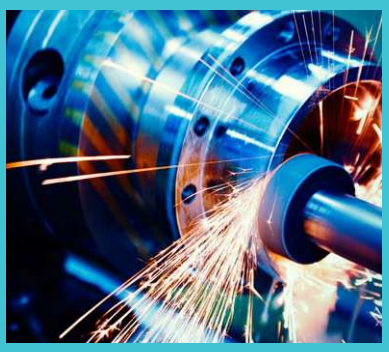
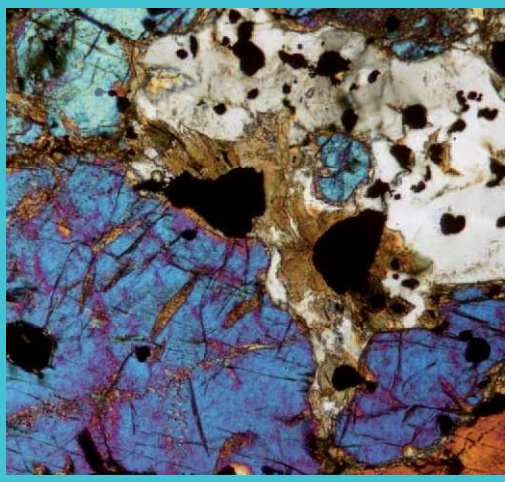
TAL TECH

RESEARCH AND DEVELOPMENT

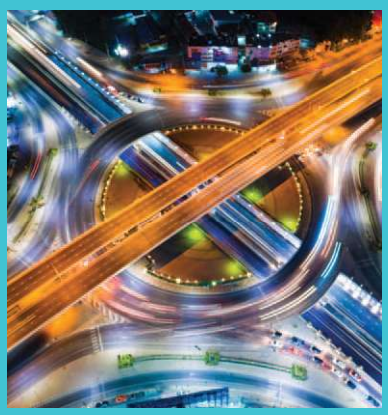




2025

TALLINN UNIVERSITY OF TECHNOLOGY

TALLINN UNIVERSITY OF TECHNOLOGY



TALLINN UNIVERSITY OF TECHNOLOGY

FOUNDED IN 1918, UNIVERSITY STATUS IN 1936

Rector: Professor TIIT LAND

e-mail: tiit.land@taltech.ee

Vice-Rector for research: Professor JAREK KURNITSKI

e-mail: jarek.kurnitski@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

1371 Academic staff — Incl. **188** professors, **857** researchers

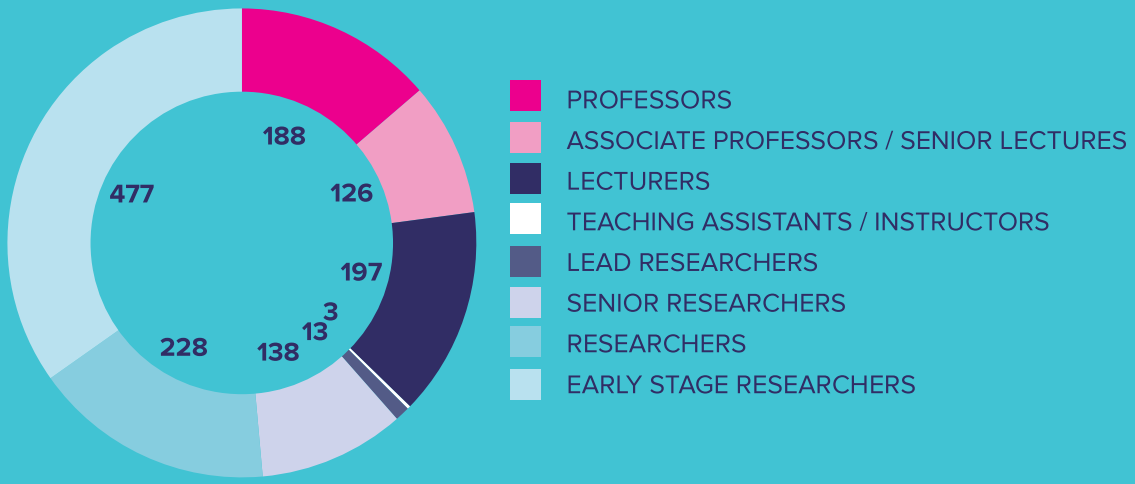
644 Doctoral students — **98** Defended doctoral dissertations

1193 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

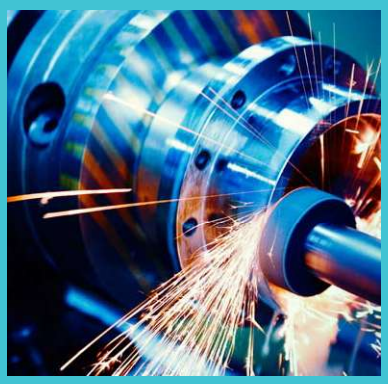
SCHOOLS

- **SCHOOL OF ENGINEERING**
- **SCHOOL OF INFORMATION TECHNOLOGIES**
- **SCHOOL OF SCIENCE**
- **SCHOOL OF BUSINESS AND GOVERNANCE**
- **ESTONIAN MARITIME ACADEMY**



CONTENTS

SCHOOL OF ENGINEERING



SCHOOL OF ENGINEERING

Dean: Tenured Associate Professor FJODOR SERGEJEV
e-mail: fjodor.sergejev@taltech.ee

Vice-Dean for Research: Tenured Full Professor ARGO ROSIN
e-mail: argo.rosin@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

496 Academic staff — Incl. 64 professors, 271 researchers

271 Doctoral students

33 Defended doctoral dissertations

491 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

DEPARTMENTS, COLLEGES

DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Director: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

DEPARTMENT OF ELECTRICAL POWER ENGINEERING AND MECHATRONICS
Director: Tenured Full Professor MART LANDSBERG, mart.landsberg@taltech.ee

DEPARTMENT OF ENERGY TECHNOLOGY
Director: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee

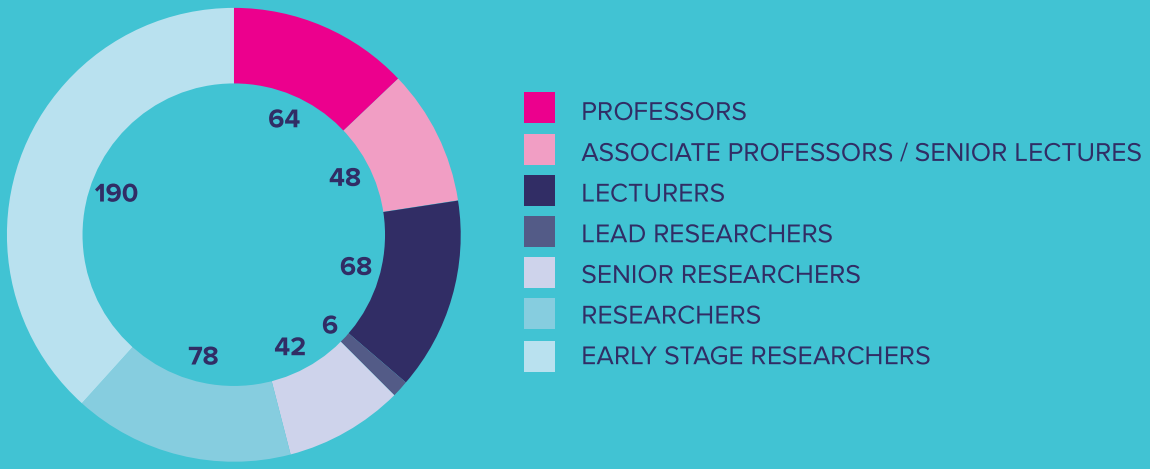
DEPARTMENT OF MATERIALS AND ENVIRONMENTAL TECHNOLOGY
Director: Tenured Full Professor MAARJA GROSSBERG-KUUSK, maarja.grossberg@taltech.ee

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING
Director: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee

KURESSAARE COLLEGE
Director: MERIT KINDSIGO, merit.kindsigo@taltech.ee

TARTU COLLEGE
Director: Associate Professor AIME RUUS, aime.ruus@taltech.ee

VIRUMAA COLLEGE
Director: MARE ROOSILEHT, mare.roosileht@taltech.ee



DEPRATMENT OF CIVIL ENGINEERING AND ARCHITECTURE

Direktor: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

141 Academic staff — Incl. 24 professors, 80 researchers

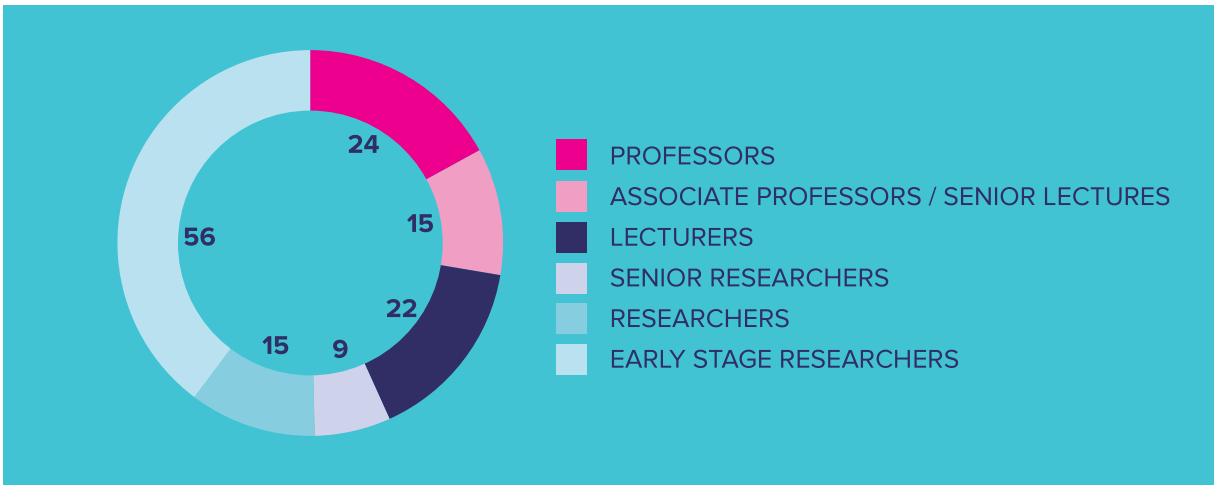
72 Doctoral students — 10 Defended doctoral dissertations

127 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH GROUPS:

- **ACADEMY OF ARCHITECTURE AND URBAN STUDIES.**
  Head: Tenured Full Professor KIMMO SAKARI LYLYKANGAS, kimmo.lylykangas@taltech.ee
- **BUILDING LIFECYCLE RESEARCH GROUP.**
  Head: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee
- **NEARLY ZERO ENERGY BUILDINGS RESEARCH GROUP.**
  Head: Tenured Full Professor JAREK KURNITSKI, jarek.kurnitski@taltech.ee
- **ROAD ENGINEERING AND GEODESY RESEARCH GROUP.**
  Head: Tenured Full Professor ARTU ELLMANN, artu.ellmann@taltech.ee
- **STRUCTURAL AND FLUIDS MECHANICS RESEARCH GROUP.**
  Head: Tenured Full Professor ALEKSANDER KLAUSON, aleksander.klauson@taltech.ee
- **STRUCTURAL ENGINEERING RESEARCH GROUP.**
  Head: Associate Professor IVAR TALVIK, ivar.talvik@taltech.ee
- **WATER AND ENVIRONMENTAL ENGINEERING RESEARCH GROUP.**
  Head: Associate Professor KARIN PACHEL, karin.pachel@taltech.ee



ACADEMY OF ARCHITECTURE AND URBAN STUDIES

Head of the research group: Tenured Full Professor KIMMO SAKARI LYLYKANGAS, kimmo.lylykangas@taltech.ee

Members: Jaan Kuusemets, Jenni Vilhelmiina Partanen, Fabian Dembski, Luca Mora, Raoul Kurvits, Epi Tohvri, Anu Juurak, Sergei Letunovitš, Mark Kovalenko, Tiina Tuulik, Toivo Tammik, Emil Urbel, Üllar Ambos, Aurika Nõmm, Külli Meister, Francesco De Luca, Lill Sarv, Ioannis Lykouras

Post-doctoral researchers: Najmeh Mozaffaree Pour, Kaarel Sikk, Peter Robert Walke

Doctoral students: Sara Thabit Gonzalez, Dominik Beckers, Laura Mrosla, Hanna Matilda Vikberg, Mahdi Rasoulinezhad, Kadri-Ann Kertsmik, Olli Ilmari Jakonen, Kofoworola Modupe Osunkoya, Francesco Tonnarelli, Payam Madelat, Jelena Kazak, Helmi Marie Langsepp, Hawke Gihm, Hamidreza Zarrinkafsh, Farah Hisham Abdelfattah Elbehairy, Juha Matti Päätalo, Seungwon Eo, Kaidi Põldoja, Irena Atkovska, Grete Tiigiste, Hana Geara, Juulia Aliide Salulaid, Blaise Nkubiyaho

TOPICS AND COMPETENCES

KEYWORDS: green transition; urban design; urbanism; planning; building performance; daylighting; sustainability; Smart City; Future City; landscape architecture; participatory planning; digital urban twins; green transition; greenhouse gas quantification; history of architecture; life cycle assessment

The research work of the Academy comprises the practical and analytical cycle of architectural design and urban planning, integrating different fields of engineering and humanities, incl. social spheres related to the functioning of the society, real estate management, etc. The Academy's research topics are related to current issues related to cities, citizens, and the built environment.

The research team has top expertise in the following fields:

- Smart Cities/Urban transition processes (L. Mora, S. Thabit, D. Beckers, F. Tonnarelli, I. Lykouras);
- Greenhouse gas quantification (K. Lylykangas, K. Kertsmik);
- Performance analysis of built/urban environment (F. De Luca, K. Lylykangas, H. Vikberg, N. Eslamirad, A. Sepulveda Luque);
- Digital Urban Twins/Participatory planning (F. Dembski, V. Prilenska, K. Grišakov, T. Tuulik, M. Allik, L. Mrosla, H. Zarrinkafsh);
- Urban data analysis/Complexity research (J. Partanen, O. Jakonen, M. Rasoulinezhad, M. Osunkoya);
- History of architecture/Learning environments (E. Tohvri).

More information: *Academy of Architecture and Urban Studies*

IN 2025, two books were published:

- Epi Tohvri's monograph "Tallinna Tehnikaülikooli kampus Mustamäe luidetel" provides, for the first time, a comprehensive account of the search for a location and the architectural history of Estonia's own technical university, from the early twentieth century to the present day.
- Mora, L., Gerli, P., Beckers, D., Thabit, S., & Tonnarelli, F. (2025). *Smart City Code: Governance Handbook for Digital Transformation Managers in the Public Sector*. New York City, NY: Elsevier. This book synthesizes five years of intensive, globally-oriented research conducted through a collaboration between UN-Habitat and TalTech. Grounded in the first global survey on smart city governance practices and aligned with the UN's principles for people-centred smart cities, it establishes a comprehensive, evidence-based framework for governing the strategic, technical, and operational dimensions of urban digital transformation.

SELECTED PROJECTS

- VHE23035, *Renewable ENergy-based Positive Homes* (2023–2026)
- VHE24049, *Quantum Inspired Valuation of circular real estate* (2024–2028)
- VEU24026, *Demonstrating a model of collaborative pre-fabricated reinvention of modernist districts into cosy living environments* (2024–2027)

SELECTED ARTICLES

Lykouras, I.; Mora, L. (2025). Material matters: Recommendations for the analysis of relational spaces in sociotechnical transition studies. Technology in Society, 80, #102764. DOI: 10.1016/j.techsoc.2024.102764.

Wang, L.; De Luca, F.; Janssen, P.; Bui, D. P. T.; Chen, K. W.; Yuan, C. (2025). A cross-platform optimization system for comparative design exploration of competing concepts and strategies. Journal of Building Engineering, 115, #114413. DOI: 10.1016/j.jobe.2025.114413.

Haque, Md. N.; Beckers, D.; Costales, E.; Aad, S.; Sharifi, A.; Mora, L. (2025). A systematic review of research on just, equitable, responsible, and inclusive smart cities. Technology in Society, 83, #103050. DOI: 10.1016/j.techsoc.2025.103050.

BUILDING LIFECYCLE RESEARCH GROUP

Head of the research group: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

Members: Raido Puust, Ergo Pikas, Emlyn David Qivitoq Witt, Roode Liias, Lauri Jaakko Koskela, Tiina Nuuter, Tanel Tuisk, Erki Soekov, Lembi-Merike Raado, Tiina Hain, Virgo Sulakatko

Doctoral students: Mattias Põldaru, Christopher-Robin Raitviir, Fariha Harun, Alok Rawat, Muhammad Mubasher, Jürgen Tammepärg

TOPICS AND COMPETENCES

KEYWORDS: multiple criteria management strategies; building information modelling (BIM); construction economics; construction management; building life cycle; technical conditions of housing; disaster resilience of built environment; civil engineering education; construction regulations, normative materials, standards; utilization of oil shale ash in the production of building materials; energy saving materials for the renovation of buildings

The research group approaches the building lifecycle as a whole, integrating the construction process and its outcomes with management strategies, technologies, building materials, economics and facilities management.

Research involves the following studies:

- Main characteristics of binders or binder constituents based on oil shale ashes from electrostatic precipitator systems;
- Basics of new utilization processes for oil shale combustion solid wastes;
- Low strength backfilling concrete based on the residues of oil shale processing;
- Frost resistance of various concretes and comparison of their test methods;
- Building properties of chemically treated timber;
- Durability characteristics (vapour and water migration) of facade systems, thermal insulation and external facade coverings.

The Research and Testing Laboratory of Building Materials has certified testing personnel, standards, methods and equipment for the evaluation of conformity for various building products: cement, mortar, grout and concrete products and products from natural and artefact stones and insulation materials.

More information: *Building Lifecycle Research Group*

IN 2025: An important goal was to find solutions to reduce the climate impacts of the construction sector. Digitalization in both the broader and narrower sense is an important measure for evidence-based environmental impact reduction in the sector. The practical aspects of the unified construction classification and its further development were addressed both in cooperation with the Estonian construction sector and through international cooperation (participation in the CCIC consortium).

SELECTED PROJECTS

- LEAAE23043, *DIGITAL: Research for Tallinn Digital Twins platform services* (2023–2027)
- VEU24010, *Housing Decarbonisation Skills for Climate, Health and Jobs* (2024–2028)
- VERT23054, *FOUNTAIN: Fostering sustainable University-industry Techno-entrepreneurial Collaborations and innovations in Asian universities* (2023–2026)

SELECTED PUBLICATIONS

Pikas, E.; Tetik, M.; Seppänen, O.; Vendel, K.-R. (2025). Advancing AECO Education: A project-Based Lean IPD Design Process and Design Management Course. International Journal of Construction Education and Research, 1–33. DOI: 10.1080/15578771.2025.2534334.

Thomas, A.; Yörük, C. R.; Usta, M. C.; Pantšenko, N.-L.; Hain, T.; Uibu, M.; Trikkel, A. (2025). Developing Mineral Foam Blocks from Oil Shale Byproducts through Accelerated Carbonation. ACS Omega, 10 (40), 47051–47064. DOI: 10.1021/acsomega.5c05438.

Rawat, A.; Witt, E.; Lill, I. (2025). A Conceptual Framework for LLM-based Multi-agent System in Construction Management. Proceedings of the 2025 European Conference on Computing in Construction: 2025 European Conference on Computing in Construction, Porto, Portugal, July 14–17, 2025. European Conference on Computing in Construction. DOI: 10.35490/EC3.2025.218.

NEARLY ZERO ENERGY BUILDINGS RESEARCH GROUP

Head of the research group: Tenured Full Professor JAREK KURNITSKI, jarek.kurnitski@taltech.ee

Members: Martin Thalfeldt, Targo Kalamees, Hendrik Voll, Simo Ilomets, Peeter Parre, Dmitri Loginov, Marko Ründva, Martin Kiil, Endrik Arumägi, Kalle Kuusk, Raimo Simson, Andrea Ferrantelli, Tuule Mall Parts, Alo Mikola, Kaiser Ahmed, Paul Klõšeiko, Jaanus Hallik, Peep Pihelo, Anti Hamburg, Leena Paap, Üllar Alev, Edoardo Scalera, Georg-Mihkel Kodi

Post-doctoral researcher: Villu Kukk

Doctoral students: Karl-Villem Võsa, Ülar Palmiste, Qidi Jiang, Martin Talvik, Lauri Lihtmaa, Helena Kuivjõgi, Kristo Kalbe, Jevgeni Fadejev, Sofia Vasman, Kadri-Ann Kertsmik, Elisa Iliste, Siim Lomp, Hannes Praks, Henri Olak, Alois Andreas Põdra, Kätriin Onemar, Renate Jaanus, Hans Kristjan Aljas, Kädi-Riin Vendel, Jevgeni Lukaštšuk, Kristina Vilba

TOPICS AND COMPETENCES

KEYWORDS: building physics, HVAC, building service systems, ventilation, indoor climate, IAQ, radon, energy performance of buildings

Zero energy buildings theme consolidates research topics of energy performance, building physics, indoor climate, building services and of some architectural elements like massing and daylight. Key research initiatives are targeted to the development of technical solutions and calculation methods for highly energy performing and zero energy buildings within active cooperation with other research areas such as architecture, construction economics, building materials and energy production.

The main research topics have been focused on technical solutions and system integration for NZEB most urgently needed in Estonia, but also on NZEB development in Europe and worldwide. In addition to solutions for new buildings, the group has been extensively working on renovation and development of an energy calculation methodology.

Some examples of the research topics and outcomes:

- Measurement of heat emission efficiency and development of a simulation methodology for EN EN15306-2;
- Development of occupancy and internal heat gain schedules for prEN16798-1 and ISO 17772-1;
- Modeling of geothermal energy piles and ground source heat pump in a whole building simulation environment for heating and free cooling purposes;
- Development of overheating prevention solutions and a temperature simulation based compliance assessment methodology for residential buildings;
- Development and validation of a simplified energy performance compliance assessment method for Estonian regulation based on the specific heat loss correlation;
- Scenario analyses for energy savings and investment needs within the framework of the Estonian energy action plan ENMAK 2030+;
- Preparation of the Estonian regulation on minimum energy performance requirements, calculation methodology and the energy performance certificate;
- Preparation of the Estonian Long-term Renovation Strategy 2020–2050;
- Development of European REHVA COVID-19 ventilation guidance, Estonian COVID-19 ventilation regulation and guidance for ventilation systems operation and improvements.

More information: *Nearly Zero Energy Buildings Research Group*

IN 2025:

- Input into the European Commission's technical guidelines. The Centre of Excellence for Energy Efficiency contributed to the two most technical guidelines prepared by the European Commission for the implementation of the revised Energy Performance of Buildings Directive (EPBD), which were published as a Commission Notice (*Zero-emission buildings and technical systems and indoor climate quality parts*). The work was carried out by Jarek Kurnitski as the leader of the EPBD Concerted Action Calculation Methods Working Group, the leader of the REHVA Technology and Science Committee and a member of the Nordic Ventilation Group. As a result of this work, the zero-emission building calculation methodology was put on a scientific basis and the air quality management and monitoring requirement for non-residential buildings was equipped with reasonable and practically applicable indoor climate parameters. These guidelines have a great impact as they are used in all Member States.

- Developments in energy efficiency calculation methodology and regulation. As a result of the work carried out within the framework of the Energy Efficiency Centre of Excellence, updated regulations were prepared setting out minimum energy performance requirements for buildings, calculation methodology and energy labelling principles (entered into force on 01.03.2025). In cooperation with the Ministry of Climate, three new projects were launched to develop energy performance regulations for buildings, which are necessary for the transposition of the directive next year. They concern new requirements and limit values for zero-emission buildings, updating the weighting factors of energy carriers used in the calculation of primary energy consumption, and developing minimum thresholds for existing non-residential buildings.

SELECTED PROJECTS

- TF24019, *Centre of Excellence in Energy Efficiency* (2024–2030)
- TEM-TA78, *Data-driven assessment of the potential and impact of energy saving flexibility technologies in buildings* (2024–2028)

SELECTED PUBLICATIONS

Seyed Salehi, S.S.; Kalamees, T.; Kurnitski, J.; Thalfeldt, M. (2024). New typical meteorological year generation method based on long-term building energy simulations. Building and Environment, 256, #111504. DOI: 10.1016/j.buildenv.2024.111504.

Simson, R.; Thomsen, K.E.; Wittchen, K.B.; Kurnitski, J. (2025). Benchmarking Danish, Estonian and Finnish NZEB requirements with European Commission recommendations in residential and office buildings. Energy and Buildings, 345, #116086. DOI: 10.1016/j.enbuild.2025.116086.

ROAD ENGINEERING AND GEODESY RESEARCH GROUP

Head of the research group: Tenured Full Professor ARTU ELLMANN, artu.ellmann@taltech.ee
Members: Kristjan Lill, Arto Lille, Kalev Julge, Luule Kaal, Ain Kendra, Nelli Ustinova, Harri Rõuk, Tiit Metsvahi, Sven Sillamäe, Kait Värat, Rainis Eksi, Julia Kutsõn, Urmo Pappel
Post-doctoral researcher: Sander Varbla
Doctoral students: Karli Kontson, Vahidreza Jahanmard, Saeed Rajabi Kiasari, Aleksei Kupavõh, Yu Yan

TOPICS AND COMPETENCES

KEYWORDS: roads, bridges, geodesy, geoinformatics

The main research topics of the Road Engineering and Geodesy research group are as follows:

- Research on stabilized pavement layers;
- Development of methodology for elastic pavement design;
- Calculation and optimization of the environmental footprint of road construction processes;
- Calculation of the CO_2 footprint of the Estonian asphalt industry and proposals to reduce it;
- Research on the road construction materials (bitumen, fillers, asphalt mixes, etc.);
- Analysis of increase in traffic and its impact, traffic safety (road safety auditing and inspection, road network impact analysis, safety analysis, etc.);
- Development of the calculation method for steel tube bridges based on the interaction between arc and soil;
- Development of bridge managing systems and life cycle calculation for bridges;
- Specification of the load bearing capacity for Soviet era standard reinforced concrete bridges according loadings based on Eurocode;
- Geoid modelling research with emphasis on the Nordic-Baltic region;
- Development of geodetic infrastructure (e.g. establishment/validation of gravity databases, geoid modelling computations, mean sea surface modelling, studies of shipborne GNSS to evaluate geoid models at sea) for finalizing hydrographic surveys in the Baltic Sea;
- Development of technological solutions for combining different spatial data acquisition sensors in a mobile platform and corresponding data processing;
- Geodetic SAR for Baltic Height System Unification and studies for marine processes.

More information: *Road Engineering and Geodesy Research Group*

IN 2025 a study was conducted to develop asphalt mixtures suitable for Estonian conditions, while replacing as much bitumen as possible with bio-based lignin. In 2025, a test section of the Randvere road in Viimsi municipality was paved. In addition to the reference mixtures, three mixtures containing lignin were paved. The proportion of lignin in the mixtures was 26–28% of the bitumen-lignin mixture.

SELECTED PROJECTS

- PRG1785, *Development of continuous DYNAmic vertical REFerence for maritime and offshore engineering by applying machine learning strategies / DYNAREF/* (2023–2027)
- TARISTU24-TK11 E*stonian Environmental Observatory* (2025–2029)
- VA24019, *Baltic Sea Dynamics through 4D Modelling and Integrated Earth Observation* (2024–2026)

SELECTED PUBLICATIONS

Rajabi Kiasari, S.; Ellmann, A.; Delpeche-Ellmann, N. (2025). Sea level Forecasting using Deep Recur-rent Neural Networks with High-Resolution Hydrodynamic Model. Applied Ocean Research, 1–32 [in print].

Jahanmard, V.; Ellmann, A.; Delpeche-Ellmann, N. (2025). Quantification of Baltic Sea Water Budget Components Using Dynamic Topography. Ocean Science [in print].

Kontson, K.; Lill, K.; Aavik, A. (2024). Statistical-empirical pavement temperature prediction models based on data from road weather stations in Estonia. Road Materials and Pavement Design, 1. DOI: 10.1080/14680629.2024.2415347.

MECHANICS OF FLUIDS AND STRUCTURES RESEARCH GROUP

Head of the research group: Tenured Full Professor ALEKSANDER KLAUSON, aleksander.klauson@taltech.ee

Members: Kristjan Tabri, Ivar Annus, Andrus Räämet, Andres Braunbrück, Anatoli Vassiljev, Madis Ratassepp, Hendrik Naar, Nils Kändler, Katrin Kaur, Mirko Mustonen, Peeter Tikerpe, Medhat Hussainov, Murel Truu

Doctoral students: Mikk-Markus Imala, Carlos Omar Rasgado Moreno, Lauri Hass, Kristjan Suits, Mikloš Lakatoš, Kerta Kõiv, Chengxiang Peng

TOPICS AND COMPETENCES

KEYWORDS: smart and resilient urban water systems including drinking water, stormwater and sewage networks, hydrodynamics, flow in pipes, climate change mitigation and adaptation, risk analysis; anthropogenic underwater noise, monitoring and analysis of underwater ambient sound; nondestructive testing, modeling ultrasound propagation in various materials; fluid structure interaction of deformable structures; ultimate limit strength of marine structures; analysis and simulation of maritime accidents; simulation and assessment of ships seakeeping performance.

The research team works in four main research fields:

1. *Modelling, planning, management and risk analysis of urban water systems.* Urban water system studies are focused on optimization, planning, development, management, risk assessment and mitigation of hydraulic systems (primarily urban drainage and drinking water systems). Research on stormwater systems focuses on implementation and improvement of digital twins of the systems in order to decrease the pluvial flooding risks in urban areas.
2. *Research on ship and marine structures.* The research focuses on the analysis of the behavior of marine structures under ultimate and accidental loads; on the analysis of the seakeeping performance of midsize fast ships and on the analysis interaction between fluid and deformable metallic structures.
3. *Underwater acoustics research.* The research focuses on the analysis of the ambient underwater sound in the Baltic Sea to assess the contribution of anthropogenic noise and its harmful effects on marine life.
4. *Non-destructive testing studies:* development of experimental and numerical methods for the development of innovative technologies for the inspection and monitoring of modern structures (aircraft, wind turbines) and materials (composite, layered additives). Current focus is on the development of guided wave tomography for the structural health monitoring of pipelines and composite structures.

More information: *Mechanics of Fluids and Structures Research Group*

IN 2025:

- A methodology was developed to assess the multiple benefits of nature-based solutions for stormwater management, taking into account flood risk mitigation, water quality improvement, heat island mitigation and changes in population well-being. The methodology was validated in five cities along the Baltic Sea. In addition, a framework for assessing small and medium-sized water companies was developed to analyze the potential for digitalizing their stormwater management.
- Ultrasonic non-destructive testing methods were developed, improving measurement efficiency and quantitative defect detection in complex geometries. A new BMOGCC-type coded excitation was developed, which increases the signal-to-noise ratio and measurement speed.

SELECTED PUBLICATIONS

Kõiv, K.; Annus, I.; Kändler, N.; Kaur, K.; Suits, K.; Truu, M. (2025). Methodology for multi-benefit analysis of nature-based solutions. Blue-Green Systems, 7 (2), 287–304. DOI: 10.2166/bgs.2025.102.

Rasgado-Moreno, C.-O.; Rist, M.; Land, R.; Ratassepp, M. (2025). Guided wave tomography of pipe bends based on full waveform inversion. Ultrasonics, 148, #107560. DOI: 10.1016/j.ultras.2024.107560.

Tabri, K.; Naar, H.; Heinvee, M.; Soo, A.; Hosseinzadeh, S.; Roosipuu, T. (2025). MV Estonia: Numerical modelling of bow arrangement collapse sequence. In: Trends in Collision and Grounding of Ships and Offshore Structures. (299–308). CRC Press. DOI: 10.1201/9781003684404-38.

STRUCTURAL ENGINEERING RESEARCH GROUP

Head of the research group: Associate Professor IVAR TALVIK, ivar.talvik@taltech.ee

Members: Alar Just, Aldur Parts, Ahti Lääne, Eero Tuhkanen, Johannes Pello, Priit Luhakooder, Mattia Tiso

Doctoral students: Katrin Nele Mäger, Johanna Liblik, Kristo Paalandi, Jane Liise Nurk

TOPICS AND COMPETENCES

KEYWORDS: structural engineering, fire resistance, Eurocode, steel structures, engineered wood

The studies of the group are related to the analysis of various building structures and foundations.

Resent research is focused on studying the performance of timber and steel structures at ambient and elevated temperatures. Design methods are developed regarding the effect of the charring layer on resistance of timber elements in fire. Interaction of timber structures with different insulation materi-als and claddings is also studied. The European test method for determining the fire resistance of ad-hesives used in engineered wood structures is under development. The research results have direct connection with the revision process of Eurocode 5.

Other topics of research cover connections and stiffness properties of cross laminated timber elements and development of probabilistic models of steel elements in fire.

The members of the group provide their expertise in industrial research and development projects of the construction sector.

The research group cooperates with other technical universities and research institutes (ETH, RISE, TUM, MPA Stuttgart).

More information: *Structural Engineering Research Group*

IN 2025: The European test method for determining the fire resistance of engineered wood adhesives was further developed. European calculation model was presented to calculate the load-bearing capacity of wooden I-beams in a fire situation. Methods for calculating the fire resistance of steel elements were supplemented.

The research group continued previously initiated studies:

- fire resistance of structures;
- assessment of strength and stiffness properties of wood in wood recycling;
- effect of adhesives on fire resistance of engineered wood;
- studies of the condition of reinforced concrete panels of existing apartment buildings for the implementation of factory renovation;
- studies to standardize the calculation values of temperature-dependent strength and stiffness properties of glulam in Europe. The results of the studies were used to supplement the new version of the European standard for the design of timber structures (Eurocode 5).

SELECTED PROJECTS

- TEM-TA80 *Development of methods for the valorization of underutilized wood and wood material in construction* (2024–2028)
- PRG2213, *Development of Wood-bio-adhesive Systems in Sustainable and Safe Engineered Wood Products in Construction* (2024–2028)
- VHE23055 *Demonstrating Real and Affordable Sustainable Building Solutions with Top-level whole life-cycle performance and Improved Circularity* (2023–2027)

SELECTED PUBLICATIONS

Vihmann, J. L.; Just, A.; Sterley, M.; Mäger, K. N.; Kers, J. (2025). The Performance of Bond Lines of Engineered Wood in Cone Heater Testing. Fire and Materials. DOI: 10.1002/fam.3295.

Mager, K. N.; Just, A. (2025). Charring design model for light timber frame assemblies with load-bearing I-joists. Fire Safety Journal, 153, ARTN 104369. DOI: 10.1016/j.firesaf.2025.104369.

Liblik, J.; Just, A. (2023). Small-scale assessment method for the fire resistance of historic plaster system and timber structures. Fire and Materials, 47 (1), 62–74. DOI: 10.1002/fam.3069.

WATER AND ENVIRONMENTAL ENGINEERING RESEARCH GROUP

Head of the research group: Associate Professor KARIN PACHEL, karin.pachel@taltech.ee

Members: Arvo Iital, Janek Laanearu, Alvina Reihan, Viktoria Voronova, Kristjan Piirimäe, Argo Kuusik, Erki Lember

Doctoral students: Yaroslav Kobets, Pavlo Lyshtva, Rene Reisner, Hanna-Lii Kupri, Susmita Banerjee, Ayankoya Yemi Ayankunle, Mark-Andrian Skljarov, Marija Klõga

TOPICS AND COMPETENCES

KEYWORDS: water quality, water resources, climate changes, hydrology, pollution load, water supply, sewerage, water monitoring, nutrients, wastewater, stormwater, sewage, sludge, waste

This is an interdisciplinary research group, where engineers, hydrologists, water chemists and other specialists from both water and environmental engineering participate. Research is developed in the following directions:

- Sustainable management of water resources and water quality. Hydrological studies of rivers from engineering viewpoint. Climate change and its impact on the quantity and quality of water. Floods and draughts.
- Studies of pressure factors affecting water quality. Regularities in water quality formation in both natural conditions as well as under various anthropogenic impacts.
- Studies in the field of riverine pollution loads. Water protection measures. Innovative methods of water monitoring (automatic systems for water monitoring). Studies on diffuse pollution and mitigation thereof.
- Urban water supply (domestic water) and sewage systems (sewerage, wastewater, stormwater), including pipelines outside buildings, internal pipelines in buildings, treatment facilities, engineering solutions and technologies, studies for improving design and construction. Pharmaceutical residues and heavy metals in municipal wastewater and sludge, as well as elaboration of relevant treatment technologies.
- Waste management. Waste utilisation. Treatment technologies for landfill leachate water, engineering solutions. Investigation of the possibilities of production of biogas from biodegradable waste and by-products of the processing industry.

More information: *Water and Environmental Engineering Research Group*

For scientific and experimental research, the group uses its own internationally accredited water quality laboratory (*https://taltech.ee/en/water-quality-research-laboratory*).

IN 2025: Within the framework of the project "Engineering tools for stratified flow processes in the built environment", large-scale sewer air-water stratified flow numerical modelling solution was developed for an urban area to perform an odor study. The modelling results give insight into the complexity of airflow dynamics in a poorly vented pipeline.

The BIO-PLASTICS EUROPE project created the Policy Framework to illustrate how the project will contribute to the EU policy recommendations for bio-based plastics systems of toys, cutlery, packaging, agricultural mulch film, and aquatic equipment.

Baltiplast project "Baltic Approaches to Handling Plastic Pollution under a Circular Economy Context" was ended. The project's main objective was to identify, test and deploy concrete solutions to handle and reduce the flow of plastic waste to the Baltic Sea, under the lenses of a circular economy.

SELECTED PROJECTS

- VEU23019EA, *Implementation of national climate change adaptation activities in Estonia* (2023–2032)
- VEU19017 *Development of an integrated water management and its modern tools in Estonia – strategic choices for future* (2019–2028).
- PRG1487 *Engineering Tools of Stratified-Flow Processes in the Built Environment* (2022–2026).

SELECTED ARTICLES

Lyshtva, P.; Voronova, V.; Kuusik, A.; Kobets, Y. (2025). Assessing the Biodegradation Characteristics of Poly(Butylene Succinate) and Poly(Lactic Acid) Formulations Under Controlled Composting Conditions. AppliedChem, 5, 3, #17. DOI: 10.3390/appliedchem5030017.

Ayankunle, A. Y.; Buhhalko, N.; Pachel, K.; Lember, E.; Drenkova-Tuhtan, A.; Heinlaan, M. (2025). Microplastics in Estonian wastewater treatment plants: First evaluation of baseline concentrations and stage-wise removal efficiency. Aquatic Toxicology, 281, 107305. DOI: 10.1016/j.aquatox.2025.107305.

Laanearu, J.; Cuthbertson, A. (2023). Hydraulics of stratified sill flows within varying channel geometries: investigating energy loss and mixing of maximal two-layer exchange. Environmental Fluid Mechanics, 1–40. DOI: 10.1007/s10652-022-09899-6.

DEPARTMENT OF ELECTRICAL POWER ENGINEERING AND MECHATRONICS

Director: MART LANDSBERG,
mart.landsberg@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

73 Academic staff — Incl. 6 professors, 65 researchers

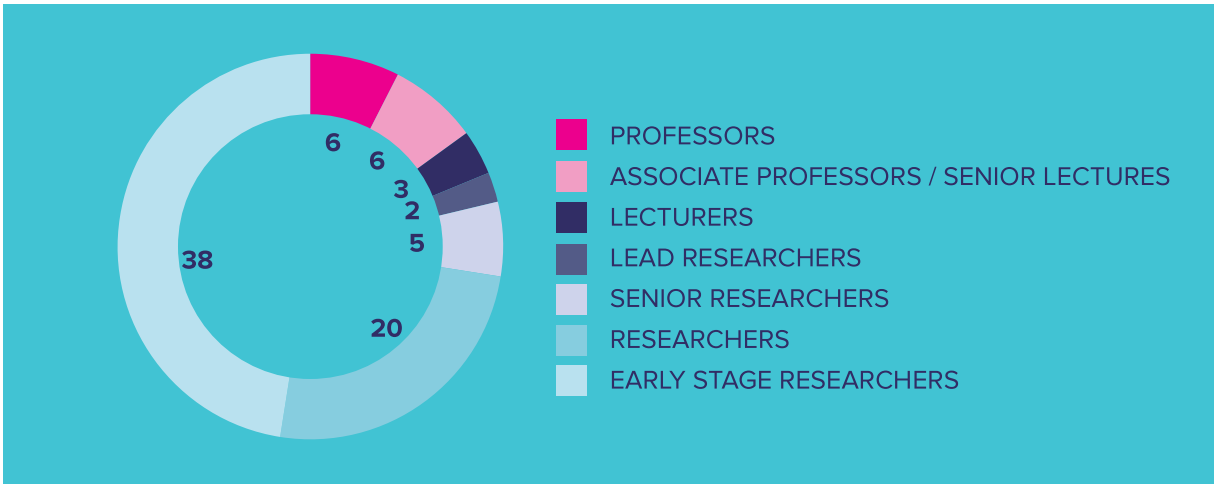
55 Doctoral students — 13 Defended doctoral dissertations

147 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH GROUPS:

- **ELECTRICAL MACHINES.**
  Head: Tenured Associate Professor ANTS KALLASTE, ants.kallaste@taltech.ee
- **ENERGY ECONOMICS AND HIGH VOLTAGE ENGINEERING RESEARCH GROUP.**
  Head: Tenured Full Professor IVO PALU, ivo.palu@taltech.ee
- **FUNDAMENTALS OF ELECTRICAL ENGINEERING.**
  Head: Tenured Associate Professor LAURI KÜTT, lauri.kutt@taltech.ee
- **MECHATRONICS AND AUTONOMOUS SYSTEMS RESEARCH GROUP.**
  Head: Tenured Associate Professor ANTON RASSÕLKIN, anton.rassolkin@taltech.ee
- **MICROGRIDS AND METROLOGY, INCL. LABORATORY OF LIGHTNING TECHNOLOGY.**
  Head: Tenured Full Professor ARGO ROSIN, argo.rosin@taltech.ee
- **POWER ELECTRONICS RESEARCH GROUP.**
  Head: Lead Research Scientist DMITRI VINNIKOV, dmitri.vinnikov@taltech.ee
- **POWER SYSTEMS RESEARCH GROUP.**
  Head: Tenured Associate Professor JAKO KILTER, jako.kilter@taltech.ee



ELECTRICAL MACHINES RESEARCH GROUP

Head of the research group: Tenured Associate Professor ANTS KALLASTE, ants.kallaste@taltech.ee

Members: Toomas Vaimann, Bilal Asad, Hadi Ashraf Raja, Hans Tiismus, Maia-Liisa Veldi, Kerdo Kruberg

Doctoral students: Siarhei Autsou, Muhammad Usman Naseer, Martin Sarap, Shahid Hussain, Muhammad Usman Sardar, Zahoor Ahmad, Suleman Saeed, Khizra Arif, Mehroz Fatima, Sumeet Khalid, Waqas Ahmed Sarwar

TOPICS AND COMPETENCES

KEYWORDS: electrical machines, generators, electrical drives, fault diagnostics, condition monitoring, artificial intelligence

The Electrical Machines Research Group is mainly involved in analysis, design, testing, development etc. of electrical machines, including wind generators. Additionally, the research group deals with electrical machine diagnostics, developing of permanent magnet materials for the use in electrical machines, novel methodologies for design and optimization of electrical machines and drives.

The main research topics of the last years have been the investigation of additive manufacturing possibilities of electrical machines and the development of this technology. Active research is going on in the field of intelligent methods for electrical machines and drive systems condition monitoring and diagnostics, involving Artificial Intelligence methods, possibilities provided by Internet of Things and Industry 4.0 technologies.

More information:
https://taltech.ee/en/electrical-machine-group

IN 2025

The project "Additivly Manufactured Electrical Machines" was continued. The project addresses questions related to defining machine types suitable for 3D printing and optimizing them according to the possibilities of 3D printing. A key consideration is the application of the electrical machine, as 3D printing is particularly suitable for specialized machines.

The project "Advanced recycled permanent Magnets for New Energy and Mobility Applications (MagNEO)" was continued in cooperation with National Institute of Chemical Physics and Biophysics (coordinator) and Tartu University. The project focuses on the development of recycling of sintered NdFeB. The recycling of NdFeB would reduce the EU´s dependence on China being more economical and cheaper compared to mining.

The project "Development of Risk- and Condition-Based Asset Management Principles" aims to understand the usability of assets managed by an electrical grid operator and develop methodologies for determining and analyzing the actual technical condition of equipment. A significant outcome is the development and potential implementation of maintenance methodologies based on a real substation provided by the client.

SELECTED PROJECTS

- PRG1827 "*Additivly Manufactured Electrical Machines*" (2023–2027)
- VERT23001 "*Capacity Enhancement in Electrical Equipment Condition Monitoring and Fault Diagnostics*" (2023–2025)
- LEEEE21116 "*Development of risk and condition based asset management principles*" (2021–2025)

SELECTED PUBLICATIONS

Plopeanu, T.; Kalda, J.; Tiismus, H.; Virro, I.; Vaimann, T.; Kallaste, A. (2025). Optimal shape of additively manufactured magnetic cores. Scientific Reports, 15, art. 42501. DOI: 10.1038/s41598-025-26678-7.

Sardar, M. U.; Vaimann, T.; Kütt, L.; Asad, B.; Kallaste, A.; Rassõlkin, A. (2025). Modeling Cable-Fed Induction Motor Drives with Optimized Impedance Characterization Across a Low to High-Frequency Spectrum. IEEE Transactions on Energy Conversion, 1–14. DOI: 10.1109/TEC.2025.3630465.

Sarap, M.; Singh, S.; Kallaste, A.; Qureshi, A. J.; Tiismus, H.; Vaimann, T.; Ghahfarokhi, P. S. (2025). Comparative Study of Advanced Heatsink Structures for Improved Thermal Performance in Axial Flux Motors. IEEE Access, 13, 100850–100860. DOI: 10.1109/ACCESS.2025.3577289.

ENERGY ECONOMICS AND HIGH VOLTAGE ENGINEERING RESEARCH GROUP

Head of the research group: Tenured Full Professor IVO PALU, ivo.palu@taltech.ee

Members: Reeli Kuhi-Thalfeldt, Jelena Šuvalova, Paul Taklaja, Victor Astapov, Ivar Kiitam, Sambeet Mishra, Hannes Agabus, Sten Buldas, Lisete Laine, Rasmus Tammis, Vladislav Musakko

Doctoral students: Maninder Choudhary, Praveen Prakash Singh, Ahto Pärl, Heiki Jakson, Alexander Varushchenkov, Johan Felix Blumfeldt, Kristopher Raik

TOPICS AND COMPETENCES

KEYWORDS: green energy economy, technology applicability and investment profitability analyses, economic and technical modelling of power system and electricity market, high voltage, insulators, partial discharges

The research team specializes in analyzing the components and challenges of the energy market to gain insight and create models using software such as EnergyPro, DigSilent, Windpro. The models consider future technologies and trends to evaluate the economic aspects of new power plants and their competitiveness. Broader models are used to analyze the energy system's impact on policies and regulations, allowing the government and policymakers to create better long-term development plans and aid economic growth. The team has international expertise in technology applicability and investment profitability analysis.

The High Voltage research laboratory activities are focused on the studies of the high voltage insulation and applications Associate with the high voltages and strong electrical fields. Most research is related to the insulators and insulation used in power lines, both overhead and cable lines are studied. Another scope of research is the effects of high loading, nonlinear loads and power quality to high voltage equipment (transformers, cable power lines etc.).

More information:
https://taltech.ee/en/energy-economics-research-group

SELECTED PROJECTS

- LEEEE24081 "*Expertise to assess the development of the frequency reserve market by Elering in accordance with (EU) 2017/2195 and the Agreement governing the operation of the Continental European Synchronous Area and its annexes (SAFA)*" (2024–2024)
- LEEEE24062 "*Partial Discharge measurements of Tootsi-Sopi wind park medium voltage underground cables*" (2024–2024)
- LEEEE25061 "*Safety in Electrical Grid Containing Distributed Generation: Practical Experiments*" (2025–2025)

SELECTED PUBLICATIONS

Choudhary, M.; Shafiq, M.; Bhattarai, A.; Kiitam, I.; Taklaja, P.; Palu, I. (2025). A Comprehensive Study of Partial Discharge Based Extrinsic Aging in Nomex Insulation Films: Modeling, Simulation and Measurement. Electric Power Systems Research, 245, #111663. DOI: 10.1016/j.epsr.2025.111663.

Pärl, A.; Singh, P. P.; Palu, I.; Sachan, S. (2025). Cost Analysis and Optimization of Modern Power System Operations. Applied Sciences, 15 (15), #8481. DOI: 10.3390/app15158481.

Maask, V.; Agabus, H.; Tiismus, H.; Astapov, V.; Ahmadiahangar, R.; Korõtko, T.; Rosin, A. (2025). Exploring the Landscape of End User Energy Flexibility: A Systematic Review of Technologies, Challenges, and Opportunities. IEEE Access, 13, 146579–146602. DOI: 10.1109/ACCESS.2025.3599989.

FUNDAMENTALS OF ELECTRICAL ENGINEERING

Head of the research group: Tenured Associate Professor LAURI KÜTT, lauri.kutt@taltech.ee

Members: Martin Jaanus, Heigo Mõlder, Kamran Daniel, Aleksander Kilk, Marek Jarkovoi, Tarmo Rosman, Toomas Vinnal, Henri Liivrand, Karl Leego, Laur Valgur, Martin Mikk Kõiv, Oliver Niin

Doctoral students: Martin Parker, Rana Muhammad Arslan Qadar, Taavi Salum

TOPICS AND COMPETENCES

KEYWORDS: electromagnetic compatibility, electric power quality, electromagnetic research, electrical engineering, circuit analysis

The main research activities are related to electric power supply quality (voltage quality, including voltage level and voltage waveform parameters, their influences and optimization; alternating voltage/current measurements and measurement data processing; investigation for influence of the voltage quality on the operation of devices and systems, etc.) and electromagnetic compatibility (EMC) (mutual electromagnetic influence of devices and systems, electromagnetic emission and immunity; wideband EM-field measurement and evaluation; influence of EM-noise on the operation of devices and systems, etc.).

In the field of electric power quality, challenges arise from the upcoming EU energy regulations, laying down requirements that can be achieved through higher amount of power electric converters related to small-power generation units including photovoltaic panels, small-power wind and other renewable producers. In order to achieve this, an investigation has to be carried out for the limits and capabilities of a public distribution network for operation without inadvertent violations of the voltage quality. The topics are closely related to both the fields of power quality (requirements to voltage quality and overload avoidance) and of EMC (requirements for devices and/or enforcement of the network against voltage degradation).

In the topics of EMC the research is targeted at conditions on how to combine different technologies in the same power supply grid (for example, power line communication and devices in the network), how to guarantee the compliance of specific electric and electronic products to the EU EMC and low voltage directives. The research group has equipment in the EMC laboratory, which also provides capabilities to test the products prior to their market release. The EMC laboratory can also provide services to the innovative electric and electronic industry, supporting faster development and market entry of their products.

More information: *https://taltech.ee/en/fundamental-electrical-engineering-group*

IN 2025: The research carried out focused on issues of electromagnetic compatibility related to power semiconductor converters. The research on DC converters addressed the mapping of electromagnetic interference generation mechanisms in partial-power converter class devices, including monitoring of converter components through refined analysis of high-frequency disturbances.

To enable more comprehensive monitoring of power supply systems, an initial prototype solution for a measurement platform was developed to support the creation and implementation of novel pre-analysis algorithm.

In the field of electromagnetic compatibility, work continued on developing measurement capability for conducted disturbances related to the operation of renewable energy sources and power semiconductor converters in distribution networks. The tools required for comprehensive measurement of renewable energy producers' electrical installations were further developed.

SELECTED PROJECTS

- TFA25100 "*Development of a base system for monitoring the status data of the electricity distribution networks to support flexibility services, to increase the use of renewable energy resources and improve reliability of the grid*" (2025–2026)
- LEEEV25081 "*Solar power plant EMF/EMC analysis*" (2025–2025)
- PRG2055 "*Tõhusad, töökindlad ja turvalised osavõimsusega elektroonilised süsteemid*" (2024–2028)

SELECTED PUBLICATIONS

Daniel, K.; Kutt, L.; Iqbal, M.N; Shabbir, N.; Raja, H.A,; Sardar, M.U.; (2024). A Review of Harmonic Detection, Suppression, Aggregation and Estimation Techniques. Applied Sciences, 14 (23), #10966. DOI: 10.3390/app142310966.

Iqbal, M. N.; Kütt, L.; Daniel, K.; Shabbir, N.; Amjad, A.; Awan, A. W.; Ali, M. (2024). Inaccuracies and Uncertainties for Harmonic Estimation in Distribution Networks. Sustainability, 16 (15), #6523. DOI: 10.3390/su16156523.

Sardar, M. U.; Vaimann, T.; Kütt, L.; Asad, B.; Kallaste, A.; Land, R. (2025). Wideband Frequency Response Analysis for Sensitive Condition Estimation of Machine's Turn Insulation Degradation Faults. 2025 IEEE Workshop on Electrical Machines Design, Control and Diagnosis (WEMDCD): Valletta, Malta, 9–10 April 2025. IEEE, 1–6. DOI: 10.1109/WEMDCD61816.2025.11014207.

MECHATRONICS AND AUTONOMOUS SYSTEMS RESEARCH GROUP

Head of the research group: Tenured Associate Professor ANTON RASSÕLKIN, anton.rassolkin@taltech.ee

Members: Tiia Tammaru, Even Sekhri, Leo Teder, Andres Kiitam, Andres Aleksander Kase, Kenari Koonik, Martin Võip, Karl Aleksander Leoste, Aure Vainu-Konnapere, Kevin Lindlaan, Margus Tõnissaar, Sven Rosenberg

Doctoral students: Mahmoud Ibrahim, Daniil Valme, Rolando Antonio Gilbert Zequera, Diana Belolipetskaja, Johannes Muru, Assem Reda Abdelhafez Fahim Meghawer

TOPICS AND COMPETENCES

KEYWORDS: design and control of mechatronic systems, propulsion drive, Digital Twins, UGV and UAV simulations, machine vision applications

The research activities of the Mechatronics and Autonomous Systems Centre are focused on the further development of mechatronics and autonomous systems. Modern vehicles (including various electric vehicles, e.g. electric cars, unmanned land and aircraft) also require energy efficiency optimization. The research team is developing several test platforms and digital twins to achieve this goal. The possibilities of combining real and virtual sensors with artificial intelligence are being explored to prolong the working life of vehicles and reduce the risk of failure.

Additionally, the main focus of R&D is the development of hardware and related software based on artificial intelligence for robotics and automation control systems and the development of user interfaces for systems, sensing, and especially new machine vision applications. The emphasis is on industrial robotics and the development of unmanned ground vehicle (UGV) and unmanned aerial vehicle (UAV) systems, as well as hardware-in-the-loop simulation and test systems.

More information: *https://taltech.ee/en/mechatronics-and-autonomous-systems*

IN 2025: Two new research projects were launched:

1. The project "Advanced Digital Tools to Accelerate the Development of Software-Defined Electric Vehicles" aims to further advance the digital twin technology of the electric powertrain in the development of software-controlled electric vehicles. The project targets the evolution of digital twins toward adaptive and intelligent levels, addressing the growing demand for efficient testing, validation, and optimization of electric propulsion systems in alignment with the EU clean energy transition objectives. Key research challenges include lifecycle management of digital twins, large-scale data processing, and reliable real-time communication. Through system integration, optimization, and technology demonstration, the project aims to make a significant contribution to the development of next-generation software-defined electric vehicle platforms.
2. "Artificial Intelligence-Based Adaptive Drive Control System". The project focuses on the development of a smart and adaptive electric drive system aimed at improving the energy efficiency and reliability of electric vehicles. The proposed solution integrates artificial intelligence-based control algorithms with advanced sensor technologies, enabling real-time adaptation to varying traffic and road conditions.

SELECTED PUBLICATIONS

- PRG2532 "*Advanced Digital Tools to Accelerate the Development of Software-Defined Electric Vehicles*" (2025–2029)
- TFA25099 "*Artificial intelligence-based adaptive drive control system*" (2025–2026)

SELECTED PUBLICATIONS

Ibrahim, M.; Järg, O.; Seppago, R.; Rassõlkin, A. (2025). Performance Optimization of a High-Speed Permanent Magnet Synchronous Motor Drive System for Formula Electric Vehicle Application. Sensors, 25, 10, #3156. DOI: 10.3390/s25103156.

Ibrahim, M.; Rassõlkin, A. (2025). Hybrid-Driven Digital Twin Modelling Framework for an EV Propulsion Drive System. IET Intelligent Transport Systems, 19, 1, #e70099. DOI: 10.1049/itr2.70099.

Gilbert Zequera, R. A.; Rjabtšikov, V.; Rassõlkin, A.; Vaimann, T.; Kallaste, A. (2024). Deep Learning methodology for charging management applications in battery cells based on Neural Networks. IEEE Transactions on Intelligent Vehicles, 1–15. DOI: 10.1109/TIV.2024.3417216.

MICROGRIDS AND METROLOGY

Head of the research group: Tenured Full Professor ARGO ROSIN, argo.rosin@taltech.ee

Members: Roya Ahmadiahangar, Tarmo Korõtko, Freddy Plaum, Vahur Maask, Madis Lehtla, Tobias Häring, Arvo Oorn, Toivo Varjas, Marti Laidre, Jaakob Lambot, Trevor Uuna, Julius Välja, Aiko Liisa Olek, Eva Tallo, Imre Drovtar, Indrek Möldre, Ketlin Tölp, Kevin Räpo, Meeli Maria Viikmaa

Doctoral students: Arqum Shahid, Martin Parker, Mitra Nabian Dehaghani Furqan Amjad, Merilin Metsik, Zeeshan Ali Shah

TOPICS AND COMPETENCES

KEYWORDS: microgrids, power system digitalization; energy communities; artificial intelligence applications in power system; energy flexibility; demand side management; energy storages; automation and diagnostic systems; electrical lighting

The research activities are focused on the development of two key research areas: electrical power supply systems (microgrids) and metrology.

Research in the field of electricity supply is focused on the research of models for predicting and characterizing the flexibility of the electricity system on demand side; on increasing the flexibility of energy communities by applying the artificial intelligence for control and optimization of energy flows, and on the development of innovative flexibility services and products. The application of the street lighting infrastructure is also being studied for a wider integration of green technologies (EVs, renewables, etc.) into the electricity system.

Research in the field of metrology is mainly focused on the development of measurement methods important in electric lighting and diagnostics of industrial equipment. In electric lighting, the impact of new lighting technologies on humans and the environment (including road safety) is studied, new lighting measurement methods are developed, e.g. for evaluating the effects of LED screens and lighting pollution. Measurement methods and algorithms suitable for diagnostics of industrial equipment are also studied in order to prevent economically costly failures and malfunctions.

More information: *https://taltech.ee/en/microgrids-and-metrology-group*

IN 2025:

The research group distinguished itself at the international level primarily through R&D results that shifted the focus from the development of individual technologies toward a systemic, data-driven, and artificial intelligence–enabled energy system. A key novelty was the treatment of renewable energy sources, energy storage systems, and end-user flexibility as a single, controllable resource rather than as isolated components.

A particularly novel international contribution was the methodology for quantifying aggregated energy flexibility, which integrates flexible capacity, activation duration, and rebound effects into a single metric. This enables a more realistic assessment of the value of flexibility across different energy markets and reduces risks for system operators and aggregators.

The analysis of the role of artificial intelligence and language models in the management of power grids proved to be particularly promising. The research

team showed that distributed AI and specialized language models enable more accurate power quality predictions, faster operational responses, and more efficient handling of complex regulatory frameworks. The systematic use of digital twins and high-quality data brought a new level of testing of energy technologies and validation of business models.

SELECTED PROJECTS

- ÕÜF3 "*Research and Development of Novel Renewable Energy and Flexibility Technologies*" (2023–2029)
- ÕÜF4 "*Research and development of novel applications for community and small-scale energy systems*" (2023–2029)
- VHE24065 "*Art of Darkness as Cultural Heritage of Urban Landscape*" (2025–2027)

SELECTED PUBLICATIONS

Shahid, A.; Ahmadiahangar, R.; Kilter, J.; Rosin, A. (2025). Data-driven quantification and aggregation of demand-side flexibility for symmetrical bidding in energy balancing markets. Electric Power Systems Research, 247, #111823. DOI: 10.1016/j.epsr.2025.111823.

Maask, V.; Rosin, A.; Korotko, T.; Thalfeldt, M.; Syri, S.; Ahmadiahangar, R. (2023). Aggregation ready flexibility management methods for mechanical ventilation systems in buildings. Energy and Buildings, 296, #113369. DOI: 10.1016/j.enbuild.2023.113369.

Plaum, F.; Rosin, A.; Ahmadiahangar, R. (2024). Novel Quantification Method of Aggregated Energy Flexibility Based on Power-Duration Curves. IEEE Access, 12, 132825–132837. DOI: 10.1109/ACCESS.2024.3461151.

POWER ELECTRONICS RESEARCH GROUP

Head of the research group: Lead Research Scientist DMITRI VINNIKOV, dmitri.vinnikov@taltech.ee

Members: Tanel Jalakas, Andrii Chub, Andrei Blinov, Indrek Roasto, Oleksandr Matiushkin, Edivan Laercio Carvalho, Vinod Kumar Yadav, Abualkasim Ahmed Ali Bakeer, Alexander Rink, Artem Fesenko, Artur Lavrov, Kristjan Uus, Siim-Erik Viiding

Postdoctoral researcher: Edivan Laercio Carvalho da Silva, Ievgen Verbytskyi, Neelesh Yadav, Sachin Chauhan Doctoral students: Hossein Afshari, Parham Mohseni Dash Agholi, Salman Khan, Sayeed Hasan, Hossein Nourollahi Hokmabad, Tofopefun Nifise Olayiwola, Salamat Ali, Hetal Sharma, Tuhin Mitra, Abdul Majid Bhat, Hans Anniste, Saqib Ali, Zeeshan Haider

TOPICS AND COMPETENCES

KEYWORDS: power converters for renewables, energy systems for near-zero energy buildings, power converters for energy storages, reliability of power electronic systems

Research in the group is focused on the development and experimental validation of advanced power electronic converters for such demanding applications as renewable energy systems, rolling stock, automotive and telecom. The key research directions include synthesis of new converter topologies, development of special control and protection algorithms, implementation of advanced components and materials, and elaboration of design guidelines for enhancing the efficiency, power density and reliability of the on-market power electronic systems.

Since 2010 the Power Electronic Group is a member of ECPE – European Center for Power Electronics e.V., which is an industry-driven research network promoting education, innovation, science, research and technology transfer in the area of Power Electronics in Europe. Moreover, the group is a part of Estonian Centre of Excellence for zero energy and resource efficient smart buildings and districts (ZEBE). The core activities in ZEBE are related to the advancing of the residential DC microgrid technology and acceleration of the transition towards highly energy-efficient and decarbonized buildings.

More information: *https://taltech.ee/en/power-electronics-research-group*

IN 2025 the research group members have participated in more than 10 different national and international R&D projects, from which the following can be highlighted:

- "*Future-Proof Power Electronic Systems for Residential Microgrids*". The main objective of this project is to make a breakthrough in the applied design of power electronic systems for residential DC microgrids (RDCμG) by the acquisition of cutting-edge knowledge in topologies, control, optimization, reliability and lifetime extension methods. It is highly expected that key competences obtained during the project will help to advance the emerging RDCμG technology by enabling novel versatile cost-effective power electronic systems, which will push forward the innovation and accelerate the transition towards highly energy-efficient and decarbonized buildings.
- "*Centre of Excellence in Energy Efficiency*" (CoE ENER). CoE aims to contribute to Estonian societal and economic challenge to transform 75% of existing building stock with poor energy performance to zero emission buildings (ZEB) with maximized co-benefits and improved life quality by 2050.
- "*SHIFT to Direct Current*" project aims to propose and implement a top-down application-agnostic approach for the design, simulation, test, validation, and application of both medium and low voltage direct current solutions.

SELECTED PROJECTS

- PRG1086 "*Future-Proof Power Electronic Systems for Residential Microgrids*" (2021–2025)
- TF24019EE "*Centre of Excellence in Energy Efficiency*" (2024–2030)
- TTK12 "*Energiatõhususe ja taastuvenergeetika tuumiktaristu*" (2025–2029)

SELECTED PUBLICATIONS

Yadav, N.; Chub, A.; Hassanpour, N.; Blinov, A.; Vinnikov, D. (2025). Protection and Control Implementation for Bidirectional Step-Up/Down Partial Power Converter for Droop-Controlled DC Microgrids. IEEE Transactions on Industry Applications, 61 (5), 7470–7480. DOI: 10.1109/TIA.2025.3561767.

Carvalho, E. L.; Mandrioli, R.; Vinnikov, D. (2025). Universal Interlinking Converter for DC-Powered Prosumer Buildings. IEEE Open Journal of Power Electronics, 6, 1967–1979. DOI: 10.1109/OJPEL.2025.3629539.

Yadav, N.; Chub, A.; Hassanpour, N.; Blinov, A.; Vinnikov, D.; Galkin, I. (2025). A Hybrid Modulation Approach for Step-Up/ Down Partial Power Converter with Improved MPPT Efficiency Around Zero Partiality. IEEE Transactions on Industry Applications, 1–10. DOI: 10.1109/TIA.2025.3525607.

POWER SYSTEMS RESEARCH GROUP

Head of the research group: Tenured Associate Professor JAKO KILTER, jako.kilter@taltech.ee

Members: Hamid Khoshkhoo, Madis Leinakse, Henri Manninen, Kaur Tuttelberg, Ülo Treufeldt, Tanel Sarnet, Marko Tealane, Brenda Pent, Eliise Kaha, Elis Vedom, Uku Sau

Doctoral students: Guido Andreesen, Pradeep Kumar Gupta, Sajjad Asefi, Ahmed Bassiouny Abdelfattah Bassiouny Faioud

TOPICS AND COMPETENCES

KEYWORDS: power system stability, wind and solar power copower system stability, wind and solar power connections, power quality, HVDC and FACTS, load modelling, relay protection, wide-area monitoring and control

Research activities in the group are focused on the development of control and protection algorithms and applications, and performing system analysis considering the challenges in modern and future power systems.

Key research areas: power system real-time control protection and analysis based on wide-area information with respect to HVDC and FACTS control, wind power integration, power quality and load modelling. Emphasis is on modern power systems where the level of generation through converters is increasing and consequently the level of system inertia is decreasing.

Other research activities are concentrated on the development and assessment of power quality mitigation methods in transmission and distribution systems considering the availability of modern compensation devices and wide-area information.

More information: *https://taltech.ee/en/power-systems-group*

IN 2025

- Algorithms for reducing the volume of power grid models were defined and developed, taking into account the addition of converter-based production units to the power systems.
- A framework for assessing the reserve market volumes of the Estonian and Baltic electricity systems was created.

- A novel approach and control algorithms were created for cooperation between industrial consumers and the power system within the framework of system services.
- A methodology for assessing and comparing the assets of network companies was further developed and mathematical approaches were developed for determining the actual state of the power switch.
- Principles for the operational control of the Estonian power system in disturbance operation were compiled.
- A methodology for cooperation between DC connections and synchronous machines in low-inertia power grid conditions was analyzed and developed.
- The challenges associated with large-scale connection of wind and solar energy and possible improvement solutions in the framework of the Estonian power system were analyzed and defined.

SELECTED PROJECTS

- TEM-TA134 "*Optimal and reliable control of power systems in the framework of large-scale renewable energy*" (2024–2028)
- LEEEE20087 "*Principles of risk-based asset management in future electricity systems*" (2020–2021)
- LEEEE25056 "*Modeling, testing and grid analysis of a Purtse energy storage system*" (2025–2026)

SELECTED PUBLICATIONS

Gupta, P.K.; Tuttelberg, K.; Kilter, J. (2025). Forecasting Corona Losses on High Voltage Transmission Lines Using Machine Learning. IEEE Transactions on Power Delivery, 40, 5, 2696–2705. DOI: 10.1109/TPWRD.2025.3593923.

Asefi, S.; Asefi, S.; Afshari, H.; Kilter, J.; Shayesteh, E.; Hilber, P.; Lindquist, T. (2025). Machine Learning-Based High-Voltage Circuit Breaker Defect Classification Utilizing Savitzky-Golay Filter. IEEE Transactions on Instrumentation and Measurement, 74, #3557009. DOI: 10.1109/TIM.2025.3604980.

Campos, N. M. D.; Sarnet, T.; Kilter, J. (2023). Novel Gramian-based Structure-preserving Model Order Reduction for Power Systems with High Penetration of Power Converters. IEEE Transactions on Power Systems, 38 (6), 5381–5391. DOI: 10.1109/TPWRS.2022.3228458.

DEPARTMENT OF ENERGY TECHNOLOGY

Director: Tenured Full Professor
ALAR KONIST,
alar.konist@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

32 Academic staff — Incl. 4 professors, 26 researchers

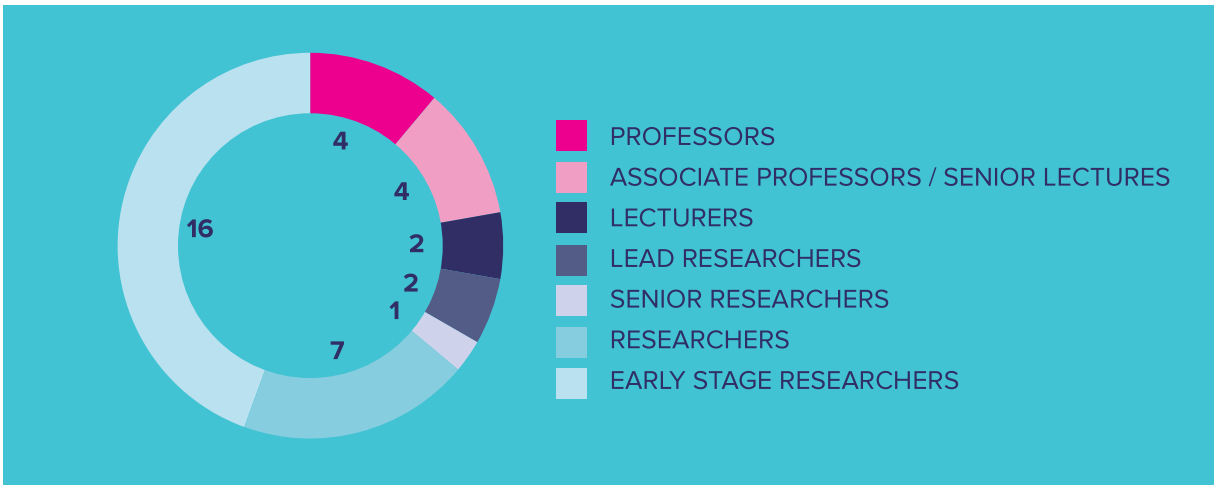
17 Doctoral students — 1 Defended doctoral dissertations

22 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 3 RESEARCH GROUPS:

- **LABORATORY OF FUEL AND AIR EMISSION ANALYSIS.**
  Head: Tenured Associate Professor OLIVER JÄRVIK, oliver.jarvik@taltech.ee
- **RESEARCH GROUP OF SUSTAINABLE ENERGY AND FUELS.**
  Head: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee
- **SMART DISTRICT HEATING SYSTEMS AND INTEGRATED ASSESSMENT ANALYSIS OF GREENHOUSE GASES EMISSIONS.**
  Head: Tenured Full Professor ANNA VOLKOVA, anna.volkova@taltech.ee



LABORATORY OF FUEL AND AIR EMISSION ANALYSIS

Head of the research group: Tenured Associate Professor OLIVER JÄRVIK, oliver.jarvik@taltech.ee

Members: Inna Kamenev, Jelena Veressinina, Mihkel Koel, Kristel Tanilas, Kadriann Tamm, Sven Kamenev, Liisi Blank

Doctoral students: Kati Roosalu, Nouman Rafique, Laura Kiolein

TOPICS AND COMPETENCES

KEYWORDS: thermodynamic properties, multicomponent mixtures, vapor pressure, correlations, pyrolysis, machine learning, fuel and ash analyses, environmental technologies

The group's work is focused on the studies of pyrolysis processes and the characterization of pyrolysis process inlet and outlet streams. This includes the measurement of composition and thermodynamic properties of pure organic compounds, mixtures, and pyrolysis oils (shale oil and bio-oil).

Additionally, there is a strong expertise in the studies of thermal behavior of solids and liquids (calorimetry and thermogravimetriy) and the parameters (molar mass distribution, rheological properties) and thermal stability of various mixtures of organic substances (oils, resins, polymers).

The group's activities are closely intertwined with the work of the Sustainable Energy and Fuels Research Group. There is also a strong collaboration with Virumaa College.

The group's recent research activities are related to the following topics:

- Determination and prediction of properties of ionic liquids and deep eutectic mixtures;
- Studies on CO_2 utilization;
- Studies on improving the quality of wastewater;
- Studies of pyrolysis and co-pyrolysis and gasification

SELECTED PROJECTS

- VEU25048 "*High-temperature thermal energy storage enabling a second life for existing fluidized bed boilers with a high efficiency*" (2025–2029)
- PRG1784 "*Sustainable and Effective Materials for Latent Heat Thermal Energy Storage Based on Amine Ionic Liquids*" (2023–2027)
- LEIEE23071 "*Determining the species composition and properties of the waste incinerated at the Iru power plant, as well as the CO2 emission*" (2023–2024)

SELECTED ARTICLES

Kaljusmaa, L.-M.; Tubli, D.; Adamson, J.; Konist, A.; Järvik, O. (2025). Thermal stability of amine and carboxylic acid based protic ionic liquids from the perspective of thermal energy storage. Journal of Molecular Liquids, 427, #127396. DOI: 10.1016/j.molliq.2025.127396.

Yang, D.; Tanilas, K.; Järvik, O.; Konist, A. (2025). Trace element quantification in solid fuel wastes by LA-ICP-MS: a review. Talanta, #128951. DOI: 10.1016/j.talanta.2025.128951.

Roosalu, K.; Kamenev, I.; Tanilas, K.; Reinik, J.; Jarvik, O. (2025). Trace elements in oil shale ashes and waste wood ashes and their leachability with a focus on chromium. Oil Shale, 42 (3), 273–290. DOI: 10.3176/oil.2025.3.02.

RESEARCH GROUP OF SUSTAINABLE ENERGY AND FUELS

Head of the research group: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee

Members: Dmitri Nešumajev, Tõnu Pihu, Janek Reinik, Alejandro Lyons Cerón, Mais Hanna Suleiman Baqain

Doctoral students: Mari Sinisalu-Sulg, Mari-Liis Ummik, Liisa-Maria Kaljusmaa, Fanfan Xu, Hannela Artus, Dan Yang

TOPICS AND COMPETENCES

KEYWORDS: fuels, combustion, pyrolysis, gasification, ash, activation energies, CO_2 emissions, CCS and CCU (inc. Oxyfuel)

Moving toward zero carbon emissions is an ultimate goal for energy technology. The group intends to tackle the problem by studying the possibilities of oxy-fuel co-combustion of oil shale (OS) and biomass in circulating fluidized bed (CFB) boiler. The proposed process will allow for the reduction of hazardous waste ash products, in addition to emissions, which have so far been generated annually in the amount of approximately six million tons. One of the most important topics the research group is dealing with is the investigation of the possibilities of using carbon capture and storage or utilization, or so-called CCUS technologies. The main goal is to investigate whether, by applying the conditions of oxygen and CO_2 combustion, it is possible to achieve a CO_2 flow of sufficient purity that could be removed from the energy production cycle in order to achieve climate neutrality.

In addition, the group deals with better characterization of fly ash, in order to enable more effective use of the ash that is formed under oxyfuel combustion conditions. The "organic and in-organic" (carbon) portion of the ash is the key to success in many new utilization schemes.

A broad-based scientific investigation of the form, sorptive properties and behaviour of the inorganic/organic material in ash samples is carried out in order to help identify new commercial opportunities.

The accredited laboratory group provides accredited sample analyses for various customers.

SELECTED PROJECTS

- TEM-TA73 "*Refinement of oil shale into raw materials for industries*" (2024–2028)
- VEU23060 "*Cyber-Physical systems and digital twins for the decarbonisation of energy-intensive industries*" (2023–2027)
- LEIEE23037 "*Ambient air emissions measurements at production units located on the territory of Enefit Power AS*" (2023–2025)

SELECTED PUBLICATIONS

Xu, F.; Neshumayev, D.; Konist, A.; (2025). Synthesis strategies and hydrogen storage performance of porous carbon materials derived from bio-oil. Chemical Engineering Journal, 505, #159381. DOI: 10.1016/j.cej.2025.159381.

Yang, D.; Tanilas, K.; Konist, A.; Järvik, O. (2025). Evaluating LA-ICP-MS and digestion-based ICP-MS methods for trace elements determination in oil shale and its solid wastes. Talanta, 295, #128319. DOI: 10.1016/j.talanta.2025.128319.

Xu, F.; Nešumajev, D.; Konist, A.; (2025). Thermal decomposition behaviors and kinetic parameter calculations during common reed and its components pyrolysis. Renewable Energy, 248, #123130. DOI: 10.1016/j.renene.2025.123130.

SMART DISTRICT HEATING SYSTEMS AND INTEGRATED ASSESSMENT ANALYSIS OF GREENHOUSE GASES EMISSIONS

Head of the research group: Tenured Full Professor ANNA VOLKOVA, anna.volkova@taltech.ee

Members: Eduard Latõšov, Andrei Dedov, Igor Krupenski, Aleksandr Hlebnikov, Srenath Sukumaran, Kertu Lepiksaar, Inge Roos

Postdoctoral Researcher: Sylvester Ikenna Ofili

Doctoral student: Hesham Ali, Janika Laht, Mohd Basit Wani, Siim Erik Pugal, Dabrel Prits, Tanel Kirs, Janita Andrijevskaja

TOPICS AND COMPETENCES

KEYWORDS: 4th generation district heating, district cooling low temperature district heating, primary energy factors, CO_2 emissions, thermal energy storage, CHP, (cogeneration of heat and power), large heat pumps, LCA, carbon footprint, cold storage

The group deals with: (1) the development of new technical solutions for the transition of district heating (DH) systems towards an intelligent, highly efficient and regenerative energy supply concept and (2) integrated assessment analysis of greenhouse gas emissions.

The group's recent research activities are connected with the analysis of:

- The heat supply option of a low temperature district heating network from the return line of a well-established high temperature district heating system.
- The impact of return temperature reduction on a high temperature district heating system.
- Monitoring the Energy Efficiency Pillar for Climate Neutrality.

- Existing large-scale DH system transition towards 4th generation DH.
- 5th generation district heating.
- Seawater based district cooling.
- Use of solar energy in district heating.
- Integration of large heat pumps into DH systems.
- Use of residual heat in district heating and cooling.
- CO_2 emissions from district heating.

SELECTED PROJECTS

- PRG2701 "*Next-Generation District Heating: Enhancing Sustainability through Multi-Level Energy Cascades and Decentralised Renewable Energy Sources*" (2025–2029)
- VIR25004 "*Local Heat Planning – Achieving the heat transition in BSR municipalities*" (2025–2028)
- VERT24071 "*Green and Digital Skills for Smart District Heating and Cooling Networks*" (2025–2028)

SELECTED PUBLICATIONS

Ali, H.; Hlebnikov, A.; Pakere, I.; Volkova, A. (2024). An evaluation and innovative coupling of seawater heat pumps in district heating networks. Energy, 312, #133461. DOI: 10.1016/j.energy.2024.133461.

Lepiksaar, K.; Kajandi, G.-M.; Sukumaran, S.; Krupenski, I.; Kirs, T.; Volkova, A. (2024). Optimizing Solar Energy Integration in Tallinn's District Heating and Cooling Systems. Smart Energy, #100166. DOI: 10.1016/j.segy.2024.100166.

Ali, H.; Dedov, A.; Volkova, A. (2024). Exploring Heat Demand Forecasting in District Heating Networks Using Random Parameter Linear Regression Model. Environmental and Climate Technologies, 28, 1, 670–685. DOI: 10.2478/rtuect-2024-0052.

DEPARTMENT OF MATERIALS AND ENVIRONMENTAL TECHNOLOGY

Director: Tenured Full Professor
MAARJA GROSSBERG-KUUSK,
maarja.grossberg@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

86 Academic staff — Incl. 12 professors, 67 researchers

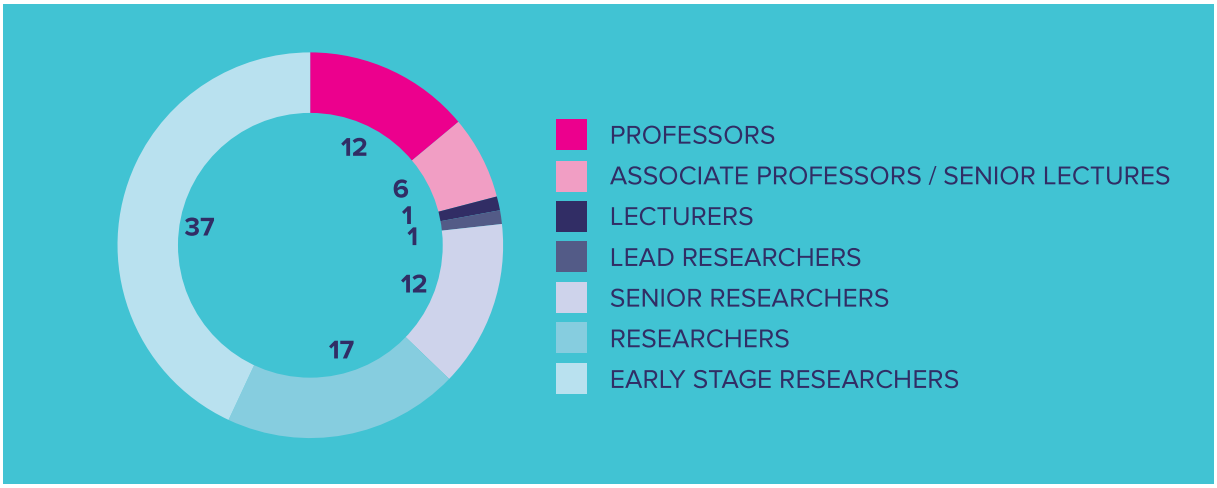
45 Doctoral students — 6 Defended doctoral dissertations

50 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 8 RESEARCH GROUPS:

- **LABORATORY OF BIOFUNCTIONAL MATERIALS.**
  Head: Lead Research Scientist VITALI SÕRITSKI, vitali.syritski@taltech.ee
- **LABORATORY OF BIOPOLYMER TECHNOLOGY.**
  Head: Researcher-Professor ANDRES KRUMME, andres.krumme@taltech.ee
- **LABORATORY OF ENVIRONMENTAL TECHNOLOGY.**
  Head: Tenured Full Professor SERGEI PREIS, sergei.preis@taltech.ee
- **LABORATORY OF INORGANIC MATERIALS.**
  Head: Tenured Full Professor ANDRES TRIKKEL, andres.trikkel@taltech.ee
- **LABORATORY OF PHOTOVOLTAIC MATERIALS.**
  Head: Tenured Associate Professor MARIT KAUK-KUUSIK, marit.kauk-kuusik@taltech.ee
- **LABORATORY OF TEXTILE TECHNOLOGY.**
  Head: Associate Professor TIIA PLAMUS, tiia.plamus@taltech.ee
- **LABORATORY FOR THIN FILM ENERGY MATERIALS.**
  Head: Tenured Full Professor ILONA OJA ACIK, ilona.oja@taltech.ee
- **LABORATORY OF WOOD TECHNOLOGY.**
  Head: Tenured Associate Professor JAAN KERS, jaan.kers@taltech.ee



LABORATORY OF BIOFUNCTIONAL MATERIALS

Head of the Laboratory: Lead Research Scientist VITALI SÕRITSKI, vitali.syritski@taltech.ee

Members: Jekaterina Reut, Roman Borozņjak, Akinrinade George Ayankojo, Anna Kidakova

Doctoral students: Vu Bao Chau Nguyen, Prachi Madan Garade

TOPICS AND COMPETENCES

KEYWORDS: Molecularly Imprinted Polymers, synthetic receptors, chemical sensors, medical diagnostics, PoCT, environmental monitoring, COVID-19 express test

The group develops smart biosensing functional materials to propose solutions with considerable potential impact on essential areas of human life such as environmental protection and medical diagnostics. By employing the molecular imprinting technology, the group designs and synthesizes polymeric materials so called Molecularly Imprinted Polymers (MIP). The main benefits of MIPs is related to their synthetic nature, i.e. excellent chemical and thermal stability associated with reproducible, cost-effective fabrication. MIPs can be easily integrated with a variety of sensor platforms including piezogravimetric, optical and electrochemical transducers and allowing label-free detection of a target analyte with high sensitivity and selectivity. The group has successfully developed sensors targeting clinically relevant analytes, including immunoglobulin G; neurotrophic factors (BDNF, CDNF); viral and disease-related proteins (SARS-CoV-2 nucleocapsid and spike proteins, hepatitis C antigen); hormones (cortisol); as well as environmental water pollutants such as antibiotics and fungicides (sulfamethizole, amoxicillin, erythromycin, azoxystrobin).

IN 2025

Electrochemical sensors employing molecularly imprinted polymers (MIPs) as selective recognition layers and ruthenium oxide (RuO_2) electrodes as transducers were successfully developed for the detection of protein and hormone biomarkers in biological samples:

- A cortisol-selective sensor was demonstrated to reliably detect cortisol in real human saliva within physiologically relevant concentration ranges, confirming the applicability of the sensing platform for non-invasive biomarker analysis. The obtained results are currently being prepared for submission as a patent application.
- Using an epitope imprinting strategy, a peptide-imprinted polymer (peptide-MIP) was developed for the selective recognition of growth differentiation factor-15 (GDF-15), a clinically relevant prognostic biomarker. The peptide-MIP was successfully integrated onto a RuO_2 electrode to form an electrochemical sensor and was validated in real biological matrices, including mouse and human serum. This study was conducted in close cooperation with the Institute of Biotechnology, University of Helsinki.

Overall, the developed sensing systems enable fast, simple, and cost-effective biomarker detection in complex biological samples, while demonstrating robust and reproducible performance with strong potential for point-of-care applications.

More information: *https://taltech.ee/en/laboratory-biofunctional-materials*

SELECTED PROJECTS

- PRG2113 "*Biomimetic Polymeric Receptors Integrated with Multi-sensor Systems for Low-cost and Fast Analysis of Complex Environments*" (2024–2028)
- TK218 "*Estonian Center of Excellence of Well-Being Science*" (2024–2030)

SELECTED PUBLICATIONS

Chau Nguyen, V. B.; Reut, J.; Ayankojo, A. G.; Syritski, V. (2025). Direct electrochemical sensing of ampicillin in aqueous media by a ruthenium oxide electrode decorated with a molecularly imprinted polymer. Talanta, 287, #127580. DOI: 10.1016/j.talanta.2025.127580.

Ayankojo, A. G.; Reut, J.; Borozņjak, R.; Syritski, V. (2025). Ruthenium oxide electrode integrated with molecularly imprinted polymer for direct electrochemical sensing of a neurotrophic factor protein. Sensors and Actuators B: Chemical, 429, 137301. DOI: 10.1016/j.snb.2025.137301.

Ayankojo, A. G.; Borozņjak, R.; Reut, J.; Tuvikene, J.; Timmusk, T.; Syritski, V. (2023). Electrochemical sensor based on molecularly imprinted polymer for rapid quantitative detection of brain-derived neurotrophic factor. Sensors and Actuators B: Chemical, 397, #134656. DOI: 10.1016/j.snb.2023.134656.

LABORATORY OF BIOPOLYMER TECHNOLOGY

Head of the Laboratory: Researcher-Professor ANDRES KRUMME, andres.krumme@taltech.ee

Members: Elvira Tarasova, Natalja Savest, Illia Krasnou, Omar Parve, Jaan Parve

Doctoral students: Anna Ilnitskaja, Gretel Brus, Aysha Siddika

TOPICS AND COMPETENCES

KEYWORDS: polymers, biopolymers, derivatives of cellulose, polymer technology, polymeric composites, reactive extrusion, textile, electrospinning, nanofibres, conductive polymers, supercapacitors, filtering materials

The main focus of the research of the laboratory is valorization of environmental resources and development of new energy storage methods for energy efficient environments. The goal is to find sustainable alternatives for fossil resources based polymeric materials by more efficient utilisation of biopolymers and recycled materials in commodity products and in specific fields.

Innovative options for the sustainable recovery of cellulose are being sought through the use of new, reusable solvent media, bio-based chemical modification reagents and energy-saving technologies. New, distillable ionic liquids are used as solvents. The use of plant oils for cellulose esterification is being studied and reactive extrusion technology is being developed. The laboratory is the only one in Estonia capable of pilot production by electrospinning technology.

The electrospinning technology is also applied for developing filter materials based on cellulose derivatives and containing antiviral agents, which prolong their life and make them carbon neutral.

The laboratory has a unique pilot production capability in Estonia in such important areas of polymer / plastics technology as compounding, extrusion and injection molding. Composites of thermoplastic and thermosetting polymers with inorganic or bio-based additives are being developed for the efficient use of secondary raw materials in the circular economy.

Properties of textile fibres obtained by different recycling methods are being explored and their suitability for manufacturing different types of (textile) materials is being studied. Producing nonwoven materials with recycled textile fibres and thermoplastic virgin fibres is the main method explored. The laboratory also develops durable and sustainable textile and clothing materials.

More information:
https://biopolymer.taltech.ee/en/

IN 2025: Development of the reactive extrusion process: Initial modeling of the process was carried out using the special software "Ludovic". The optimal cellulose concentrations in the reaction mixtures and the rheological properties of the reaction mixtures were clarified.

Possibilities for developing solvent environments were studied.

Development of separation processes was continued. A significant part of the work focused on investigating the recycling of ionic liquids specifically designed for dissolving cellulose.

Applied research on new cellulose-based bioplastics was initiated, testing the suitability of these materials for paper lamination and electrospinning.

SELECTED PROJECT

- TEM-TA103 "*New biomaterials made by reactive extrusion from cellulose and by-products of vegetable oil production*" (2024–2028)

LABORATORY OF ENVIRONMENTAL TECHNOLOGY

Head of the Laboratory: Tenured Full Professor SERGEI PREIS, sergei.preis@taltech.ee
Members: Niina Dulova, Marina Kritševskaja, Juri Bolobajev, Eneliis Kattel, Priit Tikker
Doctoral students: Kristen Altof, Irina Petrotšenko, Daniel Anselm Teittinen

TOPICS AND COMPETENCES

KEYWORDS: environmental technology, water treatment, air cleaning, soil cleaning, advanced oxidation processes, pulsed corona discharge plasma, catalytic and photocatalytic processes

The research group is competent in solving environmental technology problems, including water treatment, air and soil cleaning by using advanced oxidation processes, pulsed corona discharge plasma, catalytic and photocatalytic processes. The processes under investigation have great potential for the removal of persistent pollutants and micropollutants from water, contaminated soils and exhaust gases. Air treatment with corona pulsed electric discharge plasma as a highly energy-efficient cleaning process is applied to destroy microorgan-isms, including viruses, and to degrade volatile organic compounds.

More information: *https://taltech.ee/en/laboratory-environmental-technology*

IN 2025

The group considers one of its major achievements to be the development of a method for applying pulsed electrical corona discharge to the selective oxidation of pharmaceutical substances in human urine, with the aim of using it in the production of fertilizer for agricultural applications. To date, no similar technologies exist anywhere in the world. The results of the work have been published.

SELECTED PROJECT

- ETAG22018 "*Utilization of Aluminium-Bearing Raw Materials for the Production of Aluminium Metal, Other Metals and Compounds*" (2022–2025)
- VIR23025 "*Stormwater purification with construction and demolition waste*" (2023–2026)
- TF24021EK2 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)

SELECTED PUBLICATIONS

Altof, K.; Krichevskaja, M.; Preis, S.; Bolobajev, J. (2025). Advanced oxidation of airborne m-xylene in combination of pulsed corona discharge and post-plasma photocatalysis. Journal of Electrostatics, 138, #104104. DOI: 10.1016/j.elstat.2025.104184.

Teittinen, D. A.; Preis, S.; Bolobajev, J. (2025). Upscaling of Toluene Oxidation Using Water-Sprinkled Pulsed Corona Discharge and Photocatalysis. Processes, 13 (9), #2982. DOI: 10.3390/pr13092982.

Tan, Z.; Chen, W.; Wei, X.; Qiu, Z.; Zhuang, W.; Zhang, B.; Xie, J.; Lin, Y.; Ren, Y.; Preis, S.; Wei, C.; Zhu, S. (2025). Virus-bacterium interaction involved in element cycles in biological treatment of coking wastewater. Bioresource Technology, 416, #131839. DOI: 10.1016/j.biortech.2024.131839.

LABORATORY OF INORGANIC MATERIALS

Head of the Laboratory: Tenured Full Professor ANDRES TRIKKEL, andres.trikkel@taltech.ee

Members: Tiit Kaljuvee, Kaia Tõnsuaadu, Mai Uibu, Can Rüstü Yörük, Mustafa Cem Usta, Marve Einard

Doctoral students: Ruhany Sheherazad Azeez, Eliise-Koidula Kivimäe, Adheena Thomas, Ademola Michael Adegbile, Krevon Alet-Märtson

TOPICS AND COMPETENCES

KEYWORDS: phosphorite, graptolite-argillite, oil shale ash, precipitated calcium carbonate, GHG, thermal analysis

The activities of the laboratory are focused on three priority directions:

- Expanding the resource base of critical raw materials with basic and applied research for the development of new sustainable methods for the valorisation of Estonian phosphorite and as-sociated minerals (graptoliteargillite) – for the selective separation of valuable components such as phosphorus, vanadium and rare earths;
- Reducing greenhouse gas emissions which is one of the key objectives of the green turn, in-cluding development of chemical-technological bases of accelerated carbonation processes for alkaline industrial wastes (oil shale ash, clinker dust) as well as oxy-fuel combustion of fuels as a promising method for CO_2 capture. The possible applications are aimed to make construction materials together with simultaneous binding of CO_2;
- Applied research to reuse oil shale ash for the production of a valuable product – precipitated calcium carbonate – on an industrial scale with the possibly complete utilization of the generated residues.

The research group is part of the *Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources* and leads the sub-theme of strategic minerals. The aim of the research is to consolidate Estonia's research potential for the development and implementation of new innovative solutions for the valorization of secondary and primary mineral resources and to train the next generation of highly qualified researchers in this field. The main objectives are to increase resource efficiency, maximize the use of local resources, promote safe material circulation and recycling, and minimize the demand for new natural resources.

More information: *https://taltech.ee/en/laboratory-inorganic-materials*

SELECTED PROJECTS

- PRG1779 "*Phosphorus Fertilisers and Rare Metals from Estonian Phosphorite in a Waste-Free Way*" (2023–2027)
- TEM-TA87 "*Complex recovery of mineral mining and industrial waste as secondary raw material in the context of eco-conscious building materials and hydrometallurgy*" (2024–2028)
- TEM-TA100 "*Variability of Properties of Associated Resources of Shelly Phosphorite and Opportunities for Beneficiation*" (2024–2028)

SELECTED PUBLICATIONS

Thomas, A.; Yörük, C. R.; Usta, M. C.; Pantšenko, N.-L.; Hain, T.; Uibu, M.; Trikkel, A. (2025). Developing Mineral Foam Blocks from Oil Shale Byproducts through Accelerated Carbonation. ACS Omega, 10 (40), 47051−47064. DOI: 10.1021/acsomega.5c05438.

Azeez, R. S.; Tõnsuaadu, K.; Einard, M.; Kaljuvee, T.; Trikkel, A. (2025). Dissolution kinetics of rare earth elements from Estonian phosphate rock using hydrochloric acid treatment. Minerals Engineering, 233, #109641. DOI: 10.1016/j.mineng.2025.109641.

Kivimäe, E.-K.; Tõnsuaadu, K.; Kaljuvee, T.; Kallaste, T.; Trikkel, A. (2025). Effect of calcination of Estonian black shale on the solubility of metallic elements in sulfuric acid environment. Journal of Thermal Analysis and Calorimetry. DOI: 10.1007/s10973-025-15121-8.

LABORATORY OF PHOTOVOLTAIC MATERIALS

Head of the Laboratory: Tenured Associate Professor MARIT KAUK-KUUSIK, marit.kauk-kuusik@taltech.ee

Members: Sergei Bereznev, Mati Danilson, Maarja Grossberg-Kuusk, Reelika Kaupmees, Jüri Krustok, Valdek-Mikli, Katri Muska, Maris Pilvet, Taavi Raadik, Kristi Timmo, Mare Altosaar, Jaan Raudoja

Doctoral students: Marc Dolcet Sadurni, Katriin Reedo, Idil Mengü, Elizaveta Shmagina, Nafiseh Abbasi, Marc Vincent Heemskerk, Achmad Nasyori, Liisa Kumar, Mia-Maria Meldorf

TOPICS AND COMPETENCES

KEYWORDS: Environmentally friendly energy materials, solar energy and photovoltaic device technologies, semiconductor materials and thin films, optical and electrical characterization of materials and devices

The research activities of the Laboratory are focused on the development of solar energy and photovoltaic device technologies based on environmentally friendly inorganic semiconductor materials, including the development of various integrated solutions (BIPV, PIPV). The group possesses world-class technological competence in the synthesis of multicomponent absorber materials, targeted control of chemical composition and defect structure, and the development of scalable technological processes, including those applicable under ambient air conditions. The research group has strong and long-standing experience in the fabrication of nano- and microscale metal, metal oxide, and chalcogenide thin-film coatings using both physical and chemical deposition methods. In addition, the group has high-level expertise in the investigation of the fundamental optical and electrical properties of optoelectronic materials and devices (including solar cells, light-emitting diodes, lasers, and sensors), encompassing the analysis of defects, electronic transitions, and phase transitions.

IN 2025, the research activities of the group resulted in several internationally outstanding achievements in the fields of semiconductor materials and photovoltaics:Luminescence studies demonstrated that cadmium doping of Sb_2Se_3 thin films and single crystals creates a shallow acceptor defect with an ionization energy of 22 meV, enabling a significant increase in hole concentration and improved electrical properties of the material.

A major breakthrough was achieved in understanding and implementing the phosphorus doping mechanism in FeS_2 (pyrite). Scalable p-type doping was demonstrated via incorporation of the FeP_4 compound into the pyrite crystal structure during growth.

A comprehensive photoluminescence analysis of Cu_2GeS_3 microcrystals was carried out under pulsed and continuous-wave excitation to investigate the optical properties and defect structure of this promising material for indoor PV applications.

High-quality $Sb_{1-x}Bi_xSeI$ microcrystals covering the full compositional range were successfully synthesized using a solid-state method. For the first time, the bandgap evolution across the entire series was determined and an experimental band diagram was constructed, revealing a significant shift of the valence band maximum and a composition-driven conductivity type transition from p-type to n-type. These results are highly relevant for the design of optoelectronic and photovoltaic interfaces and highlight the potential of specific compositions for both single-junction and multi-junction solar cell applications.

More information: *https://taltech.ee/en/laboratory-photovoltaic-materials*

SELECTED PROJECTS

- PRG1815 "*Next Generation Microcrystalline Pyrite Solar Cell for Terrestrial and Extraterrestrial Applications*" (2023–2027)
- TF24020 "*GREENTECH*" (2024–2030)
- PRG1023 "*Sustainable, cost-efficient, flexible, lightweight and semitransparent multinary chalcogenide based solar cells for building integrated photovoltaics*" (2021–2025)

SELECTED PUBLICATIONS

Nasyori, A.; Pilvet, M.; Saar, A.; Krustok, J.; Danilson, M.; Kaupmees, R.; Mikli, V.; Gong, Y.; Josepson, R.; Saucedo, E.; Grossberg, M.; Kauk-Kuusik, M. (2025). In Ambient Air Processed Cu2ZnSnS4 Absorber Layers from DMSO-Based Precursors: Enhanced Efficiency via Device Post-annealing. Journal of Materials Chemistry A, 13, 30167. DOI: 10.1039/d5ta04554a.

Reedo, K.; Raadik, T.; Altosaar, M.; Pilvet, M.; Gutjuma, A.; Krustok, J.; Paaver, P. (2025). Scalable Phosphorus Doping of p-Type FeS₂ Microcrystals for Photovoltaic Applications. ACS Omega, 10 (48), 58869−58876. DOI: 10.1021/acsomega.5c07455.

Dolcet Sadurni, M.; Timmo, K.; Mikli, V.; Krustok, J.; Danilson, M.; Suchodolskis, A.; Radu, C.; Bocirnea, A.E.; Galca, A.C.; Grossberg-Kuusk, M.; Kauk-Kuusik, M. (2025). Effects of cationic substitution on the properties of Sb1-xBixSeI (x = 0–1) compounds. Journal of Alloys and Compounds, 1037, #182292. DOI: 10.1016/j.jallcom.2025.182292.

LABORATORY OF TEXTILE TECHNOLOGY

Head of the Laboratory: Associate Professor TIIA PLAMUS, tiia.plamus@taltech.ee

Member: Laura Kuningas

Doctoral students: Md Toufiqur Rahman, Katre Worth, Diana Tuulik, Md Arifur Rahman

TOPICS AND COMPETENCES

KEYWORDS: textile materials; recycling of textile materials; circular economy; reuse; technical design of apparel and textile products

The group's scientific activities are related with the following fields:

- circular economy in textile and clothing field;
- developing composite and textile materials from mechanically recycled textile fibres;
- exploring physico-mechanical properties of textile and clothing materials;
- developing textile products, apparel and protective clothing;
- exploring novel processing methods of textile materials (laser cutting, digital printing etc.).

More information: *https://taltech.ee/en/laboratory-of-textile-technology*

SELECTED PROJECTS

- TF24021EK2 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)
- LITEE24096 "*Development of a measurement methodology of LWIR range shielding efectiveness and a shielding material prototype*" (2024–2025)

SELECTED PUBLICATIONS

Mäe, T.; Plamus,T.; Majak, J.; Karunanidhi, R.; Rahman, M. T. (2023). Application of HOHWM Based Function Approximation Algorithms in Engineering Design. International Conference on Numerical Analysis and Applied Mathematics 2021: ICNAAM-2021, Rhodes, Greece, 20–26 September 2021. AIP Publishing, 250003. (AIP Conference Proceedings; 2849/1). DOI: 10.1063/5.0162255.

Mandre, N.; Plamus, T.; Linder, A.; Varjas, T.; Majak, J.; Krumme, A. (2023). Design of Performance Characteristics on Laser Treated Denim Fabric. Materials Science, 29 (4), 515–524. DOI: 10.5755/j02.ms.33259.

Mandre, N.; Plamus, T.; Linder, A.; Krumme A.; Rohumaa, A. (2023). Impact of laser fading on physico-mechanical properties and fibre morphology of multicomponent denim fabrics. Proceedings of the Estonian Academy of Sciences, 72 (2), 145–153. DOI: 10.3176/proc.2023.2.05.

LABORATORY FOR THIN FILM ENERGY MATERIALS

Head of the research group: Tenured Full Professor ILONA OJA ACIK, ilona.oja@taltech.ee

Members: Malle Krunks, Tatjana Dedova, Maciej Sibiński, Nicolae Spalatu, Atanas Katerski, Merike Kriisa, Robert Krautmann, Jekaterina Sydorenko, Arvo Mere

Postdoctoral Researchers: Daria Miliaieva, Christopher Howard Don, Dumitru Untila, Omoboyede Femi Igbari, Thanh Tai Nguyen

Doctoral students: Sajeesh Vadakkedath Gopi, Mykhailo Koltsov, Ernest Adiyiah Asare, Hadeer Hussien Ahmed Hussien Saleh, Athulya Babu Suseela, Paula Eda Stoicescu

TOPICS AND COMPETENCES

KEYWORDS: solar cells, thin films, photocatalytic coatings

The key competences of the Laboratory for Thin Film Energy Materials are:

- Development of metal oxide and chalcogenide thin films and nanostructures by cost-effective chemical and vacuum based technologies.
- Development of solar cells.
- Development of photocatalytic coatings.

IN 2025

- As an innovation, an ultrathin ZnO interfacial layer was introduced into the FTO/TiO_2-ETL/Sb_2S_3/P3HT-HTL/Au solar cell structure to modify the TiO_2/Sb_2S_3 interface. As a result, the grain size of the absorber layer increased and recombination losses at the interface were reduced. The efficiency of devices incorporating the ZnO interfacial layer under standard illumination conditions (AM 1.5G, 100 W/cm²) increased to 7.5%, and under low light intensities to 18%, while using an ultrathin 150 nm thick absorber layer. The measured efficiencies are higher than those previously reported for comparable devices based on Sb_2S_3 absorbers.
- Within the physical vapour deposition (PVD) platform, we developed a processing methodology for vapor transport deposition (VTD) that enables compact and uniform Sb_2Se_3 absorber layers and high-quality CdS/Sb_2Se_3 heterojunctions. By controlling growth kinetics and interface chemistry, solar cell efficiencies of up to 5% were achieved, accompanied by reduced recombination losses. The results provide scalable process and materials design guidelines for next-generation chalcogenide thin-film photovoltaics.

More information: *https://taltech.ee/en/laboratory-thin-film-energy-materials*

SELECTED PROJECTS

- VFP20035 "*ERA chair of emerging next-generation photovoltaics*" (2020–2026)
- PRG627 "*Antimony chalcogenide thin films for next-generation semi-transparent solar cells applicable in electricity producing windows*" (2020–2024)
- TF24020EK "*GREENTECH*" (2024–2030)

SELECTED PUBLICATIONS

Gopi, S. V.; Krautmann, R.; Katerski, A.; Josepson, R.; Untila, D.; Hiie, J.; Krunks, M.; Acik, I.; Spalatu, N. (2025). Optimization of VTD Sb₂Se₃ absorber growth rate in CdS/Sb₂Se₃ thin film solar cells: A defect perspective on chloride vs non-chloride based devices. Solar Energy Materials and Solar Cells, 293, #113856. DOI: 10.1016/j.solmat.2025.113856.

Asare, E. A.; Katerski, A.; Kriisa, M.; Josepson, R.; Rotaru, V.; Guc, M.; Payno Zarceño, D.; Navarro-Güell, A.; Grzibovskis, R.; Vembris, A.; Pérez-Rodríguez, A.; Saucedo, E.; Spalatu, N.; Krunks, M.; Oja Acik, I. (2025). Influence of Sulfur Source on Growth of In-Air Sprayed Ultrathin Film Sb2S3 for Enhanced Solar Cell Performance. ACS Applied Materials & Interfaces, 17, 47, 64753−64770. DOI: 10.1021/acsami.5c17869.

Dedova, T.; Krautmann, R.; Rusu, M.; Katerski, A.; Krunks, M.; Unold, T.; Spalatu, N.; Mere, A.; Sydorenko, J.; Sibiński, M.; Acik, I. Oja (2025). Sb2S3 solar cells with TiO2 electron transporting layers synthesized by ALD and USP methods. Solar Energy Materials and Solar Cells, 280, #113279. DOI: 10.1016/j.solmat.2024.113279.

LABORATORY OF WOOD TECHNOLOGY

Head of the Laboratory: Tenured Associate Professor JAAN KERS, jaan.kers@taltech.ee

Members: Triinu Poltimäe, Heikko Kallakas, Karmo Kiiman, Anti Rohumaa, Percy Festus Alao, Margus Kangur, Loretta Kalju, Joonas Lauri Hakonen. Tolgay Akkurt

Doctoral students: Catherine Kilumets, Tanuj Kattamanchi, Paula Eda Stoicescu, Laura Kaljula, Eldwin Maidiono, Ignatius Kristia Adikurnia, Jie Li, Maarja Mirjam Rajasaar, Sandra Rose Biby, Silvi Treial

TOPICS AND COMPETENCES

KEYWORDS: veneer, plywood, wood-polymer composites, agro-crop and natural fibre composites, fire resitance, bio-based adhesives testing, furniture and upholstery furniture products development and testing

The Laboratory of Wood Technology investigates the possibilities for using the low-quality hardwood species in veneer and veneer based products by evaluating the impact of surface properties, quality to the bond strength development.

In collaboration with nearly zero energy buildings research group, hygrothermal criteria were developed for using cross-laminated timber (CLT) panels in the design and construction of wooden buildings (PhD thesis of Villu Kukk). Within the framework of the *WoodLCC* project, the impact of moisture content and temperature to crack formation in CLT panels is investigated.

Development of biocomposites and green composites from natural fiber and agro-crop (hemp fibres and reed) is also an important part of the research work of the laboratory.

Due to the areas of use, it is important to increase the fire-safety properties of biocomposite materials, which is being studied in collaboration with the Structural Engineering Research Group.

In collaboration with the Laboratory of Polymer and Textile Technology, novel thermoplastic cellulose materials for further packaging applications are developed.

IN 2025: Research results demonstrated that aspen and black alder are viable alternatives to birch in multilayer wood composites. High quality plywood can be produced from lower grade hardwoods by optimizing veneer densification parameters.

In parallel, studies addressed two key challenges in plywood production: flammability and formaldehyde emissions.

More information: *https://taltech.ee/en/laboratory-wood-technology*

SELECTED PROJECT

- TEM-TA139 "*Bio-based sustainable and fire-resistant composite materials developed from secondary raw materials*" (2024–2028)
- MNKE22048 "*The possibilities of using Estonian underutilized wood species in new veneer-based products*" (2022–2024)
- MNKE22024 "*WoodLCC – Enhanced Life-Cycle-Costing in wood construction by novel methods for service life planning*" (2022–2025)

SELECTED PUBLICATIONS

Alao, P.; Rohumaa, A.; Dembovski, K.H.; Ruponen, J.; Kallakas, H.; Kers, J. (2025). Effect of Aspen Face Veneer Thickness on the Fire Performance of Post-Manufacture Fire-Retardant Treated Birch Plywood. Proceedings of the 11th European Conference on Wood Modification: (ECWM 2024). Firenze, Italy, April 15-16, 2024. Cham: Springer, 165–172. (Springer Proceedings in Materials; 86). DOI: 10.1007/978-3-031-99418-0_21.

Kilumets, C.; Kallakas, H.; Ralph, S.; Zhu, J.Y.; Hunt, C.G.; Rohumaa, A.; Kers, J. (2024). Effect of lignin on veneer densification and set-recovery. Construction and Building Materials, 451, #138795. DOI: 10.1016/j.conbuildmat.2024.138795.

Akkurt, T.; Rohumaa, A.; Kers, J. (2025). Effective Wood Veneer Densification by Optimizing Key Parameters: Temperature, Equilibrium Moisture Content, and Pressure. Forests, 16 (6), #969. DOI: 10.3390/f16060969.

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

Director: Tenured Full Professor
KRISTO KARJUST,
kristo.karjust@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

74 Academic staff — Incl. 13 professors, 47 researchers

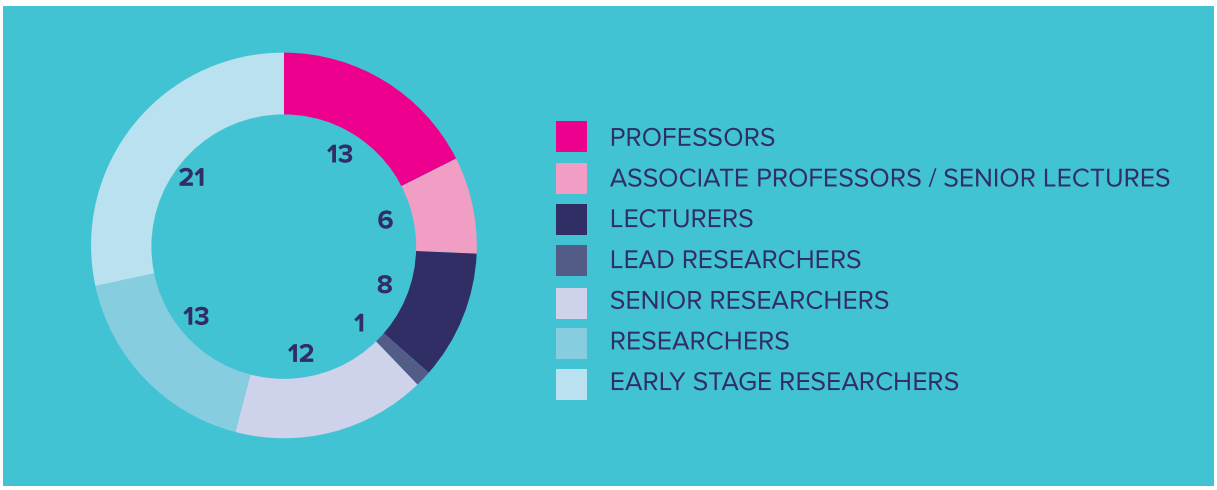
39 Doctoral students — 3 Defended doctoral dissertations

127 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 8 RESEARCH GROUPS:

- **ADDITIVE MANUFACTURING TECHNOLOGIES.**
  Head: Tenured Full Professor PRASHANTH KONDA GOKULDOSS, prashanth.konda@taltech.ee
- **ADVANCED STRUCTURES AND PRODUCTS.**
  Head: Tenured Full Professor JÜRI MAJAK, juri.majak@taltech.ee
- **AUTOMATED PRODUCTION SYSTEMS AND REAL-TIME MONITORING AND AI MODELS.**
  Head: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee
- **ROBOTICS AND AUTONOMOUS VEHICLES.**
  Head: Tenured Associate Professor RAIVO SELL, raivo.sell@taltech.ee
- **INNOVATIVE SYSTEMS FOR INDUSTRIAL APPLICATIONS.**
  Head: Tenured Full Professor IRINA HUSSAINOVA, irina.hussainova@taltech.ee
- **LOGISTICS AND TRANSPORT.**
  Head: Senior Researcher DAGO ANTOV, dago.antov@taltech.ee
- **SMART INDUSTRY.**
  Head: Tenured Full Professor TAUNO OTTO, tauno.otto@taltech.ee
- **WEAR RESISTANT COMPOSITES AND COATINGS.**
  Head: Senior Researcher JAKOB KÜBARSEPP, jakob.kubarsepp@taltech.ee



ADDITIVE MANUFACTURING TECHNOLOGIES

Head of the research group: Tenured Full Professor PRASHANTH KONDA GOKULDOSS, prashanth.konda@taltech.ee

Members: Lauri Kollo, Sokkalingam Rathinavelu, Ramin Rahmani Ahranjani

Doctoral students: Javad Karimi, Navid Alinejadian

TOPICS AND COMPETENCES

KEYWORDS: aadditive manufacturing, powder metallurgy, solidification, meta-stable materials, amorphous alloys, high entropy alloys, high temperature materials, light metals, biomaterials and mechanical properties

The research topics of the group are:

(1) Alloy design for additive manufacturing;

(2) Pre-mature failure in additively manufactured materials;

(3) Powder metallurgy of high entropy alloys for extreme environments;

(4) Processing of functional materials by additive manufacturing.

More information: *https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29781*

SELECTED PROJECT

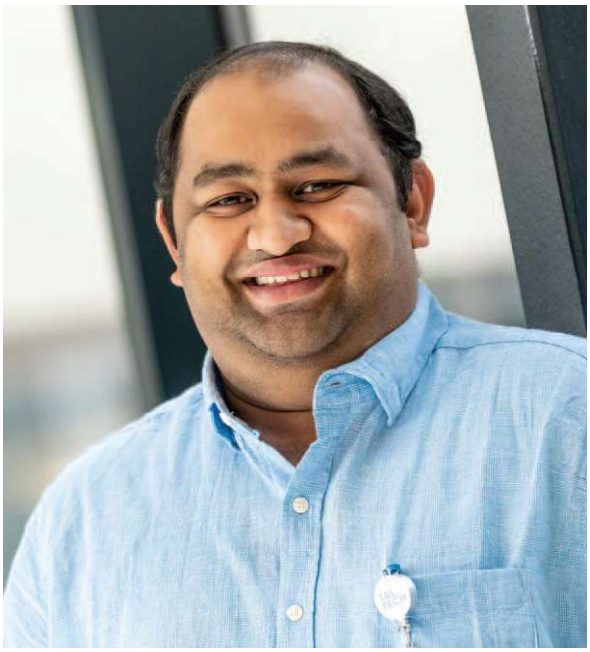
- ETAG21021 "*Waste-to-resource: eggshells as a source for next generation biomaterials for bone regeneration*" (2021–2024)

SELECTED PUBLICATIONS

Ye, Z.; Zhao, K.; Yu, Z.; Prashanth, K. G.; Zhang, F.; He, Y.; Peng, Y.; Wu, W.; Tan, H. (2024). Understanding the solute segregation and redistribution behavior in rapidly solidified binary Ti-X alloys fabricated through non-equilibrium laser processing. Additive Manufacturing, 96, #104561. DOI: 10.1016/j.addma.2024.104561.

Yang, H.; Ma, P.; Zhang, Z.; Xie, X.; Yang, P.; Zhang, H.; Jia, Y.; Prashanth, K. G. (2024). Microstructure and mechanical performances of NiCoFeAlTi high-entropy intermetallic reinforced CoCrFeMnNi high-entropy alloy composites manufactured by selective laser melting. Journal of Materials Research and Technology, 33, 6275–6287. DOI: 10.1016/j.jmrt.2024.11.022.

Baskaran, J.; Muthukannan, D.; Shukla, R.; Konda Gokuldoss, P. (2024). Manufacturability and deformation studies on a novel metallic lattice structure fabricated by Selective Laser Melting. Vacuum, 222, #113065. DOI: 10.1016/j.vacuum.2024.113065.



ADVANCED STRUCTURES AND PRODUCTS

Head of the research group: Tenured Full Professor JÜRI MAJAK, juri.majak@taltech.ee

Members: Martin Eerme, Jüri Lavrentjev, Martin Pärn, Meelis Pohlak, Fabio Auriemma, Hans Rämmal, Maarjus Kirs, Janno Nõu

Doctoral students: Katre Worth, Tõnis Raamets, Marvar Mehrparvar, Margus Villau, Lenart Kivistik, Tiina Lelumees

TOPICS AND COMPETENCES

KEYWORDS: structural analysis and design optimization, artificial intelligence, acoustics, numerical methods, composite materials

The competencies of the workgroup cover development and application of the AI based optimization algorithms, procedures and tools for design of products and production processes. One of the main directions of recent years is the implementation of Evolutionary (EA) methods and tools in engineering design. Current issues include the development of hybrid methods and the combined use of artificial intelligence tools in algorithms (ANN + EA). One subtopic is the development and adaption of new numerical methods with focus on Haar wavelet based discretization methods.

Competencies also include structural analysis of the structures and composite materials, development of higher order Haar wavelet method for solving corresponding differential equations; high speed deformations.

The research team has a long experience in wave propagation research in channels and more generally in a limited space. Various test methods for sound field decomposition have been developed. The developed applications have been used for experimental determination of acoustic properties of different materials and products, as well as for the collection of energy harvesting from acoustic noise.

Artificial intelligence is increasingly being used to solve a wide range of societal problems. The research group's work is related to several *AIRE sub-projects*.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29843

IN 2025, research activities in the field of artificial intelligence were continued. Development of product quality assessment algorithms based on convolutional neural networks (a subtype of deep neural networks) was further pursued. More specifically, algorithms for the detection of delamination and cracks were developed. The AI domain additionally includes the development and application of multicriteria decision-making methods. Due to the dominance of AI-related topics, the development and application of numerical methods based on Haar wavelets received slightly less attention this year.

SELECTED PROJECTS

- ÕÜF9 "*Development of robot-human co-creation in industry*" (2023–2029)
- AR20013 "*Smart City Center of Excellence*" (2020–2023)
- VEU25028 "*Reusable Easy to Breath and Use Masks – Elastomeric half-mask (Easy2reUse)*" (2025–2029)

SELECTED PUBLICATIONS

Paat, A.; Majak, J.; Karu, V.; Hitch, M. (2024). Fuzzy analytical hierarchy process based environmental, social and governance risks assessment for the future phosphorite mining in Estonia. The Extractive Industries and Society, 17 (101438), 1–8. DOI: 10.1016/j.exis.2024.101438.

Arda, M.; Majak, J.; Mehrparvar, M. (2024). Longitudinal Wave Propagation in Axially Graded Raylegh-Bishop Nanorods. Mechanics of Composite Materials, 59 (6), 1109–1128. DOI: 10.1007/s11029-023-10160-4.

Karjust, K.; Mehrparvar, M.; Kaganski, S.; Raamets, T. (2025). Development of a Sustainability-Oriented KPI Selection Model for Manufacturing Processes. Sustainability, 17 (14), #6374. DOI: 10.3390/su17146374.

AUTOMATED PRODUCTION SYSTEMS AND REAL-TIME MONITORING AND AI MODELS

Head of the research group: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee

Members: Jüri Riives, Martinš Šarkans, Aigar Hermaste, Kashif Mahmood, Margus Müür, Riho Uusjärv, Heiko Pikner

Doctoral student: Tõnis Raamets

TOPICS AND COMPETENCES

KEYWORDS: manufacturing execution system (MES), production monitoring, production optimisation, real time information, wireless sensor network, predictive mainenance, artificial intelligent in production

The main objective of the research is to study and develop Automated Production Monitoring System using AI models. The research group developed Production Monitoring System DIMUSA with predictive functionality that operates in near real time, focusing on SMEs.

The advanced Production Monitoring and Prediction System detects, measures and monitors the variables, events and situations which affect the performance and reliability of manufacturing systems and processes. Efficient, real-time feed of information for production control and monitoring includes data acquisition about the state of equipment, production orders, flow of materials, quality of products, process data and other necessary data which are used for making proper and optimised decisions regarding manufacturing planning, improved use of available resources, planning of equipment maintenance, etc.

More information: *https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29844*

IN 2025, the main research focus was on artificial intelligence-based production optimization, digital twins, and autonomous systems. Research into autonomous mobile robots and production logistics, both through theoretical models and applied research, was of great importance. Contributions were also made to the development of methodologies for sustainable production and environmental impact assessment.

SELECTED PROJECTS

- TT2 "*Smart Industry Centre*" (2021–2024)
- VEU22048 "*Master of Science in Smart, Secure and Interconnected Systems*" (2022–2026)
- VEU22026 "*AI & ROBOTICS ESTONIA (EDIH)*" (2022–2025)
- VEU25028 "*Reusable Easy to Breath and Use Masks – Elastomeric half-mask (Easy2reUse)*" (2025–2029)

SELECTED PUBLICATIONS

Karjust, K.; Mehrparvar, M.; Kaganski, S.; Raamets, T. (2025). Development of a Sustainability-Oriented KPI Selection Model for Manufacturing Processes. Sustainability, 17 (14), #6374. DOI: 10.3390/su17146374.

Raamets, T.; Karjust, K.; Hermaste, A.; Kelpman, K. (2025). Virtual factory model development for AI-driven optimization in manufacturing. Proceedings of the Estonian Academy of Sciences, 74 (2), 228–233. DOI: 10.3176/proc.2025.2.26.

Kelpman, K.; Karjust, K.; Majak, J. (2025). An overview of smart workplace solutions and potential imp-rovement areas. Proceedings of the Estonian Academy of Sciences, 74, 2, 155–159. DOI: 10.3176/proc.2025.2.13.

ROBOTICS AND AUTONOMOUS VEHICLES

Head of the research group: Tenured Associate Professor RAIVO SELL, raivo.sell@taltech.ee

Members: Andres Petritšenko, Martinš Šarkans, Margus Müür, Vladimir Kuts, Kaimo Sonk, Mauro Bellone, Mohsen Malayjerdi, Heiko Pikner, Rahul Razdan

Doctoral students: Krister Kalda, Andrew James Roberts, Toomas Tahves

TOPICS AND COMPETENCES

KEYWORDS: robotics, self-driving vehicles, artificial intelligence, autonomous systems, smart city

The research group is working on the development and research on complex autonomous systems, including localization, navigation, mission planning, sensorics, artificial intelligence, electro-mechanics, control, simulation and machine vision.

The topics are applied to a full range of autonomous systems, in particular to self-driving vehicles, mobile robots, industrial logistics robots and drones.

The research group's activities are aimed at future mobility and are directly related to the green transition and reducing emissions in the transport sector.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29845

IN 2025 the research group has achieved internationally visible R&D results in the fields of autonomous mobility, cybersecurity of connected transport systems, and smart city experimentation. The group has advanced validation and verification methodologies for autonomous vehicles, integrating digital twin environments with real-world pilot operations to improve safety assessment and corner-case analysis. Significant progress has also been made in zero-trust security architectures for next-generation (6G-ready) mobility ecosystems, strengthening the resilience and trustworthiness of cyber-physical trans-port infrastructures. In addition, the group has contributed to the development of scalable toolkits and implementation frameworks that support cities and industry partners in deploying autonomous and multimodal mobility solutions. These outcomes demonstrate a strong combination of experimental research, applied engineering, and international collaboration, reinforcing the group's position as a credible partner in European research and innovation networks.

SELECTED PROJECTS

- VHE24058 "*Extended zero-trust and intelligent security for resilient and quantum-safe 6G networks and services*" (2025–2027)

- LEMEE23083 "*Study for the development of a passive-adaptive autonomous navigation system for unmanned ground vehicles*" (2023–2026)
- TFA25109 "*Isejuhtivate sõidukite turvalisuse valideerimise ja verifitseerimise platvorm*" (2025–2026)

SELECTED PUBLICATIONS

Razdan, R.; Sell, R.; Akbas, M. I.; Menase, M. (2025). Perspectives on Safety for Autonomous Vehi-cles. Electronics, 14 (22), art. 4500. DOI: 10.3390/electronics14224500.

Sell, R.; Razdan, R.; Kase, K.; Rüütmann, T. (2025). The Role of AI Chatbots in Engineering Education: Experimental Findings and Implementation Strategies. International Journal of Engineering Pedagogy (iJEP), 15 (5), 4–19. DOI: 10.3991/ijep.v15i5.56681.

Gu, J.; Bellone, M.; Pivoňka, T.; Sell, R. (2024). CLFT: Camera-LiDAR Fusion Transformer for Semantic Segmentation in Autonomous Driving. IEEE Transactions on Intelligent Vehicles, 1–12. DOI: 10.1109/TIV.2024.3454971.

INNOVATIVE SYSTEMS FOR INDUSTRIAL APPLICATIONS

Head of the research group: Tenured Full Professor IRINA HUSSAINOVA, irina.hussainova@taltech.ee

Members: Fjodor Sergejev, Maksim Antonov, Mart Viljus, Sofiya Aydinyan, Rocío Estefania Rojas Hernandez, Dmitri Goljandin, Roman Ivanov, Rainer Traksmaa, Hans Vallner, Heinar Vagiström, Rahul Kumar

Doctoral students: Mansoureh Rezapourian, Arash Kariminejad

TOPICS AND COMPETENCES

KEYWORDS: ceramics; composites; multifunctional structures; bio-inspired materials; tribology; recycling; high temperature materials; chemical vapour deposition; self-propagating high temperature synthesis; microstructural analysis; mechanical testing; additive manufacturing; spark plasma sintering

The research is broadly subdivided into three main interconnected and highly interdisciplinary directions focused on (a) hierarchically structured bio-inspired multi-functional composites including but not limited to electroconductive ceramics, functionally graded and anisotropic ceramic-based composites, mesoporous ceramics, nanofibers, graphene added bulks, ceramic membranes; (b) tribology and high-temperature damage-tolerant composites for tribo-applications; (c) selective laser melting and powders for SLM/S of ceramic-metal composites and AM of complex-shaped ceramic-matrix composites.

The team has several inventions keeping research at a high international level. The most influential are (i) a self-aligned fibrous scaffold for highly anisotropic cell cultures; (ii) a method for producing nanofibers composites by combustion techniques and products comprising thereof; (iii) fibrous ceramic networks and preparation thereof by selective laser melting; and (iv) ceramic complex structures by SLS.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29846

SELECTED PROJECTS

- PRG643 "*Bio-replicating Engineering Structures for Tribo-applications (BEST)*" (2020–2024)
- MNHA23020 "*New generation of bioactive laser textured Ti/HAp implants*" (2023–2026)
- MNHA22057 "*Circular product design for automotive components made from recycled and sustain-able composite material*" (2022–2024)

SELECTED ARTICLES

Sadlik, J.; Kosińska, E.; Tomala, A.; Bańkosz, M.; Polajnar, M.; Kumar, R.; Kalin, M.; Kravanja, G.; Hribar, L.; Hussainova, I.; Nykiel, M.; Sobczak-Kupiec, A.; Jampilek, J. (2025). Effect of Laser Sur-face Texturing and Fabrication Methods on Tribological Properties of Ti6Al4V/HAp Biocompo-sites. Materials, 18, 11, #2468. DOI: 10.3390/ma18112468.

Necib, J.; Feldbach, E.; Romet, I.; Nagirnyi, V.; Hussainova, I.; Rojas-Hernandez, R. E. (2025). In-vestigation of deep UV emission of rare-earth-free Zn2SiO4 micropowders: the correla-tion of structural and luminescence properties. Journal of Luminescence, 280, #121070. DOI: 10.1016/j.jlumin.2025.121070.

Melkonyan, S.; Zakaryan, M.; Grigoryan, Y.; Kharatyan, S. Hussainova, I.; Chabanais, F.; Sham-shirgar, A. S.; Persson, P. O.Å.; Rosen, J.; Aydinyan, S. (2025). Phase and Microstructure Evolu-tion Patterns at Combustion Synthesis of High-Entropy M2AlC (M=Ti/Ta/V/Nb/Cr) MAX Phase. Journal of Materials Research and Technology, 39, 5800–5807. DOI: 10.1016/j.jmrt.2025.10.186.

RESEARCH GROUP OF LOGISTICS AND TRANSPORT

Head of the research group: Senior Researcher DAGO ANTOV, dago.antov@taltech.ee

Members: Jüri Lavrentjev, Kati Kõrbe Kaare, Hans Rämmal, Ott Koppel, Jelizaveta Janno, Anton Pashkevich

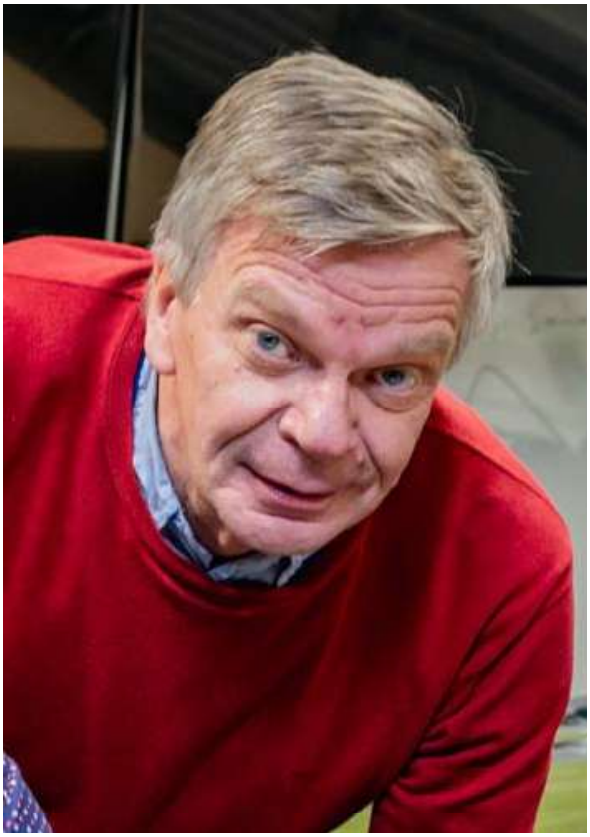
Doctoral students: Kaur Sarv, Raul Markus

TOPICS AND COMPETENCES

KEYWORDS: sustainable solutions in transport and logistics, digitization of logistics solutions, transport demand analysis

The activities of the research group are largely related and focused on the following main topics:

- sustainable solutions in transport and logistics (including achieving carbon neutrality, elements of the green turn in the transport system, safe solutions, etc.);
- optimization of the logistics system, for example the possibilities of implementing digital solutions in logistics solutions
- transport demand analysis, in particular assessments of transport demand today and in the future, which factors affect it and which solutions are feasible for its realization.



The activities of the research group are focused namely on these topics using the most modern methods for their research, starting with data collection and analysis and ending with system simulation.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29847

SELECTED PROJECTS

- VHE25032 "*Co-creation and experimentation for road-users' co-existence, empathy and behaviour, building a holistic model for traffic safety culture*" (2025–2028)
- TF24022EM2 "*Development and provision of IC modules for higher education and vocational schools: Course "Data in Supply Chains and Mobility" in the field of transport/logistics*" (2023–2024)

SELECTED PUBLICATIONS

Jairus, T.; Sadam, A.; Kõrbe Kaare, K.; Pilvik, R. (2025). Economic Feasibility of Drone-Based Traf-fic Measurement Concept for Urban Environments. Future Transportation, 5 (4), #163. DOI: 10.3390/futuretransp5040163.

Pilvik, R.; Jairus, T.; Sadam, A.; Nõmmela, K.; Kõrbe Kaare, K.; Scholliers, J. (2025). Exploitability of Maritime Fleet-Based 5G Network Extension. Electronics, 14 (11), #2210. DOI: 10.3390/electronics14112210.

Pilvik, R.; Jairus, T.; Kõrbe Kaare, K.; Sadam, A.; Gentili, A.; Nõmmela, K. (2025). Maritime Fleet-Based 5G Network Extension: A Model for Cross-border Coastal Applications. 2024 IEEE Future Networks World Forum (FNWF): Dubai, UAE, 15–17 October 2024. IEEE, 855–860. DOI: 10.1109/FNWF63303.2024.11028827.

SMART INDUSTRY

Head of the research group: Tenured Full Professor TAUNO OTTO, tauno.otto@taltech.ee

Members: Fjodor Sergejev, Toivo Tähemaa, Jüri Riives, Martinš Sarkans, Lauri Kollo, Meelis Pohlak, Aigar Hermaste, Margus Müür, Tatjana Karaulova

Doctoral students: Kristo Vaher, Simone Lucca Pizzagalli, Yevhen Bondarenko, Madis Moor

TOPICS AND COMPETENCES

KEYWORDS: smart manufacturing, industry 4.0 /5.0, digital twins, digital manufacturing

The competencies of the research group are: production digitalisation, virtualisation, simulation, development of digital twins, reconfiguring manufacturing from conventional machining technologies to 3D related.

The application of Digital Twins, artificial intelligence, robotics and augmented reality (XR) enables companies to plan, optimize and reconfigure production processes more efficiently, while reducing resource consumption and environmental impact. The group's research outcomes address key societal challenges such as labor shortages in the manufacturing sector, occupational safety and the need for a green transition. Flexible and collaborative robot-based production systems and a human-centric approach to production (Industry 5.0) support the transformation of the role of employees from physically demanding work to higher value-added activities, improving working conditions and reducing the risk of occupational accidents.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29848

IN 2025, the Smart Manufacturing Research Group achieved internationally outstanding research results in the development and application of digitalised manufacturing systems, Digital Twin technologies, Extended Reality (XR), and flexible robotic manufacturing systems. The research and development activities were closely aligned with the Industry 4.0 and Industry 5.0 paradigms, with a strong emphasis on human–robot collaboration, system flexibility, and real-time decision support. A key scientific outcome of the year was the further development of real-time, bidirectionally synchronised Digital Twin methodologies. In contrast to conventional simulation-based approaches, the developed solutions enable Digital Twins to function as active components for the validation, control, and optimisation of manufacturing and robotic systems. The integration of Digital Twins with XR-based user interfaces significantly advanced the planning, simulation, and management of production systems, supporting the design and evaluation of human-centred industrial workflows.

In applied research, the group demonstrated internationally competitive solutions for the design of flexible collaborative robotic systems and autonomously movable robotic manufacturing concepts. The developed frameworks and prototype

implementations confirmed the technical and economic feasibility of rapid reconfiguration of manufacturing systems, addressing critical challenges related to flexibility, resilience, and cost-efficient automation, particularly for small and medium-sized manufacturing enterprises.

SELECTED PROJECTS

- ÕÜF10 "*Development and manufacturing of complex products*" (2023–2029)
- TARISTU24-TK10 "*European Organisation for Nuclear Research*" (2025–2029)
- TT2 "*Smart Industry Centre*" (2021–2024)

SELECTED PUBLICATIONS

Pizzagalli, S. L.; Mahmood, K.; Boychuk, R.; Otto, T.; Kuts, V. (2025). A workflow for extended reality-based learning in engineering education. Proceedings of the Estonian Academy of Sciences, 74, 2, 103–108. DOI: 10.3176/proc.2025.2.03.

Mondellini, M.; Arlati, S.; Urgo, M.; Pizzagalli, S. L.; Kashif, M.; Terkaj, W. (2025). Comparing Traditional and eXtended Reality-based Learning: Effects on Performance, Emotions, and Cogniti-ve Aspects. In: Extended Reality: International Conference, XR Salento 2025, Otranto, Italy, June 17–20, 2025, Proceedings, Part VI. (324–336). Springer. (Lecture Notes in Computer Science; 15742). DOI: 10.1007/978-3-031-97778-7_24.

Remenyi A, L. Kuts V. Tepljakov A. Pizzagalli S, L. (2025). From Virtual to Reality: A Structured Framework to Training Humanoid Robots for Elderly Care Using Learning from Demonstration. In: Lecture Notes in Computer Science. (193–209). Springer. DOI: 10.1007/978-3-031-97772-5_13 [in press].

WEAR RESISTANT COMPOSITES AND COATINGS

Head of the research group: Senior Researcher JAKOB KÜBARSEPP, jakob.kubarsepp@taltech.ee

Members: Fjodor Sergejev, Mart Viljus, Vitali Podgurski, Kristjan Juhani, Maksim Antonov, Mart Viljus, Dmitri Goljandin, Mart Saarna, Märt Kolnes, Marek Tarraste, Andrei Surženkov, Mart Kolnes, Abrar Hussain, Priit Kulu, Andrei Bogatov, Rainer Traksmaa, Hans Vallner, Heinar Vagiström, Artur Klauson, Oleksandr Tarasov, Liudmyla Melakh, Siim Lukas Lokotar

Post-doctoral Researcher: Babak Omranpour Shahreza

Doctoral students: Sibel Yöyler, Tabeen Halawat Pampori, Furqan Anwar

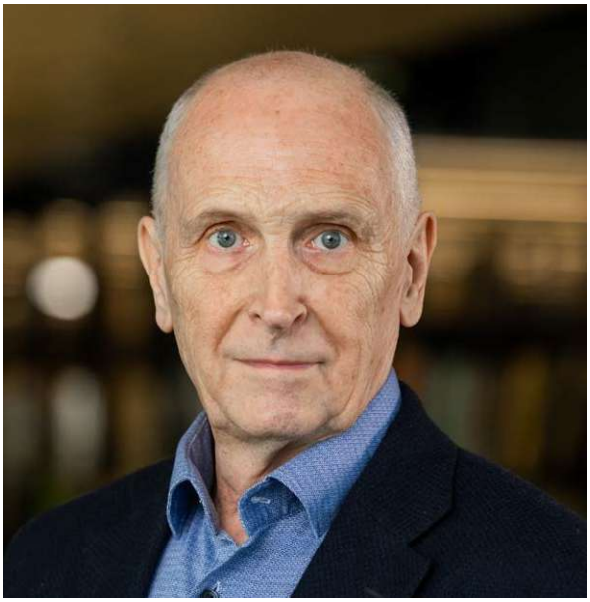
TOPICS AND COMPETENCES

KEYWORDS: ceramic-based composite, hardmetal, cermet, ceramic-matrix composite, coating, composite hardfacing, hydrogen storage material; wear resistance, materials recycling, resource-efficiency; sustainability; durability

The R&D activities of the research group have been focused mainly on the following research topics (a) wear resistant ceramic-metal composites (hardmetals/cemented carbides and cermets) with focus on reduction of critical raw materials (CRM) in composites; (b) ceramic-matrix composites based on refractory compounds; (c) wear resistant composite hardfacings with focus on reduction of CRM in coatings; (d) thin hard and diamond coatings; (e) materials recycling; (f) characterization of materials and products: composition, microstructure, mechanical and tribological (friction and wear) properties.

To find solutions to topical problems in manufacturing, research is focused on resource efficiency and reducing environmental impacts. The main research directions are: (1) materials and manufacturing technologies for enhancement of products (tools, wear resistant structural elements) sustainability, primarily in the industrial environment and (2) technologies of products reuse (giving second life to wear parts) and reprocessing waste materials (recycling).

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29849



The most important R&D results **IN 2025**:

- Advancement of critical raw materials (primarily Co) free wear resistant composite materials, in particular additive manufacturing technology of such materials;
- Research results in the field of high-entropy carbide ceramics and wear resistant composites on its bases;
- Progress in development of advanced Fe-based composite hardfacings with W-free ceramic reinforcement;
- Advancements in the field of recycling technology of polymeric and textile materials.

SELECTED PROJECTS

- PRG1145 "*Composites "ceramics – Fe alloy" for a wide range of application conditions*" (2021–2025)
- VHE22005 "*RENEW. Re-cycling of Epoxys from Nonferrous E-Waste*" (2022–2024)
- LEMEE20006 "*Car safety component productive fineblanking and functional design*" (2019–2023)

SELECTED PUBLICATIONS

Maurya, H. S.; Marczyk, J.; Juhani, K.; Sergejev, F.; Kumar, R.; Hussain, A.; Akhtar, F.; Hebda, M.; Prashanth, K. G. (2025). Binder jetting 3D printing of green TiC-FeCr based cermets- Effect of sintering temperature and systematic comparison study with Laser powder bed fusion fabricated parts. Materials Today Advances, 25, #100562. DOI: 10.1016/j.mtadv.2025.100562.

Maurya, H.S.; Juhani, K.; Tarraste, M.; Viljus, M.; Sergejev, F.; Pampori, T.H.; Hussain, A.; Kübarsepp, J. (2024). Synergistic effect of Nb and Mo on the microstructural formation of the Ti(C,N)-high chromium ferrous-based cermets. International Journal of Refractory Metals and Hard Mate-rials, 122, #106723. DOI: 10.1016/j.ijrmhm.2024.106723.

Hussain, A.; Goljandin, D.; Podgursky, V.; Rüstü Yörük, C.; Sergejev, F.; Kübarsepp, J.; Maurya, H. S.; Rahmani, R. (2024). Industrial sustainable Fabrication, SEM Characterization, mechanical Testing, ANOVA analysis of PP-PETF recycled Composites: Artificial intelligence and deep learning studies for nuclear shielding applications. European Polymer Journal, 213, #113082. DOI: 10.1016/j.eurpolymj.2024.113082.

KURESSAARE COLLEGE

Director: MERIT KINDSIGO,
merit.kindsigo@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

16 Academic staff — Incl. 1 professor, 9 researchers

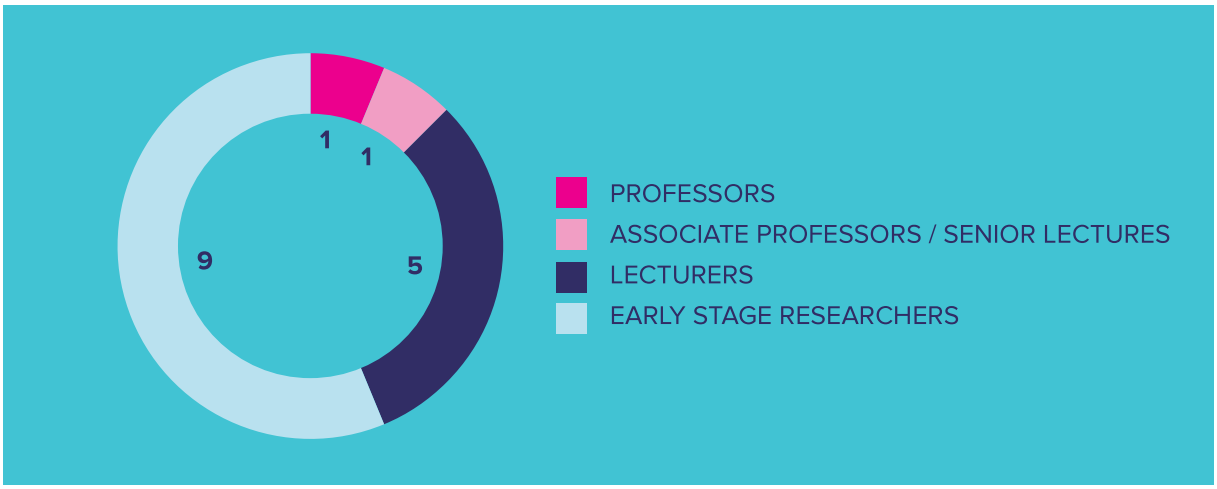
10 Doctoral students

6 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE COLLEGE CONDUCTS RESEARCH WITHIN ONE RESEARCH GROUP:

- **MARINE TECHNOLOGY AND HYDRODYNAMICS.**
  Head: Tenured Associate Professor MIHKEL KÕRGESAAR, mihkel.korgesaar@taltech.ee



MARINE TECHNOLOGY AND HYDRODYNAMICS

Head: Tenured Associate Professor MIHKEL KÕRGESAAR, mihkel.korgesaar@taltech.ee

Members: Kalju Saar, Teär Ruttar, Andrus Šults, Priit Suluste, Hans Korman

Doctoral students: Muhammed Adil Yatkin, Mert Asan, Mikloš Lakatoš, Md Al Amin Khan. Tarmo Sahk

TOPICS AND COMPETENCES

KEYWORDS: advanced ship structures, fluid-structure interaction, ship safety, accidental limit states, material modeling, marine technology, ship digital twin and perception systems

The team's research focuses on innovative solutions for ships, offshore and shore-based structures, and marine infrastructure, developing digital, autonomous, including situational-aware technologies in the marine environment. The conditions arising from the marine environment place high demands on engineering solutions, which require science-based methods to solve the problems. The methods used include numerical simulations as well as experimental testing.

IN 2025:

- PhD student Mert Asan's PhD thesis conducted experiments on the use of machine learning applications and forecasting ship motion for practical applications, such as drone landing.
- PhD student Adil Yatkin's PhD thesis made progress in the development of machine learning applications for structural strength assessment.

- The research group received ASTRA funding to develop machine learning-based strength assessment methods for industry and ARIB funding to develop practical applications for fishermen to check the filling of fishing nets.

SELECTED PROJECTS

- TARISTU24-TK6 "*Marine Technology and Hydrodynamics Research Infrastructure MARTE – Regional Knowledge Transfer Advisory and Technology Center*" (2025–2029)
- PSG754 "*Coupled Simulation Model for Ship Crashworthiness Assessment*" (2022–2025)
- MNKE25052 "*Advanced Marine Environment Monitoring and Rapid Analysis System*" (2025–2028)

SELECTED PUBLICATIONS

Sahk, T.; Kõrgesaar, M.; Yu, Z. (2025). Approach to account for external dynamics in fluid-structure interaction analysis in Abaqus. In: Innovations in the Analysis and Design of Marine Structures. (289–294). CRC Press. DOI: 10.1201/9781003642411-35.

Yatkin, M. A.; Korgesaar, M.; Romanoff, J.; Stuckner, J.; Islak, U.; Kurban, H. (2025). Exploring Various Sequential Learning Methods for Deformation History Modeling. Engineering Applications of Neural Networks : Proceedings, Part I: 26th International Conference, EANN 2025, Limassol, Cyprus, June 26–29, 2025. Ed. Iliadis, L.; Maglogiannis, I.; Kyriacou, E.; Jayne, C. Cham: Springer, 168–180. (Communications in Computer and Information Science (CCIS); 2581). DOI: 10.1007/978-3-031-96196-0_13.

Kõrgesaar, M.; Yatkin, M.A. (2025). Machine Learning Based Computational Models for Increased Accuracy and Enabling Digital Twins. Proceedings of the ASME 2025 ; vol. 7, 7: 44th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2025), Vancouver, Canada, June 22–27, 2025. American Society of Mechanical Engineers (ASME), art. V007T14A014. DOI: 10.1115/OMAE2025-157406.

TARTU COLLEGE

Director: Associate Professor
AIME RUUS,
aime.ruus@taltech.ee,
+372 620 4802

MAIN FIGURES 2025

(as of Dec. 31, 2025)

20 Academic staff Incl. 2/5 professor researchers

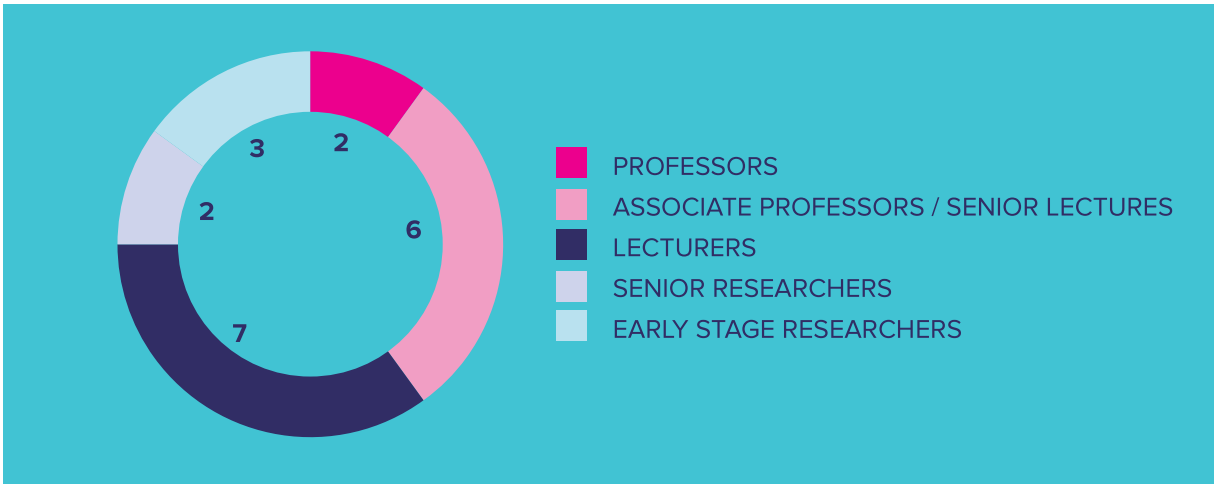
5 Doctoral students

15 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN TWO RESEARCH GROUPS:

- **BUILT ENVIRONMENT RESEARCH GROUP.**
  Head: Associate Professor AIME RUUS, aime.ruus@taltech.ee
- **SUSTAINABLE TECHNOLOGY RESEARCH GROUP.**
  Head: Senior Researcher LEMBIT NEI, lembit.nei@taltech.ee



BUILT ENVIRONMENT RESEARCH GROUP

Head of the research group: Associate Professor AIME RUUS, aime.ruus@taltech.ee

Members: Mihkel Kiviste, Zenia Kotval, Ernst Tungel, Jiri Tintera, Nele Nutt, Jane Raamets, Sirle Salmistu, Karin Muoni, Ago Rootsi, Taisi Kadarik, Kädi Veeroja, Anneliis Muravleva, Kaarel Koppel, Tuuli Muistna

Doctoral students: Minea Kaplinski-Sauk, Ardo Kubjas, Pille-Riin Peet, Kristo Kalbe, Lehar Leetsaar, Rain Martin Torpats

TOPICS AND COMPETENCES

KEYWORDS: brownfields, shrinking and ageing cities, urban planning, recycled aggregate concrete, building materi-als, indoor climate, natural and reusable finishing materials

The research topics of the team are: (1) built environment, urban and regional planning; (2) community development, economic revitalization, reuse and restoration, urban and rural settlement assessment; (3) heritage conservation in urban planning and historical landscapes and parks; (4) revitalization of brownfields; (5) examination of historical buildings; (6) construction materials, indoor climate, aspects of building physics and energy efficiency; (7) possibilities to produce recycled aggregate concrete, (8) cyber-physical systems for buildings and urban and regional planning.

These issues are topical in the field of urban planning and help to solve problems with the implementation of cyber-physics systems in construction, industry and other fields of life.

More information: *https://taltech.ee/en/tartu-college/research#p32467*

IN 2025: Advantages of Using a Seismic Piezocone Penetration Test for Analysis of a Single Screw In Situ Displacement Pile in Silty Soils – the findings of study highlighted the complexity of the correlation between CPTu readings and Vs in silty soils, emphasising the need for further research in this area.

The team completed successfully the tasks related to the European Commission-funded Horizon project eMotional Cities. The process of applying for a building permit is known to be often unpredictable, opaque, and conducted differently in different regions. This creates project delays, increased costs, and generally undermines public trust in government services. Previouss studies have analyzed problems after they arise. This study took a proactive approach by developing a preconsultation tool that addresses issues before applications are submitted. As urbanization and construction demands increase, the need for efficient, transparent permit processes will only grow. The study presents a scalable solution that is adaptable to future regulatory frameworks and application volumes.

SELECTED PROJECTS

- VFP21013 "*eMOTIONAL Cities*" (2021–2025)
- VHE23079 "*A PROactive approach for Communities to enAble Societal Transformation*" (2023–2026)
- PR1144 "*Quality control of knitwear using machine vision*" (2024–2025)

SELECTED PUBLICATIONS

Leetsaar, L.; Korkiala-Tanttu, L. (2024). Advantages of Using a Seismic Piezocone Penetration Test for Analysis of a Single Screw In Situ Displacement Pile in Silty Soils. Indian Geotechnical Journal. DOI: 10.1007/s40098-024-00942-5.

Raamets, J.; Nei, L.; Ruus, A.; Ivask, M.; Muoni, K. (2025). Humidity Impact on Air Quality in Straw- and Reed-Bale Houses. 1–12. DOI: 10.20944/preprints202508.0570.v1.

Kupper, K.; Nutt, N.; Kaplinski-Sauk, M. (2025). Data from urban tree surveys of the 19th–21st centuries as input for planning the maintenance of historical tree stands: A case study of Kaarli boulevard in Tallinn, Estonia. BALTIC FORESTRY, 31 (1), #id793. DOI: 10.46490/BF793.

SUSTAINABLE TECHNOLOGY RESEARCH GROUP

Head of the research group: Senior Researcher LEMBIT NEI, lembit.nei@taltech.ee

Members: Egge Haiba, Nele Nutt, Jane Raamets, Sirle Salmistu, Annika Joy Meitern, Aija Kosk, Tiit Lepasaar, Kärt Kanger, Karin Muoni, Mari Ivask, Kai Kalda-Kiisk, Kaire Luuk, Ellen Hiie

Doctoral student: Ardo Kubjas

TOPICS AND COMPETENCES

KEYWORDS: environmental technology, circular economy, industrial ecology, ecosystem services, environmental microbiology and -chemistry

The main competences of the group are:

- The studies of energy and material flow, LCA, efficiency in using resources.
- Development and implementation of waste recycling technologies (drug residues in sewage sludge and their degradation efficiency).
- Development of methodologies for assessing the status of the environment. In assessing the status of the environment, soil microbiological parameters and the parameters of soil invertebrates are used as bioindicators.
- Use of oil shale ash and crushed oil shale as an anti-mold agent.

More information: https://taltech.ee/en/tartu-college/research#p32468

IN 2025: The research group participated in the successful completion of the Horizon eMotional Cities project funded by the European Commission.

During a research visit to the University of South Florida (USA), a comparative analysis of the previous pollution in Tampa Bay with the potential threats to the Gulf of Finland and Lake Peipsi was conducted (Lembit Nei).

SELECTED PROJECTS

- VFP21013 "*eMOTIONAL Cities*" (2021–2025)
- MNHA23044ET "*The impact of indoor climate on health and the spread of pathogens*" (2023–2024)
- VHE23079 "*A PROactive approach for COmmunities to enAble Societal Transformation*" (2023–2026)

SELECTED PUBLICATIONS

Nei, L.; Haiba, E.; Raamets, J.; Herodes, K. (2024). Degradation of carbamazepine and triclosan in sewage sludge mixtures used for fertilizing agricultural soils. Soil Science Annual, 75 (2), #189545. DOI: 10.37501/soilsa/189545.

Nutt, N.; Nei, L.; Muoni, H.; Kubjas, A.; Raamets, J. (2024). Novel Approach to Making Environmentally-Friendly Plaster – Moisture Buffer Value of Plaster Made of Wastepaper and Different Glues. Latvian Journal of Physics and Technical Sciences, 61 (6), 59–68. DOI: 10.2478/lpts-2024-0043.

Nutt, N.; Salmistu, S.; Kupper, K.; Kotval, Z. (2024). Assessing age-friendliness of contemporary urban outdoor places in Estonia. Quality in Ageing and Older Adults, 25 (3), 204–219. DOI: 10.1108/QAOA-05-2024-0033.

VIRUMAA COLLEGE

Director: MARE ROOSILEHT,
mare.roosleht@taltech.ee,
+372 336 3922

MAIN FIGURES 2025

(as of Dec. 31, 2025)

43 Academic staff — Incl. 2 professor, 17 researchers

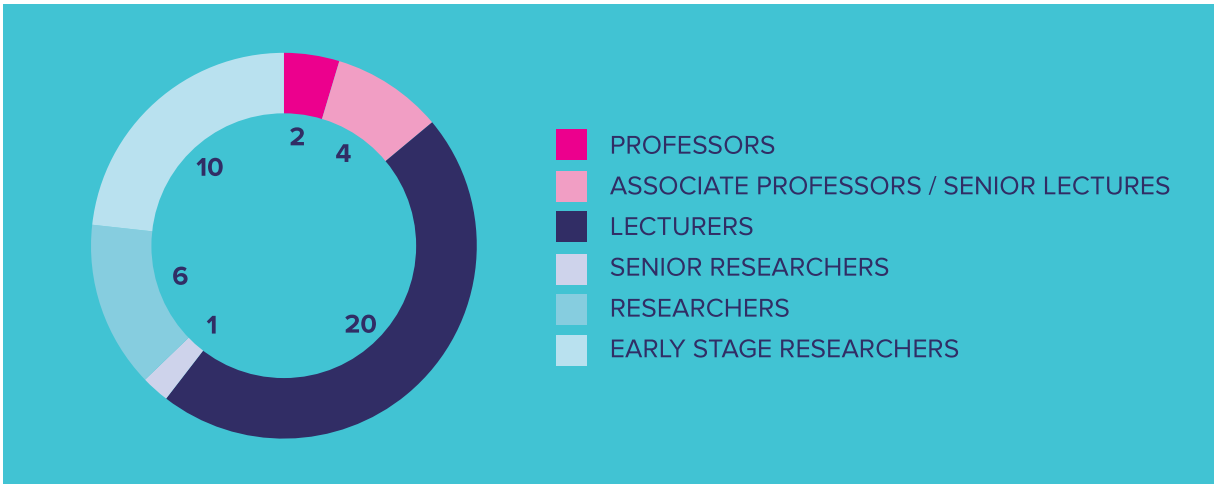
9 Doctoral students

19 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN FOUR RESEARCH GROUP:

- **APPLIED CHEMISTRY RESEARCH GROUP.**
  Head: Tenured Associate Professor ALLAN NIIDU, allan.niidu@taltech.ee
- **DEVELOPMENT OF ROBOT-HUMAN CO-CREATION WORKING GROUP.**
  Head: Senior Lecturer OLGA DUNAJEVA, olga.dunajeva@taltech.ee
- **LABORATORY OF FUELS TECHNOLOGY AT OIL SHALE COMPETENCE CENTER.**
  Head: Researcher, Laboratory Manager OLGA PIHL, olga.pihl@taltech.ee
- **MECHANICAL ENGINEERING AND ENERGY TECHNOLOGY PROCESSES CONTROL WORK GROUP.**
  Head: Senior Lecturer VEROONIKA SHIROKOVA, veroonika.shirokova@taltech.ee



APPLIED CHEMISTRY RESEARCH GROUP

Head of the research group: Tenured Associate Professor ALLAN NIIDU, allan.niidu@taltech.ee

Members: Moonika Ferschel, Martin Jürisoo, Tanel Mõistlik

Doctoral students: Bijan Barghi, Diana Berseneva, Dmitri Tsõvarev, Viktorija Mironova, Anastassia Raag

TOPICS AND COMPETENCES

KEYWORDS: metal-organic framework, CO_2 adsorption and utilization (CCSU), heterogeneous and photocatalysis, adsorption, nanomaterials, liquid separation, oil shale as raw material for chemical industry, mechanochemistry

The research group's competencies include:

- Co-valorization of CO_2 and oil shale into catalysts and adsorbents for chemical industry.
- Application of said catalysts to oxidation of organic sulfur and relevant adsorbents to adsorb sulfurous compounds form liquid hydrocarbon streams.
- Extracting added value from mining waste and process waters via selective removal of required metals.

In cooperation with University Montpellier, mechanochemical formation of API-s and metal salts are studied.

More information: *https://taltech.ee/en/virumaa-college/development*

IN 2025, two roadmaps commissioned by the Ministry of Climate were prepared with the participation of the Applied Chemistry Group. Firstly, the roadmap for CO_2 and low emission fuels and secondly, the roadmap for the wood valorisation.

SELECTED PROJECTS

- ÕÜF16 "*Circular valorization of non-fossile CO2*" (2023–2029)
- TEM-TA138 "*Sustainable Artificial Internet of Things (SAIoT)*" (2024–2028)
- TEM-TA96 "*CO2-derived carbon materials for energy storage and production*" (2025–2028)

SELECTED PUBLICATIONS

Barghi, B.; Mõistlik, T.; Panov, D.; Raag, A.; Järvik, O.; Niidu, A. (2025). Kinetic Modeling of Deep Oxidative Desulfurization over Functionalized UiO-66 from a Model Fuel Using Complex Reaction Theory. ACS Omega, 10 (16), 15947−15958. DOI: 10.1021/acsomega.4c06722.

Barghi, B.; Mõistlik, T.; Raag, A.; Volokhova, M.; Reile, I.; Seinberg, L.; Mikli, V.; Niidu, A. (2024). Deep Oxidative Desulfurization of Planar Compounds Over Functionalized Metal-Organic Framework UiO-66(Zr): An Optimization Study. ACS Omega, 9 (22), 23329−23338. DOI: 10.1021/acsomega.3c09971.

Barghi, Bijan; Jürisoo, Martin ; Volokhova, Maria; Seinberg, Liis; Reile, Indrek; Mikli, Valdek; Niidu, Allan (2022). Process Optimization for Catalytic Oxidation of Dibenzothiophene over UiO-66-NH2 by Using Response Surface Methodology. ACS Omega, 7 (19), 16288−16297. DOI: 10.1021/acsomega.1c05965.

DEVELOPMENT OF ROBOT-HUMAN CO-CREATION WORKING GROUP

Head of the working group: Senior Lecturer OLGA DUNAJEVA, olga.dunajeva@taltech.ee

Members: Jüri Majak, Žanna Gratšjova, Rivo Lemmik, Sergei Pavlov, Sónia Cláudia Da Costa Sousa, Mati Mõttus, Mare Roosileht, Siarhei Autsou, Žanna Gratšjova, Viktor Rjabtšikov, Monika Kiik

Doctoral students: Avar Pentel, Kadri Kristjuhan-Ling, Mustafa Can Özdemir, Oleg Shvets

TOPICS AND COMPETENCES

KEYWORDS: human-robot interaction; modelling; testing; artificial intelligence; robotisation of production processes; robotic workplace design; risk assessment and analysis; user trust

The working group focuses on the topic of collaborative robotics. Research areas include the study of social and psychological aspects of human-robot interaction (HRI), HRI modeling, assessment and analysis of impact factors and risks, user trust in robotic systems, robotic workplace design. The goal is to develop a methodologies and validated human-robot interaction models, impact and risk assessments. The provision of user-centered design services is also considered important.

The main activities **IN 2025**, the main outcome of the research group is the establishment of a Human–Robot Interaction (HRI) laboratory in Ida Virumaa. The focus of the laboratory is research in the field of human–robot interaction, with emphasis on the specific needs and challenges of industry in Ida-Virumaa. The laboratory enables the investigation and modelling of the psychological aspects of human-machine collaboration, human-centred workplace design, trust-related constructs, and the adaptability of devices and systems within production processes. The research group has developed an initial service package to offer companies opportunities for education, innovation, and collaboration in human–robot interaction in the Ida-Virumaa region, supporting and promoting local industrial sectors.

SELECTED PROJECTS

- ÕÜF9 RIKT "*Development of robot-human co-creation in Industry*" (2023–2029)
- TF23059 "*Increasing the volume of continuing education in Ida-Viru and developing and launching new level education curricula in vocational and higher education*" (2023–2029)

SELECTED ARTICLES:

Autsou, S.; Dunajeva, O.; Pentel, A.; Shvets, O.; Roosileht, M. (2025). Application of Fuzzy Logic for Collaborative Robot Control. Electronics, 14 (20, 4029), 1–27. DOI: 10.3390/electronics14204029.

Matsulevitš, J.; Majak, J.; Eerme, M.; Sarkans, M.; Dunajeva, O.; Kristjuhan-Ling, K.; Raamets, T.; Kekšin, V. (2025). Human-robot interaction: a conceptual framework for safety/risk analysis. Proceedings of the Estonian Academy of Sciences, 74 (2), 137–142. DOI: 10.3176/proc.2025.2.09.

Raamets, T.; Karjust, K.; Majak, J.; Hermaste, A. (2025). Implementing an AI-Based Digital Twin Analysis System for Real-Time Decision Support in a Custom-Made Sportswear SME. Applied Sciences, 15, 14, #7952. DOI: 10.3390/app15147952.

LABORATORY OF FUELS TECHNOLOGY

Head of the laboratory: Researcher OLGA PIHL, olga.pihl@taltech.ee

Members: Hella Riisalu, Larisa Grigorieva, Aleksei Penežko, Viktoria Petrova, Maria Tšepelevitš, Larissa Kruglenkova, Dmitri Suštšik, Jelena Upan, Olga Suštšik, Nadežda Merkulova, Julia Kravetskaja, Aleksandr Nossov, Eduard Pihl, Olga Kornõljeva

TOPICS AND COMPETENCES

KEYWORDS: waste fuels, waste, pyrolysis, co-pyrolysis, two-stage pyrolysis, hydrogenation, semi-coking, distillation, solid and liquid fuels, water and gas analysis, phenols, standardization

The Laboratory of Fuels Technology at Oil Shale Competence Center (OSCC) offers both direct research and analysis services in accredited areas.

THE LABORATORY'S RESEARCH MAIN DIRECTIONS ARE:

- Organic substances (including waste, plastics, tyres, RDF, SRF) pyrolysis (pyrolysis, two-stage pyrolysis, hydrogenation) at various temperatures and conditions.
- The analysis of technological properties and composition of the obtained products.

Particular attention is paid to the co-processing/processing of different materials to produce the desired chemicals. Co-processing of waste with stored oil-shale ash provides good prerequisites to be the basis for the development of industrial technology for the recycling of non-recyclable waste.

The laboratory's competencies include determining the quality of solid and liquid fuels in accordance with standards and determining the component composition of samples of gases and liquids using chromatography and mass-spectrometry methods.

The Laboratory is accredited in accordance with the requirements of the standard EVS-EN ISO / IEC 17025: 2017. The laboratory is in the working group of the Estonian Centre for Standardisation and Accreditation EVS / TK 57 "Processing of oil shale and oil shale products".

More information: *https://taltech.ee/en/oil-shale-competence-center/services*

SELECTED PROJECTS

- ÕÜF18 "*Development of a process for chemical recycling of waste non-suitable for mechanical recycling*" (2023–2029)
- TK228 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)
- LEVEE25007 "*Catalyst production*" (2025–2025)

SELECTED PUBLICATION

Penezko, A.; Pihl, O.; Sustsik, D.; Nossov, A.; Khaskhachikh, V. (2025). Production of hydrogen from packaging wastes by two-stage pyrolysis. Waste Management, 206, #115068. DOI: 10.1016/j.wasman.2025.115068.

MECHANICAL ENGINEERING AND ENERGY TECHNOLOGY PROCESSES CONTROL WORK GROUP

Head of the working group: Senior Lecturer VEROONIKA SHIROKOVA, veroonika.shirokova@taltech.ee

Members: Tatjana Baraškova, Sergei Bereznev, Karolina Kudelina, Elizaveta Shmagina

TOPICS AND COMPETENCES

KEYWORDS: nanocomposite materials; anti-corrosion coatings; renewable energy; solar panels; sustainability measurements; equipment diagnostics, , physical and mechanical properties of materials

The work group's scientific activities are focused on the following areas:

- Implementation of innovative renewable energy technologies (e.g. solar panels, wind power plants, micro-cogeneration, etc.) in the electricity system;
- Integration of novel storage technologies (e.g. hydrogen technologies, including the production and storage of ammonia and synthesis gas, Li-Ion batteries, etc.) into the electricity system;
- Adoption of advanced flexibility technologies (e.g. examining storage options in industrial processes, including heat and air storage, for offering flexibility services);
- Application of digital and AI-based solutions (e.g., analysis, forecasting, management, protection, security solutions, and monitoring systems for energy production, storage, and consumption) in energy systems;
- Solutions and implementation of small-scale and community-based energy;

- Advanced materials to ensure energy efficiency, specifically researching polymer nanocomposite protective and thermoemission films for solar and hydrogen energy;
- Universal anti-corrosion coatings based on polymer nanocomposites for broad industrial applications;
- Sustainable measurement technologies (LIDAR technologies, object measurement for material consumption and quality assessment, vibration measurements, and analysis);
- Equipment/drivers diagnostics (early fault detection, including in shafts, bearings, belts). Real-time monitoring of technological processes. Vibration measurements.
- Experimental investigation of the physical and mechanical properties of materials with different origins and compositions, including the analysis of micro- and nanohardness, microstructure, surface roughness, and wear resistance. The research also involves tensile, compression, and other mechanical tests to assess the durability and suitability of materials for various engineering applications.

IN 2025, the research group systematically developed and implemented new research and development capabilities in nanocomposite materials for renewable energy and energy storage technologies. During this period, a full set of planned scientific equipment was acquired and put into operation, enabling the establishment of the Sustainable Energy Materials Technology Laboratory. The new infrastructure is actively used in research, education, and industrial collaboration, supporting master's theses and providing analytical and technical services to regional companies.

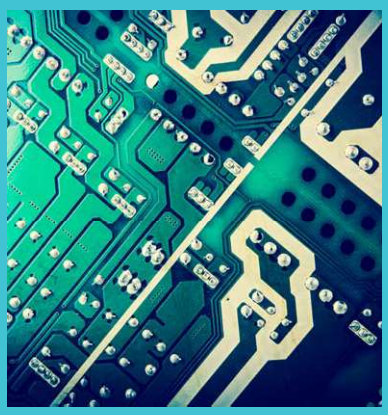
SELECTED ARTICLES

Baraškova, T.; Kudelina, K.; Shirokova, V. (2024). New Opportunities in Real-Time Diagnostics of Induction Machines. Energies, 17 (13), #3265. DOI: 10.3390/en17133265.

Shmagina, E.; Antonov, M.; Kasikov, A.; Volobujeva, O.; Khabushev, E. M.; Kallio, T.; Bereznev, S. (2024). Structural, Mechanical, and Optical Properties of Laminate-Type Thin Film SWCNT/SiOxNy Composites. Nanomaterials, 14, 22, #1806. DOI: 10.3390/nano14221806.

Barashkova,T.; Shirokova, V. (2023). Efficiency of diagnosing the condition of rolling bearings in real time. Ukrainian Metrological Journal, 4, 34–38. DOI: 10.24027/2306-7039.4.2022.276322.

SCHOOL OF INFORMATION TECHNOLOGIES



SCHOOL OF INFORMATION TECHNOLOGIES

Dean: Tenured Full Professor GERT JERVAN

e-mail: gert.jervan@taltech.ee

Vice-Dean for Research: Tenured Associate Professor MAIE BACHMANN

e-mail: maie.bachmann@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

307 Academic staff — Incl. 41 professors, 211 researchers

146 Doctoral students — 25 Defended doctoral dissertations

292 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

DEPARTMENTS

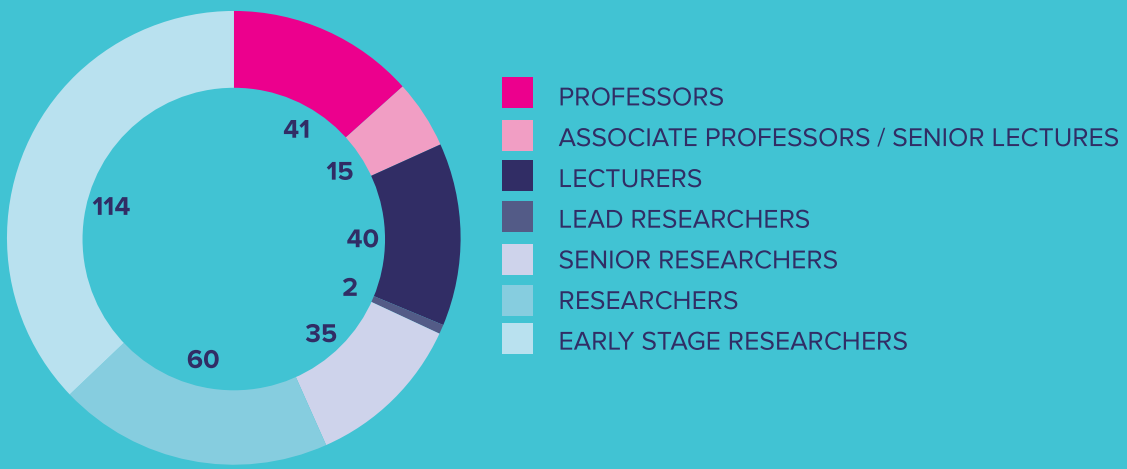
DEPARTMENT OF COMPUTER SYSTEMS
Director: Associate Professor MARGUS KRUUS, margus.kruus@taltech.ee

DEPARTMENT OF SOFTWARE SCIENCE
Director: Associate Professor MARKO KÄÄRAMEES, marko.kaaramees@taltech.ee

DEPARTMENT OF HEALTH TECHNOLOGIES
Director: Assistant Professor JANA HOLMAR, jana.holmar@taltech.ee

THOMAS JOHANN SEEBECK DEPARTMENT OF ELECTRONICS
Director: Senior Researcher ALAR KUUSIK, alar.kuusik@taltech.ee

IT COLLEGE
Director: Associate Professor SIRJA SULAKATKO, sirja.sulakatko@taltech.ee



DEPARTMENT OF COMPUTER SYSTEMS

Direktor: Associate Professor
MARGUS KRUUS,
margus.kruus@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

64 Academic staff — Incl. 10 professors, 46 researchers

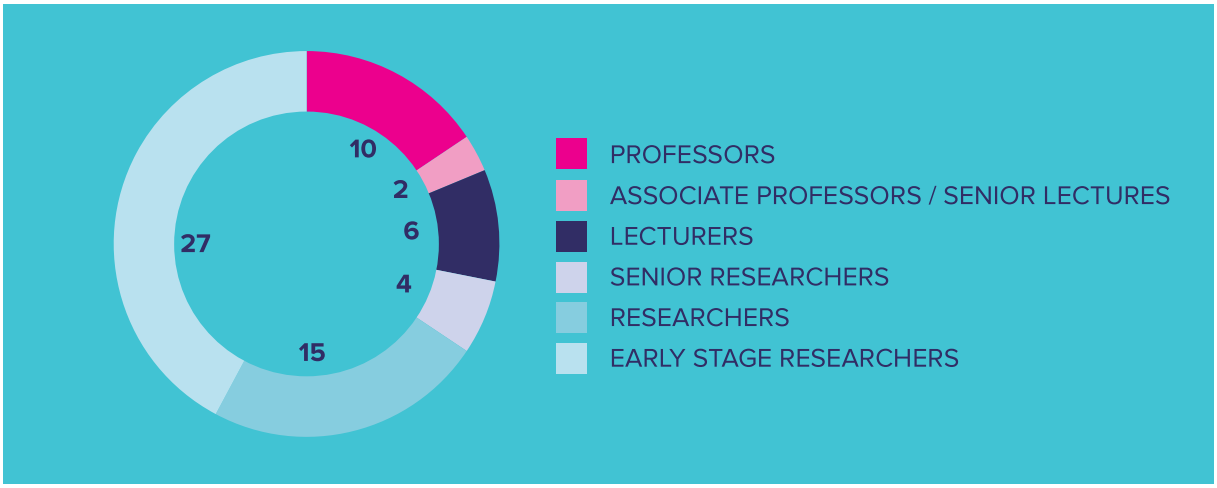
36 Doctoral students — 8 Defended doctoral dissertations

69 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH CENTRES:

- **CENTRE FOR BIOROBOTICS.**
  Head: Tenured Full Professor MAARJA KRUUSMAA, maarja.kruusmaa@taltech.ee
- **CENTRE OF DEPENDABLE COMPUTING SYSTEMS.**
  Head: Tenured Full Professor JAAN RAIK, jaan.raik@taltech.ee
- **CENTRE FOR ENVIRONMENTAL SENSING AND INTELLIGENCE.**
  Head: Tenured Associate Professor TUHTAN JEFFREY ANDREW, jeffrey.tuhtan@taltech.ee
- **CENTRE FOR HARDWARE SECURITY.**
  Head: Senior Researcher LEVENT AKSOY, levent.aksoy@taltech.ee
- **CENTRE FOR INTELLIGENT SYSTEMS.**
  Head: Tenured Full Professor EDUARD PETLENKOV, eduard.petlenkov@taltech.ee
- **CENTRE FOR TRUSTWORTHY AND EFFICIENT COMPUTING HARDWARE (TECH).**
  Head: Tenured Associate Professor MAKSIM JENIHHIN, maksim.jenihhin@taltech.ee
- **EMBEDDED AI RESEARCH LAB.**
  Head: Senior Researcher MAIRO LEIER, mairo.leier@taltech.ee



CENTRE FOR BIOROBOTICS

Head of the centre: Tenured Full Professor MAARJA KRUUSMAA, maarja.kruusmaa@taltech.ee

Members: Asko Ristolainen, Margit Egerer, Laura Piho, Elizaveta Dubrovinskaya, Simon Pierre Godon, Jaan Rebane, Andres Ernits, Pavlo Kupyn

Doctoral students: Yuya Hamamatsu, Bauyrzhan Zhakanov, Dimitris Xydianos, Gabrielle Tessa Witt, Idris Hammouche, Roza Gkliva, Youcef Abdelmoumene Aouf

TOPICS AND COMPETENCES

KEYWORDS: underwater robotics and control, underwater sensing, locomotion in multiphase environ-ments, mapping and navigation

The Centre for Biorobotics specializes in research and development of underwater robotics and sens-ing. On the robotics side we are focusing on development of locomotion and control in underwater and multiphase environments, where conventional land and underwater platforms are underperforming. In connection with robotics, we are focusing on using bioinspired sensing methods in combination with conventional tools to improve situational awareness and navigation performance of our robots. Apart from robotics, we are also applying the bioinspired sensing methods in water flow sensing in natural environments (rivers, coast etc.).

Our core competences are:

- Development and manufacturing of underwater robotic platforms.
- Robot locomotion and control in multiphase environments.
- Underwater sensing with applications in natural environments
- Mapping and navigation of unstructured environments.

IN 2025: The H2020 Project PIPEON, *Robotics and AI for Sewer Pipe Inspection and Maintenance* (total funding 8M€) was launched under the coordination of the Biorobotics Centre. PIPEON develops robotic and AI technologies for autonomous sewer inspection and maintenance to improve monitoring capabilities of sewage companies and reduce costs, enabling timely maintenance of the sewer system. The project includes 12 partners from seven countries.

We developed underwater drone control methods that address both model-based control algorithms and data-driven machine learning methods to control maneuverable underwater drones and ensure drone fault tolerance.

SELECTED PROJECTS

- VHE24076 "*Robotics and AI for Sewer Pipe Inspection and Maintenance*" (2025–2028)
- PSG940 "*AutoMap Extreme – Near Real-Time Mapping of Data in Extreme Environments*" (2024–2028)
- MOBJD1212 "*Pressure Sensor Based Sea Monitoring*" (2023–2025)

SELECTED PUBLICATIONS

Godon, S.; Prados, C.; Chemori, A.; Ristolainen, A.; Kruusmaa, M. (2025). Walking in Mud: Modeling, Control, and Experiments of Quadruped Locomotion. IEEE/ASME Transactions on Mechatronics, 1–12. DOI: 10.1109/TMECH.2025.3560588.

Hamamatsu, Y.; Remmas, W.; Rebane, J.; Kruusmaa, M.; Ristolainen, A. (2025). Cross-Platform Learning-Based Fault Tolerant Surfacing Controller for Underwater Robots. 2025 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 11263–11269. DOI: 10.1109/ICRA55743.2025.11127355.

Hamamatsu, Y.; Kupyn, P.; Gkliva, R.; Ristolainen, A.; Kruusmaa, M. (2025). Underwater Soft Fin Flapping Motion with Deep Neural Network Based Surrogate Model. 2025 IEEE 8th International Conference on Soft Robotics (RoboSoft). IEEE, 1–6. DOI: 10.1109/RoboSoft63089.2025.11020964.

For more information please visit *https://taltech.ee/en/biorobotics*

CENTRE OF DEPENDABLE COMPUTING SYSTEMS

Head of the centre: Tenured Full Professor JAAN RAIK, jaan.raik@taltech.ee

Members: Gert Jervan, Peeter Ellervee, Thomas Hollstein, Masoud Daneshtalab, Tara Ghasempouri, Ali Emre Karatopuk, Marten Roots, Madis Kerner

Post-doctoral fellow: Ali Azarpeyvand

Doctoral students: Mohammad Hasan Ahmadilivani, Abdul Haseeb, Muhammad Hassan, Sharjeel Imtiaz

TOPICS AND COMPETENCES

KEYWORDS: nanoelectronics design, reliability, security, verification and test; multi-/many-core systems; reliability of neural network accelerators

The research in the Centre for Dependable Computing Systems covers a wide range of topics in the areas of design, reliability, security, verification and testing of nanoelectronic systems (including multi-/many-core systems).

The main research activities are the following:

- AI Chips (cooperation with ETH Zürich, EC Lyon, University of Bologna);
- Hardware security (cooperation with TU Delft, LIRMM/University of Montpellier, Airbus, Frankfurt UAS);
- Cross-layer resilience in sensor networks (cooperation with Testonica Lab OÜ);
- Verification (assertion mining) (cooperation with EPFL/Lausanne, TU Hamburg, DLR).

The centre has been the initiator of several pan-European actions.

More information: *https://taltech.ee/en/research-groups-DCS#p15811*

The most significant results of **2025** were:

In March, the Estonian Chip Competence Center KIIP was founded. The project coordinator is the head of the research group J. Raik.

The international scientific conference IEEE European Test Symposium was organized in Tallinn under the leadership of the research group, which was visited by more than 240 delegates.

SELECTED PROJECTS

- VHE25036 "*Next Generation Open Innovations in Trustworthy Embedded AI Architectures for Smart Cities, Mobility and Logistics*" (2025–2028)
- PSG837, *Cross-level hardware security verification with semi-formal methods* (2023–2027)
- VFP21031IA "*Artificial Intelligence threat Reporting and Incident response System*" (2022–2024)

SELECTED PUBLICATIONS

Ahmadilivani, M.H.; Taheri, M; Raik, J.; Daneshtalab, M.; Jenihhin, M. (2024). A Systematic Literature Review on Hardware Reliability Assessment Methods for Deep Neural Networks. ACM Computing Surveys, 56 (6), 1–39. DOI: 10.1145/3638242.

Taheri, M.; Cherezova, N.; Nazari, S.; Azarpeyvand, A.; Ghasempouri, T.; Daneshtalab, M.; Raik, J.; Jenihhin, M. (2024). AdAM: Adaptive Approximate Multiplier for Fault Tolerance in DNN Accelerators. IEEE Transactions on Device and Materials Reliability, 1–11. DOI: 10.1109/TDMR.2024.3523386.

Roberts, A.; Heidari Iman, M.; Bellone, M.; Ghasempouri, T.; Raik, J.; Maennel, O.; Hamad, M.; Steinhorst, S. (2024). ADAssure: Debugging Methodology for Autonomous Driving Control Algorit-hms. 2024 Design, Automation and Test in Europe Conference (DATE): Valencia, Spain, 25–27 March 2024. IEEE, 1–6. DOI: 10.23919/DATE58400.2024.10546519.

CENTRE FOR ENVIRONMENTAL SENSING AND INTELLIGENCE

Head of the centre: Tenured Associate Professor JEFFREY ANDREW TUHTAN, jeffrey.tuhtan@taltech.ee

Members: Jaan Rebane, Andres Ernits, Helena Carmen Udu, Michael James Crooks, Elizaveta Dubrovinskaya, Gert Toming, Ali Hassan Khan, Ivan Volkov

Doctoral students: Konstantin Bilozor, Aleksandr Ivanov, Alexandra Kolosova, Kris-Robin Sirge

TOPICS AND COMPETENCES

KEYWORDS: hydropower, underwater sensing, computer vision, open government data

The Centre for Environmental Sensing and Intelligence is specialized in the development and deployment of rugged multi-modal sensors for measurements in extreme environments, data-driven modelling and eco- and ethohydraulics.

Core competences of the centre are:

- Underwater sensing in extreme environments including hydropower turbines, rivers, coastlines and glaciers.
- Real-time signal processing for rugged and reliable multi-modal autonomous sensors.
- Data-driven modeling and assimilation of outdoor sensor network data with numerical models.
- Eco- and ethohydraulic sensing and modelling, with a focus on fish and hydropower.
- Underwater multispectral cameras and automated vision methods for detection and tracking in adverse environments.

More information: *https://taltech.ee/en/environmental-sensing-and-intelligence-group*

IN 2025:

Creation and field testing of real-time underwater camera systems for automated fish species and migration.

Participation in the largest European development project on new pumping station designs to improve fish safety.

Development and implementation of a large-scale underwater monitoring system for the German Federal Hydrological Institute.

SELECTED PROJECTS

- TFM23075 "*OsteoSense: Academic and commerical solution for user-friendly human motion and bone loading analysis during indoor and outdoor exercise and rehabilitation*" (2024–2025)
- PRG2198 "*MultiFlow – Multiscale Natural Flow Sensing for Coasts and Rivers*" (2024–2028)

- VFP19046 "*River flow regulation, fish Behaviour and Status*" (2020–2023)

SELECTED PUBLICATIONS

Kösters, W. I.; Tuhtan, J. A.; Efimov, D.; Kruusmaa, M.; Hoerner, S. (2025). An open laboratory blade strike rig to evaluate the risk of injury and mortality to fish and to test passive sensors. Sustainable Energy Technologies and Assessments, 81 (104427), 1–13. DOI: 10.1016/j.seta.2025.104427.

Motta, F.; Chieffo, C.; Monoli, C.; Tuhtan, J.A.; Galli, M. (2025). Land and Underwater Estimation of Joint Angles Using MOCAP, experimental IMUs and OpenSense. IEEE Sensors Journal, 1–8. DOI: 10.1109/JSEN.2025.3565835.

Tuhtan, J.A.; Mockenhaupt, B.; de Schaetzen, F.; Issa, R.W.; Bertaud, A.; Sidler, D.; Müller, H.; Haas, C. (2025). AI video monitoring of aquatic organisms – opportunities, limits and best practice recommendations. WASSERWIRTSCHAFT, 115 (11), 54–61. DOI: 10.1007/s35147-025-2583-1.

CENTRE FOR HARDWARE SECURITY

Head of the centre: Senior Researcher LEVENT AKSOY, levent.aksoy@taltech.ee

Member: Mohammad Eslami

Post-doctoral fellow: Partha De

Doctoral student: Muhammad Sohaib Munir

TOPICS AND COMPETENCES

KEYWORDS: hardware security, trustworthy integrated circuits, ASICs, crypto hardware, obfuscation

The Centre for Hardware Security conducts research in all applied aspects of hardware security: the aim is to validate security techniques in real silicon. The Centre's research on integrated circuit (IC) design, electronic design automation (EDA), and cryptographic hardware enables trustworthy IC-based systems to be built. Threats such as hardware Trojans, reverse engineering, circuit (de)obfuscation, IP piracy, IC overbuilding, side-channel attacks, etc., are addressed through an array of technical countermeasures.

Core competences of the centre are:

- Design of Application Specific Integrated Circuits.
- Circuit obfuscation.
- Trustworthy electronic design automation tooling (from RTL to layout).
- Countermeasures to reverse engineering, side channel attacks, and piracy.
- Crypto hardware, including conventional and post-quantum cryptography.

IN THE YEAR 2025, researchers of the centre published in prestigious conferences and journals, such as Design and Test in Europe Conference (DATE), IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), and IEEE Transactions on Very Large Scale Integration Systems (TVLSI).

We discussed the security of the well-known reconfigurability-based obfuscation technique and showed that techniques that do not rely on provably secure techniques are vulnerable to potential attacks.

We introduced a removal and structural analysis attack against a compound logic locking technique for the first time, which is based on our attack against prominent logic locking techniques presented in our DATE'24 paper.

SELECTED PROJECTS

- TEM-TA138 "*Sustainable Artificial Internet of Things*" (SAIoT) (2024–2028)
- ETAG24040 "*EAGER: Hardware-Efficient Realization of UA Cryptographic Standards*" (2024–2026)
- VHE24037 "*Boosting TalTech Capacity in Reliable and Efficient AI-Chip Design*" (2024–2027)

SELECTED PUBLICATIONS

Almeida, F.; Aksoy, L.; Pagliarini, S.; (2025). RESAA: A Removal and Structural Analysis Attack Against Compound Logic Locking. IEEE Transactions on Very Large Scale Integration (VLSI) Systems, 1–13 [in press].

Aksoy, L.; Yasin, M.; Pagliarini, S. (2024). KRATT: QBF-Assisted Removal and Structural Analysis At-tack Against Logic Locking. 2024 Design, Automation & Test in Europe Conference & Exhibition (DATE): Valencia Spain, 25–27 March 2024. IEEE, 1–6. DOI: 10.23919/DATE58400.2024.10546552.

Aksoy, L.; Roy, D.B.; Imran, M.; Pagliarini, S.N. (2024). Multiplierless Design of High-Speed Very Large Constant Multiplications. 2024 29th Asia and South Pacific Design Automation Conference (ASP-DAC 2024): 29th Asia and South Pacific Design Automation Conference, Incheon, South Korea, 22–25 Jan. 2024. IEEE Computer Society, 957–962. DOI: 10.1109/ASP-DAC58780.2024.10473954.

For more information please visit: *https://taltech.ee/en/research-groups-DCS#p16436*

CENTRE FOR INTELLIGENT SYSTEMS

Head of the centre: Tenured Full Professor EDUARD PETLENKOV, eduard.petlenkov@taltech.ee

Members: Kristina Vassiljeva, Aleksei Tepljakov, Vitali Vansovitš, Kadri Umbleja, Komeil Nosrati, Ahmet Köse, Saleh Ragheb Saleh Alsaleh

Doctoral student: Azer Ramazanli, Hossein Alimohammadi, Maksimilian Tarasevich, Olutosin Ajibola Ademola, Sofia Vasman, Majid Ghorbani, Ivan Sukhanov, Konstantin Panfilov, Azad Aliyev, Mahmoud Ahmed Ali Bakeer

TOPICS AND COMPETENCES

KEYWORDS: control, modelling of dynamic systems, computational intelligence, machine learning, adaptive and self-learning systems, extended reality, digital twins, energy efficient control

The core competences of the Centre for Intelligent Systems are:

- Modelling, control, and analysis of complex nonlinear dynamic systems;
- Computational Intelligence based algorithms: Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic, etc.;
- Self-learning and adaptation methods in control systems;
- Fractional-order modelling and control;
- Distributed control systems;
- Data analysis;
- Development of research software;
- Virtual and Augmented Reality applications;
- Digital twins;
- Energy efficient control;
- Buildings automation, modelling and performance analysis.

The research group focuses on development and implementation of novel efficient control techniques for Industry 4.0 applications based on the combination of classical industrial controllers with computational intelligence methods and knowledge-based reasoning.

IN 2025: The main scientific results of the group are devoted to energy efficient control of complex systems.

The developed algorithms enable the modeling and control of complex nonlinear industrial processes. A genetic algorithm (genetic programming) based approach has been successfully applied to determine the optimal model structure. The developed methods are tested both in the research laboratory of the Centre and applied in practice in cooperation with our industrial partners.

The developed algorithms have been implemented in software and are freely available on MathWorks File Exchange and GitHub for both MATLAB and Python:

- https://www.mathworks.com/matlabcentral/fileexchange/66323-fomcon-toolbox-for-matlab
- https://github.com/outstandn/fomcon
- https://github.com/extall/fomcon-matlab

These algorithms are continuously being developed, extended, and updated.

An application software framework for automation engineers and researchers has also been developed, the first version of which is already available as open-source software: https://apc-simple.net

SELECTED PROJECTS

- VHE23048 "ENFIELD: European Lighthouse to Manifest Trustworthy and Green AI" (2023–2026)
- TF24019IA, Centre of Excellence in Energy Efficiency (2024–2030)
- TEM-TA78 Data-driven assessment of the potential and impact of energy saving flexibility technologies in buildings (2024–2028)

SELECTED PUBLICATIONS

Nosrati, K.; Belikov, J.; Tepljakov, A.; Petlenkov, E. (2024). Revisiting LQR problem of singular systems. IEEE/CAA Journal of Automatica Sinica, 11 (11), 2236–2252. DOI: 10.1109/JAS.2024.124665.

Nosrati, K.; Skiparev, V.; Tepljakov, A.; Petlenkov, E.; Belikov, J. (2024). Intelligent frequency control of AC microgrids with communication delay: An online tuning method subject to stabili-zing parameters. Energy and AI, 18, Art. 100421; 15 pp. DOI: 10.1016/j.egyai.2024.100421.

Ghorbani, M.; Tepljakov, A.; Petlenkov, E. (2024). On Robust Stability of Uncertain Control Systems With Time Delay: An Approach Based on the Overlap of Value Sets. IEEE Transactions on Automatic Control, 69 (9), 6349–6356. DOI: 10.1109/TAC.2024.3381912.

Homepage: http://is-centre.eu/.

CENTRE FOR TRUSTWORTHY AND EFFICIENT COMPUTING HARDWARE (TECH)

Head of the centre: Tenured Associate Professor MAKSIM JENIHHIN, maksim.jenihhin@taltech.ee

Members: Artur Jutman, Sergei Devadze, Anton Tšertov, Raimund-Johannes Ubar, Dmitri Mihhailov, Konstantin Shibin

Doctoral students: Hardi Selg, Mahdi Taheri, Natalia Cherezova, Ahsan Rafiq, Ashwin Santhosh, Hafsa Tanveer, Rama Mounika Kodamanchili

TOPICS AND COMPETENCES

KEYWORDS: edge-AI accelerators, hardware design, cost-efficient computing, trust-efficient computing, reliability, functional safety, system health awareness, predictive maintenance, embedded systems, intelligent autonomous systems, machine learning

The Research Centre focuses on edge-AI hardware and cross-layer reliability and self-health awareness technology for tomorrow's complex intelligent autonomous systems and IoT edge devices in Estonia and EU. The team studies advanced cyber-physical systems characterized by their heterogeneity and the emerging computing architectures employing AI-based autonomy. The centre generates knowledge to equip engineers with design-phase solutions and in-field instruments for industry-scale systems to facilitate system's crashless operation.The core competences of the group are:

- Hardware design
  - VHDL and Verilog designs
  - EDA tools (Cadence, Siemens, Synopsys platforms)
  - Application-specific computing platforms (Unmanned Aerial Vehicles)
- FPGA-based solutions and methodologies
  - FPGA SoCs (Zynq, CycloneV)
  - EDA tools (Xilinx Vivado, Altera/Intel Quartus, Lattice Diamond)
- Software and embedded SW development
  - Bare-metal applications, bootloaders, Linux drivers and Userspace applications,
  - Petalinux, Yocto, FreeRTOS and embedded SDKs, ELDK
- Cross-layer reliability and fault management
  - ML-based solutions
  - Functional Safety (ISO26262)
- Test strategy development and troubleshooting instrumentation
  - JTAG/IJTAG based solutions (standards IEEE-1149.1, IEEE-1149.6, IEEE-1687)

IN 2025: Work within the TIRAMISU and TAICHIP projects, launched last year, is actively progressing.

In 2025, TARK-TECH working group launched a new international collaboration with CERN by joining work package 7.2b of the DRD7 project and contributing to research and development activities of the Muon System of the LHCb experiment. This collaboration complements the department's ongoing involvement with the CMS BRIL group (Beam

Radiation Instrumentation and Luminosity), expanding the institute's contribution to cutting edge detector technologies, radiation measurements, electronics, and data processing solutions, and increasing Estonia's visibility within major international research infrastructures.

SELECTED PROJECT

- PRG1467 "*CRASHLESS – Cross-Layer Reliability and Self-Health Awareness for Intelligent Autonomous Systems*" (1.01.2022–31.12.2026)
- VHE24037 "*Boosting TalTech Capacity in Reliable and Efficient AI-Chip Design*" (2024–2027)
- VHE24034 "*Training and Innovation in Reliable and Efficient Chip Design for Edge AI*" (2024–2028)

SELECTED PUBLICATIONS

Ubar, R.; Raik, J.; Jenihhin, M.; Jutman, A. (2024). Structural Decision Diagrams in Digital Test. Springer Nature Switzerland AG 2024. DOI: 10.1007/978-3-031-44734-1.

Taheri, M.; Cherezova, N.; Nazari, S.; Azarpeyvand, A.; Ghasempouri, T.; Daneshtalab, M.; Raik, J.; Jenihhin, M. (2024). AdAM: Adaptive Approximate Multiplier for Fault Tolerance in DNN Accelerators. IEEE Transactions on Device and Materials Reliability, 1–11. DOI: 10.1109/TDMR.2024.3523386.

Cherezova, N.; Jutman, A.; Jenihhin, M. (2025). FORTALESA: Fault-tolerant reconfigurable systolic array for DNN inference. Microprocessors and Microsystems, 119, 105222. DOI: 10.1016/j.micpro.2025.105222.

EMBEDDED AI RESEARCH LABORATORY

Head of the laboratory: Senior Researcher MAIRO LEIER, mairo.leier@taltech.ee

Members: Uljana Reinsalu, Karl Janson, Jüri Bogatkin, Anton Jaštšuk, Jaanika Valdvee, Jüri Kajava

Doctoral students: Jürgen Soom, Olutosin Ajibola Ademola, Can Ersü, Mohamed Nazrul Mohamed Nazeer

TOPICS AND COMPETENCES

KEYWORDS: embedded machine learning, edge computing, embedded systems design, signal processing

The Embedded AI Research Lab focuses on developing and optimizing machine learning solutions in the embedded systems (edge computing). The laboratory collaborates internationally with research teams and companies from the maritime, smart city, autonomous vehicles and industrial automation sectors. Main focus is on maritime and mobility solutions.

Core competencies:

- Embedded hardware design and prototyping;
- Machine learning model optimization for embedded hardware;
- Hardware accelerators for edge computing;
- Image and video processing on edge devices;
- Radar and vision sensor fusion.

Important results **IN 2025:**

The research focused on the topics of UAV and UGV localization and navigation.

Fly or Die hackathon was organized.

SELECTED PROJECTS

- TF24032TJ "*FinEsCentre for Smart Cities – implementation of activities*" – UrbanSplash pilot project (2024–2027)
- MINM25032 "*Determination of vehicle windshield damage sizes (scale) for repair recommendation AI*" (2025–2027)

SELECTED PUBLICATION

Robal, T.; Reinsalu, U. (2025). How Do You Ride an Elevator? Passenger In-Cabin Behavior Analysis on a Smart-Elevator Platform.

In: Kornyshova, E., Deneckère, R., Brinkkemper, S. (Ed.). Smart Life and Smart Life Engineering : Current State and Future Vision. (209–236). Springer, Cham. DOI: 10.1007/978-3-031-75887-4_10.

Soom, J.; Leier, M.; Janson, K.; Tuhtan, J.A. (2024). Open Urban mmWave Radar and Camera Vehicle Classification Dataset for Traffic Monitoring. IEEE Access, 12, 65128–65140. DOI: 10.1109/ACCESS.2024.3397013.

Ersü, C.; Petlenkov, E.; Janson, K. (2024). A Systematic Review of Cutting-Edge Radar Technologies: Applications for Unmanned Ground Vehicles (UGVs). Sensors, 24 (23), #7807. DOI: 10.3390/s24237807.

More information: *https://iot.ttu.ee*

DEPARTMENT OF SOFTWARE SCIENCE

Director: MARKO KÄÄRAMEES,
marko.kaaramees@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

147 Academic staff — Incl. 18 professors, 105 researchers

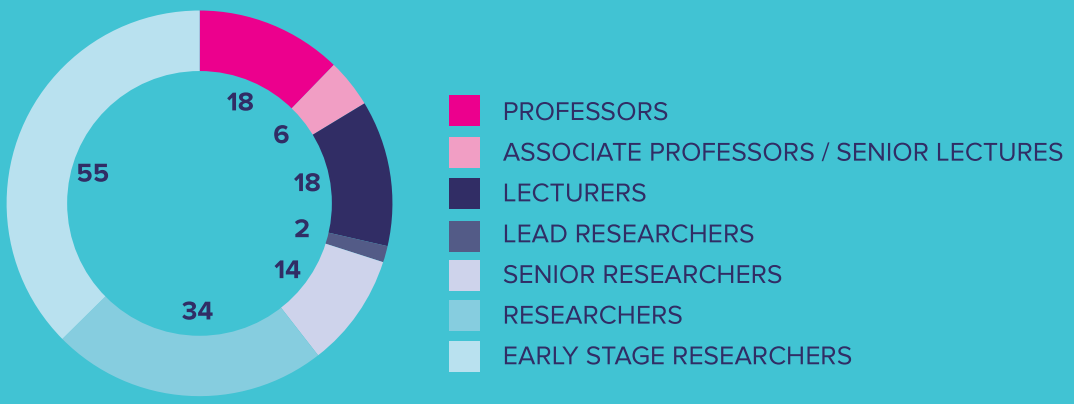
74 Doctoral students — 9 Defended doctoral dissertations

148 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 10 RESEARCH UNITS:

- **APPLIED ARTIFICIAL INTELLIGENCE GROUP.**
  Head: Senior Lecturer AGO LUBERG, ago.luberg@taltech.ee
- **BUSINESS INFORMATION TECHNOLOGY GROUP.**
  Head: Senior Lecturer ANTS TORIM, ants.torim@taltech.ee
- **CENTRE FOR DIGITAL FORENSICS AND CYBER SECURITY.**
  Head: Tenured Associate Professor RAIN OTTIS, rain.ottis@taltech.ee
- **HIGH-ASSURANCE SOFTWARE LABORATORY.**
  Head: Lead Research Scientist TARMO UUSTALU, tarmo.uustalu@taltech.ee
- **INFORMATION SYSTEMS GROUP.**
  Head: Tenured Full Professor DIRK DRAHEIM, dirk.draheim@taltech.ee
- **LABORATORY FOR COMPOSITIONAL SYSTEMS AND METHODS.**
  Head: Tenured Full Professor PAWEŁ MARIA SOBOCIŃSKI, pawel.sobocinski@taltech.ee
- **LABORATORY OF LANGUAGE TECHNOLOGY.**
  Head: Tenured Associate Professor TANEL ALUMÄE, tanel.alumae@taltech.ee
- **LABORATORY OF PROACTIVE TECHNOLOGIES.**
  Head: Senior Researcher JAANUS KAUGERAND, jaanus.kaugerand@taltech.ee
- **NEXT GEN DIGITAL STATE RESEARCH GROUP.**
  Head: Associate Professor INGRID PAPPEL, ingrid.pappel@taltech.ee
- **NONLINEAR CONTROL SYSTEMS GROUP.**
  Head: Tenured Associate JURI BELIKOV, juri.belikov@taltech.ee



APPLIED ARTIFICIAL INTELLIGENCE GROUP

Head of the research group: Senior Lecturer AGO LUBERG, ago.luberg@taltech.ee

Members: Tanel Tammet, Martin Verrev, Irina Astrova, Riina Maigre, Priit Järv, Kristiina Kindel, Karl Ivory Pappel, Bahdan Yanovich, Siim Rebane, Rein Süld, Hele-Mai Haav, Gert Kanter, Vahur Kotkas

Post-doctoral Researcher: Mohit Vaishnav

Doctoral student: Enrico Vompa, Otto Mättas

TOPICS AND COMPETENCES

KEYWORDS: (model-based) machine learning, automated commonsense reasoning, ontology based reasoning, recommender systems, logic-based software systems, complex systems modelling and simulations

The Applied AI Group conducts research in application of AI methods in various fields and systems. The group investigates applicability of machine learning, ontology based reasoning, automated theorem provers, knowledge discovery and other AI methods for solving digitalisation problems of different industrial and governmental stakeholders. The group also develops novel methods and systems for core natural language understanding and commonsense reasoning.

The group participates in the *HORIZON project CIRPASS-2* to develop a Digital Product Passport – a structured digital collection of product-related information, including data on sustainability and circularity performance.

More information: *https://taltech.ee/en/department-of-software-science/research-groups#p23624*

SELECTED PROJECTS

- TK213 "*Estonian Centre of Excellence in Artificial Intelligence*" (2024–2030)
- VEU24027 "*Digital Product Passports Enabling At-Scale and Real-Life Circular Economy Use Cases in electronics, textiles, tires and construction value chains*" (2024–2027)
- PRG1487 "*Engineering Tools of Stratified-Flow Processes in the Built Environment*" (2022–2026)

SELECTED PUBLICATIONS

Verrev, M.; Tammet, T.; Järv, P. (2025). Combining syntactic and semantic information in knowled-ge extraction pipeline. Advancements in machine learning and natural language processing: innovations and applications : 3rd International Conference on Language Processing and Knowledge Management (LPKM'2024). Ed. Belguith, L. H.; Shaalan, K. Cham: Springer, 3–12. (Lecture Notes in Networks and Systems; 1303). DOI: 10.1007/978-3-031-85067-7_1.

Koppel, T.; Tammet, T. (2025). Perspectives of electronic election systems. In: Srivastava, Biplav; Nikolich, Anita; Hickerson, Andrea; Koppel, Tarmo (Ed.). PROMISE – PROMoting AI's Safe usage for Elections Berlin: Springer [in press].

Vaishnav, M.; Tammet, T. (2025). A Cognitive Paradigm Approach to Probe the Perception-Reasoning Interface in VLMs. DOI: 10.48550/arXiv.2501.13620.

BUSINESS INFORMATION TECHNOLOGY GROUP

Head of the research group: Senior Lecturer ANTS TORIM, ants.torim@taltech.ee

Members: Erki Eessaar, Gunnar Piho, Viljam Puusep, Kristiina Hiie, Liisa Jõgiste, Inna Švartsman, Tarvo Treier, Karl-Erik Karu, Jelena Vendelin, Ahti Lohk, Epp Immato, Heiko Vainsalu, Indrek Hiie, Tauno Treier, Mart Roost, Sophie Marie Scrivener

Doctoral students: Zhe Deng, Kristian Juha Ismo Kankainen, Marten Kask, Olga Vovk, Toomas Klementi, Jane-Ly Buhvestova, Kadri Kukk, Ken Kruuser, Kristina Murtazin, Oleg Shvets, Rainer Randmaa

TOPICS AND COMPETENCES

KEYWORDS: professional applications; dependable, interoperable and evolutionarily changeable enterprise applications; business software, future professionals, professional education

The research of the Business Information Technology Group is focused on a theory and practice of de-pendable, interoperable and evolutionarily changeable enterprise applications and on the education of a future specialists in the field. The main research topics are data, enterprise information systems, and educational and medical informatics.

Group members (Gunnar Piho) made a significant contribution to the establishment of EstMIA (Estonian Health Informatics Association). As a result, a major conference of the corresponding European organization (EFMI) will be held in Tallinn in 2027.

SELECTED PROJECTS

- PRG2629 "*Medication Adherence and Treatment Efficacy in Patients with Dyslipidaemia and Achievement-oriented Novel Patient Digital Support*" (2025–2029)
- VEU22026MM1 "*Demo project 'Creating and validating a prototype of a software robot based on artificial intelligence for automatic modeling, planning, and optimization of production processes at Aktaprint Ltd*" (2024–2024)
- TEM-TA105 "*Digital health for a whole and healthy society*" (2024–2028)

SELECTED PUBLICATIONS

Bossenko, I.; Randmaa, R.; Piho, G.; Ross, P. (2024). Interoperability of health data using FHIR Mapping Language: transforming HL7 CDA to FHIR with reusable visual components. Frontiers in Digital Health, 6, Art. no. 1480600; 25 pp. DOI: 10.3389/fdgth.2024.1480600.

Bertl, M.; Kankainen, K. J. I.; Piho, G.; Draheim, D.; Ross, P. (2023). Evaluation of data quality in the Estonian National Health Information System for digital decision support. HEDA 2023: the 3rd International Workshop on Health Data, Co-located with STAF 2023, 18–21 July, Leicester, United Kingdom. CEUR-WS, 13 pp. (CEUR Workshop Proceedings; 3440).

Klementi, T.; Piho, G.; Ross, P. (2024). A reference architecture for personal health data spaces using decentralized content-addressable storage networks. Frontiers in Medicine, 11, Art. no. 1411013; 22 pp. DOI: 10.3389/fmed.2024.1411013.

More information: *https://taltech.ee/en/department-of-software-science/cooperation/business-information-technology-group*

CENTRE FOR DIGITAL FORENSICS AND CYBER SECURITY

Head of the centre: Tenured Associate Professor RAIN OTTIS, rain.ottis@taltech.ee

Members: Ahto Buldas, Risto Vaarandi, Olaf Manuel Maennel, Hayretdin Bahsi, Adrian Nicholas Venables, Eneken Tikk, Sten Mäses, Jelizaveta Vakarjuk

Doctoral students: Andrew James Roberts, Seyed Mohammad Hadi Mirsadeghi, Shaymaa Mamdouh Khalil, Marko Arik, Nikita Snetkov, Gábor Visky, Muaan Ur Rehman, Valerii Gakh, Vladimir Rostok, Allard David Dijk, Eman Salem Saadallah Saleh, Felix Nicolas Waschke, Rajesh Kalakoti

TOPICS AND COMPETENCES

KEYWORDS: cyber security, digital forensics, cryptography

The Centre for Digital Forensics and Cyber Security is a multi-disciplinary and diverse research group. The Centre works towards enhancing the competence and ability of Estonian computer security field through education, research and development. The Centre's research covers areas in network securi-ty, digital forensics, cyber operations, cryptography, cybersecurity education & human aspects, legal aspects of cyber security and maritime cybersecurity.

A number of large-scale projects are ongoing, including cooperation on the creation of a European network of Cybersecurity centres and competence Hub for innovation and Operations (ECHO), which delivers an organized and coordinated approach to improve proactive cyber defence of the European Union, through effective and efficient multi-sector collaboration; and the MariCybERA project, which will lead to establishing new multidisciplinary Centre for Maritime Cyber Security at TalTech.

Members of the research group participate in Ministry of Justice and Digital Affairs (JUSTDIGI) council on cyber security policy.

IN 2025: Research continued on applying artificial intelligence in cybersecurity within the framework of EXAI and TEM-TA5 projects. Together with TalTech's Estonian Maritime Academy we concluded the MariCybERA project, which focused on cybersecurity in the maritime domain.

SELECTED PROJECTS

- TK213 "*Estonian Centre of Excellence in Artificial Intelligence*" (2024–2030)
- VFP20050 "*ERA Chair in Maritime Cyber Security, MariCybERA*" (2021–2025)
- TEM-TA5 "*Artificial intelligence in cybersecurity*" (2024–2028)

SELECTED PUBLICATIONS

Vaarandi, R.; Bahşi, H. (2025). Using large language models for template detection from security event logs. International Journal of Information Security, 24 (3), Art no. 104; 17 pp. DOI: 10.1007/s10207-025-01018-y.

Kalakoti, R.; Nõmm, S.; Bahsi, H. (2025). Federated learning of explainable AI(FedXAI) for deep learning-based intrusion detection in IoT networks. Computer Networks, 270, Art. no. 111479; 23 pp. DOI: 10.1016/j.comnet.2025.111479.

Roberts, A.; Malayjerdi, M.; Bellone, M.; Sell, R.; Maennel, O.; Hamad, M.; Steinhorst, S.; (2025). Analysis of autonomous driving software to low-level sensor cyber attacks. 2025 IEEE/ACM 20th Symposium on Software Engineering for Adaptive and Self-Managing Systems: SEAMS 2025, Ottawa, Ontario, Canada, 28–29 April 2025. IEEE, 122–132. DOI: 10.1109/SEAMS 66627.2025.00021.

More information: *https://taltech.ee/en/centre-for-digital-forensics-cyber-security*

HIGH-ASSURANCE SOFTWARE LABORATORY

Head of the laboratory: Lead Research Scientist TARMO UUSTALU, tarmo.uustalu@taltech.ee

Members: Jüri Vain, Sven Nõmm, Niccolò Veltri, Evelin Halling, Gert Kanter, Leonidas Tsiopoulos, Silvio Capobianco, Hellis Tamm, Exequiel Matias Rivas Gadda, Denis Firsov, Hendrik Maarand, Jaak Kütt, Edvard Kallas, Epp Haavasalu, Jaak Kapten, Joonas Jürgen Kisel, Liia Jerjomenko, Liisi Nõojärv

Post-doctoral researchers: Nathanael Amariah Arkor, Bryce James Clarke

Doctoral students: Elli Valla, Cheng-Syuan Wan, Martin Simon, Rajesh Kalakoti, Michele De Pascalis, Philipp Joram, Ian Erik Varatalu, Aboubaker Seddiq Benterki, Andrea Laretto, Ioannis Andreou, Lulof Ludovicus Pirée, Mihhail Daniljuk, Ekaterina Zhuchko, Hanine Merzougui, Hiba Ben Lahbib, Kimia Soroush, Michel Viana Smykalla, Navin Ajay Pophare, Pavla Procházková, Siim Salonen, Sujisha Puthukulangara, Ulrik Sørgaard Djupvik

TOPICS AND COMPETENCES

KEYWORDS: functional and dependently-typed programming, software verification and testing, formalized programming theory

The group conducts research into theories, methods and tools for developing high-assurance software, specializing on both proofs (certified software) and testing. In recent years, applied machine learning became a distinct research area of the lab.

More information: *https://cs.ioc.ee/lsg/*

SELECTED PROJECTS

- PSG749 "*Towards final coalgebras of accessible functors in type theory*" (2022–2025)
- PRG2100 "*Explainable Artificial Intelligence-based analysis of motor tests for the evaluation of human motor and cognitive functions*" (2024–2028)
- PRG1210 "*Automata in Learning, Interaction and Concurrency (ALICE)*" (2021–2025)

SELECTED PUBLICATIONS

Arkor, N.; McDermott, D. (2024). The formal theory of relative monads. Journal of Pure and Applied Algebra, 228 (9), Art. no. 107676; 107 pp. DOI: 10.1016/j.jpaa.2024.107676.

Rivas, E.; Uustalu, T. (2024). Concurrent monads for shared state. Proceedings of the 26th International Symposium on Principles and Practice of Declarative Programming

(PPDP '24), 10–11 September 2024, Milan, Italy. Ed. Bruni, Alessandro; Momigliano, Alberto; Pradella, Matteo; Rossi, Matteo. New York: ACM Press, art. 19; 13 pp. (ACM International Conference Proceeding Series). DOI: 10.1145/3678232.3678249.

Annus, T.; Joram, P. (2024). Term search in Rust. Proceedings of the 9th ACM SIGPLAN International Workshop on Type-Driven Development (TyDe '24), September 6, 2024, Milan, Italy. New York: ACM, 62–73. DOI: 10.1145/3678000.3678210.

INFORMATION SYSTEMS GROUP

Head of the research group: Tenured Full Professor DIRK DRAHEIM, dirk.draheim@taltech.ee

Members: Rahul Sharma, Ermo Täks, Silvia Lips

TOPICS AND COMPETENCES

KEYWORDS: information systems, e-government, e-governance, e-health, data science

The mission of this research group is to contribute to TalTech in further gaining and keep-ing a leading role in ICT system architecture and design of the next generation of digital society ICT in-cluding large-scale ICT systems, ICT system landscapes, ICT ecosystems, and information exchange platforms. The research group conducts research in information system technologies that enable the future information society at the crossroads of distributed computing (including cloud technologies, software-defined networks, Internet of Things, blockchain technology) and next-generation data technologies (including data exchange platforms, automatic machine learning platforms, business intel-ligence platforms, collective intelligence platforms).

SELECTED PROJECTS

- TEM-TA141 "*Smarter use of data via machine learning*" (2024–2028)
- EITSA18020 "*IT Academy research support measures programme for 2018–2022: Artificial Intelligence & Machine Learning; Data Science and Big Data; Robots-People collaboration and the Internet of Things in Industry processes*" (2018–2023)

SELECTED PUBLICATIONS

Siddiqui, S.; Hameed, S.; Shah, S. A.; Arshad, J.; Ahmed, Y.; Draheim, D. (2024). A smart-contract-based adaptive security governance architecture for smart city service interoperations. Sustainable Cities and Society, 113, Art. no. 105717; 27 pp. DOI: 10.1016/j.scs.2024.105717.

Nguyen, T.-V.; Le, L.-S.; Shah, S. A.; Hameed, S.; Draheim, D. (2024). PenChain: a blockchain-based platform for penalty-aware service provisioning. IEEE Access, 12, 1005–1030. DOI: 10.1109/ACCESS.2023.3344038.

Bertl, M.; Bignoumba, N.; Ross, P.; Ben Yahia, S.; Draheim, D. (2024). Evaluation of deep learning-based depression detection using medical claims data. Artificial Intelligence in Medicine, 147, Art. 102745; 16 pp. DOI: 10.1016/j.artmed.2023.102745.

LABORATORY FOR COMPOSITIONAL SYSTEMS AND METHODS

Head of the laboratory: Tenured Full Professor PAWEŁ MARIA SOBOCIŃSKI, pawel.sobocinski@taltech.ee

Members: Fosco Loregian, Amar Hadzihasanovic, Arianna Sofia Jater, Eigil Fjeldgren Rischel

Post-doctoral researchers: Priyaa Varshinee Srinivasan, Alessandro Di Giorgio, Eva Fajstrup Graversen, Vincent Moreau

Doctoral students: Ekaterina Zhuchko, Clémence Chanavat, Diana-Maria Kessler, Alkis Ioannidis, Guido Boccali, Roberto Di Virgilio, Sofiya Kostadinova Taskova

TOPICS AND COMPETENCES

KEYWORDS: compositionality, open systems, applied category theory, programming languages, trustworthy software, diagrammatic reasoning, string diagrams, logic in computer science, relational methods, quantum computing

The group's goal is to study compositional techniques in the context of models of computation, understood broadly. Compositionality means that syntactic descriptions for (open) systems are designed to be compatible with their semantics. While the examples motivating the research come from a broad section of scientific disciplines (logic, control theory, formal language theory, control theory, business processes, game theory, economics, machine learning), we have identified common principles for reasoning about open systems, guided by category theory. These including a semantic universe based on relations rather than functions, and the use of the diagrammatic syntax of string diagrams. String diagrams provide an intuitive calculus for computations via diagrammatic reasoning, and fine-grained control over resources, which is important for faithful descriptions of open systems.

The group's big questions/challenges are:

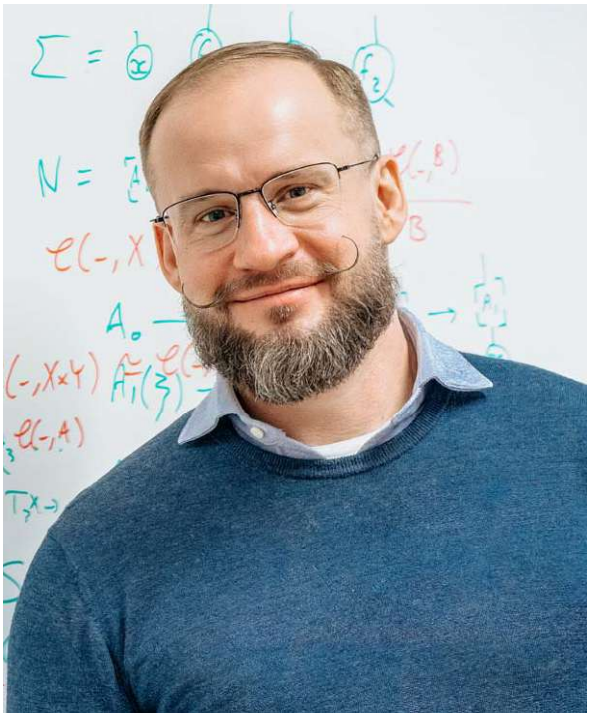
1) design a next generation of programming/specification languages that will be more suited for compositional (and therefore, more trustworthy and reliable) descriptions of systems,
2) use compositionality to improve the analysis of systems, including the design of new techniques and algorithms, and
3) design and implement tools for working with string diagrams, fast-tracking the passage from theory to practice.

A new Estonian Research Agency project, applied for **IN 2025**, has received funding, which includes the ambitious goal of developing new diagrammatic programming languages for the era of artificial intelligence.

Members of the group are working with Cybernetica AS on the modelling of cryptographic protocols as part of the *CHESS project*.

SELECTED PROJECTS

- PRG1210 "*Automata in Learning, Interaction and Concurrency (ALICE)*" (2021–2025)



- PSG764 "*Rewriting in a Directed Homotopy Theory*" (2022–2025)
- VA24038 "*String Diagrammatic Probabilistic Logic: Specification and Modelling Languages*" (2024–2025)

SELECTED PUBLICATIONS

Bonchi, F.; Di Giorgio, A.; Haydon, N.; Sobocinski, P. (2024). Diagrammatic algebra of first order logic. Proceedings of the 39th Annual ACM/IEEE Symposium on Logic in Computer Science (LICS 2024). New York: ACM, Art. 16. DOI: 10.1145/3661814.3662078.

Hadzihasanovic, A.; Kessler, D. (2023). Higher-dimensional subdiagram matching. 2023 38th Annual ACM/IEEE Symposium on Logic in Computer Science (LICS), 26–29 June, 2023, Boston, USA. ACM, 13 pp. DOI: 10.1109/LICS56636.2023.10175726.

Román, M.; Sobociński, P. (2025). String diagrams for premonoidal categories. Logical Methods in Computer Science, 21 (2), 9:1–9:20. DOI: 10.46298/LMCS-21(2:9)2025.

More information: *https://compose.ioc.ee/*

LABORATORY OF LANGUAGE TECHNOLOGY

Head of the laboratory: Tenured Associate Professor TANEL ALUMÄE, tanel.alumae@taltech.ee

Members: Einar Meister, Lya Meister, Henry Härm, Daniil Rõbnikov, Aleksei Žavoronkov, Artem Fedorchenko, Erik Illaste, Helena Grete Lillepalu, Sandipana Dowerah, Bohdan Podziubanchuk, Eva Lastik, Karol Törmikoski

Doctoral student: Joonas Kalda

TOPICS AND COMPETENCES

KEYWORDS: speech technology, phonetics, speech corpora

The Language Technology Laboratory focuses on the following topics:

- Speech recognition
- Speaker, spoken language and accent identification
- Speech corpora
- Phonetics (Estonian language prosody and vocal system, L2 speech)
- Various sub-topics of natural language processing

One of the important activities is the creation of speech technology applications targeted at society as a whole. This includes applications of end-user speech recognition as well as the key integration components that are easy to integrate. Although the focus is on speech recognition in Estonian, most of the software created in the laboratory is not specific to Estonian. The laboratory is a solid open source free software supporter.

One of the major challenges in the coming years will be the development of freely available open source large language models with support for the Estonian language, which can be used to automate many routine text-based tasks. The research group has specific plans to address this challenge and is actively collaborating with other Estonian and international partners.

Language technology also potentially plays an important role in enhancing Estonia's defense capabilities, as it enables the rapid processing of large volumes of multilingual speech and text data, and the identification of key themes and speakers. The lab has extensive experience in competitively applying such technologies.

More information: *https://taltech.ee/en/laboratory-language-technology*

SELECTED PROJECTS

- TK213U11 "*Eesti Tehisintellekti Tipp-keskus*" (2024–2030)

- TTK9 "*Language Data Research Infrastructure*" (2025–2029)
- EKTB117 "*Corpora and models for speech recognition*" (2025–2027)

SELECTED PUBLICATIONS

Olev, A.; Alumäe, T. (2024). Open source platform for Estonian speech transcription. Language Resources and Evaluation, 1–18. DOI: 10.1007/s10579-024-09777-1.

Alumäe, T.; Koenecke, A. (2025). Striving for open-source and equitable speech-to-speech translation. Nature, 637 (8046), 551–553. DOI: 10.1038/d41586-024-04095-6.

Alumäe, T.; Fedorchenko, A. (2025). TalTech Systems for the Interspeech 2025 ML-SUPERB 2.0 Challenge. Interspeech 2025, 17–21 August 2025, Rotterdam, The Netherlands. ISCA, 2098–2102. DOI: 10.21437/Interspeech.2025-1797.

LABORATORY OF PROACTIVE TECHNOLOGIES

Head of the laboratory: Senior Researcher JAANUS KAUGERAND, jaanus.kaugerand@taltech.ee

Members: Tõnu Näks, Andres Udal, Andri Riid, Taivo Kangilaski, Kalev Rannat, Igor Astrov, Tõnu Martma, Raul Savimaa, Merik Meriste, Leo Mõtus, Hannes Keernik, Jüri Helekivi

Doctoral students: Konstantin Bilozor, Johannes Ehala

TOPICS AND COMPETENCES

KEYWORDS: cyber-physical-systems, spontaneous sensor networks, fog computing, situational awareness, modelling and simulation of multi-agent and agentic systems, deep learning

The laboratory focuses on the theoretical and practical study of networked systems built from stationary and/or mobile software-intensive (proactive) components. Typical components are pervasive computing systems. The research is partitioned into three threads: (1) modeling and verification of situation-aware interaction-centered computation; (2) methods and technologies for acquiring situational information; (3) methods for interpretation of situational information for proactive decision making.

The long-term goal of the laboratory is the ability to detect and partially control the emergent behaviour in pervasive computing systems. In addition, ProLab performs research on classification, semantic segmentation and object detection using convolutional neural networks. The methodology has been applied to photographic images, point cloud collections and sound recordings.

More information: *https://taltech.ee/en/laboratory-of-proactive-technologies*

SELECTED PROJECTS

- LITEE24096 "*Development of a measurement methodology of LWIR range shielding efectiveness and a shielding material prototype*" (2024–2025)
- LEEEE21116 "*Development of risk and condition based asset management principles*" (2021–2025)
- LITEE20122 "*Intelligent Smart City and Critical Infrastructure Protection Technologies ISC2PT II*" (2020–2022)

SELECTED PUBLICATIONS

Miasayedava, L.; Kaugerand, J.; Tuhtan, J. A. (2023). Lightweight open data assimilation of Pan-European urban air quality. IEEE Access, 11, 84670–84688. DOI: 10.1109/ACCESS.2023.3302348.

Udal, A.; Kaugerand, J.; Astrov, I.; Mõlder, H.; Koit, K. (2025). Model-enhanced control for cyber-physical security: simulation of model-based navigation of an environment-coupled watercraft under disrupted global positioning conditions. 2025 MIPRO : 48th ICT and Electronics Convention, June 2–6, 2025, Opatija, Croatia, Proceedings. IEEE, 794–799. DOI: 10.1109/MIPRO65660.2025.11131811.

Pihlak, R.; Riid, A.; Yahia, S. (2025). Traffic sign classification using cost effective data augmentation. Procedia Computer Science, 270, 1748–1757. DOI: 10.1016/j.procs.2025.09.295.

NEXT GEN DIGITAL STATE RESEARCH GROUP

Head of the research group: Associate Professor INGRID PAPPEL, ingrid.pappel@taltech.ee

Members: Regina Erlenheim, Eric Blake Jackson, Innar Liiv, Silvia Lips, Arianna Sofia Jater, Erik Kangilaski, Florian Marcus, Oleksandra Dudko, Riina Palu

Doctoral students: Alena Labanava, Teona Gelashvili-Luik, Mihkel Lauk, Josephine Adhiambo Lusi, Jaanus Riibe, Koit Saarevet, Martin Tamm, Norbert Nahayo Ndashimye, Sidra Azmat Butt, Uku Sildoja, Yuliia Kravchenko

TOPICS AND COMPETENCES

KEYWORDS: public sector digital transformation, development of public services, automation and data exchange platforms

The Next Gen Digital State (NGDS) research group addresses the technological complexities of how governments can satisfy the current and future needs of their citizens. The group focuses on digital government ecosystems by investigating technologies that support digital transformation, innovation and implementation.

NGDS research group collaborates with Estonian and international public sector agencies, ministries, and departments for developing next generation government technology through cutting edge research topics focused on artificial intelligence architecture, requirements engineering, data analytics, and understanding the socio-economic effects of technological implementation. The research group's vision is to positively influence and shape the next generation of global digital governance ecosystems. The members of the group offer top-level interdisciplinary practical and theoretical research that enables successful implementation of digital government solutions and policies.

IN 2025: the research group focused on the role of artificial intelligence in the organization of the digital state and expanding international educational cooperation. Specific results of research and development activities are:

- Development of the vision of the agent state and research in collaboration with the University of Tartu. The research contributes to a new paradigm of state governance, where autonomous AI agents play a central role in providing public services and streamlining decision-making processes, reducing the administrative burden.
- Curriculum development and the "digital bridges" project: the research group launched the Erasmus+ international cooperation project Digital Bridges, which will create a digital state master's program in Morocco, Tunisia and Palestine.
- Strategic cooperation with International Telecommunication Union (ITU) within the framework of the GiGa program: an agreement was signed with the ITU to create a training program for the global GIGA initiative. The initiative aims to support developing countries in creating school internet connectivity and digital infrastructure, offering TalTech's expertise in the field of digital state architecture and capacity building.
- GovStack and global digital infrastructure: active contribution to the GovStack initiative continued, where the group supports international training programs and knowledge services, including our contribution to the "GovStack Women in GovTech challenge", which was completed by 127 female leaders from over 50 countries, strengthening the role of women in the global digital revolution.

SELECTED PROJECTS

- TK213 „*Estonian Centre of Excellence in Artificial Intelligence*" (2024–2030)
- PRG1919 „*Rethinking smartification from the margins: Co-creating Smart Rurality with and for an Aging Population*" (2023–2027)

More information: *https://egov.ee/research/*.

NONLINEAR CONTROL SYSTEMS GROUP

Head of the research group: Tenured Associate Professor JURI BELIKOV, juri.belikov@taltech.ee

Members: Ülle Kotta, Arvo Kaldmäe, Vadim Kaparin, Maris Tõnso, Hossein Nourollahi Hokmabad

Doctoral students: Abiodun Emmanuel Onile, Amna Rahmatullah, Svyatoslav Demin, Kimia Soroush, Orkhan Gahramanov, Richa Verma, Tuuli Uudeberg, Vejey Pradeep Suresh Achari

TOPICS AND COMPETENCES

KEYWORDS: non-linear control systems, algebraic methods, power systems

The group is a leading Estonian research unit in automatic control, focusing on nonlinear control systems, including also hybrid and time-delay systems. The group has made a significant contribution to the development of constructive algebraic methods. A universal algebraic methodology has been developed that simplifies the study of very different problems for nonlinear control systems from unified perspective.

Although the group is developing predominantly application-independent general methods determined by the dynamic properties of the mathematical models. The group has been recently focused on a few carefully selected applications. These include control of autonomous underwater vehicles and ionic polymer-metal composite actuators. Within the last few years, special attention has been paid to the study of practical problems arising in the limits of renewable energy integration, and determining the possible limitations of distributed energy storage devices in low inertia power systems utilizing methods from optimal control theory. In addition to the above, the group continues to develop and promote the wide spread of IT in the energy field.

IN 2025: The research group studied non-passive circuits, such as generators and inverters. The mathematical formulation was extended so that it can be applied to circuits with more than one frame of reference.

A novel and simple method for linearizing a discrete nonlinear system was proposed, which consists in using the so-called parameterized state transformation instead of the classical state transformation, and unlike the latter, it is practically always usable.

SELECTED PUBLICATIONS

- PRG1463 "*Modeling and control of Low-INErtia Systems (LINES)*" (2022–2026)
- TF24019IT "*Centre of Excellence in Energy Efficiency*" (2024–2030)
- PSG833 "*Development of Disturbance Estimation Techniques for Nonlinear Control Systems*" (2023–2027)

SELECTED PUBLICATIONS

Kaldmäe, A.; Kotta, Ü. (2025). Parameterized feedback linearization of nonlinear discrete-time control systems. IEEE Control Systems Letters, 9, 174–179. DOI: 10.1109/LCSYS.2025.3568672.

Segev, E.; Zhuk, V.; Ginzburg-Ganz, E.; Belikov, J.; Levron, Y. (2024). Extended properties of nonlinear power system models that are symmetrically configured in the narrow sense. International Journal of Electrical Power & Energy Systems [in press].

Homepage:
https://cc.ioc.ee/dokuwiki/doku.php?id=en:start

DEPARTMENT OF HEALTH TECHNOLOGIES

Director: Assistant Professor
JANA HOLMAR,
jana.holmar@taltech.ee

MAIN FIGURES 2025

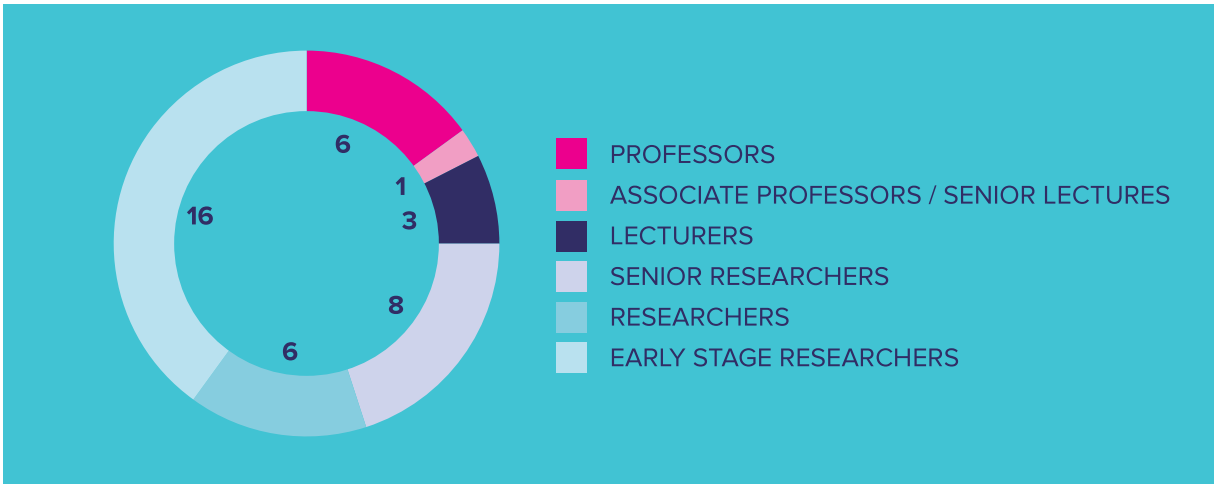
(as of Dec. 31, 2025)

40	Academic staff	Incl. 6 professors 39 researchers	
20	Doctoral students	1	Defended doctoral dissertations
44	Scientific publications*		

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 4 RESEARCH GROUPS:

- **BRAIN BIOELECTRICAL SIGNALS.**
  Head of the research group: Tenured Associate Professor MAIE BACHMANN, maie.bachmann@taltech.ee
- **eHEALTH APPLICATIONS AND SERVICES.**
  Head of the research group: Tenured Associate Professor PEETER ROSS, peeter.ross@taltech.ee
- **RESEARCH GROUP ON DIAGNOSTICS AND TREATMENT TECHNOLOGIES OF HYPERTENSION AND ATHEROSCLEROSIS.**
  Head of the research group: Tenured Full Professor MARGUS VIIGIMAA, margus.viigimaa@taltech.ee
- **SENSOR TECHNOLOGIES IN BIOMEDICAL ENGINEERING (SensorTechBME).**
  Head of the research group: Tenured Full Professor IVO FRIDOLIN, ivo.fridolin@taltech.ee



BRAIN BIOELECTRICAL SIGNALS RESEARCH GROUP

Head of the research group: Tenured Associate Professor MAIE BACHMANN, maie.bachmann@taltech.ee

Members: Jaanus Lass, Laura Päeske, Hiie Hinrikus, Maive Hanni, Mehis Taevere

Doctoral students: Tuuli Uudeberg, Anu Haabu, Märt Kalmo, Safoora Masoumirad

TOPICS AND COMPETENCES

KEYWORDS: signal processing, electroencephalography, brain disorders (e.g. depression)

The research group is experienced in the interdisciplinary area of information technology and brain physiology. The studies are aimed to detect and interpret the features in the brain electroencephalography (EEG) signal characteristic for mental disorder (e.g. depression), occupational and/or environmental stressors comprising the advanced methods of signal analysis and the knowledge about brain neuronal activity. An original Spectral Asymmetry Index (SASI) has been developed and proved as a promising method in various applications. Mental disorders, stress, and burnout are becoming an increasingly heavy burden on modern society. The research group's goal is to develope objective methods for early detection of mental disorders, enabling conscious self-care and early treatment.

More information: *Biosignal Processing Laboratory | TalTech*

2025: As a result of the research, it was found that:

- EEG measures are highly individual yet temporally individually stable over one year, highlighting that accurate EEG interpretation requires personalized baselines instead of normative population averages.
- Higuchi's fractal dimension achieves highest temporal stability within a specific kmax range, strengthening its potential as a reliable EEG biomarker.
- Frontal and frontal-occipital alpha-band EEG connections play a key role in regulating the balance between functional connectivity and small-worldness.

More information: *https://taltech.ee/en/biosignal-processing-laboratory*

SELECTED PROJECTS

- TK218 "*Estonian Center of Excellence of Well-Being Sciences*" (2024–2030)
- TAR16013 (EXCITE) (TK148) "*Estonian Centre of Excellence in ICT Research*" (2016–2023);

- AR20013IHW "*FinEst Piloting Programme by FinEst Centre for Smart Cities project "Urban Planning Well-being Score for Good Quality Living Environment""* (2021–2023)

SELECTED PUBLICATIONS

Hinrikus, H.; Koppel, T.; Lass, J.; Roosipuu, P.; Bachmann, M. (2023). Limiting exposure to radiofrequency radiation: the principles and possible criteria for health protection. International Journal of Radiation Biology, 99 (8), 1167–1177. DOI: 10.1080/09553002.2023.2159567.

Päeske, L.; Uudeberg, T.; Hinrikus, H.; Lass, J.; Bachmann, M. (2023). Correlation between elect-roencephalographic markers in the healthy brain. Scientific Reports, 13, #6307. DOI: 10.1038/s41598-023-33364-z.

Põld, T.; Päeske, L.; Hinrikus, H.; Lass, J.; Bachmann, M. (2023). Temporal stability and correlation of EEG markers and depression questionnaires scores in healthy people. Scientific Reports, 13, #21996. DOI: 10.1038/s41598-023-49237-4.

eHEALTH APPLICATIONS AND SERVICES

Head of the research group: Tenured Associate Professor PEETER ROSS, peeter.ross@taltech.ee

Members: Madis Tiik, Katrin Gross-Paju, Riina Hallik, Kerli Linna, Kadi Lubi, Doris Kaljuste, Mall Maasik, Eduard Maron, Elli Valla, Priit Kruus, Jaanika Jelistratov, Kristi Tamtik, Meelis Tivas, Mihkel Martinson, Tanel Ross

Doctoral students: Kristian Juha Ismo Kankainen, Olga Vovk, Toomas Klementi, Igor Bossenko, Marten Kask, Markus Bertl, Janek Metsallik, Anna Dudkina, Kerli Norak, Laura Palling, Maarja-Liis Elland, Michael Anywar, Secil Matasova

TOPICS AND COMPETENCES

KEYWORDS: digital health, eHealth, change management in health care

The core competencies of the research group are the development of IT solutions related to digitalization of health care (e-health) and research of the interoperability factors necessary for their implementation. The factors to be studied include strategies, standards, IT architecture, data statuses and databases used for large (national or regional) e-health systems.

The eMedLab conducts research in the areas of health data models, clinical decision support, evalua-tion and assessment of digital health technologies, human behavior related to online accessible elec-tronic health records, and components and factors of healthcare digitalization.

More information: *Centre for Digital Health | TalTech*

IN 2025: The research group's thematic scope has expanded, and as a result, the work carried out within the group is important not only for the scientific development of the field but also contributes directly to the improvement of the Estonian healthcare system. Contributions to the broader field of e-health (digital health) focus primarily on research into patient-generated health data, enabling individuals to share data collected via various devices and applications with healthcare professionals and national health information systems. In addition to this thematic area, the group conducts research into health data standardisation, IT architecture, and related topics in collaboration with the Business Information Technology research group.

Beyond technical research topics, the group also contributes to studies on the digital competencies of healthcare professionals and their development, the development of clinical radiology service models, the standardisation of psychiatric data, and the digitalisation of diagnostics and treatment in psychiatric care.

SELECTED PROJECTS

- TEM-TA105 "*Digital health for a whole and healthy society*" (2024–2028)
- VERT25001 "*Xpanding Innovative Alliance*" (2025–2028)
- TF24024 "*Estonian Center of Excellence of Well-Being Sciences*" (2024–2030)

SELECTED PUBLICATIONS

Marquis, M.; Bossenko, I.; Ross, P. (2025). RadLex and SNOMED CT integration: a pilot study for standardising radiology classification. Insights into Imaging, 16 (1), 58. DOI: 10.1186/s13244-025-01935-5.

Lubi, K. Pevkur, H.; Gross-Paju, K.; Elland, M.-L.; Ross, P. (2025). The opportunities and challenges of integrating health and social care in post-stroke patient journey: perceptions of Estonian professionals. Health Policy, 105377. DOI: 10.1016/j.healthpol.2025.105377.

Koop, C.; Kruus, P.; Hallik, R.; Lehemets, H.; Vettus, E.; Niin, M.; Ross, P.; Kingo, K. (2023). A country-wide teledermatoscopy service in Estonia shows results comparable to those in experimental settings in management plan development and diagnostic accuracy: A retrospective database study. Jaad International, 12, 81–89. DOI: 10.1016/j.jdin.2023.02.019.

RESEARCH GROUP ON DIAGNOSTICS AND TREATMENT TECHNOLOGIES OF HYPERTENSION AND ATHEROSCLEROSIS

Head of the research group: Tenured Full Professor MARGUS VIIGIMAA, margus.viigima@taltech.ee

Members: Kalju Meigas, Sergei Nazarenko, Tiina Titma, Marika Pikta

Doctoral students: Grete Talviste, Eno-Martin Lotman, Siim Saare

TOPICS AND COMPETENCES

KEYWORDS: hypertension, atherosclerosis, technologies, diagnosis, treatment

COMPETENCY:

- Research and development of novel technologies in cardiovascular medicine.
- Development of cardiovascular medical engineering.
- Clinical application of novel technologies in the field of cardiovascular medicine.
- Early atherosclerosis and development of novel technologies and devices.
- Hemodynamics of resistant hypertension and development of novel methods in guiding of drug treatment.
- Cardiovascular risk assessment (including polygenic risk score) and management.
- Diagnosis and treatment of familial hypercholesterolemia.

The research group is part of Excellence centers of the European Society of Hypertension.

The group is also an active member of the European Atherosclerosis Society International Lipid Expert Panel (ILEP) and the European Atherosclerosis Society Familial Hypercholesterolaemia Studies Collaboration (FHSC).

More information: *Centre for Cardiovascular Medicine (IH) | TalTech*

IN 2025 the implementation of the group research grant PRG2629 was initiated. The ultimate goal of the study is to reduce cardiovascular mortality in Estonia by increasing treatment adherence and empowering patients, creating a supportive self-management environment for monitoring the health plan and actively participating in the treatment process.

SELECTED PROJECTS

- PRG2629 "*Medication Adherence and Treatment Efficacy in Patients with Dyslipidaemia and Achievement-oriented Novel Patient Digital Support*" (2025–2029)
- TEM-TA105 "*Digital health for a whole and healthy society*" (2024–2028)

SELECTED PUBLICATIONS

Elshorbagy, A.; Vallejo-Vaz, A. J; Barkas, F.; Lyons, A. R M; Stevens, C. A T; Dharmayat, K.

I; Catapano, A. L; Freiberger, T.; Hovingh, G K.; Mata, P.; Raal, F. J; Santos, R. D; Soran, H.; Watts, G. F; Abifadel, M.; Aguilar-S., Carlos A; Alhabib, K. F; Alkhnifsawi, M.; Almahmeed, W.; Alnouri, F. ... Ray, K. K (2025). Overweight, obesity, and cardiovascular disease in heterozygous familial hypercholesterolaemia: the EAS FH Studies Collaboration registry. European Heart Journal. DOI: 10.1093/eurheartj/ehae791.

Banach, M.; Toth, P. P; Ahn, H.-J.; Bielecka-Dabrowa, A.; Cicero, A. F G; Covic, A.; Dalakoti, M.; Escobar, C.; Fogacci, F.; Gaita, D.; Gaita, L.; Jóźwiak, J.; Latkovskis, G.; Lewek, J.; Ntaios, G.; Okopień, B.; Pećin, I.; Pella, D.; Penson, P. E; Proietti, M. ... Lip, G. Y H (2025). Lipid management for primary and secondary stroke prevention consensus paper of the International Lipid Expert Panel (ILEP). Progress in Cardiovascular Diseases. DOI: 10.1016/j.pcad.2025.11.003.

Banach, M.; Fras, Z.; Gaita, D.; Pecin, I.; Bajraktari, G.; Bjelakovic, B.; Bytyci, I.; Ceska, R.; Djuric, D.; Gil, R. J; Jozwiak, J.; Kubilius, R.; Latkovskis, G.; Mitchenko, O.; Paragh, G.; Pella, D.; Petrulioniene, Z.; Postadzhiyan, A.; Stoian, A. P.; Szymański, P. ... Reiner, Z. (2025). The European Program for Prevention (EPP) – Implementing Proven Preventing Measures Now! Global Heart, 20 (1), #103. DOI: 10.5334/gh.1491.

SENSOR TECHNOLOGIES IN BIOMEDICAL ENGINEERING (SensorTechBME) RESEARCH GROUP

Head of the research group: Tenured Full Professor IVO FRIDOLIN, ivo.fridolin@taltech.ee

Members: Jana Holmar, Merike Luman, Risto Tanner, Nils Fredrik Arne Uhlin, Jürgen Arund, Kristjan Pilt, Moonika Viigimäe, Deniss Karai, Rain Kattai, Lucía Mariel Arana Peña, Kai Lauri, Lisette Jauk

Doctoral Students: Joosep Paats, Andrus Paats, Annika Adoberg, Kristina Kööts, Liisi Leis, Einar Kivisalu, Sandra Einstein

TOPICS AND COMPETENCES

KEYWORDS: Sensors, algorithms, sensor fusion, biofluid optics, uremic toxins, dialysis, on-line monitoring, spectrophotometry, spectrofluorimetry, signal processing, smart work wear, physical activity monitoring, energy consumption, fatigue monitoring, automatic speech recognition, speech-to-text applications

The main research field of the SensorTechBME team is to develop flexible and novel sensor technologies and algorithms in biomedical engineering applications:

- To estimate dialysis adequacy and quality securing end stage renal disease (ESRD) patients' care quality. The research is exploring spectrophotometrical and spectrofluorimetrical characteristics-signatures of the biofluids and performing various signal processing and analysis on those signals.
- To develop beyond the state-of-the-art applications incorporated into a smart wearable multi-sensor fusion system for generating valuable data about the workers' location, locomotion, physical activity, energy consumption and physiological status;
- For speech-to-text usage in healthcare and industry.

More information: *Centre for Biomedical Engineering | TalTech*

IN 2025

For the first time, a clinical research study conducted and published by the research group (Paats et al 2025), has shown that the concentration of the biomarker, C-mannosyltryptophan (CMW), in the blood of patients with chronic kidney disease (CKD) is several times higher than that of healthy individuals. The technical and methodological innovation is reflected in the first-ever determination of CMW con-centration in the dialysate used by spectrophotometric analysis. Its implementation would be a major change in current clinical practice and would help ensure more adequate assessment of treatment quality and better survival and quality of life for the patient. The study creates favorable ground for the wider use of the optical monitoring method of uremic residues developed by TalTech scientists in clini-cal practice. In addition to the novel, CMW-based, methodological approach, it is also important for the patient that the optical sensor uses the effluent dialysate fluid for measurement and does not require blood sampling. This saves blood for patients on renal replacement therapy with already impaired hematopoiesis. The proposed optical methodology significantly contributes to the move towards more environmentally friendly dialysis treatment, since when measuring concentrations with an optical sen-sor, there is no need to use blood sample tubes, costs for laboratory analyses are eliminated, and less waste is generated.

SELECTED PROJECTS

- TK218 "*Estonian Center of Excellence of Well-Being Sciences*" (2024–2030)
- PRG2643 "*A Novel Technology for Personalized Optical On-line Monitoring of Middle Molecular Weight Uremic Toxins Removal in Hemodialysis*" (2025–2029)
- PSG819 "*Development of New Optical Methods to Estimate Vascular Calcification and Monitor Inhibitors Removal During Dialysis in Patients with End-Stage Renal Disease (VasCalDi)*" (2023–2027)

SELECTED PUBLICATIONS

Paats, J.; Adoberg, A.; Leis, L.; Arund, J.; Lauri, K.; Luman, M.e; Tanner, R.; Holmar, J.; Pilt, K.; Fridolin, I.. (2025). Intradialytic optical assessment of C-mannosyl tryptophan removal using spent dialysate. Scientific Reports, 20052. DOI: 10.1038/s41598-025-01844-z.

Adoberg, A.; Leis, L.; Luman, M.; Uhlin, F.; Fridolin, I.; Viigimaa, M.; Holmar, J. (2025). Vascular calcification inhibitors in chronic kidney disease. Clinica Chimica Acta, 572, p. 120271. DOI: 10.1016/j.cca.2025.120271.

Paats, J.; Adoberg, A.; Arund, J.; Dhondt, A.; Fernström, A.; Fridolin, I.; Glorieux, G.; Gonzalez-Parra, E.; Holmar, J.; Leis, L.; Luman, M.; Perez-Gomez, V. M.; Pilt, K.; Sanchez-Ospina, D.; Segelmark, M.; Uhlin, F.; Ortiz, A. (2023). Time-averaged concentration estimation of uraemic toxins with different removal kinetics: a novel approach based on intradialytic spent dialysate measurements. Clinical Kidney Journal, 16 (4), 735–744. DOI: 10.1093/ckj/sfac273.

THOMAS JOHANN SEEBECK DEPARTMENT OF ELECTRONICS

Director: Senior Researcher ALAR KUUSIK, alar.Kuusik@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

29 Academic staff — Incl. 3 professors, 21 researchers

9 Doctoral students

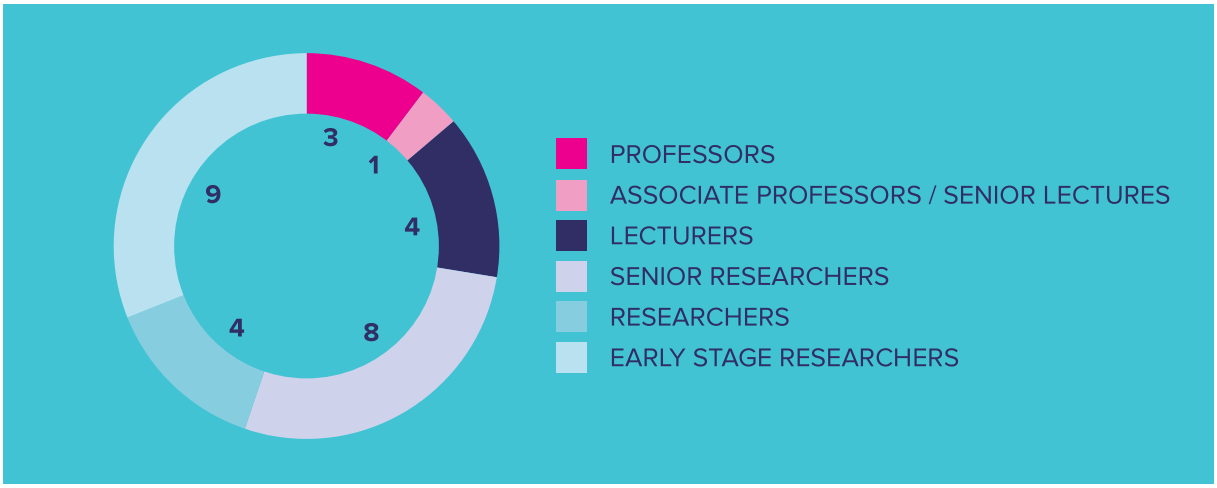
7 Defended doctoral dissertations

29 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 3 RESEARCH GROUPS:

- **RESEARCH LABORATORY FOR COGNITRONICS.**
  Head: Tenured Full Professor YANNICK LE MOULLEC, yannick.lemoullec@taltech.ee
- **MEASUREMENT ELECTRONICS RESEARCH GROUP.**
  Head: Senior Researcher MARGUS METSHEIN, margus.metshein@taltech.ee
- **COMMUNICATION SYSTEMS RESEARCH GROUP.**
  Head: Tenured Full Professor MUHAMMAD MAHTAB ALAM, muhammad.alam@taltech.ee



RESEARCH LABORATORY FOR COGNITRONICS

Head of the laboratory and research group: Tenured Full Professor YANNICK LE MOULLEC, yannick.lemoullec@taltech.ee

Members: Kaiser Pärnamets, Tamas Pardy, Ferenc Ender, Marko Koort, Rauno Jõemaa

Doctoral students: Fariha Afrin, Henri Vennikas, Alejandro Noé Díaz Vargas, Mehrab Mahdian, Anum Afroz

TOPICS AND COMPETENCES

KEYWORDS: energy-efficient Industrial Internet of Things (IIoT); bioanalytical Instrumentation and Lab-on-Chip

The research group develops methods and techniques for:

- sustainable and green electronics, including for IIoT applications and bioanalytical instrumentation;
- resource-constrained implementation of wireless connectivity technologies;
- applied embedded machine learning for decision-making and actuation.

More information: *https://taltech.ee/en/department-of-electronics/research-groups*

IN 2025: The research group contributed to finalizing the EU-funded Innovation Action project "5G-TIMBER". The work supported the rapid uptake of 5G and other digital technologies by industrial SMEs in the EU timber industry over the wood value chain.

Research on sustainable and circular economy-supporting electronic solutions was conducted within the framework of the project TEM-TA138 "SAIoT".

The management of the Estonian-funded project PSG897 "Cogni-E-spin" continued successfully, within the framework of which a new open dataset of electrospinning parameter configurations and obtained nanofiber morphologies was developed, entitled "Cogni-e-SpinDB 1.0.

The implementation of the EU-funded Pathfinder Open project "CHIRALFORCE" continued, within the framework of which the group contributed to the development of an automated in-line platform for the analysis of chiral separation for the CHIRALFORCE photonic chip.

MAJOR RESEARCH PROJECTS

- PSG897 "*Cogni-E-spin: Cognitronic Electrospinning System for Automated Quality Control of Nanofiber Product*" (2024–2028)
- VHE22018 "*Secure 5G-Enabled Twin Transition for Europe's TIMBER Industry Sector*" (2022–2025)
- TEM-TA138 *Sustainable Artificial Internet of Things* (SAIoT) (2024–2028)

SELECTED PUBLICATIONS

Afrin, F.; Ndubuisi Ezechukwu, D.; Le Moullec, Y.; Pardy, T.; Rang, T.; Koel, A. (2025). CNN-Transformer Hybrid Model Towards Automated Droplet Image Quality Assessment of Portable Imaging Flow Cytometer. IEEE EUROCON 2025 – 21st International Conference on Smart Technologies: Gdynia, Poland, June 4–6, 2025. IEEE, 1–6. DOI: 10.1109/EUROCON64445.2025.11073334.

Latif, A.; Alam, M. M.; Elgarhy, O.; Le Moullec, Y. (2024). Energy Consumption Evaluation of NOMA-based Sustainable Scheduling in 6G O-RAN. 2024 International Wireless Communications and Mobile Computing (IWCMC): 20th International Wireless Communications & Mobile Computing Conference 2024 (IWCMC 2024), Ayia Napa, Cyprus, May 27–31, 2024. Ayia Napa, Cyprus: IEEE, 484–485. DOI: 10.1109/IWCMC61514.2024.10592553.

Khan, S.; Alam, M. M.; Le Moullec, Y.; Kuusik, A.; Parand, S.; Verikoukis, C. (2021). An Empirical Mo-delling for the Baseline Energy Consumption of an NB-IoT Radio Transceiver. IEEE Internet of Things Journal, 8 (19), 14756–14772. DOI: 10.1109/JIOT.2021.3072769.

MEASUREMENT ELECTRONICS RESEARCH GROUP

Head: Senior Researcher MARGUS METSHEIN, margus.metshein@taltech.ee

Members: Andrei Krivošei, Mart Min, Olev Märtens, Paul Annus, Raul Land,

Doctoral students: Maria Jürimaa, Anar Abdullayev

TOPICS AND COMPETENCES

KEYWORDS: impedance spectroscopy, impedance tomography, eddy current, real-time, measurement, instrumentation

The group performs R&D of electrical impedance spectroscopy measurement solutions. This covers the developing and investigation of related instrumentation, signals and signal processing for several applications (including test and diagnostics e.g. in bio-, healthcare, medical and microfluidics areas, for metal, electronics and other industries).

The research group has continuous and fruitful communication with Estonian healthcare institutions (e.g. Tartu University Hospital, East Tallinn Central Hospital) as well as with various industrial companies to seek practical cooperation opportunities and socially important developments.

More information: *https://taltech.ee/en/me*

IN 2025:

The *Tem-TA43* project is actively ongoing in a challenging collaboration with doctors from the University of Tartu and the University of Tartu Clinic to develop technologies related to cardiac surgery. The first animal study was conducted, which yielded promising results. During the project, an exciting inventive solution has been created: M. Metshein et al., EE patent application P202400022, "*Method and device for determining characteristic points ofcardiac activity on an ICG signal image from a pulse waveimage based on a PPG signal*"

The group continues to contribute to the Estonian economy through cooperation with companies – an activity that in 2025 was realized as an agreement with Estonian Railways to support the goals of improving railway safety. More specifically, the research group is working on developing a data analysis methodology.

SELECTED PROJECTS

- PRG1483 "*Innovative impedance Spectroscopy: Solutions and Applications*" (2022–2026)
- TEM-TA43 "*Novel solutions for clinical monitoring of soft tissues*" (2024–2028)
- MOB3PRT12 "*New Evidences On Diabetes Prevention and Patient Empowerment*" (2025–2027)

SELECTED PUBLICATIONS

Abdullayev, A.; Rist, M.; Martens, O.; Metshein, M.; Larras, B.; Frappe, A.; Gautier, A.; Min, M.; John, D.; Cardiff, B.; Krivosei, A.; Annus, P. (2023). A DSP-based EBI, ECG and PPG Measurement Platform. IEEE Transactions on Instrumentation and Measurement, 72, 1–8. DOI: 10.1109/TIM.2023.3320771.

Abdullayev, A.; Rist, M.; Metshein, M.; Märtens, O. (2025). DSP-based Electrical Impedance Tomography Device: Implementation and Experiments. 2025 IEEE International Instrumentation and Measurement Technology Conference (I2MTC): Chemnitz, Germany, 19–22 May 2025. IEEE, 1–6 [in press].

Abdullayev, A.; Annus, P.; Krivošei, A.; Metshein, M.; Märtens, O.; Rist, M.; (2023). Improved PWM-Based Sinewave Generation: Example of the Impedance Measurement. Automatic Control and Computer Sciences, 57, 449–458. DOI: 10.3103/S0146411623050024.

COMMUNICATION SYSTEMS RESEARCH GROUP

Head of the research group: Tenured Full Professor MUHAMMAD MAHTAB ALAM, muhammad.alam@taltech.ee

Members: Alar Kuusik, Ivo Müürsepp, Osama Mohamed Mostafa Elgarhy, Priit Roosipuu, Indur Ait, Margus Rohtla, Anet Tammets, Marika Kulmar

Doctoral students: Jakob Rostovski, Mihkel Tommingas, Aleksei Fjodorov, Aamir Latif, Anum Umer, Junaid Sajid, Tõnis Kärginen

TOPICS AND COMPETENCES

KEYWORDS: radio resource and interference management, device to device communications, low-power communication technologies for healthcare, 5G and beyond, mobile positioning, Narrowband Internet of Things (NB-IoT), Body Area Networks (BAN)

The group performs R&D of interference control in wireless communication: techniques and algorithms for enabling 5G new radio, but also development of 5G testbed including support to realize massive machine type communication enhanced mobile broadband services and ultra-reliable and low latency communication services and digitalization of society (i.e., smart healthcare, smart city, industrial automation 4.0), development of vertical applications and services including connectivity, mobility, end-user community.

More information: *https://taltech.ee/en/department-of-electronics/research-groups*

IN 2025:

Work continued on previously started projects. At the national level "*AIoT*5G*" project with focus on increasing the knowledge intensity of Ida-Viru entrepreneurship. *Sustainable Artificial Internet of Things* (SAIoT) project aims to develop energy-efficient, environmentally friendly and secure Artificial intelligent Internet of Things (AIoT) software and hardware technologies. At the international level *5G-BALTICS* aims to address 5G white spaces through-out via-BALTICA 663 km transport corridor funded by European Commission. Finally, PROTECT project funded by NATO-Science for Peace and Security aims to detect malicious drones via passive radar observation and 5G cellular networks. Most of these projects addresses societal challenges related to security and sustainability of digital technologies.

SELECTED PROJECTS

- LIEEE25024 "*Pocket Siren – 5G Media Transmission in Emergency Alerting*" (2025–2026)
- VEU24064 "*Uninterrupted 5G Coverage Across Via Baltica Corridor*" (2025–2027)

- VNT24078 "*Passive Radar Observation and DeTECTion of UAVs via Cellular Networks*" (2024–2027)

SELECTED PUBLICATIONS

Umer, A.; Müürsepp, I.; Alam, M. M.; Wymeersch, H. (2025). Reconfigurable Intelligent Surfaces in 6G Radio Localization: A Survey of Recent Developments, Opportunities, and Challenges. IEEE Communications Surveys & Tutorials, 1–1. DOI: 10.1109/COMST.2025.3536517.

Khurshid, T.; Ahmed, W.; Rehan, M.; Ahmad, R.; Alam, M. M.; Radwan, A. (2023). A DRL Strategy for Optimal Resource Allocation Along With 3D Trajectory Dynamics in UAV-MEC Network. IEEE Access, 11, 54664–54678. DOI: 10.1109/ACCESS.2023.3278591.

Roosipuu, P.; Annus, I.; Kuusik, A.; Kändler, N.; Alam, M. M. (2025). Large-Scale IoT Sensor Network Planning Based on Empirical NB-IoT and LTE CAT-M Measurements for Underground Water System. IEEE Open Journal of the Communications Society, 1–13. DOI: 10.1109/OJCOMS.2025.3636292.

IT COLLEGE

Director: SIRJA SULAKATKO,
sirja.sulakatko@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

27 Academic staff — Incl. 4 professors, 9 researchers

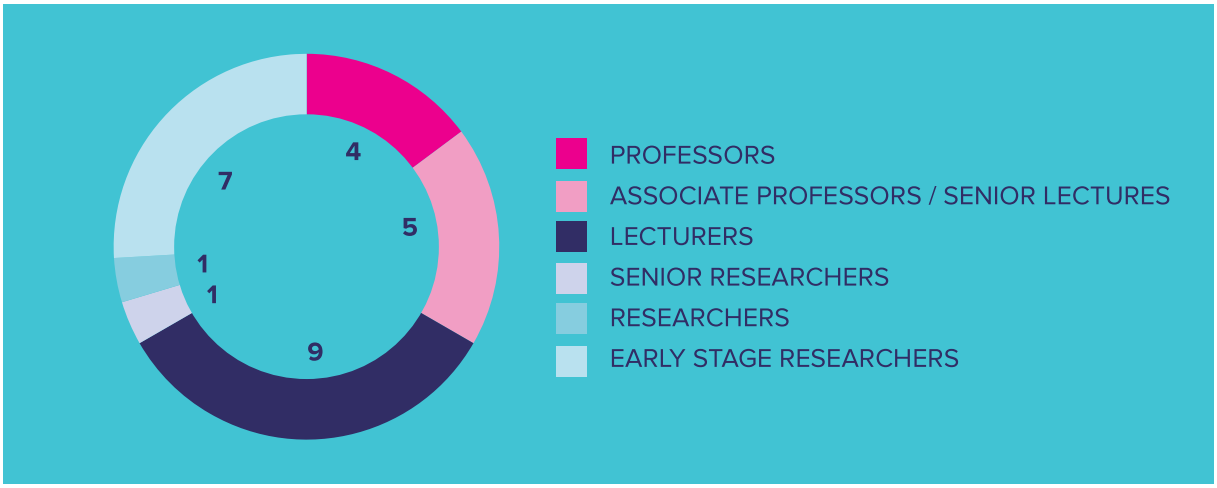
7 Doctoral students

31 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN ONE RESEARCH UNIT:

- **CREATIVITY MATTERS IT DIDACTICS RESEARCH GROUP.**
  Head: Assistant Professor JANIKA LEOSTE, janika.leoste@taltch.ee



CREATIVITY MATTERS IT DIDACTICS RESEARCH GROUP

Head of the research group: Assistant Professor JANIKA LEOSTE, janika.leoste@taltch.ee

Members: Tarmo Robal, Jaanus Pöial, Mohammad Tariq Meeran, Slavko Rakić, Katrin Kangur, Katrin Aasma

Doctoral students: Aleksei Talisainen, Tiina Kasuk, Andres Käver, Kristel Marmor, Fuad Budagov, Palmi Lahe, Tiit Vapper, Joosep Parts

TOPICS AND COMPETENCES

KEYWORDS: human-robot interaction; robot assistants, autonomous robot interaction scenarios, social service robots, telepresence robots; social presence; remote communication; hybrid learning; blended and online learning methods; artificial intelligence in education, AI didactics and hybrid intelligent assessment, STEAM integration in IT education, digital pedagogy and learning design

The Creativity Matters IT Didactics Research Group is a multidisciplinary team focused on higher education IT didactics. The main research areas include AI didactics for research and teaching, the use of telepresence robots and robot assistants in higher education and healthcare, innovative blended and web-based teaching methods, and the integration of the STEAM approaches into IT education.

The group leads several ongoing projects funded by the European Commission (Erasmus+ and CERV programmes), the Estonian Research Council, and the Estonian Centre for International Development. These projects focus on upskilling IT students' competencies, developing hybrid intelligent assessment methods for the ethical use of AI.

IN 2025

The implementation of the project "*HIAS for Inclusive and Ethical GenAI Use in Higher Education*" was started in 2025. The research project focuses on the development of a Hybrid Intelligent Assessment System (HIAS) to support ethically aligned and pedagogically grounded integration of artificial intelligence in higher education. In line with Estonia's AI Leap Initiative, the European Union's Digital Education Action Plan (2021–2027), and the DigComp 3.0 framework, the project seeks to design, pilot, and validate an explainable, multilingual, and modular assessment tool integrated into Moodle. The system will enhance self-regulated learning (SRL) and promote human-in-the-loop AI assessment practices, offering a scalable solution across disciplines and languages.

More information: *https://cm.taltech.ee/*

SELECTED PROJECTS

- VERT25050 "*Didactic Technologies for IT Education*" (2025–2027)
- ETAG25164 "*AI for Mindful Care and Aging (AMICA): Navigating vulnerability in the use and implementation of automated home care*" (2026–2029)

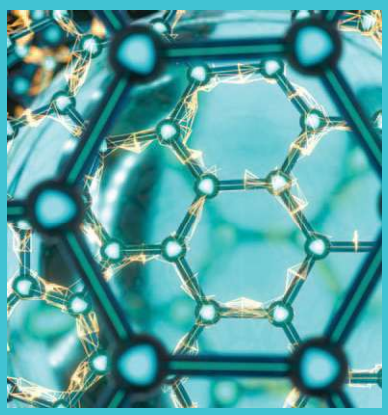
SELECTED PUBLICATIONS

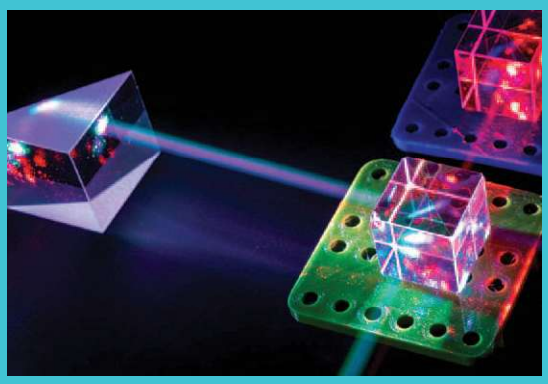
Leoste, J.; Lubi, K.; Marmor, K.ristel; Kangur, K. (2025). Evaluating Social Assistive Robots in Clinical Nursing Care: A Pilot Study on Healthcare Workers' Perceptions and Adoption. JMIR Nursing, 8, #e70305. DOI: 10.2196/70305.

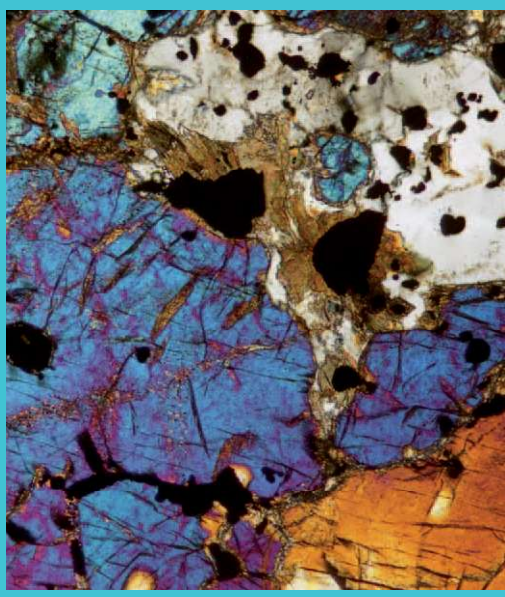
Kasuk, T.; Leoste, J.; Virkus, S. (2025). Enhancing synchronous hybrid learning with telepresence robots: a PEPCII pedagogical design model for remote and onsite student engagement. Frontiers in Education, 10, 1–15. DOI: 10.3389/feduc.2025.1554065.

Parts, J.; Leoste, J.; Tammemäe, K.; Rakic, S. (2025). A Systematic Scoping Review of Privacy Chal-lenges and Privacy Enhancing Technologies in Teleoperated Robotics. IEEE Access, 1–1. DOI: 10.1109/ACCESS.2025.3645240.

SCHOOL OF SCIENCE







SCHOOL OF SCIENCE

Dean: Tenured Full Professor ANDRUS SALUPERE
e-mail: andrus.salupere@taltech.ee

Vice-Dean for Research: Tenured Full Professor RIINA AAV
e-mail: riina.aav@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

286 Academic staff — Incl. 31 professors, 214 researchers

178 Doctoral students

25 Defended doctoral dissertations

292 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

DEPARTMENTS

DEPARTMENT OF CHEMISTRY AND BIOTECHNOLOGY

Director: Senior Researcher PIRJO SPUUL, pirjo.spuul@taltech.ee

DEPARTMENT OF CYBERNETICS

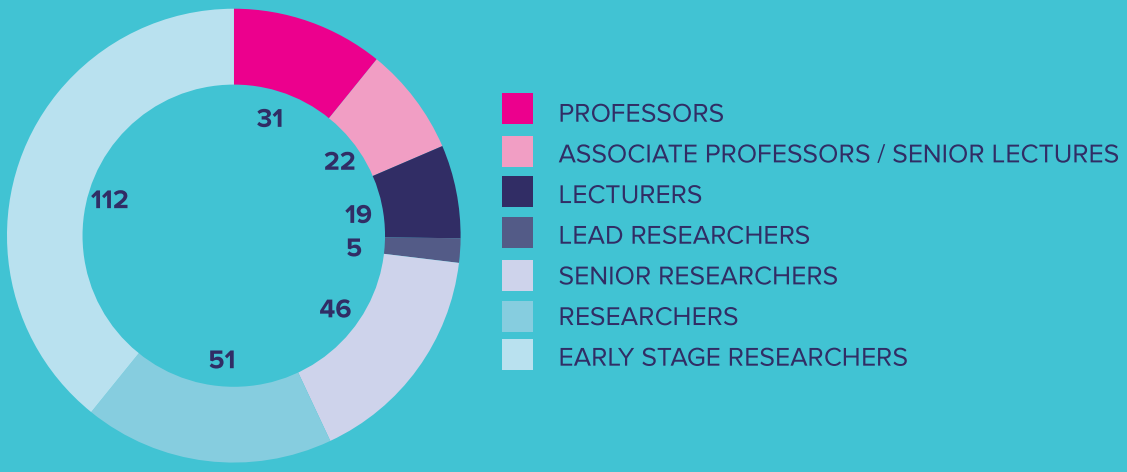
Director: Senior Lecturer ALAR LEIBAK, alar.leibak@taltech.ee

DEPARTMENT OF GEOLOGY

Director: Tenured Associate Professor OLLE HINTS, olle.hints@taltech.ee

DEPARTMENT OF MARINE SYSTEMS

Director: Tenured Associate Professor RIVO UIBOUPIN, rivo.uiboupin@taltech.ee



DEPARTMENT OF CHEMISTRY AND BIOTECHNOLOGY

Director: Senior Researcher
PIRJO SPUUL,
pirjo.spuul@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

152 Academic staff — Incl. 13 professors, 121 researchers

99 Doctoral students — 11 Defended doctoral dissertations

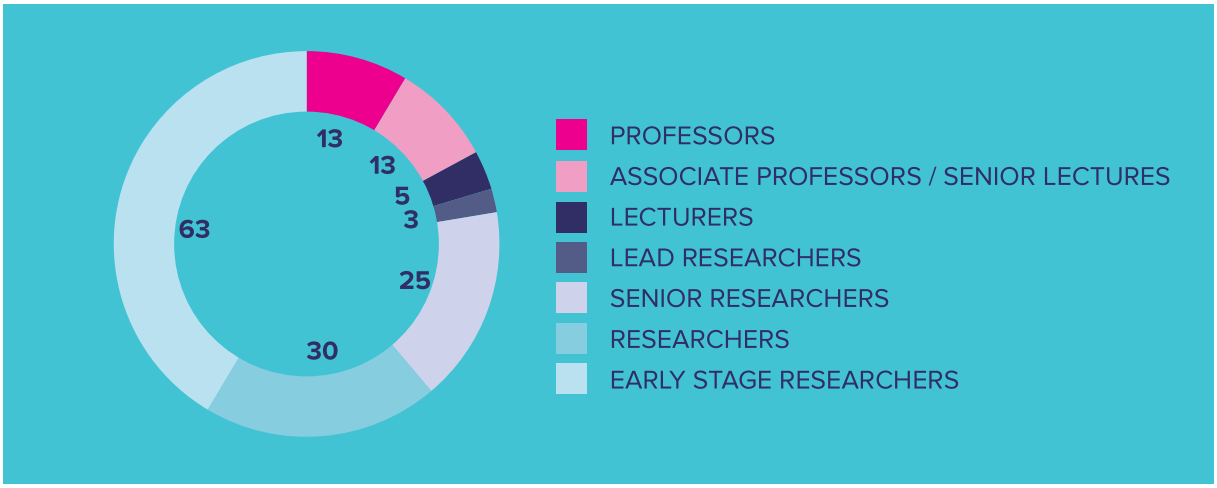
78 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN THE FOLLOWING RESEARCH GROUPS:

- **ANALYTICAL CHEMISTRY.**
  Head: Senior Research Scientist MARIA KULP, maria.kulp@taltech.ee
- **BIOCHEMISTRY OF LIPIDS AND LIPOPROTEINS.**
  Head: Lead Research Scientist AIVAR LÕOKENE, aivar.lookene@taltech.ee
- **BIOMEDICINE.**
  Head: Senior Researcher PIRJO SPUUL, pirjo.spuul@taltech.ee
- **COCATALYSIS RESEARCH GROUP.**
  Head: Senior Researcher MIKK KAASIK, mikk.kaasik@taltech.ee
- **COGNITRONIC LAB-ON-A-CHIP RESEARCH GROUP.**
  Head: Senior Researcher TOOMAS RANG, toomas.rang@taltech.ee
- **COMPUTATIONAL CHEMISTRY.**
  Head: Tenured Associate Professor TOOMAS TAMM, toomas.tamm@taltech.ee
- **DNA REPLICATION AND GENOME STABILITY.**
  Head: Senior Researcher TATIANA MOISEEVA, tatiana.moiseeva@taltech.ee
- **FOOD TECH AND BIOENGINEERING.**
  Head: Tenured Associate Professor PETRI-JAAN LAHTVEE, lahtvee@taltech.ee
- **GLIAL CELL BIOLOGY.**
  Head: Assistant Professor INDREK KOPPEL, indrek.koppel@taltech.ee
- **IMMUNOBIOLOGY OF LEUKOCYTE ACTIVATION.**
  Head: Senior Lecturer SIRJE RÜÜTEL-BOUDINOT, sirje.ruutel@taltech.ee
- **INDUSTRIAL CHEMISTRY LABORATORY.**
  Head: Senior Researcher KRISTIINA KALDAS, kristiina.kaldas@taltech.ee
- **INSTRUMENTAL ANALYSIS.**
  Head: Leading Researcher MERIKE VAHER, merike.vaher@taltech.ee
- **MICROBIOMICS.**
  Head: Senior Researcher KAAREL ADAMBERG, kaarel.adamberg@taltech.ee
- **MICROFLUIDICS.**
  Head: Tenured Associate Professor OTT SCHELER, ott.scheler@taltech.ee
- **MOLECULAR NEUROBIOLOGY RESEARCH GROUP.**
  Head: Tenured Full Professor TÕNIS TIMMUSK, tonis.timmusk@taltech.ee
- **NEUROEPIGENETICS.**
  Head: Senior Researcher KÄRT MÄTLIK, kart.matlik@taltech.ee

- **PLANT-MICROBE INTERACTIONS AND PLANT GENETICS.**
  Head: Tenured Associate Professor MARIA CECILIA SARMIENTO GUERIN, cecilia.sarmiento@taltech.ee
- **PROTEIN DESIGN.**
  Head: Senior Researcher PRIIT EEK, priit.eek@taltech.ee
- **RESEARCH GROUP OF CATALYSIS.**
  Head: Tenured Full Professor TÕNIS KANGER, tonis.kanger@taltech.ee
- **RESEARCH GROUP OF FOOD SCIENCE AND TECHNOLOGY.**
  Head: Senior Lecturer KRISTEL VENE, kristel.vene@taltech.ee
- **RESEARCH GROUP OF METALLOPROTEOMICS.**
  Head: Tenured Full Professor PEEP PALUMAA, peep.palumaa@taltech.ee
- **RESEARCH GROUP OF REPRODUCTIVE BIOLOGY.**
  Head: Tenured Associate Professor AGNE VELTHUT-MEIKAS, agne.velthut@taltech.ee
- **SMART ANALYTICS.**
  Head: Assistant Professor JEKATERINA MAZINA-ŠINKAR, jekaterina.mazina@taltech.ee
- **SUPRAMOLECULAR CHEMISTRY RESEARCH GROUP.**
  Head: Tenured Full Professor RIINA AAV, riina.aav@taltech.ee
- **SUSTAINABLE CHEMISTRY AND ENGINEERING.**
  Head: Senior Researcher YEVGEN KARPICHEV, yevgen.karpichev@taltech.ee
- **SYNTHETIC FLOW CHEMISTRY GROUP.**
  Head: Assistant Professor MAKSIM OŠEKA, maksim.oseka@taltech.ee
- **WOOD CHEMISTRY AND BIOMASS VALORIZATION TECHNOLOGIES.**
  Head: Senior Researcher YEVGEN KARPICHEV, yevgen.karpichev@taltech.ee



ANALYTICAL CHEMISTRY

Head: Senior Research Scientist MARIA KULP, maria.kulp@taltech.ee

Members: Maria Kuhtinskaja, Olga Bragina

Doctoral students: Thi Thuy Trân Ho, Olivia-Stella Salm, Evelin Solomina

TOPICS AND COMPETENCES

KEYWORDS: R&D in analytical chemistry, teaching, services

Our research aims at the development and application of new, environmentally friendly, and reliable analytical techniques for environmental, food, biomass, forensic, and clinical analysis. For that, we utilize a wide range of instrumentation tools and technologies.

We strive to contribute to a safer and healthier world by promoting the Green Analytical Chemistry concept in our research. We develop analysis techniques and procedures to decrease or eliminate solvents, reagents, and other materials that are dangerous to the individual or the ecosystem and provide rapid and energy-saving methodologies. For that, we apply statistical experimental design (DOE) to decrease the number of experiments during the process optimization stage and develop non-destructive (sample preparation minimized or eliminated) cutting-edge analytical technologies, combined with chemometric tools (multidimensional data analysis and modeling), which are almost free of hazardous chemicals and wastes, fast and provide accurate, reliable and consistent results.

IN 2025, the most important results are related to the implementation of the TEM-TA49 project. Within the project an in-depth characterisation of lignins from different origins was completed, and the resulting knowledge was directed toward the development of functional lignin-based materials (including antibacterial materials, thermoplastics, and adhesives).

One key development outcome was a more environmentally friendly and faster alternative for determining lignin and extractives in wood pulps: the method is based on ATR-FTIR measurements and chemometric modelling.

On the materials technology side, a landmark achievement in 2025 was the development of a lignin–furfural-based adhesive for bonding wood and plywood (as an alternative to phenol-formaldehyde adhesives).

Activities related to the LignoQuat antibacterial technologies also continued.

More information: *https://chemlab.taltech.ee*

SELECTED PROJECTS

- GFALKMK24 "*Deashing Kraft lignin (DeAshLignin, DAL)*" (2024–2025)
- TFA25085 *Development of the market readiness of lignin purification technology* (2025–2026)
- TEM-TA49 "*Chemical and biological valorization technologies for woody biomass and secondary lignocellulose sources*" (2024–2028)

SELECTED PUBLICATIONS

Bragina, O.; Kuhtinskaja, M.; Elisashvili, V.; Asatiani, M.; Kulp, M. (2025). Antibacterial Properties of Submerged Cultivated Fomitopsis pinicola, Targeting Gram-Negative Pathogens, Including Borrelia burgdorferi. Sci, 7 (3), #104. DOI: 10.3390/sci7030104.

Salm, O.-S.; Kers, J.; Kulp, M. (2025). Non-Anatomical Identification and Compositional Profiling of Processed Wood Using ATR-FTIR and Chemometric Modeling. Analytica – A Journal of Analytical Chemistry and Chemical Analysis, 6 (4), #46. DOI: 10.3390/analytica 6040046.

Mohan, M. K.; Ho, T. T.; Köster, C.; Järvik, O.; Kulp, M.; Karpichev, Y. (2025). Tuning ester deriva-tives of organosolv vs technical lignin for improved thermoplastic materials. Faraday Discussions. DOI: 10.1039/d5fd00068h.

BIOCHEMISTRY OF LIPIDS AND LIPOPROTEINS

Head of the Research Group: Lead Research Scientist AIVAR LÕOKENE, aivar.lookene@taltech.ee

Members: Ly Villo, Ivar Järving, Priit Eek, Robert Risti

Doctoral student: Natjan-Naatan Seeba

TOPICS AND COMPETENCES

KEYWORDS: mechanisms of lipid and lipoprotein metabolism regulation, biomolecular interactions, lipases, lipid analysis

The main topic of the research group is related to the identification of fundamental aspects of lipid and lipoprotein metabolism. The main focus of the study is on the mechanisms of regulation of lipases and lipoxygenases. We have competence and experience in the study of the structure and properties of proteins, in the analysis of biomolecular interactions, in enzymology and in the analysis of lipids. In our research we use mass spectrometry, chromatography, calorimetry, surface plasmon resonance and fluorescence-based technologies.

IN 2025:

In collaboration with partners, it was demonstrated that in lipodystrophy, leptin acutely increases hepatic secretion of triglyceride-rich lipoproteins, likely contributing to metreleptin's body-weight-independent anti-steatotic effects. At the same time, lipoprotein lipase activity was reduced in patients with lipodystrophy. A case report further suggests that intact autonomic liver innervation may be required for this effect, warranting additional investigation.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219693*

SELECTED PROJECTS:

- LLKEV24041 "*Investigation of hypertriglyceridemia drug candidates*" (2024–2025)
- SSGF21017 "*Regulation of Lipoprotein Lipase Activity in Human Plasma*" (2021–2021)

SELECTED PUBLICATIONS

Beghini, M.; Metz, M.; Baumgartner, C.; Wolf, P.; Bastian, M.; Hackl, M.; Baumgartner-Parzer, S.; Marculescu, R.; Krebs, M.; Harreiter, J.; Brandt, S.; Miehle, K.; Ceccarini, G.; Magno, S.; Pelosini, C.; Tran, C.; Gambineri, A.; Cecchetti, C.; Gard, L.-I.; Risti, R. ... Scherer, T. (2025). Leptin acutely increases hepatic triglyceride secretion in patients with lipodystrophy. Metabolism, 169, #156261. DOI: 10.1016/j.metabol.2025.156261.

Zahavi, E. E.; Rishal, I.; Oses-Prieto, J. A.; Brandis, A.; Malitsky, S.; Itkin, M.; Pokorna, S.; Cabrera-Cabrera, F.; Seeba, N.-N.; Risti, R.; Lookene, A.; Futerman, A. H.; Burlingame, A. L.; Fainzilber, M.; Koppel, I. (2025). Nucleolin perturbation alters membrane lipid homeostasis. Molecular Omics. DOI: 10.1039/d5mo00088b.

BIOMEDICINE

Head of the Research Group: Senior Researcher PIRJO SPUUL, pirjo.spuul@taltech.ee

Member: Airi Rump

Doctoral students: Olga Smirnova, Kaisa Roots, Sadia Khalid

TOPICS AND COMPETENCES

KEYWORDS: *Helicobacter pylori*, invadosomes, liver damage, actin cytoskeleton, microbiome

Biomedicine lab investigates human pathogen *Helicobacter pylori* (HP) and its role in the development of liver diseases. HP is a Gram-negative bacterium living in the hostile environment of the human stomach. About 70% of the adult population in Estonia is infected with HP. The bacterium causes gastritis and peptic ulcers, and, in some cases, gastric cancer. HP can also affect other organs including the liver. However, the mechanisms by which HP causes liver damage and promotes carcinogenesis remain largely unknown. Ongoing research is expected to increase our understanding of the mechanisms behind bacteria-induced carcinogenesis.

Main research topics include:

- Role of *Helicobacter pylori*-induced invadosomes in liver damages. We have previously shown that infection with HP induces the formation of invadosomes in hepatocytes. We are currently investigating the mechanism behind this phenomenon using in vitro approach complemented with transcriptome sequencing.
- Clinical aspects of *Helicobacter pylori*-induced liver diseases. We are using the livers of mice infected with HP to analyse short- and long-term effects of the infection with focus on different markers such as YAP1 and CD44.
- Alteration of gut microbiota by *Helicobacter pylori* leading to the progression of liver diseases. For this study, we are collecting samples from Estonian patients. Our goal is to characterize Estonian HP strains, their effect on mouth/stomach/gut microbiota and liver.
- Effect of probiotic lactic acid bacteria on HP and HP-induced inflammatory response.

IN 2025: Strains of H. pylori circulating in Estonia have been described, along with their origin, pathogenicity and antibiotic resistance. A significant result of the study is the sequencing of the complete genomes of 60 isolates, which have been analyzed and compared with other H. pylori strains found in Europe and worldwide. In total 244 H. pylori clones were isolated.

Additionally, the impact of H. pylori on the liver has been analyzed using a mouse model in collaboration with researchers from the University of Bordeaux.

Our research team isolated two novel L. salivarius strains with potential probiotic properties from

human gastric biopsies. The complete genomes of these strains have been sequenced and compared with other published L. salivarius strains.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219684*

SELECTED PROJECT

- VHE25033 "*UNCAN-CONNECT: Decentralized Collaborative Network for Advancing Cancer Research and Innovation*" (2025–2030)

SELECTED PUBLICATIONS

Seeneevassen, L.; Sifré, E.; Khalid, S.; Managau, M.; Mégraud, F.; Ménard, A.; Dubus, P.; Spuul, P.; Varon, C. (2025). Chronic Infection With Gastric Helicobacters Induces Hepatic Lesions in Mice. Helicobacter, 30, 2, #e70032. DOI: 10.1111/hel.70032.

Bondar, D.; Smirnova, O.; Nagappa, N. M.; Heinmaa, I.; Soukup, O.; Kobrlova, T.; Opravil, J.; Hrabinova, M.; Jun, D.; Starkov, P.; Spuul, P.; Kuča, K.; Mochalin, V. N.; Karpichev, Y. (2025). Nanodiamond Mediated Delivery of Pyridinium Oxime Antidotes to Central Nervous System for Potential Treatment of Exposure to Nerve Agents. Chemico-Biological Interactions, 420, #111711. DOI: 10.1016/j.cbi.2025.111711.

Varon, C.; Azzi-Martin, L.; Khalid, S.; Seeneevassen, L.; Ménard, A.; Spuul, P. (2021). Helicobacters and cancer, not only gastric cancer? Seminars in Cancer Biology, 21,#00219-4. DOI: 10.1016/j.semcancer.2021.08.007.

COCATALYSIS RESEARCH GROUP

Head: Senior Researcher MIKK KAASIK, mikk.kaasik@taltech.ee

Member: Aleksandra Murre

Doctoral students: Kirti Tomar, Rekha

TOPICS AND COMPETENCES

KEYWORDS: asymmetric synthesis; organocatalysis; Lewis acids

The research group is relatively new at the university, started operations in early 2024. The group's activities are dedicated to pushing the boundaries of chemical reactivity, with a profound commitment to environmental stewardship and sustainability. The central challenge we address is the development of environmentally benign methods for synthesizing complex compounds, particularly those that are chiral. The focus is on leveraging asymmetric organocatalysis, a field that employs renewable and less toxic small organic molecules as catalysts, in lieu of traditional transition metals. Asymmetric organocatalysis and particularly cocatalysis, with its adherence to green chemistry principles, emerges as a beacon of future technology, promising advancements that prioritize safety, efficiency, and minimal environmental impact. In an era where the demand for new chemicals, particularly in the pharmaceutical industry, is ever-growing, we strive to reduce waste, energy consumption, and environmental impact. By harnessing the synergistic effects of different catalytic systems, we want to develop innovative processes that meet societal needs and align with the goals of sustainable chemistry.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-of-chemistry/cocatalysis*

SELECTED PROJECT:

- PSG951 "*Merging Organocatalysis with Borane Catalysis in Asymmetric Synthesis*" (2024–2028)

COGNITRONIC LAB-ON-A-CHIP RESEARCH GROUP

Head of the Research Group: Senior Researcher TOOMAS RANG, toomas.rang@taltech.ee

Members: Tamas Pardy, Ants Koel, Kaiser Pärnamets, Rauno Jõemaa

Doctoral student: Fariha Afrin

TOPICS AND COMPETENCES

KEYWORDS: cognitronics, microfluidics, Lab-on-Chip solutions

The goal of the R&D activity is to create the proof of concept of and develop the methodology for low-cost, fully portable flow cytometers based on droplet microfluidics, which will allow field analysis through cognitive electronics system. In recent years the research has been carried out within the framework of the grant PRG620 "CogniFlow-Cyte: Cognitive lab-on-a-chip system for automated flow cytometry". The main objectives were as follows: (1) Integration of a systemic platform for microdroplet generation and characterization of the created solution. (2) Improvement of the algorithm for tracking emerging droplets. (3) Creation of algorithms for reliable data collection and transmission in situations where there are disturbances in the communication network. (4) Solving practical tasks using the created cytometer demonstrator, such as detecting microbeads and biocells.

The research focus is on finding the best geometry of microdroplets to enhance the analysis of their content.

IN 2025 the research activities followed the targets defined during the research grant PRG620. The attention was set on modification of droplet generation concept. Also, the activities were started to initiate the droplet sorting platform. Some specific steps were taken to upgrade the piezoelectric pumps, increasing the monodispersity and the droplet generation speed. The modifications to the used optical system were done with the aim of allowing the control pf all camera parameters in feedbacked systems. Also, developments in event-based wireless control models have been implemented using the hard- and software codesign solutions.

More information:
https://sites.google.com/view/taltechloc

SELECTED PROJECT

- PRG620 "*CogniFlow-Cyte: Cognitronic Lab-on-a-Chip System for Highly-Automated Flow Cytometry*" (2020–2024)

SELECTED PUBLICATIONS

Afrin, F.; Le Moullec, Y.; Pardy, T.; Rang, T. (2025). Lightweight CNN-based Microfluidic Droplet Classification for Portable Imaging Flow Cytometry. Proceedings of the Estonian Academy of Sciences [in press].

Ashraf, K.; Le Moullec, Y.; Pardy, T.; Rang, T. (2024). Co-Design of a Wireless Networked Control System for Reliability and Resource-Efficiency. Proceedings of the 19th Baltic Electronics Conference (BEC2024): 19th Baltic Electronics Conference (BEC2024), Tallinn, Estonia, 2–4 October 2024. Tallinn, Estonia: IEEE, 1–7. DOI: 10.1109/BEC61458.2024.10737965.

Szomor, Z.; Gyimah, N.; Fürjes, P.; Pardy, T. (2024). 3D Finite Element Modelling of Mixing Phenomena in Droplet-based Microfluidic Systems. 2024 19th Biennial Baltic Electronics Conference (BEC). IEEE, 1–4. DOI: 10.1109/BEC61458.2024.10737975.

COMPUTATIONAL CHEMISTRY

Head of the Research Group: Tenured Associate Professor TOOMAS TAMM, toomas.tamm@taltech.ee

Members: Kaie Laane, Viia Lepane, Irina Osadchuk

Doctoral students: Aleksandra Zahharova, Hanna-Eliisa Luts, Arian Lopušanski

TOPICS AND COMPETENCES

KEYWORDS: computational chemistry, density functional theory, force fields, machine learning, phosphates, rare earth metals

Research in the Computational Chemistry Research Group is focused on the study of reaction mecha-nisms and weak (host-guest) interactions utilizing modern electronic structure methods (ab initio, DFT) and machine learning methods. For macroscopic systems, computational fluid dynamics (CFD) models are utilized. We have competence in modelling of both organic and organometallic reaction complexes as well as weakly bound systems. We use quantum-chemistry software such as Gaussian, Turbomole and Orca. Besides small in-house computational facilities we have access to the ETAIS research compu-ting infrastructure, a part of which is located on TalTech campus.

Research in recent years has been focused on the development of force field and machine learning based approaches for description of inorganic compounds. In parallel we are studying the possibilities for describing conformations of metal hydroxides and intramolecular interactions. In a side project we are creating a numerical simulation model for closed-loop solid fuel combustors using the CFD ap-proach.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-of-chemistry#p2219713*

IN 2025: A machine-learning based model of chemical kinetics of phosphorite dissolution was developed. Promising results were obtained in modeling of infrared spectra of amorphous phosphate precipitates. The fluid dynamics model of a test system was developed to publication-ready level.

SELECTED PROJECT

- PRG1779 "*Phosphorus Fertilisers and Rare Metals from Estonian Phosphorite in a Waste-Free Way*" (2023–2027)

SELECTED PUBLICATIONS

Öztürk, I.; Tamm, T.; Kinal, A. (2025). DFT and QM/MM Study of interactions of NSAIDs and Beta-Blockers with DNA. ChemistrySelect, 10 (10), #e202404564. DOI: 10.1002/slct.202404564.

Osadchuk, I.; Luts, H.-E.; Zahharova, A.; Tamm, T.; Borovkov, V. (2024). Controlling Chirogenic Effects in Porphyrin Based Supramolecular Systems: Theoretical Analysis Versus Experimental Observations. ChemPhysChem, 25 (11), #e202400104. DOI: 10.1002/cphc.202400104.

DNA REPLICATION AND GENOME STABILITY

Head of the Research Group: Senior Researcher TATIANA MOISEEVA, tatiana.moiseeva@taltech.ee

Member: Olena Kachalova

Doctoral students: Sameera Vipat, Syed Shahid Musvi, Naga Raviteja Chavata

TOPICS AND COMPETENCES

KEYWORDS: DNA replication, replisome, origin firing

DNA replication remains one of the main targets of cancer therapies as cancer cells tend to proliferate faster and are generally prone to replication stress. However, most of the replication initiation research to date has been done using model organisms such as yeast Xenopus laevis egg extracts. The human DNA replication system is much more complex, and identifying human homologs using data from model systems has proven difficult, resulting in the need to re-evaluate every finding from a model system on a case-by-case basis.

The main goal of the group is to study the molecular mechanism of DNA replication initiation in human cells. Currently the research is focused on the following topics: (1) the role of DNA polymerase epsilon in replication initiation in human cells; (2) developing a novel system to study DNA replication initiation in human cells based on proximity labelling; (3) the role of Timeless protein in health and disease.

Key methods: mammalian cell culture, CRISPR/Cas9 based knock-ins, co-immunoprecipitations, immunofluorescent staining/microscopy, flow cytometry, molecular cloning, DNA fiber analysis, iPOND, proteomic screens.

IN 2025 the group worked on the following research topics:

- the non-catalytic function of DNA polymerase epsilon;
- TIMELESS protein in the initiation of DNA replication and cancer;
- identification of novel replication initiation factors using proximity-labelling proteomics.

More information: *https://moiseevalab.com/*

SELECTED PROJECT

- PRG1477 "*Molecular mechanism of DNA replication initiation in human cells*" (2022–2026)

SELECTED PUBLICATIONS

Vipat, S.; Moiseeva, T. N. (2024). The TIMELESS Roles in Genome Stability and Beyond. Journal of Molecular Biology, 436 (1), #168206. DOI: 10.1016/j.jmb.2023.168206.

Vipat, S.; Gupta, D.; Jonchhe, S.; Anderspuk, H.; Rothenberg, E.; Moiseeva, T. N. (2022). The non-catalytic role of DNA polymerase epsilon in replication initiation in human cells. Nature Communications, 13 (1), #7099. DOI: 10.1038/s41467-022-34911-4.

Ashton, N. W.; Prakash, A.; Moiseeva, T. N. (2023). Editorial: Regulatory networks in genome stability pathways. Frontiers in Genetics, 14, #1171136. DOI: 10.3389/fgene.2023.1171136.

FOOD TECH AND BIOENGINEERING

Head of the Research Group: Tenured Associate Professor PETRI-JAAN LAHTVEE, lahtvee@taltech.ee

Members: Rahul Kumar, Srdjan Gavrilovic, Juliano Sabedotti De Biaggi, Aleksandr Illarionov, Kaisa Orgusaar

Doctoral students: Paola Oliveira Monteiro, Alina Rekena, Henrique Sepulveda, Mateus Ribeiro da Silva, Saida Khalid, Abdullah Nasir, Ritwika Basu, Subhasis Behera

TOPICS AND COMPETENCES

KEYWORDS: yeast, synthetic biology, systems biology, cell factories, biotechnology, circular economy, local substrate valorization, bioinformatics, AI, biofoundry

Our research is focused on addressing global challenges of bio-sustainability, including sustainable production of food and feed, but also biochemicals and materials. We are developing novel bio-based processes where microbial cell factories are used to convert various waste carbon like food- and wood industry waste into value-added products.

Relying on the multi-disciplinary skill-set in our research group, we have established the Design-Build-Test-Learn cycle of cell factory design and bioprocess optimization. We use advanced metabolic modeling for the design of novel cell factories; we develop novel synthetic biology tools for the more efficient engineering of cell factories; and use our lab-scale bioreactor platform for the process characterization and optimization. We are additionally utilizing the advancements of additive manufacturing to develop 'living materials', which will improve biotechnology-based production processes.

By combining these approaches, we aim to translate fundamental science results in industrial biotechnology applications by constructing more efficient producer cells. Together with our global and local partners, we are developing the whole value chains in circular economy for the sustainable production of value-added products with minimal waste streams.

The year **2025** brought several important developments:

- The DigiBio biofoundry platform successfully passed the first stage.
- The Baltic Biotechnology Action Plan and Database were completed within the framework of the Bioconnect project [*https://bioconnectproject.eu/*].

Several major events were organized to introduce Baltic biotechnology and Estonian food innovation: Biotech Breakfast within the sTARTUp Day and Food Innovation Estonia within Latitude59.

More information: *https://bioeng.taltech.ee*

SELECTED PROJECTS

- PRG1101 "*A novel 3D-printable cell factory platform for growth-decoupled oleochemical production*" (2021–2025)

- VHE23056 "*Centre for Digitalisation of Biology Towards the Next-Generation of Biosusatainable Products*" (2023–2029)
- VHE24011 "*Yeast-based solutions for sustainable Aviation Fuels*" (2023–2027)

SELECTED PUBLICATION

Sepulveda Del Rio Hamacek, H.; Tingajeva, O.; Ostertag, K.; Rekena, A.; Illarionov, A.; Jõul, P.; Monteiro de Oliveira, P.; de la Caridad Martin-Hernandez, G.; Mueller, B.a; Bonturi, N.; Passoth, V.; Lahtvee, P.-J.; Kumar, R. (2025). Acidification by nitrogen metabolism triggers extracellular biopolymer production in an oleaginous yeast. Applied and Environmental Microbiology, 91, 11, art. e00947-25. DOI: 10.1128/aem.00947-25.

Senatore, V. G; Reķēna, A.; Mapelli, V.; Lahtvee, P.-J.; Branduardi, P. (2025). Ethylene glycol metabolism in the oleaginous yeast Rhodotorula toruloides. Applied Microbiology and Biotechnology, 109, #114. DOI: 10.1007/s00253-025-13504-3.

Reķēna, A.; Pals, K.; Gavrilović, S.; Lahtvee, P-J. (2025). The role of ATP citrate lyase, phosphoketolase, and malic enzyme in oleaginous Rhodotorula toruloides. Applied Microbiology and Bi-otechnology, 109, #77. DOI: 10.1007/s00253-025-13454-w.

GLIAL CELL BIOLOGY

Head: Assistant Professor INDREK KOPPEL, indrek.koppel@taltech.ee

Members: Age Utt, Florencia Cabrera Cabrera

Doctoral student: Helena Tull

TOPICS AND COMPETENCES

KEYWORDS: cell types of the nervous system, cell type-specific RNA and protein profiling, neurotrophin BDNF in non-neuronal cells

The central nervous system tissues are made of a number of different cell types, among which astrocytes are one of the most abundant type. In the CNS tissue cells are highly intermixed, posing a challenge when trying to analyze their transcriptomes and proteomes separately. Owing to the difficulties separating these cells, bulk tissue analysis has been used previously to profile mRNA and protein in tissue, giving averaged readouts across the tissue. In the past decade, cell type specific RNA analysis has seen enormous progress with the advent of single cell RNA sequencing and genetic tools for cell-type specific RNA isolation (TRAP, Ribotag). However, cell type specific proteome analysis is lagging behind and widely used, straightforward methods are not available.

Our research aim is to develop a cell type-specific proteome analysis method that is based on puromycin labeling, and to apply the method to studying neuron-astrocyte interactions in an in vitro co-culture system. In addition, we shall use the Ribotag method for cell type-specific mRNA analysis.

A key strategy we use for studying intercellular communication is activation of either neurons of astrocytes by triggering intracellular Ca2+ release by using the DREADD chemogenetic system – followed by proteomic and transcriptomic analysis of the other cell type in culture.

Our additional research interest is regulation of protein synthesis in glial cells.

Key competences: cell cultures of neurons and glial cells; cell type-specific RNA and protein analysis; adeno-associated virus (AAV) vector production and use.

More information: https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219704

IN 2025: We further developed cell-specific proteome labeling using puromycin (Puromycin Inactivation for Cell-Selective proteome Labelling, or PICSL). A transgenic mouse line was generated and imported from the country of origin (China) to Estonia, backcrossed onto a wild-type genetic background, and subjected to initial experiments to validate the functionality of the model. To this end, crosses were initiated with a cell type–specific (neuron-specific) Cre mouse line, and cell type–specific puromycin labeling was analyzed.

Using a glia–neuron co-culture system, we investigated the nature of astrocyte-to-neuron signaling following chemogenetic activation of astrocytes, focusing on the activation of neuronal signaling

path-ways and the induction of candidate gene expression identified by RNA sequencing.

In collaboration with Dr. Olga Jasnovidova (Molecular Neurobiology Research Group), we examined transcriptional enhancers in cultured rat astrocytes that are regulated upon stimulation with the neu-romodulator norepinephrine. Candidate enhancer regions were analyzed individually using molecular biology techniques.

SELECTED PROJECTS

- PRG2206 "*Probing Neuron-Glia Interactions with Cell-Selective Stimulation and Omics*" (2024–2028)
- MOBJD1210 "*AstroReg: A cartography of regulatory elements in astrocytes*" (2023–2025)
- TARISTU24-TK14 "*Experimental studies and applications of cellular processes*" (2025–2029)

SELECTED PUBLICATIONS

Zahavi, E. E.; Rishal, I.; Oses-Prieto, J. A.; Brandis, A.; Malitsky, S.; Itkin, M.; Pokorna, S.; Cabrera-Cabrera, F.; Seeba, N.-N.; Risti, R.; Lookene, A.; Futerman, A. H.; Burlingame, A. L.; Fainzilber, M.; Koppel, I. (2025). Nucleolin perturbation alters membrane lipid homeostasis. Molecular Omics. DOI: 10.1039/d5mo00088b.

Zahavi, E. E.; Koppel, I.; Kawaguchi, R.; Oses-Prieto, J. A.; Briner, A.; Monavarfeshani, A.; Dalla Cos-ta, I.; van Niekerk, E.; Lee, J.; Matoo, S.; Hegarty, S.; Donahue, R. J.; Sahoo, P. K.; Ben-Dor, S.; Feld-messer, E.; Ryvkin, J.; Leshkowitz, D.; Perry, R. B.-T.; Cheng, Y.; Farber, E. ... Fainzilber, M. (2025). Repeat-element RNAs integrate a neuronal growth circuit. Cell, 188 (16), 4350–4365. DOI: 10.1016/j.cell.2025.04.030.

IMMUNOBIOLOGY OF LEUKOCYTE ACTIVATION

Head of the Research Group: Senior Lecturer SIRJE RÜÜTEL BOUDINOT, sirje.ruutel@taltech.ee

Member: Airi Rump

Doctoral students: Kadri Orro, Roland Martin Teras

TOPICS AND COMPETENCES

KEYWORDS: immune regulation, leukocyte activation, RGS16, P2X4, P2X7, Multiple Sclerosis, melanoma, eosinophils, SarsCov2

The main research direction of the working group is leukocyte activation and its regulation. This is crucial both in the healthy organism and during the immune response. Dysfunction of these mecha-nisms is a key factor in tumors, inflammatory and autoimmune diseases and also strongly affects the ability to fight pathogens.

Two families of regulators whose immunoregulatory functions have been poorly studied have been chosen for investigation – RGS (regulators of G protein signaling, the main research object RGS16) and P2X (purinergic receptors, the main research object P2X4). Using both in vitro and in vivo models, loss-of-function and gain-of-function experiments are performed to characterize the mechanisms mediat-ed by these genes. Comparative methods are also used to assess the importance of these genes in the context of immune system evolution. The mechanisms through which RGS16 affects the course of ex-perimental autoimmune encephalomyelitis (EAE), an animal model of multiple sclerosis, and the signal-ing pathways regulated by RGS16 will be characterized. The role of P2X4 in ATP-mediated activation of eosinophils (and other cell types) is described in collaboration with PERHi, and the variability of the P2X4 gene in the Estonian population in collaboration with the Estonian Genome Database.

As a new direction, applications to the national health technology direction are promoted, developing metabolic diagnostics that could help prevent dementia resulting from the diseases under study.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219690*

SELECTED PROJECT

- PRG1832 "*H-NMR in solid state and complementary applications*" (2023–2027)

SELECTED PUBLICATION

Rump, A.; Ratas, K.; Lepasepp, T. K.; Suurväli, J.; Smolander, O.-P.; Gross-Paju, K.; Toomsoo, T.; Kanellopoulos, J.; Rüütel Boudinot, S. (2023). Sex-dependent expression levels of VAV1 and P2X7 in PBMC of multiple sclerosis patients. Scandinavian Journal of Immunology, 98 (2), #e13283. DOI: 10.1111/sji.13283.

INDUSTRIAL CHEMISTRY LABORATORY

Head: Senior Researcher KRISTIINA KALDAS, kristiina.kaldas@taltech.ee

Members: Margus Lopp, Birgit Mets, Estelle Silm, Mariliis Kimm, Andres Siirde, Kaarel Siirde, Jaan Mihkel Uustalu, Villem Ödner Koern, Galina Varlamova, Angelica Närep

Doctoral students: Maria Reinaas, Violetta Umerenkova, Kati Muldma, Kristi Rõuk, Vijay Kumar

TOPICS AND COMPETENCES

KEYWORDS: chemical technology; flow process; oil shale; oil shake ash; valorisation of residual materials; valorisation of biomass; dicarboxylic acids and their derivatives; oxidation

The Industrial Chemistry Laboratory's main purpose is to act as an interface between chemical research and industrial application. The research team includes both chemists and engineers who look for science-based solutions to chemical engineering problems faced by local companies. A lot of emphasis is put on the investigation of alternative uses of oil shale, e.g. as a raw material for fine chemicals, and on the recycling of various industrial residues. The research encompasses both fundamental studies, such as small-scale laboratory experiments as well applied research, including the construction of a kilogram-scale pilot device and the design of an industrial pilot device. As a result of studying oil shale utilization methods, a unique laboratory-scale testing unit has been developed, allowing the testing of various flow-through process regimes and the separation of resulting products. The developed equipment also allows testing of chemical transformation processes for other materials across a wide range of reaction conditions and the developing sustainable solutions to various challenges.

The main focus areas of the lab have so far been related to studying residual oil shale, the organic material contained within it, and oil shale ash. The most notable achievement is the completion of the Kerox technology, whose implementation would provide significant added value to the oil shale sector as well as to Estonia's chemical and defense industries, ensuring both economic independence and supply security. Within thematic research and development programs, the lab works on the sustainable valorization of organic components from Estonian mineral resources and secondary raw materials into chemicals.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/industrial-chemistry-laboratory*

IN 2025: As a part of the study of the Estonian kukersite oxidation process, the technological scheme of the process has been designed, built and its profitability assessed, a laboratory test unit has been created, which allows for the evaluation of the commercial use of oxidation products. The sustainable valorization of organic components of mineral resources and secondary raw materials into chemicals through chemical conversion has been studied.

The structure of Estonian oil shale has been specified, which will result in the possibility of making oil shale processing selective.

It has been shown that ashes of different origins (fly ash, bottom ash, long-term deposited ash) are suitable for obtaining deicing agents, suitable methods for separating the insoluble solid ash fraction and the technology required for concentrating the resulting salt solutions have been evaluated.

SELECTED PROJECTS

- TEM-TA128 "*Sustainable Conversion of the Organic Part of Mineral Resources and Secondary Raw Materials to High Value Chemicals*" (2024–2028)
- MNKE23052 "*Valorisation of oil shale ash into biodegradable chloride-free snow and deicing agents*" (2023–2025)
- TTK13 "*Infrastrucure of chemical synthesis and technology*" (2025–2029)

SELECTED PUBLICATIONS

Lopp, M.; Kaldas, K. (2025). Possibilities of the Direct Chemical Transformation of Kukersite Kerogen: A Critical Review. ACS Omega, 10 (36), 40740−40749. DOI: 10.1021/acsomega.5c04675.

Kaldas, K.; Muldma, K.; Simm, A.; Mets, B.; Kontson, T.; Silm, E.; Kimm, M.; Koern, V. Ö.; Uustalu, J. M.; Lopp, M. (2025). From Shale to Value: Dual Oxidative Route for Kukersite Conversion. Process-es, 13 (8), #2421. DOI: 10.3390/pr13082421.

Mets, B.; Muldma, K.; Simm, A.; Kontson, T.; Lopp, M.; Kaldas, K. (2025). Characterization of the potential of oil shales of different geological origin for the production of dicarboxylic acids using mi-crowave oxidation. Journal of Thermal Analysis and Calorimetry, 1−12. DOI: 10.1007/s10973-025-14802-8.

INSTRUMENTAL ANALYSIS

Head of the Research Group: Leading Researcher MERIKE VAHER, merike.vaher@taltech.ee

Members: Mihkel Koel, Piia Jõul, Olga Bragina, Mihkel Kaljurand

Doctoral student: Pille-Riin Laanet, Annabel Taniel

TOPICS AND COMPETENCES

KEYWORDS: separation methods, capillary electrophoresis, miniaturization, phytochemicals, antioxidativity, biomass, ionic liquids, deep eutectic solvents, banned chemicals, modified materials

The members of the group have competence in development of analytical methods and procedures and use of these in analysis of different compounds and mixtures in complicated matrices. The group has good specialists in separation methods: gas and liquid chromatography and especially in capillary electrophoresis where they use a wide variety of detectors: electrical, optical and mass spectrometrical. The group has also competence and means for supercritical extraction for a wide range of extraction parameters. The group has provided recognised results on development of porous materials – aerogels and these have been taken into use as adsorbents in analytical separation and catalysts in electrochemistry and water purification.

The aim of the present research is development and application of a variety of analytical methodologies (capillary electrophoresis, HPLC-MS, GC-MS) for analysis of different classes of compounds (banned chemicals, drugs, polyphenols, fermentable sugars) in complex matrixes such as environmental samples, body fluids, biomass and herbal extracts. The results obtained will be used to develop an expert system. Miniaturization of capillary electrophoresis apparatus is an important feature, which provides an opportunity to perform on-site analyzes.

MAIN RESULTS IN 2025:

Our research group investigated the phytochemical composition and potential inhibitory activity of meadowsweet (Filipendula ulmaria) extracts against Borrelia burgdorferi, the causative agent of Lyme disease, and the ESKAPE pathogen group. The antioxidative properties of the extracts were determined using the ORACFL method, with values varying from 3 to 31 mg TE/g. The B. burgdorferi inhibitory activities were evaluated on both the stationary phase culture and its biofilm fraction. The most effective extract (prepared from meadowsweet leaves) reduced the residual viability of the B. burgdorferi culture to 6.9 ± 2.7% after one week of incubation, compared to 88.3 ± 5.8% in the negative control. Furthermore, meadowsweet extracts were effective against the Gram-positive species E. faecium and S. aureus at concentrations as low as 0.44 ± 0.06 mg/mL. These findings demonstrate the broad-spectrum potential of the plant, as it inhibits both the Gram-negative B. burgdorferi spirochetes and structurally distinct Gram-positive ESKAPE pathogens. These results are significant given that these species pose major global public health risks.

These initial results are promising, but further research is needed to fully understand the molecular mechanisms responsible for the antibacterial and biofilm inhibiting properties and to start developing practical therapeutic strategies.

More information: https://taltech.ee/en/department-chemistry-biotechnology/division-of-of-chemistry#p2219716

SELECTED PROJECTS

- SS22004 "*Evaluation of antioxidant and antibacterial activity of plant extracts*" (2022–2023)
- TTK15 "*Estonian Center of Analytical Chemistry*" (2025–2029)
- LLKEE25010 "*A study of the chemical composition of pollen collected from different counties in Estonia*" (2025–2025)

SELECTED PUBLICATIONS

Laanet, P.-R.; Bragina, O.; Jõul, P.; Vaher, M. (2024). Plantago major and Plantago lanceolata Exhibit Antioxidant and Borrelia burgdorferi Inhibiting Activities. International Journal of Molecular Sciences, 25 (13), #7112. DOI: 10.3390/ijms25137112.

Laanet, P.-R.; Saar-Reismaa, P.; Jõul, P.; Bragina, O.; Vaher, M. (2023). Phytochemical Screening and Antioxidant Activity of Selected Estonian Galium Species. Molecules, 28 (6), 2867. DOI: 10.3390/molecules28062867.

Vaher, M.; Bragina, O. (2026). Coffee Cascara as a Source of Natural Antimicrobials: Chemical Char-acterization and Activity Against ESKAPE Pathogens. Molecules, 31 (3), #403. DOI: 10.3390/molecules31030403.

Tavares, W.R.; Jiménez, I.A.; Oliveir, L.; Kuhtinskaja, M.; Vaher, M.; Ros, J.S.; Seca, A.M.L.; Bazzocchi, I.L.; Barreto, M.C. (2023). Macaronesian Plants as Promising Biopesticides against the Crop Pest Ceratitis capitata. Plants, 12 (24), 4122. DOI: 10.3390/plants 12244122.

MICROBIOMICS

Head of the Research Group: Senior Researcher KAAREL ADAMBERG, kaarel.adamberg@taltech.ee

Members: Signe Adamberg, Signe Adamberg, Indrek Morell, Kristo Abner, Taivo Lints, Robert Risti

TOPICS AND COMPETENCES

Keywords: Gut microbiota, valorisation of bran, dietary fibres, cultivation of microbial consortia

The main topics that the research group deals with are the study of the relationship between dietary habits and health using modern methods in vitro and in nutritional experiments. The main focus of the research is on the digestion of fiber by intestinal bacteria.

The main aims are to:

- find links between the gut microbiota, nutrition and health characteristics;
- analyse metabolism of gut bacteria (development of metabolic models);
- identify patterns of gut microbiota characteristic to different diseases;
- develop new technologies to produce microbiota-based therapeutics (both bacterial and bacterial-virus i.e. phage-based);
- develop technologies to produce microbiome-supporting food products.

More information: *https://taltech.ee/#p7740368*

IN 2025:

We carried out research within the Fibre-Match project (EU Horizon EIC Pathfinder program project no. 101161484), which is related to studies of intestinal microbiota metabolism characteristic to irritable bowel syndrome. The aim of the work is to find correlations between the type of gut microbiota metabolism (metabotype) and dietary fibre breakdown in order to minimize gas production. We also develop food technologies to reduce digestive discomfort associated with the consumption of fiber-rich foods.

We continued our collaboration with the gut microbiome research group from the University of Copenhagen (group leader prof. Dennis Sandris Nielsen) in the field of cultivating artificial communities, where the current focus is on cultivating gut microbiota characteristic to inflammatory bowel disease and isolating bacterial viruses.

SELECTED PROJECTS:

- VHE24018 "*Precision nutrition approach for increasing fibre intake and health using microbiota-matched sustainable fibre sources*" (2024–2028)

- (TARISTU24-TK20) "*Infrastructure of Food Innovation Technologies*" (2025–2029)

SELECTED PUBLICATIONS:

Rasmussen, T. S.; Mao, X.; Forster, S.; Larsen, S. B.; Von Münchow, A.; Tranæs, K. D.; Brunse, A.; Larsen, F.; Mejia, J. Leonardo C.; Adamberg, S.; Hansen, A. K.; Adamberg, K.; Hansen, C. H. F.; Nielsen, D. S. (2024). Overcoming donor variability and risks associated with fecal microbiota transplants through bacteriophage-mediated treatments. Microbiome, 12 (1), #119. DOI: 10.1186/s40168-024-01820-1.

Adamberg, S.; Adamberg, K. (2024). Prevotella enterotype associates with diets supporting acidic faecal pH and production of propionic acid by microbiota. Heliyon, 10 (10), #e31134. DOI: 10.1016/j.heliyon.2024.e31134.

Paveljšek, D.; Pertziger, E.; Fardet, A.; Panagiotakos, D. B.; Savary-Auzeloux, I.; Adamberg, S.; Peñas, E.; Frias, J.; Ntantou, A.; Diamantoglou, I.; Domínguez-Soberanes, J.; Louis, S.; Chassard, C.; Praćer, S.; Vergères, G.; Matalas, A. (2025). A systematic review of prospective evidence linking non-alcoholic fermented food consumption with lower mortality risk. Frontiers in Nutrition, 12, #12:1657100. DOI: 10.3389/fnut.2025.1657100.

MICROFLUIDICS

Head of the Research Group: Tenured Associate Professor OTT SCHELER, ott.scheler@taltech.ee

Members: Pille Pata, Simona Bartkova, Immanuel Sanka, Merili Saar-Abroi, Triini Olman

Doctoral students: Veiko Rütter, David Gonzalez, Daniel Kacsor

TOPICS AND COMPETENCES

KEYWORDS: microfluidics, droplet microfluidics, digital microfluidics, antibiotic resistance, microbiology, image analysis

Microfluidics enables conducting of biological and chemical experiments in very small volumes of fluids. In basic and applied research, the volumes used in experiments usually range from 1 litre to 1 microlitre. Microfluidic devices allow automating, controlling, and performing tests using even smaller volumes. Manufacturing of microfluidic devices is multidisciplinary, including the fields of mechanics, IT, engineering, material science, chemistry, and many others. Our applications include: diagnostic tools, development of biomolecules, antimicrobial resistance studies.

IN 2025: Droplet microfluidic technologies were further developed and applied in collaboration projects with academic and private sector.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219698*

SELECTED PROJECTS

- VHE24050 "*3D Biofabricated high-perfoRmance dna-carbon nanotube dIgital electroniCKS*" (2023–2026)
- VHE23042 "*Automated in-line platform for the analysis of chiral separation*" (2022–2026)
- TFA25095 "*CELLSIEVE: Commercialization of cell screening technology for food and biotechnology industry*" (2025–2026)

SELECTED PUBLICATIONS

Saar-Abroi, M.; Lindpere, K.; Kácsor, D.; Olman, T.; Gonzalez, D.; Sulp, F. L.; Kiir, K.; Sanka, I.; Bartkova, S.; Scheler, O. (2025). High-throughput bacterial aggregation analysis in droplets. Scientific Reports, 15 (1), art. 42980. DOI: 10.1038/s41598-025-27034-5.

Bartkova, S.; Zapotoczna, M.; Sanka, I.; Scheler, O. (2024). A Guide to Biodetection in Droplets. Analytical Chemistry, 96 (24), 9745–9755. DOI: 10.1021/acs.analchem.3c04282.

Ruszczak, A.; Jankowski, P.; Vasantham, S. K.; Scheler, O.; Garstecki, P.iotr (2023). Physicochemical Properties Predict Retention of Antibiotics in Water-in-Oil Droplets. Analytical Chemistry, 95 (2), 1574–1581. DOI: 10.1021/acs.analchem.2c04644.

MOLECULAR NEUROBIOLOGY RESEARCH GROUP

Head of the Research Group: Tenured Full Professor TÕNIS TIMMUSK, tonis.timmusk@taltech.ee

Members: Kaia Palm, Richard Tamme, Jürgen Tuvikene, Mari Palgi, Epp Väli, Laura Tamberg, Annela Avarlaid, Alex Sirp, Eli-Eelika Esvald, Florencia Cabrera Cabrera

Postdoctoral Researchers: Olga Jasnovidova, Hanna Vihma

Doctoral students: Anastassia Šubina, Helen Põldsam, Annika Rähni

TOPICS AND COMPETENCES

KEYWORDS: neurotrophins, BDNF, bHLH transcription factors, TCF4/E2-2, neuronal activity-regulated transcription, Pitt-Hopkins syndrome, schizophrenia, COVID19, heart and cardiovascular diseases, melanoma

Our studies focus on the molecular mechanisms of gene expression, including transcription, mRNA and protein subcellular localization, translation, post-translational modifications, and signaling, in the nervous system and in different diseases. The main emphasis of the research is on neurotrophins, their receptors and activity-regulated gene expression. Specifically, we study (1) Molecular mechanisms controlling neural activity-regulated transcription and translation of the neurotrophin BDNF; (2) The functions of the basic helix-loop-helix transcription factor TCF4 in the nervous system of mammals and Drosophila and its deregulation in Pitt-Hopkins syndrome and schizophrenia; (3) Molecular markers in blood for early diagnostics of different diseases.

The aim of our research group is to characterize the molecular basis of expression of genes regulated by neural activity in the nervous system and its pathologies.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219701*

IN 2025:

- We focused on the regulation of Bdnf gene expression in response to different stimuli, specifically studying the effects of neuronal activity and BDNF-TrkB signaling on Bdnf transcription in cultured neurons from rats. We show that the USF family of transcription factors is specifically recruited after membrane depolarization, whereas the AP1 family participates in Bdnf regulation only after BDNF-TrkB signaling. We further describe ATF2, MYT1L, and EGR family as novel regulators of Bdnf expression by demonstrating their direct binding to Bdnf promoters. Furthermore, our results show competition between ATF2, CREB, and AP1 family in regulating Bdnf levels. Collectively, our results provide insight into the regulation of Bdnf expression upon different stimuli.
- We studied the effect of high-intensity interval (HIIT) and moderate-intensity continuous training (MICT) on cerebral energy metabolism in old rats. Both training modalities improved endurance, with HIIT demonstrating superior gains in maximal performance. However, molecular analyses revealed that MICT induced more extensive metabolic and angiogenic adaptations in the cortex and hippocampus, including the upregulation of key regulators of energy metabolism and vascularization. RNA sequencing confirmed broader transcriptomic changes following MICT, implicating pathways associated with neurogenesis, metabolic homeostasis, and cellular plasticity. These findings suggest that MICT is the preferred regimen for enhancing cerebral metabolic function and neurovascular adaptation, while HIIT serves as a complementary strategy to involve other brain metabolism-associated pathways and maximize aerobic fitness. A direct comparison of these modalities is essential for refining exercise prescriptions to support brain health in aging.

SELECTED PROJECTS

- (MOB3PRT13) "*OptimaMind: Enhancing Cognitive Longevity through Lifestyle and Nutrition*" (2025–2028)
- PRG2583 "*Gene Regulation in Intellectual Disability and Autism Spectrum Disorders With the Em-phasis on Disease-Associated Transcription Factors TCF4, SATB2, FOXP1, and Neurotrophic Factor BDNF*" (2025–2029)
- PRG805 "*Regulation of activity-dependent gene expression in the nervous system*" (2020–2024)

SELECTED PUBLICATIONS

Esvald, E.-E.; Moistus, A.; Lehe, K.; Avarlaid, A.; Subina, A.; Kuusemets, L.; Tuvikene, J.; Tim-musk, T.s (2025). Stimulus-Dependent Expression of Bdnf Is Mediated by ATF2, MYT1L, and EGR1 Transcription Factors. Journal of Neuroscience, 45 (12), #e0313242025. DOI: 10.1523/JNEUROSCI.0313-24.2025.

Kumar, A.; Karuppagounder, S. S.; Chen, Y.; Corona, C.; Kawaguchi, R.; Cheng, Y.; Balkaya, M.; Sagdullaev, B. T.; Wen, Z.; Stuart, C.; Cho, S.; Ming, Guo-li; Tuvikene, J.; Timmusk, T.; Geschwind, D. H.; Ratan, R. R. (2023). 2-Deoxyglucose drives plasticity via an adaptive ER stress-ATF4 pathway and elicits stroke recovery and Alzheimer's resilience. Neuron, 111 (18), 2831–2846.E10. DOI: 10.1016/j.neuron.2023.06.013.

Avarlaid, A.; Esvald, E.-E.; Koppel, I.; Parkman, A.; Zhuravskaya, A.; Makeyev, E. V.; Tuvikene, J.; Timmusk, T. (2024). An 840 kb distant upstream enhancer is a crucial regulator of catecholamine-dependent expression of the Bdnf gene in astrocytes. Glia, 72 (1), 90–110. DOI: 10.1002/glia.24463.

NEUROEPIGENETICS

Head: Senior Researcher KÄRT MÄTLIK, kart.matlik@taltech.ee

Member/doctoral student: Irma Laas

TOPICS AND COMPETENCES

KEYWORDS: neurons; development; ageing; epigenetics; bivalency; histone modifications

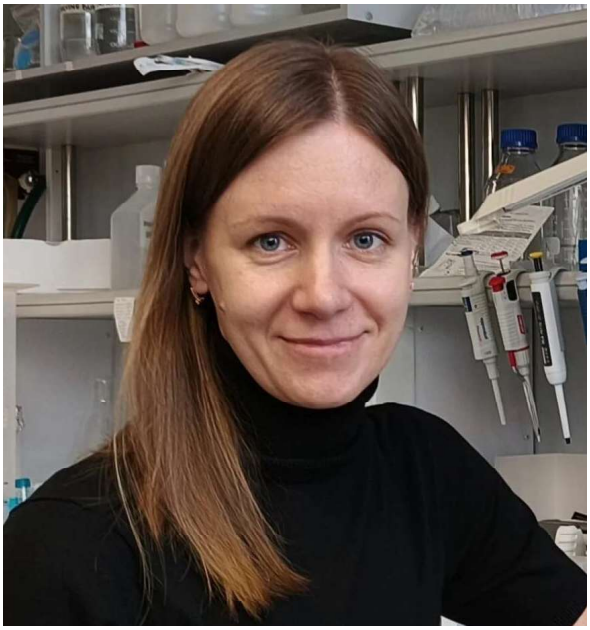
The laboratory of neuroepigenetics studies how epigenetic mechanisms control neuronal development and function throughout life. Neurons are born and mature early in development and are typically not replaced during the organism's lifetime. Therefore, once neurons have matured and become fully functional, they must remain so for a long time – in humans, for up to a hundred years or more. This means that the transcriptional programs that become established during neuronal maturation must remain stable – yet responsive to external stimuli – over the entire lifespan of an organism. We are interested in how the epigenetic landscape is set up and controls transcriptional programs in during neuronal maturation and how epigenetic and transcriptional stability are maintained in neurons throughout life.

The main research directions are studying the role of histone bivalency, H3K27me3, and methyltransferase EZH1 in neuronal development and ageing.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p7751045*

IN 2025:

We published a review article in a leading journal Genes & Development, where we described the mechanisms regulating the correct timing of gene expression programs during neuronal development (Mätlik et al. 2025, Genes & Dev). The review built upon our recent findings demonstrating the importance of epigenetic regulation in brain development (Mätlik et al. 2023, Genes & Dev). The results of this research help us understand the mechanisms ensuring the



correct timing of cell stage transitions during brain development, and explain why impaired developmental progression can lead to nervous system diseases such as autism or intellectual disability.

SELECTED PROJECTS:

- PSG1018 "*The Role of Histone Bivalency and EZH1 in Neuronal Development and Function*" (2025–2029)
- MOB3ERC113 "*Support for ERC grant application EpiNeuroLife: Epigenome in the Life of a Neuron*" (2025–2026)

SELECTED PUBLICATION

Mätlik, K.; Govek, E.-E.; Hatten, M. E. (2025). Histone bivalency in CNS development. Genes & Development. DOI: 10.1101/gad.352306.124.

PLANT-MICROBE INTERACTIONS AND PLANT GENETICS

Head of the Research Group: Tenured Associate Professor
MARIA CECILIA SARMIENTO GUERIN, cecilia.sarmiento@taltech.ee

Members: Triin Vahisalu, Merike Sõmera, Irena Jakobson, Lenne Nigul, Signe Nõu, Kairi Kärblane, Jelena Mõttus

Doctoral students: Ferenz Sustek Sánchez, Anna Ivanova-Pozdejeva, Nicoletta Cau

TOPICS AND COMPETENCES

KEYWORDS: agricultural crop diseases, plant viruses, adaptation to climate change, RNA silencing suppressors, CRISPR/Cas9, wheat pre-breeding; genotyping

We study genetic, molecular and cellular aspects of plant-microbe interactions. For this, we use various cereals, potato, tomato, and faba bean plants as hosts, as well as Arabidopsis thaliana and different tobacco species as experimental model plants.

Multifunctional ABCE genes remain a subject of study, but the main focus is on applying CRISPR-Cas technology to achieve optimal plant tolerance to both abiotic and biotic stresses. Specifically, transcriptomics and functional genomics are being employed to enhance the frost and drought tolerance of perennial ryegrass, thereby supporting agricultural sustainability. This study is conducted in collaboration with scientists from Latvia, Norway, and Lithuania.

One of our major projects is "Modern Breeding Tools for Smart Food Security (MARTA)", which aims to generate novel breeding knowledge and a toolbox of modern breeding methods to promote the development of climate- and disease-resistant, high-quality, sustainable, and high-yielding plant varieties. Our tasks include developing new breeding techniques to obtain PVY-resistant potato and drought-tolerant faba bean plants.

Within the framework of the Marie Skłodowska-Curie Actions (MSCA) COFUND programme *INNOCHEMBIO*, we have started research on obtaining PVY-resistant tomato plants using CRISPR–Cas techniques.

Under a cooperation agreement with METK, genes determining disease resistance and yield in spring and winter wheat are being investigated using phytopathological methods, genetic mapping, and DNA sequence analysis. We also develop precision breeding and genotyping tools (CRISPR/Cas, SSR, KASP, SNPs) in collaboration with METK to enable rapid and cost-effective genomic selection in barley breeding.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/plant-pathogen-interactions*

MAIN RESULTS IN 2025:

- Transcriptomic analysis of perennial ryegrass plants with different drought tolerance levels showed that the sensitive genotype responded earlier and was more affected by mild drought. Unlike the sensitive genotype, the tolerant one maintained leaf growth, promoted root development, and increased cuticular wax synthesis at later stress stages.
- A reproducible method for evaluating the editing efficiency of guide RNAs and transformation vectors *in vivo* was established using perennial ryegrass protoplasts.
- The taxonomy of plant viruses was updated in collaboration with virologists from around the world.
- Methods for in vitro cultivation, protoplast isolation and transformation of Estonian potato varieties were successfully established.
- Specific PACE markers associated with the yield of Estonian winter and spring wheat varieties were identified.

SELECTED PROJECTS

- TTK28 "*Plant biology and valorization infrastructure*" (2025–2029)
- VHE25020 "*Innovative Chemistry and Biotechnology for a Sustainable Future*" (2025–2030)
- ETAG21022 "*Improving adaptability and resilience of perennial ryegrass for safe and sustainable food systems through CRISPR-Cas9 technology*" (EditGrass4Food)" (2021–2024)

SELECTED PUBLICATIONS

Rubino, L.; Abrahamian, P.; An, W.; Aranda, M. A.; Ascencio-Ibañez, J. T.; Bejerman, N.; Blouin, A. G.; Candresse, T.; Canto, T.; Cao, M.; Carr, J. P.; Cho, W. K.; Constable, F.; Dasgupta, I.; Debat, H.; Dietzgen, R. G.; Digiaro, M.; Donaire, L.; Elbeaino, T.; Fargette, D.s ... Zhang, S. (2025). Summary of taxonomy changes ratified by the International Committee on Taxonomy of Viruses from the Plant Viruses Subcommittee, 2025. Journal of General Virology, 106, 7. DOI: 10.1099/jgv.0.002114.

Pashapu, A. R.; Statkevičiūtė, G.; Sustek-S., Ferenz; K., Mallikarjuna R.; Rognli, O. A.; Sarmiento, C.; Rostoks, N.; Jaškūnė, K. (2024). Transcriptome profiling reveals insight into the cold response of perennial ryegrass genotypes with contrasting freezing tolerance. Plant Stress, 14, 100598. DOI: 10.1016/j.stress.2024.100598.

Cardi, T.; Murovec, J.; Bakhsh, A.; Boniecka, J.; Bruegmann, T.; Bull, S. E.; Eeckhaut, T.; Fladung, M.; Galovic, V.; Linkiewicz, A.; Lukan, T.; Mafra, I.; Michalski, K.; Kavas, M.; Nicolia, A.; Nowakowska, J.; Sági, L.; Sarmiento, C.; Yıldırım, K.; Zlatković, M. ... Van Laere, K. (2023). CRISPR/Cas-mediated plant genome editing: outstanding challenges a decade after implementation. Trends in Plant Science. DOI: 10.1016/j.tplants.2023.05.012.

PROTEIN DESIGN

Head: Senior Researcher PRIIT EEK, priit.eek@taltech.ee

Members: Kaia Kukk, Hegne Pupart

Doctoral students: Maarja Lipp, Balamanikandan Saptharishi

TOPICS AND COMPETENCES

KEYWORDS: protein, enzyme, protein expression, protein purification, x-ray crystallography, precision fermentation, food additive

Proteins are biopolymers with a myriad of properties and functions: for instance, keratin is the key structural material in our hair and nails, hemoglobin transports oxygen in our blood stream, and digestive enzymes break down food into absorbable components. These diverse functions are directly related to protein structure. The goal of the Protein Design Lab is to understand these structure-function relationships in order to develop new, improved proteins that can be used for the benefit of humanity. Our main research areas cover the development of novel protein-based food additives (e.g., colorants and sweeteners), rational and AI-driven protein design, structural analysis of proteins including X-ray crystallography.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p6375659*

IN 2025:

The proof-of-concept project EAG241 was completed, in which the initial workflows for protein design and precision fermentation were implemented in collaboration with AS TFTAK. Related work continues in TEM-TA24 project of the TemTA programme with the aim of developing novel protein-based food additives and understanding the relationships between protein structure and techno-functional properties.

Collaboration continued with the KBI Wood Chemistry group and the Chair of General and Microbial Biochemistry at the University of Tartu to valorise lignin through the characterisation of new enzymes of interest.

New funding was awarded to the group by the Estonian Research Council (ETAG) – the starting grant PSG1110, which focuses on the binding kinetics of the sweet taste receptor and its ligands, begins in 2026.

SELECTED PROJECTS

- TEM-TA24 "*Structural determinants of protein techno-functional properties*" (2024–2028)

- EAG241 "*Rational Design and Precision Fermentation of Food Proteins*" (2023–2024)
- PSG1110 "*Binding kinetics and interactions of taste receptors with the focus on sweet receptor T1R2/T1R3*" (2026–2030)

SELECTED PUBLICATIONS

Pupart, H.; Eek, P. (2025). Expression and purification of bacterial dye-decolorizing peroxidases using Escherichia coli. In: Bugg, Timothy; Carro, Juan (Ed.). Lignin-Degrading Enzymes. (143–156). Elsevier. (Methods in Enzymology; 716). DOI: 10.1016/bs.mie.2025.03.004.

Baier, A. S.; Gioacchini, N.; Eek, P.; Leith, E. M.; Tan, S.; Peterson, C. L. (2024). Dual engagement of the nucleosomal acidic patches is essential for deposition of histone H2A.Z by SWR1C. eLife, 13, #RP94869. DOI: 10.7554/eLife.94869.

Kukk, Kaia (2024). Identification and recombinant production of a flavonoid glucosyltransferase with broad substrate specificity from Vaccinium corymbosum. Journal of Plant Biochemistry and Biotechnology, 33 (2), 255–259. DOI: 10.1007/s13562-024-00876-2.

RESEARCH GROUP OF CATALYSIS

Head of the Research Group: Tenured Full Professor TÕNIS KANGER, tonis.kanger@taltech.ee

Members: Kadri Kriis, Kristin Erkman, Andrus Metsala

Doctoral students: Annette Miller, Harry Martõnov, Kaarel Erik Hunt, Kerli Tali

TOPICS AND COMPETENCES

KEYWORDS: asymmetric synthesis, organocatalysis, halogen-bond catalysis, synthesis of oligosaccharides

The main research object of the group is asymmetric organic synthesis. The research includes a total synthesis of bioactive compounds and investigations of cascade, including cascade reactions. Studies of asymmetric organocatalytic reactions are of importance. Aminocatalysis based on covalent bound, hydrogen-bond and halogen-bond catalysis based on noncovalent interactions, enzymatic and co-operative catalysis are the main topics. Cascade reactions providing several new chemical bonds in one step are also studied. It increases atom-efficiency, decreases the number of steps needed and makes the whole process environmentally more benign. Practical value to studies is added by the synthesis of human milk oligosaccharides (HMO-s). The synthesis is supported by spectroscopic and crystallographic experiments, chromatography and quantum chemical calculations.

The characteristic feature of the research is the application of the principles of sustainable and green chemistry in asymmetric synthesis.

The most important research result is a new method of the synthesis of a specific HMO (6'-galactosyllactose). This new method is based on the application of the immobilised enzyme (CAL-B). It decreases considerably the number of steps needed for obtaining of the glycosylation donors and acceptors.

MAIN RESULTS IN 2025: Our group developed selective methods that derivatization of monosaccharides more manageable. An immobilised industrial enzyme, Novozyme 435, was used for selective deactylation and acetylation of sugars. This controlled behaviour enables researchers to carry out synthesis of specific human milk oligosaccharides.

Another important advance came from identifying a catalyst that directs the gylosylation reaction towards forming the desired anomer. We demonstrated that a simple pyridinium-based catalyst can reliably push the reaction towards the beta form – the version nature prefers.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/catalysis*

SELECTED PROJECTS

- TARISTU24-TK13 "*Infrastrucure of chemical synthesis and technology*" (2025–2029)
- PRG1031 "*Development and application of sustainable methods of asymmetric synthesis*" (2021–2025)
- ETR22017 "*Research professor grant*" (2022–2024)

SELECTED PUBLICATIONS

Hunt, K. E.; Miller, A.; Jarg, T.; Kriis, K.; Kanger, T. (2025). Selective Acetylation of Unprotected Thioglycosides and Fully Unprotected Monosaccharides with Candida antarctica Lipase-B. ACS Omega, 10, 19, 20047−20053. DOI: 10.1021/acsomega.5c02467.

Hunt, K. E.; Miller, A.; Liias, K.; Jarg, T.; Kriis, K.; Kanger, T. (2024). Interplay of Monosaccharide Configurations on the Deacetylation with Candida antarctica Lipase-B. The Journal of Organic Chemistry. DOI: 10.1021/acs.joc.4c02582.

Tali, K.; Hunt, K. E.; Kriis, K.; Osadchuk, I.; Kanger, T. (2025). Anion-Assisted Glycosylation of Galac-tose: A Computational Study. The Journal of Organic Chemistry, 90 (49), 17507−17517. DOI: 10.1021/acs.joc.5c02404.

RESEARCH GROUP OF FOOD SCIENCE AND TECHNOLOGY

Head of the Research Group: Senior Lecturer KRISTEL VENE, kristel.vene@taltech.ee

Members: Katrin Laos, Toomas Paalme, Signe Adamberg, Ildar Nisamedtinov, Tagli Pitsi, Tiina Randla, Allan Olspert, Inga Sarand, Tiina Lõugas, Merike Sõmera, Lachinkhanim Huseynli, Roberta Mikk

Doctoral students: Õnnela Luhila, Anna Angerjas, Atefeh Asadi, Rifaldi Lutfi Fahmi, Mariliis Mia Topp, Piret van der Sman

TOPICS AND COMPETENCES

KEYWORDS: food and drink, food processing technologies, food microbiology, food physics, food chemistry, food fermentations, food analysis, food safety and quality, nutrition, gut microbiota, cultivation technologies

The objectives of the research group: to develop and promote healthy foods and healthy diets through basic and applied research and teaching. We combine methods of chemistry, physics, sensorics, biotechnology, nutrition and food safety. Biochemical, physical and microbiological processes are followed during the whole food chain, from production of raw materials to food consumption. The wide range of competences enable to solve different problems and developments of food and biotechnology companies.

One of the most important areas is the development of science-based food technologies to produce higher value-added products. We develop processes improving product quality, process yields and cost-effective production. We are also studying the use of alternative raw materials for novel foods.

MAIN RESEARCH ITEMS:

- Bio-food systems (Toomas Paalme).
- Food sensory and instrumental analysis (Kristel Vene).
- Peptides as a source of amino acids in fermentation (Ildar Nisamedtinov).
- Food quality and structure (Katrin Laos).
- Food microbiomes: food quality, safety and innovation (Inga Sarand)
- Solid state fermentations (SSF) (Allan Olspert)

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-food-and-biotechnology#p6375670*

IN 2025: The TemTa-50 project (food reformulation) activities continued.

We started researching and applying Lactobacillus salivarius strains in functional food formats.

Activities in the frame of BIO4PACK (Horizon Europe Pathfinder) project targeted the development of biodegradable packaging incorporating bacteriophages, including the assessment of food safety and microbial stability for next-generation active packaging solutions.

Collaboration with Future Food Now OÜ (MatiFoods brand) involved the development of mycoprotein texturization technologies, product development of white fish analogues and minced meat alternatives, and scaling the technology to an industrial level (EIS R&D support).

Collaboration with Teilery OÜ focused on the development of added-sugar-free, gluten-free confectionery products (EIS innovation support).

SELECTED PROJECTS

- TEM-TA50 "*Food reformulation – reduction of sugar, salt, fat in food without changing the taste and safety*" (2024–2028)
- TFA25108 "*Salivarius+: Probiotic Food Solution Against Helicobacter pylori*" (2025–2026)
- VHE25047 "*Nature inspired alternatives for food packaging and films for agriculture*" (2025–2029)

SELECTED PUBLICATIONS

Rubino, L.; Abrahamian, P.; An, W.; Aranda, M. A.; Ascencio-Ibañez, J. T.; Bejerman, N.; Blouin, A. G.; Candresse, T.; Canto, T.; Cao, M.; Carr, J. P.; Cho, W. K.; Constable, F.; Dasgupta, I.; Debat, H.; Dietzgen, R. G.; Digiaro, M.; Donaire, L.; Elbeaino, T.; Fargette, D. ... Zhang, S. (2025). Summary of taxonomy changes ratified by the International Committee on Taxonomy of Viruses from the Plant Viruses Subcommittee, 2025. Journal of General Virology, 106, 7. DOI: 10.1099/jgv.0.002114.

Huseynli, L.; Gigl, M.; Müller, J.; Walser, C.; Frank, O.; Vene, K.; Dawid, C. (2025). Characterization of Bitter Off-Taste Stimuli in Sunflower Press Cake Using the Sensomics Approach. Journal of Agricultural and Food Chemistry, 73, 37, 23548–23559. DOI: 10.1021/acs.jafc.5c07283.

Asadi, A.; Angerjas, A.; Paalme, V.; Huseynli, L.; Sarand, I. (2025). Assessment of spoilage microbial communities in modified atmosphere-packed ready-to-eat salad during cold storage: A comparative study using MALDI-TOF MS identification and PacBio full-length 16S rRNA and ITS sequencing. International Journal of Food Microbiology, 440, #111268. DOI: 10.1016/j.ijfoodmicro.2025.111268.

RESEARCH GROUP OF METALLOPROTEOMICS

Head of the Research Group: Tenured Full Professor PEEP PALUMAA, peep.palumaa@taltech.ee

Members: Julia Smirnova, Andra Noormägi, Vello Tõugu, Merlin Sardis,

Doctoral students: Kristel Metsla, Sigrid Kirss, Elina Josefin Berntsson

TOPICS AND COMPETENCES

KEYWORDS: biometals, zinc, copper, Alzheimer's disease, Wilson's disease

The Research Group of Metalloproteomics is focused on the following topics: (1) structural and functional studies of metalloproteins participating in homeostasis of biometals: zinc, copper and iron by methods like NMR, ESI MS, ICP MS, fluorescence ja UV-VIS spectroscopy; (2) the role of biometals: zinc, copper and iron on fibrillization as well as on *in vitro* and *in vivo* toxicity of amyloigogenic peptides linked with Alzheimer's disease; (3) design of new metal-chelating ligands and elaboration of metal-chelating therapeutic strategies for Wilsons and Alzheimer's disease.

Professor Palumaa is a member of the European Molecular Biology Organization (EMBO).

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p2219696*

IN 2025, the binding of Hg(I) and Hg(II) ions to the amyloid beta peptide was investigated, revealing that these metal ions affect the peptide's structure and aggregation propensity.

New Alzheimer's disease (AD) model lines of Drosophila with modified copper metabolism were also constructed, and their survival and locomotor activity were tested.

In addition, the effects of alpha-lipoic acid on the flies' phenotype were studied. The applicability of LC-ICP-MS and ESI-MS for determining the Cu(II) binding affinities of peptides containing the ATCUN motif was evaluated.

SELECTED PROJECT

- PRG1289 "*Principles of copper metabolism and tools for its regulation in case of Wilson's and Alzheimer's disease*" (2021–2025)

SELECTED PUBLICATIONS

Berntsson, E.; Noormägi, A.; Padari, K.; Jarvet, J.; Gräslund, A.; Pooga, M.; Palumaa, P.; Wärmländer, SKTS (2025). Binding of Hg(I) and Hg(II) Ions to Amyloid-Beta (Aß) Peptide Variants Affect Their Structure and Aggregation. ChemBioChem, 26 (24), e202500252. DOI: 10.1002/cbic.202500252.

Kirss, S.; Reinapu, A.; Kabin, E.; Smirnova, J.; Tõugu, V.; Palumaa, P. (2024). a-Lipoic acid: a potential regulator of copper metabolism in Alzheimer's disease. Frontiers in Molecular Biosciences, 11, #1451536. DOI: 10.3389/fmolb.2024.1451536.

Kabin, E.; Dong, Y.; Roy, S.; Smirnova, J.; Smith, J. W; Ralle, M.; Summers, K.y; Yang, H.n; Dev, S.; Wang, Y.; Devenney, B.; Cole, R. N; Palumaa, P.; Lutsenko, S. (2023). a-lipoic acid ameliorates consequences of copper overload by up-regulating selenoproteins and decreasing redox misbalance. Proceedings of the National Academy of Sciences, 120 (40), #e2305961120. DOI: 10.1073/pnas.2305961120.

RESEARCH GROUP OF REPRODUCTIVE BIOLOGY

Head of the Research Group: Tenured Associate Professor AGNE VELTHUT-MEIKAS, agne.velthut@taltech.ee

Member: Airi Rump

Doctoral students: Inge Varik, Laura Luhari, Katariina Johanna Saretok, Mayara Cristina Batista Da Silva

TOPICS AND COMPETENCES

KEYWORDS: reproductive biology, infertility, bioinformatics, sequencing

Infertility is a worldwide problem with medical, socio-economical as well as psychological aspects. According to the European Society of Human Reproduction and Embryology, medical intervention is sought for by 15% of couples who wish to conceive their biological offspring (*www.eshre.eu*).

The Research Group of Reproductive Biology is mainly focused on the problems of female infertility and we investigate the biological processes in human ovary. Our main goal is to describe intercellular molecular interactions in the ovary and to find factors that would aid in discriminating between viable and non-viable oocytes. Various genome-wide high-throughput technologies are used in our research: next-generation sequencing, proteomics and data analysis methods in the field of systems biology to mention a few. We collaborate with all infertility clinics in Estonia in order to collect biological samples (ovarian granulosa cells, ovarian biopsies, follicular fluid, and blood samples) from fertile and infertile women.

The research group of reproductive biology is mainly focused on investigating the molecular origins of female infertility and the possibilities for diagnostics in the field. Our research subjects can be divided into three categories:

a. Research on human ovary and related etiologies of infertility.
b. The effect of environmental chemicals on ovarian function.
c. Development of methods for fertility preservation.

We use modern gene expression and cell population characterization methods: next generation sequencing, single cell technologies, functional assays in cell-line and primary cell culture models, etc. The acquired data is analysed and modelled by bioinformatic algorithms.

More information: *https://taltech.ee/en/reproductive-biology-research-group*

IN 2025: The most important results of the research group are connected with joinong in several consortia with significant applied outputs.

The international MERLON Consortium aims to develop innovative methodologies for detecting the effects of endocrine-disrupting chemicals on human reproductive health.

The Estonian research infrastructure consortium RAKERA is dedicated to advancing methodologies in cell biology and molecular biology. The research group contributes through the molecular characterization of cells by using high-throughput omics methods, the development of techniques for isolating extracellular vesicles from biological samples, and the establishment of novel cell culture systems.

The Estonian research infrastructure consortium ELIXIR-Estonia focuses on improving practices related to the generation, management, and analysis of large-scale datasets in molecular biology, as well as providing bioinformatics training for Estonian researchers. The research group supports the infrastructure by addressing challenges associated with the management and analysis of data arising from RNA sequencing technologies.

SELECTED PROJECTS

- VHE25014 "*Leveraging identification of endocrine disruptors using new approach methodologies based on human adult ovarian follicle cells*" (2025–2028)
- TTK14 "*Experimental studies and applications of cellular processes*" (2025–2029)
- TTK4 "*Estonian Life Science Infrastructure*" (2025–2029)

SELECTED PUBLICATION

Varik, I.; Saretok, K. J.; Rosenberg, K.; Quintero, I.; Puhka, M.; Volkova, N.a; Trošin, A.; Guazzi, P.; Velthut-Meikas, A. (2025). Small and Large Extracellular Vesicles from Human Preovulatory Follicular Fluid Display Distinct ncRNA Cargo Profiles and Differential Effects on KGN Granulosa Cells. Journal of Extracellular Vesicles, 14 (7), #e70119. DOI: 10.1002/jev2.70119.

SMART ANALYTICS

Head of the Research Group: Assistant Professor JEKATERINA MAZINA-ŠINKAR, jekaterina.mazina@taltech.ee

Members: Jelena Gorbatšova, Evelin Halling, Mihkel Kaljurand, Merike Vaher

Postdoctoral Researcher: Martin Ruzicka

Doctoral students: Vyacheslav Bolkvadze, Jana Budkovskaja, Mari-Liis Leinus

TOPICS AND COMPETENCES

KEYWORDS: analyzers, sensors, banned compounds, illegal drugs, microfluidics, capillary electrophoresis, fluorescence, chemometrics, quality management, Drug Hunter, precise agriculture, fertilizer, smart agriculture

"Innovation through border crossing" is our team's vision. The group focuses on the synergy of science and technology to provide practical solutions and transform scientific discoveries into innovative products.The core technologies of the research group include capillary electrophoresis, fluorescence, conductivity, gas chromatography, microfluidics, and various other modern instrumental and analytical methods.

The group develops analytical methods for the detection and quantification of psychoactive substances in biological samples and plant materials. Additionally, the research group studies various substances' pharmacokinetics and metabolism to understand their effects better and develop the corresponding detection methods.

Over the past 15 years, the group's scientists have developed and implemented various analyzers for multiple sectors and partners, such as *www.drughunter.eu* and *www.smagry.com*.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-gene-technology-and-biomedicine#p3248515*

IN 2025, the research group successfully completed a study on the rapid detection of tramadol in saliva, resulting in the development of a methodology suitable both for identifying drug abuse and for supporting individualized dosing in personalized medicine.

In collaboration with the National University of Life and Environmental Sciences of Ukraine, the international SmartAGRO project was successfully completed, within the framework of which a portable analyzer was developed for the Ukrainian partner and a fertilization model was developed for Ukrainian soils and main agricultural crops (sunflower, soybean, wheat).

In addition, a capillary electrophoresis method was successfully tested and implemented for the rapid screening of illicit cannabis products and for the quantitative analysis of cannabinoids. A methodology for the rapid analysis of new semi-synthetic cannabinoids in plant material was also developed.

SELECTED PROJECTS

- PRG3209 "*Innovative Multiplexed Electromigration-based Methods for New Emerging Drugs Analysis*" (2026–2030)
- KIK22038 (Kliima.3.01.22-0101) "*SmartAGRO*" (2022–2024)
- VHE24057 "*European Network Against Crime and Terrorism: support to TalTech for the implementation of Drug Hunter Analyzer*" (2024–2025)

SELECTED PUBLICATIONS

Pagano, G.; Loog, S. A.; Bolkvadze, V.; Gorbatšova, J.; Mazina-Šinkar, J. (2026). In-situ tramadol determination in oral fluid by portable capillary electrophoresis – deep UV fluorescence. Microchemical Journal, 221, #116851. DOI: 10.1016/j.microc.2026.116851.

Kaljurand, M.; Růžička, M.; Gorbatšova, J.; Mazina-Šinkar, J. (2023). New developments in separation science will help to contribute to the democratisation of analytical chemistry. Microchemical Journal, 195, #109443. DOI: 10.1016/j.microc.2023.109443.

Kaljurand, M.; Růžička, M.; Gorbatsova, J.; Mazina-Šinkar, J. (2023). Evaluation of different operating modes of an autosampler for portable capillary electrophoresis. Journal of Chromatography A, 1705, #464201. DOI: 10.1016/j.chroma.2023.464201.

SUPRAMOLECULAR CHEMISTRY GROUP

Head of the Research Group: Tenured Full Professor RIINA AAV, riina.aav@taltech.ee

Members: Dzmitry Kananovich, Marina Kudrjašova, Elena Prigorchenko, Karin Valmsen, Victor Borovkov, Mario Öeren, Tatsiana Jarg, Riin Satsi, Eve Schults, Ander Mägi

Doctoral students: Nele Konrad, Kristjan Siilak, Marko Šakarašvili, Jevgenia Martõnova, Jagadeesh Varma Nallaparaju, Mari-Liis Brük, Elina Suut-Tuule, Thi Thanh Ngan Nguyen, Rauno Reitalu, Ece Ferizoğlu, Ketren-Marlein Lootus, Suman Sahoo

TOPICS AND COMPETENCES

KEYWORDS: supramolecular chemistry, macrocycles, receptors, host-guest complexes, molecular containers, chirality, nuclear magnetic resonance spectroscopy, single-crystal X-ray diffraction analysis, spectroscopy, UV-vis, FS, CD, VCD, NMR

Supramolecular chemistry research group is interested in study of chiral molecular containers, like hemicucurbiturils. We are developing sustainable and efficient synthesis methods, concentrating also on mechanochemistry. We are studying molecular and supramolecular structure of macrocycles and their interactions. Supramolecular chemistry unites approaches of analytical, organic and physical chemistry to study mater in a broader way. Molecular containers are able to form host-guest complexes with other molecules and in a special case of inclusion complexes, the small molecule is fully encapsulated by the macrocycle. These complexes are held together by non-covalent interactions. We are mainly interested in macrocycles that belong to cucurbituril family, the hemicucurbiturils and their complexes and derivatives with optically attractive porphyrins. We explore the potential of new molecular containers in material and environmental science for sensing.

IN 2025: We published an efficient mechanochemical synthesis method for the preparation of biotin[6]uril – this is a milestone for scaling mechanochemical synthesis processes from milligrams to tens of grams of products with complex structures. We can use our synthesized macrocycles in supramolecular applications for the separation of organic and inorganic compounds.

We also demonstrated how the properties of porphyrins influence the self-assembly and optical properties of hemicucurbiturils and porphyrins in both solution and solid state, and created a large library of complexes with induced chirality; these materials are suitable, for example, for use as sensor materials in enantioselective electronic noses. To protect intellectual property in the USA, we filed a patent application related to the synthesis of hemicucurbiturils.

More information:
https://riinaaav.wixsite.com/grouppage

SELECTED PROJECTS

- TK228 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)

- VHE22039 "*Innovative Mechanochemical Processes to synthesize green ACTIVE pharmaceutical ingredients*" (2022–2026)
- PRG2169 "*Self-assembled Chiral Hemicucurbiturils as a Versatile Platform for Supramolecular Sensing and Separation of Chiral Compounds*" (2024–2028)
- ÕÜF17 "*The separation, processing, and recycling of rare earth metals*" (2023–2029)

SELECTED PUBLICATIONS

Casagrande, A.; Niidu, A.; Aav, R.; Kananovich, D.; Colacino, E. (2025). Green Chemistry Tools in Mechanochemistry. In: Reference Module in Chemistry, Molecular Sciences and Chemical Engineering Elsevier. DOI: 10.1016/B978-0-443-15742-4.00116-2 [in press].

Suut-Tuule, E.; Schults, E.; Jarg, T.; Adamson, J.; Kananovich, D.; Aav, R. (2025). Scalable mechanochemical synthesis of biotin[6]uril. ChemSusChem, e202402354. DOI: 10.1002/cssc.202402354.

Šakarašvili, M.; Truong, K.-N.; Ustrnul, L.; Konrad, N.; Siilak, K.; Burankova, T.; Kuroda, R.; Senge, M. O.; Borovkov, V.; Ward, J. S.; Rissanen, K.; Aav, R. (2025). Chiral Self-Assembly of Zinc and Magnesium Porphyrins with Enantiopure Cyclohexanohemicucurbiturils in Solution and in Solid State. Inor-ganic Chemistry. DOI: 10.1021/acs.inorgchem.5c04969.

SUSTAINABLE CHEMISTRY AND ENGINEERING

Head of the Research Group: Senior Researcher YEVGEN KARPICHEV, yevgen.karpichev@taltech.ee
Members: Denys Bondar, Mahendra Mohan
Doctoral students: Nandish Mudegowdru Nagappa, Nadiia Shevchenko

TOPICS AND COMPETENCES

KEYWORDS: sustainable chemicals and formulations; biodegradation, biodegradability, biomass valorization, medicinal chemistry, chemical decontamination

The research activities are focused on designing efficient, safe, and environmentally benign chemicals, formulations, and processes. We target chemical transformations in accordance with the concept of sustainability and the principles of green chemistry. Greener organic chemistry is applied to the development of more sustainable organic synthesis methods to obtain small molecules and functional materials for biomedical, environmental, or industrial applications. We explore rational design of (i) antidotes-reactivators of AChE inhibited by toxic organophosphorous compounds and (ii) potential anticancer agents using methods and practices of medicinal chemistry. We develop innovative formulations for drug delivery based on functionalized carbon nanoparticles (nanodiamonds and nanodots) and biocompatible and biodegradable platforms. Renewable feedstock in chemistry principle is fulfilled through inventing new more sustainable protocols for biomass valorization and designing novel lignin-based materials for catalysis, biomedical application, and climate-resilient construction, following principles of circular bioeconomy.

Risk management of technogenic accidents includes improvement of (i) antidotal and decontamination formulations for more sustainable kits for the first responders and volunteers; (ii) more sustainable disinfectant formulations, and (iii) prevention and reduction of chemical and biological threats with support of Artificial Intelligence (AI) and Deep Learning (DL) techniques to enable distinguishing of toxic industrial compounds, bacteria, fungi and viruses based on their unique fingerprints within a complex environment.

Main research topics:

- Greener methods for organic synthesis and medicinal chemistry.
- Renewable feedstock in chemistry via chemical valorisation lignin and peat.
- Design for degradation via biodegradability study and "benigh-by-design" approach.
- Technogenic risks mitigation via novel formulations for first responders and via reconnaissance and prevention of chemical and biological threats.

Achievements **IN 2025:**

- Development of the chemical methods for lignin valorisation via chloromethylation and/or green oxidation. Development of the functional materials from organosolv lignin, technical lig-nin, peat, and food waste-derived lignin via chemical modification. (TemTA49 project)
- Uncovering potential of carbon nanoparticles as drug nanocarrier platforms to transport char-ged pharmacophores (quaternary oximes – reactivators of acetyl cholinesterase inhibited by the organophosphorus toxicants) across the BBB model.

- Contribution to the development of the miniaturized low cost instrument for rapid reconnais-sance and detection of chemical and biological threats using benchmarking methods (MALDI-ToF) with enhanced classification of bacteria and viruses by integration of MALDI-TOfF with ML/DL (EDF TeChBioT Project).

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-of-chemistry#p2219719*

SELECTED PROJECTS

- MINM25136 "*Ligniinist lõhkematerjalide ja raketikütuste saamine*" (2025–2027)
- TEM-TA49 "*Chemical and biological valorization technologies for woody biomass and secondary lignocellulose sources*" (2024–2028)
- VEU23002 "*Surveillance and Reconnaissance Techniques for Chemical and Biological Threats*" (2022–2025)

SELECTED PUBLICATIONS

Arnaut, P.; Bracho Pozsoni, N.; Bondar, D.; Lippmann, P.; Boschuk, S.; Semenyuta, I.; Bhandary, S.; Van Hecke, K.; Karpichev, Y.; Cavarzerani, E.; Canzonieri, V.; Rizzolio, F.; Scattolin, T.; Vougioukalakis, G. C.; Ott, I.; Tzouras, N. V.; Nolan, S. P. (2025). A new generation of N-heterocyclic carbene (NHC) gold-selenolato complexes as potent anticancer agents: distinct synthetic routes and evaluation in 2D and 3D cancer models. Chemical Science, 16 (37), 17221–17231. DOI: 10.1039/d5sc04490a.

Bondar, D.; Smirnova, O.; Nagappa, N. M.; Heinmaa, I.; Soukup, O.; Kobrlova, T.; Opravil, J.; Hrabinova, M.; Jun, D.; Starkov, P.; Spuul, P.; Kuča, K.; Mochalin, V. N.; Karpichev, Y. (2025). Nanodiamond Mediated Delivery of Pyridinium Oxime Antidotes to Central Nervous System for Potential Treatment of Exposure to Nerve Agents. Chemico-Biological Interactions, 420, #111711. DOI: 10.1016/j.cbi.2025.111711.

Mohan, M. K.; Ho, T. Tran; Köster, C.; Järvik, O.; Kulp, M.; Karpichev, Y. (2025). Tuning ester derivatives of organosolv vs technical lignin for improved thermoplastic materials. Faraday Discussions. DOI: 10.1039/d5fd00068h.

SYNTHETIC FLOW CHEMISTRY GROUP

Head of the Research Group: Assistant Professor MAKSIM OŠEKA, maksim.oseka@taltech.ee

Members: Marine Anne Pinaud, Mihhail Fokin, Nora Deil, Rasmus Käsper

Doctoral students: Anastasiya Krech, Marharyta Laktsevich-Iskryk, Pallav Suman, Biswadeep Manna

TOPICS AND COMPETENCES

KEYWORDS: electrochemistry, photochemistry, organic synthesis, flow chemistry, asymmetric catalysis

The research in the group is focused on the development of new electro- and photochemical transformation in continuous-flow. Our research is multidisciplinary, as we combine modern organic synthesis techniques with chemical engineering in order to achieve high efficiency and sustainability. In electro- and photochemical reactions, electricity or light are used as traceless and green reagents to generate highly reactive species under mild reaction conditions, which gives access to the new reaction pathways. Moreover, the potential to harvest sustainable electricity from solar or wind energy and using daylight directly to perform reactions makes electro- and photochemistry highly attractive. In our group, we perform such transformation not in conventional chemical flask or test tubes, but in specially designed flow photo- and electromicroreactors, where solution of chemicals is continuously pumped through the active reactor zone. Due to the continuous nature of the process, such transformations are easy to scale up merging the gap between academia and chemical industry.

IN 2025 we successfully launched the new NordForsk AGRI-WASTE2H2 (ETAG24073) in cooperation with partners from Aalto University (Finland) and KTH Royal Institute of Technology (Sweden).

More information: *https://taltech.ee/en/department-chemistry-biotechnology/synthetic-flow-chemistry-group*

SELECTED PROJECT

- PSG828 "*Development of New Asymmetric Electrochemical Methods in Continuous-Flow*" (2023–2027)
- TF24021LK2 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)
- ETAG24073 "*Green Hydrogen and Platform Chemicals from Agricultural Residues*" (2025–2028)

SELECTED PUBLICATIONS

Krech, A.; Laktsevich-Iskryk, M.; Deil, N.; Fokin, M.; Kimm, M.; Ošeka, M. (2024). Asymmetric cyclopropanation via electro-organocatalytic cascade. Chemical Communications, 60, 95, 14026–14029. DOI: 10.1039/D4CC05092D.

Krech, A.; Yakimchyk, V.; Jarg, T.; Kananovich, D.; Ošeka, M. (2023). Ring-Opening Coupling Alkenes Enabled by Decatungstate as Photoredox Catalyst. Advanced Synthesis & Catalysis. DOI: 10.1002/adsc.202300939.

Laktsevich-Iskryk, M.; Krech, A.; Fokin, M.; Kimm, M.; Jarg, T.; Noël, T.; Ošeka, M. (2024). Telescoped synthesis of vicinal diamines via ring-opening of electrochemically generated aziridines in flow. Journal of Flow Chemistry, 14 (1), 139–147. DOI: 10.1007/s41981-023-00296-8.

WOOD CHEMISTRY AND BIOMASS VALORIZATION TECHNOLOGIES

Head of the Research Group: Senior Researcher YEVGEN KARPICHEV, yevgen.karpichev@taltech.ee

Members: Mihkel Koel, Maria Kulp, Kairit Zovo, Merike Vaher, Maria Kuhtinskaja, Piia Jõul, Epp Väli, Eve-Ly Ojangu, Hegne Pupart

Doctoral students: Olivia-Stella Salm, Kannan Thirumal Muthu, Thi Thuy Tran Ho, Mahendra Kothottil Mohan, Evelin Solomina

TOPICS AND COMPETENCES

KEYWORDS: X-ray crystallography, structural biology, biomass valorization, enzymology, rational design of biocatalysts, biocatalysis

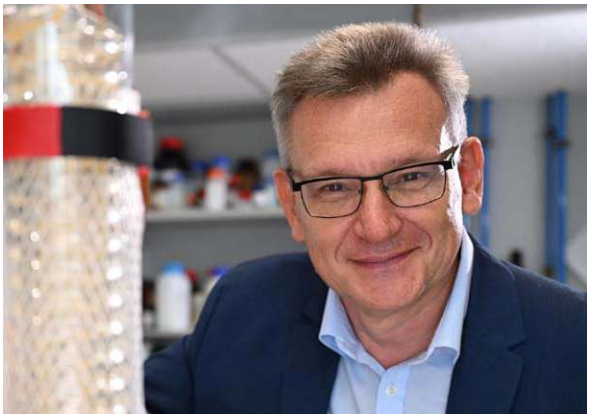
The group is involved in a variety of research and development activities related to the valorization of plant biomass. The direction of research activities that focus on the biological routes to valorization of biomass deal with soil bacteria and their enzymes as well as the study of lignolytic enzymes secreted by fungi (i.e. *Cerrena unicolor*) when grown on mandarin pomace waste as the growth substrate. In addition to that, some of the research focuses on enzymes from extremophilic organisms that are involved in the deconstruction of lignocellulosic biomass. In addition to the enzymological characterization of those enzymes, the laboratory uses X-ray crystallography and small angle X-ray scattering methods to study their structure-function relationships.

The research group is also involved in research and development activities that are focused on the development of fractionation and analytical chemistry technologies of lignocellulosic biomass and on developing novel functional materials from plant-based biopolymers.

More information: *https://taltech.ee/en/department-chemistry-biotechnology/division-of-of-chemistry#p2219727*

IN 2025: The research activities of the group werw related to the development of technologies for the valorization of plant biomass of various origins.

The direction of biological valorization of biomass was focused to: (1) isolation and characterization of new bacterial lignolytic strains and studying enzymes derived from them; (2) in-depth studies of lignocellulosic biomass degrading enzymes that originate from extremophilic organisms; (3) structural biology -characterization of enzymes of interest using protein X-ray crystallography.



The direction of analytics dealt with: (1) the characterization of various technical lignins as well as industrial phenolic wastewaters, using various analytical chemistry methodologies, and (2) the development of new functional materials from plant-derived polymers.

The main directions of the research group's work were related to technologies that benefit industries related to the valorization of lignin and secondary biomass streams.

SELECTED PROJECTS

- TEM-TA49 "*Chemical and biological valorization technologies for woody biomass and secondary lignocellulose sources*" (2024–2028)
- RESTA11 "*Development of chemical and biochemical valorization technologies for bleached che-mithermomechanical pulps (BCTMP) and secondary woody biomass sources*" (2020–2023)
- TFA25085 "*Development of the market readiness of lignin purification technology (DeAshLignin–DAL)*" (2025–2026)

SELECTED PUBLICATIONS

Pupart, H.; Lukk, T.; Väljamäe, P. (2024). Dye-decolorizing peroxidase of Thermobifida halotolerance displays complex kinetics with both substrate inhibition and apparent positive cooperativity. Archives of Biochemistry and Biophysics, 754, #109931. DOI: 10.1016/j.abb.2024.109931.

Usmani, Z.; Sharma, M.; Tripathi, M.; Lukk, T.; Karpichev, Y.; Gathergood, N.; Singh, B.N.; Thakur, V.K.; Tabatabaei, M.; Gupta, V.K. (2023). Biobased Natural Deep Eutectic System As Versatile Solvents: Structure, Interaction and Advanced Applications. The Science of The Total Environment, 881, #163002. DOI: 10.1016/j.scitotenv.2023.163002.

Brandt-Talbot, A.; Calado, V.; Castellan, I.; Crestini, C.; Galluccio, L.; Gigli, M.; Guizani, C.; Karpichev, Y.; Lange, H.; Lindner, J.-P.; Nejad, M.; Nicolau, V.; Ponnudurai, A.; Rajagopalan, N.; Rinaldi, R.; Samec, J. S. M.; Schroeter, M.; Westwood, N. J.; Wohlert, M.; Zheng, Y. (2026). Strategies for compatibilisation of extracted lignin properties with commercial applications: general discussion. Faraday Discussions. DOI: 10.1039/d5fd90059j.

DEPARTMENT OF CYBERNETICS

Director: Senior Lecturer ALAR LEIBAK,
alar.leibak@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

58 Academic staff — Incl. 8 professors, 32 researchers

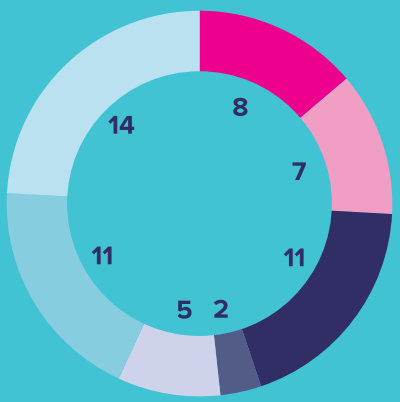
24 Doctoral students — 5 Defended doctoral dissertations

42 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 9 RESEARCH GROUPS:

- **APPLICATIONS OF MATHEMATICS IN TELECOMMUNICATION.**
  Head: Senior Lecturer GERT TAMBERG, gert.tamberg@taltech.ee
- **INVERSE PROBLEMS AND STOCHASTIC METHODS.**
  Head: Tenured Full ProfessorJAAN JANNO, jaan.janno@taltech.ee
- **LABORATORY OF SPIN DESIGN.**
  Head: Lead Research Scientist AGO SAMOSON, ago.samoson@taltech.ee
- **NONLINEAR WAVE PROPAGATION.**
  Head: Tenured Full Professor ANDRUS SALUPERE, andrus.salupere@taltech.ee
- **PERSPECTIVE MATERIALS AND TECHNOLOGIES.**
  Head: Researcher SVETLANA POLIVTSEVA, svetlana.polivtseva@taltech.ee
- **RHEOLOGY OF COMPOSITES.**
  Head: Senior Researcher HEIKO HERRMANN, heiko.herrmann@taltech.ee
- **LABORATORY OF SYSTEMS BIOLOGY.**
  Head: Tenured Full Professor MARKO VENDELIN, marko.vendelin@taltech.ee
- **THEORETICAL PHYSICS.**
  Head: Tenured Full Professor JAAN KALDA, jaan.kalda@taltech.ee
- **WAVE ENGINEERING.**
  Head: Tenured Full Professor TARMO SOOMERE, tarmo.soomere@taltech.ee



PROFESSORS
ASSOCIATE PROFESSORS / SENIOR LECTURES
LECTURERS
LEAD RESEARCHERS
SENIOR RESEARCHERS
RESEARCHERS
EARLY STAGE RESEARCHERS

APPLICATIONS OF MATHEMATICS IN TELECOMMUNICATION

Head of the group: Senior Lecturer GERT TAMBERG, gert.tamberg@taltech.ee

Members: Alar Leibak, Piret Puusemp, Peeter Puusemp

Doctoral students Olga Graf, Märt Umbleja

TOPICS AND COMPETENCES

KEYWORDS: number theory; quadratic forms; fields; approximation theory; Shannon sampling theory; Fourier' anlaysis; signal processing; image processing; cryptography

The main directions of research are as follows:

- Studying geometry of positive definite quadratic forms over number fields.
- Studying applications of geometry of quadratic forms in cryptography.
- Studying the generalized Shannon sampling operators and Kantorovich-type sampling operators, their approximation properties and possible applications.
- Studying sampling operators, defined using cosine operator framework, their approximation properties and possible applications.
- Studying applications of the sampling operators and their derivatives in Signal Processing.
- Studying possibilities of applying our approximation-theoretic results in deep learning.

The results obtained by the research group can be applied in cryptography, image processing software development, signal processing, and IoT hardware and software development.

More information: *https://taltech.ee/en/department-cybernetics/research-groups*

MAIN ACTIVITIES IN 2025

- The applications of sampling operators in medical technology were studied. The corresponding research continues.
- The application of Kantorovich-type sampling operators in the representation of derivatives was studied.
- Mellini-type sampling operators were studied.
- The study of the application possibilities of sampling operators in learning analytics was started

SELECTED PROJECT

- PRG1483 "*Solutions and Applications of Innovative Impedance Spectroscopy*" (2022–2026)

SELECTED PUBLICATIONS

Lotamõis, K.; Uuetoa, T.; Krivošei, A.; Annus, P.; Metshein, M.; Rist, M.; Margus, S.; Min, M.; Tamberg, G. (2025). An Analysis of Arterial Pulse Wave Time Features and Pulse Wave Velocity Calculations Based on Radial Electrical Bioimpedance Waveforms in Patients Scheduled for Coronary Cathe-terization. Journal of Cardiovascular Development and Disease, 12 (7), #237. DOI: 10.3390/jcdd12070237.

Kivinukk, A.; Tamberg, G. (2024). A note on the cosine operator function for Mellin sampling series. Sampling Theory Signal Processing and Data Analysis, 22 (1), 7. DOI: 10.1007/s43670-023-00081-7.

Kivinukk, A.; Tamberg, G.; (2023). On generalized Shannon sampling operators in the cosine operator function framework. In: Stephen D. Casey, M. Maurice Dodson, Paulo J. S. G. Ferreira, Ahmed Zayed (Ed.). Sampling, Approximation, and Signal Analysis (Harmonic Analysis in the Spirit of J. Rowland Higgins). In "Applied and Numerical Harmonic Analysis (ANHA)" Springer-Birkhäuser

INVERSE PROBLEMS AND STOCHASTIC METHODS

Head of the group: Tenured Full Professor JAAN JANNO, jaan.janno@taltech.ee

Members: Lassi Päivärinta, Margus Pihlak, Emilia Blåsten, Nataliia Kinash

Doctoral student: Hany Hilal Yewakiem Gerges

TOPICS AND COMPETENCES

KEYWORDS: inverse problems, fractional diffusion and wave motion, direct and inverse scattering, nonparametric statistics

The main directions of research are:

- *Inverse problems for equations containing fractional derivatives*. Inverse problems for linear and nonlinear fractional differential equations are studied. The unknowns to be determined are coefficients, source terms and kernels of generalized fractional time derivatives. Such problems occur in modelling of diffusion and mechanical processes in porous, fractal and biological media. The research is focused on both theoretical aspects and elaboration of numerical methods.
- *Direct and inverse scattering in singular and nonlocal media*. Electromagnetic and acoustic direct and inverse scattering in media with singularities or non-local features is studied. Mathematical theory of tripole and more general multipole antennas is developed. This branch is complemented by a development of new signal processing on state-of-the-art computational methods for large-scale inverse problems. Inverse problems to reconstruct in homogeneities of media with non-local properties by means of measurements of scattered acoustic waves at boundaries are investigated.
- *Elaboration of nonparametric statistical methods*. The theory of nonparametric statistical methods is developed and these methods are applied in environmental and building engineering.

More information: https://taltech.ee/en/department-cybernetics/research-groups

IN 2025 Uniqueness for inverse problems to determine simultaneously parameters and time-dependent fac-tors of source terms in fractional superdiffusion equations (fractional wave equations) containing dis-tributed fractional Laplacians was proved in two cases. In the first case, the measurement time interval and support of

the unknown source coincide. Then the set of unknown parameters include a mul-titerm fractional Laplacian. In the second case, the measurement interval follows the support of the unknown source after a lap. Then the set of parameters include a more general distributed fractional Laplacian over a Stiltjes measure.

Bayesian approach was developed to analyze fluorescence data in biology (in cooperation with Sys-tems Biology group).

SELECTED PUBLICATIONS

Gerges, H.; Janno, J. (2025). Inverse problem to determine simultaneously several scalar parameters and a time-dependent source term in a superdiffusion equation involving a multi-term fractional Laplacian. Fractional Calculus and Applied Analysis, 28, 2395–2420. DOI: 10.1007/s13540-025-00437-x.

Janno, J. (2025). Inverse Problems for Simultaneous Determination of Source Terms and Several Scalar Parameters of Fractional Diffusion Equations. In: Inverse Problems: Modelling and Simulation: Extended Abstracts of the IPMS Conference 2024. (167–173). Birkhäuser. (Trends in Mathematics; 11). DOI: 10.1007/978-3-031-87213-6_21.

LABORATORY OF SPIN DESIGN

Head of the research group: Lead Research Scientist AGO SAMOSON, ago.samoson@taltech.ee

Members: Kalju Vanatalu, Raiker Witter, Svetlana Polivtseva, Liisi Karlep, Julia Kois, Ats Kaldma, Mai-Liis Org, Neeme Danziger

Doctoral student: Meelis Rohtmäe

TOPICS AND COMPETENCES

KEYWORDS: micromechanics, radioengineering, technical ceramics, CAD, Alzheimer, NMR, MAS, metabolomics

NMR is a remarkably universal analytical method since essential spin interactions can be reliably calculated. The spectra allow in principle a 3D reproduction of the entire spin system and Associate atoms/molecules, even a dynamics of it, given sufficient resolution and sensitivity.

The group develops NMR sensors-probeheads, notably to use the most sensitive nuclei-hydrogens, in locally viscous and solid environment. The most critical feature is rapid sample spinning. We were the first to reach rates beyond 120 kHz, getting presently over 150 kHz, which facilitates a practical inverse detection in solid state NMR. The immediate sensitivity increase is two orders of magnitude. The technology is applied in contemporary priority areas: biomedical research and development of F-ion batteries as a safer and more potent alternative for Li-based energy storage. The related key competences comprise CAD/CAM design, RF circuit modelling, technical ceramics processing and micromachining.

More information: *https://taltech.ee/en/department-cybernetics/research-groups*

IN 2025 the laboratory made a big leap in NMR technology: sample rotation speeds over 250, even over 300 kHz became a reality. More precisely, 320, which exceeds the sound barrier by 10%.

In other topics – in metabolomics and energy storage, the development was quantitative.

SELECTED PROJECTS

- PRG1832 "*H-NMR in solid state and complementary applications*" (2023–2027)
- STP57 "*Development of Anionic Energy Storages*" (2023–2025)
- LLTEV23121 "*NMR Detector Module*" (2023–2025)

SELECTED PUBLICATION

Toleikis, Z.; Paluch, P.; Kuc, E.; Petkus, J.; Sulskis, D.; Org-Tago, M.-L.s; Samoson, A.; Smirnovas, V.; Stanek, J.; Lends, A. (2024). Solid-state NMR backbone chemical shift assignments of a-synuclein amyloid fibrils at fast MAS regime. Biomolecular NMR Assignments, 18, 2, 181–186. DOI: 10.1007/s12104-024-10186-2.

Mohammad, I.; Cambaz, M.A.; Samoson, A.; Fichtner, M.; Witter, R. (2024). Development of in situ high resolution NMR: Proof-of-principle for a new (spinning) cylindrical mini-pellet approach applied to a Lithium ion battery. Solid State Nuclear Magnetic Resonance, 129, #101914. DOI: 10.1016/j.ssnmr.2023.101914.

Schäfer, D.; Hankins, K.; Allion, M.; Krewer, U.; Karcher, F.; Derr, L.; Schuster, R.; Maibach, J.; Mück, S.; Kramer, D.; Mönig, R.; Jeschull, F.; Daboss, S.; Philipp, T.; Neusser, G.; Romer, J.; Palanisamy, K.; Kranz, C.; Buchner, F.; Behm, R. J. ... Rohnke, M. (2024). Multiscale Investigation of Sodium-Ion Battery Anodes: Analytical Techniques and Applications. Advanced Energy Materials, 14 (15), 2302830. DOI: 10.1002/aenm.202302830.

NONLINEAR WAVE PROPAGATION

Head of the group: Tenured Full Professor ANDRUS SALUPERE, andrus.salupere@taltech.ee
Members: Arkadi Berezovski, Dmitri Kartofelev, Tanel Peets, Kert Tamm, Jüri Engelbrecht
Doctoral students: Maria Miranda Vuin, Muhammad Zeeshan Ashraf, Päivo Simson

TOPICS AND COMPETENCES

KEYWORDS: continuum mechanics, internal variables, nondestructive testing, nonlinear waves, solitons, wave processes in axons, sound generation in string instruments, metaemaeterials, numerical experiments

The activities of the research group are focused on wave propagation in complex media and corresponding applications.

MAIN RESEARCH DIRECTIONS

- *Theory of continua and internal variables*. Developed mathematical models take into account nonlinear, dispersive and temperature effects, and multiscale of a microstructure.
- *Numerical analysis of nonlinear wave propagation*. Fourier transform and Haar wavelets related numerical methods are elaborated.
- *Wave processes in axons*. The models are developed that take into account the mechanical and thermal effects accompanying the propagation of the nerve signal.
- *Musical acoustics*. Nonlinear models that explain the mechanisms of sound generation in different string instruments are created.
- *Nondestructive testing of materials*. Methods for determining of mechanical properties of nonhomo-geneous materials and for detection of defects are developed.
- *Solitons and solitary waves*. Conditions for formation of solitonic solutions are determined.

More information: https://solmech.taltech.ee/

IN 2025 WE HIGHLIGHT THE FOLLOWING RESULTS

1. Modelling of nerve impulse propagation. The improvement of the nerve impulse propagation model and the corresponding numerical experiments were continued. The model of the electrical signal of a myelinated axon was improved.
2. Modelling of metamaterials and theory of internal variables. Sound wave propagation and attenuation through diffraction gratings under various diffraction grating reconfiguration scenarios were studied. It was demonstrated that total sound isolation can be accomplished in the idealized scenario by instantaneously altering the location of the grating elements.
3. Wave propagation in viscoelastic materials. Acoustic wave propagation in nonlinear porous felt using a one-dimensional model was studied numerically. The influence of dispersion, dissipation, band gaps, and negative group velocity was analyzed. Results showed that when loading times are much longer than the material relaxation time, these effects have negligible impact on wave propagation, indicating that felt does not exhibit significant metamaterial behavior. However, understanding negative group velocity may still enable future applications in noise and vibration control.
4. Modelling of surface waves. The evolution of waves propagating on the surface of deep water was studied. New Schrödinger-type model equation was derived, describing both, the motion of the wave packet envelope and the dynamics of the entire wave packet. An analysis of this equation was carried out.

SELECTED PROJECT

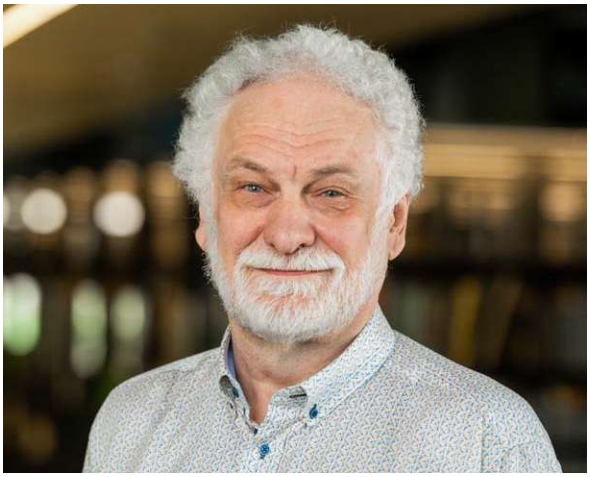
- PRG1227 "*Modelling of nonlinear wave processes in advanced materials*" (2021–2025)

SELECTED PUBLICATIONS

Vuin, M. M.; Kartofelev, D.; Salupere, A.; Simson, P. (2025). Numerical investigation into acoustic wave propagation in felt-type material with band gap and negative group velocity. Wave Motion, 139, art. 103600. DOI: 10.1016/j.wavemoti.2025.103600.

Peets, T.; Tamm, K.; Engelbrecht, J. (2023). On mathematical modeling of the propagation of a wave ensemble within an individual axon. Frontiers in Cellular Neuroscience, 17, #1222785. DOI: 10.3389/fncel.2023.1222785.

Tamm, K.; Peets, T.; Engelbrecht, J. (2022). Mechanical waves in myelinated axons. Biomechanics and Modeling in Mechanobiology, 21 (4), 1285–1297. DOI: 10.1007/s10237-022-01591-4.



PERSPECTIVE MATERIALS AND TECHNOLOGIES

Head of the group: Researcher SVETLANA POLIVTSEVA, svetlana.polivtseva@taltech.ee

Member: Mihhail Klopov

Doctoral student: Samuel Amankwaa

TOPICS AND COMPETENCES

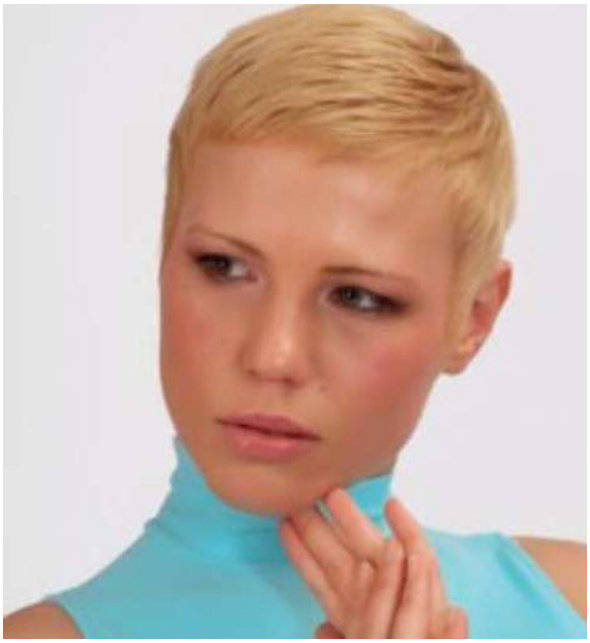
KEYWORDS: functional materials; metal chalcogenides; porous frameworks

The research focuses on nanomaterials' synthetic/post-synthetic modification to develop device-orientated functionality in metal chalcogenide matrices and organic/inorganic porous structures.

1. Post-synthetic modifications introduced into either cation or anion sublattices can significantly adjust or completely change the optoelectronic properties of pristine metal chalcogenide matrices, providing them with groundbreaking functionality unavailable through direct synthetic approaches. We can play around the applicability direction depending on the form of developed materials, such as thin films or nanostructures. Modified or completely inverted thin films can be integrated into sensors, energy-saving windows, or even used to create effective antibacterial coatings under visible light illumination. Nanosized structures with suitable structural and compositional characteristics can be used for wound-healing patches. Optoelectronic and thermoelectric properties of metal chalcogenide matrices heavily depend on crystal structure, elemental composition, and defect chemistry, which can be regulated using target complexation and solution rationalization in a chemical reactor (vessel). The group has developed its approach to synthesizing pristine matrices and transforming them into entirely new materials on the scale of thin films with a rapid processing rate.
2. Post-synthetic modification of organic porous structures via mild oxidation or inorganic fibers via engineering certain functional groups on the surface makes them compatible with biomedical, environmental, or industrial applications. The ultimate goal of the research is to create a nanofiltration system that effectively extracts heavy and precious metals from complex aqueous environments.

Research results **IN 2025:**

- Cost-effective synthesis technologies for noble metal nanostructures were developed, including nanoparticles and metal frameworks based on Cu, Ag, Au and Pt. Upscaling of the work to industrial scale is currently underway. ·
- Nanofiltration membranes containing porous organic polymers were developed, which have high efficiency in the adsorption and separation of organic pollutants and dissolved metal species in the context of water treatment. ·
- Network capabilities were enhanced by increasing access to experimental facilities and strategic collaborations that directly support ongoing and future research activities.



SELECTED PROJECT

- PSG813 "*Filter materials for turning urine into drinkable water*" (2023–2027)

SELECTED PUBLICATION

Amankwaa, S.; Prokofiev, J.; Belikov, J.; Srivastava, V.; Ivask, A.; Nefedova, A.; Zhou, B.; Liu, M.; Polivtseva, S. (2025). *Smart Water, Smart Models: Algorithmic Assessment of Water Quality under Evolving Chemical and Industrial Stressors*.

RHEOLOGY OF COMPOSITES

Head of the group: Senior Researcher HEIKO HERRMANN, heiko.herrmann@taltech.ee

Members: Andres Braunbrück, Oksana Goidyk

Doctoral student: Mark Heinstein

TOPICS AND COMPETENCES

KEYWORDS: mechanics of materials, continuum mechanics, fiber concrete, fiber orientations, computational rheology, image analysis, 3D visualization

The competences of the group have a broad range, from constitutive theory over numerical computer simulations and image analysis to virtual reality visualization of scientific data. The main research topic is concerned with the mechanical properties of composites containing short fibres. The core application is steel fibre reinforced concrete, a construction material, the use of which is gaining momentum in the building industry. The mechanical properties largely depend on the orientation of short fibres, which in turn are influenced by the production process of the structural parts made of fibre concrete. In particular, the flow of the fresh concrete mass, which is mixed with the fibres, determines the fibre orientations. Analysis of fibre orientations in experiment samples is done by x-ray computed tomography, fibre orientations are then extracted from the tomography. The group has developed its own software for this purpose. The production process of concrete parts, in particular the casting, is simulated using computational fluid dynamics (CFD) coupled to an orientation equation. Further, simulations of bending tests and split tests are performed with particle based discrete element simulations.

The research contributes to solving important environmental challenges, such as how to reduce CO_2 emissions, use natural resources sustainably and reduce the environmental impact of the construction sector: better knowledge of the properties of concrete composites leads to stronger and tougher concrete, which makes it possible to use less concrete in buildings (thinner walls, beams).

More information: *https://taltech.ee/en/department-cybernetics/research-groups*

IN 2025:

A theoretical model for linear hyperelastic materials with orthotropic inclusions is presented based on a mixture approach. The proposed material model can be applicable to a composite made of a matrix material that contains biaxial particles or to a material that is composed of particles of an orthotropic material. An example for the former could be fiber concrete with hooked-end fibers and an example for the latter could

be a composite containing tiling additives with orthotropic properties, such as wood shavings.

Simulations of different casting methods of the fiber concrete mixture with various flowabilities have been performed and compared. The influence of different casting methods in combination with four specific sets of the rheological parameters on the final fiber orientation distribution was analyzed. The results of the simulations demonstrate that even a minor change in the casting procedure can significantly alter the obtained fiber orientations and bending strength.

SELECTED PUBLICATIONS

Zaitseva-Pärnaste, I.; Herrmann, H. (2024). Comparison of 3D model generation using Structure-from-Motion by open-source software and validation with LiDAR for revealing changes in eroding coastal cliffs. Journal of Coastal Research, 1054–1058. DOI: 10.2112/JCR-SI113-206.1.

Goidyk, O.; Heinštein, M.; Herrmann, H. (2023). CFD Comparison of the Influence of Casting of Samples on the Fiber Orientation Distribution. Fibers, 11 (1), 1–16. DOI: 10.3390/fib11010006.

Herrmann, Heiko (2021). A constitutive model for linear hyperelastic materials with orthotropic inclusions by use of quaternions. Continuum Mechanics and Thermodynamics, 33 (4), 1375–1384. DOI: 10.1007/s00161-021-00979-4.

LABORATORY OF SYSTEMS BIOLOGY

Head of the group: Tenured Full Professor MARKO VENDELIN, marko.vendelin@taltech.ee

Members: Rikke Birkedal Nielsen; Mari Kalda-Kroon, Martin Laasmaa, Jelena Branovets

Doctoral students: Romain Jacques Elie Bernasconi, Hamed Karimi, Irina Česnokova, Lucia Jaska, Divya Shikha, Kärol Soodla, Maike Mona Širinov, Otto Gustavson

TOPICS AND COMPETENCES

KEYWORDS: heart; biophysics; bioenergetics; electrophysiology; biomechanics; intracellular diffusion; fluorescence microscopy; fluorescence correlation spectroscopy

In the Laboratory of Systems Biology, we use interdisciplinary approaches to tackle questions in cardiac physiology. Our team consists of researchers with backgrounds in biophysics, biology, and applied mathematics/physics. As a result, we are able to approach scientific questions on different scales, from organ to molecular level, using combinations of different experimental and theoretical techniques by focusing on quantitative analysis of the data. We study: (1) diffusion in cardiomyocytes by tracking the movement of fluorescent molecules using extended raster image correlation spectroscopy; (2) effects of creatine deficiency to establish the role of creatine kinase shuttle in the heart. We have been active in the development of new techniques and distribute them as open-source tools: deconvolution software for enhancing confocal imaging, symbolic flux analysis for genome-scale metabolic networks, and real-time sarcomere length estimation techniques.

More information: *https://sysbio.ioc.ee*

IN 2025, the Laboratory investigated adaptive mechanisms of energy metabolism and regulation in cardiomyocytes, with a particular focus on the role of intracellular spatial organization in cellular function. Using a genetically modified mouse model with creatine deficiency, it was shown that lifelong creatine deficiency does not lead to heart failure but instead induces extensive intracellular adaptations, most notably in calcium dynamics. These results indicate that disturbances in cellular energy systems can significantly affect processes that do not directly consume energy.

A new statistically robust method was developed for the quantitative analysis of molecular motion in living cells, enabling faster and more reliable assessment of intracellular diffusion and compartmentation. This approach substantially improves the interpretability of experimental data and opens new possibilities for studying cardiomyocytes and other biological systems. Furthermore, it was demonstrated that the activity of the metabolic regulator AMPK depends on muscle function and intracellular microdomains rather than solely on total enzyme abundance. This highlights the central role of intracellular spatial heterogeneity in the regulation of cellular metabolism and provides a basis for further studies in the context of metabolic disease

ESSENTIAL PROJECTS

- PRG1127 "*Energy transfer in compartmentalized heart muscle cells: impact of energy transfer remodeling on mitochondria, contractility, excitation-contraction coupling and whole heart performance*" (2021–2025)
- PSG832 "*The Role of Calcium Signaling Between Mitochondria and Sarcoplasmic Reticulum During Postnatal Development and in Disease in the Heart*" (2023–2027)

SELECTED PUBLICATIONS

Bernasconi, R.; Soodla, K.; Sirp, A.; Zovo, K.; Kuhtinskaja, M.; Lukk, T.; Vendelin, M.; Birkedal, R. (2025). Higher AMPK activation in mouse oxidative compared with glycolytic muscle does not correlate with LKB1 or CaMKKb expression. American Journal of Physiology. Endocrinology and Metabolism, 328, 1, E21–E33. DOI: 10.1152/ajpendo.00261.2024.

Branovets, J.; Laasmaa, M.; Stolova, J.; Shen, X.; Ratsepso, T.; Bernasconi, R.; Soodla, K.; Balodis, M. J.; Grahv, C.; Hendrikson, E.; Louch, W. E.; Birkedal, R.; Vendelin, M. (2025). Lifelong creatine deficiency leads to augmented sarcoplasmic reticulum calcium release but not heart failure. AJP Heart and Circulatory Physiology, 329 (2), H471–H489. DOI: 10.1152/ajpheart.00106.2025.

Karimi, H.; Laasmaa, M.; Pihlak, M.; Vendelin, M. (2025). Statistical Analysis of Fluorescence Intensity Transients with Bayesian Methods. Science Advances [in press].

THEORETICAL PHYSICS

Head of the group: Tenured Full Professor JAAN KALDA, jaan.kalda@taltech.ee

Members: Raavo Josepson, Mihhail Klopov, Tanel Mullari, Vladislav-Veniamin Pustõnski, Marek Vilipuu

Doctoral students: Eero Uustalu, Tudor Plopeanu

TOPICS AND COMPETENCES

KEYWORDS: scale-free networks, turbulence, photovoltaic materials, econphysics, complex systems, tools for physics education

Competences of the research team:

Regarding rapidly developing solar cell technology, properties of cheap and efficient photovoltaic materials (pure and doped) are being studied. One research direction is calculating basic physical parameters of new photovoltaic materials (SnSe and SnZn) using quantum chemistry and density functional theory models.

For materials technology solutions, it's important to understand localized vibrations in solids and physical mechanisms of LLM (Linear Localized Modes). We have identified conditions for generating ILM (Intrinsic Localized Modes) in various three-dimensional crystals and compared theory with an experiment.

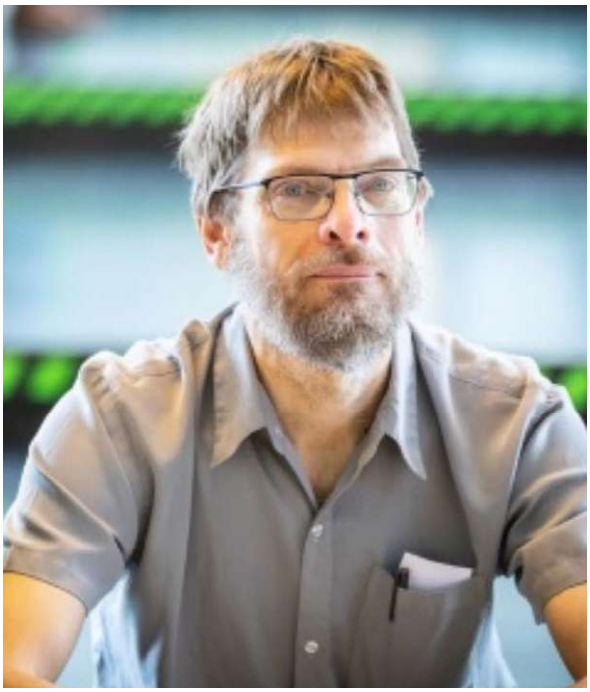
Significant attention has been paid to popularizing physics education and developing teaching materials dedicated to solving problems requiring creativity. Materials found at *https://www.ioc.ee/~kalda/ipho/* have gained great international popularity, with an average download rate of about 1000 files per day. Under TFU's leadership, the international "Physics Cup" competition is organized, and the European Physics Olympiad (EuPhO) was initiated.

More information: *https://taltech.ee/en/department-cybernetics/research-groups*

IN 2025 We proved the optimality of the "H-comb" structure for additively manufactured soft magnetic cores, demonstrating that it maximizes magnetic flux transmission while ensuring mechanical stability. We also developed a mathematical framework for dimensioning these components and validated the model, with experimental results matching theoretical predictions within 10%.

We conducted a comprehensive comparative analysis of algebraic and differential geometric approaches for transforming nonlinear discrete-time state equations into the generalized observer form. The study defined the specific assumptions, solvability conditions, and validity domains for both solutions.

We demonstrated that integrating Apollo astronaut photographs into a precise photogrammetric model creates a valuable educational tool for extracting astronomical data.



SELECTED PROJECT

- PRG1827 "*Additivly Manufactured Electrical Machines*" (2023–2027)
- COVSG22 "*Monte-Carlo analysis of the spreading rate of a virus as a function of human mobility and social distancing*" (2020–2021)

SELECTED PUBLICATIONS

Andria, J.; di Tollo, G.; Kalda, J. (2022). The predictive power of power-laws: An empirical time-arrow based investigation. Chaos, Solitons and Fractals, 162, #112425. DOI: 10.1016/j.chaos.2022.112425.

Plopeanu, T.; Kalda, J.; Tiismus, H.; Virro, I.; Vaimann, T.; Kallaste, A. (2025). Optimal shape of additively manufactured magnetic cores. Scientific Reports, 15, art. 42501. DOI: 10.1038/s41598-025-26678-7.

Mullari, T.; Kotta, Ü.; Kaldmäe, A.; Kaparin, V.; Simha, A. (2024). Extended observer form with vector fields. International Journal of Control, 97 (10), 2399–2412. DOI: 10.1080/00207179.2023.2274060.

WAVE ENGINEERING

Head of the group: Tenured Full Professor TARMO SOOMERE, tarmo.soomere@taltech.ee

Members: Kevin Ellis Parnell, Katri Viigand (Pindsoo), Andrea Giudici, Nicole Delpeche-Ellmann, Rain Männikus, Maris Eelsalu, Larysa Parnell

Doctoral students: Maarius Utso, Mikolaj Zbigniew Jankowski, Margus Rätsep

TOPICS AND COMPETENCES

KEYWORDS: wave dynamics, climate studies, coastal processes, coastal engineering, wave climatology, coastal management, remote sensing

The aim of the laboratory (*wavelab.ioc.ee*) is to promote and provide a structure for research in water waves and coastal engineering.

The focus is on complex and nonlinear phenomena, and the applications of mathematical methods in wave dynamics, coastal engineering and related climate studies. The scope involves wave theory and applications, including dynamics of solitons, surface wave modelling, wave climate, and wave-driven phenomena, with application to integrated coastal zone management and climate studies.

Emerging foci are Lagrangian transport of substances, wave and water level extremes, preventive mitigation of marine-induced hazards, and remote sensing methods, quantification of offshore sea level and its climate change driven changes using remote sensing.

IN 2025: Barotropic trends for the Barents Sea were quantified for 1975–2021.

It was shown that even fairly mild wave climate of the Baltic Sea may cause unexpectedly intense relocation of sand along and across non-equilibrium coastal profiles immediately after beach nourishment. Direct measurements of wave-driven near-bottom velocities show that the heights of single waves in the nearshore of south-eastern Gulf of Riga follow the classic exponential distribution instead of Rayleigh or Forristall distribution. Analysis of wave-driven transport of coastal sediment revealed that the western, southern and eastern shores of the Gulf of Riga have radically different structural properties. While long excursions of sediment grains are usual for the western and southern coasts, the eastern shore is split into numerous almost isolated sedimentary cells. The spatial pattern of observed alterations of coastal processes was attributed to climate change driven spatio-temporal variations in the main forcing factors. The changing properties of extremely high and low water levels were linked to the changes in the shape parameter of the generalised extreme value distribution for the entire Baltic Sea.

A new way of quantification of the Baltic Sea water volume was proposed and tested based on properties of dynamic topography of sea surface. An ensemble of numerical simulations of the Baltic Sea dynamics was employed to decompose extreme water levels of the Baltic Sea into single components. It was shown that the temporal course of extreme water levels on the Baltic Sea shores is inherently non-stationary.

An updated description of the variability and extremes of the Caspian Sea's wave climate was developed.

More information: *https://wavelab.taltech.ee/*

SELECTED PROJECTS

- EMP480 "*Solutions to current and future problems on natural and constructed shorelines, eastern Baltic Sea*" (2020–2024)
- PRG1129 "*Wave dynamics for coastal engineering and management: the advantages and challenge of the Lagrangian perspective*" (2021–2025)
- MOB3PRT25 "*Framework for Offshore Wind Turbines in Icy Conditions*" (2025–2028)

SELECTED PUBLICATIONS

Viigand, K.; Eelsalu, M.; Soomere, T. (2025). Inherent non-stationarity in the GEV distribution for extreme sea levels: Implications for coastal vulnerability in the Baltic Sea. Ocean Engineering, 341, 4, ARTN 122681. DOI: 10.1016/j.oceaneng.2025.122681.

Jahanmard, V.; Löptien, U.; Sandø, A. B.; Gierisch, A. M. U.; Dietze, H.; Lien, V.; Delpeche-Ellmann, N.; Hordoir, R. (2025). Barotropic Trends Through the Barents Sea Opening for the Period 1975–2021. Journal of Geophysical Research Oceans, 130 (130, 1), 1–20. DOI: 10.1029/2024JC021663.

Giudici, A.; Mannikus, R.; Soomere, T. (2025). Variability and extremes of the Caspian Sea's modelled wave climate. Ocean Engineering, 342 (3), ARTN 123077. DOI: 10.1016/j.oceaneng.2025.123077.

DEPARTMENT OF GEOLOGY

Director: Tenured Associate Professor OLLE HINTS, olle.hints@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

38 Academic staff — Incl. 6 professors, 27 researchers

21 Doctoral students

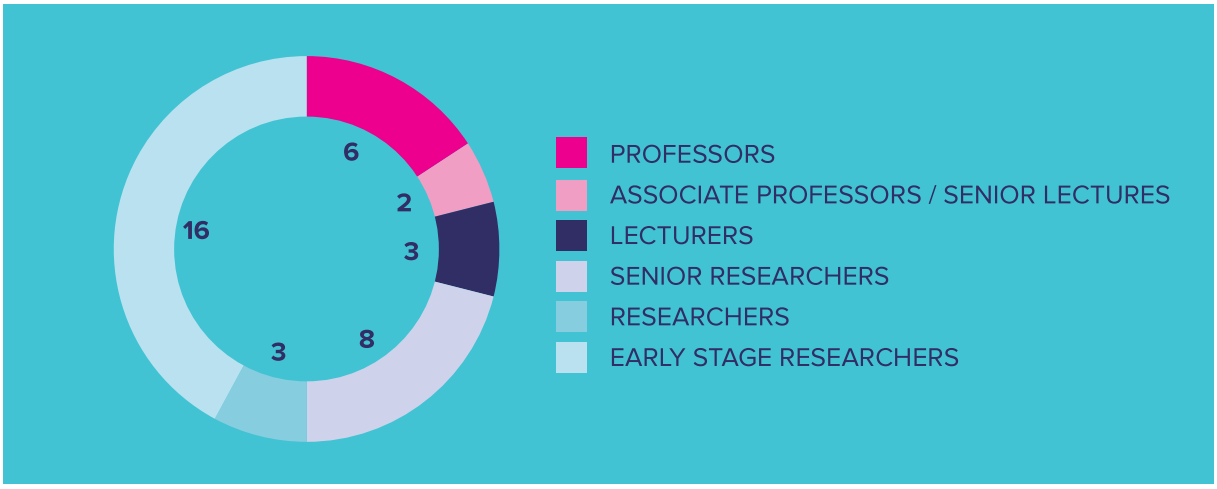
3 Defended doctoral dissertations

47 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 4 RESEARCH DIVISIONS:

- **BEDROCK GEOLOGY AND COLLECTIONS DIVISION.**
  Head: Tenured Associate Professor OLLE HINTS, olle.hints@taltech.ee
- **MINERAL RESOURCES AND APPLIED GEOLOGY DIVISION.**
  Head: Senior Researcher RUTT HINTS, rutt.hints@taltech.ee
- **MINING AND MINERAL TECHNOLOGY DIVISION.**
  Head: Senior Lecturer ERIK VÄLI, erik.vali@taltech.ee
- **QUATERNARY GEOLOGY RESEARCH GROUP.**
  Head: Tenured Full Professor SIIM VESKI, siim.veski@taltech.ee



BEDROCK GEOLOGY AND COLLECTIONS DIVISION

Head: Tenured Associate Professor OLLE HINTS, olle.hints@taltech.ee

Members: Ursula Toom, Aivo Lepland, Peep Männik, Jaak Nõlvak, Helje Pärnaste, Tiiu Märss, Erik Tzodsenidze, Linda Hints, Sonja Kõrvits, Reet Männik, Arina Gotsenko, Trinity Jõgisalu

Doctoral students: Thibaud Cyril Olivier Lieffroy, Ogechukwu Ann Moghalu

TOPICS AND COMPETENCES

KEYWORDS: bedrock, geology of Estonia, sedimentary rocks, limestone, paleoenvironment, paleoclimate, paleontology, geochemistry, stratigraphy, sedimentology, Paleozoic, Baltoscandia, Baltica, Ordovician, Silurian, paleobiodiversity, mass extinction, ice age, microfossils, fossils, geological collections, geological databases and e-services

The research group of bedrock geology holds competences on regional geology, sedimentary rocks, stratigraphy and paleontology of Estonia and beyond. Such expertise is needed in applied geosciences, but the main work of the group is aiming at better understanding of the interactions between geo- and biosphere processes in deep time. The group holds leading paleontological competence in Estonia, and for some fossil groups, leading expertise worldwide (notably for conodonts, chitinozoans and scolecodonts). The group's main research directions are:

- Paleoenvironment and paleoclimate reconstructions using multiple proxy indicators such as carbon and oxygen isotopes, sedimentology etc.
- Paleobiodiversity dynamics including mass extinction and their links with climate and environmental changes.
- Paleobiology and evolution of various groups of organisms during the Paleozoic.
- High-resolution bio- and chemostratigraphy that provides regional spatio-temporal framework and global time correlations.

The group is using the large geological collections at the department that constitute a globally unique archive of deep time Earth environments, climate and biodiversity. The group is responsible for the development and opening up this archive for researchers worldwide as part of national and pan-European research infrastructure.

IN 2025, the research group's activities focused on identifying paleoclimate and environmental changes during the Palaeozoic, assessing the reliability of geochemical and other indicators, regional stratigraphy, and elucidating patterns of biodiversity and paleoecology in the geological past.

Significant results comparing paleoclimate trends between the Baltica and Siberian continents were published, based on oxygen isotope studies of Ordovician conodonts.

Several fossil taxa, notably among stromatoporoids and trace fossils, were first described or identified in the Baltic region, thereby extending knowledge of evolutionary and biodiversity trends in Palaeozoic faunas. The revision of Cambrian shelly fossils and trace fossils revealed the first record of cloudinids and a possible priapulid in the Cambrian of Estonia.

An updated version of the regional stratigraphy of the Silurian System was compiled and published.

More information: *https://taltech.ee/en/department-geology/division-of-bedrock-geology-and-collections*

SELECTED PROJECTS

- PRG1701 "*From Greenhouse to Icehouse: Reconstructing Ordovician Climate Transitions and Biotic Responses in Baltica*" (2023–2027)
- PUTJD1106 "*Emergence and Evolution of Bioerosional Behaviour on Baltica in the Early Palaeozoic*" (2022–2024)
- TARISTU24-TK8 "*Natural History archives and common data space*" (2025–2029)

SELECTED PUBLICATIONS

Thiagarajan, N.; Lepland, A.; Ryb, U.; Torsvik, T. H.; Ainsaar, L.; Hints, O.; Eiler, J. (2024). Reconstruction of Phanerozoic climate using carbonate clumped isotopes and implications for the oxygen isotopic composition of seawater. Proceedings of the National Academy of Sciences, 121 (36), e2400434121. DOI: 10.1073/pnas.2400434121.

Hints, O.; Ainsaar, L.; Lepland, A.; Liiv, M.; Männik, P.; Meidla, T.; Nõlvak, J.; Radzevičius, S. (2023). Paired carbon isotope chemostratigraphy across the Ordovician–Silurian boundary in central East Baltic: Regional and global signatures. Palaeogeography Palaeoclimatology Palaeoecology, 111640. DOI: 10.1016/j.palaeo.2023.111640.

Männik, P.; Lehnert, O.; Joachimski, M.M. (2025). Climate changes in the Middle and Late Ordovician of the tropical belt: The δ18O record from the Tunguska Basin of Siberia and its palaeogeographical relation. Palaeogeography Palaeoclimatology Palaeoecology, 663, 112765. DOI: 10.1016/j.palaeo.2025.112765.

MINERAL RESOURCES AND APPLIED GEOLOGY DIVISION

Head: Senior Researcher RUTT HINTS, rutt.hints@taltech.ee

Members: Alvar Soesoo, Heidi Elisabet Soosalu, Eduard Pukkonen, Alla Šogenova, Kazbulat Šogenov; Toivo Kallaste, Kristjan Urtson, Andre Gregor

Doctoral students: Nata-Ly Pantšenko, Sophie Graul, Mawo Ndiaye, Juan David Solano Acosta, Ragnar Kauril, Tarmo All, Carina Sula, Tarmo All

TOPICS AND COMPETENCES

KEYWORDS: mineral resources, geochemistry, mineralogy, rare earth elements, ore genesis, geophysics, CCUS, hydrogen storage, circularity of permanent magnets

One of the research group's main focuses is the study of the genesis and characteristics of critical raw material ores. The core competencies of the group are related to sedimentary mineral resources, including metal-rich black shales, phosphorites, and oil shales, as well as deciphering the ore potential of deep-seated magmatic and metamorphic complexes.

An independent research direction is related to studies of CO_2 sequestration and the storage of CO_2 and hydrogen. The research group relies on long-term scientific work in the fields of X-ray structural analysis and interdisciplinary research related to the valorization and recycling of mineral wastes. The newest research direction of the group is the investigation of the recycling of permanent magnets, for which the development of a decrepitation laboratory was started in 2024.

IN 2025, four of the research group's scientific publications were published in Quartile 1 journals in the field. Of these, Ndiaye et al. (2025) addressed the metallogeny of black shales based on U and Mo isotope datasets. Solano-Acosta et al. (2025) proposed a detailed genetic model for the Märjamaa rapakivi massif, based on geophysical field data and geochemical evidence. Both studies were based on original results generated within the research group.

More information: *https://taltech.ee/en/department-geology/division-of-mineral-resources-and-applied-geology*

SELECTED PROJECTS

- TEM-TA100 "*Variability of Properties of Associated Resources of Shelly Phosphorite and Opportunities for Beneficiation*" (2024–2028)
- VHE24040 "*Rare earth and magnets hub for a resilient Europe*" (2024–2028)
- VHE24051 "*Recognizing European potential for hosting deep land primary CRM by combining new mineral models and advanced exploration and visualization techniques*" (2024–2027)

SELECTED PUBLICATIONS

Ndiaye, M.; Graul, S.; Liiv, M.; Kallaste, T.; Algeo, T.J.; Hints, R. (2025). Trace-metal hyper-enrichment in Tremadocian black shales of the Baltic Palaeobasin linked to transgression and ultra-slow sedimentation rates. Chemical Geology, 690, ARTN 122910. DOI: 10.1016/j.chemgeo.2025.122910.

Solano-Acosta, J. D.; Soesoo, A.; Hints, R. (2025). Integrated geophysical and emplacement modelling of the Märjamaa and Kloostri rapakivi granitoids, Estonia: Insights into intrusion geometry and tectonic controls. Precambrian Research, 430, 107938. DOI: 10.1016/j.precamres.2025.107938.

Ndiaye, M.; Pajusaar, S.; Liiv, M.; Graul, S.; Kallaste, T.; Hints, R. (2023). Fine clay shuttle as a key mechanism for V hyper-enrichment in shallow water Tremadocian black shale from Baltica. Chemical Geology, 634, 121583. DOI: 10.1016/j.chemgeo.2023.121583.

MINING AND MINERAL TECHNOLOGY DIVISION

Head: Senior Lecturer ERIK VÄLI, erik.vali@taltech.ee

Members: Tõnu Tomberg, Peeter Talviste, Martin Nurme, Karin Robam, Tony Hand, Nthati Lillian Monei, Carl-Richard Saks, Bruno Grafe, Reet Männik, Siim Roov

Doctoral students: Andrus Paat, Vesta Kaljuste, Salla-Maija Teittinen, Sander Kanter

TOPICS AND COMPETENCES

KEYWORDS: mining science, CO_2 mineral carbonation, circular economy, phosphorite, phytoremediation, entrepreneurship, ESG

The Mining and Mineral Resources Research group is responsible for research and development activities in the fields of mining science and engineering at TalTech. The mission of the group is to help young engineers and geoscientists to develop necessary skills for sustainable and safe development, extraction and closure of Estonia's mineral resources. The research and development activities of the group take place through both public and private sector funded projects.

The research field of the research group is diverse, starting with the usual mining engineering related challenges such as optimizing mining technology, reducing environmental impacts, increasing productivity, etc. The core competencies of the group include mining engineering and design, mineral economics, mining environmental impact and remediation, mine waste management, circular economic and social sustainability, quantitative resource evaluation, ESG management and mining geochemistry.

IN 2025, three research projects were completed:

1. *AGEMERA*, funded by the Horizon Europe program, aiming to develop innovative, non-invasive geophysical methods for mapping the potential of critical raw materials, thereby strengthening the EU's raw material supply security and independence in the green and digital transitions.
2. *ADMA 3*, funded by EIT RawMaterials, supported master's and doctoral education as well as industry specialist training in sustainable mineral exploration, supply, and mining challenges (e.g., energy transition, climate change).
3. EIT RM RISHUB – the core activities were focused on supporting regional innovation and skills development within the EIT RawMaterials network, creating connections between academia, science, and industry, promoting matchmaking and networking.

More information: *https://taltech.ee/en/department-geology/division-of-mining-and-mineral-technology*

SELECTED PROJECTS

- TEM-TA143 "*Construction minerals and mineral waste: possibilities for sustainable extraction and circular processing in Estonia*" (2024–2028)
- VHE22024 "*Agile Exploration and Geo-modelling for European Critical Raw materials*" (2022–2025)
- VIR23025 "*Stormwater purification with construction and demolition waste*" (2023–2026)

SELECTED PUBLICATIONS

Grafe, B.; Karu, V.; Stolzenberg, S.; Tugaoen, H., Mantescu, L. (2025). Watergenics AISRAS: Real-Time In-Situ Augmented Raman Spectroscopy for Acid-Mine-Drainage Monitoring – and how Universities can Support Deep-Tech-Startup Development in the Mining Sector. In: Clausen, Elisabeth (Ed.). SOMP Annual General Meeting & Conference 2025 Conference Proceedings. (42–56). Aachen: Verlag R. Zillekens.

Robam, K.; Hand, T.; Kanter, S.; Väli, E. (2025). Enhancing Mining Education: Integrating Online Learning and Hands-on Experience for Comprehensive Skill Development. Environment. Technology. Resources. Proceedings of the International Scientific and Practical Conference, 3, 247–252. DOI: 10.17770/etr2025vol3.8515.

QUATERNARY GEOLOGY RESEARCH GROUP

Head: Tenured Full Professor SIIM VESKI, siim.veski@taltech.ee

Members: Leeli Amon, Tiiu Alliksaar, Atko Heinsalu, Anneli Poska, Triin Reitalu, Jüri Vassiljev, Normunds Stivrinš, Merlin Liiv, Ansis Blaus, Hannah Mikenberg

Doctoral students: Varvara Bakumenko, Vladimir Karpin, Anna Lanka, Ivan Krivokorin, Mark Top, Elisabeth Renée Martveldt, Merle Luca Marie Dorsch, Eliise Poolma

TOPICS AND COMPETENCES

KEYWORDS: geoecology, paleoclimate and environment, paleodiversity, Baltic Sea, chronology

The main research aim of the Quaternary group is reconstruction of past ecosystems, vegetation history, climate and environmental change, both natural and manmade, at high temporal resolution during the last 15,000 years through multidisciplinary and multiproxy studies of natural archives such as lake, bog and marine sediments. The group focuses on better understanding the interactions between Quaternary geo- and biosphere processes, in particular, addressing the following:

- Paleoclimate variation using multi-proxy analyses (such as pollen and chironomid based inference models)
- Paleo-biodiversity (terrestrial and aquatic), functional and phylogenetic diversity dynamics and relationships with climate and environmental changes
- Past human impact upon landscapes, waterbodies, vegetation structure and land-cover
- Postglacial retreat of the ice sheet
- Shoreline displacement of the Baltic Sea

The group holds a leading position in Quaternary and palaeoecological studies in the Baltic realm. The main strengths of the group's work are related to the high-resolution paleo-datasets of the geographically and climatically constrained area.

The research of the working group is made unique by its multi- and interdisciplinary approach, including the merging of pollen, diatoms, benthic fauna of lakes and human activity data into a single collection of information, which helps to find out the extent of ongoing rapid climate and environmental changes and to predict possible consequences.

Paleoecological research and key scientific findings **IN 2025:** Reconstructions of past landscapes and vegetation patterns indicate a decline in open environments during the Pleistocene–Holocene transition, which likely contributed to the contraction of mammoth habitats. Holocene paleoclimate dynamics were identified as a key driver in the initiation and development of peatlands.

A newly developed model based on modern lake data demonstrates that continentality exerts a strong influence on chironomid assemblages and can be effectively applied in paleoclimate reconstructions. Further peatland research shows that increased pH levels resulting from emissions from the cement industry lead to long-term loss of Sphagnum moss, peat degradation, and slow ecosystem recovery, even after the cessation of pollution.

The results also highlight that both regional and local factors – such as moisture conditions, vegetation composition, and human activity – have played a major role in shaping the vegetation and hydrological dynamics of Siberian peatlands throughout the Holocene. In western Estonia, new evidence on Holocene hydroclimate and land use provides important insights into their combined effects on land cover and peat accumulation, contributing to a better understanding of the interaction between climate and human influence.

More information: https://taltech.ee/en/department-geology/division-of-quaternary-geology

SELECTED PROJECTS

- PRG1993 "*Postglacial Ecosystem Response to Episodes of Rapid Climate Change [PEREI*" (2024–2028)
- TK215 "*Estonian Roots: Centre of Excellence for transdisciplinary studies on ethnogenesis and cultural diversity*" (2024–2030)
- TEM-TA122 "*Iron-manganese concretions of the Estonian marine area: distribution, formation mechanisms and economic potential*" (2025–2028)

SELECTED PUBLICATIONS

Krivokorin, I.; Poska, A.; Vassiljev, J.; Veski, S.; Amon, L. (2025). Environment of European Last Mammoths: Reconstructing the Landcover of the Eastern Baltic Area at the Pleistocene/Holocene Transition. Land, 14 (1), ARTN 178. DOI: 10.3390/land14010178.

Roberts, H.; Andrews, L.; Słowiński, M.; Marcisz, K.; Kołaczek, P.; Amon, L.; Veski, S.; Stivrins, N.; Heinsalu, A.; Lamentowicz, M. (2025). Holocene Land-Use and Climate Forcing of Ombrotrophic Peatland Dynamics in Northwest Estonia. Journal of Geophysical Research Biogeosciences, 130 (12), e2025JG009140. DOI: 10.1029/2025JG009140.

Amon, L.; Tsyganov, A.N.; Zarov, E.A.; Burkanova, E.; Vassiljev, J.; Kulkov, M.G.; Krivokorin, I.; Chernyshov, V.A.; Mazei, N.G.; Salakhidinova, G.T.; Gulina, A.; Kuzmin, Y.; Mazei, Y.A.; Lapshina, E.D. (2025). Regional and local drivers of vegetation and humidity dynamics in Western Siberia during the Holocene: A case study of Mukhrino mire. The Holocene, 1–16. DOI: 10.1177/09596836251387252.

DEPARTMENT OF MARINE SYSTEMS

Director: Tenured Associate Professor RIVO UIBOUPIN, rivo.uiboupin@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

38 Academic staff — Incl. 4 professors, 27 researchers

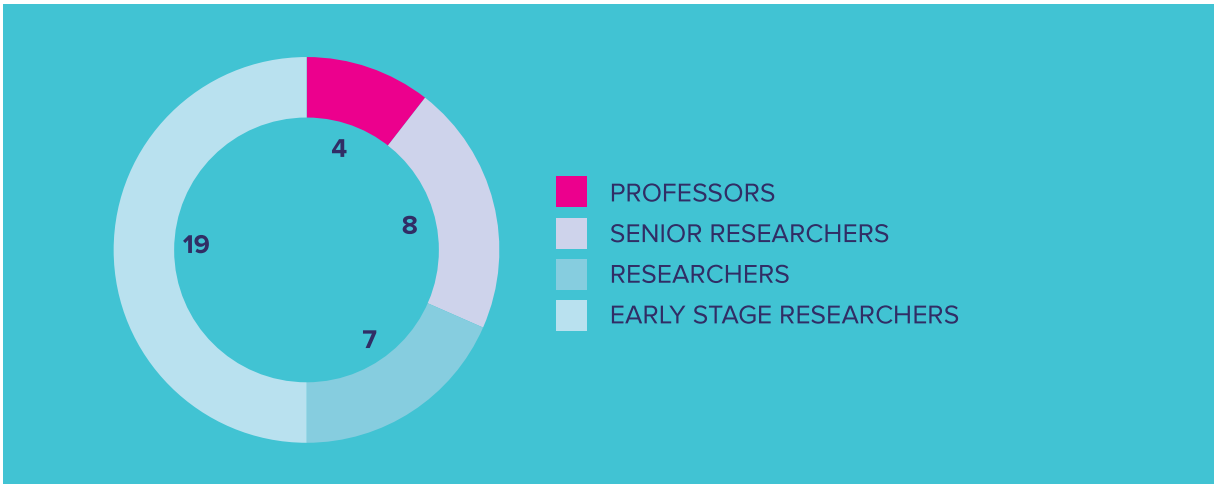
23 Doctoral students — 1 Defended doctoral dissertations

26 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 2 RESEARCH GROUPS:

- **RESEARCH GROUP ON DYNAMICS OF GRADIENT SYSTEMS.**
  Head: Tenured Full Professor URMAS LIPS, urmas.lips@taltech.ee
- **RESEARCH GROUP ON MODELLING AND REMOTE SENSING OF MARINE DYNAMICS.**
  Head: Tenured Full Professor URMAS RAUDSEPP, urmas.raudsepp@taltech.ee



RESEARCH GROUP ON DYNAMICS OF GRADIENT SYSTEMS

Head of the research group: Tenured Full Professor URMAS LIPS, urmas.lips@taltech.ee

Members: Taavi Liblik, Madis-Jaak Lilover, Germo Väli, Natalja Buhhalko, Ivan Kuprijanov, Sirje Sildever, Irina Suhhova, Villu Kikas, Fred Buschmann, Silvie Lainela, Natalja Kolesova, Kati Lind, Risto Reilson, Diana Maslova, Stella-Theresa Luik, Nelli Rünk, Kristian Pärt, Iida Virunurm

Doctoral students: Arun Mishra, Kai Salm, Oliver Samlas, Enriko Siht, Evelyn Pil, Marlene Kaljumäe, Pille Leesmäe

TOPICS AND COMPETENCES

KEYWORDS: stratification, hypoxia, submesoscale processes, micro litter, eDNA, carbon cycle, innovative observing and analysis methods

The research is focused on multiscale physical processes that influence the biogeochemical cycles of substances and control the transport and mixing in the stratified Baltic Sea, including the hypoxic layer and redoxcline. The main focus is on submesoscale processes, their local and large-scale impact on water and matter exchange between the sub-basins, coastal and open sea and vertically between the water layers that influence the dynamics of the spring bloom, mixotrophic organisms and carbon fluxes. Marine ecology studies focus on pelagic and benthic primary producers, benthic invertebrates, their dynamics and role, and impact of micro-litter and hazardous substances on marine biota.

More information: *https://taltech.ee/en/department-marine-systems/research-groups#p32667*

Research results **IN 2025:** Observational data indicate a significant deterioration of oxygen conditions in the Central Baltic Sea, with the oxygen deficit below 100 m approximately doubling between 2013 and 2024. This trend is driven by eutrophication, persistent stratification, limited oxygen transport, and climate-induced warming, suggesting that recovery is unlikely in the coming decade under current anthropogenic pressures.

High-resolution observations and modeling highlight pronounced small-scale variability in the water column, particularly in spring and late summer, linked to seasonal forcing. Episodic intensification asso-ciated with mesoscale dynamics underscores the critical role of submesoscale processes in vertical and horizontal water mass transport.

Modeling studies demonstrate that microplastic transport is highly sensitive to process representation, with key mechanisms including diffusion, biofouling, beaching, and resuspension. Simulations for the Gulf of Finland show that most microplastics remain within the basin, with elevated concentrations in the eastern region influenced by river inputs and strong spatial variability driven by circulation patterns.

Empirical observations confirm that microplastics (10–300 µm) are ubiquitous in European coastal waters, including the Baltic Sea, with concentrations ranging from 5 to 1600 particles per cubic meter.

SELECTED PROJECTS

- PRG602 "*The role of sub-mesoscale processes in structuring and large-scale dynamics of oceanographic fields*" (2020–2024)
- PSG735 "*Squeezing more out of metabarcoding data: cell abundance, activity/inactivity and community dynamics*" (2022–2025)
- VFP20003 "*Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability – JERICO-S3*" (2020–2024)

SELECTED PUBLICATIONS

Hattich, G. S. I.; Jokinen, S.; Sildever, S.; Gareis, M.; Heikkinen, J.; Junghardt, N.; Segovia, M.; Machado, M.; Sjöqvist, C. (2024). Temperature optima of a natural diatom population increases as global warming proceeds. Nature Climate Change. DOI: 10.1038/s41558-024-01981-9.

Lainela, S.; Jacobs, E.; Luik, S.-T.; Rehder, G.; Lips, U. (2024). Seasonal dynamics and regional distribution patterns of CO2 and CH4 in the north-eastern Baltic Sea. Biogeosciences, 21 (20), 4495–4519. DOI: 10.5194/bg-21-4495-2024.

Liblik, T.; Siht, E.; Buschmann, F.; Kaljumae, M.; Kikas, V.; Lips, U.; Luik, S.-T.; Maslova, D.; Part, K.; Salm, K.; Samlas, O.; Siiria, S.-M.; Sildever, S.; Skudra, M.; Tikka, K.; Tuomi, L. (2025). Recent stagnation period and unprecedented deoxygenation in the Baltic Sea: causes and consequences. Frontiers in Earth Science, 13, #1638978. DOI: 10.3389/feart.2025.1638978.

RESEARCH GROUP ON MODELLING AND REMOTE SENSING OF MARINE DYNAMICS

Head of the research group: Tenured Full Professor URMAS RAUDSEPP, urmas.raudsepp@taltech.ee

Members: Aarne Männik, Jüri Elken, Liis Sipelgas, Victor Alari, Priidik Lagemaa, Rivo Uiboupin, Sander Rikka, Ilja Maljutenko, Kaimo Vahter, Mariliis Kõuts, Svetlana Verjovkina, Avely-Agnes Pumalainen

Doctoral students: Age Arikas, Siim Pärt, Mari-Liis Kasemets, Amirhossein Barzandeh, Nikon Vidjajev, Age Aavaste, Javid Aslanli, Ali Hayatijozani, Behzad Bashiri, Jia Liu, Katriin Käärik, Paul Alexander Nemeth, Shakti Singh, Ulvi Ahmadov, Venkateswara Varma Gudimetla, Yee Chun Tsoi

TOPICS AND COMPETENCES

KEYWORDS: oceanography, meteorology, numerical modelling, remote sensing, machine learning

The research team is conducting oceanographic process research based on scientific analysis to find cause-and-effect relationships. Innovative (operational) methods for monitoring the marine environment and analyzing changes are being developed, incl. weather forecasting and climate models applied to supercomputers, to elucidate the mechanisms of atmospheric and ocean interactions; and machine learning based algorithms for satellite image processing and model data analysis. The research group has a long experience in developing applications/methods of operational oceanography, the outputs of which are information provided to the public and public authorities on water level variability, ice conditions and other parameters of marine physics.

The research group is making a significant contribution to the pan-European Copernicus program. In scientific process research and applied research, the strength of the research team is the use of big data (mass processing) for climate studies and statistical analysis of the properties of the marine environment, as well as for finding dynamic relationships.

The main research topics addressed **IN 2025:**

- Digital twin capability: A blueprint for the capability of the "digital twin" Earth system has been created, a DestinE "Digital Twin Engine" linking EuroHPC-scale simulations, data, and workflows to enable km/sub-km Earth-system experiments for extremes and climate adaptation.

- Next-generation observations: Demonstrated scalable, low-cost, open-source measurement networks. Miniature wave buoys (e.g. SFY, microSWIFT, OpenMetBuoy, LainePoiss, Spartacus) can be deployed in swarms to capture phase-resolved waves and air-sea processes.
- Baltic Sea datasets and trends: Delivered high-resolution marine heatwave maps (1982–2023) and evidence of fewer cold spells, shorter ice seasons, and declining ice extent, supporting improved understanding of regional change.
- AI-enabled applications: AI/hybrid methods are used to improve actionable coastal information and renewable-energy assessment: HIDRA2 (deep learning) predicts hourly sea-surface height for a 72-h window and outperforms hydrodynamic models for extreme sea levels, while an Energies study couples in situ wave spectra with LSTM-enhanced Sentinel-1 SAR retrievals (trained on ~71k collocations) to reconstruct spectra for wave-energy site/device tuning.

More information: *https://taltech.ee/en/department-marine-systems/research-groups#p32670*

SELECTED PROJECTS

- VHE24075 "*Digital Twin of Earth System for Cryosphere, Land Surface and Related Interactions (TerraDT)*)" (2025–2028)
- LLMEV25003 "*Copernicus Marine Service at Baltic Monitoring and Forecasting Centre COP2ph2COP2ph2*" (2024–2028)
- VEU24074 "*Enabling collaborative efforts for systemic change in Estonian River Basin Management (WetEST)*" (2025–2029)

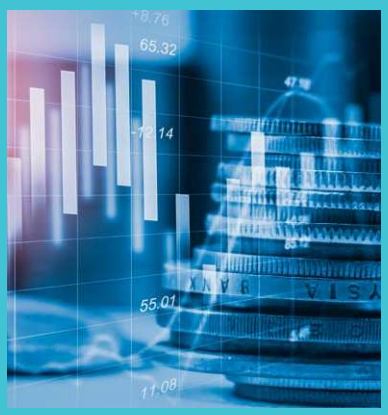
SELECTED PUBLICATIONS

Bashiri, B.; Barzandeh, A.; Mannik, A.; Uiboupin, R.; Raudsepp, U. (2025). Marine Heatwave Event Maps in the Baltic Sea (1982–2023): A Gridded Dataset from Satellite-Derived L4 SST. Scientific Data, 12 (1), art. 2003. DOI: 10.1038/s41597-025-06251-7.

Janatian, N.; Raudsepp, U.; Broomandi, P.; Fickas, K.; Olli, K.; Heimovaara, T.; Mannik, A.; Uiboupin, R.; Pahlevan, N. (2025). A review on remote-sensing-based harmful cyanobacterial bloom monitoring services. Remote Sensing Applications Society and Environment, 37, #101488. DOI: 10.1016/j.rsase.2025.101488.

Singh, S.; Maljutenko, I.; Uiboupin, R. (2025). Sea ice in the Baltic Sea during 1993/94–2020/21 ice seasons from satellite observations and model reanalysis. The Cryosphere, 19 (10), 4741–4758. DOI: 10.5194/tc-19-4741-2025.

SCHOOL OF BUSINESS AND GOVERNANCE



SCHOOL OF BUSINESS AND GOVERNANCE

Dean: Associate Professor MARI AVARMAA

e-mail: mari.avarmaa@taltech.ee

Vice-Dean for Research: Tenured Full Professor TIINA RANDMA-LIIV

e-mail: tiina.randma-liiv@t••••••ee•••

MAIN FIGURES 2025

(as of Dec. 31, 2025)

197 Academic staff — Incl. 38 professors, 73 researchers

78 Doctoral students

12 Defended doctoral dissertations

199 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

DEPARTMENTS

DEPARTMENT OF BUSINESS ADMINISTRATION

Director: MERLI REIDOLF, merli.reidolf@taltech.ee

DEPARTMENT OF ECONOMICS AND FINANCE

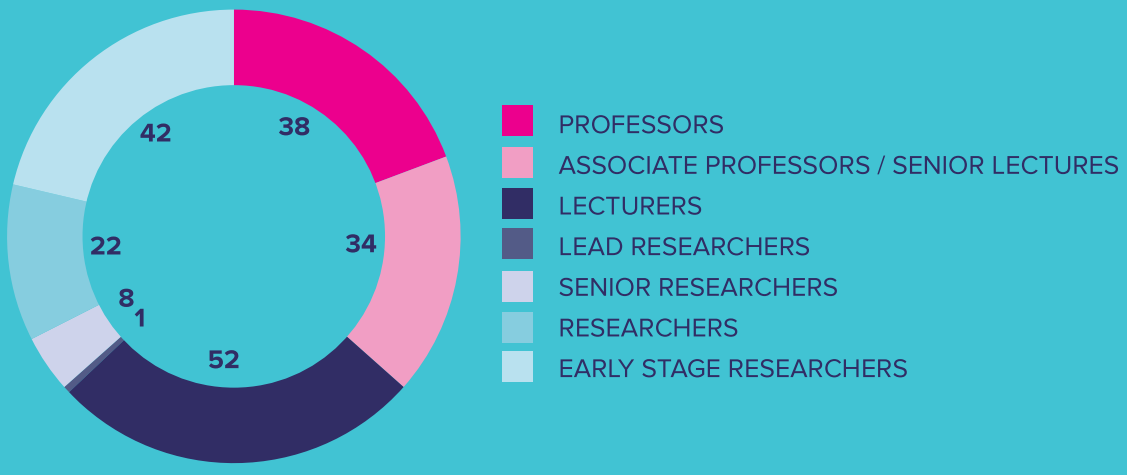
Director: Associate Professor KARIN JÕEVEER, karin.joeveer@taltech.ee

DEPARTMENT OF LAW

Director: Senior Researcher ARCHIL CHOCHIA, archil.chochia@taltech.ee

RAGNAR NURKSE DEPARTMENT OF INNOVATION AND GOVERNANCE

Director: Tenured Full Professor ERKKI KARO, erkki.karo@taltech.ee



DEPARTMENT OF BUSINESS ADMINISTRATION

Director: MERLI REIDOLF,
merli.reidolf@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

95 Academic staff — Incl. 15 professors, 34 researchers

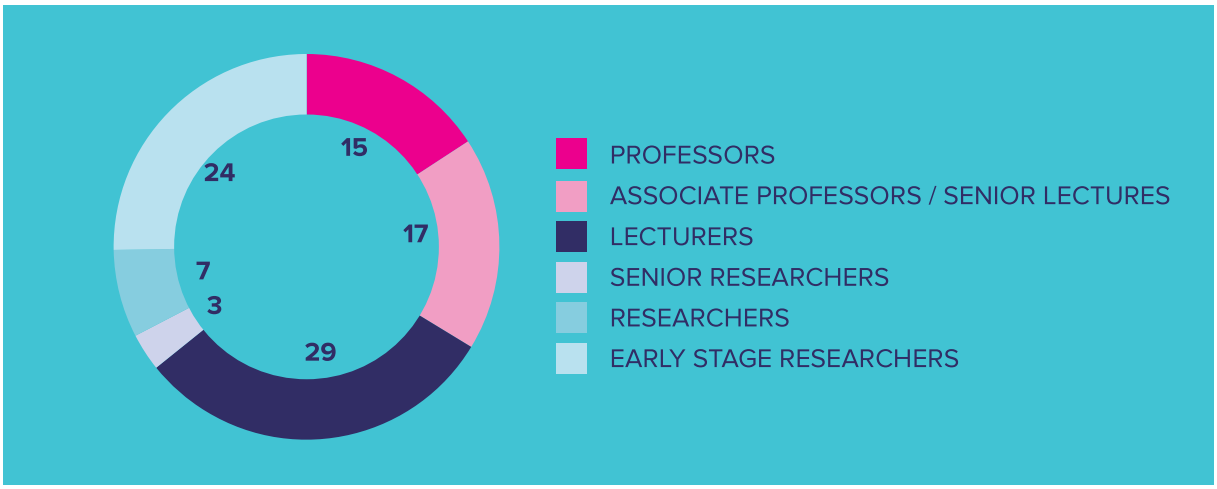
42 Doctoral students — 5 Defended doctoral dissertations

102 Scientific publications*

** Data from the Scopus (as of February 25, 2025)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 5 RESEARCH GROUPS:

- **ACCOUNTING RESEARCH GROUP.**
  Head: Visiting Professor JIRI STROUHAL, jiri.strouhal@taltech.ee
- **ENTREPRENEURSHIP RESEARCH GROUP.**
  Head: Tenured Associate Professor AKI HARIMA, aki.harima@taltech.ee
- **MARKETING RESEARCH GROUP.**
  Head: Associate Professor IIVI RIIVITS-ARKONSUO, iivi.riivits@taltech.ee
- **ORGANISATION AND MANAGEMENT RESEARCH GROUP.**
  Head: Tenured Associate Professor MARI-KLARA STEIN, mari-klara.stein@taltech.ee
- **SUSTAINABLE VALUE CHAIN MANAGEMENT RESEARCH GROUP.**
  Head: Tenured Full Professor WOLFGANG GERSTLBERGER, wolfgang.gerstlberger@taltech.ee



ACCOUNTING RESEARCH GROUP

Head: Visiting Professor JIRI STROUHAL, jiri.strouhal@taltech.ee

Members: Mari Avarmaa, Natalie Aleksandra Gurvitš-Suits, Tarmo Kadak, Paavo Siimann, Vaiva Kiaupaite-Grušniene

TOPICS AND COMPETENCES

KEYWORDS: international accounting harmonisation, financial performance evaluation, critical perspectives in accounting, ESG reporting, accounting education, real-time accounting and digitisation, costing and budgeting, strategic management accounting, green accounting, cash flow management, earnings management, accounting for financial innovations, performance management

The accounting group is active in various related research fields, using both quantitative and qualitative research methods. The research is interdisciplinary and uses critical research methods to explore some of the above research themes.

The group has active and growing links with business organisations both in Estonia and worldwide and is also actively consulting Estonian government institutions on their strategic development and training.

IN 2025 The Accounting research group delivered significant contributions to the fields of sustainability reporting, real-time economy, and digital finance. The research focused on the comparative analysis of ESG preparedness in transitional economies. The group also expanded its scope into future-oriented business modelling, thereby bridging the critical gap between traditional financial reporting and evolving digital business models.

SELECTED PROJECTS

- VHE25017 "*Driving Climate Positive Changes*" (2025–2030)
- VERT23088 "*Training Finance Sector Professionals on Environment Social and Governance Projects and Investments*" (2023–2026)
- LMMAE25044 "*Conducting a training and action plan to raise awareness on real-time economy topics*" (2025–2026)

SELECTED PUBLICATIONS

Kadak, T.; Erkki K. Laitinen (2025). How to predict Performance Management Systems success? Utilization of the critical check points. International Journal of Productivity and Performance Management [in press].

Strouhal, J.; Horák, J.; Resik, A.; Gurvitš-Suits, N. A.; Kadak, T. (2025). Stakeholders' perceptions on ESG reporting: On the case of Czechia and Estonia. JOURNAL OF INTERNATIONAL STUDIES, 18 (2), 75–93. DOI: 10.14254/2071-8330.2025/18-2/4.

Kumar Dey, R. S.; Strouhal, J.; Hamarneh, I.; Ratilla, M.; Gurvitš-Suits, N. A. (2025). Expounding the Consumption Intention Towards Green Camping Products: Goal Setting Perspective. Journal of Tourism and Services, 16 (31), 122–140. DOI: 10.29036/bj7p2v67.

More information: *https://taltech.ee/en/department-business-administration/research-groups#p22765*

ENTREPRENEURSHIP RESEARCH GROUP

Head: Tenured Associate Professor AKI HARIMA, aki.harima@taltech.ee

Members: Susanne Durst, Sirje Ustav, Urve Venesaar, Jan Harima, Basel Osama Sayed Ahmed Hammoda, Merli Reidolf, Marianne Kallaste

Doctoral students: Airi Noppel, Tommaso Aguzzi, Elisabeth Paula Martina Kraut, Ekaterina Demiankova, Talshyn Tokyzhanova, Ruzlin Akter, Jaime Joel Rodriguez Santiago, Arsh Arora, Kota Saito, Selma Fitri Ayuanshari

TOPICS AND COMPETENCES

KEYWORDS: entrepreneurial ecosystems; entrepreneurship education, inclusive entrepreneurship; migration; transnationalism; entrepreneurial competencies, entrepreneurial growth, social entrepreneurship, sustainable entrepreneurship; student and academic entrepreneurship; digitalization; twin transitions

The Entrepreneurship research group is dedicated to pioneering research and fostering innovation in the field of entrepreneurship.

We focus on key areas such as entrepreneurial ecosystems, transnational entrepreneurship, and entrepreneurship education. Our work spans both national (Estonian) and international contexts, ensuring that our research is comprehensive and globally relevant. We are committed to responsible research practices, aiming to enhance the conditions that foster entrepreneurial activity and growth and providing insights that can inform policies and practices to support diverse entrepreneurial endeavors.

Our mission is to advance the field of entrepreneurship research, develop and deliver innovative educational programs, and make a significant social impact.

IN 2025, the ETAG PSG project "The Digital-Physical Hybrid Governance of the Estonian Entrepreneurial Ecosystem" was successfully launched and has progressed substantially during the reporting period. The research group has further strengthened and expanded its international research collaborations. The research group continuously expands and maintains its global scholarly network, with members regularly presenting their research at international conferences such as ESU and other leading academic events.

SELECTED PROJECTS

- PSG1065 "*The Digital-Physical Hybrid Architecture of the Entrepreneurial Ecosystem: Multi-Level Analysis*" (2025–2029)
- KOHTO7 "*Building a Resilient Entrepreneurial Ecosystem: Unpacking Resource Recycling Mechanisms*" (2024–2026)
- MINM23017 "*Global Entrepreneurship Monitor 2023 Estonia Study*" (2023–2024)

SELECTED PUBLICATIONS

Harima, J.; Harima, A. (2025). Ecosystem leadership in catalyzing the emergence of entrepreneurial ecosystems: social capital perspectives. International Journal of Entrepreneurial Behaviour & Research, 31 (5), 1381–1399. DOI: 10.1108/IJEBR-01-2024-0084.

Harima, A.; Harima, J.; Freiling, J. (2024). Ecosystem Orchestration: Unpacking the Leadership Capa-bilities of Anchor Organizations in Nascent Entrepreneurial Ecosystems. Entrepreneurship Theory and Practice, 48 (6), 1404–1450. DOI: 10.1177/10422587241241824.

Marquardt, L.; Harima, A. (2024). Digital boundary spanning in the evolution of entrepreneurial ecosystems: A dynamic capabilities perspective. Journal of Business Research, 182, #114762. DOI: 10.1016/j.jbusres.2024.114762.

More information: *https://taltech.ee/en/department-business-administration/research-groups#p22753*

MARKETING RESEARCH GROUP

Head: Associate Professor IIVI RIIVITS-ARKONSUO, iivi.riivits@taltech.ee

Members: Katrin Paadam, Linda Desire Hollebeek, René Arvola, Kristel Kaljund, Jana Kukk, Liis Ojamäe, Oliver Parts, Volker Kuppelwieser, Aditi Sarkar

Doctoral students: Helen Vaikma, Airi Freimuth, Huma Ittefaq, Eliis Salm, Khadeeja Farrukh

TOPICS AND COMPETENCES

KEYWORDS: consumer/client/stakeholder engagement changes in consumer behavior service design and customer experience sustainable consumer behavior sustainable urban environment slow/sustainable tourism

Research within the group focuses on several interrelated lines of inquiry that examine changes in services, consumption, and urban space from an interdisciplinary perspective.

The service and relationship marketing, research direction addresses the engagement of end-users and business customers in service development and marketing processes, the co-creation of digital value, and communication based on compliance and discipline between providers and consumers, with an emphasis on sustainability and ethical principles. A key component involves the critical analysis of client-provider relationships, service delivery and improvement processes, and customer engagement. These studies have contributed to the development of cutting-edge theories, complemented by research on stakeholder interaction in service and product innovation. The service design focus builds on the dLab initiative, fostering new forms of collaboration, including service design conferences.

The consumption research direction examines consumer behavior theories, customer experience, consumer journeys, and ethical and sustainable consumption. Studies emphasize experience design and holistic customer experiences, including the impact of digital transformation from a marketing perspective.

The urban and housing studies research direction investigates the transformation of urban realities through the interconnections of socio-economic, cultural, and spatial-material processes, as well as the interplay between individual and institutional strategies. Processes related to living space and public space are analyzed from an interdisciplinary perspective, integrating sociological, architectural, urban planning, and business research theoretical and methodological approaches.

IN 2025 Adjunct Professor Linda D. Hollebeek was selected for the Clarivate Highly Cited Researcher 2025 list (for the 6th consecutive year). Her work is widely applied both in industry and in the global academic ecosystem.

SELECTED PROJECTS

- LMMEE23109 "*The Qualitative Part of the Analysis of the Measures Provided by ETAG to Support Foreign Science Collaboration*" (2023–2024)
- VERT25008 "*Agents of Change – Unhurried Horizons: The Future of Slow Tourism*" (2025–2028)

SELECTED PUBLICATIONS

Hollebeek, L.D.; Anselmsson, J.; Adomaviciute-Sakalauske, K.; Krumm, K.; Jansson, J.; Wait, M.; Ooi, B.; Riivits-Arkonsuo, I.; Lubbe, I. (2024). Online Content Creators' and Viewers' Interdependent Journeys. Services Marketing Quarterly, 45 (3), 296–318. DOI: 10.1080/15332969.2024.2364128.

Ittefaq, H.; Akhtar, N.; Siddiqi, U. I.; Islam, T.; Kuzior, A. (2024). The betrayal puzzle: Unraveling the connection between inauthenticity, corporate wrongdoing and brand betrayal with avoidance and reparation. Journal of Retailing and Consumer Services, 76, #103597. DOI: 10.1016/j.jretconser.2023.103597.

Talk, T.; Ojamäe, L.; Paadam, K.; Alatalu, R. (2023). The "Venice Syndrome" in Tallinn Old Town. Journal of Cultural Heritage Management and Sustainable Development. DOI: 10.1108/JCHMSD-03-2022-0046.

More information: *https://taltech.ee/en/department-business-administration/research-groups#p22757*

ORGANISATION MANAGEMENT RESEARCH GROUP

Head: Tenured Associate Professor MARI-KLARA STEIN, mari-klara.stein@taltech.ee

Members: Karin Reinhold, Mike Franz Wahl, Marina Järvis, Madison Winter Kurchik, Merle Ojasoo, Liina Randmann, Maris Zernand-Vilson, Aive Pevkur, Piia Tint, Tiiu Kamdron, Tarmo Koppel, Marge Sassi

Doctoral students: Velli Parts, Mari Kurashvili, Olga Tsenter; Rusudan Tsiskaridze, Maria Kütt, Ebru Metin, Kaspar Roost, Ljudmila Linnik, Amit Gupta, Artur Toikka, Anna Litvinenko, Mari-Liis Ivask, Olga Tšernikova, Aleksandr Bosler, Epp Reedik, Jaanus Mugu, Sajani Karunarathne

TOPICS AND COMPETENCES

KEYWORDS: leadership, well-being, responsible and ethical organizational development, leader-follower relationship, strategic management, knowledge and innovation management, risk management, HRM, change man-agement, occupational health, organizational and work psychology, occupational safety and risks, future of work and digital transformation, AI, work and leadership

The research group is active in a number of research fields related to organisation and management, using different theoretical lenses and research methods. The primary research interests can be grouped under responsible and sustainable leadership, AI & future of work, well-being and ethical organizational development.

The group collaborates with a number of internationally renowned researchers working within the domines of organization and management, AI & future of work, occupational safety and related research areas.

The purpose of the group is to extend the scientific body of knowledge concerning the related fields of organization and management and to contribute to practice, by better understanding the opportunities and challenges confronting Estonian organizations and beyond.

IN 2025, thtree major externally funded research projects focusing on platform work, industrial relations, and psychosocial risks and mental health continued under the leadership or with the participation of the group's members. In addition, a new project on e-rehabilitation solutions was launched, and funding was awarded to the project "The Future of Work in Estonia – AI Automation, Skills, and Work Organisation" (starting in 2026).

SELECTED PROJECTS

- MKM-POL50 "*The future of work in Estonia – AI automation, skills, and work organization*" (2026–2027)
- LMMEE24097 "*Impacts and future directions of platform work in Estonia*" (2024–2026)
- VEU23077 "*The opportunities for industrial relations to prevent and manage psychosocial risks in post-pandemic workplaces*" (2023–2026)

SELECTED PUBLICATION

Stein, M.-K.; Shollo, A. (2025). Microfoundations of rationality in the age of AI: On emotions, bodies and intelligence. Information and Organization, 35, 3, #100583. DOI: 10.1016/j.infoandorg.2025.100583.

Prokopenko, O., Järvis, M., Shahnazaryan, N., Chechel, A., Sapiński, A., Batsenko, L. (2025). Bridging Risk Ethics and Sustainability: A Data-Driven Study of Ethical Leadership Practices in Risky Business Environments. Business Ethics and Leadership, 9 (2), 211–224. DOI: 10.61093/bel.9(2).211-224.2025.

Wahl, M.; Shukla, D.; Mansour, H.; Gerstlberger, W.; Lumiste, R. (2025). Multi-Level Leadership and Collective Well-Being During Crisis in Higher Education. Scientific Papers of the University of Pardubice. Series D, Faculty of Economics and Administration, 33, 1, #2235. DOI: 10.46585/sp33012235.

More information: *https://taltech.ee/en/department-business-administration/research-groups#p22749*

SUSTAINABLE VALUE CHAIN MANAGEMENT RESEARCH GROUP

Head: Tenured Full Professor WOLFGANG GERSTLBERGER, wolfgang.gerstlberger@taltech.ee

Members: Gunnar Klaus Prause, Üllas Ehrlich, Tarmo Kalvet, Marek Tiits, Merle Küttim, Tarvo Niine, Jelena Hartšenko, Daria Podmetina, Tarmo Tuisk, Jaana Merisaar, Anne Põder, Ulrika Hurt

Post-doctoral Researchers: Chahinez Ounoughi, Georgi Hrenov, Helery Tasane

Doctoral students: Vera Gerasimova, Tarlan Ahmadov, Mihhail Kirejev, Margit Kull, Arseni Kotov, Narmin Eynizada, Sina Atari, Jaana Merisaar, Jan Terentjev, Jani Taneli Kiljala, Mari Bonnar, Svetlana Saidensal

TOPICS AND COMPETENCES

KEYWORDS: sustainable business development, operations management, sustainable innovation, environmental economics, green economy, smart supply chain management, organizational learning, data science

Sustainable value chain management deals with tasks and processes aiming at preparing and supporting the implementation of growth opportunities and innovations within the constraints of a firm's strategy. Thus, sustainable value chain management is focused on preparing, planning, implementing and evaluating a continuous stream of potential innovations.

The research group investigates potential growth and innovation opportunities within and between organizations by using interdisciplinary approaches from business, sustainability management (e.g. "Circular Economy") and environmental economics, operations and innovation management, engineering, IT, design and social sciences in the context of the European agenda for smart, sustainable and inclusive growth. Consequently, the research group deals with innovations and growth opportunities in the areas of digitalization, smart production and Industry 4.0, Big Data, strategic alliances and networks as well as industrial strategy and competitiveness studies.

The research work usually takes place in the framework of European and/or national projects and in the context of the university – business cooperation.

IN 2025, interdisciplinary projects were underway, focused on the use of wood residue in industrial symbiosis, on international trade and economic resilience, creating new ESG training modules using AI, reusing construction materials for new buildings and developing new sustainability and digitalization competences through living lab approach and art innovation.

SELECTED PROJECTS

- ÕÜF22 "*Just transition governance models and entrepreneurship pathways: monitoring and analyses*" (2024–2028)
- MNKE25114 "*Economic analyses in the process of updating the 4th period River Basin Management Plans*" (2025–2027)
- VERT25031 "*Development of dynamically changing curricula in ESG education supported by generative AI*" (2025–2027)
- PRG1573 "*Economic Complexity, Machine Learning and Economic Policy*" (2022–2025)

SELECTED PUBLICATIONS

Berthinier-Poncet, A.; Podmetina, D.; Robbins, P. (2025). The art of innovation: How arts-based initiatives can nurture innovation dynamic capabilities. Technovation, 148, #103337. DOI: 10.1016/j.technovation.2025.103337.

Funke, M.; Tasane, H. (2025). Regional economic impacts of the Øresund cross-border fixed link: Cui Bono? Regional Studies, 59 (1), ARTN 2573115. DOI: 10.1080/00343404.2025.2573115.

Tiits, M.; Karo, E.; Kalvet, T. (2024). Small countries facing the technological revolution: fostering synergies between economic complexity and foresight research. Competitiveness Review. DOI: 10.1108/CR-03-2023-0051.

More information: *https://taltech.ee/en/department-business-administration/research-groups#p22761*

DEPARTMENT OF ECONOMICS AND FINANCE

Direktor: Associate Professor
KARIN JÕEVEER,
karin.joeveer@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

33 Academic staff — Incl. 10 professors, 6 researchers

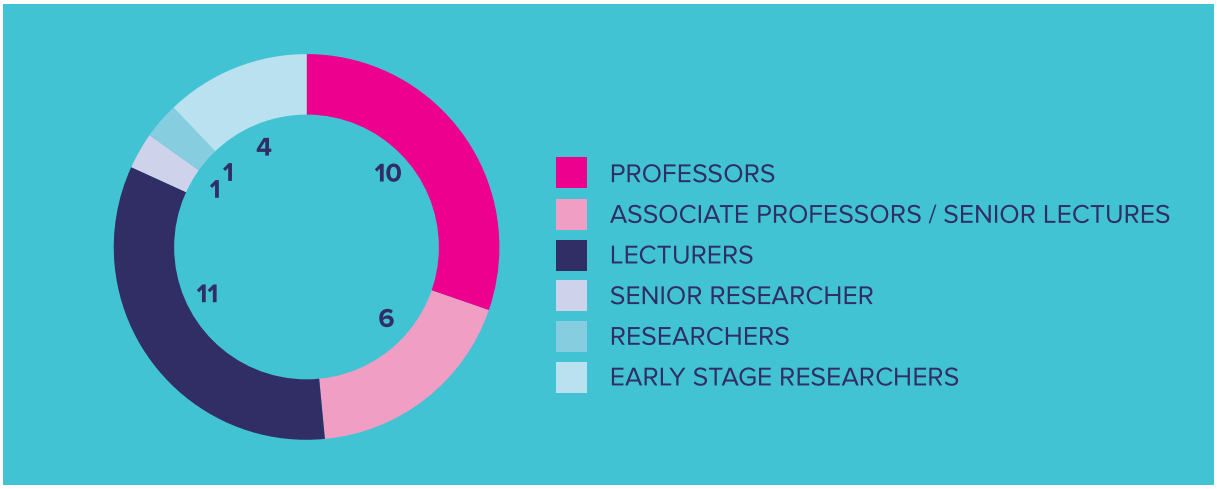
10 Doctoral students — 2 Defended doctoral dissertations

21 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 4 RESEARCH GROUPS:

- **COMPANIES' PRODUCTIVITY, INVESTMENTS AND EXPORT COMPETITIVENESS.**
  Head of the research group: Tenured Full Professor KADRI MÄNNASOO, kadri.mannasoo@taltech.ee
- **ECONOMIC PERFORMANCE: INTEGRATION, GOVERNANCE AND POLICY.**
  Head of the research group: Tenured Full Professor KARSTEN STAEHR, karsten.staehr@taltech.ee
- **FINANCE AND THE DIGITAL ECONOMY: FINANCIAL BEHAVIOUR, MARKETS, AND COMPETITIVENESS.**
  Head of the research group: Associate Professor LAIVI LAIDROO, laivi.laidroo@taltech.ee
- **HUMAN CAPITAL, MENTAL HEALTH AND SOCIO-ECONOMIC INCLUSION FOR PROMOTING SUSTAINABLE DEVELOPMENT.**
  Head of the research group: Tenured Associate Professor AARO HAZAK, aaro.hazak@taltech.ee



COMPANIES' PRODUCTIVITY, INVESTMENTS AND EXPORT COMPETITIVENESS

Head of the research group: Tenured Full Professor KADRI MÄNNASOO, kadri.mannasoo@taltech.ee

Members: Juan Carlos Cuestas Olivares, Tõnn Talpsepp, Simona Ferraro, Kaja Lutsoja, Jelena Matina, Kirsti Rumma

Doctoral students: Kaido Kepp, Miina Hõbenael, Heili Hein-Sula, Iskandar Mammadzada

TOPICS AND COMPETENCES

KEYWORDS: productivity, industrial organization, innovation, R&D, investments, export, digital economy

Research undertakes comparative studies at the micro, industry, and regional levels. Its core focus lies on capital and labour productivity, human capital, innovation, investment, and competitiveness as key drivers of economic growth in small, open and export-oriented economies. The objective is to determine optimal economic allocations and to identify the drivers and obstacles of productivity-enhancing investments, such as the adoption of new technologies and production processes, human capital development, and R&D activities.

One strand of inquiry explores regional convergence, integrating spatial dynamics and institutional factors into the analytical framework. Another emphasizes the role of digital innovation and digital empowerment, examining their impact on productivity growth and overall economic welfare.

IN 2025, the research group continued its international collaboration within the COST Action CA21163 network in the field of statistical and econometric modelling.

Beginning in 2025, the group also joined the Estonian Research Council's PRG2701 project, contributing to interdisciplinary research by conducting economic evaluations in the field of district heating.

New research directions related to electricity markets have received positive recognition. The paper by Männasoo and Mammadzada (forthcoming 2026) was accepted for presentation at the ICEEEP conference. This study estimated considerable electricity price impacts arising from interconnection interruptions in the Baltic States, underscoring the importance of maintaining adequate buffers to mitigate unexpected disruptions in external electricity supply.

A notable highlight of 2025 was the Bank of Estonia research award in the master's student category, granted to Elina Bõkovskaja for her thesis supervised by Kadri Männasoo.

SELECTED PROJECTS

- VEU22057 "*Text, functional and other high-dimensional data in econometrics: New models, methods, applications*" (2022–2026)
- LMEAE25027 "*Optimal balance between electricity costs for consumers and maintenance of the national energy system*" (2025–2025)
- PRG2701 "*Next-Generation District Heating: Enhancing Sustainability through Multi-Level Energy Cascades and Decentralised Renewable Energy Sources*" (2025–2029)

SELECTED PUBLICATIONS

Kepp, K.; Männasoo, K. (2025). Explaining switching behavior: Consumer attention and choice in car insurance market. Journal of Economic Behavior & Organization, 238, #107233. DOI: 10.1016/j.jebo.2025.107233.

Männasoo, K.; Hõbenael, M.; Ridala, S. (2024). Language skills and unemployment: Post-Soviet bilingualism in Latvia. Post-Communist Economies, 36 (2), 222–261. DOI: 10.1080/14631377.2023.2263215.

Männasoo, K.; Pareliussen, J. K.; Saia, A. (2023). Digital capacity and employment outcomes: Microdata evidence from pre- and post-COVID-19 Europe. Telematics and Informatics, 83, #102024. DOI: 10.1016/j.tele.2023.102024.

ECONOMIC PERFORMANCE: INTEGRATION, GOVERNANCE AND POLICY

Head of the research group: Tenured Full Professor KARSTEN STAEHR, karsten.staehr@taltech.ee

Members: Natalia Levenko, Alice Mikk

Doctoral students: Gerda Kirpson, Katri Urke, Ann Merit Toiger

TOPICS AND COMPETENCES

KEYWORDS: macroeconomics, international integration, international finance, public economics, labour economics, household economics, economic governance

The research group focuses on contemporary policy challenges and seeks to uncover macroeconomic and microeconomic relationships of societal importance. Key areas of research include macroeconomic dynamics, monetary economics, expectations formation, public finances, fiscal sustainability, tax evasion and financial stability. The research is typically policy-oriented and aims to devise measures to improve economic performance.

The research is mainly empirical but always grounded in economic theory. The research typically uses contemporary econometric methodologies using data from public or proprietary sources.

Most of the group members also work in Bank of Estonia and in that capacity participate in decision-making and formulation of policies.

IN 2025

The members of the group worked on several projects that investigated the impact of policies, regulation and external developments on economic performance.

A key area related to public debt accumulation in Europe. What are the macroeconomic and fiscal drivers of public debt, and how does public debt spill over to public and private interest rate? Members of the group also investigated aspects of tax evasion in Estonia. Which firms are prone to evade labour income taxes by underreporting labour income? What are the drivers of individuals engaging in tax evasion?

The group published a special issue on tax evasion in the Baltic Journal of Economics following the 2023 Shadow conference held in Tallinn. Other individual projects include the spillover of minimum wages to the wider wage distribution, sanctions and trade reallocation, drivers of macroeconomic forecast uncer-tainty, and the effect of inequality on house prices.

SELECTED PUBLICATIONS

Kirpson, G.; Staehr, K. (2024). Do Individuals Expect the Phillips Curve? Evidence from the European Consumer Expectations Survey. Economics Letters, 234, #111430. DOI: 10.1016/j.econlet.2023.111430.

Kukk, M.; Levenko, N. (2024). Interest rate spreads: Different stories for different types of loan. Research in International Business and Finance, 72 (A), 102524. DOI: 10.1016/j.ribaf.2024.102524.

Levenko, N.; Staehr, K. (2023). Self-reported tax compliance in post-transition Estonia. Economic Systems, 47 (3), #101047. DOI: 10.1016/j.ecosys.2022.101047.

FINANCE AND THE DIGITAL ECONOMY: FINANCIAL BEHAVIOUR, MARKETS, AND COMPETITIVENESS

Head of the research group: Associate Professor LAIVI LAIDROO, laivi.laidroo@taltech.ee

Members: Karin Jõeveer, Mari Avarmaa, Kristjan Liivamägi, Tõnn Talpsepp, Triinu Tapver, Kalle Ahi, Pavlo Illiashenko

Post-doctoral Researcher: Tanveer Ahmad

Doctoral students: Kaido Kepp, Silvia Viidik, Diana Tiidema, Indrek Mäe

TOPICS AND COMPETENCES

KEYWORDS: FinTech, financial literacy, financial intermediation, behavioural finance, financial economics

The research group seeks to contribute to the international academic literature that deals with contemporary topics in financial economics. Special attention is paid to the topics related to financial literacy and the impacts of the green transition and digitalisation in finance (incl., sustainable finance and FinTech solutions).

Traditional and behavioural finance theories are applied to the study of corporate finance, household finance, financial markets, and banking with the goal of better understanding the financial behaviour of individuals, companies and financial intermediaries, as well as the relationships among them (primarily in the European context). An interdisciplinary approach is used to examine the business, legislative and technological aspects of the green transition and digitalisation in finance, along with their economic impact. This is important for identifying factors that could help improve the competitiveness and performance of national economies through the implementation of appropriate regulatory measures.

IN 2025, the group's activities were strongly focused on the personal finance area, linked to ongoing project with the Ministry of Finance. The first drafts of the publications linked to the project in the area of financial literacy were prepared and their publication is expected in the coming years.

SELECTED PROJECTS

- LMEAE22102 *Financial literacy learning outcomes by age group to the Ministry of Finance* (2022–2023)
- RAM-KOS3 "*Competence Center for the Development of Financial Literacy*" (2024–2027)
- TFM25007 "*Development of experimental finance tools and IT environment*" (2025–2026)

SELECTED PUBLICATIONS

Anderson, R. W.; Jõeveer, K. (2025). Bankers' pay and the evolving structure of US banking. Journal of Corporate Finance, 95, #102864. DOI: 10.1016/j.jcorpfin.2025.102864.

Kepp, K.; Männasoo, K. (2025). Explaining switching behavior: Consumer attention and choice in car insurance market. Journal of Economic Behavior & Organization, 238, #107233. DOI: 10.1016/j.jebo.2025.107233.

Laidroo, L.; Küttim, M.; Rumma, K.; Siimann, P.; Avarmaa, M. (2024). Mandatory annual report fil-ings of private companies – why late or missing? Baltic Journal of Management, 19, 1, 123–144. DOI: 10.1108/BJM-11-2022-0431.

HUMAN CAPITAL, MENTAL HEALTH AND SOCIO-ECONOMIC INCLUSION FOR PROMOTING SUSTAINABLE DEVELOPMENT

Head of the research group: Tenured Associate Professor AARO HAZAK, aaro.hazak@taltech.ee

Members: Simona Ferraro, Merike Kukk, Tairi Rõõm, Johanna Liuhanen

Postdoctoral Researcher: Leonardo Ivarola

Doctoral students: Liina Rebane, Vladislav Fjodorov, Miina Hõbenael, Heili Hein-Sula

TOPICS AND COMPETENCES

KEYWORDS: institutions, sustainable economic development, efficiency, wellbeing, human capital, individual behaviour, mental health

The research group seeks to investigate the links between health related, behavioural and institutional factors and various economic outcomes, which could have implications for sustainable socio-economic development.development. In particular, the relationship between mental health and economic performance, human capital endowment, socio-economic inclusion and inequality, efficient implementation of modern technologies and work regulation/practices are in focus of the studies, particularly in an interdisciplinary context. Also, sustainable development problems related to climate change are studied. The results may cast light on some possibly latent or underestimated factors contributing to development and wellbeing issues and for inefficiencies in the use of human capital and modern technology in economies.

IN 2025 The most important results were related to studies on the associations between genetic predisposition to psychiatric and sleep traits and economic outcomes, which were carried out in interdisciplinary collaboration with leading researchers from the University of Helsinki and the Finnish Institute for Health and Welfare (THL) and published in high-level scientific journals (Scopus top 10%, WoS Q1).

SELECTED PROJECT

- VFP20046 (H2020), *Individual Behaviour and Economic Performance: Methodological Challenges and Institutional Context* (IBEP) (2020–2023)

SELECTED PUBLICATIONS

Hazak, A.; Kantojärvi, K.; Sulkava, S.; Kukk, M.; Jääskeläinen, T.; Salomaa, V.; Koskinen, S.; Perola, M.; Paunio, T. (2025). Genetic disparities in sleep traits and human capital development: A 25-year study in Finnish population-based cohorts. Scandinavian Journal of Work Environment & Health. DOI: 10.5271/sjweh.4255.

Hazak, A.; Liuhanen, J.; Kantojärvi, K.; Sulkava, S.; Jääskeläinen, T.; Salomaa, V.; Koskinen, S.; Perola, M.; Paunio, T. (2025). Schizophrenia genetic risk and labour market outcomes in the Finnish general population: Are schizophrenia-related traits penalised or rewarded? Comprehensive Psychiatry, 140, #152600. DOI: 10.1016/j.comppsych.2025.152600.

Hazak, A.; Kantojärvi, K.; Liuhanen, J.; Sulkava, S.; Jääskeläinen, T.; Salomaa, V.; Koskinen, S.; Perola, M.; Paunio, T. (2025). Genetic predisposition for morningness-eveningness and economic disadvantage: Evidence from Finland over 25 years. Sleep Medicine, 136, 106811. DOI: 10.1016/j.sleep.2025.106811.

DEPARTMENT OF LAW

Director: Senior Researcher
ARCHIL CHOCHIA,
archil.chochia@taltech.ee

MAIN FIGURES 2025

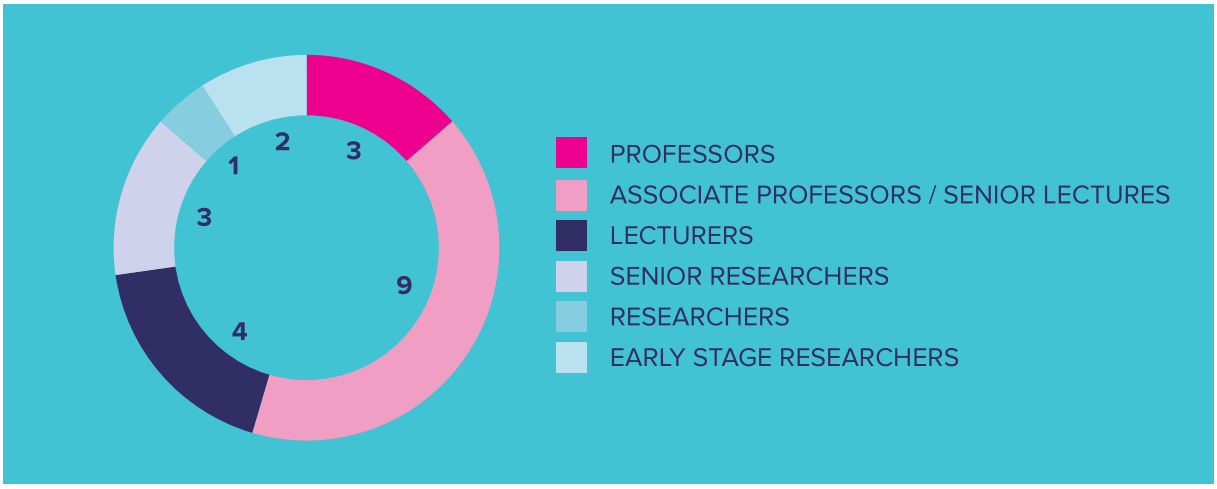
(as of Dec. 31, 2025)

22	Academic staff	Incl. 3 professors, 6 researchers	
2	Doctoral students	1	Defended doctoral dissertations
28	Scientific publications*		

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 3 RESEARCH GROUPS:

- **INTERNATIONAL RELATIONS, SECURITY, LAW AND TECHNOLOGY.**
  Head of the research group: Associate Professor HOLGER MÖLDER holger.molder@taltech.ee
- **LEGAL POLICY AND NORMATIVE FRAMEWORK OF EU DIGITAL MARKET AND TECHNOLOGIES AND IT'S APPLICATION IN PARTNER COUNTRIES.**
  Head of the research group: Senior Researcher ARCHIL CHOCHIA, archil.chochia@taltech.ee
- **PRIVATE LAW.**
  Head of the research group: Tenured Assistant Professor THOMAS HOFFMANN, thomas.hoffmann@taltech.ee



INTERNATIONAL RELATIONS, SECURITY, LAW AND TECHNOLOGY

Head of the Research Group: Associate Professor HOLGER MÖLDER, holger.molder@taltech.ee

Members: Katrin Merike Nyman-Metcalf, Evhen Tsybulenko, David Ramiro Troitino, Peeter Müürsepp, Agnes Kasper, Maria Claudia Solarte Vasquez, Archil Chochia

Doctoral student: Javad Keypour

TOPICS AND COMPETENCES

KEYWORDS: cyber and information security; international relations and technological challenges; economic security; political economy; international law; European Union; history of science

The research topics are related to international relations, international security and technology, and international law.

- International relations: International conflicts (post-Soviet space, Middle East). Political and societal reforms of the European Union; the future of NATO.
- New security challenges: Information warfare and strategic communication; information security and digital influence operations; cyber threats and countermeasures; human security.
- Psychological operations: culture of fear and strategic narratives; hybrid threats; energy security, the internet, and international relations; political and legal aspects of artificial intelligence.
- International law, humanitarian law, and human rights.

Senior lecturer Peeter Müürsepp is active in an independent field of research: history of science, philosophy of science.

More information: https://taltech.ee/en/department-law-research-groups#p35014

SELECTED PROJECTS

- VFP20040 "Mediatized Discourses on Europeanization and Their Representations in Public Perceptions" (2021–2024)
- MINV21066 "Building a legislative framework for securing Georgia's strategic assets" (2021–2023)
- VERT23015 "What role for Europe in the Indo-Pacific? Identifying regional policy responses towards the EU's Indo-Pacific Strategy 2022–25" (2022–2025)

SELECTED PUBLICATIONS

Mölder, H.; Sazonov, V.; Loik, R. (2025). Challenges to Homeland Security in Countering Latent Hybrid Threats During the War in Ukraine: The Case of Estonia. In: Vladimir Sazonov, Holger Mölder, Zdzisław Śliwa, Sergii Pakhomenko, Illimar Ploom (Ed.). Russian Influence Operations and the War in Ukraine: Hybrid Warfare and Disinformation Campaigns. (235–260). Switzerland: Springer, Cham. (Contributions to Security and Defence Studies). DOI: 10.1007/978-3-032-01461-0_10.

Munkøe, M.; Foster, N.; Mölder, H. (2025). Russia. In: Christou, G.; Vosse, W; Burton; J. and Koops; J. (Ed.). The Palgrave Handbook on Cyber Diplomacy. (xxx–xxx). Springer Nature [in press].

Mölder, H.; Voinea, C. F.; Sazonov, V. (2023). Cultural Change in Political Communities. The Impact of Populism and Extremism on the International Security Environment. Cham: Springer Nature.

LEGAL POLICY AND NORMATIVE FRAMEWORK OF EU DIGITAL MARKET AND TECHNOLOGIES AND IT'S APPLICATION IN PARTNER COUNTRIES

Head of the research group: Senior Researcher ARCHIL CHOCHIA, archil.chochia@taltech.ee

Members: Katrin Nyman-Metcalf, Ondrej Hamulak, Abel Polese, David Ramiro Ramiro Troitino, Pawan Kumar Dutt, Maria Claudia Solarte Vasquez, Kristi Joamets

Doctoral students: Olga Shumilo, Kärt Salumaa-Lepik, Melita Sogomonjan, Javad Keypour, Evelin Pärn-Lee, Alexander Antonov

TOPICS AND COMPETENCES

KEYWORDS: law and technology; EU legal policy; Digital Single market, artificial intelligence and law, regulating digital services, metaverse and law

The research topics are related to law and technology and transfer of knowledge of legal skills.

- **Law and eTechnologies:** e-residency, cryptocurrencies, smart contracts, 3D printing, software agents, digital evidence, artificial intelligence legal policies and modern technologies. Privacy law. Cyber security. Ethics of law and technology. General Data Protection Regulation (GDPR), human rights in European digital era. Rights and duties of digital e-trading.
- **ICT law:** freedom of expression, e-governance, regular legal analysis of media and communications legislations.

More information: *https://taltech.ee/en/department-law-research-groups#p29732*

IN 2025, TalTech Law School strengthened its position as a regional leader in law and technology through conferences such as FutureLaw 2025, LAITech 2025 and TalTech Legal Lab Legal Design Event Series. The school advanced research on legal tech, AI and legal design through new publications and edited volumes, while expanding industry collaboration via a strategic partnership with SuitsLegal to test AI-driven legal solutions.

SELECTED PROJECTS

- VHE25017MO "*Driving Climate Positive Changes*" (2025–2030)
- VHE22069 "*Caucasus and Central Asia Research Social Innovation: Development Assistance, Innovation and Societal Transformation*" (2023–2027)
- VERT25040 "*Supporting Innovative Methods for Pedagogical Learning in Familiarizing Youth with the EU*" (2025–2028)

SELECTED PUBLICATIONS

Göksal, S. I.; Joamets, K. (2025). The Implementation of BCTrustAI.SL Into the Automated Practices of Digital Labour Platforms to Ensure Fairness, Transparency and Accountability. Bratislava Law Review, 9, 1, 9–26. DOI: 10.46282/blr.2025.9.1.949.

Koiava, A.; Chochia, A. (2025). Challenges of GDPR Compliance with the Data Altruism Concept Under the Data Governance Act: Lessons from the Estonian X-Road Model. Baltic Journal of Law & Politics, 18 (1), 16–29. DOI: 10.2478/bjlp-2025-0008.

Kerikmäe, T.; Hamuľák, O.; Mesarcik, M. (2025). Disinformation Tackling in the Metaverse and the Digital Services Act. Cogent Social Sciences [ilmumas].

PRIVATE LAW

Head of the Research Group: Tenured Assistant Professor THOMAS HOFFMANN, thomas.hoffmann@taltech.ee

Members: Agnes Kasper, Tatjana Evas-Peeters, Pawan Kumar Dutt, Maria Claudia Solarte-Vasquez, Kaido Künnapas, Aleksi Oskar Johannes Kajander, Artem Boyarchuk, Pablo Martinez Ramil

Postdoctoral Researcher: Artem Boyarchuk

Doctoral students: Ana Koiava, Marta Terletska, Victoria Kozlova, Yuliia Kravchenko

TOPICS AND COMPETENCES

KEYWORDS: algorithm-based decision-making and liability, blockchain and smart contracts, legal frameworks for Industry 4.0/IoT, private international law, cyber security, consumer law, mediated transaction design, alternative dispute resolution methods (arbitration and mediation), labor law, Legal Tech

Our research group is committed to producing ambitious cutting-edge work in the field of private law, having a special focus on private legal relationships in digital environments. Primarily designed to iteratively develop expertise on these matters, members of the research group aim to share and disseminate their work to complement legal and social discourses and, where identifiable and necessary, actualize societal change therein. We aim to contribute to international, national and regional debates on these matters, address traditional and novel legal problems with a varied toolbox of methods, and, where appropriate, based on developed expertise, propose nuanced policy-recommendations and context-specific legal advice.

Big data, IoT, AI and the respective legal interferences of their implementation and use in society form the core subject of our research, but we have also focused on legal implications of the Gig-economy, competition law and data governance issues in Smart Cities, digital evidence, online dispute resolution and LegalTech. Also research on HCI and HCI research methods, mixed research methodology, international business transactions international mediation forms an essential part of our competencies.

The research group incorporates elements of the Value-Sensitive Design framework into discussions on societally acceptable, inclusive, human-centric and thus innovative governance mechanisms in private legal relationships.

More informatoon: *https://taltech.ee/en/department-law-research-groups#p42490*

IN 2025, the research focus was on contracts in digital environments, algorithm-based decision-making and liability; blockchain and smart contracts; legal frameworks for Industry 4.0/IoT; private international law; cyber security; consumer law; intellectual property law, labour law; and legal tech as such.

SELECTED PROJECTS

- VEU24017 "*Digitalising European Uncontested Claims Enforcement*" (2024–2026)
- VEU24053 „*Conflict Resolution with Equitative Algorithms*“ (2024–2026)
- VEU24054 "*I-tools to Design and Enhance Access to justice*" (2024–2026)

SELECTED PUBLICATIONS

Kajander, A.; Liivoja, R.; Naagel, M. (2025). Cybersecurity of weapon systems: international law requirements and technical standards. Journal of Cybersecurity, 11 (1), #tyaf017. DOI: 10.1093/cybsec/tyaf017.

Kajander, A.; Hoffmann, T. (2025). Smart City Data Commons under the Data Governance Act – Lowering the Threshold Toward Introducing Smart City Data Commons. International and Comparative Law Review, 24 (2), 7–24. DOI: 10.2478/iclr-2024-0016 [in press].

Zengin, A.; Chochia, A.; Martínez-Ramil, P. (2025). Copyright in Text and Data Mining: Legal Challenges and the AIA's Role in the EU. International and Comparative Law Review, 25 (1) [in press].

RAGNAR NURKSE DEPARTMENT OF INNOVATION AND GOVERNANCE

Director: Tenured Full Professor ERKKI KARO, erkki.karo@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

39 Academic staff — Incl. 10 professors, 27 researchers

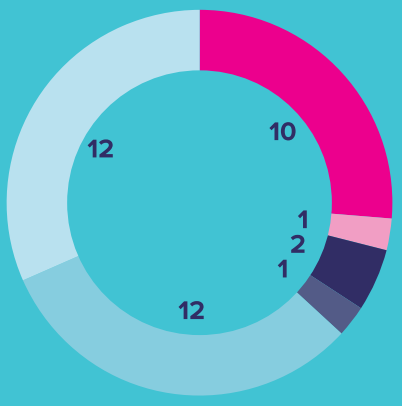
25 Doctoral students — 4 Defended doctoral dissertations

52 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH GROUPS:

- **BIG DATA IN SOCIAL SCIENCES.**
  Head of the research group: Tenured Associate Professor ANU MASSO, anu.masso@taltech.ee
- **GLOBAL GOVERNANCE.**
  Head of the research group: Tenured Full Professor WOLFGANG DRECHSLER, wolfgang.drechsler@taltech.ee
- **FISCAL GOVERNANCE.**
  Head of the research group: Tenured Full Professor RINGA RAUDLA, ringa.raudla@taltech.ee
- **PUBLIC MANAGEMENT AND POLICY.**
  Head of the research group: Tenured Full Professor TIINA RANDMA-LIIV, tiina.randma-liiv@taltech.ee
- **PUBLIC SECTOR INNOVATION.**
  Head of the research group: Tenured Full Professor VEIKO LEMBER, veiko.lember@taltech.ee
- **TECHNOLOGY GOVERNANCE AND INNOVATION POLICY.**
  Head of the research group: Tenured Full Professor ERKKI KARO, erkki.karo@taltech.ee
- **TECHNOLOGY GOVERNANCE AND SUSTAINABILITY.**
  Head of the research group: Tenured Full Professor VASILEIOS KOSTAKIS, vasileios.kostakis@taltech.ee



PROFESSORS
ASSOCIATE PROFESSORS / SENIOR LECTURES
LECTURERS
LEAD RESEARCHERS
RESEARCHERS
EARLY STAGE RESEARCHERS

BIG DATA IN SOCIAL SCIENCES

Head of the research group: Tenured Associate Professor ANU MASSO, anu.masso@taltech.ee

Member: Tayfun Kasapoglu

Post-doctoral researchers: Kateryna Lobanova,

Doctoral students: Mergime Ibrahimi, Pauline Baudens, Jevgenia Polomoshnov, Kai Jääger, Srijoni Bhattacharjee

TOPICS AND COMPETENCES

KEYWORDS: big data and social datafication, social science methods and methodologies, spatial mobility, (digital) social transformations

The research group (DataLab) focuses on fundamental research in spatial mobility, social transformations, and social datafication. Recent work explores data movements, including those driving artificial intelligence development, and their broader social and ethical implications. Methodologically, the group uniquely integrates computational social science and critical data studies, combining large-scale and digital trace data analysis (e.g. mobile phone and everyday mobility data) with innovative extensions of traditional social science methods (e.g. gamified surveys and visual narrative interviews).

Together with the School of Business and Governance, the research group has launched the *Eye-Tracking Lab*, which conducts (quasi-)experimental studies assessing the social impacts of data technologies, algorithms, and AI.

IN 2024–2025, the research group initiated several novel and strategically significant research directions. A theoretical framework for data migration has been developed, conceptualising transborder data flows as social and institutional processes and opening new avenues for the analysis of data-driven societal transformations. In parallel, the group developed an innovative large-scale methodological approach for studying perceptions of autonomous technologies by combining online and laboratory-based eye-tracking methods.

SELECTED PROJECTS

- PRG3205 "*Data Migration: A Social Transformation Framework (DATA-MIGRATION)*" (2026–2030)
- MOB3JD1261 "*The vision of freedom and necessity as factors in the formation of civil identity by Ukrainian men abroad: Multidimensional Socio-Philosophical Inquiry (MSPI)*" (2025–2027)
- VFP19031 "*FINEST TWINS: Establishment of Smart City Center of Excellence*" (2019–2026)

SELECTED PUBLICATIONS

Ibrahimi, M.; Masso, A.; Bellone, M. (2025). Sociotechnical imaginaries of autonomous vehicles: comparing laboratory and online eye-tracking methods. PLoS ONE [in press].

Masso, A.; Gerassimenko, J.; Kasapoglu, T.; Beilmann, M. (2025). Research Ethics Committees as Knowledge Gatekeepers: The Impact of Emerging Technologies on Social Science Research. Journal of Responsible Technology, #100112. DOI: 10.1016/j.jrt.2025.100112.

Baudens, P.; Hassen, M.; Pasini, J.; Mawussi, A. (2025). Mobility capacities and smartphone use of students in Kinshasa, Democratic Republic of Congo. Mobilities, 1–19. DOI: 10.1080/17450101.2024.2445307.

GLOBAL GOVERNANCE

Head of the research group: Tenured Full Professor WOLFGANG JOHANNES MAX DRECHSLER, wolfgang.drechsler@taltech.ee

Members: Vasileios Kostakis, Christos Giotitsas, Shobhit Shakya, Alexandros Pazaitis, Nikiforos Tsiouris, Salah Chafik

Doctoral students: Ülly Enn, Alicia Trepat Pont, Asimina Kouvara, Mehmet Orpak, Karin Kruup

TOPICS AND COMPETENCES

KEYWORDS: governance, P2P technologies, commons-based peer production, non-western public administration, global governance, development policy, sustainability

The Governance group deals with basic, as well as policy-focused, academic research focusing on the analysis of governance theories and paradigms in the context of modern socio-technical changes, led especially by the ICT diffusion. The group participated in the implementation of the ERC Starting Grant '*Cosmolocalism*', and two large grants, '*Centrinno*' and '*Smooth*', funded from the EU's Horizon 2020. The '*FinEst Twins: Helsinki and Tallinn as Smart and Sustainable Cities*' EU Teaming grant, 2019–26, originally emerged from this research group.

Special focus has been on the following topics:

- analysis of global paradigms of governance and comparison of Western and non-Western/Asian paradigms;
- the impact of technological changes on governance, including the emergence of the concept of smart city and the impact of P2P technologies on production and consumption traditions and governance models;
- alternative perspectives on sustainability, growth and post-growth, innovation and their metrics generally.

In all these fields the group is internationally recognized as a trailblazing think tank. This is best exemplified by the fact that both Prof. Drechsler and Prof. Kostakis are affiliates of Harvard University – at the *David Centre for Russian and Eurasian Studies* and the *Berkman Klein Centre for Internet and Society* respectively – and the former also at *UCL's Institute for Innovation and Public Purpose*, all three usually recognized as the number one institution in their specific field globally.

IN 2025, the completion of the Templeton-funded IPV project was a milestone, culminating in widely cited publications, the establishment of IPV-Net, and a high-profile book launch at The British Library.

The Memorandum of Understanding for the establishment of IPV-Net was signed in New Delhi in February 2025. The administrative headquarters of the network is now at TalTech. The network includes core partners from Qatar, Thailand, Indonesia and the United Kingdom.

SELECTED PROJECT:

- VHE22044 "*Public Administration Capabilities for Sustainable and Digital Transformation*" (2022–2025)

SELECTED PUBLICATIONS

Ongaro, E.; Drechsler, W.; Maron, F.; Meijer, A.; Shimada-Logie, H.; Tantardini, M. (2025). The contribution of the humanities to the theory and practice of public administration in the 21st century. Australian Journal of Public Administration, 1–21. DOI: 10.1111/1467-8500.70015.

Drechsler, Wolfgang (2025). Rebuilding with Care: Steps in Post-Conflict Public Administration. NISPAcee Journal of Public Administration and Policy, 18, 1, 1–10. DOI: 10.2478/nispa-2025-0001.

Bombaerts, G.; Hannes, T.; Adam, M.; Aloisi, A.; Anderson, J.; Arvidson, P. S.; Berger, L.; Bettera, S. D.; Campo, E.; Candiotto, L.; Caprioglio Panizza, S. Ciaunica, A.; Citton, Y.; D´Angelo, D.; Dennis, M. J.; Depraz, N.; Doran, P.; Drechsler, W.; Edelglass, W.; Eisenberger, I. ... Zheng, Y. (2025). Beyond the attention economy, towards an ecology of attending. A manifesto. AI & Society. DOI: 10.1007/s00146-025-02405-8.

FISCAL GOVERNANCE

Head of the research group: Tenured Full Professor RINGA RAUDLA, ringa.raudla@taltech.ee

Members: Egert Juuse, Aleksandrs Cepilovs. Johanna Vallistu, James W. Douglas

Doctoral students: Kerli Onno, Nastassia Harbuzova, Riinu Lepa, Olger Nõmm, Gerli Aavik-Märtmaa, Mikk Vainik

TOPICS AND COMPETENCES

KEYWORDS: fiscal governance, public sector financial management, budgeting, financial regulation

The group studies the developments of fiscal governance in Europe with specific focus on the spread of new budgeting principles (participatory budgeting), the impact of fiscal crisis, the evolution of institutional and discursive context. The unique specialization of the group has been to study the impact of fiscal and financial policy bureaucracies (its structure, principles of policy coordination and learning, etc.) on fiscal and financial policies in the Baltic Sea area and EU as a whole. This is a relatively novel theoretical as well as empirical focus since the countries of the region are financially and politically highly interlinked but have also asymmetrical economic relations and politico-administrative differences.

The group has gained global recognition for its research work, e.g. Prof. Raudla is in the editorial board of *Governance* (the leading journal on governance and institutional analysis), in addition to seven other international academic journals. She leads the Permanent Working Group on Fiscal Governance and Administration at IIAS (a governance and public administration research society with the widest reach globally).

IN 2025 the key focus of the group was the implementation of the research project "Experimental approaches and institutional innovations in the domains of fiscal and financial policy" (PRG1125, funded by the Estonian Research Council).

SELECTED PROJECT

- PRG1125 "*Experimental approaches and institutional innovations in the domains of fiscal and financial policy*" (2021–2025)
- VHE25006 "*Renewing Administration through Democratic Anchorage Reforms*" (2025–2029)

SELECTED PUBLICATIONS

Raudla, R.; Mohr, Z.; Douglas, J. W. (2024). Which managerial reforms facilitate public sector innovation? Public Administration, 102 (2), 771–788. DOI: 10.1111/padm.12951.

Raudla, R.; Juuse, E.; Kuokštis, V.; Cepilovs, A.; Ylönen, M. (2024). Drivers of fintech policy evolution: the role of policy learning and institutions. Policy & Politics, 1–22. DOI: 10.1332/03055736Y2024D000000042.

Raudla, R.; Juuse, E.; Kuokstis, V.; Cepilovs, A.; Cipinys, V.; Ylonen, M. (2024). To sandbox or not to sandbox? Diverging strategies of regulatory responses to FinTech. Regulation & Governance, 1–16. DOI: 10.1111/rego.12630.

PUBLIC MANAGEMENT AND POLICY

Head of the research group: Tenured Full Professor TIINA RANDMA-LIIV, tiina.randma-liiv@taltech.ee

Members: Külli Sarapuu, Külli Taro, Leno Saarniit, Johanna Madleen Rodima

Doctoral students: Ayberk Soner Kalayci, Steven Nõmmik, Anne-May Nagel, Eva Patricia Peeters

TOPICS AND COMPETENCES

KEYWORDS: public sector management, administrative reform, participation, collaboration, crisis governance, small states

Activities within the research group are based on three research themes, which all address reforms in public management, crisis governance and collaboration in public governance. Throughout the research themes, the members of the group explore both the Estonian case as well as global and European comparative perspectives. Most members of the group participate in the Horizon 2020 financed research project *ROBUST (Robust Crisis Governance in Turbulent Times – Mindset, Strategies, Evidence)*. The project explores how European societies can harness flexible adaptation and proactive innovation to deliver effective crisis responses in situations, where going back to the way things were is neither possible nor desirable.

IN 2025, the research group has dealt with three major topics within the framework of ongoing projects:

- The study of robust crisis management and, above all, the use of hybridity in crisis management, where a unique analytical framework was created, on the basis of which work will continue on collecting data from nine countries with the aim of conducting a comparative analysis.
- Exploring experimental approaches and institutional innovation in public sector management.
- A research project on the "triangle" of public service continued, where political-administrative relations in Europe are studied comparatively.

SELECTED PROJECTS

- VHE22035 "*ROBUST Crisis Governance in Turbulent Times – Mindset, Evidence, Strategies*" (2022–2026)
- VHE22044 "*Public Administration Capabilities for Sustainable and Digital Transformation*" (2022–2025)
- PRG1125 "*Experimental approaches and institutional innovations in the domains of fiscal and financial policy*" (2021–2025)

SELECTED PUBLICATIONS

Sarapuu, K; Trei, M. (2024). Organizational dilemmas of EU-funded policy development: the case of Estonian government task forces. Public Money & Management. DOI: 10.1080/09540962.2023.2203870.

Sørensen, E.; Caponio, T.; Hajnal, G.; Randma-Liiv, T.; Špaček, D.; Triantafillou, P. (2025). Comparing the implications of strategies for governing the Covid-19 pandemic for the political robustness of five European political regimes. Public Administration. DOI: 10.1111/padm.70031.

Torfing, J.; Bentzen, T.; Caponio, T.; Coroado, S.; Douglas, S.; Nommik, S.; Randma-Liiv, T.; Russo, C.; Sorensen, E.; Verhoest, K. (2025). Advancing Robust Governance in Turbulent Times: The Role of Multi-Level Governance, Hybrid Governance, and Negotiated Societal Intelligence. Public Administration, 1–15. DOI: 10.1111/padm.70011.

PUBLIC SECTOR INNOVATION

Head of the research group: Tenured Full Professor VEIKO LEMBER, veiko.lember@taltech.ee

Members: Piret Tõnurist, Jinxiao Luo, Johanna Vallistu

Postdoctoral Researcher: Peeter Vihma

Doctoral students:, Steven Nõmmik, Palwasha Ahmadzai Etebari, Kerli Onno, Marc Kristersen, Gerli Aavik-Märtmaa, Karin Kruup, Olger Nõmm, Mikk Vainik

TOPICS AND COMPETENCES

KEYWORDS: digital transformation, public sector innovation, governance of green transition, public-private partnerships

The Public Sector Innovation (PSI) research group focuses on the theory and practice of public sector innovation. Among its key research foci are topics such as the governance of green and digital twin transition, public sector digitalization and its consequences, and the foundations of public sector technological and innovation capacities.

The group has also produced important contributions to other PSI topics, e.g. public procurement of innovation, public service of co-production, public-private partnerships, sustainable communities, and the phenomenon of public sector innovation labs.

SELECTED PROJECTS

- VFP20041, H2020 projekt CENTRINNO "*New Centralities in Industrial Areas as Engines for Innovation and Urban Transformation*" (2020–2024)
- VHE22044 "*Public Administration Capabilities for Sustainable and Digital Transformation*" (2022–2025)
- VFP19031 "*FINEST TWINS: Establishment of Smart City Center of Excellence*" (2019–2026)

SELECTED PUBLICATIONS

Vihma, P.; Hukkinen, J. I. (2024). Bracing urban governance against climate crises: How to integrate high reliability into strategic decision-making? Environmental Policy and Governance. DOI: 10.1002/eet.2129.

Verhoest, K.; Callens, C.; Klijn, E. H.; Brogaard, L.; García-Ryado, J.; Nõmmik, S. (2024). Designing cross-sector collaboration to foster technological innovation: Empirical insights from eHealth part-nerships in five countries. Public Administration Review, 84 (6), 1200–1217. DOI: 10.1111/puar.13785.

Randma-Liiv, T.; Lember, V. (2022). Engaging Citizens in Policy Making: e-Participation Practices in Europe. Cheltenham: Edward Elgar.

TECHNOLOGY GOVERNANCE AND INNOVATION POLICY

Head of the research group: Tenured Full Professor ERKKI KARO, erkki.karo@taltech.ee

Members: Erik Stenfeldt Reinert, Jan Allan Kregel, Carlota Elene Perez, Rainer Kattel, Egert Juuse, Margit Kirs, Jaanus Müür

Doctoral students: Palwasha Etebari, Mahardika Fadmastuti, Marc Kristerson, Mari Anne Rosalie Rohtla, Maive Rute, Joanna Laast, Karin Kruup, Kristel Oitmaa

TOPICS AND COMPETENCES

KEYWORDS: innovation, innovation policy, technology governance

The group is the leading centre for science, technology and innovation systems and policies in Estonia.

The basic research of the group centres on the following topics:

- Techno-economic paradigms and the role of the state
- Future innovation systems and policies
- Innovation bureaucracies and management of innovation policies

The policy-oriented work of the group covers the following topics:

- Green transition and mission-oriented innovation policies
- Tackling societal challenges through innovation
- Drafting and implementing smart specialization strategies and policies in Europe and Estonia
- Management STI policies and instruments
- Evaluations of innovation polices and governance systems
- The impact of Global Value Chains on national innovation systems and policies
- Innovation in the context of smart cities

SELECTED PROJECTS

- MKM-POL30 "*Green Transition Possibilities for the Estonian economy*" (2025–2026)
- VFP19031 "*FINEST TWINS: Establishment of Smart City Center of Excellence*" (2019–2026)
- PRG346 "*Reshaping Estonian energy, mobility and telecommunications systems on the verge of the Second Deep Transition*" (2019–2023)
- VFP21049 "*BoostEuroTeQ: strengthening institutional transformations for responsible engineering education in Europe*" (2021–2024)

SELECTED PUBLICATIONS

Tiits, M.; Karo, E.; Kalvet, T. (2024). Small countries facing the technological revolution: fostering synergies between economic complexity and foresight research. Competitiveness Review. DOI: 10.1108/CR-03-2023-0051.

Juuse, E.; Karo, E. (2024). New Emerging Industries and Alternative Pathways into Global Value Chains: the Case of Estonian Automated Mobility and Delivery Industry. Journal of the Knowledge Economy. DOI: 10.1007/s13132-024-02236-w.

Müür, J.; Karo, E. (2023). Learning from public sector innovation pilots: the case of autonomous bus pilots. Innovation: The European Journal of Social Science Research, 1–24. DOI: 10.1080/13511610.2023.2286438.

TECHNOLOGY GOVERNANCE AND SUSTAINABILITY

Head of the research group: Tenured Full Professor VASILEIOS KOSTAKIS, vasileios.kostakis@taltech.ee

Members: Shobhit Shakya, Alexandros Pazaitis, Christos Giotitsas, Nikiforos Tsiouris

Doctoral students: Karin Kruup, Alicia Trepat Pont, Mehmet Orpak, Ülly Enn, Asimina Kouvara

TOPICS AND COMPETENCES

KEYWORDS: open-source technologies; sustainability; energy transitions; commons post-growth; science communication; impact assessment; action research; alternative organisations

The group explores novel approaches to creating inclusive and sustainable economic systems, intersecting political ecology, technology studies, critical management, and sustainability studies. The group examines how open collaborative practices reshape economic models and technological development, investigating the interplay between global knowledge sharing and local manufacturing. Using interdisciplinary methodologies, including participatory action research, the group co-produces knowledge with communities and stakeholders, maintaining strong ties to grassroots initiatives and commons-based networks.

Current work assesses energy communities, explores commons-based technologies' potential for environmental and social challenges, and investigates open-source solutions for local resilience and global sustainability. Supported by significant grants, including from the European Research Council, the group has published extensively in top-tier journals. It engages in knowledge transfer through academic publications, policy briefs, public lectures, and collaborative projects. By bridging theory and practice, the TGS group contributes to developing more equitable, democratic, and sustainable technological and economic systems.

The group achieved several significant milestones **IN 2025**.

The Kopli 93 and Tzoumakers makerspaces and community centers in Tallinn (Estonia) and Tzoumerka (Greece) secured municipal support and established themselves as vital community hubs.

The group advanced its research agenda through influential work examining energy systems through the lens of 'energy as commons' versus 'energy as commodity'. This led to an ERC Synergy Grant resubmission in collaboration with Vrije Universiteit Amsterdam and LUT University.

Through the EU LIFE COMET project, the group helped create a coalition of Estonian organisations, including the Ministry of Climate, to promote citizen participation in tackling energy transition issues.

New international collaborations were established, including a partnership with STAR Hub at The King's University, Canada.

SELECTED PROJECTS

- VFP21005 "*Educational Common Spaces. Passing through enclosures and reversing inequalities*" (2021–2024)
- VHE22044 "*Public Administration Capabilities for Sustainable and Digital Transformation*" (2022–2025)
- VFP19031 "*FINEST TWINS: Establishment of Smart City Center of Excellence*" (2019–2026)

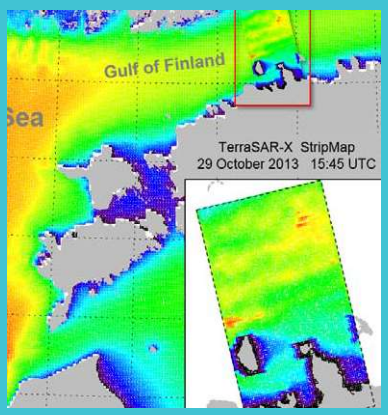
SELECTED PUBLICATIONS

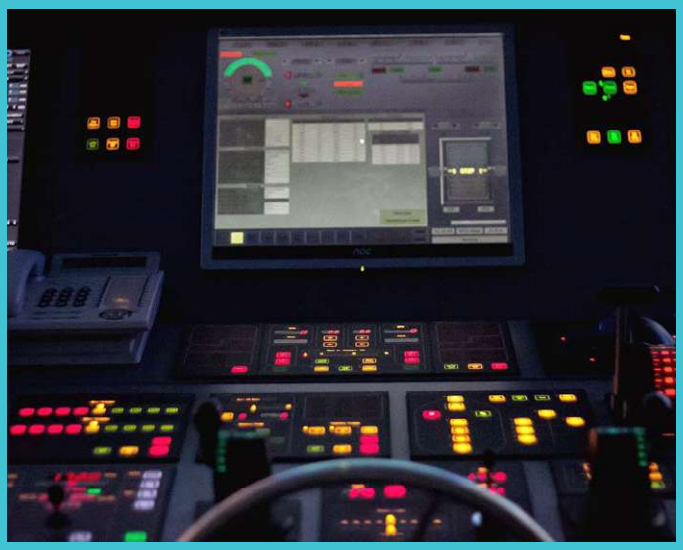
Pazaitis, A.; Giotitsas, C.; Savvides, L.; Kostakis, V. (2025). Reframing Innovation for Post-growth: Lessons from Patent Discourses in 3D Printing. Science Technology and Society, 1–29. DOI: 10.1177/09717218251326836.

Robra, B.; Pazaitis, A.; Levy, A. (2025). "A Sane Island in an Ocean of Madness": A Case of Alternative Organisational Ethics Through Post-Growth Values. Journal of Business Ethics, #140351. DOI: 10.1007/s10551-024-05921-7.

Kostakis, V.; Parker, M.; Kouvara, A. (2025). A tunnel to the other side of the world: What sort of writing can contribute to social change? Culture and Organization, 1–17. DOI: 10.1080/14759551.2025.2454377.

ESTONIAN MARITIME ACADEMY





ESTONIAN MARITIME ACADEMY

Director: ROOMET LEIGER
e-mail: roomet.leiger@taltech.ee

Director for Development: LOREIDA TIMBERG
e-mail: loreida.timberg@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

63 Academic staff — Incl. 9 professors, 26 researchers

25 Doctoral students

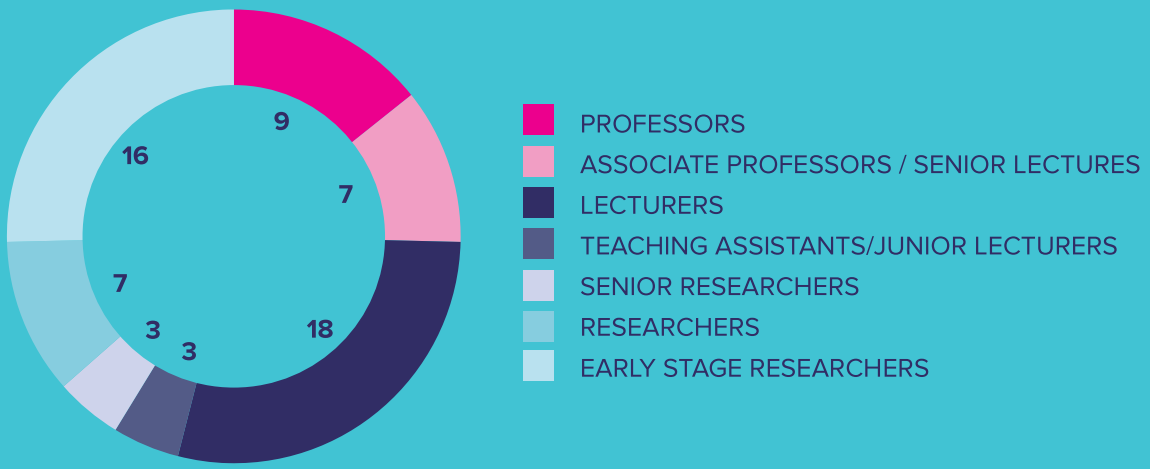
2 Defended doctoral dissertations

77 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

EMERA CONDUCTS RESEARCH WITHIN 6 RESEARCH GROUPS

- **BLUE ECONOMY AND AQUATIC RESOURCES.**
  Head of the research group: Senior Researcher LOREIDA TIMBERG, loreida.timberg@taltech.ee
- **CENTRE FOR MARITIME CYBERSECURITY.**
  Head of the research group: Research Professor SANJA BAUK, sanja.bauk@taltech.ee
- **GREEN MARITIME TECHNOLOGY.**
  Head of the research group: From 01.03.2024 Tenured Associate Professor SERKAN TURKMEN, serkan.turkmen@taltech.ee
- **MARITIME TRANSPORT.**
  Head of the research group: Tenured Full Professor ULLA PIRITA TAPANINEN, ulla.tapaninen@taltech.ee
- **NAUTICAL SCIENCES.**
  Head of the research group: Assistant Professor AMIT SHARMA, amit.sharma@taltech.ee
- **WATERWAYS SAFETY MANAGEMENT.**
  Head of the research group: Tenured Full Professor, PENTTI JOUKO SAKARI KUJALA, pentti.kujala@taltech.ee



ESTONIAN MARITIME ACADEMY (EMERA)

Head: Director ROOMET LEIGER, roomet.leiger@taltech.ee

THE AREAS OF ADVANCE IN R&D ARE AS FOLLOWS:

Maritime transport. The research focuses on two main special areas: (1) Smart and energy efficient environments. The studies analyse the present shipping business, and study how the new fuels, vessel design and operative changes will affect the shipping business models and operations. (2) Future governance. The functioning and competitiveness of shipping companies, port, and maritime sectors in various shipping market situations: cargo and passenger volumes, financial situations, availability of the fleet, even policies and public opinion.

Green Maritime technology. The aim of the studies is the implementation of the principles and strategies declared by regulatory and policy-making bodies (such as IMO, HELCOM, the EU Strategy for the Baltic Sea Region and international agreements on sustainable development) regarding various marine vehicles, especially focusing on high speed crafts.

Waterways Safety Management. The aim of the research is to contribute to the development of a competitive maritime economy through research in the fields of hydrography, waterways planning, smart solutions for aids to navigation, marine cartography and safety of navigation, while at the same time being a strong cooperation partner for the Estonian maritime sector.

Blue economy and aquatic resources. The aim of the research is to find opportunities for the sustainable application of the aquatic resources, whereas ecological principles and conditions are taken into account and hazards and risks from human operations are predicted.

The blue economy research combines knowledge of sustainable implementation of the aquatic environment; biology, chemistry and physics of the water resources; technological processes in the aquatic environment; the blue economy and the social economy.

Maritime cybersecurity. A Centre for Maritime Cybersecurity funded by the Horizon 2020 ERA Chair programme has been launched to develop the field. The research focus of the Centre is on developing innovative solutions to address the emerging security challenges in the maritime industry. This includes studying the threat landscape, identifying vulnerabilities in maritime systems, and developing cybersecurity measures to mitigate the risks posed by cyber-attacks.

Nautical Sciences are focused on the studies of the human, operational, and technological aspects of maritime navigation. By keeping the human element at the center of navigational innovation, the goal is to support safer, smarter, and more resilient maritime operations.

BLUE ECONOMY AND AQUATIC RESOURCES

Head: Senior Researcher LOREIDA TIMBERG, loreida.timberg@taltech.ee

Members: Jonne Kotta, Annmarii Hakkaja, Doris Nurk, Kristel Rauk

Doctoral students: Indrek Adler, Athira Asalatha Rajendran, Reet Laos

TOPICS AND COMPETENCES

KEYWORDS: blue economy, environment and social economy; the innovation of water's biological resources; consumers and products of blue economy; safety and quality of water's biological resources

The research group carries out development activities on production technologies and raw material enhancement in coastal areas and the aquatic environment. The aim of the research is to find opportunities for the sustainable application of the aquatic resources, whereas ecological principles and conditions are taken into account and hazards and risks from human operations are predicted.

In order to valorise aquatic resources, their biological, chemical, and physical properties are analysed, and their functional properties will be described. Technological processes are tested and developed for valorisation of the aquatic recourses. Economical and socioeconomical opportunities of blue economy are analysed and modelled in view of EU strategies, existing legislation and most importantly consumers awareness and expectations.

MAIN RESULTS IN 2025

The group members were active in blue economy activities: the EU Blue Economy Practitioners Community working group, the HELCOM Protect Baltic steering committee and working groups, and the RITA+ project "Estonian marine ecology and marine ecosystem benefits digital twin" steering committee.

The BlueGreenFeed project is nearing completion of work on breeding mealworm larvae on different grass and feather feeds. Activities continued including breeding mealworm larvae on new grass and feather components produced by project partners, describing the growth process, determining yields, and collecting mealworms for subsequent project trials, describing the growth process, determining the yield, and collecting mealwormsfor subsequent project tests. Testing of technologies for raising mealworm larvae began. Work has also started on assessing the LCA of mealworm breeding and processing.

SELECTED PROJECT

- MNHA22085 "*Synergy of blue and green sectors for resilient biomass production and processing to develop sustainable feed ingredients for European aquaculture*" (2022–2025)

SELECTED PUBLICATIONS

Alop, A.; Koit, K.; Kõster, J.; Tõnismaa, O. (2025). Course of Navigation Risk Management in the Age of New Technologies: Teaching Principles and Practices. Disruptive Technologies and Innovations Towards Sustainable Maritime Practices : Proceedings of the International Association of Maritime Universities (IAMU) Conference: 25rd International Association of Maritime Universities Annual General Assembly and Conference, AGA 2025, 16th–17th oct. 2025. Ed. Rajesh, Deepa; Svilicic, Boris. Chennai, India: AMET University, 261–266.

Adler, I.; Martin, G.; Kovalchuk, N.; Orav-Kotta, H.; Vene, K.; Tuvikene, R.; Kotta, J. (2025). Exploring the Cultivation of Ulva intestinalis in Low-Salinity Environments of the Baltic Sea. Oceans, 6 (2), 30. DOI: 10.3390/oceans6020030.

Timberg, Loreida (2025). Transport Study Programmes Green Skills. In: Futureproofing Engineering Education for Global Responsibility: Proceedings of the 27th International Conference on Interactive Collaborative Learning (ICL2024), Volume 3. (24–37). Springer Cham. (Lecture Notes in Networks and Systems; 1280). DOI: 10.1007/978-3-031-83523-0_3.

More information:
Blue Economy and Aquatic Resources

CENTRE FOR MARITIME CYBERSECURITY

Head: Research Professor SANJA BAUK, sanja.bauk@taltech.ee

Members: Ricardo Gregorio Lugo, Pentti Jouko Sakari Kujala, Kristel Toom, Kristi Treffner, Rain Ottis, Risto Vaarandi, Olaf Manuel Maennel, Igor Astrov, Leonidas Tsiopoulos, Alvar Kurrel, Dan Heering

Post-doctoral researchers: Yigit Gülmez, Aybars Oruc, Mahtab Shahin, Saeed Rahimpour

Doctoral students: Gabor Visky, Triin Muulmann, Vanessa Roberts, Radoje Džankić, Muhammed Erbas, Shaymaa Mamdouh Khalil, Gábor Visky

TOPICS AND COMPETENCES

KEYWORDS: cybersecurity, digitalization of the maritime industry, autonomous ships

The maritime industry is confronted with major challenges relative to the cybersecurity of the digital systems that are nowadays more and more pervasive in ships, port infrastructure and more globally in the logistic chain. The emergence of autonomous ships, and more largely the wide use of IoT technology in the ship and maritime infrastructures are major topics that warrant specific scrutiny. Addressing these issues need a holistic approach that would encompass the education of seafarers and the human aspect of cybersecurity, the development of a novel technological approach for "security by design" of ships, the operational process, and strategical decision making for all stakeholders. The goal of the Maritime Cybersecurity Centre is to act as a catalyst of the above-mentioned activities.

Thanks to EU Horizon 2020 grant (project MariCybERA), this research aims to play important role in Europe-wide expertise development of all dimensions of maritime cybersecurity both in research dimensions, as well in technological development and operational means. For this purpose, the research group is working with professional organisations, industries, government agencies, and academic structures both in Estonia, Europe and worldwide.

Specific focuses and competences are as following:

- Cyber awareness and education of seafarers
- Trustworthy AI for cybersecurity and autonomous ships
- Cybersecurity strategy applied to maritime digitalisation
- Maritime Security Operation Centre

IN 2025, the research focus was on cyber-physical risk assessment, digital twins, and the security of maritime systems. The group produced scientific outputs addressing cybersecurity of Maritime Autonomous Surface Ships (MASS), cyber risk modelling of shipboard mechanical subsystems, secure maritime communications, blockchain-based logistics solutions, and human factors in maritime cyber resilience.

The research group developed and tested simulation-based approaches for analyzing cyber-attacks on selected ship control and navigation systems, including rudder controllers, lubrication oil systems, and navigation components. In parallel, the group contributed to the development of threat modelling, risk assessment methods, and AI-based intrusion detection approaches adapted to maritime operational technology (OT).

SELECTED PROJECTS

- VFP20050, MariCybERA "*ERA Chair in Maritime Cyber Security*" (2021–2025)
- VEU23016 "*Collaborative, Multi-modal and Agile Professional Cybersecurity Training Program for A Skilled Workforce In the European Digital Single Market and Industries*" (2022–2025)
- VEU23044 "*Boosting cyber resilience of critical infrastructure in the water sector through innovative and co-created competence building by consortium partners and their suppliers*" (2023–2026)

SELECTED PUBLICATION

Bauk, Sanja (Ed.) (2025). Maritime Cybersecurity. Springer Nature. DOI: 10.1007/978-3-031-87290-7.

Oruc, A.; Bauk, S.; Zhou, J. (2026). A National Maritime Cyber Security Operations Center (M-SOC) Concept. Journal of Marine Science and Engineering, 14 (1), #17. DOI: 10.3390/jmse14010017.

Gülmez, Y.; Konur, O.; Erbas, M.; Bauk, S. (2025). Identifying cyber attack vulnerabilities in the main lubricating oil system of marine propulsion units. International Journal of Critical Infrastructure Protection, 51, 100810. DOI: 10.1016/j.ijcip.2025.100810.

More information:
Centre for Maritime Cybersecurity

GREEN MARITIME TECHNOLOGY

Head: Tenured Associate Professor SERKAN TURKMEN, serkan.turkmen@taltech.ee

Member: Jakub Jerzy Montewka

Doctoral student: Fatemeh Roshan

TOPICS AND COMPETENCES

KEYWORDS: marine hydrodynamics, fuel efficiency, safety, smartization

The main motivation behind the activities of the research group is the implementation of the principles and strategies declared by regulatory and policy-making bodies (such as IMO, HELCOM, the EU Strategy for the Baltic Sea Region and international agreements on sustainable development) regarding various marine vehicles, especially focusing on high speed crafts. For this purpose, the main research studies of the research group are divided into four fields:

Safety: The main focus is the development of methods for reducing the effect of HSC motion for the crew and on-board systems..

F. Roshan' thesis on "Safety improvement of high-speed planing craft development of a conceptual framework" addresses the health concern of HSC's operators when operated on high speed in rough conditions causing sleepiness, muscle and internal organ damage, and therefore reducing crew performance.

Emission Reduction: This field focuses on fuel-efficient hull forms, optimization and zero-emission propulsion systems.

Smartization: The focus is on smart ship design, unmanned high-speed craft and Digitalized Computational Fluid Dynamics (DCFD) by implementing artificial intelligence, machine learning and genetic algorithm.

Hydrodynamics of Marine Vehicles: Enhancing hydrodynamic efficiency is in focus when working on solutions to enhance resistance and propulsion, seakeeping and manoeuvring characteristics of different marine vehicles by considering safety, fuel efficiency and smartization goals. The latest focus is on seakeeping and manoeuvring of stepped hulls. A large variety of mathematical, numerical and experimental methods are under development to address the existing knowledge gap in the sector.

SELECTED PUBLICATIONS

Dogru, A.; Sozen, A.; Altunsaray, E.; Halilbese, A. N.; Karasu, H. F.; Turkmen, S.; Neser, G. (2025). NDT-Based Determination of Key Performance Elements of a Ship Propeller Model Manufactured with the Selected Laser Melting Method. Polish Maritime Research, 32 (4), 107–118. DOI: 10.2478/pomr-2025-0054.

Zhou, Y.; Turkmen, S.; Pazouki, K.; Norman, R. (2025). Retrofitted Gate Rudder System In Situ Performance Analysis Using Data-Driven Method. Journal of Marine Science and Engineering, 13 (9), ARTN 1667. DOI: 10.3390/jmse13091667.

More information: *Green Maritime Technology*

MARITIME TRANSPORT

Head: Tenured Full Professor ULLA PIRITA TAPANINEN, ulla.tapaninen@taltech.ee

Members: Olli-Pekka Hilmola, Jonne Kotta, Kristīne Carjova, Kristel Rauk

Postdoctoral Researchers: Seçil Gülmez, Deniece Melissa Aiken

Doctoral students: Mari-Liis Tombak, Tõnis Hunt, Andres Laasma, Suvi-Tuuli Lappalainen, Riina Otsason, Kadi Kasepõld, Eliise Toomeoja, Kristin Kerem, Ekku Eemeli Heljanko, Ekku Eemeli Heljanko

TOPICS AND COMPETENCES

KEYWORDS: maritime, transport, economy, environmental impacts, port emission assessment, blue economy, maritime law; shipping and port resilience

The research focuses on three main areas:

1. **Smart and energy efficient environments.** How tightening environmental regulations affect shipping companies, ports and maritime markets? The studies analyse the present shipping business, and study how the new fuels, vessel design and operative changes will affect the shipping business models and operations. Research is multidisciplinary and various methods can be used.
2. **Maritime and port governance.** The functioning and competitiveness of shipping companies, port, and maritime sectors in various shipping market situations: cargo and passenger volumes, financial situations, availability of the fleet, even policies and public opinion. This work is closely done with either authorities or companies, and often also directly from their request.
3. **Shipping and port resilience**. This line of research focuses on the ability of shipping companies and ports to anticipate, withstand, adapt to, and recover from disruptions (e.g., cyber incidents, extreme weather, accidents, supply-chain shocks, infrastructure failures), while maintaining essential operations and service continuity.

IN 2025, the research group achieved internationally visible R&D results by developing and applying evidence-based solutions for maritime transport decarbonisation, port sustainability assessment, and the advancement of data-driven decision-support methodologies.

SELECTED PROJECTS

- VHE22066 "*Autonomous Flying Ships for Inter-Island and Inland Waters Transport*" (2023–2026)
- VHE24043 "*Twinning to enable Baltic Sea vessels to meet Fit-for-55 regulations*" (2024–2027)

- VIR24014 "*Reducing CO2 emissions in island ferry traffic*" (2024–2027)

SELECTED PUBLICATIONS

Aiken, D.; Kotta, J.; Tapaninen, U. P. (2025). Exploring the multifaceted challenges and complexities involved in the effective implementation of maritime conventions. Sustainability, 17 (2), 478. DOI: 10.3390/su17020478.

Gülmez, S.; Gülmez, Y.; Tapaninen, U.P. (2025). Predicting cargo handling and berthing times in bulk terminals: A neural network approach. Case Studies on Transport Policy, 19, #101351. DOI: 10.1016/j.cstp.2024.101351.

Otsason, R.; Laasma, A.; Gülmez, Y.; Kotta, J.; Tapaninen, U. (2025). Comparative analysis of the alternative energy: Case of reducing GHG emissions of Estonian pilot fleet. Journal of Marine Science and Engineering, 13 (2), #305. DOI: 10.3390/jmse13020305.

More information: *Martime Transport*

NAUTICAL SCIENCES

Head of the research group: Assistant Professor AMIT SHARMA, amit.sharma@taltech.ee

TOPICS AND COMPETENCES

KEYWORDS: seafaring, navigation, maritime safety, artificial intelligence, the introduction of automatic control systems and remotely controlled autonomous ships, digitization, digital twins, automated ship bridge environments

Future navigation will emphasize real-time data fusion, high operational redundancy, predictive safety systems, and seamless human-machine collaboration, ensuring efficiency, resilience, and sustainability in increasingly complex marine environments.

According to the International Maritime Organisation (IMO), the human element is recognized as a key element of the safety of life on board ships and a contributing factor to most of the casualties in the shipping sector. Maritime safety and safety of navigation itself can be enhanced by strengthening the focus on the human element.

The Nautical Sciences Research Group is committed to exploring the human, operational, and technological dimensions of maritime navigation. By keeping the human element central to navigation innovation, our goal is to support safer, smarter, and more resilient maritime operations – even as we embrace increasingly autonomous technologies.

More information: https://taltech.ee/en/estonian-maritime-academy/areas-of-advance/nautical-sciences

IN 2025

The outstanding international results originating from the research group include a systematic review of cognitive and social factors impacting the VTS operations. The research group contributed to the reviewing and presenting the current state of the art research related to human factors challenges in VTS operations. The study identified and presented varied research methods utilized in VTS operations related research and shed light on existing gaps.

The research group also contributed to an ongoing study related to remote pilotage operations in a Scandinavian port where pilot tests are currently being carried out for determining the feasibility of remote pilotage. By conducting a structured qualitative study related to information requirements and decision making of the remote pilots, the research group contributed to advancing the understanding of the cognitive challenges and opportunities associated with the remote pilotage.

SELECTED PUBLICATIONS

Sharma, A.; Mallam, S.; MacKinnon, S. N.; Saetrevik, B. (2025). A systematic review of cognitive and social factors in vessel traffic services operations. Transport Reviews, 1–22. DOI: 10.1080/01441647.2025.2569578.

Sharma, Amit (2025). Facilitating Debriefings for Feedback, Discussion, and Reflection. In: Simulations in Maritime Education and Training : A Companion to Simulator Instructors. (63–78). Springer. (WMU Studies in Maritime Affairs; 12). DOI: 10.1007/978-3-032-08394-4_5.

WATERWAYS SAFETY MANAGEMENT

Head of the research group: Tenured Full Professor, PENTTI JOUKO SAKARI KUJALA, pentti.kujala@taltech.ee

Members: Inga Zaitseva-Pärnaste, Mihhail Fetissov, Jarmo Kõster, Roomet Leiger, Valentin Bratkov, Vesa Markus Sihvonen, Olev Tõnismaa

Doctoral students: Jim Henry Chen, Ahmed Nasr, Kirill Šustov, Aqsa Yaseen, Marvin Roshan Crompton Ramesh

TOPICS AND COMPETENCES

KEYWORDS: hydrography, safe waterways, navigational risk assessment, smart navigational marks

The research group aims to be a strong partner for Estonian maritime sector and work with international consortiums, contributing to the development of competitive maritime economy through research in the areas of hydrography, waterways planning, smart solutions for aids to navigation, marine cartography, and safety of navigation. Strong focus will additionally be directed on science-based higher education on all levels – Bachelor, Master, and Doctoral studies – taking into account the developments in the industry and relevant emerging competences required in the labour market.

IN 2025, the research group was actively involved in large-scale international research initiatives. The members of the research group have prepared eight Horizon Europe project proposals, including six research projects, one doctoral network and one post-graduate project, of which two have received positive funding decisions. Starting in 2026, the group participates in several major international projects with direct industrial and societal impact.

SELECTED PROJECTS

- VIR25049 "*Digitalization and robotics for effective Finnish-Estonian marine pollution response service*" (2025–2028)
- VFP20050 "*ERA Chair in Maritime Cyber Security at Tallinn University of Technology – MariCybERA*" (2021–2025)
- VEU23016 "*Collaborative, Multi-modal and Agile Professional Cybersecurity Training Program for A Skilled Workforce in the European Digital Single Market and Industries*" (2022–2025)

SELECTED PUBLICATIONS

Zhang, M.; Taimuri, G.; Zhang, J.; Zhang, D.; Yan, X.; Kujala, P.; Hirdaris, S. (2025). Systems driven intelligent decision support methods for ship collision and grounding prevention: Present status, possible solutions, and challenges. Reliability Engineering & System Safety, 253, #110489. DOI: 10.1016/j.ress.2024.110489.

Zhang, M.Y.; Shen, W.H.; Tsoulakos, N.; Wang, H.D.; Kujala, P.; Hirdaris, S. (2025). An intelligent decision support method for assisted ship maneuvering and route planning using pre-trained deep learning model. Trends in Collision and Grounding of Ships and Offshore Structures: 10th International Conference on Collision and Grounding of Ships and Offshore Structures (ICCGS 2025), Shanghai, China, 16–19 September 2025. Ed. Ling Zhu, C. Guedes Soares. London: CRC Press, 440–448. DOI: 10.1201/9781003684404-56.

Astrov, I.; Bauk, S.; Kujala, P. (2025). Exploring simulation methods to counter cyber-attacks on the steering systems of the Maritime Autonomous Surface Ship (MASS). Journal of Marine Science and Engineering, 13 (8), Art. no. 1470; 22 pp. DOI: 10.3390/jmse13081470.

More information:
Waterways Safety Management

SMART CITY CENTER OF EXCELLENCE

SMART CITY CENTER OF EXCELLENCE

Head: Assistant Professor RALF-MARTIN SOE
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MAIN FIGURES 2025

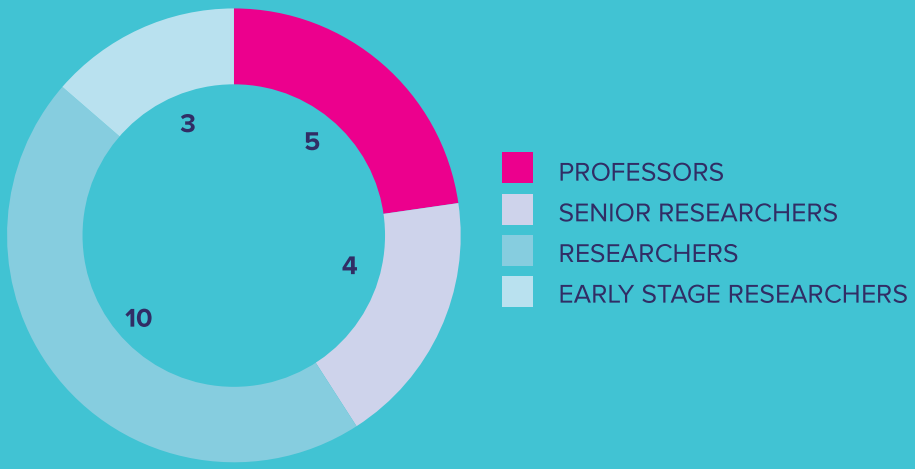
(as of Dec. 31, 2025)

22 Academic staff — Incl. 5 professors, 17 researchers

1 Doctoral students

40 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*



SMART CITY RESEARCH GROUP

Head: Assistant Professor RALF-MARTIN SOE, ralf-martin.soe@taltech.ee

Members: Einari Kisel, Mauro Bellone, Themistoklis Charalambous, Eeva Henna Helena Fabritius, Kalle Kuusk, Noman Shabbir, Kaija Veskioja, Jelizaveta Krenjova-Cepilova, Lita Akmentina, Viktorija Prilenska, Henry Patzig, Silver Sternfeldt, Külle Tärnov, Sille Sepp, Kalle Mikko Petteri Toiskallio, Serio Angela Maria Agriesti

Post-doctoral Researcher: Anniki Puura

Doctoral students: Petri Sakari Kangassalo, Pauline Baudens, Dominik Beckers, Francesco Tonnarelli, Laura Mrosla, Luiza Schuch de Azambuja, Luiza Schuch de Azambuja

Involved members: 40 TalTech and Aalto University researchers through the H2020 teaming project, who follow a jointly agreed upon Strategic Research and Innovation Agenda led by the Smart City Center of Excellence and also publish under the Smart City Center of Excellence affiliation starting from 1.12.2020.

TOPICS AND COMPETENCES

KEYWORDS: mobility, energy, built environment, governance and data

The research team is one of the leading research centres for smart city in Europe. The group's research focuses on the following research topics:

- Smart city challenges in local governments in five areas (mobility, energy, built environment, governance and data)
- Testing research-based cross-border technologies in local governments
- Smart city development and related visions and strategies

The group's applied development activities help to test various research-based solutions in real-life conditions to make the living environment more human-centered and sustainable. The research group's activities help to analyze and evaluate the current activities of the smart city in urban environments, to better understand the risks and benefits related to the development of the smart city, to identify best practices through extensive agile piloting projects and to disseminate the best solutions in Estonia as well as in the rest of Europe. The group contributes strongly to the research cooperation between Aalto University and Tallinn University of Technology, and also actively involves cities across Europe.

The Research Group is engaged in 10+ international projects, see *finestcentre.eu/grants*.

Since 2020, the FinEst Centre for Smart Cities has cumulatively published over 500 research papers, submitted over 100 competitive grant proposals and helped close to 30 PhD students to graduate.

Six large scale smart city pilots with cities and companies have been conducted (*https://finestcentre.eu/innovation-with-cities/pilot-projects/*).

Detailed information is available at *https://www.finestcentre.eu/grants* and *https://taltech.ee/en/finest-centre-for-smart-cities*

SELECTED PROJECTS

- VFP19031 "*FINEST TWINS: Establishment of Smart City Center of Excellence*" (2019–2026)
- VFP21034 "*Accelerating cities' transition to net zero emissions by 2030*" (2021–2025)
- VFP21031 IRIS, 2020 "*Artificial Intelligence threat Reporting and Incident response System*" (2021–2024)

SELECTED PUBLICATIONS

Elbehairy, F.; Mora, L.; Soe, R.alf-M. (2025). Who are you? Examining the multifaceted innovation roles of municipal governments in AI governance. Technovation, 147, #103303. DOI: 10.1016/j.technovation.2025.103303.

Alishani, A.; Olesk, M.; Soe, R.-M.; Kadak, T.; Krimmer, R. (2025). Real-Time Economy: A New Frontier in Business and Economic Growth. Halduskultuur, 23, 1–2, 129–155. DOI: 10.32994/hk.v23i1-2.314.

Fadmastuti, M.; Karo, E.; Soe, R.-M. (2024). Towards a Typology of Data-Enabled Co-Creation Platforms in Smart Cities and Mapping of Practices in OECD Countries. Journal of Urban Technology, 31, 3, 29–52. DOI: 10.1080/10630732.2024.2390795.

TALTECH RESEARCH 2025

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