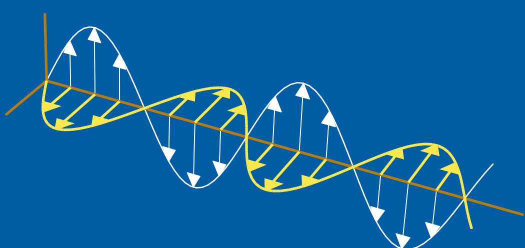
CODEN:LUTEDX/(TEAT-3024)/1-47/(2013)

Annual Report 2012

Electromagnetic Theory

Electromagnetic Theory
Department of Electrical and Information Technology
Lund University
Sweden



Editor: Gerhard Kristensson

Lund, August 16, 2013

Preface

Several important events have happened this year, which are worth mentioning.

Anders Bernland presented his thesis in June, see Figure 1 and Figure 8 on page 12, and he has already started at a new job at a well known company in Mölndal.

Figure 1: Anders Bernland (right) and the Faculty Opponent Johannes Skaar (left).

Several awards were given to members of the group. Iman Vakili received the Antenn/EMB 2012 Best Paper Award, and Christian Sohl received best teaching award from the F-section at LTH (Engineering Physics, Engineering Mathematics, Engineering Nanoscience).

Mats Gustafsson was appointed IEEE-APS Distinguished Lecturer for 2013-15. This event implies great opportunities for Mats to disseminate his research results and to broaden his international network.

The Electromagnetic Theory Group also wants to welcome professor Rebecca Seviour to the group, see Figure 2. Rebecca is holder of the Lise Meitner professorship at the engineering faculty. Professor Seviour's interaction with the group is most welcome, and makes the connection to our engagement in ESS stronger.

Gabriele Costanza started his graduate studies early this year and we wish him good luck with his studies, see Figure 2.

In Section 1.6 on page 4 a complete list of external funding during 2012 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),

Figure 2: New members of the group. From left: Rebecca Seviour and Gabriele Costanza.

VINNOVA, the Swedish Foundation for Strategic Research (SSF), the FP7 Programme (EU), Ericsson AB, 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 1.4 on page 3. We see strong mutual benefits from both parts in this interaction, and we are looking forward to continuing and deepening this collaboration.

Under the auspices of the Swedish Defence Materiel Administration (FMV) we have worked on several very interesting projects on modeling, design, and characterization of absorbing structures, and reconstruction of electromagnetic sources. These projects were multidisciplinary and engaged researchers from FOI and the industry. We value these projects highly, since they give us insight into the problems that the leading Swedish industry are facing.

Many conferences have been attended by the members of the group during 2012. A list of our efforts at conferences during 2012 is presented in Section 5.5 on page 28.

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 to fill this demand.

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, keyhole effects, and the wave propagation environment.

The two largest research facilities in Sweden, MAX IV and the European Spallation Source (ESS), are being built in Lund. This will make Lund one of Europe's major centers for particle accelerator infrastructures. Since 2010 the group has gradually increased research activities in this field, starting joint projects with both Maxlab and ESS. In December 2011 the Electromagnetic Theory Group joined the ESS design team for the Drift Tube Linac (DTL), and contracts for other research projects with the ESS and Max IV have been awarded.

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.

1.2 Personnel

The personnel employed in the group during 2012 is given in the following table:

Name	**Degree**[a]	**Position**[b]
Anders Bernland[c]	TeknL	D
Alexander Bondarik	MSc	D
Marius Cismasu	MSc	D
Gabriele Costanza[d]	MSc	D
Mats Gustafsson	TeknD, Doc	P
Anders Karlsson	TeknD, Doc	P
Alireza Kazemzadeh	TeknD	FA
Buon Kiong (Vincent) Lau[e]	TeknD, Doc	UL
Gerhard Kristensson	FD, Doc	P
Richard Lundin	TeknD	UL
Sven Nordebo[f]	TeknD	P
Kristin Persson	TeknL	D
Rebecca Seviour[g]	FD	P
Daniel Sjöberg	TeknD, Doc	P
Christian Sohl[h]	TeknD	FA
Iman Vakili	MSc	D

[a]	Doc	Docent	TeknD	PhD in Engineering
	FD	Doctor of Philosophy, PhD	TeknL	Licentiate in Engineering
	MSc	Master of Science		
[b]	D	Graduate Student	P	Professor
	FA	Postdoctoral Research Fellow	UL	Senior Lecturer

[c]Ended his employment 2012-05-31.
[d]Started his employment 2012-01-19.
[e]Employed by the Communications group.
[f]From Linnaeus University. Part time employed during 2012.
[g]Lise Meitner professor. Started her employment 2012-10-01.
[h]Ended his employment 2012-08-31.

A photo of the group is given in Figure 3.

1.3 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.

Figure 3: Part of the Electromagnetic Theory Group. Standing from the left: Mats Gustafsson, Christer Larsson, Gerhard Kristensson, Anders Karlsson, Richard Lundin, Christian Sohl, and Alexander Bondarik. Front row, from left: Anders Bernland and Marius Cismasu. The photo was taken at Söderåsen June 5, 2012.

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

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

1.4 Adjunct professors

Four adjunct professors are associated with the Electromagnetic Theory Group:

Name	**Degree**[a]	**Company**
Anders Derneryd	TeknD	Ericsson AB
Christer Larsson	FD, Doc	Saab Dynamics AB
Anders Sunesson	TeknD	ESS
Niklas Wellander	TeknD	Swedish Defence Research Agency, FOI

[a] Doc Docent
FD Doctor of Philosophy, PhD
TeknD PhD in Engineering

1.5 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**
Andreas Ioannidis	Linnaeus University, Växjö, Sweden

1.6 External funding

The external research support during 2012 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)".
- VINNOVA. *Principal investigator:* Buon Kiong Lau. *Title of the project:* "Harmonisering av Antenn och Kanal för Ökad Överföringshastighet i Avancerade Mobila Terminaler (Antenna-Channel Harmonization for Throughput Enhancement in Advanced Mobile Terminals)".
- VINNOVA. *Principal investigators:* Mats Gustafsson and Buon Kiong Lau. *Title of the project:* "Access technologies: multiple access, multiple users, multiple distributed antenna systems".
- VINNOVA. National Aeronautical Research Program (NFFP5). *Principal investigators:* Daniel Sjöberg. *Title of the project:* "Signature reduction of hull-integrated broadband antennas".
- SSF Strategic Mobility Grant. *Principal investigator:* Anders Karlsson.
- SSF Strategic Mobility Grant. *Principal investigator:* Daniel Sjöberg.
- FP7 Programme, EU. *Principal investigator:* Mats Gustafsson. *Title of the project:* "Integrated System for Transport Infrastructures surveillance and Monitoring by Electromagnetic Sensing".
- Swedish Defence Materiel Administration (FMV), sponsoring several projects in collaboration with Swedish industry.
- EOARD. *Principal investigator:* Rebecca Seviour. *Title of the project:* "Cherenkov Interactions in Metamaterials".

- STFC. *Principal investigator:* Rebecca Seviour. *Title of the project:* "Computer accelerator source for medical isotope production".
- Ericsson AB. Sponsoring the Adjunct professorship of Anders Derneryd.
- 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:* Mats Gustafsson. Research visit to Northeastern University, Boston, USA.

2 Research Activities

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

2.1 Material modeling and electromagnetic interaction

2.2 Electromagnetic scattering and design

2.3 Inverse scattering and imaging

2.4 Antennas and communication

2.5 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 3.5 and 3.8, respectively.

2.1 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).

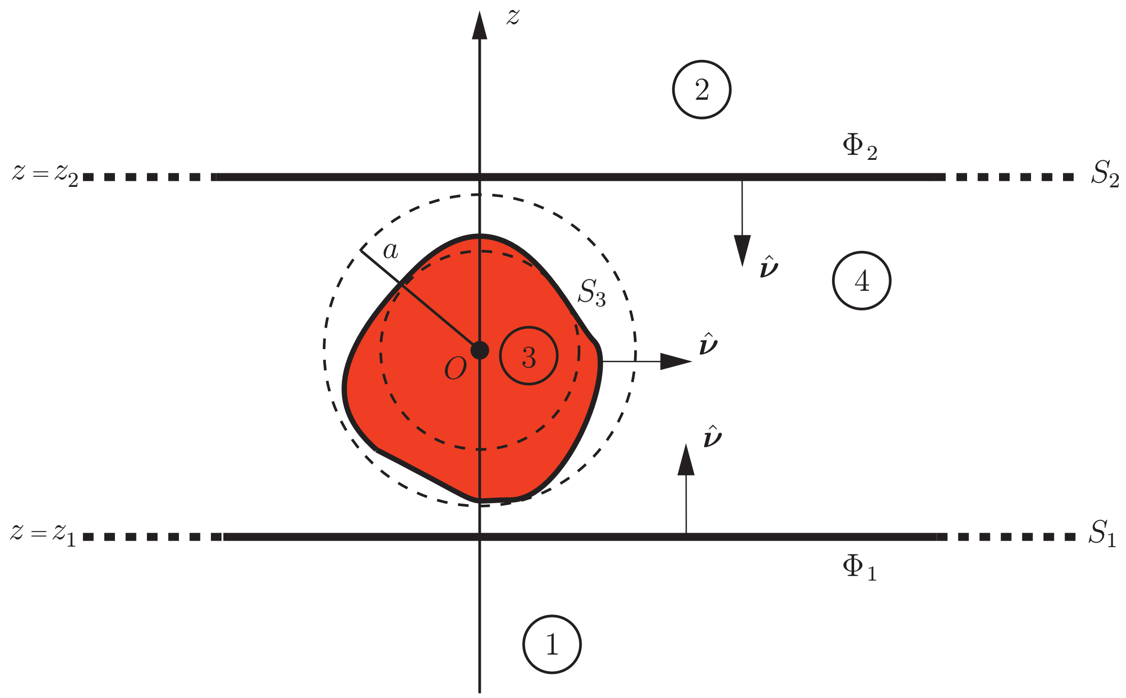


Figure 4: Example of a project under Section 2.1. Capacity evaluation of an object inside a parallel plate capacitor.

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.

Key journal publications:

M. Gustafsson. Bandwidth constraints for passive superluminal propagation through metamaterials. *Applied Physics A*, **109**(4), 1015–1021, 2012.

G. Kristensson. The polarizability and the capacitance change of a bounded object in a parallel plate capacitor. *Physica Scripta*, **86**(3), 2012.

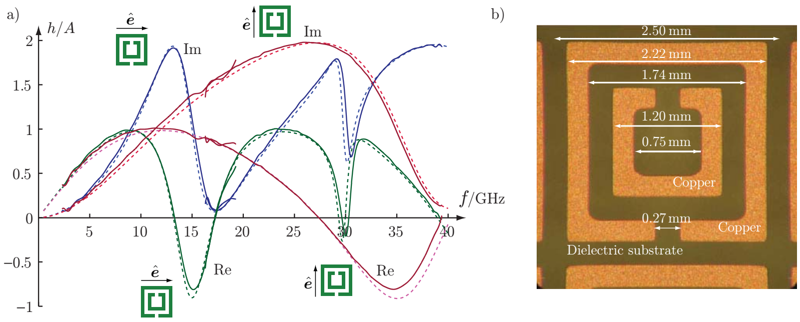


Figure 5: Example of a project under Section 2.2. a) Measured values (solid curves) and simulated values (dashed curves) for the forward scattering of an array of split ring resonators on a FR4 substrate. b) Geometry of the split ring resonators on a 0.3mm thick FR4 substrate with $\epsilon_r = 4.35$.

Key conference publications:

T. Junginger, W. Weingarten, C. Welsch, and R. Seviour. Superconducting RF Thin Films. IPAC 2012, 2012.

2.2 Electromagnetic scattering and design

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.

Key journal publications:

M. Gustafsson, I. Vakili, S. E. Bayer Keskin, D. Sjöberg, and C. Larsson. Optical theorem and forward scattering sum rule for periodic structures. *IEEE Transactions on Antennas and Propagation*, **60**(8), 3818–3826, 2012.

A. Ioannidis, G. Kristensson, and I. Stratis. On the well-posedness of the Maxwell system for linear bianisotropic media. *SIAM Journal on Mathematical Analysis*, **44**(4), 2459–2473, 2012.

Key technical reports:

Anders Karlsson, Tan Yi, and Per-Erik Bengtsson, "Absorption and scattering of light from ensembles of randomly oriented aggregates,"
LUTEDX/(TEAT-7218)/1-20/(2012).

Gerhard Kristensson, "Electromagnetic scattering by a bounded obstacle in a parallel plate waveguide,"
LUTEDX/(TEAT-7220)/1-54/(2012).

Johan Helsing and Anders Karlsson, "An accurate boundary value problem solver applied to scattering from cylinders with corners,"
LUTEDX/(TEAT-7221)/1-16/(2012).

2.3 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).

Key journal publications:

A. Bernland. Bandwidth Limitations for Scattering of Higher Order Electromagnetic Spherical Waves with Implications for the Antenna Scattering Matrix. *IEEE Transactions on Antennas and Propagation*, **60**(9), 4345–4353, 2012.

A. Fhager, M. Gustafsson, and S. Nordebo. Image Reconstruction in Microwave Tomography using a Dielectric Debye Model. *IEEE Transactions on Biomedical Engineering*, **59**(1), 156–166, 2012.

S. Nordebo, M. Gustafsson, A. Khrennikov, B. Nilsson, and J. Toft. Fisher Information for Inverse Problems and Trace Class Operators. *Journal of Mathematical Physics*, **53**(12), 123503–, 2012.

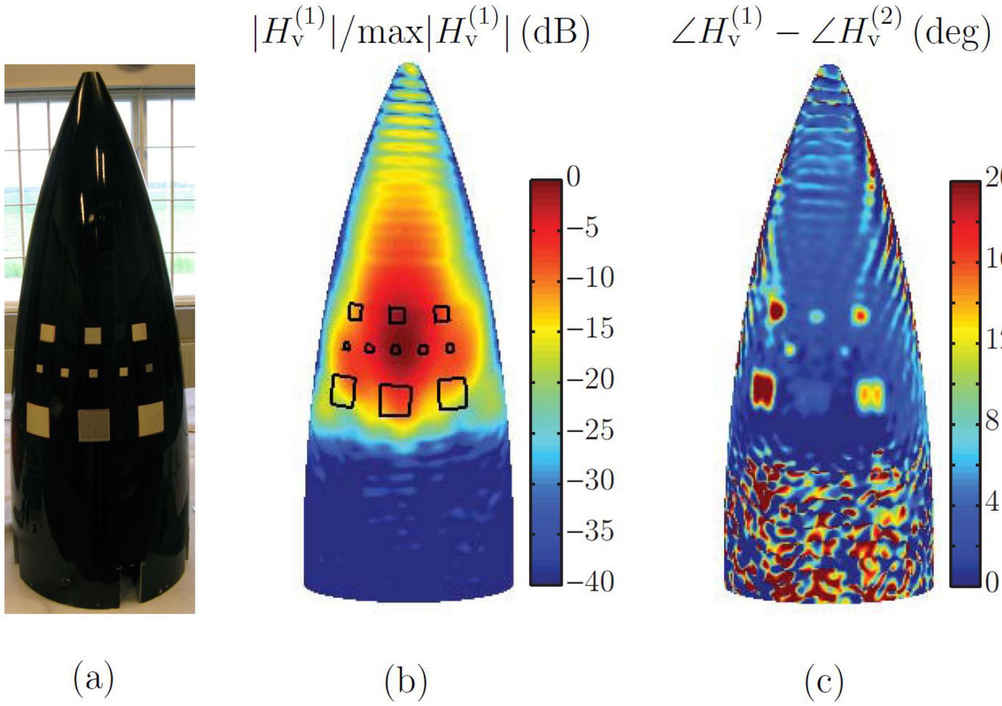


Figure 6: Radome diagnostics by reconstruction of equivalent currents on a radome surface. This is an example of a project under Section 2.3.

Key technical reports:

K. Persson, M. Gustafsson, G. Kristensson, and B. Widenberg, "Radome diagnostics — source reconstruction of phase objects with an equivalent currents approach," *LUTEDX/(TEAT-7223)/1-22/(2012).*

2.4 Antennas and communication

In a wireless system, the antenna is the interface between the electric circuit 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

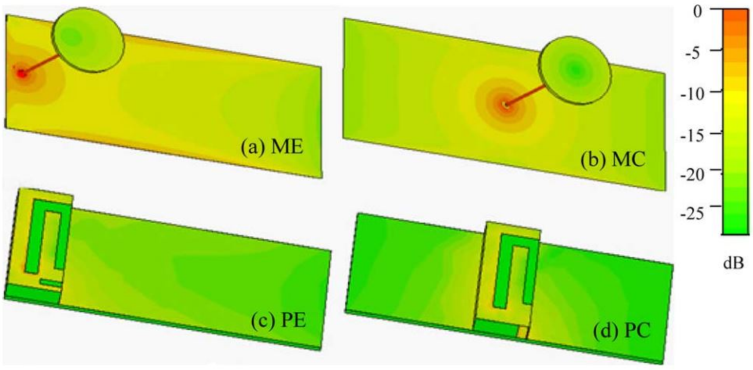


Figure 7: Example of a project under Section 2.4. Normalized magnitude of current distributions for: (a) monopole at the edge, (b) monopole at the center, (c) PIFA at the edge, (d) PIFA at the center.

MIMO systems are investigated. Computational means of simulating the antenna and related structures are also developed.

Key journal publications:

A. Bernland, M. Gustafsson, C. Gustafson, and F. Tufvesson. Estimation of Spherical Wave Coefficients from 3D Positioner Channel Measurements. *IEEE Antennas and Wireless Propagation Letters*, **11**, 608–, 2012.

M. Gustafsson, J. B. Andersen, G. Kristensson, and G. F. Pedersen. Forward scattering of loaded and unloaded antennas. *IEEE Transactions on Antennas and Propagatation*, **60**(12), 5663–5668, 2012.

B. K. Lau, M. A. Jensen, J. Medbo, and J. Furuskog. Single and multi-user cooperative MIMO in a measured urban macrocellular environment. *IEEE Transactions on Antennas and Propagation (Special Issue on MIMO Technology)*, **60**(2), 624–632, 2012.

V. Plicanic, H. Asplund, and B. K. Lau. Performance of handheld MIMO terminals in noise- and interference-limited urban macrocellular scenarios. *IEEE Transactions on Antennas and Propagation*, **60**(8), 3901–3912, 2012.

Key technical reports:

Mats Gustafsson and Sven Nordebo, "Antenna currents for optimal Q, superdirectivity, and radiation patterns using convex optimization,"
LUTEDX/(TEAT-7216)/1-21/(2012).

Jonas Fridén and Gerhard Kristensson, "Calculation of antenna radiation center using angular momentum,"
LUTEDX/(TEAT-7219)/1-21/(2012).

Mats Gustafsson and B. L. G. Jonsson, ”Stored Electromagnetic Energy and Antenna Q,”
LUTEDX/(TEAT-7222)/1-25/(2012).

2.5 Accelerator engineering

This relatively new activity started in 2010 with the establishment of collaborations with both Maxlab 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 2012 we started a new project 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.

Key journal publications:

M. Bogomilov et.al. The MICE Muon Beam on ISIS and the beam-line instrumentation of the Muon Ionization Cooling Experiment. *Journal of Instrumentation*, **7**, P05009, 2012.

Y. Xu and R. Seviour. Photonic Velocity Modulation. *New J. Phys.*, **14**, 2012.

Key conference publications:

Peggs, Horak, Roser, Lindroos, Henderson, Norlin, Hutton, Ashle, Owen, McIntyre, Kelly, Nuttall, Parks, Barlow, Cywinski, and Seviour. Thorium Energy Futures. IPAC 2012, 2012.

3 Dissertations, Published papers and Reports

3.1 Doctoral dissertations

Anders Bernland, “Integral Identities for Passive Systems and Spherical Waves in Scattering and Antenna Problems,” May 23, 2012.

Faculty opponent: Professor Johannes Skaar, Department of Electronics and Telecommunications, NTNU, Trondheim, and University Graduate Center, Kjeller, Norway.

Figure 8: Left figure: Anders Bernland (center), the faculty opponent Johannes Skaar, and the examination committee, May 23, 2012.

Examining committee:

1) Professor Martin Norgren, School of Electrical Engineering, Electromagnetic Engineering, Royal Institute of Technology (KTH), Stockholm, Sweden
2) Dr Peter Meincke, Ticra, Copenhagen, Denmark
3) Dr Johan Sten, Technical Research Centre of Finland, VTT, Finland

Alternate member: Johan Helsing, Centre for Mathematical Sciences, Lund University, Lund, Sweden.

3.1.1 Short presentation of Anders Bernland's thesis

Sum rules and physical limitations within electromagnetic theory and antenna theory have received significant attention in the last few years. However, the derivations often rely on application specific and sometimes unsupported assumptions, and therefore a mathematically rigorous and generally applicable approach seems timely. Such an approach is presented in this thesis, along with examples and all the necessary proofs. The approach is also applied in the thesis to derive sum rules and physical limitations on electromagnetic spherical wave scattering. This has not been done before, despite the widespread use of spherical wave decompositions. For example, spherical waves and the antenna scattering matrix provide a complete and compact description of all the important properties of an antenna, are crucial parts in spherical near-field antenna measurements, and have been used recently to model antenna-channel interaction and multiple-input multiple-output (MIMO) communication systems. This thesis is also the first to present a method to estimate spherical wave coefficients from propagation channel measurements.

The results of this thesis can roughly be divided into three categories: Firstly, a general approach to derive sum rules and physical limitations on input-output systems based on the assumptions of causality and passivity is presented. Secondly, sum rules and physical limitations on the scattering and matching of electromagnetic spherical waves are derived, and the implications for antennas are explored. Thirdly, a method to estimate spherical wave coefficients from channel measurements, and the results of a measurement campaign, are presented and analysed.

The thesis consists of a General Introduction and five appended papers.

3.2 Licentiate dissertations

No licentiate dissertations were presented this year.

3.3 Journal publications

J1. A. Bernland. Bandwidth Limitations for Scattering of Higher Order Electromagnetic Spherical Waves with Implications for the Antenna Scattering Matrix. *IEEE Transactions on Antennas and Propagation*, **60**(9), 4345–4353, 2012.

J2. A. Bernland, M. Gustafsson, C. Gustafson, and F. Tufvesson. Estimation of Spherical Wave Coefficients from 3D Positioner Channel Measurements. *IEEE Antennas and Wireless Propagation Letters*, **11**, 608–, 2012.

J3. M. Bogomilov et.al. The MICE Muon Beam on ISIS and the beam-line instrumentation of the Muon Ionization Cooling Experiment. *Journal of Instrumentation*, **7**, P05009, 2012.

J4. A. Fhager, M. Gustafsson, and S. Nordebo. Image Reconstruction in Microwave Tomography using a Dielectric Debye Model. *IEEE Transactions on Biomedical Engineering*, **59**(1), 156–166, 2012.

J5. M. Gustafsson. Bandwidth constraints for passive superluminal propagation through metamaterials. *Applied Physics A*, **109**(4), 1015–1021, 2012.

J6. M. Gustafsson, J. B. Andersen, G. Kristensson, and G. F. Pedersen. Forward scattering of loaded and unloaded antennas. *IEEE Transactions on Antennas and Propagatation*, **60**(12), 5663–5668, 2012.

J7. M. Gustafsson, M. Cismasu, and L. Jonsson. Physical bounds and optimal currents on antennas. *IEEE Transactions on Antennas and Propagatation*, **60**(6), 2672–2681, 2012.

J8. M. Gustafsson, I. Vakili, S. E. Bayer Keskin, D. Sjöberg, and C. Larsson. Optical theorem and forward scattering sum rule for periodic structures. *IEEE Transactions on Antennas and Propagation*, **60**(8), 3818–3826, 2012.

J9. A. Ioannidis, G. Kristensson, and I. Stratis. On the well-posedness of the Maxwell system for linear bianisotropic media. *SIAM Journal on Mathematical Analysis*, **44**(4), 2459–2473, 2012.

J10. G. Kristensson. The polarizability and the capacitance change of a bounded object in a parallel plate capacitor. *Physica Scripta*, **86**(3), 2012.

J11. B. K. Lau and J. B. Andersen. Simple and efficient decoupling of compact arrays with parasitic scatterers. *IEEE Transactions on Antennas and Propagation (Special Issue on MIMO Technology)*, **60**(2), 464–472, 2012.

J12. B. K. Lau, M. A. Jensen, J. Medbo, and J. Furuskog. Single and multi-user cooperative MIMO in a measured urban macrocellular environment. *IEEE Transactions on Antennas and Propagation (Special Issue on MIMO Technology)*, **60**(2), 624–632, 2012.

J13. H. Li, B. K. Lau, Z. Ying, and S. He. Decoupling of multiple antennas in terminals with chassis excitation using polarization diversity, angle diversity and current control. *IEEE Transactions on Antennas and Propagation*, **60**(12), 5947–5957, 2012.

J14. H. Li, Y. Tan, B. K. Lau, Z. Ying, and S. He. Characteristic mode based tradeoff analysis of antenna-chassis interactions for multiple antenna terminals. *IEEE Transactions on Antennas and Propagation (Special Issue on MIMO Technology)*, **60**(2), 490–502, 2012.

J15. S. Nordebo, M. Gustafsson, A. Khrennikov, B. Nilsson, and J. Toft. Fisher Information for Inverse Problems and Trace Class Operators. *Journal of Mathematical Physics*, **53**(12), 123503–, 2012.

J16. V. Plicanic, H. Asplund, and B. K. Lau. Performance of handheld MIMO terminals in noise- and interference-limited urban macrocellular scenarios. *IEEE Transactions on Antennas and Propagation*, **60**(8), 3901–3912, 2012.

J17. R. Tian and B. K. Lau. Experimental verification of degrees of freedom for co-located antennas in wireless channels. *IEEE Transactions on Antennas and Propagation*, **60**(7), 3416–3423, 2012.

J18. R. Tian, B. Wu, B. K. Lau, and J. Medbo. On MIMO performance enhancement with multi-sector cooperation in a measured urban environment. *IEEE Antennas and Wireless Propagation Letters*, **11**, 488–, 2012.

J19. Y. Xu and R. Seviour. Photonic Velocity Modulation. *New J. Phys.*, **14**, 2012.

J20. S. Zhang, B. K. Lau, A. Sunesson, and S. He. Closely-packed UWB MIMO/diversity antenna with different patterns and polarizations for USB dongle applications. *IEEE Transactions on Antennas and Propagation*, **60**(9), 4372–4380, 2012.

J21. S. Zhang, B. K. Lau, Y. Tan, Z. Ying, and S. He. Mutual coupling reduction of two PIFAs with a T-shape slot impedance transformer for MIMO mobile terminals. *IEEE Transactions on Antennas and Propagation*, **60**(3), 1521–1531, 2012.

3.4 Contributions in books

CB1. M. Gustafsson, C. Sohl, and G. Kristensson. A forward scattering approach to new bounds in antenna theory: applications to finite cylindrical regions. In L. Jofre, M. Martínez-Vázquez, R. Serrano, and G. Roqueta, editors, *Handbook on Small Antennas*. Antenna Centre of Excellence, 2012.

CB2. B. K. Lau and A. Sibille. Assessment and modelling of terminal antenna systems. In R. Verdone and A. Zanella, editors, *Pervasive Mobile & Ambient Wireless Communications — The COST Action 2100*, pages 149–195. Springer, 2012.

3.5 Conference publications

C1. F. Athley, A. Derneryd, J. Fridén, L. Manholm, and A. Stjernman. Performance of Smart-Phones at 750 MHz. Antenn/EMB Symposium, 2012-03-07/2012-03-08, 2012.

C2. A. Bondarik, C. Gustafson, L. Ohlsson, and D. Sjöberg. PTFE and quartz based 60 GHz patch antennas. Antenn/EMB Symposium, 2012-03-07/2012-03-08, 2012.

C3. A. Bondarik and D. Sjöberg. 60 GHz Microstrip Antenna Array on PTFE Substrate. 6th European Conference on antennas and Propagation (EuCAP 2012), Prague, Czech Republic, 2012-03-26/2012-03-30, 2012.

C4. M. Cismasu and M. Gustafsson. Optimal Charges and Currents on Small Wire Antennas. 2012 IEEE International Symposium on Antennas and Propagation, 2012-07-08/2012-07-14, 2012.

C5. A. Derneryd, L. Manholm, and S. K. Ali. High Gain Planar Array Antennas at 60 GHz. Antenn/EMB Symposium, 2012-03-07/2012-03-08, 2012.

C6. M. Gustafsson. Optimal antenna currents using convex optimization. The Radio and Antenna Days of the Indian Ocean, 2012-09-24/2012-09-27, 2012.

C7. M. Gustafsson, M. Cismasu, and S. Nordebo. Physical bounds on small antennas as convex optimization problems. IEEE International Symposium on Antennas and Propagation, 2012-07-09, 2012.

C8. J. Helsing, A. Karlsson, and D. Sjöberg. On the polarizability of squares and cubes. Swedish National Conference on Antenn/EMB, 2012-03-07/2012-03-08, 2012.

C9. A. Ioannidis, G. Kristensson, and D. Sjöberg. Direct and inverse problems in bianisotropic waveguides. Inverse Problems: Modeling and Simulation, 2012-05-21/2012-05-26, 2012.

C10. A. Ioannidis, G. Kristensson, and D. Sjöberg. Propagation inside a bianisotropic waveguide as an evolution problem. Modern Mathematical Methods in Science and Technology, 2012-08-26, 2012.

C11. T. Junginger, W. Weingarten, C. Welsch, and R. Seviour. Superconducting RF Thin Films. IPAC 2012, 2012.

C12. C. Larsson and M. Gustafsson. Wideband Measurements of the Forward RCS and the Extinction Cross Section. Antenna measurements techniques association 34th annual symposium, 2012-10-21, AMTA, 2012.

C13. H. Li, B. K. Lau, Z. Ying, and S. He. An efficient co-located MIMO antenna for compact terminals. 5th COST IC1004 Management Committee Meeting, 2012-09-24/2012-09-26, 2012.

C14. S. Nordebo, M. Gustafsson, J. Dumoulin, A. Perrone, S. Pignatti, and F. Soldovieri. Frequency analysis and data correlation for beam displacement measurements based on the ISTIMES campaign in Montagnole. EGU General Assembly, 2012-04-22, 2012.

C15. Peggs, Horak, Roser, Lindroos, Henderson, Norlin, Hutton, Ashle, Owen, McIntyre, Kelly, Nuttall, Parks, Barlow, Cywinski, and Seviour. Thorium Energy Futures. IPAC 2012, 2012.

C16. S. Rikte and A. Karlsson. Det inversa elektriska signaturproblemet för undervattensbåtar. Swedish National Conference on Antenn/EMB, 2012-03-07/2012-03-08, 2012.

C17. R. Tian and B. K. Lau. Diversity mechanisms of MIMO antennas with six degrees-of-freedom. 3rd COST IC1004 Management Committee Meeting, 2012-02-08/2012-02-10, 2012.

C18. R. Tian and B. K. Lau. Effective degree-of-freedom of a compact six-port MIMO antenna. IEEE International Symposium on Antennas and Propagation, 2012-07-08/2012-07-14, IEEE, 2012.

C19. R. Tian, B. K. Lau, and J. Medbo. Impact of Rician fading and cross-polarization ratio on the orthogonality of dual-polarized wireless channels. 6th European Conference on antennas and Propagation (EuCAP 2012), Prague, Czech Republic, 2012-03-26/2012-03-30, 2012.

C20. R. Tian, B. K. Lau, and J. Medbo. On the orthogonality of dual-polarized channels with Rician fading. 3rd COST IC1004 Management Committee Meeting, 2012-02-08/2012-02-10, 2012.

C21. R. Tian, B. K. Lau, and Z. Ying. Impact of user on the multiplexing efficiency of a MIMO terminal antenna. 3rd COST IC1004 Management Committee Meeting, 2012-02-08/2012-02-10, 2012.

C22. R. Tian, B. K. Lau, and Z. Ying. Multiplexing efficiency of MIMO antennas in arbitrary propagation scenarios. 6th European Conference on antennas and Propagation (EuCAP 2012), Prague, Czech Republic, 2012-03-26/2012-03-30, 2012.

C23. R. Tian, B. K. Lau, and Z. Ying. Multiplexing efficiency of MIMO antennas with user effects. IEEE International Symposium on Antennas and Propagation, 2012-07-08/2012-07-14, IEEE, 2012.

C24. R. Tian, B. K. Lau, and Z. Ying. On the efficiency of MIMO antennas. Swedish National Conference on Antenn/EMB, 2012-03-07/2012-03-08, 2012.

C25. R. Tian, B. Wu, B. K. Lau, and J. Medbo. On capacity improvement using multisector cooperative MIMO in a real urban macrocellular environment. 5th COST IC1004 Management Committee Meeting, 2012-09-24/2012-09-26, 2012.

C26. I. Vakili, M. Gustafsson, and D. Sjöberg. Forward scattering properties of periodic metamaterials. 6th European Conference on antennas and Propagation (EuCAP 2012), Prague, Czech Republic, 2012-03-26/2012-03-30, 2012.

C27. I. Vasilev, V. Plicanic, R. Tian, and B. K. Lau. Antenna-channel harmonization in compact MIMO terminals with adaptive impedance matching. Antenn/EMB Symposium, 2012-03-07/2012-03-08, 2012.

C28. S. Zhang, B. K. Lau, A. Sunesson, and S. He. Compact UWB MIMO antenna for USB dongles with angle and polarization diversity. International Symposium on Antennas and Propagation (ISAP'2012), 2012-10-29/2012-11-02, 2012.

C29. S. Zhang, B. K. Lau, A. Sunesson, and S. He. Diversity-rich compact UWB MIMO antenna for USB dongles. 4th COST IC1004 Management Committee Meeting, 2012-05-02/2012-05-04, 2012.

3.6 Thesis publications

T1. A. Bernland. *Integral Identities for Passive Systems and Spherical Waves in Scattering and Antenna Problems.* PhD thesis, 2012.

3.7 Diploma works

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

D1. Samra Assemnew, “Higher order mode couplers in MAX IV,”
Advisor: Anders Karlsson
Examiner: Richard Lundin

D2. Rohina Behpour and Elham Vafa, “Beam Position Monitoring System In Accelerators,”
Advisor: Anders Karlsson
Examiner: Andreas Jansson, ESS

D3. Ehsan Foroozanfard, “Design and evaluation of MIMO terminal antennas with adaptive matching in realistic user scenarios,”
Advisor: Ivaylo Vasilev
Examiner: Buon Kiong Lau

D4. Rashedul Hoque and Asfandyar Khattak, "60 GHz Ultra Wide Band (UWB) antenna design with low pulse distortion,"
Advisor: Mats Gustafsson and Iman Vakili
Examiner: Daniel Sjöberg

D5. Andreas Johansson, "Shielding Effectiveness in Nested Reverberation Chambers."
Advisor: Jan Carlsson (SP)
Examiner: Daniel Sjöberg

D6. Paramananda Joshi, "Assessment of realistic output power levels for LTE devices,"
Advisor: Tomas Persson (Ericsson Research)
Examiner: Mats Gustafsson

D7. Martin Magnusson, "Full System Simulation of Near Field Communication."
Advisor: Rune Sö (Sony Mobile AB)
Examiner: Daniel Sjöberg

D8. Farhad Shokraneh, "Scattering Properties of Nanoantennas,"
Advisor: Mats Gustafsson
Examiner: Daniel Sjöberg

D9. Doruk Tayli, "Design and Implementation of a D-Band Quasi-Optical Permittivity Measurement System,"
Advisor: Marcel Blech (Sony, Germany), Mats Gustafsson
Examiner: Daniel Sjöberg

D10. Christos Tsipogiannis, "Microwave Materials Characterization Using Waveguides and Coaxial Probe."
Advisor: Daniel Sjöberg and Christer Larsson
Examiner: Mats Gustafsson

D11. Russell Whiton and Farzanehsadat Firouzabad, "Co-located antenna design in a mobile phone,"
Advisor: Scott Vance (Sony Mobile)
Examiner: Buon Kiong Lau

D12. Tan Yi, "Verification of a generalized Rayleigh-Debye-Ganz method for predicting the scattered light from soot particles."
Advisor: Per-Erik Bengtsson
Examiner: Anders Karlsson

D13. Bangguo Zhu and Zhang Zheng, "OTA measurements and performance optimization of mobile terminals for user scenarios,"
Advisors: Zhinong Ying, Thomas Bolin (Sony Mobile)
Examiner: Buon Kiong Lau

3.8 Technical reports

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

TR1. Anders Bernland, Mats Gustafsson, Carl Gustafson, and Fredrik Tufvesson, "Estimation of Spherical Wave Coefficients from 3D Positioner Channel Measurements,"
LUTEDX/(TEAT-7215)/1-11/(2012).
Abstract: Electromagnetic vector spherical waves have been used recently to model antenna channel interaction and the available degrees of freedom in MIMO systems. However, there are no previous accounts of a method to estimate spherical wave coefficients from channel measurements. One approach, using a 3D positioner, is presented in this letter, both in theory and practice. Measurement results are presented and discussed. One conclusion is that using randomly positioned measurements within a volume is less sensitive to noise than using only measurements on the surface.

TR2. Mats Gustafsson and Sven Nordebo, "Antenna currents for optimal Q, superdirectivity, and radiation patterns using convex optimization,"
LUTEDX/(TEAT-7216)/1-21/(2012).
Abstract: The high Q-factor (low bandwidth) and low efficiency make the design of small antennas challenging. Here, convex optimization is used to determine current distributions that give upper bounds on the antenna performance. Optimization formulations for maximal gain Q-factor quotient, minimal Q-factor for superdirectivity, and minimum Q for given far-field are presented. The effects of antennas embedded in structures are also discussed. The results are illustrated for planar geometries.

TR3. Mats Gustafsson, Jørgen Bach Andersen, Gerhard Kristensson, and Gert Frølund Pedersen, "Forward scattering of loaded and unloaded antennas,"
LUTEDX/(TEAT-7217)/1-13/(2012).
Abstract: Forward scattering of antennas is related to antenna performance via the forward scattering sum rule. The forward scattering sum rule is an integral identity that shows that a weighted integral of the extinction cross section over all spectrum is proportional to the static polarizabiliy of the antenna structure. Here, the forward scattering sum rule is experimentally verified for loaded, short circuit, and open circuit cylindrical dipole antennas. It is also shown that the absorption efficiency cannot be greater than 1/2 for reciprocal linearly polarized lossless matched antennas with a symmetric radiation pattern.

TR4. Anders Karlsson, Tan Yi, and Per-Erik Bengtsson, "Absorption and scattering of light from ensembles of randomly oriented aggregates,"
LUTEDX/(TEAT-7218)/1-20/(2012).
Abstract: Ensembles of aggregates are important in the areas of aerosols and combustion physics. This paper presents one approach to the absorption and scattering

of light from aggregates where the individual primary particles are small compared to the wavelength, whereas the aggregate can be large compared to the wavelength. The method is related to the Rayleigh-Debye-Gans (RDG) theory. The difference is that the near field interaction between primary particles is included and that the primary particles can have arbitrary shape, overlap each other and have a space dependent index of refraction. Closed form expressions are presented for the absorption and scattered intensity of an ensemble of aggregates with random position and orientation. These expressions give fast and accurate numerical evaluations of the scattering and absorption from ensembles of aggregates. The numerical results are compared with the ones obtained from the T-matrix method and the discrete dipole approximation method.

TR5. Jonas Fridén and Gerhard Kristensson, "Calculation of antenna radiation center using angular momentum,"
LUTEDX/(TEAT-7219)/1-21/(2012).
Abstract: An algorithm to compute the radiation center of an antenna based on the Spherical wave expansion is introduced. The method is based on the angular momentum vector that is uniquely defined for any antenna far field pattern. The radiation center is defined as the phase reference point where the angular momentum is minimized and corresponds to minimizing the phase variations in the antenna far field pattern. In addition, this approach also allows for determination of the current distribution axis.

TR6. Gerhard Kristensson, "Electromagnetic scattering by a bounded obstacle in a parallel plate waveguide,"
LUTEDX/(TEAT-7220)/1-54/(2012).
Abstract: This paper concerns scattering of an electromagnetic wave by a bounded object located inside a parallel plate waveguide. The exciting field in the waveguide is either an arbitrary source located at a finite distance from the obstacle or a plane wave generated in the far zone. In the latter case, the generating field corresponds to the lowest propagating mode (TEM) in the waveguide. The analytic treatment of the problem relies on an extension of the null field approach, or T-matrix method, originally developed by Peter Waterman, and later generalized to deal with object close to an interface. The present paper generalizes this approach further to deal with obstacles inside a parallel waveguide. This problem shows features that reflect both the two-dimensional geometry, as well as the three-dimensional scattering characteristics. The analysis is illustrated by several numerical examples.

TR7. Johan Helsing and Anders Karlsson, "An accurate boundary value problem solver applied to scattering from cylinders with corners,"
LUTEDX/(TEAT-7221)/1-16/(2012).
Abstract: In this paper we consider the classic problem of scattering of waves from perfectly conducting cylinders with piecewise smooth boundaries. The scattering problems are formulated as integral equations and solved using a Nyström scheme, where the corners of the cylinders are efficiently handled by a method referred to as Recursively Compressed Inverse Preconditioning (RCIP). This method has been

very successful in treating static problems in non-smooth domains and the present paper shows that it works equally well for the Helmholtz equation. In the numerical examples we focus on scattering of E- and H-waves from a cylinder with one corner. Even at a size $kd = 1000$, where k is the wavenumber and d the diameter, the scheme produces at least 13 digits of accuracy in the electric and magnetic fields everywhere outside the cylinder.

TR8. Mats Gustafsson and B. L. G. Jonsson, "Stored Electromagnetic Energy and Antenna Q,"
LUTEDX/(TEAT-7222)/1-25/(2012).
Abstract: Decomposition of the electromagnetic energy into its stored and radiated parts is instrumental in the evaluation of antenna Q and the corresponding fundamental limitations on antennas. This decomposition is not unique and there several proposals in the literature. Here, it is shown that stored energy defined from the difference between the energy density and the far field energy equals the new energy expressions proposed by Vandenbosch for many cases. This also explains the observed cases with negative stored energy and suggests a possible remedy to them. The results are compared with the classical explicit expressions for spherical regions. It is shown that the results only differ by a factor ka that is interpreted as the far-field energy in the interior of the sphere. Numerical results of the Q-factors for dipole, loop, and inverted L-antennas are also compared with estimates from circuit models and differentiation of the impedance.

TR9. Kristin Persson, Mats Gustafsson, Gerhard Kristensson, and Björn Widenberg, "Radome diagnostics — source reconstruction of phase objects with an equivalent currents approach,"
LUTEDX/(TEAT-7223)/1-22/(2012).
Abstract: Radome diagnostics are acquired in the design process, the delivery control, and in performance verification of repaired and newly developed radomes. A measured near or far field may indicate deviations, *e.g.*, increased side-lobe levels, but the origin of the flaws are not revealed. In this paper, radome diagnostics are performed by visualizing the equivalent surface currents on the 3D-radome body, illuminated from the inside. Three different far-field measurement series at 10 GHz are employed. The measured far field is related to the equivalent surface currents on the radome surface by using a surface integral representation. In addition, a surface integral equation is employed to ensure that the sources are located inside the radome. Phase shifts, insertion phase delays (IPD), caused by patches of dielectric tape attached to the radome surface, are localized. Specifically, patches of various edge sizes ($0.5 - 2.0$ wavelengths), and with the smallest thickness corresponding to a phase shift of a couple of degrees are imaged.

3.9 Other reports

T1. C. Hulteberg, H. Isaksson, C. Sohl, J. Rodrigues, and F. Rusek. När blir man "självständig" forskare vid LTH? *Lärande i LTH*, **Blad 17**, 2–3, 2012.

4 Guests and Seminars

4.1 Visitors at the group of Electromagnetic Theory

Samel Arslanagic, Technical University of Denmark, Lyngby, Denmark, April 26, 2012, see Figure 9.

Rikard Bertilsson, Cognimatics AB, Ideon Science Park, Lund, Sweden, June 15, 2012.

Staffan Börjeson, Lannabo Radio AB, Kungsbacka, Sweden, October 22–23, 2012.

Margaret Cheney, Mathematics Department, Colorado State University, Fort Collins, USA, June 2–4, 2012.

Andreas Fhager, Department of Signals and Systems, Chalmers University of Technology, Göteborg, Sweden, December 18, 2012.

Jonas Fridén, Ericsson AB, Lindholmen, Göteborg, Sweden, May 28–29, October 29, 2012.

Erik Jørgensen, Ticra, Copenhagen, Denmark, January 11, 2012.

Henrik Landsmann, VHF Teknik AB, Trelleborg, Sweden, June 11, 2012.

Lars Malmgren, Maxlab, Lund, Sweden, April 16, 2012.

Peter Meincke, Ticra, Copenhagen, Denmark, January 11, May 23, 2012.

Martin Norgren, School of Electrical Engineering, Electromagnetic Engineering, Royal Institute of Technology (KTH), Stockholm, Sweden, February 6, May 23, 2012.

Johan Sten, Technical Research Centre of Finland, VTT, Finland, May 22–23, 2012.

Carl-Henrik Walde, Näsbypark, Sweden, July 2, 2012.

David Wall, Department of Mathematics and Statistics, University of Canterbury, Christchurch, New Zealand, November 1–14, 2012.

Figure 9: From the left: Daniel Sjöberg, Mats Gustafsson, Samel Arslanagic, Richard Ziolkowski, and Gerhard Kristensson.

Björn Widenberg, Applied Composites AB, Linköping, Sweden, September 6–7, 2012.

Richard Ziolkowski, Electrical and Computer Engineering Department, University of Arizona, April 26, 2013, see Figure 9.

4.2 Seminars

Richard W. Ziolkowski, University of Arizona, USA, "Passive and Active Engineering of Metamaterial-inspired Electrically Small Radiating Systems," April 26, 2012.

Anders Bernland, Presentation of PhD thesis, "Integral Identities for Passive Systems and Spherical Waves in Scattering and Antenna Problems," May 21, 2012.

Jonas Fridén, Ericsson AB, Lindholmen, Göteborg, Sweden, "Gain bandwidth limitations — Evaluated for real UEs," May 29, 2012.

Margaret Cheney, Colorado State University, USA, "Radar Imaging," June 4, 2012.

Rebecca Seviour, Lise Meitner seminar, "Tricking the light fantastic," November 8, 2012.

David Wall, University of Canterbury, Christchurch, New Zealand, "Nonlinear wave propagation in the endothelium of human arteries," November 9, 2012.

Samel Arslanagic, Technical University of Denmark, Lyngby, Denmark, "Active Coated Nano-Particles — Resonance and Transparency Effects," December 7, 2012.

4.2.1 Internal seminar series

Mats Gustafsson, "Optimal currents and physical bounds on antennas using convex optimization," January 27, 2012.

Iman Vakili, "UWB wave transmission via a non-dispersive leaky lens antenna," February 3, 2012.

Gabriele Costanza, "The ESS project and the design of elliptical cavities," February 10, 2012.

Alexander Bondarik, "60 GHz patch antenna radiation pattern measurements. High gain and wide bandwidth patch antennas," February 17, 2012.

Daniel Sjöberg, "Polarizability of particles with negative permittivity," February 24, 2012.

Gerhard Kristensson, "Carbon nanotubes — electric properties," March 2, 2012.

Iman Vakili, "Forward scattering properties of periodic metamaterials," March 15, 2012.

Anders Sunesson, "ESS RF power sources — a short overview of High Power Klystrons," March 23, 2012.

Rebecca Seviour, "Microwave Metamaterial and Photonic Interactions," April 13, 2012.

Andreas Ioannidis, "Well posedness and stability issues with applications in Electromagnetics," April 19, 2012.

Mats Gustafsson, "Electromagnetic energies," September 7, 2012.

Gerhard Kristensson, "Scattering by multiple obstacles," September 21, 2012.

Alexander Bondarik, "Connector characterization for mm-wave measurements," September 28, 2012.

Daniel Sjöberg, "On some calibration techniques for material characterization," October 5, 2012.

Andreas Ioannidis, "The eigenvalue problem for Maxwell operator," October 12, 2012.

Rebecca Seviour, "Light Matter Wave Analogues," October 26, 2012.

Anders Karlsson, “Solving scattering problems for objects with piecewise smooth boundaries in two-dimensions,” November 2, 2012.

Marius Cismasu, “Antenna Bandwidth Optimization by Global Optimization Algorithms with Single Frequency Simulation,” November 16, 2012.

Iman Vakili, “UWB, time domain lens antenna,” November 30, 2012.

5 Visits and Lectures by the Staff

5.1 Visits to other institutes and departments

Mats Gustafsson:

CNR, Naples, Italy, January 16-18, 2012.

Ticra, Copenhagen, Denmark, May 30, 2012.

Royal Institute of Technology (KTH), Electromagnetic Engineering, School of Electrical Engineering, Stockholm, June, 14-15, 2012.

Northeastern University, Department of Electrical and Computer Engineering, Boston, USA, August 2012.

NFFP5, SAAB, Linköping, September 17, 2012.

ISTIMES, FP7 Final Review Meeting, Rome, Italy, October 15, 2012.

The Swedish Defence Materiel Administration, Försvarets materielverk (FMV), Stockholm, Sweden, December 13, 2012.

NFFP5, SAAB, Järfella, December 14, 2012.

Anders Karlsson:

CEA, Saclay, France, January 26–27, 2012.

Gerhard Kristensson:

FoT-meeting, IP3.3, Applied Composites (ACAB), Linköping, Sweden, March 22, 2012.

SNRV (Swedish National Committee of URSI), annual meeting, Sveriges Tekniska Forskningsinstitut (SP), Borås, Sweden, Onsala Rymdobservatorium, Onsala, Sweden, and RUAG Space, Göteborg, Sweden, May 23–24, 2012.

Mikromodellering, FOI, Linköping, Sweden, October 17, 2012.

Forskningens behov av gratis radiofrekvenser, The Royal Swedish Academy of Sciences, Stockholm, Sweden, November 5, 2012.

SNRV (Swedish National Committee of URSI), autumn meeting, The Royal Swedish Academy of Sciences, Stockholm, Sweden, November 6, 2012.

The Swedish Defence Materiel Administration, Försvarets materielverk (FMV), Stockholm, Sweden, December 13, 2012.

Daniel Sjöberg:

Visiting Saab Dynamics AB in Linköping once a week within a Strategic Mobility grant from SSF.

NFFP5 EMSS, Efield AB, Kista, Sweden, January 2, 2012.

NFFP5, Efield AB, Kista, Sweden, March 15, 2012.

Meeting regarding future activities with FMV, Saab Aeronautics, Linköping, Sweden, May 7, 2012.

The Swedish Defence Materiel Administration (FMV), Stockholm, Sweden, June 13, 2012.

Micromodeling, FOI, Linköping, Sweden, June 14, 2012

NFFP5, Electronic Defence Systems, Mölndal, Sweden, June 19, 2012.

Planning for NFFP6, Saab Aeronautics, Linköping, Sweden, August 15, 2012.

Micromodeling, FOI, Linköping, December 12, 2012.

The Swedish Defence Materiel Administration, Försvarets materielverk (FMV), Stockholm, Sweden, December 13, 2012.

NFFP5, Electronic Defence Systems, Järfälla, Sweden, December 14, 2012.

5.2 Guest Lectures by the department's staff

Mats Gustafsson:

CNR, Naples, Italy. *Title of the talk:* "Optimum currents on antennas," January 18, 2012.

Chase seminar, Chalmers, Gothenburg. *Title of the talk:* "Antenna currents for optimal Q, superdirectivity, and radiation patterns using convex optimization," April 25, 2012.

Northeastern University, Boston, USA. *Title of the talk:* "Antenna currents for optimal Q, superdirectivity, and radiation patterns using convex optimization," August 9, 2012.

Buon Kiong Lau:

Invited Speaker for the EU COST VISTA Management Committee Meeting and Workshop, Istanbul, Turkey. *Title of Presentation:* "Advances and Opportunities in Compact MIMO Antenna Research," September 19–21, 2012.

Daniel Sjöberg:

Lecture in the "LTH Högskolepedagogisk inspirationskurs," Lund, Sweden. *Title of Presentation:* "Nätbaserade frågeformulär som stöd till tempohållning i kurser," March 22, 2012.

5.3 Awards

Christian Sohl was awarded the price Teacher of the Year by the section of Engineering Physics.

Iman Vakili received the Antenn/EMB 2012 Best Paper Award for the paper "Forward scattering experiments on periodic metamaterials in a parallel plate waveguide" coauthored with Mats Gustafsson and Daniel Sjöberg at the Swedish Radio and Microwave Days, Antenn/EMB Symposium, Stockholm, Sweden, March 7–8, 2012.

5.4 Organization of Courses and Workshops

Mikromodellering workshop, FOI, Linköping, October 17, 2012.
Program:

1. Niklas Wellander *Title:* Introduktion: Bakgrund, problemformulering
2. Christer Larsson *Title:* Litteraturstudie
3. Tomas Lundín *Title:* Semiempiriska blandningsformler
4. Niklas Wellander *Title:* Fel p.g.a. osäkerhet i mikrogeometrin
5. Daniel Sjöberg, *Title:* Frekvensberoende hos magnetiska material
6. Torleif Martin, *Title:* "Optimal my"
7. Mätmetodik (problemställningar, beräkningar, känslighet)
    a) Etablerade metoder (Standardmätning/Specialmätning)

b) Koaxprob (resultat — Christer Larsson)
c) 3D-simulering av S-parametrar (spalt) (Tomas Lundín)
d) 2D-FDTD-kod för koaxmätning (Torleif Martin)
e) Kalibreringsmetoder (LNN-kalibrering) (Daniel Sjöberg)

5.5 Participation in conferences and workshops

Gabriele Costanza:

Participated with a poster at the LINAC2012 Conference, Tel Aviv, Israel. *Title of the poster:* "Design of the Elliptical Medium-Beta cavity for the ESS," September 9–14, 2012.

Anders Derneryd:

Participated at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. March 7–8, 2012.

Participated at the 25th Swedish Antenna Measurements Society Annual Meeting, Lund, Sweden. April 26, 2012.

Mats Gustafsson:

Participated with an Invited talk at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. *Title of the presentation:* "Optimal performance and current distributions on small antennas," March 7–8, 2012.

Participated with an oral paper at META12, the 3rd International Conference on Metamaterials, Photonic Crystals and Plasmonics, Paris, France. *Title of the Paper:* "Bandwidth constraints for passive superluminal propagation through metamaterials," April 19–22, 2012.

Participated at the 25th Swedish AntennaMeasurements Society Annual Meeting, Lund, Sweden. April 26, 2012.

Participated with an oral paper at the IEEE International Symposium on Antennas and Propagation (APS'2012), Chicago, Illinois, USA. *Title of the Paper:* "Physical bounds on small antennas as convex optimization problems," July 8–14, 2012.

Participated with an oral paper at the Radio and Antenna Days of the Indian Ocean, Mauritius. *Title of the Paper:* "Optimal antenna currents using convex optimization," September 24–27, 2012.

Participated at the High Speed Wireless Center (HSWC) workshop in Ystad, Sweden, November 26–27, 2012.

Anders Karlsson:

Organized the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. March 7–8, 2012.

Chairman of the scientific committee of the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. March 7–8, 2012.

Participated with an oral paper at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. *Title of the Paper:* "On the polarizability of squares and cubes," March 7–8, 2012.

Participated with an oral paper at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. *Title of the Paper:* "Det inversa elektriska signaturproblemet för undervattensbåtar," March 7–8, 2012.

Gerhard Kristensson:

Participated at the Swedish National Conference on Radio Science (RVK12), Stockholm, Sweden, March 6, 2012.

Participated at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden, March 7–8, 2012.

Presented an invited paper at the international conference on Modern Mathematical Methods in Science and Technology (M3ST), Kalamata, Greece. *Title of the Paper:* "On the use of analytic functions in electromagnetic scattering problems," August 26–28, 2012, see Figure 10.

Chairman of a session at the international conference on Modern Mathematical Methods in Science and Technology (M3ST), Kalamata, Greece, August 28, 2012.

Christer Larsson:

Participated with an oral paper at the Progress In Electromagnetics Research Symposium 2012 in Kuala Lumpur, Malaysia. *Title of the Paper:* "SAR and ISAR for diagnostic RCS measurements," 27–30 March, 2012.

Participated with an oral paper at the Antenna Measurement Techniques Association Sympoisium, Bellevue, Washington, USA. *Title of the Paper:* "Wideband Measurements of the Forward RCS and the Extinction Cross Section," October 21–26, 2012.

Buon Kiong Lau:

Participated with three oral papers at the 3rd COST IC1004 Management Committee Meeting, Barcelona, Spain, February 8–10, 2012.

Participated with two oral papers at the European Conference on Antennas and Propagation (EuCAP'2012), Prague, Czech Republic, March 26–30, 2012.

Participated with an oral paper at the 4th COST IC1004 Management Committee Meeting,Lyon, France, May 2–4, 2012.

Participated with one special oral session paper and one poster paper at the IEEE International Symposium on Antennas and Propagation (APS'2012), Chicago, Illinois, USA, July 8–14, 2012.

Participated with two oral papers at the 5th COST IC1004 Management Committee Meeting, Bristol, UK, September 24–26, 2012.

Participated with one oral paper and organized one convened session at the International Symposium on Antennas and Propagation (ISAP) in Nagoya, Japan, October 29–November 2, 2012.

Rebecca Seviour:

Participated with a poster and an oral presentation at the International Particle Accelerator Conference (IPAC 12), New Orleans, USA. *Title of the Poster:* "RF & Surface properties of bulk & thin film Nb," and *Title of the Paper:* "Thorium energy future," May 20–25, 2012.

Participated with an invited talk and a poster at the LINAC 12, Tel Aviv, Israel. *Title of the Paper:* "Novel Materials for Particle Accelerators," and *Title of the Poster:* "Thorium energy," September 10–14, 2012.

Participated with an oral presentation at the CRISP workshop, Grenoble, France. *Title of the Paper:* "ESS 352 MHz options," September 20, 2012.

Participated with an invited talk at the Compact Accelerator Conference, Daresbury, UK. *Title of the Paper:* "Metamaterials & Photonic for Accelerators," December 9, 2012.

Daniel Sjöberg:

Participated with an invited oral presentation at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. *Title of the Paper:* "Quo vadis, metamaterials?," March 7–8, 2012.

Participated with a poster at the Swedish National Conference on Antenn/EMB, Stockholm, Sweden. *Title of the Paper:* "On the polarizability of squares and cubes," March 7–8, 2012.

Participated with an oral presentation at the workshop Sigma-Epsilon-Flyg, Royal Institute of Technology (KTH), Stockholm, Sweden. *Title of the Paper:* "Spridning från absorbentklädda cylindrar med cirkulärt tvärsnitt," March 13–14, 2012.

Figure 10: Gerhard Kristensson at his invited presentation at Kalamata, Greece.

Participated at the European Conference on Antennas and Propagation (EuCAP'2012), Prague, Czech Republic, March 26–30, 2012.

Participated with an oral presentation at the SAT-Symposium, Kvarn, Linköping, Sweden. *Title of the Paper:* "Materialnytt," March 13–14, 2012.

Organized and participated with two oral presentations in a workshop on Micromodeling, FOI, Linköping, Sweden. *Title of the Presentatins:* "On some calibration techniques for material characterization" and "On the frequency dependence of magnetic materials," October 17, 2012.

Participated at the High Speed Wireless Center (HSWC) workshop in Ystad, Sweden, November 26–27, 2012.

5.6 Examination committees

Anders Derneryd:

Member of the examination committee for Alireza Motevasselian, School of Electrical Engineering, Electromagnetic Engineering, Royal Institute of Technology (KTH), Stockholm, Sweden. *Title of the thesis:* "Electromagnetic simulation, analysis and design with application to antennas and radar absorbers," October 5, 2012.

Mats Gustafsson:

Member of the examination committee for Hui Li, School of Electrical Engineering, Electromagnetic Engineering, Royal Institute of Technology (KTH), Stockholm, Sweden. *Title of the thesis:* "Decoupling and Evaluation of Multiple Antenna Systems in Compact MIMO Terminals," June 15, 2012.

Member of the examination committee for Mattias Borg, Department of Solid State Physics, Lund University, Lund, Sweden. *Title of the thesis:* "Antimonide Heterostructure Nanowires - Growth, Physics and Devices," January 20, 2012.

Anders Karlsson:

Member of the examination committee for Alireza Motevasselian, School of Electrical Engineering, Electromagnetic Engineering, Royal Institute of Technology (KTH), Stockholm, Sweden. *Title of the thesis:* "Electromagnetic simulation, analysis and design with application to antennas and radar absorbers," October 5, 2012.

External reviewer of the Licentiate thesis for Lars Larsson, Department of Applied Mechanics, Chalmers University. *Title of the thesis:* "Analytical methods of solution to eddy current interaction problems," August 31, 2012.

Buon Kiong Lau:

Examiner for the doctoral thesis of Tarik-Ul Islam Khandoker, School of Electrical, Electronic and Computer Engineering, The University of Western Australia, Australia. *Title of the thesis:* "Time Synchronization for Underwater Acoustic Sensor Networks," April, 2012.

Pre-examiner for the doctoral thesis of Risto Valkonen, Department of Radio Science and Engineering, Aalto University, Finland. *Title of the thesis:* "Impedance Matching and Tuning of Non-resonant Mobile Terminal Antennas," October, 2012.

Member of the examination committee for Xiaoming Chen, Department of Signals and Systems, Chalmers University of Technology, Sweden. *Title of the thesis:* "Characterization of MIMO Antennas and Terminals and Measurements in Reverberation Chambers," May, 2012.

Daniel Sjöberg:

Member of the examination committee for Therese Sjödén, Linnaeus University, Växjö, Sweden. *Title of the thesis:* "Sensitivity Analysis and Material Parameter Estimation using Electromagnetic Modelling," June 5, 2012.

5.7 Referee for international journals and conferences

Anders Derneryd:

IEEE Transactions on Antenna and Propagation

IET Electronics Letters

IET Proc. Microwaves, Antennas and Propagation

Progress in Electromagnetic Research C

42nd European Microwave Conference (EuMC 2012)

Mats Gustafsson:

IEEE Antennas and Wireless Propagation Letters

IEEE Transactions on Antenna and Propagation (26 times)

International Journal of Antennas and Propagation

Journal of Mathematical Physics

Journal of Tropical Forest Science

Optics letters

URSI International Symposium on Electromagnetic Theory (EMTS 2013)

7th European Conference on antennas and Propagation (EuCAP 2013)

Anders Karlsson:

IEEE Transactions on Antenna and Propagation (three times)

Gerhard Kristensson:

Wave Motion (as editor)

URSI International Symposium on Electromagnetic Theory (EMTS 2013)

Christer Larsson:

IEEE Antennas and Propagation Magazine

IEEE Transactions on Antenna and Propagation

Buon Kiong Lau:

IEEE Journal on Selected Areas in Communications (JSAC)

IEEE Transactions on Antenna and Propagation

EURASIP Journal on Wireless Communications and Networking (JWCN)

Daniel Sjöberg:

IEEE Transactions on Antenna and Propagation

IEEE Transactions on Microwave Theory and Techniques

European Journal of Physics

5.8 Other activities

Daniel Sjöberg:

Popular lectures for high school students (NMT-föreläsningar), March 5–9, 2012.

6 Teaching Activities

6.1 Undergraduate teaching

The Electromagnetic Theory Group delivers courses in Circuit Theory and in Electromagnetic Field Theory. The students come from five educational programs: Engineering Physics (F), Electrical Engineering (E), Computer Science (D), Engineering Mathematics (Pi), and Engineering Nanoscience (N). 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 programs Wireless Communication (MWIR) and Photonics (MFOT). An overview of the courses offered by the Electromagnetic Theory Group is shown in Figure 11.

The courses on advanced level (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.

6.1.1 Undergraduate courses given during 2012

Program[a]	Name of the course	Lecturer[b]
E1	Electronics	**Anders Karlsson**(ht1) **Daniel Sjöberg** (ht2) Alexander Bondarik Iman Vakili
C2, D2	Signal Processing in Multimedia	Marius Cismasu
F2, N2	Electromagnetics and Electronics	**Richard Lundin** Marius Cismasu Alireza Kazemzadeh
E3	Electromagnetic Fields	**Richard Lundin**
E3	Engineering Aspects of an Application	Richard Lundin
F3	Electromagnetic Field Theory	**Gerhard Kristensson** Gerhard Kristensson Gabriele Costanza Iman Vakili
Pi3	Electromagnetic Field Theory	**Gerhard Kristensson** Gerhard Kristensson Iman Vakili
E4, F4, Pi4, MWIR1, MFOT1	Antenna Technology	**Mats Gustafsson** Marius Cismasu
E4, F4, Pi4	Electromagnetic Wave Propagation	**Daniel Sjöberg** Marius Cismasu
E4, F4, Pi4	Microwave Theory	**Anders Karlsson**
D4, E4, C5, MWIR2	Multiple Antenna Systems	**Buon Kiong Lau**
E4, F4, Pi4	Accelerators, particles, and fields	**Anders Karlsson** **Richard Lundin**
All programs	History of Technology	**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.

6.1.2 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. Approx-

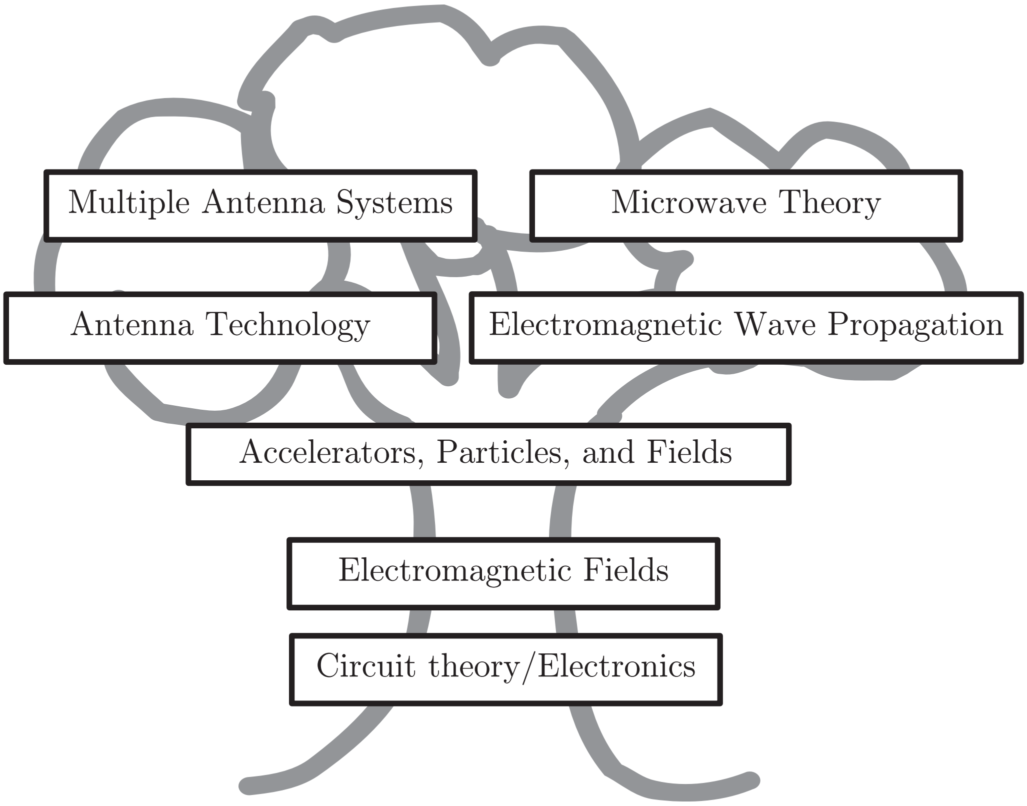


Figure 11: The undergraduate courses given by the Electromagnetic Theory group.

imately 100 students.
Course literature: Hambley, “Electric Engineering,” Pearson, 2008; “Kretsteori, ellära och elektronik, exempelsamling,” 2012.

ETE115 Electromagnetics and Electronics (7.5 ECTS credits, 62 hours):
Given to second year students on the Engineering Physics and Engineering Nanoscience, or F- and N-, 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,” 2012.

ESS050 Electromagnetic Fields (9 ECTS credits, 84 hours):
Given to third year students on the Electrical Engineering, or E-, program. Approximately 90 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. Magnetic circuits.
General electromagnetic fields: The Maxwell equations. Plane waves. Retarded potentials. Radiation fields from known sources and simple antennas. The Poynting vector.
Course literature: Popovic and Popovic, "Introductory Electromagnetics," Prentice-Hall, 2000; lecture notes; 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 programs Wireless Communication (MWER) and Photonics (MFOT). 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 in-

volve 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, and the international master program: Photonics. 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, 2012.

EITN10 Multiple Antenna Systems (7.5 ECTS credits, 42 hours):
Given to second year students enrolled in the Wireless Communications Master Program, and is also open to students enrolled in other programs (D4, E4, C5, MWIR2). Approximately 25 students.
The aim of this course is to provide a comprehensive treatment of the area of multiple antenna systems for wireless communications. The course begins with theoretical aspects of multiple antenna or multiple-input-multiple-output (MIMO) systems, which predicts huge performance gains in comparison to conventional single antenna systems. The critical role of overall channel gain and correlation (e.g. influence of line-of-sight (LOS) component in a scenario) in MIMO system performance will be emphasized. The theoretical results provided the momentum for practical implementations, several aspects of which will be covered in the course.
Course literature: Paulraj A, Nabar R, and Gore D: Introduction to Space-Time Wireless Communications, Cambridge University Press, UK, 1996. ISBN 0-521-82615-2.

ETEN15 Accelerators, Particles, and Fields (7.5 ECTS credits, 28 hours):
Given to fourth year students in the Engineering Physics, Electrical Engineering, and Engineering Mathematics programmes. Approximately 10 students.
The course describes the electrodynamics involved at the major accelerator facilities in Lund, MAX-lab and ESS. Some specific examples are calculation of the trajectories of particles in electromagnetic fields, steering of charged particles, synchrotron

radiation, the fields generated by an arbitrarily moving charged particle, Cherenkov radiation, transformation of fields between inertial frames, the theory of relativity, superconductors, the method of images, storage rings for electrons, linear accelerators, numerical calculation using a finite element program.
Course literature: Parts from Griffiths D J, "Introduction to Electrodynamics", Prentice Hall. Additional material as handouts.

6.2 Diploma Works

See **3.7 Diploma Works**.

6.3 Development and revisions of teaching materials

1. A. Karlsson and G. Kristensson. *Microwave Theory.* Tryckeriet i E-huset, Lund University, 2012.
2. A. Karlsson, G. Kristensson, and C. Sohl. *Exempelsamling i elektromagnetisk fältteori för F3 och Pi3.* Tryckeriet i E-huset, Lund University, 2012.

6.4 Graduate courses

Gerhard Kristensson:

EIT080F Vector Waves and Probe Compensation, 7.5 credit units, spring 2012.

---

7 Official Commissions

7.1 Official scientific committees

Anders Derneryd:

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

Member of COST Action IC 1004 Cooperative Radio Communications for Green Smart Environments.

Mats Gustafsson:

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

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.

Chairman of the Forskarkollegiet at the Department of Electrical and Information Technology, Lund University, January–August, 2012.

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".

Member of the evaluation board of Lund University for the Wallenberg Academy Fellows.

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).

International Advisory Board Member for the International Symposium on Antennas and Propagation (ISAP) in Nagoya, Japan, October 29–November 2, 2012.

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

Technical Program Committee (TPC) Member of the Loughborough Antennas and Propagation Conference (LAPC), Loughborough, UK, November 12-13, 2012.

TPC Member of the 2012 European Conference on Antennas and Propagation (EuCAP), Prague, Czech Republic, March 26–30, 2012.

Publications Committee Chair, Steering Committee Member and TPC Member of the 2012 IEEE Swedish Communication Technologies Workshop (Swe-CTW), Lund, Sweden, October 24–26. 2012.

Chair of Organizing Committee for Swedish Antenna Measurement Society (SAMS) for the annual meeting, April 26, 2012.

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

TPC Member of the IEEE 76th Vehicular Technology Conference (VTC)-Fall, Quebec City, Canada, September 3–6, 2012.

Associate Editor of the *IEEE Transactions on Antennas and Propagation.*

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

Reviewer for the Research Council for Natural Sciences and Engineering, Academy of Finland,

External Referee (Reviewer) for the National Research Council of Romania (CNCS).

Richard Lundin:

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

Rebecca Seviour:

Panel Member of INCITE Programme, DoE (US).

Member of EPSRC College.

Member of STFC, Particle Physics Grant Panel.

Member of STFC, Gravitational Waves Review.

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).

7.2 Other official committees

Mats Gustafsson:

Member of the Educational Board I at the Faculty of Engineering, Lund University (Utbildningsnämnd I, UN1).[1]

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.

Assistant Director of Studies for the Master of Science Educational Program in Engineering Physics at Lund University, Faculty of Engineering (biträdande programledare för civilingenjörsprogrammet i teknisk fysik vid LTH).[2]

[1] The commitment ended April 1, 2012.
[2] The commitment ended April 1, 2012.

Inspector for the PhD Student Chapter of the Student Union at Lund Institute of Technology (Inspektor för doktorandsektionen vid Lunds tekniska högskola).