



research.eu

RESULTS MAGAZINE

N°62
MAY 2017

SPECIAL FEATURE

EXTREME SPACE WEATHER LET'S GET READY



HEALTH

ADVANCING THERAPEUTIC APPLICATIONS OF GENE EDITING

» PAGE 12



ENVIRONMENT

BREAKING THE CYCLE OF FOREST LOSS IN THE AMAZON

» PAGE 24

Published by

The Community Research and Development Information Service (CORDIS) managed by the Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
cordis@publications.europa.eu

Editorial coordination

Melinda KURZNE OPOCZKY

THE RESEARCH*EU RESULTS MAGAZINES ARE FREE OF CHARGE.

For all issues of the research*eu Results Magazine you can:

- download the PDF or e-book version
- order single paper copies
- subscribe to have every issue posted to you at <http://cordis.europa.eu/research-eu>

Disclaimer

Online project information and links published in the current issue of the research*eu Results Magazine are correct when the publication goes to press. The Publications Office cannot be held responsible for information which is out of date or websites that are no longer live.

The technologies presented in this magazine may be covered by intellectual property rights.

ISSN 1831-9947 (printed version)
ISSN 1977-4028 (PDF, EPUB)

© European Union, 2017

Reproduction permitted, provided the source is acknowledged. Neither the Publications Office nor any person acting on its behalf is responsible for the use that may be made of the information contained in this publication or for any errors that may remain in the texts, despite the care taken in preparing them. For reproduction or use of photos and any other artistic material, permission must be sought directly from the copyright holder. Excluded from this constraint are the photos and artistic material owned by the European Union.

Cover photo © Red monkey, Shutterstock

“

EDITORIAL

by the editorial team

SPACE WEATHER WATCHDOGS COULD SAVE US BILLIONS OF EUROS

It's a bit of a ritual: every morning, we wake up, look at the sky and hope for mild weather. There is however another, more abstract type of weather that — despite its apparent discretion — has a major and growing influence on our lifestyles. It is commonly known as space weather, and consists of charged protons and electrons being emitted by the sun, sometimes triggering geomagnetic storms in our magnetosphere as well as other disturbances.

Space weather, in particular so-called extreme space weather events, can have huge consequences for businesses and governments. Major disturbances in sectors like power grids, precision drilling, telecommunications, ground transportation, satellite infrastructure or aviation have been ascribed to space weather in the past, and even essential services like global navigation satellite systems can be vulnerable to major storms.

‘Space weather, in particular so-called extreme space weather events, can have huge consequences for businesses and governments.’

Just like the Obama administration had put out an Executive Order requesting more coordinated preparation for severe space weather in the USA, the European Union and the European Space Agency (ESA) have this field of research high on their list of priorities. And for good reason: according to a report recently published by the Cambridge Centre for Risk Studies, a solar storm could cause a financial loss of up to EUR 570 billion for the global economy over five years.

The ESA, for instance, is working hard on a space weather warning system as part of its Space Situation Awareness programme, whilst some 76 EU-funded research projects related to space weather are indexed on CORDIS. Beyond forecasting the occurrence of space weather events, analysing their impact and developing technologies capable of withstanding the effects of space weather events here on Earth or in orbit, it's a one of a kind challenge for humanity that the scientific community is trying to resolve: that of safe human exploration of the solar system. This issue of the research*eu Results Magazine sheds light on seven projects tackling these issues.

This special feature is followed by highlights across nine themes of research: health, society, transport, environment, agriculture and forestry, industry, information and communication technology, space and fundamental research. The magazine closes with a list of upcoming events hosted by or involving EU-funded research projects.

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

”

Want more information on the contents of this issue?

For online versions or information about the contributors in this issue of research*eu Results Magazine:

CORDIS

- <http://cordis.europa.eu/projects>
- <http://cordis.europa.eu/news>



NEXT ISSUE

Focus on
European wine producers step their game up

4

SPECIAL FEATURE**EXTREME SPACE WEATHER
LET'S GET READY****4 Novel prediction tools for SEP events**

- 5 Priceless, ground-based data for solar flare observers
- 6 The keys to coping with (extreme) space weather events
- 8 Sifting through space data can lead to game-changing new discoveries
- 9 A benchmark dataset to advance heliospheric research
- 10 Solar flares in unprecedented detail
- 11 The Sun in the radio frequency band

12 HEALTH

- 12 Advancing therapeutic applications of gene editing**
- 13 Uncovering genetic links to the development of pulmonary disease
 - 14 Significant step towards personalised treatments for IBD
 - 15 Women get sicker but men die quicker disproved

16 SOCIETY

- 16 Technology to tackle lower achievement in science and mathematics education**
- 17 New insights to help Europe manage its external relations effectively
 - 18 Cooperation tools to mitigate cascading effects during crises
 - 19 Turn-taking in human communication

20 TRANSPORT

- 20 Powering the next-generation of electric vehicles**
- 21 Innovating aircraft design for better heat-control
 - 22 The potential of autonomous emergency braking for motorcycles and mopeds
 - 23 The next step towards more-electric aircraft

24 ENVIRONMENT

- 24 Breaking the cycle of forest loss in the Amazon**
- 25 New, innovative tool can track the environmental status of our seas
 - 26 Fishing the radioactivity out of nuclear waste
 - 27 New tools to increase the accuracy of biodiversity monitoring
 - 28 What happens when the seafloor runs out of breath?

29 AGRICULTURE AND FORESTRY

- 29 Biopesticides replace toxic chemical sprays**
- 30 Protecting olive trees from a deadly disease
 - 31 Insect protein to satisfy demand

32 INDUSTRY

- 32 Smart, wearable healthcare devices one step closer to mass production**
- 33 Making curved composites the PUL-AERO way
 - 34 Introducing a new member of the family of advanced, engineered components
 - 35 Coatings for car and plane parts also to be available in green
 - 36 Strengthening bonds between dissimilar materials
 - 37 The tide turns for offshore maintenance costs

38 INFORMATION AND COMMUNICATION TECHNOLOGIES

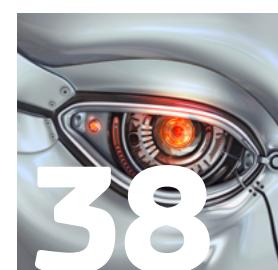
- 38 Robots of tomorrow with intelligent visual capabilities**
- 39 Novel user interfaces slated to enhance multisensory interaction

40 SPACE

- 40 Jaw-dropping discovery of earth-like planets revealed to the world**
- 41 New analytical software promises Big Bang in European astrophysics
 - 41 Computing power for the next generation of space explorers
 - 42 Giving Earth's lower orbit a spring clean
 - 43 A light-bulb moment for the early Universe

44 FUNDAMENTAL RESEARCH

- 44 Solving real world problems with applied mathematics**
- 45 Beam imaging rises to the challenge of sophisticated accelerators
 - 46 A solid-state platform for quantum technologies

47 EVENTS

SPECIAL FEATURE
EXTREME
SPACE WEATHER
LET'S GET READY

NOVEL PREDICTION TOOLS FOR SEP EVENTS

Advancing our capacity to predict ‘Solar energetic particle’ (SEP) events is essential to the smooth running of human spaceflights beyond Earth. New space weather prediction tools developed under the HESPERIA project have reached a milestone, notably by enabling earlier prediction of ‘Ground level enhancement’ (GLE) events — which pose severe radiation hazards to astronauts and tend to disrupt airline communication.

HESPERIA (High Energy Solar Particle Events foRecast-ing and Analysis) had three core objectives: building new forecasting tools based on empirical forecasting models UMASEP and REleASE; advancing scientific understanding of the physical mechanisms leading to SEPs; and exploring the possibility of incorporating its results into future space weather services.

‘Forecasting solar particle radiation storms, the so-called SEP events, is of potential interest for spacecraft and launching operations, and for the assessment of radio wave propagation conditions in the polar ionosphere of the Earth,’ Dr Olga Malandraki, Senior researcher at the National Observatory of Athens and coordinator of the project, points out. Better SEP predictions would not only make future space exploration missions safer, but also help airlines avoid exposure to resulting radiations.

Before HESPERIA was kicked off in 2015, the community was facing the need for new services able to predict solar particle storms with a significantly higher precision. The project successfully fulfils this need with SEP forecasting tools providing accurate real-time forecasting of large SEP events in the energy range of 30–50 MeV and above 500 MeV protons.

To make this possible, Dr Malandraki’s team built its novel tools — HESPERIA UMASEP-500 and HESPERIA REleASE — based respectively on empirical forecasting models UMASEP and REleASE, whose high performance is widely acknowledged by the scientific community. The first model uses early signatures in solar activity to predict SEPs, whilst the second focuses on faster particles which tend to reach spacecraft earlier than forecasted.

HESPERIA UMASEP-500 makes real-time predictions of the occurrence of GLE events from the analysis of soft X-ray and differential proton flux measured by the GOES satellite network. ‘The main innovation is that our tool utilises spacecraft proton data for the SEP forecasting, which proved to allow the tool to make successful GLE predictions earlier compared to existing predicting models based on ground-based neutron monitor measurements,’ says Dr Malandraki.

HESPERIA REleASE, on the other hand, lowers false alarm rates and increases probabilities of detection of energetic protons between 30 and 50 MeV when compared to existing tools. It does so by using near-relativistic and relativistic electrons from the ACE and SOHO spacecraft as precursors. The two tools are available from the project’s website.

Understanding SEP-related mechanisms better

Beyond its forecasting tools, HESPERIA also brings about important insights into the physical mechanisms resulting in SEPs, most notably the frequent occurrence and sometimes long duration of γ-ray events at photon energies above 100 MeV, as well as the relationship between ‘interplanetary’ (IP) proton occurrence on Earth and protons on the Sun.

‘An important finding was that the long-duration γ-ray events are accompanied by long-duration soft X-ray burst and the formation of coronal loops in the aftermath of “coronal mass ejections” (CMEs),’ Dr Malandraki says of the project’s analysis of γ-ray events above 100 MeV, which currently pose a challenge to our understanding of particle acceleration processes on the Sun leading to SEP occurrence at 1 AU. ‘Also, the long-duration γ-ray events have been found to be

accompanied by type II radio bursts at decametric and longer waves, which are produced by electrons accelerated by shock waves in the high corona and the interplanetary medium.'

With regards to IP and Sun proton occurrence, the consortium notably found that the comparatively small number of >500 MeV protons in the impulsive flare makes it highly unlikely that the latter is a significant contributor to the IP population. 'On the other hand, the number of >500 MeV protons in the sustained emissions makes it highly plausible that they come from the IP population, most likely via the nascent SEP reservoir that forms downstream of the CME-driven shock. A direct conclusion is that the CME-driven shock is the primary source of solar energetic protons both on the Sun and in IP space,' Dr Malandraki explains.

The space weather community, including launch operators, civil aviation, and satellite companies, has already shown 'great interest' in HESPERIA tools according to Dr Malandraki. In the near future, she hopes that the project will be useful to ESA's ongoing Space Situational Awareness programme, and that the Community Coordinated Modeling Center — which aims to bring together the next-generation of space-weather models — will exploit the project's results.

HESPERIA

- ★ Coordinated by the National Observatory of Athens in Greece.
- ★ Funded under H2020-PROTEC.
- ★ <http://cordis.europa.eu/project/rcn/193483>
- ★ Project website: <https://www.hesperia.astro.noa.gr>

PRICELESS, GROUND-BASED DATA FOR SOLAR FLARE OBSERVERS

We know that the chromosphere is where most solar flare radiations originate from, but gaps do remain in our understanding of their relevant physics. A consortium led by the University of Glasgow recently made an important contribution in this regard: using both space-based and ground-based data, it defines where future efforts should be targeted, and identifies where long-standing ideas about how energy travels through the solar atmosphere in a flare are in agreement — or disagreement — with observations.



© AstroStar, Shutterstock

'Areas of disagreement are always more interesting!' says Prof. Lyndsay Fletcher, coordinator of F-CHROMA (Flare Chromospheres: Observations, Models and Archives). Since the project started in early 2014, she and her team have used every possible means to further scientific understanding of solar flares and question existing models and theories. They notably found that flare energy needed to penetrate much deeper into the solar atmosphere than expected, and they established that ionisation in the chromosphere was key to flare evolution.

The project's observations were made using space-based facilities, and most importantly ground-based ones, whose observations had not been exploited to their full potential for flares prior to the project's kick-off.

'We planned to target every opportunity to bid for observing time from ground-based facilities (including through opportunities offered by the EC-funded SOLARNET project) and were rather successful,' Prof. Fletcher recalls. 'With observing time on ground-based facilities in hand, we found that solar

observing satellites such as NASA's IRIS satellite were happy to support our observations where they could. Both space- and ground-based telescopes look at only small patches of the solar disk, so we needed a strategy to have the best chance of observing flares, which are sudden and unpredictable.'

Focusing on the most complex part of a group of sunspots and locations where previous flares had been reported, the team opted for a 'sit and stare' approach that turned out to be successful: in total they managed to obtain 30 new ground-based flare datasets, and they were able to identify optimal strategies for flare observations with the new ground-based telescopes that are coming online.

Amateur solar observers, who often have access to excellent equipment, were also able to contribute. In September 2015 and July 2016, the team organised so-called F-HUNTERS campaigns to encourage these amateurs to follow F-CHROMA's flare observation targets and send their data.

'Generally the telescopes used by amateur observers can see a larger patch of the solar disk (but in somewhat less spatial detail) than the professional telescopes, so amateurs are able to "catch" flares that professional telescopes miss,' Prof. Fletcher explains. Equally, amateur telescopes can observe the broadband white light

SPECIAL FEATURE

— what your eye would see if you were projecting a solar image when a flare happened. This radiation is generally overlooked by professional equipment that emphasises more specific spectral emission lines, but is crucial to explaining the energetics of a flare.

'We are thinking about how to develop this in a way that can meaningfully support observations with the next generation of ground-based solar observatories, and how amateurs' observations could potentially be optimised to do this,' says Prof. Fletcher. 'The quality of some of the data they provided was very high and, with appropriate calibrations, can in principle be used to fill in gaps in our knowledge of how some

"Thanks to F-CHROMA, the scientific community now has access to formatted, ground-based flare data which they can use for their own research and can prepare themselves for the next generation of observatories."

particular flares developed. The whole experience, and especially the very enthusiastic response of all of our amateur colleagues, was just very uplifting for the team. It reminded us of why we do this.'

Data for everyone

All in all, F-CHROMA's careful modelling and data analysis of radiation from the chromosphere provides important answers related to increased heating, increased ionisation, flows, shocks and other changes to the plasma which are of great interest in astrophysics. The team also compared their data with computer simulations of what happens during a flare and found striking similarities – but also intriguing differences. Two completely independent flare simulation codes were also compared, and the results were, encouragingly, very similar.

'We also learned what is the most effective way to "catch" a flare in observations,' Prof. Fletcher enthuses. 'This will be vital for flare observing in the next generation of solar telescopes, since obtaining observing time on these telescopes will be very competitive.'

Thanks to F-CHROMA, the scientific community now has access to formatted, ground-based flare data which they can

use for their own research and can prepare themselves for the next generation of observatories to be rolled out as of 2019. They also have access to a suite of advanced models of the response of the flare chromosphere to different kinds of energy input, and the tools needed to simulate the radiation output for comparison with data: 'These models, called radiation hydrodynamics models, take a lot of time, expertise and computing power to run, so instead of individual scientists having to learn how to run and "nurse" the code, we have done it for them, so they are free to concentrate on the physics interpretations,' Prof. Fletcher explains.

Thanks to the data, simulations and analysis tools being made available to the community, the team now hopes that solar researchers beyond F-CHROMA and immediate collaborators will be encouraged to embark upon solar flare studies.

F-CHROMA

- ★ Coordinated by the University of Glasgow in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/project/
rcn/188819](http://cordis.europa.eu/project/rcn/188819)
- ★ Project website:
<http://www.fchroma.org/>

THE KEYS TO COPING WITH (EXTREME) SPACE WEATHER EVENTS

With over 1 300 satellites in orbit and the millions of euros of investment they represent, better understanding and forecasting of the threats posed by space weather is required. The SPACESTORM project took up this challenge almost four years ago, and is now providing stakeholders with unique insights not only into future and past space weather, but also into, how engineers should adapt their designs to avoid service disruptions.

Satellites' vulnerability to space weather is by no means a thing of the past. Sure, the last major event took place in 2003: From 29 to 31 October, the so-called Halloween solar storms disrupted over 47 satellites and even took out one Japanese satellite costing USD 640 million sparking a wave of concerns among governments, satellite operators and other stakeholders like insurance companies. But whilst these events occurred almost 15 years ago, more recent ones like the malfunctions of Galileo's atomic clocks or the loss of a Kazakh satellite in late March 2017 — which are still being investigated — may have been caused by space weather-related radiation.

'Space weather can cause interruptions in service for periods of weeks or even months, which can be very expensive for satellite operators. In the case of the KazSat-2, we know that the incident happened when the radiation belts had been enhanced, and that's just the latest example. After all these years and accumulated experience, the reality is that we still have satellite damage very likely caused by space weather events,' says Prof. Richard Horne, science leader at British Antarctic Survey and coordinator of the SPACESTORM (Modelling space weather events and mitigating their effects on satellites) project.

SPACESTORM was born out of the observation that there is room for improvement in existing space weather prediction models, that we don't know enough about space weather impacts in Low and Medium Earth Orbits, and that stakeholders should be able to make more informed decisions about how satellites should be designed. Finally, the consortium wanted to answer the question most stakeholders don't dare to ask themselves: how many satellites would be lost should an extreme space weather event occur?

To answer this question, Prof. Horne and his team decided to focus in part on the Galileo constellation. 'Information on the design of the Galileo spacecraft and how much radiation protection they include are all held in great confidence, just as for most commercial spacecraft, so it's very difficult to assess them,' he explains. 'So what we did is to try and work out what we believe is the environment in 'Medium Earth Orbit' (MEO) where the Galileo satellites fly. We calculated the worst case electron spectrum, and looked at how much shielding might be required to protect the spacecraft.'

Similar calculations were made for the geostationary orbit, using a statistical analysis of existing data along with the

© panuwat phimpha, Shutterstock



"The project created a forecasting website capable of planning changes in the radiation belt up to three hours ahead."

project's own physical model. 'It's remarkable that these two different approaches come together with a result that is very similar, which makes us quite confident in our approach,' Prof. Horne says, before continuing: 'We actually found that the flux tends towards a limiting value of between 5×10^5 and $2 \times 10^6 \text{ cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$. This corresponds to a current of between 1 and 4 pA cm $^{-2}$ — which exceeds by a factor of 10 the NASA recommended guidelines.'

Based on these results, the team found that designers would have to almost double the shielding of their satellites to be confident of surviving an extreme space weather event. 'The decision, of course, is in the hands of the business manager,' Prof. Horne points out. 'It can be done, but that's going to cost a huge amount of money in terms of launching the spacecraft. As the scientific community believes that the probability of an extreme event is one in 100 or 150 years, the question is, does your company want to plan for that kind of event or not?'

Digging into past events, forecasting future ones

Another key contribution of the project is the understanding it brings of all space weather events, both from the past and in the future. The team has been working closely with business, Governments and the European Space Agency to make sure they understand the risks and can make informed decisions about the best course of action.

To make this possible, they developed radiation belt models and reconstructed 30 years of radiation environment for the whole of the outer radiation belt, including medium and low Earth orbit for which there has been only little data available so far. All this, with much more accuracy than what was possible before.

'We tested our reconstruction by comparing it with data we had for a few periods in MEO, for example against the Giove data, and obtained a Heidke skill score of about 0.7. A Heidke skill score determines how good your forecasting is: A score of 1 is a perfect forecast, 0 is a bad one. Ours is pretty good,' Prof. Horne enthuses. Insurance companies are already showing interest in these models to examine what the radiation environment was like when space weather events occurred in the past.

The icing on the cake is that, the project created a forecasting website capable of planning changes in the radiation belt up to three hours ahead. Combined with predictions of impacts on engineering, the website can provide a risk indicator for the four main space weather risks affecting satellites. 'If satellite operators know from a forecast that their satellites will be at high risk, they can perhaps postpone manoeuvres, delay a software update, bring additional people in or make more transmission capacity immediately available,' Prof. Horne says.

Projects partners at ONERA in France went a step further with new experiments on the main materials being used on satellites. Their goal: to determine whether current lab methods of exposing materials to intense radiation for short periods can truly represent the effects of long — up to 15 years — exposure in space.

'It quickly became apparent that electrical properties are very important,' says Prof. Horne. 'Irradiating some materials like Kapton wires actually changes their conductivity, so radiation exposure tests in the lab should be complemented with more experiments on the material itself.'

One commercial company has already started using results from the project when deciding which type of satellite they should buy, and Prof. Horne believes this will eventually provide incentives for the design of a new generation of materials. With new technologies like passive emitters and electric propulsion respectively changing how satellites become charged and how much time they remain exposed to radiation, SPACESTORM results should continue to prove very useful in the near future.

Whilst the project is now completed, the forecasts will be developed further under a new project funded by the ESA, and the team is already working on improving them to be able to predict space weather up to 24 hours ahead.

SPACESTORM

- ★ Coordinated by the Natural Environment Research Council in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/188810>
- ★ Project website: <http://www.spacestorm.eu/>

SIFTING THROUGH SPACE DATA CAN LEAD TO GAME-CHANGING NEW DISCOVERIES

EU-funded scientists have analysed how phenomena observed by a European Space Agency mission vary over time, potentially unearthing new and valuable information about space.

Telescopes in space observatories gather a huge amount of data every day, but piles of it remain unsorted, gathering dust in archives. Now, an EU-funded project has finished the job of analysing reams of information collected by the European Photon Imaging Camera (EPIC) onboard the European Space Agency's XMM-Newton mission.

"Exploring the scientific content of EXTRAS' results and products will take years — we are of course going to participate actively in such a treasure hunt."

The EXTRAS (Exploring the X-ray Transient and variable Sky) project hopes that the data it has analysed will pave the way for new discoveries about the portion of space observed by EPIC. 'Now that the systematic temporal analysis of all data has been completed, scientific study and interpretation of results can start. I would say the best is yet to come!' says Andrea De Luca, EXTRAS project coordinator.

EPIC — the most powerful instrument studying the soft X-ray energy range — uses electromagnetic rays to probe space every day. Astronomers use the data collected by the telescope to observe phenomena such as extremely high temperatures and super strong magnetic and gravitational fields in a bid to improve our understanding of the universe.

'These phenomena all vary over time, and their variability is key to understanding their nature and their physical properties,' explains De Luca. However, a lot of the data collected falls into the telescope's view by chance — and a lot of this data remains buried in archives.

EXTRAS extracted and characterised the time variability of all phenomena contained in EPIC's archives since it started operating in 1999. 'We are dealing with the richest ever catalogue of data in the

soft X-ray energy range', says De Luca. The catalogue — an ongoing project carried out by a consortium appointed by the European Space Agency — contains about 500 000 sources detected by EPIC. 'We characterised all kinds of temporal variabilities, both periodic and aperiodic, including sources that pop up and disappear in a short time, known as fast transients, in hundreds of thousands of sources, spanning more than eight orders of magnitude in time scale and six orders of magnitude in flux,' he adds.

The project also developed new approaches and software to extract information from the data. They were specifically designed to cope with a wide variety of 'space weather' conditions in the environment surrounding the orbiting telescope.

Excitingly, the team has already managed to unearth a new discovery. By analysing telescope data, EXTRAS detected pulsations in an extreme ultraluminous X-ray source. 'This source is a neutron star located in another galaxy, accreting gas from a companion star and shining at a prodigious rate,

exceeding by orders of magnitude the maximum theoretical luminosity for a similar system,' explains De Luca.

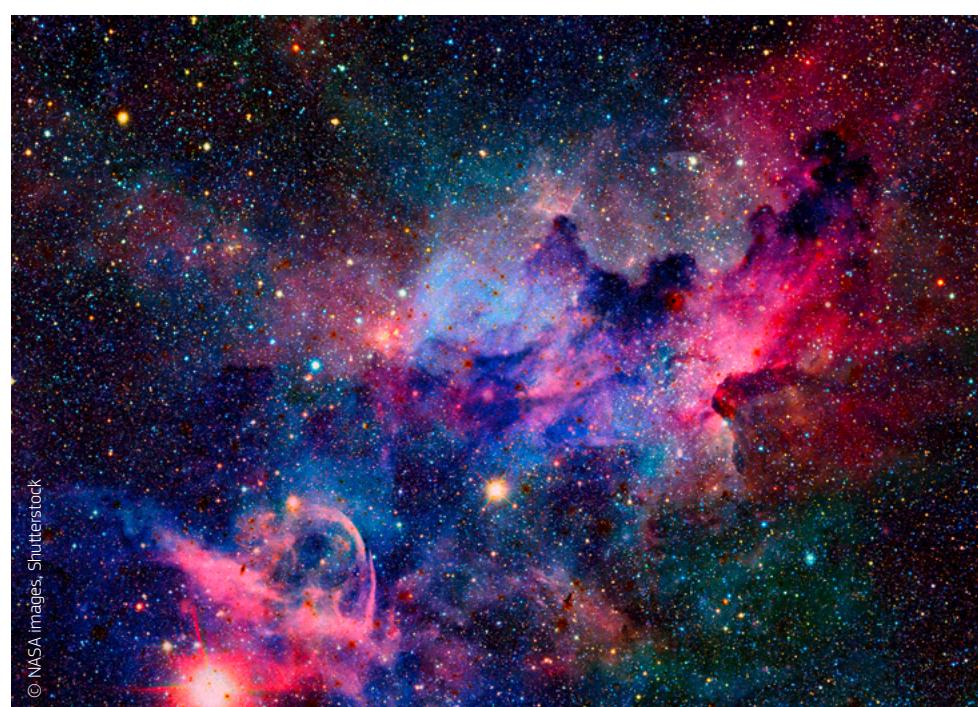
The discovery is a game-changer for the physics of accreting binary systems — one of the main branches of high-energy astrophysics — since the star behaves in a way previously not thought possible.

For De Luca this is just the tip of the iceberg. 'Exploring the scientific content of EXTRAS' results and products will take years — we are of course going to participate actively in such a treasure hunt,' he says.

All of EXTRAS' results and products — including new software tools — will soon be made publicly available via the EXTRAS Public Data Archive.

EXTRAS

- ★ Coordinated by the National Institute of Astrophysics in Italy.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/188861>
- ★ Project website: <http://www.extras-fp7.eu/>



INTERVIEW

A BENCHMARK DATASET TO ADVANCE HELIOSPHERIC RESEARCH

Visible-light imaging of the heliosphere has revolutionised the study of solar wind by adding to *in situ* measurements. Building on this advance, European space scientists are combining their expertise to generate unique catalogues and advance our understanding of the whole Sun-to-Earth system.

The HELCATS (Heliospheric Cataloguing, Analysis and Techniques Service) project focuses on 'Coronal mass ejections' (CMEs) — enormous plasma/magnetic field structures that are expelled from the Sun and propagate through interplanetary space — and 'Co-rotating interaction regions' (CIRs) — extensive swathes of compressed plasma/magnetic field that form in regions where fast solar wind catches up with slow wind.

HELCATS combines heliospheric imaging of these features with observations of their source regions on the Sun, their detailed signatures measured by spacecraft at different points throughout the solar system — including near Earth — and complementary observations using, for example, radio techniques, to provide a unique set of coordinated catalogues.

Prof. Richard Harrison, coordinator of the project and chief scientist at STFC's Rutherford Appleton laboratory, discusses the project outcomes and expected legacy.

★ Why did you choose to focus your research on CMEs and CIRs?

Prof. Richard Harrison: Members of our consortium recognised that combining our areas of expertise was critical for understanding the complex behaviour of the solar wind including CMEs and CIRs.

Moreover, CMEs are the principal drivers of potentially damaging effects on Earth (so-called Space Weather), especially if they act in concert with other CMEs or indeed CIRs. Hence,

"One of the most valuable aspects of the HELCATS projects is that it brings together, under a single and unique umbrella, catalogues based on widely differing datasets."

as well as being scientifically interesting, there is societal importance to the work.

In parallel, our group at the Rutherford Appleton Laboratory manages the Heliospheric Imager (HI) instruments aboard the NASA STEREO spacecraft. Visible-light signatures of both CMEs and CIRs can be detected by heliospheric imaging as they travel outwards from the Sun, potentially towards Earth. HELCATS was designed, not least, to maximise the awareness and usage of the HI data and the results of a variety of modelling techniques that had been developed for its exploitation. An excellent way to achieve this is by providing a coordinated set of catalogues that combine the HI data with other complementary datasets.



© Richard Harrison

PROF. RICHARD HARRISON

★ Why are the catalogues developed under HELCATS so important? What kind of advances could they potentially lead to?

The HELCATS catalogues are unique. They provide the first long-term record of CMEs and CIRs in the heliosphere — covering an entire solar cycle — coupled with catalogues of associated *in situ* events recorded near Earth and elsewhere, as well as catalogues of associated activity near and on the Sun. These catalogues will enable us to develop a holistic understanding of the evolution of solar events as they travel all the way from Sun to Earth, or to other planets.

This facility will underpin scientific research activities for many years to come. As mentioned before, the catalogues will enable novel modelling techniques to be validated, which is key to improving both our understanding of the science of the solar wind and our ability to prepare for and mitigate against potential space weather effects.

★ What would you say are the most important learnings from the project?

One of the most valuable aspects of the HELCATS projects is that it brings together, under a single and unique umbrella, catalogues based on widely differing datasets — including both physical observations and modelling results — over a number of different disciplines. Careful and thorough comparison of the catalogues provides the basis for



© Caligari260 - shutterstock

linking events generated on the Sun to their effects on Earth and on other planets. It is this holistic view that provides the most powerful impact of the project, and is the most important achievement, in my view, in terms of enabling potential scientific advances.

★ What do you hope will be the impact of HELCATS on the scientific community?

HELCATS will leave behind a tangible legacy in terms of its provision of extensive facilities that will be mined by the scientific community for many years to come. Moreover, it will provide key pointers to the most useful tools by which the potential space weather impact of CMEs and CIRs can be predicted.

★ What has been the community's feedback so far?

The wider research community is already aware that HELCATS is providing the official catalogues of solar wind structures observed by the STEREO/HI instruments; our post-project legacy planning ensures that this will continue beyond the end of the project and that the facilities will continue to be available. The wider scientific community is already exploiting HELCATS' results to produce research publications.

The space weather community is also providing very positive feedback on the project. For example the UK Met Office, which provides a space weather forecasting facility funded by the UK Government, has been closely associated with the project throughout and its members are engaged in discussions of the project outcomes. Again, a number of research papers are being published, based on the HELCATS' results, that specifically address space weather issues.

★ Do you have any plans to pursue this research after the end of the project?

The HELCATS team will ensure that the catalogues will remain available long after the project has ended, notably through their ingestion into a number of formal data centres. Moreover, upon completion of the project, a set of definitive publications has been planned and will ensure that details of the project itself and its results are widely available.

These will form the 'shop window' that the wider community will use to exploit the results of the HELCATS project, in addition to the future research that will undoubtedly be conducted by the eight groups within the HELCATS consortium itself over the years to come.

HELCATS

- ★ Coordinated by the Science and Technology Facilities Council in the United Kingdom.
 - ★ Funded under FP7-SPACE.
 - ★ <http://cordis.europa.eu/project/rcn/188809>
 - ★ Project website:
<https://www.helcats-fp7.eu/>
-

SOLAR FLARES IN UNPRECEDENTED DETAIL

Space and ground-based telescopes capture different aspects of solar flares, producing images that have helped EU-funded scientists better understand what triggers these giant explosions on the surface of the sun.

Solar flares are observed when energy stored in twisted magnetic fields — usually above sunspots — is abruptly released. In just a few minutes, they can heat material in the Sun's atmosphere, chromosphere and corona to millions of degrees Kelvin and produce a burst of radiation throughout the electromagnetic spectrum.

Within the EU-funded project FLARES (Flares throughout the solar atmosphere), scientists obtained the most detailed observations to date of intense solar flares. They had been

observed by space telescopes and ground-based observatories, fortuitously focused on the eruption site.

In particular, the X-class flare on 29 March 2014 erupted on the right side of the Sun. The Interface Region Imaging Spectrograph (IRIS), Solar Dynamics Observatory (SDO) and Reuven Ramaty High Energy Spectroscopic Imager (RHESSI) of the National Aeronautics and Space Administration (NASA) captured this eruption.

Furthermore, the Japanese Aerospace Exploration Agency's (JAXA) Hinode

satellite and Richard B. Dunn Solar Telescope at Sacramento Peak in New Mexico also observed the X-class flare. Several other solar telescopes watched the evolution of the flare as it propagated through space.

To have a record of an intense flare from so many observatories was unprecedented. Observatories from so many sources and different instruments painted a unique 3D picture of what happens during such a massive eruption on the Sun and its effects on space weather near Earth.



Using magnetograms from SDO and Hinode, scientists mapped the magnetic field's strength and direction change in the active region at the footprints of the flare just before its eruption. They revealed intense magnetic fields moving in opposite directions — a harbinger of a solar flare.

IRIS provided the most detailed view of what happens in the chromosphere and transition region through which energy and heat of the flare travelled. The National Oceanic and Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellite (GOES) detected X-rays emitted.

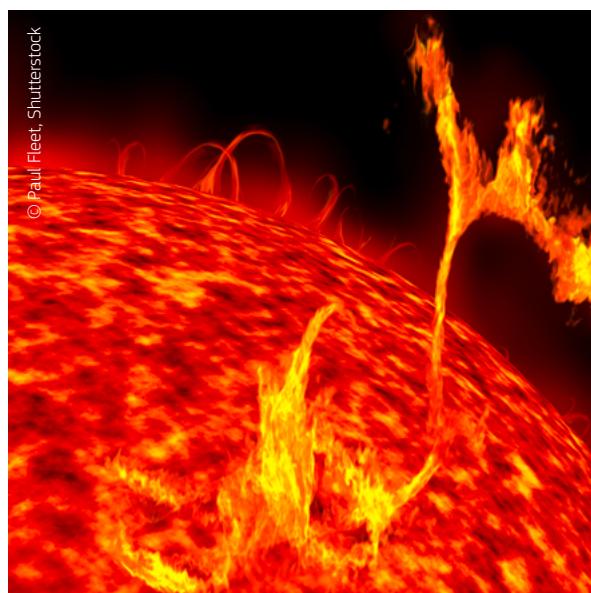
From the data collected, scientists teased a detailed picture of how the flare starts and peaks, findings that

were published in high-impact peer-reviewed journals. Coordinated observations of the flare also allowed for making an accurate forecast of the effects on the Earth's space environment, putting observatories around the world on alert.

The Sun is currently in a period of low activity, heading towards what is known as a solar minimum when there are only a few to no solar flares. Still, a better understanding of flares is required to predict the effect of solar activity on Earth accurately.

FLARES

- ★ Coordinated by FHNW in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/
rcn/186537](http://cordis.europa.eu/project/rcn/186537)



© Paul Fleet, Shutterstock

THE SUN IN THE RADIO FREQUENCY BAND

An EU-funded initiative brought together leading researchers to deepen understanding of the Sun's bursts of radio emission as observed on Earth.

Since the first detection of solar radio emission in 1942, radio observations of the Sun have provided valuable information for understanding solar structure and processes. At centimetre wavelengths, in particular, the radiation detected has its source in the photosphere and corona, namely in the solar atmosphere.

The EU-funded project RADIOSUN (Radiophysics of the Sun) worked to lay the ground for the exploitation of new observational facilities. To this end, internationally recognised experts from three EU Member States (Czech Republic, Poland and the United

Kingdom) and two eligible states (China and Russia) joined their efforts.

Cross-disciplinary training and exchange visits prepared a new generation of scientists for the analysis and interpretation of observations from some of the most powerful radio telescopes. Among these is the Atacama Large Millimetre/submillimetre Array (ALMA) in Chile consisting of 66 radio dishes.

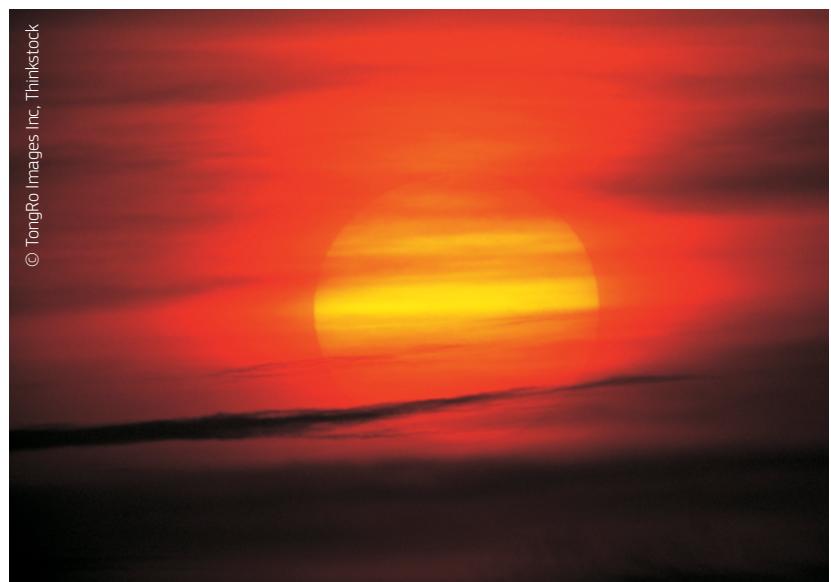
RADIOSUN fellows achieved significant advances regarding quasi-periodic pulsations observed during solar flares. They identified physical mechanisms underlying a zebra pattern, a complex and common spectral

"RADIOSUN fellows achieved significant advances regarding quasi-periodic pulsations observed during solar flares."

feature of solar flares, the formation of which was poorly understood.

The solar corona is a fertile site of waves, including fast wave trains. The team identified different types of such oscillations and used this information to create new theoretical models describing the evolution of magnetic fields driving space weather-related phenomena.

RADIOSUN research led to 49 publications in high-impact international journals. Moreover, its results have been used by the solar and heliophysics working group in the Square Kilometre Array (SKA) being built in Australia and South Africa to survey the entire sky in unprecedented detail and probe Sun-like stars.



© TongRo Images Inc, Thinkstock

RADIOSUN

- ★ Coordinated by the University of Warwick in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/
rcn/102268](http://cordis.europa.eu/project/
rcn/102268)

HEALTH

ADVANCING THERAPEUTIC APPLICATIONS OF GENE EDITING

Following a rocky start, gene therapy has resurfaced with solid gene transfer solutions that could expand its applications from the treatment of primary immune-deficiencies to the treatment of cancer. The scope of genetic engineering has recently broadened from gene replacement to targeted gene editing using engineered nucleases, which enable precise sequence modification of a locus of interest.

The idea of defective gene replacement has long been envisioned for many debilitating or fatal diseases. For inherited haematological or immune disorders, genetically modified 'Hematopoietic stem cells' (HSCs) are an ideal means of providing long-term correction given the capacity of these cells to self-renew and to differentiate into a diverse range of specialised cell types. In addition, autologous transplantation of corrected HSCs essentially overcomes the immunological complications of graft rejection and post-transplant immunosuppressive therapy.

Precclinical evidence alongside initial clinical trials support the safety and benefits of HSC-based gene therapy. However, the use of semi randomly integrating vectors might still cause adverse consequences such as insertional mutagenesis and unregulated or ectopic transgene expression. These may in turn lead to oncogenesis or elimination of the modified cells, jeopardising the efficacy of the approach.

The EU-funded SUPERSIST (Towards clinical translation of new gene targeting technologies for correcting inherited mutations and empowering adoptive immunotherapy of cancer) project wished to overcome these limitations by employing innovative key technologies for *ex vivo* gene targeting. The project came as a continuation of the successful European initiative PERSIST which delivered advanced HSC gene delivery methods for the safe and effective gene therapy of a range of human diseases.

Endogenous correction of the defective gene

Intriguingly, the SUPERSIST approach aimed to trigger the endogenous cell repair mechanisms to correct or inactivate the mutated gene. To this end, researchers utilised endonucleases, such as

'Zinc finger nucleases' (ZFNs) and 'Transcription activator-like effector nucleases' (TALENs) engineered to recognise and cut the mutated gene, awakening the homologous recombination mechanism. The enzymes were transiently delivered *ex vivo* to HSCs together with a template for the desired edit and the targeted gene was successfully modified to the new version.

As explained by the consortium, 'The approach undertaken has the advantage to restore the function of the gene as well as its physiological expression control. In addition, most disease-causing mutations affecting the genetic locus, including deletions, can be treated with the same engineered nucleases.'

The therapeutic potential of the SUPERIST genome-editing strategy was demonstrated by targeting the common gamma chain receptor (IL2RG) gene, a key component of many interleukin receptors involved in immune system function, which is defective in a severe form of primary immunodeficiency. When gene-edited HSCs were transplanted in mice, they sustained normal haematopoiesis and gave rise to functional lymphoid cells.

Immunotherapy for cancer

Over the years, gene therapy has expanded its potential applications to encompass cancer treatment, mainly by activating anti-cancer immune responses. One of the strategies aims to genetically engineer T cells to kill cancer cells by transferring cancer-specific 'T cell receptors' (TCRs) that recognise cancer antigens. However, the approach was met with limited clinical efficacy possibly due to competition with endogenous TCRs, thus increasing the risk of generating

unpredictable new specificity by mismatching the exogenous and endogenous TCR chains.

'To overcome these hurdles, the SUPERSIST consortium performed simultaneous knockout of the endogenous and introduction of tumour-specific TCR genes,' notes project coordinator Professor Naldini. In view of the clinical translation of the approach, they optimised the protocol and tested its validity in preclinical models.

Upon infusion into tumour-bearing mice, the gene-edited T cells safely cleared the tumour without producing adverse effects and presented an early memory T cell phenotype that supported their long-term persistence following transplantation. Partners further envision that 'with the support of their

SME partners they will be able to scale-up the optimised gene targeting protocols for clinical testing.'

Overall, SUPERSIST results for a targeted gene-editing approach will lead to more precise and robust gene therapy strategies. In turn, this will extend applications beyond inherited disorders such as for adoptive T cell therapy, an approach that is gaining momentum in cancer treatment.

SUPERSIST

- ★ Coordinated by Vita-Salute San Raffaele University in Italy.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/108697>
- ★ Project website: <http://www.supersist-project.eu/>

UNCOVERING GENETIC LINKS TO THE DEVELOPMENT OF PULMONARY DISEASE

Building on EU-funded research, scientists have identified genetic traits that heighten the risk of developing chronic obstructive pulmonary disease.

Chronic obstructive pulmonary disease' (COPD) is an incurable progressive lung condition that kills over 5 million people every year. While smoking remains the single most important risk factor, genetics also clearly plays a key role; only one in four smokers are likely to develop COPD.

Understanding why some people are more predisposed to developing COPD than others is important because it could lead to more effective diagnoses and treatments. For example if identified early, genetic risk factors can be used as biomarkers, and high risk individuals advised to avoid smoking to prevent the onset of COPD.

Genetic breakthrough

Scientists recently made a significant breakthrough in this direction. Building on some of the pioneering findings of the EU-funded COPACETIC (COPD Pathology: Addressing Critical gaps, Early Treatment and Innovative Concepts) project, an international team of researchers carried out a comprehensive genomic analysis and were able to identify 13 new genetic regions associated with COPD. In addition, they also discovered four genetic regions that were not previously associated with any lung function trait.

An overlap between genetic risk of COPD and two other lung diseases — asthma and pulmonary fibrosis — was found. These discoveries will enable scientists to identify high risk individuals and focus on new biological pathways to deliver therapies for patients with this disease.

'These findings would only be possible with the kind of large collaborative efforts that supports this study. Not only

do the results build on our knowledge of COPD, but also reveal potential links with other lung diseases, like pulmonary fibrosis and asthma and can form the underpinnings of a precision medicine strategy for the treatment of more than one lung disease,' said Dr James Kiley, Director of the Division of Lung Diseases of the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) in the US.

Building on knowledge

With scientific progress a continual process of building upon previous discoveries, these advances in the field of COPD and genetics grew from important ground work carried out by COPACETIC. In this project, a consortium of researchers from the Netherlands, Denmark, Germany, Sweden and Poland conducted a genome-wide scan of individuals at high risk, collecting genetic material from thousands of smokers and non-smokers from across Europe.

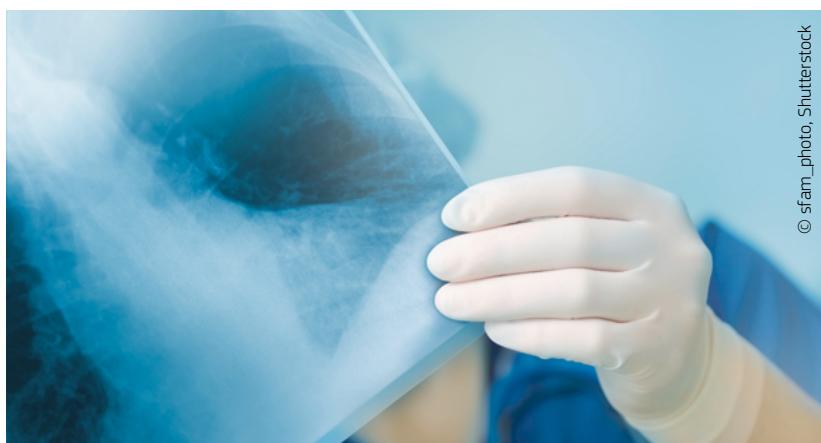
'Genome-wide association scans' (GWASs) for COPD found approximately 350 DNA variations that were subsequently

examined. Studies were also carried out to identify genes involved in chronic mucous hypersecretion and factors including, but not limited to, genetics leading to lung function decline. Baseline studies showed that COPD resulted from airflow obstruction or tissue damage, but not both.

These international efforts to better understand the genetics behind COPD have shown that while smoking remains the number one causal factor (and that stopping smoking is vital if COPD patients hope to get better), cessation on its own may not be enough to stave off the disease. While it is clear that genetics does play a role in who develops the disease, the task now is to find efficient ways of using biomarkers to identify those individuals, and to develop targeted therapies.

COPACETIC

- ★ Coordinated by the University Medical Centre Utrecht in the Netherlands.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/87972>
- ★ Project website: <http://www.copacetic-study.eu/english>



© sfam_photo, Shutterstock

SIGNIFICANT STEP TOWARDS PERSONALISED TREATMENTS FOR IBD

EU-funded researchers have made significant progress in developing new diagnostic and prognostic tools for inflammatory bowel disease that could lead to better targeted treatments and personalised care.

'Inflammatory bowel disease' (IBD) — the chronic inflammation of the entire digestive system — affects approximately 2 to 3 million people in Europe alone and causes significant discomfort and suffering. The condition is typically diagnosed through an examination of a patient's history, routine blood tests in order to find non-specific inflammatory biomarkers and invasive procedures that can sometimes prove unnecessary. Another key issue is the fact that up until now, medical professionals have been unable to accurately offer prognoses based on biomarkers alone.

'The best available tool at the moment — a faecal marker — is sensitive at picking up inflammation, but it does not differentiate between Crohn's disease and colitis,' explains IBD-BIOM (Diagnostic and prognostic biomarkers for inflammatory bowel disease IBD-BIOM) project coordinator Professor Jack Satsangi, Chair of Gastroenterology at the University of Edinburgh, UK. 'It is a good screening tool, but does not obviate the need for colonoscopy and radiology; it just reduces unnecessary ones in people who don't have inflammation. Faecal markers are also more problematic in terms of acceptability to the patients involved.'

Road to personalised treatments

Through combining a large number of previously bio-banked samples with data from new patients at the point of diagnosis, the IBD-BIOM project has been able to identify genome-wide changes in DNA methylation associated with an altered gene expression at different stages of IBD. This opens the door to identifying new biomarkers that can provide insights into disease pathogenesis.

'Our aim in this project was to develop non-invasive ways of finding more sensitive biomarkers,' says Satsangi. 'Over the next decade I predict that we'll see a move towards identifying biomarkers that enable medical professionals to

stratify patients in terms of how their diseases behave. This means that more aggressive forms of the disease can be singled out for the early use of

surgery or new biological therapies for example, while less aggressive forms of the disease can be observed without intensification of treatment.'

This project is therefore keeping European medical research ahead of the curve when it comes to personalised medicine. 'There are a whole host of new therapies and biological agents that could be used to treat IBD,' says Satsangi. 'The challenge for us is to find the biomarkers that predict response to a particular therapy. There are specific therapies that fit the right profile.'

Game changing discoveries

A key strength of the IBD-BIOM project was its ability to access a large number of samples from previous projects and to follow new patients from the point of diagnosis. From this strong pool of data, the project team was able to look at epigenetic alterations associated with IBD and defined the disease-associated methylome — the complete overview of nucleic acid methylation modifications in an organism's genome — for the first time.

'This is a game changer,' says Satsangi. 'Beforehand, people were not even sure if we could find reproducible epigenetic alterations associated with IBD. Not only were we able to find these; we were able to demonstrate that they reflect the degree of inflammation in patients, and the progression of the disease. This is a big finding.'

Another significant project achievement has been the development of activomics, a novel technology established by one of the IBD-BIOM partners for biomarker discovery. Activomics analyses the enzymes responsible for post-translational modifications (phosphorylation, glycosylation or proteolysis). The hope now is that the project findings will be used to further develop personalised care for IBD, and that new targets for targeted drug therapies might be found.

IBD-BIOM

- ★ Coordinated by the University of Edinburgh in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/105203>
- ★ Project website: <http://www.ibdbiom.eu/>



WOMEN GET SICKER BUT MEN DIE QUICKER DISPROVED

An Austrian research team has deconstructed the long accepted idea that women live longer than men in spite of experiencing worse health.



A few years back, a research team based at the Vienna Institute of Demography (VID) of the Austrian Academy of Sciences decided to tackle the so-called gender and health paradox. This is the seemingly contradictory observation that women live longer than men but experience worse health. The idea that 'women get sicker but men die quicker' gained currency during the 1960s to the 1980s but has never been properly explained..

The HEMOX (The male-female health-mortality paradox) project, led by Marc Luy, project coordinator and head of the health and longevity research group at VID, was thus born. 'This seems contradictory because if one population lives longer you would expect them to be healthier,' says Dr Luy. 'But I never believed in the paradox as I was sure there must be a logical explanation.'

He suspected women may experience worse health precisely because they live longer rather than in spite of it and decided to find a way to test this hypothesis.

The team did so by looking at the relationship between health and mortality among Catholic nuns and monks from Austria and Germany and comparing this to the general population.

Monks live longer

Studying cloister populations provides demographers with valuable insights as

they provide a rare example of an environment where men and women live very similar lives, thus making comparisons possible. 'From our previous studies we know monks live on average 4-5 years longer than ordinary men but nuns enjoy a much smaller advantage over ordinary women,' says Dr Luy.

Previous research tended to define what constitutes health in very general terms, but the HEMOX team decided to distinguish between the incidence of chronic diseases such as arthritis or asthma and ones which are life-threatening such as heart disease or forms of cancer.

'We compared members of the same sex — those who live in cloister to those who don't — to test the hypothesis that there could be a link between health and longevity. If this is true, then the male order members should live longer but spend longer in ill health than ordinary men, but with females there would not be much difference between the two groups,' says Dr Luy, 'so we collected the health and mortality data and this did confirm the hypothesis.'

Strong link found

The team extended the experiment to 30 other sub-groups of the general population. It compared groups who typically show significant differences in life expectancy, such as people with higher or lower levels of education, people who are obese

or underweight, or people with white-collar or manual jobs. 'We found a very strong positive association between life expectancy and the number of life years spent with chronic diseases and a negative association between life expectancy and life years spent with life-threatening diseases,' says Dr Luy. 'This demonstrates there is a strong link between health and longevity. When we did the same for the gender gaps in health and longevity, we found the same associations.'

The results indicate that there is a logical explanation for the so-called gender health paradox. Women do get sicker in that they typically suffer from more chronic diseases than men. However this is not because they are women but because they live longer. These new insights on gender, health and ageing could be relevant not only for public health policy but for anyone with an interest in the mechanisms behind healthy ageing.

HEMOX

- ★ Hosted by the Austrian Academy of Sciences in Austria.
- ★ Funded under FP7-IDEAS-ERC.
- ★ [http://cordis.europa.eu/project/
rcn/98387](http://cordis.europa.eu/project/rcn/98387)



SOCIETY

TECHNOLOGY TO TACKLE LOWER ACHIEVEMENT IN SCIENCE AND MATHEMATICS EDUCATION

Low achievement in mathematics and science education has become a major concern in Europe. But can technology prevent so-called lower achievers from being left behind? The FASMED project tried to find out.

Just like other EU-funded projects such as SAILS, ASSIST-ME, MASCIL or PRIMAS, FASMED (Improving progress for lower achievers through Formative Assessment in Science and Mathematics Education) comes as a direct response to the Rocard report published in 2007. This report pointed out the economic and social consequences of underachievement in mathematics and science education and recommended the adoption of an inquiry-based pedagogy — a method that invites students to resort to self-assessment rather than subject them to predefined responses.

More specifically, FASMED builds upon the observation that the highest achieving countries in Europe tend to preserve the complexity of concepts and methods when working with lower achievers, as opposed to more established approaches where material is being repeated and broken down into less and less challenging tasks.

Project partners aimed to develop resources, processes and technological tools allowing students to use technology to engage with complex concepts and methods, all this while improving their motivation. The project team also conducted interviews and case studies to gather evidence of the most effective approaches.

'There is evidence of teachers using technologies to gain information about their students' thinking, as well as to facilitate opportunities for students to learn from their peers. In interviews, students identified these practices as particularly beneficial in making their learning visible to the teacher, themselves and their peers. We recommend that technologies are utilised within classrooms to make learning more visible to all "in the moment", says Dr Jill Clark, coordinator of FASMED and executive director of Newcastle University's Research Centre for Learning and Teaching (CfLT).

According to a paper published by the project, the benefits of technology use include higher immersion, support of positive thinking habits, immediate and private feedback, and opportunities for independent and collaborative learning, along with the aggregation of student results for further analysis.

Regarding the types of technologies to be adopted, the project's case studies showed that most teachers opted for tools which were both accessible and easy to use in the classroom. The team found that the introduction of innovative technology to create a digital environment between students, peers and teachers can notably assist teachers in making more timely formative interpretations. 'We recommend the use of such technologies within classrooms to further enhance "formative assessment" (FA) practices,' says Dr Clark.

Other project recommendations include investments in networking, wireless

systems and technical support, as well as school commitments to facilitate time and space for teachers willing to plan and reflect on their practice.

Tools and resources for teachers

In addition to observations and recommendations, two of the main outcomes of FASMED are a toolkit for teachers and teacher educators as well as a 'professional development' (PD) resource.

The toolkit, which is available from the project's website and includes content in six languages, includes a collection of classroom materials produced by FASMED partners and covering three main categories: mathematics, science and time-distance graphs.

'The structure of the toolkit makes it very easy for teachers to get a first impression of different tools and find

out which teacher guides they would like to download,' says Dr Clark. Teacher guides describe classroom activities within a lesson or a series of lessons, give insight into the mathematical or scientific content, and highlight aspects of FA as well as technology used. Teachers can share their experience and adapt FASMED tools based on their own context, student abilities and available technologies.

The PD package developed by FASMED, on the other hand, reflects the range of ways in which partners have worked with teachers in their countries and offers examples for teachers and teacher educators to use. These include a set of six PD modules designed to help teachers use FA and technology more effectively in their classrooms, as well as a theoretical section on principles for effective PD and a practical section on ways in which PD can be organised. 'This section is meant to be used by

people who are organising professional development for teachers of mathematics and science but can also be used by teachers either individually or working with peers,' Dr Clark points out.

'There now remains an open question about the extent to which a website incorporating the resource will be used or valued by teachers. We are currently engaged in disseminating the toolkit to teachers and teacher educators and through this process we hope to gain valuable feedback on the use of the resources,' she concludes.

FASMED

- ★ Coordinated by the University of Newcastle in the United Kingdom.
- ★ Funded under FP7-SIS.
- ★ [http://cordis.europa.eu/project/
rcn/110968](http://cordis.europa.eu/project/rcn/110968)
- ★ Project website: <https://research.ncl.ac.uk/fasmed/>

NEW INSIGHTS TO HELP EUROPE MANAGE ITS EXTERNAL RELATIONS EFFECTIVELY

The quest to understand how EU Member States influence EU external action and policy can help create a stronger, more united Europe in its relations with the rest of the world.

In an era of a more volatile economy in Europe and increasing Euroscepticism, there is a need to strengthen and unite European external policy more than ever before. While the Lisbon Treaty has solidified the EU's European Neighbourhood Policy (ENP) and Development Aid, the new institutional setup has impacted delegation patterns amongst actors in framing the EU's external policies and affected Member States in their external relations. How Europe deals with issues like human rights, the rule of law, democratisation and trade is pivotal to the future success of the bloc.

Against this backdrop, the EU-funded DELEXPOL (Evaluating the post-Lisbon effects of delegation in the EU external relations) project recently investigated this change, offering

important insight into how EU external relations can be streamlined. 'The Lisbon Treaty without any doubt has been a significant milestone in making the EU global role more prominent,' says project partner Associate Professor Ilze Rüse from the Riga Graduate School of Law in Riga, Latvia.

Challenges of framing EU external policy

The challenge however lies in that the framing of the EU's external policies has become a process where the actors have more difficulty in agreeing amongst themselves, given the divergence of their positions in many cases. 'The effect of this complexity is often seen in lowest common denominator agreements, in other words where procedural complexity contributes to less ambitious policy output,' reveals Rüse.

Nonetheless, Member States see the delegation of the European External Action Service (EEAS) as a welcome initiative for enhancing credibility and gaining policy-relevant expertise. The new setup also increased the 'control' mechanisms of Member States that saw the EEAS as an 'agent' for implementing policies decided by individual foreign ministers rather than as the new 'EU's Foreign Ministry'.

New research theory yields enhanced results

Applying a new approach to its empirical research called the principal-agent theory, Prof. Rüse and her team found that Member States use every opportunity to control the EEAS from gaining too much autonomy in framing the EU's external policies. 'Member States used different "checks" to avoid the EEAS "slipping away" from their preferred positions and tend to hold it accountable to its mandate,' she explains. These checks include oversight, administrative procedures, institutional checks and legislative adjustments.



Despite the level of control that Member States would like to exercise, DELEXPOL found that they don't necessarily want to keep full control in framing 28 different policies regarding the EU's external action. Moreover, because of the institutional complexity created by the Lisbon Treaty, all actors need to cooperate even more closely and wisely in order not to lose the efficiency of the EU's external action.

Insight from Latvia supports young Member States

The project has also contributed to creating the Advanced Programme for the ENP countries, central Asia and western

Balkans at Riga Graduate School of Law. The institution has been able to transfer knowledge and expertise to stakeholders in Member States where reforms are still very much needed. With more Member States understanding the relevant complexities and mechanisms in navigating and managing EU external policy and action, a stronger Europe is bound to emerge on the world stage.

DELEXPOL

- ★ Coordinated by the Riga Graduate School of Law in Latvia.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108611>

COOPERATION TOOLS TO MITIGATE CASCADING EFFECTS DURING CRISES

Crisis situations are difficult enough to overcome on their own, but things can easily turn for the worse when cascading effects — situations where a physical event or system failure triggers a sequence of events in other systems, leading to consequences of a higher magnitude — come into play. The FORTRESS project set out to gain a greater understanding of cascading effects and provide stakeholders with tools to cope better with these complex phenomena.

Le'ts take a power breakdown in a defined area: if emergency power can take over for a maximum of 48 hours and the system operator expects restoration within a maximum of 96 hours, then there is a 48-hour gap where cascading events might occur. Unlike the domino effect, these events are not a linear chain of events: They can spread in any direction involving amplifications or even feedback loops.

This is where cooperation becomes essential. In the above situation, a local public transport provider possessing the largest amount of missing resources in the city could help keep cascading effects under control.

'Strengthening cooperation and communication across organisations in different sectors is a key factor for better prevention, preparedness and response,' says Dr Leon Hempel, senior researcher at TU Berlin and coordinator of the FORTRESS (Foresight Tools for Responding to cascading effects in a crisis) project. 'More than sophisticated tools, this requires a mutual understanding of critical situations. But in spite of good initiatives, for example in the field of urban resilience, cross-sectoral cooperation is still too weak in most European cities and regions and especially between Member States.'

Completed at the end of March, FORTRESS provides the means for such enhanced cooperation. The tools developed can help crisis managers and infrastructure providers from different sectors to analyse their mutual dependencies, to develop a common understanding of risks of cascading effects and to plan



© SrikaromWongsatith/Shutterstock

joint and coordinated information exchange and response during crises.

'The FORTRESS tools are very flexible and can be used at different levels and for different purposes, but first of all for cooperative scenario building. They support informal scenario discussions between different stakeholders, as well as a formalised collaboration process initiated by a civil protection authority, for example,' Dr Hempel points out.

The two tools developed under the project work in tandem. On the one hand, the 'FORTRESS model builder' (FMB) can model cross-system or cross-stakeholder dependencies in crisis scenarios. It identifies entities that may become relevant or affected during a crisis and defines the relations between these entities. 'Experts from different organisations log into the platform and indicate their dependency relations with other organisations.

"Two major field tests were conducted over the course of the project, in order to evaluate the applicability of FORTRESS tools to the preparation phase of a cross-border flooding event involving the Netherlands and Germany."

Different features and assessments trigger communication, which makes the tool unique especially for prevention.'

The 'FORTRESS incident evolution tool' (FIET) then provides users with a wide range of instruments to analyse how crises are likely to evolve or consider the

consequences of entity failure while mitigation measures are not available.

Field testing and prototypes

Two major field tests were conducted over the course of the project, in order to evaluate the applicability of FORTRESS tools to the preparation phase of a cross-border flooding event involving the Netherlands and Germany. 'End users really appreciated the flexibility of the tools and the cooperative approach to modelling. The results of the tests show that using the tools in the preparation phase can support

reasoning related to likely crisis events as well as response planning,' says Dr Hempel. In the last phases of the project, prototypes were also developed for demonstration.

The team expects FORTRESS outcomes to benefit end users as part of an integrated inter-sectoral workshop scenario building programme. 'Stakeholders are invited to model a scenario and decide on the best mitigation methods for different pathways, based on the likes of dynamic criticality assessments, which allows them to take into account the fact that the criticality of one entity can change

during the evolution of a crisis. First, electricity is crucial, but after a while water might become even more crucial as its supply directly impacts health issues.'

The FORTRESS project was completed at the end of March, and dissemination work will continue.

FORTRESS

- ★ Coordinated by TU Berlin in Germany.
- ★ Funded under FP7-SECURITY.
- ★ [http://cordis.europa.eu/project/
rcn/185488](http://cordis.europa.eu/project/rcn/185488)
- ★ Project website: <http://fortress-project.eu/>

TURN-TAKING IN HUMAN COMMUNICATION

EU-funded researchers examine the origins and implications of language processing to better understand the interactive foundations of language.

Languages, regardless of level, vary in terms of sounds, structure of words and the way words are put together to make grammatical sentences. Yet despite these clear differences, there is an underlying uniformity to the systematic ways language is used. This is most clearly seen in our informal conversations, where we take short, two second turns speaking with very small gaps in-between.

It is within these gaps that the EU-funded INTERACT (The Interaction Engine: Interactive foundations for communication) project looked in order to better understand the interactional foundations for language. What they discovered is that these foundations are visible early in ontogeny, are independent of language or modality, and are universal across cultures.

Significant insights

During the course of the project, researchers made several significant findings. For example, they found that in an informal conversation, the gap between turns speaking averages only 200 milliseconds — often less. This is remarkable considering that it takes 600 milliseconds to prepare even a single word for speaking, and 1 500 to prepare the most basic of sentences. 'What this means is that we beat the clock by predicting how the current speaker will complete the turn and already start to produce our own words as soon as we have enough information to do so,' says INTERACT Project

Coordinator Stephen Levinson. 'At the same time, however, we need to keep listening, even as we prepare to speak, in order to check our prediction and to come in on time — multi-tasking that is cognitively intense.'

To understand the cognitive challenge of turn-taking, the project specifically focused on language development in children. 'Pre-linguistic infants are reasonably quick to respond with simple vocalisations, but as they learn to understand and speak, their response times get quite slow — three to four times slower than adults — and do not pick up speed until later in childhood,' explains Levinson.

According to Levinson, in order to respond appropriately, children have to learn to recognise whether an incoming turn is, for example, a question or a request. 'At a very early age, children become attuned to often very indirect cues,' he says.

Looking back to understand the future

Based on its research, the INTERACT project determined that the timing in turn-taking is more or less constant across languages and cultures. It is also the same in non-spoken sign languages. 'The early development in infancy and the universal character of the system suggest that this may have been an early established platform in the origins of language,' says Levinson. 'Indeed, vocal turn-taking can be found across the primate order, and gestural, non-vocal turn-taking has very similar timing in the great apes.'

Project researchers also found that the existence of this interactional system can be seen in the contrast between such human cognitive syndromes as autism, where the system is impaired, and Down syndrome, where it is not (even though often times speech impediments are present).

'Our research into better understanding the human interactive speech system not only has potential benefits for medical research, above all, it will be crucial to improving human-machine interaction,' concludes Levinson.

INTERACT

- ★ Hosted by the Max Planck Society in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ [http://cordis.europa.eu/project/
rcn/99016](http://cordis.europa.eu/project/rcn/99016)





TRANSPORT

POWERING THE NEXT-GENERATION OF ELECTRIC VEHICLES

Electric motors developed by the EU-funded SYRNEMO project are coming to a car near you and are set to help Europe slash its CO₂ emissions.

Under the Kyoto Protocol, the EU is committed to reducing 'greenhouse gas' (GHG) emissions by 20% below 1990 levels by 2020 and by 80-90% by 2050. To achieve this, the transportation sector aims at cutting its emissions by 60% by 2050. Most of this reduction will likely come from road transportation, which is today responsible for 7 billion tonnes of CO₂/year — the equivalent of one fifth of the EU's total GHG emissions.

When looking at how to cut emissions in road transportation, the electric vehicle continues to stand out as a possible solution. In fact, its life-cycle specific equivalent emissions are calculated to be approximately half of those from gasoline and diesel vehicles.

Unfortunately, despite the significant progress made by the automotive industry with respect to the electric and hybrid vehicle, the public has yet to view electric vehicle technology as a viable alternative. 'Although electric vehicles are already on the market, their uptake is only in its infancy,' says SYRNEMO (Synchronous Reluctance Next Generation Efficient Motors for Electric Vehicles) Project Coordinator Michele De Gennaro. 'Before these electric vehicles replace cars that run on fossil fuels, they'll need to deliver better range and energy efficiency in a lightweight design and at a lower cost.'

Barriers to improvement

Today's electric vehicles use motors that depend on rare earth metals for manufacturing the permanent magnets. Although a key component to these motors, these metals are also the leading barrier to achieving the necessary improvements to shift towards a large-scale adoption of electric vehicles.

In fact, the vast majority of these metals are sourced from China, which not only increases the cost of electric vehicles, but also places the automotive industry at an increased risk. 'There is a risk that geopolitics could affect the supply of permanent magnets coming to European vehicle manufacturers from China,' De Gennaro explains. 'This could, in turn, cripple the manufacturing and supply of electric vehicles in Europe.'

However, if one removes the magnets from the motor, it loses three quarters of its power. 'Thus, our biggest challenge is to find alternative ways to make up for this significant loss —which is exactly what SYRNEMO sets out to provide,' says De Gennaro.

The SYRNEMO solution

The SYRNEMO project overcame this challenge by designing, prototyping and testing a rare earth free 'Permanent magnet

assisted synchronous reluctance machine' (PMaSYRM). 'This machine is specifically designed to avoid the use of rare-earth materials in the magnets by using ferrites,' says De Gennaro. 'To do this, we have pushed the development of other components of the motor, such as a novel hairpin winding for the stator and an innovative lightweight modular design for the rotor.'

"The SYRNEMO design is delivered at Technology Readiness Level 5, fit for mid-volume manufacturing in the order of tens of thousands of units per year."

formance of 133 Nm at 3600 rpm and a maximum power of 52.9 kW at 4300 rpm.

In addition to the motor, the project also delivered the design for a full drive with integrated power electronics and an air cooled housing. According to testing results, the final drive design provides a maximum torque per-

The SYRNEMO design is delivered at Technology Readiness Level 5 (i.e. technology validated in the relevant environment), fit for mid-volume manufacturing in the order of tens of thousands of units per year, and completely scalable for different vehicle segments. The SYRNEMO design is evaluated based on its machine constant of mechanical power and torque density values — two relevant benchmark values for electric motors — bringing an improvement of +45% and +25% compared to the 2016 best benchmark. 'This makes SYRNEMO the best-in-class rare-earth free synchronous machine according to both criteria,' adds De Gennaro.

SYRNEMO

- ★ Coordinated by AIT in Austria.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/project/rcn/110530>
- ★ Project website: <http://www.syrnemo.eu/>
- ★  <http://bit.ly/2ojEMgC>

INNOVATING AIRCRAFT DESIGN FOR BETTER HEAT-CONTROL

EU-funded project TOICA is radically changing the way thermal studies are performed in aircraft design. The project's platforms allow collaborative design and will facilitate early considerations of thermal impacts with potential safety and cost benefits.

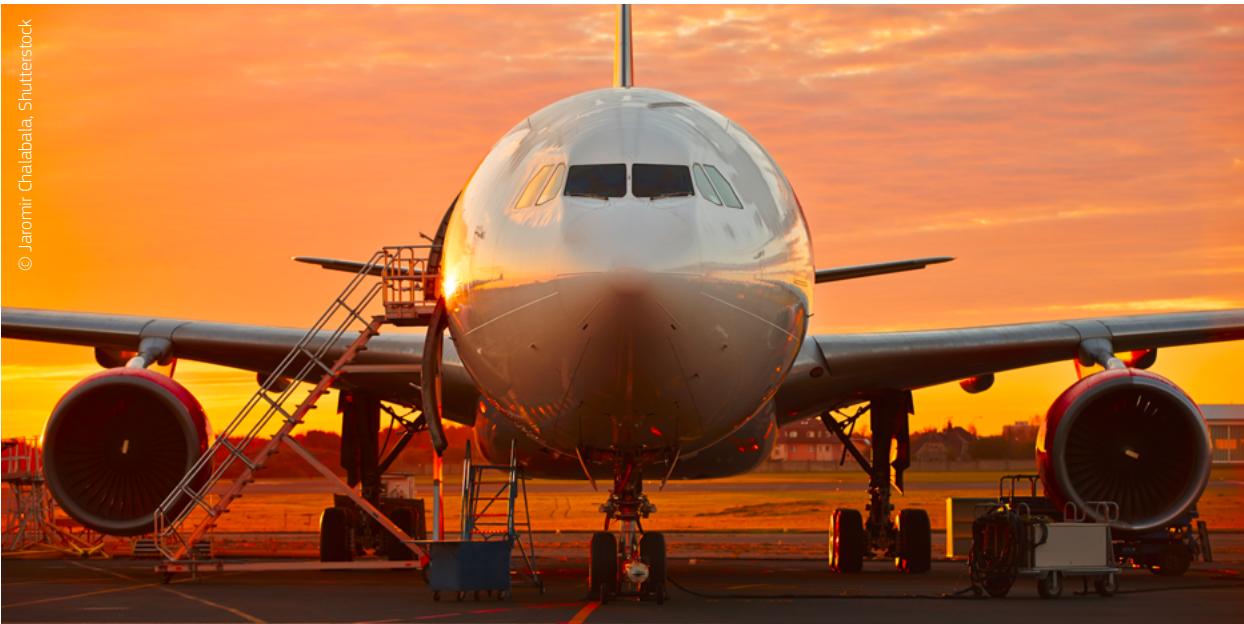
The TOICA (Thermal Overall Integrated Conception of Aircraft) project set out to radically change the way engineers perform thermal studies for new aircraft design. Thermal studies are usually performed to validate design solutions, the system installations and risk analyses in order to reach acceptable heat levels. TOICA results now enable architects to use a collaborative process at an early phase in the design to improve the prediction of thermal impacts on the

chosen configuration,' says TOICA coordinator, Pierre Arbez from Airbus in France.

Concerns with the thermal performance of aircraft stem from technological changes over the last two decades. Aircraft electrical consumption has increased by a factor of five and new engines, whilst more efficient, now produce much more heat. 'With this comes a host of issues brought on by the effects of heat on structures, systems and other equipment,' explains Arbez. By managing

and understanding thermal behaviour early in any aircraft design process some of these effects can be abated.

TOICA's 32 partners from seven European countries and Canada have developed new methods and tools that allow early analysis of thermal behaviour. One of them is the 'Behavioural digital aircraft' (BDA) which is a digital environment that allows multiple partners to share data and work together on the same design. Major companies such as Siemens,



© Jaromir Chalabala, Shutterstock

TRANSPORT

Dassault Systems and MSC Software are making their commercial design software BDA-compliant.

"TOICA methods and tools will of course be used for the design of future European aircraft, including those designed by project partner Airbus."

Together with an architect cockpit, which allowed design monitoring and control, this allows for the visualisation and manipulation of aircraft design data and results. This means that using these tools, teams or even whole supply chain partners can work together to create co-designs. 'These are very versatile tools that help steer the whole process created

by TOICA,' says Arbez. They have supported the final project outputs which include new software tools to study thermal performance of aircraft designs and new cooling hardware demonstrators.

One of the major strengths of the project was the six 'plateau' meetings. Here stakeholders were given demonstrations on real industrial use-cases so that the decision processes for creating optimal environments through thermal trade-offs were reinforced. 'During the last and final plateau, we were able to demonstrate our planned results and the architects could try their hands at working in the new environment,' says Arbez.

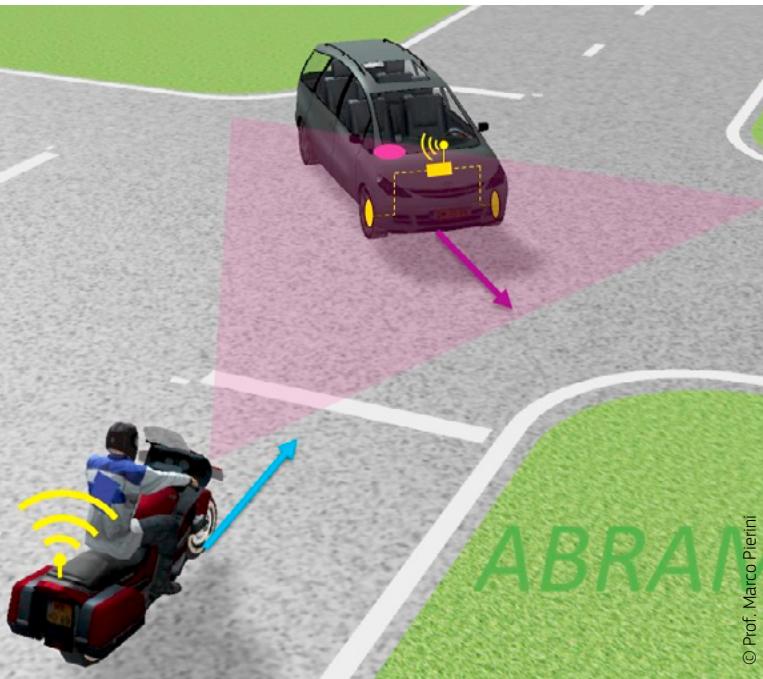
The main performance areas that TOICA was able to tackle were increasing design stability by making potential thermal problems less likely and improving the management of aircraft thermal behaviour in critical zones. Some of the new cooling techniques will also have a positive impact on the aircraft fuel consumption.

TOICA methods and tools will of course be used for the design of future European aircraft, including those designed by project partner Airbus. The tools can be applied to a variety of aircraft such as helicopters and smaller aircraft. 'TOICA has really changed the way thermal studies are performed during the design phase,' says Arbez. 'We have also proposed ways to generalise the approach to overall aircraft design.' The consortium hopes to continue capitalising on TOICA innovations in the field with future collaborative projects.

TOICA

- ★ Coordinated by Airbus in France.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/project/
rcn/110079](http://cordis.europa.eu/project/rcn/110079)
- ★ Project website:
<http://www.toica-fp7.eu/>

THE POTENTIAL OF AUTONOMOUS EMERGENCY BRAKING FOR MOTORCYCLES AND MOPEDS



© Prof. Marco Pierini

According to the European Road Safety Observatory (ERSO), the risk of a fatality while riding a motorcycle or moped per kilometre travelled is 12 times higher than for driving a car. An EU initiative has explored the potential use of a road vehicle safety system for 'Powered two wheelers' (PTWs).

'Autonomous emergency braking' (AEB) is one of the most advanced safety systems available to modern passenger cars. Independent European safety bodies have recently demonstrated its effectiveness. However, AEB is not available for PTWs, and its potential suitability is undetermined.

The EU-funded ABRAM (Autonomous braking for motorcycles) project addressed the major issues associated with evaluating and implementing autonomous braking for PTWs.

Work began with a literature review of the injury risk factors for motorcycle riders and the applicability of AEB to real-world crashes. Project partners developed and modified triggering algorithms for normal motorcycle crash scenarios. They assessed the potential benefits of AEB for motorcycles using computer simulations of real-world crash cases.

The ABRAM team analysed the feasibility of a gentle, unforeseen automatic deceleration of a motorcycle from the viewpoint of the rider. It developed a low-cost motorcycle riding simulator to measure realistic steering inputs of riders in an emergency. The simulator was then used to study rider behaviour when facing AEB activation scenarios in a virtual environment.

Researchers evaluated the validity of estimates of the effects AEB may produce in real-world motorcycle crashes. They also compared the potential benefits of both realistic and ideal AEB systems.

An on-road test identified the current capabilities and limitations of a laser scanner sensor for obstacle detection that was applied to a motorcycle. Results were compared to the

performances required by the triggering algorithms. Lastly, the team estimated the societal benefits of AEB for PTWs compared to other technologies.

ABRAM successfully demonstrated the potential advantages offered by the AEB with respect to increased road safety for motorcyclists and its widespread application.

ABRAM

- ★ Coordinated by the University of Florence in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/108631>
- ★ Project website: <http://abram-project.blogspot.be/>

THE NEXT STEP TOWARDS MORE-ELECTRIC AIRCRAFT

Aircraft manufacturers will soon be able to replace parts of the hydraulic systems for flight control with lighter and simpler electrical systems. The use of new ‘electromechanical actuator’ (EMA) technology is an important potential enabler.



The key element in the development of flight control systems has to date been hydraulic actuators, because of their proven reliability and lack of alternative technologies. However, the technology to build electromechanically actuated flight control systems is now available — an important step for the development of more-electric aircraft.

The EU-funded FLIGHT-EMA (E-RUDDER) (Advanced flight control system — Design development and manufacturing of an electro mechanical actuator with associated electronic control unit and dedicated test bench) project represents a major step forward. Researchers developed a smart primary EMA for the rudder flight control system that helps keep aircraft on course.

Its modular design facilitates easy exchange of electric and mechanical components. Parts are integrated with sensors, and control strategies support both autonomous and automatic safety control. The EMA includes an ‘Electronic control unit’ (ECU) as well as built-in test equipment. A disable device ensures that potential failures are detected in real time and an emergency actuation system is activated.

The FLIGHT-EMA (E-RUDDER) team took the new technology through a rigorous test campaign. Researchers used a custom-built test rig supporting installation of the EMA in passenger cabins of a commercial aircraft and the Copper Bird — the Clean Sky research project targeting lower environmental impact of air transport. This ensured

ample evidence of the concept’s validity.

The EU in collaboration with its aerospace industry has set ambitious goals for lowering air and noise pollution from aircraft and airport ground operations. The replacement of hydraulic systems with all-electric ones is a key component of their efforts. The FLIGHT-EMA (E-RUDDER) actuator and control system will make a major contribution to these goals and sustainability of the European aerospace sector.

FLIGHT-EMA (E-RUDDER)

- ★ Coordinated by CESA in Spain.
- ★ Funded under FP7-JTI.
- ★ <http://cordis.europa.eu/project/rcn/111098>

ENVIRONMENT

BREAKING THE CYCLE OF FOREST LOSS IN THE AMAZON

Identifying regions of self-amplifying forest loss can help maintain biodiversity, supporting climate change mitigation, according to research carried out with support from two EU-funded projects.

The Amazon is at risk of what has been described as a 'die-back circle', where forest loss increases as a result of reduced rainfall and human activities such as logging. Crucially, that reduction itself leads to yet more drought conditions. Human induced climate change also threatens to further reduce rainfall, exacerbating the situation. Being able to predict which regions of the Amazon are susceptible to this loss is therefore critical to avoid worsening conditions.

Towards this end, researchers have recently reported that the presence of a variety of tree species is a good indicator of the likelihood of survival for forest regions. Reporting in the journal 'Nature Communications', the lead-author Dr Delphine Clara Zemp of the Potsdam Institute for Climate Impact Research, Germany, reminds us why this research matters by simply stating that, 'The Amazon rainforest is one of the tipping elements in the Earth system.'

A self-sustaining but vulnerable system

The Amazon is significantly self-sustaining with plants evaporating moisture, which subsequently returns as rain. Yet at the same time it remains vulnerable to environmental changes, such as that brought about by deforestation and as a result of greenhouse gas emissions, both inhibiting moisture transportation. With the added influence of sea-surface temperature rise, all the indications are for an increase in both extremes of wet and dry seasons, especially in Southern and Eastern Amazonia.

The researchers point out in their article that while the die-back circle was relatively well known, the consequences of the atmosphere-vegetation feedback loop have been less well understood. Using a network analysis of water fluxes, they found that the more diverse the vegetation, the less vulnerable it seems to be to destruction. 'Since every species has a different way of reacting to stress, having a great variety of them can be a means for ecosystem resilience,' stated Prof. Marina Hirota from the Federal University of Santa Catarina, Brazil.

Biodiversity for climate change mitigation

These latest findings build on previous research from the team which evidenced why this feedback loop matters. The EU-funded ROBIN

(Role Of Biodiversity In climate change mitigatioN) project (finalised in 2015) looked at the role of biodiversity in climate change mitigation in tropical Latin America. They employed remote sensing data to improve techniques for monitoring, reporting and verifying carbon stocks, as well as large-scale regional models.

Researchers also analysed how different climate and socioeconomic scenarios and land-use options could influence carbon storage and biodiversity in the long term. Local case studies were conducted at different sites across a climatic gradient of tropical forest areas. Biodiversity indicators were divided into four categories (taxonomic, functional, structural and landscape) and combined into a single 'ecosystem integrity' value. This was used to represent the overall health of the ecosystem.

ROBIN found that biodiversity has a direct positive impact on climate change by absorbing carbon dioxide from the air, and so can play a key part in mitigation policies such as REDD+ (the Reducing Emissions from Deforestation and forest Degradation initiative), by providing carbon stores. Being able to identify areas under threat — and understanding the mechanism for this degradation — contributes significantly towards putting effective mitigation efforts into place. Indeed, AMAZALERT (Raising the alert about critical feedbacks between climate and long-term land use change in the Amazon), another EU-funded project involving the same researchers, had already created an early warning alert system based on land-use policies and reports from the region.

ROBIN / AMAZALERT

- ★ Coordinated by NERC in the United Kingdom / WUR in the Netherlands.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/100815>
- ★ <http://cordis.europa.eu/project/rcn/99921>
- ★ AMAZALERT website:
<http://www.eu-amazalert.org>

NEW, INNOVATIVE TOOL CAN TRACK THE ENVIRONMENTAL STATUS OF OUR SEAS

Understanding our seas is key to their sustainability. EU-funded scientists have developed new software to assess marine environments that unites existing research and new research into one, publicly-accessible tool.

EU-funded project DEVOTES (DEVelopment Of innovative Tools for understanding marine biodiversity and assessing good Environmental Status) has developed the technology that allows EU Member States, the European Commission, scientists and managers to assess the environmental status of our seas. NEAT — the Nested Environmental status Assessment Tool — includes the DEVOTool and uses 600 different indicators from biodiversity, presence of non-indigenous species, commercial fishing, food-webs, eutrophication and sea-floor integrity, to different ecosystem components like bacteria, plankton, fish or seabirds to give a holistic assessment of the sea.

'We are convinced that the project has contributed deeply to the EU's environmental protection goals by making new monitoring and modelling tools, assessment software and an enormous bulk of scientific research freely available to any scientist and manager,' says DEVOTES Project Coordinator Angel Borja.

Keeping track of the environmental status of our seas is vital to the sustainability of marine ecosystems. But it is also key to the sustainability of services that seas provide to humans such as fishing, tourism and energy production.

Unless well managed, human activities can have harmful impacts on our seas. Fishing can become over-fishing, depleting stocks and destroying habitats. Meanwhile, shipping can introduce non-native species into European waters as well as run the risk of oil spills.

Closer to the coast, discharges of waste water from agriculture and industry can cause eutrophication — a process which cuts oxygen levels in the water, killing aquatic life. At the same time, tourism can degrade coastal sites.

On a larger scale, climate change exacerbates ecosystem change and can trigger the loss of services that marine ecosystems provide to humans. And, emerging human activities like large-scale aquaculture, deep-sea mining and renewable energies can impact the marine environment in many ways.

'In general, unsustainable activities cause negative and irreversible impacts. When activities are sustainable, the delivery of ecosystem services by our seas produces a positive impact, which can be maintained over time,' explains Borja. This can include sustainable fishing, well-managed tourism and carefully planned offshore windfarms.

DEVOTES also achieved a world-first in evaluating the health of marine bacterial communities. 'For the first time ever we have developed a bacterial index, based on metabarcoding, that can assess the ecological status of bacterial communities,' Borja adds.

While it's clear that sustainable marine ecosystems are beneficial to marine life as well as humans, there are many hurdles in the way. Sea areas are governed by a range of policies which can overlap and even be contradictory. 'Good coordination among EU Member States can overcome this problem,' Borja says. Other hurdles include the cost of restoring an ecosystem to a good environmental status, as well as the time needed to achieve this.

"For the first time ever we have developed a bacterial index, based on metabarcoding, that can assess the ecological status of bacterial communities."

NEAT, including the DEVOTool, was tested in 10 different locations across European seas from the Arctic to the Black Sea covering areas ranging from 1 500 km² to more than 800 000 km².

All work carried out by the project is now public, including 180 scientific papers and a book. Borja plans to continue to spread the knowledge gathered by this project via lectures, speeches, and training courses in using NEAT. He also hopes to use the tool as part of new projects in Europe, Canada and the Caspian Sea.

DEVOTES

- ★ Coordinated by AZTI in Spain.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/project/
rcn/105613](http://cordis.europa.eu/project/rcn/105613)
- ★ Project website: <http://www.devotes-project.eu/>



FISHING THE RADIOACTIVITY OUT OF NUCLEAR WASTE

Building on previous EU-funded research into uranium, researchers have established a potential approach for safely removing radioactive elements from nuclear waste.

Cleaning up radioactive waste is difficult and often dangerous, especially when uranium is involved. In order to solve the problem of safely handling nuclear waste, a better understanding of uranium is needed.

The EU-funded UNCLE (Uranium in Non-Conventional Ligand Environments) project, which closed in 2014, focused on improving the clean up process with a study on how uranium undergoes chemical bonding and the effect this has on reactivity. As a result of this work, UNCLE researchers concluded that uranium nitride and oxo-complexes are essentially the same, the only difference being the swapping of a single nitrogen atom in nitride for an oxygen one in oxo-complexes. Researchers realised that the symmetry of the complexes and oxidation state of the uranium ions, rendered them ideal systems from which to develop quantitative models.

The problem, however, is that moving from qualitative to quantitative approaches requires a large family of molecules. To overcome this barrier, researchers identified a reliable new way to make uranium nitride complexes that allows for the preparation of a large family of molecules.

Gone fishing, with arsenic bait

Using the UNCLE-developed quantitative model, and its understanding of how elements like thorium and uranium interact with elements from around the periodic table, researchers have discovered how arsenic molecules can be employed to 'fish out' the most toxic elements from radioactive nuclear waste. According to findings due to be published soon in 'Nature Communications', researchers report the first examples of thorium with multiple bonds to arsenic existing under ambient conditions on multi-gram scales. Prior to the research, this has only been accomplished on very small scales and at temperatures approaching that of interstellar space (i.e. 3-10 Kelvin).



© Satakorn, Shutterstock

What this means is that the decommissioning of nuclear power plants could soon become safer and more effective, also offering hope for cleaner energy. 'Nuclear power has the potential to produce far less carbon dioxide than fossil fuels, but the long-lived waste it produces is radioactive and needs to be handled appropriately,' says researcher Elizabeth Wildman. 'We need to reduce the volume of nuclear waste in order to make it easier to handle and process it to remove benign elements or separate the high level from low level waste.'

Potential in soft donor atoms

The ultimate goal is to use organic molecules to selectively extract metal ions from the 'soup' of nuclear waste and fish out the more radioactive and toxic ones, leaving the rest behind. 'This requires

an understanding of chemical bonding and how the organic extracts bind to different metals,' says the UNCLE Project Coordinator, Stephen Liddle who was also

involved in the latest research. 'We can then exploit this knowledge to achieve separation by having them selectively bind to one type of metal and remove it from the soup.'

According to Liddle, there is mounting evidence that the best way of doing this is with molecules containing soft donor-to-metal binding. 'Arsenic is a soft donor, so we have prepared model complexes with it to understand the nature of the bonding,' he explains. 'Here, we have made molecules in multi-gram quantities, which are stable under ambient conditions and thus allow us to study them more straightforwardly.'

With the new knowledge and understanding that researchers hope to gain from this latest work, UNCLE's findings may soon be applied to an operational system.

"Researchers have discovered how arsenic molecules can be employed to 'fish out' the most toxic elements from radioactive nuclear waste."

UNCLE

★ Hosted by the University of Nottingham in the United Kingdom.

★ Funded under FP7-IDEAS-ERC.

★ <http://cordis.europa.eu/project/rcn/93103>

NEW TOOLS TO INCREASE THE ACCURACY OF BIODIVERSITY MONITORING

An EU-funded project has created a range of tools to give a more accurate picture of current biodiversity, aiding efforts for sustainable governance of natural resources.



© arenysam, Shutterstock

A recent article published in the journal 'Scientific Reports' states, 'Monitoring schemes provide an important source of information on biodiversity change, guiding further research, conservation assessment and planning.' The article cites The European Biodiversity Portal, designed and implemented by the EU-funded EU BON (Building the European Biodiversity Observation Network) project that offers researchers, policy-makers and others interested in biodiversity, easy access to insights on trends and modelling techniques.

The project worked on the establishment and adoption of new data standards, the development of tools to enable collaborative research and the encouragement of citizen-scientists. As a result, EU BON, by building the European Biodiversity Observation Network, has created advanced techniques for data analysis along with new approaches for modelling and strategies for future biodiversity monitoring.

Practical applications for conservation and the sustainable management of resources

The portal can help identify data sets relevant to 'Essential biodiversity variables' (EBV), which the article states, 'provide a framework for comprehensively representing the different components of biodiversity in order to measure change over time to identify

the most important gaps in data coverage and to improve monitoring practices across time and space.'

EBVs can feed into conservation strategies: the Species Population Trend Browser, one of the six EBVs, can be used to identify the trends and status of 'Species distribution' and 'Species abundance' leading to the formulation of evidence-based policies.

Asked how the portal will be useful to local stakeholders, Mr Clint Alibrandi from the Environment and Water Agency in Andalusia replied, 'This will allow stakeholders, from a local, regional or national level, to consult or work with data and tools. It will help them to refer to relevant policies concerning biodiversity on the European scale in order to be able to better transpose them to a more local context.'

Along with providing information on biodiversity at national and regional levels, the portal sets out analytical tools, such as the Species Richness Tool and the Business Analytics Dashboard, that offer charts and aggregated data, to help conservation decision making.

The best science is collaborative

To enable researchers to work together more seamlessly, the portal includes an eLab, or virtual laboratory, which lets people share documents, work on the same project, and use the same web interface, all in the knowledge that each eLab has complete data privacy.

"Remote sensing can become an important and essential component of biodiversity monitoring systems."

Collaboration within the research community is important but it is also vital to raise awareness among the general public. The project kept this firmly in mind, with elements of the portal designed to encourage participation by citizen-scientists.

EU BON has also collaborated with the European Space Agency. The ESA, amongst others, is becoming more and more committed to helping those interested in biodiversity. It can improve their capacity to use remote sensing data to monitor biodiversity trends. Talking of the use of satellite Earth Observations, Marc Paganini of the ESA said, 'If properly used with the collection of biodiversity data on the ground, and species and habitat modelling, remote sensing can become an important and essential component of biodiversity monitoring systems.' He added that there are many environments in which remote sensing is often the only way to conduct large-scale monitoring, such as wetlands or remote areas that are hard to access.

The project itself is a product of close work conducted between many different partners. Between December 2012 and May 2017, EU BON brought together 31 partners from 15 European countries, Israel, the Philippines, Brazil and more than 30 associated partners.

EU BON

- ★ Coordinated by the Museum für Naturkunde in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/project/
rcn/106533](http://cordis.europa.eu/project/rcn/106533)
- ★ Project website: <http://www.eubon.eu/>

WHAT HAPPENS WHEN THE SEAFLOOR RUNS OUT OF BREATH?

With low-oxygen seafloor areas around the world on the rise, the EU-funded HYPOX project points to warning signs for marine ecosystems.

The environment at the sea bottom is crucial for the lifecycle of many animals. Not only do these animals rely on organic material for consumption, the subsequent waste is then recycled by seafloor life back into the ecosystem, producing new biomass. The rest becomes buried in the seafloor.

A recently published study in the journal 'Science Advances' by a team of researchers from the HYPOX (*In situ* monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies) project, has found that when oxygen concentrations in the bottom-water environment are low, less organic matter can be remineralised and so more gets buried into the sea bed, having a faster and longer impact (lasting decades) than previously thought. The journal quotes Gerdhard Jessen from the Max Planck Institute for Marine Microbiology, Germany, as summarising that, 'The amount of organic matter ending up in the seafloor increases by half when the seafloor is periodically short of oxygen.'

The Black Sea laboratory

The HYPOX team took to the waters of the Black Sea, the largest naturally anoxic water body in the world (water depleted of dissolved oxygen) for near perfect outdoor laboratory conditions. The Black Sea evidences stable stratification in a natural gradient of bottom-water oxygen concentrations which ranges from well-oxygenated shallow waters, to variable oxygen conditions, leading to anoxic deeper waters at depths below 160 metres.

The study traced specific impacts of hypoxic conditions. For example, lack of oxygen has an impact on seafloor fauna which larger animals, such as worms and mussels, rely on

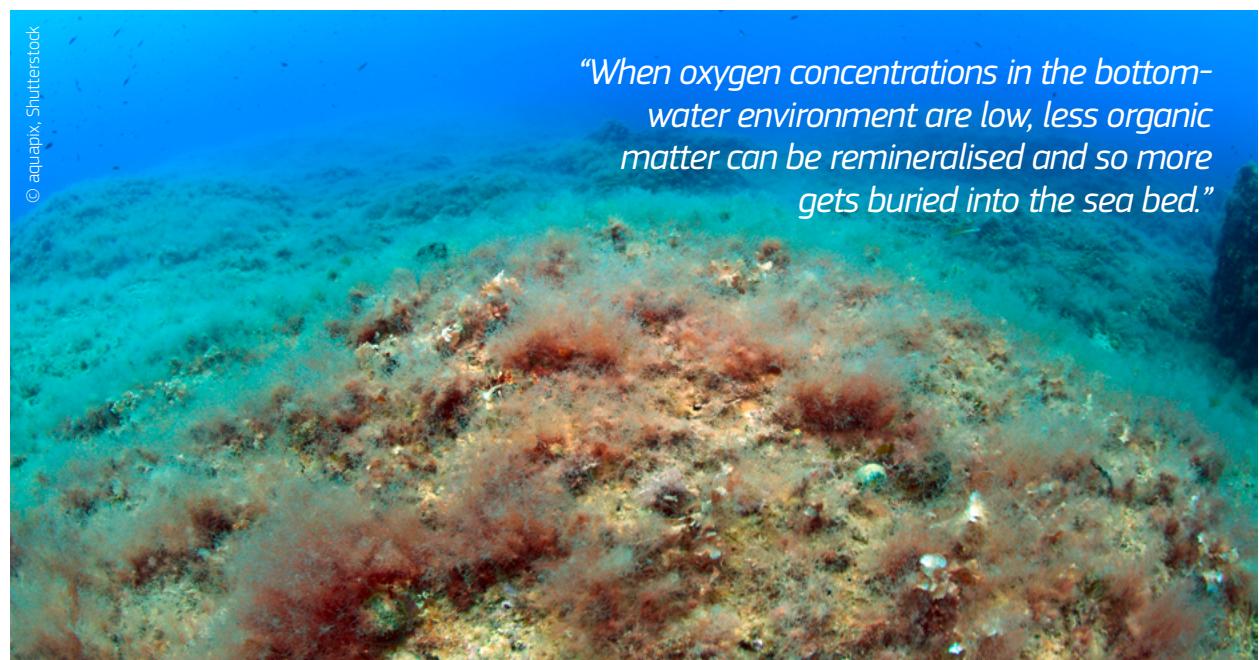
for food and shelter. Through their actions these animals in turn provide smaller seafloor creatures with nutrients. When oxygen is in short supply, larger animals often disappear and remineralisation of organic matter arriving at the seafloor becomes chiefly the job of sediment bacteria, which takes a very long time. Consequently, more organic material is removed from the nutrient system and left trapped in the seafloor. This has the knock-on effect of increasing the presence of anaerobic microorganisms which do not rely on oxygen but also produce toxins which further slow down the breakdown of matter, compounding the situation.

Detecting timely warning signs

Given the ongoing human influence on nutrient cycles along with climate change impacts, incidences of low-oxygen oceanic areas are on the rise around the world and so understanding the biogeochemical processes involved is crucial. Science Advances quotes a senior author of the study, Antje Boetius, as summarising, 'The Black Sea can teach us many lessons... as it clearly reveals the effects of fluctuating and low oxygen conditions on the ocean ecosystem, causing tremendous changes in the services of the ecosystem to us humans. Investigations such as the current one are thus essential in the face of global change, to detect warning signals from the ocean in time.'

HYPOX

- ★ Coordinated by the Max Planck Society in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/91246>
- ★ Project website:
<http://hypox.pangaea.de/>



AGRICULTURE AND FORESTRY

BIOPESTICIDES REPLACE TOXIC CHEMICAL SPRAYS

An innovative collaboration between researchers and industry has developed biological pesticides that leave no harmful chemical residues on food.

Consumer concern about chemical pesticide residues on food has created a market for safer, environmentally-friendly pesticides. Four environmentally-friendly bio-based pesticides were developed under an EU-funded collaboration between scientific researchers and pesticide companies. Two are already being sold in Europe.

The INNOVA (Innovative bio-based pesticides to minimise chemical residue risk on food) project brought together academic researchers and commercial pesticide companies to identify and develop bio-based pesticides.

A literature review was conducted at the start of the four-year project and some 100 biopesticide candidates were identified. Preliminary tests and small-scale trials were conducted on some two dozen of these before identifying those with the largest potential market — for example, grapevines account for a large portion of pesticide use within Europe — almost two thirds of all fungicides applied to crops.

INNOVA's work led to the active substance *Trichoderma atroviride* SC1, which is based on a microorganism, being registered for use in Europe. It is currently sold as a fungicide in Germany and France for use on grapes, and in the near future also on tomatoes and strawberries.

'When you apply this microorganism to the plant it immediately colonises the

wood and forms a biological barrier (against the pathogen)', says project coordinator Dr Ilaria Pertot, senior researcher and head of the department of sustainability at Fondazione Edmund Mach in Trentino, Italy. It is stable and persistent so 'one treatment lasts the entire season,' she says. 'The compound used in the past was sodium arsenite — a very toxic fungicide that has been banned.'

Bio-weedkiller

Another product developed under the project is pelargonic acid, a fatty acid derived from oils or animal fats which dissolves the protective wax on leaves, making it a natural herbicide. It has the potential to replace the widely-used weedkiller glyphosate, a powerful chemical desiccant. 'It needs reapplication and it is not as strong as glyphosate but this natural compound can be an alternative,' Dr Pertot says.

Two more biopesticides currently going through the EU registration process will be on the market within 2 to 3 years — a plant extract that interferes with the digestion of specific insects without harming humans or animals; and a compound absorbed by certain pathogens but with no nutritional value for them, so they become inactive and die.

The key to developing these biopesticides was the collaborative working relationship

between academic researchers and pesticide companies, enabled by a Marie Curie grant, Dr Pertot says. She adds that scientists are highly specialised and often unaware of the real-world context of their research; while companies are not up to date with the science or have difficulty understanding new scientific concepts.

Feasible for the grower

Together with pesticide distribution company Belchim and BIPA, a company specialised in biopesticides registration, the team worked to formulate the biopesticides and to tackle storage and distribution issues. 'Having a good active ingredient does not mean you have a good commercial product,' say Dr Pertot. 'We had to see in practice if the product is really applicable and feasible from the perspective of the grower.'

'Now we have a box with the strain formulated in the right way, so the grower just dilutes it, puts it in the sprayer and sprays it like a normal pesticide.'

INNOVA

- ★ Coordinated by Edmund Mach Foundation in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/106673>
- ★ Project website: <http://project-innova.eu/>



PROTECTING OLIVE TREES FROM A DEADLY DISEASE

The EU-funded XF-ACTORS project recently reported on its disease modelling work, key to its integrated management strategy to control the spread of the *Xylella fastidiosa* pathogen, which is putting olive groves at serious risk in Southern Italy.

X'*ylella fastidiosa*' (XF) is a bacterium which has been linked to a number of plant diseases, particularly in the Americas where it has ravaged peaches, grape-vines and citrus fruits. However, more recently the pathogen has attacked olive trees in Southern Italy and since 2013 has invaded over 23 000 ha of olives. After causing terminal shoots to wither, the disease spreads to the whole canopy causing the trees to die, affecting all of the other trees in the groves.

The XF-ACTORS (Xylella Fastidiosa Active Containment Through a multidisciplinary-Oriented Research Strategy) project aims to assess the likelihood of pathogen spread through EU territories, as well as set up prevention, early detection and control protocols for XF. The project team have used modelling to help predict the spread of the pathogen and in so doing are able to advise on the establishment of buffer zones to protect uninfected trees.

Modelling to predict XF spread

Recently published research in the journal 'Biological Invasions' by members of the team, outlines the project approach which is to model control zones currently deployed in Apulia, Italy in order to replicate the pattern of disease spread. The researchers found that when the buffer width is increased, infection risks are indeed decreased beyond the control zone, but may not stop the spread completely.

As the lead author Dr Steven White is quoted as saying, 'At these early stages of *Xylella fastidiosa* invasion, little is known about the rates of spread of this terrible disease of olive trees and how best to control it. This is largely due to biological and environmental differences between where the strain is invading and where it has originated.' In order to understand the process better, the study also looks

specifically at how the spread of XF across Europe — and beyond — might be influenced by a range of insects mobile between groves.

Introducing an integrated management strategy

XF-ACTORS will examine the pathogen biology underpinning the disease (along with that of the hosts under threat), as well as the pathogen's epidemiological traits to better understand its subsequent progression. Additionally, there will also be a focus on investigation of insect-bacteria interactions.

Beyond yielding scientific information, the project will design effective phased control strategies giving policy makers tools to contain the risk of further spread beyond Italy. This step-by-step approach looks to first prevent the pathogen's introduction into uninfected areas, for example by implementing EU certification programmes alongside developing a plan for an EU Clean Plant Network. Additionally, field-ready surveillance systems utilising remote sensing technology will be developed for early detection. When infection does occur, effective eradication strategies will be established for deployment. The project will also put pest risk assessment tools at the disposal of policy makers which will focus on any contemporary outbreaks and indicate which regions are likely to come under threat next. The project will work in tandem with another EU funded project — PONTE — whose research aims are complementary.

When an outbreak does occur, it is hoped that this approach will be able to reduce its social, economic and environmental impact. As co-author of the study, Dr Daniel Chapman says,

'Our study shows that simple models can help to plan disease management strategies in the early stages of an epidemic.

Thanks to new funding from the European Union, we will be further developing the approach to provide specific guidance on surveillance, containment and even eradication of new outbreaks.'

"The project will design effective phased control strategies giving policy makers tools to contain the risk of further spread beyond Italy."



© Gherzak Shutterstock

XF-ACTORS

- ★ Coordinated by the National Research Council in Italy.
- ★ Funded under H2020-SFS.
- ★ <http://cordis.europa.eu/project/rcn/206027>
- ★ Project website: <http://www.xfactorsproject.eu/>

INSECT PROTEIN TO SATISFY DEMAND

Researchers have successfully established fly larvae production systems in West Africa, China and Europe to address increasing protein demand.



As global demand for meat increases, so does the need to supply protein in animal feed. Currently, soya and fishmeal are the principal sources of protein in animal feed, most of which is imported from North and South America.

The EU-funded PROTEINSECT (Enabling the exploitation of insects as a sustainable source of protein for animal feed and human nutrition) initiative aimed at using the largely untapped protein potential of insects to reduce pressure on plant and fish resources.

In collaboration with researchers in China, Ghana and Mali, PROTEINSECT investigated three fly species whose larvae form a natural part of fish, chicken and pig diets. These flies are already being extensively researched and are ideal for mass production, with the added bonus of being able to grow on organic waste products.

In addition to optimising fly rearing conditions, the team evaluated the quality and safety of protein produced

from fly larvae. PROTEINSECT screened samples produced in distinct geographical locations for the presence of more than 500 potential chemical contaminants. The researchers found that all were below the recommended maximum amounts, except for one fly species that contained concerning levels of toxic cadmium.

Project partners evaluated public acceptance of eating protein derived from insects by using insect protein directly in human food. They found that over 70% of participants surveyed said they would eat insect-fed animal products.

PROTEINSECT developed fly larvae production systems in West Africa, China and Europe, together with recommendations for further improvement. The researchers developed a database of scientific information on using flies for animal feed and on the production of fly larvae for the feeding trials.

These results will reduce the environmental impact of producing protein

“Over 70% of participants surveyed said they would eat insect-fed animal products.”

for animal feed and potentially for human diets. Sustainable insect production systems may also provide sources of other valuable products such as chitin, vitamins and minerals.

Finally, organic waste remaining after insects have been reared could be used as fertilisers, reducing landfill and the use of environmentally hazardous chemicals.

PROTEINSECT

- ★ Coordinated by Fera in the United Kingdom.
- ★ Funded under FP7-KBBE.
- ★ [http://cordis.europa.eu/project/
rcn/105074](http://cordis.europa.eu/project/rcn/105074)
- ★ Project website: <http://www.proteinsect.eu/>
- ★ <http://bit.ly/1UKXKK0>

INDUSTRY

SMART, WEARABLE HEALTHCARE DEVICES ONE STEP CLOSER TO MASS PRODUCTION

Digital, personal and wearable medical devices are the future of health care. Now, EU scientists are in search of novel manufacturing processes that could bring them to the mass market.

The EU-funded project FABIMED (Fabrication and functionalisation of biomedical devices) has developed innovative mass manufacturing processes for the next generation of medical devices. With the latest moulding technology, devices can be customised in bulk batches, driving down costs.

'New medical technology will help tackle the challenges of an ageing society with growing comfort standards. Digital, wearable devices enable universal, cost-effective and constant care, and our project could help make them accessible for everyone,' says Pablo Romero, FABIMED Project Coordinator.

The manufacture of medical devices is complicated by the fact that they often have disposable elements, whilst other microcomponents such as pumps and sensors need to be integrated. Previously, the technology used to produce innovative prototypes could not scale-up to mass production. But FABIMED has bridged this gap for three products — a microneedle patch, a microfluidic film and an ultrasound sensor — by developing micro-moulds that can replicate the product at high speed and low cost.

'The moulds were micromachined and then nanostructured with very specific patterns, allowing the replicated part to incorporate customised behaviours without the need to assemble multiple microparts. This cuts costs and complexity whilst it also simplifies certification processes,' explains Romero.

The project also developed a 'quality monitor' used during the manufacturing process. This system can take such fast readings that it can measure with micron accuracy every single part in an injection moulding line. This approach dramatically reduces the time it takes to put a product on the market once a change or improvement to it has been made.

One of the products developed under the project was a drug delivery patch which, unlike conventional patches, does not deliver a

continuous stream of drugs. It is a digital device which can store a variety of drugs in sealed drug-wells, releasing them at set rates, times and sequences.

The patch can be managed via a Bluetooth connection with a mobile phone, and the microneedles in the patch are so small that they don't produce any pain or bleeding.

FABIMED used the multipart adjustable mould to produce a patch with many microneedles with one single injection moulding shot, in just a few seconds. 'This high-precision product can now be made quickly, at high quality and at low cost,' says Romero.

The project also developed a microfluidic film which can analyse blood, and a miniaturised ultrasonic transducer for intravenous medical imaging.

The three FABIMED products are now being planned for wider commercial deployment. 'With FABIMED we have contributed to lowering the manufacturability barriers for many innovative medical SMEs in Europe. Their products can be much more easily manufactured in Europe, at very competitive costs and with the highest quality,' concludes Romero.

FABIMED project partners are still collaborating to improve parts of the manufacturing process. Meanwhile, Romero is hopeful that the technology developed by the project can be extended to new uses other than medical devices.

FABIMED

- ★ Coordinated by Aimen in Spain.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/108888>
- ★ Project website:
<http://www.fabimed.eu/>

MAKING CURVED COMPOSITES THE PUL-AERO WAY

Manufacturing curved polymer composites for aerospace applications has been a labour and resource-intensive practice up till now. The EU-funded PUL-AERO project has now developed a cost-effective, continuous pultrusion process which should finally allow composites to become the material of choice for many aircraft components.



Composite carbon-fibre polymer materials are now an important structural element of aircraft, so being able to produce lighter, lower cost and higher quality composites would be a big advance for the aerospace industry. The EU-funded PUL-AERO (High quality curved aerospace composites using pultrusion manufacturing) consortium has been working on achieving this with a new advanced pultrusion production process to produce the kinds of curved composites needed in aeronautics.

Pultrusion is a continuous moulding process whereby reinforcing fibres are saturated with a liquid polymer resin and then carefully formed and pulled through a heated die to form a part. ‘Normally pultrusion is considered as a “black art”, but we have been working over the last 10 years to bring much more science into the manufacturing process,’ says PUL-AERO project coordinator John Hartley of Exel Composites in the UK. ‘The PUL-AERO project is developing additional technology to satisfy the stringent quality requirements for Aerospace as well as being able to manufacture not only straight parts but also curved sections.’

The PUL-AERO project which is made up of industry partners in the UK, Greece, Israel and France as well as Cranfield

University, UK, has designed an advanced pultrusion production line. Using pultrusion processes it can be difficult to manufacture curved parts, particularly with aerospace grade epoxy resins, which require careful temperature control and slow curing. The project worked on modelling the process and produced a commercial simulation platform. One important aspect was the modelling of the distortion that occurs in the pultrusion process which is crucial for designing curved parts.

The new pultrusion line design also integrates new resin injection equipment that works at low flow rate and includes sensor systems to monitor resin flow and pressure. One major advance has been an on-line real-time quality assurance system to carry out ‘non-destructive testing’ (NDT) of the composites once formed. ‘Previously, all profile production was NDT tested by the customer, which was very expensive in both time and cost. The principal idea is for us to be able to NDT test on-line as we are making the profile. This results in a win-win situation,’ explains Hartley.

Testing this way has the obvious advantage that any problems can be corrected and resolved immediately, ‘We don’t have to ship the profile half way around the world to be tested and then

find it fails,’ says Hartley. ‘A cost saving comes from being able to immediately establish if there is a problem with the production.’ The process has been tested and verified by project partners, both producers and end users.

Current manufacturing methods are limiting the use of curved carbon-fibre reinforced polymer composites, due to a lack of automation, very high capital equipment costs and the need for highly skilled workers. The proposed new production process is likely to help them finally become cost-effective at aerospace quality standards. Currently the leading composites company, Exel Composites, is building a new aerospace designated facility that will include a new pultrusion machine, including the equipment and technology developed in the PUL-AERO project. Full production will start in mid-2017.

PUL-AERO

- ★ Coordinated by Fibreforce Composites in the United Kingdom.
- ★ Funded under FP7-TRANSPORT.
- ★ [http://cordis.europa.eu/project/
rcn/110670](http://cordis.europa.eu/project/rcn/110670)
- ★ Project website: <http://www.pul-aero.eu/>

INTRODUCING A NEW MEMBER OF THE FAMILY OF ADVANCED, ENGINEERED COMPONENTS

Using additive nanocomposite technology uniquely blending the properties of high stiffness with dampening, the EU-funded HIPPOCAMP project helped to create efficient and environmentally friendly advanced metallic parts.

Industries, such as automotive and aerospace, face the challenge of improving manufacturing performance while at the same time meeting rigorous environmental targets. Using traditional techniques to meet ever advancing engineering demands is not only prohibitively expensive but also generates undesirable by-products and toxic waste, necessitating innovative solutions.

The HIPPOCAMP (High-power Impulse Plasma Process Operations for the Creation of Advanced Metallic Parts) project developed just such a high-yield, low cost, robust and at the same time environmentally friendly, manufacturing process. It did so by producing nanocomposites for products made of engineered metallic material, in particular, structural components for automotive, aerospace, manufacturing and wind turbine applications.

Creating a new class of 'high dynamic stiffness' nanocomposites

One of the biggest problems with conventional manufacturing is the inherent vibration of machine-tools, turbine blades and other industrial components, which can lead to increased maintenance, decreased reliability, shortened service life and so ultimately higher costs for both producer and consumer.

One of the central innovations of the HIPPOCAMP project was the creation of a carbon-based nanocomposite material which combined high stiffness with high damping capabilities, a characteristic that the team refers to as 'high dynamic stiffness'.

Professor Krisztian Kordas, a member of the project team, explained the innovative aspects of the work: 'The ultimate problem is that few materials are available that fulfil both conditions, i.e. having high loss factor and static stiffness. Structural metals are stiff but do not damp vibrations. Polymers behave the other way around. In our approach, we create materials that are made of relatively hard and stiff

components and at the same time have an engineered multi-layered microstructure that promotes scattering of mechanical waves thus enhancing damping.'

HIPPOCAMP was able to develop a scalable industrial process by combining novel approaches. Firstly, a new additive technology method called 'Plasma-enhanced chemical vapour deposition' (PECVD), using acetylene, oxygen, nitrogen and argon, was employed. This was able to generate thick layers of material at a high deposition rate which, using no toxic gases, resulted in minimum environmental impact.

Secondly, a 'High-power impulse magnetron sputtering' (HiPIMS) technology at low temperature (100 degrees), for producing a metal/gas plasma and flux of ionised material from a solid metal source, was deployed. By controlling the pulsed metal plasma discharge and flow intensity, HIPPOCAMP was able to fabricate the desired nanostructured composite. The material was then embedded in the manufacturing process with the result that it was not only effective in vibration damping but also improved performance without any significant change of size or mass of the components.

Pushing the limits of production with enhanced metal components

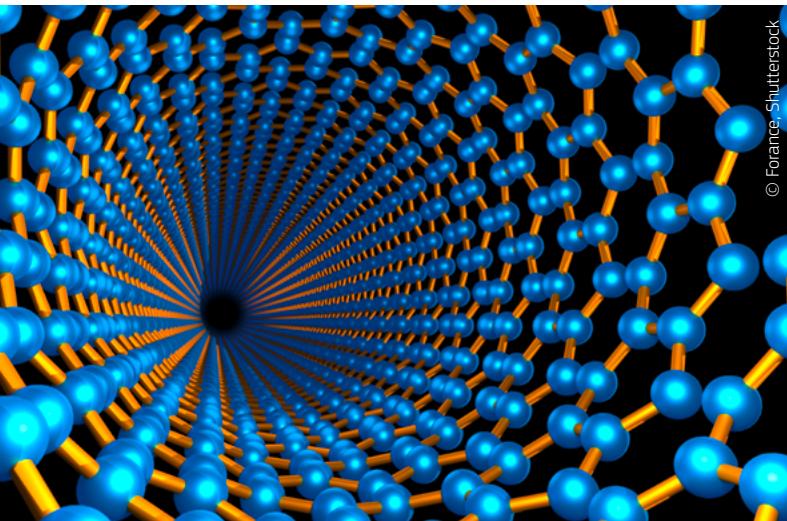
HIPPOCAMP has successfully synthesised a new class of nanocomposites characterised by their high dynamic stiffness properties at a broad range of temperatures (dubbed HiDS materials). Embedding these on metal parts has enabled the creation of industrial components (HiDS components) with a high stiffness-to-weight ratio combined with vibration damping properties along with high thermal stability.

When looking to future applications, Prof. Kordas asserts that, 'Mechanical damping can enhance the productivity of many industrial processes where vibration damping is an important limiting factor of performance. For instance, in mechanical tooling such as boring, milling and turning where the rate at which a work piece is produced is limited by mechanical vibrations and resonance. It therefore offers significant economic advantages.'

A number of HIPPOCAMP innovations are already on their way to the market. Ionautics is commercialising a new plasma generator and a new bias power supply developed by the project, while Lantier is doing the same with a new creping blade monitoring system targeted at the pulp and paper industry.

HIPPOCAMP

- ★ Coordinated by the University of Oulu in Finland.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/109371>
- ★ Project website: <http://www.hippocamp.eu/>
- ★ <http://bit.ly/2pqnG2l>



COATINGS FOR CAR AND PLANE PARTS ALSO TO BE AVAILABLE IN GREEN

The EU-funded SCAIL-UP project has developed a radically new green component coating process, making European car and plane manufacturing more efficient, competitive and environmentally friendly.

Conventional techniques for coating automotive and aeronautic engineered metallic components, such as pack cementation and Chromium VI electroplating, are often inefficient and detrimental to the environment. Both use powders, activators and acids which can be toxic, resulting in harmful waste products that have to be specially treated. Additionally, they are energy intensive, requiring high temperatures alongside two heat treatments to achieve the necessary aluminide coating microstructure.

It has long been known scientifically that electrodeposition of 'aluminium' (Al) from 'ionic liquids' (ILs) onto substrates offers promise to improve this process due to the unique nature of the compounds (stable against oxidation and reduction, high metallic salts solubility, low vapour pressure, negligible hydrogen embrittlement, easy recovery of precipitated metals and low toxicity).

However, the challenges associated with using closed systems filled with inert gas for the electrodeposition process — as electrolytes do not work under moisture containing atmosphere — presented a major barrier to ever enabling this at the industrial scale. The EU-funded SCAIL-UP (Scaling-up of the aluminium plating process from ionic liquids) project has succeeded in designing, developing and validating a 200 litre industrial scale pilot plant that was able to electroplate Al on current 3D polymeric (ABS) and metal (nickel alloys) industrial prototype parts using ILs.

Novel aesthetic and resistant components

Building on knowledge from previous projects, SCAIL-UP was able to modify process conditions for the upscaling of Al electrodeposition through ILs, proceeding along two paths. As the project coordinator Dr Mónica Solay explains, 'Process standardisation is a key factor for industrialisation and so we set out to achieve process validation and some preliminary standardisation tasks with real aeronautic and automotive prototypes.'



Firstly, focusing on the automotive sector, the team developed a plastic base (polymeric substrates), part metallised with an Al aesthetic. The base's multilayer structure confers advantages to its surface, especially high corrosion resistance. Additionally, the vehicle's energy needs are reduced due its lighter weight. The process also allows the substitution of hazardous processes, such as nickel and chrome electroplating.

Secondly, concentrating on aeronautic applications, particularly high performance gas turbine blades and vanes, the team set out to develop a new aluminising technology, which diffused the Al through a double step process consisting of initial electrodeposition utilising ILs followed by a vacuum heat treatment process, resulting in an intermetallic material (nickel aluminide). This resulted in the diffused Al surface plating protected from corrosion and oxidation at high temperatures. The project was also able to explore additional characteristics such as wear resistance and lubricity.

After attending to critical concerns such as moisture protection, corrosion of ILs, automation control, etc. the process was adapted to industrial conditions, with the pilot line then designed and built.

Offering EU factories a competitive, and green, edge

By providing an alternative to hexavalent chromium coatings, SCAIL-UP contributes directly to European environmental

"By providing an alternative to hexavalent chromium coatings, SCAIL-UP contributes directly to European environmental objectives."

objectives. As Dr Mónica Solay elaborates, 'According to the European Environmental Bureau, high-tech metals are one of the target key sectors that must be included in the next Environmental Action Programme for achieving European growth objectives in the near future. This project will give the automotive and aeronautic sectors the opportunity to choose high quality green products not possible until now, while also promoting societal awareness about the EU's environmental agenda.'

In the short term the technology development, especially for aeronautic applications, will continue to undergo pilot plant trials to refine the process. With enough customer interest the technology would be commercially exploited through in-house pilot plants as soon as it is ready and optimised. Later if the technology gains traction it is envisaged that an industrial scale plant, capable of handling higher volumes, would be established.

SCAIL-UP

- ★ Coordinated by Maier Scoop in Spain.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/project/
rcn/109186](http://cordis.europa.eu/project/rcn/109186)

STRENGTHENING BONDS BETWEEN DISSIMILAR MATERIALS

An innovative process developed by the EU-funded ADMACOM project reliably joins high performance ceramic-based materials to non-ceramics to produce lightweight components.

New ceramic-based materials with exceptional heat resistance and other high-performance properties have not been used extensively in the manufacturing industry due to a lack of reliable methods to join them to metals and other existing materials.

The EU-funded ADMACOM project (Advanced manufacturing routes for metal/composite components for aerospace) has found ways to produce 'hybrid' structures by bonding newer ceramic-based materials to traditional metals and polymers.

The properties of dissimilar materials, such as expansion or shrinkage, mechanical strength, electrical and thermal conductivity, often differ enormously making them difficult to join reliably and strongly. 'What we worked on is the nano-

structure of the two surfaces to be joined to change the surface micro-texture and so increase the surface area,' says project coordinator Monica Ferraris, a professor at the Politecnico di Torino, Italy. 'Once an uneven surface on both materials is produced by laser nano-structuring, high temperatures or other methods, then they can be mechanically interlocked with adhesives which infiltrate the uneven surface and make the bond stronger.'

"Airbus, for example, used lasers to modify the surface of materials such as silicon carbide and silicon nitride to create secure 'brush-like joints'."

even surface on both materials is produced by laser nano-structuring, high temperatures or other methods, then they can be mechanically interlocked with adhesives which infiltrate the uneven surface and make the bond stronger.'

Range of materials

University researchers, industrial designers, materials scientists and engineers from the aerospace, nanotechnology and other industries such as Airbus Group and MT Aerospace in Germany came together under the ADMACOM 'Factories of the Future' public-private partnership project to develop the joining technique with a range of materials.

Airbus, for example, used lasers to modify the surface of materials such as silicon carbide and silicon nitride to create secure 'brush-like joints'.

'What you put in between the two is a joining material just a few microns thick,' Professor Ferraris says, but it is nonetheless a strong and reliable joint. 'This can be adapted and used every time two different materials are to be joined. It is universally useful, not just for aerospace,' Ferraris says.

Fewer parts, lighter weight

Ceramics and new 'Ceramic matrix composites' (CMC) — ceramic materials embedded with fibre — are already revolutionising industrial component design, but the usual methods such as the use of additional screws to join dissimilar materials can cause stress in ceramic-based materials and make them liable to fracture.

The new process means fewer parts, including less need for screws and bolts, and reduces weight which can lead to significant energy-saving in the aerospace industry, for satellites and for high pressure turbines and nuclear reactors.

The team tested the process on many different materials, carrying out detailed microstructural analysis of surfaces and interfaces and different joining materials including adhesives, using a similar comparable test.

'A value-added result of the project is that we are in a good position to validate different joining materials using the same standardised test from the beginning of the project. Bonded materials were tested for mechanical performance, including thermal tests, using the same techniques,' Professor Ferraris says. 'We learned that surface modification, already known to strengthen wood joints, could be transferred to other kinds of materials — in this case to ceramics and ceramic matrix composites — to strengthen the joints.'

ADMACOM

- ★ Coordinated by the Polytechnic University of Turin in Italy.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/108897>
- ★ Project website: <http://www.admacomproject.eu/>



THE TIDE TURNS FOR OFFSHORE MAINTENANCE COSTS

Cutting running and maintenance costs of offshore wind turbines lies at the heart of a new approach to compressing millions of nanoparticles to create water-resistant, super-strong and long-lasting coatings.

The cost of attending to routine maintenance, so as to keep turbines running under all weather conditions, accounts for about half the yearly costs of an offshore wind farm. Other expensive costs are associated with the import of electric power needed to keep systems operational while a turbine is shut down.

The goals of EU-funded research carried out within the project HYDROBOND (New cost/effective superhydrophobic coatings with enhanced bond strength and wear resistance for application in large wind turbine blades) were directed at reducing both preventative or routine and unscheduled maintenance costs.

Maintenance is invariably expensive, and the loss of electricity production, while the work is carried out, can have an adverse effect on the profitability of an offshore wind farm. Longer distance to shore, particularly because the aim is to access higher winds, may outweigh the benefits of an increase in energy yields.

Super-hydrophobic coatings

In the HYDROBOND consortium, companies and research institutions joined their efforts to develop new superhydrophobic coatings, which can also be used against ice formation, as well as their application. Significant advances in coatings for wind turbine blades were made using a cold gas spray process.

Current coatings are thermo-sprayed onto different industrial components. Tiny 'nano-sized' powder particles are semi-melted and propelled towards a substrate or surface area, onto which they are hardened to form a coating. Post-coating work is needed to minimise internal tensile stresses developed during solidification.

Project partners optimised and tailored solid state technology and paints for cold gas spraying to the wind industry. Particles are accelerated at the substrate at speeds many times the speed of sound to achieve the necessary plasticity that enables deformation. Their speed is, however, not too high to avoid them bouncing off the substrate rather than bonding to it.



“According to our estimations, a reduction of more than 30 million tonnes of carbon dioxide (CO₂) emissions can be achieved over a period of four years.”

The team also achieved significant improvements in the powder composition. In the past, only metallic substrates were used for cold gas spraying. Thanks to HYDROBOND research, composites reinforced with nano/microceramic materials (among others) can be sprayed onto a whole range of substrates — both metallic and non-metallic.

'To combine hydrophobicity, anti-icing and wear resistance was a challenge from the beginning of the project since there was no material on the market that delivered the desired multifunctionality of wind blade surface,' stresses Professor Josep Maria Guilemany, HYDROBOND coordinator from the Thermal Spray Centre at the University of Barcelona in Spain.

The new coating technique eliminates the need for expensive active anti-icing processes that remove ice from wind turbine blades by heating. The new super-hydrophobic coatings act like passive systems since they prevent the formation of the ice.

Pushing emissions and costs down

'According to our estimations, a reduction of more than 30 million tonnes of

"carbon dioxide" (CO₂) emissions can be achieved over a period of four years after the implementation of the new super-hydrophobic coatings on turbine blades,' notes Prof. Guilemany.

He adds that 'since less maintenance will be needed, transport to offshore wind farms will be reduced as well as subsequent damage to marine habitat. Furthermore, higher efficiency of offshore wind turbines will render them more attractive than onshore wind farms.'

The first industrial demonstrations have already begun, and patents are being secured before HYDROBOND technologies are made available on the market.

HYDROBOND

- ★ Coordinated by the University of Barcelona in Spain.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/106383>
- ★ Project website: <http://hydro-bond.eu/>
- ★ <http://bit.ly/2p7Ypx9>



INFORMATION AND COMMUNICATION TECHNOLOGIES

ROBOTS OF TOMORROW WITH INTELLIGENT VISUAL CAPABILITIES

The ability to perceive and understand the dynamics of the real world is critical for the next generation of robots. An EU initiative has explored vision, which is essential for most robotic tasks.

Robots need a way to adaptively select relevant information in a given scene for further processing. They require prior common-sense knowledge about where to find a target, and should also have an idea of their size, shape, colour or texture. Robots require attention mechanisms to determine which parts of the sensory array they need to process. Attention involves selecting the most relevant information from multi-sensory inputs to efficiently carry out a target search.

The EU-funded REAL-TIME ASOC (Real-time understanding of dexterous deformable object manipulation with bio-inspired hybrid hardware architectures) project focused on the development of new mechanisms for visual attention.

REAL-TIME ASOC employed a specialised camera called a 'Dynamic vision sensor' (DVS) which is suitable for robotic applications requiring short latencies to operate in real time. It captures everything that is changing at a very high temporal resolution in microseconds. DVS records about 600 000 frames per second and reduces the amount of information by removing a scene's static areas.

Project partners began by using the DVS sensor to extract contours and boundary ownership from event information

only. Since events are solely triggered at major luminance changes, most events occur at the boundary of objects. Detecting these contours is a key step towards further processing. They introduced an approach that identifies the location of contours and their border ownership using features representing motion, timing, texture and spatial orientations. The contour detection and boundary assignment were then demonstrated in a proto-segmentation of the scene.

Scientists worked on algorithms to estimate image motion from asynchronous event-based information, and a field programmable gate array to compute visual attention. Lastly, they produced a dataset that provides both frame-free event data and classic image, motion and depth data. This helps to evaluate different event-based methods and compare them to frame-based conventional computer vision.

REAL-TIME ASOC demonstrated how tomorrow's robot will visually select and process images much like humans do.

REAL-TIME ASOC

- ★ Coordinated by the University of Granada in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/106956>

NOVEL USER INTERFACES SLATED TO ENHANCE MULTISENSORY INTERACTION

The development of new software and mobile apps that add an audiovisual component to user interfaces promises to support a number of applications. These range from enhancing accessibility to providing a new form of creative art.

Human-computer interactions have come a long way in recent years, thanks to the concept of 'Graphical user interface' (GUI). The EU-funded ENABLING AVUIS (Enabling audiovisual user interfaces for multi-sensorial interaction) project worked on taking GUI a step further by combining sound and image to create a new concept, namely the 'Audiovisual user interface' (AVUI). By audiovisualising the user interface and designing it to respond to user interaction, the project team came up with a more robust, accessible and engaging system that represents a significant upgrade from GUI technology.

To achieve its aims, the team developed mobile applications that facilitate the AVUI. This involved prototyping AVUIs, conducting relevant case studies and releasing a toolkit to implement further AVUIs. More specifically, it created AVUI prototypes by bringing together artists and developers in workshops and hackathons, making the prototypes available online to the public. The project also

created ShapeTones, an audiovisual memory game for iPhones and iPads, also available online free of charge and targeting visually and aurally challenged users.

Another key project outcome was AVZones (AudioVisual Zones), an iPad application for audiovisual performance that explores the integration of sound and image in a touchscreen environment. This was followed by ofxAVUI, a toolkit for implementing audiovisual user interfaces that promises to be useful in a number of applications.

All these efforts have been highlighted through the project website, which offers valuable online resources related to the project, such as reference materials, code source examples, a software library and tutorials. The project's results were disseminated to designers, artists, academics, students and software developers, improving the prospects of better multisensorial interfaces aimed at enhancing user experiences. These developments are expected to help bring about a marked change in

how we interact with computers, supporting target groups ranging from audiovisual artists and designers to the elderly and the disabled.

ENABLING AVUIS

- ★ Coordinated by Goldsmiths College in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/
rcn/188128](http://cordis.europa.eu/project/rcn/188128)
- ★ Project website:
<http://avuis.goldsmithsdigital.com/>

"The project team came up with a more robust, accessible and engaging system that represents a significant upgrade from GUI technology."



S P A C E

JAW-DROPPING DISCOVERY OF EARTH-LIKE PLANETS REVEALED TO THE WORLD

The EU-funded SPECULOOS project has helped to find the most incredible star system to date as seven Earth-sized planets were recently spotted orbiting the nearby star TRAPPIST-1.

The discovery of multiple rocky planets with surface temperatures which allow for liquid water make this amazing system an exciting future target in the search for life,' enthusiastically summed up Dr Chris Copperwheat, from Liverpool John Moores University in the UK, who was part of the international research team.

In their recent 22 February 2017 publication in the journal 'Nature', astronomers led by Dr Michaël Gillon, lead author of the paper and SPECULOOS (Searching for habitable planets amenable for biosignatures detection around the nearest ultra-cool stars) principal investigator from the STAR Institute at the University of Liege in Belgium, have located a planetary system containing seven planets revolving around a small red ultracool dwarf star named 'TRAPPIST-1'.

This star is some 39 light-years (229 trillion miles) from Earth and researchers used telescopes such as Liege's TRAPPIST-Sud (named after Belgium's famed Trappist beers), Chile's Very Large Telescope (VLT) and NASA's Spitzer to make in-depth photometric observations on the transiting configuration (regular light curves and passes in front of its host star) to establish the planets' atmospheric properties.

While astronomers have already discovered thousands of exoplanets (planets located outside our solar system) since the first discovery of such a world back in 1992, there are many reasons to be more excited at this latest discovery... and not just because TRAPPIST-1's slow hydrogen burning means that it will live for another 10 trillion years, more than 700 times longer than the universe has existed so far.

These observations show that at least seven planets are of similar size, temperature and illumination levels to Earth. At least the inner six planets are probably rocky like Earth and three of the planets (TRAPPIST-1 e, f and g) orbit the star's 'habitable zone' (or

'Goldilocks zone' because conditions are supposedly 'just right') and could therefore harbour oceans of water that are theoretically possible homes for life.

No other star system has ever provided mankind with such an opportunity as to study the atmosphere of exoplanets of similar size to Earth before. 'This is an amazing planetary system — not only because we have found so many planets, but because they are all surprisingly similar in size to the Earth,' commented Dr Michaël Gillon.

Researchers now wish to conduct follow-up observations using NASA's James Webb Space Telescope and the European Southern Observatory's (ESO) more powerful European Extremely Large Telescope to detect biological activity in the atmosphere and answer the biggest wonder of all: Is life ubiquitous in the Galaxy?

The answer with conclusive evidence should come sooner rather than later. 'We hope we will know if there's life there within the next decade,' specified co-researcher Dr Amaury Triaud, from the Institute of Astronomy in Cambridge, the UK.

The SPECULOOS project runs until December 2018 and has received just under EUR 2 million in EU funding to detect potentially habitable exoplanets well-suited for the detection of chemical traces of life with existing and near-to-come astronomical facilities. And they certainly may have achieved this aim following the incredible TRAPPIST-1 discovery!

SPECULOOS

- ★ Hosted by the University of Liege in Belgium.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/110775>
- ★ Project website: <http://www.speculoos.ulg.ac.be/>

NEW ANALYTICAL SOFTWARE PROMISES BIG BANG IN EUROPEAN ASTROPHYSICS

Cutting-edge software has been developed to help astrophysicists see distant galaxies as never before. With the next generation of space missions set for launch, the project will enable European scientists to take full advantage of the latest data.

Astronomers are really cosmic time travellers; distant galaxies are so far away that their light takes billions of years to reach us. Discovering these stellar systems means being able to look at the universe as it was close to the Big Bang. But while these so-called 'deep' images are crucial to our understanding of the how the universe began and consequently evolved, achieving crisp, clear images of these distant objects has often been an issue.

A window into the past

'These galaxies are so far away that astrophysicists often need to use multiple telescopes,' explains ASTRODEEP (Unveiling the power of the deepest images of the Universe) project coordinator Professor Adriano Fontana from the INAF Osservatorio Astronomico di Roma in Italy. 'The data collected from optical and, say, infra-red instruments often have different properties and can be difficult to combine. The same object viewed through different telescopes can appear very different.'

In order to address this, the ASTRODEEP project has developed new software that can make sense of multiple data supplied by the very best ESA and NASA satellites and telescopes. The best images of a particular object are used, and then information hidden in lower resolution images obtained through sophisticated mathematical image analysis techniques. Astrophysicists can then rebuild the history of the universe with never-before achieved precision.

'We used the new software on existing data to see distant stars,' says Fontana. 'Most stars are born in places where there is a lot of dust, which makes them difficult to observe when they are so far away. By combining optical and infra-red images we can peek into the dust and estimate how many new stars are hidden. We see gigantic amounts of new stars in distant galaxies, but as we get closer and closer to the Big Bang the dust decreases. This is what we expected to see, but are now able to see.'

Looking to the future

While enabling astrophysicists to look into the distant past as never before, the project is also firmly fixed on the future. The software technology developed by ASTRODEEP is being evaluated for adoption by ESA to analyse data from the satellite Euclid, scheduled for launch in 2020. The main goal of this mission is to resolve the mystery of 'dark matter' and 'dark energy'. In addition, NASA is planning to launch the James Webb Space Telescope (JWST) in the next few years.

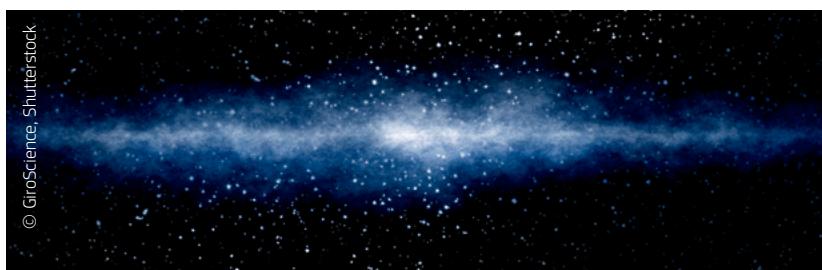
'We wanted to prepare tools that would enable European scientists to aggressively

jump on the data that will be delivered by these missions,' explains Fontana. 'We also consciously hired many young researchers for this project — as many as 14 — and many have gone on to achieve permanent positions.'

The next step, says Fontana, will be to apply these new software tools to fresh data, especially when these new instruments come online. In this respect, Europe is well-placed to be a leading player in astrophysics. 'If you consider the investment costs of such infrastructure — the JWST cost USD 8 billion while Euclid cost more than EUR 1 billion — the progress you can make with a much smaller investment like this project is huge compared to the cost,' concludes Fontana.

ASTRODEEP

- ★ Coordinated by INAF in Italy.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/project/
rcn/106789](http://cordis.europa.eu/project/rcn/106789)
- ★ Project website:
<http://www.astrodeep.eu/>



COMPUTING POWER FOR THE NEXT GENERATION OF SPACE EXPLORERS

EU-funded researchers have developed a pioneering processor to provide computing power for the next generation of space missions. These include explorations of Venus and Mars as well as the moons of Saturn and Jupiter.

A significant amount of computing power is required on board modern exploratory spacecraft in order to carry out precise operations at incredible distances, including planet entry descent and landing manoeuvres; guidance navigation and control as well as high rate data processing in science instruments. A key limitation is the fact that space-grade processors, which are so crucial to the functioning of the spacecraft, are now at the very limits of their capabilities. If mankind is to continue pushing the frontiers

of space exploration, then new computing capabilities must be found.

The EU-funded APEX (Advanced Processor Core for Space Exploration) project, which was completed in September 2016, has made significant progress in this respect. This was achieved by focussing on ARM processors, which are at the heart of the vast majority of smartphones, tablet computers and embedded devices on Earth.

Fine tuning commercial technology

'Space-qualified computing technology lags several technology generations behind commercial devices, such as ARM processors,' explains APEX principal investigator Dr Xabier Iturbe from ARM in the UK. In fact, the vast majority of space-grade processors are manufactured using radiation-hardened process technology, which leads to a notable increase in cost, power consumption and a significant reduction in performance. 'We set out to design a fault-tolerant, energy-efficient and high-performance ARM processor prototype that could be used as an embedded processor in NASA science instrument payloads,' continues Iturbe.

The APEX project began by achieving a better understanding of the computing and fault-tolerance requirements of future NASA space exploration missions, and then adapted a commercial ARM processor that is currently used in terrestrial transportation applications to meet these requirements. The team combined some well-established fault-tolerant techniques at the processor architecture level, such as lock-stepping, and developed novel energy-efficient techniques at the processor micro-architecture level. For instance, the team came up with a 'high-resilience' processor mode to execute high-criticality software routines using the least possible amount of micro-architecture components, thus reducing the vulnerabilities of the processor without impacting the performance.

The technical feasibility of this approach was demonstrated through a number of simulations, which underlined the high resilience and significant increase in performance delivered by the processor developed in APEX. Namely, it recovers from most faults provoked by radiation within microseconds, and delivers about 1.5 times more computing power than currently existing space-qualified processors.

Next step: deployment

'We expect that the technology developed in this project will enable the ARM eco-system to build radiation tolerant solutions for space and achieve higher levels of safety integrity in terrestrial applications,' says Iturbe. A number of space agencies like NASA and ESA (European Space Agency) and space equipment



© Vadim Sadovski, Shutterstock

manufacturers like Airbus have already shown an interest in using this technology if it becomes commercially available.

'The effort done in the APEX project for developing fault-tolerant, energy-efficient and high performance computing technology using commercial processors could help improving instrument avionics and increase dramatically the science returns of NASA missions,' states Dr Didier Keymeulen, principal member of technical staff at NASA's Jet Propulsion Laboratory (JPL) — California Institute of Technology and JPL scientist in charge for APEX. In fact, NASA has recently confirmed the development of an ARM-based high performance spaceflight processor, which will be used in both manned and unmanned spacecraft in the next years.

In parallel with this, the ARM University Programme, in collaboration with ESA, is creating a prototypic solution using the APEX technology to enable universities worldwide to build their 'CubeSats', miniaturised low-cost satellites for space research that can be put into Earth orbit.

APEX

- ★ Coordinated by ARM in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/189953>
- ★ Project website: <http://eu-project-apex.com/>

GIVING EARTH'S LOWER ORBIT A SPRING CLEAN

EU-funded scientists have developed an efficient method of removing the man-made space debris that orbits our planet. This could make future space expeditions safer by removing the threat of collision.

The space community has been aware for some time that close to 2 500 tons of debris currently orbits our planet, and has been looking into innovative solutions to remedy the situation. However, the sheer range of debris sizes and orbits means that different removal technologies are required, and it remains unclear exactly who will pay for such an ambitious undertaking. It is evident however that this is an issue that urgently needs to be tackled in order to ensure the safe continuation of space exploration.

'The amount of space debris orbiting the Earth has become dangerous,' says LEOSWEEP (Improving Low Earth Orbit Security With Enhanced Electric Propulsion) project coordinator Mercedes

Ruiz from SENER in Spain. 'In the last decade alone there have been at least two collisions between spacecraft in the low Earth orbit environment and the probability of more collisions is ever-increasing. This debris poses a real risk to existing and future space missions as well as to assets and people on Earth.'

Debris removal by ion beam

The EU-funded LEOSWEEP project sought to address this threat by focusing on the development of a specific 'Active debris removal' (ADR) technique, called the 'Ion beam shepherd' (IBS) concept. This concept was selected based on its suitability to contactless removal of some of the large number of discarded rocket stages that orbit our planet. By

deorbiting this debris using IBS, the project team calculated that they could potentially eliminate hundreds of tons of space debris with a few missions.

'IBS uses ion beams as an efficient and low-risk contactless way of manipulating the debris to be deorbited,' explains Ruiz. 'The orbit and / or attitude of a generic object can be changed through the momentum transfer of one or more ion beams produced by "electric propulsion" (EP) thrusters on board a nearby spacecraft.'

The technical challenges of IBS were investigated by the LEOSWEEP team, and proposed designs then validated through dedicated simulations implementing detailed models of the ion beams used for actuation on the target

as well as the ion beam-target dynamic interaction. Ground-based laboratory experiments were also carried out. A key outcome of all this hard work has been the development of a dedicated low divergence ion thruster (ITT).

'While ion thrusters have been known and used for spacecraft propulsion for many years, the ITT designed for the LEOSWEEP project is a new design,' says Ruiz. 'We were able to demonstrate that this can be used for specific IBS tasks.'

Clearing a path for implementation

Next, regulatory and legal framework issues were addressed and the way forward proposed in order to implement a first IBS ADR mission to remove

a Ukrainian upper stage rocket. 'Continuation of this work will now require the involvement of various space agencies, European Commission and Ukrainian authorities, in order to determine if the proposed solution matches their needs,' points out Ruiz. 'If so, then the next issue will be how to fund this expedition.'

By demonstrating the technological, economic and legal feasibility of this IBS technique, the LEOSWEEP project hopes to kick-start large-scale active debris removal activities in Ukraine, Europe and other space faring nations in the future. 'Project partners have also been able to improve their abilities to implement other proposed solutions in the future,' says Ruiz. 'For instance, some missions that could benefit from our achievements

"The LEOSWEEP project hopes to kick-start large-scale active debris removal activities in Ukraine, Europe and other space faring nations in the future."

include formation and tandem flying missions — which will be very important in the coming years — and asteroid deflection and retrieval missions.'

LEOSWEEP

- ★ Coordinated by SENER in Spain.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/project/
rcn/188860](http://cordis.europa.eu/project/rcn/188860)
- ★ Project website: <https://leosweep.upm.es/>

A LIGHT-BULB MOMENT FOR THE EARLY UNIVERSE

The discovery of glowing stardust in a distant galaxy could shed more light for astronomers on the characteristics of our early Universe.

Cosmic dust is forged inside stars and then scattered across the cosmos when they die, most spectacularly in supernova explosions. This dust is the key building block in the formation of new stars and planets.

In the early Universe however — before the first generations of stars died out — cosmic dust was incredibly scarce. With scientists believing that the Big Bang occurred between 12 and 14 billion years ago, this is why the discovery of large quantities of stardust in a galaxy only 600 million years old is so exciting.

Gazing back in time

The discovery was made thanks in part to the FIRST LIGHT (Early Star-Forming Galaxies and Cosmic Reionisation) project, which has enabled researcher Nicolas Laporte and colleagues at University College, London, to use the Atacama Large Millimetre/submillimetre Array (ALMA) to peer even further into our cosmic past. This international astronomy facility, in which the European Southern Observatory (ESO) is a partner, is the largest astronomical project in the world and is located on a 5 000-metre plateau in Chile.

The galaxy — called A2744_YD4 — is the youngest and most remote galaxy ever identified by ALMA, and also represents the most distant detection of oxygen in the Universe. The project team has been able to estimate that the galaxy contains an amount of dust equivalent to 6 million times the mass of our sun, and found that stars were forming at a rate of 20 solar masses per year, compared to just one solar mass per year in the Milky Way. The galaxy appears to us as it was back when the Universe's first stars and galaxies were forming.

Our cosmic dawn

So why is this significant? For a start, the detection of so much dust in such a young galaxy provides new information on when the first supernovae exploded, and hence gives us a better idea of when the first hot stars began to bathe the Universe in light. Determining the timing of this 'cosmic dawn' has been a key objective of astronomers for decades.

Also, the team has been able to estimate that significant star formation began approximately 200 million years before the epoch at which the galaxy is being observed. This provides researchers with an unprecedented opportunity to get closer to the point when the very first stars and galaxies appeared.

And finally, understanding when and how this first generation of stars appeared in the Universe has direct relevance to literally everything we know today. Our Sun, our home planet and even ourselves are the products — some 13 billion years later — of this cosmic dust that was created and scattered by the very first stars.

The success of the project to date suggests that the prospects for performing deeper and more extensive observations of similar galaxies are very promising. Further research could lead to the tracing of star formations even further back into the early Universe. In any case, further exciting discoveries will be expected to emanate from the FIRST LIGHT project, which is due for completion in September 2020.

FIRST LIGHT

- ★ Hosted by University College London in the United Kingdom.
- ★ Funded under H2020-ERC.
- ★ [http://cordis.europa.eu/project/
rcn/198684](http://cordis.europa.eu/project/rcn/198684)



© JaySi/Shutterstock



FUNDAMENTAL RESEARCH

SOLVING REAL WORLD PROBLEMS WITH APPLIED MATHEMATICS

What do tsunamis, the blood flowing through our veins, nuclear fusion, earthquakes, aircraft noise and clean energy have in common? According to the EU-funded STIMULUS project, they all share a common mathematical formulation as nonlinear systems of hyperbolic conservation laws.

The universally accepted laws of conservation, like the conservation of mass, momentum and energy, are among the most powerful physical principles we have to describe and understand real-world processes. From a mathematical point-of-view, the principle of conservation leads to nonlinear 'Partial differential equations' (PDE), which are so complex that they generally cannot be solved exactly. However, with appropriate techniques, they can be solved approximately on a finite set of discrete points or elements (i.e., the computational mesh).

This step of going from the original equations to the solution of the reduced problem on the computational mesh, called discretisation, leads to so-called numerical schemes for the solution of the PDE. 'Although the first numerical methods date back to the times of Newton and Euler, it is only with the advent of modern computers that the complex nonlinear PDE describing the conservation of mass, momentum and energy can be solved in acceptable times and for practically relevant cases,' explains Project Coordinator Michael Dumbser.

The STIMULUS (Space-Time Methods for Multi-Fluid Problems on Unstructured Meshes) project, conducted at Italy's University of Trento, has developed new universal methods for solving hyperbolic conservation laws that can be applied to many different problems. This was accomplished by unifying two traditionally distinct approaches to nonlinear

conservation laws — the finite volume and finite element method — into a single, more general framework.

The universality of mathematics

One of the project's major achievements provides a theoretical analysis and the first numerical solutions to a new universal formulation of continuum mechanics. According to Dumbser, this allows researchers, for the first time, to describe fluids and solids with exactly the same system of PDE. 'These new numerical methods are highly accurate and allow us to solve conservation laws in complex geometries in the context of numerous applications,' he says. 'For example, we developed highly efficient and accurate algorithms that can be used to simulate the generation and propagation of acoustic waves in such complex geometries as jet turbo engines, which help reduce aircraft-related noise pollution.'

Dumbser explains that these same algorithms can also be used to model tsunami waves in the ocean and to simulate seismic waves travelling in the Earth, allowing scientists to better predict the impact of earthquakes. 'Here, the same numerical algorithms as the ones developed for the simulation of aircraft noise can be applied, but to completely different fields,' says Dumbser. 'This is possible thanks to the same, universal mathematical formulation of the problem as a system of conservation laws.'

Using the same mathematical approach, the project also developed new schemes for simulating plasma flows arising in the context of 'inertial confinement fusion' (ICF). According to Dumbser, a major difficulty in ICF experiments is the complex flow instabilities that arise before the fusion process. To overcome this challenge, the STIMULUS project proposed new mathematical techniques that provide insight into the physics of these flow instabilities and, in the long-term, allows one to find new strategies for controlling and reducing them.

Moving towards market

Researchers are currently working to bring the project's results closer to market. 'The idea is to use our new,

high-order Lagrangian schemes on moving unstructured meshes for the simulation of rotating machines like gas, wind and water turbines, which are the most important mechanical devices currently used in the production of electric energy,' explains Dumbser. 'Our new algorithms are much more accurate than conventional ones and can also resolve very small flow features like turbulent vortices in complex geometries.'

STIMULUS

- ★ Coordinated by the University of Trento in Italy.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/99675>

BEAM IMAGING RISES TO THE CHALLENGE OF SOPHISTICATED ACCELERATORS

New techniques — including optical radiation imaging and non-invasive spatially coherent radiation imaging — can provide detailed beam measurements and optimise particle accelerators' performance in a variety of situations.

Beam diagnostics systems are essential elements of every particle accelerator. Without diagnostic elements, it would be impossible to operate linear accelerators for cancer radiotherapy, not to mention the world's largest atom smasher, the Large Hadron Collider. They reveal the properties of a particle beam and how it behaves within the accelerator complex.

The EU-funded project DITA-IIF (Investigations into advanced beam instrumentation for the optimization of particle accelerators) was devoted to advancing the state-of-the-art of beam diagnostics based on light emitted by a beam of charged particles.

'There are many varieties of beam diagnostics, some based on direct detection of charges and currents induced by the beam. DITA-IIF was a research project whose aim was to advance the state-of-the-art of optical or near-optical radiation diagnostics,' explained Professor Carsten Welsch, project coordinator from the University of Liverpool, United Kingdom.

Optical radiation imaging

The DITA-IIF team, led by Dr Ralph Fiorito from the Cockcroft Institute at the University of Liverpool, developed a new algorithm to analyse optical transition radiation produced when a beam intercepts a thin foil. Specifically, the shape of the measured image of optical transition radiation — the so-called point source function — from a single electron is used to calculate beam size. To achieve sub-micron accuracy, artificial artefacts such as aberrations and misalignments are isolated and removed.

'The new method is currently used to improve the resolution of optical systems developed to image micron-sized beams that are produced by the Accelerator Test Facility at the High Energy Accelerator Research Organisation in Tsukuba, Japan,' notes Professor Welsch.

Furthermore, researchers have developed a new beam imaging technique relying on an array of electronically controlled micro-mirrors. This digital light processor offers an optical mask to filter out optical radiation from the core of the beam and add the resultant image to that of the outer halo. As a spatial filter, it mitigates light diffraction around the optics systems used to image the beam.

To evaluate the performance of these beam imaging systems, researchers currently compare lab measurements with simulation results from the Zemax Optical Studio. Professor Welsch adds that 'this comparative study will improve our understanding not only of the beam imaging method but also of any digital light processor used for medical or astronomical imaging as well as remote sensing applications.'

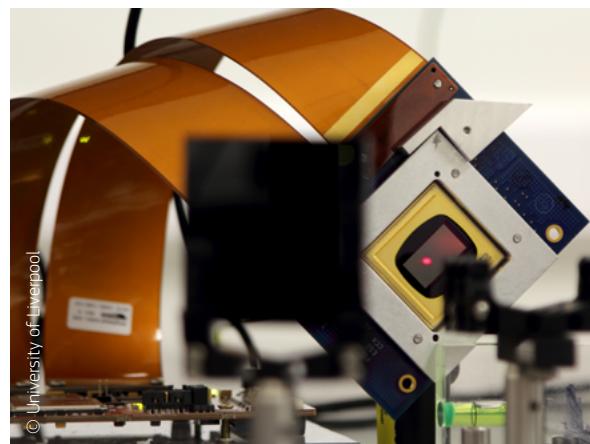
Non-invasive coherent radiation imaging

The DITA-IIF team went a step further by proposing a new beam imaging method based on measurements of coherent radiation produced when a number of electrons pass through an aperture. Both the angular and spatial distribution of the coherent diffraction radiation is captured and analysed to retrieve the beam length.

Importantly, researchers could image the point source function of coherent radiation

diffraction in the terahertz wavelength regime. Using the 20 GeV electron beam generated at the Facility for Advanced Accelerator Experiment Tests (FACET) at Stanford University in the US, they also demonstrated the lack of any contamination from other radiation sources.

Besides addressing challenges in high energy beam imaging, 'the diagnostics developed within DITA-IIF have excellent prospects for applications to a wide variety of accelerators as well as light sources. They provide better resolution in the least invasive way and are a game-changer for fully characterising a charged particle beam,' concludes Professor Welsch.

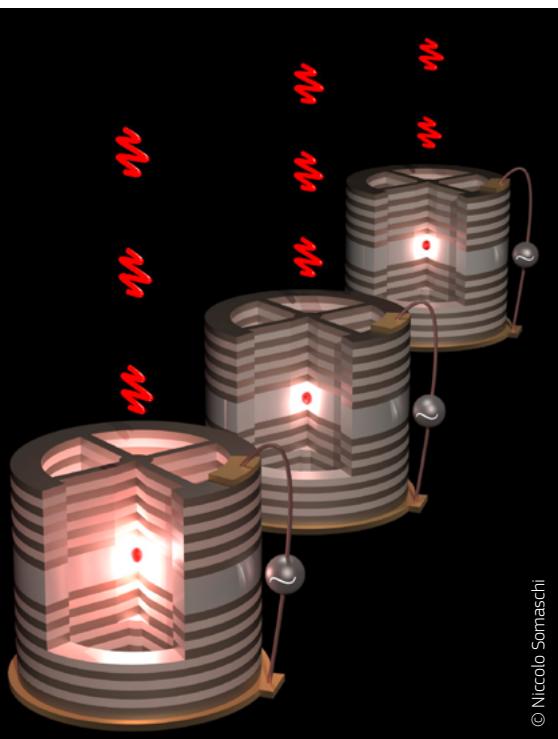


DITA-IIF

- ★ Coordinated by the University of Liverpool in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186113>
- ★ Project website: http://www.liverpool.ac.uk/quasar/research/dita_iif/

A SOLID-STATE PLATFORM FOR QUANTUM TECHNOLOGIES

EU-funded researchers have pioneered the coupling of single artificial atoms to photons within optical microcavities. Systems like quantum dots are essential building blocks for quantum information technologies, and a means to generate pure single photons on demand.



Photons are attractive candidates for both classical and quantum information processing, where they act as carriers of information. Efficient photon generation and routing, however, necessitates the development of optical devices that work at low photon numbers and reach single emitter-single photon levels.

The ideal single-photon source would produce light pulses, each containing no more than one photon. Additionally, all photons would be identical in all their degrees of freedom such as wavelength and polarisation. To develop even near-optimal single-electron sources, researchers had to overcome many scientific and technological difficulties.

In the European Research Council (ERC)-funded project QD-CQED (A quantum dot in a cavity: A solid state platform for quantum operations), they designed the first optoelectronic devices made of quantum dots precisely positioned in electrically controlled microcavities. Obtaining efficient sources producing highly indistinguishable single photons was the result of several years of research.

The challenge of perfection

'Advanced quantum protocols require quantum systems that are isolated from their environment and decoherence phenomena are minimised,' notes Dr Pascale Senellart from Centre national de la recherche scientifique (CNRS), principal investigator of QD-CQED.

Obviously, this was not the case for a solid-state photon emitter, inserted in a vibrating and fluctuating environment. Moreover, to reach the single emitter-single photon level, researchers had to couple a quantum dot to a microcavity and engineer the electromagnetic field around the emitter and force it to emit in a well-defined mode of the optical field.

'During the course of the project, we progressively understood that we could reduce both fluctuating charges and phonons — the effects of vibrations on the electronic excitation of the solid structure. To that end, we confined the optical field both spatially and temporally, while applying the electric field on the emitter,' she says.

Unlike existing techniques that involve covering the cavity with a polymer, the QD-CQED team connected pillar-shaped cavities of a few microns in diameter to bigger frames using 1D wires. The innovative configuration (illustrated in the image) was instrumental in suppressing the effects of the solid-state surrounding of the emitter.

'We could show that our artificial atom, the quantum dots consisting of thousands of atoms when inserted in a solid-state matrix, presents optical properties similar to a single natural atom in a vacuum. Importantly, our solid-state implementation offers the advantages of integration and scalability,' explains Dr Senellart.

Well beyond expectations

The new source technology provides high-quality single photons with brightness exceeding that of existing sources by one order of magnitude. Importantly, it has contributed to

"The new source technology provides high-quality single photons with brightness exceeding that of existing sources by one order of magnitude."

scaling up intermediate quantum computing tasks, such as the so-called boson sampling performed significantly faster than with the usual source technology.

The potential of the QD-CQED technology is reflected in the *Nature Photonics* paper that was among the 0.1 % most cited papers in academic physics for the year 2016. An increasing number of collaborations with researchers from the quantum optics community are being established to utilise the sources.

To date, the sources have been utilised to implement an intermediate optical computing protocol and to demonstrate two-photon gates. The team has also shown that it is possible to effectively control a stationary quantum bit with pulses of light embedding only a few photons.

Dr Senellart-Mardon concludes by saying: 'A spin-off company will be created in 2017 to allow a wider community to benefit from this progress. Two young researchers are behind this initiative; both have been supported in their research endeavours by QD-CQED. The future of optical quantum technologies appears bright!'

QD-CQED

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/100452>

EVENTS

JUNE
07

The Hague, THE NETHERLANDS

CONFERENCE

UDRIVE FINAL CONFERENCE

The EU-funded UDRIVE project will host its final event 'The UDRIVE Experience' in The Hague, the Netherlands on 7 June 2017.

The day's events will include information sharing on what data was collected, along with the main results and a discussion about their implications. The day will also look to the needs of stakeholders to take the work further. Rotating workshops will be conducted during the course of the day tailored to the needs of different types of stakeholders, such as policy makers, industry and researchers.

Additionally a networking event will be held for researchers attending the 6th Naturalistic Driving Research Symposium (NDRS2017) on 8 and 9 June.

The UDRIVE project was the first large-scale European Naturalistic Driving Study on cars, trucks and powered two-wheelers collecting data including video showing the forward view of the vehicle and a view of the driver, as well as 'Geographic information system' (GIS) data.

For further information, please visit:

http://ndrsymposium.com/udrive_experience

JUNE
21▶23

Valletta, MALTA

FORUM

EURONANO FORUM 2017

The EU-funded EuroNano Forum (ENF2017), organised by the upcoming Maltese Presidency of the Council of the European Union, will take place in Valletta, Malta, from 21 to 23 June 2017.

ENF2017 will review the latest developments in nanotechnology and advanced materials and discuss their contribution to European manufacturing across all industries.

The discussion this year will also be extended to framework conditions like education, standards, regulations, IPR and safety issues, as well as entrepreneurship and industrial policy. The programme includes sessions on finance and funding through European and national programmes, in particular Horizon 2020, smart specialisation and public-private partnership initiatives.

The Nanotech Europe 2017 Exhibition runs in parallel with the conference and offers a great opportunity for exhibitors to showcase their activities to leading research institutes, key industrial actors, high-tech SMEs, policy makers, funding organisations and media.

For further information, please visit:

<http://euronanoforum2017.eu/>

JUNE
28▶29

Aachen, GERMANY

CONFERENCE

ADAPTIVE FINAL CONFERENCE

The EU-funded ADAPTIVE project will be hosting its final conference in Aachen, Germany, from 28 to 29 June.

The final ADAPTIVE event will deliver a combination of first-hand experiences in automated driving demonstrations, a dedicated conference, and an exhibition in an environment that invites participants to network with experts and stakeholders from politics, industry and research.

The ADAPTIVE project is developing various automated driving functions for daily traffic by dynamically adapting the level of automation to situation and driver status. As well as these technical innovations, the project has also addressed legal issues that might impact successful market introduction of the technology. The project's solutions to these technical and regulatory challenges will be showcased at this final conference.

For further information, please visit:
<https://adaptive-ip.eu/index.php/events.html>

EVENTS

For more forthcoming events:
<http://cordis.europa.eu/events>

JUNE
28▶30

Middlesbrough, UK

CONFERENCE

SP2017 CONFERENCE

The EU-funded RESILIENT and PERFORMER projects are sponsoring the fifth Sustainable Places International Conference (SP2017) that will take place in Middlesbrough, UK, from 28 to 30 June 2017.

For the 5th iteration, the SP2017 call for proposals is looking for the most innovative, impactful, and market-feasible submissions within the solution framework of emerging smart buildings and cities. SP2017 brings together researchers and developers from industry and the academic world to report and more importantly debate on the latest scientific and technical innovations and applications in Energy-efficient Buildings (EeB) and smart home, community or grid implementations.

Hosted by the University of Teesside, UK, the conference will also include a site visit to the university's new offshore wind farm.

For further information, please visit:
<http://www.sustainableplaces.eu/>

→ Book your space in the next magazine!

As an FP7 project partner or coordinator you can request the writing of an article dedicated to your project, free of charge, simply by contacting our editorial team at editorial@cordis.europa.eu.

Should your project meet the criteria to be featured in one of the magazine's sections, our editors will contact you to get some background information and conduct an interview. The article will then be planned for release in the next magazine, enabling your project results to reach our large audience of over 25 000 subscribers in science and industry across Europe.

This service is offered to all completed or close-to completed EU-funded projects. Priority will be given to those projects which have resulted in the development of a new technology with potential for commercialisation over the next few years, or in potentially game-changing research for a specific field of science. If you feel like your project is a match, please feel free to book your space now!



Free subscriptions, orders and downloads



The research*eu Magazines are free of charge.

To subscribe, please go to: <http://cordis.europa.eu/research-eu>

To order a single issue of a research*eu Results Magazine, please go to:

http://bookshop.europa.eu/research_eu



Publications Office

Find out more about our online services at
publications.europa.eu



Follow us on Facebook and Twitter:
facebook.com/EULawandPublications
twitter.com/CORDIS_EU

EN