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Throughout 2003 IT'IS was able to overcome the initial challenges and turbulence since its founding four years ago by further consolidating its research organization and expanding its activities. We entered 2004 as a more effective organization dedicated to fulfilling our foundation's mission.

Our momentum is evident through the launching of a new research area "Health Support Systems" to complement our two well established fields "Measurement and Computational Techniques for Electromagnetic Analysis" and "EMF Health Risk Assessment". Dr. Michael Oberle, who initiated and leads this new research area, has acquired the first project ULTRACOM (page 16) and is currently seeking to further increase collaborative opportunities within the medical industry.

Our optimism is also visible in the expansion of our work facility at Zeughausstrasse 43 in downtown Zurich. New offices and two new laboratories – a large semianechoic chamber for general near-field, far-field and dosimetric measurements and a reverberation chamber for EMI tests – were recently constructed over two floors. By acquiring this additional space, future expansion is a viable option.

In the past year, we continued to focus on developing methodologies and addressing public concern about the possible health hazards of wireless communication applications and EM exposure in general. This is reflected by our participation in numerous projects worldwide (page 11). Our pace of innovation will progress in 2004 with continued dedication to risk assessment through the replication and expansion of studies reporting EMF induced effects. Among our main activities are those projects involving genome instability, gene and protein expression, blood-brain barrier leakage, human sleep EEG and human cerebral blood flow. These replications will be conducted in collaboration with independent and distinguished research groups.

We owe our deepest gratitude to the public institutions and industry companies listed on page 9 for their endorsement and initiative in implementing these projects.

We are especially grateful to our main industry partners, Mobile Manufacturers Forum (MMF), TDC Sunrise and SPEAG, for their nonintrusive commitment to longterm funding of our research.

Breakthroughs in scientific research almost always come through collaborations – sharing ideas and knowledge within a dedicated team environment. We owe a great debt of gratitude to our research partners in the engineering, life and medical sciences for their partnerships.

Special thanks go to those individuals at ETH who continually support our activities in a multitude of ways, including President Prof. Dr. Olaf Kübler, the IIS Laboratory of Prof. Dr. Wolfgang Fichtner, Prof. Dr. Albert Kündig, Prof. Dr. Manfred Morari and many more.

Zurich, March 2004

Prof. Dr. Niels Kuster

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Dr. Anssi Toropainen, Nokia NRC, Finland

# KEY FIGURES

## Level of Funding (in 1000 CHF)



# KEY FIGURES



## **Number of Publications**



## **Group Citation Index**

(year) represents development at ETH before establishment as an independent foundation

# SPONSORS

## **Government Agencies**

5th European Framework, Belgium 6th European Framework, Belgium Centre for Technology Assessment TA-SWISS, Switzerland Commission for Technology and Innovation CTI, Switzerland EUREKA, Switzerland German Federal Office for Radiation Protection BfS, Germany NIEHS, USA NIST, USA Swiss Federal Office of Communications BAKOM, Switzerland Swiss Federal Office for Education and Science BBW, Switzerland Swiss Federal Office of Public Health BAG, Switzerland

## **Non-Profit Organizations**

Research Foundation on Mobile Communication, Switzerland VERUM Foundation, Germany

## Mobile Manufacturers Forum

Alcatel, France Ericsson, Sweden Mitsubishi Electric, Japan Motorola, USA Nokia, Finland Panasonic, Japan Philips, The Netherlands Sagem, France Samsung, Korea Siemens, Germany Sony Ericsson, Japan/Sweden

## **Service Providers**

ARIB, Japan CTIA, USA GSM Association, Switzerland NTT DoCoMo, Japan TDC Sunrise, Switzerland

## Small and Medium Enterprises (SME)

maxwave AG, Switzerland miromico, Switzerland MTT Co. Ltd., Japan SPEAG, Switzerland

## PARTNERS

#### Universities

Communication Photonics Group, ETHZ, Switzerland Institut für Automatik, ETHZ, Switzerland Institut für Biomedizinische Technik, ETHZ, Switzerland Institut für Geophysik, ETHZ, Switzerland Institut für Lebensmittelmikrobiologie, ETHZ, Switzerland Integrated Systems Laboratory, ETHZ, Switzerland Institute for Biomedical Optics, UNIZ, Switzerland Institute for Molecular Cancer Research, UNIZ, Switzerland Institute for Pharmacology / Toxicology, UNIZ, Switzerland Neurology Clinic, UNIZ, Switzerland Neuroscience Center Zurich, Switzerland Institut für Mikrobiologie, University of Bern, Switzerland Institute for Social & Preventive Medicine, University of Bern, Switzerland Center of Radiation Medicine, TU Berlin, Germany Forschungs- und Technologiezentrum der Telekom, Germany GSF, Germany IFBH Hannover, Germany IMTEK, University of Freiburg, Germany Institute for Mobile and Satellite Technology, Germany IPK Gatersleben, Germany Max Planck Institute for Cognitive Neuroscience, Germany Max Planck Institute for Neurological Research, Germany UKBF, Germany University of Rostock, Germany ARCS, Seibersdorf, Austria AMUW, Austria University of Vienna, Austria IRCOM, France PIOM, University of Bordeaux, France Supélec, France ULP University Louis Pasteur, France ENEA, Italy ITC - ISRT, Italy UNIBO, Italy VERYC, Spain University of Thessaloniki, Greece Department of Information Technology, University of Ghent, Belgium Erasmus MC-Daniel den Hoed Cancer Center, The Netherlands Physics and Electronics Laboratory, TNO, The Netherlands University Medical Center Utrecht, The Netherlands Center for Personal Communications, Aalborg University, Denmark Danish Cancer Society, Denmark Chalmers University of Technology, Sweden Karolinska Institute, Sweden Uppsala University, Sweden Finnish Center for Radiation and Nuclear Safety, Finland Finnish Institute of Occupational Health, Finland University of Kuopio, Finland Heukeland Hospital, Norway Keele University, UK Department of Veterans Affairs, Research Center Loma Linda, USA University of California Davis, USA University of California Riverside, USA University of Maryland, USA

Washington University, USA Hokkaido University, Japan Metropolitan University of Tokyo, Japan University of Tokyo, Japan University of Zhejiang, China

#### **Public Offices and Agencies**

BAG, Switzerland BAKOM, Switzerland BfS, Germany CRL, Japan ETRI, Korea FCC, USA NIST, USA NRPB, UK

#### Private Industry

AF Industri & System, Sweden ARIB, Japan Asher Shepard Consulting, USA AT&T, USA Battelle, USA Cetelco, Denmark E-Plus, Germany Ericsson Radio Systems AB, Sweden Exponent Inc., USA France Telecom, France Fraunhofer ITEM, Germany Huber + Suhner AG, Switzerland ISE AG, Switzerland Mannesmann Mobilfunk GmbH, Germany Matsushita Communications Industrial Co Ltd, Japan maxwave AG, Switzerland MCL, UK miromico, Switzerland Mitsubishi, Japan Moteco AB, Sweden Motorola Cellular, USA Motorola's Corporate Research Laboratory, Ft. Lauderdale, USA Motorola Singapore Navstar Systems Ltd., UK Nokia Research Center, Finland Nortel, Great Britain NTT DoCoMo, Japan Qualcomm, USA RBM, Italy RCC, Switzerland Rosenberger HF Technik GmbH, Germany Sagem, France Schmid & Partner Engineering AG, Switzerland Sennewald Medizintechnik GmbH, Germany Swisscom, Switzerland T-Mobil, Germany TDC Sunrise, Switzerland TILAB, Italy

# PROJECTS

#### **Measurement and Computational Techniques**

TD SENSOR	Development of a Field Sensor in the Time and Frequency Domains
MT SENSOR	Development of a Novel Micro-Thermal Sensor for Temperature Measurements with High Spatial Resolution in RF Hostile Environments
SEMCAD++	Extension / Improvement of the TCAD Engine SEMCAD for Antennas / EMC
TRINITY	Simulation Tool for Robust Design and Integration of Next Generation Information Technology Devices (see page 12)
CSCIENCE HANDHELD	Research on the Scientific Bases to Test Compliance of Handheld and Body-Mounted Transmitters (see page 13)
CSCIENCE NIS	Methodology for Determination of the Measurement Uncertainty of Exposure Assessments Inside Buildings
EXPA INDOOR – BAG	Development of Procedures for the Assessment of Human Exposure to Electromagnetic Radiation from Wireless Devices in Home and Office Environments
BASEXPO	Development of Procedures for Assessing Human Exposure to EMF Radiation from Base Stations
STANDARDIZATION	Participation in Regulatory Activities (Standards Committees & Governments)

### Health Risk Assessment (see pages 14 – 15)

PERFORM A++	<i>In Vivo</i> Research on Possible Health Effects Related to Mobile Telephones and Base Stations (Carcinogenicity Studies in Rodents)
PERFORM B	In Vitro and In Vivo Replication Studies Related to Mobile Telephones and Base Stations
PERFORM C	Human Studies Related to Mobile Telephones and Base Stations
REFLEX	Risk Evaluation of Potential Environmental Hazards from Low Energy Electromagnetic Field Exposure Using Sensitive <i>In Vitro</i> Methods
EMF & BRAIN – SLEEP	Effects of EMF on Sleep, Sleep-EEG and Brain Function
EMF & BRAIN – CBF / CBV	Effects of High Frequency Electromagnetic Radiation on Cerebral Blood Flow and Cerebral Blood Volume as Measured by Near-Infrared Spectrophotometry
REPLICATIONS	Replication Studies of Bio-Experiments
sXc – 900 / 1800 / 1900	Optimization of Systems for the Exposure of Cells to GSM/DCS/UMTS
sXv – NTP / NIEHS	Optimization of Systems for Exposure: Dosimetry of the Reverberation Chamber Setup for the NTP / NIEHS Study by NIST
sXh – RF / ELF	Optimization of Systems for Exposure of Human Volunteers: Assessment of the ELF Exposure from GSM Handsets and Development of an Optimized RF / ELF Exposure Setup
sX3P	Evaluation of Exposure Systems (3rd Party)
САНМ	Development of Computational Animal & Human Models
EXPA EPI – CTIA	Exposure Assessment for Epidemiological Studies: CTIA Cellular Telephone Study

#### Health Support Systems

ULTRACOM

Channel Model of the Human Body for Medical Monitoring Systems (see page 16)

# TRINITY

## Background

The trend towards mobility and miniaturization in the communication, computing and medical fields will see a collaboration in ubiquitous or pervasive computing. As additional technologies emerge – such as passive optical devices – densely integrated photonic components and entire chips are finally being realized. Driven by these developments, a broad range of technical and economical factors has evoked the demand for Technology Computer Aided Design (TCAD) within the framework of these communication and information technologies. TRINITY evolved from the SEMCAD++ project, which resulted in a well-designed and highly competitive simulation platform for antenna modeling in complex environments and dosimetry.

## Objectives

TRINITY targets the provision of a high-level 3-D full-wave analysis tool capable of performing numerical analysis and optimization in a straightforward manner – based on imported CAD data without the need for simplifications. This includes the development of novel algorithms, procedures and implementations leading to enhanced 3-D full-wave simulation addressing future telecommunication devices, health support systems, advanced integrated photonics components and optical interconnects. The outlined R&D efforts of this project will broaden the application range of the simulation tool, while supporting the effective realization of miniaturized devices and providing a highly dense arrangement of functional parts.

## The Simulation Platform's Methods and Results

Its wide EM related modeling capabilities, CAD unit and postprocessor module make SEMCAD the ideal platform for the final integration of TRINITY's innovations including:

- Optimization and fine-tuning of the current Yee-FDTD kernel with respect to memory structure and data handling yielding clear benefits for reduced run-time and memory requirements
- Development and integration of a novel unconditionally

stable Alternating Direction Implicit (ADI) FDTD algorithm combining a high order of accuracy, implicitness and staggering – leading to efficient simulation capabilities for CAD models which are highly overdiscretized with respect to the wavelength

- Implementation of the latest absorbing boundary conditions (UPLM) incorporating intersections / treatment of lossy dielectric structures with ABC regions (adaption to Yee-FDTD and ADI-FDTD)
- Integration of solutions for new FDTD material types and models, for example non-linearities such as field intensity dependent permittivity, dispersive (Drude type) and anisotropic models for the representation of specific effects and functionalities such as optical switching
- Research and implementation of novel hybrid FDTD sub-cell models applicable to (thin) PEC and dielectric materials including edge singularities from static field solutions as well as different averaging schemes
- Development and integration of a generally applicable semi-automated optimization engine for all solvers including scripting capabilities based on the latest technology and interpreters (Python language) and a state-of-the-art optimization algorithm (genetic basis)
- Implementation of a high-end parallelization using 64 bit based memory integrations and optimizations (shared and distributed memory models, OpenMP / MPI basis and in-house designed memory structures) as well as an extension and improvement of the 3-D rendering engine (ACIS V13, QTech)

Ultimately, the defined performance boosters will apply to all SEMCAD solvers, offering a complete TCAD solution ranging from DC to light. Initial developments and implementations in the early stages of this project have already enabled significant breakthroughs with respect to improved 3-D modeling and the simulation of wireless devices as well as applications to photonic crystals. Furthermore, the accurate prediction of specific performance parameters has been successfully experimentally reproduced.

# CSCIENCE

## Background

In recent years, the number of wireless devices operating in close proximity to the human body has increased dramatically. The cellular telephone is already a conventional means of communication, while wireless local area networks are becoming increasingly popular due to the high degree of personal mobility they provide. In the near future, small and lightweight health support systems attached directly to the human body or even within the body will provide vital medical data via wireless communication channels. Although the benefits of these novel and emerging technologies are evident, possible health risks for the user must be minimized and the electromagnetic radiation penetrating the human body must be carefully assessed and controlled.

Within the framework of the project CSCIENCE HANDHELD, IT'IS has already contributed substantially to the evaluation of EMF exposure from cellular phones. Our research on the methodologies and procedures for compliance testing of wireless devices operating close to the human head has been incorporated into several international standards. However, emerging technologies require continuous evaluation of the mechanisms of radiation absorption as well as assessment of the thermal load. Further research is necessary for the extension of instrumentation and protocols used for compliance testing with exposure safety standards covering a wide frequency range and considering whole-body exposure.

## Objectives

The main goal of the project CSCIENCE HANDHELD is to develop a generalized compliance testing standard for wireless devices operating close to and inside the human body. This includes the characterization of absorption mechanisms covering everyday usage patterns and a broad frequency range from 30MHz to 6GHz. In addition, extended measurement procedures and equipment are being developed in order to assure the highest accuracy and reliability. All results will contribute to standardized protocols for the compliance testing of wireless devices.

## Selected Results

During the last year, several significant contributions were made with respect to numerical and experimental compliance testing. Among these were:

- Novel procedures for measurements in tissue simulating liquids at frequencies of 5-6GHz (new dosimetric field probes, new calibration setups, new liquids, improved procedures and uncertainty assessment)
- Characterization of the absorption of electromagnetic energy at different areas of the human body (evaluation of worst-case tissue composition, characterization of absorption mechanisms for different antennas, distances, frequencies, etc.)
- Extension of the body model database into SEMCAD, including the development of new anatomical and generic whole-body models as well as implementation filters for the import of anatomical models from third parties
- Continuous validation of the developed methodology for compliance testing of mobile phones with special consideration of the effects on children

## **Outlook and Future Benefits**

Within the project, novel and emerging technologies are continuously monitored and new work packages are implemented to keep pace with the latest scientific trends and developments. Expected challenges involve the proposal of a general compliance testing protocol for body-mounted, wearable and portable devices considering frequencies between 30 and 5800MHz, assessment of the thermal load for these devices, the development of exclusionary clauses for transmitters with low output power as well as compliance testing procedures.



# HEALTH RISK ASSESSMENT

Over the years, the IT'IS Foundation has played a pacemaker role in emerging and experimental near-field techniques, resulting in the establishment of IT'IS as a leading competence center for the development, provision and support of exposure systems. Our adherence to independent, unbiased, scientifically valid research and development is highly regarded by research institutes – reflected in our participation in a multitude of experiments ranging from *in vitro* and *in vivo* to human studies. IT'IS has also established the guidelines for the exposure

#### In Vitro Research with IT'IS Participation

Objectives: Investigation of possible genotoxic effects and effects on gene expression due to GSM exposure in the human HL60 cell system

Partner: Institut für klinische Chemie und Pathobiochemie, Universitätsklinikum Benjamin Franklin, Berlin, Germany

Objectives: Investigation of possible direct and indirect genotoxic effects due to ELF magnetic field exposure in several human cell lines Partner: Klinische Abteilung Arbeitsmedizin, Universitätsklinik Innere Medizin IV, Vienna, Austria

Objectives: Analysis of molecular and cellular responses of embryonic stem cells to RF and ELF electromagnetic field exposure Partner: Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Germany

Objectives: Investigation of the influence of RF EMF on differentiation and gene expression of pheochromocytoma PC12 cells and of primary cultures from nucleus stratum of rat foetuses Partner: Investigacion Bioelectromagnetismo, Hospital Ramon y Cajal, Madrid, Spain

Objectives: Effects of RF EMF on (1) pattern of expression of genes and their protein products and (2) cell cycle kinetics Partner: Laboratory of Radiobiology, STUK - Radiation and Nuclear Safety Authority, Helsinki, Finland

Objectives: Investigation of cellular responses to ELF EMF of various cell systems on different levels of signal transduction, gene expression and protein targeting Partner: Institut für Biophysik, Universität Hannover, Germany

Objectives: Investigation of possible effects of RF EMF on the human immune system dependent on the age of subjects Partner: Department of Physics, Università Bologna, Italy

Objectives: Determination of whether RF EMF are able to act as direct or indirect carcinogens using the standardized rat tracheal epithelial cells transformation assay

Partner: Laboratoire PIOM, Ecole Nationale Supérieure de Chimie et de Physique, Bordeaux, France

Objectives: Investigation of possible ELF EMF effects on the development, composition and function of neuronal nicotinic receptors in human neuronal cells Partner: Department of Pharmacology, Università Milan, Italy

Objectives: Effects on activation of ODC activity after RF exposure at

900 and 1800 MHz Partner: Laboratoire PIOM, Ecole Nationale Supérieure de Chimie et de Physique, Bordeaux, France

Objectives: Replication study of the effects on activation of ODC activity after RF exposure at 835 MHz Partner: Department of Environmental Sciences, University of Kuopio, Finland

Objectives: Replication study of genotoxic effects of RF EMF on lymphocytes at 900 and 1800 MHz Partner: Ente per le tecnologie, l'Energia e l'Ambiente, Department of Environment, Rome, Italy

Objectives: Replication study of genotoxic effects of RF EMF on lymphocytes at 900 MHz Partner: National Radiological Protection Board, Oxfordshire, UK

Objectives: Replication study of genotoxic effects due to ELF magnetic field exposure in human diploid fibroblasts Partner: Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, Naples, Italy

Objectives: Investigation of possible effects of RF and ELF exposure on genome stability Partner: Institute for Molecular Cancer Research, Universität Zürich, Switzerland

Objectives: Investigation of possible effects of GSM & UMTS exposure on protein function Partner: Institut für Krebsforschung, Universität Wien, Austria

Objectives: Investigation of possible direct and indirect genotoxic effects of GSM and UMTS exposure in several human cell lines Partner: Klinische Abteilung Arbeitsmedizin, Universitätsklinik Innere Medizin IV, Vienna, Austria design of studies with maximized relevance and has developed optimized reference exposure setups that can be produced in small numbers. Special emphasis has been placed on the provision of a high level of exposure control and on the evaluation of possible artifacts. To clarify and

analyze conflicting results, we participate in replication studies and perform dosimetric verification. Evaluation of the dose response and identification of the interaction mechanism are the main objectives in the case of positive replications.

Objectives: Investigation of possible effects of GSM and UMTS exposure on cells of the human immune system Partner: Austrian Research Centers, Seibersdorf, Austria

Objectives: Examination of possible effects of RF emissions from cellular telephones on biogenic magnetite in living cells (magnetotactic bacteria and cell cultures)

Partner: Institute for Science & Technology in Medicine, Keele University, Stoke-on-Trent, UK

Objectives: Examination of possible effects of RF EMF on cell activation processes in human cell systems Partner: Institute of Cell Biology and Biosystems Technology, Universität Rostock, Germany

#### In Vivo Research with IT'IS Participation

Objectives: PERFORM-A1: Combined toxicity / carcinogenicity studies of 900 MHz GSM & 1800 MHz DCS exposures in B6C3F1 mice (NTP-like)

Partner: Fraunhofer ITEM, Hannover, Germany

Objectives: PERFORM-A2: Combined toxicity / carcinogenicity studies of 900 MHz GSM & 1800 MHz DCS exposures in Wistar rats (NTP-like)

Partner: RCC, Basel, Switzerland

Objectives: PERFORM-A3: Evaluation of 900 MHz GSM wireless communication signals on DMBA-induced mammary tumors in Sprague Dawley rats Partner: Research Centers Seibersdorf, Austria

Objectives: PERFORM-A4: Evaluation of 900 MHz GSM exposure on Lymphoma induction in Eµ-PIM 1 transgenic mice Partner: RBM, Ivrea, Italy

Objectives: Evaluation of 900 MHz GSM wireless communication signal on DMBA-induced mammary tumors in Sprague Dawley rats Partner: Animal Center & Department of Pathology, Zhejiang University, Hangzhou, China

Objectives: Replication study of effects on memory performance in mice and rats exposed to GSM RF EMF at 900 MHz Partner: National Radiological Protection Board, Oxfordshire, UK

Objectives: Replication study of effects on memory performance in rats exposed to pulsed RF EMF at 2.45 GHz Partner: Université de Strasbourg, France

#### Human Studies with IT'IS Participation

Objectives: Effects of GSM RF EMF on human sleep electroencephalogram Partner: Department of Pharmacology and Toxicology, Universität Zürich, Switzerland

Objectives: Effects of GSM RF EMF on regional cerebral blood flow in humans Partner: Department of Pharmacology and Toxicology, Universität Zürich, Switzerland

Objectives: Effects of GSM RF EMF on waking electroencephalogram and performance Partner: Department of Pharmacology and Toxicology, Universität Zürich, Switzerland

Objectives: Examination of possible effects of 900MHz GSM wireless communication signals on subjective symptoms, physiological reactions, alertness, performance and sleep

Partner: National Institute of Psychosocial Health, Karolinska Institute, Stockholm, Sweden

Objectives: Investigation of possible effects of RF EMF on CNS processing

Partner: Institut für Umwelthygiene, Universität Wien, Austria

Objectives: Effects of RF EMF on cerebral blood flow and cerebral blood volume as measured by near-infrared spectrophotometry Partner: Biomedical Optics Research Laboratory, Clinic for Neonatology, Universitätsspital Zürich, Switzerland

# ULTRACOM



The increasing trend towards incorporating miniaturized sensor systems in medical and health surveillance has been further enhanced by the integration of wireless communications. In addition to conventional RF telemetry, alternative methods for applying wireless communications have been explored in recent years. The human body has been identified as a promising transmission medium that can serve as a tailored communication platform in medicine. The development of a comprehensive electrical model of the human body is crucial to verifying whether it can serve as a transmission medium.

ULTRACOM, a CTI funded 18 month project which began in October 2003, aims to develop a comprehensive model for data transmission through the human body. While such a model can be derived from equivalent electrical models of the human body for different frequency bands and dispersions based on known tissue dielectric properties, major challenges for resolving data communication still exist. This project, for example, will attempt to define the best signal coupling technique into and out of the body for data transmission at the lowest power consumption but with the highest reliability.

Verification of the final model will be conducted during clinical trials at the Inselspital in Bern, Switzerland. However, prior to human testing, phantoms simulating specific human tissue and organs will be used for the model development. While existing phantoms are based on single liquids for measurements at high frequencies, it is a further goal of this project to develop a novel multi-layer phantom to simulate the impact of an electric current inside the human body at low frequencies. The differences between existing phantoms, applied materials, frequency ranges of interest and human tissue equivalent parameters will be investigated.

The characterization of the human transmission channel requires verified data on resistivity and the gain of dedicated tissue layers as well as the influence of frequency and modulation on tissue impedance and current density.

## SERVICES



## **Compliance Testing**

The IT'IS Foundation conducts compliance testing for RF applications ranging from base stations to implanted devices according to all international and national EMF safety guidelines. Our customer base ranges from governments to private manufacturers; IT'IS is regarded by many as the leading, truly independent institution for dosimetric evaluations. We are not only a pacesetter for near-field analysis tools, but we have also taken a leading role in developing the most accurate and suitable testing procedures. Our foundation includes a modern near-field laboratory capable of performing dosimetric and near-field evaluations starting from a few MHz to well above 10 GHz, as well as temperature measurements in EMF-hostile environments. In 2004 we expect to receive Class C accreditation for dosimetric assessments and compliance testing. This will enable us to develop standard procedures for products for which no standard is yet available. We provide an entire range of services for compliance testing including an indoor base station, WLAN, lap-tops, mobile phones, body-mounted devices, body-worn devices, pervasive computing and implanted devices.



## Safety White Paper

Due to the leading role of IT'IS in the worldwide research effort of health risk assessment and our participation in commissions developing EMF safety guidelines (e.g., WHO, IEEE), we have been mandated by international organizations, industry and governments to draft safety white papers for existing and future technologies as well as specific novel applications. The risk evaluations may include EMF risk analysis, prediction of worst-case exposure and worst-case temperature increase, among others. IT'IS offers these services to wireless technology companies, the medical device manufacturing industry, insurance companies and governments.

#### **Customized Exposure Setups**

IT'IS provides standard and customized turn-key EMF exposure setups for human, *in vivo* and *in vitro* experiments.

# INFRASTRUCTURE

#### **Dosimetric, Near-Field and EMC/EMI Facilities**

#### Semi-Anechoic Chamber

This shielded, rectangular chamber has the dimensions 7m x 5m x 2.9m (L x W x H). It is equipped with a reflecting ground plane floor, and half of its walls are covered with electromagnetic absorbers. The chamber contains an integrated DASY4 professional system and can be utilized for all research activities involving dosimetric, near-field and far-field evaluations, the optimization and synthesis of handheld devices, body-mounted transmitters, implants, desktop applications, micro-base and pico-base station antennas, exposure setups, calibration procedures, EMI tests and so on.

#### Reverberation Chamber

This is a shielded, rectangular chamber with the dimensions  $4m \times 3m \times 2.9m$  (L x W x H) equipped with mechanical stirrers. The chamber provides a controlled and consistent environment for EM emissions and immunity testing, as well as shielding effectiveness and susceptibility testing of electromagnetic equipment.

#### Facility for Dosimetric Compliance Testing

IT'IS shares a facility with Schmid & Partner Engineering AG which meets the requirements for dosimetric evaluations. We are currently seeking Class C accreditation for all types of dosimetric evaluations. The expected accreditation date through METAS is the summer of 2004.

#### **Technical Equipment and Instrumentation**

Spectrum and Network Analyzers

- 1 Rhode & Schwarz FSP, Spectrum Analyzer 9kHz 30GHz 1 HP 8753E, Network Analyzer 30kHz – 6GHz
- 1 HP APC 85033B, Calibration Kit

#### Signal Generators and Testers

- 1 Agilent E8251A, Signal Generator, 250KHz 20GHz
- 1 Rhode & Schwarz SMT06, Signal Generator
- 6 Rhode & Schwarz SMIQ02B, Signal Generator
- 1 Rhode & Schwarz SML03, Signal Generator
- 3 Rhode & Schwarz SML02, Signal Generator
- 1 Rhode & Schwarz SMY02, Signal Generator
- 1 HP 8647A, Signal Generator 250kHz 1000MHz
- 1 Agilent 33250A, Waveform Generator
- 8 Agilent 33120A, Waveform Generator
- 1 Rhode & Schwarz CTS55, Digital Radio Tester

DASY and EASY4

- 1 SPEAG DASY4 professional
- 2 SPEAG DASY3 mini
- 2 SPEAG EASY4
- 2 SPEAG DAE3, Data Acquisition Electronics
- 1 SPEAG DAE3mini, Data Acquisition Electronics
- 2 SPEAG TGLA, Temperature Probe
- 1 SPEAG TSIL, Temperature Probe

5 SPEAG T1V3LA, Temperature Probe 2 SPEAG H3DV5, H-Field Probe 1 SPEAG H3DV6, H-Field Probe 1 SPEAG HV2D, H-Field Probe 1 SPEAG ER3DV4, E-Field Probe 1 SPEAG ER3DV6, E-Field Probe 1 SPEAG EF3DP6, E-Field Probe 1 SPEAG ET3DV4, E-Field Probe 1 SPEAG ET3DV4, E-Field Probe 1 SPEAG ET3DV5R, E-Field Probe 2 SPEAG ET3DV6R, E-Field Probe 2 SPEAG ET3DV6, E-Field Probe 2 SPEAG ET1DV1, E-Field Probe 2 SPEAG ET1DV1, E-Field Probe

#### Meters

- 1 Agilent E4419B, 3 HP 8482A, Power Meter
- 3 HP 436A, 3 HP 8481A, Power Meter
- 7 Agilent 34970A, Data Acquisition Unit
- 1 Magnet Physik FH49-7030, Gauss/Teslameter

#### Amplifiers

- 3 LS Elektronik 2450, Amplifier, 400W/900MHz
- 5 LS Elektronik 2449, Amplifier, 200W/900MHz
- 2 LS Elektronik 2448, Amplifier, 60W/900MHz
- 1 LS Elektronik 2453, Amplifier, 400W/1800MHz
- 3 LS Elektronik 2452, Amplifier, 200W/1800MHz
- 1 LS Elektronik 2451, Amplifier, 60W/1800MHz
- 1 LS Elektronik 2447, Amplifier, 5W/1800MHz
- 1 Amplifier Research 10S1G4A, Amplifier 800MHz 4.2GHz
- 2 Kalmus 717FC, RF Power Controller 200MHz 1000MHz
- 1 Nucletudes ALP336, Amplifier 1.5GHz 2.5GHz

#### Other Equipment

- 8 Maury 1878B, 3-Step Tuner
- 1 Siemens, Universale Messleitung (0.5) 1GHz 13GHz
- 2 SPEAG Dipole SCC34 Benchmark
- 1 SPEAG D900V2, Dipole 900MHz
- 1 SPEAG D1800V2, Dipole 1800MHz
- 8 Various Antennas
- 1 Tektronik 2235, Oscilloscope
- 1 Heraeus BB6620, Incubator

#### Computers

- 4 UNIX Solaris 5.6/5.8: 1 Sun Blade 100, 1 Dual 450MHz/4GB, 2 Sun Ultra Sparc II
- 17 MacOS X: 1 PowerMac Dual G5/2GHz 8GB, 8 PowerBook G4, 3 PowerMac G4, 1 eMac G4, 1 iMac G4, 2 iBook, 1 PowerMac G3
- 29 WinNT/Win2k/WinXP: 1 Dual P4 2.6GHz 2GB, 1 Athlon64 2GB, 14 P4 1.7-2.8GHz 1-2GB, 6 P3 500-700MHz 256MB-1GB, 1 Athlon 1.2GHz/1GB, 2 P4 Notebook 1-1.6GHz/1-2GB, 2 P3 Notebook 1GHz/512MB, 2 Pentium/Centrino Notebooks
- 1 LINUX: Dual P4/4GB

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Verónica Berdiñas Torres, Jürg Fröhlich, Anja Klingenböck, Neviana Nikoloski and Niels Kuster, "Relevant exposure parameters for the comparison of animal studies," International Congress of the European Bioelectromagnetics Association (EBEA), Budapest, Hungary, November 2003, p. 69.

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#### History

The IT'IS Foundation was established on November 17th, 1999 through the initiative and support of the Swiss Federal Institute of Technology in Zurich (ETH), the global wireless communications industry and several government agencies.

#### Legal status

IT'IS is a non-profit tax-exempt research foundation.

#### Mission

Evaluation of the safety and risks related to current and emerging information technologies.

Exploration of information technologies for medical, diagnostic and life support systems.

Improvement of the accessibility of information technologies for all members of society including disabled persons.

#### Commitment

The advancement of science for the benefit of society at large while maintaining strict independence from any particular interest groups. The open dissemination of research results and the education and promotion of young scientists.

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