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Annual Report 2014

Electromagnetic Theory

Electromagnetic Theory
Department of Electrical and Information Technology
Lund University
Sweden

Editors: Anders Karlsson and Mats Gustafsson

Lund, December 30, 2015

Preface

The tradition of annual reports for the electromagnetic theory group has been kept since Gerhard Kristensson was installed as professor in 1989. It is a documentation of our activities in research and teaching. For people outside the group the annual report gives an insight in our research. For our group the annual reports are documents that contain our history. Whenever we need information about earlier activities we can easily find it in the reports. During the years Gerhard Kristensson has been the editor of the annual report. He retired in December 31, 2014, and even though he is very active as emeritus, it is more than fair that he now hand over the responsibility for the annual reports to others.

An important part of the report is the research activities. In Section 2.5 on page 6 a complete list of external funding during 2014 is presented. Our research critically depends on external funding, and we are fortunate to have support from a number of sources including the Swedish Research Council (VR), European Space Agency (ESA), the Swedish National Space Board, VINNOVA, the Swedish Foundation for Strategic Research (SSF), the Swedish Defence Materiel Administration (FMV), and European Spallation Source (ESS). All these generous supports are gratefully acknowledged.

Our research is to a great extent done in collaboration with researchers from leading Swedish industry. This is borne out by the many Adjunct professors that we have in the group, see Section 2.3 on page 5. We welcome Torleif Martin as an Adjunct professor, see Fig. 2. We see strong mutual benefits from both parts in this interaction, and we are looking forward to continuing and deepening this collaboration.

Many conferences have been attended by the members of the group during 2014. A list of our efforts at conferences during 2014 is presented in Section 6.5 on page 25.

To honour Gerhard we arranged en event called Gerharddagen on January 15, 2015. In Section 1.1 we give a review of this event.

Casimir Ehrenborg and Jakob Helander, see Figure 2, started their graduate studies in the fall 2014. Marius Cismasu presented his thesis in October, see Figure 8 and Section 4.1.

Figure 1: The Gerharddagen was a great success with 55 participants.

Figure 2: Casimir Ehrenborg, Jakob Helander, and Torleif Martin.

Contents

1 The Electromagnetic Theory Group

1.1 General

The Faculty of Engineering (Lunds Tekniska Högskola, LTH) is Sweden's third largest higher educational institute for the engineering sciences, and is part of Lund University — one of the oldest and largest universities in Scandinavia. The Faculty of Engineering consists of 19 departments, some of which are divided into divisions. The Electromagnetic Theory Group is within the Department of Electrical and Information Technology.

The basis for the research and teaching activities of the group is the application of the fundamental macroscopic electromagnetic laws to the generation and propagation of electromagnetic waves in vacuum or materials. Special emphasis is given to the theoretical study of the various devices that can be constructed to amplify and regulate these effects. In our ambition to achieve these goals, analytical, numerical, and experimental techniques are utilized by the group.

The main research activities are concentrated in the area of electromagnetic scattering theory, *e.g.*, antenna and radome applications. Progress in this area is fundamental for the development of devices and technologies that use electromagnetic waves for information exchange. The last few decades have demonstrated an increasing need and demand for technology.

During the last decades, wave propagation phenomena in periodic structures has been a prosperous research field for the Electromagnetic Theory Group. Another important field of research of the group is related to antennas. The use of multiple antenna systems has received growing interest, both in industry and academia, due to the ability to increase the spectral efficiency of wireless communication. In many cases it is desirable to have both high capacity and small physical size. Research in the group has been directed towards establishing physical limitations on information capacity based on antenna size and the wave propagation environment.

The two largest research facilities in Sweden, MAX IV and the European Spallation Source (ESS), are located in Lund. This is making Lund to one of Europe's major centers for particle accelerator infrastructures. Since 2010 the group has gradually increased research activities in this field.

The home page of the Department of Electrical and Information Technology is: **www.eit.lth.se/research/emtheory**. From this home page it is easy to find more, and up to date, information of the Electromagnetic Theory Group.

Gerharddagen

Gerhard retired December 31, 2014, and to hour him we arranged the Gerharddagen on January 15, 2015. It was a day devoted for Gerhard. We invited all of his friends in the scientific world and his family. The day was filled with talks that gave an overview of Gerhards life. The day also served as a meeting for old friends. Old colleagues met each other and at lunch and dinner there was a loud sound from vivid discussions and laughter. There was a surprise for Gerhard when two video recordings with greetings from Margaret Cheney, Colorado State University, US, and from David Wall, University of Canterbury, Christchurch, New Zeeland.

The guests at Gerharddagen were:

Chalmers: Anders Boström, Peter Olsson, Thomas Rylander, Sten Salomonson

The Royal institute of Technology: Jockum Aniansson, Lars Jonsson, Martin Norgren

EIT, Lund University: Gerhard Kristensson with wife Mona-Lisa Kristensson, Mats Gustafsson, Karlsson Anders with wife Karin Allén, Richard Lundin, Daniel Sjöberg, Alexander Bondarik , Gabriele Costanza, Casimir Ehrenborg, Andreas Ericsson, Jakob Helander, Doruk Tayli, Iman Vakili, Anders Johansson, Buon Kiong Lau, Lars Olsson, Johan Wernehag, Viktor Öwall

Other departments Lund University: Johan Helsing, Elias Kristensson, Leif Sörnmo

Linnæus University: Börje Nilsson, Sven Nordebo

SNRV Carl-Henrik Walde

FMV Stefan Gabrielsson

SAAB Jakob Bjerkemo, Anders Höök, Christer Larsson, Torleif Martin, Jan Rexander, Sten Rikte

FOI Peter Krylstedt, Lars Pettersson, Niklas Wellander

ACAB Michael Andersson, Alireza Kazemzadeh, Sören Poulsen, Björn Widenberg

ESS Anders Sunesson

Ericsson Anders Derneryd, Jonas Fridén

Others Björkberg Jonas (Viati), Igor Egorov (Sigma Connectivity), Henrik Otterheim (Adobe), Kristin Persson (Zacco), Anja Skrivervik (Ecole Polytechnique, Lausanne) Ingegerd Åberg (Malmö högskola)

2 Personal summary of the activities 1989-2014

Twenty-five years of research and teaching activities create many memories and they make a nice background of the stage. It is not easy to summarize all these years in a few lines, and it is not my ambition to be exhaustive in the details. The Annual Reports give a complete picture of the activities. Looking back there are many happy and successful moments but also several dead ends.

It is natural to start in 1989, when I accepted the chair at Lund University. Leaving an internationally well-established research group at the Royal Institute of Technology in Stockholm and starting to build up a research activity at Lund University was a challenge indeed. I made the move with some hesitations. During the first years, the focus was on developing new and relevant advanced undergraduate courses. The purpose of this effort was to attract dedicated new students. Great effort was devoted to launch the new course in electromagnetic wave propagation (later split into another course in scattering theory), and many hours were spent writing a suitable advanced textbook. The course was very successful, and this plan turned out to be a very successful strategy. Almost all our new talented students in the group entered to our graduate program via this course. At that time, I had three graduate positions financed by the state, which of course made the expansion of the group a lot easier.

Despite the success with the new undergraduate course, it was obvious that we were understaffed in research personnel and senior researchers that could supervise graduate students. In retrospect, the single most important event during my 25 years at Lund University was the move of Anders Karlsson from KTH to Lund in 1992. At an instant, the senior research capacity doubled. Anders had an immediate impact on the development of the research activities. It was a big improvement of the research situation. The successful development of the group is shared with Anders.

It is well known that my enthusiasm for administrative duties is quite limited. I have done my duties to the university and been a member on almost all boards, but stayed away from all major administrative duties. Our affiliations has changed during these 25 years. During the first ten years the group was an independent department (Department of Electromagnetic Theory). The last years as an independent department we were under financial pressure, and in 2000 we amalgamated with another department and formed the Department of Electroscience. This successful merge turned also out to be too small, and in 2007 the Department of Electrical and Information Technology (EIT) was formed. The merges have been smooth, but also scientifically stimulating and rewarding for the group.

The progress of the scientific endeavor of the Electromagnetic Theory group can be illustrated by the number of technical reports that has been written over the years. These technical reports are available on our home page, and they have become a landmark of the group. Scientists all around the world have recognized our technical reports and they have made the group rather unique the way we share our knowledge.

As seen from Figure, the cumulative number has steadily been growing. Maybe the most striking observation is that we manage to produce reports at approximately the same rate during the first years as during later years when the number of potential authors was many more.

We had had many visiting scientists during the years. The annual reports list them all, but a few international scientists have returned several times or stayed during a longer period. The first that comes to mind is David Wall from University of Canterbury in New Zealand. David has visited us numerous times, and he has also provided opportunities for scientist in the group to visit New Zealand. Three times, I spent longer visits to New Zealand, and each time I returned back with new ideas that later became suitable graduate research programs. Margaret Cheney, presently at Colorado State University, was appointed the first Lise Meitner professor at the Engineering School in Lund, and this appointment had great impact on the scientific development of the group. During a whole year in the late 90's Ari Sihvola, now at Aalto University in Finland, spent a whole year with our group. All these long visits made an impact on the direction of research.

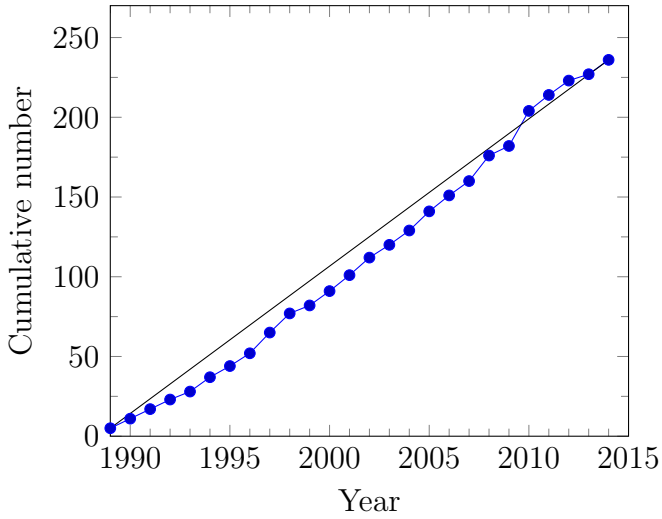

Figure 3: Cumulative number of technical reports during 1989–2014.

2.1 Personnel

The personnel employed in the group during 2014 is given in the following table:

Name	Degree[a]	Position[b]
Alexander Bondarik	MSc	D
Marius Cismasu[c]	MSc	D
Gabriele Costanza	MSc	D
Casimir Ehrenborg[d]	MSc	D
Andreas Ericsson	TeknD	FA
Mats Gustafsson	TeknD, Doc	P
Jakob Helander[e]	MSc	D
Anders Karlsson	TeknD, Doc	P
Buon Kiong (Vincent) Lau[f]	TeknD, Doc	UL
Gerhard Kristensson	FD, Doc	P
Richard Lundin	TeknD	UL
Daniel Sjöberg	TeknD, Doc	P
Doruk Tayli	MSc	D
Iman Vakili	MSc	D

[a] Doc Docent; FD Doctor of Philosophy, PhD; MSc Master of Science; TeknD PhD in Engineering; TeknL Licentiate in Engineering
[b] D Graduate Student; FA Postdoctoral Research Fellow; P Professor; UL Senior Lecturer
[c] Ended his employement 2014-10-31
[d] Started his employement 2014-08-01
[e] Started his employement 2014-11-01
[f] Employed by the Communications group.

2.2 External graduate students (industridoktorander)

This section lists the group's graduate students who are in full-time employment, and at the same time are graduate students in the Electromagnetic Theory Group.

Name	Degree[a]	Company
Michael Andersson	TeknL	Applied Composites AB, Linköping
Magnus Gustafsson	CI	Swedish Defence Research Agency, FOI
David Olsson	CI	Max IV
Renato de Prisco	MSc	European Spallation Source (ESS)

[a] CI Master of Engineering; MSc Master of Science; TeknL Licentiate in Engineering

2.3 Adjunct professors

Four adjunct professors are associated with the Electromagnetic Theory Group:

Name	Degree[a]	Company
Anders Derneryd[b]	TeknD	Ericsson AB
Christer Larsson	FD, Doc	Saab Dynamics AB
Torleif Martin[c]	TeknD	Saab Aeronautics, Saab AB
Niklas Wellander	TeknD	Swedish Defence Research Agency, FOI

[a] Doc Docent
FD Doctor of Philosophy, PhD
TeknD PhD in Engineering
[b]Ended his professorship 2014-06-30
[c]Started his professorship 2014-06-01

2.4 Visiting scientists

Several Visiting scientists take part in the scientific activities and participate in joint projects with researchers in the group. These are:

Name	University
Sven Nordebo	Linnaeus University, Växjö, Sweden

2.5 External funding

The external research support during 2014 is given by:

- The Swedish Research Council (VR). *Principal investigator:* Mats Gustafsson. *Title of the project:* "Optimal antennas integrated in communication and sensor devices".
- The Swedish Research Council (VR). *Principal investigator:* Buon Kiong Lau. *Title of the project:* "Ny antenn system design paradigm för hög prestanda i mobil kommunikation (Novel Antenna System Design Paradigm for High Performance Mobile Communications)".
- European Space Agency (ESA, prime contractor TU Eindhoven, Holland). *Principal investigator:* Daniel Sjöberg. *Title of the project:* "Circular Polarisation Dual-Optics Proof-of-Concept".
- Swedish National Space Board. *Principal investigator:* Daniel Sjöberg. *Title of the project:* "Electromagnetic homogenization of reflector antenna surfaces at vibro-acoustic co-optimization".
- VINNOVA-FFI. *Principal investigator:* Buon Kiong Lau. *Title of the project:* "Simulation and Design of Integrated Vehicular Antennas (SDIVA)".
- VINNOVA. National Aeronautical Research Program (NFFP6). *Principal investigator:* Daniel Sjöberg and Christer Larsson. *Title of the project:* Signature management for low-flying vehicles.

- VINNOVA. National Aeronautical Research Program (NFFP6). *Principal investigator:* Daniel Sjöberg and Torleif Martin. *Title of the project:* Electromagnetic characterization of composite structures.
- VINNOVA. National Aeronautical Research Program (NFFP6). *Principal investigator:* Daniel Sjöberg. *Title of the project:* Computational Method for an AEW end-fire antenna.
- Swedish Foundation for Strategic Research (SSF). *Principal investigator:* Mats Gustafsson. *Title of the project:* Applied Mathematics and the project Complex analysis and convex optimization for EM design.
- Swedish Foundation for Strategic Research (SSF) Strategic Mobility Grant. *Principal investigator:* Mats Gustafsson for collaboration with Ericsson research.
- Swedish Defence Materiel Administration (FMV), sponsoring several projects in collaboration with Swedish industry.
- Saab Dynamics AB. Sponsoring the Adjunct professorship of Christer Larsson.
- European Spallation Source (ESS). Financing of an external graduate student. *Title of the project:* "Design of drift tube linac for ESS".
- Crafoord foundation. *Principal investigator:* Daniel Sjöberg. Funds for near field measurements of millimeter waves.
- Crafoord Foundation. *Principal investigator:* Buon Kiong Lau. Design of Multi-antennas for High Performance Mobile Terminals.
- Royal Physiographic Society in Lund. *Principal investigator:* Andreas Ericsson. Funds for circular polarization selective structures.
- Royal Physiographic Society in Lund. *Principal investigator:* Iman Vakili. Funds for millimeter wave equipment.
- Royal Physiographic Society in Lund. *Principal investigator:* Gabriele Costanza. Funds for high performance computing.

3 Research Activities

The current research projects of the group are organized into four main categories:

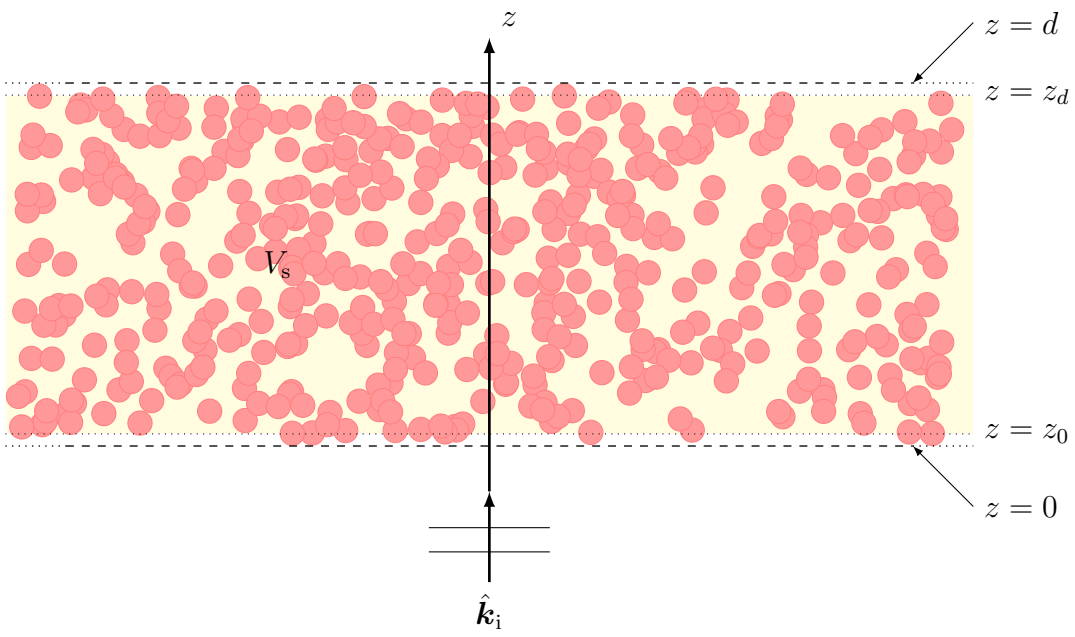

Figure 4: The geometry of the stratified scattering region used in TEAT-7236. The yellow region denotes the region V_s, which is the domain of possible locations of local origins, *i.e.*, the interval $[z_0, z_d]$.

3.3 Inverse scattering and imaging

3.4 Antennas and communication

3.5 Accelerator engineering

The following subsections give a short general description of the research conducted by the group for each research area above, followed by a list of recent literature produced within the group. Only journal papers are cited explicitly, which serves the double purpose of documenting the researchers involved, and providing key words describing the activities. Full references for conference contributions and technical reports can be found in Sections 4.4 and 4.7, respectively.

3.1 Material modeling and electromagnetic interaction

In this research area, the group's focus is on the interaction between electromagnetic fields and material structures. This includes wave propagation in complex materials and structures (inhomogeneous, nonlinear, anisotropic, chiral, frequency selective etc), and mathematical modeling of the physical mechanisms behind the interaction (representations of dispersive effects, homogenization).

The primary question in this activity examines the possibility to reduce the amount

of information needed to describe the interaction. For example, wave propagation in strongly inhomogeneous media (many parameters) can be modeled as wave propagation in homogeneous materials (very few parameters) if the wavelength is sufficiently large compared to a characteristic length for the media. This reduction is called homogenization. The properties of the effective homogeneous media must be carefully calculated, usually from a static or quasi-static field perspective. In another class of problems, interaction on an electronic scale can be modeled with voltages and currents in classical circuit models. Here the major challenge lies in constructing accurate models, including the calculation of circuit parameters from static or quasi-static field problems.

3.2 Electromagnetic scattering and design

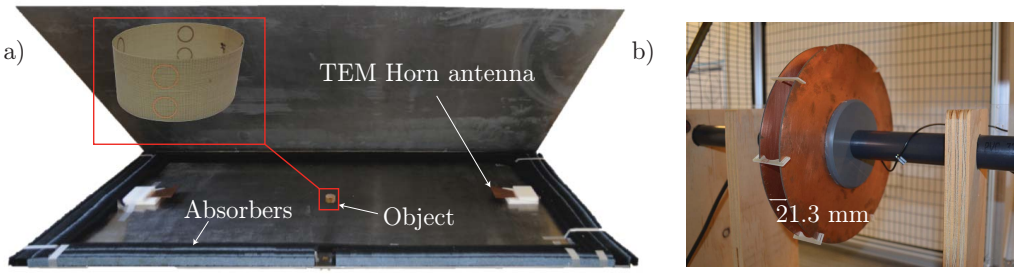

Figure 5: The parallel plate waveguide (left) and capacitor (right) used in TEAT-7229.

Under this heading, the scattering problem is of central importance, that is, when a prescribed electromagnetic field interacts with a particular object (the scatterer), the task is to determine the scattered field. There is often a particular design goal associated with the scattering, for instance to minimize the scattering for all frequencies, maximize the transmission through a panel for a certain frequency band, or maximize the scattering in order to obtain the most information on the object.

The design of complex structures and systems to obtain the design goals relies on the combination of relatively simple physical models to assert the overall function, as well as general or highly devoted numerical codes to compute the specific details of the different constituents. Much of our work in this category is performed in collaboration with industry, that often supply the broader systems perspective.

3.3 Inverse scattering and imaging

In this category, the goal is to infer information on some object or structure using electromagnetic waves, including light. Depending on what is *a priori* known about the object and scattering situation, different strategies may be employed. One alternative is to back propagate the measured field through a region which is known

(usually air), as close as possible to the scatterer, and then see what equivalent currents this corresponds to. Another alternative is to set up several theoretical models of the scatterer, and see which one fits the measured data best. This usually results in computationally demanding algorithms.

A more specific set of problems is termed imaging. Here, the aim is to obtain an overall image of the scatterer, for instance its shape or location. This can sometimes be obtained in a relatively straightforward way from the scattering data, especially in the high frequency limit (ray optics).

3.4 Antennas and communication

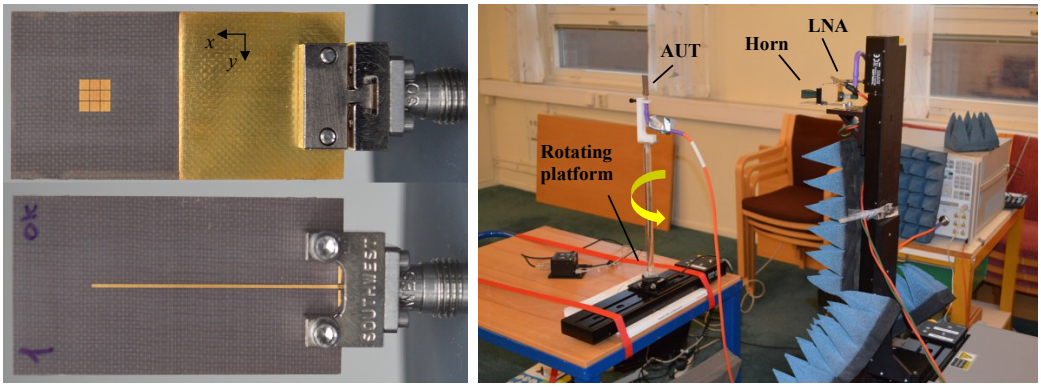

Figure 6: The gridded parasitic patch stacked microstrip antenn analyzed in TEAT-7233. (left) fabricated antenna and (right) measurement setup.

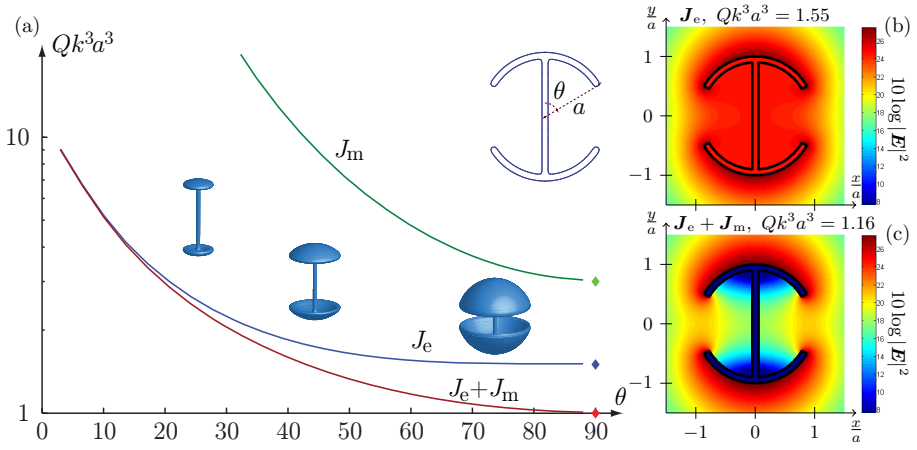

Figure 7: The capped spherical dipole as an example geometry analyzed in TEAT-7234. Minimum Q-factor for electric $\boldsymbol{J}_\mathrm{e}$ and combinations of electric and magnetic $\boldsymbol{J}_\mathrm{m}$ current densities.

In a wireless system, the antenna is the interface between the electric circuitry and waves propagating in the surrounding medium. From a system point of view, the antenna suffers from several fundamental limitations in terms of available bandwidth, gain *etc.* versus, for instance, the available volume or complexity in the matching network. New antenna concepts such as MIMO (Multiple Input, Multiple Output) provide new opportunities for increased performance.

Our investigations of antennas and wireless systems concern sharpening of fundamental limitations of antennas in various circumstances. We also deal with higher levels of integration, for instance of the antenna with the amplifier or the matching network, or the antenna and the surrounding structure, including the interaction of the user. Simple, but yet accurate, methods of quantifying the performance of MIMO systems are investigated. Computational means of simulating the antenna and related structures are also developed. Moreover, the Theory of Characteristic Modes (TCM) has been applied to achieve MIMO antenna designs for mobile terminals, which provide not only high isolation between the antenna ports, but also significantly wider bandwidths than conventional methods through effectively synthesizing and exciting multiple resonant modes on the mobile chassis.

Collaboration with other research groups at the department is established. Together with the Nanoelectronics group we develop non-dispersive and ultra-wideband antenna system consisting of a leaky lens antenna and an RTD-MOSFET wavelet generator for time domain applications at mm-wave frequencies.

3.5 Accelerator engineering

This activity started in 2010 with the establishment of collaborations with both MAX IV Laboratory and the ESS. Since the fall of 2011 we are running a project, financed by ESS, on the design of the drift tube linac of ESS. The DTL is located in the first part of the accelerator and accelerate the protons from 3 MeV to 80 MeV. The project is done in collaboration with INFN in Legnaro, Italy, and involves one PhD student, Renato de Prisco. In January 2013 a new project started that involves one graduate student, Gabriele Costanza, and concerns the design of the medium beta elliptic cavities that are an important part of the ESS accelerator. These cavities are superconducting and are used in the last part of the accelerator.

Together with MAX IV Laboratory a project concerning design of RF-units for acceleration and deflection of the electron beam has been initiated. The PhD student David Olsson is running this project in collaboration with Lars Malmgren at MAX IV and Anders Karlsson.


Figure 8: (left) Faculty opponent Anja Skrivervik and Marius Cismasu. (right) Gerhard Kristensson, Anja Skrivervik, Marius Cismasu, Peter Meincke, Jian Yang, Magnus Herberthson, Mats Gustafsson, Daniel Sjöberg, Ying Zhinong.

4 Dissertations, Published papers and Reports

4.1 Doctoral dissertations

Marius Cismasu, "Antenna Analysis and Design Using Stored Energies and Physical Limitations", October 27, 2014.

Faculty opponent: Professor Anja Skrivervik. École polytechnique fédérale de Lausanne, Switzerland

Examining committee:

1) Dr Peter Meincke, TICRA, Copenhagen, Denmark
2) Professor Jian Yang, Chalmers, Gothenburg, Sweden
3) Professor Magnus Herberthson, Department of Mathematics, Linköping University, Sweden

Alternate member: Ying Zhinong, Sony Mobile, Lund, Sweden.
Chairman: Daniel Sjöberg, Lund University, Sweden.
Supervisor: Mats Gustafsson, Lund University, Sweden.
Co-supervisor: Gerhard Kristensson, Lund University, Sweden.

Abstract: A method to estimate Q and QZ' of antennas from single-frequency current distributions is described. This single-frequency method and the concepts of physical bounds on antenna parameters and optimum current distributions are applied to different analysis and design situations of two-dimensional and three-dimensional radiating structures (i.e., antennas). The situations considered are: antenna optimization using a genetic algorithm and the single-frequency Q computation for single or multi-band operation, antenna placement optimization in a wireless device using physical bounds, and antenna optimization that includes QZ' in the objective function. Antenna performance is compared with physical bounds or optimum-current performance in the situations studied.

The results presented in this thesis suggest that single-frequency methods may re-

duce the time necessary to optimize automatically, e.g., using a computer, some antenna parameters such as bandwidth. Furthermore, physical bounds and optimum current distributions are tools that provide valuable information for the processes of antenna analysis and design

4.2 Licentiate dissertations

No licentiate dissertations were presented this year.

4.3 Journal publications

J1. Marius Cismasu and Mats Gustafsson. Antenna Bandwidth Optimization with Single Frequency Simulation. *IEEE Transactions on Antennas and Propagation*, 62(3):1304–1311, 2014.

J2. Marius Cismasu and Mats Gustafsson. Multiband Antenna Q Optimization using Stored Energy Expressions. *IEEE Antennas and Wireless Propagation Letters*, 13:646–, 2014.

J3. Stefan Gustafsson, Thomas Biro, Gokhan Cinar, Mats Gustafsson, Anders Karlsson, Börje Nilsson, Sven Nordebo, and Mats Sjöberg. Electromagnetic Dispersion Modeling and Measurements for HVDC Power Cables. *IEEE Transactions on Power Delivery*, 29(6):2439–2447, 2014.

J4. Johan Helsing and Anders Karlsson. An explicit kernel-split panel-based Nyström scheme for integral equations on axially symmetric surfaces. *Journal of Computational Physics*, 272:686–, 2014.

J5. Hui Li and Buon Kiong Lau. Efficient evaluation of specific absorption rate (SAR) for MIMO terminals. *IET Electronics Letters*, 50(22):1561–1562, 2014.

J6. Hui Li, Zachary Miers, and Buon Kiong Lau. Design of Orthogonal MIMO Handset antennas based on characteristic mode manipulation at frequency bands below 1 GHz. *IEEE Transactions on Antennas and Propagation*, 62(5):2756–2766, 2014.

J7. Sven Nordebo, Mats Gustafsson, Börje Nilsson, and Daniel Sjöberg. Optimal realizations of passive structures. *IEEE Transactions on Antennas and Propagation*, 62(9):4686–4694, 2014.

J8. Lars Ohlsson, Tomas Bryllert, Daniel Sjöberg, and Lars-Erik Wernersson. Monolithically-Integrated Millimetre-Wave Wavelet Transmitter With On-Chip Antenna. *IEEE Microwave and Wireless Components Letters*, 24(9):625–627, 2014.

J9. Kristin Persson, Mats Gustafsson, Gerhard Kristensson, and Björn Widenberg. Radome diagnostics - source reconstruction of phase objects with an equivalent currents approach. *IEEE Transactions on Antennas and Propagation*, 62(4):2041–2051, 2014.

J10. Rebecca Seviour, Ian Bailey, Nathan Woollett, and Peter Williams. Hidden-sector photon and axion searches using photonic band gap structures. *Journal of Physics G-Nuclear and Particle Physics*, 41(3):035005–, 2014.

J11. Iman Vakili, Mats Gustafsson, Daniel Sjöberg, Rebecca Seviour, Martin Nilsson, and Sven Nordebo. Sum Rules for Parallel Plate Waveguides: Experimental Results and Theory. *IEEE Transactions on Microwave Theory and Techniques*, 62(11):2574–2582, 2014.

J12. Niklas Wellander and Gerhard Kristensson. Estimates of scattered electromagnetic fields. *Mathematical Methods in the Applied Sciences*, 37(2):167–172, 2014.

J13. Torbjörn Ödman, Maria Lindén, and Christer Larsson. Reflection/Transmission study of two fabrics with microwave properties. *Studies in health technology and informatics*, 200:95–, 2014.

4.4 Conference publications

C1. Renato de Prisco, Anders Karlsson, Mohammad Eshraqi, Michele Comunian, Francesco Grespan, and Andrea Pisent. ESS DTL status: redesign and optimizations. In *IPAC2014, 2014-06-15*, 2014.

C2. Renato de Prisco, Anders Karlsson, Mohammad Eshraqi, Ryoichi Miyamoto, and Edgar Sargsyan. Error study on the normal conducting ESS linac. In *LINAC2014, 2014-08-31*, 2014.

C3. Andreas Ericsson and Daniel Sjöberg. A resonant circular polarization selective structure of closely spaced Morin helices. In *XXXIth URSI General Assembly and Scientific Symposium (URSI GASS), 2014-08-16*. IEEE, 2014.

C4. Andreas Ericsson and Daniel Sjöberg. Design and Optimization of a Wideband Circular Polarization Selective Structure. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*. PIERS, 2014.

C5. Andreas Ericsson, Daniel Sjöberg, and Niklas Wellander. Electromagnetic Homogenization of a Composite Reflector Antenna Surface. In *GigaHertz/AntennEMB, 2014-03-11*, 2014.

C6. Mohammad Eshraqi, Ibon Bustinduy, Luigi Celona, Michele Comunian, Håkan Danared, Renato de Prisco, Francesco Grespan, Mats Lindroos, David McGinnis, Ryoichi Miyamoto, Søren Pape Møller, Mark Munoz, Aurelian Ponton, Edgar Sargsyan, and Heine Dølrath Thomsen. The ESS linac. In *IPAC2014, 2014-06-15*, 2014.

C7. Mohammad Eshraqi, Renato de Prisco, Ryoichi Miyamoto, Sargsyan Edgar, and Thomsen Heine Dølrath. Statistical error studies in the ESS linac. In *IPAC2014, 2014-06-15*, 2014.

C8. Mats Gustafsson. An overview of current optimization and physical bounds on antennas. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*, 2014.

C9. Mats Gustafsson. Computational challenges for antenna analysis using current optimization. In *8th European Conference on antennas and Propagation (EuCAP 2014), 2014-04-06*, 2014.

C10. Mats Gustafsson. Optimal antenna currents. In *International Conference on Electromagnetics in Advanced Applications (ICEAA), 2014-08-04*. IEEE, 2014.

C11. Mats Gustafsson. Source reconstruction from near- and far-field data. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*, 2014.

C12. Mats Gustafsson. Stored energy and current optimization. In *URSI General Assembly and Scientific Symposium, 2014-08-16/2014-08-23*, 2014.

C13. Mats Gustafsson and Marius Cismasu. Convex and global optimization for antenna analysis. In *2014 IEEE International Symposium on Antennas and Propagation, 2014-07-07*, 2014.

C14. Mats Gustafsson, Jonas Fridén, and Davide Colombi. Convex Optimization for Analysis of Antennas with Near Field Constraints. In *8th European Conference on antennas and Propagation (EuCAP 2014), 2014-04-06*, 2014.

C15. Mats Gustafsson, Jonas Fridén, and Davide Colombi. Analysis of Antennas with Near Field Constraints using Convex Optimization. In *Swedish Microwave Days, 2014-03-11*, 2014.

C16. Mats Gustafsson and B. L. G. Jonsson. An overview of stored electromagnetic energy. In *International Conference on Electromagnetics in Advanced Applications (ICEAA), 2014-08-06*. IEEE, 2014.

C17. Mats Gustafsson and Lars Jonsson. Stored energy for small antennas from the fields and the input impedance. In *2014 IEEE International Symposium on Antennas and Propagation, 2014-07-11*, 2014.

C18. B. L. G. Jonsson and Mats Gustafsson. Polarizabilities and Fundamental Bounds on Antennas. In *International Conference on Electromagnetics in Advanced Applications (ICEAA), 2014-08-04*. IEEE, 2014.

C19. Christer Larsson. Nearfield RCS Measurements of Full Scale Targets Using ISAR. In *36th Annual Symposium of the Antenna Measurements Techniques Association, 2014-10-12*. Antenna Measurements Techniques Association, 2014.

C20. Hui Li, Apostolos Tsiaras, Benoit Derat, and Buon Kiong Lau. Analysis of SAR on flat phantom for different multi-antenna mobile terminals. In *European Conference on Antennas and Propagation (EuCAP), 2014-04-06/2014-04-10*, 2014.

C21. Zachary Miers and Buon Kiong Lau. Design of multimode multiband antennas for MIMO terminals using characteristic mode analysis. In *IEEE International Symposium on Antennas and Propagation, 2014-07-06/2014-07-11*. IEEE, 2014.

C22. Zachary Miers, Hui Li, and Buon Kiong Lau. Design of bezel antennas for multiband MIMO terminals using characteristic modes. In *European Conference on Antennas and Propagation (EuCAP), 2014-04-06/2014-04-10*. IEEE, 2014.

C23. Ryoichi Miyamoto, Benjamin Cheymol, Renato de Prisco, Mohammad Eshraqi, Edgar Sargsyan, and Ibon Bustinduy. Dynamics of bunches partially chopped with the MEBT chopper in the ESS linac. In *LINAC2014, 2014-08-31*. JACoW, 2014.

C24. Sven Nordebo and Mats Gustafsson. Computational challenges in convex optimization for antenna analysis. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*, 2014.

C25. Aurelian Ponton, Renato de Prisco, Mohammad Eshraqi, Ryoichi Miyamoto, Edgar Sargsyan, Alain France, and Olivier Piquet. ESS normal conducting linac status and plans. In *LINAC2014, 2014-08-31*, 2014.

C26. Daniel Sjöberg. Using Popular Science Summaries to Improve Writing Skills in Master Theses. In *Progress in Electromagnetics Research Symposium, 2014-08-25*, 2014.

C27. Daniel Sjöberg and Andreas Ericsson. A multi layer meander line circular polarization selective structure (MLML-CPSS). In *8th European Conference on Antennas and Propagation (EuCAP), 2014-04-06/2014-04-11*. IEEE, 2014.

C28. Daniel Sjöberg, Anders J Johansson, and Christer Larsson. Electromagnetic Properties of Heterogeneous Material Structures Produced in 3D-Printers. In *International Conference on Electromagnetics in Advanced Applications (ICEAA), 2014-08-03/2014-08-09*. IEEE, 2014.

C29. Daniel Sjöberg and Christer Larsson. Inverse Scattering in Inhomogeneously Filled Rectangular Waveguides. In *Progress in Electromagnetics Research Symposium, 2014-08-25*, 2014.

C30. Daniel Sjöberg, Sven Nordebo, and Mats Gustafsson. Convex optimization for optimal realization of material properties. In *International Conference on Electromagnetics in Advanced Applications (ICEAA), 2014-08-03/2014-08-08*. IEEE, 2014.

C31. Daniel Sjöberg, Niklas Wellander, and Andreas Ericsson. A homogenization procedure for microstructured resistive sheets. In *URSI General Assembly and Scientific Symposium, 2014-08-16/2014-08-23*. IEEE, 2014.

C32. Eugene Tanke, Renato de Prisco, Mohammad Eshraqi, Aurelian Ponton, Edgar Sargsyan, and Ryoichi Miyamoto. Benchmark of beam dynamics code DYNAC using the ESS proton linac. In *LINAC2014, 2014-08-31*. JACoW, 2014.

C33. Doruk Tayli and Mats Gustafsson. Calculating the Physical Bounds for Antennas Above a Ground Plane. In *URSI General Assembly and Scientific Symposium, 2014-08-16/2014-08-23*, 2014.

C34. Doruk Tayli and Mats Gustafsson. Determining Physical Bounds for Antennas Above Ground Planes. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*, 2014.

C35. Doruk Tayli and Mats Gustafsson. Determining Physical Bounds for Lossy Dipoles. In *Swedish Microwave Days, 2014-03-11*, 2014.

C36. Doruk Tayli and Mats Gustafsson. Investigating the Q Factor and Efficiency for Lossy Antennas Using Convex Optimization. In *8th European Conference on antennas and Propagation (EuCAP 2014), 2014-04-06*, 2014.

C37. Doruk Tayli and Mats Gustafsson. Physical bounds for antennas on ground planes. In *2014 IEEE International Symposium on Antennas and Propagation, 2014-07-07*, 2014.

C38. Iman Vakili, Mats Gustafsson, and Daniel Sjöberg. Sum Rules for Metamaterials in Parallel Plate Waveguides. In *URSI General Assembly and Scientific Symposium, 2014-08-16/2014-08-23*, 2014.

C39. Iman Vakili, Lars Ohlsson, Mats Gustafsson, and Lars-Erik Wernersson. Time Domain Material Characterizations Using Leaky Lens Antennas. In *URSI General Assembly and Scientific Symposium, 2014-08-16/2014-08-23*, 2014.

C40. Iman Vakili, Lars Ohlsson, Mats Gustafsson, and Lars-Erik Wernersson. Wideband Extraction of Material Parameters in the Mm-Wave Regime. In *Antenn/EMB, 2014-03-11/2014-03-12*, 2014.

C41. Iman Vakili, Lars Ohlsson, Lars-Erik Wernersson, and Mats Gustafsson. Complex Permittivity Extraction Using a Leaky-Lens Antenna System. In *Progress in Electromagnetics Research Symposium (PIERS), 2014-08-25*, 2014.

C42. Ivaylo Vasilev, Vanja Plicanic, Ruiyuan Tian, and Buon Kiong Lau. Experimental study of adaptive impedance matching in an indoor environment. In *IEEE International Symposium on Antennas and Propagation, 2014-07-06/2014-07-11*. IEEE, 2014.

C43. Ivaylo Vasilev, Vanja Plicanic, Ruiyuan Tian, and Buon Kiong Lau. Field measurement performance of a MIMO terminal with adaptive impedance matching. In *9th COST IC1004 Management Committee Meeting, 2014-02-05/2014-02-07*, 2014.

C44. Arthur D. Yaghjian, Mats Gustafsson, and B. Lars G. Jonsson. Quality Factor for Lossy and Lossless Antennas. In *8th European Conference on antennas and Propagation (EuCAP 2014), 2014-04-08*, 2014.

C45. Torbjörn Ödman, Maria Lindén, and Christer Larsson. Reflection/Transmission Study of Two Fabrics with Microwave Properties. In *11th International Conference on Wearable Micro and Nano Technologies for Personalized Health, 2014-06-11*. IOS Press, 2014.

4.5 Thesis publications

T1. Marius Cismasu. Antenna Analysis and Design Using Stored Energies and Physical Limitations. 2014.

4.6 Diploma works

The diploma works listed below can be downloaded from our web-page with address: **www.eit.lth.se**

D1. Casimir Ehrenborg, " Utvärdering och jämförelse mellan fas- och strålningscentrum för kanoniska antenner."
Advisor: Gerhard Kristensson and Jonas Fridén (Ericsson)
Examiner: Anders Karlsson

D2. Jakob Helander, " Teknik för millimetervågsantenner i mobilterminal och mobilstation."
Advisors: Daniel Sjöberg and Zhinong Ying (Sony Mobile Communications)
Examiner: Mats Gustafsson

D3. Marcus Isinger, "Emittance measurement system for MAX IV PC RF gun."
Advisors: Sverker Werin (MAX IV laboratory)
Examiner: Anders Karlsson

4.7 Technical reports

The technical reports listed below can be downloaded from our web-page with address: **www.eit.lth.se/teat**

T1. Alexander Bondarik and Daniel Sjöberg. Gridded Parasitic Patch Stacked Microstrip Antenna With Beam Shift Capability for 60 GHz Band. (LUTEDX/(TEAT-7233)/1-19), 2014.

T2. Marius Cismasu and Mats Gustafsson. Multiband Antenna Q Optimization using Stored Energy Expressions. (LUTEDX/(TEAT-7230)/1-9), 2014.

T3. Marius Cismasu, Doruk Tayli, and Mats Gustafsson. Stored Energy Based 3D Antenna Analysis and Design. (LUTEDX/(TEAT-7231)/1-18), 2014.

T4. Mats Gustafsson, Doruk Tayli, and Marius Cismasu. Q factors for antennas in dispersive media. (LUTEDX/(TEAT-7232)/1-24), 2014.

T5. Magnus Gustavsson, Gerhard Kristensson, and Niklas Wellander. Multiple scattering by a collection of randomly located obstacles Part II: Numerical implementation - coherent fields. (LUTEDX/(TEAT-7236)/1-15), 2014.

T6. B.L.G. Jonsson and Mats Gustafsson. Stored energies in electric and magnetic current densities for small antennas. (LUTEDX/(TEAT-7234)/1-38), 2014.

T7. Gerhard Kristensson. Evaluation of some integrals relevant to multiple scattering by randomly distributed obstacles. (LUTEDX/(TEAT-7228)/1-16), 2014.

T8. Gerhard Kristensson. Multiple scattering by a collection of randomly located obstacles Part I: Theory - coherent fields. (LUTEDX/(TEAT-7235)/1-50), 2014.

T9. Iman Vakili, Mats Gustafsson, Daniel Sjöberg, Rebecca Seviour, Martin Nilsson, and Sven Nordebo. Sum Rules for Parallel Plate Waveguides: Experimental Results and Theory. (LUTEDX/(TEAT-7229)/1-20), 2014.

5 Guests and Seminars

5.1 Visitors at the group of Electromagnetic Theory

Jonas Fridén, Ericsson AB, Lindholmen, Göteborg, Sweden, numerous visits during 2014.

Sven Nordebo, Department of Physics and Electrical Engineering, Linnaeus University, Växjö, Sweden, numerous visits during 2014.

Zhinong Ying, Sony Mobile Communications AB, Sweden, numerous visits during 2014.

Kurt Schab, University of Illinois at Urbana-Champaign, May 13, 2014.

Olof Lindgren, Swedish Foundation for Strategic Research (SSF), October 8, 2014.

Michael A. Jensen, Brigham Young University, USA, October 22-25, 2014.

Martin Stumpf, Brno University of Technology, November 25, 2014.

Said Mikki, Royal Military College of Canada, Kingston, December 11, 2014.

David Wall, Department of Mathematics, University of Christchurch, New Zealand, May 23–26, 2014.

5.2 Seminars

12-11: Said Mikki, New Perspectives on Electromagnetic Near Fields, Energy, Mutual Coupling, and Antenna Current Distribution Engineering.

12-02: Gabriele Costanza, Evolution of the Modes of a Cavity Resonator and their Dissipated Power.

11-25: Casimir Ehrenborg, A comparison between radiation center and phase center.

11-25: Martin Stumpf, Miscellaneous Applications of Time-Domain Reciprocity Theorems in Antenna Theory.

11-18: Gerhard Kristensson, Erdélyi operators and spherical waves.

11-11: Alexander Bondarik, 60 GHz patch antennas and our new radiation pattern measurement setup.

11-04: Daniel Sjöberg, Convex Optimization for Optimal Realization of Material Properties.

10-28: Iman Vakili, Time domain material characterization.

10-21: Marius Cismasu, Antenna Analysis and Design Using Stored Energies and Physical Limitations.

10-14: Doruk Tayli, Feko and Antenna Q.

10-07: Anders Karlsson, Determination of normalized magnetic eigenfields in microwave cavities.

09-30: Sten Rikte, Electric and magnetic signatures from civil vessels.

09-23: Andreas Ericsson, Maxwell's Equations in Curved Space-Time.

09-12: Mats Gustafsson, An overview of stored electromagnetic energy.

08-13: Iman Vakili, Sum Rules for Metamaterials in Parallel Plate Waveguides.

08-13: Doruk Tayli, Determining Physical Bounds for Antennas Above Ground Planes.

08-13: Andreas Ericsson, A resonant circular polarization selective structure of closely spaced Morin helices.

05-27: Gerhard Kristensson, Radiative transfer equation

05-26: David Wall, Cloaking and inverse problems - impedance tomography.

05-16: Andreas Ericsson, Antennas for Space Applications, European School of Antennas at ESTEC by ESA.

05-08: Elias Kristensson, Structured illumination - seeing through the fog.

04-23: Buon Kiong Lau, MIMO Antenna Design for Compact Terminals – Lessons Learned (2004-2014)

04-03: Marius Cismasu, Antenna Optimization using Stored Energy Expressions.

03-27: Doruk Tayli, Investigating the Q Factor and Efficiency for Lossy Antennas Using Convex Optimization.

03-20: Iman Vakili, Complex permitivity extraction of materials in mm-wave regime.

03-06: Andreas Ericsson, Resonant Circular Polarization Selective Structures.

02-27: Daniel Sjöberg, Computing polarizability in periodic structures using variational principles.

02-06: Gerhard Kristensson, Multiple electromagnetic scattering by obstacles.

01-30: Sven Nordebo, Optimal realizations of passive structures.

6 Visits and Lectures by the Staff

6.1 Visits to other institutes and departments

Mats Gustafsson:

Ericsson research, Göteborg, Sweden, numerous visits during 2014.

Electromagnetic Engineering (ETK) at Royal Institute of Technology (KTH), Stockholm, Sweden, January 27, 2014.

Chuo University, Tokyo, Japan, September 2, 2014.

Anders Karlsson:

Högskolan i Halmstad, February 25, 2014.

Gerhard Kristensson:

Swedish Defence Research Agency, FOI, Linköping, Sweden, March 18, 2014.

Buon Kiong Lau:

Aalborg University, Aalborg, Denmark, May 23, 2014

Chalmers University, Göteborg, Sweden, August 29, 2014.

Aalto University, Helsinki, Finland, December 5, 2014.

Daniel Sjöberg:

Saab Dynamics, Linköping, February 5 and 11, March 25, April 30, May 7, October 30–31, 2014.

TICRA, Copenhagen, March 19 and April 28, 2014.

Swedish Defence Material Administration, Stockholm, May 8, 2014.

Department of Mathematics, Stockholm University, May 22–23, 2014.

Saab Electronic Defence Systems, Göteborg, September 8 and December 2, 2014.

6.2 Guest Lectures by the department's staff

Figure 9: Mats Gustafsson at IEEE APS Distinguished Lecturer tours in Ahmedabad, Toronto, Kinston, and Tokyo.

Mats Gustafsson:

IEEE APS Distinguished Lecturer Program, see Figures 10 and 9.
Title of the talk: "Convex Optimization for Optimal Design and Analysis of Small Antennas," at

- Indus University, Ahmedabad, India, May 1, 2014
- University of Toronto, Canada, May 29, 2014
- Royal Military College of Canada, Kingston, Canada, May 30, 2014
- ICEAA, Aruba, August 3, 2014
- EPFL, Lausanne, September 25, 2014
- UCF, Orlando, USA, October 15, 2014
- Georgia Institute of Technology, Atlanta, USA, October 17, 2014
- University of Texas, Austin, October 22, 2014

IEEE APS Distinguished Lecturer Program.
Title of the talk: "Sum Rules and Physical Bounds in Electromagnetics," at

- University of Houston, US, October 20.
- University of Texas, Austin, US, October 21.

IEEE APS Distinguished Lecturer Program.
Title of the talk: "Near-field Diagnostics of Antennas and Radomes," at

- Ahmedabad, India, May 1, 2014
- University of Toronto, Canada, May 29, 2014

Lecture at Chuo University, Tokyo, Japan. *Title of Presentation:* "Convex Optimization for Optimal Design and Analysis of Small Antennas," September 2, 2014.

Anders Karlsson:

Lecture at Högskolan i Halmstad, Halmstad, Sweden. *Title of Presentation:* "Forskningsanläggningen ESS och MaxIV-laboratoriet i Lund," February 25, 2014.

Gerhard Kristensson:

Lecture at Swedish Defence Research Agency, FOI, Linköping, Sweden. *Title of Presentation:* "Multiple electromagnetic scattering by obstacles," March 18, 2014.

Buon Kiong Lau:

IEEE ED/AP/MTT Chapter Lecture at the Department of Radio Science and Engineering, Aalto University. *Title of Presentation:* "Design and Evaluation of Mobile Terminal Antennas for 4G and Beyond," December 5, 2014.

Figure 10: Mats Gustafsson at IEEE APS Distinguished Lecturer tours in Orlando, Atlanta, Huston, and Austin.

6.3 Awards

Figure 11: Andreas Ericsson and Daniel Sjöberg at the conference banquet.

Andreas Ericsson was awarded third prize in the Best Student Paper competition at the URSI General Assembly in Beijing for the paper "A resonant circular polarization selective structure of closely spaced Morin Helices".

6.4 Organization of Courses, Conferences, and Workshops

1. SSF Workshop at Stockholm University, Sweden, May 22–23, 2014.

Figure 12: (left) Nader Behdad at the LO/FSS workshop in Lund. (right) Sven Nordebo, Annemarie Luger, Daniel Sjöberg and Lars Jonsson at a coffee break during the SSF Workshop in Stockholm.

2. Workshop on LO/FSS by Professor Nader Behdad, University of Madison-Wisconsin, USA, held at the Department of Electrical and Information Technology, Lund, Sweden, June 16–17, 2014.

3. Buon Kiong Lau was a Steering Committee Member of the 2014 IEEE International Symposium on Antennas and Propagation and CNC/USNC/URSI National Radio Science Meeting, Memphis, Tennessee, USA, July 6–12, 2014.

4. Short course at ICEAA by Mats Gustafsson, *Title of the course:* Optimal antenna currents using MoM and convex optimization, Aruba, August 3, 2014.

6.5 Participation in conferences and workshops

Figure 13: (left) Excursion to the Great Wall of China during the URSI GASS in Beijing 2014. (right) Focus session on Optimal antennas organized by Mats Gustafsson and Lars Jonsson at PIERS in Guangzhou China 2014.

Mats Gustafsson:

Presented one paper at the Swedish Microwave Days, Göteborg, March 11–12, 2014.

Presented two papers at the 8th European Conference on antennas and Propagation (EuCAP 2014), The Hague, Netherlands, April 7–11, 2014.

Presented three papers at the 2014 IEEE International Symposium on Antennas and Propagation, Memphis, July 6–11, 2014,

Organized one special session and one short course. Presented the plenary address and two papers at the International Conference on Electromagnetics in Advanced Applications (ICEAA), Aruba, August 3–8, 2014.

Presented one paper at the URSI General Assembly and Scientific Symposium, Beijing, China, August 16–23, 2014.

Organized two special sessions and presented two papers at the Progress in Electromagnetics Research Symposium (PIERS), Guangzhou, China, August 25–28, 2014.

Presented one paper Integral Techniques for Electromagnetics (INTELECT 2014), Ovronnaz, Valais, Switzerland, September 26, 2014.

Gerhard Kristensson:

Participated in the workshop, Kungliga Fysiografiska Sällskapet, "Forskningens samhällsansvar", Grand Hotel, Lund, Sweden, May 13, 2014.

Participated in the Annual Meeting of SNRV, Linköping, Sweden, May 14-15, 2014.

Organized and chaired one special session at the URSI General Assembly and Scientific Symposium, Beijing, China, August 16–23, 2014.

Participated in the Fall Meeting of SNRV, KVA, Stockholm, Sweden, November 11, 2014.

Christer Larsson:

Presented one paper at the Progress in Electromagnetics Research Symposium (PIERS), Guangzhou, China, August 25–28, 2014.

Presented one paper at the 36th Annual Symposium of the Antenna Measurements Techniques Association, Tucson, USA, October 12–17, 2014

Buon Kiong Lau:

Convened and chaired the Special Session "Theory of Characteristic Modes for Antenna System Design in Wireless Communications" in 2014 IEEE International Symposium on Antennas and Propagation and CNC/USNC/URSI National Radio Science Meeting, Memphis, TN, July 6–12, 2014.

Daniel Sjöberg:

Swedish Microwave Days, Göteborg, March 11–12, 2014.

EuCAP'14, The Hague, Netherlands, April 7–11, 2014.

International Conference on Electromagnetics in Advanced Applications (ICEAA), Aruba, August 3–8, 2014.

URSI General Assembly and Scientific Symposium, Beijing, China, August 16–23, 2014.

Progress in Electromagnetics Research Symposium, Guangzhou, China, August 25–28, 2014.

NRFP Symposium, Stockholm, November 11–12, 2014.

6.6 Examination committees

Mats Gustafsson:

Pre-examiner for the doctoral thesis of Juhani Kataja, Aalto University School of Electrical Engineering, Finland. *Title of the thesis:* "Reliable and efficient numerical methods for time harmonic electromagnetic design problems," February, 2014.

Faculty opponent for the Licentiate thesis of Aidin Razavi, Department of Signals and Systems, Chalmers University of Technology, Sweden. *Title of the thesis:* "Optimal Near-field Antenna Apertures in Lossy Media," June, 2014.

Faculty opponent for the PhD thesis of Miloslav Capek, *Title of the thesis:* "Modal Analysis and Optimization of Radiating Planar Structures"', Czech Technical University, Prague, July 1, 2014.

Anders Karlsson:

Member of the examination committee for Lars Larsson, Department of Applied Mechanics, Chalmers University. *Title of the thesis:* "On integral equation methods of solution to eddy current interaction problems," August 22, 2014

Evaluator of thesis by Olga Shapoval, O. Y. Usikov Institute of Radio-Physics and Electronics of the National Academy of Sciences of Ukraine. *Title of the thesis:* "Resonance scattering of electromagnetic waves by finite gratings of thin metal and graphene strips," June 26, 2014.

Buon Kiong Lau:

Member of examination committee for Istvan Szini, Department of Electronic Systems, Aalborg University, Denmark. *Title of the thesis:* "Physical Layer Limitations on 4G MIMO Handset Systems," May 23, 2014.

Member of the examination committee for Ahmed Hussain, Department of Signals and Systems, Chalmers University of Technology, Sweden. *Title of the thesis:* "Characterization of Small Antennas and Wireless Devices for MIMO Systems in Multipath and Line-of-Sight," August 29, 2014.

External Examiner of the examination committee for Krishna Kumar Kishor, Department of Electrical and Computer Engineering, University of Toronto, Toronto, Canada. *Title of the thesis:* "Multi-functional Chassis-based Antennas Using Characteristic Mode Theory," October 23, 2014.

Opponent for the doctoral thesis of Janne Ilvonen, Department of Radio Science and Engineering, Aalto University, Finland. *Title of the thesis:* "Multiband and Environment Insensitive Handset Antennas," December 5, 2014.

Daniel Sjöberg:

Member of examination committee for Fei Sun, Department of Electromagnetic Design, Royal Institute of Technology, Stockholm, Sweden. *Title of the thesis:* "Transformation Optics for Controlling DC Magnetic Field," December 1, 2014.

6.7 Referee for international journals and conferences

Mats Gustafsson:

EuCAP 2014

IEEE Antennas and Wireless Propagation Letters

IEEE Transactions on Antenna and Propagation

IET Microwaves Antennas & Propagation

Anders Karlsson:

IEEE Transactions on Antenna and Propagation

Gerhard Kristensson:

Wave Motion (as editor)

URSI General Assembly (URSIGA2104).

Christer Larsson:

IEEE Transactions on Antenna and Propagation

IEEE Antennas and Wireless Propagation Letters

Buon Kiong Lau:

IEEE Transactions on Antenna and Propagation

IEEE Antennas and Wireless Propagation Letters

IEEE Antennas and Propagation Magazine

Daniel Sjöberg:

IEEE Transactions on Antenna and Propagation

IEEE Transactions on Microwave Theory and Techniques

6.8 Other activities

Figure 14: Gerhard Kristensson as the promotor of the Engineering Faculty, Lund University.

Gerhard Kristensson:

Promotor of the Engineering Faculty, Lund University, Lund, Sweden, June 5, 2014, see Fig. 14

Buon Kiong Lau:

External Evaluator of an assistant professor position at the Department of Signals and Systems, Chalmers University of Technology, Sweden.

Technical Program Committee (TPC) Member for:

1. IEEE International Conference on Communications (ICC), Sydney, Australia, June 10–14, 2014.
2. 2014 International Telecommunications Symposium (ITS), São Paulo, Brazil, August 17–20, 2014.
3. 2nd IEEE Global Conference on Signal and Information Processing (GlobalSIP) Symposium on Massive MIMO communications, Atlanta, Georgia, USA, December 3–5, 2014.

4. IEEE 25th International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Washington, DC, USA, September 2–5, 2014.
5. 2014 Loughborough Antennas and Propagation Conference (LAPC), Loughborough, UK, November 10–11, 2014.

Daniel Sjöberg:

Gave a popular seminar for high-school students during the NMT week, "Satellite communication", March 10–13, 2014.

Participated in the Annual Meeting of SNRV, November 11–12, 2014.

7 Teaching Activities

7.1 Undergraduate teaching

The Electromagnetic Theory Group delivers courses in Circuit Theory and in Electromagnetic Field Theory. The students come from six educational programs: Engineering Physics (F), Electrical Engineering (E), Computer Science (D), Engineering Mathematics (Pi), Engineering Nanoscience (N), and Biomedical Engineering (BME). In order to complete one of these programs the student must accomplish 300 ECTS credits, where one academic year corresponds to 60 ECTS credits. The nominal time to complete one of these programs is thus five years. The group also teaches courses in the international master program Wireless Communication (MWIR). An overview of the courses offered by the Electromagnetic Theory Group is shown in Figure 15.

The courses on advanced level, *i.e.*, ETEN05 Electromagnetic Wave Propagation, EITN10 Multiple Antenna Systems, ETEN10 Antenna Technology, ETEN15 Accelerators, Particles, and Fields, and ETEN01 Microwave Theory, are also offered as graduate courses as part of the PhD education.

7.1.1 Undergraduate courses given during 2014

Program[a]	**Name of the course**	**Lecturer**[b]
E1	Electronics	**Anders Karlsson**
		Alexander Bondarik
		Iman Vakili
		Doruk Tayli
		Gabriele Costanza
		Richard Lundin
F2, N2, BME2	Electromagnetics and Electronics	**Mats Gustafsson**
		Richard Lundin
		Doruk Tayli
		Alexander Bondarik
		Carl Gustafsson
		Andreas Ericsson
		Gabriele Costanza
E3	Electromagnetic Fields	**Buon Kiong Lau**
		Andreas Ericsson
F3	Electromagnetic Field Theory	**Gerhard Kristensson**
		Casimir Ehrenborg
		Iman Vakili
Pi3	Electromagnetic Field Theory	**Gerhard Kristensson**
		Casimir Ehrenborg
		Iman Vakili
E4, F4, Pi4,	Antenna Technology	**Mats Gustafsson**
MWIR1,		Jacob Helander
MFOT1		Doruk Tayli
		Zachary Miers
E4, F4, Pi4	Electromagnetic Wave Propagation	**Daniel Sjöberg**
		Doruk Tayli
E4, F4, Pi4	Microwave Theory	**Anders Karlsson**
E4, F4, Pi4	Accelerators, Particles, and Fields	**Anders Karlsson**
		Richard Lundin
IDA2	Technical Interfaces[c]	Daniel Sjöberg
IEA2	Circuits and Measurements, Advanced Course[d]	Daniel Sjöberg

[a] F1 = Engineering Physics, first year; E1 = Electrical Engineering, first year; D2 = Computer Science, second year *etc.*, MWIR = Master program in Wireless Communications, MFOT = Master program in Photonics.

[b] The examiner/lecturer is given in bold face. Only personnel in the group is listed if there has been teachers from other groups involved in the course.

[c] Course given at Helsingborg.

[d] Course given at Helsingborg.

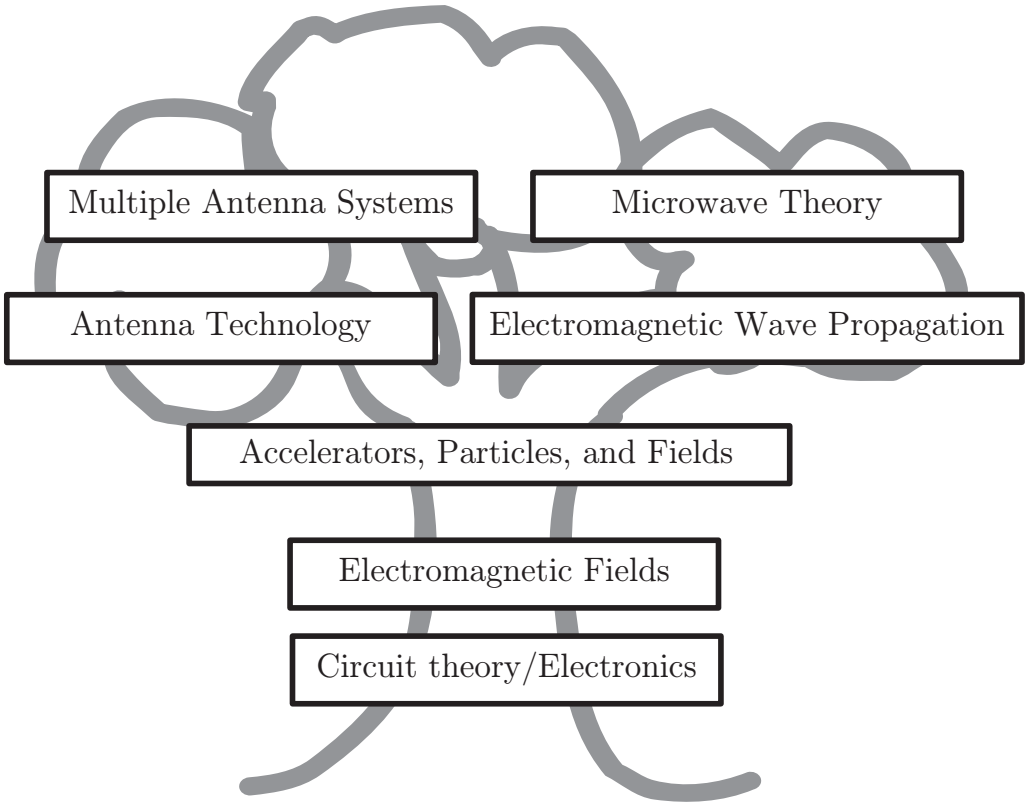

Figure 15: The undergraduate courses given by the Electromagnetic Theory group.

7.1.2 A brief presentation of the courses

ESS010 Electronics (15 ECTS credits, 110 hours):
Given to first year students on the Electrical Engineering, or E-, program. Approximately 100 students.
Course literature: Hambley, "Electric Engineering," Pearson, 2008; "Kretsteori, ellära och elektronik, exempelsamling," 2013.

ETE115 Electromagnetics and Electronics (7.5 ECTS credits, 62 hours):
Given to second year students on the Engineering Physics, Engineering Nanoscience, and Biomedical Engineering, or F-, N-, and BME-programs. Approximately 120 students.
The course includes: Potential, voltage, current, voltage source, current source, resistor, Ohm's law, Kirchhoff's laws. Capacitors, inductors, differential equations, phasors, impedance, admittance, power. Node-voltage method, Thevenin and Norton equivalents. Transfer function, Bode diagram, filters. Diodes, field-effect transistors and operational amplifiers. Transmission line theory. Electrostatics. Magnetostatics. Maxwell's equations. Properties of materials. Laboratory sessions.
Course literature: D. Sjöberg and M. Gustafsson, "Kretsteori, ellära och elektronik," Dept. Electrical and Information Technology, Lund University, 2008; problem collection; "Kretsteori, ellära och elektronik, exempelsamling," 2013.

ESS050 Electromagnetic Fields (9 ECTS credits, 84 hours):
Given to third year students on the Electrical Engineering, or E-, program. Approximately 75 students.
Vector analysis: Scalar fields and vector fields. Gradient, divergence and curl in Cartesian coordinates. Gauss's theorem and Stokes's theorem. Cylindrical coordinates. Spherical coordinates.
Quasi-stationary fields: Coulomb's law. Electrostatic fields in vacuum. Fields in the presence of dielectrics. Electric images. Current fields. Biot-Savart's law. Magnetostatic fields in vacuum. Magnetic fields in material media.
General electromagnetic fields: The Maxwell equations. Plane waves. Retarded potentials. Radiation fields from known sources and simple antennas. The Poynting vector.
Course literature: David K. Cheng, "Field and Wave Electromagnetics," (2nd Edition, Pearson New International Edition), Pearson, 2013; problem collection, KF Sigma 2002.

ETE055 Electromagnetic Field Theory (6 ECTS credits, 56 hours):
Given to third year students on the Engineering Physics program. Approximately 90 students.
The course is an introductory course in the basic electro-static and magneto-static problems. Covering the basic laws such as Coulomb's and Biot-Savart's laws. The latter part of the course covers electromagnetic problems, the Poynting vector, and the Maxwell equations. Basic wave propagation problems, *i.e.*, plane waves, retarded potentials, and radiation fields from known sources and simple antennas are also part of this course.
Course literature: D. J. Griffiths, "Introduction to Electrodynamics," Prentice-Hall, 1999; problem collection, KF Sigma 2004.

ETEF01 Electromagnetic Field Theory (7 ECTS credits, 66 hours):
Given to third year students on the Engineering Mathematics program. Approximately 40 students.
The course is an introductory course in the basic electro-static and magneto-static problems. Covering the basic laws such as Coulomb's and Biot-Savart's laws. The latter part of the course covers electromagnetic problems, the Poynting vector, and the Maxwell equations. Basic wave propagation problems, *i.e.*, plane waves, retarded potentials, and radiation fields from known sources and simple antennas are also part of this course.
Course literature: D. J. Griffiths, "Introduction to Electrodynamics," Prentice-Hall, 1999; problem collection, KF Sigma 2004.

ETEN10 Antenna technology (7.5 ECTS credits, 50 hours):
Given to fourth year students on the Engineering Physics, Electrical Engineering, and Engineering Mathematics, or F-, E-, and Pi-programs, and the international master program Wireless Communication (MWER). Approximately 40 students.
Basic electromagnetic principles with applications to antenna design and analysis are treated in this course. A broad range of antenna types from single antenna

elements to arrays of radiating elements and continuous sources are covered. Synthesis of radiation patterns is included as an integral part. The course gives a good understanding and knowledge of various types of antennas, their characteristics and various applications. Three laboratory exercises have to be carried out. These involve computer simulation and measurements of antenna parameters.
Course literature: Kraus, J. D. and Marhefka, R., "Antennas". 3 ed., McGraw-Hill, 2002.

ETEN05 Electromagnetic Wave Propagation (7.5 ECTS credits, 46 hours):
Given to fourth year students on the Engineering Physics, Electrical Engineering, and Engineering Mathematics, or F-, E-, and Pi-programs. Approximately 20 students.
Basic electromagnetic wave propagation is described in this course. The emphasis is laid on the propagation properties of plane harmonic waves in homogeneous media. Other topics treated in some detail are: dispersion, reflection, transmission, and scattering in homogeneous and inhomogeneous (stratified) media.
Course literature: Sophocles J. Orfanidis: Electromagnetic Waves and Antennas, `http://www.ece.rutgers.edu/~orfanidi/ewa/`.

ETEN01 Microwave Theory (7.5 ECTS credits, 60 hours):
Given to fourth year students on the Engineering Physics, the Engineering Mathematics, and the Electrical Engineering, or F-, Pi-, and E-, programs. Approximately 30 students.
A theoretical treatment, based upon the Maxwell equations, of wave propagation in guided structures is the basis for this project course. Three projects are performed, one of which is presented orally. The projects involve mathematical modeling and analysis as well as numerical treatment.
Course literature: A. Karlsson and G. Kristensson, "Microwave theory ," Lund, 2013.

7.2 Diploma Works

See **4.6 Diploma Works**.

7.3 Development and revisions of teaching materials

Anders Karlsson, Gerhard Kristensson:

> *Microwave Theory.* 2014.

Buon Kiong Lau, Andreas Ericsson:

> *Developed Moodle Quizzes and Supplementary Exercises in Electromagnetic Fields.* 2014.

7.4 Graduate courses

Figure 16: Participants at the final presentations in the course design, build, and test a radar system 2014.

Mats Gustafsson, Daniel Sjöberg, Christer Larsson

Design, build, and test a radar system, 7.5 credit units, fall 2013 to spring 2014.

8 Official Commissions

8.1 Official scientific committees

Mats Gustafsson:

Co-opted member of Section B of SNRV (Swedish National Committee of URSI).

Member of the Technical Program Committee at the Swedish Microwave days.

Member of the technical program Committee at Progress in Electromagnetics Research Symposium (PIERS).

Anders Karlsson:

Member of SNRV (Swedish National Committee of URSI).

Chairman of Commission B of SNRV (Swedish National Committee of URSI).

Official delegate of SNRV (Swedish National Committee of URSI) for Commission B.

Gerhard Kristensson:

Member of SNRV (Swedish National Committee of URSI).

Chairman of SNRV (Swedish National Committee of URSI).

Official Swedish delegate of URSI (Swedish National Committee of URSI).

Member of the Commission B Technical Advisory Board (B-TAB) of URSI Commission B.

Member of the Board of Editors of the international journal *Wave Motion*.

Fellow of the Institute of Physics, UK.

Member of "Kungl. Fysiografiska Sällskapet i Lund".

Convener of the Section of Applied Sciences, "Kungl. Fysiografiska Sällskapet i Lund".

Board member of "Kungl. Fysiografiska Sällskapet i Lund".

Board member of the IEEE MTT/AP Chapter of Sweden

Christer Larsson:

Co-opted member of Section B of SNRV (Swedish National Committee of URSI).

Buon Kiong Lau:

Co-opted member of Section C of SNRV (Swedish National Committee of URSI).

Member of Education Committee, Antennas and Propagation Society, the Institution of Electrical and Electronics Engineers (IEEE).

Coordinator of the 2014 Student Design Contest of the Antennas and Propagation Society, IEEE.

Associate Editor of the IEEE Transactions on Antennas and Propagation.

Chairman of Subworking Group 1.1 on "Antenna System Aspects" in COST Action IC1004.

Regional Delegate of European Association on Antennas and Propagation (EurAAP, `http://www.euraap.org/`) for Region 6 (Iceland, Norway, Sweden).

Richard Lundin:

Co-opted member of Section B of SNRV (Swedish National Committee of URSI).

Daniel Sjöberg:

Co-opted member of Section B of SNRV (Swedish National Committee of URSI).

Niklas Wellander:

Co-opted member of Section B of SNRV (Swedish National Committee of URSI).

8.2 Other official committees

Mats Gustafsson:

Capacity group leader of the Electromagnetic Theory Group.

Anders Karlsson:

Member of the Appointment Board II at the Faculty of Engineering, Lund University (Lärarförslagsnämnd II).

Gerhard Kristensson:

Member of the Board of the Faculty of Engineering (LTH), Lund University.

Member of the Board of the Department of Electrical and Information Technology, Lund University.

Buon Kiong Lau:

Director of Postgraduate Studies for the Department of Electrical and Information Technology, Lund University.

Daniel Sjöberg:

Director of Studies for the Department of Electrical and Information Technology.

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LUTEDX/(TEAT-3001)/1-9/(1989).

"Annual Report 1989/90,"
LUTEDX/(TEAT-3002)/1-17/(1990).

"Annual Report 1990/91,"
LUTEDX/(TEAT-3003)/1-15/(1991).

"Annual Report 1991/92,"
LUTEDX/(TEAT-3004)/1-20/(1992).

"Annual Report 1992/93,"
LUTEDX/(TEAT-3005)/1-23/(1993).

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"Annual Report 1994/95,"
LUTEDX/(TEAT-3007)/1-25/(1995).

"Annual Report 1995/96,"
LUTEDX/(TEAT-3008)/1-35/(1996).

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LUTEDX/(TEAT-3009)/1-56/(1998).

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LUTEDX/(TEAT-3010)/1-43/(1999).

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LUTEDX/(TEAT-3012)/1-50/(2001).

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