posters of this topic group the quota of cancelled contributions was especially high with 10 withdrawn or not presented contributions. In part, these were meant to add to the lectures on the topic of pulsed magnetic field therapy and application in pain treatment.

Noticeable was a poster contribution we will deal with here as a negative example. Its subject was a double-blind study examining pain reduction in arthritis patients achieved by means of a magnetic bracelet. For controls an identical non-magnetic bracelet was used. The results showed a definite improvement of symptoms caused by the magnetic bracelet. However, there are serious doubts on the double-blind approach, since magnetic bracelet and control bracelet can be distinguished by very simple methods. Placebo-controlled studies of this design, too, are highly controversial; significances thus found are not relevant concerning the issues in question.

High-frequency dosimetry

Discussed were different methods of high-frequency field dosimetry, mainly of radiation of mobile communication devices and installations (handheld devices, base stations) and their evaluation. Essential tools for detecting and quantifying EMF exposure are mathematical/numerical dosimetric models and high-developed software. However, despite theoretical and methodical refinements results of all model observations remain doubtful as long as they are not validated by empirical data drawn from in vivo or in vitro experiments.

One contribution dealt with unresolved questions of validation; as a result a distinct connection between empirical and theoretical methods was detected, as well as a sufficiently conclusive relation of SAR predictions using anatomical models of high-frequency fields based upon FDTD calculation compared to in vitro and in vivo tests. There was confirmation that the FDTD method achieves good theoretical approximation both concerning whole body and local SAR. For example, whole body FDTD determination during animal tests in rats showed a SAR 20% higher than found by calorimetric methods. However, a difference of 20% can be significant under various aspects; therefore, the euphoric reports of the lecturer must be taken with care.

A scientific analysis of dosimetric methods and tools would be incomplete without any contributions of the ETH Zürich workgroup around N. Kuster on newly developed methods and devices of his research group and cooperating firms. A new generation of FDTD modeling for analysis of bioelectromagnetic interaction phenomena as well as validation tests in phantom models for studies on mobile radio were introduced.

BEMS veteran O.P. Gandhi presented a similar contribution. Subject of his experiments were base stations of the American mobile radio (835 and 1900 MHz). At varying distances to base stations both methods (FDTD versus whole body model measurements) showed differences of 5-10% in peak SAR.

Further, realistic hand and head models were presented pointing to the possibility for an exact SAR determination by means of the Method of Moments (MoM). The basis for this is the discretisation of hand and head surfaces into dielectric areas. All in all, this method is thought to in future play a minor role in HF dosimetry compared to FDTD because of its limits.

Using the term 'exposure systems' a set-up for field exposure of rats was introduced. Irradiation occurs via a newly developed loop antenna adjusted to 900 MHz, defined and mounted on top of a chamber for small animals. By means of this system rat and guineapig SAR were examined; compared to FDTD calculations there were differences of 10-20%.

Moreover, different conditions of exposure to mobile phone handheld devices were presented, for example, temperature differences in the head during use of the handheld device and contact heat caused by pressing it to the head. There are the applied SAR and, on the other side, the non-electromagnetic heating caused by the contact between phone and skin, an effect that can be observed after long-time use of regular phones, too. However, this effect actually concerns only the head surface, whereas SAR heating can penetrate in depth.

In summary, the rest of the contributions had the - seemingly less spectacular - following contents:

- formulation and characterisation of stimulating liquids used for SAR determi-



nation in phantom experiments of frequency-dependence of reflection and absorption of mm-waves (37-75 GHz) by the human skin;

- a comparison of different E field probes for dosimetry of high-frequency E fields being available on the market.

The final lecture of this topic group should be mentioned under the aspect of the current risk discussion on mobile radio. Subject were the so-called 'hands free accessoires (HFA)'. The discussion has been spurred by studies and press releases of ERA Technology in the UK, mainly published by the Consumers' Association suggesting an increased deposition of radiation energy in the head caused by HFA. The contribution of C.K. Chou disproved this conclusion and the studies it was based upon. It showed in detail that the ERA studies were not conducted corresponding to internationally renowned methodical and technical standards.

Within this topic group a great number of poster presentations (N=14) was shown. Partially, posters illustrated the lectures. Part of them introduced new measurement

aids and field probes depicting their innovative qualities. Other contributions dealt with SAR analysis of different head models at various positions of the mobile radio handheld device, etc. A lot of information was provided on this topic area we can not deal with here because of lack of space.

However, we should mention certain study pertaining to the medical topic area; it dealt with the application of electrosurgical devices and the operating room personnel. During application (500-1000 kHz) mainly in surgery at separating tissue and coagulation of blood capillaries the applicator (surgeon) in part is considerably exposed to leads passing more or less close to his body. In contrary, the fields within the body of the patient can be neglected. Responsible for the strong emissions are insufficiently shielded lead wires. The exposure scenario can be compared to the contact current situation for which ICNIRP recommends a limit value of 40 mA at 0.5 MHz; this value overall is not reached, however power density at local sites reaches or even surmount the mentioned limit values near leads.



Conclusions

Whereas previous BEMS meetings could be characterised by a catchword or slogan, this year's meeting is not so easily described. As at previous events both good and less convincing contributions were presented. We could neither report on spectacular new studies nor on newly gained generally accepted insight on the current risk discussion. Secretly, participants reckoned on the publishing of the test replica-

tion of the Repacholi study on mobile radio and transgenic mice being conducted in Australia and Italy. This did not happen. The 'Germany study' of the workgroup from Mainz around J. Michaelis is already well-known, and we all vividly remember the controversial discussion.

Worth remembering are a few valuable contributions being fundamental for the understanding of interaction mechanisms of electromagnetic fields.

As already mentioned at the beginning of this report, this year's meeting - compared to the annual meetings having taken place since Copenhagen 1994 - so far was the smallest event concerning the number of presentations. Surely, this is not only due to the drastic cuts in the submitted contributions, but also to the difficulties caused by the very high dollar exchange rate.

Though table 1 shows the contributions as listed by the program; however, it gives a wrong impression. Whereas only few lectures were cancelled (N=6), in poster presentations 31 out of 139 were missing, that is over 20%. A somewhat depressing trend that will hopefully not continue next year.

In the end, none of the presented studies gives irrefutable proof of an acute health risk caused by field exposure below recommended thresholds, neither in the ELF range nor concerning higher frequencies, especially of mobile radio.

*Privatdozent Dr. Ing. Dr. med.
habil. Otto Petrowicz
Institute of Experimental Oncology
and Treatment Research at
the Technical University Munich*

'Mechani of high-frequency

Report from a journey to biophysics of living cells at exposure to mobile radio high-frequency electromagnetic fields (HF-EMF)

On May 22nd and 23rd 2001 the 'Seminar on Mechanisms for Interactions of RF Energy with Biological Systems' took place at Radisson Barcelo Hotel in Washington D.C. Besides a number of high-ranking biophysicists from the area of high-frequency research also biologists from the FGF were invited to the workshop as observers and discussion participants.