NEWSLETTER

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Around the members

- Wigner RCP, Hungary
- GSI, Germany
- ILL, France
- EPFL, Switzerland

In focus:

Technical University of Kosice, Slovakia – the success story of a unique academia-industry matching event

The interview:

Assoc. Prof. Jan Jadlovsky and Dr. Slavka Jadlovska, representatives of TUKE at HEPTech

HEPTech upcoming events

Unique diagnostic development at the Wigner Research Centre for Physics

The atomic beam probe is a unique extension of the beam emission spectroscopy (BES) diagnostic, being developed at the Wigner RCP, Hungary. BES is a special tool to diagnose plasma edge density. The working principle is the following: an accelerated ion beam is neutralized in Sodium vapor to get an atomic beam, which can be shot into the plasma, since the strong magnetic field has no effect on atoms. The beam atoms are excited by the plasma particles and emit photons during the de-excitation, which results in a glowing beam. This emission is measured by high-speed high sensitivity cameras and the researchers try to find out the plasma edge properties from that.

The scientists utilize another process with the atomic beam probe that happens simultaneously with the glowing, i.e. the ionization, since the beam atoms lose their electrons due to the collisions with the plasma particles. The magnetic field acts on the ions deflected through a curved path from the beam and collides with the wall of the machine. The spatial distribution of the ions hitting the wall carries important information about the magnetic field at the point of the ionization. The magnetic field at the ionization location depends on the current distribution, which cannot be measured by other means, and this makes the atomic beam probe a unique diagnostics. A special detector head and a measurement system were built for this purpose by the Wigner RCP team, the lab tests are currently underway and the system will be installed at the COMPASS tokamak experiment. More information

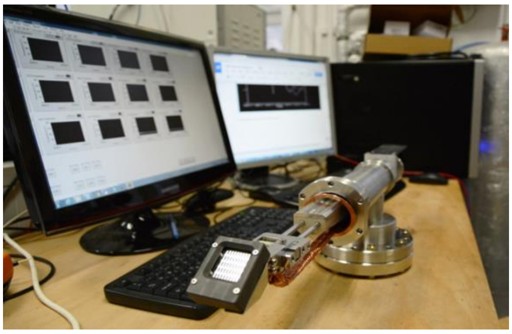


Photo: Wigner RCP

A research team measures liquid water with a temperature of -42.6º C

A research team of GSI Helmholtzzentrum für Schwerionenforschung successfully detected liquid water at a temperature far below the freezing point: -42.6ºC. This discovery is a result of the development work on experiments for the future accelerator center FAIR and it could also enable the progress in our understanding of the earth's climate.

In their research, the scientists demonstrated a new technology that achieves an unparalleled level of precision when measuring the temperature of extremely small droplets of water. The system does this by determining the temperature of a droplet on the basis of its diameter. In this process, uniform droplets of warm ultrapure water - only a few thousandths of a millimeter wide - are sprayed in a targeted jet of liquid into a vacuum chamber. The upper layers of the droplets evaporate and the inner layers cool off greatly, so the droplets shrink. This shrinkage can be precisely measured with optical methods, and the result is used to determine the droplets' temperature. A key element for such high-precision measurements is the unique instrumentation available at GSI for Raman spectroscopy, in which the droplets are illuminated with a laser beam. The spectrum and form of the scattered light enable scientists to determine the diameter of the droplets.

Droplets of supercooled water can also be found in the upper layers of the earth's atmosphere, where they exist under conditions similar to those created experimentally. More information

The experimental setup at GSI. (Photo: R. Grisenti)

Neutrons reveal hidden secrets of the hepatitis C virus

The hepatitis C virus (HCV) is a blood born virus that causes liver disease and cancer, with more than 300,000 people dying each year and 71 million people living with a chronic infection worldwide. While antiviral medicines are currently used, there is no vaccination currently available and side effects can results in a wrong diagnosis. In search of novel therapies for HCV, scientists have looked at the membrane protein p7, which plays a key role in the release of the virus.. However, there is little data available, and the crystallographic structure of the protein has not been resolved yet.

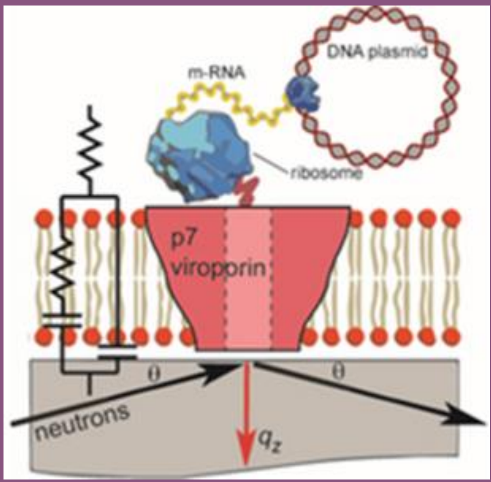
Recent investigations using neutrons have led to the development of a novel method for studying the protein's integration and structure within a native biological membrane environment. A collaboration between Synthelis SAS, University Grenoble Alpes, and the Institute Laue–Langevin (ILL) enabled researchers to observe for the first time the structure of a functional p7 protein complex from HCV within a physiologically relevant lipid bilayer, at nanoscale resolution.

To do this, the scientists performed neutron reflectometry (NR) on FIGARO, a time of flight reflectometer at the world's flagship centre for neutron science, ILL in Grenoble, France. Momentum transfer ranges of 0.008> qz> 0.2 Å-1 and minimum reflectivities of R ~ 5x10-7 were measured using wavelengths λ = 2-20 Å, two angles of incidence and a dqz/qz resolution of 10%.

The Nature Scientific Reports study found that the p7 protein from HCV assembles within the lipid membrane into oligomers that take the shape of a funnel. The conical shape indicates a preferred protein orientation, revealing a specific protein insertion

orientation, revealing a specific protein insertion mechanism, and helping to outline potential target mechanisms for future drug development.

As membrane protein dysfunction is also correlated with a wide range of diseases, this advancement in methods to analyse membrane proteins in their native condition, at an atomic scale, also has the potential to support new therapeutic approaches in other areas, such as the development of antibodies against HIV.



The cell-free preparation of supported bilayers containing p7 and NR and EIS measurements (not to scale). For neutron reflectivity, membranes were formed on quartz and an incident neutron beam was transmitted through the substrate and reflected from.

Credit: Thomas Soranzo (Synthelis SAS, University Grenoble Alpes), Donald K. Martin (University Grenoble Alpes), Jean-Luc Lenormand (University Grenoble Alpes), and Erik B. Watkins (Los Alamos National Laboratory)

More information

A tiny chip sends health signals through sweat analysis

Researchers at EPFL's [Nanoelectronic Devices Laboratory (Nanolab)] working in association with the startup [Xsensio] developed a tiny, fully portable system that can encapsulate and analyze biomarkers in a person's sweat. It includes two fluidic layers that sit between a chip and the user's skin. These layers "pump" up sweat from the skin and carry it to the sensors. As this pump relies entirely on capillary action, it runs continuously and without electricity. The miniature chip can be placed directly on the person's skin or integrated into a bracelet.

The chip contains four silicon sensors only around 20 nanometers thick and extremely sensitive. Each sensor is coated with a different material so that they can each detect different biomarkers. For instance, the sodium and potassium concentrations in the person's sweat could be determined and the body temperature and pH level could be measured.

The data the system collects can give important insight into the user's health and wellness. For example, chlorine levels can give an early indication of cystic fibrosis and ion levels can signal dehydration. Measurements of other biomarkers can flag symptoms of fatigue and stress, and eventually even risk factors for other illnesses. The collected data can be sent directly to a smartphone.

The system was presented at the 63rd International Electron Devices Meeting in San Francisco – a flagship industry event bringing together key actors from all over the world involved in the business or academic side of micro- and nanotechnology. More information

Credit: Alain Herzog , EPFL

A novel anti-tuberculosis drug goes into clinical trials

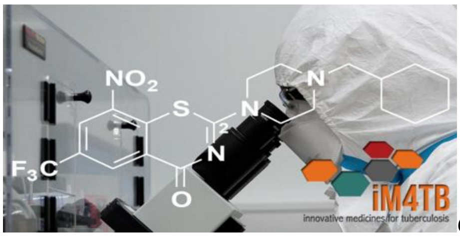
The EPFL-based non-profit organisation iM4TB has developed a novel anti-tuberculosis drug called PBTZ169 (license held by EPFL). PBTZ169 works by preventing the tuberculosis bacterium, *Mycobacterium tuberculosis*, from building its waxy cell envelope, which protects the bacterium from attack by the patient's immune system and antibiotics. By effectively destroying the envelope, PBTZ169 can kill drug-resistant tuberculosis bacteria, and potentially shorten therapy.

The antibiotic has proven effective in pre-clinical trials, while previous in *vivo studies* have shown that it works faster and more effectively than anti-tuberculosis drugs currently recommended by the World Health Organization.

Recently, Bill & Melinda Gates foundation awarded the iM4TB $2.45 million to take their innovative anti-tuberculosis drug PBTZ169 into clinical trials.

iM4TB is a non-profit entity based in EPFL's Innovation Park. Founded in 2013, its mission is *"to develop better and faster-acting medicines to fight tuberculosis and therefore bridge the gap between the scientific discovery and the market in order to provide affordable tuberculosis treatment to anyone in the world."* iM4TB is chaired by Professor Stewart Cole, a world-renowned expert in tuberculosis, who also directs EPFL's Global Health Institute.

According to the WHO, 10.4 million people fell ill with tuberculosis and 1.8 million died from it in 2015 alone. People with HIV are 30 times more susceptible to the disease, and over 95% of the deaths occur in low- and middle-income countries. More information



Credit: iM4TB

ESA and FAIR form partnership for researching cosmic radiation

One of the key questions that need to be addressed regarding the future of human spaceflight as well as robotic exploration programs is how cosmic radiation affects human beings, electronics, and materials. The detailed investigation of this topic is one of the main tasks that must be accomplished in order to provide astronauts and space systems with effective protection. To achieve this goal, the European Space Agency (ESA) will be cooperating closely in the future with the international accelerator center FAIR (Facility for Antiproton and Ion Research GmbH), which is currently being built at GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt.

When they move beyond the Earth's protective atmosphere and its magnetic field, astronauts, satellites, and space probes are exposed to cosmic rays. An essential component of cosmic rays are fast particles that are ejected into space during stellar explosions or emitted by the sun and by distant galaxies. What effects would radiation have on human beings and spacecraft during a long space journey, for example to Mars? What would happen to the sensitive electronics on board? What materials, in which thicknesses, would be suitable protective shields to mitigate these effects? Can radiation-resistant materials and electronic components be developed in a targeted manner? These are some of the basic questions that are crucial to the implementation of such space missions. The aim is to provide the best possible conditions for human beings and materials in space and to minimize the risks to health.

In the future, researchers at the FAIR accelerator facility will be able to generate the kinds of radiation that exist in space and make them available to scientists for their experiments.

For example, researchers will be able to investigate how cells and human DNA are altered or damaged by exposure to cosmic radiation and how well microchips stand up to the extreme conditions in space.

The central points of the cooperation agreement between ESA and FAIR include the research fields of radiation biology, electronic components, materials research, shielding materials, and instrument calibration. The research will be conducted at the future FAIR facility as well as at the existing accelerator facilities at GSI, which are currently being improved through major upgrading measures and prepared for their future use as preaccelerators for FAIR.

The two partners have also agreed to cooperate on technology and software developments and on additional joint activities in areas such as innovation management.

The results of the new partnership will provide future-oriented information not only for space travel but also for life on earth. For example, data from the experiments can provide more detailed insights into radiation risks on earth. They can also help to optimize radiation protection measures and improve radiation therapies for treating cancer.

ESA astronaut Alexander Gerst during an outboard operation.(Photo: ESA)

More information

Technical University of Kosice, Slovakia: The success story of a unique academia-industry matching event

Since its establishment in 1952, the Technical University of Košice not only meets a wide range of educational needs in the region of eastern Slovakia but has also proved itself as a regional leader in research in a number of technological areas and a preferred partner of industry.

The Faculty of Electrical Engineering and Informatics is one of the nine faculties at TUKE. It consists of 11 departments, one of which is the Department of Cybernetics and Artificial Intelligence. Its major research areas cover modeling and control of dynamic physical systems, intelligent methods and algorithms, and employment of information and control systems in industry.

The “Center of Modern Control Techniques and Industrial Informatics” (CMCT&II) is a research group at the Department of Cybernetics and Artificial Intelligence, focused on teaching and research in the field of advanced control techniques and industrial automation. The research and pedagogical activities of the Center are based on the five-level pyramid model of the distributed control system, built in accordance with the Industry 4.0 (Smart Industry) concept. The research is concentrated on the development of methods and tools for hybrid modeling and control of cyber-physical systems aiming to implement the obtained results at all levels of distributed control systems in accordance with Industry 4.0. Development of novel methods and algorithms for modeling, identification, control and diagnosis of nonlinear dynamical systems and their experimental verification using modern simulation tools, are also among the priorities.

In the area of fundamental research, CMCT&II members participate on behalf of TUKE in the international project "ALICE experiment at LHC at CERN: The study of highly interacting mass under extreme conditions". Currently, CMCT&II is involved in the development of a new generation of the pixel detector using the distributed control systems methodology in accordance with Industry 4.0.

Last year, representatives of CMCT&II initiated an academia-industry matching event dedicated to the implementation of Industry 4.0 technologies.

This idea triggered the creation of the Industry 4.0 Special Interest Group at HEPTech, and the organization of the event aiming to explore the mutual impact of Industry 4.0 and high-energy physics started.

The topic was unique itself, since besides the conferences discussing smart factories, products, manufacturing processes, etc., no events had been held to explore the specific links and interactions between scientific R&D and Industry 4.0 technologies.

This outstanding for Europe forum took place on 15 – 16 March 2018, in Stary Smokovec, High Tatras, Slovakia. It attracted about 80 participants, experts from business and academia. Industry demonstrated a very strong interest not only as a high level of attendance (44%) and a number of speakers but also with the sponsorship provided. The Enterprise Europe Network – Slovakia actively supported the forum and organized 25 bilateral face-2-face (B2B) meetings to enable cooperation arrangements between interested parties.

Over the two days, speakers from prominent European research institutions and leading companies, among which IBM and Siemens, discussed topics related to cyber-physical systems, modeling and simulation, big data, cloud computing and Internet of Things.

The CERN representatives valued the event as the first of its kind dealing directly with issues relating to HEP R&D in the context of the fourth industrial revolution and assumed that some of the solutions proposed by industry could be easily implemented in the CERN’s logistics. Industry representatives were enthusiastic about the opportunity to meet CERN researchers and benefited from the B2B meetings. The participants shared the opinion that HEP R&D could be considered both driver and user of Industry 4.0 technologies.

Photo: TUKE

THE INTERVIEW

Assoc. Prof. Ing. Jan Jadlovsky,
Team leader of the TUKE group in the ALICE Collaboration; Representative of TUKE at HEPTech

Dr. Slavka Jadlovska,
Chair of the Organising Committee of the event

How did you attract such a huge interest from industry – both as a percentage of participants (44%) and as a number of speakers?

The "Center of Modern Control Techniques and Industrial Informatics" (CMCT&II) closely cooperates with well-known suppliers of information and control technologies such as Siemens, IBM, MathWorks, ORACLE, etc., and with prominent manufacturing and R&D companies in the region of Eastern Slovakia (Kybernetika, ZTS VVU Kosice, US Steel Kosice, Spinea Presov, Chemosvit Svit, etc.).

We are also active members of the AT+R Cluster, which associates organizations dealing with automatic control and robotics in the region of Eastern Slovakia. After informing our industrial partners that we are co-organizing this event in cooperation with HEPTech and CERN, a number of them decided to participate in the forum and to support it financially as well.

Most speakers from companies we knew personally due to previous cooperation both at strategic and project level. Some of them used to work at the academia and we kept in touch after they moved to industry. Other speakers found the event advertised online and volunteered to give a talk.

All collaborating organizations felt there was a need to organize a conference focused on Industry 4.0. The idea was strongly supported by our partners from the academic environment as well.

What were the main challenges for organizing this academia-industry matching event and how did you address them?

The main challenges referred to the enormous communication efforts to negotiate and confirm the speakers. It was really helpful that the companies felt the need of such event.

Obtaining the B2B software required some efforts as well. Finally, we coped with the challenges thanks to the good cooperation with all our partners during the event's organisation and we are grateful for their support!

What are the plans of your research group at TUKE - the Center of Modern Control Techniques and Industrial Informatics - in relation to further Industry 4.0-related activities?

We will continue to build on our past and current results in areas such as advanced control design, distributed control systems, industrial/mobile robotics etc. in accordance with the Industry 4.0 strategy. Sub-areas such as modeling/simulation, cyber-physical systems or internet of things all apply. Our cooperation with CERN will continue as well, in line with the same principles.

As members of the Industry 4.0 Special Interest Group at HEPTech, we look forward to participate in further events on Industry 4.0 and possibly to share our insight and experience from this event.

HEPTech upcoming events

- HEPTech Leadership Training, 3rd – 4th May 2018, Abingdon, UK
- Steering Committee, 8th May 2018, at CERN, with VideoConference
- Large Laser Facilities for R&D in Industry, 24th – 25th May 2018, Prague
- HEPTech Symposium, 11-15 June 2018, ELI-ALPS, Szeget, Hungary
- Board Meeting, 19th June 2018, at CERN, with VideoConference
- Steering Committee, 17th October 2018, at CERN, with VideoConference
- Steering Committee, 21st November 2018, at CERN, with VideoConference
- Board Meeting, 7th December 2018, at CERN, with VideoConference