



# 2015

## Excellence in operation

The importance of being  
international

The bridge between academia  
and industry

Student cooperation ensures  
world-class education

KTH EE tops QS ranking





**KTH ROYAL INSTITUTE  
OF TECHNOLOGY**

# “Our faculty is our backbone”

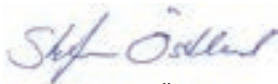
**IN MANY RESPECTS**, 2015 was an amazing year with the peak being our 16th place in the QS world rankings by subject. In light of this success, we must not forget our other impressive achievements in 2015. For instance, Associate Professor **Dimos Dimarogonas** from the Department of Automatic Control received a European Research Council grant and was also named a Wallenberg Academy Fellow. Another great accomplishment is the multi-million kronor grant from the Knut and Alice Wallenberg Foundation for research on the interconnected society.

**OUR FACULTY IS** the backbone of our academic activities and over the year we saw a number of promotions that confirm its excellence. We appointed seven new professors. One of these was Professor **Viktoria Fodor**, whose research field within networking and sharing the load on the internet is more prominent than ever.

Besides being a professor, Fodor is one of the school's several programme directors, whose unremitting work for the students in their respective programmes is the main reason for our strong reputation among international students. More and more students are applying for our bachelor and master programmes, and the development of the pedagogic work within the courses and programmes is inspiring to see.

**OUR SYSTEMATIC** and thorough efforts involved in improving the working environment are also worth mentioning, as our ambitious researchers are making strides to break new research ground that may alter stress levels. We introduced a code of conduct during the year and investments in health-related issues will continue in 2016.

The School of Electrical Engineering hosts two centres of excellence; one of these is SweGRIDS, which serves as a great example of collaboration between industry and academia. The close relationship with some of Sweden's most important companies enhances the creativeness and inspiration at the school. One clear sign of this is the school's upcoming investment in digitisation, highly recommended by representatives from Swedish industry in the Strategic Advisory Council, which will take place during 2016.



**Professor Stefan Östlund**, Head of School

School of Electrical Engineering





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## High marks for electrical and electronic engineering at KTH

Several subject areas at **KTH** Royal Institute of Technology achieved prominent places in the prestigious **QS** rankings in 2015. The highest-placed subject for **KTH** is electrical and electronic engineering, which is ranked 16th in the world – the best-ever rating for **KTH**.

**THE QS RANKINGS**, one of the largest and most-respected systems in the world for ranking educational institutions, presents various annual standings based on a combination of surveys and bibliometric data. In the QS subject ranking for 2015, KTH is among the top 25 in three subject areas.

“Electrical and electronic engineering

at KTH ended up being ranked 16th in the world,” says KTH ranking expert **Per-Anders Östling**. “This is very impressive, and probably as high as we could come given our resources.”

**Stefan Östlund** is Head of school at KTH School of Electrical Engineering, where the majority of KTH activities in electrical and electronic engineering

are conducted. He is obviously pleased and proud of the prominent placement. He notes that the school’s standing has risen steadily since subject-area rankings started, and underlines that the long-term development work has yielded clear results.

“This is not something you do in a few years,” Östlund says. “We have

worked with our development plan to create shared values among the entire teaching staff ever since the school was founded. We work in an international and multidisciplinary environment, and we constantly strive to recruit the best teachers, the best doctoral students and the best undergraduates.”

#### COLLABORATING WITH THE BEST

ABB is one of the school's most important industrial partners and its Head of External Research Collaborations, **Helena Malmqvist**, is also very pleased with the ranking result. ABB collaborates with universities in several areas, and electrical engineering is the most important of these in terms of its partnership with KTH.

“This is great fun,” Malmqvist says. “It's very important for ABB to collaborate with the best, and this makes it easier for us to argue for the cooperation with KTH. We are a global company, and international rankings are very

important in our discussions of research and partnerships.”

#### EXCELLENT REPUTATION

Success in the QS rankings depends largely on KTH's good reputation among fellow scientists and with industry internationally. KTH scores highly on the academic reputation indicator, where researchers around the world perform the assessments, and electrical and electronic engineering scored 85.5 points out of a possible 100. KTH then scored 86 points out of a possible 100 for the same subject in the employer reputation indicator, in which companies assess the quality of students.

“**WE HAVE THE** things that make for a good reputation: strong research and good education,” Östlund says. “Our students do well, even though they think that the education is the most challenging at KTH. We demand more, and this produces good results and high quality.”

The ranking for electrical and electronic engineering has improved since subject-area studies started in 2011, at which point KTH fell within the 51-100 range. By 2012, however, KTH had moved up to 40th place; in 2014 it was ranked 31st and now it is up to 16th.

As Östlund points out, the school is not single-handedly responsible for activities within the area of electrical and electronic engineering: important research is also conducted at the KTH School of Information and Communication Technology. As in other rankings, KTH scores lower on research in the QS assessment as measured by publications and citations. This is offset, however, by its unusually high scores for reputation.

“KTH's international reputation is very strong,” Östling says. “However, we are not ranked so highly in research, and this is where we need to do better.” ■

“We have worked with our development plan to create shared values among the entire teaching staff ever since the school was founded”





# KTH SPIN-OFF BOOSTS INDUSTRY COOPERATION

A growing number of enterprises are being formed through innovative cooperation between researchers and entrepreneurs. A shining example of this is cybersecurity specialist foreseeti, a **KTH** Royal Institute of Technology spin-off set up by researchers at the School of Electrical Engineering.

**ROBERT LAGERSTRÖM**, Associate Professor at KTH's Department of Industrial Information and Control Systems (ICS), says: "Our view has previously been that we're scientists and that's what we're good at, and creating start-ups is for someone else to deal with. Now there's definitely

been a change; the focus is much more on innovation and reaching out to the market with our research, especially when you can see what impact it has on society and the economy."

Lagerström says it has become more common for organisations such as Vinnova (the Swedish Government's

innovation agency) and EU-funded projects to encourage researchers to establish companies based on their research when funding new projects. Vinnova's mission is to promote collaboration between companies, universities' research institutes and the public sector. KTH has also established KTH



Innovation, which can help researchers and students transform their research ideas and findings into companies and new products.

For foreseeti, the solution was a partnership with KIC InnoEnergy, a European company dedicated to promoting innovation, entrepreneurship and education in the sustainable energy field by bringing together academics, businesses and research institutes.

KIC InnoEnergy focuses on smart energy grids, which fit nicely into foreseeti's approach to securing networks. The company thought foreseeti's business idea was so strong that it decided to invest heavily in the start-up. In addition, foreseeti got further financial help from an EU-funded project, and benefitted from the cooperation of a German company that will also be testing the solution on its customers.

"At the same time, we've had a long-term cooperation with the energy industry regarding our research, such as with ABB," Lagerström says. "They've even encouraged us to start a company earlier and said they'd become customers if we did. So, it was natural for us to start focusing on the energy sector."

KIC InnoEnergy's investments made it possible for foreseeti to employ staff, and it now has more than 10 employees with experience in research, software development, cybersecurity and sales.

Lagerström says forming foreseeti has had a great impact on the people involved. "It has really been an energy boost for the whole department and our research team. We have had some great input from various entrepreneurs, which has had a positive effect on our research. In addition we also have a lot of new contacts in the industry."

**FORESEETI'S CORE AIM** – preventing cybercrime – may seem to some like the plot of a science fiction film. But this is becoming an increasingly important task for many companies today. It is estimated that cybercrime costs industries about USD 300 billion per year. This is what triggered the researchers at KTH to develop a tool for analysing cybersecurity.

"The foreseeti solution, called securiCAD, is built on the same principle as the CAD (computer-aided design) software used by architects and the car industry, for example," Lagerström says. "It enables us to build a virtual model of IT systems and then perform simulations to prevent unauthorised access to sensitive data and functionality."

SecuriCAD works with any enterprise's IT architecture, even more complex architectures under development. It has already been used successfully in multiple sectors, including the energy and banking industries.

Part of the research team behind the prototype formed foreseeti 18 months ago, encouraged by the market potential and positive feedback they had received on their research. They also realised, however, that it would be a considerable challenge to turn their many years of research into a commercial solution. For this reason, the team decided they needed support from someone who knew how to approach the market.

Through their personal networks, members of the research team came into contact with Strategy Consultant

It has really been an energy boost for the whole department and our researchers

Joakim Nydrén from Accenture. He helped them with a pre-study, which went so well that Nydrén quit his job at Accenture to become a partner and CEO of the company.

According to the pre-study, there is great market potential for a solution such as securiCAD. It showed there is a huge gap between what enterprises need and what is available on the market.

"Joakim has taught us a lot about how the market works and how we could describe our solution in terms of the benefits companies can gain from it," Lagerström says. "For us, it was crucial to find such a partner."

**FOR FORESEETI**, 2016 will be an intense year with the focus set on establishing a customer base and becoming profitable.

"We're targeting all enterprises where IT security is highly important, including energy, financial and manufacturing industries, for example," Lagerström says. "We already have a close relationship with many of them through previous research, and now we can give them an opportunity to get a return on their investments through our solution." ■

Robert Lagerström, Associate Professor at KTH's Department of Industrial Information and Control Systems (ICS)



# ADJUNCT PROFESSORS – BRIDGE BUILDERS BETWEEN ACADEMIA AND SOCIETY

As one of four adjunct professors at the School of Electrical Engineering, **Lennart Harnefors** makes sure that the research conducted and scientific knowledge gained effectively meet the needs of people in society.

**H**ARNEFORS IS ONE of four adjunct professors at the School of Electrical Engineering. Control of power electronic systems is the common thread in his research, which becomes evident when reading his cv. He received his M.Sc. in Electrical Engineering from KTH in 1993, and four years later, he devoted his Ph.D. thesis to the subject of control of electrical drives.

**HAVING SPENT** 12 years working at Mälardalen University, most recently as Professor of Electrical Engineering, Harnefors started working at ABB's High Voltage Direct Current (HVDC) unit in Ludvika, Sweden. Then he switched to the ABB Corporate Research Center in Västerås, where he currently holds a position as Senior Principal Scientist.

"My research focuses on how electrical converters behave when they are connected to electrical circuits, and how they can be controlled and modulated in different ways," he says. "The results

can be applied to many different types of products, such as photovoltaic converters (which generate electricity using solar cells), wind turbines and robots.

"Although much of my current research deals with high-voltage converters, the principles can also have low-voltage applications



## Adjunct professors KTH: THE FACTS

Adjunct professors are assigned to work at one of KTH's schools where they have direct contact with cutting-edge scientific developments as well as educators and students.

They are well-qualified individuals, who bring specialist knowledge, experience and networks to support research as well as undergraduate, graduate and third-cycle education at KTH. Most adjunct professors here have a Ph.D. and many have a docent qualification.

They work part time at KTH – usually one day a week. Normally, their full salary is paid by their principal employer. Their adjunct professor position is a temporary one, but can be renewed following an evaluation. The total employment term may not exceed 12 years.

Besides Lennart Harnefors, the School of Electrical Engineering has three other adjunct professors:

- **Mats Bäckström**, SAAB, Department of Electromagnetic Engineering
- **Göran Ericsson**, Svenska kraftnät, Department of Electric Power and Energy Systems
- **Ulf Forssén**, Ericsson, Department of Signal Processing



“We see a trend towards using silicon carbide in electrical vehicles, so this is a hot subject”

For Harnefors personally, having the adjunct professor role has meant that his research has gained more international attention, and that he has been able to produce more scientific papers.

Looking ahead, he plans to broaden his research to encompass the study of what advantages silicon carbide offers over pure silicon in semiconductors, when applied in high-voltage converters.

“**BY USING SILICON** carbide, you can reduce the level of conduction and switching losses,” he says. “Already today, we can see that there is a trend towards using silicon carbide in electrical vehicles, so this is definitely a hot research subject.”

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They are well-qualified individuals, who bring specialist knowledge, experience and networks to support research as well as undergraduate, graduate and third-cycle education at KTH. Most adjunct professors here have a Ph.D. and many have a decent qualification.

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►► – so, from a few kilowatts up to several hundred megawatts.”

New ABB products, such as Generation 4 of HVDC Light, have been developed as a result of Harnefors’s work. He is also involved in long-term research, for instance, on next-generation HVDC products and conceptual studies.

In 2011, Harnefors was appointed Adjunct Professor of Power Electronics at KTH. In practice, this means that he is employed by ABB but spends one day a week at the School of Electrical Engineering in Stockholm.

KTH’s use of adjunct professors should be viewed in light of its ambition to maintain the highest, international standards in its research and educational programs. To achieve this goal, the institute must maintain close links with society to fully appreciate people’s need for scientific knowledge and the ways in which the results of research can be applied in practice.

As a supervisor for doctoral students, Harnefors serves as a link

between academia and society, bringing them closer together. He is currently supervising two industrial Ph.D. students, one of whom is investigating system solutions for HVDC, the subject of his thesis.

On top of this, Harnefors has been teaching a Master’s course in Control in Electrical Energy Conversion, and will continue to do so in 2016.

**HARNEFORS SAYS** that, for ABB, one obvious benefit of having a direct link with KTH, is that the company can get in contact with master’s and doctoral students who are about to finish their studies, and thereby secure the recruitment of competent staff.

ABB can also influence the education at the School of Electrical Engineering, partly through the course that Harnefors teaches at KTH and where he integrates experience from his role as Senior Principal Scientist, partly in that ABB is represented in the school’s Master’s Program Committee.

# New network aims to promote research careers for women

When **Emma Tegling** started her Ph.D. studies at **KTH Royal Institute of Technology**, she quickly noticed a high level of diversity in terms of cultural background but not as much in terms of gender. The lack of female role models inspired her to create a platform where female colleagues could collaborate, inspire and support each other.

**DURING BOTH** her graduate and Ph.D. studies, Tegling, from the Department of Automatic Control, was missing interaction with female faculty members and other inspiring role models. Wanting to contribute to change, she initiated a network for female Ph.D. students in early 2015. Tegling is now coordinating the network's activities for 2016 with colleagues **Laila Ladhani** and **Elisabet Liljebblad**.

"When it comes to academia, there are fewer women in the more senior positions," Tegling says. "There's a shortage of female role models and many Ph.D. students have a hard time picturing themselves making an academic career. Our network hopes to pinpoint the things we love about research and what potential

barriers we've encountered in order to figure out how to attract more women to academia and how to make them stay."


The network is centred on three key words – inspiration, support and collaboration. The group members support and help each other and provide suggestions on how to make the School of Electrical Engineering (EE) a better workplace. One positive side effect is an increase in inter-departmental relationships and collaborations: many receive stimulating input to their research from members of neighbouring fields.

"The network provides opportunities for us to meet inspiring role models, such as the female faculty members from our own school, but also to gain inspiration

from each other," Tegling says. "By meeting up, we're able to see that there are quite many of us, even though we're a minority. It's truly energising to see how many women there are at the EE School conducting excellent research."

Platforms for women are being created in other parts of the EE School as well. Nobless, a network for female students and alumni, was initiated in 2013. The network has a strong connection to the industry through its 50 female alumni working within the field.

With regard to these networks, it is fair to say that equality is a hot topic in both academia and industry. ■



Fritzi Töpfler, Emma Tegling, Flavia Ottonello Briano and Elisabet Liljebblad are all part of the network.



US

# FIGHTING SKIN CANCER WITH MICROWAVES

A new probe for the early detection of skin cancer is being developed to provide a faster, more accurate system for diagnosis. Besides saving lives, it promises to reduce healthcare costs.

**I**N 2011, KTH together with Uppsala University, Karolinska Institutet and Optiga launched a research project to develop a better system for diagnosing skin cancer. Research groups elsewhere had performed microwave measurements on skin before, but with limited applicability for the diagnosis of early-stage tumors.

“The reason usually was that they used macroscopic probes developed for general purposes that lacked the ability to detect small anomalies and not probes intended for medical purposes,” says **Fritzi Töpfer**, who is heading up the project, besides working on her Ph.D. at Micro and Nanosystems at KTH. “So, our approach was to develop a probe specifically for this application.”

A first probe design was ready after about half a year, followed by the development, analysis and simulations of alternative designs for at least another year. This was carried out in parallel to

the fabrication of the first prototypes.

The process that led to the realisation of how the probe should be designed started with thorough research into the general requirements for, and challenges related to, using such a probe, and looking into what was already known about the interaction of microwaves with normal and cancerous tissue.

**TÖPFER ALSO** spent time talking to dermatologists to gain an in-depth understanding of how skin cancer develops and grows, and which characteristics would be important for such a probe.

“The insights I gained formed a basis from which to decide on the general measurement principle and the frequency range to use,” she says. “We then created simulations to study and improve different probe design ideas, implementing and testing several of them.”



“Like any researcher, I would love to see my research result in a commercial product. But it's hard to predict that from where we are now”

➤➤ The most promising design was taken forward to the next stage, with prototypes first being tested on phantom materials – some which were commercially available. In order to have a meaningful characterisation of the probe, the project developed and fabricated its own Si-based test sample, which received the Best Measurement Paper Award at the European Conference in Antennas and Propagation in 2013.

**THE PROBE** has since been tested on volunteers, with a small local inflammation being induced on the skin using a chemical – a standard test widely used in the evaluation of non-invasive measurement methods.

The probe is fabricated by micromachining techniques in KTH's cleanroom in Kista, Sweden.

“I do the fabrication myself,” Töpfer says. “The fabrication process has to be tried out and improved step by step. You need to be creative to solve practical problems for unusual processing tasks: for instance, ensuring the uniform metallisation of four sides of the probe, while shielding some parts from metallisation at the same time through the use of a specially designed, custom-built mount.”

The test results showed that meas-

urements are highly reproducible.

The probe is very sensitive to permittivity differences – which is important as these are to be expected between healthy and cancerous skin. It can distinguish between different skin conditions; malignant tumours that grow in the skin result in a different measurement signal and can be identified by the probe. There are plans to carry out more measurements on animal tumour models to get statistical data.

The new probe could become the core of a diagnosis system which, could be used by non-specialists for the safe and speedy screening of patients, Töpfer says. Besides saving lives, it would also reduce healthcare costs.

“A medical diagnosis can be a complex process, but by using the probe as a screening tool, as a first test measure, you can rule out the healthy cases and send only the suspicious cases on to a specialist.”

**THIS WOULD** make the screening process more efficient, allowing more screening to be done at a lower cost – with the added benefit of making better use of the specialist's time.

After confirming the results of additional measurements taken on mice, the next step is to build an improved

prototype that is compact enough for use in the clinic on patients and enables clinical studies to be carried out.

“Like any researcher, I would love to see my research result in a commercial product,” Töpfer says. “But it's hard to predict that from where we are now. Commercialization of medical devices is an extremely long process. Extensive clinical trials are needed and market approval is a complex process.”

**THE SKIN CANCER** probe is simply put in contact with the skin, and a very low power microwave signal is applied.

The microwaves interact with the skin and are partly reflected back. The reflected signal is measured and used to determine the characteristics of the skin tissue. The screening process envisioned involves using a probe to scan the relevant area to take measurements of any suspicious lesion and the healthy area surrounding it to get a relative measurement.

The probe takes continuous measurements while scanning, and it takes just a few milliseconds to take each measurement. The probe has a narrow tip, which allows for high-resolution scanning and accurate diagnosis of small, early-stage tumours. All electronics involved can be easily integrated into a single hand-held device. ■



In the Electrum Laboratory, Fritzi Töpfer is working on the skin cancer probe.

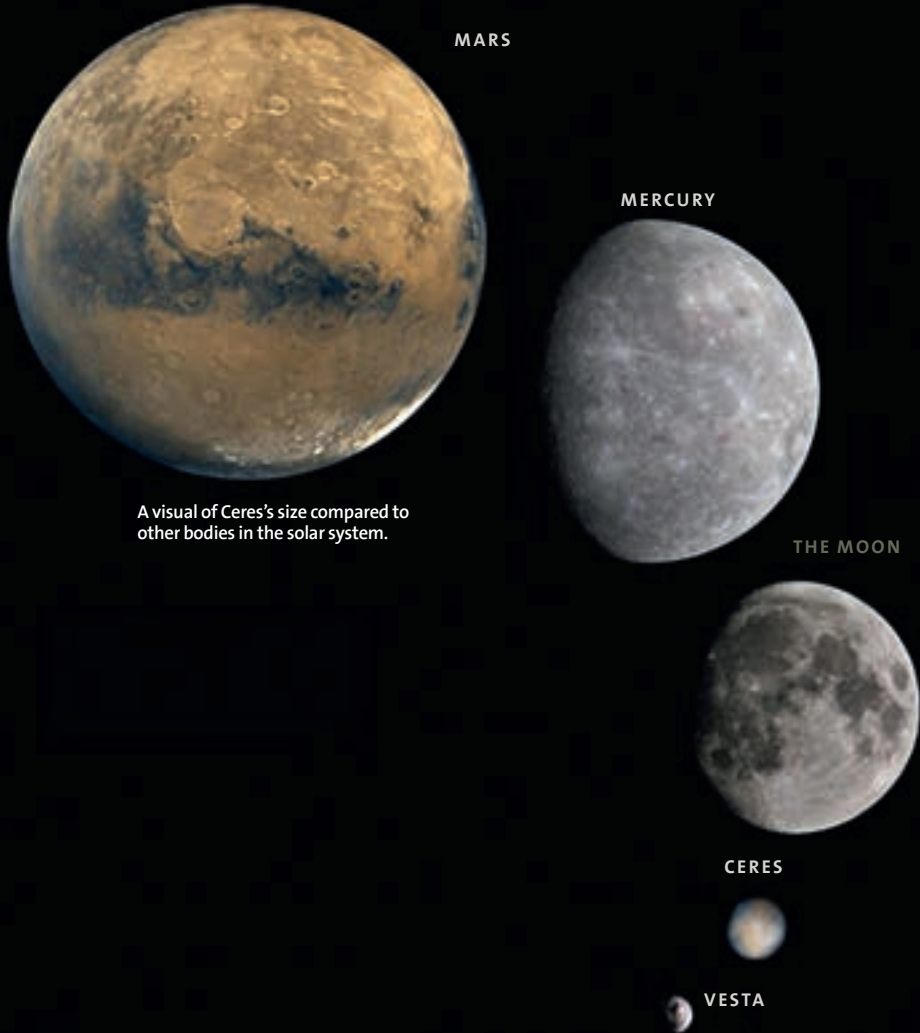






# ON THE TRAIL OF WATER VAPOUR IN A DISTANT WORLD

Locating water is hard enough in a desert on Earth... Imagine how difficult it is to find on a distant dwarf planet. Researcher **Lorenz Roth**, however, is up to the challenge. This year he plans to make one more attempt to verify reports of water vapour on Ceres. >>



**J**UST BEYOND THE orbit of Mars, there is a dwarf planet that may – or may not – spray water vapour out onto its surface. Among those attempting to corroborate the sole sighting of water vapour on Ceres – the largest body in the solar system’s main asteroid belt – is Roth, a researcher at the Department of Space and Plasma Physics.

Hints of water vapour around Ceres were spotted as early as 1991. But the water vapour was never actually seen until European Space Agency scientists reported observing it in 2014. Ever since,

however, the purported water on Ceres has been as elusive as the Loch Ness Monster.

Reclassified as a dwarf planet, the former asteroid Ceres is the largest of thousands of bodies orbiting the sun in an enormous stream of shattered remnants from protoplanets and planetesimals between Mars and Jupiter.

**BUT UNLIKE MOST** of the scattered chunks of rock, carbon and metal to be found in the asteroid belt, Ceres is nearly spherical – which compelled the International Astronomical Union

to upgrade its status from asteroid to dwarf planet in 2006. It would rank as a fully-fledged planet if it cleared the rest of the asteroids from its orbit.

That is not the only unique thing about Ceres; there is also the matter of ice, which is not very common beyond the solar system’s so-called “ice line” (between Mars and Jupiter). But there it is, in the thick frozen mantle of Ceres, and possibly locked beneath the dwarf planet’s surface – even though it is closer to the sun than the ice line.

“The density of Ceres is low, so it seems likely that there is an ice mix

## One explanation for the elusive nature of water vapour around Ceres could be that it's coming from geological activity like a geyser

in the planet – that is, it's probably not only rock," says Roth, a planetary scientist who specialises in imaging data analysis and modelling. "The best estimate is that it comprises 20 per cent water molecules mixed with rock and silicates."

The question of whether there really is water vapour on the surface of this distant object is one that has intrigued Roth, whose research into the interiors, surfaces, atmospheres and magnetospheric environment of planetary bodies has involved hours of observation with the Hubble Space Telescope to verify water plumes on Jupiter's moon, Europa.

Roth and his colleague Nickolay Ivchenko applied for four hours of time on Hubble, observing Ceres in August 2015, just as NASA's Dawn spacecraft was approaching the dwarf planet. Spoiler alert: they did not find any water

vapour – this time. But Roth says that even not detecting it can give useful clues about what is happening on Ceres.

**ATTENTION TO THE** dwarf planet has heightened since the arrival of Dawn. As scientists and space enthusiasts feasted on the gorgeous images being sent back from Ceres, Roth and his colleagues analysed data they collected while measuring the spectrum containing the light reflected from the dwarf planet and potentially from its gas environment.

They looked at signatures in the spectral waveforms that would indicate the presence of oxygen, but found nothing. "We didn't see any oxygen, so we can say there are no huge amounts of water," he says.

So the observation does not exactly close the case, he points out. "One explanation for the elusive nature of water

vapour that has been detected around Ceres could be that it's coming from geological activity, similar to a geyser, and there's no way of knowing when it could be ejected again," Roth says.

**HE EXPLAINS THAT** for his observations, NASA did not configure the Hubble telescope correctly, which slightly degraded the data. However, the space agency has promised the KTH researchers another four-hour session on Hubble in October 2016.

"It's great to get another shot at this," Roth says. "Let's say we do find oxygen now in 2016; we could tell more about how much water vapour is present then. Having documented one non-detection of water vapour in 2015, one detection of water vapour in 2016 would tell us that some important factor that controls the vapour must have changed over the course of this year." ■



# ERICSSON AND KTH MAKE A HOTBED FOR INNOVATION

The close ties between **KTH** and telecom giant Ericsson allow for a two-way learning process. And as electrical engineering and telecom move towards digital engineering, the **EE** school is ramping up its software competence.

**E**RICSSON COOPERATES with a wide range of universities around the world. But the company's bond with KTH is of special importance – not least because of their long shared history, but also because Ericsson's HQ and largest R&D centre are located in Stockholm.

Ericsson and KTH collaborate in a number of established areas, including their centres of excellence, laboratories and joint research projects. A formal partnership agreement has promoted this cooperation to the highest decision-making level, making it easier to integrate different initiatives more clearly with each party's respective strategy.

Professor **Mikael Skoglund**, the coordinator of the partnership, says: "We gain a lot of valuable insights into what Ericsson expects from us: what kind of competence they need and the direction of their business."

KTH is part of Ericsson's "5G for Sweden" initiative, where major Swedish industries and universities are invited to collaborate on positioning the country as a major player in the launch of 5G wireless systems and resulting digitalisation.

5G systems are expected to hit the market in 2020, partly replacing

and partly extending the present 4G systems. 5G technologies look beyond earlier telecom technologies' focus on communication between people. 5G will bring much better and more reliable support for industrial and societal applications and services, such as machine-to-machine communications and the Internet of Things.

"Ericsson can compare our competence with what they see at other universities across the world and also give KTH a perspective on Sweden as a competitive industrial nation," Skoglund says.

**SOFTWARE DEVELOPMENT** has always been important; now it has become a decisive competitive factor for many industries, not just telecom. The rapidly growing significance of the software, rather than the hardware, in Ericsson's products has produced a shift in the company's technological focus. Ericsson is now the world's fifth-largest software company.

"By tradition, the EE school has not been geared much towards software," Skoglund says. "Other KTH schools specialise in that, but EE needs to get stronger in this area too."

And it's not just about getting the

coding right, Skoglund points out.

Interestingly, new functions in products are implemented as software. This is the business strategy for a range of successful companies, from Apple to Tesla Motors, and it demands an end-to-end perspective on competence.

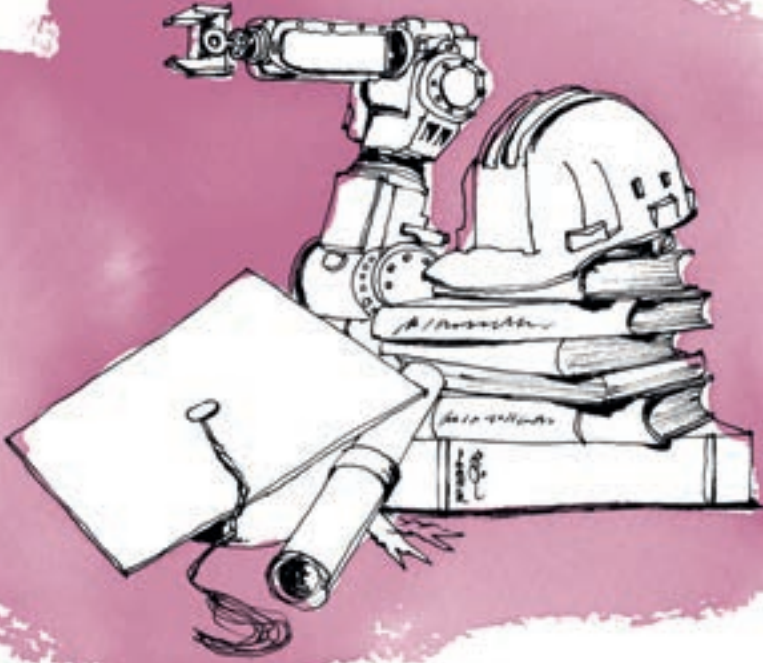
The partnership agreement gives KTH a tool for making long-term plans that also helps to avoid missing out on activities that are hard to predict.

One result of KTH's partnership with Ericsson is a better interface with the development side of the company's R&D outside of Ericsson Research, where most of the cooperation had been focused in the past.

Exchanging competence is another



Mikael Skoglund



►► important element of the partnership. As an example of this, Ericsson currently has several adjunct professors at KTH.

In 2015, a graduate programme began at EE to meet the needs of a digitalised electrical engineering industry. Students graduating from this programme will be highly interesting for Swedish companies like ABB and Sandvik, which exemplify the need for digitalisation and which are also KTH partners.

The Ericsson partnership has triggered activities on many different levels, and Skoglund cites a couple of recent examples. One of these is the Integrated Transport Research Lab (ITRL), which began as an initiative between KTH and truck giant Scania.

**“BUT AS A RESULT** of our discussions, Ericsson got to know about this basically automotive activity and joined it,” Skoglund says. “It’s an example of cross-industry matchmaking, where our top-level partnership connections show their importance.”

Then there is Digital Demo Stock-

holm, an Ericsson initiative comprising every KTH partner company. The idea is to create a platform to demonstrate different technologies that could be of particular importance to Swedish companies.

In many other countries it’s difficult to do what KTH is doing, according to Skoglund – to have a close cooperation with big companies where you can have roundtable discussions with top management is unique.

“Maybe it’s in some way a Swedish cultural quality. It’s also due to the physical presence that makes personal networking much easier, whether through planned or spontaneous meetings, which are so important for innovation and creativity.”

**“I CAN THINK** of only a few places in the world – perhaps only Boston and Silicon Valley – that have similar industrial-academic hotbed qualities.”

Sweden is also a special country in that it is home to a range of global companies.

“Here, we can interact with global companies that don’t compete with each other, so they’re inclined to cooperate.”

“Here, we have the opportunity to interact with the likes of ABB, Scania, Sandvik, Ericsson and more – all genuinely global companies with the crucial added advantage that they don’t compete with each other,” Skoglund says. “For that reason, they’re inclined to cooperate.” ■





Lorenz Roth

## Instruments selected for NASA's Europa mission

**NASA has selected nine science instruments for a mission to Jupiter's moon Europa to investigate whether it could have conditions suitable for life. Lorenz Roth from the Department of Space and Plasma Physics at the School of Electrical Engineering is a science co-investigator of the Ultraviolet Spectrograph (uvs), one of the selected instruments.**

**LAST YEAR, NASA** invited researchers to submit proposals for instruments to study Europa and find evidence for a mystical global ocean that has raised interest since NASA's Galileo mission. Nine were selected for the mission, which is scheduled to be launched in 2020. One of these was the Ultraviolet Spectrograph/Europa (uvs) with Roth as one of its co-investigators.

"I'm working with ultraviolet observations from the Hubble Space Telescope to look at auroral emissions

from Europa," Roth says. "But now with uvs on the Europa spacecraft, we will have an ultraviolet camera very close to the moon that can search for plumes from the ocean with higher accuracy and higher resolution. That is an awesome perspective."

The planned mission would involve sending a solar-powered spacecraft into a long, looping orbit around the gas giant Jupiter to perform repeated close flybys of Europa over a three-year period. ■

## Measuring our impact on society

**KTH Royal Institute of Technology has extensive experience of cooperating with companies, research institutes, authorities, municipalities and county councils. We evaluate the financial and social benefits of our research, and since 2015 we have been making concerted efforts to raise awareness of our impact on society.**

**UNDER THE IMPACT** project, we are developing a common system of guidelines and measurements of our impact both at the KTH schools and on a national level. Associate Professor **Tobias Oechtering** is leading the project at the School of Electrical Engineering.

"Nowadays, there's great interest in identifying the impact of research and education activities at universities," he says. "I believe that our school already has a significant impact on society, but we can improve the awareness of it internally and externally. To achieve this goal, we had faculty seminars addressing the topic and we're collecting our most interesting impact cases, which we'll communicate internally and externally. It already shows that all these activities help everybody involved to shape their goals. This will enhance their impact and prepare us well for the future."

The Impact project will run at KTH throughout 2016. ■



Associate Professor Tobias Oechtering, who is running the Impact project.

Irina Radulescu,  
HR Manager at the  
School of Electrical  
Engineering

“Our goal is to achieve a more balanced gender distribution in all groups and to ensure equal opportunities for men and women”

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# DIVERSITY AND EQUALITY

## ARE KEY TO A GLOBALLY SUCCESSFUL RESEARCH ENVIRONMENT

Nowadays, when research excellence is defined from a global perspective, it is vital that the School of Electrical Engineering offers a work environment that attracts and retains diverse talent. Assessing the current working environment and constant self-improvement are therefore central factors in creating an inclusive and welcoming workplace for all.

**A**T THE SCHOOL of Electrical Engineering (EE), the departments and the management strive to work innovatively with equality and diversity. Some of recent years' activities include establishing the EE School Group for equality, diversity and equal treatment, sustaining the EE Network for female Ph.D. students and organising lectures on equality and diversity targeted at different audiences. These activities stem from a conscious decision made by the school's management to deepen the focus on diversity management.

"THE SCHOOL HAS made several efforts to build an inclusive environment of equal treatment," says **Irina Radulescu**, HR Manager at the School of Electrical Engineering. "The subject is already introduced to new employees at the school's introduc-

tion meeting with a video presentation and through the EE Employee Handbook. During the meeting, they become familiarised with the EE Code of Conduct, a document listing attitudes and behaviours that are expected from employees and students in their daily work interactions."

**THE RESEARCH FIELD** of electrical engineering generally attracts more males than females. Interested in learning more about how this affects the work environment, the Department of Micro and Nanosystems welcomed a master's student in gender studies to assess its activities from a gender perspective. Based on the outcome described in the student's thesis, the management of the department has planned activities for 2016. Radulescu views such initiatives positively.

"Through interviews with female

PhD students and direct observations, both the department and the school management learned what works well and gained insights into what needs to be improved," she says. "In the long-term, our goal is to achieve a more balanced gender distribution in all groups, as well as to assure equal opportunities for both men and women in their work and study environment. Having this analysis is one important step in achieving that."

**THROUGH DETERMINED** development measures and by clearly affirming its standpoint, the school management sets the framework for the diversity activities at the school.

"Achieving an inclusive environment is, however, a team effort and everyone contributes to the work environment we build together," Radulescu says. ■

# RESEARCHERS ON A MISSION

When NASA launched four satellites from Cape Canaveral for its Magnetospheric Multiscale (MMS) mission in March 2015, they were carrying high-quality measuring equipment produced at KTH Royal Institute of Technology. Meet two of the researchers involved in such international prestige.

**T**HE KTH equipment contained in the MMS satellites was intended for measuring electric fields in space, and it was the culmination of a lot of hard and continuous development work that started many decades ago.

However, the origin of KTH's space research can be traced even further back than this. Way back in 1960, **Hannes Alfvén**, the legendary KTH Professor of Plasma Physics, initiated the first cooperation agreement between Sweden and the US in space research. This, in turn, enabled American rockets to be launched from Sweden.

As a newly appointed Professor in Space Plasma Physics in 1990, **Göran Marklund** took over as leader of the Space Group at the Department of Plasma Physics. At this time, the Space Group was finalizing a high-resolution electric field instrument to be flown on the Freja satellite, an instrument for which Marklund was Principal Investigator.

**MEASURING ELECTRIC** fields in space is complicated and highly sensitive to disturbances that the measurement itself generates. Over the

years, the Space Group has built up its expertise within this area step by step.

"Our speciality is the measurement of electric fields in space from satellites, space probes and rockets," Marklund says. "Electric fields play a vital role in many fundamental processes in space, such as particle acceleration and energy conversion processes that lie behind solar eruptions and Northern Lights phenomena on Earth and other planets."

Marklund and his group have participated in several prestigious projects, starting off with the Swedish Viking (1986), Freja (1992-1996) and Astrid 2 (1998-1999) satellites. The state-of-the-art instruments and the frontline scientific results from these missions provided by the group served as a stepping stone for invited instrument participation on big international missions, such as Cluster (ESA/NASA, 2000-), MMS (NASA, 2015-) and BepiColombo (ESA/Japan, 2017-), Europe's first mission to Mercury.

"Over the years, our group has managed to build a leading international position within experimental space physics," Marklund says. "To maintain this position and be part of the frontline

Göran  
Marklund



Karl Henrik  
Johansson



missions, continuous development of state-of-the-art space instruments is required. Looking at what we have achieved so far, I think we have reached our goal."

Compared with Marklund, Professor **Karl Henrik Johansson's** main research

## Looking at what we have achieved so far, I think we have reached our goal

interests are more down to earth. He is doing research on cyber-physical and networked control systems, targeting both basic and applied research.

The fundamental research questions that his group works with include how to efficiently close control loops over communication networks with limited resources, and how system objectives can be robustly achieved by a group of interacting agents. There are many applications related to the basic research of the group; a particular focus is on transportation systems, energy networks and industrial processes.

For instance, Johansson's group has developed new control strategies for heavy-duty vehicle platooning, which is currently being evaluated together with Scania in large-scale tests on European motorways. Another successful application is the introduction of wireless networking technology, such as new access protocols and control paradigms, for the Swedish process industry.

Since 2000, when Johansson was recruited to KTH from a postdoc at the University of California, Berkeley (UC Berkeley), he has built up a research group in networked control systems at the highest international level. The group cooperates with renowned academic institutions worldwide. UC Berkeley, CalTech (California Institute of Technology) and MIT (Massachusetts Institute of Technology) play a particularly important role with many exchanges of faculty members

and students in both directions.

"It's important to benchmark our results with researchers at other fine universities," Johansson says.

In recent decades, academic research in Asia has developed significantly. One university with a fast-growing international reputation is NTU (Nanyang Technological University) in Singapore.

**"A LOT IS** happening in Asia and for that reason it's important that KTH is present in the region," Johansson says. "Singapore is investing heavily in building up smart infrastructure systems and they put a lot of resources into basic and applied research in this area."

KTH and NTU recently started collaborating in the fields of urban science and intelligent transportation, and have launched a joint doctoral training programme. Cooperating with research groups that are focusing on the same subject is a clear benefit to KTH.

"For instance, we

study automated transport systems using NTU's test-bed with cars wirelessly connected over a local network on campus," Johansson says.

A new and exciting research project that Johansson and his group are driving together with colleagues at KTH and NTU involves getting a better understanding of the dynamics of an entire city. This knowledge will become crucial for future urban

development based on the growing amount of available real-time data. ■



KTH

“We have a common goal: to ensure a complete experience at KTH because it's important that studies and student chapter life both work well”

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At the student chapter's breakfast, students and staff discuss recruitment, courses and statistics.



# CLOSE STUDENT INVOLVEMENT MAKES FOR BETTER EDUCATION

Although government grants for undergraduate education accounted for just 11 percent of the School of Electrical Engineering's (EE's) income in 2015, the management team and 70-strong teaching staff feel passionately about undergraduate issues at the school.

**S**TUDENT COMMITMENT and a desire for dialogue have been high on the list of priorities at EE for many years and have helped ensure the development of programmes and courses.

Joakim Lilliesköld, Director of First and Second Cycle Education at EE, says student involvement and feedback are important, as they help improve individual teachers and courses and ensure the whole programme fits together.

"Similarly, our feedback can help our students develop student chapter life and become more successful students," he says. "We have a common goal: to ensure a complete experience at KTH because it's important that studies and student chapter life both work well."

**LILLIESKÖLD SAYS** the cooperation begins by trying to have an open dialogue with the students. He adds that one of the most important tools in this respect is the SNO report, which includes students' views on ongoing or recently completed courses. The report is put together by the chairperson of the Student Educational Committee and presented to the Council for first and second cycle education.

The chairperson usually attends the undergraduate council, where the heads of studies for each school and the office of student affairs regularly meet

to get up to date with everything that is happening in terms of education, both at the schools and at KTH in general.

Johan Rågmark, who was a board member of the student chapter in 2015, says the level of cooperation at EE has been excellent for some time.

"Both the school and the student chapter have a good system for spreading information and getting feedback," he says. "One of the main functions of the student chapter at KTH is study monitoring. This shows the school cares about what students think, is influenced by our criticisms and incorporates students in its development work."

"Naturally, the partnership revolves around education, but the student chapter also organises lots of activities and other events students can enjoy, and it's always fun when a school shows appreciation for that too. Reception is an excellent example of a student chapter, which plans many activities with the school to make new students feel welcome."

**ANOTHER POPULAR** activity is the student chapter breakfasts, held two or three times per term. These are attended by the entire student chapter's board, the programme director for the engineering programme, the Director of First and Second Cycle Education and the office of student affairs, which

includes student counsellors, coordinators for international exchanges and master's students among others.

"The student chapter breakfasts are unique to our school," Rågmark says. "Those of us on the student chapter board get the opportunity to meet regularly with employees at the school, who we don't come into contact with on a daily basis. Besides being a very convivial breakfast, it's extremely informative to have the opportunity to hear what's happening at the school in the different bodies. In the same way, I feel that the staff members at the school are very excited to have such direct contact with the students and be able to air thoughts and ideas in a less formal forum."

**RÅGMARK SAYS** the topics often discussed during the breakfasts are recruitment, courses and statistics.

"It's very significant that a student can sit at a breakfast with staff at the school and participate in discussions about what's happening," he says. "It really promotes our cooperation and is something the other schools should emulate."

Another example of cooperation between the school and its students is shown by EE's strategic council – a body comprising members from internal and external academies as well as industry having a student representative.

Joakim Lilliesköld believes that being >>>



Johan Rågmark, student.

represented on the strategic council is more beneficial to students than being involved in, for example, the management group.

“The benefits should be weighed against the effort,” he says. “The management group meets for 1,5 hours every other week. Some schools at KTH include students in the management group, but it’s very operational and they discuss many internal issues. For us, it’s therefore more important that students are part of our strategic council and contribute their perspectives and experiences there. The strategic council discusses plans, results from operations, master’s programmes and research areas.”

**HOSTING JOINT** events is another way to strengthen the relationship between the school staff and the students. Rågmark cites one such example as being the alumni pub event, held each autumn in conjunction with

KTH’s Alumni Day. “We’re always excited when we can partner with the school, whether it is during reception, before the alumni pub event, for recruitment events or other gatherings,” he says. “It was a lot of fun to be involved in arranging the alumni pub event and I think there are a lot of things we can develop for next year.”

**“THE ALUMNI ARE** very happy to come back to the student chapter premises, buy beverages from the students at a favourable price and get up-to-date information about the courses and the school. Many have also been interested in finding master’s thesis students or recruiting, so it’s a great opportunity for students to make connections. The alumni pub event is a fun event that is improved by the school and the student chapter working together. It’s probably also the reason why it has become the most visited alumni pub on campus in recent years.” ■

“It’s significant that a student can sit at a breakfast with staff and participate in discussions about what’s happening”



# GRANTS AND AWARDS

## A round-up of those received in 2015

### **GÖRAN STEMME** praised for **great accomplishments in medical sensors**

In 2015, Professor Göran Stemme was awarded the Erna Ebeling Prize for his accomplishments with medical sensors. The prize is given annually for outstanding achievements in medical physics and medical technology. The jury awarded Stemme the prize for "his exceptional contributions to research and innovation in medical sensors", and for his work having "produced results of great benefit to both industry and health care".

### **KTH Educational Prize** goes to **GUNNAR KARLSSON**

Gunnar Karlsson, Professor of Teletraffic Systems, is one of the recipients of the KTH Educational Prize for 2015. The award celebrates teaching staff that have made efforts to raise the quality of education at KTH and, in doing so, contributed to learning. Karlsson is at the forefront when it comes to using new technology to increase quality and reduce costs in education. He has also been widely involved in discussions of web-based courses and programmes.

### **LENNART SÖDER** receives **Wind Power Award**

Professor Lennart Söder from the Department of Electric Power Systems was honoured in 2015 for his work with renewable energy. Each year, the Swedish Wind Power Association commends a person or team that has made special efforts to promote wind power. The Swedish Wind Power Association praised Söder for his diligent work in proving the potential role of renewable energy in Sweden's energy supply.

### **DIMOS DIMAROGONAS** named **Wallenberg Academy Fellow 2015**

Robots and machines are often

programmed to perform a set task. But new Wallenberg Academy Fellow, Associate Professor Dimos Dimarogonas from the Department of Automatic Control will develop a system that allows robots and other electronic units to consider their surroundings when making decisions and to cooperate with humans.

Robots are rarely this flexible, but Dimarogonas will develop a system in which they and other electronic components, called agents, should be able to process information from their surroundings and take flexible decisions based on what is happening.

### **DAN STOKESBERRY Memorial Award** goes to **Rolf Stadler**

Professor Rolf Stadler from the Department of Communication Networks received the Dan Stokesberry Memorial Award at the Integrated Management (IM) in the Age of Big Data International Symposium in Ottawa in May. The symposium is organised by the IEEE (Institute of Electrical and Electronics

Engineers) and the IFIP (International Federation for Information Processing). The Dan Stokesberry Memorial Award is presented by the IEEE IM/NOMS (Network Operations and Management Symposium) Steering Committee bi-annually to "an individual in recognition of a particularly distinguished technical contribution to the growth of the network and service management field".

### **The Knut and Alice Wallenberg Foundation** awarded Professor

**KARL-HENRIK JOHANSSON** from the Department of Automatic Control a grant of SEK 25.3 million in 2015 to carry out research into the interconnected-society. The digital society is becoming more complex by the day as new services, appliances and people get connected. Johansson's project – Engineering the Interconnected Society: Information, Control, Interaction – will explore which scientific methods need to be evolved in order to meet future demands and expectations with regard to future integrated technology. ■



Lennart Söder

# NETWORK KNOW-HOW: SHARING THE LOAD

Our increasingly digitalised lives place ever heavier demands on networks with each passing year. For more than a decade, **Viktoria Fodor's** research has kept pace with change, helping us get the most out of the internet.

**V**IKTORIA FODOR IS confident that distributed networking will enable us to cope with an increasingly complex wireless infrastructure. "It's about making sure the load in a network is evenly distributed," she says.

Imagine you're on the committee organising a school party, and everyone has volunteered to help set up the reception hall. You and two colleagues are the first to arrive, and between you it is simple to assign tasks and communicate with each other. In order to ask for objects like scissors or masking tape, or help with moving a table, all you have to do is raise your voice to reach someone across the room.

But as other volunteers arrive, it becomes more difficult to reach the person on the other side of the increasingly

crowded hall. So you try different ways to communicate in the "network": you can walk over and address them directly, or pass your message along through an intermediary, or agree with all the other people in the hall that you'll take turns talking.

Fodor offers this scenario for lay people to appreciate how burgeoning numbers of users, devices and machines complicate the function of wireless networks.

**SINCE HER PH.D.** studies at Hungary's Budapest University of Technology and Economics in the late 1990s, Fodor has been watching the wireless space become increasingly crowded. And she has devoted her career to exploring how distributed networks can help us get the most out of wireless communications.

Soft-spoken and quick to laugh, Fodor was recently promoted to Professor at the Department of Communication Networks, where she has worked since 2007, specialising in stochastic modelling – that is, modelling random possible outcomes in a network. "What will happen in the future is random," she says. "In all networks, that's the case, because no-one knows when users will access a webpage or when sensors will transmit data. Stochastic modelling is the tool we use to describe what happens in the network if, say, data packets arrive in a random way, or the quality of our wireless connections changes."

Looking back on her earliest days at KTH Royal Institute of Technology, Fodor recalls how the convergence technologies of the past 15 years have shaped





## “We're just beginning to see a multitude of individual networks converge around each of us”

➤➤ her career, beginning with the work on reducing packet delays and loss for multimedia transmissions. “We worked for several years on improving quality and streaming,” she says, “first, for transmitting video from point-to-point, then in peer-to-peer streaming systems.”

**IT WAS AT THIS** time that the pace of technological advancement necessitated a change of scenery for the networking group.

“We had the knowledge for fixed internet when everything was wireline, but radio was coming,” she recalls. “When our group moved from Kista to the main campus, it became a real advantage to sit close to people who were involved in wireless communication.”

**AMONG THE** first jobs for the newly relocated Department of Communication Networks was a Vinnova project on future wireless networks. “This is when we got closer to the problem that radio spectrum is scarce, while everyone wants to use it,” she says.

Take our personal space, for example: our bodies and health systems will represent individual networks that are in constant motion, changing location

and thereby moving in and out of spaces where spectrum is being shared by countless other small networks, like self-driving connected automobiles and control systems for things like fire safety, production or utilities.

But efficient use of limited spectrum is by no means the only challenge. As communication networks and Internet of Things (IoT) systems enter each aspect of our lives, sustaining a digitalised society requires the efficient use of all kind of resources, including transmission energy, memory and processing power.

Fodor says the key is to use local resources as much as possible for localised work, which is what most systems are meant to do – whether they are monitoring your body or your bus stop. “If you were doing a home improvement, you’d be better off using your own, or maybe your neighbour’s, power saw, rather than taking your lumber to be cut to size at the lumberyard,” she says.

**SHARING LOCAL** resources is central to Fodor’s work on several projects, starting with the cooperative use of radio spectrum in the EU’s SENDORA (Sensor Network for Dynamic and Cognitive Radio) project; as well as with

KTHS ACCESS (Autonomic Complex Communication Networks, Signals and Systems) research centre.

“We were interested in whether neighbouring nodes could help each other’s transmission in a dense wireless network,” she says. “We showed that by offering some of their transmission resources and helping others to finish communication earlier, nodes can get access to the spectrum with lower delay, and reach a win-win situation.”

Similarly, Fodor points out that in control systems, the physical location of sensors are typically in the near vicinity of the actuators. Therefore, if sensors can agree locally about the required actions, the energy spent for communication – as well as precious reaction time – can be lowered.

**THAT’S JUST** what she has been occupied with in the EU’s Hydrobiomet project, which involved automatic monitoring and quality control at water treatment plants.

The results included fundamental design principles, signal processing and communication algorithms, and the implementation of a Wireless BioMEM Network test-bed at a water treatment pilot plant near Barcelona.

The idea of utilising local resources is further developed in the EU's GreenEyes project, which is part of its Future and Emerging Technologies initiative. Fodor and her colleagues work with image-processing researchers on techniques for systems that use cameras for tasks such as pedestrian tracking, or traffic and parking control.

**“CAMERAS TAKE** in a lot of information, but unlike people, they don't understand what they see,” Fodor says. If the camera is pointed at a car park, it takes in all the visible information, including licence plate numbers, colours and moving objects, even if all we want to know is which parking spaces are full, and which are empty.

“That's too much information,” she says. For one thing, the computational algorithms needed for image processing are too complex for simple cameras. Furthermore, if the device were to send an image to a powerful processing node, the byte-heavy content would require too much time for transmission.

“So we did something in between,” Fodor says. “A camera may have lots of other nodes around that might be able to process the infor-

mation, so it can send the content to one or more nearby units. Clearly, the challenge is now doubled. For efficient distributed processing, not only fast transmission paths need to be found — the traditional issue for networking — but these paths need to lead to units with available computational capacity.”

**THE NETWORKING** paradigms developed for the GreenEyes project are now ready to be introduced in other areas where communication and computation are time consuming, or in other words, where distributed decisions are made based on large collected datasets.

Fodor knows from experience that the IoT will continue to present unforeseen challenges; after all, she deals with modelling random outcomes on a daily basis.

“We're just beginning to see a multitude of individual networks converge around each of us,” she says.

With the emergence of endless possibilities for IoT use cases — not to mention all the yet-to-be-invented industrial and personal applications — Fodor and her group will no doubt be busy for some time to come. ■

## NEW PROFESSORS IN 2015



**HENRIK  
SANDBERG**  
*Professor,  
Department of  
Automatic Control*



**LARS JONSSON**  
*Professor,  
Department of  
Electromagnetic  
Engineering*



**MATS  
BENGTSSON**  
*Professor,  
Department of  
Signal Processing*



**MATHIAS  
EKSTEDT**  
*Professor,  
Department  
of Industrial  
Information  
and Control  
Systems*



**ALEXANDRE  
PROUTIERE**  
*Professor,  
Department of  
Automatic Control*



**JOACHIM  
OBERHAMMER**  
*Professor,  
Department of  
Micro and Nano  
Systems*

# CITATION SCORES

– here's the group that tripled them

When **Hans-Peter Nee** became head of the Department of Electrical energy conversion he saw a great potential for improvement in bibliometric performance – and decided to do something about it. His group is now cited three times more than the average.



**FIVE YEARS ON** and due to a focused effort on bibliometrics, EE's department of electrical energy conversion now stands out in the highly competitive world of research-related media. It has gone from 0.95 in 2010 to 2.96 in the so-called crown citation index.

This means the group's results have been cited almost three times more than the world average for its research field, year of publication and type of publication.

"We always had annual measurements made by our library and I was aware of the issues long before I became department head," Nee says. "The most important benefit of high bibliometric scores is the increased chances to receive funding for research."

Bibliometrics is not just used by researchers themselves but also by policymakers for evaluating research funding.

"A high score means that others like what you do," Nee says. "In a way it's a beauty contest. But knowing how to be noticed in a globalized and increasingly complex world of academia has an importance far beyond the individual ego-boost."

**RESEARCH WITH** the greatest impact in terms of high citation rates can be easily located through a citation index and often used as a way to compare and benchmark research productivity, although it is not necessarily connected, Nee points out.

Citation indexes come in many different shapes and selection methods. Examples are Google Scholar and Microsoft Academic Search.

The crown citation index normalizes a researcher's citation count by the number of citations in each field. A field-normalized citation rate allows for comparison between the raw number of citations for a publication and the world average for all publications from the same field, year and document type.

**THE FIELD-NORMALIZED** citation rate also makes it possible to compare publications from different fields, even though they may have very different publication – and citation, patterns.

A field-normalized citation rate of 1 is equal to the world average, so 1.2 indicates that the publication has been cited 20 percent above the world average of its research field.

Of special interest for Hans-Peter Nee's group is the crown citation index measure that builds on the Web of



Hans-Peter Nee

Science, a citations database run by Thomson Reuters.

"**THE CROWN** index is selective. It only indexes from a set of relevant journals, which means that not all citations and publications are accounted for. This adds a quality dimension to just looking at the sheer number of citations."

Since the crown index is based on a select set of established and influential journals, not all, it provides a weighted measure.

"Being cited in one prestigious journal says more about the quality of your research than being cited in many less prestigious publications." ■

Bibliometrics is the application of quantitative analysis and statistics to publications such as journal articles and their accompanying citation counts.

“A high score means that others like what you do”









# FACTS AND FIGURES

The KTH School of Electrical Engineering (EE) is growing fast in revenue. During the last few years, the school's EU funding has risen substantially. In five years the number of Ph.D. students has increased by about 25 per cent, to 245 full-time employments in 2015. Teaching faculty and doctoral students account for the biggest growth.

It has also been a successful year for KTH EE's educational programmes.

Since 2011 (when application and tuition fees were introduced) we have had an increasing amount of first-hand applications for our five master's programmes.

## Increase in external funding from government and industry

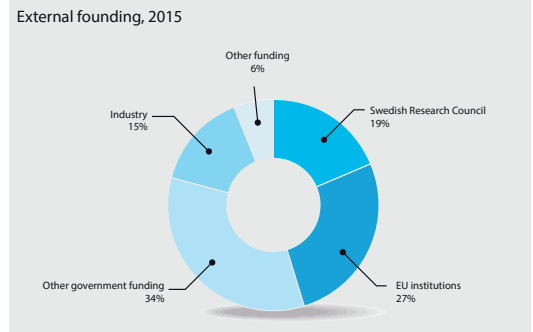
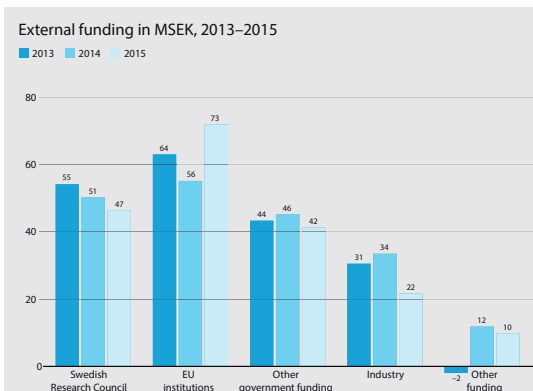
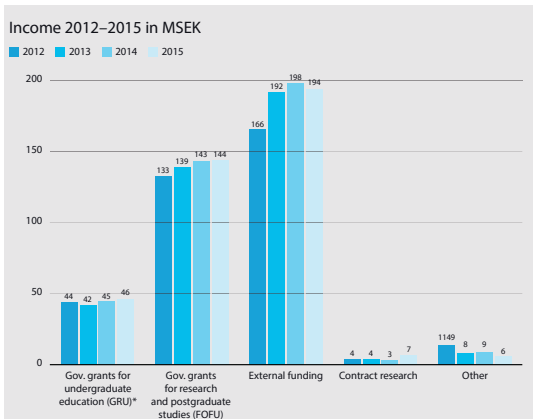
In recent years, KTH EE has experienced a steady increase in its external funding – from SEK 183 million in 2012 to SEK 235 million in 2015. In 2011, external funding amounted to 45 per cent of our revenue; that figure rose to almost 50 per cent in 2015. During 2015, there was a substantial increase in government and industry funding – these now constitute 34 per cent and 15 per cent of our overall funding respectively. This is the second year in a row that we have seen a sharp increase in these areas. This is due to

new funding from the EU, Svenska kraftnät, Elforsk, Trafikverket, Vattenfall, the Swedish Energy Agency and other partners.

Funding from the Swedish Research Council and the EU remains stable at a high level of SEK 44 million and SEK 64 million respectively. The EU has continued to be an important source of income, and we receive more EU funding than any other school within KTH. About one-fifth of all EU funding to KTH is allocated to KTH EE. Our income has increased

substantially over the last five years, thanks to the rise in EU funding and funding from the government's investment in strategic research areas. We have thus seen a steady growth in the revenue for research in the last five years, while the funding for education has remained at the same level.

Almost 87 per cent of our income in 2015 was for our research.

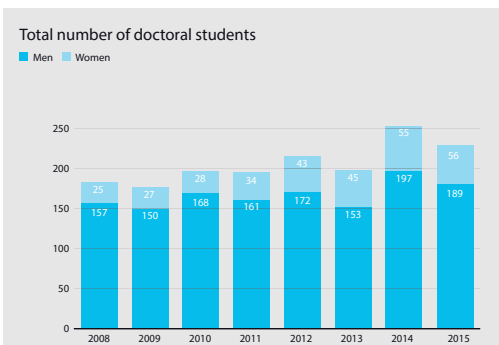
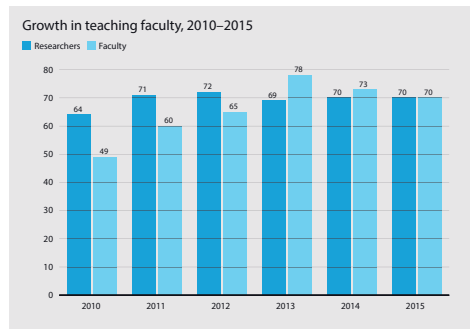
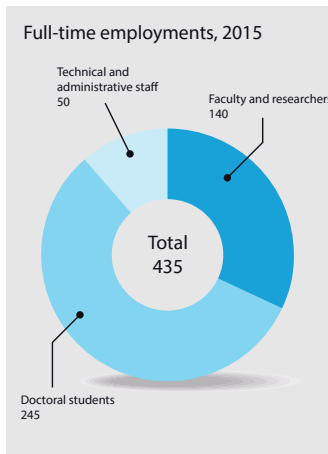


## Exceptional growth and a stronger faculty

Since its establishment, the KTH EE has grown exceptionally. In recent years alone, staff numbers increased from 314 in 2009 to 435 in 2015. The most significant growth was in the numbers of teaching staff (from 97

to 140) and doctoral students (from 179 to 245). This growth may be explained by an increased demand for our research in general, which has attracted external funding. This has enabled us to recruit highly

talented scientists, who in turn have been able to recruit more doctoral students. As a result of this, the new faculty has recruited postdocs and researchers, resulting in an increase in research associates.



## Continued growth for international student group

KTH EE educates engineers and master’s students in electrical engineering at several different levels and within several different programmes. We offer one Master of Science in Engineering (5 years), five master’s programmes (2 years) and one doctoral programme for Ph.D. students.

The five-year Master of Science in Electrical Engineering programme has a 3+2 structure; the first three years consist of a bachelor’s programme in Swedish and the last two years consist of a master’s programme in English with a large international student group (+50 per cent), often with different bachelor degrees. It is of great added value to our education that the students already begin to learn to work as engineers in a global context at KTH.

The school also cooperates in one Master of Science in Engineering programme with the School of Technology and Health (at KTH) and one Master of Science in Energy

Innovation programme within the European Institute of Innovation & Technology community, which consists of several partner schools at KTH and many other European universities.

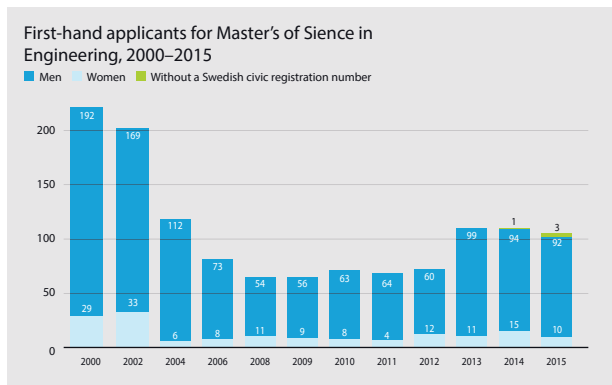
In total, we educated more than 1,000 students in 2015. Almost 400 students studied at bachelor level and nearly 450 students (including about 100 exchange students) took classes at master level. Almost 250 additional students were involved in Ph.D. studies.

### Increasing amount of first-hand applications from international students

Since 2011 (when application and tuition fees were introduced) KTH EE has received an increasing amount of first-hand applications for our five master’s programmes: electric power engineering; network services and systems; wireless systems; electrophysics; and system, control and robotics.

The five-year Master of Science in Electrical Engineering programme

Level	Name	No. students
Bachelor	Master of Science in Engineering (year 1-3)	396
Master	System, Control and Robotics	124
Master	Electric Power Engineering	98
Master	Electrophysics	23
Master	Wireless Systems	48
Master	Network Services and Systems	38
Exchange studies	Electrical Engineering	105
Ph.D. (doctoral)	Electrical Engineering	245
	<b>Total</b>	<b>1,077</b>

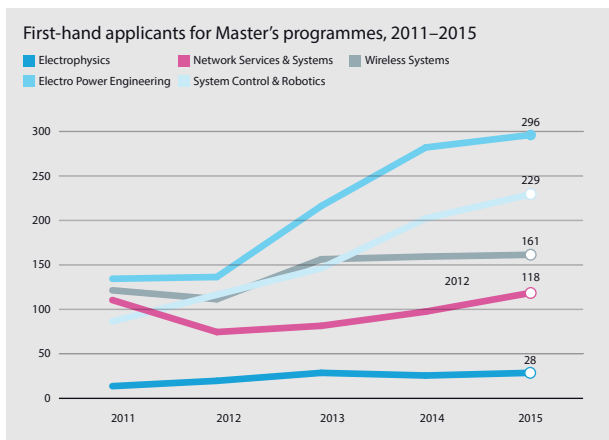


continues to have a lot of first-hand applicants; in 2015, 105 people applied for 65 places. The percentage of male applicants far exceeds the percentage of female applicants, which is an ongoing challenge for the school.

### Renewed agreements

KTH EE signed a new double-degree agreement with Télécom ParisTech, and renewed the agreement with CentraleSupélec. In 2015, the KTH EE admitted 102 exchange students from 49 universities representing 24 different countries. Most of

these came from Australia, France, Germany, Spain, Switzerland and the US. We have also been able to offer 34 students double-diploma places, where they receive two degrees; one from their home university and the Master of Science in Engineering from KTH. The majority of these students came from RWTH Aachen University in Germany and CentraleSupélec in France (a complete list of partner universities is shown below).



### DOUBLE-DEGREE CO-OPERATION AGREEMENTS

- École Polytechnique
- CentraleSupélec
- Télécom ParisTech
- RWTH Aachen University
- TU Darmstadt
- Politecnico di Milano
- Politecnico di Torino
- Keio University
- Tohoku University
- Universidad Politécnica de Madrid
- Universitat Politècnica de Catalunya – BarcelonaTech

## EXECUTIVE COMMITTEE



**Back row from left:** Göran Marklund, Space and Plasma Physics; Per Brunsell, Fusion Plasma Physics; Hans-Peter Nee, Electrical Energy Conversion; Bo Wahlberg, Automatic Control; Joakim Lilliesköld, Director of First and Second Cycle Education

**Front row from left:** Lise-Lotte Wahlberg, Head of Administration; Agneta Rune, Head of Finance; Gunnar Karlsson, Communication Networks; Stefan Östlund, Head of School; Håkan Hjalmarsson, Director of Third Cycle Education; Mikael Skoglund, Deputy Head of School Communication Theory; Göran Stemme, Micro and Nano systems.

**Not in picture:** Peter Händel, Signal Processing; Rajeev Thottappillil, Electromagnetic Engineering; Pontus Johnson, Industrial Information and Control Systems; Lennart Söder, Electric Power Systems

## STRATEGIC ADVISORY COUNCIL



**Back row from left:** Magnus Olofsson, CEO Elforsk AB; Rajeev Thottappillil, Teacher; Armin Weckman, Representative Doctoral Studies; Göran Stemme, Teacher; Joakim Lilliesköld, Director of First and Second Cycle Education; Alexander Kolmodin, Student Representative

**Front row from left:** Nickolay Ivchenko, Teacher; Lise-Lotte Wahlberg, Head of administration; Håkan Ferm, Administrative Personnel; Viktoria Fodor, Teacher; Stefan Östlund, Head of School; Ahmed Dara, Student Representative

**Not in picture:** Sara Mazur, Head of Research Ericsson AB; Mikael Skoglund, Deputy Head of School; Carl-Mikael Zetterling, KTH ICT; Katja Tollmar Grillner, Dean of Faculty; Kateryna Morozovska, Deputy Representative Doctoral Studies

## EE FACULTY COUNCIL



**Back row from left:** György Dan, Mikael Johansson, Tobias Oechtering, Kristinn Gylfason  
Wouter van der Wijngaart (chairman)

**From row from left:** Anita Kullen, Daniel Månsson, Rolf Stadler, Juliette Soulard, Magnus Jansson









# THESES

With 81 master's theses, 34 doctoral theses and 7 licentiate thesis in 11 areas, from communication theory and networks to electrical energy conversion and space and plasma physics, the KTH Royal Institute of Technology School of Electrical Engineering is committed to pushing the limits of human knowledge and maintaining its position as a world-class educational institution.

## Automatic Control

**EUHANNA GHADIMI**, Accelerating Convergence of Large-scale Optimization Algorithms

**BURAK DEMIREL**, Architectures and Performance Analysis of Wireless Control Systems

## Communication Network's

**IOANNIS GLAROPOULOS**, Coexistence and Energy Efficiency in Wireless Networks

## Communication Theory

**ZHAO WANG**, Interference Alignment with Imperfect Channel Knowledge and Secrecy Constraints

**IQBAL HUSSAIN**, Analysis and Design of Rateless Codes

**EFTHYMIOS STATHAKIS**, On Interference Management With Incomplete Side Information

**SHENG HUANG**, Linear Coding, Applications and Supremus Typicality

**FRÉDÉRIC GILBERT GABRY**, Secrecy in Cognitive Radio Networks

**HAMED FARHADI**, Coordinated Transmission for Wireless Interference Networks

**TAI DO**, Fundamental Limits in Wireless Wideband Networking

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**ANTONIOS ANTONOPOULOS**, On the Internal Dynamics and Ac- Motor Drive Application of Modular Multilevel Converters

**TOMAS MODÉER**, Cascaded Converters with Gate-Commutated Thyristors – Experimental Verification and Auxiliary Power Supply

**NAVEED-UR-REHMAN MALIK**, Modelling, Analysis, and Control Aspects of a Rotating Power Electronic Brushless Doubly-Fed Induction Generator

**GEORG TOLSTOY**, High-Efficiency SiC Power Conversion – Base Drivers for Bipolar Junction Transistors and Performance Impacts on Series-Resonant Converters

**JANG-KWON LIM**, Simulation and Electrical Evaluation of 4H-SiC Junction Field Effect Transistors and Junction Barrier Schottky Diodes with Buried Grids

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**EBRAHIM SHAYESTEHE**, Efficient Simulation Methods of Large Power Systems with High Penetration of Renewable Energy Resources Theory and Applications

**EYEDALI MOUSAVI**, Electromagnetic Modelling of Power Transformers for Study and Mitigation of Effects of GICs

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**YUWA CHOMPOOBUTRGOOL**, Aspects of Wide-Area Damping Control Design using Dominant Path Synchronphasor Signals

**CAMILLE HAMON**, Probabilistic security management for power system operations with large amounts of wind power

**MOHAMADREZA BARADAR**, On the Efficiency and Accuracy of Simulation Methods for Optimal Power System Operation – Convex Optimization Models for Power System Analysis, Optimal Utilization of vsc-type DC Wind Farm Grids and FACTS Devices

**RICHARD SCHARFF**, Design of Electricity Markets for Efficient Balancing of Wind Power Generation

**ANGELA PICCIARIELLO**, Impact of Economic Regulation on Distributed Generation Integration in Electricity Distribution Grids

**ILAN MOMBER**, Benefits of Coordinating Plug-In Electric Vehicles in Electric Power Systems – Through Market Prices and Use-of-System Network Charges

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**JÖRN CONSTANTIN RICHSTEIN**, Interactions between carbon and power markets in transition

## Fusion Plasma Physics

**IGOR BYKOV**, Experimental studies of material migration in magnetic confinement fusion devices

## Micro and Nano Systems

**HITHESH KUMAR GATTY**, MEMS-based electrochemical gas sensors and wafer-level methods

**NIKLAS SANDSTRÖM**, Integrating Biosensors for Air Monitoring and Breath-Based Diagnostics

**XIAOLEI WANG**, Partial Discharge Analysis of Stator Insulation at Arbitrary Voltage Waveform Stimulus

## Signal Processing

**EFRAIN ZENTENO BOLANOS**, Digital Compensation Techniques for Transmitters in Wireless Communications Networks

**SENAV AMANUEL NEGUSSE**, On Parameter Estimation Employing Sinewave Fit and Phase Noise Compensation in OFDM Systems

## Space and Plasma Physics

**NICOLA MANUEL SCHLATTER**, Radar Signatures of Auroral Plasma Instability

**LOVE ALM**, Cluster investigations of the extent and altitude distribution of the auroral density cavity

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**AFROOZ EBADAT**, On Application Oriented Experiment Design for Closed-loop System Identification

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**PRASADH RAMACHANDRAN**, Impedance matching of terminal antennas for energy efficient radio performance

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**JIANG ZUOYING**, Predicting Service Metrics from Device Statistics in a Container-Based Environment

**RAO AKHILA**, Team communication strategy for collaborative exploration by autonomous robots

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**ZHANG JUE**, Coordinated Multipoint Schemes with Suitable Cooperation Thresholds for Ultra Dense Networks

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**MEAD KEVIN ALLEN**, Graphene growth on SiC under Ar ambient and H-intercalation

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