ITIS FOUNDATION
2005

IT'IS FOUNDATION

2005 was another winning year for the IT'IS Foundation, highlighted by the greatest number of publications and citations ever (see Page 8), the completion of several studies, expansion into the prevalent and essential research field of medical technology and new partnerships with prominent MedTech organizations (Page 10).

IT'IS' research agenda began strong in 2005, and continued to grow throughout the year. Stronger research ties were established with the U.S. Food and Drug Administration (FDA) through a mutual Cooperative Research and Development Agreement (CRADA). Our first joint project aims at developing models of a virtual family with unparalleled 3-D CAD details to provide the medical community with new modeling capabilities.

Most of the remaining scientific issues for compliance testing of body-mounted wireless devices were resolved in 2005. Currently, we are addressing the compliance testing issues of other areas such as wireless devices in homes and offices, active wireless implants, and implant compatibility within an MRI environment (Pages 14–15).

After five dedicated and focused years and participation in over 100 studies on the risk assessment of EMF, we felt that it was time to step back and analyze the achievements and the remaining shortcomings. With similar sentiments, EMF-NET, the Swiss Agencies BUWAL and BAG, NIEHS and the VERUM Foundation supported our four-day workshop at Centro Stefano Franscini in Monte Verità. The first three days addressed the impact of the potential technical, biological and analytical confounders associated with health risk assessment. The final day focused on several plausible yet controversial scientific endpoints. Clarifying the mechanisms associated with these endpoints is also a top priority of our research agenda, i.e., genotoxic effects of ELF and RF (Prof. Primo Schär, Prof. Günter Speit), gene expression (Prof. Dariusz Leszczynski, Prof. Anna Wobus) and EEG effects (Prof. Alexander Borbély, Dr. Peter Achermann, Prof. Bengt Arnetz, Prof. Arne Lowden). The recently approved program Swiss NRP 57 on Nonionizing Radiation – Environment and Health will provide the necessary momentum to tackle effectively these uncertainties. The results of the workshop are available at http://www.itis.ethz.ch/mv.

Our Board was renewed in November 2005 as required by the Foundation Charter. Prof. Ralf Hütter and Prof. Alexander A. Borbély resigned, as did industry representatives Dr. Christer Törnevik and Dr. Michael Burkhardt. Their invaluable support and guidance over the years helped position us for growth and preeminence, especially the indispensable help of Prof. Ralf Hütter during the Foundation's inception. Prof. Peter Niederer was appointed as our new President to strengthen our Foundation to meet the demands of anticipated future growth as we enter the MedTech era.

We extend our sincere thanks to the public institutions and private companies listed on page 9 for their endorsement and initiative in supporting our current and past projects in 2005. We especially thank the Swiss CTI for funding several projects that significantly advanced the Swiss broader competitiveness in wireless technologies, and the Swiss Federal Office of Public Health for funding several specialized and highly useful research projects. We are also especially grateful to MMF, MTTCO and SPEAG, for their commitment to long-term funding which is essential for maintaining the IT'IS Foundation as the leading center of competence.

Of equal importance is the support of our many colleagues at ETH Zurich, especially President Prof. Olaf Kübler, the entire IIS Laboratory of Prof. Wolfgang Fichtner, in particular, Dr. Dölf Aemmer, Dr. Norbert Felber, Christine Haller, and Prof. Albert Kündig, Prof. Manfred Morari, Prof. Heinz Jäckel, Prof. Gábor Székely.

With each passing day, the IT'IS Foundation focuses its activities on its longstanding and core interests ensuring that the public benefits from the safe and emerging applications of electromagnetic fields in health and information technologies. We are poised as ever to maintain our innovation, productivity and preeminence through the unparalleled experience, effort and support of all our employees, students, colleagues and collaborators and the generosity of our sponsors.

Zurich, March 2006 *Prof. Niels Kuster*

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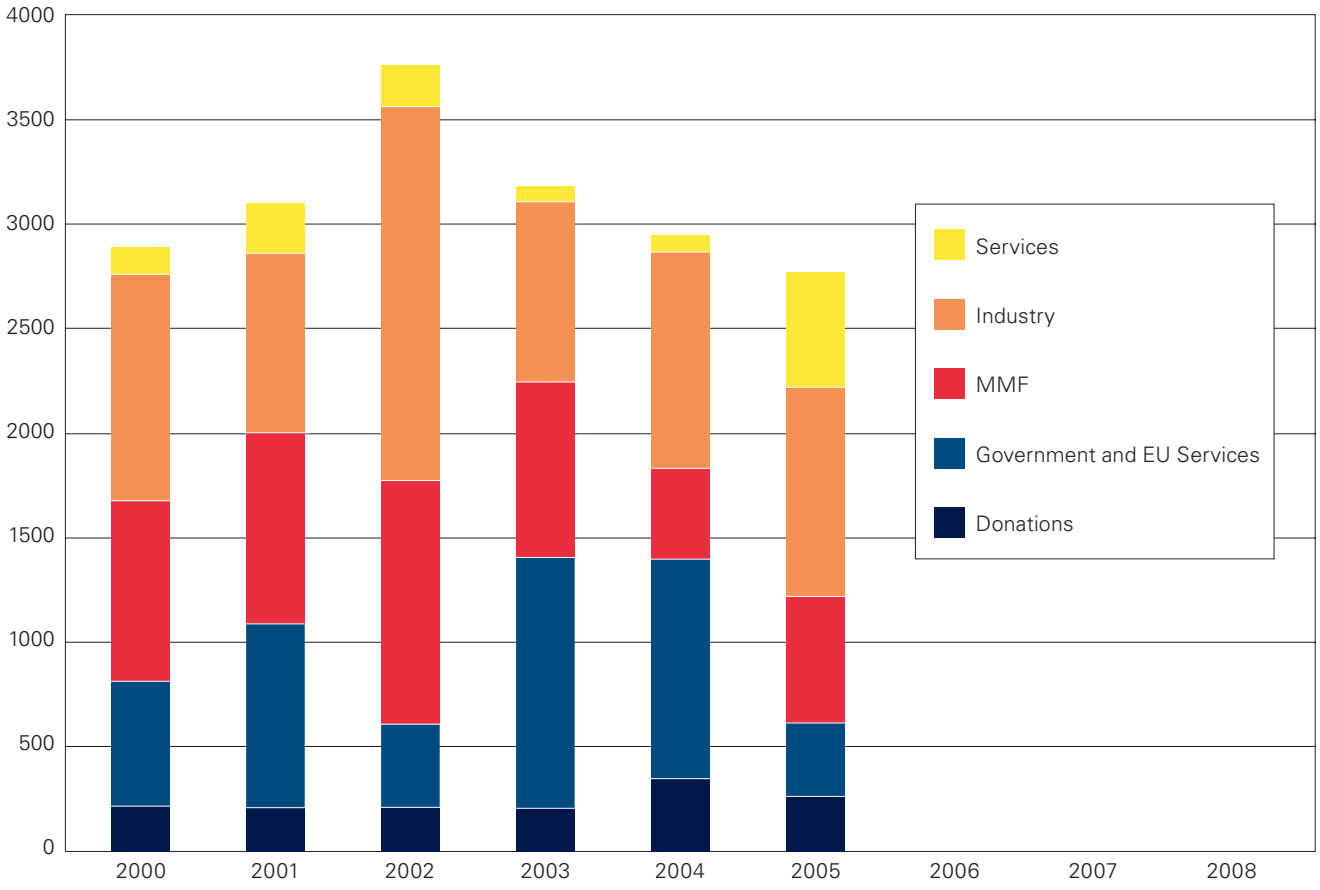
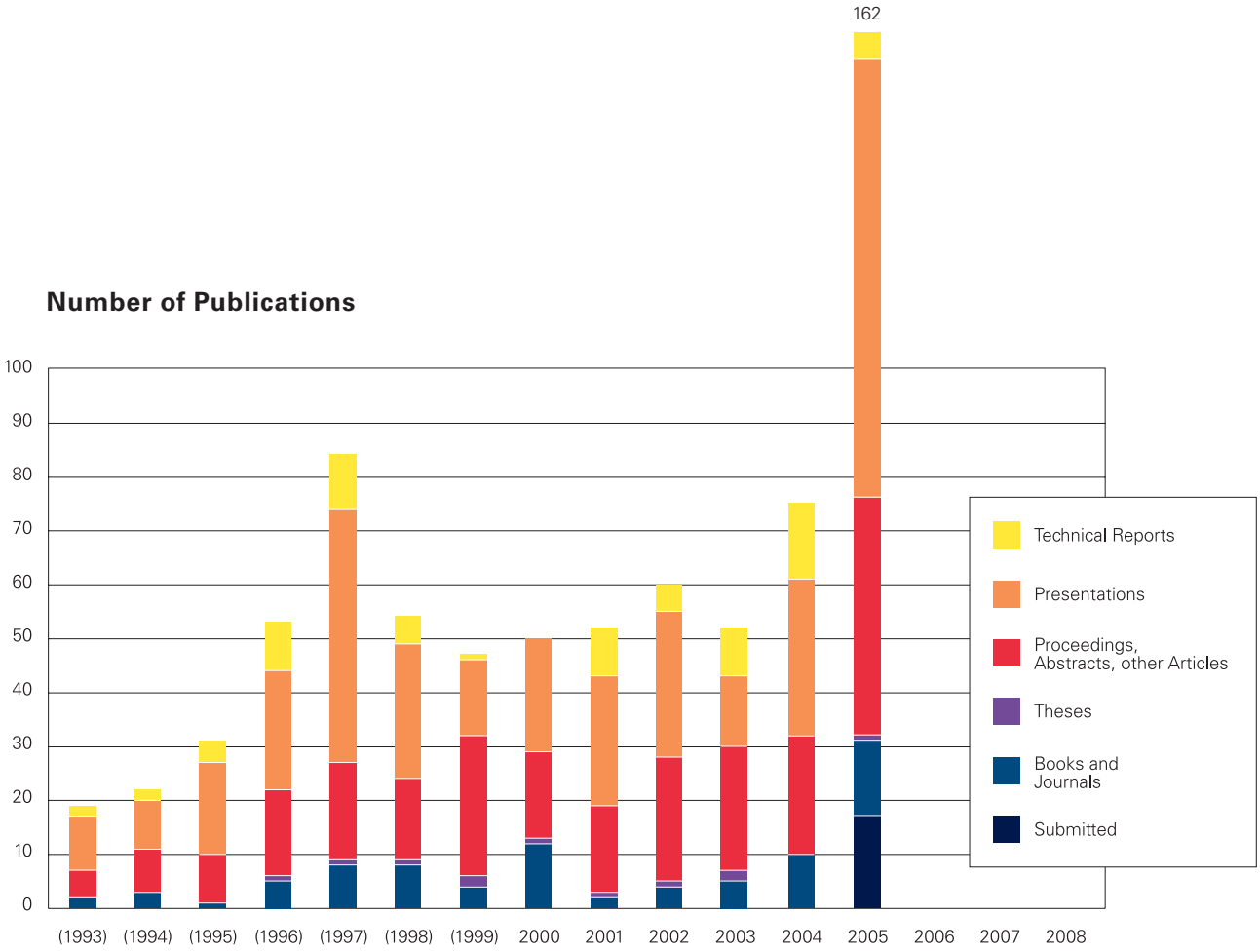
Level of Funding (in 1000 CHF)

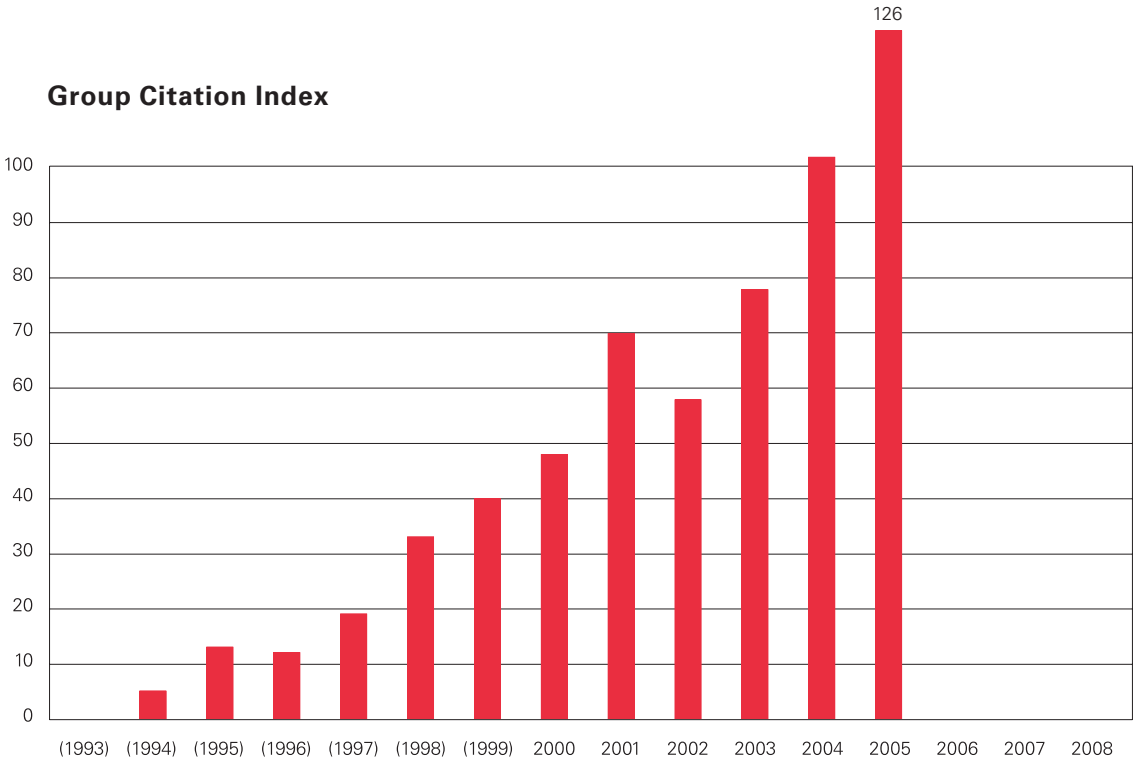


KEY FIGURES

Number of Publications



Group Citation Index



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

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PROJECTS

Measurement and Computational Techniques

TD SENSOR	development of a field sensor in the time and frequency domains (see page 13)
MT SENSOR	development of a novel micro-thermal sensor for temperature measurements with high spatial resolution in RF-hostile environments
TRINITY	simulation tool for the 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
CSCIENCE NIS	methodology for determining 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 (see pages 14–15)
BASEXPO	development of procedures for assessing human exposure to EMF radiation from base stations
EX-T	research on the effects of torso exposure to wireless devices with respect to existing compliance testing standards
STANDARDIZATION	participation in regulatory activities (standards committees & governments)

Health Risk Assessment

PERFORM A / ZHEJIANG	*in vivo* research on possible health risks from mobile phones and base stations through carcinogenic studies in rodents
PERFORM C	human studies related to mobile phones and base stations
EMF & BRAIN – SLEEP	effects of EMF on sleep, sleep EEG and brain function
EMF & BRAIN – CBF/CBV	effects of EMF on cerebral blood flow, cerebral blood volume and neural activity
REPLICATIONS	replication studies of bio-experiments
REPLICATIONS TNO	replication studies of bio-experiments focusing on UMTS-like exposure conditions
sXc – 900 / 1800 / 1900	optimization of systems for the exposure of cells to GSM / DCS / UMTS
sXv – NTP / NIEHS	optimization of systems for exposure: development and dosimetry of the reverberation chamber setup for the NTP / NIEHS study by NIST
sX3P	dosimetric evaluation of third party exposure systems
CAHM Virtual Family	generation of anatomical CAD models of an adult male, an adult female and two children for dosimetric and medical applications
EXPA EPI – CTIA	exposure assessment for epidemiological studies of mobile phone users
EX-Age	assessment of the SAR and thermal exposure of cell phone users considering age-dependent anatomical and physiological changes with particular emphasis on children

Health Support Systems

ULTRACOM	development of a channel model of the human body for medical monitoring systems
HYPER-T	research and optimization of hyperthermia treatment quality (see page 16)

NOVEL SEMI-IMPLICIT FDTD SOLVER

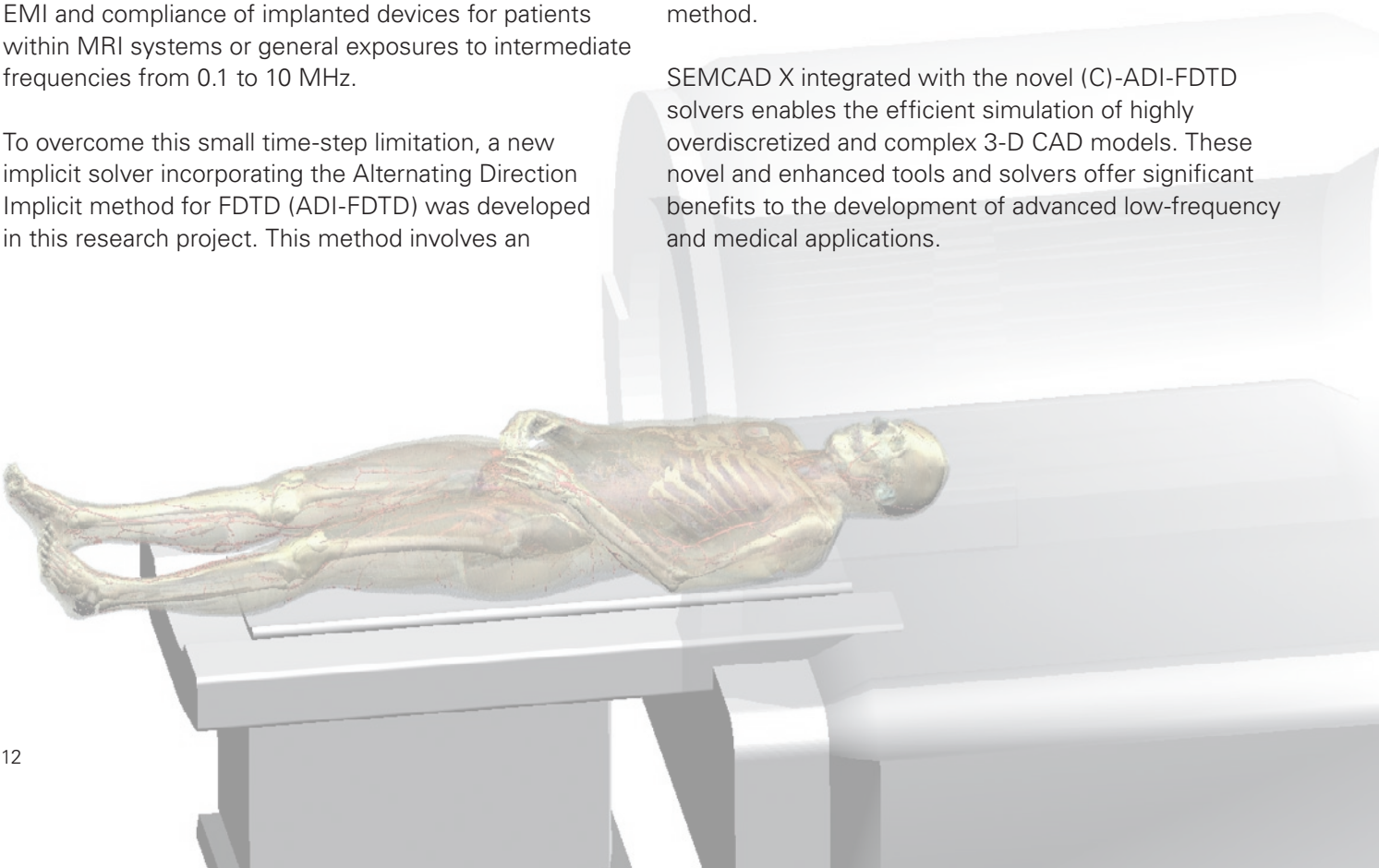
The Finite-Difference Time-Domain (FDTD) method is a popular, versatile electromagetnic modeling technique capable of simulating complex electromagnetic models for a broad range of applications. The simulation platform SEMCAD X based on the FDTD method and developed jointly with SPEAG within the framework of the CTI project TRINITY is recognized as the most effective tool to solve the EM TCAD needs of the wireless and medical industries, including antenna design, EMC and dosimetry.

SEMCAD X allows easy handling of complexities within the GUI and the solver unit. Large and complex model performance was significantly improved by exploiting the latest 64-bit technology, i.e., billions of cells can be computed within one simulation. However, as the number of voxels increases, the smallest spatial step becomes a small fraction of the wavelength. Because the temporal scheme of the FDTD method is bound by stability criteria proportional to the smallest fraction of a wavelength, the number of simulation steps increases for small models with fine geometries. In particular, runtime requirements are prohibitive for EM simulations at low frequencies requiring detailed structures embedded within large environments. Typical applications include EMI and compliance of implanted devices for patients within MRI systems or general exposures to intermediate frequencies from 0.1 to 10 MHz.

To overcome this small time-step limitation, a new implicit solver incorporating the Alternating Direction Implicit method for FDTD (ADI-FDTD) was developed in this research project. This method involves an approximate factorization of the Crank-Nicholson scheme applied to Yee's discretization. Although this technique is unconditionally stable and the time-step is no longer limited by the smallest spatial step, accuracy demands present new constraints.

The ADI-FDTD method was thus recently enhanced to further reduce staircasing errors. The newly developed conformal ADI-FDTD (C-ADI-FDTD) method was rewritten in terms of the conventional scheme but with locally enhanced updating coefficients. This novel feature of the C-FDTD and C-ADI-FDTD methods enables subsequent optimizations of the conformally enhanced solvers. The C-ADI-FDTD algorithm incorporates geometrical details with increased accuracy while maintaining unconditional stability to exploit the benefits of both methods. For certain configurations, the C-FDTD method allows speedups in the range of one order of magnitude or more. The novel C-ADI-FDTD technique, however, outperforms the standard FDTD scheme by several orders of magnitude with only a slight decrease in accuracy. Since no additional computation or memory requirements are needed for the C-ADI-FDTD method, it is moreover to be favored to the standard ADI-FDTD method.

SEMCAD X integrated with the novel (C)-ADI-FDTD solvers enables the efficient simulation of highly overdiscretized and complex 3-D CAD models. These novel and enhanced tools and solvers offer significant benefits to the development of advanced low-frequency and medical applications.

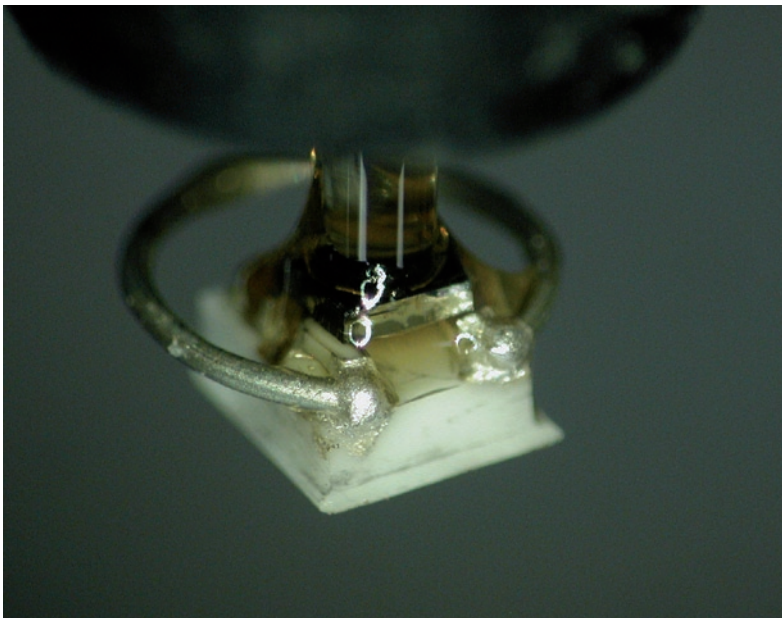


TIME AND FREQUENCY DOMAIN FIELD SENSOR

Low-cost analog radio frequency (RF) and GHz digital technologies are being used in an ever-increasing number of diverse new products containing wireless networks and intelligent sensors that will enable innovative applications and services, including medical diagnostics and therapeutics. Increased market pressure to optimize these applications will also require optimized electromagnetic RF tools, in particular, EMF sensors capable of detecting the amplitude and phase simultaneously with high spatial resolution and minimal field perturbation. Induced field distortions caused by the electric links between the sensor and the read-out can be avoided in devices based on optical remote sensing. Although various approaches to optimize high-bandwidth optical link sensors based on electroabsorption sensors, Mach-Zehnder interferometers utilizing the Pockels effect and sensors using active modulations of a LED or laser diode have been proposed, so far none of the methods have been able to analyze both amplitude and phase over a large bandwidth with high sensitivity, high resolution and minimal field disturbances.

The Time-Domain Sensor (TDS) project targets the development and characterization of a miniature optical-link magnetic-field sensor for the simultaneous recording of the amplitude and phase in the frequency range of 100 MHz to 6 GHz.

The sensor system consists of a sensor head with an attached antenna, an optical platform and a remote unit. The signal of the small loop antenna is amplified by a low noise amplifier. This circuit is used to effectively drive the VCSEL with the amplitude modulated signal. The modulated VCSEL output is transmitted to the remote unit by a multimode optical fiber and detected by a high-speed photo receiver. Power is delivered to the sensor head via a second fiber using a diode laser as the power source and a photovoltaic cell (PVC) array as the opto-electric converter. The data and power link fibers are both butt-coupled to the optical chips with acrylic light cure adhesive. The number of components required for the sensor head is minimized to achieve a high degree of miniaturization. In total, seven elements are closely packed on a small ceramic substrate (1.6 x 2 mm) with an attached loop antenna (ø=2.9 mm).



The system design is optimized for broadband use in the frequency range of 0.1 to 6 GHz. The VCSEL was identified as the dominant noise source of the sensor, limiting the minimum detectable H-field to typically $H_{\min}/\sqrt{Hz} \approx 100nA/\left(m \cdot \sqrt{Hz}\right)$ (for a loop diameter of 2.9 mm at a frequency of f=835 MHz and f=2.45 GHz). The dynamic range, defined by the 1 dB compression point, was also limited by the VSCEL to 135 dB·Hz (at f=835 MHz). The non-linear distortion of the link was investigated by two-tone measurements resulting in a spurious-free dynamic range of 95 $dB \cdot Hz^{2/3}$ (at f=835 MHz). The wide range frequency response of the sensor was evaluated in the near field of a micro strip line. The sensor H-field sensitivity was tested in the near-field of a λ/2 dipole (length: 0.1655 m, f_{res}=835 MHz).

Our simple millimeter-sized fiber link sensor platform for electromagnetic field detection uses a high bandwidth to simultaneously detect the amplitude and phase up to 6 GHz with minimal field perturbations. The platform can be applied to both E-field and H-field sensors. However, further miniaturization of the sensor platform will additionally reduce unwanted field sensitivities. A stable production process and accurate and efficient calibration procedures are also imperative to create the optimal system.

NEW CHALLENGES IN COMPLIANCE TESTING

As the wireless revolution furiously spreads to every corner of the world, into our homes and offices, and even inside our bodies, the number of high frequency sources is quickly growing. Continued public concern about the safety of RF exposure is inevitable with the rapid and increasing technological advancements of new wireless technologies, medical implants and body area networks using the entire RF spectrum. In particular, increasing RF exposure in uncontrolled and occupational environments pose a higher risk of deleterious effects because of electromagnetic interference with active implants. Modern medical diagnostic techniques, such as magnetic resonance imaging, operate at strong static field strengths preventing passive and active implant wearers from benefiting from advanced diagnostic and treatment methods. Current standards for compliance testing with radio frequency safety limits of both general mobile transmitters and medical implants lag far behind the developmental pace and are inadequate to ensure safe operation and compatibility. The IT'IS Foundation is at the forefront of this wireless revolution, and is striving to develop novel analytical methods for assessing EMC/EMI safety. Sound procedures are imperative to reliably assess the exposure to electromagnetic fields in uncontrolled environments and to warrant the safe use of medical implants.

RF Safety and Compliance of Medical Implants

Current procedures to demonstrate the safety and compliance of medical implants were developed gradually and were never rigorously analyzed for scientific and engineering reliability. Both numerical and experimental evaluations using simplified and unverified setups are unreliable because the purely numerical approach offers poor control of the uncertainty of the results, and the experimental methods cannot encompass the variability of realistic exposure situations and do not usually allow the complete assessment of the quantity of interest. The scientific basis, techniques and procedures developed for body-mounted sources cannot be directly applied for RF sources located inside the body because of the high SAR gradients and dependence of different tissues. To determine worst-case exposures, different device configurations must be considered, including the evaluation of the variability due to the mounting location within the body, the tissue composition and the position of attachments, such as pacemaker leads.

The evaluation of the patient exposure with known uncertainty is therefore only possible using a combined numerical and experimental approach. IT'IS is developing rigorous and sound procedures for demonstrating compliance of active and passive medical implants with safety limits for SAR and temperature increases.

In cooperation with one of the world's largest manufacturers of active medical implants, the following combined numerical and experimental approach for compliance testing was developed and applied:

- Development of a numerical model of the device preferably based on CAD data
- Experimental verification of the accuracy of the model through validation, e.g., field distribution, feedpoint impedance or radiated power
- Experimental evaluation of worst-case configurations, e.g., due to different positioning of the implant leads
- Numerical evaluation of worst-case configurations with respect to the tissue distribution using generic layered body models
- Verification of the worst-case configuration by simulations in anatomical high-resolution models of different adults and children
- Comprehensive uncertainty assessment

The procedure will provide agencies and manufacturers with the certitude that the device operates within the intended specifications. It is envisioned that the working group for implants, recently initiated by the FDA, will generate the basis allowing for less complex evaluations.

General Mobile Transmitters for Indoor and Office Applications

Short-range wireless RF devices are becoming increasingly and haphazardly prevalent in homes and

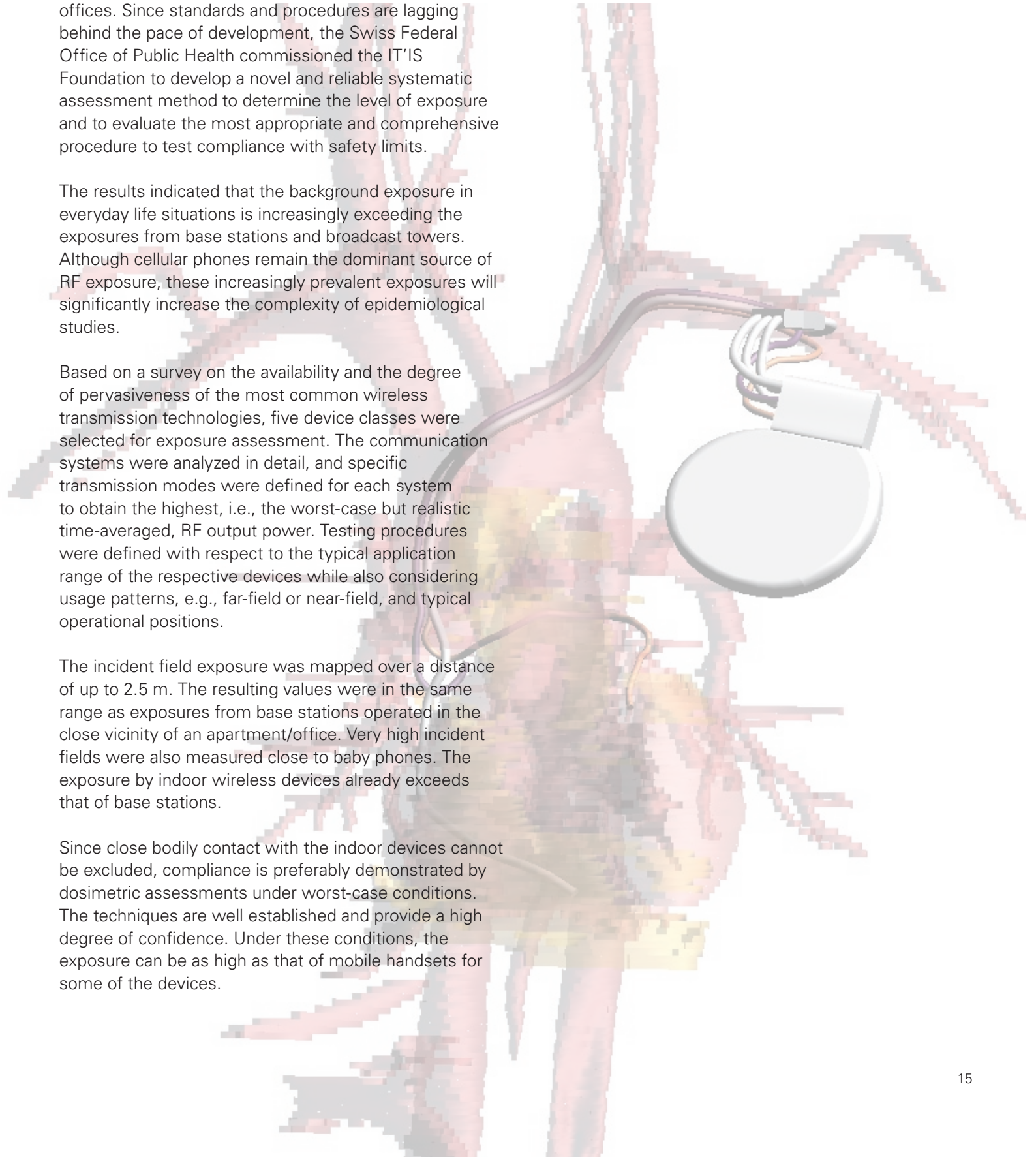
offices. Since standards and procedures are lagging behind the pace of development, the Swiss Federal Office of Public Health commissioned the IT'IS Foundation to develop a novel and reliable systematic assessment method to determine the level of exposure and to evaluate the most appropriate and comprehensive procedure to test compliance with safety limits.

The results indicated that the background exposure in everyday life situations is increasingly exceeding the exposures from base stations and broadcast towers. Although cellular phones remain the dominant source of RF exposure, these increasingly prevalent exposures will significantly increase the complexity of epidemiological studies.

Based on a survey on the availability and the degree of pervasiveness of the most common wireless transmission technologies, five device classes were selected for exposure assessment. The communication systems were analyzed in detail, and specific transmission modes were defined for each system to obtain the highest, i.e., the worst-case but realistic time-averaged, RF output power. Testing procedures were defined with respect to the typical application range of the respective devices while also considering usage patterns, e.g., far-field or near-field, and typical operational positions.

The incident field exposure was mapped over a distance of up to 2.5 m. The resulting values were in the same range as exposures from base stations operated in the close vicinity of an apartment/office. Very high incident fields were also measured close to baby phones. The exposure by indoor wireless devices already exceeds that of base stations.

Since close bodily contact with the indoor devices cannot be excluded, compliance is preferably demonstrated by dosimetric assessments under worst-case conditions. The techniques are well established and provide a high degree of confidence. Under these conditions, the exposure can be as high as that of mobile handsets for some of the devices.



NEW THERMO-SOLVER

The SEMCAD X simulation platform developed in cooperation with SPEAG is a general electromagnetic software package with a powerful front-end for predicting the EM-field in living organisms. Version 10.0 *Eiger* released at the end of 2005 offers enhanced and superior performance, e.g., with respect to speed (10 to 50 times faster) and CAD handling capabilities compared to other major simulation tools.

In addition to the EM solvers, including optimized SAR evaluations, SEMCAD X also includes a solver for the Pennes Bioheat Transfer Equation (BHTE). This equation considers blood flow by introducing a continuum model with an effect proportional to the local temperature and tissue-specific perfusion. Furthermore, specific heat generation rates can be assigned to each tissue. However, when circulatory effects prevail, the BHTE does not sufficiently account for the directivity of the blood-flow, the discreteness of blood vessels and the temperature dependence of various parameters. Although the BHTE solver was developed in 1948 and is included in most other software packages, our new model based on Pennes' approach corrects certain deficiencies by permitting:

Tensorial heat conductivity: The directivity of blood flow is accounted for. In addition, a scheme using the tensorial k reduces staircasing effects on the boundary.

Coupling to a pseudo-1-D simulation of the vessel network: The discreteness of blood flow is considered by simulating large blood vessels individually and exchanging heat with the 3-D simulation through a heat sink mechanism. Consequently, the vessel network will determine the local tensor character of the heat conductivity, enabling it to vary throughout a single organ/tissue.

Temperature dependent parameters: Perfusion, thermal conductivity and electrical conductivity (and therefore SAR) can be made temperature dependent. Although only simple dependencies are currently possible, ongoing research aims to extend this. Additionally, the metabolic heat generation rate can be time dependent.

Results from various EM simulations can be coherently added and individually scaled before they are used for heating. The scaling can be time-modulated, allowing for pulsed heating. Various boundary conditions (fixed temperature, flux, heat transfer or combinations) can be specified for all interfaces between different solids if required. A conformal subcell model was developed to reduce staircasing errors at interfaces.

The 3-D simulation was optimized for both speed and reduced memory requirements. Similar to the EM solver, the thermal solver uses the FDTD method on graded meshes, enabling highly detailed models and large simulations. The solver was integrated into the SEMCAD X front-end.

This new thermo-solver and blood flow model offers many new possibilities in BioEM because more realistic images of the induced temperature distribution and more reliable simulations can be attained. The proposed model includes many improvements over the Pennes model, while retaining its simplicity. Only the largest blood vessels (which can easily be segmented) must be specified (if desired), while helping to obtain improved behavior patterns even for regions with finer vessels. Furthermore, many parameters determined for the Pennes model can be reused. Future improvements might include models for thermoregulation, irreversible tissue changes and improved non-linearities. ADI or similar numerical schemes will be tested to further optimize speed. In 2006, suitable experimental validation benchmarks will be developed since these modeling techniques should be the basis for the reliable and accurate prediction of the temperature distribution in future hyperthermia modeling techniques and applications.

SERVICES

Antenna Design
The IT'IS Foundation is an internationally renowned competence center in several areas, ranging from investigations and validations of antennas for active medical implants and on-body wireless communication devices to consulting and design support with detailed evaluations of RF safety compliance and immunity to EMI. Consultations on standards and homologation rules include the revision of technical requirements, the assessment of regulation procedures and the evaluation of impending standards. A superbly maintained on-site laboratory for RF and LF near-field measurements in liquids and free-space ensures accurate and efficient evaluations using the latest tools for analysis and simulation, such as DASY4 and SEMCAD X.

RF Safety and Compliance of RF Transmitters and Medical Implants
The IT'IS Foundation conducts compliance testing for RF applications to satisfy all national and international EMF safety guidelines. Globally regarded as the preeminent, truly independent institute for dosimetric evaluations, the Foundation has become a pacesetter for developing advanced near-field analysis tools and is at the forefront in developing the most accurate and suitable testing procedures. The advent of the wireless revolution has encouraged the IT'IS Foundation to extend its simulation and testing capabilities to MR imaging and similar technologies. The Foundation is currently applying for Class C accreditation for testing compliance with safety limits, which will enable IT'IS to develop and apply new methodologies beyond the current test protocols specified in standards for the evaluation of devices using RF energy.

Safety White Papers
As a leading player in the global effort on health risk assessment research and an active participant in commissions developing EMF safety guidelines, the IT'IS Foundation provides a full range of safety white papers. Numerous international organizations, industries and governments have entrusted the Foundation to draft safety white papers for existing and future technologies, as well as for the devices needed for their implementation. For example, risk evaluations may include an EMF risk analysis and predictions for worst-case exposures and worst-case temperature increases.

EMF Workshops
The IT'IS Foundation organizes customized workshops on EMF-related issues of current interest in collaboration with our national and international partners. On-site and specialized workshops and seminars can also be arranged upon request.

INFRASTRUCTURE

Dosimetric, Near-Field and EMC/EMI Facilities

Semi-Anechoic Chamber
This shielded, rectangular chamber has the dimensions 7 x 5 x 2.9 m (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 DASY4professional 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, etc.

Reverberation Chamber
This is a shielded, rectangular chamber with the dimensions 4 x 3 x 2.9 m (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. Class C accreditation is expected in 2006 through METAS for all types of dosimetric evaluations.

Technical Equipment and Instrumentation

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

Signal Generators and Testers
1 Agilent E4433B, Signal Generator, 4 GHz
1 Agilent E8251A, Signal Generator, 250 KHz–20 GHz
1 Rhode & Schwarz SMT06, Signal Generator
1 Rhode & Schwarz SMIQ02B, Signal Generator
1 Rhode & Schwarz SML03, Signal Generator
2 Rhode & Schwarz SML02, Signal Generator
1 Rhode & Schwarz SMY02, Signal Generator
1 HP 8647A, Signal Generator 250 KHz–1000 MHz
1 Agilent 33250A, Waveform Generator
3 Agilent 33120A, Waveform Generator
1 Rhode & Schwarz CTS55, Digital Radio Tester

DASY and EASY4
1 SPEAG DASY4professional
1 SPEAG Twin SAM Phantom
2 SPEAG ELI4 Phantom
1 SPEAG HAC Extension
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
3 SPEAG H3DV6, H-Field Probe
1 SPEAG EX3DV3, E-Field Probe
2 SPEAG EE3DV1, E-Field Probe
2 SPEAG ER3DV6, E-Field Probe
1 SPEAG EF3DP6, E-Field Probe
3 SPEAG ET3DV6R, E-Field Probe
3 SPEAG ET3DV6, E-Field Probe
1 SPEAG ET1DV1, E-Field Probe
2 SPEAG ET1DV2, E-Field Probe
Tissue Simulating Liquids 27 MHz–6 GHz

Meters
2 Agilent E4419B, 4 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
1 LS Elektronik 2450, Amplifier, 400 W / 900 MHz
3 LS Elektronik 2449, Amplifier, 200 W / 900 MHz
2 LS Elektronik 2448, Amplifier, 60 W / 900 MHz
3 LS Elektronik 2452, Amplifier, 200 W / 1800 MHz
1 LS Elektronik 2451, Amplifier, 60 W / 1800 MHz
1 LS Elektronik 2447, Amplifier, 5 W / 1800 MHz
2 LS Elektronik 2780, Amplifier, 40 W / 2140 MHz
1 Amplifier Research 10S1G4A, Amplifier 800 MHz–4.2 GHz
2 Kalmus 717FC, RF Power Controller 200–1000 MHz
1 Nucletudes ALP336, Amplifier 1.5–2.5 GHz

Other Equipment
1 Narda H2304/101 Exposure Level Tester 1 Hz–400 KHz
8 Maury 1878B, 3-Step Tuner
1 Siemens, Universale Messleitung (0.5) 1–13 GHz
6 Validation Dipole D835, D900, D1640, D1800, D2450, D5GHz
2 SPEAG Dipole SCC34 Benchmark
8 Various Antennas
1 Tektronik 2235, Oscilloscope
1 Heraeus BB6620, Incubator
1 Opus 10 Thermo-Hygrometer
1 PTM 3000 Thermometer

Computers
4 UNIX Solaris 5.6/5.8: 1 Sun Blade 100, 1 Dual 450 MHz, 2 Sun Ultra Sparc2
20 MacOS X: 2 PowerMac G5, 3 PowerMac G4, 1 eMac G4, 1 iMac G4, 9 PowerBook G4, 1 iBook G4, 1 iBook G3, 1 PowerMac G3, 1 iMac G3
30 WinNT/Win2k/WinXP/WinXPx64: 2 Dalco AMD Dual Opteron 2.61 GHz, 1 Dalco Dual-Core AMD Opteron 2.21 GHz, 1 Dell Optiplex GX260 P4 2.2 GHz, 2 Dell OptiPlex GX110, 2 Dell OptiPlex GX100, 1 Compaq EVO, 1 Dell Dimension 4300 P4 1.5 GHz, 1 Dell Dimension 4700 P4 3 GHz, 1 Dell Dimension 5000 P4 3.2 GHz, 6 Dell Dimension 8200 P4 1–3 GHz, 3 Dell Dimension 8250 P4 1–3.4 GHz, 4 Dell Dimension 8300 P4 2.6–3 GHz, 1 Dell Dimension 8400 P4 3.2 GHz, 1 Dell Inspirion P4 2.5 GHz, 1 IBM Notebook PM 240 MHz, 2 HP Vectra vl420MT P4 1.5 GHz
3 LINUX: 1 Dual P4, 2 AMD Dual Opteron (2 aXware ClusterInABox Hardware Accelerators)

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IT'IS FOUNDATION

History
The IT'IS Foundation was established in 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. IT'IS stands for Information Technologies in Society.

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

Commitment
We are committed to the advancement of science for the benefit of society at large while maintaining strict independence from any particular interest groups. We strive for open dissemination of research results and the education and professional growth of young scientists.

Funding
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