Hands-on in Signal Processing Education at Technische Universität Darmstadt

TECHNISCHE UNIVERSITÄT DARMSTADT

Tim Schäck, Michael Muma, Abdelhak M. Zoubir

SIGNAL PROCESSING GROUP

Signal Processing Group
TU Darmstadt

Electrical Engineering

at Technische Universität Darmstadt

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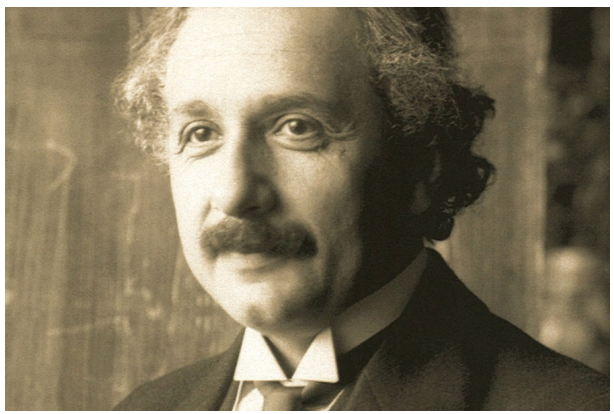
Electrical Engineering and Information Technology (etit)

- **1882:** First Chair for Electrical Engineering worldwide and appointment of Professor Erasmus Kittler
- **1883:** First course of study in Electrical Engineering worldwide
- **2007:** Bachelor Degree (3 years) + Master Degree (2 years)
- **2018:** 1.969 students in etit (12.6 % female, 33.7 % international)
- **Guiding principle:** "quality and innovation by tradition"



Albert Einstein (1919):
"In my opinion, you definitely ought to go to Darmstadt. They have a good polytechnic school there."

Agenda

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- **Curriculum**
- Interdisciplinary Hands-On Research
- Laboratories
- Competitions
- Practical Remarks

Curriculum

Overview of Hands-On Opportunities

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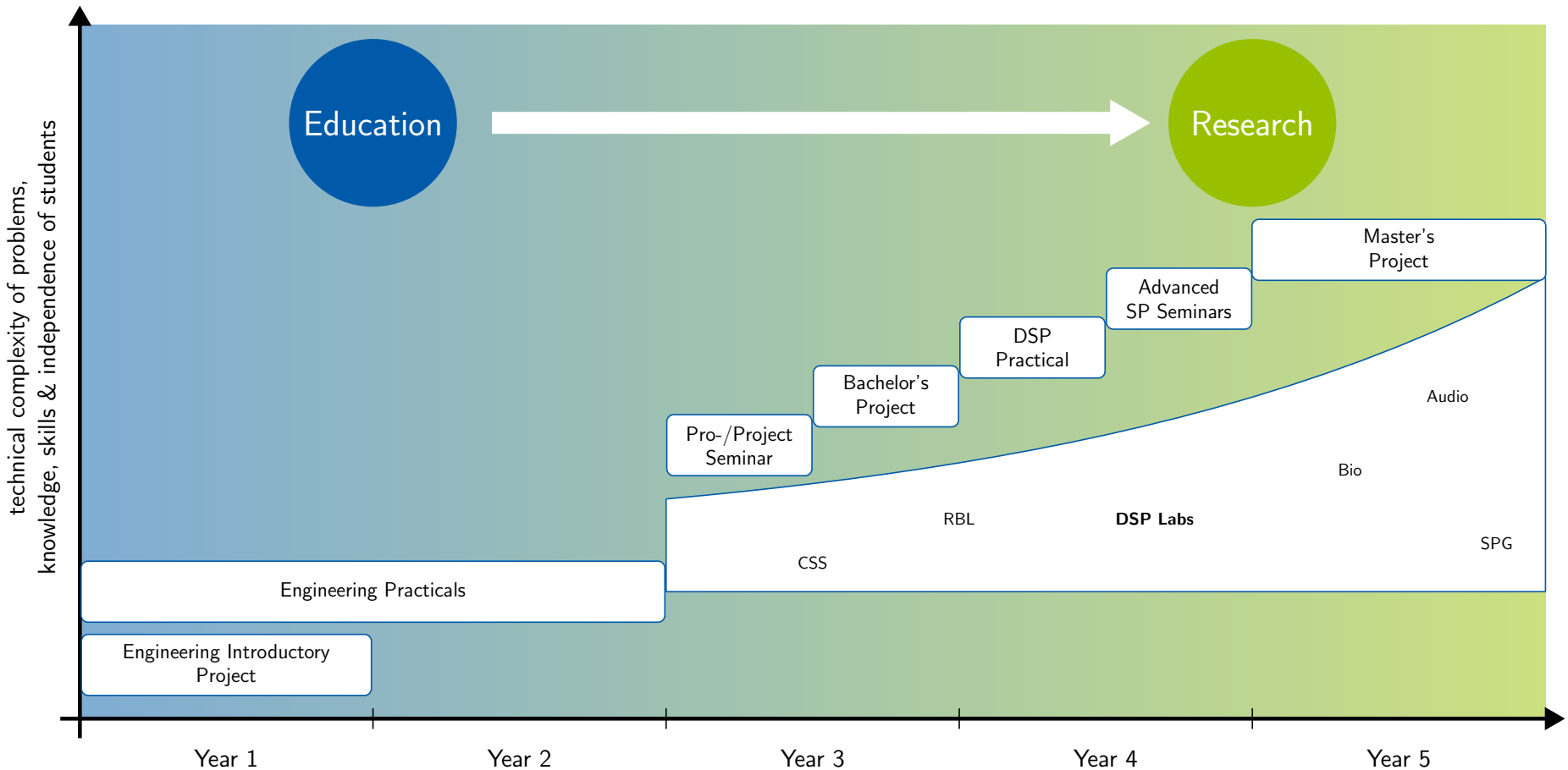

Curriculum

Year 1

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Introduction to Electrical Engineering

- Engineering Introductory Project

  Topic 2018: Technical concept for intelligent road intersections using sensor systems and beamforming

- ⊕ freshmen practice working independently in interdisciplinary teams
- ⊕ first exposure to signal processing problems
- ⓘ limited prior knowledge is assumed
- ⓘ choice of topic is essential

Curriculum

Year 2

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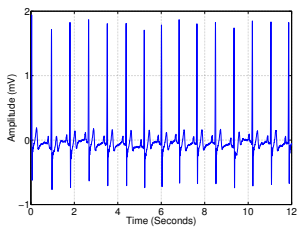
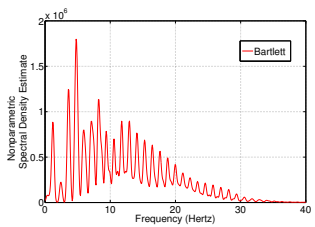
Basic Courses on Signal Processing

- Deterministic Signals and Systems
- Fundamentals of Signal Processing





⊕ practical experiments with real-world data in the lectures

⊕ inclusion of student assistants (UTAs) as a means of integration

! basic knowledge of signal processing is still missing at this point

Curriculum

Year 3

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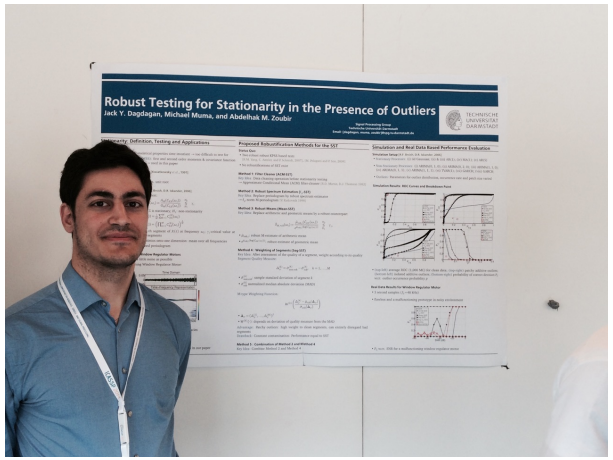
Larger Research Projects

- Communication and Sensor Systems Laboratory (CSS)
- Proseminar
- Project Seminar
- Bachelor's Thesis Project



⊕ outstanding Bachelors thesis projects can lead to conference publications
⊕ develop skills in Matlab, Latex and BibTeX
! workload of Research Associate (RA) can be high in relation to the outcome
! acquiring real data and working with it must be well planned

Curriculum

Year 4

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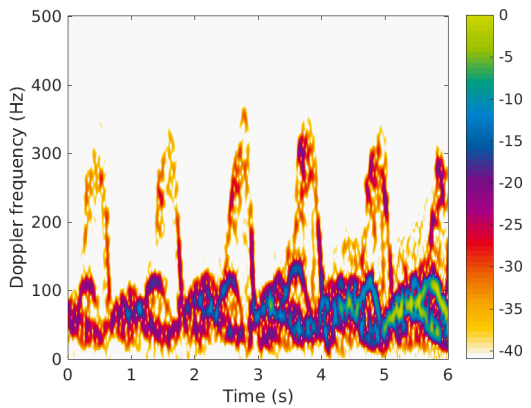
Advanced Engineering Projects

- Digital Signal Processing Practical
- Advanced Seminars in Signal Processing



- ⊕ apply concepts learned in the DSP courses using real-world data
- ⊕ deepen the knowledge in signal processing
- ⊕ students can collect their own measurements
- ⓘ time can be too short for students to gain a deep insight

Curriculum

Year 5

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Final Project

- Final Year Thesis Project (Master)

⊕ students are ready to untertake larger projects and work independently

⊕ cooperation with selected industry and research partners provides hands-on experience

⊕ recruitment of RAs

⊖ Master's students often stop at the height of their productivity

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Interdisciplinary Hands-On Research

Forum for Interdisciplinary Research (FiF) Project

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Research cooperation between signal processing and psychology

- Topic:

  Investigate the synchronization of physiological signals in emotional situations

- ⊕ databases, once established, can be reused by other students or researchers
- ⊕ the interdisciplinary nature of the project requires explaining fundamental concepts without using equations
- ⊕ excellent results could be obtained and publications were produced
- ! it takes time for students from all research fields to speak the same language
- ! detailed documentation is essential in interdisciplinary research

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Laboratories

Signal Processing Group (SPG) Lab

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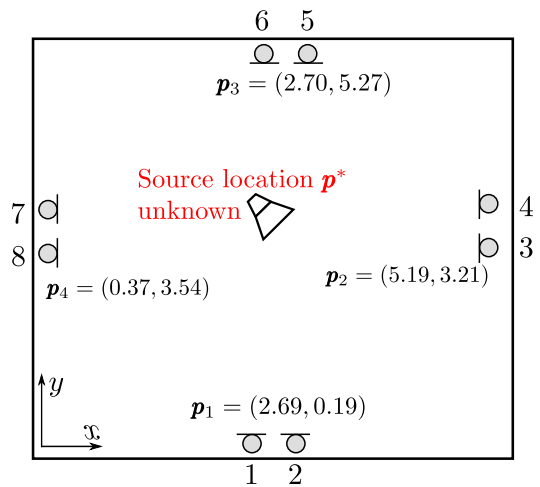
- **basic audio signal processing lab**
- biomedical sensor lab
- synthetic aperture sonar lab
- radar lab



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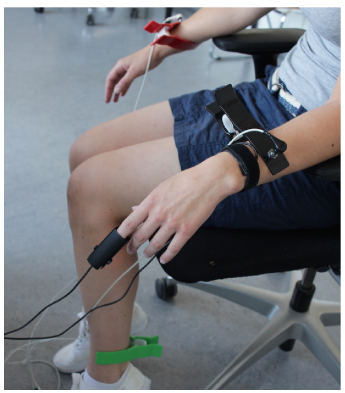

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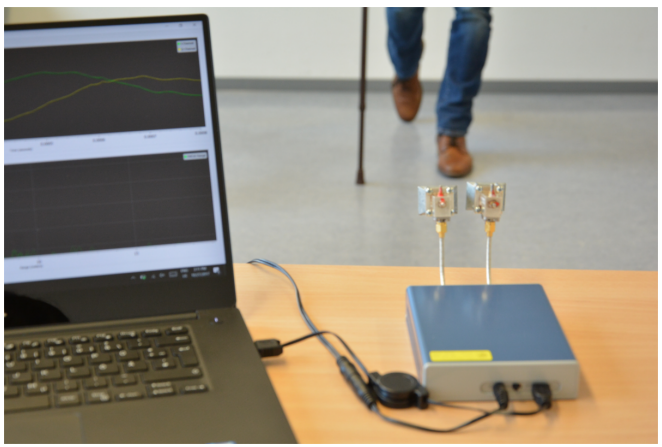

Laboratories

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⊕ students can collect their own measurements

⊕ students can carry out research jointly with RAs

⊕ even patented technologies have been developed in these labs

! keeping the lab up-to-date, providing GUIs and help to students is time consuming

Laboratories

Advanced Real-Time Audio Processing Lab

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Advanced Real-Time Audio Processing Lab

- development of algorithms for hearing devices
- focus on feedback cancellation and beamforming

Laboratories

Bioinspired Communication Systems Lab

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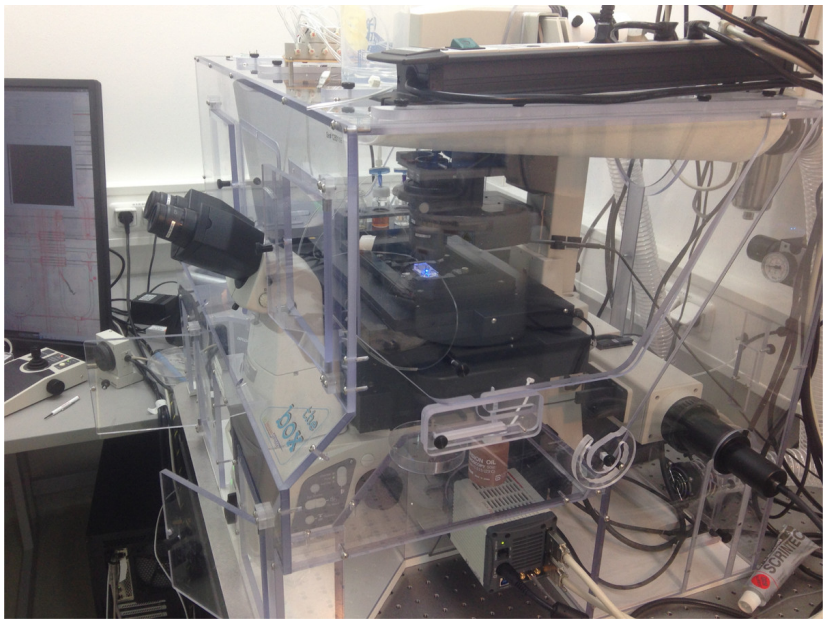
Bioinspired Communication Systems Lab

- statistical signal processing research in the context of biomolecular systems
- students can generate their own data by performing single-cell experiments



Laboratories

Receive Beamforming Lab

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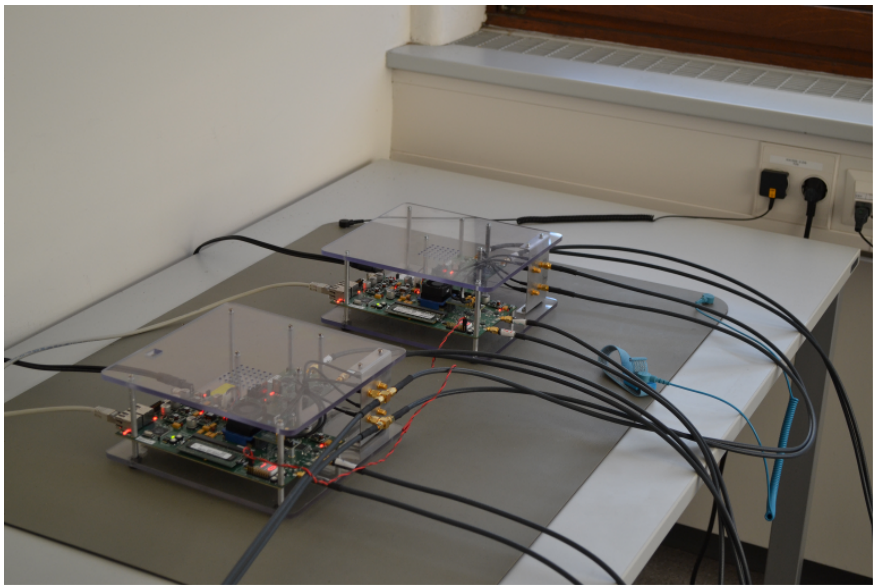
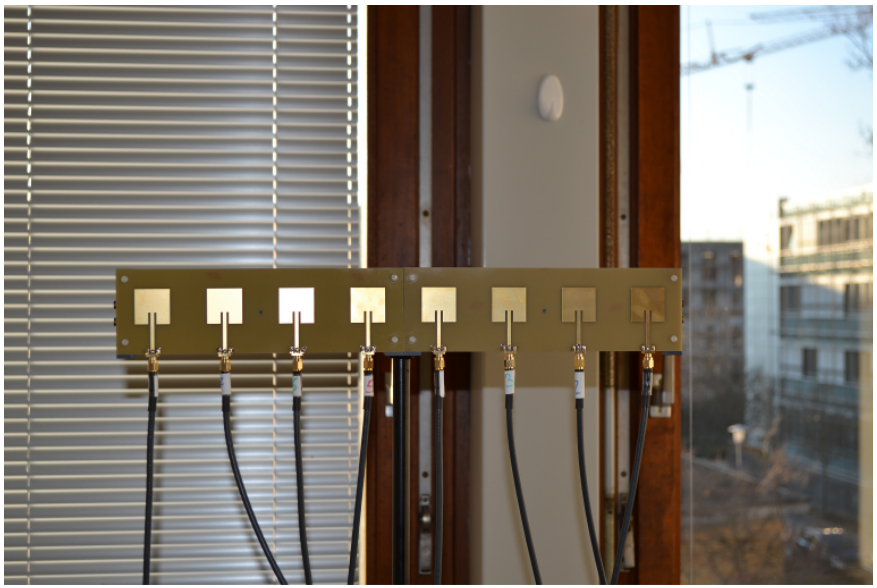
Receive Beamforming Lab

- student experiment in the field of multi-antenna receive beamforming
- main challenge: find the best trade-off between performance and complexity





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Competitions

Case Study Competition by Rohde & Schwarz

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- several hundred students from Germany and Singapore take part
- final competition in Munich using modern measurement equipment
- winning team receives a prize and money for teaching purposes

Winning team from Darmstadt at the ceremony in Munich (2012)

Competitions

IEEE Signal Processing Cup

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- several hundred students from all over the world take part
- final competition here at ICASSP
- winning team receives a grand prize and travel grant to ICASSP

Winning team from Darmstadt at their final presentation in Brisbane (2015)

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Practical Remarks

for Successful Design Projects

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- **Interculturality:**
  - give special emphasis to integrating students from other cultures
  - honest and direct communication is very important

Practical Remarks

for Successful Design Projects

TECHNISCHE UNIVERSITÄT DARMSTADT

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- **Gender equality:**
  - support by gender equality representatives helps female students
  - female RAs help attracting female undergraduate students

Practical Remarks

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- **Mentorship:**
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- **Evaluation:**
  - constantly try to improve courses, labs, and seminars through evaluations based on detailed questionnaires

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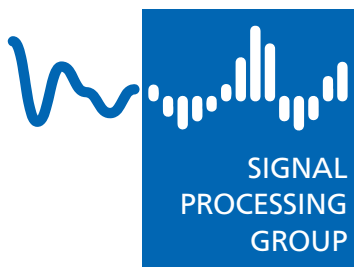
Thank you for your attention!



Prof. Abdelhak M. Zoubir
zoubir@spg.tu-darmstadt.de

Signal Processing Group
Technische Universität Darmstadt
Darmstadt, Germany