



# Research<sup>★</sup>eu

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Examining EU leadership  
in science and cultural diplomacy

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could drive bike-sharing forward

Groundbreaking device first  
to define location of falling  
space debris in real time

**SPECIAL FEATURE**  
**OBESITY: EU RESEARCH**  
**BATTLES THE BULGE**

# Editorial

## EU research at the forefront in the battle against obesity and taking space farming from fiction to reality –

### welcome to this month's Research\*eu magazine

Obesity is a growing and increasingly frightening public health concern, across the EU but also worldwide. With Eurostat estimating in 2014 that slightly over 50% of the EU population is either overweight or obese, the consequences of obesity on society will become ever costlier. For the individual, harmful health effects of being overweight include a much higher risk of developing a number of chronic diseases, such as diabetes and cardiovascular disease, but obesity also increases susceptibility to a number of mental health conditions. At a societal level, the growing rates of obesity will cause greater strain on already financially stretched healthcare systems and social resources.

This is why we're covering obesity in this month's special feature, or more specifically, how innovative EU-funded projects under the Seventh Framework Programme (FP7) and Horizon 2020 are undertaking dedicated research to answer the following crucial questions: What are the real root causes of obesity? How can a better understanding of these causes help us develop better treatments? And how can we best support those who are currently overweight or obese?

As you read through our special feature, you'll discover that the answers to these questions are by no means simple and are actually very much multi-faceted. Whilst traditional lifestyle factors, such as diet, are indeed important, other key factors in getting to grips with

obesity include genetics, metabolism and cutting-edge new technologies to provide new forms of treatment.

Meanwhile, in our **Life After** feature, we have a good old catch-up with the coordinator of the TIME SCALE project, who happily updates us on her team's efforts to develop out-of-this-world life support systems to allow the growth of crops and algae in a space-faring environment. It sounds like something from an Arthur C. Clarke novel but it's actually happening!

In **Project of the Month** we highlight the INTENS project, which contributed to an innovative study recently published in 'Nature' that showed how all cells in the foetal gut have the potential to be developed into stem cells, whilst **EU Agenda** summarises some of the best events featuring EU-funded projects that will take place in September, once everyone is back from the long summer holiday.

Until next month, if you have queries, questions, 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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- 43** September 2019



# A 15-minute acute lung infection diagnostic test with unmatched performance

*In the fight against antibiotic resistance, lower respiratory tract infections (LRTIs) are a target of choice. Fast, high-performance tests developed by MeMed Diagnostics can considerably improve diagnostics, thereby allowing for better treatment and preventing antibiotic misuse.*

Taken together, pneumonia, bronchitis and tuberculosis – known as LRTIs – are the third largest cause of death worldwide. The lack of treatments is not to blame: existing antibiotics are effective, but they are often misused due to the multiple shortcomings of routine microbiological diagnostic tests.

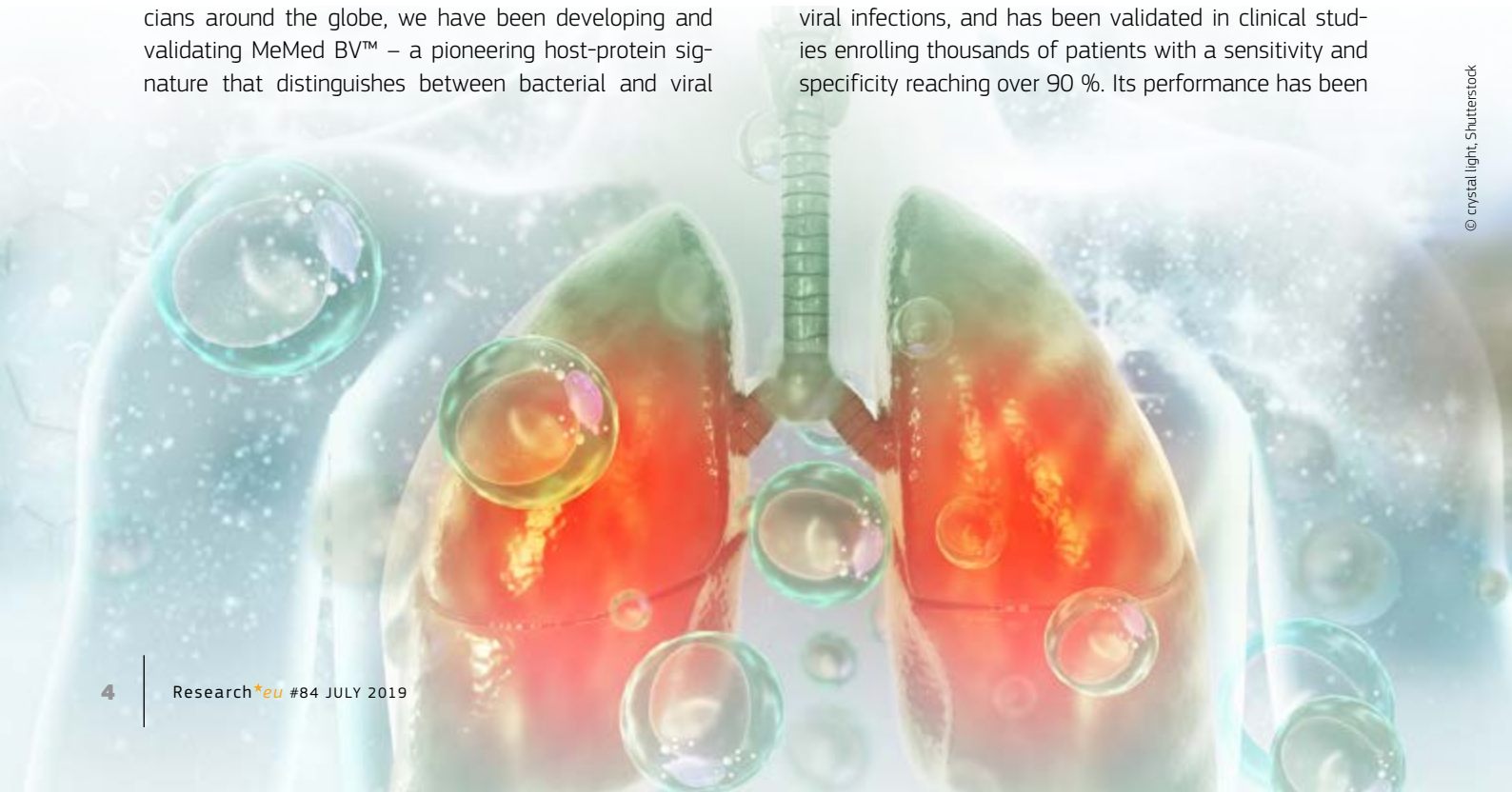
The perfect test method should be fast and accurate. It should allow for the diagnosis of inaccessible infections, avoid false alarms, and be able to deal with evolving microbes. Whilst none of the existing test methods (such as culture, molecular diagnostic and the rapid antigen test) fits the bill for LRTI, the alternative developed by Israeli SME MeMed Diagnostics offers a new approach.

“For nearly a decade, in collaboration with leading clinicians around the globe, we have been developing and validating MeMed BV™ – a pioneering host-protein signature that distinguishes between bacterial and viral

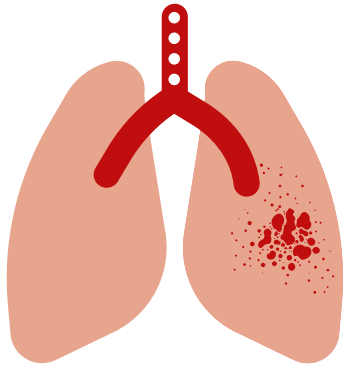
infections. It harnesses the body’s immune response to infection,” explains Dr Tanya Gottlieb, VP Scientific Affairs at MeMed Diagnostics and coordinator of the Respiratory-ImmunoDx (Clinical validation of host biomarker signature for distinguishing bacterial versus viral lower respiratory tract infections (LRTI) in adults at the point-of-need) project.

“The host signature is based on measurements of three blood borne immune-proteins: tumour necrosis factor-related apoptosis-inducing ligand (TRAIL), interferon gamma-induced protein-10 (IP-10) and C-reactive protein (CRP).”

MeMed BV™ computationally integrates these three proteins to generate a score indicative of the likelihood of a bacterial immune response. Unlike other diagnostic tests, it can tell the difference between bacterial and viral infections, and has been validated in clinical studies enrolling thousands of patients with a sensitivity and specificity reaching over 90 %. Its performance has been



## Lower respiratory tract infections (LRTIs) are the **3rd largest cause of death** worldwide



demonstrated in both children and adults, across multiple clinical syndromes and pathogens, and irrespective of coloniser presence, from 0 to 7 days after symptom onset.

Funding under Respiratory-ImmunoDx allowed the team to conduct one of these clinical studies specifically on LRTI, named OBSERVER. The study, which enrolled a total of 583 patients, consisted in validating the TRAIL/IP-10/CRP signature in adults suspected of carrying infections like bronchitis and pneumonia.

Preliminary analysis indicates that the host signature exhibited a sensitivity of 98 %, a specificity of 95 %, a positive predictive value of 91 % and a negative predictive value of 99 %, thereby demonstrating its high performance. The signature was also shown to significantly

improve the concordance between the diagnosis at the time of emergency assessment and the 'true diagnosis' (reference standard) from 56 % to 87 %.

But the project went a step further. Dr Gottlieb and her team developed a compact, easy-to-use point-of-care platform able to measure multiple proteins rapidly with lab-level precision. "The diagnostic system, called MeMed Key™, includes an analyser and a disposable cartridge that contains all the reagents. The underlying chemiluminescence and magnetic particle chemistry is similar to that of large automated immunoassay machines, with a test run time of 15 minutes for measuring the TRAIL/IP-10/CRP signature. This paves the way to application in multiple clinical settings," she enthuses.

While the MeMed BV™ test is compatible with serum – a sample type that demands coagulation and centrifugation – it is only suitable for hospitals, thereby prohibiting wider adoption by physicians. Dr Gottlieb and her team are planning to make MeMed BV™ compatible with small volumes of capillary blood to expand applicability to physician offices, as well as commercialise both tests in Europe and the United States.

### RESPIRATORY-IMMUNODX

- Coordinated by MeMed Diagnostics Ltd in Israel.
- Funded under H2020-LEIT-ADVMAT and H2020-HEALTH.
- [cordis.europa.eu/project/id/684589](https://cordis.europa.eu/project/id/684589)

## HEALTH

# Exploring a unique laser immunotherapy against cancerous tumours

*Harnessing the power of the immune system to fight disease is an area of growing medical interest. When it comes to fighting cancer, one project is using laser technology for an innovative therapy.*

Our immune systems protect us by producing antibodies to fight infections. Drug-based immunotherapies boost these natural defences against illness such as cancer. But with many patients not responding to these immunotherapies, new approaches are needed.

The EU-supported INTHER (Clinical validation and commercialization of innovative immunostimulating Interstitial Laser ThermoTherapy) project developed an innovative device to deliver minimally invasive immunostimulating Interstitial Laser ThermoTherapy (imILT). The

therapy works by attacking the tumour directly and stimulating the patient's own immune system to attack other (same-type cancer) tumours.

The effectiveness of the method was tested against solid pancreatic and breast cancer tumours confirming the therapeutic promise of the new method. The clinical uptake of imILT will reduce the treatment costs of treating solid tumours, such as incurred by surgery.

### TESTING FOR SAFETY AND EQUIPMENT USABILITY

The imILT laser light heats the cancerous tumour in a gentle and controlled way, killing it within a few days and causing it to leak antigens. These antigens activate the body's immune system, which also targets other tumours and metastases in the body.

In the case of pancreatic cancer, five patients with stage III pancreatic cancer were treated in France using imILT during open surgery. The patients tolerated the treatment well and the equipment was found to be highly usable and safe.

In Portugal, four patients with locally advanced stage III and stage IV pancreatic cancer were also treated

“ *These tests demonstrate that imILT treatment is safe, non-invasive with few side effects, and at a lower cost per patient compared to surgery or chemical treatment.* ”

using open surgery. The therapy was well-tolerated by the patients and no serious side effects resulted from the therapy.

As of November 2018, five of the patients who received imILT had a median survival time of 17 months, compared with the published results for locally advanced, inoperable pancreatic cancer, with a median survival of under a year.

As for breast cancer, two patients in the UK were treated with imILT. The treatment was well tolerated without serious side effects, and both patients were still alive when followed-up, two and 10 months (respectively), after the therapy.

“These tests demonstrate that imILT treatment is safe, non-invasive with few side effects, and at a lower cost per patient compared to surgery or chemical treatment,” says Lars-Erik Eriksson, CEO at CLS.



As the treatment happens at a low temperature (about 46 degrees for 30 minutes), the tumour's antigenic proteins are preserved, further stimulating an immunological defence and potentially offering long-term protection against tumours of the same kind of cancer: a possibility still to be properly investigated.

## TOWARDS CLINICAL PRACTICE

Currently, CLS and the two hospitals that conducted the pancreatic cancer study are collaborating further on using imILT. Results are to be jointly presented at the ECIO conference in April 2019. Additionally, the Institute of Oncology in Portugal will continue to offer imILT to patients with pancreatic cancer making it the first European hospital to routinely offer it.

The TRANBERG delivery system (the laser machine and instruments used to treat the patient, measuring and controlling laser temperature) is CE-marked and market

ready, while the imILT method (the treatment protocol) needs to be further verified with more patients.

The prevalence of pancreatic cancer is increasing significantly and lacks effective treatments. Additionally, most patients are diagnosed quite late, due to somewhat indeterminate symptoms. "If CLS can offer an alternative for these patients, improving overall survival rates, this will be a milestone. imILT can also be combined with other treatments – an area we will further explore", says Eriksson.

## INTHER

- Coordinated by Clinical Laserthermia Systems AB in Sweden.
- Funded under H2020-HEALTH.
- [cordis.europa.eu/project/id/725151](https://cordis.europa.eu/project/id/725151)
- Project website: [clinicallaser.se](http://clinicallaser.se)

## HEALTH

# A realistic look at youth smoking in seven European cities

*Cigarette smoking is a main risk factor for premature disease, disability and death in Europe. In practice, the impact of currently available strategies to address this problem often appears to be limited, especially among socially disadvantaged youth.*

The EU-funded SILNE-R (Enhancing the effectiveness of programs and strategies to prevent youth smoking: a comparative realist evaluation of 7 European cities) project aimed to identify new opportunities for policies

to prevent youth smoking in Europe. "Several measures have already been taken in European countries to prevent youth smoking. However, there is need for more efforts, and for more evidence to support these efforts," outlines Prof. Anton Kunst, project coordinator.

## SUCCESSFUL ANTI-SMOKING STRATEGIES IDENTIFIED

Despite efforts made by tobacco control NGOs, not all countries in the study – Belgium, Germany, Ireland, Italy, the Netherlands, Portugal and Finland – have adopted all the policy measures that have been shown to be effective

“ We therefore aimed to assess how policies could be implemented in such a way as to have a maximal impact on preventing youth smoking. ”



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in the past. SILNE-R therefore identified strategies that individual NGOs can apply to stimulate national and local policymakers to implement effective policies.

Where countries or regions did adopt effective policies, implementation may be partial and poor and the effectiveness may be limited. “We therefore aimed to assess how policies could be implemented in such a way as to have a maximal impact on preventing youth smoking,” emphasises Prof. Kunst.

## ELIMINATING EFFECTS OF VARIATION ACROSS EUROPE

“To negate the differences we found between NGOs, we identified various strategies where they could increase their influence on policymaking,” explains Prof. Kunst. Examples include using scientific evidence, involving national media, establishing lasting contacts with ministries and marginalising the tobacco industry.

Where policies have failed, for example, to make school premises smoke-free, the strategy could be improved in several ways. SILNE-R formulated appropriate solutions, in this case: clear communication to staff and students, empowerment of staff members who enforce the smoking bans, and progressive sanctioning of students who violate the rules.

## THE WHY AND HOW FOR TACKLING THE PROBLEMS

“We applied a methodology that is new in this field of enquiry: the ‘realist analysis,’” reports Prof. Kunst. Key to this approach is that researchers didn’t just ask the question WHETHER an intervention is effective, they also asked WHY it is (not) effective and HOW effectiveness could be increased. As Prof. Kunst points out, “this opens up a new, promising area of research. However, it takes time to explore and apply new methods of empirical research, but with some perseverance we finally managed to get novel results based on these methods.”

The qualitative, comparative research angle the team employed also came with a price. In-depth interviews were held with adults and focus group discussions with young people. Contrary to previous studies, they did this for the seven countries simultaneously. As a result, all transcripts had to be translated into one common language for training interviewers, with subsequent analysis of a huge number of transcripts.

## NEXT STEPS

SILNE-R has already produced more than 40 manuscripts, many already published by international scientific journals, but many others are still in the pipeline. “This post-project year we will be working hard to complete the remaining papers and get all papers published,” Prof. Kunst stresses.

Prof. Kunst says he would like to see an extension of the project work to the entire EU. “In the current project, we focused on learning from ‘spearhead’ countries with advanced tobacco control policies.” However, these countries are mostly found in northern and western parts of Europe. “Having realised that tobacco consumption is now especially high in countries in other parts of the EU, we would like to assess the situation in these countries using the methods that we have developed,” he concludes.

## SILNE-R

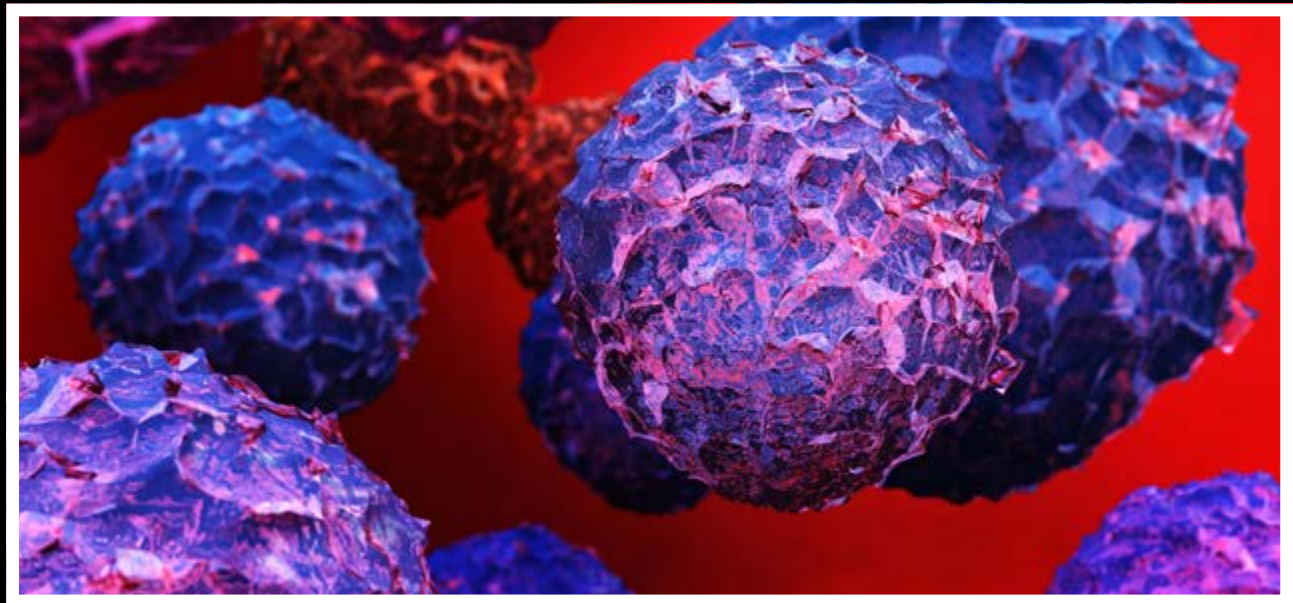
- Coordinated by AMC, University of Amsterdam in the Netherlands.
- Funded under H2020-HEALTH.
- [cordis.europa.eu/project/id/635056](https://cordis.europa.eu/project/id/635056)
- Project website: [silne-r.ensp.org](https://silne-r.ensp.org)



PROJECT OF THE MONTH

# New findings show that all immature cells can develop into stem cells

*All cells in the foetal gut have the potential to develop into stem cells, a new study published in 'Nature' and conducted at the Faculty of Health and Medical Sciences at the University of Copenhagen concludes, a partner in the EU-funded INTENS (INtestinal Tissue ENgineering Solution) project. The researchers discovered that the development of immature intestinal cells is not predetermined but is instead affected by the cells' immediate surroundings in the intestines.*



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Throughout life, the organs in the body are maintained by stem cells, which are also able to repair minor tissue damage. A better understanding of the factors that determine whether or not an immature cell develops into a stem cell may therefore be useful in the development of stem cells for therapy and transplantation.

## INTENS

- Coordinated by University College London (UCL) in the United Kingdom.
- Funded under H2020-HEALTH.
- [cordis.europa.eu/project/id/668294](https://cordis.europa.eu/project/id/668294)
- Project website: [intens.info](https://intens.info)

“ *We have gained greater insight into the mechanisms through which cells in the immature intestines develop into stem cells. Hopefully we are able to use this knowledge to improve treatment of non-healing wounds, e.g. in the intestines. So far, though, all we can say for sure is that cells in the gastrointestinal tract have these characteristics. However, we do believe this is a general phenomenon in foetal organ development.* ”

Prof. Kim Jensen,  
Biotech Research & Innovation Centre, Copenhagen University,  
INTENS project partner

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!



SOCIETY

# Examining EU leadership in science and cultural diplomacy

*“The science of two nations may be at peace while their politics are at war,” wrote the UK’s Royal Society President, Sir Joseph Banks in 1796 to a French colleague. EL-CSID explored the relevance of this principle for the EU today.*

Over recent years, the EU’s external relations have increasingly taken account of the fact that cultural exchanges and scientific collaborations can foster relations between states. A good example being SESAME, the international nuclear research facility in Jordan (co-funded by the EU), where scientists from the Arab world and Israel work together.

Despite this, there is still no overall strategy or comprehensive understanding of the longer-term implications of these efforts in today’s fast-changing, multipolar world.

The EU-supported EL-CSID (European Leadership in Cultural, Science and Innovation Diplomacy) project set out to codify and articulate the assumptions underpinning much of this work, teasing out the prevailing direction of travel, to strengthen EU policy with a series of recommendations.

## HOW DOES THE EU WANT TO PROJECT ITSELF TO THE WORLD?

EL-CSID started by mapping science and cultural diplomacy activities in Europe and beyond to understand why, where and when, concepts and policies were adopted. The project analysed relevant policy documents and conducted interviews with key practitioners and stakeholders, including 16 in-depth interviews with scientific coordinators of H2020 projects, as well as with science and culture foreign correspondents.

The findings suggest that for the EU to be an effective, trusted global actor, it cannot rely solely on ‘hard power’. Rather, it must tap its ‘soft power assets’ such as its values and traditions (including the rule of law, democracy, free speech and social welfare), as well as its vast historical and contemporary cultural portfolio, alongside its contribution to science and innovation.

“When dealing with neighbouring countries in the Middle East and North African region, science and culture could play an important role in strengthening relations,” says Prof. Luk Van Langenhove. Following this, EL-CSID proposes that all relevant European Commission departments step up interaction with the European External Action Service (EEAS).

The project also recommended that the EU develops a clear science and cultural diplomacy strategy in support of Member State activities, building its own capacity in those areas, as part of the EU’s overall security strategy. “The EU could frame its narratives and actions in support of cultural diversity, as it embodies a success story here. This would then give it more credibility as a less controversial interlocutor for state and non-state actors during multilateral initiatives,” says Prof. Van Langenhove.

For this to flourish, despite rightly being led by the EU, EL-CSID concludes that greater leadership roles should be afforded to the scientific and cultural communities that the EU represents.

## ENSURING A LEGACY

To ensure the continuation of its research, EL-CSID set up a joint science diplomacy website, together with two other Horizon 2020 projects InsSciDE and S4D4C. “Our biggest hope is that the EU supports science and cultural diplomacy by setting up a European observatory as a monitoring, capacity building and awareness raising platform,”

“ *The EU could frame its narratives and actions in support of cultural diversity, as it embodies a success story here.* ”



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says Prof. Van Langenhove. “We are also exploring the possibility of a COST action to develop a sustainable network of Science and Cultural Diplomacy scholars and practitioners.”

Towards this, Prof. Van Langenhove published ‘Tools for an EU Science Diplomacy’, an assessment of current national capacity across the EU and beyond, with a set of six recommendations for the development of an EU science diplomacy strategy.

#### EL-CSID

- Coordinated by the Free University of Brussels (VUB) in Belgium.
- Funded under H2020-SOCIETY.
- [cordis.europa.eu/project/id/693799](https://cordis.europa.eu/project/id/693799)
- Project website: [el-csid.eu](https://el-csid.eu)

#### SOCIETY

# The impact of post-war cinema on young Italian masculinity

*Gender representation in the media sends messages about the roles of men and women in society. EU-funded research shines a light on cinema’s impact on notions of Italian masculinity.*

Young-Italian 2015 (Dangerous Masculinities: Young Men in Italian Cinema of the 1940s-1960s) investigated cinematic identities and memories related to young Italian

men in the two decades spanning 1943-1963. Undertaken with the support of the Marie Skłodowska-Curie Individual Fellowships programme, this research

integrated approaches from reception and ethnographic studies with textual cinematic analysis.

“The project found that cinema and its paratexts (magazines, posters) was a central institution for articulating a young Italian masculinity that spoke directly to a post-war generation,” explains Professor Catherine O’Rawe, project coordinator. Alongside the country’s developing youth culture, this mass medium helped Italian men frame their own identity as youths.

## POST-WAR EXPERIENCES

The ethnographic aspect became more prominent as project research progressed. Project investigator Dr Enrico Biasin conducted face-to-face interviews and focus groups with older Italian men eager to recount personal experiences of post-war cinema-going and how this influenced their identity formation. Additional data sources included diaries and notebooks, some supplied by study participants and others held in the National Diary Archive in Italy. Written responses to a project-developed questionnaire also provided important study insights.

Studies delving into the memories shared by older people can play an important function in addressing critical challenges posed by an ageing population, the crisis of care for the elderly and the rise in dementia. “Young-Italian 2015 has important implications for increasing use of therapeutic practices of remembering in the context of health-care being carried out in Italy and in many other European

and non-European countries,” notes Prof. O’Rawe. Cinema can operate as a powerful vehicle for accessing long-term memory, even when short-term memory is compromised, and programmes in the United Kingdom (under the Creative Dementia Arts Programme) and in countries as far apart as Ireland and Brazil have shown the potential for communal cinema screenings to unlock memories of the past and generate feelings of positive well-being.

The recollections of this particular population group form part of a cultural heritage where cinema had a significant role in shaping the sense of national belonging. Such studies grant greater understanding of the role played by the culture industries in shaping gender identities and their narratives of the past.

## BEYOND ACADEMIA

Dr Biasin disseminated project work and the study’s results at academic conferences and seminars held in Italy and the United Kingdom. “However, his most important dissemination work was presenting his project to groups of older people from different branches of Italy’s University of the Third Age,” the coordinator states. “This contact with the public, who is also the object of the research, was hugely important to the project, and ensured that the results were heard beyond academic networks.”

The third age is considered that time after individuals have finished working full-time and/or raising families. The University of the Third Age was established in the United Kingdom in 1973 and today supports the elderly in life-long learning and developing their educational, social and creative interests.

Although Young-Italian 2015 officially ended in October 2018, Dr Biasin is currently writing a monograph on the project. This work, Prof. O’Rawe reports, “will show for the first time the capacity of narratives of male cinema-going to locate personal ‘life-histories’ of spectators in relation to representations of male identity.”

## YOUNG-ITALIAN 2015

- Coordinated by the University of Bristol in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/704227](https://cordis.europa.eu/project/id/704227)
- Project website: [enicobiasin.academia.edu](http://enicobiasin.academia.edu)



# The double truth – science and religion in the Middle Ages

*EU-funded research explored the history of science and religion, focusing on the faith-reason conflict during the Middle Ages. Scholastics of the era found ways to protect themselves while contributing to scientific exploration within the boundaries of contemporary Christian society.*



philosophy, as it would mean being associated with ideas unacceptable to Christianity.

## PROTECTING THE RIGHT TO SCIENTIFIC EXPLORATION

The project had two core goals. The first was to understand why medieval university scholastics sometimes labelled controversial theories 'heretical' even when they were not. The second focused on why some of these writers did this when in fact they were not themselves adverse to the ideas.

"BoundSci examined a high volume of medieval texts to see how academic specialists of the time approached this controversy, and what strategies they employed to engage with, or reject, new scientific ideas," Dr Giletti reports. She offers an example: "In confronting the theory that the world was eternal and its denial of Creation according to the Bible, scholastics such as Thomas Aquinas, Giles of Rome and Boethius of Dacia said that to hold the world actually was eternal was 'heretical.'" Nonetheless, they considered that it was theoretically possible. In taking this stance, they could explore the issue fully, and at the same time maintain their identities as scientists and as Christians.

## THE 'DOUBLE TRUTH'

The project employed a novel research approach by focusing on the delineation between science and heresy. "BoundSci's methodology involved turning to the voices of the controversy's protagonists themselves, in the context of their debates and their most rigorous writing on the issues," the fellow reveals. Their outbursts about heresy in fact shed light on how they used their works to actually put forward risky opinions and confrontational positions.

The BoundSci (Boundaries of Science: Medieval Condemnations of Philosophy as Heresy) project addressed the confrontation of natural philosophy (i.e. science) and religion during a scientific revolution in the late Middle Ages. This research was undertaken with the support of the Marie Skłodowska-Curie programme.

"Scholastics regularly addressed the question of the world's eternity and its conflict with Creation," notes MSC project fellow Dr Ann Giletti. European society had a deeply embedded religious outlook at the time, rendering this philosophical theory at odds with Christianity. This made it difficult for Latin scholastics to embrace natural

One unexpected research outcome concerns the double truth phenomenon – “the position of holding two contradictory ideas, one according to science or philosophy, and the other according to religion,” Dr Giletti explains. While modern scholars have said that no medieval academics actually held this view, project research determined that there were scholastics who were guilty of holding this scandalous position.

## SCIENTIFIC COMMUNITIES

As an interdisciplinary project, its impact is on the fields of history of philosophy, science and theology. “More broadly,” Dr Giletti states, “BoundSci is revealing about how scientific communities function within their societies and cultural outlooks, a matter that is acutely relevant today.”

Research findings have been disseminated through three articles, six conference and seminar papers, and six public engagement activities. BoundSci also organised the

“ *BoundSci is revealing about how scientific communities function within their societies and cultural outlooks.* ”

international conference ‘Forbidden Ideas’, held at Oxford University in April 2018. More information about the project is available through the fellow’s own writings on the BoundSci blog.

## BOUNDSCI

- Coordinated by the University of Oxford in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/701523](https://cordis.europa.eu/project/id/701523)
- Project website: [theology.ox.ac.uk/boundsci/home](https://theology.ox.ac.uk/boundsci/home)

## HOW THE DIGITAL REVOLUTION IS TRANSFORMING EU-FUNDED BRAIN RESEARCH

The human brain is arguably the most complex and sophisticated machine in existence. And as can be expected, the research focus on developing new treatment options for patients with brain disorders has taken an inevitable digital turn.

In our latest **CORDIS Results Pack on the Brain**, we show how EU-funded researchers are harnessing the power of digital technologies and the increasing clout of computing to push forward the boundaries of brain research, cognitive neuroscience and brain-inspired ICT advances.

This is a truly cross-cutting Results Pack, as neuroscience research is taking place across the full spectrum of EU-funded research programmes, so without further ado, we invite you to browse, download or order it from our website at: [cordis.europa.eu/article/id/401587](https://cordis.europa.eu/article/id/401587)





# Self-powering e-bikes could drive bike-sharing forward

*An Italian SME has come up with a smart design for hybrid bikes which can remove some of the technical and cost barriers to the spread of bike-sharing schemes in cities.*

Since the first large-scale initiatives were launched in Copenhagen and Portsmouth in 1995, bike-sharing schemes have spread to more and more European cities. The rise has been helped along by advances in technology plus a growing appreciation of the environmental benefits. But some stubborn issues remain.

Third generation bike-sharing schemes such as Vélib' in Paris or Bicing in Barcelona are based on a network of docking stations placed around the city where users pick up and leave their bikes. Building and maintaining these installations can account for between 70 % and 80 % of the costs of a scheme.

EU-funded project BITRIDE BIKE SHARING (The solution for flexible bike sharing initiatives without fixed stations), run by Italian smart mobility start-up Zehus, has developed a fleet of hybrid, self-powering bikes which promises to overcome some of the issues that hold such schemes back.

The BITRIDE BIKE SHARING solution consists of a hub on the rear wheel of the bike which contains a motor, batteries, electronics and sensors in a single unit weighing three kg. The motor acts like a dynamo – charging itself as the bicycle goes along. “It gives you power as you go uphill and when you start from a traffic light, but it generates power when you go downhill, when you brake or when you go at constant speed,” says Mr Giovanni Alli, after-sales manager at Zehus.

## SELF-SUFFICIENT BIKES

Being self-powering means smaller, cheaper but still good quality batteries and no need to plug in the bike for charging. “There have been tests of electrification of bike-sharing schemes in the past but they were not sustainable due to the cost of battery packs,” says Mr Paolo Lisanti, CTO at Zehus: “We tried to fix this with our technology which includes a motor which charges in a really efficient way.”



Surplus energy generated by the motor has been harnessed to create value-added services. A set of four sensors turns on LED lights to signal stopping or left or right turns, thus improving safety. It also powers a tracking device which not only indicates the position of the bike but can also alert to unusual behaviour by cyclists and help reduce vandalism and theft. This is backed up by a locking device which can be activated remotely.

## NO NEED TO DOCK

Having trackable bikes eliminates the need for physical docking stations, the biggest cost for conventional schemes. Instead cyclists can leave the bikes inside designated areas of the city, known as virtual parking stations (VPSs).

In some cities, what is known as 'free floating' parking for e-bikes has caused problems as cyclists may dump bikes anywhere and end up blocking pavements and generally misusing public space. "Our mobile app can understand if the bike is inside the VPS so it will allow you to lock the bike, otherwise it will invite you to go to a VPS," says Mr Lisanti: "If someone dumps an unlocked bike, there can be penalties."

“ There have been tests of electrification of bike-sharing schemes in the past but they were not sustainable due to the cost of battery packs; we tried to fix this with our technology which includes a motor which charges in a really efficient way. ”

A survey of users of a 350-bike pilot in Milan in 2018 found that 82 % wanted to continue using the service, while 60 % described the bike in hybrid mode as either comfortable or very comfortable.

Zehus is now preparing for commercial launch of the system and is in talks with Italian train operator Ferrovie Nord about launching an integrated train-bike service in the Lombardy region.

## BITRIDE BIKE SHARING

- Coordinated by Zehus SPA in Italy.
- Funded under H2020-TRANSPORT, H2020-LEIT-ICT and H2020-SME.
- [cordis.europa.eu/project/id/756656](https://cordis.europa.eu/project/id/756656)

## TRANSPORT

# More efficient design makes new generation electric ferries cheaper to run

*Ferries are an indispensable mode of transport, yet they can be high emitters of nitrogen oxides and particulate matter, their ballast can pollute and the wash they create causes erosion that limits their use in sensitive areas. The EU's GFF project has some answers.*

In many places across Europe ferries supply a service that is impossible to replace, so the hunt is on to transform the boats used from diesel consuming polluters to cleaner, more efficient transport options. Technological developments focus on the reduction of nitrogen oxides (NOx) and particulate matter (PM) – seriously hazardous to people's health in urban areas – and energy efficiency measures.

Methanol, gas and electrical propulsions are the replacements currently in place to achieve emission targets. The EU-supported GFF (Green Fast Ferry – the world's first 30 knots battery powered Air Supported commuter ferry) project has favoured the latter. It has developed a fully-electric, high-speed passenger craft, which will be



“ *It's like a Tesla on water.* ”

the only zero emission ferry on the market that matches the performance of high-speed, diesel commuters.

Their ferries can travel at 30 knots (55 km/h) and have extended autonomy (26 km routes in 30 min.). One thing that has been holding back the uptake of electric ferries is the recharging time, but GFF has managed to overcome this obstacle. “Fast recharge in port now takes less than 15 min.,” says Hans Thornell, GFF project manager.

GFF is based on patented technology: the Air Supported Vessel (ASV) uses a pressurised air cushion which, running under the hull, reduces energy consumption by 40 %.

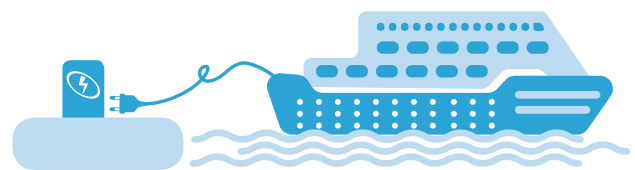
“Our ferries can substitute existing diesel commuter ferries and can be used in sheltered waters, and inland, where conventional fast ferries are not permitted to go due to coastal erosion. Green Fast Ferries have a greatly reduced wake wash so we have huge market potential in inland waterways, archipelagos and urban waterways. It's like a Tesla on water,” he says proudly.

The 190 kWh LTO battery system was installed during the BB Green project, supported under FP7. BB Green is now an industry recognised brand. A 500-hour endurance

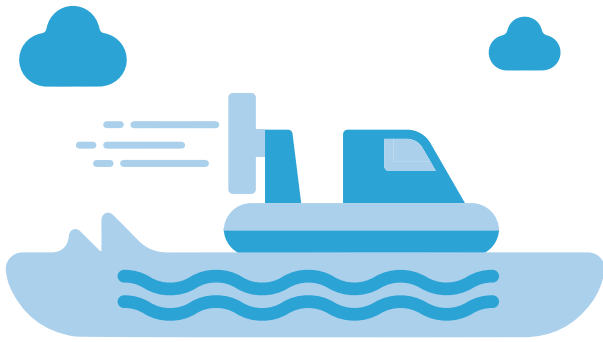
test focused on cell voltage variation, and on efficient use of energy. The batteries performed extremely efficiently. “The battery pack has been used at between 5 % and 95 % state of charge and the 4 224 cells have had a voltage spread of 0.6 %, even though the cell balance function was deactivated almost half of the time,” explains Thornell.

The GFF project has met its key objectives. “The first by having a Technical Ship Specification ready to be sent to

## Less than 15 minutes



### – the time for ferry recharge at port



**40% less energy consumed** thanks to  
 pressurised air cushion technology

any potential customer along with a price and a selected ship yard. The second objective has been met by dissemination of Green Fast Ferries' features through speeches at

25 conferences, references in 354 articles worldwide and a large number of real demo tours with potential customers. Today we are actively working on 12 commercial opportunities, two of which have resulted in concrete offers."

The project's next step is a proof of concept. "Even if stakeholders have been on board the prototype on demo tours, almost no-one dares to be the first customer. We have to get the first new-built BB Green in operation, as well as the charging infrastructure," adds Thornell.

**GFF**

- Coordinated by Echandia Marine Sweden AB in Sweden.
- Funded under H2020-TRANSPORT, H2020-LEIT-ICT and H2020-SME.
- [cordis.europa.eu/project/id/738295](https://cordis.europa.eu/project/id/738295)
- Project website: [bbgreen.info](http://bbgreen.info)
- [bit.ly/2VKD0Ks](https://bit.ly/2VKD0Ks)

**TRANSPORT**

# A future with zero road deaths – is it possible?

*While European roads are the safest in the world, many lives are still lost on them. Can anything be done to prevent these fatalities? An EU-funded project proves there is.*

A reported 25 300 people lost their lives on EU roads in 2017. Vulnerable road users (VRUs) accounted for almost

half of these road victims, where 21 % of all people killed on roads were pedestrians and 8 % were cyclists.



## THE WORK AHEAD

The PROSPECT (PROactive Safety for PEdestrians and CyclisTs) project set out to reduce these statistics by targeting the two VRU groups with the most fatalities: cyclists and pedestrians. “We sought to enhance road safety by significantly improving the effectiveness of active VRU safety systems compared to those in the market,” explains Iлона Cieslik, the project coordinator.

By expanding the scope of VRU scenarios and improving overall system performance, project partners believed this would help them lay the foundations for the next generation of active VRU safety systems for cars. This should ultimately reduce crashes – mainly at intersections.

## PROJECT IMPACT

PROSPECT developed and assembled three vehicle demonstrators. On the hardware side, the integration of an increased number of recent radar and camera sensors, featuring a higher field of view and at a greater resolution, was achieved.

On the software side, the project was able to extract more meaningful features from these sensors. For example, instead of just detecting a cyclist they are also able to detect the intentions of a cyclist, giving cars the ability to react accordingly. These systems were then integrated into test vehicles.

PROSPECT results have visible implications for policies and regulations in understanding the real-world benefit of new advanced driver-assistance systems and related functions. Apart from technology demonstrators that will help maintain and extend leadership of European car manufacturers in intelligent vehicles and for autonomous driving, PROSPECT took a step forward in defining test and assessment methods for Euro NCAP consumer testing automatic emergency braking VRU systems.

The project further supports EU decision-makers with an implemented novel benefit estimation methodology, including an assessment of the combined effect of active and passive safety measures. Cieslik reports: “Following the results of the PROSPECT benefit analysis, the local benefit regarding fatalities showed a 55–98 %

“ We sought to enhance road safety by significantly improving the effectiveness of active VRU safety systems. ”

decrease from the PROSPECT-like algorithms, depending on the use case.”

It is estimated that the PROSPECT systems will increase the annual number of lives saved in the EU from 79–95 in 2025 to 280–336 in 2030. The corresponding estimates for reduced numbers of seriously injured people are 439–697 in 2025 and 1 558–2 474 in 2030.

## LOOKING TOWARDS THE FUTURE

Standardisation activities are foreseen to continue beyond the project’s duration, boosting competitiveness among car manufacturers. Cieslik further notes that “all industrial partners in this project are keen to bring the second-generation (pro) active VRU safety systems to the market.”

There are also several customer-based opportunities, especially in testing services with PROSPECT use cases and consulting services for local governments, infrastructure providers and insurance companies.

The project foresees that by 2025 the transfer of PROSPECT VRU active safety systems to other vehicle platforms will be realised. This gives hope that a future without roadside fatalities may actually be a reality.

Cieslik concludes, “we would like to thank PROSPECT’s partners for their contribution to the work described in the article.” View the project’s work on YouTube.

## PROSPECT

- Coordinated by IDIADA Automotive Technology SA in Spain.
- Funded under H2020-TRANSPORT.
- [cordis.europa.eu/project/id/634149](https://cordis.europa.eu/project/id/634149)
- Project website: [prospect-project.eu](https://prospect-project.eu)



# Climate changes mobilise organic pollutants held in Arctic terrestrial compartments

*Europe's scientists have explored the impact of climate warming and permafrost melting on persistent organic pollutants (POPs) in polar food webs.*

The EU-funded BioPollAr (Impact of global change on the remobilization and Bioaccumulation of organic Pollutants in PolAr aquatic food webs) project has studied the effect of climate change on the availability of contaminants in Arctic and Antarctic ecosystems and food webs. European and international researchers involved in this project have also focused their research on investigating the presence of emerging pollutants such as organophosphate esters (OPEs) and perfluoroalkyl substances (PFASs) in Arctic and Antarctic biota, terrestrial and marine ecosystems.

The study involved the analyses of temporal series of POPs (from legacy, such as polychlorinated biphenyls (PCBs)), organochlorine pesticides, recently regulated flame retardants, polybrominated diphenyl ethers (PBDEs) and emerging POPs (such as PFASs and OPEs). The analyses used more than 1 000 samples from fish, plankton, water, soil, vegetation and the atmosphere taken from 2015 to 2017 together with archived samples from biota taken yearly since the 1990s.

Some of the results found revealed a positive correlation, over the last two decades, between the concentration of POPs in Arctic char (*Salvelinus alpinus*) from four lakes in the Canadian High Arctic, and the interannual variations of the North Atlantic Oscillation (NAO). "This fact together with increasing Arctic temperatures could increase POP concentrations in char over the following decades, particularly if there are nearby secondary sources," says Dr Ana Cabrerizo, a Marie Skłodowska-Curie research fellow.

## LONG-RANGE TRANSPORT OF POLLUTANTS

Another key result developed during the EU project revealed, for the first time, that permafrost melting, due to warming in the Arctic, is releasing a large amount of stored POPs bound to organic matter into aquatic systems. "This is having a significant impact on Arctic lakes and their simplistic food webs," notes Dr Cabrerizo.

“Due to its remoteness and absence of anthropogenic activities, all pollutants found in freshwater and terrestrial compartments have been introduced through long-range atmospheric transport.”

This important result was observed on lakes on Melville Island, in the Canadian High Arctic at Cape Bounty Arctic Watershed Observatory (CBAWO). CBAWO is a remote and uninhabited location, 400 km from the nearest Arctic community and represents an environment largely unimpacted by direct human activity. “Due to its remoteness and absence of anthropogenic activities, all pollutants found in freshwater and terrestrial compartments have been introduced through long-range atmospheric transport. This area therefore is of great value for studies on POPs and climate change,” Dr Cabrerizo explains.

Freshwater environments such as lakes and rivers and marine environments are major ecosystem features of the Arctic region, providing important sources of food like Arctic char, and seals, as well as drinking water. “Alteration of organic carbon sources such as soil sediments due to accelerated warming that have been noticed in our study area, will reduce food quality and make it more

contaminated, especially with legacy PCBs and DDTs, as already shown in our studies,” she warns.

### NEW THREATS IDENTIFIED

Work carried out on recently regulated pollutants like BDEs and emerging OPEs and PFASs provided novel insight. The findings of the project proved that not only are legacy POPs transported to the most remote places of the world, but ‘new’ chemicals are also being detected in the most pristine regions of the world, and the effects of this on polar food webs and ecosystems are still unknown, explains Dr Cabrerizo. She also states that international policies should take this fact into serious consideration.

The outcomes of BioPollAr will support national and international policies on chemical management and be of special interest for local Inuit communities who live in the Arctic.

### BIOPOLLAR

- Coordinated by the Spanish National Research Council in Spain.
- Funded under FP7-PEOPLE.
- [cordis.europa.eu/project/id/628303](http://cordis.europa.eu/project/id/628303)
- Project website: [idaea.csic.es/project/biopollar](http://idaea.csic.es/project/biopollar)

## CLIMATE CHANGE AND ENVIRONMENT

# Setting the stage for a climate services market observatory

*Climate services are now in abundance but are not being distributed in the most efficient ways. The MARCO market research project aims to change this.*

There is now an abundant supply of climate-related data, tools, products and services within society. But just how effectively this influx of skills and knowledge currently serves decision-making in public and private sectors is unclear. The industry suffers from a lack of visibility and

transparency, and an imperfect match-up between those who supply climate information, and those who need it.

Yet in the face of climate change, drastic action is needed urgently. Any climate-related services should therefore be

adopted by society as efficiently as possible. This requires an initial widespread understanding of the entire climate services market, and an understanding of its possible evolution and growth.

This is where the Horizon 2020-funded MARCO (Market Research for a Climate Services Observatory) project comes in. MARCO gathered together market research firms, climate scientists, climate service practitioners and innovators – along with other relevant stakeholders – to build up a detailed profile of the climate services industry across the EU.

## ASSESSING THE SCENE

“While MARCO did not focus on individual, specific climate services, one of the core components of the project was a trailblazing series of case studies,” explains Dr Thanh-Tâm Lê, Climate-KIC Director for the Mediterranean. Each of the studies focused on a particular sector in a given geographic area: real estate in Copenhagen; mining at EU level; legal services in London; renewable energy in Denmark; water supply and sanitation in Catalonia; critical energy infrastructures in Germany and Poland; forestry and agriculture in France; urban infrastructure in Munich; and tourism in Austria.

The project consisted of market research from multiple perspectives as well as qualitative and quantitative methodologies. However, the end goal was to assess the opportunity for setting up an observatory of the market of climate services, which may one day be centred on a web interactive platform.

The project identified areas of great potential for market expansion of climate services within the European Union: some of the biggest growth opportunities are in Central and Eastern EU Member States. MARCO research also found that while some sectors already benefit from a substantial offer of climate services today, others are very likely to emerge more strongly in the next few years (e.g. health, forestry, tourism and energy infrastructure).

Better links between public and private providers are important for developing more advanced climate services, the project found. And the development of more advanced or sophisticated climate services on seasonal to decadal time scales might provide further market opportunities.

The team believes providing market players with an updated and active repository will be key to increasing visibility of providers and purveyors and to allowing interested end-users to easily access information on the climate services that are relevant to them and available. MARCO advocates strengthening and harmonising climate resilience legal frameworks, as well as tracking climate finance schemes and investments in both public and private domains.

## A COMPLEX LANDSCAPE

“MARCO was a ground-breaking attempt to study, map and analyse the complex, heterogeneous market for climate services. This was all the more challenging as it is still maturing and fast-evolving,” says Dr Lê. “It was also a thrilling human experience,” he adds, “gathering experts from very different backgrounds, with sometimes markedly contrasting convictions. This certainly generated some tensions and differences, but also lively, innovative cross-perspectives.”

The MARCO team is now pushing for a coordinated platform, combining features of an observatory and a community support platform, articulated with other existing and upcoming instruments (Copernicus Climate Change Service, Climateurope, national platforms), to fully enable the market for climate services within the EU.

### MARCO

- Coordinated by Climate-KIC in France.
- Funded under H2020-ENVIRONMENT.
- [cordis.europa.eu/project/id/730272](https://cordis.europa.eu/project/id/730272)
- Project website: [marco-h2020.eu](https://marco-h2020.eu)
- ▶ [bit.ly/2vJFlkC](https://bit.ly/2vJFlkC)





SPECIAL FEATURE

# OBESITY: EU RESEARCH BATTLES THE BULGE

## Editorial

### The new smoking of the twenty-first century?

Obesity has become one of the major public health challenges for both developed and developing nations, with some rather chilling statistics. Worldwide, 1.9 billion adults and 42 million children are overweight or obese. Within the EU itself, Eurostat estimated in 2014 that 51.6 % of the EU's population was overweight. One in three children in the EU is overweight.

Socially, the sensitive topic of people's weight has entrenched itself into our culture, with cultural expressions including the 'Plus Size' movement in fashion and the growing backlash over the concept of 'fat shaming' (the idea that making overweight people feel ashamed of their weight may motivate them to make healthier decisions) being just two examples.

However, whilst it should always be encouraged to promote a positive body image, the scientific evidence is clear: Being overweight or obese can drastically impact an individual's health, significantly increasing the risk of chronic diseases such as type-2 diabetes, cardiovascular disease, certain cancers, hypertension and coronary heart diseases. Alongside physical diseases, being overweight can also lead to a wide range of psychological disorders, such as depression.

Asked what the root cause of obesity is, many would be immediately prompted to reply food and diet. And, as our front cover to this issue highlights, these are indeed essential

ingredients in the causes of obesity. But it's really not that simple and many other factors are at play, which also must be addressed if this growing public health problem is to be stopped in its tracks and reversed.

Over the following pages, you'll read about eight EU-funded projects that have taken on obesity and have contributed significantly to our fundamental understanding of the condition, as well as provided possible solutions that can help us confront this growing public health crisis. Projects such as **Child-MHO**, **EASY** and **NeuroEE** have made exciting breakthroughs in the lab, showing how the role of genetics and metabolism can have a direct impact on a person's weight. Meanwhile, the ERC-funded **i2MOVE** project is developing a new generation of neural interfaces to provide innovative treatments for people who are overweight or obese.

From a sociological point-of-view, the **OBESCLAIM** project has studied the role of nutritional labelling on food products in the fight against obesity. Finally, the **INNOREFAT** project, from an innovative Spanish SME, has utilised an intriguing combination of lemon verbena and hibiscus to develop an innovative product that has proven to help people lose weight.

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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## Lemon verbena and hibiscus join forces to tackle metabolic syndrome

*Metabolaid fits with the times. As people across Europe increasingly rely on plant-based medicines for their needs, it provides them with a nature-inspired solution to deal with Metabolic Syndrome – one of the most threatening epidemics of the 21st century.*

It might not be obvious, but diabetes, stroke, Alzheimer's, cancer and heart disease all have something in common. They are related to Metabolic Syndrome (MetS), which affects no less than 25 % of the world's population.

The INNOPREFAT (Natural Food formulation for the prevention and treatment of Obesity and Metabolic Syndrome obtained with herbal extracts) project proposes to tackle MetS with Metabolaid, a compound activating a metabolic switch called AMPK. The latter can inhibit fat accumulation in the adipose tissue and liver, all this while favouring energy usage in muscle cells.

"We have ample experience in analysing the effects of various active, purified compounds from botanical extracts found in the Mediterranean," says Dr Arturo Lizón, coordinator of the INNOPREFAT project on behalf of Spanish company Monteloeder. "In the case of Metabolaid, we first added a battery of possible purified extracts to cell cultures derived from human adipose tissue. We then proceeded to assess which of these extracts activated AMPK with the most efficiency. The next step consisted in formulating a combination of the most efficient extracts to identify possible synergies."

### LOSING WEIGHT, REGULATING HUNGER

Lemon verbena and hibiscus stood out. Initial clinical studies showed that individuals taking Metabolaid while following a controlled diet were losing twice as much weight as those only following a diet. Furthermore, parameters such as blood pressure, cholesterol/triglycerides and blood glucose levels were shown to decrease significantly in patients who had used Metabolaid for two months.



© Monteloeder

“Of course there are many ingredients that can make you lose weight, regulate your cholesterol or control glucose metabolism. But Metabolaid is the first to do it all and, with a total of six clinical studies conducted so far, it is also the one providing the most science-backed evidence,” says Dr Lizón.

Another major benefit of Metabolaid lies in how it regulates hunger. By analysing several appetite-regulating hormones, the team found that their product was able to maintain the levels of ghrelin – a hunger-inducing hormone secreted by the stomach – unchanged as patients underwent an eight-week diet. Likewise, these patients expressed over 50% more satiety-inducing GLP-1 hormone than the Placebo group undergoing a diet only.

“This ultimately caused the group taking Metabolaid to lose more weight while feeling more satisfied with the amount of food they consumed. They also felt an overall improved sense of wellbeing,” Dr Lizón explains.

“Of course, there are many ingredients that can make you lose weight, regulate your cholesterol or control glucose metabolism. But Metabolaid is the first to do it all.”

## WORLDWIDE ORDERS

Clients from the US, Europe and Asia have already placed their first orders for Metabolaid, whose production was recently scaled up thanks in part to funding under the SME Instrument. Shipments will start in June 2019. Monteloeder has also signed several multi-year supply contracts with pharma and nutraceuticals companies in Europe and America.

Patients buying Metabolaid will also benefit from a dedicated app tracking consumption, evaluating habits and providing advice. “As technology advances, measurements of other product effects, such as improving cardiovascular conditions (heart rate, blood pressure), cholesterol and glucose, will be readily available to the consumers as wearable devices. These parameters will be incorporated into the app, providing it with a second life”, Dr Lizón concludes.

## INNOPREFAT

- Coordinated by Monteloeder in Spain.
- Funded under H2020-SME and H2020-FOOD.
- [cordis.europa.eu/project/id/783838](https://cordis.europa.eu/project/id/783838)
- Project website: [monteloeder.com/en/innoprefat](https://monteloeder.com/en/innoprefat)
- ▶ [bit.ly/2YJX6SF](https://bit.ly/2YJX6SF)

## ‘Favourable adiposity’ already exerts its influence in childhood, study finds

*The Child-MHO project has investigated the existence of increased adiposity (a condition of being severely overweight) combined with a favourable cardiometabolic profile in childhood. Its findings could eventually lead to new treatment paths.*

The popularisation of the term ‘obesity’ can easily make us forget about the complexity of the condition. For example, it is generally acknowledged that obesity increases the risk of cardiometabolic diseases. But while this may be true, this link has recently revealed itself not to be absolute.

“Not all individuals with obesity have cardiometabolic comorbidities – some are ‘metabolically healthy’,” explains Prof. Tuomas Kilpeläinen, associate professor at the Novo Nordisk Foundation Centre for Basic Metabolic Research. “Conversely, some individuals with normal weight develop a ‘metabolically obese’ cardiometabolic

risk profile.” In other words, a normal body weight doesn’t rule out the possibility of sharing the same risk profile as a patient with obesity.

## DO MULTIPLE GENETIC VARIANTS HOLD THE KEY?

To this day, the mechanisms underlying these atypical profiles have remained poorly understood. But researchers are getting there. Recent work has unveiled multiple human genetic variants associated with higher adiposity combined with a healthier cardiometabolic risk profile. These findings suggest that innate biological mechanisms have an important role in the development of the ‘metabolically healthy obese’ and ‘metabolically obese with normal weight’ phenotypes. They also provided a starting point for research under the Child-MHO (Genetics of metabolically healthy obesity (MHO) and metabolically unhealthy normal weight (MUNW) in children, and the childhood predictors of adulthood MHO and MUNW) project, which was undertaken with the support of the Marie Skłodowska-Curie programme.

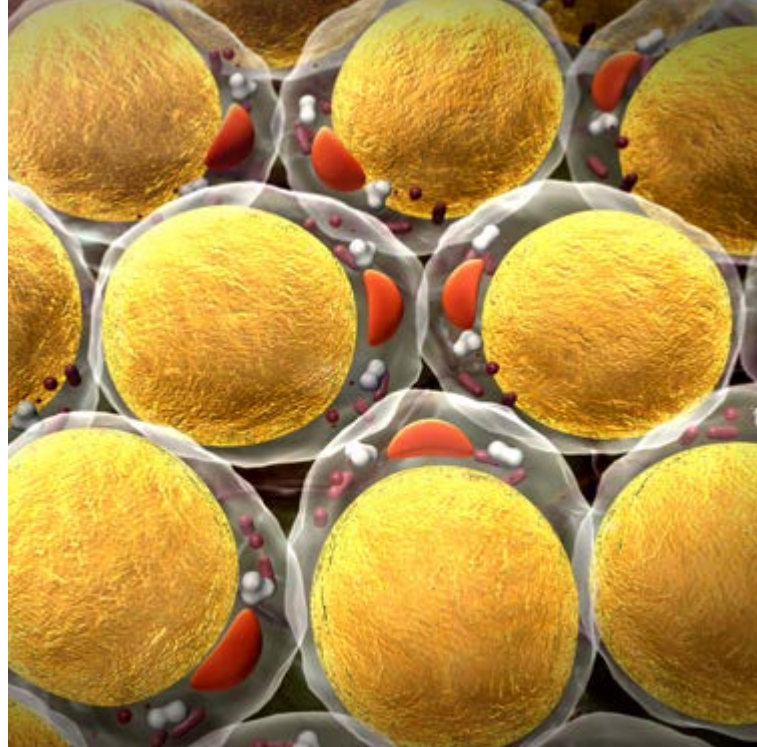
As Prof. Kilpeläinen points out, the discovery of novel genes, proteins and pathways uncoupling adiposity from higher cardiometabolic risk is a game-changer. It sheds light on the condition’s underlying biology and opens avenues for developing new treatments against obesity-related cardiometabolic complications. But there is one thing we still don’t know about the so-called ‘favourable adiposity’: how early it arises in the patient’s life.

“It is important to find out whether the genetic influences favouring higher adiposity but a healthier cardiometabolic profile, or vice versa, are already present in childhood. Such knowledge provides further insight into obesity’s underlying biology and gives possibilities for early identification of individuals who are at highest risk of cardiometabolic disease if gaining weight. This may even help in developing novel treatments and designing appropriate weight-management interventions,” Prof. Kilpeläinen explains.

## IDENTIFYING EARLY-LIFE FACTORS

To lift the veil on this early existence, Prof. Kilpeläinen and his team used the recently discovered genetic variants. They

“ *This may even help in developing novel treatments and designing appropriate weight-management interventions.* ”



also took advantage of long-term follow-up data from childhood to adulthood to identify early-life factors that predict the development of a normal-weight yet ‘metabolically obese’ phenotype. Finally, they used data from several European child cohorts in these analyses.

All this work led to the confirmation that the genetic predisposition to increased adiposity but favourable cardiometabolic profile indeed exerts its influence already before puberty.

“This association pattern is reflected by a favourable change in body fat distribution,” says Prof. Kilpeläinen. “We also found that an increase in adiposity from childhood to adulthood is a strong predictor for the development of a normal-weight but ‘metabolically obese’ phenotype. This suggests that weight gain can be detrimental to cardiometabolic health even among individuals who retain normal weight.”

The findings of Child-MHO may help in identifying children who are most prone to developing cardiometabolic impairments as they gain weight. The project’s results also highlight the importance of early weight management through a healthy lifestyle in children, in particular those with a tendency for abdominal adiposity.

“We hope our research will support ongoing efforts to develop better treatments and preventive measures against obesity-related cardiometabolic comorbidities,” Prof. Kilpeläinen concludes.

## CHILD-MHO

- Coordinated by the University of Copenhagen in Denmark.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/796143](https://cordis.europa.eu/project/id/796143)

# How Suv420h protein inhibition could soon help treat obesity

*The EU-funded EASY project brings, for the first time, concrete evidence that Suv420h enzymes can have beneficial effects on the metabolism of patients with obesity. The project team is already considering potential treatment options building upon this outcome.*

It was strongly suspected but never evidenced: the role of Suv420h in the regulation of metabolism could be the first step towards new, more effective treatments for obesity and metabolic syndrome. Thanks to tests on mice, the project team has found that organisms lacking Suv420h proteins benefit from improved metabolic functions. They are also resistant to diet-induced obesity.

## AN EXCITING FINDING

“When fed with a high-fat containing diet, mice without the Suv420h1 and Suv420h2 enzymes gained less weight compared to control mice in which their expression was normal,” says Dr Simona Pedrotti, Postdoc fellow at HSR Research and coordinator of EASY (Epigenetic approach for the treatment of obesity). “This clearly demonstrates that the epigenetic regulators Suv420h control metabolism and body weight in response to environmental stimuli.”

Prior to the project, environmental factors were known to modulate the aberrant expression of several key genes through epigenetic mechanisms. In the case of obesity and other metabolic disorders, dietary factors seemingly

alter the epigenome in several human tissues of importance for metabolism. This, in turn, can affect gene expression and pathogenesis.

“The most exciting aspect of our finding is that Suv420h proteins regulate metabolism by directly inhibiting the expression of PPAR- $\gamma$  – a master transcriptional regulator of lipid storage and glucose homeostasis. This was of great interest to us. While PPAR- $\gamma$  ligands of the thiazolidinedione class are already used as insulin sensitisers in the treatment of diabetes, their use has been limited by adverse effects. These include heart failure, fluid retention and bone fragility. Our results, on the other hand, indicate that targeting Suv420h could help in dissociating the benefits of PPAR- $\gamma$  activation from its side effects,” Dr Pedrotti explains.

## WHEN SUV420H IS DEPLETED

Besides the improvement in metabolic function, the team found that Suv420h depletion is associated with several systemic effects. Mice lacking Suv420h proteins indeed present an increased number of ‘beige’ adipocytes within their white adipose tissue.

“The beige adipocyte is a type of adipose cell able to produce heat and increase energy expenditure. These cells possess characteristics between those of the white fat cell – an accumulator of energy – and the brown cell which produces heat. Beige adipocyte has recently generated much interest because of its ability to dissipate energy,” says Dr Pedrotti.

“*The most exciting aspect of our finding is that Suv420h proteins regulate metabolism by directly inhibiting the expression of PPAR- $\gamma$ .*”



The depletion of Suv420h proteins in mice also results in increased expression of genes encoding for secreted proteins known to act on other tissues and stimulate energy expenditure. All these findings tend towards an improvement in metabolic function upon Suv420h deletion.

The project consortium went a step further by describing the first epi-drug able to activate brown adipose cell metabolic activity, which is disrupted in obesity. They found that Suv420h inhibition is not toxic to brown adipocytes. It is also sufficient to activate both PPAR- $\gamma$  expression and mitochondria respiration. *In vivo* inhibition has proved unfeasible so far, but the team is currently looking into ways to overcome this issue.

The project, which was undertaken with the support of the Marie Skłodowska-Curie programme, is scheduled for completion at the end of 2019. In the meantime, the team intends to investigate whether depletion of Suv420h also has beneficial effects on other metabolic conditions, and particularly diabetes.

#### EASY

- Coordinated by San Raffaele Hospital in Italy.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/746974](https://cordis.europa.eu/project/id/746974)

## The role of nutritional labels in the fight against obesity

*The EU-funded OBESCLAIM project investigated whether the health-related claims found on food packaging influence a consumer to choose healthier options.*

The increase in obesity has resulted in it becoming one of the most common causes of death in both developed and developing countries. One way to push dietary habits towards healthier food choices, while also satisfying the need for convenience, is to purchase processed foods with certain nutrition (e.g., fat-free) and health information (e.g., lower cholesterol) on the product's packaging. To facilitate this, the EU has introduced various regulations on presenting nutritional and health information on the front of pre-packaged food products.

In response to these regulations, the agro-food industry is increasing its efforts to generate healthier products with reduced saturated fats, sugars and salt. The retail sector is also amplifying the presence of processed products with nutritional and health claims in local markets.

Yet even with these efforts, the question remains: do health-related claims on product packaging lead consumers to choose healthier foods?

The EU-funded OBESCLAIM (Fighting against obesity in Europe: The role of health related-claim labels in food products) project decided to find out.

### UNDERSTANDING PURCHASING DECISIONS

Undertaken with the support of the Marie Skłodowska-Curie programme, the project investigated four specific topics: the prevalence of health-related claim labels in the Spanish food market; consumer understanding, use and perception of health-related claim labels; how these labels lead consumers to choose healthier foods and thus serve as a tool for reducing obesity; and the role economic, social, psychological and emotional factors play in determining consumer preferences.

From this investigation, researchers Azucena Gracia and Tiziana de Magistris demonstrated that nutritional claims could be a valid tool in the fight against obesity. "We discovered that the decision-making process for buying food with health-related claims is influenced primarily by personal factors and not economic and social-demographic ones," says de Magistris. "In other words, psychological factors could trigger people to buy healthy products."

The researchers also found that purchasing decisions can depend on cognitive abilities like emotional intelligence,



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which allow people to manage their emotions better and make correct choices. At the same time, body image and emotional eating styles also play an important role. For example, the results indicate that consumers value light products (toasted bread, cheese, potato crisps) positively, and tend to avoid buying products with low salt content. Moreover, obese people who are satisfied with their body image are more willing to pay for food products with nutritional claims (lower salt and fat content) than obese people who are dissatisfied with their body image.

### FURTHER INVESTIGATION NEEDED

According to Gracia, the OBESCLAIM project has advanced our understanding of the effect that psychological factors

“We discovered that the decision-making process for buying food with health-related claims is influenced primarily by personal factors and not economic and social-demographic ones.”

have on consumer decision-making when purchasing products with health-related claims. “These personal factors should be taken into consideration, either by enterprises or by policymakers, when designing their marketing and policy strategies,” she says.

Although these results could already contribute to the prevention of diet-related diseases and improve the well-being of society, more investigation is needed. “A multidisciplinary approach, combining different areas such as food science, neuroscience, economics and psychology and using virtual reality or biometric data, for example, may be useful in the future, keeping in mind that these activities should remain focused on the active engagement of consumers,” adds de Magistris.

### OBESCLAIM

- Coordinated by the Agrifood Research and Technology Centre of Aragón in Spain.
- Funded under FP7-PEOPLE.
- [cordis.europa.eu/project/id/332769](http://cordis.europa.eu/project/id/332769)

## Treating obesity with neuromodulation

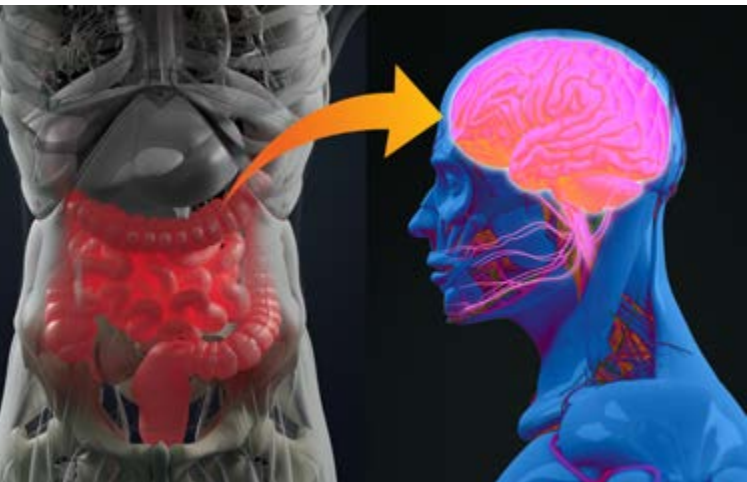
*The EU-funded i2MOVE project is developing a new generation of neural interfaces to provide innovative treatment for people suffering from being overweight or obese.*

As one of the leading causes of death, obesity has reached the level of being a global pandemic. Today, more than 1.9 billion adults and 42 million children are either overweight or obese, and these numbers continue to increase. In fact, after a steady increase for many years, life expectancy rates in the EU fell in 2017 – with obesity being a key contributor.

“As obesity is complex, multifactorial and systemic, prevention, management and treatment are usually not simple,” says Konstantin Nikolic, the coordinator of the ERC-funded i2MOVE (An Intelligent Implantable

MOdulator of Vagus nervE function for treatment of Obesity) project. “Although there are several approaches currently available, from soft nudging to hard implantable electrical stimulators and bariatric surgery, most have either had limited success or come with significant risks.”

The i2MOVE project looks to tackle obesity by developing an innovative technological solution, namely, a bio-inspired implant. “The aim is to target the vagus nerve, which transmits information between the gut and the brain,” explains Nikolic. “By doing so, we want to stimulate



© Anatomy Insider, Shutterstock

the nerves in the abdomen to mimic what happens after you have a meal so that we can control your appetite.”

## THE GUT-BRAIN AXIS

The project developed a microchip that sticks within the gut and that can tell the brain whether the stomach is full or empty using simple microchip technology. “Unlike the vagus nerve stimulation devices (VNS) currently on the market and used for treating epilepsy, the i2MOVE solution incorporates physiological feedback (in the form of vagal nerve activity) and artificial intelligence to marry food intake with stimulation,” says Nikolic.

At the core of the i2MOVE device is a novel, integrated System-on-Chip (SoC) that was completely designed and tested within the project. The SoC consists of a multichannel front-end for the electrical and chemical recording of neural activity. Its processing capabilities involve on-chip local machine learning algorithms that determine when and by how much to stimulate.

With the SoC developed, project researchers achieved the significant milestone of conducting chemical sensing *in vivo* using an implanted i2MOVE sensor. In the test, researchers successfully detected changes in neural extracellular pH, which is associated with both the cholecystokinin hormone and gastric distension. Furthermore, the system’s algorithms successfully used any detected changes in pH to automatically trigger the implanted VNS device.

“To my knowledge, this is the first closed-loop neuromodulation device that uses multi-signal modality to achieve decision making and stimulation dose titration in a closed-loop implant,” adds Nikolic.

## FUTURE NEUROMODULATION DEVICES

In the next phase of development, the device will undergo pre-clinical trials, during which the device will be implanted and functional in an awake, moving animal. “This is a necessary stage before planning a clinical trial in humans,” explains Nikolic.

The technology developed in the project has also been finding its way into other areas, including gastric cancer treatments, cough suppression, cardiac ischemia detection, and a so-called ‘soft’ approach to obesity through behavioural change based on personalised food product recommendations. “As for the project’s overall legacy, I expect that neurochemical sensing will become a crucial signal modality for monitoring a range of neural activity,” says Nikolic.



Worldwide, more than  
**1.9 billion adults** and  
**42 million children** are  
either overweight or obese

### I2MOVE

- Hosted by Imperial College of Science, Technology and Medicine in the United Kingdom.
- Funded under FP7-IDEAS-ERC.
- [cordis.europa.eu/project/id/319818](http://cordis.europa.eu/project/id/319818)
- Project website: [imperial.ac.uk/a-z-research/i2move](http://imperial.ac.uk/a-z-research/i2move)
- ▶ [bit.ly/2QJjVlr](https://bit.ly/2QJjVlr)

# New research avenues to prevent co-morbidities in obese patients

*The EU-funded ReprObesity project has investigated the mechanisms behind sexual dysfunctions caused by obesity. Its preclinical findings might eventually help prevent co-morbidities.*

In the long list of obesity's side effects stands hypogonadism. This reproductive disorder, which causes reduced fecundity rates in women and very low levels of testosterone in men, has been known to arise with morbid obesity over the last two decades. The mechanisms at play are still poorly understood.

One thing that seems more and more plausible, however, is the fact that obesity-induced hypogonadism might actually worsen the probability of co-morbidities in patients with obesity. This is a vicious circle that the ReprObesity (Overweight-induced Hypogonadism as major factor for the generation and/or perpetuation of Metabolic Co-morbidities of Obesity: Contribution of Epigenetic Regulatory Mechanisms) project – undertaken with the support of the Marie Skłodowska-Curie programme – has been investigating since October 2016.

## UNCOVERING THE REPRODUCTIVE CONSEQUENCES OF OBESITY

“While the ‘sexual’ consequences of hypogonadism might be more tangible (and of concern only for a fraction of obese patients), the wider implications of inappropriately

low sex steroid levels for patients’ metabolic profile remain ill-defined,” says Manuel Tena-Sempere, Professor in Physiology at the University of Cordoba, Spain. “Better understanding of the mechanisms and consequences of obesity-induced hypogonadism may help us reduce such co-morbidities, but also tackle some reproductive and metabolic diseases.”

## IT'S ALL IN THE KISS

To get there, the project built upon previous preclinical evidence that Kiss1 neurons – a type of neuron in the hypothalamus expressing the Kiss1 gene to produce kisspeptins – are suppressed in conditions of obesity. Such a kisspeptin deficit would, in turn, result in central suppression of the reproductive axis.

“Previous work from various groups, including our own, had revealed that the regulation of Kiss1 neurons involves epigenetic mechanisms in physiological conditions. So, we decided to find out whether epigenetic mechanisms – which include not only changes in DNA methylation and histone acetylation but also small, non-coding RNAs – play a pathophysiological role in the generation of obesity-induced hypogonadism,” Prof. Tena-Sempere explains.

The molecular basis for the epigenetic/miRNA regulation of Kiss1 in conditions of obesity had never been studied before. While still in progress, the project has already opened new avenues for the regulation of the reproductive axis in physiological and pathological conditions. Prof. Tena-Sempere believes that ReprObesity's preclinical data will help, over the long term, with the development of better tools for the management of reproductive and metabolic diseases in clinical settings.

“This ambitious research line is still ongoing and some of its results will hopefully materialise in the coming months or years,” notes Prof. Tena-Sempere. “What I can tell you is that we have already disclosed novel epigenetic pathways that significantly contribute to development of obesity-induced hypogonadism. Most importantly, our work goes beyond demonstrating the pathophysiological relevance of hypogonadism in metabolic disease linked



“ *This ambitious research line is still ongoing and some of its results will hopefully materialise in the coming months or years.* ”

to obesity. It also illustrates how these epigenetic mechanisms might be targeted to reverse (part of) the metabolic and cardiovascular complications of obesity.”

## LOOKING TO THE FUTURE

The project team intends to keep expanding its molecular and *in vivo* preclinical work, with a view to identifying the

molecular basis and translational implications of RepObesity’s findings. “Our long-term goal is to define better strategies to help obese patients and fight against the frequent metabolic and reproductive co-morbidities of this condition,” Prof. Tena-Sempere concludes.

## REPROBESITY

- Coordinated by the University of Cordoba in Spain.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/655232](https://cordis.europa.eu/project/id/655232)

# New technologies can stimulate brown adipose tissue activity to facilitate weight loss

*The ICI-THROUGH project has advanced, state-of-the-art technology to estimate brown adipose tissue activity in patients, and its results could potentially revolutionise the market for anti-obesity products.*

Brown adipose tissue (BAT) is present in rodents throughout life. In humans, BAT is found primarily in infants and young children, and it has been considered to be essentially non-existent and without physiologic relevance in adults. But since its presence was identified in adult patients in 2009, BAT has become a major source of

excitement within scientific communities. Its important role in insulin sensitivity could bring about exciting new treatments for obesity and diabetes, and some believe it could even prevent or cure the likes of cardiovascular disease and several cancers.

ICI-THROUGH (Intersectoral collaboration for innovation in non-invasive techniques to estimate human brown adipose tissue activity), which was undertaken with the support of the Marie Skłodowska-Curie programme, focused its research on obesity. Until now, practitioners wanting to measure the activity of BAT had to use positron emission tomography/computed tomography (PET/CT) imaging. This is a highly invasive, harmful (due to high radiation levels) and expensive technique which is almost exclusively used for cancer detection and requires well-equipped facilities.

“Developing non-invasive techniques to estimate brown adipose tissue activity is an intersectoral and interdisciplinary endeavour in itself,” says Dr Andreas Flouris, coordinator of the project on behalf of the University of Thessaly.

“SMEs can easily find the right applications for the right market, but these markets are constantly changing.



They need research skills and access to state-of-the-art research facilities to keep innovating, while universities produce cutting-edge research that rarely reaches the market.”

ICI-THROUGH delivers the best of both worlds through the association of two academic and two industrial partners. By working together, they created a non-invasive, practical and inexpensive method to estimate human BAT activity. They also managed to combine PET/CT imaging, thermal video and image analysis, and heat and mass transfer models. By doing so, the team was able to quantify the heat produced by BAT which, in turn, provides extremely valuable information on how it consumes energy.

“The system is based on heat/mass transfer equations and formulas we developed, which are covered in a patent application to be submitted over the coming months. Extensive validation studies show that the developed prototype provides a valid estimation of a person’s brown adipose tissue activity, as assessed via a PET-CT scan,” Dr Flouris explains.

With this information, health professionals could soon prescribe appropriate interventions to maximise the energy utilised by BAT. This, in turn, will facilitate weight loss.

Dr Flouris is also confident that the commercialisation of non-invasive devices to accurately estimate BAT activity will revolutionise the global anti-obesity products market,

“Extensive validation studies show that the developed prototype provides a valid estimation of a person’s brown adipose tissue activity, as assessed via a PET-CT scan.”

which is currently estimated at EUR 50 billion. Meanwhile, food or pharmaceutical companies could use these non-invasive devices to test the effects of different products on thermogenesis, metabolic rate, energy balance and weight loss.

But there is still work to be done, as Dr Flouris admits. “To date, we have demonstrated the system prototype in an operational environment. We are currently making further improvements to ensure that it is complete and qualified. From thereon, we will include all system components in a patent application. The final stage will be to prove the actual system in the operational environment, such as a hospital or a pharmaceutical company.”

#### ICI-THROUGH

- Coordinated by the University of Thessaly in Greece.
- Funded under H2020-MSCA-RISE.
- [cordis.europa.eu/project/id/645710](https://cordis.europa.eu/project/id/645710)
- Project website: [ici-through.com](http://ici-through.com)
- ▶ [bit.ly/2QTI6jR](https://bit.ly/2QTI6jR)

## New insights into the mechanism driving obesity

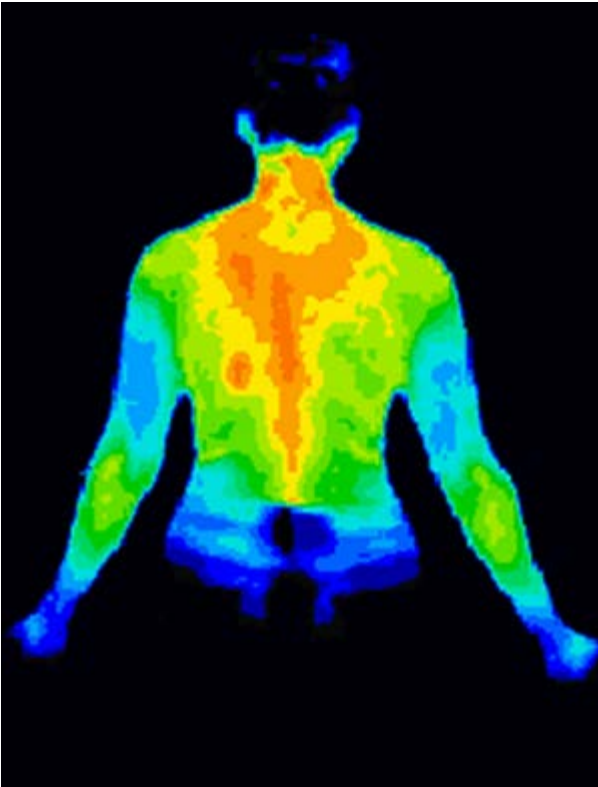
*Obesity represents one of the key healthcare challenges of the 21st century because of its prevalence and association with heart disease, cancer and type 2 diabetes. The NeuroEE project’s ultimate aim is to identify new ways to prevent and treat obesity.*

According to the Eurostat website, half of the adult EU population are overweight and 16% are clinically obese. However, the most striking and worrying data is about children, where it is reported that one in three European children is either overweight or obese. Given the associated health consequences of obesity, this is a serious concern.

The EU-funded NeuroEE (Delineation of a brain circuit regulating energy expenditure to impact body weight) project sought to provide insights into thermogenesis (the way the body produces heat) in brown adipose tissue to understand how increased energy expenditure can be harnessed to reduce

body weight. Understanding this may aid in the development of new therapies and medications to improve the lives of those suffering from obesity and related diseases.

As a recipient of a Marie Skłodowska-Curie fellowship, lead researcher Dr Pablo Blanco Martínez de Morentin was able to make a key discovery, “I found that disruption in the function of a particular population of cells in the brain is sufficient to affect overall body weight by specifically increasing brown adipose tissue thermogenesis and energy expenditure. This could have important implications for the future prevention and treatment of obesity.”



## A FINE BALANCE BETWEEN BRAIN AND BODY

The project considered the dynamic between energy expenditure and homeostasis. In some situations, energy expenditure can be in the form of heat release, as nutrients can also serve as fuel in thermogenesis. Brown adipose tissue is a specialised tissue in our bodies that controls thermogenesis, and its main regulator is the neurotransmitter norepinephrine which is released from the sympathetic nerves.

Dr Martínez de Morentin's previous research indicated that a critical node between the ventromedial hypothalamus and brown adipose tissue is the raphe pallidus, a brain region known to control the activity of spinal cord norepinephrine-producing cells that regulate the activity of brown adipose tissue. This tissue, in turn, influences the energy expenditure. "My work centred around finding the specific brain signals that tell the norepinephrine cells to do this."

Supervised by Professor Lora Heisler, one of the leaders in the field of the relationship between the neurotransmitter serotonin and obesity, Dr Martínez de Morentin is grateful to have been given the opportunity to conduct the research on both a scientific and personal-development level. "I was given the opportunity to lead a project, not only scientifically, but also from a professional, managerial and financial perspective. I believe that this has had a major impact on my

career development and am very thankful to the European Commission and Professor Heisler for this opportunity."

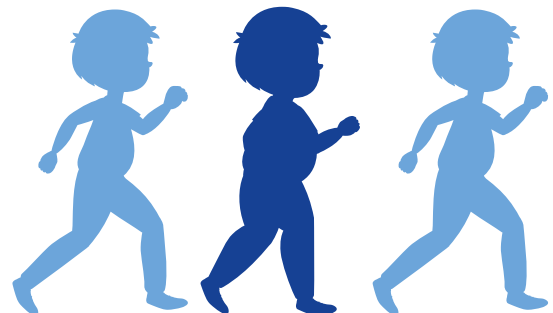
The NeuroEE project was conceived as a study to understand the underpinnings of the process that regulates body weight. Now Dr Martínez de Morentin hopes his findings will feed into the design of new medications that may ultimately assist with weight loss in those individuals where diet and exercise alone have not been successful, but where weight loss is essential to improve health.

"One of the key discoveries from this project is the identification of a new population of cells located within the brain that reduce body weight by increasing thermogenesis and energy expenditure. My goal is to take this discovery further and clarify how these cells perform this essential function."

### NEUROEE

- Coordinated by the Rowett Institute, University of Aberdeen in the United Kingdom.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/660219](https://cordis.europa.eu/project/id/660219)
- Project website: [abdn.ac.uk/rowett/research/index.php](https://abdn.ac.uk/rowett/research/index.php)

One in three  
European children  
is either overweight or obese





# From farm-to-fork analysis of antimicrobial resistance

*Antimicrobial use is rife in the agricultural industry with a potential risk for humans. With antimicrobial resistance on the rise there is an imperative need to analyse the relationship between antimicrobial use and animal health and welfare, food security and economics.*

The EU-supported EFFORT (Ecology from Farm to Fork Of microbial drug Resistance and Transmission) project aimed to provide scientific evidence and high-quality data to inform decision-makers, the scientific community and other stakeholders of the consequences of antimicrobial resistance in the food chain. As Dr Jaap Wagenaar, the project coordinator, explains: “By understanding the eco-epidemiology of antimicrobial resistance from animal origin, we set out to predict and limit future development and exposure to humans of the most clinically important resistance.”

EFFORT developed new techniques for detecting resistance genes in the faeces of animals. They did so by sequencing all DNA in faecal samples (‘metagenomics’). The result was what Dr Wagenaar describes as an

unbelievable amount of information in the form of DNA sequences, all of which had to be analysed by bioinformatic tools.

The team designed new approaches in order to deal with all the incoming data. “The lab methods and computer programs developed during the project evolved very quickly. So we learned by doing! It was exciting to be at the forefront of the developments in this field of research.” The amount of data collected was so huge that only 0.5 % has been analysed so far. But as the data is available to other European projects there are findings still to come.

“Based on the resistance genes, we used modelling to detect the levels of resistance to which people are



exposed.” The researchers also conducted studies on bacterial strains isolated from animals and the environment, to see how they behave. The team asked: Are bacteria with antimicrobial resistance genes as fit as the ones without? Why are some clones very good at spreading? Do they need the selective pressure of antimicrobials or can they spread without? “The more information you collect, the more precise the estimations are of how bacteria will spread.”

But while research of bacteria in isolation provided the researchers with interesting insights, they also conducted real-life intervention studies aimed at reducing the use of antimicrobials in veterinary practice. This part of the project was performed on poultry and pig farms. By coaching farmers, the project was able to encourage the reduction of the antimicrobials used.

“When you look at the farm systematically, you can come up with advice for changes in areas such as hygiene, ventilation and feed. It was also a question of rethinking old habits, challenging the ‘But I always use...’ mentality. Some farmers do not want to take any risk and are convinced that they need antimicrobials at certain time points in production. They expect their animals will become ill if they don’t. So it’s necessary to verify if that supposition is actually correct.”

The research team was made up of 19 partners from 10 European countries. They came together to share their

“Based on the resistance genes, we used modelling to detect the levels of resistance to which people are exposed.”

expertise in domains as wide-ranging as the epidemiology of resistance genes, veterinary microbiology, whole genome sequencing for bacteria and the economics of animal husbandry.

EFFORT’s findings are of interest to policy-makers and the scientific community alike: “The fact that we have been able to collect in a systematic way so much data from nine countries reflects this. One of the first publications was in Nature Microbiology, which shows the scientific importance of our work,” says Dr Wagenaar proudly.

#### EFFORT

- Coordinated by the University of Utrecht in the Netherlands.
- Funded under FP7-KBBE.
- [cordis.europa.eu/project/id/613754](http://cordis.europa.eu/project/id/613754)
- Project website: [effort-against-amr.eu](http://effort-against-amr.eu)
- ▶ [bit.ly/2PTntT](https://bit.ly/2PTntT)

## FOOD AND NATURAL RESOURCES

# Better detection of foreign bodies in food processing plants protects consumers

*While consumer safety comes first, product rejections and recalls in the food industry damage brand reputation and can lead to loss of business. A newly developed inspection system developed by an EU project offers rapid detection of foreign bodies in food.*

Despite the best efforts of processing plants to eliminate foreign body contaminants, they can remain in food that reaches consumers, causing injury and even death

(especially in infants). While there is a range of detection systems available, none provides a comprehensive safeguard. For example, X-rays can detect objects with

different densities (such as glass or dense plastic), but struggle with very small contaminants such as hair or those of low density, such as cardboard. Moreover, X-rays are expensive and pose safety concerns.

The EU-supported HYPERA (Affordable Hyperspectral Imaging System for on-line foreign body detection and chemical composition analysis) project developed an on-line quality inspection system for automated chemical composition analysis and foreign body detection, for the food industry (and other process industries). The non-destructive hyperspectral imaging (HSI) system is capable of rapid, consistent detection of a wide range of foreign bodies in modern food processing plants.

### THE HSI SYSTEM

The IRIS-built non-destructive hyperspectral imaging (HSI) system integrates both spectroscopic and computer vision techniques to simultaneously provide spectral and spatial information.

The hyperspectral camera detects hundreds of bands of light. The infrared (IR) spectrum is much richer in terms of chemical composition than the visible three band spectrum (VIS) that people see. Using IR allows the system to detect a wide variety of anomalies in foods. "If conventional spectroscopy provides the answer to the 'What', and conventional computer vision to the 'Where', HSI

“*HYPERA is great news for consumers. It will prevent future food scares and scandals, guaranteeing safe, healthy and high-quality food.*”

answers the question of 'Where Is What', says Mr Alejandro Rosales, Science & Technology Manager at IRIS.

When combined with chemometric (i.e. multivariate) analysis, HSI can predict the concentration and distribution of multiple components in a sample, making the technique attractive for many routine food industry quality inspections.

The HYPERA® system comprises two different monitoring modules. The reflection module not only detects contaminants but also measures food composition including fat, moisture and protein, acting as a multi-functional tool to assess food quality. The transmission module is particularly suitable for detecting opaque bulky foreign bodies. The system is seamlessly mounted into production conveyor lines.

The team tested HYPERA® at the industrial facilities of four food processors from Spain and Ireland where it was trialled in five different food applications, successfully detecting foreign bodies in pizzas, ready-to-eat (RTE) foods, processed fruit and vegetables, and cooked meats.



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## SHIFTING GEAR FROM R&D TO PRODUCT ACCELERATION

The EU's SME Instrument funding aims to quickly scale promising technology. It has enabled the cross-disciplinary team (representing photonics, chemometrics, software development and Artificial Intelligence) to achieve performance improvements for this disruptive technology.

"HYPERA® is great news for consumers. It will prevent future food scares and scandals, guaranteeing safe, healthy and high-quality food," says Director of IRIS, Mrs Oonagh McNerney. "As it drives forward advanced, data-driven processing technologies, it will also play a role in boosting the competitiveness of the European food industry, in line with Industry 4.0 ambitions."

The scaled-up system (patent pending) offers over 95 % accurate identification for applications targeted to date,

and is now nearly market ready. The team have already secured their first sales and first distributor partnership and are currently focussed on their market strategy. This is targeted at food processing companies initially, before pharma, chemical and other process industries.

From a technical standpoint, mathematical deep learning tools are being used to improve the technology's penetration range, to detect deeply embedded foreign bodies, as well as extending the range of identifiable smaller contaminants.

### HYPERA

- Coordinated by IRIS Technology Solutions in Spain.
- Funded under H2020-FOOD and H2020-SME.
- [cordis.europa.eu/project/id/726572](https://cordis.europa.eu/project/id/726572)

## FOOD AND NATURAL RESOURCES

# A little-known sea vegetable is set to revolutionise world cuisine

*The North Atlantic Sea is home to a tiny marine organism that is a true gastronomic gem. But how can the rest of the world enjoy it when it is solely found there? An EU-funded project shows the way.*

*Vertebrata lanosa* (*Polysiphonia lanosa*) is a sea vegetable from the red algae family that resembles the taste of truffles. It is a very delicate product as its flavour can be easily affected by many things such as the season, location and weather. On account of these factors, it is also a challenging food item to share with the world.

For the SEAGEM (Developing a process to bring a unique Icelandic natural food sea gem worldwide) project though, no challenge is too great. Taken on by Íslensk hollusta, a leading supplier of innovative food products from natural Icelandic resources, "SEAGEM aimed to bring *Vertebrata lanosa* to cuisines around the world," outlines project

coordinator Eyjólfur Friðgeirsson, Icelandic biologist and CEO of Íslensk hollusta.

### IF THERE'S A WILL, THERE'S A WAY

Introducing the project, Friðgeirsson explains: "In 2015, we started collecting, processing, presenting and selling *Vertebrata lanosa*, which we have called sea truffles, to restaurants in France, Iceland and other Scandinavian countries."

Several chefs observed its truffle-like aroma, prompting Friðgeirsson to contact the Science Institute of the University of Iceland to test the aroma profile of



© Íslensk hollusta

“SEAGEM aimed to bring *Vertebrata lanosa* to cuisines around the world.”

*Vertebrata lanosa*. Friðgeirsson notes: “If the *Vertebrata lanosa* could be regarded in any way as a marine analogue of the earth truffle, it could become a product of great economic value.”

From there, Phase 1 of the SEAGEM project involved a technical feasibility study that analysed the tests. Additionally, its commercial and financial feasibility of bringing it to the rest of the world was evaluated.

### WHAT DID SEAGEM DISCOVER?

An analysis of the tests carried out on *Vertebrata lanosa* showed that “dimethyl sulphide is present in the vegetable,” reports Friðgeirsson. This is “one of the few compounds identified by scientists, expert sniffers and truffle experts as being responsible for the aroma of earth truffles.”

SEAGEM further carried out an assessment of their current and potential distributors within their target regions: Europe, Asia Pacific and the United States. An in-depth analysis of the market environment for the food item and of their target market segments showed that high-end restaurants, speciality food shops, high-end catering and food producing companies should be targeted. Within

this analysis, competitors were looked at and a commercialisation strategy for the sea truffle, including a pricing strategy that will lead to a profit margin of 84-86 %, was developed.

Additionally, “we consolidated a business plan based on previous work, with a forecast of operations costs and sales of the sea truffle during the first five years of commercialisation.” This forecast yielded an accumulated net income of EUR 6.2 million.

### WHAT’S IN STORE FOR SEAGEM?

Friðgeirsson notes: “Based on the work done in Phase 1, we conclude that we can continue with Phase 2 of the SEAGEM project.” The project has started to study the chemical composition of sea truffles using their own resources and in cooperation with the University of Iceland and the University of Turku in Finland. Friðgeirsson adds: “We just completed an application for necessary funds to continue to study them – to gather, process and present them to the market,” which means sea truffles may soon be a feature of world cuisine.

### SEAGEM

- Coordinated by Íslensk hollusta EHF in Iceland.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- [cordis.europa.eu/project/id/826356](https://cordis.europa.eu/project/id/826356)
- Project website: [islenskhollusta.is](http://islenskhollusta.is)



# High-tech stretchable lightweight tape could benefit industries from aerospace to automobiles

*PTFE – known widely by the popular brand Teflon™ – has been around for decades. Now an EU-funded project has developed a stretchable tape version, making a high-tech product fit for the space age.*

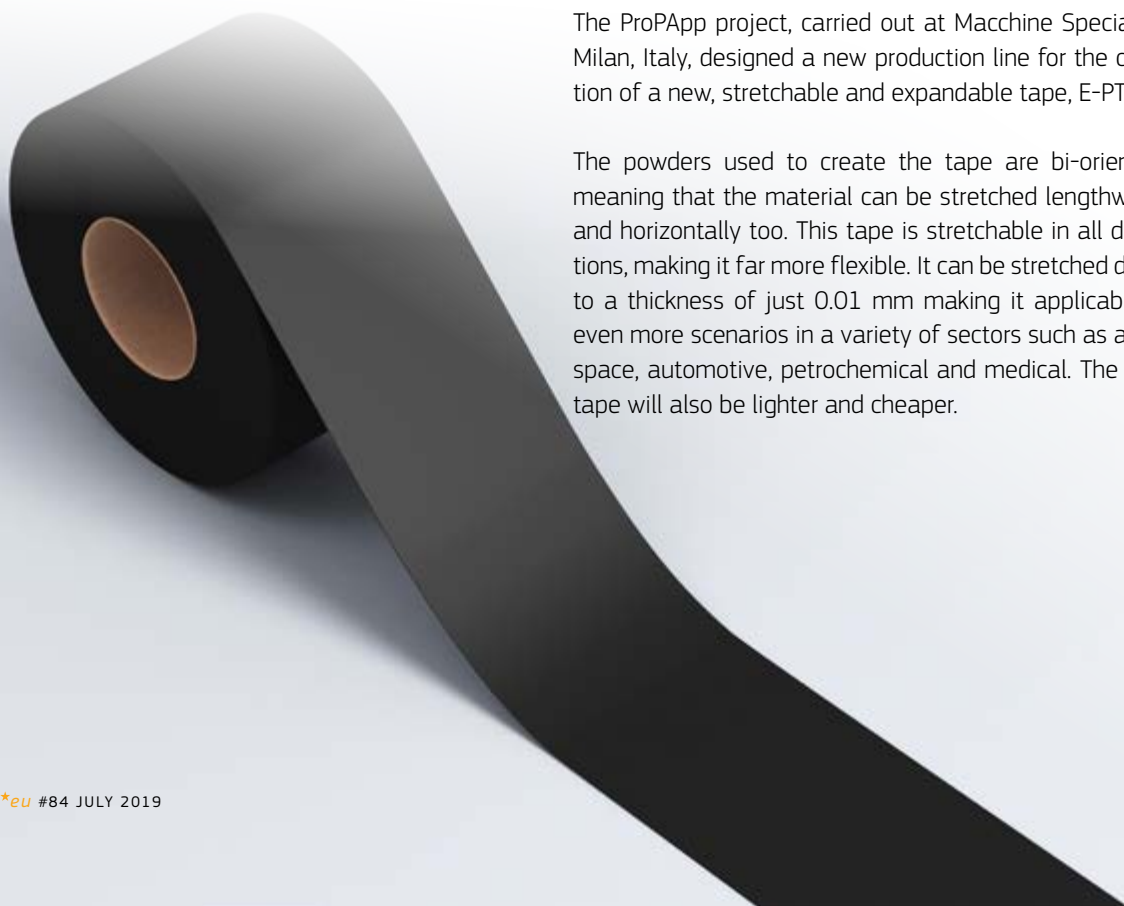
The Horizon 2020-funded ProPApp (New PTFE Production Process for High Value Applications) project improved and streamlined the production of an old and widely used polymer, bringing the technology into the space age. Polytetrafluoroethylene (PTFE) is a synthetic polymer created in the 1960s, commonly known by its biggest brand name, Teflon™. It's used widely in everything from cookware to cable production, often taking the form of a versatile coating – the non-stick protective layer in many frying pans, for example.

PTFE's unique chemical bonding gives it characteristics of extreme durability. It can withstand a wide range of temperatures, remaining stable from -50 °C to over 350 °C. It is acid-resistant and non-sticky. Its long life makes it ideal for applications across many industries.

But it is dense, and difficult to process. What's more, the techniques to do so are not very well known, meaning that although PTFE is a useful material, its uses have been constrained. This is particularly true of the tape form, produced for many industries, as PTFE tape doesn't expand further than 20 %.

The ProPApp project, carried out at Macchine Speciali in Milan, Italy, designed a new production line for the creation of a new, stretchable and expandable tape, E-PTFE.

The powders used to create the tape are bi-oriented, meaning that the material can be stretched lengthways, and horizontally too. This tape is stretchable in all directions, making it far more flexible. It can be stretched down to a thickness of just 0.01 mm making it applicable in even more scenarios in a variety of sectors such as aerospace, automotive, petrochemical and medical. The new tape will also be lighter and cheaper.



“ *It can be tensioned in both directions, bringing it to the desired thickness to obtain a gradually thinner tape, until it becomes a membrane, permeable to air but impermeable to water.* ”

The fact that it is resistant when stretched in any direction means that it can be treated further, explains Giovanni Sironi, General Manager at Macchine Speciali and ProPAPP project leader. “It can be tensioned in both directions, bringing it to the desired thickness to obtain a gradually thinner tape, until it becomes a membrane, permeable to air but impermeable to water.” The light-weight version of PTFE is 50 % less dense and will have high-performance uses in electrical and power cables.

Now that the project has been completed, the team would like to scale up production and adoption into other countries, selling specialised plants for the construction of the tape. Two of these have already been sold, says Sironi.

“This new element to our business will permit us to come up with new solutions as we develop this cutting-edge technology. But we haven’t lost sight of the traditions we

have built up over 20 years which have enabled us to export our machinery across the world.”

Formed in 1996, Macchine Speciali have become production experts in the cable industry. They pride themselves on listening to customer feedback to inspire innovation in new products, and for the past two decades have been investigating the production limitations of PTFE, which is how they devised the idea for E-PTFE. They welcomed the support that the EU provided for the project, giving them the boost to refine and scale up production.

“Horizon 2020 is definitely a valuable contribution for companies that want to innovate to propose something new and attractive – and why shouldn’t we aim to improve the world of work, industry, and society? Our project would be very proud to be able to achieve these goals too.”

#### PROPAPP

- Coordinated by Macchine Speciali SRL in Italy.
- Funded under H2020-SME and H2020-LEIT-NANO.
- [cordis.europa.eu/project/id/710279](https://cordis.europa.eu/project/id/710279)
- Project website: [propapp.eu](https://propapp.eu)
- ▶ [bit.ly/2WxwdAP](https://bit.ly/2WxwdAP)

## INDUSTRIAL TECHNOLOGIES

# Low-cost miniaturised sensors ‘see’ trace gases

*An EU-funded project developed novel components for miniaturised sensors for detecting harmful gases, offering a low-cost, more practical alternative to conventional technology operating in the infrared light spectrum. This disruptive technology could make security affordable for the industrial, civil and military area.*

Infrared gas sensors are the cutting-edge technology for detecting harmful or explosive gases. However, currently available devices are either complicated, expensive or heavy. Furthermore, they are limited by low sensitivities and require large gas sample amounts.

Led by a consortium of European research centres and industrial partners, the EU-funded project MIREGAS

(Programmable multi-wavelength Mid-IR source for gas sensing) introduced breakthrough components that can be integrated for multi-gas analysis. Compared to conventional infrared gas sensor technologies, the new components provide better accuracy at a lower price – the wavelengths of light can be filtered more precisely and interfering gas components can be excluded. The infrared



wavelength range helps detect the ‘molecular fingerprints’ of many trace gases.

### FAST AND AFFORDABLE MULTI-SENSING

The project consortium created a device that uses only one light source for multi-gas analysis, as opposed to several lasers. The light source utilises technology that was originally developed for optical communications applications – this minimises measuring costs compared to traditional spectroscopy measurement.

The MIREGAS device can make multiple measurements with one tuneable and switchable multichannel optical filter and pick out individual gases from a mixture of emissions. These include methane, ethane, butane, propane, carbon dioxide and water. It has the potential to detect numerous gases simultaneously, which is useful in industrial processes and environmental monitoring applications.

### PROJECT ACHIEVEMENTS

MIREGAS is filling a gap in the market, as affordable high-performing infrared sources are not available. MIREGAS’s tiny and low-cost gas sensor uses several breakthrough components that entail important benefits in terms of cost, volume production and reliability. These include a novel superluminescent light-emitting diode (SLED), a silicon photonic integrated circuit (PIC) spectral filter, moulded infrared optics, and high-volume assembly and packaging technologies.

Project members demonstrated a wideband single-mode SLED emitting at 2.65  $\mu\text{m}$  that reached an output power of nearly 0.5 mW with a 300 nm wide spectrum. To form a collimated beam from the SLED, they developed a new type of low-oxygen, heavy-metal-oxide glass that transmits mid-infrared radiation and is formed in a moulded-glass process called hot embossing. Moulded glass

“*Cost-effective multi-wavelength light sources are instrumental for the wide penetration of infrared gas sensors.*”

lenses that fit into a TO-can architecture were experimentally produced.

The newly developed low-loss PIC owns two unique features: in addition to the conventional optical communications wavelengths at 1 550 nm, it is applicable for mid-infrared wavelengths; it also allows for integrating active devices such as laser diodes or photodetectors directly on the PIC chip. Packaging and assembly of the tiny sensor involved submicron alignment of the SLED that is flip-chip bonded to the silicon PIC.

### SENSING A BRIGHT FUTURE

MIREGAS breakthrough technologies will enable project partners to reach a new level of selectivity and accuracy in multi-gas measurements at competitive price levels. “The possibility of tailoring the spectral output to match any wanted set of absorption lines with any desired bandwidth below 3 500 nm is the major advantage of our light source when compared to the single narrow line of a tuneable laser. Cost-effective multi-wavelength light sources are instrumental for the wide penetration of infrared gas sensors,” project coordinator Dr Pentti Karioja explains.

“Our novel light source combining silicon photonics and infrared gas sensing will be advantageous not only for gas sensing but also for all kinds of mid-infrared sensors, process analysis technology, environmental and food safety, and security applications,” notes Pentti. This should open new business opportunities and strengthen their technological position in providing gas measurements for demanding applications.

### MIREGAS

- Coordinated by the VTT Technical Research Centre in Finland.
- Funded under H2020-LEIT-ICT.
- [cordis.europa.eu/project/id/644192](https://cordis.europa.eu/project/id/644192)
- Project website: [h2020-miregas.eu](https://h2020-miregas.eu)



# Monitor in the cloud to weed out computer network malfunctions

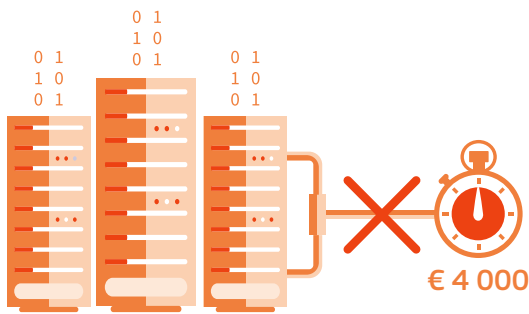
*New 'plug-and-play' software could help to reduce massive costs related to computer network downtime.*

As most businesses are now completely dependent on computer networks, they are also at the mercy of their malfunctions. The costs associated with regular failures and network downtime are massive: surveys have put the average at around EUR 30 000 per hour, and average losses at around EUR 5 million each year. In data centres, increasingly fundamental for digitised societies both in the EU and around the world, costs can reach a staggering EUR 4 000 per minute.

Most current network visibility and security products that deal with such issues are hardware-based, and very expensive. Licence costs must be paid upfront and deploying network monitoring often means specialised technicians must be called out, leading to further losses in time and money. This means solutions are not widely spread enough, and network problems are.

SDN-Polygraph (Cloud-based Monitoring Service for Software Defined Networks), an EU-funded project, has developed a cloud-based monitoring solution that can spot and even mitigate malfunctions in the networks, flexible software with an equally flexible costing plan and unique features.

“The first requirement to avoid malfunctions and correctly operate a network is network visibility,” explains SDN-Polygraph project coordinator Dr Valentín Carela-Español. This means giving engineers the ability to understand what exactly is happening within the networks: seeing which applications are being used, detecting and mitigating attacks, and rooting out the causes behind performance issues.



## In data centres, costs from network failures can reach € 4 000 per minute

The project's aim was to create a scalable, cloud-based, zero-hardware network visibility and security solution, as part of the technical revolution currently underway known as Software Defined Networking (SDN). SDN allows networks to incorporate software components to make it programmable, flexible and more resilient.

The solution was SDN-Polygraph, a piece of software running in the cloud that can be activated with just one click and will seamlessly collect and analyse data, such as network traffic statistics, to pinpoint problems speedily. It can also act on the network to mitigate attacks, such as DDoS, which can bring systems down through a distributed flood of incoming traffic. SDN-Polygraph, which

“ The first requirement to avoid malfunctions and correctly operate a network is network visibility. ”

can be easily applied to almost any existing computer network, can work with either traditional or SDN networks.

“All the original objectives have been achieved,” says Dr Carela-Español. “However, they have also been redefined, to focus on traditional networks due to the limited and slow introduction of SDN networks in the market.”

Dr Carela-Español says it's difficult to select just one thing to be most proud of from the project, and that the company was pleased to have received support from EU funding. “Probably the most important development for us, thanks to the project, is our ability to take our idea to a scale that would have been inconceivable for a small company like ours. It's taken years, but all our efforts have paid off.”

Indeed, the EU-funded project not only led to the development of a successful piece of technology, but also meant that the company, Talaia Networks, could grow. “We went from three full time employees to 10-12 full time employees, and this allowed the company to grow in all possible directions,” says Dr Carela-Español.

### SDN-POLYGRAPH

- Coordinated by Talaia Networks SL in Spain.
- Funded under H2020-LEIT-ICT and H2020-SME.
- [cordis.europa.eu/project/id/726763](http://cordis.europa.eu/project/id/726763)
- Project website: [sdn.polygraph.io](http://sdn.polygraph.io)

### DIGITAL ECONOMY

# Augmented reality realised in construction

*Building sites are often chaotic, disorganised and dirty spaces, making it hard to track the progress of installations. Integrating virtual elements into these sites should give contractors, architects, developers and their clients a much clearer impression of the building design.*

The building sector accounts for 40 % of energy use in the EU. The Energy Efficient Buildings project, a joint initiative

of the European Commission and the construction industry, was created to reduce the projected energy use in

“ *The key innovation of INSITER is the development of intuitive and cost-effective tools for self-inspection with the use of augmented reality.* ”

buildings in 2030 by 50 % using today's best practices and technologies.

Buildings rarely meet their energy efficiency and quality expectations. The EU-funded project INSITER (Intuitive Self-Inspection Techniques using Augmented Reality for construction, refurbishment and maintenance of energy-efficient buildings made of prefabricated components) was established to close the gap between the predicted and actual energy savings of energy-efficient buildings based on prefabricated components. INSITER presented a set of advanced tools and methodologies that prevent or significantly minimise energy losses caused by faulty assembly of the building components or defective installations of mechanical, electrical and plumbing systems during the construction phase. “Our forward-looking concepts rely on on-site inspection processes during the construction phase as opposed to the traditional post-inspection approach,” notes André van Delft, CEO and founder of DEMO Consultants, the Netherlands-based company that coordinated INSITER.

### REAL-TIME REVIEW OF BUILDING CONSTRUCTION

Augmented reality's presence may be more common in the entertainment and video game industries. Yet, its application has plenty of benefits for the construction industry. Instant access to a digitised database allows inspectors to accurately compare what is being built against the building information model (BIM). Problem areas are thus easier to recognise and serious concerns can be identified and resolved instantly.

“The key innovation of INSITER is the development of intuitive and cost-effective tools for self-inspection with the use of augmented reality. Unlike virtual reality which creates a totally new and independent environment of the real world, augmented reality takes a 3D model and combines it with real-time information from the building,” notes van Delft. Combining virtual architectural designs with the reality of the building site increases efficiency and accuracy, reduces errors and saves time, money and resources. “What's more, augmented reality can be integrated with mobile applications that make triangulation calculations from geospatial information, global and



indoor positioning systems, enabling users to access it on smartphones or tablets,” adds van Delft.

### INTELLIGENT 3D COMPUTER MODELS

Even the most sophisticated visualisation technology depends on the quality of the data underpinning it. This is where BIM comes in.

The BIM tool helps create and manage information, allowing teams to use a coherent system of 3D computer models and its relevant information rather than separate sets of documents or drawings. Having the same spatial understanding of the built environment enables architects, contractors and structural engineers to work more collaboratively when accessing and updating the design and therefore reduces failure costs.

INSITER offers users the opportunity to display enhanced planning data from measurement and diagnostic instruments by integrating them with BIM. This includes data collected from 3D laser scans, thermal imaging cameras, and acoustic and vibration detectors during INSITER's field demonstration activities. Project members updated the computer models throughout the entire lifecycle of the buildings, even after completion, to assess maintenance.

Demonstration cases included a rooftop extension of a healthcare centre in Germany, refurbishment of a school

complex in Italy, monitoring performance of a newly constructed office building in Spain, and renovation of a university building in the Netherlands.

Combining several cutting-edge technologies, application of INSITER could considerably reduce the mismatch of energy performance between the design and commissioning stages of a building. These should help avoid costly mistakes while ensuring good build quality and optimal energy saving throughout the entire building lifecycle.

## INSITER

- Coordinated by DEMO Consultants BV in the Netherlands.
- Funded under H2020-LEIT-ADVMANU.
- [cordis.europa.eu/project/id/636063](https://cordis.europa.eu/project/id/636063)
- Project website: [insiter-project.eu](https://insiter-project.eu)
- ▶ [bit.ly/2WvnYFt](https://bit.ly/2WvnYFt)

## DIGITAL ECONOMY

# TV any way you like it

*The TV industry is about to let go a little, to give the viewer more control over how their programming is presented. Welcome to a world of multi-screen personalised TV.*

Gigantic, ultra-high definition TV screens are no longer the ultimate viewing experience. Today, many people watch TV with multiple additional devices beside them.

Although internet-streaming content is challenging conventional TV broadcasters, streamed content rarely complements the main broadcast. Instead, the two modes often clash.



“We enable personalisation of television by using object-based broadcasting [OBB].”

Many viewers would prefer to watch major TV events with synchronised supplementary content cast to small screens. Yet, so far, the demand has gone largely unmet.

## NEW SOFTWARE ENVIRONMENT

To meet the demand, the EU-funded 2-IMMERSE (Creating and Delivering Shared and Personalised Multi-Screen Broadcast and Broadband Experiences) project developed a software environment enabling customisable, interactive, multiscreen TV content. The environment includes the knowledge and tools needed to deliver content in this mode, plus guidelines for extending the infrastructure.

“We enable personalisation of television by using object-based broadcasting [OBB],” says Doug Williams, 2-IMMERSE technical project manager, “which is where content objects – graphics, video and audio – are rendered at the client device rather than prior to transmission.”

The software, which is based on familiar internet technologies, allows companion devices to discover and jointly run services. The system defines the role each screen should take in the multiscreen experience. The innovation also allows users to interact with the content and remotely share experiences with each other.

## PROTOTYPE DEVELOPMENT

Researchers created and evaluated a series of five open-source prototype OBB systems, intended for homes and public spaces. Each prototype introduced new features and capabilities.

The first system demonstrated the project’s basic principle and established the Theatre at Home concept. Users were able to watch a Shakespeare production as in a real theatre: being able to chat with friends, or refer to texts including script and synopses of the play. The next prototype used a MotoGP broadcast to introduce responsive design features, user profiles, and user selection of additional video feeds.

The next two prototypes featured a presentation of the Emirates FA Cup Final, bringing in real-time service customisation separately for homes and public Fanzones. Fanzones are public spaces equipped with large screens, often just outside sport stadiums, where fans without tickets gather to watch events. The final prototype, Theatre in Schools, added multiscreen interactive educational services featuring several different modes for teachers and students. This allowed students to create and share responses to the Shakespeare play.

The team’s presentation of the MotoGP won the 2018 HbbTV award for best multiscreen service. Other project prototypes were nominated for the British Market Research Society’s award for Best Innovation.

The service prototypes favour fans of sports and live theatre, as well as English and Drama educators, but the project’s concept is not limited to these domains. Almost any TV genre could be adapted to the 2-IMMERSE concept.

Researchers hope to foster a community of practice based around the software the project has released. “We hope TV production companies will embrace the concept,” adds Williams, “adapting their workflows and products to allow the generation of video, graphics and audio that can be handled in an object-based broadcasting way.” The project will continue working with telecommunication companies to explore the potential of OBB for sport broadcasts and other areas.

The era of viewers passively watching broadcast TV is ending. Thanks to 2-IMMERSE, viewers will soon have many options for interactivity and customisation.

## 2-IMMERSE

- Coordinated by the British Broadcasting Corporation in the United Kingdom.
- Funded under H2020-LEIT-ICT.
- [cordis.europa.eu/project/id/687655](https://cordis.europa.eu/project/id/687655)
- Project website: [zimmerse.eu](https://zimmerse.eu)
- ▶ [bit.ly/2WqNVWC](https://bit.ly/2WqNVWC)



# Groundbreaking device first to define location of falling space debris in real time

*With over 13 000 artificial objects and almost 1 700 operating satellites orbiting our planet every day, space debris poses a safety hazard to operational spacecraft, air traffic, people and property on Earth. An EU initiative introduced technology to monitor space vehicles and satellites as they re-enter Earth's atmosphere.*

Most objects and satellites are destined to re-enter the atmosphere and hopefully burn out. Unfortunately, on average 10-40 % of satellite mass survives re-entry and impacts the Earth's surface. This increasing risk led space agencies to impose progressively stricter regulations, but it's currently impossible to accurately predict the impact area of surviving fragments.

## TAKING SPACE DEBRIS MANAGEMENT TO ANOTHER LEVEL

For high perceived risks, authorities are forced to close large airspace that may be potentially affected, leading

to costs that exceed several million euro. The EU-funded DeCAS project (The first real-time monitoring device able to determine the impact area of space vehicles' fragments during re-entry into the Earth's atmosphere and minimize risks for people and property) "addresses the critical issue of safeguarding air traffic, people and infrastructure around the world through a precise, efficient and cost-effective system that will make our planet a safer place," says coordinator Prof. Piermarco Martegani. "Our patented technology will enable relevant authorities to respond in a timely manner by becoming aware of the exact location, extent of debris – or footprint – and the dynamics of debris as it dissolves."

The DeCAS team developed a novel system that predicts exactly how and where all space debris will impact the planet whenever a breakup occurs. It's based on an approach to tracking the space debris area from the inside rather than from the ground or space. The approach's main feature is a small and lightweight device that's mounted on space vehicles and launchers. It tracks and models in real time the trajectory of the fragments and their impact area. The device can also be applied as a complementary technology to improve

On average **10-40 %**  
of satellite mass  
survives re-entry and impacts  
the Earth's surface.



“ Not only does it protect sensitive installations, air traffic and civilians worldwide, it's also the most cost-efficient and easy-to-install solution available today. ”



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current ground- and space-based systems already in place. It can easily be installed on any launcher to track debris.

## A SIGNIFICANT ADVANCEMENT IN SATELLITE DEBRIS SECURITY

The device functions as a type of smart fragment that autonomously determines its position during re-entry and predicts the impact's location. During the re-entry phase of space vehicles such as satellites or rocket bodies, the unit is triggered by sensors and transmits the space debris' position and direction to ground stations. This exact signal instantly provides the required data to all relevant agencies, including civil authorities, military space organisations and air traffic control centres. As a result, these agencies can determine exactly how to direct and maintain whatever safety protocols are needed for the affected footprint. What's more, space vehicle operators and manufacturers won't need to depend only on very expensive approaches provided by competing space technologies.

In 2017, project partners successfully tested the system during a space debris mitigation satellite mission called D-Sat. They demonstrated the system's architecture concept and communication abilities, and validated its software functionalities and performance.

Prof. Martegani lauds the DeCAS solution's innovations. "This 'inside' space debris tracking approach is the first of its kind in tackling the ongoing debris issue because it focuses on the re-entry phase. Not only does it protect sensitive installations, air traffic and civilians worldwide, it's also the most cost-efficient and easy-to-install solution available today."

### DECAS

- Coordinated by Aviosonic Space Tech in Italy.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- [cordis.europa.eu/project/id/816895](https://cordis.europa.eu/project/id/816895)
- Project website: [aviosonic.it](https://aviosonic.it)



LIFE AFTER...

# Catching up with TIME SCALE: Taking space farming from sci-fi to reality

*One of our most popular special features in 2018 was issue 73's focus on Europe's efforts to take an active role in the world's renewed interest in space exploration. In this month's 'Life After', we reconnect with Dr Ann-Iren Kittang Jost, the coordinator of one of the projects showcased in that special feature, TIME SCALE, who updates us on her team's efforts in developing innovative life support systems to enable the growth of crops and algae in a space-faring environment.*

"Yes, all is going well!" Dr Kittang Jost enthusiastically begins, as she outlines how she and her team remain dedicated to realising viable crop and algae cultivation systems for human space exploration. "TIME SCALE partners are today developing hardware for higher plants and algae on the International Space Station (ISS) with the same long-term objective as for the TIME SCALE project [which officially ended in April 2018]." Whilst TIME SCALE (Technology and Innovation for Development

of Modular Equipment in Scalable Advanced Life Support Systems for Space Exploration) had focused on improving plant-growing techniques in low gravity, the team have also recently been implementing their technology in ground facilities to gain knowledge and experience in advance of possible future human exploration beyond Earth.

## COMMERCIALISATION ACTIVITIES TAKE OFF

TIME SCALE had also been working on several products that could be commercialised, and indeed were, by the formal end of the project. "Two of our products, the Compact Gas Chromatography (GC) system from Interscience and the multi-ion analyser from Clean-Grow are now on the market," says Dr Kittang Jost. "In fact, the Compact-GC system comprises two commercial products, a thermal desorption module offering the capability of trace analysis of Volatile Organic Compounds and a programmable oven module that considerably speeds up analysis. The multi-ion analyser is capable of measuring 8 ions."



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*"We believe that the European Space Agency (ESA) should now use the ISS R&D platform to the fullest extent and fill in the knowledge and technology gaps of crop and algae cultivation."*

**Dr Ann-Iren Kittang Jost**  
Project coordinator of TIME SCALE  
© NTNU Samfunnsforskning

Additionally, a camera system for real-time plant health monitoring is also currently being followed up for a licensing agreement, and a possible spin-off company with a focus on water and nutrient management systems has been identified as having business potential for both Space and Earth applications, although these both have yet to be realised.

## TO ISS AND BEYOND

The TIME SCALE project has prepared the ground for R&D on human space flight on the ISS and beyond. "We believe that the European Space Agency (ESA) should now use the ISS R&D

platform to the fullest extent and fill in the knowledge and technology gaps of crop and algae cultivation. This would be done using a centrifuge allowing the simulation of fractional gravity (e.g. Lunar or Martian gravity)," says Dr Kittang Jost.

## TIME SCALE

- Coordinated by NTNU Social Research in Norway.
- Funded under H2020-LEIT-SPACE.
- [cordis.europa.eu/project/id/640231](https://cordis.europa.eu/project/id/640231)
- Project website: [timescale.eu](https://timescale.eu)



FUNDAMENTAL RESEARCH

# When chemicals skip to our tune

*EU funds posted a Munich postdoctorate student to Canada where he caught on camera the ultrafast motion of electrons and manipulated chemical reactions.*

Dr Matthias Kübel from Ludwig-Maximilians University in Munich has made important advances in using lasers for research into chemical reactions during EU project ATTOCHEM (Attosecond imaging and control of chemical dynamics).

Supported by the Marie Skłodowska-Curie programme, Dr Kübel spent two years at the National Research Council in Ottawa, Canada, researching electrons and nuclei at work during photochemical reactions – reactions triggered by light absorption. He also explored ways to manipulate molecules.

Dr Kübel believes his research helps in the quest for a better understanding of the movement of electrons during photochemical reactions such as photosynthesis in plants, damage to DNA and the process of vision in the human eye.

A better understanding could contribute to being able to control those chemical reactions and therefore to breakthroughs in inhibiting DNA damage that can lead to cancer or developing new green energy sources. “One can think of a biomolecule as a little machine that fulfils a certain task,” he explains. “The machines are switched



on when one (or several) of its electrons is excited. This leads to electron motion, a current within the molecule.

“So far, we have been able to visualise the structure of our little machines but the opportunities to actually see how they work have been scarce.”

At the NRC laboratory, Dr Kübel developed a method to see those little machines at work and to image the electron and nuclear dynamics underlying fast chemical reactions.

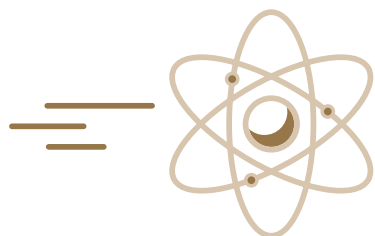
This is quite a feat since the electrons move fast – typically in femto or even attoseconds (0.0000000000000001 seconds). An attosecond relates to a second as a second does to the age of the universe. In his work, Dr Kübel developed a new type of streak camera, allowing attosecond measurements of electron motion in strong laser fields. He called this method, the STIER technique.

## THE SHORTEST TIMESCALES IN NATURE

A conventional streak camera contains a pair of plates onto which a rapidly changing voltage is applied. The varying voltage is used to spread out a time-dependent signal onto a position sensitive detector, mapping time to space.

But for Dr Kübel's purposes it wasn't fast enough. He replaced the changing voltage with an infrared laser

## Electrons move fast – even in attoseconds



0.00000000000000000001  
seconds

“*Developing new chemicals and revealing new reaction pathways by applying laser light is the dream of coherent control.*”

field. “The electric field varies in a well-controlled manner more than 1 000 times faster than what can be achieved with conventional electronics,” he says.

That allowed him to map the time-dependence of strong-field ionisation onto the final velocity of photoelectrons. He then measured them with a photoelectron spectrometer for the attosecond measurements.

As well as observing molecules in motion, ATTOCHEM proved the STIER technique could be a way to transiently modify how a molecule is held together. “We can manipulate for which geometries a molecule splits apart and for which it doesn't,” says Dr Kübel. “We did this for the very simple molecule hydrogen and the results are quite striking and very different from what has been observed before.”

He also extended his method to selectively split bonds in the gas acetylene.

Dr Kübel is excited about continuing his research back in Germany on more complex molecules: “Developing new chemicals and revealing new reaction pathways by applying laser light is the dream of coherent control.”

### ATTOCHEM

- Coordinated by Ludwig-Maximilians University Munich in Germany.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/657544](https://cordis.europa.eu/project/id/657544)
- Project website: [attoscience.ca/researchhighlights/STIER](https://attoscience.ca/researchhighlights/STIER)

# Innovative techniques and new data shed light on whale evolution

*Baleen whales are the largest animals on Earth, a remarkable example of evolutionary adaptation and key ecosystem engineers. They owe their success to filter feeding, but when and how this strategy emerged remains a central question in marine mammal evolution.*

Baleen whales, or *mysticetes*, have an unusual way of feeding. Without teeth, they rely on baleen – a comb-like sieve made of the protein keratin – to filter vast quantities of small prey directly from seawater. How and when whales evolved this filter feeding continues to be a mystery.

Like all mammals, the earliest whales had teeth, and some of them were fearsome predators. The emergence of modern baleen whales from these ancient raptorial forms is one of the most striking evolutionary transitions in the history of mammals, with enormous implications for global ocean ecology. “However, the



mechanics, timing and context of this transition remain highly controversial,” says Dr Felix Marx, coordinator of the EU-funded MYSTICETI (The oldest and the rarest - combining insight from both hemispheres to gain a global picture of baleen whale origins and macro-evolution) project.

To address this problem, project partners created a comprehensive data set on the anatomy of living and extinct *mysticetes*, reconstructed their evolutionary relationships, and used detailed observations on the feeding behaviour and anatomy of whales, dolphins and seals to understand how ancient baleen whales fed. Lastly, they synthesised the results to trace the gradual emergence of filter feeding among early whales.

### HOW DID WHALES TRANSITION FROM BITING PREY WITH TEETH TO FILTER FEEDING?

It was previously thought that baleen first appeared in a family of extinct whales that still had teeth, and that those early forms were capable of both biting larger prey and filter feeding. Researchers showed that this was probably not the case.

Instead, ancient *mysticetes* had teeth as sharp as those of lions and caught their prey by using a combination of biting and suction. Baleen and filter feeding evolved only later, after these early whales had almost lost their teeth. Importantly, this idea fits with not only the evidence from fossils, but also the way living marine mammals feed.

As part of this research, project members described several new species of extinct whales and an extremely rare specimen of fossilised baleen. They also showed that ancient *mysticetes* – unlike their living descendants – formed distinct coastal and offshore assemblages characterised by different feeding strategies.

Finally, the scientists provided a detailed study of the second-oldest *mysticete* ever found, dating back about

“MYSTICETI sheds light on one of the most profound evolutionary transitions in the history of mammals, and illuminates the ecology of the largest animals ever to live.”

34 million years. To their surprise, they found that this whale grew to be rather large – 8-12 m long – even though it wasn't yet capable of filter feeding.

### NOVEL HYPOTHESIS FOR FILTER FEEDING EVOLUTION IN WHALES

Overall, team members proposed an entirely new framework to better understand and classify both baleen whale evolution and the feeding behaviour of living marine mammals. “These advances will directly benefit future studies on marine mammal evolution and feeding ecology,” notes Dr Marx. “More broadly, our results may inform reconstructions of global ocean ecology over the past 30 million years.”

“MYSTICETI sheds light on one of the most profound evolutionary transitions in the history of mammals, and illuminates the ecology of the largest animals ever to live,” he concludes. “Given the role of baleen whales as ecosystem engineers, understanding their origins is a crucial piece of the broader puzzle of global ocean ecology.” This research was undertaken with the support of the Marie Skłodowska-Curie programme.

#### MYSTICETI

- Coordinated by the Royal Belgian Institute of Natural Sciences in Belgium.
- Funded under H2020-MSCA-IF.
- [cordis.europa.eu/project/id/656010](https://cordis.europa.eu/project/id/656010)
- Project website: [naturalsciences.be/en/science/do/5453/scientific-research/research-projects/project/6627](https://naturalsciences.be/en/science/do/5453/scientific-research/research-projects/project/6627)



## AGENDA

# SEPTEMBER 2019

**PERUGIA, ITALY**  
EnABLES Summer School –  
'Powering the Internet of Things 2019'

→ [nipslab.org/nips-summer-school-2019/powering-the-internet-of-things-2019](https://nipslab.org/nips-summer-school-2019/powering-the-internet-of-things-2019)

**3→6  
SEPT**

**8→10  
SEPT**

**NOTTINGHAM, UNITED KINGDOM**  
16th UK Heat Transfer Conference

→ [thermasmart.eng.ed.ac.uk/news/20190129/16th-uk-heat-transfer-conference](https://thermasmart.eng.ed.ac.uk/news/20190129/16th-uk-heat-transfer-conference)

**WORLDWIDE**  
International Day for the  
Preservation of the Ozone Layer

**16  
SEPT**

**24→27  
SEPT**

**FLORENCE, ITALY**  
11th International Symposium on  
Digital Earth

→ [actris.eu/Events/Eventsdescriptions/ACTRISatISDEE11.aspx](https://actris.eu/Events/Eventsdescriptions/ACTRISatISDEE11.aspx)

**LONDON, UNITED KINGDOM**  
CompBioMed Conference 2019

→ [compbiomed-conference.org](https://compbiomed-conference.org)

**25→27  
SEPT**

**26  
SEPT**

**WORLDWIDE**  
World Maritime Day

**MORE  
EVENTS**

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

**18-21  
SEPT**

**BUDAPEST, HUNGARY**

European Conference on Crop Diversification 2019

The conference will explore how we can achieve the full potential of cropping system diversification for improved productivity, delivery of ecosystem services and resource-efficient and sustainable value chains. Convened by the *DiverIMPACTS* project in collaboration with its partners in the Horizon 2020 Crop Diversification Cluster: *Diverfarming*, *DIVERSify*, *ReMIX*, *LegValue*, *TRUE*. *INSUSFAR* is also supporting the organisation of the conference.

→ [cropdiversification2019.net](https://cropdiversification2019.net)

# RESULTS PACK ON REDUCING THE R&I DIVIDE

Delve into our latest Results Pack, where we chronicle the efforts of 10 EU-funded projects to bridge Europe's R&I gap by tapping into our continent's unexploited potential. This will be achieved through the increased participation of all EU Member States in the Horizon 2020 framework research programme (and its eventual successor, Horizon Europe).



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