

# CAMPUS DIAGONAL -BESÒS

## Research Newsletter

### Summer 2020

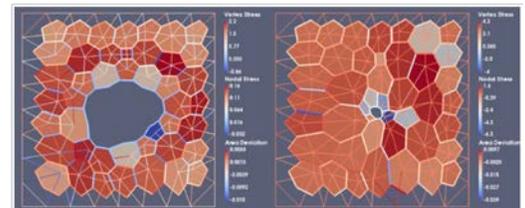
#### FOREWORD

## Campus Diagonal-Besòs Pursuing Excellence

The Vice-Rectorate for Science Policy of the **Universitat Politècnica de Catalunya (UPC)** publishes an annual review of the research activities performed at the different UPC Faculties/Schools, Departments and Research Groups.

(EEBE), has boosted to the **second position** in terms of normalized research productivity (i.e., number of published papers per researcher), in a ranking that compares research outputs from 16 UPC Faculties and Schools (see Pages 5-6).

#### IN THIS ISSUE



#### Research Bites

A selection of high-impact articles, among those published by CDB researchers during the **second semester of 2019**, in areas such as bioengineering, material science, mathematics, chemical engineering or electronics, is displayed on Pages 2-3. An overview of one of the CDB research groups, CoDAlab, is presented on Page 4. These snapshots show the rich and diverse research landscape that characterize the Campus.



#### News & Events

Funding opportunities, new research grants, past and future events, and research awards given to CDB researchers, can be found on Pages 5-6.



The last report (Sept. 2019) undeniably proves that the **Campus Diagonal-Besòs (CDB)** is consolidating its leading role in research and innovation at UPC: its flagship, the **Barcelona East School of Engineering**

*Welcome to the Campus Diagonal-Besòs, where future's science and technology is being forged.*

# Research Highlights

## MODIFYING IMPLANT SURFACES TO FACILITATE BONE REPAIR AND REGENERATION

**M. Fernández-Yagüe, R. Perez-Antoñanzas, J.J. Roa, M. Biggs, F.J. Gil & M. Pegueroles.** "Enhanced osteoconductivity on electrically charged titanium implants treated by physicochemical surface modifications methods", *Nanomedicine: Nanotechnology, Biology, and Medicine* 18, 1 (2019) [Q1, 8/213 in *Pharmaceutical Science*; IF=5.57]

Following implantation, dental implant stability can become compromised due to poor bone tissue integration and reactive foreign-body encapsulation. A key tenet of bone tissue engineering is biomimetic design, and in particular the development of responsive surfaces that promote ion exchange with interfacing tissues. Facilitating the ionic events that occur during bone repair, hold promise as orthopedic fixation strategies.

In this study, performed by researchers of the **Biomaterials, Biomechanics and Tissue Engineering** group (BBT) and **CIEFMA**, simple thermochemical and oxygen plasma processes are described and assessed in vivo as functional approaches for the development of dental implants with enhanced integration potential. Titanium implants functionalized to present a charged surface exhibited enhanced osteoconductivity through ionic tissue exchange. Furthermore, charged surfaces obtained functional mechanical stability as early as 4 weeks post implantation via increased bone implant contact and total bone area ingrowth.

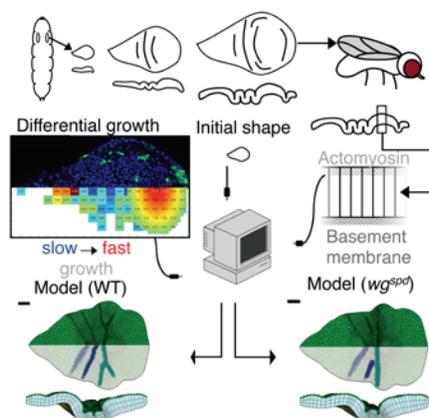
## PREDICTING SHAPES DURING EMBRYO DEVELOPMENT

**M. Tozluoğlu, M. Duda, N.J. Kirkland, R. Barrientos, J.J. Burden, J.J. Muñoz & Y. Mao,** "Planar Differential Growth Rates Initiate Precise Fold Positions in Complex Epithelia", *Developmental Cell* 51, 299 (2019) [Q1, 3/86 in *Developmental Biology*; IF=9.19]

Why a human body has a specific shape? Can we predict the final form of an organism from its embryo, which contains just a few cells? Embryo development is regulated by biochemical, genetic, and mechanical processes. The embryonic material is a

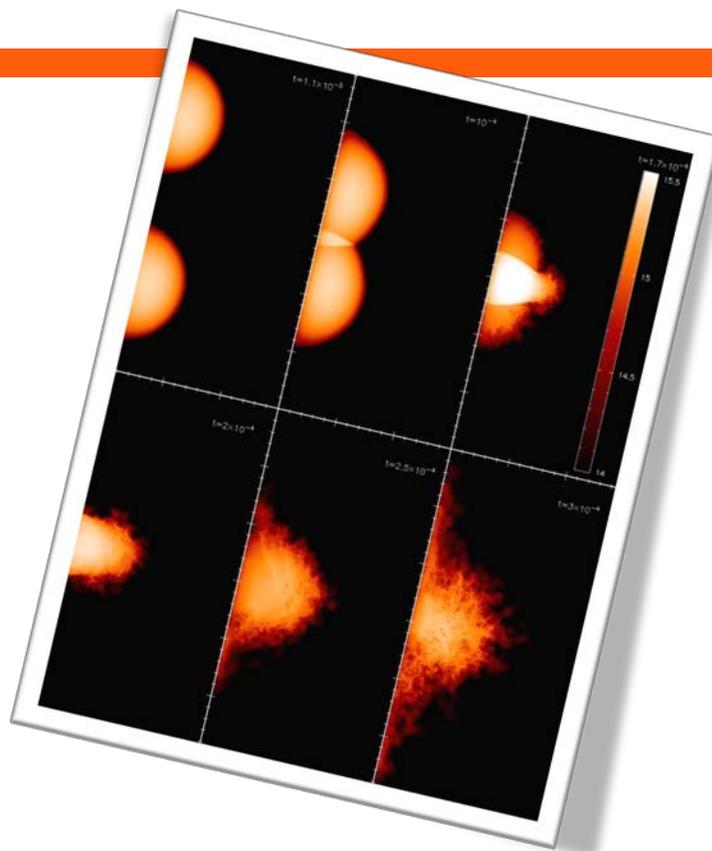
mixture of solid and fluid components acting at different scales in time and space. This gives no easy answer to the questions raised above, despite the robustness of the process.

This article, with participation of a researcher of the **Numerical Methods for Applied Sciences and Engineering** group (LACAN), aims at answering these questions through image analysis and numerical modeling, taking the folds of a fly wing as a reference model. By measuring local growth, and calibrating cell remodeling rates and material viscoelastic properties, the study succeeds to numerically simulate the observed folds and shapes of the wing during the first 90 hours of its development, and also captures aberrant development of mutated organisms.



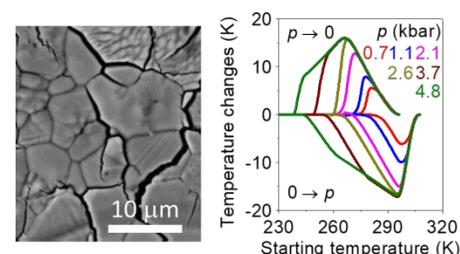
## COOLING BY PRESSURIZING MAGNETIC MATERIALS

**A. Aznar, P. Lloveras, J.-Y. Kim, E. Stern-Taulats, M. del Barrio, J.L. Tamarit, C.F. Sánchez-Valdés, J.L. Sánchez Llamazares, N.D. Mathur & X. Moya,** "Giant and Reversible Inverse Barocaloric Effects near Room Temperature in Ferromagnetic MnCoGeB<sub>0.03</sub>", *Advanced Materials* 31, 1903577 (2019) [Q1, 2/866 in *Mechanical Engineering*; IF=25.81]



Magnetic materials have traditionally attracted interest because they can be used for cooling when subjected to changes in external magnetic fields. This has been proposed as alternative to current compressors that use harmful fluids, provided that optimal materials are found. Composition-related MnCoGe compounds have been deeply studied due to a highly energetic magnetostructural transition that leads to large cooling power. However, their brittleness and the low sensitivity of the transition to magnetic field makes its implementation difficult in machines that work cyclically.

Researchers of the **Group of Characterization of Materials (GCM)** have shown that the large volume change at the magnetostructural transition in B-doped MnCoGe makes it more sensitive to pressure, which additionally permits the use of powder. Furthermore, these materials have high density and high thermal conductivity, and therefore offer a good prospect for pressure-driven solid-state cooling methods.



### CERAMIC AND POLYMERIC MEMBRANES FOR MINE WATERS TREATMENT

López, J., Reig, M., Vecino, X., Gibert, O. & Cortina, J.L., "Comparison of acid-resistant ceramic and polymeric nanofiltration membranes for acid mine waters treatment", *Chemical Engineering Journal* 382, 122786 (2020) [Q1, 11/524 in *Industrial and Manufacturing Engineering*; IF=8.36]

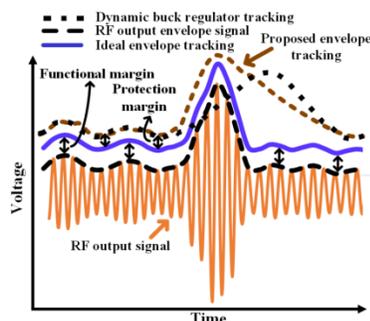
Acid-resistant ceramic and polymeric nanofiltration membranes are relevant materials for sustainable management of acidic streams. In this work, conducted by researchers of the **Resource Recovery and Environmental Management** group (R2EM), the performance of two acid-resistant membranes: TiO<sub>2</sub> ceramic and MPF-34 (proprietary layer) was tested with solutions mimicking acidic mine waters. Model solutions were composed by Al, Fe, Ca, Cu, Zn and rare earth elements such as La, Dy, Sm, Nd, Pr and Yb. The effect of acidity and Al/Fe concentrations was studied. Both membranes allowed the transport of H<sup>+</sup> but exhibited differences related to the metallic ions transport. While MPF-34 presented metal rejections around 80% regardless of the concentration of Al and Fe, the TiO<sub>2</sub> membrane provided a sequence of rejection values from 5 to 30%, with highest values achieved for trivalent transition metals. These differences in the sequence of rejections suggested that the chemical properties of the TiO<sub>2</sub> layer played a relevant role.

### ENVELOPE TRACKING TECHNIQUES FOR WIRELESS AND WEARABLE TECHNOLOGIES

S. Prakash, H. Martínez-García, M.H. Naderi, H. Lee & J. Silva-Martínez, "An Agile Supply Modulator with Improved Transient Performance for Power Efficient Linear Amplifier Employing Envelope Tracking Techniques", *IEEE Transactions on Power Electronics* 35, 4178 (2020) [Q1, 16/1891 in *Electrical and Electronic Engineering*; IF=7.22]

Battery run-time becomes a critical selling parameter for electronic wireless devices, wearable technologies, and portable electronic devices with ever increasing functional densities. With significant power consumption, on-chip power amplifiers (PAs) are instrumental components that determine battery run-times. The power efficiency of such PAs is low at power back-off (PBO) levels, which are frequent during PAs operation. An envelope tracking technique is recommended in literature to increase the power efficiency of PAs at PBO levels. With

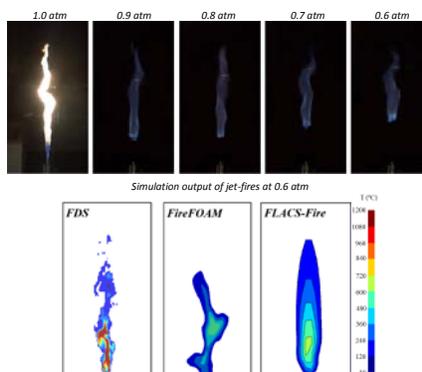
this technique, the power supply voltage of a PA has adaptation capability to the information in order to increase the energy efficiency of the system and, as a result, improves battery lifespan.



A researcher from the **Energy Processing and Integrated Circuits** group (EPIC) has participated in this work, that presents an agile supply modulator with optimal transient performance that includes improvement in rise time, overshoot and settling time for the envelope tracking supply in linear PAs. To this end, the authors propose an on-demand current source module: the bang-bang transient performance enhancer. Its goal is to follow fast variations in input signals with reduced overshoot and settling time without deteriorating the steady-state performance of the voltage regulator.

### CHARACTERIZATION OF METHANE JET FIRES

B. Rengel, A. Àgueda, E. Pastor, J. Casal, E. Planas, L. Hu & A. Palacios, "Experimental and computational analysis of vertical jet fires of methane in normal and sub-atmospheric pressures", *Fuel* 265, 116878 (2019) [Q1, 14/614 in *Energy Engineering and Power Technology*; IF=5.13]



Accidental jet fires occurring in industrial facilities can involve severe consequences as they can trigger domino effect. The assessment of the flame-geometry descriptors of the jet can contribute to prevent flame impingement on plant equipment, hence reducing inventory loss

and structural collapse. Experimental tests on jet fires can provide useful data on their main characteristics, which eventually allows deriving empirical or semi-empirical models. Nevertheless, experiments are expensive and not always feasible in all range of conditions that characterize real situations. Therefore, exploring the predictive capacity of computational fluid dynamics (CFD) models for characterizing accidental jet-fires is of outmost importance.

Researchers from the **Centre for Technological Risk Studies (CERTEC)** have performed a large number of experimental jet fire tests and have studied the capability of three CFD codes to predict the geometric and thermal characteristics of vertical methane jet fires, identifying the main strengths and weaknesses of each code.

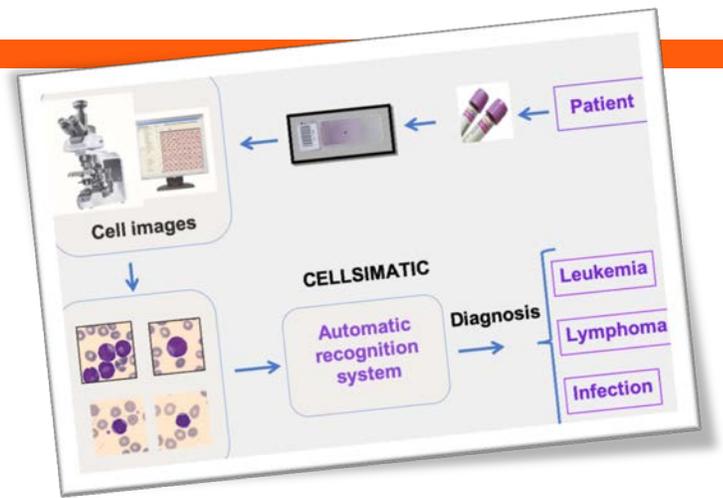
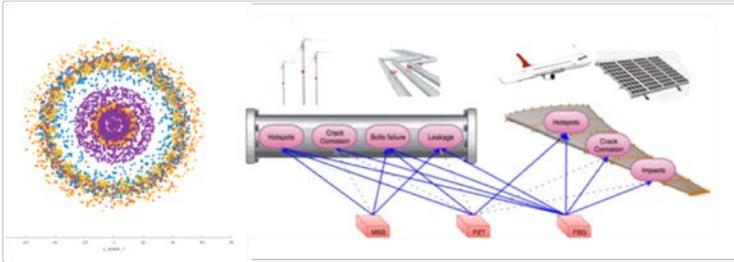
### METHODS FOR FEMORAL ROTATION IN TOTAL KNEE ARTHROPLASTIES

J.A. Hernández-Hermoso, L. Nescolarde-Selva, D. Rodríguez-Montserrat, J.C. Martínez-Pastor, E. García-Oltra & S. López-Marne, "Different femoral rotation with navigated flexion-gap balanced or measured resection in total knee arthroplasty does not lead to different clinical outcomes", *Knee Surgery, Sports Traumatology, Arthroscopy* 27, 1 (2019) [Q1, 14/425 in *Surgery*; IF=3.15]

This paper hypothesizes that the femoral rotation in a total knee arthroplasty (TKA) can vary in the same knee depending on the method used to establish it, although it may have little influence in clinical functional scores. A group of 38 patients who had TKA surgery through a bone resection technique was compared with a group of 40 patients operated with computer assistance (navigation) and a flexion gap balance technique (FB-CAS), to assess clinical and radiographic alignment differences at two years follow-up.

In 36 of the FB-CAS group patients both methods were used. Intraoperatively, femoral rotation navigated was established in reference to the transepicondylar axis, as the rotation that balanced the flexion gap. The equivalence of this rotation with the rotation measured by a posterior condylar reference template was determined. No differences in antero-posterior and lateral radiographic alignment of prosthetic components, patellar height or tilt were observed. Rotation of the femoral component in TKA can vary in the same knee depending on the surgical method used to establish it. This variation in femoral rotation is apparently sufficiently small as to have no effect on the 2-year clinical score.

RESEARCH GROUPS



CoDALab in a nutshell

**CoDALab** (*Control, Modelling, Identification and Applications*) is a *Generalitat de Catalunya's Consolidated Research Group* since 2009. It was founded by José Rodellar in 1985. The group consists of 11 members and it's arranged into three units: one located at the EEBE-CDB, another one at Manresa School of Engineering (EPSEM) and the other at the Terrassa UPC Campus. The EEBE unit is formed by Fayçal Ikhouane, Luis E. Mujica, Francesc Pozo, José Rodellar, Magda L. Ruiz, and Yolanda Vidal. Thus, it is composed by people with backgrounds in mathematics, physics, and engineering. The group is active in an interdisciplinary intersection of applied mathematics, systems and control theory and engineering. It covers both theoretical and applied research and has grown through the collaboration with other national and foreign leading research groups. The EEBE unit has a research lab at CDB that allows faculty and PhD students to conduct research in different areas such as structural control and health monitoring, wind turbine fault diagnosis, and automatic classification of blood cell microscope digital images.

# RESEARCH GROUPS @ CDB

## Control, Modelling, Identification & Applications (CoDALab)

At present time, CoDALab's research lines at the EEBE are, mainly, the following:

- Automatic classification of blood cell microscope digital images based on deep learning methods
- Wind turbine fault and damage diagnosis based on machine learning and deep learning methods
- Structural health monitoring for damage diagnosis based on experimental data
- Rate-dependent hysteresis: modeling, analysis and identification, with applications to magnetorheological dampers

CoDALab'S RECENT RESEARCH HIGHLIGHT

**M. Ruiz, L.E. Mujica, E. Alferez, L. Acho, C. Tutivén, Y. Vidal, J. Rodellar and F. Pozo, Wind turbine fault detection and classification by means of image texture analysis, Mechanical systems and signal processing, 107, 149-167 (2018)**

CoDALab'S RESEARCH FAST FACTS

Source: <https://futur.upc.edu/CoDALab>

RESEARCH OUTPUTS

- 428 research papers in indexed journals
- 599 contributions to Conference Proceedings
- 116 research and text books
- 44 PhD theses
- 6 patents

FUNDING & AWARDS

- 81 R+D+I international & national competitive projects
- 20 awards and special grants

FOR MORE INFORMATION

Prof. José Rodellar, [jose.rodellar@upc.edu](mailto:jose.rodellar@upc.edu)



WHAT/WHICH/HOW

# WHAT is a Ground-Penetrating Radar?

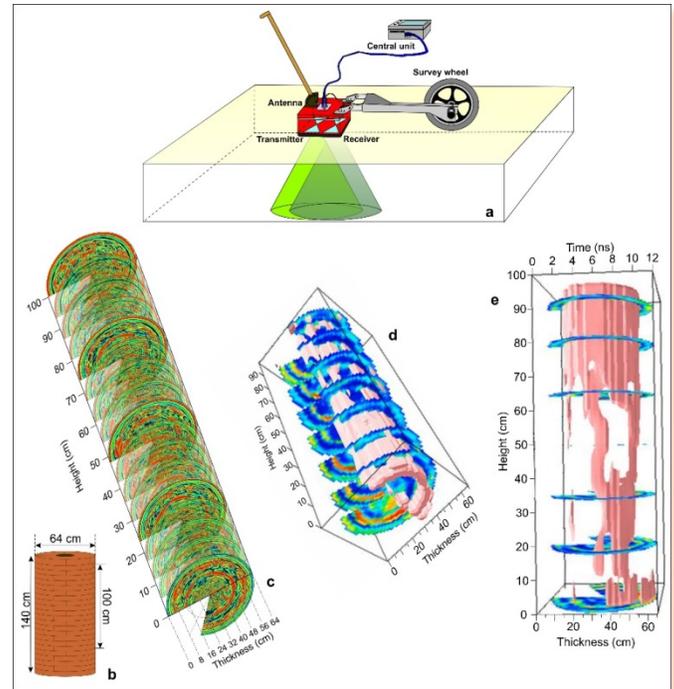
By Prof. Vega Pérez (GIES, Dept. Materials Strength and Structural Engineering, EEBE-CDB)

A **ground-penetrating radar (GPR)** is a survey technique widely used as a non-destructive test for non-metallic structures and infrastructure assessment. The method is based on the emission of 1 - 10 ns electromagnetic pulses from a transmitter antenna, which propagate through a medium. Abrupt discontinuities in the electromagnetic parameters of the medium (conductivity or dielectric permittivity, mainly) create surfaces where reflections and refractions are produced. The reflected signal travels to the surface where a receiver antenna detects its arrival (Panel a in the enclosed figure). The receiver antenna incorporates an electronic circuit, connected to an amplifier and a receiver circuit.

Electromagnetic arrivals generate an audio frequency band pulse that is sent through a highly screened cable to the central unit, where the signal is reconstructed, processed and stored. Each received pulse shows up as a single trace (Panel b). Therefore, by moving the antenna on the medium surface, a 2D

image record is obtained, revealing the existence of anomalies driven by electromagnetic changes in the inner materials. The most usual survey method is based on the reflection of the energy, being applied to the detection of bodies embedded in the medium.

Analysis of the scattered energy, frequencies and wave velocities could provide additional information about the medium conditions, allowing the detection of early damage in the structures. For example, clutter produced as a consequence of backscattered energy could be used in the analysis of heterogeneities, and the wave attenuation could be applied in determining corrosion of metallic bodies embedded in concrete or other non-metallic materials.



**FURTHER READING ON GPRs**

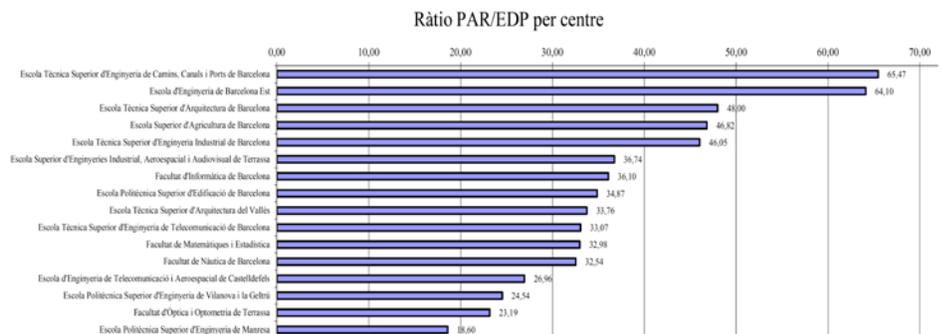
V. Sossa, V. Pérez-Gracia, R. González-Drigo and M. Rasol, *Lab Non Destructive Test to Analyze the Effect of Corrosion on Ground Penetrating Radar Scans, Remote Sensing* 11, 2814 (2019)

# THE EEBE @ THE UPC RESEARCH RANKINGS

The last research report (2018) endorsed by the Vice-Rectorate for Science Policy of the Universitat Politècnica de Catalunya (UPC),

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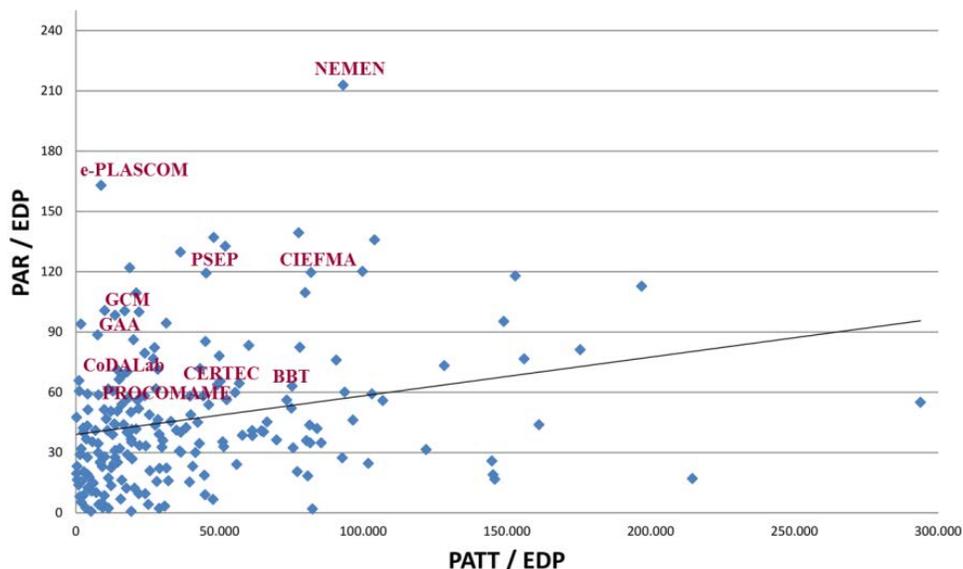
positioned the **Barcelona East School of Engineering (EEBE)** at the forefront of the 16 UPC Schools and Faculties in overall research outputs, with **8782 PAR**. This represents an increase in research productivity of **13%** with respect to 2017.



In terms of normalized ratios, the EEBE ranks **second**, with a noticeable average of **64.1** research points per researcher (or **PAR/EDP**).

With regard to **EEBE-based Research Groups**, the ranking is led by **NEMEN (Nanoengineering of Materials Applied to Energy)**, with **212.92 PAR/EDP** (and 92950.29 PATT/EDP, which measure the normalized funding per researcher, in terms of research grants, contracts, patents...). Four additional research groups based at EEBE (i.e., **e-PLASCOM**, **CIEFMA**, **PSEP** and **GCM**) have exceeded **100 PAR/EDP** during 2018.

The 10 most productive EEBE-based research groups are shown in the enclosed graph that displays the productivity (PAR/EDP) vs funding (PATT/EDP) landscape at UPC during 2018.



## AWARDS, GRANTS & EVENTS

### PhD Theses Defended

**Jhonatan Camacho** (Advisor: Magda L. Ruiz/Rodolfo Villamizar, CoDALab), "Robust structural damage detection by using statistical hybrid algorithms" (Jul/2019)

**Gabino L. Martínez** (Advisor: Jordi Llorca/Lluís Soler, NEMEN), "Nanoestructuras de TiO<sub>2</sub> de baja dimensionalidad para la obtención fotocatalítica de H" (Jul/2019)

**Mario M. Valero** (Advisor: Eulàlia Planas/Elsa Pastor, CERTEC), "Infrared image processing tools for automated aerial remote sensing of active wildland fires" (Oct/2019)

**Manuel Rivas** (Advisor: Jordi Puiggalí/Luis J. del Valle, PSEP), "Hydroxyapatite-based materials for smart antitumor drug delivery systems, endocytic pathways and endosomal trafficking" (Oct/2019)

**Laura Puigví** (Advisor: Anna Merino/José J. Rodellar, CoDALab), "Caracterització morfològica de cèl·lules limfoides normals, reactives, anormals i blàstiques de sang perifèrica mitjançant processament digital d'imatges" (Oct/2019)

**Roberta di Febo** (Advisor: Trinitat Pradell/Judit Molera, GCM), "Identification of microcrystalline phases in lead glazes of ceramics from 17th to 19th centuries: archaeometric implications" (Oct/2019)

**Antoni Pérez-Poch** (Advisor: Fermín Sánchez/Núria Salán, BCN-SEER/CIEFMA), "Análisis del impacto de metodologías activas en la educación superior" (Oct/2019)

**Oleg Balabanov** (Advisor: Núria Parés/Anthony Nouy, LACÀN), "Randomized linear algebra for model order reduction" (Oct/2019)

**Maximilien Lopes** (Advisor: Carlos E. Alemán/Catherine A.G. Michaux, IMEM-BRT), "Smart hybrid nanomaterials for biomimetic membranes" (Nov/2019)

**Pau Turón** (Advisor: Carlos E. Alemán, IMEM-BRT), "Concepts, perspectives and implications of a hybrid system made of nucleic acids biopolymers and hydroxyapatite mineral" (Nov/2019)

**Daniela A. Sandoval** (Advisor: Joan J. Roa/Luis M. Llanes, CIEFMA), "Small-scale testing of micromechanical response of cemented carbides" (Nov/2019)

**Filippos Ioannou** (Advisor: José J. Muñoz, LACÀN), "Mechanical modelling of tissue repair in 3-dimensions" (Nov/2019)

**Gerardo Gómez** (Advisor: Jordi Llorca/Herbert Sixta, NEMEN), "Valorization of Low Concentration Sugar Side-Stream from Dissolving Pulp Production" (Dec/2019)

**Emma Roca** (Advisor: Lexa D. Nescolarde, IEB), "Endurance races effects in non-elite runners by clinical biomarkers and bioimpedance measurements" (Dec/2019)

**Utkudeniz Öztürk** (Advisor: José María Cabrera/Jessica Calvo, PROCOMAME), "Hot forming behavior of ni-base superalloys and their modeling" (Dec/2019)

**Francisco de B. Rengel** (Advisor: Eulàlia Planas/Elsa Pastor, CERTEC), "Validation of CFD codes for risk analysis of accidental hydrocarbon fires" (Dec/2019)

**Julio López** (Advisor: José Luis Cortina/Oriol Gibert, R2EM), "Integration of nanofiltration and diffusion dialysis for the sustainable management of acidic liquid wastes" (Dec/2019)

### New Research Grants

*RISC3CAT Base3D*, AGAUR/Generalitat de Catalunya, 001-P-001646 (2019 – 2021), PIs: Maria Pau Ginebra (BBT), Jordi Llorca (NEMEN), Joan Josep Roa (CIEFMA) and Jessica Calvo (PROCOMAME)

*MAXPROFR. Development of a fire retardant and eco-friendly solution for boat protection during refitting*, European Commission, INTERREG MED 3MED17\_1.1\_M2\_003 4 Helix + (2019), PI: Miguel Sánchez Soto (e-PLASCOM)

*ENGAGE: ENgineering extracellular matrix-based de novo proteins with high Affinity to Growth factors for Enhancing bone regeneration*, European Commission, H2020-MSCA-IF-2018 (838621 — ENGAGE; 2019-2021), PI: Maria-Pau Ginebra (BBT)

*Smart health ecosystem (tools, apps and devices) for personalized medicine and Healthcare in Respiratory diseases and Sleep disorders*, MCIU/AEI/FEDER, European Union, RTI2018-098472-B-I00 (2019-2021), PI: Raimon Jané (BIOSPIN)

*Enhanced performance (corrosion and mechanical integrity) of hard material substrates by means of PVD AlCrSiN coatings and ion implantation (HardProtect)*, MICINN, PGC2018-096855-B-C41 (2019-2021), PI: Emilio Jiménez (CIEFMA)

*Transversal Programme in Medical Image PostProcess, Training Professionals: 3D Printing*, European Inst. Innov. & Tech., EIT\_HEALTH-KIC\_LE-19787-EXPERT3D (2019), PI: Raúl Benítez (ANCORA)

*Recubrimientos de biomateriales de doble acción para infecciones bacterianas e integración de Tejidos*, MICINN, RTI2018-098075-B-C21 (2019-2021), PI: José María Manero Planella/Marta Pegueroles (BBT)

*RISC3CAT FusionCAT*, AGAUR/Generalitat de Catalunya, 001-P-001722 (2019-2021), PI: Jordi Llorca (NEMEN)

### New Postdoctoral Fellows

**Dr. Núria J. Divins** (NEMEN, Beatriu de Pinós postdoctoral fellow)

# CAMPUS DIAGONAL-BESOS

## Research Newsletter

Edited by:

Sots-Direcció de Recerca, EEBE  
[sd.recerca.eebe@upc.edu](mailto:sd.recerca.eebe@upc.edu)

Universitat Politècnica de Catalunya (UPC)

Av. Eduard Maristany, 16  
 08019 Barcelona



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Campus Diagonal-Besòs