Technical University of Denmark

NEWSLETTER

HEARING SYSTEMS IN PROFILE

August 2017

HEARING SYSTEMS

CONTENTS

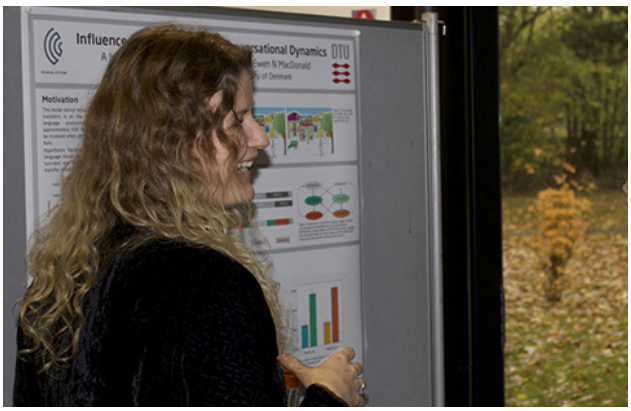
News, awards and prizes

Leftmost: Niclas Alexander Janßen, François Guérit, Wiebke Lamping, Suyash Joshi, Charlotte Navntoft visiting PhD Student University of Basel, Switzerland and Andreau Parades Gallardo. Photo Niclas Alexander Janßen

Student Travel Award for the Conference on Implantable Auditory Prostheses in Californina

Several researchers from the Hearing Systems group have been granted a Student Travel Award to attend the 2017 Conference on Implantable Auditory Prostheses (CIAP) which took place at Granlibakken conference center, Lake Tahoe California, on July 14-19. The Student Travel Award covered stay and board at the conference center for the researchers.

The Conference on Implantable Auditory Prostheses is a series of biennial international research conferences on cochlear implants and auditory brainstem implants. CIAP provides a unique forum for the presentation and discussion of fundamental scientific research from a diversity of basic science disciplines, as well as clinicians, engineers, and technical staff. The close interaction among leading scientific researchers from around the world facilitates the exchange of up-to-the-minute research results. CIAP is affiliated with the Association for Research in Otolaryngology.



At CHSCOM2017, the fourth International Conference on Cognitive Hearing Science for Communication in Linköping, Anna Josefine Sørensen presented results from her Master's project in an oral presentation titled: "The effects of noise and second language on turn taking in task-oriented dialog". Her trip was sponsored by a scholarship from Phonak which covered the conference fee, transportation and accommodation.

News from abroad

Professor Christopher Rozell (Georgia Institute of Technology) and Torsten Dau both brought their families which also were invited to stay at Kavli Institute during the conference.

Torsten Dau at workshop in Santa Barbara

From June 19 to July 21, Torsten was an invited participant of the workshop on "Physics of Hearing: From Neurobiology to Information Theory and Back", organized by the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.

The workshop covered various topics, including the biophysics and active sensing in the inner ear; psychoacoustics and human auditory modeling; the mathematical structure of natural sounds; auditory cognition and processing in central brain areas; speech comprehension and language development in children; speech and speech-recognition technology; compressed sensing and sparse recovery modeling as well as deep neural networks for speech recognition. Various tutorials, seminars and discussion meetings provided opportunities to connect with the other colleagues and to build relations that go beyond those typically established through conferences.

"For me, the major impact of the talks and discussion meetings was to get a good sense of current challenges and ways to approach key research questions, new directions, experimental and modeling paradigms and technologies and perspectives in the different researchers' main areas," Torsten Dau explains.

"This was very interesting, particularly given the multi-disciplinary character of the program, while having reasonably common overall goals, for example in terms of understanding physiological signatures, information coding principles, neural correlates of perception, hearing deficit compensation and other aspects," he says.

News from Abroad

Melbourne

Mélanie Nolan (leftmost), Andreu Paredes Gallardo, Thomas Bentsen, and Abigail Kressner from the Acoustic Technology and Hearing Systems Groups were all visiting Melbourne on their external research stays in the spring. Abigail Kressner and Thomas Bentsen (Hearing Systems) were collaborating with Cochlear Limited for three months, Andreu (Hearing Systems) visiting the Bionics Institute for 4-5 months and Mélanie (Acoustic Technology Group) was visiting Royal Melbourne Institute of Technology (RMIT) University for two months.

New CAHR Consortium

The Danish hearing-aid companies, Oticon, GN Hearing, and Widex, continue to support the Centre for Applied Hearing Research (CAHR) and have signed a new consortium agreement for the period of 2017-2020. The three main research goals are as follows:

- Apply advanced computational models of auditory perception and speech processing in the normal and impaired auditory system for optimized modelbased fitting of hearing aids.
- Incorporate acoustic scene analysis in hearing aids (e.g., applying new techniques to hearing aids, such as incorporating head movements, etc.).
- Develop tests using virtual sound environments that are relevant to the everyday experiences of hearing-impaired listeners to better evaluate hearing aid features in realistic conditions.

Cambridge

Wiebke Lamping and François Guérit, both PhD students in the Hearing Systems Group, are currently collaborating with Robert P. Carlyon and his Hearing and Language group at the Medical Research Council (MRC) in Cambridge, UK.

François and Wiebke focus their research on cochlear implants (CI). In 2016 and early 2017, both held a position as Research Assistant in Carlyon's group, where they carried out experiments to test the efficacy of a drug, an oral modulator of voltage-gated potassium channels, which is hypothesized to improve hearing in CI listeners.

In August 2017, Wiebke started an external stay of six months within the same group, where she will focus on understanding limitations in pitch perception of CI users. François is already collaborating on a project studying the electrode-neuron interface and its sources of variability. For his project, both Danish and British CI users have been participating in the listening experiments.

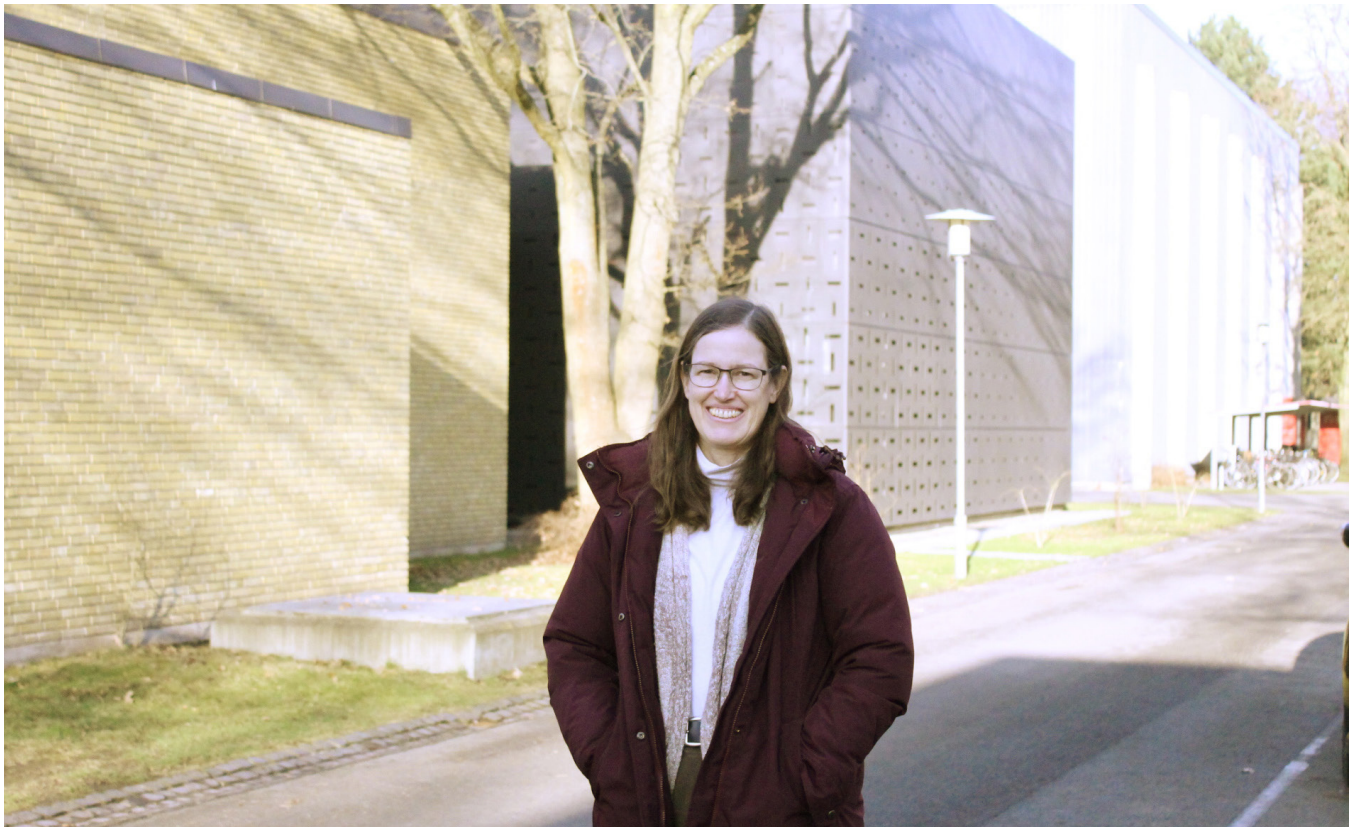


Photo by Eva Helena Andersen.

Visiting Professor at Hearing Systems

As part of a one-year Fellowship from her university, Laurel Carney, Marylou Ingram Professor in Biomedical Engineering, University of Rochester, New York, has been Visiting Professor at Hearing Systems, DTU Electrical Engineering for half a year. In the autumn of 2016, she was at the University of Oldenburg in the Department of Neuroscience, where she worked with Professor George Klump, and then stayed for the spring in Denmark. In this way she could combine two of the main areas of her research, neuroscience and modelling in human hearing.

Laurel Carney's expertise in physiology, behavioral research and computer modeling gives new dimensions to hearing research. Through computer modelling, it is possible to simulate the effects of background noise and different degrees of hearing loss, read the changes and then decode the neural information by observing how the responses change. This work may be important for the development of hearing aids for listening in background noise. Her research group in Rochester makes recordings of how neurons respond to sounds, and the scientists are actually able to compare the detection patterns in the parakeets to the parakeets' behavior. Then they can compare behavioral abilities of parakeets and humans. In this way, they hope to find out how the neurons in the brain are coding sound.

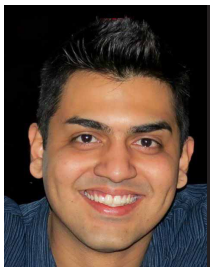
"We try to learn about the bird brain's strategy for discriminating complex sounds, and we believe it must be comparable to the human strategy, since human's and some bird's listening behavior are so similar. Timing in background noise is important to understand, and we need to understand how hearing loss would affect that timing," she explains.

Head of Hearing Systems Torsten Dau, was very happy to have Laurel Carney, who is known worldwide for her research, as Visiting Professor in the research group:

"Laurel Carney's expertise in physiology, behavioral research and computer modeling makes it exciting to work with her and we are proud to have had the chance to have her in our group as a Visiting Professor and are looking forward to future collaboration," he says.

Staff news

PhD Defences



On March 17, Suyash Narendra Joshi successfully defended his PhD thesis titled "Modelling auditory nerve responses to electrical stimulation ." He now works as a Post Doc in the group.

On April 21, Henrik Gert Hassager successfully defended his PhD thesis titled "Characterizing perceptual externalization in listeners with normal, impaired and aided-impaired hearing". Henrik Gert Hassager now works at Widex as a Technical Audiology Engineer.

On May 23, Richard Ian McWalter successfully defended his PhD thesis, "Perceptual and neural response to sound texture". Richard McWalter is now a Post Doc in Josh McDermott's Laboratory for Computation Audition in the Department of Brain and Cognitive Sciences at Massachusetts Institute of Technology (MIT) in Boston.

Board member of H.C. Ørsted Foundation

As of June 2017, Torsten Dau is a member of H.C. Ørsted foundation's steering committee. The foundation is administered at DTU and primarily supports equipment and technical components to further strengthen researchbased projects and initiatives.

Assistant professor at Hearing Systems Group

In April 2017, Tobias May was appointed an Assistant Professor in speech signal processing and hearing technology. Tobias May's main focus will be on signal processing strategies to improve the ability of people with hearing impaiment to communicate in challenging acoustic environments. His approach is to combine modern machine learning strategies with concepts from auditory signal processing and perception.

Golbarg Mehrai has in July 2017 started a position at Decibel Therapeutics in Boston, USA. During her time as a postdoc in our group, supported by the EU and DTU, Golbarg Mehraei investigated the effects of auditory-nerve and cochlear damage on auditory attention. In her studies, she combined concepts from auditory neuroscience with insights from new paradigms to measure selective attention and cognitive processing load. Within the scope of this project, she worked with, among other things, structural magnetic resonance imaging as well as new concepts of signal processing in the application of "cognitive" hearing aids.

Since the 1st of August, Heidi Kofod Christensen Audiologist, joined the Hearing Systems Group, in order to recruit test subjects and conduct a patient test for Michal Fereczkowski's. project. Besides DTU, she will be working at Bispebjerg or Rigshospitalet at their audiological departments.

New PhD project

The effect of hearing loss and noise on conversational dynamics

Anna Josefine Sørensen

It is commonly known that hearing-impaired listeners tend to withdraw from and avoid noisy situations leading to reduced social interaction and isolation, and one of the central goals of hearing rehabilitation is to regain people's ability and willingness to socialize. This project aims to investigate the temporal dynamics in conversations between two or more people to advance our fundamental understanding of how hearing loss influences communication. Moreover, we anticipate this project will inspire and support the development of new conversation-based test paradigms. Based on the results from this project, it may be possible to objectively evaluate novel hearing aid processing strategies and features via measures of conversational dynamics.

Visiting student

Supervised learning of direct-sound components using binaural signals

Robin Champenois, École normale supérieure Paris, France

Hearing aids perform level-dependent amplification, such that low-level sounds are amplified more than higher-level sounds, in order to compensate for the reduced dynamic range of hearing-impaired listeners. Although such a conventional compression scheme can restore the audibility of low-level sounds, it was recently shown to strongly distort the spatial perception of sounds in reverberant environments. A new direct-sound driven compression scheme was shown to preserve the spatial perception by applying compression to time-frequency units dominated by the direct sound and linearizing the processing for time-frequency units dominated by reverberation.

New Post Doc projects

Improving hearing-aid outcomes by tailoring hearing-aid settings with a Spectro-Temporal Modulation test

Johannes Zaar

Johannes Zaar has been granted funding for a two-year Post-Doc project from the Oticon Foundation. Starting in August, the project "Improving hearing-aid outcomes by tailoring hearing-aid settings with a Spectro-Temporal Modulation test" will be conducted in collaboration with the Interacoustics Research Unit/Interacoustics A/S as well as Oticon A/S. The goal of the project is to define a clinical Spectro-Temporal Modulation (STM) test procedure that is complementary to the standard pure-tone audiometry and thus allows for the improvement of individual hearing-aid prescriptions. Furthermore, Johannes will continue his work on speech perception in normal-hearing and (aided) hearing-impaired listeners and related computational models of the auditory system, in particular focusing on the co-supervision of several PhD projects within this area.

Auditory-filter based compression estimates for extended clinical diagnosis of hearing loss

Michal Fereczkowski

This project aims to develop a diagnostic test to estimate an individual's cochlear-compression characteristics from estimates of their auditory-filter characteristics, in a large group of hearing impaired listeners. The use of DPOAE I/Os as an objective alternative will be explored. The clinical utility of these tests will be validated through cross-correlation and post-hoc comparison of fitting and satisfaction. Finally, the project will explore the possibility of HI listeners conducting the behavioural test on their smartphone. By quantifying the relationship between cochlear-compression and auditory-filter characteristics, it will be possible to more accurately include individualized hearing loss into computational models of auditory processing.

Recent publications

Journal papers

Joshi S, Dau T, Epp B (2017) A Model of Electrically Stimulated Auditory Nerve Fiber Responses with Peripheral and Central Sites of Spike Generation. J A R O 1525-3961

May T (2017) Influence of binary mask estimation errors on robust speaker identification
Speech Communication (87) 40-48

Zaar J , Dau T (2017) Predicting consonant recognition and confusions in normal-hearing listeners
Journal of the Acoustical Society 141 (2) 1051–1064

Scheidiger C, Allen JB, Dau T (2017) Assessing the efficacy of hearing-aid amplification using a phoneme test .
Journal of the Acoustical Society of America 141 (3) 1739–1748

Hassager H, Wiinberg A, Dau T (2017) Effects of hearing-aid dynamic range compression on spatial perception in a reverberant environment. Journal of the Acoustical Society of America 141 (4) 2556–2568

Fereczkowski M, Jepsen ML, Dau T, MacDonald E (2017) Investigating time-efficiency of forward masking paradigms for estimating basilar membrane input-output characteristics P L o S One 12 (3)

Fuglsang S, Dau T, Hjortkjær J (2017) Noise-robust cortical tracking of attended speech in real-world acoustic scenes. Neuroimage .

Mehraei G, Paredes Gallardo A, Shinn-Cunningham B, Dau T (2017) Hearing Research. 346, 34-44. Auditory brainstem response latency in forward masking, a marker of sensory deficits in listeners with normal hearing thresholds.

Wendt D, Hietkamp RK, Lunner T (2017) Impact of Noise and Noise Reduction on Processing Effort: A Pupillometry Study. Ear & Hearing

Bjerre L, Larsen T, Sørensen AJ, Santurette S, Jeong C (2017) On-site and laboratory evaluations of soundscape quality in recreational urban space. Noise and Health 19 (89) 183-192

Bianchi F, Hjortkjær J, Santurette S, Zatorre R, Siebner H, Dau T (2017) Subcortical and cortical correlates of pitch discrimination: Evidence for two levels of neuroplasticity in musicians. Neuroimage

Hassager H, May T, Wiinberg A, Dau T (2017) Preserving spatial perception in rooms using direct-sound driven dynamic range compression. Journal of the Acoustical Society of America141(6) 4556–4566

Conference Papers

May T, Kowalewski B, Fereczkowski M, MacDonald E (2017) Assessment of broadband snr estimation for hearing aid applications. Presented at: 19th International Conference on Acoustics, Speech and Signal Processing, 2017, Kyoto.p 231-235

Ahrens A, Marschall, M , Dau T (2017) Evaluating a Loudspeaker-Based Virtual Sound Environment using Speech-on-Speech Masking. Presented at: 43. Jahrestagung für Akustik, DAGA 2017, Kiel. P 1138-1141

Kowalewski B, MacDonald E, Strelcyk O, Dau T (2016) Auditory-model based assessment of the effects of hearing loss and hearing-aid compression on spectral and temporal resolution. Part of: Proceedings of ISAAR 2015, Nyborg DK

Patents

Fereczkowski M, MacDonald E, Dau T (Inventors) (2016) Methodology and apparatus for determining psychoacoustical threshold curves.

PhD theses

Suyash Narendra Joshi (2017) Modelling auditory nerve responses to electrical stimulation

Henrik Gerd Hassager (2017) Characterizing perceptual externalization in listeners with normal, impaired and aided-impaired hearing

Richard Ian McWalter (2017) Perceptual and neural response to sound texture

Master projects

Auditory frequency tagging for attention controlled BCI. Sandra Solli
Supervisors: Torsten Dau, Jens Hjortkjær, Søren Fuglsang (DTU)

Development and evaluation of an external, gaze-steered microphone array for improving spatial selectivity of hearing aids.
Golam Reza Sadeghnia Supervisors: Marton Marschall (DTU), Thomas Lunner (Eriksholm Research Centre)
This master project is conducted in collaboration with Eriksholm Research Centre

Statistical modeling of pupil curves to quantify differences in processing effort on group- and individual-level. Patrycja Ksiazek
Supervisors: Dorothea Wendt (DTU/Oticon A/S), Thomas Lunner (Eriksholm Research Centre)
This master project is conducted in collaboration with Eriksholm Research Centre

Imagery Based Spelling System for Motor Disabled People. Cecilie Duun-Christensen.
Supervisor: Bastian Epp, Adnan Vilic

Encoding models in auditory functional magnetic resonance imaging. Mette L. V. Carstensen.
Supervisors: Torsten Dau, Jens Hjortkjær, Søren Fuglsang

Investigation of the subjective-objective relationship in arborne sound insulation. Christian Gjertsen.
Supervisors: Ewen MacDonald, Jonas Brunskog

Perceptual analysis of vehicle indicator and warning sounds. Mikael Kjær Petersen
Supervisors: Ewen MacDonald, Wookeun Song; Brüel & Kjær

Comparison of objective and subjective measures of cochlear compression.Konstantinos Anyfantakis
Supervisors: Ewen MacDonald, Bastian Epp, Michal Fereczkowski

Perception of frequency modulation in hearing-impaired listeners.
Isabel Schindwolf. Supervisors: Sébastien Santurette and Marianna Vatti (Eriksholm Research Centre)

Auditory processing of pitch in trained musicians. Samuel Cocks
Supervisors: Sébastien Santurette and Federica Bianchi

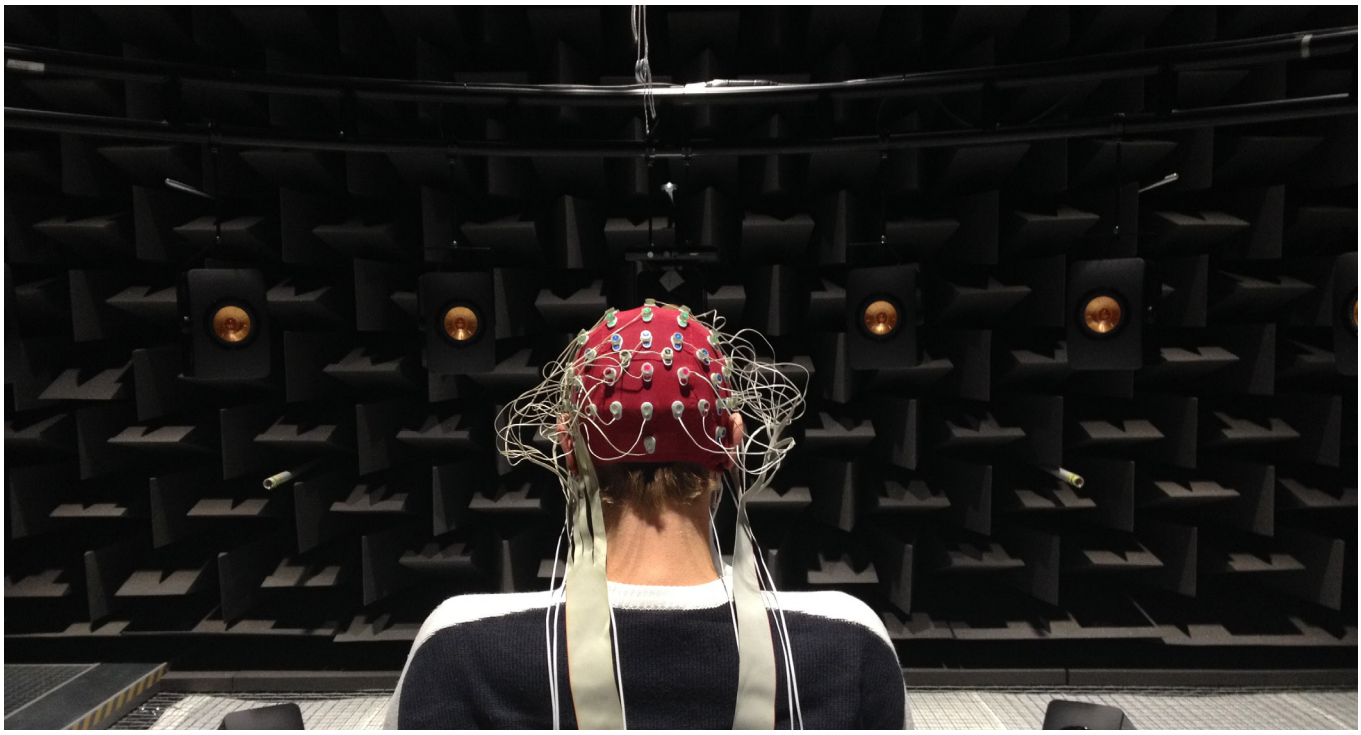
Real-time attention control of auditory feedback. Søren Vørnle Nielsen
Supervisor: Jens Hjortkjær (DTU)

Bachelor projects

Music Training Software for CI recipients. Pablo Brazell
Supervisor: Jeremy Marozeau(DTU)

Investigating higher-order spectra for the analysis of nonlinear properties of the inner ear of humans. Martin Brundgaard.
Supervisor: Bastian Epp (DTU)

Development of a microcontroller-based hearing impariment simulator. Rolf Pihl
Supervisor: Bastian Epp (DTU)



Several researchers are part of the The Cognitive Control of a Hearing Aid (COCOHA) Horizon 2020 project, which has the ambitious aim of creating a hearing-aid system that can be cognitively steered by the user. In this project, methods and algorithms will be developed to decode brain signals picked up by EEG electrodes, and to extract attention and intention signals, matching them to acoustic sources in the environment. Photo by Søren Fuglsang (Audio Visual Immersion Lab)