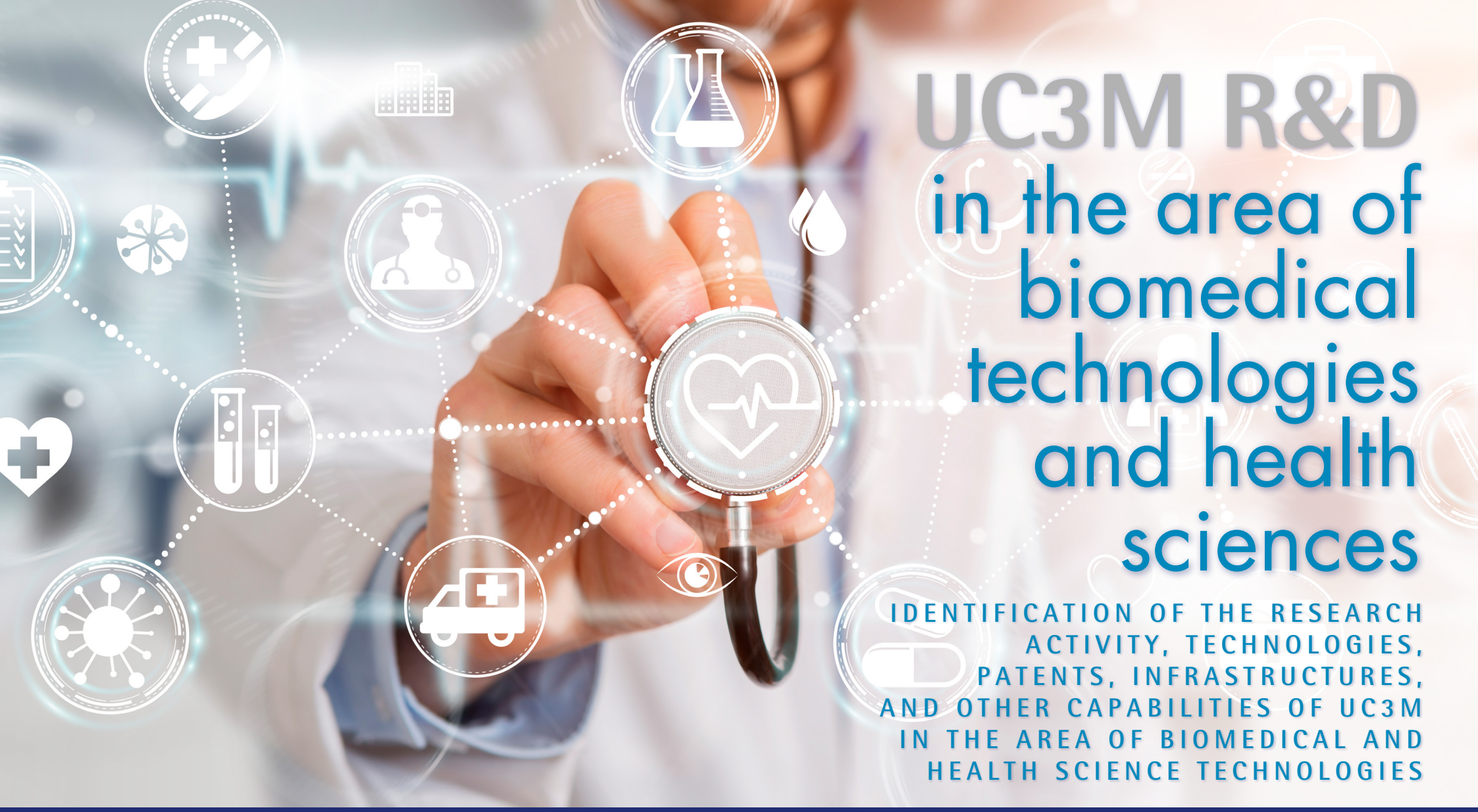
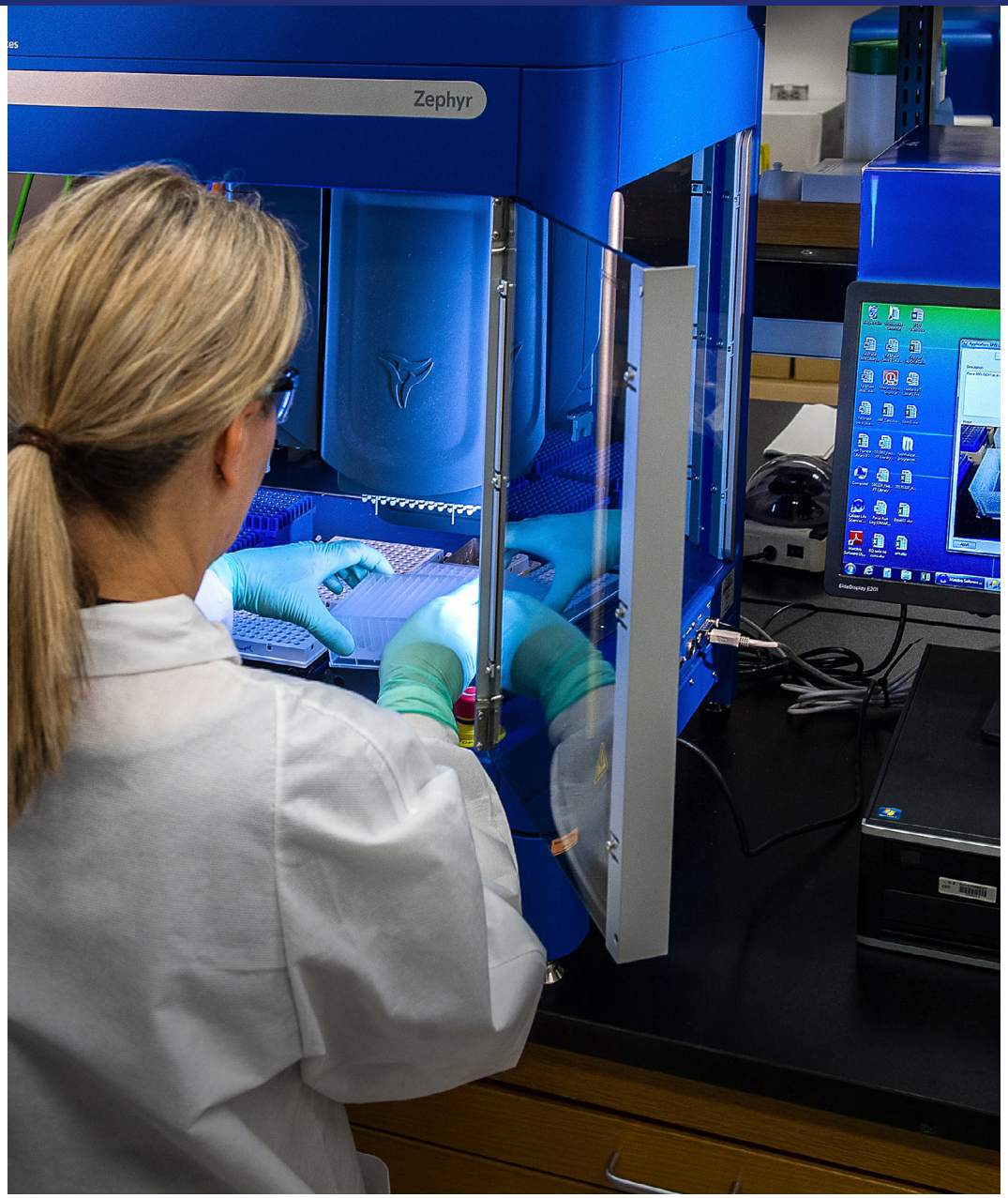


# UC3M R&D in the area of biomedical technologies and health sciences

IDENTIFICATION OF THE RESEARCH ACTIVITY, TECHNOLOGIES, PATENTS, INFRASTRUCTURES, AND OTHER CAPABILITIES OF UC3M IN THE AREA OF BIOMEDICAL AND HEALTH SCIENCE TECHNOLOGIES

uc3m | Universidad Carlos III de Madrid
Vicerrectorado de Política Científica
Servicio de Apoyo al Emprendimiento y la Innovación




The Entrepreneurship and Innovation Support Service of Universidad Carlos III de Madrid (UC3M) presents the potential of UC3M in this "technological map" through lines of research developed within the framework of national and international R&D projects, patents, and other results attained by the researchers of UC3M in the area of Biomedical Technologies and Health Sciences.

The global knowledge achieved, the experience in collaborating with the industry, the existence of UC3M very own infrastructures and laboratories, and above all, multidisciplinary nature of UC3M are unique characteristics providing added value for rendering a comprehensive support to the innovation of institutions, large enterprises, and SMEs.

We invite you to delve into the knowledge of UC3M and to collaborate with us in our new R&D&I projects.

**Entrepreneurship and Innovation Support Service,**
**Universidad Carlos III de Madrid**

**Contact:**
comercializacion@uc3m.es

*Date updated*
May 2022

# Table of Contents

LIBRARY SCIENCE AND DOCUMENTATION ..... 8

Technologies Applied to Information and Documentation (TECNODOC) ..... 8
*PI: Antonio Hernández Pérez*

BIOENGINEERING ..... 9

Biomedical Imaging and Instrumentation Group (BiiG) ..... 9
*PI: Manuel Desco*

Tissue Engineering and Regenerative Medicine-Integrative Biomedicine (TERMeG-INTEGRA) ..... 11
*PI: Luis Jorcano Noval*

Tissue Engineering and Regenerative Medicine-Rare Diseases (TERMeG-Rare Diseases) ..... 12
*PI: Marcela del Río Nechaevsky*

MATERIAL SCIENCE ENGINEERING AND CHEMICAL ENGINEERING ..... 14

In-service Materials Performance (CSM) ..... 14
*PI: Miguel Ángel Martínez Casanova, Francisco Javier Velasco López*

Polymeric Composites and Interphases (GMCPI) ..... 15
*PI: F. Javier González Benito*

Modelling, Numerical Simulation and Industrial Mathematics (GMSMI) ..... 16
*PI: Luis López Bonilla*

**Polymers and Composites** ..... 18
*PI: Juan Baselga*

**Material Synthesis and Processing (SIPMAT)** ..... 20
*PI: Alejandro Varez, Belén Levenfeld*

**Powder Technology (GTP)** ..... 21
*PI: Elena Gordo, José Manuel Torralba*

INTERNATIONAL LAW, ECCLESIASTICAL LAW, AND PHILOSOPHY OF LAW ..... 23

**Human Rights, State of Law and Democracy** ..... 23
*PI: Rafael de Asís, Fco. Javier Ansuátegui*

PUBLIC STATE LAW ..... 24

**Services of General Interest, Economic Activity and Public Intervention** ..... 24
*PI: Tomás de la Cuadra Salcedo*

SOCIAL LAW ..... 25

**Social Security and the Prevention of Labour Risks (GISSPRL)** ..... 25
*PI: Carmen Carrero*

ECONOMICS ..... 26

**Economics of Health and Medicine** ..... 26
*PI: Félix Lobo*

STATISTICS ..... 27

**Department of Statistics** ..... 27
*PI: José Niño Mora*

PHYSICS ..... 28

Remote Sensing Laboratory and Imaging Sensors in the Infrared (LIR) ..... 28
*PI: Fernando López*

Nano-Structured and Multifunctional Materials ..... 29
*PI: Miguel Ángel Monge*

COMPUTER SCIENCE ..... 30

Computer, Communications and Systems Architecture (ARCOS) ..... 30
*PI: Jesús Carretero*

Computer Security Lab (COSEC) ..... 31
*PI: Juan E. Tapiador*

GIGABD ..... 32
*PI: Jorge Luis Morato*

Applied Artificial Intelligence (GIAA) ..... 33
*PI: José Manuel Molina, Jesús García*

Human Language and Accessibility Technologies (HULAT) ..... 34
*PI: Paloma Martínez*

Knowledge Reusing ..... 36
*PI: Juan Llorens*

Planning and Learning (PLG) ..... 37
*PI: Fernando Fernández Rebollo*

SOFTLAB ..... 38
*PI: Ángel García Crespo*

SYSTEMS ENGINEERING AND AUTOMATION ..... 39

Robotics Laboratory (Robotics Lab) ..... 39
*PI: Miguel Ángel Salichs, Carlos Balaguer, Luis Moreno*

Intelligent Systems Laboratory (LSI) ..... 41
*PI: Arturo de la Escalera, José María Armingol, Francisco José Rodríguez*

MECHANICAL ENGINEERING ..... 42

MAQLAB: Machine Laboratory ..... 42
*PI: Cristina Castejón*

Experimental Mechanics, Calculus and Transportation (MECATRAN) ..... 43
*PI: Beatriz López Boada, María Jesús López Boada*

Mechanical Simulation and Optimisation (SIOMEC) ..... 44
*PI: María Belén Muñoz Abella, Lourdes Rubio Ruiz de Aguirre*

Mechanical and Biomechanical Component Manufacturing and Design Technology (FabDis) ..... 45
*PI: Henar Miguélez, José Luis Cantero*

TELEMATIC ENGINEERING ..... 46

ADSCOM (Advanced Switching and Communication Systems) - Network Technologies Group (NETTEC) ..... 46
*PI: David Larrabeiti*

NETCOM (Networks and Communication Technologies) - Network Technologies Group (NETTEC) ..... 47
*PI: Arturo Azcorra, Francisco Valera*

GRADIENT (Educational Technologies Laboratory) – Telematic Applications and Systems Group (GAST) ..... 48
*PI: Carlos Delgado Kloos*

Pervasive Computing Laboratory - Telematic Applications and Systems Group (GAST) ..... 49
*PI: Carlos Delgado Kloos, Carlos García Rubio, Andrés Marín López, Luis Sánchez Fernández*

THERMAL ENGINEERING AND FLUID ENGINEERING ..... 50

Fluid Mechanics (GMF) ..... 50
*PI: Francisco Javier Rodríguez Rodríguez, Wilfried Coenen*

MATHEMATICS ..... 51

Interdisciplinary Complex Systems Group (GISC) ..... 51
*PI: José A. Cuesta*

Numerical Methods and Applications ..... 53
*PI: Miguel Ángel Moscoso*

ELECTRONICS TECHNOLOGY ..... 54

Microelectronics Design and Applications (DMA) ..... 54
*PI: Luis Entrena, Luis Hernández Corporales*

Photonic Displays and Applications (GDAF) ..... 55
*PI: José Manuel Sánchez Pena, Carmen Vázquez*

Instrumentation Sensors and Techniques ..... 56
*PI: Pablo Acedo*

SIGNAL THEORY AND COMMUNICATIONS ..... 58

Machine Learning for Data Science (ML4DS) ..... 58
*PI: Jerónimo Arenas*

Multimedia Processing (GPM) ..... 59
*PI: Fernando Díaz de María*

Signal Processing and Learning (GTSA) ..... 60
*PI: Antonio Artés*

UC3M – BANCO SANTANDER BIG DATA INSTITUTE ..... 62

UC3M-Santander Big Data Institute (IBiDat) ..... 62
*PI: Rosa E. Lillo*

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **LIBRARY SCIENCE AND DOCUMENTATION** | | | |
| **Technologies Applied to Information and Documentation (TECNODOC)**<br><br>**PI: Antonio Hernández Pérez** | • Healthcare documentation.<br>• Health vocabulary and metadata.<br>• FAIR data in health. | **European Projects**<br>• FAIR4Health.<br><br>**R&D National Plan Projects**<br>• On-line training in Information Sources in Health Sciences intended for healthcare professionals.<br>• Support and management of the survey on healthcare strategies in palliative care, diabetes, cancer, and heart disease.<br>• Consultancy, Technical Assistance, and Training in the Area of Patient Safety.<br>• Obtaining on-line training resources in patient safety.<br><br>**Private Funding**<br>• National Health System surveys on cancer and heart disease. | **Experience and Capabilities**<br>Group specialised in auditing and starting up projects related to the implementation of digital information systems. |

## BIOENGINEERING

### Biomedical Imaging and Instrumentation Group (BiiG)

**PI: Manuel Desco**

**LINES OF RESEARCH**

- High resolution imaging in laboratory animals.
- Biomedical heart imaging.
- Magnetic resonance imaging.
- Neuroimaging.
- Multimodal imaging: development of RM, CT, and nuclear image analysis tools.

**RESEARCH PROJECTS**

**European Projects**

- Project ERA4TB (European Regimen Accelerator for Tuberculosis).
- TAHITI: Improving Therapy and intervention through imaging.
- PreDict-TB: Model-based preclinical development of anti-tuberculosis drug combinations.

**R&D National Plan Projects**

- Application of new molecular imaging technologies and advanced reconstruction and processing methods for cardiovascular applications.
- Radiation hormesis in Oncology.
- Multi-scale imaging platform for accelerating the development of drugs for treating pulmonary infections.
- Use of advanced imaging techniques in small laboratory animals for cardiovascular applications.

**R&D Regional Plan Projects**

- Augmented reality for environments of surgical planning, simulation, training, and navigation: HoloMed.
- Cerebrospinal fluid flow and its role in the pathogenesis of syringomyelia.
- Implementation of metamaterials in systems for protecting the human hand.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

Research in medical imaging techniques both in relation to the development of new technologies and advanced reconstruction and processing methods and to their practical application in the areas of X-ray tomography, nuclear, magnetic resonance, and optical tomography imaging. The highly multidisciplinary nature of the group facilitates a strong connection to real clinical and pre-clinical needs.

**Technological Offer (Covid 19)**

- **High-precision X-ray system for coronavirus**
  In collaboration with Hospital Gregorio Marañón (HGUGM), Instituto de Investigación Sanitaria San Carlos and Sedecal Molecular Imaging (SMI).
- **New ICU ventilator prototype for COVID-19**
  In collaboration with HGUGM.
- **Adaptation of a sleep apnoea apparatus as respiratory support for patients with COVID-19**
  In collaboration with HGUGM.
- **New high-precision X-ray system to improve the diagnosis of COVID-19 with artificial intelligence.**

**Patents**

- *Celda centelleadora* (Scintillator Cell) (P201631258).
- Multiple-loading device for a flat laser beam microscope (ES2607633, WO2017055673). Sample-holding device for a microscope (P201630364, PCT/ES2017/070184).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **BIOENGINEERING** | | | |
| Biomedical Imaging and Instrumentation Group (BiiG)<br><br>PI: Manuel Desco | | **Private Funding**<br>• X-ray tomography imaging system for mice and PDMS microfluidics chips for Time Lapse studies.<br>• Acquisition of topology by means of a surface scanner for the evaluation of scoliosis. | • *Equipo y método de generación de tomografías* (Equipment and method for generating tomographies) (P201730341).<br>• Microscope and method for generating 3d images of a collection of samples (ES2567379, WO2016062907, EP15851669.0, US15/521,220).<br>• *Sistema de detección de radiación gamma y sistema de resonancia magnética* (Gamma radiation detection system and magnetic resonance system) (P201631388).<br><br>**Software Registrations**<br>• FUX-SIM.<br>• RapTor.<br>• XAP-LAB.<br><br>**Equipment**<br>• **Medical Imaging Laboratory**<br>The available medical (CT, PET, CT-PET, optical, fluorescence tomography FMT, magnetic resonance) imaging resources are among the most complete in the country.<br>The lab also has access to the common facilities in the Experimental Medicine and Surgery Unit at Hospital Gregorio Marañón: laboratories, confocal microscopy, animal housing, operating rooms, mechanical and electronic workshop, etc. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## BIOENGINEERING

### Tissue Engineering and Regenerative Medicine- Integrative Biomedicine (TERMeG-INTEGRA)

**PI: Luis Jorcano Noval**

**LINES OF RESEARCH**

- Human tissue, especially skin engineering.
- Skin regeneration: study of the molecular mechanisms involved in skin repair and regeneration and identification of new therapeutic targets.
- Redox signalling in the skin and skin diseases.
- Technology for 3D Bioprinting of tissues, particularly human skin:
  - development of bioprinters.
  - generation of ad hoc bioinks for clinical use and in the testing of pharmaceuticals and cosmetics.
- Tissue modelling in microfluidics systems (tissue-on-a-chip) for clinical use and in the testing of pharmaceuticals and cosmetics.
- Cellular biomechanics.

**RESEARCH PROJECTS**

**European Projects**

- CONEX-Plus MSCA-COFUND. Synergy between 3D bioprinting of functional human skin and bactericidal graphene: new approaches for wound healing and infections treatment.

**R&D National Plan Projects**

- Peroxiporin-mediated signalling in skin physiology.
- PRINTHAIR: Method for the production of human hair follicles based on 3D bioprinting.
- Experimental and computational methodology for three-dimensional characterisation of cellular kinematics and dynamics in tissue morphogenesis.
- Methodology for measuring intercellular forces during tissue morphogenesis.
- Development of a bioactive dressing based on fibrin and active bioingredient. Fibrodress.

**R&D Regional Plan Projects**

- BIOPIELTEC-CM: New Technologies for Tissue Manufacture and Optimisation: the Skin as a Model System.

**Internal Projects (UC3M Funding)**

- Strategic action in tissue bioengineering and engineering.
- Biocompatible Magneto-Active Structures to Simulate Skin Wound Healing: an Experimental-Computational Coupled Approach.

**Private Funding**

- Advisory services in the area of research and development of tissue engineering products.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- 3D bioprinting of human tissues.
- Development of bioinks for 3D bioprinting.
- Tissue modelling in microfluidics systems (tissue-on-a-chip) for the analysis of pharmaceuticals, cosmetics, and chemicals.
- Mixed CIEMAT-UC3M Biomedical Engineering Unit.
- Collaboration with the Sensor and Instrumentation Techniques Group (UC3M) in the area of skin healing:
  - Development of minimally invasive detection systems.
  - Bioelectronics: development of optical and electrochemical sensors and actuators.
- Collaboration with Arcelor for the development of graphene-based bioinks.
- Collaboration with the Centro Comunitario de Sangre y Tejidos de Asturias (CCSTA) in the area of tissue engineering.
- Collaboration with the Instituto de Ciencia y Tecnología de Polímeros (ICTP- CSIC) for the development of new "smart" (sensing and actuating) dermal matrices for monitoring skin transplants.

**Patents**

- "Method for obtaining three-dimensional structures for tissue engineering", PCT/ES2008/000191.
- "Artificial dermis and production method therefore", PCT/ES02/00087.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## BIOENGINEERING

### Tissue Engineering and Regenerative Medicine-Rare Diseases (TERMeG-Rare Diseases)

**PI: Marcela del Río Nechaevsky**

- Modelling of highly prevalent dermatological diseases: Psoriasis, Atopic Dermatitis, and Chronic Ulcers.
- Clinical, physiopathological, cellular, and molecular characterisation of rare dermatological diseases: Epidermolysis Bullosa, Kindler Syndrome, Xeroderma Pigmentosum, Familial Melanoma, Netherton Syndrome, Pachyonychia Congenita, Lamellar Ichthyosis, cutaneous Scleroderma, Gorlin Syndrome. Modelling of genetic diseases of the skin.
- Advanced therapies: cell therapy, gene therapy, and tissue engineering.
- Pharmacological therapy and nanotherapy for dermatological diseases.
- Regenerative medicine: adult stem cells (epidermal and mesenchymal stromal cells).
- Ohmic technologies: functional and comparative analysis of interaction networks and metabolic pathways in rare diseases.

**European Projects**

- *MutaEB:* Mutation-targeted gene and pharmacological therapies for dystrophic and junctional Epidermolysis Bullosa.
- *CURE EB:* Pre-clinical development of a gene editing medicinal product for epidermolysis bullosa.

**R&D National Plan Projects**

- *MULTITEREB:* Development and pre-clinical assessment of advanced multimode therapies for Recessive Dystrophic Epidermolysis Bullosa.
- *ACCI-CIBERER:* Integrated metabolomic and transcriptomic analysis (RNA seq) for identifying mechanisms mediating the therapeutic effect of mesenchymal stem cells (MSCs) in patients with Recessive Dystrophic Epidermolysis Bullosa.
- Pre-clinical biosafety assessment of *ex vivo* gene editing therapy for Epidermolysis Bullosa.
- *MesensistemEB:* Preliminary safety and efficacy study of the infusion of adipose tissue-derived mesenchymal stem cells for the treatment of Recessive Dystrophic Epidermolysis Bullosa (Extended).

**R&D Regional Plan Projects**

- *AVANCELL-CM:* Advanced precision therapies in cell and tissue regeneration and repair.

**Experience and Capabilities**

- **Clinical Trials**
  - *WINGS:* Topical QR-313 in Recessive Dystrophic Epidermolysis Bullosa (RDEB) Due to Mutation(s) in Exon 73 of the COL7A1gene.
  - *MesensistemEB:* Preliminary safety and efficacy study of the infusion of bone marrow-derived haploidentical mesenchymal stem cells for the treatment of Recessive Dystrophic Epidermolysis Bullosa.
  - *WOUND:* Pilot, single-centre, non-comparative clinical trial to evaluate the preliminary safety and efficacy of the administration of adipose tissue-derived MSCs (AT-MSCs) injected into the borders of an ulcer and three-dimensionally assembled in a fibrin matrix obtained from platelet-rich plasma (AT-MSC Sheets) in patients with chronic wounds resistant to conventional treatment.
- **Patents**
  - Gene editing for the treatment of epidermolysis bullosa (EP20382027.9).
  - FPR2 receptor agonist aptamers and uses thereof (PCT/ES2020/070378).
  - Inhibitors of TGF-ß1 and endoglin producers for use in the treatment of epidermolysis bullosa (PCT/ES2019/070757).
  - Method for preparing three-dimensional structures for tissue engineering (PCT/ES08/00191).
  - Artificial dermis and production method therefor (PCT/ES2002/000087).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **BIOENGINEERING** | | | |
| Tissue Engineering and Regenerative Medicine-Rare Diseases (TERMeG-Rare Diseases)<br><br>PI: Marcela del Río Nechaevsky | | **Private Funding**<br>• Genetic diagnostics and research in Epidermolysis Bullosa.<br>• MesenSistemEB clinical trial co-funding.<br>• *TRIDs:* Generation of genetically modified cell lines containing representative antisense mutations in genes causing genetic diseases of the skin (Epidermolysis bullosa and others) and use of an organotypic model for identifying translational read-through drugs (TRIDs). | • **Orphan Drug**<br>· Autologous skin equivalent graft composed of keratinocytes and fibroblasts genetically corrected by CRISPR/Cas9-mediated excision of mutation-carrying COL7A1 exon 80 (EMA/OD/0000013899).<br>• **Fundación Jiménez Díaz Chair for regenerative medicine and tissue bioengineering research (Mixed UC3M-CIEMAT Unit)** https://portal.uc3m.es/portal/page/portal/actualidad_cientifica/noticias/catedra_medicina_regenerativa<br>• **Complex Wound Unit (IIS-FJD-CIEMAT-UC3M).**<br>• **CIBER Rare Disease Unit U714.**<br>• **Skin Disease Model Unit (CIBERER; Mixed CIEMAT-UC3M Unit).**<br>• **Regenerative Medicine Unit (CIBERER; Mixed CIEMAT-UC3M Unit).** |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### In-service Materials Performance (CSM)

**PI: Miguel Ángel Martínez Casanova and Francisco Javier Velasco López**

- Surface treatment: adhesives and coatings.
- Organic coatings.
- Composites.

**Internal Projects (UC3M Funding)**

- GRABOND: Graded adhesive bonding between dissimilar materials with healing and recycling properties.

**Private Funding**

- Improvement of polymer material adhesiveness by means of atmospheric plasma torch treatment for adhesive bonds.
- Plasma treatments for polymer materials.
- Optimisation of materials by means of using nanostructured particles and surface modification. Subproject 3: Application of nanoparticles as additives in polymer materials.
- Development of high-performance binders for diamond inserts.
- New transparent materials for the tempesting of critical equipment.

**Experience and Capabilities**

- Plasma treatments
  - Types of plasmas: low-temperature, high-energy plasmas.
  - Atmospheric plasma (APPT).
- Atmospheric Plasma Treatments (APPT)
  - Sterilising metallic surgical material and increasing wettability.
  - Long-term polyethylene activation for disposables.
  - Treatment of tissues to render them super-hydrophilic.

Experience with natural fibres, synthetic fibres, cork, etc.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Polymeric Composites and Interphases (GMCPI)

**PI: F. Javier González Benito**

- Thermoplastic nanocomposites with special electrical properties.
- Antibacterial thermoplastic nanocomposites.

**Sub-lines:**

- Characterisation of polymers and polymer matrix composites.
- Atomic force microscopy.
- Cell adhesion.
- Nano-thermal strain (determination of thermal expansion coefficients of thin films).
- Nano-piezo strain.

**R&D National Plan Projects**

- New nanocomposites with special electrical properties and development of new characterisation methods: nano-piezo strain and nano-thermal strain.
- Prevention of diseases with antimicrobial materials in the food and healthcare sectors.

**Private Funding**

- Prevention of diseases with antimicrobial materials in the food and healthcare sectors.

**Experience and Capabilities**

- Preparation of materials.
- Characterisation of materials
  - Structure (DRX, FTIR, Fluorescence).
  - Morphology (MO, SEM, AFM).
  - Thermal properties (DSC, TGA, nano-thermal strain).
  - Mechanical properties (stress, bending, nano-indentation, etc.).
  - Electrical properties (spectroscopy to determine impedance, conductivity, dielectric strength, etc.).
- Materials with potential applications as pressure sensors.
- Materials for the controlled release of drugs.
- Antibacterial thermoplastics.

**Patents**

- *Dispositivo para la obtención de fibras de diámetro nanométrico o micrométrico* (Device for obtaining fibres of a nanometric or micrometric diameter) (ES2752882).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Modelling, Numerical Simulation and Industrial Mathematics (GMSMI)

**PI: Luis López Bonilla**

- Angiogenesis:
  - Formation of blood vessels applicable to macular degeneration.
  - Tumour-induced angiogenesis.
- Growth and development of bacterial films (Biofilms).
- Cell population aggregation and movement.

**R&D National Plan Projects**

- Mathematical and technical models for cell aggregates.
- Hybrid models for nano and biosystems.

**Experience and Capabilities**

- Angiogenesis models including cell signalling, biomechanics, and the evaluation of possible therapies.
- Statistical analysis, topological analysis of data, and shape recognition.
- Identification of factors that favour or impede the formation and survival of bacterial biofilms in the design and use of hospital devices leading to operating protocols and designs that reduce the risk of infections derived from biofilms. In collaboration with other research groups, modification of surfaces to remove already formed biofilms.
- Reduced models for the processing of large databases and acceleration of numeric codes.
- Molecular dynamics simulations, Monte Carlo, Boltzmann lattice, stochastic and deterministic differential equations.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Modelling, Numerical Simulation and Industrial Mathematics (GMSMI)

PI: Luis López Bonilla

**Others**

- Study (in collaboration with UCM) which mathematically describes how metastasis starts. https://doi.org/10.1371/journal.pcbi.1008407.
- Mathematics for improving the treatment of macular degeneration.
- Mathematical simulation that recreates the progression of age-associated macular degeneration, offering further knowledge on how this disease is generated and an evaluation of the most effective treatments.

**Equipment**

The GMSMI has substantial capacity both in terms of hardware and software to handle numerical simulation projects.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Polymers and Composites

**PI: Juan Baselga**

- Nanostructured polymers and copolymers for energy applications.
- Materials for electromagnetic shielding.
- Functionalised smart polymers for biomedical applications.
- Biosensors and bioactive materials for use in food.
- Polymeric micro- and nano-capsules.

**R&D European Projects**

- Nano-COnductive-polymer composites with predefined architecture and customised dielectric and EMS properties (GHz frequency domain) dedicated to shielding and absorbent PANels for special building (NACOPAN).

**R&D National Plan Projects**

- Nanoparticle dispersion in thermosetting hybrids.
- Playing darts with nanoparticles.
- Nanocomposites with hierarchically structured architectures.
- Nanocomposites with functionalised particles.
- Advanced Functional Materials For Application in Roads and Buildings (MAMCE).
- Synthesis and applications of doped carbon nanotubes.
- Self healing and rEsistant Asphalts for PORTs.

**R&D Regional Plan Projects**

- Polymer-based nanostructured materials: interphase phenomena relating to their properties and advanced applications.

**Internal Projects (UC3M Funding)**

- Strategic Actions in Nanocomposites and Advanced Fibres.

+

**Experience and Capabilities**

- Synthesis of polymers and copolymers.
- Preparation and characterisation of nanocomposites.
- Polymer photophysics and photochemistry.
- Study of the electromagnetic properties of materials.
- Manufacture of porous carbon fibres and structures.
- Functionalisation of polymers and nanoparticles.
- Study of specific interactions with DNA.
- Encapsulation of repairing agents.

**Patents**

- *Materiales para apantallamiento electromagnético* (Materials for electromagnetic shielding), ES2509390.
- Nanoreinforced polymers, WO2013160508-A1; ES2431492-A1.
- Method for obtaining copper double salt nanocompounds and use thereof as a catalyst and microbicide, P201930641/PCT/ES2020/070439.
- Method for manufacturing a hybrid material for conducting electrical currents 19382471.1-1103.
- Self-healing asphalt by rejuvenator-containing microcapsules activable at will by irradiation PCT/EP2020/054868; EP 3 702 411 A1.
- *Material compuesto antimicrobiano y su uso como material de envasado para alimentos frescos* (Antimicrobial composite material and use thereof as a packaging material for fresh foods) P202031251.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING | | | |
| Polymers and Composites<br><br>PI: Juan Baselga | | **Private Funding**<br>• Aircraft Lightning Strike Protection with Graphene Hybrid Nanomaterials (LIGHTGRAPH).<br>• Nanoreinforced composites with Advanced Mechanical and Electrical Properties.<br>• NANOBRAK: Development of biocompatible nanoreinforced polymer materials for bio-healthcare use. | **Equipment**<br>• Mechanical, thermal, and electrical characterisation laboratory.<br>• Polymer synthesis and characterisation laboratory.<br>• Spectroscopic characterisation laboratory.<br>• Optical and electron microscopy laboratory. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Material Synthesis and Processing (SIPMAT)

**PI: Alejandro Varez, Belén Levenfeld**

- Ceramic or metal powder injection moulding (CIM, MIM).
- Powder extrusion moulding (PEM).
- Polymer mixes.
- Rheological behaviour of polymeric systems.
- Synthesis and structural characterisation of ceramic materials.
- Biomaterials.

**European Projects**

- HINMICO: High throughput integrated technologies for multimaterial functional Micro Components (MNG).

**R&D National Plan Projects**

- Bioactive Acrylic Cements: Preparation and Application of composite systems for surgery and stomatology.

**Private Funding**

- Developments of steel-loaded filaments for 3D printing.
- Application of the Ceramic Injection Model to the Manufacture of Dental Pieces Used in Orthodontics.
- Problem of nanoparticles in their production process and its application in dental implants.

**Experience and Capabilities**

Multidisciplinary research group with extensive experience in the synthesis, processing, and characterisation of metal and polymer composites.

**Equipment**

The group has the technical capability and facilities to prepare both ceramic materials (ceramic method, sol gel, liquid solutions, mechanical grinding, etc.) and polymer materials. The group also has the equipment needed for the structural, microstructural, electrical, thermal, and mechanical evaluation and characterisation of the developed materials.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Powder Technology (GTP)

**PI: Elena Gordo, José Manuel Torralba**

- Development of materials (design, processing) by means of powder technology.

  Mostly metals and metal-ceramic composites.

  Including:
  - Production of nanoparticles.
  - Development of coatings.

**European Projects**

- EIT Raw Materials.

**R&D National Plan Projects**

- Design of Sol-Gel type biodegradable coatings with antimicrobial properties for the prevention and local treatment of infections on biomaterials for clinical use.
- Smart Manufacture of Advanced Materials for Transportation, Energy, and Health.
- Development of tribocorrosion-resistant biofuntionalised hybrid surfaces on new Ti alloys.
- Processing of inorganic composites using bond-based additive manufacturing techniques.
- PeTitNeST: High Performance Titanium by Near Net Shape Technologies.
- Processing by associating colloidal and powder metallurgical techniques for the design of metal-ceramic nanocomposite structures.

**R&D Regional Plan Projects**

- ADITIMAT-CM. Additive Manufacturing: from material to application.
- New structural and functional materials based on nanostructured and/or nanoparticle reinforced composites.

+

**Experience and Capabilities**

- Development of Ti by PM
  - Design of alloys.
    - Modification of the composition.
    - Replacement of harmful elements (V).
    - Use of master alloys.
  - Colloidal processing.
    - Use of fine particles.
    - Design of microstructures and microarchitectures.
    - Introduction of second phases (e.g.: ceramic nanoparticles).
    - Dense, porous, gradient, sheet materials.
    - Slip casting, spray-dry, pressing, and sintering.
  - "Net-shape" or "near-net shape" technologies.
    - Conventional: processing and sintering.
    - Advanced: HIP, hot pressing.
    - Heat treatments.
- Magnesium for biodegradable implants.
- MIM: very small complex parts.
- Coatings and surface modification.
- Development of nanoparticles by means of spray pyrolysis.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATERIAL SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

### Powder technology (GTP)

PI: Elena Gordo, José Manuel Torralba

**Internal Projects (UC3M Funding)**

- ImprUDent: Improved Ultrasonic Dental devices with net shape and advanced.

**Private Funding**

- Study of the optimal vacuum sintering cycle for obtaining 316L stainless steel porous coatings used in biocompatible implants.

**Technological Offer (Patents)**

- *Procedimiento para la obtención de un recubrimiento sol-gel, composición de recubrimiento y uso de la misma* (Method for obtaining a sol-gel coating, coating composition and use thereof).
- *Proceso para la fabricación de piezas metálicas y/o cerámicas utilizando un sistema ligante termoplástico basado en polisacáridos* (Process for manufacturing metal and/or ceramic parts using a thermoplastic system based on polysaccharides).
- *Procedimiento de obtención de esponjas metálicas* (Method of obtaining metal sponges) (co-owned with CSIC).
- *Aleaciones de titanio de bajo coste y método para la preparación de las mismas* (Low-cost titanium alloys and method for the preparation thereof).
- *Recubrimiento sol-gel con nanopartículas cerámicas para la protección de un sustrato y procedimiento para su obtención* (Sol-gel coating with ceramic nanoparticles for the protection of a substrate and method for obtaining same).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| INTERNATIONAL LAW, ECCLESIASTICAL LAW AND PHILOSOPHY OF LAW | | | |
| **Human Rights, State of Law, and Democracy**<br><br>**PI: Rafael de Asís, Fco. Javier Ansuátegui** | • Bioethics.<br>• Bioethics and sexual and reproductive rights.<br>• Biorights as a new class of human rights.<br>• Patients' rights.<br>• Clinical research in human beings.<br>• Science, biotechnology, and human rights.<br>• Professional ethics and deontology. | **R&D National Plan Projects**<br>• Social determinants of health and justice: The challenges of the right to health.<br>• Accessibility and non-discrimination of persons with a disability in the public sphere.<br>• Problems with euthanasia.<br><br>**R&D Regional Plan Projects**<br>• Qualitative and quantitative study of the information received by oncology patients in hospitals in the Regional Community of Madrid.<br><br>**Internal Projects (UC3M Funding)**<br>• Clinical Trials: implications for citizens.<br><br>**Private Funding**<br>• FIPSE study on arbitrary discrimination against people with HIV or AIDS.<br>• Advising about risks for rights and quality of consent.<br>• Proposed legal regulation of early care. | |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| PUBLIC STATE LAW | | | |
| **Services of General Interest, Economic Activity and Public Intervention**<br><br>**PI: Tomás de la Cuadra Salcedo** | • Healthcare, education, and social services.<br>• Free market public assistance.<br>• Non-economic public services. | **R&D National Plan Projects**<br>• The future of the welfare state in the European Union: a common model of essential public services in Europe.<br><br>**R&D Regional Plan Projects**<br>• The legal-administrative intervention in biomedical sciences; from bioethics to bioregulation. | |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **SOCIAL LAW** | | | |
| **Social Security and the Prevention of Labour Risks (GISSPRL)**<br><br>**PI: Carmen Carrero** | • Protection of certain groups.<br>• Susceptible subjects, maternity benefits and risks during pregnancy and protection of maternity within the scope of employment.<br>• Incapacity, disability and handicaps, and prevention of labour risks.<br>• New pathologies (moral harassment, brain and cardiovascular illnesses, etc.).<br>• Work accident rate and the protection of dependent persons under age 65.<br>• Preventive measures in the workplace, maintenance of health conditions, quality of life, and protection of dependent persons over age 65. | **R&D National Plan Projects**<br>The labour-related, preventive and social security treatment of diseases resulting from work.<br>The legal statute of an informal caregiver as a key element to an integrated system for the protection of dependent persons. | **Experience and Capabilities**<br>The GISSPRL has a highly qualified human potential and the most advanced technical support for handling questions of great interest for companies in reference to the prevention of labour risks, in and of itself considered, but also connected with the reparative aspect of Social Security.<br>The characteristics of the group allow handling these subjects globally, but also from very precise perspectives, such as gender and the requirement for plans for equality in the workplace, disability and dependence, and a multicultural atmosphere. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## ECONOMICS

### Economics of Health and Medicine

**PI: Félix Lobo**

- Health and healthcare economics.
- Economics of medicine and the pharmaceutical industry.
- Economic analysis of the right to healthcare services.
- Hospital and healthcare services administration and management.
- Basic rights and health. Ethics of healthcare.
- Healthcare administrative law.
- Sociology of healthcare services and professions.

**Private Funding**

- AbbVie-UC3M Chair for economics of medicine.
- Creation of an area of health economics and policies at Funcas.
- Innovative drugs and public budgets in Spain: future prospects.
- ABBOTT Chair for economics of medicine.
- Study of the economic evaluation of an *in vitro* test for blood diseases.

**Experience and Capabilities**

Chair for Economics of Medicine, Universidad Carlos III of Madrid - ABBVIE.

Created in 2009 for the purpose of promoting post-graduate education and research in the field of social sciences applied to medicine.

- Studies from the macroeconomic perspective
  - Magnitude and development of pharmaceutical expenditure.
  - Intervention on prices by States.
- Studies from the microeconomic perspective
  - Techniques for the economic evaluation of medicine.
- Other studies:
  - Current situation of price intervention systems in the European Union.
  - Problems with the economic evaluation of innovative drugs.

**Others**

*"La intervención de precios de los medicamentos en España: Panorama de la regulación y los estudios empíricos"* (The intervention on drug prices in Spain: Panorama of the regulation and empirical studies). Author: Felix Lobo. Springer Healthcare, ISBN: 978-84-940-3468-8.

## STATISTICS

### Department of Statistics

**PI: José Niño Mora**

#### LINES OF RESEARCH

- Biostatistics.
- Bioinformatics.
- Genomics.
- Big Data.

#### RESEARCH PROJECTS

**R&D National Plan Projects**

- New strategies in penalised regression with applications in health, demographics, and economics.
- Higia: Development of a system based on pattern recognition and computer vision to improve the diagnosis of Attention Deficit and Hyperactivity Disorder.
- Advanced statistical methods for complex data.

**Internal Projects (UC3M Funding)**

- PEARL: Programme Enhancing Adolescent Resilience for Life.
- Statistical methods based on functional data and high-dimension data with applications in finances and biostatistics.
- Strategic action in Models of Data Science and Big Data.

**Private Funding**

- DATA SCIENCE Chair.

#### TECHNOLOGICAL OFFER / OTHERS

**Experience and Capabilities**

Multidisciplinary team made up of more than forty PhD holders in the areas of Statistics, Econometrics, and Operations Research. It is comprised of the members from four multidisciplinary groups specialising in:

- Statistical Modelling and Data Analysis
  PI: Rosa Elvira Lillo Rodríguez, Daniel Peña Sánchez de Rivera, Ismael Sánchez Rodríguez-Morcillo
- Macroeconomic and Financial Prediction and Analysis
  PI: Antoni Espasa
- Operations Research
  PI: Francisco Javier Nogales
- Non-parametric and Computation-Intensive Techniques
  PI: Juan Romo

They use the most advanced methodologies and the most appropriate computational tools to solve data modelling, prediction, analysis, and optimisation problems.

**Technological Offer**

- Video game to identify ADHD symptoms and evaluate the severity of the lack of attention in each case.

**Equipment**

- Computer programmes for data processing and simulations.
- Analytical and computational tools to help in the decision.
- Computer equipment for intensive numerical calculation.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| PHYSICS | | | |
| **Remote Sensing Laboratory and Imaging Sensors in the Infrared (LIR)**<br><br>**PI: Fernando López** | • Spectral analysis<br>· Applications of infrared imaging in biomedicine.<br>• Thermography and radiometry<br>· Biomedical applications. | **Internal Projects (UC3M Funding)**<br>• Strategic action in Advanced Multispectral Imaging Sensors in the Infrared.<br>• Line in Research, Innovation, and Development of Advanced Infrared Multispectral Sensors. | **Experience and Capabilities**<br>• Spectral analysis of tissues and biomolecules.<br>• Sorting techniques using spectral images using PCA and others.<br>• Use of active imaging techniques (Flash Pulsed Therm., etc.) to perform in-depth profiling and detect anomalies within tissues.<br>• Study of the gases produced by the human body and their relationship with different pathologies.<br>• Thermal and spectral analysis capacity in all visible and infrared bandwidths. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| PHYSICS | | | |
| **Nano-Structured and Multifunctional Materials**<br><br>**PI: Miguel Ángel Monge** | • Biomaterials and biological materials. | **R&D Regional Plan Projects**<br>• Physical and biological characterisation of composites of hydroxyapatite reinforced with $Y_2O_3$ nanoparticles produced by slip casting.<br>• Multifunctional Materials for the Challenges of Society.<br><br>**Internal Projects (UC3M Funding)**<br>• Strategic Action in Advanced Materials.<br>• Strategic Action in Structural Materials and Reinforced Materials.<br>• Strategic Action in the Processing and Characterisation of nanostructured and multifunctional materials.<br>• Strategic Action in the Production and Characterisation of new multifunctional materials. | **Experience and Capabilities**<br>• Lightweight materials<br>· Processing and characterisation of Al and Ti.<br>· Hydroxyapatite-based materials. |

## COMPUTER SCIENCE

### Computer, Communications and Systems Architecture (ARCOS)

**PI: Jesús Carretero**

**LINES OF RESEARCH**

- E-Health.
- Modelling and simulation.
- Big Data.
- Parallelisation of applications and optimisation.
- High performance cluster and cloud computing.
- Mobile and distributed systems.
- Remote systems monitoring.

**RESEARCH PROJECTS**

**European Projects**

- European regimen accelerator for tuberculosis.
- Adaptive Multi-tier Intelligent Data Manager for Exascale *(ADMIRE).*
- Exascale programIng models for extreme data processing *(ASPIDE).*
- GOVeIN European e Invoicing Project: Implementation of the European electronic invoice within the Public health.
- RePhrase: Refactoring Parallel Heterogeneous Resource-Aware Applications.

The results of this research may be applied in various fields, such as optimisation of applications for the diagnosis of mental illnesses.

**R&D National Plan Projects**

- Medium and Long-term Simulation of Covid-19.
- Project NECRA: New Clinical Scenarios with Advanced Radiology.
- New Methods in High-End and Edge Computing for Data-Intensive Computing.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- ***Medical image processing.***
- ***Simulation of the spread of epidemics***
  - EpiGraph Tool (scalable simulation tool for epidemiological spreading based on social data).
  - Large-scale data-intensive applications in cloud systems.
    - Processing of diagnostic image banks.
    - Problems with large-scale data from social media or health databases.
  - Massive data processing.
    - Parallel applications.
    - Workflows.
  - Cloudification.
    - Transfer of applications to the cloud.
- ***E-HEALTH***
  - Remote monitoring.
  - Remote doctor-patient communication.

**Technological Offer (Covid 19)**

- ***Computer simulator that recreates the spread of COVID-19 in Europe***
  https://www.uc3m.es/ss/Satellite/UC3MInstitucional/es/Detalle/Comunicacion_C/1371288689200/1371215537949/Crean_un_simulador_informatico_que_recrea_la_propagacion_del_COVID-19_en_Europa#:~:text=Un%20equipo%20de%20investigadores%20espa%C3%B1oles,distanciamiento%20social%20y%20el%20transport

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## COMPUTER SCIENCE

### Computer Security Lab (COSEC)

**PI: Juan E. Tapiador**

- Safety and e-health (biosignal and implantable medical devices).
- Computer forensics.
- Security in smart devices (sensors, RFID, smartphones, wearables).
- Cybersecurity.

**European Projects**

- ENJECT: European Network for the Joint Evaluation of Connected Health Technologies (TD COST Action TD1405).

**R&D National Plan Projects**

- SPINY – Security and Privacy in the Internet-of-You.

**R&D Regional Plan Projects**

- CIBERDINE – Cybersecurity: Data, information, risks.

**Internal Projects (UC3M Funding)**

- Strategic action in the Protection of Personal Data (Services and Security Mechanisms, Cybersecurity, and Computer Forensics).

**Private Funding**

- INDRA Chair for Cybersecurity.

**Experience and Capabilities**

- Creation of a system for reducing medication errors in hospitals and assuring the "five-right method" in the administration of drugs to patients.
- Security analysis in implantable medical devices (IMDs).
- Design and implementation of security mechanisms for implantable medical devices.
- Development of identification systems based on biomedical signals.
- Study of biomedical signals and their implications in computer security.
- Document on the security of automated files containing personal data.
- Development of new cryptographic protocols and products.
- Methodology for the discovery of network vulnerabilities.

**Others**

The group presides the Network for National Research Excellence in Cybersecurity (RENIC), made up of 18 universities and research centres.

## COMPUTER SCIENCE

### GIGABD

**PI: Jorge Luis Morato**

**LINES OF RESEARCH**

- Deep learning applications and data enrichment.
- Accessibility and comprehensibility of data.
- Veracity and reliability of data.
- Infrastructures to facilitate BigData.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- Advanced and multidisciplinary estimation of the complexity and comprehension of documents with a high degree of consultation. National Plan, Challenges in Research.
- CLARC: European Clearing House for Open Robotics Development Plus (ECHORD++). Subproject "Smart Clinic Assistant Robot for CGA (CLARC).

**Private Funding**

- Content hosting services on the web and technical assistance for the on-line training platform in the standardisation of the clinical content in the Medical History in the National Health System.
- Secure CES application maintenance for user management, technical support, and troubleshooting.
- Course on risk management and improved patient safety.
- On-line course for the development of projects for improved patient safety and implementation of good practices in healthcare centres.

**TECHNOLOGICAL OFFER / OTHERS**

**Software Registrations:**

- Automatic detection of authors of scientific publications.

**Patents**

- *Método de estimación del posicionamiento en sistemas de recuperación de información* (Method of estimating the positioning in information retrieval systems).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **COMPUTER SCIENCE** | | | |
| **Applied Artificial Intelligence (GIAA)**<br><br>**PI: José Manuel Molina, Jesús García** | • Machine vision.<br>• Knowledge engineering.<br>• Data Fusion Systems and Contextual Information.<br>• Artificial Intelligence/Machine learning. | **R&D Regional Plan Projects**<br>• GenObIA-CM: Design, by means of artificial intelligence, of predictive algorithms for the identification of individuals at risk of developing overweight/obesity and their associated pathologies: Provision of genetic analysis. | **Experience and Capabilities**<br>• Smart Information Management (Data Mining, Dashboards, DSS, Hierarchical Analysis).<br>• Design of Data Mining tools using smart data recovery techniques.<br>• Automatic Behavioural Analysis based on video sensors.<br>• Advanced Vision Systems.<br>• Data Optimisation, Prediction, and Analysis Software.<br>• Extraction of behaviours from smart data analysis. |

## COMPUTER SCIENCE

### Human Language and Accessibility Technologies (HULAT)

**PI: Paloma Martínez**

**LINES OF RESEARCH**

- Natural Language Processing (NLP): entity recognition, information extraction, text classification, semantic knowledge representation (ontologies and corpora), text simplification, and generating summaries.
- Accessibility: methodological approaches for accessible applications as well as accessibility to goods and services. Integration of accessibility requirements in the software development process and in interaction of a person with a disability with user interfaces.

**RESEARCH PROJECTS**

**European Projects**

- TrendMiner: Large-scale, Cross-lingual Trend Mining and Summarisation of Real-time Media Streams.

**R&D National Plan Projects**

- DeepEMR: Clinical information extraction using deep learning and Big Data techniques.
- Multilingual information extraction in health and its application to scientific and informative documentation.

**R&D Regional Plan Projects**

- Natural Language Processing for Rare Diseases (NLP4Rare)-cm-uc3m.

**Internal Projects (UC3M Funding)**

- Strategic Action in the Application of language technologies to information extraction in different domains and content accessibility.
- DDIExtraction: Extraction of Drug-Drug Interactions from BioMedical Texts.
- QUEST: Quality of life system Enabling Senior Travel.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Extracting information about drugs, diseases, adverse effects, and pharmacological interactions. Lexical simplification of adverse effects.
- Extracting information and generating summaries about rare diseases.
- Automatic semantic analysis of health information (clinical notes, scientific publications, etc.).

**Applications**

- Support for ICD9/10, SNOMED, CT, CIMA, MedDRA coding.
- Human operator help systems (e.g.: diagnosis in ER discharge reports).
- Monitoring of medical events in different media (blogs, social media, etc.).
- Automatic selection of patient cohorts for clinical trials and epidemiological studies.
- Generating summaries in the medical history of a patient.
- Simplifying medical information for patients and family members.

**Technological Offer**

**EASIER:** system that helps people, mainly people with an intellectual impairment, to better understand texts.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| COMPUTER SCIENCE | | | |
| Human Language and Accessibility Technologies (HULAT)<br><br>PI: Paloma Martínez | | | **Software Registrations**<br>• DrugDDI corpora.<br>• DrugNer corpora.<br>• DrugNerAr corpora.<br>• System for extracting information in the pharmacological domain. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **COMPUTER SCIENCE** | | | |
| **Knowledge Reusing**<br><br>**PI: Juan Llorens** | • Development of model driven software.<br>• Process and project management.<br>• New technological innovation methods.<br>• Organisation of Processes for Reutilisation.<br>• Software Process measurement.<br>• Knowledge representation, retrieval and reusing. | **R&D National Plan Projects**<br>• Automatic generation of an oncology ontology.<br>• Development of a computational simulator in membranes for the study of cross-hierarchical dynamics in the development of bacterial resistance to antibiotics (Design and development of the semantic engine).<br><br>**Private Funding**<br>• IRSST Chair: R&D&I for a smart digital transformation of Occupational Health and Safety.<br>• Collaborative health: Prevention of infectious diseases based on smart analysis in social media and citizen participation.<br>• Integral Multiple Device Platform for the prevention, monitoring, and treatment of degenerative chronic diseases based on semantics, data mining, and collective intelligence technologies - PreMyTECD.<br>• Content hosting services on the web and technical assistance for the on-line training platform in the standardisation of the clinical content in the Medical History in the National Health System. | **Experience and Capabilities**<br>• Electronic Management of clinical data. Solutions:<br>· Implementation of search engines.<br>· Development of data-intensive software applications.<br>• Software improvement.<br>• Handling a large amount of data. Solutions:<br>· Complex technologies for structured information representation.<br>· Search engines.<br>· Decision support systems.<br>• Development of projects to improve patient safety and implementation of good practices in healthcare centres.<br>• Risk management and improvement in patient safety. |

## COMPUTER SCIENCE

### Planning and Learning (PLG)

**PI: Fernando Fernández Rebollo**

**LINES OF RESEARCH**

- Artificial Intelligence.
- Social Robotics and Assistive Robotics.
- Task Planning.
- Machine learning.
- Problem solving.
- Decision Support Systems.

**RESEARCH PROJECTS**

**European Projects**

- CLARK- Smart Clinic Assistant Robot for CGA.
- European Clearing House for Open Robotics Development Plus.

**R&D National Plan Projects**

- Automatic planning-based social training architectures.
- Design, automatic planning, and evaluation of neurorehabilitation therapies led by a socially interactive robot.
- Service life technologies for social robots in smart homes.
- THERAPIST: An autonomous and socially interactive robot for motor and neurorehabilitation therapies.

**Private Funding**

- Autonomous Social Robotics for Pediatric Assistance and Active Aging.
- Artificial intelligence for the social healthcare sector.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

Development of Motor Rehabilitation Therapies and Geriatric Evaluation with Humanoid Robots:

- *CLARK*
  Development of a hospital infrastructure that allows the geriatric evaluation of patients.
- *NAO Therapist*
  New therapeutic motor rehabilitation tool for children in which an interactive and fully autonomous social therapeutic robot is capable of sensing the patient's reactions and determining whether or not the patient is doing their exercises correctly.

**Others**

- INROBICS
  A UC3M spin-off proposing a new rehabilitation model using artificial intelligence and social robots for helping people with functional or neurological limitations to improve their quality of life, www.inrobics.com.

## COMPUTER SCIENCE

### SOFTLAB

**PI: Angel García Crespo**

**LINES OF RESEARCH**

- Biometrics: Security, Accessibility.
- Application integration.
- Database technologies.
- Data modelling techniques.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- TRAZAMED: Integral platform based on RFID and DATAMATRIX identification technologies for the traceability of medicinal products.

**Internal Projects (UC3M Funding)**

- OMEGA: Open Mobile e-Health Services Platform based on Linked Data for the Medical Cross-Domain.

**Private Funding**

- Integrated platform for leisure, medical management and acquisition of vital signs for individual use for hospital assistance and domestic teleassistance, accessible for users with motor or sensory disabilities. Vital and accessible health (*SAlud Vital y Accesible,* SAVIA).
- Pervasive SUB.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- *IRIS Laboratory*
  The laboratory facilities have been used to host a large number of research projects which utilised the lab's connectivity capabilities and its available equipment.

**Technological Offer**

- Pervasive SUB Project
  Pervasive SUB technology, developed by Universidad Carlos III of Madrid (UC3M), Telefónica, and FASOCIDE (Federation of Associations of Deaf and Blind People) is a worldwide pioneer software that allows deaf and blind people to receive and enjoy television contents without intermediaries at the same time as the people around them.
- GoAll Application
  The GoAll app allows deaf and blind people to access television contents live. It subtitles and transcribes TV broadcasts, for example the daily news programme on RTVE, into Braille.
- System for the detection of behavioural modifications for the early identification of needs.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## SYSTEMS ENGINEERING AND AUTOMATION

### Robotics Laboratory (Robotics Lab)

**PI: Miguel Ángel Salichs, Carlos Balaguer, Luis Moreno**

- Design of robotics systems
  - Customised mechanics, hardware, software, control, actuators, and sensors.
- Manipulation and locomotion
  - Gripping, strolling, cooperation (hands-arms-legs-sight).
- Robot-human interaction
  - Cognitive systems, multimodal interfaces (sight, speech, touch, strength).
- Personal and assistive robots
  - Elderly, disabled, children with problems, Alzheimer's.

**Specific Lines of Research in Health:**

- Assistive robotics: Usability and control interfaces.
- Medical instrument guidance.
  Guidance of healthcare instruments used inside the body with stereotaxic techniques.
- Development of technical aids and support products.

**European Projects**

- MONARCH: Multi-Robot Cognitive Systems Operating in Hospitals (MGMT).
- Rethinking Robotics for the Robot Companion of the future - RoboCom++.

**R&D National Plan Projects**

- Robotised inspection of healthcare personnel protection suits in relation to the high-level isolation of patients, including Ebola.
- Smart Heterogeneous Multirobot System for Assisting the Elderly.
- Development of robotic exoskeletons for the rehabilitation of an upper limb.
- Robotic system to help children with cerebral palsy walk.
- Social robots for physical, cognitive, and emotional stimulation of the elderly.
- Development of social robots to help the elderly with cognitive deterioration.
- Modelling, evaluation, and rehabilitation of patients with upper limb muscle rigidity by means of collaborative robots.

**Experience and Capabilities**

- Development of robotised support systems and medical devices for clinical and surgical environments: exoskeletons, prostheses, etc.
- Development of patient assistance robots in hospital and rehabilitation environments and their user-friendly control and handling systems.
- Fusion of sensory information: vision, strength, speech, touch, gestures, etc.
- Right-handed manipulation of devices and their control: algorithmics and implementation.
- Applications of new soft robotics & biocompatible materials: smart sensors & actuators.

**Others**

- Development of robots to help people who live alone, in collaboration with the Universidad Politécnica of Cartagena (UPCT).

**Patents**

- *Dispositivo electromecánico portátil of asistencia* (Portable electromechanical assistance device) (ES2415304).

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **SYSTEMS ENGINEERING AND AUTOMATION** | | | |
| Robotics Laboratory (Robotics Lab)<br><br>PI: Miguel Ángel Salichs, Carlos Balaguer, Luis Moreno | | **R&D Regional Plan Projects**<br>• RoboCity2030-DIH-CM. Madrid Robotics Digital Innovation Hub.<br>• RoboCity2030-III-CM. Robotics applied to improving the quality of life of citizens.<br>• COMANDER: Safe and multimodal cooperation with robotic assistants for people with special needs.<br><br>**Internal Projects (UC3M Funding)**<br>• Strategic Action in Smart Robotics.<br>• Strategic Action in Robotics and Automation. Social Robotics.<br>• Strategic Action in robotic Exoskeletons and Advanced Movement Planning Algorithms.<br><br>**Private Funding**<br>• Robotics for Providing Assistance to People with Special Needs: Technical Specifications.<br>• Social robot to help the elderly.<br>• Rehabilitation programme by means of serious games ASEPEYO-UC3M.<br>• Robotic Mechanisms with SMA Technologies. | |

## SYSTEMS ENGINEERING AND AUTOMATION

### Intelligent Systems Laboratory (LSI)

**PI: Arturo de la Escalera, José María Armingol, Francisco José Rodríguez**

**LINES OF RESEARCH**

- Computer vision.
- Design of perception systems.
- Pattern recognition.
- Artificial intelligence.
- Control systems.
- Robotised systems.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- Projects relating to applications of computer vision to smart systems.

**Internal Projects (UC3M Funding)**

- Line of Research in Intelligent Autonomous Systems.

**Private Funding**

- Chair for Machine Vision.
- Sensor fusion projects.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Object recognition and classification.
- Action recognition.
- Design of classifiers based on CNNs.
- Image processing.
- Sensor fusion.
- Systems calibration.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MECHANICAL ENGINEERING

### MAQLAB: Machine Laboratory

**PI: Cristina Castejón**

- Kinematic and dynamic synthesis and analysis of machines and mechanisms. Machine maintenance and diagnostics
  - Application a medical devices.
- Computer-aided design, analysis and simulation. MEF and SEM.
- Rapid prototyping, 3D printing.
- Robotic elements.
- Magnetomechanics and Nanomechanics.
- Instrumentation and experimental methods.

**R&D National Plan Projects**

- Design and control of bipedal robot using passive dynamics techniques.

**R&D Regional Plans**

- Optimal design methodology for service robots (PASIBOT).

**Internal Projects (UC3M Funding)**

- Strategic action in advanced research in industrial engineering of machines and mechanisms.
- Robotised system for externally acting on urban elements with reduced accessibility.
- Mechanical system computer simulation and analysis: Application to lifting and transport systems.

**Experience and Capabilities**

The MAQLAB group performs development and innovation tasks in the field of mechanical engineering. Its activities include research projects relating to advanced mechanisms, special mechanisms, magnetomechanics, applied tribology, biomechanics, and monitoring and measurement techniques.

**Technological Offer**

- BIOPUNCH: *Dispositivo automático para la realización de biopsias cutáneas* (Automatic device for performing skin biopsies) (Spanish patent ES2537831)
  - Proposed mechanism.
  - Primary verification of behaviour with analytical models.
  - Patented design.
  - Test prototypes made to scale with a 3D printer.
- Therapeutic cutlery
  - Design, improvement and optimisation.
  - Prototype (3D printer).
- Rectoscope
  - Spanish patent ES2639867 (co-owned with Hospital La Paz).
  - Design and prototype done.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| MECHANICAL ENGINEERING | | | |
| **Experimental Mechanics, Calculus and Transportation (MECATRAN)**<br><br>**PI: Beatriz López Boada, María Jesús López Boada** | • Biomechanical modeling and study of the impact on the performance of tasks.<br>• Effects of caffeine on muscle action.<br>• Injuries in new models of urban mobility, such as the autonomous vehicle. | | **Experience and Capabilities**<br>• Biomechanical modeling of variable resistance mechanical drives.<br>• Ergonomic studies for the modeling of workstations.<br>• Development of a muscle electromyography (EMG) equipment through the use of low-cost sensors. Validation carried out using high-end equipment with the collaboration of different international universities.<br>• Muscular characterization of the behavior of the lower torso of a subject for the study of possible injuries.<br>• Study focused on injuries that can occur after emergency braking in an autonomous driving vehicle.<br><br>**Technological equipment**<br>• Surface muscle electromyography (EMGs) equipment Delsys<br>• High speed camera.<br>• Passive markers for kinematic analysis<br><br>Commercial profile |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| MECHANICAL ENGINEERING | | | |
| **Mechanical Simulation and Optimisation (SIOMEC)**<br><br>**PI: María Belén Muñoz Abella, Lourdes Rubio Ruiz de Aguirre** | • Computer-aided modelling and engineering.<br>• Biomechanics.<br>• Optimisation techniques applied to mechanical engineering.<br>• Design and manufacture of prototypes of small mechanical and biomechanical devices. | **R&D National Plan Projects**<br>• Identification of cracks in one-dimensional mechanical elements by means of methods for the detection of non-linearities.<br><br>**Private Funding**<br>• Cryogenic treatment for the sustainable integral production of hardened metal part machining. | |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **MECHANICAL ENGINEERING** | | | |
| **Mechanical and Biomechanical Component Manufacturing and Design Technology (FabDis)**<br><br>**PI: Henar Miguélez, José Luis Cantero** | • Advanced manufacturing technologies.<br>• Mechanical design of personal protections.<br>• Biomechanics. | **European Projects**<br>• Enhanced Neutralisation of explosive Threats Reaching Across the Plot.<br><br>**R&D National Plan Projects**<br>• Advanced design and manufacture of integral personal protections for military use and for State law enforcement forces and agencies.<br><br>**Internal Projects (UC3M Funding)**<br>• Strategic action in advanced manufacturing technologies.<br>• Line of research in the mechanical modelling and manufacture of prototypes.<br><br>**Private Funding**<br>• Design and manufacture of advanced head and torso protections taking into account biomechanical effects and the gender perspective. (PROTEC BIO GENE) | **Experience and Capabilities**<br>• Development of surgical devices and manufacture of prototypes.<br>• Additive manufacturing in biomedical applications.<br>• Tissue simulations for surgical preparation.<br>• Computer-aided design, manufacture and engineering: CAD-CAM-CAE.<br>• Mechanical design of implantable elements.<br>• Manufacturing oriented design.<br>• Damage identification techniques.<br><br>**Supervised Theses**<br>• Experimental and numerical analysis of a human femur fracture.<br><br>**Equipment**<br>• Work stations and finite element numerical simulation software.<br>• Behaviour subroutines for an internally developed material.<br>• Machine tools: machining centre, CNC lathe.<br>• Mechanical element test benches, measurement systems.<br>• 3D polymer material printers. |

## TELEMATIC ENGINEERING

### ADSCOM (Advanced Switching and Communication Systems) Network Technologies Group (NETTEC)

**PI: David Larrabeiti**

**LINES OF RESEARCH**

- Adaptive system communication middleware design.
- 5G Networks.
- Cognitive networks.
- Communication protocols.
- Content Delivery Networks (CDN).

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- Flexible and elastic optical network technologies with Tb/s capacity for 5G support.

**R&D Regional Plan Projects**

- EMPATÍA-CM. integral protection of victims of gender violence by means of multimodal affective computation.
- Advanced techniques for enhancing the intelligence of 5G networks.

**Internal Projects (UC3M Funding)**

- HEALTHYLIFE: Motivational and personalised system for promoting HEALTHY coproductive LIFEstyle.
- INPROFOR: Intelligent Searching and Processing of Multimedia Information for Forensic Purposes, using Data and Privacy Protection.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Development of middleware for accessible distributed adaptive systems.
- Network user modelling for adaptive applications in televisions, computers and mobile terminals.

**Technological Offer**

- *Sistema y método para for determinar un estado emocional de un usuario* (System and method for determining a user's emotional state), Patent ES2762277 (Publication date: 22/05/2020). Owned by UC3M / UPM.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **TELEMATIC ENGINEERING** | | | |
| **NETCOM (Networks and Communication Technologies) Network Technologies Group (NETTEC)**<br><br>**PI: Arturo Azcorra, Francisco Valera** | • Network architectures.<br>• Communication protocols.<br>• Wireless and mobile networks.<br>• Peer-to-peer systems. Distributed services. | **European Projects**<br>• EMpowering transatlantic PlatfOrms for advanced WirEless Research.<br>• EMpowering transatlantic PlatfOrms for advanced WirEless Research.<br>• 5G-TRANSFORMER: 5G Mobile Transport Platform for Verticals.<br><br>**R&D National Plan Projects**<br>• Evolving towards self-managed networks and services for 5G of the future.<br><br>**Internal Projects (UC3M Funding)**<br>• Strategic action in Smart Networks and Services beyond 5G. | **Experience and Capabilities**<br>The NETCOM Research Group works closely with the international research institute, IMDEA Networks, in various research projects and scientific activities. The two groups conduct complementary research projects in the areas of network architectures, communication protocols, wireless and mobile networks, peer-to-peer systems and distributed services.<br><br>**Oferta Tecnológica**<br>• New system for emergency healthcare situations based on 5G<br>5TONIC, the open research laboratory and innovation on 5G technologies funded by Telefónica and IMDEA Networks has presented together with SAMUR-PC and Universidad Carlos III of Madrid (UC3M) a novel system for emergency situations based on 5G developed within the framework of the European innovation project 5G-TRANSFORMER. https://www.uc3m.es/ss/Satellite/UC3MInstitucional/es/Detalle/Comunicacion_C/1371281045439/1371216052710/Nuevo_sistema_para_situaciones_de_emergencia_sanitaria_basado_en_5G. |

## TELEMATIC ENGINEERING

### GRADIENT (Educational Technologies Laboratory) Telematic Applications and Systems Group (GAST)

**PI: Carlos Delgado Kloos**

**LINES OF RESEARCH**

- E-Learning.
- Real and mixed virtual environment (2D/3D) training simulators.
- Training gamification. Serious indoor and outdoor games.
- Mobile learning. Augmented indoor and outdoor learning experiences using tags.
- Machine learning based on data from wearable (physiological, motion and location) sensors.
- Recommendation systems for helping to self-manage health.
- Algorithms for supporting rehabilitation based on data from wearable sensors.
- Assistive technologies.
- Adaptive interfaces.
- Motivation in fragile people with chronic diseases.
- Prediction of situations requiring the intervention of a healthcare professional after the detection of patterns in sensed data from wearable sensors.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- UNICARE: Universal health monitoring and intelligent care for a connected society powered by crowd-sensing learning and adaptation to each individual via noninvasive but pervasive sensing.
- REMEDISS: Sensorised medical network that allows remote, in-home patient monitoring.
- Surgical simulation platform - SimLap.

**Internal Projects (UC3M Funding)**

- CACUMA: Social Collaborative Authoring, Curating and USe of Educational Materials.
- PhyMEL-ICT: Physical, Mental and Emotional Learning supported by Information and Communication Technologies.

**Private Funding**

- Hybrids – Hybrid simulation systems for clinical training.
- Adaptation of Phymel methodology to clinical training by means of using simulators.
- Study on adapting e-learning platforms for medical simulation.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Modular and flexible expeditious design of learning experiences in real virtual and mixed environments based on existing courses through the use of templates and simulation engines.
- Design of games, storyboards and interaction for skill-based training and evaluation: learning objectives, missions, rewards and analysis.
- Design of training experiences in situ based on mobile learning.
- Design of training experiences using augmented reality.
- Use of gamification techniques in technology-led learning environments.
- Design and validation of machine learning algorithms for the self-management of health.
- Development of personal recommenders.

**Technological Offer (Software)**

- PhyMEL-WS Wheelchair Simulator.
- SimGenFM.

## TELEMATIC ENGINEERING

### Pervasive Computing Laboratory Telematic Applications and Services Group (GAST)

**PI: Carlos Delgado Kloos, Carlos García Rubio, Andrés Marín López, Luis Sánchez Fernández**

**LINES OF RESEARCH**

- Management of dynamic patient consent in case of emergencies: event-activated credentials.
- Flexible and efficient medical record management systems.
- Pattern extraction and anomaly detection.
- Design and development of mobile applications.
- Internet of Things (IoT).
- Attribute-based encryption.
- Cybersecurity.

**RESEARCH PROJECTS**

**R&D&I National Plan Projects**

- Surigcal Simulation Platform Project - SimLap.

**Private Funding**

- Hybrids - Hybrid simulation systems for clinical training.
- Adaptation of Phymel methodology to clinical training by means of using simulators.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Solutions for improving user privacy in medical record management.
- Detection of anomalous behaviours in movements of users in an individual and collective manner.
- Experience in design and development of mobile applications.

**Technological Offer**

- Software: PhyMEL-WS Wheelchair Simulator.
- Android application for measuring breathing rate, http://hdl.handle.net/10016/28990.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## THERMAL ENGINEERING AND FLUID ENGINEERING

### Fluid Mechanics (GMF)

**PI: Francisco Javier Rodríguez Rodríguez, Wilfried Coenen**

- Biofluid dynamics:
  - Physics of microbubble transport using ultrasound.
  - Bubble dynamics in soft materials.
  - Formation of complex coatings of interest in tissue engineering.
  - Evaporation of droplets in the context of infectious disease transmission.
  - Cell tissue dynamics.
  - Cerebrospinal fluid dynamics and medicines transport in the spinal canal.
  - Hydrodynamic effects on the development of central nervous system pathologies: normal pressure hydrocephaly, syringomyelia

**European Projects**

- COmpound COatings NUrturing applications in Tissue Engineering.

**R&D National Plan Projects**

- Development of a non-invasive pressure measurement technique based on the analysis of the acoustic spectrum of microbubbles.
- Complex interphase dynamics with applications in the environment, energy generation, and new materials.
- Mechanisms for the generation of microdroplets and microbubbles that can be applied to industrial, pharmacological, and medical processes.

**R&D Regional Projects**

- Cerebrospinal fluid flow and its role in the pathogenesis of syringomyelia.

**Experience and Capabilities**

- Theoretical and numerical modelling of microbubble dynamics in soft materials.
- Experiments on microbubble dynamics under the action of ultrasound, using high-speed videos and acoustic equipment.
- Theoretical and experimental analysis of the formation of thin films forming complex coatings.
- Theoretical analysis and post-processing of experiments on monolayer cell tissue movement.
- Theoretical modelling of the flow in the spinal canal induced by periodic variations in cerebral pressure.
- Individualised methodology for 3D anatomical reconstruction and prediction of the flow and transport in the spinal canal based on magnetic resonance measurements.
- Numerical simulations of the flow of cerebrospinal fluid in the central nervous system.

## MATHEMATICS

### Interdisciplinary Complex Systems Group (GISC)

**PI: José A. Cuesta**

**LINES OF RESEARCH**

- Statistical mechanics and non-linear dynamics.
- Materials and nanostructures science.
- Microfluidics and fluid adsorption in structured substrates.
- Complex fluids.
- Granular media.

**RESEARCH PROJECTS**

**European Projects**

- BESAFE: Artificial Intelligence enhancement of Surgical Technology for reduction of human behaviour related surgical accidents.

**R&D National Plan Projects**

- Micro-reasoning for behaviour: An ICT-based approach for understanding human behaviour and interaction.
- Evolutive dynamic processes: viruses, ecosystems and social behaviours.
- Complex fluids and their interphases.
- Non-linear statistical and dynamic mechanics of biological and social systems.
- Biological physics of cyanobacteria differentiation.
- Physics of the differentiation and formation of nitrogen fixing cell patterns in cyanobacteria.
- Statistical physics for cities: mobility and inequality models.

**R&D Regional Plan Projects**

- PRACTICO-CM Computational Psychiatry and Integral Behaviour Models.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Design of solutions for the control of dynamic and variable processes which involve large volumes of data (genomics and proteomics).
- Complex network analysis.
- Mathematical models for predicting fluid equilibrium and dynamic properties of complex fluids, such as liquid crystals and colloidal suspensions.
- Modelling of processes of wetting on nanometric scales and of the surface adsorption of liquids in substrates with a structure. These are relevant for the design of lubrication systems and the handling of fluids from short distances, with important healthcare applications.
- Theoretical and experimental study of vibrated granular particle monolayers with an emphasis on the role of entropy in the formation of spatial patterns.
- Big "Complex/Social" Data Detection, management and prediction of behaviours, opinions and the diffusion of information in social media.
- Modernised spread of epidemics in cities using human mobility data.
- Evaluation of possible confinement and reopening strategies by means of infection, economic impact, and social impact models.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| MATHEMATICS | | | |
| Interdisciplinary Complex Systems Group (GISC)<br><br>PI: José A. Cuesta | | | Possible health-related applications:<br>• Using Big Social Data for the early detection of health-related behaviours in social media.<br>• Modelling of advanced materials in nanotechnology: selective growth of cellular aggregates and biocompatible materials. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## MATHEMATICS

### Numerical Methods and Applications

**PI: Miguel Ángel Moscoso**

- Diffuse optical tomography.
- Molecular imaging.
- Microwave imaging for the early detection of breast cancer.
- Inverse problems.
  Wave propagation in biological tissues.

**European Projects**

- Integrated Technologies for In-Vivo Molecular Imagingbb.

**R&D National Plan Projects**

- Ultrarapid 3d optical imaging with phase information in *in vivo* microscopy.
- Optical imaging of mesoscopic tissues: Theory, computation and applications in biology.
- Computational models for non-invasive techniques for the reconstruction of image of interest in biomedicine.
- Direct and inverse problems in biophotonics.
- Efficient numerical algorithms for microwave imaging: applications in the early detection of breast cancer.

**Others**

- Image Reconstruction Algorithms for Optical Diffusion Tomography with Large Data Sets Using the Radiative Transport Equation.
  *Funding: NSF.*
- A Mathematical Investigation of Light Propagation in Tissues for Physiological Monitoring and Tissue Imaging.
  *Funding: NSF*

**Experience and Capabilities**

- Development of new mathematical and computational algorithms for the reconstruction of images from contour data.
- Diffuse optical tomography, optical molecular imaging, and microwave imaging for the early detection of breast cancer.
- New imaging approaches in biomedicine.
- Evaluation of the precise modelling of wave propagation in tissue (the direct problem) and strategies for the reconstruction of efficient images (the inverse problem).
- System and method for the reconstruction and display of electrical heart activation.

**Supervised Theses**

- Mathematical techniques for the reconstruction of fluorescence images with applications in biomedicine.
- Microwave medical imaging using level set techniques.

## ELECTRONICS TECHNOLOGY

### Microelectronics Design and Applications (DMA)

**PI: Luis Entrena, Luis Hernández Corporales**

**LINES OF RESEARCH**

- Ultra-low consumption circuit miniaturisation.
- More efficient circuits and systems, processing according to biological models.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- Time-referenced data acquisition interfaces for sensors, medical imaging, and communications.

**R&D Regional Plan Projects**

- Ultra-low power A/D converters based on Dual Slope Sigma-Delta modulators for biomedical sensors.

**Private Funding**

- Development of a bandpass DS modulator for medical instrumentation.
- Development of new ADC (Analog-Digital Converter) architectures for biosensor interfaces.
- Design and characterisation of the main building blocks of ADCs for medical instrumentation.
- Feasibility study of the bandpass Sigma-Delta modulator for medical instrumentation.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Conception, design and development of data converters:

  Applications:
  - Communications (online, wireless).
  - Sensors.
  - Biomedicine.
- Complete application-specific integrated circuit or ASIC design flow.
- Design and development of low power consumption-specific and/or high scalability-specific circuits in different CMOS technologies.

**Experience in the Biomedical Field**

- Collaborative Research Programme (UC3M-IMEC) focused on the following fields:
  - Multi-standard readout circuits for EEG-ECG.
  - Analog-digital converter design.
  - Biopotential readout sensor and circuit design.
- Project with AMS (European semiconductor company).
  - Integrated receiver for MRI.
  - Concept receiver development.
  - Analog-digital converter design.

## ELECTRONICS TECHNOLOGY

### Photonic Displays and Applications (GDAF)

**PI: José Manuel Sánchez Pena, Carmen Vázquez**

**LINES OF RESEARCH**

- Assistive technologies: Research and prototypes in technologies relating to health and well-being
  - Microcontrolled electronic/optical systems -> different disability profiles.
  - Reduced vision support products (AR, VR).
- Electro-optic devices and applications.
- Photonic devices for optical networks: MUX, routers, attenuators, interleavers.
- Advanced instrumentation and sensors
  - Nanosensors.
  - Instrumentation and monitoring with optical fibres.

**RESEARCH PROJECTS**

**R&D National Plan Projects**

- Spanish Centre for Subtitling and Audio Description.
- Sustainable technologies for sensing and communications based on optical fibres in the area of transport and biomedicine.

**R&D Regional Plan Projects**

- SINFOTON2-CM. Sensors and Instrumentation in Photonic Technologies 2.
- Content accessibility service for persons with a disability.
- Performance of an accessible visit to Christmas lights in the city of Madrid.

**Internal Projects (UC3M Funding)**

- Strategic action in the development of electro-optical systems for biomedical, healthcare, and industrial applications.

**Private Funding**

- Indra-Adecco Foundation Chair for accessible technology.
- LED-based output signalling system for athletes with a hearing disability.
- Social CRM: Design, analysis and prototyping of a dependent ICT platform for a general public help line.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Active filters: electrochromic (EC).
  Application: EC glasses for patients with reduced vision.
- Augmented reality for patients with residual vision and anopsias.
  Application: vision rehabilitation
- Intracellular sensor based on resonant nanoparticles.
- Non-invasive temperature sensors.
- Self-referenced sensor networks based on biocompatible micro-structured polymeric fibres.
- Designs of highly selective resonance ring structures for potential identification of tumours in lab-on-a chip systems.

**Patents**

- *Dispositivo para rehabilitación de rodilla* (Device for rehabilitation of the knee) (P202030163).
- *Dispositivo y procedimiento para la detección de temblor en un paciente* (Device and method for the detection of tremors in a patient (patent application P201930816).
- *Dispositivo de ayuda y protección en la visión* (Device for aiding and protecting vision) (ES2334960)

## ELECTRONICS TECHNOLOGY

### Instrumentation Sensors and Techniques

**PI: Pablo Acedo**

**LINES OF RESEARCH**

- Optical instrumentation and sensors
  - Design and development of optoelectronic instrumentation systems and laser systems: from the hardware to the processing algorithms and integration of user interface.
- New optical sources and photonic architectures
  - Design and characterisation of photonic architectures for the generation, processing and detection of multimode coherent sources (optical frequency comb generators) millimetric signals and THz.
- Spectroscopy (UV/VIS/NIR/MIR/THz) and Applications (biomedical, environmental, and industrial)

**RESEARCH PROJECTS**

**European Projects**

- CELTA: Convergence of Electronics and Photonics Technologies.
- AEROMIC: Development of New digital Microphone- MEMS-Sensors for wind tunnels with open/closed test sections and flight tests.
- Code: Re-Farm: Consumer-driven demands to reframe farming systems.

**R&D National Plan Projects**

- Development, validation, and evaluation of a new non-invasive tool for measuring sustained hyperglycaemia using millimetric wave spectroscopy.
- Development, validation, and evaluation of a new non-invasive flap monitoring system in reconstructive surgery.
- Multimode photonic sources for spectroscopy and interrogation of optical fibre sensors.

**R&D Regional Plan Projects**

- New technologies for the manufacture and optimisation of tissues: skin as a model system.
- Conception and design of an optical diagnosis system for breast cancer using infrared laser diodes.

+

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

- Instrumentation systems development Development of the complete system.
- Laser emitters, detectors, and lighting optics for optical sensors.
- Preamplification and conditioning.
- System integration in FPGAs.
- Classification algorithms based on SVMs. Neural Networks, PCA, ICA, etc.
- Electrochemical sensors for biomedical applications.
- Diffuse spectroscopy systems for non-invasive biomedical applications.
  - Development of a contactless system for the evaluation of vascularisation in artificial skin implants (Collaboration with CIEMAT).
  - Development of a system for non-invasive flap monitoring in reconstructive surgery (Collaboration with Hospital Universitario La Paz).
- Development of spectroscopic systems for the detection of metabolites in non-invasive schemes (through the skin). Collaboration with University of Frankfurt/CIEMAT.
  - Development of a non-invasive system for the detection of sustained hyperglycaemia. Validation against the HbA1c measurement (Collaboration with Hospital Fundación Jiménez Díaz).
- Optomicrofluidics for *in vitro* detection of metabolites.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|
| **ELECTRONICS TECHNOLOGY** | | | |
| Instrumentation Sensors and Techniques<br><br>PI: Pablo Acedo | | **Private Funding**<br>• Fundación Jiménez Díaz Chair for regenerative medicine and tissue bioengineering research. | • Development of Point-of-Care Systems based on optomicrofluidic and electrochemical heads for the detection of metabolites and other molecules of interest.<br>• Use of fluorescence techniques and multimode optical sources. |

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## SIGNAL THEORY AND COMMUNICATIONS

### Machine Learning for Data Science (ML4DS)

**PI: Jerónimo Arenas**

- Applications of machine learning in magnetic resonance imaging (MRI) of the human brain, particularly in spectroscopic, structural, and functional MRI.
  The group develops techniques for the detection and characterisation of mental disorders and techniques for the functional mapping of the brain as alternatives to the standard SPM.

**R&D National Plan Projects**

- Machine learning of characteristics and metrics that can be interpreted for computational intelligence.

**Internal Projects (UC3M Funding)**

- ANIMA: Analysis of NeuroImage through Machine learning Algorithms for understanding of mental disorders.

**Private Funding**

- Development of algorithms for the multivariate analysis of structural neuroimaging data for Project 11F1S038 (CP10/00604).

**Experience and Capabilities**

- Characterisation of mental disorders by means of neuromarkers extracted from neuroimages.
- Fusion of different sources of information for characterising mental disorders
  - sMRI.
  - fMRI.
  - Gene arrays.
  - Psychological tests.
- Design of neuromarkers on sMRI/fMRI for other pathologies.
- Application of the neuromarker methodology to another type of medical imaging.
- Time series analysis (extension of spatial relations between voxels to temporal relations between samples of the series): Search for critical segments in a set of time series.
- Fusion of heterogenous sources of information.
- Optimisation/adaptation of the application of machine learning algorithms to any database.
- Machine learning for Big Data.

## SIGNAL THEORY AND COMMUNICATIONS

### Multimedia Processing (GPM)

**PI: Fernando Díaz de María**

#### LINES OF RESEARCH

- Machine vision
  - Systems for helping in the diagnosis based on explainable artificial intelligence.
  - Visual salience: What regions of the image are relevant for the medical expert?
  - Automatic feature extraction for the study of neutrophil populations from 4D videos of intravital microscopy.
  - Human-robot interaction in the area of assistance.
  - Autonomous control of neuroprosthetics.
  - Early diagnosis of melanomas.
  - Quantitative follow-up of alopecia.
  - Quantitative evaluation of the quality of semen from microscopic images.
- Speech processing applications
  - Diagnosis and follow-up of Parkinson's disease.
  - Diagnosis and follow-up of Alzheimer's disease.

#### RESEARCH PROJECTS

**R&D National Plan Projects**

- Salience and attention: Representation, interpretation and emergency (SAPIENS).
- Artificial Intelligence and cognitive models for Symmetric HumAn RobOt iNteraction (SHARON).

**Internal Projects (UC3M Funding)**

- Strategic Action in Applications of Image and Video Processing and Machine vision.
- Strategic action in intelligent solutions based on machine vision and machine learning.

**Private Funding**

- Development of a support system for interpreting a renal ultrasound through artificial intelligence.
- "Technical collaboration, testing, and validations of optical components for SQS System". Funding Company/Administration: ZOITECHLAB S.L.

**Others**

- Agreement between UC3M and the Foundation for biomedical research of Hospital Universitario Ramón y Cajal to carry out the project entitled "Renal ultrasound interpretation software".

#### TECHNOLOGICAL OFFER / OTHERS

**Experience and Capabilities**

- *Machine vision:*
  - Explainable artificial intelligence.
  - Human-artificial intelligence interfaces based on components characteristic of the communication between humans.
  - Neural networks capable of learning in dynamic and imperfect scenarios based on data automatically generated by means of advanced sensors.
  - Reinforcement learning: human-robot interaction.
  - Systems to aid in the diagnosis
    - 2D, 4D and 4D object segmentation, detection, tracking (video) and classification, patterns, cells, etc.
    - Incorporation of expert (medical) knowledge in automatic systems.
    - Analysis of consistency between the tentative diagnosis and characteristics of the image.
    - Recovery of images corresponding to similar cases.
    - Detection of salient regions or events.
    - Quantitative measurements of regions of the image.
- *Speech signal processing* in the context of neurological diseases:
  - Parkinson's: tracking the progression of the disease and/or the efficacy of medication in patients.
  - Alzheimer's: systems to aid in the diagnosis by means of the analysis of spontaneous speech.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## SIGNAL THEORY AND COMMUNICATIONS

### Signal Processing and Learning (GTSA)

**PI: Antonio Artés**

- Signal detection and classification.
  - Parametric and non-parametric, centralised and distributed.
  - Biological signal classification.
- Machine learning for signal and image processing
  - Design of (discriminative and generative) classifiers and estimators.
  - Extraction of discriminative information for classification and estimation.
  - Data mining in healthcare, genetic, and supporting databases for experiments.
- Advanced signal and image processing techniques
  - Non-linear filtering, high dimensional complex systems.
  - System simulation.
- Information theory
  - Wireless system performance limits.
  - Data compression.

**European Projects**

- Machine Learning for Personalized Medicine (MLPM).

**R&D National Plan Projects**

- Machine learning and massive computation for personalised medicine and quantitative climate analysis (CLARA).

**R&D Regional Plan Projects**

- Computational Psychiatry and Integral Behaviour Models (PRACTICO-CM).
- Detection of behavioural changes and its application in psychiatry.
- Environment and Genes in Schizophrenia (AGES).
- Automatic characterisation of behaviour by means of latent models based on deep networks.

**Private Funding**

- Advisory services in the area of signal processing and machine learning solutions in the health sector.
- Creation of an algorithm characterising human behaviour by means of data aggregation (Deep-Darwin).
- Early detection of crisis in autism (PETRA).
- Epileptic seizure detector with inertial sensors.

**Experience and Capabilities**

- *Psychiatry:*
  - Determination of underlying causes and discriminatory factors in mental diseases (based on healthcare and genetic data).
  - Characterisation of behaviour by means of "wearable" devices.
  - Progression of psychiatric disorders.
- *Neurology:*
  - EEG processing in Man-Machine Interfaces.
  - Portable functional imaging from an EEG.
  - Monitoring epileptic seizures.
- *Cardiology:*
  - Causality measurements for detecting activation focal points in atrial fibrillation.
  - Simulation of mechanisms for the generation and maintenance of atrial fibrillation.
  - Outpatient monitoring by means of: inertial sensors, ECG, EEG, GSR, and imaging.

**Technological Offer**

- **cuidaTEA**

  Free mobile application that attempts to improve the communication of people with an Autism Spectrum Disorder (ASD).

  The application is in the clinical study experimental phase, in collaboration with the Instituto de Investigación Sanitaria Fundación Jiménez Díaz.

+

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## SIGNAL THEORY AND COMMUNICATIONS

### Signal Processing and Learning (GTSA)

PI: Antonio Artés

**Equipment**

- Data collection system for clinical trials.

**Others**

- EVIDENCE-BASED BEHAVIOR (eB2)

  A UC3M spin off with the participation of the university in share capital since 2017.

  Activity: Development of tools – solutions for the attention and care of patients by means of artificial intelligence and mobile technologies, https://eb2.tech/.

| R&D GROUP | LINES OF RESEARCH | RESEARCH PROJECTS | TECHNOLOGICAL OFFER / OTHERS |
|---|---|---|---|

## UC3M – BANCO SANTANDER BIG DATA INSTITUTE

### UC3M–Santander Big Data Institute (IBiDat)

**PI: Rosa E. Lillo**

**LINES OF RESEARCH**

- Visualizing High Dimensional Functional Data Sets for Task fMRI data exploration
  In collaboration with the Biomedical Instrumentation and Imaging Group of Hospital General Universitario Gregorio Marañón, IBiDat works on visualising techniques for high dimensional data of this type.
- asgl PACKAGE
  Line of research dealing with how to process high dimensional data, in which the number of variables in a data set is greater than the number of observations. This high dimensional problem has become quite common in recent years and can be found in many areas, such as in biomedicine.

**RESEARCH PROJECTS**

- Variable selection in high dimensional applications. Project originating in a biomedical application performed within the framework of a collaboration between UC3M and Hospital Gregorio Marañón of Madrid.
  In the last decade, the cost of obtaining sequenced cancer cell RNA has dropped significantly.
  The new challenge tries to analyse said information so as to enable understanding and helping patients.
  This research approaches a modern statistical challenge that is closely linked to computational breakthroughs.
- Trial enrollment simulator
  Design and development of a discrete event simulation engine to predict the dynamics for the recruitment and enrolment of subjects in clinical trials, with the capacity to incorporate the uncertainty of the parameters and take into account stochastic noises in the trial enrolment processes.
- New strategies in regression penalised with applications in health, demographics, and economics.

**TECHNOLOGICAL OFFER / OTHERS**

**Experience and Capabilities**

Development of new methods and tools for the analysis of large heterogeneous and dynamic data sets.

**Others**

- David Griol, secretary of IBiDat, receives the Social Council Award from the University of Granada in Innovation in the Area of Health for his paper "Hispabot Covid 19".

*Co-funding:*

Activity of the Project "UC3M Plan for Promoting Innovation and R&D Result Transfer in the Production Sector of the Community of Madrid with Priority in the Southern Metropolitan Area" with Ref.: OI2018/PC-UC3M-5152 and the acronym PC-UC3M. This project was awarded in the 2018 Call for Grants for fostering technological innovation and promoting technology transfer to the production sector comprised within the priorities of the Regional Research and Innovation Strategy for Smart Specialization (RIS3) of the Community of Madrid through technological innovation coordinating entities. It is co-funded by the European Regional Development Fund which provides 25% of the funding and by the Community of Madrid which provides another 25% within the framework of the FEDER 2014-2020 operational program.


uc3m | Universidad **Carlos III** de Madrid

Vicerrectorado de Política Científica

Servicio de Apoyo al Emprendimiento y la Innovación