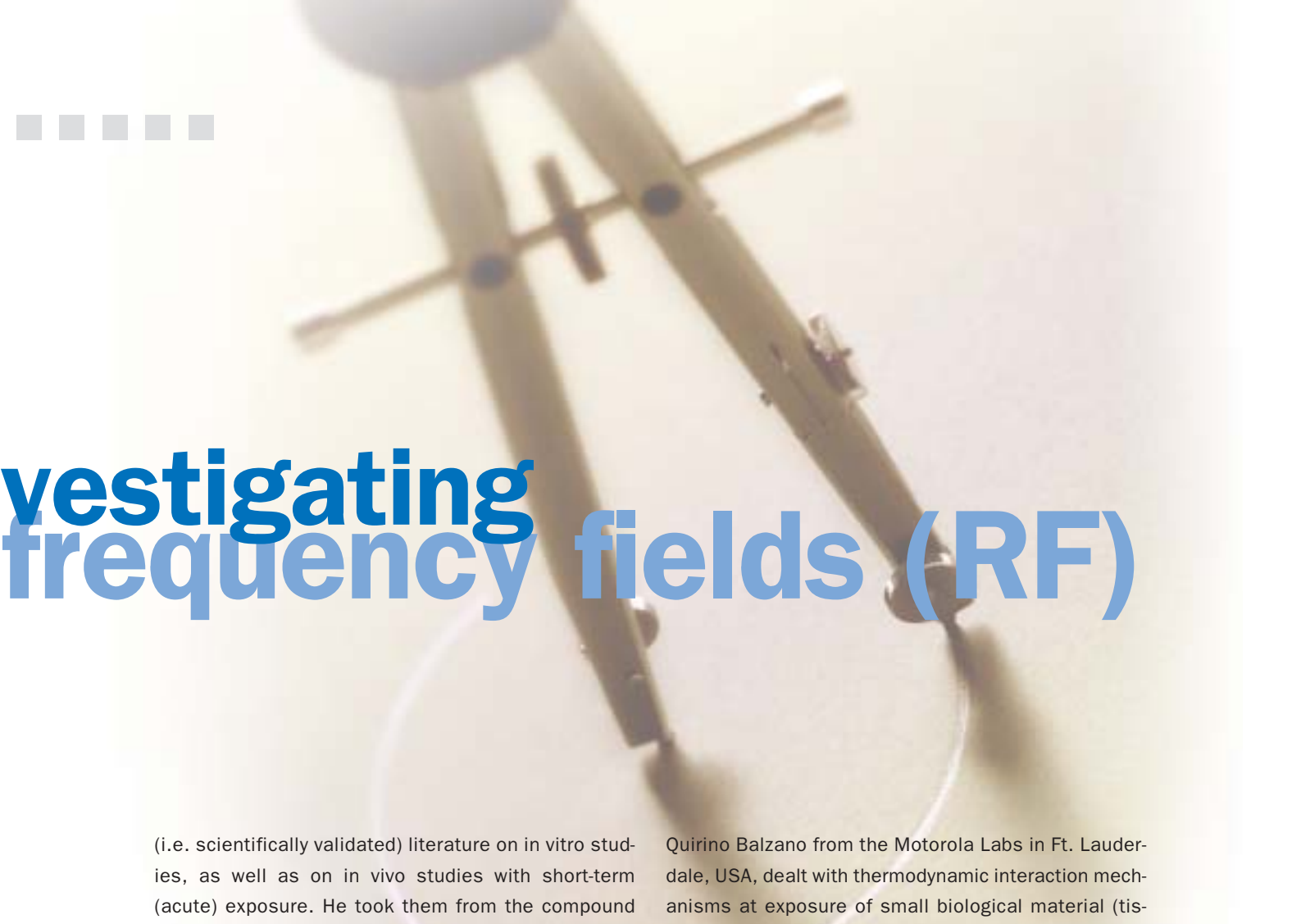
Studies in in radio

by Frank Gollnick

This session was a combination of survey lectures on the research into radiofrequency fields, a lecture on thermodynamic interaction mechanisms, dosimetrical issues, and a lecture on effects from millimeter waves.

In her survey lecture on completed EMF studies, **Cindy Sage** of Sage Associations, Santa Barbara, USA, a known mobile radio critic with her own building biology company and one of the signatories of the "Salzburg Resolution", voiced the opinion that there is a ratio of 4 : 1 of studies published in the years from 1990 to 2004 showing bioeffects of mobile radio fields of low intensity compared to studies showing no such effects (401 : 118 studies). Moreover, she claimed that chronic exposure causes stress and that there were negative cumulative effects on health. As the short lecture could only present selected examples from the corresponding literature, her argumentation could not be duly examined in this session. Sage demanded lower limits and a corresponding policy in her country. In the following discussion, the selection of literature and the presented background of demanded measures mainly caused objection among attending experts.

The literature survey lecture of **Mais Swicord** and colleagues from the Motorala Labs in Ft. Lauderdale, USA, was wholly different from her lecture. Swicord concentrated his survey on the existing peer-reviewed



vestigating frequency fields (RF)

(i.e. scientifically validated) literature on in vitro studies, as well as on in vivo studies with short-term (acute) exposure. He took them from the compound of a total of approx. 1300 studies investigating biological effects from radiofrequency fields being listed in the literature database of the WHO (World Health Organization). Single surveys showed the corresponding numbers presented by existing publications, and also those of still ongoing studies in categories with or without biological effects (as far as they were already published), as well as divided due to study results. Swicord concluded that studies done in the research fields 'DNA damages', 'gene expression' and 'blood-brain barrier' overall failed to give clear evidence of damaging biological effects from radiofrequency fields. The majority of publications dealing with these issues did not report any effects.

Similar conclusions could be drawn from the analysis of results regarding other research endpoints. Insofar, further research efforts looking for potential interaction mechanisms or possible health-detritous effects would be unnecessary.

In discussion, the incomplete selection of literature as well as drawn conclusions were criticized, same as regarding the previous lecture.

Asher Sheppard (Asher Sheppard Consulting, Redlands, USA) and his colleagues Mais Swicord and Quirino Balzano from the Motorola Labs in Ft. Lauderdale, USA, dealt with thermodynamic interaction mechanisms at exposure of small biological material (tissue parts, cells, cell components, molecules) to radiofrequency fields. They summarized the knowledge gained during various international workshops and seminars organized on the this topic in recent years, besides results of commissioned exact calculations promoted by Motorola and the MMF (Mobile Manufacturers Forum) not yet published. Among others, the following questions were asked (and answered):

- To what extent can a very small watery region (10 µm, approx. the size of a cell) be heated by field exposure? Calculations demonstrated that heat conduction in these dimensions (even at a SAR of 10 W/kg) is to fast and to effective for microscopic hot spots to develop. After not more than 3.5 microseconds introductory vibration phase, temperature increases by only 10^{-8} K (being much closer to 0 than all other temperature changes normally occurring in such cell volumes).
- Are larger molecules (macromolecules) able to selectively absorb energy from the fields used by radio applications by becoming resonant? At the nuclear level, such resonances are not possible, since adjacent water molecules damp movement too strongly. An examplary calculation for a hem-group (arranged group of atoms in hemoglobin, the

red blood dye) showed the the lowest frequency for a possible incidence of molecular resonance with approx. 150 GHz is about 100 times larger than those of mobile radio frequencies.

In summary, a number of new calculation models succeeded in demonstrating conditions under which the energy of electromagnetic fields as used by radio applications can be enhanced in tissues, cells and molecules by its multiple; however, the fast heat exchange (heat diffusion) prevents substantial local temperature increases potentially leading to biological effects. Nonlinear interactions with biological material and energy absorption through resonating molecular structures, as other suggested non-thermal effects, are highly improbable at frequencies below approx. 100 GHz. The discussion following the lecture addressed the question whether further research should more intensively investigate the subcellular level, e.g. water structure, in the shown direction. In this context, a new publication in the journal "Nature", spring 2004, was mentioned (Ritz et al., Nature 429;177, 2004), according to which the magnetic compass of migrating birds was based in chemical reaction (radical pair mechanism) potentially affected by electromagnetic fields (range up to 10 MHz).

A new approach for the development and testing of a personal dosimeter for electromagnetic fields was presented by **Joe Wiart** from France Telecom. His study radiofrequency technologically analyzed the newly developed and in the meantime commercially available portable system. The range of the device frequency seletively operating with isotrope probes comprises radio, television, GSM 900, GSM 1800 and UMTS fields. The dosimeter was tested in persons during their normal daily activity, as well as stationary.

Wiart and colleagues examined the influence of the body of the device wearers and to this end developed an own statistical method to adapt the system by calibration factors as exactly as possible to the different main characteristics of individual measured frequency bands. This statistical approach was validated by referential measurements performed with other frequency selective measurement devices, thus optimizing adaption. In combination with other methods (numeric calculation, monitoring of base stations), the device shall serve to test the feasibility of a planned population study where personal field doses shall be recorded. In future, the device shall be further improved so as to automatically identify (and react accordingly) whether it is worn on the body or stationary. Also, automated statistical analysis of won data and an extension to other relevant frequency bands are planned.

At present, **Mona Shum** and colleagues (Exponent, Inc., Menlo Park, USA) are working on a larger project investigating the relevance of parameters such as mobile phone design, supply network technology, base station density, work space, time of day, and regional network supply factors of the transmission energy arriving at the mobile phone (and the energy transmitted from there, respectively). This is a cooperation with the group around Nils Kuster (IT'IS Zurich) and with Asher Sheppard (Asher Sheppard Consulting, Redlands, USA).

This is also a crucial factor in population studies on chronic mobile radio field exposure which has been insuffiently considered so far. The project is promoted by the American Cellular Telephone and Internet Association (CTIA), in cooperation with the U.S. Food & Drug Administration (FDA). Shum presented preliminary results of a pilot study where some of the mentioned parameters were measured with modificated mobile phones. Factors affecting the variation of en-

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ergy transmitted by the mobile phones were determined by means of an internal recording of the transmission power control inside the specially designed phone. Specific scenarios for the operation of a mobile phone inside rooms, in free space and in the car determined by involved technicians were examined (e.g.: at different stories of an office building, inside a car in city traffic or on the highway, on foot in the city or in free space, at different times of day, with or without hands-free devices, etc.). Technicians made 6-min standardized mobile phone calls each, under realistic conditions. Meanwhile, transmission power of the mobile phones was recorded every 2.5 seconds in Watt.

The pilot study showed that the selected methods helps to obtain conclusive data. Based on this, the data shall be processed further to obtain a matrix of exposure parameters for the following parts of the study. As a next step, similarly performed measurements with a total of 4 head phantoms are planned; the modificated mobile phones shall serve as a reference. Towards the end of the project work, determined differences shall be exactly referable to the different application conditins. This can be a valuable basis for future population studies.

In the last lecture of this session, **Robert Blystone** from the Air Force Research Lab in Brooks City-Base, USA, spoke about the influence of millimeter waves on the skin of mammals. His research team put the focus on temperature development in the skin layers and their computerized visualization.

According to Blystone, the background of study was the increasing commercial and military use of the applied frequencies 35 GHz and 94 GHz. According to the findings of other authors, there is a still causally unexplained blood pressure decrease in rats after about one hour of similarly strong treatment wth the same frequencies. Moreover, body temperature rises to up to 43 C. Due to the small penetration depth of millimeter waves, a direct heating of the animals' insides from fields is not possible. It is still unclear whether heat conduction to the insides is due to the network of capillaries in the skin, via blood transport, or whether a nerve-conducted impulse via temperature and pain receptors in the skin triggers an internal reaction – or if other phenomena still play a part in this.

Blystone applied 35 GHz or 94 GHz fields with a power flux density of 75 mW/cm², over up to 75 min to a shaved skin area (approx. 10% of body surface). As an additional control served a group without field exposure; environmental temperature was increased to 42° C. Sectional preparations of the exposed skin areas were examined to find out about irradiated energy pathways. Using an infrared thermography probe, the temperature at the skin surface and subcutaneous temperature (in binding tissue below skin) were determined during the treatment. Maximum temperatures were 44° C (at 35 GHz) on the skin surface and 48.5° C (at 95 GHz) in the subcutaneous area. The digialized images of sectional preparations of skin and hair follicles were processed two- and three-dimensionally and morphometrically evaluated. A lot of detailed information was collected. Blystone concentrated strongly on the 30-days hair cycle of rats and its relevance to energy absorption in the skin. But ultimately, he could not give an answer to the above mentioned core issue.

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