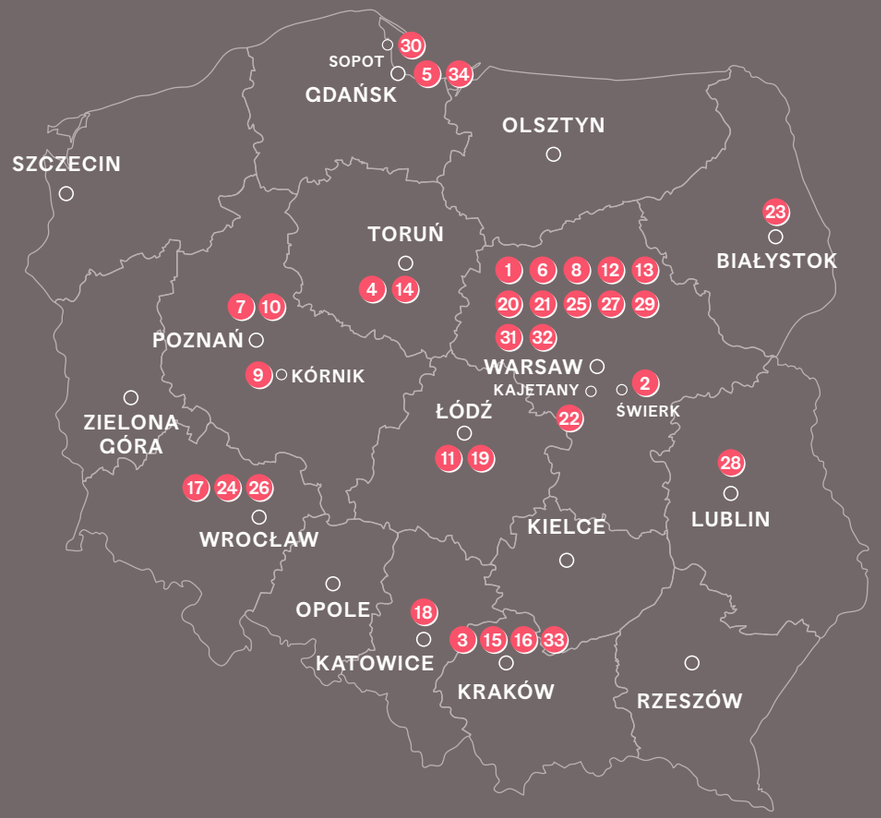
Science in Poland

in 34 Snapshots

Location of Snapshots



Facts about Poland

POPULATION

38,43 million

MEMBER OF THE EU SINCE

2004

GDP COMPOSITION (2017)

Services. 57.4%

Industry. 40.2%

Agriculture 2.4%

GDP GROWTH

Source: World Bank national accounts data, OECD National Accounts data files (2019)

Science in Poland in 34 Snapshots

POLISH NATIONAL AGENCY FOR ACADEMIC EXCHANGE

Science in Poland

in 34 Snapshots

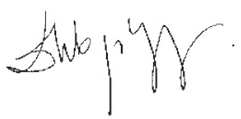
Foreword
Explore the World of Polish Science

Łukasz Wojdyga

NICOLAUS COPERNICUS, who 'stopped the Sun and moved the Earth,' Maria Skłodowska-Curie's Nobel Prizes for her research on the radiation phenomena and discovering radium and polonium, the kerosene lamp invented by Ignacy Łukasiewicz, the Monte Carlo method devised by Stanisław Ulam, Hilary Koprowski as the inventor of the polio vaccine, discovery of vitamins by Kazimierz Funk, the Polish Enigma code breakers – mathematicians Henryk Zygalski, Jerzy Różycki and Marian Rejewski, Rafał Lemkin's contribution to international law, Bohdan Paczyński's gravitational microlensing... All these are beautiful and well-known pages in the history of Polish science. What is happening in Polish science today?

Polish scientists continue to co-create the common structure of world science. They solve scientific problems individually and in research teams, often international ones, in modern laboratories, using extensive research infrastructures and in their own offices, at universities and in scientific and research institutes dedicated to various fields and specializations of science, scattered all over Poland.

The book, which I am handing over to you, is an invitation to explore the fascinating, multifaceted world of Polish science and researchers, observed at work, when they are genuinely passionate about their scientific goals. I would like to thank the Conference of Rectors of Academic Schools in Poland for inspiration and cooperation during the process of preparing this publication. I wish you a great read!



— Łukasz Wojdyga
Director General at the Polish National Agency
for Academic Exchange NAWA

Foreword
Collage of Science and Research

Professor Tomasz Szapiro

THE PUBLICATION you are holding in your hands was prepared with the support of the Scientific Committee I have the honour to chair. It is composed of scholars with remarkable achievements in numerous scientific domains and extensive experience in carrying out and evaluating research projects. They had accepted the invitation to join the Committee, convinced that Polish research needs support in the form of professional promotion. Professional promotion of research – the mission of the Polish Agency for Academic Exchange NAWA – is the first stage of a most essential process, which will accelerate the pace of research, facilitate access to research funding and help Poland appear as an attractive partner to scholars all over the world.

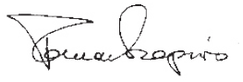
The starting point in the work on the present book was the material that had been gathered by the Conference of Rectors of Academic Schools in Poland and subjected to expert assessment. Thus, the Committee's role consisted in specifying the criteria that the materials provided to NAWA had to meet in order to be included in the publication and in pointing out any elements, which needed to be complemented or expanded. The limited size of the book, however, meant that it was necessary to select the content from a very broad range of studies carried out by Polish research centres. Accepting the fact that this would result in a less representative content of the book, the Committee recommended that the priority be diversity with regard to both the projects and their scale on the one hand and the prestige of the institutions they represented on the other hand. This selection is meant to showcase studies, which contribute to the global knowledge and science.

As a result, we have created a collage of snapshots showing personalities, discoveries and state-of-the-art of scientific infrastructure. It resembles an album from a journey across all of Poland with commentary in the form of data, interviews, figures and essays.

Science in Poland in 34 Snapshots is not an attempt at ranking the best projects, scholars or institutes. The readers could easily add to it numerous other 'snapshots' with equally attractive content and high scholarly value.

The essence of our message is simple: the Polish scholarly centres constitute a part of global research community and possess an interesting and valuable development potential. Each region of our country, each discipline and each institution boast of individuals and teams who can become very attractive cooperation partners in ambitious, innovative research work. This profusion can hardly be demonstrated on the pages of such a small book. We are merely signalling the competences, resources and openness in every dimension – to people and to ideas.

Thus, I would like to encourage you to engage in research with Polish scholars. It is a road to your own 34, and perhaps even 134 snapshots and a fascinating new scholarly adventure!



— Prof. Tomasz Szapiro, Chair of the Scientific Committee

Composition of the Scientific Committee

Professor Ewa Bartnik
University of Warsaw, academic field: natural sciences, biology

Professor Ewa Bińczyk
Nicolaus Copernicus University in Toruń, academic field: humanities, philosophy

Professor Antoni Cygan
Rector of the Academy of Fine Arts in Katowice, academic field: arts, painting

Professor Marek Krawczyk
Medical University of Warsaw, academic field: medical sciences, surgery, transplantology

Professor Magdalena Król
Warsaw University of Life Sciences, academic field: agricultural sciences, cancer biology

Professor Joanna Kurczewska
Institute of Philosophy and Sociology of the Polish Academy of Sciences, academic field: social sciences, sociology

Professor Mieczysław Muraszkiewicz
Warsaw University of Technology, academic field: engineering and technology, computer science

Professor Henryk Skarżyński
Institute of Physiology and Pathology of Hearing, academic field: medical sciences, otolaryngology

Professor Roman Słowiński
Vice-President of the Polish Academy of Sciences, Poznan University of Technology, academic field: engineering and technology, computer science, AI

Professor Tomasz Szapiro
Chair of the Committee, Warsaw School of Economics, academic field: social sciences, economic science, management

Professor Agnieszka Zalewska
The Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences, academic field: natural sciences, physics

Contents

Natural sciences

The OGLE Project: The Largest Sky Survey Worldwide

The Optical Gravitational Lensing Experiment (OGLE) has brought new, world class scientific discoveries of an international standard and set new directions of research in modern astronomy. This large-scale sky survey is led by Professor Andrzej Udalski.

01

'We watch very large areas of the sky and mostly analyse fluctuations in the brightness of objects, which indicate that something interesting is happening there. At the moment, we are watching more than two billion stars, which makes it one of the largest databases worldwide. In addition, we have been watching them non-stop for many years.'
– Prof. Andrzej Udalski

The Milky Way above the Las Campanas Observatory located in the southern Atacama Desert in Chile. The telescope in the foreground on the right is the heart of the Polish OGLE project.

THE DISCOVERY of more than 80 extrasolar planets, one million variable stars and one of the largest objects in the Solar System – those are only some of the achievements of the astronomers from the Astronomical Observatory of the University of Warsaw over the course of 27 years of the major Polish observation project called the Optical Gravitational Lensing Experiment (OGLE).

Observations are conducted with the use of a photometric telescope with a diameter of 1.3 metres and a powerful 32-chip mosaic CCD camera, both located at the Las Campanas Observatory in Chile. It is one of the best observational locations on our planet.

Professor Andrzej Udalski, the OGLE project leader.

Detection of the First Gravitational Microlensing Events

The observations make it possible to analyse how the brightness of objects fluctuates over time. This is related to one of the major objectives of the project, that is searching for phenomena described as gravitational microlensing, first discovered by OGLE. 'These are extremely rare phenomena. The light emitted by the source, that is another star in our Milky Way, is lensed by an object located between the source of light and the observers. This effect allows us to estimate the mass of the lens,' says Prof. Udalski. Predicted by Einstein, the phenomenon was introduced in modern physics by the outstanding Polish astrophysicist, Professor Bogdan Paczyński, in the 1980s.

Search for Far and Near Objects

Microlensing has been used to study the dark matter in the Milky Way, among other things. Moreover, it has been applied to discover extrasolar planets – it is currently one of the basic tools used to detect them, as it enables finding very distant objects. The second fundamental method of detecting distant planetary systems is the transit method, also pioneered by the Polish astronomers from the OGLE project. These two methods have already led to the discovery of more than 80 exoplanets in the OGLE project.

The OGLE astronomers have completed the longest catalogue of variable stars worldwide, with approximately one million objects. Furthermore, they regularly discover unique novae, dwarf novae or supernovae and study distant quasars. The OGLE team studies objects located closer to Earth

as well. Among other things, it has discovered one of the largest objects in our Solar System with a diameter of 470 kilometres, named Dziewanna (after the Slavic goddess of the wild nature, forests and the hunt).

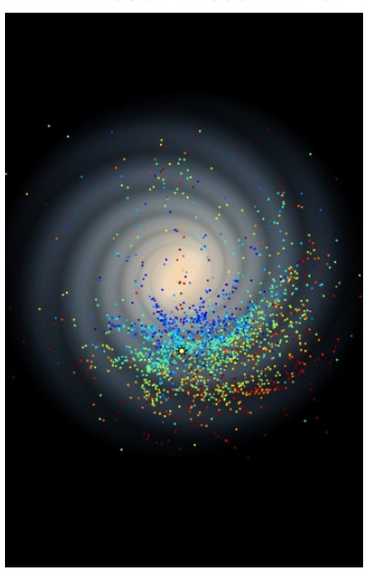
International Cooperation is a Must

'Our research involving gravitational microlensing requires international cooperation, because these events are unique and we are not able to provide round-the-clock observation on our own,' explains Prof. Udalski. That is why the scientists share information with astronomers from countries such as the USA, Australia, New Zealand and Japan. The unique databases of the OGLE project are open to astronomers all over the world, who are thus able to make new discoveries.

The OGLE team has published more than 550 research papers, including over a dozen in *Nature* and *Science*.

Astronomical Observatory of the University of Warsaw
astrouw.edu.pl/index.php/english-front

BREAKTHROUGH DISCOVERY OF POLISH ASTRONOMERS



The new three-dimensional map of the Milky Way was recently constructed by Polish astronomers using a sample of over 2400 Cepheids, the majority of which were newly identified in the photometric data collected by the OGLE survey. It is the first map that is based on direct distances to thousands of individual objects as distant as the expected boundary of the Galactic disk. The map demonstrates that the Milky Way disk is not flat, it is warped at distances greater than 25000 light years from the Galactic centre. The map also allows astronomers to trace recent star formation in the Milky Way.

The discovery has been published in Science:
'A three-dimensional map of the Milky Way using classical Cepheid variable stars', D. M. Skowron, J. Skowron, P. Mróz, A. Udalski, P. Pietrukowicz, I. Soszyński, M. K. Szymański, R. Poleski, S. Kozłowski, K. Ulaczyk, K. Rybicki, and P. Iwanek 2019, Science, 365, 478, doi:10.1126/science.aau3181.

Source: en.uw.edu.pl

Essay
The Polish School of Astrophysics

Professor Kazimierz Stępień

EXTRAORDINARY ACHIEVEMENTS of Polish astrophysicists over the last decades have prompted the international astronomical community to recognise the existence of a phenomenon called the Polish school of astrophysics. At present, Polish scientists take part in many international consortia investigating virtually all aspects of the Universe. Two very successful, purely Polish observational projects: Optical Gravitational Lensing Experiment (OGLE) led by Professor Andrzej Udalski and All Sky Automated Survey (ASAS) with Professor Grzegorz Pojmański in charge belong to the most widely recognised projects of this kind worldwide. Polish astronomers amount to about 1.4 percent of professional astronomers in the world, yet they are authors or co-authors of 2.6 percent of all scientific publications related to the Universe (more than 90 percent of them are in astrophysics). The average citation rate of these papers is about 20 percent higher than the world average. This is clear proof of international reputation of the Polish school of astrophysics.

The school was created by a few young astronomers who took an interest in this research area and survived World War II. They were Wilhelmina Iwanowska, Jan Mergentaler, Antoni Opolski, Stefan Piotrowski and Włodzimierz Zonn. They established new astrophysical groups in Toruń, Warsaw and Wrocław. Soon, Kraków followed suit. Having been educated before the war, they were able to deliver very high level university courses and start research in some of the most advanced areas of astrophysics. We can call them the parents of the Polish school of astrophysics. From the very beginning, they followed the principle that there is no national astronomy; a scientific achievement means an achievement in world science. They also understood that to reach a world-class level in science, constant and frequent personal contacts with leading research institutions had to be maintained. Thanks to that approach, already the first generation of their students achieved results recognised in the world astronomy. Unfortunately, the progress in Polish astronomy was hampered in the early 1950s due to the political situation resulting in a complete isolation of the Polish scientists from the Western countries.

'Polish astronomers amount to about 1.4 percent of professional astronomers in the world, yet they are authors or co-authors of 2.6 percent of all scientific publications related to the Universe.'
– Prof. Kazimierz Stępień

This changed in the second half of the 1950s. From then on, our mentors put a lot of effort to send young PhDs for a one-year or a couple of years' stay to the best astrophysical institutions in the West. When coming back to Poland, they brought new ideas, close ties with their foreign peers and a lot of original observational data resulting in important discoveries. There was, however, also a dark side to this freedom: several renowned astronomers decided to emigrate. Fortunately, most of them maintained contacts with their homeland by inviting younger colleagues, supporting scientific libraries or providing observational and computational instrumentation.

In subsequent decades, the astrophysical centres differentiated their research areas: Warsaw specialised in binary stars and stellar evolution, Kraków in radioastronomy and cosmology, Toruń in radioastronomy and stellar observations, and Wrocław in solar physics and pulsating stars. The most prominent member of the Polish school of astrophysics was Bohdan Paczyński, Professor Piotrowski's student and one of the best astrophysicists of the 20th century in the world. His papers on evolution of single and binary stars, gamma ray bursts and microlensing of starlight were milestones in the development of astrophysics. As one of the very few scientists, he received all most prestigious awards and distinctions in astronomy. The other first students of the 'parents' include the world-renowned Wojciech Dziembowski (helio- and astroseismology), Stanisław Grzędzielski (interplanetary and interstellar matter), Krzysztof Serkowski (polarisation of starlight, instrument construction), Józef Smak (binary stars), Wiesław Wiśniewski (stellar photometry) and Wojciech Krzemiński (variable stars), to name just a few. The second generation of the students who became world authorities in their research areas is too numerous to list.

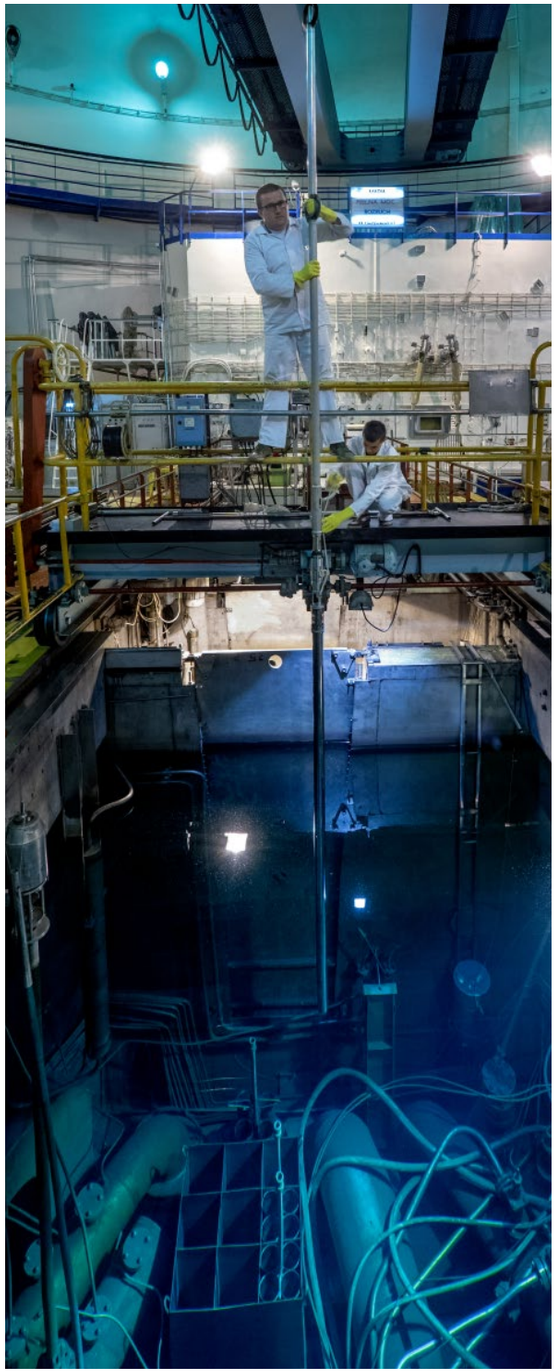
Poland has recently become a member of the European Southern Observatory, a European organisation for research in astronomy possessing the most advanced, modern observation facilities. This assures our participation in several ground-breaking scientific projects.

Prof. Kazimierz Stępień, Member of the Observatory Scientific Council, Honorary Member of the Polish Astronomical Society, Director of the Astronomical Observatory of the University of Warsaw (1980-1986)

NCBJ: From Fundamental Research to Production of Radiopharmaceuticals

Experts at the National Centre for Nuclear Research in Świerk near Warsaw carry out fundamental research in the areas of elementary particle physics, nuclear physics and cosmology as well as applied research, which consists in designing new materials. Moreover, the institute is involved in manufacturing radiopharmaceuticals.

02



Polish scientists have collaborated with experts from Switzerland and China in the work on the POLAR detector, whose purpose is to measure the polarisation of gamma radiation bursts (GRB) in space.

THE NATIONAL CENTRE for Nuclear Research (NCBJ) is one of Poland's major research institutes. It has the sole nuclear research reactor in the country at its disposal – Maria, used for reactor research and work on nuclear fuel.

'The number of such reactors in Europe has been decreasing radically in recent years. As a result, the interest in cooperating with us is growing,' says Paweł Sobkowicz, DSc., Deputy Director for Innovation and Commercialisation.

The research facility maintains extensive international cooperation, e.g. with Germany, France, the US and Switzerland, including the greatest laboratory worldwide – the European Organisation for Nuclear Research CERN in Geneva.

Based on the achievements of the Polish co-creators of the world's most powerful laser XFEL located in Hamburg, the NCBJ team is currently working on a Polish free electron laser – PolFEL. Moreover, the Polish scientists have collaborated with experts from Switzerland and China in the work on the POLAR detector, whose purpose is to measure the polarisation of gamma radiation bursts (GRB) in space. Apart from that, the NCBJ is

a major global manufacturer of radiopharmaceuticals, which are exported to 80 countries.

A Wide Range of Research

The institute is constantly developing. It is building a modern centre for design and synthesis of molecularly targeted radiopharmaceuticals CERAD, which will use a cyclotron – a unique facility in Europe (another similar accelerator is currently under construction in Jülich, Germany). It will also create a laboratory of industrial radiography for the needs of fundamental research and industry. The lab will allow to detect safety risks, e.g. faulty bridge welds.

The centre provides a wide range of research and design services for domestic and foreign partners, e.g. it tests the radiation resistance of materials or analyses the environmental impact of industrial installations. In addition, it offers PhD programmes and research fellowships.

National Centre for Nuclear Research
ncbj.gov.pl/en

The Cyclotron Centre Bronowice: Cancer Radiotherapy and Basic Research Combined

The Cyclotron Centre Bronowice (CCB) at the Henryk Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences, in Kraków (IFJ PAN) is an ultramodern, state-of-the-art equipped research centre.

03

THE MAIN ACTIVITY of CCB is cancer radiotherapy using active proton scanning beams – a unique up-to-date technique worldwide. The CCB activities rely on the two available proton cyclotrons: an in-house constructed 60 Mev AIC-144 cyclotron and a dedicated, IBA-produced 230 MeV Proteus C-235 cyclotron – where the energy of its proton beam may be continuously varied from 70 to 230 MeV. In proton radiotherapy, the beams produced by these cyclotrons achieve much more precise alignment of delivered therapeutic dose distributions with the tumour volume than that possible in conventional radiotherapy using megavolt X-ray beams. This makes the irradiation procedure much safer for the patient as unwanted irradiation of healthy tissues and critical organs (such as the spinal cord), located in close vicinity of the treated tumour volumes, is avoided.

Precision of the Gantry Beam

In the treatment of tumours, the latest gantry technology is used, where the scanning proton beam can be directed at any angle by a rotating arm. Two such arms - or gantries - are available at CCB. The precision of gantry beam delivery is better than 1 mm. To treat tumours located within the patient's eyeball, a fixed horizontal 70 MeV proton beam is used at CCB, where the delivery precision is about 0.1 mm.

'Worldwide, CCB is one of the very few facilities where basic research can be performed along with its main activity – proton radiotherapy,' explains Professor Marek Jeżabek, General Director of IFJ PAN.

Basic research at CCB is carried out in the areas of nuclear physics, nuclear detectors, materials engineering, medical physics, clinical dosimetry and radiobiology. Of particular interest in such experiments is the ability to precisely tune the energy of the proton beam over the energy range 70-230 MeV. For example, the response (e.g. survival) of biological material, or defects in electronic circuits after their irradiation, may be tested using proton beams of different energies.

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‘Energetic protons are abundantly present in cosmic space, so such investigations are of importance to space and aviation industries and to radiation protection of cosmonauts in space or flight-crews during long-distance high-altitude commercial flights,’ adds Professor Marek Jeżabek.

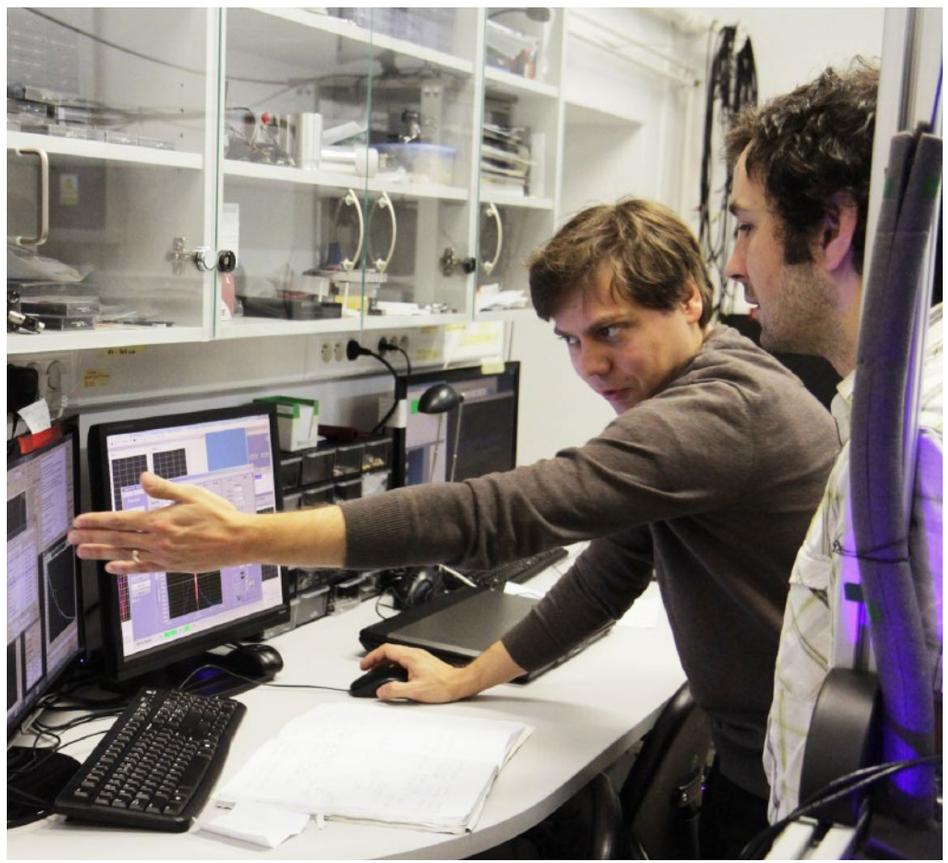
Research and Commercial Services

Radioactive isotopes for research purposes are produced at CCB. CCB also offers commercial services, such as radiation tests of new materials, biological substances, nuclear detectors applied in physics and in medicine, space industry electronics.

The CCB infrastructure lends itself to international cooperation – it is used 24/7 by international research teams from almost all countries in Europe and teams on other continents, for example in the United States or Japan.

The Henryk Niewodniczański Institute of Nuclear Physics PAS
Cyclotron Centre Bronowice
ccb.ifj.edu.pl/en.home.html

FAMO Laboratories: Extensive Research in Physics



Scientists from the National Laboratory of Atomic, Molecular and Optical Physics (KL FAMO), a research centre at the Institute of Physics of the Nicolaus Copernicus University in Toruń, Poland, carry out world class experimental research in the areas of atomic, molecular, and optical physics.

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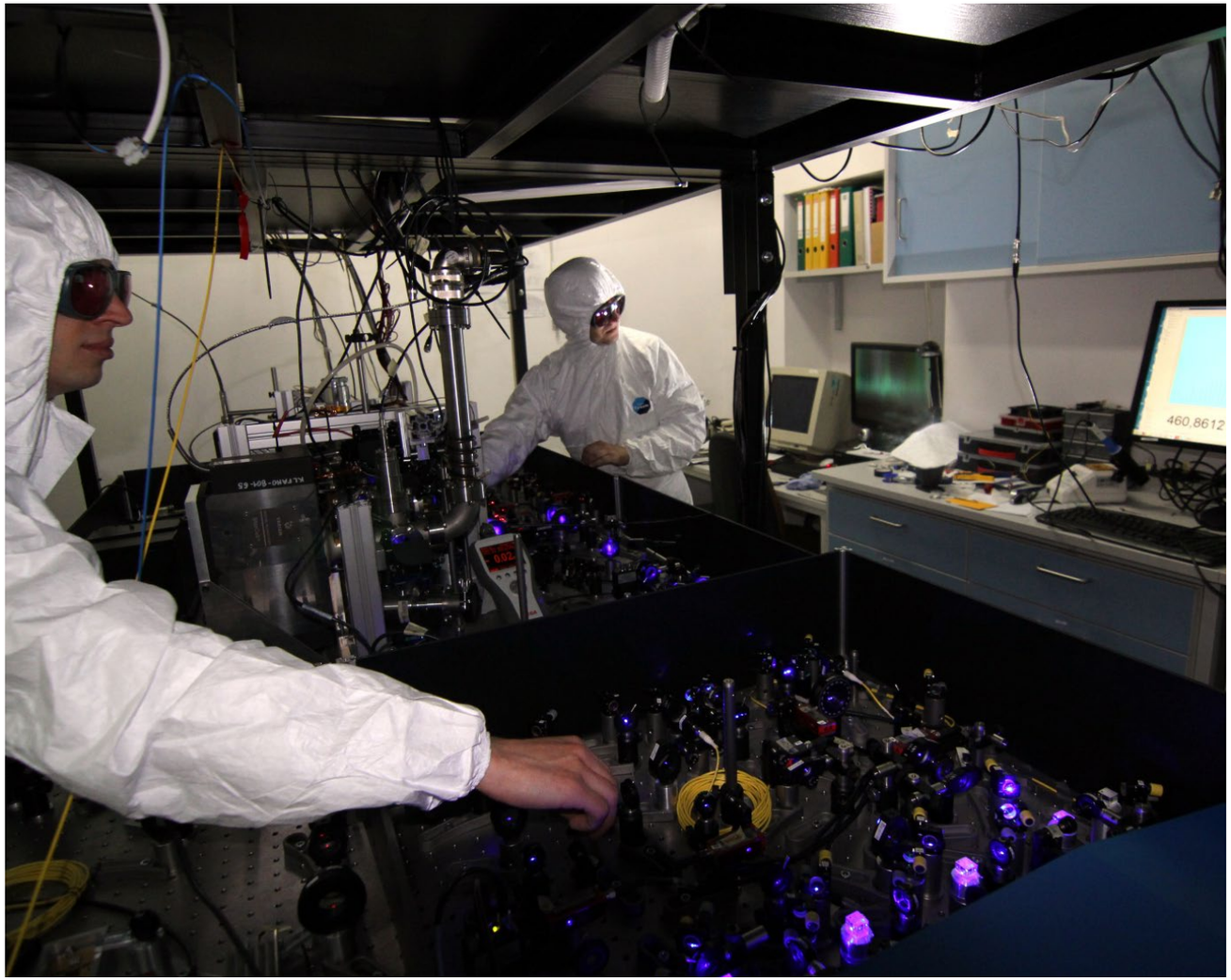
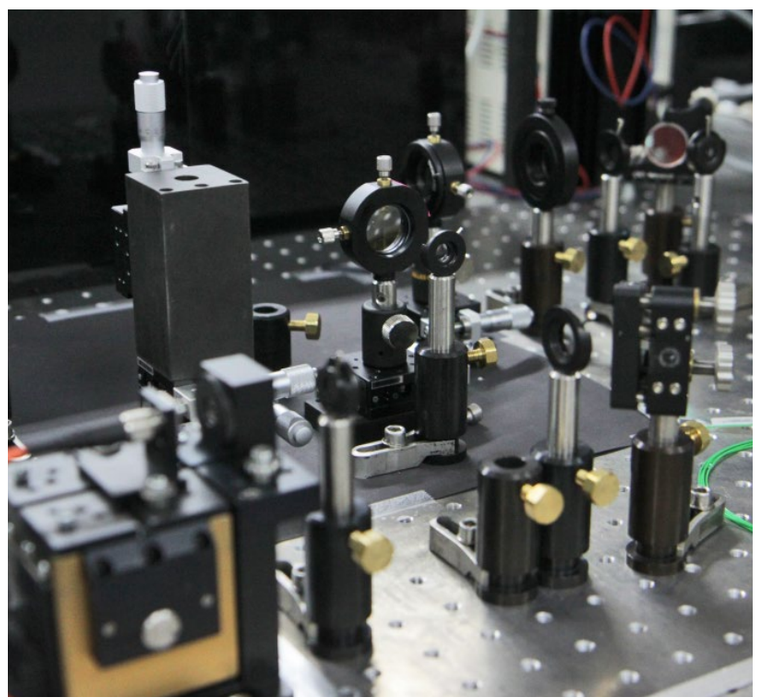


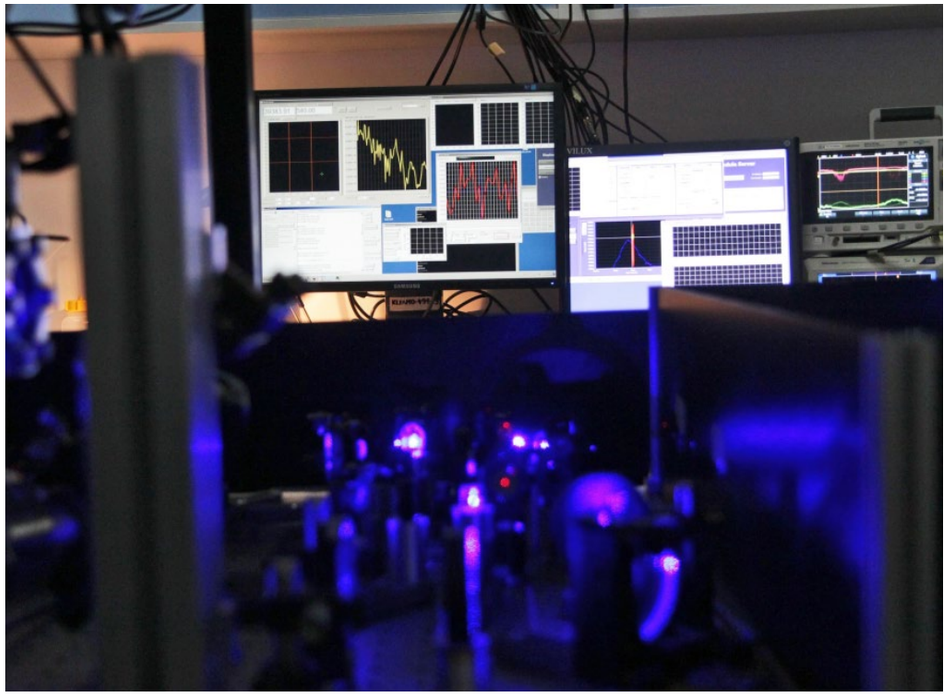
Currently, the lab runs joint research with more than twenty centres located on almost all continents, including Northern America, Europe, Asia and Australia.

THE RESEARCH results in the creation of precise measuring instruments – optical clocks – and enables secure communication with satellites and detection of explosive hazardous substances. KL FAMO was established in 2002 in order to facilitate international cooperation of physicists. Currently, the lab runs joint research with more than twenty centres located on almost all continents, including Northern America, Europe, Asia and Australia.

'According to our regulations, we provide access to our infrastructure to research teams in Poland and abroad,' declares the director of KL FAMO, Prof. Michał Zawada.

One of the major projects carried out by the laboratory involves developing optical atomic clocks, currently the most precise measuring instruments and frequency standards. Only a few facilities in the world have similar clocks, and the precise time measurements play a vital role in numerous areas of science and technology. Thanks to the devices built in Poland, the laboratory cooperates among others with the European Association of National Metrology Institutes (EURAMET).





Other Domains of Research

Another domain where international cooperation matters a great deal is research on individual photons and quantum information. The FAMO physicists are working on a secure transfer and processing of quantum information. It plays a role e.g. in secure communication with satellites with the use of quantum channels.

Furthermore, the laboratory team is working on a project involving ultraprecise spectroscopy. It is particularly useful in atmospheric research of exoplanets, detection of explosive substances and greenhouse gas monitoring.

Nicolaus Copernicus University in Toruń
National Laboratory of Atomic, Molecular and Optical Physics (KL FAMO)
famo.fizyka.umk.pl/index.php/en/

Essay
The Polish School of Particle Physics

Professor Agnieszka Zalewska

PARTICLE PHYSICS deals with the fundamental constituents of matter and their interactions. In the study of the origin of the Universe, particle physics, which reproduces the conditions as close as possible to the Big Bang, is complementary to astronomy, which does it by looking further into space. The physicists and engineers involved in the development of accelerators, detectors, electronics and IT tools required by particle physics, overcome successive technological barriers and contribute significantly to the general development of technology. Note that the WWW protocol was created at CERN (European Laboratory for Particle Physics) for the use of large international collaborations involved in particle physics experiments.

The founding fathers of the Polish school of particle physics were Professor Marian Mięsowicz in Kraków and Professors Marian Danysz and Jerzy Pniewski in Warsaw. The research initiated by Mięsowicz in the 1930s and continued by the three professors after the war was concerned with cosmic rays. The most spectacular achievements from this period include the discovery of the first hyper-nucleus, made by Danysz and Pniewski in 1952 (nominated several times for the Nobel Prize) and in Kraków the identification of the background from the natural radioactivity of rocks in the study of cosmic muons (the first Polish paper published in the Physical Review after the war, in 1950).

CERN has been particularly important for the development of the Polish school. This leading laboratory of particle physics was founded in 1954 as a joint project of twelve European countries. For political reasons, Poland was unable to participate, but owing to the contacts of professors Danysz, Mięsowicz and Pniewski, their students were being invited to work at CERN since the late 1950s. Soon Polish groups began joining international collaborations, analysing in Poland the data acquired at CERN. Also Polish theorists, working on the phenomenology of particle interactions, gained recognition. As a result, as early as in 1964, as the only country from the Soviet block, Poland enjoyed the status of observer in the CERN Council. On 1 July 1991, again as the first among the eastern countries, Poland became a full member of CERN. Since the 1970s, Polish scientists have been taking part in the leading CERN experiments, contributing also advanced equipment built in Poland. Poles were co-authors of top discoveries like the determination of the number of families of the fundamental particles of matter in experiments at the LEP collider, or the discovery

'Poles were co-authors
of top discoveries like
the determination of the
number of families of the
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matter in experiments at
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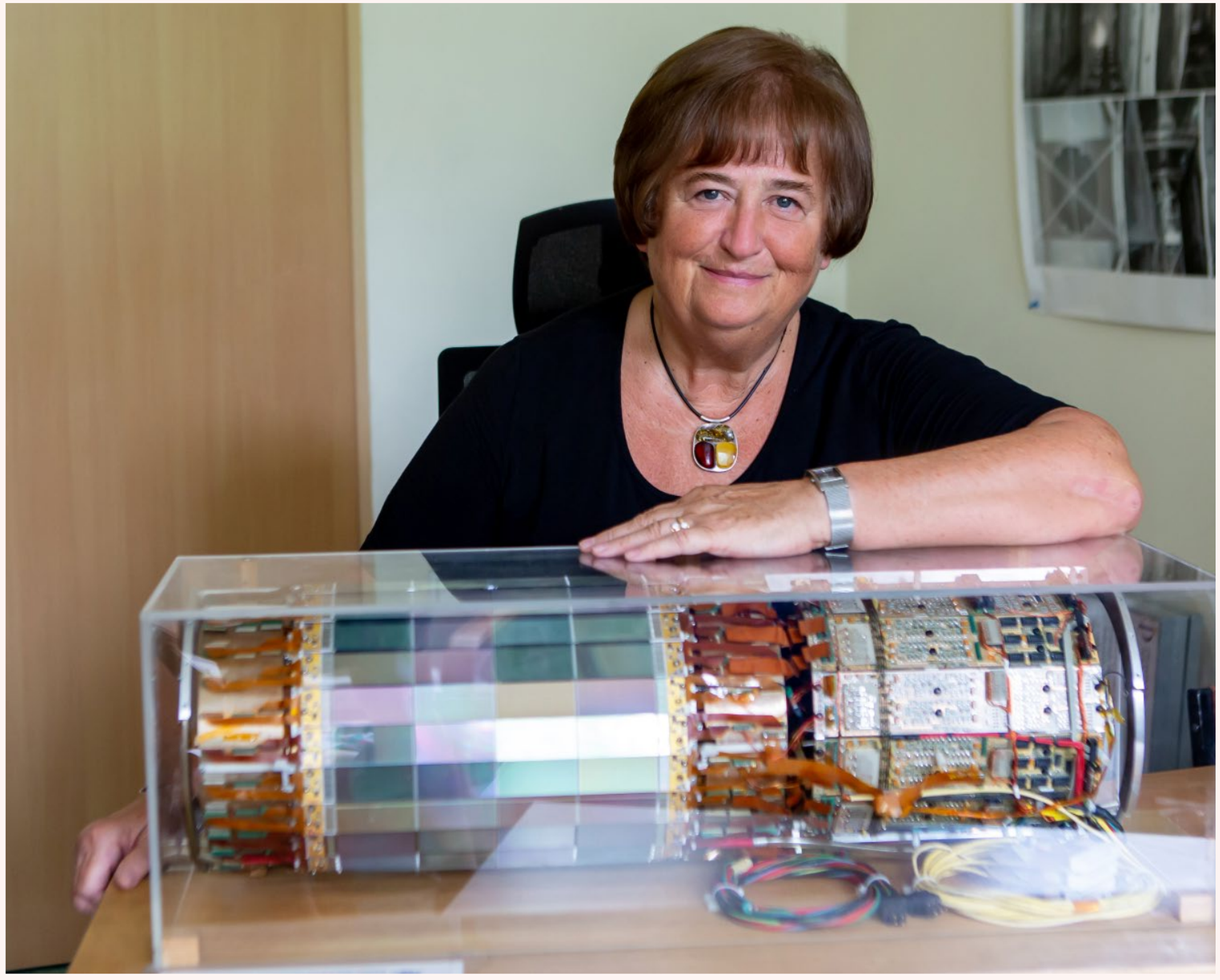
discovery of the Higgs boson
in experiments at the LHC
collider.'
– Prof. Agnieszka Zalewska



of the Higgs boson in experiments at the LHC collider. Thanks to achievements of the Polish particle physicists, many of them were invited to give plenary talks at the most important international conferences. Signs of the position of Poland at CERN include the participation of Poles in the governing structures of experiments, their success in getting prestigious positions and scholarships, membership in scientific committees, in particular the Scientific Policy Committee advising the CERN Council, Polish companies signing contracts with CERN, and finally Polish scientists being elected to the position of Vice-President and recently to the position of President of the CERN Council (up to now the only President from beyond the twelve countries that have founded CERN).

Besides the leading centres in Warsaw and Kraków, groups connected with particle physics are working in Katowice, Kielce, Łódź and Wrocław, with smaller groups in some other centres. Although CERN is our leading partner, Polish scientists also work in other prestigious laboratories, e.g. in Italy, Japan and the US in the field of neutrino physics. The synergy of particle physics and particle astrophysics is gaining importance and should also be emphasised.

In this short text, it is not possible to name all the physicists, engineers and technicians who have contributed significantly to the development of the Polish school of particle physics. Thus, only the names of the three founding fathers, who were and are unquestionable authorities for the community of particle physicists in Poland, have been given.

Prof. Agnieszka Zalewska, Physicist specialising in experimental particle physics, Member of the Polish Academy of Arts and Sciences, President of the CERN Council (2013-2015), Member of the Standing Identification Committee for the selection of members of the Scientific Council of the European Research Council (from 2014), Member of the Execution Board of the European Strategy Forum on Research Infrastructures (from 2016).

International Centre for Theory of Quantum Technologies: Innovative Centre of Excellence

The newly established International Centre for Theory of Quantum Technologies (ICTQT) at the University of Gdańsk is an innovative centre where scientists from all over the world will conduct research into the fundamental issues of quantum physics, communication and quantum information as well as quantum technologies.

05

Prof. Marek Żukowski, the ICTQT Director (from the left), Prof. Paweł Horodecki, research group leader.

ICTQT research teams will implement projects on new technologies, including cybersecurity and new quantum computation techniques.

ICTQT IS financed within the International Research Agendas Programme (IRAP) of the Foundation for Polish Science. IRAP provides for the establishment of innovative centres of excellence for high quality research in international teams. Two of the projects implemented in Poland under IRAP are carried out at the University of Gdańsk. The strategic partner of ICTQT is the Institute for Quantum Optics and Quantum Information (IQOQI-Vienna), Austrian Academy of Sciences, one of the key scientific centres in this field worldwide.

University of Gdańsk – Cradle of Gdańsk School of Quantum Information

The University of Gdańsk is a reputed centre of research into quantum information theory. The establishment of ICTQT is another step towards the intensification of this direction of research. 'We will be developing the theory of quantum technologies. This is related to the explosive expansion of research into a new branch of physics: quantum information science. It has evolved from research into the foundations of quantum mechanics,' explains Professor Marek Żukowski, the ICTQT Director. 'Poland has played a significant role in the development of quantum information theory and it so happened that Gdańsk became the first centre in Poland to specialise in this field,' emphasises Prof. Żukowski.

ICTQT research teams will implement projects on new technologies, including cybersecurity and new quantum computation techniques. The research will be crucial for the future security and development of quantum internet, quantum computers and networks, as well as quantum simulations. 'In the near future, you can expect us to present new designs of generators of truly random numbers. We are also going to create blueprints of new quantum cryptographic systems that have the crucial trait: to test them, one does not need to know how they work. We also intend to work on quantum sensors and theoretical aspects of quantum computers,' promises the ICTQT Director.

Greater Security of Quantum Data Transmission

Both random number generators and quantum communication devices can be used in future situations, in the case of which secrecy or the randomness of numbers is required. Such solutions would benefit, for example, public or financial institutions, where data security is of key importance.

There are six research groups working at ICTQT. Professor Paweł Horodecki is in charge of one of them. ‘In the team, we study those features of quantum systems, which are used or can be used to create new methods of quantum information processing. We analyse everything in relation to the basic problems of communication theory. Particularly interesting are the combinations of quantum processes and methods. Another example of a line of research is the insight into the nature of quantum memory and the attempt to answer the question where its useful boundaries are. Some of the analyses carried out by the team are tested experimentally by a renowned quantum optical laboratory in Stockholm,’ explains Prof. Horodecki.

ICTQT plans to liaise with other research and scientific centres as well as industrial partners. Joint scientific projects are currently underway in cooperation with, among others, Stockholm University, LMU Munich and the University of Vienna.

University of Gdańsk
International Centre for Theory of Quantum Technologies (ICTQT)
ictqt.ug.edu.pl

TUgbOAT: Search for a Universal Algorithm

Computer scientist Professor Piotr Sankowski from the University of Warsaw is looking for algorithms that would work best regardless of the circumstances. His work may contribute to the development of modern computer science.

06

THE EUROPEAN Research Council (ERC) is one of the most important and prestigious institutions to offer grants to researchers. Prof. Piotr Sankowski from the Faculty of Mathematics, Informatics and Mechanics of the University of Warsaw belongs to a small group of scientists who have received an ERC grant more than once.

His first grant was for designing and analysing approximation algorithms for problems whose precise solution is impossible due to the excessive time the calculations would take. The second grant concerned the commercialisation of the results. The latest one (amounting to more than 1.5 million euros) is funding a research project entitled 'Towards Unification of Algorithmic Tools'. Its objective is to develop universal algorithms.

An algorithm is...

PROF. PIOTR SANKOWSKI: ...a list of instructions for the computer that informs it how to perform simple tasks in order to ultimately carry out more complex operations. Different problems require different instruction' sets.

And a universal algorithm?

It's an algorithm that is as good as possible regardless of the given problem's details. Let's assume that we have one problem to solve, e.g. multiplication. The thing is, today we can imagine ten different algorithms prescribing how the computer is supposed to multiply, but we can't select the best algorithm, because each of them is good in a different case. One algorithm works best in practice. Another is better, but only in theory. The next one works best for specific numbers, and so on. That is why using algorithms is difficult, because you need to be an expert to know which algorithm should be used in a given case. In addition, the newest and best algorithms are hard to apply, so essentially people don't use them. The reason for this problem is that we have no universal solutions.

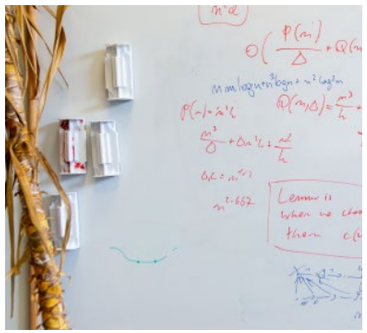
'We want our solutions to be simple and universal. We hope that our research will affect the practical use of algorithms.'
– Prof. Piotr Sankowski

Your team is trying to develop such universal algorithms. What problems are they supposed to solve?

We are focusing on three areas. First, we want to design universal algorithms for static graph problems. A graph can be compared to a road map with roads and crossroads. One of the simplest problems that algorithms can solve on graphs is to look for the shortest route from point A to point B.

The second area are online problems. The situation is different here, because we don't have all the data. If we take our road map again, in this case we find out the road has been suddenly closed. The new algorithm has to deal with uncertainty about the future. The third area involves using additional properties of data.

What does that mean?
Let's get back to the example with finding the shortest route. It can turn out that this problem should be dealt with differently if we are thinking of Europe's road map and differently if it's Africa's. That's why one algorithm works best for the road map of Europe and another – for the road map of Africa. What we want to achieve is to develop a universal algorithm, which would be able to use these special data properties.



Can your research have an impact on the work of IT specialists?
Although better and better algorithms are created all the time, they are not widely used because they are so complex that no one knows how to use them. We want our solutions to be simple and universal. We hope that our research will affect the practical use of algorithms.

University of Warsaw
en.uw.edu.pl
duch.mimuw.edu.pl/~tugboat

POLISH IT STUDENTS REGULARLY WIN MEDALS AT IT COMPETITIONS

A real sensation is the team from the University of Warsaw, which has been in each of the last 25 finals of the International Collegiate Programming Contest – the oldest and most prestigious IT contest for students. Altogether, computer scientists from University of Warsaw have won the world championship twice and collected fifteen medals up to 2019.

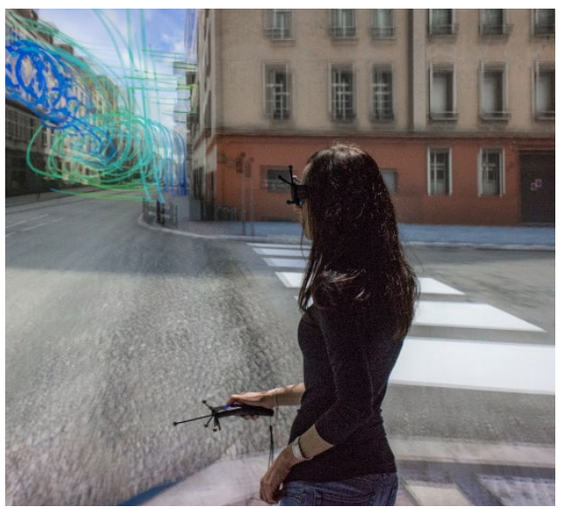
Other Polish teams are successful as well. The Jagiellonian University has entered the finals twelve times in total and has won three medals. The University of Wrocław has been in the finals eleven times and has won three medals, and the AGH University of Science and Technology in Kraków and Poznan University of Technology have both reached the finals once.

Poznań Supercomputing and Networking Center: Where the Technologies of the Future Are Born

R&D centre operates in Poznań and tests innovative solutions concerning networks and digital and communications technologies.

07

TEN YEARS AGO, the world went into raptures over the technology of high definition image display. Yet the world did not include the scientists at the Poznań Supercomputing and Networking Center (PSNC) affiliated to the Institute of Bioorganic Chemistry of the Polish Academy of Sciences. They were already working on equipment to enable image display in 4K resolution. Today, 4K is becoming popular in households, but is not the subject of studies at the PSNC. Not any more. Now, the researchers there are working on 8K 3D technology. For the purpose of their studies, they established an experimental cinema at the PSNC. It is equipped with innovative projectors and cameras, which record image in this resolution (following special modifications introduced by Sony for the needs of the PSNC). Its screen displays three-dimensional 8K videos.



The experimental cinema is one of several dozen specialist labs at the PSNC. These include a medical laboratory with telemedicine equipment and labs where new user interfaces are developed. ‘We are a research and development centre for information and communication technologies. Our mission and our objective involve everything where the Internet meets various sectors of the economy,’ says Damian Niemir, Public Relations Manager at the PSNC. ‘We are trying to be one step ahead in that we study technologies that will soon be applied in commercial products,’ he adds.

Various Areas of Activity

The PSNC began its activity with projects involving supercomputer calculations and online networks. Over time, the center expanded its activity to other areas. Today, it is involved in work on the new media, Industry 4.0, energy efficiency, smart cities, intelligent agriculture and forestry as well as space technology, but also e-government or cultural heritage. It cooperates with major industry actors as well as SMEs and start-ups. For instance, it participated in the German-Italian-Spanish project EVER-EST, in which data about the Earth useful e.g. for geologists or seismologists were gathered. In Fit4Work, the PSNC together with its partners from the Netherlands, Spain, Slovenia and Romania are working on an IT solution for professionally active seniors. In addition, it has created innovation centres in cooperation with Microsoft and Huawei.

Today, PSNC is involved in work on the new media, Industry 4.0, energy efficiency, smart cities, intelligent agriculture and forestry as well as space technology, but also cultural heritage or e-government.

Moreover, the Poznań Center belongs to the consortium that runs Euratom's nuclear fusion programme.

Multidisciplinary Approach

In the course of more than 25 years of the PSNC's existence, it has been engaged in the completion of over 200 research projects, including more than 40 in the EU Framework Programme for Research and Innovation Horizon 2020. 'We are trying to combine technologies based on engineering, in which we specialise, with other disciplines. For example, we wonder how clouds, the technology of which we are developing, could be applied in medicine. Or how the PSNC could help in art&science with its expertise in biometrics or motion capture,' Niemir explains.

Poznań Supercomputing and Networking Center affiliated to the Institute of Bioorganic Chemistry of the Polish Academy of Sciences
psnc.pl

Polish Polar Station Hornsund: A Unique Place for Research

The Stanisław Siedlecki Polish Polar Station in Hornsund is located at the bay of Isbjørnhamna in the fjord of Hornsund in the southern part of Spitsbergen. It lies within the South Spitsbergen National Park, which was established to protect the unique Arctic nature.

08

Polish Polar Station in Hornsund carries out an extensive year-round monitoring programme, including seismological, Earth magnetism, glaciological and oceanographic observations.

THE YEAR-ROUND Polish Polar Station in Hornsund is run by the Institute of Geophysics of the Polish Academy of Sciences in Warsaw. The location of the facility gives researchers a rare opportunity to study climate change and changes in biological diversity. Southern Spitsbergen is a particularly attractive place for research, because it shows a cross section of all geological formations on a short stretch of 40 kilometres. In addition, the station was built at the site of the strongest climatic fluctuations in the area.

'Being a modern, interdisciplinary research platform, the station offers a range of laboratories, including chemistry, biology, oceanography, seismology, meteorology, atmospheric physics and Earth magnetism labs,' says Station Manager Włodzimierz Sielski. The expanded living area can lodge up to forty people at once.

Arctic Studies in Various Fields

The scientists at the station carry out Arctic studies in various fields, including atmospheric physics, glaciology, biology, polar ecology, geophysics and geology. The research is conducted by Polish and international teams, including teams from Norway, Czechia, France, the US and Italy. The station maintains international cooperation with more than thirty research institutions. One of the flagship projects it is involved in is INTERACT.

INTERACT is an international cooperation network of polar research stations and research institutions that conduct polar studies. The network's objectives are to make the infrastructure of polar stations more available to scientists and to strengthen cooperation between research institutions and research stations.

The Hornsund station is a permanent member of this prestigious network, which offers access to research sites as well as logistical support to scientists from around the globe.

Unique Data Collection

Moreover, the Polish Polar Station in Hornsund carries out an extensive year-round monitoring programme, including seismological, Earth magnetism, glaciological and oceanographic observations. The data collected as a result of the measurements are sent to a number of international databases.

Researchers interested in using the Polar Stations's infrastructure in their studies should register in the database Research in Svalbard (RiS) and then fill in the application form on the station's website.

Institute of Geophysics Polish Academy of Sciences
Stanisław Siedlecki Polish Polar Station in Hornsund
hornsund.igf.edu.pl/en

Essay

Polar Research as a Bridge for Strengthening International Cooperation

Professor Piotr Głowacki

ALTHOUGH LOCATED far from the polar regions, Poland has a long tradition of studying these still not fully researched areas of our planet. The first Poles who reached the frigid zones were scientists exiled by the Russian tsar to Siberia in the 19th century.

Polar research naturally combines activities in the fields of exact and natural sciences as well as technology and engineering. The results of the studies, as well as the logistic and exploration activities, contribute to other domains as well, such as medical sciences, humanities or social sciences.

Poland's participation in cooperation and competition by taking part in the global research of the polar regions has a major impact on our international position. Poland is represented in the Scientific Committee on Antarctic Research, International Arctic Science Committee, and European Polar Board and is a signatory to the Svalbard Treaty and the Antarctic Treaty. Several places in the polar regions have geographical names of Polish origin, such as Polakkbreen (Poles' Glacier) and Kopernikusfjellet (Copernicus Mountain) in Svalbard, Polonia Glacier in Greenland, as well as Arctowski Icefield and Warszawa Icefield in the Antarctic.

'The Polish polar stations and vessels are regarded to be international research platforms and play the role of centres that attract research teams specializing in many fields of science.' – Prof. Piotr Głowacki

Research carried out in the polar zones is the reason for Poland's presence in the Arctic and in Antarctica, with all the incurred costs, but also with all the benefits, such as development and access to knowledge, international reputation as well as exploration and exploitation of the polar ocean resources and mineral resources. Particularly valuable are the studies of the beginnings of the Earth, as they are extremely promising in the polar regions. Another significant aspect is the application of knowledge based on own research with regard to the directions and pace of global climate change. We are able to gain such data by examining the most sensitive circumpolar areas. This can result in measurable effects related to the country's climate policy and involvement in new areas of economic activity in the warming Arctic.

Research in the polar zones is by definition international. Consequently, it is fairly obvious that international standards must be met and international methods and technology must be applied. They are the driving force for highly specialized and interdisciplinary research at the highest world level. Poland's research infrastructure consisting of the polar stations in Spitsbergen and in Antarctica is very much in line with all the seven priorities in the area of research and innovation defined by the European Union in the Horizon 2020 programme, as well as the priorities identified in the National Smart Specialisations (KIS – 2018) and in the 'Strategy for Polish Polar Research 2017–2027' adopted by the ministries.

The Polish polar stations and vessels are regarded to be international research platforms and play the role of centres that attract research teams specializing in many fields of science. They are the ambassadors of Polish science and the place where major international and national projects can be launched. Their ability to attract potential partners and funds depends primarily on high quality and modern infrastructure as well as potential in terms of equipment.

The extensive research programme will ensure Poland's permanent contribution to creating international databases and access to national archives with observation data. The programme will be carried out thanks to close collaboration with university centres, members of the Polish Polar Consortium. It consists of five research institutes of the Polish Academy of Sciences, eleven higher education institutions and one commercial institute, with the University of Silesia as the leading institution. The scientific staff at the Polish Polar Consortium is composed of more than 500 active experts in various fields, with more than 100 associate and full professors, around 150 assistant professors, more than 200 junior researchers as well as about 50 qualified technicians and logistics specialists.

The institution where majority of future polar researchers are educated is the Centre for Polar Studies at the University of Silesia in Katowice with its International Environmental Doctoral School and master's studies.

The Committee on Polar Research of the Polish Academy of Sciences has been the coordinating body for Polish studies carried out in the Arctic and in the Antarctic regions for more than forty years.

Prof. Piotr Głowacki, Chair of the Committee on Polar Research of the Polish Academy of Sciences; Member of the Board of Directors, Svalbard Integrated Earth Observing System (SIOS); Member of the Executive Committee, Forum of Arctic Research Operators (FARO); Head of the Polar and Marine Research Department in the Institute of Geophysics of the Polish Academy of Sciences (2002-2016)

POLISH POLAR STATIONS

Henryk Arctowski Polish Polar Station on King George Island, Institute of Biochemistry and Biophysics of the Polish Academy of Sciences (Antarctic Peninsula)

Stanisław Siedlecki Polish Polar Station in Hornsund, Institute of Geophysics of the Polish Academy of Sciences (Spitsbergen)

Dobrowolski Station Institute of Geophysics of the Polish Academy of Sciences (East Antarctica)

Stanisław Baranowski Polar Station of the University of Wrocław (Spitsbergen)

Nicolaus Copernicus University Polar Station, Kaffiøyra (Spitsbergen)

Adam Mickiewicz University Polar Station (AMUPS), Petuniabukta (Spitsbergen)

Climate Change: How Trees Adapt

Scots pine is the main forest tree species in Europe, especially in its northern and eastern parts. Intensive studies across the whole continent demonstrate the way the species had to adapt to changing environmental conditions in the past. In view of the current climate change, forests are facing new major challenges.

09

THE PROJECT funded by the National Science Centre, 'Geographic trends of variability of functional features of Scots pine in Europe in the context of climate change and ecological processes', aimed to study Scots pine across its entire range of distribution – from Spain to the northern border of the Scandinavian forests. The team led by Professor Jacek Oleksyn, Director of the Institute of Dendrology of the Polish Academy of Sciences in Kórnik, examined 92 populations of Scots pine across Europe. The team identified the genetic types within this species. Based on the geographic distribution of genetic types, it was possible to identify the likely refugia where the species survived the last glaciation. The probable migration routes of the species after the ice sheet retreated from Europe were also reconstructed. As it turned out, having moved across the continent, the pine from refugia located in Western Europe and the Balkan Peninsula crossed the Danish Straits and populated the western part of Scandinavia: Sweden and Norway.

The trees that reached Finland were the descendants of those which had survived the glaciation in the refugium in the Eastern European Plain covering the western part of today's Russia. Both these types of trees are encountered in Poland. In contrast, forests in Turkey and Spain have their own, genetically unique pines.

The studies have shown that the average lifespan of pine needles has decreased by nearly two years in Scandinavia in the last one hundred years.

Platform enabling pine needle collection and analysis at various heights.

Retrieving tree bore with a Pressler drill allows trees' age to be determined and to calculate the dynamics of their annual growth in thickness.

Reading the History Rooted in the Woods

Professor Oleksyn began researching pine trees after reading a unique book by the Swedish naturalist, Nils Sylven. Sylven published the results of his detailed studies on the ecology of the Scandinavian pines in the years 1916 - 1917. Once we confront historical information with current observations, we can see what has changed over the course of the last century.

'Human life is too short to observe changes in tree populations. A perspective of several years is the only way to verify the hypotheses on how our forests used to respond to climatic changes in the past, how they adapted to local conditions, colonized new areas, or succumbed to adversities,' says Professor Jacek Oleksyn.

Scientists investigated the migration pathways of particular genetic types of pine trees by analysing their DNA. They also took samples from tree trunks by drilling. Based on the cores, they were able to decode the information about how the trees had been growing over the course of the years. By comparing the data obtained from the cores with the historical meteorological data, researchers were able to trace the impact of climatic conditions on the tree growth. They could also make attempts at predicting the reaction of trees to future climatic conditions. Additionally, they studied the soil, in which the trees grew, as well as other environmental variables.

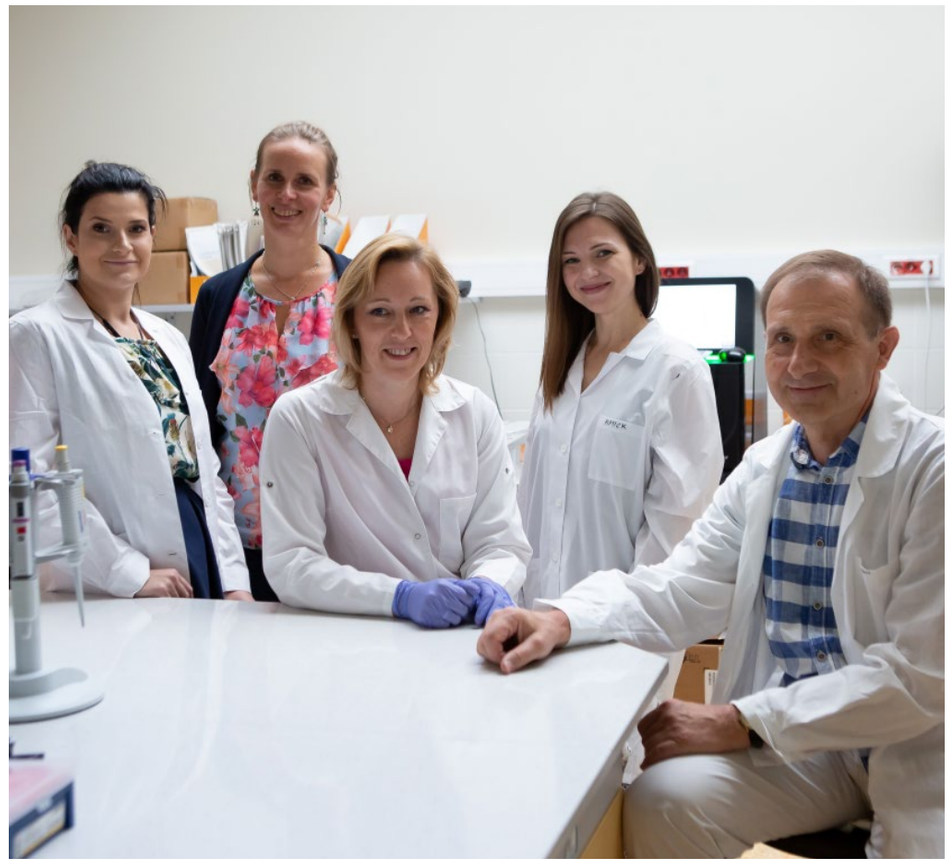
The Lifespan of a Pine Needle Has Decreased

In each of the studied places, the trees have adapted to local conditions: the length of day and night, the temperatures and humidity at different times of the year. This process has taken them thousands of years. Yet, the current fast pace of climate changes has an adverse impact on them. The studies have shown that the average lifespan of pine needles has decreased by nearly two years in Scandinavia in the last one hundred years. In Sylven's time, the needles lived and stayed on trees for even 11 years. Nowadays, it is about nine years.

This result obtained by Professor Oleksyn's team proves the utmost vulnerability of the northernmost European forests to climatic changes. In many European regions, the pine stands on sandy soils die out on a massive scale, even though the Scots pine generally grows well there. Research on trees and their reaction to environmental changes is under way. A better understanding of the compensatory mechanisms, by which pine trees used to cope with changes in environmental conditions in the past, is likely to tell us how to better protect forests today and in the future.

The Institute of Dendrology
Polish Academy of Sciences
idpan.poznan.pl/home-eng

European Centre for Bioinformatics and Genomics: Multi-level Studies of Biological Systems



Research institutions in Poznań integrate interdisciplinary teams and state-of-the-art computer technology to develop life sciences. By providing specialist equipment and professional staff, they have created a unique research environment.

10

The ECBiG team is running a project whose objective is to develop a database describing the composition of and variation in the microbial flora of Polish citizens (Polish Microbiome Map).

Removing bone material for archeogenomics tests.

THE EUROPEAN Centre for Bioinformatics and Genomics (ECBiG) was established in 2007 as a research consortium by the Institute of Bioorganic Chemistry of the Polish Academy of Sciences (IBCH PAS) and the Institute of Computing Science of the Poznan University of Technology. ECBiG is a unique Polish research centre dedicated to multi-scale and multi-level studies of biological systems. It comprises laboratories of structural genomics (protein bioengineering and crystallography, subcellular structure analysis, biomolecular NMR), functional genomics (sequencing, mass spectrometry, cell and tissue culture) and bioinformatics (structural bioinformatics, systems bioinformatics, bioinformatics of nanosystems and biosystems as well as DNA, RNA and protein analysis).

Multidirectional Research

The top-of-the-line equipment at the ECBiG allows to carry out multidirectional studies of complex biological systems, investigate the genetic background of both physiological and pathological processes, and search for the relations between the genotype and the organism's phenotypic traits.

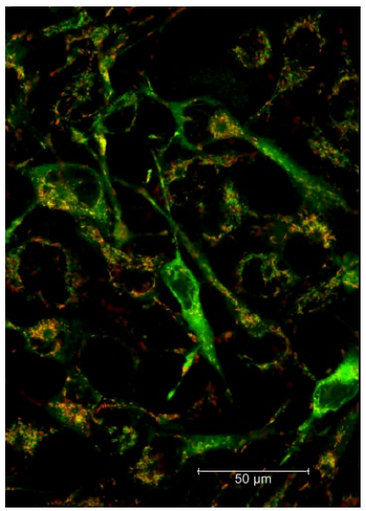
Taking up this kind of challenges requires scientists to use a wide range of already existing tools offered by bioinformatics, but also to develop their own specialist software and databases, the Internet portal RNApolis (http://rnapolis.pl/) being an excellent example. The Poznań Supercomputing and Networking Center affiliated to the IBCH PAS additionally enhances the ECBiG's IT infrastructure by providing computing power and servers for data archiving.

Thanks to its scientific and infrastructural potential, ECBiG has been involved in cooperation with numerous Polish and foreign research institutions for many years. This cooperation has resulted in a long list of completed projects and scientific publications in the area of plant, animal and human genomics. Many of them concern the issues of pathogenesis, prevention, diagnosis and treatment of human diseases.

Knowledge for Society

The objective of one of the ECBiG's strategic projects is to develop the Genomic Map of Poland (GMP). The GMP is a Polish infrastructure comprising advanced bioinformatics tools and databases that are necessary for the further progress of research in the field of genomics. The results of the project will include creating the Polish reference genome, a map of genetic variation in the Polish population, algorithms to analyse the relations between the genotype and the phenotype of the examined persons, as well as software needed to create visualisations of genome-wide data. Similar studies have been carried out in only some countries worldwide, including the US, the UK, Iceland, the Netherlands, Sweden, Japan, South Korea and China. Moreover, the ECBiG team is running a project whose objective is to develop a database describing the composition of and variation in the microbial flora of Polish citizens (Polish Microbiome Map).

'An extremely interesting and definitely the most interdisciplinary direction at ECBiG at present is archaeogenomics, that is studies of ancient DNA, which enable us to verify hypotheses concerning the human past,' says Professor Marek Figlerowicz, Director of the Institute of Bioorganic Chemistry of the Polish Academy of Sciences.

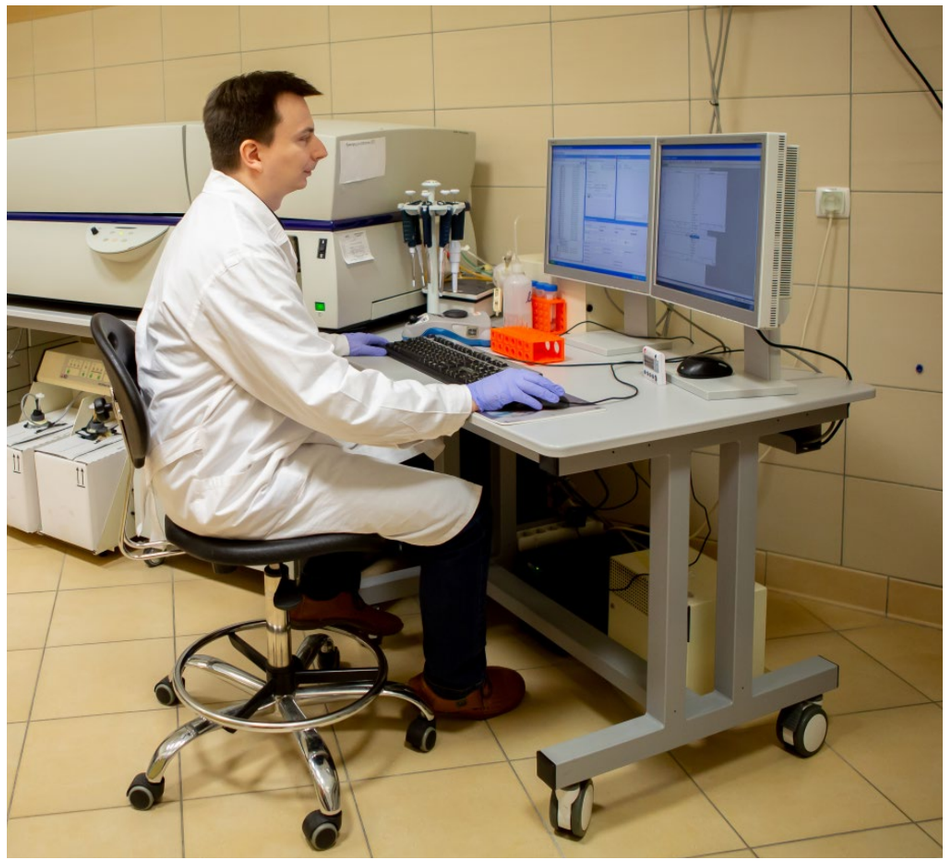


Analysis of mitochondrial membrane potential (JC-1) in human cancer cells (T98G). Image obtained with a confocal microscope.

Carried out in collaboration with archaeologists, historians and anthropologists from Poland, Germany and Czechia, the project entitled 'Dynasty and Population of the Piast State in the Light of Integrated Historical, Anthropological and Genomic Studies' attempts to answer a range of vital questions concerning Polish and European history. 'In the papers that have been published so far, we have described the processes that shaped the unexpectedly complex genetic structure of the population that inhabited the territory of today's Poland in the first centuries of the Common Era. Our next publications will reveal whether any population replacement occurred in this area in the first millennium A.D. and where the Piast dynasty originated from,' Professor Figlerowicz announces.

European Centre for Bioinformatics and Genomics
ecbig.pl

TESTOPLEK: The Role of Multidrug Resistance Transporters



Will chemotherapy work for a specific patient? Scientists from the University of Lodz developed tests that might help answer this question.

11

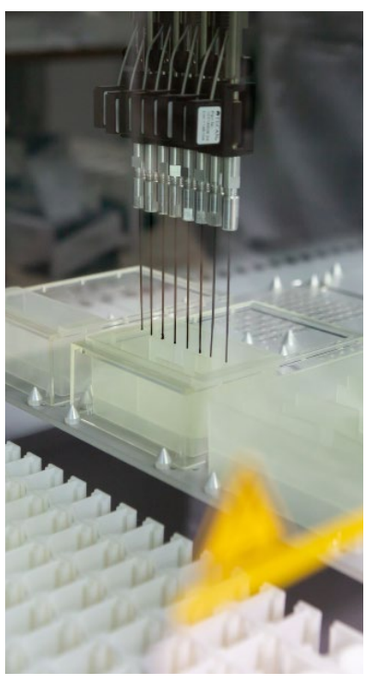
More than 12 thousand samples of genetic material from Polish donors are collected in the biobank created as part of the TESTOPLEK project.

CHEMOTHERAPY IS the standard method of treatment of various types of tumours. The problem is that it sometimes fails to bring the expected results. The reason is that the patient has an acquired or innate multidrug resistance. What this means is that the drugs they receive in the chemical cocktail cease to destroy cancer cells. The main cause of this phenomenon is an increased level of multidrug transporters in the patient, that is special ABC proteins which transport the drugs from the cells.

Key Transporters

Scientists at the Department of Molecular Biophysics of the Faculty of Biology and Environmental Protection at the University of Lodz decided to examine this phenomenon in their project entitled 'TESTOPLEK - Role of multidrug transporters in pharmacokinetics and toxicology - in vitro tests in pharmaceutical and clinical practice'. 'Our chief aim was to develop tests that could indicate which transporter we are dealing with, and consequently, whether it makes sense to use a certain therapy in a patient or whether it wouldn't work and we should rather look for something else,' explains Professor Grzegorz Bartosz, the leader of the project.

The greatest challenge the researchers had to face was the fact that the above-mentioned ABC proteins are characterised by poor specificity, that is they are able to transport a wide range of compounds. In addition, these transporters are normally produced by certain healthy human cells and are supposed to protect specific parts of the body, e.g. the brain or the developing foetus, from the harmful impact of toxic substances. Their level only rises in cancer cells. 'That is why it is not always sufficient to ascertain the presence of a specific protein in the test tube. For the patient's survival,



The additional value of these studies is the development of a new method to ascertain sex and hair colour, which can be used e.g. in forensic science and archaeology. Moreover, genetic methods of identifying drug-resistant pathogenic yeasts have been developed.

the crucial question is whether that protein is fully active,' Prof. Bartosz explains.

Results of the Project

The TESTOPLEK project, which has already been completed, brought several results. Among other things, the scientists developed new methods to evaluate proteins responsible for multidrug resistance. They created a biobank, in which more than 12 thousand samples of genetic material from Polish donors are collected. The additional value of these studies is the development of a new method to ascertain sex and hair colour, which can be used e.g. in forensic science and archaeology. Moreover, genetic methods of identifying drug-resistant pathogenic yeasts have been developed.

And most importantly, the researchers managed to develop two tests that measure the protein activity levels of ABC transporters in a tissue sample. This might lay the foundations for the development of diagnostic tests. At present, the department is looking for a business partner, who would commercialise the invention and develop it into diagnostic tests applicable in medical practice. 'We have the theoretical foundations, we have validation procedures, we have patent protection for our technology. We can grant a licence to a company that would undertake to produce the tests,' says Prof. Bartosz.

The TESTOPLEK project brought several results.

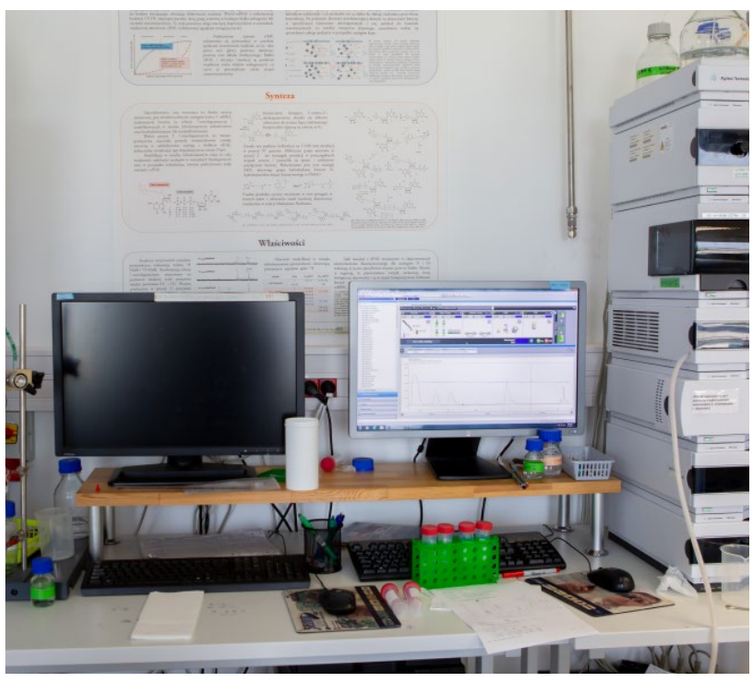
University of Łódź
Faculty of Biology and
Environmental Protection
biol.uni.lodz.pl/en

Centre of New Technologies University of Warsaw: A Partner of the Scientific Community

The Centre of New Technologies of the University of Warsaw (CeNT UW) is an interdisciplinary research institute, which focuses on investigation of phenomena related to biology, chemistry and physics.

12

THE SCIENTISTS at CeNT UW cooperate with a wide range of research centres both in Poland and abroad. They tackle fundamental scientific problems and carry out projects that benefit the society and the economy. Among other things, they are attempting to increase the stability of mRNA. If this is achieved, a new chapter can open in developing effective genetic vaccines to fight diseases such as malignant tumours. The solutions developed at the CeNT UW are currently at the stage of advanced clinical trials. Those results are also successfully implemented by the centre's spin-off company – Warsaw Genomics. It performs tests that indicate the risk of developing genetically determined cancers and facilitate their early detection and effective treatment. The tests are a part of the National Cancer Risk Assessment Program 'BadamyGeny.pl'.



CeNT UW strives to become an active partner of the scientific community in the areas of chemistry, biology, physics and IT.

Friendly Work Environment

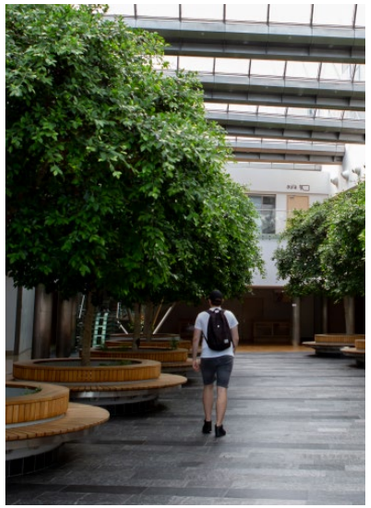
CeNT UW creates a friendly work environment for both junior and recognised scientists. Moreover, it promotes education and training of PhD students. The European Commission granted the University of Warsaw the right to use the 'HR Excellence in Research' logo in 2016. It certifies that university meets the requirements for institutions with regard to implementing the principles set out in the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers. These principles are also implemented at CeNT UW. Moreover, on account of its continuous development, CeNT UW keeps looking for ambitious staff members at various stages of their scientific careers.

World Class Infrastructure

At present, CeNT UW comprises more than thirty laboratories, where researchers tackle the key issues of modern science, such as lifestyle and neurodegenerative diseases, cancer vaccines, new energy sources and the application of quantum phenomena in optical technologies.

CeNT UW strives to become an active partner of the scientific community in the areas of chemistry, biology, physics and IT. In order to attain this goal, it continues to invest in infrastructure and adapt the existing one to the evolving needs of the CeNT UW staff.

'We follow the principle of open access to technologically advanced equipment to make it available to research teams not only at CeNT UW, but also at other units of the University of Warsaw as well as external academic centres at home and abroad. Part of our work is dedicated to research projects carried out in collaboration with business,' says Professor Ewa Bulska, Acting Director of CeNT UW.



International and Interdisciplinary Cooperation
The scope of research carried out at CeNT UW covers numerous projects that combine several fields of science. At the centre's core are two international research agenda units:
Centre for Quantum Optical Technologies (QOT), established in partnership with the University of Oxford; it aims to explore the practical utilisation of quantum phenomena such as superpositions and entanglement, in optically controlled system, with the long-term prospects of their practical utilisation.
Regenerative Mechanisms for Health (ReMedy), established in partnership with the Medical Centre of the University of Göttingen; the goal of ReMedy is to understand and harness stress-evoked adaptability of cells at the molecular and biochemical level in order to combat human diseases and pathologies.

University of Warsaw
Centre of New Technologies
cent.uw.edu.pl/en

Cancer Immunotherapy: A Story of How One Atom Has Been Substituted

At the Centre of New Technologies University of Warsaw, a group of scientists led by Professor Jacek Jemielity is working on the development of a vaccine to support the immune system in the fight against cancer.

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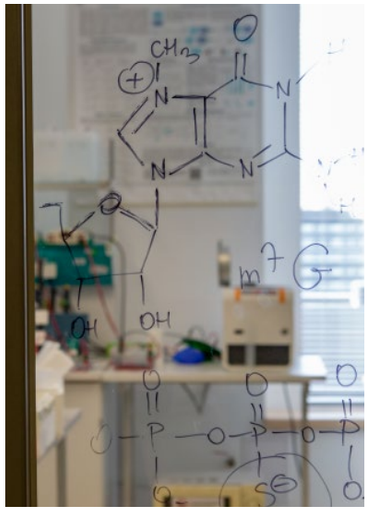

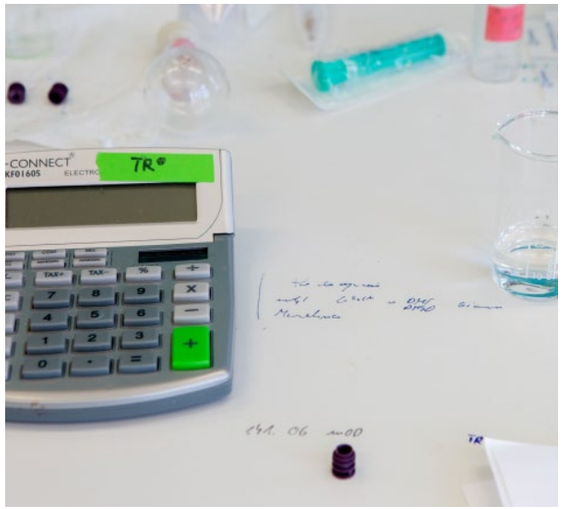

NEW CANCER CELLS are constantly being created in our body. Fortunately, they cannot survive for long. The defence mechanisms of our body are usually able to eliminate them before they start to multiply and cause the disease. However, sometimes, as a result of a combination of extremely unfavourable circumstances, the body's defence mechanisms do not react quickly and effectively enough, and a tumour develops. The cancer vaccine, which is being developed by the scientists, by analogy to traditional vaccines, is intended to stimulate the creation of immune system's special forces: T lymphocytes, called killer cells, which prevent the development of the disease.

'A lot of our research involves international cooperation. We make the vacancy notices available to the international research community. We are happy to recruit talented scientists, regardless of their nationality.'
– Prof. Jacek Jemielity

How does the so-called cancer vaccine work?
PROF. JACEK JEMIELITY: On the surface of cancer cells there are specific proteins, different than on the surface of normal cells. These proteins are called antigens. We supply the body with the genetic information of the antigen that is found on the surface of the patient's tumour. The same protein is produced by the cells in the patient's body, causing the immune response and the production of T cells engineered to destroy cancer cells. In contrast to preventive vaccination, this is not done before the disease occurs. Our vaccine is given to people who have already been diagnosed with cancer.

Isolated antigens are not administered as in the case of traditional vaccines, but the patient's organism is forced to produce them. How do you do that?

We use mRNA, meaning messenger RNA. It is crucial in the process of protein production. The proteins needed for the construction and functioning of the body's cells are encoded in the DNA found in cell nuclei. They are produced outside the nucleus, in cytoplasm. The blueprint for a protein is not supplied from the nucleus to the cytoplasm in the original form of DNA, but in the form of a copy – precisely the mRNA molecule. By modifying the mRNA and bringing it to the body, you can cause the desired protein to be produced. In the case of immunotherapy, modified mRNA is injected into the patient's lymph nodes, which is where T cells are trained.

Prof. Jacek Jemielity, Associate Professor and Group Leader of the Laboratory of Bioorganic Chemistry, Centre of New Technologies University of Warsaw, Poland.

What is your team's invention all about?
We have developed a reagent that can improve modified mRNA. It is more durable and easier to translate. This is a very subtle transformation because mRNA contains 1-2 thousand nucleotides, thus about 80 thousand atoms. In this structure, we substitute a single atom for a different one. The licence to develop our invention was purchased by a German company operating on the genetic immunotherapy market. Next, two global pharmaceutical companies purchased a sublicence from this company and initiated clinical trials of mRNA therapy. We are working on more inventions. Our goal is to make the production of our reagent more efficient. We are also working on improving the methods of administration of therapeutic mRNA.

What is needed for such vaccines to be mass-produced and to treat various cancers?
The entire scientific community and the companies investing in this field are waiting for the first mRNA-based therapy to be approved by an official regulatory authority in Europe or the USA. The market that will drive clinical trials will then open up.

What does your international cooperation look like?
A lot of our research involves international cooperation. We make the vacancy notices available to the international research community. We are happy to recruit talented scientists, regardless of their nationality.

University of Warsaw
Centre of New Technologies
Laboratory of Bioorganic Chemistry
cent.uw.edu.pl/en

Speeding up the Degradation of Plastic: Innovation with the Use of Nature

An innovative biopreparation made from fungi has been developed by research team led by Professor Grażyna Barbara Dąbrowska from the Chair of Genetics at the Faculty of Biology and Environmental Protection of the Nicolaus Copernicus University in Toruń. It can accelerate the decomposition of plastic waste even by 20 percent.

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Fungi used for plastic biodegradation (in Petri dishes) and the plastic fragments after fungi treatment in soil (above Petri dishes).

THE INVENTION is effective particularly in the case of waste made of polyethylene terephthalate (PET), which is used to manufacture beverage bottles and fibres for textile applications, such as the production of polar fleece. Used disposable packaging, including those made of PET, are among the most popular types of waste at landfill sites all over the world. In addition, plastic waste poses a threat to the environment, particularly the oceans and seas. Classic petrochemical polymers need from 500 to even 1000 years to biodegrade. The innovative preparation could reduce this time by an average of 15 percent, and even 20 percent in the case of PET. Moreover, it would accelerate the decomposition of biodegradable materials which are similar to classic plastics, but which degrade within a few months to several years.

'The biological preparation contains *Trichoderma*, a genus of saprophytic fungi. They are microorganisms naturally present in the environment. They can produce hydrolytic enzymes, which decompose polymers,' says Prof. Grażyna B. Dąbrowska.

Natural and Environmentally Friendly

The scientists have selected fungi which are additionally able to stick to the polymer surface thanks to the special proteins they generate. 'The secretion of these proteins by the fungi increases the enzymatic productivity and efficiency in degrading synthetic materials,' the researcher explains.

Moreover, the use of the preparation has a positive impact on the soil quality and improves the condition of plants. Using the preparation in the soil stimulates the development of other soil microorganisms and, thanks to the fungi's ability to produce numerous hydrolytic enzymes and phytohormones, makes the plants grow faster and develop more lateral roots, which enables them to better absorb nutrients.

Immunity and Strength

The method of obtaining the preparation has been patented. The scientists argue that it is cheap and safe in production, because the fungi used in the preparation occur commonly on the soil surface all over the world and their cultivation does not require any special conditions. They can be isolated from the surface of agricultural soil and from tree bark.

Classic petrochemical polymers need from 500 to even 1000 years to biodegrade. The innovative preparation could reduce this time by an average of 15 percent, and even 20 percent in the case of PET.

Researchers from the Nicolaus Copernicus University have studied microorganisms for a long time, trying to identify ones that could help deal with waste. A species is tested by cultivation on media containing harmful substances, such as salt, heavy metals or plastics. Alternatively, the culture has limited access to standard carbon sources.

'We noticed that these fungi's potential to grow is comparable to that in control conditions (where no harmful substances are present and the fungi have access to a standard carbon source),' says Prof. Grażyna B. Dąbrowska.

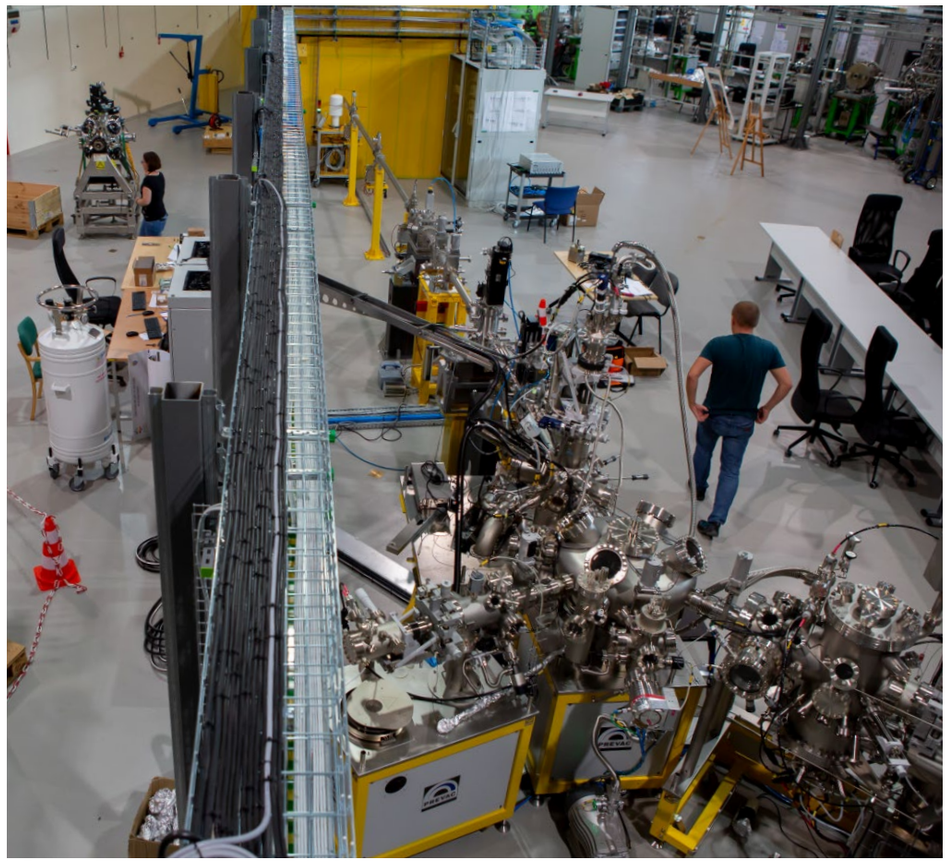
Easy to Use Granules

The scientists patented a mode of production of the preparation in the form of granules. The biological substance is contained in an ecological polymer made from marine algae. The granules have to be scattered over a given surface. Then, it suffices to water them or to wait for rain, and the substance becomes active.

The solution can be used e.g. by entrepreneurs dealing with recycling and reprocessing synthetic materials. In addition, it can be used, for example, at public landfill sites, or to reclaim illegal dumping grounds. For now, the preparation is manufactured exclusively in the laboratory in Toruń and is not used on a larger scale, but the researchers hope to find business partners interested in mass production soon.

Nicolaus Copernicus University in Toruń
Faculty of Biology and Environmental Protection
biol.umk.pl/en

SOLARIS Synchrotron: A Unique Device in Central and Eastern Europe



The SOLARIS synchrotron, a source of electromagnetic radiation of unique properties, ranked among the top devices of that type worldwide, is located at the SOLARIS National Synchrotron Radiation Centre at the Jagiellonian University in Kraków.

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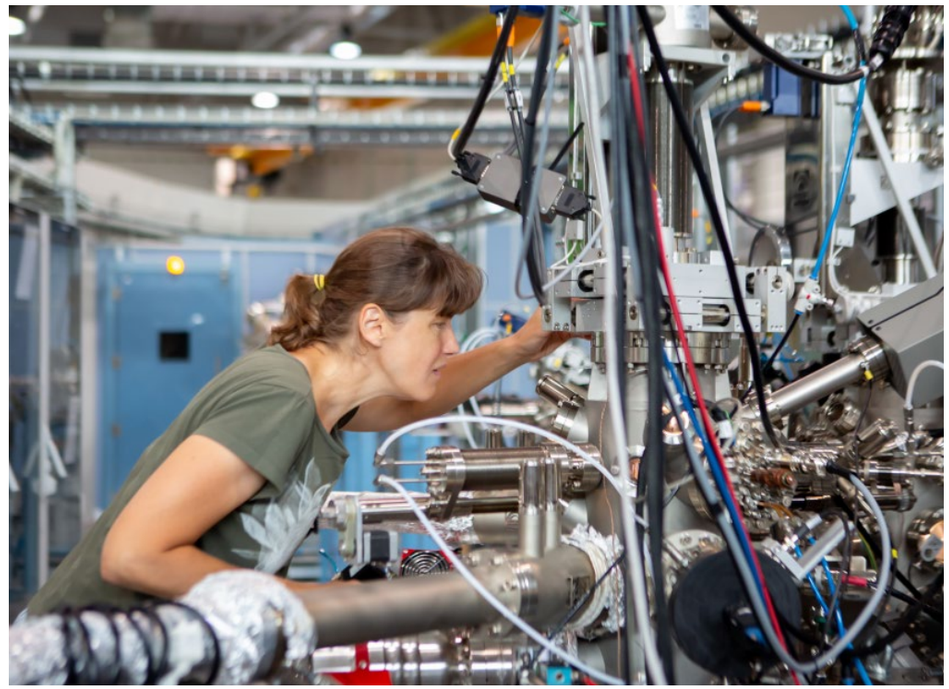
IT IS THE FIRST device of its kind used in multiple areas of research in Central and Eastern Europe. The synchrotron radiation in the SOLARIS Centre enables innovative research in areas ranging from biology, chemistry and physics through material engineering and nanotechnology to medicine and pharmacology. Synchrotron radiation (also called synchrotron light) is produced inside the synchrotron, which is connected to beamlines with end stations. Thanks to the synchrotron, researchers can learn both the chemical composition and the structure of the examined substance, because the synchrotron light can penetrate the examined matter.



World-class Infrastructure
The goal is to put more than a dozen beamlines into operation round the clock. At present, researchers have at their disposal: a photoemission electron microscope (PEEM), a universal X-ray absorption spectroscopy end station (XAS) and an UARPES end station for conducting studies using the technique of angle-resolved photoemission spectroscopy (ARPES). The PEEM/XAS beamline can be used in research areas such as surface chemistry of materials or geology. The ARPES technique is applied, among other things, in studying new electronic materials and nanostructures.

The centre's newest device is the state-of-the-art electron cryomicroscope Titan Krio G3i.

SOLARIS Opened for Researchers Around the World

New beamlines will be in operation at the SOLARIS Centre in 2020. Six of them are currently being designed or built. The centre's newest device is the state-of-the-art electron cryomicroscope Titan Krio G3i, which will allow scientists to do research in the area of structural biology.

Beam time at the centre's end stations can be applied for by all interested scientists from Poland and abroad. The use of the SOLARIS infrastructure is free of charge to researchers around the world. Calls for proposals are issued twice a year: in spring and in autumn.

Jagiellonian University
SOLARIS National Synchrotron Radiation Centre
synchrotron.uj.edu.pl/en_GB

Luminescent Chemical Sensors as a Source of Information

Chemical compounds with unique properties involving reaction to light and groundbreaking application in the motor, printing and aviation industries as well as molecular biology have been invented at Cracow University of Technology.

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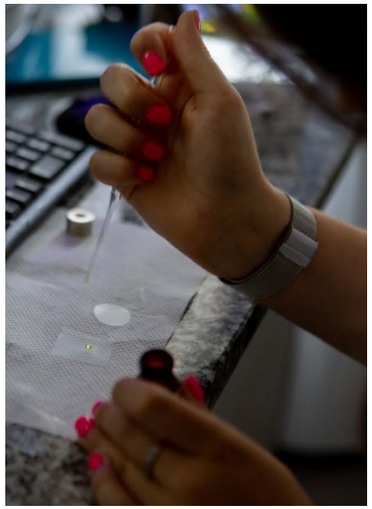
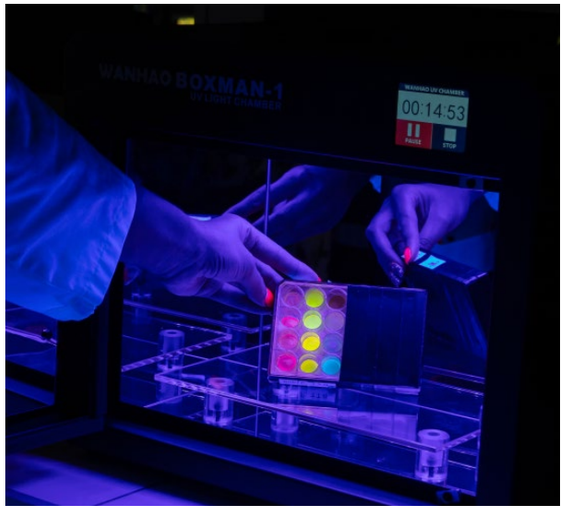




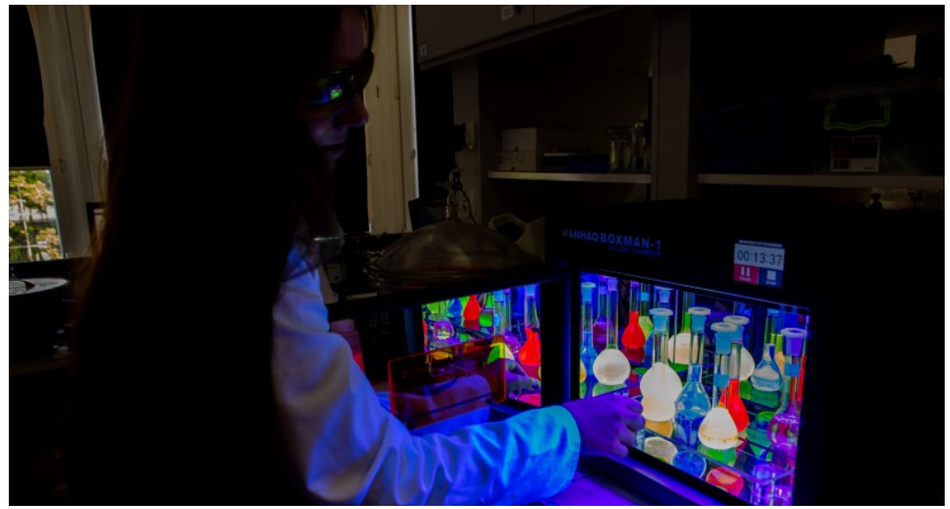
Chemical molecular sensors from light-emitting rare earth elements.

‘CHEMICAL MOLECULAR sensors are entirely new compounds of rare earth metals. They have been developed to monitor the processes of photopolymerisation and kinetic changes in polymeric layers,’ explains Dr. Joanna Ortyl from the Laboratory of Photochemistry and Optical Spectroscopy of the Cracow University of Technology.

The invention made by the researcher can be used in the automotive, furniture and printing industries, in manufacturing packagings for the food sector and in applications where materials are subject to photocuring, that is hardened through exposure to light. The luminescent organo-inorganic molecular sensors invented by Dr. Ortyl enable measuring the properties of varnishes, glues, paints and other substances that harden upon exposure to light without any mechanical interventions in the material. In addition, the measurements may be taken at the moment of curing, that is on-line and in-situ. For example, Dr. Ortyl’s method allows to measure the thickness of the coating of paint put on the car body and find out how long it takes to dry.

Luminous Compounds of Rare Earth Metals

Dr. Ortyl’s sensors were developed on the basis of compounds of europium, terbium and samarium, whose analogs are used, for example, to produce diodes – LED-type light sources. ‘The chemical sensors made from them are luminescent in the visible region of the light spectrum. Depending on the type used, it is possible to obtain a sensor that is red,



orange, green, up to the range close to the near-infrared region NIR,’ says Dr. Ortyl.

Molecular sensors are chemical compounds in the form of colourless powders or possibly liquids. Added to the cured composite in trace amounts, they can give information on the progress of chemical reactions in the material. In the course of photopolymerisation, they absorb light and then emit electromagnetic radiation of a specific colour, which in turn carries information about the processes in the material. Chemical sensors do not affect the properties of the polymeric composites and the resulting polymer coatings. Dr. Ortyl’s invention has been patented.

In her study of the new compounds, the scientist used the unique method developed in the Laboratory of Photochemistry of the Cracow University of Technology – the Fluorescence Probe Technology (FTP). ‘This method of monitoring the course of photopolymerisation allows to optimise the parameters of the process and control the quality of the products,’ says Dr. Ortyl.

Pressure and Heat Sensors

Together with her research team, Dr. Ortyl continues studies on the use of sensors from rare earth metals. She is testing sensors that could be applied to measure pressure changes. These sensors are expected to be cheaper than the currently used compounds based on platinum, which is relatively expensive when used for such purposes. The

Sensors were developed on the basis of compounds of europium, terbium and samarium, whose analogs are used, for example, to produce diodes – LED-type light sources.

Dr. Joanna Ortyl, the project leader.

pressure sensors developed by Dr. Ortyl's team are sensitive to pressure fluctuations and not only to changes in oxygen concentration, as in the case of the current pressure sensors. Thanks to their unique properties, the new sensors will be able to measure changes caused not only by the pressure of air, but also by liquids (e.g. water in the course of immersion, on the surface of ships) or solids. Moreover, the researcher is working on temperature sensors applied in the form of polymer coatings.

The luminescent organo-inorganic molecular sensors invented by Dr. Joanna Ortyl enable measuring the properties of varnishes, glues, paints and other substances that harden upon exposure to light without any mechanical interventions in the material.

Medal-winning Photosensitisers

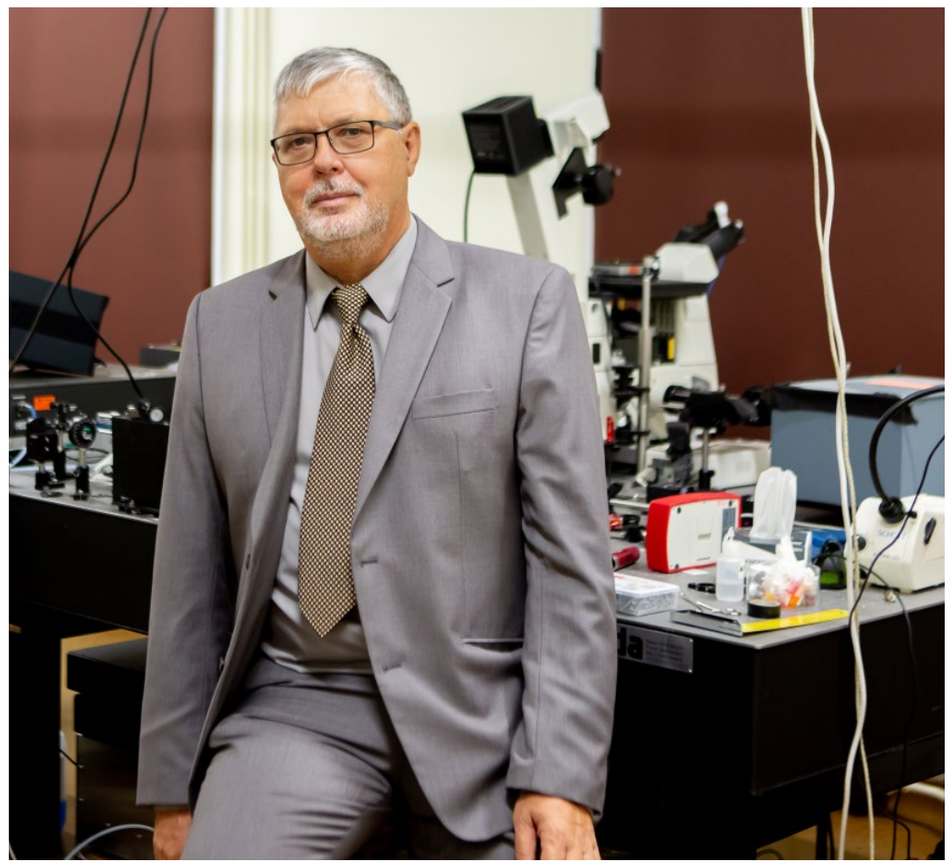
In addition, Dr. Ortyl carries out research on photopolymerisation. Her team's invention 'New photoinitiating systems for processes of cationic, free-radical and hybrid photopolymerisation under UV and visible light' was awarded the golden medal at the Silicon Valley International Invention Festival – SVIIF in the United States in 2018. The invention are new photosensitisers that absorb the energy of light radiation and transfer it to substances that take part in photochemical reactions, which accelerates surface hardening.

Cracow University of Technology
Faculty of Chemical Engineering and Technology
Laboratory of Photochemistry and Optical Spectroscopy
pk.edu.pl/en

The project 'Organic and inorganic luminescent probe as a tool to monitor and control processes photopolymerization on-line and off-line in the production of polymer coatings' was supported by the National Centre for Research and Developments within the project LIDER.

Contract No. LIDER/014/471/L-4/12/NCBR/2013, 2013.

Discovering New Applications of Lasers



Professor Marek Samoć at Wrocław University of Science and Technology is testing how high power lasers can be used at the interface of biology, chemistry and physics to tackle important social problems.

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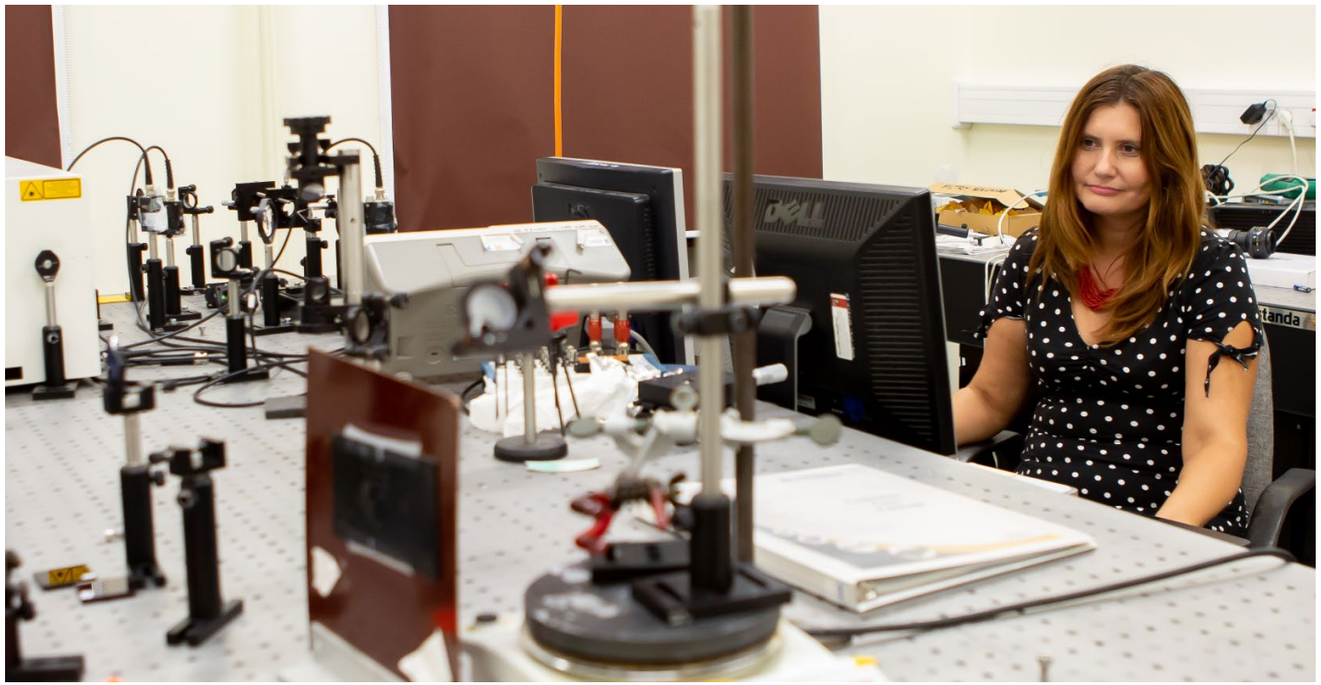
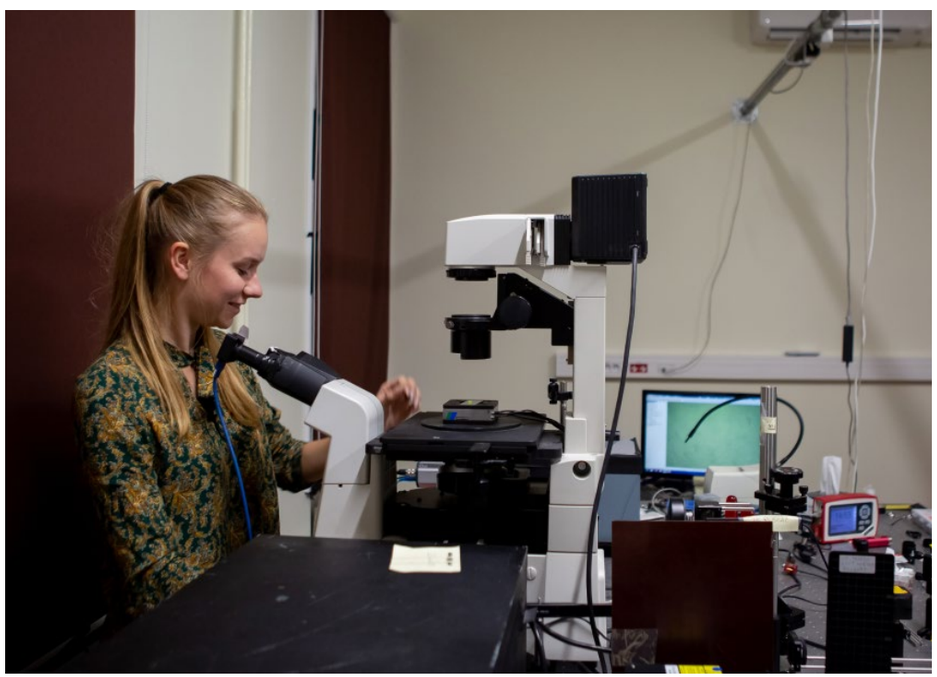
IF ONE TRIED to describe Professor Marek Samoć's research interests with one word, that word would be 'lasers'. Professor Samoć carried out research in Canada and in the United States. He worked at the Laser Physics Centre of the Australian National University in Canberra for 17 years. He decided to return to Poland in 2008. He is currently head of the Advanced Materials Engineering and Modelling Group at Wrocław University of Science and Technology.

The team you are in charge of has become one of the key research centres studying nonlinear optics in the world. What projects do you carry out?
PROF. MAREK SAMOĆ: We work on interdisciplinary projects which require expertise in physics, chemistry, biology and electronic engineering. I always say that gaps in one's knowledge can be filled, but success also requires enthusiasm and broad horizons. Nowhere have I had students as fantastic as here in Poland.

'New directions in the study of nonlinear optical phenomena and their physicochemical consequences'. This is the title of your most recent research project. What does this rather hermetic name mean?
The title is indeed hard to understand for anyone other than an expert in the field. I specialize in the applications of high power lasers. High power does not mean that the laser needs to have the dimensions of a huge wardrobe. These are rather lasers which emit light in the form of pulses. The pulses commonly last around 10-13 seconds. By way of comparison, light travels the distance of 300 thousand km in one second. During one pulse, it can only travel 30 microns. Due to its extreme brevity,

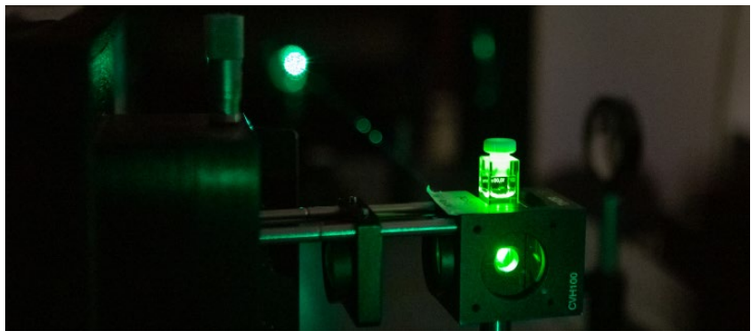




the pulse is also very intense. The light emitted by such lasers sometimes has a surprisingly strange effect on matter. And these effects are what we call nonlinear optical properties.

What does it mean that is has a strange effect?
For example, matter, which is normally transparent, becomes opaque or begins to glow when exposed to such short pulses. These are examples of nonlinear optical properties.

Usually, we use a laser that operates in the near-infrared spectral range, that is something we cannot see any more. But if we focus the beam, e.g. with the use of a microscope, on a biological sample, this sample can glow green, red, blue or in other visible colours. The glowing can provide us with a great deal of information, e.g. whether the sample contains pathogens or indicators of the onset of a disease. We proved several years ago that the so-called amyloids, that is protein forms that occur in humans in Alzheimer's disease, react to laser pulses much more strongly than the native forms of these proteins. This phenomenon can be used to detect and monitor amyloids.



Has the project brought any interesting results yet?
Yes, for instance we have demonstrated that coordination polymers can be used as an optical thermometer and remotely measure the temperature of living tissue with micrometer resolution. This is of crucial importance from the perspective of cancer treatments where the tumour is destroyed by its gradual heating by several degrees. This procedure has to be carried out with immense precision.

In addition, we are working on drug carriers with several functionalities: e.g. they kill cancer cells and at the same time glow, thus showing the physician where the tumour is located in the body.

Will it ever be possible to apply the results of your studies in practice?
That is our goal. We would like these fantastic tools – lasers – to be used to solve vital social problems, e.g. to diagnose neurodegenerative diseases at an early stage or improve cancer treatment methods.

'The gaps in one's knowledge can be filled, but success also requires enthusiasm and broad horizons. Nowhere have I had students as fantastic as here in Poland.'
– Prof. Marek Samoć

Wrocław University of Technology
Advanced Materials Engineering and Modelling Group
kimmz.webcloud.pwr.edu.pl

The project funded by the National Science Centre in Poland under agreement no. DEC-2013/10/A/ST4/00114

COALBYPRO: Carbon Dioxide Captured in a Mineral

Minerals synthesised from fly ash to adsorb carbon dioxide. This is the goal of the Central Mining Institute in Katowice and an international team of scientists.

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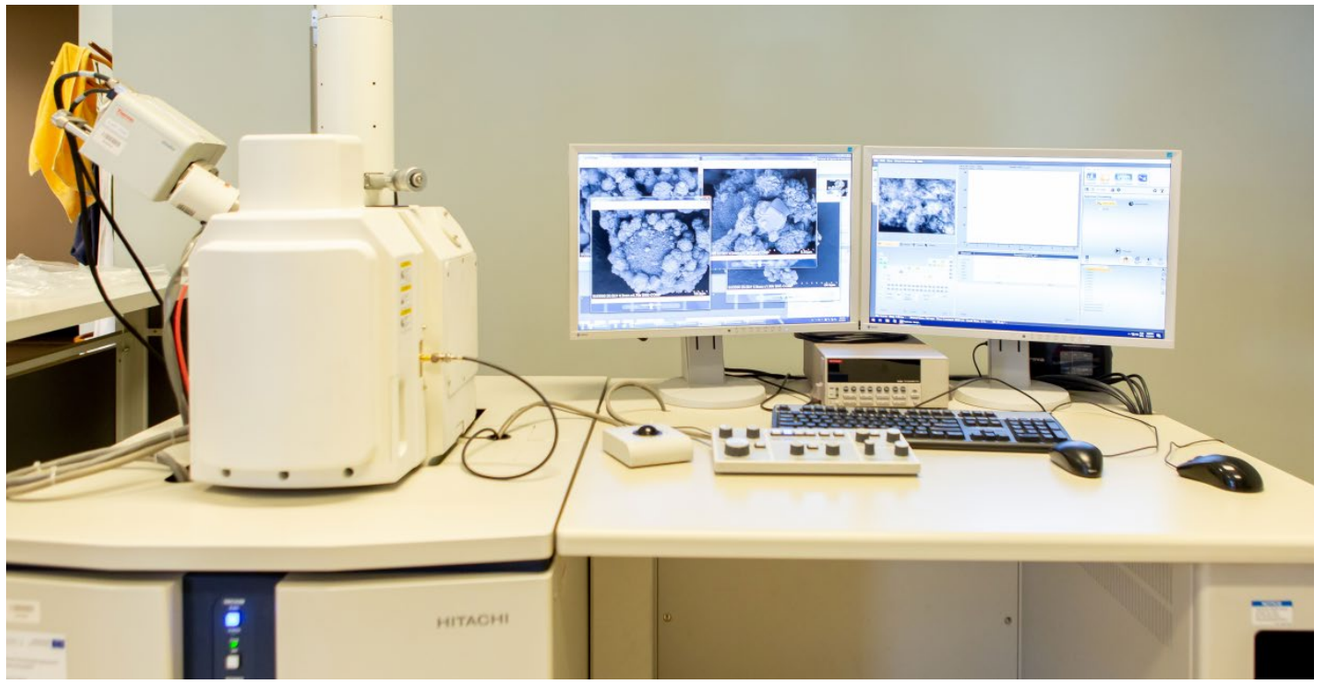


Studies of zeolites' CO2 sorption have been carried out on a laboratory scale. Tests on a semi-technical scale on the PSEA installation located in Czechia are supposed to confirm the effectiveness of the invention.

THE OBJECTIVE of the project 'COALBYPRO: Innovative management of COAL BY-PROducts leading also to CO2 emissions reduction' is to develop methods of using fly ashes – by-products of coal combustion – to synthesise zeolites (minerals that can capture CO2). The project is funded under the EU's Research Fund for Coal and Steel. It is carried out by an international research consortium led by the Centre for Research and Technology Hellas (CERTH) from Greece. Other participants of the project are representatives of three research centres in Czechia and one in Germany.

Zeolites are a unique group of minerals also called 'molecular sieves': their structure forms a network of very fine empty cavities. Thanks to them, zeolites can capture various substances just as a sponge absorbs water.

Zeolites are a unique group of minerals also called 'molecular sieves'.

Depending on the diameter of the pores, zeolites adsorb greater or smaller volumes of various particles. Carbon dioxide is captured in the pores more easily than many other gases, with the best effects achieved in the case of zeolites X. This type of the mineral does not occur naturally, but it can be synthesised. As a result, zeolites X can be designed optimally so that they adsorb as much CO2 as possible.

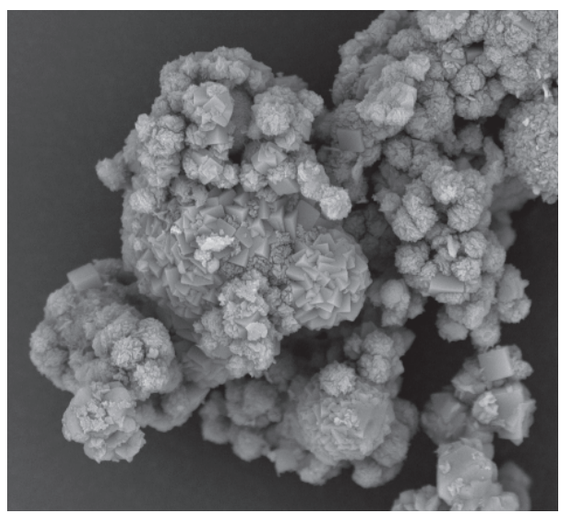
Exhaust Gases Purified with Fly Ash

The researchers' idea consists in capturing CO2 in fly ashes and in fly ash-derived zeolites. The benefit is twofold, because the procedure allows to capture the unwanted gas and make use of industrial waste at the same time. 'The most frequently applied method of zeolite synthesis from coal fly ash is hydrothermal treatment. In the case of fly ashes from the combustion of hard coal, the scientists applied hydrothermal synthesis, and in the case of lignite, the ashes were subjected to sintering with sodium hydroxide prior to hydrothermal synthesis. Optimising the parameters (temperature, time) of the process of zeolite (sorbent) synthesis from fly ashes enabled us to reduce the costs of their production,' explains Prof. Barbara Białecka from the Central Mining Institute, one of the project participants. In addition, the scientists have developed a method to reuse some of the substances needed to create the sorbent several times.

One Step Away from Entering the Market

The researchers have synthesised various types of zeolites from fly ash, including zeolites X. They are developing the principles of a technology of CO2 sorption on an industrial scale. The relevant patent application is pending. Until now, studies of zeolites' CO2 sorption have been carried out on a laboratory scale. Tests on a semi-technical scale on the PSEA installation located in Czechia are supposed to confirm the effectiveness of the invention. The knowledge on the application of zeolites as gas (including CO2) sorbents is not very common. That is why one of the project's objectives is to promote its results in order to attract the interest of potential industrial partners. Apart from zeolites X, the scientists have obtained new structures similar to zeolites, which may be used in radioactive waste treatment and in the construction industry.

The Central Mining Institute
gig.eu/en



Zeolites' structure forms a network of very fine empty cavities.

ENVIROTEX: Fabrics That Can Protect Humans

Textiles that protect against harmful environmental factors have been invented in Łódź by the team led by Professor Jadwiga Sójka-Ledakowicz. They can be used to produce almost anything, from shielding around transmitter stations to protective gloves for the staff at security printing works.

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SUNLIGHT CAN cause cancer. Electromagnetic field can upset the endocrine system. And one spark in a mine can cause an explosion. The Textile Research Institute, a member of the Łukasiewicz Research Network, in collaboration with five other Polish universities and research centres, has invented specialist textiles which protect humans from electromagnetic fields, UV radiation or static electricity.

Three groups of fabrics have been developed in the project 'New generation barrier materials protecting man against harmful impacts of the environment' – Envirotex.

Innovative Barrier Textiles

The first group protects from electromagnetic fields (EMFs). 'We all know what the Faraday cage is. Our fabrics can easily replace it. They even have a broader application, because they attenuate the electromagnetic field in the frequency range from several dozen MHz to more than 2 GHz. Their attenuation exceeds 30 dB,' explains Prof. Jadwiga Sójka-Ledakowicz, the project coordinator.
In order to obtain textiles with such properties, the scientists applied the technique of magnetron sputtering – for the first time ever in textile research – in order to deposit thin metal coatings onto fabrics. The project team designed and manufactured a special device for that purpose.

Clothing and products made of the new textiles have been tested, for example, in museums and archives, but also by civil engineers, farmers and lifeguards working on the beach.

'It was a great scientific challenge to choose the right metal oxides and their alloys so that we could deposit an extremely thin layer onto polypropylene nonwoven and cause the material to acquire electroconductive properties,' says Prof. Sójka-Ledakowicz.

The new textiles have a wide range of applications, e.g. in hospitals – as screens protecting persons who operate diagnostic equipment, in banks – as facing protecting server rooms from data leakage, or as shielding around transmitter stations.

Gloves, Roller Blinds, Screens

The second group are fabrics that protect from ultraviolet radiation in the ranges: UVA, UVB and UVC. The researchers have managed to develop two types of absorbers. The organic, triazine-based ones penetrate the structure of the fabric and absorb radiation. The inorganic ones based on micronised metal oxide particles are deposited on the textile in the form of a paste or dispersion; they reflect radiation. As a result, two types of protective materials with UPF > 40 have been developed, of which one can be used in the production of clothing elements and the other – in technical products such as roller blinds, screens, garden furniture etc.

Clothing and products made of the new textiles have been tested, for example, in museums and archives, but also by civil engineers, farmers and lifeguards working on the beach. 'Staff at the security printing works who examine documents with

UVC-emitting lamps have tested the gloves', says the project coordinator.

The last group of fabrics protects against static electricity. This is the above mentioned example with the sparkover. The researchers have developed a technology to manufacture an electroconductive thread that can be used in the clothing of people working in areas at risk from static electricity. They have also developed conductive tapes for protective apparel.

Protected IP

The innovative solutions developed in the Envirotex project have obtained 17 patents, including international ones. Moreover, they have gained the interest of the industry. 'We have signed licence agreements, know-how agreements and letters of intent. I trust that products using our fabrics will soon become available on the market,' says Prof. Sójka-Ledakowicz.

Łukasiewicz Research Network – Textiles Research Institute
iw.lodz.pl/en/home

Artificial Blood from the Warsaw University of Technology

Shelves in the refrigerator at the Laboratory of Biomedical Engineering are stacked with bottles of artificial blood. The milky liquid does not look like human blood. Yet it is expected to take over some of its functions.

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Prof. Tomasz Ciach at the Laboratory of Biomedical Engineering.

CREATING A HUMAN BLOOD substitute is a task that has been undertaken by scientists from various laboratories, including labs in the US or the UK. The research team from the Faculty of Chemical and Process Engineering at the Warsaw University of Technology led by Professor Tomasz Ciach has developed red blood cell substitute which can carry oxygen and may be used for transfusions and preserving human organs for transplantation.

Blood Made of Polysaccharides

The artificial blood has exceptional properties. It can be stored for many years, is free of antigens, viruses and bacteria, and can be transfused to anyone, because it is compatible with all blood groups.

'We hear of the search for the right blood group for the purposes of surgery, or of summer blood bank shortfalls, when more accidents happen and the demand for blood grows. At the same time, a blood transfusion means the risk of transmitting a disease, even one that contemporary medicine may not even be aware of. Then there are cases where the patient objects to blood transfusion on account of their religion. The synthetic substitute solves all these problems,' says Prof. Tomasz Ciach.

Artificial blood from the Warsaw Laboratory of Biomedical Engineering was obtained from polysaccharides and perfluorochemicals in the process of chemical synthesis. Just like human blood, it is able to transport oxygen. When it enters the bloodstream and reaches the lungs, it binds to oxygen and transports it to the tissues. Moreover, the substitute transports carbon dioxide from the tissues to the lungs.

Ready for Commercialisation

The team is currently testing transfusing the blood substitute on laboratory animals and examining to what extent it saturates their organs with oxygen. According to Prof. Tomasz Ciach, the results are promising. The next stage will be clinical trials; the researchers are looking for an investor.

The team has also developed prototype equipment for preserving organs for transplantation in artificial blood. 'At this point, a kidney, a liver or a heart are stored in ice. They have to be transplanted within several hours, because they are slowly dying. Organs preserved in blood substitute could be stored at a temperature similar to body temperature for several weeks,' Prof. Tomasz Ciach explains.

In order to introduce artificial blood and the equipment for preserving organs onto the market and into hospitals, the company NanoSanguis, a spin-off of the Warsaw University of Technology, its co-owner, has been founded. NanoSanguis carries out research and obtains funding to commercialise the inventions.

The team has also developed prototype equipment for preserving organs for transplantation in artificial blood.

From the Lab to the Operating Room

Prof. Ciach's laboratory is the venue of ever new solutions to medical and pharmaceutical problems. The scientists carry out projects with partners from countries including Germany, the UK, Austria, Japan, the Netherlands and South Africa.

'Our objective in every project is to find a solution that would be applicable in medicine,' emphasises Prof. Tomasz Ciach.

A German hospital is currently testing vascular grafts. They are made of polyurethane nanofibres, whose surface has been modified so that it prevents a coagulation cascade while supporting adhesion and development of endothelial cells, which naturally line the human circulatory system. Several inventions have already been brought to the international medical market: the technology of coating coronary stents with a polymer that releases drugs and the technology of urological catheter coatings that relieve pain and prevent infections. Next in line is the technology of producing hydroxyapatite nanoparticles for bone implants.

Artificial blood can be stored for many years.

Warsaw University of Technology
Faculty of Chemical and Process Engineering
of the Warsaw University of Technology
biomedlab.pw.edu.pl/home

Medical and health sciences

Expert Help for Patients with Rare Diseases

European Reference Networks are based on the idea of joining forces across borders to improve the clinical care of persons with rare diseases. For patients, it means a professional and faster diagnosis. For doctors – an opportunity to acquire knowledge and refine treatment modalities.

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ONE OF the most serious problems experienced by people suffering from rare diseases is to receive a diagnosis. ‘A disease is considered to be rare if it affects fewer than one person in 2000. We cannot expect a general practitioner or even a specialist at a hospital to know the symptoms of such diseases considering that statistically, they have a chance to encounter a patient of that type once every 15–20 years. That said, the sooner the patient is diagnosed, the more effective the treatment is,’ explains Professor Piotr Milkiewicz, member of the board of the European Reference Network ERN RARE-LIVER, whose objective it is to help patients with rare hepatological diseases.

Platform for Conducting Research

The Liver and Internal Medicine Unit of the Medical University of Warsaw led by Prof. Milkiewicz is one of 28 centres in Europe that are members of ERN RARE-LIVER. Other full members are units located in Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the UK. Moreover, the network has four affiliated partners and thirteen collaborative partners.

‘The patients who are referred to us fairly often have atypical clinical symptoms and abnormal liver blood tests or imaging studies that could be challenging to interpret. It is definitely an advantage for patients, who can count on specialist diagnostics and the possibility to consult the best experts in Europe, because the cooperation within the network entails the possibility of consultations online,’ Prof. Milkiewicz says. ‘We can share test results and ask colleagues from other centres for their opinion, e.g. when interpreting the results of a liver biopsy, which is sometimes a very difficult task.

In addition, the network constitutes a huge platform for research. While one unit can present its experience with a couple of dozen patients, together we can analyse and publish results of, for example, one thousand patients,’ Prof. Milkiewicz explains.

Dr. Marcin Krawczyk, a hepatologist from Saarland University Medical Center in Homburg, Germany, emphasises that today it is difficult to

The Liver and Internal Medicine Unit of the Medical University of Warsaw led by Prof. Milkiewicz is one of 28 centres in Europe that are members of ERN RARE-LIVER.

carry out research without cooperating with other institutions, including foreign ones. The pace of scientific progress forces research units to specialise. Cooperation enables scientists to make use of the greatest strengths of each research project participant. ‘I work in Poland and in Germany. When Prof. Milkiewicz and I were writing a publication on rare chronic liver disease, in this case primary sclerosing cholangitis (PSC), we analysed the molecular and biochemical aspects in Germany, while the diagnostic and therapeutic evaluations were carried out in Poland,’ says Dr. Krawczyk.

Scientific Project to Improve the Quality of Patients’ Lives

In addition, various research projects are carried out at ERN RARE-LIVER in collaboration with patient organisations. Their objective is to improve the quality of life of patients suffering from rare diseases. The concept is to alleviate the bothersome and sometimes devastating symptoms of the diseases themselves, but also side effects of the treatment. One example could be therapy with steroid drugs, which is used to treat autoimmune hepatitis. The drug eliminates the symptoms of the

Prof. Piotr Milkiewicz (from the right) Dr. Marcin Krawczyk (in the middle).

disease, but also alters the patients' appearance. It may, for example, cause uneven deposits of fat tissue , e.g. on the back of the neck and on the face, producing the effect of the so-called moon face. 'Autoimmune hepatitis often affects young women. Problems with their appearance quite often cause depression. Patients with depression, in turn, cease to take medication, and so we have a vicious circle,' Prof. Milkiewicz explains.

There are 24 reference networks in total in the European Union, each specialising in diagnosing a different group of diseases. They include 900 specialist health care units from more than 300 hospitals in 26 EU member states.

Medical University of Warsaw
Liver and Internal Medicine Unit
hepatologia.org/en

Essay
The Polish School of Transplantology

Professor Marek Krawczyk

THE ACHIEVEMENTS of Polish doctors and scientists in the area of transplantation medicine have allowed to implement numerous programmes of vascularised organ and bone marrow transplantations, which have saved the lives of thousands of patients.

The first work towards a renal transplantation was carried out at the Centre of Experimental Surgery of the Polish Academy of Sciences under the supervision of Professor Jan Nielubowicz, Professor Tadeusz Orłowski in Warsaw and Professor Wiktor Bross in Wrocław. It was their teams that, only twelve years after the first kidney transplantation in the US, performed successful transplantations in Warsaw and in Wrocław. It was a clear achievement of the clinicians and researchers behind the Iron Curtain.

In December 1967, the news spread around the world that the first heart transplant had been performed by Christiaan Barnard. Poland developed a heart transplantation programme as well, following a successful transplant performed by a team of cardiovascular surgeons led by Professor Zbigniew Religa in 1985 in the Cardiosurgical Department (in Zabrze) of the Silesian Medical University. The centre – now headed by Professor Marian Zembala – still boasts world class achievements. Encouraged by Prof. Religa's success, further institutions joined the programme, including the Cardiosurgical Department of the then Medical University in Kraków headed by Professor Antoni Dziatkowiak.

1966

26 January 1966 – first deceased-donor kidney transplant, Prof. Jan Nielubowicz and Prof. Tadeusz Orłowski and their teams, Medical University of Warsaw

1966

31 March 1966 – first living-donor kidney transplant, Prof. Wiktor Bross and his team, Wroclaw Medical University

1984

first bone marrow transplant, Prof. Wiesław Jędrzejczak and his team, Military Institute of Medicine (current name)

1984

first kidney transplant in a child, Dr. Wojciech Kamiński and Prof. Piotr Kaliciński and their team, Children's Memorial Health Institute in Warsaw

A vital stage in the development of transplantation medicine in Poland was to determine the diagnostic criteria of brain death, which was accomplished in the 1980s by teams of experts in anaesthesiology and intensive care medicine, neurosurgery and forensic medicine. This step facilitated the harvesting of organs from deceased donors.

Parallel to the programme of organ transplantation in adults, Poland developed a programme of paediatric transplantation, particularly transplantation of kidney and liver, led by Professor Piotr Kaliciński and including transplants of segments of the liver from living donors.

The progress of transplantology in Poland opened the possibility to initiate programmes of complex transplantations, including limb and face transplants. The development of clinical programmes was accompanied by new research projects run by Polish doctors and scientists, who thus contributed to the progress of world transplantology. The studies began in the 1960s, when Prof. Jan Nielubowicz's team developed its own antilymphocyte sera. In the late 1960s and early 1970s, a team led by Professor Wojciech Rowiński invented a new solution for storing kidneys and demonstrated the protective effects of lidocaine and dopamine in the case of an ischaemia-reperfusion injury to an organ. In the course of preparing a liver transplantation programme, another research team, headed by Professor Waldemar Olszewski, developed a model of pathogenesis of hyperacute transplant rejection.

'The development of clinical programmes was accompanied by new research projects run by Polish doctors and scientists.' – Prof. Marek Krawczyk

1985
first heart transplant, Prof. Zbigniew Religa and his team, Silesian Center for Heart Diseases in Zabrze (current name)

1988
first simultaneous pancreas and kidney transplant, Prof. Jacek Schmidt and his team, Medical University of Warsaw

1990
first liver transplant in a child, Prof. Piotr Kaliciński and his team, Children's Memorial Health Institute in Warsaw

1990
first parathyroid cells allotransplant, Prof. Tadeusz Tołłoczko and his team, Medical University of Warsaw

1996
first lung lobe transplant, Prof. Tomasz Grodzki and his team, Pomeranian Medical University in Szczecin (current name)

1997
first single-lung transplant, Prof. Marian Zembala and his team, Silesian Center for Heart Diseases in Zabrze (current name)

1999
first living-donor liver transplant, Prof. Marek Krawczyk and his team, Medical University of Warsaw, and Prof. Piotr Kaliciński and his team, Children's Memorial Health Institute in Warsaw

2006
first upper limb transplant, Prof. Jerzy Jabłecki and his team, St. Hedwig of Silesia Hospital in Trzebnica

In the 1990s, Prof. Zbigniew Religa's team developed a heart support system for patients suffering from a cardiac failure. In addition, a number of Polish transplantologists' achievements have been based on analyses of the results of the previously performed transplantations. In the years 2014–2016, Professor Michał Grąt with a team of surgeons at the Department of General, Transplant and Liver Surgery headed by myself developed and implemented, in clinical practice, new criteria for qualifying patients suffering from hepatocellular carcinoma for liver transplantation, thus increasing the number of patients who could benefit from this method of radical treatment.

Hopes for Polish transplantology are high also on account of the advanced preparations made by Professor Waldemar Patkowski from the Department of General, Transplant and Liver Surgery of the Medical University of Warsaw. Prof. Patkowski's goal is to introduce a device for perfusion of a deceased-donor liver, which will notably increase the number of livers used for transplants.

The great achievements of the pioneers of Polish transplantology listed on the time axis were the foundation stones of the Polish school of transplantology, which consists of dynamically developing transplantation centres known all around the globe.

Prof. Marek Krawczyk, Chairman of Science Committee of the Conference of Rectors of Academic Schools in Poland, Member of Polish Academy of Sciences, Corresponding Member of Polish Academy of Arts and Sciences, Rector of the Medical University of Warsaw (2008-2016), Head of the Department of General, Transplant and Liver Surgery MUW (1998-2016), President of European Surgical Association (2016-2017)

2008

first transplantation of the islets of Langerhans, Prof. Andrzej Chmura and his team, Medical University of Warsaw

2013

first face transplant, Prof. Adam Maciejewski and his team, Maria Sklodowska-Curie Institute – Oncology Centre, branch in Gliwice

2019

first simultaneous heart and liver transplant, Prof. Mariusz Kuśmierczyk and his team, Institute of Cardiology in Warsaw and Prof. Krzysztof Zieniewicz and his team, Medical University of Warsaw

2019

first simultaneous lung and liver transplant, Prof. Marian Zembala and his team, Silesian Centre for Heart Diseases, Zabrze and Ass. Prof. Robert Król and his team, Medical University of Silesia in Katowice

Skarżyński's Method of Partial Deafness Treatment: The Polish School of Otosurgery in World Science

Partial Deafness Treatment (PDT) is a programme developed by Professor Henryk Skarżyński and dedicated to patients who cannot hear middle and high-frequency sounds, or most of whose hair cells have been damaged, which hampers their communication with the environment.

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WHILE EFFECTIVE COMMUNICATION provides a basis for the development of modern communities, the percentage of persons with a hearing disability is growing, particularly in ageing societies. Skarżyński's method of Partial Deafness Treatment gives millions of such people a chance to fully regain their hearing and live a normal life. That is why this method may be listed among the achievements of contemporary science and medicine.

The phenomenon of PDT consists in supporting the patient's residual acoustic hearing with the so-called electric hearing, which is developed thanks to inserting a cochlear implant following a six-step procedure proposed by Skarżyński. The surgery involves implantation of the device under the scalp and an atraumatic insertion of the cochlear implant's electrodes into the deaf part of the cochlea while preserving the properly functioning areas of the inner ear (cochlea). Fixed behind the patient's ear, the external part of the system (the speech processor) transforms the sound into electric microstimuli, which are then transmitted through the skin to the implanted electrode. Next, they stimulate the endings of the auditory nerve and are transmitted to the cerebral cortex, where they are received as an understandable hearing sensation.

Regaining Hearing and Communication with Others

Combining the patient's own residual hearing with electric hearing produces extraordinary results. After the treatment, patients who could understand less than twenty percent of acoustic information achieve a level of hearing that allows them to easily communicate with others, talk on the phone, enjoy listening to music and even develop their artistic passions such as playing various instruments or singing and composing music. Some are even as good as professional musicians, which is demonstrated, for example, during the International Music Festival for Children, Youths, and Adults with Hearing Disorders 'Beats Of Cochlea' – an event which has been held annually for five years now on Prof. Skarżyński' s initiative.

During the 49th workshop at the World Hearing Center, Prof. Skarżyński performed more than one thousand demonstration surgeries.

Thousands of Surgeries

Professor Skarżyński carried out the world's first surgery to complement acoustic hearing with electric hearing in a partially deaf adult patient in 2002, and in a child – in 2004.

'I have performed more than 4.5 thousand such surgeries since then. Other otosurgery centres in the world have performed no more than tens or hundreds,' Prof. Skarżyński says. Between 15 and 20 thousand surgeries per year have been carried out over the last 16 years in the World Hearing Center headed by Prof. Skarżyński – that is several hundred percent more than anywhere else in the world.

Professor Henryk Skarżyński systematically promotes the PDT programme, which is currently implemented in more than fifty institutes around the globe. 'The Polish school of otosurgery gained recognition in world science and medicine because

we had strong arguments,' Prof. Skarżyński says. 'Our presentations at global and continental congresses and the publications of the results of patients who had undergone surgeries following my method left no doubt that it was least invasive. Admittedly, however, it is far from simple and requires experience and responsible courage. I have performed more than 200 thousand surgeries in my professional life. In order to promote the most notable achievements, I had to take the risk and carry out surgeries with a live broadcast in Poland and in more than a dozen countries on three continents,' adds prof. Skarżyński.

Professor Henryk Skarżyński systematically promotes the PDT programme, which is currently implemented in more than fifty institutes around the globe.

Achievements of the 'Polish School of Otosurgery'

Together with 46 scientists from all continents, Prof. Skarżyński developed the world's first system of classifying the results of treatment. Then, in 2007, he initiated the world's greatest series of international workshops – Window Approach Workshop (WAW). During the 49th workshop at the World Hearing Center, Prof. Skarżyński performed more than one thousand demonstration surgeries, which were watched by more than four thousand experts from all continents. The scientific achievements of the Polish school of otosurgery include almost three thousand publications and scientific contributions.

Institute of Physiology and Pathology of Hearing
World Hearing Center
whc.ifps.org.pl/en

Bialystok PLUS Study: Race Against the Diseases of Civilisation

Cardiovascular diseases, diabetes and cancer are conditions which plague the entire modern world. Scientists keep looking for means to stop this alarming trend. A unique multidisciplinary cohort study is currently being held in Poland – the only such in the country and one of the few worldwide.

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Prof. Karol Kamiński leads the Bialystok PLUS study.

THE AIM of Bialystok PLUS is to identify the causes of lifestyle diseases. It is held at the Medical University of Bialystok under the direction of Professor Karol Kamiński.

The combination of imaging, functional, biochemical and molecular tests in the innovative study will help to find new ways to prevent chronic diseases, promote a healthy lifestyle and improve the organisation of healthcare. It will allow to discover new methods of early disease detection or even to predict the conditions that may affect the population in the future.

Comprehensive Health Assessment

Ten thousand citizens of Białystok aged between 20 and 80 will be randomly selected to participate in Bialystok PLUS study. They will then undergo non-invasive tests every five years. What makes this study unique is that the health of the participants will be assessed on the basis of detailed medical history and more than thirty specialist examinations, including ultrasound scans of various organs, spirometry, fundus photography or MRI, as well as biochemical tests and dental exams.

Laboratory of Molecular Imaging and Technology Development provides the possibility to carry out unique research in the areas of medicine, information technology and physics.

The microbiome, that is the bacteria present in an individual's body, will also be evaluated. The project also aims to collect and store samples of blood, urine, stool, saliva and gingival crevicular fluid for future examinations with the use of innovative methods.

'We assessed more than five hundred people in the pilot survey. We are currently carrying out the main part of the study. Almost three hundred persons have already taken part in it, and over one hundred of them have had an MRI', says Prof. Karol Kamiński.

The first conclusions from Bialystok PLUS study indicate that the following factors frequently affect disease development in Białystok: improper diet, overweight and obesity, carbohydrate metabolism disorders and disorders of the thyroid.

Cooperation Proposals Are Welcome

The project is modelled on the Study of Health in Pomerania SHIP, which has been running since 1997 at the University of Greifswald, Germany, the official partner of the Polish team.

'We will collaborate in analysing the results so that the groups can be larger and the results more reliable, as we wish to discover phenomena

that concern the entire human population', Prof. Kamiński explains. 'Most of the results we have obtained will be made available for use to researchers in Poland and abroad', he assures. The scientists are open to cooperation with researchers from a whole range of scientific domains, such as sociologists, demographers and economists, who can use the extensive records to carry out various further studies.

Laboratory of Molecular Imaging and Technology Development

Some of the tests carried out in the project, for instance the magnetic resonance imaging, will be conducted at the Laboratory of Molecular Imaging and Technology Development, which is equipped with a unique diagnostic apparatus – a PET/MR scanner, one of only two such devices in Poland.

The scanner combines positron emission tomography with magnetic resonance imaging. The Laboratory provides the possibility to carry out unique research in the areas of medicine, information technology and physics, such as searching for early markers in Alzheimer's disease and diagnosing and monitoring inflammatory diseases and cancer. The Laboratory is available to medical sector businesses that run clinical trials.

Medical University of Bialystok
Department of Population Medicine and Civilization Diseases Prevention,
science.bialystok.plus

Wrocław Walk Again: Reconstruction of Severed Spinal Cord

'Medical miracle' – this is how the world media ranging from BBC to Al Jazeera described the pioneering surgery involving the reconstruction of a severed spinal cord, which had been carried out in Wrocław. Now, the Dr. Paweł Tabakow is doing more research to turn this miracle into a medical standard.

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THE FEAT accomplished by Dr. Paweł Tabakow and his team from the Neurosurgery Clinic at the University Clinical Hospital in Wrocław and the Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences in Wrocław went down in the annals of medical history. A male patient was lying on the operating table. He was paralysed from his waist down as a result of a knife attack, which had cut through his spinal cord. Dr. Tabakow opened the patient's skull and removed a part of his brain tissue called the olfactory bulb. Twelve days later, the patient underwent a second operation. The doctor opened the spine and transplanted glial cells and fibroblasts grown in culture from the brain tissue into the damaged area of the spinal cord. He bridged the gap in the cord with nerve grafts taken from the skin of the patient's calf. The spinal cord partly regenerated and the man could walk on his own again. This is the only such case in the world.

The pioneering surgery was possible thanks to the cooperation of physicians and researchers from Poland and the UK. Scientists from the University College of London led by Prof. Geoffrey Raisman had carried out similar experiments on animals. Based on their work, the team from the University Clinical Hospital in Wrocław developed an original therapeutic method of regenerating the human spinal cord. The method could give people suffering from paralysis a chance to make a complete recovery. Yet before such surgeries can become standard, the effectiveness of the new technique has to be confirmed. This is the objective of the 'Wrocław Walk Again' project. The project is funded by the Nicholls Spinal Injury Foundation.

The team developed an original therapeutic method of regenerating the human spinal cord. The method could give people suffering from paralysis a chance to make a complete recovery.

What happened during the first stage of the project?

DR. PAWEŁ TABAKOW: The project was registered on clinicaltrials.gov – an experimental studies website. The European Medical Agency granted us the right to culture olfactory glial cells. We are about to conclude the certification process for a cell culture laboratory which will enable us to use technologically advanced tissue-engineered products in humans. This certificate demonstrates the excellence of our university. It has already opened up entirely new research horizons for us and the university is receiving next project proposals.

But most importantly, we have combed the entire globe and found the one perfect patient among 500 candidates. He has undergone preoperative physiotherapy and is waiting for the surgery to reconnect his spinal cord. We are still looking for the second patient.

The pioneering surgery was possible thanks to the cooperation of physicians and researchers from Poland and the UK.

Have you found only one?

We are looking for a person, whose spinal cord was cut through with a sharp-edged tool, e.g. a knife or a scythe. This type of injury is rare. We have chosen it in order to obtain unambiguous proof that the method works. We want to end the speculations of doubters who claim that it was the uninjured fibres in the cord that caused a spontaneous improvement.

'Wrocław Walk Again' was registered on the experimental studies website clinicaltrials.gov.

Will the next surgery be the same as the first one?
It will be similar but not identical. We keep evolving. We began studies on the use of glial cells in spinal cord regeneration in 2002. At that time, we used to remove them from the nasal cavity. Then, we became the world's first team to remove them from the olfactory bulb. Now, we intend to introduce certain modifications, e.g. we want to transplant cells suspended in the extracellular matrix and try the technique of minimally invasive microsurgery of the spinal cord.

When will the method developed in Wrocław spread to other hospitals?
Medicine needs replicability. 'Wrocław Walk Again' is supposed to prove the effectiveness of the method. The next step will involve several clinics around the world operating on a group of patients with various spinal cord injuries.

Which patients will ultimately qualify for such surgeries?
Those with the most severe cord injuries, where it was either damaged mechanically or not anatomically severed. It is estimated that three million people suffer from such injuries worldwide.

Wroclaw Medical University
walk-again-project.org/#/en

Human Insulin Analogues with Prolonged Activity

According to the estimates of the World Health Organisation, more than 300 million people will be suffering from diabetes in 2025. Scientists from the Łukasiewicz Research Network – Institute of Biotechnology and Antibiotics have developed 'candidates' for new long-acting drugs for diabetics.

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The Institute specializes in research and development of biopharmaceuticals.

DIABETES IS a disorder that manifests itself in an impaired production of insulin – a hormone that controls the glucose level in blood. Untreated diabetes leads to serious eye damage, failure of the kidneys and heart, or even death. That is why, in order to control the disease, diabetic patients using insulin require injections, sometimes several times a day.

Innovative Biopharmaceuticals

A solution that could improve the quality of life of diabetics are the insulin analogues developed at the Institute of Biotechnology and Antibiotics (IBA) as a part of the project entitled 'Centre of Medicinal Product Biotechnology. Package of innovative biopharmaceuticals for human and animal therapy and prophylaxis.', in which the scientists developed long-acting analogues of human insulin, among other drugs.

'Our aim was to produce insulin analogues with prolonged action, which would provide a stable therapeutic effect. It means that the patient would not have to take the medication frequently: it would suffice to take one dose per day, or even one every few days,' explains Dr. Marta Zapotoczna, IBA Deputy Director.

The Institute specializes in research and development of biopharmaceuticals. To produce the insulin analogues, the researchers used genetically modified *Escherichia coli* bacteria with a gene encoding modified insulin. The bacteria were used to produce large amounts of proteins with specific properties. Proteins obtained in this manner then become the active drug. As a result, the team obtained proteins with decreased solubility in a neutral environment. In other words, once injected into the body, the new forms of the hormone took longer to absorb into the bloodstream and remained active for a longer period.

'We are best known for insulin and its analogues, but we develop and produce vaccines, a growth hormone, interferons and other products as well,' Dr. Zapotoczna says.

Three Promising Variants

The researchers successfully produced several variants of the insulin analogues, with three deemed particularly promising by the team. The action of insulin AKR was ultralong, showing activity in animals even up to 28 days. On the other hand, the insulin SK3R was the most similar to the marketed insulin glargine, but additionally did not cause dangerous fluctuations in the sugar level in blood. The third substance developed at IBA is a rapid-acting human insulin analogue, biosimilar to the preparation already known on the market – insulin lispro.

'The new technologies were characterised by simplicity and high effectiveness with a high degree of purity of finished products. Combined with the good results of the set of preclinical trials and stability tests, this has confirmed that they are perfectly suitable for commercialization,' says Dr. Monika Bogiel.

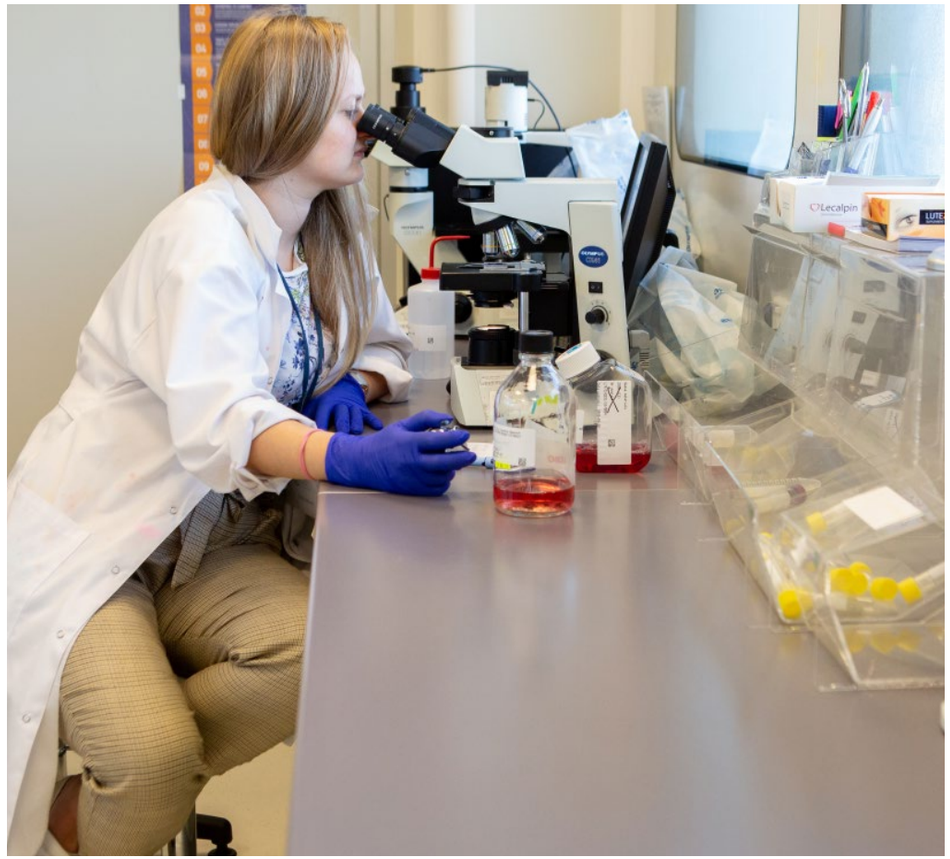
The inventions have been patented and attracted the interest of industry. The rapid-acting insulin analogue will be produced in India, and insulin AKR is presently the subject of negotiations between IBA and a pharmaceutical company.

This is not the first time that the IBA has developed insulin. It was here that the first Polish biotechnological drug and the world's third recombinant human insulin were invented in the 1990s. 'We are best known for insulin and its analogues, yet this is not the only group of biopharmaceuticals we develop. We develop and produce vaccines, growth hormone, interferons and other products as well. We are able to invent a new biopharmaceutical drug and bring it all the way to the stage of production in accordance with the GMP guidelines,' Dr. Zapotoczna says.

Dr. Marta Zapotoczna, IBA Deputy Director.

Łukasiewicz Research Network – Institute of Biotechnology and Antibiotics
iba.waw.pl/en

NEOLEK: Integrated Laboratory of Experimental Oncology and Innovative Technologies



Working on new drugs requires studies that meet the standards of Good Laboratory Practice. One such laboratory is located in Wrocław; it combines fundamental research with applied studies.

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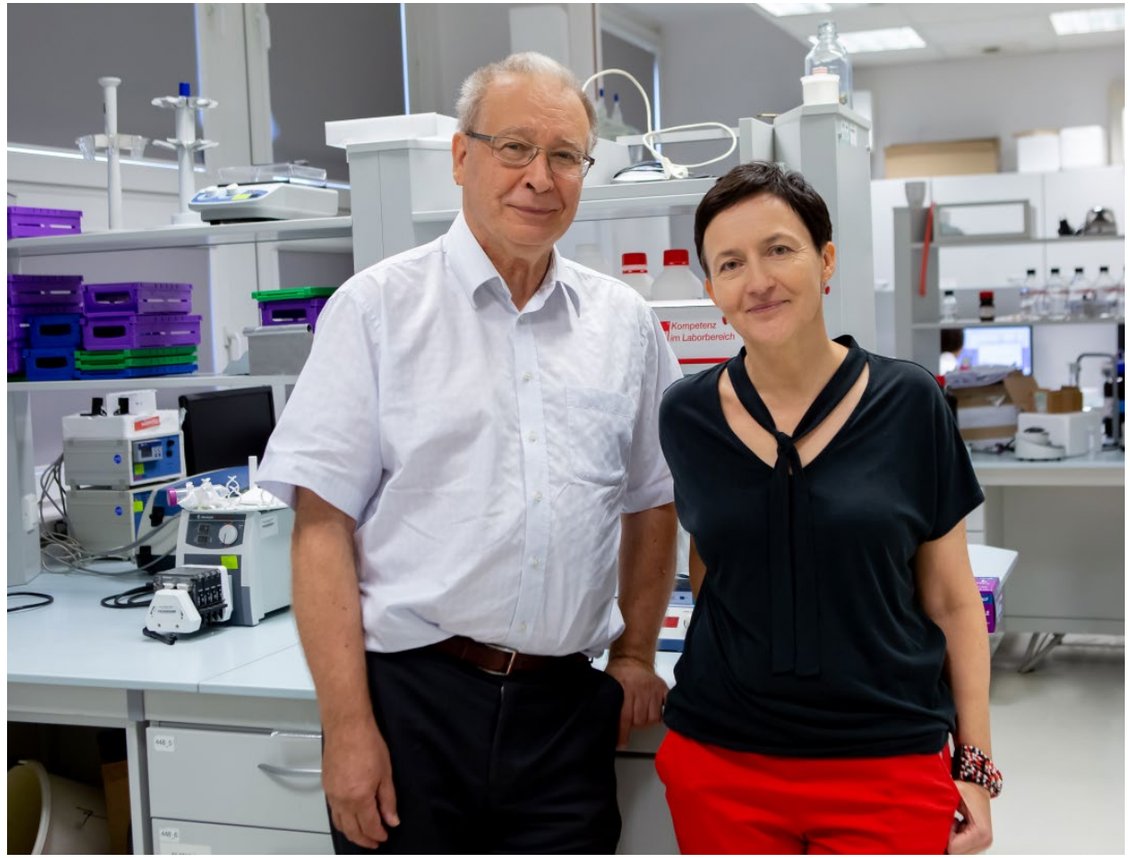
GOOD LABORATORY PRACTICE – GLP – is an international certificate that confirms that the studies are performed in compliance with the highest standards. NeoLek – Integrated Laboratory of Experimental Oncology and Innovative Technologies, which is part of the Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences in Wrocław, has obtained this certificate.

'The concept behind the foundation of NeoLek was to combine biological and chemical research in one organisational unit,' says Professor Janusz Boratyński, head of the Laboratory of Biomedical Chemistry. NeoLek is made up of two labs: the Laboratory of Experimental Anticancer Therapy led by Professor Joanna Wietrzyk and the Laboratory of Biomedical Chemistry led by Prof. Janusz Boratyński.

Researchers at the Laboratory of Experimental Anticancer Therapy test preparations for their anticancer activity. The spectrum of their studies is broad: from in vivo tests on approved cell lines (NeoLek has approximately 300 approved cell lines) to animal testing. One of NeoLek's major projects involves the study of the anticancer properties of vitamin D and its derivatives.



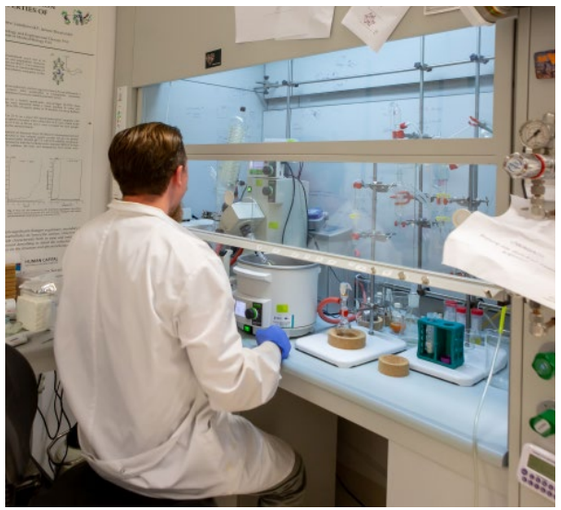
Prof. Janusz Boratyński, Head of the Laboratory of Biomedical Chemistry, with Prof. Joanna Wietrzyk, Head of the Laboratory of Experimental Anticancer Therapy.

'The concept behind the foundation of NeoLek was to combine biological and chemical research in one organisational unit.'
– Prof. Janusz Boratyński

The team at the Laboratory of Biomedical Chemistry, in turn, develops preparations based on drug-carrier systems, which enable delivering the therapeutic substances directly to the pathological tissue. Moreover, the scientists study the properties of boron compounds. NeoLek is planning to participate in the research on promising cancer treatment modalities such as the Boron Neutron Capture Therapy (BNCT).

A Wide Range of Activity

NeoLek does not limit its activity to studies on cancer treatment. In the course of examining the physicochemical properties of bacteriophages (bacterial viruses), the scientists from the laboratory developed an original, scalable technology for obtaining pyrogen-free bacteriophage preparations. As Prof. Boratyński emphasises, these studies



greatly contribute to research on drug-resistant bacterial infections, and in particular to the application of bacteriophages in the treatment of infectious diseases.

In addition, NeoLek performs contract research for industrial customers: screening tests *in vitro* and *in vivo*, as well as chemical analyses. Companies usually order advanced analyses, because they receive results that meet the GLP standard, which is required in formal reports and in further application.

Ludwik Hirszfeld Institute of Immunology and Experimental Therapy
Polish Academy of Sciences
iitd.pan.wroc.pl/en
neolek.pl/en

Agricultural sciences

Trojan Horse to Fight Cancer

When asked about her discovery, Professor Magdalena Król says that she has a Trojan horse with armed warriors enter the tumour site. Armed with drugs, the warriors are supposed to reach those parts of solid tumours that no medications are currently able to penetrate. The discovery can become a turning point in oncological treatment.

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PROFESSOR MAGDALENA KRÓL received a prestigious grant from the European Research Council (ERC) to continue her work. The studies are carried out under the project 'Entrapment of hypoxic cancer by macrophages loaded with HAP' at Warsaw University of Life Sciences (WULS-SGGW) in close collaboration with the University of Warsaw and the Medical University of Warsaw. In 2017, the ERC listed Professor Król's undertaking as one of ten most interesting projects financed by the Council in the course of its decade-long history. Professor Król established a start-up company Cellis in order to commercialise the discovery. This biotechnological company is developing a cell-based technology that might be used in the future for cancer treatment and diagnosis.

The ERC describes the projects that it finances as 'high risk – high gain'. How high are the stakes for your project?
PROF. MAGDALENA KRÓL: The ERC reviewers described my project as 'high risk – extremely high gain'. The project is very complex. It comprises many stages, at which something could go wrong, but if we obtain positive results at each stage, we have a chance to develop a new cell-based method of delivering drugs to solid tumours.

What makes this method innovative?
There are various systems of delivering drugs to the tumour. Scientists try to have the medications transported by metal nanoparticles, proteins or antibodies, but so far no researcher has managed to design a method where live cells are used to transfer the drug to the tumour site, to its most inaccessible parts.

How did you notice that this was possible?
When we look inside a neoplastic tumour, we can see that it is an autonomous being living in another organism. This autonomous area contains various types of cells, each of them playing a particular role at various stages of the tumour's development. In order to grow, the tumour has to ensure a suitable

Professor Magdalena Król established a start-up company Cellis in order to commercialise the discovery. This biotechnological company is developing a cell-based technology that might be used in the future for cancer treatment and diagnosis.

growth of blood vessels. This is the area where we can currently deliver drugs. Yet tumours have certain avascular, that is inaccessible, regions, which are located far away from blood vessels (the cancer cells grow faster than new blood vessels can develop). These regions are highly hypoxic, that is deprived of oxygen. Even modern preparations used in anti-cancer therapy are not able to penetrate these regions. Thus, the cancer cells located there survive chemotherapy and are responsible for relapse or metastasis. From the physiological point of view, however, such hypoxia attracts macrophages, that is immune system cells, which induce the process of developing new blood vessels. And so we came up with the idea to use the macrophages to deliver the drugs to those inaccessible regions.

They are the Trojan horse?
In a way, yes. Since the macrophages naturally penetrate the tumour, we thought that – just as the Trojan horse helped hidden warriors enter Troy – the macrophages could transport anticancer drugs, that is our warriors, into the inaccessible regions of the tumour. However, we need to make sure that the drug delivered to the tumour site will be active. That is why we use appropriate protein structures which ensure that the drug is properly encapsulated. This package, in turn, is loaded into the macrophage, and the complete 'Trojan horse' is sent to the tumour site. The macrophages transfer their load to the cancer cells very quickly. It is a peculiar

mechanism, a new discovery made by our team. We have called it TRAIN: TRAnsfer of Iron-binding proteiN. We are testing its application in diagnosing or treating other diseases.

What is the current stage of your project?
We are at the stage of preclinical trials. We are studying the TRAIN mechanism at the level of fundamental research and working on applying the results of in vitro and in vivo tests on mouse models to humanised models. We are trying to find out what groups of medications can be loaded using this mechanism so as to achieve the desired results at the tumour site.

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Valuable Plant Extracts and Probiotics to Save Bees

Humans have profited from immune boosting herbs and probiotics for thousands of years. Professor Aneta A. Ptaszyńska from the Maria Curie-Skłodowska University in Lublin has developed such substances for honeybees in order to help them fight a dangerous and frequent fungal infection – nosemosis.

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HONEYBEES DO NOT only make honey and other products that are valuable to humans. Their role as pollinators of both wild and cultivated plants cannot be overestimated, either. Yet keeping honeybee colonies in a good condition is growing increasingly difficult due to changes in the environment, e.g. chemical pollution and large-area monocultures, that is the cultivation of a single crop in a given area.

The mass extinction of honeybees that has been observed for over a decade now, called the colony collapse disorder (CCD), does not have one direct cause, yet several factors are especially frequent. One of them is nosemosis – an intestinal infection that results in weakness and malnutrition, often ending in the death of the entire colony. The disease affects beekeeping all over the world. In Poland, with more than 70 thousand farms that keep around 1.5 million bee colonies in total, it is estimated that colonies infected with nosemosis constitute 20 percent of the entire population. The infection could be effectively treated with an antifungal drug, but such drugs cannot be used: once administered to the honeybees, they penetrate the honey, and substances of that type are harmful to humans.

Formulations to Boost Bee Immunity

A research team from Lublin decided to tackle this problem. They used adaptogenic plants, such as ginkgo, magnolia vine and ginseng, which stimulate the immune system not only in humans, but also in bees. The scientists developed a preparation that can be administered directly to honeybees. 'Based on herbal extracts, the formulation stimulates immunity in honeybees, which is indicated by the increased activity of phenol oxidase. The increased oxidase activity following the administration of the preparation shows that the immune system has been activated, allowing the insects to fight infections with pathogenic microorganisms more easily,' Prof. Aneta Ptaszyńska explains.

The second method is to develop a probiotic to support the insects' intestinal flora. Similarly, as in humans, it plays a crucial role in preventing intestinal infections in bees. 'We isolated the bacteria from the digestive system of healthy bees from colonies in a very good condition. This makes our product unique on the market and distinguishes it from the group of available probiotics that contain microorganisms not dedicated to a specific group of animals. When we give the bees a probiotic that occurs in their environment naturally, we can be sure that it will both support the microbial flora in their digestive system and be safe for the environment,' the researcher adds. The honeybees that receive the probiotic live longer, can assimilate nutrients more easily and are more successful in fighting infections.

The disease affects beekeeping all over the world.

The honeybees that receive the probiotic live longer, can assimilate nutrients more easily and are more successful in fighting infections.

Both these innovative formulations have been patented. The team is working on successive ones.

Awards for Saving Bees

Prof. Ptaszyńska was awarded for her work with the main prize in the 9th edition of the contest 'Innowacja jest kobietą' ('Innovation is a Woman') organised by the Foundation 'Kobiety Nauki' ('Polish Women Scientists Network'), which promotes women's achievements in the research sector. Moreover, Prof. Ptaszyńska presented her inventions at the International Trade Fair 'Ideas – Inventions – New Products' iENA 2018 in Nuremberg, where they won the silver medal. They were awarded gold medals by the international jury of EUROINVENT and by the World Invention Intellectual Property Associations (WIIPA). In addition, the inventions won the international EIFFEL award granted by the Association of French Inventors and Manufacturers at the 117th International Inventions Trade Fair CONCOURS LÉPINE in Paris.

Maria Curie-Sklodowska University
umcs.pl/en/

DELab UW: Studies of Digital Economy, Society and Politics

DELab UW – Digital Economy Lab – is an inter-faculty research institute at the University of Warsaw, which analyses changes in society, economy and politics driven by new technologies.

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THE INTERDISCIPLINARY TEAM of DELab UW consists of economists, sociologists, lawyers, computer scientists and data scientists. They are experts in the mechanisms of digital transformation. The team carries out both research and commercial projects, and it cooperates with businesses and public institutions.

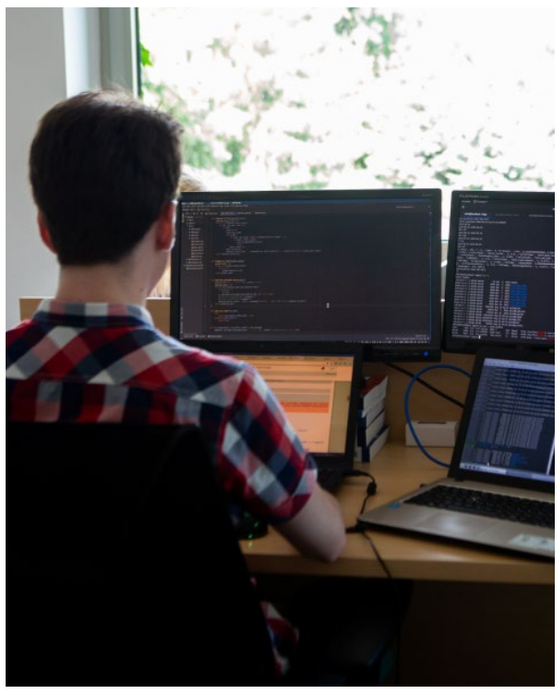
DELab UW was founded at the University of Warsaw in 2013 with the support of a grant from Google. The company commissioned DELab to prepare a series of reports on digital competences in small and medium enterprises in more than a dozen European countries.

Areas of Cooperation

The team cooperates with representatives of business, Polish public authorities (Ministry of Foreign Affairs, Ministry of Digital Affairs, Ministry of Entrepreneurship and Technology) and international institutions, such as the European Bank for Reconstruction and Development (EBRD). This cooperation has resulted in the completion of projects concerning the EU's Digital Single Market, geo-blocking, the development of Industry 4.0, e-identification and e-authentication, the future of work (including the banking sector), changes in the transport sector and the competences of the future.

DELab UW is deeply engaged in international cooperation. In the project entitled Engineroom, the team together with experts from the UK and Spain is studying current technological trends.

DELab UW cooperates with international institutions.



The team carries out both research and commercial projects, and it cooperates with businesses and public institutions.

Together with partners from Toruń (Poland), Italy, Bulgaria, Slovakia and Estonia, DELab UW participates in the SharOn project devoted to sharing economy, which is funded from the European Union's Horizon 2020 programme. Another project is ChainReact, carried out in collaboration with, among others, the University of Cambridge and the Greek Centre for Research and Technology Hellas (CERTH). Its objective is to increase the social awareness of connections between corporations and smaller businesses. Furthermore, in projects funded by the Polish National Science Centre, DELab staff research online privacy, new business models, the creative sector and copyright.

University of Warsaw
DELab UW – Digital Economy Lab
delab.uw.edu.pl/en

Innovative Approach to Social Cognition

We perceive other people, ourselves as well as social institutions in terms of two types of content, described as agency and communion. It is the first category that largely affects our self-perception, as proven by Professor Bogdan Wojciszke, precursor of studies on agency in Poland.

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FOR HIS STUDIES on agency and communion carried out together with Prof. Andrea Abele from the University of Erlangen-Nuremberg, the European Association of Social Psychology awarded Prof. Wojciszke with the prestigious Serge Moscovici Medal in 2017. Prof. Wojciszke studied matters related to love and power for many years. He is the author of numerous books, including *Psychologia miłości: intymność, namiętność, zaangażowanie (Psychology of Love: Intimacy, Passion, Commitment)* and *Procesy oceniania ludzi (Processes of Forming Judgments of Other People)*.

The researcher has been awarded an Alexander von Humboldt Foundation Research Fellowship and held research fellowships at the University of Aberdeen, the Max Planck Institute in Berlin, Cambridge and Oxford. He has won numerous awards, including the Foundation for Polish Science Prize.

What is the current subject of your research?
PROF. BOGDAN WOJCISZKE: The major area of my interest for the last ten years has been the existence of two types of content in perceiving other people, oneself, and social institutions, that is two dimensions of social cognition, which are called agency and communion. Agency pertains to the effectiveness of our actions, the focus on achieving our goals, as well as competence. Communion, on the other hand, involves functioning in social relations and those features which help us establish and maintain social connections. I carry out these studies in international collaboration with Prof. Andrea Abele from the University of Erlangen-Nuremberg.

What conclusions can be drawn from your research?
It turns out that when we compare the relevance of these two types of content, it is different depending on whether we are looking at others or at ourselves. When we are looking at others, we pay attention chiefly to the communal content, that is whether another person can offer us anything good or rather do us harm, whether their intentions are good or bad. Whether we have a positive attitude to someone or, on the contrary, avoid them, is very strongly affected by the way we perceive their communal characteristics. If that person is warm, cordial, moral and honest, we strive to stay in touch with them. At the same time, we barely care for their agency: their competence and ability to achieve goals.

Self-perception greatly depends on how we perceive our agentic features and hardly on how we see the communal ones.
It is similar with our family and friends, with our own child: we perceive them mainly in terms of their agency.

And how do we perceive ourselves?
Interestingly, when we look at ourselves, the perception is completely opposite. We do not pay attention to our morality, honesty, but rather assume that we possess those qualities. Instead, we strongly focus on our agency, competences, ability to accomplish goals and the extent, to which we come closer to or further from succeeding. Self-perception greatly depends on how we perceive our agentic features and hardly on how we see the communal ones. It is similar with our family and friends, with our own child: we perceive them mainly in terms of their agency.

Do the studied populations, e.g. in Poland and in Germany, differ in this respect?
In fact, they do not. We thought that the dominance of agentic content in self-perception could largely result from culture. Individualistic cultures (e.g. in the UK) emphasise individual agency, while collectivist ones (e.g. in China) – teamwork skills. However, we carried out various studies e.g. in China, Japan, Colombia, and it turned out that there, too, self-perception greatly depends on what people think of their agency and to a minor extent on how they evaluate their communion. This is precisely the same as in the classic individualistic cultures, such as the UK or the Netherlands.

Are you planning to continue the research? In which countries?
Yes, the research continues in Poland and in Germany. So far, we have examined several thousand people.

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english.swps.pl/sopot/faculty-of-psychology

How Has the Language of the Aztecs Changed?

An international research group led by Professor Justyna Olko from the University of Warsaw studied the centuries-long history of Nahuatl, which has changed under the influence of the Spanish language and culture.

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NAHUATL USED to be the language of the Aztec empire. It is from Nahuatl that we borrowed the words chilli, avocado and chocolate. Today, it is an endangered indigenous language in Mexico. Funded by a grant from the European Research Council, the project entitled 'Europe and America in contact: a multidisciplinary study of cross-cultural transfer in the New World across time' focused on the history and the mechanisms of change in Nahuatl.

The research was mainly carried out in the states of Tlaxcala and Veracruz, where numerous Nahuas – descendants of the Aztecs – still live. The findings show that Nahuatl did not change as much as it is commonly believed. Its modern speakers are able to read texts from the 16th century. According to official estimates, modern Nahuatl is spoken by approximately 1.5 million Mexicans. These are mostly elderly people living in small, scattered communities.

Professor Olko specialises in ethnohistory, anthropology and sociolinguistics, with a special focus on the cultures and history of Mesoamerica. She is actively involved in the revitalisation of endangered languages, including Nahuatl and minority languages in Poland.

What changes did you detect in Nahuatl in the course of your research?

PROF. JUSTYNA OLKO: In some respects, Nahuatl gradually became more similar to Spanish. It absorbed many Spanish words. Structural changes also took place, altering the typological profile of the language. Yet Nahuatl remained in a fairly good condition until recently. Paradoxically, five centuries of colonisation contributed to its extinction less than the processes of the last hundred years.

Which processes do you have in mind?

The 19th century brought the notion of the nation-state with one language and one coherent culture. Minority and indigenous languages as well as their users became subject to discrimination and were perceived as an obstacle to modernisation. There

Professor Justyna Olko is actively involved in the revitalisation of endangered languages, including Nahuatl and minority languages in Poland.

were even instances of deliberate 'linguicide' by means of a compulsory transition of indigenous children to the dominant languages. Such practices were common in Mexico, but also elsewhere.

Are endeavours to save endangered languages not merely opposition against inevitable transformations?

Language death is a natural process, but it was in the 20th century that it drastically gained momentum. A considerable number of minority language users have experienced marginalisation and discrimination because of their heritage languages. People who have a worse command of the dominant language are considered less educated and have fewer opportunities to find a good job. Certainly, this process cannot be completely reversed or contained. Still, modern states are beginning to realise that linguistic and ethnic diversity are assets that deserve protection, e.g. by introducing minority languages into schools. But this is not enough.

What does a language need to survive?
People have to speak it on a daily basis. And they should use it to create cultural texts. As researchers, we took up activities to support various initiatives in the course of the project 'Engaged Humanities' (2016–2018) and some other undertakings. For instance, we have been collaborating with local activists to support the survival of Wymysiöeryś.

This language is spoken exclusively in the town of Wilamowice in southern Poland. Until recently, due to post-war repressions and ban on using the language, it was spoken merely by several dozen oldest community members. Now, this group has also embraced several dozen young users. Wilamowice has become a laboratory of language revitalisation, which is visited even by... the Nahuas, descendants of the Aztecs. The revitalisation process is supported by young people, local organisations, municipal authorities and the local school. Four theatre plays have been written and staged in Wymysiöeryś. The experience gained and lessons learnt in the course of these activities can be useful for other communities worldwide, including in Mexico.

University of Warsaw
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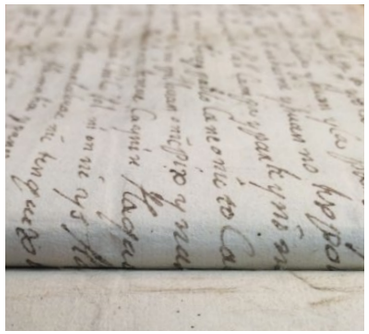
Center for Research and Practice in Cultural Continuity
culturalcontinuity.al.uw.edu.pl



Manuscript wirtten in Nahuatl.

Archaeological Excavations in Sudan

The Christian kingdom of Makuria located in modern-day Sudan existed for several centuries, surrounded by powerful Muslim neighbours. Its decline is researched by the team of archaeologists led by Dr. Artur Obłuski. They are excavating the kingdom's old capital city – Dongola.

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Polish archaeologists from the University of Warsaw have conducted research in Sudan since the 1950s and saved numerous relics of the city of Faras.

‘UMMA – Urban Metamorphosis of the community of a Medieval African capital city’ is a project funded by a European Research Council grant awarded to Dr. Artur Obłuski. Dr. Obłuski is the Acting Director of the Polish Centre of Mediterranean Archaeology (PCMA) of the University of Warsaw and Director of the PCMA’s Research Centre in Cairo. The aim of the UMMA project is to investigate the fate of the community inhabiting Dongola in the wake of the destructive Mamluk invasions and the king abandoning the city in the 14th century. The kingdom fell, yet the community survived. Dongola became a city-state similar to the Greek poleis. ‘The city’s ruins occupy an area of 200 ha.

This is equivalent to the area of eleventh-century Cairo, one of the world’s major cities of the time. According to sixteenth-century accounts, Dongola flourished in that period thanks to trade’, says Dr. Artur Obłuski, the project’s leader.

Flourishing Mediaeval Metropolis

The excavations in Old Dongola revealed pottery made in Ottoman workshops located in the Balkans or in China of the middle Ming period. Other finds recovered on the site were reckoning counters, or jetons, minted in Nuremberg, as well as beads from all over the world, including Sri Lanka, the Netherlands and Czechia. A factory, or trading post, was established in Old Dongola by Genoese merchants. The secret behind the success of the city, which morphed from a fallen state’s capital into an independent, flourishing metropolis within 150 years, is one of the two subjects of study in the project. The second aspect involves an analysis of the religious changes. The traces of conversion from Christianity to Islam, which began in the 14th century, should still be visible in what is left of the mediaeval households in Dongola.

UMMA archaeologists documenting a residential quarter in the citadel of Old Dongola.

Dr. Agata Deptuła collecting field samples for analysis.

A Nubian State

Makuria was one of three states which emerged in the 4th century in a region called Nubia. Today, most of these lands belong to Sudan. These states adopted Christianity in the mid-6th century and managed to survive despite the Arab conquests in the neighbouring regions. ‘The kingdoms in mediaeval Nubia halted the Islamic expansion in Africa for some 600 years,’ Dr. Obłuski says.

First, this was possible because of a conflict between various groups within Islam. Nubia began to flourish in the 10th century, when the Shiite dynasty of the Fatimids came to power in Egypt. The new Egyptian rulers had a common goal with the Christians: to not succumb to the influence of other Islam states governed by Sunni leaders. Secondly, the Nubian people were not exactly known for their peaceful nature. Only after adopting Christianity and establishing closer trade relations with Constantinople did they cease to harass the Byzantine Empire with their raids. Their art of war, refined over many centuries, and the legendary good aim of the Nubian archers’ successfully deterred any potential invaders.

Tobacco pipe imported from the Ottoman empire in the 17th/18th century.

'All the evidence indicates that Nubians were slave traders. A seventh-century treaty included the condition that Makuria would deliver 300 slaves a year to Egypt in return for maintaining peace. We can also find mentions of Nubian slaves and mercenaries,' adds Dr. Obłuski.

The Accomplishments

Polish archaeologists have conducted research in Sudan since the 1950s. The mission led by Prof. Kazimierz Michałowski carried out rescue excavations in areas flooded in the aftermath of the construction of the Aswan High Dam on the Nile. They saved numerous relics of the city of Faras – the capital of another Nubian kingdom, Nobadia. Cooperation with the Sudanese authorities resulted in the researchers obtaining a permit to excavate Old Dongola as well as Soba, the capital of the third Nubian kingdom – Alwa, located in the vicinity of modern-day Khartoum.

University of Warsaw
The Polish Centre of Mediterranean Archaeology
pcma.uw.edu.pl/en

Scientists Investigate a Manuscript Collection

Philologists from the Jagiellonian University in Kraków have examined a collection of three thousand Romance manuscripts preserved in almost five hundred bound volumes. Thanks to their studies, the rediscovered works could be restored to European culture.

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THE JAGIELLONIAN LIBRARY is the repository of the so-called Berlin collection, that is a part of the library that once belonged to the kings of Prussia. It comprises many thousands of archival items, including manuscripts by Boccaccio and Giordano Bruno or original sheet music by Mozart, Beethoven and Bach. Among them is also a collection of Romance manuscripts. They were the subject of the research project entitled 'The history of the collection of Romance manuscripts from the former Preussische Staatsbibliothek zu Berlin, kept at the Jagiellonian Library in Kraków'.

'It was virgin territory, it had not been studied at all,' lead researcher Professor Piotr Tylus recalls the beginnings of the project. A team of sixteen scholars from the Institute of Romance Studies faced 467 bound volumes. Almost each of them included from several to several dozen manuscripts – almost 3000 pieces in total, composed in five languages: French, Italian, Portuguese, Spanish and Catalan, over the course of seven centuries (from the 13th to the early 20th century). It was often unclear what the texts were, as the catalogue from 1918 contained inaccuracies and errors, and the manuscripts were often neither titled nor signed.

Restoring Identity

What does the collection comprise? What are these manuscripts? When were they composed? Who were the authors? Who were the first and subsequent owners? How did the manuscripts end up in the Prussian kings' library? Are they valuable originals, on the basis of which new editions could be produced, or are they only copies of copies, with no particular textological value? Those are only some of the questions that the philologists wanted to answer.

'It was a genuine investigation,' Prof. Piotr Tylus says. 'In many instances, we studied the history of the documents on the basis of indirect data. For instance, a note in a document said that the book had belonged to a Charles de Croÿ, Prince de Chimay. We found out that prior to becoming Prince de Chimay, Charles de Croÿ had been Count of Chimay until 1486. It follows that the manuscript was composed after 1486.'

The studies carried out by the philologists from the Jagiellonian University allowed to unveil a part of European history, and the descriptions of manuscripts are a great tool for anyone who might want to study specific documents in the future.

Prof. Piotr Tylus studied collection of Romance manuscripts.

The scholars not only studied the history of each manuscript, but also carried out textological work. 'It meant identifying the author and the text, and if a given text had been kept in various manuscripts, we compared it with manuscripts from other collections. We travelled to foreign libraries and archives and used various sources and databases. Each text posed a different challenge,' Prof. Tylus explains.

Novels and Cooking Recipes

Each manuscript was meticulously described, including the author, the title, the date of composition, the content and the information on any existing copies. It took the team three years to examine the entire collection. The scholars found out that it included literally everything: literature and cook books, travel journals and legal texts, philosophical and religious works, scientific and pseudoscientific treatises, chronicles and diplomatic reports. Some documents are valuable from the bibliophilic point of view, as for example a fifteenth-century manuscript bound in *cuir de Cordoue*, that is gilt leather with embossed floral motifs. It is the fourth example of such binding known in the world. Other works are valuable for textological reasons, such as the sole copies of specific pieces, e.g. the literary history of Charlemagne's parents or the oldest (thirteenth-century) Italian version of the story of Alexander the Great.

The studies carried out by the philologists from the Jagiellonian University in Kraków allowed to unveil a part of European history, and the descriptions of manuscripts prepared by the scholars are a great tool for anyone who might want to study specific documents in the future.

The project has one more outcome. 'We have shown that it is possible to carry out this type of interdisciplinary research in terms of both thematic and linguistic diversity here in Kraków,' emphasises Prof. Piotr Tylus.

Jagiellonian University
Faculty of Philology, Institute of Romance Studies
ifr.filg.uj.edu.pl/en

Gdańsk Shakespeare Theatre: The Bard in Classic and Avant-garde Style

Gdańsk takes an important place on the world map of Shakespearean centres. The city owes this significance to Professor Jerzy Limon from the Faculty of Languages of the University of Gdańsk.

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PROFESSOR JERZY LIMON is an Anglicist, theatre historian, translator of English literature, writer, specialist in theatre studies and outstanding expert on William Shakespeare and his era. He has published a number of books and several dozen articles on theatre, including the English Renaissance theatre. Yet more than anything, Prof. Limon is a promoter of Shakespeare's work. Thanks to Prof. Limon, theatres from all over the world gather in Gdańsk every year in order to present their adaptations of the Bard's plays. So far, around 200 different theatre companies from more than 30 countries have participated in the Shakespeare Festival, including stagings prepared by theatre directors such as Peter Brook, Luk Perceval, Lev Dodin, or Eimuntas Nekrosius.

Prof. Limon is the originator and director of the Gdańsk Shakespeare Theatre. He was awarded the Officer of the Order of the British Empire in 2014 for his services of popularising Shakespeare's oeuvre. In 2019, he was presented with the prestigious Pragnell Shakespeare Award.

Theatres from all over the world gather in Gdańsk every year in order to present their adaptations of the Bard's plays.

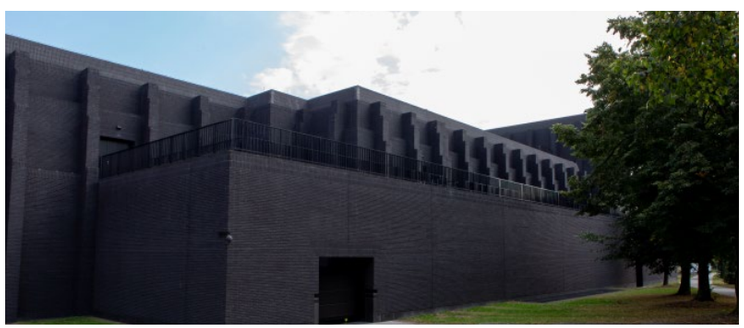
Where did the idea to create the Gdańsk Shakespeare Theatre come from?

PROF. JERZY LIMON: It originated from tradition: Gdańsk was first visited by English actors at the beginning of the 17th century, and they kept coming for more than half of the century. At that time, it was the largest and wealthiest city on the Baltic coast and a number of its inhabitants came from England and Scotland. From the beginning the actors became very popular. A special wooden building to host theatrical performances was even erected, where the actors performed under conditions very similar to those they had in London.

So we thought that since The Globe had been reconstructed in London, why shouldn't we revive the tradition of English actors' visits to Gdańsk and create an educational and artistic centre focused on Shakespeare.

The theatre was preceded by Gdańsk Shakespeare Days.

We brought the first performance from Great Britain in 1993. It was the Oxford State Company's staging of *The Comedy of Errors*. The English group also played a pantomime in the Long Market in Gdańsk. It attracted an audience of fifteen to twenty thousand people! Gdańsk Shakespeare Days



morphed into the Gdańsk Shakespeare Festival in 1997. But it was not until 2011 that we began to build the theatre. It was a long and tiring process. It goes without saying that the patronage of HRH The Prince of Wales was crucial to the final success, although the funding came from the European Union, the local municipality of Gdańsk and the region of Pomerania.

What is the concept behind the Gdańsk Shakespeare Theatre?

We want to show the diversity of contemporary theatre. That is why we don't only follow the current trends, but stage both classic and newest, cooler performances.

There are many Shakespeare festivals. What makes the one in Gdańsk so special?

A permanent element of our event are education activities. All performances are combined with lectures, activities for young people, meetings with the authors etc. We have our own independent programme 'SzekspirOFF'. It shows fringe theatres and various performances.

Performances in the Gdańsk Shakespeare Theatre, the 23th Shakespeare Festival.

Is it easy to promote Shakespeare in a country other than the UK?
Paradoxically, it is easier in Poland than in English-speaking countries. The Bard's language is fascinating for experts, but lay people and the young in particular have to struggle with his texts: the language is outdated, plenty of words have become obsolete; there are forgotten proverbs and out-of-date cultural and political codes. All this renders reception much more difficult. In translations, however – and we do have new translations fairly often in Poland – Shakespeare regains his voice. This modern language brings the work closer rather than introducing more distance.

Does the Gdańsk Shakespeare Theatre play only Shakespeare?
During the summer holidays, yes. In all other months, it is a normal theatre with a diverse repertoire. We run the 'Theatres of Europe and the World' cycle, in which we show performances of groups e.g. from the UK, Romania, Israel or China. Moreover, we show theatres from Poland, we offer educational programmes. The theatre is alive all year round, and is not only about Shakespeare.

Gdańsk Shakespeare Theatre
teatrszekspirowski.pl/en

Essay
Universities and Art. The Case: Poland

Professor Antoni Cygan
Professor Tomasz Szapiro

On the set of the Lodz Film School promotional film 'The Raven'.

ART UNIVERSITIES in Poland form a unique community of outstanding artists and teachers who guide their pupils towards the highest professional standards. What makes them unique is the time devoted directly to the adepts by renowned masters who dedicate some of their time to work at higher education institutions. On average, there are less than four students per instructor! This gives the teachers an unequalled opportunity to engage in intense individual work and to share their own philosophy of art. Thus, experienced pedagogues are able to accompany their students on their way towards artistic initiation.

Another distinguishing feature is the ability to bring the traditions of the grand Polish art schools into the modern times. The academic artistic genealogies extend over several generations and shape the combination of wisdom derived from tradition (the legacy of artists such as Grotowski, Abakanowicz or Lutosławski), reliable technique, artistic defiance and the endeavours to find one's own concept of artistic form. All these elements are clearly reflected in the curricula. They are the best way to release what defines the adepts' natural creativity.

Many art schools have modern, excellently equipped infrastructure. Moreover, they boast the highest rate of internationalization in comparison to the entire Polish higher education system – around five per cent of the arts students are foreigners from all parts of the globe.

Art schools are involved in cultural events also thanks to their close cooperation with the Ministry of Culture: they constitute vibrant

cultural centres with immense impact on the spiritual landscape of the respective Polish cities – they organise concerts, exhibitions and spectacles, among other things.

Art schools form an integral part of the Polish system of higher education. They carry out research and award academic degrees. Similarly as academic higher education institutions, public art schools are the subject of particular concern to the Polish authorities. They are mainly financed from public funds: they are supervised by the Minister of Science and Higher Education as well as the Minister of Culture and National Heritage. An academic community of art schools can compete for research grants on the same terms as researchers from other universities. They are represented on all major collegiate bodies within the higher education system. This fact demonstrates that the outstanding achievements in the area of science and arts both require great care, as they form two paths to truth that serves the humanity. It demonstrates that both science and art are indispensable in a healthy society. Art makes use of technology and scholarly cognitive strategies: it remodels them and engages with them in a dialogue. It is also a space for mediation between the once separate communities, which now meet through new technologies. It offers a unique opportunity of making breakthroughs in both art and science.

Public art schools, similarly to academic schools, are funded in accordance with the principle that more is given to the best, that is the institutions with greater achievements. This common principle underlies the various methods of comparing achievements in art and in science, including academic promotion. The requirements for obtaining academic degrees in arts are very rigorous. In order to meet them, one has to be able to combine artistic craftsmanship with scholarly value.

Differentiating between the truth of art and the truth of science is pointless. In each case, truth is discovered by following the methods that are proper for scholarly or artistic work, as the case may be. In art, these methods render it possible to separate the wheat from the chaff, bad writing from literature, daub from masterpiece painting and noise from music, just as the scholarly rigours enable us to distinguish science from pseudoscience and scientific hoax.

The common traits of science and art are their universal character and their appreciation for facts. Passion, impulse, the master/pupil relationship, the sense of mission and the significance of absolute values, as well as social sensitivity move the compasses in both areas – science and art alike. The unique incubator of the Polish system of art schools has produced numerous world renowned artists. Many of them have also worked in higher education institutions in Poland and abroad, where they have their students and followers.

Prof. Antoni Cygan, President of the Conference of Rectors of Artistic Schools in Poland, Rector of the Academy of Fine Arts in Katowice (2012-2020), painter

Prof. Tomasz Szapiro, President of the Accreditation and Rankings Committee of the Conference of Rectors of Academic Schools in Poland

Fine arts

1. *Art of Fashion conference at the Academy of Fine Arts in Gdańsk.*
2. *Stained glass workshop, the Eugeniusz Geppert Academy of Art and Design in Wroclaw.*
3. *Moving Image and Interaction Lab of the Academy of Fine Arts in Katowice.*
4. *Sculptural and performative workshops, University of the Arts Poznań.*
5. *Modern building of Academy of Fine Arts in Warsaw.*
6. *Annual Student Art Exhibition at The Academy of Fine Arts in Krakow.*
7. *The Center for Creative Industries – Academy of Art, Szczecin.*
8. *Main building of the Strzemiński Academy of Fine Arts Łódź.*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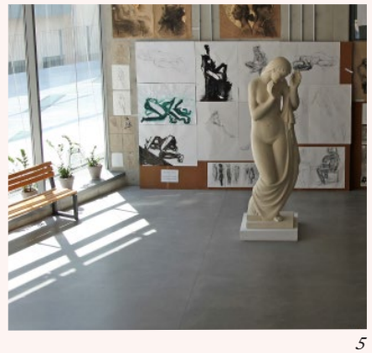
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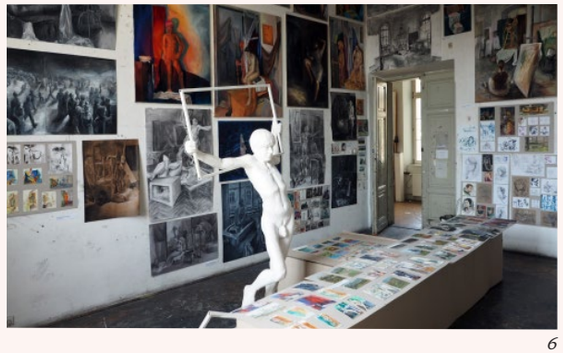
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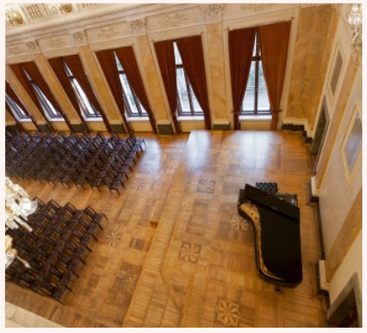

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Music

1. *Symphony Orchestra of the Karol Szymanowski Academy of Music in Katowice.*
2. *Faculty of Vocalism and Acting of the Stanisław Moniuszko Academy of Music in Gdansk.*
3. *Chamber Hall of the Grazyna and Kiejstut Bacewicz University of Music in Łódź.*
4. *Recital Hall of the Academy of Music in Kraków.*
5. *The Fryderyk Chopin University of Music in Warsaw.*
6. *Official Opening of the Karol Lipiński Academy of Music in Wrocław Concert Hall.*
7. *Project of the new building of the Feliks Nowowiejski Academy of Music in Bydgoszcz.*
8. *Violin Making Workshop at the Ignacy Jan Paderewski Academy of Music in Poznań.*

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Performing arts

1. *„To the Source", directed by Ewa Kaim-AST, National Academy of Theatre Arts in Krakow.*
2. *The Aleksander Zelwerowicz National Academy of Dramatic Art in Warsaw.*

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p. 181	Bartek Cieniawa/AST National Academy of Theatre Arts in Krakow; Bartek Warzecha/The Aleksander Zelwerowicz National Academy of Dramatic Art in Warsaw

THE MOST IMPORTANT POLISH INSTITUTIONS IN THE FIELD OF SCIENCE

Ministry of Science and Higher Education

Ministry of Science and Higher Education was established in May 2006. The ministry deals with issues connected with students, universities and scientists. It pursues a policy in the area of science and higher education in Poland. Experts prepare strategic solutions, care for the implementation of EU programmes and funds. The ministry supports the development of Polish universities, research institutes and scientific institutes of the Polish Academy of Sciences. The scientific community - agencies such as the National Science Centre, the National Centre for Research and Development and the Polish National Agency for Academic Exchange - co-decide on the distribution of funds for science.

ul. Hoża 20, ul. Wspólna 1/3
00-529 Warszawa
gov.pl/web/science

Polish National Agency for Academic Exchange (NAWA)

NAWA is a new institution that was established on October 1st, 2017. It is set up to coordinate state activities driving the process of internationalization of Polish academic and research institutions. The mission of NAWA is to foster the development of Poland in the area of science and higher education. NAWA goals are: support international mobility of students, academics and researchers and the process of internationalization of Polish HEIs and research institutions; promote Polish science and higher education and popularise teaching of the Polish language.

ul. Polna 40
00-635 Warszawa
nawa.gov.pl

National Centre for Research and Development (NCBR)

The main task of the NCBR is management and execution of strategic research and development programmes leading directly to the development of innovativeness. Among the tasks of the NCBR are: support of commercialisation and other forms of transfer of scientific research results, management of applied research programs and performance of national security and defence projects.

ul. Nowogrodzka 47a
00-695 Warszawa
ncbr.gov.pl

National Science Centre (NCN)

NCN is a government agency supervised by the Ministry of Science and Higher Education, set up in 2011 to support basic research in Poland. With a budget of over € 313 M a year, NCN funds projects in Arts, Humanities and Social Sciences, Life Sciences and Physical Sciences and Engineering. The NCN has set up 11 types of funding schemes addressed to researchers at different stages of their career.

ul. Twardowskiego 16
30-312 Kraków
ncn.gov.pl

The Łukasiewicz Research Network

The Łukasiewicz Research Network is a newly established (2019) unique project of great commercial potential. It integrates market players providing attractive, comprehensive and competitive business solutions in the fields of automation, chemicals, biomedicine, ICT, materials, and advanced manufacturing. With 8,000 staff and 38 research institutes located in 11 cities across Poland, it is the third largest research network in Europe.

Centrum Łukasiewicz
ul. Poleczki 19
02-822 Warszawa
lukasiewicz.gov.pl

Polish Academy of Sciences (PAS)

PAS is a national research institution founded in 1952. Its mission is to work comprehensively to further the advancement of science, in the service of society and for the enrichment of Poland's national culture, while adhering to the highest standards of research quality and ethical norms. The academy is an elected body of scholars. The basic scientific unit is the research institute.

Palace of Culture and Science
Plac Defilad 1
00-901 Warszawa
institution.pan.pl

Polish Academy of Arts and Sciences (PAU)

PAU was founded in 1872 as a result of the transformation of the Kraków Learned Society. After Poland regained its independence in 1918, the institution was renamed the Polish Academy of Arts and Sciences and became an official national representative of Polish learning, which entailed its participation in works of international organizations. PAU was a founder member of the International Union of Academies (IUA).

ul. Sławkowska 17
31-016 Kraków
pau.krakow.pl

Main Council of the Research Institutes (RGIB)

RGIB was established by the law in 2010. It represents interests of the research institutes to the state and local government authorities and to the scientific, economic and public organizations as well as to the opinion-forming elites. It participates in economic, public and specifically in science and innovation policies. RGIB consists of 106 research institutes.

ul. Instytutowa 1
03-302 Warszawa
rgib.org.pl

The Foundation for Polish Science

The Foundation for Polish Science has been in operation since 1991. It is a non-governmental, non-political, non-profit institution which pursues the mission of supporting science. It is the largest source of science funding in Poland outside of the state budget. The foundation realizes its statutory purposes through: support for distinguished scholars and research teams in all fields of inquiry; assisting innovative ventures and commercialisation of scientific discoveries and inventions.

ul. I. Krasickiego 20/22
02-611 Warszawa
fnp.org.pl

The Conference of Rectors of Academic Schools in Poland (CRASP)

CRASP was formed by Polish institutions of higher education with powers to award the doctor's degree (or equivalent) in at least one scientific discipline. CRASP is the representative body of academic schools. Founded in 1997, CRASP has 108 members (including 12 non-public schools) and 9 institutions have the status of an associated institution. The Conference of Rectors of Public Vocational Schools has the status of an associated conference.

University of Warsaw
Krakowskie Przedmieście 26/28
00-927 Warszawa
krasp.org.pl

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nawa.gov.pl/researchinpoland

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Universities and research centres in Poland

NUMBER OF STUDENTS IN POLAND

1.122 million

NUMBER OF RESEARCHERS IN POLAND

120,422

NUMBER OF UNIVERSITIES IN POLAND

387

NUMBER OF RESEARCH INSTITUTES OF THE POLISH ACADEMY OF SCIENCES

76

NUMBER OF RESEARCH INSTITUTES IN POLAND

118

NUMBER OF INSTITUTES IN THE ŁUKASIEWICZ RESEARCH NETWORK

38

NUMBERS OF UNIVERSITIES AND RESEARCH INSTITUTES IN EACH REGION OF POLAND WITH THEIR MAIN ACADEMIC CENTRES

	UNIVERSITIES	INSTITUTES OF POLISH ACADEMY OF SCIENCES	RESEARCH INSTITUTES	TOTAL
mazowieckie WARSAW	94	41	69	204
wielkopolskie POZNAŃ	36	7	8	51
śląskie KATOWICE	33	5	12	50
małopolskie KRAKÓW	29	11	5	45
dolnośląskie WROCŁAW	33	2	4	39
łódzkie ŁÓDŹ	23	3	8	34
pomorskie GDAŃSK	26	4	2	32
lubelskie LUBLIN	17	1	5	23
podkarpackie RZESZÓW	18	0	0	18
kujawsko-pomorskie TORUŃ, BYDGOSZCZ	17	0	1	18
zachodniopomorskie SZCZECIN	16	0	0	16
podlaskie BIAŁYSTOK	14	1	0	15
świętokrzyskie KIELCE	12	0	0	12
warmińsko-mazurskie OLSZTYN	7	1	2	10
opolskie OPOLE	6	0	2	8
lubuskie ZIELONA GÓRA, GORZÓW WLKP	6	0	0	6

Source: POL-on - Polish Higher Education Information System (2019)

Science in Poland in 34 Snapshots is not an attempt at ranking the best projects, scholars or institutes. Its message is simple: the Polish scholarly centres constitute a part of global research community and possess an interesting and valuable development potential. Each region of Poland, each discipline and each institution boast of individuals and teams who can become very attractive partners in ambitious, innovative research work.

From foreword by Professor Tomasz Szapiro

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