LATVIAN ACADEMY OF SCIENCES

YEARBOOK 2020

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EGILS LEVITS,
PRESIDENT OF LATVIA

Dear members of the scientific community,
Dear academicians,

I see the Latvian Academy of Sciences as a socially responsible knowledge institution. We expect the Academy to be modern and open. Its tasks range from raising of public awareness on current scientific developments to inspiring youth to pursue a career in science. Privilege of being a scientist comes with responsibility towards Latvian society or our taxpayers. Responsibility to disseminate the latest Latvian scientific research results, give insights into their applicability and raise public awareness on specific aspects of science. Composed of the most experienced Latvian scientists, Academy should serve as the source of inspiration and knowledge to youth.

Latvian higher education and science is currently going through major changes. Change is always hard. However, there is no growth without change. Our country needs bright, modern academia. I welcome all changes that raise the quality and competitiveness of the national science sector and I wish you endless energy in pursuit of this goal.

I am extremely happy to see that the lines of Latvian Academy of Sciences' full members are getting younger. It promotes academic continuity and ever closer cooperation between 'seasoned' scientists and young scientific minds. United scientific community is a great force and resource, a real catalyst for change in the sector in terms of better legal framework and funding opportunities.

Science is one of priorities of my presidency. I am delighted to follow all the inventions and global success of Latvian scientists. I celebrate our young science stars who have reached new scientific heights and am pleased about the input of industries and government sector in improving the governance of science.

I wish you a productive year in advancing science for better Latvia! Let the work begin!


ACADEMIA
SCIENTIARUM
LATVIENSIS

OJĀRS SPĀRĪTIS,
PRESIDENT OF THE LATVIAN ACADEMY OF SCIENCES

Dear colleagues throughout the broad world of science,

Trying to imagine the scale of cosmic dimensions and comparing these to the scale of the Earth and its sub-units, even the time our planet has existed might subjectively seem to be small. Why? Because today the rate at which information is doubling and technology is advancing is surprisingly rapid; this engenders a feeling that time is "tightening up", or that it has started to pass faster. There is some truth in this view.

Today we spend a significant part of our working life devoted to science, such that we may feel privileged to belong to a particular social group, to be part of a special community that has the privilege of being at the epicentre of the birth of new theories, new experiences, experiments without end, and new knowledge. This feeling is unusually appealing, since it allows us to be present at events described in Genesis, Chapter 1, to experience these and ourselves to write a continuation of this chapter. Our enthusiasm, furthermore, is fuelled by awareness that our work is progressing not only at one institute, university, or even at national level, but also that, through global collaboration, we are collectively augmenting the knowledge pool of all mankind.

This new issue of the Yearbook of the Latvian Academy of Sciences will reach its recipients early in 2020, and with it we wish to reach out to scientists and other partners – administrators in education and science, both in Europe and elsewhere throughout the world – to inform them what our country is investigating, how we look at global challenges in IT, advances in the fields of translation, infographics and artificial intelligence. Latvian energy specialists are successfully developing energy saving programmes and are researching alternative forms of energy. Our scientists participate in the international investigation of how to mitigate climate change and reduce CO2 emissions, obtaining thereby new insights; they have also made new discoveries in the fields of smart materials, biomedicine, genetics and pharmacology, as well as in space exploration. Shortages of healthy food and its uneven distribution throughout the world is no secret. However, Latvia, as one of the Baltic States, is a country with long-standing agricultural and horticultural traditions and is making great strides in the development of organic food technology. Study of the physical and chemical properties of wood, as well as understanding bacterial protection issues, has allowed the development of promising building and insulating materials, as well as medicines and products for plant protection.

Science in the 21st century transcends national borders and has become an evolving international challenge for civilization. Thus, the goal of prosperity of a science-educated society applies not only for our country, but also for all humanity, on whose behalf we address everyone as potential partners in solving common scientific problems. It is only through cooperation that science can advance in a globalised world.

Translated by **Eduards Bruno Deksnis**

GLIMPSES ON INTERNATIONAL COOPERATION OF THE LATVIAN ACADEMY OF SCIENCES

Ilze Trapenciere, Advisor to the President on the International Affairs; Head of the International Department, Latvian Academy of Sciences

International relations are probably the only focus of the work of the Latvian Academy of Sciences (LAS), where many activities are carried on in an almost unchanged manner and where the description of our partners has experienced no changes. For this reason, parts of this section follow the information presented in the previous issue of this collection [1].

PARTICIPATION IN THE INTERNATIONAL ACADEMIC ORGANISATIONS

The Latvian Academy of Sciences represents Latvia in the following scientific organisations that join Academies in Europe or across the world:

- **The European Federation of National Academies of Sciences and Humanities** (ALLEA). "All European academies" or ALLEA (founded in 1994) brings together classic European academies of natural sciences and academies of humanities and social sciences. The objective of ALLEA is to facilitate the exchange of information and experiences between academies to achieve high standards in research and ethics, and to promote independent discussion on strategy and policy of science at the European level. Latvian Academy of Sciences in ALLEA is represented by Full Member of the LAS Ojārs Spārītis, President of the Latvian Academy of Sciences.
- **European Academies Science Advisory Council** (EASAC) is the voice of independent science advice, mobilising Europe's leading scientists to guide EU policy for the benefit of society. The EASAC is a relatively young organisation (founded in 2001). EASAC is the association of the National Academies of Science of the EU Member States, Norway and Switzerland. The objective of the EASAC is to direct the joint competencies of the academies in advising to EU governmental bodies and politicians in decisions that require scientific expertise. EASAC takes on the role of independent academic experts, bringing together the top-level competencies and experiences of European Academies. Expert networks have been formed in the three main programmes (biosciences, energy and environment). EASAC also engages in a dialogue with national policy-makers, striving to promote evidence-based decision making in Europe.
- **The InterAcademy Partnership** (IAP) is a global network of more than 130 National Academies of Science, Medicine and Engineering. IAP was founded in 2016, uniting three global academy networks, the oldest of which was founded in 1990. In IAP, the academies work together to support the role of science and its efforts to seek solutions to address the world's most challenging problems. IAP harnesses the expertise of the world's scientific, medical and engineering leaders to advance sound policies, improve public health, promote excellence in science education, and achieve other critical development goals. IAP also uses the expertise of its leading members to assist in building the capacity of its less-experienced and newest members, thus strengthening their ability to take on an advisory role in their own nations and to contribute to global discussions.
- **The International Science Council** (ISC) is a non-governmental organisation with a unique global membership that brings together 40 in-

ternational scientific Unions and Associations and over 140 national and regional scientific organisations including Academies and Research Councils. The ISC was founded in 2018 as the result of a merger between the International Council for Science (ICSU) and the International Social Science Council (ISSC). The Council's activities focus on three principal areas of work: science-for-policy to stimulate and support international scientific research and scholarship, and to communicate science that is relevant to international policy issues; policy-for-science to promote developments that enable science to contribute more effectively to major issues in the international public domain; and scientific freedom and responsibility to defend the free and responsible practice of science. ICS activities include a broad range of issues, from global sustainability, poverty, urban health and wellbeing and disaster risk reduction, to data, observing systems.

– Since 2016, the Latvian Academy of Sciences regularly participates in workshops, conferences and other activities of the **Scientific Advice for Policy by European Academies** or SAPEA project on a variety of issues. The SAPEA project enables to share knowledge and expertise from across Europe as it is part of the European Commission's Scientific Advice Mechanism. SAPEA brings together outstanding expertise in engineering, humanities, medicine, natural and social sciences from over 100 academies, young academies and learned societies across Europe. Together with the Group of Chief Scientific Advisors, SAPEA provides independent scientific advice to European Commissioners to support their decision-making. SAPEA aims to stimulate debate in Europe about the role of evidence in policy-making. SAPEA is funded by grant from the EU Horizon 2020 programme.
– Latvia is represented in *Academia Europaea* and *Academia Scientiarum et Artium Europaea* through individual membership of outstanding Latvian scientists, full and corresponding members of the LAS. Five outstanding scientists of Latvia are members of the *Academia Europaea*, and 17 prominent Latvian scientists are members of *Academia Scientiarum et Artium Europaea*.

BILATERAL AGREEMENTS BETWEEN THE ACADEMIES

The encouragement of international contacts has always been one of the priorities of the Latvian Academy of Sciences. Every year, the LAS refreshes the existing collaboration links and creates new ones with academies of sciences from different countries. In 2019, new cooperation agreements were made with Hamburg Academy of Sciences and Humanities and Kazakhstan National Academy of Sciences.

As of January 2020, LAS has concluded bilateral agreements on scientific cooperation with foreign partner academies: Austrian Academy of Sciences, Azerbaijan National Academy of Sciences, National Academy of Sciences of Belarus, Bulgarian Academy of Sciences, Chinese Academy of Social Sciences, the Czech Academy of Sciences, Estonian Academy of Sciences, Finnish Academy of Science and Letters, Academy of Sciences – Institute of France, Georgian National Academy of Sciences, Berlin–Brandenburg Academy of Sciences and Humanities, Saxon Academy of Sciences and Humanities, Hamburg Academy of Sciences and Humanities, Hungarian Academy of Sciences, National Academy of the Linsey, Italy, Israel Academy of Sciences and Humanities, Lithuanian Academy of Sciences, Kazakhstan National Academy of Sciences, Montenegrin Academy of Sciences and Arts, Polish Academy of Sciences, Russian Academy of Sciences, Slovak Academy of Sciences, Slovenian Academy of Sciences and Arts, Royal Swedish Academy of Letters, History and Antiquities, Swiss Academy of Sciences, Ministry of Science and Technology, National Academy of Sciences of Ukraine, Academy of Sciences of the Republic of Uzbekistan.

INTERNATIONAL MOBILITY OF RESEARCHERS

The Latvian Academy of Sciences supports short-term international mobility of researchers. The international mobility is based on cooperation agreements between the Latvian Academy of Sciences and its partner academies. In 2020, the LAS has 17 active agreements on the exchange mobility of researchers. The mobility is open to all Latvian scientists.

The grants are modest, but every little bit helps. The budget of the LAS also covers the reception expenses of foreign researchers in Latvia. The expenses of our scientists abroad are borne by the academy's partners in target countries. The work of the programme is directed by the International Department of the Academy. International mobility fellowships offer valuable opportunities for international researchers and postgraduate students to work and do research at the Latvian Academy of Sciences, Universities and research institutions. Fellowships provide for 350 mobility days per annum.

There are cooperation project activities with the Polish Academy of Sciences, Bulgarian Academy of Sciences and the Czech Academy of Sciences. The cooperation project agreements provide the possibilities of cooperation during the time period of three years.

Professor **Jānis Spīgulis**, Full Member of the Latvian Academy of Sciences, head of the cooperation project between the Latvian Academy of Sciences and the Bulgarian Academy of Sciences, tells about the cooperation project "Multispectral and fluorescent imaging of skin tumours": "This project facilitates new technologies for non-contact early diagnostics of skin malformations, including cancers. Development of multispectral (field of expertise of Latvian partners) and fluorescent (field of expertise of Bulgarian partners) imaging techniques and their combination allow increasing both sensitivity and specificity of diagnostics."

Professor **Jurijs Dehtjars**, Full Member of the Latvian Academy of Sciences, introduces to the results of his cooperation project with the Bulgarian Academy of Sciences: "The project deals with sponge-like nanoporous aluminum films (black aluminium, BA) that absorb optical radiation (OR) extremely effectively. BA are targeted to harvest OR radiation and convert it to heat and electricity. Thermal stability of BA was explored, the BSc thesis was developed (defended 2019, June). BA capacity for nanodosimetry, when alpha particles and protons are absorbed by a nanovolume, was tested."

Gita Seņķa, Vice Rector of the Latvian Culture College, head of the cooperation project with the Bulgarian Academy of Sciences, highly appreciates the educational opportunities provided by the cooperation: "The project has provided opportunities for modernisation of the content of education and training at the Latvia Culture College, as undertaken research activities regarding digitization of cultural heritage and analysis of process of interaction between different cultures and new technologies is directly related to the development of technological programmes in college. The research topics discover the latest trends in the digitization of cultural heritage and use of the outcomes in the study process, thus promoting the quality of contents of the study programmes and competitiveness of college in educational arena."

Inese Runce (Institute of Philosophy and Sociology, University of Latvia) has a long cooperation with the Bulgarian Academy of Sciences: "Our project of collaboration launches the third phase of collaboration between the Bulgarian and Latvian Academy of Sciences. The team of project had already the long-lasting collaboration experience, which resulted in top-level international scientific forums organised in the Baltics and Bulgaria, project seminars held in Rīga and Sofia, various publications and new established links with the experts of many countries outside the scope of our collaboration. We are publishing our results in the *Yearbook of Balkan and Baltic Studies* (YBBS), which is a peer-reviewed (SCOPUS un DOAJ) annual English language journal for the study of humanities (incl. ethnology, folklore, religiosity, and migration studies), global relations and influences of the past events and modern developments in the area. It will be a joint publication of Bulgarian, Lithuanian, Estonian, and Latvian Academies of Sciences, Centre of Excellence in Estonian Studies, Institute of Ethnology and Folklore Studies with Ethnographic Museum, Estonian Literary Museum, Lithuanian Institute of History, Institute of Philosophy and Sociology, University of Latvia. Besides, we also organise a conference in Rīga, Latvia, "Balkan and Baltic States in the United Europe – History, Religion, and Culture IV. Religiosity and Spirituality in the Baltic and Balkan Cultural Space: History and Nowadays" on June 19–20".

Professor **Anna Stafecka**, Corresponding Member of the LAS, leader of the cooperation project between

the Latvian Academy of Sciences and the Czech Academy of Sciences, "Latvian – West Slavic Linguistic and Cultural Connections: Past, Present, Perspectives" tells about the project: "The aim of the project is to establish wider scientific cooperation between researchers from the Czech Republic and Latvia. The project participants work on common research topics, relevant research methods and preparation of the concept of a multi-author monograph, in which an important aspect is the investigation of the linguistic vitality of the dialects functioning on the borderlands.

A special attention is paid also to the multilingualism on the borderlands." Scientific conference and project workshop was organised by the Institute of the Slavic languages of the Czech Academy of Sciences in Prague. A project workshop and a scientific conference "Language in society" is organised in Latvia in February 2020, commemorating the 147th anniversary of the linguist Jānis Endzelīns, academician of the Latvian Academy of Sciences" (Principal investigator Professor Anna Stafecka, Institute of the Latvian Language, University of Latvia).

INTERNATIONAL AWARDS

In partnership with international organisations, academies, research institutions and companies the Latvian Academy of Sciences organises the awarding of a number of prizes, among them the Walter Zapp Prize (since 2004), the L`ORÉAL Baltic – UNESCO fellowship "For Women in Science" (since 2005), the European Prize of the European Academy of Sciences and Arts or Felix Award (since 2001), as well as a Medal of the Baltic Academies of Sciences (since 1999).

Walter Zapp [2] prize is awarded by the Latvian Academy of Sciences, the Patent Office of the Republic of Latvia, and the company Minox. The prize is awarded for an outstanding invention or a complex of inventions. The prize was awarded for the first time in 2005, celebrating Walter Zapp's 100th birthday.

In 2019, the Walter Zapp prize was awarded to Professor Maija Dambrova (Fig. 1), Full Member of the LAS. The academician received the award in recognition of her outstanding contribution to the development of new medicines and determining their activity and her remarkable inventions that have received recognition on a global level. *Dr. pharm.* Maija Dambrova is among the most renowned inventors of her generation in the Baltic States. In addition, M. Dambrova has developed new pharmacological *in vitro* and *in vivo* methods to determine the active mechanisms of potential medicines. The Professor has also invented new perspective substances that help the human body to deal with cardiovascular diseases and act on the receptors in the central nervous system. The World International Property Organisation database contains 118 registered inventions with M. Dambrova as author or co-author.

Fig. 1.
Dr. pharm.
Maija Dambrova

L'Oreal Baltic scholarship "For Women in Science" is the support programme for female scientists. It promotes the professional development of Baltic female scientists, helping achieve new goals and enhance the contribution to both science and society. The programme was brought to Latvia by the L´Oréal Baltic For Women in Science Programme Honorable Patroness, Professor, Dr. Vaira Vīķe-Freiberga (President of Latvia, 1999–2007).

The scholarship programme is implemented in cooperation with the academies of sciences of the three Baltic States and the Latvian, Estonian, and Lithuanian National UNESCO Commissions. Since the implementation of the scholarship programme in Latvia 15 years ago, 45 female scientists received the award for their contribution to science. Since 2017, the

scholarship programme has been expanded, and four scientists from Lithuania and four from Estonia have been awarded. One prize in each country is awarded to a women scientist up to 40 years old with a doctoral degree for research in the fields of life, environmental sciences, physics and engineering.

Two prizes in Latvia, one in Lithuania and one in Estonia are awarded to PhD candidate up to 33 years old to finalise thesis research in the fields of life, environmental sciences, physics and engineering. Each of the Baltic countries has its own separate Programme Jury that will carefully assess applications from candidates from that country.

In 2019, the scholarships were granted to Latvian researchers: *Dr. pharm*. Marina Makrecka-Kūka, *Mg. sc. ing*. Jana Vecstaudža and *Mg. sc. ing*. Laura Dembovska, Lithuanian scientist Jurgita Skiecevičiene and Milda Alksne, and the scholarships for Estonian researchers – to Karina Parta and Tuula Sepa.

Dr. pharm. Marina Makrecka-Kūka was awarded the fellowship for her work in the field of pharmaceutical research: "Acylcarnitines, mitochondrial fitness & immunometabolism: novel target for healthy aging". *Mg. sc. ing*. J. Vecstaudža received the fellowship for her research in the field of materials science "Nanostructured and biomimetic amorphous calcium phosphate biomaterials for bone tissue engineering" and *Mg. sc. ing*. Laura Dembovska (engineering) received the fellowship for her project "Alkali-activated aluminosilicate composites with heat-resistant aggregates for industrial applications".

COOPERATION BETWEEN THE BALTIC ACADEMIES OF SCIENCES

The tradition of holding the Baltic Conferences on Intellectual Cooperation takes its history back to the 1920s. In the beginning, conferences were organised by the Institute of Intellectual Cooperation at the League of Nations (Paris). Estonia, Latvia, Lithuania, and Finland, were regularly participating at the Congresses, and conferences occasionally were attended by Sweden and Denmark.

The 1st Baltic Congress on Intellectual Cooperation took place in Kaunas (Lithuania) in 1935, and subsequently the conferences were held on annual basis with participation of university academics, scientists, public figures (ex-ministers, ambassadors), and politicians. By the end of the 1930s, six Conferences on Intellectual Cooperation have been held. The last conference was the "Baltic Week" in Tallinn (Estonia) in 1940. In the 1990s, Royal Swedish Academy of Sciences and the Norwegian Academy of Sciences and Letters together with the Baltic Academies organised legal conferences in order to discuss legal and constitutional issues with special focus on the Baltic States. In 1990, Estonian, Latvian, and Lithuanian Academies of Sciences issued a communique on cooperation. It was then decided that the Academies would encourage scientific collaboration. However, only in 1999 the tradition of historic Baltic Conferences on Intellectual Cooperation was revived at the 7th Conference held in Rīga. The 16th Baltic Conference on Intellectual Cooperation took place in Vilnius, the Lithuanian Academy of Sciences, on 2–3 May 2019. The topic of the conference was "Genes: from the Past to the Future". Conference mostly focused on biomedical sciences. Internationally recognised scholars from the Baltic academies of sciences and from Germany and Finland presented their research results. The presentations of the first day of the conference focused on the impact of modern genetics and genomics on plant selection, medical practice, and the emergence and development of novel scientific disciplines. The ways of how the latest achievements in genetics and genomics are changing the perception of the history of human populations had been demonstrated on the example of Lithuania on the second day of the event.

The latest technologies of biomedical research – bioinformatics, medical biotechnologies, genome editing tools for the analysis of the human genome – enable research into and the development of ethnogenesis-related issues. Studies into variations in DNA sequence make it possible to reconstruct the evolutionary history, origin, and structure of the human populations and to detect differences and similarities between individuals or populations. Modern ethnogenetic research is developed by collating archaeological, genomic, and linguistic data. Comparison of results produced by separate branches of science is interesting to the general public as it facilitates a better understanding and

Fig. 2.
Dr. habil. biol. Isaak Rashal, Full Member of the LAS, receives the Award of the Baltic Academies of Sciences in Vilnius, May 2019

clarification of the theory of the origin of nations. The next Baltic Intellectual Cooperation Conference is to be held in Tallinn (Estonia) in 2021, and it will address technical sciences.

BALTIC ACADEMY AWARD

Since 1999, also an international award – Medal of the Baltic Academies of Sciences is awarded during the Baltic Conferences on Intellectual Cooperation. Medals and diplomas of the three Baltic Academies of Sciences for the development of intellectual relations between the Baltic countries are awarded to scientists and intellectuals. In 2019, the Baltic awards were presented to the Latvian geneticist Professor **Isaak Rashal** (Fig. 2) for essential research in genetics and important pedagogical and organisational input into development and strengthening of basic and applied research in plant genetics in Latvia, Lithuania and Estonia; to the Estonian geneticist Professor **Maris Laan** for major input into cooperation in basic and clinical reproductive genetic research between Estonia, Latvia and Lithuania; and to the Lithuanian geneticist Professor **Vaidutis Kučinskas** for seminal results in research that have enabled essential reconsideration of the histories of the origin of the Baltic populations and identification of their genome diversity and similarities, performed jointly with Latvian and Estonian scientists.

INNOVATION - THE DRIVING FORCE OF THE 21ST CENTURY IN THE BALTIC SEA

The conference "Innovation – Power of the 21st Century" (24–26 February 2020, Rīga) discussed the challenges and opportunities in the Baltic Sea countries in terms of science, technological development and innovation. The conference was organised with the support of the INTERREG project "Smart-Up Baltic Sea Region", aiming at improved cooperation between the countries of the Baltic Sea to address social challenges by seeking methods to build the capacity to implement regional innovation and RIS3 strategies.

The main keynote speakers at the opening of the Conference "Innovation – Power of the 21st Century", Rīga, 24 February 2019. From the left: I. Muižnieks, Elected Rector, University of Latvia; R. Nieminen, President, Finnish Academy of Sciences and Letters; S. Kilin, Deputy Chairman, Presidium, National Academy of Sciences, Belarus; M. D'Hooge, Senior Head of Unit, European Investment Bank; A. Kužnieks, Head, Representation of the European Commission in Latvia; T. Tukiainen, Professor, Alto University; A. Ērglis, Vice President, Latvian Academy of Sciences; V.Vīķe-Freiberga, Patroness of the Conference, President, Republic of Latvia (1999–2007); O. Spārītis, President, Latvian Academy of Sciences; K. Ploka, Advisor to the Minister of Finances; J. Banys, President, Lithuanian Academy of Sciences

During the conference, more than 15 experts from the Baltic Sea region shared their ideas and experience on possible initiatives for innovation cooperation. Participants discussed the development and specialisation of the Baltic Sea Smart Specialisation Strategy (RIS3), the European Union's research and innovation objectives and national cooperation in research, technological development and innovation, the region's biggest challenges and common challenges. The conference also discussed the establishment of the Innovation Platform in the Baltic Sea Region. The conference adopted "Rīga Declaration" for the cooperation of the science academies of the region and the universities in the pursuit of scientific projects, as well as the development of a scientific innovation platform for the Baltic Sea region. The declaration might become a starting point for improved cooperation on the so-called "principle 3S": environmental sustainability through circular economic methods; public health through life sciences, biotechnology and medical research; increased economic potential and increased overall security through cooperation with the Baltic Sea countries. "The Rīga Declaration has provided the basis for a shared vision among national academies of sciences on how and in what direction science needs to develop," stresses academician Ojārs Spārītis, President of the Latvian Academy of Sciences. "The common objective of the countries of the Baltic Sea region is to develop a knowledge based society and economy. In order to achieve this goal, it is essential for all partners to be committed to academic autonomy and integrity, to implement the principles of "open science", to develop all forms of institutional and scientific cooperation, and to find and develop different support instruments to ensure cooperation. "

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1. Latvian Academy of Sciences, Yearbook of the Academy of Sciences, 2019; www.lza.lv

2. Walter Zapp (1905, Rīga, Latvia – 2003, Binningen, Switzerland) was a Baltic German engineer, the "inventor of a camera smaller than a cigar and weighing less than a cigarette lighter" that started the production of camera in Rīga, in 1938. Zapp invented a number of photographic improvements. Zapp moved to Germany (1941) and established Minox GmbH (in 1945) to manufacture improved versions of his camera. After 1950, he served as a consultant to the Minox company. https://www.minox.com/en/about/walter-zapp/

FOR WOMEN IN SCIENCE PROGRAMME – EMPOWER, SUPPORT, ACCOMPANY, CHANGE PERCEPTIONS

Karin Laar, Corporate Communication Manager, For Women In Science programme Manager for Baltic countries, L´Oréal Poland Baltic HUB
Ilze Dimanta, *Dr. biol.*, Scientific and Regulatory Affairs Manager, For Women In Science programme Manager for Baltic countries, L´Oréal Poland Baltic HUB

The multifaceted scientific landscape gathers talented, young, and already experienced scientists, adding significant value to our society. Globally, despite of many women leading groundbreaking research, women still represent only 29% of researchers [1]. In the Baltic countries we are closer to gender parity; however, as the world hurdles towards a future threatened by climate change, diseases and resources scarcity, we must lose no time in recognising and promoting science, especially putting forward achievements of women scientists. The L'Oréal-UNESCO For Women in Science initiative began 21 years ago. Established in 1998 and managed by the Foundation L'Oréal in partnership with UNESCO (the United Nations Educational, Scientific and Cultural Organisation), the For Women In Science programme seeks to improve the representation of women in scientific careers, strong in the conviction that the world needs science, and science needs women. The programme works together with the National Science Academies who share the vision for more inclusive worlds and wish to highlight the work of women scientists by carefully selecting the winners of the national competitions. The L'Oréal-UNESCO For Women in Science Programme awards fellowships to female PhD students and PhD holders each year in national and regional competitions. Each year there are over 6500 applications, and more than 250 talented young women scientists are supported to pursue promising research projects in 54 national and regional programmes covering 118 countries.

After the national competitions every year, 15 outstanding young researchers are identified as the future of science among the winners of the 275 national fellowships awarded worldwide. They receive an additional grant, thus giving them greater visibility among the international scientific community, it is designed to accelerate the advancement of young women in science globally. In 2019, as one of 15 International Rising Talents, L´Oréal Baltic For Women in Science winner from Lithuania was selected – Vilnius University scientist *Dr.* Urtė Neniškytė who is researching how our brains develop in early childhood (6 months to 6 years), with particular reference to anomalies that can lead to serious mental illness. She is currently exploring why excessive synapses sometimes remain, rather than being removed or "pruned" for optimum efficiency. Aberrations in this "synaptic pruning" process can result in neurodevelopmental diseases such as autism, schizophrenia and epilepsy. *Dr.* Urte Neniskyte's aims to uncover what determines which synapses should be maintained and which should be removed, and how the process could be modified to correct any errors, before a disease can develop.

Simultaneously, each year, the L'Oréal-UNESCO For Women in Science award recognises five eminent female scientists from the five regions of the world for their remarkable contribution to the advancement

of research. As role models for future generations, brilliant and committed in the most competitive fields of research of our time, *the global laureates* illustrate the remarkable contributions that women can bring to science. To date, 107 laureates have been honoured, distinguished for the excellence of their scientific work. Three of them: Ada Yonath, Elizabeth H. Blackburn and Christiane Nüsslein-Volhard have won Nobel Prizes for science.

L´ORÉAL BALTIC FOR WOMEN IN SCIENCE YOUNG TALENTS PROGRAMME

In 2004, led by strong initiative from the Baltic Young Talents Programme Honourable Patroness, ex-President of Latvia Vaira Vīķe-Freiberga, L´Oréal Baltic, the Latvian Academy of Sciences and Latvian National Commission for UNESCO began implementing the programme For Women in Science in Latvia, and the first three talents were recognised in 2004.

In 2019, the Programme celebrated the 15th anniversary in Latvia and was proud to have recognised 45 scientists in Latvia and to have expanded cooperation to Estonia and Lithuania since 2017, up to date four scientists have been awarded from Estonia and four – from Lithuania. Latvian, Estonian, and Lithuanian Academies of Science, National Commissions of UNESCO and L´Oréal Baltic are working together to empower more women scientists to achieve scientific excellence and participate equally in solving the great challenges of science.

L'Oréal Baltic For Women in Science ceremony, 15th anniversary in 2019 at the University of Latvia. All winners (Latvia, Estonia, and Lithuania), with, from the left: Lithuanian Science Academy president Prof. Jūras Banys, Regional Jury of Latvia member Prof. Mārcis Auziņš, Regional Jury of Latvia member Prof. Vija Kluša, President of the the Latvian Academy of Sciences Prof. Ojārs Spārītis, Latvian National Commission for UNESCO General Secretary Baiba Moļņika, Assel Utegenova, Deputy Coordinator of the Network of National Commissions for UNESCO, Regional Jury of Latvia president Prof. Ivars Kalviņš, Baltic Young Talents Programme Honourable Patroness, ex-President of Latvia Dr. Vaira Vīķe-Freiberga, L´Oréal Poland Baltic HUB Country General Manager Niels W. Juhl
Photo: Jānis Saliņš

Winners of 2019 are currently working on their proposed topics:

1) Onco-Multi-Omics approach in gastric cancer research, *Dr.* Jurgita Skiecevičienė (Faculty of Medicine, Institute for Digestive Research, Lithuanian University of Health Sciences);
2) Acylcarnitines, mitochondrial fitness & immunometabolism: novel target for healthy aging, *Dr. pharm.* Marina Makrecka-Kūka (Latvian Institute of Organic Synthesis);
3) Adaptations to polluted oncogenic aquatic environments: a study of contemporary evolution in Baltic Sea flounders, *Dr.* Tuul Sepp (Department of Zoology, University of Tartu, Estonia);
4) Nanostructured and biomimetic amorphous calcium phosphate biomaterials for bone tissue engineering. *Mg. sc. ing.* Jana Vecstaudža (Biomaterials Innovations and Development Centre, Rīga Technical University/Institute of General Chemical Engineering, Latvia);
5) Alkali-activated aluminosilicate composites with heat-resistant aggregates for industrial applications, *Mg. sc. ing.* Laura Dembovska (Faculty of Civil Engineering, Institute of Materials and Structures, Rīga Technical University, Latvia);
6) The effects of air humidification and irrigation on ectomycorrhizal colonizers of silver birch, *Mg. sc.* Kaarin Parts (Institute of Ecology and Earth Sciences, University of Tartu, Estonia);
7) Angiogenic potential promotion by constructs designed for bone tissue regeneration, *Mg. sc.* Milda Alksnė (Life Sciences Centre, Institute of Biochemistry, Department of Biological Models, Vilnius University, Lithuania).

During the 15 years of programme existence, various scientific research topics have been completed and valuable outcome has been made in the form of scientific publications, products, patents for discoveries and, of course, in tremendous development of scientific careers.

Table 1. A few of research topics by Latvian scientists For Women in Science Programme 2005–2018

The role of melanocortins and plant antioxidants for inhibiting neuroinflammation and oxidative stress in the early stages of neurodegenerative processes (2005)	Latvian Academy of Sciences Full Member, Professor, *Dr. habil. biol.* Ruta Muceniece
The role of genetic factors in the effectiveness of cisplatin therapy in lung cancer patients (2005)	Latvian Academy of Sciences Full Member, Professor, *Dr. biol.* Aija Linē
The role of nuclear factor kB in cardiac cell survival under ischemic conditions (2006)	Latvian Academy of Sciences Full Member, Professor, *Dr. pharm.* Maija Dambrova
Modification of fullerene and its derivatives for electrochemical studies and improvement of solubility (2006)	Asoc. Prof. *Dr. chem.* Māra Plotniece
The role of peptidergic and non-peptidic regulation in manifestations of stress and depression (2007)	*Dr. med.* Baiba Jansone
Synthesis and characterisation of potential gene transfection agents – self-assembling polyfunctional pyridinium derivatives (2007)	Latvian Academy of Sciences Corresponding Member, *Dr. chem.* Aiva Plotniece
Hydrogen storage in lanthanum nickel alloys and composite material development, improvement of their physical and chemical properties to increase an amount of absorbed / desorbed hydrogen in metal hydrides (2007)	Latvian Academy of Sciences Corresponding Member, *Dr. phys.* Līga Grīnberga
The application of autoantibodies in the development of cancer serodiagnostic, prognostic and novel therapeutic approaches (2009)	*Dr. biol.* Karina Siliņa
An effect of vitamin A on molecular mechanism in human heart forming cells *in vitro* (2009)	*Dr. biol.* Inese Čakstiņa
Properties and diffusion of tritium accumulated in fusion reactor materials (2010)	*Dr. chem.* Elīna Pajuste
Genetics of rheumatoid arthritis in Latvian population (2011)	*Dr. med.* Liene Ņikitina-Zaķe
Phase transitions and physical properties of Na1/2Bi1/2TiO3-based solid solutions (2011)	*Dr. phys.* Marija Dunce
Development of calcium phosphate bone cements / biodegradable polymer composites for local drug delivery (2012)	*Dr. sc. ing.* Dagnija Loča
Role of nitric oxide metabolism in the pathogenesis of diabetic nephropathy in Latvian population (2013)	*Dr. med.* Jelizaveta Sokolovska
Identification of individuals at high risk of developing melanoma (2014)	Latvian Academy of Sciences Corresponding Member, *Dr. biol.* Dace Pjanova
Synthesis and properties of news fluorescent probes comprising lipid-type amphiphilic self-assembling moiety as theranostics (2015)	*Dr. chem.* Laura Beķere
Development of nanostructured biocomposites with antiosteoporotic properties (2016)	*Dr. sc. ing.* Kritīne Šalma-Ancāne
Microbiome of different tick species in Latvia: exploring possible impacts on the ecology of tick-borne diseases (2017)	*Dr. biol.* Renāte Ranka
Determination of pigments used in the traditional dyeing processes of textiles using chromatography (2018)	*Dr. chem.* Ilva Nakurte

For women to flourish in science, excellence in research is just the first step. We know that leadership is vital to banishing the discrimination that too often prevents women from progressing. That is why, in addition to vital funding and recognition, we offer our fellows the opportunity to build strong leadership skills, and a network with fellow women scientists. We must encourage mentorship, collaboration and strong role models as key means to help more young women break the glass ceiling. We need further to promote the value of learning and education, reaching young women and girls by creating awareness on scientific educational programmes.

Moreover, this plays an important role in our countries. In Latvia L´Oréal Baltic For Women in Science fellows, during a survey and interviews conducted in May 2018, emphasised that a large number of challenges is not connected to gender roles, but rather to the overall scientific landscape in the country, and the same challenges are faced by men daily. On personal level, the biggest challenge is

time planning and finding time both for science and for family. Less of fellows are concerned of competition, prejudice, or lack of financing. When speaking about discrimination in the field, the scientists indicate that it is rare or non-existent. The non-existence of women in leading positions in all fields of science is the main cause of inequality in science and it depends on the field of study. For majority of fellows (90%) receiving L'Oréal Baltic For Women In Science rewards has been a true career achievement, 10% view it as recognition and acknowledgment, even as bonus to their existing work. Emotional impact of the reward is to be emphasised, as the key drivers for participation are encouragement by colleagues, recognition acquired and prestige of the fellowship. Financing plays an important role as well, 25% of fellows say.

At the 15th anniversary of the programme L'Oréal Baltic For Women in Science, we must remember there is still much more to be done to achieve true gender equality in science. We want to accelerate this transformation, undertaking our initiative to support, train and raise awareness of women, in the service of science. We remain determined, and we are moving steadily towards making our vision a reality.

REFERENCE

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L'Oréal Baltic For Women in Science 15th anniversary in 2019 in the University of Latvia. Winners representing 2005–2019 with L´Oréal Poland Baltic HUB Country General Manager Niels W. Juhl
Photo: Jānis Saliņš

SCIENCE POLICY

100 YEARS OF LEGAL HISTORY – LATVIA'S CONSTITUTION AND CIVIL CODE

Philipp Schwartz, *Dr. jur.*, Turku, Finland

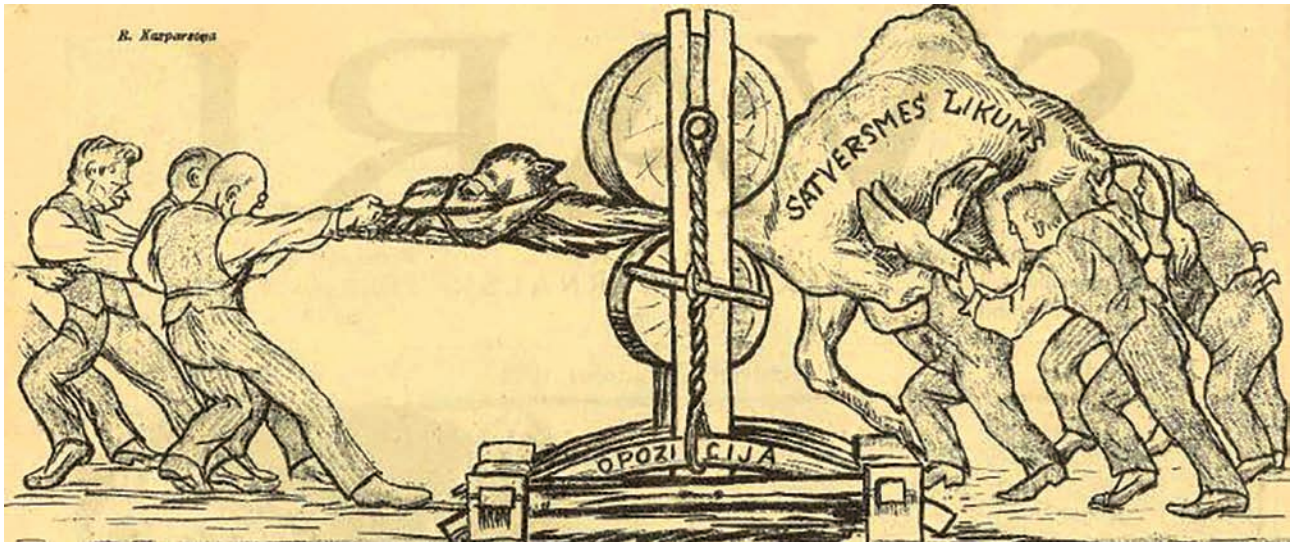
Big celebrations were held on the occasion of the 100th anniversary of the Republic of Latvia in 1918. But the celebrations were not over with 18 November 2018 and more 100th anniversaries followed – e.g., in 2019, the 100th anniversary of the establishment of the Latvian Foreign Service, the University of Latvia, the Latvian National Library or the Latvian Music Academy. This does not come as a surprise as even if independence was declared on 18 November 1918, the Latvian state with all its institutions, legal system etc. needed to be established. When looking at the two cornerstones of the legal system and hence the Latvian state, the Constitution and the Civil Code, it took further, respectively, four and 20 years for these laws to enter into force. Hence, their 100th anniversaries are still to come in 2022 (Constitution) and 2038 (Civil Code).

This process starting on 18 November 1918 and lasting until 1922 and 1938, respectively, is indeed an interesting process. Although having started in the same situation, the codification work of both cornerstones of the legal system of Latvia took very different ways. Interestingly enough, both laws have some things in common and are different in other aspects. These parallels and differences are then not only of interest for those interested in Latvian (legal) history. They have to be seen in the overall historical context of the period after the First World War with many states in Central Europe coming into being. It is a development which can neither be seen independent from global developments nor did this process had an impact only within the borders of the young Republic of Latvia. Hence this article is about the parallels and differences between both laws and those aspects which make them interesting from an international perspective – asking questions which could be taken up by the international research community.

JOINT STARTING POINT – DIFFERENT FINALISATION

On 18 November 1918, the Republic of Latvia was declared. Naturally, a newborn state wants and needs to build its own (legal) foundation – with the constitution laying out what this newborn state is all about and a civil law regulating the relationships between the individuals. And naturally, this foundation is not built within one day. Especially not in circumstances as the ones on Latvian territory after 18 November 1918. Although Latvia had declared its independence, it still took a bit more than two years until the full *de jure* recognition in 1921. Before that, the years 1918 until 1920 were the years of the Latvian War of Independence, a military conflict on the territory of the newly established Republic of Latvia. But once this situation was overcome, the work on both an own constitution and an own civil code started.

The codification work and its duration already show substantial differences between the Latvian Constitution and the Civil Code. The drafting of the Constitution was a relatively quick process, especially compared to the somewhat never-ending work on the Latvian Civil Code. On 17–18 April 1920, the Latvian population elected its first ever own parliament, the so-called Constitutional Assembly. As the name Constitutional Assembly already indicates, one of the main tasks was to work out a constitution for the young Republic of Latvia. This took a bit



Caption (in Latvian): "Dromedary in the Constitutional Assembly"
(The dromedary being the Constitutional law squeezed through the mill stones of the opposition) [1]

less than two years with the Constitution being adopted on 15 February 1922 and entering into force on 7 November of the same year. The codification history of the Latvian Civil Code is actually a much longer one. It also started in 1920 with the first codification committee being set up. But it should take 17 more years and in total three committees until eventually on 28 January 1937 the final Civil Code was adopted and entered into force on 1 January 1938. Two years to have an own constitution versus 18 years for having an own civil code. The Constitution was drafted and entered into force shortly after a period of war (not only the First World War, but also the already mentioned Latvian War of Independence from 1918 to 1920). The Latvian Civil Code, on the other hand, obviously needed a period of peace and stability between 1920 and 1937 to be developed and adopted. The Latvian Constitution was adopted by a democratically elected legislative body (the Constitutional Assembly) while the Latvian Civil Code was adopted by the Cabinet of Ministers in times of the authoritarian regime of Kārlis Ulmanis (1877–1942). It was actually after the coup d'état in 1934 that the government under Kārlis Ulmanis suspended the Latvian Constitution. It can only be speculated if the Latvian Civil Code of 1937 had ever been finalised, if Latvia had ever got its own Civil Code before it was occupied by the Soviet Union in 1940. It could be an interesting experiment to imagine which civil law system Latvia would have adopted after regaining its independence in 1990 if the Latvian Civil Code of 1937 had not existed. It would be equally interesting to further research why the one law took only two years while the other one took 18 years although both started at the same time in the same circumstances? One answer could be that for the civil law, it is possible to operate for a while on the basis of the existing civil law. At least as long as it does not contradict the basic principles and values of the new state. While a constitution as the basis of a state has to be created specifically for this state and previous constitutions can hardly be used, not even temporarily.

THE LATVIAN PERSPECTIVE – HOW "LATVIAN" ARE THE LATVIAN CONSTITUTION AND CIVIL CODE?

Both the Latvian Constitution and the Latvian Civil Code are not only the cornerstones of the Latvian legal system, but cornerstones of the Latvian self-understanding. Until 2014, the Constitution had only a simple introductory sentence stating "The people of Latvia, in freely elected Constitutional Assembly, have adopted the following State Constitution". In 2014, the Constitution was complemented with a new preamble describing the foundations of

the Latvian state and the identity of the Latvian State, its history and values in an explicit way. This new preamble serves as the "business card of Latvia's constitutional system." [2] Interestingly enough the father of this new preamble is today's Latvian State President Egils Levits who considered that the new preamble helps in creating a joint understanding of the Latvian identity [3]. What makes the new preamble unique is that "Usually preambles comprise issues that are relevant at the moment when the constitution is created, whereas in the case of Latvia the Preamble reflects the constitutional reality spanning almost 100 years." [4]

The importance of the Latvian Civil Code has to do with the political and ideological aspects of having an own civil code. But not so much with the content itself which to a large extent is the old civil law from 1864 (*internal continuity*) only "wrapped" in a new "dress" in the form of the Latvian Civil Code (*external discontinuity*). The politicisation and ideologisation of the Latvian Civil Code (over)emphasising its 'Latvianness' is a very interesting aspect of its codification history [5]. One of the most obvious signs is that the Latvian Civil Code was quite quickly called "President Ulmanis Civil Code" after the time of Latvian State President Kārlis Ulmanis. When it comes to the name, parallels to the Code Napoléon are obvious.

THE INTERNATIONAL PERSPECTIVE – INFLUENCES FROM ABROAD AND INFLUENCES ABROAD

Despite being the Latvian Constitution and the Latvian Civil Code, an international influence cannot be neglected. Especially when looking at the persons which were involved in shaping and drafting both the Latvian Constitution and Civil Code. Out of the 152 members of the Constitutional Assembly 16 belonged to political parties or groups representing minorities: six Baltic Germans, six Jews and four Russians. And it was the Baltic German lawyer and politician, member of Parliament Paul Schiemann (1876–1944) who in 1930 brought up the necessity of an institution protecting the Constitution. The first draft law on the establishment of a constitutional court was presented in 1934 by another Baltic German Helmuth Stegman (1892–1983). However, this draft did not get the necessary majority. The Latvian Constitutional Court was eventually established in 1996. The last and decisive (third) codification committee of the Latvian Civil Code, working from 1933 to 1936, consisted of seven Latvians, two Baltic Germans and one Russian. A more thorough analysis using the method of network analysis could provide further interesting findings [6].

The German Weimar Constitution of 1919 is often referred to as basis for the Latvian Constitution [7]. But the Weimar Constitution was not the only source of inspiration. The members of the Constitutional Assembly in their discussions actually referred to many more countries (without that the respective constitution necessarily had a direct impact on the Latvian Constitution). According to the Constitutional Assembly's transcripts they referred 30 times to the United States of America, 29 times to England, 25 times each to Switzerland and Germany and 22 times to France. But also to many other countries around the world including, e.g., Japan and Peru. And also modern research draws a wider circle than referring only to the Weimar Constitution [8].

It is interesting that the Latvian Constitution originally did not include fundamental human rights. Only after Latvia regained its independence in 1990, the reinstated Constitution was complemented in 1998 with an own chapter on the fundamental human rights. However, the Latvian Constitution should have had from the very beginning, in 1922, a part on fundamental human rights and freedoms. This part was drafted together with the (first) part on the foundations and organisation of the state and its governance. But in the final vote the (second) part on the fundamental human rights did not receive the necessary majority.

Both the Latvian Constitution and the Latvian Civil Code stick out. The Latvian Civil Code was in certain aspects well ahead of its time. Worth mentioning in this context are the introduction of the principle of irretrievable marital breakdown as a justification for divorce and that the Civil Code was prohibiting the operation of enterprises endangering human health. And together with the Greek Civil Code of 1946, the Latvian Civil Code is the last one based on

Roman law [9]. What is equally remarkable for the Latvian Civil Code of 1937 is that it was actually the only civil code in Central Europe which got beyond the status of a draft getting adopted and entered into force during the interwar period. Many, most other countries in Central Europe did not manage to get beyond a draft civil code before the upheavals caused by the Second World War [10].

While in an overall European and even global context, the Latvian Constitution of 1922, reinstated after Latvia regained its independence in 1990 after 50 years of Soviet (and German) occupation and hence in force still today, is remarkable for being "the oldest Eastern or Central European constitution still in force and the sixth oldest still-functioning republican basic law in the world" and one of the shortest [11]. Neighbouring countries like Estonia and Lithuania, equally affected by an illegal Soviet occupation and being challenged with (re)establishing an own legal system after regaining their independence, however did not reintroduce their pre-war constitutions. Both adopted in 1992 a new constitution. One reason being that Lithuania (in 1928) and Estonia (in 1938) had adopted a new constitution under the authoritarian regimes of Antanas Smetona (1874–1944) and Konstantin Päts (1874–1956). Ironically, the Latvian Constitution had remained the constitution of a democratic state especially because the Latvian authoritarian regime of Kārlis Ulmanis had suspended it after the coup d'état in 1934.

CONCLUSIONS – THE INTERPRETATION AND RELEVANCE OF THE CODIFICATION HISTORY FOR TODAY

One might ask why the (codification) history of the Latvian Constitution and the Latvian Civil Code should be of interest today, a bit less than 100 years after they were created. The Latvian Constitution and Civil Code came into being in an overall European and global historical context. But only once a law enters into force and is applied it proves its readiness for everyday reality. At the same time the understanding of how a law actually was created, what was the historical background and what were the motives behind, is essential for its application today. Not least the shortness of the Latvian Constitution and its 'laconism' require to look by (historic) interpretation at the ideas behind the words written down a long time ago – especially since this laconism was intended by the Latvian Constitutional Assembly [12].

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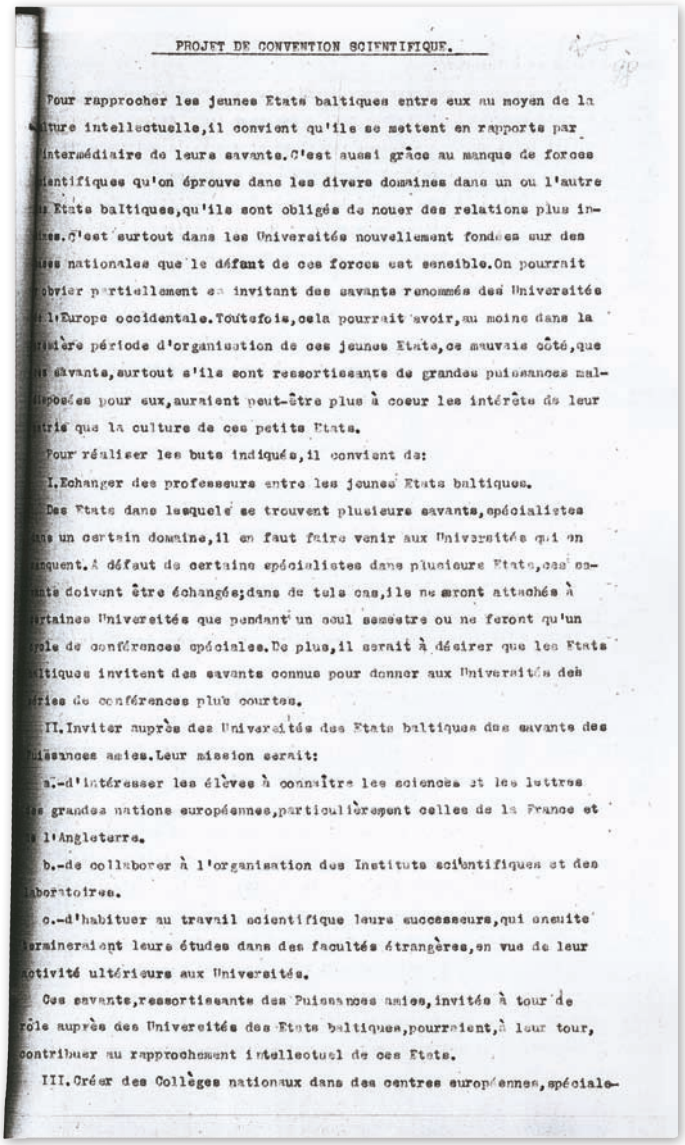
THE RĪGA (BULDURI) CONFERENCE OF 1920 AND A DRAFT SCIENCE CONVENTION BETWEEN THE BALTIC STATES

Ojārs Spārītis, President of the Latvian Academy of Sciences



PROJET DE CONVENTION SCIENTIFIQUE.

Pour rapprocher les jeunes Etats baltiques entre eux au moyen de la
ture intellectuelle,il convient qu'ils se mettent en rapports par
intermédiaire de leurs savants.C'est aussi grâce au manque de forces
ientifiques qu'on éprouve dans les divers domaines dans un ou l'autre
s Etats baltiques,qu'ils sont obligés de nouer des relations plus in-
mes.C'est surtout dans les Universités nouvellement fondées sur des
ses nationales que le défaut de ces forces est sensible.On pourrait
obvier partiellement en invitant des savants renommés des Universités
l'Europe occidentale.Toutefois,cela pourrait avoir,au moins dans la
mière période d'organisation de ces jeunes Etats,ce mauvais côté,que
s savants,surtout s'ils sont ressortissants de grandes puissances mal-
disposées pour eux,auraient peut-être plus à coeur les intérêts de leur
trie que la culture de ces petits Etats.

Pour réaliser les buts indiqués,il convient de:

I.Echanger des professeurs entre les jeunes Etats baltiques.

Des Etats dans lesquels se trouvent plusieurs savants,spécialistes
ns un certain domaine,il en faut faire venir aux Universités qui en
nquent.A défaut de certains spécialistes dans plusieurs Etats,ces sa-
nts doivent être échangés;dans de tels cas,ils ne seront attachés à
rtaines Universités que pendant un seul semestre ou ne feront qu'un
rcle de conférences spéciales.De plus,il serait à désirer que les Etats
ltiques invitent des savants connus pour donner aux Universités des
ries de conférences plus courtes.

II.Inviter auprès des Universités des Etats baltiques des savants des
issances amies.Leur mission serait:

a.-d'intéresser les élèves à connaître les sciences et les lettres
s grandes nations européennes,particulièrement celles de la France et
l'Angleterre.

b.-de collaborer à l'organisation des Instituts scientifiques et des
boratoires.

c.-d'habituer au travail scientifique leurs successeurs,qui ensuite
rmineraient leurs études dans des facultés étrangères,en vue de leur
tivité ultérieure aux Universités.

Ces savants,ressortissants des Puissances amies,invités à tour de
rôle auprès des Universités des Etats baltiques,pourraient,à leur tour,
contribuer au rapprochement intellectuel de ces Etats.

III.Créer des Collèges nationaux dans des centres européennes,spéciale-

Original cover page of the Convention on Science, "Projet de Convention Scientifique"

In the context of the year 2019 occasion of the Baltic Conference on Intellectual Cooperation, special attention needs to be drawn to the Draft of a Science Convention which was developed in 1920 shortly after the independent states of Latvia, Lithuania and Estonia were founded. The document was drawn up during the Rīga (Bulduri) Conference that had been convened on the initiative of the Latvian Foreign Minister Zigfrīds Anna Meierovics, the Latvian Foreign Minister. It has not lost its relevance today – almost a century later. I, therefore, propose that the text (translated into English from the original French version) of this forward-looking policy document be included in the Proceedings of this Conference, together with some reflections on the substance of the draft Convention and the manner in which it was created.

The title "Letonika" of the State Research Programme of Latvia shows that our thoughts and feelings focus on two basic political concepts: "state" and "Latvia" (in 1920, Latvia was identified in diplomatic circles by the French noun "Lettonie", whence the term "Letonika"). What is ordering or hierarchy that applies to these concepts, given that we are presently commemorating Aspazija (Elza Rozenberga) and Rainis (Jānis Pliekšāns), poets who returned to Rīga from exile in Switzerland to a warm welcome on 10 April 1920? What is the place for the two hundred years of Latvian academic science in this commemoration of the sesquicentenary of the two poets that we celebrate as well as the UNESCO calendar of historic events and anniversaries of eminent personalities? It can be said

that in awaiting a new stage production by the Latvian National Theatre of the play by Rainis, "*Uguns un Nakts*" (Fire and Night), we have had to update the place of Rainis and Aspazija in our cultural consciousness. It will be an opportunity for the public to recall the power of Rainis' ideas and spirit, the national and universal nature of Aspasia's high ethical imperatives, as well as to celebrate, whilst awaiting the centenary of the founding of our state, the global altruism of both geniuses and compare their contribution in the light of modern day human values.

By linking the notions of "Latvia", "state" and "Rainis", we can add a fourth – science – so as to arrive at the unifying event – the Rīga or Bulduri Conference, which engaged Rainis, just months after his return from Switzerland, in defining science development goals and objectives. The first Latvian Foreign Minister, Zigfrīds Anna Meierovics, began preparations for the forthcoming Baltic–Scandinavian Political Conference as early as April 1920 wherein he hoped to draw up and subsequently to ratify a military alliance and mutual assistance treaty to counter Russian aggression, to create an Entente. Unfortunately, the Scandinavian countries ignored an invitation to attend, and the Bulduri conference, which lasted from August 6 to 6 September 1920, saw only six participant states: Latvia, Lithuania, Estonia, Poland, Finland and Ukraine. Inasmuch as the majority of representatives did not hold the requisite rank to agree a significant foreign policy objective, nor any official mandate, discussion of other issues of a much wider scope were included in the conference agenda. Five working committees were set up for the duration of the conference: 1) Mandate, 2) Editorial, 3) Economic, 4) National economy, and 5) Culture, Social Affairs and Health. A total of 21 economic resolutions, seven draft agreements and 11 draft conventions resulted from intensive work of the committees.

Opening of the Rīga (Bulduri) Conference by the Prime Minister of Latvia, Dr. Kārlis Ulmanis, 6 August 1920

We shall pay special attention to the work of the Committee on Cultural, Social and Health Affairs. Jānis Pliekšāns (Rainis), was elected Chairman at the 7 August 1920 meeting of this committee. Interests of the Republic of Latvia were represented in this committee by the Minister of Education Kārlis Kasparsons, but on the part of the Allies: Finland – Leonard Aström and Erkki Reijonen, Poland – Vitold Kamenecki, Lithuania – Vladislavas Natkevičius, Estonia – Alfred Möttus. Working over the period of 7–20 August this committee drafted four conventions: (1) on art, (2) science, (3) copyright protection for literary and artistic works, and (4) a convention on health issues, in addition to a project on state guarantees to safeguard national cultural interests. Researchers studying the history of literature are most certainly aware of the importance to their field of the study of the 20 August plenary session of the Bulduri Conference, wherein Jānis Pliekšāns presented a draft Convention on legal protection of literary and artistic works, i.e. copyright. At a second meeting in September, Jānis Pliekšāns, as chair of the Committee for Culture, Social Affairs and Health, outlined the convention on art as drafted by the said committee. Its text has been published and evaluated by art historian Ginta Gerharde-Upeniece (Art and Diplomacy in the Republic of Latvia 1918–1928, in *Latvia Transformed from de facto to de jure. Art and Epoch*. Rīga, LNMM, Neputns, 2008). So far, however, the role played by the Bulduri Conference in the creation of a unified Baltic education and science space has not been investigated by researchers studying the history of science in Latvia, nor has the text of the convention on science been published, notwithstanding the contemporary relevance of this convention disclosed at the threshold of the centenary of the Latvian state.

It is in the context of Rainis' 150th birthday and the VI Congress of Letonica (Latvian Studies) that the text and content of the science convention may be of great interest to us, both because of the involvement of our major intellectuals of our country, Kārlis Kasparsons, Minister of Education of Latvia from 1918 to 1920, and the poet, lawyer and public figure Jānis Pliekšāns (Rainis). This document contains such forward-looking theses of the national education and science strategy. Up to now such theses have been only partially realised, and therefore, they are still relevant even as Latvia approaches a hundred years of its existence. To date, the full text of the Convention has not been published; however, the Washington Minutes of the Baltic Conference Held at Bulduri in Latvia 1920 (Washington, D.C. 1960), provided an abbreviated version of the Convention. The full text of the Convention can be found in the Conference Proceedings, located at the Latvian State Historical Archives (LVVA, 1313 f., apr. 2, 70, p. 98, p. 98, p. 99). On 21 August, Minister Kārlis Kasparsons presented the content of the science convention to the plenary session of the Bulduri Conference. The text, which featured many strategically important tasks in a modern way, according to Z. A. Meierovics' definition of the goal of this Conference, was to create and strengthen an "Entante" of the Baltic States.

I will mention several theses of the draft convention in which an evaluation of the real situation was coupled to tasks that needed to be performed. These included a commitment to bring the new Baltic States closer together through intellectual culture, and to establish mutual contacts between scientists. The shortage of teaching staff at Baltic universities was addressed by inviting short-term lecturers from Western European countries to stimulate students' interest in the scientific achievements of the major European nations, fostering collaboration between research institutes and laboratories, and training local professionals to study at national universities. The Convention provided for the rotation of guest lecturers at Baltic universities in order to promote intellectual convergence between countries.

The commission chaired by Jānis Pliekšāns had incorporated into the science convention a number of provisions related to education, including promotion of national college-like institutions in European science centres – Paris and Edinburgh – to introduce Latvian students to the culture of nations. The idea of establishing joint scientific institutions in the Baltic States, which may not be viable for each individual country, is a modern one. In this context, the Convention encouraged the Baltic States

to establish a joint Louis Pasteur Institute, which as a science centre in the early 20th century has proven its effectiveness in research and development of vaccines and training to handle epidemics, controlling imported drugs, treating locally outbreaks of rabies. It was intended that joint publication would take the place of scientific periodicals.

From today's standpoint, the goal set 95 years ago has been achieved, of establishing contacts between the Baltic States, both in science and education, to bring university programmes closer together and enable university degrees and degrees to be aligned. In order to bring together the Baltic peoples in the cultural and political spheres, the Convention recommended opening Baltic and Finnish language departments in the universities of the Baltic States. The Convention provided for setting up and maintaining a science information and coordination office in one university city in the Baltic States to deal with rotation of teachers, funding education shortfalls, financial sharing, and pooling of resources for joint budgeting. The call in the Science Convention for creating new tools sounds contemporary as is the thesis of commercialisation of innovative scientific inventions. Encouraging holding regular conventions and congresses was the final provision of the science convention as drawn up by the Baltic delegates in 1920.

At the concluding session of the month-long Bulduri Conference, held in Rīga Castle on 6 September 1920, Latvian Prime Minister Kārlis Ulmanis would sum up: "This conference, triggered by the need for unity, does not yet mean complete consensus on the issues that have been thoroughly debated. … but it has demonstrated an ability to agree content and spirit The will for Baltic unity will serve as a powerful plan of action, coordinating our individual and collective efforts." Unfortunately, when the delegates returned home, ratification of the agreements, conventions and protocols drawn up at the conference did not follow, but in the face of the tense international situation and individual diplo-

The Latvian Delegation to the Rīga (Bulduri) Conference assembled in Rīga Castle. From left to right: Kārlis Ramats, Pēteris Radziņš, Zigfrīds Anna Meierovics, Dr. Kārlis Ulmanis, Jānis Pliekšāns (Rainis), Kārlis Kasparsons, Voldemārs Zāmuēls, Hermanis Albats. August 1920. Original held by the Museum of Literature, Theatre, and Music

matic struggles in each country, these documents remained at the level of goodwill. The author and chief organiser of the conference – Zigfrīds Anna Meierovics, the first Minister of Foreign Affairs of the Republic of Latvia, viewed the political, economic and cultural co-operation of the Baltic States from a long-term perspective, and indeed his vision of a Baltic Union was far-sighted. After his death, however, nobody fought so fiercely for the Bulduri conference results to be implemented and it was partly forgotten. In some cases, government ministers, when planning their sectorial development strategies, returned to the theses of the conventions elaborated at the Bulduri Conference. Jānis Pliekšāns had the opportunity to occupy the post of Minister of Education of the Republic of Latvia.

In August 1920, Jānis Pliekšāns and the delegates, Z. A. Meierovics, Kārlis Kasparsons as well as other participants of the Bulduri Conference, succeeded in creating a vision of international scientific cooperation, based on the idea of consolidating a single intellectual, economic and political space in the Baltic. This idea has not lost its relevance today, given the ongoing visible and invisible competition between various political and economic powers to dominate the spiritual, economic and political space of the Baltic States.

Translated by **Eduards Bruno Deksnis**

LATVIAN SCIENCE POLICY: EUROPEAN DIMENSION

Eugene Eteris, LAS Senior Adviser

Science, research and innovation activities are the main driving force for the Latvian socio-economic development as the country's prospective growth depends on scientific research and knowledge-like smart specialisation. National potentials are great in elaborating perspective visions for Latvian innovative research and a science's component in Latvian political economy will provide a solid background for both national innovative growth and productive research.

However, it has to be a political decision aimed at supporting Latvian science and innovation policy to show the most progressive directions; no doubt that Latvian science policy will show the most optimal perspectives for political choices.

CHALLENGING ROLE OF SCIENCE, RESEARCH AND INNOVATION

Modern European science and technology policy directions are presently slowly turning towards "research, innovation and investment", called R&I, and oriented towards European prospective positions in a world of science and technologies. Some ideas in these policies are already under discussion within the Latvian growth strategy (e.g., mainly concerning *future and emerging technologies*, FET). Innovation in science and technology will play a key role in reconciling the Latvian optimistic objectives for a welfare society.

Latvian experts are unanimous about FET: adequate development can be reached by intensive investment; however, the share of GDP for R&I has been at about 0.5% in Latvia, which is even lower compared to 0.85% in Lithuania and 1.28% in Estonia and the EU's aims for science and research in national funding for 2020 shall be about 3 per cent. The three Baltic States' long-term goals are still smaller and different: e.g., about 1.5% in Latvia, 1.9% in Lithuania, and 3% in Estonia. Thus, among main difficulties for Latvian R&I is "an obvious lack of cooperation and dialogue among business and scientific communities, as well as with the government". Latvian experts also acknowledged that "national entrepreneurs lack information on how to go successfully from an idea to the creation of an innovative product".

More in: *Latvijas Zinātņu Akadēmijas Vēstis (Section A. Humanities and Social Sciences)*. 2018, Vol. 72, No. 4, p. 66. See also http://innovation.lv/inovacija/.

One of the strategic guidelines for Latvian growth is through an active role of science, research and innovation. It seems that combined and coordinated efforts among Latvian decision-makers are needed in order for Latvian business gaining advanced positions in Europe and globally. It is in this direction that contemporary debates about the role of science and innovation in the national socio-economic development shall take place to gain the necessary competitive advantages. Such debates shall include "future and emerging technologies", which represent short- and long-term research directions' inclusion into science and technology areas.

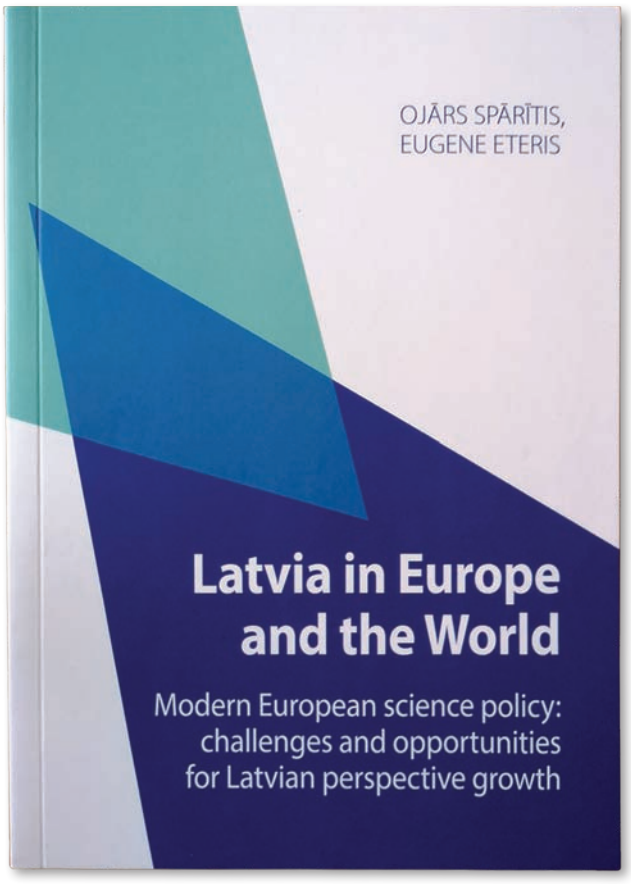
Significant changes have already occurred in approaches to science and research policy (SRP) in numerous EU states: main shifts on the European science policy's level are from *research and development* (R&D) directions, which were dominant in the last century into *research, innovation and investment* (R&I) schemes to combine national and the EU scientific potentials.

Latvian science policy after regaining independence was marked by establishment of the Latvian Council of Science in 1991. In accordance with the Law on Scientific Activity, the Latvian Council of

Science was created as a "collective institution" of Latvian scientists and researchers under the supervision of the Ministry of Education and Science.
Besides, the Council serves as an advisory body to the Latvian Government on research and training issues, on formulation and implementation of scientific achievements, on higher education and generally, on R&I policy in the country. The Council takes part in competitive R&I funding, as well as in promotion of Latvian scientific resources and fostering international scientific cooperation.
More in: https://rio.jrc.ec.europa.eu/en/organisations/latvian-council-science

SCIENCE POLICY AS PART OF THE NATIONAL GROWTH STRATEGY

Latvian science policy is broadly discussed in the book: Ojārs Spārītis, Eugene Eteris. *Latvia in Europe and the World: Modern European Science Policy: Challenges and Opportunities for Latvian Perspective Growth* [1].



In the **first place**, it is important to underline Latvian SRP's role within the European "scientific environment", which includes researchers' efforts from all EU member states. As soon as the research, innovation and technology are within the EU's shared and supporting competences, the Baltic States and Latvia are heavily relying on the EU's financial assistance; the EU's financial priorities for the next seven years' budget include "maximizing the impact of EU research and innovation in the member states progressive development". It is expected that the EU's post-2020 budget for research will be significantly increased. Since the Baltic States lack adequate financial recourses, some serious funding is required to maintain these states' excellence in scientific research to turn scientific discoveries into a number of practical industrial and developmental applications. Several countries globally have already done so: China has already overtaken the EU in terms of R&D spending as a share of GDP; South Korea, Japan and the United States are at the top of the global ranking.
Some new R&I directions have already appeared in the EU and the Baltic States, e.g. "human brain project", which provides additional understanding of the human brain and its diseases, as well as perspective directions in graphene and quantum research. But the Baltic States and Latvia have to figure out their own specific and progressive R&I spheres corresponding to the existing national needs and priorities.
Latvian experts are striving to "fill the gap" through more extensive use of various forms of support and assistance from the EU institutions, which are providing necessary information on the process of "leading research process" into innovative goods and services.
Secondly, it is about the role of Latvian science policy in the state's "smart growth perspective", which is becoming one of the most important parts of the country's perspective strategy. It is evident that the digital transformation in the Baltic States is going to change the old-fashioned policy-making "instrumental approaches" and provide benefits as more optimal and efficient policy instruments. In this sense it is clear: by reducing administrative costs (and workforce involved) in the public sector, use of

the digital options can result in more effective policy's settings for corporate entities and governmental structures.

Latvian government has to strengthen scientific and research activities though rejecting an academic misconduct and refraining from needless "over-theoretic" research, in particular with a limited national research budget. In this regard, closer ties between the education and research activities – particularly in the universities – are needed; not only in the demand for enlarged up-skilling (according to fast changes in present workforce) but also with the more creative approach in universities to supplement the academic degrees with professional qualifications.

The new science policy is more about the next generation of scientists in Latvia rather than about the need for increased research funding. Existing tensions and contradictions in the Latvian academic community are only making a negative impact on research activities and careers of young and perspective scientists. A strong emphasis on quantifiable research outputs is needed with closer connections to modern and prospective Latvian socio-economic issues. Contemporary researchers and educators' dependence on the EU's funding for research, innovation and development only tarnish individual research and R&I institution-building.

It was planned to allocate in 2019 more than €770 million from the budget to Latvian Ministry of Education and Science, which is €25 million more than a year before; the main share of these funds (47%) will go to teachers' salaries, the action co-financed through EU funds.

Thirdly, Latvian science-research-innovation policy (SRI) shall be aimed at launching a new strategic path for the country' growth towards the next level of modern issue in finding Latvia's "specialisation" niche in global and European competitiveness. Finding such a specific Latvian strategy in "smart growth" is required by the EU-2020 strategy: it is going to be a new direction in Latvian prospective growth, the path which is not going to be easy both in finding and implementing, with the use of science, research and innovation activities; the latter can facilitate the process.

Science and research activity in Latvia is generally connected to universities; however, presently, with the overwhelming intrusion of information and communications technology (ICT) and digital agenda into almost all spheres of socio-economic development, several other focal points emerged in the Baltic States and Latvia which are greatly extending research and innovation spheres in these countries.

However, it is still for the policy-makers to decide the ways Latvia can achieve its vision of "inclusive innovation" and identify which policy options are really aimed at achieving innovative growth. More on the "specialisation" issues in:

https://ec.europa.eu/digital-single-market/en/glossary#letter_g

Fourth, it is highly important to approach the national science policy as a vital component of Latvian prospective growth, which is primarily to maintain a high level of well-being. To reach this objective, structural reforms restoring competitiveness, raising productivity and boosting employment will be needed.

For example, the labour market needs to function better and incentives for workers need to be further strengthened. Science, technology and innovation are more than ever crucial to boosting growth and jobs, and to addressing global and European challenges: from socio-economic development to climate change, environmental quality, and health.

Therefore, support and sufficient financial resources from the budget will be needed for research, innovation and education. The task is to maintain the willingness for structural reforms, while keeping national economy constantly growing: civil society shall inspire Latvian efforts towards well-being.

The EU institutions have provided Latvian scientific community with some ideas towards prospective research directions. Among most prominent directions could be included *quantum technologies*: the first phase began in 2018 and will last at least three years under the EU's Horizon 2020 programme. The quantum project aims to turn European research activity into industrial implementation within most promising technological developments. Quantum research has a short but fruitful history: the first

quantum revolution expanded global scientific horizons to lasers and transistors used in computers, mobile phones and modern internet. The second quantum revolution has started in the 21st century and is based on the growing ability to sense and manipulate quantum effects in customised systems and materials. This includes totally new concepts for various practical devices with the real practical impact in such spheres as ultra-precise synchronization and enhanced sensitivity devices; guaranteed data privacy and communication security; high-speed computing power in modern computing technologies.

CONCLUSION

National decision-makers will have to approach Latvian scientific and research community as an important part of the whole national socio-economic transition towards sustainable growth. Several external factors, e.g., the EU strategy, the UN sustainable development goals and climate change agreement play a vital role in forming Latvian government's approaches to the national science policy.

However, national political and economic potentials shall be used more actively in, e.g., "green" growth and circular economy, active use of digital/ICT solutions and supporting progressive SMEs. Scientific "component" shall be decisive in the political and economic approaches in defining progressive specialisation sectors in Latvian prospective growth. It is these sectors that are going to form Latvian economic "immune system", with Latvian "industrial renaissance" including all spheres of manufacturing and green economy. Besides, Latvian firms shall have more public assistance in order to have better opportunities for Latvian companies to compete in Europe and other parts of the world.

However, the first comprehensive national science's concept appeared only in 2009, about a decade ago (!) and only by the strong influence from the EU institutions. More in:
https://www.lzp.gov.lv/index.php?option=com_content&task=view&id=148&Itemid=112

There are about 1.8 million researchers working in thousands of European universities, research centres and leading manufacturing industries. By working together across borders, sectors and disciplines, the member states can push the boundaries of science towards developing practical applications that can make difference to people's lives.

The EU institutions have already formulated socio-economic, political and financial commitments for the member states facing future and emerging technologies. The priorities are the following: a) developing a dynamic environment for research and innovation; b) allowing ideas to progress smoothly from laboratories to market; c) attracting and retaining world-class talents; and d) making sure that the EU and the member states remain science leaders in the world.

In some spheres of knowledge, Latvia is having excellent, EU- and world-wide scientific researchers. LAS' belief in Latvian potentials is based on the necessary changes both in the general approach to science with adequate changes to the legal aspects in research and education and the way the academic institutions are currently functioning. The LAS community hopes that this approach will instigate the needed radical changes in the Latvian academic landscape, with a view of "greater science" in national education and research institutions.

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ASSOCIATION OF LATVIAN YOUNG SCIENTISTS – A VALUED PARTNER FOR SCIENCE POLICY MAKING IN LATVIA

Kristaps Jaudzems, Chair of ALYS Work Group on Science and Education Policy

Association of Latvian Young Scientists (ALYS) is a non-governmental organisation founded in 2005 with the aims of 1) representing young scientists in science policy making, 2) promoting networking and exchange of ideas between researchers, and 3) developing and popularising science in Latvia. ALYS is governed and funded by its approx. 250 members, which include both doctoral students and early career researchers within 10 years of their doctorate. The members are affiliated with universities, research institutes and other organisations located in Rīga and Latvia's regions.

While its members are mostly from Latvian research institutions, the activities of ALYS go far beyond our national borders, as the organisation is an active member of EURODOC (European Council of Doctoral Candidates and Junior Researchers) and a national representative at Global Young Academy. ALYS is also a partner of European Young Academies and Northern-Baltic Young Academies cluster. International cooperation provides the possibility to discuss the diverse challenges faced by young scientists all over the world and to exchange experiences on how to tackle them. Furthermore, participation in international young scientist events gives ALYS members the opportunity to contribute to the solving of global science problems such as achievement of the United Nations Sustainable Development Goals or gender equality in academia.

Nationally the association's activities are focused in three areas: science communication, organisation of networking events and science policy making. ALYS recognises the importance of science communication to the general public as well as to the industry and governmental sector. By communicating the stories and research achievements of young researchers from different science disciplines, the association aims to promote the prestige of researcher's profession, engage students in research projects and strengthen the role of science in Latvian society. Active use of social media tools such as Twitter and Facebook has allowed it to reach several thousands of people. Besides, within the past few years ALYS has organised several direct engagement outreach activities, such as "Forum for future scientists" (aimed at pupils), discussions "Ask me anything" and "What are Latvian scientists researching?" as part of the 100th anniversary of the National Library of Latvia (aimed at general public), ALYS Summer camp (partly aimed at industry), and social events "Science brunches" and "Pint of science" (partly aimed at science administrators working in the governmental sector). The latter three events also promote networking and cooperation among researchers, which is another aim of ALYS activities. In addition to those mentioned, ALYS has organised a series of events dedicated to exchange of experiences between doctoral students "Young researcher get-together", the event "How to succeed in science" to share experiences and tips on researcher career advancement, and "ALYS Canoe trip" and hiking tours to enhance social relations between the association members in a non-formal environment.

However, in the author's opinion, the most important focus area of ALYS activities is science and higher education policy, because the decisions

made today will affect the development of science in Latvia and will be felt by the current and future generation of young scientists for years or even decades. Participation in science policy has been the focus of the organisation in the last decade resulting in numerous initiatives. The association unites the voices of the young researchers from different disciplines and brings their views and ideas to the stakeholders of science policy making. This is the task of ALYS Work Group on Science and Education Policy, which is introduced in the next section.

ALYS WORK GROUP ON SCIENCE AND EDUCATION POLICY

Science and higher education policy and governance has been one of ALYS priorities since its establishment. ALYS strives to actively participate in the discussion and improvement of science policy initiatives and research programmes proposed by the Latvian government as well as to develop its own initiatives aimed at systemic improvements in science governance. The goal of these activities is not only to advocate for and help solve the problems of young researchers, but also to contribute to our country's development and transformation into knowledge-based economy. For this purpose, ALYS has established the Work Group on Science and Education Policy, which is responsible for organising internal discussions and surveys, preparing of opinion papers and articles as well as communicating them to the government and other stakeholders. The Ministry of Education and Science of the Republic of Latvia has acknowledged ALYS as the major organisation representing the opinion of young scientists by signing a memorandum of cooperation in 2009. Thus, ALYS is currently one of the most important social partners of the ministry in the area of science and higher education policy.

The members of ALYS Work Group on Science and Education Policy meet at least monthly to discuss matters as well as legislative aspects of science and higher education policy initiatives, research programmes etc. on the political agenda. Discussions between the meetings are facilitated by active use of cloud services. Opinion documents and/or commentary articles are prepared and submitted to the responsible governmental institution or to the media based on the outcome of these discussions. Furthermore, representatives of the work group are regularly invited to the meetings of Committee of Education, Culture and Science of the Parliament of the Republic of Latvia, events organised by the Ministry of Education and Science etc. The chair of ALYS Work Group on Science and Education Policy is also an official member of the Latvian Council of Science (LCS).

Within the past few years, the ALYS Work Group on Science and Education Policy has been involved in the rulemaking for numerous initiatives, the most important being LCS Fundamental and Applied Research grant programme and PostDoc Latvia grant programme. The proposals have been extensively discussed and negotiated with most of the government representatives and research sector stakeholders. However, the greatest efforts in recent years have been invested in the formulation of a new funding model for research institutions.

THREE-PILLAR RESULT-ORIENTED MODEL FOR THE ALLOCATION OF INSTITUTIONAL (BASE) FUNDING

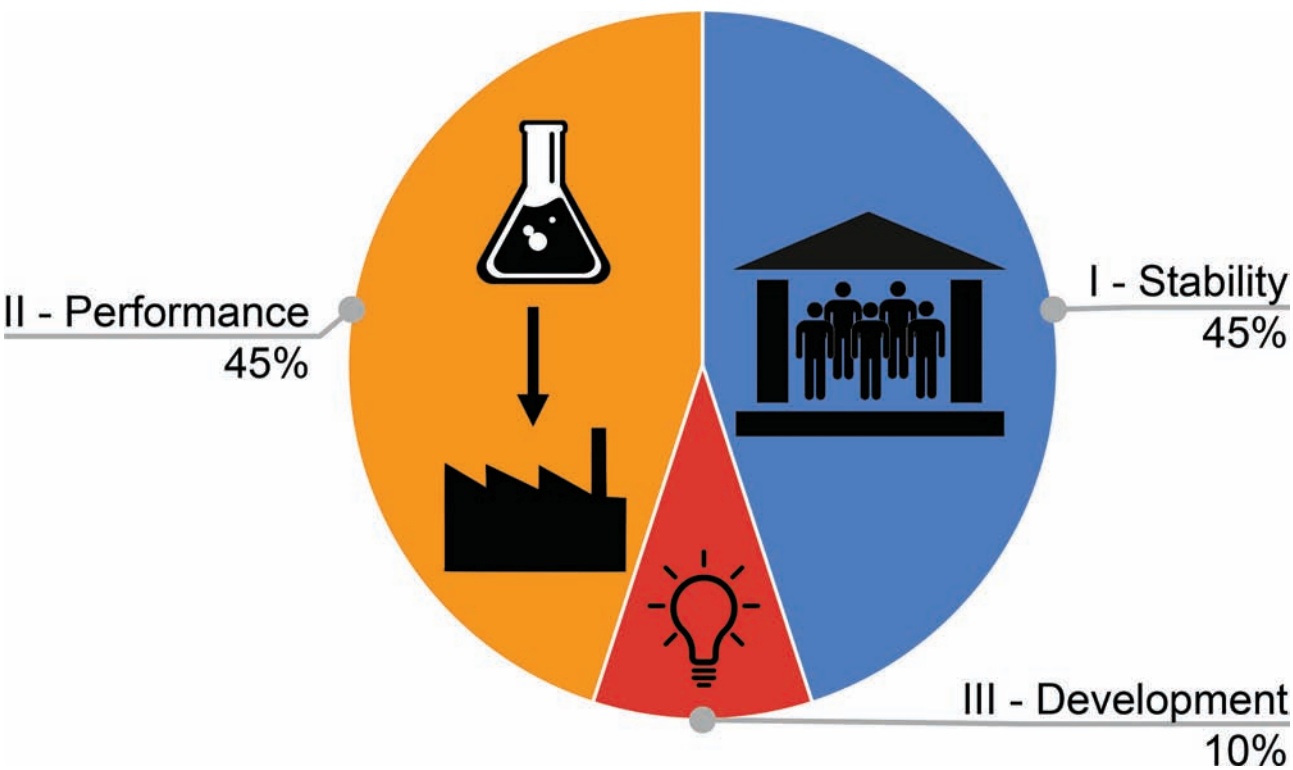
Latvia's expenditure on research and development (R&D) lags far behind other European countries (according to Eurostat data for 2018: Latvia invests 0.64% of GDP in R&D, Lithuania 0.88%, Estonia 1.40%, EU-average 2.11%). As suggested by a study of the Bank of Latvia (https://www.makroekonomika.lv/ieguldijumi-izglitiba-un-zinatne-atslega-izklusanai-no-zemu-ienakumu-slazda) this may result in slow growth of productivity and the country's economy getting stuck in the low-income trap. Investing in education and science in Latvia is the key to getting out of the low-income trap. However, the investment needs to be allocated and managed efficiently in a result-oriented way, as in the more advanced countries we want to resemble.

In summer 2018, the ALYS Work Group on Science and Education Policy started work on a proposal for a new institutional (base) funding model that would enable these preconditions to be implemented on the road to a higher standard of living in the country. A model comprising three pillars was proposed:

the first should ensure institutional stability and growth of the R&D personnel, the second should be based on performance indicators and the third should allow the development of world class infrastructures and research initiatives. The conception involved regular consultations with representatives of the Ministry of Education and Science. Although our views were often different, discussions and reasoning led to the current version of the model that takes into account both the needs of the researchers and the important points of the ministry. The developed concept was discussed with the most outstanding scientists of Latvia – visionaries, as well as other players in the field – representatives of the Latvian Academy of Sciences, Latvian Council of Science, Latvian Chamber of Commerce and Industry, Latvian Trade Union of Education and Science, Latvian Student Union and multiple largest research institutions. All the parties involved proposed ideas, additions and criticisms, which allowed to develop the three-pillar model to a widely accepted initiative across the R&D sector.

The model was introduced to politicians of the Subcommittee on Higher Education, Science and Innovation of the Commission of Education, Culture and Science of the Parliament of the Republic of Latvia on 22 January 2019. ALYS was asked to present its proposal, and the members of the Subcommittee showed their support and willingness to change the current system. The meeting ended with a plan for future meetings to further develop the model.

The final model of the institutional (base) funding allocation mechanism is based on three pillars: 1) stability component proportional to a limited number of group leaders at the institution, 2) performance component calculated based on the results of the institution's scientific performance, and 3) development component. Each state-owned scientific institution shall qualify for and receive institutional (base) funding depending on its numerical



ALYS' three-pillar result-oriented model for allocation of institutional (base) funding.
In the three-pillar model, the first and second pillar funding represent 45% each of the total institutional (base) funding. The funding received from first pillar shall be proportional to the group leader positions allocated to an institution based on its capacity. Performance indicators in the second pillar shall be calculated based on the number of doctoral dissertations defended in the organisation (10% weight), the number and quality of publications produced (30% weight), the amount of research grant funding (30% weight) and the amount of private sector funding (30% weight). The proportion of the third pillar for development initiatives is 10%

indicators (number of group leaders, scientific performance indicators and participation in development projects). In order to create a core of highly qualified and independently funded scientific staff at each institution, the institutions shall receive stable funding for six years for a limited number of internationally recruited research team leaders. The optimal number of group leaders at the institution shall be evaluated by international experts (within the framework of the regular international evaluation of institutions). Every six years, an assessment of group leaders is to be planned. If the performance is good and excellent, the number of institutional group leaders shall be increased. If not, the number of positions shall be reviewed. The second pillar funding component shall be allocated based on the performance of the scientific institutions over the past three years (number and quality of scientific articles published, amount of funding obtained through grants and through collaboration with the industry, number of new doctors prepared). Unlike the funding of project competitions, where scientific groups and institutions compete with the ideas that they intend to realise in the future, the institutional (base) funding shall be allocated on the basis of existing achievements over the previous three years. Funding from the third pillar shall be planned as an investment in initiatives that are crucial to the Latvian research community (for example, joint infrastructure development and sharing for specific purposes).

Representatives of the Ministry of Education and Science have acknowledged the need to revise the current institutional funding model and have committed to start working on the necessary legislation changes for implementation of ALYS' three-pillar model for allocation of institutional (base) funding.

COOPERATION BETWEEN THE INSTITUTE OF ECONOMICS OF THE LATVIAN ACADEMY OF SCIENCES AND THE INSTITUTE OF ECONOMICS OF THE CHINESE ACADEMY OF SOCIAL SCIENCES

Ņina Linde, *Dr. paed.*, Associate Professor, Director of the Institute of Economics of the Latvian Academy of Sciences

Cooperation between two Academies – the Latvian Academy of Sciences (LAS) and the Chinese Academy of Social Sciences (CASS) – began already in 2016, when Academies' Presidents Prof. Ojārs Spārītis and Prof. Wang Weiguang signed the Agreement of Scientific Cooperation recognising the importance of international scientific cooperation in both countries.

In 2019, the Institute of Economics of the LAS took important steps to strengthen mutual relations with the Institute of Economics of the CASS.

On 6 June 2019, the Institute of Economics of the LAS, together with the Institute of Economics of the CASS, and in cooperation with Investment and Development Agency of Latvia (LIAA) organised the international round table discussion on "Cooperation of China and Latvia in scientific and investment field", which took place at the Latvian Academy of Sciences. In order to introduce a wider audience with the current economic situation in China and scientific contribution to China's economic growth, as well as to discuss and define scientific cooperation opportunities between Latvia and China, the event brought together entrepreneurs and researchers, municipality representatives and public authorities, policy-makers responsible for science and investment policy, and journalists. Chinese scientists introduced the audience to the issues of Chinese economic growth, "One Belt, One Road" policy and China's foreign direct investment flow. Latvian scientists emphasised current scientific cooperation of Latvia and China and prospects of its development, but the LIAA representative described investment environment in Latvia and showed the best examples of the projects with China. During the discussion, representatives of both the Latvian and Chinese science sectors discussed the future possibilities of cooperation opportunities between the two countries in the field of research and investment, including European grant programmes, and talked about future project ideas in economic and educational fields. The meeting was marked by the signing of Cooperation memorandum between the Institute of Economics of the LAS and the Institute of Economics of the CASS.

Chinese delegation was represented by Prof. Pei Changhong, former director of the Institute of Economics of the CASS, Prof. Liu Xiahui, chief editor of the *Journal of Economic Research*, *Dr.* Xie Qian, associate chief editor of the *Journal of Economic Research*, and *Dr.* Chen Xin, assistant professor of the Institute of Economics.

Prof. Pei Changhong presented Chinese foreign investment flows and Chinese investment in countries involved in the Silk Road initiative. The professor mentioned the need to improve the information platform on Silk Road's external investments and to

The international round-table discussion "Cooperation of China and Latvia in scientific and investment field" was opened with welcoming speeches by the President of the Latvian Academy of Sciences *Dr*. Ojārs Spārītis (in the middle), by Director of the Institute of Economics of the Latvian Academy of Sciences *Dr*. Ņina Linde (on the left) and by former director of the Institute of Economics of Chinese Academy of Social Sciences (CASS) Prof. Pei Changhong (on the right), 6 June 2019

Director of the Institute of Economics of the Latvian Academy of Sciences *Dr*. Ņina Linde together with delegation of researchers from China during the III International Economic Forum, 31 October 2019

Prof., *Dr.* Chen Xin, Deputy Director General of the Institute of European Studies of the Chinese Academy of Social Sciences, welcome speech during the III International Economic Forum, 31 October 2019

reduce information asymmetry, meaning to obtain sufficient information from all interested parties. The discussion raised interest in scientific cooperation with China and joint projects, while representatives of the Institute of Economics of the CASS expressed their interest in launching scientific and academic cooperation with the Baltic States, and in particular, with Latvia.

To give more insight to Chinese researchers on business environment in Latvia, participants of the round table discussion visited the company "Madara Cosmetics", which is the leading company in Latvia in the field of cosmetics, with innovative production approaches.

Institute of Economics of the LAS invited Chinese colleagues to visit and speak at the III International Economic Forum, which covered topics such as business support, disruptive factors, science-based solutions, and international cooperation.

The International Economic Forum is annually organised by the Institute of Economics of the LAS, bringing together scientists, entrepreneurs, politicians from more than 20 different countries. On 31 October 2019, a delegation of researchers from China came to Latvia in the lead of Pei Changhong and *Dr.* Chen Xin to present and discuss China's positive experience in the digital economy. At the opening ceremony of the III Economic Forum. *Dr.* Chen Xin welcomed the Forum guests with an inspiring speech. Pei Changhong, Professor of the University of Chinese Academy of Social Sciences, who has a broad range of experience in the field of science, spoke about the newest trends of Chinese economic growth, digital economy, and Asian experience. Prof. Pei Changhong is also president of the Academic Association for China's Commerce and a member of the National Committee on the 13th of CPPC. He has engaged in the research on Political Economics and China's Open Economy fields in the long run.

His representative works include 60-years of China's Foreign Trade, China's Open Economy in Post-crisis Era, Building an Open Economy for 40 years in China. As Prof. Pei Changhong's typical essays include Global Economy Governance, Public Goods and China's Opening Up, Quantitative Estimation of Public Ownership's Dominant Position and its Development Trend in China, and the Analysis of Political Economics on the Digital Economy, his presentation was a great way of exchange of experience and gave a broad view for the participants of III Economic Forum about the development of economics in China. In his presentation, Dr. Pei Changhong introduced the newest economic strategy in China and how the development of China's e-commerce and mobile payment is going on the front rank around the world and as well as how it

has changed the structure of enterprises and organisations and created new challenges. Members of the delegation of the Institute of Economics at CASS, later on, participated in the overview discussion with the speakers and experts.

In addition, in 2019, the Institute of Economics of the LAS and the China-CEE (Central and Eastern Europe) institute agreed on strengthening the cooperation in the field of science. As the Chinese Academy of Social Sciences had established a think-tank at Budapest (China-CEE Institute) and is publishing weekly briefings on the countries in Central and Eastern Europe, as well as on Greece, it was agreed that the Institute of Economics of the LAS is going to provide weekly briefings to the China-CEE Institute regarding domestic policy, economy, social development, as well as external relations in Latvia. Weekly briefings are published and available at the website of the China-CEE Institute (www.china-cee.eu).

Prof. Pei Changhong took an active part in the experts' discussion during the III International Economic Forum, 31 October 2019

LIFE SCIENCES

VALUES OF LATVIA'S NATURE IN FOCUS OF RESEARCH: FROM BASIC SCIENCE TO APPLICATIONS IN INDUSTRY

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The science as nearly everything has fashionable problems and if the discussion handles "priority research areas", "smart specialisation" etc., actually the discussion touches on something fashionable at the current moment. However, fashion in science, just as everywhere, is changing quite rapidly, the new ideas not always survive as time goes on. Thus, for a country like Latvia it is of importance to keep research directions that are significant for local society, where the studies made in Latvia can contribute to the field of research internationally, and where Latvia is just the right place to study the problem.

One of such directions of research is studies of bogs and peat. The first point: Latvia is if not the only one, but one of not so many countries, where bogs, their ecosystems and other related aspects can be studied – as in Western Europe and many other countries these are fully destroyed or significantly altered. Secondly, there are good traditions and huge experience accumulated in this kind of studies, starting from first Baltic German scientists describing bogs in Latvia, continuing with studies during the first period of Latvia's independence period, by Pēteris Nomals (1876–1949), who worked with modern methods in bog research, continuing with studies coordinated by the State Peat Institute. Hence in Latvia we have history, presence and definitely a future of bog and peat research.

Presence of bog and peat research has diverse faces: both researchers working on different topics and significantly differing targets of the research. One of the key directions in bog research is directly related to climate change problems, analysis of the climate of past – studies of paleoclimate. Bogs in this respect can serve as living archives of the past and reflect the climate change character (natural climate change) over past 10 000 years as well as contemporary, human-induced changes, and provide the possibility to reconstruct not only temperature, but also precipitation, drought and other climate impacts of the part of the whole Baltic region as demonstrated in studies of Laimdota Kalniņa [1] and Normunds Stivriņš [2] and others. As archives of the past, bogs store information also about the history of pollution and when analysing the peat composition we can see the impact of recent human pollution, the presence of radionuclides coming from first Soviet nuclear tests, accumulation of trace elements in the upper layers of bogs (Inese Silamiķele [3]) and adverse impacts of intensification of agriculture on bog ecosystems. The use of plant pollen remains (palynology) can be used to study the changes of landscape, agricultural practices and, for example, the impacts of crusaders, in 12th–13th centuries, on agricultural practices in Latvia.

Of course, bogs are not only the past but also the present, and bog landscapes are a unique landmark for Latvia. Not in many branches of science we can speak about "Rīga research school", but this is true about landscape science represented by Professor Aija Melluma, Professor Oļģerts Nikodemus [4], Assistant Professor Anita Zariņa [5] and others. The Rīga Landscape School studies it from the perspective of human–nature interactions, and recently new remote sensing technologies (studies

Peat profile sampling – *Dr. geogr.* Oskars Purmalis at field work. Photo: L. Arbidāns

Researcher Linda Ansone-Bērtiņa is studying properties of peat humic substances

of Zigmārs Rendenieks) are applied to identify complex effects in nature. A special object of landscape studies in Latvia are bog, e.g. by Anita Namatēva revealing the need to protect natural bogs and their significance also from the perspective of national identity.

Unique bog ecosystems are the topic of studies for biologists, covering all levels of living nature, analysing biodiversity and elaborating biological diversity conservation measures to protect it. The next level of bog biodiversity includes studies of bog ecosystem services. Since bogs and wetlands cover more than 10 per cent of the territory of Latvia, they are really important in stabilising of hydrological regime, microclimate and many species of living organisms. One of plant species in bogs

are mosses – a unique group of lower plants. Recent studies of moss composition demonstrate a huge potential of their application in biomedicine, agriculture and food industry [6]. Bog berries are a rich source of biologically active substances with a wide application potential in biomedicine, thus unveiling a new dimension of the significance of natural resources [7].

Not only bog biota, but also peat is a significant natural resource, and peat mining in limited amounts to produce growth substrates is of importance for national economy as well as for regional development of Latvia. Nowadays, traditional peat mining as a result of close cooperation between scientists and peat producers is transformed into sustainable and wise use of bog resources: mining includes bog restoration (renaturalisation of exhausted sites), redevelopment and support to semi-natural use of bogs – paludiculture: growth of berries and other cultures in peat mining sites. Thus, research contributes to mitigating adverse impacts of intensive mining, but at the same time supporting creation of job positions and sustainability of the country [8].

Peat is a rich source of humic substances, and their research is of importance to study living organic matter transformation (humification) process within the carbon biogeochemical cycle, properties and structure of humic substances, but also perspectives of their application in industry and agriculture [9]. Peat humic substances as the refractory element of carbon flows is one of major storage of carbon compounds on the Earth, and their studies can help to understand of CO2 release from organic matter during its decay. Their studies can enrich knowledge on organic carbon flows and impacts on the environment in the context of climate change process. On the other hand, peat humic substances have the ability to bind metals and toxic trace elements and thus can be used in medicine and technologies, their application improves fertility of soils and have huge potential for applications as biostimulants in agriculture. This part of research is going on in close cooperation with industrial enterprises that are interested in the production of humic substances and have a direct application potential in various fields [10].

Thus, traditional research directions in Latvia concentrating on a nationally significant study object is of importance for rational use of national resources, their protection, and confirm a high level of science in Latvia and international visibility in scientific community. Peat and bog studies are attracting students and will provide the continuity of this direction of research.

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RESEARCH OF MITOCHONDRIAL FITNESS: FROM HEALTHY AGEING TO INFLAMMATION

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ENERGY, MITOCHONDRIA AND HEALTHY AGEING

The energy is vital. For our every movement or thought cells rely on energy generated by mitochondria. Organism uses energy in a "non-stop" mode, thus, the maintenance of normal mitochondrial function is essential. Every research that deals with living organisms meets energy requirement aspect and, thus, faces mitochondria. As Dr. Nick Lane from the Department of Genetics, Evolution and Environment, University College London, said, "The underlying principles are universal. Even aliens need mitochondria."

More and more researchers aim to address the following questions of mitochondrial research:

- Since the child inherits mitochondria from his mother, the aspect of gender gets even more intriguing in mitochondrial research; is there any difference between male and female mitochondria?
- The population of the world is ageing rapidly, and this sets social and economic challenges. Quality of life becomes an important aspect in ageing society. Healthy ageing is one of the most important topics in the nowadays research. Do mitochondria get old together with us? Or mitochondria determine that we are getting old?
- The environment and lifestyle are key factors in the quality of life. These factors determine mitochondrial health – how fit are our mitochondria; thus, determine our fit and well-being. Can we, by changing lifestyle, improve our mitochondrial fitness?

While a growing number of studies focuses on genome, including mitochondrial DNA (mtDNA), proteome, metabolome and other "-omics" to explore the "secret" of healthy ageing, the mitochondrial function remains comparatively unexplored, but may turn out to provide key information for healthy ageing and to prevent diseases. For example, a physically active and nutritionally healthy lifestyle induces mechanisms that maintain aerobic performance and support mitochondrial health. Functional mitochondrial competence and aerobic fitness reduce several age-related health risks, including type 2 diabetes, depression and Alzheimer's disease; whereas a sedentary lifestyle not only has a negative impact on mitochondrial function, but also is a major risk factor for the development of metabolic and neurodegenerative disorders. Overall, how well we feel is directly dependent on how fit and well are our mitochondria. The measurements of mitochondrial physiology provide novel insight not only into different disease pathogenesis, but also gives an opportunity to identify novel targets for intervention (nutritional, physical, pharmacological) to improve the quality of life and find treatment against diseases.

MITOCHONDRIA AND IMMUNE CELLS

Like each type of tissues has it own characteristics, mitochondria from different tissues differ. They have their own specific needs, abilities and capacities. For example, heart has enormous energy demands and is fully "packed" with mitochondria that normally are working at their highest capacity. On the other hand, adipose tissues, the main function of which is storage of lipids, have only few mito-

chondria per cell that normally are not working at their maximal rate. Although studies into mitochondria and metabolism of immune cells date back a few decades, it has only been in recent years that the tight link between bioenergetics and function has become apparent. Immune cells have a unique ability to rapidly respond to inflammation, infection, and other perturbations (like Western high fat and/or high carbohydrate diet and sedentary lifestyle). This "fast response" ability is bioenergetically expensive and should be supported by a unique and flexible way how cell gets energy to support its functioning. Metabolic choices (which substrates and how much cell "consumes/utilizes" to get energy as ATP) are recognised as characteristics and controllers of immune cell activation. Collectively, studies on immune cell energy metabolism state that the pro-inflammatory immune cells have reprogramming of metabolism from mitochondrial oxidative phosphorylation to glycolysis, while anti-inflammatory-activated cells rely on oxidative phosphorylation and fatty acid oxidation. However, data on time-dependent changes in metabolic choices of immune cells are lacking (Fig. 1). Understanding of how a cell gets energy at each state of activation could provide the basis for metabo-

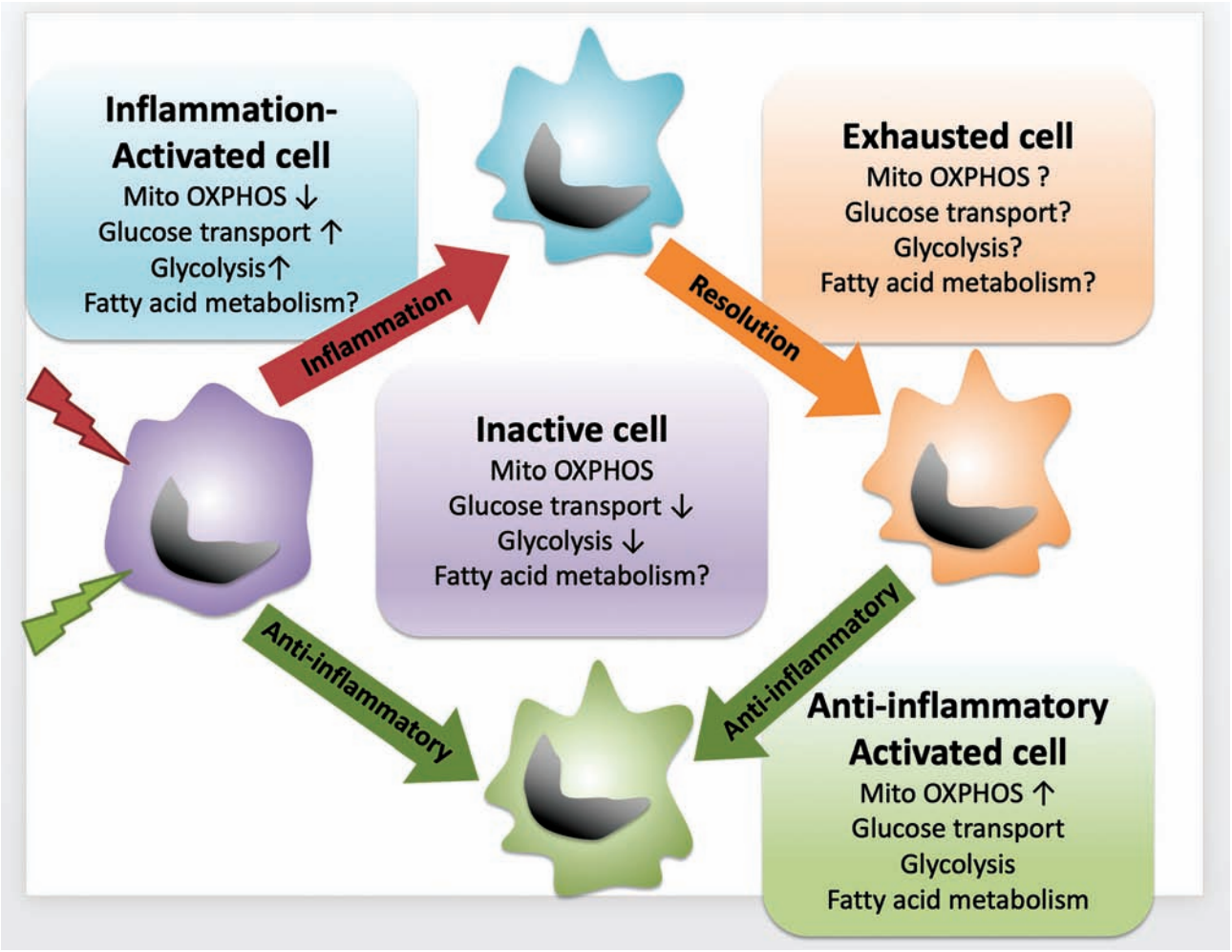

Fig. 1.
Energy metabolism pattern in immune cells

lism-targeting therapies to restore/support cell functioning, thus, ensuring better recovery and outcome after acute inflammation (like sepsis).

MITOCHONDRIA, IMMUNE CELLS AND HEALTHY AGEING

Unhealthy diet, sedentary lifestyle, and ageing result in the loss of mitochondrial function, chronic inflammation and subsequent development of diseases like diabetes mellitus, atherosclerosis, heart failure and neurodegenerative disorders. Changes in the mitochondrial function and energy metabolism pathways are associated with the response of immune cells to stimulus (like inflammation). Metabolic diseases (like diabetes, atherosclerosis) are characterised by both altered mitochondrial function and chronic inflammation status, thus indicating that there is a possible link between immunity and mitochondrial function.

A growing number of studies on mitochondrial function in human blood cells have showed association of impairment in bioenergetics of immune cells neurodegenerative diseases, depression and heart failure [1]. Moreover, studies showed that there is a strong link between alterations in mitochondrial function of immune cells and inflammation status [2]. Altogether, these data indicate that there is a crosstalk between mitochondrial fitness in immune cells, inflammation and functioning of other organ systems. Since it is well documented that a physically active and nutritionally healthy lifestyle supports normal mitochondrial functioning, immunity status and reduces the risk for the development of diabetes, cardiovascular and neurodegenerative disease, the questions arise if immune cells are ensuring crosstalk between organs on bioenergetics level (Fig. 2).

CONCLUDING REMARK

Research of immune cell bioenergetics provides the basis for novel approaches for treatment of acute and chronic inflammation-related diseases, as well as shows that immune cells can act as an organ-to-organ communication tool on bioenergetics level.

ACKNOWLEDGEMENT

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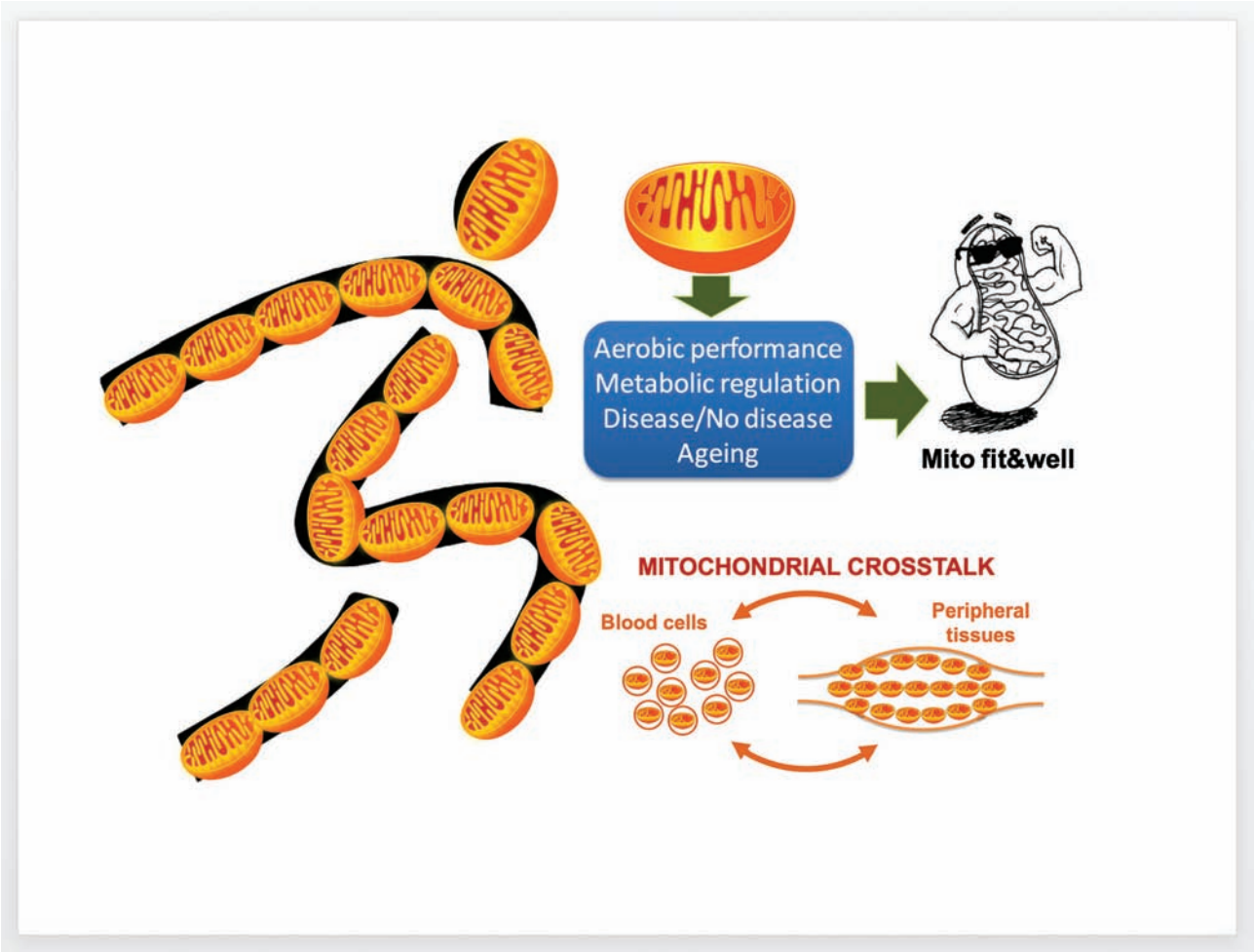

Fig 2.
Mitochondrial fitness and bioenergetic crosstalk

BALTIC BIOMATERIALS CENTRE OF EXCELLENCE PROJECT WILL BOOST BIOMATERIAL RESEARCH IN THE REGION

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On 1 January 2020, the Baltic Biomaterials Centre of Excellence (BBCE) for advanced biomaterials research and development will be launched based on the long-term strategic cooperation between Rīga Technical University (RTU), Latvian Institute of Organic Synthesis (LIOS), Rīga Stradiņš University (RSU) and LLC Rīga Stradiņš University Institute of Stomatology (RSU IS), on the one part, and AO Research Institute Davos, Switzerland (ARI) and Friedrich-Alexander University of Erlangen, Nuremberg, Germany (FAU), on the other part.

The strategic direction of the BBCE is research and development of patient-specific personalised solutions for bone tissue regeneration. BBCE will ensure a full cycle of bone regeneration biomaterial development starting from the materials, preclinical investigations, and finally, the clinical trials. The BBCE project will be implemented under the European Commission's Horizon 2020 Spreading Excellence and Widening Participation Teaming Phase 2 programme that funds actions to create new centres of excellence in low Research and Innovation (R&I) performing countries, built on partnerships between leading scientific institutions and partner institutions in low R&I performing countries. EUR 15 million has been awarded to finance the establishment of the centre through the EU's programme Horizon 2020. Raised EU funding is only a half of the total funding ensured for the establishment of the BBCE. Another EUR 15 million for infrastructure development will be provided by the Government of Latvia, European Regional Development Fund and the project partners in Latvia themselves.

Europeans are an aging population, and although the number of lived years increases, the number of "healthy life years" stays at the same level or grows slower, leading to an increased demand for health care services. Especially, the need for bone joint replacement implants and bone replacement implants is increasing with older age. Musculoskeletal conditions are the second largest contributor to disability worldwide (affecting, e.g., joints (osteoarthritis, rheumatoid arthritis, psoriatic arthritis, gout, ankylosing spondylitis) and bones (osteoporosis, osteopenia and associated fragility fractures, traumatic fractures)). These are not just conditions of

Fig. 1.
Below: the agreement on the establishment of the Baltic Biomaterials Centre of Excellence (BBCE), signed by Jānis Ločs, Coordinator of the BBCE, and Director General DG RTD Mr Jean-Eric Paquet. Photo: His excellency President of Latvia Egils Levits, First Lady of Latvia Andra Levite, BBCE project partners and EC representatives at the BBCE kick-off meeting on 29 January 2020, Rīga, Latvia

European Commission

The Horizon 2020 Spreading Excellence & Widening Participation programme celebrates new excellent research partnerships across Europe

Following evaluation by an international panel of independent experts the European Commission awards **€15 million** to

BBCE

2018 Teaming Phase 2 project

coordinated by **Rīgas Tehniskā universitāte** in partnership with

Latvijas Organiskās Sintēzes Institūts (LV)
Rīgas Stradiņa Universitāte (LV)
SIA Rīgas Stradiņa Universitātes Stomatoloģijas Institūts (LV)
AO-Forschungsinstitut Davos (CH)
Friedrich-Alexander-Universität Erlangen Nürnberg (DE)

to develop a **Centre of Excellence** in Latvia.

Congratulations on this outstanding initiative and your contribution to bridging the Research & Innovation divide in Europe.

Brussels, 24 September 2019

Jean-Eric Paquet,
Director General for Research and Innovation

Janis Ločs,
On behalf of the project

Research and Innovation

older age – they are relevant across the life-course, typically characterised by pain and limitations in mobility, dexterity and functional ability, reducing people's ability to work and participate in social roles with associated impacts on mental wellbeing, and at a broader level – impacts on the prosperity of communities. Joint disorders, for example, constitute for more than a half of all the chronic conditions of persons aged 60 and over, while back pain is the second leading cause of sick leave. The data of the Latvian Central Statistical Bureau show that in 2013, 36% of Latvian population was older than 50 years and 14.2% – older than 70 years. The prognosis for 2050 is alarming – 52% of the population will be older than 50 years and 23% will be older than 70 years. Increased longevity leads to: 1) a higher number of bone joint implants and bone replacement; 2) increase of healthcare costs for drugs and surgery, and 3) loss of productivity. Osteoarthritis currently affects over 40 million Europeans and 80% of people with osteoarthritis have restricted movement, and 25% of them cannot even perform their main daily life activities. For example, annual

costs in United Kingdom for the topical and oral nonsteroidal anti-inflammatory drugs that are prescribed after surgeries were estimated to be EUR 26.8 million and EUR 35.8 million, respectively. As the world's population is ageing, the extent of the problem will increase, causing a huge burden on the societies and health care systems.

Dental health is one of the most important factors for healthy ageing. Technological advances in the dental implantation are the milestone for the excellent results, sustaining patient's life quality and aesthetic self-esteem. Additionally, from the beginnings of the modern dental implantology, numerous projects regarding the selection of patients, treatment protocols, surgical technology and bone substitute materials have been implemented, indicating the lack of the ideal method and material. One of the most topical issues related to this multi-factor problem is the selection of the best-performing bone substituting materials and its clinical approbation. This is also one of the major issues in periodontology, where bone replacing materials are used to promote the bone formation and periodontal regeneration.

Therefore, the first seeds for the foundation of BBCE have been put in the ground already more than 20 years ago through joint multidisciplinary research project between RTU, RSU, and RSU IS on biomaterials development and bone tissue regeneration, which resulted in translation of biomaterials research into the clinic. Development and implementation of Teaming Phase 1 was the "catalyst" to initiate establishment of BBCE, and in June 2018, the agreement between BBCE core partner consortium (RTU, LIOS, RSU, and RSU IS) was signed.

Based on the RIS3 in Latvia and Germany, as well as of the Switzerland's research strategy directions, it is clear that establishment of BBCE in Latvia will have national support in all project partner countries; therefore, the success rate for the implementation of the project is very high and credible. The linkage between the project partners and RIS3 is summarised in Figure 2.

EU Structural Funds Programme for Research and Innovation for the period of 2014–2020 that is directly targeted at promotion of RIS3 fields in Latvia (total budget of EUR 115.3 million) as well as many other state budget and EU funds financed pro-

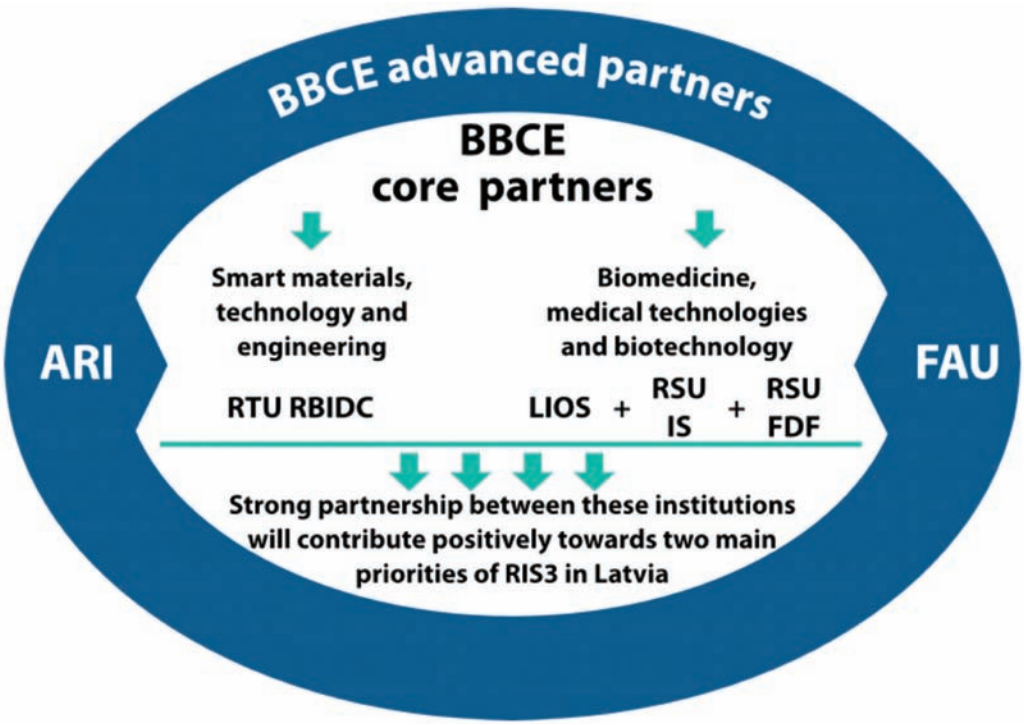

Fig. 2.
Linkage between BBCE partners and RIS3 in Latvia

grammes, aimed at RIS3 facilitation, contribute to achieving RIS3 micro level indicators. However, the planned outcome indicators (e.g., investment in R&D as a percentage of GDP, private sector investments in R&D, the number of R&D personnel) may not be achieved by the current policy mix, indicating a need for a revision of incentives created by the programmes. Hence BBCE **will ensure sustainable quality of the research and technology transfer potential in the field of biomaterials for medical applications**, mainly focusing on areas possessing the best available scientific and research capacities (identified in the National RIS3) – in particular on research of biomaterials, advanced materials, nanotechnology, biomedicine and biopharmacy.

The activities of the BBCE will provide an opportunity to combine existing expertise and infrastructure to create critical mass and excellence in the development of biomaterials for bone regeneration and solutions for creative biomedical applications. The expected impact of the BBCE project in the long term will be achieved through fruitful cooperation between the BBCE core partners in Latvia and industry (including small and medium-sized enterprises) bringing the high performance products into the market, increasing scientific excellence, elevating the impact factor of peer-reviewed publications and Hirsch index in the field of biomaterials. Collecting the "critical mass" of high-level scientists and/or technology developers will be achieved ensuring career development to provide highly-qualified staff at BBCE core partners able to work in a multinational and interdisciplinary environment and capable to cope with their future career demands in an efficient and innovative way.

The BBCE headquarters will be located at the RTU campus in Ķīpsala (Fig. 3), and will be based on the Rūdolfs Cimdiņš Rīga Biomaterial Innovation and Development Centre (RBIDC). Furthermore, the research infrastructure of LIOS, RSU, and RSU IS will be expanded to provide a full-fledged platform for the full development cycle of new biomaterials. Significant impact of the BBCE on all national partners is foreseen in the development of infrastructure, strengthening research excellence, cooperation ability with industry and valorisation intensity (Fig. 4).

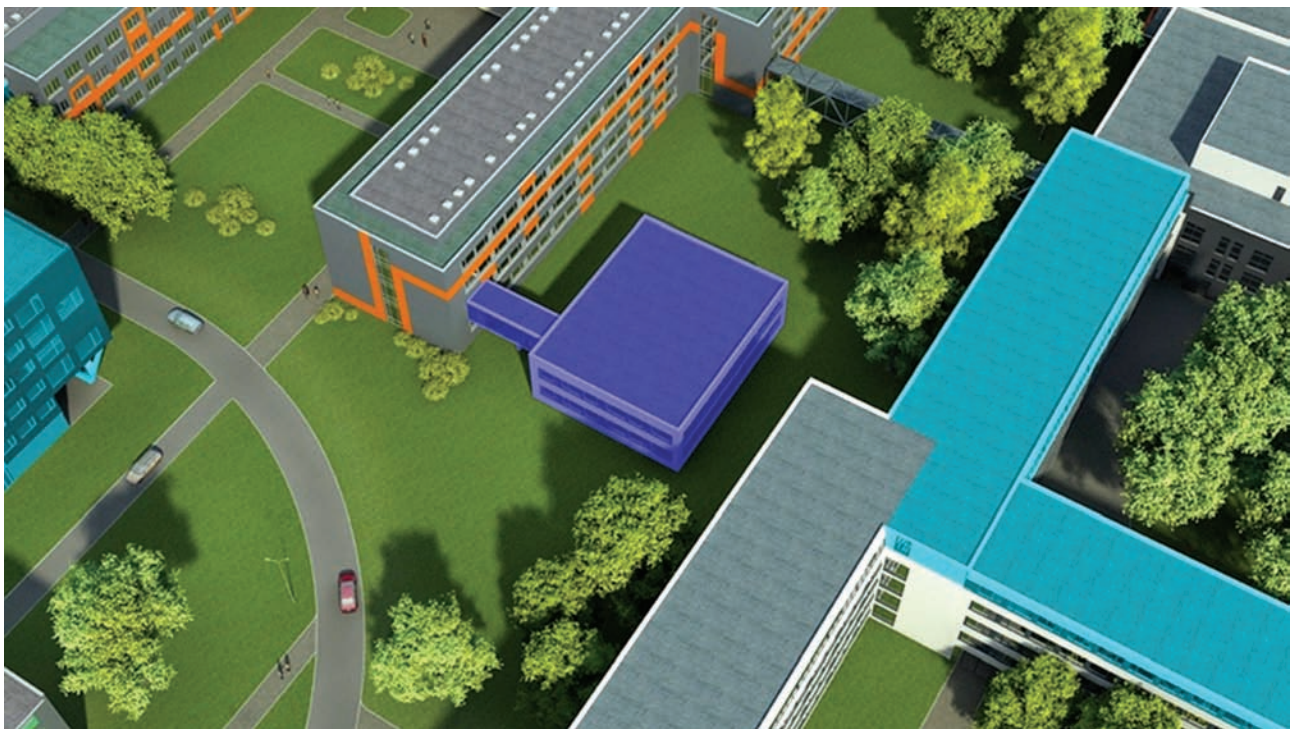

Fig. 3.
BBCE headquarters at the RTU campus in Ķīpsala (Rīga, Latvia)

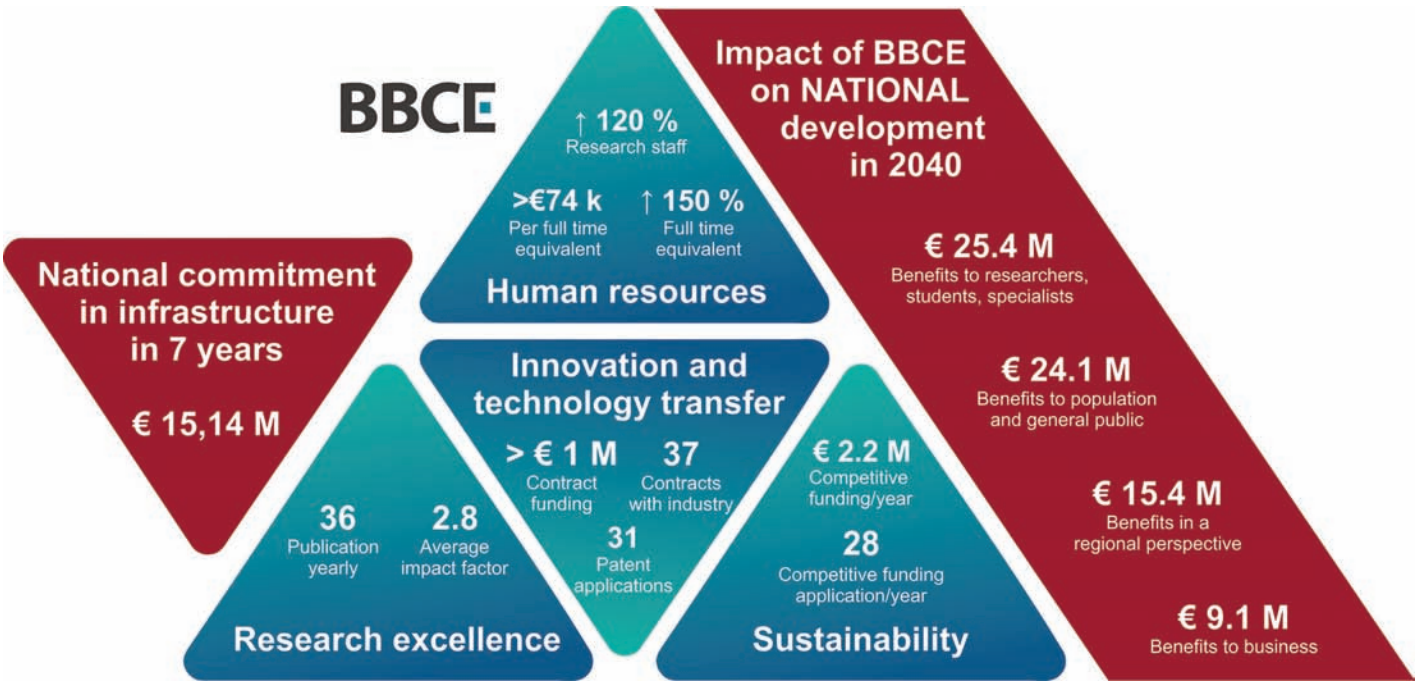

Fig. 4.
Impact of BBCE on the national development

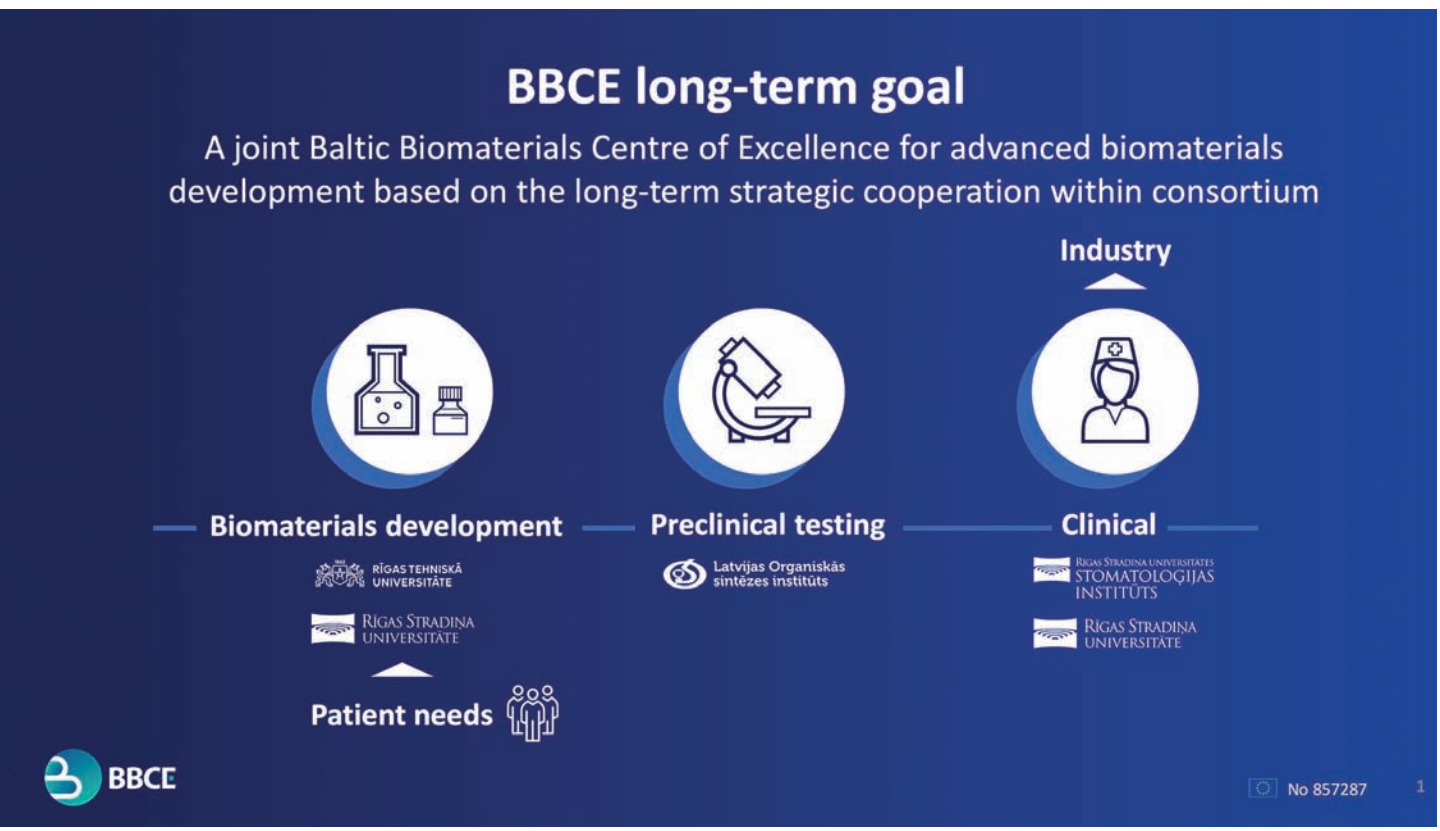

Fig. 5.
Full cycle of biomaterials development for bone regeneration

The RBIDC is a part of RTU. RTU RBIDC scientists are working on well-defined materials science research areas for bone tissue replacement and regeneration. Materials such as calcium phosphate ceramics and bone cements as well as phosphate glasses and glass-ceramics are historically developed research areas in RTU RBIDC for more than 20 years. More recent research fields include also calcium phosphate and polymer composites, microencapsulation of biologically active substances, scaffolds for controlled drug delivery and nanostructured implant composites with drug eluting properties. RTU RBIDC is the biggest and the most modern biomaterial research centre in the Baltics. LIOS is the leading centre in medicinal chemistry and drug discovery in the Baltic states, and the Laboratory of Pharmaceutical Pharmacology (LPP) has vast experience in preclinical testing of biological/pharmacological activity in *in vivo* and *in vitro* systems and ADME-tox studies. In future LIOS plans to implement the Good Laboratory Practice (GLP) system for the general toxicology studies in rodents. LIOS combines basic research practices with applied research to ensure impactful management of intellectual property. There has been a long-lasting cooperation between RTU RBIDC and LIOS on investigations of biomaterials developed in RTU RBIDC. RSU is the leading academic and research institution in the field of medicine, dentistry and pharmacy in Latvia. It holds a unique place in Latvian scientific field, providing a full research translation cycle from bench to bedside. Currently, RSU is running a project to set up a new Finished Dosage Form Laboratory (FDF) to promote research in pharmaceutical technology. It is planned that the lab will be set up in 2022 and it will gradually expand its research area from oral solid pharmaceutical dosage forms to biomaterials as drug delivery systems. Biomaterials developed at RTU RBIDC, in cooperation with clinicians from the RSU IS, have been tested in clinical practice in more than 400 patient cases. RSU IS is the only dental medicine and oral and maxillofacial surgery institution in Latvia that, in addition to multidisciplinary clinical work, also fosters academic and scientific activity in the field of stomatology. RTU RBIDC research fields and scientific capacity will be the core for the development of BBCE and by adding the crucial experience of RSU FDF, RSU IS, and LIOS LPP research fields, full-cycle development of biomaterials will be covered.

Two leading research organisations with an international reputation in research and innovation excellence will contribute towards the establishment and growth of BBCE: ARI, fosters excellence in applied Preclinical Research and Development within trauma and disorders of the musculoskeletal system and translation of this knowledge to achieve more effective patient care worldwide; and FAU, focuses on the design, fabrication and characterisation of a wide range of biomaterials, which includes bioceramics, bioactive glasses, composites, for tissue engineering scaffolds, nanoscale drug delivery systems and bioactive coatings.

BBCE scientists will research and develop new biomaterials for bone repair, as well as facial, oral and jaw surgery, orthopaedics and in other areas. The project is intended to bring together the strengths of each of the partners in strategic scientific expertise and creating a centre of excellence for comprehensive biomaterial research, with an emphasis on regenerative bone materials (Fig. 5). The knowledge generated by BBCE is expected to have a high technology transfer potential and contribute to the development of an innovative industry in Latvia. It is intended that the BBCE in Latvia will facilitate the development of the medical technology and biomaterials research industry by providing a complete product development cycle from the laboratory to the clinic. The BBCE will also make a significant contribution to the development of national research infrastructure, attract prominent foreign scientists, faculty, and students, strengthen researcher collaboration with the industry and attract foreign investment in the area of research.

PORTABLE DEVICE FOR EARLY NONINVASIVE DIAGNOSIS OF SKIN CANCER

Ilze Ļihačova, University of Latvia, Institute of Atomic Physics and Spectroscopy
Aleksejs Ļihačovs, University of Latvia, Institute of Atomic Physics and Spectroscopy
Dmitrijs Bļizņuks, Rīga Technical University, Faculty of Computer Science and Information Technology

From the left: Aleksejs Lihačovs, Ilze Lihačova, Dmitrijs Blizņuks

TOPICALITY AND AIM OF THE RESEARCH

Skin melanoma is a malignant skin cancer whose incidence is increasing every year worldwide. Especially it is widespread in industrialised countries, where most of all are fair-skinned people. It is estimated that the incidence of skin melanoma will increase by 22% in 2019 [1]. Early diagnosis is very important for skin melanoma patients – the sooner melanoma is detected, the more likely it could be cured completely. However, it is not easy to distinguish skin lesions even by experienced professionals. For example, Figure 1 shows various skin formations that are not so easily distinguished visually.

Currently, there are several issues that make early diagnosis of skin melanoma difficult:

- patients' low awareness of skin melanoma, its risks and prevalence;
- low availability of specialists in rural areas;
- high cost of dermatologist or oncologist's consultation;
- long queues for state-funded specialist's (dermatologist, oncologist) consultation;
- subjectivity of experienced professionals during diagnostics (sensitivity and specificity for melanoma detection varies from 58–73% and 53–69%, respectively) [2];
- additional diagnostics with expensive equipment by trained technicians.

To solve these problems, it is necessary to create an easy-to-use and inexpensive skin diagnostic device that could be used by general physicians in routine patient screening. The development of such an equipment is the aim of our groups scientific work.

METHOD AND DEVICE DEVELOPMENT

Method using optical density images. The portable device developed for early contactless diagnosis of skin cancer is based on the methodology developed by I. Lihačova (ex. Diebele), which was first published in 2012 [3]. The method was developed based on differences in the average optical density (OD) spectra of skin lesions obtained with a multispectral imaging camera (see Fig. 2) [4]. The melanoma diagnostic parameter p' was created by combining three optical density images at the following wavelengths: 540 nm, 650 nm, and 950 nm. It was

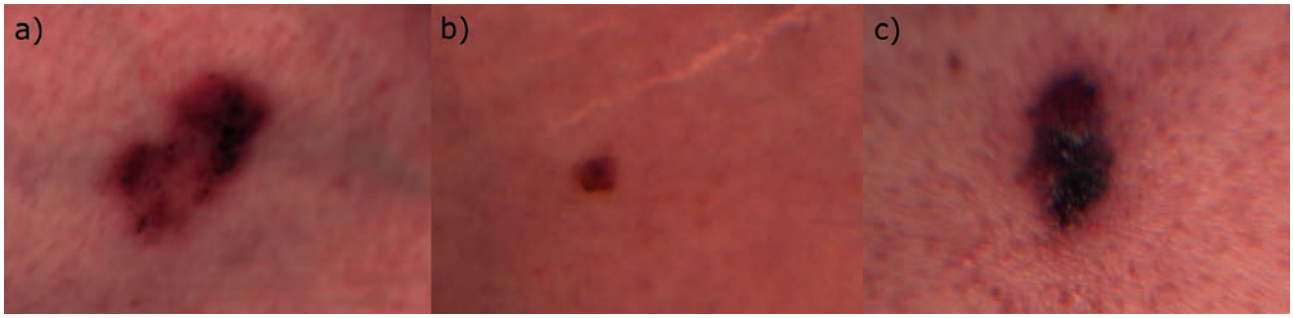

Fig. 1.
RGB images of a) basal cell carcinoma, b) nevus, and c) melanoma

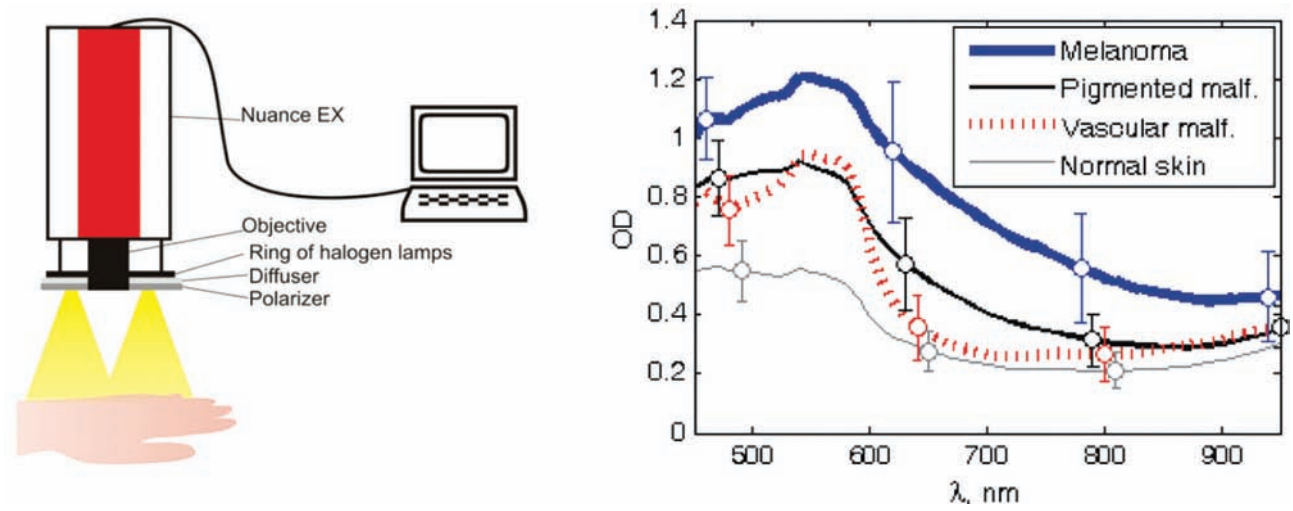

Fig. 2.
Multispectral imaging setup and average OD spectra from melanoma, benign pigmented lesions, vascular lesions and normal skin [6]

possible to distinguish melanomas from nevi with high-sensitivity (97%) and specificity (96%) and differentiate pigmented basal cell carcinomas from nevi and melanomas with 100% sensitivity and 95% specificity [5].

Method using autofluorescence intensity. To increase the number of studied lesion groups, the method was supplemented with skin autofluorescence (AF) measurements. By measuring the intensity of skin autofluorescence (405 nm excitation) in the spectral range of 515–700 nm, it was possible to distinguish seborrheic keratoses from basal cell carcinomas, melanomas, pigmented and dysplastic nevi. It was obtained that seborrheic keratoses unlike the other lesion groups show higher fluorescence intensity than the surrounding skin (see Fig. 3). Results showed that it is possible to discriminate seborrheic keratoses from other lesions with 100% sensitivity and 100% specificity. These results were described in an article by A. Lihačovs in 2018 [7].

Adapting methods to a portable device. By simplifying the previously developed method now diffuse reflectance images were used instead of optical density images for the melanoma diagnostic parameter p' calculations. Based on the above described methods (diffuse reflection and autofluorescence) and combining them, a portable device (Fig. 4) was created using 405 nm, 526 nm, 663 nm, and 964 nm light-emitting diodes (LEDs), diffuser, orthogonal placed linear polarisers, 515 nm long pass filter, lens, and IDS camera [8]. The diodes were selected as close as possible to the wavelengths used in the developed methodology.

Using developed device clinical measurements were initiated and the first results were promising – melanomas can be distinguished from basal cell carcinomas, nevi, seborrheic keratoses, hyperkeratoses, and hemangiomas with 100% sensitivity and

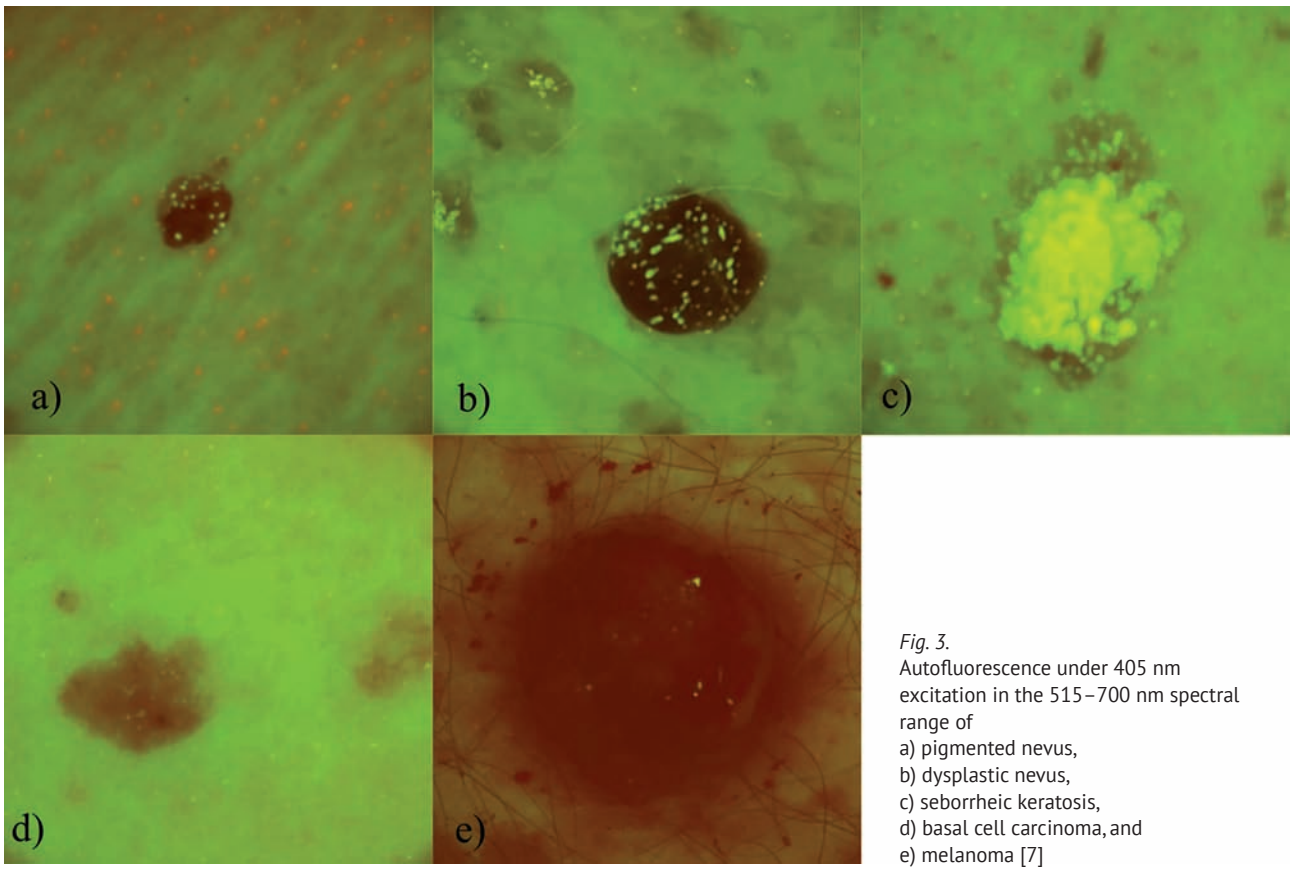

Fig. 3.
Autofluorescence under 405 nm excitation in the 515–700 nm spectral range of
a) pigmented nevus,
b) dysplastic nevus,
c) seborrheic keratosis,
d) basal cell carcinoma, and
e) melanoma [7]

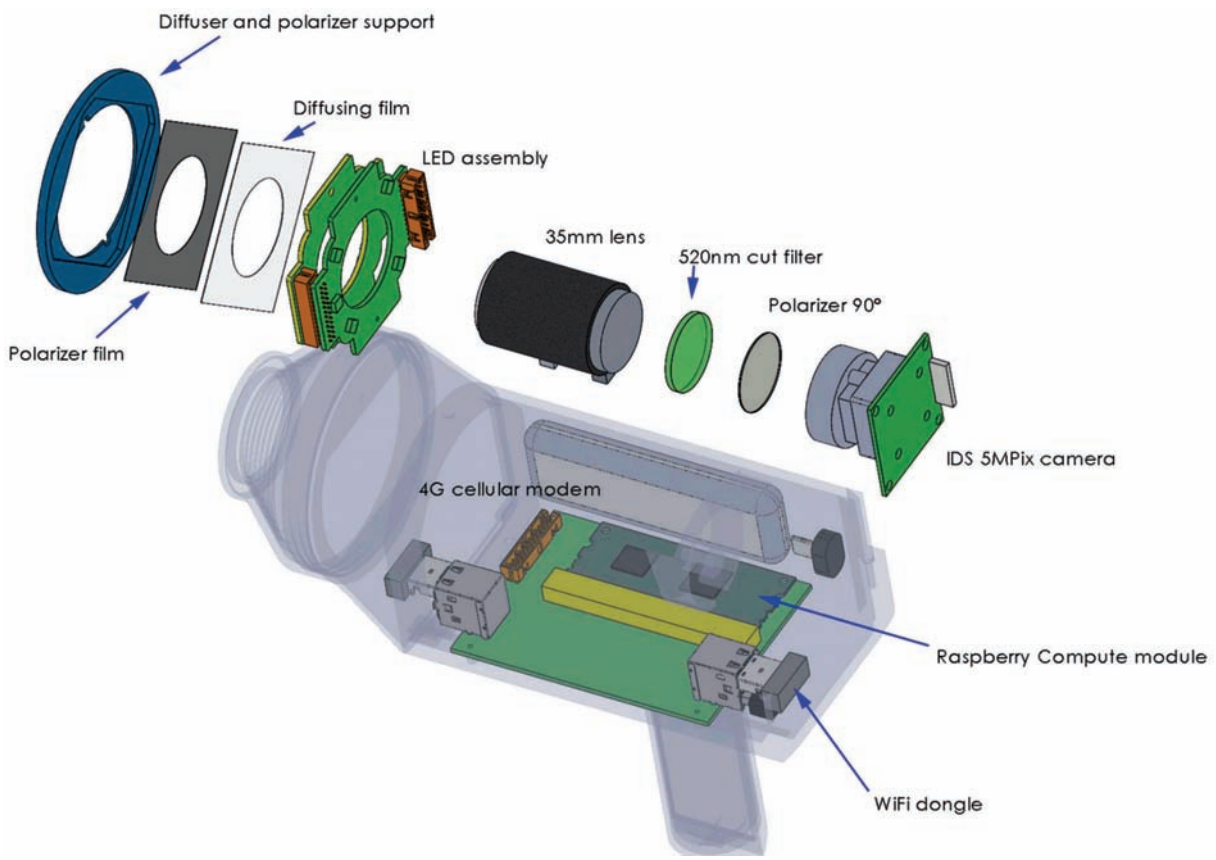

Fig. 4.
The prototype for data acquisition. Device consists of 4 × 405 nm, 4 × 526 nm, 4 × 663 nm, 4 × 964 nm LEDs, 2 linear polarisers placed at right angles, diffuser, 515 nm long pass filter, 5Mpix IDS camera [8]

100% specificity (Fig. 5). These results were published by I. Lihačova in 2018 [9]. However, this method currently does not distinguish basal cell carcinomas from other benign skin lesions.

Another method to apply to the portable device: skin autofluorescence photobleaching for skin cancer diagnostics. As it is known, photo-bleaching is a process that involves the conversion of fluorescent dye molecules into fluorophores that are unable to fluoresce. However, the possible mechanism of tissue autofluorescence photo-bleaching is still unclear. The main hypotheses describing the photo-bleaching phenomenon considered in literature are: a) spontaneous fluorophore decomposition (after a certain amount of cycles of absorption/emission), b) photo-bleaching due to interactions with other dye-molecules, and c) photo-bleaching due to interaction with oxygen molecules and their derivatives – reactive oxygen species. For parametric mapping of skin AF intensity decrease (photobleaching) rates a sequence of filtered AF imaging under 405 nm LED excitation for 20 seconds at a power density of ~7 mW/cm2 with a frame rate 0.5 fps was recorded by cloud-based prototype device (Fig. 4). In order to visualize the skin AF decrease rates during the 20 seconds of continuous 405 nm LED excitation, the following image processing expression were applied:

$$I(t) = a \cdot \exp(-t/\tau) + A \qquad (1)$$

where t is time, I(t) – AF intensity at a given moment, A – residual intensity or background intensity, τ – time constant and a fitting constant. Photobleaching parameters (A, τ and a) were calculated using non-linear least-square regression analysis. The planar distribution of fitting parameters (Fig. 6) was performed using MatLab software. Obtained results demonstrate promising perspectives for skin diagnostics; however, the interpretation of the achieved results is still under discussion. Probably proposed technology could be reflected in the development of new approaches for analysis of tissue/cells response on optical excitation. These methodologies will lead to development of new cost-effective approaches for evaluation of tissue metabolic activity and tissue diagnostics. We assume that evaluation of cells/tissue "wellness" (metabolic activity) hypothetically could be measured by analysis of fluorescence recovery time after photobleaching. Insofar, as photobleaching cause an oxidative stress of exposed cells/tissue, measuring of fluorescence recovery could be related to cells/tissue ability to restoration, directly indicating on their metabolic activity. Additional studies are required to find correlations between tissue metabolic states and photobleaching parameters. Recovery time after photobleaching further should be investigated at different tissue/cells metabolic conditions.

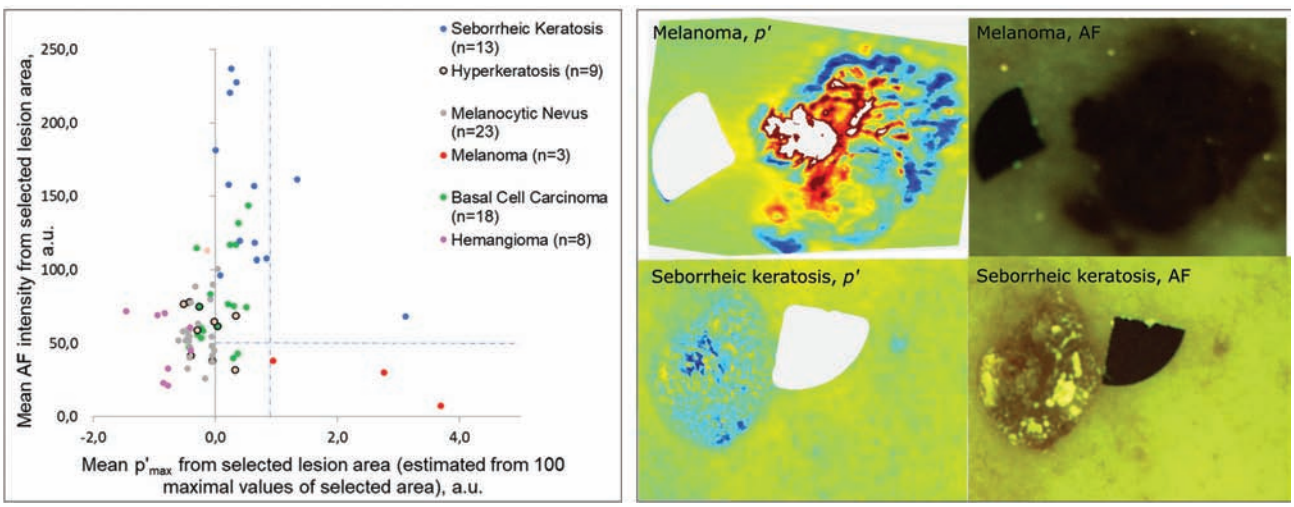

Fig. 5.
Distribution of AF and melanoma diagnostic parameter p' for different groups of skin lesions and p' and AF image examples for melanoma and seborrheic keratosis [9]

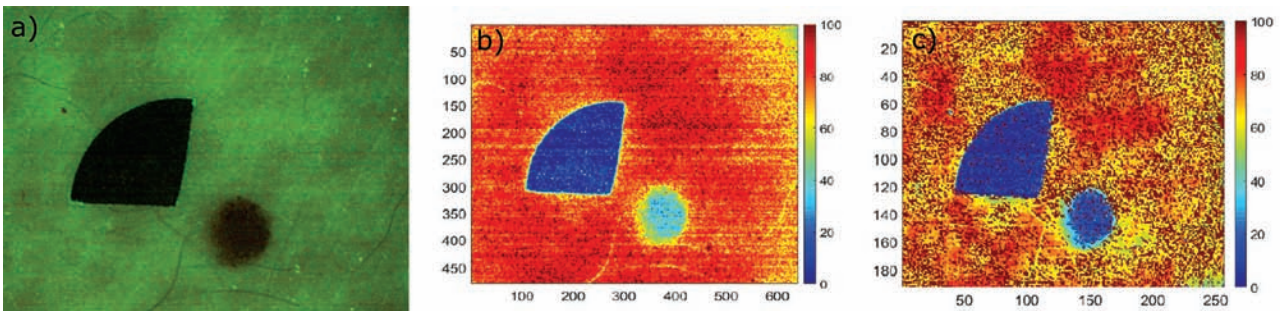

Fig. 6.
a) Filtered RGB autofluorescence image of pigmented benign lesion, b) G-band signal of RGB autofluorescence image, c) photobleaching parameter A distribution image. Parameter A is obtained from G-bands image sequence under continuous 20 sec. 405 nm LED excitation

Cloud computing service as a provider of easy to use access to diagnosis results. Figure 7 presents the general structure of the cloud computing system [10]. The main node (www.checkyourskin.eu) acts as load balancer by redistributing incoming skin images between available computation nodes. Computation nodes (CN) are launched and deactivated based on the actual number of incoming analysis requests. Each CN provides the Application Programming Interface (API) as a set of standard programming interfaces for receiving requests from the main node. To standardise diagnostic algorithm coding, Matlab scripts are used. All communications between nodes and skin image transfer from the devices are performed over a secure HTTPS channel.

The main users of the system are general practice doctors who directly communicate with patients and operate the device. For each patient, the system creates a personal profile that holds complete history of all analyses. Each device is used by one specific doctor, as a result, in his digital profile the doctor sees a list of all the scans received from the device and can correlate each of them with one of his patients. In order to protect personal data, the patient's personal code is converted to hash code that allows finding specific patient in future but prevents from restoring the original personal code. During the patient's admission, the doctor performs a scan, and the device automatically sends skin images to the main www.checkyourskin.eu service node. Then the doctor is able to evaluate diagnosis

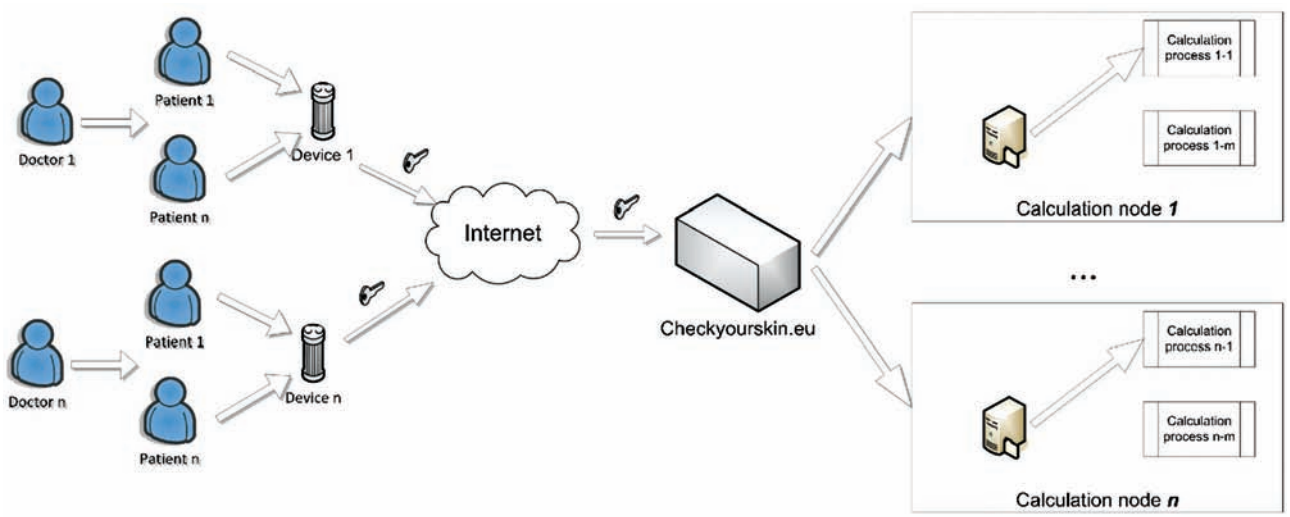

Fig. 7.
General structure of the system created

results and original images from his personal web page. Each image is attached either to an already existing analysis or a new analysis can be created. Cloud-based approach combines a virtually unlimited amount of resources, allowing to create scalable diagnostic system, while being inexpensive and robust, since only currently the required amount of resources are acquired from cloud provider. An additional advantage is the centralised management of the algorithms used for analysis, which allows promptly implementing changes in diagnostic algorithm.

CONCLUSIONS

The potential impact of the developed prototype device for multimodal skin imaging on society was demonstrated during the clinical approbation. During the clinical study, the prototype device was tested in primary care level (prototype was tested by General Practitioner, GP). During device approbation at GP practice, two melanoma cases at early stage were suspected and patients were quickly forwarded to the Oncology Centre for accurate diagnostics and treatment (the diagnosis was confirmed). Thereby, patients involved to the study received an opportunity for free and fast examination of skin lesions with subsequent (in the case of suspected malignancy) fast forwarding to the oncologist. To summarise, the proposed technique has good perspective as a counselling device for skin lesion examination on possible malignancy.

ACKNOWLEDGMENTS

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OPPORTUNITIES AND CHALLENGES FOR LATVIAN FOREST SCIENCE – THE ROLE OF FOREST SCIENTISTS IN FORESTRY

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Tālis Gaitnieks, *Dr. silv.*, Scientific Director of the Latvian State Forest Research Institute "Silava", Full Member of the Latvian Academy of Sciences

The basis for the development of the Latvian state is and will be the rational and meaningful use of its resources. In terms of resources, two of them are particularly significant – the Latvian people and the land of Latvia. Neither of these is in particular abundance. Earth's resources are limited and severely constrained – we cannot increase them, therefore we should strive to use them more effectively.

Latvian forest scientists operate according to the accepted definition of forest science – forest science is the study of forest ecosystems and their relationship with human society. Scientists working within this definition of forest science are less numerous than scientists who study forests solely as an ecosystem. Often we also find other views in the forestry sector – that forest science is an instrument to support the forestry business, while forestry business is based on rational land use.

The Latvian State Forest Research Institute "Silava" (LSFRI Silava) was established in 1946 and will celebrate its 75th anniversary next year. LSFRI Silava was originally called the "Forestry Problems Institute" – thereby including the basic condition that there are problems that need to be solved. One of the problems at the time was moving sand – knowledge was needed on how to prevent dunes from spreading. Scientists solved this situation by learning how to establish pine stands on pure sand that are now 60–80 years old. Currently, Latvian forest science has progressed from problem solving to meeting new challenges. There are two main challenges for Latvian forest science – to continue being a stable knowledge centre for the development and competitiveness of the Latvian forest sector, as well as to promote its international growth and recognition. Often these challenges are contradictory – Latvia is a competitor with other nations in the international timber market, while the national forest industry is not interested in theoretical ideas that are of interest to the international scientific community, but in practical solutions and recommendations applicable in Latvia.

In order to obtain precise information on the state of Latvian forest resources, a statistical forest inventory, known as the National Forest Inventory (NFI), has been conducted in Latvia since 2004. It is an independent, scientifically implemented forest assessment system using 16 157 permanent circular plots (PL) in Latvia, evenly distributed in tracts over a 4×4 km grid, four PL per tract. Each plot has an area of 500 m^2 and each plot is assessed every five years. If trees are growing in the plot, each tree is measured and its coordinates are fixed. The plot centre is secret and no forest owner knows if a plot is on their property. In 2018, the third five-year cycle ended, and in 2019, LSFRI Silava initiated the fourth NFI measurement cycle.

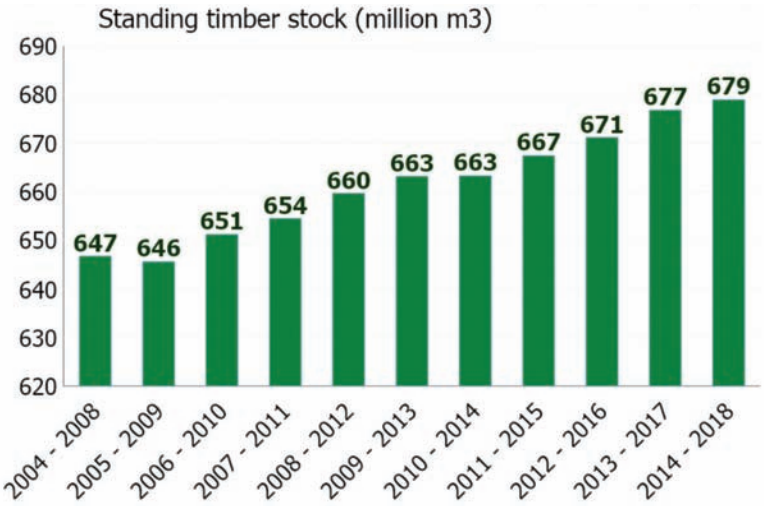
Results of National Forest Monitoring show that in 2019, Latvia's forests contained the largest amount of wood resources in the foreseeable past – 679 million m^3 (+/– 1.15%) of standing stock in Latvian forests. Forest land in Latvia occupies 3.59 million hectares or 55.6% of the country's territory, including forest stands, clearings, swamps, glades and for-

est infrastructure. Every year, felling by humans occurs in 4.6% of the forest area in Latvia, including 1.4% in regeneration fellings, resulting in 17.3 million m^3 of timber. 16.7 million m^3 of timber is removed from the forest and used for both industrial and domestic consumption. Every year 6.3 million m^3 of timber are lost due to natural factors, mainly wind, insect and fungi damage, of which 0.3 million m^3 are utilised by humans. During the last five years, the amount of standing stock in Latvian forests has increased by 3.2 million m^3, which means that each year at least 26.8 million m^3 of timber is produced in forests as a result of tree growth.

Latvian forests have a considerable stock of wood resources in relatively old forests – in stands that have reached the parameters when final felling is allowed in Latvia and where there are no restrictions on tree felling in the interests of nature protection, standing stock has increased by 20.2 million m^3 over the past five years and has reached 278.6 million m^3 (www.silava.lv).

The state of Latvia's forest resources and its growing dynamics is influenced by two factors. On the one hand, Latvian forest management policies, compared to other forestry nations in the region, are strictly regulated, cautious and prohibitive. For example, Finland does not regulate the forest owners' decision on the main felling, but in Latvia concepts inherited from the former USSR regarding sawlog dimensions when permitting final felling or regeneration cuttings are still utilised. Forest scientists support forestry sector initiatives to liberalise and renew legislation to promote efficient land use and increase practical implementation of knowledge generated by forest scientists. For example, allowing forest owners to produce marketable logs before the tree reaches the felling age as set during the Soviet era, while also requiring a higher reforestation quality, are prerequisites for increasing timber resources as well as intensifying carbon sequestration in Latvian forests in the future.

The second aspect resulting in the increase in the amount of timber in Latvian forests is purposeful, science-based forestry. Research and knowledge of LSFRI Silava in improving the productivity, quality and health of Latvian forests are in demand in the Latvian business sector. According to the Ministry of Education and Science (MoES) (www.izm.gov.lv), in



Dynamics of standing stock in forests over 5-year cycles.
(Source: *Latvian National Forest Inventory*, www.silava.lv)

2018, 26.8% of business sector funding for Latvian science was invested directly in LSFRI Silava. The memorandum signed in 2011 between LSFRI Silava and Joint Stock Company "Latvian State Forests" states that the knowledge created jointly by the institute and the company is freely available to the Latvian forestry sector in order to promote its overall competitiveness. Such a strategic step has significantly contributed to the development of Latvian forest science, including international competitiveness.

Twelve research programmes lasting 4–6 years have been implemented within the partnership of LSFRI Silava and JSC Latvian State Forests. The research is carried out in accordance with the research directions defined in the LSFRI Silava operational and development strategy. The most extensive studies were carried out in forest breeding (*Mg.* Arnis Gailis, *Dr.* Martins Zeps), forest adaptation and climate mitigation (*Dr.* Āris Jansons, *Dr.* Una Neimane), forest biotic risks (*Dr.* Tālis Gaitnieks, *Dr.* Agnis Šmits), improvement of forest tree growth conditions (*Dr.* Andis Lazdiņš), research and adaptation of forest regeneration technologies (*Dr.* Dagnija Lazdiņa) and tree growth modelling (*Mg.* Jānis Donis, *Mg.* Guntars Šņepsts). Research on the interaction between forestry and the environment has a significant role in the cooperation between the commercial sector and forest science. The influence of sustainably intensive forestry on environmental parameters in model territories (*Dr.* Zane Lībiete),

the role of broadleaved forest stands (*Dr. hab.* Māris Laiviņš) and the impact of human activity on the population of capercaillie (*Dr.* Jānis Ozoliņš) are investigated. The importance of national knowledge on the role of forestry in climate change mitigation, including carbon sequestration in forests, is increasing (*Dr.* Andis Lazdiņš, *Dr.* Āris Jansons, *Dr.* Kaspars Liepiņš). This knowledge will become more and more relevant due to the forecast economic growth in Latvia, which will generate additional GHG emissions, requiring compensatory mechanisms. In cooperation with JSC "Latvijas Finieris", LSFRI Silava has long-term research programmes on growth processes of birch forest stands and plywood plantations and production technologies (*Dr.* Kaspars Liepiņš).

In addition to business-supported research programmes, LVMI Silava is developing research programmes within other financial instruments. One of the ten achievements of Latvian science in 2019 is the study "Even-aged spruce forests in Latvia", which was carried out by LSFRI Silava within the framework of the MoES state research programme (*Dr.* Jurģis Jansons, *Dr.* Janis Donis, *Dr.* Tālis Gaitnieks, *Dr.* Āris Jansons, *Dr.* Dagnija Lazdiņa, *Dr.* Zane Lībiete, *Dr.* Dainis E. Ruņģis). Opportunities and risks for the management of planted even-aged spruce stands, which occupy at least 200 thousand hectares of the most fertile Latvian forest land, were investigated. This interdisciplinary study included forest management, genetic, phytopathological and technological aspects. Forestry industry was provided with a rational spruce cultivation model by renewing stands, as well as by information on the risks and significant deterioration of growth potential in previously overly densely planted stands that are currently 40–50 years old. After repeated measurements (after 11 years) of 285 initially high-yielding spruce stands, their growth was found to be significantly impaired. In such a situation, decaying stands should be allowed to be felled and purposefully restored, rather than being required to be managed by sanitary felling. The research was compiled in a monograph published in 2019 entitled *Even aged spruce forests in Latvia*.

The development of forest science in Latvia was significantly influenced by the financing of EU structural funds and direct programmes available to science. The "Competence Centres" programme, developed by the Ministry of Economics, enabled efficient transfer of forest breeding results to plant production (*Dr.* Āris Jansons), use of stand management technologies and remote sensing in forestry (*Dr.* Andis Lazdiņš), as well as for control of root rot (*Dr.* Tālis Gaitnieks, *Dr.* Natālija Burņeviča). Early stage researchers at LSFRI Silava are implementing eight ERDF postdoctoral research support programme studies. Internationally significant ERDF-funded studies on the effects of wind on spruce and birch forests have been launched under the leadership of leading researcher Āris Jansons. In 2019, LSFRI Silava became the lead partner in the EU LIFE Programme study OrgBalt: Demonstration of climate change mitigation measures in the Baltic States and Finland (managed by leading researcher Andis Lazdiņš).

Significant opportunities for the development of interdisciplinary research are the expertise of LSFRI

Repeated surveys of 283 even aged spruce stands after 11 years have shown a significant decrease in the ratio of stable stands and an increase in the ratio of declining stands (Zane Lībiete, 2019)

Silava in molecular genetics, which is increasingly being integrated into the traditional LSFRI Silava research directions (*Dr. biol*. Dainis E. Ruņģis). The scientific achievements of the LSFRI Silava wildlife management group, especially in the study of Latvian large carnivore populations, are gaining international importance (*Dr. biol*. Jānis Ozoliņš, *Dr. biol*. Guna Bagrade).

In 2019, improvement and supplementation of the scientific infrastructure, as foreseen in the LSFRI Silava Operational and Development Strategy, was continued. In 2019, the renovation of the institute's central building was completed, a technical laboratory was established and 84 sets of scientific equipment were purchased.

LSFRI Silava continued its active cooperation with the forestry sector, which was highly valued and widely appreciated. In 2019, two Latvian Forest Science Days were held, with more than 120 participants each. In the past year, LSFRI Silava scientists twice received the forest sector award "Zelta Čiekurs" ("*Gold Cone*") – for the contribution of science to the development of the forest sector received by the forest breeding team led by researcher Arnis Gailis, and in December 2019, leading researcher Dagnija Lazdiņa received the award for scientific communication with society.

In 2019, focussed cooperation with the Latvian University of Life Sciences and Technologies (LULST) continued. LSFRI Silava scientists at the Forest Faculty teach bachelor and master courses as well as participate in the study process with guest lectures and presentations in forest field and experimental trials. LSFRI Silava leading researcher Āris Jansons is leading the PhD programme in Forestry. The Forestry Doctoral studies Council has successfully operated within the framework of LULST, where the participants have been delegated on parity principles by LSFRI Silava, the Latvian Institute of Wood Chemistry, LULST and SIA Forest and Wood Products Research and Development Institute. Opportunities for collaboration encourage increasing participation of LULST faculty members in research programmes implemented by LSFRI Silava. Forest science and higher education is supported by the Forest Research Station, which was jointly established by LSFRI Silava and LULST in 2014, and manages 28 000 ha of national research forests.

Reconstruction of the LSFRI Silava central building in Salaspils in the summer of 2019. Photo: Agnis Šmits

Participants in the Latvian Forest Science Day "Forests and forestry in a changing climate", 17 November 2019 at Jaunkalsnava. Photo: Ilze Zepa

Forest science and higher education communication centre "Mežmāja" in the Talsi hills, Šķēde Forest District of the Forest Research Station. Photo: Jānis Vilks

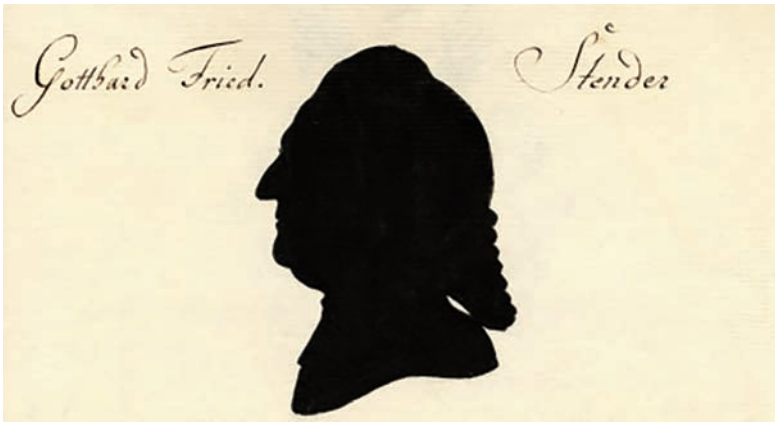
CURRENT RESEARCH TOPICS IN HUMANITIES AND SOCIAL SCIENCES

GOTTHARD FRIEDRICH STENDER AS A LATVIAN AND A EUROPEAN SCHOLAR

Māra Grudule, *Dr. philol.*, professor at the Faculty of Humanities, University of Latvia; senior researcher at the Institute of Literature, Folklore and Arts, University of Latvia, Full Member of the Latvian Academy of Sciences

Rīga is considered to have been the ideological centre of the Enlightenment in the Baltic. Nevertheless, the ideas of the Enlightenment reached the Duchy of Courland during the first half of the 18th century. This was directly related to intellectuals living there who were graduates of the University of Halle, such as Joachim Baumann (1712–1759), Superintendent of Courland, and his close friend and colleague, Gotthard Friedrich Stender (1714–1796). The Enlightenment in Courland was characterised by the founding of the Jelgava Peter's Academy (*Academia Petrina*), a modern secondary educational institution (1775), the work of the publishing house owned by Johann Friedrich Steffenhagen (1744–1812) – the main centre for Latvian literature up until the mid-19th century (1769) – and activities of the Courland Society for Literature and Art (Kurländische Gesellschaft für Literatur und Kunst, founded in 1815), recognised to be a precursor to the Latvian Academy of Sciences.

Gotthard Friedrich Stender was descended from a long-established family of Lutheran pastors, and came into the world in Selonia, at the Lašu Rectory in 1714; he continued the family tradition and studied theology at the Universities of Jena and Halle (1736–1739). After returning to Courland, Stender worked as a private tutor in Lielbērstele, as a teacher in Jelgava and, from 1744 onwards, was a pastor at Linde-Birzgale, and later at Žeime parish. In 1759, Stender travelled abroad with his family, stayed first in the Duchy of Brunswick-Lüneburg, and later in Copenhagen, where he taught geography, presumably at a cadet school and also produced globes, and then briefly stayed in St. Petersburg. In 1766, Stender returned to Courland and served as a pastor in Sēlpils and Sunākste parishes until the end of his days in 1796. Stender had two sons and three daughters, and his eldest son, Alexander Johann Stender (1744–1796), actively continued his father's work of bringing enlightenment to the people. His contacts with Latvians and Latvian culture were sustained by other descendants over several generations. His grandson Johann Christian Stender (1787–1862) collected folk songs and published a description of Staburags, a scenic cliff on the banks of the River Daugava, his great-grandson Karl Gottlob Stender (1830–1897) encouraged choral traditions in Sunākste and organised song festivals. His great-great-grandson Johannes Carl Ernst August Stender (1864–1945) collected Latvian place names.



G. F. Stender's silhouette

Gotthard Friedrich Stender had a wide range of interests. He translated 18th century German poetry into Latvian. As early as in 1753, a translation appeared of *Die auf ein starkes Ungewitter erfolgte Stille (The Calm After the Thunderstorm)* by the late Baroque master Barthold Heinrich Brockes (1680–1747) with the poetry recast by Stender. With publication of

German songs, poems and odes, Stender brought to Latvian poetry the spirit of the Rococo era, anacreontic themes and reinforced the role of sentimentality; with publication of the collection of fables, *Jaukas pasakas un stāsti* (*Lovely Tales and Stories*, 1766), and he also laid the foundations for secular prose in Latvian.

Gotthard Friedrich Stender paid great attention to youth education in Courland; he promoted the establishment of schools and provided educational reading material for Baltic Latvian and German youth. In compiling his textbooks, Stender followed the ideas and practices of 18th-century German pedagogy. For example, in the collection of stories from the Old and New Testaments, *Maza Bībele jeb Svēti stāsti* (*The Little Bible, or Sacred Stories,* 1766), Stender added poetic summaries and also questions to encourage in-depth reading of the text. This book underwent many editions up until the end of the 19th century – the Latvian playwright Rūdolfs Blaumanis (1863–1908) stated in his play *Pazudušais dēls (The Prodigal Son)* written more than 100 years later, in 1893, that the book by Stender was central to education at home. Stender also recommended that children's games, or the so-called songs meant for dancing, be adopted as a methodical element at school; he also published recommendations for teachers raising literacy (1782) and the first illustrated ABC book in Latvian (1787).

Latvian texts published by Stender are characterised by the use of correct, rich language. Although a German by nationality, he grew up and spent most of his life in Courland, the majority of whose inhabitants were Latvians. Stender, like other Baltic Germans, was thought to be fluent in Latvian since childhood, but unlike his brethren, he did not lose interest in the Latvian language throughout his life. In 1761, Stender published a grammar and a dictionary of the Latvian language, and became known among the Baltic Germans as *der berühmte Lette* [1], or "the famous Latvian". The grammar by Stender, for the first time, described extensively the diversity of languages spoken in Courland and dialectical differences, as well as the link between the Latvian language and Lithuanian as a related language. The dictionary *Lettisches Lexikon* (*Latvian Lexico*n, 1789), compiled by Stender, included indexes of given names, toponyms found in Courland and Livland (Vidzeme), names of plants, mushrooms, fish, insects, birds and animals. It has been an important source of language studies a hundred, and even two hundred years later, as well as for Latvian writers such as Rainis (1865–1929) and for students of the history of language history such as Jānis Endzelīns (1873–1961). The contribution made by Stender to linguistics continues to inspire international interest today.

Having attended as a youth lectures given by the German philosopher Siegmund Jakob Baumgarten, student of the famous Christian Wolff (1679–1754), Stender was a rather conservative representative of theological rationalism. His main philosophical work, *Wahrheit der Religion (The Truth of Religion*, 1772, 1784[2]), was popular with Russian and German Freemasons. It was also translated into Russian (1785, 1820[2]), while its second German edition which appeared at the suggestion of Freemasons, is cited in a number of literary texts written by German Freemasons during the 19th century.

Gotthard Friedrich Stender also was interested in geography. He was commissioned in 1764 by the King of Denmark and the Royal Danish Library to produce two large globes, which are still impressive today thanks to their accuracy, unexpected for the mid-18th century, of the contours of Asia and superb technical execution. The globes are well preserved and today belong to the Treasury of the Royal Danish Library. Stender also showed interest in geography in a number of publications, perhaps the most notable of which is his *Augstas gudrības grāmata* (*Book of High Wisdom,* 1774, 1776[2], 1796[3]), which was the first popular science publication in Latvian. It gives broad insight into nature, geography and world history, and through suggested experiments, offers the reader an opportunity to engage in the study of natural processes and also to compile a calendar. This book presented, for the first time in the Baltics (!), a heliocentric view of the world. The odes published in its appendix – translations from the German language and the author's own compositions – touch upon ideas of time and space, eternity and infinity, and are considered to be the beginnings of Latvian philosophical poetry.

Promotion by Gotthard Friedrich Stender of a mechanical washing machine has to be understood in the context of technological enlightenment. Perhaps Stender borrowed the idea of building such a


Augſtas Gudribas
Grahmata
no Paſaules un Dabbas.
Sarakſtita
no Sehrpilles un Sunnakſtes
Baſnizkunga Stender.
Jelgawâ un Aiſputtê,
pee Jekoppe Friedrike Hinz,
1776.

Title page of *Augstas gudrības grāmata [Book of High Wisdom]* by G. F. Stender (1776)

machine from the *Gentleman's Magazine*, popular in Europe in the 18th century. His publication *Beschreibung einer neuen höchst bequemen Waschmaschine* (Description of a New Extremely Comfortable Washing Machine, 1765) was the first description in German of how to wash clothes mechanically. It was reviewed and reissued in Konigsberg, Brunswick and Berlin. Later, Christian Schäffer (1718–1790), a teacher in Regensburg, using the description and construction details provided by Stender turned manufacturing washing machines into a profitable business. Stender obviously had no interest in making profits. Subsequently Stender showed no interest in the subject of washing machines or any other technical devices.

Stender was also a skilled draughtsman, as is evident not only by the scheme of the washing machine and the aforementioned globes, but also from the illustration engravings for the third edition of a book of sermons by Georg Mancelius, the title page of the book of songs from Courland and the illustrated Latvian alphabet book. Illustrations for Stender were not only a tool for entertainment but also a didactic tool, with the illustrations accompanying the Courland Latvian Lutheran Songbook and inspirational couplets at the beginning of each chapter being striking examples.

The contribution made by Gotthard Friedrich Stender to Latvian music has been barely studied. While Stender himself was not a composer, nevertheless, he transplanted German musical traditions to Latvian culture. Stender translated the cantata *Der Tod Jesu* (*The Death of Jesus,* 1755), music composed by Carl Heinrich Graun (1703 or 1704–1759) with words written by Karl Wilhelm Ramler (1725–1798). It is a good translation, suitable for musical performance. It is not known whether the cantata was sung in Latvian during the life of Stender. The full cantata was performed on Good Friday, 31 March 2015, in Rīga at St. Mary Magdalene Church, under the direction of Māris Kupčs, an early music expert. The cantata testifies to appreciation by the translator of how the text complements the musical score. In addition, translations by Stender of German songs, although published without sheet music, often include an indication of melody in lieu of a subtitle and are to be appreciated within the musical tradition of the Enlightenment, whereby music becomes an additional element in the education and training of singers.

Stender translated a collection of songs by a fellow resident of Courland, the poetess, Elisa von der Recke (1754–1833) a half-sister of the Duchess Dorothea (von Biron, born von Medem, 1761–1821), *XII von Elisens geistlichen Liedern beym Clavier zu singen* (12 spiritual songs by Elisa for piano accompaniment, 1784) into Latvian, *Ielīzes divpadesmit svētas dziesmas* (*The Twelve Sacred Songs of Elisa,* 1789). Although the translation contains no indication of how they should be sung, the fact is noteworthy that the German original was arranged by the German composer Johann Gottlieb Naumann (1741–1801) and also that Naumann composed all

12 songs of von der Recke. In the Latvian edition, Stender maintains the sequence of texts corresponding to the original, follows exactly the original form of the song and also dedicates his collection to the Duchess of Courland, addressing her directly in the introduction to the book. The question of whether Stender hoped that the Duchess might sing the songs of Elisa von der Recke in Latvian must be left unanswered.

The personality of Stender reveals how European science and culture at that time, just like today, was united, how focused it was on overcoming language and political barriers, and its role as a medium of communication and dissemination of news. Stender was directly involved at all levels of the European network of ideas during the period of the Enlightenment: he travelled widely, he participated in the work of several societies, published in German periodicals in Europe and in the Baltics. Experience gained at the University of Halle encouraged Stender to employ new pedagogical techniques; the orphanage where he worked in return for food was a real test case for new teaching methods, observing how a child's curiosity is stimulated by images, sound, and even the presence of physical objects. Working as a professor of geography at a school for young cadets in Copenhagen, however, may have been helpful later when finalising the text of the *Book of High Wisdom* (1774).

Stender has been associated with several societies in various ways, no doubt that Freemasonry took on a prominent role in his life, and it was with their support that he received a well-paid commission to produce both of these globes for the King of Denmark and the Royal Library (1764). Despite never having been to Göttingen, Stender was a full member of its Royal German Society, as evidenced by references to his books, a manuscript on religious philosophical issues (1765) and his Latvian grammar, which are kept in the Göttingen University Science Library, and a review of the Grammar by Stender in the Göttingen Collection of Scientific Papers (1766) [2].

A globe produced by G. F. Stender for the King of Denmark (1764)

The trajectory of his life shows that Stender intersected with the pietism of Halle and the Duke of Brunswick-Lüneburg; freemasons, diplomats, the Royal House and staff of the Royal Library of Denmark, as well as the British Admiralty; members of the Royal German Society of Göttingen, the Duke of Courland. His works have been published in Königsberg, Jelgava, Aizpute, Rīga, Brunswick, Berlin and Copenhagen in German, Latvian, Latin and Russian. The Estonian translation of the book *Lovely Tales and Stories* (1766) by Stender [3] is considered to be one of the cornerstones of Estonian secular literature. In Latvia, the name of Stender has become synonymous with important values associated with the Enlightenment. It is usual to remember him as a populariser of science and a founder of a new era in the history of Latvian literature. Stender pioneered the Enlightenment movement, and by the early 19th century, he had several followers who continued to broaden the horizons of Latvian knowledge, fuelling their thirst for education, and strengthening their national self-esteem. It is in this sense that in the Age of Enlightenment the early beginnings of the Awakening of the Latvian people may be found. Every republication or translation of works by Stender represents a fascinating voyage through time bringing greetings from the brilliant ideas of the Age of Enlightenment –the Latvian edition of his *Latvian Grammar* (2015), translated by literary historian Zigrīda Frīde, has become a bibliographic rarity; also, the facsimile edition of Stender's illustrated ABC book has been sold out (2014). Visitors to the National Library of Latvia continue to be attracted to viewing a model of the washing machine, proposed by Stender and sited next to a reading room named after Stender. Gotthard Friedrich Stender is still present today in Latvian cultural space – an opinion that is no exaggeration.

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Translated by **Eduards Bruno Deksnis**

NATIONAL RESEARCH PROGRAMME, LATVIAN HERITAGE AND FUTURE CHALLENGES FOR THE SUSTAINABILITY OF THE STATE, INTERFRAME-LV 2019–2021

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The main goal of the national research programme (NRP) is formulated as an intention to develop guidelines for further sustainable development of the state of Latvia, outlining the main operational models in the context of global change-driven processes.

According to the research aim, the objective of the first year of the NRP is to aggregate information on the climate, economic and social changes taking place in the world, the European Union, the Baltic States, and Latvia in particular, and consider the changes to develop the guidelines.

In 2019, according to the objective of the NRP, the research work was focused on several priorities.

Firstly, an analysis of structural changes in the economy was done.

The process of structural changes in the world as a whole, in the European Union, in the Baltic States and particularly in the national economy of Latvia was analysed. The information obtained and processed suggests that the structural adjustment of the economic system is increasingly occurring. This is the result of both geographical and political reorganisation, yet even more so as a result of climate change and the effect of the 4.0 Industrial Revolution, one of the most prominent features of which is the digitalisation of the economy and society. Digitalisation is increasing the share of information and communication services as a kind of business and expanding cross-border trade in goods and services. In the structure of the national economy, the newly perceived segmental formations, such as the circular economy and the bioeconomy, gain importance. The features of these changes are increasingly evident in Latvia as well.

As a result, structural analyses of the economy are gaining more and more importance as a separate section in statistical information (EUROSTA, OECD). The Central Statistical Bureau (CSB) of Latvia has also started making and publishing data representing structural changes both in the CSB yearbook and in separate information sources on the Internet.

Official EU and OECD documents as well as scientific research papers on structural changes in the economy increasingly emphasise the need for a more detailed analysis of the effect of structural changes on the economy as a system and on society as a community, thereby raising the public's awareness of the changes and readiness for them.

Secondly, the digitalisation of the national economy and society as a multifaceted phenomenon in the EU, the Baltic States and especially in Latvia – not only in the country as a whole but also in the regions and administrative territorial units – municipalities – has been analysed in greater detail.

An analysis of the information obtained in the course of the research has led to a conclusion that

The working-group meeting of the INTERFAME Project, National State Research Programme, September 16, 2019

the creation of the e-environment is the prerequisite for expansion of the digitalisation process both in public administration and in the economy. In Latvia, it is favourable for digitalisation processes. High-speed and ultra-fast fixed and mobile broadband networks are widely available to institutions and individuals, not only in urban but also in rural areas. At the same time, Latvia is lagging behind the EU average, as well as the other two Baltic States in terms of digital business integration. Large national companies and foreign companies make most success in developing and expanding e-business. By contrast, of the total small and medium-sized enterprises, (C:\ mvu), only about a tenth is engaged in online marketing nationally and half of them sell their products outside the country. At the same time, the data processed by LURSOFT and the CSB show that small and medium-sized businesses operating not only in cities under state jurisdiction but also in rural areas can benefit from these, albeit small, successes in e-commerce, indicating the potential for economic diversification in the rural areas of the country.

An in-depth analysis of digitalisation as a phenomenon and an assessment of the form it takes in Latvia led to a refined understanding of the phenomenon as such. The introduction of e-commerce starts with digitisation, evolves into digitalisation, and leads to the creation of a digital platform, generating maximum returns on the techniques, technologies and human labour employed.

The advancement of the digitalisation process requires more IT professionals to be involved in business. The current education system does not prepare as many IT professionals as needed, and the demand for them in the labour market exceeds the supply. The introduction of new technologies and the development of entrepreneurship also require enhancing relevant training programmes in this specialisation in line with the latest trends and technical/technological change and the demand of the labour market to improve the quality of communication between entrepreneurs and employees.

Thirdly, new research has been launched within INTERFRAME-LV – sociological surveys to identify public opinions on changes in the public life.

The first of these focuses on the digitalisation process in small and medium-sized businesses, which in Latvia and the EU as a whole account for more than 90% of the total enterprises. As already pointed out, the digitisation of economic activity in small and medium-sized enterprises enters much more slowly than in large enterprises. This is especially true for e-commerce. In order to explain the factors influencing this situation, a set of questions on the use of the e-environment in a company, its application options and the attitude of the managers, specialists and employees to the process of these changes was prepared. The respondents involved in the survey represented three countries – Latvia, Belarus, and Romania. A comparison of the views of the respondents from the mentioned countries contributes to a deeper understanding of the situation in Latvia.

E-business expansion is seen as a positive phenomenon by the representatives of all the three countries, whether it is a business owner/manager, an ICT specialist or simply an employee. The age of the respondent – a young person (up to 30 years), middle-aged (30–50 years), or older than 50 does not change the views. The age of the respondent only makes an effect on the requirements of the business owner/manager and employees with regard to the nature of the employee as such: the older the respondent, the more emphasis is placed on the role of professional knowledge; cooperation, mutual empathy, etc. Data processing and comparisons of the results to draw conclusions is still continued.

However, increasing the number of respondents and the involvement of another country in a joint survey on the expansion of digitalisation are not excluded in order to identify common and divergent features in the processes that would allow for the transfer of positive experience and to avoid various risk variations.

The second survey, which has been launched, is aimed at identifying public opinions in order to assess the activities of national institutions, urban/rural municipalities and local communities themselves in ensuring the sustainable existence and development of the state of Latvia. It is important to assess the effect of all the three change agents on the changes that are currently occurring in the country, and even more so from the perspective of what is needed. The survey includes representatives from Rīga as the capital city and five planning regions, allowing for the comparison of aspects also across the entire country.

Since similar surveys have already been conducted within the NRP EKOSOC-LV in 2015 and 2017, a very important research objective is to compare the data of the survey of 2019 with the results of the surveys of 2017 and 2015. This gives an opportunity to assess or take action and change the direction of change agents every two years to see what is improving and what is changing for each change agent.

The results obtained indicate that the ratings for all the three change agents become more critical, i.e. decreases. However, national institutions as a whole receive the lowest rating in all the three surveys, while the municipality as a local authority has the relatively highest rating.

The data of all the three surveys have been primary processed. At the current stage of the research, a more detailed analysis is being done, revealing the respondents' views on the situation in nine cities under state jurisdiction, or, more broadly, in the country's rural space, further subdivided into its constituent regions.

Beginning with 2020, research agenda includes the production of a monograph in English on the basis of the research done, work is underway to plan its content in order to produce the publication by Latvian scientists that is internationally recognised.

PUBLICATION OF A COLLECTION OF KGB OPERATIONAL DOCUMENTS IN LATVIA, 2018

Indulis Zālīte, Consultant at the Centre for the Documentation of the Consequences of Totalitarianism (CDCT), head of the CDCT from 1995 to 2008.

On 20 December 2018, almost 30 years after the restoration of Latvian independence and dissolution of the Latvian SSR KGB, a collection was published of operational documents generated by the Soviet secret service in Latvia and placed on the website of the National Archives of Latvia. Public interest focussed most on secret informants card files, an automated counter-intelligence database of agent reports, "Delta Latvija". It should be noted that only a small part of all KGB card files were left behind in Latvia. Furthermore, no files were found of personal or job details of agents, wherein one could find information on how KGB agents were recruited to gather information, about their motivation, deployment, and area of operation, which would permit verifying and refining data contained in the card files.

Prior to April 1993, when the said documents were handed over to the Centre for the Documentation of the Consequences of Totalitarianism (CDCT) following a decision of the Supreme Council of the Republic of Latvia, they had been held in the guarded premises of the Latvian Parliament (Saeima). The first reference to the agency card files was made in 1994, when, after elections to the 5th Saeima, the then head of the CDCT, Paulis Kļaviņš, notified the Mandate and Petitions Committee of the Saeima that the names of five newly elected deputies were found among the LSSR KGB card files held by the CDCT. The mandates of these deputies were suspended during the period wherein the fact of cooperation with the KGB was investigated; the Foreign Minister resigned. One month later, the Saeima adopted the Law "On the Use of Documents of the former LSSR KGB and Establishing the Fact of Cooperation with the KGB". The procedure was thereby established for use of documents, the right of individuals to obtain all information held about themselves by the KGB and left by Latvia, as well as the legal procedure for verifying the fact of cooperation with the KGB.

During the following years, the Saeima adopted a number of special laws that imposed restrictions on former USSR / Latvian SSR security staff and their informers, such as denying them the right to hold positions in public administration, the judiciary, the public sector, to become naturalised citizens, to obtain security clearance to work with official documents containing secret information, to obtain the status of a politically repressed person, as well as other laws. The Act on KGB Documents provided the right for anyone to apply to the CDCT for any information about themselves contained in the KGB document collection left in Latvia, thus allowing former agents not to apply for positions they were denied. In such cases, the names of these persons were not disclosed. From my own experience, I can report that many individuals took advantage of this opportunity.

Information from the KGB documents was also used to investigate cases of unlawful repression against the Latvian population during the occupation period, for example, in cases related to eradication of the national resistance movement. A total of four former members of the security service were convicted, while a number of criminal cases were abandoned due to death of the suspect.

The law stated explicitly that KGB staff and their informers had a duty to provide an explanation to the CDCT about their activities in the KGB and the

general activities of the KGB, but did not provide any legal instrument or incentive to implement this obligation, such as the information provided to remain confidential for a specified period.

In June 2006 and again in October 2006, the Saeima voted to publish the KGB card files that were found in Latvia, but on both occasions President Vaira Vīķe Freiberga returned the amendments to the Saeima for reconsideration.

The President stressed that the Saeima had not achieved a differentiated approach to the use and publication of KGB documents, such that the public benefit would be commensurate with violation of the rights of certain individuals, rights protected by the Satversme and international human rights law binding on Latvia. The letter of the President to Ingrīda Ūdre, Chair of the Saeima, accompanying the action of the President indicated that information found in the card files did not allow differentiating between reports submitted by KGB agents about so-called ideological crimes from those reports that contributed to the fight against criminal offenses which are also classified as crimes in the contemporary legal space of Latvia.

Furthermore, the President opined that "the idea that the publication of the card files of KGB agents would put an end to mutual suspicion, turn a painful page in Latvian history and establish historical justice is illusory". The letter emphasised the fact that, "according to records held by the Centre for the Documentation of the Consequences of Totalitarianism, the Latvian State has in its possession only a small part of the overall KGB agent card files, so that publishing it, and implementing the collective responsibility principle for people noted therein, cannot be regarded as a just and objective approach to dealing with our history. It is therefore not clear what would be gained or the benefit to the public of publishing such incomplete information."

The President concluded, "It is possible that honest answers to these questions, corresponding to the interests of the state, may explain why no post-socialist state in Eastern Europe has acted in the way that the Latvian Saeima intended to do."

For the sake of clarity it should be noted that the names of about 4500 persons registered as agents of state security organs remain at the disposal of Latvia. In total, between 1944 and 1991, no less than 32 000 to 36 000 agents were registered by the Latvian SSR KGB. In addition, the USSR Border Guards and agents of Military Counterintelligence operated on the territory of the Latvian SSR. The Intelligence Service of the Soviet Armed Forces also operated in the Latvian SSR; in terms of numbers, of which we have no knowledge, these agents exceeded those of the Latvian SSR KGB by approximately a factor of three. Similarly, Latvia does not have the names of agents who lived abroad among émigrés and who cooperated with Soviet state security organs in the occupied Latvia.

The existing arrangements for the use of KGB documents ensured a balance between the protection of the democratic system of the country (denial of office, standing for election, to earn certain status, etc.) and the availability of KGB documents that could be used legally to prove or disprove the fact of cooperation. Case law confirms that it has been largely impossible to prove someone's cooperation with the KGB relying on the KGB card files of agents held in Latvia and the "Delta Latvija" database as a direct source of evidence.

In 2014, the Saeima once again addressed the so-called "Cheka bags" issue and decided that the KGB documents would be made public after scientific research. In order to achieve this goal, a Committee to Investigate the Committee for State Security Committee was established, tasked with evaluating the collection of KGB documents and make recommendations to the Saeima for further decisions, as well as to prepare relevant scientific comments within a four-year period. However, due to the incompetent management, a chaotic working style and the lack of parliamentary oversight, no study of the documents was carried out. Without regard to other possible solutions the Saeima then took a radical decision to publish the documents without commentary or assessment.

In October 2018, the Saeima voted to amend the KGB Law, with provision for publication of the collection of KGB documents on the Internet home page of the Latvian National Archives (LNA), inserting in the 1994 text a new objective: "develop a means to inform the public about the control of society, by the totalitarian regime, the mechanism and

Electronic data carriers of the KGB, using which the electronic database "Delta Latvija" was compiled. The data carriers were damaged, therefore they had remained in Latvia. The KGB did not anticipate that Latvia had good IT specialists who could read the information contained therein

Statistic card files of the KGB in its original "package" – two attaché cases

instruments employed by this regime, as well as to raise the ability of the public to recognise the consequences of this regime, how to overcome them and further the development of Latvia as a democratic state, by placing the KGB documents at the disposal of Latvia public." However, during the four years of its operation, the Committee set up to enquire into the Latvian SSR did not assess any foreseeable impact of these amendments to the law; thus, the question of whether the publication of the documents would achieve its stated objective was left unanswered.

In order to head off possible claims against the state by people who declare information about themselves to be false, the new amendments to the law stated that "information published by the National Archives of Latvia is informative and without legal consequences in the absence of a court judgement".

Following the publication of the card files, several persons named therein have demanded the prosecutor's office to verify information about their alleged cooperation with the KGB, and in all cases courts have not established such conscious cooperation with the KGB. It is safe to predict that this trend will continue in the future. Legal consequences flowing from court rulings in these cases have been extinguished, but the ethical consequences cannot be ignored. The fact that the KGB card files include the names of true criminals and ideological whistle-blowers, as well as the names of agents who have helped with criminal investigations and who have not cooperated or been aware of their name on the files, renders matters even more complicated.

Likewise, the law does not provide any legal instrument to protect the reputation of deceased people solely if their names are included in the KGB card files and with no additional information as to why their names are listed. It is appreciated that the dead themselves cannot provide any arguments in their defence. However, this information has the most direct impact on the lives of relatives of the deceased.

There is also the issue of double agents who collaborated with both the Latvian SSR KGB and Western secret services during the Cold War, such as Imants Lešinskis, or those who worked with the national resistance movement such as Eduards Pleps in the post-war period.

It is important not to ignore those cases when a person publicly acknowledges the fact of his cooperation, but whose name cannot be found in the part of the card files held in Latvia.

One benefit of the amendments to this Law is that, thus far, limited access to KGB documents have been made available for scientific study and that during implementation of the said Act the KGB documents were digitized.

The professional approach taken by the mass media ("Delfi", "LSM", "Ir" magazine) is appreciated by researching and interviewing the people whose names are mentioned in the register, as well as soliciting expert opinions of experts. Journalists through their investigations are expanding the information base by seeking out and interviewing potential eyewitnesses not mentioned in the KGB documents, thus trying to make up for the lack of academic research. However, the lack of alternative sources of information often precludes judging the veracity of the interviewees' view of historical events.

In the context of the aforementioned amendments to the Law, the New Rīga Theatre produced in 2019 a play entitled "History Research Commission", on the extent to which published information could be credible and how it could be used to manipulate the public. The theatre troupe conducted its own independent research, interviewing people named in the register, former KGB staff and their contemporaries. The show has already gained international recognition.

However academic researchers are still silent. This can be partly explained by the inertia inherent in this environment, but alongside the work of investigative journalism, I would also like to see an academic study on the general functioning, tasks and working methods of the state security organs of the Latvian SSR.

Therefore, at the moment, there are more questions than answers. It is still unclear whether before acting the legislator carried out any assessment of the likely short-term or long-term impact of such legislative changes. Has publication of documents with-

out prior scientific research, evaluation and scientific commentary turned out to be a shot in the foot? What is more important to society: to know the individual names or to understand and evaluate the methods of operation of the repressive apparatus of the Empire of Lies and forgive those who helped to reveal it? At a closed session held on 24 August 1991, in Jēkaba Street, Edmunds Johansons, chairman of the Latvian SSR KGB, stated that out of 138 members of the Supreme Council who voted for the restoration of Latvian independence, 36 were KGB agents. The question is not whether these 36 are villains or heroes. It is important to understand that without their votes the Declaration of Independence would not have been accepted. The question remains: could new injustices be tolerated in the fight against injustice once cultivated by the KGB?

Thus, before the publication of the "Cheka bags", the public ought to have known that only a small part of the agency's card file collection was found in Latvia and that there were no documents containing information on the nature and substance of the possible cooperation. A person may also have been made into an agent without his consent. It is known that this was practiced mainly by the units tasked with scientific-technical intelligence gathering and ideological counter-intelligence. However, in the late 1980s, and between 1990 and 1991, operational contacts were often formalised as a way for KGB operatives to "enhance" their performance.

It is not without reason that information supplied by informants of the former secret services in other post-communist countries was granted confidential status for a limited period. This allowed valuable information to be saved for further historical research.

Unfortunately, the 1994 Act did not provide for this instrument either. Now this opportunity has been lost irretrievably.

It should be noted that guidance was ignored for a two-step publication as initially called for in 2014. In the first phase, the information would only have been available to researchers, so that after serious scientific study, information could have been published in the second phase as research findings.

Given the circumstances in Latvia, such an approach would have made more sense, because, as has been emphasised several times, the most important part of the collection of KGB documents was removed to Russia in the early 1990s, and these documents will not be available in the foreseeable future. The part of the card files left in Latvia is fragmentary, selectively and tendentiously selected, practically unverifiable and, in some cases, also erroneous. This is precisely what allows evaluation of this segment of the card files to be yet another provocation on the part of the KGB.

Following publication of the collection of KGB documents, new research topics have been identified as to whether and how publication has influenced understanding how the Soviet secret services operated during the occupation period, the public response to the revelations, their impact on individual relationships and the development of democracy in general; additionally how the KGB is still affecting Latvian society with this segment of the card files left behind in Latvia.

Information has been taken from the archives of the CDCT, as well as the author's own archive, and press materials have been used in preparation of this article.

Translated by **Eduards Bruno Deksnis**

MANAGEMENT AND RESEARCH IN TECHNOLOGIES AND ENGINEERING

RĪGA TECHNICAL UNIVERSITY'S COLLABORATION WITH THE CENTRE FOR EUROPEAN NUCLEAR RESEARCH

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The history and the idea of establishing a contact point between CERN (Centre for European Nuclear Research) and Latvia was a well-known necessity since yesteryears, but the chain of events that brought HEP RTU (Centre of High Energy Physics and Accelerator Technology, Rīga Technical University) and Latvia to this point started in 2005 when, following the persistent effort and will of the country and the scientific community to cooperate with CERN, Latvian researchers from the University of Latvia (UL) and the Rīga Technical University united and successfully participated at the Baltic Grid project. As a result, in January 2012, the Latvian Ambassador to Geneva at that time, Raimonds Jansons, started direct collaboration with CERN. Consequently, in the same year, the first meeting between CERN Director-General and RTU Rector, together with RTU delegation, took place at CERN where the next-steps collaboration strategy was set up. Six months after the meeting, in October 2012, plans were implemented and CERN signed the collaboration agreement with RTU.

The agreement signed between CERN and RTU allowed for the first time in the history opened exchange of CERN members, and Latvian researchers and students between countries, offering, among other things, the chance of organising guest lectures by various CERN researchers in Latvia, visits of Latvian doctoral students, teachers, and students to CERN, and participation in EU-funded projects coordinated by CERN – projects in which the Latvian scientists saw numerous areas of scientific collaboration related to power electronics and energy, robotics, and material science after the RTU scientific delegation visited CERN in January 2015.

In November of the same year, RTU signed the Memorandum of Understanding with CERN on membership in the Future Circular Collider (FCC) research project. Since then, Latvian researchers have been contributing actively on the new concept development for the FCC tunnel, its operation and repair by using robots and telemanipulation, as well as laser cladding. Furthermore, the FCC research project involves also integration of the existing CERN accelerator facilities (SPS, Tevatron, LHC), after being upgraded to reach higher energy levels and resolution.

In 2017, RTU agreed to participate in the ARIES (Accelerator Research and Innovation for European Science and Society) projects coordinated by CERN, together with other European top scientific institutions. In total, three RTU research teams and two industrial application teams took part in the ARIES project to transfer the advantages and usability of particle accelerators technology to science and society.

After the year 2016, there were multiple involvements of Latvia in several high-energy particle physics projects coordinated by CERN, which was the first time in 20 years that Latvia worked so extensively with CERN – to the meeting of the Latvian Minister of Education and Science, Kārlis Šadurskis, and Fabiola Gianotti, CERN Director-General in October of the same year. In the meeting the two authorities signed the agreement on scientific and technical collabora-

tion in high-energy particle physics between the Republic of Latvia and CERN. The action that followed those strategic decisions made in the past resulted in several events involving the international organisation (CERN) and RTU, for the benefit of young students, science and industry in Latvia.

To help implementing those and new benefits for Latvia, the RTU Senate established, in 2017, the Centre of High Energy Physics and Accelerator Technology, which has already been in operation almost for three years. The centre acts as a contact point between CERN and Latvia and works actively on the implementation of particle accelerators for society. One of the most recent remarkable success achievements is the leadership of the ARIES Prove of Concept (PoC) project in the development of hybrid electron accelerator system for treatment of marine diesel exhaust gases, which officially started at the same time when the Centre was established.

CURRENT PROJECTS AT HEP

Fig. 1.
Members of the ARIES PoC at the Rīga Shipyard during the experiment show up on 5 July 2019

This experiment was performed at the Rīga Shipyard in July 2019, together with other European institutions, and implies the first test of a particle accelerator to clean the exhaust gases of a ship, with encouraging results (Fig. 1). The development of this innovative solution claims to reduce the content of harmful pollutants contributed by the maritime traffic – a single cruise ship emits as much particulates as one million cars.

Several technologies are being explored to reduce the content of sulphur and nitrogen oxides and of particulate matter in the exhausts of maritime diesel engines. However, the solution proposed by accelerator scientists consists in a combination of irradiation by an electron beam accelerator of a few hundred kilovolts, and subsequent purification in a "wet scrubber". The electrons induce molecular excitation, ionization and dissociation, thus breaking the larger NOx and SOx molecules, and easing their removal in a small scrubber placed after the accelerator. The scrubber washes out the polluting molecules using water.

The experience and knowledge gained thanks to collaboration, experimental work performed by all the partners, and coordination work by HEP RTU help in better understanding of this novel gas treatment technology, which will lead to further development of this technology in the year 2020, when the members of the original ARIES PoC project together with new partners will work on the Horizon 2020 EU research and innovation programme. In this programme scientists and industrial partners want to boost the technological level of the concept proved in Rīga.

STUDY PROGRAMME TO BRING THE FUTURE

Furthermore, the HEP RTU works on the development of a study programme on fundamental interdisciplinary research in the field of high-energy particles and accelerator technology in the Baltic region, and enrolling Latvian scientific staff, academic staff, students and industry in nuclear research on the national and international levels, in particular the Compact Muon Solenoid (CMS) experiment at CERN. Therefore, the CERN Baltic Group (CBG) is an establishment where currently all participants (among them RTU) join their efforts to foster particle physics and accelerator technology research, and education community, in the Baltic States (Latvia, Estonia, Lithuania). The development of such a multidisciplinary master/doctoral level study programme in High Energy Physics and Accelerator Technologies strengthens the Baltic High Energy Physics community.

Taking CERN as a reference, technology transfer from particle physics can also add high-value tech-

nology in classical industries such as the food industry and material science, production, innovative diagnostic and therapeutic methods, computing and imaging techniques. These are all proven examples of the way how scientific achievements can contribute to the benefits of society and on the long term will benefit Latvia and her citizens. The programme is planned to be developed together with the University of Latvia as a joint study programme of both universities, with RTU as a responsible partner and project applicant, attracting experts from the University of Latvia based on an employment contract. It is planned to conclude an agreement between the two universities on the creation of study programme.

DEVELOPMENT STATUS OF THE STUDY PROGRAMME AND DISSEMINATION

Fig. 2.
Latvian student group on the Shadow Day at CERN

HEP RTU was working even before the official establishment in bringing particle physics, also in early stages, to the Latvian students. Since 2016, HEP RTU has organised a scientific mission for pupils on Latvian Shadow days to CERN (Fig. 2). On these trips to CERN, every year RTU PhD students and school students are guided around CERN and introduced or get a deeper understanding of fundamental physics, research and research facilities performance.

On a regular basis, RTU HEP is working on the coordination of the Baltic research institutions' activities towards CERN and related collaborations/experiments, and in addition to strengthening and development of Baltic High Energy Physics community. One of the most recent actions to develop and strengthen the community was celebrated in Kaunas University of Technology, Lithuania on 9–10 October 2019.

Eight Baltic research institutions and CERN gathered for a regular meeting to discuss the latest scientific collaboration successes, including joint scientific projects with CERN, to boost particle physics and accelerator technology expertise in the Baltic (Fig. 3).

In this meeting future joint actions of the CBG were planned and discussed, e.g., the annual organisation of the CERN Baltic School of High Energy Physics and Accelerator Technologies, starting from 2020, or support of continuous expert work for development of the doctoral and master study programme on the above subjects.

The group is also working to strengthen Baltic Industry engagement in collaboration with CERN in the series of events, and networking opportunities during 2020, and to closely coordinate scientific and industrial engagement in the CERN-based CMS experiment.

PARLIAMENTARY SECRETARY OF THE MINISTRY OF EDUCATION AND SCIENCE, ANITA MUIŽNIECE, VISITS CERN

As Latvia continues its path towards membership of the Centre for European Nuclear Research, a delegation from the Ministry of Education and Science visited CERN on 11 October 2019, at the initiative of Toms Torims, Professor of RTU and CERN Scientific Associate. Anita Muižniece, Parliamentary Secretary of the Ministry of Education and Science, was introduced with CERN activities and scientific achievements.

They were accompanied by the Ambassador of Latvia to the UN in Geneva, Jānis Kārkliņš, and Toms Torims. Latvian representatives met a large delegation of CERN scientists and representatives, including RTU PhD student and CERN Researcher Artūrs Ivanovs. During the visit, participation of Latvian scientists in CERN experiments, joint scientific

Fig. 3
4th CERN Baltic Group Meeting in Kaunas

Fig. 4.
Anita Muižniece, Parliamentary Secretary of the Ministry of Education and Science, visits CERN

projects and plans for future were discussed. The activities of CERN Baltic Group were discussed and supported. The delegation visited the CMS experiment and CERN laboratories, and met Latvian scientists working at CERN. CERN expert group was invited to visit Latvia on 20 November 2019 to work on the application file and to coordinate the next steps. For 60 years, CERN has been a world's leading science centre with globally significant scientific breakthroughs. It is CERN that invented the Internet, but one of the most well-known inventions is the existence of Higgs boson, proven by the Large Hadron Collider six years ago. For Latvian scientists, membership in CERN will open up new opportunities to conduct research, participate in CERN scientific projects and to collaborate with other countries, and for doctoral students to develop their doctoral thesis at CERN, citadel for world's physicists. Industry will be able to apply for CERN tenders as scientific activities require a variety of technological equipment that can be supplied by Latvian companies (Fig. 4).

The opportunities to collaborate in EU-founded projects coordinated by CERN has led to participation of RTU in several ARIES projects, together with other European top scientific institutions. In total, three RTU research teams and two industrial application teams took part in the ARIES project to transfer the advantages and usability of particle accelerators technology to science and society. The research teams focussed their scientific expertise in WP 2, Training, Communication and Outreach for Accelerator Science in Europe; WP 15, Thin Film for Superconducting RF Cavities (SRF); and WP 16, Intense RF modulated E-Beams. One of the industrial application teams worked on the development of a hybrid electron accelerator system for treatment of marine diesel exhaust gases while the other worked for the Nuclear Medicine Centre together with Faculty of Medicine of the University of Latvia intending to join CERN MEDICIS.

TILDE'S NEURAL MACHINE TRANSLATION TECHNOLOGY

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Toms Bergmanis, *Mg. sc. comp.*, Tilde

Machine translation (MT) is the technology that allows using computers to automate translation from one language to another [1]. MT enables us to read and navigate through foreign language web sites and helps us to cross language barriers in mutual communication both at work and leisure. It increases the productivity of professional translators and everyone in need of translating alike.

In what follows, we give a brief introduction to the history of MT. We then continue with a description of how we approach MT at Tilde. We then close with an outline of future directions of development for Tilde MT and MT in general.

HISTORICAL BACKGROUND

Although ideas of machine translation date back to as early as the 17th century [2], the first working prototype of a digital machine translation system was possible only after the introduction of digital computers. In 1952, a team of researchers from IBM and Georgetown University demonstrated the first ever machine translation system that could translate a limited vocabulary of 250 words from Russian into English [3]. It was the first example of a direct (or dictionary-based) machine translation system. As translating words in isolation cannot ensure

The team behind Tilde MT

translation quality, during the sixties and seventies researchers focused on exploring other rule-based MT methods that consider the sentence structure and morphological and syntactic agreements between words. Rule-based methods, however, were impractical as developing them was laborious and demanded linguistic expertise. Thus, during the eighties, researchers started to explore ways for developing MT systems that did not require immense human effort. This is when the first data-driven MT methods [5] and statistical MT (SMT) methods were proposed [6]. SMT systems learned to translate by collecting word and phrase translation statistics from large translation memories created by human translators. While being faster to develop and providing better translations than the rule-based alternatives, SMT systems did not analyse the sentence as a whole, but rather considered phrases of multiple words in isolation. Thus, better methods were still necessary. Although the first neural machine translation (NMT) methods were proposed in the nineties [7, 8], it took almost two decades for NMT and its supporting technology to mature. Ever since 2015, when NMT systems outperformed SMT systems for the first time [9], the focus of MT research has been on NMT. Since then, Tilde MT has continuously improved to offer linguistically informed state-of-the-art MT technology.

TILDE MT TECHNOLOGY

Since the very inception of Tilde MT, our ambition has been to be a top-tier international player in our field. Achieving this goal has meant that we have had to compete with the technology giants of our time in delivering MT technology while preserving our core focus on providing high-quality machine translation capabilities for small and morphologically rich languages. In what follows, we describe how continuous innovation, language and client-oriented approach have been paramount in establishing Tilde MT as an internationally recognised machine translation technology.

Technology open to innovation. Key to Tilde MT success in the international arena has been continuous innovation of MT technology. Instrumental to it has been our industry-academia partnership of a span of two decades [10]. As a result, Tilde MT, together with its partner organisations from the leading European universities and MT research groups, has contributed significantly to the advancement of modern generations of MT technology. An example is the *LetsMT* project [11], a joint effort with the University of Edinburgh and other partner organisations, which enabled MT technology to small and morphologically rich languages and established the *Moses* statistical machine translation system as the go-to MT framework at the time. A decade later, our tightly-knit partnership continues [12] with the advancement of *Marian* [13] – the fastest neural MT framework today [14]. The affinity to the cutting-edge technology gives Tilde MT a natural competitive edge. In 2016, for example, Tilde MT rolled out the first publicly available neural MT systems for small languages (Latvian and Estonian) [15] only shortly after the technology giant Google rolled out the first NMT system for large languages [16]. In 2017, most of our competitors chose the computationally heavy deep Long Short-Term Memory (LSTM) [17] neural MT models, which, while slow, had been proven to be highly successful in language processing tasks. To circumvent the long training times of computationally cumbersome deep architectures, Tilde MT opted for a less known alternative – Multiplicative LSTM (MLSTM) [18] neural models. Tilde MT's shallow MLSTM models proved to be faster to train and cheaper to deploy, yet yielded results better or on par with the next best alternative [19, 20]. In the fall of 2017, however, a new state-of-the-art neural network architecture, the Transformer architecture, was proposed [21] – a change that was swiftly integrated in Tilde MT technology [22].

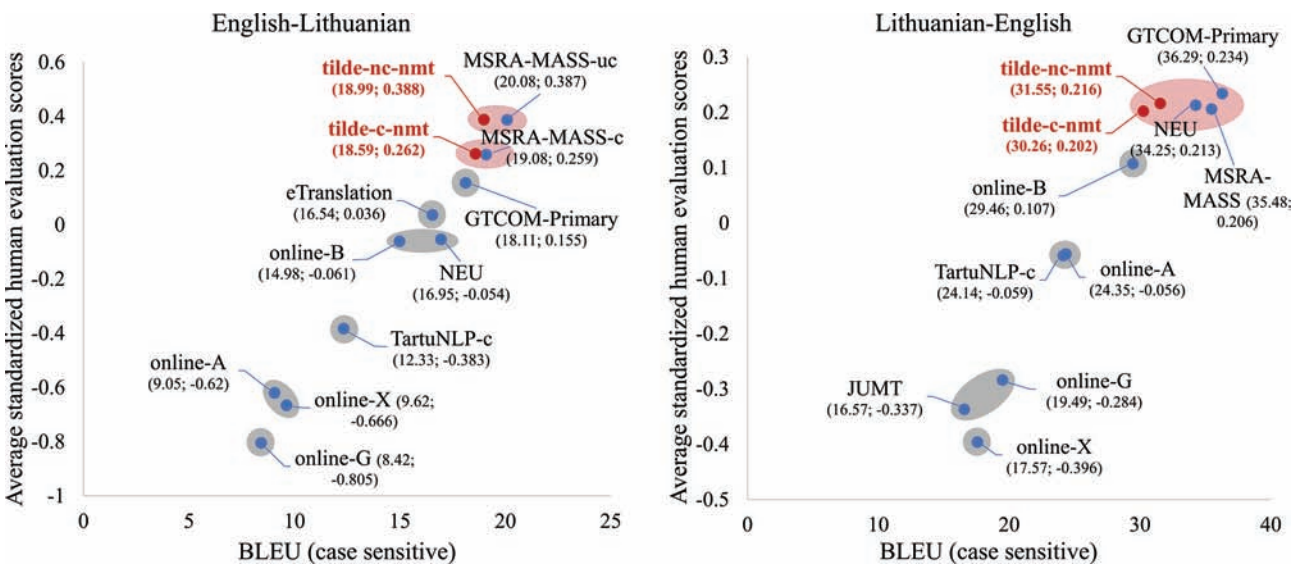
Technology tailored to language. As Tilde MT started with the effort to introduce MT technology for the Latvian language [11], all our language technology is designed with small and morphologically rich languages in mind. As a result, the Baltic language family rooted perspective has shaped our approach to MT by making our solutions customisable to account for natural language phenomena and writing conventions of each language. Some of the methods we have introduced are: 1) morphological structure-aware representation of words which has shown improvement over the commonly used lan-

guage-agnostic methods, 2) special handling of translation of proper nouns and named entities which tend to be rare in training data, and 3) training data selection that ensures coverage of topics and writing styles that are relevant to the source language speakers. The individual approach, together with the cutting-edge technology mentioned earlier, has made Tilde MT to stand out among its competitors and has earned the loyalty of our clients. For example, since 2017, Tilde MT has provided MT services for the Presidencies of the Council of the European Union [23]. Successful delivery of machine translation services for an array of different European languages such as Latvian, Estonian, Bulgarian, German, Romanian, and Finnish proves the versatility of our technology. Another example is Tilde MT's continuous success in the "Olympic Games" of MT (or more precisely the shared tasks on news translation of the Conference on Machine Translation; WMT) in 2017, 2018, and 2019, where Tilde MT's translations between the English and the languages of the Baltic states were rated best in human evaluation by professional translators [19, 20, 22, 24, 25, 26].

Importance of data. Neural network architectures and linguistically motivated methods are not the only factors that affect on whether an MT system will be of high quality or not. The quality [27] and domain adherence [25] of data used for training MT systems often plays a more critical role. The success of Tilde MT at the "Olympic Games" of MT can also be partially attributed to the data preparation methods as well as to the MT model training strategies.

Since the launch of Tilde MT platform, we have focused on developing methods that reduce noise in data [11]. Noise in data may be present due to a number of issues, such as partial translations, incorrectly aligned sentences, issues in client data processing workflows, etc. NMT models are much more sensitive to noise [27] than the previous SMT models, even to an extent where systematic noise can corrupt the whole system, and render it unusable. Therefore, during the last three years, we have improved our methods such that they allow training state-of-the-art models even when dealing with noisy data [25, 27].

Last but not least, when developing MT systems for clients (or for specific domains) it is crucial that the systems achieve superior quality when translating data from that particular domain. Therefore, MT system domain adherence needs to be ensured. In Tilde MT, this is typically carried out using various domain adaptation techniques. In domains, where large amounts of parallel training data are available, we train domain-specific systems. These systems provide high-quality translations as they are trained to account for the idiosyncrasies of language as used in each area. There are, however,



Human [26] (y axis; higher is better) and automatic (x axis; higher is better; calculated by Tilde) evaluation results for English–Lithuanian and Lithuanian–English of WMT 2019; systems ranked with the same place are grouped together

smaller domains for which in-domain data is scarce. In such cases, it is not possible to train a high-quality domain-specific system from scratch. To circumvent problems due to scarce training data, we first train a high-quality system for a much larger general domain and then use the available in-domain data to further adapt the MT system for the specifics of the required domain.

Building domain-specific systems, however, is not always practical as one client depending on their projects might want to translate texts from various domains. For cases like these, Tilde MT provides systems that are capable to adapt dynamically to each sentence individually [28; 29] based on similar sentences from the Tilde Data Library [31] or client's own translation memories. Additionally, these systems readily learn from the user feedback provided in the form of post-edited machine-translated sentences [30].

Future directions. Machine translation is far from being a solved research problem and, considering the continuous change of language, it will never be a completely solved problem. There are, however, many areas that have already seen significant improvements, and there are areas that will be significantly improved also in the future.

Currently (i.e. up to late 2019) publicly available MT systems all translate isolated sentences. If a system receives a longer paragraph, the system breaks down into individual sentences and translates each sentence separately. Such an approach does not consider cross-sentential dependencies and may result in incoherent translations of paragraphs. For instance, when translating the text: "The girls went to a movie. They liked it.", into Latvian, the word "they" must be translated using a feminine pronoun, however, when translating isolated sentences, "they" becomes ambiguous. By not considering cross-sentential dependencies, MT systems may mistranslate the word using a masculine pronoun. To address this issue, researchers have started investigating methods that allow using previous sentences as contexts [32, 33], or even translate the whole paragraph in one go [34]. When such systems will be widely available, translations of documents will become more coherent and fluent.

Expanding beyond sentence boundaries provides a means to provide access to more contextual information for MT systems. However, there are cases where the contextual information that is required to translate a sentence correctly is not found in the text itself but is rather external (i.e., correct translation depends on the gender of the speaker). An example is the translation of "I have been in love" into Latvian. It is crucial to know speaker's gender as otherwise it is unclear whether "been" should be translated as "bijis" or "bijusi". The text alone might not contain such information. Thus, integration of additional external knowledge might be required to allow MT systems to translate into languages with a grammatical gender correctly. Methods for addressing issues regarding the translation of grammatical gender are still an emerging area of research in MT.

An area where public MT systems are available only for a couple of large languages is speech translation (for instance, simultaneous translation of meeting or conference speeches and offline translation of recorded speeches). Speech translation combines multiple artificial intelligence technologies. Namely, it combines speech recognition, machine translation, and speech synthesis, into one solution that can understand the spoken language from an audio signal, generate translations, and optionally generate an audio signal of the translated speech. Currently, there are no speech translation systems available for the languages of the Baltic states, but active research is taking place [35] to enable this technology also for these languages.

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ENGINEERING RESEARCH INSTITUTE "VENTSPILS INTERNATIONAL RADIO ASTRONOMY CENTRE" OF THE VENTSPILS UNIVERSITY OF APPLIED SCIENCES AND ITS BROAD-SCOPE RESEARCH

Juris Freimanis, *Dr. phys.*, Engineering Research Institute "Ventspils International Radio Astronomy Centre", Ventspils University of Applied Sciences (ERI VIRAC), leading researcher
Artis Aberfelds, ERI VIRAC, scientific assistant; University of Latvia, PhD student
Boris Ryabov, *Dr. phys.*, ERI VIRAC, leading researcher
Juris Kalvāns, *Dr. phys.*, ERI VIRAC, leading researcher
Romass Pauliks, *Dr. ing.*, ERI VIRAC, leading researcher
Artem Sukharev, Candidate of Physical and Mathematical Sciences (Ukraine), ERI VIRAC, guest leading researcher, postdoctor
Karina Šķirmante, ERI VIRAC, researcher; University of Latvia, PhD Student

HISTORY, BASIC EQUIPMENT AND PEOPLE

The scientific institute mentioned in the heading, shortly VIRAC (http://virac.eu/en/home/), is a multidisciplinary institute – structural part of Ventspils University of Applied Sciences (VUAS, https://venta.lv/en/). VIRAC consists of several departments. The cornerstone of its research is astronomy (mainly astrophysics), but it is involved in the remote sensing of the Earth, space communications technology etc. VIRAC has about 80 full-time and part-time employees; about 26 of them have doctoral degree (both numbers are somewhat changing from time to time). The budget is varying strongly because a large part of it comes from projects. VIRAC's budget in 2019 was about 4.5 MEUR. A large part of the basic infrastructure (32 m and 16 m radio antennae) was inherited from top secret Russian army base overtaken in 1994 when Russian military left Latvia, in the secret town Irbene on the western coast of Latvia, about 30 km north-east from Ventspils town. Tracking and guidance systems were damaged by Russian military.

In order to refurbish and operate the radio telescopes, the scientific institute – Ventspils International Radio Astronomy Centre (VIRAC) was established directly under the Latvian Academy of Sciences. The first radio astronomical observations in VIRAC were carried out in 1997. In 2004, VIRAC was merged with the Ventspils University College (VUC, recently renamed as Ventspils University of Applied Sciences, VUAS). Along with radio astronomy, the preparatory work for remote sensing of the Earth was done.

In spring 2010, VIRAC was joined with the Engineering Research Centre of VUC, and it got the current name – Engineering Research Institute "Vent-

spils International Radio Astronomy Centre" (ERI VIRAC). The short name is still VIRAC. Several electronics and mechanics engineers entered VIRAC staff.

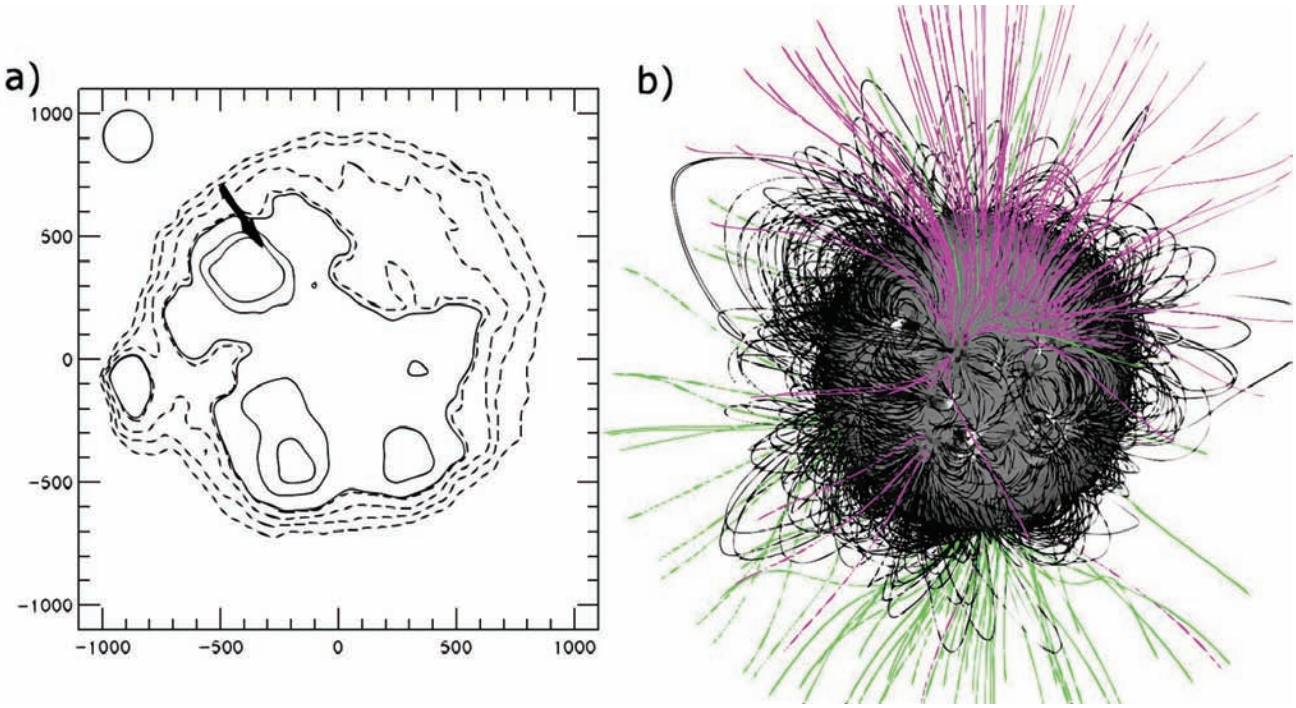
Very substantial improvement of both the fully steerable radio antennae (RT-32 and RT-16), as well as the receivers, took place in 2012–2015, with the investment of about 8.5 MEUR, mainly from EU structural funds. VIRAC was accepted into EVN (European VLBI network, see https://www.evlbi.org/home) in autumn 2016; simultaneously Latvia as a country was accepted into JIV ERIC (https://jive.eu/). Currently we have 4.4–8.8 GHz cryogenic receivers and 1.6 GHz warm receivers on both telescopes. We plan to build new 1.6 GHz and 17–34 GHz cryogenic receivers.

The next big step was building of LOFAR station, a completely new type of radio telescope for 10–80 MHz and 110–240 MHz ranges (see http://www.lofar.org/), in Irbene during 2017–2019. VIRAC was accepted into ILT (the International LOFAR Telescope) on 2 October 2019.

ASTROPHYSICS AT VIRAC

One of the most intense directions of radio astronomical observations at VIRAC is cosmic maser research (methanol, OH and excited OH at 6.7, 1.6 and 6.0 GHz). Some peculiar patterns of variability were found, along with some flaring masers. Probably three new excited OH masers were discovered in the Galactic plane very recently. The whole EVN network observed three cosmic maser sources on 31 October 2019, according to VIRAC scientists' observing proposal.

Another important object of astronomical radio observations is the Sun. Nowadays the solar research at VIRAC embraces two main directions: the sources of slow solar wind and the construction of the up-to-date model of the sunspot atmosphere. Solar radio observations and modelling are used to study the topology of large coronal magnetic structures. This is the base for solution the set of problems of space weather, in particular, for the interpretation of forthcoming measurements by Parker Solar Probe and the planned Solar Orbiter probe.



(a) Radio map of the Sun taken with the VIRAC 32-m radio telescope on 18 July 2013. The arrow points to the reduced microwave emission due to open-field region extended from coronal hole towards the active region on the Sun;
(b) Modelled magnetic field lines in the solar corona (open field lines in red and green colour; closed field lines – in black). Courtesy of the *Latvian Journal of Physics and Technical Sciences*, 2017, Vol. 54, Issue 3, p. 58

VIRAC's radio telescopes regularly participate in the very long baseline interferometric observational sessions of the European interferometric network EVN, targeting galaxies, quasars etc. and reaching the spatial resolution of several milliarcseconds. One of such EVN sessions took place on 17 August 2017, with the participation of VIRAC's 32 m dish, helping to discover and identify the source of gravitational waves. Many interferometric observations together with the Russian satellite *RadioAstron (Spektr-R)* at 5.6 GHz and 1.6 GHz have been carried out as well; the interferometric baseline was up to 320 000 km, leading to the theoretical spatial resolution of 4×10^{-5} arcsec and 1.4×10^{-4} arcsec, correspondingly.

In 2017, VIRAC started the observations of fast variability of several active galactic nuclei (AGN) – BL Lac objects, quasars, Seyfert galaxies at 5, 6.1, 6.7 and 8.4 GHz, with the characteristic times from several hours (intraday variability) to several days and tens of days (interday variability). Support with the related optical observations was provided by the observatories Mayaki (Odessa, Ukraine), Vihorlat (Slovakia) and Baldone (Latvia). Observations of the radio source OJ 287 at frequencies 6.1 and 6.7 GHz and in V, R, I filters showed significant interconnection between quasi-periods of fast variability of this object in radio and optical bands.

VIRAC performs active research in theoretical astrochemistry. Processes in the interstellar ices are of particular interest. Molecules, such as carbon monoxide and water, accumulate on the surfaces of dust grains in the interstellar and circumstellar medium. We have quantified parameters characterising processing of such icy mantles – photodissociation efficiency for solid-state molecules in ices and the rate of desorption induced by energetic cosmic-ray particles. Necessary theoretical background was provided to experimental and observational studies, in addition to studies of the formation of organic molecules in the interstellar medium.

Studies in the mathematical theory of polarized radiative transfer have resulted in the clear expression for Green's function of radiative transfer equation in homogeneous infinite medium with cylindrically symmetric radiation field, as well as expressions for cylindrically symmetric eigenfunctions of transfer equation. The general expressions for the streaming operator of polarised radiation in arbitrary curvilinear coordinate systems, without and with refraction in the medium, were obtained.

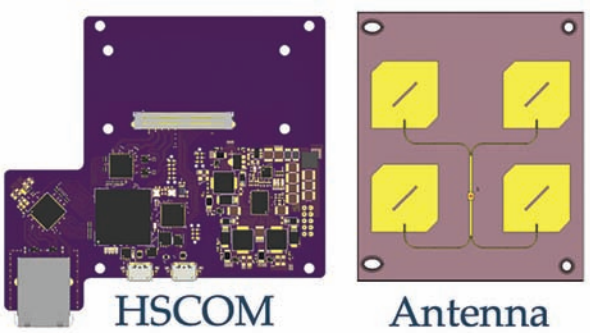
Studies of mass outflows from post-asymptotic giant branch (post-AGB) stars have begun recently. Monte Carlo computer code for polarised radiative transfer modelling has been developed, as polarisation can reveal fine peculiarities of the structure of circumstellar dust envelopes.

One of the research activities is to use the hyperfine transitions of known hydroxyl radical (OH) at its 18 cm wavelength as a reflected signal from comets using a radar VLBI approach. The research group adapted Irbene RT-32 radio telescope for weak (~0.1Jy) astronomical object detection at 1665.402 MHz and 1667.359 MHz frequencies. Novel data processing methods were used to acquire a weak signal – spectral analysis of signal using Fourier transform and continuous wavelet transform. Multiple observations of comets (Comet C/2018 W2(AFRICANO) and Comet C/2017 T2 (PANSTARRS)) were carried out in 2019.

SPACE COMMUNICATIONS AND THE OTHER ELECTRONICS

VIRAC's Electronics and Satellite Technology Division is a nanosatellite subsystem integrator focused on the research and development of high-speed communication solutions.

As a result of several years of collaboration with the Estonian Student Satellite Foundation, we have developed a high-speed communications module that is planned to be used on the ESTCube-2 nanosatellite.



Nanosatellite high-speed communication subsystem (HSCOM)

Another important direction under way is the development of Internet of Things (IoT) measurement subsystem for various space applications.

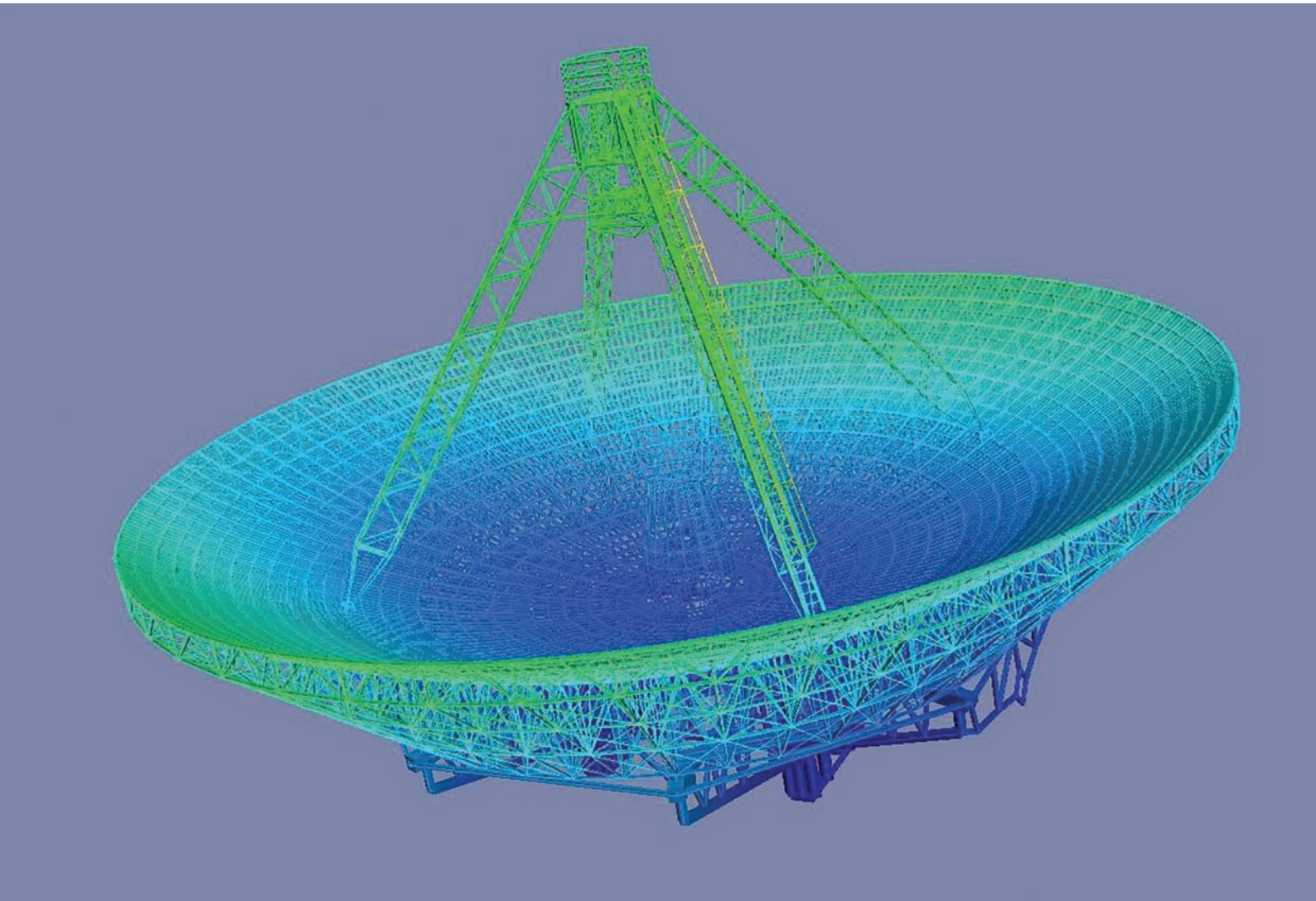
HIGH-PERFORMANCE COMPUTING

Studies in the VIRAC's High-Performance Computing Department focus on the processing of high velocity and high volume numerical data, which includes processing and analysing radio astronomical data, computer-aided engineering, computer-aided problem solving in physics and mathematics.
Multiple astronomical data processing methods with parallel algorithms were developed, tested and applied using VIRAC HPC cluster facilities with 30 high-performance servers. Multiple information systems related to automatic data correlation, data monitoring and analysis were developed in 2019.
VIRAC's research in engineering physics is related to numerical hydrodynamics (CFD) and mechanics calculations (including the effect of wind flow on different types of objects, numerical models of engineering tools); modelling of magnetohydrodynamic (MHD) phenomena; application of methods of calculation of the physical fields to support local industry, such as calculations of mechanical loads of individual components of newly developed products.

CONCLUSION

VIRAC is a developing scientific institute, and it has gained certain international recognition, due to its publications in respected international scientific journals and participation in European VLBI network. It has a great potential for scientific growth; however, the main precondition for that would be a substantial increase of funding of fundamental science in Latvia.

Numerical model of the radio telescope RT32 in Irbene – model developed in HPC department using finite element method (FEM)



LATVIAN HYDROGEN ASSOCIATION: ACTIVITIES AND PERSPECTIVE

Aivars Starikovs, Latvian Hydrogen Association, Chairman of the Board

Latvian Hydrogen Association (H2LV) is an association with the aim to implement zero-emission technologies in Europe to reduce the impact on environment, and to support the development of energy efficiency usage. Zero-emission transport and promotion of its necessary infrastructure, and support for its implementation is set as one of the main pillars for H2LV, as well as specialising in the development of zero-emission strategies and project management services in hydrogen as alternative fuel fields.

During the last years, H2LV staff has gathered knowledge and experience in energetics, chemistry and physics and has participated in different studies on hydrogen as vehicle fuel implementation. H2LV staff specialises in hydrogen technology integration in public transport and compilation of project proposals that could ease the possibilities to reach the zero-emission aims for different types of entities.

H2LV has a strong connection with the Latvian Academy of Sciences as one of the founders providing the contribution in reaching the following initiatives:

- To speed-up educational and technological progress in the implementation of hydrogen technologies in Latvia and to create a bond with enterprises in this specific field across Europe;
- To ease the implementation of hydrogen technologies that would result as a reduced impact on environment by increasing energy efficiency and energy production;
- To combine educational entities, state entities and hydrogen technology producers under a joint umbrella and to represent H2LV in national and international conferences etc.

H2LV is an active member of Hydrogen Europe – a leading European association promoting hydrogen as the enabler of a zero-emission society. H2LV representative is elected in Hydrogen Europe Board. Hydrogen Europe is collaborating with the European Commission and the research community in a public-private partnership the Fuel Cells and Hydrogen Joint Undertaking (FCH JU). The FCH JU drives a funding stream worth €1.3 billion to accelerate the market introduction of these clean technologies in energy and transport. The technical committees which are made up of Hydrogen Europe and Hydrogen Europe Research members are responsible for shaping the annual funding calls for proposals. H2LV are participants in: Gas Grid; Mobility; Truck; Maritime Working Groups together with representatives of EU institutions and field stakeholders.

H2LV staff has participated in projects that challenge low-energy efficiency and zero-emission vehicle and infrastructure implementation. The most important hydrogen-related activities in Eastern Europe:

- Study "For the purpose of developing research about sustainable hydrogen production opportunities in the city of Rīga" as a part of CEF-Transport project "H2Nodes-evolution of a European hydrogen refuelling station network by mobilising the local demand and value chains" to evaluate the hydrogen implementation benefits in Rīga;
- Primary assessment of Latvian Railway shunting locomotive operational usage and possibilities to deploy hydrogen electric shunting locomotives in railway infrastructure;

Toyota Mirai with full hydrogen tank starts its way from Brussels to Rīga for tests of Rīga Hydrogen Refuelling Station

Test refuelling of hydrogen FC range extended trolleybus in Rīga

– In collaboration with the Latvian Academy of Sciences, participation in the project "Management of a Joint Procurement Strategy for Fuel Cell Buses" to coordinate the development and evaluation of the common methodology to perform joint procurement for transport operators across Northern Europe;
– Coordination of the National Priority State Research Programme 2010–2013 "LATENERGI", sub-programme "Hydrogen production, storage and usage; technological solutions, implementation methodology research and prototyping for national economy";
– Co-researchers in the study "Hydrogen technology usage for public transport needs in the city of Rīga, economic and environmental issues";
– Participants of the international project "HIT-2-corridors"; hydrogen as transport fuel infrastructure implementation on TEN-T core networks North Sea – Baltic sea and Scandinavian–Mediterranean corridors.
– Invited as experts for developing a national policy framework for alternative fuel implementation in Latvia (2016);
– Participants of the international study "Use of fuel cells and hydrogen in the railway environment" (2019);
– Development of zero-emission strategy for Jelgava Public transport operator (2019).

H2LV staff has experience in organising events and conferences:
– International Conference of the Latvian Hydrogen Association, "Hydrogen and Fuel-cell Studies and Usage in Different Fields" (2012);
– Organising the first fuel-cell electric bus promo tour in Rīga (2013);
– Organising the first FCEV Toyota Mirai promo tour in the Baltic states during Rīga HRS tests in 2018
– COTER 3rd conference "Integrated Mobility and Urban Development Solutions for Cities" (2015);
– "13th European Week of Regions & Cities, Open Days 2015, local event" organising a part of the fair "Alternative, environmentally sustainable and economically affordable energy solutions for mobility in functional urban areas" (2015).
– Baltic Sea Region Hydrogen Network Conference (2017).

Main partners of H2LV:
– Hydrogen Europe;
– Fuel Cells and Hydrogen Joint Undertaking (FCH JU);
– Element Energy limited;
– Hydrogen Sweden;
– Hydrogen and Fuel Cells Association of Germany;
– Danish Partnership for Fuel Cells and Hydrogen;
– Norwegian Hydrogen Forum;
– Bulgarian Hydrogen Association;
– Ukraine Hydrogen Council.

THE FIRST LATVIAN SCIENTIFIC ANTARCTIC EXPEDITION

Kristaps Lamsters, *Dr. geol.*, University of Latvia
Jānis Karušs, *Dr. geol.*, University of Latvia

INTRODUCTION

Despite being the coldest, driest, less populated and almost isolated from the rest of the world, Antarctica holds an enormous amount of fresh water in the form of the largest Ice Sheet on our planet that has a power to raise sea level globally, disturb oceanic and atmospheric circulation, and influence our daily life and economics through climate change feedback. Still, Antarctica is the less studied continent and the mystery of fast-flowing ice streams, subglacial lakes and changing icy world is far from fully understood. Only 200 years have passed since one of the first sightings of Antarctica occurred in 1820 when the first Antarctic Circumnavigation Expedition led by Captain T. T. Bellingshausen was implemented. Of course, there was a competition for a discovery of the white continent and only three days later Antarctica was seen by English naval officer Edward Bransfield during a British expedition, and an American seal hunter and explorer Nathaniel B. Palmer saw Antarctica in 1820 as well. Although Antarctica was discovered, scientific studies started only a century later. During the 19th century, a large number of scientists still stuck to the Great Deluge (Biblical Floods) hypothesis instead of the Ice Age theory. The end of the 19th century and the beginning of 20th century was marked by the first expeditions to Antarctica organised by several nations, for example, German, Belgian, French and British expeditions, which made scientific surveys and mapped for the very first time the territories of the Antarctic Peninsula. The beginning of 20th century was a birth for Latvian polar research as well because Latvian researchers were involved in the Arctic exploration through Latvian membership in the international association Aeroarctic led by famous explorer Fridtjof Nansen, and geophysicist Leonīds Slaucītājs even led several Antarctic expeditions of Argentina.

Nowadays, the Antarctic Peninsula (Fig. 1) is considered as a region of rapid warming occurring over the last 50 years. Atmospheric temperatures have increased around the Antarctic Peninsula rising by approximately 0.5 °C per decade since 1950. The annual mean surface temperature has increased most of all at the Vernadsky station by about 2.5 °C since the 1950s. Glaciers of the Antarctic Peninsula have been retreating at least since the 1970s and the ice mass loss is dominated by the West coast of the Antarctic Peninsula and Larsen A and B Ice Shelves. It is known that glaciers across the Antarctic Peninsula are very sensitive and respond more directly to climate change. Warming in this region of Antarctica is considerable and has a substantial influence on glacier reduction. However, local investigations of small glaciers on islands at the western coast of the Antarctic Peninsula indeed are very rare. Thus, addressing the lack of knowledge about the ice caps around the Vernadsky station – probably the most warmed region of Antarctica, the first Latvian scientific expedition was conducted in 2018.

Since 2014, scientists from the Faculty of Geography and Earth Sciences, University of Latvia, have conducted seven scientific expeditions to Polar Regions developing the field of polar studies at the University of Latvia and Latvia in general. Expeditions have been organised to Iceland (2014, 2015, 2017, 2018), Greenland (2016), Antarctica (2018) and Svalbard (2019). Although the main goal of these polar expeditions was investigation of glacier thickness, internal structure and subglacial topography using ground penetrating radar (GPR) and unmanned aerial vehicles (UAV), interdisciplinary

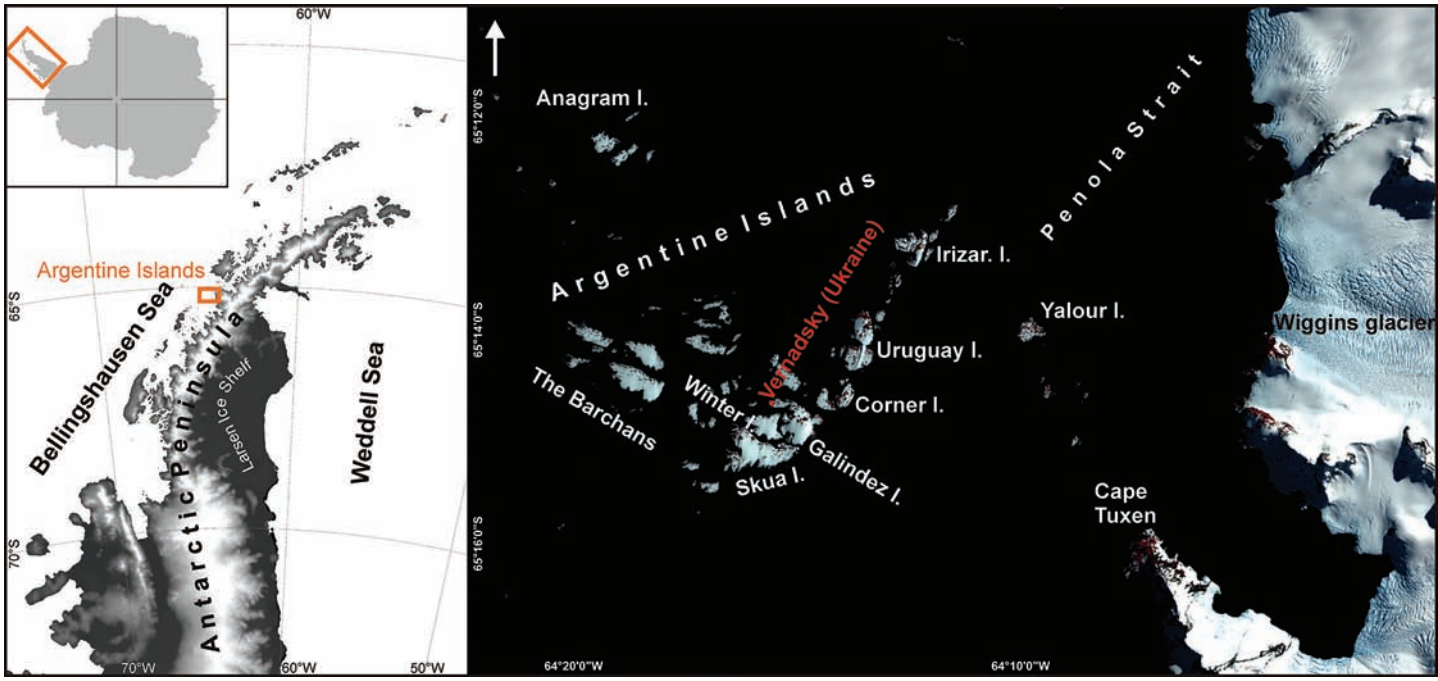


Fig. 1.
Location of the study area

Fig. 2.
The environment of Antartica and used equipment. a) A team of Latvian scientists in Antarctica. From the left: Jānis Karušs, Māris Krievāns and Kristaps Lamsters; b) Vernadsky Station; c) performance of GPR measurements; d) aerial surveying with UAV

studies were performed in the fields of geology, geomorphology, glaciology, soil science, remote sensing, microbiology and pollution problems. Thereby, a new research field in Latvia – polar studies, has been developed at the University of Latvia. Scientific expeditions to the Arctic or Antarctica are organised each year and the results of polar studies are being published in international scientific journals and presented at international scientific conferences. The established goal of these studies is the construction of the Latvian seasonal polar station in Antarctica that is an essential step for long-term studies in this region.

The first expedition to Antarctica is considered as a significant step forward starting long-term studies in this region. For realisation of the former and further polar studies, it is substantial to cooperate with countries which operate research stations in Antarctica. Therefore, the cooperation agreement was signed between the University of Latvia and the National Antarctic Scientific Centre of Ukraine in 2017, and the first expedition to the Vernadsky Station was conducted in 2018 by geologists of the Faculty of Geography and Earth Sciences – Jānis Karušs, Kristaps Lamsters and Māris Krievāns (Fig. 2A).

STUDY AREA AND RESEARCH HISTORY

Vernadsky station (Fig. 2B) is situated on the Galindez Island in the group of Argentine Islands, Wilhelm Archipelago, which is opposite Kiev Peninsula of the west coast of the Graham Land of the Antarctic Peninsula (Fig. 1). Administration of the station is performed by the National Antarctic Scientific Centre of Ukraine under the Ministry of Education and Sciences of Ukraine. The history of this research station is long and can be traced back even to the year of 1935, when the wintering base of the British Graham Land Expedition (1934–1937) was built on the nearby Winter Island. After that it disappeared mysteriously and the further base was established by the Falkland Islands Dependencies Survey in the same place in 1947 and called as Base F. The main hut was named Wordie House and it is still standing and designated as a Historic Site or Monument (HSM 62) under the United Kingdom Antarctic Heritage Trust. In 1954, a new station was built on the adjacent Galindez Island and renamed as Station F (Faraday) in 1977. After the year of 1996, the former British Faraday station was transferred to Ukraine. A symbolic one pound was paid for this transfer and the station was renamed as "Akademik Vernadsky". The station is scientifically important as it holds the longest meteorological observations in Antarctica, and other long-term studies as upper atmospheric physics, geomagnetism, ozone layer, seismology, ecology, biology, and glaciology.

METHODS

The expedition to the Argentine Islands, Antarctica, was implemented from 18 February to 4 April 2018. Measurements of ice thickness and structure by ground penetrating radar (GPR) and aerial surveys with unmanned aerial vehicle (UAV) of the ice caps located on the largest Argentine Islands were performed including Galindez, Northern Barchan, Southern Barchan, Winter, Skua, Uruguay, Corner, and Irizar islands. In total, more than 62 km of GPR profile lines were recorded in great detail consisting of a dense crosswise grid with a distance between the profile lines of 25 m. Such an approach was chosen to get the best possible models of the subglacial topography which was supposed to be heavily articulated as the exposed rock surfaces on all of the surveyed islands. The measurements were performed by two GPR systems – Zond 12-e with 75 MHz antenna (developed by a RadSys company in Latvia) and VIY3-300 with 300 MHz antenna (Transient Technologies, Ukraine). Zond 12-e (Fig. 2C) allowed reaching best results where the ice thickness was largest and VIY3-300 were most suitable for shallow ice measurements. Both used systems proved to be very accurate and fully comparable. The GPR data obtained with Zond GPR were processed and interpreted with Prism 2.6 software and the data obtained with VIY GPR were processed and interpreted with Synchro and Planner software. The electromagnetic impulse propagation speed was determined using englacial hyperbolic reflections allowing more precise determination of the ice thickness.

Aerial images were obtained with UAV – DJI Phantom III Advanced Quadcopter (Fig. 2D) which is ca-

pable of approximately 20 min of flight time during cold weather. This UAV is equipped with a GPS/GLONASS satellite positioning system and a 12 megapixel digital compact camera. The planning and execution of flights (automated missions) were done with Pix4Dcapture software, and the UAV was launched from the highest areas of islands at 60 m above the launching point. The images were obtained with 85% overlap allowing the construction of accurate digital surface models. Fourteen ground control points (GCP) were placed on each island on average. During the photogrammetric process, these GCP are used for precise referencing of the obtained images. Frequent storms, strong wind, coldness and precipitations were the main external factors influencing the use of UAV and making it sometimes difficult and even risky. Flights were carried out in the time spans when the weather conditions were most suitable for better distinguishing of land and ice cover. A total area of 4.48 km2 was covered during the successful UAV missions obtaining 10041 aerial photographs in total. Orthomosaics and digital surface models (DSM) were developed in Agisoft Metashape Professional software. Models of ice thickness and subglacial topography were created using ESRI ArcMap software.

Global Navigation Satellite System (GNSS) receivers Magellan ProMark 3 were used for coordinate and altitude acquisition of GCPs and for positioning of the start and end points of GPR profile lines. Measurement system consisted of two GNSS receivers – one was used as a base station and the other as a rover. Post-processing of GNSS data was done in "GNSS solutions" software. The average base station position accuracy was ~9.3 cm and the precision of measured GCPs and GPR profile points was 8 cm on average allowing reaching optimal accuracy for the performed study.

Besides of the aerial and geophysical surveys, ~30 kg of cryoconite, soil, sediment, and water samples were collected from glaciers ice-free areas including different environments as vegetated land, mosses, saltwater, small ponds, streams, and inlets to characterise the sedimentary processes, soil development, pollution and microbial diversity in this part of Antarctica. Analyses of persistent organic pollutants are being performed in the Institute of Food Safety, Animal Health and Environment "BIOR". Analyses of bacteria and bacteriophages are being carried out in Latvian Biomedical Research and Study Centre. The culture-based isolation, whole genome sequencing and further genomic characterisation of novel bacteriophages, including a first known *Sporosarcina* sp. infecting phage, from samples collected from soils of the Antarctic Peninsula are processed by Ņ. Zrelovs et al. Analyses of diatoms are performed by I. Grudzinska at the Institute of Plant Sciences, University of Bern. Sedimentary environments are being characterised by analysing the micromorphological features of mineral grains by Edyta Kalińska at the Department of Geomorphology and Palaeogeography of the Quaternary, Nicolaus Copernicus University, Poland. Results are in progress and several scientific publications could be expected in the near future.

ICE THICKNESS AND SUBGLACIAL TOPOGRAPHY OF THE ARGENTINE ISLANDS

We obtained new high-resolution orthophoto maps and DSMs of eight of the Argentine Islands are including Galindez, Winter, Skua, Corner, Uruguay, Irizar, and two of the Barchans. The final pixel size of DSMs is 13.8 cm/px and 3.4 cm/px of orthomosaics on average. Such high-resolution orthomosaics were generated for the first time of the Argentine Islands and can be further used for different scientific and other purposes as monitoring of ice cap changes, vegetation cover, wildlife populations or infrastructure.

The islands are commonly characterised by a complex and undulated topography with steep southern slopes of ice caps. The generated 3D models of islands (Fig. 3) are representing these topographical characteristics in great detail. We have calculated the minimum and maximum elevation, relative height, area and perimeter of each island. The highest point reaching 79.08 m above ellipsoid, for example, is found on Uruguay Island. The islands on average are only 34 m high, and the largest is Skua Island which area reaches 0.55 km2.

The GPR surveys have allowed construction of the subglacial topography and ice thickness models. The maximum thickness of studied ice caps reaches

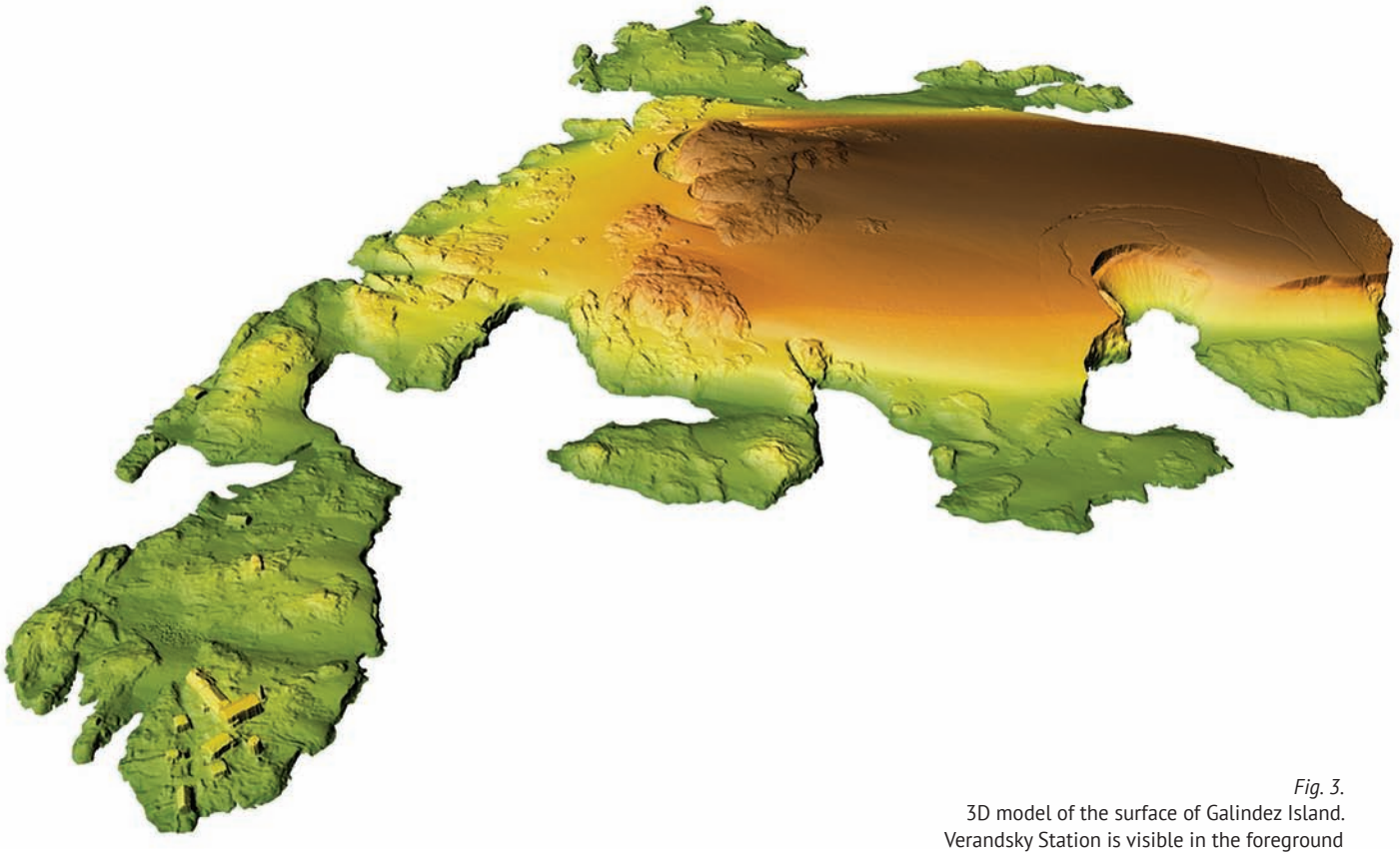


Fig. 3.
3D model of the surface of Galindez Island.
Verandsky Station is visible in the foreground

36 m. Almost all GPR data suggest that the subglacial topography of the Argentine Islands is quite articulated commonly consisting of numerous humps. Distinct rock hills are located on the northern or central parts of some islands (e.g. Uruguay, Galindez Islands). Ice caps of the Argentine Islands are comparatively small in general and they cover approximately 50% of the land surface of islands on average. On Irizar Island ice covers only 23% of the island surface, while on Winter Island ice covers up to 72% of the land. Individual snow and ice patches are found on all islands but they change their shape and location from year to year. The maximum ice thickness exceeds 30 m only on two islands (Galindez and Skua), and the average ice thickness of all islands is only 5 m. Only on the Galindez Island the average ice thickness reaches 11.6 m. The thickest and also the largest (by volume) ice caps are observed on Galindez, Uruguay and Skua islands. Areas with the highest ice thickness are located in the wind shadow of the largest hills if there is a land in the southern direction of the hill. Surprising structure is found on Uruguay Island where a very narrow elongated ice ridge is not supported by any topographic uplift in the subglacial topography. This prominent ice ridge has developed in the wind shadow of the largest hill. The same situation is true for the largest ice ridge on the southern part of Irizar Island as well. Ice caps on Galindez, Corner, and Skua islands seem to have developed as ice shadow features as well.

FUTURE PROSPECTS

We have demonstrated that application of small UAVs in polar glacier mapping is an accurate, affordable and available method allowing the generation of high-resolution orthomosaics and DSMs. Using low-frequency GPR, we have measured ice thickness on the largest ice caps on the Argentine Islands and constructed the first ice thickness and subglacial topography models revealing the peculiarities of the geological structure and glacier development. The obtained maps can be used further for the monitoring of ongoing changes of ice cap and polar environment. Our collaboration partners from

several institutions in Latvia have proved their capability as well to study polar microbial diversity and pollutants, and even to discover new bacteria and bacteriophages.

For the future work in Antarctica we realise that it is essential for Latvia to sign the Antarctic Treaty, which regulates the international relations in this region, in order to ensure the involvement of Latvian scientists of full value in Antarctic research. From 28 EU Member States, 20 have already signed the Antarctic Treaty, and 22 of the 82 research stations in the Antarctic are operated by the EU Member States. We are also looking to expand our cooperation with countries operating research bases in Antarctica. For the future work in Antarctica it is essential to develop collaborative projects between countries which are interested and capable to carry out polar investigations. The involvement of Latvian scientists in Antarctic research would strengthen the role of Latvia dealing with global environmental problems that is defined as a priority of EU. Therefore, the strategic aim of Latvia would be the development of National Antarctic research programme and establishment of a seasonal research station in Antarctica.

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We thank the National Antarctic Scientific Centre (NASC) of Ukraine and crew of the 22nd Ukrainian Antarctic Expedition at the Akademik Vernadsky Station for their help during our stay and fieldwork in Antarctica.

SCIENTISTS OF RĪGA TECHNICAL UNIVERSITY HAVE MADE SIGNIFICANT RESEARCH IN THE DEVELOPMENT OF TRIBOELECTRIC NANOGENERATORS

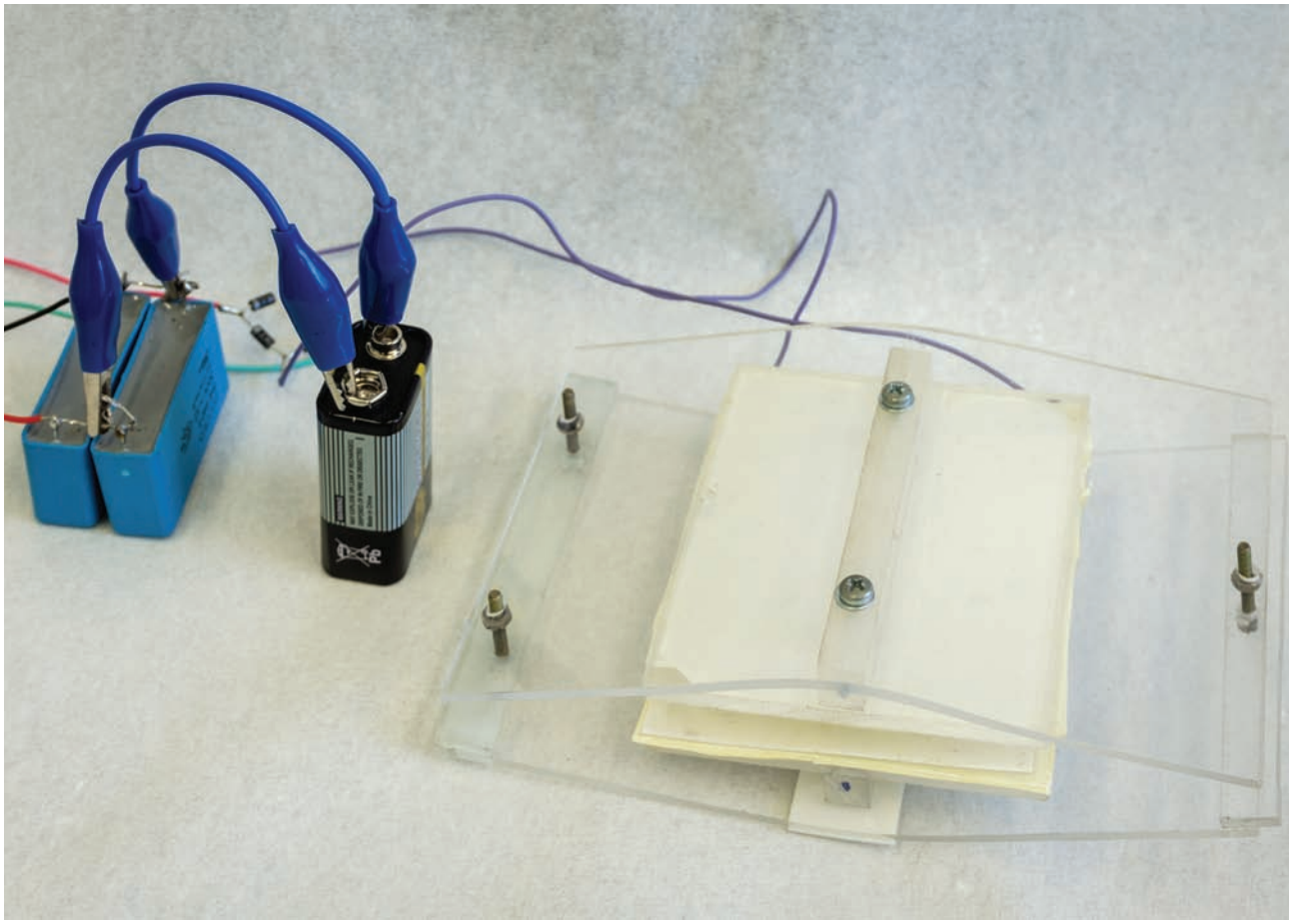
Andris Šutka, *Dr. sc. ing.*, Associate Professor, Rīga Technical University (RTU), Head, RTU Research Laboratory of Functional Materials Technologies; Corresponding Member of the Latvian Academy of Sciences
Linards Lapčinskis, *Mg. sc. ing.*, researcher, Institute of Technical Physics, RTU, doctoral student, programme "Material sciences", RTU

Triboelectric nanogenerators that are researched by RTU scientists is a new type of device that allows the conversion of ambient mechanical energy into electrical. Mechanical energy surrounds us in many forms – as human motions, vibrations, sounds, noises or wind. "Tribo-" comes from Greek "rub", so the simplest explanation of this device might be – generator that turns friction into electricity. The preposition "nano" is used because often functionality is enhanced by nano-sized components. The main principle of triboelectric nanogenerators is that two materials are contacted and when they are separated a static charge is formed on the surface. Similar effect can be seen after rubber balloon is rubbed against a sweater. Density of this charge is determined by bonds formed during contact. So, if the surface of material is nanostructured, the total contacting surface will be much larger allowing to form a higher count of bonds. This way also the density of surface charge will be higher.

The list of possible applications for nanogenerators is quite extensive – they can charge various portable devices, replace batteries in sensors and detectors or even act as sensors themselves. Researchers emphasise that nanogenerators obviously won't be a technology to replace wind turbine generators or hydro electro stations, however, the power generated by these devices will be enough to run, for example, small sensors that now use low power batteries. Wider use of this technology would allow to diminish the damage done to the environment when used batteries are discarded. Additionally, it is worth remembering that batteries are not only harmful to environment after disposal but are also relatively expensive to fabricate.

While the first research about nanogenerators dates back to 2012, the work of RTU researchers has resulted in a new type of nanogenerators, where the mechanism is similar to one seen in triboelectric nanogenerators. In the new nanogenerators, contact layers are replaced by polarised layers of ferroelectric materials allowing to reach a significantly higher performance. The picture shows one of the prototypes built on the basis of these materials. Using rectifying circuit and capacitors the electrical energy harvested from mechanical motions can be stored in the battery. Membrane type nanogenerator will have a possibility to be integrated in clothes, shoes, interior objects and so on.

Scientists admit that the greatest challenge is to perceive and explain all aspects of working mechanism to have full understanding of material suitability. There is still an ongoing debate about the origin of this effect in polymer materials as different mechanisms are proposed. RTU researchers have shown strong evidence to support the theory



Triboelectric nanogenerator device using electrically polarized ferroelectric contact layers

that charge forms when molecules are broken due to mechanical actions. This allows small pieces of polymer to transfer on other surfaces and take the charge with them. Full understanding of the mechanism has allowed scientists to identify the best materials to be used in construction of energy harvesters.

Triboelectric nanogenerators were elaborated as part of European Regional Development Fund project "Hybrid energy harvesting systems". The main idea of the project was developed by RTU lead researcher *Dr. sc. ing.* Andris Šutka and the core of the team consists of researchers from RTU Institute of Technical Physics and Research Laboratory of Functional Materials Technologies. The team consists of chemists, electrical engineers and physicists confirming the interdisciplinary nature of the project. Work on this project was started in 2017 and it has resulted in many highly ranked publications. Papers "Inversely polarised ferroelectric polymer contact electrodes for triboelectric-like generators from identical materials" and "The role of intermolecular forces in contact electrification on polymer surfaces and triboelectric nanogenerators" were published in the prestigious journal *Energy and Environmental Science* (impact factor – 33.25). In the journal *Materials Horizons* (impact factor – 14.36) there was published the paper "Dramatic increase in polymer triboelectrification by transition from a glassy to rubbery state".

THE STRADIŅŠ FAMILY AND THE LATVIAN ACADEMY OF SCIENCES

Pēteris Trapencieris, *Dr. chem.*, Chair of the Division of Chemistry, Biology and Medicine, Full Member of the Latvian Academy of Sciences

Jānis Stradiņš speech of welcome at the 150th Anniversary readings "Higher Education of Latvia for the future of Latvia"

The Latvian Academy of Sciences (LAS) is closely linked with the names of three generations of members of the Stradiņš family – academician Pauls Stradiņš (1896–1958), his son, academician Jānis Stradiņš (1933–2019), and three grandsons of Pauls Stradiņš: academician Andrejs Ērglis, Pēteris Stradiņš, Corresponding Member of the LAS, and Pauls Stradiņš, Foreign Member of the LAS. I should like only to outline briefly, how the LAS was founded in 1946, its transformation following 1990, and its further evolution and how these relate to the family name of Stradiņš.

It proved impossible for several reasons to establish an Academy of Sciences in Latvia during the period following proclamation of the Republic of Latvia on 18 November 1918, up until the outbreak of the Second World War. Precursors to the LAS have been identified as the Science Commission of the Rīga Latvian Society (1920–1932) and the Science Committee (*Academia Scientarium Latviensis*, 1932–1940), both headed by the linguist and sinologist Pēteris Šmits, and the linguist Jānis Endzelīns. Pēteris Valeskalns was unable to establish the LAS as a branch of the USSR Academy of Sciences during the first year of Soviet occupation, i.e. in 1940/1941.

However, immediately after the end of the Second World War, formation began of the Academy of Sciences in Latvia. All scientists who had remained in Latvia took an active part in this process and, despite a lot of absurd moments, they set up one of the most robust and efficient Academies of Sciences in the USSR. Pauls Stradiņš, as an academician, made a significant contribution to the Academy of Sciences in the field of medicine, laying the foundations for the scientific career of his son, Jānis Stradiņš. P. Stradiņš was an excellent educator, surgeon and oncologist, founder in Latvia of the Museum of Medical History. When the Academy of Sciences of the Latvian SSR (LSSR) was established by a decision taken 7 February 1946 by the Council of People's Commissars (Ministers) of the Latvian SSR, the medical doctor Pauls Stradiņš was one of the first 13 full-time members.

The first session of the LSSR Academy of Sciences was held on 14 February 1946 (and is considered to be the date of when the LAS was founded). The agronomist (a specialist in cattle breeding and grazing) Paulis Lejiņš, who was held in high regard and trusted by the public in Latvia, was elected as its first President. However, Pauls Stradiņš benefitted from no lesser public confidence, which helped in creating an excellent hospital with a strong medical staff. This, in turn, allowed creation of the first museum of medical history on the territory of the USSR. Circa 1955, Professor Pauls Stradiņš, under the auspices of the established museum, planned to start publishing regularly

J. Stradiņš family in 2006 – roots, support and back, all the foundation and sequel

collections of articles on medical history; he invited his son Jānis Stradiņš to write an article on the overall situation of the natural sciences in Latvia during the 18th and 19th centuries. At the initiative of Professor Pauls Stradiņš, a magazine started to be published in 1957, bearing originally the name, *Iz istorii meditsini*. Since 1992, this publication is known as *Acta medico-historica Rigensia* and is published by the Institute of Medical History of Rīga Stradiņš University in cooperation with the Pauls Stradiņš Museum of Medical History. The magazine continues to be published today and academician Jānis Stradiņš was its editor-in-chief until his retirement.

Encouraged by his father, Jānis Stradiņš studied chemistry, and not history, as he appreciated Soviet-era problems associated with historical research. Hence, J. Stradiņš always regarded history as his second specialty, after chemistry, although history ought to be ranked as his first, closest to his heart. Moreover, Jānis Stradiņš' interest in the history of chemistry and his outstanding ability as an orator were noted by Professor Emīlija Gudriniece, on the occasion when J. Stradiņš presented a wide-ranging and profound report to the Science Student Society on the chemist Paul Walden, wherein he discussed the Walden Inversion effect. After his graduation from the State University of Latvia, she offered J. Stradiņš the post of lecturer in the history of chemistry. From 1956 to 1961, he succeeded in developing his interest in history, whilst lecturing on the history of chemistry. During this time, J. Stradiņš became convinced that not only the achievements of scientists in Russia and large countries should be known, but also the historical contribution to world chemistry made by Baltic scientists. This was the beginning of Professor Stradiņš' interest in Theodor von Grotthuss, Friedrich Wilhelm Ostwald, and Paul Walden. Encouraged and supported by his father, J. Stradiņš dared to revise negative perceptions of Baltic Germans and their contribution to Latvian science and culture, all rooted in Latvia. A revised view was endorsed and accepted by the 1st Baltic Conference on the History of Natural Sciences and Medicine, held in Rīga in June 1958, which adopted a resolution on the basis of a paper by P. Stradiņš and J. Stradiņš. This forward-looking stance helped to facilitate contacts between Latvian scientists and Baltic German colleagues already during the Soviet era – with the natural scientist Heinrich von Knorr and the legal scholar Dietrich Andrè Loeber.

Effective 4 January 1990, academician J. Stradiņš was Vice-President of the Academy of Sciences and was responsible for the history of Latvian science and foreign and honorary members of the LAS. Change could then begin, once on 4 January 1990 the General Assembly of the Academy of Sciences of the Latvian SSR empowered the President of the Academy to address the Council of Ministers of the Latvian SSR, requesting changing the name of the Academy to that of the Latvian Academy of Sciences. After collapse of the USSR, several problems of science inherited from the Soviet era had to be overcome – how to combine the work of LAS institutes and that of institutions of higher education, how to achieve autonomy of scientific institutes, and how to transform the system for financing science activities, to stop paying the salaries of academicians and revising the system of rewarding individual scientists. These processes were more or less successful only as a result of active engagement of and activities by academicians of the LAS. During the early stages of the Awakening, a number of scientists had formed the Latvian Scientists' Union (LSU), which was initially the ideological driving force for reorganisation of the Latvian Academy of Sciences, and which was followed on to a discussion at the LSU Council on 23 March 1990. Discussions then continued throughout 1990 and 1991. All scientists at that time espoused a motto best formulated by academician Elmārs Grēns in June 1991 – science must be protected! I will touch upon some of the suggestions offered by J. Stradiņš on the process whereby the Academy of Sciences of the Latvian SSR was transformed during the 1990s into the present-day personal Latvian Academy of Sciences.

Academician J. Stradiņš acknowledged in Volume 3 of his biobibliography, written in 2017, that: "Throughout history, I have striven to be a catalyst for developments, nudging processes along, with a penchant for highlighting and advancing lively and progressive ideas that are relevant to evolution." The most important achievement, where his role of catalyst was the most important, was transformation of the Academy of Sciences of the Latvian SSR into the present-day LAS. Academician Jānis Stradiņš was the catalyst for many different processes:

- in 1961, he urged academician G. Vanags to write memoirs recalling his student days and his teacher, Paul Walden;
- in 1984, he started to correspond with Professor Edvīns Vedējs (Edwin Vedejs, USA), which culminated with the award of the status of Foreign Member of the Latvian Academy of Sciences to E. Vedējs in 1992, and the wide-ranging scientific cooperation by the latter with Latvian chemists over 25 years;
- the issue of symbols of the LAS was first raised at the meeting on 25 October 1990 of the Presidium – the LAS coat of arms, colours and flag. At its 6 December 1990 meeting, the LAS General Assembly accepted the proposed colours of the LAS and decided to continue discussions;
- he encouraged discussion of the LAS could be reorganised and transformed into a "personal" Western-type Academy of Sciences. In debates at the LAS General Meeting in January 1991, J. Stradiņš advanced proposals that were twofold in nature, those that were implemented in the near future – to create a personal Academy of Science following a foreign model; with it having the role of providing expertise; the urgent need to renew its membership LAS so that the LAS not turn into a gerontocracy. The other group of proposals was more radical and some of these have not come to pass – in the future, the LAS might move from its current premises (a Stalin-era skyscraper originally intended as temporary lodging for kolkhoz representatives visiting Rīga) to the House of the Blackheads, which would be more prestigious, an academic at 65 could vacate his seat in favour of a younger colleague;
- advanced the concept of a Charter and Statute for the LAS, the draft of a Charter and Statute was drafted by the LAS Constitutional Committee chaired by J. Stradiņš and elected by the LAS General Meeting on 28 March 1991; both of these were published for discussion in the November 1991 issue of *Zinātnes Vēstnesis*;
- at the 11 April 1991 meeting of the Presidium of the LAS, J. Stradiņš proposed a review of the LAS system of awards by establishing medals and conferring prizes and medals on outstanding individuals in the history of science and culture in Latvia. This proposal evolved over several years and was finally adopted in 1998, when academician J. Stradiņš was elected President of the LAS;
- in 1998, he encouraged to restructure the sys-

tem of awards and stipends conferred by the LAS. On 22 September 1998, the Senate of the LAS adopted a resolution on organisation of the awards system of the Academy of Sciences and setting up new awards of recognition by the LAS. All previously established awards by the LAS were attributed names (Friedrich Zander, Gustavs Vanags, Heinrihs Skuja, Pauls Stradiņš, Pauls Lejiņš, Jānis Endzelīns, Kārlis Balodis, Vilis Plūdonis, Arveds Švābe, Fricis Brīvzemnieks) and were retained. The decision also provided for establishing new awards (the Rainis Prize for outstanding creative achievement in science or culture; Edgars Siliņš Prize for fundamental research in physics; Piers Bohl Prize for excellence in mathematics; Eižens Āriņš Prize for excellence in computer science; Alfrēds Vītols Prize for achievements in engineering and energy; Arvīds Kalniņš Prize for the best work in forestry, wood research and processing; Teodors Celms Prize for the best work in philosophy; Tālivaldis Vilciņš Prize for the best work in sociology; Kārlis Mīlenbahs Prize for practical results in Latvian linguistics). The decision reaffirmed that the highest scientific award of the LAS is the LAS Grand Medal, and that the Rainis Prize is, in terms of prestige, the next after the LAS Grand Medal;

– suggested replacement of stipends to university students with award recognising the achievements of young scientists. On 22 September 1998, the Senate of the LAS decided that young scientist awards should be given to master's and doctoral students, or to young researchers who have just defended their master's or doctoral theses, setting the maximum age at 30 for nomination for such an accolade. J. Stradiņš was the initiator for two young scientists' awards named after Latvian chemists. This resulted in the Emīlija Gudriniece Prize and the Mārtiņš Straumanis and Alfrēds Ieviņš Prize. Mārtiņš Eduards Straumanis, in collaboration with Alfrēds Ieviņš had developed, in 1935–1937, a new method for precise determination of elemental cell parameters of crystals (asymmetric method), which is currently widely used in x-ray laboratories all over the world.
– proposed nomination of the status of Honorary Member of the RTU (*post mortem*) for Paul Walden (2011), Friedrich Zander, Zigfrīds Meierovics, Mikhail Dolyach-Dobrovensky, Hugo Celmiņš, and Ignatius Moscicki (2012);
– J. Stradiņš recognised that the Baltic German political, administrative and intellectual elite, up until the proclamation of Latvian independence in 1918, had hindered inclusion of Latvians in academic life. The first scientists who were either Latvian or of Latvian origin (D. H. Grindelis, P. Walden) emerged while integrating into the German environment, or who did not call attention to their nationality. However, the role played by J. Stradiņš was also particularly significant for inclusion of Latvian-speaking Baltic German scientists into Latvian national cultural heritage. It is thanks to J. Stradiņš, that the 150th anniversary of P. Walden (2013), the 300th anniversary of G. F. Stender (2014) and the 200th anniversary of the foundation of the Courland Literary and Art Society (2015) were included in the list of international commemorations observed by UNESCO;
– issuing commemorative badges for Nobel Laureate Wilhelm Ostwald (2001) and his pupil Paul Walden (2003). Stradiņš' ability was also amazing in finding patrons, who this time were Valdis Jākobsons (Grindeks) and Juris Savickis (Itera Latvija), as well as the individual who implemented the idea, the sculptor Andris Vārpa. Pēteris Stradiņš, son of J. Stradiņš, is now following in his father's footsteps and has begun the process of setting up memorials in the ancestral region of Sēlija.

Academician Jānis Stradiņš could rightly be proud of the value of each of his books, but I will mention just two that characterise his great responsibility for Latvia and science: a monograph of 700 pages published in 1998, *The Latvian Academy of Sciences: Origins, History, Transformations, Part I; Latvians and Latvia, Academic Papers*, published in 2013 comprising 4 volumes and 2400 pages. This work, supported by the Letonica National Research Programme of Latvia, with Jānis Stradiņš heading the team of authors including Ilga Jansone, Maija Kūle, Tālavs Jundzis, Viktors Hausmanis, Andrejs Vasks, and Guntis Zemītis, was acclaimed in 2014 by the Cabinet of Ministers of the Republic of Latvia. The extensive personal archives of Jānis Stradiņš will continue to be invaluable for researchers in various disciplines.

Translated by **Eduards Bruno Deksnis**

ACHIEVEMENTS IN SCIENCE 2019

The award ceremony to honour the best achievements in scientific research of 2019

THEORETICAL SCIENCE

I Theoretical calculations allow to explain how graphene enhances the photoelectric conversion efficiency of dye sensitised solar cells

Research team: Corresponding Member of the LAS Roberts Eglītis, LAS academician Juris Purāns, *Dr. phys*. Jānis Kleperis, *Dr. phys*. Anatolijs Popovs, and *Dr*. Ran Jia (PRC). Institute of Solid State Physics, Latvian University, Institute of Theoretical Chemistry, University of Jilin (PRC)

One of the 2019 year Nobel Prize winners in chemistry John B. Goodenough (USA) in 1980 discovered the cathode material for a 4V Li ion batteries; but that it is possible to design also 5 Volt batteries was demonstrated in the theoretical calculations for the cathode material Li2CoMn3O8 carried out by the joint Latvian–Chinese research team. Theoretical calculations allowed to explain how the graphene enhances the photoelectric conversion efficiency of dye sensitised solar cells. A large amount of calculations were made for eight technologically most important ABO3 perovskite neutral (001) and polar (011) surfaces, and a theory was developed, which explains the systematic trends in the behaviour of ABO3 perovskite surfaces. The effects of boron (B) and nitrogen (N) substitutions in 4,12,2-graphene on its geometric structure and mechanical as well as electric properties have been calculated from first principles. The piezoelectricity induced by B/N atom substitutions in 4,12,2-graphene owing to the deformation of the pristine graphene symmetry was discovered.

II New reagent for organic synthesis with potential application in medicinal chemistry was discovered

Research team: *Mg. chem*. Renāte Melngaile, *Bc. chem*. Armands Kazia, Artūrs Sperga, *Dr. chem*. Jānis Veliks. Latvian Institute of Organic synthesis

More than a quarter of the currently used drug molecules contain at least one or more fluorine atoms. Analysis of recent trends in medicinal chemistry shows that almost a half of the registered drugs by the US Food and Drug Administration contain at least one fluorine atom in their structures. This tendency shows that also in the future synthesis of fluorinated derivatives will be a perspective approach for the design of new pharmaceutical drugs, and an important part of the manufacturing process. This is a constant challange for chemists requiring development of new methods and reagents for the synthesis of fluoroorganic compounds. We have developed a new reagent for the fluoromethylene – an important organic fluorine containing buildingblock incorporation. Most of the currently used methods involve the use of, for example, ozone depleting reagents or gasoeous compounds which involves various technological issues for their application in the laboratory. Our method and the reagent will allow more straignthforward synthesis of new fluorine containing molecules and it has a good potential for the application in a manufacturing of active pharmaceuticals.

III The new double Volume III of the academic publication *Art History of Latvia* presents the so-far most comprehensive research-based overview of the de-

velopment of fine art, book art, architecture, professional applied art, folk art and artistic life in the territory of Latvia from the late 18th century until 1890

Eduards Kļaviņš, Elita Grosmane, Valdis Villerušs, Imants Lancmanis, Inese Sirica, Kristiāna Ābele, Daina Lāce, Silvija Grosa. *Art History of Latvia III: 1780–1890*. Edited by Eduards Kļaviņš. Rīga: Institute of Art History of the Latvian Academy of Art; Art History Research Foundation, 2019. Book 1, 424 pp., 627 ill.; Book 2, 392 pp., 537 ill. ISBN 9789934882401 (Latvian), 9789934882418 (English)

The new double Volume III of the academic publication *Art History of Latvia* presents the so-far most comprehensive research-based overview of the development of fine art, book art, architecture, professional applied art, folk art and artistic life in the territory of Latvia from the late 18th century until 1890, revealing the particularity, achievements and activities in the period of Classicism and Romanticism (1780–1840) and the period of Historicism and Realism (1840–1890). The text is illustrated with 1164 images, and a parallel English edition makes the whole study available to international audience. Supervised by director of the Institute of Art History (IAH) of the Latvian Academy of Art (LAA) *Dr. habil. art*. Eduards Kļaviņš, the team of authors includes seven other members – IAH senior researchers *Dr. art*. Elita Grosmane, *Dr. art*. Kristiāna Ābele and *Dr. art*. Daina Lāce, LAA teaching staff members *Dr. art*. Silvija Grosa, *Dr. art*. Inese Sirica and *Dr. h. c*. Valdis Villerušs as well as the ex-director of the Rundāle Palace Museum *Dr. h. c*. Imants Lancmanis. English translation was prepared by IAH senior researcher *Dr. art*. Stella Pelše. The publication was supported by the State Culture Capital Foundation and the Zuzāns family.

IV Within the context of the international academic thought, for the first time the notion of the migration of cultures, its types and relation to different approaches in culture studies has been defined

The research team includes researchers from the Institute of Philosophy and Sociology, Latvian Language Institute, Institute of Literature, Folklore and Art, Institute of Latvian History of the University of Latvia

The collective monograph *Latvia: Migration of Cultures (Latvija: kultūru migrācija*. Rīga: LU Akadēmiskais apgāds, 2019, 808 pp.) is an innovative and unique interdisciplinary study that represents the interaction of several cultures since the first people settled in the present day territory of Latvia. Within the context of the international academic thought the study for the first time defines the notion of the migration of cultures, its types and relation to different approaches in Culture Studies. Researchers of the migration of cultures describe various areas of human activities: material culture (historians), interaction of languages (linguists), migration of myths and other elements of folklore (folklorists, literary scholars), history of ideas and religion as a manifestation of the migration of cultures (philosophers, scholars of religion, historians), boundaries between aesthetic culture and national identity, ideology, politics, and nationhood (philosophers, historians), reflections of the migration of culture in literature and other forms of art.

V The monograph discusses the Second World War trauma and historical memory including cross-disciplinary studies and successfully integrating various research methods

Inguna Daukste-Silasproģe. *Waiting for the Boat: Latvian Authors as Refugees in Sweden (Gaidot laivu. Latviešu rakstnieki bēgļu ceļos*. Rīga: LU LFMI, 2019). Institute of Literature, Folklore and Art of the University of Latvia

The monograph *Waiting for the Boat: Latvian Authors as Refugees in Sweden* by LAS corresponding member *Dr. philol*. Inguna Daukste-Silasproģe focusses on a chronologically and geographically narrowed view of political and historical developments through a prism of an individual's distress, echoed in documents, correspondence, testimony and literary texts. The period covered in the monograph symbolically forms a vector from (1) the coast of Kurzeme and the way in a refugee boat across the sea; to (2) the new country of residence in Sweden as a refugee, where one has to reassert their skills and knowledge by leading two parallel lives – the Swedish and the Latvian. The Latvian life turns out to be surprisingly plentiful and allows

the refugee to survive emotionally both the foreign land and being cut off from Latvia, where the Baltic Sea is the border. The everyday and working life, the periodicals, social and cultural events in Latvian writers' life, even the literary process itself have been characterised. The theoretical basis of the monograph consists of the works of Latvian and foreign researchers discussing the Second World War trauma and historical memory, including cross-disciplinary studies, successfully integrating various research methods. The author of the monograph has produced a unique methodology for her own research, a set of self-accredited research tools supplemented with a viewpoint from literary history. The monograph is also accompanied by a variety of attachments and extensive photographic material. In 2019, the monograph received the Egons Līvs Memorial Award "Krasta ļaudis" (Coast People).

APPLIED SCIENCE

VI The new technology enables better technical solutions for improving energy efficiency by bi-directional implementation power flow into the DC power grid

Research team: LAS academician Leonīds Ribickis, *Dr. sc. ing.* Oskars Krievs, *Dr. sc. ing.* Pēteris Apse-Apsītis, *Dr. sc. ing.* Dāvis Meike, *Dr. sc. ing.* Andrejs Stepanovs, *Mg. sc. ing.* Ansis Avotiņš, *Mg. sc. ing.* Armands Šenfelds, *Mg. sc. ing.* Kristaps Vītols, *Mg. sc. ing.* Maksims Vorobjovs, *Mg. sc. ing.* Mārcis Priedītis, *Mg. sc. ing.* Artūrs Paugurs, *Mg. sc. ing.* Oskars Bormanis. Rīga Technical University, Institute of Industrial Electronics and Electrical Engineering

The developed and approved unique system is in cooperation with the German car manufacturer Daimler AG for use in the Mercedes-Benz automobile industry. The new technology enables better technical solutions for improving energy efficiency (saving up to 15% of electricity) by bi-directional implementation power flow into the DC power grid. This is the first step towards the idea of tomorrow's factories, where energy-efficient and sustainable robotic production through the use of innovative tools, methods, and technologies take place. Based on this technology, as part of the move to the green industry, a new concept factory casing has been built – Factory56 in Sindelfingen, which also uses a developed system (DC network and robotic recuperative energy recovery) to reduce CO2 emissions. It will also power the building's climate systems. (https://www.daimler.com/innovation/case/connectivity/industry-4-0.html)

VII The functionality of visual system has been investigated for people working with an innovation in information visualisation – the volumetric 3D image display produced in Latvia

Research team: *Mg.* Tatjana Pladere, *Mg.* Karola Panke, *Mg. math.* Māra Delesa-Vēliņa, *Bc.* Viktorija Andriksone, *Bc.* Vita Konošonoka, *Bc.* Gunita Jankovska, student Kristaps Kļava, student Marina Seļezņova, resident Reinis Pitura, *Dr. phys.* Gunta Krūmiņa in collaboration with *Dr. sc. ing.* Krišs Osmanis, *Mg. sc. ing.* Ilmārs Osmanis, *Dr. phys.* Roberts Zabels, *Mg. sc. comp.* Rendijs Smukulis, *Mg. sc. ing.* Una Kandere. Faculty of Physics, Mathematics and Optometry of the University of Latvia, Ltd. "Light-Space Technologies", Faculty of Medicine, Rīga Stradiņš University

Within the successful collaboration between science and industry, the functionality of visual system has been investigated for people working with an innovation in information visualisation – the volumetric 3D image display produced in Latvia. The display opens up new opportunities to use the high-quality spatial images and reduce visual discomfort. The research explored how the depth perception, visual functions and work efficiency benefit when using the volumetric display compared to everyday 2D image displays. Due to the wide support of Latvian medical professionals and students, the properties of visual perception of specific users working with the innovative visualisation device have been determined. The findings of the research contribute to the development of innovative 3D image displays not only in Latvia, but also in the world. The obtained results demonstrate that its implementation and scientifically based application in the professional fields can significantly improve the work ergonomics and efficiency.

VIII Previously unreported pathogenic variants that affect a specific region of the slow Myosin Binding Protein-C (sMyBP-C) and are associated with a neuromuscular disease phenotype – mild myopathy together with a myogenic tremor are found

Research team: *Mg. biol.* Jānis Stāvusis, *Dr. med.* Baiba Lāce, *Mg. biol.* Dita Kidere, *Dr. biol.* Inna Iņaškina. Latvian Biomedical Research and Study Centre

Within the framework of the Neuromuscular Disease Project, the research team has managed to find previously unreported pathogenic variants that affect a specific region of the slow Myosin Binding Protein-C (sMyBP-C) and are associated with a neuromuscular disease phenotype – mild myopathy together with a myogenic tremor. Such a combination of symptoms has not yet been described for any one disease, furthermore, until now it was considered that tremor is caused only by neurogenic defects. In collaboration with the partners from USA (University of Maryland, National Institute of Health), data is still being gathered from biochemical and molecular biology experiments, as well as from the evaluation of the created mouse model, in order to fully characterize this novel phenotype. This research is providing new insights into previously not described biological mechanisms and might help in understanding and solving similar clinical cases.

IX Conceptually new approach to achieve high solid state emission

Research team: *Mg. chem.* Kaspars Leduskrasts, *Dr. chem.* Artis Kinēns, LAS academician Edgars Sūna. Latvian Institute of Organic Synthesis

In artificial light sources and in various everyday devices (telephones, computer and TV screens) light is emitted by solid luminophores that typically possesses low emission efficiency. A conceptually new approach to design highly emissive solid state organic luminophores has been developed at Latvian Institute of Organic Synthesis. The new concept is based on the use of intermolecular electrostatic interactions, which are well known in organic chemistry but have not yet been used in the design of organic luminophores. This new approach helps to: 1) increase the emission efficiency of solid organic luminophores; 2) facilitate the design of light-emitting materials and simplify architecture of light-emitting devices (e.g. OLEDs), thus significantly reducing their production costs; 3) create new optical sensors, luminescent materials for biomedical applications and sunlight resembling artificial light sources.

X Interdisciplinary study of even-aged spruce stands in Latvia

Research team: *Dr. silv.* Jurģis Jansons, *Mg. silv.* Jānis Donis, LAS academician Tālis Gaitnieks, LAS corresponding member Āris Jansons, *Dr. silv.* Dagnija Lazdiņa, *Dr. silv.* Zane Lībiete, Corresponding Member of the LAS Dainis Edgars Ruņģis, Latvian State Forest Research Institute "Silava"

An interdisciplinary study on spruce forests in Latvia has been completed at the Latvian State Forest Research Institute "Silava", covering forestry and breeding, genetics and phytopathology, as well as technological and economic aspects. Opportunities and risks for the management of planted even-aged spruce stands growing in at least 200 thousand hectares of the most fertile forest lands of Latvia have been studied. In the 1970s and 1980s, overly dense spruce stands were extensively planted, which currently have grown to be stunted and weakened middle-aged stands. Planted spruce forests, as opposed to unmanaged forests, are very productive at a young age, but subsequently tree growth decreases, and trees are damaged by wind and decay. As a result of the research, the Latvian forest sector was provided with knowledge of optimal management models when renewing spruce stands, as well as information about the significant risks associated with the deterioration of growth potential in overly densely-planted 40–50 year old stands. By repeatedly assessing (after 12 years) 285 spruce stands throughout Latvia, it was confirmed that their growth has not improved but significantly deteriorated. In such situations, declining stands should be cleared and purposefully renewed, ensuring regulatory changes to enable this. In correctly managed spruce stands, it is possible to grow saw logs well within a human lifespan – 40–50 years. The study was initiated by the Latvian forest sector, and was started in 2014 within the framework of the

National Research Programme. The results of the research are summarised in a monograph *Even-aged spruce stands in Latvia*, published in 2019 (Daugavpils University Academic Press "Saule", ISBN 978-9984-14-853-3), presented to the Latvian forest sector on Forest Science Day organised by LSFRI "Silava" on 30 May 2019 in Gulbene Municipality and Jaunkalsnava, attracting more than 120 participants. The scientific team involved in the study received a letter of gratitude from the President of the Latvian Academy of Sciences on Forest Science Day.

DIPLOMA OF THE PRESIDENT OF THE LATVIAN ACADEMY OF SCIENCES

I Technology for time measurement with pico-second precision for use in spacecraft

Research team: *Dr. comp.* Vladimir Bezpalko, *Dr. comp.* Eugene Boole, *Mg. sc. ing.* Vadim Vedin. Institute of Electronics and Computer Science (IECS)

The need for very precise recording of time instants of events exists in many scientific research and technologies. For example, in the field of signal processing, in the satellite laser ranging, in LIDAR systems and for time scales synchronisation in distributed measuring systems. The technology for measuring the time of events developed in the IECS was previously used in these systems only in the ground segment. However, measurements of time moments with the possible high precision are also necessary in space equipment, including LIDAR systems, ranging systems, as well as time and data transfer systems. Thanks to the project of the European Space Agency (ESA), IECS scientists were able to modernise their time measurement technology in such a way that it could be used in accordance with the conditions and requirements of spacecraft engineering. A specialised module has been developed and, in cooperation with the Czech Space Research Centre, was duly tested. ESA rated it as the best contender for use in future space missions and recommended to continue work with potential partners (in Portugal, the UK, and the Netherlands) on the development of various versions specialised for the respective missions (landing of the spacecraft on the moon, research of asteroids, etc.).

II Theoretical modelling of self-assembling processes in prospective perovskites for green energy applications

Research team: *Dr. rer. nat.* Jurijs Mastrikovs, *Dr. phys.* Dmitrijs Zablockis, *Dr. rer. nat.* Guntars Zvejnieks, *Dr. phys.* Leonīds Rusevičs, *Dr. habil. phys.* Vladimirs Kuzovkovs, LAS academician Jevgēņijs Kotomins. Institute of Solid State Physics of the University of Latvia

Functional oxide materials with perovskite structure and explicit dielectrical, piezoelectrical, pyroelectrical and electrochemical properties play an essential role in the technologies of the future. Applying nature-inspired principles of self-assembling, properties of nanodevices can be significantly enhanced, including optimisation of the electrochemical processes in such devices. It is of high importance to create a truly ordered structure. As a result of the performed research, for the first time, a systematic description of the topology of the polar perovskite surface, dynamics of the surface defects, molecular and atomic chemisorption, dissociation and migration on the surface has been given. A complex cascade of the surface electrochemical reactions was discovered and described in details. Based on the electron structure of the surface, the study showed how ordering appears in self-assembling mesoscale objects, growing from a disordered solution of nanoparticles, and how surprisingly sensitive the thermodynamics of the process to the peculiarities of the nanophysics of the polar surface appears to be. The obtained results are important for development of new generation devices for "green" energy such as piezoelements and fuel cells.

III New methods in maxillofacial surgery with the use of innovative bioceramic materials that provides bone density and volume restoration in patients with osteoporosis and bone atrophy

Research team: Corresponding Member of the LAS Andrejs Skaģers, *Dr. med.* Ilze Šalma, *Dr. med.* Ģirts Šalms, LAS corresponding member Māra Pilmane, *Dr. med.* Ingus Skadiņš, *Dr. med.* Juta Kroiča, Corresponding Member of the LAS Jānis Ločs, Corresponding Member of the LAS Dagnija Loča, *Dr. sc. ing.* Līga Bērziņa-Cimdiņa, *Dr. sc. ing.* Vita Zālīte. Rīga Stradiņš University, Rīga Technical University

Introduction of new methods in maxillofacial surgery with the use of innovative bioceramic materials that provides bone density and volume restoration in patients with osteoporosis and bone atrophy. Experimental studies of biomaterials for local treatment of osteoporosis using morphological, biomechanical and radiological bone tissue analyses were performed. Clinical trials in oral and maxillofacial surgery demonstrated the efficacy of the developed operative methods for alveolar bone augmentation in peri-implant patients using biomaterials produced in Latvia. These bone replacement materials can be used not only in oral and maxillofacial surgery, but also in other areas, such as traumatology and orthopaedics, where bone regeneration is required.

IV New mechanisms and efficacy markers for the treatment of type 2 diabetes in the gut microbiome of patients discovered

Research team: *Mg. biol*. Ilze Elbere, *Mg. biol*. Monta Ustinova, *Mg. biol*. Ivars Silamiķelis, *Mg. biol*. Laila Silamiķele, Corresponding Member of the LAS Ilze Konrāde, LAS academician Valdis Pīrāgs, LAS academician Jānis Kloviņš. Latvian Biomedical Research and Study Centre, Human Genetics and Molecular Medicine Group, Rīga Stradiņš University

The Human Genetics and Molecular Medicine group of the Latvian Biomedical Research and Study Centre has conducted a complex, multidimensional, and several years long study of the effectiveness of type 2 diabetes therapy. It included extensive molecular analysis, as well as obtaining phenotypic and clinical information, in newly diagnosed patients with type 2 diabetes mellitus, for the first time treatment has been started with the most commonly used antidiabetic drug, metformin. Experiments in the diabetic mouse model have also been conducted to obtain more detailed information. The results provide information on both metformin-induced changes in intestinal microbiome and RNA expression levels, as well as on genetic and epigenetic background. In addition, the data obtained are used to identify molecular markers for predicting the frequently observed gastrointestinal side effects of metformin, as well as to provide missing explanations of the molecular mechanisms of metformin action. In patients with diabetes who are not responding to metformin therapy, no changes in the gut microbiome have been observed during treatment, thus providing further evidence of the important role of the microbiome in the functioning of this drug. The unique discovery of potential biomarkers for predicting treatment efficacy is with widespread use, since on average 20–40% of patients receiving metformin fail to achieve their glycaemic target. In addition, the composition of the microbiome has been shown to be largely population-specific, so the results obtained have the greatest potential for the development of personalised medicine approaches specifically for the Latvian population.

V Genome-wide association study of diabetic kidney disease highlights biology involved in glomerular basement membrane collagen

Research team includes international authors and Latvian researchers: *Dr. med*. Jeļizaveta Sokolovska, LAS academician Valdis Pīrāgs, *Dr. biol*. Vita Rovīte. Faculty of Medicine of the University of Latvia, Latvian Biomedical Research and Study Centre

Although diabetic kidney disease demonstrates both familial clustering and single nucleotide polymorphism heritability, the specific genetic factors influencing risk remain largely unknown. To identify genetic variants predisposing to diabetic kidney disease, we performed genome-wide association study (GWAS) analyses. Through collaboration with the Diabetes Nephropathy Collaborative Research Initiative, we assembled a large collection of type 1 diabetes cohorts with harmonised diabetic kidney disease phenotypes. We used a spectrum of ten diabetic kidney disease definitions based on albuminuria and renal function. Our GWAS meta-analysis included association results for up to 19 406 individuals of European descent with type 1 diabetes. We identified 16 genome-wide significant risk loci. The variant with the strongest association (rs55703767) is a common missense mutation in the collagen type IV alpha 3 chain (COL4A3) gene, which encodes a major structural component of the glomerular basement membrane (GBM). Mutations

in COL4A3 are implicated in heritable nephropathies, including the progressive inherited nephropathy Alport syndrome. The rs55703767 minor allele (Asp326Tyr) is protective against several definitions of diabetic kidney disease, including albuminuria and ESKD, and demonstrated a significant association with GBM width; protective allele carriers had thinner GBM before any signs of kidney disease, and its effect was dependent on glycemia. Three other loci are in or near genes with known or suggestive involvement in this condition (BMP7) or renal biology (COLEC11 and DDR1). The 16 diabetic kidney disease-associated loci may provide novel insights into the pathogenesis of this condition and help identify potential biologic targets for prevention and treatment.

VI New approach towards phosphorescent organic materials for use in solution processed organic light emitting diodes

Research team: *Dr. chem*. Kaspars Traskovskis, LAS academician Valdis Kokars, *Mg*. Ilze Māliņa, *Mg*. Armands Rudušs, *Dr. phys*. Aivars Vembris, *Mg*. Natālija Tetervenoka, *Mg*. Igors Mihailovs, Corresponding Member of the LAS Sergejs Beļakovs. Faculty of Materials Science and Applied Chemistry of Rīga Technical University, Institute of Applied Chemistry, Institute of Solid State Physics of the University of Latvia, Latvian Institute of Organic Synthesis

Due to the unmatched image quality, the vast majority of commercially available mobile smart devices use integrated organic light emitting diode (OLED) displays. Implementation of low-cost solution-based production methods would promote the use of this technology in such areas as OLED TVs and lighting panels. Chemists of Rīga Technical University and physicists of Institute of Solid State Physics, University of Latvia have developed novel organometallic phosphorescent materials that can be integrated in solution processed devices and show competitive performance characteristics. It was demonstrated for the first time that an attracting interaction between the active molecules and attached functional groups can be used to enhance light emission efficiency of the materials.

VII Unique perspective on the Baltic cultural space is created where this space is viewed as a united cultural region, the formation of which has been strongly influenced by German culture

Research team: *Dr. phil*. Raivis Bicevskis, Jost Eickmeyer, *Dr. hist*. Andris Levans, Anu Schaper, Björn Spiekermann, Inga Walter. Faculty of History and Philosophy, Department of Philosophy and Ethics, Department of History and Archaeology of the University of Latvia

For the first time in the history of European and Latvian science, a unique perspective has been created on the Baltic cultural space, where this space is not viewed separately (Latvian/Estonian cultural space as separate from Lithuanian cultural space), but as a united cultural region the formation of which has been strongly influenced by German culture. The study provides a broad insight into previously unexplored aspects of Baltic cultural history – in the areas of text, institutions, educational institutions, everyday material culture, acting persons, music, museums and societal transformation. It was sponsored by the Heidelberg Academy of Sciences. It is a unique and innovative event in the field of humanities in Latvia in recent years. Latvian researchers have made significant contributions to the development of new theoretical and conceptual tools to take a new and fresh look at the transfers, contacts, and shared history of the Baltic and German cultural space (*Baltijas–Vācijas kultūru sakari no 16. līdz 19. gadsimtam: mediji – institūcijas – personas. Baltisch-deutsche Kulturbeziehungen vom 16. bis 19. Jahrhundert: Medien – Institutionen – Akteure*. Bd. II: Zwischen Aufklärung und nationalem Erwachen. Winter Verlag Heidelberg, 2019, 588 seiten).

Džemma Skulme. 2008
Photo: Gints Mālderis

DŽEMMA SKULME

HONORARY MEMBER OF THE LATVIAN ACADEMY OF SCIENCES

20.09.1925–9.11.2019

Džemma Skulme, a talented painter, public figure, organiser of artistic life, politician, mother, and a strikingly beautiful woman, has been "ours" from 1992 onwards when she was unanimously elected by the Academy as an Honorary Member of the Latvian Academy of Sciences. Džemma Skulme regarded conferral of this status as acknowledging her personal conscience, and also as recognition of her credibility; upon receipt of this title, the artist felt truly honoured, as her work was henceforward equated with academic distinction. In her distinguished career, both as an artist and one who guided artistic life, academicism never featured in her appreciation of cultural processes; nonetheless her rich life experience, talent, intuition, knowledge of man and art, gave academic value to her every observation, word and insight. That is what we loved about her in life, and, despite her passing, we cannot speak of Džemma Skulme in the past tense. Her paintings were flamboyant featuring a full spectrum of colours, her femininity was tinged with extraordinary brilliance, and her mind possessed the breadth and acuity worthy of a scientist. She was, and remains, an outstanding personality in Latvian art, Latvian society, as well as a role model for all of us.
Man, the nation and its destiny, woman, a mother and her eternal sacred role in the world, from the birth of mythology to today, were themes central to the art of Džemma Skulme. She supported and cultivated honesty as the highest principle to be followed in life and art. Džemma Skulme has left each and every one of us with the bequest: "The fate of a small nation is important. It often is, or may be, in the hands of others. To that end, the talent of the people and values created by the people in any field, must be built upon and honoured."

With an expression of deepest respect and gratitude for the rich life of the artist, one where there was a place for communion with the entire academic family,

Ojārs Spārītis
President of the Latvian Academy of Sciences