THE MAGAZINE

FOR PARTNERS AND CLIENTS

AUSTRIAN INSTITUTE OF TECHNOLOGY

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Coordinated by AIT, secure communication networks are currently being set up in Europe. Photo: GettyImages

The casting machine at AIT-LKR Ranshofen: Trials on a pilot plant scale serve to optimise numerous parameters in production processes.

HOW INDUSTRY IS BECOMING EMISSION-FREE

As part of the NEFI (New Energy for Industry) innovation network, the "envIoTcast – Environmentally Friendly Casting" project demonstrates how to avoid CO_2 in production processes.

The decarbonisation and transformation of the industrial energy system is an essential contribution to achieving national and European climate targets, since the manufacturing industry is responsible for a significant portion of the energy consumption and CO_2 emissions worldwide. However, industry has so far largely refrained from using CO_2-neutral technologies instead of relatively affordable natural gas for economic reasons. However, as a result of the current price dynamics, climate-neutral technologies have currently become economically competitive.

For this purpose, the AIT Austrian Institute of Technology is taking a close look at several energy-intensive high-temperature processes – such as smelting, casting, heat treatment and mechanical processing – in the NEFI project "envIoTcast – Environmentally Friendly Casting". The major goals of the project are to increase energy efficiency by up to 30 per cent by reducing heat losses, increasing waste heat utilisation and central control of processes, and to completely decarbonise the remaining energy consumption by switching to CO_2-neutral primary energy sources.

"The envIoTcast project develops and demonstrates the modern, sustainable concept of Green Foundry 4.0. The first results show that even in energy-intensive sectors such as steel and aluminium processing, fossil fuels can be completely replaced by renewables," explains Wolfgang Hribernik, head of the AIT Center for Energy and NEFI network coordinator. Under the leadership of AIT, partners from Upper Austrian industry and research such as LKR Leichtmetall-

kompetenzzentrum Ranshofen GmbH, HOFMANN Wärmetechnik GmbH, Ing. Martin Johann Fischer and the Upper Austrian location agency Business Upper Austria are working together in envIoT-cast.

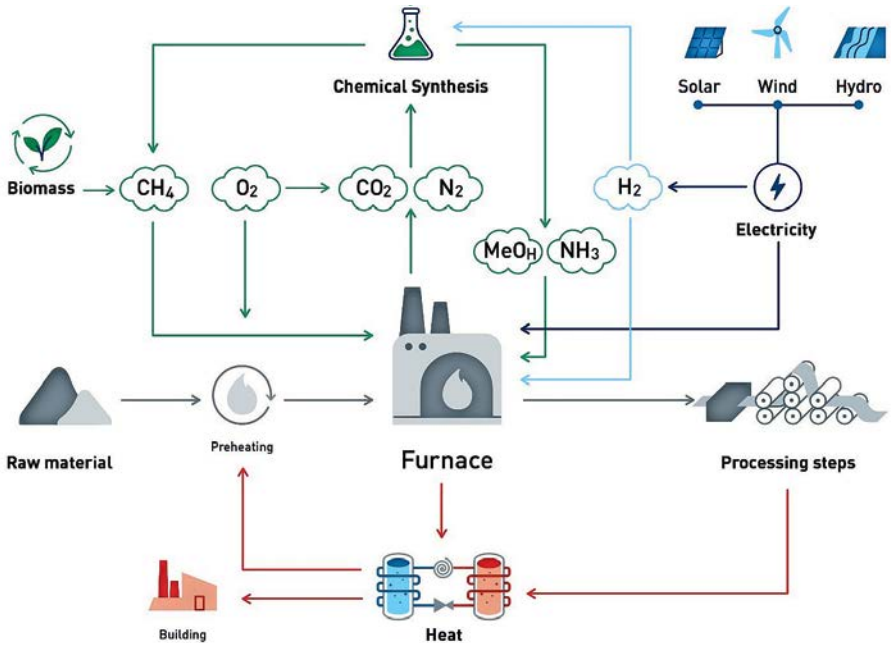
One of the real use cases in Green Foundry 4.0 is the decarbonisation of industrial furnaces in steel processing. "In envIoTcast, we are investigating several industrial companies in terms of a feasible switch to alternatives for natural gas. With our labs and simulation methods, we can see which energy source represents a climate-neutral alternative for the respective industrial furnace and production process. Many furnaces can be heated with green electricity instead of natural gas; others can be switched to green hydrogen, biomethane or synthetic methane," explains project manager Christoph Zauner.

To be specific, these decarbonisation potentials are being investigated in heat treatment plants at various voestalpine sites. When it comes to the heat treatment of metal in the course of steel processing, the ONE alternative to natural gas does not exist. Rather, the question that arises is which energy source is the most suitable for the respective specific application. Options include green electricity and green methane, which is produced by purifying biogas or synthesising it with hydrogen and CO_2.

"In particular at high temperatures above 900 °C, green methane produced by methanisation or in biogas plants is a very good alternative. There is also great potential in the use of furnace waste heat and the digitisation of processes, whereby up to 30 per cent of energy can be saved," says Zauner. When natural gas is burned in industrial furnaces, it produces a flue gas with about 15 percent by volume (vol%) CO_2, 15 vol% H_2O and 70 vol% N_2. The CO_2 component can be separated using proven technologies and converted ("methanised") back into methane (CH_4) using green hydrogen. This "green methane" can then be burned again in the furnace without any process changeover. This results in a cycle in which no CO_2 is released into the atmosphere. Such plants can be realised with today's components up to the 100 MW range and have already been operating successfully in the 10 MW range for years.

"In the Green Foundry 4.0, additional solutions are being developed for more energy efficiency through waste heat utilisation as well as for the digitisation of process flows for climate-neutral production," adds Hribernik. The solutions are scalable on a global scale and have enormous potential for decarbonising the energy supply.

The production of casting parts takes place in foundries in several sequential individual steps – smelting, casting, heat treatment, mechanical processing – which are currently largely separated from each other in terms of energy and information technology. For this reason, no holistic energy optimisation has taken place to date.



Schematic representation of the future fully decarbonised energy system for steel processing: The concept is based on a set of suitable CO_2-neutral energy sources and different technological innovations.

Photos: AIT, AIT/Florentina Queder

NEFI – New Energy for Industry

NEFI – New Energy for Industry is part of the "Energy Model Region" and pursues the approach of decarbonising the industrial energy system with the help of key technologies "made in Austria". The NEFI innovation network has formed around a consortium consisting of the AIT Austrian Institute of Technology (coordinator), Montanuniversität Leoben, the Upper Austrian Energy Saving Association and the Upper Austrian location agency Business Upper Austria, and brings together a wide range of experience in the field of energy research and project implementation. The continuously growing consortium with more than 100 companies, research institutes, and public institutions is developing technological and systemic solutions in the first 24 projects for the implementation of the energy transition in industry. The Climate and Energy Fund supports the NEFI projects with a total of 30.2 million euros, endowed with funds from the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). Significant support comes from the two industrially strong federal states of Upper Austria and Styria.

Christiane Egger (Upper Austrian Energy Saving Association), Markus Achleitner (Upper Austrian Provincial Councillor for Economic, Scientific and Research Agendas), Henriette Spyra (Section Head at BMK) and Wolfgang Hribernik (AIT, NEFI Network Coordinator) at the second scientific NEFI conference in Linz in mid-October.

At the second international scientific conference of the NEFI Innovation Network in Linz in mid-October, around 35 speakers from research, business, and politics discussed the transformation and decarbonisation of the industrial energy system with the approx. 220 participants.

The Young Scientist Award was presented as well: First place went ex equo to Vanessa Zawodnik (Montanuniversität Leoben) and Nadine Brunnhuber (Institute of Industrial Ecology), third place went to Jana Reiter (AEE Intec).

Keynotes and session presentations of the NEFI conference are available for download at https://www.nefi.at/de/nefi-konferenz.

www.nefi.at

NEFI projects with AIT participation

In addition to enviotcast, the AIT is also significantly involved in or coordinates many other ongoing NEFI projects. Cases in point are:

In the **Heat Highway** project, industrial waste heat is used for the decarbonisation of the heat supply of regions.

EDDY – Enhanced Drying focuses on optimising industrial drying in the agricultural commodity industry and the food industry.

Low Pressure Steam Heat Pump (LEAP) focuses on the development of innovative integration measures of heat pump systems for low-pressure steam supply from industrial waste heat.

The **Industry4Redispatch (I4RD)** project is examining innovative, grid-supporting solutions that enable the provision of flexibility from the demand and supply side at the distribution network level.

In **Clean Energy for Tourism (CE4T),** energy demand, energy efficiency, and the use of renewable energies in the tourism industry – especially in winter tourism – were optimised.

In the **Smart Anergy Quarter Baden (SANBA)**, a low-temperature heating and cooling network was developed on the site of the former Martinek barracks in Baden which uses industrial waste heat, geothermal energy, photovoltaics, and solar thermal energy.

The **Cascade** project focuses on the use of geothermal energy in industry and the district heating network. Deep and shallow geothermal resources are analysed in three areas in Upper Austria.

The goals of the **GreenSteel** project are to develop concepts and technical solutions in order to decarbonise steel production by 100 per cent. The solutions are also tested and shown at selected locations.

Photo: AIT/NEFI

Many soils are contaminated with oil products and other chemicals.

WITH BACTERIA IN THE FIGHT AGAINST POLLUTION

The EU project MIBIREM, led by AIT, aims to exploit the potential of microbiomes for the purification of contaminated soils and groundwater.

There are currently 324,000 significantly contaminated sites in Europe, such as refineries, power plants, and chemical industry production sites. These contaminated soils pose a significant risk to people and the environment. Conventional rehabilitation technologies are often complex, too expensive and technically demanding. Biology offers a different approach to the problem – specifically: Microbiomes, i.e. the totality of microorganisms that colonise a particular biosphere. Some bacteria, fungi and other microorganisms are able to break down organic substances in the soil and groundwater: Those local microbiomes produce enzymes that can remove pollutants from the environment. This process is called "bioremediation".
A Europe-wide research consortium under the scientific leadership of the AIT Austrian Institute of Technology now wants to exploit and optimise the potential of this natural process. In the just launched Horizon Europe project "MIBIREM – Toolbox for Microbiome based Remediation" which is funded by the EU with nearly six million euros, an innovative toolbox for the identification, analysis, cultivation, and enlargement of microbiomes for bioremediation in the environment will be developed and applied over the next four and a half years.

Toolbox with innovative methods

Three use cases were selected – to be specific: Cyanides (salts and compounds of hydrocyanic acid), HCH (hexachlorocyclohexane) and PHC (petroleum hydrocarbons). The performance of the microbiomes is tested in pilot trials under real field conditions. The improvement of the functions of microbiomes in the degradation of pollutants in soil and groundwater is an important contribution to achieving the European environmental goals for soil health and food.
"The resulting MIBIREM toolbox should help to make better use of pollutant-degrading microbiomes in the future," explains MIBIREM's scientific coordinator, Thomas Reichenauer (AIT Center for Health & Bioresources). Eleven partners from six EU Member States (Austria, Belgium, France, Germany, Italy and the Netherlands) are also on board, with the Austrian RTDS group coordinating the project.

AIT microbiome expert Angela Sessitsch again among the "Highly Cited Researchers"

Already for the fifth year in a row, Angela Sessitsch, Head of the Competence Unit Bioresources at the AIT Center for Health & Bioresources, is among the most frequently cited researchers worldwide. She is one of 46 research personalities working in Austria on this list – and one of only two women in this ranking. Scientific papers published and cited between 2011 and 2021 were used for the analysis by the data company Clarivate Analytics. A total of 6,938 scientists from 69 countries rank in the top one percent in their scientific field.
Sessitsch has been researching microbiomes – the entirety of all microorganisms at a given location – and their interactions with plants for many years. One of the aims is to minimise the need for fertilisers and pesticides and to make plants more resistant to climate change. Angela Sessitsch is also Vice President of the ÖGMBT – Austrian Association of Molecular Life Sciences and Biotechnology.

Further information on the ranking: https://clarivate.com/highly-cited-researchers/analysis/

Photo: GettyImages, AIT/Thomas Teskey

Quantum physical phenomena allow the establishment of absolutely secure communication networks.

SECURE QUANTUM COMMUNICATION

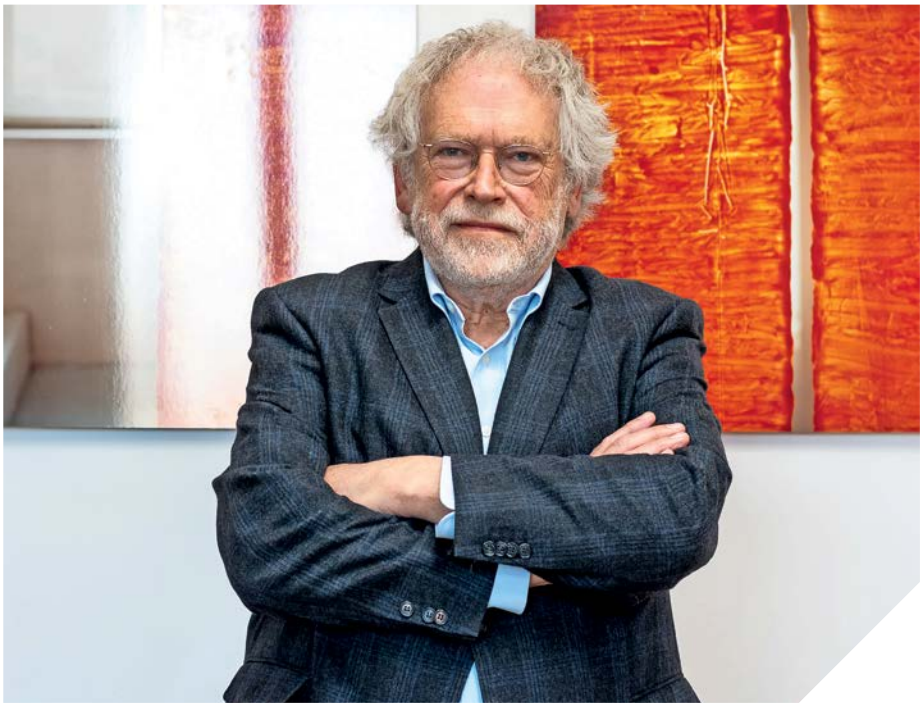
In his basic research, physics Nobel Prize winner Anton Zeilinger laid the foundation for the development and practical implementation of quantum communication technologies at the AIT Austrian Institute of Technology. The objective is to make this secure technology suitable for everyday use and to establish a quantum communication network in Europe.

One of the most important measures against cybercrime is the encryption of data. Modern cryptography methods are de facto indecipherable, but face the challenge that the key must be transmitted from the sender to the recipient in an absolutely secure way. Quantum physics will help here in the future: With the help of "entangled" particles, you can exchange confidential information – and you notice immediately if someone is listening in on this communication. The Viennese quantum physicist Anton Zeilinger (University of Vienna, Austrian Academy of Sciences) showed about 25 years ago that this principle can be used in practice in the form of so-called "teleportation". Zeilinger was awarded the 2022 Nobel Prize in Physics for this work on quantum-physical entanglement in October – together with his colleagues John Clauser and Alain Aspect.

Technical application of the scientific findings

Researchers from AIT have been involved in Zeilinger's experiments from the very beginning: They develop the technical equipment for quantum cryptography and organise large research networks, such as the EU project SEQOQC involving 41 partners from twelve countries. Meanwhile, AIT has acquired an excellent international reputation as a specialist in both terrestrial and satellite-based quantum cryptography and as a coordinator of major European projects.

Currently, the work is particularly focused on the miniaturisation of the devices required for quantum communication. "We are building prototypes that have the same functionality as large lab set-ups but are integrated on an optical chip," explains AIT researcher Hannes Hübel. The aim is to create small and compact terminals that can be easily utilised by users who have a fibre-optic connection – similar to the way a modem is used today to access the Internet from a computer. For instance, a miniaturised QKD transmitter with a photonically



The Viennese quantum physicist Anton Zeilinger was awarded the 2022 Nobel Prize in Physics for his groundbreaking work. His ideas are now being brought to practical fruition – with strong AIT participation.

integrated chip carrying all components such as lasers, modulators and attenuators was recently presented at Europe's largest IT security trade fair "it-sa". This transmitter generates quantum cryptographically secured keys at a rate of 1kbit/s over a distance of 30 kilometres. Also presented was a compact quantum random number generator in which the randomness is based on quantum mechanical effects and therefore cannot be predicted. This allows today's existing encryption algorithms to be significantly strengthened as well.

On the way to a quantum industry

This research and development is taking place as part of the large European Quantum Flagship programme which was launched in 2018 with a time frame of ten years and a funding volume of one billion euros. As part of this, AIT is leading the UNIQORN project (Affordable Quantum Communication for Everyone: Revolutionizing the Quantum Ecosystem from Fabrication to Application). Together with 17 partners from Europe, photonic technologies are being used to advance the miniaturisation of quantum applications towards system-on-chip solutions (see also page 16). The project "CiViQ" (Continuous Variable Quantum Communications) focuses on the cost-efficient integration of quantum communications into the emerging optical telecommunications networks. 21 partners are working on flexible and cost-effective systems for the distribution of quantum keys. In this project, AIT is developing QKD prototypes and specialised software for use in the field.

Testbeds and secure networks

Another line of attack to make quantum communication suitable for everyday use is the establishment of networks and testbeds in Europe. Already in September 2019, the EU launched the Horizon 2020 project "OPENQKD" (Open European Quantum Key Distribution Testbed), which is scheduled for three years and funded with 15 million euros. The AIT-led consortium comprises 38 partners from 13 countries – with the aim of establishing a secure network for quantum communications in Europe and thus launching a European ecosystem for quantum technology providers and application developers. This includes e.g. storage in cloud infrastructures, the protection of sensitive medical information (testbed in Graz), and communication data of public authorities (testbed in Vienna).

"OPENQKD" is also the first pilot project under the " EuroQCI" initiative (European Quantum Communication Infrastructure Initiative), in which a European cybersh-ield based on a quantum communication infrastructure is to be established over the next ten years. The "QCI4EU" study in which the user requirements and use cases are specified has been running since February 2020 with AIT as project partner. Based on this, an overall system architecture for EuroQCI will be developed. This system architecture is composed of terrestrial and space-based solutions that are "secure by design" and cover the entire European Union.

Quantum technologies have long since arrived in space as well. The project "QUARTZ" (Quantum Cryptography Telecommunication System) has been running since 2018. It is supported by the European Space Agency ESA and includes eight other renowned research institutions, universities, and companies in addition to AIT and project coordinator SES (the world's leading satellite operator). It is developing a satellite-based cybersecurity system based on quantum encryption. Thanks to the unlimited coverage provided by satellites, the limitations of fibre-based QKD systems that exist today – with transmission ranges of a few hundred kilometres – can be overcome, and a globally available cybersecurity system can also be made available for networks in remote regions.

FOCUS ON PERFORMANCE

Digital Safety & Security
Presentation of the latest security technologies

Together with its partners X-Net, Rimage Europe, LISEC and ThreatGet, AIT presented exciting innovations at the "it-sa" trade fair in Nuremberg, Europe's largest trade fair for IT security. In addition to the equipment for absolutely tap-proof quantum communication (see page 6) and the Fake Shop Detector, which automatically detects fake shops on the internet as a plug-in for internet browsers and warns users of dangers in real time, the ThreatGet security tool, which has already won several awards, was on display as well: This system is based on Artificial Intelligence and makes it possible for the first time to analyse the entire system architecture of safety-critical applications, such as connected vehicles. The Sec³ Secure Cloud Connecting System, which offers maximum security for machines and IoT devices in accordance with the principle of "Security by Isolation" (SBI), met with great interest in the area of "Industry 4.0": It prevents a single successfully attacked IoT device from mutating into an attack vector against all devices connected to the cloud. The USB-based Rimage RX400 storage device copy system offers fast and secure data storage and sharing in areas where cloud solutions reach their limits, providing valuable services in particular for sensitive data, such as in the medical environment or forensics.

Energy
AIT showed the latest technologies in heat pumps

The world's leading trade fair and conference for refrigeration, air conditioning, ventilation, and heat pump technology gave the AIT Center for Energy the opportunity to present its latest technologies to an expert audience from industry and research. Augmented reality simulators for optimising industrial applications and heating/cooling applications with heat pumps and renewable energies were shown on a smartphone basis and with Microsoft HoloLens. In the process, heat pumps and plants are fully visualised in 3D as freely rotatable and zoomable holograms; complex production and energy data are clearly displayed, enabling planning and optimisation of future CO_2-neutral industrial sites and sound-optimised residential complexes. A further innovation, in which AIT is a European leader, is the investigation and optimisation of sound immissions from air-heating pumps using an acoustic camera, acoustic dome, and vibration sensors. Heat pumps with alternative refrigerants – such as HFOs (hydrofluoroolefin) and natural refrigerants (such as propane, butane or isobutane) – and minimal refrigerant quantities were presented as well.

Innovation Systems & Policy
Responsible Research and & Innovation

In the EU project DigiTeRRI which was recently concluded with a major conference in Vienna, three traditional industrial regions in Austria, France, and Sweden (Styria, Grand Est, and Värmland) are being supported in taking advantage of the opportunities of digitisation. In DigiTeRRI, roadmaps for a responsible transition to self-sustaining, digitised industrial innovation ecosystems were developed together with many stakeholders. Another focal point were the challenges that arise in the interplay between business, science, politics, and society. Openness, democratic accountability, and agility are to contribute to promoting resilience within these new, digitalised innovation ecosystems. Important attributes for a successful transition are gender equality, science education, open access, public engagement, and ethics, supporting both organisations and citizens in their adaptation to the transition. Ultimately, the project developed twelve measures in each area and implemented them in the three regions.
www.digiterri.eu

Video with project coordinator Marianne Hörlesberger:
https://youtu.be/dfw4KIKeVxE

Photos: GettyImages, AIT, www.digiterri.eu

Low-Emission Transport

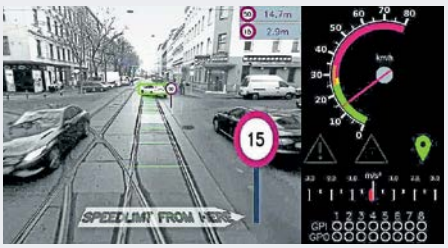
Highly successful Light Metal Days 2022

How can lightweight construction contribute to making mobility more sustainable? What possibilities are there to minimise resource consumption in the aluminium industry by means of recycling and circular economy approaches? And what will the "Green Foundry 4.0" of the future look like (see also p. 2)? These and many other questions were the subjects of the 12th Ranshofen Light Metal Days 2022 which took place on 6–7 October 2022 at the University Mozarteum Salzburg under the title "Green Processes & Sustainable Materials". Three keynotes, 18 presentations from research and industry, a panel discussion as well as a pitch and a poster session made the Light Metals Days one of the most high-profile events in the light metals sector. The conference was rounded off by a sociable evening in Salzburg's LOFT, with a view of the Salzach and the beautiful historic city centre. In an accompanying industrial exhibition, renowned companies from industry, research, and testing technology presented the latest trends and technologies. And in a poster exhibition, young scientists provided an insight into current research results.

www.lmt.ait.ac.at

Vision, Automation & Control

How tramways are becoming intelligent and autonomous



Many new cars are already equipped with driver assistance systems that serve road safety. Tramways are being equipped with such systems as well. AIT has done pioneering work in this field and has already developed two such systems: firstly, a system that helps drivers to avoid dangerous overspeeding; and secondly, a system that warns of obstacles via a stereo camera to prevent collisions. The assistance systems are already being used in many fleets, e.g. in Frankfurt or Zurich.

Building on this, a system has now been developed in the INTELLiTRAM project (Intelligent Tramways through Sense, Learn and React) that uses Artificial Intelligence (AI) to learn to understand traffic situations. The primary aim is to prevent injuries to persons. "In order to operate even more safely in the future, tramways need to learn anticipatory behaviour," explains AIT project manager Christian Zinner. Another objective is (partially) autonomous driving – e.g. when parking in the service yard. Europe's largest rail vehicle manufacturer Alstom (formerly Bombardier) and Mission Embedded participated as well. The three-year project was funded in the FFG programme "Mobility of the Future" by the Climate Protection Ministry.

Energy

Two new doctoral programmes

The AIT Center for Energy is now starting two new doctoral programmes in cooperation with universities. Together with Graz University of Technology, a PhD programme for the development of innovative hydrogen technologies with a focus on reversible high-temperature electrolysis will be launched in the summer semester of 2023. In doing so, the two institutions want to accelerate the development of innovative and efficient technologies for the production of green hydrogen and further strengthen their collaboration. High-temperature electrolysis is a promising process, but still requires some research, particularly with regard to the materials used and its integration into industrial processes. These questions are to be addressed in four dissertations – two at AIT in Vienna and two at the Graz University of Technology – with a three-year duration.

A second new PhD programme, together with Delft University of Technology (TU Delft), focuses on the transformation of the energy system by means of Artificial Intelligence (AI) and Machine Learning. The focus is on the potentials associated with digitisation for an efficient, reliable, and safe operation of the energy infrastructure. With the help of AI, innovative methods for the planning and operation of future sustainable energy systems are to be developed in six dissertations with a four-year duration.

Photos: AIT (2), TU Delft

Health & Bioresources

Winfried Neuhaus heads the EU network IMPROVE

AIT Principal Scientist Winfried Neuhaus (Competence Unit Molecular Diagnostics of the Center for Health & Bioresources) coordinates the COST Action "IMPROVE – 3Rs concepts to improve the quality of biomedical science". The aim of this EU network is to use the experience from the 3R field to improve reproducibility and predictability in biomedical research. The abbreviation 3R stands for Replace (replacement of animal experiments), Reduce (reduction in the number of experiments), and Refine (improvement of experiments). In the process, obtaining better scientific data goes hand in hand with animal welfare in scientific work and experimental design.
Neuhaus heads the Biological Barriers Group at AIT and is an expert in the field of alternatives for animal models. Besides his role at AIT, he is president of EUSAAT, a society that promotes animal model alternatives, and acts as coordinator of the European 3R Centres EU3Rnet. With Neuhaus, the first professorship for alternatives to animal experimentation was also recently established at the Danube Private University.

Innovation Systems & Policy

EU missions in Austria

The EU's five missions are to shape European research in the coming years. Together, solutions to some of the greatest challenges of our time, such as climate change, polluted waters and soils, and the fight against cancer, are to be found. A study conducted by AIT together with Joanneum Research has now surveyed the starting position and potential of the Austrian RTI landscape in terms of mission-oriented research. "The data collected in interviews, online surveys and from funded national or H2020 projects as well as publications in the Web of Science as part of the baseline study span thematic landscapes and provide insights into the strategic orientations, specialisation patterns and cooperation structures or needs of relevant research actors both across missions and within the five missions," says project leader Andrea Kasztler from the AIT Center for Innovation Systems & Policy. The results show that Austria has connecting points for positioning itself at the European level in all five missions. An above-average positioning has already been achieved in the mission areas Cities, Climate, Cancer, and Soil in HORIZON 2020. At the same time, the survey reveals that the environmentally oriented missions have potential for synergy.
https://era.gv.at/public/documents/4713/Baseline_Studie_zu_EU-Missionen_in_Österreich_v2.pdf

Low Emission Transport

BatWoMan: Climate-friendly batteries

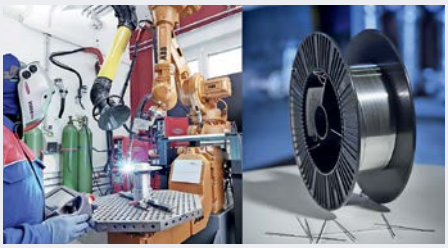
Electric vehicles use energy much more efficiently than conventional vehicles with combustion engines and thus play a decisive role in the achievement of climate targets. And yet, the resource-conserving, sustainable, and climate-friendly production of battery cells still poses a major challenge. This is where the EU research project BatWoMan ("Carbon Neutral European Battery Cell Production with Sustainable, Innovative Processes and 3D Electrode Design to Manufacture") led by AIT comes into play: Together with six partners from Germany, Spain, Italy, and Sweden, new, innovative, and above all sustainable processes for battery cell production are being developed to support the EU on its way to CO_2 neutrality in manufacturing accumulators. The development focuses on energy-efficient processing of 3D-structured electrodes, innovative electrolyte filling processes and cost- and energy-efficient cell conditioning. An AI-based platform will digitally support these manufacturing strategies. In order to display sustainability, a battery data space is being created on which all relevant cell construction processes and the use of raw materials and energy are displayed. This should e.g. serve for recycling.

Photos: AIT (2), BatWoMan

Vision, Automation & Control
Hotspot of image processing

Under the motto "From Sensor to Decision", AIT scientists presented four innovative approaches to automated surface inspection at VISION, the world's leading trade fair for image processing in Stuttgart. ICI:microscopy's inline 3D-microscopy method is suitable for inspection tasks with extremely high resolutions (up to 700 nm) and large inspection areas (see also p. 15). The TinyScan360°, a miniaturised 3D stereo scanning system, allows the smallest cavities to be measured and exact digital replicas to be created. The strength of xposure:photometry lies in the reliable detection of defects at very high inspection speeds, even for difficult surface properties. ICI:inspect combines light field and photometry and simulates human inspection such as tilting the object and changing the viewing perspective. In this way, even the most subtle changes in the surface are detected and evaluated by intelligent algorithms. With its open booth design and live demonstrators, the AIT booth attracted more than 120 different companies. The fact that AIT is a key player is also shown by the visitor statistics. Of the 6,500 trade fair visitors, one in ten visited the AIT booth.

Low-Emission Transport
MAST3RBoost: New types of hydrogen tanks



As a contribution to decarbonising the transport sector, the EU project MAST3RBoost (Maturing the Production Standards of Ultraporous Structures for High Density Hydrogen Storage Bank Operating on Swinging Temperatures and Low Compression) has now been launched. It aims to create an industrially viable solution for H_2 storage at a cryogenic storage temperature (~–180°C) under compression (100 bar) through the development of a new generation of ultra-porous storage materials (activated carbons/ACs and metal-organic frameworks/MOFs) for hydrogen-powered vehicles (road, rail, air, and water transport). The aim is to increase the H_2 uptake capacity by 30 per cent and to transition lab-scale synthesis processes into industrial-scale manufacturing processes. AIT's LKR Light Metal Competence Centre Ranshofen is contributing its expertise in wire-arc additive manufacturing (WAAM) to the project led by Envirohemp (Spain). "The demonstrator component, a new type of hydrogen tank, is to be manufactured at the LKR using WAAM. This will involve the use of special aluminium and magnesium alloys developed at the LKR," explains Stephan Ucsnik, who is responsible for the AIT project. In the sense of a circular economy approach, recycled raw materials in particular are used.

Technology Experience
The future of hybrid worlds

The aim of the "COVID Pop-up Hub" project initiated by the BMK (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology), which was launched at the beginning of the Corona crisis, was to identify topics that are important to learn from the crisis and for dealing with other crises. This was discussed by experts and interested persons in an online platform in the three topic areas of future scenarios, state intervention, and distancing. The follow-up project "COVID Pop-up Lab" saw a stronger focus on hybridity – the interaction of real and virtual worlds. It turned out that hybrid spaces (including the question of which technologies are necessary for this) are THE big topic for successful collaborative work. At the closing event of the Pop-up Lab, it was now agreed that hybridity, which received a boost from virtual meetings and video calls during the pandemic, was here to stay. However, human beings and their needs would have to be brought further into centre stage. Integration and inclusion are becoming increasingly important, they said. "Hybrid spaces are only at their beginnings," emphasised Manfred Tscheligi, head of the AIT Center for Technology Experience, at the final discussion. The objectives are known – now it is time to build the hybrid spaces of the future, says Tscheligi.

Photos: AIT, AIT/LKR, AIT/timeline/Rudi Handl

Awards for technologies from AIT

The Virtual Reality training solution for police training in Europe, developed under the leadership of the AIT Center for Technology Experience in the EU project SHOTPROS, has now been awarded the eAward. VR training offers enormous advantages, particularly in the police sector, because a wide variety of operational scenarios can be trained and analysed under realistic conditions at different levels of difficulty.

The AIT Center for Energy was able to earn an extremely honourable nomination for the State Award for Innovation 2022 – namely for the special VERENA award: Together with Austria Email AG, the World-Direct eBusiness solutions GmbH and the University of Innsbruck, the "smartBoiler ECO Grid" system, which uses hot water appliances as flexible consumers or energy storage units in the electricity grid, was developed.

AI5PRODUCTION: KNOW-HOW FOR COMPANIES

The new European Digital Innovation Hub (EDIH) "AI5production" started its work at the beginning of November 2022. It is intended to support domestic manufacturing companies with up to 3,000 employees in all aspects of digitisation. The AIT Austrian Institute of Technology is participating – together with 15 other partner organisations – with the Center for Digital Safety & Security (coordinator at AIT), the Center for Technology Experience, the Center for Vision, Automation & Control and the LKR Light Metal Competence Centre Ranshofen.

At the kick-off event in Vienna's House of Industry, Claudia Schickling, coordinator of AI5production and head of the Pilot Factory Industry 4.0 at the Vienna University of Technology, outlined the four pillars on which AI5production's comprehensive offering rests: Access to test infrastructure (test before invest); skills and training activities; access to the partners' innovation ecosystem; and networking – with the aim of developing individual problem solutions through to support in finding funding opportunities for all aspects of digitisation. As Manfred Tscheligi, Head of the AIT Center of Technology Experience, emphasised in his keynote speech, people must always be at the centre of all automation. "The move towards Industry 5.0 brings a new understanding of roles for workers, but it is always important to pay attention to safe and inclusive work environments and Human Centered AI." This includes a focus on the necessary abilities and digital skills of the employees as well as on the usability and acceptance of new technologies.

The EDIHs are funded by the European Commission as part of the "Digital Europe" programme and from the national side by the BMAW. In total, 17 million euros are available.

www.ai5production.at

FIGHTING TOGETHER AGAINST FAKE

The AIT Austrian Institute Of Technology and the Austria Press Agency (APA) are strengthening their collaboration in the field of fake news detection. Already in the past years, the research project "defalsif-AI" was a focus of collaboration in which a new, AI-supported tool was developed that checks texts, images or videos and provides indications of manipulated digital content and targeted disinformation with just a few clicks. AIT and APA now jointly represent Austria in the German-Austrian Digital Media Observatory (GADMO) and are implementing this in Austria. Launched on 1 November 2022, this cross-border initiative to fight misinformation is the largest association of fact-checking professionals and researchers in the German-speaking world. Besides AIT and APA, dpa Deutsche Presse-Agentur, Agence France Presse (AFP), the research network Correctiv and numerous scientists are participating as well. GADMO is coordinated by the Institute for Journalism at the Technical University of Dortmund. GADMO sees itself as a central contact point for all researchers in the field of disinformation as well as all fact-checking institutions active in Austria and Germany. The initiative is funded by the EU Commission and is part of the Europe-wide network of the European Digital Media Observatory (EDMO) with to date nine hubs in 17 European countries.

Photo: GettyImages

AUTOMATION TECHNOLOGY: HOW INTELLIGENT MACHINES SUPPORT PEOPLE

Artificial intelligence (AI) methods are used in many ways in production processes and in the development of autonomous machines and vehicles. At this year's "Berlin Science Week" at the beginning of November, AIT experts discussed with colleagues from the University of Augsburg, the Technical University of Berlin, and L3S Austrian how intelligent machines can support humans and help solve major problems of the future.

Artificial Intelligence (AI) is no longer just a topic for the future. Rather, AI methods are permeating more and more areas of our life and work. This ranges from useful tools for our everyday lives to their use in healthcare, urban planning, and detecting fake news, through to speech algorithms and the development of (partially) autonomous vehicles and machines.

Cooperation with humans

Intelligent machines of the future are not to replace humans, but to support them. The idea is to combine the respective strengths of humans and machines. Intelligent machines can relieve humans of strenuous, dangerous, and monotonous work and make production processes more efficient, flexible, sustainable, and resilient. The human individual can concentrate on more complex, supervisory or creative activities and work towards holistic problem solving. In the process, the technical processes are consistently aligned with the needs and necessities of people (Human Centered Design).

These topics were the main focus of a panel discussion organised by AIT as part of the "Berlin Science Week" at the "Einstein Center Digital Future" in Berlin at the beginning of November. Under the title "AI-enabled Automation: How Intelligent Machines Support Humans", leading experts contributed their know-how – specifically: Andreas Kugi (Vienna University of Technology, AIT), Lydia Kaiser (Technical University of Berlin), Matthias Scheutz (Tufts University, AIT), Elisabeth André (University of Augsburg), Manfred Tscheligi (University of Salzburg, AIT) and Johannes Winter (L3S).

Top-class panel discussion at the "Berlin Science Week" on the topic of "AI-enabled Automation: How intelligent machines support humans" (from left to right): Martin Kugler (moderator, AIT), Andreas Kugi (Vienna University of Technology, AIT), Elisabeth André (University of Augsburg), Manfred Tscheligi (University of Salzburg, AIT), Lydia Kaiser (Technical University of Berlin), Johannes Winter (L3S), Matthias Scheutz (Tufts University, AIT), and Wolfgang Knoll (Managing Director AIT)

The panel discussion identified numerous areas of application where intelligent machines can help us meet future challenges, such as increasing productivity and competitiveness, improving quality, conserving resources, avoiding CO_2 emissions or addressing the ever-increasing labour shortage.

Watch the whole discussion:

Photo: AIT/Hlava

INNOVATION BOOSTS BUSINESS PERFORMANCE AND EXPORT SUCCESS

Exporting businesses show higher productivity, employment, and value creation. An essential key to success is Research and Development (R&D).

More than half of Austria's economic output (GDP) is generated abroad. But interestingly enough, relatively little was known about the exporting companies until now. A joint study by the Vienna Institute for International Economic Studies (wiiw) and the AIT Austrian Institute of Technology (AIT) on behalf of the BMAW (formerly BMDW) has now provided a remedy: Robert Stehrer (wiiw), Bernhard Dachs and Maria Yoveska (both AIT) analysed 5,000 domestic companies in the field of manufacturing of material goods, of which around 3,500 also sell their products abroad.

"Companies that export are much larger, more innovative, more productive and also more profitable, pay higher wages, invest more and also do more to protect the environment," the researchers conclude.

In numbers: Export-oriented companies are on average two to three times larger and have a factor of 1.2 to 1.6 higher labour productivity (per hour worked). Moreover, they account for 90 per cent of employment, turnover, investment, and environmental expenditure. Austria's "export champions" are mainly to be found in large-scale industry: In 2019, the largest five percent of companies accounted for 65 percent of exports by value. The importance of exports for business activity is closely related to company size: While companies with up to 49 employees earn on average less than 20 percent of their turnover abroad, companies with over 1,500 employees are almost exclusively exporters (97% of turnover).

Export-oriented companies also invest much more money in research and development and digitisation. This becomes particularly evident in the high-tech sector: With 80 percent, high-tech companies account for the highest proportion of research-conducting companies, and with 70 percent, they also account for the largest share of exports in terms of turnover. As Bernhard Dachs explains, the one determines the other. "Lucrative export opportunities create incentives for the development of innovative products. Indeed, research and development are the basic prerequisites for being internationally competitive," he explains. Policymakers should therefore do all they can to strengthen research and development, productivity, and export opportunities for businesses.

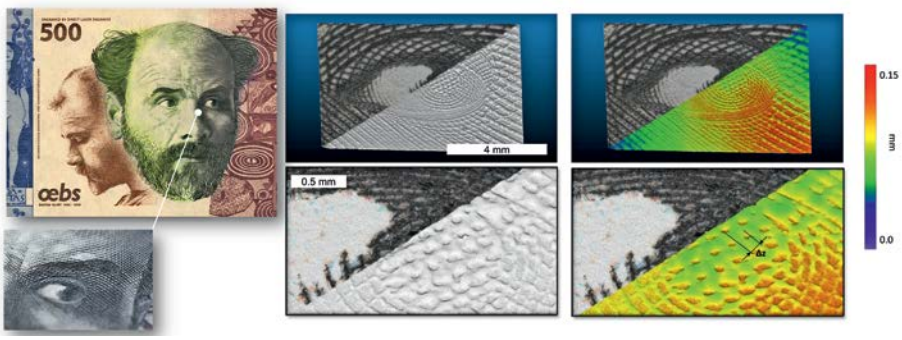
Related publication: Robert Stehrer, Bernhard Dachs and Maria Yoveska, "A Snapshot on the Characteristics and Dynamics of Austrian Exporting Firms", wiiw Research Report 462, Sept. 2022; Download: wiiw.ac.at/p-6308.html

Photo: GettyImages

THE SMALLEST DETAILS VIEWED LARGE

A new inline microscopy method shows the test results quickly, with high resolution, and in a large field of view. It thus meets the manufacturing industry's need for high-performance quality inspection systems.

Inline inspection in industrial processes where parts continuously move in a production line is becoming more and more an indispensable tool for industrial quality inspection. However, the desired capture speeds and the requirements for high-precision imaging often encounter the limits of what is physically possible – such as a large field of view with high spatial resolution. At the AIT Center for Vision, Automation & Control, a novel light field and photometry system was developed that solves this conflict of objectives through the combination of microscopic imaging with special projection optics to create a parallax effect. Together with an innovative image processing, this microscopic inline system delivers high-resolution 3D images at high speeds by using an xy transport table to change the optical perspective. This can be used to calculate a stereoscopic 3D topology by taking a series of images while an object is moved through the camera's field of view.
In a theoretical treatise, the expected achievable depth resolution and its dependence on the baselines set and numerical apertures used were calculated. Finally, it could be shown experimentally that scanning speeds of up to 12 mm/s at a depth resolution of 2.8 µm and a lateral scanning of 700 nm/pixel can be achieved in this way, which is suitable for inspection in the high-precision manufacturing industry.



The results of our proposed microscopic imaging setup when scanning a test banknote provided by OEBS: The intaglio print is clearly visible on the eyeball at a measured depth of 57 µm. The bottom left shows the result of a single line captured at high speed (12 mm/s).

Proof by means of two use cases

Specifically, two use cases were examined in cooperation with OEBS (Oesterreichische Banknoten und Sicherheitsdruck GmbH), a 100% subsidiary of the Oesterreichische Nationalbank [Austrian National Bank]. First, a test printing plate provided by OEBS was scanned with trenches of varying depths from 350 µm down to 25 µm. Although the printing plate has little texture, the system was able to reconstruct the surface shape. Secondly, a test banknote provided by OEBS with the portrait of the painter Gustav Klimt was examined, which has various security features, including intaglio printing. At a speed of 7 mm/s, the area around Klimt's eye in particular was imaged. The height of the intaglio on the eyeball could be measured accurately at 57 µm. Thus, this system is perfectly suitable for the quick safety check of very small details. In order to prove that the system is also capable of working at a speed of
12 mm/s, a central line of the Klimt banknote, which has a similar quality and similar details, was captured at this speed.
It could thus be demonstrated that with such a system 3D structures of security features and printing plates can be visualised and used for fast inline quality checks and security controls.

Related publication:
Ginner, L.; Breuss, S.; Traxler, L., "Fast Inline Microscopic Computational Imaging", Sensors 2022, 22, 7038. https://doi.org/10.3390/s22187038

Photo: AIT/test banknote courtesy of OEBS

Scientific Papers

Integrated chip for quantum communication

As a result of the UNIQORN project in the European Quantum Flagship programme, chips with integrated photonics for quantum communication applications were developed. This involves the use of three different integration platforms for the production of components and subsystems on chips for quantum communication devices – namely monolithic indium phosphide-based integration, hybrid polymer-based integration, and a CMOS-compatible silicon platform. The selection of the different platforms was made in order to use the best features of each platform for the planned quantum communication device. For example, the indium phosphide platform was used to produce a transmitter chip for the distribution of quantum keys with lasers, modulators and attenuators; this chip was evaluated in a QKD experiment. Entangled single photon sources based on non-linear optics were built on the polymer in a hybrid way together with waveguides and other passive micro-optical elements. Finally, a silicon-based receiver with co-integrated detector and transimpedance amplifier was produced.

A. Trenti, M. Achleitner, F. Prawits, B. Schrenk et al., "On-chip quantum communication devices", IEEE/OSA Journal of Lightwave Technology, 30506-2022.R1, doi 10.1109/JLT.2022.3201389

Measurement of inflammatory factors in saliva

Lateral flow devices (LFDs) enable cost-effective decentralised testing with a short time to result and are therefore an indispensable tool for point-of-care diagnostics. At AIT, a novel LFD device with electrochemical readout was developed for the quantitative detection of CRP (C-reactive protein) in filtered human saliva. CRP is a known biomarker for inflammations. The detection of CRP is made possible by a sandwich assay with specific antibodies. The subsequent enzymatic reaction leads to a product that can be oxidised by an electrochemical sensor placed on the LFD strip, generating a concentration-dependent and analyte-specific electric current. Through optimisation of the system, detection limits of 3 and 25 ng/ml were achieved in buffers and filtered saliva, respectively. Finally, a sensor with four different channels was introduced for testing simultaneous multi-channel measurements. Thus, the possibility of simultaneous multi-channel measurement (multiplexing) was demonstrated.

L. Petruzzi, Th. Maier, P. Ertl, R. Hainberger, "Quantitative detection of C-reactive protein in human saliva using an electrochemical lateral flow device", Biosensors and Bioelectronics: X, 10 (2022) 100136, doi: 10.1016/j.biosx.2022.100136

Adaptive flow control method for solenoid valves

Solenoid valves are used for power distribution in hydraulic drive systems for commercial vehicles. These are generally subject to manufacturing tolerances and thus large parameter fluctuations. The adaptive control aims to achieve a high control quality even with fluctuating, uncertain or unknown system parameters. No manual adjustment of the controller parameters is required in the process. A new current control method for solenoid valves developed at AIT consists of adaptive, model-based feedforward and feedback control. The system parameters are estimated using a recursive least squares method. This solution differs from existing approaches in the adaptive feedforward control and the way parameter estimation is performed.

The control concept was tested on three solenoid valves from different applications. The results showed a high control quality and a fast parameter convergence despite the non-linear dependence of the inductance on current and position. The results were compared with two control methods known from the literature: Both were exceeded by the proposed control concept.

M. Schwegel, T. Glück, V. Shaferman, L. Zaccarian and A. Kugi, "Adaptive Two-Degrees-of-Freedom Current Control for Solenoids: Theoretical Investigation and Practical Application," in IEEE Transactions on Control Systems Technology, 2022, doi: 10.1109/TCST.2022.3211457

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