



#85

AUGUST/SEPTEMBER 2019

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**SPECIAL FEATURE**  
**VAST, COMPLICATED, (DIS)ORDERLY?**  
**UNLOCKING THE SECRETS**  
**OF THE COSMOS**

# Editorial

## Cartesian doubt: how EU science questions everything, from the origins of our Universe to capitalism

welcome to this month's Research\*eu magazine

In the 17th Century, René Descartes came up with the concept of 'Cartesian doubt': the constant questioning of existing beliefs. Cartesian doubt applies to any field of research or intellectual reasoning. It has undoubtedly contributed to the dizzying growth of knowledge, innovation and well-being over recent centuries.

A perfect example relates to the very origins of our Universe. Galileo Galilei, a contemporary of Descartes, was incarcerated for theorising that the Earth revolved around the Sun, and not the opposite. By sparking Cartesian doubt among his peers, he contributed to a vast domino effect that culminates with the likes of Georges Lemaître's Big Bang Theory and suspicions around the existence of dark matter.

Almost a hundred years later, research around the Universe's constant expansion, the formation of celestial objects and dark matter is still buzzing. Some researchers are trying to fill the gaps related to the Big Bang, the formation of galaxies and galaxy clusters, or cosmic inflation. Others do not hesitate to question widely-supported theories such as Einstein's general relativity to find out whether other, competing theories could explain the expansion of the Universe. This month's special feature is, in a way, an ode to Cartesian doubt and science's commitment not to leave any stones unturned.

But the truth is, there is no need to look at the stars to picture what Cartesian doubt is about. In our **Life After** feature, Dr Matilde Massó, coordinator of the FUSION project, tells us about her work since the project's end in 2018. The piece calls into question the move from a productivity-based capitalism to a system driven by financial markets. It exposes the shortcomings of this model and considers alternatives.

Our **Project of the Month** is not about Cartesian doubt per se. But by opening the doors to a joint EU/US development of the Next Generation Internet, it could very well become a case in point for how innovation doesn't necessarily arise from fierce competition.

As usual, the magazine closes with an EU Agenda summarising some of the best events featuring EU-funded projects that will take place in October.

Until next month, if you have queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at [editorial@cordis.europa.eu](mailto:editorial@cordis.europa.eu)

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**Editorial coordination**  
Birgit Alice BEN YEDDER

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# The role of our gut biome in our health and well-being keeps unfolding

*The evidence is piling up: the gut microbiome influences the development and function of the immune, endocrine and nervous systems, which regulate energy balance and behaviour. The MyNewGut project looked into the role of the biome and the disease risk-reduction potential of dietary intervention.*

The MyNewGut (Microbiome Influence on Energy balance and Brain Development-Function Put into Action to Tackle Diet-related Diseases and Behavior) project received support from the EU to shed light on the contribution of the human microbiome to nutrient metabolism and energy balance. Project coordinator Prof. Yolanda Sanz, head of the Microbial Ecology, Nutrition & Health Research Unit based at the National Research Council (IATA-CSIC) in Valencia, explains: "We also wanted to identify microbiome-related features that contribute to, or predict, obesity and associated disorders. We looked at how the microbiome is influenced by environmental factors and its role in brain and immune development and function in humans."

One case study conducted by the consortium involved the transference of gut microbiota from healthy donors to subjects with metabolic syndrome via faecal microbiota transplants (FMT). They demonstrated that a 'healthy microbiota' increases the striatal dopamine receptor expression in the brain (SPECTscans), which is a system involved in improved appetite control. This led to reductions in food intake in a human intervention trial.

"The findings demonstrate one of the causal mechanisms whereby the gut microbiota positively impacts energy balance and so improves metabolic health," explains Prof. Sanz. "These findings could enable researchers to specifically target the gut-brain axis. This could be done either by diets that enrich our gut microbiota with these bacteria, or by providing the identified bacteria or metabolites as novel therapeutics. This could beneficially change food intake and behaviour in humans in the future."

High-protein diets (HPD) are all the rage at the moment. The project considered their impact through a randomised double-blind, placebo-controlled, parallel-design intervention trial. This investigated the effects of both the amount and types of proteins (casein or soy protein) on healthy, overweight volunteers.

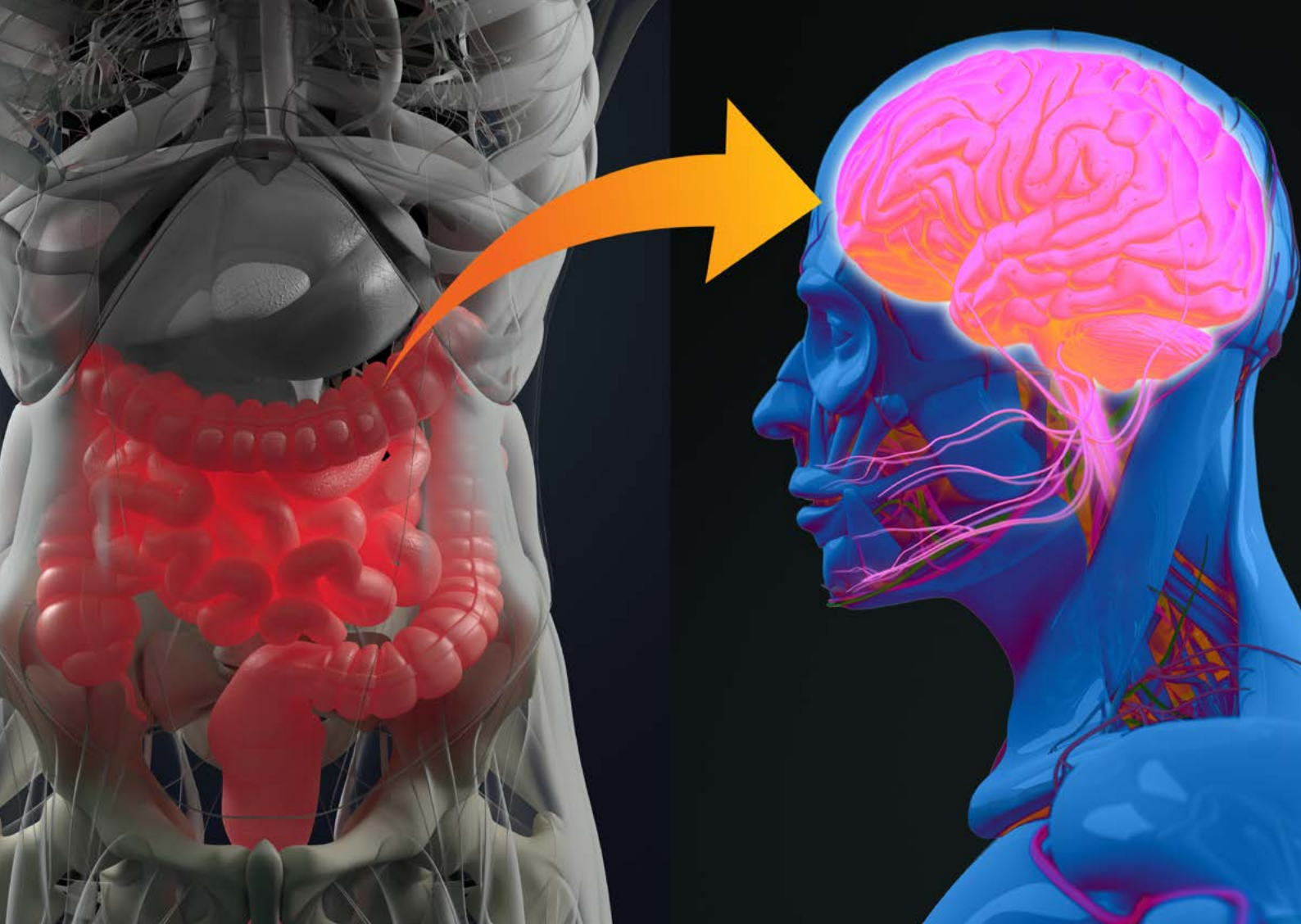
"Although HPD are often effective for losing body weight, the increased protein intake also increases the proportion of protein products that reach the large intestine and are metabolised by the colonic microbiota. This generates toxic compounds, which also depend on the protein type, and should be considered in dietary recommendations."

Their findings are extensive, and highly relevant to our modern lifestyles. Through a longitudinal study conducted in children, the consortium also considered the impact of an unhealthy diet, including a high intake of simple sugar and fat. This is associated with a low-diverse microbiota and heightened inflammation in normal weight children who later develop obesity, compared to children who remained normal weight.

"This finding suggests that the gut microbiome is part of the individual's features that contribute to predicting normal or excessive body-weight gain and obesity onset. This information could help in early detection of obesity risk and the implementation of early dietary preventive measures."

MyNewGut consortium members demonstrated that young adults born by C-section have higher stress responses than those who were delivered vaginally. "This is of importance





“ *These findings could enable researchers to specifically target the gut-brain axis. This could be done either by diets that enrich our gut microbiota with these bacteria, or by providing the identified bacteria or metabolites as novel therapeutics.* ”

given the relationship between stress and mental and metabolic illness and the C-section rates, which are increasing globally.” C-section rates in the EU exceed 30 % while levels of around 12 % are recommended by the World Health Organization. They showed a clear negative impact on the neurodevelopment of young children combined with antibiotic use in the first few days of life.

The project’s identification of new bacterial strains could give rise to a new generation of probiotics, able to tackle obesity and its metabolic complications more effectively. “The biobank of human indigenous gut bacteria generated

by the CSIC harbours valuable biological material, which can be exploited further for future applications in nutrition and clinical practice.”

#### MYNEWGUT

- Coordinated by the Nutrition & Health Research Unit of the National Research Council (IATA-CSIC) in Spain.
- Funded under FP7-KBBE.
- [cordis.europa.eu/project/id/613979](http://cordis.europa.eu/project/id/613979)
- Project website: [mynewgut.eu](http://mynewgut.eu)
- [bit.ly/2MFUrbN](https://bit.ly/2MFUrbN)

# Developing a thermostable needle-free vaccine

*Most vaccines are highly vulnerable to damage. If not stored at the recommended temperature, they can become ineffective. MACIVIVA has developed a thermostable vaccine in powder form which supports high temperature variations, and is administered by capsules or nasal spray.*

Virosomes are small particles used as vaccine delivery systems, usually in liquid form, as with the majority of market approved vaccines. They can easily become ineffective by accidental freezing and can only withstand temperatures up to 15-25 °C for a few hours a day, otherwise the vaccinal antigens can degrade.

Freeze dried (or lyophilised) virosomes stored frozen in glass vials were developed more than 10 years ago for the virosome-based malaria vaccine, (administered by injection), but while they can withstand higher temperatures, it is still only for short periods.

To improve temperature stability, the EU's MACIVIVA (MANufacturing process for Cold-chain Independent Viro-some-based VAccines) project has transformed a liquid HIV vaccine candidate into solid powder form which can withstand freezing conditions and longer periods at high temperatures (up to 40 °C). The project removed water from the virosome by heat spray drying or freeze

drying, without altering the virosome structure, particle size or antigenicity of the vaccinal peptides and proteins.

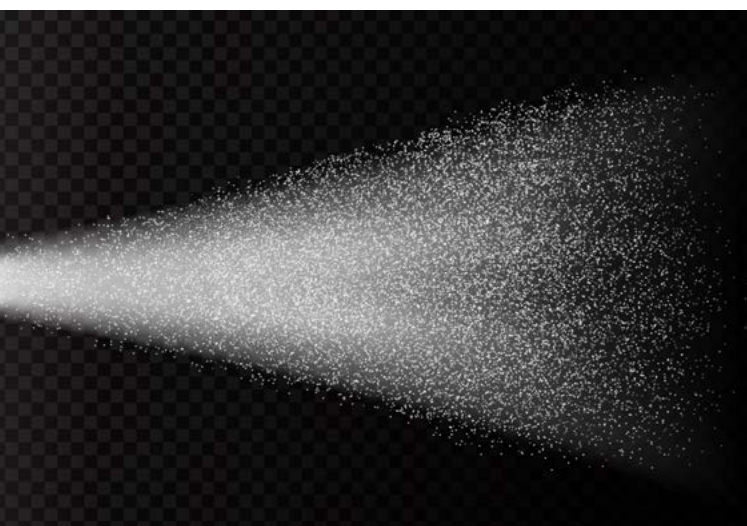
## OVERCOMING COLD CHAIN DEPENDENCY

Vaccines rely on efficient cold supply chains to retain their bioactivity during storage and transport at 4-8 °C or frozen below -15 °C, and don't support much high temperature variation. This makes them vulnerable to problems during transport, handling and storage, if the cold chain is interrupted. Consequently, millions of vaccines are discarded each year.

MACIVIVA's solution was to remove water using their adapted manufacturing process which protects the resultant powder-form vaccine for several months, even when exposed to freezing conditions or high temperatures (up to 40 °C). "The development of safe, bioactive, thermostable HIV and malaria vaccines are particularly suitable for warm and developing countries," says Dr Sylvain Fleury, Chief Scientific Officer of Mymetics, and Coordinator of the project.

As MACIVIVA's approach avoids the need for a reconstitution step, the vaccines are ready for direct administration using a nasal spray or as a tablet. Another key innovation was that the antigen and adjuvant (immune response enhancer) are on the same particle, producing an 'all in one vaccine'.

"Our needle-free vaccine can be self-administered under professional health care supervision," says Dr Fleury. "It eliminates the risk of needle injury and needle sharing, as can happen in poorer countries. Not to mention offering an alternative for those with a fear of needles."



To date, the solid powder vaccines have been tested in animals. The results confirmed that MACIVIVA's vaccines maintained the initial immune response properties of the liquid form, with specific antibodies induced against the antigens.

## TOWARDS CLINICAL DEVELOPMENT

Currently, the technology is available to companies interested in manufacturing products by spray drying or lyophilisation. The first generation liquid form HIV vaccine has been shown to be safe and well tolerated in human trials.

However, the adjuvanted HIV candidate powder form vaccine, to be administered by capsules or nasal spray, will first require a toxicology study, before human clinical trials (Phase I/II trial, then a Phase III trial with at least 10 000 volunteers).

The team is presently seeking funding to start the clinical trials, first in adults and then with the vaccination of

children and teenagers to prevent HIV-1 infection, the priority target population. "Aside from the potential to protect people from illness, MACIVIVA's vaccine manufacturing processes and know-how help maintain European competitiveness in the sector, encouraging further investment and creating job opportunities," says Dr Fleury.

## MACIVIVA

- Coordinated by Mymetics in the Netherlands.
- Funded under H2020-LEIT-NANO.
- [cordis.europa.eu/project/id/646122](https://cordis.europa.eu/project/id/646122)

“The development of safe, bioactive, thermostable HIV and malaria vaccines are particularly suitable for warm and developing countries.”

## HEALTH

# Quick, robust testing method for diabetic comorbidities brings analysis out of the lab

*General practitioners need easy and rapid access to laboratory diagnostics in order to effectively manage the diabetes epidemic in primary care. One EU-supported project is providing healthcare professionals with the tools they need.*

The incidence of diabetes in Europe in 2017 is estimated at 8.8 % of the adult population (58 million), and set to rise to 10.2 % (66.7 million) by 2045. Comorbidity (the co-existence of one or more additional conditions in people with a specified medical condition) is highly prevalent in diabetic patients. These include hyperlipidaemia, hypertension, renal impairment and ischaemic heart disease, giving rise to longer-term micro- and macro-vascular complications. According to the WHO, of the top 10 causes of death, diabetic comorbidities are at the top of this list (ischaemic heart disease), second place is stroke

and diabetes alone is at seventh place – with incidence rates running at 9.4, 5.8 and 1.6 million, respectively.

"Hospital inpatient expenses are the largest cost category at 30 %, 35 %, 49 % and 65 % of overall costs in the UK, Germany, Ireland and USA, respectively," explains Jerry O'Brien, Chief Executive of Radisens Diagnostics, the company behind the MEDMICO (Moving to Efficient Diabetes care: Multimode Integrated CO-morbidity diagnostics platform) project.

The cost of managing the co-morbidities far outweighs managing diabetes alone, as the former demand monitoring and care from a range of different clinical pathways. “Studies show that clinicians are more likely to change a patient’s clinical management if their diabetes monitoring is done at the point-of-care (POC) in the clinic, compared with laboratory testing. So, monitoring of diabetic comorbidities can improve patient outcomes at a lower cost to the healthcare system.”

POC devices for testing a subset of diabetic comorbidities are on the market, requiring many drops of blood (and painful fingers!), refrigerated storage and complicated use.

Which is where MEDMICO steps in. The project developed a platform, Gemini, that comprises a POC ‘desktop’ reader prototype and a series of test cartridges. “A drop of blood is applied to the test cartridge and put into the reader which runs the tests in a matter of minutes. We have test cartridges to monitor for diabetes, cardiovascular disease and kidney disease in development, with other tests relating to inflammation and iron deficient anaemia in the pipeline,” says O’Brien.

Each test cartridge contains biological reagents, such as enzymes, antibodies and other biochemical components that typically require refrigerated storage to maintain their function. Radisens is developing technology to protect these reagents from the environment, thereby allowing cartridges to be stored at room temperature while maintaining performance.

**8.8%** of adults  
are estimated to have  
**diabetes**



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As a result, the patient will not need to wait the 30 minutes, or more, required by competing technologies to reach room temperature from cold storage before the test is performed. This is especially important for monitoring these comorbid diseases in the physician’s office, pharmacy and retail clinics, and other decentralised clinics.

“The fact that the tests will not need cold storage and are quick and simple to use also has the potential to be very useful in developing countries.”

Along with developing the testing systems, the company has also spent part of the project’s time running method comparison studies internally, using clinical samples. These demonstrate that the Gemini platform is on course to meet the target of laboratory-grade performance and long-term stability.

“We are most proud of the talented, multi-disciplinary and innovative teams who have developed the myriad patented technologies all in-house. These include some of the toughest blood tests, in terms of assay performance requirements, smart microfluidic cartridges, reliable and easy-to-use device prototypes and in-house,” says O’Brien.

#### MEDMICO

- Coordinated by Radisens Diagnostics Limited in Ireland.
- Funded under H2020-HEALTH.
- [cordis.europa.eu/project/id/666676](https://cordis.europa.eu/project/id/666676)
- Project website: [radisens.com](https://radisens.com)



# Inclusive visions for a new EU partnership with the Mediterranean

*Within Europe, perception of the EU is often positive. However, as this differs in the South, one project adopted a 'decentred' research approach to find out why, what the implications are, and what can be changed.*

When the EU conceives of Mediterranean stakeholders, policy instruments and policy issues, its standpoint often marginalises local perspectives and needs, while not sufficiently considering the role of other global actors. This can result in fragmented and incoherent policies, constructing the region as both threat and opportunity, as a series of borders rather than a shared space.

The MedReset (A comprehensive, integrated, and bottom-up approach to reset our understanding of the Mediterranean space, remap the region, and reconstruct inclusive, responsive, and flexible EU policies in it) project envisaged a more reflexive EU, devising more inclusive, flexible, and responsive policies. After analysing EU discourse, MedReset applied a novel methodology to create a conceptual map of the Mediterranean as it exists in the lived experiences of its stakeholders (from civil society, diplomacy and the state, amongst others), leading to policy recommendations.

## DECENTRED METHODOLOGY

When it comes to 'framing' the Mediterranean region and its issues, MedReset departed from the typical Eurocentrist approach by adopting a bottom-up methodology.

The research explored four crucial policy areas: 'political ideas', 'agriculture and water', 'industry and energy' and 'migration and mobility', against a three-dimensional framework of stakeholders, policy instruments and policy issues.

There were two rounds of consultations, with EU decision makers and stakeholders in Lebanon, Morocco, Egypt and Tunisia. The first round followed a loose interview guide, with the results forming the basis for developing hypotheses, tested in the second structured round of interviews.

In tandem, the team conducted a survey (in-depth interviews and focus groups) with ‘elites’ (policymakers, experts, journalists, academics, doctors, etc.) in Egypt, Israel, Iran, Turkey, Saudi Arabia, Qatar, Tunisia, Lebanon and Morocco. In this way, the perceptions and priorities of Southern shore partners were at the heart of the research, rather than being only marginally included. In all, the team interviewed around 700 people.

“Our new decentring methodology invited EU stakeholders (policymakers and civil society) to position themselves in relation to structured inputs from Mediterranean stakeholders,” says Dr Daniela Huber. “This approach gave Southern stakeholders a voice, generating new insights about how the EU could become more inclusive (of various stakeholders), flexible (in terms of policy instruments) and responsive (in terms of policy issues and peoples’ needs).”

MedReset found that the EU is often viewed as being invisible, with policies frequently unknown or overshadowed by those of Member States, resulting in seemingly incoherent and sometimes contradictory policies – especially regarding democracy, human rights and social equality. There was additionally perceived to be a substantial gap between Southern policy expectations and actual EU outputs.

While EU aid is viewed more positively than that of other actors, existing civil society assistance is not considered sufficient if not accompanied by political pressure. Additionally, EU rhetoric predicated on the notion of universal

rights as a European phenomenon was rejected, as it denies local actors their own agency.

## TWO SIDES OF THE SAME COIN

Could it be that increased EU awareness about its role in various Mediterranean policy areas might also inspire reflection about policies within the EU itself? “Several of our European interviewees pointed out the importance of reflexivity on social justice issues within the EU. This is of utmost importance in times of rising nationalist populism,” Dr Huber says.

The team will publish four major policy reports, with the policy recommendations and infographics already available. The results of the ‘elite’ survey are being published in an open access book, and the consortium of 12 research institutions is also working together on another book highlighting the added value of this research.

## MEDRESET

- Coordinated by the Institute of International Affairs in Italy.
- Funded under H2020-SOCIETY.
- [cordis.europa.eu/project/id/693055](https://cordis.europa.eu/project/id/693055)
- Project website: [medreset.eu](https://medreset.eu)
- <http://bit.ly/2FBt3oe>

## NOW ON CORDIS: INCREASINGLY SMART, INCREASINGLY SUSTAINABLE: EUROPE'S CITIES GET AN UPGRADE

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**31 OCTOBER 2019** is **World Cities Day** and so we invite you to explore our issue of **Research\*eu** magazine highlighting seven EU-funded projects that are turning the notion of a ‘digital city’ from concept to reality, with a particular focus on smarter and more efficient mobility, waste management, air quality and citizen engagement.

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[cordis.europa.eu/article/id/401807](https://cordis.europa.eu/article/id/401807)



# Should beliefs or history decide if a building is a church or a museum?

*While there is general consensus on the historical value and importance of religious spaces and objects, disagreements and conflicts often arise in relation to their use and treatment. Research funded by the Marie Skłodowska-Curie programme highlights the different religious and heritage approaches to the issue.*

“My main motivation in this research was to investigate what happens when religious spaces and objects are brought into the apparently non-religious domain of heritage through practices of restoration and conservation,” outlines Dr Alanna Cant, research fellow on the MEXRES (Restoration and Faith: practicing religion and conservation in Mexico’s historic churches) project. To do so, she conducted ethnographic research in Santa Cruz Mixtepec. Located in the southern Mexican state of Oaxaca, the village is home to a majority Catholic population and a ruined 16th century Dominican monastery.

The monastery is presently the focus of a heritage conservation project jointly managed and financed by the Mixtepec municipal authority, the Mexican federal government and a private cultural foundation. “I selected a site where local authorities were working together with heritage experts,” Dr Cant explains. “I wanted to see not only how conflict develops in such scenarios, but also the points at which these different perspectives agree and reinforce one another.”

## COMPETING VIEWS

MEXRES research shows that stakeholders from the domains of religion and heritage hold very different perspectives regarding the nature of religious objects and spaces, their value and how they should be treated. “This results in competing views about not only where resources should be spent, but also what the building should ultimately be used for,” the fellow elaborates.

Project research resulted in three main sets of observations. The first, Dr Cant notes, is that “studying the ways

that religious and heritage actors engage one another during conservation projects not only tells us about religious heritage, it also helps us to understand the relationship of religion and non-religion/secularism in contemporary societies.”

Second, rather than straightforward politics of culture or property ownership, religious heritage projects produce a relational social and material field in which the sacred and historic values of buildings and objects are negotiated. Finally, she reports, “the nature of these fields is characterised by particular kinds of emotions, aesthetics and ‘historicities’ – different understandings of the past and its importance to the present and the future.”



© MEXRES

## CONTRIBUTIONS TO CULTURE, IDENTITY AND HISTORY

The project's work could inform more nuanced heritage practices and policies in different national contexts. As Dr Cant states: "It shows that although local communities or churches may broadly be in support of heritage projects, their understandings of the heritage site, and how it should be used, may still be at odds with typical heritage perspectives." MEXRES findings also bring to the fore how legal designations and regimes of ownership can impact ways in which a religious community can continue to use a certain space for religious purposes.

Dr Cant has actively shared information about MEXRES and its outcomes through journal articles, conferences and seminars, a workshop and a public lecture. She also continues to make all bibliographic and historical information regarding the community of Santa Cruz Mixtepec available to community members, depositing copies in the municipal and church archives. The fellow plans to build on this project for greater understanding of how

“My main motivation in this research was to investigate what happens when religious spaces and objects are brought into the apparently non-religious domain of heritage through practices of restoration and conservation.”

Catholicism and the Catholic church as an institution contribute to understandings of culture, identity and history in Mexico.

### MEXRES

- Coordinated by the University of Kent in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/701601](https://cordis.europa.eu/project/id/701601)
- Project website: [alannacant.com/restoration-and-faith](https://alannacant.com/restoration-and-faith)

## SOCIETY

# Citizens' experiences and cultural heritage of communist dictatorships

*Almost one third of the global population has lived or lives in a country that was or is communist. EU-funded research explored citizens' experiences of communist dictatorships and their engagement with the associated heritage.*

"The main goal of the CHODIA project was to better comprehend the processes of heritagisation of the recent past and the inheritance of the experience of communist dictatorships today," says project fellow Dr Francesco Iacono. Heritagisation is the process through which objects, places and practices become cultural heritage. This process lends itself to the re-appropriation of and shift in engagement with recent cultural heritage.

Undertaken with the support of the Marie Skłodowska-Curie programme, project research focused on Albania – the locus of an extremely harsh Stalinist regime in the years 1945-1991. As Dr Iacono notes, the material and immaterial legacy of the regime has been treated with ambivalence and even been somewhat neglected. "The idea was to understand from direct questions and observations what Albanians thought of this heritage and the complex relationships this was made of," he further elaborates.



## MIXED METHODS RESEARCH

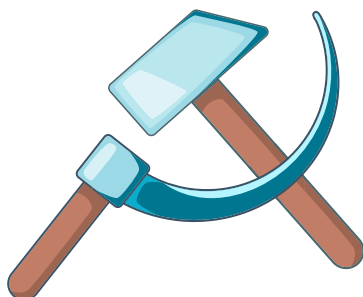
Dr Iacono employed both qualitative/ethnographic and quantitative methods. He interviewed people from the most diverse social backgrounds as well as heritage specialists, “obtaining perspectives that provide a well-rounded picture of how this topic is perceived in the country.” For quantitative data collection, new techniques employing mobile phones and a cloud-synched audio database allowed him to record answers in their natural language. These were then transcribed and analysed.

The results of CHODIA (Cultural Heritage of Dictatorship in Albania) research showed the diverse perspectives of all components of Albanian society in relation to this heritage, highlighting also the possible factors contributing to such diversity. Project work further uncovered the different forms of engagement that Albanians had with such heritage.

## DOUBLE NARRATIVES

A unique aspect of CHODIA lies in the fellow’s “problematisation of the concept of ‘unwanted heritage’ and the acknowledgement of the double nature of the memory and heritage of communist dictatorships.” That is, states and main institutional actors offer a different perspective compared to citizens’ private memories emerging after and as a result of the fall of communist regimes. This double memory has produced contrasting, and sometimes clashing, narratives. As Dr Iacono explains, these can be and have been mobilised in the political arena of many post-socialist countries.

**Almost 1/3 of the global population has lived or lives in a country that was or is communist**



## BEYOND THE ALBANIAN CONTEXT

The results of CHODIA are directly relevant to Albania alone. Yet, the particular case is broadly comparable to other countries that have experienced a communist dictatorship. It follows then that this research makes it possible to identify important analogies and by extension has considerable significance, particularly for Europe. “Project findings can help shape more inclusive and balanced representation strategies of the past under communist regimes, able to incorporate different perspectives and thus contribute to the way future citizens of the EU look at their past.”

Dissemination activities include traditional scientific publications and outreach activities in the United Kingdom as well as Albania. Dr Iacono has presented project work through social networks and the project’s blog.

In its final year, CHODIA organised a workshop and the international conference ‘Heritage and Dictatorship’. The latter hosted more than 70 participants from all over the world, and offered a far-reaching overview of the relationship between heritage and authoritarianism and, by extension, more broadly, authority.

## CHODIA

- Coordinated by the University of Cambridge in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/701285](https://cordis.europa.eu/project/id/701285)
- Project website: [chodia.wordpress.com](https://chodia.wordpress.com)



LIFE AFTER...

# Catching up with FUSION: If 'money is the root of all evil', what's the alternative?

*Economic growth is ever-increasingly driven by financial markets as we move away from a productivity-based model of capitalism. Where once finance was a tool used to provide capital for producers, it has become a means to an end for speculators cashing in on private and public debt along with fluctuations in currency valuations. This basis for national economic growth is unstable and the resulting profits, unequitable.*

One year on from featuring in REU75, we get back in touch with Dr Matilde Massó, Associate Professor at Coruña University (Spain), to see how her research under FUSION (The effects of financial capital accumulation on employment and wealth distribution), undertaken with the support of the Marie Skłodowska-Curie programme, has evolved and what new insights she has gained since last we spoke with her.



“For the moment, I’m working on the initial ideas for a theoretical prototype of a new monetary concept that will be collected in a book and a journal article that are in the process of publication.”

**Dr Matilde Massó**

Project coordinator of FUSION  
© Matilde Massó

In Dr Massó’s opinion, economic instability is an inherent feature of capitalism, leading to noticeable fluctuations of economic outcomes. “High levels of public indebtedness in Europe, and the commercial crisis of USA with China and Mexico, are important factors that will affect the growth of the global economy. It is worth remembering that most financial crises follow self-fulfilling mechanisms. The fear of the next crisis, combined with an unsustainable situation, is enough to bring on a downturn.”

The idea that the current model is the only way to proceed is one that her research challenges, and it is in that awareness-raising of alternatives that she feels the project lives on. “I’m working hard to disseminate the main results of the project through journal articles and a book that has been approved for publication by Routledge in 2020-2021. In addition, I’m the guest editor of a special issue on the social consequences of



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financialisation that will be published in 2020.”

FUSION explored new monetary forms to overcome the challenges associated with the social consequences of under-employment. It considered a system of valorisation based on a ground-breaking unit of account that allowed for a more balanced relationship between individual preferences, general interest and the common good.

“For the moment, I’m working on the initial ideas for a theoretical prototype of a new monetary concept that will

be collected in a book and a journal article that are in the process of publication,” says Dr Massó. Although the project has ended, Dr Massó is set to challenge the current perspective that there is no alternative way to measure value.

## FUSION

- Coordinated by the University of Leeds in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/746622](https://cordis.europa.eu/project/id/746622)
- Project website: [fusion.leeds.ac.uk/](https://fusion.leeds.ac.uk/)



# New software improves energy efficiency in EU hospitals

*Medical centres are woefully inefficient. This new software predicts the best ways to change that.*

Improving energy efficiency across the EU would be an effective way to lower greenhouse gas emissions, significantly helping towards reaching the reduction targets set by the European Commission. This means creating effective analytical and decision-assisting tools to see where the problems lie.

Medical centres typically use large amounts of energy, and inefficiently. They must adhere to strict regulations – such as air quality – which take energy to meet. Hospitals often require the near-constant use of specialised technical machinery, too; each piece of equipment coming with a different electrical profile.

“Energy consumption and pollution emissions can’t be significantly reduced at a European level without dramatically improving energy efficiency in hospitals,” says Daniele Liberanome, Head of International and Special Projects at Zephyro in Milan, and STEER (Support Tool for Energy Efficiency pROgrammes in medical centres) researcher.

So the Horizon 2020-funded STEER project developed a method with which medical centres across the EU – as well as governments, utilities providers, auditors and internal management – could assess and monitor the energy usage across each facility. Energy consumption can therefore be measured, showing where easy-won efficiency gains could come from. This facilitates the creation of medium-to-long-term plans to reduce energy use. The prediction software is based on mathematical models, which identify and rank variables in medical centres that use considerable amounts of energy.

This research, which was undertaken with the support of the Marie Skłodowska-Curie programme, was divided into five phases. First, data were collected directly from hospitals. Then Liberanome highlighted energy-related issues in hospitals and devised a model to describe them. This involved simulating environments within hospitals, and directly correlating with the previously harvested data. The models were tested and tweaked accordingly, and a sensitivity analysis was carried out. Finally, the team funnelled all of the knowledge it had acquired into creating a piece of predictive and analytical software.

“We developed an open source web-based application: a software prototype that presents a scenario-based assessment and prediction tool,” says Liberanome.



He hopes that in using the STEER model, hospitals – and eventually other energy-consuming institutions – will be able to create energy efficiency plans, compare efficiency levels between similar hospitals, plan energy-based investments, and adopt new, energy-efficient technologies. Hospitals should also be able to import ‘best practices’ from other similar buildings, homogenising and improving systems across the EU.

## HEALING INEFFICIENCY

STEER found numerous variables that contributed to poor energy consumption practice in the hospitals they tested the programme in. These include heating and cooling systems, lighting, overall energy system efficiency, and long working hours. There were a couple of hurdles to jump in the process, particularly as some hospitals lacked the necessary data the team needed to do their analysis.

Using machine learning, however, the research was able to define the relative contribution of each variable to overall energy consumption. One important finding was showing how crucial it is to invest in building insulation, even if this requires higher investment and a longer return-on-investment (ROI).

There are clear short- and long-term benefits. In the short term, hospitals benefit from a more stable energy consumption profile and less overall consumption. As investments are carried out and new machinery becomes fully

“Energy consumption and pollution emissions can’t be significantly reduced at a European level without dramatically improving energy efficiency in hospitals.”

operational, results continue into the long term, compounded by awareness campaigns and the improved training of staff to use the new tools.

Liberanome is proud of the work done: “The results are interesting, we overcame the difficulties that we had to face, we reached the targets and, most importantly, we created a strong and cohesive team.”

The project group intends to continue developing the prototype with the support of some other consortium members, while pushing new projects and ideas. “We are looking to create a wider and stronger collaboration,” Liberanome adds.

## STEER

- Coordinated by Zephyro in Italy.
- Funded under H2020-MSCA-RISE.
- [cordis.europa.eu/project/id/645694](https://cordis.europa.eu/project/id/645694)
- Project website: [steer.ctadventure.com](https://steer.ctadventure.com)

## ENERGY

# Better protection for wind turbine blades from lightning strikes

*With lightning strikes costing wind turbine operators up to EUR 1.5 million in repairs and lost revenue, a replacement, ready-to-install, lightning protection system which can pay for itself in 2-3 years is already sparking much interest.*

The remote locations of many wind turbines (WTs) make maintenance and repair expensive and logistically

challenging, especially for offshore. A significant cause of damage is lightning strikes, a problem compounded by





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increasing WT size. A single instance of lightning bolt damage to a blade will take the entire turbine out of operation.

The EU's SME support enabled the LIBI (Lightning Interception Blade Implant) project to further develop, test, certify and bring to market a lightning protection system (LPS) – the LIBI – suitable for manufacturers, sub-suppliers and plant operators. The result has been over 30 adaptations of the generic LPS concept to meet the specifications of customers.

## HIGH-PERFORMING AND READY TO INSTALL

As lightning damage, alongside leading edge erosion, is the dominant risk in WT blade operations, all WT blade manufacturers are required to install an LPS. Traditionally, manufacturers have used in-house solutions, which are labour-intensive and expensive, given that LPS development cycles can be several months. Additionally, LPS are complex when factoring in materials, processes, manufacturing, weight, time and cost requirements.

“Based on our customer experience, and after testing many designs in our lab, we found that traditional LPS were too complex, depended on the skills of installation technicians and with each new blade design required a new LPS,” says project coordinator, Dr Søren Madsen. “So we decided to invent a generic, pre-tested and pre-certified system, which just needs a simple adaptation for each blade design.”

LIBI is an implant which is embedded into the blade structure to ensure 100 % lightning strike interception effectiveness. The tip of the LIBI extends to the blade tip, which

together with the first pair of side receptors (approximately 1 m from the tip) provides attachment points for lightning strikes. Once the LIBI is struck, the current travels via a down conductor (high-voltage cable for the first 10-15 m, conventional cable thereafter) inside the blade to the blade root. The insulation encasing the internal metal parts ensures that the initial discharges cannot attach through the blade shell, minimising blade failure.

Over half of the work is typically done upfront in the factory, making the process faster, while ensuring consistent and high manufacturing quality. The system can also be retrofitted for blades with insufficient lightning protection, or blades already damaged by lightning. Both new blade and retrofit solutions have been certified.

## GREEN ENERGY INCENTIVES

The LIBI will drastically reduce WT downtime due to lightning damage, increasing production, while reducing the cost of wind power – creating incentives to replace coal-fired plants with green wind energy. “We strongly believe that LIBI is an important step to make modern wind energy more competitive, to the benefit of all the planet's citizens,” says Dr Madsen.

All the mandatory verification tests (required by the International Electrotechnical Commission (IEC 61400-24 Ed2)) have been conducted, including two high voltage tests to determine capture efficiency and two high current tests checking for arc root erosion on the receptors, as well as for the current conduction capability of the cable and connections. The design has also been exposed to mechanical tests, alongside low and elevated temperatures (-40 °C to +65 °C).

LIBI is currently being sold in large quantities across the European and Asian wind energy markets. As of last October, around 2 000 systems had been installed and the expectation for 2019 is to exceed 6 000.

## LIBI

- Coordinated by Global Lightning Protection Services in Denmark.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-ENERGY.
- [cordis.europa.eu/project/id/726659](https://cordis.europa.eu/project/id/726659)
- Project website: [libi-blade.com](https://libi-blade.com)



CLIMATE CHANGE AND ENVIRONMENT

# Earth observation satellites help track wildlife populations

*Combining animal tracking with Earth observation (EO) data is fundamental to studying an animal's population ecology and behaviour. Integrating the various webtools and statistical packages available to deal with the acquisition and storage of these EO datasets is challenging.*

Scientists can combine animal tracking data with remotely-sensed EO data from the European Space Agency's Copernicus EO programme, providing new and exciting opportunities for wildlife protection. However, exploiting EO datasets can be a problem for scientists that do not have the technical capabilities to access and process this information.

The EU-funded EO4wildlife (Platform for wildlife monitoring integrating Copernicus and ARGOS data) project designed an open cloud platform to facilitate data integration for researchers. The consortium developed a system to access the Sentinel satellites' EO data along with an operational and easy-to-use platform to query, mine and extract information from different databases. This included the use



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of Open Geospatial Consortium (OGC) standards for sensor observation.

The EO4wildlife platform includes a toolbox of interoperable data processing services and features that connect to animal tracking databases, access large data collections from the Copernicus Marine core service, sample relevant environmental indicators, and run environmental models in a scalable processing environment.

## STANDARD FORMAT DEVELOPED

Based on the tracked locations, the platform can automatically extract several EO variables, like chlorophyll-a and sea surface temperature, using data from the new Sentinel satellites and other sources. It provides several options for extracting data, and user-defined solutions for temporal and spatial resolution. "Services were initially based on dedicated scenarios that were founded on the interests of different scientific communities: seabirds, sea turtles, marine mammals and pelagic fishes," says project coordinator Jose Lorenzo.

Consortium members also developed a generic EO4wildlife XML format to standardise not only the ARGOS location data coming from the users' platforms like seabirdtracking.org and seaturtle.org but also any animal track from any other scientific community. Emphasis was placed on the meta-data description of the ARGOS and EO data and EO4wildlife services to follow the ISO/OGC/European standards. ARGOS is a satellite-based system that collects, processes and disseminates location and environmental data from fixed and mobile platforms worldwide.

## BENEFITS ACROSS THE WORLD

EO4wildlife will contribute to the efficient and widespread exploitation of the existing and planned European space infrastructure (especially Copernicus with its sentinel satellites) via a platform enabling access to Sentinel EO data, ARGOS databases, additional thematic databank portals, and other EO and MetOcean databases. It also provides additional facilities to develop and run algorithms for dedicated data analysis and modelling.

“The platform allows scientists to connect to the Seabird Tracking Database, hosted by BirdLife International, which now curates more than 11 million locations for more than 100 species.”

The project therefore benefits large communities of multidisciplinary research scientists from around the world, including biologists, ecologists and ornithologists, who can collaborate whilst using European Sentinel Copernicus EO more extensively and effectively. "For example, the platform allows scientists to connect to the Seabird Tracking Database, hosted by BirdLife International, which now curates more than 11 million locations for more than 100 species," comments Lorenzo.

Moreover, data can be uploaded to explore how seabird tracking and oceanographic variables can be combined to develop predictive habitat utilisation and species distribution models. "These can be used to set up dynamic management tools for authorities like fisheries, shipping and Marine Protected Areas to help them make real-time decisions to protect selected seabird species and enhance scientific knowledge of pelagic fish migration routes, reproduction and feeding behaviours for better species management," Lorenzo concludes.

## EO4WILDLIFE

- Coordinated by Atos in Spain.
- Funded under H2020-LEIT-SPACE.
- [cordis.europa.eu/project/id/687275](https://cordis.europa.eu/project/id/687275)
- Project website: [eo4wildlife.eu](https://eo4wildlife.eu)
- ▶ [bit.ly/2KJQjon](https://bit.ly/2KJQjon)



# Dust from ancient times helps predict future climate change

*Mineral (desert) dust in the Earth's atmosphere affects the planet's climate and has done so for millions of years. EU-funded scientists integrated paleodust observational data since the last interglacial period with cutting-edge climate simulation software to significantly enhance model prediction accuracy and subsequent decision-making.*

Mineral dust enters the atmosphere largely through wind erosion of exposed soil. During the several days and several thousand kilometres that the dust particles can remain airborne, they absorb and scatter solar and thermal radiation, affect cloud and ice nucleation, and alter the absorbance and reflection properties of surfaces. By transporting elements such as iron and phosphorous to remote locations, wind-blown dust also supports ecosystem functions which in turn affect the carbon cycle.

A pressing need to understand and predict climate change is fostering accelerated interest in global dust cycles. With support from the Marie Skłodowska-Curie Programme, scientists working on the DUSC3 (DUST, Climate and Carbone Cycle) project enhanced a state of the art climate model that includes global dust cycle dynamics. Scientists integrated large amounts of paleodust observational data, filling important knowledge gaps and increasing the accuracy of predictions of future impacts of aerosol feedback on climate change.

## LEARNING FROM THE PAST, PREPARING FOR THE FUTURE

Fluctuations in the global dust cycle are recorded in the Earth's land, ice and oceans. Researchers of paleodust cycles investigate variability in the alternation of glacial and interglacial cycles as well as over shorter time scales. During glacial periods, large ice sheets covered the Earth at high latitudes, affecting the Earth's climate and leading to drought, desertification and a decline in sea levels. Of particular interest is the last glacial maximum, or LGM, the time during the last glacial period when the largest extent of Earth was covered by ice sheets. This occurred approximately 21 000 years ago. At that time, dust emissions were more than twice as much as today.



DUSC3 scientists integrated paleodust records from different sedimentary archives since before the last glacial period began, approximately 130 000 years ago, and used them in combination with the latest Institut Pierre Simon Laplace (IPSL) climate model, IPSL-CM6.

The work has enabled a reconstruction of time series of mass accumulation rates including size formation. It will now also enable a reconstruction of the global dust cycle during the LGM that is well-constrained by observational data. The project data has also been added to a web platform for dissemination of the research results in numerical and graphical formats.

As Samuel Albani, the lead researcher supported by the Marie Skłodowska-Curie Programme, explains, "Improvements in the representation of dust particle size distributions



linked with an emission scheme more dependent on land cover [facilitate] a better representation of dust-climate feedback and open the way to an increased and more accurate coupling of the dust cycle with other components of the IPSL Earth System Model.”

## A NEW BENCHMARKING TOOL

DUSC3 has delivered an enhanced paleodust database available on a web platform as well as significant enhancements to the IPSL-CM6 climate model. According to Albani, the former “...will constitute a benchmarking tool for [PMIP4] Paleoclimate Modelling Intercomparison Project dust experiments, and for the paleodust community at large in the coming years.”

Enhancements to IPSL-CM6 are expected to have far-reaching impacts within the climate modelling area and beyond, providing rationale for policy-making in the context of climate change to governments, and public and private decision-makers.

## DUSC3

- Coordinated by the University of Versailles Saint-Quentin-en-Yvelines in France.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/708119](https://cordis.europa.eu/project/id/708119)
- Project website: [researchgate.net/project/DUSC3-Dust-Climate-and-the-Carbon-Cycle](https://researchgate.net/project/DUSC3-Dust-Climate-and-the-Carbon-Cycle)

## CLIMATE CHANGE AND ENVIRONMENT

# Alpine lakes reveal importance of viruses in freshwater environment

*Viruses are a key component of lakes and rivers but remain understudied. EU researchers investigated sediments from alpine lakes to better understand the structure and diversity of viral communities in freshwater ecosystems.*

Viruses are among the most abundant biological entities on Earth and can be found across a range of habitats, including rivers and lakes, and in some of the harshest environments. They impact on bacterial communities and can influence their evolutionary dynamics, mineralisation processes, energy transfer across trophic levels and greenhouse gas emissions.

Despite controlling important ecological processes in aquatic systems, the factors governing viral community dynamics and ecological functions in freshwaters remain poorly understood. The metaVir-Alp (Alpine lakes benthic viral community structure and diversity: a metagenomic and ecological approach) project with the support of the Marie

Sklódowska-Curie Programme addressed this knowledge gap, focussing on viral communities in freshwaters, which are particularly relevant for the Alpine region and other EU areas.

Scientists characterised the genetic diversity, structure and function of viral and bacterial communities in freshwater systems along an altitudinal gradient combining metagenomics, microbiology and advanced computation. “We used the endangered alpine lakes as a model system,” explains project coordinator, Dr Federica Pinto. “Specifically, we focused on four lake sediments that are hotspots of carbon cycling due to the large deposition of terrestrially derived carbon and the greenhouse gases outgassing.”

“Our results will therefore provide the basis for more informed and accurate future virome investigations.”

## IMPROVED INVESTIGATION OF THE VIROME

A pre-sampling session was first carried out to implement and validate the protocols for the various steps, including sample collection, viral-enriched samples generation, and virome library preparation. The second stage involved two other field sessions that enabled researchers to construct a comprehensive dataset with physico-chemical data and viral and microbial abundance profiles for each lake.

Scientists also generated a DNA bank of 34 microbial and 34 viral communities with the aid of high-throughput sequencing. “These two extensive datasets expanding on the spatial and temporal dimensions of lakes are extremely valuable for supporting current and future studies of freshwater microbial and viral communities of alpine lakes”, Dr Pinto explains.

Results showed that the choice of filters’ pore size is important when employing filtration as a viral enrichment method for high-throughput sequencing. Furthermore, since viral-enriched samples contained a significant portion of microbial taxa, particular care should be taken in the computational pre-processing step of the metagenomes before any further analysis.

These limitations in virome studies were validated in public datasets where the biases were even stronger. The virome refers to the collection of nucleic acids, both RNA and DNA, that make up the viral community associated with a specific ecosystem. “Our results will therefore provide the basis for more informed and accurate future virome investigations,” states Dr Pinto.

## NEW MICROBIAL GENOMES STUDIED

Furthermore, the development of a viral-specific computational metagenomic pipeline will enable the characterisation of new viral groups and understanding viral assemblage structure in natural environments.

Scientists also genetically characterised the Cyanobacteria *Tyconema bourrellyi*. This important species can produce neurotoxins that are harmful to both human and animal health. In addition, three new microbial genomes of potential symbionts of cyanobacterial organisms were recovered and assembled.

metaVir-Alp will benefit microbiologists, bioinformaticians and limnologists, producing the first metagenomic database on viral communities in freshwater sediments, integrating both the project’s new samples and the few samples available in the literature. “This will pave the way for new research in both basic and applied microbiology in freshwaters and will fill a gap in environmental virology by producing a highly valuable viromes sequence database,” Dr Pinto concludes.

## METAVIR-ALP

- Coordinated by the University of Trento in Italy.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/704603](https://cordis.europa.eu/project/id/704603)
- Project website: [segatalab.cibio.unitn.it](https://segatalab.cibio.unitn.it)





SPECIAL FEATURE

# VAST, COMPLICATED, (DIS)ORDERLY? UNLOCKING THE SECRETS OF THE COSMOS

## Editorial

### The inexhaustible quest: astrophysics and the mysteries of the cosmos

The night sky is not just inspiring and beautiful. It's the origin story of our very existence, and one of the greatest mysteries science has ever had to solve. This month's special feature looks into some of the latest EU-funded attempts to unlock the mysteries of the Universe.

The cosmos is so immense that it'd be easy to think it is way beyond our comprehension. Look through a telescope and even the simplest question becomes an impassable wall: Is the Universe finite or infinite? What was the pre-Big Bang era like? What's the fate of the Universe?

Luckily enough, the immensity of the Universe combined with the limited – although incredibly fast – speed of light provides us with a time machine of sorts. Take your telescope again, and think of everything you see as a glimpse into the past.

Each time a state-of-the-art telescope is inaugurated, we redefine the boundaries of Universe observation. In 2016, the Hubble space telescope spotted a galaxy as it stood 13.4 billion years ago. As we were writing these lines, the same telescope had just identified a black hole that challenges Einstein's theories of general and special relativity. The pace at which astrophysicists keep making new discoveries never ceases to amaze. Meanwhile, supercomputers have started mapping out the Universe and predicting its evolution.

EU researchers actively participate in this continuous quest. In the following pages, you will read about some of the latest EU-funded attempts at doing so. These efforts cover most of the Universe's story, from the Big Bang's initial gravity waves (BeyondPlanck) to the creation and characteristics of stars (StarFormMapper), low surface brightness galaxies (DIGESTIVO) and galaxy clusters (ClusterGal).

You will also find out how, somewhere in between, RADIOFOREGROUNDS and CosmicDawn have been furthering scientific understanding of cosmic inflation – the phenomenon that has caused the Universe to expand exponentially since its early age. Projects such as GalaxyDance even go as far as questioning the existence of dark energy by confronting general relativity with modified gravity theories.

No matter what the future holds for astrophysics, there is one thing we can predict: EU research is and will continue to play an important role in unlocking the secrets of the cosmos.

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

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## Revelations from the greatest particle acceleration in the universe

*Scientists have characterised critical components masking primordial radiation generated during the Big Bang. Outcomes will help to reveal the processes in those first instants that occurred with energy a trillion times more than that possible with the most sophisticated particle accelerators available.*

According to our current understanding, the universe was created 13.8 billion years ago, nearly instantaneously, in an event now called the Big Bang. An infinitesimally small, infinitely hot and dense 'singularity' occurred that expanded and cooled very rapidly in far less than fractions of a second.

Understanding what happened during that rapid inflation will provide a window on physical processes and energy scales (magnitudes) of relevance to numerous fields of scientific endeavour. However, the clues the Big Bang left behind are hidden in 'noise' generated by our cosmos over billions of years.

An EU-funded consortium working on the RADIOFOREGROUNDS (Ultimate modelling of Radio foregrounds: a key ingredient



The **universe** was **created**  
**13.8 billion years ago**





“A detection of this primordial B-mode signature would open a new window in fundamental physics, at energy scales way beyond the Standard Model of particle physics.”

for cosmology) project set out to characterise an important component of this noise. Doing so will enable scientists to remove it from observations, thus revealing the remnants of the Big Bang and the birth of our universe.

## FOREGROUND VERSUS BACKGROUND

According to project coordinator José Alberto Rubiño-Martín, the Big Bang provided: “(...) the primordial seeds for the formation of all structures that we see in the cosmos nowadays (...). Cosmic microwave background (CMB) is the relic light that was present in the infant universe and that we can now detect in microwaves.” Scientists are particularly interested in a subtle twist in the orientation of light associated with CMB known as B-mode polarisation.

This B-mode polarisation signal is very small and hidden by the foreground radiation emitted by our own galaxy and intergalactic sources. Rubiño-Martín explains: “A detection of this primordial B-mode signature would open a new window in fundamental physics, at energy scales way beyond the Standard Model of particle physics, ...12 orders of magnitude (1 000 000 000 000 times) larger than those achievable with the Large Hadron Collider at CERN. Only by using the universe as our particle accelerator, can we approach those energy scales.”

## TEASING OUT THE DETAILS

Two physical processes producing microwave emission in our galaxy, synchrotron emission and anomalous

microwave emission (AME), are key. In both of them, the galactic magnetic field plays a major role. However, polarisation of the synchrotron emission was not well-characterised, and it was unknown whether the AME was polarised or not.

AME peaks around 20 GHz, whereas synchrotron dominates at frequencies below 30 GHz. The team combined data from the northern sky QUIJOTE CMB experiment at the Institute of Astrophysics of the Canary Islands (IAC) (10-20 GHz) with nine all-sky maps from the European Space Agency's Planck satellite (30-857 GHz). In ground-breaking work, scientists produced four state-of-the-art legacy maps of northern sky emission at 11, 13, 17 and 19 GHz.

In this way, as Rubiño-Martín explains: “we have provided a detailed description of the polarisation properties of the synchrotron emission. The polarised synchrotron is found to be more complex than originally expected. (...) In addition, with QUIJOTE we have set the most stringent upper limit to date of the polarisation fraction of the AME, which is found to be almost negligible.” These results are expected to have a huge impact on the CMB community and our ability to study the inflation period.

RADIOFOREGROUNDS scientists are sharing their developments with publicly available open-source software tools, maps and foreground models.

## RADIOFOREGROUNDS

- Coordinated by IAC in Spain.
- Funded under H2020-LEIT-SPACE.
- [cordis.europa.eu/project/id/687312](https://cordis.europa.eu/project/id/687312)
- Project website: [radioforegrounds.eu](https://radioforegrounds.eu)
- [bit.ly/2YZHGub](https://bit.ly/2YZHGub)

# Understanding the formation and evolution of massive stars

*Combining data from the European Space Agency's Herschel and Gaia missions, the EU-funded StarFormMapper project aims to get a complete picture of how massive stars and star clusters form.*

The question of how stars are formed, particularly those stars that are much more massive than the Sun, is one that continues to intrigue astronomers and physicists alike. Although researchers know that their origins lie within giant complexes of astronomical dust and molecular gas, this material blocks their view and prevents them from getting a good look at the newly formed star itself. Instead, researchers can only view young stars via the infrared radiation that is re-emitted by the surrounding dust.

To help researchers 'see' through this material, the European Space Agency (ESA) launched two satellite missions: Herschel, which traces a new star's infrared embedded phase, and Gaia, which traces the more evolved and visible phase. By combining the data gathered by these two missions, the EU-funded StarFormMapper (A Gaia and Herschel Study of the Density Distribution and Evolution of Young Massive Star Clusters) project aims to get a complete picture of massive star and star cluster formation.

"This project wanted to know whether these two missions could be combined to study the crucial evolutionary stage when the stars have formed but have not yet fully emerged as visible objects," says Dr Stuart Lumsden, project coordinator. "Doing so would help address questions of how massive stars form, how these associations and clusters evolve, and whether the later visible stage still contains an imprint of how things started or whether this information is wiped out during early evolution."

## THE CHALLENGES OF COLLABORATION

Extracting the full scientific value of the combined data required new, automated statistical techniques and common user tools. This was achieved via a collaboration between Quasar Science Resource, a software SME, and a group of academics led by the University of Leeds. Whereas Quasar created the infrastructure, the academic group developed the scientific techniques.

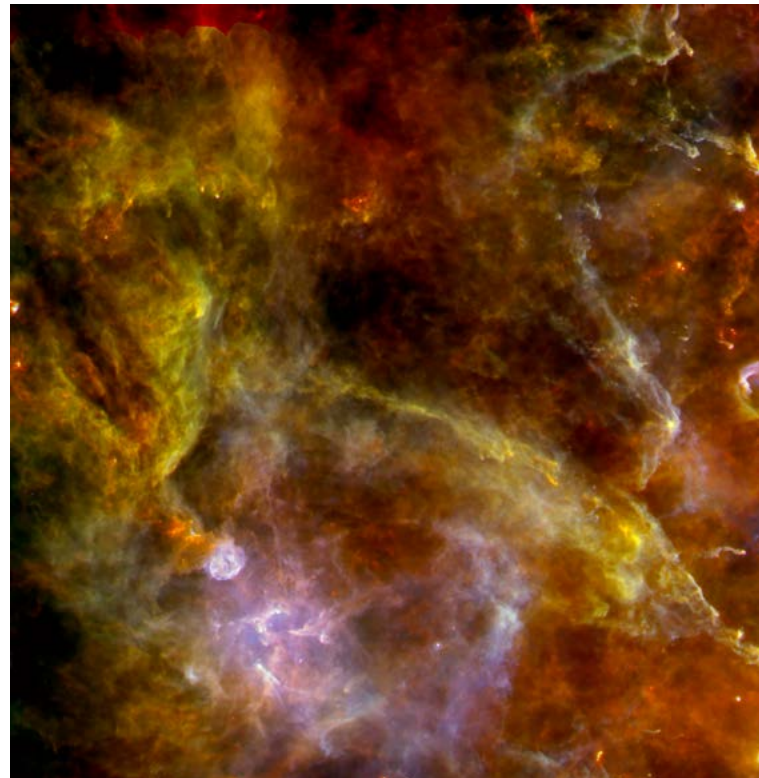
While Quasar has been very successful at creating a potential software programme to link directly to the ESA's archive where the Gaia and Herschel data are stored,

getting to that point wasn't always easy. According to Dr Lumsden, the different methods used by developers and academia often made collaboration a challenge: "This has been a real eye-opener, since some of our academic colleagues struggle to see beyond the typical outputs of papers, conferences, etc. to creating items of community-wide value," he explains. "I'm impressed by the willingness of the SME to engage, and I hope we've learned some things that could help similar efforts in the future prosper a bit more readily."

## GALACTIC EVOLUTION

Although the project continues to be a work-in-progress, several important results have already been achieved. For example, during testing, the new software techniques have shown promise in their ability to address the specific scientific questions regarding star formation that the project set out to answer. Researchers also started developing

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“This is fascinating information that we look forward to sharing not only with the scientific community, but also with the general public – as keeping them engaged is essential to the ongoing success of publicly funded research like ours.”

creative methods for sharing the project's insights into star formation with schools and communities.

“Once the project is complete in May 2020, our scientific results will underpin the study of how galaxies evolve,” adds Dr Lumsden. “This is fascinating information that

we look forward to sharing not only with the scientific community, but also with the general public – as keeping them engaged is essential to the ongoing success of publicly funded research like ours.”

#### STARFORMMAPPER

- Coordinated by the University of Leeds in the United Kingdom.
- Funded under H2020-LEIT-SPACE.
- [cordis.europa.eu/project/id/687528](https://cordis.europa.eu/project/id/687528)
- Project website: [starformmapper.org](https://starformmapper.org)

## Dark energy vs. modified gravity: which one will prevail?

*Einstein's theory of general relativity predicts the existence of dark energy – a mysterious form of energy that permeates space and accelerates the expansion of the Universe. But what if Einstein was wrong and there was no such thing as dark energy? The GalaxyDance project has been investigating this scenario.*

As accurate as it has proven to be so far, general relativity is not the only theory that can account for gravitation. In fact, there are various alternative theories out there. Scientists are just not sure how these can resist observation and simulations.

To close this gap, the GalaxyDance (Dance of galaxies: testing General Relativity and alternatives using galaxy velocity fields) project, undertaken with the support of the Marie Skłodowska-Curie programme, has been using information encoded in peculiar velocity statistics of galaxies in the Local Universe as well as observed redshift space distortions (RSD) of distant galaxies.

Dr Wojciech Hellwing, coordinator of the project and Research Fellow at the Centre for Theoretical Physics of the Polish Academy of Sciences, discusses the project's findings so far.

### What makes the expansion of the Universe so difficult to comprehend?

As we go deeper and further in our observations of the Universe, we are still puzzled by some of its properties. One of these is the accelerated expansion of space-time, which is presently attributed to dark energy. But the truth

is, we need to consider dark energy only if Einstein's theory of gravity is valid at all scales of the cosmos.

There are other possible explanations for the accelerated expansion that do not require dark energy. These theories go beyond general relativity and are commonly called 'modified gravity'. Testing general relativity and these alternatives at the intergalactic scale is a pressing and important issue for modern extragalactic astronomy, and it was the purpose of GalaxyDance.

### Can you tell us more about your approach?

GalaxyDance introduces a novel approach that consists in using low-order statistics of galaxy velocities and clustering to test Einstein's theory of gravity and its counterparts. This test covers intergalactic scales, a regime in which the theory of gravity has not been rigorously tested so far. I have demonstrated that this approach has several unique advantages: it is gravity-model independent, free of significant galaxy bias and largely unaffected by baryonic physics.

I have used state-of-the-art computer simulations that recreate a virtual Universe in a supercomputer. By running and analysing these simulations, we can test beyond-GR theories and outline promising results.



### What makes this approach particularly innovative?

The use of large supercomputer simulations was previously impossible in beyond-GR models, due to their complexity and numerical expensiveness. To mitigate this problem, we have decided to use a speed-up algorithm which – at the expense of some accuracy – can model the evolution of the Universe much more efficiently.

I have successfully demonstrated that, in the case of cosmic velocities, such an approximated approach is sufficient to obtain robust results.

### What are the project's most important outcomes?

Undoubtedly, the new set of large, state-of-the-art simulations of alternative theories which will allow for unprecedented studies of cosmic velocity fields.

We have already demonstrated that low order statistics of the galaxy velocity field should contain a strong signal of modified gravity. However, we have also shown that, to measure and extract this signal, dedicated and thorough modelling of the impact of our nearby cosmic structures, such as the Virgo galaxy cluster, will be of paramount importance for the success of our method.

### What do you still hope to achieve before the end of the project?

We will implement additional modelling of the processes that determine galaxy colours, luminosity and shapes. This will enable the creation of artificial galaxy catalogues showing what would have been created in a Universe ruled by alternatives to Einstein's theory of gravity.



**Dr Wojciech Hellwing**  
Project coordinator of GalaxyDance  
© Wojciech Hellwing

*“I have used state-of-the-art computer simulations that recreate a virtual Universe in a supercomputer. By running and analysing these simulations, we can test beyond-GR theories and outline promising results.”*

From thereon, we will compare our results with the existing and forthcoming astronomical observations to provide new stringent tests of gravity on the largest scales.

### What has been the feedback from the scientific community so far?

Many colleagues expressed interest and even enthusiasm regarding our results when we presented them at international cosmological conferences. Furthermore, we have started new collaborations with colleagues who have complementary expertise in galaxy observations (from Lyon in France) and in the modelling of nearby cosmic structures (colleagues from Potsdam in Germany). We are very excited about these.

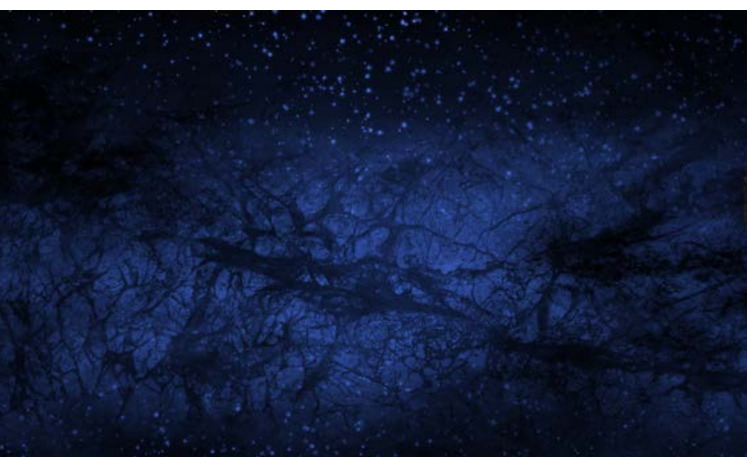
### What do you hope will be the long-term impact of the project? How does it prepare the scientific community for the era of big cosmological data?

GalaxyDance will provide a new way to make cosmological tests of gravitational theories a reality. The final results, no matter which theory (dark energy or modified gravity) they favour, will have far-reaching and ground-breaking consequences for our understanding of the Universe on the largest scales.

If our tests eventually provide a signature of new physics foreseen in beyond-GR theories, it will shake our current view and understanding of the large-scale evolution of the cosmos. If, on the other hand, our inquiry strengthens general relativity, it will mean that we need to look harder to explain the mystery of dark energy.

#### GALAXYDANCE

- Coordinated by the Center for Theoretical Physics of the Polish Academy of Sciences in Poland.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/748525](https://cordis.europa.eu/project/id/748525)





# EU project lays transparent galaxies bare

*The DIGESTIVO project has considerably advanced our understanding of low surface brightness galaxies. In doing so, they have found dark matter in a new type of very low surface brightness object where it was previously reported not to be present.*



matter haloes) project in collaboration with the observational team led by Dr Ignacio Trujillo.

“It is only now, with the advent of new deep surveys, that these objects can finally be explored in large numbers. Likewise, the enormous increase in supercomputing capabilities allows for running extremely high-resolution simulations. These, together with a proper modelling of the feedback mechanisms governing galaxy formation, can help us reproduce LSB galaxies.”

DIGESTIVO's work, which was undertaken with the support of the Marie Skłodowska-Curie programme, is fundamental. The so-called Lambda Cold Dark Matter model – which explains the origins of the cosmos – doesn't provide enough information to understand the formation of LSB galaxies. As more and more such galaxies are being observed, this poses a growing problem to astrophysicists.

“To clear these grey areas, we have been using new observational strategies. We also used extended deep surveys to statistically address the properties of these LSB galaxies and ultra-deep imaging to explore the most promising, faintest targets,” says Dr Trujillo.

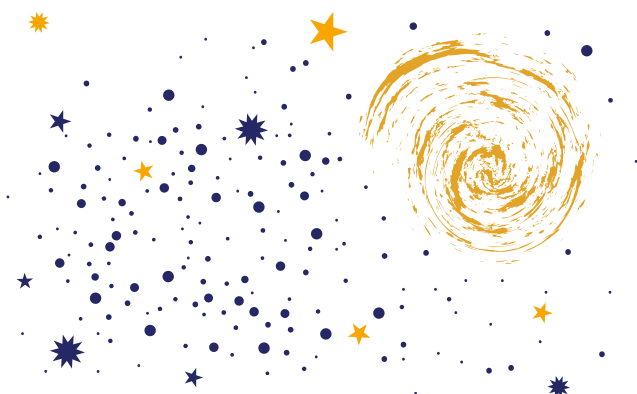
Amongst the project's most important outcomes is the understanding of how LSB galaxies form in a cosmological context. “We got there by conducting some of the world's highest resolution cosmological simulations. We also ran, for the first time, detailed simulations of galaxies able to reproduce the main features of these objects, such as their extreme size and faintness. This all resulted in the finding that LSB galaxies form as a result of coplanar mergers of smaller galaxies and aligned accretion of gas at early times, together with stellar feedback-driven strong outflows of gas from the centre. This makes the central distribution of stars and dark matter very shallow, reproducing the observed dynamics of these objects,” explains Dr Di Cintio.

Meanwhile, Dr Trujillo and his team have been exploring a new type of very LSB objects where dark matter was reported not to be present. They undertook a detailed observational analysis of these galaxies and, at the same

For a long time, studying the Universe's galaxies was all about the observation of the things we could see: stars, planets and other celestial objects. Astrophysicists have long theorised that dark matter exists, and that it accounts for 85 to 90 % of all matter in the universe. But whilst the scientific community hasn't been able to observe it directly, studying parts of the universe where it was believed to be most prominent – such as low surface brightness (LSB) galaxies – is a great starting point.

Apart from their very existence, we still know very little about the almost transparent LSB galaxies. How do they form and evolve? How are they linked to their dark matter haloes? How do they fit within the current cosmological model of galaxy formation?

“The detection and modelling of these type of galaxies is extremely demanding from an observational and theoretical point of view,” explains Dr Arianna Di Cintio, a theoretical astrophysicist who coordinates the DIGESTIVO (The Diffuse Galaxy Expansion Signatures In Various Observables project: understanding the emergence of diffuse, low surface brightness galaxies and the link to their dark



## Dark matter accounts for 85 to 90% of all matter in the universe

time, explored cosmological predictions based on these simulations. “We have found that these objects can be understood within the current scenario, provided that the dark matter is distributed very homogeneously in their inner parts with a so-called extended core dark matter halo.”

“The extended cores in dark matter haloes that we found within our simulated LSBs are of great interest for the community. They will help explain an increasing number of observations where the dynamics of LSB galaxies are not easy to understand.”

All in all, DIGESTIVO offers invaluable insights into the formation and characteristics of LSB galaxies. It also provides a better picture of mass distribution within galaxies. “The extended cores in dark matter haloes that we found within our simulated LSBs are of great interest for the community. They will help explain an increasing number of observations where the dynamics of LSB galaxies are not easy to understand,” Dr Di Cintio concludes.

### DIGESTIVO

- Coordinated by IAC in Spain.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/748213](https://cordis.europa.eu/project/id/748213)

## Using different sources of data to investigate the beginning of the universe

*The EU-funded CosmicDawn project is using theoretical and observational research to better understand the origins of our universe.*

With the 2009 launch of the Planck satellite, the European Space Agency (ESA) set out to image the cosmic microwave background (CMB) radiation left over from the Big Bang. Although large volumes of data on the early universe have since been collected, a lot of questions remain unanswered: Where did the initial fluctuations in the density of the universe come from? Why is the universe so big but mostly empty? Why is it so spatially flat?

To help answer these questions and others, the EU-funded CosmicDawn (Understanding the Origin of Cosmic Structure) project combined theoretical and observational research to better understand the origin of cosmic structure. “Our understanding of the origins of fluctuations in the early universe contains a whole bunch of assumptions,” says Dr Hiranya Peiris, project coordinator. “We

want to test those fundamental assumptions, on top of testing specific models as well.”

### THE INFLATION THEORY

A key component in the project’s work is inflation – a theoretical framework used to describe the accelerated expansion of space in the time immediately following the Big Bang. “Inflation is a mechanism by which you can create structure in the very early universe and help explain some of the classic puzzles surrounding the Big Bang,” says Dr Peiris.

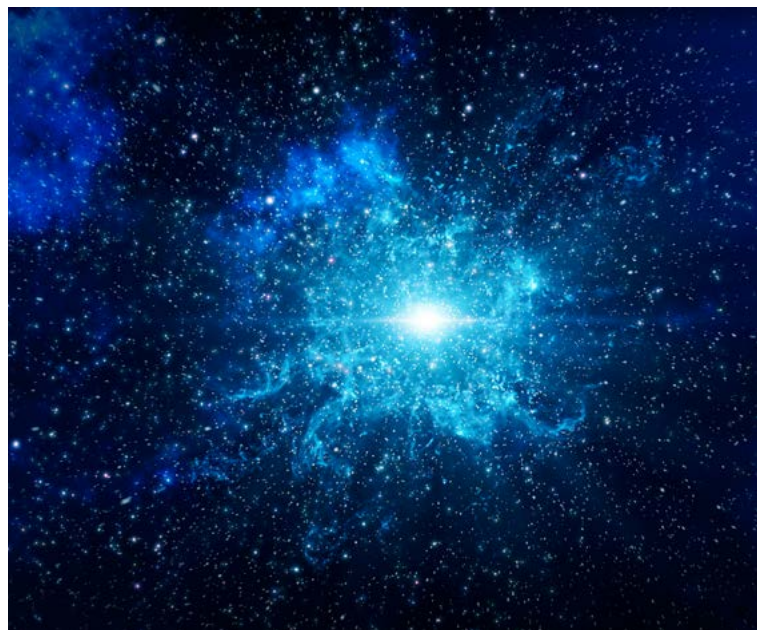
To test the theory of inflation, researchers relied on both the CMB data gathered by the Planck satellite and data from large galaxy surveys. Although the two approaches sample different periods in the history of the universe,

both data types are complementary in that they essentially allow researchers to map out the early universe. “By testing a cosmological model with the CMB data, you can predict what you should see in the late time universe in a galaxy survey,” explains Dr Peiris.

### PROGRESS MADE, MORE WORK TO BE DONE

During the project, researchers discovered that although the simplest inflationary models were compatible with the data, these models did not fit ‘naturally’ within theories of fundamental physics. As a result, researchers had to turn to new approaches to further explore the fundamental physics. These included using tools from numerical relativity and modelling condensed matter systems, the latter of which could conceivably allow one to conduct in-lab studies of the physical processes that may have taken place in the early universe.

Overall, Dr Peiris says significant progress has been made in the project: “we have worked out very strong constraints, narrowing down the range of mechanisms by which cosmic structure could have been produced in the very early universe,” she says. “Just as important, we also identified where we need to improve our understanding of both theory and observation to understand the origins of cosmic structure.”



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### COSMICDAWN

- Hosted by University College London in the United Kingdom.
- Funded under FP7-IDEAS-ERC.
- [cordis.europa.eu/project/id/306478](https://cordis.europa.eu/project/id/306478)

## New galaxy cluster simulations lift the veil on important mysteries of galaxy formation

*Not all galaxies are made equal. Some are isolated, some thrive in groups like our very own Milky Way, and some are part of mega-structures called galaxy clusters. By running first-of-their-kind simulations of these clusters, Dr Yannick Bahé successfully addresses a missing link in the scientific understanding of galaxy formation.*

Modern astrophysics revolves around two essential means: observation – which has always been at the heart of the discipline – and theoretical interpretations. These are very interdependent: Observations tell scientists about the state of the universe at a certain point in time, and they can be fed into models and simulations lifting the veil on its evolution.

In some cases, however, available simulations fall short of expectations. Let’s take the case of galaxy clusters – a collection of galaxies living in very dense associations. The state-of-the-art ‘EAGLE’ simulation, which is ideal for reproducing isolated galaxies in detail, fails to consider massive clusters. A uniform simulation such as EAGLE would have to model an unfeasibly large volume of data to include a massive cluster.





Dr Bahé, first as Postdoc at the Max Planck Institute for Astrophysics in Garching, Germany, and now at the University of Leiden, has set himself the goal of overcoming these difficulties. In 2017, he and other researchers presented, for the first time, the results of so-called ‘Hydrangea’ simulations – a spin-off project based on EAGLE.

“The idea is to carefully select a region where a galaxy cluster has formed within a very large, low-resolution simulation, and then simulate only this region at the required high resolution. This is still computationally challenging – the simulation had to be run on one of the largest supercomputers in Germany – but it was a success. Hydrangea simulations have now proven their worth as tailor-made tools for studying the formation and evolution of galaxy clusters,” Dr Bahé explains.

The ClusterGal (Investigating the mechanisms that shape galaxies in and around massive clusters) project builds upon this new suite of simulations to crack the secrets of galaxy clusters. Besides the simulations themselves, Dr Bahé has developed specific tools for their analysis. One example of such a tool is a code allowing detailed reconstructions of individual galaxies’ history as they interact with others within the same cluster.

“The idea is to carefully select a region where a galaxy cluster has formed within a very large, low-resolution simulation, and then simulate only this region at the required high resolution.”

“There are several points that became clear through this analysis. First, the simulations are not perfect and go against observational measurements in some aspects. For example, although most of the galaxies have formed the expected number of stars in the simulations, the most massive, central galaxy clusters are too massive by a factor of ~3 compared to what is measured from observations,” says Dr Bahé.

Another inaccuracy is related to cluster outskirts and even galaxies further inside the cluster, which appear to undergo a stronger suppression of their star formation than that observed. This may indicate that current star formation models need revising, or that fundamental aspects of the real Universe are still missing from the simulations.



“One key finding from the project is how galaxies are much less likely to be disrupted in a cluster than previously thought. A lot of a galaxy’s dark matter is stripped by tidal forces as it falls into a cluster (which was known before), but a significant number of stars in the galaxy’s centre almost always survive. This means that, in a statistical sense at least, we can compare observed cluster galaxies at higher redshift (long lookback times) and in the local Universe, to infer how the overall galaxy populations evolve,” Dr Bahé enthuses.

Fundamentally, ClusterGal’s results confirm that galaxy clusters are directly influenced by their environment. This finding is likely to lead to follow-up studies, as galaxy

clusters are essential pieces in solving the galaxy formation puzzle. As Dr Bahé points out: “cluster galaxies are special, and without understanding how they became so, our picture of galaxy formation is necessarily incomplete.” This research was undertaken with the support of the Marie Skłodowska-Curie programme.

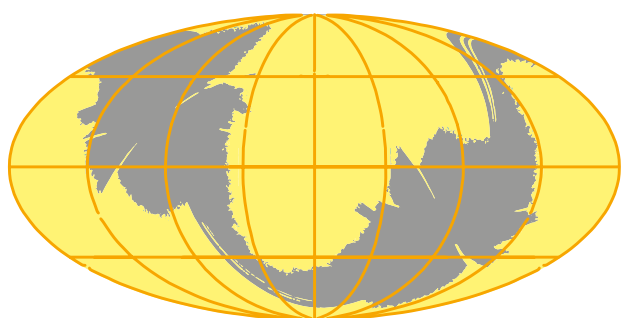
## CLUSTERGAL

- Coordinated by the University of Leiden in the Netherlands.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/747645](https://cordis.europa.eu/project/id/747645)

## A new way of analysing Planck satellite observations

*The EU-funded BeyondPlanck project is taking an iterative approach to detecting the primordial gravity waves created during the Big Bang.*

One of modern physics biggest achievements is the development of high-precision cosmology, or the science of the origin and development of the universe. Using the leftover heat from the Big Bang, known as cosmic microwave background (CMB), cosmologists have pinpointed such important cosmological parameters as the age and energy content of the universe to per cent accuracy.

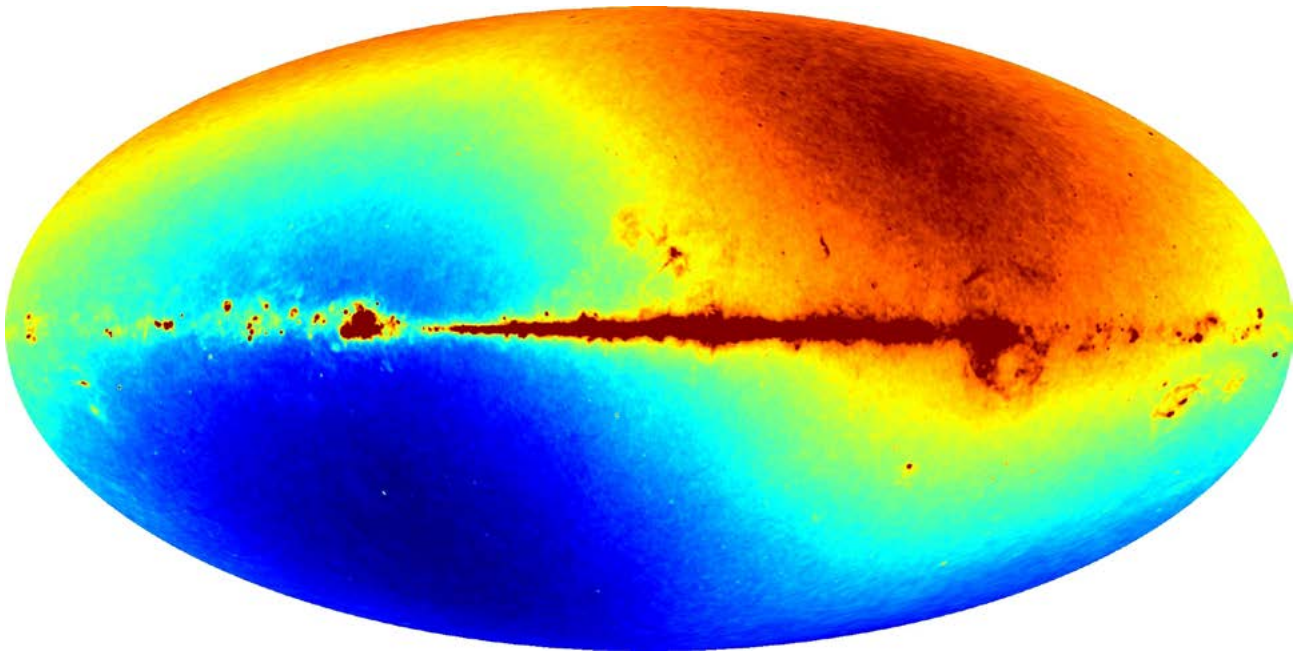


**90 seconds:**  
time it took BeyondPlanck researchers to produce a single sample of the Planck 30 GHz map

A major milestone in high-precision cosmology was the successful completion of the European Space Agency’s (ESA) Planck mission, which was designed to look for the signatures of density waves created during the Big Bang. Compared to previous satellites, Planck benefited from a much higher level of sensitivity, to the point that it wasn’t limited by instrumental noise. However, this high sensitivity created new problems, including interference from instrumental systematics and confusion from the astrophysical foreground emissions of the Milky Way.

With future satellite missions set to be at least 10 times more sensitive than Planck, new methods are needed to overcome these challenges. To help, the EU-funded BeyondPlanck (Delivering state-of-the-art observations of the microwave sky from 30 to 70 GHz for the next decade) project is developing an entirely new way of jointly analysing Planck observations.

“Instead of analysing Planck’s cosmological, astrophysical and instrumental data sets linearly, the BeyondPlanck project is taking an iterative approach,” says Hans Kristian Eriksen, project coordinator. “Doing so allows us to analyse the foregrounds, which can then be fed back into the calibration process to gain better foreground estimates, which in turn leads to better calibration, and so on.”



“*I believe our method will redefine the field in the coming decade, enabling much more robust results from a wide range of experiments.*”

## RECORD-BREAKING SPEED

Although the project is still a work-in-progress and research remains fluid, several important results have already been achieved. One of the most impressive results so far is the production of a single sample of the Planck 30 GHz map in only 90 seconds, including calibration, noise estimation and map making.

“This is faster than the other steps in the pipeline, including foreground modelling,” says Eriksen. “Our work has therefore proved that it is indeed possible to perform the kind of iterative sampling analysis that we hypothesised at the start of this project.”

## METHODS FOR THE FUTURE

With the necessary infrastructure and code now nearly complete, researchers are turning their attention to harvesting the scientific results through an entirely new

method of performing end-to-end analysis of CMB observations. Although the core goal of the project is to use this new method to produce better Planck results, researchers are confident that it will be equally applicable to future experiments. It may even play an important part in the future detection of gravitational waves from the Big Bang.

“I believe our method will redefine the field in the coming decade, enabling much more robust results from a wide range of experiments,” says Eriksen. “Most importantly, by allowing different experiments to be analysed jointly, our machinery will allow researchers to exploit synergies between different experiments in a seamless manner.”

## BEYONDPLANCK

- Coordinated by the University of Oslo in Norway.
- Funded under H2020-LEIT-SPACE.
- [cordis.europa.eu/project/id/776282](https://cordis.europa.eu/project/id/776282)
- Project website: [beyondplanck.science](https://beyondplanck.science)



# Investigating the link between food and depression

*It is thought that people with obesity have an increased risk of developing depressive symptoms and depression. MoodFOOD conducted the first trial to directly test the impact of a food-related behavioural therapy alongside a multi-nutrient supplement on the prevention of depression.*

According to a recent Eurostat study, obesity rates for the 19 European Member States for which data was available range from 8.0 % - 23.9 % for women and 7.6 % - 24.7 % in men (Eurostat 2011). Alongside this, the WHO has calculated that each year about 7 % of the European population suffers from a major depression – making it one of the most prevalent disorders in the EU. This places a heavy burden on individuals, families and society as a whole.

MoodFOOD (Multi-country collaborative project on the role of Diet, Food-related behaviour, and Obesity in the prevention of Depression) looked at the links between the two disorders to ask whether improving food-related behaviour and nutrient intake could help prevent depression, specifically for people prone to being overweight.

Based on a large number of studies and careful analysis, the researchers came to three conclusions. Firstly, a healthy diet – high in fruit, vegetables, whole grains, fish, pulses and olive oil, and low in red meat and full-fat dairy products – may reduce the risk of developing depression. Secondly, in people with obesity, weight loss can lead to a reduction in depressive symptoms. Thirdly, current evidence does not support the use of nutritional supplements in order to prevent depression.

## EXAMINING THE LINKS BETWEEN MOOD AND FOOD

After reviewing the scientific literature, the MoodFOOD researchers developed a theoretical model to highlight which relationships between food and depression merited further investigation. The model also incorporated the influence of lifestyle, the environment and psychology.

“We started with observational studies which linked nutritional intake and nutritional behaviour to depressive symptoms and vice versa. We also made an inventory of studies that had investigated the effect of specific nutrients on depression or depressive symptoms,” says Prof. Ingeborg Brouwer.

Based on this work, the team developed nutritional strategies designed to prevent depression for a randomised clinical trial involving 1 025 overweight adults (body mass index 25-40 kg/m<sup>2</sup>) aged 18-75 years with elevated depressive symptoms (Patient Health Questionnaire - 9, scores  $\geq 5$ ).







## About **7%** of the European population suffers from a major depression every year

The team chose a Mediterranean-like diet for the food-related behavioural therapy. For the nutrient supplement therapy, they combined several promising nutrients at dosages reported to be effective in some individual studies, but very unlikely to cause harm (1 412 mg omega-3 fatty acids, 30 µg selenium, 400 µg B-11 vitamin, and 20 µg D-3 vitamin plus 100 mg calcium). Twenty one individual and group food-related behavioural activation (F-BA) sessions were undertaken over a year, versus no F-BA (blinded to researchers).

While results within the study and outside of it have suggested a link between a healthy diet and overall health (mental as well as physical), primary analysis of the trial's results showed the link not to be as unequivocal as the team had hoped.

"What is clear is that there is no magic bullet. Daily nutritional supplements over a year did not perform better than placebos," says Prof. Brouwer. "Therapeutic sessions aimed at making changes to healthier dietary behaviour also did not convincingly prevent depression. However, there was some evidence that it prevented episodes in those participants who attended a recommended number of sessions, suggesting repeated and sufficient exposure is key."

The researchers continue to analyse the available data to identify future research opportunities. In the meantime, all the MoodFOOD guidelines and tools are currently available through the project website.

### MOODFOOD

- Coordinated by VU Amsterdam in the Netherlands.
- Funded under FP7-KBBE.
- [cordis.europa.eu/project/id/613598](http://cordis.europa.eu/project/id/613598)
- Project website: [www.moodfood-vu.eu](http://www.moodfood-vu.eu)

### FOOD AND NATURAL RESOURCES

## AI sows the seed for farming success

*An EU-funded initiative has used artificial intelligence (AI) to help farmers boost crop growth.*

The world's population is growing rapidly, with 70 % more food predicted to be needed by 2050. Farming therefore needs to become highly efficient and precise to ensure high yield and quality with minimum use of harmful chemicals.

To achieve this aim, many farmers are using variable precision agriculture tools such as ground sensors, drones and satellite photo images that improve crop growing efficiency. However, the major consideration, in this precision agriculture area, should be to determine which crops



and which genetic combination (variety) of seeds are best to grow.

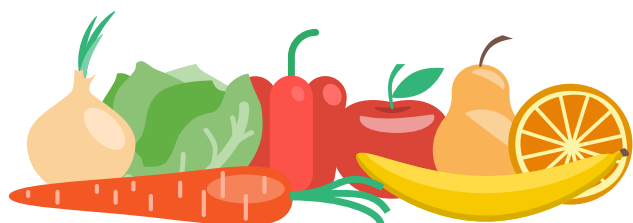
Each crop has many seed varieties available, and new ones are introduced annually. Moreover, at present there is no single place where farmers can access comprehensive comparable information on seed varieties that takes into consideration all the necessary parameters.

The SeedOPT (Seedwiz Plant Variety OPTimizer Boosting Crop Growth for Global Food Security) project has addressed this need by creating an online platform that allows farmers to select seeds from the most suitable plant varieties based on data that is continuously uploaded and updated by seed providers. "This includes a vast number of properties reflecting the genetic potential of the variety, combined with GIS and environmental data, disease resistances, farmer means of production and market needs," says project coordinator Limor Gruber.

### AI AIDS FARMERS

Parameters are analysed by AI algorithms to provide farmers with a comprehensive comparative matrix that recommends the optimal seed varieties to grow. The platform can help each farmer select the right seed variety to grow and the best agricultural inputs for their plot of land, thereby increasing yield and quality, while reducing the use of chemicals that negatively impact on the environment.

**70% more food** will  
**be needed** by **2050**



Most leading seed companies in Europe operate using an exclusive distribution model. This means many farmers must rely on regional distributors and are limited to seed varieties from this limited number of sources, leading to inefficient production. "SeedOPT's online platform connects all farmers including the local small farmer to



the global village, giving easy and immediate access to complete information previously not available to them and enabling them to make product comparisons, as well as offering the ability to purchase seed varieties directly from source, which was not previously possible," Gruber explains.

### HIGHER YIELDS AND LESS ENVIRONMENTAL IMPACT

Crowd source information generated by the SeedOPT users provides vital insights. "The accumulated data is extremely valuable for the entire agro-industry, market trends, preventing plant disease spread, crop yield forecasts, growth distribution, seed variety usage and more compared to current solutions, which are limited, non-standardised and manual," emphasised Seedwiz CEO and co-founder Dr Nissim Yonash.

In addition, the AI algorithms developed by SeedOPT will analyse the data to predict which crops are most suitable for growing in new regions. According to Dr Yonash: "We will be able to recommend seed companies extend their activities to new markets using their genetic materials."

SeedOPT is a unique, standardised, automated and comprehensive platform freely accessible to any farmer, based on a clear win-win model between all key stakeholders in the market. "Optimisation of crop growth through the online platform will contribute to an increase in food supply and food quality in Europe and around the world. It will also contribute to mitigation of the effects of climatic change and increase a crop's ability to withstand ever evolving pests and diseases," Dr Yonash concludes.

### SEEDOPT

- Coordinated by Seedwiz Ltd in Israel.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- [cordis.europa.eu/project/id/827597](https://cordis.europa.eu/project/id/827597)
- Project website: [seedwiz.com](https://seedwiz.com)



# Renewable, durable clothes are a FIBFAB fit for a green future

*The textiles industry is trying to become more environmentally-friendly.  
The FIBFAB project is turning that goal into a reality.*

Each year Europe produces tonnes of fabrics for clothing, usually by combining natural fibres (such as cotton or wool) with synthetic fibres (like polyester). Blends of natural and synthetic fibres are used to improve comfort and durability in the final product. However, these fabrics are difficult to recycle, since the fibres become intertwined and can no longer be separated.

In line with wider EU goals, European textile companies are aiming to be more environmentally-friendly and produce more renewable and recyclable materials and clothing. At the same time, European clothing businesses must make a shift towards innovative and high added value products to counter the competition with low-wage countries.

The Horizon 2020-funded FIBFAB (Industrialization of biobased textile fabrics for clothing applications) project aims to be at the forefront of these trends, by creating new sustainable polymers for the production of more environmentally-friendly clothing.

"The aim of the FIBFAB project is to produce clothes using sustainable materials," says Dr Nuria López Aznar, a materials expert at AIMPLAS and FIBFAB scientific technician. "The majority of material used in the textile sector is polyester, whose suppliers are from Asian countries, so the other objective was to reduce dependence on those countries."

FIBFAB hopes to industrialise and launch biodegradable and sustainable fabrics for use in casual, protective and workwear clothing, based on the polylactic acid (PLA) polymer.

## IMPROVING PLA

PLA is a renewable resource: the fermentation of sugars from corn or beet produces lactic acid, a monomer which can be used to produce the polymers needed for clothing. But commercially-available PLA doesn't fulfil all the mechanical and thermal requirements for some textile applications. Current PLA fibres have poor thermal resistance, for example, and can degrade during intense wash cycles.

FIBFAB has been working on the creation of a new compound based on PLA, with additives that enhance crystallinity. This compound has improved mechanical properties, hydrolytic stabilisation (letting it survive washing cycles) and all the properties needed to be used in the melt spinning process to create fibres.



“Although the material developed was designed for use in specific products and production lines, this is just a starting point to develop other materials.”

After many trials, they succeeded in producing a polymer that can create 100 % biodegradable and recyclable clothing, that also meets industry standards.

## EXPANDING SALES

Some commercial textiles producers have already expressed interest. During the project proposal preparation, some of the partners involved the development stage – SINTEX in the Czech Republic and YÜNSA in Turkey – were in contact with producers like Adidas and Hugo Boss, both of which showed interest in seeing the final results.

The team thinks the new material could be used beyond textiles, too. “Although the material developed was designed for use in specific products and production lines, this is just a starting point to develop other materials,” says Dr López Aznar.

The project was a big challenge, she explains, because the fibres need to have such high-performance properties. A huge number of experimental trials had to be carried out to obtain a lot of compounds, with different formulations, to be tested in textile equipment. Eventually, the team found a suitable compound that fulfilled the required properties.

The FIBFAB project ends this summer. Until then, the team is gathering up the material in large amounts: the plan is to create T-shirts to be distributed during workshops, fairs and exhibitions to get some further customer feedback, before introducing the product into the market.

## FIBFAB

- Coordinated by AIMPLAS in Spain.
- Funded under H2020-Societal Challenges and H2020-Industrial Leadership.
- [cordis.europa.eu/project/id/737882](https://cordis.europa.eu/project/id/737882)
- Project website: [fibfab-project.eu](https://fibfab-project.eu)
- ▶ [bit.ly/2KIQQG6](https://bit.ly/2KIQQG6)

## INDUSTRIAL TECHNOLOGIES

# Pioneering method for on-site testing and monitoring of beer quality

*There's an unmet need for a rapid, accurate and handy device to analyse contamination levels in draught beer. An EU initiative has introduced a portable, reliable and low-cost method for detecting bacterial or yeast contamination of beer.*

At present, breweries have little control over the quality of draught beer delivered to customers. While kegs are sterile leaving the breweries, the moment they are connected to a beer line, there is a risk of contamination. “Agar plating is the gold standard method for detecting

levels of contamination in beer served from the tap, but it's time-consuming, can't be performed on-site and test results take up to 5 days,” says Vivienne Williams, coordinator of the EU-funded INISH MINI-BAR (Inish Mini for On-Site Rapid Detection of Bacteria in Beer Directly from





“For patrons, there’s only one test that matters – the quality of beer served.”

the Tap) project. The adenosine triphosphate lumino-meter test is quicker than agar plating, but doesn’t measure levels of contamination directly from beer and is less reliable.

## ON-SITE BEER QUALITY MONITORING DONE DIFFERENTLY

INISH MINI-BAR addressed both methods’ limitations by developing a portable device that rapidly and accurately analyses the levels of bacteria, yeast and debris in draught beer on-site and directly from the tap. It enables the consistency of cleaning to be monitored, thus enabling beer line cleaners to adjust their cleaning schedules as needed. The innovation also identifies problem areas or taps in bars. These areas may be associated with parts of the bar that aren’t being cleaned correctly or used enough.

Robust with an easy-to-use touchscreen display, the device integrates microfluidic sample handling and impedance detection on-chip with advanced electronics. This minimises sample handling and generates results in just 60-90 seconds. Impedance detection allows bacteria, yeast and debris to be counted and analysed. The

innovation requires minimal sample preparation and results are easy to interpret. A red light indicates that a sample contains above 20 000 particles/mL. In such cases, the beer line needs to be cleaned immediately. A green light shows that a line is clean.

## COMPETITIVE ADVANTAGE

Project partners performed trials to test levels of contamination in 40 beer samples from bars in Dublin. They carried out agar plating on the same samples to assess the reliability and accuracy of the results gathered from the developed technology. Results show that the device is an excellent alternative to the lab-based agar plating.

In partnership with a beer line cleaning company, the project team carried out an on-site field trial in the United Kingdom. The device successfully demonstrated the ability to identify problem areas in bars and allow line cleaning routines to be validated. Additional on-site trials are planned throughout 2019 around the world in collaboration with major brewing and beer line companies.

One of the key environmental benefits of this novel technique is the considerable reduction in water consumption. It’s expected to reduce the frequency of line cleaning by about 20 %, saving millions of litres in one territory alone.

“INISH MINI-BAR will ultimately help beer companies and bar owners increase profits, reduce lost customers and do damage control because of poor-quality products,” concludes Williams. “For patrons, there’s only one test that matters – the quality of beer served.” Given the increasing popularity of low- and non-alcoholic beers that are nevertheless more susceptible to bacterial contamination, the technology may prove even more useful.

## INISH MINI-BAR

- Coordinated by Cellix Limited in Ireland.
- Funded under H2020-FOOD and H2020-SME.
- [cordis.europa.eu/project/id/755731](https://cordis.europa.eu/project/id/755731)
- Project website: [wearecellix.com/inishmini-bar](https://wearecellix.com/inishmini-bar)
- ▶ [bit.ly/2lydkYS](https://bit.ly/2lydkYS)



# Meet the smart factory that is turning shop floor staff into innovative problem-solvers

*How to improve the productivity levels of shop floor staff is a question many companies seek answers to. However, for one EU-funded project, the answer is very clear.*



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Introducing the FACTS4WORKERS (Worker-Centric Workplaces in Smart Factories) project, coordinator Martin Wifling says: “We aimed to support the work of the factory shop floor using the latest state-of-the-art (SotA) technology, ultimately creating a smart environment.” To do this, FACTS4WORKERS set out to develop smart factories that are attractive to workers.

## THE ANSWER

“This can be achieved by providing tailored services that ensure the efficient transfer of knowledge and information to empower workers to deal with their increasingly

difficult tasks,” explains Wifling. Tailored services will help increase workers’ problem-solving and innovation skills and improve cognitive job satisfaction. The end result will be higher levels of productivity.

Additionally, the project worked to deliver for the eight contexts-of-use worker-centric solutions with technology readiness levels between five and seven. For these reasons, FACTS4WORKERS worked towards placing already available IT enablers into a seamless and flexible smart factory infrastructure that is based on worker-centric and data-driven technology building blocks. “A human-centric approach, usability, user experience and technology

“*Smart factory data is the hidden ‘treasure’ to be unfolded by our developed technologies and services.*”

acceptance are also of key interest to the project,” confirms Wifling.

## THE FACTS4WORKERS SOLUTION

The project proposes a worker-centric smart factory solution through the development of a modular smart factory infrastructure. “Smart factory worker-centric human-computer interaction/human-machine interaction building blocks provide workers with novel ways to interact with information and knowledge inside the working environment adopting the latest devices,” explains Wifling. The building blocks provide the content for selected worker interfaces.

Smart factory infrastructure, the back-end infrastructure, includes the latest developments in data enrichment and aggregation, including semantics and linked data, datafication and analytics, and visualisation frameworks. “Smart factory data is the hidden ‘treasure’ to be unfolded by our developed technologies and services, ranging from multiple data sources and data formats,” adds Wifling.

## HIGHLIGHTING ACHIEVEMENTS

“Based on human-centred design approaches, the project developed structured development processes that take into account the main aspects concerning work satisfaction and innovation skills,” notes Wifling. Further to this and in cooperation with Virtual Vehicle and FACTS4WORKERS partners, a basic toolset for blue-collar workers was developed. It is based on existing SotA technologies and is available now as a ready-to-deploy prototype that allows for ICT applications specifically tailored towards the needs of workers.

FACTS4WORKERS also developed an architecture whereby it is easy to exchange, adapt, apply, deploy and maintain the services within the factory IT infrastructure. “Utilising SotA frameworks such as Docker and Angular, the architecture enables the integration of specific services with the best possible methods for doing a particular job well,” explains Wifling.

## THE FUTURE IS PROMISING

The knowledge gained in FACTS4WORKERS will be used by its scientific partners in follow-up projects in the future. The industrial partners also aim to further develop the prototypes. Additionally, the results of the project will be used in other measures that seek to improve job satisfaction and problem-solving skills, and thus workers’ productivity levels.

On a final note, Wifling adds: “Making sure the tailored services are accepted by potential users is vital. They have a significant cost saving potential.”

## FACTS4WORKERS

- Coordinated by the Virtual Vehicle Research Centre in Austria.
- Funded under H2020-LEIT-ADVMANU.
- [cordis.europa.eu/project/id/636778](https://cordis.europa.eu/project/id/636778)
- Project website: [facts4workers.eu](https://facts4workers.eu)

▶ [bit.ly/2MUa4MX](https://bit.ly/2MUa4MX)



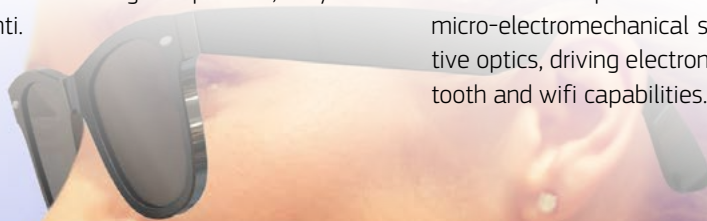
# World's smallest laser projector blazes trail for VR and AR eyewear

*Until now, it hasn't been possible to build lightweight, sleek virtual reality (VR) and augmented reality (AR) eyewear, or smart glasses, because of the large size and complexity of the electronics and optics required. However, an EU initiative has built pioneering laser technology that will make commercial and industrial VR and AR eyewear products a reality.*

With EU funding, the REALITY (Revolutionary projector platform for virtual and augmented reality eyewear) project has developed a novel visible laser light source and projector for next-gen VR and AR eyewear designed for consumers and professionals. "We have created a revolutionary red-green-blue (RGB) laser that's more than 90 % smaller than the solutions of leading competitors," says coordinator Dr Tomi Jouhti.

## LASER PROJECTORS FOR BEYOND STATE-OF-THE-ART AR EYEWEAR

Project partners integrated the RGB laser into the world's smallest ultra-compact retinal scanning display projector engine that's capable of providing a full colour 3D experience. The complete solution includes laser light sources, micro-electromechanical system imaging devices, adaptive optics, driving electronics, acceleration sensors, Bluetooth and wifi capabilities.



With the REALITY laser projector engine, customers will be able to build AR smart glasses that are always safe. “We have the only eye-safe laser technology in the world,” notes Dr Jouhti. Laser eye safety has been a major concern in the industry. Thanks to the novel laser technology, it won’t be an issue anymore. “The lasers are totally safe for the eyes, even without any feedback electronics – they are inherently eye-safe.”

### LEAVING COMPETING PRODUCTS BEHIND

Due to the small size of the laser solution – RGB laser and beam combiner – it’s possible to create consumer-friendly eyewear that looks like ordinary glasses or sunglasses. By keeping the cost of material under EUR 100, the REALITY team will be able to offer the eyewear at attractive retail prices.

The innovation promises a crystal-clear image day and night. The lasers provide zero visible background light unlike any other laser or light-emitting diode solution. There are no brightness limitations since the lasers are based on a non-linear effect. This is why the technology can easily control the brightness and image quality even in the lowest ambient light (night). Even during sunny days, the laser power can be slightly increased to provide a bright image, but still using 10 times less laser power

than the eye safety limit. Current AR smart glass solutions are dim and can’t be used outdoors.

The REALITY product enables a single prescription-ready lens solution for users needing correction. A thin reflective hologram – an important part of the optical path – can be laminated on any conventional lens. Most solutions require multiple lenses if the customer needs prescription lenses and wants to use AR smart glasses.

These strong competitive advantages are bringing the innovative products to the market. “We have shipped laser projector prototypes to some of the largest consumer electronics companies in the world,” says Dr Jouhti. “They’ll get a better understanding of this new retina scanning display concept, how it works, why it works the way it does, and what the technology’s limitations and opportunities are today and in the next five years.” In the second half of 2019, the consortium expects to sign its first major deal involving AR smart glass products. Other agreements are expected to soon follow.

### REALITY

- Coordinated by Brighterwave OY in Finland.
- Funded under H2020-LEIT-ICT and H2020-SME.
- [cordis.europa.eu/project/id/756043](https://cordis.europa.eu/project/id/756043)
- Project website: [brighterwave.com/](https://brighterwave.com/)

## DIGITAL ECONOMY

# Leading-edge platform makes dream of application-aware network a reality

*Unmet challenges concerning explosive demand for mobile internet data volumes pressure telecom companies and negatively impact the service quality for end users. An EU initiative has delivered a dynamic bandwidth management solution enabling the smart distribution of mobile internet bandwidth for telecoms.*

Mobile internet isn’t reliable enough for mission-critical applications, such as remote healthcare and autonomous

driving. The overall user experience can also be improved significantly if different types of traffic like mobile gaming



“*The disruptive innovation helps to identify the exact data needed for each internet-connected device or application on-the-fly and deliver the required bandwidth accordingly.*”

and internet protocol television are treated according to their inherent needs. “An operator that’s able to provide service level agreement (SLA) assurances and enhanced quality of experience (QoE) will also be able to monetise the network more efficiently,” says Mika Skarp, Founder and Chief Technology Officer of Cloudstreet, coordinator of the EU-funded AWARENET (The World’s First Application-Aware Network: Enabling Dynamic Bandwidth Management and Guaranteed Data Connection Quality in Mobile Networks) project.

A pressing issue in the domain is that mobile operator revenues have been flat for over a decade, while data use has grown exponentially. “This equation is unsustainable, and it means that operators’ ability to invest in new technologies like 5G is limited,” he adds.

To address this issue, AWARENET has provided operators with the tools needed to generate new revenue from premium quality-assured connectivity. It allows for SLA and QoE guarantees in mobile networks, ensuring that mission-critical use cases can be reliably delivered over the mobile internet. It’s expected that end users will be able to rely more on the mobile network, adopting completely new ways of working because they will be free of the need for wired connectivity. This will greatly impact sectors such as public safety, healthcare, fixed wireless access and video contribution.

### TRANSFORMING EXISTING SOLUTION INTO MARKET-READY TELECOM PRODUCT

Project partners further developed and scaled up their existing dynamic profile controller (DPC) solution. In 2016, the year before AWARENET started, this innovative network slicing platform was awarded Best Connectivity Solution at the World Communications Awards.

The project team is busy commercialising the product to enable mobile operators to deliver customer-oriented services within their current and future networks. “The disruptive innovation helps to identify the exact data needed for each internet-connected device or application

on-the-fly and deliver the required bandwidth accordingly,” explains Skarp. It enables instant and fully automated network optimisation to serve each end user’s precise data requirements at any particular moment, without affecting other network users’ connections. “Our DPC is the world’s first commercially available application-aware network solution.”

The solution is able to dynamically change network settings per application and provide predictive quality of service management for mission-critical applications. The DPC makes 5G-type services available on 4G networks as well when providing admission control mechanisms for 5G network slices.

AWARENET provides a blueprint for how mission-critical applications can be run over the mobile internet. Parts of the technology have already been implemented into 3rd Generation Partnership Project standards, and the overall concept of an awareness application program interface is recognised as a necessity for future networks.

During AWARENET, the consortium won a TM Forum award for Outstanding Catalyst Business Impact. TM Forum recognises Catalyst teams that have demonstrated outstanding work. Catalysts are proof-of-concept projects implemented by TM Forum members that connect diverse organisations in developing innovative, commercially viable prototypes of new digital services and business models.



"Thanks to AWARENET, we're working closely with two global tier-1 companies in the telecommunications and critical communications sectors," concludes Skarp. "Additionally, we're starting our first two commercial deliveries for the Asia-Pacific and Europe, Middle East and Africa regions."

#### AWARENET

- Coordinated by Cloudstreet OY in Finland.
  - Funded under H2020-LEIT-ICT and H2020-SME.
  - [cordis.europa.eu/project/id/756407](https://cordis.europa.eu/project/id/756407)
  - Project website: [cloudstreet.co](https://cloudstreet.co)
- ▶ [bit.ly/2X2Lux2](https://bit.ly/2X2Lux2)

#### DIGITAL ECONOMY

# Fun, inventive and dynamic: new approaches to digital skills and making technologies

*We know digital technology is radically changing the way people work, and many of tomorrow's jobs can't even be imagined today. But education systems are struggling to interpret what this imperative means for their pupils.*

Teachers and education authorities are doing their best to try and make their students digitally literate. Safety online, forays into programming and building circuits are finding their way onto some syllabi. But the approach is far from uniform and doesn't go far enough, and all too often it is only the well-funded schools that have the means to try and prepare their pupils for what is around the corner.

As early as 2013 the European Commission noticed that the challenge is not the lack of technology in schools but the huge variation in the use of technology, meaningfully, in education (European Commission, 2013, Survey of schools: ICT in education). In addition to this, most use of technology in education and training today does not support 21st century learning skills. In many cases, new technologies are simply reinforcing old ways of training and learning in current school settings and very often they

are introduced according to a narrow perception as being suitable only for talented children.

The EU-funded eCraft2Learn (Digital Fabrication and Maker Movement in Education: Making Computer-supported Artefacts from Scratch) project set out to challenge the status quo and foster the recognition that the ability to make and programme technological equipment promotes knowledge and skills that are valuable for every citizen. The project aimed to reinforce personalised learning and teaching in STEAM education (science, technology, engineering, arts and maths), and to assist the development of 21st century skills that promote inclusion and employability for youth in the EU.

But it was all very well for the project to establish there is an ever-increasing skills gap: they needed to identify exactly who requires what, in order to go beyond an analysis of the problem towards some practical solutions.

“We want to increase awareness of the need for digital fabrication and making technologies in education.”

“To get a clearer idea of what was required we developed ‘personae’, target people whose needs and contexts we analysed. We considered primary and secondary students, headteachers and teachers of various ages and subjects,” explains eCraft2Learn’s senior researcher and coordinator, Dr Calkin Suero Montero, based at the School of Educational Sciences and Psychology at the University of Eastern Finland.

Based on their initial research, the team went on to design, pilot and validate an ecosystem based on digital fabrication and making technologies for creating computer-supported artefacts.

The team harnessed, and contributed to, existing technical platforms such as Arduino and Raspberry Pi electronics, cloud-based 3D printer simulators, and maker-community-generated content. To help educators embrace this new approach, the team has also developed a space for teachers.

Students can collaborate through the digital platform. Signing up is easy: all it takes is the creation of a new session id by the teacher. “We are always happy to have users registering. Our package of activities and lesson plans are available to teachers from around the world, not just Finland and Greece, the pilot countries.” There is also an online support community platform. Anyone can register and participate in the community, sharing ideas and experiences.

eCraft2Learn is also addressing business needs. They have made sustainable, collaborative networks with local industries in a bid to enable students to become project-solving, ambitious entrepreneurs. “We want to increase awareness of the need for digital fabrication and making technologies in education. One way of doing so was to use industry-academy led workshops.”



© eCraft2Learn

Looking back at the project, Dr Suero Montero is proud of the empowerment that the eCraft2Learn hands-on learning activities have fostered in the participating students and teachers – the joy and ownership that the groups experience when finishing their project after pitfalls and lessons learnt is truly rewarding for all. “There is no better outcome than to see people (both students and teachers) learning as they go and applying what they know to new domains. eCraft2Learn is a true example of deeper learning and first-hand knowledge construction for technology fluency. It is a privilege to be part of such an enterprise!”

## ECRAFT2LEARN

- Coordinated by the University of Eastern Finland in Finland.
- Funded under H2020-LEIT-ICT.
- [cordis.europa.eu/project/id/731345](https://cordis.europa.eu/project/id/731345)
- Project website: [project.ecraft2learn.eu](https://project.ecraft2learn.eu)
- [bit.ly/2WyyV8d](https://bit.ly/2WyyV8d)



PROJECT OF THE MONTH

# Next Generation Internet building on EU-US collaboration

*If the Next Generation Internet is to make the best of the internet we have, to the benefit of all, while weeding out the less desirable elements, we need to put our heads together. The NGI Explorers project is part of the Fellowship Programme that provides top Internet researchers and innovators from Europe with the opportunity to develop their ideas through 'Expeditions' to the United States. The goal? Working side-by-side with a partner in the USA for three or six months to boost the impact of high-tech products and business ideas.*



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The selected candidates, 'the Explorers', will get on board this immersive journey, which is entirely sponsored by the European Commission under the Next Generation Internet Initiative, to gain the skills and build the networks in the USA that will act as a catalyst for their ambitious ideas. The programme is focussing on emerging technologies such as AI, Blockchain, IoT, Big Data and all those enablers that will drive the Digital Economy in the next 15 years.

The first Open Call for interested participants has been launched and organisers invite interested candidates to check the website for more information. Two more Open Calls will come in 2020, so stay tuned.

## NGI GODFATHERS PROG.

- Coordinated by F6S Network in the United Kingdom.
- Funded under H2020-LEIT-ICT.
- [cordis.europa.eu/project/id/825183](https://cordis.europa.eu/project/id/825183)
- Project website: [explorers.ngi.eu](https://explorers.ngi.eu)

“ We are in the middle of an information revolution, but we need to try and imagine what the Internet will look like in the distant future if we want to have a hand in shaping it. Connected devices, homes, cars, this we can foresee, but what will the Internet of the third millennium look like and how can we design for that now? By enabling Europe's best researchers and innovators to work closely with the best Internet talent in the US, we can make the most of the technological opportunities and catalyse the impact of their disruptive ideas. It's more vital than ever to make sure we maximise common ground. ”

Iwona Stefanik, Coordinator of NGI Explorers and Project Manager at F6S Network

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](mailto:editorial@cordis.europa.eu) and tell us why!





## SECURITY

# Novel system monitors the impact of vibrations in buildings and infrastructures

*Almost half the buildings Europeans live and work in are unable to withstand even small earthquakes. An EU initiative introduced technology that continuously monitors vibrations to understand how a structure's behaviour evolves over time to detect potentially dangerous abnormalities.*

Europe has millions of structures in seismic areas, and about 70 % are over 30 years old. Internal modifications, restructuring interventions and external mechanical stresses can contribute to jeopardising their stability over time. "We always think of earthquakes as destructive events, but they're natural events," says Gianni Alessandrini, coordinator of the EU-funded Quakebots (Artificial Intelligence and IoT for seismic monitoring) project. "The real killers are the buildings, which in many cases are built without anti-seismic criteria or on unsuitable soil."

## USING AI AND IOT FOR DISASTER MANAGEMENT

Project partners developed a vibrational and seismic monitoring system that combines the latest technology in AI, IoT and cloud computing. The system is a network of intelligent sensors installed on buildings that monitor in real time even the slightest vibrations. If the device records anomalies or deviations in a structure's behaviour, a notification is sent to users via smartphone, email or SMS.

© 2018 Damiano Fedeli





## Almost **half of** European buildings are **unable to withstand** even small **earthquakes**

The sensors are connected to a specially built cloud platform that's completely customisable. It adapts to the needs of each client concerning the complexity of the information to be displayed. Once connected, the device begins to collect and send data to the cloud platform. "We have worked to create a cloud platform that's highly scalable and has the potential to handle millions of buildings with very low latency," explains Alessandrini.

Quakebots' solution continually monitors a structure at little cost to individuals and large companies alike. It's easy to install, fully automatic, and doesn't require any particular attention or maintenance. New features are being added, and it's possible to integrate services developed by third parties. Users can obtain an overall view of the monitored structure with just a few clicks. "Quakebots stands out from other vibrational and seismic monitoring systems for its quality, precision and ease of installation," he adds.

Alessandrini calls 2018 very productive and rewarding. It began when Quakebots' unique proposition and value

earned it a Horizon 2020 SME Instrument Phase 1 award, a major funding prize from the European Commission for further product development and commercialisation.

### 24/7 MONITORING OF BUILDINGS IN ITALY

Project partners tested the device at the Italian National Agency for New Technologies, Energy and Sustainable Economic Development. The University of Perugia certified the system. Pilots in more than 70 Italian municipalities monitored city halls, schools, hospitals and public buildings. The system is already installed in the vaults of Giotto and Cimabue at the Basilica of Saint Francis of Assisi to ensure continuous monitoring of one of the most important historical buildings in Italy.

Wise Robotics, project coordinator, also signed several partnership agreements to extend its commercial network and services. "One of the main achievements of 2018 was monitoring the EXXON Mobil industrial warehouses inside the refinery in Augusta, Sicily," says Alessandrini.

Public administrations, cultural heritage managers, condo and real estate owners, companies and factories have already adopted the system. Over 340 devices are at work throughout Italy, and the number is steadily growing.

#### QUAKEBOTS

- Coordinated by Wise Robotics in Italy.
- Funded under H2020-SECURITY and H2020-SME.
- [cordis.europa.eu/project/id/806911](https://cordis.europa.eu/project/id/806911)
- Project website: [quake.cloud](https://quake.cloud)

#### SECURITY

## New tech ahoy for safer ship evacuations

*Your ship's in trouble. You need to know where everyone is before you can get them off. New technologies make that possible.*

The two most prominent passenger ship accidents in recent years – the Costa Concordia and the Sewol ferry – resulted

in 32 and 304 deaths, respectively. In both cases, delayed and disorderly evacuations contributed to the tolls.



These incidents highlight a need for improved evacuation management. Currently, neither passengers nor crew can be located. People could be trapped in inaccessible areas of a ship, yet rescue authorities would not know.

The EU-funded LYNCEUS2MARKET (An innovative people localisation system for safe evacuation of large passenger ships) project provided technological solutions to these problems. The venture was an extension of a previous EU project, LYNCEUS. The earlier undertaking created technologies for localising and tracking people during shipping emergencies, and tested the equipment at laboratory and pilot scales. The new project united industry players, to continue development and realistically test the technologies in preparation for market release.

## TRACKING PASSENGERS

All project technologies advance the state-of-the-art. They fall into two categories.

“First are systems for on-board passenger and crew localisation and tracking during emergency evacuation,” says project coordinator Melinda Kuthy. A network of wireless nodes throughout the ship detects smart devices issued to passengers, including key cards, life jackets and bracelets. All devices upload information in real time to a centralised decision-support system on the ship’s bridge; life jackets and bracelets also monitor passenger heartbeats. Every individual can thus be accounted for and remotely assessed for medical needs.

Senior staff would use the system to display the locations of all personnel and determine the best course of action under given circumstances. For example, the decision-support system may recommend guiding evacuations around a hazardous part of the ship.

“Our second set consists of search and rescue systems for locating passengers and crew after abandoning ship,” adds Kuthy. Electronic signals from search drones activate radio beacons on life jackets. In addition, the team developed life jacket patches that reflect radar signals. The positions of any passengers in the water can therefore be triangulated regardless of time of day or visibility. This information is also uploaded to the central control system. Hence, survivors are more likely to be rescued before the onset of hypothermia.

## REFINEMENT AND TESTING

LYNCEUS2MARKET researchers significantly advanced the earlier technologies in terms of design, miniaturisation, network interface and power management. The devices are now small, cheap and convenient. The system is also compatible with existing types of bracelets and key cards. The team furthermore refined aspects of the control system, including data feeds, passenger database formats, visualisation modules and situational awareness algorithms.

During the largest ever test of its kind, researchers released overboard 200 dummies wearing life jackets. All were rapidly located and retrieved. In addition, the control system was installed and successfully operated on a large cruise ship. Users, including passengers, reported high levels of acceptance and satisfaction.

The team continues negotiations with end users. The final systems should soon be ready for market uptake. Eventually, the system may also be expanded beyond maritime rescue contexts, to other applications such as ski fields and amusement parks.

Project developments will make ship evacuations more orderly and faster. Therefore, passengers will be more likely to abandon a ship safely. If anyone does enter the water, the new systems will facilitate their prompt rescue.

## LYNCEUS2MARKET

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- Coordinated by RTD Talos Ltd in Cyprus.
- Funded under H2020-TRANSPORT.
- [cordis.europa.eu/project/id/636286](https://cordis.europa.eu/project/id/636286)
- Project website: [lynceus-project.eu](https://lynceus-project.eu)





## FUNDAMENTAL RESEARCH

# Composite pulses make for error-free quantum computing

*Stable qubits resilient to the detrimental effects of environmental noise are critical for commercialising quantum computing applications. EU-funded researchers demonstrated efficient error correction for qubits, marking a significant step towards fault-tolerant quantum information processing.*

To develop their full potential, quantum computers will need to meet specific criteria: They need to have a considerably high number of qubits and be capable of processing errors. Qubits are particularly prone to errors: a passing radio wave or a flash of light is enough to disrupt its quantum state and cause havoc with a quantum computer's calculations.

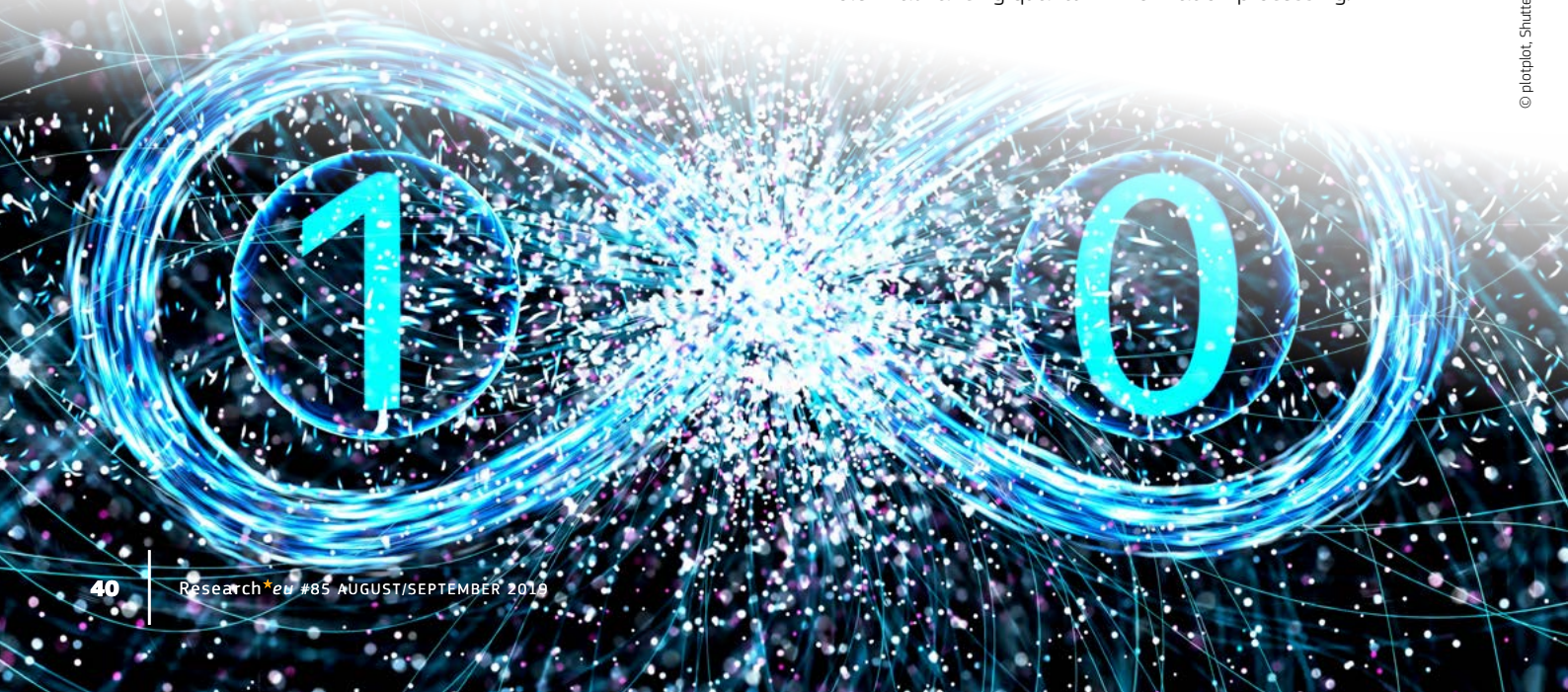
### MORE ACCURACY IN QUANTUM COMPUTATIONS

Undertaken with the support of the EU-funded Marie Skłodowska-Curie fellowship, the COPQE (Composite Pulses for Quantum Engineering) project conducted breakthrough research on reducing environmental noise and optimising control over qubits. The project's novelty lies in the development of composite pulses, a quantum engineering technique capable of correcting any errors present in quantum information processing. This fault tolerance was achieved using quantum error correction, where information is encoded redundantly, enabling error detection without destroying quantum data.

"Composite pulses boast several advantages: They give qubits – independently of their initial state – an incredible level of control, precision and insensitivity to the presence of errors. They also help create high-fidelity quantum states of qubits sent down in defect integrated photonic waveguides," notes project coordinator Dr Elica Kyoseva. Composite pulses demonstrated a negligible loss of fidelity – the precision rate was above the limit of 99.99 % for quantum information processing – with minimal pulse overhead (the smallest sequence contained only two pulses).

### 'LIGHTING' THE WAY TO QUANTUM COMPUTING

The research conducted by COPQE strengthens the power of integrated quantum photonics on quantum computing. Integrated quantum photonics – the science of generating, manipulating and detecting light in regimes where it is possible to coherently control photons – is a fundamental field in exploring quantum phenomena. Due to photons being particularly attractive carriers of quantum information, quantum photonics is also expected to play a central role in advancing quantum information processing.





“Project results will form the cornerstone platform to experiment with various protocols for quantum information processing. They also bring high-fidelity quantum computing in integrated photonic circuits closer to practical reality,” Dr Kyoseva points out. As she further describes, composite pulses were initially developed to mitigate fluctuations in the strength of the driving oscillating field in nuclear magnetic resonance. Since then, they have attracted considerable interest in quantum engineering due to their robustness against errors. So far, no composite pulses have been realised in integrated photonics systems.

## QUANTUM COMPUTING IMPACT

Being able to run processes in parallel compared to classical computers, which perform tasks sequentially, quantum computers will analyse big data and solve complex optimisation problems significantly faster. “Quantum computers have a huge potential to redefine existing industries including quantum computing security, financial services, drug development, material science, pharmaceuticals and other data-heavy industries. To this end, a lot of effort is dedicated to pushing the technology beyond the realms of laboratory to emerge into reality. The most significant roadblock is the extreme sensitivity of quantum systems to their

“Quantum computers have a huge potential to redefine existing industries.”

surrounding environment which significantly reduces the accuracy of quantum operations and destroys quantum computations,” notes Dr Kyoseva.

A lot of science and engineering is still required to improve qubit stability. Reducing noise and optimising the error control over the qubits is a significant step towards this direction. Project methods for qubit control based on composite pulses are highly relevant to error-free quantum information processing.

## COPQE

- Coordinated by the Institute of Solid State Physics, Bulgarian Academy of Sciences in Bulgaria.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/705256](https://cordis.europa.eu/project/id/705256)
- Project website: [elkyoseva.wixsite.com/elica-kyoseva/h2020-grant-705256-copqe](https://elkyoseva.wixsite.com/elica-kyoseva/h2020-grant-705256-copqe)

## FUNDAMENTAL RESEARCH

# A peek inside nature's pesticide factory

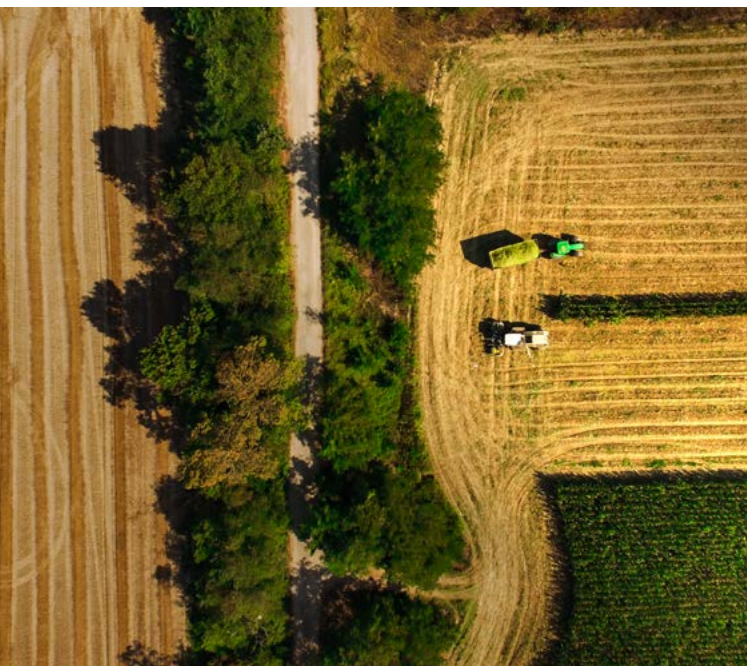
*Some roundworms exploit the symbiotic bacteria in their guts to kill insects for the worms to eat. EU-funded scientists have discovered a signalling pathway that may promote bacterial survival, with important implications for eco-friendly pesticides.*

According to the Food and Agriculture Organization of the United Nations (FAO), approximately one third of the world's population makes a living from agriculture. This task is complicated by insect pests, which destroy billions of euros worth of crops every year.

Chemical pesticides are the primary weapon against these invaders, but they are not environmentally

sustainable. Fortunately, nature has provided an eco-friendly solution in the form of roundworms that kill insects.

The entomopathogenic nematode (EPN) called *Heterorhabditis* is commercially available and widely used to control insect pests. However, it may lose its efficacy during storage prior to use. With the support of the Marie



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“Using a targeted genetic approach, we identified a signalling pathway in *Photorhabdus* that is required for the persistence of the bacteria in the nematode.”

Skłodowska-Curie programme, researchers working on the STEP-N-UP (Stilbene and entomopathogenic nematodes: Unlocking the potential) project have uncovered a signalling pathway critical to the maintenance of entomopathogenic properties that could help preserve or extend shelf-life.

## LYING IN WAIT TOGETHER

*Heterorhabditis* is a holobiont, an organism that forms a small ecosystem by hosting various symbionts. In this case, the ‘hostee’ is a bacterial partner, *Photorhabdus*. As project coordinator David Clarke explains, “*Photorhabdus* colonise the gut of a special developmental stage of the nematode called the infective juvenile (IJ) and the colonised IJ is in fact the commercially available EPN product.”

The IJ invades the larvae of insects and regurgitates the bacteria, killing the insects. The nematode feeds on their decomposing bodies.

IJs can remain viable for several months without feeding and it is critical that the gut bacteria remain viable as well. This is essentially the ‘shelf-life’ of the EPN product. However, very little is known about how the bacterial symbionts stay alive and well.

## KEEPING DEADLY BACTERIA ALIVE

On the hypothesis that the EPN feeds the bacteria, researchers started looking for RNA evidence suggesting active nutritional exchange between the two organisms. They studied transcriptional profiles of IJs colonised with bacteria and compared them to those without. Surprisingly, there was no evidence of exchange.

Clarke’s team, including Marie Skłodowska-Curie scholar Dr Dana Blackburn, then turned to the bacteria. According to Clarke, “Using a targeted genetic approach, we identified a signalling pathway in *Photorhabdus* that is required for the persistence of the bacteria in the nematode.”

It turns out the so-called Cpx pathway, well-described in another gut-dwelling bacteria, *Escherichia coli* or *E. coli*, must be active for *Photorhabdus* to remain viable in its host.

The STEP-N-UP discovery has important implications for increasing the shelf-life of nature’s pesticide *Heterorhabditis*. Future research could also lead to enhanced food security to feed a growing population. Finally, given that human gut microbiota has been shown to produce a range of small molecules that influences human immune development, results could impact our understanding of human health and disease.

## STEP-N-UP

- Coordinated by University College Cork – National University of Ireland, Cork in Ireland.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/706272](https://cordis.europa.eu/project/id/706272)



## AGENDA

# OCTOBER 2019

**BERLIN, GERMANY**  
Mediterranean Aquaculture Industry Forum  
→ [performfish.eu/events](https://performfish.eu/events)

**7→10  
OCT**

**14→16  
OCT**

**HELSINKI, FINLAND**  
European Big Data Value Forum  
→ [european-big-data-value-forum.eu](https://european-big-data-value-forum.eu)

**14→16  
OCT**

**NEW YORK, UNITED STATES  
OF AMERICA**  
17th International Conference on  
Smart Living and Public Health (ICOST 2019)  
→ [project-pulse.eu/how-does-ai-impact-urban-living-and-public-health](https://project-pulse.eu/how-does-ai-impact-urban-living-and-public-health)

**16  
OCT**

**WORLDWIDE**  
World Food Day

**29→30  
OCT**

**AJACCIO, CORSICA, FRANCE**  
Second European conference on  
*Xylella fastidiosa*  
→ [ponteproject.eu/conferences/second-european-conference-on-xylella-fastidiosa-how-research-can-support-solutions](https://ponteproject.eu/conferences/second-european-conference-on-xylella-fastidiosa-how-research-can-support-solutions)

**31  
OCT**

**WORLDWIDE**  
World Cities Day

**MORE  
EVENTS**

[cordis.europa.eu/  
news](https://cordis.europa.eu/news)

**2-4  
OCT**

**GRAZ, AUSTRIA**  
CIVITAS Forum 2019

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→ [civitas.eu/forum2019](https://civitas.eu/forum2019)

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Accelerating the uptake of renewables represents a key solution to decarbonisation and climate change mitigation. Our new Results Pack introduces nine projects that are specifically aimed at reducing barriers to using more sustainable energy sources.



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