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## 04 A WORD FROM THE RECTOR

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PAULO JORGE FERREIRA  
University of Aveiro

# **A WORD FROM THE RECTOR**





Climate change, ocean degradation, loss of biodiversity, the problems posed by the food, energy, and transportation needs of nearly eight billion people, the management of large cities, social inequalities, health, and pandemics are among the great challenges of our time.

These problems are global, political and scientific. To overcome them, it is not enough to act in a single part of the planet, at a local or national level; it is necessary to act in an cooperative manner on all continents. To understand them, it is not enough to resort to one field of knowledge; it is necessary to combine several disciplines.

These difficulties and the urgency with which action is needed make the broad, open, and transparent sharing of scientific results a necessity. Everyone wins: the scientific community, the decision-makers, and the citizens.

Investing in open science is investing in our future.

ARTUR SILVA  
University of Aveiro

# **MESSAGE FROM THE VICE-RECTOR**



Institutions are living challenging times, but also times full of opportunities. Recently, the COVID-19 pandemic underlined the need for science policies to stop delaying the sharing of scientific information. Open Science, as a broad term, unveils how science shall become more open, accessible, efficient, democratic and transparent. This principle of openness and transparency in the whole research cycle will foster this Open Science revolution, promoting, as well, an increase in public trust and interest in science and the public's participation in research activities.

Open Science represents both challenges and opportunities driven by new, digital tools for scientific collaboration, experiments and analysis and which make scientific knowledge more easily accessible by professionals and the general public, anywhere, at any time. While great steps in Open Science have been and are presently being given to enable increased access to vital information, it is necessary to provide a policy, infrastructure and research output publishing system that is prepared for the current and future crises we have yet to face, both as individuals and as institutions.

In many countries, impactful changes are happening and we need to exchange more in order to understand these good practices better and propose new actions at an institutional, national and international scales. It is a priority area for European research, science and innovation policy. The definition of 8 pillars, namely (1) the future of scholarly publishing, (2), the FAIR data, (3) the European Open Science Cloud, (4) education and skills, (5) rewards and incentives, (6) next-generation metrics, (7) research integrity and (8) citizen science, illustrate the broad scope of Open Science, as foreseen by the European Commission, and it is clear that multiple groups within the university need to contribute towards its implementation.

To support this movement, the European Commission has supported a number of collaborative efforts at the regional level to increase up-take for the European Open Science Cloud (EOSC) and also made available the Open Research Europe (ORE), an open access publishing platform for the publication of research stemming from Horizon 2020 and Horizon Europe funding across all subject areas, making it easy for beneficiaries to comply with the open access terms of their funding and offer researchers a publishing site to share their results and insights rapidly and facilitate open, constructive research discussion.

At national level, a National Policy for Open Science is underway. The work was initiated by the Government and Ministry for Science, Technology and Higher Education and the following pillars were set for the policy for Open Science in Portugal: (1) transparency in practices, methodology, observation and data collection, (2) public availability and re-use of scientific data, (3) public access and transparency in scientific communication, (4) use of web-based tools to facilitate scientific collaboration.

Despite the wish to converge with international best practices, in particular with the initiatives of this domain established within the

European Union, the National Foundation for Science and Technology has a policy on management and sharing of data and other results arising from FCT-funded research, which, in practice is a general call for researchers to share their data, and not a mandatory policy at the moment. It is described in two terms: one of them focuses on publications, when institutional repositories have already been implemented in most higher education institutions; the other is devoted to data and other results of projects financed by FCT.

Knowledge should be shared at all stages of the R&D&I lifecycle and across the different disciplines, which makes it of particular importance to integrate open science practices as an elementary component from the beginning of each project. Infrastructures must be, however, provided. The Portuguese Open Access Scientific Repository (RCAAP) was created in 2008, preceded by the recommendation of the Council of Rectors of Portuguese Universities (2006) for the establishment of institutional repositories and their aggregation in a single portal.

The Institutional Repository of the University of Aveiro (RIA) is an information system that stores, preserves, disseminates and gives access to the intellectual production of the University of Aveiro in digital format, through the Web, under an open access regime. By bringing together the Institute's scientific publications on a single platform, RIA intends to share the scientific and technical knowledge produced at the University and to facilitate this access to the scientific production, contributing to the generation of new knowledge, allowing rapid dissemination and visibility and impact.

A recent effort by the University of Aveiro, through the Library, Document Management and Museology Services and the Information Technology and Communication Services, in collaboration with the Research Support Office, was the creation of the University of Aveiro Research Data Repository – DunAs, based on Dataverse, an open source platform. The project aims to implement an open repository for the archive and publication of research data, promoting its visibility, impact and reproducibility.

For research performing organisations, as universities, and other stakeholders to embrace Open Science principles, policies and practices, there needs to be a culture change in these organisations. It refers, similarly, to ongoing changes in the way research is conducted: for scientists themselves, through increasing the use of open access scientific publishing and open data, and for the public, through increasing their understanding of and participation in science.

Successful engagement with Open Science requires, therefore, this holistic vision by the institution, working together to deliver a set of goals in a complex and evolving mix of themes and priorities, to which all members can commit. Academic, administrative, legal and cultural issues need to be considered. Such changes are expected to enable greater transparency, collaboration and research integrity in the short term and improve scientific quality in the long term.





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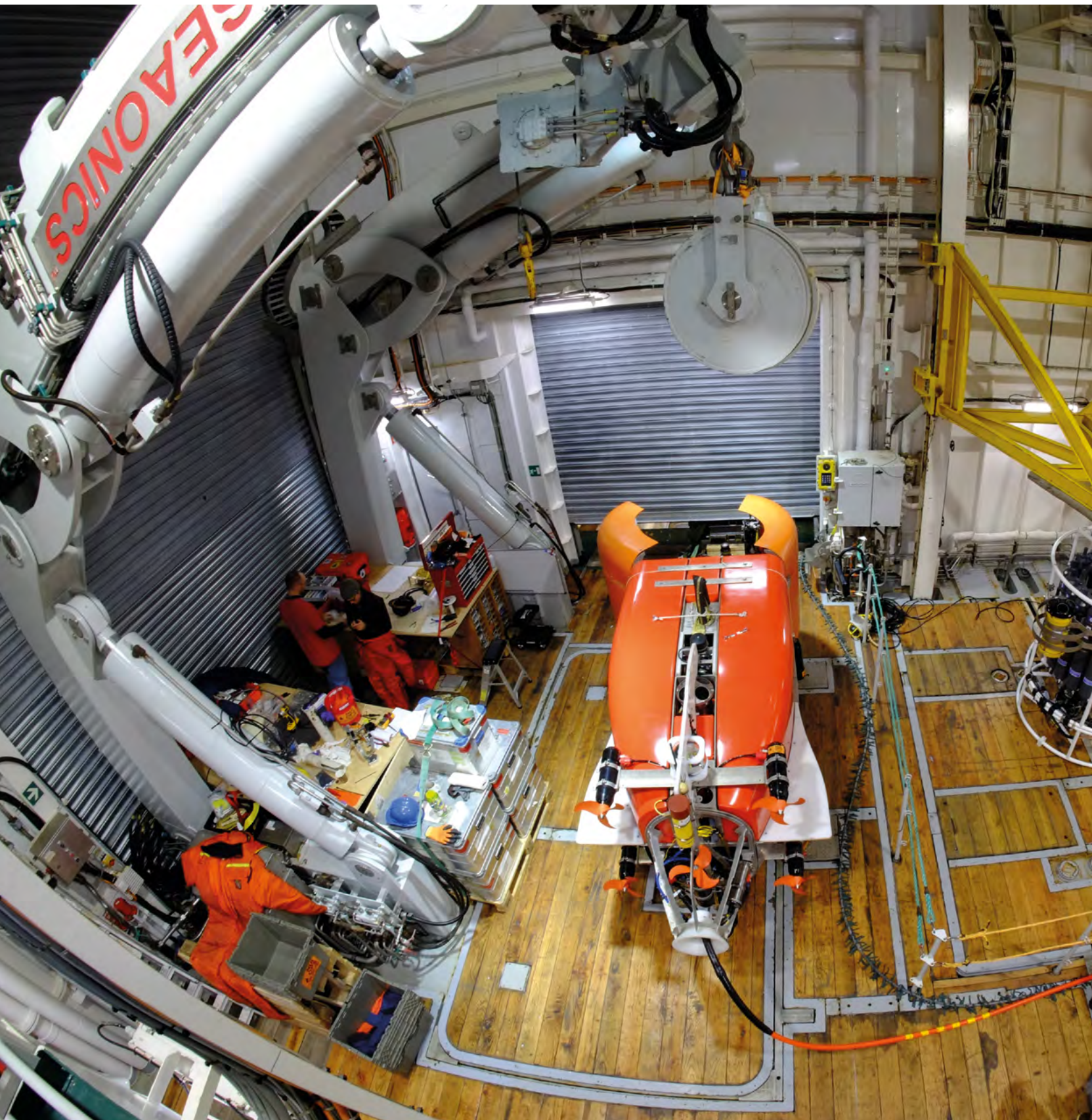


A man in a white space suit is floating in a dark, starry space. He is wearing a helmet with a clear visor and has his mouth open in a wide, joyful smile, showing his teeth. His hands are visible, and he appears to be reaching out. The background is a deep black with scattered white stars and a few faint, glowing nebulae. The overall mood is one of wonder and exploration.

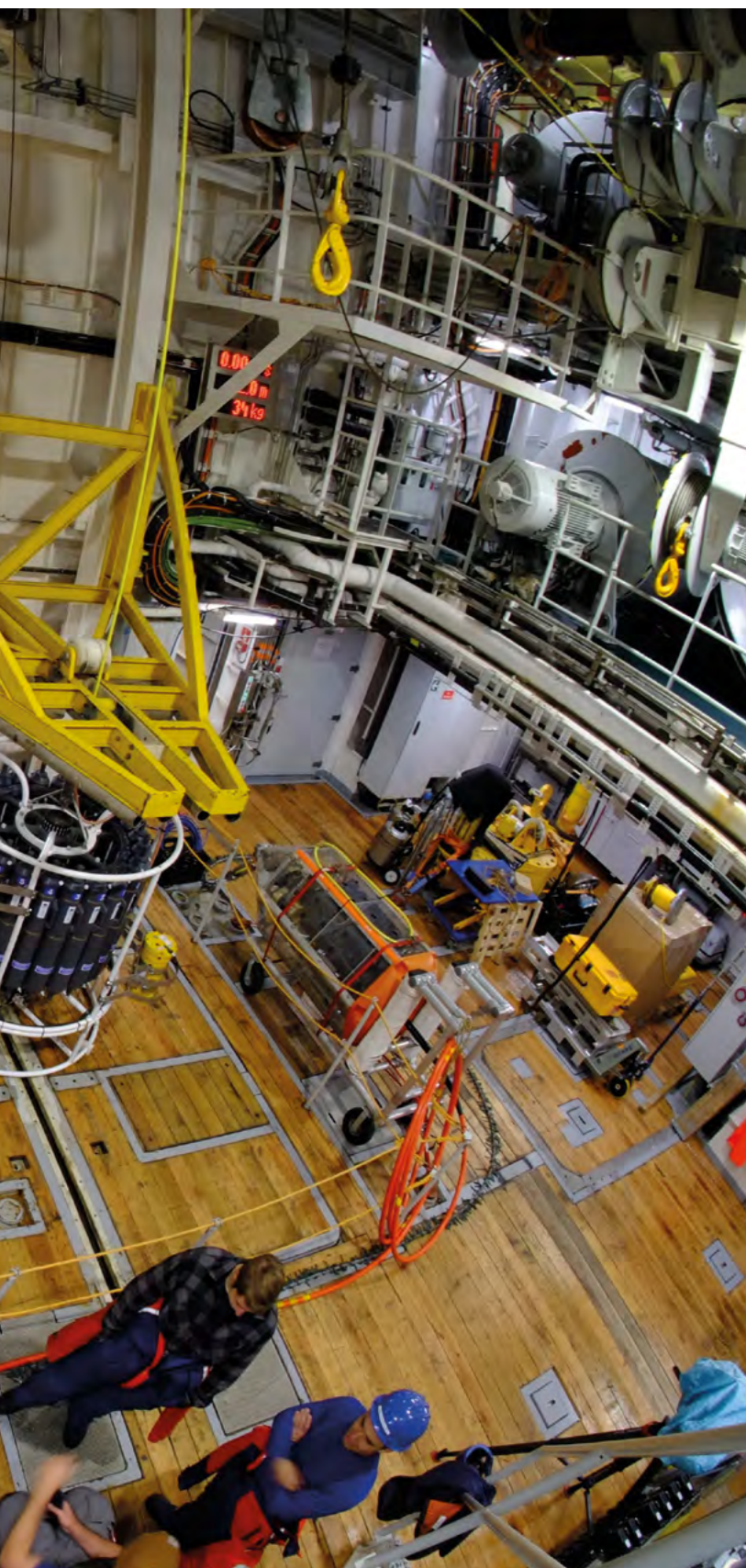
# **RESEARCH UNIVERSE**



# Interdisciplinary research centres and facilities







The research matrix of the University of Aveiro (UA) is the basis of an interdisciplinary and transdisciplinary research, based on the sharing of experiences, the exchange of information, the improvement of practices and the promotion of joint projects among researchers from the different scientific areas at the campi. This integrated structure permits the articulation and harmonization of the teaching and research environments, as well as the association with innovative science outreach activities.

Furthermore, the continuous capacity-building effort in terms of infrastructure (buildings and scientific equipment) and lines of research, including human resources and people, has been essential to improve its competitiveness and thus ensure a better future and a greater and more effective contribution to regional development.

The University of Aveiro hosts 20 research units, all classified as very good or excellent in the last evaluation process promoted by the National Foundation for Science and Technology. Eight of these research units were labelled or integrate Associated Laboratories.



# Research centres







### **CESAM**

#### **Centre for Environmental and Marine Studies**

*CESAM's interdisciplinary expertise on environmental and marine sciences enables an active contribution to science-based knowledge supporting socio-ecological systems sustainable management and smart specialization.*

**Unit coordinator: Amadeu Soares**



Research areas: Soils, Agriculture and Forest Resources, Freshwater and Marine Ecosystems and Resources, Integrated Environmental Systems and Climate, Environment and Health and Environmental Economy.

[www.cesam-la.pt/](http://www.cesam-la.pt/)

### **CLLC**

#### **Centre for Languages, Literatures and Cultures**

*The Centre for Languages, Literatures and Cultures, based in the Department of Languages and Cultures, is an intercultural research unit in the Humanities, with an inter and transdisciplinary orientation.*

**Unit coordinator: Anthony David Barker**



Research areas: Between Texts - Literary Hermeneutics; Between Cultures - Cultural Hermeneutics; Between Languages - Variation, Translation, Learning.

[www.ua.pt/cllc](http://www.ua.pt/cllc)



## CICECO

### Aveiro Institute of Materials

*Its mission is to create and disseminate scientific and technological knowledge to develop, process and apply materials that will anticipate and address the challenges of a global society.*

**Unit coordinator:** João Rocha



Research areas: Inorganic Functional Nanomaterials and Organic-Inorganic Hybrids; Multifunctional Ferroic Ceramics and Nanostructures; Carbon Materials, Composites and Functional Coatings; Biorefineries, Biobased Materials and Recycling; Biomedical and Biomimetic Materials; and Computer Simulation and Multiscale Modeling.

[www.ciceco.ua.pt](http://www.ciceco.ua.pt)

## CINTESIS

### Center for Health Technology and Services Research

*Integrated in the Associated Laboratory RISE - Rede de Investigação em Saúde, CINTESIS is a multidisciplinary research unit that includes researchers from the Department of Education and Psychology and from the Health School.*

**Pole coordinator:** Óscar Ribeiro



Research areas: social and behavioral gerontology, clinical gerontology and geriatrics, mental health, chronic disease management, and health care.

[www.cintesis.eu](http://www.cintesis.eu)

## CIDMA

### Center for Research and Development in Mathematics and Applications

*CIDMA is a R&D unit hosted at DMat-UA with the main goal of carrying out fundamental and applied research in Mathematics and to prepare new researchers through postgraduate and advanced education.*

**Unit coordinator:** Delfim Torres



Research areas: Algebra and Geometry, Complex and Hypercomplex Analysis, Functional Analysis and Applications, Gravitational Geometry and Dynamics, History of Mathematics and Mathematical Education, Optimization, Graph Theory and Combinatorics, Probability and Statistics, and Systems and Control.

[www.cidma.ua.pt](http://www.cidma.ua.pt)

## CIPES

### Center for Research in Higher Education Policies

*CIPES's mission is to engage in scholarly research in order to advance critical thought and promote informed understanding about the vital policy issues confronting higher education at both the national and international arenas.*

**Pole coordinator:** Teresa Carvalho



Research areas: The growth of the Centre and its activities has led to the identification of three main Research Groups: system level policies, institutional and organisational analysis, and relationship between higher education and the environment.

[www.ua.pt/cipes](http://www.ua.pt/cipes)

## CIDTFF

### Research Centre on Didactics and Technology in the Education of Trainers

*Founded in 1994, CIDTFF has a mission anchored in the responsibility of research in education: to produce knowledge able to contribute to educated, qualified and critical citizens.*

**Unit coordinator:** Maria Helena Araújo e Sá



Research areas: Education; Multiliteracies and Sustainability; Diversities and Curriculum; Professional and Human Development; Educational Policies, Quality and Evaluation; Multimodal Educational Resources; Professional and Organizational Practices.

[www.ua.pt/cidtff](http://www.ua.pt/cidtff)

## DigiMedia

### Digital Media and Interaction

*Interdisciplinary research centre focused on media innovation and interaction design, working in three lines: Digital Studies, Digital Experience and Digital Contents.*

**Unit coordinator:** Nelson Zagalo



Research areas: Media Technology, Media Arts and Communication.

[www.digimedia.web.ua.pt](http://www.digimedia.web.ua.pt)

## **GEOBIOTEC**

### **GeoBioSciences, GeoTechnologies and GeoEngineering**

*Focusing on Geo-Resources/Geo-Environment, Geobiotec works with the most important national mining projects, with skills and resources on industrial minerals, geostatistics, geochemistry, geophysics, mineralogy, medical geology and geomaterials.*

**Unit coordinator: Fernando Rocha**



Research areas: Lithospheric Evolution, Complex Environmental Systems, Georesources, Geotechnics and Geomaterials.

[www.ua.pt/pt/geo/page/17534](http://www.ua.pt/pt/geo/page/17534)

## **GOVCOPP**

### **Governance, Competitiveness and Public Policies**

*GOVCOPP's mission is to produce research and knowledge that contribute to economic efficiency and good governance practices in specific territorial contexts, with a particular focus on the Centro region.*

**Unit coordinator: Varqá Carlos Jalali**



Research areas: Competitiveness, Innovation, Sustainability, Public Policy, Institutions, Decision Support Systems, Territory, Development and Tourism

[www.ua.pt/govcopp](http://www.ua.pt/govcopp)

## **iBiMED**

### **Institute of Biomedicine**

*iBiMED's mission is to improve life quality and reduce health care costs through advanced biomedical and clinical research focused on personalized medicine and biomarkers of healthy aging.*

**Unit coordinator: Manuel Santos**



Research areas: Human ageing, protein aggregation, epigenome, ageing related diseases, systems biomedicine, clinical studies.

[www.ua.pt/ibimed](http://www.ua.pt/ibimed)

## **Research Institute for Design, Media and Culture [ID+]**

*ID+ is a multidisciplinary R&D Consortium that aims to develop, legitimise and communicate design and artistic research and practices in academic, social, cultural and economic contexts.*

**Pole coordinator: Vasco Branco**



Research areas: Design, Art, Media and Culture

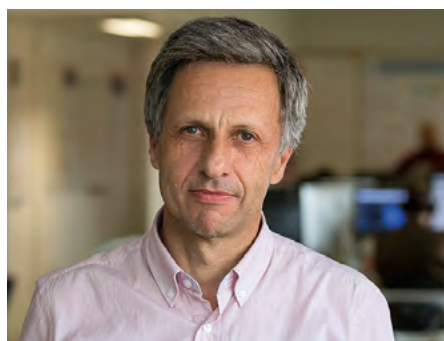
[www.idmais.org](http://www.idmais.org)

## **IEETA**

### **Institute of Electronics and Informatics Engineering of Aveiro**

*IEETA is mainly a Computer Science and Engineering RU, with a strong multidisciplinary character, organized in three groups: Biomedical Informatics and Technologies; Intelligent Robotics and Systems; Information Systems and Processing.*

**Unit coordinator: Armando Pinho**



Research area: Information Processing, Information Systems, Biomedical Informatics, Biomedical Technologies, Intelligent Robotics, Intelligent Systems.

[www.ieeta.pt](http://www.ieeta.pt)

## **i3N – Institute for Nanostructures, Nanomodelling and Nanofabrication**

*i3N/ Aveiro focus on micro and nanofabrication, green and clean energy, nanomaterials and functional interfaces, biomedical devices and systems and theoretical and computational studies.*

**Pole coordinator: Florinda Costa**



Research areas: Modelling of materials behaviour, Nanofabrication and micro-technologies and exploit of their multi-functionalities, Physical characterization of self-assembled nanostructures, Development of (opto)electronics and photonics devices and systems.

[www.i3n.org](http://www.i3n.org)



## IT

### Instituto de Telecomunicações

*Instituto de Telecomunicações (IT) is a research unit that is in the front line fostering (nurturing) new ideas and emerging technologies for increasingly agile and easy ways to access ubiquitous information.*

**Pole coordinator:** José Carlos Pedro



Research areas: Wireless Technologies; Optics and Photonics; Networks and Services; Information and Data Sciences; and Basic Sciences and Enabling Technologies.  
[www.it.pt](http://www.it.pt)

## LAQV-REQUIMTE

### Associated Laboratory for Green Chemistry

*Laboratory for a world in which Sustainable Chemistry is used as a powerful and dynamic tool to tackle the societal, economic, and environmental challenges of modern life, contributing to a World Sustainable Development.*

**Pole coordinator:** Francisco Amado



Research areas: Organic Chemistry, Natural Products, Food Science /Biochemistry and Mass Spectrometry.  
[www.laqv.requimte.pt](http://www.laqv.requimte.pt)

## RISCO

### Risks and Sustainability in Construction

*RISCO aims to promote the development of sustainable and resilient cities through safe, environmentally friendly, efficient and sustainable construction solutions and built heritage conservation.*

**Unit coordinator:** Romeu Vicente



Research areas: Assessment and mitigation of risks in the built environment, Sustainable and resilient solutions for the built environment, Built heritage safeguarding, conservation, renovation and retrofit.  
[www.ua.pt/en/risco](http://www.ua.pt/en/risco)

## TEMA

### Centre for Mechanical Technology and Automation

*TEMA follows the natural evolution of the mechanical engineering for the future, developing research on two mobilizing domains: sustainable manufacturing solutions and technologies for the wellbeing.*

**Unit coordinator:** António Bastos



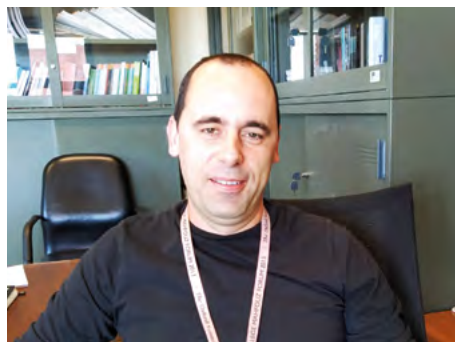
Research areas: Advanced Mechanical Engineering and Fracture Mechanics, Applied Energy, Biomechanics, Nanoengineering, Transportation Technology and Simulation Software Research and Development.  
[www.ua.pt/tema](http://www.ua.pt/tema)

## WJRC

### William James Research Centre

*The core mission of the WJCR is to advance research and training in psychology with a broad interdisciplinary approach, including neurosciences, social and cognitive psychology, psychobiology, psychometrics, and statistical modeling.*

**Pole coordinator:** Marco Vasconcelos



Research areas: Cognition, Social Cognition and body odors, Health, Social development  
[www.williamjamescr.org](http://www.williamjamescr.org)

## INET-md

### Institute of Ethnomusicology – Research Centre on Music and Dance

*INET-md carries out transdisciplinary research on music and dance, using current perspectives from a broadening spectrum of musical, sound, and dance disciplinary fields, as tools both for fundamental research and for developing actions of social responsibility.*

**Pole coordinator:** Susana Sardo



Research groups: Ethnomusicology and Popular Music Studies; Historical and Cultural Studies in Music; Dance Studies; Creation, Performance and Artistic Research; Education and Music in Community; Musical Acoustics and Sound Studies.  
[www.inetmd.pt](http://www.inetmd.pt)







# Strategic projects started in 2021



## ELECTROCOFS

### Molecular Design of Electrically Conductive Covalent Organic Frameworks as Efficient Electrodes for Lithium-Ion Batteries

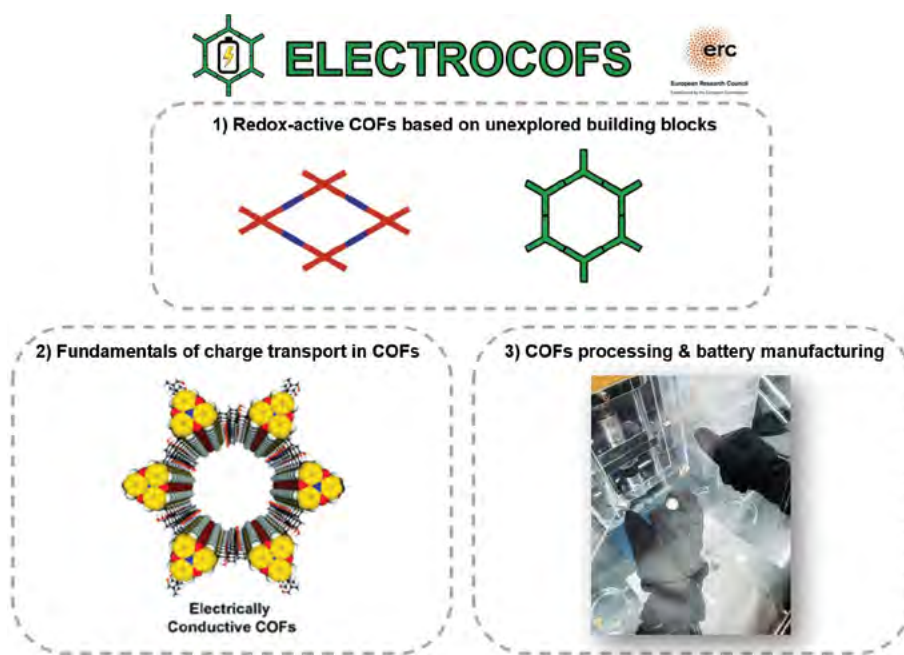
The European Research Council (ERC) has awarded Manuel Souto, researcher at CICECO-Aveiro Institute of Materials and Assistant Professor at the Department of Chemistry of the University of Aveiro, a highly prestigious Starting Grant (ERC-StG) worth 1.5 million euros. The ERC project ELECTROCOFS aims at exploring a new generation of porous organic polymers, known as Covalent Organic Frameworks (COFs), to be used as electrodes in lithium batteries.

Organic materials have received much attention as alternative electrodes because of their high theoretical capacity, resources availability and sustainability. In particular, organic porous materials such as COFs have emerged in the past few years as promising organic electrode materials due to their high stability, high ionic conductivity and outstanding chemical and structural versatility. In addition, their properties can be predicted by computational modelling allowing chemical design through theoretical calculations.

One of the advantages of these materials is their great versatility, because their physical properties can be modulated *à la carte* by chemical design. The choice of the organic building blocks (considered as Lego pieces) and the way in which they are joined together are decisive in the final properties of the resulting materials. This will be one of the major challenges to achieve an optimal balance between some key electrode parameters, such as capacity and stability.

Another major project challenge is to increase COFs electrical conductivity, as this is the main bottleneck for certain applications. An important goal of the project is to further understand at the fundamental level the charge transport in these materials, so the project will also have a major impact on other fields, such as optoelectronics, and on the development of other energy storage devices, besides lithium batteries.

Another important objective is to optimize COFs processing, in order to increase the performance of the batteries. Thus, the ultimate goal of ELECTROCOFS project will be to manufacture and test lithium batteries using conductive COFs electrode materials, assessing the influence of the processing techniques on the electrochemical performance.



This project has received funding from the European Union Horizon 2021 – ERC, under grant agreement ID: 101039748.

More information  
[www.electromolmat.com/projects/electrocofs](http://www.electromolmat.com/projects/electrocofs)







A research ship is visible on the left side of the frame, partially obscured by the edge. The sea is covered with numerous ice floes of various sizes. The sky is a mix of orange, yellow, and blue, indicating a sunset or sunrise. The water reflects the colors of the sky. The overall scene is serene and cold.

# **SPOTLIGHT ON RESEARCH DISSEMINATION**



# Research Summit 2021







Under the theme “Art, Science and Innovation in times of trouble”, the 4<sup>th</sup> edition of the Research Summit brought the UA's research community together! The event was attended by over 800 participants during 3 days, including an on-site session with the presence of invited speakers and all UA's Research Units and 2 more days with online presentations from students.

The Rector, Paulo Jorge Ferreira, and the Vice-rector for Research, Innovation and 3<sup>rd</sup> Cycle, Artur Silva, opened the summit on Wednesday, emphasizing the Research Summit's aim to increase collaboration, moving the state-of-art further and boosting on-campus research. The opening session was followed by the intervention of Catarina Resende de Oliveira, President of AICIB – Agência de Investigação Clínica e Inovação Biomédica, presenting her vision on current health challenges, particularly in the context of clinical academic centers. The morning session continued with the first presentations by the Research Units, aiming at fostering the inter-and transdisciplinary work among UA researchers, after which naturally contacts among researchers with mutual interests established. The program included a roundtable, moderated by the Vice-Rector Artur Silva, discussing the research challenges in post-pandemic times, gathering contributions from researchers Carlos Jalali, João Rocha, Manuel Santos, Sandra Soares, Susana Sardo and Susana Sargento. The afternoon session started with the intervention of Stephon Alexander, from Brown University, USA, entitled “The Jazz of Physics: The Link Between Music and The Structure of the Universe”, supported by the American Corner (SBIDM-UA). In this talk, Alexander revisited the interconnection between music and the evolution of astrophysics and the laws of motion. He explored new ways music, in particular jazz music, mirrors modern physics, such as quantum mechanics, general relativity, and the physics of the early universe. Finally, he discussed ways that innovations in physics have been and can be inspired from “improvisational logic” exemplified in Jazz performance and practice. The lecture was followed by more presentations of UA's Research Units, completing the interventions on themes such as environment, epidemics control, public health, technology and music, among others. For the closing session of day 1, the Portuguese Minister of Health, Marta Temido, addressed the participants with a message of acknowledgment regarding UA's research contribution towards the pandemic challenges. Day 2 and 3 were highly attended, with over 800 intervenients, along the 7 simultaneous rooms each day, with 50 doctoral programs, more than 700 PhD students and 75 professors involved in the jury, as all pitches were evaluated by a jury.

For a 2<sup>nd</sup> edition, the program PIIC-UA (Scientific Research Incentive Program) was part of the presentation sessions. Around 50 students pitched the activities developed under this initiative to promote their enrolment in science during the 1<sup>st</sup> and 2<sup>nd</sup> cycle of training.

# Academia de Verão





## SUMMER ACADEMY

The Summer Academy is an initiative of the University of Aveiro (UA) that every year provides a first contact with academic life and a diverse set of scientific, sports and leisure activities, especially for students from the 5<sup>th</sup> to 12<sup>th</sup> grades. In 2021, the event held its 15<sup>th</sup> edition, with activities adapted to the country's pandemic situation, and counted on the participation of 125 students from 10<sup>th</sup> to 12<sup>th</sup> grades.

The scientific activities are organized by both the organic and research units of UA – in a total of 16 departments, 4 polytechnic schools and 20 research units, each proposing activity programs for each Summer Academy edition.

UA's organizational culture has always been committed to the promotion of the public acknowledgment of science, the concern in communicating the scientific advances at UA and the development of “science for all” initiatives. Since its foundation, UA promoted an Open Day, later transforming it into an Open Week, and recently creating the Summer Academy, which is dedicated to strengthening the ties between society and the scientific world and promoting the scientific areas and the different offer of study cycles. The creation of a dedicated communication structure for UA, in the mid-1990s, and the Fábrica – Live Science Centre, in 2004, were very innovative and pioneer initiatives in the context of Portuguese universities. Nowadays, these structures develop permanent activities and are devoted to the global university community.

UA's concerns about science outreach and public engagement with scientific and technological issues is also seen as an opportunity of improvement of the citizenship and welfare of our society. This is an all-year round premise that is also laid in the Summer Academy objectives.

Children and young students are welcome and challenged to join scientific and cultural activities proposed by the UA, especially during the summer period, and also other initiatives during the academic year.









# **RESEARCH HIGHLIGHTS**



# EcoHealth – a dialogue between ecology and infectious diseases

Rita T. Torres<sup>1</sup>, João Carvalho<sup>1</sup>, Ana M. Figueiredo<sup>1</sup>, Josman D. Palmeira<sup>1</sup>

<sup>1</sup> – Department of Biology & CESAM, University of Aveiro

## FIGURE 1

Wild ungulates are reservoirs of zoonotic diseases and can be used as strategic sentinel species in terrestrial environments, providing early warning of potential risks to human, animal and environmental health.

The ongoing COVID-19 pandemic is a stark reminder of the role that wildlife reservoirs may play in global public health. As human populations grow, expand, and transform landscapes, contact with wildlife increases and disease emergence has been an important consequence of this acceleration in interaction. Nearly 70% of all emerging infectious diseases in humans currently arise from wildlife reservoirs, yet most research on infectious diseases has been focused on the clinical setting. A 'Eco-Health' approach is urgently required to interpret the complex ecological mechanisms underlying disease ecology. We have been using wild ungulates as sentinels and bioindicators of some infectious diseases as these animals: i) are ubiquitous, ii) have been increasing in number and geographical range, iii) have considerably large home ranges, iv) are widely hunted, being the source of food-borne diseases, and v) overlap their habitat and distribution with livestock and humans, serving as a link between human-influenced

settings and natural areas. We have implemented a national epidemiological surveillance network directed to wild ungulates to identify populations at risk, high risk areas, and to design a proactive management agenda. Additionally, the ecological analysis will allow the detection of geographical clusters of diseases outbreaks. Our results have revealed that wild ungulates are reservoirs of important diseases (e.g. bacteria and genes resistant to antibiotics, Hepatitis E virus, Porcine circovirus, *Blastocystis* sp.) and potential vehicles of food-borne diseases. Further steps will allow the evaluation of anthropogenic activities on the occurrence of infectious diseases in wild ungulates and determine how landscape features influence the dissemination of diseases by these species. This will contribute to unravel our understanding of the potential role that natural ecosystems play in the emergence, maintenance and dispersal of infectious diseases by wild animals.





# Nearshore bathymetry estimation by indirect methods

Diogo Santos<sup>1</sup>, Tiago Abreu<sup>2,3</sup>, Paulo A. Silva<sup>2,4</sup>, Fábio Santos<sup>1,2</sup>, Luísa Júlio<sup>5</sup>, Telmo Silva<sup>5</sup>, Cristina Bernardes<sup>1,2</sup>, Paulo Baptista<sup>1,2</sup>

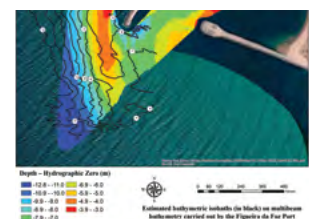
The monitoring of physical processes and the generation of databases with high spatial and temporal resolution is essential to know the evolutionary dynamics of coastal systems and define future evolution tendencies. The topo-bathymetric monitoring by in-situ methods, although highly accurate, due to operational limitations, does not always allow to capture the real-time response of the system to extreme (storm) events. Due to this fact, under such conditions, port authorities face management issues related with water security levels for commercial traffic in the port entrance, which are potentially exposed to intense sedimentary transport.

NAVSAFETY is a research project funded by Direção Geral de Política do Mar (Fundo Azul) aiming to develop innovative solutions using remote sensing technologies to provide near real-time bathymetric information at port mouths and adjacent geographic domains (depths less than 15 m).

The use of inverse methods, based on signal decomposition techniques - wavelets, is being successfully applied to investigate the dynamic of submerged bars using wave data from various image sources. The developed algorithms, have been especially efficient in retrieving the bathymetry during more energetic wave events. The results are promising, in particular, the ones achieved from multi-images data sources (video cameras). Validation tests have revealed accuracy levels of some decimetre, when compared with in-situ bathymetric survey. This enables to generate bathymetric estimation services which are been implemented through dedicated mobile applications. Thus, the NAVSAFETY web app emerged as a solution that will be very useful for different user profiles. The application presents information on the state of the sea and weather, specific information, such as the bathymetric estimate, and scientific research-related information, such as the evolution of depth values at the harbor mouths.



- 1 – Department of Geosciences, University of Aveiro
- 2 - Department of Civil Engineering & CESAM, University of Aveiro
- 3 - Department of Civil Engineering, School of Engineering - Polytechnic Institute of Porto
- 4 - Department of Physics & CESAM, University of Aveiro
- 5 - Department of Communication and Art & Digimedia, University of Aveiro



# Challenges for a more sustainable agriculture: predicting the fate of nano-enabled nutrients and fungicides in the plant-soil continuums

Sónia M. Rodrigues<sup>1</sup>, Matheus Miranda<sup>2</sup>, Sandra Rodrigues<sup>1</sup>, Diana Dias<sup>1</sup>, Bruno Morais<sup>2,3</sup>, Mariana B. Oliveira<sup>3</sup>, João Mano<sup>3</sup>, Astrid Avellan<sup>4</sup>

1 – Department of Environment and Planning & CESAM, University of Aveiro

2 - Department of Chemistry & CESAM, University of Aveiro

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## FIGURE 1

Transmission electron microscopy image of ZnO NPs coated with basil seed mucilage.  
(Author: Matheus Miranda).

## FIGURE 2

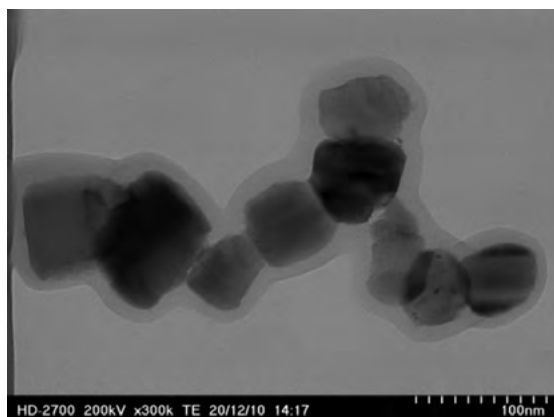
Application new developed materials to plant leaves.

Emerging trends in nano-enabled agriculture propose solutions for targeted and smart delivery of nutrients and pesticides, and for improving plant response to biotic and abiotic stresses, while reducing nutrient and pesticides losses to air, soil and water, and reducing deterioration on soil fertility and health. However, the fate, efficacy, and nano-specific effects of nanoparticles upon application to plants via soil or leaves are currently still largely unknown. Research developed by CESAM RG BPP members focus on nano-bio interactions towards a deeper understanding of observed bioactivities of inorganic nanoparticles and for the characterization of nanospecific bioavailability effects on plants (1–5). We have already reported that nanoparticles applied to the leaves can deliver macro and micro elements to plant roots and rhizosphere soil to enhance plant vigor and health and that the mobility of NPs in planta is mainly controlled by NPs size and surface charge(5, 6). We developed and validated tools to assess how biogeochemical conditions influence nanoparticles reaction in rhizosphere soils(3, 4). We discussed how localized biogeochemical conditions at the rhizosphere drive short-term kinetic reactions and increase the

phytoavailability of metal ions dissolved from inorganic NPs. We also demonstrated that the immobilization of ZnO NPs onto natural polymers is a way to produce materials that release Zn in a controlled manner in the rhizosphere, and that such materials can supply enough Zn for a plant to grow well while reducing Zn losses (4). Mechanisms of cuticle uptake or mucilage-mediated root uptake and translocation to different plant parts are currently being studied by members of BPP CESAM in collaboration with CICECO and by colleagues at GET-Toulouse. Results of these investigations will allow to propose a rationale for the synthesis of nano-enabled structures that can lead to desired fate at the plant interfaces and to assess the real efficacy of nano-enabled nutrients and fungicides.

## Funding:

This work was supported by the project AgriTarget (POCI-01-0145-FEDER-029258 and PTDC/BAA-AGR/ 29258/2017) funded by FEDER, through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds (Portuguese OE), through FCT/MCTES.





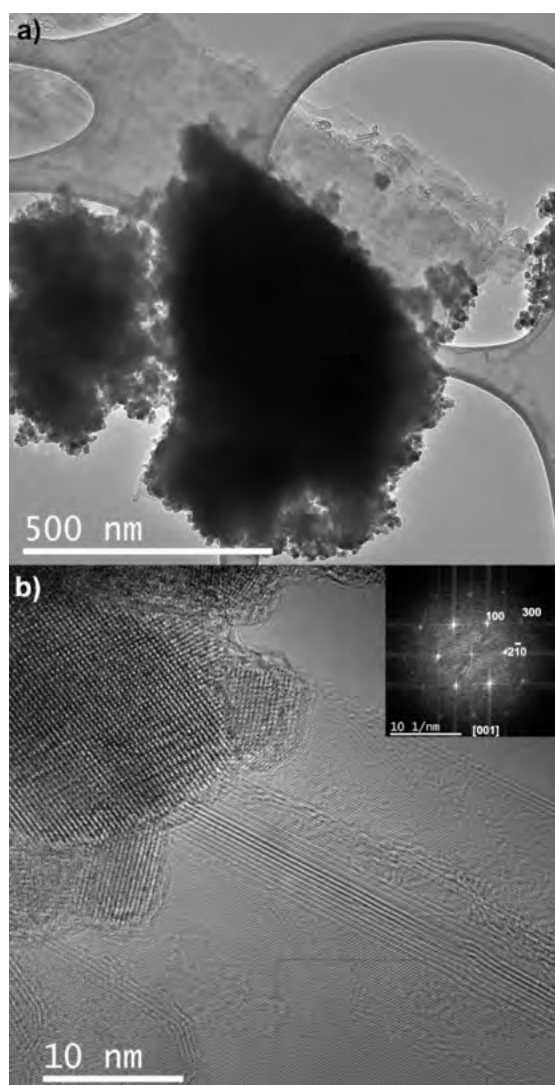
# Graphene-TiO<sub>2</sub> hybrids for photocatalytic aided removal of VOCs and nitrogen oxides from outdoor environment

David M. Tobaldi<sup>1</sup>, Dana Dvoranová<sup>2</sup>, Luc Lajaunie<sup>3,4</sup>, Nejc Rozman<sup>5</sup>, Bruno Figueiredo<sup>6</sup>, Maria Paula Seabra<sup>1</sup>, A. Sever Škapin<sup>5</sup>, José Juan Calvino<sup>3,4</sup>, Vlasta Brezová<sup>2</sup>, João António Labrincha<sup>1</sup>

Outdoor air is a valuable resource for current and future generations. While many policies and regulations on air quality have been promulgated worldwide over the past decades, airborne pollution still negatively affects health, therefore the life-style of human beings. Nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds

(VOCs) are common anthropogenic air pollutants. The exposure to those gases has been reported to be as the 5th ranking human health risk factor worldwide. Photocatalysis is one of the most investigated solar (photo)reactions to reduce this global threat. Titanium dioxide (TiO<sub>2</sub>), an Earth-abundant material, is amid the most promising photocatalysts. However, the relatively high recombination rate of the photogenerated exciton, dissipating the energy as light or heat, strongly reduces the resulting photocatalytic activity. To tackle this drawback, we have synthesised, via a green, clean, and simple sol-gel method, titania/graphene (0.5 and 1.0 wt% graphene nanoplatelets) hybrid nanomaterials. Photocatalytic activity was tested against three major pollutants found outdoor: nitrogen oxides (i.e. NO<sub>x</sub> = NO + NO<sub>2</sub>), and two different VOCs – benzene and isopropanol. Upon UV-A irradiation, distinct radicals were formed in presence of isopropanol and benzene, thus leading to different yet complex reaction pathways.

Results showed that the addition of 1.0 wt% of graphene to TiO<sub>2</sub> enabled a two-fold increase in the photocatalytic removal of those gaseous pollutants, being fully recyclable over repeated tests. Indeed, the addition of graphene nanoplatelets to that semiconducting material acted as a highway for the electron mobility, enhancing the separation of the photogenerated exciton, thus decreasing their recombination rate. This makes our material an ideal candidate for multi-purpose environmental applications.



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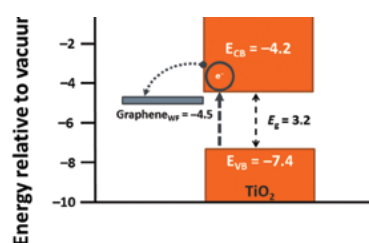
**FIGURE 1**

a) TEM image acquired on TiO<sub>2</sub> modified with 1 wt% graphene nanoplatelets, thermally treated at 450 °C. b) HR-TEM image acquired on the same sample. The inset shows the FFT calculated on the area highlighted by the red square.

**FIGURE 2**

Proposed mechanism for improved spatial charge carrier separation in a graphene-TiO<sub>2</sub> hybrid material (following to UV-Vis excitation). In the band diagram, relative to the absolute vacuum scale, the dashed yellow arrow shows the electron transferring in titania (from the valence band to the conduction band) due to photocatalysis; the dotted yellow arrow depicts the successive electron transferring from the conduction band of TiO<sub>2</sub> to graphene.

**Potential Vs AVS**



# Measuring precise nuclear moments by studying isolated molecules: new experimental data and accurate electronic theory meet

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## FIGURE 1

Schematic explanation of PAC measurement on a free molecule. The Cd nucleus (dark blue) with quadrupole moment  $Q$  interacts with the electric-field gradient of the electrostatic potential at the nucleus  $V_{zz} = \partial^2 \Phi / \partial x \partial y$  (EFG) created by the Cd electron distribution (grey) modified by bonding to the bromine atoms (brown). This is observed by the modulation of the time-distribution of the two  $\gamma$  rays emitted in decay of radioactive  $^{111}\text{mCd}$ . The energy splitting of the nuclear intermediate state (due to quadrupolar coupling) is directly seen as transition frequencies ( $\omega$ ) in the Fourier transform.

Nuclear quadrupole moments ( $Q$ ), a measure of charge asymmetry in nuclei, are essential as benchmarks for nuclear structure models and to interpret experimentally determined nuclear quadrupole interactions in terms of electronic and molecular structure. Experimentally accessible via the quadrupole interaction frequency  $\nu_Q = eQV_{zz}/h$  one needs to know  $V_{zz}$ , the electric-field gradient (EFG) at the nuclear site, whose value must come from theory, to date only precise enough for free atoms or small molecules. Experimental  $\nu_Q$  data in such environments are, however, only available for nuclear ground states. On the other hand, studies of short-lived nuclear excited states had up to now only been possible in solids, where theory is yet not sufficiently accurate.

Using the pure radioactive isotope beams available at the ISOLDE-CERN (Isotope mass Separator On-Line facility) and chemically combining into halide molecules,

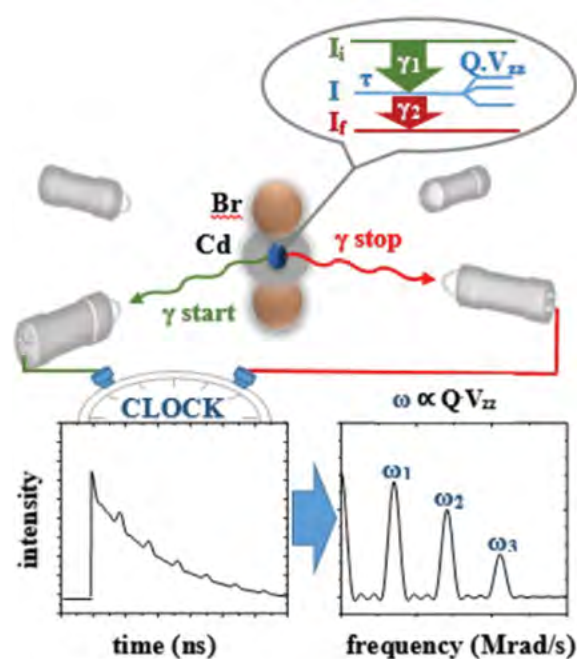
the solid-state technique of  $\gamma\gamma$  perturbed angular correlation was for the first time applied to measure  $\nu_Q$  for nuclear excited states in isolated small linear molecules (Cd and Hg halides).

The technical challenge was the production of a highly diluted gas sample of the radioactive molecules such that no intermolecular collisions occur during the measurement time, typically below 100 ns, depending on the half-lives of the intermediate nuclear state of the radioactive isotope used.

Combined with state-of-the-art ab initio electronic structure calculations of  $V_{zz}$  for these small molecules, the nuclear quadrupole moment  $Q$  has been obtained from the measured  $\nu_Q$  for two excited states,  $^{111}\text{Cd}(5/2+)$  and  $^{199}\text{Hg}(5/2-)$ , and its value confirmed with different compounds. In the past, numerous solids were investigated by PAC and other solid-state methods and the  $Q$  value now obtained allows quoting more precise values for the EFG. One might hope that the presently not very accurate solid-state theory calculations can be improved by comparison with reliable experimental data.

## Reference

H. Haas et al., Free molecule studies by perturbed  $\gamma\gamma$  angular correlation: A new path to accurate nuclear quadrupole moments. Phys. Rev. Letters 125, 253001 (2021)





# Bioengineering organotypic 3D microtumors for anti-cancer drug discovery

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Bioengineering human 3D tumor models that recapitulate major disease hallmarks has a unique potential to significantly accelerate anti-cancer therapeutics discovery and preclinical screening. The development of human tumor surrogates has however remained highly challenging owing to tumors' biological complexity and self-evolving features. Emulating living tumors' microenvironment in an *in vitro* setting requires the precise inclusion of distinct cell populations that dynamically interact and interface with the tumor extracellular matrix (ECM). The tumor-ECM is recognized to support cancer and stromal cell proliferation and differentiation. In the context of tumor progression, ECM alterations also play a critical role in resistance to therapeutics and metastatic processes.

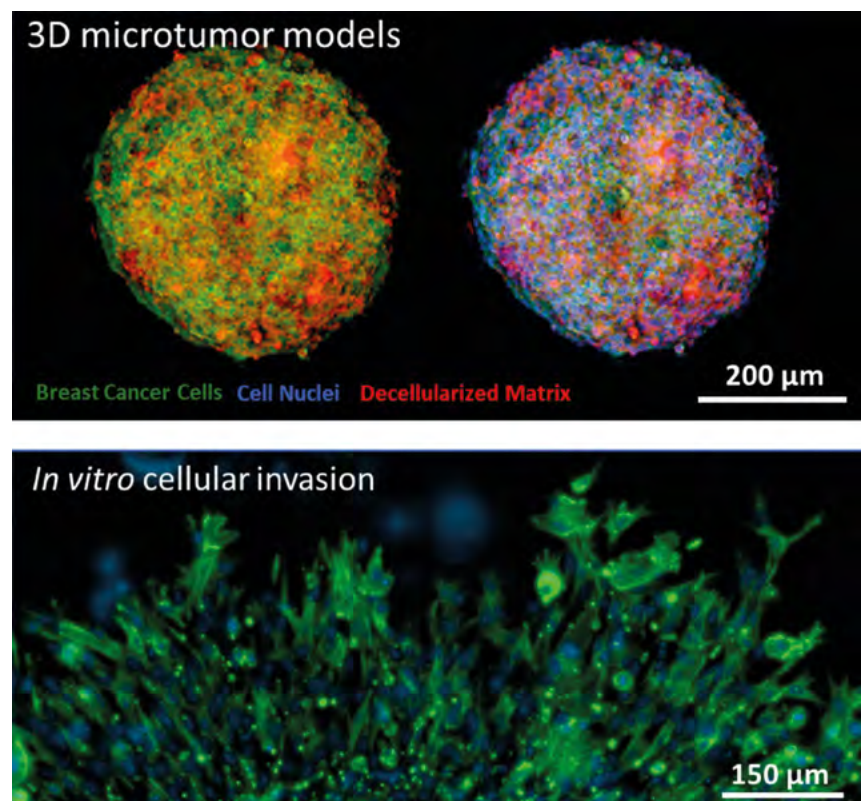
Envisioning to recapitulate the major components of human breast cancer microenvironment, this research employed breast tissue-derived decellularized extracellular matrix (dECM) for *in vitro* fabrication of organotypic 3D tumor models envisioning to augment biomimicry. The bottom-up fabrication strategy

involved dECM-microfibrillar fragments combined with major human cell components, enabling to analyze leading chemotherapeutics for breast cancer therapy. This methodology facilitated the preservation of microarchitectural features of native ECM, therefore providing an alternative route for facile dECM components inclusion without requiring extensive processing. Foreseeably, such closer-to-human avatars are envisioned to be used for large scale screening of next-generation precision therapeutics that may provide more tractable advances in the management of breast cancer, as well as other solid human neoplasias.

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## FIGURE 1

3D Breast cancer microtumor models bioengineered with native tumor microenvironment components. Microtumors' cellular invasion into surrounding artificial tissues modelled in a preclinical setting.



# Newton's problem of minimal resistances

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## FIGURE 1

A. Plakhov. Method of nose stretching in Newton's problem of minimal resistance. *Nonlinearity* 34, 4716-4743 (2021).

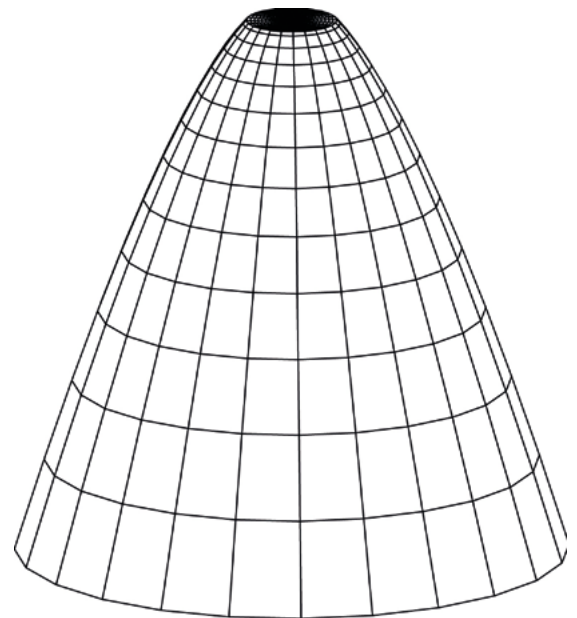
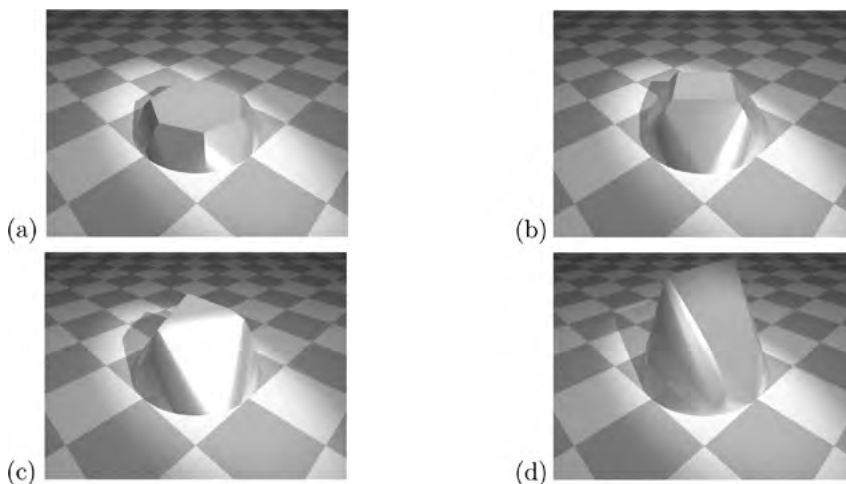
## FIGURE 2

A. Plakhov. A solution to Newton's least resistance problem is uniquely defined by its singular set. *arXiv:2109.14207v3* (2021).

A rigid body moves in a highly rarefied medium. One can think, for instance, of an artificial satellite of the Earth moving at a low altitude (100 to 1000 km), where the atmosphere is extremely thin. As a result of collisions of the body with the medium particles, the force of resistance is created, which acts on the body and slows down its velocity. The problem is to find the convex body with fixed length and maximal width that has the smallest resistance.

This problem was studied by I. Newton (1687) in the class of rotationally symmetric bodies, and is now one of classical problems that gave rise to Calculus of Variations. Mathematically, the problem amounts to minimizing the integral  $\int_0^1 \frac{1}{1+\varphi'(x)^2} dx$  in the class of concave functions  $\varphi$  such that  $0 \leq \varphi \leq M$ , where  $M$  is the parameter of the problem. In Fig. 1, Newton's solution for  $M=2$  is shown.

The new life to the problem was given in the 1990s, when it became clear that in the general case (without any assumption of symmetry) the optimal shape does not coincide with Newton's one. Mathematically, the more general problem is to minimize  $\iint_{\Omega} \frac{1}{1+\nabla u(x,y)^2} dx dy$  in the class of concave functions  $0 \leq u \leq M$  on the unit disk  $\Omega$ . The problem remains open until now. The results of numerical simulation on the optimal shape are shown in Fig. 2, when  $M$  equals 0.4 (a), 0.7 (b), 1 (c), and 1.5 (d). Both numerical simulation and some theoretical arguments lead to the conjecture, first stated in 1990s, that the regular part of the surface of the optimal body can be foliated by line segments (similarly to cylindrical and conical surfaces). This conjecture is proved in the papers [1,2] by the author. The proof is based on the novel method of bilateral variation of a convex body called *nose stretching*.





# A potential glimpse of dark matter from gravitational waves

Juan Bustillo<sup>1,4,5</sup>, Nicolas Sanchis-Gual<sup>2</sup>, Alejandro Torres-Forné<sup>3</sup>, Jose Font<sup>3</sup>, Avi Vajpeyi<sup>4</sup>, Rory Smith<sup>4</sup>, Carlos Herdeiro<sup>2</sup>, Eugen Radu<sup>2</sup>, Samson Leong<sup>5</sup>

The detection of gravitational waves has been an outstanding breakthrough of 21<sup>st</sup> century science, which has been delivering unprecedented information about the most mysterious objects in the Universe, such as black holes and neutron stars.

Yet, the promise of gravitational waves is even more formidable: can they give us a glimpse of new physics, in particular unveiling some of the deepest mysteries of current science, such as the nature of dark matter?

In this letter (Phys. Rev. Lett. 126 (2021) 8, 081101), one of the most intriguing gravitational wave transients, GW190521, is given a different interpretation, which presents a potential glimpse towards new physics and the nature of dark matter.

The letter shows that the unique features of GW190521 make it consistent with a merger of two exotic compact objects (named Proca stars) which are lumps of dark matter. This interpretation is shown to be statistically slightly favoured over the standard binary black hole merger interpretation, suggested by the LIGO-Virgo collaboration. Moreover, it determines the mass of a new fundamental dark matter particle, the fundamental constituent of the exotic Proca stars: an ultralight vector boson with mass of about  $8 \times 10^{-13}$  eV.

If this interpretation is supported by future events yielding population studies, gravitational waves have just started to unveil the nature of dark matter, becoming, in the process, the new generation of particle detectors.

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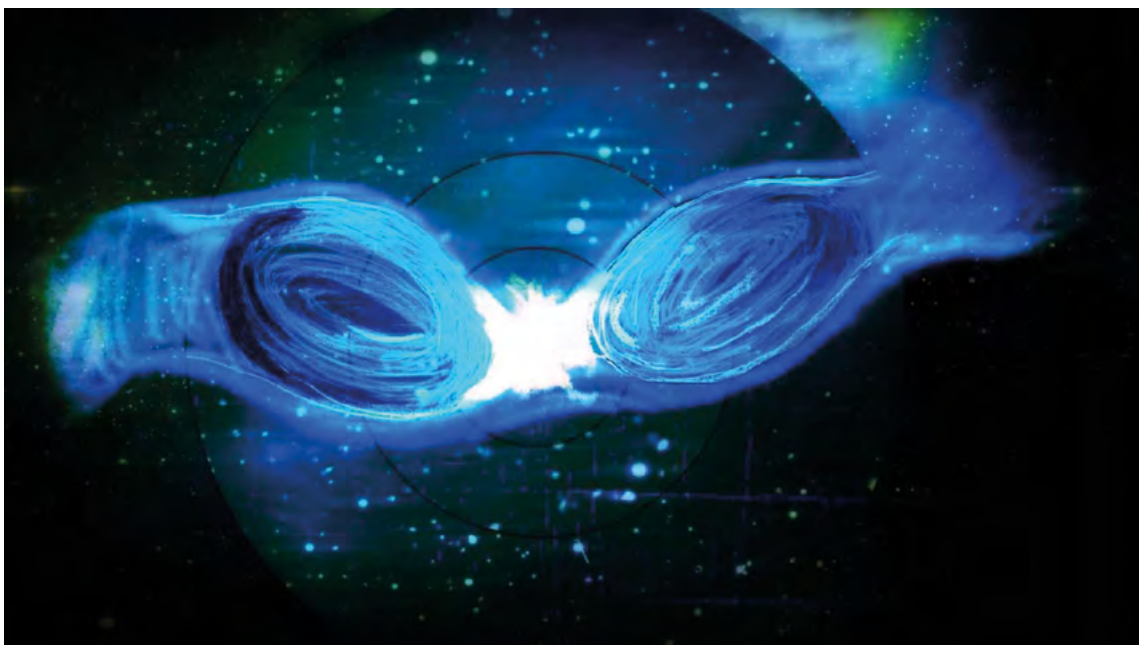
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## FIGURE 1

An artistic impression on the collision of two dark matter stars (Proca stars) and the corresponding emission of gravitational waves. Credit: Nicolás Sanchis-Gual and Rocío García-Soutomodel.



# TEDS - Framework for Education for Sustainability: enhancing competencies in Education

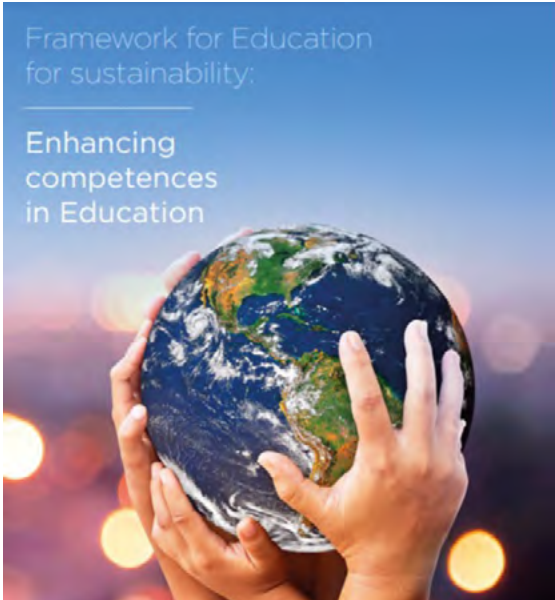
Kalle Juuti<sup>1</sup>, Anni Loukouvies<sup>1</sup>, Jari Lavonen<sup>1</sup>, Milla Haäkkinen<sup>1</sup>, Patrícia Sá<sup>2</sup>, Ana Isabel Andrade<sup>2</sup>, Jane Machado<sup>2</sup>, Cristina Sá<sup>2</sup>, António Moreira<sup>2</sup>, António Mendes<sup>2</sup>, Betina Lopes<sup>2</sup>, Bruna Batista<sup>2</sup>, Francisco Silva<sup>2</sup>, Filomena Martins<sup>2</sup>, Gabriela Portugal<sup>2</sup>, Helena Araújo e Sá<sup>2</sup>, Manuela Gonçalves<sup>2</sup>, Mónica Lourenço<sup>2</sup>, Nilza Costa<sup>2</sup>, Rui Vieira<sup>2</sup>, Vânia Carlos<sup>2</sup>, Dora François<sup>3</sup>, Bruno Lebouvier<sup>3</sup>, Philippe Tanguy<sup>3</sup>, Carole Voisin<sup>3</sup>, Vincent Caruana<sup>4</sup>, Mark Mifsud<sup>4</sup>, Estela Dauksiene<sup>5</sup>, Margarita Tereseviciene<sup>5</sup>

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**FIGURE 1**  
 The framework presents some principles to design teaching activities organized by competencies for education for sustainability.

Project TEDS (Teacher education for sustainability) aims the design of proposals for and from in-service teacher education concerning education for sustainability (EduS). Therefore, the project is focused on preparing schools to educate for sustainability through in-service teacher education thus contributing to the EU level goals for a more sustainable society. The project is being developed by a team including researchers from 5 European countries: Portugal, France, Malta, Lithuania and Finland. The first product delivered is a framework based on the interaction between knowledge, skills and values important for the education for sustainability. Four topics were selected: Environment and natural resources, Responsible use of digital technologies, Dialogue, diversity and social inclusion and Economic and financial literacy. The selection of these topics reveals that knowledge related to sustainability is not exclusively centered on the environmental sphere, although this is undeniably a crucial aspect of this concept. The framework was built on the results of the deductive content analysis of policy documents, dissertations, and PhD theses in each country using a software of qualitative analysis developed in the University of Aveiro (webQDA - <https://www.webqda.net/>). This analysis was focused on looking for evidence of the presence of education for sustainability competencies and suggestions to promote sustainability in schools in those documents.

Project TEDS adopted a system of five transversal education competencies for sustainability: i) systems-thinking competency, ii) strategic competency, iii) anticipatory competency, iv) normative competency, and v) interpersonal competency. The framework was the base for the third phase of the project (IO3). This phase demanded the conception, implementation and assessment of teacher education modules involving in-service teachers working with 6 to 17-18 years old students in the five countries taking part in the project.



COMPETENCY	DESIGN PRINCIPLE
tems-thinking competency	Understanding the importance of analyzing the role played by people different from us, in society.
nticipatory competency	Previewing consequences (positive and negative) of certain attitudes towards persons or social groups, in terms of understanding the role they play in the human society.
Strategic competency	Learning to accept that differences are important, because they have positive consequences for social balance.
Normative competency	Analyzing present norms and values, to identify their possible contribution to dialogue and social inclusion.
terpersonal competency	Individually or collectively analyzing one's conception of other people/groups, based on the idea of acceptance.





# Shooting skinks for good: Producing a movie improves attitudes towards a threatened species

Carlos A. Fonseca<sup>1</sup>, Xana Sá-Pinto<sup>2</sup>, Herculano A. Dinis<sup>3</sup>, Raquel Vasconcelos<sup>4</sup>

Biodiversity loss is one of today's most important sustainable development (SD) problems. Among other factors, biodiversity loss is influenced by humans' attitudes (feelings, actions, and perceptions) towards species. Species such as reptiles are often feared and persecuted by human populations, despite the important ecosystem services they provide. Changing attitudes towards these species is fundamental to ensure its conservation. In this study we show how engaging local communities in the development of conservation products and strategies contribute to improving their attitudes towards threatened species. Following a Project-Based Learning (PBL) approach we engaged Cabo Verdean high school students in the development of a conservation movie about the threatened endemic reptile species *Chioninia vaillanti* and analyzed how this affected their attitudes towards reptiles in general and the target species in particular. More specifically, students were asked to write a script, shoot and produce a short film aimed at changing the

attitudes of their community towards *C. vaillanti*. A public event was organized to present the movie to the community. Students' attitudes towards the species was evaluated before and after this activity, through a questionnaire and students' learning outcomes were studied through interviews and the content analysis of the movie. Our results show that this activity resulted in a significant increase of students': i) positive feelings towards reptiles; ii) increased perception of reptiles' importance; iii) positive actions towards the focal species; iv) knowledge about the biology of *C. vaillanti*, as well as about the threats and reasons to conserve it. The results also show that the reason that the students most often used to support the species conservation was its endemism. These results further support the potential of PBL approaches that explore local contexts and issues for promoting education for SD.

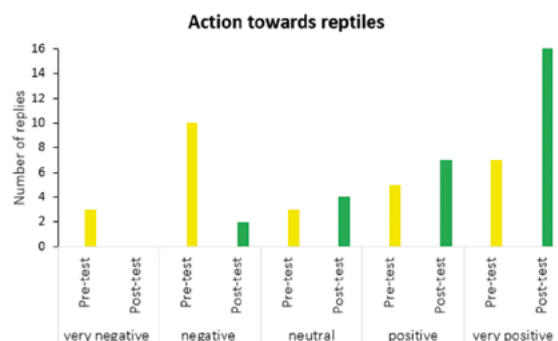
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**FIGURE 1**

A scene from the movie recorded by the students that was presented to the community (see more in: [www.youtube.com/watch?v=5Up6nSp5gUc&ab\\_channel=RaquelVasconcelos](https://www.youtube.com/watch?v=5Up6nSp5gUc&ab_channel=RaquelVasconcelos)).

**FIGURE 2**

Frequency of the different categories of answers of students in the pre-test (in yellow) and post-test (in green).



# The Onset of Chronic Musculoskeletal Pain in High School Adolescents: Associated Factors and the Role of Symptoms of Central Sensitization

Rosa Andias<sup>1</sup>, Anabela G. Silva<sup>2</sup>

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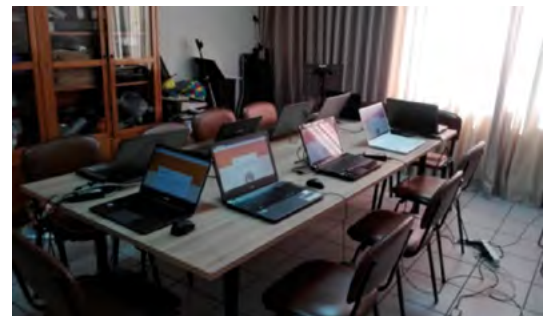
## FIGURE 1

Data collection set up at the schools.

Chronic musculoskeletal pain in adolescents is reaching a prevalence that is similar to that of adults. Furthermore, having chronic pain at an earlier age is a very important risk factor for reporting pain when adult. Existing studies exploring the factors associated with new onset pain in adolescents are of very low to moderate methodological quality and none have explored whether symptoms of central sensitization (symptoms associated with increased responsiveness of nociceptive neurons in the central nervous system to their normal or subthreshold input) could contribute to the onset of pain in adolescents.

This study aimed to investigate the association between sociodemographic data, physical activity, depression, anxiety and stress, sleep, and symptoms of central sensitization at baseline, in asymptomatic adolescents, and the onset of pain at 6 months follow-up.

A total of 252 asymptomatic adolescents were assessed at baseline with an online questionnaire and reassessed at 6-months follow-up to ascertain the presence of pain. Of the 231 (91.7%) adolescents who completed the questionnaire at the follow-up, 127 (55.0%) remained asymptomatic and 88 (38.1%) reported a new onset of pain. Multivariable analysis showed that being female (OR = 2.34, 95% CI = 1.28 to 4.27) and reporting more self-reported symptoms of central sensitization (OR = 1.04, 95% CI = 1.01 to 1.07) were associated with the onset of chronic pain at follow-up. Considering the increasing prevalence of chronic musculoskeletal pain in adolescents, understanding the factors that may be associated with its new-onset may help to design more effective intervention strategies and, thus, minimize its maintenance and negative impact.





# ‘Standing together in the face of COVID-19’: the experiences of the kidney failure triad – patients, family, and healthcare professionals – during the pandemic

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Patients with kidney failure are exceptionally vulnerable to serious complications from SARS-CoV-2 as they combine multiple risk factors (e.g., less efficient immune system). Patients on hemodialysis need to travel to a dialysis unit 3 to 4 times a week to receive renal replacement treatment, adhere to complex dietary and fluid restrictions, care for the vascular access, practice exercise, and take different medications to maximize treatment adequacy and quality of life. All these requirements are crucial for survival but may represent an additional challenge to manage during the COVID-19 outbreak, affecting patients and their close family members who provide the bulk of support. The pandemic has also increased the complexity of the requirements to prevent and control the spread of the virus in hemodialysis centers, which can put healthcare professionals under exceptional pressure. The Together We Stand project investigated the experiences of patients undergoing in-center hemodialysis, family caregivers, and dialysis care professionals during the current pandemic using a mixed-methods approach. Results showed that COVID-19 brought several challenges for patients (e.g., electrolyte imbalances; difficulties managing dietary and fluid restrictions, increased isolation; fear of severe complications from COVID-19), caregivers (e.g., fear of contaminating the patient; additional care responsibilities, such as transporting patients to and from the dialysis center), and healthcare professionals (e.g., increased work overload; emotional exhaustion; interference with family life). Participants also expressed greater psychological distress, with family caregivers reporting increased burden and symptoms of depression that predicted a poorer quality of life. These results were published in renowned scientific journals in the field of Nephrology and presented at the ISN World Congress of Nephrology 2022, receiving great attention from the scientific community and social media.

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FIGURE 1

The impacts of the COVID-19 pandemic on the kidney failure triad.



# Change in research and in higher education institutions: forms of resistance in a research-action project

Sara Diogo<sup>1</sup>, Carina Jordão<sup>2</sup>, Teresa Carvalho<sup>2</sup>, Hana Himi<sup>3</sup>, Maya Ashkenazi<sup>3</sup>, Veronika Mešková<sup>4</sup>, Anita Thaler<sup>5</sup>, Jennifer Dahmen-Adkins<sup>6</sup>

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**FIGURE 1**  
Mapping CHANGeR's resistance experiences based on the analysis provided by FESTA .

When compared with other regions in the globe, Europe, notably Northern Europe, has been classified as the 'promised land' of gender equality, especially in the education sector. For Higher Education Institutions (HEIs), an important step towards the promotion of a gender equality culture lies in the creation of the European Research Area (ERA), as the EU stipulated targets to increase women participation in industrial research and technology and in leading positions. Specific funding was thus assigned to promote gender equality in HEIs and several projects have been approved to design and implement Gender Equality Plans (GEPs). However, despite evidence of positive results of GEPs implementation, there are also difficulties and risks, considering the barriers and resistance when trying to implement practices that aim for more gender equal and more inclusive working environments. Resistance, however, and opposition to gender equality policies have

been a relatively new problem in Europe, and the reasons explaining it are yet not fully studied or understood. While some resistance can be of a more institutional nature, e.g. available resources and/or the (in)existence of a gendered agenda, other reasons to resistance have a more individual basis (sensitivities; status quo; personal traits). This study exposes the experience of the implementation of a GEP in the implementing institutions of the CHANGE project – Challenging Gender (In)Equality in Science and Research consortium, reflecting specifically on the structural and cultural challenges faced by the implementing partners so far, looking to the similarities and differences among different institutional contexts (Table 1). This reflection is based on the FESTA project – Female Empowerment in Science and Technology Academia – a similar FP7 funded project initiative. Despite national and organizational differences, four different types of resistances which are independent from the institutional and/or national contexts were identified: fear of feminism; assumption of HEIs as gender neutral and the presence of dominant discourses on excellence and merit; devaluing knowledge on gender equality; and lack of institutional or personal support.

Start up/Initiation [Relevant in Organisations]	Data Collection [Relevant in Organisations]	Execution/ Implementation [Relevant in Organisations]	Additional experiences from CHANGeR [Relevant in Organisations]
No funding for gender equality work NIB; UAVR; UNIZA	Standing in front of an "All is well" wall BBC; UAVR; UNIZA	Shooting the messenger BBC; NIB; UAVR	Fear of feminism, Image of objector of the traditional values UNIZA
Women are not born for science UAVR	Resistance to reflect one's own role NIB; UNIZA; UAVR	Refusal to engage with a gender equality project NIB; UAVR	Women are especially gifted for admin project work UNIZA; NIB
Introduce gender to high-level management BBC; NIB; UAVR; UNIZA	Delicate matter of sharing information – e.g. salaries BBC; NIB	Science is an elite sport UAVR	Confusing of the process/system Criticism with the criticism of the people UNIZA; NIB
Resistance to EU projects (none)	No need to hide hostility UNIZA	Women uncomfortable with gender UAVR; UNIZA	Fear to become the CHANGeR (team member, ambassador for gender equality) NIB
Fear of feminism ALL	Not all women cooperate NIB; UAVR	When there's no benefit NIB; UNIZA	Convince people that any type of actions are needed NIB
	Resistance from academic council NIB; UNIZA	Lack of interest/Resistance to learn about gender NIB; UAVR	Low interest in workshops from the highest management level NIB
	Negativism and low interest about gender equality ALL	Lack of commitment to gender equality work NIB; UAVR	Passive resistance, minimal cooperation, making initiative "fade away" BBC; NIB
	Resistance to a CHANGeR NIB; UAVR	Resistance from women NIB; UAVR	Fear of being exposed BBC; NIB
	Objections from a female researcher NIB; UAVR	Convince people that on-the-job actions are needed IFAM; NIB; UAVR	
		Silence speaks NIB	
		Resistance from new head of department NIB	
		Low interest in workshops BBC; NIB; IFAM; UAVR	
		Mismatch of gender policy and gender reality NIB	

Source: authors.



# Academics' Societal Engagement in the Humanities and Social Sciences: A Generational Perspective from Argentina, Germany, Portugal, and Sweden

Christian Schneijderberg<sup>1</sup>, Anders Brostrom<sup>2</sup>, Teresa Carvalho<sup>3</sup>, Lars Geschwind<sup>2</sup>, Monica Marquina<sup>4</sup>, Lars Muller<sup>1</sup>, Nicolas Reznik<sup>4</sup>

Political discourse and policy reforms worldwide have highlighted the importance of promoting the knowledge economy by stimulating academics' societal engagement (ASE). Such narratives partly aim at influencing academics' attitudes and behaviors. Earlier work that has investigated such influence has tended to overlook the development in Humanities and Social Science (HSS), and focused on Science, Technology, Engineering, and Mathematics (STEM) fields. This paper contributes to filling this gap. Based on the assumption that academics' views are, to a significant extent, shaped during their early years in academia, we investigate whether there are generational differences in attitudes to ASE. Four different higher education systems are investigated: Germany, Sweden, Portugal, and Argentina, based on the international Academic Profession in the Knowledge Society survey (APIKS 2018). We used a confirmatory technique, as it allowed us to test the relationships between the dependent variable (ASE-importance) and independent variables (Table 1). Data analysis reveals marked country-level differences in the way academics perceive the importance of ASE activities. Overall, there are marked country-level differences in how academics perceived the importance of ASE activities. Academics in Argentina and, in particular, Portugal were markedly more likely than their peers in Germany and Sweden to state that they saw ASE activities as 'very important'. The exception to this pattern was that Portuguese researchers did not perceive much connection between their ASE activities and their careers, which may be due to the lack of recognition of ASE activities in Portuguese performance assessment systems. In the case of Argentina, there was a striking difference across all three generations between the strong perception of the importance of ASE activities and the low level of ASE activities reported (Table 2). Overall, there is no strong evidence that the current generation of HSS academics has very different attitudes to ASE than previous generations.

Name	Description	Range
<i>Dependent variables</i>		
Research Teaching Reputation Career	Importance of ASE for academics' research academics' teaching academics' reputation academics' career advancement	1 (Not important) – 5 (Very important)
Discipline HEI mission	academics' discipline mission of academics' HEI	
<i>Independent variables</i>		
Rank	Individual characteristics Professors (professor and associate professor; senior faculty) Non-professors and junior academics	1 = professor 0 = non-professor (assist. prof, lecturer, researcher, etc.)
Gender	Gender	0 = male 1 = female
ExternalWork	Work experience outside of universities in government, industry, and self-employment	0 = no 1 = yes
TimeBudget	Time budget (average per week) for ASE	0-1 (percentage of time dedicated to ASE in relation to other functions. (100% = time devoted to research + teaching + management + ASE + other)
Applied	Research characteristics Applied/practically oriented	1 (Not at all) – 5 (Very much)
Inter-/Multidisciplinary	Inter-/Multidisciplinary	
FundingExpectations	HEI expectation Raising substantial amounts of external funds	1 (Not at all) – 5 (To a very high extent)

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2 – Institute of Technology, Sweden  
3 – Department of Social, Political and Territorial Sciences & CIPES, University of Aveiro  
4 – Universidad Nacional de Tres de Febrero, Argentina

FIGURE 1

Source: APIKS-survey 2018.

FIGURE 2

ASE activities in Argentina, Germany, Portugal, and Sweden across different generations of academics in HSS (in percentages, with number of observations in brackets; multiple answers possible). Source: APIKS-survey 2018.

Country	ASE Activities Index	Post-2006 Generation	1995–2006 Generation	Pre-1995 Generation	Total
Argentina	Commercialization	29.63 (72)	32.14 (54)	41.44 (46)	32.95 (172)
	Industrialization	14.40 (35)	18.45 (31)	20.72 (23)	17.05 (89)
	Dissemination	34.98 (85)	45.83 (77)	49.55 (55)	41.57 (217)
	Supervision	12.35 (30)	17.86 (30)	23.42 (26)	16.48 (86)
Germany	Commercialization	45.07 (466)	60.58 (252)	63.54 (183)	51.84 (901)
	Industrialization	50.29 (520)	50.48 (210)	51.74 (149)	50.58 (879)
	Dissemination	68.96 (713)	84.38 (351)	83.68 (241)	75.09 (1305)
	Supervision	58.41 (604)	63.70 (265)	68.75 (198)	61.39 (1067)
Portugal	Commercialization	54.38 (87)	54.25 (217)	57.35 (195)	55.44 (499)
	Industrialization	64.38 (103)	65.25 (261)	65.88 (224)	65.33 (588)
	Dissemination	75.63 (121)	82.25 (329)	85.88 (292)	82.44 (742)
	Supervision	50.63 (81)	60.75 (243)	53.24 (181)	56.11 (505)
Sweden	Commercialization	51.61 (48)	54.67 (193)	58.91 (281)	56.55 (522)
	Industrialization	35.48 (33)	47.31 (167)	41.09 (196)	42.90 (396)
	Dissemination	67.74 (63)	71.67 (53)	71.07 (339)	70.96 (655)
	Supervision	21.51 (20)	20.40 (72)	25.37 (121)	23.08 (213)

# Insecure domestic workers during COVID 19 confinement in Portugal a cultural studies perspective

Maria Baptista<sup>1</sup>, Larissa Latif<sup>1</sup>, Alexandre Almeida<sup>1</sup>

<sup>1</sup> – Department of Languages and Cultures & CLLC, University of Aveiro

FIGURE 1

FIGURE 2

Credits: www.freepik.com

This quantitative study aims to produce, analyze, systematize and disseminate statistical data on the impact of COVID-19 on insecure domestic workers in Portugal - whose position was already precarious. The observations include a gender perspective and take into account possible aggravation caused by intersections with race, class, age, the migrant situation and territory. It is intended to contribute to the production of data that support the design and application of public policies to face this crisis and its consequences.

The population estimation was based on data on domestic workers from CENSO (INE, 2011) and on the estimation by Eurostat (2018) of the index of precarious workers in Portugal. The total estimated population is 281,482 subjects. The sample from 384 individuals was calculated to reflect this population and the heterogeneous distribution of subjects. We have a confidence level of 95% and margin of error of 5%. To ensure regional

representation, quotas were calculated for each region of Portugal (NUTS II), including the mainland and autonomous regions, based on population distribution (INE, 2011). All quotas have been reached. The surveys, answered between March and June 2021, contained 22 questions, of which 13 were direct and 9 were formulated on a Likert scale. The data collected through the surveys were processed using the SPSS program.

The descriptive and preliminary analysis points to the social fragility of the subjects in the sample with regard to education, work and salary security, as well as exposure to contagion by covid-19. Due to the greater incidence of female subjects in the sample, it is to be considered that the gender asymmetry found in Portuguese society may exacerbate this fragility, as well as the situation of emigration and racialization. These first indicators can be deepened by cross-referencing quantitative data, as well as by a subsequent qualitative study.





# Gamers4Nature Project – Game creation tools to promote Environment and Biodiversity preservation awareness

Pedro Beça<sup>1</sup>, Ana Isabel Veloso<sup>1</sup>, Rita Santos<sup>1</sup>, Gonalo Gomes<sup>2</sup>, Eduardo Ferreira<sup>3</sup>, Milene Matos<sup>4</sup>, M3nica Aresta<sup>1</sup>

Creating engaging opportunities for young people to learn more about nature can act as a trigger for environmental awareness and consciousness about the importance of preserving nature and the balance of ecosystems. In the field of environmental and biodiversity preservation education, games emerge as an innovative approach to raise environmental awareness among younger audiences.

As digital games' potential to enhance motivation for learning has been recognized a few years to this part, challenging youngsters to create games addressing nature and biodiversity preservation revealed a greater involvement with the theme and a deeper understanding of what is learned.

When recent work in the field of educational research establishes a relationship between students' involvement in the creation of games and an increase in the interest about the addressed themes, the Gamers4Nature project (PTDC/COM-OUT/31047/2017) aims to raise young student's awareness on the importance of environmental preservation through the creation of digital games.

Along its timeframe (June 2018 to May 2022), the Gamers4Nature project directly involved more than 320 upper-secondary and undergraduate students who, using the G4N Toolkit to Game Design – a physical artifact that includes a set of resources and tools designed to support the creation of mobile digital games – created more than 66 playable prototypes of digital games addressing environmental awareness themes.

The project's results and the validity of its approach are disseminated in 6 book chapters, 10 conference papers, 6 workshops and 8 international webinars. It also led to another project (Erasmus+ funding), that currently involve 4 European upper-secondary schools, more

than 50 students and 12 teachers. The project was also the basis for 8 undergraduate projects (7 NTC and 1 Computing Engineering), 4 master degree projects (MDJD), 5 master degree thesis (3 MCMM, 2 Design), 4 PhD Thesis (2 ICPD, 2 PDMMEdu) and 2 Students@DigiMedia research activities.

#### Funding

The Gamers4Nature project PTDC/COM-OUT/31047/2017 has the financial support of FCT - Foundation for Science and Technology (Portugal)/MCTES – Ministry of Science, Technology and Higher Education and FEDER under the PT2020 agreement.

- 
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4 – Associa3o Bioliving
- 

**FIGURE 1**

Gamers4Nature Toolkit to Game Design

**FIGURE 2**

Students using the G4N toolkit along a game creation session



# STEAM City Kit: Storytime with a hands-on maker touch

Rui Raposo<sup>1</sup>, Mário Vairinhos<sup>1</sup>, Laura Ferreira<sup>2</sup>

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**FIGURE 1**

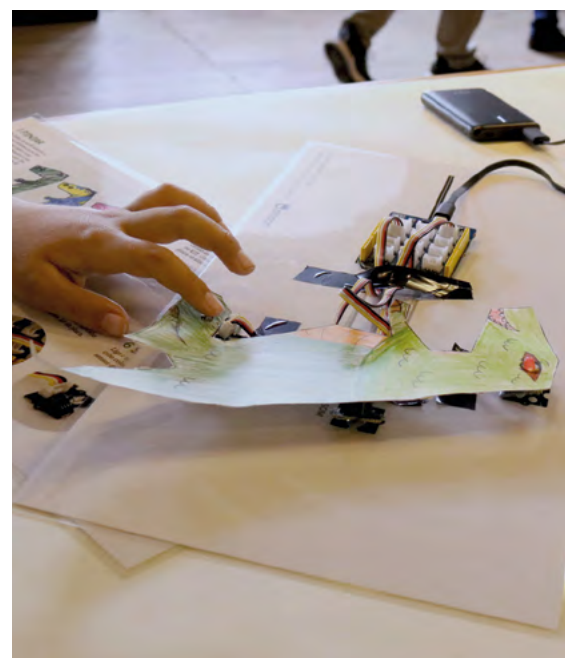
Part of the story "O Dinossauro Tomé-Rex", which will afterwards promote the activity illustrated in Figure 2.

**FIGURE 2**

Example of an activity held at Fábrica Centro Ciência Viva using the STEAM City Kit.

The project STEAM City Kit was developed within a wide range of other projects in the Aveiro Tech City project. Its main purpose is to provide primary school students and teachers with hands-on activities that combine challenges and skills from different fields, such as physical computing, arts and crafts, and storytelling. Promoting skills in young people aged between 5 and 7 years in IT, electronics, and logic faces several difficulties. On the one hand, reading and comprehension skills at these ages are not yet fully acquired or consolidated, which prevents the use of the numerous teaching materials and tools available for other age groups. On the other hand, we see a scarcity of teaching resources available in the market and education research specifically for this age group since the introduction of knowledge in technology involves a certain degree of technical complexity. The STEAM City Kit project empowers the role of narrative and storytelling in teaching IT to children by placing the student as an active agent at the centre of the learning process. The inclusion of stories combined with content customization strategies creates a strong feeling of empathy and motivation in the child to carry out the

activity. Two activities were designed and developed, which resort to stories, content personalization, physical computing, sensors, and actuators. Besides a Groove Beginner Kit for Arduino®, the kits also include two activity books with original children's stories, developed by team members and can be used in storytime sessions to provide a context for the activities done afterwards. Over 900 kits have been distributed to the more than 30 TechLabs in schools in the municipality of Aveiro, and a multidisciplinary team from Fábrica Centro Ciência Viva de Aveiro has provided training and support for using the kit. We hope this experience can spark students' interest in physical computing and programming by bringing a hands-on maker touch into the equation.



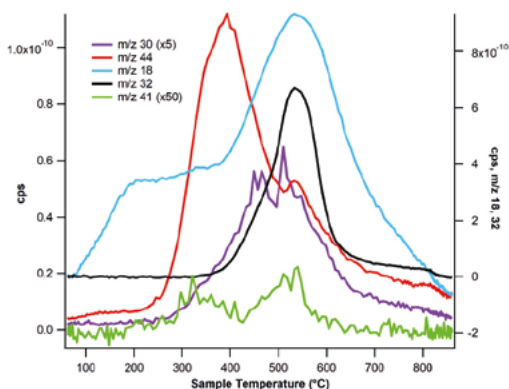


# The role of clay minerals in the preservation of Martian organics, Implications for Curiosity Rover on Mars

Slavka Andrejkovičová<sup>1</sup>, Amy McAdam<sup>2</sup>, Jennifer Stern<sup>2</sup>, Jennifer Eigenbrode<sup>2</sup>, Christine Knudson<sup>2,3</sup>, Fernando Rocha<sup>1</sup>, Paul Mahaffy<sup>2</sup>

In an early Earth scenario, clay minerals are considered to provide one of the most likely substrates where organic matter could have been concentrated and possibly transformed by abiogenic catalytic reactions to polymeric organic networks that were the forerunners of biopolymers. This supports suggestions that clay minerals may have had an important sequestering and possibly catalytic role in the organic chemical evolution in the early Solar System. During its traverse in the Gale crater, the Curiosity rover detected a diversity of clay minerals at different locations. Ancient organic molecules have been recently discovered in situ by the Curiosity rover in the Martian regolith despite the current harsh conditions of the surface of Mars. Among the many types of organic compounds of fundamental importance for life, it is amino acids that have attracted the most attention because they are the building blocks of proteins. Amino acid adsorption on smectite is relevant to prebiotic processes involving possible catalytic reactions in the early Solar System, as implied by the clay-organic correlation found in meteorites, and the generation and modification of organic components essential for the origin of life. Therefore, this project addresses the unexplored question if amino acids could be preserved on Mars by clay minerals. Curiosity carries onboard SAM instrument, specifically

designed to detect organic materials in Martian soils. The oven in SAM heats the sample up to 860 °C and outcome from this instrument are masses of evolved gases. Laboratory synthesized glycine-intercalated clay mineral (nontronite) was analyzed by laboratory SAM-like instrument and CO<sub>2</sub> (m/z 44) evolution from this analog sample was compared with CO<sub>2</sub> evolution from Martian samples. The preliminary results show that CO<sub>2</sub> evolution from glycine-nontronite between 300-500 °C is consistent with CO<sub>2</sub> evolution in Martian sample Mojave (MJ).



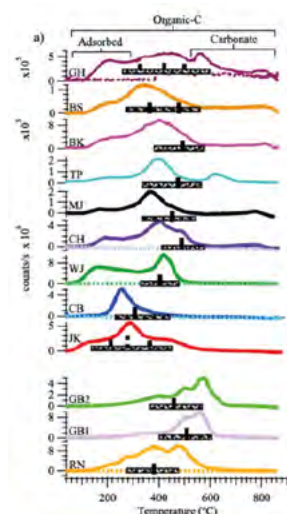
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3 – CRESST, University of Maryland College Park, College Park, MD, 20742 USA

**FIGURE 1**  
CO<sub>2</sub> evolution (m/z 44) from Glycine-nontronite Mars analog

**FIGURE 2**  
CO<sub>2</sub> evolutions from several Martian samples



# The accumulation of Cu in vineyard soils under integrated and organic production

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## FIGURE 1

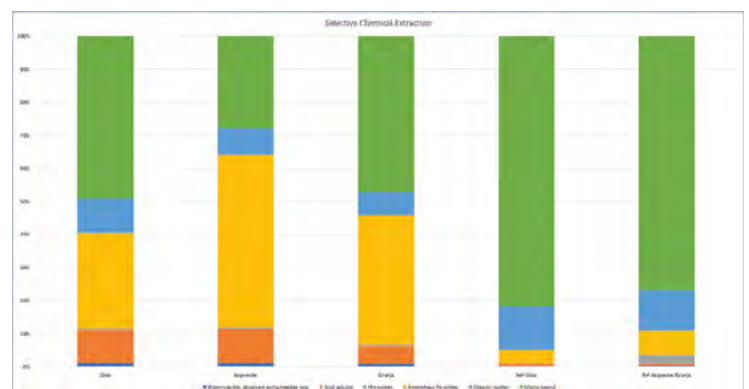
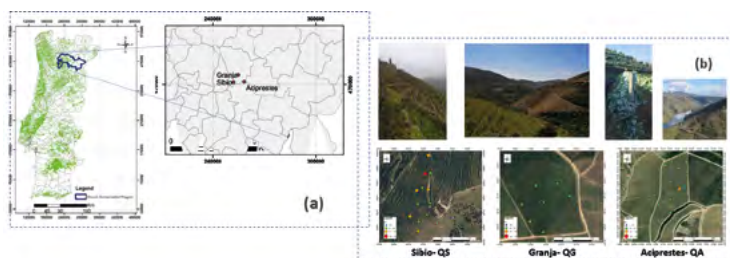
(a) Douro Demarcated Region location; (b) Levels of Cu in each soil sample location and some photos of the region.

## FIGURE 2

Results of the selective chemical extractions for each plot and reference soils.

The rate of conversion of conventional vineyards into organic farming is currently increasing. Nevertheless, the environmental and economic advantages of organic farming are still controversial, particularly due to the high amount of Cu used. In the Douro Region (Fig. 1a), well known by the production of Porto wine, along with the existence of very old vineyards, there is a growing number of vineyards in organic production mode, and thus, soils contamination by Cu is of special concern. Hence, in order to evaluate the inputs and fate of Cu in vineyard soils, samples were collected from 3 areas with 15-20 years old vines (Fig. 1b): two plots (QG & QA) under integrated production mode and one plot (QS) under organic production. In order to evaluate the geological background inputs, reference soils (forest soils without direct anthropogenic influence) were also collected. Soil physical-chemical parameters (e.g.: pH, organic matter, and potentially toxic element concentrations) were determined to characterize the different vineyards. Further, a sequential selective extraction (SSE) was carried out to study the solid phases of Cu and to study the mobility of Cu. Results

showed that Cu concentrations were higher in vineyard soils when comparing to the background values. Concentrations were particularly high in soils under organic production (Fig. 1b), with some values above the 100 mg/kg required by the Portuguese legislation for agricultural soils receiving sludges (Decreto-Lei nº 276/2009). Differences in the behavior and fate of Cu were observed between plots, as can be seen in the results of the sequential chemical extraction (Fig. 2). In addition, the mobility of Cu in vineyard soils is clearly higher than in the background soils. In vineyard soils, a significant fraction of Cu is associated with the acid soluble phase which may result in additional risks for the environment, and increasing its toxicity for plants.





# A Portuguese miracle - The politics of the first phase of COVID-19 in Portugal

Patrícia Silva<sup>1</sup>, João Moniz<sup>1</sup>, Edna Costa<sup>2</sup>

Facing the pandemic with exceptionally low casualties, Portugal has been internationally praised as an outstanding example, particularly when compared to other European countries. During the first phase, the Portuguese case was acclaimed as a miracle, a reflection of the appraisal that the country acted fastest and adopted more stringent measures, variables that would have been most successful. This research argues that politics mattered in dealing with the pandemic. First, the pandemic hit Portugal at a time of political stability, exceptional in the context of southern Europe. Second, lower levels of political polarisation on the government's handling of the sanitary and a climate of cross-party collaboration are key factors in understanding the Portuguese case. With the onset of the pandemic crisis, Portugal witnessed a rallying effect around the country leadership, that was translated into a unified message that enabled the government to enact stringent confinement measures quickly.

The third argument pertains the organizational level, particularly the centralization of power and decision-making that enabled a cohesive policy response. The centralized (vertical) structures and instruments reinforced some control over local governments to minimize the potential risks of fragmented policy responses, while also allowing considerable room of manoeuvre and additional powers to subnational governments.

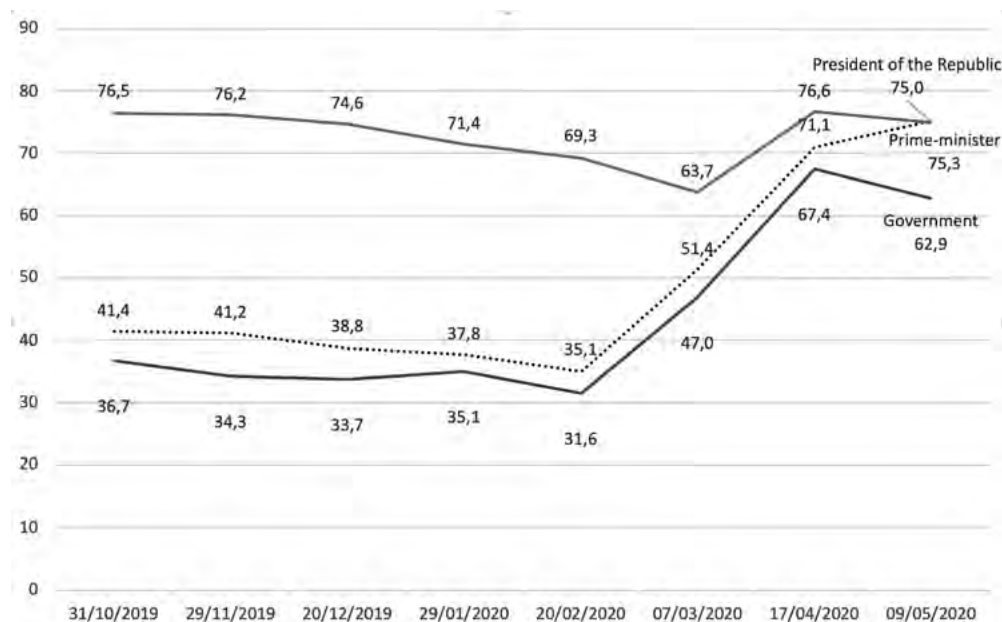
Country unity eroded as the lockdown dragged on. The rampant growth in cases during the deconfinement stages exposed social inequalities, with the virus disproportionately affecting the most fragile groups. The combination of a new spike in cases, public disagreement with health experts and decreasing support from opposition parties are liable to strain relations between government and citizens, who become increasingly frustrated with government management of the pandemic.

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<sup>2</sup> – University of Minho

**FIGURE 1**

Performance evaluation of Government, Prime Minister and the President of the Republic.

Sources: The Portuguese Regulatory Authority for the Media (ERC). Notes: percentages report to percentages of respondents who evaluate the performance as positive and very positive.



# Efficiency and equity in the spatial planning of primary schools

Jan Wolf<sup>1</sup>, Fillipe Feitosa<sup>1</sup>, João Marques<sup>1</sup>

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**FIGURE 1**

Efficiency vs equity in school location.

**FIGURE 2**

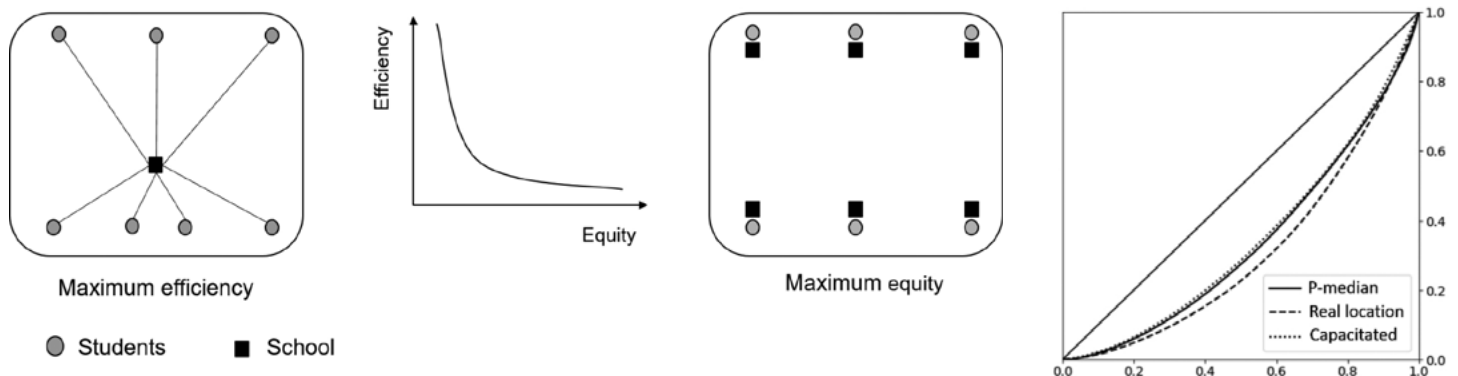
Gini coefficient in the accessibility to schools for different spatial distributions.

The shrinking populations of many regions in Portugal have led to a discussion about the criteria which should guide the restructuring of public services at the local scale and the policy goals that should guide them. This discussion is particularly concerned with the conflicting goals of limiting increasing per capita costs and providing an adequate level of accessibility throughout the territory. The planning of school facilities can, thus, be framed by the concept of efficiency – the capacity to adjust the means used to obtain a given policy goal – and equity – the fair provision of services to different populations. But while providing a well-established conceptual framework, exactly what these concepts mean in the spatial planning of services is still up for debate.

This article contributes to this debate by analyzing the spatial distribution of primary schools at a local case-study. It is based on a linear programming approach to optimize the resources needed for the operation and installation of school facilities and the level of

accessibility that is provided, solving a capacitated facility location problem and a p-median facility location problem. The solutions to those problems were used as benchmarks for the actual spatial distribution of schools, identifying how it could be made more efficient or equitable and the criteria which have been prioritized in recent school planning policies.

The main findings were that concentrating students in fewer locations could lead to significant cost reductions, given the importance of school sizes for per capita costs, but that this concentration would have a significant impact on the equity in the accessibility to this kind of service. Comparing more efficient or equitable solutions to the actual spatial distribution of schools also allowed to conclude that, in the analyzed context, changes to the spatial distribution of schools were made with significant equity concerns, and very far from cost minimizing solutions.





# Understanding the drivers of vaccine hesitancy against COVID-19 in Portugal

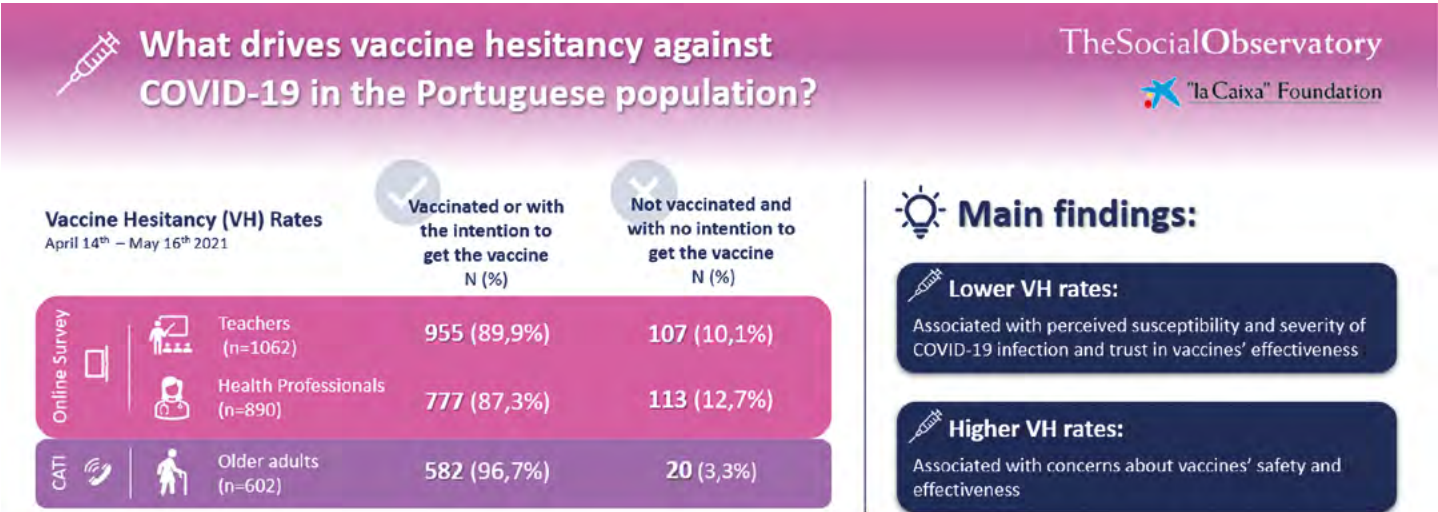
Marta Estrela<sup>1</sup>, Tânia Magalhães Silva<sup>1</sup>, Vítor Roque<sup>2</sup>, Eva Rebelo Gomes<sup>3</sup>, Adolfo Figueiras<sup>4,5</sup>, Fátima Roque<sup>2,6</sup>, Maria Teresa Herdeiro<sup>1</sup>

COVID-19 has become a public health emergency of international concern and many efforts have been made to contain the spread of the disease, notably the fastest-ever vaccine development. However, despite the high efficacy of the vaccines approved, their effectiveness is only observed when most of the population adheres to the vaccination process, thus being of utmost importance having low levels of vaccine hesitancy (VH). The VH is defined as the unwillingness to be vaccinated, regardless of the availability of vaccines, being usually related to doubts and worries towards vaccine efficacy and safety and, since the beginning of the Portugal vaccination process in December 2020, has been a heavily discussed topic among the Portuguese population. To understand what drives VH in the Portuguese population, we conducted a cross-sectional study with older adults, teachers, and health professionals, funded by the La Caixa Foundation Social Research Call (LL-20-04-01). Though vaccine hesitancy

rates were very different among these groups (3.3%, 10%, and 12%, respectively), the main concerns associated with VH were similar across all populations. Worries about the vaccines' safety and efficacy were amongst the strongest determinants to higher VH rates. On the other hand, those who recognized the severity of COVID-19 complications and felt less concerned about COVID-19 complications after getting vaccinated were more likely to accept vaccination against the disease. This study resulted in a published dissemination paper (<https://bit.ly/35K7O4X>), one submitted paper, under review in the scientific journal Vaccine and two published articles in indexed journals (Age and Ageing, 2022, 51(3):afaco13 and Eur J Clin Invest, 2022: e13785) that are featured in the WHO Global Research Database on Coronavirus Disease. Furthermore, it was awarded the 2<sup>nd</sup> prize as the Best Poster Award at the 42nd Annual Meeting of the Portuguese Society of Allergy and Clinical Immunology (SPAIC).

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 2 – Guarda Polytechnic Institute & Research Unit for Inland Development (UDI-IPG)  
 3 – Allergy and Clinical Immunology Service, University Hospital Center of Porto  
 4 – Health Research Institute of Santiago de Compostela (IDIS), University of Santiago de Compostela, Spain  
 5 – Consortium for Biomedical Research in Epidemiology and Public Health (CIBER Epidemiology and Public Health - CIBERESP)  
 6 – Health Sciences Research Center, University of Beira Interior (CICS-UBI)

FIGURE 1  
 Graphical Abstract.



# Cosurface capacitive interdigitated stimulators of high osteoinductive and conductive performance for new personalized acting-sensing prosthetic implants

Bárbara M. de Sousa<sup>1</sup>, Clara R. Correia<sup>2</sup>, Jorge A. F. Ferreira<sup>3</sup>, João F. Mano<sup>2</sup>, Edward P. Furlani<sup>4</sup>, Marco P. Soares dos Santos<sup>3,5</sup>, Sandra I. Vieira<sup>1</sup>

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<sup>3</sup> – Department of Mechanical Engineering & TEMA, University of Aveiro  
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## FIGURE 1

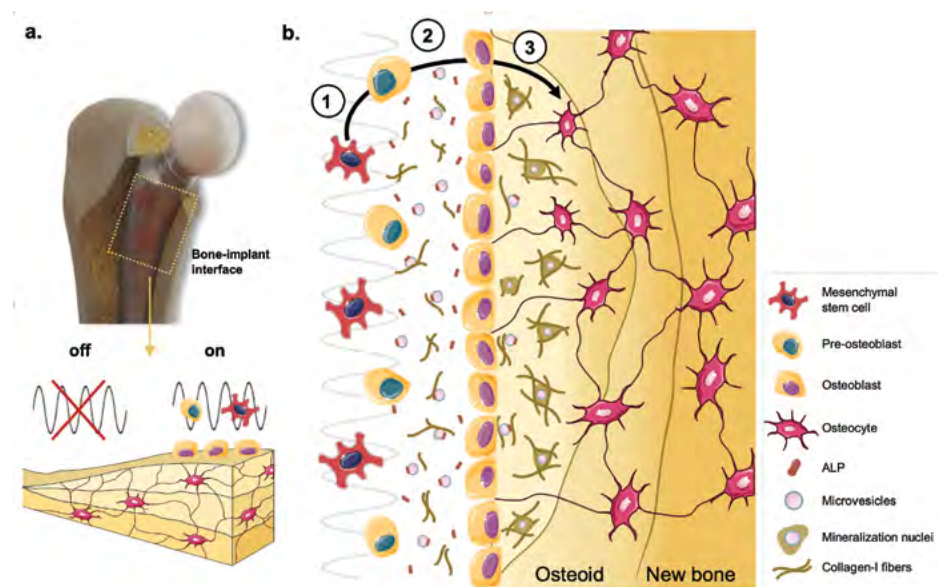
High osteoinductive and osteoconductive performance of cosurface capacitive stimulators at high frequency. Future innovative bioelectronic implants will deliver capacitive electrical stimulation of high frequency (HF, 60 kHz) around the bone-implant interface. HF stimuli promote osteodifferentiation of mesenchymal stem cells into pre-osteoblast (1) and further proliferation and maturation into osteoblasts (2). HF stimulation induces active secretion of collagen-I, alkaline phosphatase (ALP) and microvesicles with membranar ALP. These microvesicles progress as mineralization nuclei for hydroxyapatite crystals early deposition, alongside with collagen-I fibers that rearrange into a tight matrix. The mineralized matrix progressively entraps last-stage bone cells, the osteocytes (3) in the newly formed osteoid, that gradually becomes the new bone.

Musculoskeletal disorders are among the uppermost causes of disability, and the incidence of replacement arthroplasties is relatively high and increasing. Given that current passive clinical implants do not reduce implant failures and revision surgeries, these are also increasing worldwide. Novel bioelectronic devices comprising biophysical stimulators ('acting') and bone monitoring systems ('sensing') are thus on demand, aiming for long-term implant survival and personalized actuation, according to the monitored osseointegration states.

Our interdisciplinary team has been developing a novel implantable electrical stimulation system promoting bone maturation and mineralization, hardly achievable with classic capacitive parallel electrodes. We here show the in vitro osteoinductive and osteoconductive effects of a cosurface capacitive stimulator, integrating micro-scaled interdigitated electrodes (100  $\mu\text{m}$ ) and operating at high frequency (HF, 60 kHz) to be compatible with sensor abilities.

This sensing-compatible HF electrical stimulation system significantly enhanced matrix maturation and mineralization of osteoblasts and osteodifferentiating mesenchymal stem cells (Fig. 1). HF stimulation induced osteoconductive effects on pre-osteoblasts, including increased ALP activity, collagen-I synthesis, matrix and mineral deposition. An innovative proteomic analysis on microvesicles secreted by electrically stimulated osteoblasts revealed specific pathways of osteodifferentiation and matrix mineralization favored by the electric stimulation. HF stimulation also enhanced collagen-I synthesis and hydroxyapatite deposition by osteodifferentiated stem cells.

This work provides insights on a novel cosurface capacitive system, validating a stimulation setup of high osteoinductive and osteoconductive in vitro performance. These promising cosurface stimulators may be integrated in novel bioelectronic implants, aiming for bone-implant interface monitoring and personalized therapeutics.





# Effect of Exercise Training among Patients with Resistant Hypertension: EnRich Trial

Susana Lopes<sup>1</sup>, José Mesquita-Bastos<sup>1</sup>, Catarina Garcia<sup>2</sup>, Daniela Figueiredo<sup>3</sup>, Jorge Polonia<sup>4</sup>, Alberto J. Alves<sup>2</sup>, Fernando Ribeiro<sup>1</sup>

Resistant hypertension is a complex condition characterized by the limited success of the available treatment options to lower blood pressure, namely antihypertensive drugs and renal denervation. It is an important medical and societal concern given its economic and health-related burden. In addition to the cost of multiple medications, those with resistant hypertension show higher risk of myocardial infarction, stroke, heart failure, chronic kidney disease or death. Although exercise is recommended globally as a first-line approach for the treatment of hypertension, it is with great delay that its efficacy is tested in resistant hypertension. The Exercise Training in the Treatment of Resistant Hypertension (EnRich) trial was designed to test with a rigorous design if aerobic exercise training compared with usual care indeed reduces blood pressure among patients with resistant hypertension. Sixty patients were randomized (1:1 ratio) to a 12-week

moderate-intensity (50-70% VO<sub>2</sub>max) aerobic exercise program, 3 sessions per week, added to usual care or a usual care group. The aerobic exercise reduced 24-hour and daytime ambulatory blood pressure as well as office systolic blood pressure, by 7.1/4.4, 8.4/5.7 and 10 mm Hg, respectively, and improved cardiorespiratory fitness and several biomarkers of cardiovascular risk. These results provide clinicians with evidence to embrace moderate-intensity aerobic exercise as a coadjutant therapy targeting this patient population. The EnRich results were published in renowned journals (e.g. JAMA Cardiology) and presented at several congresses. EnRich had a relevant scientific and societal impact being awarded with several prizes (e.g. Menção Honrosa, in Prémios Nunes Correa Verdades de Faria, SCML 2022, and Boas Práticas de Envelhecimento Ativo e Saudável categoria Saúde+, CCDRC 2019, best oral communication and travel grants).

1 – School of Health Sciences & iBiMED, University of Aveiro

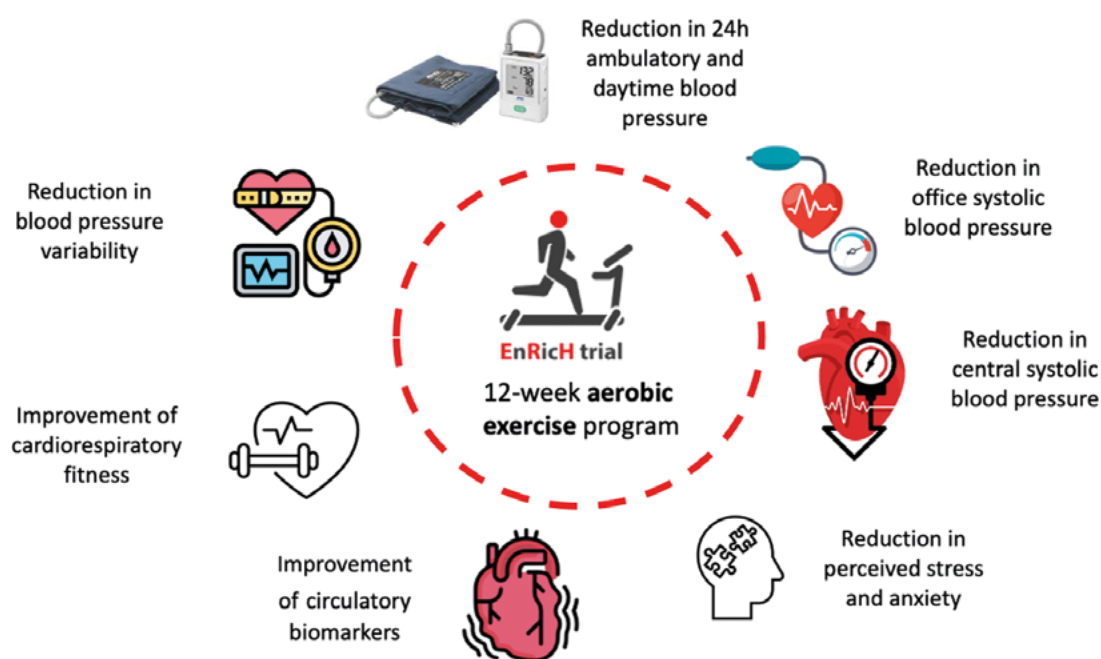
2 – Research Center in Sports Sciences, Health and Human Development (CIDESD), University Institute of Maia

3 – School of Health Sciences & CINTESIS@RISE, University of Aveiro

4 – Faculty of Medicine, Centre for Health Technology and Services Research (CINTESIS), University of Porto

## FIGURE 1

Benefits of the 12-week aerobic exercise program of the EnRich trial among patients with resistant hypertension.



# High-root topological insulators

Anselmo Marques<sup>1</sup>, Luísa Madail<sup>1,2</sup>, Ricardo Dias<sup>1</sup>

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<sup>2</sup> – International Iberian Nanotechnology Laboratory, Braga

**FIGURE 1**

Three times squarable sine-cosine topological chain on top, with its successive squared version below, whose energy spectra are shown in the same color at the right.

**FIGURE 2**

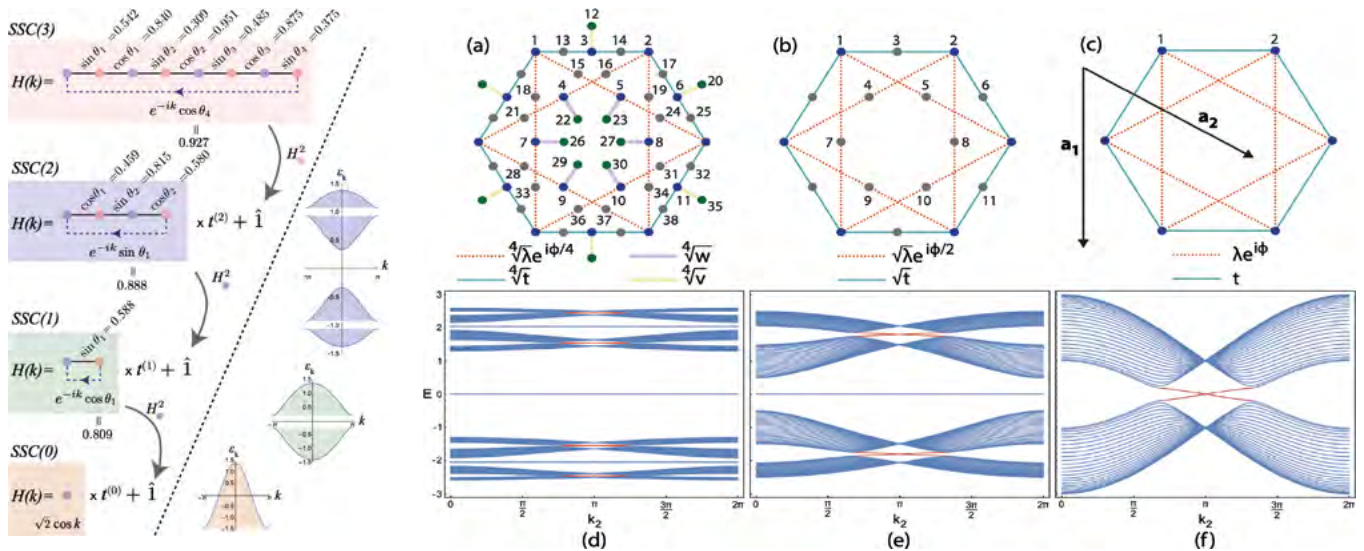
Plaquette of the Haldane model in its (a) quartic-root, (b) square-root, and (c) original version. The respective energy spectrum of each case for a ribbon geometry (open along  $a_1$  and periodic along  $a_2$ ) is shown below in (d)-(f), with bulk (edge) bands in blue (red).

Topological insulators (TIs) are materials with an electronic insulating bulk and conductive edge states, which are protected by the presence of certain symmetries in the model, meaning that they are robust against perturbations that respect these symmetries. Recently, it has been shown that to obtain the topological invariants of a class of TIs with finite energy topologically protected states, modified approaches are required such as the squaring of the Hamiltonian. This approach defines the so-called squared-root topological insulators (SRTIs) and relies on the fact that the square of the SRTI Hamiltonian in the Wannier basis is a block diagonal matrix. More precisely, it is the direct sum of two blocks that have the same spectrum but different eigenstates (one of the blocks being the Hamiltonian of a known topological insulator).

An extension of the SRTI concept has been proposed in our works below, which may be described as a generalized root of order  $2n$  (a square-root operation applied  $n$  times) of a tight-binding model. The latter

model may be topological to start with or, if not, topological behavior may be introduced at any given step of the sequence of  $n$  square-root operations. We label these Hamiltonians as High-Root Topological Insulators (HRTIs). Squaring  $n$  times a HRTI, we obtain an outwards directed rooted tree (arborescence in graph theory) which connects the HRTI to the multiple diagonal blocks in the  $n$ -times squared Hamiltonian [with at least one of the arborescence nodes/blocks corresponding to the Hamiltonian of the known topological insulator].

In Fig. 1, we show an example of a 23-root 1D linear chain on top, which requires 3 squaring operations to arrive at the smaller parent model on the bottom, with the respective energy spectrum at each step shown at the right. In Fig. 2, starting from the 2D Haldane model in (c), we derive its square- and quartic-root versions in (b) and (a), respectively. The bottom row shows their respective energy spectra, where the number of topological edge bands is seen to increase with the root degree of the model.





# Laser-Induced Graphene: from physical sensing to electrochemical biosensors

Nuno F. Santos<sup>1</sup>, Bohdan Kulyk<sup>1</sup>, Sónia O. Pereira<sup>1</sup>, Alexandre F. Carvalho<sup>1</sup>, António J. S. Fernandes<sup>1</sup>, Florinda M. Costa<sup>1</sup>

The ability to directly synthesize laser-induced graphene (LIG) on different carbon-containing flexible materials such as polyimide and paper (Fig. 1) opens the door to a wide range of potential applications, from consumer electronics to biomonitoring. LIG, with its foamy graphene structure having high specific area, is inexpensive, fast, and easy to produce when compared to many other forms of graphene. This way, electrically conductive paths can be promptly defined on insulating substrates by selective laser scribing.

Using this approach, several sensors employing LIG were developed (Figure 2). LIG scribed tracks defining electrical circuits on paper enabled the fabrication of strain and bending sensors based on the intrinsic piezo-resistive response of this exciting material, attaining a gauge factor of 42 for the former [1]. Also,

LIG electrodes were fabricated and successfully used in electrochemical sensors to detect dopamine with excellent sensitivities, for both LIG produced with IR (10600 nm) and UV (355 nm) radiation [2]. Additionally, the electrochemistry of glucose oxidase adsorbed by LIG electrodes demonstrated its adequacy for glucose biosensors, taking advantage of LIG's superior electron transfer characteristics and high surface area [3]. These results open the door to novel applications in environmentally friendly, low-cost, flexible point-of-care sensing platforms for personalized medicine scenarios.

<sup>1</sup> – Department of Physics & i3N, University of Aveiro

**FIGURE 1**

Schematic illustration and electron microscopy images depicting the conversion of polyimide and paper into laser-induced graphene (LIG).

**FIGURE 2**

Schematic illustration and response of different chemical and physical LIG sensors.

[1] Laser-Induced Graphene from Paper for Mechanical Sensing

B. Kulyk, B.F.R. Silva, A.F. Carvalho, S. Silvestre, A.J.S. Fernandes, R. Martins, E. Fortunato, and F. M. Costa  
ACS Appl. Mater. Interfaces. (12 pgs) 2021.

<https://dx.doi.org/10.1021/acsami.0c20270>

[2] IR and UV Laser-Induced Graphene: Application as Dopamine Electrochemical Sensors

N.F. Santos, S.O. Pereira, A. Moreira, A.J.S. Fernandes, F.M. Costa

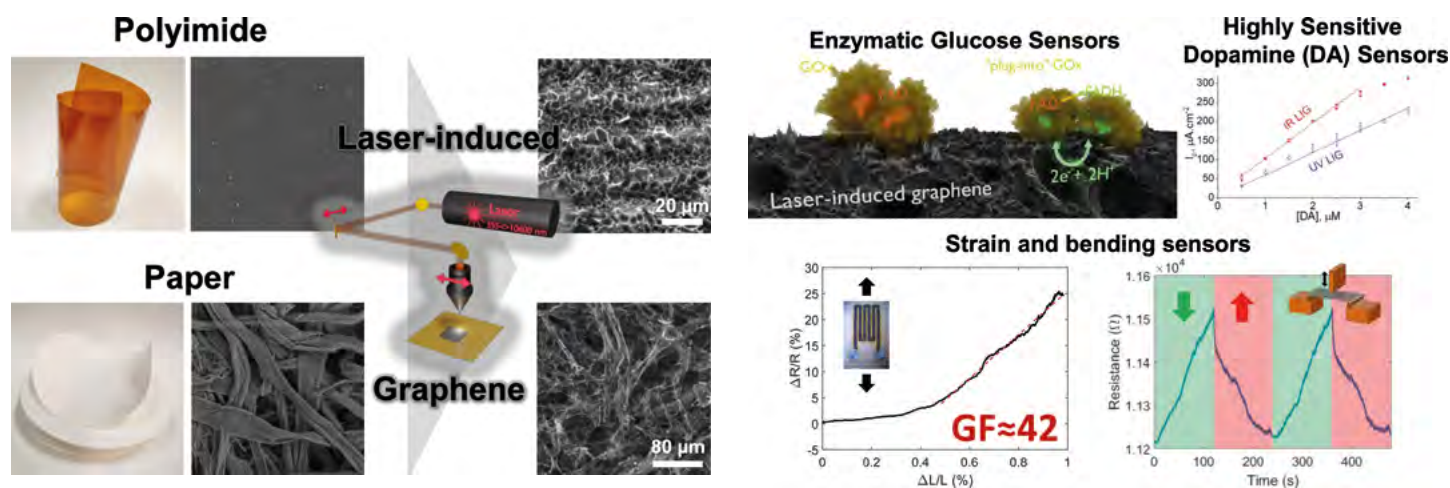
Advanced Materials Technologies, 2021, 6(6) (13 pgs) 2100007. <https://doi.org/10.1002/admt.202100007>

[3] Electrochemical response of glucose oxidase adsorbed on laser-induced Graphene.

S.O. Pereira, N.F. Santos, A.F. Carvalho, A.J.S. Fernandes, F.M. Costa

Nanomaterials, 11(8), 1893 (18 pgs) 2021.

<https://doi.org/10.3390/nano11081893>



# Microwave versus conventional porcelain firing: the effect on the colour

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1 – Department of Physics & i3N, University of Aveiro  
2 – Porcelanas da Costa Verde S.A., Vagos  
3 – CTCV, Coimbra  
4 – Department of Mechanical Engineering & TEMA, University of Aveiro

**FIGURE 1**

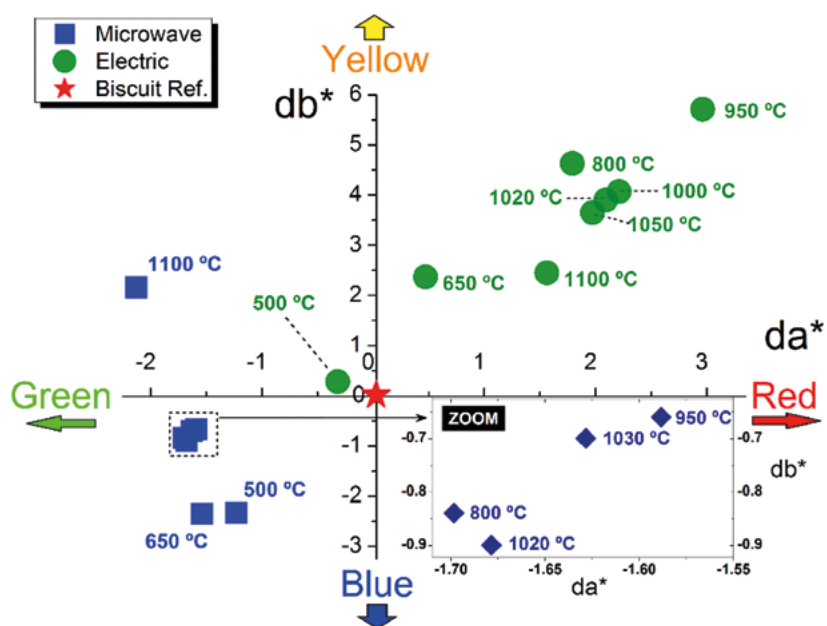
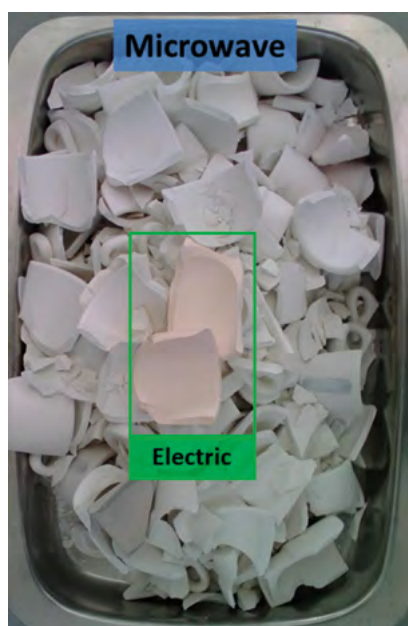
Fragments of samples fired in the microwave and electric furnaces.

**FIGURE 2**

Space colour coordinates ( $a^*$  and  $b^*$ ) relative to the biscuit reference sample. Samples fired up to 1100 °C in both microwave and electric furnaces are presented.

Porcelain undergoes several transformations during firing with associated colour changes, which depend mainly on the impurities of the raw materials, the surrounding atmosphere, and the firing temperature. During the process of firing, the raw materials are subjected to a set of chemical and physical transformations, with mullite, quartz and a vitreous amorphous phase being the main constituents of the fired ware. Some transformations are responsible for colour changes, such as the kaolinite dehydroxylation that starts at around 450 °C – 600 °C, depending on several factors such as its order-disorder state. The heating technology also seems to affect the ware's colour. Microwave heating technology is an alternative firing technology, without compromising the porcelain quality and mechanical performance, with gains in the manufacturing time and energy efficiency, having lower emission of pollutant gases when used in the manufacturing of such products.

This work analyses the colour of microwave and electrically fired samples from room to temperatures up to slightly above 1400 °C, and compares their colours with that of the reference samples gas fired. Below 1100 °C, the colour of the microwave fired samples is within the green-blue spectra, and the colour of the electrically fired samples is within the yellow-red spectra. Above 1100 °C, and up to 1400 °C, the colour of the microwave fired samples converge to the yellow-red spectra, as to the colour of the reference samples. Microwave heating promotes faster crystallochemical transformations, occurring at lower temperatures, responsible for the colour differences, especially for firing temperatures below the porcelain's eutectic temperature. This study aims to a better understanding of microwave porcelain firing, focusing on the reasons behind the observed colour differences when compared with conventional firing.





# Allergen.me – Development of a universal code for the assessment of allergens presence in food products

Ivo Fonseca<sup>1</sup>, Mário Vairinhos<sup>1</sup>, Joana Quental<sup>1</sup>, André Moreira<sup>2</sup>

Food allergies are a health problem that affects around 10% of the European population, mostly children. The prophylaxis of this disease depends mainly on searching, reading and understanding the labels present on food products. Factors such as the disparity between label formats, poor legibility or confusing textual information contribute to making labelling difficult to read for the general population, and completely inaccessible to the traditionally more excluded sectors of the population such as seniors or people with cognitive difficulties.

This research addresses the problem of communicating food information regarding the presence of allergens to a diverse population. A theoretical stance was taken as to consider that information as being situated and embodied, that is, in which the creation of meaning takes place through the interaction of a body with a world endowed with physical, social and cultural context. Based on this stance, allergen.me was developed: an allergen communication system centered on a visual code suitable for use by people with distinct bodily capabilities and different cultural backgrounds, accessible both through action with an analog code (specifically, a personalized card) and a digital app configured with the user's preferences. The influence of the physicality and spatiality of the card in the interpretation of the code and in the

context of social interaction induces the adoption of behaviors that facilitates embodied cognition, such as the metaphorical mapping of information, the expansion of social organization of action and the use of epistemic actions. Through a phenomenological research approach that involved the collaboration and evaluation by food allergy sufferers and relatives, it was observed that the proposed system presented a high level of subjective understanding, reduced cognitive effort in the process of identifying food allergens, and has been observed to be more accessible to people with visual and cognitive impairments than the commonly used allergen communication solutions.

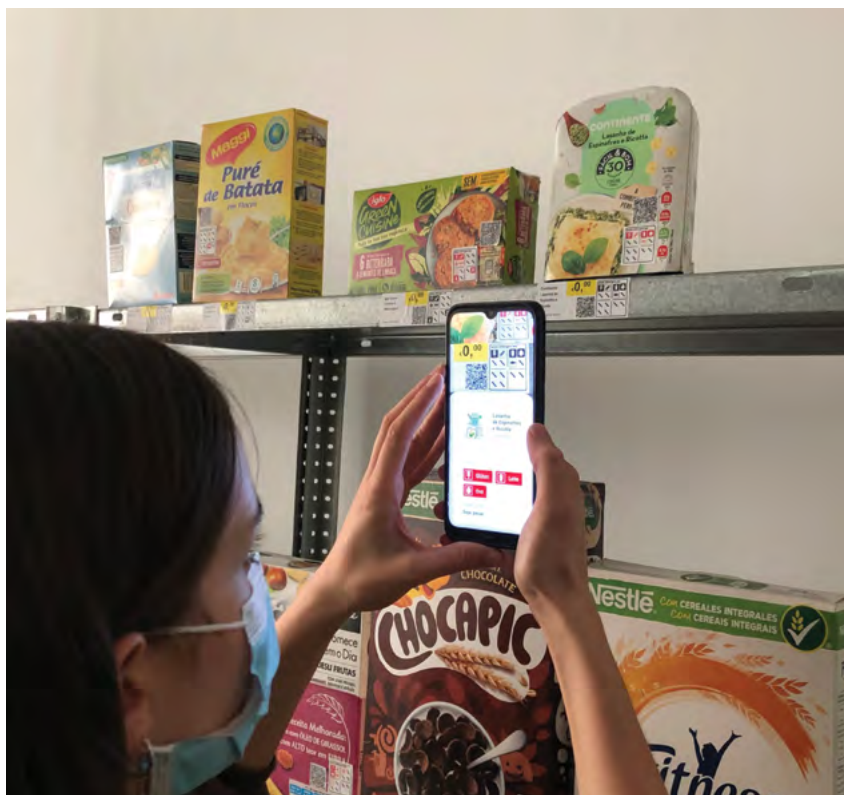
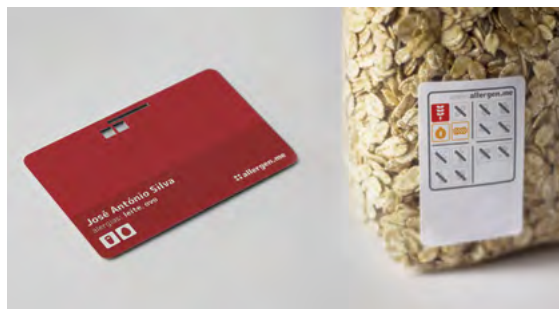
1 – Department of Communication and Arts & ID+, University of Aveiro  
2 – Faculty of Medicine, University of Porto

**FIGURE 1**

Example of a personal allergen identification card, together with a food product with the visual code of the allergen.me system.

**FIGURE 2**

App of the allergen.me system during an evaluation session.



# Paving the road towards Collaborative Augmented Reality

Bernardo Marques<sup>1</sup>, Samuel Silva<sup>1</sup>, António Teixeira<sup>1</sup>, João Alves<sup>1</sup>, Tiago Araújo<sup>2</sup>, Tiago Madeira<sup>1</sup>, Carlos Ferreira<sup>3</sup>, Andreia Santos<sup>4</sup>, António Rocha<sup>5</sup>, Paulo Dias<sup>1</sup>, Beatriz Sousa Santos<sup>1</sup>

1 – Department of Electronics, Telecommunications and Informatics & IEETA, University of Aveiro

2 – Department of Electronics, Telecommunications and Informatics, University of Aveiro & Federal University of Pará

3 – Department of Economics, Management, Industrial Engineering and Tourism & IEETA, University of Aveiro

4 – Department of Geosciences & GEOBIOTEC, University of Aveiro

5 – Bosch Thermotechnology S.A., Aveiro

## FIGURE 1

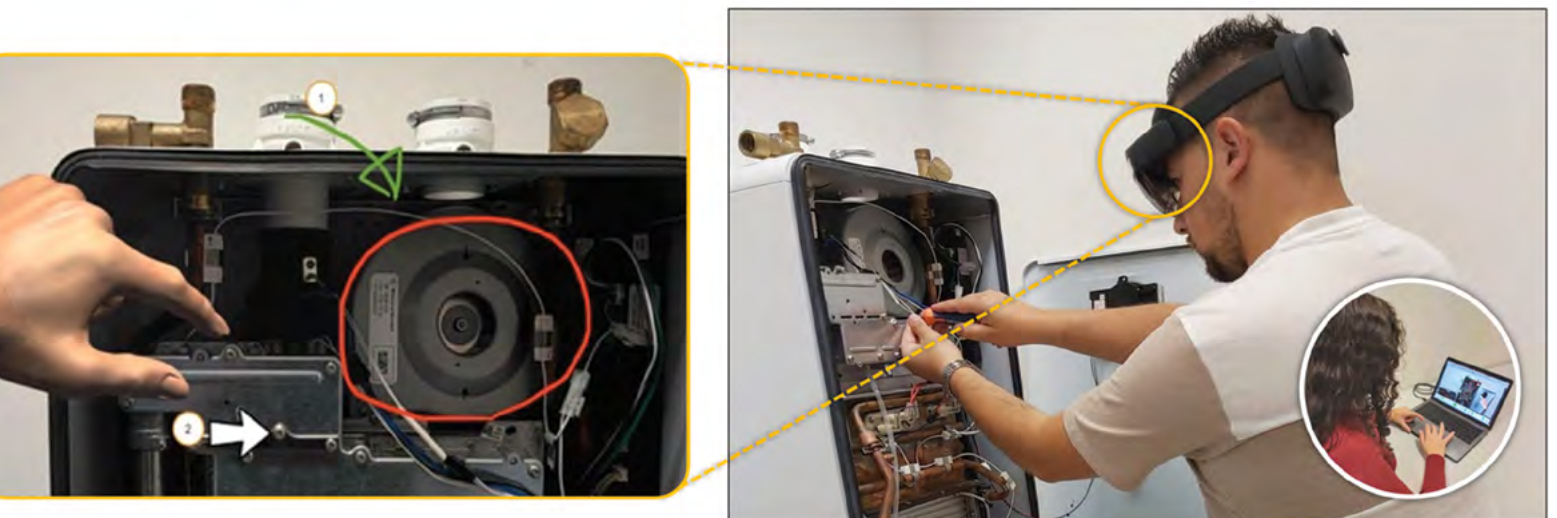
Scenario of remote collaboration supported by Augmented Reality (AR). The on-site technician can visualize the instructions suggested by the remote expert on top of the real-world environment while conducting a maintenance procedure in a hands-free setting.

The world is facing a new reality, becoming an increasingly complex and connected ecosystem where problem resolution often requires a wide range of expertise that is not available from single individuals. To this end, collaboration is a key instrument of human progress, but remote scenarios are increasingly common and challenging to address. To support collaboration, researchers have been exploring Augmented Reality (AR) by overlaying responsive computer-generated information on top of real-world environments. This has proven to be a powerful tool for analysis, discussion, and resolution of complex activities, given the ability to enhance situation understanding.

This research analyzes the maturity of Collaborative AR research and identifies that while much has been advanced regarding the overall technologies, the field faces barriers to its evolution. At the onset of these limitations is a lack of a more systematic understanding of which aspects are core to how these systems support collaboration. Building on the experience gathered with industrial partners, to whom these aspects are central, the authors propose a collaboration-centered

characterization of Collaborative AR systems going beyond the common approach of focusing on the technological apparatus. Instead, the authors argue that dimensions, such as the characteristics of the team, how it communicates, and how each individual interacts with the system are paramount to both define and understand how collaboration unfolds and to improve how research should be analyzed and reported.

The proposed taxonomy offers a broader and more systematic perspective over Collaborative AR and provides the grounds to establish a roadmap for future advances in bringing remote collaboration to a higher level of efficiency and user experience. In the long run, this should contribute to the development of an infrastructure for resilient knowledge transfer and provide an agile response to support problem solving.





# Automatic analysis of artistic paintings using information-based measures

Jorge Silva<sup>1</sup>, Diogo Pratas<sup>1,2</sup>, Rui Antunes<sup>1</sup>, Sérgio Matos<sup>1</sup>, Armando Pinho<sup>1</sup>

Artistic paintings are concrete visual expressions of human evolution and creativity to share emotions, values, visions, beliefs, and trends of history and culture. Likewise, creating, interpreting, and analyzing artistic paintings is complex and hard to compute because it is a social, contextual and subjective process.

One nontrivial aspect of artistic paintings analysis is measuring the information contained in those paintings. In particular, artistic paintings contain information correlated to schools, periods, and artists.

The artistic community widely uses automatic computational analysis of artistic paintings for authentication of artistic paintings. Currently, this process does not substitute human experts completely; however, it is an essential additional control for fraud. Furthermore, new techniques can be helpful in authorship attribution, fraud detection, art style categorization and art content explanation.

We introduce novel solutions for automatic computational analysis of artistic paintings to address the problems of artist authentication. Specifically, we analyze how different authors expose information in their works of art. Furthermore, we infer what information quantification can tell us about the author's style, way of painting, and relationships with other authors.

To perform this analysis, we use Normalized Compression (NC) to calculate a local complexity matrix that characterizes each artist and use these matrices to construct a phylogenetic tree that portrays the relationships between artists in terms of how they compose their paintings. Finally, we use the regional complexity fingerprints and other auxiliary features to improve the state-of-the-art style and artist classification results. The complete study is supported by an extensive website (<http://panther.web.ua.pt>) for fast author characterization and authentication.

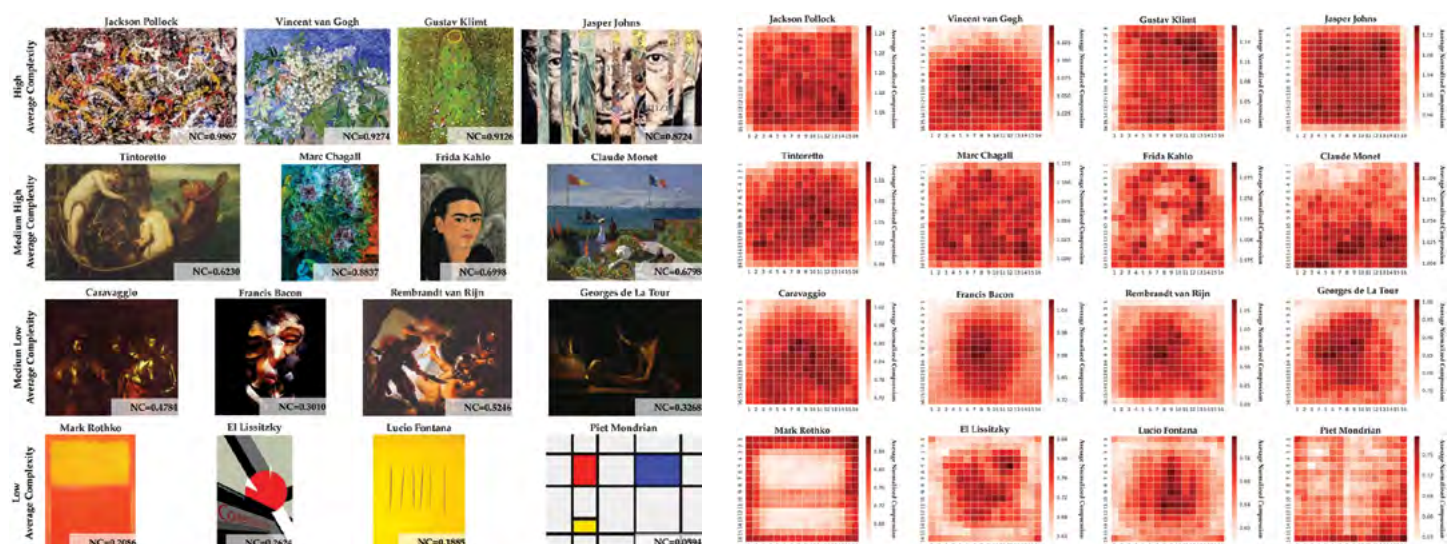
1 – Department of Electronics, Telecommunications and Informatics & IEETA, University of Aveiro  
2 – Department of Virology, University of Helsinki

FIGURE 1

Examples of artistic paintings with different levels of complexity. The Normalized Compression (NC) value of each painting is displayed in the lower right corner.

FIGURE 2

Heat maps of the local complexity matrix (fingerprint) of some authors, computed with the NC. This fingerprint shows the author's range of complexity and the locations in the canvas painted with more detail (or complexity). To see all matrices, please visit the website.



# A general approach to hand-eye calibration through the optimization of atomic transformations

Eurico Pedrosa<sup>1</sup>, Miguel Oliveira<sup>2</sup>, Nuno Lau<sup>1</sup>, Vítor Santos<sup>2</sup>

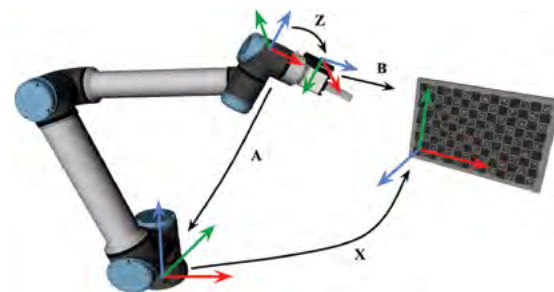
<sup>1</sup> – Department of Electronics, Telecommunications and Informatics & IEETA, University of Aveiro

<sup>2</sup> – Department of Mechanical Engineering & IEETA, University of Aveiro

**FIGURE 1**

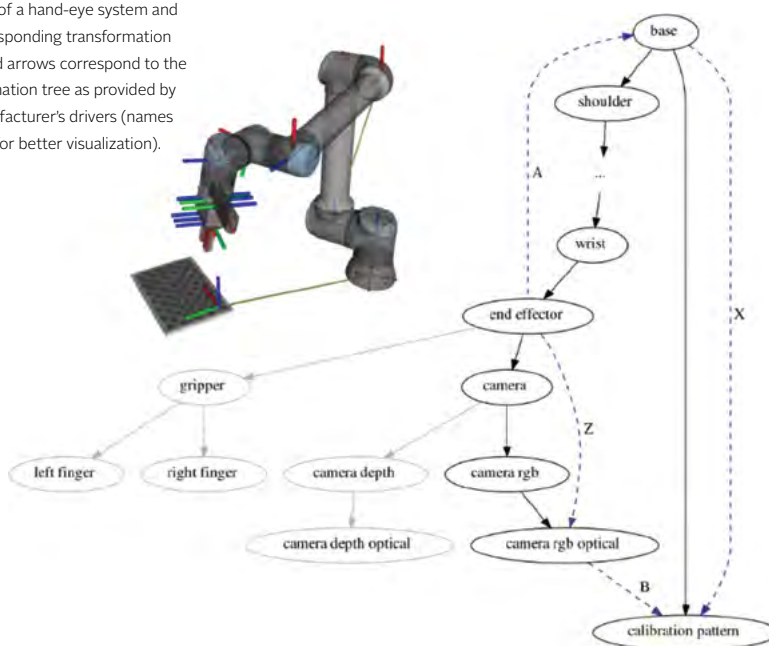
Visual representation of the hand-eye problem. A represents the known geometric transformation from the hand to the robotic arm base, B denotes the known transformation from the eye to the calibration pattern, X specifies the unknown transformation from the robotic arm base to the world object, and Z is the unknown transformation from the hand to the eye.

To operate adequately, robotic systems must have an accurate estimate of the pose of each sensor with respect to each other or to a common frame, a critical requirement for the process of data fusion. A well-known calibration problem is the hand-eye calibration (Fig. 1). It can be defined as the process of estimating the transformation between the end-effector (i.e., the hand of a robotic arm) and a camera (i.e., the eye) mounted somewhere on that end-effector.



**FIGURE 2**

Example of a hand-eye system and the corresponding transformation tree: Solid arrows correspond to the transformation tree as provided by the manufacturer's drivers (names adapted for better visualization).



Our proposal for general hand-eye calibration makes use of a bundle adjustment like optimization framework for intrinsic and extrinsic calibration anchored on the reprojection error. Furthermore, it requires the definition of a transformation tree graph (Fig. 2), which contains topological information about the relationship of coordinate frames in the system. This data structure enables the efficient retrieval of the unique topological route from one point in the graph to another, i.e., the path from one frame to another. By preserving the original complete chain of partial transformations, it is possible to generalize the entirety of the hand-eye calibration problem. We refer to these transformations as atomic transformations, in the sense that they are not aggregated, i.e., they are indivisible. The method that we propose uses these atomic transformations to formulate the optimization procedure. As such, we refer to it as ATOM.

Our approach is seamlessly integrated with the robot operating system framework (ROS) and allows for the interactive positioning of sensors and labeling of data, facilitating both the data acquisition and labeling and the calibration procedures. Results show that the proposed approach can handle any calibration use case with a minimal initial configuration. The approach is compared with several other state-of-the-art hand-eye calibration algorithms and the results show that the approach produces accurate calibrations when compared to the state of the art.



# 5GAlner: Portugal 5G+IA Networks Reliability Center

José Quevedo<sup>1</sup>, André Perdigão<sup>2</sup>, David Santos<sup>2</sup>, Rui Silva<sup>2</sup>, Rui Aguiar<sup>2</sup>

The 5GAlner initiative brings together different stakeholders, namely academics, operators, vendors and vertical industries. The goal is to facilitate vertical markets’ digital transition to 5G by providing an environment for easy innovation, development, and experimentation. Covering a broad 5G ecosystem, the aggregated expertise not only potentiates the evolution of mobile communications technologies, but also the creation, consolidation and validation of novel business models. Additionally, the resulting insights drive the development of advanced functionalities that empower verticals with high-performant, easy-to-use shareable solutions, thus fostering the adoption of 5G technologies.

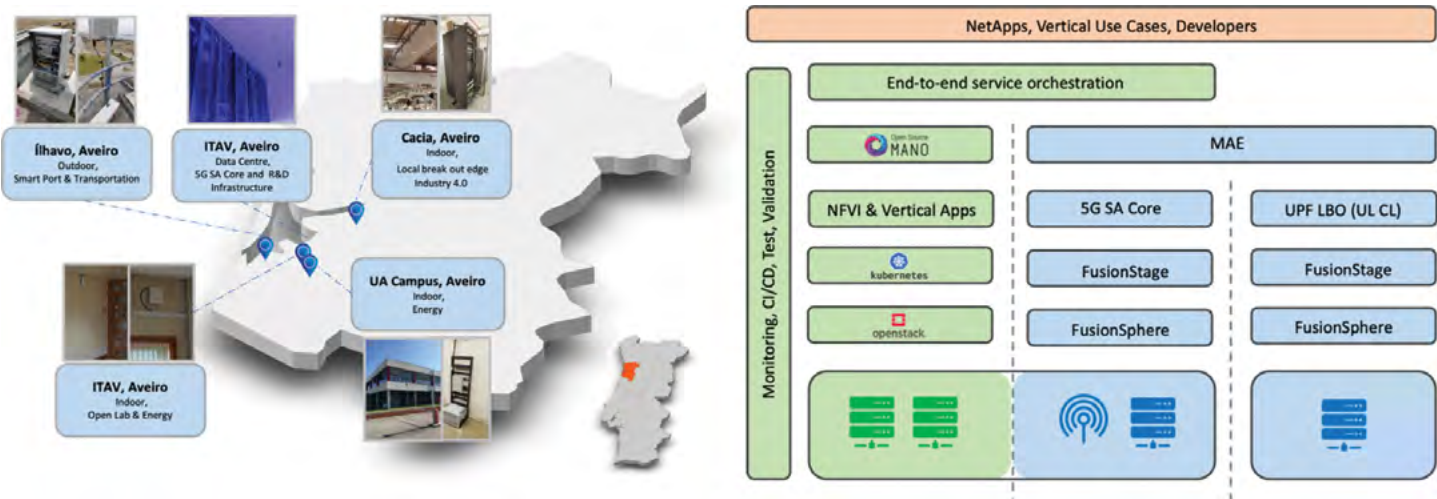
The 5GAlner infrastructure includes resources with very disparate characteristics, creating an ideal environment for technological innovation and validation. High-end research-grade resources are leveraged for going from early concept development into proof-of-concept prototypes which can later go into an end-of-line validation on state-of-the-art commercial-grade 5G SA equipment. The infrastructure is continuously evolving and open for collaboration and experimentation, thus increasing the reach of the platform and associated tools.

Overall, 5GAlner provides a real-life environment for developing, integrating and testing novel solutions for 5G and beyond technologies. With various use cases already running (e.g., Industry 4.0, Transportation, Energy), 5GAlner is increasing the 5G awareness of vertical industries (e.g., Bosch, EFACEC) and has been providing support to national and international projects (e.g., H2020 5GASP, H2020 5Growth, P2020 Augmanity, Portuguese 5G mobilizer). As a result, the impact of this reference competence centre is not contained but spans over a plethora of technologies and applications, acting as an enabler to scientific innovation in multiple disparate domains.

1 – Institute of Telecommunications, University of Aveiro  
 2 – Department of Electronics, Telecommunications and Informatics & IT, University of Aveiro

**FIGURE 1**  
 5GAlner sites at (i) Aveiro Seaport, (ii) Institute of Telecommunications, (iii) University of Aveiro and (iv) Bosch Thermotechnology.

**FIGURE 2**  
 5GAlner infrastructure overview featuring both research-grade (in green) and commercial-graded (in blue) solutions..



# System-Aware Digital Signal Processing in Optical Communications

Manuel Neves<sup>1</sup>, Abel Lorences-Riesgo<sup>2</sup>, Paulo Monteiro<sup>1</sup>, Fernando Guiomar<sup>1</sup>

<sup>1</sup> – Department of Electronics, Telecommunications and Informatics & IT, University of Aveiro

<sup>2</sup> – Optical Communication Technology Laboratory, Paris Research Center, Huawei Technologies France.

**FIGURE 1**

Illustrative figure showcasing a communication-systems constellation before and after the correction of the laser phase noise impairment, through the usage of the developed technique..

**FIGURE 2**

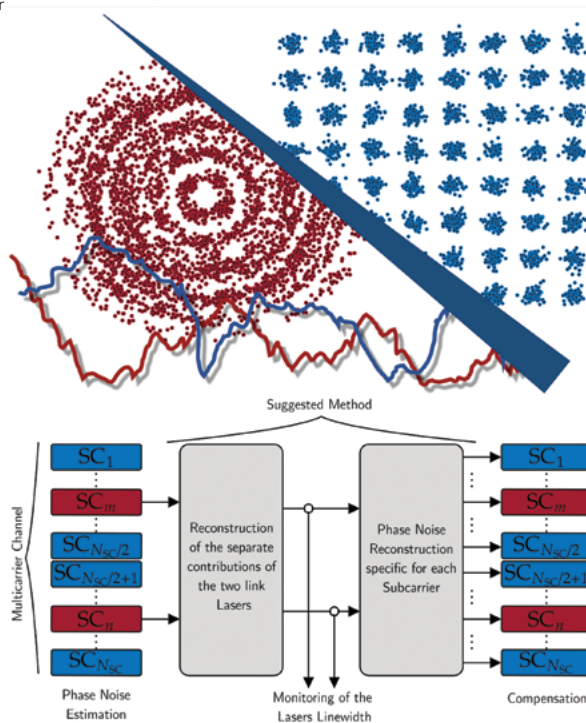
High-level diagram of the technique developed. SC stands for subcarrier, and NSC for the number of subcarriers of the considered system.

The average internet user does not often come across optical fibers, and thus naturally does not acknowledge their crucial role in our beloved internet. Optical fibers are indeed the backbone of internet systems, counting several millions kilometers laid around the globe. Making use of digital signal processing techniques, we can efficiently transmit information between any two arbitrary locations in the world.

Even though optical communications have initially taken a lot of knowledge and techniques from well-established radio-frequency communication theory, the restless demand for higher internet capacity, and subsequent interest in maximizing the communication rate per optical fiber cable, has brought to light some very own impairments specific to this domain. In this article, we

report the invention of a carrier-phase recovery (CPR) algorithm tailored to the optical fiber channel [1]. This innovative algorithm has been initially developed within the scope of an MSc thesis, leading to the publication of an article in the prestigious IEEE Journal of Lightwave Technology and also a PCT patent application (pending approval). Instigated by the practical benefits of the proposed CPR method for high-capacity optical fiber systems, this work has also captured the attention of major industrial players, ultimately leading to a collaboration between Instituto de Telecomunicações (IT) and Huawei Technologies France. In this collaboration, a dedicated experimental campaign has been carried out, leading to a highly scored publication in the top European conference in the field [2,3].

This work, which has been developed within the Optical Communication Systems and Networking research group of IT, is part of a broader research line that encompasses multiple innovative contributions on different aspects of advanced digital signal processing, modulation and coding for Terabit-capacity modern optical communication systems, leading to an effective transfer of knowledge between the academic and industrial realities, being these achievements greatly supported by the Optical Radio Convergence Infrastructure for Communications and Power Delivering infrastructure (ORCIP).



- [1] M. S. Neves, P. P. Monteiro and F. P. Guiomar, "Enhanced Phase Estimation for Long-Haul Multi-Carrier Systems Using a Dual-Reference Subcarrier Approach," in *Journal of Lightwave Technology*, vol. 39, no. 9, pp. 2714-2724, 1 May 2021.
- [2] C. S. Martins et al., "Maximizing the Performance of Digital Multi-Carrier Systems with Transmission-Aware Joint Carrier Phase Recovery," 2021 European Conference on Optical Communication (ECOC), 2021, Paper Tu4C2.6.
- [3] M. S. Neves et al., "Leveraging Dispersion-Aware Phase Recovery for Long-Haul Digital Multi-Carrier Transmission: An Experimental Demonstration," in *Journal of Lightwave Technology* (Early Access).



# Can porphyrinoids defeat cancer?

Nuno Moura<sup>1</sup>, Catarina Ramos<sup>1</sup>, Mariana Mesquita<sup>1</sup>, Ana Monteiro<sup>1,2</sup>, Sara Gamelas<sup>1</sup>, Filipe Morais<sup>1</sup>, Cristina Dias<sup>1</sup>, Carla Santos<sup>1,3</sup>, Sara Fateixa<sup>2</sup>, Tito Trindade<sup>2</sup>, Amparo Faustino<sup>1</sup>, Graça Neves<sup>1</sup>

Nowadays, malignant disorders are the second leading cause of death worldwide and are induced by the uncontrolled growth of abnormal cells resulting from DNA mutations. Despite the recognized advances in cancer treatments, alternative strategies are still required to overcome some drawbacks of the current treatments, such as severe radiation damage, limited applicability, lack of specificity, and acute side effects. In this sense, Photodynamic Therapy (PDT) has been pointed out by the scientific and medical communities as one of the most promising approaches for the treatment of malignant diseases. Among the organic-based photosensitizers (PS), porphyrinoids are the most studied, and some were already approved for clinical use.

Our group developed several strategies to improve the efficiency of meso-tetraarylporphyrins PS against malignant diseases. Water-soluble 5,10,15,20-tetrakis(1-methylpyridinium-4-yl)porphyrin (TMPyP) and its tetracationic pyridinium inverted analog showed to

be efficient PS to kill MCF-7 breast cancer cells via autophagic flux and necrosis (Fig. 1-left). TMPyP and its metallo complexes are also able to stabilize DNA G-Quadruplexes (G4), thus inhibiting the telomerase activity, which is a useful approach in anticancer drug design (Fig. 1-right). Furthermore, non-charged reduced porphyrin derivatives can be considered as PS when incorporated into micelles. This strategy allows to improve their water-solubility and retain their PS properties, enabling apoptosis-mediated death of PC-3 prostate cancer cells (Fig. 2). Another approach involved the immobilization of both neutral and cationic porphyrin derivatives in graphene oxide (GO) and graphene quantum dots (GQDs). The porphyrin@carbon nanomaterials displayed enhanced PS ability against T24 bladder and T47D breast cancer cells, demonstrating the potential of graphene-based nanomaterials as platforms to deliver porphyrin-based PS without compromising their photosensitization capability (Fig. 2).

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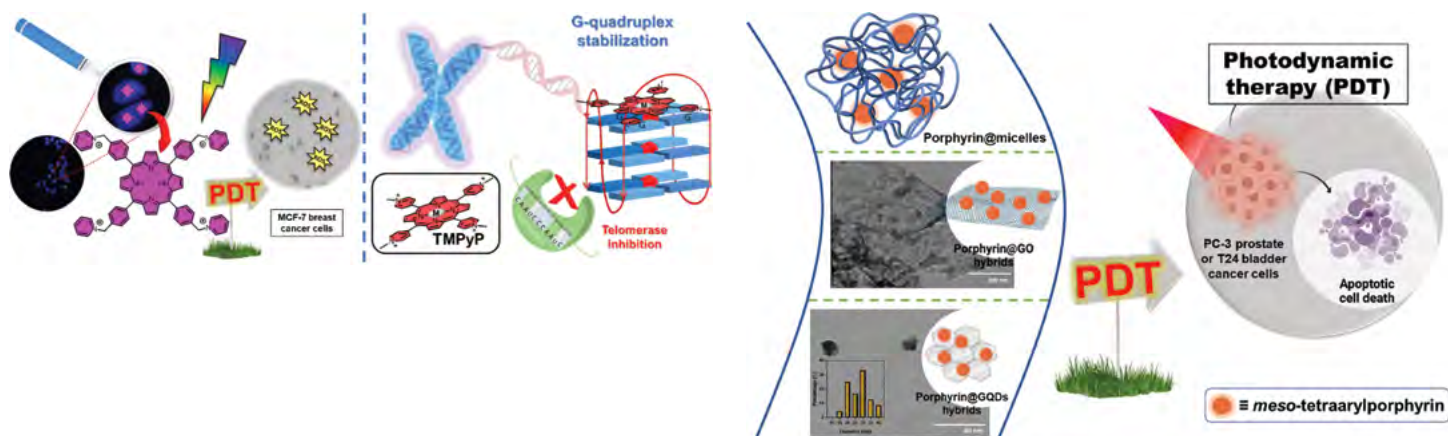
3 – Instituto Superior Técnico & CQE, University of Lisbon

FIGURE 1

PDT approach towards MCF-7 breast cancer cells (left) and G4 stabilization/telomerase inhibition by cationic meso-tetraarylporphyrins (right).

FIGURE 2

Incorporation of porphyrin derivatives into micelles and immobilization into carbon-based nanomaterials as effective strategies to deliver PS for PDT.



# Targeting Protein Aggregation with Steroid-Quinoline Hybrids and Chromeno[3,4-*b*]xanthenes

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## FIGURE 1

Steroid-quinoline hybrids with wide and marked disaggregation capacities. Micrographs of cells incubated with Aβ1–42 alone (left) or in combination with compound 4c (center) or 6c (right).

## FIGURE 2

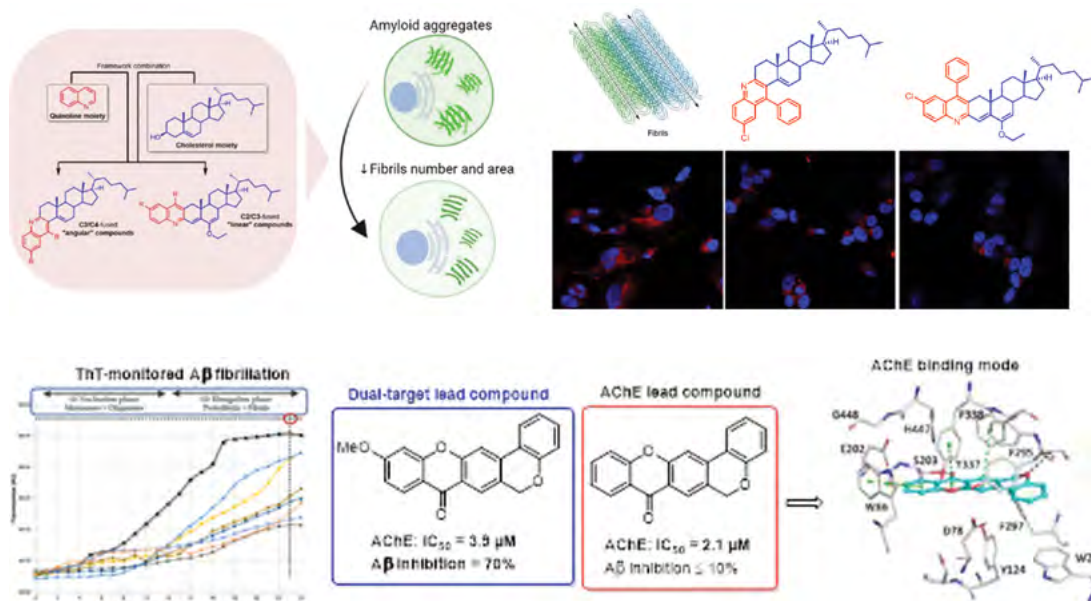
Chromeno[3,4-*b*]xanthenes as first-in-class AChE and Aβ-aggregation dual-inhibitors. In vitro inhibition of Aβ-self aggregation (left); Aβ1–42 and AChE dual-target lead compounds (center); AChE binding mode of chromeno[3,4-*b*]xanthenes (right).

Inhibiting and/or reversing protein aggregation is a vital tool to fight protein-misfolding disorders such as Alzheimer's, Parkinson's, and cardiovascular diseases. The most recognizable type of protein aggregation is perhaps the amyloid-β, associated to Alzheimer's disease. Different types of small-molecule compounds have been developed in attempting to stop the Aβ1–42 aggregation, which ultimately leads to the formation of senile plaques. It seems that hitting protein aggregation alone is not enough to provide disease-modifying effects. Therefore, the drug discovery paradigm for conformational disorders is shifting for multi-target compounds, designed to hit protein aggregation in combination with other targets. Following this quest, we develop two types of multi-functional compounds - Steroid-Quinoline Hybrids and Chromeno[3,4-*b*]xanthenes (Fig. 1 and 2).

The Steroid-Quinoline Hybrids were designed as hydrophobic structures, based on the framework combination approach. This set of non-toxic compounds

proved their efficacy inhibiting the Aβ 1–42 self-aggregation in vitro by delaying the growth phase and/or reducing the number of fibrils in the steady state (Fig. 1). Their efficacy was further demonstrated against pre-aggregated Aβ1–42 peptides in cellular assays in neuroblastoma cells, as they reverted both the number and the average area of fibrils back to basal levels (Fig. 1). The anti-aggregation effect of these hybrids was further demonstrated in a cellular model of general protein aggregation expressing a protein aggregation fluorescent sensor (Fig. 1).

Chromeno[3,4-*b*]xanthenes were designed, synthesized, and evaluated as first-in-class acetylcholinesterase (AChE) and Aβ aggregation dual-inhibitors (Fig. 2). The core structure of chromeno[3,4-*b*]xanthenes emerged as AChE lead with IC<sub>50</sub> of 2.1 μM, whether the methoxy-substituted derivative stood up as AChE and Aβ aggregation dual-inhibitor with IC<sub>50</sub> of 3.9 μM and 70% inhibition, respectively (Fig. 2).





# Microalgae are sustainable bio-factories of healthy lipids

Tiago Conde<sup>1,2</sup>, Daniela Coutov, Tânia Melo<sup>1,2</sup>, Margarida Costa<sup>3</sup>, Ana Figueiredo<sup>1</sup>, Bruna Neves<sup>4</sup>, Joana Silva<sup>3</sup>, Rosário Domingues<sup>1,2</sup>, Pedro Domingues<sup>1</sup>

The transition to more sustainable and healthier diets, capable of preventing non-communicable and age-related diseases, involves the development of new food sources and ingredients with high nutritional value, with sustainable production and reduced environmental impact. Microalgae are a sustainable and an alternative to traditional protein and lipid sources that can contribute to the transition to more environmentally friendly and healthier nutritional components, such as vitamins, proteins, and lipids. [1]

The mass spectrometry group of the Department of Chemistry of the University of Aveiro and its collaborators carried out an extensive lipidomic study of microalgae to describe the lipidomic profile and bioactivity [2-3], the best food grade lipid extraction methods [4] and how culture conditions influence the lipid profile of microalgae [5]. These findings contribute to the development of new lipid-rich microalgae-based nutraceuticals with great potential as human health supplements.



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4 – Department of Medical Sciences & iBiMED, University of Aveiro

**FIGURE 1**

Dry algae powder.



**FIGURE 2**

Liquid chromatography–mass spectrometer at the Chemistry Department of the University of Aveiro.

[1] Conde, T.A., et al. Microalgal lipid extracts have potential to modulate the inflammatory response: A critical review (2021) *International Journal of Molecular Sciences*, 22 (18), 9825.

[2] Conde, T.A., et al. Polar lipidomic profile shows *Chlorococcum amblystomatis* as a promising source of value-added lipids (2021) *Scientific Reports*, 11 (1), 4355.

[3] Conde, T.A., et al. Microalgae as sustainable bio-factories of healthy lipids: Evaluating fatty acid content and antioxidant activity (2021) *Marine Drugs*, 19 (7), 357.

[4] Couto, D., et al. Chemoplasticity of the polar lipid profile of the microalgae *Chlorella vulgaris* grown under heterotrophic and autotrophic conditions (2021), *Algal Research*, 53, 102128.

[5] Melo, T., et al. Ethanol extraction of polar lipids from *nannochloropsis oceanica* for food, feed, and biotechnology applications evaluated using lipidomic approaches (2021) *Marine Drugs*, 19 (11), art. no. 593 DOI: 10.3390/md19110593 (2021) *Marine Drugs*, 19 (8), 414.

# Prediction of fatalities for potential strong earthquakes in Portugal

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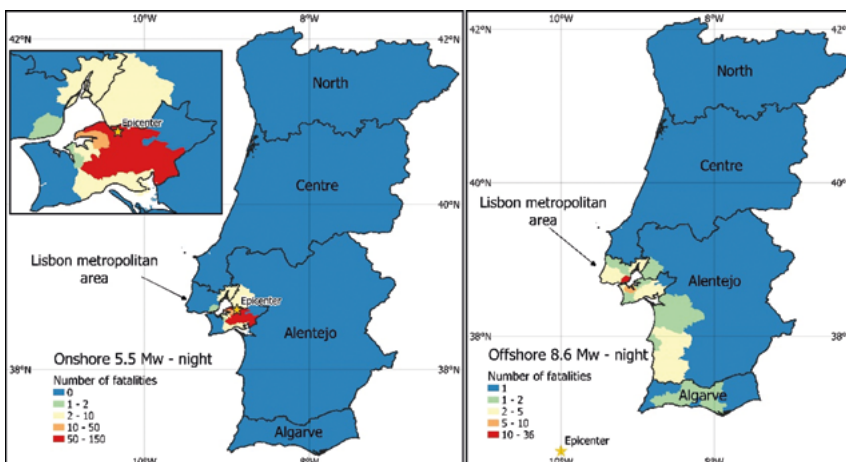
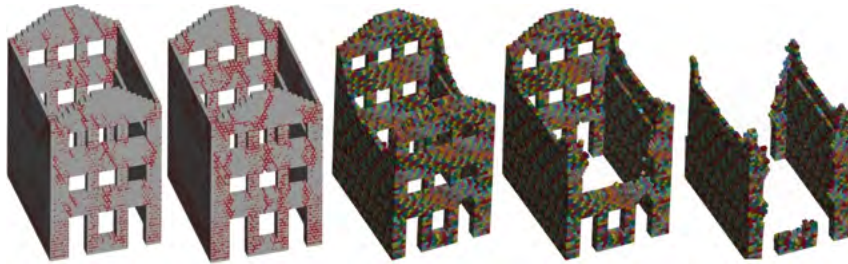
<sup>2</sup> – Department of Geography and Environmental Management, University of the West of England, United Kingdom

**FIGURE 1**

Distinct stages of damage for a 3-storey masonry building.

**FIGURE 2**

Onshore and Offshore earthquake scenarios for an event occurred during the night.



Earthquakes have demonstrated a high destructive power around the world producing both economic and human losses. The Portuguese masonry building stock has experienced strong earthquakes in the past (e.g. 1722 ~M6.0 Algarve, 1755 ~M8.5 Lisbon, 1909 M6.3 Benavente, 1969 M7.8 Algarve) demonstrating a poor performance.

The study started with a characterization of masonry buildings by gathering geometric and mechanical properties. After that, advanced numerical modelling was conducted to predict the response of masonry buildings against a set of earthquake records. The latter approach allowed us to implement an innovative

procedure for a more accurate assessment of fatalities. Outcomes were employed for the development of earthquake scenarios for the two most common sources of earthquakes in Portugal. An onshore M5.5 event was investigated, the latter is produced by a crustal fault at a very superficial depth. This is the critical event that can affect the Metropolitan Area of Lisbon because of its closeness to the populated area but also its superficial character. A second offshore M8.5 event was developed, in this case the event arises near the Pombal fault. The latter event affects a larger area but produces less losses, it could be explained because of the large distance at which the event takes place.

Simulations were performed at different times of the day (i.e. day and night) since the dynamic of the population changes accordingly. During the night, most of the population is at home, while during the day most people is in public but not in residential buildings. It was found that for events occurred during the night where 280 and 110 fatalities are predicted in average for onshore and offshore events, however the uncertainty around these values is still significant.

Research is still being conducted with promising results, outcomes might be used to aid the development of emergency response plans and the formulation of strategies for earthquake risk reduction.



# Sediment dynamics in artificial nourishments

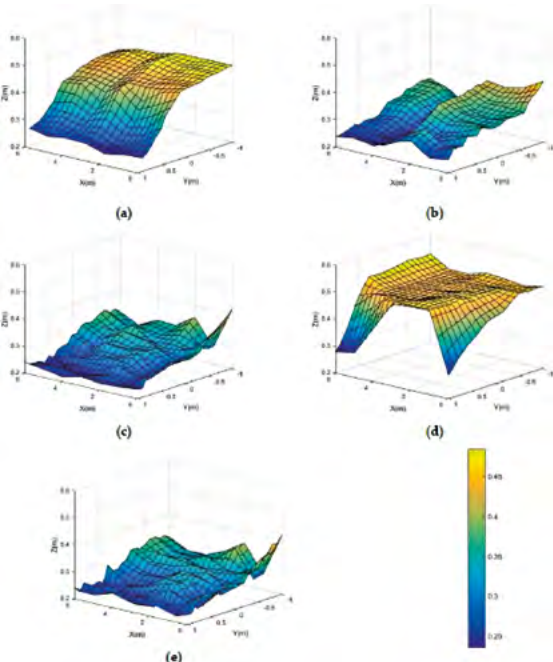
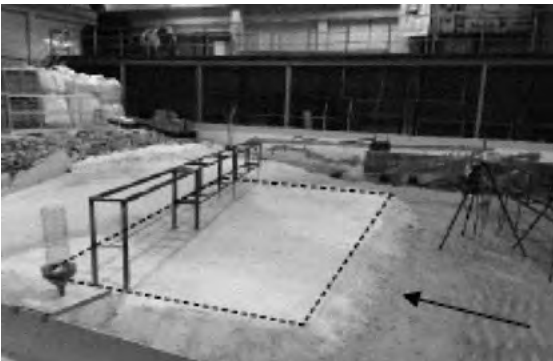
Carlos Coelho<sup>1</sup>, Margarida Ferreira<sup>1</sup>, André Guimarães<sup>1</sup>, Paulo A. Silva<sup>2</sup>

Serious erosion problems related to significant negative sediment budgets in the coastal systems have been identified worldwide. Artificial nourishments are a coastal erosion mitigation strategy that compensates the negative sediment budgets by adding sediments to the coastal system. The coastal processes' complexity, the sediment transport dynamics and the morphological impact of artificial nourishments are difficult to assess. Cross-shore and longshore sediment transport distribution, shoreline evolution impacts after nourishments, longevity of the nourishment, and its interaction with other coastal interventions are some of the topics under research and discussion, supported by physical and numerical modelling.

Hydrodynamic, sediment transport, and morphological variations due to the presence of a nearshore nourishment were monitored in a reduced scale 3D movable bed physical experiment (Figure 1). The nourishment enlarged the emerged beach width, inducing an increase in the flow velocities range and suspended sediments concentration, which led to an overall increase of the total sediment transport. Looking at the morphological and volume variation over time (Figure 2), the authors

were able to assess the lifespan of the nourishment in the reduced scale model, as well as its impact on the sediment transport rates.

The artificial nourishment effects on the longshore sediment transport and shoreline evolution were simulated with the LTC numerical model to assess the sediment's permanence at the deposition site and the re-nourishment frequency. The results also show an increase of the overall beach width, with the greatest nourished volume scenarios presenting the highest area gains. However, by distancing even further the beach from its dynamic equilibrium, the sediment transport rates are superior for the greater volumes' scenarios. These sediment transport rates decrease overtime, as the beach returns to its original dynamic state.



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2 – Department of Physics & CESAM, University of Aveiro

**FIGURE 1**  
View of the laboratory experiments in a wave tank.

**FIGURE 2**  
Bathymetric and topographic digital model terrain of the beach, along time.

# Quality Assurance of Welded Construction of Industrial Boilers

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<sup>1</sup> – Department of Mechanical Engineering & TEMA, University of Aveiro  
<sup>2</sup> – ISEP-School of Engineering, Polytechnic of Porto

**FIGURE 1**  
Sectional View of Steam Boiler: 1, 4 – Flat Ends; 2, 3 – Shell; 5, 6, 7, 8, 9, 10 – Combustion chamber; 11 – Anchors; 12 – Smoke tubes (exchanger).

**FIGURE 2**  
Results of macroscopic test for pWPS 01 - Cross Section 2.

For decades the use of pressure equipment in several industrial facilities is an undeniable reality. A special variant of pressure equipment are boilers (Fig. 1).

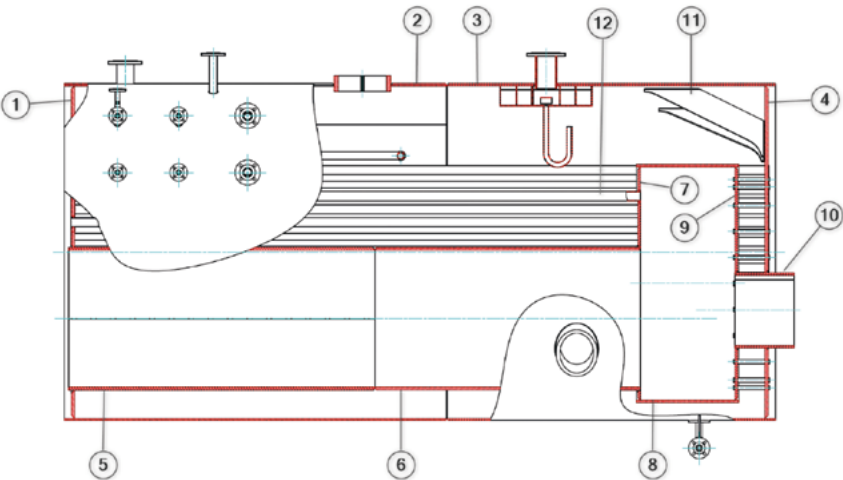
Contrary to what happened in the past, there are currently very specific building codes and standards, which have come to standardize the best construction rules and practices, to make the use of this equipment safe.

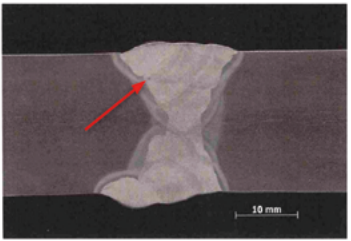
Manufacturers whose product is based on welded construction and subject to CE marking, are obliged to know and implement all the necessary provisions for the conformity of their product from its conception to the product's availability on the market.

In accordance with European community regulations and directives, for boilers subject to firetube direct flame action, the ISO12953 harmonized building code allows for the regulation of their manufacturing. As with any code, it contains most of the specific information about the construction, but it refers to the specific information

about certain requirements for other standards, as it happens in several aspects related to welding. Although sometimes, final acceptance must be done according to the criteria of the parts of the main code.

One method to eliminate the possibility of failure to meet requirements is to identify all essential variables provided for in the building or qualification code, and then carry out a targeted and compliant needs assessment with the applicable harmonized code in accordance with the construction specification that must be derived from the design. This will allow tuning between project and execution within the domain of validity of each essential variable. Fig. 2 shows an example of macroscopic test for the survey of qualification needs of procedures and welding in accordance with ISO15614, based on the specification for the welded construction from each welding to be carried out, and on the observance of the particularities provided for in ISO12953-4 in concerning the design of welded joints.



Test specimen		
Ref.	ST2	
Orientation	Cross section	
Etchant	Nital 2%	
Test Temp. (°C)	21	
Imperfection reference	2011	
Dimension (mm)	h = 0,1	
Test Procedure		ISO 17639:2003
Acceptance Criteria		ISO 15614-1:2017 + EN 12953-5
Result		Imperfection below the acceptance criterion / Acceptable



# A Study on Vehicle Noise Emission Modelling: Correlation with Air Pollutant Emissions, Impact of Kinematic Variables and Critical Hotspots

Antonio Pascale<sup>1</sup>, Paulo Fernandes<sup>1</sup>, Claudio Guarnaccia<sup>2</sup>, Margarida C. Coelho<sup>1</sup>

This work proposes a methodology suitable for analyzing the sound power levels ( $L_w$ ), carbon dioxide ( $CO_2$ ), and nitrogen oxides ( $NO_x$ ) emissions along a trip, and consequentially assessing the related critical hotspots.

The estimation of noise and pollutant emissions from six vehicles (four diesel, one gasoline, and one hybrid-electric powered) driven along three different routes (one National Road and two highways) was conducted, in a combined way, through seven Noise Emissions Models – NEMs (namely, Lelong, Harmonoise, Nouvelle Méthode de Prevision du Bruit – NMPB, Common Noise aSSessment methOdS – CNOSSOS, SonRoad, Acoustical Society of Japan Road Traffic Noise Model – ASJ, and Vehicle Noise Specific Power model – VNSP) and the Vehicle Specific Power (VSP) methodology, respectively.

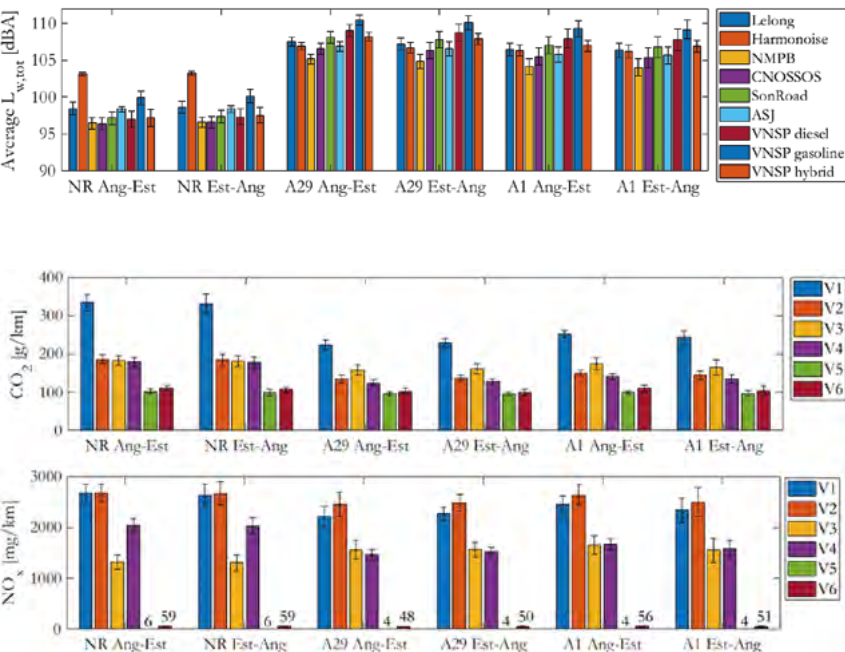
The inputs required by the models (vehicle speed and acceleration and road grade) were extrapolated from On-Board Diagnostic (OBD) system and GPS data recorded during monitoring campaigns. The specificities of each model were analyzed, and the role played by the kinematic variables in noise and exhaust emissions assessment was highlighted.

Results show that all the tested NEMs estimated higher noise levels on the highways, while VSP predicted higher emissions on the National Road. This happens because speed is the main input variable in NEMs, while acceleration has an impact on noise estimation in the low-speed range (below 50 km/h). For pollutant emissions evaluation, acceleration plays a fundamental role also at the high-speed range (above 50 km/h), where a transition from a cruising condition to an acceleration phase leads to significant variations in terms of VSP values.  $L_w$  values, estimated with NEMs that use acceleration correction terms, present a positive moderate-to-high correlation with VSP ones. Moreover, the models that neglect acceleration in noise estimation fail to recognize traffic control treatments as critical hotspots.

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<sup>2</sup> – Department of Civil Engineering, University of Salerno (Italy)

**FIGURE 1**  
Noise assessment results (with standard deviation values).

**FIGURE 2**  
Exhaust emission assessment results (with standard deviation values) in terms of  $CO_2$  per unit distance and  $NO_x$  per unit distance; V1 to V4 diesel-powered cars, V5 gasoline-powered car, and V6 hybrid-electric-powered car..



# Constantly Timing, but Not Always Controlled by Time

Cristina Santos<sup>1,2</sup>, Marco Vasconcelos<sup>1</sup>, Armando Machado<sup>1</sup>

<sup>1</sup> – Department of Education and Psychology & WJCR, University of Aveiro

<sup>2</sup> – Arizona State University, USA

## FIGURE 1

One of the operant chambers used in the experiment.

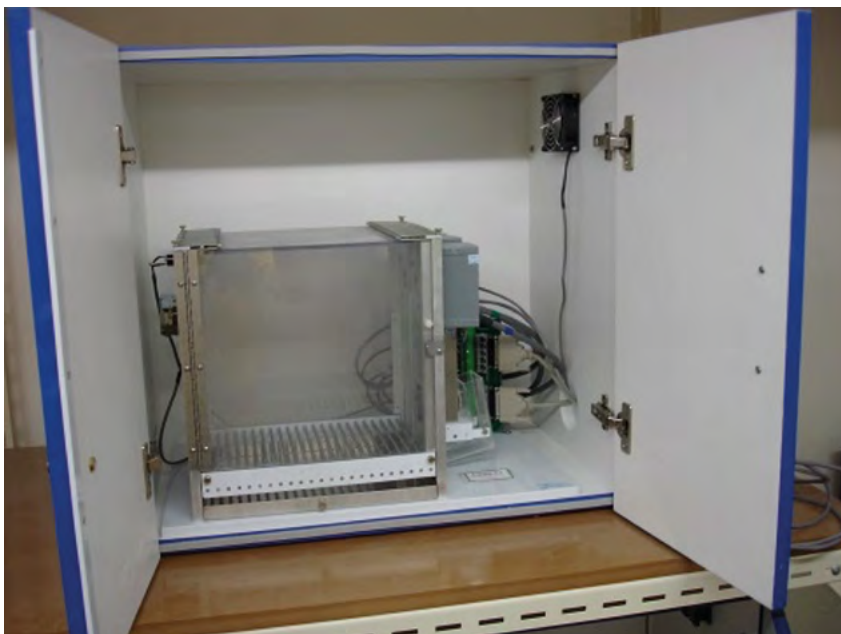
Being able to predict and adapt to changes in the environment is perhaps the main advantage afforded by the ability to learn. One way to study the properties of this ability is to expose animals to predictable changes and track their behavioral adaptation. The Midsession Reversal Task (MSRT) implements such a predictable change: In a discrete-trial session, animals choose recurrently between stimuli S1 and S2; responses to S1 are reinforced during the first half of the session, whereas responses to S2 are extinguished; and during the second half of the session, responses to S1 are extinguished whereas responses to S2 are reinforced.

Absent the ability to count, the most efficient way to solve the MSRT is by following local cues: If the previous choice was reinforced, repeat the choice on the next trial; if it was not, make a different choice. Surprisingly,

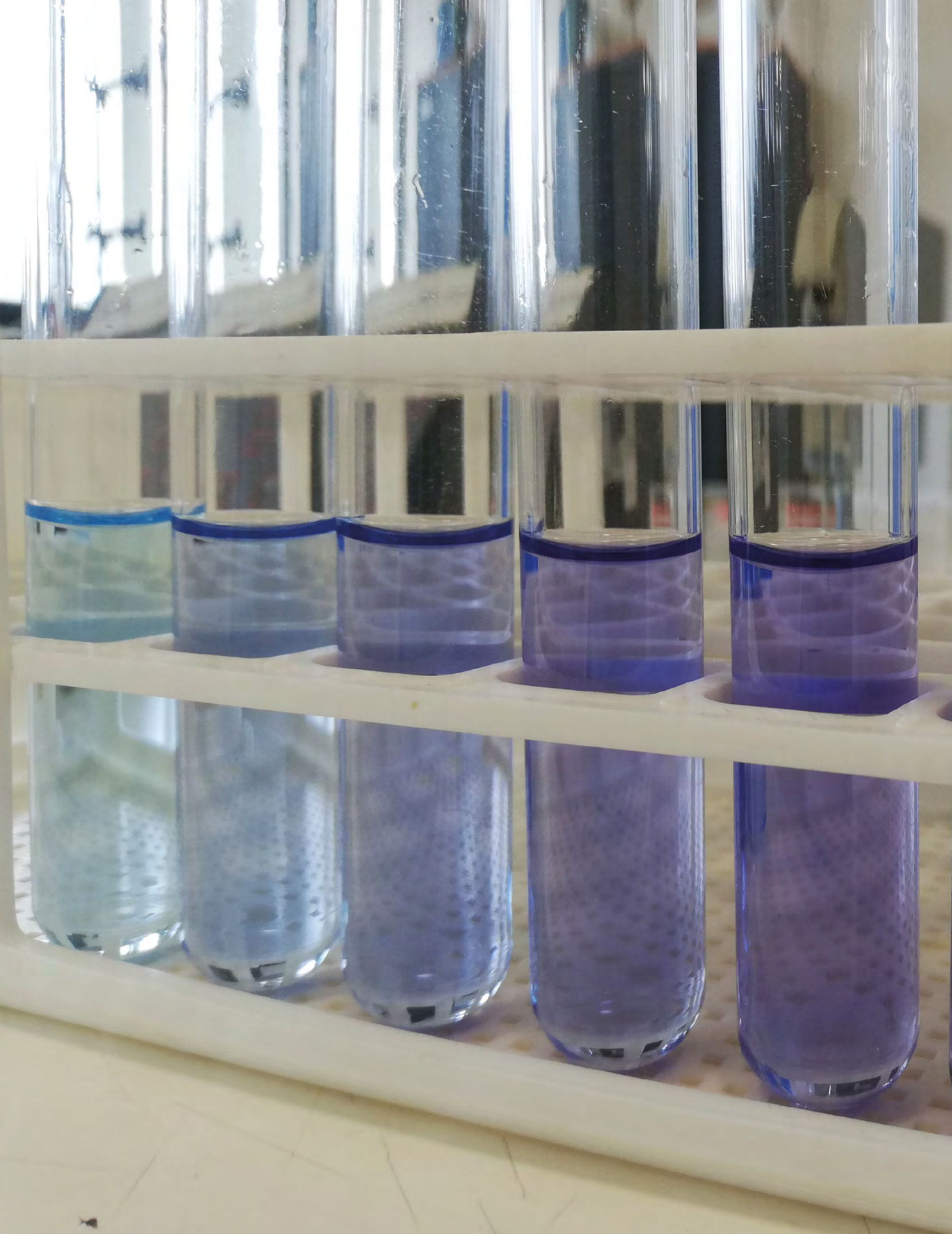
research shows that, at least with visual discriminations, pigeons choose S2 before the contingency reverses and S1 after, suggesting that they may be timing the interval from the beginning of the session to the reversal.

To test the role of temporal and local cues, we exposed pigeons (*Columba livia*) to a modified MSRT. To weaken the temporal cue, we varied the location of the reversal trial randomly across sessions; to weaken the local cue, we varied the payoff probabilities associated with S1 and S2. Pigeons' performance was inconsistent with the exclusive use of either cue. Instead, both cues influenced choice dynamically: When payoff was higher for S1 than S2, behavior was less time-controlled than when the payoff was higher for S2 than S1, or when they were equal. We propose a mixture model of joint control for the MSRT.

This research was conducted at the Animal Learning and Behavior Lab of the University of Minho and is now published (<https://doi.org/10.1037/xan0000263>). It is part of C. Santos' PhD thesis and is nominated for the Early Career Award from the American Psychological Association Division 3.









6





# **QUICK FACTS AND STATS**

# People

## FACULTY BY DEPARTMENT

UNIVERSITY	FACULTY (FTE)			
	TOTAL	TOTAL	PERCENTAGE OF WOMEN	PERCENTAGE OF FOREIGNERS
	2020	2021	2021	
Department of Biology	31,10	32,10	39%	19%
Department of Chemistry	43,90	43,90	42%	24%
Department of Civil Engineering	16,55	17,55	25%	6%
Department of Communication and Art	85,50	89,30	28%	21%
Department of Economics, Management, Industrial Engineering and Tourism	52,15	57,10	62%	26%
Department of Education and Psychology	39,85	41,50	66%	14%
Department of Electronics, Telecommunications and Informatics	77,20	79,60	8%	10%
Department of Environment and Planning	15,00	16,00	69%	13%
Department of Geosciences	14,30	14,30	42%	28%
Department of Languages and Cultures	46,65	47,80	63%	18%
Department of Materials Engineering and Ceramics	14,00	13,00	46%	15%
Department of Mathematics	57,80	56,80	48%	23%
Department of Mechanical Engineering	31,10	32,60	11%	9%
Department of Medical Sciences	24,35	24,25	59%	33%
Department of Physics	49,00	46,00	27%	24%
Department of Social Sciences, Policy and Planning	19,60	20,85	33%	12%
<b>POLYTECHNIC SCHOOLS</b>				
Águeda School of Technology and Management	60,75	61,45	48%	12%
School of Accounting and Administration of Aveiro	76,00	76,90	3%	5%
School of Design, Management and Production Technologies of Aveiro North	31,60	30,60	33%	0%
School of Health Sciences	51,50	55,60	61%	8%
<b>TOTAL</b>	<b>837,90</b>	<b>857,20</b>	<b>42%</b>	<b>16%</b>

## RESEARCHERS BY DEPARTMENT

UNIVERSITY	RESEARCHERS (FTE)			
	TOTAL	TOTAL	PERCENTAGE OF WOMEN	PERCENTAGE OF FOREIGNERS
	2020	2021	2021	
Department of Biology	114,00	101,00	68%	19%
Department of Chemistry	132,00	119,00	66%	17%
Department of Civil Engineering	8,00	5,00	40%	0%
Department of Communication and Art	16,00	14,00	64%	21%
Department of Economics, Management, Industrial Engineering and Tourism	3,00	4,00	50%	25%
Department of Education and Psychology	18,00	21,00	90%	5%
Department of Electronics, Telecommunications and Informatics	14,00	11,00	64%	9%
Department of Environment and Planning	42,00	35,00	69%	40%
Department of Geosciences	10,00	9,00	78%	6%
Department of Languages and Cultures	1,00	2,00	50%	50%
Department of Materials Engineering and Ceramics	9,00	42,00	40%	31%
Department of Mathematics	31,00	17,00	29%	71%
Department of Mechanical Engineering	22,00	25,00	48%	20%
Department of Medical Sciences	40,00	17,00	65%	24%
Department of Physics	64,00	59,00	29%	44%
Department of Social Sciences, Policy and Planning	14,00	10,00	50%	10%
<b>POLYTECHNIC SCHOOLS</b>				
Águeda School of Technology and Management	0,00	0,00	0,00	0,00
School of Accounting and Administration of Aveiro	1,00	0,00	0,00	0,00
School of Design, Management and Production Technologies of Aveiro North	1,00	0,00	0,00	0,00
School of Health Sciences	2,00	2,00	100%	0%
<b>TOTAL</b>	<b>542,00</b>	<b>493,00</b>	<b>53%</b>	<b>20%</b>

## STAFF BY CATEGORY

UNIVERSITY	FTE			
	TOTAL	TOTAL	PERCENTAGE OF WOMEN	PERCENTAGE OF FOREIGNERS
	2020	2021		
Full Professors	59,15	60,35	15%	35%
Associated Professors	147,00	155,00	42%	21%
Assistant Professors	373,95	379,00	40%	16%
Lecturer	24,00	21,20	19%	11%
Other Teaching Staff	13,95	19,10	76%	18%
Researchers	431,00	440,00	60%	23%
Post-Doctoral Students	111,00	57,00	47%	40%
<b>POLYTECHNIC SCHOOLS</b>				
Coordinator Professors	27,90	28,90	55%	0%
Adjunct Professors	146,60	149,15	50%	0%
Lecturer	45,35	46,50	49%	1%
<b>TOTAL</b>	<b>1379,90</b>	<b>1356,20</b>	<b>48%</b>	<b>19%</b>

## PHD STUDENTS BY DEPARTMENT

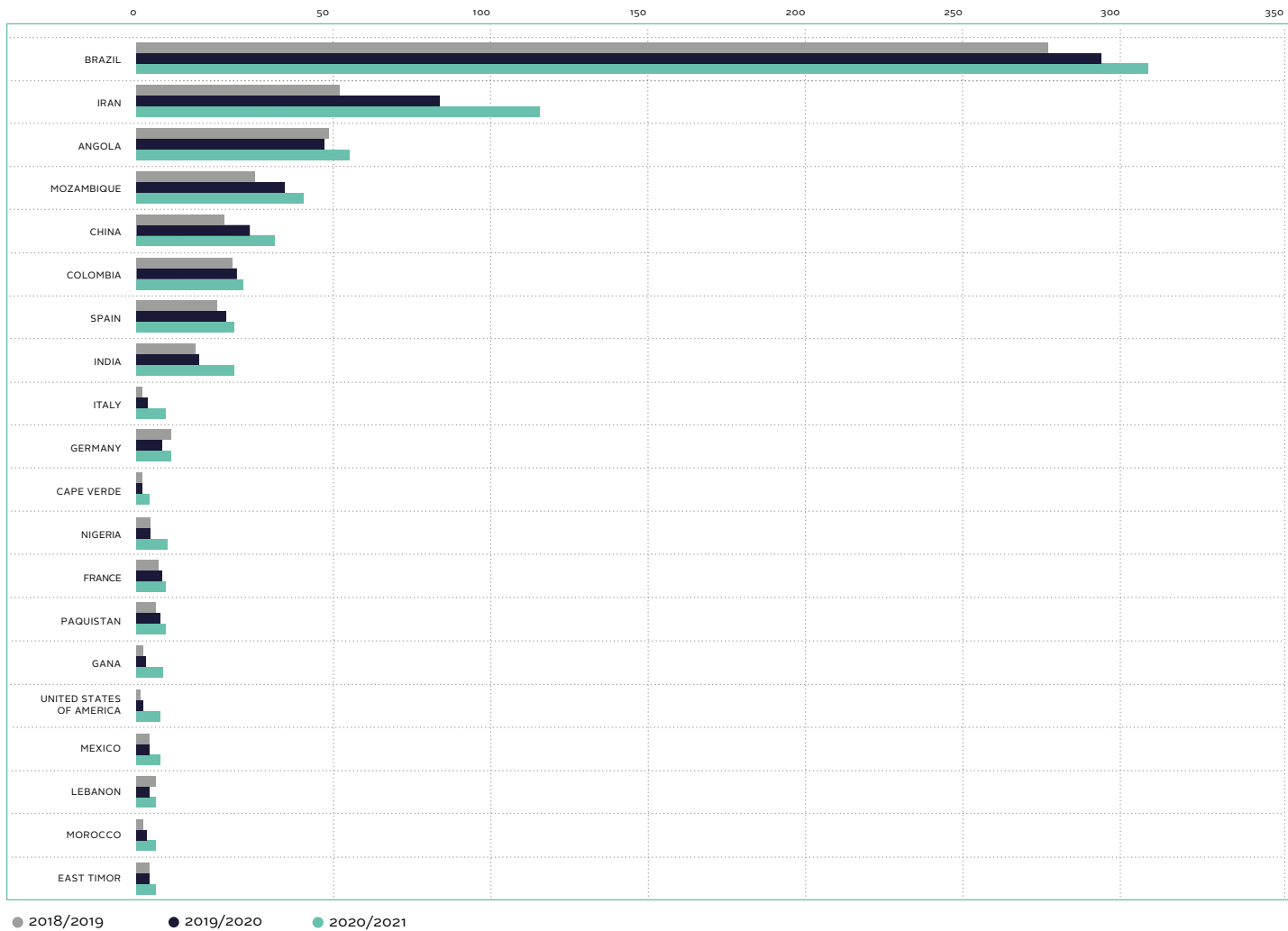
DEPARTMENT	PHD STUDENTS				
	TOTAL	TOTAL	PERCENTAGE OF WOMEN	PERCENTAGE OF FOREIGNERS	PERCENTAGE OF NEW STUDENTS
	2019/2020	2020/2021			
Department of Biology	135	146	67%	21%	26%
Department of Chemistry	236	251	60%	18%	39%
Department of Civil Engineering	67	78	26%	51%	38%
Department of Communication and Art	233	263	51%	52%	28%
Department of Economics, Management, Industrial Engineering and Tourism	313	345	48%	46%	32%
Department of Education and Psychology	279	279	74%	43%	25%
Department of Electronics, Telecommunications and Informatics	154	181	21%	34%	24%
Department of Environment and Planning	95	96	40%	48%	31%
Department of Geosciences	15	14	64%	43%	50%
Department of Languages and Cultures	85	109	62%	58%	43%
Department of Materials Engineering and Ceramics	95	113	39%	30%	30%
Department of Mathematics	36	37	41%	46%	38%
Department of Mechanical Engineering	86	71	32%	28%	48%
Department of Medical Sciences	84	108	74%	11%	43%
Department of Physics	119	87	39%	23%	46%
Department of Social Sciences, Policy and Planning	93	116	39%	55%	32%
<b>TOTAL*</b>	<b>1840</b>	<b>2294</b>	<b>48%</b>	<b>35%</b>	<b>31%</b>

\* The students of joint doctoral studies are considered in each participating department. Therefore, the sum of the students by department is superior to the total.

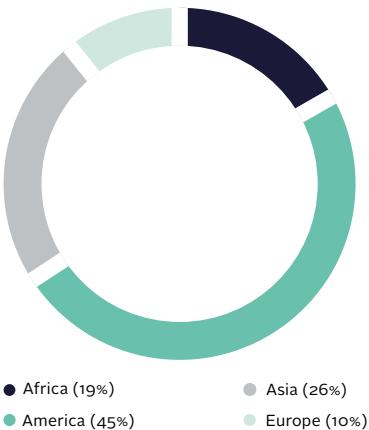


# Top 20

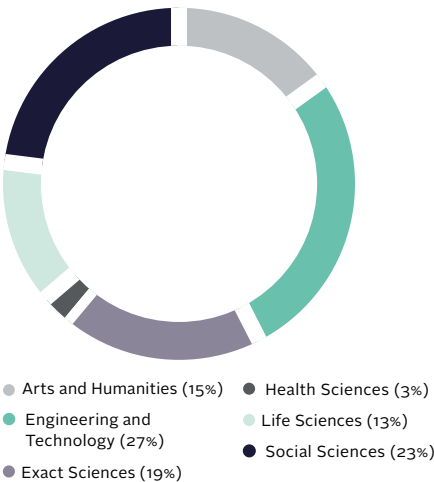
FOREIGN PHD STUDENTS BY NATIONALITY



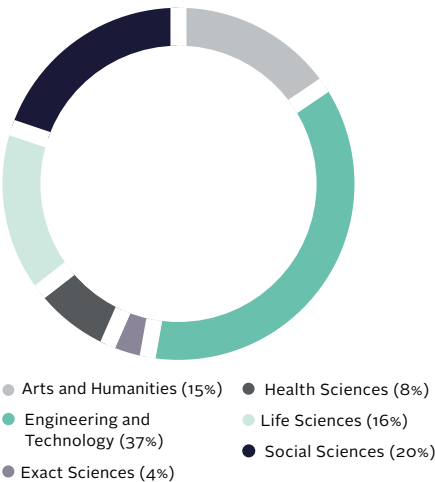
FOREIGN PHD STUDENTS BY CONTINENT



MSC THESES



PHD THESES



# SCI Papers

TOP 10 SUBJECT AREAS FOR PAPERS PUBLISHED IN 2021	RECORD COUNT	% OF 2,968
Environmental Sciences	432	14.555 %
Materials Science Multidisciplinary	332	11.186 %
Chemistry Multidisciplinary	237	7.985 %
Chemistry Physical	221	7.446 %
Physics Applied	177	5.964 %
Engineering Electrical Electronic	174	5.863 %
Biochemistry Molecular Biology	127	4.279 %
Energy Fuels	101	3.403 %
Engineering Chemical	98	3.302 %
Food Science Technology	84	2.830 %

\* Data retrieved from ISI Web of Knowledge SM (Thomson Reuters) on 28th March 2022

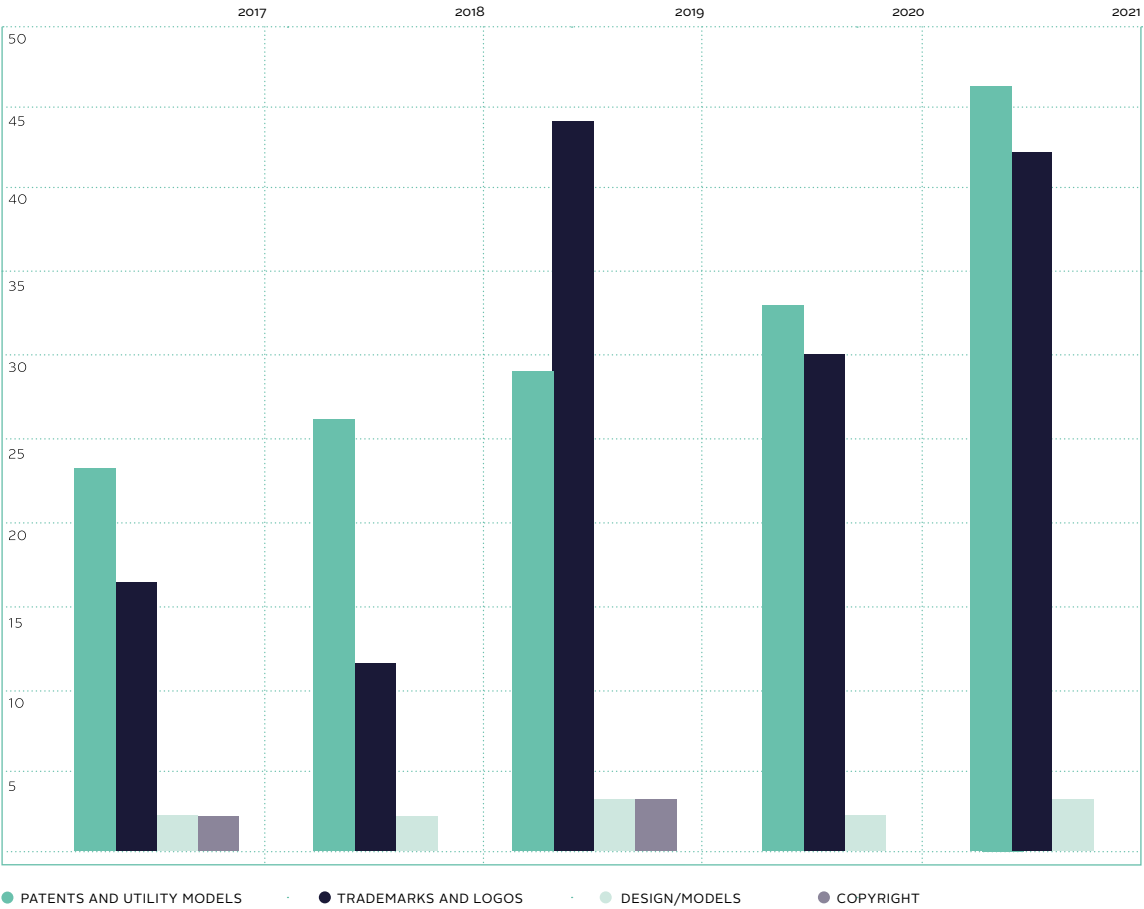
TOP 10 CITED PAPERS	TOTAL NR CITATIONS (2017-2021)
Kunkle, BW; Grenier-Boley, B; Sims, R; Bis, JC; Damotte, V; Naj, AC; et al (2019). Genetic meta-analysis of diagnosed Alzheimer's disease identifies new risk loci and implicates A beta, tau, immunity and lipid processing. NATURE GENETICS, 51 (3): 414-430	670
Brodkorb, A; Egger, L; Alming, M; Alvito, P; Assuncao, R; et al. (2019). INFOGEST static in vitro simulation of gastrointestinal food digestion. NATURE PROTOCOLS, 14 (4): 991-1014	464
de Sa, LC; Oliveira, M; Ribeiro, F; Rocha, TL; Futter, MN (2018). Studies of the effects of microplastics on aquatic organisms: What do we know and where should we focus our efforts in the future?. SCIENCE OF THE TOTAL ENVIRONMENT, 645: 1029-1039	422
Sims, R; van der Lee, SJ; Naj, AC; Bellenguez, C; Badarinarayan, N; Jakobsdottir, J; et al (2017). Rare coding variants in PLCG2, ABI3, and TREM2 implicate microglial-mediated innate immunity in Alzheimer's disease. NATURE GENETICS, 49 (9): 1373-1384	404
Ventura, SPM; e Silva, FA; Quental, MV; Mondal, D; Freire, MG; Coutinho, JAP (2017). Ionic-Liquid-Mediated Extraction and Separation Processes for Bioactive Compounds: Past, Present, and Future Trends. CHEMICAL REVIEWS, 117 (10): 6984-7052	403
Wainwright, M; Maisch, T; Nonell, S; Plaetzer, K; Almeida, A; Tegos, GP; Hamblin, MR (2017). Photoantimicrobials-are we afraid of the light?. LANCET INFECTIOUS DISEASES, 17 (2): E49-E55	291
Almeida, R (2017). A Caputo fractional derivative of a function with respect to another function. COMMUNICATIONS IN NONLINEAR SCIENCE AND NUMERICAL SIMULATION, 44: 460-481	291
Prata, JC; da Costa, JP; Lopes, I; Duarte, AC; Rocha-Santos, T (2020). Environmental exposure to microplastics: An overview on possible human health effects. SCIENCE OF THE TOTAL ENVIRONMENT, 702, 134455	269
Brites, CDS; Balabhadra, S; Carlos, LD (2019). Lanthanide-Based Thermometers: At the Cutting-Edge of Luminescence Thermometry. ADVANCED OPTICAL MATERIALS, 7 (5), 1801239	268
Justino, CIL; Comes, AR; Freitas, AC; Duarte, AC; Rocha-Santos, T (2017). Graphene based sensors and biosensors. TRAC-TRENDS IN ANALYTICAL CHEMISTRY, 91: 53-66	266

\* Data retrieved from ISI Web of Knowledge SM (Thomson Reuters) on 28th March 2022

# Intellectual Property

INTELLECTUAL PROPERTY RIGHTS REGISTRATION

	2017	2018	2019	2020	2021
Patents and Utility Models	23	26	29	33	46
Trademarks and Logos	16	11	44	30	42
Design/Models	2	2	3	2	3
Copyright	2	0	3	0	0





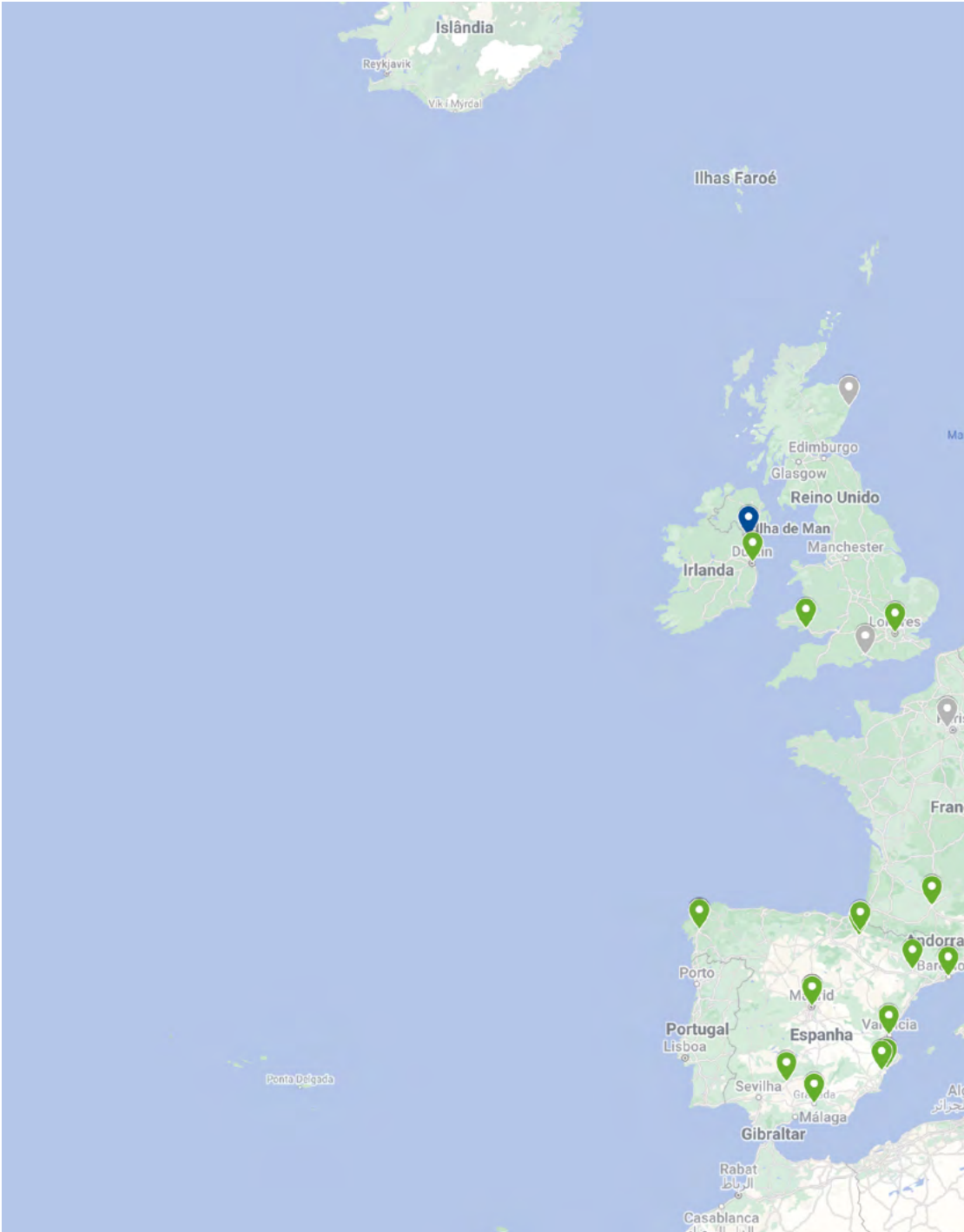
# International Projects

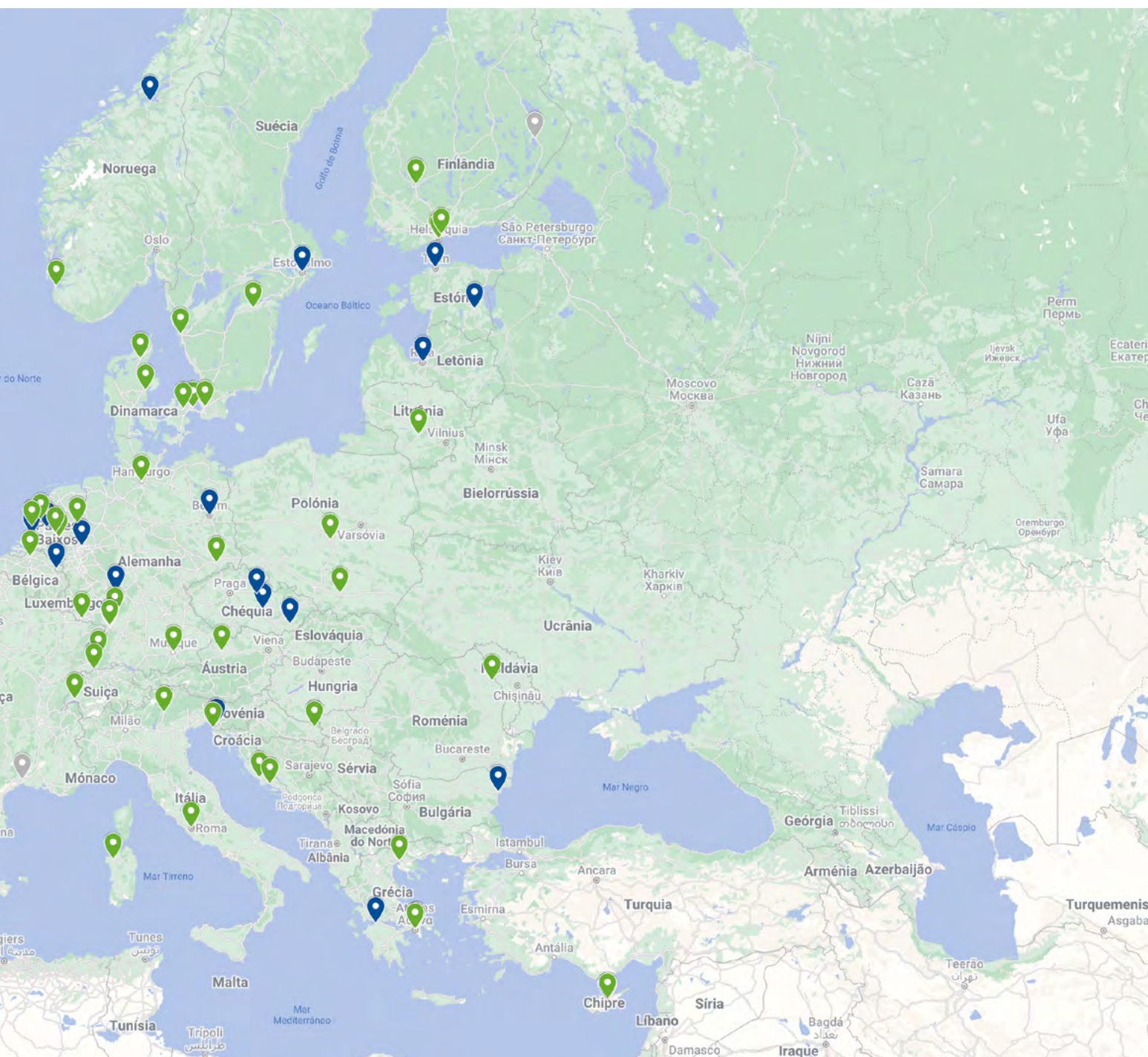
## EU-FUNDED PROJECTS STARTED IN 2021

EUROPEAN RESEARCH COUNCIL (ERC GRANTS)	ACRONYM	LOCAL COORDINATOR
Rise of the 3rd dimension in nanotemperature mapping	ThermoRise	Nuno João Silva
Kleptoplasty: The sea slug that got away with stolen chloroplasts	KleptoSlug	Sónia Cruz
Full human-based multi-scale constructs with jammed regenerative pockets for bone engineering	REBORN	João Mano
HORIZON 2020 - PROJECTS COORDINATED BY UA	ACRONYM	PROJECT COORDINATOR
Viruses and Epitranscriptomics: seeking novel targets for antiviral therapy	EpiViral	Daniela Ribeiro
Human Platelet Lysates-based Scaffolds for Interfacial Multi-tissue Repair	InterLynk	João Mano
Eco-friendly corrosion protective coatings based on smart nanotechnology platforms for a circular economy	COAT4LIFE	João Tedim
HORIZON 2020 – MONOBENEFICIARY PROJECTS	ACRONYM	PROJECT COORDINATOR
Institutional, BEhavioural , critical and adaptive economics towards Sustainable Development, management of natural capital and circular Economy	BESIDE	Ana Lillebø
Genetic and epigenetic resistance to oncogenic transformation of an epithelium	OncoResist	Rui Martinho
Luminescent Metal Organic Frameworks for anti-counterfeiting and logic computing	LUMIMOF	João Rocha
HORIZON 2020	ACRONYM	LOCAL COORDINATOR
Chronic exposure scenarios driving enviRONmental risks of Chemicals	CHRONIC	Susana Loureiro
ECIU University Research Institute for Smart European Regions	SMART-ER	Artur Silva
Developing a holistic risk-wise strategy for european wildfire management	FIREURISK	Ana Isabel Miranda
A Pan-European Solid-State NMR Infrastructure for Chemistry-Enabling Access	PANACEA	Mariana Sardo
Engineered Conductive Proteins for Bioelectronics	E-PROT	Manuel Melle-Franco
Pilot Application in Urban Landscapes - Towards integrated city observatories for greenhouse gases	PAUL	Mário Cerqueira
ERASMUS + - PROJECTS COORDINATED BY UA	ACRONYM	PROJECT COORDINATOR
The leaders of tomorrow	E(U) Leaders	Marlene Amorim
ERASMUS +	ACRONYM	LOCAL COORDINATOR
Integration of sustainable development goalS in uniVersities for better climate change manage-ment	INVOLVE	Ana Velosa
Cloud computing for Digital Education Innovation	CodeIN	Elisabeth Pereira
Covid, Migrants and Minorities in Teacher Education: A Fake News Observatory to promote Critical Thinking and Digital Literacy in Times of Crisis	CoMMITTEd	Helena Araújo e Sá
A model for Interactive (A)Synchronous Learning in Online STEM Education	e-CLOSE	Natália Martins
Enhancing the development of educators digital competencies	EDUDIG	Ana Balula
e-learning ONE HEALTH	e-InnoEduCO2	Pedro Pombo
Collective Creativity and Community Education in Cinematographic Literacy for a Climate Action Tourism	EDUCinema ClimaTurAction	Pedro Pombo
Mathematical models for teaching three-dimensional geometry using virtual reality	Math3DgeoVR	Nina Szczygiel
Development of BIM knowledge in higher education to boost the competencies of young people and reinforce the interdisciplinarity in European Universities	BIM4HEI	Fernanda Rodrigues
Consumer Awareness for Responsibility towards Environment	CARE	Margarida M. Pinheiro
Valorisation des biographies langagières - parcours numérique	A-PEL	Rosa Maria Faneca
Partnership for virtual laboratories in civil engineering	PARFORCE	Uwe Kahler
We-Europeans - Countering populism through active European citizenship	We-Europeans	Marta Ferreira Dias
UCPM	ACRONYM	LOCAL COORDINATOR
Vulnerable Elements in Spain and Portugal and Risk Assessment	VESPRA	Ana Isabel Miranda
INTERREG EUROPE - PROJECTS COORDINATED BY UA	ACRONYM	PROJECT COORDINATOR
Cooperative Information platform for low carbon and sustainable mobility_additional activities	CISMOB	Jorge Bandeira

NETWORK OF EUROPEAN UNIVERSITIES AND COMPANIES WORKING WITH UA IN EU PROJECTS STARTED IN 2021

- AUSTRIA** EDUDIG
- BELGIUM** PAUL
- BULGARIA** TANDEM+
- CROATIA** CodeIN, EUFORIA, FIREURISK, TANDEM+
- CYPRUS** E(U) Leaders, FIREURISK
- CZECH REPUBLIC** COAT4LIFE, TANDEM+
- DENMARK** CHRONIC, PANACEA, PAUL, SMART-ER
- ESTONIA** COAT4LIFE
- FINLAND** EDUDIG, FIREURISK, PAUL, SMART-ER
- FRANCE** E-PROT, PAUL, SMART-ER
- GERMANY** CoMMITTeD, e-CLOSE, EpiViral, FIREURISK, InterLynk, PANACEA, PAUL, SMART-ER
- GREECE** E(U) Leaders, EUFORIA, FIREURISK
- IRELAND** SMART-ER, TANDEM+
- ITALY** FIREURISK, InterLynk, INVOLVE, SMART-ER
- LATVIA** COAT4LIFE
- LITHUANIA** COAT4LIFE, SMART-ER
- NORWAY** COAT4LIFE, SMART-ER
- POLAND** e-CLOSE, Math3DgeoVR, PAUL
- ROMANIA** e-InnoEduCO<sub>2</sub>
- SLOVENIA** INVOLVE
- SPAIN** CoMMITTeD, e-CLOSE, EDUCinema, ClimaTurAction, e-InnoEduCO<sub>2</sub>, E-PROT, FIREURISK, IBERIFIER, INVOLVE, PANACEA, PAUL, SMART-ER, VESPRE
- SWEDEN** CHRONIC, CISMOB Additional Activities, PANACEA, PAUL, SMART-ER
- SWITZERLAND** CHRONIC, PANACEA, PAUL
- THE NETHERLANDS** CHRONIC, CoMMITTeD, E(U) Leaders, EpiViral, FIREURISK, InterLynk, PANACEA, SMART-ER
- UNITED KINGDOM** E-PROT, FIREU





● Companies      ● Universities      ● Projects coordinated by UA



# Budget

## TOTAL BUDGET OF THE PROJECTS STARTED IN 2021 BY RESEARCH CENTRE AND FUNDING AGENCY\*

RESEARCH CENTRE	CCDRC	EUROPEAN UNION	FOUNDATION FOR SCIENCE AND TECHNOLOGY	INNOVATION AGENCY	OTHERS INTERNATIONAL	OTHERS NATIONAL	2020	2021
CESAM		5 400 932	3 283 664	572 842	463 382	1 215 113	4 046 303	10 935 934
CICECO		7 095 218	1 854 632	1 987 705			8 523 991	10 937 554
CIDMA		53 315	294 982				122 761	348 297
CIDTFF		104 165					62 520	104 165
CINTESIS							181 489	
CIPEs							18 724	
DIGIMEDIA		45 342		270 125			240 045	315 467
GEOBIOTEC			22 231	163 377			105 169	185 607
GOVCOPP		186 957	676 740	260 953		515 063	548 353	1 639 713
I3N			354 797	1 046 688			968 993	1 401 485
IBIMED	692715	763 387	261 461				635 547	1 717 564
ID+							69 257	
IEETA			249 746	939 163			1 668 169	1 188 910
INET-MD			249 818				43 664	249 818
IT		2 304 470	908 607	2 640 291			8 851 744	5 853 367
NOT INTEGRATED**	674656	817 503		200 875		337 411	8 391 480	2 030 445
REQUIMTE			293 799		12 651		1 155 543	306 449
RISCO		171 315	378 517	202 010		75 000	336 617	826 842
TEMA		109 582	501 338	1 225 436	364 132		1 811 400	2 200 489
<b>TOTAL</b>	<b>1 367 372</b>	<b>17 052 186</b>	<b>9 330 333</b>	<b>9 509 465</b>	<b>840 165</b>	<b>2 142 587</b>	<b>37 781 769</b>	<b>40 242 107</b>

\* Contracts with industry and multiannual budget of research centres not included

\*\* Projects not integrated in research centers

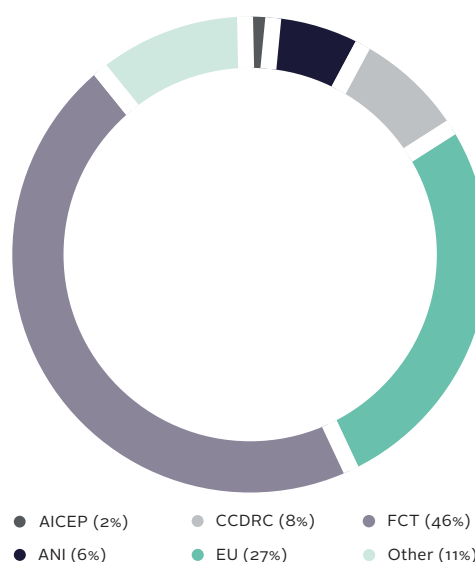
in euros

## APPROVED BUDGET UNDER EU-FUNDED PROJECTS\*

EUROPEAN PROGRAMMES	2020	2021
H2020 - ERC AdG		2 499 683
H2020 - ERC CoG	1 999 793	1 988 354
H2020 - ERC StG		2 255 461
H2020 - ERC PoC	300 000	
H2020 - ERACHAIR		2 498 621
H2020 - FETOPEN		374 109
H2020 - TWINNING		603 572
H2020 - INFRAIA		311 926
H2020 - ITN-ETN		237 720
H2020 - RISE	540 500	388 400
H2020 - IF	147 815	307 630
H2020 - NMBP	54 668	1 639 930
H2020 - ICT	1 067 109	557 000
H2020 - ECSEL		299 900
H2020 - PILOT		14 445
H2020 - EDIDP		1 178 125
H2020 - SWAFS		145 521
H2020 - INFRADEV	30 869	
H2020 - SFS	537 971	
H2020 - LC	344 669	280 000
H2020 - MG	405 316	
H2020 - NFRP	11 250	
COST ACTION	54 540	
RFCS	514 558	
Erasmus +	1 231 423	940 107
LIFE+	263 778	
INTERREG SUDOE	242 798	
INTERREG EUROPE		109 582
CEF TELECOM		292 969
UCPM		129 130
<b>TOTAL</b>	<b>7 747 056</b>	<b>17 052 186</b>

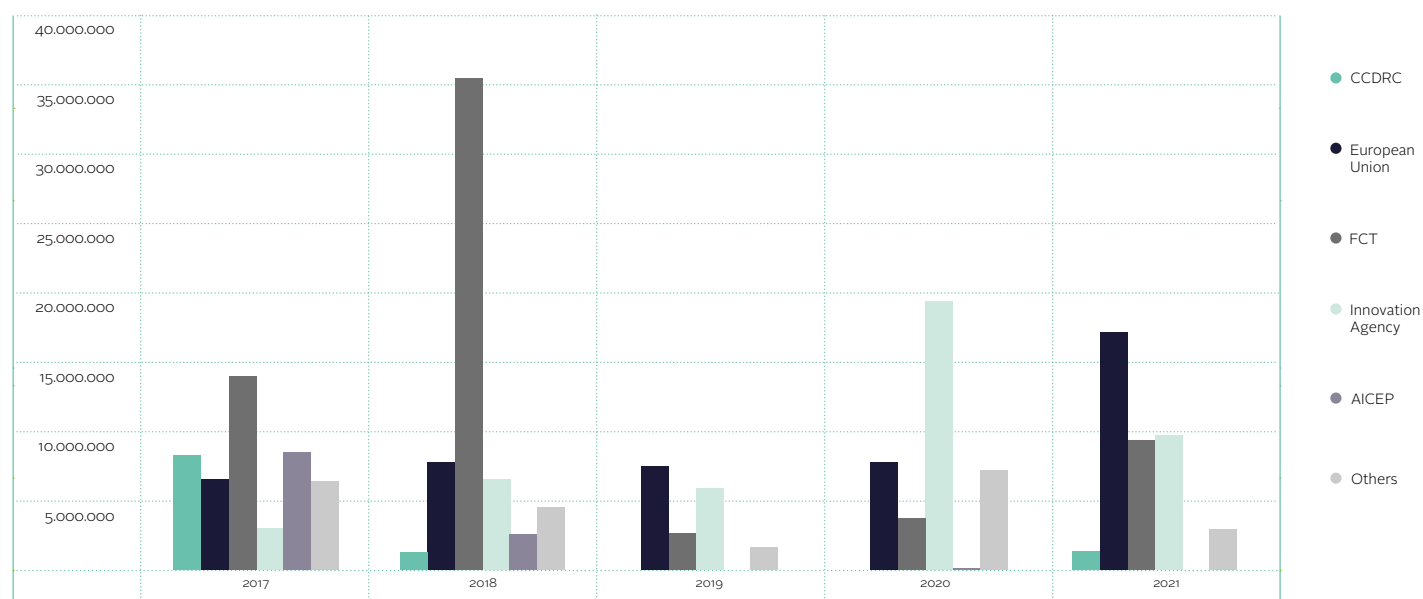
\* in euros

## DISTRIBUTION OF RECEIVED FUNDS BY FUNDING AGENCY\*



\* Contracts with industry and multiannual budget of research centres not included

## TOTAL BUDGET OF THE PROJECTS STARTED PER YEAR AND FUNDING AGENCY\*



\* Contracts with industry and multiannual budget of research centres not included

A large, bold, white number '7' is centered on the page, overlaid on a photograph. The photograph shows a dark, pebbly beach with several chunks of white ice scattered across it. In the bottom right corner, a crab is visible, with a black object (possibly a pen or pencil) resting on its back. The lighting suggests a low sun, creating a warm glow on the ice and the crab.

7



# RESEARCH SUPPORT





# Research Support Office





The University of Aveiro is a research-driven university. The excellence of its staff and quality of its infrastructures have been essential to carry out crosscutting research that contribute to the society – locally, nationally and internationally; this has put the University of Aveiro amongst the most renowned higher education institutions. Also, by supporting mobility across alumni, staff and the academic body and by fostering international research collaborations on the basis of individual academic interests, the University of Aveiro and its Research Support Office aim to deliver exceptional academics ready to face the challenges of globalization.

During 2021, 664 national and international research and technology transfer projects have been active in UAVR, of which 51 funded by ERASMUS+ and 57 by Horizon 2020. Among the H2020 projects are 6 ongoing ERC Grants, 1 ERA Chair and 1 TWINNING project. The projects are developed under the 20 research centers hosted by UAVR which act in many different scientific areas. All research centers have been classified as very good or excellent in the last evaluation process promoted by the National Foundation for Science and Technology.

The Research Support Office works as the main contact point and interface unit for Research Units and Associated Laboratories, researchers, funding agencies and other relevant stakeholders in the research and innovation ecosystem. Our extensive and ever-expanding network has a strong international character and a presence around the world which has served to boost several project proposals. The office provides high quality advisory, administrative, technical, contracting and financial services to researchers of all disciplines at the University, assisting the research community in its efforts to secure external funding (national, regional, international; grants, awards and prizes).

Formed by highly skilled officers with mixed backgrounds, the main action lines of the office are 1) Research development; 2) Strategy support and implementation and 3) Research grants and contracts. The office thus covers most of the life-cycle of the projects, working closely with faculty and researchers in order to identify funding opportunities and bring together interdisciplinary groups of researchers with common interests; disseminating funding information, partnership opportunities, as well as training events; supporting and coordinating strategic activities/projects; providing advice on costing and submission of grant applications as well as University's authorization for submission; supporting negotiations of contract terms with funders and collaboration agreements with other HEIs and public sector collaborators and formalizing of contracts and agreements.

**RESEARCH SUPPORT OFFICE**  
[research@ua.pt](mailto:research@ua.pt)







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