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#79
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BRINGING YOU THE RESULTS OF EU RESEARCH AND INNOVATION

Precision diagnosis and treatment
for difficult to treat cancers

Intuitive freshness indicator
helps consumers reduce food waste

Better plastics
through cleaner technology

SPECIAL FEATURE

HELPING THE 5 IN 10 000: INNOVATIVE THERAPIES AGAINST RARE DISEASES

Editorial

A focus on rare diseases, showcasing the winner of the prestigious Innovation Radar Award and more –

welcome to this month's official Research*eu magazine

February, unless you're a fan of St Valentine, is arguably one of the most depressing months of the year (probably second only to January). It's cold and dark, and lighter days and Easter are still weeks away. This is also a time of year where many people are struck with the seasonal cold or flu. Sniffles, coughs and sneezes are still being frequently heard in offices, homes and on public transport systems across the continent.

Whether you're in the grip of a seasonal *grippe* or not, this month we'd like you to check out our special section that is this month focusing on rare diseases. Up to 36 million Europeans are right now, as you read these words, afflicted by one of around 6 000 conditions classified as rare diseases. In anticipation of the globally-marked Rare Disease Day on 28 February, we wanted to shine a light on some of the most exciting EU-funded research being carried out to find treatments and therapies to help those patients coping with life-changing rare conditions.

Meanwhile, in our **Project of the Month** feature, we're showcasing the winner of the extremely prestigious Innovation Radar prize which was awarded during the European Commission's ICT 2018 conference in Vienna that took place in December 2018. Even though we didn't win the fight for a front row seat, CORDIS was actually there in Vienna to soak up the ambience and energy as the winner was announced (and we had a great time!). In this month's **Life After**, we're going for a gritty, yet futuristic, CSI vibe as we catch up with the **VALCRI** project that has developed a highly promising criminal intelligence analysis system that utilises the latest advances in Big Data.

EU Agenda, as usual, shines a spotlight on upcoming EU-funded project-led events and international days and you can indulge yourself in the latest developments in our regular nine thematic sections.

As usual, if you'd like to send us your feedback, questions and/or suggestions, please send them to: editorial@cordis.europa.eu

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HEALTH

Precision diagnosis and treatment for difficult to treat cancers

Despite large-scale genome re-sequencing studies for major cancers, no comparable efforts exist which examine all kinases in biological subtypes of breast cancer. RATHER set out to address this, concentrating on two poor-prognosis subtypes of breast cancer.

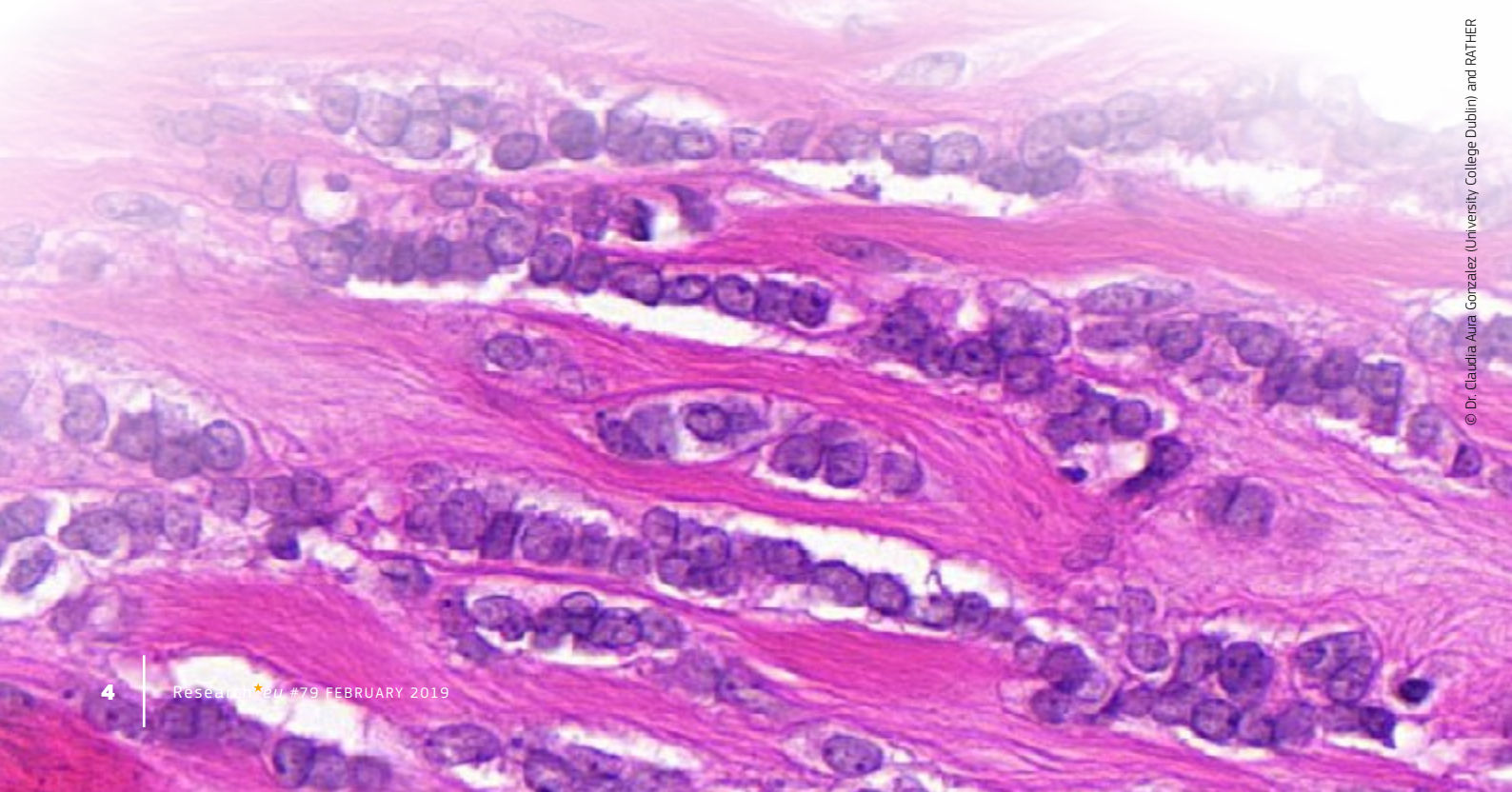
Cancer genotyping has correlated the responses to targeted anti-cancer drugs with mutations in specific genes. Many of these mutations occur in signalling components, known as kinases. The difficult-to-treat subtypes of invasive lobular carcinoma (ILC) or triple negative (TN) breast cancer, which account for 25 % of all breast cancers, currently have a lack of targeted therapies, leading to poor patient prognosis.

The EU-supported RATHER (Rational Therapy for Breast Cancer: Individualized Treatment for Difficult-to-Treat Breast Cancer Subtypes) project developed specific biomarker signatures to accurately predict outcome in patients with ILC (using the MammaPrint test) or response to therapy in patients with TN breast cancer (using the BRCAness test), as well as uncovered novel treatments for both breast cancer subtypes.

RATHER's results have immediate clinical potential to expand the reach of MammaPrint (an already approved diagnostic assay) into the subgroup of ILC breast cancers. The project has also contributed to several clinical trials, with the work yielding new diagnostic and therapeutic approaches, now paving the way for advances in breast cancer management.

TAILORING OF MEDICINE

Many cancers make changes to key cellular proteins, known as kinases. As well as playing a key part in physiological pathways, when it comes to cancer, kinases also act like molecular switches to control how it grows and spreads. RATHER investigated the genes that produce kinase proteins to determine if specific changes to the gene code, or other alterations in a patient's cancer cells, can explain why the cancer forms and spreads.



© Dr. Claudia Aura Gonzalez (University College Dublin) and RATHER

> *By uncovering changes to particular kinases and the function of the mutated protein, and then tracing that back to the patient's specific breast cancer subtype, we discovered several new ways to accurately predict the outcome for patients and potentially also treat patients with this subtype more effectively.*

RATHER explored the rate of activation of all kinases (the 'kinome') in TN breast tumours lacking the oestrogen-, progesterone- and HER2 receptors (15 % of breast cancers) and ILC of the breast (10 % of breast tumours); in particular, 518 kinase genes were sequenced to identify mutations associated with either breast cancer. In addition to DNA sequencing, kinase alterations were also assessed at the mRNA and protein level, as well as for evidence of copy number variation.

Alterations were examined using computer-based systems and pre-clinical lab models. As project coordinator Prof. William Gallagher explains, "Our work has identified differences in breast cancers of various subtypes and is based on the fact some of these alterations will turn out to be involved in driving the disease, not just random effects."

Where available, small molecule inhibitors were selected based on their ability to limit the growth of cells expressing subtype-specific kinase alterations.

The RATHER consortium took a leading role in a multi-centre, Phase Ib/II clinical trial of a novel kinase inhibitor drug called 'taselisib'. The initial Phase Ib trial successfully showed that a combination of traditional endocrine therapy (the drug tamoxifen) and this new kinase inhibitor was well tolerated by patients.

As Prof. Gallagher summarises, "By uncovering changes to particular kinases and the function of the mutated protein, and then tracing that back to the patient's specific breast cancer subtype, we discovered several new ways to accurately predict the outcome for patients and potentially also treat patients with this subtype more effectively."

RATHER contributes directly towards applications that will provide not only improved diagnostics, but also therapeutic options for breast cancer, one of the leading causes of cancer-related deaths in women.

RATHER's work aligns with wider efforts towards more individualised cancer treatment. The Phase II clinical trial of the novel kinase inhibitor is now underway alongside complementary trials.

RATHER

- Coordinated by University College Dublin in Ireland.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/258967
- Project website: ratherproject.com

HEALTH

Translating big metabolomics data into molecular knowledge

The metabolomics field promises to advance our understanding of biology, physiology and medicine. The METASPACE project aims to advance the clinical use of metabolomics through novel bioinformatics and cloud computing tools.

Metabolomics complements genomics, transcriptomics and proteomics by providing information on biochemical processes and revealing the contributions of non-genetic factors, such as the environment, diet and microbiome. In spatial metabolomics, the challenge is to localise hundreds of metabolites with cellular and sub-cellular resolution.

AN OPEN-SOURCE BIOINFORMATICS ENGINE

Recent technological advances in high mass resolution imaging mass spectrometry have made the imaging of metabolites in biological tissue sections possible. However, a major bottleneck is the lack of bioinformatics methods for molecular interpretation of spatial metabolomics data. To address this, scientists from the EU-funded METASPACE (Bioinformatics for spatial metabolomics) project developed an open online community platform that integrated bioinformatics tools into validated workflows for clinical use. "Our ultimate goal was to generate a research ecosystem for exploiting spatial metabolomics data beneficial to both academia and industry," explains project coordinator Dr Theodore Alexandrov.

METASPACE developed algorithms for high-throughput putative annotation of hundreds of metabolites, including a novel score for quantifying whether a metabolite is present in cells of a tissue section. For example, it can find oncometabolites in a tumour section or drugs delivered to and metabolised in the kidney cortex. These algorithms were implemented as cloud software with a user-friendly interface on the METASPACE website.

> *"Our ultimate goal was to generate a research ecosystem for exploiting spatial metabolomics data beneficial to both academia and industry."*

The scientific team engaged the scientific community in Europe and worldwide who provided over 3 000 public datasets in the largest data sharing effort in the field of spatial metabolomics. The METASPACE team evaluated the engine in a clinical case study of oesophageal cancer as well as in drug development applications for pharmaceutical R&D. The use of cloud technologies enabled processing of more than 50 TB of raw data.

THE FUTURE OF METASPACE

METASPACE is already used by over 200 scientists from over 70 labs across the world. The project Twitter account actively disseminates news and engages the community of more than 400 followers. Dr Alexandrov confesses that "this project transformed my view on modern science and its impact. It was very inspiring to see the scientific

© Theodore Alexandrov

community agreeing to share their data, and thus creating a big public knowledge base of spatial metabolomes."

Collectively, the information on the metabolites detected in tissue sections from animal models and clinical human samples lays the foundation for further research in the field of spatial metabolomics and for addressing important biomedical questions. The increasing need for metabolite annotation highlights the impact of the project especially with respect to disease-associated metabolomes. Importantly, the platform enables biologists and clinical specialists without mass spectrometry or bioinformatics experience to translate complex data into molecular knowledge.

From the beginning, METASPACE was designed as an open-source and open-access project. The aim was to stimulate sustainable development in this field with a platform capable of incorporating future algorithms, software and services.

Outreach efforts have led to the collaboration in the ERC Consolidator grant-funded METACELL, where the METASPACE platform will be used for detection of cellular metabolites. The engine will also be employed as a test bed in the EU ICT CloudButton project for the development of novel cloud technologies.

From an industrial perspective, there is great potential for the METASPACE platform to be incorporated in the drug discovery and testing workflows of big pharma. Looking towards the future, Dr Alexandrov is confident that "METASPACE will facilitate future biomedical discoveries, support efficient therapies and drive innovation, thus creating novel R&D opportunities in Europe."

METASPACE

- Coordinated by the European Molecular Biology Laboratory in Germany.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/634402
- Project website: metaspace2020.eu

HEALTH

Innovative new treatment for obesity will reduce impact of diabetes: is the 'exercise pill' just around the corner?

The number of people living with diabetes quadrupled between 1980 and 2014. None of the drugs available to treat diabetes reduces insulin resistance – a primary cause of obesity-induced T2D. One EU-supported project has found a new approach that may be able to do just that.

The number of adults around the world with diabetes quadrupled from 108 million in 1980 to 422 million in 2014. About 90 % of these people have type 2 diabetes (T2D) – a major cause of kidney failure, blindness, nerve damage, amputations, heart attack and stroke. It is estimated that only around 10 % of type 2 diabetics reach the goal of living a complication-free life.

Current treatment of T2D either stimulates insulin production in pancreatic β-cells (GLP-1 receptor agonist) or blocks reuptake of glucose in the kidney, so glucose ends up in urine (SGLT2 inhibitors). When the pressure on the β-cells becomes too high to produce more insulin and these treatments fail, the last stage is to take injections of insulin.

Diabetes is an epidemic that threatens the economies of all EU Member States. Our project can deliver a novel drug treatment regimen to clinicians and their patients.

"Currently there is no approved drug that can increase glucose uptake in muscle (the main job of insulin) or reduce systemic insulin resistance that will relieve the pressure on β-cells. 0304 can do all these things," says the AMPK-DIAB (A small molecule AMP activated protein kinase (AMPK) activator, denoted 0304, as a novel innovative drug for the treatment of type 2 diabetes) project coordinator Dr Thomas Edlund. 0304 is one of the O-series of AMPK activator compounds. Dr Edlund explains that exercise causes energy levels to drop in cells. To restore energy levels, the enzyme AMPK is activated.

AMPK activation increases uptake of glucose and lipids and stimulates the oxidation of these nutrients to generate energy, along with increasing blood flow to supply tissue with these nutrients. So the ability to activate AMPK with a drug-like, small molecule is the holy grail: it would give rise to the 'exercise pill'.

The number of adults around the world with diabetes quadrupled

from 108 million in 1980 to 422 million in 2014

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"Basically," says Dr Edlund, "this is exactly what we have achieved. 0304 mimics all the beneficial effects of exercise on obesity, T2D, fatty liver, the cardiovascular system and many other physiological functions. Animals that are treated with 0304 actually run for much longer distances than control animals." 0304 can now be developed to treat obesity and associated diseases and complications, and he explains that it is safe and well-tolerated in both animals and humans.

As it increases energy expenditure in animals by a novel, unique mechanism which results in the animals losing fat mass while eating even more, 0304 is extremely well-suited to treating the global epidemic of obesity. No other drug on the market can increase energy expenditure.

Betagenon, the Swedish company behind the AMPK-DIAB project, is hoping to target a high-risk population of T2D patients. "The main problem with T2D is the devastating complications, which to a large extent are caused by reduced blood flow in the tiny capillaries. 0304 potently increases blood flow so it can address these complications in obese T2D patients," he explains.

They have successfully completed an exploratory 28-day, Phase IIa clinical trial in patients with T2D, currently on metformin, and are now conducting target product profiles, from a commercial perspective, for each disease for which 0304 could be an option.

"Diabetes is an epidemic that threatens the economies of all EU Member States. Our project addresses this challenge by delivering a novel drug treatment regimen to clinicians and their patients. 0304 will fill the knowledge gap at an EU-wide level. To date, no company has been able to pre-validate an efficient small molecule AMPK activator," says Dr Edlund.

AMPK-DIAB

- Coordinated by Betagenon AB in Sweden.
- Funded under H2020-LEIT-BIOTECH and H2020-SME.
- cordis.europa.eu/project/id/754268
- Project website: betagenon.se

SOCIETY

A research toolbox sheds light on social identity changes in Europe

An EU initiative has studied the cultural dynamics characterising societies and institutions, and their impact. The resulting analyses can guide the development of policies to effectively address the crisis in Europe.

Europe faces a complex social and institutional crisis that can be adequately countered only if it is understood in depth. Facets of the crisis include such diverse factors as the politicisation of European institutional and monetary integration, the weakening of the partnership among European countries, xenophobia, radicalisation and the rise of far-right/populist parties.

The EU-funded Re.Cri.Re. (Between the representation of the crisis and the crisis of representation. How crisis changed the symbolic background of European societies and identities. Implication for policies and policy making) project aimed at "understanding the cultural dynamics underpinning the social identities that are active within European societies and drawing implications from that for policymaking," says project coordinator Marco Boaria. "This is extremely valuable because such dynamics moderate the impact of policies, particularly in times of crisis." Re.Cri.Re. analysed this influence and impact to better understand how to develop targeted policies.

By examining the cultural dynamics that portray societies and institutions, and the dynamic forces that ultimately influence policy, Re.Cri.Re. was able to gather suggestions to improve the efficiency of policies operating in, or for the sake of, a post-crisis scenario. Project partners examined what kind of social identity change occurs in Europe during a crisis. To frame better policies at local, national and European levels, they analysed different cultures of European societies and how the socio-economic crisis impacted them.

> *"The expected impact of Re.Cri.Re. is to understand how to develop policies that are able to leave the socio-economic crisis behind and to strengthen the resilience of societies."*

GUIDELINES TO EMPOWER POLICYMAKING

With the assistance of policymakers, opinion leaders and stakeholders, researchers developed and approved general and context-specific guidelines for designing culture-sensitive policies. The guidelines provide a strategic and methodological framework that is able to enforce policymaking's capacity for coping with the crisis. Boaria envisions these key research documents as an important guide for policymakers to make decisions and develop actions that really consider the different contexts, cultures, visions, problems and needs.

Studies provided evidence of the impact of symbolic universes on several psycho-social dimensions and phenomena. These include mental function, political orientation, and attitudes towards foreigners, institutions and welfare agencies.

CRISIS AND CHANGES OF SOCIAL IDENTITY

The project team produced scientifically-grounded and contextualised knowledge regarding social identity change. These changes are ongoing within European societies as a consequence of the crisis.

Even though Re.Cri.Re. was completed in mid-2018, the team is committed to improving the exploitation of the outcomes at the level of their impact on policymaking,

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societies and institutions. To this end, it developed three lines of work intended to provide continuity to Re.Cri.Re.'s future cultural, political and strategic implications. The first is the creation of the European Institute of Cultural Analysis for Policies with the ambition of becoming a think tank to further develop and promote the Re.Cri.Re. methodological approach. The second is a systematic presence in the media. Lastly, a series of studies has been carried out to further specify and approve the guidelines.

European citizens and policymakers now have the opportunity to better understand cultural dynamics for informed policymaking. "The expected impact of Re.Cri.Re. is to grasp how to develop policies that are able to leave the socio-economic crisis behind and to strengthen the resilience of societies," concludes Boaria. "Of equal importance is renewing the promotion of integration and European identity, and strengthening the sense of solidarity in the public sphere."

Scientific coordinator Sergio Salvatore adds: "There's a strong feeling that Re.Cri.Re. has just started to discover fundamental findings. The end of the project will instead be the launch of a new policy vision."

RE.CRI.RE

- Coordinated by the European Association for Local Democracy in France.
- Funded under H2020-SOCIETY.
- cordis.europa.eu/project/id/649436
- Project website: recrire.eu

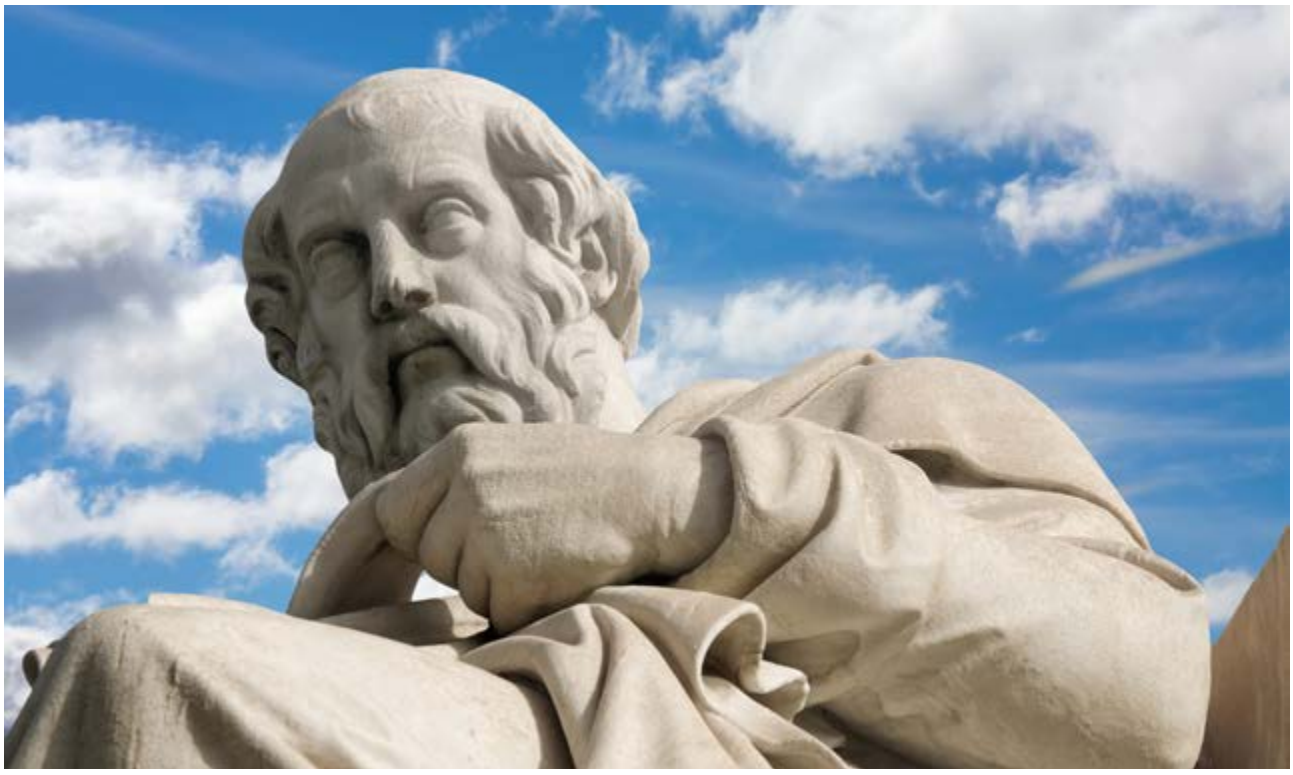
Pioneering edition of Philodemus' History of the Academy reveals 20 % more content

Philodemus' History of the Academy is a centre-piece of Greek philosophical literature and a milestone of European culture. Innovative techniques applied by the AcadHist project have now revealed intriguing new details.

The book History of the Academy by the Epicurean philosopher Philodemus was passed down on two papyrus rolls and discovered in the ancient Roman town of Herculaneum in the 1750s. The information contained in the papyri – known as PHerc. 1691/1021 and PHerc 164 – sheds light on the development of the ancient Platonic Academy.

However, research has shown that considerable improvement could be made on the last edition of this book. The current availability of pioneering techniques for reading papyri, along with the potential to develop new improved editorial methods, has paved the way for a groundbreaking edition.

This was the challenge taken up by the EU-supported AcadHist (Philodemus' History of the Academy: Groundwork for a New Innovative Critical Edition) project which has produced a text that is becoming widely adopted by the scholarly community. Indeed, its methods have resulted in 20 % more content than the previous edition. This has revealed additional information about Academic



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> *We were not expecting this huge increase in the reconstructed Greek text, which is unusual for a papyrus book which has already been edited several times. The identification of a new speech by the Greek orator Hyperides was a major and thrilling discovery.*

philosophers, of great relevance for historians of ancient philosophy and literature, philologists and papyrologists.

PERFORMING PIONEERING ANALYSIS

Much of what is known about the history of the Platonic school is only found in Philodemus' History of the Academy and not in other ancient sources. This makes it a unique contribution to our understanding of crucial developments inside the Academy and its most prominent figures such as Plato, Arcesilaus, Carneades, Philo and Antiochus.

Explaining the rationale for AcadHist, Marie-Curie Fellow Dr Kilian Fleischer says, "While the last critical edition provided by Tiziano Dorandi in 1991 deserves respect, it could not benefit from the multispectral images of papyri available today and was also based on outdated editorial criteria."

Dr Fleischer reconstructed the original anatomy of the roll and replaced some misplaced columns, as well as clarified the position of PHerc. 1691 with respect to PHerc. 1021. He also compared his own manual transcriptions with previous multispectral images and the newest NIR hyperspectral images provided by the project. This culminated in two different transcripts: a diplomatic one, with papyrological apparatus, and a literary one, with philological apparatus.

AcadHist's systematic microscopic reading of the original manuscripts, compared with old drawings of papyri and NIR hyperspectral images, alongside an innovative editorial system, surprisingly revealed much more text. As Dr Fleischer recalls, "We were not expecting this huge increase in the reconstructed Greek text, which is unusual for a papyrus book which has already been edited several times. The identification of a new speech by the Greek orator Hyperides was a major and thrilling discovery."

AcadHist sought input from renowned papyrologists, classical philologists and historians of ancient philosophy for a collaborative revision. The team did so during a workshop held in September last year and by making a version of the text available through the project's website.

ON THE TRAIL OF LOST ANCIENT TEXTS

AcadHist's NIR Hyperspectral Imaging experiments on the book, which have improved the legibility of the recto and again made the text visible on the verso 200 years after its first discovery, offer an advanced diagnostic technique for Herculaneum papyri analysis. "These are likely to be applied to other papyri and medieval manuscripts, involving physicists, chemists and other specialists in the recovery of lost ancient texts," Dr Graziano Ranocchia, the project's supervisor, adds.

Dr Fleischer is now finalising the critical edition of the book by integrating the new text into a monograph complete with a comprehensive introduction and a detailed commentary, supported by a three-year DFG fellowship at the University of Würzburg.

ACADHIST

- Coordinated by the National Research Council in Italy.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/703798
- Project website: iliesi.cnr.it/philodemus/

ENERGY

Exercising citizen power for a low carbon economy: a global first to make home fuel from atmospheric CO_2

To help with the EU's ambition for Europe to become a competitive low carbon economy by 2050, the 'willpower' system creates methanol fuel from surrounding atmospheric CO_2, benefitting the automobile and energy sectors, and others.

One area ripe for consumer engagement towards a low carbon economy is the heating sector, which was responsible for around 54 % of all EU CO_2 emissions in 2016, according to Eurostat.

To help reduce this, Gensoric received EU support to develop their 'willpower' (make your own fuel from CO_2) system – the first worldwide to tap CO_2 to generate fuel for heating and other applications. The core technology is a patent protected, widely validated electro-biocatalytical technology that runs under ambient conditions.

'Willpower' produces methanol from air (atmospheric CO_2) and water. As the chemical reactions occur under very mild conditions using standard enzymes, without hazardous materials or high-pressure tanks, it is deployable without specialist safety requirements. This opens up an enormous potential market.

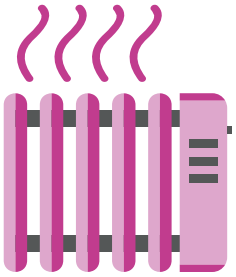
INTELLIGENT ELECTRODES

The 'willpower' project designed electrodes which actually create the right setting for the desired chemical reaction. As project coordinator Mr Antonio Martinez explains, "It all started with the crazy idea of making intelligent electrodes. Electrodes traditionally provide voltage and deliver electrons, but ours also 'feel' the working temperature, expanding the scope of what they can do." Here, this means ensuring chemical reactions to deliver big end-product yields.

Explaining the electro-biocatalytical process, Mr Martinez compares it to a reversal of what our livers do when processing alcohol, as it uses enzymes to cascade three chemical reactions to transform the alcohol into water, CO_2 (that we expel) and heat.

The team built a reactor chamber with their custom electrodes and enzymes, which, once atmospheric CO_2 is captured in water, facilitates the right sequence of chemical reactions to produce energy, stored as methanol. As methanol is extremely safe and easily transportable, it can be used on demand.

Mr Martinez summarises, "When you realise that it would typically take 625 kg of lithium-ion-batteries to store as much energy as 10 kg of methanol contains, it offers a very smart and efficient alternative."



The heating sector was responsible for around 54% of all EU CO_2 emissions in 2016

Project expediency necessitated the use of commercially available, non-specific enzymes in the reactor chamber – achieving around 20% efficiency. However, they are confident that customised enzymes can double that, and, with additional measures (currently underway), efficiency could reach around 80%.

The system (reactors and CO_2 capture units, based on space technology) was designed to be modular, meaning that it could be scaled according to need, making it flexible enough to use CO_2 from other sources, such as exhaust systems.

REVOLUTIONARY POTENTIAL

The technology could be a real game-changer. As Mr Martinez says, "Firstly, the idea that combustion always pollutes the environment is now proved false. Not only is our system clean and CO_2 neutral, but CO_2 is actually a useful ingredient. Also, for the first time, citizens will have direct access to decentralised energy production."

Aside from emissions reductions, 'willpower' aligns with other EU strategies. For example, by offering alternatives to oil and gas imports from unstable regions. Also, primarily using energy from renewables means it can store that energy at a greater capacity than power packs and batteries.

To get to market, the team is optimising efficiency and costs, by testing new materials for electrodes and customising the catalytic enzymes to boost methanol output. Additionally, as methanol burns for heating it releases water and CO_2, and the team wants to reuse these as inputs for yet more methanol.

WILLPOWER

- Coordinated by Gensoric GMBH in Germany.
- Funded under H2020-ENERGY, H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/726539
- Project website: willpower-energy.eu/index.php/en/

ENERGY

Smart storage heaters benefit households and business

EU-funded researchers have investigated the use of local small-scale smart heat storage devices and their role in the future EU energy landscape.

The Horizon 2020 RealValue (Realising Value from Electricity Markets with Local Smart Electric Thermal Storage Technology) project demonstrated how small-scale smart electric thermal storage systems (SETS) can meet householders' space and water heating needs in a low-cost and energy-efficient manner, whilst enabling the electricity industry to exploit its energy storage capacity.

Traditional night storage heaters contain an insulated thermal core that stores heat during the night to take advantage of abundant low-cost energy. The heat is then released during the day when demand and prices are higher. SETS are more flexible than traditional storage heaters as the core can be charged at any time, to suit electricity grid conditions.

Like traditional night storage heaters, SETS is designed to reduce the large differences in peak and off-peak electricity demand. "SETS is a direct replacement for existing electric thermal storage heaters and water tanks with a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combined load of 55 GW across the EU. It can also replace direct electric resistance heaters with a further connected load of 93 GW," says Project Director Rowena McCappin.

RealValue, using SETS connected to a cloud aggregation platform, issues optimised charging schedules to appliances, allowing them to take on charge during the night or day, based on grid constraints and market price signals. "We see SETS as a means for an ordinary person to participate in the evolving energy system. Not everybody is going to have the money to invest in a Tesla battery, an electric car, a wind turbine, or PV for their roof. But lots of people have storage heaters heating their buildings, consuming a large amount of energy. We see SETS as being a means for these people to be active and important cogs in the future EU energy system," explains McCappin.

EUROPE-WIDE PARTICIPATION

The project involved participants of different ages and backgrounds from Ireland, Germany and Latvia. They included social housing tenants, private home owners, and those responsible for business premises and other public buildings.

This diversity reflects the different environments where the technology can be used. "SETS space and water heating

> *"SETS is a direct replacement for existing electric thermal storage heaters and water tanks with a combined load of 55 GW across the EU."*

systems were deployed in 750 properties across Germany, Ireland and Latvia," McCappin comments.

Researchers have also equipped properties with smart plugs, sensors and smart meters. In Germany, project partners developed a 'retrofit' solution to enable advanced control of traditional storage heaters. The heating appliances are linked to an aggregation platform via the internet, which at cloud level provides the ability to interpret the flexibility of the devices.

BETTER UNDERSTANDING OF GRIDS AND PRICES

This information is transmitted to a cloud optimisation engine that is integrated with the electricity grids in each country, allowing an understanding of the current and future wholesale prices, and other network constraints. "An optimised charging schedule for each appliance is calculated and passed through the gateway to be activated, providing load balancing services," claims McCappin.

Through the backend, data can be extracted from individual appliances, and software and security updates can be pushed to the gateways. In addition, participants may access an app (available on phone, tablet and desktop), which provides remote control of the devices as well as insight into the energy usage.

RealValue will provide multiple benefits. "These include financial savings to the whole electricity supply chain, from generation and distribution, through to wholesale markets and suppliers and ultimately to end users like home owners and property managers," McCappin concludes.

REALVALUE

- Coordinated by Glen Dimplex Heating & Ventilation in Ireland.
- Funded under H2020-ENERGY.
- cordis.europa.eu/project/id/646116
- Project website: realvalueproject.com
- bit.ly/2HieZnO

ENERGY

Wind turbine for city rooftops

An EU-funded initiative has developed a wind turbine capable of exploiting the low-velocity turbulent wind conditions found in urban environments.

High electricity prices and the lowering costs of renewable technologies and energy storage are leading European energy consumers towards a distributed generation and self-consumption model. Electricity consumers are increasingly becoming prosumers (producers and consumers), who decide at a given moment whether to buy electricity from the grid, to self-consume, or even to export it to the grid.

Furthermore, European energy regulations require EU consumers to commit to clean and energy-efficient objectives like the Energy Performance of Buildings Directive. This directive requires all new buildings to be nearly zero-energy (NZEB) by the end of 2020. This may be achieved by reducing energy consumption and using renewable sources of energy such as wind power.

Wind power is an abundant source of renewable energy but it is not very common in urban areas. This is due to the existence of obstacles like buildings and other structures that convert high speed laminar flow into a low speed turbulent flow. Moreover, traditional wind power turbines are not designed to work with low speed wind (2 to 6 m/s) and turbulent flows.

A NOVEL DESIGN

The EU-funded Horizon 2020 EOLI FPS (Roof top wind turbine for urban areas) project addressed this challenge successfully. They developed and patented a rooftop vertical axis wind turbine (VAWT) specifically designed to work under low windspeed conditions found in the urban environment. "Its internal rotor design facilitates the creation of vortexes out of the wind turbulence that drastically increases the driving force of the laminar wind," says project coordinator Sergio Pedrosa. "Furthermore, it is safe, noiseless, does not vibrate and fits into the urban landscape."

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"EOLI FPS is the only small wind technology specially designed to work under low-speed turbulent winds and thus the only reliable, cost-effective, safe option for urban environments," explains Pedrosa. Currently, it can produce 1 000 watts at 6 m/s wind speed with a maximum power output of 2 500 watts. "Thanks to its permanent magnet generator technology the VAWT can start producing electricity at only 2 m/s wind speed. Its height is 125 cm, the diameter 180 cm and it weighs 143 kg," Pedrosa adds.

CHEAPER, GREENER ENERGY

The wind turbine offers the customer energy at a cost of EUR 0.05 per kilowatt hour (kWh) produced, which compared to the current European average cost of EUR 0.21 per kWh for the electricity network amounts to a saving of EUR 1 102.50 per year (for an electricity consumption of 9 922 kWh/year). According to Pedrosa: "A single EOLI FPS turbine can produce 5 250 kWh per year, thereby preventing the annual emission of 1.5 tons of CO_2 into the environment. In addition, EOLI FPS is safe and bird-friendly due to its protective cover protection."

As the VAWT is designed specifically for use in urban areas, it is a reliable, cost-effective and safe option for office buildings, malls, hotels, public buildings like schools and hospitals, and private residences. "Our simple, reliable and affordable VAWT operates silently, while reducing the cost of electricity for the end users by 75 %. Prototypes have already been developed and tested in several locations in Spain, demonstrating the technical viability and the high performance of our in-house manufactured systems," Pedrosa points out.

EOLI FPS

- Coordinated by Reacción Uptheworld SL in Spain.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership
- cordis.europa.eu/project/id/816706

CLIMATE CHANGE AND ENVIRONMENT

Mining waste for value in the EU

The European Union imports a significant amount of important metals as it does not have its own natural mineral resources. Researchers investigated the recycling of end-of-life raw materials to find ways to secure sustainable supply, add economic value and reduce greenhouse gas emissions.

The limited supply of many important metals used in the European Union is raising concerns about future availability. Everyday materials such as copper are expected to run out within decades, so it is important to secure continued access to this critical resource by recycling.

"End-of-life recovery and recycling are important sustainable management strategies for securing long-term supply of these resources," says QUMEC (Quantifying urban mines in Europe and related implications for the metal-energy-climate change nexus) supervisor, Fabrizio Passarini. The Marie Skłodowska-Curie QUMEC initiative set out to find out the quantity of mineral resources in 'urban mines' and how much effort it would take to recover these resources. The researchers looked at the historical appetite and socio-economic metabolism of the European Union countries to assess how to efficiently use such secondary resources.

The QUMEC project was primarily interested in harnessing the untapped potential improvements in recycling efficiency. "Current end-of-life recycling efficiency of these metals is very low, because of metal losses during and after use," says Passarini. The team looked at the size of current urban mines for certain critical metals. They also looked into future opportunities and barriers to recycling, and the options available to reduce carbon emissions.

The team evaluated the amount of waste and scrap generated at end-of-life processing facilities, data that was not readily available. The researchers used material flow analysis (MFA) to track physical flows of metal stocks along the known lifecycle of a given resource. They then used this analysis to define long-term strategies on how to efficiently recover secondary resources from waste and scrap for recycling.

The team applied MFA for each target metal and extended it to the most recent years possible for each. "For copper, our analysis covered the last 60 years," says Passarini. "For rare earth metals, we considered the last two decades, as their role in modern technology was limited to a few niche uses before the 1990s."

To address the environmental sustainability of metal recycling, the researchers applied a life cycle assessment (LCA) analysis and combined the information with the earlier MFA.

The combined analyses helped measure the potential for energy savings and reduction in greenhouse gas emissions. QUMEC successfully created a model utilising all of this data.

The researchers tackled questions such as, "How much material has been extracted from the ground? How much has been recovered from ores and minerals? How much has been further processed and incorporated into products?" They identified the industries that produced the greatest amounts of waste and scrap metal, which in some cases was greater than the natural resources found in some areas of Europe.

"While securing sustainable access to vital raw materials, pursuing efficient recycling would clearly benefit the environment, with substantial potential for energy savings and emission reductions," says Passarini. "These results have provided scientific evidence to support mitigation policies for climate change through recycling raw materials for the circular economy."

The research team concluded that, for some metals, the cycle of mining and reuse could be potentially closed within the European Union.

QUMEC

- Coordinated by the University of Bologna in Italy.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/704633

CLIMATE CHANGE AND ENVIRONMENT

Satellites help predict sea ice hazards

Satellite remote sensing provides general information about sea ice, such as its extent and concentration. This is inadequate for activities like ice charting, navigation and off-shore oil and gas exploration – they require detailed information on hazardous sea ice conditions.

Climate warming causes the shrinking and thinning of pack ice, allowing greater extent of shipping and an increase in oil and gas exploration and mining activities in the Arctic. However, severe sea ice conditions still exist, and their monitoring is needed. In general, sea ice hazards are related to sea ice thickness and deformation.

The EU-funded Horizon 2020 SPICES (Space-borne observations for detecting and forecasting sea ice cover extremes) project focused on detecting sea ice cover extremes and the automatic production of 'sea ice warning' products. "These products are based on a wide variety of Earth Observation (EO) data obtained from space-borne sensors, and numerical weather prediction (NWP) model data," says project coordinator Dr Jari Haapala. "We also used a variety of *in situ* snow and sea ice data as well as airborne remote sensing data to develop and validate sea ice products," he adds.

ICE THICKNESS MEASURED

Ridges form on top of the sea ice when wind and ocean currents force ice floes together, creating major obstacles to shipping, and are automatically detected via satellite images. Project partners developed a new algorithm to detect ridging intensity from synthetic aperture radar (SAR) images, proving an important new parameter for ice navigation.

The European Space Agency's CryoSat-2 satellite was designed for climate research. However, scientists found that daily trajectory data of sea-ice thickness can be used to detect extremes in sea ice cover. "We developed a new product for assessing regional thickness changes with daily resolution as well as for detecting thick ice with high resolution," claims Dr Haapala.

> *We developed new products for assessing regional thickness changes with daily resolution as well as for detecting thick ice with high resolution. The service could be based on a partnership between the ECMWF and national forecasting centres or private companies, with the ECMWF providing global forecasts, while scientific institutions and SMEs supply tailored products and service to the clients.*


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In the marginal ice zone, where the transition from open ocean to sea ice takes place, ocean waves form 'pancake ice' featuring elevated rims. SPICES successfully used new field data to develop algorithms for detecting pancake ice, which can be driven by waves towards the pack ice, where it piles up and freezes, adding to its thickness.

NEW MAPPING TECHNIQUES

Researchers also used Sentinel-1 SAR data to develop a new method for mapping the extent of the 'fast ice', which covers the seawater but is 'fastened' to the Arctic coastline. In addition, scientists improved the use of MERIS, a medium resolution imaging spectrometer, and Ocean Land Colour Instrument sensors for detecting inter-annual and regional variability in pack ice albedo (the ability to reflect sunlight that would otherwise be absorbed and cause warming) and melt ponds.

Finally, researchers integrated sea ice products into prediction models. "Numerical experiments with European Centre for Medium Range Weather Forecasting (ECMWF) seasonal prediction models suggest that using sea-ice thickness observations leads to improved seasonal forecasts for years with extremely low extent summers of sea ice," Dr Haapala points out.

The products can be integrated into operational service chains by the European Organisation for the Exploitation of Meteorological Satellites Ocean and Sea Ice Satellite Application Facility, national Ice Services and the Copernicus Marine Services.

Dr Haapala envisages a large potential market for seasonal sea ice forecasting services. "The service could be based on a partnership between the ECMWF and national forecasting centres or private companies, with the ECMWF providing global forecasts, while scientific institutions and SMEs supply tailored products and service to the clients," he concludes.

SPICES

- Coordinated by the Finnish Meteorological Institute in Finland.
- Funded under H2020-LEIT-SPACE.
- cordis.europa.eu/project/id/640161
- Project website: h2020-spices.eu
- bit.ly/2OtlRBn

CLIMATE CHANGE AND ENVIRONMENT

The first on-site recycling solution for synthetic turf

Estonian SME Advanced Sports Installations has developed a first-of-its-kind on-site cleaning, recycling and replacement solution for synthetic turf on football fields. The company promises major cost savings, along with a 70 % lower environmental footprint.

To most football field owners, using synthetic turf instead of real grass can only sound like a bright idea: it's easy to maintain, saves a lot of water and doesn't require pesticides or fertilisers. But there is another side to the coin. At

end of life, synthetic turf most often ends up on landfills or incinerated. In the EU alone, that's 650 000 tonnes of rubber, sand and plastic mixed waste piling up every year.

"There are, of course, a few solutions for managing old fields, essentially incineration combined with energy production," says Roomer Tarajev, PR and media manager at Advanced Sports Installations. "But none of them takes place on-site. It would typically require eight to 12 trucks to transport used turf over thousands of kilometres from field to factory – which makes for a large carbon footprint."

The company has an alternative: two trucks coming directly to the site, equipped with a unique technology that can clean, separate, dry and reuse all materials contained in old synthetic turf.

The ARENA (The first on-site mobile solution for complete synthetic grass recycling and materials reuse) system is very fast: in maximum eight hours (four times faster than state-of-the-art practices), an entire football field can be rolled up. The rolls are then processed off-field, cleaned, renovated and rolled again, while the infill can, if required, undergo a separation process to recover rubber and sand. "The processed materials meet the highest quality standards and can be reinstalled or reused in many sports or construction applications," Tarajev points out. The whole process can be completed in only seven days, that is, half the time needed with current replacement processes.

As synthetic turf is not just made of sand and rubber, the company also devised a solution to handle the turf itself, which is made of plastic yarn. "We have built our own recycling factory in the heart of Estonia, in the city of Põltsamaa. It allows us to process worn out artificial turf (free of sand and rubber infill) and produce agglomerate which can then be used by the plastics industry to replace expensive virgin materials," Tarajev enthuses.

The first benefit of this approach lies in its environment-friendliness: The reuse and recycling of all materials in the synthetic turf reduce its environmental impact by 70 %. And as the process mostly takes place on-site, it also decreases CO_2 emissions by 95 %.

The second benefit is the creation of an entirely new business model: the 5G leasing. Whilst sport facilities and municipalities previously had to purchase and replace their synthetic turf every 10 years, next-generation football fields will benefit from lease agreements.

> *"The processed materials meet the highest quality standards and can be reinstalled or reused in many sports or construction applications."*

"It is the first time that a football field can be leased up to 60 months, as before ARENA we were just not able to remove installed turf and reinstall it with the same quality level," Tarajev explains. The success of this formula has already started to extend beyond the sports industry, with temporary removable turf being used in various indoor halls for clients needing to use the surface for various purposes.

The next step? "We want to make the industry CO_2 neutral. Even with our on-site technology we can't avoid CO_2 emissions, but we believe that CO_2 neutrality could be achieved through a compensation mechanism such as investment in forest plantation, etc. The aim is to balance the stress on nature. This is something we believe has a future," Tarajev concludes.

ARENA

- Coordinated by Advanced Sports Installations Europe in Estonia.
- Funded under H2020-SME and H2020-ENVIRONMENT.
- cordis.europa.eu/project/id/726618
- Project website: sportsinstallations.com

PROJECT OF THE MONTH

Showcasing the winner of the 2018 Innovation Radar Prize

On Thursday 6 December 2018, Gr3n (pronounced 'green') won the Innovation Radar Prize at the major ICT 2018 event in Vienna, Austria, organised by the European Commission. The highly prestigious prize was awarded due to Gr3n's development of its innovative DEMETO technology that increases both the proportion of PET/polyester that can be recycled, and the overall quality of the recycled plastics produced. This was achieved through Gr3n's participation in the EU-funded ***SYMBIOPTIMA*** *project.*

Once discarded, a lot of PET/polyester items result in waste which can only be burned for energy or which ends up as landfill, as they cannot be recycled using standard mechanical techniques. To address this environmental problem, the DEMETO technology uses a patented microwave radiation technology and associated chemical process to disassemble polymers to collect their constituent building blocks for reuse as virgin PET/polyester.

By the end of 2019, the plan is to finish a demo plant capable of handling 1 000 tonnes per year, and with more funding through the subsequent Horizon 2020 DEMETO project, the next phase is full commercialisation of the technology.

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> *"There is nothing (available) yet at the industrial scale, but this is a race... I have a request every week because everybody is struggling with this [waste] problem"*

Dr Maurizio Crippa
CEO, Gr3n

SYMBIOPTIMA

- Coordinated by Spirax-Sarco Ltd in the United Kingdom.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/680426
- Project website: symbioptima.eu

... and for more information on the follow-up DEMETO project:

DEMETO

- Coordinated by Processi Innovativi SRL in Italy.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/768573
- Project website: demeto.eu

If you are interested in having your project featured in 'Project of the Month' in an upcoming issue, please send us an email to editorial@cordis.europa.eu and tell us why!

SPECIAL FEATURE

HELPING THE 5 IN 10 000: INNOVATIVE THERAPIES AGAINST RARE DISEASES

Editorial

Not common but not forgotten

Rare Disease Day is observed on the last day of February every year to raise awareness with policymakers and the public for all rare diseases and the impact that they have on the lives of patients. There are over 6 000 rare diseases that affect over 300 million people worldwide, with between 27 million and 36 million in Europe alone. Some 80 % of rare diseases are of genetic origin but can also include rare cancers, auto-immune diseases and congenital malformations. A disease is considered rare in Europe if it afflicts fewer than five in every 10 000 people.

What makes diagnosing and treating patients with rare diseases more difficult is the fact that patient populations (as well as disease experts) are spread across the continent and that many conditions that fall under the 'rare diseases' umbrella are difficult to diagnose and classify. One rare disease might affect only a handful of patients across the entire EU, whilst another could affect up to 245 000. Consequently, many patients find it difficult to access high-quality care and treatment.

That's why EU-wide funding through Horizon 2020 and its predecessor, the Seventh Framework Programme (FP7), plays such a vital role in rare diseases research in Europe. From 2014 to 2020, nearly EUR 900 million of funding has been made available to more than 160 collaborative projects related to rare diseases. By encouraging multinational cooperation, scarce knowledge and resources can be better utilised so that rare diseases can be more efficiently tackled across the entire EU.

This month's special feature of Research*eu magazine is focusing on seven recently-finished or soon-to-be-finished EU-funded projects that are working to bring hope to the millions of EU citizens that are afflicted by rare diseases. One of our featured projects is hoping to bring forward an effective treatment for Batten disease, an extremely rare neuro-degenerative disorder that mostly impacts children. Another project is leading the work on employing the drug nitisinone to treat patients suffering from alkaptonuria, also known as 'black bone disease'. Other rare diseases covered in this issue that you may not have heard of include Fanconi anaemia (FA) and ataxia telangiectasia, also known as Louis-Bar syndrome.

But this is exactly why we're covering them and supporting heightened awareness in anticipation of Rare Disease Day – because not only do patients deserve to have their stories told but there also needs to be wider dissemination of the innovative research being carried out that aims to provide patients with the treatments and therapies they need to live longer, happier and fulfilling lives.

We look forward to receiving your feedback. You can send questions or suggestions to: editorial@cordis.europa.eu

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SPECIAL FEATURE

HELPING THE 5 IN 10000: INNOVATIVE THERAPIES AGAINST RARE DISEASES

Towards an effective gene therapy for Batten disease?

Batten disease may still be fatal to this day, but research is moving forward. Efforts under the EU-funded BATCure project raise hope for an effective treatment aimed at three specific sub-types of this rare group of diseases.

The omnipresence of Parkinson's and Alzheimer's diseases could easily make us forget that neurodegenerative conditions are affecting not just our elders. Batten disease, with an estimated 1 400 new cases across the globe every year, is a lesser known, less widespread group of diseases that mostly affects children. It is ultimately fatal and cannot be cured.

Prof. Sara Mole, Professor of Molecular Cell Biology at UCL, is all too familiar with this condition. She has spent the past 20 years trying the fill the gap, with her most recent efforts having been funded under the BATCure (Developing new therapies for Batten disease) project. "For the three types of neuronal ceroid lipofuscinoses (NCL) or Batten disease covered by BATCure, treatment is currently palliative only, with no slowing down of the diseases," she explains.

The three sub-types have largely been neglected in the past due to the complex nature of the mutated proteins, which to be understood requires a transdisciplinary and coordinated approach. These include CLN3 – the most

There are an estimated

1 400 new cases of Batten disease across the globe every year

> *It may be possible to improve aspects of the disease using drugs, as well as understanding the effects of the disease on the metabolism.*

common type of Batten disease – which is responsible for over 50 % of cases worldwide. Patients will generally experience symptoms such as progressive dementia, motor decline, blindness and epilepsy.

The team hoped to develop new gene therapies for these sub-types as well as look at the wide range of available drugs to see if some of them could be repurposed for Batten disease treatment. All in all, they developed new models, identified new therapeutic target pathways, established new monitoring and diagnostic techniques, and identified compound leads. They are currently determining the therapeutic potential of these compounds using zebrafish, assessing gene therapy for the brain and delivering a small molecule therapy to mice.

"We believe that supplementation with a healthy gene is possible," says Prof. Mole. "Besides, we also think that it may be possible to improve aspects of the disease using drugs, as well as understanding the effects of the disease on the metabolism."

The team has been testing its gene therapy options for the three types of Batten disease in mouse models, while specifically targeting the eye and brain which are the organs most affected in the disease. "We've made important progress in gene therapy that shows how other cells in the eye than those initially expected needed to be reached by the vector to prevent visual failure, at least in the mice. This required specialised vectors," Prof. Mole explains.

To proceed with a clinical trial, the team will first need to produce and test the grade of gene therapy vector required for treating children in animals, as well as design the trial itself. They are already looking into funding opportunities to help them reach these goals.

When BATCure treatment becomes available, patients can expect the slowing down of disease progression or even prevention of onset altogether. Prof. Mole is also confident that the project's approach can benefit research on other diseases in the future.

BATCURE

- Coordinated by University College London in the United Kingdom.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/666918
- Project website: batcure.eu

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EryDex: an innovative treatment for Ataxia telangiectasia (AT)

AT, also known as the Louis–Bar syndrome, is a rare neurodegenerative disease that can cause severe movement and mental disabilities for patients. Whilst no treatment exists, research on steroid-induced improvement of the neurological signs of the disease is ongoing, and a phase 3 trial expecting to be fully enrolled by mid-2019 could very well change patients' lives.

Once eagerly anticipated by patients suffering from AT, corticosteroids have so far failed to provide the viable treatment option they had been waiting for. Sure, most patients showed a clinical response with short-term benefits for their neurological function. But these improvements came at the cost of corticosteroid-induced side effects that led to the discontinuation of long-term treatment.

This setback, however, didn't sound the death knell of research on corticosteroids. In January 2016, the EU-funded IEDAT (Intra Erythrocyte Dexamethasone in the treatment of Ataxia Telangiectasia) project was initiated with the ambition of kick-starting a phase 3 clinical trial for EryDex – an innovative product allowing the safe and long-term delivery of low doses of a corticosteroid.

"EryDex is made by *ex vivo* encapsulation of Dexamethasone Sodium Phosphate (DSP) in patients' erythrocytes, which are then injected once per month," explains Guenter Janhofer, CMO of EryDel, producer of EryDex. "DSP is dephosphorylated by intra-erythrocytes' phosphatases to release biologically-active dexamethasone – a corticosteroid commonly used for a variety of diseases – in the blood."

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When IEDAT started, the company had already tested EryDex in a six-month proof-of-concept trial on 22 AT patients, resulting in improvement of neurological symptoms with no evidence of typical steroid side effects.

FROM PHASE 3 TO MARKET

IEDAT was strictly about conducting a phase 3 trial that would hopefully confirm the benefits of EryDex on the neurological symptoms of AT and its good tolerability. The enrolment in the trial is half way through and is expected to open the doors to EMA and FDA approval as the first-ever treatment for AT.

"EryDex could constitute a first line treatment for AT patients, improving their quality of life and hopefully slowing down disease progression. EryDel's efforts on AT could also bring directly and indirectly a better understanding of the disease's history, mechanism of actions as well as help raise more attention within the scientific and industrial communities," Janhofer says.

The EU is not the only one believing in EryDel's treatment. The company successfully collected funding from venture capitals covering a significant part of the trial's cost, including financing from Sofinnova Partners of EUR 26.5 million.

Besides EryDex, the project has also helped set up an EU patient registry at the initiative of the UK's AT Society. The registry will enable the monitoring of the epidemiology (prevalence and incidence) of AT, the development of an

> *"EryDex could constitute a first line treatment for AT patients, improving their quality of life and hopefully slowing down disease progression."*

evidence-based natural history of the condition, the identification of biomarkers, the development of clinical guidelines, and the audit of treatments for AT and their outcomes.

"Our plan is to bring EryDex to the EU and US market by completing the clinical development and file for regulatory approval. Besides, we intend to pursue EryDex' clinical development for other diseases as well as leverage its proprietary red blood cells technology platform to develop other products from other rare diseases," Dr Luca Benatti from EryDel concludes.

IEDAT

- Coordinated by EryDel in Italy.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/667946
- Project website: iedat-project.eu

A mutation-agnostic therapy for cystic fibrosis

Cystic fibrosis (CF) is a genetic disorder caused by defects in a protein involved in the traffic of salt in and out of cells. TAT-CF's new therapeutic approach for this condition, which notably causes severe damage to the lungs and digestive system, could be a game changer.

Scientists across Europe are hard at work trying to deliver the 200 new therapies for rare diseases awaited by the EU before 2020. Saying that CF is one of the biggest challenges facing them would be an understatement: Whilst mutations and resulting malfunction of the CFTR protein have long been identified as the cause of the disease, the number of possible mutations – over 2 000 – means that therapeutic approaches must be mutation-specific and can only benefit patients sharing the same functional defect. That is, unless the field can witness a complete paradigm change.

Researchers funded under TAT-CF (Novel therapeutic approaches for the treatment of cystic fibrosis based

> *We had to find the right balance between molecular properties, transport activity and toxicity of the candidates to select the appropriate leads for our project.*

on small molecule transmembrane anion transporters) project have been intending to rock the boat since 2016. Instead of investigating new mutation-specific treatments, they have been working on molecules able to mimic CFTR function, potentially enabling mutation-agnostic therapies that can benefit all CF patients. "The current results in clinical trials for combinations of potentiators and correctors are very encouraging. But the downside is that these developments cannot provide therapeutic options to all CF patients. In particular, there are several classes of mutations, such as nonsense mutations, resulting in no CFTR being produced. In this case, pharmacological modulation or rescue of CFTR activity is completely ineffective," Dr Roberto Quesada explains.

"More than 200 compounds were evaluated by the different partners involved in our consortium," says Dr Quesada, coordinator of the project. "We had to find the right balance between molecular properties, transport activity and toxicity of the candidates to select the appropriate leads for our project."

The compounds have been tested on cell lines obtained from patients with different mutations and through gene editing. As Dr Quesada points out, "this means that we have been able to test them in cells and organoids having different functional defects as well as models in which CFTR expression was completely absent."

Using synthetic epithelium derived from primary human bronchial epithelial cells, the team could show that the compounds they selected could bring CF epithelia function to normal values in terms of fluid reabsorption and mucus viscosity – two key parameters in the pathophysiology of CF patients.

Besides, the compounds were tested in combination with approved CF drugs and observed additive effects, which could also be envisaged to be a promising approach for the treatment of different mutations.

The next step for TAT-CF partners is *in vivo* research to confirm the obtained results. For testing on relevant animal models, the team has decided to focus on pulmonary disease as the main cause of morbidity and mortality of CF patients. They have already developed nanoformulations suitable for pulmonary delivery and performed ADME-Tox studies in mice models. "Now, we would need to confirm their safety and efficacy in an appropriate animal model for respiratory tract disease before proceeding with clinical trials in humans," Dr Quesada explains.

All in all, TAT-CF's research paves the way to new therapies bypassing CFTR function using synthetic molecules. A patent application has already been filed, and the consortium is currently looking for new (public or private) sources of funding.

TAT-CF

- Coordinated by the University of Burgos in Spain.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/id/667079
- Project website: tat-cf.eu

New, personalised treatment concepts for rare anaemia

Splenectomy's mixed results have pushed a consortium of EU researchers to investigate novel diagnosis and treatment pathways for patients suffering from rare anaemia. Their new concept is currently undergoing clinical trials.

There is no such thing as a simple guide on how to deal and cope with anaemia. Not only can the condition have multiple causes, but even in the case of two patients sharing the same disease origin – such as protein mutation – the impact of this dysfunctional protein on each patient can vary immensely. What's more, even the same patient can see the severity of his/her symptoms vary over time.

COMBINING DIFFERENT TECHNIQUES

In this context, scientists working under the CoMMiTMenT (Combined Molecular Microscopy for Therapy and Personalized Medication in Rare Anaemias Treatments) project have been looking for a viable method to identify the specificities of a patient's condition and the most suitable treatment. Their plan consists in investigating the combination of different techniques to assess the frequency of occurrence of terminally damaged cells, identifying the pathology through a machine-learning system, and pointing at suitable targets for therapeutic intervention.

"It is always a good idea to combine two different techniques in one approach or even in a single device," says Dr Lars Kaestner on behalf of Saarland University. "Initially, the idea behind CoMMiTMenT was to combine optofluidic microscopy (which allows for the identification and selection of a subpopulation of cells) with scanning ion conductance microscopy (to characterise their electrophysiological properties). As this didn't work out as expected, we ended up developing a device that combines microfluidics (lab on a chip) with optical microscopy. We call it MeCheM: It can do similar things as we anticipated from our initial concept."

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MORE EFFECTIVE, PERSONALISED TREATMENT

Unlike splenectomy, which consists in removing the patient's spleen to increase the number of red blood cells and effectively removes most quality control for these cells, MeCheM allows for more effective and personalised treatment. For those patients sensitive to the adverse effects of splenectomy, which can include stroke or cardiac infarction, this is a potential life changer, one that also has potential to apply to a large spectrum of rare anaemias.

PROMISING FINDINGS AND NEXT STEPS

Indeed, project findings have notably revealed the existence of several 'common denominators' of various rare anaemia. This, according to the consortium, suggests that a combination of several drugs could potentially provide stabilisation of red cells and improve the quality of lives of a larger group of patients, in turn "making rare anaemias more attractive for pharmacological companies."

The team specifically tested its concept on sickle cell disease and came up with a new medication that targets the so-called NMDA-receptor (Memantine). "A pilot clinical trial was conducted in Zürich with very promising results, and a follow-up with a bigger number of sickle cell disease patients is taking place in Afula, Israel," says Dr Kaestner. "MeCheM is used to check for the appropriate Memantine dose to avoid the symptoms of the disease." A new diagnostic test for Hereditary Xerocytosis, another rare form of

> *It is always a good idea to combine two different techniques in one approach or even in a single device.*

anaemia, was also investigated with the development of a novel assay based on existing technology.

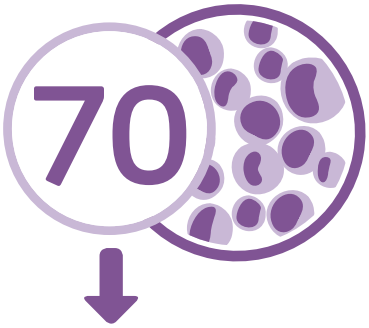
Once clinical trials have been completed, patients can expect better diagnoses and treatments resulting in fewer symptoms. In the meantime, Dr Kaestner intends to pursue his research. "I applied to become coordinator within a new consortium to understand mental co-morbidities associated with red blood cell related diseases. We submitted the first stage application under the acronym 'Res-Q', and we are also compiling a new ITN proposal dealing with red blood cells in flow called 'EVIDENCE'," he says.

COMMITMENT

- Coordinated by Saarland University in Germany.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/602121
- Project website: rare-anaemia.eu

A safe, efficient gene therapy trial for Fanconi Anaemia patients

Researchers with the EU-funded EuroFancoLen project demonstrated the feasibility of engrafting patients with phenotypically-corrected cells – opening the door to the use of gene therapy for FA patients.



the number of genetic and mutational diagnoses of FA patients conducted during the EuroFancoLen project

Fanconi Anaemia (FA) is a rare, inherited syndrome characterised by the early development of bone marrow failure and an increased predisposition to cancer. Unfortunately, the only known curative therapy – the transplantation of haematopoietic stem cells (HSC) from healthy donors – comes with a range of complications. Furthermore, given that only a few FA patients have a histocompatible donor, researchers favour treating FA-A patients via the genetic correction of autologous HSC. (FA-A patients are those with mutations in the most commonly affected FANCA gene).

"Although promising, the advancement of such treatment has been limited," says Dr Juan Bueren, a researcher with the EU-funded EuroFancoLen (Phase I/II Gene Therapy Trial of Fanconi anemia patients with a new Orphan Drug consisting of a lentiviral vector carrying the FANCA gene: A Coordinated International Action) project. "This is primarily due to difficulties in collecting sufficient numbers of HSC from the bone marrow of FA patients, but also because of the difficulties of correcting *ex vivo* the genetic defect of the very fragile FA HSCs."

It was against this backdrop that EuroFancoLen project researchers set out to develop a safe and efficient gene therapy trial for FA patients.

A NOVEL APPROACH

During the project, over 70 genetic and mutational diagnoses of FA patients were conducted. These diagnoses included whole exome sequencing and, in cases of mutations with unknown clinical significance, additional functional studies. "Our aim was to demonstrate the safety and efficacy of conducting gene therapy with lentiviral

vectors – a completely novel approach to treating FA-A patients," explains Dr Bueren.

From these clinical trials, the project first demonstrated the possibility of collecting clinically relevant numbers of CD34+ cells using plerixafor and G-CSF, two HSC mobilising drugs. CD34 is a well-known marker for bone marrow-derived progenitor cells, especially for HSCs.

Next, researchers developed an optimised procedure for correcting mobilised peripheral blood CD34+ cells from FA-A patients by transduction with lentiviral vectors. This is a gene therapy method involving the insertion of therapeutic genes that are mutated in a given patient. "Using an optimised transduction procedure for FA HSCs, we demonstrated the repopulating ability and proliferation advantage of corrected HSCs when these cells are transplanted into immunodeficient mice," says Dr Bueren.

Finally, researchers conducted a gene therapy trial for FA-A patients based on the transduction of plerixafor/G-CSF mobilised CD34+ cells with the therapeutic vector. This was followed by an infusion of these cells in non-conditioned patients.

A NEW DOOR OPENS

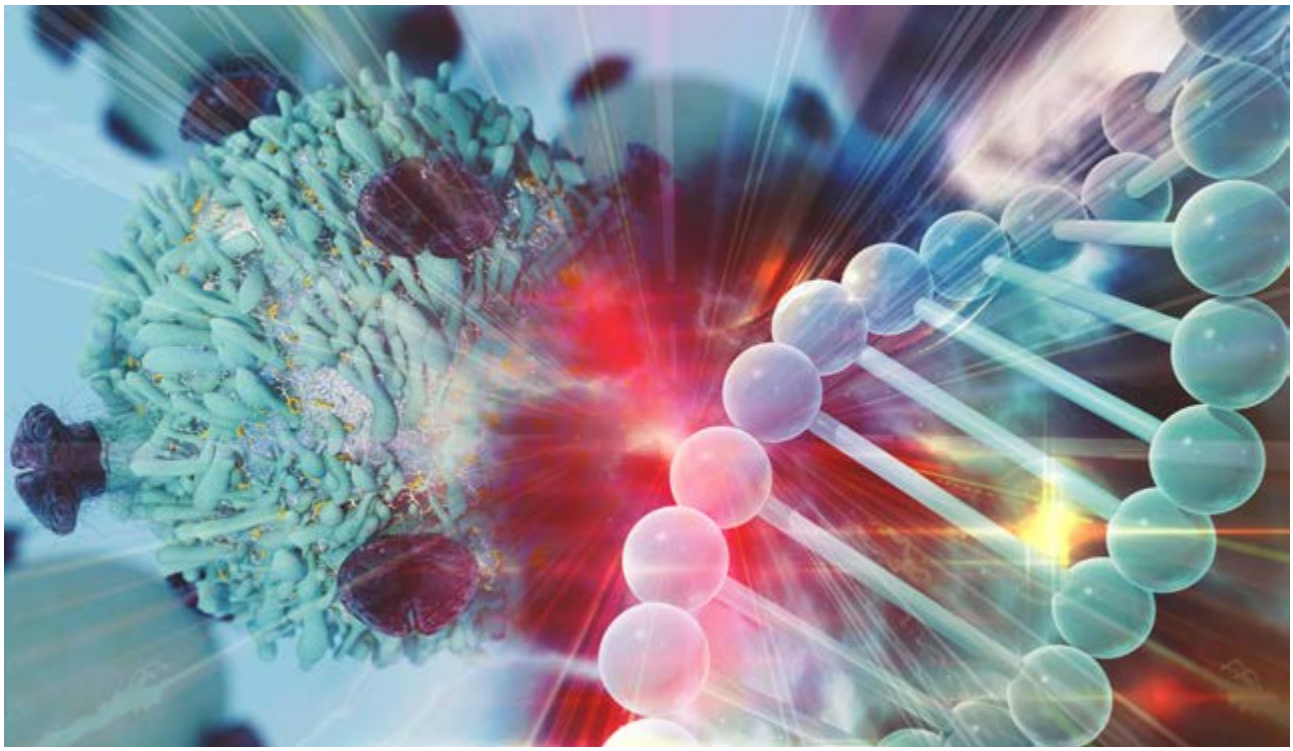
Despite the absence of conditioning, a progressive engraftment of gene-corrected cells has been observed in most patients. In one patient with the longest follow-up (30 months post-infusion), the proportion of gene-corrected cells in blood and bone marrow surpassed 50 %. In patients with relatively high levels of corrected cells, an evident correction in the behaviour of T-lymphocytes and bone marrow progenitor cells was observed. Researchers also observed a trend of ameliorated bone marrow failure in these patients. Importantly, no evidence of genotoxic insertions was noted in any of the treated patients.

"These trials showed the feasibility of engrafting patients with phenotypically-corrected cells – opening the door to the use of gene therapy for FA patients," adds Dr Bueren.

Currently, researchers are working to register a new medicinal product consisting of autologous, genetically-corrected CD34+ cells for FA patients.

EUROFANCOLEN

- Coordinated by the Centre for Energy, Environmental and Technological Research (CIEMAT) in Spain.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/305421
- Project website: eurofancolen



New AKU treatment comes closer to commercialisation

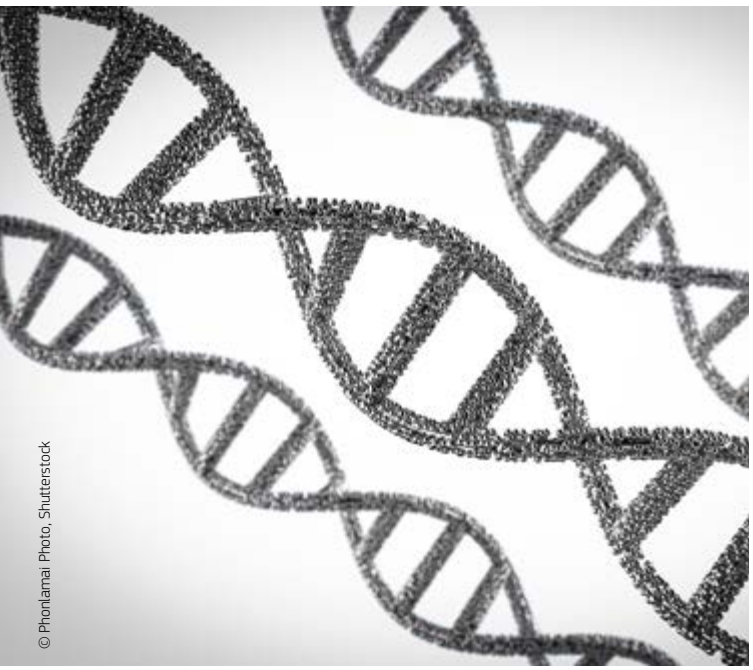
Nitisinone is probably the biggest source of hope for alkaptonuria (AKU) patients right now. Research efforts under the DevelopAKUre project are bringing its commercialisation within reach.

The story moved citizens all across Europe: Five years ago, Nick Sireau, a father of two running a charity, finds out that his two sons share a common rare disease called AKU or 'black-bone disease'. He leaves his job to seek a cure, takes up the position of CEO at a patient research group called the AKU Society founded by a patient called Robert Gregory, and helps obtain over EUR 6 million of EU funding to investigate a drug called nitisinone.

At the time, nitisinone was already in use for treating another rare disease and had been found to lower urine homogentisic or HGA – a chemical formed during the breakdown of tyrosine that accumulates in AKU patients and causes serious health complications – by 95 %.

Fast-forward to 2018. DevelopAKUre (Clinical Development of Nitisinone for Alkaptonuria), the project investigating nitisinone supported by the AKU Society and coordinated by the Royal Liverpool and Broadgreen University, is close to completing its third study.

The project has already successfully determined the appropriate nitisinone dose for AKU patients, confirmed the efficacy of the treatment and found out when ochronosis (the process leading to the morbidity of AKU) begins during the human life cycle. Dr Lakshminarayan Ranganath, project coordinator, discusses its outcomes so far, as well as follow-up plans.



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How would you explain the current absence of a treatment for AKU?

The first reason is historical, due to the delayed onset and lack of appreciation of the severe morbidity at paediatric age: Paediatricians have been slow in their efforts to develop a treatment for AKU.

Then, although it was shown to lower urine HGA by 95 %, the first nitisinone interventional study in AKU was declared inconclusive by the FDA – the regulatory body in the USA. This could be due to the small numbers of patients included in the study, the lack of a correct dose of nitisinone in AKU, an incomplete understanding of the natural history of AKU, or the use of a single outcome (lateral rotation of the hip) to decide upon effectiveness.

So what makes you think nitisinone is still the way to go, and what makes your approach particularly innovative?

DevelopAKUre came at the perfect time. When we kicked off the project, the deficiencies in the earlier nitisinone study had been understood and the design of DevelopAKUre benefitted from other activities: a systematic effort to identify more patients with AKU (we had a pool of more than 500 patients to recruit from); the fact that, besides lowering HGA, nitisinone was also shown to stop or prevent the fundamental process responsible for severe multisystem morbidity (ochronotic pigment formation); the better characterisation of the natural history of AKU thanks to a clinical study we carried out; and the development of a more global and sensitive measurement of the effect of nitisinone called the AKU Severity Score Index or AKUSSI.

Moreover, the design of DevelopAKUre incorporated a robust dose response study in AKU, and the very important

Dr Lakshminarayan Ranganath
Project coordinator of DevelopAKUre
© Lakshminarayan Ranganath

> *The European Medicines Agency recognised the importance of HGA as a clinical feature in AKU and supported and enabled our clinical programme.*

question of when in the life cycle of an AKU patient should treatment with nitisinone begin was also considered.

What would you say have been the most important outcomes of the project so far?

The DevelopAKUre project is still ongoing, as one of our three studies will conclude in 2019 after statistical analysis.

However, our first study – SONIA 1 (Suitability of Nitisinone In Alkaptonuria 1) – employing nitisinone in a liquid formulation is already completed. Its main conclusion is that an 8 mg dose was most effective as it led to near-normalisation of HGA in all patients. SONIA 1 also helped us understand the pharmacokinetics and pharmacodynamics of nitisinone in AKU for the first time. The metabolic state of AKU before and after nitisinone is now better understood thanks to a 24-hour profiling of tyrosine pathway metabolites, the characterisation of the renal handling of metabolites as well as a quantification of the amount of tyrosine converted daily into ochronotic pigment.

Our other completed study is SOFIA (Subclinical Ochronosis Features In Alkaptonuria). SOFIA has shown that ochronosis, the main pathophysiological event in AKU, can be present before the age of 20. Other features of AKU were also found early in life and a follow-up study at paediatric age will soon begin in the UK. This will better inform us on whether nitisinone should be given to patients younger than 16 years old.

The longest study – SONIA 2, a four-year nitisinone outcomes study – will complete its clinical phase in January 2019. Data analyses beyond January 2019 will establish whether clinical outcomes have also benefited from nitisinone, paving the way to an application for marketing authorisation.

What has been the feedback from the European Medicines Agency so far?

One of the most important activities likely to affect the outcome of DevelopAKUre was the pre-study meeting with the EMA. The EMA recognised the importance of HGA as a clinical feature in AKU and supported and enabled our clinical programme.

What are your follow-up plans?

Once all the data from our studies has been analysed, we will decide whether a marketing authorisation application will be filed or not. Assuming approval by the EMA, this should be followed by national pricing and reimbursement processes.

DEVELOPAKURE

- Coordinated by Royal Liverpool and Broadgreen University in the United Kingdom.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/304985
- Project website: developakure.eu
- bit.ly/2SWf3Lt

Supporting global cooperation in rare disease research

To ensure the International Rare Diseases Research Consortium (IRDiRC) has the support it needs to coordinate global research on rare diseases, the EU-funded SUPPORT-IRDiRC project established the IRDiRC Scientific Secretariat.

Collectively, around 7 000 rare diseases affect some 30 million people in the EU alone. These diseases have a substantial impact on public health, society and national economies. Their rarity and diversity pose specific challenges for research, healthcare, and the development and marketing of treatments. Consequently, many patients

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with a rare disease lack timely and accurate diagnosis – and even fewer receive tailored treatments.

With research into rare diseases happening around the world, it is important that results are shared, not siloed. Increasingly, global coordination of these efforts is widely recognised as necessary to avoid duplication, fragmentation, redundancy and research gaps, and to accelerate translation of results into diagnostics and treatments.

The IRDiRC was established to do exactly this: to enable all people living with a rare disease to receive an accurate diagnosis, care and available therapy within one year of seeking medical attention. To ensure the Consortium had the organisational and communication support it needed to work toward this ambitious vision, the European Commission funded the SUPPORT-IRDiRC (Support for international rare disease research to serve the IRDiRC objectives) project, which established the IRDiRC Scientific Secretariat.

"The IRDiRC Scientific Secretariat is an integral part of IRDiRC's productivity," says Project Manager, Dr Anneliene Jonker. "Through the project's support, the IRDiRC has been able to advance its goals and catalyse progress in rare diseases research."

SUPPORTING THE IRDIRC

The SUPPORT-IRDiRC project reinforced international cooperation in research on rare diseases in numerous ways. For example, by organising meetings and supporting coordinated actions between the Consortium's stakeholders, the project facilitated the exchange of information, optimised the use of resources, and enabled the sharing and publication of data. Through its support for the development of standard operating procedures and adoption of data standards – including a better classification of

"Through the project's support, the IRDiRC has been able to advance its goals and catalyse progress in rare diseases research."

rare diseases – the project also contributed to the establishment of standard policies and guidelines.

The project assisted the Consortium in knowledge management through the collection of rare disease research outcomes, monitoring global policy developments, measuring progress, and sharing emerging best practices in rare diseases research. It also helped the IRDiRC communicate its outcomes to its members, the rare disease community, and the public in general.

INCREDIBLE PROGRESS IN RARE DISEASE RESEARCH

"Over the past six years, IRDiRC has made great strides toward its goals, growing from 30 to 60 members, setting up three new committees, running 10 Task Forces, publishing 15 articles, organising international conferences, gathering over 500 stakeholders in rare diseases for annual discussions, and establishing a roadmap for the future," says Jonker. "The IRDiRC Scientific Secretariat and IRDiRC work in close collaboration to achieve incredible progress and enhance global coordination of rare diseases research."

Although the SUPPORT-IRDiRC project has ended, the Scientific Secretariat continues to be an intrinsic part of IRDiRC. It will now be sustained through the European Joint Programme for Rare Diseases, where it will continue to assist IRDiRC and the rare disease community. "The standards, guidelines, goals and meetings resulting from the project have set a solid foundation for rare disease research for the next decade," Jonker concludes.

SUPPORT-IRDIRC

- Coordinated by Inserm in France.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/305207
- Project website: irdirc.org/support-irdirc

Intuitive freshness indicator helps consumers reduce food waste

The EU-funded MultiSens project's innovative freshness indicator can be integrated directly into food packaging.

Every year, over 89 million tonnes of food is wasted in the EU alone. With the average European household responsible for 42 % of this food waste, many initiatives working to reduce waste focus on the consumer.

Once such initiative is the EU-funded MultiSens (A revolutionary quality indicator platform for the food industry) project, which is developing a revolutionary quality indicator platform for the food industry. With the bulk of consumer-level food waste attributed to food going bad, MultiSens researchers are building an intelligent packaging platform that will alert customers about the content's quality.

"Although there have been several attempts to develop a freshness indicator capable of monitoring a product's freshness, none of these smart labels is geared towards consumers," says Dr Isabel M. Perez de Vargas Sansalvador, MultiSens project coordinator and Marie Curie fellow. "What we propose is an original, non-invasive quality determination system for packaged meats."

EASY-TO-USE FRESHNESS INDICATOR

The MultiSens freshness indicator is integrated directly into the food packaging, where its sensors can detect carbon dioxide (CO_2) levels. "Our research has correlated meat freshness with the concentration of CO_2," explains Dr Perez de Vargas Sansalvador. "A change in CO_2 level during storage is a clear indicator that bacteria are growing inside the package or that the package itself has been compromised."

Researchers are experimenting with two different ways to implement the sensor into the package. In one prototype, the freshness indicator is attached to the outside of the

> *By simply taking a photo of the sensor, the consumer will immediately know the quality of the meat, allowing them to make an informed purchasing decision.*

package, but in direct contact with the inner atmosphere. In the other, the sensor is printed directly into the film covering the package.

Both designs are supported by a user-friendly mobile phone application. "By simply taking a photo of the sensor, the consumer will immediately know the quality of the meat, allowing them to make an informed purchasing decision," says Dr Perez de Vargas Sansalvador. "Back at home, they can also use the phone app to monitor freshness at any time."

Researchers are now working on sensors capable of detecting ammonia and hydrogen sulphide. Currently, MultiSens sensors are available only for pork products, although the sensor architecture was built to be adapted for use with any type of packaged food.

INSPIRING EUROPE'S YOUTH

According to Dr Perez de Vargas Sansalvador, her research is about more than knowing the quality of packaged meat – it's about raising awareness on how individuals can help reduce food waste. Knowing that the key to reducing waste is to get this message across to today's youth, she has spent considerable time visiting local schools and talking about her research. "Students have to know why it is important for our world to reduce food waste," she says. "If every single person reduces their waste, it will have a huge impact on our environment."

MULTISENS

- Coordinated by the University of Granada in Spain.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/706303

FOOD AND NATURAL RESOURCES

A 'life-oriented' paradigm for future agriculture

It's time for a change. With agricultural diversity at an all-time low, the DIVERSIFOOD consortium has been gathering valuable knowledge on forgotten and underused crops to build a more diverse, sustainable market where quality comes first.

Throughout the 1970s, scientists in Europe started compiling gene banks for edible plant species. As modern varieties and agricultural practices were taking the market by storm, they felt like they didn't have much time before entire plant varieties went extinct.

History proved them right: whilst around 7000 plants have historically been used in agriculture, 75% of the world's food currently comes from just 12 plants and five animals. According to the FAO, 60% of the world population's caloric input is generated from three plants only: rice, wheat and maize. And gene banks haven't evolved much since they were created.

"Our project is based on two hypotheses: the first is that cultivated plant diversity is the foundation for creating more sustainable and resilient food systems. The second is that the ultimate goal of such resilient agricultural systems is to provide high-quality food," says Dr Véronique Chable, senior scientist at INRA and coordinator of DIVERSIFOOD (Embedding crop diversity and networking for local high quality food systems).

The project's main objective is to develop a food-quality concept along these lines. Covering the whole food chain from genetic resources to marketing, the consortium has been evaluating the genetic resources of a dozen underutilised and forgotten plant species, creating innovative

> *Instead of breeding uniform varieties (such as pure lines, F1 hybrids and clones), we have been creating new population varieties where all the plants within a single population are genetically different.*

breeding methods, managing diversity in Community Seed Banks, conducting surveys, and providing recommendations for the better management of seed systems and better organisation of research. This is what Dr Chable calls a "life-oriented" paradigm, aiming to boost diversity at all levels of the value chain.

"Instead of breeding uniform varieties (such as pure lines, F1 hybrids and clones), we have been creating new population varieties where all the plants within a single population are genetically different. This is essential for sustainability, crop performance, food quality and plant health," says Dr Chable.

75% of the world's food
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Besides reviving diversity, the consortium hopes the project will enable a cultural shift where living processes, rather than the laws of markets, will come first. DIVERSIFOOD's new organisational models are expected to help sustain pioneering and multi-actor processes embedded in territories and communities, and to support the emergence of diversity-based food systems that are sustainable in the long run. "Meanwhile, DIVERSIFOOD is questioning which avenues can be envisaged to effectively support and


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finance these local and collective initiatives," Dr Chable points out.

The project is scheduled for completion in February 2019. From that point onwards, the team will be aiming for a broader implementation of their concept. "It is time to start a transition from proofs-of-concept and success stories to a more systematic deployment of our collective, multi-actor and multi-knowledge approach to food systems diversity. We will collectively mobilise citizens and policy makers, with a focus notably on scientists who require adequate transdisciplinary training, and farmers within networks who need assistance and support to successfully undertake plant breeding and research activities. Neither the project's funding framework, nor the 'market' can fulfil these needs on their own. We need to seek alternative organisational and funding models having an impact at a significantly larger scale," Dr Chable concludes.

DIVERSIFOOD

- Coordinated by INRA in France.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/id/633571
- Project website: diversifood.eu

Advanced bioaerosol detection and modelling supports forecasting and mitigation efforts

Fungal spores in the atmosphere have implications for both human health (as aeroallergens) and plant health (as pathogens). The SUPREME project developed drone, DNA detection and modelling technology to advance scientific understanding and support early response planning.

Applying DNA detection technology to bioaerosols has meant that scientists now know much more about the wide diversity of these, as well as revealing details that were previously not possible.

Part of the challenge of continuing this work is the task of capturing the bioaerosols in the field. To help develop a solution for scientists to adequately analyse fungal spores, the EU-supported SUPREME project designed and tested an Unmanned Airborne Vehicle (UAV) to sample these bioaerosols. The data gathered was combined with pre-existing data to develop and apply a mathematical model which could explain fungal spore emissions as a result of harvesting.

As well as offering new scientific understanding, these DNA-based approaches also enable more targeted mitigation efforts to avoid damage to people and plants.

GETTING OFF THE GROUND

The UAV was designed in conjunction with a private company. Explaining the process, project coordinator and Marie-Curie Fellow Prof. Carsten Skjoth, recalls, "We

> *Our advanced atmospheric model, DNA detection techniques and new emissions detection approaches – all have substantial potential on their own – but in combination they could revolutionise the field and generate scientific results with a really positive impact on society.*

started by outlining the requirements necessary for what it should observe and then looked at parameters, such as what sort of spore quantities it would need to handle."

The end result was a custom built, low-cost drone, which is capable of flying for significant periods of time and is very efficient in capturing large amounts of spores. However, it can also prove challenging to operate as it requires a lot of open space, difficult to find in the regions typically under study. Additionally, it can take quite a long time to launch and generally requires handling by two people.

As Prof. Skjoth says, "Frankly it was a mixed success, but we learned a lot. We know that the drone can be made more fit-for-purpose if a compromise is reached between flying time and ease of use and launch speed."

The project also developed the first iteration of a new generation of globally applicable atmospheric models that are capable of simultaneously and consistently catering for physics-, chemistry- and biology-led investigations.

This working atmospheric transport model (Biochem), can successfully handle bioaerosols with various degrees of complexity, depending on the research focus. Indeed, "The modelling tool is arguably among the most advanced of its kind, potentially just as complex as atmospheric chemistry models in the way it connects the tool with detection, using DNA approaches. As well as sparking new research directions, it can also be used as a straightforward forecasting tool. This application is currently done within the NERC-funded PollerGEN project which focusses on grass species," Prof. Skjoth adds.

FROM FUNDAMENTAL RESEARCH TO FORECASTING

The new SUPREME modelling tool is likely to be a cornerstone for bioaerosol forecasting in the UK. The model also functions effectively as an advanced research tool, enabling investigations into important scientific questions related to human health, such as on co-exposure (combined exposure of air pollution and pollen) or the effects of bioaerosols on the climate (present and future). It also allows spores to be separated into sub-groups in a way not possible using optical microscopes.

"Our advanced atmospheric model, DNA detection techniques and new emissions detection approaches – all have substantial potential on their own – but in combination they could revolutionise the field and generate scientific results with a really positive impact on society," concludes Prof. Skjoth.

The team are now further exploring how satellite data can be combined with the detection and advanced modelling methods, offering richer insights. Furthermore, new approaches for DNA techniques to analyse bioaerosols are being tested. Two new methods for the detection of emissions of pollen and spores have also been undertaken as part of a pilot study this year and will be applied on a larger scale in 2019.

SUPREME

- Coordinated by the University of Worcester in the United Kingdom.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/id/630745

INDUSTRIAL TECHNOLOGIES

Better plastics through cleaner technology

A technology breakthrough, which replaces up to 50 % of oil-based raw materials in polymer manufacture with carbon dioxide (CO_2), helps reduce emissions and enhances the performance of manufactured plastics.

New catalyst technology that enables waste CO_2 to replace oil-based raw materials in polymers to produce cheaper, higher-performing plastics is being commercialised under the EU-funded CO2Catalyst (Pilot scale demonstration of novel CO_2 co-polymerisation catalysts in the PU polyol market) project.

"Our technology allows CO_2 to be introduced into polymer manufacturing," says Jill Dearnaley, Operations Director at Econic Technologies, UK which received EUR 2.49 million in EU funding to demonstrate and commercialise the technology.

CO_2 is much cheaper than the oil-based raw materials currently used in polymer manufacture. Econic's technology allows up to 50 % of oil-based raw materials to be replaced by waste or readily available CO_2, so "there's a huge economic benefit," Ms Dearnaley says.

The use of CO_2 also has environmental benefits with significant reductions in greenhouse gas emissions. "For every tonne of CO_2 that we incorporate into the polymers, we can prevent the emission of a further two tonnes of CO_2," she says.

According to Econic's projections, a 30 % market adoption of the patented technology by 2026 would reduce CO_2 emissions by 3.5 million tonnes per year – equivalent to taking more than 2 million cars off the road each year.

ENHANCED PROPERTIES

Other technologies have been developed and incorporate CO_2 into polymers, but Econic's patented CO2Catalyst technology "is unique because it allows you to tune how much CO_2 you want to incorporate into the polymer," explains Ms Dearnaley. "This means you can tailor it to the properties of your end-use products."

> *For every tonne of CO_2 that we incorporate into the polymers, we can prevent the emission of a further two tonnes of CO_2.*

Polymers containing waste CO_2 can be useful in a variety of polyurethane products, such as: rigid foams used in wall panels and shoe soles; flexible foams in mattresses; elastomers used in window seals; or coatings to protect wood floors and furniture.

The use of CO_2 also enhances the properties of the end products. Rigid foams used in building insulation demonstrate improved flame retardance and reduced smoke emission on burning. Coatings are more robust – more resistant to temperature changes, weather and water damage and can be abrasion-proof, thereby protecting metal, wood and other surfaces from scratching.

DEMONSTRATION PLANT TO PROMOTE CUSTOMER ADOPTION

Under the CO2Catalyst project, Econic designed and built a customer demonstration facility in Runcorn, near Liverpool.

"Potential customers can walk around and see a functioning plant that looks like what they have, but on a smaller scale," Ms Dearnaley says. "Typically, this type of chemistry requires high temperatures and pressures to work, but our technology works in industrially-relevant conditions so it can be retro-fitted into existing assets."

Safety aspects have been paramount in setting up the demonstration facility and many safety experts were involved in the design and construction as well as site management. "It was a bit of a challenge finding a site for the demonstration facility, because there are not many places that can deal with this type of chemical process," she explains.

"Our facility is really helping us with commercialisation and customer adoption, as they can see first-hand the viability of our technologies."

The project's focus is currently on adoption of the catalyst technology within the EUR 45 billion polyurethane industry. Work is also beginning on its adoption in other plastics industries.

CO2CATALYST

- Coordinated by Econic Technologies Ltd in the United Kingdom.
- Funded under H2020-ENVIRONMENT and H2020-SME.
- cordis.europa.eu/project/id/734039
- Project website: econic-technologies.com

INDUSTRIAL TECHNOLOGIES

Energy-efficient refrigeration for smaller facilities

An EU-funded project has developed a prototype refrigeration unit that provides 70 % primary energy savings for smaller plants.

Climate change targets set by the 2015 Paris Agreement will only be met if significant energy and emissions savings are made not just by big industrial plants but also by smaller units.

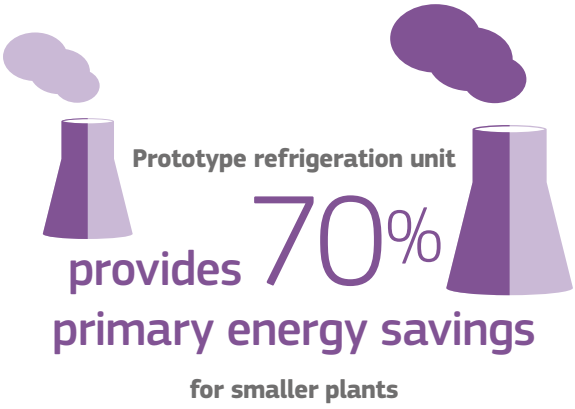
A new refrigeration technology, ECOiCE, which recycles waste heat to save up to 70 % of primary energy usage and greenhouse gas emissions during the chilling process, is being rolled out to small and medium-sized facilities under the EU's TRISORP (Energy saving and reducing carbon dioxide emission by applying advanced ammonia/water absorption chillers and decentralised Trigeneration (CCHP) technology to small and medium enterprises) project.

Compression cooling used in a wide range of industrial processes requires a huge amount of electrical power. The TRISORP prototype "is designed for small and medium-size applications for which no alternative to energy-intensive and environmentally harmful compression chillers is available," says TRISORP project coordinator Günter Bellmann from Kälte-Klima-Sachsen GmbH (KKS) in Wermsdorf, Germany, a manufacturer of cooling systems.

"We achieve energy savings with a new application of a well-known principle – the absorption chiller – to a range of uses in between the normal household refrigerator and big industrial plants," Dr Bellmann says. "It can be used in hotels, food processing plants, dairies and supermarkets; it has a very broad range of uses."

"The big energy saving is derived from using waste heat from the CHP – the Combined Heating and Power plant – or from solar energy and other energy sources to cool down a liquid used as a refrigerant," Dr Bellmann explains. "We use the waste heat which would otherwise be distributed to the environment."

At the same time, CO_2 exhaust emissions are reduced. "It is particularly useful where there is no grid available as a source of energy or where solar energy or LNG (liquefied natural gas) is used as fuel," Dr Bellmann adds.



The big energy saving is derived from using waste heat.

SIMPLE IS CLEVER

Further cost savings are achieved by reducing the number of steps in the production process and making the ECOiCE technology as simple as possible so it can be combined or retro-fitted to any CHP or gas turbine, Dr Bellmann says.

"For the prototypes, we use 'intelligent simplicity' which means using only as many electronic and mechanical parts as absolutely necessary," Dr Bellmann says. Having fewer parts reduces the number of faults that could develop. Usually an industrial system is developed for general use, but many of the functions are unnecessary. "So we keep it as simple as possible," he says, adding this makes it easier to combine with existing machinery in a plant.

PROTOTYPES DEVELOPED

Under the project, KKS produced the plant and developed interfaces for the CHP and other peripherals, some of it with CHP manufacturers, partners and subcontractors. A 25 kW prototype was used with a distributor of food with own manufacturing in Germany to replace a compression refrigerator. In addition, the technology was further developed for models with 50 kW and 100 kW cooling capacity. "A 100 kW plant costs about half compared to four 25 kW plants," Dr Bellmann notes.

Six demonstrator units have been set up in Germany, including at a meat processing company and several food distributors, who use it for storage cooling.

EU funding also enabled the project to find sales partners and technical partners to install and maintain the technology abroad such as in Spain and Austria. In Chile, the ECOiCE technology is currently being prepared for use in a meat processing plant.

TRISORP

- Coordinated by KKS in Germany.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-ENERGY.
- cordis.europa.eu/project/id/724982
- Project website: kaelte-klima-sachsen.de/unternehmen/trisorp/

DIGITAL ECONOMY

New router brings unshakeable connectivity to police cars and ambulances

Geographical mobile network coverage can be as low as 80 %. Now imagine you're driving an ambulance or police car: this 20 % can make a major difference. Thanks to a new multi-channel router brought about by the OpSec project, full coverage is now within reach.

The rationale behind the OpSec (Goodmill – Operational Security Through Ensured Connectivity) project and Goodmill, the SME that engineered it, is simple yet difficult to argue against: as much as users want the 'killer app' that will meet their requirements, such a killer app is only as good as the mobile network it's depending on. Only flawless connectivity can fit the bill.

This is particularly true for Public Safety and Security (PSS) professionals such as police officers or paramedics, who have no choice but to rely on telecommunications to guarantee their personal safety and that of the people they serve. In such a context, connectivity can be a matter of life and death.

"There are more and more mobile applications enabling safer and more efficient operations for PSS, and these keep growing in importance. We at Goodmill saw a gap in the market, and believe that closing it requires much more than putting an office router into a vehicle and

> *We at Goodmill saw a gap in the market, and believe that closing it requires much more than putting an office router into a vehicle and expecting it to work.*

expecting it to work. Our solution is designed, engineered and optimised for the mobile wireless challenge," says Petteri Suomalainen, founder and CEO of Goodmill.

Goodmill's router combines dedicated and commercial networks with WiFi and other routes of data transfer to achieve up to 99.9 % availability. It can be installed in a vehicle with only basic knowledge of networking.

Say an ambulance is driving at 180 km/h in an emergency mission: the router can be used to send the likes of online ECG information and get real-time instructions from hospital staff to give special emergency treatment to the patient. A police officer, on the other hand, would find the system useful when stopping a car. With Goodmill, an online database request can be made to check for criminal records or gun registrations based on a plate number.

The router is packed with innovative features, one of the most important being mobile-IP tunnelling, which ensures a smooth transition between networks. "Mobile-IP completely insulates the higher layers – apps and services – from the 'messy details' of the underlying radio networks. Besides, our quality estimation and link selection algorithms can work hand-in-hand with Mobile-IP to ensure that the most appropriate link is in use at all times. Lately, we even optimised multiple link capacities and simultaneously took care of application prioritisation challenges. With this, we make sure that the most important data are always delivered," Mr Suomalainen explains.

The company hopes to reach a 20 % market share by 2020 and has already sold equipment to national roll-outs in Finland, Norway, Iceland, Kuwait and Qatar, where thousands of Goodmill routers are now in use. With OpSec, Mr Suomalainen and his team focused on improving the technology to reflect the recent increase in the need for data capacities and the need for more modern security features. They also focused on developing US-specific features which would fulfil the needs of that market.

"Our market segment is loyal and global, but conservative in their processes. Public safety decision making is sometimes very bureaucratic and it is impossible to make the decision a critical one, despite the urgent need for the capabilities we provide. With this funding, we could address totally new and promising markets that would not have been otherwise possible to enter, such as Mexico, Canada and the USA," Mr Suomalainen concludes.

OPSEC

- Coordinated by Goodmill Systems in Finland.
- Funded under H2020-SECURITY and H2020-SME.
- cordis.europa.eu/project/id/755919
- Project website: goodmillsystems.com

DIGITAL ECONOMY

ICT tracking technologies to promote walking and cycling

Individuals and society overall stand to gain if there's a shift from vehicle usage to more cycling and walking. An EU initiative has created an innovative approach through movement-tracking ICT tools and services to encourage and reward walking and cycling, especially in cities.

Public authorities and other stakeholders in Europe and around the world are seeking ways to deliver sustainable urban mobility. Getting away from vehicle-based transport and moving towards increased cycling and walking can generate numerous benefits for walkers, cyclists and society as a whole. Such a shift will have a

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positive impact on traffic congestion and atmospheric pollutants. It will also have a favourable effect on the health of those who opt to walk or cycle, and also indirectly on those who don't.

The EU-funded TRACE (Opening the cycling and walking tracking potential) project "targeted established measures to promote cycling and walking to the workplace, to school, for shopping purposes or simply for leisure," says project coordinator Paulo Ferreira. These measures were enhanced with dedicated tracking-based tools to promote behavioural change and support mobility planning.

IT TOOLS IN AN EFFORT TO BOOST CYCLING AND WALKING

"To fully exploit the huge potential of walking and cycling," he adds, TRACE developed ICT tracking technologies for the promotion and planning of cycling and walking in cities. By expanding the knowledge and leveraging the potential of cycling and walking tracking, the project triggered innovative cycling and walking promotion initiatives and planning practices.

Project partners created, refined and delivered new applications that "support the need to change the culture and incentives faced by travellers," Ferreira explains. They also addressed the requirement to provide sensible information for planners seeking to improve cycling and walking conditions. Users, policymakers, and walking and cycling practitioners were closely involved in all stages of the project.

> *By taking advantage of the emergence and market uptake of ICT tools that enable affordable and accessible ways of walking and cycling tracking, TRACE hopes European city dwellers will leave their cars at home more often.*

Team members pursued ICT tracking services via an open knowledge base of cycling and walking tracking possibilities, challenges, solutions and benefits. They created open-access tools to address fundamental ICT challenges to be used by market-oriented application developers. At the same time, the team actively cultivated the direct involvement of commercial actors interested in developing top-notch tools for cycling and walking promotion.

INSPIRING, ENABLING AND REWARDING MODAL CHANGE

TRACE developed two types of tracking tools focused on behavioural change and mobility planning. The tools are designed to encourage and reward citizens using bicycles through the involvement of local businesses as

checkpoint providers. Coaching, prizes, social status and achievement points are also used as positive incentives towards this modal shift. The tracking tool supports mobility planners and policymakers in interpreting the most relevant information produced by tracking systems. It allows them to identify and rank issues and monitor specific space and time frames.

The dedicated tracking-based tools were tested in eight European cities used as pilot sites. Researchers evaluated the results in terms of impacts, success factors and benefits. They also addressed important issues such as data privacy, cost, interoperability, financial/tax incentives, infrastructure planning and service concepts. Lastly, a toolkit presents a set of practical recommendations and guidelines for launching campaigns to promote cycling and walking.

"By taking advantage of the emergence and market uptake of ICT tools that enable affordable and accessible ways of walking and cycling tracking, TRACE hopes European city dwellers will leave their cars at home more often," concludes Ferreira. The developed tracking tools should fuel the uptake of congestion-busting measures to better foster and plan cycling and walking in cities.

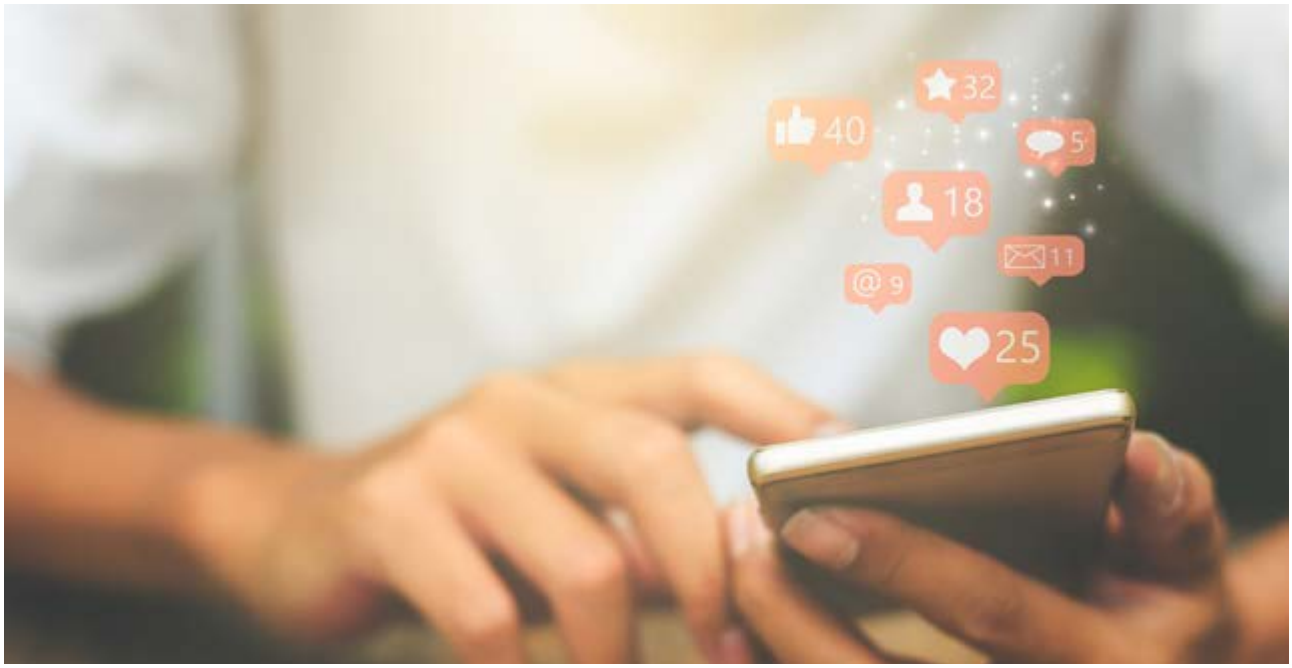
TRACE

- Coordinated by INESC ID in Portugal.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/id/635266
- Project website: h2020-trace.eu

DIGITAL ECONOMY

Coaching the European media community for success

Broadcasting, internet and communication services are converging as new technology progressively breaks down the barriers between them. An EU project is helping the European media adapt their business models to these challenging trends by setting the right priorities for research and innovation.



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> *Here in Europe, we have to keep innovating and then try to spread the results across the world through products and services made in Europe. We cannot compete with Facebook just by establishing another Facebook.*

Developments in areas such as artificial intelligence, virtual reality or 5G mobile networks are creating opportunities for Europe's digital content and media industries to create a whole new range of products and services. But lack of communication and cooperation is holding the sector back. "We can still observe a gap in discussions between the large technology providers and the small technology adopters preventing the establishment of common strategies for technology take-up," says Halid Hrasnica, programme manager at Eurescom and project coordinator of VITAL MEDIA (Vision, Insights and Trends for Awareness and Leadership in Media).

This is where VITAL MEDIA comes in. The EU-funded project has spent the past two years getting the big fish and the smaller ones from the media, social media and creative industries as well as representatives of broadcasters and telecoms operators to sit around the same table and define the research roadmap for the future of their industry.

If you are wondering why this is necessary, comparing the respective strengths of the North American and European social media industries may help. "Europe's position in social media is weak – most of the big players such as Google or Facebook are in the US," says Dr Hrasnica, "fake news is an example of how this can affect us – it is hard for us to fight this because social media data analytics are not in the hands of European players."

STRENGTHENING EUROPEAN SOCIAL MEDIA

Strengthening the sector's sense of community was the first project aim. Working under the umbrella of the EU's New European Media Initiative or NEM, the VITAL MEDIA team set about bringing in new members from underrepresented regions, including Eastern Europe and Ireland. It established a network of NEM ambassadors to reach out to people in relevant organisations and encourage them to join. Four regional clusters – two in France and one each in Spain and the UK – were active in the project; they organised brokerage events to put local companies in touch with each other and produced a handbook of the media landscape and ecosystems in Europe for facilitating future cooperation.

Face-to-face events were backed up by developing online tools such as the NEM Collaboration Platform and a redesigned website and improved social media presence for NEM.

FOCUS ON HORIZON EUROPE

This revitalised European media community has produced an impressive list of publications in the brief two-year lifespan of the project. These included the NEM Strategic Research and Innovation Agenda 2025, firmly aimed at the EU's 2021–2027 framework programme Horizon Europe, and a total of eight position papers on media-relevant areas of technology including data, next generation internet, hyper-personalisation and content distribution. For the policymakers, this was completed by publishing two White Papers on the need for policy dialogue in convergence and social media, in November 2017, and on the future of European social media, in December 2017.

Although not part of the original remit, social media became an important focus of the project. In addition to the White Papers, NEM's 2017 annual summit, organised by VITAL MEDIA, was dedicated to the topic and the project has helped create awareness in the NEM community of the need for companies to act on social media.

"Here in Europe, we have to keep innovating and then try to spread the results across the world through products and services made in Europe," says Dr Hrasnica, "we cannot compete with Facebook just by establishing another Facebook."

VITAL MEDIA

- Coordinated by Eurescom GmbH in Germany.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/id/688310
- Project website: nem-initiative.org

SECURITY

Crowdsourcing emergency management services

As climate change increases the number of extreme weather events, the EU-funded I-REACT project is developing an innovative tool that integrates a range of data from multiple sources – including information provided by citizens through social media and crowdsourcing.

Over the past 30 years, the number of climate-related disasters around the world has reached an unprecedented level. In the last 10 years alone, extreme weather events have caused 700 000 deaths and resulted in more than EUR 1.5 trillion in losses worldwide. And it's only getting worse: due to climate change, extreme weather events will increase in frequency and will last even longer.

"Greater evaporation will lead to increased water vapour in the atmosphere, producing more intense precipitation that – together with rapid snow melt – increases the likelihood of floods," says Fabrizio Dominici, project coordinator of the EU-funded I-REACT (Improving Resilience to Emergencies through Advanced Cyber Technologies) project. "Higher temperatures will also increase the frequency of wildfires, as well as other disasters."

According to Dominici, currently available risk management systems have limited effectiveness when applied to large-scale climate-related disasters. "Despite technological progress and the availability of large amounts of data, no platform provides real-time integration and analysis of all the available data that can be used to improve the prediction and management of disasters," he says.

The I-REACT project is the first European-wide platform that integrates a range of data (i.e. Copernicus Earth observation, weather and climate services) coming from multiple sources, including information provided by citizens through social media and crowdsourcing. This multi-pronged approach means critical information can be produced faster. It also allows citizen involvement to be used by civil protection services and policy-makers to effectively prevent and/or react against disasters.

INCREASED AWARENESS AND CITIZEN ENGAGEMENT

I-REACT aims to improve society's resilience to natural hazards by using novel, socio-technical approaches and cyber technologies. The system allows responders to

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> *I-REACT provides the increased awareness and citizen engagement that is so critical to being able to deal more effectively with crises arising before, during and after emergency events.*

integrate their existing systems with functionalities based on the analysis of large sets of European data and services. For example, with I-REACT, it is possible to create a European-wide risks computation, with high geographical resolution, that takes into account critical infrastructures, land-cover, natural hazards, weather forecasting and user-generated content from social media.

"I-REACT integrates existing emergency management systems and multiple data sources, including Earth observation, social media, augmented reality, wearables and drones," explains Dominici. "As a result, it provides the increased awareness and citizen engagement that is so critical to being able to deal more effectively with crises arising before, during and after emergency events."

The project also developed a mobile application (available on Google Play) that empowers citizens to report on natural events and hazards and to carry out an initial check of community reports. To engage more people with the system, the application features several fun quizzes and a rewards programme. The application is also a powerful tool for alerting citizens of possible risks and providing them with emergency information.

MARKET-READY

Although still a work-in-progress, the project has already achieved a number of important results. "In about two years, we have designed, implemented and delivered a very innovative and operational Emergency Management System that can be effectively exploited and marketed soon after the end of the project," adds Dominici.

I-REACT

- Coordinated by ISMB in Italy.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/700256
- Project website: i-react.eu
- bit.ly/2S7y4Kk

SECURITY

Facing disasters: young people's experience matters!

When disaster strikes, children and young people are often seen as one of the most vulnerable groups, needing to be spared as much as possible from the tough realities at hand. Whilst that may be true, the CUIDAR project argues that they can actually bring valuable experience and knowledge to the table.

We know for a fact that communities all have their own strengths and vulnerabilities, and that, in case of disaster, the least disadvantaged can activate internal resilience capacities to face and recover from a crisis. What is less recognised however – at least in Europe – is how children and young people also have such a range of capacities, and their own role to play.

"It is true that children are particularly vulnerable in case of disasters, but they are also excellent disseminators of information. They have the potential to be a catalyst for positive change within their communities, and can actively participate in disaster risk reduction activities," explains Prof. Maggie Mort, coordinator of the CUIDAR (Cultures of Disaster Resilience among children and young people) project on behalf of Lancaster University.

In countries such as the USA, New Zealand, Japan and Australia, a shift is already ongoing: children's participation has become an important aspect of disaster management, and

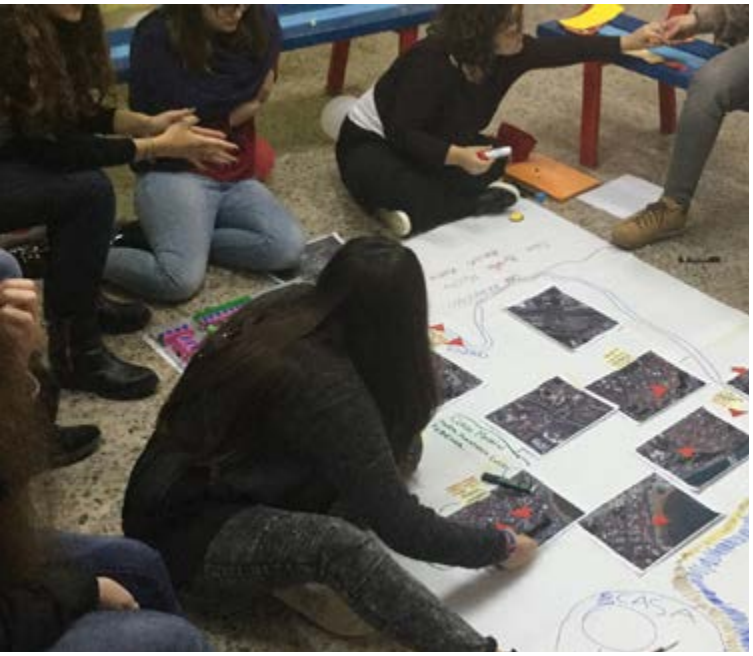
> *It is true that children are particularly vulnerable in case of disasters, but they are also excellent disseminators of information. They have the potential to be a catalyst for positive change within their communities, and can actively participate in disaster risk reduction activities.*

their needs, views and capabilities are increasingly taken into account.

Europe, however, is still behind, as shown by research under CUIDAR. "We reviewed policies, EU and nationally-funded projects, as well as scientific literature. Whilst we found a range of initiatives aimed at raising children's awareness of risk, there was very little evidence of children meaningfully participating in emergency management or community resilience work in the partner countries," says Prof. Mort, coordinator of the project on behalf of Lancaster University.

In fact, children and young people are rarely even considered as a group with experience and knowledge valuable enough to take it into account.

The CUIDAR consortium, together with the NGO Save the Children, has been addressing this problem since 2015 by means of: dialogue with children and young people; mutual learning exercises involving both children and disaster experts; national-level dialogue with policy-makers; and a European level platform to share best practices. The project also came up with the first EU Framework for engaging with children and young people in disaster management.



The most important achievement of CUIDAR, according to Prof. Mort, was the active participation of over 550 children from Italy, Spain, Portugal, Greece and the UK. "The children came from a wide range of backgrounds, and, in the case of Greece, children with visual and hearing impairment were involved and could share their experiences," she points out.

Practitioners and policy-makers were also closely involved in the project, and Prof. Mort says their reactions were "overwhelmingly positive". CUIDAR was notably a chance to introduce them to the basic rights of children (e.g. Article 12 of the UN Convention on the Rights of the Child) and to the highly practical and incisive proposals and suggestions coming from children consulted over the duration of the project.

"Stakeholders showed a strong willingness and commitment to follow this up in their own daily work, and we hope that our dissemination work, which includes a six-minute film, will continue to bring them on board. Moreover, we are currently writing a book about the main issues identified from CUIDAR, and further publications are in the pipeline," Prof. Mort says.

Ultimately, the project consortium hopes that the CUIDAR Framework will be widely adopted and will help shape a safer world for children, young people and adults. "All plans made to enhance and protect the public should take all cultural groups into account. Our work highlights how this also applies to children and young people whose citizenship has for too long been neglected. We argue that if societies are to become resilient, then children and young people's voices must be heard and understood throughout disaster preparedness, response and recovery," Prof. Mort concludes.

CUIDAR

- Coordinated by Lancaster University in the United Kingdom.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/653753
- Project website: lancaster.ac.uk/cuidar

LIFE AFTER...

Catching up with VALCRI: Harnessing Big Data to successfully fight crime

In February 2018, we covered the VALCRI project in our special section on 'New technologies for fighting crime'. We talked to project coordinator, Prof. William Wong, on how VALCRI was developing a highly promising criminal intelligence analysis system based on visual analytics and cognitive engineering. VALCRI ended in June 2018. Prof. Wong has been telling us how the development of their system has progressed.

The rollout of the VALCRI (Visual Analytics for Sense-making in CRiminal Intelligence analysis) system has continued to be a high priority for Prof. Wong and his team. "Since summer 2018, we have made contact with police forces within and outside the EU, and the VALCRI system has been installed at secure sites with these forces," states Prof. Wong. "We anticipate starting trials with actual data in early 2019."

OVERCOMING THE PRIVACY CONUNDRUM

One of the most important issues to arise during the project concerned privacy and data protection. "It was not a simple matter of just restricting data access, but rather for example understanding how, once a person's profile is enmeshed in the data used to calculate the profiles and networks of criminals and criminal activities, it becomes extremely difficult for a person 'to be forgotten' if he or she is later found to be innocent," explains Prof. Wong.

"Understanding the specific nature of the [privacy] challenges allowed us to develop new approaches and designs that incorporate ethical and privacy considerations from the start rather than as a later add-on to the design."

Part of the VALCRI team spent two years trying to anonymise around one million records in the dataset being used to develop the VALCRI system. Another team was tasked with trying to de-anonymise the data. "Over six months they were unfortunately able to discover the identity of one individual, meaning the dataset could not be released as originally planned," says Prof. Wong. "While it is easy enough to randomly anonymise data, anonymising data while retaining meaningful relationships between entities across multiple datasets is a significant challenge." Although the dataset couldn't be released publicly, VALCRI partners did obtain permission for it to be re-used in a newer Horizon 2020 project, SPIRIT.

ONWARDS AND UPWARDS

As the VALCRI system moves towards the trials stage, the project team are confident that their experiences will help them to ensure the system is fully compliant with European privacy laws. Indeed, 2019 looks to be an exciting year for Prof. Wong and his team.

"New jobs have been created to develop VALCRI into products that police end-users will be able to purchase and deploy, and during the trials, the system will also be studied to ascertain how expert investigators and analysts could use the technology to extend their investigative capacities," concludes Prof. Wong. "We believe that VALCRI, when fully operational, will give law enforcement agencies the power of information to protect the freedom and security of Europe and its citizens."

VALCRI

- Coordinated by Middlesex University Higher Education Corporation in the United Kingdom.
- Funded under FP7-SECURITY.
- cordis.europa.eu/project/id/608142

Prof. William Wong
Project coordinator of VALCRI
© William Wong

> *"We believe that VALCRI, when fully operational, will give law enforcement agencies the power of information to protect the freedom and security of Europe and its citizens."*

FUNDAMENTAL RESEARCH

Game theory and AI offer more precise calculations for quantum physics

The increasing precision of experimental data coming from the world of quantum physics presents an enormous computational challenge for theoreticians. To meet this, the ERC-supported HEPGAME project has borrowed techniques from AI and gaming.

Quantum Field Theory (QFT) is a conceptual framework which combines various strands of theoretical physics such as quantum mechanics and special relativity. It is also the basis for the construction of models which simulate the workings of subatomic particles, with the interaction of these particles visually represented by the computational tool known as Feynman diagrams.

The nature of QFT calculations necessary to interpret the quantities of experimental data from initiatives such as the Large Hadron Collider (LHC) is such that each level of accuracy subsequently leads to yet more complicated and larger calculations. As this progression rests on the availability of new mathematical approaches, it presents ever-greater challenges for computation which can manipulate formulas that can be up to many bytes in size.

Reflecting on current computational tools, Dr Jos Vermaseren, HEPGAME (Solving High Energy Physics Equations using Monte Carlo Gaming Techniques) researcher, adds, "To get the maximum benefit from findings such as those from the LHC requires extreme accuracy. Current calculations were completely unthinkable in the mid-70s when I was a graduate student. Nowadays we have 1 million times the CPU power – never mind storage capacity – and can run programmes for days, weeks or even months, rather than seconds."

One method that the project adopted to expand the range of calculations available was the Monte Carlo Tree Search (MCTS) borrowed from game theory. MCTS's ability to automatically compact mathematical expressions, which have to be repeatedly evaluated numerically, has resulted in it becoming part of the computer algebra system known as Form.

As Dr Vermaseren further explains, "Imagine a game of chess with its range of possible moves. Each move leads to reaction moves, creating a giant tree of possible games. MCTS allows us to assess the range of possible pathways against their outcomes to find the optimum direction to take for the desired result."

HEPGAME also used the Forcer programme to solve the Integration By Parts (IBP) identities for a category of Feynman (four-loop massless propagator) diagrams, thereby making them calculable. Specifically, it was able to compute moments of splitting functions and structure functions in 'Deep Inelastic Scattering'. This approach is used to determine the quark and gluon contents and behaviour of protons more accurately. Almost all precision calculations for the LHC rely on these results.

Additionally, HEPGAME succeeded in finding a way to extract divergent parts from individual integrals occurring in Feynman diagrams. For this, the Rstar programme was used in conjunction with Forcer to compute divergences of up-to-5-loop propagator diagrams.

WILL NEURAL NETS BE GAME-CHANGERS?

The team is continuing to work on this two-pronged approach of simplifying expressions, while solving the IBP relations, for calculations too complicated to be currently handled.

Projecting ahead, the development of neural nets might offer the necessary step-change towards interpreting increasingly precise data. As Dr Vermaseren explains, "The

simplification of expressions can be very much improved by training neural nets. It should also be possible to train neural networks to themselves devise methods to solve the IBP relations for reactions that are currently too complicated for our tools."

Towards this end, Dr Vermaseren is currently working with AI systems which could potentially do just that. These developments will also need more powerful computer algebra, therefore two ex-members of the team are working on the creation of a successor to Form.

HEPGAME

- Hosted by NWO in the Netherlands.
- Funded under FP7-IDEAS-ERC.
- cordis.europa.eu/project/id/320651

FUNDAMENTAL RESEARCH

Watching a gas turn into a supersolid

When matter is cooled to near absolute zero, intriguing phenomena emerge. In an international first, EU-funded researchers have succeeded in generating a 'quantum' liquid from extremely cold atoms that is 100 million times less dense than normal liquids.

By cooling down a superfluid gas known as a Bose-Einstein condensate, researchers within the EU-funded DipInQuantum (Dipolar quantum gases of Dysprosium) project succeeded in coaxing the condensate into a quantum phase of matter that has a crystalline-like structure and can flow like a liquid but without inner friction.

SELF-BOUND DROPLETS

While ultracold atoms are commonly found in a gas phase, recent evidence has surprisingly shown that under special circumstances condensed atoms can form 'self-bound' liquid droplets. "The interactions between the magnetic

> *Combining quantum gas, liquid and crystal into a single state of matter could be the path to genuine supersolids, a spatially ordered material with superfluidic properties.*

dipoles of lanthanide atoms in an ultracold gas can produce a 'self-bound' liquid droplet. This provides a useful isolated system for probing the quantum-mechanical properties of ultracold gases," notes Dr Tilman Pfau, who has been in charge of the DipInQuantum project.

At the origin of this new phase is the coexistence of repulsive and attractive forces that perfectly balance to generate this self-bound system. Self-organisation is a key characteristic in many-body systems, where order arises spontaneously due to interactions between particles. "In our case, the stability of these self-bound droplets depends on a fine balance of three interactions. The contact forces and quantum fluctuations determine the repulsive component of the interactions, while the dipolar forces account for the attraction component," notes Dr Pfau.

Recent findings suggest that self-bound ensembles of ultracold atoms can exist for atom number densities that are 100 million times lower than in a helium droplet, which is formed from a dense quantum liquid. However, the experimental proof of such ensembles has remained elusive until now because they require forces other than the usual zero-range contact interaction, which are either attractive or repulsive, but never both. These droplets are the dilute counterpart of strongly correlated self-bound systems such as atomic nuclei and helium droplets.

QUANTUM GAS, LIQUID AND CRYSTAL ALL-IN-ONE

The project team cooled down a gas of dysprosium atoms very close to absolute zero. These atoms can be viewed as tiny magnets given that dysprosium is the most magnetic element. For their investigations, researchers created a superfluidic gas with 3 000 dysprosium atoms and levitated them with a high magnetic field. As a result, they observed regular patterns consisting of microscopic droplets. During magnetic levitation, the droplets initially lost atoms, and as soon as they reached a critical atom number, they evaporated turning into a gas.

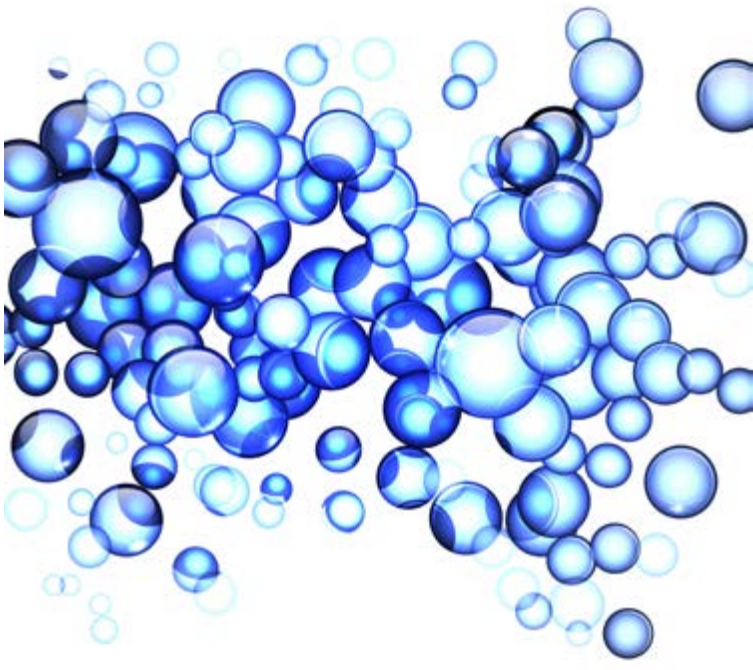
"We discovered a new state of matter that exhibits the seemingly contradictory characteristics of both a gas, crystal and a superfluid," notes Dr Pfau. Researchers believe that quantum fluctuations play an important role in the droplet existence. Given Heisenberg's uncertainty principle, the atoms forming the droplet cannot stay completely at rest inside it and remain in a perpetual motion instead. These atoms confined to a small volume generate quantum pressure. This makes the droplet unstable and the atoms evaporate into an expanding gas. "Combining quantum gas, liquid and crystal into a single state of matter could be the path to genuine supersolids, a spatially ordered material with superfluidic properties," adds Dr Pfau.

Dysprosium atoms carrying a stronger dipole moment have raised hopes for conducting ground-breaking experiments in the quantum field. As exceptional magnets, they greatly aid the study of quantum liquid droplets.

Until now, supersolids, which are both a superfluid and a solid at the same time, have been a theoretically predicted state of matter. Using a legitimate method that exploits a Bose-Einstein condensate, DipInQuantum has successfully opened the way for further investigation into this strange state of matter.

DIPINQUANTUM

- Coordinated by the University of Stuttgart in Germany.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/703419



AGENDA

MARCH 2019

5→7 MARCH

VALENCIA, SPAIN
INFORM final conference: 'Interfaces in Organic and Hybrid Thin-Film Optoelectronics'
→ nanoge.org/INFORM/home

7→9 MARCH

UTRECHT, THE NETHERLANDS
GRACE Conference 2019: 'Gender and Cultures of In/Equality in Europe: visions, poetics, strategies'
→ graceproject.eu/conference2019

8 MARCH

WORLDWIDE
International Women's Day
→ un.org/en/events/womensday

19→20 MARCH

ESPOO, FINLAND
EARTO Annual Conference
→ earto-ac2019-espoo.eu

22 MARCH

WORLDWIDE
World Water Day
→ worldwaterday.org

25→29 MARCH

KARLSRUHE, GERMANY
CEBAMA Final Workshop and International Conference
→ igdtp.eu/event/cebama-final-workshop-and-international-conference/

MORE EVENTS
cordis.europa.eu/news

20–22 MARCH

BUCHAREST, ROMANIA
European Robotics Forum 2019 (ERF2019)

The European Robotics Forum, the most influential meeting of the robotics community in Europe, will host a major exhibition where companies, universities and research institutes will showcase the most advanced European prototypes, products, services and projects funded under the EU's Horizon 2020 research programme.

→ eu-robotics.net/robotics_forum

CORDIS HAS A NEW WEBSITE

As it enters its 25th year on the web, the CORDIS website has got a great new look! The new design aims to improve your user experience by making it easier to find the information most relevant to you and to bring EU research results to the professionals who can really use them.

Check out the new site at:
cordis.europa.eu
Find out more at:
cordis.europa.eu/news/rcn/130467

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