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 an 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

Preface i

Contents iii

1 The Electromagnetic Theory Group 1

1.1 General ........................................ 1

2 Personal summary of the activities 1989-2014 3

2.1 Personnel ..................................... 4

2.2 External graduate students (industridoktorander) ................. 5

2.3 Adjunct professors ............................... 5

2.4 Visiting scientists ............................... 6

2.5 External funding ................................. 6

3 Research Activities 7

3.1 Material modeling and electromagnetic interaction .................. 8

3.2 Electromagnetic scattering and design ............................. 9

3.3 Inverse scattering and imaging .................................. 9

3.4 Antennas and communication .................................... 10

3.5 Accelerator engineering ..................................... 11

4 Dissertations, Published papers and Reports 12

4.1 Doctoral dissertations ................................ 12

4.2 Licentiate dissertations .................................. 13

4.3 Journal publications ..................................... 13

4.4 Conference publications ................................... 14

4.5 Thesis publications .................................... 18

4.6 Diploma works ..................................... 18

4.7 Technical reports ..................................... 18
5 Guests and Seminars

5.1 Visitors at the group of Electromagnetic Theory .......................... 19
5.2 Seminars .................................................................................. 20

6 Visits and Lectures by the Staff

6.1 Visits to other institutes and departments ................................. 21
6.2 Guest Lectures by the department’s staff ................................. 22
6.3 Awards ..................................................................................... 24
6.4 Organization of Courses, Conferences, and Workshops .......... 24
6.5 Participation in conferences and workshops ............................ 25
6.6 Examination committees ........................................................... 27
6.7 Referee for international journals and conferences .............. 28
6.8 Other activities ......................................................................... 29

7 Teaching Activities

7.1 Undergraduate teaching ............................................................. 30
7.2 Diploma Works ................................................................. 34
7.3 Development and revisions of teaching materials ................... 34
7.4 Graduate courses ................................................................. 35

8 Official Commissions

8.1 Official scientific committees ................................................. 35
8.2 Other official committees ..................................................... 37
The Electromagnetic Theory Group

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.
Gerhard retired December 31, 2014, and to honor 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 Gerhard's 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 Zealand.

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


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

Linnaeus 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 scientists 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.](image)

### 2.1 Personnel

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Andersson</td>
<td>TeknL</td>
<td>Applied Composites AB, Linköping</td>
</tr>
<tr>
<td>Magnus Gustafsson</td>
<td>CI</td>
<td>Swedish Defence Research Agency, FOI</td>
</tr>
<tr>
<td>David Olsson</td>
<td>CI</td>
<td>Max IV</td>
</tr>
<tr>
<td>Renato de Prisco</td>
<td>MSc</td>
<td>European Spallation Source (ESS)</td>
</tr>
</tbody>
</table>

2.3 Adjunct professors

Four adjunct professors are associated with the Electromagnetic Theory Group:
6 Personal summary of the activities 1989-2014

<table>
<thead>
<tr>
<th>Name</th>
<th>Degreea</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anders Derneryd</td>
<td>TeknD</td>
<td>Ericsson AB</td>
</tr>
<tr>
<td>Christer Larsson</td>
<td>FD, Doc</td>
<td>Saab Dynamics AB</td>
</tr>
<tr>
<td>Torleif Martin</td>
<td>TeknD</td>
<td>Saab Aeronautics, Saab AB</td>
</tr>
<tr>
<td>Niklas Wellander</td>
<td>TeknD</td>
<td>Swedish Defence Research Agency, FOI</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sven Nordebo</td>
<td>Linnaeus University, Växjö, Sweden</td>
</tr>
</tbody>
</table>

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)”.


- 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 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:

3.1 Material modeling and electromagnetic interaction

3.2 Electromagnetic scattering and design
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.](image)

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 antenna analyzed in TEAT-7233. (left) fabricated antenna and (right) measurement setup.](image)

![Figure 7: The capped spherical dipole as an example geometry analyzed in TEAT-7234. Minimum Q-factor for electric $J_e$ and combinations of electric and magnetic $J_m$ current densities.](image)
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.
4 Dissertations, Published papers and Reports

4.1 Doctoral dissertations


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


### 4.4 Conference publications


18 Dissertations, Published papers and Reports


4.5 Thesis publications


4.6 Diploma works

The diploma works listed below can be downloaded from our web-page with address: [www.eit.lth.se](http://www.eit.lth.se)

   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](http://www.eit.lth.se/teat)


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.


5 Guests and Seminars

5.1 Visitors at the group of Electromagnetic Theory


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.


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

5.2 Seminars


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.


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


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.


04-03: 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 permittivity 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:


Gerhard Kristensson:
Visits and Lectures by the Staff


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:


TICRA, Copenhagen, March 19 and April 28, 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


Anders Karlsson:


Gerhard Kristensson:


Buon Kiong Lau:

24 Visits and Lectures by the Staff

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

6.3 Awards

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”.

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

6.4 Organization of Courses, Conferences, and Workshops

Visits and Lectures by the Staff

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.


6.5 Participation in conferences and workshops

Mats Gustafsson:

Presented one paper at the Swedish Microwave Days, Göteborg, March 11–12, 2014.
Visits and Lectures by the Staff

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


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

Buon Kiong Lau:


Daniel Sjöberg:


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.


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

6.6 Examination committees

Mats Gustafsson:


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.


Buon Kiong Lau:


Daniel Sjöberg:


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.


3. 2nd IEEE Global Conference on Signal and Information Processing (GlobalSIP) Symposium on Massive MIMO communications, Atlanta, Georgia, USA, December 3–5, 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, \textit{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

<table>
<thead>
<tr>
<th>Program</th>
<th>Name of the course</th>
<th>Lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Electronics</td>
<td>Anders Karlsson, Alexander Bondarik, Iman Vakili, Doruk Tayli, Gabriele Costanza, Richard Lundin</td>
</tr>
<tr>
<td>F2, N2, BME2</td>
<td>Electromagnetics and Electronics</td>
<td>Mats Gustafsson, Richard Lundin, Doruk Tayli, Alexander Bondarik, Carl Gustafsson, Andreas Ericsson, Gabriele Costanza</td>
</tr>
<tr>
<td>E3</td>
<td>Electromagnetic Fields</td>
<td>Buon Kiong Lau, Andreas Ericsson</td>
</tr>
<tr>
<td>F3</td>
<td>Electromagnetic Field Theory</td>
<td>Gerhard Kristensson, Casimir Ehrenborg, Iman Vakili</td>
</tr>
<tr>
<td>Pi3</td>
<td>Electromagnetic Field Theory</td>
<td>Gerhard Kristensson, Casimir Ehrenborg, Iman Vakili</td>
</tr>
<tr>
<td>E4, F4, Pi4, MWIR1, MFOT1</td>
<td>Antenna Technology</td>
<td>Mats Gustafsson, Jacob Helander, Doruk Tayli, Zachary Miers</td>
</tr>
<tr>
<td>E4, F4, Pi4</td>
<td>Electromagnetic Wave Propagation</td>
<td>Daniel Sjöberg, Doruk Tayli</td>
</tr>
<tr>
<td>E4, F4, Pi4</td>
<td>Microwave Theory</td>
<td>Anders Karlsson</td>
</tr>
<tr>
<td>E4, F4, Pi4</td>
<td>Accelerators, Particles, and Fields</td>
<td>Anders Karlsson, Richard Lundin</td>
</tr>
<tr>
<td>IDA2</td>
<td>Technical Interfaces</td>
<td>Daniel Sjöberg</td>
</tr>
<tr>
<td>IEA2</td>
<td>Circuits and Measurements, Advanced Course</td>
<td>Daniel Sjöberg</td>
</tr>
</tbody>
</table>

---

**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.
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.

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.
ESS050 Electromagnetic Fields (9 ECTS credits, 84 hours):
Given to third year students on the Electrical Engineering, or E-, program. Approximately 75 students.

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.

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.

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. Syn-
thesis 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. Approximately 20 stu-
dents.
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 Mathe-
matics, 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.

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.
“Annual Report 1988/89,”
LUTEDX/(TEAT-3001)/1-9/(1989).

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

“Annual Report 1990/91,”

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

LUTEDX/(TEAT-3005)/1-23/(1993).

“Annual Report 1993/94,”
LUTEDX/(TEAT-3006)/1-22/(1994).

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

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

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

“Annual Report 1998,”
LUTEDX/(TEAT-3010)/1-43/(1999).

“Annual Report 1999,”

“Annual Report 2000,”
LUTEDX/(TEAT-3012)/1-50/(2001).

“Annual Report 2001,”
LUTEDX/(TEAT-3013)/1-55/(2002).

“Annual Report 2002,”
LUTEDX/(TEAT-3014)/1-51/(2003).

“Annual Report 2003,”
LUTEDX/(TEAT-3015)/1-49/(2004).

“Annual Report 2004,”
LUTEDX/(TEAT-3016)/1-53/(2005).

“Annual Report 2005,”
LUTEDX/(TEAT-3017)/1-52/(2006).

“Annual Report 2006,”
LUTEDX/(TEAT-3018)/1-44/(2007).

“Annual Report 2007,”
LUTEDX/(TEAT-3019)/1-42/(2008).

“Annual Report 2008,”
LUTEDX/(TEAT-3020)/1-51/(2009).

“Annual Report 2009,”
LUTEDX/(TEAT-3021)/1-41/(2010).

“Annual Report 2010,”
LUTEDX/(TEAT-3022)/1-55/(2011).

“Annual Report 2011,”
LUTEDX/(TEAT-3023)/1-51/(2012).

“Annual Report 2012,”
LUTEDX/(TEAT-3024)/1-47/(2013).

“Annual Report 2013,”
LUTEDX/(TEAT-3025)/1-47/(2014).