UC3M R&D IN knowledge map in aeronautics, space, and "new space"

IDENTIFICATION OF THE RESEARCH ACTIVITY, TECHNOLOGIES, PATENTS, INFRASTRUCTURES, AND OTHER UC3M CAPABILITIES

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

The Entrepreneurship and Innovation Service Supportz SEI of the Universidad Carlos III de Madrid wants to present the potential of the university in this "knowledge map" through the research areas developed in the frame of R&D projects, both national and international, patents and other results of UC3M investigators, in the aeronautical, space and "new space" sectors.

The global knowledge obtained, the experience of collaborating with the industry, the existence of infrastructures and proper laboratories and, above all, the multidisciplinary nature of UC3M are characteristics that provide an added value so that our support towards the innovation of institutions, big companies and SMEs has an integral quality.

We invite you to deepen the knowledge of the UC3M and to collaborate in new R&D and innovation projects.

Entrepreneurship and Innovation Service Support
Universidad Carlos III de Madrid

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ENGINEERING

LAW

MATHEMATICS AND PHYSICS

APPLIED R&D&I LABORATORIES IN THE SCIENCE PARK

OTHERS

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

ENGINEERING

MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

In-service Material Behaviour (CSM)

PI: Miguel Ángel Martínez, Francisco Javier Velasco

- Surface treatments and adhesion: adhesives, paints, and coatings
- Corrosion
- Organic coatings
- Composites

European Projects

- ESSIAL: Electrical Steel Structuring, Insulating and Assembling by means of the Laser technologies
- The inhibition synergism of some plant extracts and common inorganic inhibitors to enhance the corrosion control of the embedding steel bars in concrete (NATCON)

– Private Funding

- Consultancy services in the area of bonding technologies
- Consultancy services in the area of adhesives

Experience and Capabilities

This group has an extensive experience in the field of materials, material processing, material properties, and in-service material behaviour.

- Development of surface treatments to improve the adhesion of environmentally sound paints, varnishes, and adhesives
- Behaviour of durable elastic adhesives in aggressive media for use in vibration- and impact-resistant structural bonding
- Optimisation of the adhesive bonding of different materials
- Evaluation of the in-service behaviour of metallic materials. Technical services for performing chemical, electrochemical and microstructural testing
- Evaluation of corrosion processes in aggressive media and provision of solutions
- Tribology studies: friction and wear

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

MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Polymer composites and interfaces (GMCPI)

PI: Francisco Javier González Benito

- Design and implementation of new nanocomposites, thermoplastic matrix multifunctional materials (electrical, mechanical, and thermal characterisation)
- Blow spinning and electrospinning solution as a method for the preparation and surface modification of materials
- Nanoscale material characterisation.
- Polymer mixtures and composites
- Interfaces and fluorescence in probes and markers
- Physicochemical characterisation of materials

National Projects

- Preparation by solution blow spinning and characterisation of bio-compatible multifunctional thermoplastic materials constituted by submicrometric fibres

Private Funding

- Testing methods and techniques to characterise the mechanical properties of polymeric systems used in the coating industry
- Study of the mechanical behaviour of materials used as intumescent paints

Experience and Capabilities

- Composites with a mono- and multicomponent matrix (interface study)
- Design, preparation, and characterisation of multifunctional nanocomposites with a thermoplastic matrix

Infrastructures

- Electron Microscopy Laboratory
- Atomic Force Microscopy Laboratory
- Polymer Characterisation Laboratory
- Material Preparation Laboratory
- Material Technology Laboratory

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

MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Polymers and Composites (GPC)

PI: Juan Baselga

- Composites (processing; properties; interfaces; multifunctional composites)
- Luminescence techniques in polymers, composites, and nanocomposites
- Hybrid thermosetting polymers and polymer mixtures
- Heat-sensitive polymers (smart materials)

National Projects

- Nanocomposites with hierarchically structured architectures
- Self-healing and REsistant Asphalts for PORTs - SEAPORT

Private Funding

- Research for the development of nano-reinforced composites with advanced mechanical and electrical properties
- Development of composites with advanced mechanical properties

Experience and Capabilities

The research conducted by this group focuses on the field of polymers addressing different problems related to composite materials, modification of thermosetting polymers, hybrid networks, nanocomposites, smart pavements, porous materials based on graphite and nanocarbons for electromagnetic shielding, metal-nanocarbon hybrids for advanced electrical applications, and stimuli-responsive hybrid polymer materials.

Technological Offer (Patents)

- *Materiales para apantallamiento electromagnético* (Materials for electromagnetic shielding) (ES2509390)
- *Polímeros nanorreforzados* (Nano-reinforced polymers) (ES2431492)

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

MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Powder Technology (GTP)

PI: José Manuel Torralba, Elena Gordo, Antonia Jiménez, Mónica Campos

- Particle synthesis and powder production
- Coatings and surface treatment
- Thermodynamic and kinetic simulation
- Additive manufacturing
- MIM and PIM
- Material characterisation
- Sintered materials: lightweight alloys (titanium, aluminium, magnesium), superalloys (Ni, Co), special steels.

European Projects

- Powder Metallurgy Approaches for Next-Generation Bipolar Plate Materials (PERMEABLE)

National Projects

- Development of metal components with a high added value by 3D printing based on highly sustainable MIM technology for the transport sector - 3DMIM
- Processing inorganic composites using link-based additive manufacturing techniques
- Development of biofunctionalised, tribocorrosion-resistant hybrid surfaces on novel Ti alloys
- Development of new generation high-performance anti-corrosion coatings (RECORD)
- METALPRINT: Synergy of sustainable sintering and 3D printing technologies for metal parts with a high added value for the transport sector
- Development of novel, sintered, alumina-forming martensitic steels

Regional Projects (Community of Madrid)

- ADITIMAT-CM. Additive Manufacturing: from material to application
- Smart manufacturing of advanced materials for transport, energy, and health

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Experience and Capabilities

This group specialises in the development of solutions in the field of powder technology/pulvimetallurgy

The group's capability includes thermodynamic design of novel alloys, prototype development by ingot casting, powder manufacturing and characterisation, and manufacturing by advanced consolidation techniques (including additive manufacturing, powder injection moulding, and electric field assisted sintering techniques).

Technological Offer (Patents)

- *Placa bipolar de una pila de combustible de membrana polimérica y procedimientos de fabricación* (Bipolar plate of a polymer membrane fuel cell and manufacturing methods) (PCT/ES2022/070303)
- *Aleaciones de titanio de bajo coste y métodos para la preparación de las mismas* (Low-cost titanium alloys and methods for preparation thereof) (ES2341162)
- *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) (ES2686890)
- *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 polysaccharide-based thermoplastic binding system) (ES2356952)

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

MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING

Powder Technology (GTP)

PI: José Manuel Torralba, Elena Gordo, Antonia Jiménez, Mónica Campos

Private Funding

- Study for the addition of graphene and ceramic nanoparticles for the preparation of alternative hardmetals
- Study of novel, low environmental-impact materials for 3D printing
- Study and development of surface coatings for panels made of composite material with metal particles (REMACO – Composite material coatings)
- Obtaining gas-atomised, powder Cu-Mn master alloys
- Powder characterisation for AM

- *Recubrimiento sol-gel con nanoparticulas 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) (ES2334542)

Group's video

Infrastructures

LACTE - Company scientific-technological support laboratory

News

- *Desarrollan una nueva técnica para fabricar componentes de titanio* (A new technique for manufacturing titanium components has been developed)
- *Tenemos la fórmula para crear supermateriales que rozan los principios de la magia: las aleaciones de alta entropía* (Finding the formula to create supermaterials verging on the principles of magic: high-entropy alloys)

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
IT			
Computers, Communications, and Systems Architecture (ARCOS) **PI: Jesús Carretero**	• Real-time systems: · Simulation of real-time systems in airplanes and trains · Wireless sensor networks · Remote system monitoring	**National Projects** • New methods in high-end and edge computing for data-intensive computing **Regional Projects (Community of Madrid)** • Big dAta-Hpc Convergence: from sensors to applications • New techniques for developing real-time, on-board software for platforms. Next generation MPSoC **Private Funding** • UC3M -SENER Aeroespacial Chair • Research Program for testing and rapid prototyping in Avionics	**Experience and Capabilities** This group is involved in the development of new software for large-scale distributed and parallel systems. These activities encompass the development and optimisation of real-time distributed and parallel applications, reliable designs, and high-performance computing, including cross-layer optimisations of HPC storage I/O stack, parallel file systems, I/O acceleration of scientific workflows, automatic tuning of parallel I/O based on machine learning, dynamic monitoring of HPC infrastructures, convergence of HPC and Bigdata software stacks, and resource allocation elasticity in HPC and cloud. **News** • *En busca de computación paralela más rápida, eficiente y sostenible* (In search of faster, more efficient, and more sustainable parallel computing)

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
IT			
Applied Artificial Intelligence Group (GIAA) **PI: Jesús García, José Manuel Molina**	• Air Traffic Control (ATC) • Unmanned vehicles • Machine learning and data mining techniques • Evolutionary computation and multi-objective optimisation • Agents and multiagent systems: sensor management • Computer vision • Contextual information and data fusion systems • Surveillance systems • Inference in adaptive, non-linear dynamic systems	**National Projects** • SIMBAT: Solutions for Intelligent Monitoring based on drone data and AI Tools • Concepts of aerial vehicles in the city: transportation, urban planning, and security • SIMBAT: Solutions for Intelligent Monitoring based on drone data and AI Tools • Unmanned aircraft air traffic management and operation support technologies • Advanced port and airport monitoring: concepts, tools, and evaluation • Autonomous multirotor-based surveillance and security System (ADVISE)	Artificial intelligence – Machine learning • Classification • Rules • Prediction Data fusion/Information/Sensors • Tracking • Control · Data analysis, Big Data · Decision-making support systems · Smart video · Internet of things · Autonomous browsing · Surveillance systems **Technological Offer** • Camera-based surveillance system for monitoring and identifying ground traffic in airports (planes, trucks, and buses) by means of cameras • Airport data fusion simulation system for the processing of surface radar and integration with other sensors, following the A-SMGCS paradigm • Optimisation, prediction, and data analysis software • System of software agents for surveillance • Context-based reasoning system for high-level fusion • Multi-sensor fusion platform for monitoring systems

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
IT			
Applied Artificial Intelligence Group (GIAA) PI: Jesús García, José Manuel Molina			**Equipment** • Time-of-flight and Kinect cameras • High-performance computing systems, cameras, localisation, and communications network • Unmanned ground vehicle (UGV) and lightweight UAVs with sensors for navigation Group's video

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
IT			
Planning and Learning (PLG) **PI: Fernando Fernández Rebollo**	• Artificial intelligence • Task planning • Machine learning • Problem resolution • Heuristic optimisation • Decision support systems	**National Projects** • Intermodal strategic planning by artificial intelligence techniques. GoalPLAN • Activity recognition and automatic planning for the design of smart assistants • Intelligent planning system for collective transport with optimised route generation (PLICOGOR) • Software for the joint re-planning of airline resources in the event of incidents **Private Funding** • Job Scheduling • Rotation Network Optimisation • OPTIMA – Work shift optimisation • DC-II Prototype Tasking & Data Centres	**Experience and Capabilities** The group's activities focus on task planning, scheduling, and machine learning. The group has extensive experience in a wide variety of techniques capable of automating services and complex activities of companies and provides proposals with complete integrative vision. **Technological Offer** • **Mission Planning:** Autonomous systems, single spacecraft/constellations, mission planning systems • **Scheduling:** ESTRACK-Planning-System, maintenance, and use of antennas with several services (individual or in group) • **Decision making:** Automatic validation of civil/military flight plans (AMPinC). Cost, effort, and quality prediction (Complexity, Cost and Change Impact Based on Models). Video del grupo

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

AEROSPACE ENGINEERING

Space Propulsion and Plasmas Team (EP2)

PI: Eduardo Ahedo

LINES OF RESEARCH

- Hall effect thrusters
- Electrodeless (RF and microwave) plasma thrusters
- Magnetic nozzles and thrust vector control
- Ion thrusters
- Hollow cathodes
- Micropropellants (pulsed plasma thrusters and electrospray)
- Plasma plume characterisation
- Plasma-spacecraft interaction
- Active space debris removal
- Plasma-material interaction
- Wave-plasma coupling
- Plasma turbulence and instabilities
- Numerical methods for rarefied plasmas
- Development of plasma diagnostic systems
- Data-driven data analysis techniques
- Space plasmas

RESEARCH PROJECTS

– European Projects

- CHEOPS MEDIUM POWER: Consortium for Hall Effect Orbital Propulsion System-Phase 2 covering MEDIUM POWER needs (H2020)
- CHEOPS LOW POWER: Consortium for Hall Effect Orbital Propulsion System-Phase 2 covering LOW POWER needs (H2020)
- ASPIRE: Advanced Space Propulsion for Innovative Embodiment of space Exploration
- HIPATIA: HelIcon PlasmA Thruster for In-space Applications (H2020)
- EDDA: European Direct-Drive Architecture (H2020)
- ZARATHUSTRA: Revolutionizing advanced electrodeless plasma thrusters for space transportation (ECR Starting Grant)
- ECOMODIS: Electron cooling model for simulation of ep induced plasma interactions with satellites (ESA)
- EP-DTK: Electric propulsion diagnostic for plasma thrusters (ESA)

National Projects

- SUPERLEO: Sustainable propellants for very low earth orbit plasma thrusters
- CSAT: Centre for research and integration of space technology and nano/micro-satellites
- COMIT: Compact mini plasma thruster for new space applications
- ESPEOS: ESPEOS: Electric space propulsion for earth orbit satellites

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TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

EP2 is a research group with 20 years of experience. The group is currently formed by 6 PhD researchers, about 15 PhD students, all of them on scholarships, and 2 external senior researchers. The international component exceeds 40%.

EP2 has extensive experience in carrying out collaborative projects of the Framework Programs and the European Space Agency (ESA). It has worked with leading European companies, laboratories, and universities in the field of electric space propulsion and space missions, such as Airbus DS, Thales, Safran, Sitael, Ariane Group, Sener Aerospacial, Deimos, ONERA, DLR, CNRS, CNR, etc. EP2 has also been funded by the European Research Council and the US Air Force Office for Scientific Research.

Since its foundation, EP2 receives continuous funding from successive national R&D plan programs, and in recent years also from the R&D calls of the Community of Madrid.

The main **CAPABILITIES** of the group are:

1) Theory: Basic research in fundamental phenomena of plasma physics for propulsion
2) Simulation: Complete development of numerical codes (fluid, kinetic, and hybrid; 2D and 3D) of complete plasma discharge in a thruster and an adjacent region
3) Prototyping: Design and manufacturing of propellant and plasma diagnostic equipment prototypes
4) Test: Development of experimental campaigns for propellant characterisation
5) Space systems engineering

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
AEROSPACE ENGINEERING			
Space Propulsion and Plasmas Team (EP2) PI: Eduardo Ahedo		**Regional Projects (Community of Madrid)** • MARTINLARA-CM. Millimetre wave Array at Room Temperature for INstruments in Leo Altitude Radio Astronomy • EXOPLAWIN. Stellar wind-exoplanetary magnetosphere interaction study by means of artificial plasma sources and computational models • PROMETEO: Plasma propulsion and nuclear fusion: innovating space transport **Private Funding** • UC3M-ISDEFE SPACE CHAIR • UC3M-SENER Aeroespacial Chair • Development of an advanced model of the Helicon Plasma Thruster (AIRBUS-DS-F)	EP2 has a laboratory with 3 vacuum chambers for testing 1 kW, 100 W, and 10 W plasma thrusters. The main chamber measuring 1.5 m in diameter and 3.5 m in length has a xenon pumping speed of 37000 l/s and reaches a continuous vacuum pressure of less than <2E-5 mbar when up to 20 sccm of Xe are injected. The chamber is equipped with different diagnostic tools: various probes, reaction balance, RPA, mechanical arms, spectroscope, high-speed camera, and network analysers. Group's video

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

AEROSPACE ENGINEERING

Aerospace Engineering Research Group

PI: Stefano Discetti

Aerodynamics

- Bioinspired aerodynamics
- Fluid-structure interaction
- Turbulence
- Turbulent heat transfer
- Computational fluid mechanics
- Supercomputing
- Experimental aerodynamics
- Advanced dynamic thermofluid measuring techniques
- Artificial intelligence applications in turbulent fluid control

Air navigation

- Aircraft trajectory optimisation
- Meteorological uncertainty management
- Aviation induced environmental impact
- Artificial intelligence applications in air traffic management

Aeronautical technology

- Aerostructures
- Multidisciplinary design and optimisation
- Unconventional aircraft
- Unmanned air vehicles (UAVs)
- Structural health diagnosis
- Structural dynamics and vibro-acoustics

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European Projects

- NEXTFLOW: Next-generation flow diagnostics for control
- ALARM: multi-hAzard monitoring and earLy wARning systeMm
- FlyATM4E: Flying Air Traffic Management for the benefit of environment and climate
- ISOBAR: Artificial Intelligence Solutions to Meteo-Based DCB Imbalances for Network Operations Planning
- FMP-Met: Meteorological uncertainty management for flow management positions
- START: a Stable and resilient ATM by integrating Robust airline operations into the network
- E.T.PACK: Electrodynamic Tether Technology for Passive Consumable-less Deorbit Kit
- E.T.PACK-F: A Ready-to-Fly Deorbit Device Based on Electrodynamic Tether Technology
- A Consumable-less Propulsion System Based on a Bare-Photovoltaic Tether

National Projects

- Active control of turbulence for sustainable aircraft propulsion
- Meteorological uncertainty management for a more efficient air traffic: meteorological data provision and storm evasion

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Experience and Capabilities

Five areas of research:

- Aeroelastic and Structural Design Lab (ASDLab)
  - Aerostructures
  - GAircraft Design MDAO
  - Flight Physics
- Computational Fluid Dynamics Lab

  Study of fundamental phenomena in complex and/or turbulent flows. They analyse these complex flows using High Performance Computing tools that run in massive parallel supercomputers. Experts in developing and running Direct Numerical Simulation (DNS) and/or Large Eddy Simulation (LES) solvers.
- Dynamics and Control in Aerospace Systems
  - Aircraft operations (applications of optimization and Aritificial Intelligence in the field of meteorology and climate change related to aviation)
  - Aerospace control, modeling and analysis (collaborations with industry and ESA on its application to re-entry vehicles, reusable launchers, satellites & spacecraft, and manned and unmanned aircraft)
  - Space flight dynamics
- Experimental Aerodynamics and Propulsion Lab
  - Machine-learning flow control
  - Advanced flow diagnostics
  - Data-driven fluid mechanics
  - Wall-bounded turbulence
  - Convective heat transfer

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AEROSPACE ENGINEERING

R&D GROUP

Aerospace Engineering Research Group

PI: Stefano Discetti

LINES OF RESEARCH

- Composite materials and advanced materials
- Airborne energy generation systems
- Modelling, control design, and analysis with robust methods

Space technology

- Space tethers
- Mission analysis and trajectory optimisation
- Orbit determination and space surveillance and tracking
- Satellite design and systems engineering
- Space debris removal
  Modelling, control design, and analysis with robust methods

RESEARCH PROJECTS

- Flight modelling and testing of airborne wind energy and power generation systems
- Centre for research and integration of space technology and nano/micro-satellites (CSAT)

Regional Projects (Community of Madrid)

- Prediction and control of turbulent flows with advanced statistical techniques (PREDATOR-CM-UC3M)
- Aviation and climate change: HYDROGEN-powered aircraft model design and climate-optimal aircraft operations using ArTificial INtelliGence
- Electrodynamic space tether-based deorbiting equipment avionics systems
- Emerging technologies for robust control in aerospace engineering

Private Funding

- Development of energy generation systems with airborne systems
- Simulation of mid-scale aerotool
- Optimum next generation aircraft and integrated rear end (Oneire)
- Integrated Multi-Actuator CONtrol System for Payloads LoS and Satellite (MACON)
- Collaboration agreement for the creation of the UC3M-SENER Aeroespacial Chair (ST3LLAR)

TECHNOLOGICAL OFFER / OTHERS

- Tethers Applied to Aerospace Engineering
  - Airborne Wind Energy
  - Space Tethers

Technological Offer (Patents / Software)

- FONKS-C: Free-of-noise Kinetic Solver for Cylindrical Geometry (M-004149/2021)
- BETsMA v2.0 (M-007775/2020)
- LAgrangian Kite SimulAtors (LAKSA) (M-007673-2017)
- Flexible Single-Line Kite Simulator "KiteFlex" (M-007734/2016)

Equipment / Infrastructure (Facilities)

- Wind tunnel
- Hydrodynamic tunnel
- Instruments for non-intrusive measurements (velocimetry for planar and volumetric particle imaging, infrared thermography)
- Instruments for measurements with probes (hot wire anemometry, microphones, pressure transducers, etc.)
- Anechoic chamber for aeroacoustics testing
- Navigation and Flight Mechanics Lab
- Additive Layer Manufacturing for Aeronautics Lab (ALMA lab)
- Chemical Propulsion Lab
- Open system mission computer
- Hangar with flying arena for UAVs

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS
MECHANICAL ENGINEERING		
Organisation Engineering **PI: Alfonso Durán, Isabel García**	• Product and process innovation • Integral evaluation (social-technical-economic) of alternative designs for complex systems. • Modelling and simulation • Strategic planning of the information systems • Production planning, programming, and control systems	**European Projects** • ICARUS: Innovative Changes in Air transport Research for Universally designed Services **Private Funding** • AIRBUS-UC3M Chair on healthy company, well-being, and performance

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

MECHANICAL ENGINEERING

Mechanical Simulation and Optimisation Group (SiOMec)

PI: Belén Muñoz Abella, Lourdes Rubio

- Identification of defects in mechanical elements.
- Health Monitoring
- Fracture and fatigue of mechanical components
- In-service behaviour of mechanical components in fatigue and fracture
- Direct and invert approach of mechanical problems
- Simulation of mechanical systems
- Computer-aided modelling and engineering
- Biomechanics
- Optimisation techniques applied to mechanical engineering
- Small mechanical and biomechanical devices design and prototyping

National Projects

- ROTACRACK: Development of simple theoretical models and commissioning of a virtual laboratory for defining a methodology for identifying fissures in rotary beams
- VIBROCRACK: Identification of fissures in one-dimensional mechanical elements by means of methods for detecting non-linearity
- PROFISEJE: Propagation of fatigue fissures in rotary shafts
- SHAFTCRACK: Detection and identification of fatigue fissures in rotary shafts by means of genetic algorithms

Regional Projects (Community of Madrid)

- Analysis of the influence of damage in the dynamic response of wind turbine blades made of a composite material
- Development of a non-destructive method for the detection and identification of fissures in non-rotary shafts

Experience and Capabilities

- This group specialises in the finite element modelling of normalised and non-normalised mechanical components, as well as in the study of their behaviour under service conditions
- Experienced in the use of conventional optimisation methods and of methods such as neural networks and genetic algorithms for solving inverse problems in mechanical engineering
- Development of research projects in the field of fracture by developing numerical and experimental models of fissured elements. These models are used for the detection and identification of fissures

Equipment

- Rotary beam test bench
- High-performance computer equipment
- Rotor dynamic test bench
- Machine for creating fissures by means of resonance
- Bench for the static testing of shafts and beams
- Bench for the dynamic testing of shafts and beams
- Vibration data acquisition equipment
- Contactless, dual axis measuring microscope

MECHANICAL ENGINEERING

R&D GROUP

Mechanical and Biomechanical Component Manufacture and Design Technologies (FABDIS)

PI: Mª Henar Miguélez, José Luis Cantero

LINES OF RESEARCH

- Machining
  - Numerical modelling of machining processes
  - Process definition and optimisation
  - Machinability tests
  - Machining of prototypes
  - Use of CAD-CAE-CAM computer applications
  - Study on the machining of special materials
  - Ecological machining
- Additive manufacturing (metals and polymers).
- Development of artificial intelligence tools applicable in manufacturing processes: neural networks and machine learning.
- Projectile impact analysis. Protection design.
- Manufacturing-oriented design
- Plastic deformation forming processes
  - Numerical modelling of plastic deformation processes
  - Process definition and optimisation
  - High temperature folding
- Computer-aided design, manufacturing, and engineering: CAD, CAM, CAE
- Design of mechanical and biomechanical components
- Genetic algorithms
- Damage identification techniques

RESEARCH PROJECTS

National Projects

- Defect analysis in fibre-reinforced laminates due to manufacturing processes and effect on fatigue behaviour
- DIGITDRILL - Digitalisation of industrial drilling process
- Development of a new lightweight shield by means of a combined experimental-numerical methodology
- Drilling of CFRP/Ti hybrid components and damage tolerance due to machining during in-service behaviour of aeronautical structural joints
- Modelling the drilling process of carbon fibre composite materials
- Comprehensive design and additive manufacturing of patient-specific polymer implants
- Experimental and numerical analysis of biomechanical effects in ballistic torso protection

Private Funding

- Drilling process improvement based on data analysis
- Drilling process improvement based on data analysis step 2 (Drilling Digitalisation: Data analytics + AI for Drilling Process Improvement)
- UGV material ballistic behaviour analysis

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

The group has over 20 years of experience in conducting research relating to machining processes and other manufacturing processes (6 years of collaboration with Airbus Getafe)

Experience in manufacturing:

- Data analytics and artificial intelligence - Smart Manufacturing (in collaboration with UC3M Smart Systems Lab.)
- Optimization of machining processes for low machinability materials
  - Drilling and turning of heat-resistant alloys
  - Drilling of CRRPs and CRRPs-meta stacks
- Additive manufacturing (metals and polymers). Collaboration with UPV
- Technologies applied to the analysis of manufacturing processes
  - Wear testing (optical microscopy and SEM-EDS)
  - Machining monitoring: shear forces, temperature, etc.
  - Numerical modelling (MEF)
  - Component damage and quality control

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

TELEMATIC ENGINEERING

Network Technologies (NETCOM)

Coordinator: Francisco Valera

- Network architecture and distributed services
- Communication protocols
- Internet of the Future
- Content Delivery Networks (CDN)
- Mobile and vehicular networks
- Wireless networks
- Optical access networks, metropolitan networks, and backbone networks
- Network science
- Security in communications networks
- Energy efficiency in telecommunication systems and networks
- High-performance switching
- Traffic analysis
- Internet of Things (IoT)
- Cognitive networks
- 5G networks
- Connected industry

European Projects

- LABYRINTH: Unmanned traffic management 4d path planning technologies for drone. Swarm to enhance safety and security in transport
- Remote area Access Network for 5th GEneration (5GRANGE)
- Evolving FIRE into a 5G-oriented experimental playground for vertical industries (5GINFIRE)
- Zero-touch security and trust for ubiquitous computing and connectivity in 5G networks
- Integrating 5G enabling technologies in a holistic service to physical layer 5G system platform

National Projects

- Dronext: rapid deployment of a multiservice communications infrastructure for protection, security, and defence
- New technologies for the sustainable development of 6G in extreme environments - Subproject 3 - 6G-Xtreme III: CON-SAT - New technologies for the sustainable development of 6G in extreme environments with picosatellite technologies and smart control

Regional Projects

- Advanced techniques for enhancing the intelligence of 5G networks

Experience and Capabilities

This group is formed by the following subgroups:

a) NETCOM (Network and Communication Technologies)
PI: Arturo Azcorra

- Network Architectures
- Communication Protocols
- Wireless and Mobile Networks
- Peer-to-Peer Systems
- Distributed Services

Internal communications:

Design and deployment of a network-centric remotely controlled systems of piloted aircrafts for INTA

- Complete design of the UAS network communications system
  - Deployment of GCS and UAV IP router for SIVA
  - DRONE Project for the Ministry of Defence

b) ADSCOM (Advanced Switching and Communication Systems)
PI: David Larrabeiti

- Multimedia networks
- Real-time multimedia data transport (RTP/RTCP) network design
- Traffic modelling for efficient bandwidth and delay communications

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
TELEMATIC ENGINEERING			
Network Technologies (NETCOM) Coordinator: Francisco Valera			**Technological Offer** • Secure multipath ad-hoc communication networks • On-board multimedia networks, multipoint optical networks • Telecommunication network optimisation • Security in communications protocols **Infrastructure** • 5TONIC laboratory

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUID ENGINEERING			
Power Systems Engineering (ISE) **PI: Domingo Santana**	• Thermochemical processes of solid fuels (biomass gasification and combustion, fuel characterisation) • Multiphase flow simulation (CFD) • Non-intrusive measuring techniques in thermal engineering and fluid mechanics • Two-phase flow characterisation • Studies on jet development	**Regional Projects (Community of Madrid)** • Elastocaloric materials for solid cooling (eCOOL-CM-UC3M) **Private Funding** • Thermal-mechanical design of a liquid hydrogen evaporator	**Experience and Capabilities** **Infrastructure** • Biomass fuel testing laboratory (BIOLAB) Service for fuel energy analysis and characterisation

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

THERMAL AND FLUID ENGINEERING

Thermal Engineering, Energy, and Atmosphere (ITEA)

PI: Antonio Lecuona

- Particle image velocimetry (PIV)
- Burners stabilised by rotation
- Heat and mass transport. Combustion
- Jet dynamics
- Environmental impact on the atmosphere by forms of matter and energy. Technical acoustics
- Efficient energy and thermal systems of low environmental impact
- Reduction of thermal machinery and engine emissions into the atmosphere
- Thermal fluid dynamic laser instrumentation
- Computer simulation of flows of industrial and environmental interest

European Projects

- HOT - Humidity Optimisation Tool

Private Funding

- Aerospace research and development in Castilla la Mancha

Experience and Capabilities

Extensive knowledge and experience within its scientific discipline allows this group to achieve its common goal of offering effective services in a wide technological spectrum. Researchers from the group work with expert collaborators in fundamental analytical and numerical techniques, giving the group internationally proven soundness.

- **Particle image velocimetry (PIV)**
  Result: development of a solid database for fluid field at the outlet of aircraft reactor nozzles (at 1/10 scale) which has been used for the validation of numerical simulation codes to enable predicting the fluid and acoustic field at the outlet of air reactors, for the purpose of substantially reducing the noise of large civil aviation aircraft.

Equipment (in collaboration with UCLM)

- Testing of engines of up to 200 kW with the capacity to evaluate the indicated cycle and energy balance
- Combustion chamber of up to 200 kW
- Stereoscopic particle image velocimetry system with a high spatial (LFCPIV) and temporal (Dynamic PIV) resolution
- Laser Doppler interferometer with phase information (PDA)
- High-speed image analysis in digital video
- Equipment for measuring polluting combustion gases

THERMAL AND FLUID ENGINEERING

R&D GROUP

Fluid Mechanics (GMF)

PI: Francisco Javier Rodríguez

LINES OF RESEARCH

- Combustion
- Multiphase flows
- Electrochemical system modelling and characterisation
- Computational fluid mechanics
- Heat and mass transport
- Heat Pipes
- Explosion dynamics
- Evaporation of expiratory droplets and fuel

RESEARCH PROJECTS

National Projects

- Study on Fibre Optic Temperature Sensor
- Efficient biofuel combustion applied in portable power generation
- Numerical-experimental study on the safety and combustion of hydrogen and hydrogen-derived fuels
- Training in hydrogen technologies and hydrogen-derived fuels
- Cavitation in Continuum Media
- Geothermal energy and flow battery hybridisation for temperature control in zero-energy commercial buildings
- Modelling and optimisation of new electrochemical system architectures and components for energy storage and conversion
- Modelling and development of membrane-free flow micro batteries based on miscible electrolytes
- Strategic positioning of Community of Madrid in green hydrogen and fuel cell R&D&I - GREEN H2
- Explosion hazards in h2-air mixtures and mitigation measures
- Experimental and theoretical study of the evaporation of expiratory droplets containing coronavirus

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TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- **Sustainable combustion**
  Technologically applicable reactive flows: hydrogen combustion, synthetic fuels, biofuels, ignition, chemical kinetics, compressibility effects, flame stabilisation and propagation.
- **Jets and blasts**
  Structure and stability properties of jets and blasts in technologically relevant contexts
- **Multiphase flows**
  Turbulent multiphase flows and submerged waves. Low Reynolds number flows
- **Wave dynamics**
- **Modelling and characterisation of electrochemical systems**
  Multiphase transport in porous media
  PEM fuel cells
  Flow batteries
  Microfluidics
- **Explosion dynamics**
  Rapid methods for evaluating the effects of explosions on environment

Facilities

- Low Speed Wind Tunnel
- Recirculating Water Channel
- Ultrasound Laboratory
- Computer Cluster
- Combustion Cell
- Fuel Cell Test Station

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUID ENGINEERING			
Fluid Mechanics (GMF) PI: Francisco Javier Rodríguez		**Regional Projects (Community of Madrid)** • Study of detonation and explosion hazards in hydrogen-air mixtures (H2SAFE-CM-UC3M) • Evolutionary optimisation of geometries and use of nanofluids for electric vehicle battery cooling (NANOCOOLEVB-CM-UC3M) • Design and optimisation of membrane-free flow micro batteries • Technical-economic optimisation of design and manufacturing variables of additively manufactured heat pipes **Private Funding** • H2 Fire Tests with Optical Technologies • Study on Fibre Optic Temperature Sensor • Study on the performance of porous heat pipes obtained by additive manufacturing • Experimental study of the effect of heat pipe filling method on heat pipe performance • Thermo-mechanical design of an evaporator for liquid hydrogen **Others** • ENERGY FOR FUTURE (E4F): Online monitoring of electrolyte properties in micro/macro redox flow batteries for improved system control (GA-101034297, UE-H2020-MSCA-COFUND)	**Equipment** • High Speed Cameras • Compact Continuous Wave Solid State Laser **Infrastructure** Biomass fuel testing laboratory (BIOLAB) Service for fuel analysis and energy characterisation

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SYSTEMS AND AUTOMATIC ENGINEERING			
Robotics Lab **PI: Miguel A. Salichs, Carlos Balaguer, Luis Moreno**	• Aerospace systems • Visual tracking and servoing • Robotics for space	**European Projects** • LABYRINTH:. Unmanned traffic management 4D path planning technologies for drone. Swarm to enhance safety and security in transport **Private Funding** • SWARM: Air traffic control system for unmanned devices for safe and highly reliable applications • Decoupled exoskeleton system for loading and unloading of airport baggage • Fast Marching for UAVs	**Experience and Capabilities** The activity of the Robotics Lab in the aerospace sector focuses on two different areas: visual navigation of autonomous satellites and simulation of general Eurofighter aircraft systems. **Technological Offer** • Platform for satellite identification and recovery. The scaled experimental platform allows the recognition and inspection of satellites in orbit by means of vision systems located on other satellites • Outdoor mobile robot. For application in the aerospace sector, navigation, planning. The propulsion system for the robot is autonomous Group's video

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SYSTEMS AND AUTOMATIC ENGINEERING			
Intelligent Systems Laboratory (LSI) **PI: Arturo de la Escalera, José Mª Armingol**	• Intelligent transportation systems • Autonomous aircraft navigation and control • Hybrid power architectures for autonomous aircraft with high payload capacity • Computer vision • Micro robotics • Computer integrated manufacturing • System modelling and simulation	**Regional Projects (Community of Madrid)** • Cooperation of drones with high capabilities for extinguishing forest and urban fire **Private Funding** • Drilling process improvement based on data analysis step 2 (Drilling Digitalisation: Data analytics + AI for Drilling Process Improvement) • Development of a three-dimensional and hyperspectral reconstruction of environments explored by robot • Detection of regions of environmental interest from hyperspectral information and validation of the demonstrator in real environments • Design of a UAV navigation and control system • Design and development of algorithm for autonomous navigation of aerial platforms with swarm flight control	**Experience and Capabilities** Group with over 30 years of experience in issues relating to intelligent vehicles, development of several systems in the field of perception technologies and intelligent systems applied to aircraft. **Platforms** • **Unmanned aerial vehicle:** · Drone swarm (quadcopters): autonomous and coordinated navigation of small drones equipped with GNSS devices, perception sensors, and embedded real-time processing systems (Jetson Xavier) · Captive aircraft (hexacopter) on rail vehicle with autonomous navigation capacity and real-time rail infrastructure inspection from aerial angle.

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

MECHANICS OF CONTINUOUS MEDIA AND THEORY OF STRUCTURES

Lightweight Structures Dynamics

PI: David Varas, Jorge López

LINES OF RESEARCH

- Behaviour of metallic structures against impact
- Behaviour of structures made of composites against impacts
- Development of material behaviour models at high strain rates
- Analysis of the behaviour of ice under impact conditions
- Behaviour of fuel tanks subjected to impact (HRAM)
- Analysis of impact of composite fragments
- Identification and numerical and experimental characterisation of the models of compressible anisotropic plasticity in both quasi-static and dynamic regimes
- Homogenisation in elastic regime, for materials with anisotropic elasticity and microstructure

RESEARCH PROJECTS

European Projects

- BEDYN: Development of a methodology (test, measurement, analysis) to characterize the BEhaviour of composite structures under DYNamic loading
- GRAPHENE Core 2: Graphene-based revolutions in ICT and beyond
- GrapheneCore3: Graphene Flagship Core Project 3

National Projects

- Analysis and development of auxetic protections for carbon/epoxy structures
- Safe operation of tubular receivers by means of methods of inverse thermoelastic analysis II

Private Funding

- NEOTAIL-Cien-Impact test campaign 22
- FUSELAGE

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

This group specialises in the field of structure behaviour in a dynamic regime.

The group has developed various experimental methodologies for carrying out complex high and medium velocity impact tests. The group also has extensive experience in developing behavioural models for materials under high strain rates and simple analytical models for modelling impact phenomena.

The group conducts both publicly and privately funded research projects, where it has worked with leading companies, mainly in the aeronautic sector.

Infrastructures

Material mechanical characterisation laboratory (LABMEC)

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

MECHANICS OF CONTINUOUS MEDIA AND THEORY OF STRUCTURES

Structural Elements Dynamics and Fracture

PI: Ramón Zaera

- Dynamic behaviour of structural elements: experimental simulation and analysis.
- Energy-absorbing structures
- Problems of impact on structural elements for aeronautic use
- Constitutive models of materials under a high strain rate
- Fracture mechanics
- Damage mechanics
- Fracture testing under dynamic conditions
- Metal matrix composites
- Residual stress in structural elements

European Projects

- BEDYN: Development of a methodology (test, measurement, analysis) to characterise the BEhaviour of composite structures under DYNamic loading
- GrapheneCore3: Graphene Flagship Core Project 3
- ELEMENT: CROR Engine debris Middle level Impact and Mechanical test

National Projects

- Experimental-Computational framework for the development of metamaterial-based smart structures
- Experimentation and modelling of the mechanical and electrical behaviour of electroactive polymer smart structures
- Development of lightweight, self-supporting, multi-layered metal-based shields reinforced with advanced fibres

Private Funding

- Structural response of aeronautical RX antenna panel subjected to impact loads
- Impact behaviour of thermoplastic polymers for aeronautical applications

Experience and Capabilities

This group has extensive experience in analysing mechanical behaviour against impact and fracture of mechanical and structural elements, mastering both experimental and numerical simulation methodologies.

The group provides services to the industry in those fields which require knowledge about the mechanical properties of any type of material at different strain rates and temperatures, particularly in dynamic and impact conditions.

Infrastructures

Material mechanical characterisation laboratory (LABMEC)

News

- R&D&I to increase aeronautical safety
- Prediction of the behaviour of an aircraft structure in the event of an external impact
- New launchers for analysing impact resistance and improving shields

Group's video

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

MECHANICS OF CONTINUOUS MEDIA AND THEORY OF STRUCTURES

Advanced Materials Mechanics

PI: Enrique Barbero, Sonia Sánchez

- Analysis and modelling of laminate and sandwich structures subjected to high and low impulsive loads
- Analysis and modelling of composite energy-absorbing structures
- Damage tolerance study of composite structural elements subjected to different load conditions
- Behaviour of Eco-structures manufactured from natural and/or recycled and recyclable materials
- Analysis and modelling of repairs and attachments in laminate and sandwich structures

European Projects

- BEDYN: Development of a methodology (test, measurement, analysis) to characterise the BEhaviour of composite structures under DYNamic loading

National Projects

- Development of lightweight, self-supporting, multi-layered metal-based shields reinforced with advanced fibres
- Study of the impact and post-impact behaviour of wind turbine blades manufactured from sandwich structures
- Analysis and modelling of thin laminate structural adhesive repairs for the air transport sector
- Analysis of mechanical attachments in aeronautical structures subjected to impulsive loads
- Experimental and numerical analysis of the mechanical behaviour under dynamic conditions of structural elements manufactured from biodegradable composites
- Analysis of the influence of damage on the dynamic response of composite wind turbine blades

Private Funding

- Dynamic tensile analysis on aeronautical materials
- Analysis of the compression behaviour of A400-M aeronautical components
- Innovation in advanced composites and optimized rear-end (ICARO)

Experience and Capabilities

Analysis and modelling of structural elements manufactured with sandwich and composite materials subjected to impulsive loads, as well as study of the damage tolerance of said elements. The group has extensive experience in the development of non-standard test methodologies.

Infrastructures

- Material mechanical characterisation laboratory (LABMEC)
- Aeronautical structure impact laboratory (ImpactLab)

Group's video

MECHANICS OF CONTINUOUS MEDIA AND THEORY OF STRUCTURES

R&D GROUP

Nonlinear Solid Mechanics

PI: José Antonio Rodríguez

LINES OF RESEARCH

- Experimental characterisation of the mechanical behaviour of metallic materials under wide ranges of strain rate and temperature, and for different stress conditions
- Development, calibration, and implementation in numerical codes of nonlinear constitutive models to describe the mechanical behaviour of metallic materials
- Experimental, analytical, and numerical study of damage, ductile fracture, and localisation processes in metallic materials subjected to complex loading conditions
- Experimental and numerical study of dynamic perforation processes of metallic structures
- Protective structure impact and fragmentation testing

RESEARCH PROJECTS

European Projects

- PURPOSE: Opening a new route in solid mechanics: Printed Protective Structures (ERC Starting Grant 2017)
- QUANTIFY: Unravelling the role of anisotropy in material failure (MSCA-RISE)
- OUTCOME: The outstanding challenge in solid mechanics: engineering structures subjected to extreme loading conditions (MSCA-ITN-ETN)
- DIAGONAL: Ductility and fracture toughness analysis of functionally graded materials (MSCA-SE)

National Projects

- A pending challenge in solid mechanics: the effect of anisotropy and porosity on mechanical strength and ductility of printed metals
- Cavitation in Continuum Media
- Perforation across the scales
- Building bridges across the scales: influence of spatial-temporal scale lengths on dynamic fracture

Private Funding

- The mechanics and physics of dynamic localisation and fracture in heterogeneous ductile materials
- Microinertia: myth or reality?

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

The members of NSM collaborate actively with researchers from different prestigious institutions in Europe, America, and Asia.

NSM also carries out technology transfer activities and works with multitude of companies in the aerospace sector.

Group's video

Flyer Technological innovation on Solid Mechanics at transportation and civilian security industries

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

ELECTRONIC TECHNOLOGY

Microelectronics Design and Applications (DMA)

PI: Luis A. Entrena, Luis Hernández

- Design with FPGAs and SoCs. Acceleration hardware, reconfigurable computing, and digital signal processing
- CAD tools for electronic design (EDA)
- Design of A/D and D/A converters for audio and communication applications. Sigma-Delta architectures in time continuum and VCO-ADC
- Design of integrated circuits in CMOS technology for interface with MEMS sensors
- Design of high-speed A/D converters for RF
- Radiation-hardened, fault tolerant circuits
- Fault injection. Validation of fault tolerance through emulation and radiation
- Digital processing instruments of planetary exploration sensors
- Hardware security

International Projects

- RADNEXT - RADiation facility Network for the EXploration of effects for indusTry and research
- Online Detection And Diagnosis For Radiation-Induced Errors In COTS Microprocessors
- Verification of SEU-mitigation techniques in 3rd/4th generation Flash FPGAs
- Validation of Approximate logic circuits at 28 nm

National Projects

- RENASER4 - Design and verification of heterogeneous computing systems-on-chip for space and terrestrial applications under irradiation
- RENASER3 - Design and verification of nanoscale electronic circuits for space and terrestrial applications in radiation environments
- Extending the dust sensor into a multi-parameter integrated atmospheric mini-instrument for the surface of Mars based on an infrared spectral array
- MARS DS'18 (Science and Technology for the *in-situ* characterisation of the atmosphere

Regional Projects (Community of Madrid)

- MadridFlightOnChip
- Design of fault tolerant SoCs (System-on-Chip) for space applications

Experience and Capabilities

This is a group specialising in providing comprehensive services for the design of customised integrated circuits and integration of electronic solutions (build-in systems).

Design of digital electronic circuits, both application-specific integrated circuits (ASICs) and circuits implemented through programmable hardware (FPGA and SoC).

Hardened design for space applications. Hardening validation by fault injection through emulation and irradiation.

Technological Offer

- Design of integrated digital, analogue, and mixed-signal circuits based on ASIC, FPGA, and SoC technologies.
- Design and characterisation of robust circuits against ionizing radiation for aerospace applications, by means of the application of selective hardening techniques and validation by fault injection through emulation or irradiation campaigns.
- Consultancy in the use of FPGAs, microprocessors, and SoCs for space applications.

Patents

Dispositivo y procedimiento para la identificación unívoca de un circuito integrado (Device and method for the univocal identification of an integrated circuit) (ES2684846B1)

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

ELECTRONIC TECHNOLOGY

Photonic Displays and Applications (GDAF)

PI: José Manuel Sánchez Pena, Carmen Vázquez

LINES OF RESEARCH

- Advanced instrumentation and sensors
- Analogue radio over fibre (ARoF) communications with 5G-NR signals
- Light power supply through optical fibre (PoF)
- Optical access network monitoring and integration with mobile communications fronthaul
- Modelling of devices with nanoparticles and optical forces
- Sensors and communications with plastic optical fibres
- LiFi communications

RESEARCH PROJECTS

European Projects

- BlueSpace: Building on the Use of Spatial Multiplexing 5G Networks Infrastructures and Showcasing Advanced technologies and Networking Capabilities

National Projects

- Nano-assembled materials for light sensing and manipulation in a wide spectral range (I): Phase-adaptive devices and meta surfaces
- Sub-wavelength thin-film structures for photonic circuits
- New technologies for the sustainable development of 6G in extreme environments - Subproject 1 - 6G-Xtreme I: PoF - New technologies for the sustainable development of 6G in extreme environments with optical fibres and power over fibre technology
- Advanced optical fibre-based intelligent technologies

Regional Projects (Community of Madrid)

- SINFOTON2-CM. Sensors and instrumentation in photonic technologies 2
- Photovoltaic remote powering through optical fibre for measurement and control in extreme environments

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

This group conducts research on photonic and electronic devices and systems for communications and industrial applications.

Technological Offer

- System for monitoring WDM-PON optical access networks and self-referencing techniques
- Remote powering with fibre using light to power low-consumption sensor networks and integrated antennas in fronthaul radio over fibre in mobile networks
- Development of instrumentation systems which allow multi-point monitoring by means of the development of optical fibre-based quasi-distributed systems
- Software applications and hardware designs for a deep space optical communications link

Patents

- *Pirómetro con alta resolución espacial* (High spatial-resolution pyrometer) (P202130347)
- *Método y sistema para la monitorización de redes de fibra óptica* (Method and system for monitoring optical fibre networks) (ES2760798B2)
- *Lente sintonizable de cristal líquido* (Tunable liquid crystal lens) (ES2801023)

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRONIC TECHNOLOGY			
Photonic Displays and Applications (GDAF) PI: José Manuel Sánchez Pena, Carmen Vázquez			• *Sistema y método de monitorización de potencia y temperatura en redes de fibra óptica* (System and method for monitoring power and temperature in optical fibre networks) (ES2760798-B2) • *Pirómetro de fibra óptica a dos colores* (Two-colour fibre optic pyrometer) (PCT/ES2016/070269) **Equipment** • Specialty Fibre Fusion Splicer FSM100P+, Fujikura • 2 W, 5 W, 40 W high-power laser. Tunable DFB 1460-1560 nm • Lightwave Component Analyser (20 GHz@1550 nm) • Vector Signal Generator up to 20GHz • RF spectrum analyser (31.5GHz). RF signal generator up to 20 GHz • BER Tester 12.5Gbs. OSA 650-1700nm • RSoft Fullwave. BeamPROP. FemSIM. Optimiser. COMSOL. VPI. Altium

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

ELECTRONIC TECHNOLOGY

Electronic Power Systems Group (GSEP)

PI: Andrés Barrado, Emilio Olías

LINES OF RESEARCH

- Electronic power conversion systems
- Renewable hybrid power systems.
- Magnetic component design and optimisation.
- Electromagnetic compatibility.

RESEARCH PROJECTS

European Projects

- ESSIAL: Electrical Steel Structuring, Insulating and Assembling by means of the Laser technologies

National Projects

- Power distribution system for hydrogen-powered drones
- Modelling and control strategies for interconnection stabilisation of electronic power converters
- ELECTRA: Electric Aircraft Platform

Regional Projects (Community of Madrid)

- Development of new solid-state lithium batteries and their electronic charging and energy management system for application to biomedical devices and unmanned aircraft
- Advanced power electronic converter control unit based on Zynq technology. UltraSCALE, applicable to multi-converter systems
- New bidirectional DC-DC converters with galvanic isolation for high power applications

Private Funding

- Hydrogen fuel cell drone propulsion system
- Auxiliary electric propulsion system for light and sport general aviation

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TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Electronic energy conversion systems
- Design of magnetic components
- Renewable hybrid energy systems
- Electric mobility
- IIoT – Industrial Internet of Things

Aeronautics experience

Fuel Cell Powered

Systems powered with fuel cells

- Optimisation of the systems for different parameters

Drones powered with fuel cells

- Optimization of the systems and design of arquitectures

Modelling

- Modelling different elements of power systems

Aircraft

Aircraft PDS

- Analysis and modelling of PDS and sub-systems

Aircraft: solid-state power controllers (SSPC)

- Active Control Strategies for SSPC

Hybrid Airplane

- Adds-on Electric Motor Emergency & Boost Power

Battery charger for Full Electric Airplane

- Resonant converters

Health monitoring

- Health monitoring of power systems
- Eddy currents and CFRP

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRONIC TECHNOLOGY			
Electronic Power Systems Group (GSEP) PI: Andrés Barrado, Emilio Olías		• SIC-based high-performance AC-DC converters for TV and RADIO transmitters • Innovation Management Chair (UC3M -AIRBUS OPERATIONS S.L.)	**Technological Offer (Patents)** • *Convertidor y método de conversión bidireccional de corriente continua a corriente continua sin aislamiento galvánico* (Converter and method for the bidirectional conversion of direct current to direct current without galvanic isolation) (ES2706391 B2). • *Método y sistema de alimentación de una carga constituida por una pluralidad de cargas elementales, en particular de LED* (Method and system for powering a load consisting of a plurality of fundamental loads, particularly LED loads) (ES2391218) • *Procedimientos de control activo para la conexión de cargas altamente capacitivas mediante SSPCs* (Active control methods for the connection of highly capacitive loads by means of SSPCs) (ES2398884) • *Convertidor de corriente alterna-continua de una etapa con corrección de factor de potencia* (Single-step alternating-direct current converter with power factor correction) (ES2192992) Group's video Power Smart Control (PSC) **A UC3M spin-off with UC3M participation in the share capital since September 2016.** Design, development, and distribution of specialised software. Provision of engineering services related to software, equipment, and electronic systems used for electrical energy control, conversion, and conditioning.

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

ELECTRONIC TECHNOLOGY

Optoelectronics and Laser Technology (GOTL)

PI: Guillermo Carpintero

- Integrated microwave photonics through design, implementation, and characterisation of photonic integrated circuits (PICs) for the generation of signals with frequencies ranging from microwave up to the Terahertz range
- Broadband wireless communications using photonic-enabled transmitters and electronic Schottky receivers.
- Design, modelling, and characterisation of photonic integrated semiconductor lasers for both with continuous-wave (CW) emission and mode-locking
- Millimetre and terahertz range antenna arrays with photonic phase control for beam steering in 5G applications.
- Design and development of diode laser systems for high-power nanosecond pulse generation using high-power diode lasers (HPDLs) and high-current short pulse drivers
- Interferometric instrumentation systems with high-sensitivity optical fibres for the measurement of ultrasound, vibrations, and temperatures

European Projects

- TERAOPTICS: Terahertz Photonics for Communications, Space, Security, Radio-Astronomy, and Material Science
- Integrated microwave photonic technology for wide-frequency tuning signal generation

National Projects

- Photonic integrated circuits for advanced radiometers in the millimetre range for new generation instruments in earth observation

Regional Projects (Community of Madrid)

- MARTINLARA-CM. Millimetre wave Array at Room Temperature for INstruments in Leo Altitude Radio Astronomy
- Development of agile and compact wireless communication links for aerospace environment by means of integrating photonics and microwave techniques

Private Funding

- Photonic rf tuneable demultiplexer for broadband satellites (THORMUX)

Experience and Capabilities

The group has extensive experience in the development of 2D and 3D telemetry and vision systems for robotics, development, characterisation, and modelling of laterally coupled lasers, development of optical sensors and optoelectronic instrumentation, optical communications, laser interferometry, and high-speed communications systems.

Patents

- Hybrid structure for ultra-wideband terahertz generation and reception with semiconductor devices (EP22382348)
- Dielectric radio frequency (RF) bidirectional coupler with power divider/combiner functionality (EP21382573)
- Ultra-wideband interconnection probes (EP20382960)
- *Controlador y método de control de una pila de diodos* (Controller and control method for a diode battery) (ES2710080B2)
- *Multiplexor y demultiplexor óptico compacto de elevado número de canales* (Compact optical multiplexer and demultiplexer with a high number of channels) (ES2684177B1)
- *Imagen hiperspectral basada en peine doble de frecuencias* (Hyperspectral imaging based on double frequency comb) (ES2801023)

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

ELECTRONIC TECHNOLOGY

Sensors and Instrumentation Techniques (SIT)

PI: Pablo Acedo

- Sensors
  Design, development, and testing of electronics for acoustic and ultrasound sensors, optical sensors, and fibre optic sensors, and quantum sensors
- New optical sources and photonic architectures
  Design and characterisation of photonic devices and architectures for the generation, processing, and detection of signals in the optical, millimetre wave, and THz ranges. Electronic warfare.
- Spectroscopy
  (UV/VIS/NIR/MIR/THz)
- Interferometry and instrumentation for applications (biomedical, environmental, and industrial)

European Projects

- AEROMIC: Development of New digital Microphone-MEMS-Sensors for wind tunnels with open/closed test sections and flight tests
- NANOSTAR: A collaborative platform to provide a relevant training on nanosat technology through Student Challenges

National Projects

- Linear and nonlinear spectroscopy of dual optical frequency combs for biomedical, environmental, and industrial applications

Private Funding

- Research of a new NV centre-based quantum sensing platform. Preliminary study of the experimental scheme (Arquimea Research Center)
- Optical Backbone for Future Aircraft (AIRBUS Defence and Space)
- ESCAPHIB: Tail structures and systems for a hybrid propulsion passenger aircraft (Alava Ingeniería/ AIRBUS)

Experience and Capabilities

This group has extensive experience in optical sensors and instrumentation

- Spectroscopy (UV/VIS/NIR/MIR/THz), interferometry, and applications (biomedical, environmental, industrial)
- New optical sources and photonic architectures
- Optical and optical fibre sensors

Technological Offer

- SHM & NDE/NDT – Fiber optic sensing & non-contact sensing
- Electronic warfare systems based on photonic technology. Optical sampling (AIRBUS D&S, INDRA Sistemas).
- Local oscillator and clock distribution systems in phased array radars using photonic technologies. (INDRA Sistemas).
- Instrumentation – High temperature & distributed sensing ESCAPHIB – Fiber optic distribution fire detection
- Instrumentation – Wind tunnel test and Flight tests AEROMIC jti-CS2 – aeroacustic MEMS microphone Arrays
- Sensors – Optical sensor for runaway condition assessment (Patent EP3742155, US 11,433,903 B2)
- Sensors – Vision

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRONIC TECHNOLOGY			
Sensors and Instrumentation Techniques (SIT) PI: Pablo Acedo			• Sensors – High-precision aircraft guidance: accurate autonomous landing of drones (AIRBUS D&S) • Spectroscopy – Hyperspectral imaging. Direct dual-comb imaging in the near-IR • *Imagen hiperspectral basada en peine doble de frecuencias* (Hyperspectral imaging based on double frequency comb) (Patent ES2800823)

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

SIGNAL AND COMMUNICATIONS THEORY

Communications

PI: Ana García Armada

- Multi-antenna systems (MIMO) for broadband communication
- Multi-carrier modulation OFDM
- Turbo-coding
- Channel estimation, synchronism, and power peak reduction
- Cooperative transmission and relays
- Signal processing in digital communications
- Coordinated transmission and cancelling interference in cellular systems
- Communication system simulation and modelling
- Application of the preceding techniques in next-generation mobile systems and satellite communications systems

European Projects

- Reconfigurable Intelligent Surface-Assisted VLC for battery-free IoT devices
- TeamUp5G: New RAN TEchniques for 5G UltrA-dense Mobile networks (Network ITN-ETN)

National Projects

- Energy- and cost-efficient communications with universal coverage
- Massive MIMO and visible light communications techniques to improve data rate and coverage in Areas of Difficult Access (ADAs)

Regional Projects (Community of Madrid)

- MadridFlightOnChip
- GEOlocalisation of medium-high speed resources and users using visible light and infrared

Private Funding

- UC3M-SENER Aeroespacial Chair
- Massive MIMO optimisation in millimetre waves for 5G radio access systems (AMATISTA PROJECT)

Experience and Capabilities

This group specialises in the analysis, design, and evaluation of fixed and mobile communications systems, as well as the development of signal processing techniques to improve their performance, which allows offering alternatives to optimise the applications and services supported therein.

- Multi-antenna systems (MIMO and massive MIMO)
- OFDM multi-carrier modulation and variants (for NB-IoT, 5G, etc.)
- Signal analysis, detection, and inhibition
- Coordinated transmission and interference cancellation (Small cells, etc.)
- Random access mechanisms and radio resource management (IoT, Multicast, Broadcast, etc.)

Technological Offer (Patents)

- *Constelaciones de alto rendimiento en un sistema de comunicaciones multiusuario con detección no coherente* (High-performance constellations in a multi-user communications system with non-coherent detection) (P202130905)
- *Método, sistema y dispositivo para la recepción de transmisiones ópticas multiusuario* (Method, system, and device for receiving multi-user optical transmissions) (ES2713578B2)

Group's video

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

SIGNAL AND COMMUNICATIONS THEORY

Communications

PI: Ana García Armada

News

The Communications Group participates in the St3llar Chair (https://st3llar.uc3m.es/) with the company SENER Aerospacial for the development of the first UC3M-SENER mini-satellite based on a reconfigurable design.

The MFOC project is presented at the Go2SpaceHubs in February 2021:

https://go2space-hubs.eu/
Agenda Tuesday February 16 - Go2Space-HUBS

Equipment

Laboratory. The group has equipment for communications systems simulation and prototyping.

A clean room is being built and equipped for the design, construction, and measurements of micro-satellites. This laboratory will house measuring equipment for space communications systems.

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

SIGNAL AND COMMUNICATIONS THEORY

Radiofrequency, Electromagnetics, Microwaves, and Antennas Group (GREMA)

PI: Daniel Segovia

- Antenna arrays
- Stacked and self-diplexed radiators
- New technologies in antenna construction: Electronic Band Gap Materials (EBGs), Frequency Selective Surfaces (FSS), and Metamaterials.
- Antenna feedback
- Adaptive or intelligent antennas
- High-performance broadband active antennas
- Numerical methods and signal processing techniques aimed at developing passive and radiant electromagnetic structures
- Advanced methods of synthesis for filter and multiplex design for satellite communication
- Microwave circuit and subsystem simulation, design, construction, and measurement in hybrid, monolithic, and wave guide technologies

European Projects

- Terahertz technology for ultra-broadband and ultra-wideband operation of backhaul and fronthaul links in systems with SDN management of network and radio resources

National Projects

- Construction of an ecosystem for the research and the development in non-terrestrial networks (satellite and HAP) and B5G (3GPP rel. 17 and later) - Subproject 1 - 6G-INTEGRATION-1 Integration of NTN in mobile devices and backhauling for B5G
- Construction of an ecosystem for the research and the development in non-terrestrial networks (satellite and HAP) and B5G (3GPP rel. 17 and later) - Subproject 4 - 6G-INTEGRATION-4: B5G onboarding in NTN including HAPs
- Next-generation submillimetre range photonic upconversion-based radiometers for earth observation
- Base station antenna to support new 5G Carrier Aggregation services n

Regional Projects (Community of Madrid)

- Microwave Materials Characterisation Using Heterogeneous Systems-on-Chip for the Space Environment (MIMACUHSPACE-CM-UC3M)
- MARTINLARA-CM. Millimeter wave Array at Room Temperature for INstruments in Leo Altitude Radio Astronomy

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Experience and Capabilities

- **Antennas & RF**
  - Metamaterials and sensors
  - Filters and multiplexers
  - Measuring facilities
  - Manufacturing facilities
  - Antenna design
- **Computational electromagnetics**
  - HOFEM: Higher-Order FEM
  - HPC facilities
  - Computational resources flexibility with virtualisation technologies.
- **Terahertzs**
  - Increase THz emitted power.
  - Increase detectors sensibility
  - Photonic Integrated Circuits (PICs) for photoconductive antennas
  - Design and characterisation of novel structures and antenna geometries.
  - Submm wave active antennas on SiGe Technology
  - Ultra-Wide Band antennas
  - Arrays

Patents

- *Antena apilada multifrecuencia con metamateriales* (Stacked multi-frequency antenna with metamaterials) (P20093085)

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SIGNAL AND COMMUNICATIONS THEORY			
Radiofrequency, Electromagnetics, Microwaves, and Antennas Group (GREMA) PI: Daniel Segovia		**Private Funding** • INDRA-UC3M Chair in radiofrequency technologies • Miniaturised Antennas for Planetary Mission Probes	

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

SIGNAL AND COMMUNICATIONS THEORY

Radio Technologies and Applications Group

Responsable: Eva Rajo

LINES OF RESEARCH

- Printed antennas: multiband, multimode, etc.
- Artificial surfaces, periodic structures, and metamaterials. Soft and hard surfaces
- Antennas for specific applications such as: MIMO systems, implantable and textile antennas, industrial applications
- Antenna arrays: mutual coupling
- Radiofrequency systems and devices for communications, positioning, and identification
- Optimisation in Electromagnetism
- Leaky wave antennas
- Surface plasmons
- Transformation optics
- Lenses
- Technologies for radar and radio-determination
- Nano-electromagnetism
- Technology management and technological surveillance techniques

RESEARCH PROJECTS

National Projects

- Efficient antenna systems for future communication networks
- Antenna designs for moving SATCOM in Ka-band based on the use of metasurfaces

Private Funding

- SMART-OR-LIVE
- Overlapped subarray fed reflector antennas for SAR instrument, tender European Space Agency
- Radio technologies for maritime IoT

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

This group has extensive experience (and is internationally renowned) in the field of electromagnetics

- Microstrip Patch Antennas
- Soft surfaces
- EBGs
- Reconfigurable devices
- Optimisation techniques
- Ridge gap waveguide
- Metamaterials
- Surface plasmons
- Transformation optics
- Sub-wavelength imaging

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
SIGNAL AND COMMUNICATIONS THEORY			
Signal Processing and Learning Group (GTSA) **PI: Antonio Artés, Joaquín Miguez**	• Detection and classification of signals and images • Machine learning for image and signal processing • Advanced techniques of adaptive signal processing	**European Projects (European Space Agency)** • Uncertainty propagation meeting space debris needs **Regional Projects (Community of Madrid)** • Advanced methods for the characterisation of orbital uncertainty applied to space debris detection and tracking **Private Funding** • Assessment of collision avoidance manoeuvre planning for low-thrust missions • Monitoring of the development of algorithms for multispectral satellite image analysis • Stress level assessment with non-intrusive sensors	**Experience and Capabilities** • Development and analysis of orbital uncertainty propagation methods, including the effects of low-power manoeuvres • Design and evaluation of stochastic orbital propagators • Bayesian filtering and inference methods for orbital determination • Atmospheric density modelling using machine learning methods • Re-entry prediction

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

LAW

PRIVATE LAW

Society, Technology, and Commercial Law (SOCITEC)

PI: Marta García Mandaloniz

- Commercial contracting law: purchase and sale, transportation, insurance

National Projects

PI: Teresa Rodríguez de las Heras

These projects do not relate exclusively to Aeronautics and Space but address the modernisation of security interests Law from the perspective of the Cape Town Convention and its Aeronautical Protocol (in force).

- Modernisation of the Spanish law on security interests to facilitate access to credit and financing in an international context
- Reform of the Spanish law on security interests in an international context
- Technological innovation for the modernisation of security interest systems: Electronic registries, digital assets, and platforms

(Good Practice Guide on Electronic Records (based on the Dublin Aviation Registry of the Cape Town Convention).

Participation of María José Morillas:

Transport as an engine of socioeconomic development: protection of the weak contracting party and progress in sector liberalisation

- Transport in the face of technological development and globalisation: new solutions in terms of liability and competition
- Organisation and management of ports and sea shipping in the new European context: efficiency and sustainability (PyNMES)

Experience and Capabilities

Teresa Rodríguez de las Heras

- Member of the Aviation Working Group Spanish Contact Group (AWG)

Mª José Morillas

- II Centro de Derecho Internacional del Transporte (CEDIT)-RURAL CAJA Award in the category of best monograph for the work entitled "Ground handling: activity and contracts"
- Member of the Board of Directors of the Spanish Association of Air and Space Law (AEDAE) since 2020
- Appointment as member of the Advisory Board of the Aerospace Legal Observatory, April 2021

Publications (Books, book chapters, and articles)

- The Cape Town Convention on international interests in mobile equipment and its aeronautical protocol
- Space activities: risk and safety.
- Business regulation in space: present and future
- International secured financing transactions on aviation equipment: the Cape Town Convention and its Protocol

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PRIVATE LAW			
Society, Technology, and Commercial Law (SOCITEC) PI: Marta García Mandaloniz			• Alternative dispute resolution procedure before the State Aviation Safety Agency • The benefits of arbitration in the resolution of disputes in the aerospace sector • Air carrier's period of responsibility • Ground handling services and other auxiliary aeronautical activities • The effectiveness of passenger airline liability: problems in practice and possible solutions • The European Union and Latin America facing the challenges of aviation law • Insuring the risks of space activities **More Publications by members of the group** **Conference attended by members of the group** **Others** Collaboration of Professor Pilar Perales in the elaboration of topics for the case of international competition in arbitration and commercial law in relation to various satellite-related legal problems, 2018. More info. Group's video

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PUBLIC STATE LAW			
Services of General Interest, Economic Activity, and Public Intervention **Antonio Fortes Martín** (Investigador del Grupo)	• Air transport • Air navigation services • Airport infrastructures and management	**Regional Projects (Community of Madrid)** • Present and future challenges in aviation law **Others** • Current situation and future challenges in the regulation of sustainable mobility in Andalusia (sea transport, air transport, land transport, and urban mobility). Its role in the energy transition	**Experience and Capabilities** **Books** • Public and private in aviation law. Present and future challenges • Organisation and administrative control of air traffic **Book chapters** • Supervision, control, and sanctioning regime. RPAS and public safety. Supplementary regime in administrative procedures • The public function of aeronautical activity supervision • Borderless airspace and single European sky, the part for the whole of air operations • The squaring of the circle or the impossible total execution of the ruling handed down for the Ciudad Santo Domingo-Madrid/Barajas Airport case **Journal articles** • "The legal-administrative discipline of operations with remotely piloted aircraft" • "Principle of territoriality and "territorialisation" of competences. Concerning airport organisation". • "Towards a (Pan) European Air Union? Supranational air traffic network management in the EU • "Administrative action and market in the provision of air navigation services" • "Air traffic discipline in terms of noise" +

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PUBLIC STATE LAW			
Services of General Interest, Economic Activity, and Public Intervention Antonio Fortes Martín (Investigador del Grupo)			**Congresses, seminars, conferences** • Academic Co-Director of the Scientific Conference "Ownership and management of transport infrastructures in liberalised sectors. Transformations of the legal regime" • VI STEM, Seminar on the Theory and Methodology of Public Law. University of Seville, 2015. Communication: "Principle of territoriality and territorialisation of competences. Concerning airport organisation" • Member of the Organising Committee and Academic Co-Director of the National Scientific Conference "Public and private in aviation law: present and future challenges", UC3M, 2014 • Congress on new developments in environmental law. University of Granada. Guest speaker: " Air traffic discipline in terms of noise (concerning SCJ of 13 October 2008)"

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PRIVATE INTERNATIONAL AND SOCIAL LAW			
ACCURSIO **PI: Esperanza Castellanos, Juliana Rodríguez** **Mª José Castellanos**	• Aviation and international transport law	Project in collaboration with the Autonomous University of Barcelona, entitled: **ADLAW (Autonomous Driving Law) Project Research Group for research on Autonomous Driving and legal security of transport** Coordination of the research subgroup: 1.– **Unmanned aircraft and urban aerial mobility. Civil liability and insurance.** Dr. María José Castellanos (coordinator), Dr. Massimiliano Piras, Dr. Kristiaan Clement Bernauw.	**Experience and Capabilities** This is an inter-university group dedicated to the study and dissemination of private international law **Publications (Books, book chapters, and articles)** • Operation of international registrations on both manned and unmanned aircraft (drones) • Drones legal framework: the new Regulation (EU) 2018/1139 • International leasing contracts for large civil aircrafts • International sale and purchase of large civil aircrafts • International regulation of aviation safety • Choice of competent court between the clauses of air transport contracts • Novelties on the competent jurisdiction in international passenger air transport contracts - Brussels I-BIS Regulation and Montreal Convention • Implementation of the International Register of Interests in Aircraft Equipment Items in Spain • Towards a common market for drones: Delegated Regulation (EU) 2019/945 and Implementing Regulation (EU) 2019/947

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PRIVATE INTERNATIONAL AND SOCIAL LAW			
ACCURSIO PI: Esperanza Castellanos, Juliana Rodríguez Mª José Castellanos			**Conferences** • Urban air transport: reality or science fiction? • Drones and safety: are they compatible? • The future of air transport: "flying cars" and their possible regulatory framework • Implementation of the International Register of Interests in Aircraft Equipment Items in Spain • Adhesion contracts with general contracting conditions typical of airlines. The Ryanair case and the double strategy of the Spanish courts

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

MATHEMATICS AND PHYSICS

PHYSICS

Remote Sensing Sensors and Infrared Imaging Laboratory (LIR)

PI: Antonio J. de Castro González

- Infrared for space applications
- Non-destructive testing
- Behaviour models
- Spectral analysis
- Visualisation of gases in the infrared
- Atmospheric measurements
- Simulation of radiometric scenarios
- Detector design and development
- IR remote sensing
- Temperature measurement in complex scenarios

European Projects

- High Temperature Characterisation and Modelling of Thermoplastic Composites
- Enhancing process efficiency through improved temperature measurement

National Projects

- Extending the dust sensor into a multi-parameter integrated atmospheric mini-instrument for the surface of Mars based on an infrared spectral array
- Science and Technology for in-situ characterisation of the atmosphere of Mars. Development of the dust sensor instrument for the ESA/IKI EXOMARS18 mission. Phases A/B AND C/D
- Thermal conductivity characterisation
- Meiga-Metnet Martian dust sensor. Based on an infrared spectral microsensor and a dust sweeper

Private Funding

- Future Leakage Identification Systems (FUGAS)
- Monitoring, analysis, and testing activities for the simulation of high temperature events on composite structure for CERTERIN WP9
- Monitoring, analysis activities for the simulation of fire events on composite structure

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Experience and Capabilities

This group provides solutions to industrial and scientific problems by means of the infrared technology

- Spectral analysis
- Thermography and radiometry
- Non-invasive analysis
- Simulation and design

Aeronautics experience

- CFRP under fire load
  Development in collaboration with Airbus Military, from empirical measurements, predictive models for predicting the behaviour of carbon fibre composite materials under fire load. Furthermore, as a result of the significant investment in instrumentation for non-invasive infrared analysis that has been made in recent years, all the results obtained can be validated.
- Gas combustion and detection
  Application to hydrogen:
  · Hydrogen flames
  · Hydrogen leaks
- Gas combustion analysis
- Flying forest fires from air

Technological Offer

- Detection of micro-leaks in fuel tanks
- Dust and gas micro-sensor qualified for space missions

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R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PHYSICS			
Remote Sensing Sensors and Infrared Imaging Laboratory (LIR) PI: Antonio J. de Castro González		• Obtaining empirically thermal diffusivity, thermal conductivity, and specific capacity of composite specimens in fire Validation through models • Overheat detection system (OHDS) in Air Supply System (Airbus A350)	• Gas detection and quantification systems by means of IR • Design and incorporation of IR techniques in the testing and calibration of materials, devices, and systems • Design and development of low-weight and low-volume IR sensors for specific applications **Patents** *Método y dispositivo para la detección y medida de la concentración de gases* (Method and device for the detection and measurement of gas concentration) (ES2478698) **Equipment** • InfraRed Lab • LATIR: Tecless and shutterless infrared calibration Group's video **News** *Nuevos materiales punteros termoplásticos para el sector aeroespacial* (New cutting-edge thermoplastic materials for the aerospace sector) **Others** SENSIA SOLUTIONS, S.L Spin-off of the Remote Sensing Sensors and Infrared Imaging Laboratory (LIR) of the UC3M. Adaptation and optimisation of IR technology to provide an ad-hoc solution to problems that conventional thermography systems are not able to address on their own.

R&D GROUP	LINES OF RESEARCH	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
MATHEMATICS			
Modelling. Numerical Simulation, and Industrial Mathematics (GMSMI) **PI: Luis López Bonilla**	• Non-linear electronic transport in nanostructures • Out-of-equilibrium statistical mechanics • Field theories and statistical mechanics • Computational materials: Defects in solids and multiscale simulations. Graphene. Materials for nuclear fusion. Molecular dynamics, Monte Carlo, density functional theory • Mathematical physics. General relativity. Combinatorics • Astrodynamics and artificial satellite control	**Regional Projects (Community of Madrid)** • Development of predictive tools for hydrogen combustion in gas turbines	**Experience and Capabilities** • Geostationary satellite modelling and control software • Software upgrade for optimal geostationary satellite control • Astrodynamics and space geodesy · Orbital geostationary satellite control · Space geodesy and navigation Group's video

R&D GROUP	DESCRIPTION	SERVICES

APPLIED R&D&I LABORATORIES IN THE SCIENCE PARK

APPLIED R&D&I LABORATORIES IN THE SCIENCE PARK

Aeronautical structure Impact Laboratory (IMPACTLAB)

PI: José Antonio Loya, Jorge López Puente

The Aeronautical Structures Impact Laboratory is formed by a team of qualified professionals with extensive experience in providing innovative solutions to the industry, related to the mechanical behaviour of components and the calculation of structural elements.

It has facilities for carrying out mechanical tests (with specific experience in the field of dynamic and impact testing) in a wide range of strain rates and temperatures. The laboratory has 6 pneumatic launchers (of different calibres, from 7 mm to 500 mm) to perform high-speed impact testing (up to 1000 m/s) in a wide range of energies (up to 300 KJ). It also has extensive experience in the modelling of solid mechanics problems using self-developed tools and commercial numerical codes.

The following is some of the most outstanding innovative technological solutions offered by the group:

- Experimental high-velocity impact testing on aeronautical structures (using ice projectiles, bird projectiles, metal fragment projectiles, etc.)
- Analysis of the impact behaviour of aeronautical and aerospace structural elements.
- Development of specific methodologies for the study of damage tolerance under different loading conditions of aeronautical and aerospace structures manufactured with composite materials.
- Safety and defence of mobile systems subjected to impact loads.
- Analysis and modelling of lightweight structures subjected to impact loads.
- Conducting energy absorption tests.

R&D GROUP	PRIORITY LINES OF RESEARCH	ACTIVITIES

OTHERS

OTHERS

AIRBUS-UC3M Joint Centre for Technological Activities

Science Director: Pablo Zumel

- Automatic docking
- Observation, control, and planning systems for automatic docking of in-flight refuelling booms
- Mission systems
- Multispectral infrared sensors. Integration in airborne platforms for environment, security, defence, and civil protection. Non-destructive evaluation
- Security evaluation
- Biometrics. Communications network security. Protection of the on-board wireless communications network.
- Integrated vehicle health monitoring (IVHM)
- Sensing and detection. Optical fibre sensors for monitoring carbon fibre structures. Aircraft preventive maintenance
- More/All Electric Aircraft (MEA/AEA)
- New architectures in power distribution systems. Subsystem modelling. Protection and control components. Generation systems
- Power supply systems for UAV and mission aircraft. Portable equipment (soldier of the future)
- Fuel cells: characterisation and integration of methanol cells.
- Radiofrequency
- Active reconfigurable arrays. Printed element. Selective surfaces. Finite array design. Printed antennas. Antenna measurement
- Computational electromagnetism. Analysis of open problems with FEM. Hybrid and multi-hybrid methods. Automatic adaptivity with FEM
- Electromagnetic compatibility and Tempest-EMC.
- Occupational safety. EMI-EMC characterisation of materials, structures, and systems. Testing and pre-certification

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The Joint Technological Activity Centre is a space for joint action between AIRBUS, UC3M, companies, and other social agents to promote innovation processes, as well as the generation and transfer of knowledge and technology in the aerospace sector.

Its objective is to contribute to the improvement of the competitiveness of the productive fabric and to economic and social development.

- Research and technological development
- Technological services: auditing, surveillance, and foresight, etc.
- Development of technology maps and plans
- Analysis, certification, testing, and technological consultancy services
- Dissemination and transfer of technology
- Customised sectorial training
- Support for the generation of EBTs

Infrastructures

The Centre has in-house laboratories located in the UC3M Science Park.

R&D GROUP	PRIORITY LINES OF RESEARCH	ACTIVITIES
OTROS		
AIRBUS-UC3M Joint Centre for Technological Activities Science Director: Pablo Zumel	• Tempest of aeronautical equipment and systems. EMC and Tempest training • Microelectronics • Design and implementation of FPGA-based solutions. • Specific software • Tactical datalinks • On-board software • System modelling • Physics of flight and propulsion • Aerothermodynamics, aeroacoustics, and tunnel testing. Particles in dispersed flows. Jet modelling. Power plant integration • Numerical and experimental aerothermodynamics. Internal flows of aeronautical interest. Dynamics of spacecraft. CFD and numerical simulation • Manufacturing • Simulation and experimentation in manufacturing technologies: optimisation, automation, and damage control in production processes. • Structural dynamics and vulnerability: experimentation and numerical simulation. • Structural element test and analysis. Vulnerability and impact • Mould release agents, adhesives, and surface treatments of composite surfaces	

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.

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Vicerrectorado de Política Científica

Servicio de Apoyo al Emprendimiento y la Innovación