



#106
OCTOBER 2021

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Understanding bacteria
that live inside volcanoes can bolster
climate models

Cracking steam cracking technology
with eco-friendly furnaces

Helping robots get to grips
with the real world

SPECIAL FEATURE
INNOVATIVE EU RESEARCH
TARGETS BREAST
CANCER

Editorial

Better prediction and treatment of breast cancer, eco-friendly furnaces and how volcanic bacteria boost climate models

Welcome to this month's Research*eu magazine

Earlier this year, a close friend of your editor elected to have a preventative double mastectomy. She is just 33. This is a difficult decision that many women will face. Born with both BRCA1 and BRCA2 genes, my friend will spend her life with an elevated risk of cancer. While recovering from this operation, she was already weighing up whether to freeze her eggs, or hope to find a partner and fall pregnant before the time comes for a prophylactic oophorectomy.

Cancer is a pernicious disease that dominates and steers the lives of many, even those who have not developed it. This issue's special feature focuses on research in this field, a major recipient of EU funding. As a consequence, improved risk assessments, earlier diagnoses, advanced and more personalised treatments, and better support throughout the process are all helping to reduce the mortality and morbidity associated with cancer.

Yet unlike polio or malaria, cancer isn't an enemy we can vanquish. The threat is written into our biology itself: the same processes that allow us to repair our bodies are exploited by tumours to grow themselves. Indeed, it's increasingly common for doctors to speak of managing tumours instead of eradicating them, mindful that aggressive therapies can drive the evolution of deadlier cancers.

The language which we use to discuss cancer has also shifted. It's no longer fashionable to talk of battles and fights, with the inherent

suggestion that those who lose their lives to the disease have failed in some way. Although we haven't given up on curing cancer, we are learning to live with it.

This is reflected in Europe's Beating Cancer Plan, which goes beyond medicine to actions spanning policy areas from employment, social policy and equality, to marketing, agriculture and energy. My friend is destined to live in the shadow of a cancer she doesn't have – one she may never get. But if she and women like her can learn to live with cancer, so too should we as a society.

And in **Life After**, we return to see how the **BILLON** project is helping Europeans participate in the ever-growing digital economy, using blockchain technology to enable cross-border payments and instant bank-to-bank transfers. Meanwhile, your editor and many others were rattled by headlines suggesting that the Gulf Stream shows signs of collapse. The research behind these revelations is supported by **TIPES**, our **Project of the Month**.

Hopefully the world will keep spinning long enough to bring you our next issue. As always, if you have any queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu

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Editorial coordination
Birgit Alice BEN YEDDER

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A safe, effective and affordable Zika vaccine

By adapting efficient vaccine platforms and developing relevant animal challenge models, researchers continue to pursue the development of an effective, cost-efficient vaccine against the Zika virus.

Primarily transmitted to people via the bite of an infected *Aedes* mosquito, the Zika virus has been reported in 87 countries. Yet despite new information on the virus' incidence, prevalence, and patterns of transmission, no specific treatment or vaccine is available. Without a vaccine, the focus has been on alternative preventive measures.

However, such alternative measures are both challenging and only partially effective. As a result, when South America faced a large Zika outbreak in 2016, the World Health Organization (WHO) made developing a Zika vaccine a major priority.

Answering the WHO's call is the EU-funded project ZIKAVAX (Fast track development of a Zika vaccine based on measles vector).

"Our aim was to develop a safe, effective and affordable preventive vaccine against infection from the Zika virus," says Nicola Viebig, chief scientific officer at the European Vaccine Initiative.

PROMISING RESULTS

To achieve this goal, researchers used a vaccine delivery platform technology based on a measles vaccine vector (MV). The platform has demonstrated proof of principle in humans and a preclinical track record of rapid adaptability and effectiveness for a variety of pathogens.

To start, researchers successfully screened more than 40 Zika antigens and selected three vaccine candidates for further testing in animal models. The recombinant measles-Zika vaccine candidates (MV-ZIKV) were assessed for immunogenicity and protective efficacy, first in a mouse model and then in a non-human primate (NHP) model of Zika virus infection.

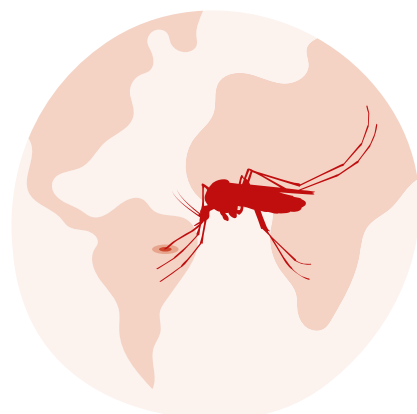
Both the mouse and NHP challenge models were further standardised and refined by the ZIKAVAX consortium.

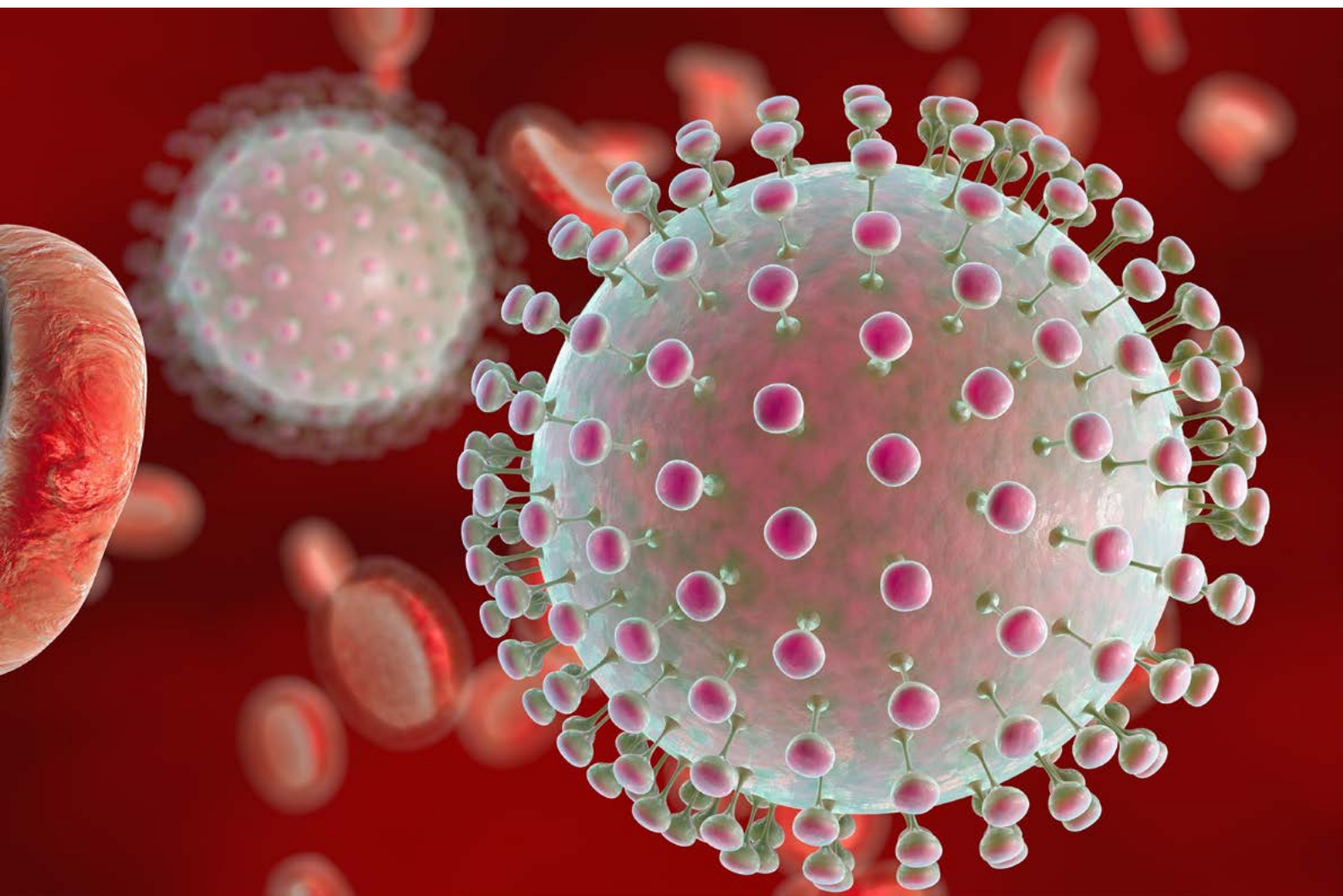
"Based on the results, one of the vaccine candidates was selected for evaluation in NHP challenge studies for immunogenicity and efficacy, in comparison to a control vaccine and a first generation MV-ZIKV vaccine," explains Frédéric Tangy, director of Research at the French National Centre for Scientific Research and head of the Viral Genomics and Vaccination Unit at Paris' Institut Pasteur.

"Following the promising results in the preclinical animal models, the selected vaccine candidate was transitioned to further clinical development," adds Roger Le Grand, director of the IDMIT research department.

The vaccine was produced according to good manufacturing practice and assessed in repeated dose toxicity studies in NHPs. Stability of the vaccine was demonstrated over 24 months, with a first-in-human Phase I clinical trial conducted in Austria to demonstrate the safety and immunogenicity of the MV-ZIKV candidates in 48 adult volunteers.

As of July 2019, the **Zika virus**
had been reported
in **87 countries**





“The Phase I clinical trial data indicated that the vaccine candidate was well tolerated and induced immune responses that are currently being further evaluated,” remarks Katrin Ramsauer, chief scientific officer at Themis Bioscience.

TOWARDS AN EFFECTIVE, COST-EFFICIENT VACCINE

According to Viebig, a lack of relevant animal challenge models has been a major bottleneck for the development of Zika vaccines. “The ZIKAVAX project developed Zika challenge models not only in mice but, more importantly, in NHPs, a species highly relevant for studying Zika virus infections and interventions,” she says.

“This represents a major step towards developing a vaccine.”

The challenge model developed within the project will be made available to other researchers from the public and private sectors.

“Our aim was to develop a safe, effective and affordable preventive vaccine against infection from the Zika virus.”

“This alone will address what has been a major obstacle in the vaccine development process and significantly increases the chances of developing effective vaccines as cost-efficiently as possible,” concludes Viebig.

ZIKAVAX

- Coordinated by the European Vaccine Initiative in Germany
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/732432
- Project website: euvaccine.eu/zika-virus-disease/ZIKAVAX

Acoustic technology for detecting tumour DNA in blood

European scientists have come up with a novel DNA biosensor capable of detecting circulating tumour DNA in serum combined with a highly specific allele-specific polymerase chain reaction assay in less than 2 hours. The technology also detects cancer mutations starting from tissue, allowing the parallel performance of liquid and tissue biopsy.



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Polymerase chain reaction (PCR) is a DNA amplification method that can produce millions of copies of a DNA sample. Originally developed in the 1980s by Kary Banks Mullis, who received the 1993 Nobel Prize in Chemistry, it has revolutionised molecular biology.

PCR has brought DNA studies to a new era, becoming the gold standard for most genetic testing and significantly contributing to the Human Genome Project. Currently, droplet digital PCR (ddPCR), the state of the art in terms of sensitivity, is prohibitively expensive for broad implementation in diagnostic labs. The alternatives, such as Sanger sequencing and Cobas PCR tests are more affordable but of significantly lower sensitivity than ddPCR.

AN ACOUSTIC-BASED SENSOR FOR DNA DETECTION

To address this problem, the EU-funded CATCH-U-DNA (Capturing non-Amplified Tumor Circulating DNA with Ultrasound Hydrodynamics) project developed a simple and highly specific DNA amplification and quantification method.

“Our goal was to develop an ultra-sensitive method for detecting circulating tumour DNA in liquid biopsies of cancer patients,” explains project coordinator Electra Gizeli.

For this purpose, researchers came up with a highly sensitive allele-specific PCR (AS-PCR) assay that selectively amplifies target mutations in genes implicated in melanoma, colorectal and lung cancers. Amplified DNA binds onto a novel, ultra-sensitive biosensor that leads to the binding of liposomes. This alters the acoustic energy and provides a signal proportional to the immobilised DNA.

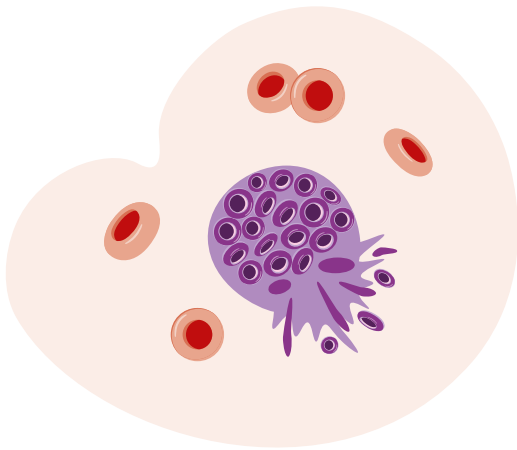
The CATCH-U-DNA platform has the capacity to detect up to 24 DNA targets in parallel in less than 2 hours. Its sensitivity exceeds all commercially available quantitative PCR methods and is much cheaper than ddPCR. Moreover, compared to other DNA array or biosensing platforms normally employed in DNA detection, the acoustic technology allows the processing of non-purified samples and overcomes the need for sample heating.

In collaboration with the Oncology Department of the University of Crete, the CATCH-U-DNA approach successfully detected the BRAF V600E and KRAS G12D cancer mutations in formalin-fixed paraffin embedded tissue and plasma samples of lung, colorectal and melanoma cancer patients. The platform detected a single DNA molecule carrying the BRAF V600E point mutation in a 10 000 fold excess of the wild-type allele, demonstrating a sensitivity of 99.99 %.

IMPLEMENTATION OF CATCH-U-DNA PLATFORM IN LIQUID BIOPSIES

According to the WHO, cancer is the second leading cause of death worldwide. Given that numbers are predicted to

According to the WHO, cancer
is the **2nd leading cause**
of death worldwide



“ Our goal was to develop an ultra-sensitive method for detecting circulating tumour DNA in liquid biopsies of cancer patients. ”

cost-effectiveness. Importantly, it will bring personalised medicine a step closer to reality.

Future plans include the commercialisation of the technology by the project partner AWSensors in Spain, which developed the new acoustic platform and sensor array. The platform is expected to find applications in both laboratory research and the clinical sector.

rise due to the ageing population, there is an imminent need for improved and prompt diagnosis.

The detection of tumour DNA in peripheral blood through liquid biopsies is a promising and non-invasive approach, known to outperform standard approaches, such as solid tissue biopsies, ultrasound scans and MRI. “With a simple blood test, liquid biopsies identify DNA released from cancer cells to reveal a wide range of information about the tumour,” remarks Gizeli. The CATCH-U-DNA platform will simplify the process and improve its sensitivity and

CATCH-U-DNA

- Coordinated by the Foundation of Research and Technology – Hellas in Greece
- Funded under Horizon 2020-FET
- cordis.europa.eu/project/id/737212
- Project website: catch-u-dna.com

HEALTH

More than milk: how the maternal microbiome shapes infant health

*An infant's first and most defining microbial exposure comes from its mother.
A better understanding of the factors shaping this can lead to improved dietary
advice for mothers and more effective formula for children.*

The first breast milk produced by mothers shortly after delivery, known as colostrum, is rich in bioactive compounds including microbes to seed the infant's gut microbiome. However, little is known about the degree to which this transfer of microbiota from mother to infant continues throughout the breastfeeding period.

The EU-funded MAMI (The Power of Maternal Microbes on Infant Health) project set out to increase our knowledge of this process and the factors affecting maternal microbiota. “This idea started when I became a mum,” explains project coordinator María Carmen Collado.



© SeventyFour/Shutterstock

“Everyone was focused on my baby, but what about me? Maternal microbes, breast milk, maternal diet, everything that happens to the mum is reflected in the baby.”

There is extensive evidence of factors shaping infant microbiota, but little is known about which factors modulate the maternal microbiota during gestation and lactation. “Alteration in maternal microbiota would be reflected in the infant microbiota, with consequences for short- and long-term health outcomes,” notes Collado.

PERSONALISED DIET

“Breast milk is more than just nutrition,” says Collado. “It contains bioactive components, including immune substances such as cytokines, hormones, and also, bacteria, their metabolites and oligosaccharides that are not used by humans, but provide bacteria with food.”

The composition of breast milk changes constantly, adapting to the infant’s requirements. To understand this process better, Collado and her colleagues at the Spanish National Research Council (CSIC) recruited 250 mothers and their newborns and followed them for the first 24 months of the infants’ lives.

The researchers collected data on microbiota, diet, infant growth, biomarkers, health outcomes such as allergies, and more. “This work allowed us to identify that the maternal diet is really important to shaping the microbiota of the infant,” adds Collado.

“We need to learn how to take care of our microbes during the crucial periods in human life: pregnancy, lactation and early life.”

“Everything that happens to the mum is reflected in the baby.”

PROMOTING ADEQUATE MICROBIOMES

Collado hopes that the work will allow clinicians to offer new dietary guidance for expectant mothers in terms of microbial composition. “While we have recommendations to avoid specific foods during pregnancy, nobody is telling us how to take care of our microbiome,” she notes.

The next step, she says, is to describe the functionality of each microbial species, which will allow researchers to quantify the level of dysfunction in a microbiome and better understand which species can be added to fill any gaps.

Furthermore, the development of food supplements, functional foods and other therapies based on microbial replacement and modulation, to promote adequate microbiota transfer to neonates, would be valuable for healthy development of the neonatal microbiome.

These advances would offer new tools for both mother and neonates to modulate the microbiota mainly in those cases where antibiotics, unbalanced diet or lack of breastfeeding practices alter the microbiota.

The project was supported by the European Research Council. “For me this was a dream – it allowed me to build my team, to research my own ideas, and of course opened up other projects,” remarks Collado.

She is now studying the microbiota of premature infants, as well as studying how the maternal microbiota changes during pregnancy, and how these changes are reflected in foetal and neonatal development.

MAMI

- Hosted by the Spanish National Research Council in Spain
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/639226

Printing money: how the economics of 16th century publishing houses reshaped Europe

New research shows that movable type wasn't enough to kick-start the Renaissance – a vibrant, competitive print industry was also needed.

The invention of Johannes Gutenberg's printing press sparked a cultural revolution in 16th century Europe. By lowering the price of disseminating knowledge, it acted as a key driver in changes to society, particularly belief in religion. Yet little quantitative analysis has been carried out to measure the impact of this innovation.

The INFO TECHNOLOGY (Information Technology and Institutions Supporting Human Capital Accumulation and Exchange) project, supported by the European Research Council, sought to shed light on the ways in which the printing business helped to shape the kind of ideas that were shared among the public. "It's about how one of the largest changes

in information technology in history played out and changed Europe," says project coordinator Jeremiah Dittmar.

RENAISSANCE START-UPS

Dittmar and his team carried out historical detective work to identify every German-language printer operating in 16th century central Europe, with details of what kinds of materials they were producing over time. They then used data mining tools, such as the kind usually employed for sentiment analysis on social networks, to draw out trends in the kinds of ideas being shared in the published works.



“We gathered detailed evidence on the competitive structure of the printing industry,” explains Dittmar, who carried out the work at the London School of Economics and Political Science in the United Kingdom. “What that allows us to show is that a host of changes attributed to the technology itself were shaped by the underlying economics of the industry.”

Unlike guilds, which were the common business archetype at the time, publishing was largely unregulated, and available to anyone who could pull together the initial large investment needed to build a press, and attract a stable of authors. “It was a highly concentrated industry, with a handful of producers jockeying for dominance in local markets,” adds Dittmar.

His team found that where many small publishing houses vied for dominance, there was an increased variety of material being shared among the public. In areas where just a few publishers dominated, such as Cologne, the control of new ideas and censorship of dissenting opinions was more pronounced.

“Where there were more competitive markets, we see large increases in overall output, a reduction in price, and greater diffusion of innovative, radical, socially daring content,” says Dittmar. “Economic competition led to the spread of ideas that were otherwise tightly controlled.”

OLIGOPOLIES OLD AND NEW

This throttling of ideas was not limited to religious and political works. In cities with a diverse publishing industry, new innovations in business were quicker to

“Economic competition led to the spread of ideas that were otherwise tightly controlled.”

spread. These included cashless payments and new accounting techniques.

“We see all sorts of downstream outcomes, more people achieving things in the business field, cities developing in a more dynamic way,” notes Dittmar. “Free press is an engine for the whole economy.”

The finding that oligopolies have a strong influence on the breadth of ideas shared in society is highly relevant with the advent of the World Wide Web, another revolutionary publishing tool that is controlled by a small number of companies.

“It is sometimes assumed that science and technology unproblematically map into the development of ideas and economic development,” says Dittmar. “This history indicates that the nature of economic competition shapes how science and technology drive social and cultural outcomes.”

INFO TECHNOLOGY

- Hosted by the London School of Economics and Political Science in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/638957

LEVERAGING NEW SKILLS FOR THE BUILDING SECTOR TO DELIVER ON THE EUROPEAN GREEN DEAL

Europe’s ambitious climate targets are the driving force behind many of the EU’s current policy and research priorities. Transforming Europe’s building stock offers a significant opportunity to reduce the EU’s overall energy usage and contribute to these goals.

Nearly zero-energy building (NZEB) standards became mandatory in Europe as of December 2020, requiring robust skills from all professionals involved. Increasing the rate at which the existing building stock is being renovated also requires equipping a large workforce with the necessary skills.

The CORDIS Results Pack on Construction Skills highlights six EU-funded projects working within the BUILD UP Skills initiative, which provides innovative training and new skills to building sector professionals to help enable such a transformation. These focus on ‘trigger mechanisms’, such as one-stop shops, subsidies, awareness campaigns and supporting public authorities with skills-based procurement.

To find out more, browse, download or order a physical copy of the Results Pack here:

cordis.europa.eu/article/id/430447



Piecing together Jewish life in medieval Europe

A groundbreaking project is giving a voice to ordinary Jews who lived, worked and loved in medieval Europe. This open approach to history is reshaping our understanding of daily life.

From around 1100 to 1350, medieval Europe was a place of relative calm and plenty. This was a period that also witnessed the expansion of Jewish communities across northern Europe, a diaspora known as the Jews of Ashkenaz.

"If you were to look at a map of that time, you would see Jewish communities spreading and growing across what is now Germany, northern France and England," says investigator Elisheva Baumgarten, professor of Jewish History at the Hebrew University of Jerusalem in Israel.

"This diaspora is critically important to understand. When Jews open any Torah commentary today, much of what they read will have been written by medieval Ashkenazic Jews."

Records of Jewish life during this time however tend to be selective. As with much medieval history, the written word was the preserve of the elite – secular rulers, Christian

leaders or learned rabbis – and much of what is recorded has to do with moments of crisis and religious tensions.

But as Baumgarten stresses, ordinary Jews continued to live their lives, through good times and bad. "If the current global health pandemic has taught me anything, it is that everyday life goes on, even in moments of crisis," she adds.

VOICES FROM THE PAST

The BeyondtheElite (Jewish Daily Life in Medieval Europe) project sought to give a voice to the thousands of ordinary Jews who interacted daily with their Christian neighbours, signed business deals and led complex lives. To achieve this, Baumgarten and her team collected a range of Hebrew, Latin and vernacular sources, ranging from prayer collections to business contracts.

The project focused on four key areas, starting with rituals. "Through rituals, we have been able to learn more about social interactions," explains Baumgarten. "We also looked at spaces, and found that Jews were everywhere."

The project team looked at objects as well, the assumption being that objects belonged to everyone, not just the elite. And finally, the project looked at people.

"Who are these Jewish people?" asks Baumgarten. "What we find is that they are not just money lenders. They had multiple trades. They might not have been part of guilds,

© Elisheva Baumgarten



“We need this narrative of inclusion and exclusion, of living together and apart.”

but they had professions. The daily reality of their lives is different than the ideas of communal social structure that have been written about based on the lives of communal leaders and scholars.”

SHARED EUROPEAN HISTORY

BeyondtheElite has demonstrated the importance of listening to everyday voices, and giving ordinary people agency and meaning. “Most medieval Jews weren’t learned rabbis,” she says. “Communal life only happens because ordinary people participate.”

By doing so, the project offers a corrective as to how we should view European history as a whole. “We need this narrative of inclusion and exclusion, of living together and apart,” notes Baumgarten. “Jews lived next door to Christians and interacted with them constantly, and we have to show that.”

The project team, which includes students from around the world, has produced a number of collected volumes and monographs, a range of materials to help schoolteachers teach the Middle Ages, and a book of primary sources for undergraduate teaching.

The project has also partnered with Israeli artists, who will interpret some of the project findings. The hope is that this exhibition will travel, helping to shed new light on this complex, fascinating and critical facet of our shared European history.

BEYONDTHEELITE

- Hosted by the Hebrew University of Jerusalem in Israel
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/681507
- Project website: beyond-the-elite.huji.ac.il

SOCIETY

How early childhood empathy can shape attitudes to nature

Debates are ongoing about how we can positively transform our relationship with the environment, including with other animals. ChildEmp looked at how children in the Amazonian rainforest develop empathy with non-human entities, to suggest educational approaches.

Some researchers suggest that the root of the current climate crisis can be traced back to the Western objectification of nature which views nature as a resource to be controlled and exploited.

The ChildEmp (Understanding children’s empathy: an ethnographic study among the indigenous Runa of the Ecuadorian Amazon) project, supported by the Marie Skłodowska-Curie Actions, investigated how the development of empathy in the early childhood of the Ecuadorian rainforest’s Runa people shapes attitudes to the natural world.

ChildEmp was guided by an understanding that empathy is a long-term process of socialisation through everyday



“ChildEmp suggests that a relationship with nature depends as much on culturally variable ways of understanding similarity, as on any intimacy with non-humans.”

practice and that social and cultural factors allow some non-humans to be perceived as ‘more like us’ and so more worthy of empathy.

“ChildEmp suggests that a relationship with nature depends as much on culturally variable ways of understanding similarity, as on any intimacy with non-humans,” says Marie Skłodowska-Curie research fellow Francesca Mezzenzana from the University of Kent, the project host. “A key implication is that taking culture seriously is imperative when addressing human-environment relationships and educational practices.”

BLENDING ANTHROPOLOGY AND PSYCHOLOGY

Indigenous Amazonian societies are renowned in anthropological literature for recognising intentions, feelings and desires in non-human natural entities, such as trees and rivers.

To research the Runa people, ChildEmp benefited from a blend of anthropology’s long-term observations about how communities frame and codify their world, and psychology’s wealth of experiential knowledge about childhood socialisation.

ChildEmp’s methodology was principally participant observation involving immersion in the daily life of the Runa. Three toddlers (from a few weeks to 3 years old) and three older children (between 3 and 6 years old) were observed.

Mezzenzana lived amongst the families, participating in domestic life, including joining foraging trips, and observing child play and storytelling. Some of the activities were videotaped for later analysis.

“I first looked at how children conceive non-humans, then I explored how they showed empathy towards them in everyday life and how educational practices influenced that,” explains Mezzenzana.

An example of how the Runa recognise agency in non-humans was the way they perceive earthworm

communication, noticing the collective sounds they make when in danger.

“When assessing non-human behaviour, Western approaches usually look for evidence of intentionality; for the Runa this collective sound already evidences communication,” adds Mezzenzana.

“Interestingly, this attribution of agency to non-humans doesn’t automatically translate into greater empathy which seems to be based on long-term familiarity and intimacy with non-humans.”

EDUCATIONAL IMPLICATIONS

One implication of ChildEmp’s findings is that our relationship with the natural environment can be modified through education. This is relevant to European initiatives seeking to teach children, especially in urban settings, to ‘reconnect’ with nature and become better environmental stewards.

“But, my research highlights that nature is not simply a neutral object. As children’s experience of it is mediated by specific cultural frameworks, direct exposure doesn’t guarantee better environmental citizens,” she notes.

Mezzenzana is currently working on the design of education programmes, alongside a cross-cultural study into how children in different environments develop empathy towards non-humans.

“Western children often empathise with animals they might never have seen in real life, such as lions. Runa children show more empathy towards animals they actually interact with. This begs questions about the influence of books, the internet and TV,” says Mezzenzana.

CHILDEMP

- Coordinated by the University of Kent in the United Kingdom
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/746363



TRANSPORT AND MOBILITY

Giving citizens a stand to improve their cities

Many urban and peri-urban areas of EU cities face common mobility challenges. Through a people-oriented approach, the Cities-4-People project has been working to improve transportation and increase urban sustainability.

Commuters usually face various problems associated with convenience, access to live information and infrastructure. These issues must be addressed to improve mobility experience across Europe and make cities a better place to live.

INCLUDING CITIZENS IN URBAN MOBILITY DESIGN

The EU-funded initiative Cities-4-People (New approaches for community-driven sustainable mobility innovations at neighbourhood and urban district level) has involved citizens in the co-development of solutions and in the design of their local mobility ecosystems. "Our project has

empowered local communities to engage and interact towards changing their city for the better," explains project coordinator Isabel Froes.

Partners have set up citizen mobility communities in five areas across Europe (Budapest, Hamburg, Istanbul, Oxfordshire and Trikala) and implemented five pilot programmes. The Cities-4-People team tested the effectiveness of prototype and pilot innovative and smart mobility solutions that address pressing and real urban mobility challenges.



IMPROVING MOBILITY NETWORK IN EUROPEAN CITIES

Citizens of Budapest joined forces to transform the mobility landscape of the city, focusing on bringing people closer to the Danube riverbank. This initiative was undertaken in collaboration with mobility providers and involved the design of a busy transport hub that includes e-cars, scooters and bikes.

The usage of this environmentally friendly and sustainable means of transport has enabled citizens to reach their destination on time and at lower costs compared to using their own car. Up to now, more than 30 000 users have benefitted from the service.

The municipality of Üsküdar in Istanbul is a densely populated region and mobility is complicated, especially for vulnerable groups, such as the elderly, children, and people with impairments. Cities-4-People installed resting points such as benches and improved pavement conditions for visually impaired citizens.

In addition, renovation of the pavement and lighting in Salih Solman Park was intended to make it 'everyone's garden'. Such practices are expected to extend to other green areas in the city.

To address traffic congestion around Oxfordshire, Cities-4-People implemented transport services on demand. These include a shopper service and a connector that transfers people from peripheral villages to the Barton shopping centre.

ENHANCING EUROPEAN CITY INFRASTRUCTURE

Expanding the bike infrastructure was the predominant solution that citizens of Altona, an urban borough of Hamburg, chose to implement. The city installed bike racks including racks for cargo bikes on roads used by cyclists after receiving input from local stakeholders. Altona added sprayed-on logos on the ground to distinguish cargo bike racks.

“ Our project has empowered local communities to engage and interact towards changing their city for the better. ”

Trikala citizens expressed their wish to combine different activities in the centre where all services are gathered. To accommodate this, Cities-4-People installed storage lockers at the central info point for people to leave their heavy luggage.

Alongside pedestrianisation of the streets around the main square, this solution is expected to reduce traffic in the centre and facilitate cycling and walking. Trikala has also provided electric scooters for citizens with mobility impairment to move around the centre of the city.

LESSONS LEARNED

Besides the permanent solutions implemented during Cities-4-People, the project underscored the importance of citizens in the co-creation process, especially when it comes to neighbourhood mobility.

To raise awareness of this fact, project partners collaborated with other projects (Metamorphosis, SUNRISE and Looper) to produce a 'Big Messages' brochure to encourage citizen participation in the urban planning of their neighbourhood.

CITIES-4-PEOPLE

- Coordinated by the Copenhagen Business School in Denmark
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/723194
- Project website: cities4people.eu
- ▶ bit.ly/cities-4-people_video

Novel sensor boosts collision-avoiding capabilities of aircraft

An EU-funded project is adapting cutting-edge technology from the automotive sector to enhance aviation safety.



© ODESSA Consortium

In general aviation, the main causes of accidents stem from mid-air, near mid-air, and on-ground collisions. Sensors can play a key role in preventing accidents caused by such collisions. However, current ones on the market are expensive, making it challenging for small aircraft and helicopters to acquire them.

Addressing this, the EU-funded ODESSA (Obstruction DETection Sensor for Surveillance on Aircraft) project, with Thales – a global high-technology leader – as Topic Manager, set out to provide aeroplanes and helicopters with an affordable sensor to reduce collisions close to the ground, for example, during take-off and landing and on-ground manoeuvres. To achieve this, the project harnessed the benefits of mature automotive technology, specifically low-cost and dependable radars combined with video cameras that are mounted on vehicles for the early detection of obstacles.

INTRODUCING ODESSA THE SENSOR

“We have developed a prototype, ODESSA, a small-size and low-weight and power consumption sensor which can be installed on small aircraft or drones, to detect obstacles in the short range,” explains Pietro Borgh, project coordinator. It is based on the combination of radar technology, derived from advanced driver assistance systems, with advanced image processing

algorithms. The radar provides target detection, and the camera improves detection reliability through object classification. “The sensor has a maximum range of 140 m with 15° of elevation and 40° of azimuth, at a speed of 50 km/h,” adds Borgh. The sensor equipment is composed of two major sub-assemblies, the control unit and the sensor unit, which are industrialised and certified according to civil aviation standards.

“The conclusions of the project confirmed that the ODESSA sensor equipment could be installed on drones or light aircraft, provided that the right trade-off between performance and dimensions – size, weight, power and consumption – is granted according to the aircraft capabilities and market positioning,” notes Borgh. The project further confirmed its usefulness for vertical take-off and landing (VTOL) aircraft during all flight phases and for non-VTOL aircraft during the taxi phase, due to its 140 m range. “Indeed, ODESSA improves the capability to provide correct target identification, even when the visibility is dramatically reduced due to rain, smoke and sand, so permitting a safer VTOL flight and landing,” remarks Borgh. The sensor also acts independently from airport sensor infrastructures.

TOWARDS SAFER AVIATION

Looking towards the future, the project’s ambition is to have the ODESSA sensor installed on all small aircraft as well as improve Terrain Awareness and Warning System or Traffic Collision Avoidance System capabilities in civil aviation platforms. Such work will contribute to the development of the Modular Surveillance System in the Clean Sky 2 Systems.

Discussing the project’s next steps, Borgh says: “Interconsulting, the project’s lead coordinator, will look for potential partners interested in developing the ODESSA sensor for the light aviation, aero-taxi and drone markets. We will use our prototype to show how the sensor performs and its capabilities.” The project

will also carry out a market survey to explore potential customers and develop a specific business plan for promising opportunities.

Project partners – InnoSenT, CNRS and Siralab – will further focus on planning for industrialisation and certification activities. “The ODESSA sensor solution, after specific industrialisation work, has the potential to become a mandatory device, at least for drones but not

limited to them, due to the expected increase in air traffic in the foreseen future,” concludes Borgh.

ODESSA

- Coordinated by Interconsulting in Italy
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/821263

TRANSPORT AND MOBILITY

Data sharing technology helps to organise the skies

Allowing passenger jets to share trajectory data with ground control will improve traffic management and reduce wait times and environmental footprint by removing unnecessary buffers.

Despite a drastic slowdown due to COVID-19, air traffic in Europe is expected to reach pre-pandemic levels by 2024, with estimates from 2018 predicting an average growth rate of 2 %, culminating in over 16 million flights annually by 2040.

The EU-funded PJ31 DIGITS (Initial Trajectory Information Sharing) is the 31st project within the framework of the SESAR Joint Undertaking, a public-private partnership set

up to modernise Europe's air traffic management (ATM) system. With sister project DIGITS-AU, its focus is on delivering advances in ATM based around the sharing of 4D trajectory data.

Currently, air navigation service providers predict the trajectory of flights based on their radar position and their expected performance, computed through a generic classification of the aircraft model.

These are used to maintain safe separation between aircraft in flight and estimate when they will arrive at their destination and enter the landing queue.

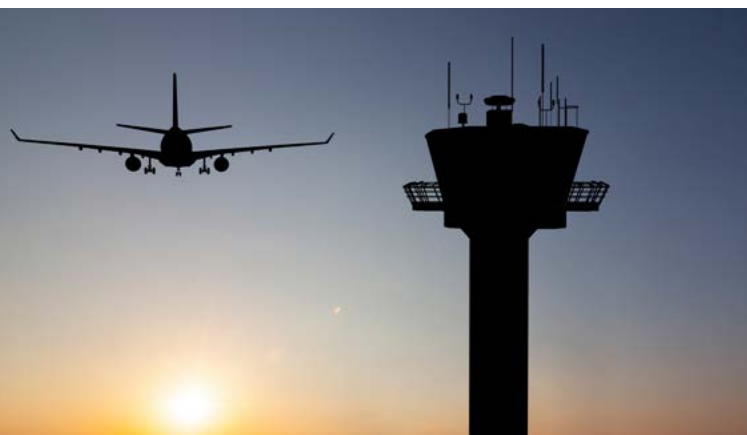
AUTOMATIC DEPENDENT SURVEILLANCE

However, “the same aircraft fully loaded or very light will have a very different performance profile, especially during the climb phase,” explains Thierry Harquin, project coordinator and ATM senior manager at Airbus. “And once the aircraft is airborne, there are many potential changes due to weather, traffic, and airline policy settings.”

The best way to get a more accurate trajectory prediction is to interrogate the aircraft itself, which has a flight management system with estimates of all the trajectory data.



**Estimates predict over
16 million flights
annually by 2040**



© eisin ergin, Shutterstock

“This has been used by pilots in modern cockpits for years, but so far has not been accessible from the ground,” says Harquin. “The basic project concept is to share this valuable on-board information with ground air traffic control.”

This sharing technology is known as Automatic Dependent Surveillance – Contract, or ADS-C, and has continuously updated information on an aircraft’s current and predicted 3D positions, speeds and time to destination along its trajectory.

NEW SAFETY BARRIERS

A 3-year demonstration saw ADS-C software upgrades installed in 90 aircraft, involving six airlines (Air France, British Airways, easyJet, Iberia, Novair and Wizz Air).

The PJ31 DIGITS project worked with a number of air traffic control centres, including the Maastricht Upper Area Control (MUAC) covering Belgium, the Netherlands and Luxembourg, Flugsicherung in Germany (DFS), ENAV in Italy and NATS in the United Kingdom.

“The basic project concept is to share this valuable on-board information with ground air traffic control.”

While three centres trialled the technology in ‘shadow mode’, training staff in a non-operational room, MUAC made the decision to deploy the technology with a subset of trained controllers, displaying the more accurate trajectories alongside traditionally calculated pathways on controller monitoring equipment.

Analysis of more than 20 000 flights demonstrated that the system reduced inaccuracy of ATM prediction models by 30-40 %. These controllers also received an automated warning when the airborne- and ground-predicted trajectories diverged, providing a new safety barrier.

The EU has mandated that from 2027 the system should be installed on all new aircraft, and all air navigation service providers in Europe should be able to receive and process this data in their ground tools.

The improved data will allow air traffic controllers to more efficiently manage aircraft flow, and reduce time spent in holding patterns, cutting aviation’s environmental impact. Future SESAR projects will use the improved data sharing to enrich conflict detection tools, and delivery improvements to arrival management.

PJ31 DIGITS

- Coordinated by Airbus in France
- Funded under Horizon 2020-TRANSPORT
- cordis.europa.eu/project/id/731818



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→ bit.ly/CORDIScovery_Aviation



Understanding bacteria that live inside volcanoes can bolster climate models

Extremophiles living in the hot, acidic soil around volcanoes are adept at cycling chemicals such as methane, offering clues for how we can capture these greenhouse gases.

A key aspect of climate change is the rapid rise in greenhouse gases such as methane, which is released from wetlands and thawing permafrost. Due to its abundance, methane is an attractive fuel, but remains difficult to capture.

One possible solution is to look for microbes which can fix methane from the atmosphere. The EU-funded VOLCANO (Microbiology of extremely acidic terrestrial volcanic ecosystems) project searched for these, and other organisms, in the hot, acidic soils found in volcanic regions.

"We are extremely interested in the cycle of elements in nature: nitrogen, carbon, sulfur, organisms that metabolise

these elements, and how that works in an ecosystem," explains project coordinator Huub Op den Camp.

ISLAND VOLCANOES

To hunt for novel organisms, his team at Radboud University in the Netherlands turned to three extremophile hotspots in Italy: the Solfatara volcano near Naples, the island of Vulcano near Sicily, and the island of Pantelleria near the coast of Tunisia.

"The Solfatara volcano won't erupt, but there is still activity, with bubbling mud pots, and fumaroles, hot steam venting out of the earth," says Op den Camp. These fumaroles



supply concentrated gases such as methane and CO₂, and all the sites feature soils with high temperatures – up to 100 °C at 50 cm depth – and low pH.

To capture the microbes, the team drilled cores and collected samples of soil before rushing back to the hotel. “Once back at the hotel, we used the room as a lab to inoculate everything on the spot,” he adds. “We returned in 24 hours, and installed the new incubations in our laboratory.”

The bacteria were identified using two techniques. In the first, Op den Camp and his team followed a metagenomics approach, extracting DNA directly from the mixed samples. A second approach involved enrichment and culturing the bacteria to finally isolate the different species present.

NEW DISCOVERIES

The team were able to characterise hundreds of bacterial species, including members of a new genus not previously known to science. Several of these species were methanotrophs – bacteria that feed on the methane present in the soil.

“How they use atmospheric methane is an important question,” notes Op den Camp. “The concentration of methane in the atmosphere is increasing, if you could isolate an organism that can easily take it out, that could be very helpful.” He adds that a better understanding of how microbes mediate the flow of methane between the atmosphere and sources such as wetlands will help to improve climate models.

“Once back at the hotel, we used the room as a lab to inoculate everything on the spot.”

Other strains of interest isolated by Op den Camp’s team include a species that was able to readily convert methane into methanol, an important precursor in the chemical industry, and a bacterium on Pantelleria that lives on a diet consisting solely of gas.

“The only thing this bacterium needs is hydrogen, CO₂ and oxygen,” he says. “They fix CO₂ like a plant does with sunlight; except they burn hydrogen to provide the energy to do it.”

Another species was shown to lose half the carbon it fixes into the surrounding medium, which could make it especially useful for producing organic compounds.

Following this project, Op den Camp plans to find ways to isolate the key players in this microbial ecosystem: “Researchers are never done, there are always new questions that open up, and a lot of really interesting things that are worthwhile studying.”

VOLCANO

- Hosted by Radboud University in the Netherlands
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/669371
- Project website: ru.nl/microbiology/research

CLIMATE CHANGE AND ENVIRONMENT

A new way of studying very old ice cores

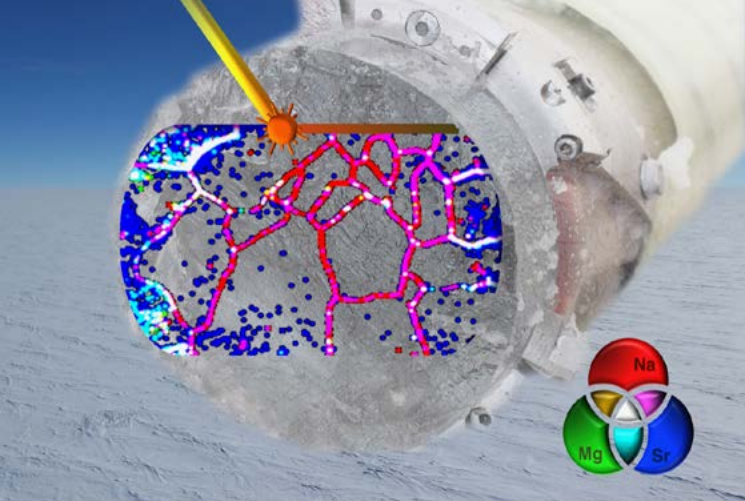
Buried deep under layers of Antarctic ice is a wealth of information that could help us better understand climate change. To access this information, one EU researcher has advanced a new method for taking and analysing ice core measurements.

The key to preparing for a future defined by climate change is to understand the past. But what if that past is buried deep under layers of Antarctic ice?

“Antarctic ice cores are a unique archive, allowing us to study past climate variations associated with atmospheric

temperature and circulation as well as the greenhouse gas concentrations from hundreds of thousands of years ago,” says Pascal Bohleber, a researcher at Ca’ Foscari University of Venice.

Deciphering the oldest part of an ice core record requires the study of the deepest layers of ice. With the support



© Pascal Bohleber

of the EU-funded GOLD-ICE (Next generation analysis of the oldest ice core layers) project, Bohleber, a Marie Skłodowska-Curie fellow, set out to do exactly that. “With this project, I targeted a new way of investigating previously untapped palaeoclimatic signals that are stored in the highly thinned deep layers of Antarctic ice cores,” he adds.

DEMONSTRATING THE POTENTIAL OF LA-ICP-MS

Based on their unique set of palaeoclimate information, Antarctic ice cores could deliver an important missing piece of the climate puzzle – the cause of the so-called mid-Pleistocene transition.

“We know that this period, which occurred roughly 1.2 million years ago, saw a reorganisation in the periodic shifts from warm to cold climates,” explains Bohleber.

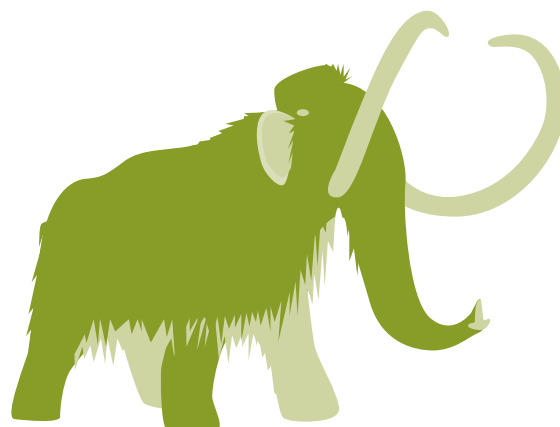
“This represents a fundamental change in the dynamics of our climate system, and Antarctic ice may give us the key to figuring out what caused it.”

A particular challenge to doing this is that the ice becomes increasingly thinner the deeper the drill, making it difficult to identify palaeoclimatic signals. As current technology doesn’t provide the required level of detail, there is a growing demand for a high-resolution solution for taking ice core measurements.

One leading contender is Laser-Ablation Inductively-Coupled Plasma Mass Spectrometry (LA-ICP-MS). A high-resolution, micro-destructive technique for glacio-chemical analysis, LA-ICP-MS’ true differentiator is that its laser is able to remove just a few tenths of a microlitre of ice from the surface.

“The GOLD-ICE project aimed to further demonstrate the potential of LA-ICP-MS for ice core analysis, paving the way for its use in such next-generation ice core projects as the EU’s Beyond EPICA Oldest Ice Core initiative,” remarks Bohleber.

The mid-Pleistocene transition occurred roughly 1.2 million years ago



MISSION ACCOMPLISHED

The project succeeded in advancing LA-ICP-MS as a powerful technique for producing images of the chemical sample’s composition at micron-scale resolution and over comparatively large areas. Bohleber also adapted this state-of-the-art chemical imaging to the unique needs involved in the studying of ice cores, including the ability to look at the chemical stratigraphy in deep ice in 2D.

“We now have a better understanding of the physical origin of LA-ICP-MS ice core signals, which will help avoid misinterpretation and thus is a big step towards exploiting this technology’s full potential,” says Bohleber.

“In other words, the overarching goal of the GOLD-ICE project has been reached – in the midst of a pandemic – and I am extremely happy about this achievement.”

The project also allowed Bohleber to build a network with the European ice core community, and through these connections the work done during the GOLD-ICE project promises to play an important role in the Beyond EPICA initiative.

He has also been awarded another Marie Skłodowska-Curie Fellowship and is beginning to work on a new EU-funded project that represents the next step in the use of LA-ICP-MS in studying ice cores.

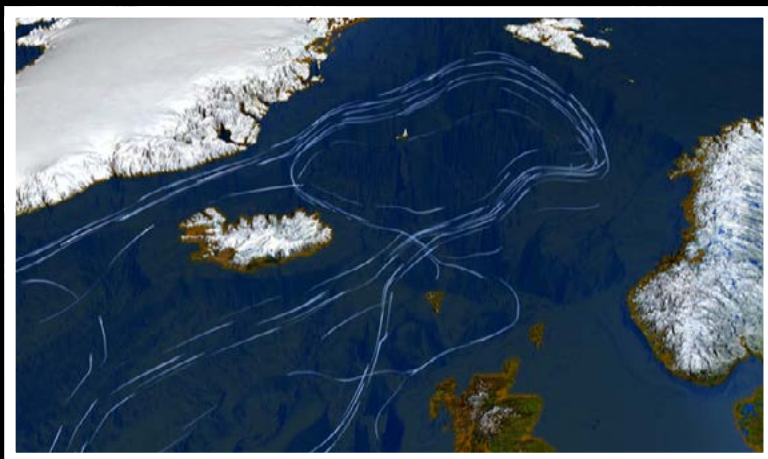
GOLD-ICE

- Coordinated by Ca’ Foscari University of Venice in Italy
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/790280
- Project website: bit.ly/GOLD-ICE



An urgent warning as a vital ocean current system appears to show signs of collapsing

A new study published in 'Nature Climate Change' and supported by the EU-funded TiPES project has highlighted how the Atlantic current system – of which the Gulf Stream is a part – appears to be showing clear signs of instability and potential collapse. If this happened, it would have a major cooling effect on Europe's climate.



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“ *The loss of dynamical stability would imply that the AMOC has approached its critical threshold.* ”

Niklas Boers, study author and member of the TiPES project

The study was led by Niklas Boers of the Potsdam Institute for Climate Impact Research (PIK) which is a member of the TiPES (Tipping Points in the Earth System) consortium. It found, through a detailed survey of contemporary observations and early warning signals (such as the salinity patterns of ocean waters), that the Atlantic Meridional Overturning Circulation (AMOC), the Atlantic current system, may have been gradually losing its stability over the course of the last century.

This is both worrying and surprising. Worrying because the AMOC is not only responsible for the relatively mild temperatures in Europe, it also influences weather systems worldwide. If the AMOC were to collapse, which has so far not been considered likely under the current levels of global warming (hence the surprising aspect of the study results), this would have severe consequences on global and especially European weather and climate. There would be increased cooling in the northern hemisphere, sea-level rise in the Atlantic, an overall fall in precipitation over Europe

and North America, and further afield it could even disrupt the annual tropical monsoon season.

Previously, climate scientists hadn't forecast a possible collapse of the AMOC system until at least 2100. This new and very important study may indicate that that forecast may now need to be revised.

For more information, please see the original article in 'Nature Climate Change': bit.ly/TiPES

TIPES

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-ENVIRONMENT
- cordis.europa.eu/project/id/820970
- Project website: tipes.dk

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

INNOVATIVE EU RESEARCH TARGETS BREAST CANCER

Editorial

“When someone has cancer,
the whole family and everyone
who loves them does, too” –

country singer Terri Clark, whose mother died of the disease.

With our attention focused on the global pandemic over the past 2 years, it's been easy to overlook the fact that other health crises continue in the background. Surgeries have gone unperformed, treatments discontinued, and diagnoses not made. In the wake of the pandemic, exhausted medics will face a backlog of cases made worse by this delay.

There is no doubt that among these patients there will be many cases of breast cancer, the focus of our special feature. Every year, more than 350 000 women in the EU are diagnosed with breast cancer, and 90 000 die from the disease.

No surprise then, that cancer is one of five mission areas identified by the EU as a major societal challenge to be addressed through the Horizon Europe framework programme. Already, mortality from breast cancer is in decline, thanks to effective treatments and tools for the early detection of tumours.

‘A cure for cancer’ is still a favoured shorthand for a medical miracle, but beating cancer means much more than better treatments. Firstly, we must develop more accurate assessments of patient risk, as the FBC predisposition and BRIDGES projects aim to do.

Identifying those who are not at risk is as important as knowing who is; better precision in this space will cut overtreatment

and reduce the incidence of unnecessary, life-changing surgery. More importantly, it will better allow women to make informed choices about their bodies and their health.

We are also making strides in our understanding of breast cancer, which is not a single disease but a cluster of related cancers. Researchers for the B-CAST and CLONCELLBREAST projects have investigated the genomics of breast cancer, bringing these differences into focus so that tumours can be better characterised and categorised.

The PredAlgoBC project puts such knowledge into action by connecting cancer types to the most effective treatments available for them. And the BOUNCE project focuses on the often-overlooked aspect of patient resilience, investigating which factors can be bolstered to support those living with breast cancer.

Through its continued support for research in this area, the EU aims to prevent cancer where possible, and offer earlier diagnosis, better treatment, and a higher quality of life where it is not. In doing so, it hopes to save more than 3 million lives by 2030. It's not a cure for cancer, but it's something to be proud of.

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

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Breast cancer predisposition genes exposed

Scientists know that a subset of genes are linked to familial breast cancer. However, this link has yet to be clearly determined or ruled out for many newly emerging genes. The FBC predisposition project aims to clear up remaining doubts.

Of all women affected by breast cancer every year, 5% to 10% of cases result directly from gene variants passed on from a parent. This is called familial breast cancer (FBC), and there is still much we don't know about it. In over 60% of FBC cases, the genes responsible – although unequivocally present – remain undetermined.

The FBC predisposition (Unraveling novel Familial Breast Cancer (FBC) predisposition genes) project, supported by the Marie Skłodowska-Curie Actions programme, was set up with these cases in mind. Its goal is to identify novel genes and disease-causing variants in FBC and use them to improve patient monitoring and counselling. Claus Storgaard Sørensen, coordinator of the project on behalf of the University of Copenhagen, has been screening an FBC patient cohort of 135 early-onset patients since 2020, which has led to the identification of 270 new genes that may be involved in breast cancer onset.

Why are experts still unsure about the genetic predispositions of most FBC cases? What makes these genes particularly difficult to identify?

Claus Storgaard Sørensen: There are two major issues at play. Firstly, dozens of genes work together to limit genome instability and prevent cancer development such as FBC. Each gene encodes a protein that is comprised of hundreds of amino acids. In principle, every single amino acid can be mutated in several ways (into other



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Claus Storgaard Sørensen
Project coordinator,
FBC predisposition
© Claus Storgaard Sørensen

“We have now confirmed how new putative predisposition genes serve to maintain genome integrity.”

amino acids, deleted or duplicated). This all results in a very high number of possible mutations, some of which are neutral and show no negative effect. For all of the detected mutations, we need to conduct precision experiments to understand whether they are detrimental to patients. This is an enormous task spanning tens of thousands of mutations.

Secondly, BRCA1 and BRCA2 are the two best-characterised FBC genes, where many mutations are known to predispose FBC. However, BRCA1 and BRCA2 mutations only occur in a minority of FBC cases (frequently estimated to account for about 15 % of cases). Thus, we now need to identify the remaining genes that have so far managed to escape our research efforts. These new genes are less frequently mutated, which means that they are more challenging to identify.

How does your project overcome these difficulties and what makes your approach particularly innovative?

We have gathered a unique cohort of women with early-onset breast cancer, under 33 years old with no mutations in BRCA1/BRCA2. In all these patients, the genetic predisposition is very marked, but we clinicians have so far been unable to identify the cause. Next generation sequencing of blood samples has identified mutations in a number of genes that could be predisposing. Concretely, this means that these women may have inherited variants in new FBC-predisposing genes.

We investigated whether the flagged genes are involved in genome maintenance. This is done with parallel screens in human cell lines, where we downregulate all potential FBC genes. This has yielded a list of potential new FBC genes that serve to promote genome stability.

Speaking of results, what would you say is the most important outcome of the project so far?

The key finding is that we have now confirmed how new putative predisposition genes serve to maintain genome integrity or, in other words, hinder a key step in cancer development.



In over 60 % of Familial Breast Cancer cases, the genes responsible remain undetermined

Have you identified specific predisposition genes yet? Can you tell us more about these?

This is still ongoing, but I can already tell you that the results are very promising. We do expect several of the genes to be bona fide FBC genes.

What do you still need to achieve before the project's end?

We need to characterise the mechanism of function of the new FBC genes, since we are not sure of how they function in cells to promote genome stability. We also need to establish whether mutations identified in our cohort display reduced function, that is, whether cells expressing mutated genes are prone to genomic instability.

What would be the ultimate benefits of your research for patients?

Our project will identify new tumour suppressors that will provide tools for early diagnosis and counselling. Our findings also hold promise for targeted cancer treatment, as several of the FBC genes protect cells against cancer therapies. Thus, when these particular genes are disabled by mutations, we can employ targeted treatments exploiting this cancer-specific vulnerability.

FBC PREDISPOSITION

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/896102

New algorithms that better predict breast cancer risk

Clinical data obtained from 120 000 people will soon help women across Europe assess their lifetime risk of developing breast cancer. The BRIDGES project used this data to develop a tool able to combine various risk factors into a single risk-score.

Some 90 000 women die of breast cancer every year in the EU despite the relatively high efficacy of first-line treatments. For those with a genetic predisposition, disease can be prevented through the likes of intensified screening, chemoprevention or prophylactic surgery. But even for the most cautious and informed women, these efforts are still very much hit or miss. The trouble is, cancer risks associated with most gene variants are still unknown, or have large uncertainties.

To enable better patient counselling and management, practitioners need more reliable evaluation methods. The BRIDGES (Breast Cancer Risk after Diagnostic Gene Sequencing) project was launched in 2015 to allow for more accurate identification of women at high risk of breast cancer. Peter Devilee, coordinator of the project on behalf of the Leiden University Medical Center (LUMC), discusses the project's breakthroughs and their expected impact on future cancer care.

What are the remaining obstacles to the association of specific genes with breast cancer risks?

Peter Devilee: We have been able to significantly associate a gene with breast cancer risk for a while now, but there is indeed a problem with the confidence intervals of the effect sizes which are generally too wide. Moreover, existing association analyses have been conducted on too small samples, which means that some uncovered associations could be spurious. An important question prior to our project was how to best determine this effect size, because many of the existing approaches introduce statistical biases. The main obstacle is sample size and the need for extensive and accurate descriptions of a patient's disease history.

How do you propose to overcome these problems?

We proposed two things in our project: The first is to investigate the association of breast cancer with each gene tested by commercial companies on their 'oncogene



panels' in a very large series of cases and controls. The second objective focuses on the genes that were already solidly associated with breast cancer: We want to assess with the highest possible accuracy their effect size, that is, try to narrow down existing confidence intervals. We previously built a very large case-control data set with DNA samples and extended clinical data, which covers over 120 000 individuals from the general population, which provided us with a head start.

Did you use other data sources as well?

No, but the project required us to generate the DNA sequencing of the genes of all individuals who took part in our studies. Given the large sample-size – unprecedented in 2014, when the project was conceived – we needed to develop a methodology that had a very high throughput at a very low cost per sample. We finally managed to sequence 35 genes at a price under EUR 10 per sample.

What are the project's most important outcomes?

The project has succeeded in narrowing down confidence intervals for the five 'major' breast cancer genes: BRCA1,



Peter Devilee
Project coordinator, BRIDGES
© Peter Devilee

“*The tool is intended mostly for healthy women who would like to prevent breast cancer development.*”

BRCA2, PALB2, CHEK2 and ATM. Four other genes (BARD1, RAD51C, RAD51D, TP53) were also definitively uncovered as ‘breast cancer genes’. This will have important clinical ramifications for women receiving genetic counselling. We excluded 19 genes from being associated with breast cancer, although there remains a remote possibility that these genes may be associated with a very low risk (the rarity of their occurrence precluded the exclusion of risks <2-fold). For several other genes, the study found suggestive associations with, for example, certain subtypes of breast cancer such as oestrogen receptor-negative breast cancer, which has certain prognostic features. Larger follow-up studies will have to find out whether these associations are real or not.

How do your online tools work exactly? Who can use them?

The results of our study are currently being incorporated into an online tool called CanRisk. The algorithm running behind that tool is called BOADICEA and has been developed by one of the BRIDGES partners, the University of Cambridge. This tool combines various risk factors, both genetic and non-genetic (such as family history, BMI, hormonal status, parity, etc.), into a single risk-score. With this score, women know what their risk of developing breast cancer over their lifetime is.

Anyone would be able to use the tool, but at present the entry of variables is so strictly protocolised and demanding that it's intended for use by healthcare providers, for example genetic counsellors.

What are the concrete benefits for patients?

The tool is intended mostly for healthy women who would like to prevent breast cancer development. This includes, for example, women who suspect they are at risk (for example because their mother had breast cancer) and are considering preventive measures such as prophylaxis, more intensive screening, or lifestyle adaptations. For breast cancer patients, the tool might help predict the odds of developing a second breast cancer, but that feature is still under development.

What are your follow-up plans, if any?

Because the tool has been externally validated and CE-marked as a medical device, it is ready to be introduced in cancer family clinics, and several centres are already exploring its use. We will need to find out when to use it, how to use it, and how individuals will respond to this knowledge of personalised risk.

Another potential impact is related to population screening programmes for breast cancer that are being run in many EU countries. These are usually offered to women reaching a certain age, but many have been advocating a risk-based entry into these programmes, which should prove to be more cost-effective. This is not as simple as it sounds though. We need more evidence of our solution's efficacy, and this implies large population-based efforts in which individuals can exploit genetic data for personal health improvement. This is an issue that receives much attention in the new Horizon Europe Health programme.

BRIDGES

- Coordinated by the Leiden University Medical Center in the Netherlands
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/634935
- Project website: bridges-research.eu

Tumour ‘goldmine’ offers fresh insight into breast cancer subtypes

A collection of clinical, genetic and lifestyle data from 100 000 breast cancer patients will lead to better estimates of individual risk, improved prognoses and fewer deaths.

Every year, over 350 000 women in the EU are diagnosed with breast cancer, and more than 90 000 die from the disease. Yet these statistics obscure a great heterogeneity in the malignancy of the tumour and the treatment options available.

“Breast cancer is not one disease, it consists of several subtypes, and we need special preventative measures to tackle that,” explains Marjanka Schmidt, project coordinator of the EU-funded B-CAST (Breast CAncer STratification: understanding the determinants of risk and prognosis of molecular subtypes) project. “The end point is to better predict which woman is likely to develop which breast cancer subtype.”

B-CAST builds on the EU-funded COGS project, which identified a large number of germ line variants that influence the risk of breast cancer. The development of cancer is determined by a complex interplay of these genetic risk factors with lifestyle and environment.

The aim of B-CAST was to identify women with a moderate to high risk of breast cancer, identify the subtype of cancer that is most likely to develop, and define the prognosis of that particular subtype.

TUMOUR DATABASE

To achieve this, epidemiologist Schmidt and her team at the Netherlands Cancer Institute combined large-scale pathologic-molecular analyses of over 20 000 breast tumours with clinical data from 100 000 breast cancer patients.

“We also generated a unique data set of 10 000 tumours, containing not just germ line information but also tumour sequence data, copy number aberrations, and so on, to better measure the genetic profile of the tumour,” says Schmidt.

The clinical data contained information on both the tumour and the patient, including lifestyle characteristics, details of the diagnosis, and the presence of immunohistochemical

markers. Collaborators in Spain helped to isolate the DNA and panel sequence these 10 000 tumours.

“We were hoping to see a more complete view of the genetic landscape. This is a larger and more representative sample than anything published before,” notes Schmidt.

With this information, Schmidt hopes to uncover patterns that influence the development of particular cancer subtypes. The collaborating team developed a polygenic risk score covering 313 single nucleotide polymorphisms that offers a powerful and reliable predictor of breast cancer risk.

The funding also allowed the group to make BOADICEA cancer prediction model more accessible, translating it into Dutch, French, German and Spanish. Clinicians use this to stratify patients, offering those at high risk further treatment such as an MRI scan.

HEALTHIER LIVES

A key question was quantifying the importance of lifestyle factors in breast cancer subtypes, an overlooked part of managing risk. An inventory of national guidelines carried out in the context of B-CAST found that advice for reducing the risk of breast cancer was almost non-existent.

“A small percentage of breast cancers can be prevented by reducing alcohol consumption, maintaining a healthy



© Monkey Business Images, Shutterstock

“ *This is a larger and more representative sample than anything published before.* ”

weight, and performing regular physical exercise,” remarks Schmidt. “The advice is there for heart disease guidelines, but not for the most common cancer in women.” She adds that, in the future, risk models like BOADICEA will aid the provision of genetic counselling that is focused on each individual in the family rather than on the proband.

The work was supported by the European Research Council, funding Schmidt says was essential. “What we have pulled off with all these partners could never have been done if each partner went to national funders. To coordinate that, so that you’re all successful at the same time, would have been impossible.”

Describing the new database as a “goldmine”, Schmidt concludes that it will continue to generate new discoveries and research papers for the next 5 years.



Every year, over 350 000 women in the EU are diagnosed with breast cancer

B-CAST

- Coordinated by the Netherlands Cancer Institute in the Netherlands
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/633784
- Project website: b-cast.eu

How metastasising tumours reprogramme healthy cells to help them spread

EU-funded research on the role cancer-associated fibroblasts play in facilitating breast cancer metastasis could open the door to new ways of treating advanced metastatic cancers.

Mortality from breast cancer is almost exclusively the result of tumour metastasis, the process where cancer cells travel through the blood or lymph system to form new tumours in other parts of the body. As advanced metastatic cancers are currently incurable, the key to treating them lies in better understanding the biology of tumour metastasis.

“The early stages of metastasis, between the resection of the primary tumour and the diagnosis of clinically evident metastasis, represent a ‘black box’ in human patients, limiting our ability to predict or prevent metastatic relapse,”

says Neta Erez, who heads the tumour biology laboratory at Tel Aviv University. “Uncovering the mechanisms that underly the metastatic process is the most significant and urgent quest in cancer research today – and an essential prerequisite for discovering new therapeutic targets.”

Through the EU-funded MetCAF (Uncovering the Role of Cancer Associated Fibroblasts in Facilitating Breast Cancer Metastasis) project, Erez and her lab set out to address this knowledge gap.

CANCER-ASSOCIATED FIBROBLASTS

The project, which was supported by the European Research Council, aimed to uncover the changes in the lung metastatic niche that facilitate and enable the growth of disseminated breast cancer cells. To do this, researchers focused on characterising the changes in cancer-associated fibroblasts (CAFs), stromal cells in the lungs that are ‘reprogrammed’ to support tumour cells.

“ *Uncovering the mechanisms that underly the metastatic process is the most significant and urgent quest in cancer research today.* ”

“We previously discovered the role CAFs play in mediating tumour-promoting inflammation,” explains Erez. “This research expands on this prior work to better understand the role CAFs play in the formation of a permissive metastatic niche that enables the growth of disseminated tumour cells.”

After overcoming some issues with isolating fibroblasts from the lungs in a robust and reliable manner, the project has made several important findings. For example, by demonstrating the heterogeneity and plasticity of CAFs in breast cancer metastasis, researchers were able to identify the factors that cause CAFs to be ‘rewired’ into tumour-promoting mechanisms.

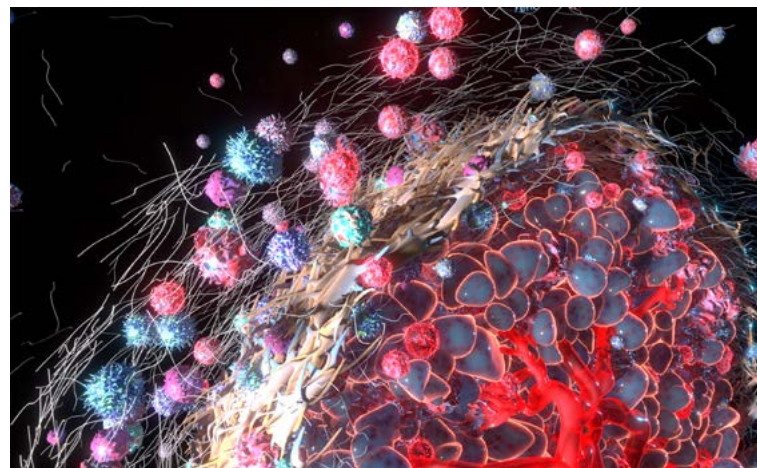
Researchers also demonstrated that CAFs support the formation of lung metastases by mediating inflammation and modulating the function of immune cells to create a hospitable metastatic niche. “When fibroblasts sense tissue damage, they activate fibrosis and inflammation that enable breast cancer metastasis,” remarks Erez.

Investigating the origin of CAFs, researchers discovered that a substantial subpopulation of CAFs don’t actually reside in the lungs as once thought, but are recruited from the bone marrow. “These bone marrow-derived CAFs have distinct functional roles from resident CAFs and are important for inducing the formation of new blood vessels that support tumour growth,” adds Erez.

FACILITATING METASTASIS

Although research remains ongoing, the MetCAF project has significantly advanced our understanding of how metastases-associated fibroblasts co-evolve with tumour progression and promote metastasis by mediating inflammation and modifying the immune system.

“The key takeaways from this project are that the tumour microenvironment is extremely heterogenic and



that fibroblasts play an important role in facilitating metastasis,” says Erez.

Of course, none of these findings would have been possible without the support of a stellar team of students and postdocs. “These PhD students and postdocs spearheaded the experiments and the discoveries,” adds Erez. “I am extremely proud of the excellent and independent scientists they have become.”

The research team is currently working to characterise the immune microenvironment in lung metastasis at the single-cell level. Erez is also in the process of expanding her research to include bone and brain metastasis – two of the most common sites of breast cancer distant metastasis.

METCAF

- Hosted by Tel Aviv University in Israel
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/637069
- Project website: bit.ly/MetCAF-website

The genomic cartographers drawing an atlas of breast cancer

By redefining breast cancer as a heterogeneous group of 11 different diseases, researchers aim to significantly advance our understanding of tumour biology – and our ability to treat the condition.

Despite decades of research and significant advancements in treatment, breast cancer remains the leading cause of cancer death in women. In part, this is because breast

cancer isn’t a homogeneous disease, but rather what can best be described as a collection of very different diseases, each of which evolves and interacts differently.

“One of the greatest challenges to treating breast cancer is that it is a heterogeneous group of 11 diseases, each of which is defined by its own unique genomic profile.”

New research being conducted by the CLONCELLBREAST (Clonal and cellular heterogeneity of breast cancer and its dynamic evolution with treatment) project, supported by the European Research Council, has redefined breast cancer as a constellation of distinct genomic entities. “One of the greatest challenges to treating breast cancer is that it is a heterogeneous group of 11 diseases, each of which is defined by its own unique genomic profile,” says Carlos Caldas, a professor of Cancer Medicine at the University of Cambridge and CLONCELLBREAST principal investigator. “To make things more complex, each tumour is composed of clones, the evolution of which impacts metastasis and resistance to therapy.”

UNDERSTANDING INTEGRATIVE CLUSTERS

Having identified the 11 distinct genomic entities of breast cancer, Caldas and his research team turned their attention to unravelling the clonal and cellular heterogeneity of the disease and its dynamic evolution with treatment. “Our goal was to define intra-tumour heterogeneity in tumours that have been classified into one of the 11 genomic subtypes, which we call integrative clusters,” explains Caldas.

However, doing so was easier said than done. According to Caldas, because the tissues being studied were frozen at cryogenic temperatures, researchers were unable to isolate single cells. Instead, they had to develop a workaround, which in this case involved optimising protocols for single nucleus DNA and RNA sequencing.

Now that they could profile the frozen tissues, researchers were able to confirm that tumours within each of the 11 integrative clusters have prototypical intra-tumour heterogeneity at the genomic, functional and cellular levels. Caldas explains this means that malignant cells are not a single clone but a family of clones that can be characterised at the single cell level using shallow, whole genome sequencing. It also means these cells are



a constellation of malignant cell phenotypes that can be characterised at the single cell level using RNA sequencing.

“Profiling the tumour microenvironment at the single cell level and cataloguing stromal cells and immune cells has given us a unique view of breast cancers with profound diagnostic and therapeutic implications,” adds Caldas.

A SINGLE CELL ATLAS OF BREAST CANCERS

Having characterised intra-tumour heterogeneity at an unprecedented scale, researchers used the collected data to create a single cell atlas of breast cancers.

“Representing the full spectrum of the diseases, including tumours from all 11 integrative clusters, this atlas is the first of its kind,” notes Caldas. “The single cell atlas of breast cancer will significantly advance our understanding of tumour biology, including dormancy and metastases, and will help unravel drug resistance and why only a very small fraction of breast cancers respond to immunotherapy.”

In addition to the atlas, the project has already published three papers in ‘Nature Communications’, with several more to come. Once the project is complete, all collected data will be made available to the research community via the EMBL-EBI portal.

CLONCELLBREAST

- Hosted by the University of Cambridge in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/694620

A predictive tool to help women bounce back from cancer

Resilience is an indispensable part of living with breast cancer. Lifestyle, along with psychological, biological and clinical factors all play a role in a patient's prognosis. The BOUNCE project aims to provide both clinics and patients with tools that can predict resilience-dependent outcomes.

Coping with and surviving breast cancer is not just a matter of benefitting from the best and most suitable treatment option. It's also a question of personal resilience, which involves complex factors such as biology, lifestyle, optimism, interpersonal connections or even spirituality. But while resilience studies do exist, most of them focus on emotional distress and functional impairment resulting from diagnosis and treatment. What gives patients strength, on the other hand, remains a grey area.

"A strength-based perspective can improve our understanding of protective factors and the role they play in diagnosis and treatment outcomes. But to get there, we need a multidimensional approach," says Paula Poikonen-Saksela, clinical lecturer at Helsinki University Hospital's Comprehensive Cancer Center and coordinator of the BOUNCE (Predicting Effective Adaptation to Breast Cancer to Help Women to BOUNCE Back) project.

BOUNCE attempts to conceptualise and assess resilience over a long period of time. The project uses a multimethod

and multitrait conceptualisation of resilience that considers it either: as a trait or potential; as a process or trajectory; or as a quality-of-life outcome in long-term follow-up.

The project team compiled a battery of scales and questionnaires which was then refined and condensed by a group of expert psychologists. The questionnaires were circulated to patients in different languages. "This was a time-consuming process which took longer than expected. We had to keep patients motivated to remain in the study and answer all our questions for the entire 18-month follow-up period, which was made even more complicated by the COVID-19 pandemic. Thanks to coordinated efforts from study physicians and research assistants, we eventually managed to reach the projected number of 600 patients who provided 1 year of follow-up data," Poikonen-Saksela explains.

PSYCHOLOGICAL SUPPORT

With this work completed, the project team proceeded to develop a dedicated clinical model. This will help practitioners identify the trajectories of resilience-related outcomes (such as quality of life) over time, as well the major variables that can predict these trajectories. Eventually, the model will be turned into a prediction tool that will help health professionals predict future levels of resilience-related outcomes based on patients' status and scores for certain crucial variables. The tool will also come with basic clinical recommendations to facilitate informed decision-making.

"A spin-off clinical study is currently under way in Helsinki and Milan," Poikonen-Saksela adds. "It will examine basic aspects of the clinical model and the applicability of a clinical workflow involving our upcoming decision support tool. In Helsinki, we collect information about patients' compliance, their actual need for resilience measurement, and the usefulness of digital interventions. In Milan, the main objective is to test the feasibility of the resilience predictor tool in clinical practice. Resilience scores will



be measured at baseline, during and after targeted psychological interventions to detect any changes during treatment. We will closely observe which variables are affected by a psychological intervention.”

The project is scheduled for completion in April 2022. The remaining time will be used for further data collection and improvement of the statistical models, as well as to conduct a cost-benefit analysis for the decision support module in clinical settings. Big benefits would considerably change clinical practice, enabling practitioners to provide personalised recommendations for the psychological support given to their patients.

“ We eventually managed to reach the projected number of 600 patients who provided 1 year of follow-up data. ”

BOUNCE

- Coordinated by Helsinki University Hospital in Finland
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/777167
- Project website: bounce-project.eu

Machine learning algorithms match tumours with treatments

Combining data from the European Union and United States, the PredAlgoBC project has identified new biomarkers for breast cancer tumours. These could eventually be used to identify new, personalised treatment options.

Cancer researchers and oncologists are increasingly supportive of replacing standard treatments with patient-specific ones that account for disease heterogeneity. In the case of breast cancer, the fact that clinicians don't have enough information on patient-specific tumour characteristics sometimes leads to relapses in the form of metastatic cancer. Whilst first-line treatments for breast

cancer treat around 90% of patients successfully, this survival rate goes down to 27% for metastatic cancer.

To solve this problem, experts have been building huge databases matching specific tumour characteristics (potential biomarkers) with specific treatment responses in patients. But they're just getting started, and only a few biomarker signatures have reached the clinic so far.



"This is what we call the 'curse of dimensionality,'" says Agnes Basseville, researcher at the Institut de Cancérologie de l'Ouest (ICO) in France and coordinator of the PredAlgoBC (Machine learning prediction for breast cancer therapy) project. This research was undertaken with the support of the Marie Skłodowska-Curie Actions programme. "We currently have too many measured characteristics for not enough patients, and the machine learning (ML) algorithms we use to analyse biomarker data do not perform well in such a setting."

The PredAlgoBC project aims to fill this gap by combining various mathematical approaches with thorough biological analysis. With this work, Basseville hopes to ensure that the information given by the algorithm will be usable in the clinic.

"We built the project mainly around two public databases: GEO (American) and ENA (European). We were able to collect data from over 4000 patients with breast cancer along with related follow-up information. By combining data sets, we obtain sufficient statistical power to provide a comprehensive overview of tumour complexity, although some of the data we wanted to harvest, namely RNA-Seq, is available only upon request and after a 6-month evaluation of this request. Due to time constraints, we decided to not use it."

HORMONOTHERAPY BREAKTHROUGH

The data set compiled was split into two parts. The first was used to teach the algorithm how to better predict treatment outcome, after which the second was used to test the prediction performance of the project's model. "In that way, we can compare model predictions with the known response and determine whether our models are good performers or not," Basseville explains. For each model, the variables were ranked based on their importance in the overall prediction. The best-ranked variables are the ones that can be tested as potential biomarkers.

"This is what we call the 'curse of dimensionality'. We have too many measured characteristics for not enough patients."

While the predictions are not yet good enough to be used in the clinic, variable ranking has allowed the team to identify neural development actors as key tumour components linked to poor responses to hormonotherapy. This is a serious breakthrough as such a link had never been formally identified before.

Another project outcome is the implementation of a deep learning algorithm to create virtual patient cohorts. These are particularly handy, as they enable the sharing of patient-level data without disclosing any information on real-world subjects. Finally, the project's newly found biomarkers will soon be presented in a peer-reviewed article. Basseville and her team will follow it up with the new data sets being compiled that will help them further validate these biomarkers.

"The next step will consist in defining the best way to evaluate these components in the clinic, using ICO tools to operate the test routinely with assays like PCR or immunohistochemistry. Once we have chosen the best clinical assay, we'll need to perform a retrospective analysis on patients at ICO to validate our new markers and confirm how helpful they are when deciding who should receive hormonotherapy," Basseville notes.

This process, which will be accompanied by research on how to best exploit the new biomarkers as a new target for treatment, is expected to take several years.

PREDALGOBC

- Coordinated by ICO in France
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/841313



A growing opportunity: turning mushroom substrate into fertiliser

Mushroom cultivation results in waste substrate, costly for growers to process. In line with the bio-based circular economy, Smartmushroom developed an environmentally friendly technique to upcycle agricultural waste as fertiliser.

Just as plants get their growth nutrients from soils, mushrooms get them from substrates comprised of livestock and agricultural waste. After cultivation, with nutrients depleted these are known as spent mushroom substrates (SMSs).

SMS is commonly recomposted for fertiliser, but with a high moisture content (around 70%) it first has to be dried to reduce transportation costs. This traditionally involves leaving the substrate outside, relying on the sun.

The EU-supported project Smartmushroom (Smart Management of spent mushROOM subSTrate to lead the MUSHROOM sector towards a circular economy) has developed and demonstrated a process which uses biogas generated from fresh SMS to dry a mix of digestate and SMS for conversion into pelletised fertiliser.

"This organic fertiliser can be sold to any region in Europe," says project coordinator Pablo Martínez from the Mushroom Technological Research Centre of La



Rioja. “As farmer demand for pellets is higher than the manufacturing capacity of our pilot plant, we are happy with the project results.”

PRODUCING ORGANIC FERTILISER

Smartmushroom’s new methanogenic technique uses hydrolysis followed by anaerobic digestion. The resultant biogas powers a drying process with up to 28 % humidity which, by using condensation and adsorption through sepiolite filters, accelerates water removal from the SMS.

The dried SMS can then be enriched with natural nitrogen, phosphorus and potassium fertiliser, tailored to specific agricultural needs, before being pelletised.

The project carried out several trials focused on three areas.

To test anaerobic digestion, the team experimented with different digestion mixtures at lab scale. With SMS as the main raw material, other agri-waste substrates were added to optimise biogas generation and increase methane content. This enabled the team to set the optimum feed parameters for a pilot plant. The best ratio proved to be seven parts SMS to two parts waste water from marmalade manufacturing, and one part glycerine.

The dryer’s temperature, timing and belt speed were adjusted to maximise its biogas-driven performance, while accommodating composition variations. This enabled an automatic setting to be established for the dryer.

The SMS-based pellets were tested as fertiliser for several crops – including lettuce, cauliflower, pepper, tomato, broccoli, vineyard and cereal. This was done in greenhouse and open fields in Serbia and Spain. “These trials were so successful that the farmers participating wanted to continue using the pellets,” notes Martínez.

The project built an SMS-ADryer pilot plant at Sustratos de La Rioja, the authorised mushroom waste manager in the region. The anaerobic digesters are installed in a modular container version, as opposed to a concrete building, to accommodate varying SMS quantities. The dryer is composed of a burner which dries the SMS to

“As farmer demand for pellets is higher than the manufacturing capacity of our pilot plant, we are happy with the project results.”

the humidity required by the production line making the pellets.

“The results have been very positive, with the pilot plant able to convert 36 000 tonnes of fresh SMS into 8 500 tonnes of organic fertiliser pellets annually,” adds Martínez.

MUSHROOMING BENEFITS

Smartmushroom’s innovation will not only save growers waste management costs, calculated at EUR 29.2 million for the whole European sector according to Martínez, but actually create a source of revenue.

The system also offers environmental benefits, as the process is carbon sequestering, transferring atmospheric carbon dioxide into the soil. It also helps mitigate soil degradation by adding fertiliser with up to 50 % organic matter.

“Increasing the value of mushroom waste, Smartmushroom can increase growers’ profits, benefiting employment and a more competitive agri-sector,” remarks Martínez.

With industrialisation simulations already available, the pilot plant is ready to be scaled up. COVID-19 travel restrictions allowing, the team will soon organise visits to the plant.

SMARTMUSHROOM

- Coordinated by the Mushroom Technological Research Centre of La Rioja in Spain
- Funded under Horizon 2020-LEIT and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/820352
- Project website: smartmushroom.eu

How wheat can develop immunity to pathogenic bacteria

Bacterial diseases are a threat to plants as well as humans and animals, jeopardising food security. T-REX helps uncover a mechanism by which some wheat cultivars recognise pathogenic bacteria, boosting resistance.

Bacterial diseases amongst European crops primarily affect fruit trees and vegetables, reducing yields and shortening produce shelf life. Perhaps the most severe is *Xylella fastidiosa*, which can destroy olive groves.

Bacterial diseases are often controlled by spraying crops with various solutions, such as copper and zinc salt, which are often ineffective and can be environmentally problematic. Building disease resistance is sometimes attempted but is not durable as bacterial strains typically overcome resistance.

Most pathogenic bacteria use the so-called type III secretion system (T3SS), where needle-like probes inject proteins into plant cells to make them more vulnerable to the bacteria.

To help understand this process, the EU-supported project T-REX (Developing healthy crops for EU: T3SS-Recognition EXploration (T-REX) for plant immunity against bacteria) studied wheat cultivar's interaction with the T3SS; as it is integral to bacterial infection, wheat recognition of it should confer long-lasting immunity.

T-REX used the T3SS from *Pseudomonas syringae* – a bacterium that causes diseases on the leaves and other organs – to inject proteins from other pathogens into wheat. The team found that some wheat cultivars may recognise the T3SS.

“When we compared *P. syringae* growth in T3SS-recognising and non-recognising wheat, we found indications that recognition delayed bacterial growth by about a day,” says project coordinator Hans Thordal-Christensen from the University of Copenhagen, the project host. “This was very exciting because recognition of T3SS was previously only known for animals.”

This research was undertaken with the support of the Marie Skłodowska-Curie Actions programme.

INVESTIGATING THE GENETIC ASSOCIATION

The T-REX team injected a non-pathogenic soil bacterium, artificially expressing the T3SS, into the leaves of wheat cultivars and observed the outcome. They found that in some cultivars, the leaf tissue dies within 24 hours as a sign of immunity, while in others, nothing happens. This suggested that some cultivars can recognise the T3SS.

Using the same methodology, to identify the gene responsible for T3SS recognition, the team tested 440 cultivars of the WAGTAIL collection, finding one third recognise the T3SS. With about 20 000 genetic differences in these cultivars already analysed, the team was able to locate the gene responsible for T3SS recognition on the chromosomes.

“We found that this ability seems to be mediated by a single gene mapped to a chromosome segment of about 10 genes. Which specific gene remains uncertain,” notes Thordal-Christensen.



The team also wanted to locate the part of the T3SS that the wheat recognises. With the T3SS consisting of 28 different bacterial proteins, one way to find the telltale protein is to produce and inject the proteins one by one.

“We produced and purified many of the 28 T3SS proteins from *Escherichia coli*, then tested if they cause leaf tissue death. Unfortunately, we have not yet found the key protein, so will keep looking,” he adds.

WIDENING THE SCOPE

By increasing knowledge about plant science in general and plant immunity specifically, T-REX helps pave the way to a more resource-efficient and environmentally friendly agriculture.

“We can advise wheat breeders to use the 10-gene chromosome segment in cultivars to improve resistance to *Pseudomonas* bacteria and provide genetic markers to confirm they got the right segment,” says Thordal-Christensen. “Once we identify the specific gene responsible, we hope

“ *This was very exciting because recognition of T3SS was previously only known for animals.* ”

to also improve resistance to bacteria in other plant species.”

Another research focus is to understand how pathogen effectors manipulate the plant immune system. The team is using the bacterial T3SS to introduce effector proteins into plant cells, then experimenting to make plant effector targets insensitive to these to boost immunity.

T-REX

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795806
- Project website: bit.ly/T-REX_MSCA

FOOD AND NATURAL RESOURCES

A smart way to measure feed levels and upgrade the animal feed supply chain

Farmers need to know the amount of animal feed contained in their silos to avoid disruption to the supply chain. An EU-funded initiative has developed an easy to install, cost-efficient solution.

Animal feed suppliers have difficulty managing and planning deliveries to farms because of the inconsistent demand for their product. One of their main challenges is having to rely on farmers knowing their stock levels and forecasting their needs, which introduces an uncontrollable element into the feed supply chain.

Most farmers check their feed silos once or twice a week, tapping them manually to get an approximation of the feed level. When the silos are almost empty, the farmers

contact the animal feed suppliers, who then have around 24-48 hours to make their delivery. As a result, suppliers can fail to operate in an optimal way and incur additional costs for both themselves and the farmers.

The INSULO (Disruptive IoT solution for optimising the animal feed supply chain) project addressed this challenge by providing the necessary data required to allow suppliers to optimise the feed supply, thereby reducing CO₂ emissions throughout transportation and production and benefitting



both suppliers and farmers. “The goal was to develop a commercially ready sensor with a scalable deployment and a platform for software licensed on a subscription basis,” says project coordinator and CEO of INSYLO Technologies, Jaume Gelada.

SIMPLE TO INSTALL

Researchers developed a smart way of monitoring the feedstock levels inside silos at a very low cost. Their solution is based on a patented volumetric 3D sensor that accurately measures the volume of a silo’s content by creating a topographical map of the inside of the silo. In addition, temperature and humidity conditions are monitored to achieve optimal storage conditions and avoid possible fungal or bacterial contamination.

The device only takes 5 minutes to install and is permanently connected to the internet thanks to a wireless sensor network that is available even in areas without mobile phone coverage. Furthermore, the sensor does not need to be connected to the electricity grid as it is powered by solar panels and a set of rechargeable batteries, making it entirely self-sufficient. As the INSYLO sensor is completely autonomous, it is not necessary to extend the electricity grid to the silo or perform maintenance.

INSTANT REORDERING

The INSYLO solution allows farmers and suppliers to collaborate through a cloud-based platform that can be accessed any time, anywhere and on any device. “You can

“ *The INSYLO solution will completely disrupt the feed supply chain. The main impacts comprise the optimisation of the feedstock inventories, production batches, delivery routes and raw materials purchases. This translates into savings of up to EUR 500 per silo a year.* ”

analyse consumption patterns, replenishment cycles and future trends. When stocks are below the set level, the INSYLO device sends a message via email or smartphone offering the possibility of sending the restocking order with a simple click,” Gelada explains.

By applying the power of artificial intelligence, it is possible for the very first time to forecast feed demand (i.e. refill orders) and optimise feed trucks’ delivery routes. “Once adopted by our target clients (feed suppliers), the INSYLO solution will completely disrupt the feed supply chain. The main impacts comprise the optimisation of the feedstock inventories, production batches, delivery routes and raw materials purchases. This translates into savings of up to EUR 500 per silo a year,” comments Gelada.

Farmers will also benefit by no longer needing to climb to the top of a silo to check the feed level, thus reducing an occupational hazard, and can be confident that they will never run out of feed for their livestock. “Finally, from an environmental point of view, since INSYLO technology optimises feed delivery routes, it can reduce the carbon footprint of the feed supply chain by up to 25 %,” Gelada concludes.

INSYLO

- Coordinated by INSYLO Technologies in Spain
- Funded under Horizon 2020-FOOD and Horizon 2020-SME
- cordis.europa.eu/project/id/806162
- Project website: insylo.com/en
- bit.ly/INSYLO_video



INDUSTRIAL TECHNOLOGIES

Cracking steam cracking technology with eco-friendly furnaces

Innovative technology geared at emissions and energy reduction in steam cracking furnaces provides an important solution to the chemical industry.

Steam cracking is the most energy-consuming process in the chemical industry and globally it uses about 8% of the sector's total primary energy. Improving energy efficiency has an immediate payout as energy costs account for roughly 70% of the net production costs in typical ethane- or naphtha-based olefin plants.

The EU-funded IMPROOF (Integrated model guided process optimization of steam cracking furnaces) project improved the energy efficiency of the radiation section of a steam cracking furnace by at least 20%. This has the added benefit of reducing greenhouse gas emissions and nitrogen oxides (NO_x) per ton ethylene produced by about 25%.

INNOVATIVE TECHNOLOGY GEARED AT EMISSIONS AND ENERGY REDUCTION

IMPROOF used advanced coil materials, combined with a new cost-effective 3D furnace and reactor, which yielded

30% fuel savings and 30% less carbon dioxide (CO_2) emissions. This improved process control and provided a more uniform heat transfer thus increasing run lengths. In addition, the application of high emissivity coatings on the external surface of the radiant coils further improved the energy consumption.

"One of the most important ways to reduce the energy input in steam cracking furnaces per ton ethylene produced is to reduce coke formation on the reactor wall of the long tubular reactor mounted in the furnaces," explains Kevin Van Geem, project fellow. The project demonstrated the advantage of combining their technological innovations with an anticipated increase in the time on stream by a factor of 3. Thus, cleaning the furnace and downtime is necessary once every 3 months instead of monthly.

While the COVID-19 crisis affected the progress of the project and made data acquisition and a one-to-one comparison difficult, it did not stop the project's consortium



“One of the most important ways to reduce the energy input in steam cracking furnaces per ton ethylene produced is to reduce coke formation on the reactor wall of the long tubular reactor mounted in the furnaces.”

from operating intensively. Works included: pilot plant testing and advanced process simulation; evaluating techno-economic, environmental and operational advantages of the project; and disseminating and commercialising the project results and producing experimental data on the combustion of biogas and bio-oil surrogates.

THE OLEFIN INDUSTRY AND RELEVANT STAKEHOLDERS TAKE NOTICE

“IMPROOF has been operative for more than 4 years, and the impact of our project is huge. More and more companies see how they can reduce CO₂ emissions,” adds Van Geem. The power of advanced 3D modelling can help to boost production, reduce CO₂ and NO_x emissions and enhance cost/benefit ratios. The petrochemical industry is also considering combining innovative technologies such as high-emissivity coatings of refractories with coated reactors.

This is also of relevance for endothermic processes such as steam reforming, glass production, electrification and more.

The methodology followed by IMPROOF is getting substantial attention because of its ability to be used for electrification of steam cracking. If green electricity can be used, CO₂ emissions could be reduced by 30 % and a more impressive emissions reduction of 90 % could be achieved if the concentrated CO₂ is captured.

The results were disseminated widely at workshops and conferences, stakeholders such as Plastics Europe, universities and companies, and in bilateral meetings with academicians and industrial actors. “This has boosted interest in the project and also the technology. The project is very visible in the olefin industry with numerous requests for presentations at companies not partners of the project,” concludes Van Geem.

IMPROOF

- Coordinated by Ghent University in Belgium
- Funded under Horizon 2020-LEIT-ADVMANU
- cordis.europa.eu/project/id/723706
- Project website: improof.cerfac.fr

INDUSTRIAL TECHNOLOGIES

Reactive process fluids will help parts give friction the slip

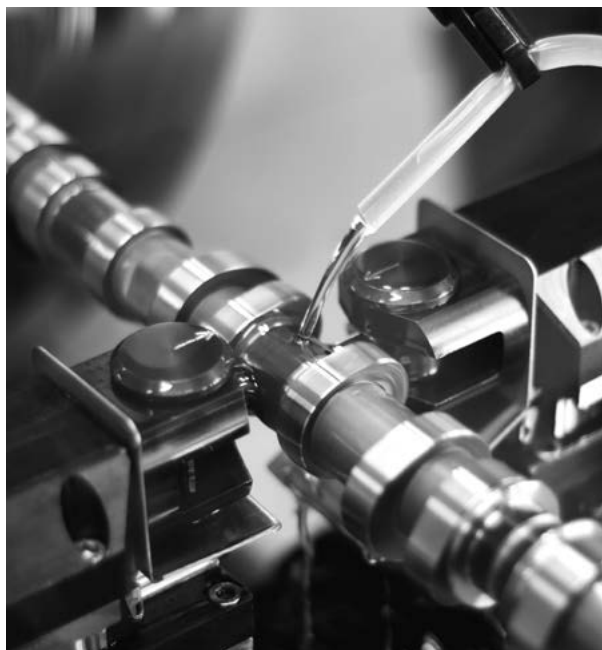
The relative motion of metal over metal is ubiquitous in automotive and industrial applications – as are the friction and wear it generates. Pioneering surface treatment that is easily integrated into existing machinery helps lubricants do more for less.

Although solutions such as lubricants and coatings have advanced, most still face important limitations with consequences for the competitiveness of manufacturers and for the environment. Triboconditioning® technology for surface optimisation, developed by the Swedish SME Applied Nano Surfaces (ANS), is based on reactive process fluids that form nanolayers on steel or cast-iron components. EU support for the Triboconditioning (Development of an innovative and cost-efficient process for friction and wear reduction) project pushed the technology readiness level across the finish line for specific

applications, resulting in three licence agreements, two with major automotive original equipment manufacturers.

SLIP-SLIDING AWAY

The Triboconditioning project focused on four different product groups: big bores, small bores, shafts and gears. Christian Kolar, CEO of ANS and project coordinator, explains the technology: “We apply special process fluids with reactive chemistries to surfaces and then use hard tools and high pressure to press in surface peaks while



sliding on the surface. The heat generated makes the fluid react with the surface, forming low-friction anti-wear nanolayers chemically bound to the surface.”

The result is a smooth surface with very good load-bearing and optimised surface chemistry. The latter significantly improves lubricant film formation, increasingly important as industries move towards lubricants with lower viscosity and fewer harmful additives.

FLEXIBLE PROCESS, FLEXIBLE LICENSING PARTNERSHIPS

Triboconditioning® minimises friction and wear and enhances the effect of a variety of lubricants. The process can be applied using standard machining and tooling systems which brings great flexibility and easy implementation.

Customers can send their components to ANS for in-house treatment in cases requiring prototyping, manufacturing scale-up testing or limited volume production (up to about 100 000 parts per year). A partnership network is being established to offer similar services in markets where ANS does not yet have facilities. As production volumes increase, ANS supports the customer in transferring the process technology to the customer's plant or its supplier. A licence agreement covering the right to use the Triboconditioning® process can be implemented as a fixed annual fee per product area or a variable fee per treated part.

The **compound annual growth rate** of the global **electronic vehicle market** from 2019 to 2026 is predicted to reach **25.6 %**



OPTIMAL PERFORMANCE WITH LOWER COST AND ENVIRONMENTAL IMPACT

Triboconditioning® optimises the surface of steel or cast-iron components both physically and chemically, whereas existing technologies typically target one or the other. As compared to these, Triboconditioning® significantly improves performance with limited added cost, lower environmental impact and minimal waste.

Kolar summarises: “Triboconditioning has enabled us to move from lab/early production testing to full-scale implementable systems to help our customers lower friction and wear. We also began developing our novel gear treatment process during the project. It has significantly minimised friction and wear in gear contacts, widely applicable in industry and for electric vehicles (EVs). In the latter, it can improve drive range and vehicle transmission longevity as well as minimise transmission noise.”

The compound annual growth rate of the global EV market from 2019 to 2026 is predicted to reach 25.6 %, increasing from EUR 103 billion to EUR 508 billion. Bores, shafts and gears of all kinds will be on the path of least resistance thanks to Triboconditioning®.

TRIBOCONDITIONING

- Coordinated by Applied Nano Surfaces in Sweden
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/823307
- Project website: triboconditioning.com
- ▶ bit.ly/Triboconditioning_video



Helping robots get to grips with the real world

Universal algorithms for interacting with physical objects will overcome an unsolved problem in robotics, allowing machines that can walk and work alongside us.

Although robots are an increasingly common presence in our lives, they are still largely restricted to controlled environments such as assembly lines, or applications where they only need to avoid physical objects, rather than interact with them.

“The key issue we face today in robotics is when you want them to walk, climb and manipulate objects,” explains project coordinator Ludovic Righetti, senior researcher at the Max Planck Institute for Intelligent Systems and associate professor at New York University.

“Managing physical interaction is an unsolved problem in robotics, the most difficult issue we’re facing. We can develop ad hoc algorithms for a few sensors. But a general theory for any robots, nobody knows how to do that.”

MACHINES IN MOTION

The EU-funded CONT-ACT (Control of contact interactions for robots acting in the world) project aimed to develop fundamental knowledge and generic algorithms that would address this issue. The project had two pillars: the first was to use an understanding of physics to derive the basic principles of physical interaction. The second was data from real robot experiments to improve the behaviour of this system.

Righetti’s group had already developed a generic method to control legged robots, teaching the machines how to adjust the force applied by their motors to keep their balance. To advance this, they had to solve the same problem for a robot in motion. “This is hard to solve in real



time,” says Righetti. “Whatever we’re doing, we need to solve it in a few tens or hundreds of milliseconds.”

By breaking down the complexity of the problem, Righetti and his team were able to create a set of algorithms that would let the robot move its entire body. “We designed a controller that allows the robot to respond to changes in the environment,” he adds.

“So, walking up uneven stairs, or if someone pushes it, we came up with algorithms that deal with that.”

The team also developed machine learning techniques that allow the robots to integrate information from additional sensors. “We have robots with tactile surfaces that can detect contact, and measure force and pressure. But if you look at algorithms that control how these robots grasp and manipulate objects, usually they do not use this information,” says Righetti.

VIRTUAL SPACE

Combining this data is crucial to building a generic handling algorithm. “If you look at the raw data, when you change one slight thing, like the shape or colour of an object, the readings from sensors will be very different,” notes Righetti. “But they do describe something similar.”

By mapping these inputs to a virtual space, robots can learn general models of their environment and acquire behaviours that enable them to handle similar unseen

“*Whatever we’re doing, we need to solve it in a few tens or hundreds of milliseconds.*”

objects and environments, rather than having to be taught how to interact with each variation of it.

Righetti admits that, ultimately, he was not able to crack the biggest unsolved problem in robotics: finding algorithms to make robots truly autonomous.

But he says his team was able to make significant progress toward that goal. “We now have algorithms that are pretty mature, and are among the fastest and most reliable that exist today.”

He adds that making further developments to robotic movement and physical interaction with objects and the environment is likely to dominate his research for the next few years: “The story is far from finished. We keep making a lot of progress and we’ll continue our goal of finding a fundamental set of algorithms.”

CONT-ACT

- Hosted by the Max Planck Society in Germany
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/637935

DIGITAL ECONOMY

New technology supports community radio in small rural communities

Radio is the lifeblood of culture, but can be expensive and administratively difficult. A new internet-based system addresses these problems.

Local media, especially radio, help define and sustain remote communities and minority cultures. Due to commercial difficulties, such media are in decline in many

parts of Europe. Consequences include the loss of local journalism and the homogenisation of culture. Many rural

“Any individual can be simultaneously a broadcaster and/or listener, which puts people back at the centre of radio.”

communities in Europe only receive centralised radio that is poorly interactive and indifferent to local issues.

Community radio, organised by local volunteers, offers an alternative way of providing local news and representation. But community organisations face many financial, technical and legislative difficulties establishing local radio stations. The technical challenges can be considerable, since radio stations require costly studio facilities and powerful transmitters. Although internet radio partially solves these problems, many parts of Europe still have limited internet or mobile coverage.

The EU-funded GrassrootWavelengths (Grassroot Wavelengths: Highly Networked Grassroots Community Radio through a scalable digital platform) project developed an effective and affordable alternative to conventional radio. The concept allows for studio-less production and broadcast of FM radio and eliminates much of the expensive equipment associated with commercial radio stations. The project adapted, refined and brought together many cloud-based technologies, explored and fostered local communities' adoption of them, and devised models for the technologies' eventual introduction across Europe.

CLOUD-BASED RADIO PRODUCTION

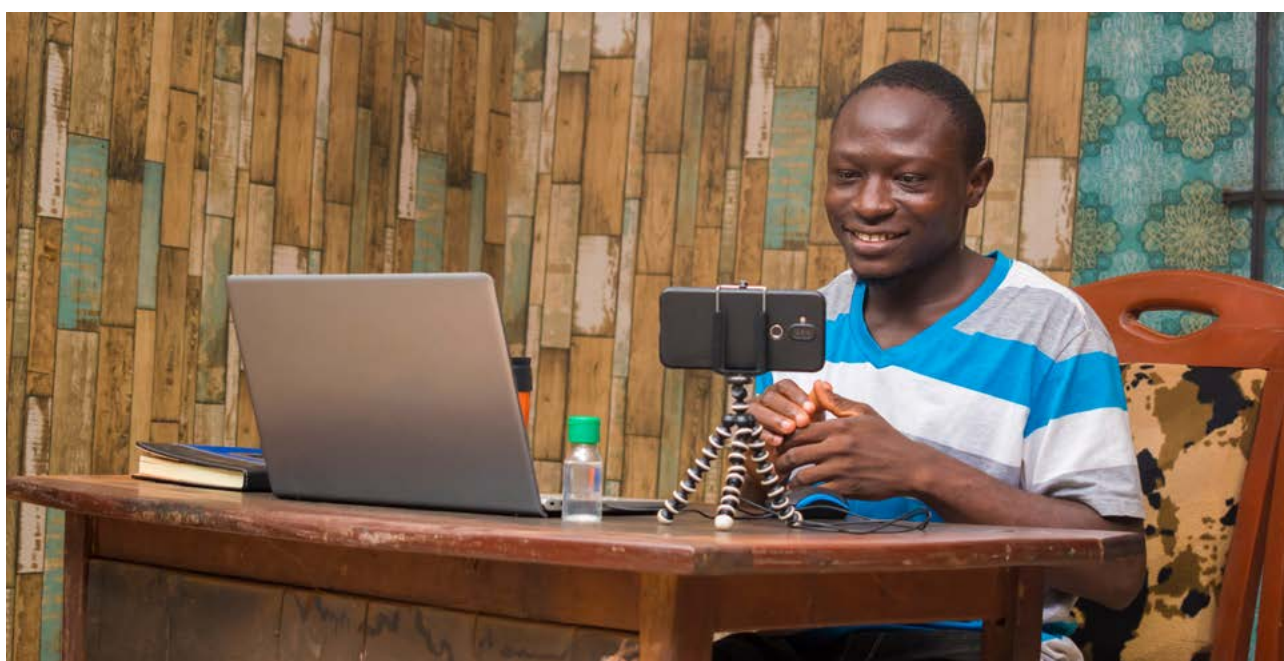
The project is based on the RootIO system, a set of open hardware and software technologies designed for creation and transmission of radio programming without a physical studio. Project researchers updated RootIO to comply with EU broadcasting standards, and tailored it to address the needs of local groups.

RootIO has two major components. One part is a web platform that allows amateur producers to create their own radio content – either live or pre-recorded – and to schedule broadcasting from a local FM station. Since a studio is unnecessary, producers can work from anywhere. RootIO also includes a cloud data system, which sends digital audio from the web platform to a low-power FM radio transmitter.

Listeners can use any normal FM radio receiver. They may also listen via internet live streaming, and interact with the station using the web application.

COMMUNITY BENEFITS SHOWN

Project researchers trialled the system at seven rural locations in Ireland, Portugal and Romania. These trials demonstrated the benefits of local radio programming to communities too small to be served by a radio station. The addition of local stations brought citizens more information about their own communities. This introduced local content, including news and announcements



– particularly health advice programmes, which proved invaluable during the COVID-19 pandemic –, oral history, and much more. “This type of radio brings people closer,” says John McCarthy, one of the project coordinators, “because any individual can be simultaneously a broadcaster and/or listener, which puts people back at the centre of radio.”

The team also created a sophisticated and realistic-sounding text-to-speech (TTS) system, which allows the automated reading of online content. Among many potential uses, this could automate time-consuming broadcasting tasks, such as emergency alerts, leaving producers free for content development.

GrassrootWavelengths demonstrated a social need, and market, for the concept. The new platform greatly simplifies the once technical complexity of radio production, making it cheaply and easily available to remote or minority communities.

GRASSROOTWAVELENGTHS

- Coordinated by the Madeira Interactive Technologies Institute in Portugal
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/780890
- Project website: bit.ly/GrassrootWavelengths

DIGITAL ECONOMY

Cutting-edge solution is bringing new life to still photos

An EU-funded project has developed novel tools that are revolutionising how people use photography to portray stories.

Advances in technology have opened the door to new ways of telling stories, from uploading photos and videos on social media platforms to immersive 3D and virtual reality experiences. As a result, there is a staggering amount of digital content available at the click of a button. For creative storytellers, this raises questions on

how to best repurpose this content and the innovative tools required to do so.

With a focus on photojournalism, fashion and festival industries, the EU-funded FotolnMotion (Repurposing and enriching images for immersive storytelling through smart digital tools) project developed a solution for repurposing photos for immersive storytelling. “We have successfully delivered an integrated tool able to automatically, in a few seconds, create an appealing video clip from a still photograph with storytelling and branding effects,” explains Konstantinos Thivaos, member of the coordination team of INTRASOFT International, the project host. To achieve this, the project capitalised on and advanced novel technologies based on research and developments in image analytics and recognition by INESC and 3D technologies by QdepQ, both project partners.

A CLOSER LOOK AT THE SOLUTION

The tool is available in desktop and mobile versions whereby users can transform their photos into spatial



“We have successfully delivered an integrated tool able to automatically, in a few seconds, create an appealing video clip from a still photograph with storytelling and branding effects.”

and 3D video experiences by applying automated editing functions and dynamic effects made possible thanks to artificial intelligence (AI) object identification and 3D technology. Despina Anastasopoulos, a member of the coordination team notes: “The advanced technologies of explainable AI and deep learning were fully utilised to develop a tool that could support the targeted industries.”

The key and innovative aspect of the solution is its ability to generate useful metadata for the creative process, thereby reducing the costs of content production. It also offers simple capture and video creation possibilities, prosumer grade filters and machine learning-driven story generation, as well as easy dissemination to video formats and social media. “Furthermore, the annotation tool, implemented within the mobile app of the FotoInMotion tool, is a prototype to create a synthetic media service that can connect to any industrial platform available in the market,” adds Paula Viana from INESC.

A NEW ERA OF STORYTELLING

FotoInMotion’s technological outcomes will enhance the way creative industries use photography in storytelling and impact on other photography-related fields. “Maria Goirigolzarri from NOOR, an international documentary photo agency and the project’s pilot partner, highlighted

that ‘having a tool that uploads an image and receives automatic recognition of objects in the picture and automatic key-wording of those objects would be of high value in the photojournalism industry, and not only,’” outlines Anastasopoulos.

The Italian fashion company Marni, also a project pilot partner, sees the potential of the web and mobile app for public relations and communications teams in industries such as fashion, as it provides a stand-alone tool for digital reporting on social media. “Sten-Kristian Saluveer, from the Black Nights Film Festival and Storytek, also part of the project’s pilot programme, found the solution’s template and semi-automatic functionality an extremely valuable tool for the events and festival community,” says Anastasopoulos.

Moving forward, the project is currently investigating the possibility of exploiting the outcomes of FotoInMotion either by capitalising on the work for further research or by identifying market opportunities. Anastasopoulos concludes: “Several approaches that can contribute to increasing the performance of the solution, additional functionalities and adaptation to other application scenarios were identified and will be kept in mind.”

FOTOINMOTION

- Coordinated by INTRASOFT International in Belgium
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/780612
- Project website: bit.ly/FotoInMotion-archive



Now you've read the articles, why not download our **CORDIS**covery podcast episode on virtual reality?

→ bit.ly/CORDIScovery_VR



Catching up with BILLON: Bringing innovative blockchain technology into the financial mainstream

*We featured the BILLON project in the October 2020 issue of Research*eu and learnt about their innovative blockchain technology that allows all Europeans, regardless of age, wealth or nationality to participate in the ever-growing digital economy. Robert Kaluza, e-money CEO of the Billon Group based in the United Kingdom and Poland, fills us in on how far their technology has advanced and their most exciting recent developments.*



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BILLON (Disrupting the economy – FinTech blockchain solution revolutionises direct payments. Secure, low-cost and simple bank-free payments for everyone) was all about opening up access to frictionless, secure, simple and low-cost digital payments to everyone, and the way they did this was to develop blockchain technology that didn't rely on any intermediary, such as a bank or card provider. They successfully obtained licences to process e-money transactions in their native Poland (the first to do so) as well as the United Kingdom, and won several major industry accolades because of their blockchain technology.

Continued international and domestic success

But how are they doing now? "We've just completed a key milestone in our technological development by launching the Unified Enterprise DLT System," says Kaluza. "This platform consolidates our previous solutions using blockchain to manage various asset classes – national currencies, documents and other tokens – into a single high-performance distributed ledger." This means Billon will be unable to unlock the full potential of

its enterprise blockchain technology by connecting separate flows of money and data into one truly seamless process.

Billon's idea for blockchain transactions with national currencies also gained acceptance from some of the leading financial institutions in Europe and the United States. "FIS, a world-leading provider of banking IT, invested in Billon and used our blockchain technology for instant money transfers in its new Modern Banking Platform," Kaluza continues. "Leveraging the FIS system, we're also working on a cross-border payments system with Raiffeisen Bank International to enable instant bank-to-bank money transfers between Austria and other CEE countries."

On the home front, Billon's Polish e-money licence also secured some great deals. ERGO Hestia, a leading Polish insurance company, applied Billon's mass payout solution to deliver instant refunds of premium overpayments to clients, whilst another client, a food delivery company, used Billon's e-money capabilities for the instant digitisation of cash collection. This allowed couriers to deposit cash anywhere, receive funds instantly and have an immutable audit trail.

Kaluza does admit though that the pandemic has delayed some projects. "But I'm convinced that we'll come out victorious as providers of technology that is accelerating the digital transformation."

The importance of EU funding

Overall, the EU funding provided to Billon gave it crucial help in gaining visibility on international markets (whilst Europe and the United States remain the key priorities, they're also tentatively exploring the possibility of expanding their business presence to Singapore) and established brand awareness in a crowded blockchain/DLT arena.

"With EU funding we have been able to really move beyond the concept stage and develop strong partnerships with companies like FIS and Raiffeisen," concludes Kaluza. "This is something that very few blockchain companies have achieved and this wouldn't have been possible without our participation in the Horizon 2020 programme."

BILLON

- Coordinated by Billon in Poland
- Funded under Horizon 2020-LEIT-ICT and Horizon 2020-SME
- cordis.europa.eu/project/id/783861
- Project website: billongroup.com/technology



Robert Kaluza
e-money CEO of the
Billon Group
© Billon

"FIS, a world-leading provider of banking IT, invested in Billon and used our blockchain technology for instant money transfers in its new Modern Banking Platform."

Stellar objects beyond Neptune offer clues about our origin

The outer solar system is a treasure trove of celestial material, holding secrets about the evolution of our planetary system. LUCKY STAR used stellar occultation techniques to reveal more about ring dynamics, atmospheric physics and orbits.

A stellar occultation occurs when a solar system body – such as a planet, satellite, comet or asteroid – passes in front of a star, blocking its light. These occultations, lasting from seconds to an hour, reveal astronomical information to a degree of accuracy impossible using other means, such as space-borne telescopes.

Trans-Neptunian objects (TNOs) are bodies which orbit the Sun beyond Neptune. Occultations have been used to detect narrow rings around TNOs, and atmospheres about 1 billionth of Earth's atmospheric pressure.

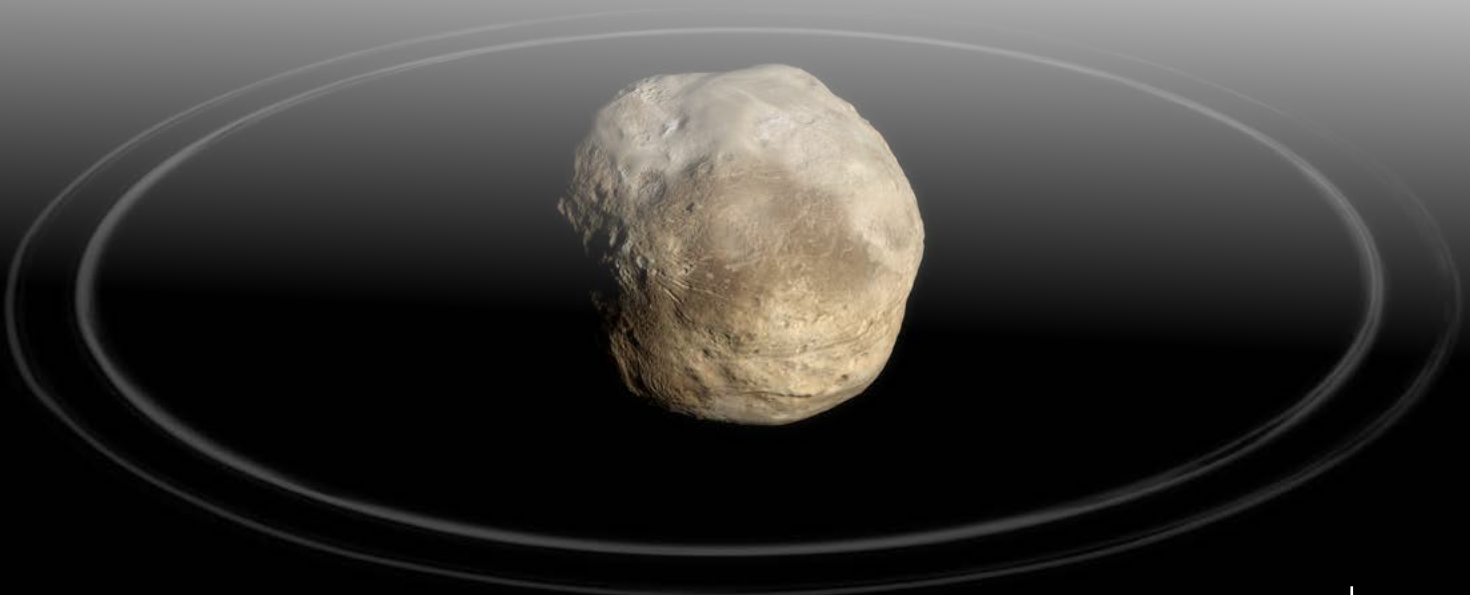
The EU-supported LUCKY STAR (Exploring the outer solar system beyond Neptune using stellar occultations) project has advanced knowledge about TNOs using this technique. "We called the project 'LUCKY STAR' because

we focused on the few stars among billions occulted by solar system objects, highlighting the rarity of the events observed," explains Bruno Sicardy, project coordinator from Sorbonne University, the project host.

CELESTIAL DISCOVERIES

LUCKY STAR analysed occultation data collected from a range of professional astronomical sources, as well as from over 150 amateur astronomers. This was augmented by data from the Gaia astrometric catalogue to boost the efficiency of the stellar occultation method.

"Measuring the position of objects in relation to nearby Gaia stars, weeks prior to the occultation, allowed us to



“We called the project ‘LUCKY STAR’ because we focused on the few stars among billions occulted by solar system objects.”

predict very accurately when and where the event will be observable,” says Sicardy.

The team discovered a dense ring around the dwarf planet Haumea. Combined with the surprising discovery of rings around the asteroid-like Chariklo by Sicardy’s team in 2013, this showed that rings are not exclusive to the four giant planets of Jupiter, Saturn, Uranus and Neptune, as was previously thought.

Additionally, the team mapped the trajectory of Pluto to within 50 km, the most accurate to date, and was also able to chart the seasonal evolution of Pluto by monitoring its atmosphere from 2002 to the present day.

They also discovered a spectacular threefold increase in Pluto’s atmospheric pressure between 1988 and 2016. “Pluto’s atmosphere is controlled by the sublimation of nitrogen ice at its surface, warmed by solar rays. Pluto’s orbit is very elliptic, resulting in large variations of solar warming over time,” adds Sicardy.

“Additionally, as its axis of rotation is highly inclined relative to that orbit, large surface areas can be in permanent night or permanent day. Both result in very intense seasonal cycles on Pluto.”

Kilometre-sized objects beyond Pluto were also detected. Their size, shape, reflecting properties and densities offer

clues about their formation and so could reveal how the early solar system evolved through the collisions between small primordial ‘planetesimals’.

BACK TO THE FUTURE

Sicardy’s stellar occultation observations and analysis have previously provided key inputs for space missions such as Voyager 1 and 2 to the giant planets, Cassini-Huygens to Saturn and Titan, and New Horizons to Pluto and Arrokoth.

The team is currently working on numerical simulations of collisional rings around small bodies, like dwarf planets. Preliminary results show that a resonance effect, where orbiting bodies exert gravitational influences on each other, might explain the locations of both Chariklo’s and Haumea’s rings.

“If confirmed, this effect may explain the formation of satellites, such as ring particles around bodies such as Chariklo and Haumea,” notes Sicardy.

Of particular interest is the use of stellar occultations to detect the slow orbital evolution of some asteroids, caused by the subtle push of solar radiations. “This will allow us to not only trace the history of those bodies, but possibly predict potentially hazardous Earth impacts,” says Sicardy.

LUCKY STAR

→ Hosted by Sorbonne University in France

→ Funded under Horizon 2020-ERC

→ cordis.europa.eu/project/id/669416

→ Project website: lesia.obspm.fr/lucky-star

SPACE

Ringling stars help us sound out distant planets

Researchers used NASA’s Transiting Exoplanet Survey Satellite to survey 100 000 red giant stars, discovering a planet that had survived against the theoretical odds.

Asteroseismology is an emerging field revolutionising astrophysics by focusing on the sound waves that move through stars to deepen our knowledge about the galaxy.

During the PULSATION (Detecting and characterizing exoplanets around evolved stars with NASA’s TESS mission) project, asteroseismologists from the Institute

of Astrophysics and Space Sciences at the University of Porto in Portugal used NASA's Transiting Exoplanet Survey Satellite (TESS) to survey about 100 000 stars, detecting a hot Saturn and a warm sub-Saturn, and discovering more about previously known planets including one that should theoretically never have survived.

"The information contained in the oscillations of stars allows fundamental stellar properties like the mass, radius and age of a star to be precisely determined," explains Tiago Campante, a researcher from the Institute whose work was supported by the Marie Skłodowska-Curie Actions programme.

His team is assembling an online catalogue of the planets and their host stars to help scientists answer some of the most important outstanding questions about how stars and their planetary systems evolve.

MISSION BONUS

TESS was primarily designed to find new planets around bright, nearby stars. Its photometer continuously collects starlight, observing a strip of the sky for 27 days before moving to another vista. That precision offered asteroseismologists like Campante an opportunity.

“Information contained in the oscillations of stars allows fundamental stellar properties like the mass, radius and age of a star to be precisely determined.”

Stars are traversed by sound waves excited by convective motions near their surface, making them ring ever so slightly. This causes tiny changes in their brightness. "With a photometer that is precise enough, one can measure these brightness fluctuations and decompose them into a star's natural modes of oscillation," adds Campante.

The researchers conducted an automated transit search on TESS light curves of about 100 000 red giant stars, with a focus on giant planets with orbital periods from their stars of less than 20 days. Their wide-field survey is the first to systematically combine asteroseismology with transit photometry to characterise exoplanets.

PLANETARY SURVIVOR

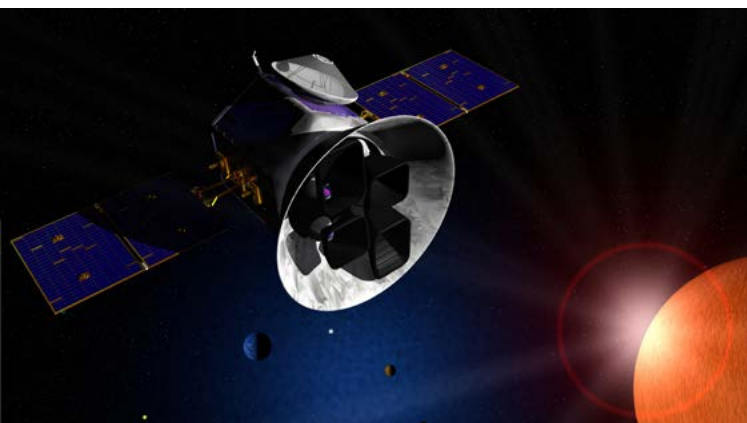
As well as discovering two Saturn-like planets, the survey also shed light on several that were known before the launch of TESS in 2018. The researchers looked at the orbital evolution of one in particular, HD 203949 b, after inferring its mass, size and age through asteroseismology.

They were surprised this planet had not been engulfed by the envelope of the star, which would have expanded beyond the current planetary orbit during the red giant phase of evolution. They put forward a hypothesis in 'The Astrophysical Journal' on how tidal interactions between the planet and sun may have led to its survival.

Campante shared his findings with a wider public, in particular during a secondment to Ciência Viva, an agency set up to promote science and technology. He used astronomy to increase interest in science among the old and young, commenting: "The public was usually very keen to know how one gets involved in a major space mission like TESS!"

PULSATION

- Coordinated by the Institute of Astrophysics and Space Sciences in Portugal
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/792848





FUNDAMENTAL RESEARCH

A transformative, light-harvesting cubic crystal

Methylammonium lead iodide holds promise for improved solar cells, lightwave computing, safer X-ray imaging, highly sensitive radiation detectors, and more.

Methylammonium lead iodide is a perovskite crystal that interacts strongly with light, offering potential applications in solar cells and light-emitting diodes (LEDs). The EU-funded PICOPROP (Photo Induced Collective Properties of Hybrid Halide Perovskites) project set out to investigate the material further.

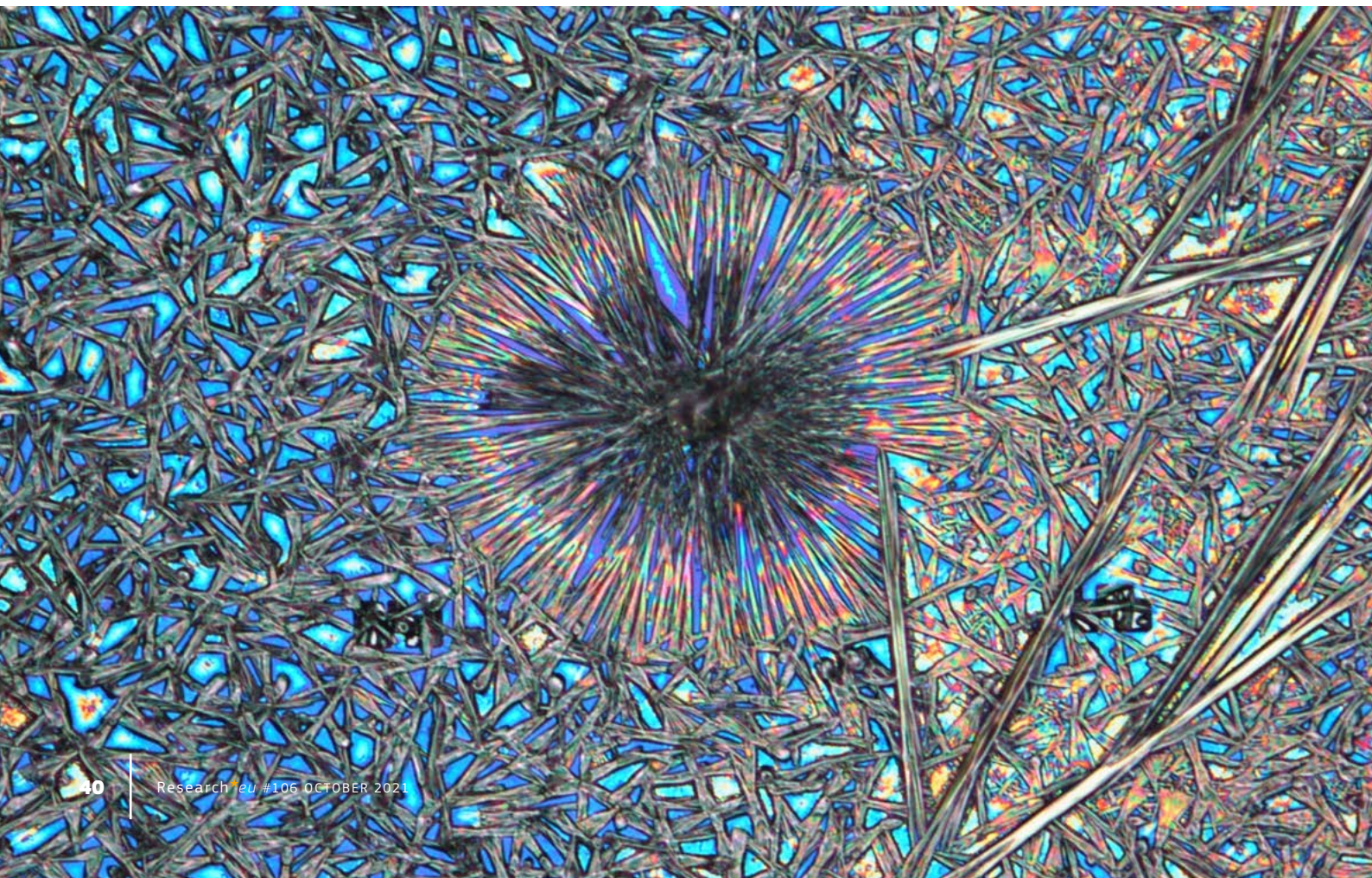
“It’s really very good for photovoltaics,” explains project coordinator László Forró. “When exposed to sunlight, the photoelectrons produced live for a long time.” This allows high concentrations of photoelectrons to be harvested from the crystal, leading to solar cells with efficiencies of up to 25%.

The tendency for photoelectrons to persist for a long time in the crystal led Forró to conjecture that the crystals could be given superconducting properties at relatively high

temperatures. “This is a holy grail for us, as it would mean we could transmit electricity with zero loss,” he remarks.

A second strand of research, carried out at the Swiss Federal Institute of Technology Lausanne, looked at whether pulses of light could allow researchers to tune the material’s magnetic properties. This would offer a cheap way to store data in optical computing, which uses photons instead of electrons to alter bits.

“Since we can produce lots of photoelectrons, we wondered if we could change the magnetic structure – and we could,” adds Forró. “This was splendidly demonstrated, and since then several big companies have been interested in our research.”



HIGH-SENSITIVITY DETECTORS

The ability to generate large amounts of electrons when exposed to light means that methylammonium lead iodide is also well-suited to other applications. By coaxing the material to grow in nanowires, and attaching these to sheets of graphene, Forró and his colleagues were able to build a light detector sensitive enough to detect even a single photon.

This sensitivity could make the composite material highly valuable in applications such as medical imaging. “Since we can so easily detect photons, just measuring the current of photoelectrons, we propose an X-ray scanner that uses a very low flux of X-rays,” explains Forró. “The radiation dose required for similar image quality is reduced by a factor of 10 000.”

Methylammonium lead iodide could also replace the expensive and relatively insensitive germanium crystals in gamma ray detectors. “For this you need a big crystal, as gamma photons are very energetic and can go through lots of material,” notes Forró.

“So we elaborated how to grow these crystals, as big as 3.8 kg. That’s like a newborn baby!” Two of the researchers from the PICOPROP project are now working on a commercial spin-out producing these crystals.

ENVIRONMENTAL SAFETY

The major challenge to commercialising methylammonium lead iodide is resolving its toxicity. “I am not a newcomer to this business,” says Forró. “I immediately appointed a

“*We elaborated how to grow these crystals, as big as 3.8 kg. That’s like a newborn baby!*”

biologist who was studying health hazard aspects of this material.”

Together, the team found a way to blend the perovskite with phosphate. In the event that a device breaks apart and is inundated with water, the phosphate reacts with the lead to immobilise it and prevent toxic run-off.

Ultimately, Forró was not able to produce stable superconductivity in methylammonium lead iodide but he remains undaunted.

“You have to dream to discover really new stuff,” he adds. Several branches of the project are now being investigated for commercialisation, including the X-ray detector, which was awarded an EU proof of concept grant.

Having reached retirement age in Switzerland, Forró is now moving to the United States to open a quantum materials lab. He concludes: “I still have a lot of ideas and energy.”

PICOPROP

- Hosted by the Swiss Federal Institute of Technology Lausanne in Switzerland
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/670918

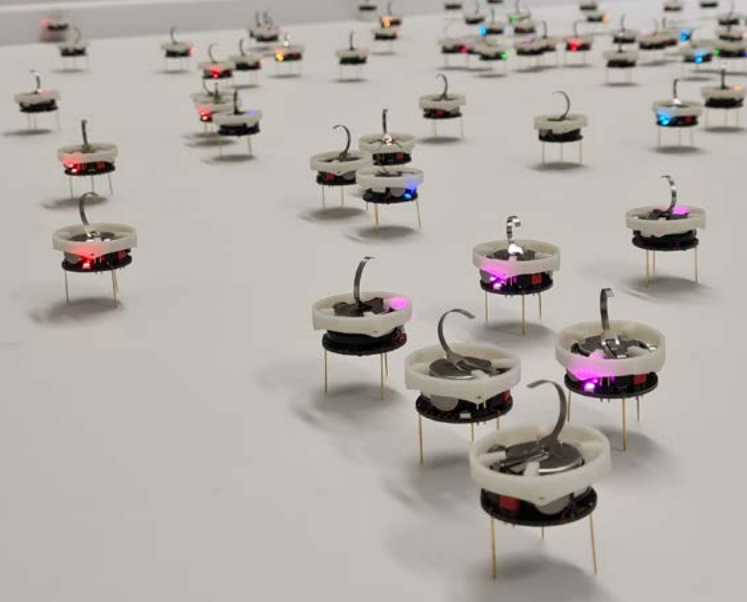
FUNDAMENTAL RESEARCH

How honeybees can help swarm robots – and us – make better decisions

New research finds that the underlying rules of decision-making are conserved across individuals, groups and superorganisms such as insect swarms.

In order to operate effectively, swarms of automated robots need to share information among themselves and

come to a decision on what to do. The EU-funded DiODE (Distributed Algorithms for Optimal Decision-Making)



project sought to uncover universal truths about the architecture of this deliberative process.

“Our goal was to find out how groups can make decisions in the best possible manner,” says project coordinator James Marshall, professor of Theoretical and Computational Biology at the University of Sheffield. His team drew from neuroscience, decision theory, mathematics, political science and psychology in their investigations.

“The motivation for this approach is that lots of swarm robots work with heuristics that are ad hoc, using little tricks,” he explains. “For swarm robots to become a respectable tech worth deploying, we need to reason more as to how the group will behave.”

QUORUM SENSING

A major result was identifying what voting threshold should be used for making a decision. “In political science it’s often assumed you should use a simple majority threshold, with the Condorcet Jury Theorem stating that the more group members you have, the better decisions you get,” adds Marshall. “We showed there’s more nuance to it.”

Borrowing from signal detection theory, Marshall and his team demonstrated that apparently binary decisions, such as a swarm of bees deciding if a location is a good nesting site or not, are more complex, as they carry the risk of both false negatives and false positives.

“When we consider this nuance, the optimal quorum levels needed in a group change, and can be supermajority or sub-majority depending on things such as the relative costs of the different kinds of error,” he notes.

“*We found a beautiful mathematical structure in this space, it was the most aesthetic mathematical moment in my career.*”

Marshall says that in nature, decisions are typically based on quorum sensing rather than a supermajority, triggering a decision when a certain threshold is reached. “We found a beautiful mathematical structure in this space, it was the most aesthetic mathematical moment in my career,” he adds.

Another distinction Marshall notes is that while human democracies tend to vote in a decisive act, in nature decisions are shaped more gradually, with new information constantly being fed in. “With a swarm, it’s not a single vote but an ongoing process, where the bees influence one another during the vote, and bees will inhibit competitor bees.”

WISDOM OF THE CROWD

Marshall’s team conducted further research which aimed to identify the optimal way of balancing the time it takes to reach a decision with the value arising from that decision, two critical factors for the efficient operation of drone robots.

The project was supported by the European Research Council. “This enabled me to establish a long-term team that collected expertise together,” says Marshall. “It was an opportunity to focus on these issues over a long enough time to make coherent progress.”

The group’s findings have now been made available in a web portal, so that other researchers can test ideas in model organisms. They will also feed into a spin-out company headed by Marshall, Opteran Technologies, which aims to encode animal-like brains in silicon for automated machines.

DIODE

- Hosted by the University of Sheffield in the United Kingdom
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/647704
- Project website: diode.group.shef.ac.uk



AGENDA

DECEMBER 2021

VIENNA, AUSTRIA & ONLINE

INSPIRE Flash Radiotherapy and Particle Therapy Conference

→ frpt-conference.org

1 → 3
DEC

2 → 3
DEC

DUBLIN, IRELAND & ONLINE

Citizen's Energy Forum

→ bit.ly/EU_CEF

INTERNATIONAL
World Soil Day

5
DEC

7 → 11
DEC

MADRID, SPAIN & ONLINE

9th IEEE Workshop on Advances in Network Localization and Navigation

→ bit.ly/EU_LOCUS

ONLINE

ENLIGHTENme: Shaping light for health and wellbeing in cities

→ enlightenme-project-conference.com

16 → 17
DEC

27
DEC

INTERNATIONAL

International Day of Epidemic Preparedness

10 DEC

ONLINE

EMBL Conference: SARS-CoV-2 – Two Years On

The COVID-19 pandemic has become the most devastating challenge to global health for a century. In an unprecedented mobilisation, thousands of scientists worldwide have focused their attention, in a highly collaborative way, on understanding the SARS-CoV-2 virus and the disease it causes.

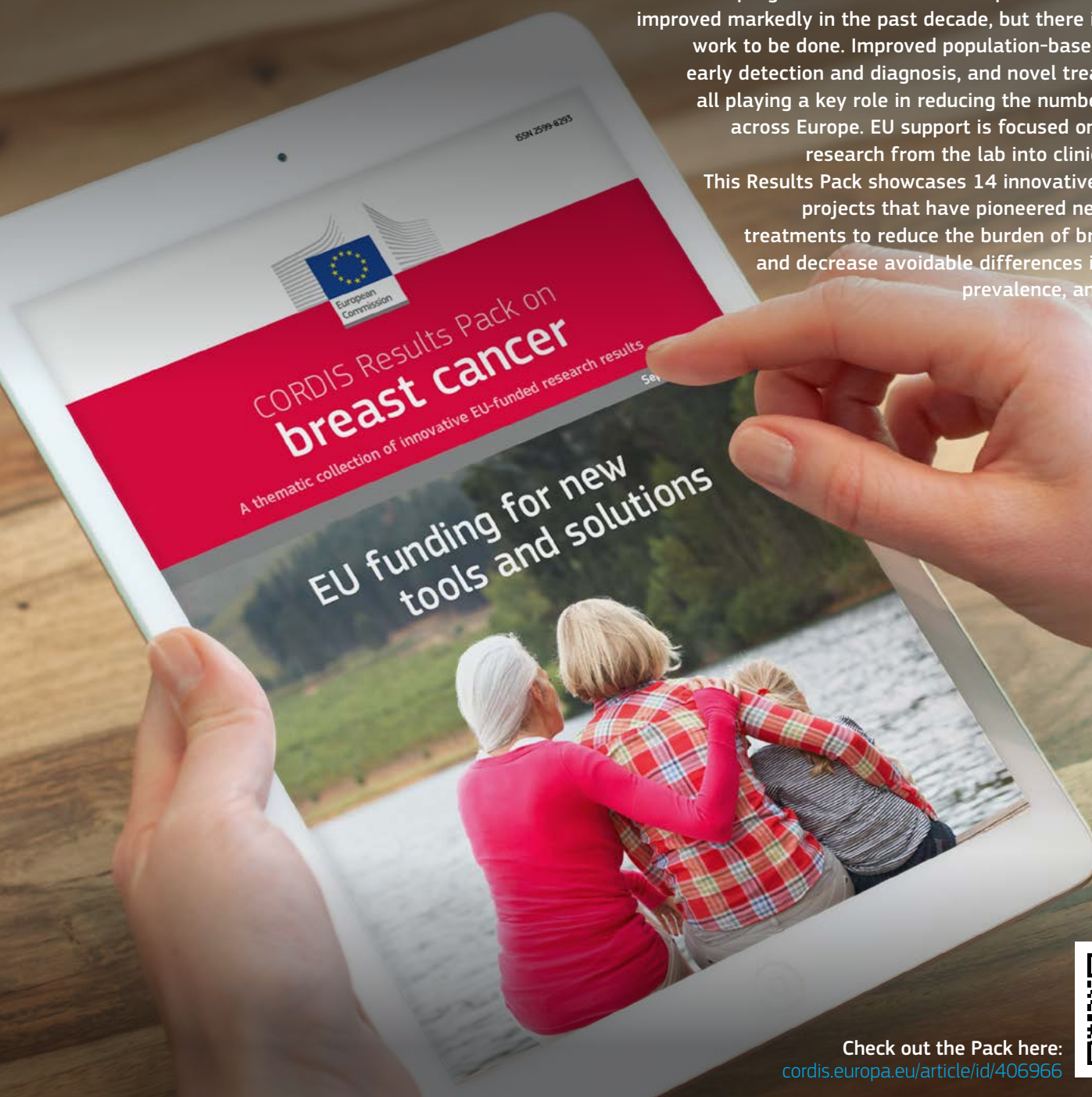
This online conference will bring experts from different fields together to present our current knowledge on SARS-CoV-2 molecular biology and epidemiology and strategies and approaches to anti-infectives and vaccines, with the ongoing challenge of protecting the global population against a moving target.

→ bit.ly/EMBL_TYO

Whilst at the time of writing all of these events were scheduled to take place, we advise all of our readers to regularly check the status of each event due to the continued uncertainty caused by the novel coronavirus epidemic in Europe – events may be cancelled, rescheduled or reformulated (e.g. switched to being a digital event only) at any time.

RESULTS PACK ON BREAST CANCER

The prognosis for breast cancer patients in Europe has improved markedly in the past decade, but there is still much work to be done. Improved population-based screening, early detection and diagnosis, and novel treatments are all playing a key role in reducing the number of deaths across Europe. EU support is focused on taking this research from the lab into clinical practice. This Results Pack showcases 14 innovative EU-funded projects that have pioneered new tools and treatments to reduce the burden of breast cancer and decrease avoidable differences in incidence, prevalence, and mortality.



Check out the Pack here:
cordis.europa.eu/article/id/406966



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