

DTU ELEKTRO IN BRIEF

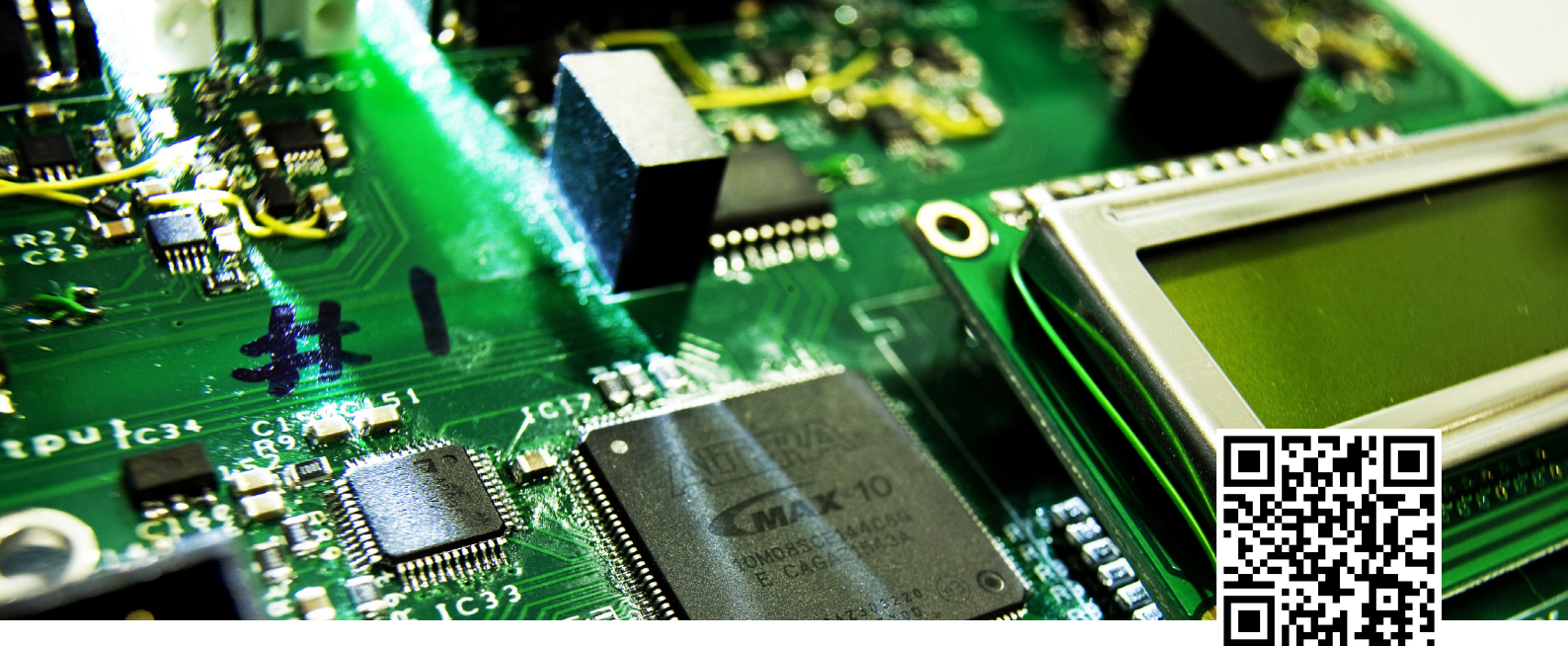


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www.elektro.dtu.dk

WORLD-CLASS RESEARCH OF BENEFIT TO SOCIETY

For university departments as ours it is the aim to conduct research that will radically change the way society acts and the way its citizens make use of technology.

Our research is highly relevant to society and we engage in an increasing number of strategic projects, with a major part of our income now generated by competitive grants. We are also in close contact with industry for strategic initiatives. Because of the many new research projects it is possible for us to start a large number of very interesting PhD projects and to welcome a large number of talented Postdocs. They contribute significantly to research and innovation.

Fortunately, we attract many students who wish to specialize in Electrical Engineering, Biomedical Engineering, Acoustics or Power Engineering. We strive to offer modern and timely

training. Our different study programmes continue to fill with constantly increasing student numbers.

We hope you will enjoy reading about the innovative research we engage in and visit our webpages where you will find many more details. We look forward to future contact and collaboration.



Kristian Stubkjær
Professor,
Head of Department



RESEARCH, COLLABORATION AND INNOVATION

DTU Electrical Engineering - also known as DTU Elektro - has around 280 highly skilled employees. We conduct state-of-the-art research within acoustics, antenna and microwave technology, audiology, biomedical engineering, power electronics, robotics, playware, electric power and energy.

An important part of our research is carried out in extensive collaboration with industry partners and in interaction internationally with leading private and public researchers. It is our goal to ensure research and engineering training at the highest international level.

We are one of DTU's most innovative departments. We have an ambitious innovation strategy and focus on inventions, patents, licence/sale of inventions and software, Proof of Concept funding, start-up companies and bench-free agreements

for start-ups. Innovation is thus an integrated part of our activities concerning education, research and scientific advice.

Our department cooperates with companies on collaborative research, technology in the form of patents, student projects and access to research facilities and infrastructure.

EDUCATION AND TEACHING

At DTU Elektro we educate engineers in Electrical Engineering technologies as well as Biomedical Engineering. We offer studies at BEng, BSc, MSc and PhD levels and participate in international Master programmes.

Bachelor of Science (BSc)

The BSc programmes are 3-year research-based undergraduate engineering programmes which qualify students for an MSc programme.



Master of Science (MSc)

The MSc programmes at DTU are 2-year research-based programmes at the highest technological level. Students acquire the qualification and skills necessary to analyse, synthesize and evaluate theory and experiments relating to complex engineering systems, problems, and solutions.

Joint international Master programmes

The possibility of graduating with a dual degree from two internationally acclaimed top universities by studying one year abroad is at hand. This means that the students get to spend one year at DTU and one year at KAIST, Korean Advanced Institute of Science and Technology.

PhD school at DTU Elektro

At DTU Elektro we have an international research environment with PhD students and researchers from all over the world. The PhD programme is a 3-year research programme where the PhD student is trained to become a researcher. Our PhD students are funded by industrial scholarships, research schools and DTU scholarships. The department has around 100 PhD students.

DTU programmes offered via DTU Elektro

BSc

Electrical Engineering

Biomedical Engineering - offered in collaboration with the University of Copenhagen.

MSc

Electrical Engineering

Engineering Acoustics

Biomedical Engineering - offered in collaboration with the University of Copenhagen.

DTU Elektro also take part in the DTU MSc programmes:

Sustainable Energy

Wind Energy

Our department contributes to the two following DTU-KAIST Dual Degree MSc programmes:

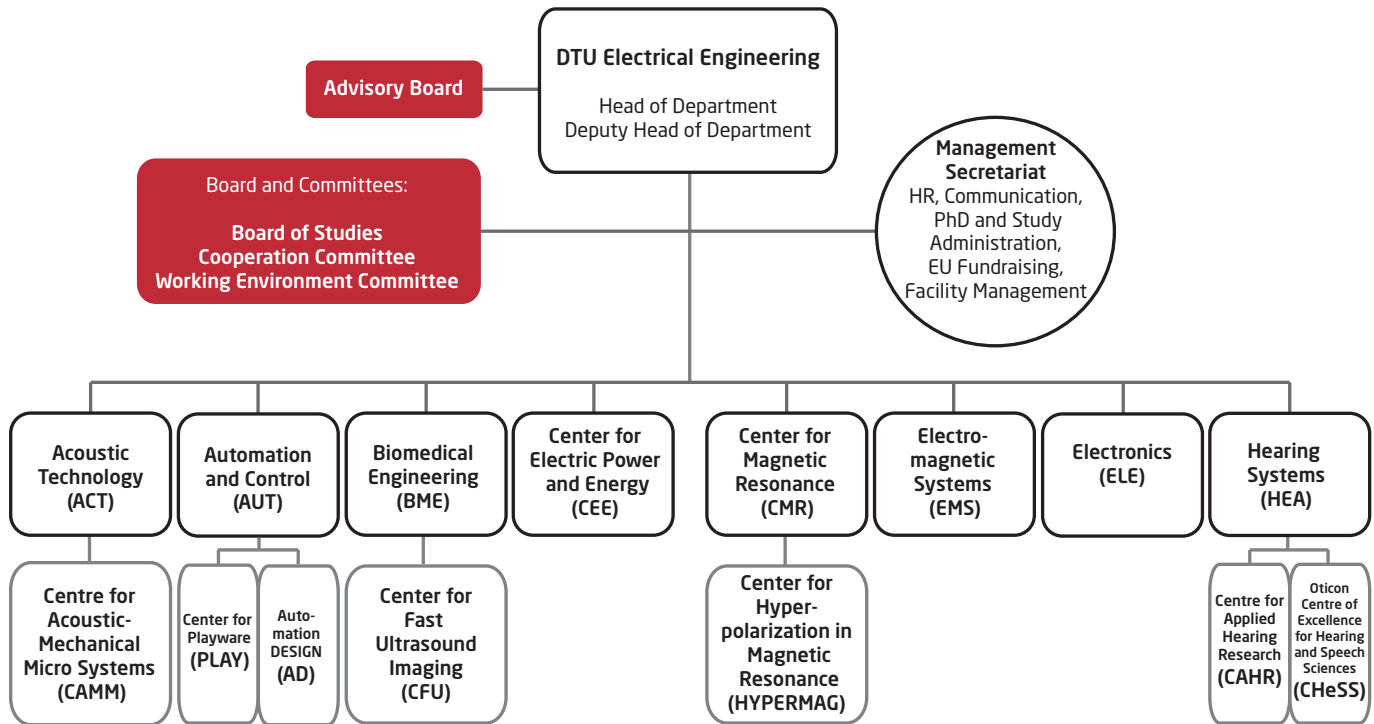
Electrical Engineering

Engineering Acoustics

We are also involved in the following Bachelor of Engineering (BEng) programmes at DTU Diplom:

Electrical Engineering

Electrical Energy Technology



ORGANIZATION IN BRIEF

DTU Elektro is organized into eight groups and eight centres which carry out state-of-the-art research and educational activities. The department also consists of a management secretariat maintaining HR and communication activities, PhD and study administration, EU fundraising as well as facility management.

The Head of Department has an Advisory Board consisting of representatives from relevant business areas. The Advisory

Board gives advice on the department's activities in education, research and innovation.

The Board of Studies at the department is responsible for formulating and planning our undergraduate and graduate courses as well as evaluation, grading and development of courses.

On the following pages we are proud to present our 8 groups and their cutting-edge research.

GROUPS

Acoustic Technology (ACT)
Automation and Control (AUT)
Biomedical Engineering (BME)
Center for Electric Power and Energy (CEE)
Center for Magnetic Resonance (CMR)
Electromagnetic Systems (EMS)
Electronics (ELE)
Hearing Systems (HEA)

CENTRES

AutomationDESIGN (AD)
Centre for Acoustic-Mechanical Micro Systems (CAMM)
- jointly with DTU Mechanical Engineering
Centre for Applied Hearing Research (CAHR)
Center for Electric Power and Energy (CEE)
Center for Fast Ultrasound Imaging (CFU)
Center for Hyperpolarization in Magnetic Resonance (HYPERMAG)
- jointly with DTU Chemistry
Center for Playware (PLAY)
Oticon Centre of Excellence for Hearing and Speech Sciences (CHeSS)

MANAGEMENT

Professor **Kristian Stubkjær**, *Head of Department*
Professor **Michael A.E. Andersen**, *Deputy Head of Department, Head of ELE*
Associate Professor **Finn T. Agerkvist**, *Head of ACT*
Associate Professor **Ole Ravn**, *Head of AUT*
Associate Professor **Thomas Sams**, *Head of BME*
Professor **Jacob Østergaard**, *Head of CEE*
Professor **Joachim Holbøll**, *Deputy Head of CEE*
Professor **Jan Henrik Ardenkjær-Larsen**, *Head of CMR*
Professor **Olav Breinbjerg**, *Head of EMS*
Professor **Torsten Dau**, *Head of HEA*
Associate Professor **Jens Christian Andersen**, *Chairman of the DTU Electrical Engineering Board of Studies*



Mission and Vision statement

Mission:

DTU Electrical Engineering will advance knowledge and educate students within our fields to the benefit of society

Vision:

to be among the leading international departments within Electrical Engineering

to provide highest-level research-based education at BSc, MSc, and PhD levels that is attractive to both domestic and international students

to provide cutting-edge research and innovation in close collaboration with industry, society, as well as other leading institutions

to emphasize the linking of theory and modelling to the experimental test and validation of results

to be an attractive and motivating workplace for guests, students and staff.



www.act.elektro.dtu.dk

ACOUSTIC TECHNOLOGY (ACT)

The field of research for our Acoustic Technology group includes room and building acoustics, mechanical systems and vibro-acoustics, sound field analysis methods, array techniques, electro acoustics and numerical methods for acoustics and vibration. We are focused on exploiting the interaction between these fields in order to develop improved acoustic technologies which help to characterize and reduce noise sources and improve the acoustic environment and/or to improve the quality of communication and reproduced sound.

We have state-of-the-art experimental facilities and equipment including several anechoic and reverberant chambers, and have a strong emphasis on experimental validation of methods.

ACT hosts the Centre for Acoustic-Mechanical Micro Systems, which is a collaboration between DTU Electrical Engineering, DTU Mechanical Engineering and the Danish hearing aid industry. The centre is focused on the interaction between mechanics and acoustics, which play an important role in small systems such as hearing aids.

Facts about ACT

Research areas:

Sound field analysis and measurements
Electroacoustic and transducer technology
Structure-borne sound
Architectural acoustics

Affiliated centre:

Centre for Acoustic-Mechanical Micro Systems (CAMM)

Head of group:

Finn T. Agerkvist
+45 4525 3941
fa@elektro.dtu.dk

Head of CAMM centre:

Jakob Søndergaard Jensen

Staff:

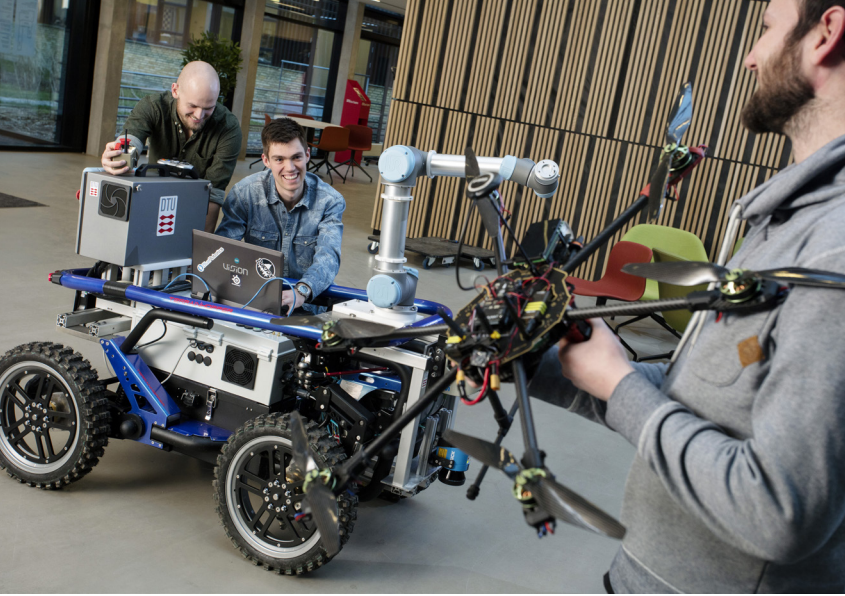
Approx. 19 staff members including PhDs and Postdocs

Main research facilities:

Anechoic chambers, reverberation rooms

Address:

DTU Lyngby Campus, Ørstedes Plads, building 352



www.aut.elektro.dtu.dk

AUTOMATION AND CONTROL (AUT)

Our Automation and Control group's field of research and teaching is within methods and technologies for control and supervision of technical systems. At present, there are many areas of application such as robotics, autonomous vehicles, industrial systems and processes, marine vehicles, drones as well as playware. The competences of the group include modelling and control of systems with discrete or continuous dynamics, fault-tolerant control and diagnosis, sensor fusion, applications of agents, knowledge-based systems in automation and decision-support systems for plant-wide diagnosis. The approach taken is a systems approach to analysis, design and synthesis on automated systems and the focus is on theory and methods to increase availability, reliability and safety of industrial systems and processes.

Part of AUT activities is the cross-disciplinary Center for Playware which focuses on showing how playful aspects of robotics and interactive technology may provide motivation for any citizen to perform different kinds of interaction. The combination of modern artificial intelligence, modular robotics and entertainment provide novel opportunities in play, rehabilitation, sport, music, teaching, etc. We run diverse state-of-the-art laboratories to facilitate an interdisciplinary research effort. Mobile robots and robot arms are available and used in research projects with industry and teaching.

Facts about AUT

Research areas:

- Mobile and modular robotics
- Fault-tolerant operation
- Digitalisation in industry
- Fault-tolerant control
- Sensor processing and fusion

Affiliated centres:

- Center for Playware (PLAY),
- AutomationDESIGN (AD)

Head of group and AD centre:

Ole Ravn
+45 4525 3560
or@elektro.dtu.dk

Head of PLAY centre:

Henrik Hautop-Lund

Staff:

Approx. 30 staff members including PhDs and Postdocs

Main research facilities:

Playware Lab, Mobile robotics Lab, Control Lab, REMORA Lab

Address:

DTU Lyngby Campus, Elektrovej, building 326



www.bme.elektro.dtu.dk

BIOMEDICAL ENGINEERING (BME)

Our BME group conducts research within diagnostic ultrasound imaging, biomedical signal processing, cellular signalling, neural stimulation, and biomechanics. Center for Fast Ultrasound Imaging continues the efforts towards the development of the ultrasound scanners of the future with better spatial resolution, image contrast, and depth penetration in human soft tissues.

Our biomedical signal processing research specializes in automatic multi-modal signal acquisition, analysis, classification and interpretation for continuous monitoring of hospitalised as well as home care patients. Another focus in signal processing concerns brain-computer interface (BCI) technology, which assists disabled people with severely impaired motor systems to communicate with the outside world.

In cellular signalling we aim at understanding selected cellular signalling processes and use this knowledge to control collective cellular behaviour. This involves mathematical models of the signalling, binding and transport which is at the heart of bacterial biofilm formation. This leads to continued improvements of treatment strategies of biofilm infections in immuno compromised patients and patients with implants. Research areas within biomedicine and biomechanics focus on cardiovascular solid and fluid mechanics as well as biomechanics of the locomotor system.

Facts about BME

Research areas:

- Ultrasound imaging
- Biomedical signal processing
- Biomechanics and biomedicine
- Brain computer interfaces
- Cellular information processing

Affiliated centre:

Center for Fast Ultrasound Imaging (CFU)

Head of group:

Thomas Sams
+45 4525 5725
ts@elektro.dtu.dk

Head of CFU centre:

Jørgen Arendt Jensen

Staff:

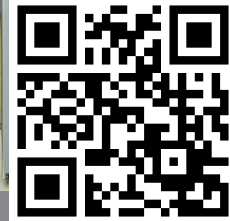
Approx. 20 staff members including PhDs and Postdocs

Main research facilities:

SARUS

Address:

DTU Lyngby Campus, Ørstedes Plads, building 349



www.cce.elektro.dtu.dk

CENTER FOR ELECTRIC POWER AND ENERGY (CEE)

At our Center for Electric Power and Energy we are working for a sustainable future. Our research focuses on the rapid transformation of the energy system by developing new technologies, knowledge, theory and methods which enable the most integrated, market-based and flexible energy system based on digital solutions and renewable energy in a cost-effective manner. CEE aims at covering the gap from theoretical concepts to lab-validation and real-world deployment.

CEE works closely with industry to make sure that our research solves real-life problems related to the green transformation of the energy system and integration of renewable energy in the grid. For example we develop solutions to make electrical vehicles work as an integrated part of the system - not only consuming electricity, but also actively contributing to the grid - leading to a more sustainable and efficient electricity market. CEE takes great pride in our pioneer research but also in teaching our students about electric power technologies, electricity markets and digital energy solutions to educate them on how to optimize electricity demand, generation, grid infrastructures and the associated ICT-solutions and energy markets. CEE offers state-of-the-art testing facilities under the collective brand: PowerLabDK. The world-class facilities contain flexible test laboratories, large-scale experimental facilities, and a complete full-scale power distribution system on the Island of Bornholm, which also serves as a data source and platform for full-scale and real-life experiments.

Facts about CEE

Research areas:

Digital energy solutions
Interconnected energy system
Optimized electric energy technologies

Head of group:

Jacob Østergaard
+45 4525 3501
joe@elektro.dtu.dk

Staff:

Approx. 94 staff members including PhDs and Postdocs

Main research facilities:

PowerLabDK, which includes multiple labs in Lyngby, Ballerup, Risø and on the Island of Bornholm. Operated in collaboration with DTU Diplom and Bornholms Energi og Forsyning. Visit: www.powerlab.dk.

Address:

DTU Lyngby Campus, Elektrovej, building 325
DTU Risø Campus, Frederiksborgvej 399, building 776



www.cmr.elektro.dtu.dk

CENTER FOR MAGNETIC RESONANCE (CMR)

Our CMR group's field of research and teaching is within Magnetic Resonance Imaging (MRI) and Spectroscopy. Magnetic Resonance is a powerful spectroscopic technique providing detailed information about the structure and dynamics of molecules (Nuclear Magnetic Resonance (NMR)) or high-resolution anatomical and functional images (MRI).

Through technological and methodological research and innovation we enable the study and manipulation of complex processes and systems previously not visible, e.g. the inner workings of living cells or the stimulation of brain neurons. Potential applications include improved clinical diagnosis, treatment monitoring and personalized medicine.

Part of CMR activities is HYPERMAG, a center of excellence funded by the Danish National Research Foundation, which is committed to studying basic research questions of nuclear spin hyperpolarization, exploiting the technique's vast enhancement of the MR signal to enable new applications within medicine, biology and chemistry.

We run diverse state-of-the-art laboratories to facilitate an interdisciplinary research effort. MR scanners are available through extensive collaboration with university hospitals.

Facts about CMR

Research areas:

Hyperpolarization
Neurophysics
MRI acquisition methodology
High field MRI

Affiliated centre:

Center for Hyperpolarization in Magnetic Resonance (HYPERMAG)

Head of group and centre:

Jan Henrik Ardenkjær-Larsen
+45 4525 3918
jhar@elektro.dtu.dk

Staff:

Approx. 23 staff members including PhDs and Postdocs

Main research facilities:

NMR Lab, Cell Lab, Chemistry Lab, RF and MW Lab

Address:

DTU Lyngby Campus, Ørstedes Plads, building 349



ELECTROMAGNETIC SYSTEMS (EMS)

Our Electromagnetic Systems group conducts research and teaching in theoretical and applied electromagnetics; this includes antenna technology, antenna measurements, circuit and component technology including integrated circuits, computational techniques, imaging, and structured materials.

Most applications are for microwave wireless communication and sensing such as satellite antennas, high-accuracy nearfield antenna testing, hearing aid and high-speed wireless communication, medical imaging, and radars; while some applications are for sub-THz and optical frequencies such as integrated circuits, photonic components, and nano-sensors. The EMS group has substantial cooperation with Danish and European industry, e.g. within several projects for the European Space Agency (ESA) and the European Union (EU).

EMS operates the DTU-ESA Spherical Near-Field Antenna Test Facility that constitutes an ESA external reference laboratory for high-accuracy testing of satellite antennas. Experimental testing is vital to research and teaching in wireless technology, and the group is developing the DTU Electromagnetic Test Centre that will provide state-of-art measurement capabilities for antennas, components, and circuits in the entire microwave frequency range from 300 MHz to 300 GHz.

Facts about EMS

www.ems.elektro.dtu.dk

Research areas:

- Electromagnetic field theory
- Antenna technology and measurements
- Microwave technology and measurements
- Electromagnetic metamaterials
- Terahertz electronics

Head of group:

Olav Breinbjerg
+45 4525 3814
ob@elektro.dtu.dk

Staff:

Approx. 23 staff members including PhDs and Postdocs

Main research facilities:

DTU-ESA Spherical Near-Field Antenna Test Facility

Address:

DTU Lyngby Campus, Ørstedes Plads, building 348





www.ele.elektro.dtu.dk

ELECTRONICS (ELE)

Our Electronics group conducts fundamental as well as applied research in power electronics as well as analog, power and mixed-mode IC design on physics, component-, and system levels ranging from MW to mW power converters. We continue to be the research leaders within:

High efficiency fuel cell and solid oxide electrolysis cell power converters – obtained by both system and component level optimization of the power losses and the physical properties behind these losses. The key to ultra-high efficiency is a holistic understanding of all the loss mechanisms combined with the impedance levels in all parts of the converters.

Switch-mode (class D) audio power amplifiers: For more than 20 years we have obtained audio quality and efficiency specifications that are second to none. This is reached by research into mixed continuous and discrete time sampling as well as modeling of state-of-the-art self-oscillating multi loop control systems.

Very high frequency power converters with high power densities have been achieved by increasing the switching frequencies the 30-300 MHz range. The power converters built with discrete components can be reduced by further increasing the switching frequency and enabling both PwrSiP and PwrSoC which could be used for products like intelligent LED lighting and miniature chargers.

Facts about ELE

Research areas:

Power electronics
Switch-mode technology
Analog, power, and mixed-mode IC design
Signal conditioning

Head of group:

Michael A. E. Andersen
+45 4525 3601
ma@elektro.dtu.dk

Staff:

Approx. 28 staff members including PhDs and Postdocs

Main research facilities:

State-of-the-art labs and equipment for power electronics and IC design, process design kits and software for IC design, EMC chamber, climate chamber, probe station, semi-automatic pick-and-place machine (rework station), reflow oven, and various soldering equipment.

Address:

DTU Lyngby Campus, Elektrovej, building 325



HEARING SYSTEMS (HEA)

Our Hearing Systems group is concerned with speech communication, auditory signal processing and perception, audiology, objective measures of auditory function, and hearing-instrument signal processing.

The majority of our research is conducted at our Centre for Applied Hearing research (CAHR) and the Centre for Hearing and Speech Sciences (CHeSS). The goal of this research is to increase our understanding of the functioning of the human auditory system and to provide insights that are useful for technical applications such as hearing aids, speech recognition systems, hearing diagnostics tools, and cochlear implants.

The Hearing Systems group is involved in several EU projects and also a part of collaborative projects between universities, audiological clinics, and hearing instrument manufacturers. In addition to gaining a fundamental understanding of human hearing, the goal is to improve quality of hearing care for people with hearing loss.

Facts about HEA

www.hee.elektro.dtu.dk

Research areas:

- Auditory signal processing
- Modelling of auditory perception
- Computational neuroscience of hearing
- Audiology
- Objective measures of auditory function

Affiliated centres:

- Centre for Applied Hearing Research (CAHR),
- Oticon Centre of Excellence for Hearing and Speech Sciences (CHeSS)

Head of group and centres:

Torsten Dau
+45 4525 3977
td@elektro.dtu.dk

Staff:

Approx. 45 staff members including PhDs and Postdocs

Main facilities:

Audio-Visual Immersion Lab, Psychophysics lab, Physiology lab, Communication lab

Address:

DTU Lyngby Campus, Ørstedes Plads, building 352



DTU Electrical Engineering
Department of Electrical Engineering

DTU Electrical Engineering
Department of Electrical Engineering
Technical University of Denmark
Ørstedss Plads, building 348
2800 Kgs. Lyngby
Denmark

+45 45 25 38 00
elektro@elektro.dtu.dk
www.elektro.dtu.dk
www.facebook.com/dtuelektro
www.linkedin.com/company/dtu-elektro